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Test and Measurement
Division

Operating Manual

AUDIO ANALYZER

UPD

2 Hz to 300 kHz

1030.7500.02/.04/.05

Software version UPD 3.09

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Tabbed Divider Overview

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Data Sheets

Safety Instructions
Certificate of quality
EC Certificate of Conformity
List of R & S Representatives

Tabbed Divider

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1 Preparations for Use

1.1 Start-up Procedure

1.1.1 Setting up the Audio Analyzer

The UPD can be operated in the following positions:

- Horizontal position: fold out the front feet provided on the instrument bottom in order to obtain an enhanced view to the LC display.
- Vertical position; tilted on its rear panel. Fold out the feet provided on the rear panel and use a 90% offset power connector (included in the accessories supplied).

Note: *To ensure optimum performance of the audio analyzer observe the following:*

- Do not cover the lateral ventilation openings.
- Adhere to the permissible ambient temperature specified in the data sheet.
- Avoid moisture condensation. If it has already occurred, dry out the instrument before switching it on.

1.1.2 Rackmounting

Mounting into 19”-racks is possible using the 19”-adapter ZZA-95 (order no. 0369.4911.00).

Note: *To ensure optimum performance of the audio analyzer observe the following:*

- Be sure sufficient air is supplied within the rack.
- There must be adequate space between ventilation openings and rack housing.
- Make sure air convection for the heat sink at the instrument rear is not impeded.

1.1.3 Power Supply

The UPD is powered by AC voltages of 100 V, 115 V, 120 V, 220 V, 230 V and 240 V, each with a tolerance of ±10 % and frequencies between 47 Hz and 63 Hz.

Before initial power-up, check that the correct supply voltage is set. If it is not correct, it must be reset as follows:

- Remove the power cord.
- Open cap of voltage selector using a slotted screwdriver.
- Remove both fuse holders and insert fuses with the appropriate value (included in the accessories supplied):

  Rated voltages 100 to 120 V,
  2 fuses T 3.15 L (IEC 127-2/III)

  Rated voltages 220 to 240 V,
  2 fuses T 1.6 L (IEC 127-2/III)

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- Insert the fuse holder.

  Remove the cylinder labelled with the rated voltages and re-insert it such that the value visible in the cap window when fitted corresponds to the desired rated voltage. If there is no suitable imprint, select the value closest to the desired one.

- Close the cap.

1.1.4 Switching-on

Note: *Make sure no diskette is available in the disk drive when turning the audio analyzer ON (press ON/OFF switch on the front panel).*

Switch-on of the UPD is followed by the system start-up, self-test of the controller and loading of the MS-DOS operating system as well as of the measurement and operating software from the hard disk. While the UPD switch-on logo is being displayed, the self-test of the measurement hardware is executed (see Section **4.2 Function Test**). The last UPD setup which has been automatically stored is subsequently loaded from the CMOS-RAM, setting the UPD to the status valid before switch-off.

Note: *If no characters are displayed on the screen after switch-on, the contrast control may be maladjusted (only UPD04 with monochrome display). Set the contrast for the desired angle of view.*

For operation of an external monitor, refer to Section **2.17 Connecting External Devices**.

Note:

- The system self-test also includes checking the availability of an external keyboard (see 1.1.6 Connecting an External Keyboard). If an external keyboard is connected, it can be used for operating the UPD.
- With the use of an external keyboard, the storage test of the system can be aborted - while the storage addresses are being counted up - using the ESC key.
- The message

  PRESS <DEL> IF YOU WANT TO RUN SETUP/EXTD-SET

  is displayed during system start-up. Pressing this key allows you to enter the SETUP program where system configuration, date and time can be defined. We advise against calling this program as changing its settings, though inadvertently, may cause the UPD to work incorrectly or not work at all.

  Calling this program is required only after battery replacement. (Section **4.3 Troubleshooting**, deals with battery replacement and setups and, in addition, how to correct a maladjusted SETUP.) If required, date or time should be changed using the DOS commands DATE and TIME (see 2.15.9 or DOS manual).

1.1.5 Switching-off

- Wait until there are no accesses to the hard disk or disk drive anymore (LED OFF).
- Remove the diskette from the drive.
- Press the ON/OFF key on the front panel. (All UPD setups are maintained.)

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1.1.6 Connecting an External Keyboard

Note:
Connect the keyboard only with instrument switched off. Otherwise, correct function of the keyboard cannot be guaranteed.

The keyboard connector is fitted to the rear of the instrument (KEYBOARD label). Any standard PC keyboard may be used.

In normal operation, the keyboard facilitates the entry of commentary texts, file names etc. If the controller mode of the UPD is selected, e.g., in order to store measurement results in documents, the keyboard assumes its usual PC function (cf. **2.18 UPD Used as Computer**).

Section 2.1.1 (Front View of the Instrument) includes an overview of the assignment of the key functions of the UPD front panel to short-key combinations of the external keyboard. This assignment table can be looked up at any time in the help function (press front panel key HELP or F1 on **the ext. keyboard) under the key-word "UPD".**

The automatic repetition rate with constant key stroke and the associated delay can be modified in the OPTIONS panel (Rep rate, Rep delay).

Either a keyboard with German or English key assignment can be selected:

- change to DOS (press SYSTEM key)
- call "BOOTSET" program and make appropriate selection
- enter UPD to return to measuring operation

1.1.7 Connecting a Mouse

Note:
Connect the mouse only with the instrument switched off. Otherwise, correct operation cannot be guaranteed.

The complete UPD may be mouse-controlled. Particularly, the entry of commentary texts, file names etc. is easier than via the front panel keys, only (selecting the keys of a "screen keypad"). Mouse control is described in Section **2.3**.

The UPD requires the appropriate mouse driver in the path C:\MOUSE of the UPD named mouse.com., which must be available on a 3.5"-disk.

Proceed as follows:
(In the subsequent example, the mouse driver to be installed is called msmouse.com and is located in the root directory of the disk)

- Connect external keyboard. Connect mouse to the interface COM1 and switch on the instrument
- Press ESC while the UPD switch-on logo is displayed to change to the DOS level
- Insert the disk with the driver to be installed in the 3.5" drive.
- Execute the following DOS command: copy a:msmouse.com c:\mouse\mouse.com
- Enter UPD: the UPD operator interface is started.

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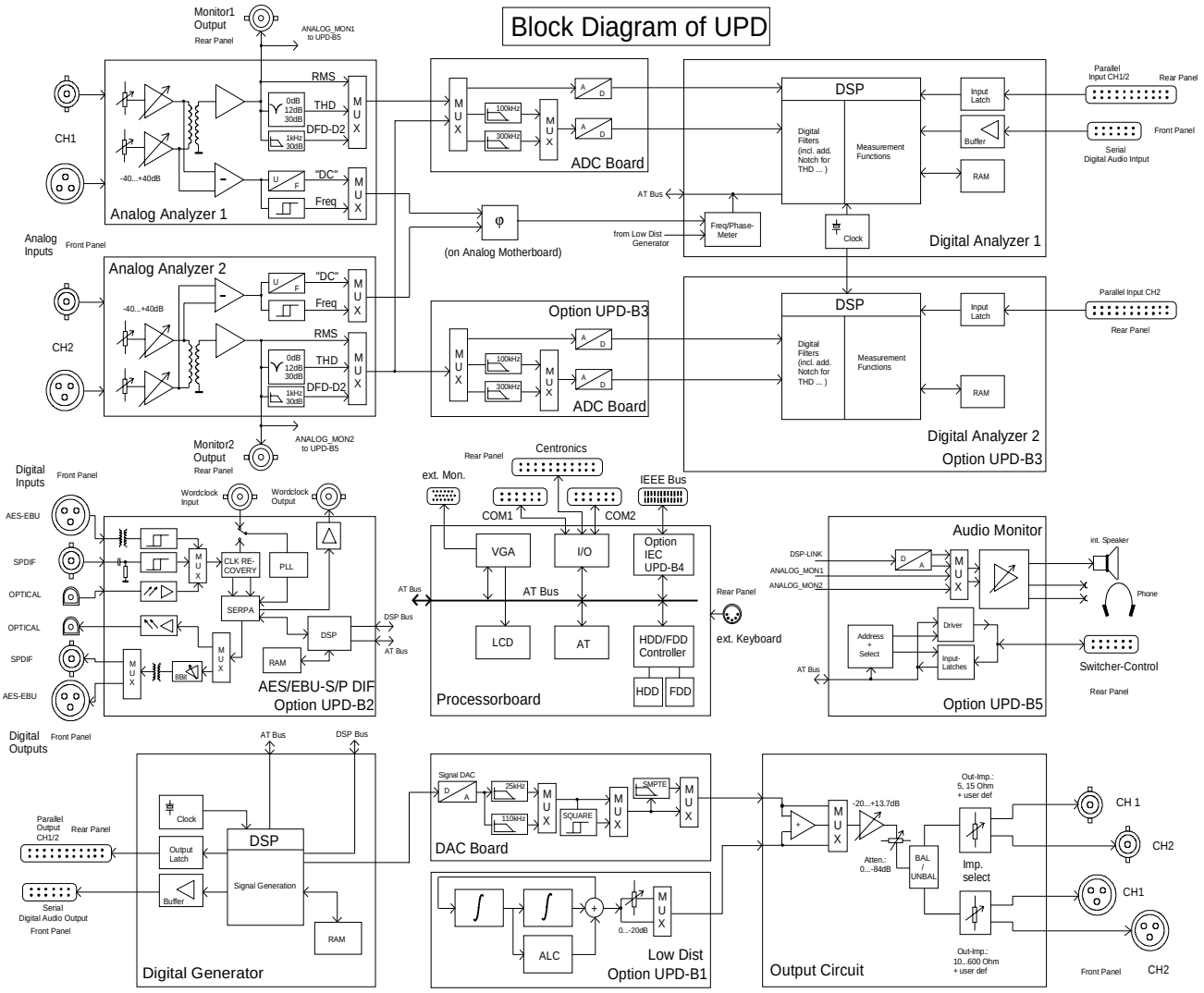
1.1.8 Block Diagram



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1.2 Fitting Options and Plug-in User Cards

Important!
All options are sensitive to electrostatic charge. Handle them in line with ESD regulations.

Assembly (applies to all options):

- Turn the UPD off, disconnect the power cable.
- Unscrew the feet from instrument rear (four Phillips screws).
- Slide the upper panelling slightly to the rear and withdraw.
- After having fitted the option remount all covers, brackets and clamps in reverse order to that of removal. Fit the panelling and the instrument feet.
- Turn the UPD on. Install supplementary software supplied, if any, according to instructions. The software automatically recognizes the fitted option.

1.2.1 Fitting the Low-distortion Generator Option (UPD-B1)

- Remove the cover plate from the analog unit (on the right when seen from the front).
- Unscrew the board holding device from the center panel.
- Insert the board into the short slot X26 of the analog motherboard.

After installation of the board, level and frequency accuracy must be calibrated. No external measuring equipment is required for this purpose as the generator signal is measured via an internal connection by the analyzer. However, be sure the other two boards of the analog generator and of the analog analyzer have been adjusted and calibrated.

The frequency is measured using the frequency counter in the UPD.

The voltage is calibrated relative to the universal generator: the reference is not the measuring accuracy of the analyzer but the signal of the universal generator ANLG 110 kHz. The LOW DISTORTION GENERATOR thus provides the same level accuracy as the factory-calibrated universal generator.

Caution:
During calibration, any cables must not be connected to the outputs of the generator or to the inputs of the analyzer.
Ambient temperature 23±5 ^{O}C.
Warm-up time of UPD at least 2 hours

Calibration:

- Turn UPD on.
- Wait until the instrument has warmed up.
- Invoke the calibration routine in the OPTIONS panel under CALIBRATION GEN by selecting ONCE in line LDG Auto. The calibration is executed automatically.

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1.2.2 Fitting the AES/EBU-S/P DIF Option (UPD-B2)

- Fit the option into AT slot no. 5 (identification SLOT 5, see top side of rear panel).
- Remove the clamp over the large plug-in cards.
- Remove the mounting bracket of the second four plug-in cards (2 screws on instrument rear panel) and withdraw rear-panel section.
- Insert the option into AT slot no. 5.
- The UPD basic unit already contains the cables (one ribbon cable, three shielded cables) connecting the front-panel connectors to the option board.

  Ribbon cable → X51

  Coax cable W510 → X510

  Coax cable W512 → X512

  Balanced cable W511 → X511

- Connect jumper wire W50 to connector X50 of option and connector X50 (3rd from behind) of plug-in card A 12.

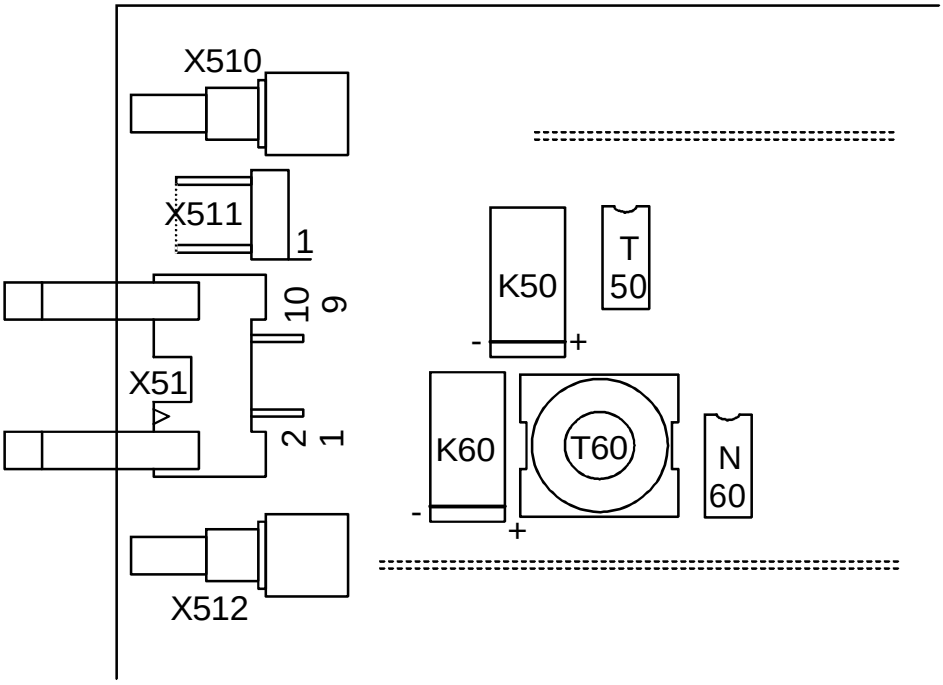

Fig. 1-1 Connector assignment on option board

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1.2.3 Fitting the High-speed Option (UPD-B3)

Note: *This option can be fitted only in a Rohde & Schwarz service station because of the calibration required after its installation.*

- The larger one of the two option boards is fitted into the last AT slot (identified by SLOT 8 on top side of rear panel).
- Remove the clamp from the large plug-in cards.
- Detach the mounting bracket from the second four plug-in cards (2 screws on instrument rear panel) and remove rear-panel section.
- Disconnect the following cables:

Cable	Plug-in card	Connector
W93	A12 (SLOT 6)	X90 (first from behind)
W32	A12 (SLOT 6)	X30 (second from behind)
W31	A11 (SLOT 7)	X30 (first from behind)

- Insert the option into the AT slot stated above.
- Connect the following cables in the order given below:

Cable	Plug-in card	Connector
W35	A15 (SLOT 8)	X30 (first from behind)
W31	A11 (SLOT 7)	X30 (first from behind)
W32	A12 (SLOT 6)	X30 (second from behind)
W93	A12 (SLOT 6)	X90 (first from behind)
W71	A11 (SLOT 7)	X71 (second from behind)
W71	A15 (SLOT 8)	X71 (second from behind)

- Remove the cover from the chamber for the analog hardware (to the right when seen from the front).
- Tilt the UPD on its side, remove the lower panelling.
- Remove SMB connector from the bottom of the analyzer board for channel 2 (directly next to the side panel). Withdraw the board from the UPD.
- Remove the smaller one of the two shielding covers on component side.
- Insert the second option board into the open chamber: fix the hooks on the shielding panel and insert the board fixing it from the rear of the main board with the two screws supplied.
- Mark with a cross the field ”ADC-Board included” on the adhesive label on the shielding panel of the analyzer board using a felt-tip pencil.

Note: *When reassembling the UPD do not forget to plug in the coax connector.*

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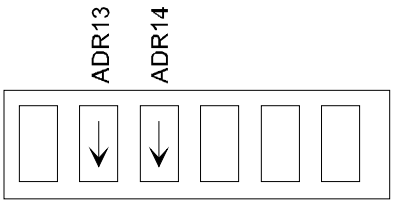
1.2.4 Fitting the IEC-625/IEEE-488 Option (UPD-B4)

- Fit the option into AT slot no. 1 (identified by SLOT 1, see top side of rear panel).
- Remove the bracket of the first four plug-in cards (2 screws on instrument rear panel) and withdraw rear-panel section.
- Unplug cable W145 of the adjacent controller card.
- Check on correct selection of address range, DMA channel and interrupt line.

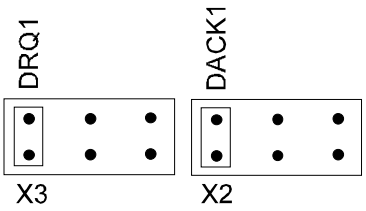
Address range:
Switch S1
(Top view)



Used addresses:

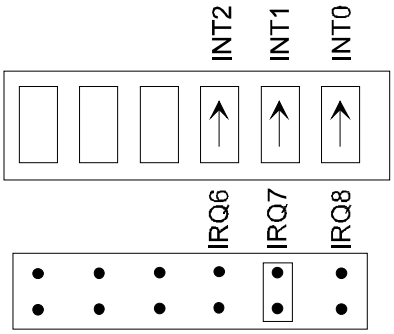
02E1	06E1	0AE1	0EE1
12E1	16E1	1AE1	1EE1
82E1	86E1	8aE1	8EE1
92E1	96E1	9AE1	9EE1

DMA channel:



Select DMA channel 1 using the plug-in jumpers.

Interrupt line:
Switch S1
(Top view)



Select Interrupt 7 using switch and jumper.

- Insert the option into AT slot no. 1.
- Reconnect cable W145.
- Install the software in line with the supplied instructions.

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1.2.5 Fitting User Plug-in Cards

Any free AT slot can be used for fitting the cards. Install them in the same way as the IEC-625 option described above.

Note: *Interrupts 10 and 11 out of the free interrupts of an AT are already used in the UPD. The I/O addresses 390H-393H and the DMA channels 5 and 6 are assigned.*

With the IEC-625/IEEE-488 option (UPD-B4) fitted, the addresses, DMA- and interrupt lines stated above are also assigned.

1.2.6 Fitting the Option Headphone/Speaker Output /Parallel I/O (UPD-B5)

This option is fitted according to the instructions supplied. The board is fitted into the vacant AT slot No. 4. The control of the board is implemented for software version 2.07 and greater. In the case of older instruments with motherboard version 0.00, the analog input cannot be directly monitored.

1.2.7 Fitting the Option Jitter/Interface Tester (UPD-B22)

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1.3 New Installation of UPD Software

Following two disks are supplied together with your UPD:

- MS-DOS System Disks, containing all programs associated with MS-DOS.
- UPD Program Disk, including the complete UPD operating and measurement software.
- UPD Example Disk, including examples for IEC/IEEE remote control, Universal Sequence Controller - K1 as well as default setups for various measurement applications.

The operating system and the UPD software including the example files are already installed on the built-in hard disk of each UPD supplied. The supplied floppies are needed only when the complete software or a sections thereof has been deleted inadvertently by the user. The MS-DOS and UPD software as well as the example files can also be installed separately.

Note: *The UPD software is supplied in packed format and unpacked only during installation (the software then considerably exceeds the capacity available on the diskette). The unpacking program may output messages such as "Exploding...", "Unpacking" etc. These messages are correct and do not mean faulty installation.*

Installing the MS-DOS operating system:

- Connect the external keyboard.
- Turn the UPD on, insert 1st disk.
- Press the CTRL + ALT + DEL keys (or STRG + ALT + ENTF).
- The installation program is started.

Continue the installation following the notes on the screen.

Installing the UPD operating and measurement software:

- Connect the external keyboard.
- Turn the UPD on.
- Exit the UPD operating software by pressing the ESC key while the switch-on logo is being displayed on the screen or, with the UPD operating software loaded, by pressing the SYSTEM key and Enter (corresponds to "Normal Exit to DOS" in the selection box).
- Insert the UPD program diskette.
- Key in A:, press Enter.
- Key in UPDINST, press Enter.

The UPD software is now copied to the hard disk.
Continue the installation following the notes on the screen.

The UPD operator interface will then be displayed on the LCD screen.

Note: *If an updated version of MS-DOS or of the UPD software is to be installed, also proceed as described above.*

Installation of UPD example files:

- Connect external keyboard
- Switch on UPD
- Quit UPD software by pressing the ESC key while the switch-on logo is being displayed on the screen or, with the UPD software loaded, by pressing the SYSTEM key and Enter (corresponds to "Normal Exit to DOS" in the selection box).
- Insert UPD-EXAMPLE floppy
- Key in A:, and terminate with "Enter"
- Key in SETINST, and terminate with "Enter"

The UPD example files are now copied onto the hard disk. The UPD software can now be started as usual.

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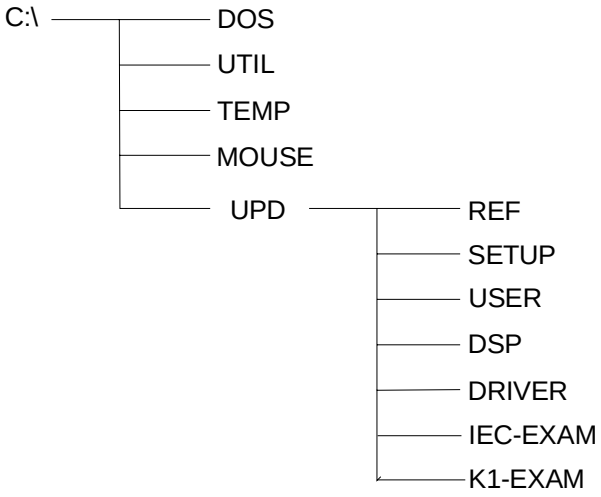
The files copied to the hard disk during installation are stored in the following directory structure:



The READ.ME file in the C:\ directory refers to the contents of the individual directories and files.

After installation, the \DOS, \UTIL and \UPD paths are defined.

Note: *To ensure correct functioning of the UPD measurement and operating software, do not modify the directory structure stated above nor the paths.*

Operation of the UPD using DOSSHELL
Setting of the keypad:

DOSSHELL is a program of operating system MS-DOS which permits the fast change between different applications.
Whether UPD is to be executed together with DOSSHELL is set using command BOOTSET. This command also permits the selection of the keypad between German and English key assignment.

Advantages in using DOSSHELL:

- easy changeover between UPD and other programs (e.g. editor and user programs)

Disadvantages in using DOSSHELL:

- UPD absolutely requires an external keypad to be operated.
- UPD becomes slower because the space available for the UPD becomes smaller.
- Operation using the mouse can lead to malfunction of DOSSHELL.

Further notes on DOSSHELL: cf. MS-DOS manual

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Achtung !!!!!

Die Seiten 2.1...2.9
kommen extra hinzu

Bitte um Rückfrage
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2.2 Introduction To Operation

2.2.1 Brief Introduction

General information

Subsequent to switch-on, the instrument assumes the same state as prior to switch-off. This applies for *all setting parameters* of the UPD, ie, also for those which are currently not displayed.

The UPD is operated using the cursor (inverted field) and the keys SELECT, BACKSP, CANCEL and ENTER . The cursor indicates the input field for which an entry is expected. The cursor can be moved from one input field to another using the spinwheel and the ↑, ↓, PAGE↑, Page↓, Tab → and Tab ← keys. The cursor cannot be placed on fields with indicating function only. They are displayed in a different grey or another colour.

Panel Structure

Associated functions and settings are displayed together in panels:

- **Analyzer panel**
  - selection of the instrument (analog or digital interfaces, frequency range)
  - configuration of the interfaces
  - trigger conditions (incl. external sweep)
  - measuring functions (incl. sweeps of tracking filters)
  - selection of the filters
- **Generator panel**
  - selection of the instrument (analog or digital interfaces, frequency range)
  - configuration of the interfaces
  - selection of the test signals incl. level setting
  - sweep of the generator signals
- **Filter panel**
  - definition of the filter characteristics
- **File panel**
  - storage and loading of instrument settings and measured-value sequences
  - editing of files and directories
- **Display panel**
  - definition of the type of graphical display
  - selection of multiscans
  - scaling of x and y axes
  - entry of tolerance lines
- **Graph panel**
  - selection of cursor and marker functions
  - graphical analysis of the measurement results
- **Status panel**
  - user-configurable panel (only in combination with graphical display)
- **Options panel**
  - settings for
  - remote control
  - parameter link
  - printer/plotter
  - COM2 interface parameters

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- external keyboard
- external monitor
- result display: selection of number of digits and update rate
- display mode and language of help texts
- version numbers of hardware and software and options fitted
- control of an external checkpoint selector
- calibration

Basic rules of operation

Operation of UPD is particularly easy when the following recommendations are borne in mind:

1. First select instrument
- since the settings are loaded when an instrument is selected (see also "Parameter-link function")
- besides, the selection of functions, eg, may change upon an instrument change

2. Always proceed from top to the bottom
- as modifications of parameters of individual menu items may influence the selection or the specified range of menu items further down, they never influence those in the lines above

  Example: the setting times for the sweep are not displayed until the sweep function is switched on
- advantage: the panels are always as short as possible and thus clearly arranged!

3. Edit display panel only after generator and analyzer setting,
- since it depends on the selected measuring function what can be graphically displayed
- many settings of the DISPLAY panel may be copied from other panels, which speeds up operation

Selection of function and entry of values

Selection of functions and parameters:

First open input box (SELECT key or space key on external keyboard), then

either: - select function or parameter using the arrow keys or the spinwheel
or: - enter the first letter of the desired function on the external keyboard

Pressing the "Enter" key acknowledges the selection, "CANCEL" retains the previous selection.

Entry of numeric values:

either:
- open the input box (SELECT key or space key on external keyboard or first digit of the number to be entered)
- numeric entry
- terminate with "Enter"

the unit remains unchanged

or:
- open the input box and make the numeric entry (as above)
- terminate by selecting the unit via softkey (or the corresponding function key on the external keyboard)

or:
- change spinwheel function by pressing ENTER or one of the cursor keys (← or →)
- vary the numeric values using the spinwheel without opening the input box, the position of the digit to be changed can be selected using the cursor keys (← or →)

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The permitted range for the selected function is displayed in the operator guidance line (between panels and softkeys).

Help Functions

The UPD provides a variety of help functions to support the user:

1. HELP function

- A HELP information is provided for each input field, optionally in German or English (HELP key or F1 of the external keyboard, selection of the language in the OPTIONS panel).
- The help information corresponds always to the firmware version of the instrument

2. ONLINE help

The permitted range for the selected menu item is indicated in the operator guidance line (between the panels and the softkeys), respectively.

3. Entries exceeding the specified range

Entries which exceed the specified range permitted for the selected function are not accepted, an acoustic warning is output and the entry is modified to the respective minimum or maximum value.

4. SHOW I/O

If the measured value can not be displayed, eg, due to a missing or inappropriate input signal, the message "-Input?- Press SHOW I/O" is displayed. Pressing this key causes notes on possible error causes to be displayed together with the input and output configuration.

5. OUTPUT OFF

All UPD outputs can be switched off using this key, eg, in order to protect a connected device under test.

2.2.2 Introductory Examples

This section provides an introduction to the operation of the UPD via the front-panel keyboard by way of examples which base on each other (operation via external keyboard or mouse, see Section 2.3 General Instructions for Use).

The examples are:

- Loading the default setup
- Frequency response measurement of the analog UPD generator from 15 Hz through 20 kHz using the sweep function
- Cutting in a filter
- Ways of presentation of measurement results
- FFT of a two-tone signal, measured at digital interface
- Hard copy of screen

Note: Menu items which are not explained in the examples remain unchanged.

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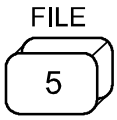
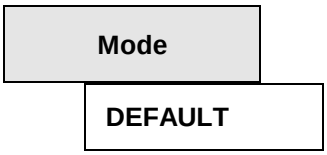
Example 1: Loading the Default Setup

(Only required to ensure that equal conditions prevail in the examples given below)



Press the figures key 5 on the front panel. As the instrument is currently not expecting a numerical input (LED above the figures keys does not light up) the secondary function indicated above the keys is automatically executed. In this example, it is the FILE function.
Causes the appertaining panel (= input window) to be displayed on the screen. The panel contains the menu items dealing with file management.



Using the keys above, place the cursor to the input field in the second line of the panel (= right-hand column of menu item ”Mode” under the heading LOAD INSTRUMENT STATE), press SELECT, select DEFAULT with the cursor, close the window using ENTER. The UPD default setup is loaded.

Note: *The operating sequence ”SELECT, selection by means of the cursor or the spinwheel, ENTER” is always necessary to select a parameter and not explicitly stated in the following texts.*

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Example 2: Frequency Response Measurement of the UPD Generator in the Range from 15 Hz to 20 kHz using the Sweep Function

Analyzer settings:

GEN

7

ANLR

8

FILTER

9

Causes the panel for setting the analyzer filters to be displayed on the screen instead of the DISPLAY panel and then changes to the ANALYZER panel. The cursor is always located in the last-selected panel.

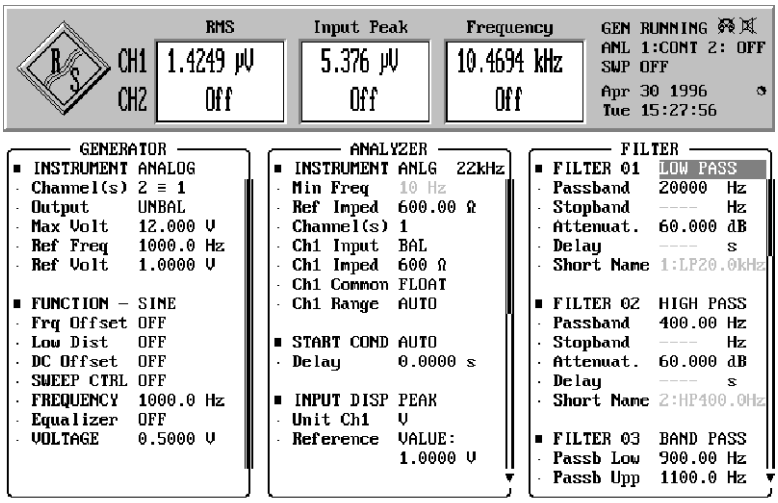

Fig. 2-3

ANALYZER

ANLG 22 kHz

Define which one of the six analyzers is to be used. The preset parameter is ANLG 22 kHz, which is designed for the analog interfaces and the frequency range up to 22 kHz. The panel displayed on the screen indicates all possible ways of setting this analyzer; the settings of the other analyzers, eg the analyzer DIG 48 kHz are suppressed, however retained.

Channel(s)

1&2

Define which channel is to be measured. Select two-channel measurement.

CH1 Input

GEN 1

Select the input on which the measurement is to be carried out. Switch channel 1 to GEN 1 and channel 2 to GEN 2. The generator outputs are now connected internally to the analyzer inputs. (This feature is required, eg, for performing precise gain measurements or, as in this example to execute the examples without changing external connections.)

CH2 Input

GEN 2

FREQ / PHASE

Freq & Phase

Switch to simultaneous frequency and phase measurement.

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FUNCTION

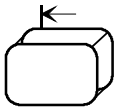
RMS&S/N

Define the measurement function. All measurement capabilities are listed in the selection window (SELECT key). Keep the preset RMS measurement (CANCEL key).

The UPD measures continuously, which is why the measurement results of the signal currently output by the generator are already displayed on the upper range of the screen:

- the first window shows the results for both channels of the selected measurement function, which is here the rms measurement (the heading of the window reflects the selected function)
- the second window gives the peak level of the input signal, also for both channels
- the third window outputs the frequency of the input signal and the phase between both channels

Generator settings:



Switch to the next input field to the left: in this case to the GENERATOR panel after pressing the key max. twice, and to the position the cursor had when this panel was quit, in this example to the first line.

GENERATOR

ANLG 25 kHz

Specify which one of the five generators is to be used. The preset parameter is ANLG 25 kHz, which is the generator for the analog interfaces and the frequency range up to 25 kHz.

FUNCTION

SINE

Specify the type of signal to be output. The selection window lists all possible types of signals. Keep the presetting, which is sine-wave.

SWEEP CTRL

AUTO SWEEP

Define whether a sweep is to be carried out, whether the sweep is specified by parameters or a list and whether the sweep is to be continued automatically or manually via rotary knob. Switch to AUTO SWEEP. The panel shows some additional lines in which the sweep parameters are to be specified:

X Axis

FREQ

Define which parameter is to be swept, here the frequency.

Start

20 kHz

Specify the start and stop values of the sweep. With a frequency sweep selected, frequency values are expected:
Enter the start value of 20 kHz: place the cursor to the input field, press SELECT (the LED DATA above the entry block for digits lights up indicating that these keys have now the function of figures keys and cannot be used to select panels), key in 20, press softkey kHz (= F6), thus closing the input window. Select the input field for the stop value using the cursor key.

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Stop

15 Hz

Place the digital cursor to the second position using the ← key, set 15 Hz using the rotary knob.

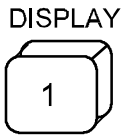
VOLTAGE

1,0 V

Specify the output voltage. Set to 1.0 V.
The permissible range of values is output in the operator guidance line (above the softkeys).

Note: *The maximum level which is still permitted to be output can be defined in the menu item "Max. volt" (in the upper panel section) (protects custom circuits against destruction in case of a keying error). The upper range limit permissible for inputs is thus limited to this value and accordingly varied in the operator guidance line.*

Setting the Display Parameters:



Causes the DISPLAY panel to be displayed on the screen (at the position of the FILTER panel) and the cursor to be placed in this panel. Contains all parameters of graphical presentation.

OPERATION

CURVE PLOT

The standard setting CURVE PLOT is used to display the measurement results in the form of a curve.

Trace A

FUNC CH1

Define which data are to be collected in the measured value memory A. Here, the parameter FUNC CH1 specifies the results of the function currently active for channel 1. With rms measurement selected in the analyzer, the results of this measurement are collected.

Unit

dBr

Specify the unit with which the Y axis is to be scaled. (It is possible to select a different unit from that selected in the ANALYZER panel for numerical display of the measurement result. A different unit can be selected even at a later date in order to rescale an already available trace.)
Hint: The ↑ key allows for jumping to the end of the selection box, thus obtaining dBr very fast.

Scale

MANUAL

The standard setting AUTO ONCE causes the scaling to be effected automatically whenever a measurement function is changed. At the beginning of the sweep, the full-scale values are set to a useful start value. After the sweep has been completed, the measured full-scale values are taken as the basis for rescaling.
Switch to Manual. Scaling can now be specified in the lines TOP and Bottom.

TOP

0.2 dBr

Enter the full-scale values +0.2 dBr and -0.2 dBr.
The full-scale values can be entered in units other than specified for scaling of the axis. (Renders conversion of the full-scale values when changing the scaling unit unnecessary.)

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Bottom

-0.2 dBr

Trace B

PHASE

Switch to manual scaling. The scale for trace B is displayed in the right-hand margin of the graphics window.

Scale

MANUAL

The phase measurement values are collected in the measured value memory B.

TOP

+ 1°

Enter full-scale values of ±1°.

Bottom

- 1°

X AXIS

FREQ

Indication value only. Is automatically set to the sweep control variable.

Scale

Auto

Automatically scale the X axis with the start and stop values of the sweep.

SPACING

LOG

Select between linear and logarithmic scaling of the X axis (= sweep parameter). Keep the presetting LOG.

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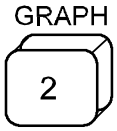
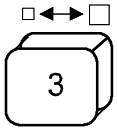
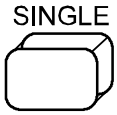


Toggle key switching from the selected input panel to the window for graphical presentation of traces, bargraphs or trace lists and vice versa. Press the key.
The graphics window will appear in **full** display (because the key was pressed when the panels were shown in full display, ie 3 panels simultaneously).



Switches from full-screen to part-screen mode and vice versa.

The panel selected last (here: DISPLAY panel) is shifted to the left on the screen, the GRAPH window being displayed next to it on the right side instead of the two other panels (split-screen mode).



Start a single sweep. The current measured values are output in the measurement result window and, at the same time, both traces are displayed. The sweep starts at the high frequencies (because of start value = 20 kHz). The graph window is now active, ie the → and ← keys, the rotary knob and the softkeys refer to the graphical display.

The measurement of the sum frequency response of generator and analyzer is thus complete.

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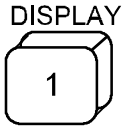
Example 3: Cutting in a Filter



Select the DISPLAY panel again.

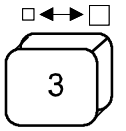
TRACE B
OFF

Switch off trace B.

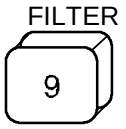
TOP
10 dBr

Reset the top full-scale value of trace A to 10 dBr and the bottom full-scale value of trace A to -90 dBr.
You can select Scale Auto Once instead, causing the scaling to be automatically matched at the end of the sweep.

Bottom
- 90 dBr



Switch from part-screen to full-screen mode (here: 3-panel display as the cursor was in a panel).



Select the FILTER panel. Up to 9 filters can be defined by the user at the same time: Enter the type of filter (lowpass, highpass...), attenuation, passband or center frequency and bandwidth you wish to use in the menu item "FILTER XX", finished. To make the entry more convenient for you, some filters are predefined.

Filter 05

Scroll to the first notch filter.
The parameters displayed in green or grey are values which have been determined by the internal filter design program. These values are for your information and cannot be changed.

If you need help, press the Help key to open the help window, which provides you with brief information on the current menu item, here the filters. You may select key words highlighted in the help text and obtain further information on these items by pressing SELECT.

Cancel closes the help window (also ENTER).

Center Frq
4 kHz

Set the center frequency to 4 kHz, the (band)Width to 500 Hz and Atten(uation) to 50 dB. The filter is now defined and is automatically designated "5:NO4000 Hz".

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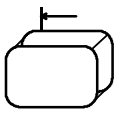
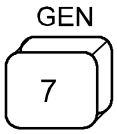


Select the ANALYZER panel using eg the tabulator key (press twice) and scroll to its end using eg the Page↓ key.

Filter

5:N04:00 KHz

Define the filters activated in the selected rms measurement. Scroll to the first menu item "Filter" under the heading FUNCTION, open the selection window containing a list with the nine filters defined in the FILTER panel together with their short designations and all weighting filters. All settable filters can be made visible by scrolling with the ↓ and ↑ cursor keys.
Place the cursor on Filter 5:NO4000 Hz and select using Enter.
The filter is now being calculated. The displayed filter parameters are updated in the FILTER panel.



Select the GENERATOR panel.

Frequency:

Spacing

LIN Points

Select linear spacing between sweep variables.

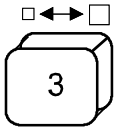
Start

3500 Hz

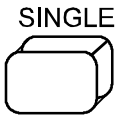
Change the start and stop values of the sweep to 3500 Hz or 4500 Hz in order to facilitate analysis of the stopband of the notch filter.

Stop

4500 Hz



Switch from full-screen (3 panels) to split-screen mode.



Start a new sweep. The frequency response for channel 1 with the notch filter activated is displayed. Scaling of the X axis is automatically matched to the new sweep values.

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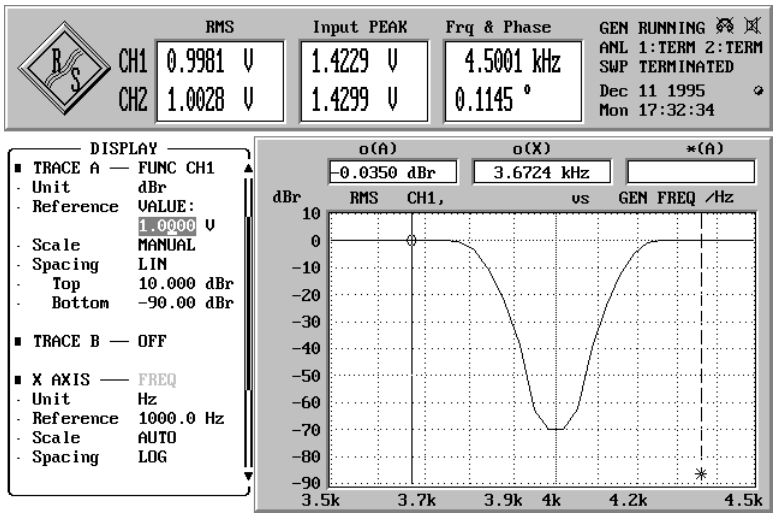

Fig. 2-4

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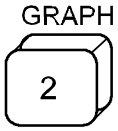
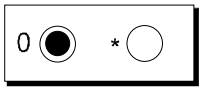
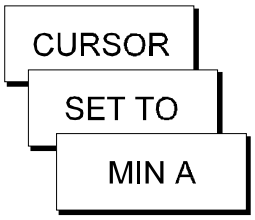
Example 4: Ways of Presentation of Measurement Data



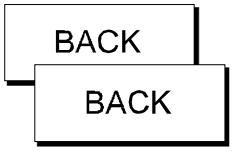
The graphical display window is activated, ie all entries (eg via rotary knob, softkeys) are relevant for graphical display.



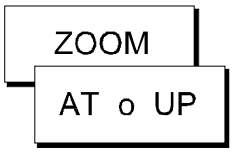
The softkey indicates by the filled circle which cursor is active, ie can be moved using the cursor keys or the rotary knob (in the example 0-cursor). Select the 0-cursor by pressing the softkey.



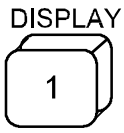
Graphical display and the cursor function can be altered using these softkeys. The key sequence CURSOR, SET TO, MIN A, for example, sets the (active) cursor to the minimum value of the sweep.



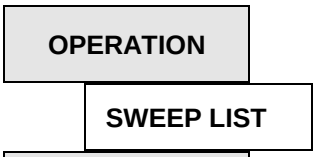
The Back softkey allows you to return to the next higher menu level. Press twice.



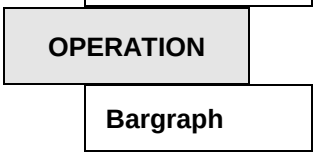
The X axis is zoomed symmetrically around the 0-cursor by the factor of 2 with each key depression.



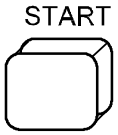
Select the DISPLAY panel.



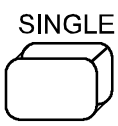
Display of measured value list for the most recent sweep. This list can be stored eg for further processing (FILE panel, "STORE TRACE/LIST": "STORE" ∅ "TRACE A", select a file name).



Select bargraph display. The function to be displayed and the other parameters can be selected independently for each bargraph. The minimum and maximum values indicated are reset whenever the START key is pressed.



Start a continuous sweep. The current rms values and frequency are indicated in bargraph display.



Ends the continuous sweep at the end of the last sweep.

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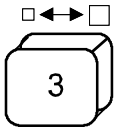
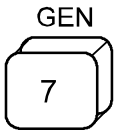
Example 5: FFT of a Two-tone Signal, Measured at Digital Interface



Select 3-panel display.



Select the GENERATOR panel.

GENERATOR
DIG 48 kHz

Select the generator for the digital interfaces with a sample rate of 48 kHz or less.

Channel(s)
1

Set single-channel output.

Output
Intern

Switch to the internal digital interface to the analyzer.
(This mode has been implemented for testing purposes. It allows the digital outputs/inputs to be connected to each other without any external cable connections required.)

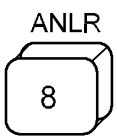
FUNCTION
DFD

A difference tone is generated. A box is first displayed containing the question: "Really Parameter Link Yes/No". Yes means that the corresponding DFD measurement is automatically switched on in the analyzer. Acknowledge by entering NO in this example, since an FFT is to be made. Select mean frequency (enter in menu item "Mean Freq") and difference frequency (menu item "Diff freq") is generated. The total level is 100 % FS (full scale), ie the peak value of the level matches the maximum number that can still be displayed (”all bits set”).

MEAN FREQ
10 kHz

Enter mean and difference frequency.

DIFF FREQ
80 kHz



Select the ANALYZER panel.

ANALYZER
DIG 48 kHz

Select the analyzer for the digital interfaces with a sample rate of 48 kHz or less.

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Input

Intern

Switch to the internal digital interface to the generator. The generator is connected internally to the analyzer. (The internal sample rate is fixedly set to about 43 kHz.)

Function

FFT

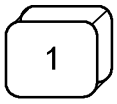
Select FFT analysis selection in a box can always be made, alternatively, by entering the first letter on the external keyboard, ie „F“ in this example).

FFT-Size

8192

Specify the size of the calculated FFT in number of points. The higher the FFT, the higher the frequency resolution (see DISPLAY menu item "Resolution"), however the more the measuring time (see DISPLAY menu item "Meas Time").

Display

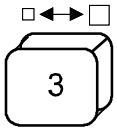


Trace A:

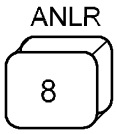
Unit

dBFS

Select unit of the Y axis. Scaling is made automatically, since the "Scale" parameter is set to "AUTO ONCE".



Switch to part-screen mode.
The spectrum of the difference tone signal is displayed.



Select ANALYZER panel.

Zooming

ON (2 ... 256)

Increases the frequency resolution by one center frequency (menu item "Center") through digital preprocessing of the signal by the zoom factor (DISPLAY menu item "Zoom-Fact"). The frequency range displayed is thus decreased by the same factor (menu item ”Span”).

Note: *Not to be confused with the Zoom in Graph where the measured data are only displayed in zoomed form. Here, the measurement is really made at this higher resolution!*

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Center

5 kHz

Set to 5 kHz (= center frequency of difference tone signal)

Span

2.94 kHz

Select 2.94 kHz. This results in an expansion by a factor of 16 (zoom factor). In the graphics window, the zoomed spectrum is displayed (see Fig. 2-5).

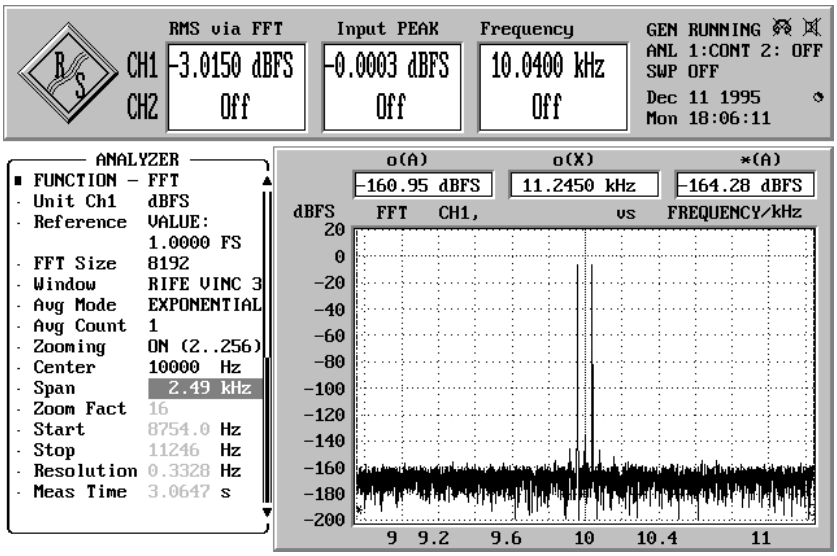

Fig. 2-5

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Example 6: Hardcopy of Screen

Span

Use the key in the “Span“ line to enter the first column of the panel. The SELECT key is used to tick off this line and generate a copy of this line in the status panel.

STATUS

4

Activate the STATUS panel. In this panel, all lines which have been ticked off by the user in one of the panels are listed. It is thus possible to sum up all particularly important parameters in one panel and to print them out together with the measurement results.

Span

1.25 kHz

The UPD can also be operated from the status panel: select a span of 1.25 kHz (the frequency resolution is increased again).

Essential parameters can thus be modified without changing the panel.

For generation of a hard copy, just connect a printer to the parallel interface and configure the UPD appropriately:

OPTIONS

0

Select the OPTIONS panel.

Destin

Printer

Select hardcopy output to a printer.

Printname

xxx

Select the appropriate printer driver from the list provided. Subsequently, change to the type of display which is to be printed (eg, activate status panel again).

HCOPY

Starts the printout. Printing is a background process, allowing you to further operate the UPD.
With very fast printers, we recommend stopping the measurements by pressing the STOP key. Printing itself will then be made more rapidly.

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2.3 General Instructions for Use

The UPD is very easy to operate, especially when you observe the following helpful tips:

- **First select the instrument (both generator and analyzer)**

  Reason: An individual set of parameters is provided for each instrument. This parameter set is saved when changing the instrument and restored when returning to the instrument. It must be loaded first before beginning to make new entries. When changing an instrument, the current choice of functions may change also (eg, analog instruments do not offer selection of the sampling rate).

- **Always proceed from ”top to bottom” in the panels.**

  Reason: Variations in parameters of individual menu items may affect the selection or the range of values of menu items further down, however not of menu items above.

- **Edit the DISPLAY panel only after the generator and the analyzer have been set.**

  Reason: What can be displayed graphically also depends on the selected measurement function. Since many setting parameters of the DISPLAY panel are automatically adopted from other panels, only slight changes, if any, may have to be made to the display parameters.

General Hints as to Mouse Operation

If a mouse is connected to the UPD (see Section 1.1.7 Connecting a Mouse), an arrow the position of which can be changed by moving the mouse appears on the screen. The arrow can be moved across the entire screen. If the cursor is on the desired position, the action (see the following Section) is always triggered by pressing a mouse key (= clicking on a field).

Further, the mouse can be used to

- select between the three different display modes:
  3-panel display, part display and full display, with the left and right mouse key being pressed simultaneously in the shaded area (cf. Fig. 2-7 a and c). The mouse click to change the display modes must be at a position in the panel which is not assigned by an operable field.
- change between panel and graphics in the part display, with the left mouse key being pressed in the shaded area (cf. Fig. 2-7 b).
- change the panel by clicking the panel heading using the left mouse key (cf. Fig. 2-7 d).

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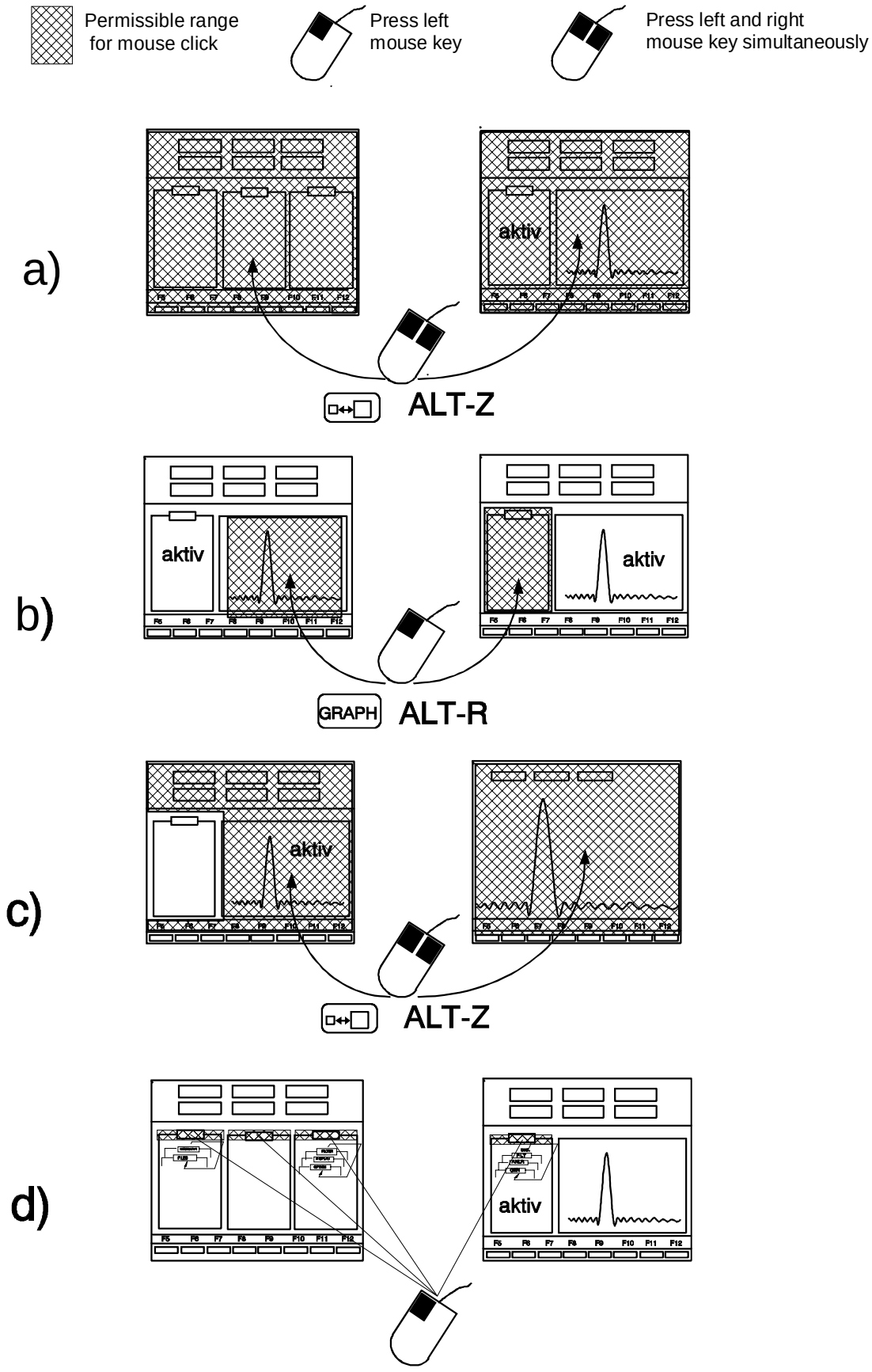

Fig. 2-6

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2.3.1 Panels

Related settings and functions are always combined to form a so-called panel in the UPD. Each panel has a name (= heading in the upper margin of the panel), which is used to call the panel.

In addition to the panels, there is another window in which the measurement results are displayed graphically. Selection and activation of this graphics window matches that of a panel, which is just larger than the panel.

Only one panel can be active at one time. An active panel is characterized by the cursor (field in inverse display) being placed in it, ie entries can be made only in this panel. On the whole, there are eight panels (incl. graphics window), a maximum of 3 panels being displayable on the screen at one time.

A panel is selected and, if required, displayed on the screen using

- the panel keys on the front panel
- the short-key combinations of the external keyboard (option) (see Table 2-1)

Switchover between visible panels is also possible by:

- the Tab →, Tab ← keys.
- moving the mouse cursor (arrow) to the desired panel and clicking on a field
- the short-key combination of the external keyboard (option).

When a panel is called, the position of the cursor matches that at the time when the panel was left (exception: changing the panel using the mouse; in this case the position of the mouse cursor is relevant). Thus, you can quickly switch between constantly recurring input points.

The keys on the front-panel keypad named DATA/PANEL are assigned two functions. The first is the fast selection of the panels (see Table 2-1), the second function is that of a input block for numbers. Switchover from first to second function and vice versa is made automatically. If the UPD expects the entry of figures (after having pressed the SELECT key with the cursor placed on a field for the entry of numerical values, see Section 2.3.2 Data Entry), the keys serve as figures keys, otherwise as keys for panel selection. If the entry of data is expected, the LED above the designation DATA lights up.

Table 2-1 Panels and their functions

Panel name	Front panel key	Key combination ext. keyboard	Function
Analyzer	ANLR	Alt-A	Settings of all six analyzers
Generator	GEN	Alt-G	Settings of all five generators
Filter	FILTER	Alt-T	Filter definitions of the analyzers
File	FILE	Alt-F	Loading and storing of traces and lists, editing of files and directories
Display	DISPLAY	Alt-D	Parameters for graphical presentation of measurement results
Status	STATUS	Alt-S	Summary of user-definable menu items of any panel
Options	OPTIONS	Alt-O	Settings for printer/plotter, ext. keyboard, ext. monitor, information on options fitted Control of an external checkpoint selector Calling of calibration routines
Graphics	GRAPH	Alt-R	Activates panel or graphical display (toggle function)
Full-screen/part-screen	□◄►□	Alt-Z	Switching from full-screen to part-screen mode (toggle function)

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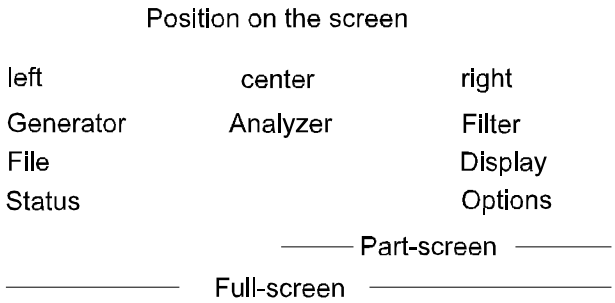
Note: *For a complete list of short-key combinations for operation via an external keyboard, refer to Section 2.1.1, Front-panel View or to the HELP menu under UPD (HELP key or F1 of the external keyboard).*

Every panel has a fixed position on the screen (except when part-screen mode is simultaneously selected, see the following Section):



The GRAPH key allows to switch from the active panel to graphical display and vice versa.

The □◄►□ key is used to change from the full-screen mode (graphic display over the entire screen or 3-panel display, depending on whether the graphics mode or a panel is active) to the split-screen mode (a panel is displayed next to the graph) and vice versa.

In split-screen mode, the panel used most recently moves to the left side of the screen. Any subsequently called panel is placed in this position, too, allowing the user to display and print any panel (especially the → STATUS panel) together with the graphical presentation of results at a time.

After the split-screen mode has been switched off, the currently used panel is shifted back to its normal position.

Scrolling in the panel

If a panel has more lines than can be displayed on the screen section, the ↑, ↓, Page↑ and Page↓ keys (or the corresponding keys on the external keyboard) or the spinwheel can be used for scrolling in the panel. The bar in the right-hand margin of a panel stands for its complete size, the dark section representing the section currently visible on the screen. Arrows point to the direction in which to scroll to bring the invisible lines into the window.

With the mouse connected, the panel contents is scrolled by one line whenever the respective arrow is selected. Holding down the mouse key causes the contents to be scrolled until the key is released. Any desired panel section can be made visible by selecting the dark part of the bar and positioning it appropriately by moving the mouse with the key held down.

STATUS panel

This special panel can be called only in part-screen mode. Any line in any panel can be marked with a tick in the first column (select the position using the Tab ←, ↑ and ↓ keys, press SELECT, the tick is switched on or off (toggle function)). Each marked line is taken over into the so-called STATUS panel, thus allowing the user to sum up all important parameters in one panel. It can be simultaneously displayed with the measurement results and their graphical representation, which is of particular interest for the documentation of results (see **2.8 STATUS Panel**).

The UPD can be operated from the STATUS panel as well as from all other panels, thus allowing you to execute any repetitively used control sequence from one panel only.

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Changing an instrument

The UPD has six analyzers (one in each of the measurement ranges 22 kHz, 100 kHz and 300 kHz for the measurement on analog interfaces, three for the measurement on digital audio interfaces with sample rates of up to 48 kHz, 192 kHz and 768 kHz). All analyzers are set in the ANALYZER panel. The generators are set correspondingly in the GENERATOR panel.

Each of these instruments has its own data set, each with a different structure. The data sets are different with respect to

- the selection of the displayed menu items (= lines of panel). All settings possible *for the selected instrument (eg of the analyzer for analog interfaces in the frequency range* up to 22 kHz) are executed, the settings of the other instruments are suppressed (eg of the analyzer for digital interfaces for a sample rate of up to 768 kHz), but retained in the background. This ensures fast and convenient operation of the UPD despite the wide variety of possible settings.
- the permissible range of values for the parameters. It is not possible, for example, to set a sample rate of 96 kHz in the analyzer ”DIG 48 kHz”, however it is feasible in the analyzer ”DIG 192 kHz”.
- the selection of the functions. To give an example, the analyzer for the frequency range up to 22 kHz is provided with more measurement capabilities than the analyzer for the frequency range up to 300 kHz.

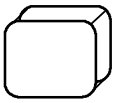
Parameter Link

When the instrument is changed it may sometimes be useful not to use the parameters that had been set last but the ones of the currently employed instrument. This is the case, for instance, when converters are to be checked and the same measurements are to be performed at the digital interfaces which had been performed at the analog interfaces. A selection can be made in the OPTIONS panel whether and which of the current instrument parameters should not to be overwritten by the loaded data set (see 2.15.9 Parameter Link). If this so-called parameter link is activated, a query box is displayed when the instrument is changed, where the user can select again whether the parameter link is to be carried out or not.

For switching between the instruments, follow the instructions below:

➢ Place the cursor on the input field of the first panel line (= right-hand column of the line named ANALYZER or GENERATOR) using the mouse or the ↑, Page and Tab → keys. Then press

SELECT

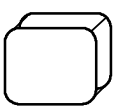


press

(or any mouse key or space on the external keyboard). A selection window with a list of all available analyzers or generators will be displayed.

➢ Select an instrument using the ↑ and ↓ keys, rotary knob or mouse and press

ENTER



press

(or any mouse key or Enter on the external keyboard). The selection window is closed and the settings of the ”former” instrument are saved. The panel with the menu items and all settings appertaining to the instrument most recently selected is built up anew.

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Changing Functions or Parameters

Changing a function (eg from RMS to THD measurement or, from sinewave to multi-sinewave generation) is performed analogously to changing an instrument, which is explained above: all menu items including the parameters appertaining to the function are retained. (The frequencies and amplitudes of all multi-sinewaves are still present, even when the frequency and amplitude of the single sinewave have been changed in the meantime).

Also when changing parameters, the menu items not required are suppressed, their parameters are however retained and are available again when they are activated.

Example 1:
Select: balanced input, impedance 600 Ω, change to unbalanced output and an impedance of 5 Ω for an intermediate measurement. When switching back to the balanced output, an impedance of 600 Ω is automatically set.

Example 2:
Changing from "Off" to, for example, "AUTO SWEEP" in the menu item "Sweep CTRL" causes the menu items (= lines) required in this mode "Start", "Stop", "Points" etc. to be displayed together with the parameters set for the most recent sweep. These lines are cancelled again, when the sweep is switched off.

Note: *The order of the menu items in the panel is selected such that varying a parameter may induce changes in the lines further down, however never in lines further up in the panel. We advise you to proceed in the given order from top to bottom.*

Parameter link (Parameter Link)

It may sometimes be required with changing a function that the set of parameters which had been set last time is not set, but that the one of the currently used function is set instead. This parameter link can be selected in the OPTIONS panel (see 2.15.9 Parameter Link). If this so-called parameter link is activated, a query box is displayed with changing the function where the user can select once again, whether the parameter link is to be carried out or not.

2.3.2 Data Entry

The cursor (field in inverse display) indicates for which input field an entry is currently expected. The cursor can be moved from one input field to the other using the spinwheel, the front-panel keys ↑, ↓, Page↑, Page↓, Tab → and Tab ← or the corresponding keys on the external keyboard. Some fields in the column with the input fields have display function only, the cursor cannot be placed into them. They are displayed in a different colour or in a different grey shade. Menu items without input field serve as headings.

Note: *The same menu item may have an input field or just serve as heading depending on the parameters selected in other menu items.*
Note Section 2.3.2.6 Data Input or Output during Measurements

2.3.2.1 Selecting a Parameter

Place the cursor on the desired input field. Press the SELECT key (or the space bar on the external keyboard) or any mouse key to open a selection window containing all parameters appertaining to this menu item. The spinwheel, the cursor ↑ and cursor ↓ keys or the mouse are used to select the parameters. The window is closed again using ENTER (also with external keyboard), CANCEL (or ESC on external keyboard) or by pressing a mouse key. The parameter of the selection window is taken over with ENTER whereas the former setting is retained with CANCEL. Also, the parameter is accepted when

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selected with the mouse or, the window is closed while the former setting is retained when any point outside the selection window is selected using the mouse.

Note: *The contents of the selection windows are not constant but vary depending on the other settings selected.*
For a list of all key combinations assigned to the front-panel keys of the external keyboard, refer to Section 2.1, Front- and Rear-panel Views. The key combinations are therefore not explicitly specified in the following description.

2.3.2.2 Entry of Numerical Data

Entry using the spinwheel

– Place the cursor on the desired input field using the spinwheel or cursor keys ↓ or ↑.

– Set the numerical cursor (= underscore) to the position to be incremented or decremented using cursor keys ← or → . If the position need not be changed press the ENTER key.

– The colour of the field changes and the spinwheel is now in the "value change" mode. Change the figure using the spinwheel.

The digits can be varied only within the range of values specified in the user guide line. A warning is audible on reaching the limit values (can be deactivated, see 2.15.2 Beeper On / Off)

Note: *Some settings require other settings in the panel to be varied (example: when changing the reference voltage, all settings referring to this value must be converted). In this case, the complete panel must be rewritten whenever a value is changed, thus slowing down the spinwheel function.*

After quitting the field using one of the keys ↓ , ↑ , PgUp, PgDn or CANCEL, the spinwheel is again in the "roll" mode.

Sweep parameters (eg generator frequency or level) can be incremented and decremented around a user-defined value. This is done by determining the step width for the manual sweep.

Entry using the numeric keypad

Position the cursor to the desired input field, press SELECT or any mouse key or a number key on the external keyboard causing a small input window with the current value to be displayed. (The number of digits available in the input window may be higher than that of the input field allowing the user to enter values with a higher accuracy than can be displayed in the panel, if required. After having closed the window the rounded value appears in the panel.)

If the value is to be re-entered completely, simply enter the figure using the numeric keypad. The first key depression automatically deletes the old value. The BACKSP key is used to delete the figure to the left of the cursor during input.

If you wish to change only individual figures, place the numerical cursor on the respective position using the → or ← and enter the desired figure (changing the position of the numerical cursor before the entry of the first figure or deleting a character causes the former value to be retained).

Close the window using

- ENTER: the value entered anew is accepted
- CANCEL: the old value is retained
- Softkeys: the selected unit is set and the value entered anew is accepted
- Clicking with the mouse inside the input window: the value entered anew is accepted

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- Clicking with the mouse outside the input window: the value entered anew is not accepted

Entries outside the specified range of values are not accepted, a warning is audible (can be switched off, see 2.15.2 Beeper On / Off) and the entry is changed to the appropriate minimum or maximum value.

Changing the unit at a later date

Place the cursor on the unit field (using Tab ∅ in the numeric input field) causing a softkey line with the units permissible for this menu item to be displayed. The current numeric value is converted for the selected unit by pressing the respective softkey (see also next Section).

2.3.2.3 Using the Softkeys

The softkeys (eight keys at the bottom screen margin) are used for the entry of units and operation of graphical display. The MORE softkey switches to further softkeys available to this operating point, the BACK softkey returns to the next higher softkey level.

The softkeys can be activated

- using the front-panel keys
- using the function keys on the external keyboard specified in the softkey labelling
- by clicking by means of the mouse.

2.3.2.4 Help Line

The help line is between the panels and the softkeys and always refers to the input field marked by the cursor. It provides you with information on which keys to use for further operation or the permissible range of values. Entries outside the specified range are not accepted, a warning is audible and the entry is replaced by the appropriate minimum or maximum value.

Note: *The maximum permissible range of values may depend on other settings, ie is not constant. For further information on the current menu item, press the HELP key.*

2.3.2.5 Entry of File Names

Position the cursor on the input field of the menu item the file name of which is to be changed and press the SELECT key. A dialog window consisting of three more windows will be displayed.

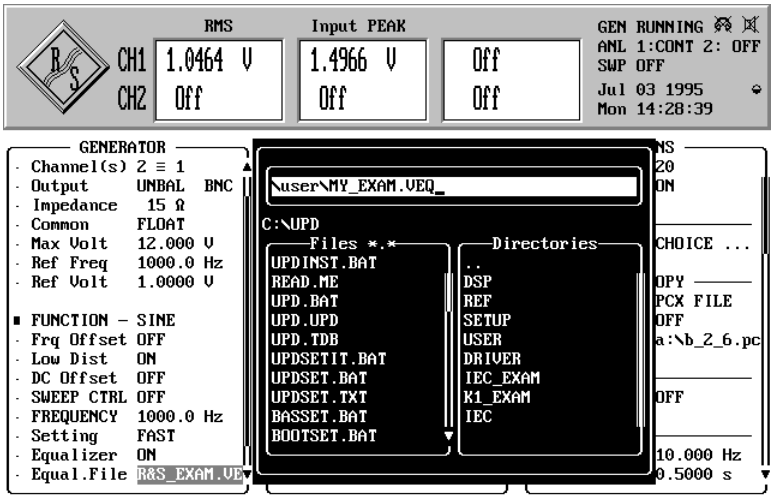

Fig. 2-8

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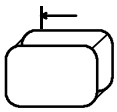
- The top window serves for editing the file name (incl. path name, if required). When selecting the dialog window, it is preassigned with the current file name of the selected menu item. The line below indicates the currently used path (disk drive and directory, see also paragraph ”Working Directory”).

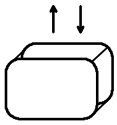
- The "Files" window allows you to select an already available file. This window lists all files contained in the current path of the file type provided as standard for this menu item. (The type of file is identifiable by the three letters after the point. Different types of files are used for the different tasks of a file (eg limit file, sweep list file etc.) to facilitate file management. For a list of all types and their meanings, see Section 2.9.1, Loading and Storing).
- The "Directories" window allows the user to change the directory. It contains the subdirectories (if any) of the current path. The directory name "..." represents the higher-order directory with respect to the current directory.

The Tab ← and Tab → keys can be used to switch between the above windows.

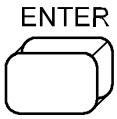
Selecting an already available file



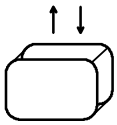
Change to the Directories window using the tab key in the open dialog window.



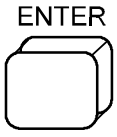
Select the desired directory. Scrolling is possible as in a panel, also with PgUp, PgDn or the spinwheel (see Section 2.3.1, Panels: Scrolling in the Panel).



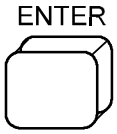
The newly selected, current path is displayed, the window contents are updated, *.xxx is entered as file name, where xxx stands for the type of file provided as standard for the selected menu item.



Change to the Files window and select the desired file.



The selected file name is taken over into the input window where it can still be modified (see below "Entering a new file name"). Entering an already available file name is to be preferred, in particular when no keyboard is used as entering a completely new name is then time-consuming.



Close the dialog window, storing or loading is effected with the name stated in the input window. CANCEL closes the window without any operation carried out, the old file name being retained.

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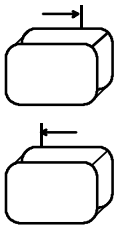
Entering a new file name



➢ Change to the uppermost window.
The file name to be entered must comply with the MS-DOS conventions: a maximum of eight characters followed by a point and the data type consisting of a maximum of three characters. The <> = , ; : . * ? [] () /\ + ! characters must not be used.

There are three ways of entering the file name:

- using an external keyboard
- with the help of the mouse (also with no external keyboard connected)
- via the front-panel keyboard.

For entries without using an external keyboard, place the input cursor (" /\" character) on the position there characters are to be entered using the → or ← key. Press the mouse key or the SELECT key. A selection window with all characters which can be entered will be displayed. Select a character (using the mouse or →, ← keys), which is then inserted into the file name at the cursor position whenever a mouse key or the SELECT key is pressed. An entry at the first position causes the former file name to be automatically deleted. BACKSP is used to delete the character to the left of the input cursor. Close the selection window using the ENTER key, by selecting <ok> in the selection window or by selecting one of the three windows in the dialog window with the help of the mouse.

When using an external keyboard, editing is made directly in the input window, the above selection window with the alphabet is not displayed. On **power-up**, the UPD checks whether an external keyboard is connected. (Being not initialized when connected after power-up of the UPD, the key-board does not function properly.)

The following can be entered in the input window (see also previous section "Working Directory"):

- File name without path specification: The path specified in the next line is used. Storing and loading is initiated using ENTER.
- File names with wild cards (don't care characters * and ?). ENTER serves to display the respective files in the FILES window, eg *.LUP is used to list all files of this type. The search for file types other than the standard files is thus possible.
- Only a path. The path and window contents are correspondingly updated.
- File name incl. the complete path specification. Storing and loading is initiated using ENTER.

Using the working directory (Working Directory)

Files can be summed up in a working directory for certain projects or instrument users (see Section 2.9.1, Loading and Storing). The path specified in the menu item WORKING DIRECTORY of the FILE panel (eg C:\PROJECT1) precedes all file names used in the UPD at the time of loading or storing, provided they do not begin with "\" or "Drive:\".

Example:
Entering the file name MEAS5\MYFILE.XYZ results in the path C:\PROJECT1\MEAS5\MYFILE.XYZ, to use the above example again.

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2.3.2.6 Data Input or Output during Measurements

Internal and external sweep switched off

(**External sweep:** The parameter AUTO is not selected for menu item START COND of analyzer)
All entries are permissible at any time. After having terminated an entry (ENTER), the present measurement or output is aborted, the newly selected parameters are set and the measurement or output is restarted.

Note that with graphical display (eg continuous FFT, bargraph, histogram of intermodulation measurement), the graphics output is interrupted when a selection window is opened, however the measurement continues. After having closed the window, the graphics is restored, or, when display parameters were changed, the graphics is deleted and built up again with the new settings (in the case of continuous FFT, this is performed only at the end of the present FFT).

Internal or external sweep switched on

(**External sweep:** The parameter AUTO is not selected for menu item START COND of analyzer)
Any entry causes the sweep to be stopped (ie it is stopped after conclusion of the current sweep) and then the action initiated by the activated key to be executed because modifications to parameters during a sweep may affect the measurement, thus rendering the measurement results displayed on the screen questionable.

Exceptions:

The following keys can be activated or the following actions can be made without aborting a sweep:

- Entries in the DISPLAY panel
- Display of any panel without varying parameters
- Rotary knob (enables a manual sweep, (see Sweeps)
- Softkeys of graphical display of results

Changes in the GENERATOR, ANALYZER, FILTER or STATUS panels cause the internal instrument status to be set to "measurement invalid" because the measurement results do not match the setting parameters. The attempt to save or print these measurement results is prompted by an appropriate warning (see Section 2.9.1 "Loading and Storing" and Section 2.14 "Printing"). It is no longer possible to continue the sweep using the CONT key, a restart with the START or SINGLE key is required.

Modifications to parameters in the DISPLAY, FILE and OPTIONS panels do not affect the measurement results; the internal instrument status is "measurement valid". Entries are immediately processed. (Exception: With continuous FFT, modifications to the display parameters are considered only in the next spectrum to be output). The measurement can be continued with the CONT key.

Note: *See also 2.11 Starting and Stopping a Measurement or a Sweep.*

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2.3.3 Display of Measured Values

The display windows for a maximum of 6 measurement results are in the upper section of the screen except for in full-screen mode.

To the right of the windows, there are status information on the current instrument state, see 2.3.4 Status Display.

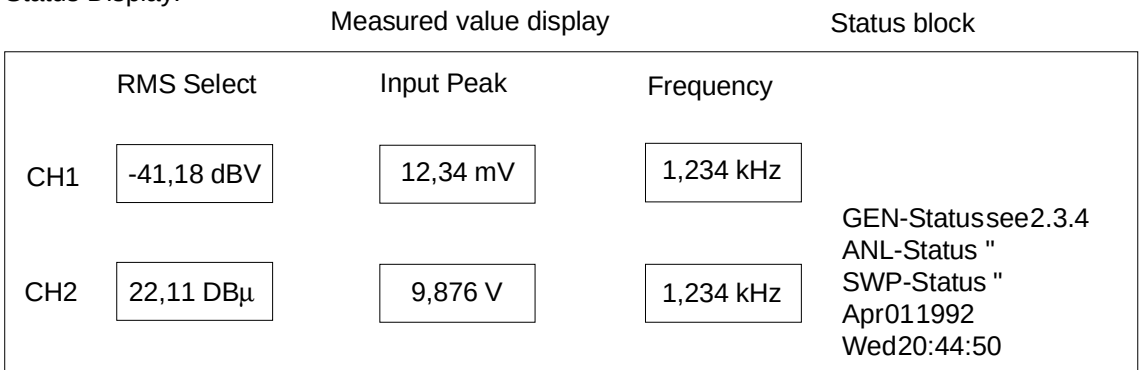

Fig. 2-8

1st column: Measurement results of the selected measurement functions ...

2nd column: Measurement results of the measuring function selected in menu item "Input Disp" (in the example, peak value display of input levels) ..

3rd column: Frequency and phase measurement results ...

... each for both channels at one time.

Display of measured values:

1.234 V	Valid measurement result The measurement results are shown in 3 ½-, 4 ½- or 5 ½-digit display ie the decimal point jumps at the transition 2.999 ↔ 3.00, 29.99 ↔ 30.0, 299.9 ↔ 300 etc. If a measured value happens to be in the transition range, hysteresis prevents an unsteady display. The number of digits and the rate of updating the displayed measurement results can be selected in the option panel - depending on the measurement function (see). Independent of this reading rate, the measurement rate can be selected for the individual functions (see 2.6.5 Functions). Only the function influences the measurement accuracy. With fluctuating measurement results it is advisable to reduce the number of digits to be displayed (reading resolution) in order to obtain a steady display. The measurement results can be displayed with various units individually for each channel. The unit is selected in the analyzer panel with the measurement function.
OFF	The measurement channel or function is OFF, for example, Input Peak = OFF
– – – –	There is no measurement result related to the selected function available, eg, there are no frequency measurement results during DC measurements.
-INPUT ?- Press SHOW I/O	The measurement result cannot be displayed because of an inappropriate input signal. A hint about how to eliminate the error appears when pressing the SHOW I/O key (see 2.3.5).

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2.3.4 Settling Process

2.3.4.1 Introduction

Why is settling necessary:

If a modification is made at the generator of the UPD and if the settling time of the test item is known, it can be considered using the delay indication in the analyzer panel (cf. 2.6.4 Ways of Starting the Analyzer). Settling processes within the UPD are automatically considered so that the user does not need to take these times into account. The analyzer supplies settled, valid measurement results.

If there is a test item with an unknown transient response between the generator and the analyzer of the UPD or if a test item is fed by an external generator, a transient response will usually be observed at the measurement result after a change of the signal or a manipulation at the test item (in the case of a high measurement rate compared to the settling time) until the display has stabilized. The steadied readout is then accepted to be valid.

The settling process in the UPD has the aim of imitating and automating this procedure. A measured value is only output if it satisfies a certain accuracy the user can enter freely (maximal deviation from the settled final value, later the expression ”tolerance” is used). The settling process is preferably used in cases where measurements are to be made at test items with an unknown or changing settling time. The settling process can be combined with a delay so that an undesired signal characteristic can be ignored before the settling process begins as of the starting time of the measurement (change of generator or of signal with external sweep). The settling process can also be used to steady the readout by rejecting values which do not comply with the accuracy entered.

How is the settling process realized?
The value measured by the UPD is permanently compared with up to 5 measured values stored immediately before. A measured value is only accepted as valid if it is within the tolerance limits entered by the user with regard to the previous measured values. Otherwise it is rejected and included in the series of comparison values for the next measured value.

Where can settling be set?
The settling process can be applied to:

- External sweep (START COND → FREQ CH1 | FREQ CH2 | VOLT CH1 | VOLT CH2)
- Frequency results (FREQ/PHASE → FREQ)
- Phase results (FREQ/PHASE → FREQ&PHASE)
- Function results for all functions except for FFT, POLARITY and WAVEFORM (START COND → AUTO)

The settling process for the external sweep and the settling process for the frequency, phase or function measurement can be combined.

Exception:
Settling process in combination with external sweep with a change of the frequency as trigger condition (setting START COND → FREQ CH1 | FREQ CH2) cannot be combined with a settling of the frequency results. Reason: There are already settled frequency results which do not have to be weighted using a settling process again!

All settling settings can be activated in the ANALYZER panel in the corresponding panel sections under menu item ”Settling”.

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2.3.4.1 Settling Parameters:

The appropriate settling parameters are stored for every measurement function so that the settling settings once selected and well tested are effective in a change of the function.

Settling:

Settling→EXPONENTIAL
sets a result comparison window with an exponential characteristic whose lock-in range is determined by the setting ”tolerance”. This setting is ideal for measurements on test items with a normal exponential transient response and usually covers most applications (cf. Fig. 2-7.1).

Settling→FLAT
sets a result comparison window with a fully flat characteristic (tolerance band) whose lock-in range is determined by the setting ”tolerance”. With a very small tolerance entered, this setting only supplies a measurement result if the test item has quasi completely settled. Due to this stricter settling condition, the time until a valid measured value is recognized is usually longer than with the EXPONENTIAL setting (cf. Fig. 2-7.1).

Settling→AVERAGE
causes an arithmetic averaging for the number of measured values set in samples. After a restart of the measurement by pressing the Single key at the UPD or a parameter entry which must result in a restart of the measurement such as modifications of the generator signal or of the settling parameters themselves, the average is only output when the number of measurements set by means of "samples" has been made. If the memory is full of measurement results, the most previous result is dismissed and the average output with every new result. In this phase, an abrupt change of the signal results in a creeping change of the average (low-pass properties).

Samples:

This value indicates the number of measured values used for tolerance and resolution comparison. Samples = 6 means that the latest measured value is compared with the 5 last measured values.

Tolerance:

The tolerance value denotes the maximally permissible deviation from the previous measured value a settled measured value may have in order to be classed as valid by the UPD. The value of the maximally permissible deviation of the current measured value compared to the 2nd/3rd/4th and 5th last measured value is determined by the EXPONENTIAL | FLAT setting.

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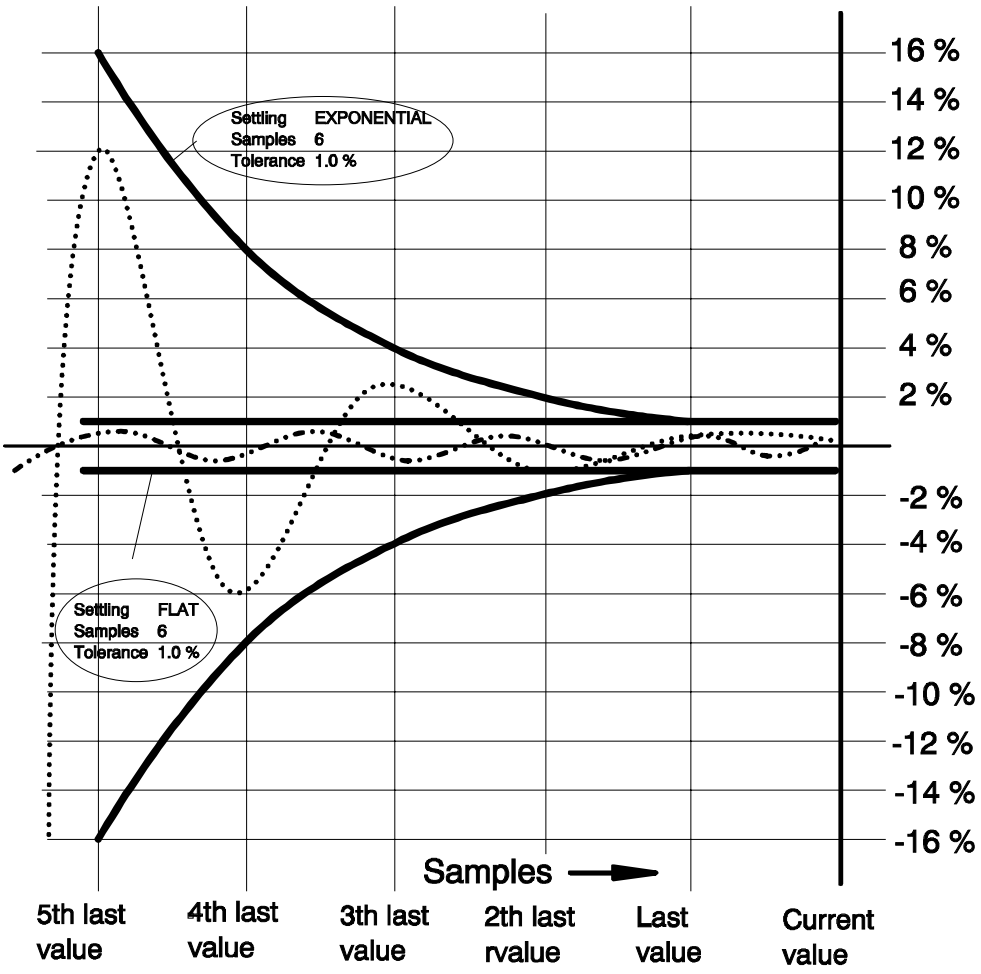

Fig. 2-9 Tolerance characteristic

When the measured values are checked as to whether they satisfy the tolerance condition,

- volt is always used as a basis for the measurement result for level measurements RMS & S/N, RMS SELECT, PEAK & S/N, Q PK & S/N and DC,
- % is used as a basis for the measurement result for intermodulation measurements THD, THD+N/SINAD MOD DIST, DFD, DIM and WOW & FL, and
- Hz is used as a basis for the measurement result for frequency measurements, irrespective of the unit in which the measurement result is displayed.
  For a phase measurement, it is only possible to set the resolution (see resolution).

Examples:

In the following examples, Settling → EXPONENTIAL and samples = 6. If the tolerance is 1%, this means that the current measured value must be identical to

- the last measured value ±1% (or ±0.086 dB)
- the 2nd to the last measured value ±2% (or ±0.172 dB)
- the 3rdto the last measured value ±4% (or ±0.340 dB)
- the 4th to the last measured value ±5% (or ±0.668 dB)
- the 5th to the last measured value ±16% (or ±1.289 dB).

Level measurement, tolerance 1%:
A measured value of 1 V is displayed as settled, when

- the last measured value is between 0.99 and 1.01 V (±1%)
- the 2nd to the last measured value is between 0.98 and 1.02 V (±2%)

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- the 3rd to the last measured value is between 0.96 and 1.04 V (±4%)
- the 4th to the last measured value is between 0.92 and 1.08 V (±8%)
- the 5th to the last measured value is between 0.84 and 1.16 V (±16%)

Intermodulation measurement, tolerance 1%:
A measured value of 0.01 % is displayed as settled, when

- the last measured value is between 0.0099 and 0.0101 % (±1%)
- the 2nd to the last measured value is between 0.0098 and 0.0102 % (±2%)
- the 3rd to the last measured value is between 0.0096 and 0.0104 % (±4%)
- the 4th to the last measured value is between 0.0092 and 0.0108 % (±8%)
- the 5th to the last measured value is between 0.0084 and 0.0116 % (±16%)

Intermodulation measurement, tolerance 0.1 dB (1.16 %):
A measured value of -80 dB (0.01%) is displayed as settled, when

- the last measured value is between -80.1 and -79.9 dB (±1.16%)
- the 2nd to the last measured value is between -80.2 and -79.8 dB (±2.32%)
- the 3rd to the last measured value is between -80.4 and -79.6 dB (±4.63%)
- the 4th to the last measured value is between -80.8 and -79.2 dB (±9.26%)
- the 5th to the last measured value is between -81.7 and -78.5 dB (±18.53%)

Frequency measurement, tolerance 1 %:
A measured value of 1000 Hz is displayed as settled, when

- the last measured value is between 990 and 1010 Hz (±1%)
- the 2nd to the last measured value is between 980 and 1020 Hz (±2%)
- the 3rd to the last measured value is between 960 and 1040 Hz (±4%)
- the 4th to the last measured value is between 920 and 1080 Hz (±8%)
- the 5th to the last measured value is between 840 and 1160 Hz (±16%)

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Resolution:

With very small measured values, especially at the lower measurement limit of the UPD, or in the case of signals with superimposed noise, a relatively large measuring error may occur so that the measured value often is no longer within the exponential tolerance characteristic. In this case, a minimum value of the result resolution is considered, the "resolution" value, which serves as the starting value for an exponential resolution characteristic and which has exactly the same curve (EXPONENTIAL or FLAT) as the exponential tolerance characteristic. (see Fig. 2-10)

A value outside the exponential tolerance characteristic which has been caused by superimposed noise is not expressive with regard to the transient response of the test item. If the measured value satisfies the resolution entered by the user, however, it is accepted as being valid nevertheless.

If, eg, the current measured value is not within the tolerance limit required compared to the 4th last result, the amount of the difference between the current measured value and the 4th last value is found and compared to the resolution value No. 4. If this difference value is smaller than the resolution value, the measurement result is considered to be valid.

The accuracy of the phase measurement results is the same throughout the entire range from 0 to 360°. Observing the tolerance for phase measurement results would not be very useful, because the slightest phase fluctuations about 0° would cause large tolerance jumps and thus continuously violate the tolerance conditions. Therefore, only specification of the resolution is possible for the phase measurement, ie the absolute offset of the current phase measurement result compared to the previous phase measurement results in degree.

Example:
Phase measurement with resolution 1°:
A phase result is indicated to be valid if the magnitude of the difference between the current measured value and
- the last measured value < = 1°
- the 2nd last measured value < = 2°
- the 3rd last measured value < = 4°
- the 4th last measured value < = 8°
- the 5th last measured value < = 16°

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Example by means of the followwing panel setting:

Settling	EXPONENTIAL
Samples	5
Tolerance	1.0 %
Resolution	0.5 mV

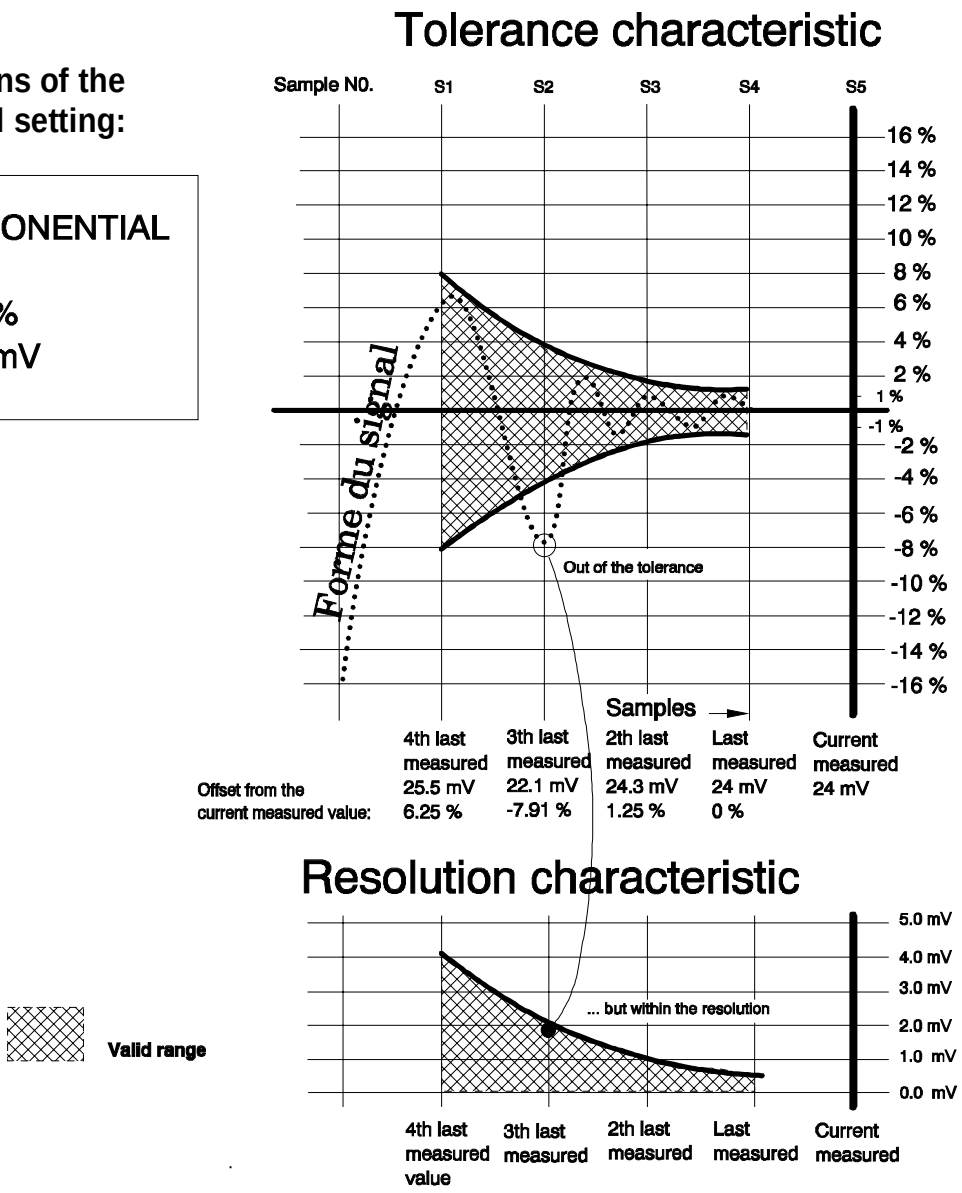

Fig. 2-10 Connection between tolerance and resolution

The EXPONENTIAL traces are always calculated to the basis 2. The sampling points of the exponential tolerance characteristic, eg starting from tolerance 1%, are calculated to: 1%, 2%, 4% and 8%. The sampling points of the resolution trace, eg starting from a resolution of 0.5 mV, are calculated to: 0.5 mV, 1 mV, 2 mV and 4 mV. The offset of the current measured value compared to the 3rd last measured value is -7.91% and is therefore not within the desired tolerance. When the amount of the difference between the current measured value (24 mV) and the 3rd last measured value (22.1 mV) is smaller than or equal to the resolution value [S2] (2 mV), the current measured value is accepted as being valid nevertheless.

$|24\ mV - 22.1\ mV| = 1.9\ mV$

Since 1.9 mV < 2 mV, the current measured value is valid.

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Timeout:
Timeout denotes the time which may elapse from the start of a measurement until the settling mechanism has recognized a settled measurement result. If the measured value does not stabilize within this time, the measuring loop is aborted and the note "Input - Press SHOW I/O" output instead of a measured value. During a sweep with a graphical curve display, a gap in the curve trace indicates that a measured value is missing. In the case of settling with an external sweep (cf. next paragraph) a timeout is not considered. If option Highspeed (UPD-B3) is fitted, the timeout period begins simultaneously for both channels after "delay" (see below) has elapsed. If option Highspeed is not fitted, channels Ch1 and Ch2 are measured sequentially and the timeout period reset with every change of the channel after "delay" has elapsed.

2.3.4.2 Settling with External Sweep:

For better understanding the following explanations, please read menu items
- "Min VOLT"
- "Start"
- "Stop"
- "Variation"

in Section 2.6.4, Ways of Starting the Analyzer, Ext. Sweep

When the external sweep (START COND → FREQ CH1 | FREQ CH2 | VOLT CH1 | VOLT CH2) is used together with the settling process, the following measurement procedure results (see fig. 2-11):

1. Check whether a level of at least the value indicated in "Min Volt" is present at the measurement input. (Only true of an external sweep with triggering on frequency changes (START COND → FREQ CH1 | FREQ CH2)
   No: Execute step 1.

2. Wait for the stabilization of the frequency with setting: START COND → FREQ CH1 | FREQ CH2,
   or
   the stabilization of the level with setting: START COND → VOLT CH1 | VOLT CH2
   by means of the settling process.

3. Check whether the level or the frequency are in the range
   indicated by "Start" and "Stop".
   No: Execute step 1.
   Yes: - Wait the time indicated under delay to permit a test item to settle.
   - Execute function measurement (possibly including function settling)
   - Proceed function result to the display

4. Check whether a change in level or frequency by at least the value
   indicated in "Variation" has occurred.
   No: Execute step 4
   Yes: Execute step 1

Note on the delay:
A delay with an external sweep with settling process is useful when measurement is carried out on test items showing a slow transient response of the level due to a change in frequency (eg hearing aids with sound-level limiter or compander/expander circuits with fast level rise times and slow decay times). A frequency change has to be set as a trigger condition (START COND → FREQ CH1 | FREQ CH2). If the settling mechanism supplies quickly steadied values for the frequency results but the level is far from having stabilized, the lapse of the level settling time can be waited for using delay.

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External sweep with settling process example:

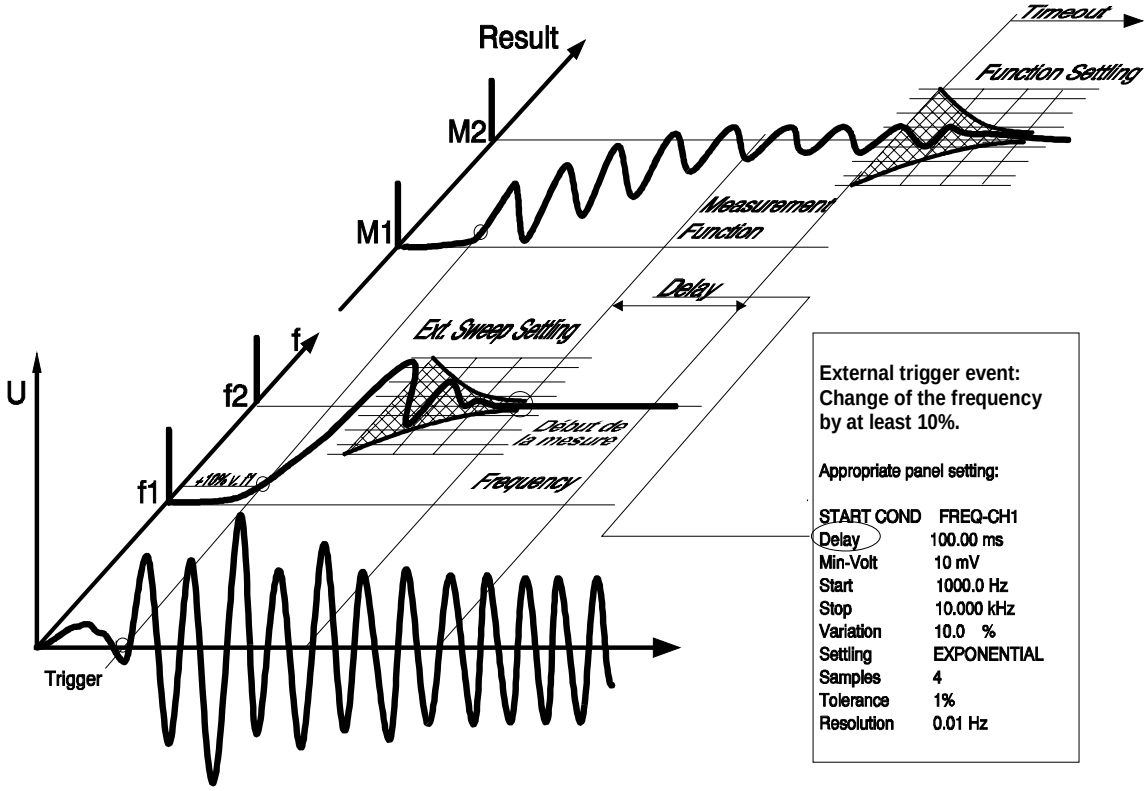

Fig. 2-11 External sweep with settling process

2.3.4.3 Settling Check and Optimization

Settling check

If the SHOW I/O key is pressed during a fault-free measurement run with activated settling process, the settling control characters "r", "t" or "-" appear in a suggested result window or after the text "Ext. Sweep", indicating whether the result display or the trigger event were possible because of a fulfilled tolerance or resolution condition. According to this display, the tolerance or resolution value can be varied until the desired transient response is achieved.

Example of an indication in SHOW I/O display:

	Func		Freq
CH1	rtttr		rrt
CH2	ttttr		ttt

Ext. Sweep: trt

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Explanation:
"**t**": tolerance condition fulfilled
eg, "t" at the third position: tolerance condition of the current measurement result compared to the 3rd last measurement result was fulfilled.
"**r**": resolution condition fulfilled, only
eg, "r" at the fifth position: the tolerance condition of the current measurement result compared to the 5th last measurement result was

n o t fulfilled, the resolution condition was fulfilled instead.

Exception:
Since no tolerance condition can be specified for the phase measurement, a settled phase measurement result is always characterized by "r".

"**-----**": No settled measurement result.
Remedy:
- Increase tolerance and resolution value
- Reduce the number of samples
- Switch from FLAT to EXPONENTIAL.

"rrrrr" The measurement result is too unsteady or noisy for the selected tolerance condition.
Remedy:
Select greater tolerance value.
If a still smaller resolution value was selected, "-----" would be displayed.

"rttrt" The measurement result is still too unsteady or noisy for the selected tolerance value.
Remedy:
The more unsteady this display, the greater the tolerance value to be selected.

"ttttt" The measurement results lie all inside the specified tolerance range.
The tolerance condition can be tightened by using a smaller tolerance value or the setting Settling → FLAT until an "r" appears sporadically.

Note: *If varying or fluctuating measurement results are to be observed although the tolerance condition is fulfilled, this may be due to the following reasons:*
- Slowly rising or falling measured values (compared to the measurement rate)
- Sudden, but rare variation of the measured values compared to the measurement rate.

Optimizing the settling parameters:

In order to obtain maximal measurement rates in connection with the settling mechanism, the DELAY time under START COND → AUTO (cf. 2.6.4) is to be observed. This is the time elapsing from the setting of the generator until the restart of a measurement (and thus the start of the settling process) (cf. 2.6.4) in order to take into account possible dead times of a test item. The UPD automatically considers the settling time of the generator and the analyzer. If the value 0.0 s is entered for DELAY, no additional delay is effective and a maximum measurement rate is achieved.

As the settling process in the UPD can be used for individual measurements, the suitable settling parameters can be easily determined by observing the measurement results and by trying.

Delay value if the UPD generator is used

Measurement of the DUT delay using the time-controlled measurement functions Timetick or Timechart (START COND → TIME TICK or TIME CHART, cf. 2.6.4 Ways of Starting the Analyzer) and graphical display. After a generator modification, determine the time until the sudden signal change.

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Delay value with external sweep

In the case of unknown signals, short dead times of the test item up to approx. 100 ms can be determined using function WAVEFORM, for longer dead times we recommend to use a storage oscilloscope. If test bands, test CDs etc. are used, possible manufacturer's instructions can be used. Trying delay values for the external sweep is usually not successful since settled measured values might occur, but possibly at an undesired point of time.

Sample value

A high value makes high demands on the transient response of the test item. No general statements possible.

Tolerance value

Select bar display until the min/max values are within the desired limits. A tolerance indication of 1% is suitable for most AF applications. In the case of noisy test bands with considerable level fluctuations, eg, the tolerance value must not be selected too small as otherwise settled measured values would never be obtained. Tolerance values of approx. 5% with 3 samples can be useful.

If noisy signals are weighted via the settling process, a steadied readout can be achieved by suitably setting "tolerance". However, the measurement rate decreases as possibly very many measured values have to be rejected until the settling condition is satisfied. The settling process offers the possibility of averaging (cf. AVERAGE).

Resolution value

Observe value displayed. The resolution value should always remain near the UPD resolution. If, eg, the level result fluctuates by 2 mV, a value which is approx. 5 times higher, ie 10 mV, would be suitable as resolution value.

Caution! *Two high a resolution value would permanently signal settled measured values although the tolerance conditions would permanently be violated.*

Timeout:

The longest time the UPD takes to measure the test item can be determined by experimenting. If this time is slightly increased, it can be used as timeout period and guarantees a maximal rate of the test run in the case of timeout being exceeded.

For explanation of how to enter settling commands see 2.6.5.1, Common Parameters of Analyzer Functions

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2.3.5 Status Display

The status information is always displayed in the top right section of the screen and contains information on the current status of the generator, analyzer and sweep system as well as date and time.

Exception: In full-screen mode (see 2.10.9, Switching between Full-screen and Split-screen Mode), date and time are displayed flush right in the operator guidance line.

Status display GEN Status

GEN OFF: Both generator channels are off.
GEN RUNNING: Generator outputs signal.
GEN BUSY: Generator-DSP is temporarily processing the waveform.
GEN HALTED: No generator output signal because of the setting not yet concluded or invalid.
GEN OVERRUN: The sample rate applied to the external input (see 2.5.3) is too high for the selected digital generator.
Remedy:
- Select a lower external sample rate. Recall the function.
- Select a faster digital generator

Status display ANL Status

ANL WAIT FOR TRIG: The analyzer waits for the trigger condition set under START COND (see 2.6.4).

ANL1: 2:

Separate status information for analyzer channels 1 | 2:

OFF: Channel OFF, no status messages
OVER: Overranges may occur when
- a measurement range has been fixed using FIX (see 2.6.2 Range)
- a signal with a level featuring a crest factor > 2 is applied to the range limit
- a DC portion is superposed on the signal with a lower range limit of 2 Hz
- DC control is applied to the input configuration BAL.

UNDR: Underranges may occur when a measurement range has been fixed using FIX or LOWER (see 2.6.2 Range)
RANG: Ranging. No measurements possible!
SNGL: Single measurement running
CONT: Continuous measurement running
TERM: Single measurement terminated
STOP: Measurement stopped

(see 2.11 Starting and Stopping a Measurement)

CAL: Cyclic internal DC offset calibration of A/D converter in the analog analyzers or DC offset calibration of input levels in measurement function DC. Calibration, see 2.15.7
ORUN: The sample rate applied to the external input (see 2.6.3) is too high for the selected digital instrument.
Remedy:
- Set a lower external sample rate Recall the function.
- Select a faster digital instrument

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Status display SWP Status after modifications to the settings

SWP OFF:	No sweep	see 2.11, Starting and Stopping a Measurement
SWP INVALID:	Sweep invalid because not yet started or parameter varied	
SWP TERMINATED:	Single sweep terminated	
SWP STOPPED:	Sweep was stopped and can be continued	
SWP CONT RUNNING:	Continuous sweep running	
SWP SNGL RUNNING:	Single sweep running	
SWP MANU RUNNING:	Manual sweep running	
SWP UNDERRANGE:	On account of an underrange, valid, yet inaccurate measured values occurred during a sweep.	

Other status displays:

In the section where date and time is displayed, the following status messages are displayed. Data and time are displayed again when the cause for the error has been removed.

PRINTER NOT READY
- After the H COPY key has been pressed, the UPD recognizes that no printer is connected.
- The connection to the printer has been interrupted while files or lists (see 2.14.1 and 2.14.2) are being printed.

CONVERTING SETUP — The setup of a previous UPD program version is being converted to be loadable by the latest UPD program version.

WAIT FOR CAL: ANA OFFSET — The analyzer requires an offset calibration. It is currently not feasible because cyclic DC-offset calibration has been switched off (see 2.15.7) or, due to a running sweep, has been disabled.

The operator guidance line shows the following status message:

DUMP SCREEN TO TEMPORARY FILE — Pressing the H COPY key causes the screen contents to be copied to a temporary file. While this status message is being displayed, operation of the UPD is not possible.

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2.3.6 Error Messages

All error messages in manual mode are displayed in a window in the center of the screen until ENTER is pressed.

The error message contains a hint about its recovery, if possible.

Error messages in measurement mode

In measurement mode, error messages may occur on account of inappropriate input signals or settings, thus disabling the display of measured values. Instead, the following hint is displayed in the window:

```
-INPUT ?-
Press SHOW I/O
```

Fulfilling this request by pressing the SHOW I/O key on the UPD front panel (or ALT + I on the keyboard) sets a graphics to show the currently active inputs/outputs (see 2.12) and a text giving information about why the display of measured values is not possible. If there are more than one message, the messages can be called one after the other by repeatedly pressing the SHOW I/O key. Messages issued more than 30 seconds ago are not displayed.

The UPD front-panel graphics is removed and the measurement mode is entered again when

- all messages have been read out and the SHOW I/O key is pressed again.
- CANCEL or ESC is pressed.

Fatal errors with error messages

Just in case an internal software error making it impossible for the UPD program to run should occur, which is never to happen, the DOS operating system is branched to. The following error message will be displayed.

"Save setup to C:\UPD\SETUP\UPD.SET and Exit to DOS!"
"Internal Error No. xxx -- press any key!" where xxx is the error number.

Before returning to the DOS operating system, the current setup and a fault diagnostics buffer including the error number xxx is stored from the battery-backed RAM of the UPD to the hard disk under the name C:\UPD\SETUP\UPD.SET.

You can facilitate troubleshooting for the R&S service personnel by including the UPD.SET file.

To this end, connect a keyboard to the UPD (see 1.1.6 Connecting an External Keyboard), insert a 3½ ”-disk into the disk drive and enter the DOS command:

```
COPY C:\UPD\SETUP\UPD.SET A:
```

When the UPD is put into operation again after a fatal error, the power-up picture includes the hint
”Error in prev. run! CANCEL → default setting, ENTER → previous setting”
offering you the following possibilities

- CANCEL: ... booting the UPD with its default setting
- ENTER: ... booting the UPD with the previous setting which might be faulty.

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Fatal errors without error message

In the case of a fatal error without error message, the UPD was no longer capable of storing the information which provides the above selection box when the UPD is put into operation again. Analogous to the above selection box, you can select between two ways of starting the UPD:

Booting the UPD with the setup most recently stored in the CMOS-RAM

This setup may be correct despite the faulty response of the UPD. To avoid having to re-enter the settings most recently input, try to start the UPD with this setup.

- Switch power switch off and on (no further action necessary).

In case the above attempt fails,

boot the UPD

Enter the following and terminate using ENTER:

UPD -d	The setup "DEFAULT SET" in the directory C:\UPD\SETUP supplied with the UPD is loaded.
UPD -s	The UPD is loaded with the setup indicated without space character subsequent to "-s". The file name should be combined with a path name, eg, -sA:\SETUP\MYSETUP\.SET OR -sC:\UPD\USER\MYSETUP.SET (The file names indicated are examples).

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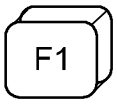
2.3.7 Help Function

Calling the HELP function:

UPD front panel



External keyboard

A HELP information can be called for any input field in the panels (context-sensitive). It is displayed in a window in the center of the screen. Depending on the size of the HELP information, waiting times of several seconds may occasionally occur, which is indicated by the note

Just a moment please!

If the HELP information extends the range provided in the window, paging is possible by way of the Page ↑ and Page ↓ keys. A scroll bar at the right margin of the window indicates the position of the visible text section with respect to the complete HELP information. Highlighted fields within the HELP information serve as cross-references for a more detailed description. Cross-reference information is selected using the ↑, ↓, →, ← keys and displayed using SELECT. The HELP window is used and scrolled in the same way as is a panel (see 2.3.1 Panels).

Requesting a HELP information stops the output of graphics.
Measurement results can still be output.

Selection of the language

The help text can either be displayed in German or English language. The languages can be selected in the OPTION panel under the menu item Language (cf. 2.15.4)

Help information on the graphics softkeys:

By calling the help function with active part or full display, the user obtains the help information on the graphics softkeys.

2.3.8 Simplification of Panels

The UPL and UPD menu lines are arranged in the same way in all the panels. This means the UPL or UPD user works in a familiar environment with any unit and in any setup.

However, this also has the effect that some menu lines – which are important for certain applications – are located down at the bottom outside the visible window. Vice versa, menu lines that may not be needed for the application on hand are located further up, taking up all the space in the visible range.

For this reason, the panels for particular UPL/UPD applications can be simplified by clearing the visible range from menu lines that are momentarily not required. Every panel can be modified such that the 18 most important menu lines are arranged in the upper range which is visible in the panel window.

When a menu line is eliminated, a new section labelled "Hidden Commands" appears at the end of the panel, which now contains the eliminated menu line. If several menu lines are eliminated, they will be arranged in this section in the same order as in the upper range of the panel. Of course, the hidden menu lines can still be used and may also be restored to their original positions whenever desired.

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Each menu line can be hidden and restored via the associated check box.

Action	Key on UPD keyboard	Key on external keyboard	UPD response
Hiding	BACKSPACE	BACKSPACE or DEL	Menu line is moved to "Hidden Commands" section
Restoring	BACKSPACE	BACKSPACE or INS	Menu line is moved back to original position

Note: *If all menu lines of a panel have been restored, the empty "Hidden Commands" section will disappear.*

If an external keyboard is connected, the "Hidden Commands" sections of the panels can be temporarily "hidden" by pressing CTRL H. This is not stored in the device setup, ie when the unit is started anew, the "Hidden Commands" are again visible. While the unit is on, the "Hidden Commands" are made visible again by pressing CTRL H a second time.

Note: *The status panel does not contain a "Hidden Commands" section. By pressing the BACKSPACE key, the menu lines in the original panel are hidden or restored. The status panel is reduced by switching off the tick for the menu lines that are currently not needed.*

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2.4 Units

There are two types of units available in the UPD:

- Units for the display of measurement results:
  Select a display unit for every measurement function in the ANALYZER panel. The measurement result will be displayed with this unit in the measured value window (see 2.3.3 Display of Measured Values). The unit is selected under the menu item “UNIT“ of the respective measurement function subsequent to opening the window.
- Units for the input of values via all 6 panels (eg reference values, frequencies, level etc.). While data are entered, all appropriate units are offered on the softkeys thus enabling termination of the value entry by selection of the unit. Opening of the selection window is not required (cf. 2.3.2.2, Entry of Numerical Data).

2.4.1 Units for the Display of Measurement Results

To simplify the matter

- the data to be entered are designated in the conversion formulae below with their unit, only.
  Example: "dBu" means: value in dBu.
- the conversions into µ, m, k, M are omitted

Units for analog level measurement results:

Functions: RMS & S/N, RMS SELECT, PEAK, QPEAK, DC and Input Disp: PEAK, Input Disp: RMS.
Basic unit: Volt (V[V])

Table 2-2

Value in	IEC/IEEE-bus notation	Conversion formula
V	V	
dBV	DBV	20 * lg (V)
dBu	DBU	20 * lg (V/0.7745967)
dBm	DBM	$10 * \lg (V^2*1000/R_{REF})$
W	W	V^2/R_{REF}
Δ%V	CPCTV	$(V/V_{REF}-1)*100$
ΔV	DV	$V-V_{REF}$
V/Vr	VVR	V/V_{REF}
%V/Vr	PCTVVR	$100 * V/V_{REF}$
Δ%W	DPCTW	$(((V^2/R_{REF})-P_{REF}) * 100)/P_{REF}$
ΔW	DW	$(V^2/R_{REF}) - P_{REF}$
P/Pr	PPR	$(V^2/R_{REF})/P_{REF}$
%P/Pr	PCTPPR	$(V^2/R_{REF})/P_{REF} * 100$
dB	DBR	$20 * \lg (V/V_{REF})$

R_{REF} = Value of reference impedance from ANALYZER panel

V_{REF} = Reference value from ANALYZER panel of functions RMS & S/N, RMS-SELECT, PEAK, QPEAK, DC or Input Peak measurement

P_{REF} = V_{REF}^2 / R_{REF}

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Units for digital level measurement results:

Functions: RMS & S/N, RMS-Select, PEAK, QPEAK, Input Disp: PEAK, Input Disp: RMS
Basic unit: Full Scale FS 0 to 1

Table 2-3

Value in	IEC/IEEE-bus notation	Conversion formula
FS	FS	
%FS	PCTFS	FS×100
dBFS	DBFS	20 × lg (FS)
Hex *)	HEX	FS×65535
Δ%	DPCT	$(FS/V_{REF}-1) \times 100$
dBr	DBR	$20 \times lg (FS/V_{REF})$
LSBs	LSBS	$FS \times 2^{audiobits-1}$
bits	BITS	$ld (FS \times 2^{audiobits-1} + 1)$

V_{REF} = Reference from the ANALYZER panel of the functions RMS & S/N, RMS-SELECT, PEAK, QPEAK, DC or Input-PEAK/RMS measurement

*) Level measurement result in hex
The full-scale value measured at the digital interface as the result of a digital analyzer function is displayed as a 6-digit hexadecimal number (6 digits = 24 bit = 23 bit mantissa +1 sign bit) in the measured value window, for example:

Table 2-4

FS value	Hex display
1.0	7FFFFF Hex
0.9	733333 Hex
0.5	400000 Hex
0.0001	000347 Hex
0.0	000000 Hex
-0.0001	FFFCB9 Hex
-0.5	C00000 Hex
-0.9	8CCCCD Hex
-1.0	800000 Hex

All digital analyzer functions provide FS values in the range from 0 to 1. Exception: the peak measurement functions PEAK & S/N and Q-PK & S/N may provide FS values < 0 or >1, irrespective of the PEAK mode selected. All values < -1 and >1 are displayed as 80000 hex and 7FFFFF hex, respectively.

FS values > 1 may occur

- with the function PEAK & S/N together with Meas Mode PK+, when applying a square signal. Being band-limited, overshoots at the edges (Gibb's phenomenon) occur, which, with peak evaluation, are included as part of the measurement result.
- with the measurement function PEAK & S/N together with Meas Mode PK to PK or PKabs.

FS values < 0 may occur

- with the function PEAK & S/N together with Meas Mode PK-.

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Units for analog and digital interference level measurement results:

Functions: THD, THD+N/SINAD, MOD DIST, DIM, DFD
Basic unit: %

Table 2-5

Value in	IEC/IEEE-bus notation	Conversion formula
%	PCT	
dB	DB	20 * lg ([%] * 100)

Unit for analog and digital S/N measurement results:

Functions: RMS, PEAK, QPEAK with S/N measurement on

Table 2-6

Value in	IEC/IEEE-bus notation	Conversion formula
dB	DB	20 * lg(S/N)

S: Measured level with generator on
N: Measured level with generator off

Units for analog and digital frequency measurement results:

Basic unit: Hz

Table 2-7

Value in	IEC/IEEE-bus notation	Conversion formula
Hz	HZ	
ΔHz	DHZ	$Hz-F_{REF}$
Δ%Hz	DPCTHZ	$100 * (Hz - F_{REF})/F_{REF}$
Toct *	TOCT	$lg (Hz/F_{REF}) * 9.96578$
Oct	OCT	$lg (Hz/F_{REF})/0.30103$
Dec	DEC	$lg (Hz/F_{REF})$
f/fr	FFR	Hz/F_{REF}

*) Toct = Third Octave
F_{REF} = Reference parameter from ANALYZER panel of frequency measurement

Units for phase measurement results:

Basic unit: degree

Table 2-8

Value in	IEC/IEEE-bus notation	Conversion formula
°	DEG	
RAD	RAD	$P[°] * (\pi/180)$
Δ°	DDEG	$P[°] - D_{REF}$
ΔRAD	DRAD	$(P[°] - D_{REF}) * (\pi/180);$

D_{REF} = Reference parameter from ANALYZER panel of phase measurement

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Units for group-delay measurement results:

Basic unit: s

Table 2-9 Units for group delay measurement results

Value in	IEC/IEEE-bus notation	Conversion formula
s	S	
Δs	DS	τ[s] - D_{REF}

D_{REF} = "Reference" parameter from the ANALYZER panel of the phase measurement

Unit for analog and digital wow & flutter measurement results:

Basic unit: %

Table 2-10 Analog and digital wow & flutter measurement results

Value in	IEC/IEEE-bus notation	Conversion formula
%	PCT	

Unit for digital jitter measurement results:

Basic unit: UI

Table 2-11 Unit for digital jitter measurement results

Value in	IEC/IEEE-bus notation	Conversion formula
UI	UI	
%UI	PCTUI	100 × UI
dBUI	DBUI	20 × log (UI)
ppm	PPMUI	10^6 × UI
ns	NS	10^9 × UI /(128 × sample frequency)
dBr	DBR	20 × log (UI/V_{REF})

Unit for digital phase measurement results (PhaseToRef):

Basic unit: UI

Table 2-12 Unit for digital phase measurement results

Value in	IEC/IEEE-bus notation	Conversion formula
UI	UI	
%FRM	PCTFRM	100 × UI / 128
°FRM	DEGFRM	360 × UI / 128
ns	NS	10^9 × UI /(128 × sample frequency)

The quantity of a fault caused by jitter and delay is normally specified in UI (unit interval). An UI is defined as the narrowest pulse width of the digital audio signal (eye width) and is independent of the selected sampling rate. UI corresponds to a clock period of the digital signal (biphase clock). With digital audio signals one UI corresponds to a 128th of the sampling period, in the case of 48 kHz one UI is approx. 163 ns.

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2.4.2 Units for Entry of Values

To simplify the matter

- the input values are designated only by the unit in the following conversion formulae.
  Example: "dBu" actually means "value in dBu".
- the conversions into µ, m, k, M have been left out.

Table 2-13 Absolute analog level units (without reference voltage)

Conversion formula		IEC/IEEE-bus notation
Vpp = depending on the generator function (see 2.5.4 for respective signal function)		VPP, VPP, UVPP
dBu = $20 * \lg (V/0{,}7746)$	$V = 0{,}7746 * 10^{(dBu/20)}$	DBU
dBV = $20 * \lg (V)$	$V = 10^{(dBV/20)}$	DBV
dBm = $10 * \lg (V^2 * 1000/R_{REF})$*)	$V = \sqrt{10^{(dBm/10)} * R_{REF} / 1000}$	DBM
W = V^2/R_{REF}	$V = \sqrt{(W * R_{REF})}$	W, mW, uW

*) Fixed reference impedance of generator R_{REF} = 600 Ω.

Table 2-14 Relative analog level units (with reference voltage)

Conversion formula		IEC/IEEE-bus notation
$\Delta V = V - V_{REF}$	$V = \Delta V + V_{REF}$	DV, Dm,V, DuV
$\Delta\%V = (V/V_{REF} - 1) * 100$	$V = V_{REF} * (1 + \Delta\%V/100)$	DPCTV
$V/Vr = V/V_{REF}$	$V = V/V_r * V_{REF}$	VVR
$\%V/Vr = V/V_{REF} * 100$	$V = \%V/Vr * V_{REF}/100$	PCTV/VR
$\Delta W = (V^2 - V_{REF}^2)/R_{REF}$	$V = \sqrt{(dW * R_{REF}) + U_{REF}^2}$	DW
$\Delta\%W = (V^2 - V_{REF}^2) * 100/V_{REF}^2$	$V = \sqrt{U_{REF}^2 * (\Delta\%W / 100 + 1)}$	DPCTW
$P/Pr = V^2/V_{REF}^2$	$V = \sqrt{P / Pr * U_{REF}^2}$	P/PR
$\%P/Pr = V^2/V_{REF}^2) * 100$	$V = \sqrt{\%P / Pr * U_{REF}^2 / 100}$	PCTPPR
$dBr = 20 * \lg (V/V_{REF})$	$V = 10^{(dBr/20)} * V_{REF}$	DBR
V/on = V/Burstamp[V]	V = V/on * Burstamp[V]	V/VON
%on = 100 * V/Burstamp[V]	V = %on * Burstamp[V]/100	PCTON
dBon = 20 * lg (V/Burstamp[V])	$V = 10^{(dBon/20)}$ * Burstamp[V]	DBON

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Table 2-15 Absolute digital level units (without reference)

Conversion formula		IEC/IEEE-bus notation
bits = - 3.322 * lg (FS)	FS = $\frac{2^{bits}-1}{2^{Audiobits}-1}$	FSBIT
%FS = 100 * FS	FS = %FS/100	PCTFS
dBFS = 20 * lg (FS)	FS = 10 $^{(dBFS/20)}$	DBFS
LSBS = FS * 2 $^{audiobits-1}$	FS = $\frac{LSBS}{2^{Audiobits}-1}$	LSBS

Table 2-16 Relative digital-level units (with reference)

Conversion formula		IEC/IEEE-bus notation
dBr = 20 × lg (FS/V_{REF}) 20 * lg (FS/V_{REF})	FS = 10 $^{(dBr/20)}$ ×* V_{REF}	DBR
Δ% = 100 × (FS/V_{REF} - 1)	FS = (Δ% / 100 + 1) × V_{REF}	DPCT
%on = 100 *× FSV/Burstamp[FS]	FS = %on ×* Burstamp[FS]/100	PCTON
dBon= 20 *× lg (FS/Burstamp[FS])	FS =10 $^{(dBon/20)}$ ×* Burstamp[FS]	DBON

Table 2-17 Absolute time units

Conversion formula		IEC/IEEE-bus notation
scyc = s * signal frequency	s = cyc / signal frequency	S, MS, USCYC, KCYC, MCYC
min = 60 s	s = min / 60	MIN
cyc = s * signal frequency	s = cyc / signal frequency	CYC, KCYC, MCYC

Table 2-18 Relative time units

Conversion formula		IEC/IEEE-bus notation
Δs = s -T_{REF}	s = Δs +T_{REF}	DS, DMS, DUS
min = 60 s	s = min / 60	MIN
cyc = s * signal frequency	s = cyc / signal frequency	CYC, KCYC, MCYC

Table 2-19 Absolute frequency units

Conversion formula	IEC/IEEE-bus notation
Hz	HZ, KHZ

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Table 2-20 Relative frequency units (with reference)

Conversion formula		IEC/IEEE-bus notation
$\Delta Hz = Hz - F_{REF}$	$Hz = \Delta Hz + F_{REF}$	DHZ, DKHZ
$f/fr = Hz / F_{REF}$	$Hz = f/fr * F_{REF}$	FFR
$\Delta\%Hz = 100 * (Hz - F_{REF}) / F_{REF}$	$Hz = \Delta\%Hz * F_{REF}/100 + F_{REF}$	DPCTHZ
$Toct^*) = lg (Hz/F_{REF}) * 9{,}96578$	$Hz = 2^{(Toct/3)} * F_{REF}$	TOCT
$Oct = lg (Hz/F_{REF}) * 3{,}32193$	$Hz = 2^{(Oct)} * F_{REF}$	OCT
$Dec = lg (Hz/F_{REF})$	$Hz = 10^{(Dec)} * F_{REF}$	DEC
*) Toct = third octave = Terz		

Table 2-21 Absolute phase unit

Conversion formula		IEC/IEEE-bus notation
rad = °· * (PI/180)·	° = rad * (180/PI)	RAD

Table 2-22 Relative phase unit

Conversion formula		IEC/IEEE-bus notation
$\Delta° = ° - D_{REF}$	$° = \Delta° + D_{REF}$	DDEG
Δ RAD = (° -D_{REF}) * (π / 180)·	° = (Δ RAD * 180 / π) +D_{REF}	DRAD

Table 2-23 Deviations (tolerance) compared to the previous measured values in the settling function (see 2.3.4 and 2.6.5.1

Conversion formula		IEC/IEEE-bus notation
$\% = (10^{dB/20} - 1) * 100$	$dB = 20 * lg (\%/100 - 1)$	DB, PCT

Table 2-24 Step size of a logarithmic level sweep

Conversion formula		IEC/IEEE-bus notation
$MLT = 10^{dB/20}$	$dB = 20 * lg (MLT)$	MLT, DB

Table 2-25 Absolute resistance unit

Conversion formula	IEC/IEEE-bus notation
Ω	OHM, KOHM

Legend:

FS:	Abbreviation for Full Scale = ratio 0 to 1
V_{REF}:	Level reference value in V or FS → *)
R_{REF}:	"Ref Imped" parameter from ANALYZER panel
F_{REF}:	Frequency reference value in Hz
Burstamp:	High level of generator burst signal, see 2.5.4.5, BURST
Signal frequency:	Frequency of generator burst signal or pulse signal, see 2.5.4.5 BURST, 2.5.4.6 SINE2BURST
D_{REF}:	Phase reference value in ×
MLT:	Multiplication factor (marked by "*" in the panel)

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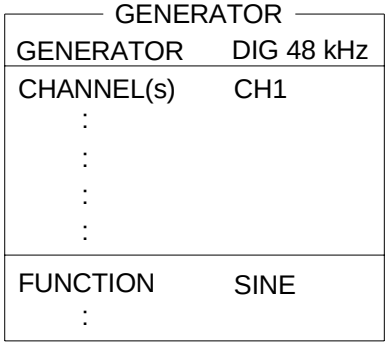
2.5 Generators (GENERATOR Panel)

Activating the GENERATOR panel:

- *UPD front panel*: GEN
- *External keyboard*: ALT + G
- *Mouse*: (repeated) clicking of the panel name, until the generator panel is displayed.

If the GENERATOR panel is already visible on the screen, it can also be activated by actuating one of the TAB keys (repeatedly) or by a mouse-click.
Advantage: The panel need not be established again.

The GENERATOR panel is always displayed on the left side of the screen and consists of configuration and function segments.



Select the analog or digital instrument.

Configuration segment for setting the outputs.
(output connectors, channel select, output impedance / sample frequency, oversampling factor, etc.)
see 2.5.2 Configuration of the Analog Generators
see 2.5.3 Configuration of the Digital Generators

Functions (waveforms) of the Generator, see 2.5.4

When changing the function (generator signal)

- the current function is stored to the hard disk;
- the desired function is loaded from the hard disk, initialized and started.

When changing the generator (eg from DIG48 to ANLG25)

- the current generator with all settings and the current function is stored to the hard disk;
- the desired generator with the currently active function is loaded from the hard disk, initialized and, if possible, started.

Note: *The "parameter link" function which can be selected in the OPTION panel may be used to influence the UPD with changes of function and instrument. As requested, existing settings in the function and/or configuration segment of the generator panel are accepted for the new function or instrument - if physically possible. A change of instrument from ANLG 110 to ANLG 25 kHz can be performed by way of example without the function and its frequency parameters changing in the panel.*

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2.5.1 Selecting the Generator

GENERATOR

The GENERATOR panel contains the settings for 2 analog and 3 digital generators. The instruments differ from each other in their frequency ranges and the possible functions (waveforms).

ANLG 25kHz	Two-channel analog generator, 2 Hz to 25 kHz
ANLG 110kHz	Two-channel analog generator, 2 Hz to 110 kHz
DIG 48kHz	Two-channel digital generator, 2 Hz to 21.934 kHz
DIG 192kHz	Two-channel digital generator, 2 Hz to 87.75 kHz
DIG 768kHz	Single-channel digital generator, 2 Hz to 351 kHz

The standard universal generator can be supplemented by the Low-distortion Generator option (UPD-B1) for sinewave generation in the analog ranges. The LOW DIST GEN can be used for sinewave signals (SINE) and for two-tone signals (DFD, DIM, MOD DIST).

Advantages:

- Low distortion (SINE)
- Enhanced signal quality for intermodulation signals (DFD, MOD DIST);
- Enables signal generation for analog dynamic intermodulation measurements DIM; (without low-dist. gen. possible in the digital range only).

The generator you select affects the following features in the instrument (apart from analog / digital switchover):

- ➢ maximum clock rate of generator in the digital range; with a fixed sample frequency (32 kHz, 44.1 kHz or 48 kHz), different oversampling factors are thus possible.
- ➢ single-channel / two-channel mode (see above)
- ➢ functions that can be generated (see Table 2-10)
- ➢ frequency resolution
- ➢ lengths of intervals with burst signals (see 2.5.4.5 SINE BURST and 2.5.4.6 SINE^2 BURST)

Frequency ranges of digital generator instruments:

The maximum generator output frequency is given by:

$$f_{max} = \text{Sample frequency} \times \text{oversampling factor} \times 117 / 256$$

The sample frequency and oversampling factor in the configuration segment of the GENERATOR panel are set using the menu items Sample-Frq and Oversamp, respectively.

Depending on the digital instrument selected, the following oversampling factors or external clock rates can be selected in the GENERATOR panel.

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Table 2-10 Possible oversampling factors

Instrument	Oversampling factors	Max. external clock rates	Multiplex possible
DIG 48 kHz	1	48 kHz	yes
DIG 192 kHz	1, 2, 4	192 kHz	yes
DIG 768 kHz	1, 2, 4, 8, 16	768 kHz	no

No oversampling factor can be selected for a sample frequency applied externally (see Section 2.5.3 Configuration of the Digital Generators).

Clock rates of digital GENERATOR instruments in single-channel mode and multiplex mode:

The internal clock rate is given by

$$f_{max} = Sample\ frequency \times oversampling\ factor \times 117 / 256$$

External clock rate (per channel)

$$f_{max} = Sample\ frequency \times oversampling\ factor \times 117 / 256$$

Table 2-11 Availability of the generator functions depending on the generator selected

Function/Generator	Analog		Digital		
	25 kHz	110 kHz	48 kHz	192 kHz	768 kHz
SINE	yes	yes	yes	yes	yes
MULTISINE	yes	yes	yes	yes	yes
SINE BURST	yes	yes	yes	yes	yes
$SINE^2$ BURST	yes	yes	yes	yes	yes
SQUARE	yes	no	yes	yes	yes
MOD DIST	yes	yes	yes	yes	yes
DFD	yes	yes	yes	yes	yes
DIM	with UPD-B1 only	no	yes	yes	no
RANDOM	yes	yes	yes	yes	yes
ARBITRARY	yes	yes	yes	yes	yes
POLARITY	yes	no	yes	no	no
FM	yes	no	yes	no	no

There are 3 states the active generator (visible in the panel) can assume (see Status Display, Section 2.3.4):

- RUNNING: Set function (generator signal) is output via the specified interface.
- BUSY: Generator output signal is calculated.
- HALTED: Generator is halted; the outputs are terminated.

RUNNING, ie a signal is constantly output, is the normal status of the generator. It is automatically restarted after having (re)set the generator.

The generator can be manually restarted at all times by recalling the generator or the function (open the respective selection window and confirm using ENTER). This may, eg, be required with burst signals, if a new interval is to be started, immediately.

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The setting of some signals (eg specific noise signals) involves a lot of computations. During this time, the generator does not produce any signal and is in the BUSY state. After having successfully concluded the computations, the generator automatically re-enters the RUNNING state. If further settings are made or keys are pressed during computation, the calculation is aborted and automatically restarted. The generator shortly enters the HALTED state.

Other reasons for halting the generator (HALTED):

- Faulty setting (eg wrong file name for an equalization or sweep list).
  Remedy: eliminate the cause of error; restart, if required.
- On the digital instruments:
  Applying a too high external frequency (generator is ”overrun”).
  Remedy: reduce the external clock frequency and restart.

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2.5.2 Configuration of the Analog Generators

The generator can be used as balanced or unbalanced source with one or two output channels. Various internal resistors are selectable - there is even the possibility of fitting an additional resistor in each output.

The complete generator is designed to be floating to frame potential. The banana jack plug GEN COM is connected to generator ground.

The below overview of possible settings is followed by substitute circuit diagrams showing the three different output circuits (unbalanced signal, balanced signal, or common-mode test signal).

Channel(s)

The deactivated channel is internally terminated with the set internal impedance. Crosstalk attenuation does not depend on the internal impedance set.

OFF	both channels off
1	channel 1 on, channel 2 off
2	channel 2 on, channel 1 off
2 ≡ 1	identical signal on both channels
2 ≡ -1	channel 2 inverted against channel 1

Output

With the use of BNC connectors, the XLR connectors are deactivated with high impedance and vice versa.

UNBAL	**BNC**	unbalanced signal	BNC connector(s)
BAL	**XLR**	balanced signal	XLR connector(s)
COMTST	**XLR**	common-mode test signal	XLR connector(s)

Impedance

Selection of the output impedance, if Output UNBAL has been selected

5 Ω
15 Ω
USER DEF

Impedance

Selection of the output impedance with Output BAL or Output COMTST selected

10 Ω
30 Ω
200 Ω
600 Ω
USER DEF

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Common

FLOAT GROUND

Floating generator ground
Generator ground connected to frame

Volt Range

The selection of the voltage range determines the setting of the generator output voltage.

AUTO

The internal signal paths are fully driven, the output voltage is set with the aid of the output amplifier.
Advantage:
Optimum noise and THD values with measurements at constant level, eg frequency sweep.

Enter a maximum voltage in the next menu line under "Max Volt"; higher voltages than the one specified here *are not permissible.*

FIX:

The output amplifier is set to the specified maximum voltage. The actual output voltage is obtained by means of small digital samples on the D/A converter. Setting the analog hardware is not required when the output voltage is changed. Thus voltage drops as may be caused by attenuator switching are avoided.
Advantage:
Fast level change and better transients in the case of measurements with small level changes, eg frequency sweep using an equalization file (this setting should be used for loudspeaker measurements).

Enter the numeric value of the voltage range in the next menu line; higher voltages than the one specified here *are not possible.*

***Note**:* *This setting is ignored when the Low Distortion Generator option (UPD-B1) is used. Level adjustment of the Low Distortion Generators is always performed using the AUTO algorithm.*

Max Volt

Limit value for output voltage; prevents inadvertent entry of too high voltage values.

The rms value for sinewave signals is entered, ie the peak value of Max Volt is higher by the factor $\sqrt{2}$.

Ref Freq

Reference value for the relative frequency units.
A change of the reference frequency causes all reference-related frequency inputs to change.
The relative frequency of the generator signal is retained.

Varying the reference frequency may thus shift the fundamental of a distortion spectrum set by means of multisine without the harmonics having to be recalculated and set again by the user, by way of example.

Ref Volt

Reference value for the relative voltage units.
A change of the reference level causes all reference-related voltage inputs to be changed.
The relative voltage of the generator signal is retained.

Varying the reference voltage may, eg, shift a level sweep defined by relative start and stop levels by a constant “gain factor“.

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2.5.2.1 Unbalanced Output (Output UNBAL)

The output signal is applied between internal and external conductor of the BNC female connector. The external conductors of both BNC female connectors are connected to generator ground GEN COM.

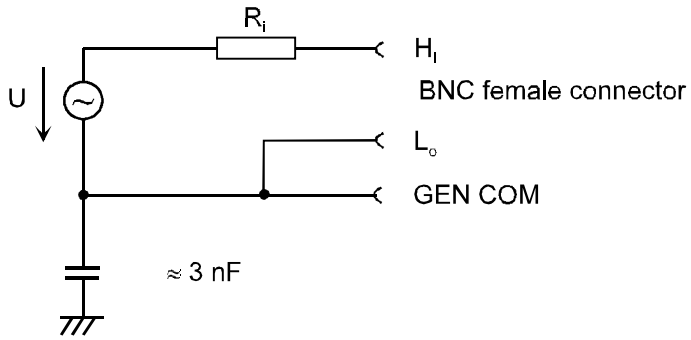
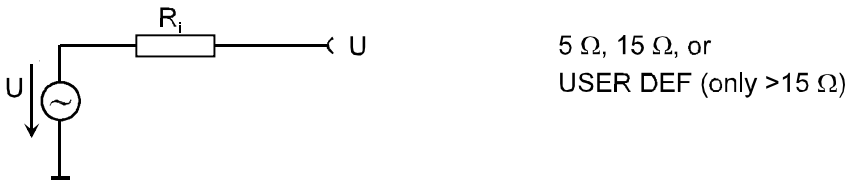


Fig. 2-12 Unbalanced output

Depending on the channel and impedance, the following output circuits are possible (capacitances are omitted):

Channel(s)
1 or 2



Channel(s)
2 = 1

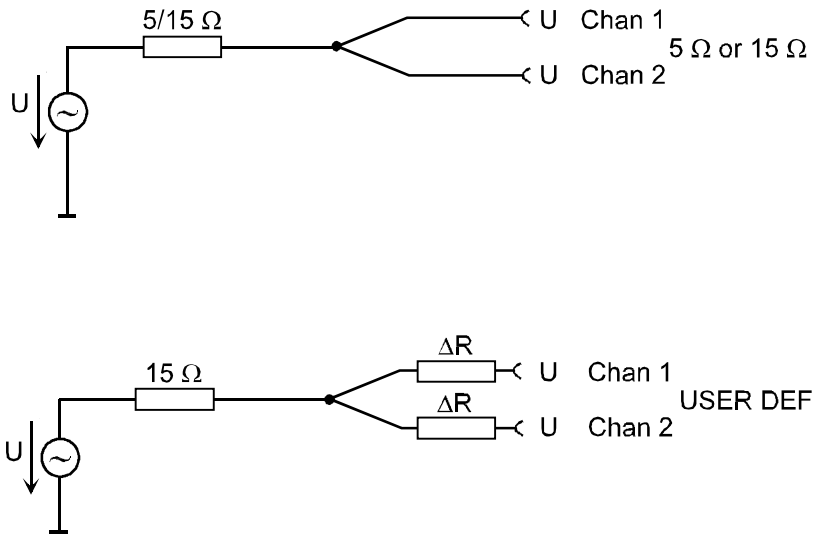


Fig. 2-13 Unbalanced output

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Channel(s)
2 = -1

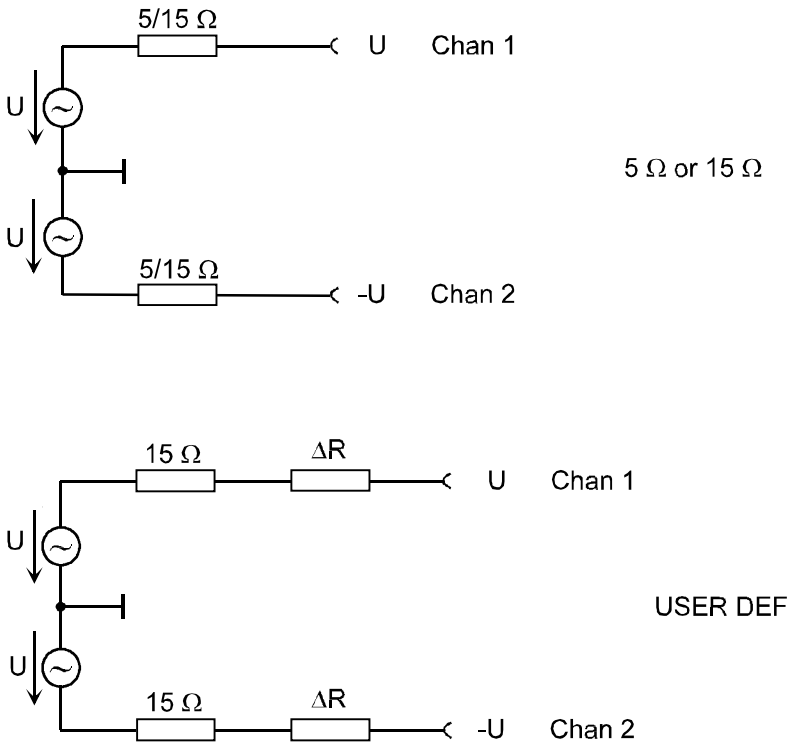

Fig. 2-14 Unbalanced output

2.5.2.2 Balanced Output (Output BAL)

The output signal is applied between contacts 2 and 3 of the XLR female connector. The source impedance is presented by two equal resistors, one in each signal line.

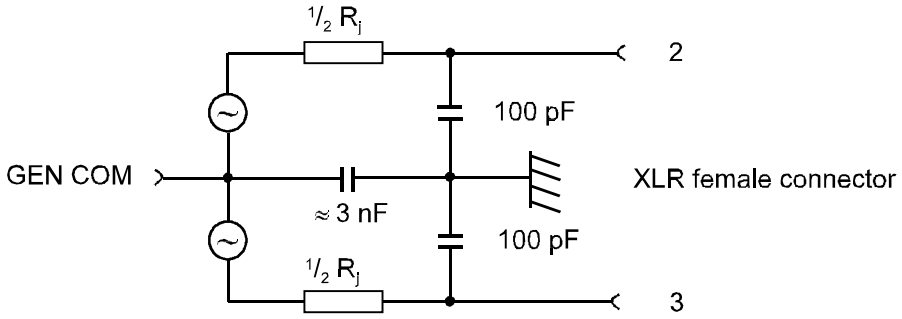

Fig. 2-15 Balanced output

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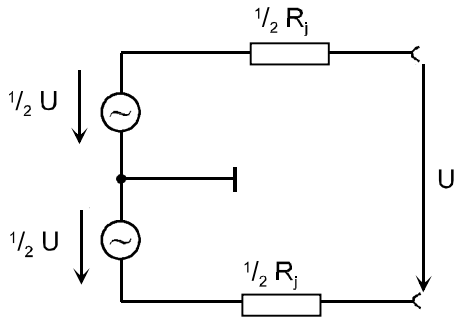
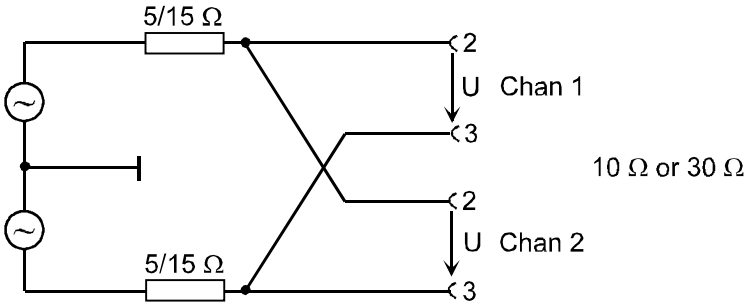
Depending on channel and impedance, the following output circuits are obtained.
(Capacitances are not included in the figure):

Channel(s)
1 or 2

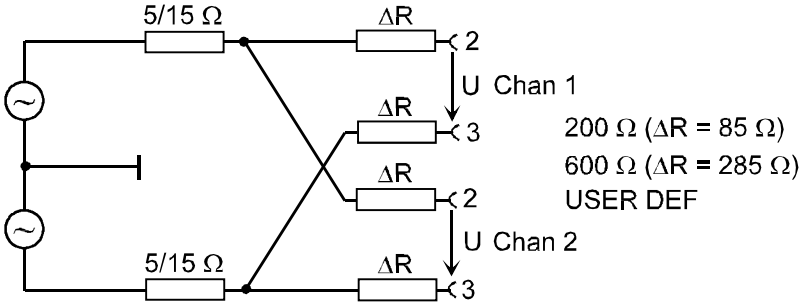


10 Ω, 30 Ω
200 Ω, 600 Ω
USER DEF (only > 30 Ω)

Channel(s)
2 = 1



10 Ω or 30 Ω



200 Ω (ΔR = 85 Ω)
600 Ω (ΔR = 285 Ω)
USER DEF

Channel(s)
2 = -1

With channel 2, pins 2 and 3 of the XLR female connector are exchanged.
The signal of channel 2 is inverted compared to channel 1,
otherwise as with channel(s) 2 = 1

Fig 2-16 Balanced output

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2.5.2.3 Balanced Output with Common-mode Test Signal (Output COMTST)

The same output signal is applied to contacts 2 and 3 of the XLR female connector. The reference is the generator ground GEN COM. The source impedance is made up of 2 equal resistors, one in each signal line. This configuration of the generator output is suitable for testing the common-mode rejection of balanced devices under test.

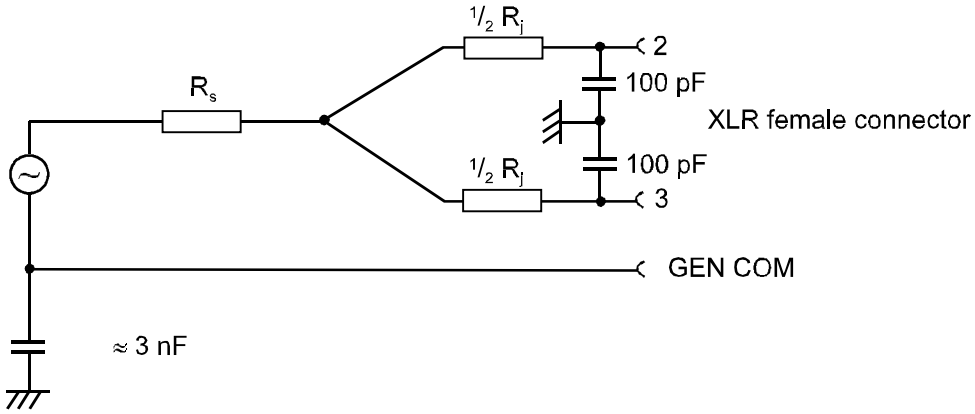

Fig. 2-17 Output with common-mode signal

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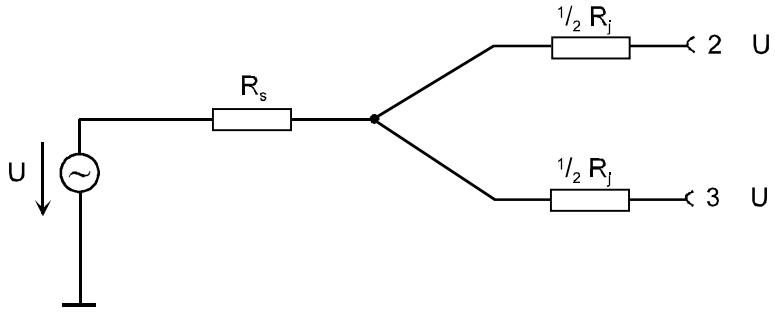
Depending on the channel and impedance, the following output circuits are obtained (capacitances are omitted):

The common source resistance R_S is:

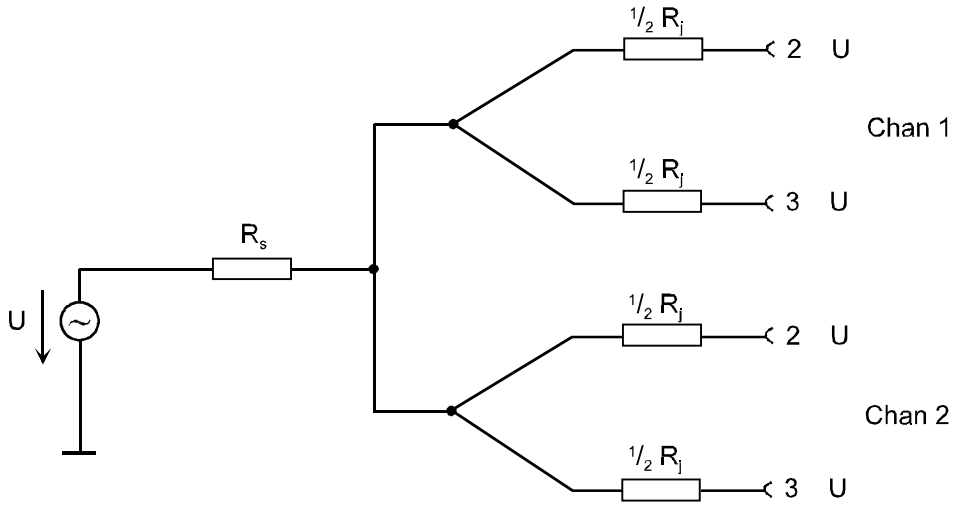
5 Ω, with R_i = 10 Ω

15 Ω with R_i = 30 Ω, 200 Ω, 600 Ω, USER DEF

Channel(s)
1 or 2



Channel(s)
2 = 1



Channel(s)
2 = -1

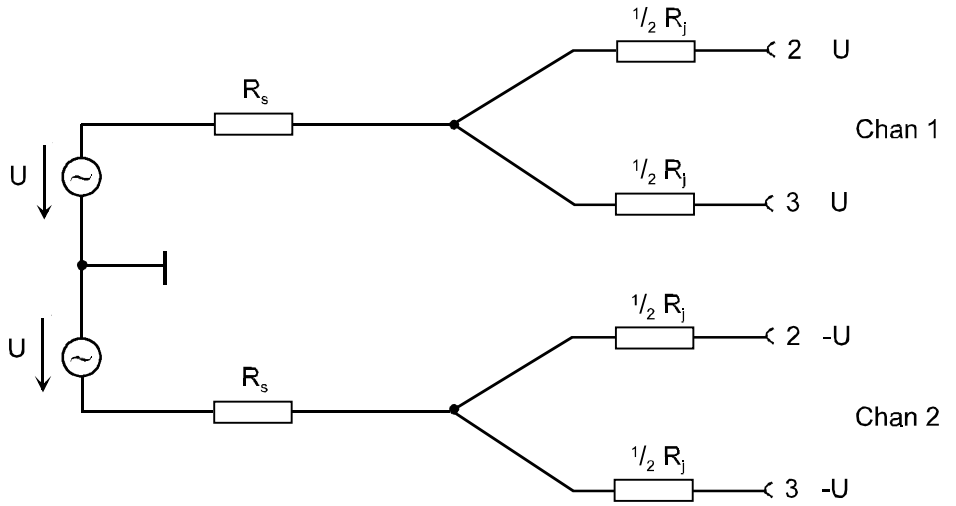


Fig. 2-18

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2.5.2.4 User-definable Resistors (USER DEF)

Special measurement spheres often require specific internal resistors.

Any additional internal resistance R_{user} can be implemented in both channels for both the balanced and the unbalanced output by fitting several resistors (ΔR) on the OUTPUT CIRCUIT board of the analog generator.

Note: *All modules are electrostatic sensitive devices. Handle them in line with ESD regulations.*

Equations:

UNBAL	$\Delta R = R_{user} - 15\Omega$
BAL:	$R = 0.5 \times R_{user} - 15\Omega$

Mounting:

- Switch off the UPD.
- Remove the top panelling and cover of the analog unit (to the right when seen from the front).
- Withdraw the OUTPUT CIRCUIT board (second next board to the center panel).
- Unscrew the cover from component side.
- Solder tags for fitting additional resistors (ΔR) are available on the board for both channels of the balanced and unbalanced output:

UNBAL:	channel 1: D R	between	X807, X808
	channel 2: Δ R	between	X907, X908
BAL:	channel 1: Δ R	between	X803, X804, and X805, X806
	channel 2: Δ R	between	X903, X904, and X905, X906

These special resistors can be different for the balanced and unbalanced outputs, they can even have different values in both channels.
Switch the user-definable resistors on by selecting USER DEF in the dialog box for impedance.

2.5.2.5 Output Power

The output amplifier, attenuator and all internal resistors are short-circuit proof. The peak current is limited to about 200 mA. With a maximum rms value of the output voltage of 24 V balanced and 12 V unbalanced, the maximum power loss in the load resistor (with a short-circuit in the internal resistor) is 3.4 W or 1.7 W.

Take this into account when dimensioning the user-definable resistors.
Delicate devices under test might be damaged or even destroyed by an output voltage inadvertently selected too high. For this reason, the maximum settable voltage can be limited (Max Volt).

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2.5.3 Configuration of the Digital Generators

2.5.3.1 Common Settings:

Src Mode

(Source Mode)
Displayed only when generator instrument DIG 48 kHz is selected.
States the values to be generated at the digital interfaces. A selection is only possible when the Jitter option (UPD-B22) is installed; without the option only audio data can be generated.

AUDIO DATA

Generates audio data without jitter. The audio signal is available at all digital interfaces.

***Note**:* *In the fast digital generators (DIG 192 kHz and DIG 768 kHz) only audio data can be generated. The menu item "Src Mode" is therefore not available.*

JITTER

An analog jitter signal is added to the audio data stream. All frequency and level settings are referenced to the jitter signal. The audio data content can be adjusted in addition using the auxiliary generator ("AUX GEN"). The jitter signal is only available at the digital interfaces AES / S/P DIF / OPTICAL.

PHASE

Same as JITTER, but here the frame phase of the audio data stream to the REF output (rear) can be adjusted instead of the audio data content. Due to the user selectable phase there are the following restrictions:

Sync To: GEN CLK only
Sync Out: ***not*** SYNC PLL
Ref Out: REF GEN only
Jitter Ref: ***not*** SYNC PLL (ANALYZER panel))

***Note**:* *Although a jitter signal is also generated with this menu item, PHASE should only be switched on if the selectable phase reference is required.*

COMMON ONLY

An analog signal is superimposed symmetrically onto the audio data stream on the two lines of the AES/EBU socket. All frequency and level settings are referenced to the analog common-mode signal; the audio data are constant. The common-mode signal is only available at the AES/EBU digital interface.

Channel(s)

OFF
1
2
2 ≡ 1
2 ≡ -1

Set the currently active output channel. This item is only displayed when the Src Mode AUDIO DATA is active. Since all other sources modes affect the digital data *stream* but not the data *content,* specifying a channel would be meaningless.

The exact meaning also depends on the interface used,
(see Table 2-24, Interfaces).

Note: *When using the PARALLEL output (not multiplexed) or the INTERNal connection, channel 2 cannot be selected. When the generator is switched to output channel 2, 2 ≡ 1 or 2 ≡ -1, the output interface PARALLEL MUX is automatically selected.*

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Output

SERIAL MUX
SERIAL
PARAL MUX
PARALLEL
AES/EBU
S/P DIF
OPTICAL
INTERN

This item is only displayed when the Src Mode AUDIO DATA is active. In all other source modes only the digital interfaces AES / S/P DIF / OPTICAL are active and cannot be individually selected.

The output interface can be selected from:
(see also Table 2-4)

Serial universal output, multiplex mode
Serial universal output
Parallel output, multiplexed
Parallel output
Digital interface, XLR
Digital interface, BNC
Optical interface
Interface to analyzer

Note: *With the jitter option (UPD-B22) installed, the four digital interfaces AES / S/P DIF / OPTICAL and INTERN are active simultaneously, if one of them is selected.*

The available interfaces (in Src Mode AUDIO DATA) depend on the instrument used:

- DIG48kHz: all interfaces in all modes
- DIG192kHz: AES, S/P DIF, OPTICAL, INTERN no longer selectable
- DIG768kHz: only SERIAL and PARALLEL in single-channel mode

Note: *If the jitter option (UPD-B22) is not installed and the digital analyzer is to measure via the internal connection, the INTERNal interface must also be selected in the digital generator.*

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Table 2-24 Overview of interfaces

Output	Channel	Explanation
SERIAL	OFF 1 2 2 ≡ 1 2 ≡ -1	No output Output on channel 1 Output on channel 2 Same output on both channels Normal output on channel 1, inverted on channel 2
SERIAL MUX4	OFF 1 2 2 ≡ 1 2 ≡ -1	No output Multiplexed output on channel 1 Only samples with wordselect = setting of WordselCh1 include audio data, samples on second channel: 0. Multiplexed output on channel 2 Only samples with wordselect unequal to setting of WordselCh1 include audio data, samples on second channel: 0. Multiplexed output Both channels include (equivalent) audio data. Multiplexed output Samples with wordselect = setting of WordselCh1 include non-inverted audio data, samples of second channel include inverted audio data.
PARALLEL	OFF 1 2 2 ≡ 1 2 ≡ -1	No output Output to parallel interface Not possible Not possible Not possible
PARAL MUX	OFF 1 2 2 ≡ 1 2 ≡ -1	No output Multiplexed output Only samples with wordselect = setting of WordselCh1 include audio data, samples on second channel: 0. Multiplexed output Only samples with wordselect unequal to setting of WordselCh1 include audio data, samples on second channel: 0. Multiplexed output Both channels include (equivalent) audio data. Multiplexed output Samples with wordselect = setting of WordselCh1 include non-inverted audio data, samples of second channel include inverted audio data.
INTERN	OFF 1 2 2 ≡ 1 2 ≡ -1	No output Output via internal connection to analyzer Not possible Not possible Not possible
AES/EBU S/P DIF OPTICAL	OFF 1 2 2 ≡ 1 2 ≡ -1	No output Output on channel 1 Output on channel 2 Same output on both channels Normal output on channel 1, inverted on channel 2

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Oversamp

1
2
4
8
16

(Oversampling)
Selectable with fast generators only
(DIG 192 kHz and DIG 768 kHz)

Set a clock multiplier; depending on the instrument 1 to 16 can be selected. See Table 2-24.

Note: *The oversampling factor refers to the full word length. Higher oversampling factors (eg 64) are often used with bit stream converters (1-bit-sigma-delta converters) which are normally controlled with an oversampling factor of 1. In this case oversampling is effected, for example, with the considerably higher bit clock (sample clock rate x word length).*

The ***internal sample clock rate*** is given by:

Sample clock rate = basic clock rate x oversampling factor x multiplex factor

The multiplex factor is 1 for normal signals and 2 for multiplexed signals.

The ***system clock rate*** (also referred to as ***sample rate***) is obtained by:

System clock rate = basic clock rate x oversampling factor

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Table 2-25

Instrument	Basic clock rate [kHz]	Multiplex possible	Oversampling possible factors
DIG48	32, 44,1, 48	yes	no
DIG192	32, 44,1, 48	yes	*2, *4,
DIG768	32, 44,1, 48	no	*2, *4, *8, *16

The maximum signal frequency is 117/256 x system clock rate.

An oversampling factor cannot be selected for an externally applied sample frequency, the internal sample clock rate matches the external one.

The two's complement (signed integer) is used as the **data format** for the serial and parallel interface .

Examples:	MSB,	... LSB:	0010000...0	=	+0.25	x	full scale
	MSB,	... LSB:	0111111...1	=	+1.00	x	full scale
	MSB,	... LSB:	1000000...1	=	-1.00	x	full scale
	MSB,	... LSB:	1100000...0	=	-0.50	x	full scale

(MSB = most significant bit)

Max Volt

This item is only displayed when the Src Mode AUDIO DATA is active.

Limit for the output voltage; prevents too high voltages being entered inadvertently.

Ref Volt

Reference value for relative voltage units.
A change of the reference level causes all reference-related voltage entries to be changed as well. The relative voltage of the generator signal remains unchanged.

For instance, by varying the reference voltage, a level sweep defined by means of relative start and stop levels can be shifted by a constant "gain factor".

Units (depending on Src Mode):

AUDIO DATA: FS | %FS | dBFS | Δ% | LSBs | dBr | bits

JITTER/PHASE: UI | %UI | dBUI | ppm | ns | UIr | dBr

COMMON ONLY: V | mV | µV | dBV | dBu

Note: *If the reference value is entered with a reference-related unit (eg "dBr"), the entered value is converted into the basic unit relative to the **previous** reference value and stored. This new reference value is then displayed in relation to the **new** reference value (eg "0 dBr"). Thus any reference value can be easily changed by any desired factor or dB value.*

Example: *0.174 FS - 10 dBr = 0.055 FS*

Ref Freq

Reference value for relative frequency units.
A change of the reference frequency causes all reference-related frequency settings to be changed as well. The relative frequency of the generator signal remains unchanged.
For instance, the fundamental of a distortion spectrum set by means of multisine can be shifted by varying the reference frequency without the harmonics having to be recalculated and set again by the user.

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2.5.3.2 Serial Universal Interface

The serial universal interface is available in all 3 digital generator instruments. In the generators DIG 48 kHz and DIG 192 kHz it can also be used in the multiplex mode. In this case the two channels (irrespective whether active or not) are output sequentially via the audio data line of channel 1 (Pin 10, see Table 2-26).

Sync To

(Generator synchronized to)
indicates the synchronization mode of the digital audio generator.

GEN CLK

Synchronization to internal clock generator.

EXTERN

Synchronization to an external clock applied to the generator via line SCLKIN (pin 4, see Table 2-26).
The sample rate of the external signal is to be explicitly specified in the next menu line.

Sample Frq

Setting the output sample rate.

32 kHz
44,1 kHz
48 kHz

If the generator is internally clocked,
("Sync To" GEN CLK)
a selection can be made between 3 fixed frequencies .

If the generator is externally clocked,
("Sync To" EXTERN)
the external sample frequency is entered here as a numeric value.

Important:
If the entered frequency does not correspond to the applied one, the frequency of all generated signals is shifted accordingly. The applied frequency must not exceed the maximum sample clock rate (48000Hz x max. permissible oversampling rate) of the selected instrument by more than 5% (with DIG768kHz by more than 2%), as otherwise faulty signals would be produced or the output aborted.

The minimum sample rate is 100 Hz.

Status indication: GEN: OVERRUN;

Remedy:
Restart the selected generator instrument by selecting it again.

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Wordlength

Set the data bits per output sample.

- **8** — 8 audio bits
- **16** — 8 to 16 audio bits
- **24** — 8 to 24 audio bits
- **32** — 8 to 28 audio bits; the other 4 bits are not used (bits 28 to 30) or needed for left/right identification (bit 31).

Wordoffset

(Word offset)
Set the position of the sync pulse (= word clock) or the Wordselect line (= WordselCH1) relative to the beginning of the sample data. Range: -word length/2 to +word length/2-1 (see Fig. 2-19). This setting changes the significance of the audio bits. Shifting the synchronizing pulse by one bit position in the direction of the MSB causes the signal amplitude to be "doubled". With a signal amplitude between 0.5 and 1.0 FS (full scale), a maladjusted word offset causes jumps in the signal!

Audio Bits

Word width of generated audio samples in bits.

The value range depends on the word length:

Word length	= 8:	8
	= 16:	8 to 16
	= 24:	8 to 24
	= 32:	8 to 28

If the word width is reduced, the values of the audio samples are rounded to the specified word width.

Note: *With a word length of 32, bits 28 to 30 are not used; bit 31 carries the left/right information (for multiplex operation).*

Wordclock

With SERIAL only
Set the polarity of the sync pulse.
The active edge of the word-clock signal (referenced to the beginning of the data) is rising or falling.

- **RISING**
- **FALLING**

Bitclock

Set the polarity of the clock used for the output of individual bits.

Note: *Faults in transmission (sporadic errors) may be caused by crosstalk.*
Remedy:
- ➢ *Terminating the lines*
- ➢ *Inverting the bit clock*

- **RISING**
- **FALLING**

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WordselCh1

(Word select channel 1) with SERIAL MUX only.
The SWSOUT line contains a squarewave signal of a frequency equal to the sample rate.

LOW When the data of channel 1 are output, SWSOUT = LOW

HIGH When the data of channel 1 are output, SWSOUT = HIGH

Frq Bitclock

(Frequency bit clock)
Display field only, cannot be changed.
Equation:
Bit clock = word length x sample clock rate (see above)

Bit Order

Set the bit order:

LSB FIRST The least significant bit is output first.

MSB FIRST The most significant bit is output first.

Terminal conditions:

All outputs are operated by ICs of the 74AC-family via a protective resistor of 22 Ω and are thus temporarily short-circuit-proof. If the short-circuit is too long, the driver IC is overheated and may fail.

Fast switch-off:

Pressing the OUTPUT OFF key causes all outputs (except for OUT5V) to be switched to high impedance (TRI-STATE). When the OUTPUT OFF key is pressed once more, the audio signals are again connected to the outputs.

Table 26 Pin assignment and signals (serial universal interface)

Signal name	Pin	Remark
GND OUT5V GND	7.8 12 1.2	5 V, 50 mA
Channel 1: SCLK SDATAA SWSA	 9 10 11	Channel 1: (with SERIAL MUX: 1&2) Output, bit clock Output, audio data Output, sync pulse (word clock) by MUX: wordselect
Channel 2: SCLK SDATAB SWSB	 15 14 13	Channel 2: Output, bit clock Output, audio data Output, sync pulse (word clock)
SCLKIN SWSOUT	4 6	Input, external bit clock Output, wordselect with SERIAL MUX (Frequency = audio clock)

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Setup + hold times:

Serial data are stable >5 ns before the clock edge and >10 ns after the clock edge.

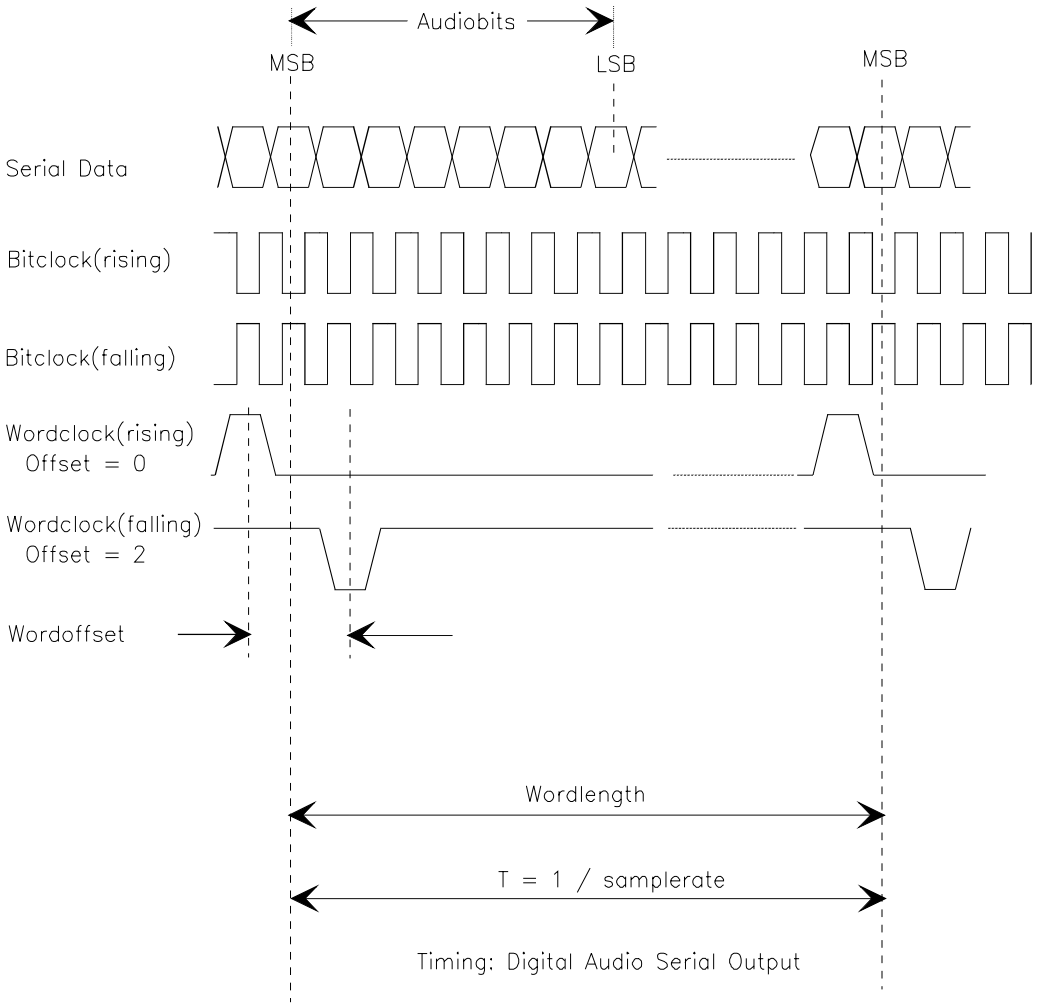

Fig. 2-19

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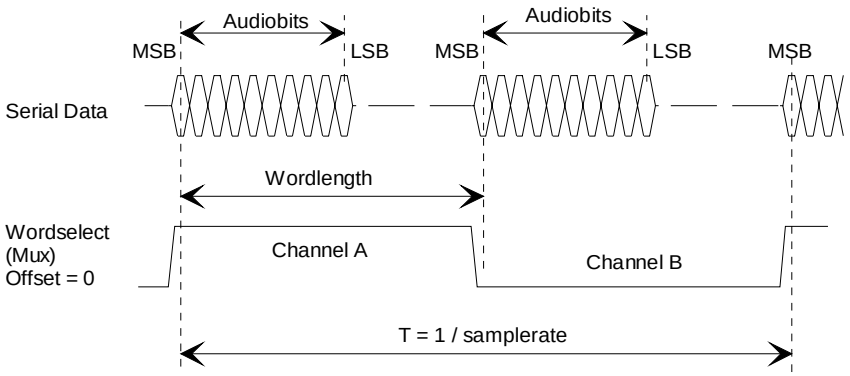

Timing: Digital Audio Serial Mux Input/Output

Fig. 2-20

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2.5.3.3 Parallel Interface

The parallel interface is a 37-contact sub-D connector at the rear of the instrument, labelled DIGITAL AUDIO OUTPUT.

It is available in all three digital generator instruments; in generators DIG 48 kHz and DIG 192 kHz it can also be used in the multiplex mode. In this case the audio data of the two channels (whether are active or not) are output successively via the audio data pins of the Sub-D connector.

Sync To

(Generator synchronized to)
indicates the synchronization mode of the digital audio generator.

GEN CLK

Synchronization to external clock generator.

EXTERN

Synchronization to an external clock signal applied to the generator via the EXSTRBIN line (pin 36, see Table 2-27).
The sample rate of the external signal is to be explicitly specified in the next line.

Sample Frq

Set the Output sample rate.

32 kHz
44,1 kHz
48 kHz

If the generator is internally clocked,
("Sync To" GEN CLK)
a selection can be made between three fixed frequencies.

If the generator is externally clocked,
("Sync To" EXTERN)
here the external sample frequency is entered here as a numeric value.

Important:
If the entered frequency does not correspond to the applied one, the frequency of all generated signals is shifted accordingly. The applied frequency must not exceed the maximum sample clock rate (48000Hz x max. permissible oversampling rate) of the selected instrument by more than 5% (with DIG768kHz by more than 2%), as otherwise faulty signals would be produced or the output aborted.

The minimum sample rate is 100 Hz.

Status indication: GEN: OVERRUN;

Remedy:
Restart of selected generator instrument by selecting it again.

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Audio Bits

Word width of generated audio samples in bits.

Value range: 8 to 28

If the word width is reduced, the values of the audio samples are rounded to the specified word width.

WordselCh1

(Word select channel 1)
(This setting is displayed with PARAL MUX only). Set the assignment of channel 1 with PARAL MUX:

LOW

HIGH

LOW: channel 1 is assigned low level on the LR line.

HIGH: channel 1 is assigned high level on the LR line.

LR (pin 34) is the control line which identifies left and right in multiplex operation.

Wordclock

Set the polarity of the strobe signal, for more details refer to Timing. (Fig. 2-15)

RISING

FALLING

Terminal conditions and fast switch-off: as with serial interface

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Table 2-27 Pin assignment and signals (parallel interface)

Signal name	Pin	Remarks
GND	16	
OUT5V	17	5V, 50 mA
GND	19	
GND	18	
Digital Audio Bit 27 (MSB)	2	Output
Digital Audio Bit 26	3	
Digital Audio Bit 25	4	
Digital Audio Bit 24	5	
Digital Audio Bit 23	6	
Digital Audio Bit 22	7	
Digital Audio Bit 21	8	
Digital Audio Bit 20	9	
Digital Audio Bit 19	10	
Digital Audio Bit 18	11	
Digital Audio Bit 17	12	
Digital Audio Bit 16	13	
Digital Audio Bit 15	14	
Digital Audio Bit 14	15	
Digital Audio Bit 13	20	
Digital Audio Bit 12	21	
Digital Audio Bit 11	22	
Digital Audio Bit 10	23	
Digital Audio Bit 09	24	
Digital Audio Bit 08	25	
Digital Audio Bit 07	26	
Digital Audio Bit 06	27	
Digital Audio Bit 05	28	
Digital Audio Bit 04	29	
Digital Audio Bit 03	30	
Digital Audio Bit 02	31	
Digital Audio Bit 01	32	
Digital Audio Bit 00 (LSB)	33	Output
LR (Wordselect)	34	Output, with PARA MUX only
PSTROBE	35	Output, clock, polarity selectable
EXSTRBIN	36	Input, external strobe (audio clock)
not connected	37	

Important: *Always connect external devices adjusted to MSB, as otherwise the MSBs are extended with incorrect signs.*

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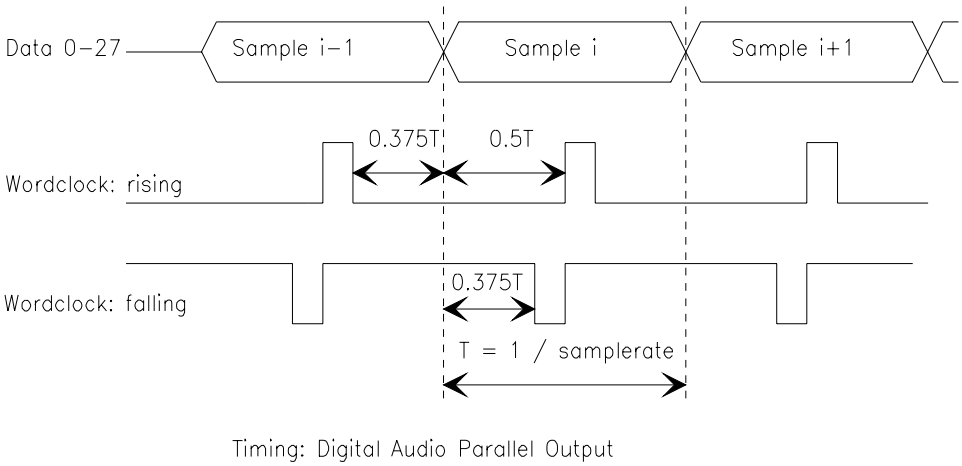

Timing: Digital Audio Parallel Output

Fig. 2-21

2.5.3.4 Digital Interfaces AES / S/P DIF / OPTICAL

Outputs via these interfaces are only possible if option UPD-B2 (AES/EBU) is installed and the generator instrument DIG48kHz is selected.

The audio data produced by the digital generator are transferred to option UPD-B2, where the necessary supplementary bits (validity, parity, user bits, ... ; see Section 2.5.3.4.4, AES/EBU Protocol Definition) are added.

When the Jitter option UPD-B22 is installed in addition,

- a jitter signal can be generated on all three interfaces,
- the phase relation between digital output and reference output can be set as required in addition to the generation of a jitter signal,
- or a common-mode signal can be generated on the AES/EBU output.

Audio Bits

This item is only displayed if Src Mode AUDIO DATA is active. Word width of generated audio samples in bits.

Value range: 8 to 24

If the word width is reduced, the values of the audio samples are rounded to the specified word width.

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2.5.3.4.1 Configuration *without* Jitter Option

Sync To

(Generator synchronized to)
indicates the synchronization mode of the digital audio generator.

AUDIO IN

Synchronization to audio input signal.
The clock rate of the analyzer is entered (in next menu line) and updated in the case of changes.

WORDCLK INP

Synchronization to an external word clock signal applied to the generator via the BNC connector at the rear of the instrument.
The sample rate of the external signal is to be explicitly specified (in the next menu line).

GEN CLK

Synchronization to external clock generator.
The fixed-frequency sample rate of the internal clock generator can be selected (in the next menu line).

Sample Frq

Set the output sample rate.
Depending on the synchronization selected in the generator menu line "Sync To", the following sample rates can be selected:

32 kHz
44.1 kHz
48 kHz

The three fixed frequencies can be selected if the generator is internally clocked. This is selected with the menu line
"Sync To" GEN CLK.

If the generator is synchronized to the analyzer,
("Sync To" AUDIO IN),
the analyzer sample frequency is entered here as a numeric value.

If the generator is externally clocked,
("Sync To" WORDCLK INP)
the numeric value of the external sample frequency is entered.

Important:
If the entered frequency does not correspond to the applied one, the frequency of all generated signals is shifted accordingly. The applied frequency must not exceed the maximum sample clock rate (48000Hz x max. permissible oversampling rate) of the selected instrument by more than 5% (with DIG768kHz by more than 2%), as otherwise faulty signals would be produced or the output aborted.

Status indication: GEN: OVERRUN;
Remedy:
Restart the selected generator instrument by selecting the generator again.
Note: *The selected sample rate can be automatically transferred to the channel status bits provided the channel status file used or the "panel file" contains the necessary key words (see* **2.5.3.4.4 AES/EBU Protocol Definition**). *The supplied example files with the extensions *.PGC and *.PPC are configured correspondingly. When the panel file is used, the user may select in the protocol menu of the GENERATOR panel whether the rate should be automatically transferred (GEN SMPLFRQ rate) or whether a fixed sample rate is to be entered in the channel status bits.*

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S/P DIF V_{pp}

Appears only if the digital signal S/P DIF has been selected.

Set the output voltage of the digital S/P DIF signal.
(Peak-to-peak voltage when terminated with a nominal impedance of 75 Ω).

The voltage is twice as high in open-circuit operation.

Setting range: 10 mV to 1.5 V

AESEBU V_{pp}

Appears only if the digital signal AES/EBU has been selected.

Set the output voltage of the digital AES/EBU signal.
(Peak-to-peak voltage when terminated with a nominal impedance of 110 Ω).

The voltage is twice as high in open-circuit operation.

Setting range: 20 mV to 5.1 V

2.5.3.4.2 Configuration *with* Jitter Option (UPD-B22):

PhaseToRef

Appears only when Src Mode PHASE is selected.
Set the frame phase between the digital audio output and the REF output (at the rear).
Value range: -64 UI to +64 UI (corresponds to -180º to +180º).
Units: UI | %FRM | ºFRM | ns

S/P DIF Out

Indicates the data available at the S/P DIF output.

AUDIO OUT

The *generated* AUDIO data are present (as at the AES/EBU and optical outputs).

AUDIO IN

The *received* digital AUDIO data (from the AES/EBU or S/P DIF input) are present (front panel). For example, an oscilloscope may be connected to this output to analyze the input signal.

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Cable Sim

(Cable simulation)
A cable length can be simulated at the AES/EBU or the S/P DIF output.

OFF Cable simulation switched off.

LONG CABLE The simulation of a cable of approx. 100 m length is switched on for both electrical outputs.

SHORT CABLE The simulation of a short cable with a length of only a few meters is switched on for both electrical outputs.

***Note**:* *Cable simulation is also effective when the AUDIO IN signal is applied to the S/P DIF output.*

Sync To

(Generator synchronized to)
Indicates the synchronization mode of the digital audio generator. Depending on the active "Src Mode", some of the items cannot be selected.

AUDIO IN Synchronization to audio input signal;
not possible with JITTER ONLY or PHASE.

REF IN Synchronization to REF input signal (XLR connector at the rear);
not possible with PHASE.

SYNC IN Synchronization to SYNC input signal (BNC connector at the rear)
not possible with JITTER ONLY or PHASE.

GEN CLK Synchronization to internal clock generator which is able to generate either one of the three fixed frequencies or a user-defined one.

Sync Mode

Displayed only if the generator is synchronized to the SYNC input (rear). Indicates the sync mode used.

VIDEO 50 The sample frequency is synchronized to a 50 Hz refresh rate (Europe).

VIDEO 60 The sample frequency is synchronized to a 60 Hz refresh rate (USA).

Note: *With VIDEO 50 and VIDEO 60 a corresponding composite video signal must be present at the SYNC input.*

1024 kHz The sample frequency is synchronized to a 1024 kHz reference signal.

WORD CLK The sample frequency is synchronized to the word clock signal at the SYNC input.

WRD CLK INV The sample frequency is synchronized to the inverted word clock signal at the SYNC input.

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Sample Frq

Set the output sample rate .
Depending on the synchronization selected in the generator menu line "Sync To" the following sample rates are possible:

32 kHz
44.1 kHz
48 kHz

The three fixed frequencies can be selected when the generator is internally clocked or synchronized via the SYNC IN connector. This is selected with menu line
"Sync To" GEN CLK or SYNC IN.

VALUE

To be able to enter a user-defined value, the generator has to be internally clocked:
"Sync To" GEN CLK

EXTERN

An external clock can be entered as numeric value when the generator is synchronized via the SYNC IN with a (possibly inverted) word clock signal or via the REF IN connector:
"Sync To" SYNC IN or REF IN
"Sync Mode" WORD CLK or WORD CLK INV

Important: *If the entered frequency does not correspond to the frequency applied, the frequency of all generated signals is shifted accordingly. The applied clock rate must be between* ***30 kHz and 52.5 kHz****. Exceeding these limits may cause the synchronization to be lost or the generator processor to be "overrun".*

Status indication: GEN: OVERRUN;

Remedy:
Restart the generator instrument by selecting it again.

SYNC TO ANL

If the generator is synchronized to the analyzer input signal, this selection item is displayed. The item cannot be changed. Synchronization to the analyzer is determined by the menu line
"Sync To" AUDIO IN.
In this case the numeric value of the sample frequency is transferred to the ANALYZER panel and cannot be changed in the generator.

Note: *The selected sample rate can be automatically transferred to the channel status bits provided the channel status file used or the "panel file" contains the necessary key words (see* gaesprot*). The supplied example files with the extensions *.PGC and *.PPC are configured correspondingly. When the panel file is used, the user may select in the protocol menu of the GENERATOR panel whether the rate should be automatically transferred (GEN SMPLFRQ rate) or whether a fixed sample rate is to be entered in the channel status bits.*

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Sync Out

Indicates the clock signal applied to the SYNC output (BNC connector at the rear).

- **AUDIO IN** — Digital AUDIO input signal (instrument front).
- **REF IN** — REF input signal (XLR connector at the rear);
- **SYNC PLL** — Signal from external synchronization PLL (eg input signal without jitter)
- **GEN CLK** — Internal generator clock

Type

Indicates the SYNC OUT signal type

- **WORD CLK** — Word clock signal (sample frequency)
- **BIPHASE CLK** — Biphase clock signal (128 times the sample frequency)

Ref Out

Determines the signal applied to the REF output (XLR connector at the rear).

- **AUDIO IN** — (Buffered) AUDIO input signal
- **AUD IN RCLK** — AUDIO input signal reclocked via the internal sync PLL.
- **AUDIO OUT** — Generated AUDIO signal (same as on the instrument front)
- **REF GEN** — Generated reference signal that can be defined as constant low (ALL ZERO) or constant high (ALL ONE) in the "Data" menu line below.

Data

Displayed only with REF GEN selected as REF OUT signal.
Defines the audio data output at the REF OUT output (XLR connector at the rear).

- **ALL ZERO** — All data bits are *re*set (low level)
- **ALL ONE** — All data bits are set (high level)

S/P DIF Vpp

Set the output voltage of the digital signal at the S/P DIF interface.
Peak-to-peak voltage when terminated with the nominal impedance (75 Ω); the voltage is twice as high in the case of open-circuit operation.

Setting range: 0 mV to 2.125 V; resolution 8.33 mV

Note: *The voltage at the AES/EBU interface is always 4 times as high as the voltage selected here.*

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AESEBU Vpp

Set the output voltage of the digital signal at the AES/EBU interface. Peak-to-peak voltage when terminated with a nominal impedance of 110 Ω; the voltage is twice as high in open-circuit operation.

Setting range: 0 mV to 8.5 V

Note: *The voltage at the S/P DIF is always ¼ of the voltage selected here.*

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2.5.3.4.3 Generating Jitter, Phase and Common Mode

With digital audio interfaces there are two types of signals that have to be measured, eg in the course of a quality check. One is the digitally coded analog signal, the other the digital signal. The digital signal, too, has analog parameters such as peak-to-peak voltage, frequency, etc. It may be subject to interference like an analog signal. This means that noise or other AC voltages may be superimposed which might cause the edges to be shifted, for instance. This effect is called jitter and, if it is large enough, the audio signal can no longer be decoded or regenerated correctly. To examine the compatibility to jitter, an exactly defined interference signal which can be generated by the UPD generator is required.

The lines for the signal connections can be configured as balanced lines, which is quite usual in analog technology. Thus, coupled-in interference, eg from ground (hum) loops should be ineffective. However, in practice this attenuation is not always sufficient so that a common-mode voltage from a certain value upwards may also prevent signal decoding and regeneration. The UPD can generate this common-mode voltage on the digital signal for testing instruments. Of course, a common-mode signal cannot be generated on the unbalanced and the optical output.

The UPD can thus generate and simulate two types of interference of digital audio signals: a specific shift of the signal slopes (jitter) and the superposition of a common-mode voltage on digital lines. The internal analog generator is available for generating these interfering voltages. The sine and noise functions (arbitrary and random) are particularly suited for practical applications.

With a number of applications it is desirable to measure also the audio content of the signal in addition to the jitter, ie to produce an audio signal containing jitter. Thus the effect of the interference on the audio signal can be directly measured. UPD offers an operating mode for this case too. In the source mode JITTER, a sinusoidal audio signal (AUX GEN) can be defined, the frequency and level of which can be adjusted.

Jitter and delay are normally specified in UI (unit interval). UI is defined as the smallest pulse width of the digital audio signal (eye width) and is independent of the selected sampling rate. An UI corresponds to the clock period of the digital signal (biphase clock). With digital audio signals, one UI corresponds to a 128th of the sampling period, at 48 kHz it is approx. 163 ns.

If several, digitally coded signals have to be combined, as is commonly done in studios for instance, the concurrence of the signals is also of importance. Associated frames containing the instantaneous values (samples) of the left and the right channel must not be delayed such that they can no longer be combined. UPD is able to simulate this error by rendering the phase between the digital output on the front panel and the independent reference generator (output at the rear) adjustable. This refers to the phase within a frame (64 bit or 128 UI).

Even with a highly accurate clock-frequency generation of the individual instruments, the frequencies will inevitably start to shift with respect to each other, which is at first noticed as a phase offset (see above). As a result individual samples are omitted or doubled. This effect can be avoided by distributing a frame sync or word clock to all instruments for synchronization, or to synchronize all instruments to a common clock frequency (eg 1024 kHz or the video sync pulses). Hence, if the UPD is to behave like an ideal source of digital signals, it must be integrated in this synchronization concept. It can therefore be synchronized via the SYNC IN connector at the rear of the instrument to the signals selected by means of the "Sync Mode" command.

In addition to the method described above, the generator can also be synchronized to the digital signal at the analyzer input using a clock frequency. A distinction has to be made however between the input on the front panel and the input of the reference receiver on the rear panel. The generator can also be operated with its own crystal oscillator.

The selected mode (PHASE, JITTER ONLY or COMMON ONLY), ie the superimposed interference voltage always refers to the digital output on the front panel. The reference generator (output on the rear) is used as a reference. If the generator is operated with external synchronization (‘Sync To’ not set to GEN CLK), the reference corresponds to the synchronization. The synchronization output ("sync out" at the rear) is as always without jitter or phase shift.

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2.5.3.4.4 AES/EBU Protocol Definition

Selection of the generator output AES/EBU, S/P DIF or OPTICAL causes an additional PROTOCOL section to be displayed in the GENERATOR panel. This section combines all commands for the definition of protocol information (channel status data, user data, validity, parity).

Note: *On the rear panel, there is the BNC female connector WORDCLOCK OUT" to which a TTL signal is applied with the sample frequency. The left channel (1) is identified with low, the right channel (2) with high.*

PROTOCOL — Determines the entry of protocol information.

PANEL OFF	Channel status data cannot be entered. The last-defined status is maintained; only the display in the panel is switched off. If the generated channel status data are of no interest, all unwanted menu lines can thus be removed from the GENERATOR panel.
ENHANCED	The full protocol data generation can be entered and is displayed in the GENERATOR panel.

Validity — Set the validity identification within the AES-EBU data stream.

NONE	Validity bit not set
1	Validity bit set in channel 1 only (= left, A)
2	Validity bit set in channel 2 only (= right, B)
1&2	Validity bit set in both channels

Parity — Specify whether the protocol is generated with parity errors.

TRUE	All samples are generated with the correct parity.
WITH ERR	Setting the error rate with commands No. Trues, No. Falses and Offset.

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No. True

Specify the number of samples with correct parity bit.

Numerical entry from 100 to 1,000,000

Information on the definition of parity errors:
A number of samples with correct parity bit (offset) is output first. Then a cyclical sequence consisting of a number of samples with false parity bit (No. False) is output followed by a number of samples with correct parity bit (No. True). "True" and "False" are repeated alternately.
The numbers refer to the sum of L and R samples.

Applications:

- If the sum of No. True and No. False is equal to 384, the positions of the parity errors within a block can be determined using Offset.
- A very large offset can be used to ensure reliable settling of the test hardware.

No. False

Specify the number of samples with false parity bit .

Numerical entry from 0 to 1000

With the setting 0, only correct parity bits are output.

Offset

Specify the number of samples with correct parity bit until the first parity error occurs.

Numerical entry from 0 to 1000000

For more details refer to No. True.

Block Err

Specify the interval (in blocks) at which errors in the start-of-block-preamble sequences are generated.

Numerical entry from 0 to 100000

0: no error, all start-of-block preambles are correct.
1 to 100000: After the specified number of samples, a start-of-block preamble is replaced by a normal "left" preamble (missing start of block).

Sequ. Err

Specify the interval (in blocks), at which errors in the preamble sequence are generated.

Numerical entry from 0 to 10000

0: no error, all preambles are correct.
to 10000: A block with a sequence error is generated at every specified interval of blocks. For this reason each 48th preamble in this block is replaced by a right one. The sequence " L R R R L" is generated instead of the sequence " L R L R L". This inverted sample has the status information and the audio data of the corresponding left channel, only the preamble is inverted.

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Ch Stat. L

Define how the channel status data LEFT are generated. This also includes the operating mode (AES3, CRC or RAW), which has to be the same for left and right channel. If neither AES3 nor CRC is defined for the left channel, any operating mode can be selected with menu line Ch Stat. R.

ZERO

All channel status data bits are 0. The operating mode (AES3, CRC, RAW) is defined with command Ch Stat. R.

FILE + AES3

UPD generates local timecode and CRC, all other channel status data are defined using the following file.

PANEL + AES3

UPD generates local timecode and CRC, all other channel data are set using the panel defined by the "Panelfile" file.

FILE + CRC
PANEL + CRC

As FILE + AES3 or PANEL + AES3, but UPD but local timecode is not generated by the UPD put a fixed setting.

FILE PANEL

As FILE + AES3 or PANEL + AES3, but UPD generates neither timecode nor CRC (RAW mode).

The setting that can be made here affects Ch Stat. R. Any settings under Ch Stat. R that are incompatible with the selection made here causes a corresponding error message to be output and the setting to be rejected.

The following restrictions apply:

- PANEL (= user definable generator commands) can only be used with Ch Stat. L or Ch Stat. R.
- The operating mode must be the same in both channels.

BINARY..

If this parameter is selected, a window is displayed which allows for binary entry of the individual channel-status bits. The data are copied in with OK. BIN ENTRY can be used only once with Ch Stat. L or Ch Stat. R. The SELECT key (or space bar on the external keyboard) causes the respective bit to change from 0 to 1 or vice versa.

***Note**: Local Time Code is a counter defined in accordance with AES3 which indicates the time elapsed since the beginning of transmission in samples. This counter is incremented by the UPD in the PANEL+AES and/or FILE+AES modes by 192 per frame. The value indicated in the file or panel is used as a start value.*

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Filename

Specify a file containing channel status data for LEFT.

Preset file type: *.pgc

The data are each defined in one line. Keywords in the file specify for which bits and side (left, right or both) the data are defined.
However, with this command only the definitions containing data for the left or for both sides are considered. Thus the same file can be used for both sides.

Syntax:

Side: AES_CHAN_STAT or AES_CHAN_STAT_BOTH mark the beginning of data for both sides. Analogously, AES_CHAN_STAT_RIGHT and AES_CHAN_STAT_LEFT indicate the beginning of data for one side.

These keywords may be used in any order and as often as desired.

Data: In the file values are entered using the following line:

Keyword BIT followed by a destination range and the respective value.

Example: BIT:12-15, 1

(Bits 12-15 are assigned "0001")

It is also possible to use the generator status data of the analyzer. In this case, enter the keyword ”TRACK” instead of a value.

Example: BIT:12-15, *TRACK*

The sample rate selected in the configuration section of the UPD generator (see Section 2.3.5) can be entered automatically in the specified bit positions using the keyword RATE_TRK. With the aid of the bit position, the UPD is able to identify whether the sample rate has to be coded in the consumer or the professional format and enters the respective values accordingly.

Example: BIT:6-7, *RATE_TRK* (professional format)

BIT:24-27, *RATE_TRK* (consumer format)

The time can be entered into the UPD using the keyword ”TIME” instead of a value. The time is multiplied by the currently selected sample rate (see Section 2.5.3) to obtain the number of samples produced since midnight.

Example: BIT:112-143, *TIME*

Note: *When the generator is started, the local time (bits 112 to 143) is set to 0 and incremented by the sample rate. The local time therefore indicates the number of samples produced since the generator start. In a protocol analysis the time elapsed since the generator start can be determined with the aid of the sample rate.*

The absolute time (bits 144 to 175)) with the number of samples produced since midnight is loaded when the generator is started and remains unchanged. In a protocol analysis the time of the generator start can be determined with the aid of the sample rate.

Thus the current time can be determined at any time by adding "Local" and "Time".

Example file: R&S–AES3.PGC (professional format)

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Ch Stat. R

Define how the channel status data RIGHT are specified.

The setting that can be made here depends on Ch Stat. L. The PANEL can be assigned only once and the operating mode (AES3, CRC, RAW) must be the same in both channels.
For more details on individual commands refer to Ch Stat. L.

ZERO	All channel status data bits are 0. (The operating mode (AES3,CRC,RAW) is determined by Ch Stat. L. If Left should be set to ZERO too, the operating mode is RAW).
EQUAL L	The two sides are identical; all definitions made for the left channel are copied to the right. The operating mode is defined by Ch Stat. L.
FILE+AES3	This selection is only displayed if ZERO, FILE+AES3 or PANEL+AES3 is selected for Ch Stat. L.
PANEL+AES 3	This selection is only displayed if ZERO or FILE+AES3 is selected for Ch Stat. L.
FILE+CRC	This selection is only displayed if ZERO, FILE+CRC or PANEL+CRC is selected for Ch Stat. L.
PANEL+CRC	This selection is only displayed if ZERO or FILE+CRC is selected for Ch Stat. L.
FILE	This selection is only displayed if ZERO, PANEL or FILE is selected for Ch Stat. L.
PANEL	This selection is only displayed if ZERO or FILE is selected for Ch Stat. L (see Ch Stat. L).

Filename

Specify a file containing Channel Status data for RIGHT

Preset file type: *.pgc

The data are each defined in a line. Keywords in the file specify for which bits and side (left, right or both) the data are defined (see also specifications for the left side).
However, with this command only the definitions containing data for the right or for both sides are considered. Thus the same file can be used for both sides.

Format: see Ch Stat. L

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CRC Error

Define the interval (in blocks) used for the generation of errors in the CRC of the status data.

Numerical entry from 0 to 100,000

0: no error, all CRCs are correct.
1 to 100000: After the specified number of blocks one CRC error is generated simultaneously in both channels. (CRC error: the correct CRC is replaced by the inverted bit pattern).

This command is displayed only when the operating mode of the channel status data is CRC or AES3.

User Mode

Specify how to generate the user data.

ZERO

All user bits are initialized to be 0.

FILE DEF

User bits are output according to the definitions in the subsequent file.

Note: *Changing the user bits briefly stops both the generator and the analyzer.*

Filename

Specify a file containing user data..

Preset type of file: *.pgu

The file contains both user data for the left and the right side. The keyword AES – USER – DATA – LEFT is used to indicate the beginning of data for the left side. Analogously, AES – USER – DATA – RIGHT is used for the right side.

In the following lines, values must be entered as hexadecimal numbers without any further designations . Each line contains 32 bits.

The UPD repeats cyclically the user bits read in, the length of each cycle being equal for both sides. Reading in less bits on one side than on the other causes zeros to be inserted. 6 characters (or a multiple thereof) result in correlated user data from the beginning of the block.
The maximum permissible number of user bits is 4096 words = 16384 bytes = 131072 bits per side.

Example: AES – USER – DATA – RIGHT
0 x 55504420 # = 'UPD '

Panelfile

Specify a file which contains the definitions of the user-programmable panel. This menu item is only displayed when a panel has been specified for Ch Stat. L or Ch Stat. R.

Preset type of file: *.PPC

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Panelfile

This file allows an input field to be defined which is tailored to the current requirements. It thus defines the screen display for the entry of actual values. To this end, enter the respective command designations, the permissible range of values and the destination of the setting into the file. Sample files for the "professional" format according to IEC 958 are contained in the “C:\UPD\USER“ file supplied with the instrument (R&S_AES3.PPC and R&S_CONS.PPC).
4 types of commands are permissible:

- **Selection commands**

  Entering the keyword SELECTION or EXTSELECT followed by parameters defines a selection command.
  The entry of keyword RATE_TRK followed by parameters specifying the sample rate defines a special selection command which causes also the selection item GEN SMPLFRQ to be displayed. RATE_TRK must only be used where (in the consumer or professional format) the bits for the sample rate have already been defined; in all other cases the keyword has the same effect as SELECTION.

  Examples:
  - SELECTION " Use", BIT:0, 0="CONS", 1="PROF"
    Bit 0 of the channel status data can be switched between ANLR TRACK, CONS and PROF using the menu line "Use".
  - SELECTION " Usermod", BIT:12-15, 0="not ind", 3="USER"
    The four bits 12 to 15 can be switched between ANLR TRACK, not ind and USER using the menu line "Usermod".
  - RATE_TRK " Rate", BIT:6-7,
    0="not ind", 1="44.1 kHz", 2="48 kHz", 3="32 kHz "
    Bits 6 and 7 of the channel status data can be switched between ANLR TRACK, not ind, "44.1 kHz", "48 kHz", "32 kHz" and GEN SMPLFRQ using the menu line "Rate". By selecting GEN SMPLFRQ the sample rate selected in the generator configuration section is automatically transferred to the channel status data.

  Note:
  - *Max. 12 normal selection commands and 3 extended ones are permissible.*
  - *The UPD automatically inserts the selection ANLR TRACK, which causes the corresponding bits of the analyzer to be copied.*
  - *The BIT interval must not be larger than 32.*
  - *Max. 8 selections per command (SELECTION) are permissible. Any value within the specified bit range can be assigned to the selections.*
  - *In the case of overlapping bit ranges, the most recent setting overwrites the bits defined before.*
  - *Up to 24 selection possibilities are permissible with EXTSELECT.*

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- **Text commands**

  Entering the keyword TEXT followed by parameters defines a text command.

  Example:
  - TEXT " Origin", BIT:48-79
    (The 32 bits 48 to 79 of the channel status data are filled with the text characters to be entered here.)

  Note:
  - *Max. 4 selection commands are permissible.*
  - *The BIT interval must not be larger than 32, ie max. 4 text characters (ASCII) per command are permissible.*
    - *When no text is entered, the UPD copies the corresponding analyzer contents.*

- **Value commands (normal)**

  Entering the keyword VALUE followed by parameters defines a value command, which allows the specification of status bits as numbers. These numbers can even be multiplied by a multiplier specified in the file.

  Example:
  - VALUE " Abs.Hour", BIT:144-175, MULT:SET_RATE MULT:3600
    (The value defined here is entered into the 32 bits 144 to 175, the number after MULT (3600 * and SET_ RATE = set sample rate) being multiplied by the value before it is entered.)

  Note:
  - *Max. 12 value commands are permissible.*
  - *The BIT interval must not be larger than 32, the entry is limited to 31 bits.*
  - *When entering -1 into the panel, the corresponding analyzer bit range is copied.*
  - *The keywords MULT are optional. The keyword SET _ RATE can also be used as multiplier.*

- **Value commands (additive)**

  The entry of the keyword ADDVALUE followed by parameters defines a value command, the value being added to already available values.

  Example:
  - ADDVALUE " Abs.Min", BIT:144-175, MULT:2880000
    (The value entered here is added to the 32 bits 144 to 175 of the channel status data. Prior to the addition, the number after MULT (2880000 = 60 * 48000) is multiplied by the value).

  Note:
  - *See under value command (normal).*

  Examples: R&S_AES3.PPC for panel acc. to AES3 format
  R&S_CONS.PPC for panel acc. to consumer format

  In the panel, the UPD displays the commands in the order
  1. SELECTION/EXTSELECT/RATE_TRK
  2. VALUE / ADD VALUE
  3.TEXT

  In the file, any desired order is permissible.

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2.5.3.5 Digital Interface INTERN

Internal digital connection between generator and analyzer (with DIG 48 kHz only).

If the jitter option (UPD-B22) is *not* installed, this mode is limited to channel 1 and the fixed sample frequency 43619.7917 Hz.

Audio Bits

Word width of generated audio samples in bits.

Value range: 8 to 28

If the word width is reduced, the value of the audio samples are rounded to the specified word width.

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2.5.4 Functions

Function	
SINE	Single sine, dither may be included
MULTISINE	up to 17 sines (with all generators)
SINE BURST	Sine burst signal
SINE^2 BURST	Asymmetrical sine burst
SQUARE	Square signal (not with ANLG 110 kHz)
MOD DIST	Test signal for intermodulation distortions
DFD	Test signal for difference frequency distortions
DIM	Test signal for dynamic intermodulation measurements (with DIG 48 kHz, DIG 192 kHz; analog only with ANLG 25 kHz together with LDG option)
RANDOM	Random noise
ARBITRARY	Arbitrary waveform
POLARITY	Test signal for polarity measurements (with DIG 48 kHz and ANLG 25 kHz)
MODULATION	Frequency- and amplitude-modulated sine (with DIG 48 kHz and ANLG 25 kHz)
FSK	Frequency shift keying (not with DIG 768 kHz) is only required for the CCITT O.33 (via automatic control).
DC	DC signal (with DIG 48 kHz and ANLG 25 kHz)

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2.5.4.1 Common Parameters signals of Generator Signals

2.5.4.1.1 Common Parameters of SINE, DFD, MOD DIST Signals

Frq Offset

Frequency offsets when entering frequencies.

+1000 ppm

Set the frequency with an offset of +0.1%

Note: *If reference is made to the generator frequency via GENTRACK with frequency offset switched on, the **set** frequency and not the actually generated one is used as reference (2.6.5.1, Ref Gen)*

OFF

Set the frequency without offset

Dither

For digital generators only.

ON

A noise component is superposed on the signals. The amplitude of the noise component can be entered in the next menu line. The power density function (PDF) can be entered further down.

OFF

No superposed noise

PDF

Only for digital generators, with activated dither
Select the amplitude distribution (probability distribution function) of the superposed noise signal.

GAUSS

Gaussian distribution

TRIANGLE

Triangular distribution from -peak to +peak

RECTANGLE

Equivalent distribution from -peak to +peak

Low Dist

(Low Distortion Generator)
For analog generators only. Activate/deactivate the low-distortion generator (see 2.5.1 Selecting the Generator).

ON

(Only with UPD-B1 option); a sinewave is produced by the low distortion generator: with double sine, the other signal is generated by the universal generator.

OFF

All signals are produced by the universal generator.

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Setting

FAST

Only for analog generators and with the low distortion generator switched on.

Fast settling of the low-distortion sine

PRECISION

High frequency accuracy of the low-distortion sine by readjusting the frequency once. Since the frequency of the low-distortion generator is remeasured internally, the frequency setting time exceeds FAST setting.

2.5.4.1.2 Common Parameters of All Generator Functions

DC Offset

permits the superposition of a settable direct voltage on the generator output

ON

The signals are superimposed a DC voltage content. The amplitude of the DC voltage content can be entered in the next menu line.
This selection is permitted for all functions of the digital generator, whereas, in the analog generator it is not permitted with

- the DIM function,
- the SQUARE function
- low-distortion generator switched on

Effects on the AC signal:

- the settable total AC voltage is smaller
- the DFD signal has an S/N ratio which is poorer by 30 dB

OFF

no DC voltage signal active

Note: *for the analog generators, offset is limited on ± 5 V (UNBAL and COMTST) or ± 10 V (BAL)*

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2.5.4.1.3 Common Parameters of SINE, DFD, MULTI, RANDOM Signals

Equalizer

Activate/deactivate an equalizer table comprising frequencies and associated voltage gain factors. As a function of frequency, the set voltage or frequency line can be multiplied by an equalization factor (if necessary after interpolation between the two adjacent frequency values) before it is switched to the outputs. The corrected voltage may be measured internally using the analyzer. Setting: ANALYZER panel "Chx Input GENy", x = test channel (1 or 2), y = generator channel (1 or 2); Display as measurement result.

***Note**: When an equalization factor >1 is entered, the corrected voltage may exceed the selected maximum voltage (entry under menu item "Max Volt") or the physically possible voltage. In this case the output voltage is limited (to the lower one of the two values).*

***Typical application:** Simulation of preemphasis effects; measurement with constant power on frequency-responsive DUTs.*

ON

Equalizer switched on. The menu item ”Equal. file” is activated, ie the file listed there is loaded.

***Note:** If reference is made to the generator voltage with GENTRACK when the equalizer is switched on, the **set** and not the corrected voltage is used as a reference (2.6.5.1, Reference).*

OFF

Unaffected output voltage

Equal. file

(Equalizer file) only with equalizer → ON

Menu item for entering the name of the equalizer file. The file is opened and loaded into an internal buffer.

If the entered name is invalid (drive not ready, file not found, format invalid, et message is output and entered in the menu line "not found".

For entering file names see 2.3.2.5;
For generating an equalizer file see 2.9.1.2 Loading and Storing of Series of Measured Values and Block/List Data ("Store→EQUALIZATN").

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2.5.4.2 Sweeps

With many generator functions, it is useful to output signal parameters (level, frequency, in the case of burst signals also switch-on time and length of intervals) not only statically but to vary them with respect to time. A sweep system allowing 2 parameters to be varied simultaneously (two-dimensional sweep) is available for these signals.

- One-dimensional sweep: the parameter specified under X axis is varied from start to stop or according to the LIST file.
- Two-dimensional sweep: the parameter specified under Z axis is set to the start value or the first entry in the 1st LIST file. The parameter defined under X axis is varied from start to stop or in accordance with the 2nd LIST file. The Z parameter is then set to the next value and the sweep of the X parameter starts again from the beginning. The two-dimensional sweep is concluded when the Z parameter has assumed its final value. When a Z sweep is switched on, Scans in the DISPLAY panel is set to GROUP and Scan count is set according to the number of Z points.

The so-called "LIST buffers", with a length of 1024 entries each, serve as data source for the sweep parameters. The total length of the LIST buffers is obtained by multiplying the lengths of X and Z buffer; with one-dimensional sweeps, the length of the Z buffer is to be defined as 1. If you specify too many items, the last ones, ie those exceeding 1024 are ignored. Each buffer contains a table, which can either be derived from user specifications (normal sweep) or is loaded from a file (list sweep; see Sweep→Ctrl).

With "normal sweeps", tables with equidistant rising or falling values are generated depending on whether the start value is lower or higher than the stop value. As soon as a “normal“ sweep is switched on or a new start value is selected, the start value is set in the instrument hardware, in order to keep the settling time with starting of sweep as short as possible. Sweeping from high to low frequencies allows the beginning of the sweep curve to be displayed faster than its end because high frequencies require less measuring time.

With “list-controlled sweeps“, the values for the sweep parameters can be spaced as desired, however, they must be consecutive (just as with “normal“ sweep) (see 2.9.3, Series of Measured Values (Sweeps and Scans) and Block/List Data).

If a running sweep is stopped or switched off, the swept parameters retain the current numeric values.

Note: *Sweeping from high to low frequencies allows the beginning of the sweep curve to be displayed faster than its end because high frequencies require less measuring time.*

For starting and stopping the sweep, see 2.11.

Table 2-16 List of sweepable function parameters depending on the function selected:

Function	VOLTAGE	FREQUENCY	ON-TIME	INTERVAL
SINE	yes	yes	---	---
MULTISINE	no	no	---	---
SINE BURST	yes	yes	yes	yes
$SINE^2$ BURST	yes	yes	yes	yes
SQUARE	yes	yes	---	---
MOD DIST	yes (Total Volt)	yes (user frequency)	---	---
DFD	yes (Total Volt)	MEAN yes (mean frequency)	---	---
DIM	yes (Total Volt)	no (standardized frequency pans)	---	---
RANDOM	no	---	---	---
ARBITRARY	no	---	---	---
POLARITY	no	---	---	---
FM	no	no	---	---

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Remark:

In addition to the above generator sweeps, several analyzer sweeps can be performed:

- time-controlled analyzer sweeps are selected under menu item START COND in the ANALYZER panel (for all measurement functions)
- external frequency or level sweeps are also selected in the ANALYZER panel under menu item START COND (for all measurement functions)
- the bandpass mean frequency can be swept in the RMS SELECT measurement.

Only one generator or one analyzer sweep can be active at a time. If a 2nd sweep is selected, the first sweep is switched off again and a warning is read out.

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SWEEP Ctrl

Activate/Deactivate the sweep system and specify the data source and sweep run.

OFF

The sweep system is switched off; all parameters are entered directly into the panel by the user.

AUTO SWEEP

The sweep runs automatically after having pressed the START or SINGLE key (see 2.11, Starting and Stopping a Measurement).
The data of the sweep parameters are obtained from user specifications (start/stop value and step size or number of points); "normal" sweep
Sweep stepping can be synchronized with the analyzer in menu item Next Step.

AUTO LIST

The sweep runs automatically after having pressed the START or SINGLE key (see 2.11, Starting and Stopping a Measurement).
The data of the sweep parameters are read from file; (list sweep) for generation of lists, see 2.9.1.2, menu item STORE TRACE/LIST, Store → X AXIS, Store → Z AXIS.
Sweep stepping can be synchronized with the analyzer in menu item Next Step.

MANU SWEEP

The sweep is controlled by means of the rotary knob and/or the cursor keys. When you press the START key, the 1st sweep point is set (and measured). Any further sweep point must be explicitly requested using the rotary knob or by pressing a cursor key (see 2.11, Starting and Stopping a Measurement).
The data of the sweep parameters are obtained from user specifications (start/stop values and step size or number of points); normal sweep.
When sequencing the manual sweep, the result of the current measurement is not waited for, ie the current measurement and possibly a set analyzer delay are aborted.

MANU LIST

The sweep is controlled by means of the rotary knob and/or the cursor keys. When you press the START key, the 1st sweep point is set (and measured). Any further sweep point must be explicitly requested using the rotary knob or by pressing a cursor key (see 2.11, Starting and Stopping a Measurement).
The data of the sweep parameters are read from a file; (list sweep).
For generation of lists, see 2.9.1.2, menu item STORE TRACE/LIST, Store → X AXIS, Store → Z AXIS
When sequencing the manual list sweep, the result of the current measurement is not waited for, ie the current measurement and possibly a set analyzer delay are aborted.

Notes on manual sweep:
In order to control manual sweeps using the rotary knob or the cursor keys, the graphics must be active (full-screen or part-screen mode). When the sweep is started, the switchover to the graphics panel occurs automatically. The feature ”manual sweep” can be used to vary generator parameters with a user-definable increment. The increment is defined by a fixed “step“ (with MANU SWEEP) or by a variable step size defined per file (with MANU LIST). In remote control mode, the command ”INIT:NEXT<n>” is used to continue.
Individual sweep points can be skipped by turning the rotary knob fast. Also, sweep points can be repeated by turning the rotary knob back.

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The measured values are represented by means of crosses in the Curve Plot mode. With the DISPLAY panel setting Scan count >1 selected, these crosses are not deleted before being updated but remain on the screen. With strongly fluctuating measurement values, the representation approximates the shape of a bar. If sweep steps are skipped or advanced too fast, a NAN (Not A Number) value is entered. When reaching the end of sweep, the complete trace (with the latest measured values) is obtained.

Next step

With automatic sweep system and automatic sweep stepping ("Sweep Ctrl → AUTO SWEEP" or "Sweep Ctrl → AUTO LIST").
Select the sweep synchronization.

ANLR SYNC

Analyzer synchronization:
The sweep continues after a valid measured value has been obtained; recommended in generator/analyzer mode.

DWELL VALUE

Time synchronization with fixed time:
The sweep continues after a specified time has elapsed. The time is defined in menu item "Dwell". Required for sweeps with external analyzer.

DWELL:File

Time synchronization using times specified in a list
The sweep continues after specified times which are read out of a list and interpolated on the basis of the existing X axis. Required for sweeps with external analyzer, when the measuring or settling time of the analyzer and/or the DUT depends on the respective sweep point.

Dwell File

With automatic file sweep ("Sweep Ctrl → AUTO LIST") and list-controlled time synchronization ("Next step → DWELL FILE") only.
Specify a file containing the dwell times

The file is opened and loaded into an internal buffer.

If the name entered is not valid (drive not ready, file not found, invalid format, etc.), an error message is output and the reason for the fault is entered into the menu line.
For entry of file names, see 2.3.2.5; for generation of the list, see 2.9.1.2 Loading and Storing of Traces and Lists.

Dwell

Only with automatic sweep and list-controlled time synchronization ("Next step → Dwell:Value").

Enter a dwell time for all sweep points.

Value range:	0 to 1000 s.
Units:	s | ms | µs | min
Resolution:	1 ms

Note: *During IEC/IEEE-Bus operation, the dwell time can only be implemented with an accuracy of 50 ms.*

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X Axis

With an active sweep system only.
Select the sweep parameter (one-dimensional sweep) or the 1st sweep parameter (two-dimensional sweep).

VOLT Signal voltage (SINE, SINE BURST, SINE^2 BURST , SQUARE) or total voltage (MOD DIST, DFD, DIM) is swept.

FREQ Signal frequency (SINE, SINE BURST, SINE^2 BURST, SQUARE), useful frequency (MOD DIST) or center frequency (DFD) is swept.

ON TIME Time of high level with burst signals is swept.

INTERVAL Interval time with burst signals is sweept.

Z Axis

With active automatic sweep only
Select the 2nd sweep parameter for a two-dimensional sweep.

OFF Sweep is one-dimensional

VOLT Sweep is one-dimensional

FREQ Sweep is two-dimensional, the 2nd. sweep parameter is the signal voltage (SINE, SINE BURST, SINE^2 BURST) or total voltage (MOD DIST, DFD).

ON TIME Sweep is two-dimensional, the 2nd sweep parameter is the signal frequency (SINE, SINE BURST, SINE^2 BURST, SQUARE), wanted frequency (MOD DIST) or center frequency (DFD).

INTERVAL Sweep is two-dimensional, the 2nd sweep-parameter is the time of the high level (only with burst signals).

Sweep is two-dimensional, the 2nd sweep parameter is the interval time (only with burst signals).

Note: *With two-dimensional sweeps of "ON TIME" and "INTERVAL", the minimum value of "INTERVAL" must exceed the maximum "ON TIME" value. With normal sweep, this is ensured by limitation and, if required, correction of the start and stop values with entry already. However, with list sweep, the user should make sure that this condition is met in the lists used, since a required, automatic correction is not carried out until the sweep is running - thus, unexpected results may be obtained.*

Note: *Theoretically, the same parameter may be entered for the X and Z axes (eg, VOLT in both directions) - and this is not prohibited in the operator surface. This does, however, not make sense in normal practical use.*

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Spacing

With normal sweep only (”Sweep Ctrl → AUTO SWEEP” or ”Sweep Ctrl → MANU SWEEP”);
Determine the sweep range spacing.

LIN POINTS

The sweep range is linearly divided by a number of points to be specified. The number is entered under menu item ”Points”.

LIN STEPS

Beginning from ”Start”, the sweep range is divided into intervals using a linear step size to be specified under menu item ”Step”.

LOG POINTS

The sweep range is logarithmically divided by a number of points to be specified. The number is entered under menu item ”Points”.

LOG STEPS

Beginning from ”Start”, the sweep range is divided into intervals using a logarithmic step size to be specified under menu item ”Step” (multiplier without unit)

Note: *No conversion is performed when switching from ... POINTS to ...STEPS and vice versa; the set values are retained in the back-ground. The numeric value for ”STEP” remains the same when switching between LIN STEPS and LOG STEPS.*

Start

With normal sweep only (Sweep Ctrl →AUTO SWEEP or Sweep Ctrl→ MANU SWEEP)
Enter the start value for the (above) sweep parameter.
Range of values, unit and resolution: as for the appertaining sweep parameter.
If a start value is entered that is identical with the stop value, the stop value is automatically loaded with the old start value.
In this way, the sweep direction can be easily reversed by means of a single entry.
Note: *The start value of the sweep parameter is set in the instrument hardware with entry already (not with starting the sweep). The settling time with starting the sweep can thus be minimized.*

Stop

With normal sweep only (Sweep Ctrl→AUTO SWEEP or Sweep Ctr→ MANU SWEEP)
Enter the stop value for the (above) sweep parameter
Range of values, unit and resolution: as for the appertaining sweep parameter.
If a stop value is entered that is identical with the start value, the start value is automatically loaded with the old stop value.
In this way, the sweep direction can be easily reversed by means of a single entry.

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Points

With normal sweep only ("Sweep Ctrl→AUTO SWEEP" or ”Sweep Ctrl→ MANU SWEEP”) and "Spacing→LIN POINTS” or ”Spacing→LOG POINTS" selected.

Value range: 2 to 1024.
Units: None (integer)

Enter the number of sweep points for the (above) sweep parameter. The sweep range is divided into (points - 1) steps. 2 points at least (start and stop value) are required.

Step

With normal sweep only ("Sweep Ctrl→AUTO SWEEP" or Sweep Ctrl→ MANU SWEEP”) and "Spacing→LIN STEPS" or ”Spacing→LOG STEPS” selected.

Enter the step size for the (above) sweep parameter.
With *linear* step, the absolute step size is always entered, ie, the number value is positive even, if the start value exceeds the stop value.

With *logarithmic* step, the multiplication factor is entered, which is required for each sweep point to obtain the next sweep point. If start and stop value are interchanged (reversal of the sweep direction), the reciprocal value is constituted.

Valid range of values: see user guide line. The step size is to be selected as high as to result in not more than 1023 individual steps.

Unit and resolution: With linear spacing as for the appertaining sweep parameter. With logarithmic spacing, no unit can be entered (factor without unit).

Exception: *In the case of voltage sweeps With two-dimensional sweeps,* (X axis Volt), *the logarithmic scaling can be entered either as a factor or in dB*

FREQ FILE

With list sweeps only ("Sweep Ctrl→AUTO LIST" or "Sweep Ctrl→ MANU LIST”)

Enter the file name for a frequency list; for entry of file names see 2.3.2 Data Entry

The signal frequency (SINE, SINE BURST, SINE^2 BURST, SQUARE), the useful frequency (MOD DIST) or the center frequency (DFD) is swept.

VOLT FILE

With list sweep only ("Sweep Ctrl→AUTO LIST" or "Sweep Ctrl→ MANU LIST”)

Enter a file name for the amplitude list; for entry of file names see 2.3.2 Data Entry

The signal voltage (SINE, SINE BURST, SINE^2 BURST, SQUARE, DIM) or the total voltage (MOD DIST, DFD) is swept.

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ONTIM FILE

With list sweeps only ("Sweep Ctrl→AUTO LIST" or "Sweep Ctrl→ MANU LIST")

Enter a file name for the "ON-Time" list in the case of burst signals; for entry of file names see 2.3.2 Data Entry

The burst duration (SINE BURST, SINE^2 BURST) is swept.

INTV FILE

With list sweeps only ("Sweep Ctrl→AUTO LIST" or "Sweep Ctrl→ MANU LIST")

Enter a file name for the interval list in the case of burst signals; for entry of file names see 2.3.2 Data Entry

The burst interval (SINE BURST, SINE^2 BURST) is swept.

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2.5.4.3 SINE

Frq Offset

See 2.5.4.1 Common Parameters for the Signals SINE, DFD, MOD DIST.

Dither

For digital generators only;
See 2.5.4.1 Common Parameters for the Signals SINE, DFD, MOD DIST.

PDF

For digital generators only;
See 2.5.4.1 Common Parameters for the Signals SINE, DFD, MOD DIST.

Low Dist

For analog generators only;
see 2.5.4.1 Common Parameters for the Signals SINE, DFD, MOD DIST.

ON

Signals are generated by the low-distortion generator

OFF

Signals are generated by the universal generator

DC Offset

See 2.5.4.1.2, Common Parameters for all Generator Functions

SWEEP CTRL

see 2.5.4 SWEEPS

Frequency

Entry of sine frequency; may be used as a sweep parameter.

Specified range: 10 Hz to f_{max}
f_{max} generator-dependent; see 2.5.1 Selecting the Generator
Resolution: 1 mHz
Units: Hz | kHz | ΔHz | ΔkHz | f/fr | Δ%Hz | Toct | Oct | Dec

Setting

For low-distortion generator only;
see 2.5.4.1 Common Parameters for the Signals SINE, DFD, MOD DIST.

Equalizer

See 2.5.4.2.5, Common Parameters for SINE, DFD, MULTI, RANDOM
The sinewave voltage is corrected.

ON

Equalizer is switched on. Menu item ”Equal. file” is activated, ie the file listed under this menu item is loaded.

OFF

The output voltage is not affected.

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Equal. file

(Equalizer file)
With Equalizer → ON only; see 2.5.4.1.3 Gem. Param. für SINE DFD MULTI RANDOM.

Voltage

Entry of sinewave amplitude; may be used as a sweep parameter

Value range: digital (audio data mode):
:
0 to 1 FS
digital (jitter mode):
0 to 5 UI (jitter peak amplitude)
digital (phase mode):
0 to 0.25 UI (jitter peak amplitude)
digital (common mode):
0 to 7.071 V_{rms}
analog: 0 to 12 V_{rms} for UNBAL (BNC)
or COMTST (XLR)
0 to 24 V_{rms} for BAL (XLR)

Caution: *Voltage limitation of the rms value by means of menu item "Max Volt", see 2.5.2 Configuration of the Analog Generators / 2.5.3 Configuration of the Digital Generators*

Units digital (audio data mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr
digital (jitter mode):
UI | %UI | dBUI | ppm | ns | UIr | dBr
analog and digital common mode:
V | mV | µV | V_{pp} | mV_{pp} | μV_{pp} | V/V_r |
dBu | dBV | dBr | dBm |
Δ%V | ΔV | ΔmV | ΔµV

Peak-to-peak amplitude (analog): $V_{pp} = V_{rms} \times 2 \times \sqrt{2}$;

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2.5.4.4 MULTISINE

Up to 17 single sine voltages can be superposed on each other.

They are generated exclusively by the universal generator.

The phase angles of the single sine voltages can be determined in different ways:

- automatic optimization to obtain a minimum crest factor
- specification of a desired crest factor
- entry of the phase angles of all active sine lines

The resulting total peak value depends on the frequencies of the individual sine and from the selected crest factor, if any. Thus, the voltage may increase when varying individual frequencies. Irrespective of the crest factor selected, the set maximum voltage (”Max volt”, see 2.5.2 Configuration of the Analog Generators / 2.5.3 Configuration of the Digital Generators) is however never exceeded since the worst case is taken as the basis for linear superposition when entering the single voltages.

Further specific multi-tone signals are selected using the functions

- MOD DIST (2 sinewave amplitudes with the ratios 1:1 to 10:1)
- DFD (2 equivalent sinewave amplitudes)
- SINE (1 sinewave with any amplitude)
- RANDOM, Domain Freq (7488 sine lines at fixed frequency offset with any amplitude)

With the first 3 functions, a ”Frq Offset” or ”Dither” with ”PDF” (in the digital generator) can be set. The low-distortion generator can additionally be used in the analog generator, if the UPD-B1 option is fitted.

DC Offset

See 2.5.4.1.2, Common Parameters for all Generator Functions

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Spacing

Set the frequency spacing:

USER DEF

The value entered is corrected to the next settable value.
The range of values depends on the selected generator and its sample rate (see 2.5.1, Selecting the Generator):

Lower limit:
ANLG 25 kHz: 5.8 Hz
ANLG 110 kHz 23.4 Hz
DIG instruments: Sample frequency / 16384
Int. sample frq. = Sample Frq * Oversamp
Units: Hz, kHz

ANLR TRACK

The value specified for the FFT analysis frequency spacing is automatically adopted. The value is also displayed in the ANALYZER panel under "FFT:Resolution" (see 2.6.5.13 FFT). This setting is ideal for an analysis using the rectangular window. With no FFT selected in the analyzer, the setting is rejected (error message!).

Equalizer

See 2.5.4.1.3 Gem. Param. für SINE DFD MULTI RANDOM
Each active frequency line is corrected.

ON

Equalizer switched on. Menu item "Equal. file" file is activated, ie the file indicated there is loaded.

OFF

The output voltage of all the frequency lines are unaffected.

Equal. file

(Equalizer file)
with equalizer → ON only;
see 2.5.4.1.3 Gem. Param. für SINE DFD MULTI RANDOM

Mode

Select the input mode for the individual sine voltages:

EQUAL VOLT

The same amplitude applies for each single sine; it is entered as "Volt No 1

DEFINE VOLT

An amplitude can be defined for each single sine, individually.

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Crest Fact

Selection of the algorithm for determination of the phase angles of the singles sines and thus of the crest factor for the total signal.

OPTIMIZED

Automatic *minimization of the crest factor* by internally optimizing the individual phase angles.

VALUE:

Specification of a *desired crest factor.* The phase angles of the single sines are modified internally such that the resulting crest factor approximates the desired value as close as possible. The accuracy of this method depends on the total number of lines.

DEFINE PHAS

Entry of the *phase angles of all active sine lines*

No of sine

Value range: 1 to 17
Units: none

Entry of number of desired tones, ie the sines that can be edited. In the EQUAL VOLT mode, the entry also influences the maximum amplitude that can be entered for a single sine tone (see "Volt No (i) ").

For a better overview, the max. 17 frequencies, levels and phase values are not set in the GENERATOR panel but in a special dialog window, which is automatically opened after "No of sine" or the "Choice ..." command below. In this window, the individual frequency and level and phase menu items can be copied into the STATUS panel by ticking them off. Subsequent to closing the window, they can be displayed and entered in the STATUS panel.

Choice ...

Opens a special clearly arranged dialog window where the individual sine frequencies, levels and phases can be displayed and entered.

In this window the individual frequency, level and phase menu items can be copied into the STATUS panel by ticking them off. After closing the window, the values can be displayed and entered in this panel.

Note: *The dialog window described is also automatically opened when "No of sine" is entered.*

Freq No (i)

Entry of sinewave frequency i (i = 1 to 17)

Value range: f_{min} to f_{max} (depending on generator)
f_{min}: Value from spacing
f_{max}: see 2.5.1 Selecting the Generator

Units: Hz | kHz | ΔHz | ΔkHz | f/fr | Δ%Hz | Toct | Oct | Dec

The single frequencies may lie as close to each other as desired or may even be superposed on each other (taking the resolution into account).

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Phase No (i)

Entry of the phase angle of the single sine i (i = 1 to 17)

The reference point is an ideal point in time T0, where all sine lines begin with the phase 0.
If the sine line No. 1 is to be used as reference frequency, it must be assigned phase 0.

Value range: 0 to 360°
Unit: ° or RAD

If 2 or more single lines have the same frequency, ie, they coincide, the first of the lines defines the (common) phase. The subsequent frequency lines are assigned the same phase angle.

Volt No (i)

Entry of sinewave amplitude i (i = 1 to 17)

Specified range: the total voltage of V_{max} is available for all n single sines (n = "No of sin", 1...17) and the DC offset:

digital: (audio data mode): V_{max} = 1 FS
(jitter mode): V_{max} = 5 UI
(phase mode): V_{max} = 0.25 UI
(common mode): V_{max} = 7.071 V_{rms}

analog: V_{max} = 12 V_{rms} for UNBAL (BNC) or COMTST (XLR)
V_{max} = 24 V_{rms} for BAL (XLR)

Caution: *Voltage limitation of the rms value by menu item "Max volt", see 2.5.2, Configuration of the Analog Generators / 2.5.3 Configuration of the Digital Generators.*

V_{max} is split up into the single sine voltages as follows:

- in EQUAL VOLT mode, any sine may be as large as (V_{max} - DC)/n
- in DEFINE VOLT mode, any sine may be as large as the difference between (V_{max} - DC) and the sum of all other active single sines

Units: digital (audio data mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr
digital (jitter of phase mode):
UI | %UI | dBUI | ppm | ns | UIr | dBr
analog and digital common mode:
V | mV | µV | V_{pp} | mV_{pp} | $µV_{pp}$ | V/V_r |
dBu | dBV | dBr | dBm |
Δ%V | ΔV | ΔmV | ΔµV

Peak-to-peak amplitude (analog):
$V_{pp} = V_{rms} \times 2 \times \sqrt{2}$;

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Total Gain

Enter a gain factor (in dB), which allows the rms value resulting from the superimposition of the single voltages to be increased or decreased.

Unit: dB

TOTAL PEAK

Read only, no input field

Indicates total peak value of multi-tone signal. The value is usually below the sum of the single peak values if internal phase optimization has been selected.

Units: digital (audio data mode):
FS | %FS | dBFS | LSBs | bits
digital (jitter or phase mode):
UI | %UI | dBUI | ppm | ns
analog and digital common mode:
V | mV | µV | dBu | dBV | dBm

TOTAL RMS

Read only, no input field (only analog)

Indicates total rms value of multi-tone signal.

Units: V | mV | µV | V_{pp} | mV_{pp} | μV_{pp} | dBu | dBV
V/V_r | dBr | Δ%V | ΔV | ΔmV | ΔµV

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2.5.4.5 SINE BURST

Sine periodically varying between high and low level.

DC Offset

See 2.5.4.1.2, Common Parameters for all Generator Functions

SWEEP CTRL

see 2.5.4 SWEEPS

FREQUENCY

Entry of sine frequency; may be used as a sweep parameter.

Value range: 2 Hz to f_{max}
(50 Hz to f_{max} for DIG 768 kHz)
f_{max} depending on generator; see 2.5.1 Selecting the Generator
Resolution: 1 mHz (50 Hz for DIG 768 kHz)
Units: Hz kHz ΔHz ΔkHz f/fr Δ%Hz Toct Oct Dec
Side-effect: ON TIME is adjusted, if required.

VOLTAGE

Entry of high-level sine amplitude, ie the amplitude during burst time. May be used as a sweep parameter.

Specified range: 0 to V_{max}
digital: V_{max} = 1 FS
analog: V_{max} = 12 V_{rms} for UNBAL (BNC) or COMTST (XLR)
V_{max} = 24 V_{rms} for BAL (XLR)

Caution: *Voltage limitation of the rms value by menu item "Max volt", see 2.5.2 Configuration of the Analog Generators / 2.5.3 Configuration of the Digital Generators*

Units:
digital (audio data mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr
analog: V | mV | µV | V_{pp} | mV_{pp} | μV_{pp} | V/V_r |
dBu | dBV | dBr | dBm |
Δ%V | ΔV | ΔmV | ΔµV

Peak-to-peak amplitude (analog): $V_{pp} = V_{rms} \times 2 \times \sqrt{2}$;
Side-effect: "Low level" may be adapted.

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Low Level

Entry of low-level sine amplitude, ie the amplitude during OFF time (following ON TIME until the end of INTERVAL).

Value range : 0 to high level (VOLTAGE)
Units: digital (audio data mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr | %on | dBon
analog: V | mV | µV | V_{pp} | mV_{pp} | μV_{pp} | V/V_r | dBu | dBV | dBr | dBm | V/on | %on | dBon | Δ%V | ΔV | ΔmV | ΔµV

As to the unit:
In addition to the standard voltage specifications (absolute or relative to the reference value), further relative units referring to high level can be used. They are

%on, dBon; in the analog range also V/on

If a unit of this kind is selected, the ratio

low level : high level

is always kept constant when the high level is varied. This means that changing VOLTAGE (also during a sweep) changes the low level, too.
With all other units, varying VOLTAGE affects the low level only when VOLTAGE becomes smaller than the low level.

Peak-to-peak amplitude (analog): $V_{pp} = V_{rms} \times 2 \times \sqrt{2}$;

ON TIME

Entry of burst duration, ie the time during which the sine is at high level

Value range: lower limit: (1 sample)
ANLG 25 kHz: t_{min} = 10.417 µs
ANLG 110 kHz: t_{min} = 2.604 µs
digital: $t_{min} = 1 / (sample_{Frq} \times$ oversampling factor)
upper limit:
60 s (DIG 768 kHz: 20 ms)

Units: s | ms | µs | cyc | kcyc | Mcyc

Side-effect:
Entering a burst duration exceeding the length of an interval causes the interval length to be increased to burst duration ***+ t_{min}.***

As to the unit: *Apart from standard time specifications, the burst duration can also be specified in cycles. The selection of this unit, which is relative to frequency, results in the number of cycles - and not the burst time - remaining constant when the frequency is changed, ie increasing the frequency decreases the burst duration of the burst signal, thus decreasing the ratio ON–TIME : INTERVAL.*

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INTERVAL

Entry of burst interval length; may be used as sweep parameter.

Value range: lower limit: burst duration set
upper limit: 60 s (DIG 768 kHz: 20 ms)
Units : s | ms | µs | cyc | kcyc | Mcyc | min

As to the unit: *Apart from standard time specifications, the burst interval can also be specified in cycles. The selection of this unit, which is relative to frequency, results in the number of cycles and not the interval time remaining constant when the frequency is changed, ie increasing the frequency decreases the interval of the burst signal. If the "ON TIME" is not specified in cycles, the ON_TIME : INTERVAL ratio increases.*

Note*: When generator settings are changed and a measurement is (re)started, the generator is automatically started anew and begins the interval with the ON TIME, ie with high level (taking into account the Burst On Delay).*

BurstOnDel

(Burst on delay)

When starting the generator (eg, subsequent to changing or acknowledging the function) or starting the measurement, the burst signal normally adopts the "burst on"-state, ie high level. Certain applications, however, require the high level state to be delayed, eg, in order to trigger to the high level. The start delay of the burst signal is intended to be used for these applications; the generator puts out the low level.

Value range: 0 to 60 s

Note*: The digital generator 768 kHz cannot be started with a defined delay as the burst signal has to be calculated prior to the output (similar to the arbitrary signal) and cannot thus be output without a delay.*

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2.5.4.6 SINE² BURST

Sine²-wave signal which is periodically switched on and off. Either positive or negative pulses (also partial pulses) can be generated (by entering a negative voltage). Typically, the signal is not DC-free.

DC Offset

See 2.5.4.1.2, Common Parameters for all Generator Functions

SWEEP CTRL

see 2.5.4 SWEEPS

FREQUENCY

Entry of sine² frequency; may be used as sweep parameter.

Value range: 2 Hz to f_{max} (50 Hz to f_{max} for DIG 768 kHz)
f_{max} depending on generator; see 2.3.2 selecting the Generator
Units: Hz | kHz | ΔHz | ΔkHz | f/f_r | Δ%Hz | Toct | Oct | Dec
Resolution: 1 mHz (50 Hz for DIG 768 kHz)

Note: *The period of this signal is defined as the time required for a pulse.*
Side-effect: *"ON TIME" is adjusted, if required.*

VOLTAGE

Entry of sine² amplitude; may be used as a sweep parameter.

Value range: 0 to V_{max}
digital: V_{max} = 1 FS
analog: V_{max} = 12 V_{rms} for UNBAL (BNC) or COMST (XLR)
V_{max} = 24 V_{rms} for BAL (XLR)

Units: digital (audio data mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr
analog: V | mV | µV | V_{pp} | mV_{pp} | $µV_{pp}$ | V/V_r |
dBu | dBV | dBr | dBm |
Δ%V | ΔV | ΔmV | ΔµV

Caution: *Voltage limitation of the rms value by means of menu item "Max volt", see 2.5.2 Configuration of the Analog Generators / 2.5.3 Configuration of the Digital Generators*

As to the unit:
When negative voltages are entered, the pulse is inverted. Conversion to logarithmic units (dBFS, dBu, dBr, dBV) is not possible in this case.

Peak-to-peak amplitude (analog): $V_{pp} = V_{rms} \times 2 \times \sqrt{2}$;
V_{rms} is the rms value during pulse time, the level during OFF time is not considered when calculating the rms value.

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ON TIME

Entry of pulse duration, ie the time sine^2 is switched on; may be used as a sweep parameter.

Value range: lower limit: (1 sample)
ANLG 25 kHz: t_{min} = 10.417 µs
ANLG 110 kHz: t_{min} = 2.604 µs
digital: t_{min} = 1 / ($sample_{Frq}$ x oversampling factor)
upper limit :
60 s (DIG 768 kHz: 20 ms)
Units: s | ms | µs | cyc | kcyc | Mcyc

Side-effect:
Specifying a burst duration longer than the interval length causes the latter to be increased to burst duration + t_{min}.

As to the unit: *Apart from the standard time specification, the pulse duration can also be specified in cycles. The selection of this unit, which is relative to frequency, results in the number of cycles - and not the pulse time - remaining constant when the frequency is changed, ie increasing the frequency decreases the pulse duration, thus decreasing the ON–TIME : INTERVAL ratio.*

INTERVAL

Entry of interval length; may be used as a sweep parameter.

Value range: lower limit: set burst duration
upper limit: 60 s (DIG 768 kHz: 20 ms)

Units: s | ms | µs | cyc | kcyc | Mcyc

As to the unit: *Apart from the standard time specifications, the burst duration can also be specified in cycles. The selection of this unit, which is relative to frequency, results in the number of cycles - and not the interval time - remaining constant when the frequency is changed, ie increasing the frequency decreases the interval of the burst signal. If the ON TIME is not specified in cycles, the ON–TIME : INTERVAL ratio increases.*

Note*: When generator settings are changed and a measurement is (re)started, the generator is automatically started anew and begins the interval with the ON TIME (taking into account the Burst On Delay).*

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BurstOnDel

(Burst on delay)

When starting the generator (eg, subsequent to changing or acknowledging the function) or starting the measurement, the burst signal normally adopts the “burst on“-state, ie the high level. Certain applications, however, require the high level state to be delayed, eg, in order to trigger to the high level. The start delay of the burst signal is intended to be used for these applications; the generator puts out the low level.

Value range: 0 to 60 s

Note: *The digital generator 768 kHz cannot be started with a defined delay as the burst signal has to be calculated prior to the output (similar to the arbitrary signal) and cannot thus be output without a delay.*

2.5.4.7 SQUARE

Square signal (DC-free); not available for ANLG 110 kHz

DC Offset

See 2.5.4.1.2, Common Parameters for all Generator Functions

SWEEP CTRL

see 2.5.4.2 Sweeps

FREQUENCY

Entry of square-wave frequency; may be used as a sweep parameter.

Value range: depending on generator; in the digital range, also on the clock rate (or oversampling factor)

ANLG 25 kHz: 2 Hz to 10 kHz
DIG 48 kHz: 2 Hz to $sample_{Frq}$ / 4
DIG 192 kHz: 2 Hz to $sample_{Frq}$ x oversamp / 4
DIG 768 kHz: 50 Hz to $sample_{Frq}$ x oversamp / 4

Units: Hz | kHz | ΔHz | ΔkHz | f/fr | Δ%Hz | Toct Oct | Dec

Resolution: analog: 1 mHz
digital: non-linear

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VOLTAGE

Entry of square-wave amplitude; may be used as a sweep parameter.

Value range: 0 to V_{max}

digital: V_{max} = 1 FS

analog: V_{max} = 12 V_{rms} for UNBAL (BNC) or COMST (XLR)

V_{max} = 24 V_{rms} for BAL (XLR)

Units:

digital: FS | %FS | dBFS | LSBs

analog: V | mV | µV | V_{pp} | mV_{pp} | μV_{pp} | dBu | dBV
V/Vr dBr | Δ%V | ΔV | ΔmV | ΔµV

Caution: *Voltage limitation of the rms value by means of menu item "Max volt", see 2.5.2 Configuration of the Analog Generators / 2.5.3 Configuration of the Digital Generators#*

Peak-to-peak amplitude:: $V_{pp} = V_{rms} \times 2$

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2.5.4.8 MOD DIST (Two-tone Signal to SMPTE)

Superposing 2 sinewave signals: low-frequency interfering signal and high-frequency useful signal; interfering signal is 1 to 10 times stronger than useful signal.

For intermodulation measurements to SMPTE (Society of Motion Picture and Television Engineers) and modulation distortion analysis to .

Frequencies

- Recommendation DIN-IEC 268-3:

Interfering signal f_1

f_1 between 0.5 and 1.5 octaves above the lower limit frequency of the DUT:

f_u + 0.5 octave ≤ f_1 ≤ f_u + 1.5 octaves

Useful signal f_2

f_2 between 0.5 and 1.5 octaves below the upper limit frequency of the DUT:

f_o - 1.5 octaves ≤ f_2 ≤ f_o - 0.5 octaves

$f_2 \geq 8 \times f_1$

- SMPTE standard:

interfering signal: f_1 = 60 Hz

Useful signal: f_2 = 7 kHz

Amplitude ratio interfering signal : useful signal:

4:1 (SMPTE standard); to DIN, 10:1 is also possible

With the LDG option fitted, the useful signal in the analog range can be generated by the universal generator or, alternatively, by the low-distortion generator.

Note: *For intermodulation measurements to MOD DIST, an appropriate measurement function is to be set in the ANALYZER panel (see 2.6.5.8).*

Note: *If the selection "Function tracking Gen → Anl" is ticked off in the OPTIONS panel under menu item "Param Link", the measurement function MOD DIST is switched on in conjunction with the function changeover of the generator to MOD DIST:*

Frq Offset

See 2.5.4.1 Common Parameters for the Signals SINE, DFD, MOD DIST

Dither

For digital generators only;
see 2.5.4.1 Common Parameters for the Signals SINE, DFD, MOD DIST

PDF

For digital generators only;
see 2.5.4.1 Common Parameters for the Signals SINE, DFD, MOD DIST

Low Dist

For low-distortion generator only;
see 2.5.4.1 Common Parameters for the Signals SINE, DFD, MOD DIST

ON

The useful signal is generated by the low-distortion generator, the interfering signal by the universal generator (less inherent intermodulation).

OFF

Both signals are produced by the universal generator.

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DC Offset

see 2.5.4.1.2, Common Parameters for all Generator Functions

SWEEP CTRL

see 2.5.4.2 Sweeps

UPPER FREQ

Entry of useful frequency; may be used as a sweep parameter.

Value range: 240 Hz to f_{max} or
4 kHz to f_{max} when using low distortion generator
f_{max} depending on generator; see 2.5.1
Units: Hz | kHz | ΔHz | ΔkHz | f/fr | Δ%Hz | Toct | Oct | Dec
Resolution: 1 mHz (50 Hz for DIG 768 kHz)

LOWER FREQ

Entry of interfering frequency

Value range: 30 Hz (50 Hz for DIG 768 kHz) .. UPPER FREQ / 8 or
30 .. 500 Hz when using low distortion generator
Units: Hz | kHz | ΔHz | ΔkHz | f/fr | Δ%Hz | Terz | Oct | Dec
Resolution: 1 mHz (50 Hz for DIG 768 kHz)

Setting

For low-distortion generator only:
see 2.5.4.1 Common Parameters for the Signals SINE, DFD, MOD DIST

VOLT LF:UF

Entry of interfering level : useful level ratio as a real number.

Value range: 1.0 to 10.0

In the analog range, this ratio affects the level of the total rms voltage which can be input via "TOTAL VOLT".

Unit: none

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TOTAL VOLT

Entry of total amplitude of both sinewave signals; may be used as a sweep parameter.

Value range:
digital: 0 to 1 FS
analog: 0 to 10.964 V_{rms} for UNBAL (BNC) or COMTST (XLR)
0 to 21.927 V_{rms} for BAL (XLR)

Note: *The analog voltage which can actually be set depends on the selected voltage ratio "Volt LF:UF"; the data indicated here apply for the voltage with 10:1.*

Caution: *Voltage limitation of the rms value by means of menu item "Max volt", see 2.5.2 Configuration of the Analog Generators / 2.5.3 Configuration of the Digital Generators*

Units: digital (audio data mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr
analog: V | mV | µV | V_{pp} | mV_{pp} | μV_{pp} | V/V_r |
dBu | dBV | dBr | dBm |
Δ%V | ΔV | ΔmV | ΔµV

In the analog range, the maximum peak voltage is $\sqrt{2}$ x 12 V (UNBAL) or $\sqrt{2}$ x 24 V (BAL). Hence, the following restriction applies

$V_{pp} \leq 33.941\ V_{pp}$ (UNBAL) or
$V_{pp} \leq 67.883\ V_{pp}$ (BAL)

$V_{pp} = V_{1pp} + V_{2pp}$

The total voltage is divided into useful signal and interfering signal in a (selectable) ratio. The maximum total rms voltage, which is obtained from the square sum of the single rms values, thus depends on the interfering signal : useful signal level ratio. The specifications for the range of values stated above are relative to the ratio 10 : 1. The closer the ratio comes to the value 1 : 1, the lower the maximum obtainable total rms voltage. With 1 : 1, it is 8.485 V_{rms} (UNBAL) or 16.97 V_{rms} (BAL).

As a rule, the relationship between total peak-to-peak voltage and total rms voltage can be expressed as follows:

$$V_{pp} = \frac{V_{eff} \times 2 \times \sqrt{2} \times (k+1)}{\sqrt{(k^2+1)}};$$ k = "VOLT LF:UF"

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2.5.4.9 DFD (Difference Frequency Distortion)

Two closely spaced sinewave signals of the same amplitude; for intermodulation measurements (DFD method to DIN-IEC 268-3, former DIN 45403, Sheet 3).

With the LDG option fitted, the low-frequency sinewave in the analog range can be produced by the function generator or, alternatively, the low-distortion generator.

Note: *For intermodulation measurements to DFD, an appropriate measurement function is to be set in the ANALYZER panel (see 2.6.5.10).*

Note: *If the selection "Function tracking Gen → Anl" is ticked off in the OPTIONS panel under menu item "Param Link", the measurement function DFD is switched on in conjunction with the function changeover of the generator to DFD:*

Frq Offset

see 2.5.4.1 Common Parameters for the Signals SINE, DFD, MOD DIST

Dither

For digital generators only;
see 2.5.4.1 Common Parameters for the Signals SINE, DFD, MOD DIST

PDF

For digital generators with dither switched on, only;
see 2.5.4.1 Common Parameters for the Signals SINE, DFD, MOD DIST

Low Dist

For analog generators only;
see 2.5.4.1 Common Parameters for the Signals SINE, DFD, MOD DIST

ON

The high-frequency sinewave is generated by the low-distortion generator, the low-frequency sinewave by the universal generator.

OFF

Both signals are produced by the universal generator.

DC Offset

See 2.5.4.1.2, Common Parameters for all Generator Functions

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Equalizer

see 2.5.4.1.3 Gem. Param. für SINE DFD MULTI RANDOM.
Each of the two difference frequencies is equalized.

ON

The equalizer is switched on. Menu item "Equal. file" is activated, ie the file indicated there is loaded.

As a result of equalization it may happen that the two (in fact equal) sinewave voltages are weighted with different equalization factors and can thus no longer be identified as DFD signal by the analyzer. If such an error message is displayed, it is recommended to switch to the measurement mode "IEC 118", which is more tolerant to differences of the two DFD lines.

OFF

The output voltage of the two DFD frequencies is not affected.

Equal. file

(Equalizer file)
with equalizer → ON only;
see 2.5.4.1.3 Gem. Param. für SINE DFD MULTI RANDOM.

Mode

Select the input mode for the DFD frequencies.

IEC 268

Enter center frequency (MEAN FREQ) and difference frequency (DIFF FREQ). When a frequency sweep is selected (for the X or Z axis), the center frequency is swept.

IEC 118

Enter upper DFD frequency (UPPER FREQ) and difference frequency (DIFF FREQ). When a frequency sweep is selected (for the X or Z axis), the UPPER FREQ is swept.

Note: *For the DFD measurement too, the two standards can be selected under the menu item "Meas Mode".*

SWEEP CTRL

See 2.5.4.2 Sweeps

MEAN FREQ

Entry of mean frequency; may be used as a sweep parameter.

Value range: 200 Hz to (f_{max} - 1000 Hz)
f_{max} depending on generator;
see 2.5.1 Selecting the Generator

Units: Hz | kHz | ΔHz | ΔkHz | f/f_r | Δ%Hz | Toct | Oct | Dec

Resolution: 1 mHz; (DIG 768 kHz: 100 Hz)

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DIFF FREQ

Entry of frequency difference between the two sines

Value range: 80 Hz to 0.55 * MEAN FREQ, max. 1 kHz
(DIG 768 kHz: 100 Hz)
f_{min} depending on generator;
see 2.5.1 Selecting the Generator

Units: Hz | kHz | ΔHz | ΔkHz | f/f_r | Δ%Hz | Toct | Oct | Dec

Resolution: 1 mHz (DIG 768 kHz: 100 Hz).
Rec. to DIN-IEC 268-3: 80 Hz

Setting

For low-distortion generator only;
see 2.5.4.1 Common Parameters for the Signals SINE, DFD, MOD DIST

The low-distortion generator may only be operated in the precision mode with DFD measurement, which is why PRECISION is the only selection offered for Setting.

TOTAL VOLT

Entry of total amplitude of both sinewave signals; may be used as a sweep parameter.

Value range:
digital: 0 to 1 FS
analog: 0 to 8.485 V_{rms} for UNBAL (BNC)
or COMTST (XLR)
0 to 16.971 V_{rms} for BAL (XLR)

Caution: *Voltage limitation of the rms value by means of menu item "Max volt", see 2.5.2 Configuration of the Analog Generators / 2.5.3 Configuration of the Digital Generators*

Units:
digital (audio data mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr
analog: V | mV | µV | V_{pp} | mV_{pp} | μV_{pp} | V/V_r |
dBu | dBV | dBr | dBm |
Δ%V | ΔV | ΔmV | ΔµV

The maximum peak-to-peak voltage in the analog range is $\sqrt{2}$ x 12 V (UNBAL) or $\sqrt{2}$ x 24 V (BAL). Hence the following limitation applies:

$V_{pp} \leq 33.941\ V_{pp}$ (UNBAL) or
$V_{pp} \leq 67.883\ V_{pp}$ (BAL)

$V_{pp} = V_{1pp} + V_{2pp}$

With two equivalent single voltages $V_{1pp} = V_{2pp}$, the maximum permissible total rms voltage is:

$$U_{rms} = \sqrt{\left(\frac{U_{1PP}}{2\cdot\sqrt{2}}\right)^2 \cdot 2} = \frac{U_{1pp}}{2} = \frac{U_{pp}}{4}$$

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2.5.4.10 DIM (Signal for DIM Measurements)

Dynamic Intermodulation Distortion (DIM); for intermodulation measurements (DIN-IEC 268-3, as of 1991).
A sinewave of higher frequency is superposed on a low-frequency squarewave.

The total amplitude only can be defined by the user. The square has the quadruple (peak) amplitude of the sinewave signal.

In the analog range, DIM is possible only with the LDG option and ”ANLG 25 kHz” selected; the sinewave is generated by the low-distortion generator.

With "ANLG 110 kHz" and "DIG 768 kHz", DIM is not possible.

Note: *An appropriate measurement function (only "ANLG 22 kHz") is to be set in the ANALYZER panel for intermodulation measurements to DIM (see 2.6.5.9).*

Note: *If the selection “Function tracking Gen → Anl“ is ticked off in the OPTIONS panel under menu item “Param Link“, the measurement function DIM is switched on in conjunction with the function changeover of the generator to DIM:*

DC Offset

See 2.5.4.1.2, Common Parameters for all Generator Functions

Square/Sin

For sine and square, selection is possible between 2 fixed frequency pairs.

2.96/14 kHz — Square signal 2.96 kHz, sinewave signal: 14.0 kHz

3,15/15 kHz — Square signal 3.15 kHz, sinewave signal: 15.0 kHz

Bandwidth

For analog generators only
In the analog range, the square signal is limited to 30 kHz or, optionally, 100 kHz.

30 kHz — Band limitation at 30 kHz

100 kHz — Band limitation at 100 kHz

SWEEP

see 2.5.4.2 Sweeps

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TOTAL VOLT

Entry of total amplitude of the square and sinewave signal; may be used as a sweep parameter.

Value range:

digital: 0 to 1 FS

analog: 0 to 10.155 V_{rms} for UNBAL (BNC)
or COMTST (XLR)
0 to 20.31 V_{rms} for BAL (XLR)

Caution: *Voltage limitation of the rms value by means of menu item "Max volt", see 2.5.2 Configuration of the Analog Generators / 2.5.3 Configuration of the Digital Generators*

Units:

digital: FS | %FS | dBFS | LSBs

analog: V | mV | µV | V_{pp} | mV_{pp} | μV_{pp} | dBu | dBV
V/V_r | dB_r | Δ %V | ΔV | ΔmV | ΔµV

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2.5.4.11 Random (Pseudo Noise)

Set generator signals which have the same or similar characteristics as noise (eg closely spaced sine lines in the frequency domain). There are two ways of defining these signals:

- Specify the amplitude density distribution in the time domain (Domain: TIME)
- Specify the amplitude frequency distribution in the frequency domain (Domain: FREQ)

This function is available in all generators.

DC Offset

See 2.5.4.1.2, Common Parameters for all Generator Functions

Domain

FREQ

Sine lines with settable amplitudes are generated and superposed on each other using defined frequency spacings to produce the output signal. In order to minimize the resulting peak value of the signal, individual lines can be phase-optimized relative to the other lines. Minimum form factors (= peak/rms) can thus be obtained. Depending on the selectivity of the analyzer, the output signal is not displayed as a sequence of single lines, but as a noise signal with continuous level above the frequency.
The frequency-defined noise allows for generating up to 7488 single tones with any amplitude (multitone).

Special application:
When the frequency spacing of the sine lines generated here **exactly** matches the analysis spacing used for the FFT, an FFT analysis is feasible without leakage. A selectivity of one line can thus be obtained with the square window. The setup consisting of this generator and analyzer allows you to precisely determine the frequency response of a device under test at one go.

Note: *As the optimization is very compute-bound, a few seconds of computing time before the output is started may be required by the generator, especially with small frequency spacings and wide noise band. →Status display: "GEN: BUSY". Entering data while GEN: BUSY is being displayed aborts the computations and the generator enters the GEN:HALTED state. The generator restarts automatically.*

TIME

In this mode, noise signal generation is effected by nested random functions which have been optimized to produce evenly distributed noise. Periodicity is the case only after a runtime of at least 1 day.

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Spacing

Definition of the frequency spacing, ie the space between the individual frequency lines:
(displayed with Domain = FREQ only)

USER DEF

The frequency spacing can be set. The value entered is corrected to the next settable value. The limits and settable frequency values depend on the sample rate (see 2.5.1 Selecting the Generator) and the generator selected. The lower frequency limit for the digital instruments is the ratio

system clock rate / 16384

The range of values depends on the sample frequency and the generator (f_{max})

Units: Hz, kHz

ANLR-TRACK

The value specified for the FFT analysis spacing is automatically adopted. The value is also displayed in the ANALYZER panel under "FFT:Resolution" (see 2.6.5.13 FFT). This setting is ideal for an analysis using the rectangular window. With no FFT selected in the analyzer, the setting is rejected (error message!).

Shape

(displayed with Domain = FREQ only)
Specify the function which is used to determine the amplitudes of the single sine lines.

WHITE

All the sine lines between start value (see below) and stop value have the same amplitude.

PINK

The amplitude of the sine lines between start and stop value is proportional to $\sqrt{1/f}$

THIRD OCT

As PINK, however band-limited to $^1/_3$ octave = 1 third octave (TOCT) with settable mean frequency.

FILE

The amplitudes of the single lines are set using floating numbers which are read from a file.

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Shape File

There are two different file formats for Domain Freq: the ASCII file with the extension .FTF which is generally written by the user and the shape file with the extension .VEQ! which is normally generated from trace data (sweep or FFT). The latter is also offered in the basic setting in the file panel. It can however be overwritten by the user. - For Domain TIME, a file cannot be loaded.

File format 1:
The file is a pure ASCII file where the amplitudes of the single frequency lines starting from 0 Hz are entered as floating numbers; the space between the lines is determined by ”Spacing” which can be entered in the panel. The numbers specify only the amplitude ratio between the lines and not the output amplitude (which is determined after phase optimization using ”VOLTAGE PEAK”). The file must have a line with the keyword `'FREQUENCY_FILE'` before the numbers. Comment lines begin with '#' and are allowed anywhere. No difference is made between upper-case and lower-case letters. The preset type of file is '.FTF' (= frequency table file).
Example: `'r&s_exam.ftf' in directory C:\UPD\USER.`

File format 2:

The shape file generated in the FILE panel with Store Trace/List is used. The inverted form of a frequency response is generally used (Invert 1/n ON) so that, using this "pre-distorted" spectrum, a flat frequency response can be achieved after the DUT. Both of the formats ASCII and REAL can be loaded, the standard file extension is: VEQ!

Using a shape file obtained from an FFT:
Feed the noise signal from the generator into the DUT, set an FFT with a rectangular window such that a closed trace (comparable with a sweep curve) is obtained and save the FFT as a shape file.
The essential settings in detail from left to right:

GENERATOR Panel:		ANALYZER Panel:		FILE Panel	
FUNCTION	RANDOM	FUNCTION	FFT	Store	EQUALIZATN
Domain	FREQ	Window	RECTANGULAR	Invert 1/n	ON
Spacing	ANLR TRACK			Filename	XXX.VEQ
Shape	WHITE				

To display the straightened trace, feed the noise signal to the DUT taking into account the shape file XXX.VEQ.

GENERATOR Panel:	
FUNCTION	RANDOM
Domain	FREQ
Spacing	ANLR TRACK
Shape	FILE
Shape file	XXX.VEQ

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Equalizer

(Displayed with Domain Freq only)

ON

See 2.5.4.1.3 Gem. Param. für SINE DFD MULTI RANDOM.
Each individual frequency line is equalized.

Equalizer switched on. Menu item "Equal. file" is activated, ie the file indicated there is loaded.

The set (peak or rms) voltage and the calculated crest factor refer to the *non-equalized* total signal (as is the case with single and multitone signals). The voltage measured at the outputs is not identical with the value indicated in the GENERATOR panel for "VOLT PEAK" and "VOLT RMS".

OFF

The output voltage of all frequency components of the noise signal is not affected.

Equal. file

(Equalizer file)
With Equalizer → ON only;
see 2.5.4.1.3 Gem. Param. für SINE DFD MULTI RANDOM.

Crest Fact

(Displayed with Domain Freq only)

Selection of the algorithm for determination of the phase angles of the singles sines and thus of the crest factor for the total signal.

OPTIMIZED

Automatic *minimization of the crest factor* by internally optimizing the individual phase angles

VALUE:

Specification of a *desired crest factor.* The phase angles of the single sines are modified internally such that the resulting crest factor approximates the desired value as close as possible. The accuracy of this method depends on the total number of lines thus spacing and frequency range.

Lower Freq

(Displayed with Domain Freq only)

Set the lower limit of the range for the generated noise (with Shape WHITE and PINK). The limits for this setting are

f_{lowlim}= 1 x spacing
f_{uplim} =117/256 x sample rate - 1 x spacing

The values entered are rounded to integer multiples of "spacing".

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Upper Freq

(Displayed with Domain Freq only)

Set the upper limit of the range for the generated noise (with Shape WHITE and PINK). The limits for this setting are

f_{lowlim} = lower frequency + 1 x spacing
f_{uplim} =117/256 x sample rate

The values entered are rounded to integer multiples of "spacing".

MEAN FREQ

(displayed with Domain Freq, Shape THIRD OCT only)

Set the mean frequency with one third-octave. The output starts with the line which is most closely to the center frequency / 1.12246 and ends with the line which is most closely to the center frequency x 1.12246

VOLT PEAK

Set the peak output level.

VOLT PEAK and VOLT RMS are coupled via the crest factor (which is constant for a specific signal). A change of VOLT PEAK therefore immediately affects the figure for VOLT RMS. If the crest factor is changed, RND PEAK will remain unchanged.

Specified range: 0 to V_{max}

digital: V_{max} = 1 FS
V_{max} = 10 V (Mode Common)
V_{max} = 2,5 UI (Mode Jitter)
analog: V_{max} = 16,97 V for UNBAL
V_{max} = 33,94 V for BAL

Units:

digital (audio data or phase mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr
digital (jitter mode):
UI | %UI | dBUI | ppm | ns | UIr | dBr
analog and digital common mode:
V | mV | µV | V/V_r | dBu | dBV | dBr | dBm | Δ%V | ΔV | ΔmV | ΔµV

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VOLT RMS

Set rms output voltage (with analog generators only).

VOLT PEAK and VOLT RMS are linked by the crest factor (which is constant for a specific noise signal). Therefore, a change of VOLT PEAK immediately changes the numeric value of VOLT RMS.

Units: V | mV | µV | V/V_r | dBu | dBV | dBr | dBm | Δ%V | ΔV | ΔmV | ΔµV

Note: *VOLT RMS can only be entered when the generator is RUNNING. While the noise signal is calculated (GEN BUSY) the crest factor is not yet known so that an entry is at first rejected and the voltage 0.0 is entered. To ensure that the generator outputs the noise signal with the correct (peak) amplitude after the calculation, it is recommended to enter VOLT PEAK which is possible any time.*

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PDF

(displayed with Domain = TIME)
(PDF = Probability Density Function) Select the amplitude distribution function of the output signal:

GAUSS

Normal (Gaussian) distribution which is cut off at triple the σ-value of the Gaussian distribution curve.

TRIANGLE

Triangle distribution from -peak to +peak.
Equivalent distribution from -peak to +peak.

EQUIVALENT

The Gaussian and triangle distributions are obtained by calculation on the basis of equivalent distribution.

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2.5.4.12 Arbitrary (User-Programmable Signal)

Output of any arbitrary waveform, which may consist of up to 16384 points (= samples). The waveform is read from a file, 2 different formats being supported.

DC Offset

See 2.5.4.1.2, Common Parameters for all Generator Functions

Filename

a) **AWD format:** Output file of the arbitrary waveform designer. The arbitrary waveform designers are software packages for generating any waveform that can be run on AT-compatible PCs (eg on UPD).
The files have the extension *.awd and can be generated with software UPD-K2 and AWD-K2. UPD-K2 is a version of AWD-K2, which has been adapted to UPD requirements, without the capability to load curves from DSOs.

Notes:

- *The curve in UPD-K2 should be set to ±1 for full output. A scaling in volts is not evaluated in the UPD.*
- *The signal path of the analog generator contains a lowpass filter, which causes phase distortions at higher frequencies.*
- *Sample rates of generators*
  ANLG 25 kHz: 96 kHz
  ANLG 100 kHz: 384 kHz
  DIG 48 to 768 kHz: set rate
  The curve is output with the selected sample rate. If the file is output with a higher sampling rate, the output frequencies are shifted correspondingly.

b) **ASCII format:** The individual samples are entered into the file as a sequence of numbers (FLOAT format). During the output, a numeric value of 1.0 corresponds to the peak voltage specified in the VOLTAGE PEAK field. The file must contain a line with the keyword `'TIMETAB–FILE'` in front of the numbers. Comment lines begin with '#' and are allowed anywhere. No difference is made between upper-case and lower-case letters. The preset type of file is '.ttf' (= time table file).

Example: `' r&s_exam.ttf' in the C:\UPD\USER directory.`

The loaded waveform is continuously repeated (without gaps) during output, even if less than 16384 points have been indicated.

The number of samples automatically results from the number of curve samples included in the file.

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VOLT PEAK

Set the peak output level.

VOLT PEAK and VOLT RMS are coupled via the crest factor (which is constant for a specific signal). A change of VOLT PEAK therefore immediately affects the figure for VOLT RMS.

Specified range: 0 to V_{max}

digital: V_{max} = 1 FS
V_{max} = 10 V (Mode Common)
V_{max} = 2,5 UI (Mode Jitter)

analog: V_{max} = 16,97 V for UNBAL
V_{max} = 33,94 V for BAL

Units:

digital (audio data or phase mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr

digital (jitter mode):
UI | %UI | dBUI | ppm | ns | UIr | dBr

analog and digital common mode:
V | mV | µV | V/V_r | dBu | dBV | dBr | dBm | Δ%V | ΔV | ΔmV | ΔµV

VOLT RMS

Only for format AWD und TTF; Setting of rms output voltage (in the analog generator only).

VOLT PEAK and VOLT RMS are coupled via the crest factor (which is constant for a specific noise signal). A change of VOLT RMS therefore affects the VOLT PEAK value.

Units: V | mV | µV | V/V_r | dBu | dBV | dBr | dBm | Δ%V | ΔV | ΔmV | ΔµV

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2.5.4.13 POLARITY (Polarity Test Signal)

Specific SINE^2 BURST signal with the following characteristics:

FREQUENCY: sample rate/80 (DIG 48 kHz)
1.2 kHz (ANLG 25 kHz)
ON-TIME: 1 cyc
INTERVAL: 2 cyc

The amplitude of the signal only can be selected by the user. The signal is not DC-free.

With "ANLG 25 kHz" and "DIG 48 kHz" only

DC Offset

See 2.5.4.1.2, Common Parameters for all Generator Functions

VOLTAGE

Entry of SINE2 amplitude;
Value range:
digital: 0 to 1 FS
analog: 0 to 12 Vrms for UNBAL (BNC)
or COMTST (XLR)
0 to 24 Vrms for BAL (XLR)

Caution: Voltage limitation of the rms value by means of menu item ”Max volt”, see 2.5.2 Configuration of the Analog Generators / 2.5.3 Configuration of the Digital Generators.

Units:
digital (audio data mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr
analog V | mV | µV | V_{pp} | mV_{pp} | μV_{pp} | V/V_r |
dBu | dBV | dBr | dBm |
Δ%V | ΔV | ΔmV | ΔµV

Peak-to-peak amplitude (analog): Vpp = Vrms x 2 x $\sqrt{2}$;

Vrms is the rms value during pulse time, the level during OFF time is not allowed for in rms value calculation.

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2.5.4.14 MODULATION (Modulated Sine)

Setting a modulated sinewave signal. Either FM or AM can be used. This function is only available for the instruments ANLG 25 kHz and DIG 48 kHz.

Note: *This generator function could be found as FM in the UPD software up to version 3.08. AM modulation could not be selected but the call parameter -tam could be activated. With the -tam parameter active, the previous FM function is converted into the AM mode when MODULATION is called.*

Mode

Determines the type of modulation.

FM

Frequency modulation; output of a frequency-modulated sinewave signal.

AM

Amplitude modulation; output of amplitude-modulated sinewave signal.

Mod Freq

Setting the modulation frequency

Specified range: 1 µHz to f_{max}
f_{max} depending on generator; see 2.5.1 Selecting the Generator

Carr Freq

Setting the carrier frequency

Deviation

Setting the deviation in % (FM mode) .

Specified range: 0 to 100 %

Example: *Output frequencies of 3960 Hz to 4040 Hz are obtained with 4 kHz carrier frequency and 1% deviation.*

Mod Depth

Setting of modulation depth in % (AM mode).

Specified range: 0 to 100 %

Example: *Output levels of 9.90 V to 10.1 V are obtained at 10 V carrier amplitude and 1% modulation depth.*

Carr Volt

Setting the carrier amplitude

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2.5.4.15 FSK (Frequency Shift Keying)

Frequency shift keying only for CCITT.O33; generates a sequence of two different sine frequencies, each frequency value being output for 9 ms (baud rate 110). The data coded like that can only be defined by the Option UPD-K33 or UPD-K1.
Frequency #1: 1850 Hz, logic 0
Frequency #2: 1650 Hz, logic 1

Volt no 1	Level for both frequencies

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2.5.4.16 DC Voltage

SWEEP CTRL

See 2.5.4.2 Sweeps

Voltage

Entry of DC amplitude; may be used as sweep parameter.

Specified range: digital (audio data mode):
0 to 1 FS
analog: 0 to 5 V for UNBAL (BNC) or COMTST (XLR)
0 to 10 V for BAL (XLR)

Caution: *Limiting of rms voltage with menu item 'Max Volt', see 2.5.2 Configuration of the Analog Generator / 2.5.3 Configuration of the Digital Generator*

Units:
digital (audio data mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr
analog: V | mV | µV | V_{pp} | mV_{pp} | $µV_{pp}$ | V/V_r |
dBu | dBV | dBr | dBm |Δ%V | ΔV | ΔmV | ΔµV

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2.5.5 Auxiliary Generator

An auxiliary generator is available in the digital generator in the source mode JITTER, which is able to generate sinusoidal data signals. Thus

- *digital* audio signals (sinewave) with adjustable frequency and amplitude and a
- *superimposed jitter signal* of any waveform

can be generated *simultaneously.*

This menu line can only be selected if the options UPD-B2 (AES/EBU interface) and UPD-B22 (Jitter) are fitted.

AUX GEN

Activate the auxiliary generator for generating an audio data stream with sinusoidal content.

OFF

Auxiliary generator switched off. An audio data stream with the content 0 is produced.

DIG DATA

The auxiliary generator produces a sinusoidal data signal.

Channel(s)

Set the channel for the sinusoidal audio data stream.

OFF

Both channels are off,
(frame transmission signal present, data content of both channels = 0)

1

Channel 1 contains sinusoidal data, channel 2 = 0

2

Channel 2 contains sinusoidal data, channel 1 = 0

2 ≡ 1

Sinusoidal data on both channels

2 ≡ -1

Sinusoidal data of channel 2 are shifted by 180° as against the data of channel 1.

Data Freq

Enter the frequency for the sinusoidal data content of the audio signal.

Value range: resolution up to 21.75 kHz
Resolution: sample rate / 192; corresponds to 250 Hz at 48 kHz
Units: Hz | kHz | ΔHz | ΔkHz | f/fr | Δ%Hz | Toct | Oct | Dec

Note: *When a (new) audio frequency is entered, the sinewave signal has to be newly calculated by the universal generator. This causes the jitter signal to be briefly interrupted.*

Data Ampl

Enter the amplitude of the sinusoidal data content of the audio signal.

Value range: 0 FS to 1 FS
Units: FS | %FS | dBFS | LSBs | bits

Note: *When a new audio data amplitude is entered, the sinewave signal has to be newly calculated by the universal generator. This causes the jitter signal to be briefly interrupte.*

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2.6 Analyzers (ANALYZER Panel)

Activate the ANALYZER panel:

UPD front panel:	ANLR key
External keyboard:	ALT + A
Mouse:	(repeated) click on the panel name, until the ANALYZER panel is displayed

If the ANALYZER panel is already visible on the screen, it can be activated also by actuating one of the TAB keys (repeatedly) or by mouse-click.
Advantage: The panel need not be established again.

Changing the analyzer *function* causes

- the current measurement function to be stored on the hard disk;
- the desired measurement function to be loaded from the hard disk, initialized and started (if possible)

Changing the *analyzer* (eg, DIG48 instead of ANLG22) causes

- the current analyzer to be stored on the hard disk with all settings and the current measurement function;

the desired analyzer with the active measurement function to be loaded from the hard disk, initialized and started.

Note: *The "parameter link" function which can be selected in the OPTION panel may be used to influence the UPD with changes of function and instrument. As requested, existing settings in the function and/or configuration segment of the GENERATOR panel are accepted for the new function or instrument - if physically possible. For instance, a change of instrument from ANLG 110 to ANLG 22 kHz can be performed without the current settings in the panel to change.*

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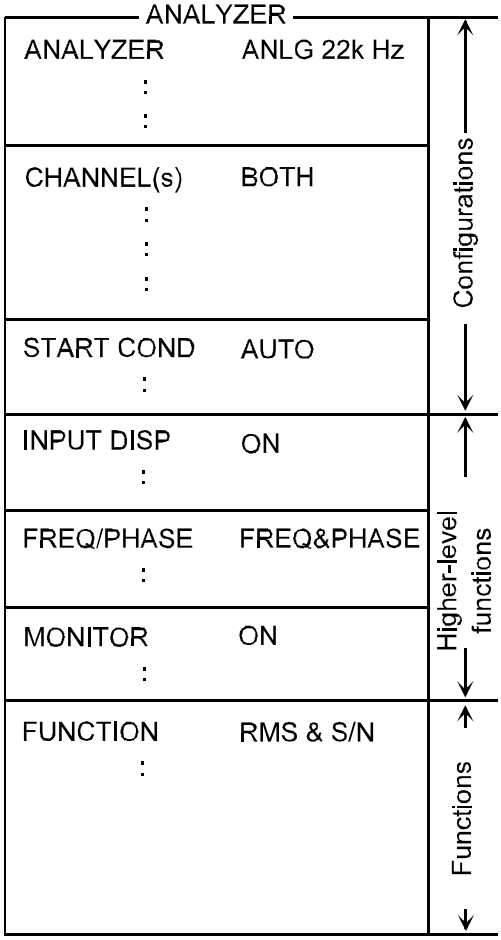
2.6.1 Selecting the Analyzer

The ANALYZER panel makes the settings for 3 analog and 3 digital analyzer instruments available.

It consists of the following segments:



Selection of the analog or digital instrument, lower measurement limit, reference impedance for power units, configuration segment for setting the test inputs.

(Input connectors, channel selection, input impedance, sample frequency, oversampling factor, etc.)
see 2.6.3 Configuration of the Digital Analyzers
see 2.6.2 Configuration of the Analog Analyzers

Ways of starting the analyzer, see 2.6.4

Input signal, see 2.6.5.16 Input Peak

Combined frequency / phase measurement, see 2.6.5.17

Connector for oscilloscope, see 2.6.6 Monitor output.

Functions, see 2.6.5.2 to 2.6.5.17

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When switching from one analyzer instrument to the other, the data of all segments are stored for the current instrument, the data of the new instrument are loaded and the panel contents can be entered anew. When changing to a different analyzer function, the settings in the configuration range are retained.

Measurement range limits of the ANALYZER instruments:

Table 2-17

Instrument[1)]	Lower limit	Upper limit
ANLG 22 kHz	DC/2 Hz/10 Hz	21.9 kHz
ANLG 100 kHz	DC/20 Hz	100 kHz
ANLG 300 kHz	DC/50 Hz	300 kHz
DIG 48 kHz	2 Hz/10 Hz	2)
DIG 192 kHz	10 Hz/100 Hz	2)
DIG 768 kHz	10 Hz/100 Hz	2)

1) The frequency value refers to the upper limit of the analog analyzers

2) Limit depends on sampling rate

Lower limit:

DC: Setting the DC function in one of the analog analyzer instruments results in DC coupling of the input unit

2 Hz/10 Hz: The menu item "Min Freq" in the analyzer instruments ANLG 22 kHz and DIG 48 kHz offers selection of the lower limit. If the test signal does no longer contain any frequencies below 10 Hz, the measurement speed can be increased by selecting the higher range limit.

- 2 Hz: Input unit is DC-coupled.
  The input unit is controlled by DC signals. Limit check responds to both AC and DC signals. A superposed DC signal may cause the switchover to a less sensitive range, thus possibly reducing the accuracy of AC measurements.
- 10 Hz: Input unit is AC-coupled.

20 Hz:
50 Hz: Input unit is AC-coupled.
These selection items are *displayed* in the "fast" analog analyzers (ANLG 100 kHz and ANLG 300 kHz) under menu item "Min Freq"; since these analyzers do not provide any other lower limit, this menu item is disabled, here.

10 Hz/100 Hz: Selection of the lower limit is offered in the "fast" digital analyzers (DIG 192 and DIG 768 kHz) under menu item "Min Freq". If the test signal does not contain any frequencies below 100 Hz, the measurement speed can be increased by selection of the higher range limit.

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Upper limit:

Signals can be measured up to this limit.

Measurement range limits of the digital analyzer instruments:

The maximum measurement frequency is given by

f_{max} = *sample frequency x oversampling factor x 117/256*

Set the sample frequency and the oversampling factor in the configuration segment of the ANALYZER panel using menu items Sample-Frq and Oversamp, respectively.

For more details, refer to 2.6.3 Configuration of the Digital Analyzers.

The internal sample frequency is given by:

f_{ab} = *sample frequency x oversampling factor*

External sample frequency (per channel)
(no oversampling factor selectable)

f_{abext} = *sample frequency*

Availability of functions depending on the ANALYZER instrument:

Table 2-18

Instrument	Measurement functions																
	RMS	RMS sel	PEAK	Quasi PEAK	DC	THD	THD +N	MOD DIST	DIM	DFD	Wow& Flutter	FFT	Polarity	Filter-Simulation	Cohe-rence	PhasToRef DigInpAmp	WAVE-FORM
ANLG 22 kHz	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	-	yes
ANLG 100 kHz	yes	yes	-	-	yes	yes	yes	yes	-	yes	-	yes	yes	yes	-	-	yes
ANLG 300 kHz	yes	yes	-	-	yes	yes	yes	yes	-	yes	-	yes	yes	yes	-	-	yes
DIG 48 kHz	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
DIG 192 kHz	yes	yes	-	-	yes	yes	yes	yes	-	yes	-	yes	yes	yes	-	-	yes
DIG 768 kHz	yes	yes	-	-	yes	yes	yes	yes	-	yes	-	yes	yes	yes	-	-	yes

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Higher-level functions:

The selected function can be complemented by higher-level supplementary functions.

INPUT DISP measurement: see 2.6.5.16

- PEAK Display of the peak values of the two input signals
- RMS Display of the rms value for the measurement functions THD, THD+N, FFT, MOD DIST and DFD
- BITS Display of the bit activity for the digital instruments

If INPUT DISP RMS is set and a measurement function is selected which does not allow for RMS display or where it does not make sense, "-----" is displayed in the Input RMS window. Other INPUT PEAK (such as PEAK) measurements can still be performed.

FREQ/PHASE measurement
see 2.6.5.17

- FREQuency display on all channels switched on
- FREQuency display on channel 1, PHASE display on channel 2; selectable only with two-channel measurement
- FREQuency display on channel 1, GRPDEL(group delay) display on channel 2, selectable only with two-channel measurement

Note:: If FREQ/PHASE, FREQ&PHASE or FREQ&GRPDEL is set (in the digital analyzer) and a measurement function is selected which does not allow for phase measurement or where it does not make sense, "-----" is displayed in the "Freq & Phase" window (channel 2). Two-channel frequency measurements (FREQ/PHASE FREQ) can still be performed.

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2.6.2 Configuration of Analog Analyzers

The two-channel analog analyzer features unbalanced, balanced and floating test inputs. Both channels can be configured individually, their measurement inputs are DC-decoupled from each other and from frame potential. The configuration is explained by way of the below ANALYZER panel and its menu items.

ANALYZER Panel

Min Freq

Selection and display of the lower frequency range limit.
Settable only with ANALYZER ANLG 22 kHz. With analyzers ANLG 1(kHz and ANLG 300 kHz it is a mere display function.
For ANALYZER ANLG 100 kHz and , mere display function.

2 Hz

DC coupling of the inputs with AC and DC measurements
Even with AC measurements, DC parts in the measurement signal control the input amplifier, which might reduce the resolution and accuracy of the display.

10 Hz

AC coupling of the inputs.
In balanced mode, however, the input resistors are always DC-coupled (see ”Impedance”).The DC function renders selection of this parameter ineffective (see 2.6.5.5, DC).

Ref Imped

(Reference Impedance)
Reference impedance as reference for computing the units dBm, W, Δ%W, ΔW, P/Pr and %P/Pr (see 2.4, Common Parameters of All Functions). The current setting is displayed. The reference impedance can be reset after having opened the selection window.

<Value>

Setting range 1 mΩ to 100 kΩ

Channel(s)

Select the input channels.

1

2

The selected channel only is active, the other one is switched off.
In balanced mode, the input impedance is retained at the XLR female connectors when the channel is switched off (see ”Input” BAL XLR, ”Impedance”).

1 & 2

Both channels are active and can be configured individually.

2 ≡ 1

Both channels are active and equally configured. Initial selection causes channel 2 to be set using the parameters of channel 1.

1 ≡ 2

Both channels are active and equally configured. Initial selection causes channel 1 to be set using the parameters of channel 2.

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Input

Select the input mode.
The current setting is displayed. (See also 2.12, Display of Selected Inputs and Outputs). The input mode can be reset after having opened the selection window.

UNBAL BNC

Unbalanced, floating inputs via BNC female connectors (see Fig. 2-17)
Deactivated inputs are floating and open.

BAL XLR

Balanced to ground, floating inputs via XLR female connectors (see Fig. 2-18).
Deactivated inputs are floating, set input impedances are retained.

GEN1
GEN2

Internal connection of a generator channel to the analyzer channels. Allows the device-internal measurement of the voltages at the generator connectors. The generator output is loaded by each analyzer channel by 2 x 100 kΩ in balanced mode and 100 kΩ in unbalanced mode (see Figures 2-19, 2-20 and 2-21). The input connectors (female) of the appertaining analyzer channels are inactive.

ANALYZER Panel

Impedance

Select the input impedance- selectable only in BAL-XLR mode.

1 M Ω

With balanced input, BAL XLR, balanced to ground, floating design.

300 Ω

As with impedance 300 Ω

600 Ω

As with impedance 300 Ω

20 kΩ

Allows the setting of a resistor in balanced mode, which you can fit into each of the channels (see ”User-definable Resistors” - at the end of this section).

USER DEF

Note: *In the UNBAL BNC mode, the only impedance provided is the high-impedance 1 M Ω input impedance, which is why the menu item is not offered.*

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Common

FLOAT

Common reference of potential of BNC input female connector, selectable in the UNBAL mode only.
BNC external conductor floating against frame ground.
Permissible voltage ≤ 25V AC or 50V DC against frame ground.

GROUND

BNC external conductor connected to frame ground (PE conductor).
Switchover to BAL-, GEN mode at a later date or switching off the set unbalanced channel renders the reference to ground ineffective.
Important:
Reference to measurement potential only, no safety connection to VDE 0411!
When connecting a measurement source, a current of 2 A via the device-internal ground connection should not be exceeded, otherwise the device may be damaged.

Range

Select the measurement range.
Allows the optimum voltage range to be set depending on the measurement sphere. After having opened the selection window, 3 modes are offered for selection.

AUTO

Automatic selection of the range.

FIX:

The set range is retained in any case.

Note: *When switching from AUTO →FIX, the currently valid channel range is used. In the configuration Channels → 2≡1 or 1≡2, the less sensitive of the two ranges of channel 1 and 2 is transferred.*

LOWER:

The set range is kept as the lowest range. Overloads cause higher ranges to be automatically switched over to.

After having chosen the FIX and LOWER modes, the rated value set for the range is displayed in the subsequent line where a new range can be set after having opened the selection window.

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Table 2-19 Ranges

Rated RMS or DC values	Input unbal	Input Bal	Analyzer ANLG	
			22 kHz	100/300 kHz
1 mV	yes	yes	- [1]	yes [2]
3 mV	yes	yes	- [1]	yes [2]
10 mV	yes	yes	- [1]	yes [2]
30 mV [1]	yes	yes	yes	yes [2]
100 mV	yes	yes	yes	yes
300 mV	yes	yes	yes	yes
1 V	yes	yes	yes	yes
1,8 V	yes	yes	yes	yes [2]
3 V	yes	yes	yes	yes

Rated RMS or DC values	Input unbal	Input bal	Analyzer ANLG	
			22 kHz	100/300 kHz
6 V	yes	yes	yes	yes [2]
10 V	yes	yes	yes	yes
18 V	yes	yes	yes	yes [2]
30 V	yes	yes	yes	yes
60 V	yes	-	yes	yes [2]
100 V	yes	-	yes	yes
180 V	yes	-	yes	yes [2]
300 V	yes	-	yes	yes

[1] With analyzer instrument ”ANLG 22 kHz”, the most sensitive measurement range is limited to 30 mV.
The great dynamic range of the audio A/D converter however allows measurements down to a few µV to be performed with a high measured value resolution (lower limit → 0 V).

[2] With the DC function, the next insensitive and valid range is internally set when selecting the range.
(see 2.6.5.5 DC)

An optimum dynamic range for the measurement of non-linear distortions is guaranteed by spacing the range below 1 V in 10-dB steps while using 5-dB steps in the range above 1 V. Overranges or underranges in the current measurement range causes the switchover to the next possible range provided that RANGE AUTO is selected. The same is true for RANGE LOWER, however switchover to the next lower range is performed only when the range limit selected in the menu is not violated.

The range values are rms values for sine or other waveforms with a crest factor of $\sqrt{2}$ or less.

Caution: *For measurements on dangerous contact voltages > 25 V AC or 50 V DC, observe the limit values to VDE 0411, Part 1.*
We recommend that the peak currents from a test voltage source be limited to the following maximum values:
for DC: to 2.0 mA
for AC to 1 kHz: to 0.7 mA
for AC > 1 kHz: to 0.7 mA x f/kHz, maximum 70 mA.
Furthermore, the reference point of the test source and the instrument frame should be grounded.

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Equivalent circuit diagrams of test inputs:

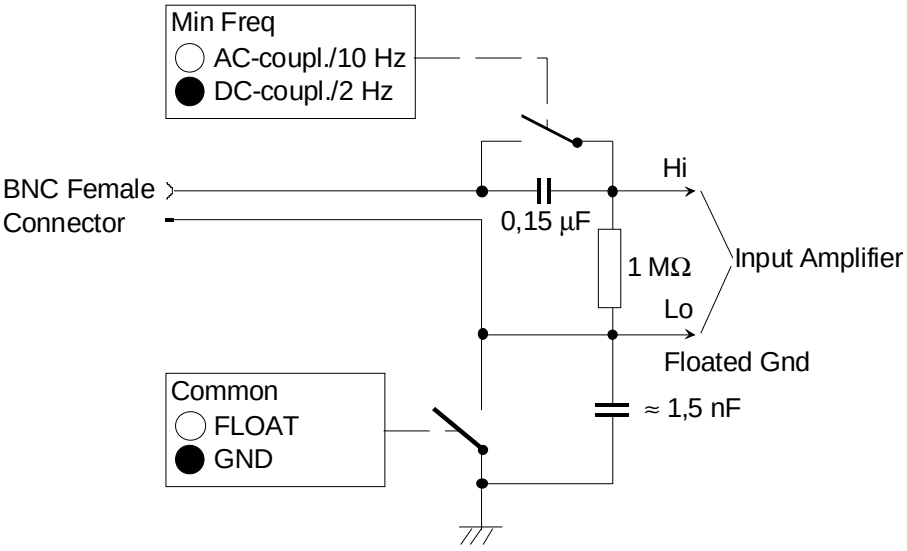

Fig. 2-22 Unbalanced input, Input UNBAL BNC (channel 1 or 2)

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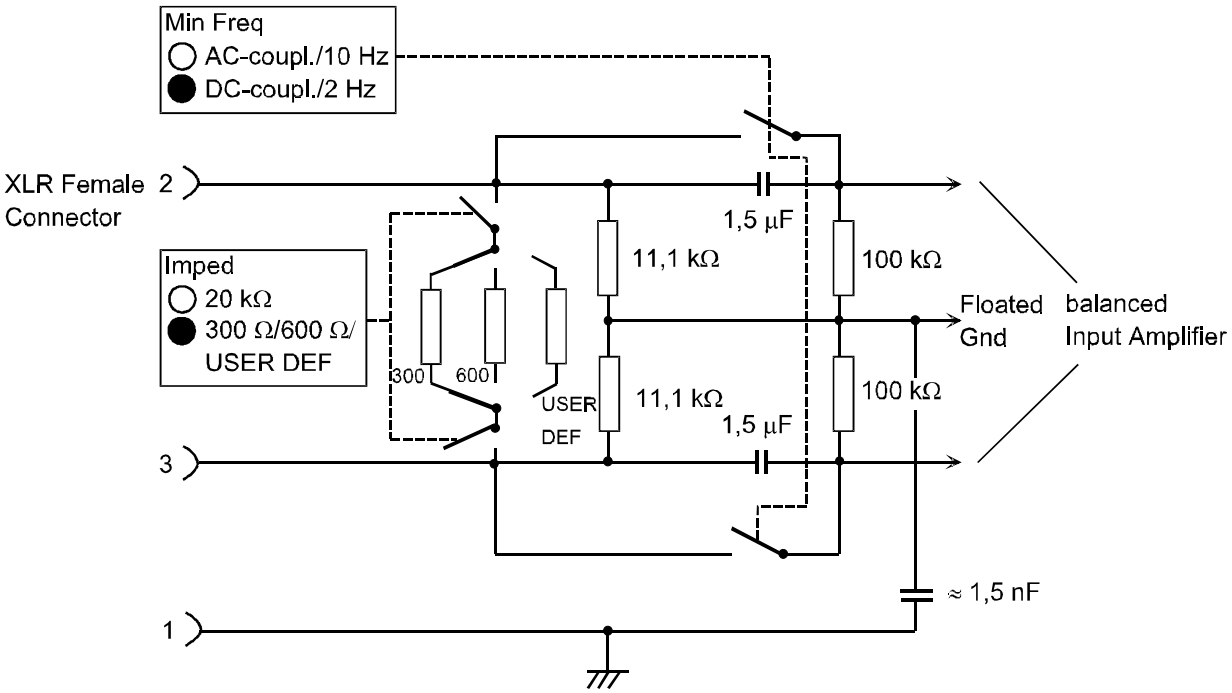

Fig. 2-23 Balanced input, (Input BAL XLR, channel 1 or 2)

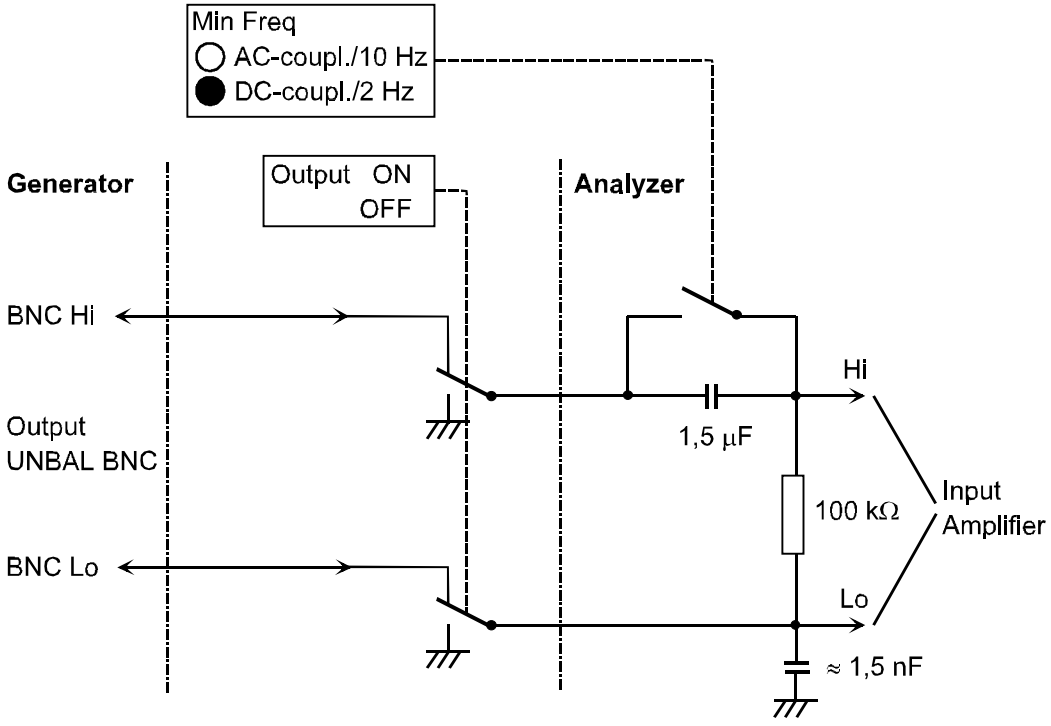

Fig. 2-24 Internal connection to generator output UNBAL BNC

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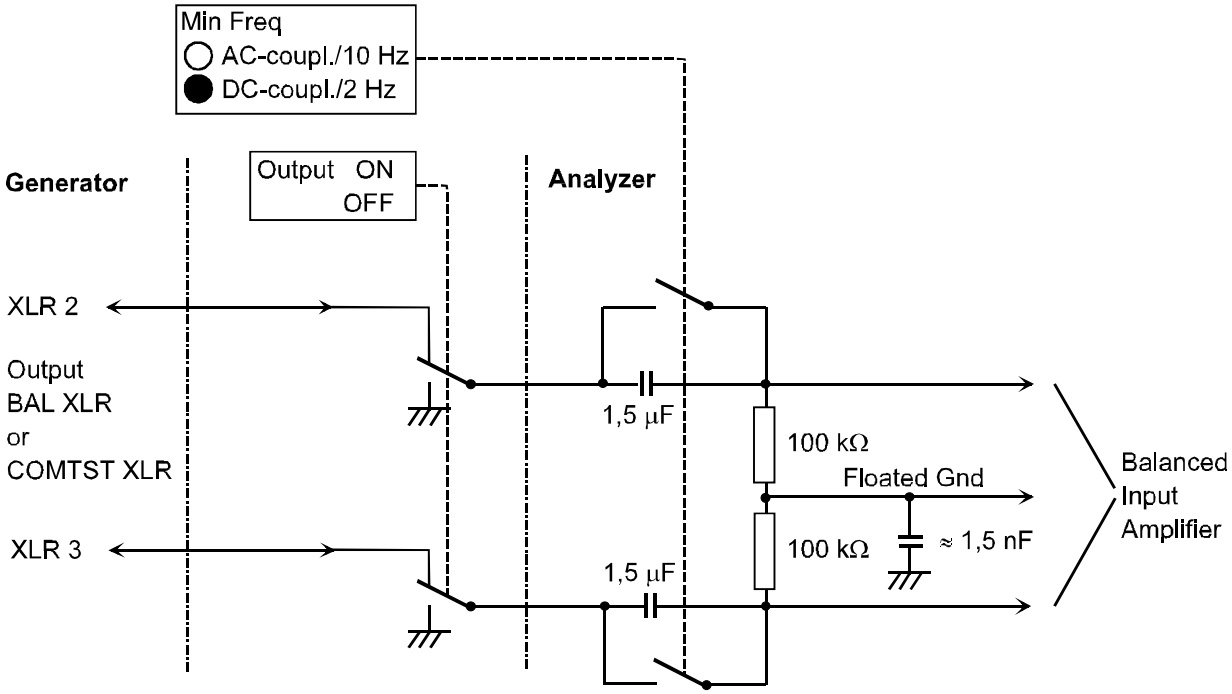

Fig. 2-25 Internal connection to generator output BAL XLR

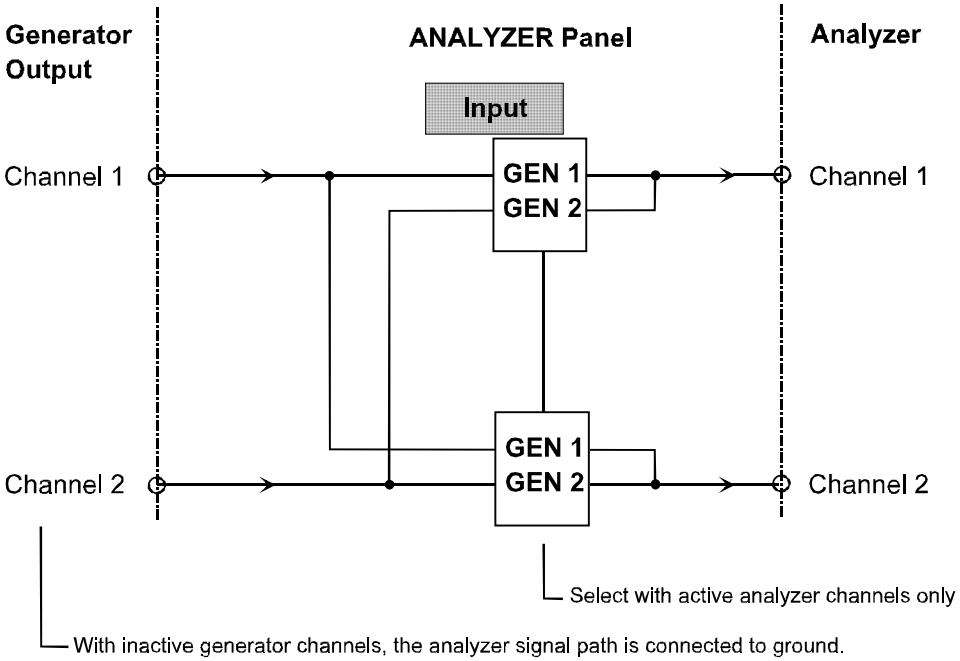

Fig. 2-26 Internal signal paths

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User-definable Input Impedances (USER DEF)

For specific measurement spheres, the input impedance of the balanced measurement input can be configured separately for each channel. Both analyzer channels in the UPD can each be retrofitted with one additional resistor.
Calculation and specification:

- R_{USER}, desired input resistance in the range about 1 Ω to max. 20 kΩ at the XLR female connector, resulting from paralleling the 20-kΩ input and the additional input resistor R.
- $$Fitted\ resistor\ R = \frac{1}{\frac{1}{R_{USER}} - \frac{1}{20\ k\Omega}}$$
- Max. loading capability: 1W
- With the USER DEF setting, limited maximum measurement voltage at the XLR female connector : $V = \sqrt{(1\ W \times R_{user})}$ or max. 35 V

Installation (by authorized service personnel only):

Note: *All boards are electrostatic sensitive devices. Handle them in line with ESD regulations.*

- ➢ Remove the power plug from the UPD.
- ➢ Withdraw the upper panelling and shielding cover (front-panel, right-hand).
- ➢ Withdraw the boards Analog Analyzer CH1 or, as the case may be, CH2 using the detent levers and disconnect the coaxial connections at the bottom side.
- ➢ Unscrew left-hand cover on component side.
- ➢ Solder the additional resistor to the soldering tags P250, P251.

Switch-on:
Select the parameter USER DEF in the dialog window of menu item ”Impedance”.

State as delivered:
No resistor is factory-fitted, leading to the effective input impedance of 20 kΩ when selecting the menu parameter USER DEF.

Monitor:
Connector for oscilloscope, see 2.6.6 - Monitor
Available for:
- all analog analyzer instruments

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2.6.3 Configuration of Digital Analyzers

Note: *Prior to setting the analyzer, the generator should be suitably configured as unwanted generator settings might cause unnecessary restrictions in the analyzer panel.*

If the generator is not used as a digital signal source, it is recommended to switch it to analog operation to prevent generator-dependent links to be established.

2.6.3.1 Common Settings:

Meas Mode

(Measurement Mode)
Displayed only when the analyzer instrument DIG 48 kHz is selected.

Specifies what should be measured at the digital interfaces. A selection is only possible if the Jitter option (UPD-B22) is fitted; without the option only audio data can be measured.

AUDIO DATA

Measurement of digital audio data.

Note: *Since only audio data can be measured in the fast digital analyzers (DIG 192 kHz and DIG 768 kHz), the menu item "Meas Mode" is not displayed.*

JITTER/PHAS

Measurement of jitter at the selected digital audio input and the phase offset to the reference signal (REF IN at the rear of the instrument).

COMMON/INP

Measurement of COMMON signal (at the AES/EBU connector) and the digital input amplitude (at the AES/EBU and the S/P DIF connector).

Note: *A COMMON measurement is not possible at the unbalanced digital input (S/P DIF). For this reason the function result of the COMMON measurement is always determined at the balanced output (AES/EBU) irrespective of the selected input. Selecting the digital input therefore only affects the measurement function DIG INP AMP and the frequency measurement SAMPLE FREQ.*

Note: *With measurement modes Jitter/Phas and Common/Inp, only measurement functions generating a level result are meaningful. For this reason the selection is limited to level measurement functions (RMS and peak) and FFT and waveform display. In the case of FFT, rms values are displayed.*

The measurements of Phase To Ref and digital input amplitude are selected as additional measurement functions in the Jitter/Phas or Common/Inp mode.

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Min Freq

2 Hz

10 Hz

100 Hz

Displayed only if Meas Mode AUDIO DATA is active.

Select the lower frequency range limit:

DIG 48kHz	Selection between 2 Hz/10 Hz
DIG 192kHz	Selection between 10 Hz/100 Hz
DIG 768 kHz	Selection between 10 Hz/100 Hz

All functions in AUTO (eg Meas Time AUTO) become faster with a higher frequency range limit, ie the measurement rate increases!

Channel(s)

1

2

BOTH

Displayed only if Meas Mode AUDIO DATA is active. All other analyzer modes affect the digital data *stream* and not the data *content* so that specifying the channel would be meaningless.

Set the currently active channel:

Measurement on channel 1 only; data of channel 2 are ignored.

Measurement on channel 2 only; data of channel 1 are ignored.

Measurement on both channels.

The meaning depends on the interface used, see the overview of interfaces below.

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Input

Select the input interface:

SERIAL MUX

Serial universal input, multiplexed; displayed only when Meas Mode AUDIO DATA is active.

SERIAL

Serial universal input; displayed only when Meas Mode AUDIO DATA is active.

PARAL

Parallel input, multiplexed, displayed only when Meas Mode AUDIO DATA is active.

PARALLEL

Parallel input; displayed only when Meas Mode AUDIO DATA is active.

AES/EBU

Balanced digital input, XLR; only with AES/EBU option UPD-B2 installed

S/P DIF

Unbalanced digital input, BNC; only with AES/EBU option UPD-B2 installed.

Note: *In the Meas Mode COMMON/INP (with Jitter option UPD-B22) a warning is displayed that a COMMON measurement cannot be performed at the digital input. The COMMON MODE signal is always measured at the AES/EBU connector irrespective of the digital input selected. Only the DIG INP AMP and the SAMPLE FREQ measurement are made at the S/P DIF.*

OPTICAL

Digital input, optical, TOSLINK, with AES/EBU option UPD-B2 only.

INTERN

Digital input, from internal generator.
Without the Jitter option UPD-B22, also the generator must be set to INTERN for an internal measurement.
With Jitter option UPD-B22, an internal measurement can be performed even if the generator is set to *AES/EBU, S/P DIF* or *OPTICAL*.

Available interfaces depending on the instrument used:

- DIG 48kHz: all interfaces in all modes
- DIG 192kHz: AES/EBU, S/P DIF, OPTICAL, INTERN no longer possible
- DIG 768kHz: SERIAL and PARALLEL only (no MUX operation)

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Table 2-20 Overview of interfaces

Input	Channel	Explanation
SERIAL	1 2 BOTH	Measurement on channel 1 Measurement on channel 2 Measurement on both channels
SERIAL MUX	1 2 BOTH	Multiplexed input on channel 1 Only samples with a Wordselect line status identical to the Wordselect setting are measured. Multiplexed input on channel 1 Only samples with Wordselect different from Wordselect setting are measured. Multiplexed input on channel 1. Both channels are measured.
PARALLEL	1 2 BOTH	Measurement on parallel interface Measurement on second parallel interface, with UPD-B3 (high-speed) option only. Simultaneous measurement on both interfaces, with UPD-B3 option only.
PARAL MUX	1 2 BOTH	Multiplexed input Only samples with Wordselect identical to WordselCh1 setting are measured. Multiplexed input Only samples with Wordselect different from WordselCh1 are measured. Multiplexed input Both samples with Wordselect = HIGH and = LOW are measured.
INTERN (*without* UPD-B22)	1	Only 1 channel possible
AES/EBU S/P DIF OPTICAL INTERN (*with* UPD-B22)	1 2 BOTH	Measurement on channel 1 Measurement on channel 2 Measurement on both channels

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Sample Freq

32 kHz

44,1 kHz

48 kHz

VALUE:

AUTO

CHAN STATUS

Displayed only when Meas Mode AUDIO DATA is active.

Set the signal sample rate.

When the sample frequency (numeric entry or preset) is selected, the analyzer is informed on the sample frequency of the test signal to enable the correct measurement of the audio signal frequencies. This information is irrelevant for analyzer synchronization.
Range for VALUE: 30 kHz to 52.5 kHz.

Without the *jitter option* and with inputs SERIAL, SERIAL MUX, PARALLEL and PARAL MUX, an appropriate internal clock is generated when one of the 3 fixed frequencies is selected. This clock is available at the interfaces for control of an external circuit; otherwise this (generated) clock is irrelevant for the measurement.

When selecting VALUE, an entry field is displayed in the next line where the frequency applied can be entered; clocks at the interface are not generated in this case.

The measured sample rate is automatically entered as the Sample Freq. The sample rate is updated once every second if the value has changed by at least 0.01%.

For determining the Sample Freq, the respective channel status bits in the AES/EBU protocol are decoded. Depending on the format (consumer or professional) different bits are interpreted (24 to 27 or 6 to 7). The sample rate is updated as soon as the channel status bits show another sample rate.
If the channel status bit does not provide any information ("not indicated") or if protocol analysis is switched off, the sample rate determined last is retained but can be changed by the user.

Important: *If the frequency set does not match the frequency applied, all filters and frequency measurements are correspondingly shifted in frequency! The frequency applied to the UPD (sample rate) must not exceed the respective maximum sample clock rate (48000 Hz x maximum permissible oversampling rate) of the selected instrument by more than 10%. Otherwise faulty measurements may occur or the measurement is aborted.*

Oversamp

1
2
4
8
16

(Oversampling)
Set a clock multiplier; depending on the instrument, 1 to 16 are selectable, see Overview.

Note: *This oversampling factor refers to the full word length. Higher oversampling factors (eg 64) are often used with bit stream converters (1-bit-sigma-delta converters). The converters are usually controlled with an oversampling factor of 1.*

The internal system clock rate (also referred to as sample rate) is given by:

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System clock rate = basic clock rate ¥ oversampling

Specifying the frequency by selecting VALUE does not permit selection of an oversampling factor; the internal sample frequency matches the external one.

Table 2-21

Instrument	Basic clock rate [kHz]	Multiplex possible	Oversampling possible factors
DIG48	32 44.1 48	yes	no
DIG192	32 44.1 48	yes	* 2, * 4,
DIG768	32 44.1 48	no	* 2, * 4, * 8, * 16

Hence, the following frequency ranges of the digital ANALYZER instruments result:

f_{max} = sample rate x 117/256

Maximum measurement frequency in kHz

Table 2-22

	Sample frequency	Oversampling factors				
		1	2	4	8	16
DIG 48 kHz	32 kHz 44.1 kHz 48 kHz	14.63 20.15 21.94	---- ---- ----	---- ---- ----	---- ---- ----	---- ---- ----
	VALUE 100 Hz to 52.5 kHz	direct entry of frequency without oversampling factor 117/256 x clock rate				
DIG 192 kHz	32 kHz 44.1 kHz 48 kHz	14.63 20.15 21.94	29.25 40.31 43.87	58.50 80.62 87.75	---- ---- ----	---- ---- ----
	VALUE 100 Hz to 300 kHz	direct entry of frequency without oversampling factor 117/256 x clock rate				
DIG 768 kHz	32 kHz 44.1 kHz 48 kHz	14.63 20.15 21.94	29.25 40.31 43.87	58.50 80.62 87.75	117.00 161.24 175.50	234.00 322.48 351.00
	VALUE 100 Hz to 1000 kHz	direct entry of frequency without oversampling factor 117/256 x clock rate				

The two's complement is used as **data format** (signed integer).

Examples:
MSB, ... LSB: 0010000...0 = +0.25 x full scale
MSB, ... LSB: 0111111...1 = +1.00 x full scale
MSB, ... LSB: 1000000...0 = -1.00 x full scale
MSB, ... LSB: 1100000...0 = -0.50 x full scale
(MSB = most significant bit)

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2.6.3.2 Serial Universal Interface

Located on the UPD front panel, labelled DIGITAL AUDIO INPUT, 15-contact sub-D connector.

Wordlength

8
16
24
32

Set the data bits per input sample:
8, 16, 24 or 32 bits.

Wordoffset

Set the position of the synchronizing pulse or wordselect signal (see Fig. 2-22) relative to the beginning of the sample data.
Range: -WordLength/2 ... +WordLength/2-1. The softkey allows the significance of the audio bits to be altered. Shifting the synchronizing pulse by one bit position towards the MSB (= smaller word offset) 'doubles' the signal amplitude. With the signal amplitude being between 0.5 and 1.0 FS (full scale) (and therefore doubling being not possible), a maladjusted word offset causes incorrect measurements because any less significant bit is always interpreted as MSB, except when the setting is correct. With the word offset of the converter being unknown, the proper position must be determined using the trial-and-error method.

Audio Bits

Word width of analyzed audio samples in bits.

The value range depends on the word length:

With word length	= 8:	8
	= 16:	8 to 16
	= 24:	8 to 24
	= 32:	8 to 28

If the word width is reduced, the values of the audio samples are cut to the specified word width.

Word clock

RISING

FALLING

Set the polarity of the synchronizing pulse: RISING or FALLING (active edge).

Bit clock

RISING

FALLING

Set the polarity of the bit clock: RISING or FALLING.

Note: *Faults in transmission (sporadic errors) may be remedied by inverting the bit clock. The reasons for errors of this type may be crosstalk of the clock line on the data or violation of the setup- and / or holdtime request of the receiver.*

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Bit Order

Set the bit order:

MSB FIRST The less significant bit is the first to be received.

LSB FIRST The most significant bit is the first to be received

WordselCh1

(This setting appears with SERIAL MUX only). Set the assignment of channel 1 with SERIAL MUX:

LOW Channel 1 is assigned low-level on the WORDSEL A (PIN 11) line.

HIGH Channel 1 is assigned high-level on the WORDSEL A (PIN 11) line.

Terminal conditions:

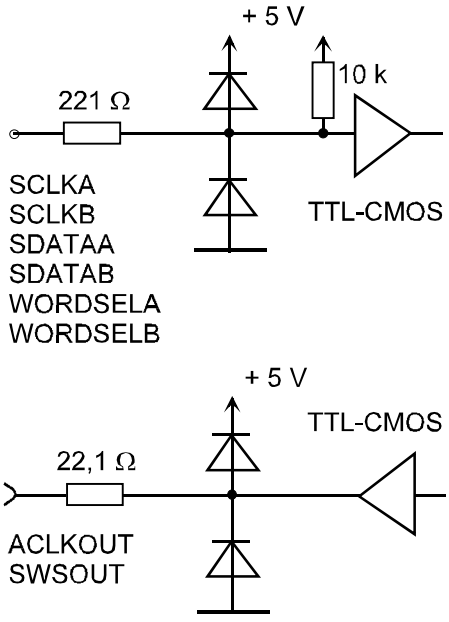
All outputs (clock lines) are operated by modules of the 74AC-family via a protective resistor of 22 Ω and are thus temporarily short-circuit proof. A short-circuit too long causes the driver module to be excessively heated, which may then fail. All inputs feature TTL switching thresholds and are applied via a protective resistor of 220 Ω to modules of the 74ACT-family.

Setup time: (the time during which, before a clock pulse, data must not change): 15 ns
Hold time: (the time during which, after a clock pulse, data must not change): 5 ns

Fast switch-off:

Pressing the OUTPUT OFF key causes all outputs (except for OUT5V) to be switched to high-impedance states (TRI-STATE). Clock signals are applied again when depressing the OUTPUT OFF key once more.

Table 2-23 Pin assignment and signals (serial interface):



Signal name	Pin	Remark
GND OUT5V GND	7,8 12 1,2	 5 V, 50 mA
Channel 1: SCLKA SDATAA WORDSELA	 9 10 11	With SERIAL MUX: channel 1&2 Input, bit clock Input, audio data Input, synchronizing pulse or wordselect
Channel 2: SCLKB SDATAB WORDSELB	 15 14 13	 Input, bit clock Input, audio data Input, synchronizing pulse
ACLKOUT SWSOUT	4 5	Output, bit clock output (8 to 32-fold audio clock) Output, audio clock

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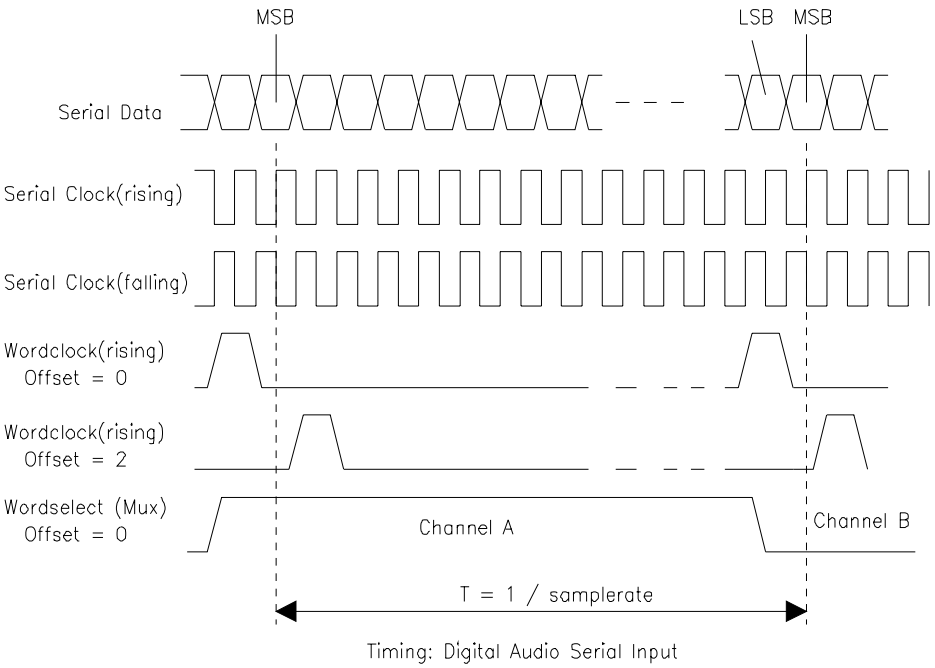
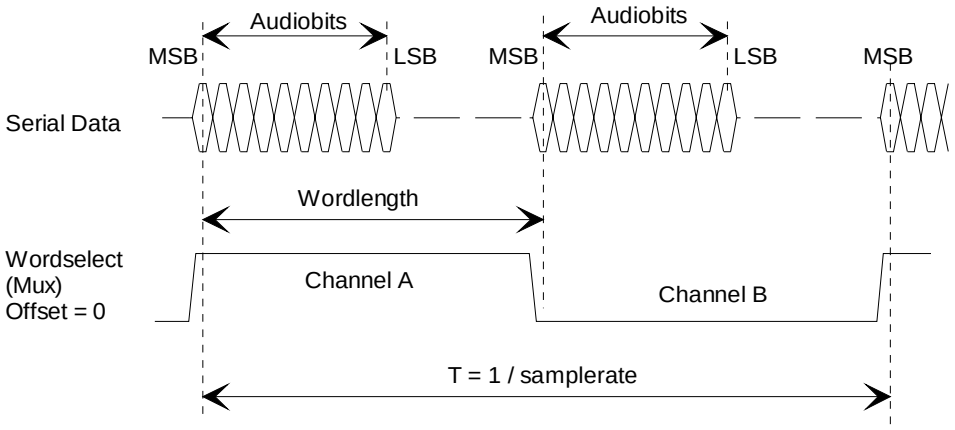
Timing:



Timing: Digital Audio Serial Input

Fig. 2-27

Timing:

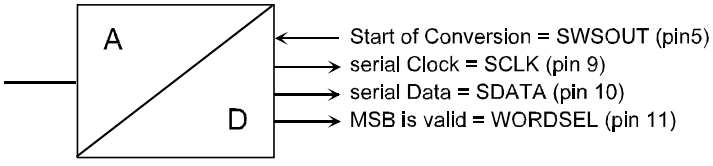


Timing: Digital Audio Serial Mux Input/Output

Fig. 2-28

Example:
In the following, the connection of the analog/digital converter ADC MAX121 is given by way of example.

Wiring:



Setting UPD:

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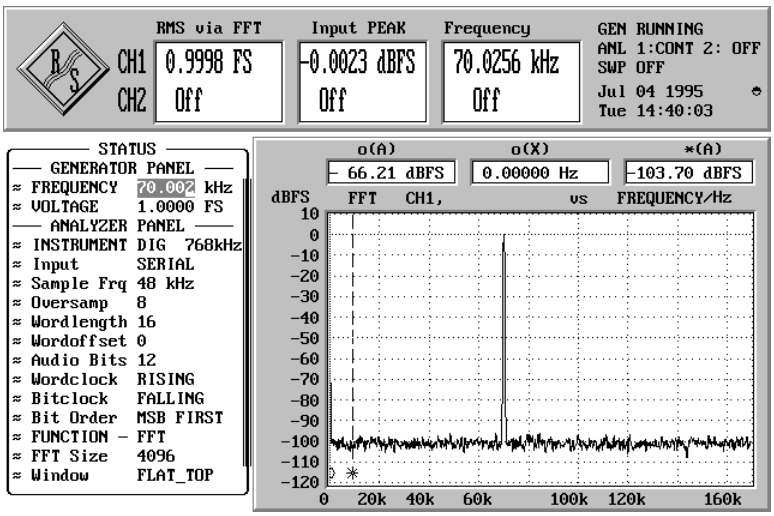

Bit rate = 48 kHz x 8 x 16 = 6.144 MHz

Max. signal frequency = $\frac{117}{256}$ x sampling rate = $\frac{117}{256}$ x 48 kHz x 8 = 175.5 kHz

2.6.3.3 Parallel Interface:

Located on the UPD rear panel, labelled with DIGITAL AUDIO INPUT, 37-contact D-SUB connector. The interface is located on the Digital Analyzer board or on the UPD-B3 option (high-speed extension).

Note:

- *with PARALLEL input (not multiplexed), channel 2 can be selected only when the High-speed option is fitted.*
- *with PARALLEL input (multiplexed), the female connector labelled with 'Channel 1/2' can only be used.*

Settings:

Audio Bits

Word width of analyzed audio samples in buts.

Value range: 8 to 28

If the word width is reduced, the values of the audio samples are rounded to the specified word width.

WordselCh1

(This setting appears with PARAL MUX only). Set the assignment of channel 1 with PARAL MUX:

LOW

Channel 1 is assigned low-level on the LR line.
see Table 2-23

HIGH

Channel 1 is assigned high-level on the LR line.
see Table 2-23

Word clock

Set the polarity of the strobe signal (RISING or FALLING). For more details, refer to Timing.

RISING
FALLING

Table 2-24 Pin assignment and signals (parallel interface):

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Signal name	Pin	Remark
GND	16	
OUT5V	17	5 V, 50 mA
GND	19	
GND	18	
Digital Audio Bit 27 (MSB)	2	
Digital Audio Bit 26	3	
Digital Audio Bit 25	4	
Digital Audio Bit 24	5	
Digital Audio Bit 23	6	
Digital Audio Bit 22	7	
Digital Audio Bit 21	8	
Digital Audio Bit 20	9	
Digital Audio Bit 19	10	
Digital Audio Bit 18	11	
Digital Audio Bit 17	12	
Digital Audio Bit 16	13	
Digital Audio Bit 15	14	
Digital Audio Bit 14	15	
Digital Audio Bit 13	20	
Digital Audio Bit 12	21	
Digital Audio Bit 11	22	
Digital Audio Bit 10	23	
Digital Audio Bit 09	24	
Digital Audio Bit 08	25	
Digital Audio Bit 07	26	
Digital Audio Bit 06	27	
Digital Audio Bit 05	28	
Digital Audio Bit 04	29	
Digital Audio Bit 03	30	
Digital Audio Bit 02	31	
Digital Audio Bit 01	32	
Digital Audio Bit 00 (LSB)	33	
LR (Wordselect)	34	Evaluated with PARAL MUX only
PSTROBE	35	Read clock (audio clock)
PCLKOUT	36	Output, bit clock output (32 * set clock rate)
PWSOUT	37	Output, set audio clock

Important: *Always connect external devices adjusting to the MSB, as otherwise the most significant bits are read with incorrect signs (leading to faulty measurements).*

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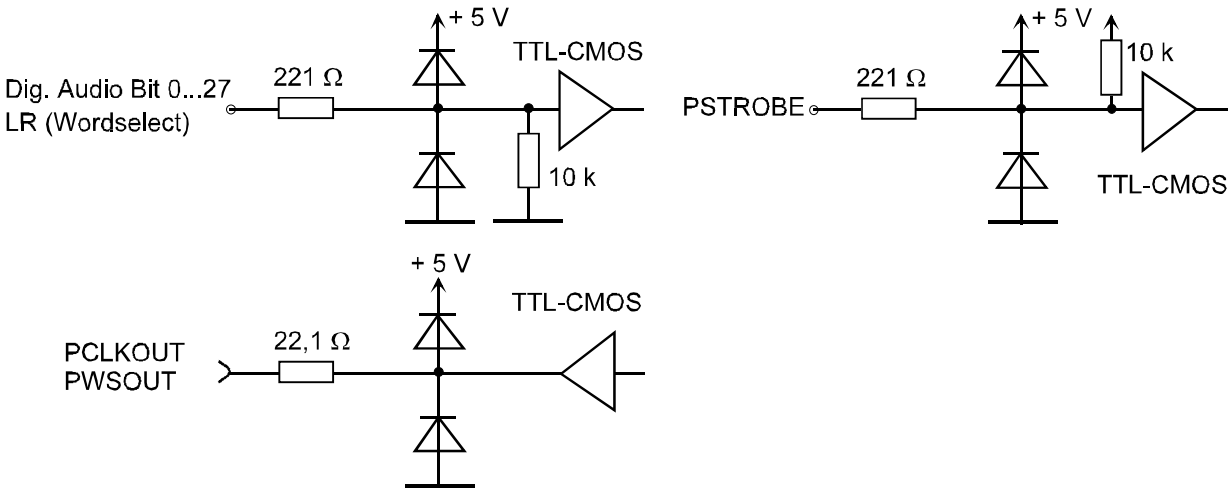

Terminal conditions and fast switch-off: as with serial interface

2.6.3.4 Digital Interfaces AES/EBU, S/P DIF, OPTICAL

Measurements on these interfaces are possible only if the AES/EBU option (UPD-B2) is installed and the analyzer instrument DIG48kHz is selected.

The input data are read by the UPD-B2 option (AES/EBU S/P DIF). After the extra bits (validity, parity, user bits, ...) have been removed, the audio data are transferred to the analyzer.

If the Jitter option (UPD-B22) is installed in addition,

- the jitter of the digital signal can be measured on all three interfaces,
- the phase reference between the selected digital input and the reference input can be determined,
- the digital input amplitude can be measured at both electrical inputs,
- a common-mode signal can be measured at the AES/EBU interface.

All mentioned signals can be produced by the generator with the aid of the jitter option.

Ch1 Imped

Displayed only if the jitter option is *not* installed and the AES/EBU input is selected.

110 Ω

10 kΩ

Selection of input impedance

Termination of balanced AES/EBU line with the rated impedance.

High-impedance monitoring of UPD on existing connection

Sample Frq

See 2.6.3, Configuration of Digital Analyzers

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Jitter Ref

(Jitter reference)
Displayed only with installed jitter option if Meas Mode JITTER/PHASE is selected.
Specify the signal the *jitter* measurement should be referenced to.

Note: *The phase measurement is always referenced to the REF input.*

VARI (PLL)

The reference signal is the sample signal obtained from the input signal via the sync PLL. Synchronization is via the VCO with maximum capture range (sample frequency 30 kHz to 52.5 kHz).
Not possible if Src Mode JITTER/PHASE has been selected in the generator because the generator needs the internal PLL for phase generation.

32.0 (PLL)
44.1 (PLL)
48.0 (PLL)

The reference signal is the sample signal obtained from the input signal via the internal sync PLL. Synchronization is via the fixed-frequency VCXO.
Not possible if Src Mode JITTER/PHASE has been selected in the generator because the generator needs the internal PLL for phase generation.

Note: *Synchronization to the input signal by means of the internal PLL should only be selected if the jitter signal is generated by an external unit.*

GEN CLK

Reference signal is the generator clock.
Possible *only* if also the generator is synchronized to the internal generator clock (Menu item "Sync To GEN CLK" in the GENERATOR panel).

Note*:* *GEN CLK is only useful if the jitter signal is generated by the internal generator.*

Audio Bits

Displayed only if Meas Mode AUDIO DATA is selected.

Word width of analyzed audio samples in bits.

Value range: 8 to 24

If the word width is reduced, the values of the audio samples are rounded to the specified word width.

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Range

Selection of measurement range

Displayed only with jitter option fitted and Meas Mode JITTER/PHASE or COMMON/INP selected.

Permits optimum setting to a voltage range which depends on the jitter or common-mode signal.

AUTO

Automatic range selection

FIX (MAX)

The highest measurement range available in the Meas Mode is set and maintained.

Note: *Internally, FIX (MAX) corresponds to the analog 3 V range of the 100 kHz analyzer.*

.

2.6.3.5 Measuring the Jitter, Phase and Common Mode

With digital audio interfaces there are two types of signals that have to be measured, eg in the course of a quality check. One is the digitally coded analog signal, the other the digital signal. The digital signal, too, has analog parameters such as peak-to-peak voltage, frequency, etc. It may be subject to interference like an analog signal. This means that noise or other AC voltages may be superimposed which could cause the edges to be shifted. This effect is called jitter and, if it is large enough, the audio signal can no longer be decoded or regenerated correctly. Since the employed decoders often fail far before the theoretical limit is reached, the information on the jitter response obtained in practice within the system is of great importance.

The lines for the signal connections can be configured as balanced lines, which is quite usual in analog technology. Thus, coupled in interference, eg from ground (hum) loops should be ineffective. However, in practice this attenuation is not always sufficient so that a common-mode voltage from a certain value upwards may also prevent signal decoding and regeneration. The UPD can measure this common-mode voltage on the digital signal. Of course, common-mode voltages are not possible on the unbalanced and the optical output.

The UPD can thus measure two types of interference of digital signals: the shift of the signal slopes (jitter) and the superposition of a common-mode voltage on digital lines. The analog analyzer is available for measuring these interfering voltages. The functions RMS (&S/N), peak as well as FFT analysis and oscilloscope display (WAVEFORM) are particularly suited for practical applications. The spectral analysis permits first conclusions to be drawn as to the cause of the interference (eg superimposed AC hum or switching power supply). The interference caused by the common-mode voltage can be directly read as voltage.

Jitter and delay are normally specified in UI (unit interval). UI is defined as the smallest pulse width of the digital audio signal (eye width) and is independent of the selected sampling rate. An UI corresponds to the clock period of the digital signal (biphase clock). With digital audio signals, one UI corresponds to a 128th of the sampling period, at 48 kHz it is approx. 163 ns.

For measuring the jitter a reference clock must be available. For this purpose a highly stable internal oscillator or a PLL (phase locked loop) can be used if the UPD is externally synchronized (via the " "Sync In" connector at the rear panel). The PLL integrates phase deviations as a function of time. Since both the internal oscillator and the PLL are also used for the digital generator, analyzer and generator cannot be set completely independent of each other.

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If several digitally coded signals have to be combined, as is common practice in studios for instance, the concurrence of the signals is also of importance. Associated frames containing the instantaneous values (samples) of the left and the right channel must not be delayed such that they can no longer be combined. Excessive delays may cause samples to be left out or doubled. The UPD can measure this shift as the phase between the digital input on the front panel and the reference channel ("Ref In" connector at the rear).

2.6.3.6 Digital Interface INTERN:

Internal digital connection between generator and analyzer.

Measurements on this interface are only possible when the analyzer instrument DIG48Hz is selected.

Caution: *If the jitter option (UPD-B22) is not installed, the interface INTERN must also be selected for the generator. The sample rate is fixed at 43619.7917 Hz and a measurement is only possible in 1 channel.*

With the jitter option installed, interface AES/EBU, S/P DIF, OPTICAL or INTERN may be selected for the generator and the measurement can be made in 1 or 2 channels.

Audio Bits

Word width of analyzed audio samples in bits.

Value range: 8 to 28

If the word width is reduced, the values of the audio samples are rounded to the specified word width.

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2.6.4 Ways of Starting the Analyzer, Ext. Sweep

Available for

all six ANALYZER instruments.

Theory of operation

"START COND" determines when, how often or the conditions which must prevail to trace measured values.

Depending on the selection of START COND, the measured value is - when the conditions required for tracing of measured values are met - triggered, displayed in the measurement result window and saved in an UPD-internal trace buffer. The trace buffer may contain up to 17 k (17408) measurement data depending on the application.

The measured value list can be displayed or represented in the form of graphics (see 2.10). If the options UPD-K1 or UPD-B2 are fitted, it can also be read in via a self-controlled program or external controller.
Depending on the selection of START COND, the measurement either starts immediately (AUTO) or only when the desired trigger condition is fulfilled.
With START COND not AUTO, an external sweep (START COND → FREQ CH1/2, FRQ FST CH1/2, VOLT CH1/2) or periodic measured value tracing (START COND → TIME TICK, TIME CHART) or armed single (START COND→LEV TRG CH1/2) is started using the START or SINGLE keys (see 2.11 Starting and Stopping a Measurement).

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START COND

(Start Condition) specifies an event triggering off a measurement.

AUTO

Continuous measurement mode without trigger condition. The measured values are stored in the trace buffer only, if the frequency sweep of the selective RMS measurement or any generator sweep is active, simultaneously.
The SINGLE or START keys allow you to switch between single and continuous measurement when no sweep is active.
The AUTO mode must be activated to enable the sweep of the frequency of the selective rms measurement (see 2.6.5.3 RMS SELECT) or of the generator parameters (see 2.5.4.2). Several sweeps at the same time are not permissible and can therefore not be set.

TIME TICK

The measured values are triggered at regular intervals. The intervals for starting measurements are determined by the distance between the time ticks. The measured values are entered in the buffer and displayed in the measurement result window.

The START key is used to start a sequence of periodic tracings of measured values, which is restarted from the beginning when the number of sweep points specified under ”Points” is reached.
If the time tick is greater than the measuring time, the next time tick is waited for after each single measurement; no measurement is performed during this period.
If the time tick is smaller than the measuring time, the next time tick is only triggered after completion of the measurement. The sweep is then indicated with corrected X axis, i. e. the single measured values are entered with correct timing.
The SINGLE key allows you to start a single sequence of periodic tracings of measured values. The sweep enters the SWP TERMINATED state when the number of sweep points specified under ”Points” is reached. The analyzer state is then ”TERMINATED”.

TIME CHART

Measured values (of the running continuous measurement) are entered in a time chart in the time pattern that can be entered under "Time". Contrary to TIME TICK, where a new (single) measurement is started with each tick and the result is only entered after completion of the measurement, TIME CHART also permits to display intermediate results. This is useful in particular in the case of quasi-peak measurements.

TIME cannot be simultaneously active with the frequency sweep of the selective rms measurement or any generator sweep!

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START COND

FREQ CH1
FREQ CH2

Tracing of measured values because a change in frequency was noted at ANALYZER input channel 1 or channel 2.

FRQ FST CH1
FRQ FST CH2

With the START or SINGLE key, an external frequency sweep is started, which in turn starts a single measurement on the occurrence of a trigger event or, as the case may be, after a delay to be entered. The measurement result is entered in the measured value buffer.
Starting a continuous sweep using the START key causes the sweep to be restarted after any change in frequency in the direction from stop to start frequency (see 2.11).
A single sweep started by the SINGLE key is stopped by a measured value beyond the stop frequency.
Changes of the frequency of STOP and START are ignored.

Note: *FRQ FST CH1/2 can be selected for especially fast frequency sweeps with clean signals (eg from the CD). If however the signal has a large noise component, the slower measurement procedure FREQ CH1/2 must be used.*

FREQ CH1|FREQ CH2 |FRQ FST CH1|FRQ FST CH2 cannot be simultaneously active with the frequency sweep in the RMS Select measurement or any generator sweep!

Note: *By activating the associated setting, unwanted interfering signals like voice can be made ineffective. However, with floating sweep, the settling must be switched off..*

VOLT CH1
VOLT CH2

Tracing of measured values because a change in voltage was noted at ANALYZER input channel 1 or channel 2.

With the START or SINGLE key, an external voltage sweep is started, which in turn starts a single measurement on the occurrence of a trigger event or, as the case may be, after a delay to be entered. The measurement result is entered in the measured value buffer.
Starting a continuous sweep using the START key causes the sweep to be restarted after any change in voltage in the direction from stop to start level (see 2.11).
A single sweep started by the SINGLE key is stopped by a measured value beyond the stop level.
Changes of the voltage of STOP and START are ignored.

VOLT CH1|VOLT CH2 cannot be simultaneously active with the frequency sweep in the RMS Select measurement or any generator sweep!

Note *In most cases (except floating sweep, for instance) it is recommended to perform the external voltage sweep with Settling switched on to prevent individual samples to be triggered too early when voltage transitions are measured. Two samples are sufficient for setting the settling parameter; the resolution should be set to minimum.*

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START COND

LEV TRG CH1
LEV TRG CH2

Triggering (single shot) because of a *level* detected at analyzer input channel 1 or 2. Measured values are not stored in the trace buffers and, consequently, there is no graphical display via the X axis.
Using the START or SINGLE key, level monitoring is enabled. It waits for the level to enter the range between Start and Stop for the first time. Then a single measurement is started - possibly after the entered delay.
If the continuous trigger has been started with the START key, new triggering in the specified range takes place only if the level had been out of this range at the upper or lower end. Hence, level monitoring is only reactivated when a level is detected outside the specified range.

EDG TRG CH1
EDG TRG CH2

Triggering (single shot) caused by a voltage *edge* detected at the analyzer input channel 1 and 2. The measured value is neither stored in the buffers nor graphically displayed via the X axis.
Level monitoring is started with the START or SINGLE key but it is only activated when a level outside the start-stop interval is measured. Triggering is performed when a level occurs for the first time in the range between Start and Stop (edge trigger). A single measurement is then started - possibly after the specified delay.
If continuous trigger has been started using the START key, new triggering in the specified range only takes place when the level had been out of the range at the upper or lower end. Hence, level monitoring is only reactivated when a level is detected outside the specified range.

By pressing the STOP key, an external sweep is finished. By pressing the CONT key, the continuous measurement mode is started again.

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Delay

The menu item START COND → AUTO, FREQ CH1/2, FRQ FST CH1/2, LEV TRG CH1/ 2, VOLT CH1/2 allows the user to enter a delay time, which is effective with:

- Signal modifications at the generator (entry of values, variations via rotary knob)
- Sweeps
- STOP/CONT or START key depression (continuous measurement)
- SINGLE key depression (single measurement)
- Modifications in the ANALYZER panel
- Modifications in the GENERATOR panel
- Modifications in the FILTER panel
- Modifications of the switcher commands in the OPTIONS panel

Delay determines the waiting time required from the events stated above to the restart of a measurement in order to allow the device under test to settle.

Range of values: 50 ms to 10 s
Units: s | ms | µs | min

Note:
Delay is considered in single measurements only, ie in single measurements triggered by the SINGLE key or sweep sequencing in the START COND → AUTO mode or on the occurrence of a trigger with external sweep.
During continuous measurements, delay is considered in the first measurement only. The following measurements are made without delay.

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Time

In the menu item START COND→TIME│ TIME CHART the intervals between the single tracings of measured values can be specified.

A single measurement is started after every time **tick**. A new measurement is only triggered when the last measurement has been completed. This means that if a time tick is selected which is smaller than the measuring time, the time tick is adapted internally to the measuring time; ie, it is extended to be identical.

With the start condition TIME ***CHART,*** the current measured value is entered upon expiry of the time entered, independent of the number of measured values obtained in the meantime, if any. Ie, if a time is selected which is smaller than the measuring time, the same result is traced several times (with different X values). If this effect is to be avoided, "Time" must be increased.

Range of values: 10 ms to 2000 s
Units: s | ms | µs | min
Resolution: 1 ms

Points

The menu item START COND→TIME│ TIME CHART allows the number of entries in the measured value buffer to be entered.

Range of values: 1 to 1024

Note: *A time tick scan is terminated after (points x time tick) seconds have elapsed. If the individual measurement cannot be performed at the time tick-rate selected - due to exceeded time-tick rates - the trace buffer contains less than "points" measured values.*

Min VOLT

The menu items START COND → FREQ CH1 │ FREQ CH2 │ FRQ FST CH1 │ FRQ FST CH2 allow the entry of a minimum voltage to be applied to the ANALYZER input in order to trigger a measurement.

Value range:
digital (audio data mode): 0.00001 to 1.0 FS
analog: 0.00001 ... 300 V

Units:
digital (audio data mode):
FS | %FS | dBFS | LSBs | bits
analog:
V | mV | µV | dBu | dBV | dBm | W | mW | µW

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Start

Stop

The menu items START COND →FREQ CH1 | FREQ CH2 | FRQ FST CH1 | FRQ FST CH2
VOLT CH1 | VOLT CH2 | LEV TRG CH1 | LEV TRG CH2

allow the entry of the start and stop values. The frequency or level applied to the ANALYZER input must not exceed the start/stop limits in order to trigger the measurement.
By single sweeps, the STOP value is used to recognize the end of the sweep. The STOP value should therefore be somewhat smaller than the expected signal range.

Range of values FREQ CH1/CH2 | FRQ FST CH1/CH2:
total valid range (see 2.6.1)

Value range and units VOLT CH1 | VOLT CH2:
- analog: 10 µV to 300 V
  V | mV | µV | dBu | dBV | dBm | W | mW | µW
- digital (audio data mode):
  LL to 1.0 FS
  FS | %FS | dBFS | LSBs | bits

LL: The lower limit for the level start/stop values depends on the number of audio bits (see 2.6.3). It may however not be less than 1 mFS and can be calculated as follows:
$LL = 2^{-Audio\ Bits}$

Variation

The menu items START COND →
FREQ CH1 | FREQ CH2 | FRQ FST CH1 | FRQ FST CH2
VOLT CH1 | VOLT CH2
allow the entry of a value in percent by which the input frequency or input voltage must be varied at least in order to trigger a measurement.
Changing the frequency or voltage in the direction from stop to start by this numeric value causes a restart of the sweep if continuous sweep has been set.

Note: *Select the variation 5 % to 10 % smaller than the expected change in order to guarantee reliable triggering on the one hand and to prevent triggering on intermediate values on the other hand.*

Range of values:
for frequency sweeps: LL to 50%

for level sweeps: LL to 900 % (= 20 dB)

Unit: % (for level sweeps also dB)

LL: The lower limit for the entry of variation is not less than 0.1% and is output such that not more than 1024 measured values are generated (depending on the spacing between start and stop values).

Settling

(see 2.3.4, Setting Process)

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2.6.5 Functions

FUNCTION	
OFF	No measurement function, measurement of Input RMS/PEAK and frequency/phase, however, enabled
RMS & S/N	True rms measurement of AC voltages see, 2.6.5.2
RMS SELECT	Selective rms measurement with narrow bandpass, see 2.6.5.3
PEAK & S/N	Determining the maximum peak value within a monitoring interval, only in the analyzers ANLG 22 kHz and DIG 48 kHz, see 2.6.5.4
Q PK & S/N	Peak value detection with subsequent defined rising and falling times, only in the analyzers ANLG 22 kHz and DIG 48 kHz, see 2.6.5.4
DC	DC measurement, see 2.6.5.5
THD	Distortion measurement (harmonic distortion, only), see 2.6.5.6
THD+N/SINAD	Distortion or SINAD measurement (with consideration of broadband noise), see 2.6.5.7
MOD DIST	Intermodulation measurement with high-frequency useful sinewave signal and a low-frequency interfering sinewave signal, see 2.6.5.8
DFD	Dynamic intermodulation measurement with low-frequency square signal and high-frequency sinewave signal, only in the analyzers ANLG 22 kHz and DIG 48 kHz, see 2.6.5.9
DIM	Intermodulation measurement to DFD method by two adjacent tones with relatively high frequencies, see 2.6.5.10
WOW & FL	Wow and flutter measurement, only in the analyzers ANLG 22 kHz and DIG 48 kHz see 2.6.5.11
POLARITY	Polarity measurement to check the signal polarity of a DUT, see 2.6.5.12
FFT	Graphical spectrum display, see 2.6.5.13
FILTER SIM.	Filter simulation, see 2.6.5.14
WAVEFORM	Waveform display, see 2.6.5.14
COHERENCE	Measuring the transfer function and coherence of two signals, see 2.6.5.16
DIG INP AMP	Only with built-in jitter option (UPD-B22) in the COMMON/INP measurement mode; measurement of digital input amplitude at the AES/EBU and S/P DIF interfaces, see 2.6.5.17
PHAS TO REF	Only with built-in jitter option (UPD-B22) in the JITTER/PHAS measurement mode: measurement of phase between selected digital input and reference input, see 2.6.5.18

Note: *The addition "& S/N" means that this function allows for S/N measurements.*

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2.6.5.1 Common Parameters of Analyzer Functions

DC Suppress

(DC Suppress)

With the **digital** measurement functions RMS & S/N und RMS SEL a DC component in the test signal can be suppressed so that it is not present in the measurement result. To do so the actual DC value is determined for each measurement and then considered in the measured value by calculation. As the DC measurement is performed in parallel with the main measurement it does not affect the measurement time.

ON The DC component of the signal to be measured is suppressed (AC coupling); only the AC component is considered in the measurement result.

OFF The DC content of the signal to be measured is *not* suppressed (DC coupling) and contained in the measurement result.

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S/N Sequ

(S/N sequence)
The functions RMS & S/N, PEAK & S/N, Q PK & S/N offer the possibility of S/N measurements (signal-to-noise). The generator signal at the device under test is alternately switched on (signal) and off (noise) and a measurement is performed in each case. During signal-on-phase the selected filters are turned off in order to exclusively weight the noise signal. The ratio of the two measured values in dB expresses the S/N ratio of the device under test.
Any desired generator setting is permissible.
A deactivated generator means:

- with analog generator instruments, the output voltage is switched off with the output resistance being constant
- with digital generator instruments, a level value of 0.0 full scale is output with the clock rate being unvaried (all bits to 0)

ON

S/N measurement on

Note:

- *To avoid measurement errors caused by superimposed DC, a filter with high-pass characteristics should be cut in. If this is not the case, a corresponding error message is displayed when the S/N mode is switched on.*
- *With measurements at low frequencies, where a highpass filter cannot be used, a (file-defined) delay filter with a delay of approx. 1.5 s should be used instead. This allows the DC transition occurring upon generator switch-off to decay before the noise measurement is started.*
- *The selectable filters only affect the noise measurement. If they are to affect the signal measurement, too, this can be achieved by using the command line parameter "-o2".*

OFF

S/N measurement off

Unit

Selection of units for measurement results for both channels. Measurements which usually have both channels with the same unit, provide a common menu item for both channels for selection of the (display) unit.

Refer to the functions for the respective computation basis
For conversion formulae refer to

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Function	Analog units selectable:	Digital units selectable:
Intermodulation measurements MOD DIST | DFD | DIM	% | dB	% | dB
Distortion measurements THD Meas Mode: SELECT di ALL even d ALL odd di ALL di	% | dB	% | dB
Meas Mode: SEL di LEV even di LEV odd di LEV di	V|dBV|dBu|dBm|W|Δ %V|ΔV|V/V_r|%V/V_r|Δ %W|ΔW|P/P_r|%P/P_r|dB	FS|%FS|dBFS|Δ %|dB_r|LSBs

Function	Analog units selectable:	Digital units selectable:
Distortion measurements THD+N Meas Mode: THD+N | NOISE | SINAD	% | dB	% | dB
Meas Mode: LEVEL THD-N | LEVEL NOISE	V|dBV|dBu|dBm|W|Δ %V|ΔV|V/V_r|%V/V_r|Δ %W|ΔW|P/P_r|%P/P_r|dB	FS|%FS|dBFS|Δ %|dB_r|LSBs
Wow & Flutter measurements	%	%
Transfer function (COHERENCE Trace A, Ch1/Ch2)	% | dB	% | dB
Coherence measurement (COHERENCE Trace B)	γ^2	γ^2

Unit Ch1

Selection of the units of measurement results for channel 1.

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Unit Ch2

Selection of units of measurement results for channel 2.

With all level measurements, the (display) units for the two channels can be selected independent of each other, eg, in order to constitute one channel as absolute quantity and the other channel with any reference.

Selectable analog units (applicable also for Meas Mode COMMON/INP in the digital instrument):

V | dBV | dBu | dBm | W | Δ%V| ΔV | V/V_r | %V/V_r | Δ%W |ΔW | P/P_r | %P | P_r | dB_r

Selectable digital units (Meas Mode AUDIO DATA):

FS | %FS | dBFS | Δ% | dB_r | LSBs | bits

The measurement functions PEAK and QPEAK as well as the INPUT DISP displays allow for selecting the HEX unit, in addition.

Selectable jitter units (Meas Mode JITTER/PHAS):

UI | %UI | dBUI | ppm | ns | UI_r | dB_r (for jitter)

UI | %FRM | ºFRM | ns (for phase)

For conversion formulae and notation of result display units for IEC/IEEE-bus control, see 2.4 Units

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Reference

Reference values for the analyzer measurement function and the Input Disp measurement.
All measurements which obtain dimensional results, can be displayed either absolutely or referred to a reference. If a reference-related unit (to be recognized by the addition "r" or the prefix "Δ") is selected, the displayed result takes into consideration the reference entered here.
Each measurement function and each of the superior functions provide their own reference, which applies for both channels, respectively.
The selection made here is entered into the display panel per default, if an appropriate trace (FUNC CH1/2 or IMP RMS CH1/2) and the selected display reference is *not* FILE, HOLD or OTHER TRACE.

Value

Display and entry of a fixed reference value.
Per default, this entry is entered into the display panel if an appropriate trace (FUNC CH1/2 or IMP RMS CH1/2) has been selected and the display reference has been set to VALUE.
The range of values depends on function and domain:

Units:

digital (audio data mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr
digital (jitter mode):
UI | %UI | dBUI | ppm | ns | UIr | dBr
analog and digital common mode:
V | mV | µV | dBu | dBV | dBm | W | mW | µW

Value range, DC measurement function:

digital (audio data mode):	-100 to 100 FS
analog:	-1000 to 1000 V

Value range, other (level) measurement functions and INPUT DISP:

digital (audio data mode):	100 pFS to 100 FS
digital (jitter mode):	100 pUI to 100 UI
analog (and common mode):	100 pV to 1000 V

STORE CH1

The level measurement result of channel 1 is stored on depression of the ENTER key. The reference value does not change during the measurement. This selection item is displayed with two-channel measurement, only.

STORE CH2

The level measurement result of channel 2 is stored on depression of the ENTER key and displayed as new reference value. The reference value does not change during the measurement. This selection item is displayed with two-channel measurement, only.

STORE

The level measurement result of a one-channel measurement is immediately stored as the reference value. The reference value does not change during the measurement. This selection item is displayed with two-channel measurement, only.

MEAS CH1
MEAS CH2

Each level-measurement result of channel 1 or channel 2 is stored as reference value and can then be used (by both channels) for reference-related representation (floating reference). To this end, a reference-related unit must be selected. This selection item is displayed with two-channel measurement, only.

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Reference

GEN TRACK

The presently valid generator voltage and each newly set generator voltage are stored as the reference value and can then be used (by both channels) for a referenced display. A referenced unit must be selected in this case.
If the measured value is RMS-weighted, the RMS value of the generator voltage is used. If it is a peak value (INPUT DISP PEAK, PEAK function), the peak value of the generator voltage is used.
If the domains of generator and analyzer are different, a ***conversion factor*** of

$$\frac{1\ FS}{1\ V}$$

is calculated.

Note: The generator voltage selected in the panel is always used as reference instead of the actually output generator voltage. This applies, in particular, if equalization is switched on (cf. 2.5.4.3 SINE). If reference is to be made to the actually output voltage, the latter must be measured (internally) (CH1 Input GEN CH2) and the measurement result (of channel 2) must be referred to the measured voltage (Reference MEAS CH1).

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Ref Phase

(Reference phase)
Reference value for the phase measurement.
This menu line is displayed only, if two-channel measurement and the phase or group-delay measurement have been selected.
Results of phase and group-delay measurement can be displayed either absolutely or referred to a reference. If a reference-related unit (to be recognized by the prefix "Δ") the result is displayed taking into consideration the reference entered here.

VALUE

Display and entry of a fixed reference value.
Per default, this entry is entered into the display panel if an appropriate trace (FREQ CH1/2) has been selected and the display reference is set to VALUE.

Specified range and units for:

- Phase measurement:
  Value range: -360° to +360° or -2π to +2π
  Units: °|RAD
- Group-delay measurement:
  Value range: -10 s to +10 s
  Units: s | ms | µs | min

STORE

The results of phase or group-delay measurement are stored on depression of the ENTER key and displayed as new reference value. The reference value does not change during the measurement.

FILTER

For the functions in the ANALYZER panel

- RMS & S/N (RMS measurement), 4 filters
- PEAK & S/N (peak measurement), 3 filters
- QPK & S/N (quasi-peak measurement), 3 filters
- THD+N/SINAD (distortion measurement), 1 filter

can be selected and assigned to the ANALYZER function (see 2.7 Analyzer Filters).

Note: *Apart from these filters of digital design, an analog notch filter can be switched on additionally with the analog measurement functions RMS, RMS SELECT, QPK and FFT for elimination of individual frequency lines (see menu item Notch (Gain) in this section).*

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POST FFT

POST FFT is an FFT subsequent to the functions
- RMS & S/N
- THD+N/SINAD
- WOW & FL.

The input signal is sampled, the sampled values are stored and analyzed according to the selected function. Subsequent to obtaining the result, an FFT is calculated from the sampled values and graphically displayed. Then, the measurement of the selected function is restarted and the activated filters, if any, begin to settle again.

For more details on the FFT including all its parameters, refer to Section 2.6.5.13.

ON

POST-FFT is calculated; however, it is displayed only, if the operation SPECTRUM has been selected in the DISPLAY panel.
With generator sweep, the end of the POST FFT algorithm determines the sweep stepping, thus reducing the sweep rate!
POST-FFT is switched on *coercively*, if the phase measurement is selected for the measurement function RMS (with two-channel measurement).

OFF

POST-FFT is not calculated.
This selection is made to achieve a maximum measurement speed.
POST-FFT is switched off *coercively*, if
- the S/N measurement or
- the special mode TRIGGERED FIX

is used for the RMS function.

FFT-Size

Enter the FFT size (256 to 8192), see 2.6.5.13 FFT.

Start

Only display (no entries possible) of frequency limits of generated spectrum.

Stop

Resolution

Only display (no entries possible) of frequency resolution.

Window

Select the window function. For possible windows and their applications see 2.6.5.13, FFT.

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Notch (Gain)

For the functions RMS & S/N, RMS SELECT, Q PK & S/N and FFT, the three analog analyzers offer an analog notch filter of 2nd order to be activated for narrow-band suppression of interfering frequency lines. With notch switched on, one of 3 gain factors can be selected:

OFF	Analog notch filter off
0 dB	Analog notch filter on; no gain effective
12 dB Auto	Analog notch filter on; gain 12 dB
30 dB Auto	Analog notch filter on; gain 30 dB

Note: *If frequency components occur outside the analyzer frequency range, the notch gain may cause the analyzer to be overdriven. In this case, the notch gain is reduced step by step, which is indicated by adding "Auto" in the items 12 dB and 30 dB.*

Notch Freq

Selection of the notch filter center frequency.

AUTO

Numerical entry of the notch filter center frequency
Range of values: 10 Hz to 110 kHz
Units: Hz | kHz

VALUE
1.2345 kHz

Switching on VALUE causes the latest valid notch frequency to be displayed. When switching over from AUTO to VALUE, eg, and the (external) test signal having a frequency of 100 kHz, the frequency displayed is 100 kHz.

GEN TRACK

With the generator signal function set to SINE, BURST, SINE2 PULSE or SQUARE, the current generator frequency specified under generator menu item FREQUENCY is used as notch filter center frequency. Any other signal function leads to an error message.

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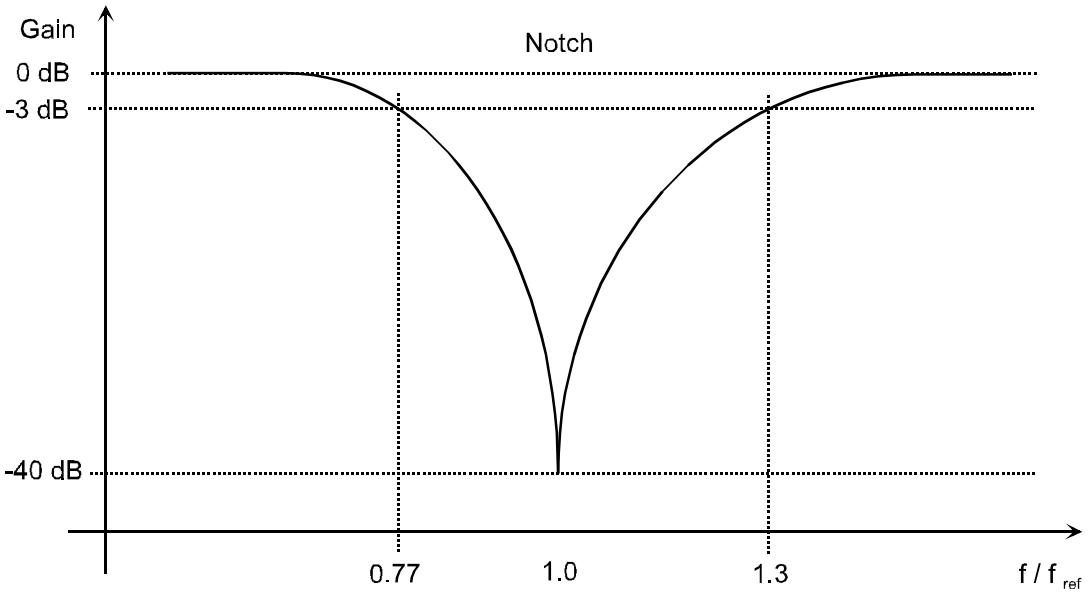

Fig. 2-29 Characteristic of analog notch filter

Application example: quantization noise measurement

Since the notch filter follows the input levelling stage, the fundamental level determines the drive of the input circuit. The measurement range in which the fundamental is measured therefore determines the dynamic range of the quantization noise measurement.

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Settling
Freq Settl
Phas Settl
Fnct Settl

Most measurements can be succeeded by a settling or averaging procedure in order to obtain settled measured values even with settling DUTs.
Exceptions and special features:

- Settling cannot be realized with *group-delay measurement*, since the measured value is defined with varying frequency, only.
- From the physical point of view, settling is not required with the measuring functions *POLARITY* and *FILTSIM*
- The *WAVEFORM* function does not allow for selection of settling, but averaging (menu item Interpol).
- The *FFT* function does not allow for selection of settling, but it provides two different averaging modes (menu item Avg Mode NORMAL or EXPONENTIAL)
- Settling cannot be selected with the digital measurement modes *JITTER/PHAS* and *COMMON/INP*, but the above-mentioned averaging procedures with measurement functions *FFT* and *WAVEFORM.*

OFF

Settling process switched off; availability of the measurement result upon shortest possible time. This setting should always be selected if maximum measuring speed is required.

EXPONENTIAL

Settling with exponential course of the tolerance taking into account the resolution of the measured value.

FLAT

Settling with horizontal course of tolerance taking into account the resolution of the measured value.

AVERAGE

Arithmetic averaging of the results

For further information see 2.3.3, Settling Process

Samples

To menu item Settling → EXPONENTIAL | FLAT:
Number of subsequent measured values compared in the settling proces
If, eg, value 6 is entered here, this means that the latest measured value compared to 5 preceding measured values.
Specified range: 2 to 6

To menu item Settling → AVERAGE
Number of measured values used for arithmetic averaging.
Specified range: 2 to 100

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Tolerance

To menu items Settling → EXPONENTIAL | FLAT:
The tolerance value denotes the maximally permissible deviation from the preceding measured value a settled measured value may have in order to be identified as valid.
The value of the maximally permissible deviation of the current measured value compared to the 2nd/3rd/4th and 5th last measured value is determined by the setting EXPONENTIAL | FLAT .

For further information see 2.3.3, Settling Process

Unit:	% or dB WOW flutter and frequency measurement, only % permissible
Specified range:	0.001 % to 10 % or 0.000087 dB to 0.828 dB

% and dB values can be converted into one another:

$$\%\ \text{value} = \left(10^{\frac{\text{dB-value}}{20}} - 1\right) \times 100$$

$$\text{dB value} = 20 * \lg\left(\frac{\%\text{-value}}{100} + 1\right)$$

Resolution

To menu items Settling → EXPONENTIAL | FLAT:
Measured value resolution considered if the measured value does not satisfy the tolerance limits.

For further information, see 2.3.3, Settling Process

Specified range and units depend on domain and function:

- RMS & S/N | RMS SELECT | PEAK & S/N | Q PK & S/N | DC / external level sweep:
  analog: 0,1 µV to 10 V; V |mV |µV |dBV |dBu |W |mW |µW | dBm
  digital: Min-FS to 0.1 FS; FS |% FS |dBFS |LSBs | bits | Δ% | dBr
- THD+N/SINAD | THD | MOD DIST | DFD | DIM | WOW & FL:
  0.000001 % to 10 %; % | dB
- Frequency measurement / external frequency sweep:
  100 µHz to 10 Hz; Hz | kHz
- Phase measurement:
  0.0001 ° to 10 ° ° | RAD

MinFS: $2^{(-1 * \text{audio bits})}$ however, not smaller than 100 nFS
Exception: a resolution of up to 1 nFS can be entered for the external level sweep, allowing the settling procedure to be used also for *very small levels.*

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Timeout

If the settling mechanism does not recognize a stabilization of the measured value within the time stated under ”timeout”, the test loop is aborted and "Input - Press SHOW I/O" output instead of a measured value. A gap points to the missing value in the graphical curve display of a sweep.
For further information, cf. 2.3.3 "Settling Process"

Specified range: 0.001 to 10 s
Unit: s

Recommended Values:

For the majority of measurements on AF instruments, the following settings are suitable:

- Settling EXPONENTIAL
- Tolerance 1% (approx. 0.1 dB)
- Resolution: value of the last but one digit displayed in the result window
  eg, with a displayed value of 10.0000 Hz, this is 1 Hz
- Timeout 1 s

SPEAKER (see 2.6.7, Headphone/Speaker output)

OFF
INPUT CH1
INPUT CH2
INPUT CH1&2
AES CH1
AES/E CH2
AES/E CH1&2
FUNCT CH1
FUNCT CH2
FUNCT CH1&2

Pre Gain (see 2.6.7, Headphone/Speaker Output)

Spk Volume (see 2.6.7, Headphone/Speaker Output)

Phone Out (see 2.6.7, Headphone/Speaker Output)

= SPEAKER
PERMANENT

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2.6.5.2 RMS (incl. S/N)

Available for all analyzers.

Analog mode:

True rms measurements of AC voltages (frequency ranges of the analog ANALYZER instruments, see 2.6.1, Selecting the Analyzer) of any desired waveform in the range of 1 µV to 300 V with a resolution of 0.1 µV in the most sensitive measurement range.
With a lower measurement limit of

- 2 Hz, a superimposed DC signal controls the input unit and may adversely affect the measurement accuracy (see 2.6.1 Selecting the Analyzer, Range Limits)!
- 10 Hz, there is AC coupling; this leads to a higher measurement speed (with AUTO or AUTO FAST) and a shorter settling time.

Digital mode:

The signal content is indicated as a true rms full-scale value from 0.0 to 1.0.

In the digital range, the lower measurement limit can be set only in the DIG48kHz instrument. In this case, only the AUTO measuring speed is affected.

Note: *If all converter bits are set, 1.0 FS (= 0.0 dBFS) is displayed.*

S/N Sequ (see 2.6.5.1, Common Parameters of Analyzer Functions)

DC Suppres Selectable in the digital analyzer only;

Note: *DC suppression is only effective for the measured RMS value. With post-FFT a DC component is displayed even if DC suppression is switched on. A DC-free FFT display can only be obtained with the FFT measurement function.*

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Meas Time

(Measuring time)
The rms measurement time serves to match the measurement rate to the signal frequency. It depends on the measurement requirements whether a short measuring time or high accuracy will have priority.

AUTO FAST
AUTO

Automatic matching of the measuring time to the signal frequency with consideration of the signal period. The measuring time is matched as far as possible to the input signal; with AUTO FAST, a maximum algorithmic error of 1% (with AUTO: 1‰) may arise. With very weak signals, the measuring time is limited to 1 period according to Min Freq.

Notes:

1. *In the case of very noisy or distorted signals or multitone signals, the automatic measurement modes - particularly AUTO FAST - may not be able to detect the signal period. To avoid measurement errors, these signals should preferably be measured with GEN TRACK or - if an external generator is used - with the measurement mode VALUE.*
2. *To allow automatic-mode measurement of the signals described under 1 with the advantage of high measurement speed, the minimum measurement is optimized automatically. Only the first measurement – without post-FFT – is performed using the high measurement speed. For all other measurements the measurement time is increased to 100 ms or the measurement time of post-FFT, respectively, which enables higher accuracy. This means that the first triggered measurement result (eg. when sweeping) is obtained very fast, while the subsequent results are more accurate.*

FIX 50 MS
FIX 200
FIX 1000

Fixed measurement times of 50, 200 or 1000 ms are used. Since the signal cannot be monitored for whole periods, these measurement modes may possibly abort. The measurement time should be long compared to the period to reduce the probability of abort to a minimum.

Note: *Because of unavoidable abort, the FIX modes should only be used if automatic modes are ruled out because of poor signal quality or low signal levels and generator tracking is not possible (eg for measurements with an external generator).*

VALUE

Numeric entry of measurement time. As measurement errors might occur in this case too when the measurement time is not matched to the period, this mode should only be selected if the period of the signal is exactly known.

Value ranges:

ANLG 22 kHz:	100 µs to 10 s
ANLG 100 kHz:	100 µs to 575.94 ms
ANLG 300 kHz:	100 µs to 191.98 ms
DIG 48 kHz:	100 µs to 10 s
DIG 192 kHz:	100 µs to 98284 / sample freq.
DIG 768 kHz:	100 µs to 98284 / sample freq.

Int. sample freq. = Sampl Frq * Oversamp

Units: s | ms | µs | min

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Meas Time

TRIGGERED

Special measurement mode; a single measurement (with selectable measurement time) is performed as soon as the signal exceeds a (selectable) trigger threshold for the first time. This measurement mode in conjunction with a burst generator signal allows the *first period* of a signal to be measured.

Application: *Anechoic measurements on loudspeakers, measurement of short signal pulses.*

Notes:

- *TRIGGERED should be selected with single-channel measurement with fixed voltage range, only.*
- *Triggering on level thresholds can be selected using START CONDition LEV TRG CH1/2, also.* ***Any*** *measuring function (e.g., WAVEFORM") can be selected. The measuring mode described here can, however, be used for RMS measurement, only. Advantage: the measurement starts* ***without delay****.*
- *In TRIGGERED mode, neither filters nor POST FFT nor Settling can be set.*

GENTRACK

Measurement over (at least) one period of the generator signal. To do so the generator frequency is matched to the analyzer sample rate, if required. At high frequencies, the measurement time is extended to several periods to increase the measurement accuracy.
Particularly suited for measuring very noisy or distorted signals as well as for extremely fast sweeps.
The period length is calculated from the signal frequency entered in the GENERATOR panel. For this reason this measurement mode should only be used with use of the UPD *function* generator.

Notes:

1. *If the MODDIST signal is used as generator signal, the measurement time is referred to the LOWER Frequency, which normally dominates.*
2. *When using the low-distortion generator, small frequency offsets may occur which may lead to a reduction of the measuring accuracy if the measuring time is coupled to the rated frequency. The measurement rate AUTO should be used in these cases.*

FIX 50/200/1000 MS and VALUE are fixed integration times without consideration of the signal period. This leads to the following consequences depending on the meas. time/signal period ratio:

- Meas Time is integer multiple of signal period:
  Optimum integration effect. Steady display!
- Meas Time larger than, yet no integer multiple of signal period:
  Integration effect, however beats occur in the display.
- Meas Time smaller than signal period:
  No integration effect. The measurement result follows the signal waveform.

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Unit Ch1/2

(see 2.6.5.1, Common Parameters of Analyzer Functions)

Reference

(see 2.6.5.1, Common Parameters of Analyzer Functions)

Notch (Gain)

(see 2.6.5.1, Common Parameters of Analyzer Functions)

Filter

(see 2.7. Selecting the Analyzer Filters)

A maximum of 4 filters can be selected.

Fnct Settl

(see 2.6.5.1, Common Parameters of Analyzer Functions)

Post FFT

(see 2.6.5.1, Common Parameters of Analyzer Functions)
Switching on the POST FTT improves the digital frequency-measurement result for frequencies above 4 times the FFT resolution. This can be noticed in particular with high frequencies and/or noisy signals.

POST FFT is switched off coercively, if the Meas Time TRIGGERED is selected or S/N measurement is switched on.

Note: *With active Post-FFT a DC part that might exist is always displayed in the FFT spectrum, e.g. even when DC suppressing is switched off. A DC free FFT display can be achieved via measurement function FFT.*

Trig Level

(Trigger level);
Is displayed with Meas Time TRIGGERED, only.

Sets the trigger threshold which determines the start of the RMS measurement.
The trigger level applies in relation to the full-scale value selected under menu item Ch1/2 Range as a fixed voltage range.

Specified range: -240 dB to 0 dB
Unit: % or dB

SPEAKER

(see 2.6.5.1, Common Parameters of Analyzer Functions)

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2.6.5.3 RMS SELECT (Selective RMS Value)

Available for all analyzers.

Selective rms measurement with narrow bandpass.

DC Suppres

Selectable in the digital analyzer only;

Meas Time

(Measurement time)
The rms measurement time serves to match the measurement rate to the signal frequency. It depends on the measurement requirements whether a short measuring time or high accuracy will have priority.

AUTO FAST
AUTO

Automatic matching of the measuring time to the signal frequency with consideration of the signal period. The measuring time is matched as far as possible to the input signal; with AUTO FAST, a maximum algorithmic error of 1% (with AUTO: 1‰) may arise. With very weak signals, the measuring time is limited to 1 period according to Min Freq.

***Notes**:*

1. *In the case of very noisy or distorted signals or multitone signals, the automatic measurement modes - particularly AUTO FAST - may not be able to detect the signal period. To avoid measurement errors, these signals should preferably be measured with GEN TRACK or - if an external generator is used - with the measurement mode VALUE.*
2. *To allow automatic-mode measurement of the signals described under 1 with the advantage of high measurement speed, the minimum measurement is optimized automatically. Only the first measurement is performed using the high measurement speed. For the following measurements the measurement time is increased to 100 ms, which enables higher accuracy. This means that the first triggered measurement result (eg. when sweeping) is obtained very fast, while the subsequent results are more accurate.*

FIX 50 MS
FIX 200
FIX 1000

Fixed measurement times of 50, 200 or 1000 ms are used. Since the signal cannot be monitored for whole periods, these measurement modes may possibly abort. The measurement time should be long compared to the period to reduce the probability of abort to a minimum.

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Meas Time

VALUE

Numeric entry of measurement time. Since measuring errors might occur in this case too when the measurement time is not matched to the period, this mode should only be selected if the period of the signal is exactly known.

Value ranges:
ANLG 22 kHz: 100 µs to 10 s
ANLG 100 kHz: 100 µs to 575.94 ms
ANLG 300 kHz: 100 µs to 191.98 ms
DIG 48 kHz: 100 µs to 10 s
DIG 192 kHz: 100 µs to 98284 / sample freq.
DIG 768 kHz: 100 µs to 98284 / sample freq.
Internal sample freq.. = Sampl Frq * Oversamp.

Units: s | ms | µs | min

GENTRACK

Measurement over (at least) one period of the generator signal. To do so the generator frequency is matched to the analyzer sample rate, if required. At high frequencies, the measurement time is extended to several periods to increase the measurement accuracy.
Particularly suited for measuring very noisy or distorted signals as well as for extremely fast sweeps.
The period length is calculated from the signal frequency entered in the GENERATOR panel. For this reason this measurement mode should always be used with use of the UPD *function* generator.

Notes:

1. *If the MODDIST signal is used as generator signal, the measurement time is referred to the LOWER Frequency, which normally dominates.*
2. *When using the low-distortion generator, small frequency offsets may occur which may lead to a reduction of the measuring accuracy if the measuring time is coupled to the rated frequency. The measurement rate AUTO should be used in these cases.*

Unit Ch1/2

(see 2.6.5.1, Common Parameters of Analyzer Functions)

Reference

(see 2.6.5.1, Common Parameters of Analyzer Functions)

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Bandwidth — Bandwidth of bandpass

BP 1%
BS 1% — Geometrically symmetrical bandwidth 1%

BP 3%
BS 3% — Geometrically symmetrical bandwidth 3%

BP 1/3 OCT
BS 1/3 OCT — 1/3 octave = Third-octave, geometrically symmetrical bandwidth ≈ 23%

(obtained from $\sqrt[6]{2} - \frac{1}{\sqrt[6]{2}} = 0.2315 = 23.15\%$)

BP 1/12 OCT
BS 1/12 OCT — 1/12 octave, geometrically symmetrical symmetrical bandwidth ≈ 6%

(obtained from $\sqrt[24]{2} - \frac{1}{\sqrt[24]{2}} = 0.0577 = 5.77\%$)

BP FAST
BS FAST — same as BP/BS 1/3 OCT, for 40 dB attenuation only
but with considerably shorter settling time.

BP FIX:
BS FIX: — Arithmetically symmetrical bandwidth using numerical entry
Units: Hz, kHz
Range of values: Range of values for the numerical entry of the bandwidth (FIX:):

Analyzer	Range for bandwidth
ANLG 22 kHz	9.9 Hz
ANLG 100 kHz	70.4 Hz
ANLG 300 kHz	211.2 Hz
DIG 48 kHz DIG 192 kHz DIG 768 kHz	$\frac{\text{sample freq.}}{4800} * 0.99$

$$f_{cmin} = \frac{\text{sample freq.}}{4800} \quad \text{(minimum center freq.)}$$

Int. sample freq. = Sampl Freq.*Oversamp

Note: *For Third Octave filters the 0,1dB-bandwidth is reduced in order to obtain an attenuation of 3 dB at the cut-off frequencies. Hence the effective bandwidth is lower than the theoretical value.*

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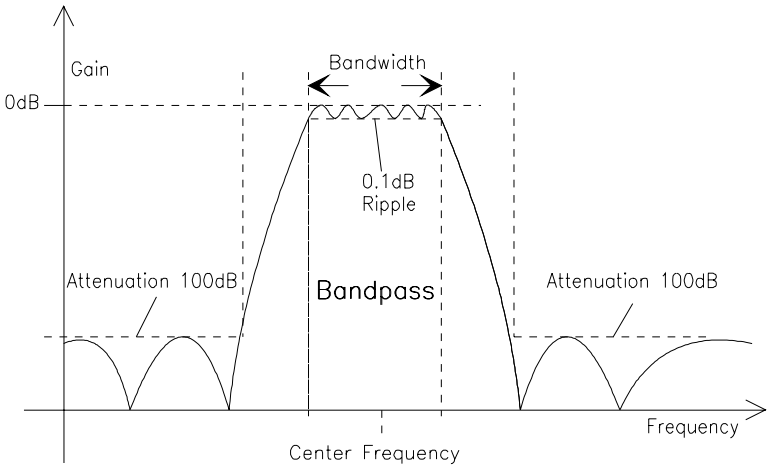

Fig.2-30 Bandpass used for selective rms measurement

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Frequency sweep of selective RMS Measurement

The band center frequency of the selective rms measurement can be swept using various procedures. A table with a maximum of 1024 frequency entries is generated. As desired, the individual frequency points can be

- calculated from user specifications (SWEEP CTRL → AUTO SWEEP | MANU SWEEP)
- loaded from file as list sweep (SWEEP CTRL → AUTO LIST | MANU LIST)
- derived from the individual frequencies of the generator setting MULTISINE (SWEEP CTRL → GEN MLTSINE).

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SWEEP CTRL

(Sweep control)
Used to select whether and how to sweep the band center frequency. In the case of analog analyzers, the notch frequency of the switch-selectable analog notch filter is also swept.

OFF

The sweep system is switched off. The band center frequency can be selected via menu item FREQ MODE (see below).

***Note**:* *With this setting, the sweep system is available for generator or analyzer sweeps. By selection of FREQ MODE and switching on a generator frequency sweep or external frequency sweep the band center frequency can be swept over the generator frequency or over the frequency of an external generator.*

AUTO SWEEP

Pressing the START or SINGLE key causes the sweep to run automatically (see 2.11 Starting and Stopping a Measurement).
The sweep parameter data are calculated from the user specifications (start/stop values and step size or number of points); “normal“ sweep

AUTO LIST

Pressing the START or SINGLE key causes the sweep to run automatically (see 2.11, Starting and Stopping of Measurements or a Sweep).
The sweep parameter data are read from a file (list sweep); refer to 2.9.1.2, menu item STORE TRACE/LIST, Store → X AXIS,
Store → Z AXIS.

MANU SWEEP

The sweep is controlled by means of the spinwheel and/or the cursor keys. After pressing the START key, the first frequency of the selective rms measurement only is set. Any further frequency is requested using the spinwheel or by pressing a cursor key (see 2.11 Starting and Stopping of Measurements or a Sweep).
When sequencing the manual sweep, the result of the current measurement is not waited for, ie, the current RMS SELECT measurement and an analyzer delay, if set, are aborted.

MANU LIST

As with AUTO SWEEP, the sweep parameter data are calculated from the user specifications (start/stop values and step size or number of points); "normal" sweep

GEN MLTSINE

The sweep sequence is similar to that of MANU SWEEP; the sweep parameter data are, however, read from a file (similar to AUTO LIST); (list sweep).

(Generator multisine)
The bandpass center frequency of selective RMS measurement is subsequently set to the multisine frequencies entered in the generator panel (see 2.5.5.4, Multisine). The generator signal function is assumed to be set to MULTISINE.

This setting is mostly used for fast frequency response measurements. The sweep runs automatically when the START or SINGLE key is pressed (see 2.11 Starting and Stopping of Measurements or a Sweep).

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Notes on manual sweep:
In order to control a manual sweep using the spinwheel or the cursor keys, the graphics panel must be active (full-screen or split-screen mode). When the sweep is started, the switchover to the graphics panel is automatic. When "manual sweep" is selected, the band center frequency can be varied with a user-definable increment. The increment is defined by a fixed STEP (with MANU SWEEP) or by a variable step size defined in a file (with MANU LIST). With remote control, the command "INIT:NEXT<n>" is used to continue.
Subsequent to setting a new sweep point, a continuous measurement is performed on this point. All measured values thus obtained can be read off from the display or from the curve plot (in the form of crosses). With sweep sequencing, the value *last* measured is stored.
By turning the spinwheel fast, individual sweep points can be skipped (to be recognized as gaps in the graphical curve display), or repeated when the spinwheel is turned back.
The measured values are indicated by crosses in the Curve Plot mode. If Scan count >1 has been selected in the DISPLAY panel, the crosses are not deleted prior to a new character, but remain on the screen. With strongly fluctuating measured values, the representation approximately takes the shape of a bar. If sweep steps are skipped or advanced too fast, a NAN (not a number) value is entered. When the end of the sweep is reached, the complete trace (with the last-measured values, respectively) is obtained.

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Spacing

Spacing of the sweep ranges for menu items EP CTRL → AUTO SWEEP | MANU SWEEP

LIN POINTS

The sweep range between Start and Stop is linearly spaced by a number of points to be specified under menu item "Points".
The step size in Hz can be derived from the number of linear points:

$$Step[Hz] = \frac{|Stop[Hz] - Start[Hz]|}{Points - 1}$$

LIN STEPS

The sweep range between Start and Stop is spaced in frequency intervals determined by the linear step size to be specified under menu item "Step".
The number of points can be calculated from the linear step size in Hz:

$$Points = \frac{|Stop[Hz] - Start[Hz]|}{Step[Hz]} + 1$$

LOG POINTS

The sweep range between Start and Stop is logarithmically spaced by a number of points to be specified under menu item ”Step”.
The multiplier for the step size can be derived from the number of logarithmic points:

$$Step = \left(\frac{Stop[Hz]}{Start[Hz]}\right)^{\frac{1}{Points-1}}$$

LOG STEPS

The sweep range between Start and Stop is spaced using a logarithmic step size to be specified under menu item ”Step” as multiplier without unit.

Note: When switching from ...POINTS to ...STEPS, no conversion is performed. The set values are retained in the background. When switching between LIN STEPS and LOG STEPS, the number specified for ”Steps” remains the same.

Start

Displayed with normal sweep on (SWEEP CTRL → AUTO SWEEP | MANU SWEEP Enter the start or stop value for sweeping the band center frequency.

Stop

For the range of values and units, see FREQ MODE → FIX.

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Points

Displayed with normal sweeps (SWEEP CTRL → AUTO SWEEP | MANU SWEEP) if the spacing LIN POINTS or LOG POINTS has been selected.

Range of values: 2 to 1024
Units: integer value without unit

Step

Displayed with normal sweeps (SWEEP CTRL → AUTO SWEEP | MANU SWEEP) if LIN STEPS or LOG STEPS has been selected with Spacing.

Enter the step size for the frequency sweep of the band center frequency.
Range of values:
The step size must be selected such that max. 1023 single steps (= 1024 sweep points) result. The step size must not be larger than the absolute difference between Stop and Start.
For the valid range of values, see operator guidance line.

Units with	Spacing → LIN STEPS:	Hz | kHz
	spacing → LOG STEPS:	no unit, because of multiplier

Filename

Displayed with list sweeps only (SWEEP CTRL → AUTO LIST | MANU LIST) if LIN POINTS or LOG POINTS has been selected.

File containing the frequency values for the frequency sweep of the band center frequency. (For the format of the sweep lists, see Appendix).

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FREQ MODE

Displayed only with band center frequency switched off (SWEEP CTRL → OFF).
Specification of the band center frequency.

FIX:

With analog analyzers, this implies specification of the notch frequency of the switch-selectable analog notch filter.

Numerical entry of a fixed band center frequency, ie, also notch frequency, if notch switched on (menu line NOTCH (Gain) in the analog analyzers).
The minimum and maximum possible center frequency is determined by the instrument selected and the bandwidth specified and displayed in the operator guidance line. (For table with values, see below.)

For other measurement spheres, the generator can be swept, however does not affect any change in frequency of the selective rms measurement.

GEN TRACK

(Generator Tracking)
The band center frequency - and also the notch frequency (menu line Notch(Gain) in the analog analyzers), if switched on - tracks the generator frequency. This can be varied by the user (entry of value, spinwheel in menu item "FREQUENCY" of the generator) or by a generator frequency sweep.
By means of the factor entered in the next menu line it can be determined whether the center frequency should directly track the generator frequency (factor = 1) or be a multiple thereof. If the factor is an integral multiple, it may be used for measuring single harmonics.
The bandpass center frequency can be tracked to the generator signal functions SINE, MULTISINE, BURST, SINE2 PULSE, "SQUARE", only; any other signal function causes an error message.

Note: *When using the low-distortion generator small frequency offsets may occur which may lead to faulty measurements if the band center frequency is fixed to the rated frequency and if the actual frequency is beyond the selected passband or stopband. In such cases, the measured frequency should be referred to (FREQ MODE MEAS CH1/2).*

FREQ CH1
FREQ CH2

The band center frequency - and also the notch frequency (menu line Notch(Gain) in the analog analyzers), if switched on, tracks the frequency measured on channel 1 or 2.

Note: *Switching over the input channels 1↔2 causes the frequency mode to be switched over FRQ CH1 ↔ FRQ CH2, too..*

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Factor

Displayed only with FREQ MODE → GEN TRACK.

Specifies the factor by which the center frequency of the bandpass or bandstop filter is higher than the generator frequency. An integral factor >1 allows a single harmonic to be measured. With the factor 1 the fundamental can be selected.

Specified range: 1 to 20

Note: *The factor does not affect the notch filter frequency. With GEN TRACK selected, the notch filter is set exactly to the generator frequency without considering the "factor" so that a wider dynamic range can be obtained through the suppression of the fundamental irrespective of the measurement task.*

Notch (Gain)

(see 2.6.5.1, Common Parameters of Analyzer Functions)
An analog notch can be switched on additionally in the analog analyzers to improve the stopband attenuation if bandstop has been selected (menu item Bandwidth BS...).

The notch frequency is coupled directly to the band center frequency of the selective filter, ie it is selected via menu item FREQ MODE.

Filter

(see 2.7, Analyzer Filters)
Another (digital) filter can be selected in addition to the selective filter and the analog notch.

Application: *Highpass filter for DC suppression.*

Fnct Settl

(see 2.6.5.1, Common Parameters of Analyzer Functions)

SPEAKER

(see 2.6.5.1, Common Parameters of Analyzer Functions)

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Value range of bandpass center frequency:

The minimum and maximum possible center frequency is determined by the instrument selected and the bandwidth specified and is displayed in the user guide line.

Analyzer	f_C with bandwidth 1%	f_C with bandwidth 3%	f_C with bandwidth 1/3 OCT	f_C with bandwidth 1/12 OCT	f_C with bandwidth FIX:
ANLG 22 kHz	10 Hz to 21.83 kHz	10 Hz to 21.61 kHz	10 Hz to 19.54 kHz	10 Hz to 21.31 kHz	$5{,}05\,\text{Hz} + \frac{bw_{fix}}{2} \ldots f_{N1} - \frac{bw_{fix}}{2}$
ANLG 100 kHz	71 Hz to 124.4 kHz	71 Hz to 123.1 kHz	71 Hz to 111.4 kHz	71 Hz to 121.,4 kHz	$35{,}91\,\text{Hz} + \frac{bw_{fix}}{2} \ldots f_{N2} - \frac{bw_{fix}}{2}$
ANLG 300 kHz	213 Hz to 348.3 kHz	213 Hz to 344.8 k Hz	213 Hz to 311.8 kHz	213 Hz to 340.0 kHz	$107{,}7\,\text{Hz} + \frac{bw_{fix}}{2} \ldots f_{N3} - \frac{bw_{fix}}{2}$
DIG 48 kHz DIG 192 kHz DIG 768 kHz	$f_{cmin} \cdots \frac{f_N}{1{,}005}$	$f_{cmin} \cdots \frac{f_N}{1{,}015}$	$f_{cmin} \cdots \frac{f_N}{1{,}12246}$	$f_{cmin} \cdots \frac{f_N}{1{,}0293}$	Int. sample freq. * 0.1052E-3 + $\frac{bw_{fix}}{2} \ldots f_{N-} \frac{bw_{fix}}{2}$

f_c = Bandpass center frequency

f_{cmin} = $\frac{\text{Int. sample freq.}}{4800}$ (minimum center frequency)

f_N = Int. sample freq.* $\frac{117}{256}$ (useful frequency)

Int. sample freq.= Sampl Freq*Oversamp

bw_{fix} = bandwidth entered in numerical form

f_{N1}=21.94 kHz

f_{N2}=125 kHz

f_{N3}=350 kHz

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2.6.5.4 PEAK, Q-PEAK (Peak and Quasi-peak Weighting incl. S/N)

Available in the analyzers ANLG 22 kHz and DIG 48 kHz.

PEAK measurement

Peak value detector follows the waveform without delay.

Quasi-PEAK measurement

Peak value detection with subsequent and defined rising and falling times. This measurement is used for interference voltage measurements to CCIR 468-4 and DIN 45405.

For the peak and quasi-PEAK measurement, the maximum peak value of the input signal is determined and displayed within the monitoring interval selected under menu time "Intv Time". Subsequently, the peak value memory is cleared and the next peak value is searched for. The principle of operation is comparable to that of a maximum pointer instrument.

As to the measurement:

- *With the use of the analog analyzer an internal DC offset is also part of the measured value. The DC offset can be minimized using the "CAL Zero" function in the OPTIONS panel.*
- *When applying a square signal, it is bandlimited by the upper limit of the selected analyzer, leading to overshoots at the edges (Gibb's phenomenon). The overshoots are also measured during peak weighting, so that a measured value exceeding the input peak may be obtained. Particularly in the digital range, FS values >1 may be measured (see footnote 2.4 Units - Hex).*

S/N Sequ

(S/N sequence)
(see 2.6.5.1, Common Parameters of Analyzer Functions)

Meas Mode

(Measurement mode)
of PEAK measurement (see 2.4, Units).

PK + The positive peak voltage is measured

PK - The (absolute) negative peak voltage is measured

PK to PK The peak-to-peak voltage is measured

PK abs The absolute (positive or negative) peak voltage is measured

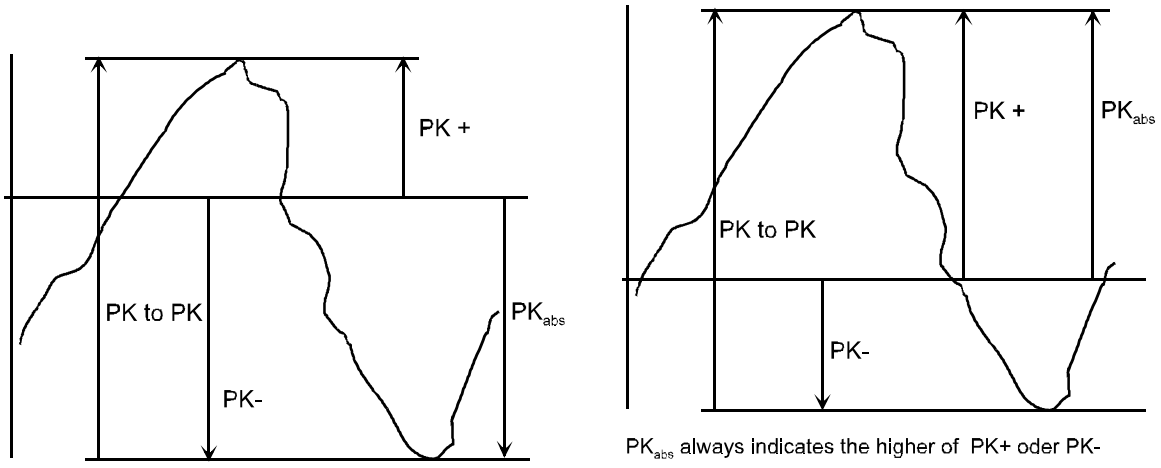

Fig. 2-31 Signal with measurement modes

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Intv Time

(Interval time)
Monitoring interval for peak value detection
Selection depends on the type of input signal and measurement sphere. Universal specifications cannot be made.

FIX 50 MS	50 ms, PEAK only
FIX 200 MS	200 ms, PEAK only
FIX 1000 MS	1000 ms, PEAK only
FIX 3 SEC	3000 ms, quasi-peak only
VALUE	Numerical entry. Value range: 20 ms to 10 s, Units: s | ms | µs | min

***Notes on quasi-peak measurement**:*
In order to obtain settled measured values, the measuring time should not drop below 3 s with triggered measurements and sweeps.

Unit Ch1/2

(see 2.6.5.1, Common Parameters of Analyzer Functions)

Reference

(see 2.6.5.1, Common Parameters of Analyzer Functions)

Notch (Gain)

Quasi-peak only

(see 2.6.5.1, Common Parameters of Analyzer Functions)

Filter

(see 2.7, Analyzer Filters)

A maximum of 3 filters can be selected.

Fnct Settl

(see 2.6.5.1, Common Parameters of Analyzer Functions)

SPEAKER

(see 2.6.5.1, Common Parameters of Analyzer Functions)

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2.6.5.5 DC Voltage

Available for all analyzers.

Particularities of analog DC measurement:

DC voltages can be measured at the Unbal input from 0 to ±300 V, at the Bal input from 0 to ±35 V. The DC reference point is the external conductor of the BNC female connector and connecting point 3 of the XLR female connectors for the unbalanced input (UNBAL BNC) and balanced input (BAL XLR), respectively (see 2.6.2). For selecting the measurement range for DC measurements, see 2.6.2, Table 220.

During a DC measurement, overloading of the measurement path because of a superimposed AC voltage causes a less sensitive range to be automatically set, which however means less measuring accuracy.

Meas Time

If the DC voltage is superposed by an AC voltage, specifying the Meas Time as integration time relative to the signal period of the AC voltage has different effects:

Meas Time is an integer multiple of signal period:
An integration effect results. The AC voltage is ***not*** included as part of the DC measurement result. Steady display!

Meas Time larger than, yet no integer multiple of signal period:
As above, yet beats occur in the display

Meas Time smaller than signal period:
No integration effect. The AC voltage component is part of the DC measurement result. The DC measurement result follows the AC voltage characteristics.

FIX 200 MS

Measurement time: 200 ms

VALUE

Numerical entry.
Value range: 1 ms to 1.5 ms
Units: s | ms | µs | min

Unit Ch1/2

(see 2.6.5.1, Common Parameters of Analyzer Functions)

Reference

(see 2.6.5.1, Common Parameters of Analyzer Functions)

Fnct Settl

(see 2.6.5.1, Common Parameters of Analyzer Functions)

SPEAKER

(see 2.6.5.1, Common Parameters of Analyzer Functions)

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2.6.5.6 THD Measurement

Available for all analyzers.

For distortion measurements, apply an extremely pure sinewave signal to the device under test. Select the signal frequency such that the significant components of the distortion spectrum are still below the upper range limit (see 2.6.1, 2.6.2, 2.6.3) of the selected ANALYZER instrument.

A signal not meeting the requirements leads to a SHOW I/O message (see 2.3.5):

- The signal has no zero crossings in the viewed frequency range and is not suitable for distortion measurements:
  "Can't find zero crossing in Signal"
- With the setting "Fundamentl GEN TRACK" (fundamental frequency of THD+N measurement is coupled to the current generator frequency), an unsuitable signal function is selected in the GENERATOR:
  "No valid GEN-Function (SINE, BURST, S2PULS or SQUARE)"

With the signal function SINE (see 2.5.4.3) and the low-distortion generator (option UPD-B1), the UPD generator provides a sinewave signal that meets the high quality demands.

Principle of measurement

The UPD allows the distortion of single harmonics or combinations thereof (d2 to d9) to be measured, the amplitudes of the single harmonics being selectively measured and the root of their square sum can be displayed as RMS value or related to the total rms value. A selection is made in the menu item "Meas Mode". Depending on the selected mode different units are used:

- V or FS for RMS display
- % or dB for ratio display

$$U_{THD}[dB] = 20 \times \log \frac{\sqrt{Ud2^2 + \ldots + Ud9^2}}{\text{total rms value}}$$

$\sqrt{Ud2^2 + \ldots + Ud9^2}$: square sum of selected harmonics

Display of the measurement result:

Apart from displaying the THD in the result display, a graphical (histogram)) or a numeric display of the fundamental and of individual harmonics can be switched on. This is done by selecting OPERATION SPECTRUM or SPECTR LIST in the DISPLAY panel. All harmonics in the frequency range are indicated in the histogram. The selected harmonics contained in the result are marked by wide bars, all others by narrow bars so that they can be distinguished.

Note: *If the fundamentals applied to the two measuring inputs have different frequencies, the frequencies indicated in the graphics refer to the channel which is displayed in trace A.*

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Meas Mode

(Measurement mode)
Select the harmonics to be measured and the way of display. The harmonics are then displayed above the measured value window. "THD 2–4–6–8", for example, means that the 2nd, 4th, 6th and 8th harmonic distortions are measured.

SELECT di	Any combination of harmonic distortions d2 to d9. The measurement result is the root from the square sum of the selected harmonic distortion ***referred to the total RMS value***. Display in % or dB.
All even di	Like SELECT di, all ***even*** harmonics (d2, d4, d6, d8) being selected.
All odd di	Like SELECT di, all ***uneven*** harmonics (d3, d5, d7, d9) being selected.
All di	Like SELECT di, ***all*** harmonics (d2 to d9) being selected.
LEV SEL di	Any combination of harmonic distortions d2 to d9. The measurement result is the root from the square sum of the selected harmonic distortion, display as ***RMS value*** (with any level unit).
LEV even di	Like LEV SEL di, all ***even*** harmonics (d2, d4, d6, d8) being selected.
LEV odd di	Like LEV SEL di, all ***uneven*** harmonics (d3, d5, d7, d9) being selected.
LEV all di	Like LEV SEL di, ***all*** harmonics (d2 to d9) being selected.

di 2 4 6 8

Displayed only, if either SELECT di or LEV SEL di has been selected as Meas Mode.

√	**d2**
	d3
√	**d4**
	d5
√	**d6**
	d7
√	**d8**
	d9

Select any combination of harmonics.

After selecting the desired harmonics using the ↑ and ↓ keys, the harmonic distortion measurement can be selected (√) or disabled by means of the SELECT key.

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Dyn Mode

(Dynamic mode)
Analog analyzers only
Determines the possible dynamic range of measurement results and thus the measurement rate.

FAST

A fast measurement with less dynamic range is performed.

PRECISION

If the measured value is better than 60 dB (Analog 22 kHz) or 50 dB (Analog 100 kHz or 300 kHz), the measurement is performed with wider dynamic range and with the analog notch filter cut in. The measuring time increases correspondingly. If the THD value of the signal drops below 50 or 60 dB, the measurement is performed in the FAST mode.

Unit

(see 2.6.5.1, Common Parameters of Analyzer Functions)

Reference

(See 2.6.5.1 Common Parameters of Functions)
only available in level measurement modes (LEV...).

This value may be entered manually if desired. Otherwise, the current RMS value will be automatically entered, if the reference value of INPUT DISP RMS is stored with the STORE (or STORE CH1 or STORE CH2) function.

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Fundamentl

Specify how the fundamental frequency is to be determined.

AUTO

The UPD automatically determines the fundamental frequency (while THD measurement is being performed).

VALUE
1000,0 Hz

Numerical entry of fundamental frequency
Range of values:

ANLG	22 kHz:	5.8 Hz	to	21.9 kHz
ANLG	100 kHz:	41.7 Hz	to	125 kHz
ANLG	300 kHz:	125 Hz	to	350 kHz
DIG	48 kHz:	} int. sample freq./8192 to useful bandwidth		
DIG	192 kHz:			
DIG	768 kHz:			

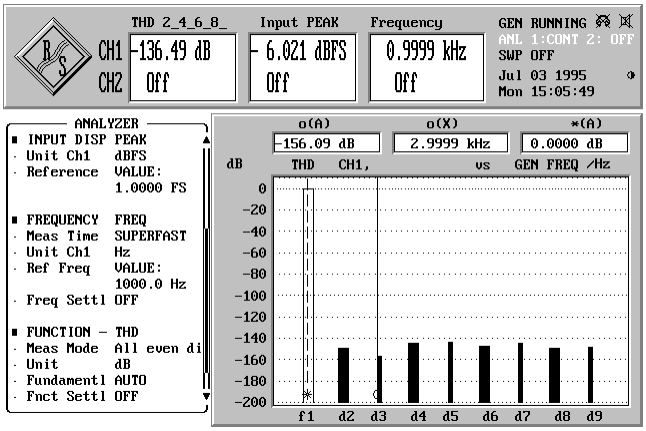
Useful bandwidth = int. sample freq. * Oversamp * 117/256

GEN TRACK

With the generator signal function set to ”SINE”, "MULTISINE", ”BURST” ”SINE2 PULSE” or ”SQUARE”, the current generator is used as fundamental frequency. The latter can be varied by the user (entry of value, spinwheel under generator menu item FREQUENCY) or by means of a generator frequency sweep.
Selecting any other signal function results in an error message (see 2.3.5).

Note: *With active low-distortion generator, its actual frequency is determined in each measurement by means of an internal frequency measurement, which increases the total measuring time. With a view to the measurement rate, the operating mode GEN TRACK should be avoided in this case.*

The settings VALUE and GEN TRACK are preferably used for signals with high harmonic content to increase the setting accuracy.



Graphical presentation of THD measurement results in the form of a histogram see 2.10.1 and 2.10.2

Fnct Settl

(see 2.6.5.1, Common Parameters of Analyzer Functions)

SPEAKER

(see 2.6.5.1, Common Parameters of Analyzer Functions)

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2.6.5.7 THD+N/SINAD Measurement - (Total Harmonic Distortion+Noise)

Available for all analyzers.

For THD or SINAD measurements, apply a highly pure sinewave signal to the device under test. Select the signal frequency such that the significant components of the THD spectrum are still below the upper measurement limit (see 2.6.1, 2.6.2, 2.6.3) of the used ANALYZER instrument.

If the signal offered does not meet the requirements, a SHOW I/O message is output (see 2.3.5):

- In the frequency range up to 300 kHz, the fundamental wave cannot be found:

"Can't find fundamental"

- The frequency of the found fundamental wave is less than the lower limit value (for its calculation, see below, Fundamentl VALUE):

"Fundamental too low"

- For the setting Fundamentl GEN TRACK (fundamental frequency of THD+N measurement is coupled to the current generator frequency), an unsuitable signal function is selected in the GENERATOR:

"No valid GEN-Function (SINE, BURST, S2PULS or SQUARE)"

With the signal function SINE (see 2.5.4.3) in combination with the low-distortion generator (option UPD-B1), the generator in the UPD offers a sinewave signal meeting the high demands on its spectral purity.

Principle of measurement

The fundamental is filtered out and the total remaining energy consisting of harmonics and broadband noise within the band limits specified with "FrqLim Low" and "FrqLim Upp" is calculated with the aid of one or several FFTs. The user can select the size of the *first* FFT for starting the calculation,.

- implicitly by selecting measurement time (with post FFT switched off)
- explicitly by selecting FFT size (with post FFT switched on).

A compromise has to be made between measurement speed and accuracy. If the selected FFT size is not sufficient to measure the fundamental of the test signal, the FFT size and, if required, the zoom factor are gradually increased.
The energy of the noise and, if applicable, the harmonics can either be displayed as an RMS value or put in relation to the total rms value, the total rms value being band-limited to "FrqLim Upp". The selection is made under the menu item "Meas Mode". Depending on the selected measurement mode, the units are as follows:

- - V or FS for RMS display
- - % or dB for ratio display

In the measurement modes "NOISE" and "LEVEL NOISE" all harmonics in addition and the fundamental are filtered out from the total signal. With each harmonic also the noise energy of the respective sideband is filtered so that at very low frequencies - and therefore when a large number of harmonics exists - a great part of the noise energy is lost. For this reason these measurement modes should only be used with high frequencies (> 100 ∗ FFT resolution) and large "FFT Size".

Measurement limits

The lower frequency limit for the measurement signal is instrument-dependent and as follows:

- 10 Hz in ANLG 22 kHz and the DIG 48 kHz instrument,
- 20 Hz in the ANLG 100 kHz instrument,
- 70 Hz in the ANLG 300 kHz instrument,
- 30 Hz in the DIG 192 kHz instrument,
- 100 Hz in the DIG 768 kHz instrument.

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The frequency of the fundamental must be limited at the upper end such that the harmonic to be measured is still below the frequency limit of the respective analyzer or below the selected "FrqLim Upp".
For noise measurements (measurement mode NOISE and LEVEL NOISE, harmonics not considered), the harmonic must be at least 36 times the lowest possible resolution (indicated under Post-FFT). For instance, with ANLG 22 kHz instrument and a sample rate of 48 kHz in the digital analyzer, a lower limit of 105.46875 Hz is obtained.
THD-N Post-FFT is only possible if the fundamental of the measurement signal is six times the resolution indicated under Post-FFT (see "FFT Size"). To reduce the resolution and therefore the lower frequency limit, the FFT size may have to be increased.

Measurement speed

The measurement speed depends on the (selectable) FFT size and the required dynamic measurement range.
The required FFT size is obtained from the frequency of the signal to be measured and the required accuracy. The larger the FFT, the finer the frequency resolution and the lower the bottom measurement limit. With low frequencies and high accuracy requirements, a large FFT must be selected and a longer measurement time be taken.
For measuring particularly low-distortion signals, the dynamic range can be extended by selecting the Precision mode. In this case the measurement time will be doubled, however.
To obtain a maximum measurement speed, two parameters can be optimized:

- Selection of smallest-possible FFT size or matching the FFT size to the fundamental of the measurement signal. The FFT size should be such that the fundamental to be measured is at least 10 times the resolution displayed under Post-FFT (12 times in the digital analyzer). Only then can be total signal be measured with a single FFT. If the UPD generator is used as a signal source, *Fundamental GEN TRACK and FFT Size 512 ("Meas Time SUPERFAST".)* should be selected.
- Selection of *Dynamic Mode FAST* if the signal to be measured does not require the full dynamic range.

Display of measurement results:

In addition to the total harmonic distortion (in the result display), the frequency spectrum can also be represented graphically or numerically as POST FFT. This is the case when OPERATION SPECTRUM or SPECTR LIST in the DISPLAY panel.

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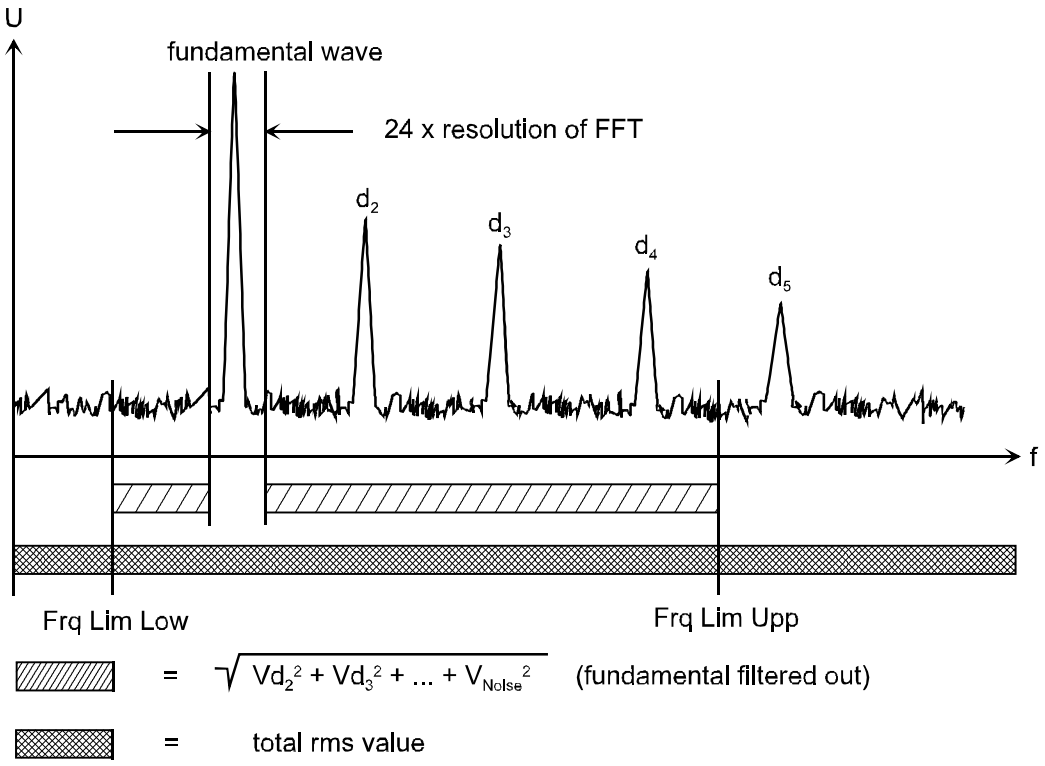

Fig. 2-32

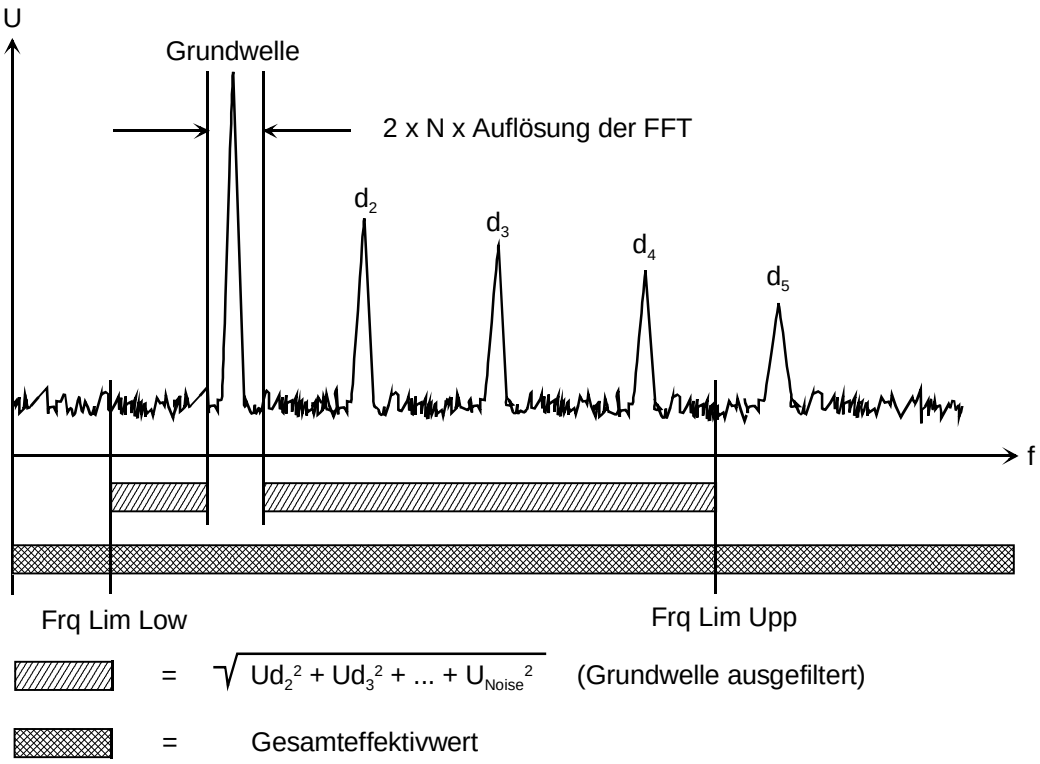

Bild 2-33

N = 12 for DIG 48 kHz
10 for ANLG 22 kHz, DIG 192 kHz and DIG 768 kHz

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7.5 for ANLG110 kHz
8.5 for ANLG 110 kHz

$$U_{THD+N}[dB] = 20 * \log \frac{\sqrt{U_{d2}^2 + U_{d3}^2 + ... + U_{noise}^2}}{\text{total rms value}}$$

THD+N measurements provide negative dB-values, SINAD measurements result in positive dB-values. The magnitudes of the values are identical.

$\sqrt{U_{d2}^2 + U_{d3}^2 + ... + U_{noise}^2}$ = Square sum of all harmonic + distortions noise within the frequency range specified under FrqLim Low and FrqLim Upp.

Meas Mode

(Measurement mode)
Select the measurement and display modes. The selected measurement mode is displayed above the result window.

THD + N

The THD including noise is measured; the result is the root of the square sum of the selected harmonic and the noise voltage, ***referred to the total RMS value***; display in % or dB.

SINAD

As THD+N, but displayed as reciprocal value; display (positive) dB only.

NOISE

Only the noise is measured; the result is the noise voltage ***referred to the total RMS value***; display in % or dB.
Application:
Measurement of non-harmonic interferences such as RUB & BUZZ measurement of loudspeakers.

LEVEL THD+N

The THD including noise is measured, the result is the root of the square sum of the selected harmonic and the noise voltage; display as RMS value (in any level unit).

LEVEL NOISE

Only the noise is measured; the obtained noise voltage is displayed as RMS value in % or dB.

Dyn Mode

(Dynamic mode) in analog analyzers only.
Determines the possible dynamic of the measurement result and thus the measurement rate.

FAST

A fast measurement with low dynamic is performed.

PRECISION

The measurement is performed with a higher dynamic and with the analog notch filter cut in; the measuring time increases correspondingly.

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Rejection

Displayed only in the analog instruments when Dyn Mode FAST is selected.

NARROW

The fundamental is blanked (extremely narrowband). Thus, interference components very close to the carrier can be recognized.

WIDE

To suppress the carrier, a notch filter is used with a characteristic which was commonly used in the past in analog measuring instruments. The measured values are improved due to the broadband filtering, since harmonic components close to the carrier are also suppressed.

This mode should be used if the measurement results should be comparable to those of analog instruments.

Meas Time

(Measurement time)
The measurement time is used to adapt the measurement speed to the required accuracy. To obtain a higher measurement speed the (initial) FFT size is reduced.

SLOW

Measurements are performed with the greatest FFT size (8k zoom FFT). Additional FFTs (with a higher zoom factor) are only required for extremely low frequencies. This setting should be selected in particular when only the noise (NOISE or LEVEL NOISE) is measured so that harmonics are suppressed with a bandwidth as narrow as possible.

FAST

The initial FFT is measured with reduced FFT size (2 k). With low frequencies, additional FFTs (with more points and a higher zoom factor) are required.

SUPERFAST

The initial FFT is measured with the smallest FFT size (0.5 k). Additional FFTs (with more points and a higher zoom factor) may be required. This setting should only be selected if the measurement result need not be too accurate and the frequency of the signal to be measured is not very low.

***Note**: With post-FFT switched on, the FFT size can be set as required irrespective of the settings made here, i.e. the selected measurement speed is ignored.*

Unit

(see 2.6.5.1, Common Parameters of Analyzer Functions)

Reference

(See 2.6.5.1 Common Parameters of Functions)
only available in level measurement modes (LEV...).

This value may be entered manually if desired. Otherwise, the current RMS value will be automatically entered, if the reference value of INPUT DISP RMS is stored with the STORE (or STORE CH1 or STORE CH2) function.

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Fundamentl

Determines how to obtain the fundamental frequency.

AUTO

UPD determines the fundamental frequency automatically (while the THD+N measurement is being performed)

VALUE

Numerical entry of fundamental frequency.
Range of values:

ANLG	22 kHz:	10.0 Hz to 21.9 kHz
ANLG	100 kHz:	20.0 Hz to 125 kHz
ANLG	300 kHz:	70.0 Hz to 350 kHz
DIG	48 kHz:	12∗sample freq./(8∗8192) to useful bandwidth
DIG	192 kHz:	
DIG	768 kHz:	

Useful bandwidth = Sample freq * Oversamp * 117/256

The setting VALUE is to be preferred for signals with a high noise component if an external generator is used as a signal source.

GEN TRACK

With the generator signal function set to SINE, MULTISINE, BURST SINE2 PULSE or SQUARE, the current generator frequency is used as the fundamental. The latter can be varied by the user (entry of value, spinwheel under generator menu item FREQUENCY) or by means of a generator frequency sweep.
Selecting any other signal function results in an error message.
Thus the setting accuracy for signals with a high noise component is improved and the measurement speed increased.

With a fundamental the frequency of which cannot be measured with the set FFT size, the latter is increased until the measurement can preferably be performed with a single FFT (or 2 FFTs in the precision mode). Thus the maximum measurement speed can be obtained for each generator frequency with FFT size 512.

The setting GEN TRACK is to be preferred whenever the internal generator is used as the signal source.

Note: *With FAST setting, in particular, the current frequency of the active low-distortion generator may slightly deviate from the frequency set in the GENERATOR panel. This may lead to small frequency error occurring with determination of the harmonics, thus slightly reducing the accuracy of the measurement result. Therefore, the operating mode GEN TRACK should not be used in conjunction with the low-distortion generator.*

The settings VALUE and GEN TRACK are preferably used for signals with high harmonic content to increase the setting accuracy.

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Filter

OFF
A WEIGHTING
C MESSAGE
CCITT
CCIR WTD
CCIR UNW
DEEM 50/15
DEEMPH 50
DEEMPH 75
DEEMPH J.17
RUMBLE WTD
RUMBLE UNW
DC NOISE HP
CCIR ARM
IEC TUNER

The THD+N measurement result can be weighted using one of 14 different filters (see 2.7.1). User definable filters are available, too.

Frq Lim Low

Lower band limit of THD+N / SINAD measurement function; this limit does *not* influence the calculation of the total RMS value.

.
Value range:

ANLG	22 kHz:	10.0 Hz to 21.93 kHz
ANLG	100 kHz:	20.0 Hz to 124.9 kHz
ANLG	300 kHz:	70.0 Hz to 349.81 kHz
DIG	48 kHz:	12∗sample freq./(8∗8192) to useful bandwidth
DIG	192 kHz:	
DIG	768 kHz:	

Int. sample freq. = Sample freq * Oversamp
Useful bandwidth = Sample freq. * 117/256

Frq Lim Upp

Upper band limit of THD+N / SINAD measurement function and of the total RMS value.
Range of values:

ANLG	22 kHz:	(Freq Lim Low + 8.79 Hz)	to	21.94 kHz
ANLG	100 kHz:	(Freq Lim Low + 62.5 Hz)	to	125 kHz
ANLG	300 kHz:	(Freq Lim Low + 187.5 Hz)	to	350 kHz
DIG	48 kHz:	(Frq Lim Low + Int. sample frq./5461.3) to useful bandwidth		
DIG	192 kHz:			
DIG	768 kHz:			

Useful bandwidth = Sample freq * Oversamp * 117/256

Note: *If the fundamental of the measurement signal is above "FrqLim Upp", relative measurements (THD+N, SINAD and NOISE) are not useful because the energy of the fundamental of the reference is filtered out. In this case an error message is output.*

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Only harmonic distortions and noise components *within the specified band limits* are used for calculation.

For calculating the total RMS value only frequencies *below "FrqLim Upp*" are considered.

Fnct Settl

(see 2.6.5.1, Common Parameters of Analyzer Functions)

POST FFT

(see 2.6.5.1, Common Parameters of Analyzer Functions)
There is ***no*** post-processing of measuring data for POST FFT, the measurement can thus be terminated faster.

OFF

ON

Subsequent to obtaining the result of the THD+N measurement, the measured data are prepared for ***POST FFT display***. The display can be selected in the DISPLAY panel, eg as FFT spectrum.

Of the following five FFT setting parameters only the FFT size can be modified, all others are displayed.

Note: *If the selected FFT size is too small, the Post-FFT cannot be displayed.*

FFT Size

Size of FFT used for calculating THD-N and Post-FFT; settable in steps of 2 between 512 and 8192.

512
1024
2048
4096
8192

A larger FFT size (ie more calculated points) entails a finer frequency resolution, a reduced lower frequency limit and a higher accuracy but also correspondingly longer measurement times.

The selected FFT size determines the display of the Post-FFT and the initial size of the zoom FFT used for calculating THD-N. An FFT size which is not sufficient to resolve the fundamental of the signal has the following consequences:

- The Post-FFT cannot be displayed; an error message is output in the displayed graph.
- Additional FFTs with an increased number of samples are automatically calculated and the measurement time increases accordingly.

To be able to perform a *Post*-FFT, it must be ensured that the fundamental is by the factor 6 above the displayed resolution (or 36 for all (LEVEL) NOISE measurements).

If required, the FFT size has to be increased or another analyzer instrument selected.

To avoid additional FFTs being performed (because the FFT size is too small) without having to switch to a large and therefore slow FFT, it is recommended to use "Fundamental GEN TRACK" when an internal generator is used. With this setting the fundamental is known before the 1st FFT is started so that the smallest possible FFT (≥ "FFT Size") can be used.

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Window

Always RIFE VINC 2 (analog) or RIFE VINC 3 (digital)

***Note**: For more specialized applications the parameter "-tthdn" may be used to select the FFT window to be used for the THD+N measurement.*

Start

Display value, not identical with Frq Lim Low

Stop

Display value (useful bandwidth), not identical with Frq Lim High

Resolution

Display value; determines the lower frequency limit of the measurement.

SPEAKER

(see 2.6.5.1, Common Parameters of Analyzer Functions)

Direct aural monitoring of the residual THD+N signal is not possible. However, the distortion can be monitored when a narrowband bandstop filter is switched on during the RMS SELECT measurement. The signal after the bandstop filter corresponds to the residual signal of the THD+N measurement (see 2.6.7 Headphone/Speaker Output).

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2.6.5.8 MOD DIST (Modulation Factor)

Available in all analyzers.

For modulation distortion measurements, apply a frequency mixture consisting of a low-frequency interfering sinewave signal (eg 60 Hz) and a high-frequency useful sinewave signal (eg 7 kHz) to the DUT. The amplitude of the interfering signal should be equal to or higher than that of the useful signal. According to DIN IEC 268 Part 3, selection of a peak amplitude ratio interfering : useful signal = 4 : 1 is to be preferred.

When the signal offered does not meet the requirements, a SHOW I/O message (see 2.3.5) is output:

- Useful signal is not in the frequency range from 2 kHz to 110 kHz:

"Cannot find high tone in the range from 2 to 110 kHz."

- Interfering signal is not in the frequency range from 0 Hz to 1100 Hz:

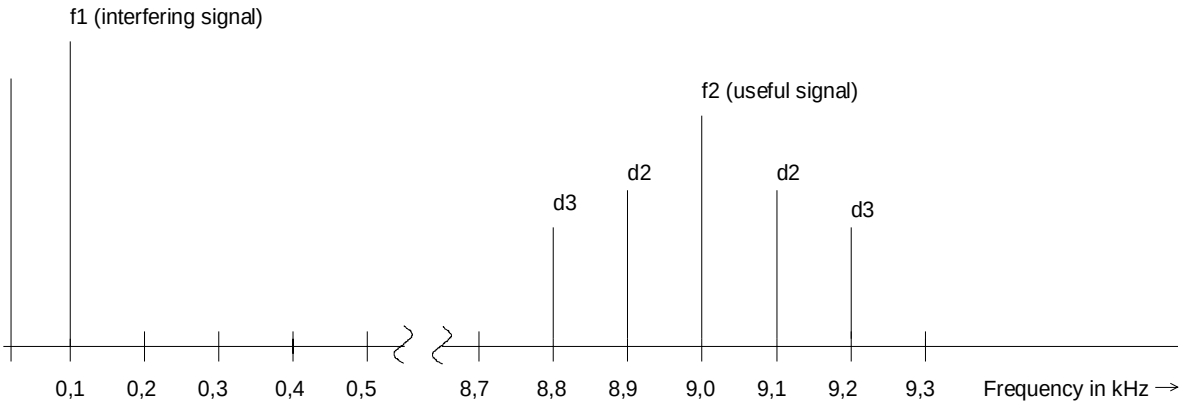
"Cannot find low tone in the range from 0 to 1100 Hz."

With the signal function MOD DIST (see 2.5.4.8), the UPD generator offers the above frequency mixture, allowing the frequencies and amplitude ratio of interfering and useful signal as well as the total level to be specified. Total level and useful frequency can be swept.

Principle of measurement

Unaffected by noise due to selective measurement, the UPD measures the intermodulation products of 2nd and 3rd order in line with DIN IEC 268 Part 3 and does the square sum of the intermodulation products. (Contrary to the DIN IEC 268 Part 3 Recommendation, the total intermodulation distortion is measured to permit comparisons with the hitherto commonly used SMPTE measurement procedures).

Note: *If the intermodulation signals applied to the two measuring inputs have different frequencies, the frequencies indicated in the graphics display refer to the channel displayed in trace A.*



d2 = Intermodulation product of 2nd order
d3 = Intermodulation product of 3rd order

Fig. 2-34

Modulation distortion of 2nd order:

$$dm2 = \frac{|U_{(f1+f2)}| + |U_{(f2-f1)}|}{U_{(f2)}}$$

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Modulation distortion of 3rd order:

$$dm3 = \frac{|U_{(f2-2f1)}| + |U_{(f2+2f1)}|}{U_{(f2)}}$$

Square sum:

$$dm(2+3) = \sqrt{dm2^2 + dm3^2}$$

MOD DIST [dB] = 20 * lg (dm(2+3))

Display of measurement result:

In addition to displaying the total intermodulation distortion in the result display, an additional graphical (histogram) or numerical display of the useful frequency and the signal frequency and of the individual intermodulation products can be switched on. This is effected by selection of OPERATION SPECTRUM or SPECTR LIST in the DISPLAY panel.

Note: *If the intermodulation signals applied to the two measuring inputs have different frequencies, the frequencies indicated in the graphics refer to the channel which is displayed in trace A.*

Dyn Mode

(Dynamic Mode), in the analog analyzers, only.
determines the possible dynamic of the measurement result and thus the measurement rate.

FAST

A fast measurement with less dynamic is performed.

PRECISION

If the measured value is better than 55 dB (Analog 22 kHz) or 40 dB (Analog 100 kHz or 300 kHz), the measurement is performed with higher dynamic and analog notch filter cut in; the measuring time increases, correspondingly. If the intermodulation value of the signal drops below 55 or 40 dB, the measurement is performed in FAST mode.

Unit

(see 2.6.5.1 Common Parameters of Functions)

Fnct Settl

(see 2.6.5.1 Common Parameters of Functions)

SPEAKER

(see 2.6.5.1 Common Parameters of Functions)

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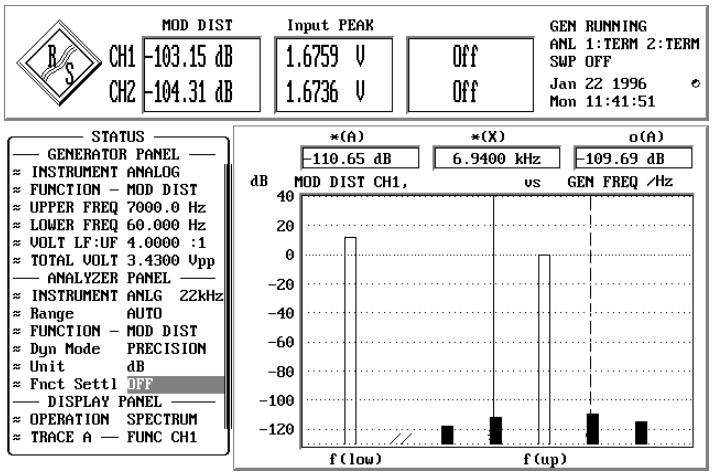

Graphical presentation of MOD DIST measurement results in the form of a histogram, see 2.10.1 and 2.10.2.

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2.6.5.9 DIM (Dynamic Intermodulation Distortion)

DIM is available in the ANALYZER instruments ANLG 22 kHz and DIG 48 kHz.

For the dynamic intermodulation distortion measurement (DIM), apply a frequency mixture, consisting of a low-frequency squarewave superposed by a high-frequency sinewave with a peak-amplitude-ratio of square : sine = 4 : 1, to the device under test. To DIN IEC 268 Part 3, the squarewave is to be spectrally limited to 30 kHz or 100 kHz using a one-pole lowpass.

The UPD is able to weight two squarewave/sinewave frequency mixtures:

To DIN IEC 268 Part 3:
square 3.15 kHz / sine 15 kHz
as against DIN for applications in the RF range:
square 2.96 kHz / sine 14 kHz

For deviations exceeding

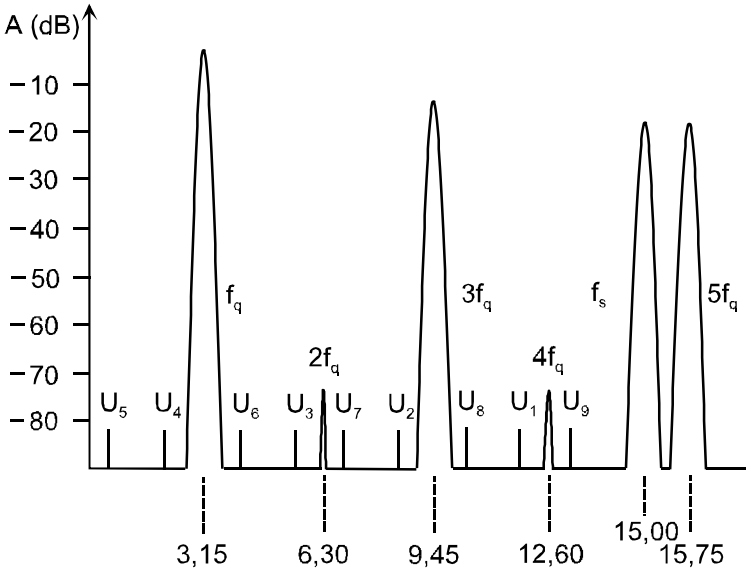
- ±2 % of the specified squarewave frequency or
- ±5 % of the specified sinewave frequency

the following SHOW I/O messages (see 2.3.5) are output.
"No squarewave at defined frequency." or
"No sinewave at defined frequency."

With the signal function DIM (see 2.5.4.10), the UPD generator offers the two frequency mixtures stated above, besides, the band limitation of the squarewave can be set to 30 kHz or 100 kHz and the total amplitude can be set.

Principle of measurement

The UPD selectively measures the nine components of dynamic intermodulation, which are caused by the device under test and are within the AF range. As against the obsolete principle of measurement, which is to filter out only two or three interfering lines in the lower frequency range using a lowpass and obtain a measurement result impaired by noise, the UPD now provides a measurement result unaffected by noise due to the selective measurement of each individual interfering line. The intermodulation distortions provided by the new method may be higher than with the former method, yet conforming to standards.



Intermodulation components		Frequency kHz
Frequency	Voltage	
$5f_q - f_s$	U_5	0,75
$f_s - 4f_q$	U_4	2,40
$6f_q - f_s$	U_6	3,90
$f_s - 3f_q$	U_3	5,55
$7f_q - f_s$	U_7	7,05
$f_s - 2f_q$	U_2	8,70
$8f_q - f_s$	U_8	10,20
$f_s - f_q$	U_1	11,85
$9f_q - f_s$	U_9	13,35

Fig. 2-35 Frequency spectrum of signal for DIM measurements illustrated by the example of a frequency mixture of square 3.15 kHz / sine 15 kHz

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$$DIM-WERT\,[dB] = 20 * lg(d)$$

$$d = \frac{\sqrt{U1^2 + U2^2 + U3^2 ... + U9^2}}{U_s}$$

fq = squarewave frequency
fs = sinewave frequency
V1...V9 = rms value of spectral components
Vs = rms value of sinewave signal
d = dynamic intermodulation distortion

Display of the measurement result:

In addition to displaying the dynamic intermodulation factor in the result display, an additional graphical (histogram) or numerical display of the squarewave frequency and the sinewave frequency (according to the meas. mode selected) and of the individual intermodulation products can be switched on. This is effected by selection of OPERATION SPECTRUM or SPECTR LIST in the DISPLAY panel.

Note: *If the intermodulation signals applied to the two measuring inputs have different frequencies, the frequencies indicated in the graphics refer to the channel which is displayed in trace A.*

Unit

(see 2.6.5.1, Common Parameters of Analyzer Functions)

FREQ MODE

Select reference frequencies.

FIX:

Two fixed reference frequency pairs can be selected in the menu line Square/Sin (see next command).

GEN TRACK

With the generator signal function set to DIM, the reference frequency pair specified under generator menu item Square/Sin (see 2.5.4.10) is used as reference frequency pair in DIM measurements.
If, by mistake, any other generator signal function is set, an error message is displayed (see 2.3.5):

Generator function invalid!
To use FREQ MODE → GENTRACK, DIM must be set as generator function!

Square/Sin

Two reference frequency pairs

2.96/14 kHz

Squarewave frequency 2.96 kHz, sinewave frequency 14 kHz

3.15/15 kHz

Squarewave frequency 3.15 kHz, sinewave frequency 15 kHz

Fnct Settl

(see 2.6.5.1, Common Parameters of Analyzer Functions)

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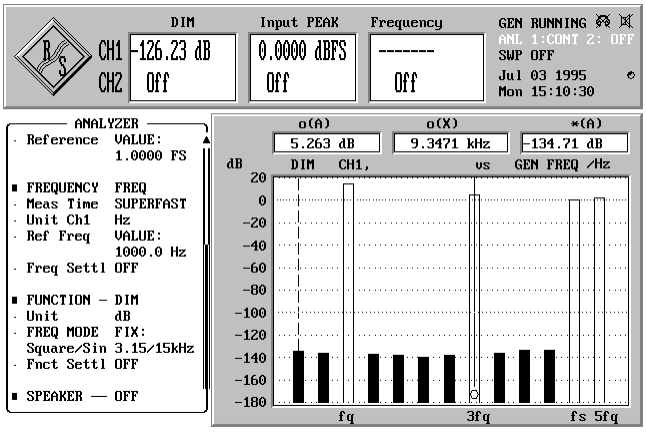
SPEAKER

(see 2.6.5.1, Common Parameters of Analyzer Functions)



Graphical presentation of DIM measurement results in the form of a histogram see 2.10.1 and 2.10.2

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2.6.5.10 DFD (Difference Frequency Distortion)

Available for all analyzers.

To measure the difference frequency distortion of 2nd or 3rd order, apply a frequency mixture to the device under test. The frequency mixture is to consist of two sinewave signals of the same amplitude with. To DIN IEC 268 part 3, an arithmetic mean frequency out of the terz band (5, 6.3, 8, 10, 12.5, 16, 20 kHz). and a frequency offset of 80 Hz is to be selected preferably.

Frequency limits for d_2- and d_3-measurements:
$2f_2$-f_1 must still be within the frequency range of the instrument set (see 2.6.1).

When the signal offered does not meet the requirements, a SHOW I/O message is output (see 2.3.5):

- The frequency difference is higher than 2100 Hz:

"Frequency difference of IMD-Tones seems to be too large; (> 2100.0 Hz)"

- The frequency difference is less than 70 Hz:

"Frequency difference of IMD-Tones seems to be too small; (<70.0 Hz)"

- The levels of the two sinewave signals differ by more than 20 %:

"Level of IMD-Tones seems to be too different; (more than 20 %)"

> ***Note**: In the measurement modes to **IEC 118** a level check of IMD tones is **not** performed. A DFD measurement is therefore also possible with strongly distorted IMD signals (eg due to frequency response of DUT or transmission link).*

With the signal function DFD (see 2.5.4.9), the UPD generator offers the above frequency mixture allowing the mean frequency, frequency difference and total amplitude to be specified by the user.

Principle of measurement

With Meas Mode d_2 or d_3, being set, the UPD measures selectively. Thus being unaffected by noise, the intermodulation products of 2nd or 3rd order are measured in accordance with DIN IEC 268 part 3.

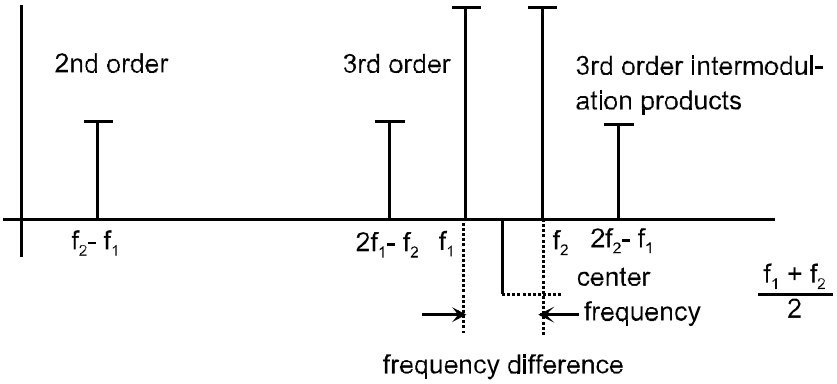

Fig. 2-36

Difference frequency distortion of 2nd order:

$$d_2\,[\mathrm{dB}] = 20 \times \lg \frac{\left|U_{(f_2 - f_1)}\right|}{2 \times U_{(f_2)}}$$

Difference frequency distortion of 3rd order:

$$d_3\,[\mathrm{dB}] = 20 \times \lg \frac{\left|U_{(2f_2 - f_1)}\right| + \left|U_{(2f_1 - f_2)}\right|}{2 \times U_{(f_2)}}$$

to IEC 118

$$d_2\,[dB] = 20x \lg \frac{\left|U_{(f_2 - f_1)}\right|}{U_{(f_2)}}$$

$$d_3\,[dB] = 20x \lg \frac{\left|U_{(2f_1 - f_2)}\right|}{U_{(f_2)}}$$

to IEC 118

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Display of the measurement result:

In addition to displaying the difference frequency distortion (d2 or d3) in the result display, an additional graphical (histogram) or numerical display of the center frequency and the difference frequency (according to the meas. mode selected) and of the individual intermodulation products can be switched on. This is effected by selection of OPERATION SPECTRUM or SPECTR LIST in the DISPLAY panel.

Note: *If the intermodulation signals applied to the two measuring inputs have different frequencies, the frequencies indicated in the graphics refer to the channel which is displayed in trace A.*

Meas Mode

Measurement mode for selecting the order of the intermodulation products and the measurement standard.

d2 (IEC 268)

Measurement and display of 2nd order intermodulation product referred to the *twice* the "Upper Frequency" (to IEC 268)

d3 (IEC 268)

Measurement and display of 3rd order intermodulation products referred to *twice* the "Upper Frequency" (to IEC 268)

d2 (IEC 118)

Measurement and display of 2nd order intermodulation products referred to the "Upper Frequency" (to IEC 118)

d3 (IEC 118)

Measurement and display of *lower* 3rd order intermodulation product referred to the "Upper Frequency" (to IEC 118)

Note: *Measurements on hearing aids are mostly performed acc. to IEC 118. Due to the different calculation formula used, the result of the d2 measurement to IEC 268 is better by approx. 6 dB.*

Dyn Mode

Dynamic Mode, only for Meas Mode → d2;
determines the possible dynamic of the measurement result and thus the measurement rate.

FAST

A fast measurement with less dynamic is performed.

PRECISION

If the measured value is better than 70 dB (Analog 22 kHz) or 50 dB (Analog 100 kHz or 300 kHz), the measurement is made with higher dynamic. The measuring time increases, correspondingly. If the intermodulation value of the signal is below 70 or 50 dB, the measurement is performed in FAST mode.

Unit

(see 2.6.5.1, Common Parameters of Analyzer Functions)

FRnct Settl

(see 2.6.5.1, Common Parameters of Analyzer Functions)

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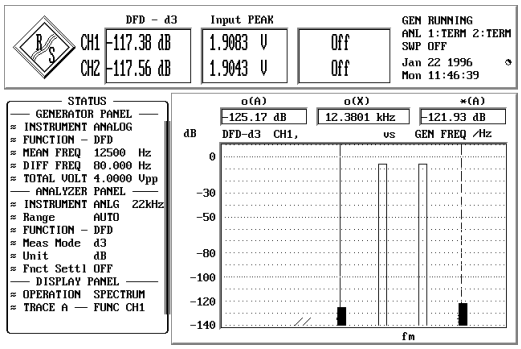
SPEAKER

(see 2.6.5.1, Common Parameters of Analyzer Functions)



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2.6.5.11 Wow & Flutter

Available only in the instruments DIG 48 kHz and ANLG 25 kHz.
Measurement of the frequency deviation of a recording device (wow & flutter). To this end, a sine tone with fixed frequency (usually 3.15 kHz or 3.00 kHz) is reproduced by a reference sound carrier. During its reproduction, frequency errors occur because of cyclic variations. Frequency distortion is specified in percent of the carrier frequency. These deviations are determined using different weighting filters and methods depending on which standard is applied.

Principle of measurement
The input signal is limited symmetrical to the test frequency (=3 kHz to NAB and JIS, =3.15 kHz to DIN) using a bandpass filter (passband width 1000 Hz, attenuation 80 dB, Bessel characteristic), subsequently, it is subject to FM demodulation. The demodulator output is sampled at 1/16 of the original sampling frequency and stored for POST FFT. A higher sampling rate is not useful because the signal is band-limited. Following a bandpass which can be cut in, the respective weighting is selected depending on the standard.

Standard

Set the standard applying to the measurement:

DIN/IEC

Standards:	DIN 45507 / IEC 386 / CCIR 409-J		
Reference frequency:	3150 Hz		
Weighting filters:	weighted:	bandpass, center frequency 4 Hz	
	unweighted:	highpass, 0.5 Hz	
Weighting method:	quasi-peak,		
	time constants:	rising time:	30.8 ms,
		falling time:	606 ms

NAB

Standards:	NAB Rec.		
Reference frequency:	3000 Hz		
Weighting filters:	weighted:	bandpass, center frequency 4 Hz	
	unweighted:	highpass, 0.5 Hz	
Weighting method:	averaging the detected frequency error signal, time constant: 300 ms		

JIS

Standards:	Japan Industry Standard	
Reference frequency:	3000 Hz	
Weighting filters:	weighted:	bandpass, center frequency 4 Hz
	unweighted:	highpass, 0.5 Hz
Weighting method:	rms weighting, integration time 2 sec	

2 Sigma 5 s
2 Sigma 10 s

2-sigma weighting to IEC 386/1988.
Its purpose is to determine a threshold v for the wow and flutter value such that 5 % of the magnitudes of the measured values are higher than threshold v, ensuring that sporadically occurring outliers do not affect the measurement result.
The integration time is selectable: 5 or 10 seconds.

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Weighting

ON The measurement is weighted using a weighting filter, bandpass 4 Hz.

OFF Weighting filter off, highpass 0.5 Hz.
Maximum weighting bandwidth in both cases: 200 Hz

Frequency response of weighting filter (to DIN 45507, IEC P386, CCIR Rec. 409-1):

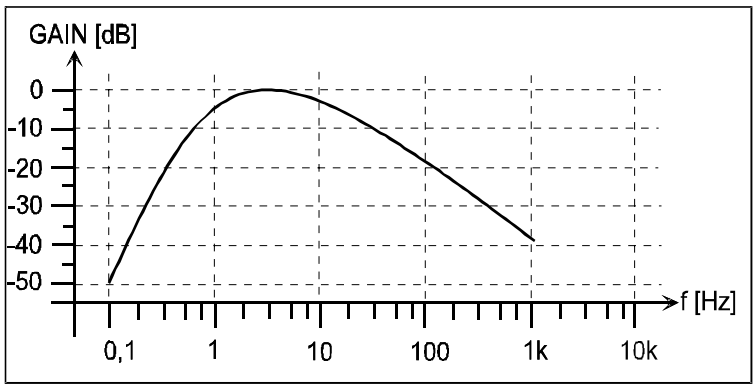

Fig. 2-36 Frequency response of weighting filter

Unit

(see 2.6.5.1 Common Parameters of Functions)

The W&F measurement result can be indicated in %, only.

Fnct Settl

(see 2.6.5.1 Common Parameters of Functions)

Post FFT

(see 2.6.5.1 Common Parameters of Functions)

ON Display of the frequency spectrum of the data which have been FM-demodulated and weighted with the weighting filter. The wow and flutter measurement is aborted after about 2 seconds with POST FFT selected. The available, demodulated data are subsequently used for calculation of an FFT.

OFF No POST FFT (thus no interruption of the measurement).

FFT Size

Enter FFT size (256 to 8192). (see 2.6.5.13, FFT).

Window

Select the window function; possible windows and their applications, see 2.6.5.13 FFT.

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Start

Display of the frequency limits of the generated spectrum (no entry). Since the demodulator stage samples by the factor 16, the upper limit of the spectrum is

Stop

127/256 * sampling rate / 16

already (For sampling rate, cf. 2.6.1 Selecting the Analyzer).

Resolution

Display of frequency resolution (no editing).

SPEAKER

(see 2.6.5.1 Common Parameters of Functions)

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2.6.5.12 POLARITY (Polarity Test)

Available for all analyzers.

The POLARITY measurement serves to check whether a device under test passes on an applied signal with the same polarity or with reversed polarity. To this end, set the POLARITY function on the generator (see 2.5.4.13) and apply the generator test signal (SINE^2 BURST signal) to the DUT.

Principle of measurement:

The analyzer weights and displays the polarity of the DUT output signal. In order for the convention

without polarity reversal = "+1 POL " is displayed
with polarity reversal = " - 1 POL " is displayed

to be true, the DUT must be applied a ***positive*** SINE^2 BURST signal. The UPD generator provides a suitable signal function (POLARITY) for this purpose.

The signal can also be applied externally to the DUT, provided that a suitable SINE^2 BURST signal is used.

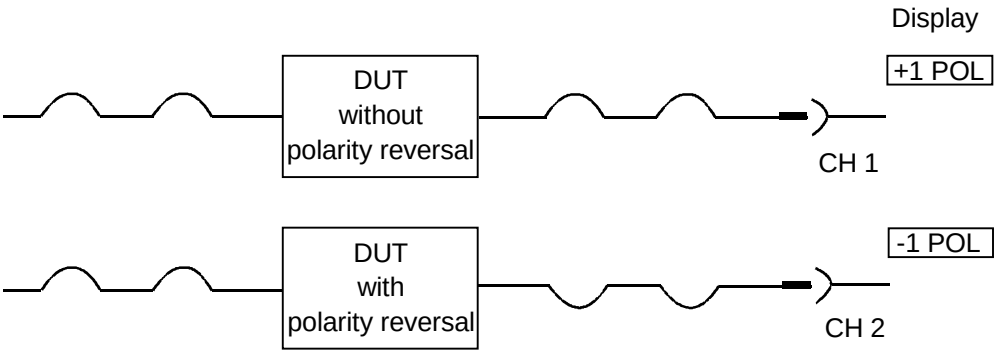

Fig. 2-37

SPEAKER (see 2.6.5.1 Common Parameters of Functions)

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2.6.5.13 FFT (Spectrum)

Available in all analyzers.

Spectrum display of the unfiltered input signal, transforming into the frequency range being effected by way of the so-called fast Fourier transform (= FFT). The graphical or numerical display of the FFT can be selected in the DISPLAY panel (menu item OPERATION). The graphical display is in line with the parameters set in the DISPLAY panel. The section to be displayed (in the x and y directions) can be selected independent of the frequency range and zoomed zone selected in the ANALYZER panel. If, due to inappropriate settings in both panels, a result is outside the visible screen , this can be remedied quickly by selection of the AUTO scaling for the X and the Y-axis (see also 2.10, Graphical Data Presentation).

Note: *Spectrum display of a **filtered** input signal is possible by way of menu item POSTFFT of the function RMS & S/N.*

Unit Ch1

Selection of unit for the display of the RMS value for Channel 1 (see 2.6.5.1 Common Parameters of Functions)

The selection **entered** here is referred to for display of the spectrum in the DISPLAY panel, as standard. However, it may be overwritten in the DISPLAY panel (by entry under menu item Unit of TRACE A or B).

Unit Ch2

Selection of the unit for display of channel 1; like “Unit Ch1“

Reference

(see 2.6.5.1 Common Parameters of Functions)

Notch (Gain)

(see 2.6.5.1 Common Parameters of Functions)

FFT Size

256
512
1024
2048
4096
8192

FFT size, settable from 256 to 8192 in binary steps.

The larger the FFT size (more calculated points), the better the frequency resolution, however the longer the measuring time.

The number of displayable lines is a function of FFT Size and Zooming according to the subsequent formula:

Zooming ON:	maximum	FFT Size *117/256 * 2
Zooming OFF, analog:		FFT Size *117/256
Zooming OFF, digital:		FFT Size *127/256

Note: *The number of displayable lines may be reduced with the "Zooming ON" setting - part of the frequency lines may fall within the negative frequency range due to eccentric “Center“ setting.*

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Window

Selection of the window function:

In system theory, the FFT treats a block of data (finite-length signal sequence) as though it is one period of a periodic sequence. In practice, however, discontinuities usually occur at the ends of the block. The discontinuities would be weighted as pulses (with white spectrum). This pulse spectrum masks the actual (useful) signal spectrum (leakage).
Remedy: The ends of the finite-length signal sequence for the FFT are smoothly tapered to zero by windowing the data. The FFT then treats the signal as one period of a periodic sequence. Window functions thus help to minimize the leakage (at the expense of resolution).

Range of applications of the windows:

HANN
The HANN window combines both spectral resolution with good leakage suppression for distant interferences, yet has a relatively wide bell-shaped curve around the signal lines.

RECTANGULAR
Window function switched off.
When the signal fits exactly with an integer number of periods into the block windowed for the FFT, there will be no discontinuities at the block ends. In this case, a window is not necessary and maximum frequency resolution can be obtained. This characteristic is advantageous for fast and frequency-precise measurements of frequency responses in the case of the generator signals RANDOM / Domain: FRQ (so-called FFT noise, see 2.5.4.11 RANDOM, Domain = Frequency) and MULTISINE (see 2.5.4.4).
(See 2.6.9.3 Fast Frequency-response Measurement)

BLACKMAN-H
The main lobe falls off very steeply to about 80 dB; however below this point, this window has considerable leakage.

RIFE-VINC 1
RIFE-VINC 2
RIFE-VINC 3
Suppression of distant interferences is excellent with all 3 windows. With increasing order of the windows, the width of the main lobe decreases at the bottom of the single lines and increases at the top.
Various trade-offs between frequency resolution and suppression of close interferences can thus be made.

HAMMING
Offers no significant advantages, has been implemented for the sake of completeness.

FLAT_TOP
The top of the main lobe (which is caused only by a single sine line) is as wide as to include always two adjacent lines with approximately the same height.
Advantage: The amplitude can be precisely read from the graphics as against with other window functions.
Disadvantage: Bad frequency resolution.

KAISER
The trade-off between resolution, close interference suppression and distant interference suppression determines the selection of parameter ß (from 1.5 to 20). With ß=8, selectivity is good but distant interference suppression is only about -90 dB. With ß=16, distant interference suppression is excellent, however the main lobe is relatively wide.
(see 2.6.5.1 Common Parameters of Functions)

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Avg Mode

Selection of the averaging method in the FFT

NORMAL

The entered number of FFT cycles is executed, the partial results added and then divided by this number.
Waterfall (OPERATION mode WATERFALL) display with sweep represents the waterfall with respect to all sweeps points.

EXPONENTIAL

Averaging is executed continuously. The current result is calculated to:

$$AVG(n) = \frac{1}{k} \cdot FFT(n) + \frac{k-1}{k} \cdot AVG(n-1)$$

In case of waterfall display with sweep (OPERATION mode WATERFALL), a waterfall of the intermediate results is displayed for every sweep point; then the waterfall is cleared (for the next sweep point).

Notes: *After a restart of the measurement (eg caused by SWEEP, calibration or cursor movement), averaging is started anew.*
Average is not executed if the display mode is set to MAX HOLD.

Avg Count

Number of averaging procedures (with Avg Mode NORMAL) or k (Avg Mode EXPONENTIAL, see AVG(n) formula.

Zooming

Determines, whether the FFT is calculated from the entire frequency range or from a section only.

OFF

"Normal" FFT, frequency range from 0 to range limit.
Range limit:

- analog: 117/256 * (internal) sampling rate
- digital: 127/256 * sampling rate.

(For the sampling rates of the individual instruments, refer to 2.6.1 Selecting the Analyzer.)

ON (2...256)

Zoom the frequency range by one center frequency (→ Center) by processing the signal in the time domain before the FFT (see notes below). Zooming is effected with a factor of 2, 4, 8, ... up to 256. The factor is determined by the span. The measuring time is doubled with each zoom step. The maximum zoom factor depends on the selected instrument (see below).

Zoom Fact

(Read only, can't be changed)
Display of the zoom factor.

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Start

(Read only, can't be changed)
Display of the lower measurement limit in Hz or kHz:

with normal FFT:	0 Hz
with ZOOM-FFT:	frequency of 1st line which lies in the positive frequency range

Stop

(Read only, can't be changed)
Display of the upper measurement limit in Hz or kHz

See table xx1.

Center

This menu item is displayed only with Zooming ON. Center of the zoomed zone, continuously variable within the useful range of the respective instrument.

With the center frequency set closer to the ***lower*** range limits (0 Hz) than span /2, part of the frequency lines are allotted to the negative frequency range. These lines are ***not*** calculated, they are, however, not available for the frequency resolution.

If the center frequency is set closer to the ***upper*** range limits than span /2, part of the frequency lines exceed the frequency range. These lines contribute to the calculation and are displayed, in order to enable evaluation of the behaviour at the range limits. For normal applications, this setting should be avoided, since the measured rms value may become incorrect due to aliasing components.

Span

This menu item is displayed only with Zooming ON. You can select out of 8 (with DIG 48 and ANLG 25), 4 (with ANLG 100 and ANLG 300) or 3 (with DIG 192 and DIG 768) possible zooming zones. SPAN is the entire range displayed, except for the event that Center was selected such that part of the FFT is below 0 Hz (see Center). The selection list for span is calculated depending on the current sampling rate and labelled.

Resolution

(Read only, can't be changed)
Spacings between the FFT lines in Hz or kHz. Line spacings down to the mHz range can be obtained by selecting a high zoom factor (very small span) and a long FFT (large FFT size).

Range of values:

normal FFT

ANLG 22 kHz	5.8598 * 8192 / FFT Size
ANLG 100 kHz	41.667 * 8192 / FFT Size
ANLG 300 kHz	125.00 * 8192 / FFT Size
DIG 48 kHz	Sample Freq / FFT Size
DIG 192 kHz	Sample Freq * Oversampling / FFT Size
DIG 768 kHz	Sample Freq * Oversampling / FFT Size

Zoom FFT:
Value of the normal FFT /Zoom factor

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Meas Time

(Measurement Time)
(Read only, can't be changed)
Time required by the analyzer for signal recording.

SPEAKER

(see 2.6.5.1 Common Parameters of Functions)

Instrument	upper range limit for FFT	
	with normal FFT	with Zoom-FFT (depending on "Center"; maximum)
ANLG 22 kHz	21.938 kHz	21.938 kHz
ANLG 110 kHz	125 kHz	125 kHz
ANLG 300 kHz	350 kHz	350 kHz
digital	127/256 * Sample Frq	117/256 * Sample Frq

Table xx1: upper range limit for the FFT as a function of the analyzer instrument and zooming

Note: *The antialiasing filters in the analyzer ANLG 100 and ANLG 300 are effective before reaching the upper range limit, already*

Additional information on FFT:
Width of bell-shaped curve (worst case) in lines:

Table 2-26

Window:	**-20 dB**	**-40 dB**	**-60 dB**	**-80 dB**	**-100 dB**
Hanning:	4	7	14.5	29	64
Rectangular:	6.7	68	∞	∞	∞
Blackman-Harris:	4.5	6	7	8	21.5
Rife-Vinc 1:	4	6	9	14	21
Rife-Vinc 2:	5.5	7	9	11	16
Rife-Vinc 3:	6.5	8.2	10	12	14.5
Hamming:	3	4	29	∞	∞
Flat_Top:	7.5	9	11	14	19
Kaiser (ß=8):	3.5	4.2	6	11.5	
Kaiser (ß=16):	4.5	6	8	11	15

∞ this suppression is (hardly) never obtained.

Frequency measurement: With FFT, the spectral line with the highest signal amplitude in the with FFT: spectrum is entered as frequency value in the respective display field. With the exception of window = Kaiser, the adjacent lines are included as part of the frequency calculation, thus increasing the accuracy (on the assumption of single sine lines). In particular with the windows HANN, RIFE VINC 1 to -3, high accuracy can be obtained.

Amplitude accuracy: Depending on the window and position of the single signal lines relative to the FFT lines, system-related display read errors of up to -3 dB occur. The error is worst when the selected window is narrow at its top, the input signal falling on the center between two FFT lines (eg in rectangular windows).
Using the cursor function IMAX (interpolated maximum) for reading the peak values in the display causes the interpolation to be made on the actual peak value, the windows HANN, RIFE-VINC 1-3 providing an accuracy of more than 1 % (on the assumption of single sine lines, only).

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Implementing the FFT:

The FFT has been implemented as decimation-in-frequency-FFT in complex presentation with 32-bit floating numbers. For coding, in particular the rounding noise has been optimized, reducing the errors due to FFT processing to less than -130 dB. The data are input to the analyzer at a time, the FFT being computed subsequently. Thus, the measurement is not continuous, which does however not adversely affect the measurement (with usually stationary signals).

With ZOOM-FFT, the input signal is shifted by way of convolution with a Dirac pulse at the center frequency so that the selected range falls on frequency values around zero. After lowpass filtering and subsequent undersampling, the range can be displayed with a better resolution.

A ZOOM is always implemented in three stages (up to the factor of 8), an additional stage being possible with the analog instruments ANLG100 and ANLG300. Zooming up to the factor 256 is feasible when using the ”slow” instruments ANLG25 and DIG48. The input signal for the FFT will be complex when shifting the input signal using a single Dirac pulse. For this reason, 7488 (analog) or 8128 (digital without zoom) points are displayable with an FFT of 8192 points! With ZOOM, the center frequency is visible in the display at about -140 dB (on technical grounds).

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- **Resolution, measurement time and span**

  Example: DIG 48 and ANLG25: (sample rate = 48 kHz, 8192 FFT points)

  Table 2-27

	Max. SPAN [Hz]	Max. Resolution [Hz]	Measurement time [ms]
FFT	23807	5.8593	170.71
ZOOM 2:1	21938	2.9296	348.12
ZOOM 4:1	10969	1.4648	696.25
ZOOM 8:1	5485	0.7324	139.,5
ZOOM 16:1	2742	0.3662	2785
ZOOM 32:1	1371	0.1831	5570
ZOOM 64:1	686	0.0915	11140
ZOOM 128:1	343	0.0457	22280
ZOOM 256:1	171	0.0228	44560

  SPAN and resolution are proportional to, measuring time is reciprocal to the sample rate.

- Window functions:

  All window functions (except for Kaiser) are computed according to the following formula:

$$\text{Window(i)} = \sum \text{A(n) x cos} \frac{2\pi \text{ni}}{\text{FFT}-\text{Size}}$$

  where A(n) is the respective amplitude factor of line n.

  Coefficients A(n):

  Table 2-28

	A(0)	A(1)	A(2)	A(3)	A(4)
HANNING:	0.50000	-0.50000	0.0	0.0	0.0
RIFE-VINC 1:	0.37500	-0.50000	0.12500	0.0	0.0
RIFE-VINC 2:	0.31250	-0.46875	0.18750	-0.03125	0.0
RIFE-VINC 3:	0.2734375	-0.43750	0.21875	-0.06250	0.0078125
BLACKMAN-H:	0.35875	-0.48829	0.14128	-0.01168	0.0
HAMMING:	0.54000	-0.46000	0.0	0.0	0.0
FLAT–TOP:	0.18810	-0.36923	0.28702	-0.13077	0.02488
RECT:	1.00000	0.0	0.0	0.0	0.0

  The KAISER window is given by:

$$Window(ß) = \frac{BESSEL\,(ß * \sqrt{1-\frac{4n^2}{N^2}})}{BESSEL\,(ß)}$$

  where BESSEL (ß) is the modified Bessel function of 1st order.

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2.6.5.14 FILTER SIM

The FILTER SIM function is not used for measurement purposes, but serves to check a selectable combination of filters or user-defined filters for their sum frequency response. For this purpose, filters can be selected as with the functions RMS, PEAK and QUASI-PEAK.

The filter simulation takes place with a fixed pattern in the frequency domain. This pattern results in system clock /8192; (eg a sampling rate of 48 kHz results in 5.86 Hz). The range from 0 Hz to half the sampling rate is simulated, producing 4096 output points in the graphics.

Functioning of the simulation:

The filters used in the UPD are IIR (= infinite impulse response) filters. These filters are defined by poles and zeroes in the complex Z-level, conjugated complex poles and zeroes being combined to a real biquad.

These biquads feature the following transfer function:

$$H(z) = b_0 \times \frac{z^2 + b_1 z + b_2}{z^2 - a_1 z - a_2}$$

4 biquads constitute an UPD filter, the coefficients b0 of the single biquads being multiplied so that a common gain is obtained. Up to 4 of such 8-pole UPD filters can be used in measurement functions.

This sum transfer function (sum of all single transfer functions) is evaluated for

z = exp(jw) with w = (0 ... i * Π / 4096) and i = 0 ... 4096

the denominator and numerator polynomials and the filter gain being calculated at the simulation points. Hence, the filter simulation features only a fixed resolution, extremely sharp filters (eg very narrow-band notch filters) cannot be simulated in this way. Actually, such filters should not be used at all, because, in the case of pole and zero positions near the unit circle, numerical accuracy problems occur or these filters have a tendency to show so-called limit cycles (ie signals at the filter output without a corresponding signal at the filter input).

The above frequency pattern does not apply to the use of the filters in measurements (RMS, PEAK, QUASI-PEAK), since the filters are calculated in the time domain in this case.

Filter

(see 2.7, Analyzer Filters)

Up to 4 filters can be simulated

SPEAKER

(see 2.6.5.1 Common Parameters of all Functions)

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2.6.5.15 Waveform (Display in the Time Domain)

Available in all analyzers.
This function is used to display the input signal in the time domain. The trigger state being displayed in the result window, the signal in the graphics window. Level values can be read from the graphics window using the cursors.

As is the case with all other functions, this function, too, is executed separately in the two channels, ie each channel triggers individually. In the graphical display, **no** relation with respect to time between the two channels is defined.

Triggering:

UPD waits for the specified slope at the defined level.
To allow continuous monitoring without gaps and to display also non-triggering (too weak) signals, the user can chose between 2 trigger modes.

- CONTINUOUS (pressing the START button) starts a continuous measurement which at the latest after 10 times the memory depth (trace length) sets off automatic triggering. This is indicated in the display by 'Not triggered'. Signal monitoring is then continued.
- SINGLE (pressing the SINGLE key) starts a single measurement that monitors the signal unit the trigger threshold is exceeded or the STOP key is pressed. The measured signal is only displayed in the case of a trigger event. There are no monitoring gaps in the mode.

The time axis of each channel is relative to the trigger point of the respective channel.

Settings:

In the ANALYZER panel only the mode, the trigger condition and the memory depth are set. Scaling of the picture (X and Y axis) is set in the DISPLAY panel (see Section 2.10).

Standard display of the samples, max. trace length is 7488 samples. Interpol can be switched on.

(Only for the instruments ANLG 22kHz and DIG 48kHz)
With the function Waveform, the input signal is first fed to a peak-value detector (absolute value generation). Following this, the number of samples set under Comp Fact are combined. This peak value is then used as the input signal of the waveform function. Thus the x-axis is so to speak compressed, which allows long times to be acquired.
Interpol can't be switched on.

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Meas Mode

Determines the memory depth and processing mode

STANDARD

Usual display of the samples, max. TRACE length is 7488 samples.
For smoothing the curve display (with periodic signals), the Interpol mode can be switched on in addition. Recommended for short records and with periodic signals.

COMPRESSED

(Only for the instruments ANLG 22kHz and DIG 48kHz)
In Compressed mode, the input signal is first fed to a peak-value detector (absolute value generation). Following this, the number of samples set under Comp Fact are combined. This peak value is then used as the input signal of the waveform function. Thus the x-axis is so to speak compressed, which allows long times to be acquired.
Interpol can't be switched on.
Recommended, if ***long*** recording times are required and only the ***characteristic of the peak values*** is of interest.

***Note**: The compressed WAVEFORM can also be logarithmically displayed when the respective setting is made in the DISPLAY panel. The setting can be made by a specific entry (Spacing LOG) or by selecting a logarithmic unit. Power units (eg W, %P/P_r) can be used as well.*

***Applications:** Investigation of transitions, eg on circuits with AGC (automatic gain control)*

UNDERSAMPLE

For ANLG 22 kHz and DIGITAL analyzers only.
The input signal is "undersampled", i.e. the samples specified under Comp Fact are arithmetically averaged and then used as input sample for the waveform function. As a result the X axis is compressed similar to the compressed mode and long periods can be recorded.
"Interpol" cannot be switched on.

Recommended if ***long*** recording times are required and the ***time template of the signal*** is of interest.

ENHANCED

(For the instruments ANLG 22 kHz and DIG 48 kHz only) with single-channel operation.
Trace lengths up to 64 k samples can be recorded (corresponds to 1.365 s with 48 kHz sample rate or in the analog analyzer), however only one curve can be displayed.
Interpol can no longer be switched on.
Recommended, if ***long*** recording times are required and the ***exact curve trace*** is of interest.

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Comp Fact

(Only for Meas Mode COMPRESSED or UNDERSAMPLE)

Selection of the compression ratio for the compressed waveform displays. Number of samples which are comprised to one sample for the waveform.

Range of values 2 to 1024

Unit

Select unit for waveform display.
(see **2.6.5.1 Common Parameters of** Functions)

The selection ***entered*** here is standard for waveform display in the DISPLAY panel. However, it may be overwritten in the DISPLAY panel (by an entry under Unit for TRACE A or B).

Note: *Contrary to the entries in the DISPLAY panel, the unit entered here is stored when the function or the instrument is changed and available again upon switch-back to the waveform.*

Selectable analog units (applies also to Meas Mode COMMON/INP in the DIGITAL instrument):

V | dBV | dBu | dBm | W | Δ%V| ΔV | V/V_r | %V/V_r | Δ%W |ΔW | P/P_r | %P | P_r | dB_r

Selectable digital units (Meas Mode AUDIO DATA):

FS | %FS | dBFS | Δ% | dB_r | LSBs | bits

Selectable jitter units (Meas Mode JITTER/PHAS):

UI | %UI | dBUI | ppm | ns | UI_r | dB_r

Note: *Logarithmic units can only be used in the Meas Mode COMPRESSED.*

Ref Volt

(see **2.6.5.1 Common Parameters of** Functions)
The reference value for the waveform display can only be numerically entered; this menu item corresponds to the value entered under "Reference VALUE".

Trig Level

Set the trigger threshold. The threshold is entered as a fixed voltage, ie, irrespective of the current range (which is set either fixed or using AUTO RANGE).

Value range:

digital (audio data mode):	± 1 FS
digital (jitter mode):	± 10 UI
analog and digital common mode:	± 300 V

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Trig Slope

Indicates the triggering edge.

RISING

Rising edge

FALLING

Falling edge

Interpol

(Only Meas Mode STANDARD)

1
2
4
8
16
32

Selects the number of interpolation steps used for the display of the traced waveform.

No interpolation

Interpol > 1 causes switch-on of the interpolation algorithm

This setting can be used to obtain a smoothed display in the case of few samples per period of the input signal. The maximum permissible trace length is however reduced with this setting.
Recommended with high frequencies, which allow for recording of few samples per period, only.

Trace Len

The maximum settable Trace Len is a function of the sample rate and of the interpolation value and of the selected measurement mode.

Value range: 1 µs to max. *Trace Len*

The following holds: $\max \text{Trace Len} = \frac{\text{Speichertiefe} \times \text{Comp Fact}}{\text{Abtastrate} \times \text{Interpol}}$

The *memory depth* for the Meas Mode is

- NORMAL and COMPRESSED 7488 samples
- ENHANCED 65535 samples

SPEAKER

(see 2.6.5.1, Common Parameters of Analyzer Functions)

2.6.5.16 Coherence Measurement and Transfer Function

Available in instruments DIG 48kHz and ANLG 25kHz only.

The analyzer calculates the transfer function CH1/CH2 (trace A) and the coherence function (similarity, trace B) of two signals. The graphics or numerical display of the coherence can be switched on in the display panel (under menu item OPERATION). The graphics display is according to the parameters set in the DISPLAY panel. The section to be displayed (X and Y direction) can be selected independent of the frequency range and the zoomed section selected in the ANALYZER panel.

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Measurement technique:

The complex FFT is calculated in each channel. The two channels are measured at exactly the same time. The two FFTs are cross-correlated and averaged. The square of this cross-correlation is divided by the determined values of the individual FFTs. The coherence result is thus independent of the selected measurement ranges.

$$\gamma^2 = \frac{\left|\sum \text{channel1} \otimes \text{channel2}\right|}{\sum|\text{FFT(channel1)}| \cdot \sum|\text{FFT(channel2)}|}$$

The following applies:

$$0 \leq \gamma^2 \leq 1$$

$\gamma^2 = 1$ means that, at this frequency, channel 2 has a linear dependence on channel 1. The measurement result becomes more accurate as the averaging depth increases.

The transfer function is calculated as follows:

$$H(z) = \frac{\sum|\text{FFT(channel2)}|}{\sum|\text{FFT(channel1)}|}$$ associated standard: ANSI S3.42-1992

Application:

The coherence measurement function uses test signals covering the total audio spectrum. It is therefore useful to set the generator to (time and frequency-defined) noise.
The generator signal should be connected simultaneously to the input of the DUT and to analyzer channel 2 (reference channel). The output of the DUT is connected to analyzer channel 1 (measurement channel).

Note: *The coherence measurement performs elaborate calculations and requires synchronous two-channel input signals. This gives rise to a few restrictions:*

- Option UPD-B3 (High-speed) must be built in.
- Coherence is only available for instruments DIG 48 kHz and ANLG 22kHz.
- If the coherence is measured, the digital option UPD-B2 cannot be used (neither generator nor analyzer).
- Since the coherence measurement is a comparison measurement of channel 1 and 2, both channels must be active.

Contrary to other measurements, the measurement result in this case is not calculated but two curves are produced instead that can only be stored and loaded together (as DUAL FILE in the DISPLAY panel).

- Trace A (menu item FUNC CH1): transfer function CH1/CH2
- Trace B (menu item FUNC CH2): coherence result γ^2

The number of the completed averaging procedures (n) is displayed in the result display relative to the number of the desired averaging procedures (m):

averaging *n of m*

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Unit

Select the unit for the display of the transfer function: % or dB.

The value selected here is also used as standard for the spectrum display in the DISPLAY panel but can be overwritten (under menu item Unit of TRACE A in the DISPLAY panel).

***Note**: The designations Ch1 and Ch2 used here do not refer to the measurement channels.*

FFT Size

FFT size, adjustable in steps of 2 between 256 and 8192.

256
512
1024
2048
4096
8192

A larger FFT size (ie more calculated samples) yields a finer frequency resolution but also correspondingly longer measurement times.

Window

Select window function

HANN
RECTANGULAR
BLACKMAN-H
RIFE-VINC 1
RIFE-VINC 2
RIFE-VINC 3
HAMMING
FLAT_TOP
KAISER

Same as with FFT

Avg Count

Number of averaging procedures. To obtain accurate results, a maximum number of averaging is required for the coherence function. Averaging figures above 30 are recommended.

Start

(Display field only, cannot be modified.)
Display of lower measurement limit in Hz or kHz:
Since zoom FFT is not available here, the lower limit is always 0 Hz.

Stop

(Display field only, cannot be modified.)
Display of upper measurement limit in Hz or kHz.

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Resolution

(Display field only, cannot be modified.)
Display of spacing of FFT lines in Hz or kHz.
Value range: 5.8598 × 8192 / FFT size

Note: *A normalization factor can be entered in the DISPLAY panel for trace A (transfer function) (or be taken from the cursor position). Thus the transfer function can be set to 0 dB at any position.*

2.6.5.17 Measurement of Digital Input Amplitude

Available only in the DIG 48kHz instrument, measurement mode COMMON/INP and with jitter option (UPD-B22) installed.

Measurement of digital input amplitude at interfaces AES/EBU or S/P DIF.

Meas Time

When a longer integration time is selected, noise pulses may be eliminated by averaging to reduce the measurement result.

FIX 200 MS

Measurement time 200 ms

VALUE

Numeric entry of measurement time.
Value range: 100 µs .. 1,5 s
Units: s | ms | µs | min

Unit

Select the unit for the measurement result.

Selectable units:
V | dBV | dBu | dBm | W | Δ%V| ΔV | V/V_r | %V/V_r | Δ%W |ΔW | P/P_r | %P | P_r | dB

Reference

(see **2.6.5.1 Common Parameters of** Functions)

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2.6.5.18 Measuring the Phase between Digital Input and Reference Signal

Available only in the DIG 48kHz instrument, measurement mode JITTER/PHAS and with jitter option (UPD-B22) installed.

Measurement of phase between selected digital input and reference input REF IN at the rear of the instrument.

Meas Time

FIX 200 MS

VALUE

When a longer integration time is selected, noise pulses may be eliminated by averaging to reduce their effect on the measurement result.

Measurement time 200 ms

Numeric entry of measurement time.
Value range: 100 µs .. 1,5 s
Units: s | ms | µs | min

Unit

Select unit for result display.

Selectable phase units:
UI | %FRM | ºFRM | ns

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2.6.5.19 INPUT Display

Available for all analyzers.

INPUT DISP

Selection of measured values for the result display in the middle.

OFF

Input display switched off.

BITS

For the digital instruments, a bit activity display of the input peak value can be set as bit pattern in the result window. This display is suitable for troubleshooting on digital interfaces.
The bit sequence, the width of which is set with the "Audio Bits" parameter in the ANALYZER panel, is always displayed left-justified in the window. When more than 24 bits are displayed, the least-significant bits are not shown. When less than 24 bits are displayed, the bits at the right of the bit limit are indicated as 0. The example shows the display for the setting "Audio Bits 16".
Thus bits stuck because of a hardware error, ie "hung up" bits, can be easily determined.
The bit activity display is not available for IEC/IEEE-bus operation.

RMS

Display of analog RMS value. Displayed in the analog analyzers only and effective for measurement functions THD, THD+N/SINAD, MOD DIST, DFD and FFT. The value can also be displayed as a sweep curve (DISPLAY → TRACE A → INP RMS CH1/2).

PEAK

Display of input peak value as a numeric value.
In the **digital analyzers** the input signal is sampled with a user-defined sample rate (see **2.6.3**).

In the **analog analyzers** the input signal is sampled with the following clock rates after input level control:

ANLG 22 kHz	with	48 kHz
ANLG 100 kHz	with	341.3 kHz
ANLG 300 kHz	with	1024 kHz

The input peak measurement mainly serves for checking the input level and yields the peak value of the AC-coupled input signals before the filters.

Exception: *With the analog notch filter switched on in the analog measurement functions RMS, RMS SELECT, QPEAK or FFT, the input peak value is detected **after** the notch filter.*

Note: *If an AC measurement with DC coupling is performed in the ANLG 22kHz analyzer (Min Freq 2 Hz), the maximum AC peak value of always indicated. The DC level is not considered.*

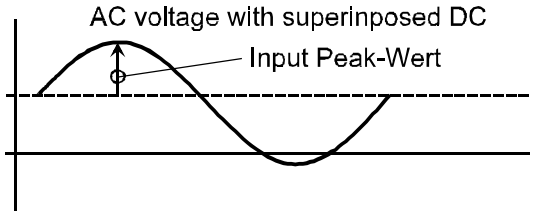

Fig. 2-38

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Unit Ch1/2	for INPUT DISP → PEAK or INPUT DISP → RMS (see 2.6.5.1, Common Parameters of Analyzer Functions)
Reference	(see 2.6.5.1, Common Parameters of Analyzer Functions)

INPUT DISP → BITS:

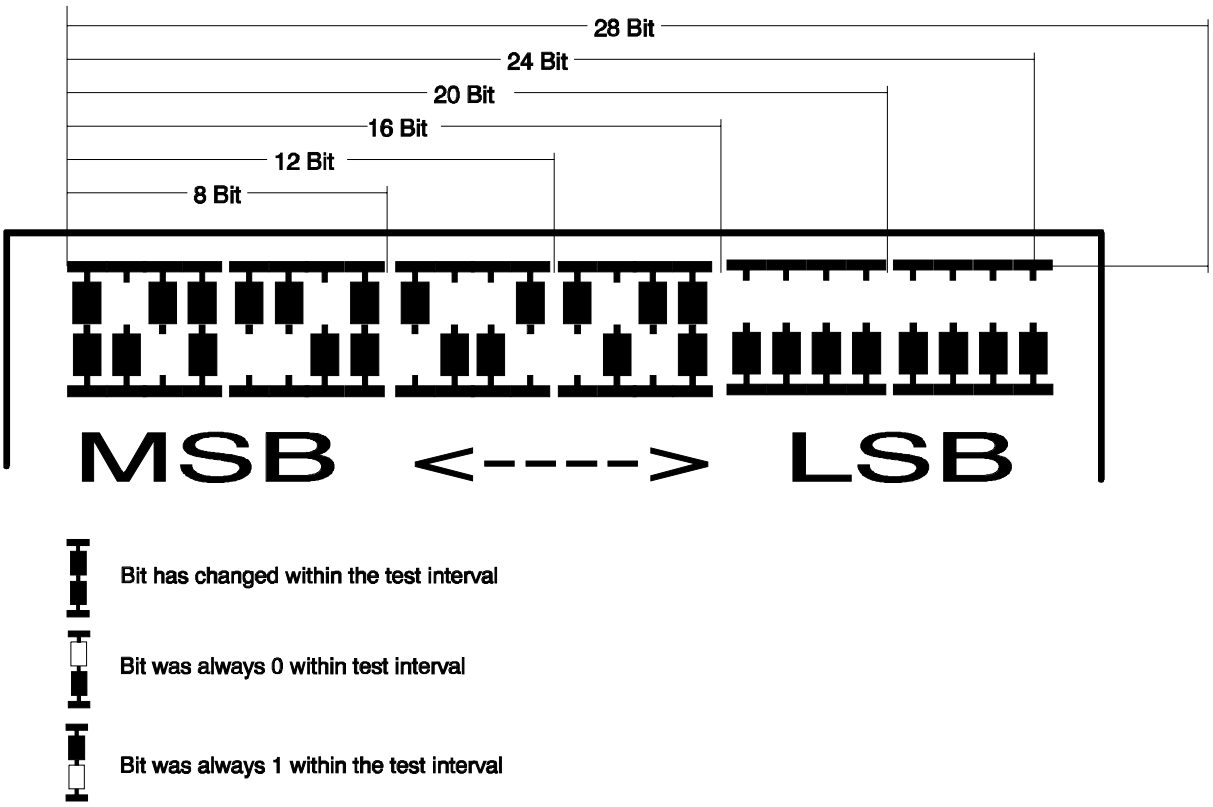

Fig. 2-39 Bit activity display

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2.6.5.20 Frequency Measurement

With the menu item FREQ/PHASE among the higher-ranking functions of the ANALYZER panel four measurement modes can be selected:

OFF	No frequency measurement, therefore higher function measurement speed
FREQ	Frequency measurement in both channels
FREQ&PHASE	Frequency measurement in channel 1, phase measurement between channel 2 and 1
FREQ&GRPDEL	Frequency measurement in channel 1, measurement of group-delay or continuous phase between channel 2 and 1
SAMPLE FREQ	Display of input sample frequency (of both channels)

Table 2-31 Frequency measurement

Instrument	Measurement functions combined with frequency measurement															
	RMS	RMSsel	PEAK	QPEAK	DC	THD	THD+N	MOD DIST	DIM	DFD	Wow&F	FFT	Polarity	Filter simul	Coher	WAVE FORM
ANLG 22 kHz	√	√	√	√	n	√	√	≈	≈	≈	√	√	√	n	n	√
ANLG 100 kHz	√	√	-	-	n	√	√	≈	-	≈	-	√	√	n	-	√
ANLG 300 kHz	√	√	-	-	n	√	√	≈	-	≈	-	√	√	n	-	√
DIG 48 kHz	√	√	n	n	n	√	√	n	n	n	n	√	n	n	n	n
DIG 192 kHz	√	√	-	-	n	√	√	n	-	n	-	√	n	n	-	n
DIG 768 kHz	√	√	-	-	n	√	√	n	-	n	-	√	n	n	-	n

√ valid frequency measurement result
- function measurement not possible (cannot be selected with this instrument)
- frequency measurement result not possible or not of interest (Display "-----")
≈ frequency measurement result only conditionally valid as the input signal is a frequency mixture.

Unit Ch1/2

Select unit for result display for channel 1 or 2.

For the frequency measurement, the (display) units can be selected separately for the two channels, eg to allow an absolute value to be displayed for one channel and a relative value for the other.

Units: Hz | ΔHz | Δ%Hz | Toct | Oct | Dec | f/f_r

For conversion formulae and notation of result display units for IEC/IEEE-bus control see **2.4 Unit**

Ref Freq

(see **2.6.5.1 Common Parameters of** Functions)

Freq Settl

(see **2.6.5.1 Common Parameters of** Functions)

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Analog frequency measurement

For analog frequency measurements, a minimum measuring time can be selected with the "Meas Time" command. The measurement begins with a rising zero crossing of the signal and ends after a time resulting from the minimum measuring time and the time elapsed before the next rising zero crossing of the signal occurs. Thus, always integer multiples of the signal period are measured.
After processing the control signal levels, the frequency and phase measurements of the analog analyzers are always performed as broadband measurements without filtering (3-dB measurement bandwidth approx. 500 kHz).

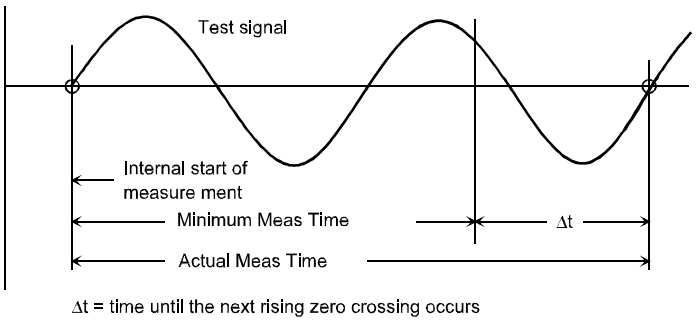

Fig. 2-40

Note: *In the case of DC coupling of the test input (analyzer ANLG 22 kHz: Min Freq 2 MHz), DC components superimposed on the input signal cause malfunctions if the total signal is unipolar.*

Meas Time

Measurement Time to be entered for analog analyzers only
Minimum time for frequency measurement

SUPERFAST 50 ms

FAST 200 ms

SLOW 1000 ms

VALUE Numerical entry.
Value range: 1 ms to 1.6 s
Units: s, ms, µs

Digital frequency measurement

For digital analyzers a separate frequency measurement time cannot be selected; the frequency information is obtained as far as possible from the selected function measurement using various procedures:

1. With RMS measurements (without post-FFT) from the number of zero crossings.
2. With all other measurements from the FFT.

The advantage of the 1st method is high measurement speed while the 2nd method yields accurate measurement results also at poor S/N ratio and/or high frequencies. If no other measurement has to be performed simultaneously, the user may optimize the frequency measurement by choosing an appropriate measurement function:

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1. RMS measurement function (without post-FFT) for signals featuring a good S/N ratio at high to medium frequencies.
2. FFT or RMS function with post-FFT for signals with a poor S/N ratio and moderately low frequencies.

With RMS selected, the accuracy of the frequency measurement can be improved by switching on post-FFT. With post-FFT switched on, the measured frequency above a certain lower frequency limit is determined from the FFT, irrespective of whether spectrum display is optionally selected or not (menu item OPERATION in the DISPLAY panel). This lower frequency limit of FFT is four times the FFT resolution and can therefore be modified by the user via the FFT size. (see 2.6.5.2 RMS).

With FFT-supported frequency measurements the measurement accuracy depends on the following parameters:

- *Window function:* best choice are the RIFE VINCent windows 1 or 2.
- *FFT size*: as large as possible, preferably 8192
- *Zoom FFT*: although zoom FFT extends the measurement time (same as a large FFT size), it further improves resolution and accuracy (particularly at low frequencies).
- *Zoom factor*: Settable by selecting the "Span". The smaller the span, the higher the zoom factor and the better the frequency resolution and accuracy.
  Note: "Span" and "Center" must be selected so that the desired measurement range is covered from "Start" to "Stop".
  Recommended: An excellent measurement accuracy can be obtained with zoom factor 2 without the frequency range of the instrument having to be reduced. In this case "Center" should be set to "Span / 2".

Example: In the measurement range DIG 48 kHz, FFT should be configured as follows:

FFT Size	8192
Window	RIFE VINC 2
Avg Count	1
Zooming	ON (2 to 256)
Center	11.975 kHz
Span	21.94 kHz

With this configuration the following measurement range and resolution are obtained:

Zoom factor	2
Start	6.25 Hz
Stop	21.938 kHz
Resolution	2.9297 Hz

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2.6.5.21 Combined Frequency, Phase and Group Delay Measurement

Only for

- analog instruments in the dual-channel mode (Channel(s): 1 & 2 | 2 ≡ 1 | 1 ≡ 2)
- digital instrument DIG 48 kHz in conjunction with the measurement function FFT and serial inputs AES/EBU, S/P DIF or OPTICAL in dual-channel mode (Channel (s): BOTH)

Table 2-32 Availability of phase/group-delay measurement

Instrument	Measurement functions combined with phase measurement															
	RMS	RMSsel	PEAK	QPEAK	DC	THD	THD+N	MOD DIST	DIM	DFD	Wow&F	FFT	Polarity	Filter simul	Cohe r	WAVE-FORM
ANLG 22 kHz	√	√	√	√	n	√	√	≈	≈	≈	√	√	√	n	n	√
ANLG 100 kHz	√	√	-	-	n	√	√	≈	-	≈	-	√	√	n	-	√
ANLG 300 kHz	√	√	-	-	n	√	√	≈	-	≈	-	√	√	n	-	√
DIG 48 kHz	n	n	n	n	n	n	n	n	n	n	n	√	n	n	n	n
DIG 192 kHz	n	n	-	-	n	n	n	n	-	n	-	n	n	n	-	n
DIG 768 kHz	n	n	-	-	n	n	n	n	-	n	-	n	n	n	-	n

√ valid phase and group-delay measurement result
- function measurement not possible (function not selectable in this instrument)
n phase or group-delay result not possible or useful (Display "-----")
≈ phase and group-delay measurement result only conditionally valid as the input signal is a frequency mixture.

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With phase measurements, the phase difference between the signals of channels 2 and 1 is determined.The phase-measurement results are in the 0 to 360° and -180 to +180° ranges. With frequency sweep running, however, the phase may be continuously measured, ie outside the 360° and -180° limits (continuous phase measurement), provided certain conditions are fulfilled (see group-delay measurement).
For continuous phase measurement select GROUP DELAY and a phase unit.

The signal of channel 1 serves as reference signal.

The analog phase can be measured between

- equally configured inputs, eg
  Channel 2 UNBAL (BNC) → Channel 1 UNBAL (BNC) or
  Channel 2 BAL (XLR) → Channel 1 BAL (XLR)
- differently configured inputs, eg
  Channel 2 UNBAL (BNC) → Channel 1 BAL (XLR)
  Channel 2 BAL (XLR) → Channel 1 UNBAL (BNC)

Important:
With phase measurements at the

- unbalanced input (BNC), the outer conductor of the BNC female is used as phase reference point .
- balanced input (XLR), the phase reference point is the XLR contact 3.

(See 2.6.2, Configuration of Analog Analyzers)

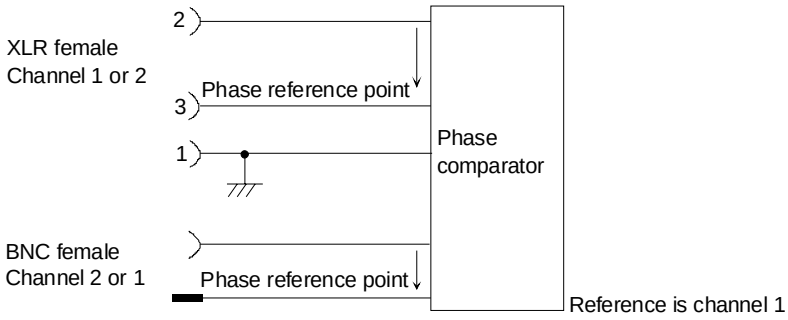

Fig. 2-41

For ***group delay measurements,*** the phase is differentiated with respect to the frequency, ie the differential quotient is evaluated:

$$\tau_2 = \Delta\varphi / (2\pi \times \Delta f) \qquad \Delta\varphi = \varphi_{2meas} - \varphi_{1meas}$$

For ***continuous phase measurements,*** the difference of two consecutive phase-measurement results is added to the first phase-measurement result:

$$\varphi_2 = \Delta\varphi + \varphi_1 \qquad \Delta\varphi = \varphi_{2meas} - \varphi_{1meas}$$

Both measurements are available in the GROUP DELAY menu item. They are only defined for *changes* in the frequency and therefore only make sense in conjunction with frequency sweeping. If they are attempted at a constant frequency, an error message will be issued.

If a frequency sweep is to be set for measuring group delay or continuous phase, the following should be noted:

- The frequency step width or a number of sweep points should be selected so that the phase difference between two consecutive sweep points is not greater than 180°.

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- Linear spacing should be selected; with logarithmic spacing the frequency increments at the bottom could turn out to be too small and the phase changes at the top too great.

When measuring group delay versus frequency (eg by means of a generator frequency sweep), the first sweep point is not defined since a reference point for calculating the delta values of frequency and phase is available as from the 2nd frequency value.

Meas Time

(see frequency measurement)

The measurement time selected for the analog frequency measurement is also used for the (analog) phase measurement.

***Note**: With digital analyzers, a measurement time cannot be selected for frequency, phase or group-delay measurements.*

Unit Ch1/2

Select the unit for result display for channel 1 or 2.

Units selectable for frequency measurements (channel 1):
Hz | ΔHz | Δ%Hz | Toct | Oct | Dec | f/f_r

Units selectable for phase measurements (channel 2):
° | RAD | Δ° | ΔRAD

Units selectable for group-delay measurements (channel 2):
s | Δs

***Note**: Continuous phase is obtained by selecting ° or* RAD *under GROUP DELAY.*

For conversion formulae and notation of result display units for IEC/IEEE-bus control see **2.4 Unit**

Ref Freq

(see **2.6.5.1 Common Parameters of** Functions)

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Format Pha

- **0 ... 360°**
- **-180 ... +180°**
- **360 ... 0°**
- **0 ... 2Π**
- **-Π ... +Π**
- **-2Π ... 0**

(Format phase)
Phase display range:

0 to 360°, selectable for UNIT CH2	°|Δ°
-180 to +180°, selectable for UNIT CH2	°|Δ°
-360 to 0°; selectable for UNIT CH2	°|Δ°
0 to 2π; selectable for UNIT CH2	RAD | ΔRAD
-π to +π; selectable for UNIT CH2	RAD | ΔRAD
-2π to 0; selectable for UNIT CH2	RAD | ΔRAD

***Note**: Continuous phase representation (-∞ to +∞) is possible under GROUP DELAY if a phase unit is selected instead of the usual time unit.*

Ref Phase

(see **2.6.5.1 Common Parameters of** Functions)

Freq Settl

(see **2.6.5.1 Common Parameters of** Functions)

Phas Settl

(see **2.6.5.1 Common Parameters of** Functions)

2.6.5.22 Measurement and display of analyzer sample frequency

Available in the digital analyzers only.

With SAMPLE FREQ selected, the measured sample frequency is displayed on the activated channels (or in the JITTER/PHAS or COMMON MODE measurement window). Irrespective of whether menu item FREQ/PHASE is selected or not, the sample frequency is always measured internally and can be displayed in the PROTOCOL panel.

Unit Ch1/2

Select units for result display for channel 1 or 2.

Units selectable for sample rate:
Hz | ΔHz | Δ%Hz | Toct | Oct | Dec |f/f_r

For conversion formulae and notation of result display units for IEC/IEEE-bus control see **2.4 Unit**

Ref Freq

(see **2.6.5.1 Common Parameters of** Functions)

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Freq Settl (see **2.6.5.1 Common Parameters of** Functions)

2.6.6 Monitor Output

Available for the three analog analyzers, only.

Theory of operation

The analog input signal is applied from the input level stage and before the filters via a low-distortion level attenuator to the monitor outputs (UPD rear panel, see Fig. 2-2, No. 9), which are primarily provided for the connection of an oscilloscope and also of headphones.

The monitor outputs are AC coupled.
When the channel(s) are switched off, 0 V is applied to the corresponding monitor output(s).

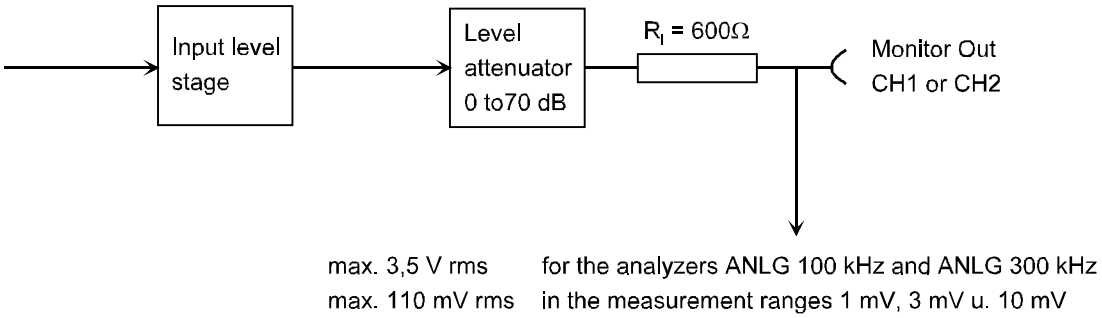

Fig. 2-42 Theory of operation of monitor output

The option UPD-B5 (Headphone/Speaker Output, Parallel I/O see 2.6.7) permits monitoring of analog and **digital** signals **after** the filters

ANALYZER Panel

Monitor Monitor output

ON Active

OFF Inactive

Attenuation Level attenuation from 0 to 70 dB (highest attenuation = 70 dB).
Unit in dB only.

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2.6.7 Headphone/Speaker Output

The Headphone/Speaker Output UPD-B5 permits to monitor both analog and digital test signals during measurement. Aural monitoring is via the built-in loudspeaker or the externally connected headphones . The impedance of the headphones should be 600 Ω to guarantee a distortion-free operation even at full volume. When connecting headphones with a lower impedance, distortions have to be taken into account depending on the volume. The maximum peak voltage at the headphones is 8 V.

Block diagram:

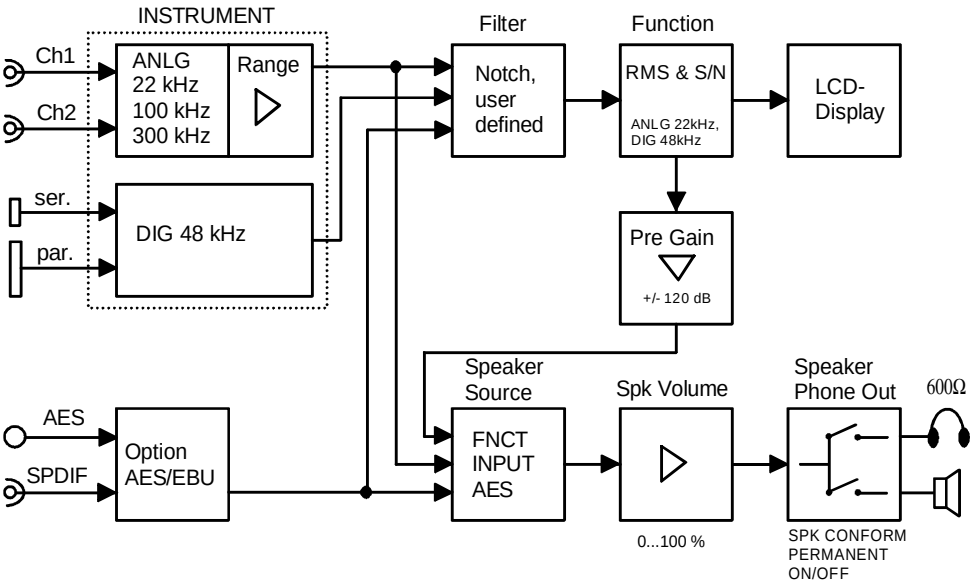

Fig. 2-43 Block diagram of headphone/speaker output

Both the input signals of the analog analyzers (INPUT) and the output signals of the analyzer function RMS & S/N (FUNCTION) may serve as signal sources for the monitor output. When monitoring in the case of FUNCTION, a user-selected filter can also be cut into the signal path. Pre Gain permits a signal amplification of +/- 120 dB. This permits to boost even weak residual signals such that they can be monitored. If the AES/ EBU option is installed, the AES/EBU signal can also be monitored at the input (AES).
A level control (volume) permits setting of the volume. In the case of Phone SPEAKER, the internal loudspeaker is automatically switched off by connecting the headphones. In the case of Phone PERMANENT, only the loudspeaker is switched on and off using the Speaker-off key.

The Speaker menu is located at the end of the ANALYZER panel and linked to the measurement function, i.e. it is stored and loaded together with the function. Thus the monitoring output can be configured separately for each measurement function. For instance, a high preamplification is required for monitoring residual signals (RMS SEL with tracking bandstop filter) while a considerably lower preamplification is sufficient for (filtered or unfiltered) RMS measurements to avoid overdriving and excessive volumes.

To protect the user against excessive volumes (particularly when headphones are connected), the monitoring output is automatically switched off when SETUP settings are loaded, the analyzer instrument or a function is changed or the Speaker command is given. In this case the monitoring output has to be switched on again with the Speaker-off key (LOCAL key). If headphones are used, the Speaker menu should be checked prior to switching on to avoid excessive volumes increased through inadvertent gain setting ("Spk Volume", "Pre Gain").

Note: *Although an oscilloscope can also be connected to the monitor output for signal monitoring, it is primarily designed as control output for aural monitoring of the input signal.*
Due to noise sidebands of the internal PLL, a THD+N measurement does not provide the excellent data usually supplied by the measurement path of the UPD. However, these non-harmonic interfering signals are inaudible due to the psychoacoustic masking effect of the human ear.

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ANALYZER panel

SPEAKER

Monitoring output
With ANALYZER DIG 192kHz and DIG 768kHz, monitoring is not possible. The icons for loudspeaker and headphones are not displayed.

OFF

Monitoring output switched off

INPUT CH1

Monitoring of analog analyzer input signal of channel 1

INPUT CH2

Monitoring of analog analyzer input signal of channel 2

INPUT CH1&2

Monitoring of analog analyzer input signals of channel 1 and channel 2 (stereo operation). If channel 1 or channel 2 is selected as analyzer input, the lefthand or righthand phones output is monitored, correspondingly.

AES/E CH1

Monitoring of left channel of interfaces of AES/EBU option

AES/E CH2

Monitoring of right channel of interfaces of AES/EBU option

AES/E CH1&2

Monitoring of both channels of interfaces of AES/EBU option (stereo operation).

Note: *Monitoring the AES/EBU interface signals is only possible if option AES/EBU is built in.*

FUNCT CH1

Monitoring the analyzer output with function RMS & S/N and RSM SELECT for channel 1
If the high-speed option is *not* built in, single-channel operation (Channel(s) = 1) must be switched on.

FUNCT CH2

Monitoring of analyzer output with function RMS & S/N and RSM SELECT for channel 2
If the high-speed option is *not* built in, single-channel operation (Channel(s) = 2) must be switched on.

FUNCT CH1&2

Monitoring of analyzer output with function RMS & S/N and RSM SELECT of both channels 1 and 2 (stereo operation). Stereo monitoring of the analyzer function output is only possible with the high-speed option.

Note: *Monitoring of the analyzer output with function RMS & S/N is only possible for the analog analyzer 22 kHz and the digital analyzer 48 kHz.*

Pre Gain

For the menu items SPEAKER - FNCTC1/2/1&2 a gain or attenuation of the function output can be set in the range +/- 120 dB. If the gain is set too high, the signal is limited at the monitor output.

Spk Volume

Volume for the monitor output, settable from 0 to 100%

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Phone

Configuration of monitor output at the phones connector.

= SPEAKER

When connecting the headphones, the internal loudspeaker is automatically switched off.

Phones output is operated in conformance with the loudspeaker, i.e. the Speaker-off key (LOCAL key) switches off the internal loudspeaker or phones output. The monitor signal sounds either from the built-in loudspeaker or from the connected headphones.

PERMANENT

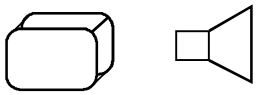
Phones output is permanently switched on. Speaker-off key only acts on the internal loudspeaker irrespective of whether the headphones are connected up.
In this case, the internal loudspeaker also remains active with the headphones inserted.

Keys for speaker control:

LOCAL-Taste

This key is used to switch the internal loudspeaker in local mode of the UPD on/off (Speaker-off key). In the remote mode, the first keystroke switches to the local mode.

+ / - Taste



This key opens a box for faster setting of the monitoring volume (Spk Volume).

Example of application: Monitoring the distortion component of the measuring signal:

Monitoring the residual signal during the THD+N measurement is not possible with the UPD.

However, in the case of an RMS SELECT measurement, the distortion component can be aurally monitored when a narrow bandstop filter is cut in. The signal after the bandstop filter corresponds to the residual signal of a THD+N measurement. The frequency of the bandstop filter can be permanently set or set automatically when the frequency in the GENERATOR panel is changed.

The DUT can be connected eg between analog generator output 1 and analog analyzer output 1.

Make the following settings on the UPD:

Load the UPD default setup in the FILE panel:

```
LOAD INSTRUMENT STATE
Mode        DEF SETUP
```

Make the following settings in the ANALYZER panel:

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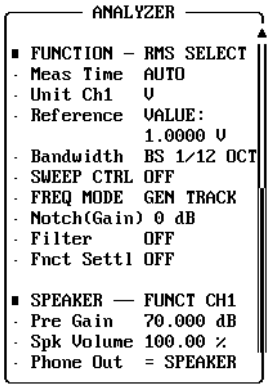

With FREQ MODE = GEN TRACK, the bandstop center frequency tracks the frequency setting in the GENERATOR panel.
FREQ MODE = FIX holds the bandstop center frequency irrespective of the generator frequency.

With NOTCH(Gain) = 0 dB, an analog notch filter is cut in. This increases the stopband attenuation by 40 dB (in addition to the 100 dB stopband attenuation of the bandstop filter).

Switching on the loudspeaker: Press speaker-off key (LOCAL key), open the volume box (+/- key) and set the desired volume.

With the setting of Pre Gain, the residual signal can now be raised to exceed the aural threshold. Depending on the distortion factor of the DUT, the harmonics of the test frequency can be clearly discerned from the noise.

The menu items "Bandwidth" and FREQ MODE can be set differently depending the selected generator:

- Internal universal generator (Low Dist --> OFF)

Select FREQ MODE --> GEN TRACK: Since the universal generator has a very high frequency stability, a very narrow bandwidth can be set (bandwidth --> BS 1%). When the generator frequency is varied, the fundamental is automatically suppressed by the tracking bandstop filter.

- Internal low-distortion generator (Low Dist --> ON; Setting PRECISION)

If PRECISION is selected, the frequency of the low-distortion generators is measured and adjusted each time a (new) frequency is entered. If the same generator frequency has been used in the measurements for an extended period of time, the generator frequency may drift and be slightly outside the stopband range of the bandpass filter BS 1%. In this case the fundamental is not completely suppressed. ***Remedy***:

  – select either a wider bandstop filter (bandwidth --> BS 3%, BS 1/3 OCT, BS 1/12 OCT) *or*

  – select FREQ MODE --> FIX and tune the center frequency manually to the generator frequency or vary the generator frequency by a few Hz until maximum suppression of the fundamental is obtained again.

- External generator:

Select FREQ MODE --> FIX and adjust the center frequency as exactly as possible to the generator frequency. Select a broad bandpass filter for non-frequency-stabilized generators (bandwidth --> BS 3%, BS 1/3 OCT, BS 1/12 OCT).

Notes *on monitoring the residual signal during the RMS SELECT measurement:*

- *To ensure uninterrupted operation, automatic settings of the measurement speed (AUTO, AUTO FAST) should not be used.*

- *Under unfavourable conditions, the internal DC offset of the notch filter may cause the monitoring output to be overdriven or muted.*

Remedy:

  – *Perform or switch on DC offset calibration in the OPTIONS panel,*
  – *Switch on highpass filter (filter --> HP...).*

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2.6.8 User-programmable Parallel I/O Port

If an UPD is equipped with the options

- UPD-B5 "Monitor Output, Parallel I/O" (see 2.6.7) and
- Automatic Control Program UPD-K1 (see Manual Automatic Control of the UPD with R&S Basic UPD-K1 1031.4204.02),

the parallel port of the option UPD-B5 can be freely programmed via the BASIC commands of the option UPD-K1.

The 8 bits of port 278h (632d) can be programmed as inputs or outputs as required by setting d5 of output port 27Ah (634d) to 0 or 1.
d5 = 0: Port 278h is output port (8 open collector outputs)
d5 = 1: Port 278h is input port (8 inputs in CMOS logic).

The 3 bits d0, d1 and d3 of port 27Ah (634d) are permanently connected up as inverting open-collector outputs.

The 4 bits d3 to d6 of port 279h (633d) are permanently connected up as inputs.
If no input level is applied, ones are read in by the pull-up resistors so that 120d (78h) is read in after masking out the 4 bits.

The following BASIC program example consisting of 4 program sections that can be executed with RUN 10, RUN 100, RUN 200 and RUN 300 illustrates the various possible ways of control of the input/output ports.
For program entry see manual "R&S BASIC Interpreter".

```
10 REM Switch port 278h (632d) as output port and change d0 between 1 and 0
20 IOcode=239: '                    239 (EFh) = mask for output port
30 Aus=Aus AND IOcode: '            set d5 to 0 to switch port 278h (632d) as output port
40 OUT 634,Aus: '                   without affecting the other bits
50 OUT 632,1: 'd0 = 1
60 OUT 632,0: 'd0 = 0
70 GOTO 50
80 END

100 REM Switch port 278h (632d) as input port and read in permanently
110 IOcode=32: '                    32(20h) = mask for input port
120 Aus=Aus OR IOcode: '            set d5 to 1 to switch port 278h (632d) as input port
130 OUT 634,Aus: '                  without affecting the other bits
140 PRINT INP(632): '               Read in port 278h(632d) and output on screen
150 GOTO 140
160 END

200 REM Permanently read in input port 279h (633d)
210 REM Mask out d3, d4, d5 and d6. If no input level is applied,
220 REM ones are read in by the pull-up resistors so that 120 (78h)
230 REM is displayed.
240 Ein=INP(633)
250 Ein=Ein AND 120: '              120 (78h) masks out the bits d3, d4, d5 and d6
260 PRINT Ein
270 GOTO 240
```

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```
300 REM Output on output port 27Ah (634d)
310 REM The output is in inverted form. d5 is set as in line 20 or 110
320 REM in order not to change the setting defining whether port 278h (632d) operates as
330 REM input or output port.
340 FOR I=0 TO 254
350 Aus=I AND 11: '                 only change d0, d1 and d3
360 IF IOcode=239 THEN Aus=Aus AND IOcode: 'do not change d5
370 IF IOcode=32 THEN Aus=Aus OR IOcode
380 OUT 634,Aus
390 NEXT I
400 GOTO 340
410 END
```

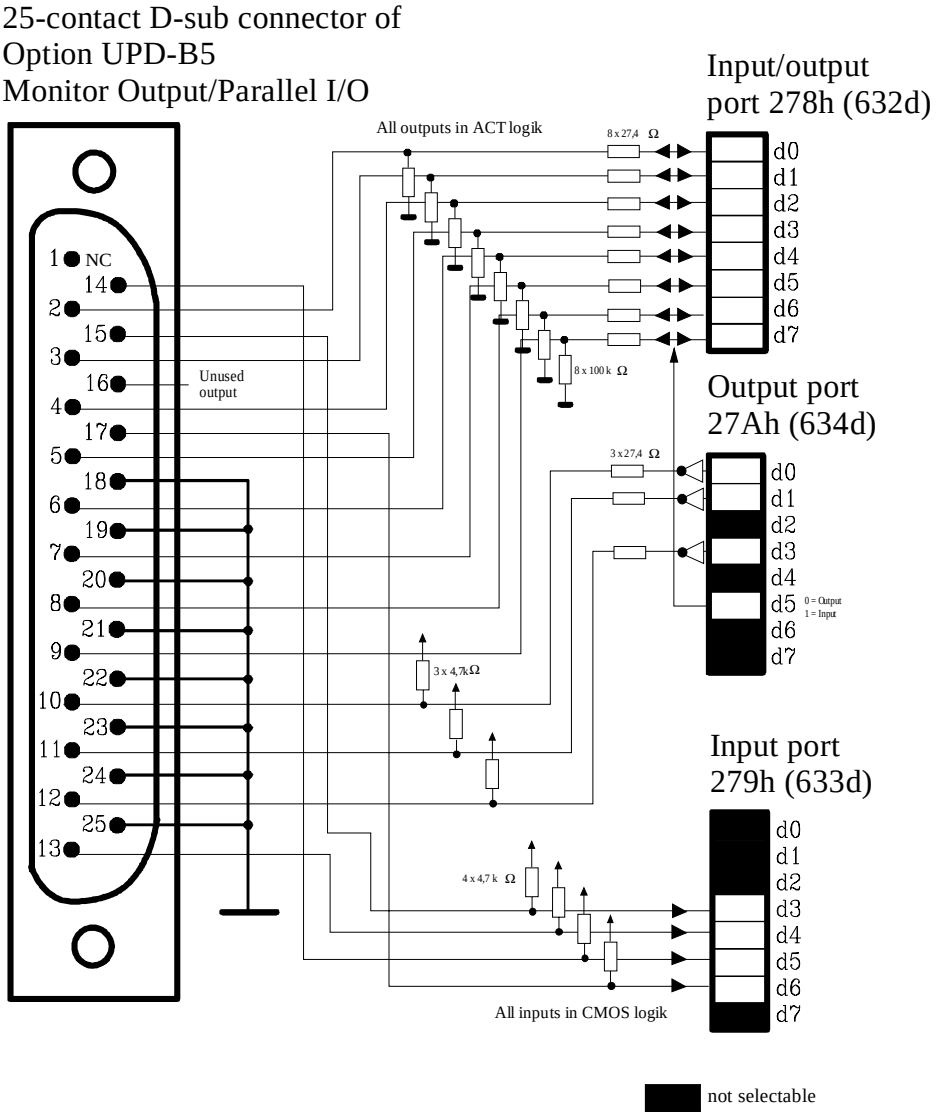

Fig. 2-44 Assignment of 25-contact sub-D connector of option UPD-B5 (Headphone/Speaker Output Parallel I/O)

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2.6.9 Applications

2.6.9.1 Stereo Crosstalk Measurements

Crosstalk is the undesired coupling of signals from one channel into another. It is normally indicated as a function of frequency. The measurement is performed by modulating one channel and measuring the amplitude in the unmodulated channel. Since the coupled-in signal level is normally low and may correspond in magnitude to the signal-to-noise ratio, the full dynamic range should be used. The values are indicated in dB, the output amplitude of the driven channel is used as a reference.

- Basic setting

The generator is set to SINE and a frequency sweep is activated. Since crosstalk normally does not show steep variations versus frequency, 20 to 30 test points with logarithmic spacing will be sufficient in the range from 20 Hz to 20 kHz. VOLTAGE is set such that the maximum voltage is attained at the DUT output.

The RMS & S/N function (with S/N Seq OFF) is used in the analyzer to measure the level in the AUTO or AUTOFAST mode. This is a 2-channel measurement, ie Channel(s) is set to 2≡1. In the case of AUTO the different levels are automatically matched. INPUT DISP and FREQ/PHASE measurements should be OFF to increase the measurement speed.

Since the measurement is to be displayed as a CURVE PLOT, Operation is set accordingly in the DISPLAY panel. Scan count is set to 1. Scale B is selected to NOT EQUAL A. Unit should be set to dBr for both channels and the Normalize value to 1.0 * or 0 dB.

- Measuring crosstalk from CH2 to CH1

Switch the generator to Channel(s) 2 to drive channel 2.
Set Trace A to FUNC CH1 in the DISPLAY panel and Reference to MEAS CH2.
Trace B is OFF. Pressing the SINGLE key starts the first measurement sequence.

- Holding the measurement

Since the crosstalk of the other channel should be represented in the same display, the first measurement must be "frozen" using Trace A HOLD. If Scale has not yet been set to AUTO ONCE, automatic scaling can be selected now.

- Measuring crosstalk from CH1 to CH2

Channel(s) 1 is now selected in the GENERATOR panel to drive channel 1.
FUNC CH2 is selected for Trace B and MEAS CH1 as a reference.
Pressing the SINGLE key starts the second sweep.

- Post-processing/storage

Since, , the crosstalk values measured in the two channels are normally not very different, the scale of Trace A can be used with Scale B EQUAL A.

The complete measurement can now be stored in a file by entering Store TRACE A+B and a file name in the FILE panel. Screen Hard Copy can be selected in the OPTIONS panel for documentation and the printout is triggered with the HCOPY key.

- Transfer of controlled functions to the STATUS panel

This measurement is a typical application for the STATUS panel. To avoid repeated switching between the GENERATOR and DISPLAY panel during the measurement, the command lines to be executed can

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be marked and are thus transferred to the common STATUS panel (see **2.8 STATUS Panel**). Assuming that nothing has been marked before, the Channel(s) command is ticked off in the GENERATOR panel, and TRACE A, Reference (A), TRACE B, Reference (B) and probably Scale B in the DISPLAY panel.

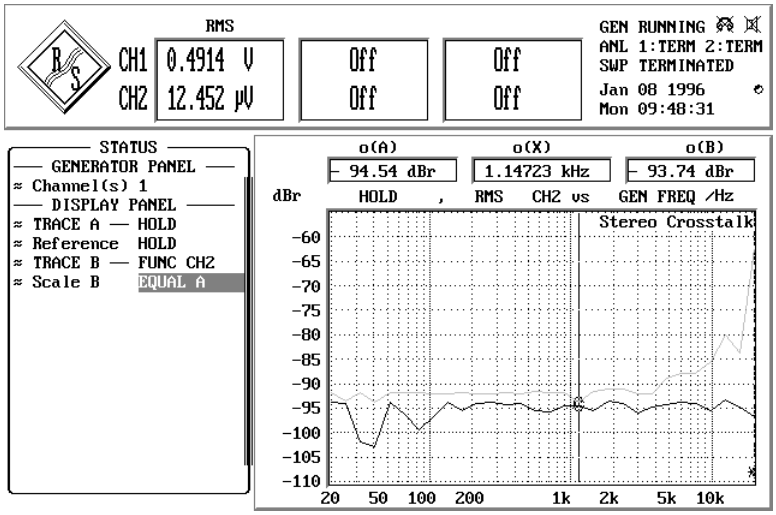

Fig. 2-45 STATUS and GRAPHICS panel with crosstalk measurement

2.6.9.2 Linearity Measurements

Linearity measurements are performed to investigate the characteristic of the output level with reference to the input level. The unit is usually dBr, but also V/Vr is used. Usually, the linearity of a DUT is of interest with different input voltages, allowing for a (generator) level sweep. With an ideally linear DUT, the sweep curve would be a horizontal line in parallel to the X-axis.

The UPD does not offer an individual function for linearity measurements but they are defined as special reference of the level measurements. ***Advantages:***

1. The linearity measurement is not confined to one single measurement function; *all level measurements* (RMS, RMS SELECT, quasi-peak and all peak measurements) can be used for linearity measurement.
2. Switch-over between the linearity measurement and the (absolute) level measurement is enabled by selection of the unit (menu line "Unit 1" or "Unit 2"). It is thus possible to display the linearity measurement in one channel and the absolute level in the other channel.
3. The selection of the reference (menu line Reference) offers switchover between fixed and floating reference value (linearity measurement). It is thus possible to display the linearity measurement in one channel and a level referred to a fixed reference in the other channel.

Note: *The floating reference used for linearity measurement is defined* ***"floating reference value"*** *in this operating manual. In contrast to the usual "fixed reference value", each measured value is assigned its* ***own*** *reference value.*

The linearity measurement can be performed by means of a sweep, the measured values of which can be displayed numerically or graphically in the GRAPHICS panel and normalized. Moreover, the linearity deviation of each measured (level) value can be read off the result window directly - without setting and performing a sweep.

Either the internal generator (select GEN TRACK) or - when both channels are switched on - one of the two measurement channels (select MEAS CH 1/2) can be selected as reference for the linearity measurement. Selection of a measurement channel as reference is required, if an external generator is used or if reference is to be made to a specified location of the setup.

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Note:: *A two-channel linearity measurement assumes that one of the channels is needed as reference. If MEAS CH1 or MEAS CH2 is selected as reference, one-channel linearity measurement is possible, only; the other channel supplies constantly 0 dBr (since it is referred to itself).*

If the linearity measurement is a sweep which is displayed in the graphical window, additional references can be made:

1. The level curve of a reference item (golden unit), once measured and stored as a trace file - can be selected as reference in the DISPLAY panel (select FILE). It is thus possible to display the linearity deviation referred to this golden unit, without the latter being available with measurement.
2. The level curve measured in the other trace (or loaded from file) can be selected as reference directly in the DISPLAY panel (select OTHER TRACE). It is thus possible to subsequently refer the level curves of the two channels to each other.
3. The sweep shows the linearity deviation (eg, in dBr) from the selected reference curve. It need not necessarily be about 0 dBr, but also below or above 0 dBr, if the DUT is subject to gain or attenuation. This amplification factor of the DUT can be compensated by a normalization factor which can, alternatively, be entered numerically or by automatic 0-dB normalization to the current cursor position.

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Note: *When measuring D/A or A/D converters using the internal UPD generator, the linearity measurement (with GEN TRACK) leads to the physical problem of referring an analog voltage to a digital one (or vice versa). The UPD internally calculates with a* ***conversion factor*** *of*

1V / 1FS or 1FS / 1V

Similar to the amplification factor, the conversion factor of the converter can be compensated by the normalization factor.

One-channel linearity measurement referred to measurement channel 1:

1. Select the analyzer (ANLG 22 or ANLG 110 kHz) depending on the frequency range required.
2. Select one of the level measurements (RMS, RMS SELECT, quasi-peak or peak) and the mode, if necessary according to the measurement task.
3. If a curve is to be swept, further settings have to be made in the DISPLAY panel. Operation must be set to Curve Plot, FUNCT CH2 should be selected for trace A and trace B should be OFF.
4. Select the unit dBr or V/Vr for channel 2 and trace A (in the ANALYZER - and DISPLAY panel, if required).
5. Select MEAS CH1 as reference (menu line "REFERENCE" in the ANALYZER panel and DISPLAY panel, if required); the measurement result of channel 2 is then referred to the input of channel 1.
6. The linearity deviation is displayed in the result display of channel 2 with the selected unit. Starting the (SINGLE) sweep initiates graphical display of the linearity characteristic over the input level.

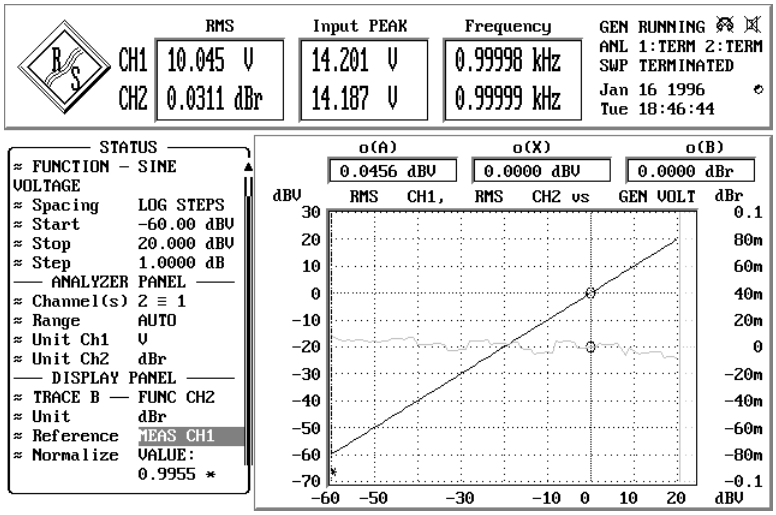

Fig. 2-46 "LINEAR1.PCX": Configuration of the UPD for the linearity measurement with reference to channel 1, display of the linearity wave on trace B and the absolute reference channel on trace A.

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Two-channel linearity measurement referred to the internal generator:

1. First, configure and set the internal generator (sinewave, level sweep, if required, signal frequency, etc.)
2. Select the analyzer (ANLG 22 or ANLG 110 kHz) depending on the frequency range required.
3. Select one of the level measurements (RMS, RMS SELECT, quasi-peak or peak) and the mode, if necessary according to the measurement task.
4. If a curve is to be swept, further settings have to be made in the DISPLAY panel. Operation must be set to Curve Plot, FUNCT CH1 should be selected for trace A and FUNCT CH2 for trace B.
5. Select the unit dBr or V/Vr for both channels and both traces (in the ANALYZER panel - and DISPLAY panel, if required).
6. Select GEN TRACK as reference (menu line "REFERENCE" in the ANALYZER panel and DISPLAY panel, if required); the measurement result of both channels is then referred to the generator level.
7. The linearity deviation is displayed in the result display of channel 2 with the selected unit. Starting the (SINGLE) sweep initiates graphical display of the linearity characteristic over the generator level.

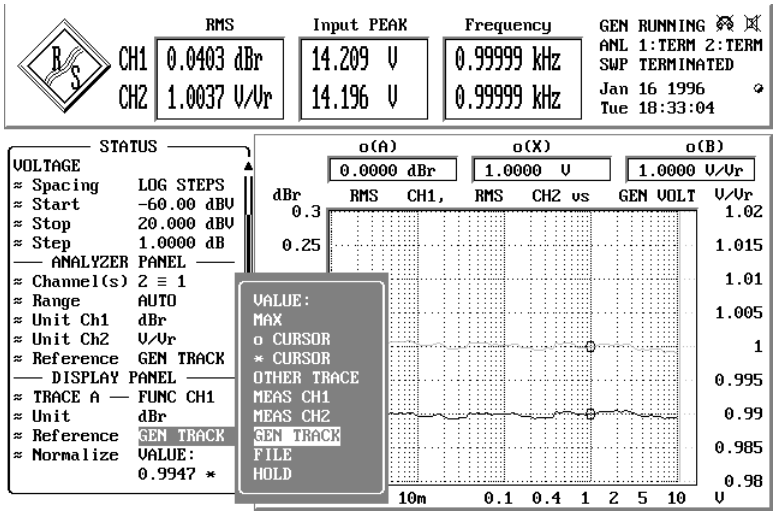

Fig. 2-47 Configuration of the UPD for two-channel linearity measurement with reference to the internal generator; display of the linearity characteristic of both channels

Following termination of the sweep, the swept curves can be normalized to one (or 2 different) point(s) (eg, 1 V). The curve is thus shifted in the vertical direction such that it intersects with the 0-dBr line at the selected reference points:

1. Switch over to the GRAPHICS panel (GRAPH key or ALT+R), activating one or both graphics cursors, if required
2. Move the cursor(s) to the desired reference point(s).
3. Return to the DISPLAY panel (DISP key or ALT+D),.
4. Open the menu item Normalize of Trace A; select O-Cursor or ✸- cursor, depending on which one was used for marking the reference point.
5. Repeat step 4 for Trace B, if required.

Note: *If the linearity characteristic is to be determined for various frequencies, this can be realized via the two-dimensional sweep (with frequency on the Z-axis). The individual waveforms are overlapping in the display and result in a set of curves.*

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2.6.9.3 Fast Frequency-Response Measurements

Usually, frequency-response measurements are performed using (generator) frequency sweeps and RMS measurement. Although the UPD offers quite a high RMS measurement speed (approx. 15 ms per measured value), such a sweep may lead to total measuring times, which are unacceptable due to the large number of sweep steps to be performed.

Combining the FFT function with the generator signal RANDOM, Domain FREQ is an alternative therefore. The generator can be synchronized to the spacing of the analyzer, ie, each generated frequency line of the (pseudo) random signal is assigned exactly one line of the FFT. Therefore, FFT windowing may be omitted, thus obtaining maximum frequency and level accuracy.

After generation of the generator random signal, all measurements can be performed at the speed of one single FFT. Thus, the measurement speed depends only on the FFT size, however, it should be selected such that the desired (linear) frequency resolution is just obtained.

Note: *Logarithmic spacing is not possible with FFT; irrespective of this, logarithmic scaling of the X-axis can be selected in the DISPLAY panel.*

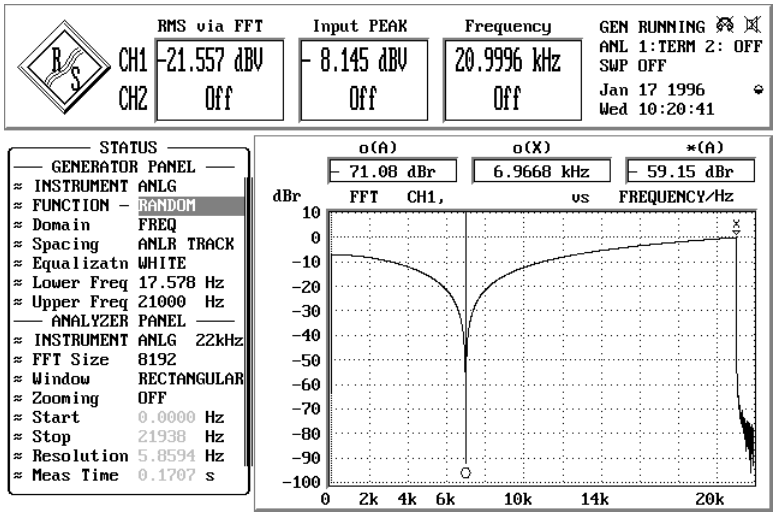

Fig. 2-48 Configuration and result of fast frequency-response measurement

2.6.10 Optimizing the Measurement Speed

In the case of remote control a high measurement speed is particularly important as the measurement time directly influences the program execution time. For this reason section **3.15.10** gives program sequences permitting the maximum measurement speed to be obtained.

Short measurement times are desirable even in manual operation, particularly for sweeps and FFTs, to make sure that realtime response is be obtained (eg in adjustments). For this reason a few general hints are given here to keep measurement times short. The measures to be taken can be classified in 4 groups:

1. Measures for speed optimization *not affecting* the measurement accuracy,
2. *Compromise* between measurement time and accuracy or dynamic range,
3. Optimization using the *internal* generator,
4. Increasing the sweep speed.

These hints are available in a brief form under "Optimization" as part of the UPD online help (see **2.3.7 Help Function**).

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2.6.10.1 Speed Optimization without Influencing the Measurement Result

- Selection of suitable analyzer instrument

If the ANLG 22kHz and DIG 48kHz instruments are used, the two channels can be measured without pre-sampling. In this case the maximum dynamic range of the converter is used and the minimum *lower* frequency limit. These analyzers should therefore be given preference as long as the *upper* frequency limit is sufficient for the measurement.

- Switching off the unused test input

An unused test input may considerably increase the measurement speed as the measurement is only completed when a result has also been obtained for the unused channel. Some functions (eg RMS with automatic measurement time, THD+N) take a considerably longer time for measuring a low-level signal (noise). If a signal is present in the 2nd channel, the measurement time is slightly longer than in 1-channel operation, because also the 2nd channel has to be completely evaluated and displayed. If the high-speed option is not installed, the two channels are measured sequentially, which at least doubles the measurement time.

- Switching off the "Beeper"

In the setting "Beeper ON" there is a short sound of several 100 ms duration after each (single) sweep which indicates the sweep ending. During this time no device activities are possible. Especially with short sweeps this dead time is disturbing. Therefore the Beeper function should be switched off while sweeps are running - especially under remote/automatic control - if no acoustic reply of sweep end is required.

- Switching off displays that are not required

If the displays for FREQUENCY and INPUT DISP are not required, they should be switched off. Apart from saving time for evaluation and display of these values, some measurement functions (eg RMS) can be terminated sooner.

- Switching off the settling function

The settling function is not required for most test signals. If the DUT supplies a stable signal, settled results are obtained in the UPD even without the Settling function being switched on. Settling (or averaging) multiplies the measurement time by at least the set number of samples (see **2.3.4 Settling Process**). If the DUT has settling problems, these problems can be eliminated by delaying the measurement start (see also below) provided the settling time is roughly known.

- Switching off unused filters

The settling time of each (digital) filter increases the total measurement time. Unused filters should therefore be switched off in the ANALYZER panel.

- Switching off the start delay for the measurement (Delay under START CONDITION)

Delays and settling problems of the DUT are compensated for by a delay of the start of the measurement. The start of the 1st measurement after each change of a generator or analyzer setting - and therefore each single sweep point - is delayed by the set period. If the delay is no longer required, it should be set to 0.0 (see **2.6.4 Ways of Starting** the Analyzer Ext. Sweep).

- Manual selection of analyzer level range (analog signals only)

If the test signal level is roughly known and a reduction of the measurement dynamic is acceptable, the analyzer level range should be selected manually (Range FIX). A range covering the highest expected level should be set, an UNDERRANGE should be taken into account. This prevents a new measurement with corrected range setting to be performed. Range LOWER can be selected to ensure that the measurement is not made invalid by a signal exceeding the upper range limit. In this mode the measurement range can be corrected in the case of OVERRANGE (see **2.6.2 Configuration of the** Analog Analyzers).

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2.6.10.2 Compromise between Measurement Time and Accuracy or Dynamic Range

The methods listed here can only be performed with certain measurement functions.

- Selecting a lower dynamic range (Dynamic Mode FAST, only with the analog measurement functions THD, THD+N/SINAD, DFD, MOD DIST)

With signals not able to use the full dynamic range of the UPD, eg distortion factors above 0.1%, a precision measurement need not be performed. Thus the measurement time can be reduced by about a factor of 2 without any loss of measurement accuracy.

- Reducing the FFT size for FFT and THD+N

Halving the FFT size also halves the FFT measurement time. This also applies to FFT-supported measurement functions like THD+N or SINAD.

When a THD+N/SINAD measurement is performed, reducing the FFT size not only shortens the measurement time for (Post-)FFT but also that for THD+N/SINAD - irrespective of whether Post-FFT is activated or not, however at the expense of the measurement accuracy (see 2.6.5.7 THD+N/SINAD).

- Reducing the numerical value for "Measure Time" with RMS, RMS SELECT, PEAK, Q-PEAK and DC

If a fixed measurement time is used, it can be directly entered as a numerical value. The shorter the measurement time, the lower the accuracy, of course. The specified measurement time refers to each measurement. A new measurement performed because of an unfavourable (UNDERRANGE) or incorrect (OVERRANGE) level range in the AUTO range extends the total measurement time.

- Selection of AUTO FAST for RMS and RMS SELECT

Selecting autoranging (AUTO or AUTO FAST) for RMS measurements guarantees the shortest possible measurement time for the desired accuracy irrespective of the test frequency in the case of unknown signals. If an accuracy of 1% is sufficient, AUTO FAST is recommended (see 2.6.5.2 RMS).

- Increasing the "Span" for Zoom-FFT

The "Span" selected for Zoom-FFT should not be narrower than necessary for the required frequency resolution. Doubling the span halves the frequency resolution and the measurement time. (see 2.6.5.13 FFT).

- Increasing the "Bandwidth" for RMS SELECT

The wider the bandwidth of the digital bandpass or bandstop filter, the shorter the measurement time. The measurement speed can therefore be increased if the signal frequency is less selective (see 2.6.5.3 RMS SELECT).

- Reducing the attenuation and/or the skirt selectivity of user-defined filters

Both measures reduce the settling time of the filter and therefore the measurement time (see 2.7.2 Creating the User-definable Filters).

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2.6.10.3 Speed Optimization Using an Internal Generator

- Select GEN TRACK modes, if available (RSM, RMS SELECT, THD, THD+N/SINAD)

Selecting Meas Time GEN TRACK for RMS and RMS SELECT permits the measurement time to be exactly set to whole periods of the set generator frequency. To achieve this the generator frequency may have to be slightly modified (see 2.6.5.2 RMS).

With Fundamental GEN TRACK selected for RMS SELECT, a preliminary measurement for determining the frequency is not required (see 2.6.5.3 RMS SELECT).

With Fundamental GEN TRACK selected for THD+N/SINAD, the 1st FFT can be performed with correct resolution even if the selected FFT size is too small. This almost doubles the measurement speed at low frequencies and a small FFT size (see 2.6.5.7 THD+N/SINAD).

If a pure THD measurement is performed, selecting Fundamental GEN TRACK does not noticeably increase the measurement speed. Since the fundamental must be exactly defined for the THD measurement, Fundamental AUTO should be used, particularly when the low-distortion generator is used as a signal source.

- Fast frequency response measurement

If the noise generator (Domain FREQ, Shape FILE) is synchronized to the FFT analyzer of the UPD, a real-time frequency response analysis can be performed (see 2.6.9.3 Fast Frequency Response Measurement).

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2.6.10.4 Optimizing the Speed of Generator Sweeps

- Use of universal generator instead of the low-distortion generator

The universal generator is superior to the low-distortion generator with a view to frequency setting time and accuracy and should therefore be preferred as a sweep generator. The low-distortion generator should be used only if its excellent THD and S/N ratio are required.

- Doing without equalization of the generator signal (SINE and DFD)

If signal equalization is activated, the level has to be newly set when the frequency is changed. This extends the total setting time and therefore the sweep time. In the case of very fast sweeps, equalization should preferably be switched OFF (see 2.5.4.1.3 Gem. Param. für SINE DFD MULTI RANDOM).

- Synchronization of generator to the analyzer (Next Step ANLR SYNC)

When the generator and analyzer of the UPD are used together, the generator sweep should always be synchronized to the analyzer. This ensures that the generator is switched *exactly when* all measurement results are available (if required also frequency and input on the active channels).

DWELL should only be used in conjunction with an external analyzer (see 2.5.4.2 Sweeps).

- Manual selection of generator level range (only in the case of analog level sweeps with the universal generator).

If a reduced dynamic range can be accepted for the generator, the generator setting and settling time can be reduced by selecting a fixed level range (see 2.5.2 Configuration of the Analog Generator).

- Reducing measurements at low frequencies (particularly with RMS, RMS SELECT and THD+N):

==> selecting linear instead of logarithmic spacing,

==> increasing the start frequency or the stop frequency (for a sweep from top to bottom).

Low frequencies require longer measurement times. For this reason there should not be too many sweep points in the lower frequency range.

- Reducing the sweep points or increasing the spacing, list sweep

The duration of a sweep increases linearly with the number of sweep points. Too many sweep points should therefore be avoided. In the list sweep the spacing of the individual sweep points can be selected as required so that clusters of points can be placed in areas of particular interest without significantly increasing the total number of sweep points. (see 2.5.4.2 Sweeps).

- Switching off the result display and the status display

When sweeps are performed, the display of single measured values in the result display is in most cases unnecessary or even useless, particularly when the values are updated at a high rate. The same applies to the status display so that both displays can be switched off together. Omitting the output time - which is independent of the measurement time - is particularly noticed in the case of fast sweeps (see 2.15.5 Setting the Displays). The measurement can still be followed by means of the sweep curve or the bargraph display; the complete sweep list can be displayed any time in the GRAPHICS panel (see 2.10.4 Display of Lists).

- Switching off the graphic cursor

For most applications display and update of the cursor values are not required while running sweep. Only the terminated sweep is analyzed by means of graphic cursors. Therefore the graphic cursors can be switched off during the sweep run and so the sweep time can be reduced (see 2.10.2 Trace and Spectrum Display).

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2.7 Analyzer Filters (FILTER Panel)

The FILTER panel has been devised for definition of the filters which can then be used in the ANALYZER panel. Before a user-definable filter can be selected in the analyzer, it must be created in the FILTER panel.

Activating the FILTER panel:
UPD front panel: FILTER
External keyboard: ALT + T
Mouse: (repeated) click on the right panel name, until the FILTER panel is displayed.

If the FILTER panel is already visible on the screen, it can be activated also by actuating one of the TAB keys (repeatedly) or by mouse-click.
Advantage: The panel need not be established again.

Filter

For the functions

- RMS & S/N (rms measurement) → 4 filters possible
- PEAK & S/N (peak measurement), → 3 filters possible
- Q-PK & S/N (quasi-peak meas.) → 3 filters possible
- THD+N/SINAD (distortion measurement) → 1 filter possible
- RMSSEL (selective RMS measurement) → 1 filter possible
- FILTSIM (filter simulation) → 4 filters possible

any desired filters from the filter selection window can be set in the ANALYZER panel. This window contains user-definable filters (the first 9) and weighting filters, which are referred to by their short names in the FILTER panel or by a name complying to the standard. You can select any desired filter (also several times) and assign to the ANALYZER measurement function.

The sum frequency response of all selected filters can be graphically displayed using the analyzer function FILTSIM (see 2.6.5.16).

2.7.1 Weighting Filters

The user-definable filters in the UPD (see 2.7.2 Creating User-definable Filters) are complemented by 13 pre-defined weighting filters, which are automatically matched to the current sample rate. Due to the digital realization, the frequency response absolutely complies with the standard. With a very small sample rate (eg 32 kHz in the DIG48 instrument), some sections of the filter functions are close to the measurement range limit, resulting in distortions in these sections (with eg a sample rate of 32 kHz, distortions may occur in the range over 13.5 kHz). Yet, the filter is still within the permissible tolerances. For this reason, it is not possible to set weighting filters in combination with sample rates smaller than 30 kHz.

Note: *The weighting filters cannot be set in the filter panel, but are automatically available with the filter command of the respective measuring function.*

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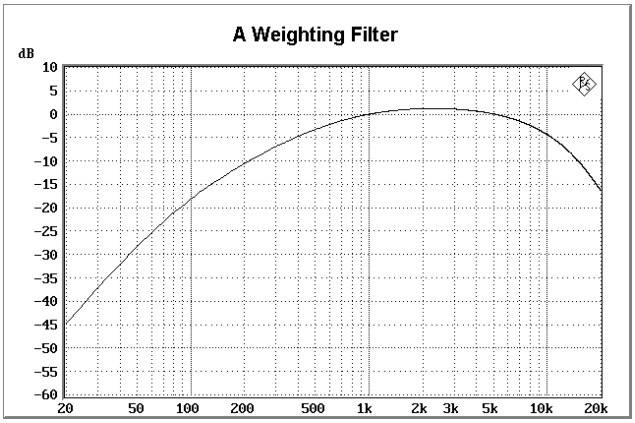
Filter: A Weighting

Standard(s): DIN 45412

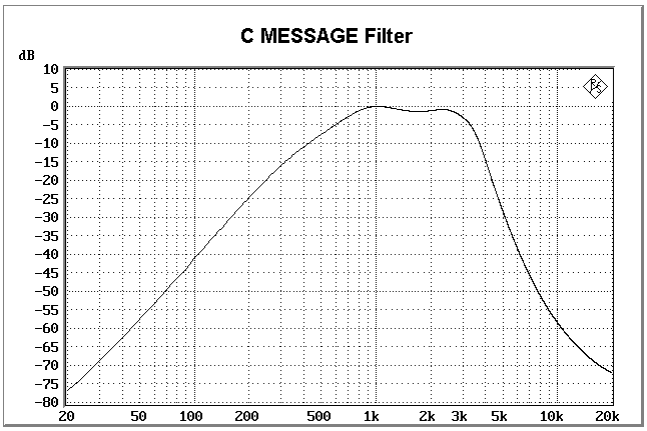
Application: Weighting for disturbing voltage measurements



Filter: C Message

Standard(s): IEEE 743-84

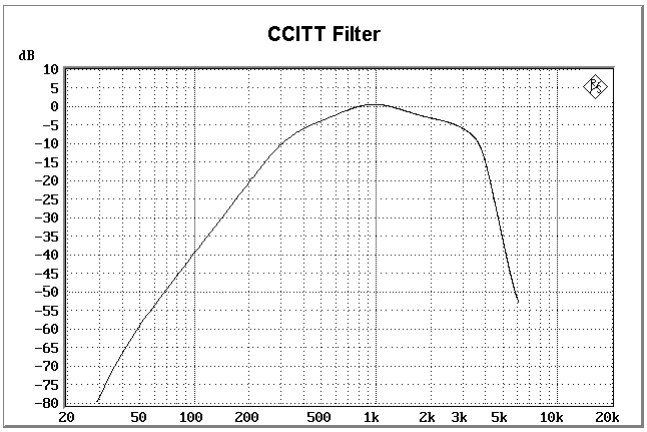
Application: Transmission measurements



Filter: CCITT

Standard(s): CCITT 0.41
IEEE Rec. 743-84
CISPR 6-76
CCITT Rec. P.53

Application: Psophometric measurements



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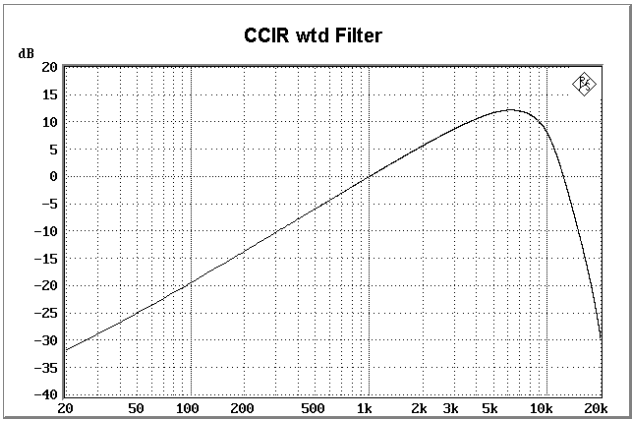
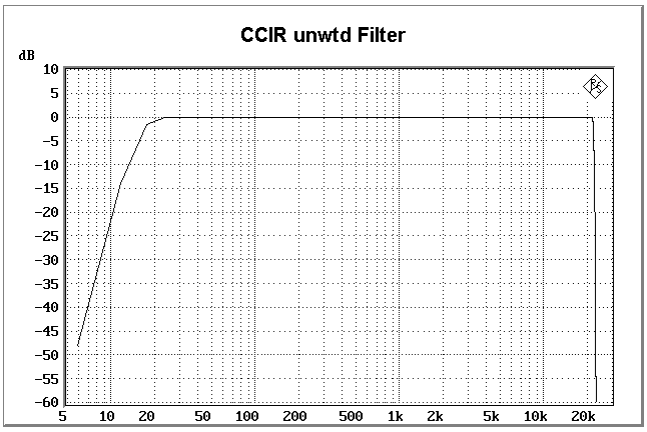
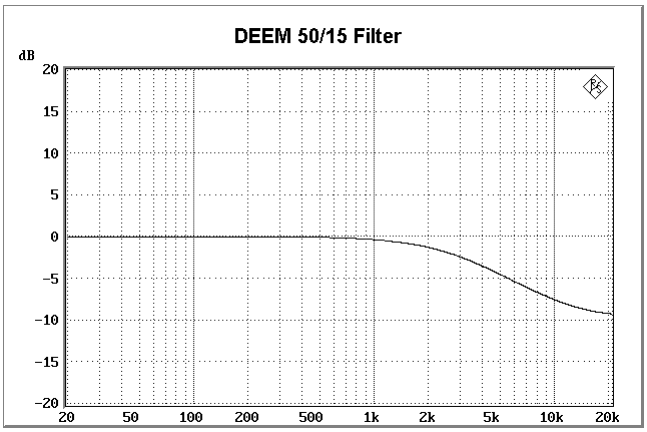
Filter:	CCIR wtd
Standards:	CCIR Rec. 468-4 DIN 45405 CCITT Rec. N21 CISPR 6-76
Application:	Weighting for disturbing voltage measurements



Filter:	CCIR unwtd
Standard(s):	CCIR Rec. 468-4
Application:	Bandpass from 20 Hz to 20 kHz for band-limited, unweighted



Filter:	DEEM 50/15
Standard(s):	CCIR Rec. 651
Application:	Compact discs



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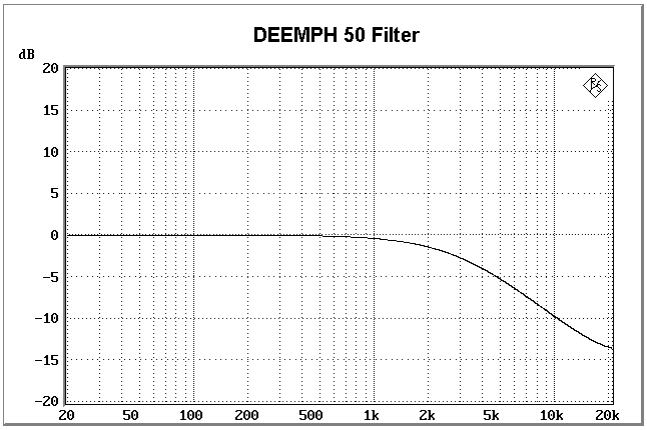
Filter: Deemph 50

Standard(s): ARD Specs 5/3.1

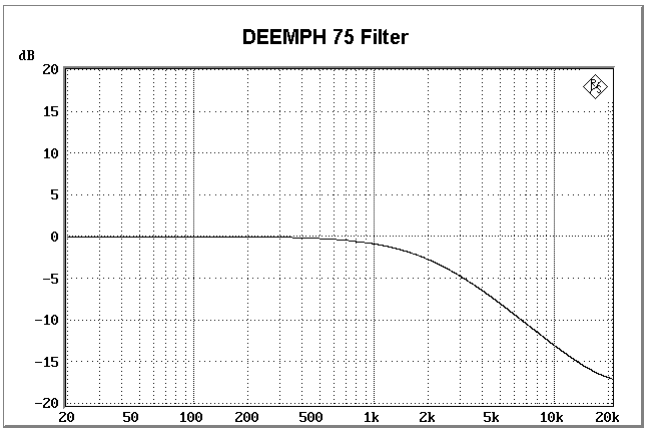
Application: Interference and noise voltage measurements to DIN 45405



Filter: Deemph 75

Standard(s): same as Deemph 50

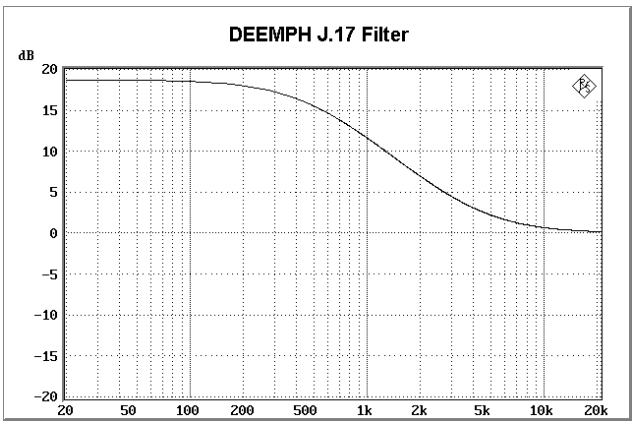
Application: Interference and noise voltage measurements to DIN 45405



Filter: Deemph J.17

Standard(s): CCITT J.17

Application: Interference and noise voltage measurements to DIN 45405



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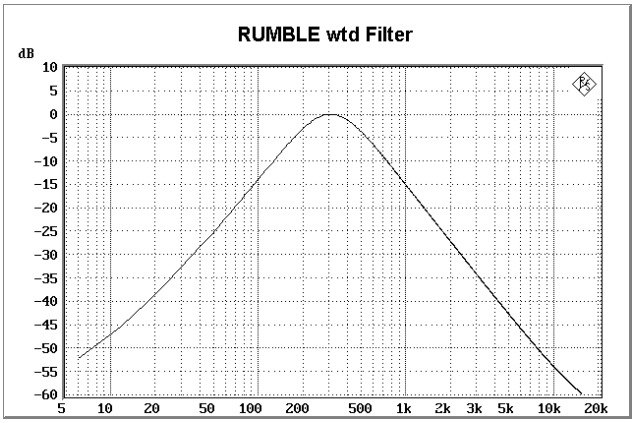
Filter: Rumble wtd

Standard(s): DIN 45539

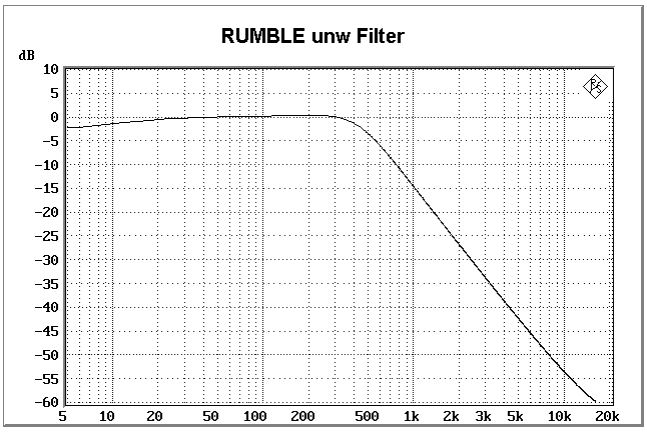
Application: Testing of record players
Noise voltage measurements



Filter: Rumble unwtd

Standard(s): DIN 368.3
DIN 45539

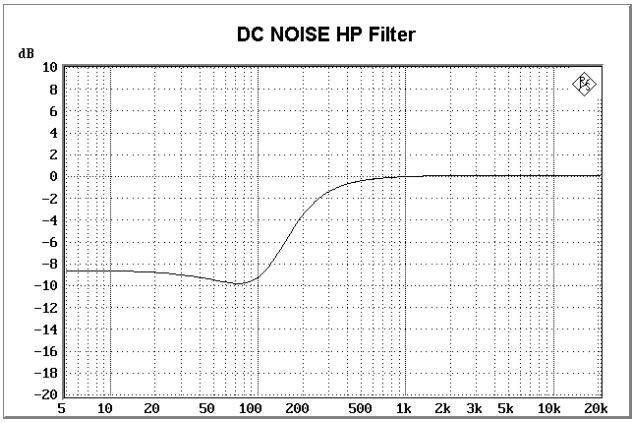
Application: Testing of record players
Noise voltage measurements



Filter: DC noise HP

Standard(s): ARD Specs. 3/4
ARD Specs. 12/2

Application: Highpass for DC noise measurements



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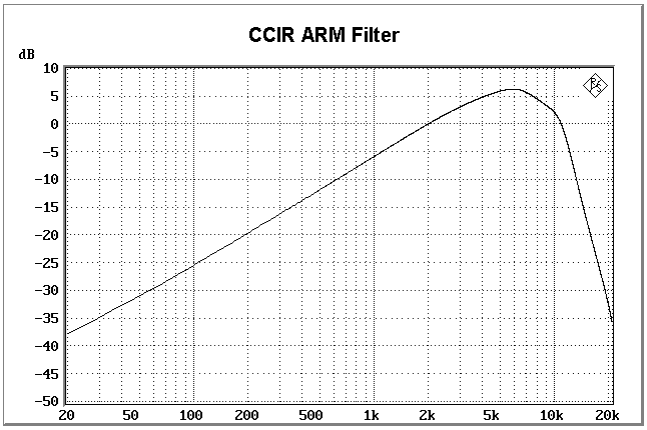
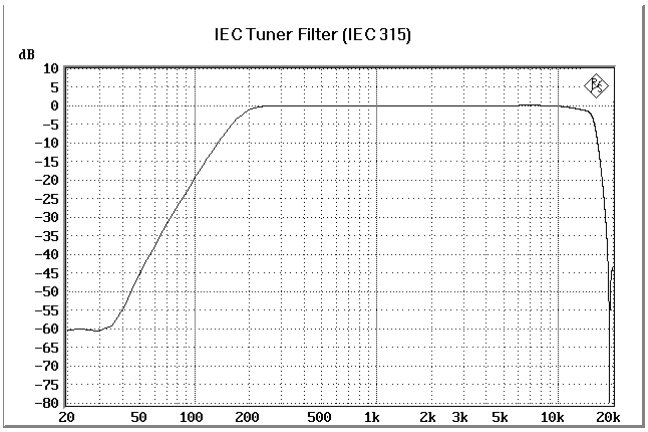
Filter: CCIR ARM

Standard(s): CCIR
DOLBY
NAB Standard



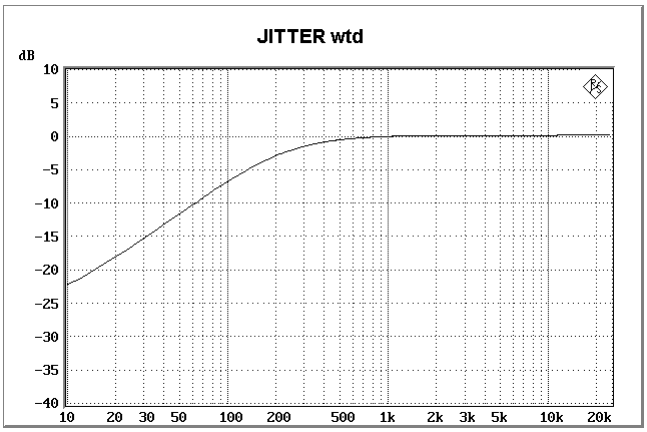
Filter: IEC Tuner
Standard: DIN/IEC 315

Application: Measurement on tuners



Filter JITTER wtd
Standard: AES 3

Application: Weighting of jitter transfer function



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2.7.2 Creating the User-definable Filters

The FILTER panel is made up of 9 filter items designated as FILTER 01 ... FILTER 09. Each filter item can be assigned a filter type LOW-PASS, HIGH-PASS, BAND-PASS, BAND-STOP, NOTCH, 1/3 OCT FLT, OCTAVE FLT, FILE-DEF, which are referred to below. Each filter type is predefined by its cutoff frequencies and the desired filter attenuation. After the filter has been calculated, further filter data (settling time, actual attenuation, stopband range, which are displayed in a different colour) are available in the FILTER panel.

There is also the possibility of reading in any desired filter by selecting ”FILE DEF”.

Any filter defined in the FILTER panel is provided with a short name, which is then used to call the filter in the ANALYZER panel. The short name refers to type and cutoff frequency of the filter.

The filters have been implemented as recursive filters (= IIR filters) with 8 poles.

The filters are defined in terms of their frequency limits, which is why the contents of the FILTER panel is independent of the selected ANALYZER instrument ANLG 25 kHz to DIG 768 kHz. Filter parameters which used to make sense for a certain instrument may be futile in combination with another instrument.

Example:
A lowpass with a cutoff frequency of 50 kHz is a commonly used filter with the ANALYZER instrument DIG 768kHz, however ineffective in the instrument DIG 48kHz.

For this reason, proceed in the following order when setting the filters:

1. Switch all filters in the ANALYZER panel off:
   Enter any desired filter parameters in the FILTER panel. The filter parameters are neither checked nor updated.
2. In the ANALYZER panel, select a filter from the FILTER panel: now, the parameters of the filters are checked:
   a) Valid filter parameters: filter is set
   b) Invalid filter parameters: error message on the screen, filter remains OFF
3. Try to modify in the FILTER panel filter parameters of a filter selected in the ANALYZER panel:
   A dialog window appears where you can enter the new filter parameters. When you press the O.K. key in the dialog window the filter parameters are checked.
   a) Valid filter parameters: filter is set
   b) Invalid filter parameters: error message on the screen, the dialog window remains open for further entry of filter parameters.

Exiting the filter dialog window using CANCEL or ESC causes

- the filter in the ANALYZER panel to be switched OFF.
- the most recently valid filter parameters to remain unchanged in the FILTER panel.

Note: *A type of filter can be repeatedly assigned with the same or different filter parameters to the 9 filter items!*
The sum frequency response of the set filters can be displayed with the help of the simulation (see FILTSIM function).
You can select the filters in the ANALYZER panel in any desired order. For reasons of stability, it is however useful to select the filter with the ”hardest” characteristics (eg very narrow bandstop filters) as the last one (below in the panel).
It is possible to superpose several filters of the same type and with equal filter parameters for one measurement function. To give an example, a very steep 80-dB lowpass (in this case, with 16 poles, yet double ripple in the passband range) can be realized by superposing two 40-dB lowpasses.

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2.7.2.1 Common Parameters of All Filters

Attenuat

(Attenuation). Specify the desired filter attenuation in dB (example: 40 dB). After the filter has been checked and set, the actually realized attenuation (usually higher) is entered. Filter attenuations can be implemented about every 10 dB.
Exception: The filter calculation file (see 2.7.2.6, Internal Calculation of Filters) has been modified.

Delay

(Read only)
Enter the estimated settling time of the filter in seconds.
This value is updated only when the filter is checked.
Exception: *File-defined filters. Subsequent to entry of the coefficients, the software calculates a delay and enters it in the menu line where it can be modified manually.*

Shortname

(Read only)
Specify a short name later used to call the filter in the ANALYZER panel. The short name is made up of an abbreviation (2 letters) for the filter type and the frequency (LP = lowpass, HP = highpass, BP = bandpass, BS = bandstop, TZ = terz filter, OC = octave filter, NO = notch filter). The frequency value is updated only when the filter is checked.

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2.7.2.2 Lowpass / Highpass

Filter

Select a lowpass or highpass.

LOW PASS

HIGH PASS

Order

Specifies the filter order

4
8

By reducing the filter order from 8 (standard) to 4, faster but less steep filters can be created. The order can be determined separately for each highpass or lowpass filter.

Passband

Specify the cutoff frequency of the passband range.

Stopband

(Read only). Display of the cutoff frequency of the stopband range, which is determined by the selected attenuation and passband range. This value is updated only when the filter is checked.

The base filters used have eight poles, 'elliptic C'-type to /SAAL 88/ with a ripple of 0.1 dB in the passband range.

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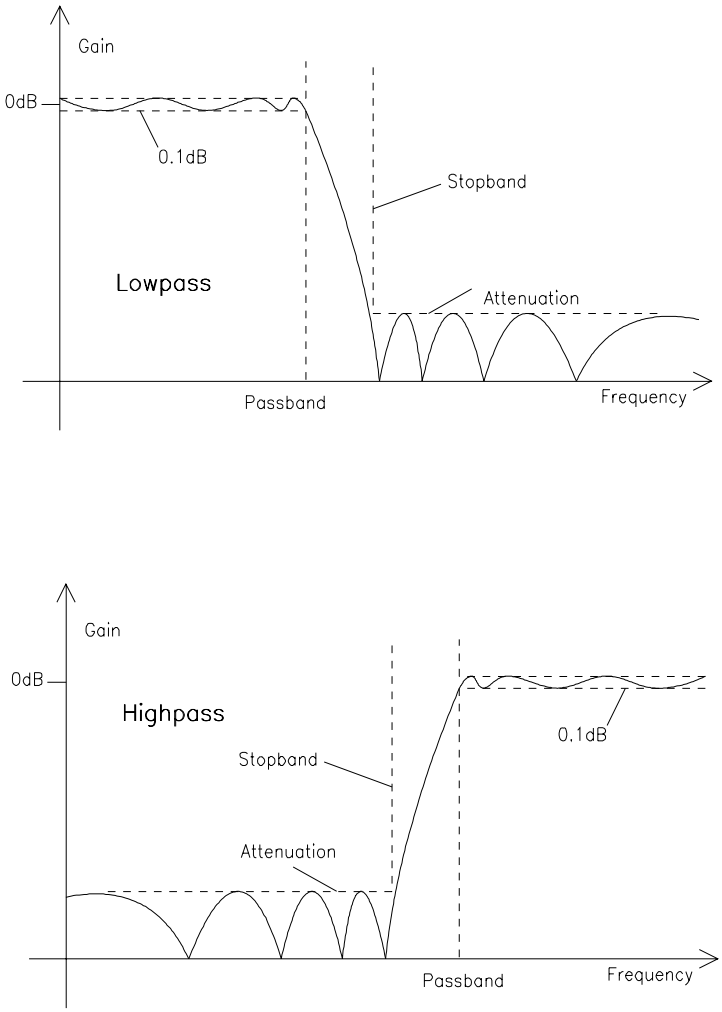

Fig. 2-45 LOW-PASS and HIGH-PASS frequency response together with filter parameters

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2.7.2.3 Bandpass / Bandstop

Filter

BAND PASS

BAND STOP

Passb Low

Enter the lower cutoff frequency of the passband range.

Passb Upp

Enter the upper cutoff frequency of the passband range.

Stopb Low

(Read only)
Display of the lower cutoff frequency of the stopband range, which is determined by the selection of attenuation and passband range. This value is updated only when the filter is checked.

Stopb Upp

(Read only)
Display of the upper cutoff frequency of the stopband range, which is determined by the selection of attenuation and passband range. This value is updated only when the filter is checked.

The base filters used have 4 poles, 'elliptic C'-type to /SAAL 88/ where one base filter is used for the upper and one for the lower filter edge. As 'elliptic C' has a pole at infinity, a bandstop of this type features a pole in the center between the two passband frequencies.

Values for Passbd low and Passbd upp which are close to each other cause long settling times during realization and the danger of limit cycles (oscillations of the filter on account of self-excitation induced by rounding noise). In this case, it is useful to simulate the filters before the measurement (see analyzer function FILTSIM).

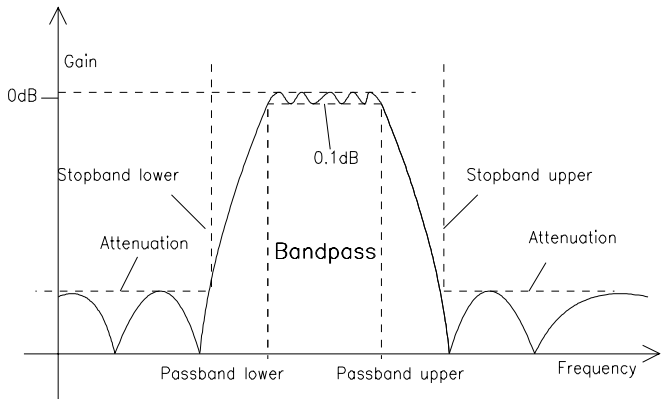

Fig. 2-46 BAND-PASS and BAND-STOP frequency response together with filter parameters

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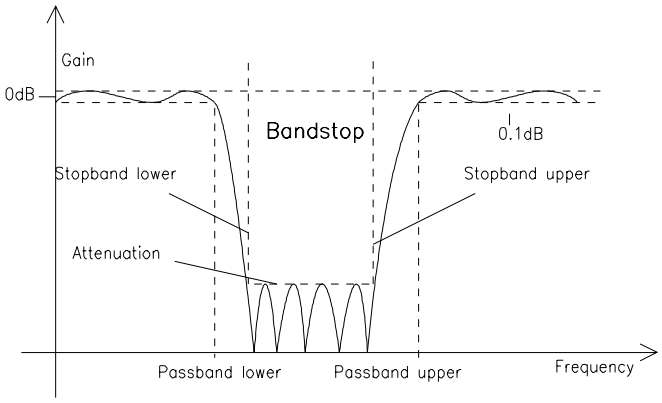

Fig. 2-47 BAND-STOP frequency response together with filter parameters

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2.7.2.4 Notch

Filter

NOTCH FLT

Center Freq

Enter the center frequency of the bandstop.

Width

Enter the difference between upper and lower cutoff frequency of the passband range.

Stopb Low

(Read only)
Display of the lower cutoff frequency of the stopband range, which is determined by the selection of attenuation and passband range. This value is updated only when the filter is checked.

Stopb Upp

(Read only)
Display of the upper cutoff frequency of the stopband range, which is determined by the selection of attenuation and passband range. This value is updated only when the filter is checked.

The base filters used have 4 poles, 'elliptic C'-type to /SAAL 88/ where one base filter is used for the upper and one for the lower filter edge. As 'elliptic C' has a pole at infinity, a bandstop of this type features an attenuation pole at the center frequency.
Use:
Attenuation of single frequencies in the signal.

Small values for "width" cause long settling times during realization and the danger of limit cycles (oscillations of the filter on account of self-excitation induced by rounding noise). In this case, it is useful to simulate the filters before the measurement (see analyzer function FILTSIM).

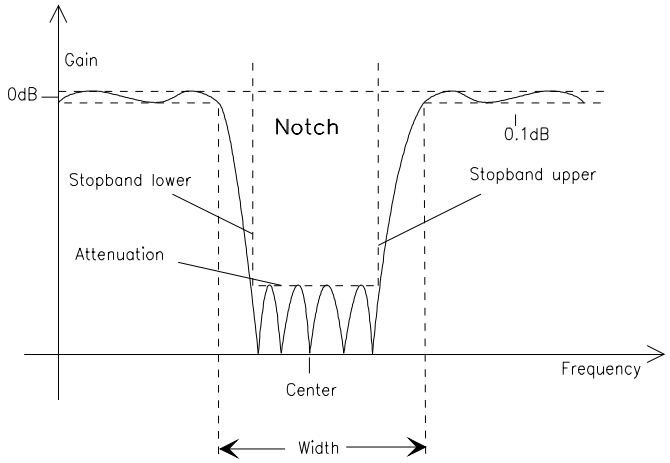

Fig. 2-48 Notch filter frequency response together with filter parameters

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2.7.2.5 Third-octave / Octave

FILTER

1/3 OCT FLT

OCTAVE FLT

(1/3 OCT FLT = 1/3 octave = TERZ)

Center Freq

Enter the center frequency of the bandstop.

Width

(Read only)
Enter the difference between upper and lower cutoff frequency of the passband range.

(Read only)
Display of the lower cutoff frequency of the stopband range, which is determined by the selection of attenuation and passband range. This value is updated only when the filter is checked.

(Read only)
Display of the upper cutoff frequency of the stopband range, which is determined by the selection of attenuation and passband range. This value is updated only when the filter is checked.

These filters have been implemented as bandpasses (see 2.7.2.3 Bandpass / Bandstop) which are geometrically symmetrical to the center frequency, thus allowing the passband cutoff frequencies to be calculated from the center frequency:

1/3 octave filter:	Passbd low	= Center Freq	/	1.12246
	Passbd upp	= Center Freq	x	1.12246
Octave filter:	Passbd low	= Center Freq	/	1.41421
	Passbd upp	= Center Freq	x	1.41421

Note: *For these filters the 0,1dB-bandwidth is reduced in order to obtain an attenuation of 3 dB at the cut-off frequencies. Hence the effective bandwidth is lower than the theoretical values of third octave and octave filters.*

theoretical bandwidth third octave: $\sqrt[6]{2} - \frac{1}{\sqrt[6]{2}} = 0.2315 = 23.15\%$

theoretical bandwidth octave: $\sqrt[2]{2} - \frac{1}{\sqrt[2]{2}} = \frac{1}{\sqrt{2}} = 0.7071 = 70{,}71\%$

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2.7.2.6 Internal Calculation of Filters

All filter parameters are transformed from the Z range (digital, sampled) to the S range (analog, continuous) using the sample rate valid for the respective instrument. In the S range, the filter parameters are normalized to a passband limit of 1.0. The filter suitable for this transformed filter with respect to the type (ie, elliptic C and eight-pole for highpasses and lowpasses and four-pole for bandpasses) and minimum desired attenuation is searched for in the filter data base. This filter is then denormalized and retransformed while the actual stopband and actual attenuation are being calculated.
This transformation is performed with the currently effective sample rate. The predefined cutoff frequencies are maintained, however different stopband frequencies will be obtained (depending on the selected sample rate). When the sample rate on which the calculation is based does not match the actual clock rate (e.g. in the case of a wrong entry), both passband frequency and stopband frequency are shifted.
After the start of the measurement (e.g. through a new setting, pressing of the START key or in the case of SWEEP), UPD waits for a certain settling time per filter before the actual signal integration. This settling time is calculated on the basis of the desired attenuation and the filter coefficients. If (in exceptional cases) the time calculated is too small, the filters have not completely settled at the start of the measurement.
To remedy this, the following trick is possible:
If the FILE_DEF filter ”DELAY.COE” is selected, a settling time can be entered there which is considered in addition to the normal settling time in the measurement. Filter DELAY.COE has no function otherwise.

The filter data base is filled with the filters in the 'ref_lp.rlp' file in the C:\UPD\REF directory on start of the system software.

The filters contained in this file are derived from /SAAL 88/. Their ripple in the passband range is 0.1 dB.

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2.7.2.7 File-defined Filter ("FILE-DEF")

For applications requiring additional filters which are not offered by the instrument, any desired filter can be read in from a file. The filter in the file must be an IIR filter with 8 poles/zeros. The filter must be designed (in the Z range, ie digital, sampled) with reference to the sample rate used in the respective ANALYZER instrument. Two data formats are supported:

a) Coefficient output file of FDAS, version 2.1 and 2.2. FDAS is a filter design program from the company of Momentum Data Systems. Select a cascade of biquads with 32-bit float number representation as implementation for generation of the filter with the help of FDAS.

   Example: see R&S_EXAM.COE file in the C:\UPD\USER directory

b) ASCII file where the poles and zeros (in the Z level) must be entered as floating numbers. 8 poles and zero positions (4 pairs) only are permissible. Unused poles and zeros must be shifted to the origin of the Z level.

   File format:

1st line:	Identification: 'pole zero file'
2nd line:	Key word 'gain' followed by a float number: specification of filter gain
following lines:	Key word 'pole' or 'zero' followed by real and imaginary part. Complex conjugate pairs must be consecutive and be at the 1st, 3rd, 5th or 7th position, respectively.

   The transfer function is given by:

$$S(z) = gain * \frac{\prod_{i=0}^{3} (z - z_{oi}) * (z - z_{oi}^*)}{\prod_{i=0}^{3} (z - z_{pi}) * (z - z_{pi}^*)}$$

   where S(z) is the normalized transfer function, z_0 are zeros and z_p are poles.

   The filter should be checked using the simulation.

   Comment lines are to begin with '#' and are permissible anywhere; no difference is made between upper-case and lower-case letters.

   Example: see EXAMPLE.ZPZ file in the C:\UPD\USER directory

Literature:

/SAAL88/: Rudolf Saal, Handbook of Filter Design, 2nd edition, Hüthig 1988

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2.8 STATUS Panel

Activating the STATUS panel:

UPD front panel: STATUS
External keyboard: ALT + S

The STATUS panel can be activated only in split-screen graphics mode (see 2.10.8 Switching between Full-screen and Split-screen Mode) and is always on the left side of the screen.

The STATUS panel displays only those command lines of a panel which have been ticked (select the position before the line using the tab ← keys, press SELECT, the tick is switched on and off (toggle function). The UPD thus offers the possibility of displaying a clearly structured excerpt from all settings on the left side of the screen.

Instead of using the other panels, the UPD can also be operated from the STATUS panel, allowing you to carry out constantly recurring operator sequences from one panel only. Use of the STATUS panel is especially advantageous for display and, if required, printout (see 2.14) of graphics on the right side together with the essential UPD settings on the left side of the screen.

Empty STATUS panel.
No command lines have
been ticked off.

```
STATUS

No commands selected!

Only commands which are
ticked off appear in
the STATUS-Panel.

For further information
press HELP!
```

Command lines in the GENERATOR,
ANALYZER and DISPLAY panel
have been ticked off.

```
STATUS

GENERATOR PANEL
≈Channel (s)      1
≈Output           UNBAL BNC
≈FUNCTION -       SINE
≈FREQUENCY        10.000 Hz
≈VOLTAGE          3.0000 V

ANALYZER PANEL
≈Channel (s)      1
≈CH1 Input        UNBAL BNC
≈FUNCTION -       RMS & S/N
≈Meas Time        AUTO FAST

DISPLAY PANEL
≈OPERATION        BARGRAPH
≈Unit             V
≈Spacing          LIN
```

Fig. 2-49

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2.9 Series of Measured Values, Files and Loadable Instrument Settings (FILE Panel)

The FILE panel is activated by pressing the FILE key (UPD front panel) or the key combination ”ALT F” (external keyboard). The FILE panel is always displayed on the left side of the screen.

2.9.1 Loading and Storing

Files can be stored to hard disk (drive C:) or diskette (drive A:, can also be addressed as ”B:”). All system files, and, in the default setting, the user files too, are available on hard disk. The user files can also be written to or read from diskette.

UPD system software updates are also loaded from diskette (see 1.3, Software Re-installation). For storing files on diskette, DOS- formatted 3.5” floppies are required. Unformatted disks can be formatted on operating system level using the command

```
FORMAT A:
```

An external keyboard is required for this purpose.

Insert the diskettes with the metal slider pointing to the front and the label to the left. The diskette is ejected by pressing the eject key.

On the left side of the diskette, there is a lockable write protection; the disk is write-protected when the hole is free.

The individual types of files are characterized by reserved file types (file extensions), which are listed in the table below. It also provides information on where, ie in which panel, the file is loaded.

Table 2-31

Extension	Meaning
.AES	Report information AES/EBU+S/P DIF
.BAT	Batch file for automatic execution of several programs; reserved (DOS)
.BPZ	Binary file with poles-zeros
.CAL	Calibration file; reserved for calibration factors
.COE	Coefficient file for filters (see 2.7.2.7)
.COM	Executable programs; (eg BIOSW.COM); reserved (DOS)
.DWL	Dwell time for automatic generator sweeps: loaded in the GENERATOR panel, menu item ”Dwell List”
.ERR	Error file for limit violations loaded in the DISPLAY panel by selecting Trace A/B→FILE; OPERATION→LIM REPORT;
.LOG	Prolog and epilog for HPGL (see 2.14 Printing / Plotting)
.PLT	Colour palette information for PCX and printer (see 2.14 Printing / Plotting)

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Extension	Meaning
.EXE	Executable programs; (eg UPD_UI.EXE); reserved (DOS)
.FTF	Amplitude/Frequency table for generation of noise in the frequency domain (see 2.5.4.11)
.GL	Screen Copy (HPGL format) is generated in the UPD for subsequent output to a HPGL printer
.HLP	Help file
.LLW	Limit curve (LOWER) loaded in the DISPLAY panel under the heading LIMIT CHECK, ”Lim, Lower” menu item ”File name”
.LUP	Limit curve (UPPER) loaded in the DISPLAY panel under the heading LIMIT CHECK, ”Lim, Upper” menu item ”File name”
.NPZ	reserved for filters
.NRM	Normalization file reserved for filters
.OUT	DSP files reserved for programs to be down-loaded to the DSPs
.PAC	Report analysis (AES/EBU, S/P DIF), screen control file for channel status data
.PAU	Report analysis (AES/EBU, S/P DIF), screen control file for channel status data
.PCX	Screen Hard Copy (Destin PCX file) generated in the UPD to be copied to other programs
.PGC	Report generation (AES/EBU, S/P DIF), user data, file for channel status data
.PGU	Report generation (AES/EBU, S/P DIF), user data, file for channel status data
.PPC	Report generation (AES/EBU, S/P DIF), user data, file for definable report panel
.RLP	Reference lowpass (reserved for filters, see 2.7.2.7)
.SAC	Partial setup; loaded in the file panel under the heading LOAD INSTRUMENT, menu item Mode→ACT SETUP
.SCO	Setup; loaded in the FILE panel under the heading LOAD INSTRUMENT, menu item Mode→COMPL SETUP
.SPV	Sweep list for generator voltage loaded in the GENERATOR panel, menu item VOLTAGE or TOTAL VOLT (depending on the function) for X- or Z-axis sweep
.SPF	Sweep list for frequency of the generator or selective rms measurement; loaded in the GENERATOR panel, menu item FREQUENCY, MEAN FREQ or in the ANALYZER panel, menu item ”File name” for X- or Z-axis sweep
.SPO	Sweep list for burst duration loaded in the GENERATOR panel, menu item ”ON-TIME” for X- or Z-axis sweep
.SPI	Sweep list for burst interval loaded in the GENERATOR panel, menu item ”INTERVAL” for X- or Z-axis sweep
.TRC	Trace lists for recording of measured values loaded in the DISPLAY panel by selecting Trace A/B→FILE
.TTF	Time table for generation of arbitrary signals (see 2.5.4.12)
.VEQ	Equalizer file loaded in the GENERATOR panel, menu item ”Equal File” or as RANDOM Freq-File
.ZPZ	Pole-zero file reserved for filters
.CFG	File with instructions for specific work lists

Note: *Reserved files must not be changed or renamed.*

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2.9.1.1 Loading and Storing Default Setups and Complete Setups

Setups are loaded and stored by entering a file name under the menu item "File name". If the desired file name is already in the menu line, it is sufficient to open and close the appertaining selection box. (see 2.3.2 Data Entry).

LOAD INSTRUMENT STATE Loading an instrument setup

An instrument state can be loaded either user-defined or with reference to an application. The untrained user is advised to start with the application level which provides a great number of predefined measurement setups. The default setup or user-defined setups can only be loaded via USER DEF.

Applicat

Permits the instrument to be preset according to the application.

USER DEF

Instrument setup according to user-defined measurement or instrument presettings.

Setups stored under a user-defined name can be explicitly loaded by selecting the respective item.

Note: *USER DEF must also be selected when the default setup is loaded or a PCX picture should be displayed. (See next menu line).*

ANLG – ANLG
ANLG – DIGI
DIGI – ANLG
DIGI – DIGI

Instrument setup depending on the domain (analog or digital) selected for generator and analyzer and on the measurement to be performed. The first word denotes the generator domain, the second the analyzer domain.

After selecting one of these items, the application can be selected in a special dialog box of the next menu line (Measuring).

ACTUAL setups are used for these measurements, which are stored in the UPD directories SETEXAM \ AA to SETEXAM \ DD and assigned a 40-character info text describing the application. The setups are sorted in alphabetical order according to this info text.

The setups can of course also be directly accessed (under USER DEF). The experienced user is free to adapt the files and/or their info text to specific requirements or to extend the directories by adding own SAC setups.

Notes:

- *To use this application level the EXAMPLE/SETUP floppy must be installed.*
- *Upon new installation of the EXAMPLE/SETUP floppy, all application setups are updated. For this reason modified setups should be stored under another file name.*

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Mode

Select the setup to be loaded.

DEFAULT

(Default setup)
The Rohde&Schwarz *default* setup (see **3.5**) is loaded.
The setup also includes all latent (ie presently inactive) functions and instruments. A change of this setup is not recommended but possible by overwriting the DEFAULT-SET file with a setup stored in the COMPL SETUP mode.

COMPLETE

(Complete setup)

The *complete* instrument setup is loaded.
This setup includes also all latent (ie presently inactive) functions and instruments as well as all comments that can be entered in the hardcopy(see **3.6.6 Output Unit**).
Under this item only c**omplete setups** (with any file extension, eg also *.SET) can be loaded.

ACTUAL

(Actual setup)
The *current* instrument setup (with or without measured values and curves) is loaded. Loading such a setup does *not* influence the currently inactive instruments and functions.
Under this item only "**Actual Setups**" and "**Actual +Data Setups**" **actual setups** (with any file extension) can be loaded. ;
the latter contain additionally measured values and measured curves and therefore require a longer total loading time especially when the curves have to be displayed.

SETUP

An instrument setup is loaded. The setup type (actual or complete) can be identified by means of the file extension.
Under this item any setup with the file extension ***.SAC or *.SCO** can be loaded; other extensions are not permissible.

VIEW PCX

This item allows the display of (4-bit) PCX pictures on a 1:1 scale. PCX files recorded in the UPD can thus be subsequently displayed on the UPD.
The PCX picture is displayed until any key is pressed.

Note: *The PCX pictures do not contain softkeys. The current (unlabelled) softkeys are therefore displayed.*

Measuring

(available only when Applicat USER DEF is *not* selected). Opens a dialog box where the measurements pertaining to the selected application are listed in alphabetical order. The name of the (SAC) file loaded when a measurement is selected is indicated in addition. From this information the experienced user can see the files to be modified to suit his specific requirements.

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STORE INSTRUMENT STATE Storing an instrument setup

Mode

Select the setup to be stored.

COMPLETE

(Complete setup)

The *complete* instrument setup is stored.
It includes all latent (ie currently not active) functions and instruments as well as the comment entered when a printout is made (see 2.14.1 Screen copy). A file with the extension ".SCO" occupies about 80 Kbytes of mass storage.

ACTUAL

(Actual Setup)
The *current* setup is stored. It includes only the currently active instruments and function. A file (with the extension ".SAC") occupies about 8 Kbytes of mass storage.

ACTUAL+DATA

(Actual setup including data)
The current instrument setup *including measured values and curves* is stored. The memory required by these setups depends on the size of the active traces.
The measurement or the sweep should be "TERMINATED" before storing to ensure that valid measurement results are available.
If only measured *values* (without curves) should be stored, the traces must be switched OFF in the DISPLAY panel.

Note: *If valid measurement **curves** are available, this type of setting takes up much more memory space (up to several 100 Kbyte) and requires longer loading times than actual setups. For this reason it should only be used where the curves are really needed.*

When loading a new instrument setup, the former setting is overwritten. All lists (equalizer, limits, etc.) are filled with files the names of which are contained in the new setup. If a file cannot be loaded (eg the specified equalizer file has been cleared in the meantime), an error message is generated and the error source is displayed as file name in the menu line.

Note: *When loading setups, their file names may not exist (eg because they have been deleted in the meantime or the setup has been adopted from another UPD). In such cases, the cause of the error (usually "not found") is stated below the respective entry (eg "File name").*

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Attrib

(Attributes)
For storing only.

READ ONLY

The stored file is write-protected.

READ/WRITE

The stored file can be deleted or overwritten.

Deleting a write-protected file requires the R-attribute to be deleted using the DOS command ATTRIB on operating system level.
Syntax: `ATTRIB -R file name`
The use of an external keyboard is necessary for this purpose. We therefore recommend that the write protection be used only when a setup is not to be changed any more.

Info Disp

(Info display), displayed when a setup is *loaded* (LOAD INSTRUMENT STATE).

A comment of max. 39 characters describing the measurement task, the DUT or the like, may be entered for each setup under the menu item Info Text in the FILE panel. This comment can be displayed via the file selection window so that the purpose of a selected setup is known *before* the setup is loaded.

OFF

The "info text" of a selected setup is not displayed, scrolling through the file selection window is possible at maximum speed.

Note *The info display should be switched off when a floppy is accessed (drive A), because the long times required for opening floppy files would considerably slow down scrolling in the file selection window.*

ON

The info text of a selected setup is displayed in the user guide line. This slightly slows down scrolling in the file selection window as the info text of each setup has to be read out.

Info Text

Specified when the setup is *stored* (STORE INSTRUMENT STATE).

Entry of a comment of max. 39 characters describing the measurement task, the DUT or the like. This comment can be displayed via the file selection window when the setup is *loaded.* (see "Info disp").

Filename

Causes a file with the specified file name to be loaded or stored.

If the file cannot be opened, an error message and "not found" is entered in the menu line.

For entering file names see 2.3.2.5.

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2.9.1.2 Loading and Storing Series of Measured Values and Block/List Data

Series of data from recorded sweeps or FFT, waveform or filter-simulation data can be stored in files for several purposes:

- To load them at a later date as a record, for the purpose of comparison or subsequent processing. The series of measured values are loaded using the DISPLAY panel commands and are displayed in the form they were stored. They can however be provided with a different scaling or converted into other units.
- The files can be called from other programs and their data further processed. This is best be done using the EXPORT or ASCII format. The structure of an ASCII file is shown in some examples (R&S_EXAM.TRC in the C:\UPD\USER directory) which are provided with detailed comments. For more detailed descriptions refer to section 2.9.1.3 Format of Block/Listen Data. The EXPORT format has neither a header nor a supplement and can therefore be directly imported into other programs. Since it has no additional information it cannot be loaded in UPL / UPD.
- Stored traces can be used in the UPD for several purposes: As reference traces for other traces if the results are displayed in relative units. For this, the stored traces are loaded by means of FILE under Reference in the DISPLAY panel. Moreover, the trace files can be used to provide equalization data for the generator.

The data are stored in files using commands in the FILE panel (also see 2.3.2.5, Entry of File Names). A series of measured values (Y or Y2) and its associated X-axis values are stored by means of Store TRACE A or TRACE B. If a variable reference value (ie a reference value as a function of the X axis) and a relative unit (ie a unit needing a reference) are active, the reference values too are stored in the file. If a Z-axis sweep is selected in the generator, the Z-axis values too are stored. The entire scaling information as well as the function labelling are appended in coded form. If User Label is switched to on in the DISPLAY panel, user-defined function labels and units are also stored.

With command Store TRACE A + B, the data of the second series (trace B with the scaling of Y2) are stored, too, with their associated reference values. The corresponding format can be loaded as a dual trace by means of DUAL FILE in the DISPLAY panel. If Scan count >1 in the DISPLAY panel is active, which is always the case with Z-axis sweeps, the above series of measured values are stored not as one but as several scans (see 2.9.3.3, Scan count >1). Scan groups too can be loaded from the DISPLAY panel as a unit (see 2.9.3.3, Scan count >1).

The files are loaded for the functions they are needed. In the GENERATOR panel, for example, the sweep, dwell, and equalization files are loaded. Sweep and dwell files are also used in the analyzer mode for selective rms measurements. In the DISPLAY panel, traces (from sweeps or FFTs), reference traces (for sweeps) and limit-value files are loaded.

All measured values are stored with their basic units: levels in V, frequencies in Hz, times in s, phases in degrees, related quantities in %. Notice that S/N data - such as S/N levels - have to be indicated in positive dB values. Ie, 0 dB are 100%, 20 dB are 1000%, the number value being 1000.

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Storing traces and sweep lists

Store TRACE/LIST

During a sweep, various buffers are created for sweep parameters, measured values, limit violations and waiting times, if any. This menu item serves to select which one of these buffers is to be stored.

TRACE A
TRACE B

Store the TRACE A or the TRACE B buffer; (specify in the DISPLAY panel which measured values are to be collected in which trace buffer) (see 2.10.1, Parameters for Display of Traces and Spectra). In addition to the trace data, the values of the appropriate X axis as well as the values for scaling from the display panel are stored to permit the curve to be displayed as it was scaled in storing.
If a variable reference and a relative unit are used, the corresponding reference trace is stored too. If Scan count >1 is selected in the DISPLAY panel, a group of traces, or pair of traces, determined by Scan count is stored in the file (with reference traces, if applicable).

TRACE A+B

A pair of traces (or a group of trace pairs if Scan count is set to >1) is stored in a file. The pair(s) of traces can be loaded as a unit by means of DUAL FILE under TRACE A.

X AXIS

Note:

When traces are stored, the X axis, and in the case of a 2-dimensional sweep the Z axis, are stored as well.
*For assignment to the sweep parameter see "X Axis" and "Z Axis" in the GENERATOR panel (see **2.5.4.2 Sweeps**).*
*The list formats (file types) can be seen in the table of section **2.9.1**.*

Store the list with the sweep points for the sweep parameter lying on the X axis (for generation of lists used in the list sweep).
For the generation of a sweep list, proceed as follows:

GENERATOR panel

- Activate the sweep system (”Sweep Ctrl → AUTO SWEEP”)
- Set the X axis to the desired parameter (eg FREQ for the frequency sweep list)
- Select the start and stop values as well as spacing of the desired parameter (recommended: LIN POINTS or LOG POINTS)
- Enter the number of sweep points, which determine the number of entries in the sweep list generated later.
- To avoid the generator waiting for the synchronization with the analyzer, select "Next stop → DWELL" and a short "Dwell".

Start the sweep by pressing the START key. When the sweep enters the SWP ... RUNNING state, the sweep list is available; the sweep can be aborted.
Generating or modifying sweep lists is also possible using a text editor (e. g. EDIT from DOS).

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Store

Z AXIS

Store the list with the sweep points for the sweep parameter lying on the Z axis (with two-dimensional sweep only, for generation of lists used in the list sweep).

For generation of the Z-sweep list, it is advisable to proceed as described under generation of the above-mentioned X list, however, set the values for the Z axis in the generator panel.

Generating or modifying sweep lists is also possible using a text editor (eg EDIT from DOS).

DWELL VALUE

For sweeps with time synchronization only; store the buffer for the dwell time. The time data are obtained either from a file (with list sweep) or they are all equal (with Next Step Dwell). The dwell time or the file name for the active dwell list is entered in menu item ”Dwell” or ”Dwell List” in the GENERATOR panel (see 2.5.4.2 Sweeps).

LIM UPPER
LIM LOWER

The upper or lower limit curve (tolerance mask) is stored to file.

When a limit curve is loaded as described in Section 2.10.7 Limit Check, a list including all interpolated X-Y pairs is output.

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Store

EQUALIZATN

(Equalization)
Special case: store the frequency response of a device under test, eg, as equalization file, which can then be read in for frequency-response compensation purposes

- in a sweep with a generator sinewave signal under menu item ”Equal. file” in the GENERATOR panel
- or as generator RANDOM function with Domain FREQ and Equaliz FILE.

For this purpose, the inverse frequency response normalized at any frequency can be stored (see menu item Norm Freq or Invert 1/n). The measurement data (frequency response) must be provided in one of the trace buffers, which can be selected under menu item "Volt sourc".

For generation of an equalization file, proceed as follows:
Connect the DUT to channel 1 and select this input/output in the generator and the analyzer. The generator is set to a frequency sweep using „FUNCTION → SINE“ (cf. 2.5.4.2 Sweeps). In the analyzer, the swept voltage of the DUT is determined using the function RMS & S/N. Entry of TRACE A → FUNC CH1 in the DISPLAY panel fills the trace buffer A, which is then referred to as data source for the equalization file using the command Voltsource →TRACE A described below. Prior to storing the equalization file by entry of file name, the user should enter a standard frequency (eg, 1 kHz) and Invert 1/n → ON.

Data obtained by filter simulation can also be converted into an equalization file. To this end select the function → FILTERSIM and set TRACE A → FUNC CH1 in the DISPLAY panel. In contrast to the above-mentioned file-generation, neither a sweep must be performed nor the DUT connected.

LIM REPORT

(Limit Report)
Stores the list of limit violations. With sweeps and FFT, 0, 1, 2 or 3 is entered in this "error report". To interpret this code refer to the explanations below. Limit values or limit curves are indicated in the DISPLAY panel under the menu items "Lim upper" and "Lim lower" (see **2.10.7 Limit Check**).

Re LIM REPORT
Interpretation of limit report file:

The limit report list is organized like the contents of a limit file (see **2.9.1.4 Editing Limit Files**) and contains the information
0, 1, 2 or 3 for each frequency.
0: No limit violation
1: A value or trace defined in the DISPLAY panel as `MODE = LIM UPPER` was **exceeded** by a sweep or FFT curve
If several sweep or FFT curves are displayed, eg
- one curve on Trace A and one on Trace B, with `CHECK = TRACE A+B` selected in the DISPLAY panel,
- or several sweep scans are set in the DISPLAY panel,

the curve has exceeded the upper limit.

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2: A value or trace has fallen below the value defined as `MODE = LIM LOWER`.
If more than one sweep or FFT traces are displayed, one of the traces is below the lower limit.

3: If the "Lim lower" and the "Lim upper" value or trace (`Mode = LIM LOW&UP`)
are simultaneously displayed and more than one sweep curve is displayed, eg
- one curve on Trace A and one on Trace B with `CHECK = TRACE A+B` selected in the DISPLAY panel,
- or several sweep scans are set in the DISPLAY panel,

3 indicates that a sweep curve is **below** the lower limit and that **at the same** time another sweep curve has **exceeded** the upper limit.
3 cannot be indicated for FFT curves as the limit check for `TRACE A+B` **cannot** be performed simultaneously.

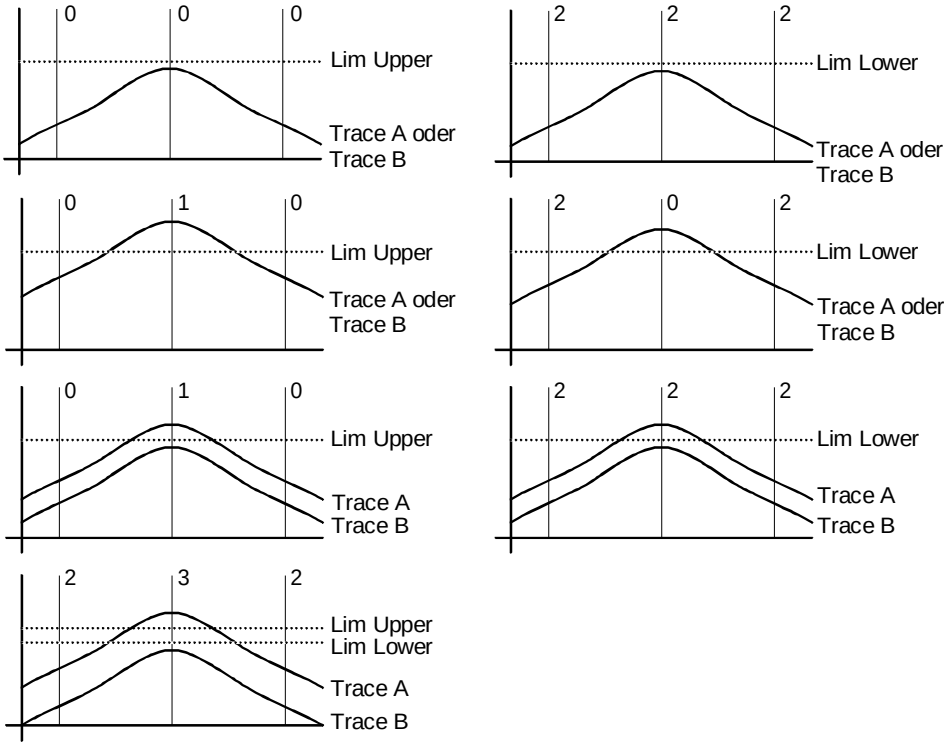

Fig. 2- xx Examples of codes used for limit violations

In the event that in the FILE panel

```
┌──────── FILE ─────────┐
│STORE TRACE/LIST       │
│Store       LIM REPORT │
│Format      ASCII      │ or REAL
```

`Format = ASCII` has been selected, 0, 1, 2 or 3 are stored as ASCII values, for
`Format = REAL` the codes are stored as binary values (4 bytes each) to IEEE standard.

The X values, for which a limit violation has been detected, are identified by a comparison of the trace file and the LIM REPORT file (SCPI does not allow for a more convenient solution:

Limit report for sweep traces:

The sweep trace used for the limit check is selected in the DISPLAY panel as follows:

```
┌──────── DISPLAY ──────┐
│LIMIT CHECK ---------- │
│CHECK       TRACE A    │ or TRACE B or TRACE A+B
```

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Note:

> `CHECK = TRACE A+B` *in conjunction with a limit violation can only be set for sweep traces (not for FFT traces) if* `Scale B = EQUAL A` *has been selected for* `TRACE B` *(the scale of Trace A is also used for Trace B).*

To view the limit violations, select

```
DISPLAY
OPERATION SWP LIM REP
```

.

Only limit violations will be displayed.

To determine the X values at which limit violations occurred, the trace file has to be generated to allow a comparison of the trace file and the LIM REPORT file:

```
FILE
STORE TRACE/LIST
Store      TRACE A      or TRACE B
Filename   XXX.TRC
```

In contrast to the display where only limit violations are shown when `OPERATION = SWP LIM REP` has been selected, the trace file contains **all** sweep points.

Example:

Contents of trace file

```
213
2
10
1     } see 2.9.1.3 File head
10
0
0
#--X---------Y ----
100         0.1138
166.81      0.2326
278.265     0.4104
464.159     0.6457
774.264     0.8959
1291.55     1.0891
2154.44     1.1521
3593.81     1.1058
5994.84     0.9271
10000       0.6069
```

The data following here are irrelevant for viewing the LIM REPORT file and have therefore been omitted!

Contents of LIM REPORT file

```
213
2
9
1     } see 2.9.1.3 File head
10
0
0

0
0
0
0
0     } Limit report
1
1
1
1
0
```

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Limit report for FFT curves:

The FFT curve used for the limit check is selected in the DISPLAY panel as follows:

```
┌──────── DISPLAY ─────────┐
│LIMIT CHECK ------------  │
│CHECK       TRACE A       │ or TRACE B
```

Note:

*Limit violations of FFT curves can only be checked for TRACE A **or** TRACE B. TRACE A+B cannot be selected!*

To view the limit violations in the display, select

```
┌──────── DISPLAY ─────────┐
│ OPERATION SPC LIM REP    │
```

Only limit violations will be displayed on the screen.

To determine the X values at which a limit violation occurred, the trace file has to be generated to allow a comparison of the trace file and the LIM REPORT file:

```
┌──────── FILE ────────────┐
│ STORE TRACE/LIST         │
│ Store      TRACE A       │or TRACE B
│ Filename   XXX.TRC       │
```

Note:

*In contrast to the sweep trace, **only** the limit violations are stored for an FFT trace in the trace file. Therefore, when a suitable "Lim upper" value is selected, the noise floor of the FFT can be suppressed and the data volume reduced.*

Example:

Contents of trace file

```
213 ⎫
2   ⎪
76  ⎪
1   ⎬ see 2.9.1.3 File head
3   ⎪
0   ⎪
0   ⎭
#--X---------Y-----     →
9984.38     0.5991      →
9996.09     0.9714      →
10007.8     0.8815
```

The data following here are irrelevant for viewing the LIM REPORT file and have therefore been omitted.

Contents of LIM REPORT file

```
213⎫
2  ⎪
9  ⎪
1  ⎬ see 2.9.1.3 File head
3  ⎪
0  ⎪
0  ⎭

1 ⎫
1 ⎬ Limit Report
1 ⎭
```

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Format

Selection of file format used for storing. (The format need not be specified for loading as UPL / UPD automatically identifies the stored format).

REAL

Data are stored in binary form and assigned the basic unit. (File extension: .TRC)
Advantage: fast access when loading the data into UPL / UPD, short files.
Disadvantage: this format cannot be read by the user.

ASCII

Data are stored in ASCII format and assigned the basic unit. (File extension: .TRC)
Advantage: data can be read and processed by UPL / UPD and by any text editor or other program.
Disadvantage: when reading data into external programs, the auxiliary information has to be removed and numeric results may have to be converted from the basic unit to the required unit.

EXPORT

Data are stored as plain text in tabulated form without auxiliary information. (File extension: .EXP)
Trace data are indicated with the unit used in the graphics display (display: numeric value with unit), reference data with the basic unit (display: numeric value without unit). The columns are separated by tab stops; headers (before each new scan) always start with '#'.
Advantage: the data can be read and processed without any problem by any text editor or other program. Data need not be converted.
Disadvantage: EXP files cannot be read by UPL / UPD because the auxiliary information has been removed.

Voltsource

For Store → EQUALIZATN only.

TRACE A
TRACE B

The trace buffer specified here must be the one containing the measurement data; the ANALYZER and DISPLAY panels must be appropriately configured (see "Store → EQUALIZATN").

The voltage data are read from the trace buffer A/B.

Normfreq

For Store → EQUALIZATN only.

Specify the frequency on the voltage value of which is normalized. Selecting the frequency at which the frequency response curve has its maximum means that the equalization file contains values from 0 to 1 only. If any other frequency is selected, factors higher than 1 occur.

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Invert1/n

ON
OFF

For Store → EQUALIZATN only.

Inverting the frequency response causes, with the equalizer switched on, the device under test to get an equalized frequency response. Application: constant outgoing power (independent of frequency response), pre-/ deemphasis

The equalization curve is stored in inverted form.
The equalization file is not inverted.

Filename

Causes the trace or list to be stored under the specified file name.

If the file cannot be opened, an error message and ”not found” is displayed in the menu line.

For entering file names, see 2.3.2.5.

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2.9.1.3 Format of Block/List Files

Overview

The following text describes the format of the Trace/List files, as it is used internally for storage of measured values and sweep, dwell, equalization and limit lists. This is of interest for the user only, if he wants to copy values into other programs, edit files or create new files for internal use. The subsequent description is intended to offer support in this case. You may additionally refer to the supplied example files (R&S_EXAM.*) in the directory \UPD\USER. These ASCII files contain comments and some of them are even available in various versions (eg, R&S_EXAM.TRC, R&S_E209.TRC, R&S_E212.TRC).

Numeric data formats (ASCII and REAL)

All values are stored with their basic units. Physically useful values have an exponent between E 6 (120 dB or mega) and E-12 (-240 dB or pico). (They are converted with the units set for curve representation).

In contrast to that, with limit files the numbers are interpreted as factors to the reference value (see 2.10.7, Limit Check).

Notice in advance the description of the differences between the REAL format (binary according to 4-byte IEEE Standard) and the readable ASCII notation. The advantage of the first format is the compact setup and fast access, since the numbers do not have to be converted. However, the user normally prefers using the ASCII format which is easier to handle.

In the REAL format, the numbers are not separated by a separator and they are arranged in successive blocks, eg, all X values first, succeeded by the Y values. With multiscan data (see 2.9.3.3, Group of Curves) the X values then come again, followed by the Y values etc.

In the ASCII format, all data of an index are arranged in a printable line, the data are separated by a space character and the line is terminated by carriage return / line feed (called CR/LF in the following). Multiscan data are also arranged successively, in this format.

Up to version 211 of the file format, the ASCII numbers like the REAL numbers were arranged in blocks and all numbers were separated by CR/LF. If the previous format is continued to be used for compatibility reasons, it can be generated by setting a call parameter. This parameter is -o8 and must be inserted in the AUTOEXEC.BAT subsequent to the line containing the UPD(.bat) call using an editor at the DOS level.

Setup

Explanation of the file setup can be most clearly arranged in simplified Backus-Nauer form. The meaning of each individual line is explained in detail in the following.

```
file := header_struct, trace [,info_struct]

        trace := scan | multiscan | fft_scan

                fft_scan := y_block, x_def [, y2_block]
                multiscan := scan 0, count 1, scan 1 [, count n, scan n]....
                scan := ascii_scan | real_scan

                        ascii_scan := ascii_sample 0,  [, ascii_sample n ]...
                                ascii_sample := x, [, y [, ref] [, y2 [, ref2] ] ], „CR/LF“

                real_scan := y_block [, x_block [, ref_block] [, y2_block [, ref2_block] ] ]
```

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x_block, y_block, ref_block, y2_block and ref2_block are blocks of REAL (IEEE 4- byte float). With fft_scan, y_block and y2_block may also be ASCII numbers separated by CR/LF.

x, y, ref, y2, ref2 are numbers in the ASCII notation, separated by spaces. CR/LF is appended to ascii_sample.

The ASCII format allows for inserting comments. They begin with '#' character and are terminated by subsequent CR/LF. Maximum 80 characters are permitted.

File

The first line explains that a trace/list file always consists of a header_struct and a trace of numbers, followed by an info structure, if desired. In the following, an individual chapter is dedicated to each of the above-mentioned key-words.

File header (header_struct)

The header is always stored in the ASCII format and contains 7 integers (16-bit integer) with the following meaning:

```
213  # version of fileformat this file is built with
0    # format: 0 for ASCII, first all y values then all x values
#               1 for binary (ieee float), successive blocks like format 0
#               2 for ASCII, pairs of values, first y then x values
1131 # mode:    16 bit integer consisting of
#               3 bits (LSBits) comb: 1 for y only, 2 for x+y, 3 for x+y+z,
#               DSP data: 4 for fft, 5 for waveform, 6 for filtsim
#               1 bit new: true since sw vers 2.09
#               2 bits dual: 0:for mono, 1:dual with equal scale,
#                            2:dual with 2 scales
#               2 bits multi: 0:single, 1:multi scan ( 2, 3 unused )
#               2 bits ref_trc_a: 0 no reference or value
#                                 1: reference trace on file
#                                 2, 3 unused
#               2 bits ref_trc_b: like ref_trc_a
#               4 bits (MSBits) reserved
3    # scan count (of first scan if multi scan)
5    # count of entries for scan 1
1    # x scale: 0 for lin, 1 for log
0    # y scale: 0 for lin, 1 for log
```

- The first number contains the version number of the file format. All previous formats can be read from an updated software version but not vice versa, which is why an update of the instrument software is advisable.

- The second number indicates the format. 0 means an earlier ASCII format, which contained the figures in successive blocks similar to the sequence used by the REAL format. A detailed description is not given at this place. - 1 means that the following numbers are given in the REAL format. 2 stands for the described ASCII format with Y and X values arranged in pairs.

- With the third number, each bits is assigned a meaning:

  Bits 0 to 2 explain the data structure.

  Value

  1 stands for a one-dimensional row (eg, sweep-list),

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2 for two dimensions (eg X and Y data),

3 for three dimensions (generally multiscan data with Z axis),

4 indicates two-dimensional data with fixed X values (given by start and delta values), generally FFT data

5 same as 4, but for waveform data and

6 for filter simulation data.

Bit 3 is always set to one starting with version 209 and indicates that the subsequent data are also defined in the data structure described here.

Bits 4 and 5 indicate whether the trace is a mono trace (0) or a dual trace (1).

Bits 6 and 7 indicate single scan(0), multiscan (1), or multiscan with Z sweep (2).

Bits 8 and 9 indicate whether the Y axis contains a reference value (1) (thus, Y data consist of 2 numbers) or not. If not, these bits are set 0.

Bits 10 and 11 have a similar meaning as bits 8 and 9, however, they refer to the second Y value (y2) with dual trace.

The remaining four bits have been reserved for extensions.

- The fourth number indicates Scan Count, the number of scans contained in this file.
- The fifth number represents the maximum index + 1, ie, the number of x (or y, ref , y2, ref2) samples of a scan.

  Note that, with multiscan, each scan may consist of a different amount of X-Y data (eg, with external sweep) which is why the current number of the following values is indicated before each new scan.

- The sixth number is a 0, if the X axis interpreted to be linear, 1 stands for logarithmic scaling. The interpolation of intermediate values of limit curves, which are neither horizontal nor vertical, uses this information for the X and the Y direction. For a correct graphics display it is important for the file entries to be consistent with the actual scaling as in the display the samples are linked by straight lines. If the values are not identical, "bent" (elliptic) curve segments are obtained in the calculation. Since elliptic segments are not drawn they cannot be identified.

- The seventh number is similar to the sixth but refers to the Y axis.

Trace

The header, especially the third number specifies how to interpret the subsequent trace.

- One-dimensional

The group of one-dimensional traces/lists (eg, frequency list of a sweep) is simply a sequence of numbers, which is separated in the ASCII notation by CR/LF and directly successive in the REAL format. Bits 0 to 2 of the third number in the header are assigned the value 1.

• Two-dimensional

The significant group of two-dimensional data (eg, dwell, equalization, limit) contains pairs of numbers in the ASCII format
x_0 y_0 CR/LF
x_1 y_1 CR/LF
x_2 y_2 CR/LF etc.,
x being the independent and y the dependent value.

The sequence in the REAL format is x_0 x_1 x_2 .... y_0 y_1 y_2....This pattern applies always which is why it is not indicated with each of the subsequent items.

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Bits 0 to 2 of the third number of the header assume the value 2, ie, sample and scan are defined as follows:
ascii_sample = x, y
scan = $sample_0$ [, $sample_n$]...
real_scan = x_block, y_block

- Two-dimensional with reference value

Mono traces (one-channel measurements) may contain a reference value or not; it is therefore put in brackets in the following notation:
ascii_sample = x, y [, ref]
This means that the numbers are arranged as follows:
x_0 y_0 [ref_0] CR/LF
x_1 y_1 [ref_1] CR/LF
x_2 y_2 [ref_2] CR/LF etc.

A dual sample (two measured values for the same X value) is obtained by:
ascii_sample = x, y [,ref] , y2 [, ref2]

Generalized, a sample is defined as follows:
ascii_sample = x, [, y [, ref] [, y2 [, ref2]]]

An ASCII scan is obtained by a number of samples:
ascii_scan = $Sample_0$ [$Sample_n$]...

A REAL scan consists of a number of blocks:
real_scan = y_block [, x_block [, ref_block] [, y2_block [, ref2_block]]]
the X block being defined as
x_block .= x_0, x_1, [x_n]...

- Three-dimensional (multiscans)

Multiscans are obtained by successive series of scans:
multiscan = $scan_0$, $count_1$, $scan_1$ [,$count_n$, $scan_n$]....
Notice that the number of data of $scan_0$ has been defined in the header, whereas the subsequent ones are indicated prior to the subsequent traces.

If a multiscan has been obtained by a Z sweep, a one-dimensional field of Z values is added to the multiscan. Bits 0 to 2 of the third number of the header are set to 3.

- One-dimensional with steady X axis

The above-mentioned applies only for trace data which have been obtained by (internal or external) sweeps. FFT data, waveform data and filter-simulation data are characterized by a steady X axis, ie, the X axis is defined by two values in this case. These values are start value and difference value and are named x_def, the structure is defined as fft_scan. (See section "Setup" above).

Multiscan, reference values and Z sweep are skipped, however, dual trace is possible. The different values of the bits 0 to 3 are selected for plausibility check with loading traces and do not imply different data structures.

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Info Structure (info_struct)

This data field contains values which appear in the DISPLAY panel and guarantee that a stored trace which is loaded corresponds exactly to its appearance prior to storage. Therefore, the scaling values, eg, have to be included in the file. This structure is used with storage of trace A, trace B or dual trace, only.

It is reserved and should not be modified, since error could lead to undefined program states. The reason is that all error possibilities are eliminated with user entry and that this structure is considered to be consistent with use. Besides, it contains data which cannot be described here since they would go beyond the scope of this section. It is advisable, if required, to have a file created by the UPD by means of storing a trace variable/variable trace. All settings can be made in the DISPLAY panel and the structure described is completely inserted.

info_struct := trace_no, trace_group, x_info, y_info, y2_info, strings, norm_y1, norm_y2

trace_no indicates trace A (0), trace B (1) or dual trace (3).

trace_group indicates the type of X axis, in order not to mix frequency and time axes.

x_info := unit, ref_val, ref_unit, log_flag, upper_val, upper_unit, lower_val, lower_unit
y_info and y2_info are set up like x_info.

strings .= x_string, y_string and y2_string are the user-defined axis labels.

norm_y1 and norm_y2 stand for the normalization factors.

unit consists of code (16 bits) and group (16 bits) and specifies the unit of the axis;

ref_val is the reference value used;

ref_unit is the unit assigned to the reference value (expressed again by means of code and group);

log_flag is 0 with linear scale (not zero with log);

upper_val is the top or right limit of the axis;

upper_unit indicates code and group of the assigned unit;

lower_val and lower_unit mean the values for the bottom or left limit of scale.

2.9.1.4 Editing Limit Files

Level limit files can be edited in MS DOS with any editor capable of generating text files. The sample files R&S_EXAM.LLW (LLW = **L**imit **L**o**W**er) and R&S_EXAM.LUP (LUP = **L**imit **UP**per) used for demonstrating the data structure are stored in the directory C:\UPD\USER.
Each file consists of a header followed by the actual data. Additional information can be stored with the aid of comment lines.
The meaning of the **7 header values** can be seen in Section 2.9.1.3, **2.9.1.3 Format of Block/Listen** Data

Example:
A limit file should be edited with the aid of which the FFT curve of a DUT can be checked for limit violations. The limit curve should have the following characteristic:

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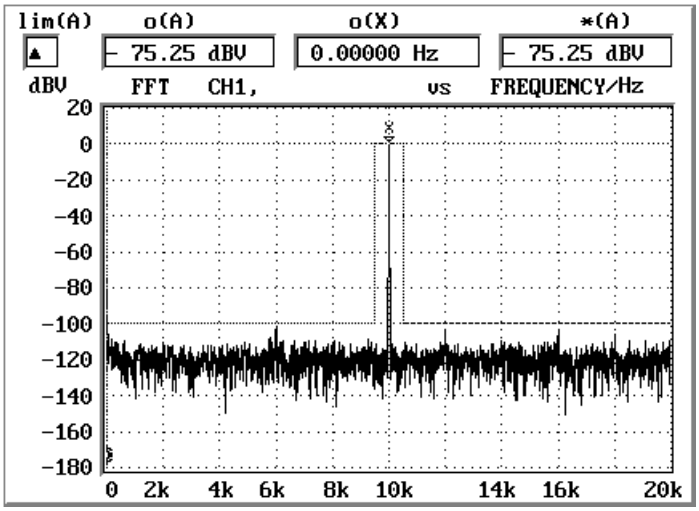

The 7 header values are determined as described in section **2.9.1.3 Format of Block/Listen** Data/ File header:

1st number = **213** Number of file format for UPD version 3.02
For UPD versions > 3.02 this number can be determined by storing a trace file (see **2.9.1.2 Loading and Storing** of Series of Measured Values and Block/List Data) and entering TYPE `xxx.TRC | MORE` in DOS. The first number displayed is the number of the file format.

2nd number = **2** Data of this limit file are in ASCII format, X-Y display next to each other

3rd number = **10** 10 is the decimal equivalent of 1010:

d15 d0

0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0

↑ two-dimensional (X and Y values)

↑ always 1

4th number = **1** Number of data records. In the case of limit files it is always 1.

5th number = **6** Number of subsequent pairs of X-Y values. 6 samples are required for the desired characteristic of this example.

6th number = **0** Linear interpretation of X axis. Irrelevant for this example with purely horizontal and vertical lines.

7th number = **0** Linear interpretation of Y axis. Ditto
The interpolation of intermediate values of limit curves, which are neither horizontal nor vertical, uses this information for the X and the Y direction. For a correct graphics display it is important for the file entries to be consistent with the scaling selected in the DISPLAY panel, as in the display the samples are always linked by straight lines. If the values are not identical, "bent" (elliptic) curve segments are obtained in the calculation. Since elliptic segments are not drawn they cannot be identified.

The entries for the Y values in the limit files must be multiplication factors which, together with the value set in the DISPLAY panel under

DISPLAY

TRACE A	FUNCT CH1
Limit Ref	**VALUE**
	1.0000 V

form the level value used for the limit check.

Note:

*The **use of multiplication factors** in the limit file permits limit curves to be shifted in the display by modifying the `Limit Ref` value, eg to adapt them to a changed generator level or to another DUT.*

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Thus, a multiplication factor of 0.00001 (1V • 0.00001 = 0.00001V = -100 dBV) is for instance calculated for the desired Y value -100 dBV.

X values	Desired Y values in the graphics display	Multiplication factors for entry in the limit files
20 Hz	-100 dBV	0.00001
9500 Hz	-100 dBV	0.00001
9500 Hz	0 dBV	1.0
10500 Hz	0 dBV	1.0
10500 Hz	-100 dBV	0.00001
20000 Hz	-100 dBV	0.00001

The contents of the desired limit file is as follows:

```
213
2
10
1
6
0
0
#----X-----Y---
20      0.00001
9500    0.00001
9500    1.0
10500   1.0
10500   0.00001
20000   0.00001
```

This file is stored for instance under C:\UPD\USER\MYLIM.LUP in MS-DOS and loaded for display on the UPD as described in section 2.10.7 Limit Check:

```
┌──────── DISPLAY ─────────┐
│LIMIT CHECK ------------  │
│  Lim Upper    FILE       │
│  Filename     MYLIM.LUP  │
```

Note:

Additional information on the use of limit files is given in the Application Notes ***1GA33_1D*** *(German),* ***1GA33_1E*** *(English) or* ***1GA33_1L*** *(American) which can be obtained from your local Rohde & Schwarz agency.*

2.9.1.5 Generating a Limit File from a Trace File

Example:
The passband of a DUT with C MESSAGE characteristic is to be checked for compliance with a specific tolerance with the aid of an upper and lower limit curve.

The simplest way to generate the two limit files is to derive them from a trace file obtained by means of a sweep via a C-MESSAGE filter.
In this case the samples of the limit curve correspond exactly to the X values of the sweep (provided they have not been manually changed) so that the Y values need not be interpolated to obtain information on limit violations.

In this example the UPD-internal C-MESSAGE filter is used.

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Generating a trace file:

- Load default setup:

```
┌──────── FILE ────────┐
│LOAD INSTRUMENT STATE │
│Mode        DEF SETUP │
```

- Establish internal connection to the generator, set the C-MESSAGE filter as required for an RMS measurement and select dBV as display unit.

```
┌──────── ANALYZER ────────┐
│Ch1 Input...GEN CH1       │
│Filter      C MESSAGE     │
│Unit Ch1    dBV           │
```

- Select AUTO SWEEP with 10 sweep points (for an easy-to-handle number of limit points later on) and set the output level to 0 dBV:

```
┌──────── GENERATOR ────────┐
│SWEEP CTRL  AUTO SWEEP     │
│Points      10             │
│VOLTAGE     0.0000 dBV     │
```

- Switch to trace display and select a logarithmic scale for the X axis:
-

```
┌──────── DISPLAY ────────┐
│OPERATION    CURVE PLOT  │
│X AXIS                   │
│Spacing      LOG         │
```

  Select split-screen display (Taste ↔ or ALT Z)
- Trigger the sweep with the SINGLE key and the C-MESSAGE filter curve is displayed..
- This curve is not stored as TRACE file under the file name CMESS.TRC:

```
┌──────── ANALYZER ────────┐
│STORE TRACE/LIST ----     │
│Format       ASCII        │
│Filename     CMESS.TRC    │
```

  The file is now available under C:\UPD\USER\CMESS.TRC with frequencies in Hz and levels in V.
- Quit UPD (press SYSTEM key or CTRL F9).

Generating limit files from the trace file

The CMESS.LUP (upper limit curve) and CMESS.LLW (lower limit curve) files are generated in DOS from the CMESS.TRC file by varying the level values in V obtained from the TRACE file by means of a user-selected editor until the desired tolerance mask is obtained.

*The Y values to be entered in a limit file are **multiplication factors** which, together with the value specified in the DISPLAY panel under*

```
┌──────── DISPLAY ────────┐
│TRACE A        FUNCT CH1 │
│Limit Ref      VALUE     │
│               1.0000 V  │
```

form the level value used for the limit check.
The limit curve can be shifted by varying the `Limit Ref` *value.*

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Contents of C:\UPD\USER\CMESS.TRC:

```
213
2
10
1
10
1
0
#--X---------Y-------
20000       0.000251874
9283.18     0.00154384
4308.87     0.109695
2000        0.879042
928.318     0.978155
430.887     0.317451
200         0.0551856
92.8318     0.00598586
43.0887     0.000624106
20          7.48084e-05
```

The data following here are irrelevant for the generation of limit files and have therefore be omitted.

Contents of C:\UPD\USER\CMESS.LUP:

```
213  ⎫
2    ⎪
10   ⎪
1    ⎬ Unchanged from CMESS.TRC
10   ⎪ 1)
1    ⎪ 2)
0    ⎭ 3)
#--X---------Y---
20000       0.0004
9283.18     0.01
4308.87     0.5
2000        1.2
928.318     1.1
430.887     0.5
200         0.08
92.8318     0.009
43.0887     0.0009
20          0.0004
```

Contents of C:\UPD\USER\CMESS.LLW:

```
213  ⎫
2    ⎪
10   ⎪
1    ⎬ Unchanged from CMESS.TRC
10   ⎪ 1)
1    ⎪ 2)
0    ⎭ 3)
#--X--------Y----
20000       0.00001
9283.18     0.0008
4308.87     0.03
2000        0.7
928.318     0.9
430.887     0.16
200         0.03
92.8318     0.003
43.0887     0.0001
20          0.00001
```

Multiplication factors determining the limit samples together with the `Limit Ref` value in the DISPLAY panel.

1) Number of limit samples

2) Interpretation of X axis:: 0 = linear, 1 = logarithmic

3) Interpretation of Y axis: 0 = linear, 1 = logarithmic

See **2.9.1.3 Format of Block/Listen** Data / File header

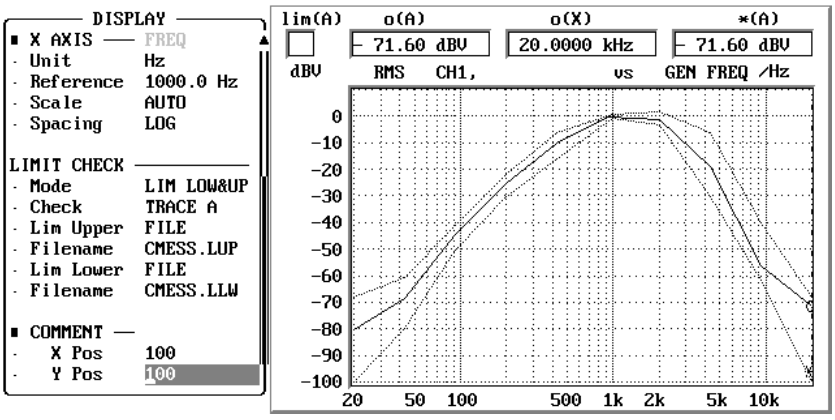
Loading limit files and detecting limit violations:

After a restart of the UPD, the two limit files

```
DISPLAY
LIMIT CHECK ---------
Lim Upper     FILE
Filename      CMESS.LUP
Lim Lower     FILE
Filename      CMESS.LLW
```

are entered and the desired tolerance mask is displayed.

If a sweep is triggered with the SINGLE key, the characteristic of the C-MESSAGE filter is within the tolerance band, as expected, and no limit violation is signalled.



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To verify the limit check, a limit violation can be provoked by increasing the sweep level in the GENERATOR panel from 0 dBV to, eg, 1 dBV or by varying the `Limit Ref` value, which shifts the limit curve.
In the top lefthand corner of the graphics display the icon

appears indicating a limit **overrange** by an arrow pointing upwards.

To determine the source of the limit overrange,

```
DISPLAY
OPERATION    SWEEP LIST
```

can be selected in the DISPLAY panel. A list of all sweep parameters is displayed. The limit violation is marked by an upward arrow in the lefthand margin of the list.
After a change from split-screen to full-screen display (key ↔ followed by GRAPH or ALT Z and then ALT R) an extended list of the sweep parameters is displayed together with the points of the two limit curves.

Note:

*If the **X values** have been transferred from the trace file into the limit file unchanged, the value in columns 3 and 4 is the product of the multiplication factor in the limit file and of the `Limit Ref` value in the DISPLAY panel. If the **X values have been modified,** the **interpolated** limit values for the frequencies in column 2 are displayed in columns 3 and 4.*

```
   RMS   CH1,              vs   GEN FREQ
 o-> - 70.76 dBV             20.000 kHz   - 68.0 dBV  -100.0 dBV
     - 55.17 dBV              9.283 kHz   - 40.0 dBV  - 61.9 dBV
     -18.215 dBV              4.309 kHz   - 6.02 dBV  -30.46 dBV
     -0.1195 dBV              2.0000 kHz    1.584 dBV  -3.098 dBV
▲     0.8245 dBV              928.3  Hz     0.399 dBV  -1.570 dBV
     - 8.955 dBV              430.9  Hz   - 6.02 dBV  -15.92 dBV
     -24.175 dBV             200.00  Hz   -21.94 dBV  -30.46 dBV
     - 43.46 dBV              92.83  Hz   - 40.9 dBV  - 50.5 dBV
     - 70.91 dBV              43.09  Hz   - 60.9 dBV  - 80.0 dBV
     - 74.79 dBV             20.000  Hz   - 68.0 dBV  -100.0 dBV
```

↑ Measured level
↑ Sweep frequency
↑ Samples of upper limit curve (CMESS.LUP)
↑ Samples of lower limit curve (CMESS.LLW)

```
DISPLAY
OPERATION    SWP LIM REP
```

causes a list of limit violations to be displayed. In this example this is only one:

```
   RMS   CH1,              vs   GEN FREQ
▲     0.8245 dBV              928.3  Hz     0.399 dBV  -1.570 dBV
```

Note:

*Additional information on the use of limit files is given in the Application Notes **1GA33_1D** (German), **1GA33_1E** (English) or **1GA33_1L** (American) which can be obtained from your local Rohde & Schwarz agency.*

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2.9.1.6 Generating a Limit File Using the Application Program

For a convenient generation of limit files for frequency response measurements the Application Note **1GA33_1D** *(German)***, *1GA33_1E*** *(English) or* ***1GA33_1L*** *(American)* can be used in conjunction with the application program **LIMIT.BAS** which can be obtained from your local Rohde & Schwarz agency.

To be able to use this program the Universal Sequence Controller option UPD-K1 must be installed. With the aid of this option complete measurement sequences can be run program-controlled on the audio analyzers.

To be able to run the application program LIMIT.BAS under the Universal Sequence Controller UPD-K1, the firmware version 3.0 or a higher one is required in the UPD. An external keyboard must be connected in addition.

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2.9.2 Editing Files and Directories

The following files are available under the heading UTILS in the FILE panel, which is called by pressing the FILE key.

The UPD software is supported by the MS-DOS operating system and uses its file manager, which is normally not of importance for the user. It however provides extended capabilities, which you can make use of, if desired. For reasons of internal management, the UPD software assigns a fixed data type (extension) to each file type depending on its function, allowing the identification of the file type. The extension consists of up to three letters after the point in the file name and is usually not available to the user in other menu items (the extension used is specified in the menu items concerning files as well as in the list given in Section 2.9.1).

Delete — A file can be deleted using this command. All menu commands used to store files overwrite an existing file with the same name or create a new file.

Work dir — (Working directory)

If a directory is specified under "Work dir" that exists in the UPD, the specified directory is selected as the working directory. If the directory does not exist, the entry is interpreted as a file name indicating a control file where working directories for various file types (file extensions .SCO, .SAC etc) can be specified. If the control file is not found either, three possibilities are offered to the user in a dialog box:

1. "Create": The entry is interpreted as the name of a new working directory which is then opened and activated.
2. "Work dir unaffected": The entry is stored under "Work dir" without the currently used working directory being changed. When a setup is loaded containing an entry under "Work dir" that has been generated in this way, the current working directory remains unaffected. *This means that by entering a non-existing working directory, setups can be generated that do **not** change the current working directory.*
3. "Back to filebox": An incorrect entry has been made; a working directory can be selected again in the file box.

Specifying a directory:

Files can be arranged in directories allowing classification depending on, for example, the user or the project. The working directory, which precedes all file names and path names (unless they begin with a "\" in the main directory) is thus selected. Independent of the working directory, there are also directories which are used by the UPD-internal software.

Example: Work dir C:\UPD\DUT04

No.	Data input	Data access to
1	SWEEP.SCO	C:\UPD\DUT04\SWEEP.SCO
2	\SWEEP.SCO	C:\SWEEP.SCO
3	\UPD\DUT05\SWEEP.SCO	C:\UPD\DUT05\SWEEP.SCO

Storing files in the main directory (example 2) or in the UPD system directories (\UPD,\UPD\REF,\UPD\DRIVER, etc.) should be avoided.

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Specifying a file with control instructions:

The specified file contains control instructions by which a working directory is defined for various types of file.

All file names entered into the file box without a path being specified are searched for in, and taken from, the working directory defined in the control file. The working directory shown in the file box under the specified file name can be checked against the file name displayed on the UPD.

(Control file (ASCII text):	Meaning:
#Comment 1	Any comment, marked with #
.SCO C:\EXAMPLE\SETUP	Loading and storing of setups
.SAC C:\EXAMPLE\SETUP	according to \EXAMPLE\SETUP
.TRC C:\EXAMPLE\TRACE	Loading and storing of traces
#Comment 2	
.PPC C:\UPD\USER	Protocol definitions
.PAC C:\UPD\USER	
.PAU C:\UPD\USER	
.* C:\UPD\USER	Preset directory

The control file can be created at the DOS level using any type of editor capable of generating unformatted ASCII text.

.* Designates the working directory that is set if a type of file not included in the control file is entered (default directory).

Marks comment lines.

Leading and filling blanks are ignored. Entries can be made in any order.

If no appropriate entry is found for a specified file type, the directory specified after ".*" is used as working directory. If no entry exists for ".*", the path information (eg C:\UPD\USER) is extracted from the file name designating the control file (eg C:\UPD\USER\EXTDIR:CFG) and entered as working directory. If in the control file a working directory is specified that does not exist, an error message is output.

Note: *Several users can use setups jointly and store the results separately by using the same path for the setups and different paths for the data to be stored.*

Example:

Mr. MILLER, Mr. BAKER and Mr. SMITH are sharing an UPD. Each user wants a working directory of his own with the corresponding setups using the .SCO and .SAC file types and each one establishes a path named SETUP.

Mr. MILLER	mainly works with .TRC trace files and therefore needs a path named TRACE.
Mr. BAKER	mainly works with .COE filter coefficient files and therefore needs a path named COEFF.
Mr. SMITH	mainly works with .FFT arbitrary waveform files and therefore needs a path named ARBIT.

All files of a type other than mentioned above are to be directly written to/read from paths C:\UPD\USER\MILLER, C:\UPD\USER\BAKER or C:\UPD\USER\SMITH.

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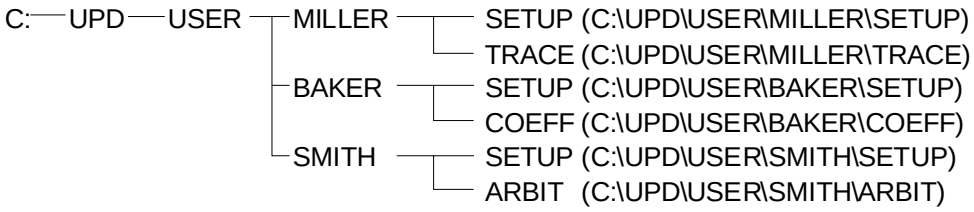
The above requirements can be fulfilled by structuring the working directories as follows (at the DOS operating system level):



The assignment of file types to working directories is made in separate control files which are best stored under C:\UPD\USER:

MILLER .CFG

```
# Working directories, depending on file type
.SCO   C:\UPD\USER\MILLER\SETUP
.SAC   C:\UPD\USER\MILLER\SETUP
.TRC   C:\UPD\USER\MILLER\TRACE
# Default working directory
.*     C:\UPD\USER\MILLER
```

BAKER.CFG

```
# Working directories, depending on file type
 .SCO  C:\UPD\USER\BAKER\SETUP
 .SAC  C:\UPD\USER\BAKER\SETUP
 .COE  C:\UPD\USER\BAKER\COEFF
 # Default working directory
 .*    C:\UPD\USER\BAKER
```

SMITH.CFG

```
# Working directories, depending on file type
.SCO   C:\UPD\USER\SMITH\SETUP
.SAC   C:\UPD\USER\SMITH\SETUP
.TTF   C:\UPD\USER\SMITH\ARBIT
# Default working directory
.*     C:\UPD\USER\SMITH
```

After switching on the UPD, each user enters, under "Work dir" in the FILE panel, the path and name of his control file, or loads a setup in which the path and name of his control file are already entered.

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2.9.3 Series of Measured Values (Sweeps and Scans) and Block/List Data

With sweeps, values measured as a function of a variable input quantity are recorded and can be represented in various ways graphically or as numbers. UPD can simultaneously record two traces (Trace A and Trace B). These are in the following referred to as 1 scan.

The variable input quantity, which is usually entered along the X axis, is determined by the sweep parameters. There are three sweep modes, of which only one can be active at a time:
generator, analyzer and external/time-controlled sweep.

- In the generator sweep, the frequency or the output voltage can be automatically varied (in steps). For sine burst measurements, the ON time and the length of intervals (see 2.5.5.2, Sweeps) can be varied in addition.
- In analyzer sweeps, the "receive" frequency can be automatically stepped in (frequency-) selective rms measurements, with sweep parameter settings similar to those used in generator sweeps (see 2.6.5.3, RMS SELECT). If the multisine function (with up to 17 simultaneous frequencies) is active in the generator, a sweep list can be generated with UPD set to SWEEP CTRL GEN MLTSIN. With this list, the analyzer is automatically tuned to all generator frequencies in consecutive order.
- The third group of sweeps are external sweeps that are likewise set in the analyzer mode. With external sweeps, time-varying signals are analyzed that are not stepped by one of the UPD sweep systems but by external control. The analyzer picks up measurement values after a frequency or level change and interprets the frequency or level as X-axis parameters. Furthermore, measured values can be collected at certain intervals. In this case, time will be taken as the X-axis parameter.

In the DISPLAY panel, the set sweep parameters are always used for the X axis. The units used depend on the physical quantity measured. The righthand and the lefthand limit are determined by the start and the stop values of the sweep parameters and set using the X-axis autoscaling function.

2.9.3.1 Scan count =1

From the six values simultaneously measured, two can be used for the two independent Y axes (trace A and trace B). These values may be the distortion factors of the lefthand and righthand channel, for example, but also different physical quantities such as voltage and phase. The quantities to be measured are set in the ANALYZER panel; the values to be recorded as a trace are selected in the DISPLAY panel even if a trace is not to be displayed but stored in a file.

Measured values frequently have to be referenced to other values (the measured values being expressed in relative units). If a reference value is constant (eg 1 mW), it can be taken into account immediately. If the reference value is a function of the X axis, a reference trace will result. With UPD, such traces can also be formed from a series of measured values, for example, or from the generator voltage or frequency, or may be loaded from a file (eg as reference traces).

In all, the following is stored for one scan: two traces, two reference traces and the X-axis data since, in the case of external sweeps, the latter are also obtained through measurements values and cannot be calculated.

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2.9.3.2 Interpolation to a Common X Axis

To allow any traces to be used as reference traces or to be displayed simultaneously for the purpose of comparison, and measured by means of the movable cursors, all traces would have to have the same X values. However, any X divisions can be used on the UPD as the values of the traces and reference traces are interpolated to the set X axis. The interpolated values are displayed as traces or numerals. The original X and Y values are displayed only if no sweep is selected (and thus no X axis is set). (Excepted are all limit traces; they are displayed using the original and not the interpolated values (see 2.10.8, Limit Check).)

For interpolation, the X and Y values of the four traces and reference traces are stored in the UPD, yielding a total of eight series of numbers plus the four interpolated series plus the current X-axis values. This results in 13 series of 1024 values each.

UPD also interpolates further series of numbers: the limit traces for the upper and lower ranges, the equalization trace for the generator voltage, and the dwell trace for sweep stepping. Thus, only a few measured values are required for each trace. In interpolation, linear or logarithmic scaling of the X and Y axes is taken into account as, when switching from linear to logarithmic scaling, segments of an ellipse would be displayed instead of a straight line.

All traces are interpolated once at the start of a sweep to make for enhanced measurement speed. In the case of external sweeps, the X values are unknown at the start of the sweep. In this case, interpolation cannot be made prior to the sweep but must be performed during the sweep.

2.9.3.3 Scan Count >1

The number of traces generated with UPD is not limited to one X sweep but can be increased to n sweeps by means of the setting Scan count <n> (in the DISPLAY panel). A group of traces will be obtained as graphical representation. All traces are stored (in the UPD and also as a file, if desired) and can be displayed as one unit, rescaled and recalled. In the Scan GROUP mode, the 13 series of numbers mentioned above are multiplied by the number of scans.

In the generator mode, a second sweep can be made in addition to the X sweep. The second sweep is referred to as Z sweep as it is usually represented along the Z axis. When Z sweep is selected, the number n of the scans is automatically set to the number of the Z points (Scan count is set according to the number of Z points).

In the Scan count >1 mode, a series of traces (or a series of pairs of traces) is usually displayed. In autoscaling of the Y axes, all available traces are included. Any other operations, eg setting the cursor to the min. or max. values, only apply to the current scan. For out-of-tolerance checks (limit checks), all traces are checked against the same two limit traces, the out-of-tolerance symbol applies to the current pair of traces.

The current scan (with one or two traces) is selected with the PAGE UP/PAGE DOWN keys on the keyboard. The current value, ie the scan index, is indicated by a number between the out-of- tolerance field and the lefthand cursor-value field. The scan index is set by remote control with command DISPlay:TRACe:INDex <n>.

The point of intersection of the cursor with the current trace (or pair of traces) is visually emphasized by means of a circle. It is thus possible to allocate the cursor values indicated in the windows unambiguously to the current scan.
The most recently recorded scan is displayed with a number (”#n”) in the upper left corner providing the space is not occupied by the out-of-tolerance field.

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If one of the list modes (SWEEP LIST, SPECTR LIST, SWeeP LIMit REPort or SPeCtrum LIMit REPort) is selected, the corresponding lists are generated anew after a change of the scan index (with the PAGE UP/ PAGE DOWN keys), since only one scan (pair of traces with X axis) can be displayed at a time.

With FFT, a large amount of numbers (up to 7424) is obtained, although no more than one scan is available. For this reason, the scan index is used for organizing the number in 1-k blocks and selecting them accordingly. This is not only useful for the screen display but also for reading the block data via remote control or the UPD Universal Control with BASIC (UPD-K1). With remote-control command DISPlay:TRACe:INDex, a 1-k block is selected to which the subsequent inputs and outputs with FFTs refer. With sweeps, the command serves for selecting a desired scan from a group (or to select the Z index). The index runs from 0 to Scan count -1.

Another way of reducing the numbers transferred with FFTs is by using the out-of-tolerance function. Only values above the limit value defined by UPPER LIMIT are accepted as measurement values and can be read with LIST1 and TRAC1 or TRAC2 if OPERATION SPC LIM REP is set in the DISPLAY panel (see 3.2.14, Reading Blocks of Measured Values).

In the case of sweeps, "0" is entered in the trace index in the error report block if sweep values are out of tolerance. If the limit in channel 1 is exceeded, 1 is entered, with channel 2, 2 is entered; if limit violations occur in both channels, 3 is entered. The X and Y values belonging to this index will be found under the same index in the LIST1 and TRAC1 or TRAC2 blocks.

If no group of scans is selected (Scan count =1), the measurement currently being taken is indicated by means of a gap moving along the trace. If several traces are displayed on the screen (Scan count >1), the gap may no longer be visible; instead, t he set sweep value is marked by an arrow on the X axis.

With time-controlled measurements, which are selected by means of START COND TIME TICK or TIME CHART in the ANALYZER panel, the time is entered along the X axis. With these measurements, the X axis can be extended using the scan group mode. The stop value results, for example, from time = 1 s and points = 100 to yield 100 s. With scan count = 5, the monitoring period is extended to 500 s. The cursor value always indicates the total time; with scan index = 5, 400 to 500 s would be obtained in this case. As for the traces, however, the X-axis values would be in the range 0 to 99 in this example.

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2.10 Graphical Result Display (DISPLAY and GRAPHICS Panels)

The DISPLAY panel is used to set how the measurement results are graphically **presented**. Important: **what (and how)** is measured is set in the ANALYZER panel, or, with sweeps, in the GENERATOR panel. How the measurement is displayed can be changed at a later date, too. Also, curves can be retrieved from files and redrawn.

The DISPLAY panel is built up using the front-panel key DISPLAY or key combination Alt+D on the external keyboard. The menu items in the DISPLAY panel affect the GRAPHICS panel which occupies either 2/3 of the screen (part-screen graphics mode) or the complete screen (full-screen graphics) (selectable by the o × O key or key combination ALT-Z).

OPERATION

CURVE PLOT

The results of a sweep, function of time (waveform) or FFT are entered as line diagram in the Cartesian coordinate system. As a rule, two dependent variables (TRACE A and TRACE B) can be displayed above an independent variable (X AXIS). With LIMIT check activated, the tolerance masks are also included. The extensive command menu provided on the softkeys allows you to scale and zoom the display and to dimension the display using the CURSORs (see 2.10.1 and 2.10.2).

SWEEP LIST
SPECTR LIST

The measurement results of a sweep or (post) FFT are output in the form of digits. The three columns (TRACE A, TRACE B and X AXIS) are complemented by a fourth column where violations of the UPPER or LOWER LIMIT curve are marked. In full-screen graphics mode, two additional columns indicate the LIMITS (interpolated between intermediate values!) (see 2.10.3 and 2.10.4) if LIMIT CHECK has been activated (see 2.10.7).

SWP LIM REP
SPC LIM REP

As opposed to TRACE LIST, the digit lines with measured values exceeding the tolerances only are displayed (see 2.10.3 and 2.10.4), which is possible only with LIMIT CHECK activated (see 2.10.7).

BARGRAPH

The current measured values are displayed analogously in the form of bars ('signal level meter'). This type of indication is ideally suited for measurements where the relative size or change in size - and not the exact value - is desired. Max. 3 BARGRAPHS are displayed. The extreme values are marked by trailing pointers (see 2.10.5 and 2.10.6).
The bargraphs #1 and #2 are freely selectable, the bargraph #3 is automatically assigned the following functions (in the order of their priority):

1. with activated sweep: swept parameter (x-axis or sweep curve)
2. with activated phase measurement: Phase
3. with activated frequency measurement: Frequency channel 1 or channel 2
4. Generator frequency (if selected generator function permits frequency to be entered)

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OPERATION

SPECTRUM

With FUNCTION FFT or a post-FFT selected in the ANALYZER panel, the frequency spectrum calculated by the DSP is displayed (SPECTRUM is automatically set with FFT or FILTER SIM selected in the ANALYZER panel).

With FUNCTION DIM, MOD DIST, DFD or THD selected in the ANALYZER panel, the spectrum components of the stimulae and interference products can be displayed in the form of a histogram (see 2.10.1 and 2.10.2).

PROTOCOL

In the GRAPH window, the protocol data of the digital interface are displayed. Evaluation of the protocol is made simultaneously with the respective function (see 2.10.8).

PROTO AUTO

PROTO AUTO enables the automatic decoding of the channel status bits irrespective of the professional bit value (see 2.10.8 PROTOCOL Analysis).

Mode

With FFT spectrum only

DEL BEF WR

This is to select a trace, or pair of traces (trace A and trace B). Each new trace will overwrite the previous trace(s).

MAX HOLD

This key is used to switch on the MAXimum HOLD function. FFT AVERAGE cannot be set unequal to 1 in the ANALYZER panel with OVERL/MAX H selected, see 2.6.5.13.

Note: *MAX Hold can only be selected if the display is switched off (Avg count1).*

WATERFALL

Shifts the single curves in the Z axis to obtain a spatial impression. One channel only can be traced at a time, which is why 1 or 2 must be selected under ”Channel(s)” in the ANALYZER panel. To obtain a useful display, scaling is to be set as follows:

1. TRACE Top is to be set such that the upper half (or 3/5) of the coordinate system is empty (ie is not occupied by the first trace).
2. X-AXIS Right such that about half of the coordinate system is free.
3. TRACE Bottom is to be set above the noise limit, making noise invisible by clipping and emphasizing significant spectral components.

Note: *Waterfall can only be selected with one-channel analyzer.*

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Scan Count

(With CURVEPLOT, SWEEP LIST, SWP LIM REP and BARGRAPH operation only, not with spectrum displays)

Defines the number of single traces or trace pairs to be measured and displayed. If a Z sweep is selected in the generator, the number of Z values is automatically entered in Scan Count.

1

A single trace or a trace pair (Trace A and B) should be measured or loaded. Each new curve overwrites the previous one. With this setting a continuous sweep (without Z axis) is performed repeatedly but only the last one is stored.
If a single-scan trace is loaded from the file, the file overwrites the current contents of the trace buffer.
If a multiscan trace is loaded from the file, only the 1st scan is loaded into the trace buffer, all others are ignored.

>1

With this setting, not only one measurement sequence (sweep run, scan) is measured and displayed but as many as required. However, only the selected number, but not more than 17, are internally stored in or read from a file. Non-stored scans are only displayed in the curve plot and lost durin tinuous sweep (without Z axis) is terminated after the specified number of sweeps but only the last 17 sweeps are stored.
If a single-scan trace is loaded from a file, this scan is *appended* to the existing scans.
If a multiscan trace is loaded from the file, the trace buffer is *cleared* and the number of scans specified here is loaded into the trace buffer, all other scans of the file are ignored.
If more than the specified number of scans are performed, only the last (max. 17) scans are stored.
If more than 17 scans are specified, only the last 17 are stored.

For more details refer to section (see 2.9.3.3 Scan Count >1)

***Note**: Scan Count can be **increased** any time for storing more scans in the trace buffer. **Reducing** the Scan Count clears the trace buffer and provides an empty display again.*

User Label

OFF

The units and function labelling in the graphical display are automatical generated by UPD.

ON

The user can assign units and function labelling of his own. This is of interest in particular for remote control if measured values were converted. The labelling is entered in Unit/Label under Trace A/B or X axis. When User Label is switched from OFF to ON, the labelling assigned by UPD appears in the input fields and can be overwritten by the user.

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2.10.1 Parameters for Display of Traces and Spectra (DISPLAY Panel)

TRACE A

TRACE B

Is used to select which measurement results are to be collected and graphically represented as TRACE A (or TRACE B) eg in the case of a sweep.

Caution: Display of the trace can be switched OFF (invisible) by means of a softkey.

OFF

No measured values are collected and hence, nothing can be displayed under this TRACE.

FUNC CH1

(Function Channel 1)
The results of the measurement of channel 1 currently selected in the ANALYZER panel by way of FUNCTION are used. Possible only when FUNCTION in the ANALYZER panel is not OFF.

FUNC CH2

As above, however for channel 2.
(Function Channel 2)

FREQ CH1

Frequency meter channel 1. Possible only with FREQ/PHASE in the ANALYZER panel not OFF and OPERATION not SPECTRUM.

FREQ CH2

Frequency meter channel 2. Possible only with FREQ/PHASE in the ANALYZER panel set to FREQ and OPERATION not SPECTRUM.

PHASE

Phase meter between channel 1 and 2. Possible only with FREQ/PHASE in the ANALYZER panel set to FREQ&PHASE and OPERATION not SPECTRUM.

INP RMS CH1

RMS measurement results channel 1. Only possible if measuring function THD or THD+N/SINAD and channel 1 are set.

INP RMS CH2

RMS measurement results channel 2. Only possible if measuring function THD od THD+N/SINAD and channel 2 are set.

HOLD

Does not collect new values but continues to display the old trace.
HOLD is only accepted as input if valid trace data or FFT data are provided.

A sweep stored in a file in the FILE panel (TRACE LIST) can be recalled and displayed, eg for comparison purposes, using this option.
Sweep lists can be stored as a group of traces (Scan count >1 in the DISPLAY panel) in a file. To recall this group of traces, Scan count must also be set to this number, otherwise an error message is output. (See 2.9.1.2, Loading and Storing of Series of Measured Data and List/Block Data, and 2.9.3.3, Scans count >1).
If a pair of traces is stored in a file (with Store TRACE A+B in the FILE panel) and if this pair is loaded by means of FILE, only trace A is used and trace B is ignored. To load the pair of traces, the parameter DUAL FILE should be used.

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TRACE B

(continued)

FILE

Sweep lists and FFT files can be loaded. The following basic conditions must be satisfied to load a sweep list.

- The display OPERATION must be set to CURVE PLOT, SWEEP LIST or SWP LIM REP.
- All sweeps must be switched to OFF (or START COND to AUTO) or the sweep parameter (FREQ, VOLT, TIME) must be identical to the X-axis of the trace file to be loaded.

The following conditions must be satisfied to load an FFT or a FILTER SIM file.

- The display OPERATION must be set to SPECTRUM, SPECTR LIST or SPC LIM REP.

For loading a waveform file

- the WAVEFORM function must be set in the ANALYZER panel (this causes CURVEPLOT to be set automatically in the display).

When loading the trace file, TRACE A has the function of a ”master” trace; trace B is the ”slave” trace:

- The "master" trace can always be loaded as soon as the above basic conditions are satisfied. In addition to the trace data, the stored display settings including the complete X axis are also loaded (cf. Section 2.9.1.2, menu item STORE → TRACE A/B). If a sweep has been selected, the loaded trace is interpolated on the X list specified by the sweep.

DUAL FILE

- When trace A is switched off, TRACE B becomes the ”master” trace.
- Being the "slave" trace, TRACE B must conform to the X scale of the ”master” trace; ie, only the trace data and the appropriate Y scale are loaded. The curve is interpolated on the X axis already specified. If this X-axis is incompatible, the ”slave” trace is switched off.

GROUP DELAY

In the FILE panel, a pair of traces can be stored as a unit in a file by means of TRACE A + B under STORE. The pair of traces can be recalled by means of DUAL FILE (under TRACE A). The parameter of trace B, too, is set to dual trace and the scaling of both traces as well as any reference values or reference traces are loaded from the file.

GROUP DELAY can be switched on only, if FREQ/PHASE has been set to FRQ&GRPDEL in the ANALYZER panel (this is possible with two-channel measurement, only. The group delay calculated from the phase measurement is displayed).

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Filename

(Displayed with TRACE A/B FILE only)
The name of the file with a sweep or FFT to be displayed is entered. If an error occurs during loading, ”NOT FOUND” is output in this line.

Scale B

EQUAL A

The second (dependent) measured value is displayed using the same scaling as for Trace A. Any values for UNIT, REFERENCE, SCALE, SPACING, TOP and BOTTOM need not be entered for the second axis. This requires however that the same function is selected for TRACE A and B (only the channel may be different).

NOT EQUAL A

Different scaling for the second sweep.

Unit

Is used to specify the unit with which the results are to be displayed (see 2.4 Units). Recorded sweeps can be redisplayed with other units at any time. Traces loaded using TRACE A/B FILE therefore need not be drawn in the same way as they have been stored.

Unit/Label

Entry of a string which specifies a freely definable unit and axis label. The string consists of 5 characters for the unit which are centered and if need be padded with blanks, and 12 characters for the axis label which are also centered and if need be padded with blanks. There is a separate ”Unit/Label” command for each trace and the X axis.

Reference

Displayed only when a relative unit has been selected in the menu item "Unit".

Selecting the reference: this may be a single numeric value or a data record (reference trace). The reference applies to all traces, ie top, bottom, measured and limit values.

MAX

The maximum value of a measurement sequence is stored once as a reference value.

∗ CURSOR
o CURSOR

The value marked by the ∗ or o cursor is stored once (not in the case of BARGRAPH).

VALUE:

A numeric value is entered in addition.

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Reference

FILE

The reference trace is loaded from the file. The file name is entered in the following line.
If a pair of traces is stored in a file, trace A is loaded. If a reference trace is assigned to trace A, the reference is ignored. If Scans GROUP is selected, a group of traces is loaded. If the number of traces stored does not coincide with the Scan count number, an error message is output.

OTHER TRACE

The reference trace is loaded with the trace data of the other trace. Every new measured value of the other trace is simultaneously entered in this reference trace and is then immediately available for representation of the new test point. If the other trace is OFF or inactive (eg because an invalid file name has been entered), a corresponding warning is output. If the other trace is incompatible (eg TRACE A FREQ CH1 and TRACE B→INP RMS CH1), a corresponding warning is output. If the other trace is set to FILE or HOLD, the compatibility is not checked.

MEAS CH1

The reference trace is cleared and then loaded with the measured values of channel 1. These are

- function measurement results of channel 1 if trace ”FUNC CH1” or ”FUNC CH2” is selected
- frequency measurement results of channel 1 if trace ”FREQ CH1” or ”FREQ CH2” is selected
- input rms measurement results of channel 1 if trace ”INP RMS CH1” or ”INP RMS CH2” is selected

This choice is only offered if both channels are activated and TRACE (with activated phase measurement) is not set to FREQ CH1 or PHASE.

MEAS CH2

The reference trace is cleared and then loaded with the measured values of channel 2 (as above, however, channel 2).

GEN TRACK

The reference trace is cleared and loaded with the currently valid generator setting in every measurement. This is

- the generator rms value valid at the respective test point if trace ”FUNC CH1” or ”FUNC CH2” is selected,
- the generator frequency valid at the respective test point if trace ”FREQ CH1” or ”FREQ CH2” is selected,
- the generator rms value valid at the respective test point if trace ”INP RMS CH1” or ”INP RMS CH2” is selected.

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Reference

HOLD

The reference trace is not changed any more. If HOLD is selected without valid reference trace data being provided, a warning is output and the last valid reference is set again.

FILE INTERN

This option can be selected only if a reference trace was stored in the file. FILE INTERN is set automatically if a trace loaded from a file has a reference trace assigned to it.

REF 997 Hz
REF 1000 Hz

The value measured at 997 Hz or 1 kHz is taken once as a reference value for a single sweep run. With FFT traces, the nearest bin (actually measured frequency line) is taken, with frequency sweeps interpolation is made between the two neighbouring points.
If the X axis is not the frequency axis (for example in the case of level sweeps or waveform traces), an error message is output and the reference value remains unchanged.

Limit Ref

Select a reference for calculating limit curves if the selected unit is **not** a relative unit.

> ***Not*** *Limit files consist of numeric values without unit which become physical units only after multiplication with the reference value. For this reason a reference value is required also in case of a non-referenced display.*

MAX

The maximum value of the measurement sequence is stored once as the reference value.

∗ CURSOR
o CURSOR

The value marked by the ∗ or o cursor is stored (not with BARGRAPH).

VALUE:

A numeric value with unit is entered.

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Normalize

If a relative unit (eg dBr or V/Vr) and a running reference value - ie OTHER TRACE, MEAS CH1, MEAS CH2 or GEN TRACK - are used, the displayed trace is normalized. By shifting the whole curve, a specific value can be declared 0 dBr or V/Vr = 1 (by which the normalization value is multiplied).

A normalization factor may also be considered for the transfer function (Trace A of measurement function COHERENCE) to shift the curve displayed % or dB. This is desirable, for instance, if a gain factor between channel 1 and 2 is to be eliminated by calculation for the display.

VALUE

The normalization factor is entered as a numeric value.

o CURSOR

The required normalization factor is calculated by normalizing the Y value marked by the o cursor. Normally this is the value at 1 kHz, ie the cursor has previously been set to 1 kHz. By making this selection the value will be entered under VALUE.

∗ CURSOR

Same as above, but the ∗ cursor is used.

Scale

AUTO ONCE

Uses the minimum and maximum values of the current sweep for scaling of TRACE A and B (once) and rescales after changing the function using FUNCTION in the ANALYZER panel or TRACE A/B in the DISPLAY panel. The sweep or FFT start/stop values of the GENERATOR or ANALYZER panel are adopted for the X axis. The following menu items TOP and BOTTOM or LEFT and RIGHT are no longer displayed because they have been set in doing so.
If there are not yet any measured values available, preset range limits are used for the time being and rescaled after the end of the sweep. When changing the measurement function (using TRACE A/B or FUNCTION in the ANALYZER panel with FUNC CH1/2 or GRAPH ON/ OFF with SMPTE, THD and DFD) an automatic rescaling is performed after the first measurement in the SCALE AUTO ONCE state. (Re-) START does not initiate a new scaling.
If Scan count >1 is selected, AUTO ONCE is executed only when all scans have ended (eg z weep).
The full-scale values of the new scaling are determined about 5 % lower or higher than the exact values. Using an intelligent algorithm, 'even' values appropriate for the scale are selected.

MANUAL

Leaves the scaling to the user.

With a new scaling the image is deleted and redrawn after the rescaling. This applies also to an FFT started by the Single key. With FFT in Continuous mode (started by Start key), however, the running FFT is still drawn, the new scaling being considered only in the next FFT.

Note: *If Scale AUTO ONCE is selected, autoscaling is performed when switching between LIN and LOG.*

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Spacing

LIN

Divides the Y-axis linearly.

LOG

Divides the Y-axis logarithmically. With logarithmic units (dB) selected, LIN only can be selected.

Notes: *If Scale → AUTO ONCE is selected, autoscaling is performed when switching between LIN → LOG.*

Top

The menu item is displayed only with TRACE A/B SCALE MANUAL. The item serves to set the upper value of the Y-axis (of the scale for the measured values). Negative or 0 values are not permissible with SPACING LOG and logarithmic (dB-) units.

Bottom

(With TRACE A/B SCALE MANUAL), the menu item serves to set the lower value of the y-axis (of the scale for the measured values). The value must be smaller than that of TOP. Negative or 0-values are not permissible with SPACING LOG and logarithmic (dB-) units.

Notes on scaling the Y axis:

- *When a new display unit is selected, this unit is assigned to all values from top to bottom. After this changes can be made as required. Thus it is possible, for instance, to select a logarithmic scale (eg dBr) as a unit and to enter absolute units (eg. V) for the top and bottom value.*
- *Exception: if a reference trace is active, specifying an absolute unit for top and bottom would be nonsensical. No unit is therefore offered in this case; numeric values are assigned the unit selected under "Unit".*
- *If a referenced unit has been selected for top or bottom, the measured curve is vertically shifted when the reference value is changed.*

Left

(With X AXIS SCALE MANUAL), the menu item sets the left value of the X-axis (of the independent value). Negative or 0 values are not permissible with SPACING LOG and logarithmic (dB) units.

Right

(With X AXIS SCALE MANUAL), the menu item sets the right value of the X-axis (of the independent value). The value must be selected higher than that for LEFT. Negative or 0 values are not permissible with SPACING LOG and logarithmic (dB) units.

COMMENT

Allows the entry of a comment with a length of max. 27 characters, which is output together with the curve in the case of OPERATION CURVE PLOT.

X Pos

(X Position)
Defines the X position of the comment. X is the relative distance to the 0-point (bottom, left) in % (0 to 100) of the coordinate system.

Y Pos

(Y Position)
Defines the Y position of the comment. Y is the relative distance to the 0-point in % (0 to 100) of the coordinate system. 0-point is on the left side at the bottom. The reference point for the text is the first letter (bottom, left).

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2.10.2 Trace and Spectrum Display

Basically, two dependent values (TRACE A and TRACE B) can be displayed above an independent value (X AXIS), the scales for TRACE A and TRACE B being displayed on the left-hand and right-hand margin, respectively (unless the same scaling has been selected by way of TRACE B, SCALE B: EQUAL A). The measurement functions selected for display are faded in on the upper margin in the form of letters.

Overrange values are not displayed (the curve is interrupted). Underrange values are indicated in the status line SWEEP INFO in the top, right corner. Measured values not fitting into the selected coordinate system are displayed as horizontal line at the top or bottom.

With THD, MOD DIST, DIM and DFD measurements, the measured values can be displayed in the form of a histogram above the frequency axis (with OPERATION SPECTRUM), the frequency axis being not true to scale and invariable.

To allow any traces to be used as reference traces or to be displayed simultaneously for the purpose of comparison, and measured by means of the movable cursors, all traces would have to have the same X values. However, any X divisions can be used on the UPD as the values of the traces and reference traces are interpolated to the set X axis. The interpolated values are displayed as traces or numerals. The original X and Y values are displayed only if no sweep is selected (and thus no X axis is set). (Excepted are all limit traces; they are displayed using the original and not the interpolated values (see 2.10.7, Limit Check).)

There are two cursors (→ see page 2.196!) marked by * and o, respectively. They can be moved across the display using the rotary knob or the direction keys. The measured values below the cursor positions are displayed in three windows (depending on the function set, also difference values). The cursor jumps from measured value to measured value. If there are more measured values than can be displayed as points (eg with FFT), the maximum out of the measured values displayed on one point is displayed. Here, the cursor jumps from line to line.

Also, the cursor can be moved outside the coordinate system and indicate the appertaining values. In this case, its symbol is placed in the top corners.

If no group of scans is selected (Scan count =1), the measurement currently being taken is indicated by means of a gap moving along the trace. If several traces are displayed on the screen (Scan count >1), the gap may no longer be visible; instead, the set sweep value is marked by an arrow on the X axis.

The current scan (with one or two traces) is selected with the PAGE UP/PAGE DOWN keys on the keyboard. The current value, ie the scan index, is indicated by a number between the out-of- tolerance field and the lefthand cursor-value field. The point of intersection of the cursor with the current trace (or pair of traces) is visually emphasized by means of a circle. It is thus possible to allocate the cursor values indicated in the windows unambiguously to the current scan.

With LIMIT check switched on (see 2.10.7, Limit Check), the tolerance masks are displayed, too.

An extensive command menu on the softkeys allows you to scale, zoom the display, select the cursor functions and to set markers on the single frequency lines or the harmonics of the FFT.

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The cursor can be moved and the softkeys can be operated only after the GRAPHICS panel has been selected using the front-panel key GRAPH or the key combination ALT-R.

The softkey menus have max. 3 levels. The extremely left key (labelled with ”BACK”) always returns to the preceding menu level. Its designation is indicated above the BACK softkey and constitutes together with the text displayed in center above the remaining 7 softkeys the heading of the current menu.

Some softkeys indicate ON or OFF states, where ◯ is the symbol for OFF and ◉ for ON.

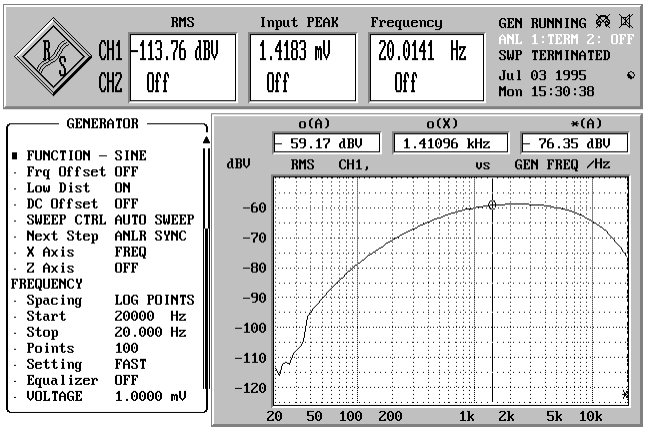

Fig. 2-50

The first two levels of the softkey menu tree are dealt with below. A third level, if any, is explained subsequently.

CURVE

A ◉

B ◯

switches the display of curves or lines on or off (toggle key). Display only is affected. (With TRACE A/B in the DISPLAY panel OFF, nothing can be displayed. Changing a function (using TRACE A/B in the DISPLAY panel) switches A and B to ON.)

AUTOSCAL

ALL

Rescales the X- and Y-axes using the present measured values of a sweep or the FFT. If there are no measured values, the preset range limits are used and scaled after the end of the sweep. The present display including the axes are deleted and subsequently redrawn (see also AUTOSCALE).

A

The left-hand trace-A axis only is rescaled, the A curve is redrawn.

B

The right-hand trace-B axis only is rescaled, the trace-B curve is redrawn. Ignored with SCALE B set to EQUAL A.

X

The X-axis only is rescaled (not with SPECTRUM and Analyzer FUNCTION THD, MOD DIST, DIM or DFD).

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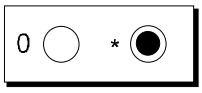


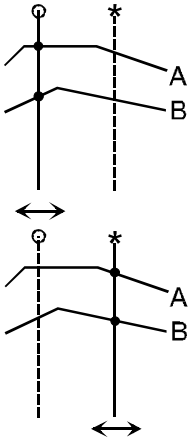
Switches alternately the * cursor or the o cursor active. The active cursor only can be moved using the rotary knob or the direction keys and can display the measured values. The softkeys pressed subsequently (HLINE, SET TO and ON/OFF) refer to the active cursor. The inactive cursor is displayed in short dashes.
The o-cursor is used for the ZOOM function and as reference for the *-cursor and horizontal cursor. The * cursor can be switched over to horizontal line (not with SPECTRUM).

*** CURSOR**

The subsequent softkeys serve to select the various cursor functions. The units of the numerical values are determined by the axis scaling.

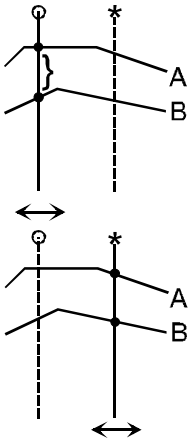
A , B

Display of the measured values of curves A and B at the cursor position as well as the appertaining X value.

Graphics	Labelling of display field	Selected softkey
	oA oB oX *A *B *X	oCURSOR A,B *CURSOR A,B

A - B

Display of the difference value between curves A and B at the position of the cursor and of the X value (useful only with identical physical variables).

Graphics	Labelling of display field	Selected softkey
	oA-oB (unit of A !) oX *A-*B (unit of B !) *X	oCURSOR A-B *CURSOR A-B

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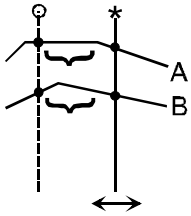
*** - o**

(With active *-cursor only). Display of the difference between the values at the positions of the *- and o-cursor on curve A (or curve B) and the difference between the X values.

Graphics	Labelling of display field	Selected softkey
	*A-oA *B-oB *X-oX	*-o

HLINE →

(With active * cursor and Operation Curve Plot only). Switchover of * cursor to horizontal cursor. This associated subsequent command level is explained below.

SET TO →

Sets the active cursor to specific values. This associated subsequent softkey command level is referred to below.

ON/OFF

Switches alternately the cursor on and off. A deactivated cursor is no longer displayed.

ZOOM

Zooms the display in X direction. The ZOOM function is not active with histogram indication (OPERATION SPECTRUM and simultaneously Analyzer FUNCTION THD, MOD DIST, DIM or DFD).

AT o UP

Zooms the display on the X axis by the factor 2 (repeated activation is possible). The center used is the o cursor which is then also placed in the center. Changes the LEFT and RIGHT parameters of the X axis in the DISPLAY panel.

AT o DOWN

Compresses the display on the X axis to half the size (can be pressed repeatedly). The o cursor is the center, which afterwards is in the middle. Changes the LEFT and RIGHT parameters of the X axis in the display panel.

CEN TO o

Sets the center of the X-axis of the new coordinate system to the value of the o-cursor without zooming. Changes the LEFT and RIGHT parameters of the X axis in the DISPLAY panel.

o TO *

The end values of the new (zoomed) X axis are predefined by the X-values of the two cursors which will subsequently be placed on these cursor values. Changes the LEFT and RIGHT parameters of the X-axis in the DISPLAY panel. In order to obtain a scrolling effect, the cursors can be shifted to X values outside the displayed range; the values continue to be displayed.

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UNZOOM

Restores the original X axis, defined by X AXIS LEFT and RIGHT. UNZOOM is also performed internally when modifying and setting a parameter which changes the X axis. Restores the original LEFT and RIGHT parameters of the X axis in the DISPLAY panel.

UNDO

Cancels the last ZOOM action (one-time).

MARKER

TRACEA →

TRACEB →

(With FFT only). Switches on the display of triangular markers above the marked measured value on trace A (or B) ON. The functions are on the next softkey level and described below.

MORE

SETREF

Sets reference values for the conversion of relative units in the softkey level described below.

The **functions of the third (and last) level** of the softkey menu is referred to in the following:

* CURSOR

HLINE

A

B

(With Operation Curve Plot (not with FFT) only)
The * cursor is switched over to horizontal line. Its Y value and the X values of its intersections with trace A (or B) are displayed, if available. If there are several intersections, the extreme, right-hand and the extreme, left-hand intersections are used. When changing its position via rotary knob or direction keys the cursor jumps from measured value to measured value, usually meeting exactly only 1 intersection (left or right). The, in each case, other (last) intersection is no longer valid and therefore marked "i" in the display. With softkey B, the intersections with trace B are displayed.

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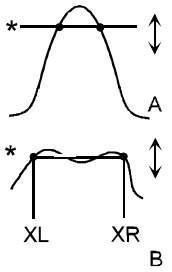
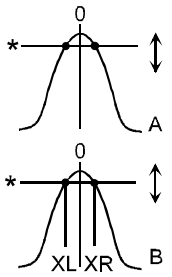
Graphics	Labelling of display field	Selected softkey
	*Y *XAL *XAR *Y *XBL *XBR	HLINE A HLINE B

Δ A

Δ B

The * cursor is switched over to horizontal line. The difference between its Y value and that of the o-cursor is displayed. The intersections with trace A or, as the case may be, trace B are displayed (see above). Use: simple measurement of the -3-dB points.

Graphics	Labelling of display field	Selected softkey
	oA-*Y *XAL *XAR oB-*Y *XBL *XBR	Δ HLINE A Δ HLINE B

MARKER

A

B

MAX

With FFT only; sets the first marker (triangle marked by X) to the maximum value of trace A (or B).

o-CURSOR

With FFT only; sets the first marker to the value defined by the o cursor. Trace A (or B) is used.

VIEW OFF

With FFT only; deletes the first marker on trace A (or B) and the harmonics.

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HARM ◉

(Harmonics) with FFT only; sets or deletes alternately the markers 2 to 9 of the harmonics (frequency multiples) of the first marker. The values of trace A (or B) are marked. With the first marker (triangle marked by ”X”) being on the fundamental wave, K2 to K9, for example, are marked.

CURSOR

SET TO

MIN A

MIN B

(Not with FFT). The active cursor is set to the minimum value of the sweep (in the displayed section). It is also displayed as the cursor value. The measured values of trace A (or trace B) are used.

IMAX A

IMAX B

(With FFT only). The active cursor is placed on the interpolated maximum, which may be higher than the values displayed (see 2.6.5.13 FFT). This value is displayed as cursor value, too.

MAX A

MAX B

The active cursor is placed on the maximum value of the sweep (in the displayed section). It is also displayed as the cursor value. The Y values of trace A (or trace B) are used.

MARKER

(With FFT only). The active cursor is placed on marker 1 of the FFT. Its value is then displayed as cursor value.

NEXTHARM

(With FFT only). The active cursor is placed on the next marker of the FFT. Its value is then displayed as cursor value.

MORE

SETREF

(Set Reference)
Sets the reference value TRACE A REFERENCE in the DISPLAY panel to the current value of the *-cursor. In this case, the cursor must not have HLINE function. Effective only with relative scaling units and causes trace A to be redrawn. Applies analogously to TRACE B, where SCALE B must not be set to EQUAL A.

A WITH *

B WITH *

A WITH o

B WITH o

Sets the reference value TRACE A REFERENCE to the current value of the o-cursor. In this case, the cursor must not have HLINE function. Effective only with relative scaling units and causes trace A to be redrawn. Applies analogously to TRACE B, where SCALE B must not be set to EQUAL A.

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2.10.3 Parameters for List Display (DISPLAY Panel)

TRACE A

Used to select which measurement results are to be collected during a sweep as TRACE A (or TRACE B), which are then displayed as a list of numbers in the GRAPHICS panel (graphics window).

TRACE B

FUNC CH1

(Function channel 1)
The results of the current measurement of channel 1, which has been selected in the ANALYZER panel by way of FUNCTION, are used. Possible only when FUNCTION in the ANALYZER panel is not OFF.

FUNC CH2

As above, however of channel 2.

FREQ CH1

(Frequency channel 1) Frequency meter channel 1. Possible only when FREQ/PHASE in the ANALYZER panel is not set to OFF.

FREQ CH2

Frequency meter channel 2. Possible only when FREQ/PHASE in the ANALYZER panel is set to FREQ.

PHASE

Phase meter between channel 1 and 2. Possible only when FREQ/ PHASE in the ANALYZER is set to FREQ&PHASE.

HOLD

Does not collect any new values but holds the old ones.
HOLD is only accepted as input if valid trace data or FFT data are provided.

OFF

Switches the display in the form of a list off.

FILE

DUAL FILE

A sweep stored to file in the FILE panel (STORE TRACE/LIST) can be recalled and displayed, eg for comparison purposes, using this option. The subsequent menu line is required for this purpose.
Also see 2.10.1, Trace A/B FILE and DUAL FILE.

GROUP DELAY

The group delay calculated from the phase is used.

FILE NAME

(Displayed with TRACE A/B FILE only). Enter the name of the file with a sweep or FFT to be displayed. If an error occurs during loading, NOT FOUND is output in this line.

UNIT

Determines the unit with which the results are to be displayed (see also Section 2.4 Units). Recorded sweeps can be reprinted at any time using any other unit.
When, after selection of a new function or a new instrument, the present unit can no longer be used, the units set for the measurement in the ANALYZER or GENERATOR panels are automatically adopted for the new function.

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REFERENCE	The reference value is required for the relative units and the limit curves.
MAX	The maximum value of the sweep is adopted once as reference value.
o CURSOR	The value the cursor is placed on is adopted once.
VALUE:	A numeric value with unit is entered. See Reference in section 2.10.1 for further settings.
...	

2.10.4 List Display (SWEEP/SPECTR LIST, SWP/SPC LIM REPORT)

The results of an FFT or a sweep are output as numbers using SPECTR LIST or SWEEP LIST. TRACE A, TRACE B and X AXIS are displayed in 3 columns which are complemented by a fourth column in which violations of the UPPER or LOWER LIMIT curve by the measurement result are indicated by way of arrows (triangles) pointing upward or downward. To this end, limit check must be activated in the FILE panel. In full-screen graphics mode, the LIMITS, if active (LIMIT CHECK not OFF), are indicated in additional two columns (interpolated in the case of intermediate values).

The symbol for the o-cursor is displayed in the left edge of the screen in the line with the value on which the cursor is placed (also with trace presentation). After a new picture has been set up the cursor is placed in the center and can be moved using the rotary knob or the direction keys. When the cursor reaches the edge of the picture, the display is scrolled line for line. Any new sweep deletes an old line replacing it by a new line.

As opposed to **SWEEP** or **SPECTR LIST**, **LIM REPORT** displays only those measured values exceeding the upper tolerance mask (LIMIT UP) or the lower tolerance mask (LIMIT LOW). Limit check must be activated in the FILE panel for this purpose. Any new sweep deletes the old display completely and sets it up anew from top to bottom. If there are more lines than can be displayed on the screen, the picture segment can be shifted using the rotary knob or the direction keys.

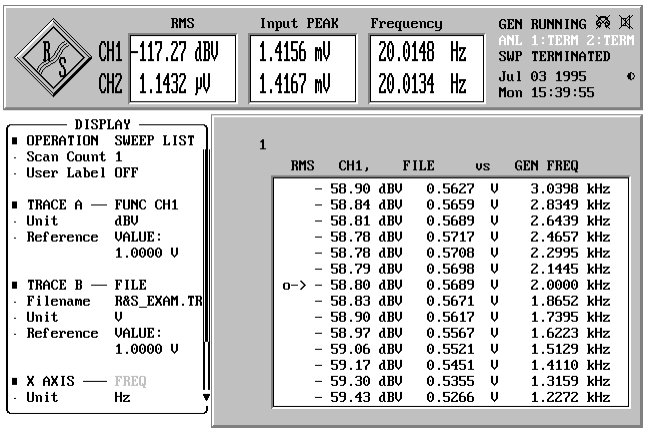

Fig. 2-51Page/ up/down : scan select

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2.10.5 Parameters for BARGRAPH Display (DISPLAY Panel)

BARGRAPH1

Used to select which measurement results are to be indicated as bargraph.

BARGRAPH2

FUNC CH1	(Function channel 1) The results of the current measurement of channel 1, which has been selected in the ANALYZER panel by way of FUNCTION, are used. Possible only when FUNCTION in the ANALYZER panel is not OFF.
FUNC CH2	As above, however of channel 2.
FREQ CH1	Frequency meter channel 1. Possible only when FREQ/PHASE in the ANALYZER panel is not set to OFF.
FREQ CH2	Frequency meter channel 2. Possible only when FREQ/PHASE in the ANALYZER panel is set to FREQ.
PHASE	Phase meter between channel 1 and 2. Possible only when FREQ/ PHASE in the ANALYZER is set to FREQ&PHASE.
OFF	Switches the display in the form of a list off.
GROUP DELAY	The group delay calculated from the phase is used.

BARGRAPH X

Displays the X value of the current sweep. If no sweep is active, the display contains, if possible
the phase, if phase measurement is switched on
frequency of channel 1 or channel 2 or generator frequency
(if selected generator function allows for frequency input),
if frequency measurement is switched on

UNIT

Determines the unit with which the results are to be displayed (see also Section 2.4 Units).

REFERENCE

The reference value is required for the relative units.

MAX	The maximum value is adopted once as reference value.
VALUE	A numeric value with unit is entered.
...	

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Scale

AUTO ONCE

Uses the minimum and maximum values for scaling (once) and rescales after changing the function using FUNCTION in the ANALYZER panel or TRACE A/B in the DISPLAY panel. The menu items LEFT and RIGHT are no longer displayed because they have been set in doing so. For BAR 3, the sweep start/stop values are adopted from the GENERATOR or ANALYZER panel.

MANUAL

Leaves the subsequent scaling to the user.

SPACING

LIN

Linear spacing of the display axis.

LOG

Logarithmic spacing of the display axis. With logarithmic units (dB) selected in UNIT, LIN only can be selected.

LEFT/BOTTOM

(With SCALE MANUAL,) sets the bottom left value of the display. Negative or 0-values are not permissible in combination with SPACING LOG or logarithmic (dB-) units.

RIGHT/TOP

(With SCALE MANUAL,) sets the top right value of the display. The value must be higher than that of LEFT. Negative or 0-values are not permissible in combination with SPACING LOG or logarithmic (dB-) units.

AUTOSCAL

ALL

Rescales the axes of BAR1 and BAR2 using the current maximum values of the measurement and BAR3 using the sweep start/stop values.
If there are no measured values, the range limits are used.

BAR1

BAR1 only is rescaled (otherwise as ALL).

BAR2

BAR2 only is rescaled (otherwise as ALL).

BAR3

BAR3 only is rescaled (otherwise as ALL).

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2.10.6 BARGRAPH Display (GRAPHICS Panel)

BARGRAPH indication is used to display the current measured values analogously in the form of bars. Bargraph display is suited for applications in which the relative magnitude or changes in magnitude are significant and not the exact value. A maximum of 3 bargraphs can be displayed. Values exceeding the displayable range are indicated by a triangular arrow on the left or right side.

The peak values measured in the monitoring interval (after Start) are marked by a pointer, identifiable by the thin line, its left end marking the minimum value, the right end the maximum value. The pointer can be reset using the Start key.

With limit check activated in the FILE panel (LIMIT not OFF), also the limit values (interpolated in the case of intermediate values) are displayed in the form of brackets. When changing the independent axis (eg the frequency with sweeps), the brackets are automatically set to the appropriate values. The bargraph changes its colour when violations of the limits occur.

The minimum and maximum values during the monitoring interval are displayed as numbers above the bargraphs. In full-screen mode, the difference between maximum and minimum value is indicated, too.

BARGRAPH3 represents the current X value of the set sweep, the measured frequency or phase or the generator frequency. The field remains empty when no sweep is started.

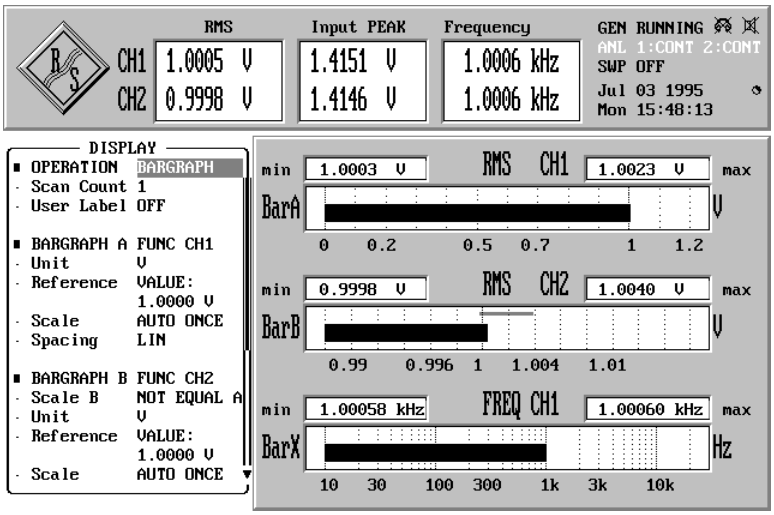

Fig. 2-52

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2.10.7 Limit Check

The following commands are available under the heading LIMIT CHECK in the DISPLAY panel which is called by pressing the DISPLAY key or the key combination Alt-D on the external keyboard.

A lower and an upper limit or, as the case may be, a limit curve can be defined for the measurement, each measured value of a sweep or an FFT being compared with the limits. With trace display, they are included in the coordinate system; with bargraph indication, they are marked by lines (varying in position). With SWEEP LIST, lines containing measured values out of tolerance are marked by a triangle. With LIM REPORT active, measured values violating the limits are indicated or stored. (See also OPERATION command in the DISPLAY panel in Section 2.10 and STORE TRACE/LIST in the FILE panel in Section 2.9.1.2.)

With CURVE PLOT, limit violations are marked in the top, left edge by an arrow pointing downwards (lower limit is violated) or by an arrow pointing upwards (upper limit or limit line is exceeded). A single exceeded limit marks the whole sweep as out of the tolerance. Overrange values are violations of the tolerances as opposed to underrange values.

When relative units are used, the limits are converted using the reference value in the DISPLAY panel.

Check

Determine the trace (or bargraph) to be checked.

TRACE A

Trace A (or BARGRAPH 1) or, optionally Trace B (or BARGRAPH 2) can be checked.

TRACE B

TRACE A + B

Both curves are checked together for limit violations. As there is only one tolerance band, this is only useful when the physical measured quantity is the same. To ensure this, this item can only be selected when Trace B QUAL A has been selected. The reference value of trace A is used.

Mode

LIM LOWER

The lower limit is checked.

LIM UPPER

The upper limit is checked.

LIM LOW&UP

The lower and upper limits are checked.

OFF

The limit check is switched off.

Lim Upper

Lim Lower

Determine how the lower/upper limit is set.

VALUE

A lower/upper limit value with unit, which is constant for all X values, is entered. With a relative unit, the appertaining reference value is taken over from the DISPLAY panel (TRACE A/B REFERENCE).

FILE

A lower/upper limit curve is specified.

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Filename

This serves to load the file with the limit curve. If mode LIM LOWER or LIM LOW&UP is switched on, the curve for the lower limit can be loaded with the extension .LLW added to the file name. In the UPPER or LIM LOW&UP mode, the file has the extension .LUP.
These files contain X-Y pairs, the Y value being a factor which is multiplied with the set reference value (TRACE A (or B) REFERENCE VALUE from the display panel) to obtain an absolute value. By changing the reference value, the tolerance mask of the Y scale can be shifted.
Since the following measurements are relative measurements there is no reference value and only the units % and dB are used: THD, THD+N, MOD DIST, DFD, DIM, WOW&FL.
In these cases the limit must be entered in %, eg 5 for 5% for the upper limit value, a lower limit (LIM LOWER) being not required.
Only a few sampling points are required. The intermediate values necessary for monitoring the tolerance of a sweep or an FFT are interpolated when the sweep is started. This requires the indication whether the X and Y axes are divided linearly or logarithmically, so that correct values can be calculated in the case of segments not running horizontally or vertically. These straight lines become elliptical segments in the other division, respectively. If points are required before or after the last sampling point, the last slopes to the interpolation are continued.
In the case of full-screen mode, the interpolated limit values are also indicated for every measured value in the graphics window with OPERATION SWEEP/SPECTR LIST or SWP/SPC LIM Report.

Note: *Up to version 1.15, the limit curves with OPERATION CURVEPLOT are also drawn as a curve in this interpolated form so that their resolution was coupled to that of the set sweep, with the entered sampling values being generally only exact when many sweep points were used. In later versions, the sampling points are always drawn independently of the set sweep.*
The file format is described in the example files R&S EXAM.LLW and R&S EXAM.LUP in the form of comments. The parameters of the sampling points are arranged in successive blocks, ie first the Y values, then the X values. In the files R&S E212.LLW and R&S E212.LUP the parameters are listed in pairs, ie Y and X values are in the same line.

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2.10.8 PROTOCOL Analysis

The digital analyzer does not only allow for measurement and display of the audio-data contents, but also for analysis of the transmitted information. This is the channel status and user data, the meaning of which depends on their application and protocol. Additionally, this protocol analysis includes display of other (transmission) errors.

The colours for the protocol can be changed in the OPTIONS panel under TRACES COLOR/LINE (see 2.15.5.4 Graphics Display with Selectable Colours)

OPERATION

PROTOCOL

PROTO AUTO

In what form the channel status or user data are displayed depends on which protocol file (Proto File) is selected.

The channel status data are visualized by automatic decoding of the professional bits:

- If bit #0 is set (professional mode), the protocol file for the professional mode R&S_AES3.PAC will be loaded. The remaining bits will be decoded in the professional mode.
- If bit #0 is reset (professional mode), the protocol file for the consumer mode R&S_CONS.PAC will be loaded. The remaining bits will be decoded in the consumer mode.

Note: *For the user data, the protocol file must always be explicitly named, ie if display of the user data is selected ('Source USER L' or 'USER R'), PROTO AUTO has the same effect as PROTOCOL.*

Screen display:

The screen (consisting of 16 lines, each with 50 characters) is divided into two sections:

TOP: Invariable elements in the protocol:

Validity: shows the state of the validity bit in the respective channel.

Parity errors: indicates the sum of parity errors that have occurred up to this point in time. This number is reset to zero on selection of a new analyzer or when pressing the start key.

Change: indicates any changes in the channel status data
- NO: no changes
- LTC: changes only in the fields 'local time code' (bits 112 to 143) and CRC (bits 184 to 191).
- YES: changes in any other bit position.

Other: shows whether the, in each case, other channel is the same or different.

Errors: indicates the errors that have occurred:
- UNEXP BB: unexpected preamble for beginning of block (too early)
- SQ BLOCK: missing (gap) preamble for beginning of block
- NOT LOCK: missing preamble for beginning of block
- PREAMBLE: invalid preamble
- SQ L/R: error in channel sequence (L/R)
- RATE ERR: measured clock rate and set rate deviate from each other by more than 200 ppm
- NONE: no error

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BOTTOM: These 13 lines can be matched to the currently used protocol with the help of a protocol control file.

The error counters Parity error, CRC – left and CRC – right can be reset by pressing the start key or reselecting the analyzer.
Changing status bits are displayed and output in red.
Bits that have not changed since the latest output are displayed in green.
Comments (PRINT command) are displayed in yellow.

Example:

Protocol Analysis: Channel Status Left

Validity:	R:0	L:1	Parity errors:	_____
Change:	YES	Other:EQUAL	Errors:	NONE
Byte:	= = = = = = =	AES3	= = = == = =	
0:	Format:	professional	Mode:	linear PCM
	Emph:	J.17	Source:	unlocked
	Rate:	48 kHz		
1:	Chanmod:	stereo	Usermod:	AES18
2:	Auxmod:	20 no	Length:	23/19 R:0
3-4:	Vector:	12	Grade:	2
	enh. Rate	not ind	Scaling:	1/1.001
6-13:	Origin:	UPD _	Destin:	R&S _
14-21:	Local:	01234567	Time:	12:45:00
22:	Reliabty:	0-5:1 6-13:0	14-17:0	18-21:0
23:	CRC L:	_____	CRC R:	_____
Measured sample rate: 48000.2				

↑ Text entered by UPD

↓ as up here: user defined

This example was generated with the protocol file R&S _ aes3.pac.

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Source Select the data to be displayed.

CHAN STAT L	Channel status data left are displayed.
CHAN STAT R	Channel status data right are displayed.
USER L	User data left are displayed.
USER R	User data right are displayed.

With CHAN STAT L or R, the following line is read out on the screen:

Proto File

Proto File selects the interpretation file for channel status data.
Selection from: file name, preset type of file: *.pac

Description:

The protocol information is displayed in two sections; the two upper lines are displayed in a fixed format and contain information on validity, parity, other errors and differences between the two channels. The other lines are formatted using the specifications in the file, the individual bits being assigned any output text you desire. This file can be modified to suit any protocol you desire.

Example: see R&S ⎯ AES3.PAC

File format: same as with USER DAT, see below

Note: This line does not appear in OPERATION PROTO AUTO; the correct protocol file is loaded instead.

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With USER DAT, the following lines are displayed:

FORMAT	Format selects the interpretation mode.
	Selection from: BINARY, HEX, ASCII, AES18
BINARY	User data are represented in a 01010 sequence. Representation is block aligned.
HEX	User data are represented as a hexadecimal, numerical sequence. Representation is block aligned.
ASCII	User data are represented as text. Representation is block aligned.
FILE	Interpretation, block aligned

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Proto File

Proto File selects the interpretation file for user data.

Selection from: file name, preset type of file: *.PAU

File format:

The protocol file has the following structure:

One line for each operation, followed by parameters which are separated by commas. The parameters allow the representation of any bits (1 to 32) from the selected data, the output position being freely selectable. Each line must not contain more than 255 characters.

Operations:

PRINT: Text output (independent of data)

Example:

PRINT 26, 5, "Usermod:"

(in column 26, line 5 the text "Usermod:" is entered)

VALUE: Output of values, either as hex number (default)
or
as text provided that an assignment is present.

Example:

VALUE 17, 3, BIT:2-4, 0="not ind", 4="no empf", 6="50/15 "

(in column 17, line 3, the contents of the three bits (2,3,4) are represented as hex (or text, in case the value is 0, 4 or 6)

VALUE 17,11, CRC _ L _ ERR

(in column 17, line 11, the contents of the CRC left frequency counter is represented)

As to the output width:
If there are text assignments, the largest text determines the output width; In case there are no text assignments, the number of bits to be represented determines the output width.

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As data source, the following specifications are permissible:

- 'BIT' followed by ':' and definition of the bits:
  - a number from 0 to 191: single bit
  - an interval (eg 4-9): combined sequence of bits, max. 32 bits permissible
- 'CRC _ L _ ERR':Internal error counter of CRC _ error left.
- 'CRC _ R _ ERR':Internal error counter of CRC _ error right.
- 'MEASURED _ RATE': measured sample rate (represented as 5.1-digit floating number (eg '48001.2')

BINARY: same as VALUE, however default output as bit pattern

TEXT: Text output (in ASCII) using a number of letters determined by the number of selected bits; Each TEXT operation allows only 32 bits to be represented; for longer text outputs, several subsequent text lines are to be used.

Example:

TEXT 17, 8, BIT:48-79
(in column 17, line 8, the contents of the 32 bits is represented as text)
Characters that cannot be printed are replaced by '?' or, if '0', by '.' .

TIME: Time output (in the form of 12:45:56) of the selected number divided by the specified rate. Number/rate are interpreted as seconds since midnight.

Examples:

TIME 35, 9, BIT:144-175, RATE:48000.0
TIME 35, 9, BIT:144-175, RATE:SET _ RATE

(in column 35, line 9, the contents of the 32 bits are represented as time (eg 12:34:45)

'RATE:' Should correspond to the sample rate, can be specified as floating number.
As an alternative, the following specifications are also possible:
MEASURED _ RATE: measured clock rate
SET _ RATE: clock rate set in the panel

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2.10.9 Switching between Full-screen and Split-screen Mode

Split-screen graphics mode offers you the possibility of complementing the graphical representation with a panel. The large measured value display on the upper screen edge is maintained, too. In full-screen graphics mode, the graphics has been scaled up to occupy the complete screen. The only differences between split-screen and full-screen mode are the two additional columns with the limits for the output of lists (SWEEP/SPECTR LIST and SWP/SPC LIM REPORT) and the display of the difference between minimum and maximum value with BARGRAPH, which are offered in full-screen mode only.

After having selected the GRAPHICS panel using the GRAPH key (or key combination Alt-R), you can choose between full-screen and split-screen mode using the front-panel key □◄►□ (or key combination Alt-Z) or by clicking the mouse (see also 2.3, G. Instructions for Use and 2.3.1, Panels).

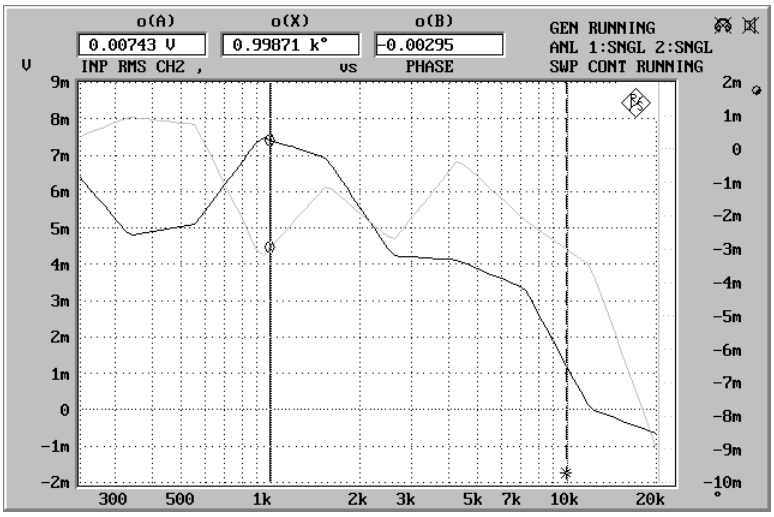

Fig. 2-53 Full-screen display

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2.11 Starting and Stopping Measurements or a Sweep

2.11.1 Overview of Measurement and Sweep Systems

Basically, a differentiation is made between measurements and sweeps:

- Measurements, in the narrower sense, are understood to be single or continuous measurements of frequency, phase, input peak, or one of the measurement functions. The latter include S/N measurements, which can be activated during the AC level measurement functions (rms, peak and quasi-peak), and in which the measurement is first performed with and then without a generator signal and the two results are then referenced to each other. The FFT function, too, is handled as a measurement, and so is the post-FFT function, which can be activated for some measurement functions although the relevant frequency lines are represented graphically or in the form of tables (similarly to sweeps).
- Sweeps are test runs in which the individual measurements are triggered by predefined generator or analyzer settings or by external events. Generator and analyzer sweeps are defined either by entering the start and stop values, the spacing and the points/step or by means of a sweep list. With both methods, a list of settings (along the X axis) is defined, which is executed after the sweep is started. In the case of generator sweeps, the list may be two-dimensional, ie include two variable generator parameters. This is referred to as Z sweep because the Z axis is swept in addition to the X axis. External sweeps (adjustable in the ANALYZER panel under "Start Cond"), on the other hand, have no fixed X axis. Instead, the X axis is defined by an external voltage or frequency or by a time tick. The sweep system will be activated when a sweep is switched on.

Measurements and sweeps are controlled by means of control keys START (Ctrl F5), SINGLE (Ctrl F6) and STOP/CONT (Ctrl F7), and by specific events referred to as abort events. The control keys and abort events control the measurement system when the sweep system is inactive (no sweep switched on). When the sweep system is active (generator, analyzer or external sweep switched on), the selected sweep is controlled by the control keys and abort events, and the sweep in turn controls the measurement system.

Abort event:

Definition:
Any event that renders a current measurement or sweep invalid. This includes modifications of settings in the GENERATOR, ANALYZER or FILTER panels and in the relevant sections of the STATUS panel.

Effects:

- The current measurement or sweep is aborted and restarted.
- A completed (single) measurement is restarted.
  (Note: This is valid only for manual control, no restart is made with remote or automatic control.)
- A completed (single) sweep is normally not affected to allow the user to record the individual scans of a multiscan trace with changed UPD settings. Only if the abort event causes two sweep settings to be changed (eg start/stop, number of sweep points), the sweep becomes invalid (status display at top right of display).

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2.11.2 Switching Measurement Modes On and Off

UPD can measure up to six parameters simultaneously and display them numerically or graphically. These parameters are:

- Measurement functions of channels 1 and 2
- Input peak, rms, or bit activity of channels 1 and 2
- Frequency of channels 1 and 2, or frequency of channel 1 and phase difference between channels 1 and 2

Measurement modes are switched off

- directly by user entries (channel selection, switching off of "Input Disp", "Frequency" or "Function" in the ANALYZER panel); this will be indicated by "OFF" in the window for the corresponding measured value,
- indirectly by selecting a test function, an analyzer instrument or an input that is not compatible with the selected measurement mode (measurement modes selected in the ANALYZER panel but not physically feasible, eg frequency measurement with the DC measurement function on, are marked by "------" in the window for the corresponding measured value).

In the (single) measurement mode, all measurement functions that are switched on and active are performed. A measurement is completed when all relevant results (including a settling period, if applicable) are available. Only then can a sweep be stepped or a triggered result be fetched in the remote control mode. This also means that the measurement speed of the UPD as a whole is determined by the speed of the slowest measurement mode or function. To achieve maximum measurement speed, it is recommended that only the measurement modes really needed be switched on.

Note:
Without the HIGHSPEED option UPD-B3, channels 1 and 2 are measured sequentially, which means that the time required for 2-channel measurements is twice that needed for 1-channel measurements.

The display of measured values can be switched off completely irrespective of the selected measurement mode. In this case, the status displays, too, are switched off. Switch-off is effected by selecting the "Meas disp" menu item in the OPTIONS panel or by pressing the Ctrl D hotkey on the external keyboard. Switch-off of the display results in a substantial reduction of measurement time. This mode is useful, for example, if only the generation or representation of sweep traces and spectra is of interest and not the output of individual measured values..

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2.11.3 Operating States of Measurement System (No Sweep Active)

The operating states of the measurement system are indicated (in the upper right of the display.)

ANL WAIT FOR TRIG: The analyzer waits for the trigger condition set with START COND (cf. 2.6.4).

ANL1: 2:

Status information separate for analyzer channel 1 | 2:

OFF:	channel switched off, no status information
SNGL:	single measurement running
CONT:	continuous measurement running
TERM:	single measurement terminated
STOP:	measurement interrupted

There are further messages indicating, for example, operating states relating to running measurements (eg RANG) or to terminated measurements (eg. OVER in case no valid result was obtained due to OVERRANGE).
See section 2.3.4 for further details on status displays.

Continuous measurements:
The system operates with continuous measurements as the default mode. The UPD is set to this mode after switch-on. The UPD goes through all active measurement functions asynchronously until one of the following events occurs:

- SINGLE key is pressed: Switchover to single measurements is made. A measurement already started will always be completed. When all measurements are completed, the system stops in the TERMinated status. To reactivate the continuous measurement mode, press START or STOP/CONT.
- STOP/CONT key is pressed: The current measurement is stopped and the system is brought to the STOP status. To reactivate the continuous measurement mode, press START key or press STOP/ CONT key again.
- START key is pressed: The current measurement is aborted, the non-return pointers and the min./max. values of the BARGRAPH as well as FFT averaging are reset, and the continuous measurement is restarted.
- Occurrence of an abort event: The current measurement is aborted and continuous measurement is restarted.

Single measurements:
Each type of measurement is performed only once, then the system stops in the TERMinated status. This status does not necessarily mean that a valid result was obtained. If an error occurs during a measurement, the message "Input? Press Show-IO" appears in the window for the corresponding measured value, and an NAN value (Not A Number, 9.97e37) is read via remote and automatic control. A single measurement will be restarted, after completion of the previous measurement, by pressing the SINGLE key or by the occurrence of an abort event.

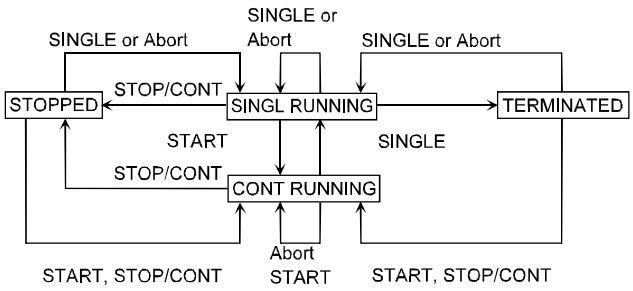

Fig. 2-54 Status diagram of measurement system (no sweep active)

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2.11.4 Overview of Sweep Modes

The UPD features a variety of sweep modes which are briefly described in the following:

Predefinable sweeps:

- Generator sweeps
  - Time-synchronous sweeps (DWELL sweeps)
  - Sweeps synchronized with the analyzer (AUTO sweeps)
  - Manual sweeps (MANU sweeps)
- Analyzer sweeps
  - Sweeps synchronized with the analyzer (AUTO sweeps)

External sweeps:

- Time-tick sweeps
- Time-chart sweeps
- External frequency sweeps
- External level sweeps
- External level trigger

All of the above sweeps can be performed as single or a continuous sweeps.

All predefinable sweeps can be performed as parameter sweeps with a constant increment or as list sweeps.

All generator sweeps can be performed as one-or two-dimensional sweeps (X or Z sweeps, respectively) provided that there is more than one sweepable parameter for the selected generator function.

External sweeps have no fixed X axis. The X value for each measurement point is determined during the sweep.

One-dimensional sweeps can be performed as one-pass or as group scans, two-dimensional sweeps can be performed as group scans only. Single or group scan can be selected under menu item "Scan count" in the DISPLAY panel:

- With count = 1, only one trace is shown for every sweep; the old trace is successively erased as the new trace is drawn.
- With count >1, all traces recorded as from START are superimposed on top of each other. The last 17 traces are internally stored and can be rescaled if required.

With manual sweeps, the GRAPHICS panel will be activated automatically when a sweep is started. After starting a sweep, each sweep point must be triggered separately by means of the rotary knob or the cursor keys. Sweep stepping has priority over the current measurement being performed, ie the generator will be set to the sweep point next selected even if the previous measurement is not yet completed.

External level trigger can be regarded as an intermediate between a sweep and a measurement. On the one hand, this function behaves like an external one-point level sweep, on the other hand, the measured value is not represented graphically, nor is it stored in a trace buffer.

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2.11.5 Switching Sweeps On and Off

The various sweep modes are selected directly in the associated panels of UPD:

- Generator sweeps under SWEEP CTRL in the GENERATOR panel
- Sweeps of the tracking filters of the RMS SEL function under SWEEP CTRL in the ANALYZER panel
- External sweeps under START COND in the upper section of the ANALYZER panel

Before a sweep is switched on, it must be ensured that no other sweep is active. If another sweep is active, an error message is output prompting the user to switch the sweep off that is not needed. This procedure appears to be cumbersome, it is however necessary for the following reason: A change of a (generator or analyzer) function or a tool may cause a second sweep to be activated. Would the first sweep be switched off automatically, this would confuse the user and, in many cases, produce an effect that is not desired.
After switching a sweep mode on, the measurement system will continue to perform continuous or single measurement; only by starting the sweep will the sweep system take over and control the measurement system. When switch-off is made during a running sweep, the system will go to the continuous measurement mode.

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2.11.6 Operating States of Sweep System

The operating states of the sweep system are indicated in the upper right of the display:

SWP OFF	sweep system switched off
SWP INVALID	sweep invalid due to changes of parameters or because sweep is not yet started
SWP CONT RUNNING	continuous sweep running
SWP SNGL RUNNING	single sweep running
SWP MANU RUNNING	manual sweep running
SWP TERMINATED	single sweep terminated
SWP STOPPED	sweep was stopped, can be continued.

Continuous sweeps:
Continuous sweeps are started by pressing the START key. When the stop value of a sweep is attained, restart is made from the start value. This is continued until one of the following events occurs:

- In continuous sweeps with Scan count >1: When the number of sweep runs defined in "Scan count" is completed, the sweep system goes to the "SWP TERMINATED" status.
  Note: *With Z sweeps, the number of Z-axis points is transferred to the DISPLAY panel as the lower limit of "Scans".*
- SINGLE key is pressed: Switchover to single sweep is made. The trace currently drawn is completed, then the system goes to the "SWP TERMINATED" status. To reactivate the continuous sweep mode, press START key. To activate the continuous measurement mode, press STOP/CONT key.
- STOP/CONT key is pressed: The current sweep, and the system, are stopped ("SWP STOPPED" status). To reactivate the continuous sweep mode, press START key (sweep is restarted), or press STOP/CONT key again (sweep is continued). To activate the continuous measurement mode, switch the sweep mode off.
- START key is pressed: The current sweep is aborted, the non-return pointers and the min./max. values of the BARGRAPH as well as FFT averaging are reset, and the continuous sweep is restarted.
- Occurrence of an abort event: The current sweep is aborted and continuous sweep is restarted.
- The sweep mode is switched off: Switchover is made to the continuous measurement mode.

Deviating from these general status transitions, there are the following
special conditions for some sweep modes**:**

- Level- or frequency-swept external sweeps: Trigger values that are closer to the start value by more than the difference relative to the latest measured value are detected as a retrace and the sweep is restarted.
- Level-triggered external sweeps: The level must fall below the start value after each externally triggered measurement for the level trigger to allow for the next measurement.
- All external sweeps: pressing the STOP/CONT key terminates the current sweep ("SWP TERMINATED" status). Continuation of that sweep is not possible (see 2.11.7 Operating and 2.6.4 Ways of Starting the Analyzer).

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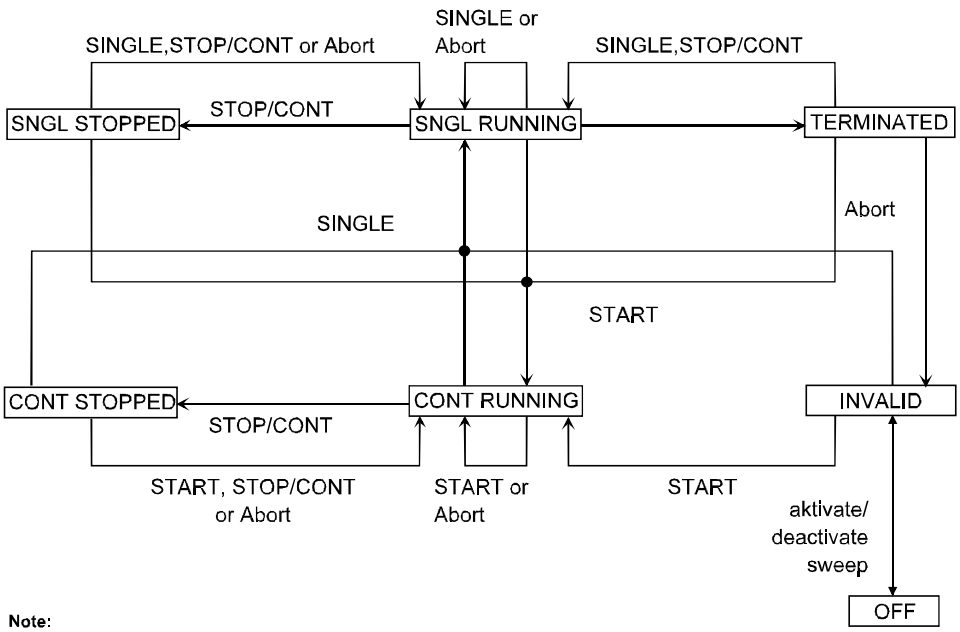

Note:
The states "SNGL STOPPED" and "CONT STOPPED" are briefly indicated in the status display with "STOPPED".

Fig. 2-55 State diagram of sweep system

Single sweep:
Single sweeps are started by pressing the SINGLE key and are performed only once. When the stop value (of the X axis) is attained, the system goes to the "SWP TERMINATED" status. With Z sweeps, therefore, each new Z point (and the corresponding X-axis sweep) must be triggered separately.
A running single sweep is stopped or aborted by one of the following events:

- SINGLE key is pressed: The current single sweep is aborted and then restarted.
- STOP/CONT key is pressed: The current measurement and the sweep system are stopped ("SWP STOPPED" status). To reactivate the single sweep, press the SINGLE key (sweep is restarted), or the STOP/CONT key again (sweep is continued).
- START key is pressed: The current sweep is aborted, the non-return pointers and the min./max. values of the BARGRAPH as well as FFT averaging are reset, and continuous sweep is started.
- Occurrence of an abort event: (see 2.11.1) The current single sweep is immediately aborted and then restarted.
- The sweep mode is switched off: Switchover is made to the continuous measurement mode.

After termination of a single sweep, the following can happen:

- SINGLE key is pressed: The single sweep is restarted.
- STOP/CONT key is pressed: Switchover is made to the continuous measurement mode. To reactivate the single sweep, press SINGLE.
- START key is pressed: The non-return pointers and the min./max. values of the BARGRAPH as well as FFT averaging are reset, and continuous sweep is started.
- Occurrence of an abort event (change of sweep configuration): The sweep system goes to the SWP INVALID status.
- The sweep mode is switched off: Switchover is made to the continuous measurement mode.

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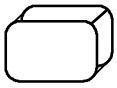
Deviating from these general status transitions, there are the following **special conditions** apply to some sweep modes**:**

- Level- or frequency-swept external sweeps: Trigger values closer to the start value than the last measured value are ignored. Trigger values beyond the stop value cause the current single sweep to be terminated (resulting in SWP TERMINATED status).
- Level-triggered external sweeps: A single sweep is considered terminated following the first externally triggered measurement (resulting in SWP TERMINATED status). Pressing the SINGLE key makes the level trigger ready for the next trigger event.
- All external sweeps: When the STOP/CONT key is pressed, the current sweep is terminated (SWP TERMINATED status). Continuation of that sweep is not possible.

Summary: Key functions

START

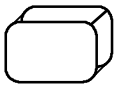


Start continuous or manual sweep (only with active sweep system, see 2.5.5.2 Sweeps) and active measurements.

Sweep system active:
Resets sweeps (peak-, average values and non-return pointers are reset and graphical representation deleted) and starts sweeps; new state: RUNNING
With manual sweep selected, any new sweep setting must be triggered using the rotary knob.
While the sweep is running, any entries in the GENERATOR, ANALYZER or FILTER panel or in the corresponding sections in the STATUS panel cause the sweep to be aborted. Permissible keys (not changing the state):
- LCD off
- softkeys
- rotary knob

Sweep system inactive (sweep state ”OFF”):
Resets measurements (averaging, peak-, average values and non-return pointers are reset) and (re)starts continuous measurement.

SINGLE



Sweep system active:
In the sweep states SNGL RUNNING, STOPPED, TERMINATED or "INVALID":
- Starts a single or manual sweep

In the sweep state CONT RUNNING:
- Switches from continuous to single sweep

Sweep system inactive (sweep state ”OFF”):
Key refers to single/continuous measurement:
- Analyzer state SNGL RUNNING, STOPPED or TERMINATED: starts a single measurement
- Analyzer state CONT RUNNING: switches from continuous to single measurement.

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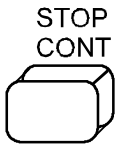

Sweep system active:
In the sweep state CONT RUNNING or SNGL RUNNING:
- Aborts the sweep; new state: STOPPED
- Analyzer is switched to "wait for trigger".

In the sweep state STOPPED:
- Continues the sweep without reset; new state: SNGL RUNNING or CONT RUNNING

In the sweep state INVALID or TERMINATED:
- Continuous measurement is started.

Sweep system inactive (sweep state OFF):
Key refers to single /continuous measurement
- Analyzer state ...RUNNING: aborts the measurement immediately
- Analyzer state STOPPED or TERMINATED: starts continuous measurement.

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2.11.7 Operating Modes of External Frequency or Level Sweep

With external sweep, the analyzer has to decide independently, whether a new measured value is applied, which is to be recorded and displayed. It is important that the X axis is continuously rising or falling. A reversal of the sweep direction must be interpreted as retrace or ignored. The question is: when does a new sweep begin and what are "come-offs" which can be ignored.

The following settings are of importance for an answer:

Start condition
Stop condition
Possibly settling
Starting the measurement using the Start key
Terminating the measurement using the Stop key

- An external sweep which is started using the **Single** key starts as soon as the start condition is reached and terminates after the stop condition has been reached. "Terminated" is then displayed, ie, the sweep is terminated. In order that the end of an external sweep will be recognized, the stop condition must be set such that it can be recognized with certainty. For example, by a frequency sweep up to 20 kHz, the stop condition must be set a little before 20 kHz, which means that the entire length of the sweep cannot be acquired. In the case of a Single measurement, measured values are only plotted in ascending order. Stray measurement values which would lead to a backward signal are ignored. In this operating mode, it is recommended to set Scan count to 1 in the DISPLAY panel.

- An external sweep which is started using the **Start** key starts as soon as the start condition is reached and is not terminated automatically. Every discontinuity in the measurement sequence or the reaching of the stop condition causes the actual sweep to be aborted. If the start condition is again satisfied, the trace up to this point is completely deleted and a new sweep is plotted. In this operating mode it is thus not allowed that an external sweep contains any stray measurement values which would lead to a backward signal. If the stop condition is set such that it is never reached (e. g. to 25 kHz when the sweep only goes up to 20 kHz), the external sweep is actually plotted up to the last measured point. If several external sweeps should be measured in a quasi-continuous operating mode and displayed, the display mode Scan count >1 must be selected in the DISPLAY panel. Each new sweep start then increments the scan index, all sweeps are simultaneously displayed and can be evaluated.

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2.11.8 Several Sweep Traces Displayed in a Diagram

To be able to compare different sweeps, it is useful to display them in a single diagram. This can be done in different ways in the DISPLAY panel:

***Note**: Unless specified otherwise, a generator frequency sweep without Z sweep is assumed for all examples:*

SWEEP CTRL	AUTO SWEEP
X axis	FREQ
Z axis	OFF

1. Two separate traces can be displayed with an identical or different Y axes. Each trace may contain up to 17 single scan curves. Provided they contain dimensioned values, the traces may be referenced to each other so that the deviation of each sweep point can be directly read (e.g. in dB).

TRACE A	FUNCT CH1
Unit	dBr
Reference	OTHER TRACE
TRACE B	FUNCT CH2
Unit	V
Reference	VALUE

   Trace B is displayed in V, Trace A is referenced to Trace B and displayed in dBr.

2. A trace file containing the sweep trace or a trace group of a previous (reference) measurement can be loaded into each of the two traces. Thus it is possible to compare

   – a currently measured sweep trace to a reference trace, or

TRACE A	FUNCT CH1	
TRACE B	FILE	
Filename	ref2trcb.trc	(contains 1 mono scan, for instance))

   – two previously measured and stored sweep traces.

TRACE A	FILE	
Filename	ref2trca.trc	(contains 1 mono scan, for instance)
TRACE B	FILE	
Filename	ref2trcb.trc	(contains 1 mono scan, for instance)

3. Each trace can be referred to a reference trace. In this case the trace is displayed with the selected *relative* unit. Two traces of this kind can be simultaneously displayed in one diagram.

TRACE A	FUNCT CH1	
Reference	FILE	
Filename	ref3trca.trc	(contains 1 mono scan, for instance)
TRACE B	FUNCT CH2	
Reference	FILE	
Filename	ref3trcb.trc	(contains 1 mono scan, for instance)

   The SINGLE key starts a 2-channel sweep measurement

4. Within one trace, a group of up to 17 scans can be processed, i.e. rescaled and stored. Any number of scans can be displayed; the number can be specified under Scan Count. Each scan can be triggered using the SINGLE key. After each scan (TERMINATED is indicated as sweep status), the user may not only change settings on the DUT but also any parameter on the UPD (except sweep parameters). Thus it is possible, for instance, to record a scan in another measurement mode (THD all even, THD all odd) or with another measurement function (THD, THD+N), provided the basic unit of the measurement function is not changed. (It is not possible, for instance, to make up a trace with scans of RMS measurements and THD measurements.) The measured curves can also be stored as a single trace.

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Scan Count	3
FUNCTION	THD
Meas Mode	ALL EVEN
SINGLE key starts	scan #1
Meas Mode	ALL ODD
SINGLE key starts	scan #2
FUNCTION	THD+N/SINAD
Meas Mode	THD+N
SINGLE key starts	scan #3

***Notes**:*

- *If Scan Count > 17 is selected, only the last 17 of the recorded scans can be processed. Previous scans are only visible on the screen and lost during rescaling or storing..*
- *Pressing the START key clears all previously recorded or loaded scans.*
- *To clear previous scans and to record a single one, press the START and then the SINGLE key*

5. Using the SINGLE key, scans may be added to a multiscan trace or individual scans can be replaced, provided a valid sweep is set. By loading a stored (reference) multiscan trace (dual traces are also possible), a new sweep measurement can be added to the curves of a reference trace (and stored).

Scan Count	10	
TRACE A	DUAL FILE	
Filename	ref5trc.trc	(contains 5 stereo scans, for instance)
TRACE A	FUNCT CH1	
SINGLE key starts	scan #6	

***Note**: Pressing the START key clears all previously recorded or loaded scans.*

6. Single scans can be loaded together with a measured or loaded multi- or single-scan trace provided the X and Y axes are compatible.

Scan Count	10	
TRACE A	DUAL FILE	
Filename	ref5trc.trc	(contains 5 stereo scans, for instance)
Filename	ref61trc.trc	(contains 1 stereo scan, for instance)
Filename	ref62trc.trc	(contains 1 stereo scan, for instance)
Filename	ref63trc.trc	(contains 1 stereo scan, for instance)
Filename	ref64trc.trc	(contains 1 stereo scan, for instance)
Filename	ref65trc.trc	(contains 1 stereo scan, for instance)

This (stereo) multiscan made up to 10 stereo scans can be stored again under a new file name (under STORE TRACE A+B in the FILE panel).

***Note**:*

When combining a multiscan and several single scans, the multiscan must be loaded first. Combining two or more multiscans is not possible.

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7. Single scans can be loaded or recorded together with an existing Z sweep. For this purpose Z sweep must be switched off in the GENERATOR panel after completion and Scan Count be increased by the number of additional scans.

Z axis	VOLT	(in GENERATOR panel)
POINTS	10	(in GENERATOR panel)
Scan Count	10	(display only)
TRACE A	FUNCT CH1	
TRACE B	FUNCT CH2	

   The START key triggers the Z sweep. When the sweep is terminated:

Z axis	OFF	(in GENERATOR panel)
Scan Count	12	
TRACE A	DUAL FILE	
Filename	ref71trc.trc	(contains 1 stereo scan)
Filename	ref72trc.trc	(contains 1 stereo scan)

Note:

Only single scans (mono or stereo) can be recorded or loaded with a recorded or loaded multiscan.

8. When a setup stored as ACTUAL+DATA contains a complete sweep, the setup is loaded with all its recorded sweep traces. The sweep can be continued with the SINGLE key provided a sufficiently high Scan Count has been set.

   Thus an ACTUAL+DATA reference setup can be created, for instance, to which the sweep trace of the DUT can be added. This new trace group can of course be stored again as an ACTUAL+DATA setup or as a multiscan trace file.

Note:

The START key clears all previous sweep traces.

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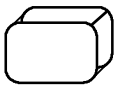
2.12 Display of Selected Inputs / Outputs

SHOW I/O



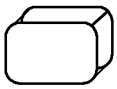
Shows a picture of the UPD front panel; the active inputs and outputs are marked by arrows.

The LC display shown indicates which inputs and outputs have been selected on the UPD rear panel.

Pressing the key while the message ”Input? Press SHOW I/O” is being output in (at least) one of the measured value displays causes the messages on measurement errors, which may have occurred, to be displayed, too (see Section 2.3.5 Error Messages).

2.13 Fast Switch-off of Outputs

OUTPUT OFF



Switches all outputs off (incl. the clock lines of the digital interfaces).

States:
- Digital outputs are of high resistance; no clock.
- Analog outputs are terminated (impedance is retained); output level = 0 V.
- Digital inputs supply no clock.

When switched off, the lines can be reactivated only by pressing the OUTPUT OFF key again.

An LED indicates the state of the key. LED on signifies OUTPUT OFF.

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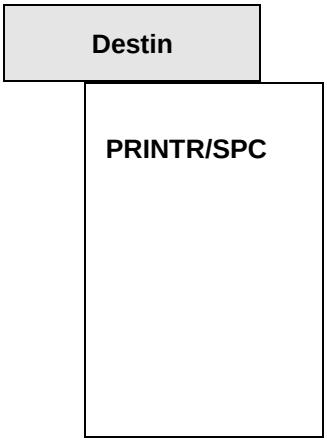
2.14 Printing / Plotting / Storing the Screen Contents (OPTIONS Panel)

Use the H COPY (hardcopy) key on the front panel to initiate printing, plotting or storing to file of the screen contents displayed at the instant the key is pressed.

The following menu items are available in the OPTIONS panel under the heading SCREEN HARD COPY.



(Destination) indicates where and in which format the printout should be performed. The printout is triggered with the H COPY key (see below):

Graphics are output in the form of pixel data to a printer using its special print format (abbreviation **SP**e**C**ial). Printing is performed in the background while the UPD is accomplishing other tasks.

Note: *Printing is in progress in the background while the UPD is performing further measurements. This output can be accelerated by stopping the measured value output or the sweep using the STOP/CONT key.*

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Destin (*continued*)

PLOTTR/HPGL

Control characters are output in HP-GL format, a language specifically defined for plotters, yet also supported by some printers (see Destin = PRINTR/HPLG below). HP-GL format offers the advantage of the resolution being determined by the output unit instead of by the UPD screen (slashes without disturbing stages). The size of the output is defined by the configuration of e.g. the plotter as all vectors are plotted relative to the configuration (see under P1, P2 ”point” and ”size/rotate” in the plotter manual).

FILE/PCX

Screen hard copy to a file using PCX format.
The PCX format (pixel format) was defined by the ZSoft company for PC Paintbrush and is accepted by most programs capable of loading graphics (MS WINDOWS programs and others).

FILE/HPGL

Screen hard copy to a file using HP-GL format.

Apart from most plotters (eg R&S DOP 2), some laser printers and some programs with graphics import capabilities also understand the HP-GL format. It is vector-oriented and offers the advantage of the resolution being determined by the output unit instead of by the UPD screen (slashes without disturbing stages). In addition, the size of the output is defined by the configuration of eg the plotter as all vectors are drawn relative to the configuration (see also plotter manual).

Note: *If HPGL data are to be used as a drawing in other programs, the result obtained is not always optimal. A few widespread (Windows) programs ignore e.g. the text format instructions or do not properly present the colour and the dashed lines. Therefore, programs are available on the market for matching and printing purposes.*

PRINTR/HPGL

Screen hard copy to a printer using HP-GL format.
Control characters are output in HP-GL format, a language specifically defined for plotters, yet also supported by some printers.
In most cases printers have to be enabled to interpret HPGL information by a sequence. This prolog is provided in a prolog file with the name GL_PRO.LOG. There is also a file with the name GL_EPI.LOG for the epilog. These files are located in the UPD\REF directory and may be changed by the user. For each character to be sent the files contain 1 - 3 (ASCII-) characters with following space interpreted as 1 Byte in decimal notation. As example the files HPLJ3_P.LOG and HPLJ3_E.LOG are delivered which initialize and reset the printer laserjet3 as desired.
All files mentioned can be found in the subdirectory \UPD\REF.

PRINTR/PS

Screen hard copy to a printer using PostScript format.

FILE/PS

Screen hard copy to a file using PostScript format.

FILE/EPS

Screen hard copy to a file using encapsulated PostScript format.
Colors and line styles for PostScript Outputs see 2.14.4.1 PostScript Configuration File PS.CFG

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Copy

(With Destin PLOTTR/HPGL, FILE/HPGL, PRINTR/HPGL, PRINTR/PS, FILE/PS and FILE/EPS only)

SCREEN

The complete screen contents is output, including all labels and cursor displays as well as the curves/bargraphs with scales. In part-screen graphics mode, the display of the current measured values and a panel are additionally included. The softkeys and operator guidance line are masked out and replaced by date, time and R&S logo.

CURVE/GRID

The curves/bargraphs including the scales and scale labels are output, however not the cursors and other labels.

CURVE

The curve(s) displayed on the screen are transmitted only, thus reducing the time required for output.

Note: *If the 3-panel display is selected, an UPD PostScript copy is* ***not*** *prepared for CURVE/GRID and CURVE (empty space) as this display does not contain a trace.*

Default: SCREEN

Printname

(With Destin PRINTR/SPC only)

drivername

For most laser and ink-jet printers as well as for dot-matrix printers with 9 or 24 pins, a printer driver can be selected as described below which converts the internal graphics (pixel-) format into control characters for the connected printer with graphics capabilities.
To print out in colour, select the appropriate colour printer (colour). Otherwise select the type (B/W). The R&S PDN printer corresponds to the type Fujitsu DL 2000 series.
If the new printer drivers, version 2.11 and later are used, it is possible that the size of figures printed out will be different than they previously were. The size of the print-out can be set by selecting a different resolution with the new command Prn Resol and the commands X Scaling and Y Scaling. The size of the print-out can be read out in cm with Prn Width and Prn Height. Because it is possible that a changed resolution Prn Resol can change the background colour of the frame of the GRAPH panel and of the measurement result display field such that any text no longer stands out enough, the colour of the background can be switched to white using the new command Frame Col.

Printer 0 (default printer) has a particular meaning. It represents the printer which the user selected last. Loading a setting from file (SETUP) does not overwrite the type selected by the user, if this printer 0 is set in the setup.

Note: *Printing is performed in the background while the UPD is already carrying out further measurements. To speed up the output, stop the measured value output or the sweep using the STOP/CONT key.*

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FrameCol

(Only with Destin = PRINTR/SPC, FILE/PCX, PRINTR/PS, FILE/PS, FILE/EPS)

Selecting the background colour of a GRAPH panel frame and the measurement result display for printing out the display contents or copying them to a file.
WHITE should be selected if a grey background is too dark for easy reading.

WHITE

White

FILE DEF

Colour defined in files.
Destin = PRINTR/SPC, FILE/PCX
Colour No. 2 (backgrnd frames) defined in files UPD\REF\PRN_BW.PLT (BW printer) or \UPD\REF\PRN_CL.PLT (colour printer) is used.
Destin = PRINTR/PS, FILE/PS, FILE/EPS
The colour information for the frames of the GRAPH panel is taken from the PostScript configuration file \UPD\REF\PS.CFG, key word "Background Frame Color" .

Default: WHITE

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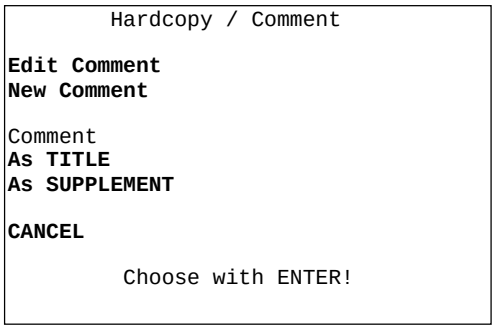
Comment

(Only with Destin PRINTR/SPC, PRINTR/PS, FILE/PS, FILE/EPS)
Defines if a comment is to be printed together with the screen contents.

ON

Destin = PRINTR/SPC:
After pressing H COPY (CTRL F8), a selection box appears with the following options: create comment, edit comment, and generate screen hardcopy.

Destin = PRINTR/PS, FILE/PS, FILE/EPS
Pressing the HCOPY key causes a window to be opened, where text can be entered or edited and a selection can be made whether the text should be inserted as a headline (TITLE) **above** the UPD plot or as a comment (SUPPLEMENT) **below**:



TITLE and SUPPLEMENT cannot be entered simultaneously.

Two text lines in Times New Roman Bold are reserved for the TITLE. A variable number of text lines (5 to 28) in Times New Roman can be entered as a SUPPLEMENT, depending on the orientation (`PORTRAIT | LANDSCAPE`) and the selected number of plots per page (`Plots/Page`). (See gray areas in the drawing under plots/page further down).

OFF

After pressing H COPY, a screen hardcopy is generated without a comment.

Default: ON

Left Mrgn

(Only with Destin PRINTR/SPC)
Margin of a hard copy

Specified range: 0 to 80 characters

Note: *Not all printers support the positioning of the graphics printout!*

Default: 10

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Prn Resol

LOW

MEDIUM

HIGH

(Only with Destin PRINTR/SPC)

Whether a resolution can be set and which one depends on the printer used. The resolution affects the size of the printing format. The actual size of the printing format is shown in the lines Prn Width and Prn Height.

Low resolution (*e.g.* 75 dpi)

Medium resolution (*e.g.* 150 dpi)

High resolution (*e.g.* 300 dpi)

Default: HIGH

X Scaling

Y Scaling

(Only with Destin PRINTR/SPC)

Each printer has a specific resolution in dots/inch of the X and Y axes which, in conjunction with the screen resolution, may not always yield a suitable print format. To obtain a well-balanced ratio for the X and Y axes and to make optimum use of the available sheet area, some printers require scaling of the X and Y axes (preferably in integer multiples), as well as the assignment of a suitable print format (landscape or portrait).

Note: *When using non-integer multiples, pixels are suppressed or printed several times, which may degrade the quality of the hardcopy.*

The actual size of the printing format is shown in the lines Prn Width and Prn Height. For an orthomorphic projection, a width/height ratio of 640/435 = 1.47 must be set.

Specified range: 0.1 to 10 for X and Y axes

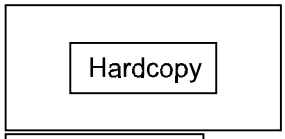
Orientatn

LANDSCAPE

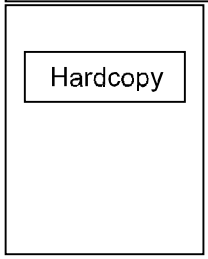
PORTRAIT

(Only with Destin PRINTR/ SPC, PRINTR/PS, FILE/PS and FILE/EPS)

= Horizontal format



= Vertical format



Note*: PostScript printouts (up to 6 pictures/page) are automatically placed optimal with no regard to selected orientation; see Plots/Page below!*

Default: LANDSCAPE

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Color

(Only with Destin PLOTTR/HPGL, FILE/HPGL, PRINTR/HPGL, PRINTR/PS, FILE/PS and FILE/EPS)

ON

Destin = FILE/HPGL:
Information is stored **in colours** in the file referred to as "Filename".

Destin = PLOTTR/HPGL, PRINTR/HPGL:
Relation of colors to **color pens** see 2.14.2 Output in HP-GL Format

Destin = PRINTR/PS, FILE/PS and FILE/EPS
Information, which scan or which line will be painted in which color, in which line style and in which line width, is taken from file C:\UPD\REF\PS.CFG (see 2.14.4.1 PostScript Configuration File PS.CFG).

OFF

Destin = FILE/HPGL:
Information is stored in **black-and-white** mode in the file referred to as "Filename".

Destin = PLOTTR/HPGL, PRINTR/HPGL:
Only **one color pen** is used.

Destin = PRINTR/PS, FILE/PS and FILE/EPS:
Curves, bargraphs and linegraphs in gray shades. Information, which scan or which line will be painted in which **shades of gray**, in which line style and in which line width, is taken from file C:\UPD\REF\PS.CFG (see 2.14.4.1 PostScript Configuration File PS.CFG).

Default: OFF

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Filename

(with destinations FILE/PCX, FILE/HPGL, FILE/PS and FILE/EPSonly)
Filename under which the PCX, HPGL or PostScript information is stored.

Destin = FILE/PCX
A PCX file with the extension *.PCX is created under the specified file name.

Destin = FILE/HPGL
A HPGL file with the extension *.GL is created under the specified file name.

Destin = FILE /PS:
A PostScript file with the extension *.PS is created under the specified file name. This file can be sent in DOS (e.g. `copy TEST.PS PRN:`) to a PostScript printer.

Destin = FILE /EPS:
An Encapsulated PostScript-File with the extension *.EPS is created under the specified file name. It differs from a *.PS file only in the first and second line (printed in bold in the example below):

Example:
`%!PS-Adobe-3.0` **`EPSF-3.0`**
`%%BoundingBox: 45 205 559 733`

The BoundingBox contains information about dimensions and position of the image in the PostScript default coordinate system in pixels (one pixel = 1/72 inch = 0.35 mm) and informs the program executing the image integration on the size and position of the plot.
Data **`45 205 559 733`** from the above example specify the X and Y coordinates of the bottom left-hand and top right-hand corner of the plot in the PostScript default coordinate system.

To avoid this name having to be entered in the OPTIONS panel every time a printout is triggered, the user is queried on storing a file under the name of an already existing file, whether

- this file should be overwritten as from now (without any further query),
- the file should **not** be stored (and therefore not overwritten),
- a new file name should be generated by an automatic increment of the (end) number of the file name displayed in the OPTIONS panel.

Notes on automatic increment:

- If the name does **not** contain a number, **one** number is added (starting with 1).
- If the filename contains **at least one** number, the numbers are considered spacers and incremented as long as there is no filename overflow (new filename contains more characters than the original one).
- When the last possible number is exceeded, an error message is output.

Examples for automatic increment:

SCREEN.PCX	→ SCREEN**1**.PCX	...	SCREEN**9**.PCX
SC**1**BW.PCX	→ SC**2**BW.PCX	...	SC**9**BW.PCX
SC**06**COL.PCX	→ SC**07**COL.PCX	...	SC**99**COL.PCX

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Plot on

(With Destin PLOTTR/HPGL, PRINTR/HPGL and PRINTR/PS only)
Select the interface for HP-GL output.

COM2

The printer is connected to the serial COM2 interface (RS-232). Data transmission parameters for transmitter (UPD) and receiver (printer) must be identical. The parameters are set in the UPD with the COM2 PARAMETER commands in the OPTIONS panel and on the printer normally by means of slide switches.

LPT1

Some plotters and most of all printers can also be operated using the (parallel) printer interface. This setting is required especially for laser printers with HP-GL interpreter or PostScript printer.

IEC BUS

Some plotters and printers offer an IEEE-Bus interface. The bus address of the plotter/printer is set with the subsequent menu line 'IEC Adr.'

Default: COM2

IEC Adr

(With Destin PLOTTR/HPGL or PRINTR/HPGL only, if 'Plot on = IEC Bus' is selected)

IEEE-Bus address of plotter or printer connected.

Prn Width

(Only with Destin PRINTR/SPC, display function only)
Width of the printing format in cm.

An orthomorphic projection of the printing format results when the width/height ratio is 640/435 = 1.47 (435 is the height of the printing format in pixels without the softkey row).

Prn Height

(With Destin PRINTR/SPC, display function only)
Height of the printing format in cm.

Paper Size

(With Destin = PRINTR/PS, FILE/PS or FILE/EPS only)
Paper format

A4

The UPD plots are optimally positioned for paper format A4 (21 cm * 29.6 cm) and made up of 600 * 845 pixels (one pixel = 1/72 inch = 0.35 mm) in the PostScript default coordinate system.

LETTER

The UPD plots are optimally positioned for paper format LETTER (21.6 cm * 27.9 cm) and made up of 617 * 797 pixels.

Default: A4

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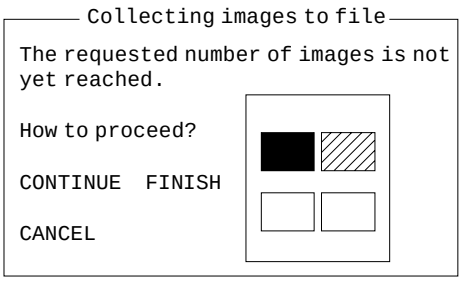
Plots/Page

Number of UPD plots to be positioned on a PostScript page.

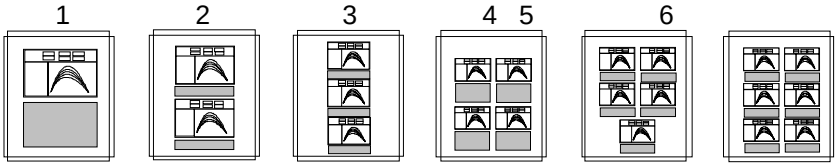
When two or more UPD plots (Plots/Page≥ 2) are printed on a page, the HCOPY key opens up a window where the page to be printed and the positions of the UPD plots are displayed:



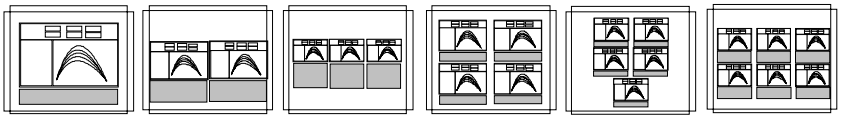
Filled-out box: the image has been already positioned
Hatched box: this image is being processed
Empty box: these images remain to be positioned

This window also allows the PostScript output to a printer or file to be aborted. Already positioned images are retained.

Automatic positioning, depending on paper orientation:
Orientatn = PORTRAIT



Orientatn = LANDSCAPE



Specified range: 1 to 6
Default: 1

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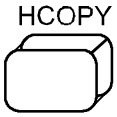

(CTRL F8)

If Comment OFF is selected, pressing H COPY triggers a hardcopy without comments.

If Comment ON is selected, a dialog box opens after H COPY has been pressed. It is then possible to create a new comment for the printout, to edit an existing one or to actually trigger the hardcopy. In this box it can also be decided whether the hardcopy should be printed

- with or without comment
- with or without form feed.

***Note**: With form feed suppressed, several screen copies may be printed on the same page.*

While a print procedure is in progress, pressing H COPY opens a dialog box where the printer output can be stopped or continued. A new screen copy can only be started after the previous one has been either terminated or aborted.

There are 4 kinds of outputs available; the user can determine the colour representation in different ways:

2.14.1 Screen Copy to Printer (pixel-oriented)

If dialog or selection boxes are active on the screen, their content is printed too. Thus particularly error messages or help texts can be printed.
Besides, an additional comment of max. 1500 characters can be entered via a dialog box and also printed out. This comment is also stored as additional file under the same name but with the extension ".CTX" when a COMPL SETUP is stored and loaded, too, when this setup is loaded. The comment file can be edited using a text editor.
Specify the type of device used for printout of the hard copy in the OPTIONS panel. Activate this panel by pressing the OPTIONS key or key combination ALT-O on the external keyboard.

If display of the cursors and their associated values in the display fields is not desired, the pointers can be switched off. Select OFF in the softkey menu under *-cursor and o-cursor.

Starting a screen copy:

Press the H COPY key (or CTRL-F8 on the external keyboard) if **no** printout is in progress. UPD requires a few seconds to prepare the screen copy and then continues with the measurements while printing is taking place in the background.

Different dialog boxes may be displayed when the hardcopy key is pressed:

- "Printer not ready" (error message):
  The connected printer is not switched on, it is OFF-LINE or the printer is not connected at all. After eliminating the fault, hardcopy can be restarted.

- "Hardcopy already in progress!":
  A screen copy is being made. Prior to starting a hardcopy the previous procedure must be terminated or interrupted.

- "Hardcopy / Comment".
  A comment or form feed can be added to the screen copy. If this is not desired, the dialog box can be blanked by selecting "Comment OFF" in the OPTIONS panel.

Speeding up a screen copy:

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A hardcopy is in progress in the background while the UPD continues with the measurements. Copying can be speeded up by stopping the result output or sweep with the STOP/CONT key.

The print command can be output via remote control using the HCOPy:WAIT command. In this case printing is performed in the foreground and the time required for printing only depends on the speed and the buffer size of the printer. The program is continued when the printing procedure is terminated. This mode is recommended when several copies are to be made in succession as in this case it can be ensured that a new copy is only started after the previous one has been completed.

Aborting a screen copy:

A stroke of the H COPY key during printing opens a dialog box with the aid of which the current copy procedure can be stopped. Printing is stopped while the dialog box is displayed on the screen.

- If the procedure is aborted **before** the actual printout is started, i.e. during its preparation, the printer output is not started.
- If the procedure is aborted while the printout is **in progress**, all characters sent to the printer before the stop will be printed. The printout of these characters, which are already in the printer buffer, can only be stopped at the printer itself, i.e. by switching the printer off.

Colour handling

Pixel-oriented data on printer via printer driver for ,e.g., a hard copy of screen
Colour printers use another colour system than the screen (additive colour system red, green, blue with screen in contrast to subtractive colour system, e.g., cyan, magenta, yellow and black with printers). Also, the print-out of a yellow curve on a black background on white paper leaves something to be desired. Therefore, the colours are converted and can be adapted to user requirements. The desired colour for each of the 16 possible colours is read from the file PRN_CL.PLT, which can be edited by the user.
The only way to utilize shades of gray for differentiation purposes on black and white printers is to leave out individual points. This process, which is called dithering, is controlled by the file PRN_BW.PLT. The file contains cells of 8 x 4 points for each "gray" pen and can also be changed by the user to meet his needs. The colour 10 (Trace B) is dithered only, if the printer resolution exceeds one printer point per screen pixel.
Both files described above are located in the directory \UPD\REF and contain a description of their contents in the form of comments.
The colour No. 2 is used for the background of the frames and is drawn light-gray on the screen. If the black inscription does not contrast enough with this background, the latter can be set to WHITE using the command FrameCol. The colour specified in the file is no longer used, as is the case with selection of FILE DEF.

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2.14.2 Output in HP-GL Format

Vector-oriented outputs in HP-GL format are usually output to plotters (Destin = PLOTTR/HPGL), however some laser printers also support the HP-GL format (Destin = PRINTR/HPGL), e.g. for plotting measurement traces. The output data can be filed, too (Destin = FILE/HPGL).

The colours for screen output and the assignment of the plotter pens can be looked up in the table below:

Table 2-2 Colours of screen output and assignment of plotter pens

Function/ type	UPD-LCD	UPD colour monitor	Plotter pen	Recommended colour
Panel	black	black	1	black
Trace A	black	green	2	green
Trace B	grey	yellow	3	blue
Axes B	grey	yellow	3	blue
Scales	grey	red	4	light red (thin line)

Prior to output of the HPGL data and vectors an initialization sequence is transmitted to the drawing device at the selected interface or to the file. With plotters, this sequence may be the information about P1/P2 points (sheet or drawing size) or on the sheet format (portrait/ landscape). Printers usually require an initialization sequence to be able to interpret HPGL information. If Destin = PRINTR/HPGL is selected this sequence is loaded in a prologue file designated GL_PRO.LOG. There is also an epilogue sequence, which is designated GL_EPI.LOG. These files are stored in the UPD/REF directory and can be modified by the user as required. They contain, for each character to be sent, 1 to 3 (ASCII) characters followed by a blank. This sequence is interpreted as 1 byte in decimal notation. HPLJ3_P.LOG and HPLJ3_E.LOG are supplied as sample files for initialization and reset of Laserjet3 printer. All files referred to are included in the \UPD\REF directory.

2.14.3 Output in PCX Format

Outputs in PCX format to file for further processing in other programs (Destin = FILE/PCX)..

The PCX file format contains a palette information. In this version used by UPD it consists of 16 entries, which assign the 16 colour types one colour, each, by means of indicating the respective red, green and blue portions. With black/white printout (Color OFF), only 16 black/gray/white hues are assigned. These palettes are filed in the UPD\REF directories under the names PCX_BW.PLT and PCX_CO.PLT. They can be edited by the user if other colours are required. The files contain comments indicating which pen is used for which colour.
The colour No. 2 is used for the background of the frames and is drawn light-gray on the screen. If the black inscription does not contrast enough with this background, the latter can be set to WHITE using the command FrameCol. The colour specified in the file is no longer used, as is the case with selection of FILE DEF.

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2.14.4 Output in PostScript Format

Outputs in vector orientated PostScript format on a PostScript capable printer (Destin = PRINTR/PS) or on file for further processing (Destin = FILE/PS) or integration into other programs (Destin = FILE/EPS).

PostScript is a frequently used graphics format for use with high-quality terminals, e.g. laser printers. The PostScript format implies a complete programming language with commands permitting a high-quality graphics hardcopy to be made irrespective of the printer type, provided the printer is equipped with a PostScript option.

Upon a stoke of the HCOPY key, UPD generates a plot of the screen content or of parts thereof with the aid of suitable PostScript commands. These commands are sent to the PostScript printer either directly or via the LPT1 or COM2 interface, or they are stored in a file (*.PS) which may be processed by users familiar with PostScript and viewed on the screen of a PC with the aid of a *previewer*.
This procedure should be adopted in the development phase of the PostScript copy to save paper and toner.
An Encapsulated PostScript file (*.EPS) can also be created. This file allows the UPD plots to be integrated into another PostScript file, document or graphics representation (see section 2.14.4.2 Integrating and Output of PostScript Files).

Frequently used previewers are **GhostScript**, **GhostView** and **GSview**. They are available as free-ware on the Internet under the address **http://www.cs.wisc.edu/~ghost/**.

Up to 6 different UPD plots including head line or comments can be stored in a PostScript file according to a fixed pattern, format A4 or LETTER, PORTRAIT or LANDSCAPE, colour or monochrome print and the desired screen section being selectable.

PostScript settings are done in the OPTIONS panel:

Information about traces and lines to be printed and colour/shade of gray, line pattern and line width to be used can be seen in the PostScript configuration file PS.CFG (see section 2.14.4.1 PostScript Configuration File PS.CFG).

Overview of PostScript commands in the OPTIONS panel:

```
SCREEN HARD COPY ----
Destin     PRINTR/PS     Output of PostScript format to printer
           FILE /PS      Output of PostScript format to file (*.PS)
           FILE  /EPS    Output of Encapsulated PostScript format to file (*.EPS)
Color      ON | OFF
Copy       SCREEN        | CURVE/GRID | CURVE
Comment    ON            | OFF
Paper Size A4            | LETTER
Orientatn  LANDSCAPE     | PORTRAIT
Plot on    COM2          | LPT1              For Destin  PRINTR/PS only
Plots/Page 1...6
Filename   A:\UPD.PS                         For Destin FILE /PS only
           A:\UPD.EPS                        For Destin FILE /EPS only
```

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2.14.4 1 PostScript Configuration File PS.CFG

The PostScript configuration file C:\UPD\REF\PS.CFG is a text file which contains all information about colour, gray level, line width and line pattern for

- curves of TRACE A (Scan 1 to 17),
- curves of TRACE B (Scan 1 to 17),
- limit curves (upper, lower)
- Y grid (low, medium and high priority)
- X grid (low, medium and high priority)

With **logarithmic scales** the grid line priority
"high" has the values ..., 0.1, 1, 10, ...,
"medium" the values ..., 0.5, 5, 50, ... and
"low" is used for all other lines.

With **linear scales** the assigned grid line priority depends on the start and end value of the scale and is therefore difficult to predict.

The file has to be edited with an ASCII editor in the DOS operating system.
Several comment lines in the header of file PS.CFG inform on permissible line patterns, colours, gray shades and line widths.

Example of a PostScript configuration file PS.CFG

```
# The following linestyle strings are available:
# ------ or ______, ------,  ......,  .-.-.-
#
# The following color strings are available:
# red, green, blue, yellow, magenta, cyan,
# black, gray9, gray8, gray7, gray6, gray5,
# gray4, gray3, gray2, gray1, white
#
# The following gray levels are available:
# 0.0 (black) ... 1.0 (white)
#
# The following width values are available:
# Values > 0.0
#         ----------- Line ---------
#         Style   Color   Gray Width
TRAC A
Scan1:    ______  red     0.1  1.0
Scan2:    ------  green   0.2  1.0
Scan3:    ......  blue    0.3  1.0
Scan4:    .-.-.-  cyan    0.4  1.0
Scan5:    ------  magenta 0.5  1.0

TRAC B
Scan1:    ------  green   0.1  1.0
Scan2:    ------  gray1   0.2  1.0
Scan3:    ......  gray2   0.3  1.0
Scan4:    .-.-.-  gray3   0.4  1.0
Scan5:    ------  gray4   0.5  1.0

LIMIT LINE
Upper:    ......  yellow  0.4  2.5
Lower:    ......  yellow  0.4  2.5

GRID Y
Priority low:    ......  blue    0.4  1.0
Priority medium: ......  blue    0.4  1.0
Priority high:   .-.-.-  blue    0.4  1.0

GRID X
Priority low:    ......  red     0.4  1.0
Priority medium: ......  red     0.4  1.0
Priority high:   ......  red     0.4  1.0
#        color      gray
#       r  g  b
BACKGROUND COLOR
Frame: 0.7 0.7 0.7   0.7
Plane: 1.0 1.0 1.0   1.0
```

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The expressions printed in bold are keywords required by the UPD for the search of parameters under Style, Color, Gray and Width. The parameters must be in the same line as the keyword and separated by at least one blank. Only the lines required for creating the PostScript format must be available. Faulty or missing entries are recognized when the file is accessed and in this case an error message is output on the UPD screen.

The following can be selected for lines:
Style: 4 line patterns
Color: 17 colours and shades of gray for a colour PostScript copy (`Color = ON`)
Gray: Any number of gray shades for a monochrome PostScript copy (`Color = OFF`)
Width: Any number of line widths

2.14.4 2 Integrating and Output of PostScript Files

Integrating PostScript files in word processing and design programs

The EPS files created by the UPD are particularly suitable for integrating PostScript files in word processing and design programs. Most of these programs cannot interpret the contents of an EPS file. As a rule they show a frame with or without diagonal lines, or a light-gray rectangular with the name of the EPS picture is displayed instead of the drawing. However, the EPS file is completely and correctly printed out.

To get an idea of the picture content in word processing or design programs, a coarsely rastered bit map can be inserted in the EPS file. The bit map can be evaluated and displayed by some user programs without interpretation of the EPS file.

For this purpose a bit map has to be inserted into the EPS file generated in the UPD. The picture in the EPS file is in the form of a hexdump. The free-ware program **GSview** mentioned before is particularly suitable in this case.

Example:

After the start of **GSview**, the name of the EPS file into which the bit map should be integrated is entered under **File - Open**. Under **Bearbeiten - EPS Vorschau einfügen** (Edit - Insert EPS preview) a selection of graphics formats for creating the bit map is displayed, e.g. **Windows Metafile.** Subsequently the name of the EPS file with bit map is specified.

An EPS file with a bit map thus generated can be integrated in Microsoft Word 6.0, for instance, where the bit map is displayed in the Word document.

Example:

After starting the Windows program **Microsoft Word 6.0,** a window is opened with **Einfügen - Grafik** (Insert - Graphics), where the **file type Encapsulated Postscript (*.EPS)** and the **file name** of the EPS file to be inserted are selected.
The bit map is now displayed in the document. With **File Print...** the PostScript picture (not the bit map) is printed with the highest possible resolution, provided the correct PostScript printer driver is installed (see "Printout of PostScript files").

The Windows graphics program **CorelDRAW 5.0** is able to directly interpret and display an EPS file of the UPD:

Example:

File - Import - Aufzulistender Dateityp (file type listed) **- PostScript (Interpreted) (*.eps, *.ps)**

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Printing PostScript files:

If a PostScript printer is available, EPS files can be directly printed, e.g. with command "**copy SCREEN.EPS prn:**" in **DOS.** Under **Windows** a printout at this low level is not possible. Here it is advisable to integrate the EPS file as described in a word processing or design program, a graphics program or in GSview with subsequent printout.

For printing EPS files that have been integrated in a word processing or design program, or *.PS or *.EPS files loaded with GSview, an appropriate PostScript printer driver should be installed. **It is not sufficient** to just connect a PostScript printer; a suitable PostScript printer driver should also be available.

Without an adequate printer driver being installed, Windows does not know that a PostScript printer is available and only an empty frame or, if a bit map is integrated in the EPS file, a coarsely rastered bit map is printed.

*To obtain a true PostScript hardcopy, a Postscript printer driver is **indispensable**, e.g. printer driver* **"HP LaserJet 4/4M PostScript"** for **HP laser printer LaserJet 4 Plus.**
Only in this case the original EPS file will be printed with the highest possible resolution.

Installation of a new printer driver under Windows 3.11:
Main group - system control - printer - add printer

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2.14.5 Output of Measurement Traces and Lists

The following menu item is available in the OPTIONS panel under the heading PRINT.

The measured values and other block data are output to the printer as numbers (in ASCII code) using this key (immediately executed, the H COPY key need not be pressed).

Type	
	The first column contains the data selected in the following. The values which would be on the X axis with Curve Plot, usually the swept values, are contained in the second column.
OFF	Function is off.
TRACE A **TRACE B**	Prints the measured values selected for TRACE A (or TRACE B) in the DISPLAY panel. Also, units (and reference values, if any) are taken over from the DISPLAY panel.
EQUALIZATN	Prints the values of the equalization table.
LIM REPORT	Prints only values exceeding the limits. Limit check must be activated.
DWELL VALUE	Prints the values for the sweep dwell time.
LIM UPPER	Prints the upper limit curve.
LIM LOWER	Prints the lower limit curve.
X AXIS	Prints the values of the X axis only.
Z AXIS	Prints only the values of the Z axis.
TRACE A + B	Prints both traces next to each other. The X axis is output in the 3rd column.

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2.15 Setting and Displaying Auxiliary Parameters (OPTIONS Panel)

Activate the OPTIONS panel by pressing the OPTIONS key (UPD front panel) or key combination ”ALT O” (external keyboard). The panel is displayed on the right side of the screen.

2.15.1 IEC/IEEE-Bus Address and COM2 Interface Parameters

UPD IEC adr

Defining the UPD IEC/IEEE-bus address when connecting it to an IEC/IEEE-bus.
Application: see 2.16, Connecting External Devices

Note: *The IEC/IEEE-bus address set or selected upon start-up of the UPD remains unchanged when a setup or the default setup is loaded.*

Value range:	0 to 31
Default:	20
Unit :	none

COM2 PARAMETER

Determining the parameters for the serial COM2 interface. The parameters set here apply to a screen copy on a plotter with its COM2 interface selected. The parameters set here must match the parameters of the connected device (plotter).

Note: *The COM2 parameters set upon start-up of the UPD or selected by the user remain unchanged when a setup or the default setup is loaded. This prevents the interface parameters, which have to match those of the connected device, being inadvertently overwritten.*

COM1 parameters can only be set at the operating system level using the DOS command MODE. Setting can be performed
- by changing the AUTOEXEC.BAT file,
- via the SYSTEM key after the UPD has been quit,
- after execution of the SHELL command in the Automatic Sequence Controller UPD-K1.

Further information on **baud rate**, **parity**, **data bits** and **stop bits** can be obtained from the UPD online help or the DOS help at the operating system level with command HELP MODE under section "Configure Serial Port".

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Baud Rate — Transmission speed in baud (bits/s)

2400 Baud	
3600 Baud	
4800 Baud	
7200 Baud	
9600 Baud	
19200 Baud	(Default setting)
38400 Baud	
56000 Baud	

Parity — Parity check

NONE	Parity check switched off
EVEN	Check for even parity (default setting)
ODD	Check for *odd* parity

Data Bits — Number of data bits

7	
8	(Default setting)

Stop Bits — Number of stop bits

1	
2	(Default setting)

Handshake — Type of synchronization

RTS/CTS	Hardware handshake via RTS and CTS line (default setting)
XON/XOFF	Software handshake

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2.15.2 Beeper On/Off

Beeper

ON	A brief warning tone is heard in the case of error messages, of value ranges or limit violations and at the end of sweeps.
OFF	Beeper is switched off.

2.15.3 Keyboard Settings

The settings refer to both the UPD front panel and the external keyboard (if available).

Rep rate

(Repetition rate)

Number of generated key codes per second (unit: Hz) with repetitive triggering.

Range of values: 0 (no repetitive triggering) to 20 Hz
Default: 10 Hz

Rep delay

(Repetition delay)

Time delay until repetitive triggering responds
(Unit: s).

Range of values: 0.25 to 1.0 s
Default: 0.5 s

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2.15.4 Language of Help Texts

Language

Set the language used for the online help. The assignment of the external keyboard remains unchanged but can be modified, for instance, via the help program "BOOTSET.BAT".

***Note**: The selected language remains unchanged when a setup or the default setup is loaded.*

ENGLISH Help texts appear in English, the keyboard is set to UK (English).

GERMAN Help texts appear in German, the keyboard is set to GR (German).

The keyboard is assigned with the aid of various AUTOEXEC.BAT files which are generated by copying using the auxiliary program BOOTSET.BAT.
AUTOEX_E.BAT is copied to C:\AUTOEXEC.BAT for UK,
AUTOEX_D.BAT for GR. These files call the configuration file C:\UPD\USERKEYB.BAT where the standard key assignment can be overwritten or further user-defined actions performed.

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2.15.5 Display Settings

Extern disp (External Display)

INTERN ONLY	Display on the built-in LCD screen only.
BOTH COLOUR	Display on the external VGA monitor, too (see 2.16 Connecting External Devices); use a colour monitor for colour output. The display has been optimized for colour display, thus leading to reduced contrast quality on the built-in LCD screen.
BOTH BW	The data are additionally displayed on the external VGA monitor (see 2.16 Connecting External Devices), however only black-and-white. The contrast quality on the built-in LCD screen is not reduced in this mode.

Switches the internal LCD screen off in order to increase the life of the screen and to minimize disturbing influences (eg with remote control or with the use of an external monitor).

An LED indicates the state of the key. When the LED is on, the LCD is off. When the LED is off, yet the LC display is still off, the reason might be the contrast control being maladjusted.

2.15.5.1 Switching the Measurement Display ON/OFF

Meas Disp (Measurement Display)

OFF	Measured value and status displays are switched off. This increases the performance of the measurement routines. Sweeps are up to 15% faster. To be recommended for sweeps and FFTs if maximum performance is required. The status display reads the message "MEAS DISPLAY OFF" "Ctrl D to resume"
ON	The measured value displays are switched on, measured value and status display are activated.

Note: *The Meas Disp OFF/ON states can be switched via an external keyboard using the key combination Ctrl D.*

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2.15.5.2 Reading Rate of Measurement Results

Read Rate

MAX SPEED	Maximum output speed of measurement results
6/S	6 measurement results / second
3/S	3 measurement results / second
1/S	1 measurement result / second

Note:
- *The setting is only effective in the Continuous mode. With sweeps, Start Condition Timechart and individually triggered measurements, results are always output at maximum speed.*
- *The output via IEC/IEEE bus is not affected and always performed at maximum speed.*

2.15.5.3 Resolution of Measurement Results

Read Resol

CHOICE ...

A selection box appears after the SELECT key is pressed, in which the resolution of the measured value in trailing decimal places can be inputted for each measurement result window.
0: automatic display of the trailing decimal places
1 to 4: 1 to 4 trailing decimal places, whereby the result may be filled out with zeros

2.15.5.4 Graphics Display with Selectable Colours

When individual traces, trace groups (see section 2.9.3.3 Scan Count >1) and bars are displayed, a specific colour or shade of gray can be assigned to each trace or bar for easy distinction. Colour or shade of gray depends on the colour or monochrome representation selected under the menu item `Extrn Disp` (see section 2.15.5 Setting the Displays).
In addition a line pattern and line width can be assigned to sweep traces and trace groups.
Settings for colour/shade of gray, line pattern, line width are made in the OPTIONS panel under

DISPLAY ——————————
TRACES COLOR/LINE ——

The settings for colour and line pattern for max. 17 scans in channel A and channel B are stored in the self-explanatory text file C:\UPD\REF\TRCCOL.CFG.
In exceptional cases this file can be edited using an ASCII editor in the DOS operating system, on the condition that positions and length (correct number of trailing blanks) of the text are not changed.

Note: *If the file has been destroyed by mistake, it can be newly created using commands* `Scan conf = DEFAULT` *with a default setting.*
All scans of TRACE A are green, those of TRACE B yellow, uninterrupted, narrow lines.

The colour and line-pattern settings stored in this file are setup-independent and **remain unchanged when a setup or the default setup is loaded.**

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Trace groups:
For trace group display (see 2.9.3.3 Scan Count >1) a colour/shade of gray and a line pattern can be assigned to max. 17 scans in channel A and channel B (DISPLAY panel: `Scan count ≥ 2`).
If more than 17 scans are displayed on the UPD, the 18th scan is assigned the colour and line pattern of the 1st scan, etc.

Single sweep traces:
If only one sweep trace is displayed in channel 1 and channel 2
(DISPLAY panel: `Scan count = 1`), the colour/shade of gray and the line pattern specified under `Scannr.A = 1` and `Scannr.B = 1` will be assigned. Settings for `Scannr.A/B = 2...17` are meaningless.

Display of FFT, waveform and filter simulation:
ANALYZER panel:
FUNCTION = FFT | WAVEFORM | FILTER SIM
For displaying the traces in channel 1 and channel 2 for the above-mentioned measurement functions the colour/shade of gray specified under `Scannr.A = 1` and `Scannr.B = 1` is assigned. Assigning a line pattern is not useful and not performed.
Settings for `Scannr.A/B = 2...17` are meaningless.

Bargraph for DFD, DIM and MOD DIST measurement:
ANALYZER panel:
FUNCTION = DFD | DIM | MOD DIST
For a vertical bar display of channel 1 or channel 2 for these measurement functions, the colour/shade of gray specified under `Scannr.A = 1` and `Scannr.B = 1` is assigned. Assigning a line pattern is not useful and not performed.
Settings for `Scannr.A/B = 2...17` are meaningless.

Bargraph display:
The horizontal bars for BarA, BarB and BarX are displayed in the colour/shade of gray specified under `Scannr.A = 1.` If a limit violation occurs for one the bars (DISPLAY panel: LIMIT CHECK...) the colour/shade of gray changes as specified under `Scannr.B = 1` . Settings for `Scannr.A/B = 2...17` are meaningless.

PROTOCOL panel:
Parameters are displayed in the colour/shade of gray specified under `Scannr.A = 1,` comments are printed as specified under `Scannr.B = 1.` Variable parameters are always printed in red.

Result display:
The six measured values in the result display are represented in the colour/shade of gray specified under `Scannr.A = 1`, if no display of trace groups has been selected (DISPLAY panel: `Scan count ≥ 2`).

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Scan conf

MANUAL

Colour/shade of gray and line pattern for each scan number entered with commands Scannr.(A) and Scannr.(B) can be separately changed.

DEFAULT

Automatic assignment of colour and line pattern to 17 scans of Trace A and Trace B. All scans of trace A are green (uninterrupted), and all scans of trace B yellow (dotted) narrow lines.

AUTO COLOR

Automatic assignment of colours to 17 scans of Trace A and Trace B, GREEN, YELLOW, BLUE, CYAN, MAGENTA and WHITE being assigned repeatedly in exactly this order. BLACK, DARK GRAY and LIGHT GRAY are assigned to the monochrome display.

Traces A and B are distinguished by the type of lines used, ——— for trace A and ..... for trace B.

Note: *If WHITE proves to be unfavourable for a scan because the limit lines are (normally) drawn in white, different colours can be assigned to these scans using the following commands.*

AUTO LINE

Automatic assignment of line patters to 17 scans of Trace A and Trace B, with the 4 thin line patterns ——— , ------, ... and .-.-.- being assigned repeatedly in this order.

To distinguish the traces, trace A is shown in green and trace B in yellow.

Scannr.(A)
Scannr.(B)

Scan number 1 to 17, to which a colour/shade of gray or a line pattern is to be assigned using commands `Color(A/B)` and `Line(A/B)`.

If the **scan number 0** is entered, all 17 scans are assigned the same colour/shade of gray and the same line pattern, when command

```
Color(A/B)
```

or

```
Line(A/B)
```

is entered.

Specified range: 0 to 17
Default: 0

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Color (A)
Color (B)

Assignment of colour/shade of gray to individual scans

GREEN
YELLOW
BLUE
CYAN
MAGENTA
WHITE

BLACK
DARK GRAY
LIGHT GRAY

Colour of scan number specified with command
`Scannr.(A)`
or
`Scannr.(B)`,
if colour display is selected using command `Extrn Disp = BOTH COLOR`.

Shades of gray specified with command
`Scannr.(A)`
or
`Scannr.(B)`,
if monochrome display is selected using command `Extrn Disp`

Note: *If colour/shade of gray is selected while* **`Scannr.(A/B) = 0`**, *all 17 scans will be assigned the same colour. To avoid this being done inadvertently, a query has to be confirmed before the command is executed.*

Line (A)
Line (B)

Line pattern for scan number specified with
`Scannr.(A)`
or
`Scannr.(B)`.

Normal line width

Triple line width

Note: *If line pattern is selected while* **`Scannr.(A/B) = 0`**, *all 17 scans will be assigned the same pattern. To avoid this being done inadvertently, a query has to be confirmed before the command is executed.*

2.15.6 Input, Output and Routing Switchers

2.15.6.1 Introduction

The use of switchers is advantageous when measurements on instruments with several inputs and outputs are performed or signals are to be distributed to several inputs in order to avoid frequent and time-consuming changes in the cabling. Every switcher permits a two-wire connection of 2 points to 12 other points to be established via a relay matrix.

Control of the switchers is only possible if the UPD is equipped with option UPD-B5 "Monitor Output, Parallel I/O". This option allows the UPD to control switchers from Audio Precision.
Detailed information on the individual switchers can be obtained from the Operating Manual for System One in the appertaining section.

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Useful information on handling and control of switchers is to be found in Application Note No. 1GP AN 13.

The following instruments can be controlled:

- Input switcher type SWR-122F with 2 XLR male and 12 XLR female connectors
- Output switcher type SWR-122M with 2 XLR female and 12 XLR male connectors
- Routing switchers type SWR-122P with 5-contact XLR connectors
- SWR-122T with 5 screw connections instead of 1 XLR plug-in connector. It can be configured as input, output or routing switcher by means of jumpers.

2.15.6.2 Installation

The switcher with the address 0 is usually connected via an 8-bit parallel interface and an ordinary 25-pin printer cable with sub-D male and female connector to the sub-D female connector of option UPD-B5 (see Fig. 2-2 Rear view) of the UPD. At the rear panel of the switcher, two equivalent 25-pin connectors (female and male) are located, which can be used as required for connection to the UPD. The next switcher is connected to the free plug-in connector. If several switchers of the same type are used, they must be assigned addresses which are to be set at the rear of the instrument; see next section.

In the following, input switchers will be referred to as EU, output switchers as AU and routing switchers as KU.

2.15.6.3 Addressing Switchers

Every switcher is assigned an address between 0 and 15 via a coding switch at the rear. Thus a maximum of 16 input switchers and 16 output switchers with 12 channels each can be cascaded so that 192 inputs and outputs can be controlled.
The switcher with the address 0 controls the channels 1 to 12, the switcher with the address 1 controls the channels 13 to 24, etc.
Whether a switcher is to operate as an EU or AU is determined by two jumpers inside the instrument. However this is already to be taken into account when ordering the switcher, because the EUs are equipped with 2 XLR male and 12 XLR female connectors, whereas AUs are equipped with 2 XLR female and 12 XLR male connectors.

EU and AU can be operated with one and the same address. An EU ignores control signals intended for an AU and vice versa.
Since the switchers do not signal whether they are configured as EU, AU or KU, the UPD cannot output respective warnings. However, it automatically finds out the addresses of the switchers and outputs a warning if a switcher that is not connected is addressed by entering a channel number.

2.15.6.4 Input Switcher

Range of application:
Measurements with the UPD on instruments with several outputs, eg mixer units, multitrack tape recorders, magnetic tape units or distributing amplifiers.

Configuration:
Of each switcher, one of 12 input channels can be through-connected to output A and/or output B.

Note: *If one and the same input channel is connected to the switcher outputs A and B, both connectors are connected with each other.*

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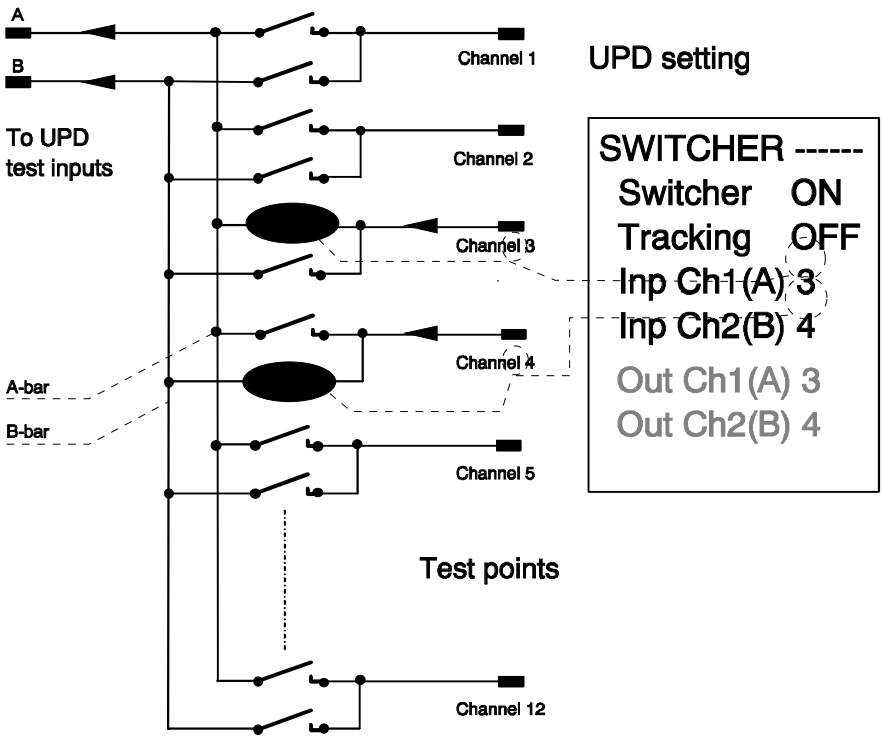

Fig. 2-56 Basic circuit diagram: input switcher with 2 through-connected channels

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2.15.6.5 Output Switchers

Range of application:
A test item with several inputs is supplied with the signal of the UPD generator. If the generator signal is applied to all channels except one, the crosstalk attenuation can be measured on the channel that is not through-connected.

Configuration:
An AU can be operated in three ways:

> Connect switcher input A and/or B two one of the 12 output channels.

Note: *If one and the same output channel is connected to the switcher inputs A and B (short-circuit between the two generator outputs), different reactions are obtained depending on the generator setting selected:*

- *If the generator is set to Channels(s) 2 = 1 (in-phase signal at both outputs), the output impedance of the generator is halved, whereas the generator output voltage remains unchanged.*
- *If the generator is set to Channels(s) 2 = -1 (phase rotation of the signals by 180·), the generator output level is compensated to approx. 0 V.*

No damage is caused to the short-circuit-proof UPD generator!

> The UPD generator signal applied at input B of the AU is through-connected to all outputs of the AU and thus distributed to all inputs of a device under test.

> The UPD generator signal applied at input B of the AU is through-connected to all outputs of the AU except one. This version is primarily used for measuring crosstalk attenuations of the through-connected channels on the open channel.

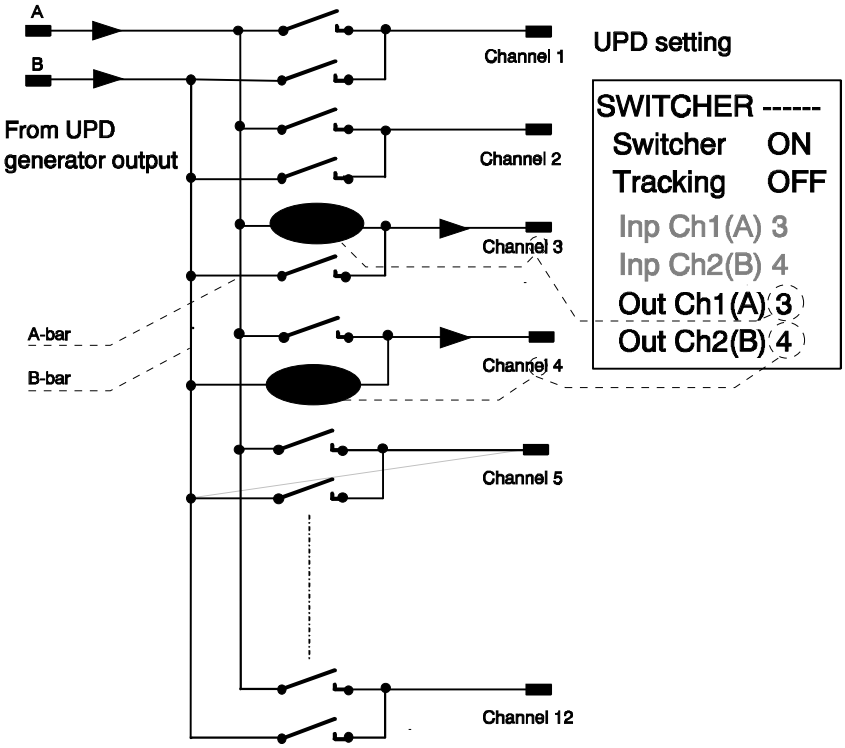

Fig. 2-57 Basic circuit diagram: output switcher with two through-connected channels

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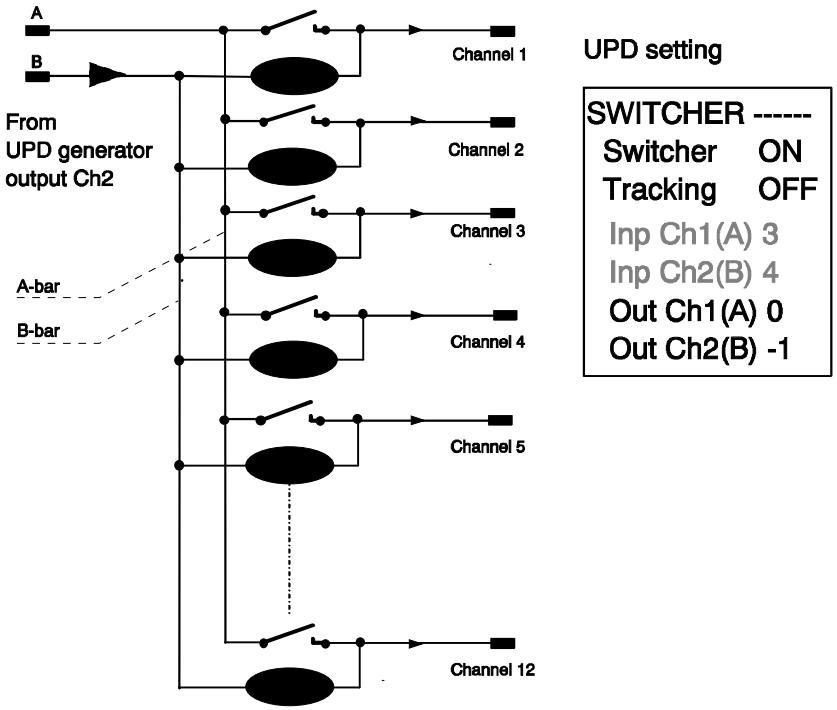

Fig. 2-58 Basic circuit diagram: output switcher, two channels through-connected

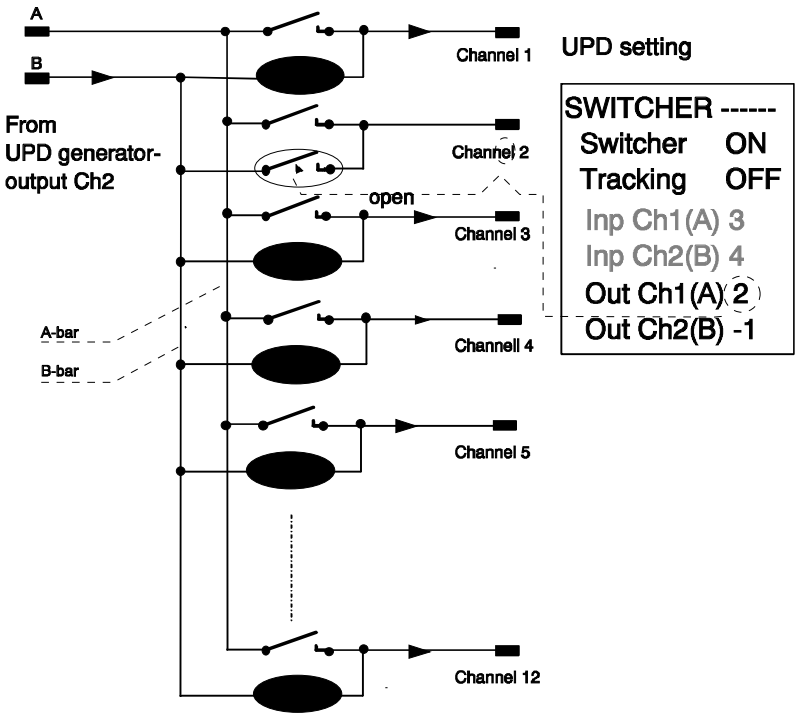

Fig. 2-59 Basic circuit diagram: output switcher, all channels through-connected

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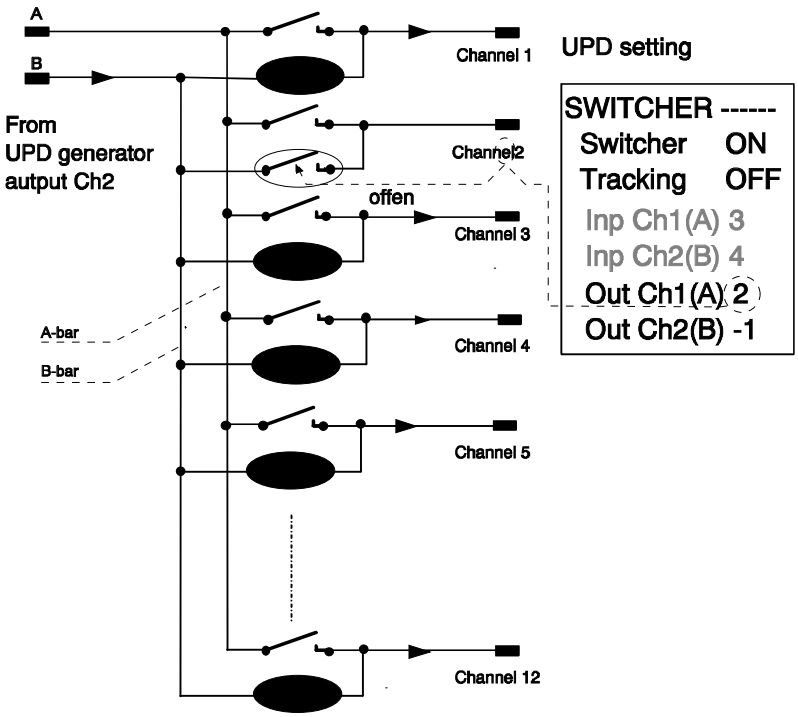

Fig. 2-60 Basic circuit diagram: output switcher, all channels through-connected except one

2.15.6.6 Routing Switcher

Range of application:
A KU can be cut into the connection lines of individual components of an AF equipment or into the transmission chain of studio equipment as well as into the nodes of mixer units, ie the output of a device and the input of the subsequent device are applied to a KU connector. Depending on the measuring task, the relay contacts of the KU connect the output of the previous and the input of the subsequent device or interrupt the connection so that the UPD generator signal can be fed in. Measurements can be performed at any point. When opening the connections, measurements are possible on the unloaded outputs of a component.

Configuration:
The KU differs considerably from an EU or AU. A KU must not be operated with an address that has already been assigned to an EU or AU.

Connection and control of the KU is explained by means of the example illustrated in Fig. 22-5. To perform stereo measurements, two KUs are required. They can be set to the same address by means of a coding switch at the rear provided they are configured with this coding switch as KU A and KU B (see Fig. 22-8).

Control of routing switcher explained by way of an example:
In the following example (Fig. 22-5), both KUs are set to the address 0 (see 2.15.6.10 Setting the Address of the Input, Output and Routing switchers), the upper KU is configured as KU A, the lower one as KU B (see 2.15.6.11 Assignment of Routing switcher).

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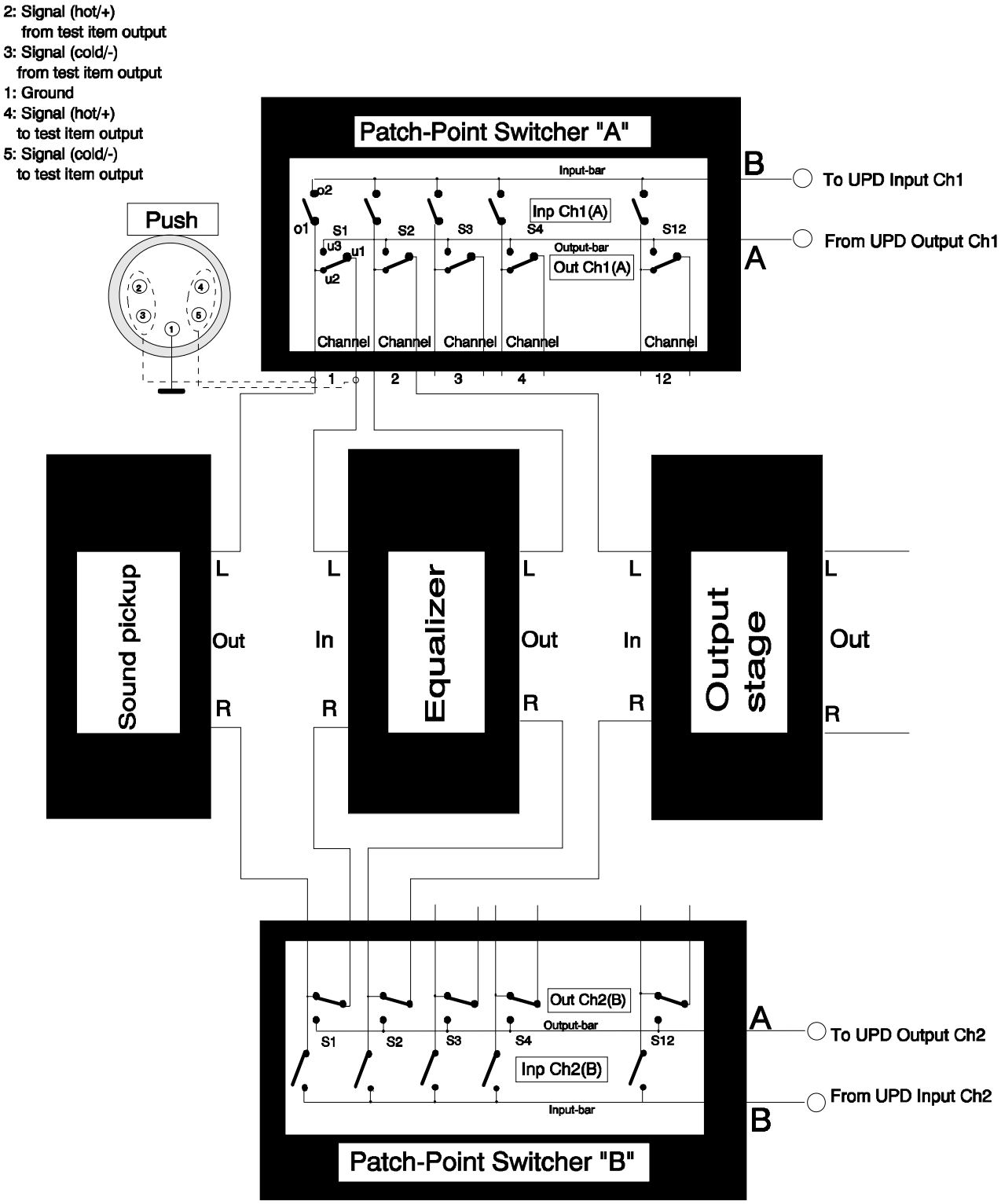

Fig. 2-61 Routing switcher, connected into an AF transmission chain

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Examples of control of the contacts in the case of the KU:

Setting in the OPTIONS panel see 2.15.6.7

- All signal paths of the upper KU A are through-connected (all contacts u1-u2 closed): ····· OUT Ch1(A) = 0
- All signal paths of the lower KU B are through-connected (all contacts u1-u2 closed): ····· OUT Ch2(B) = 0
- The 4th of the 12 signal paths of the KU A is open. Enables supply by UPD generator (S3 u1-u3 closed) ····· OUT Ch1(A) = 4
- The 3rd of the 12 signal paths of the KU B is open. Enables supply by UPD generator (S3 u1-u3 closed) ····· OUT Ch2(B) = 3
- All switches of the KU A to the UPD test input are open. (all contacts o1-o2 open): ····· INP Ch1(A) = 0
- The 3rd of the 12 switches which connects the test signal to the analyzer input is closed (S3 o1-o2 closed): ····· INP Ch1(A) = 0

Signal flow between sound pickup and output stage in channels A and B not interrupted, no signal monitoring:

Relay contacts of
routing switcher A

S1/u1-u2 closed, S2/u1-u2 closed ····· OUT Ch1(A) = 0

S1/o1-o2 open S2/o1-o2 open ····· INP Ch1(A) = 0

Routing switcher B

S1/u1-u2closed, S2/u1-u2 closed ····· OUT Ch2(B) = 0

S1/o1-o2 open S2/o1-o2 open ····· INP Ch2(B) = 0

Measurement of the signal between sound pickup and equalizer in channels A and B. Signal flow is not interrupted.

Relay contacts of
routing switcher A

S1/u1-u2closed, S2/u1-u2 closed ····· OUT Ch1(A) = 0

S1/o1-o2closed, S2/o1-o2 open ····· INP Ch1(A) = 1

Routing switcher B

S1/u1-u2closed, S2/u1-u2 closed ····· OUT Ch2(B) = 0

S1/o1-o2closed, S2/o1-o2 open ····· INP Ch2(B) = 1

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Measurement of signal between equalizer and output stage in channel A only. Signal flow is not interrupted.
Relay contacts of
Routing switcher A

S1/u1-u2 closed, S2/u1-u2 closed ..... OUT Ch1(A) = 0

S1/o1-o2 open, S2/o1-o2 closed ..... INP Ch1(A) = 2

Routing switcher B

S1/u1-u2 closed, S2/u1-u2 closed ..... OUT Ch2(B) = 0

S1/o1-o2 open, S2/o1-o2 open ..... INP Ch2(B) = 0

Connection between sound pickup and equalizer, two-channel interruption and two-channel feed-in of UPD generator signal at the equalizer input. Two-channel measurement at the output of the equalizer.
Relay contacts of
routing switcher A

S1/u1-u3 closed, S2/u1-u2 closed ..... OUT Ch1(A) = 1

S1/o1-o2 open, S2/o1-o2 closed ..... INP Ch1(A) = 2

Routing switcher B

S1/u1-u3 closed, S2/u1-u2 closed ..... OUT Ch2(B) = 1

S1/o1-o2 open, S2/o1-o2 closed ..... INP Ch2(B) = 2

Connection between equalizer and output stage interrupted in the right channel only and UPD generator signal fed into the right input channel of the output stage. Simultaneous two-channel measurement of the output signal of the equalizer.
Relay contacts of
routing switcher A

S1/u1-u2 closed, S2/u1-u2 closed ..... OUT Ch1(A) = 0

S1/o1-o2 open, S2/o1-o2 closed ..... INP Ch1(A) = 2

Routing switcher B

S1/u1-u2 closed, S2u1-u3 closed ..... OUT Ch2(B) = 2

S1/o1-o2 open, S2/o1-o2 closed ..... INP Ch2(B) = 2

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2.15.6.7 Control of Switchers from the OPTIONS Panel

The connected switchers can be set in the OPTIONS panel.

Switcher

OFF	Switcher control	off
ON	Switcher control	on

The UPD automatically checks which addresses are assigned to the connected switchers. If the commands described in the following are used to set a channel number without a switcher being connected, a warning is output.

2.15.6.7.1 Individual Channel Setting

If Tracking is set to OFF in the OPTIONS panel under SWITCHER, the desired channels can be set independently of each other.

Tracking

OFF	No automatic channel offset

The OPTIONS panel is then displayed as follows:

```
OPTIONS

√ NONAME          GEN    -NA-
√ NONAME          ANL    -NA-

SWITCHER
√ Switcher        ON
√ Tracking        OFF
√ Inp Ch1(A)      1
√ Inp Ch2(B)      1
√ Out Ch1(A)      2
√ Out Ch2(B)      2

CALIBRATION       ANL
√ Zero Auto       ON

CALIBRATION       GEN

  SERVICE         password ?
```

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Inp Ch1(A)

Channel connected to the A bar of the EU
Value range: 0 to 192

Inp Ch2(B)

Channel connected to the B bar of the EU
Value range: 0 to 192

Out Ch1(A)

Channel connected to the A bar of the AU
Value range: 0 to 192

Out Ch2(B)

Channel connected to the B bar of the AU.
If **Out Ch2(B)** = -1 and **Out Ch1(A)** = 0 is defined, all channels of the B bar of the AU are through-connected.
If **Out Ch2(B)** = -1 is defined and a channel number unequal to 0 selected for **Out Ch1(A)**, all channels of the B bar of the AU are through-connected except this one.

Value range: -1 to 192

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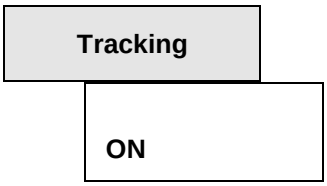
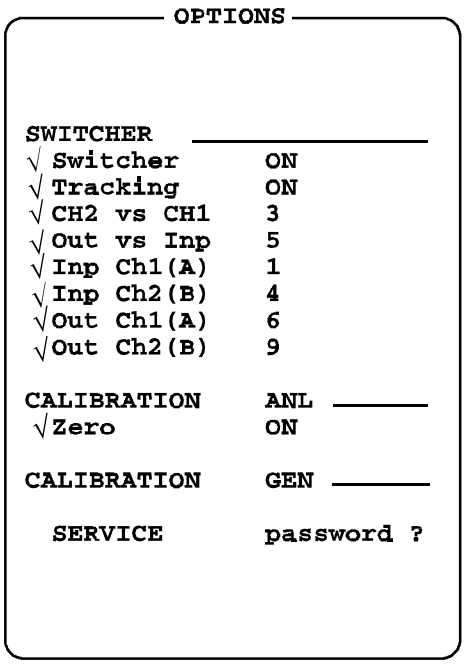
2.15.6.7.2 Measurements with Automatic Channel Offset

If Tracking is set to ON in the OPTIONS panel under SWITCHER, an offset between the channels of a switcher or between the channels of an EU and an AU can be entered. Modification of a channel then causes other channels to be also modified according to the offset specified.
A possible application is measurement of the crosstalk attenuation to the adjacent channel in the case of multi-channel instruments.



The OPTIONS panel is then displayed as follows:



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Ch2 vs Ch1

Offset of channel B (Ch2) compared to channel A (Ch1) with EU and/or AU by the value of **CH2 vs CH1**. (see Fig. 22-6).
0: no offset
positive values: offset towards higher channel numbers
negative values: offset towards lower channel numbers
A modification of **Ch2 vs Ch2** causes a modification in the command lines **Inp Ch2(B)** and **Out Ch2(B)**.

Value range: -192 to 192

Out vs Inp

Offset between the through-connected channels of an AU compared to those of an EU by the value of Out vs Inp (see Fig. 22-6).
0: no offset
positive values: offset towards higher channel numbers
negative values: offset towards lower channel numbers
A modification of Out vs Inp causes a modification in the command lines **Out Ch1(A)** and **Out Ch2(B)**.

Value range: -192 to 192

Inp Ch1(A)

Channel connected to the A bar of the EU.
A modification of this command causes a modification of the next three command lines, **Inp Ch2(B), Out Ch1(A)** and **Out Ch2(B)**.

Value range: 0 to 192

Inp Ch2(B)

Only display function.
Channel connected to the B bar of the EU

Value range: 0 to 192

Out Ch1(A)

Channel connected to the A bar of the AU.
A modification of this value varies the value in **Out Ch2(B)** by the value indicated in **Ch2 vs Ch1** as well as the values in the command lines **Inp Ch1(A)** and **Inp Ch2(B)** by the value indicated in **Out vs Inp**.

Value range: 0 to 192

Out Ch2(B)

Display function only.
Channel connected to the B bar of the AU.
Out Ch2(B) cannot assume the value -1, because crosstalk measurements are assumed to be performed and sudden through-connection of all channels of the AU is not wanted.

Value range: 0 to 192

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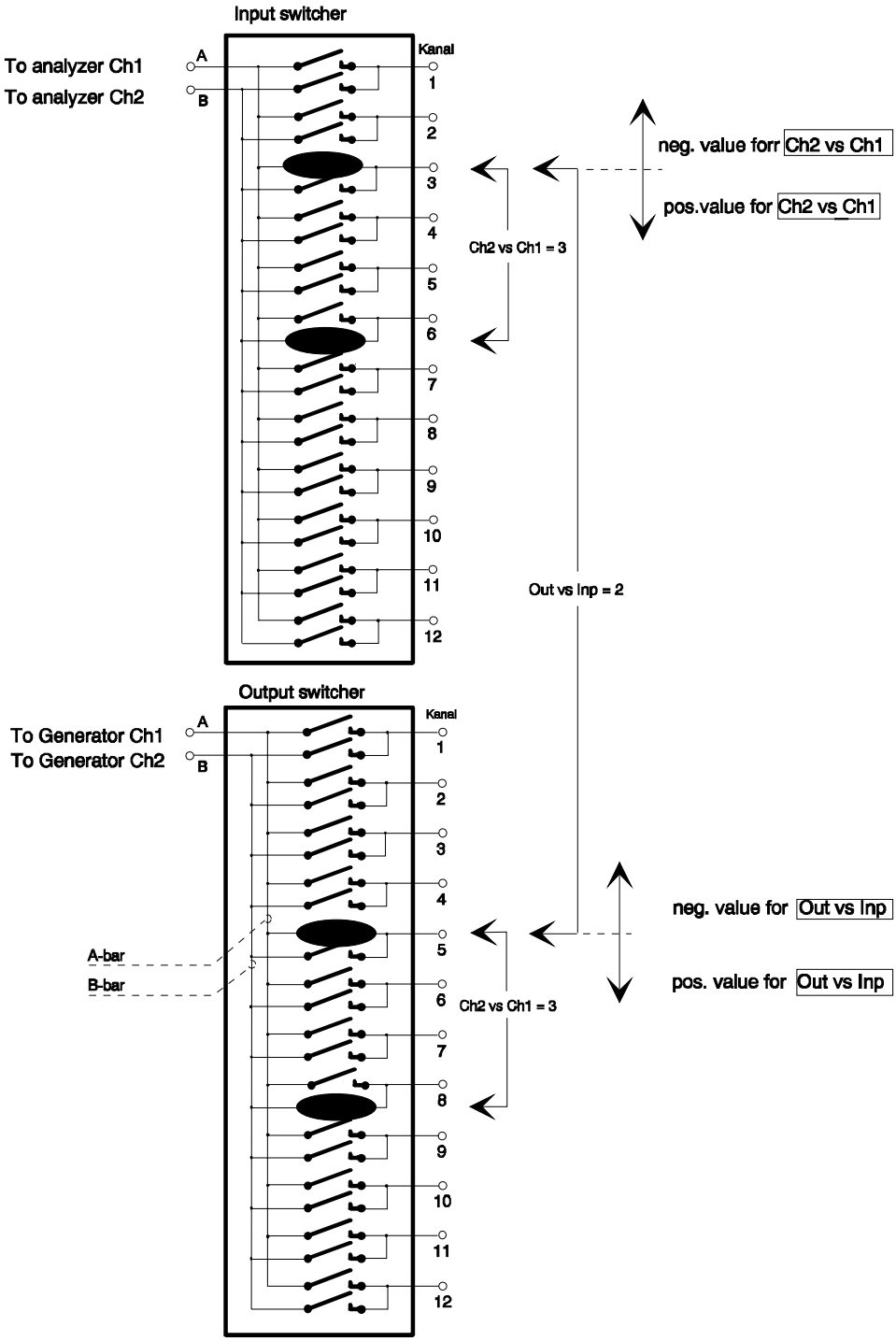

Fig. 2-62 Offset between input channels as well as between output switcher channels and input switcher channels using the TRACKING setting

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2.15.6.8 Restarting a Measurement after Channel Switchover

After each channel switchover, a relay debounce time of 20 ms is allowed to expire before a measurement is started. In addition, the time period indicated under START COND → Delay (see 2.6.4 Ways of Starting the Analyzer, Ext. Sweep) can be added to this time in order to take into account the settling times of a DUT due to switching.

2.15.6.9 Controlling the Switchers using the Universal Sequence Controller

For comprehensive measurements on multi-channel instruments, all switcher settings and measurements can be performed with the Universal Sequence Controller UPD-K1 (see 3.16, Automatic Control of UPD with R&S Basic) and thus optimally matched to the measurement task.

2.15.6.10 Setting the Address of Input, Output and Routing Switchers

Switch at the rear of the instrument

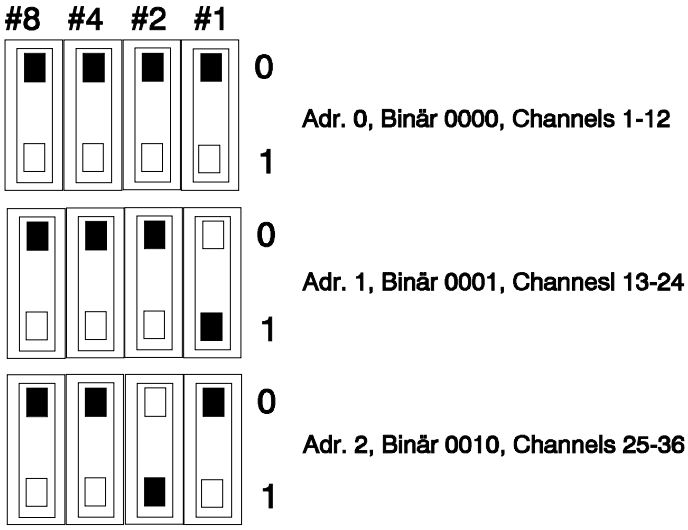

Fig. 2-63 Setting the address of the input, output or routing switchers

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2.15.6.11 Assignment of Routing Switcher to Command Lines in the OPTIONS Panel

Switch at the rear of the instrument

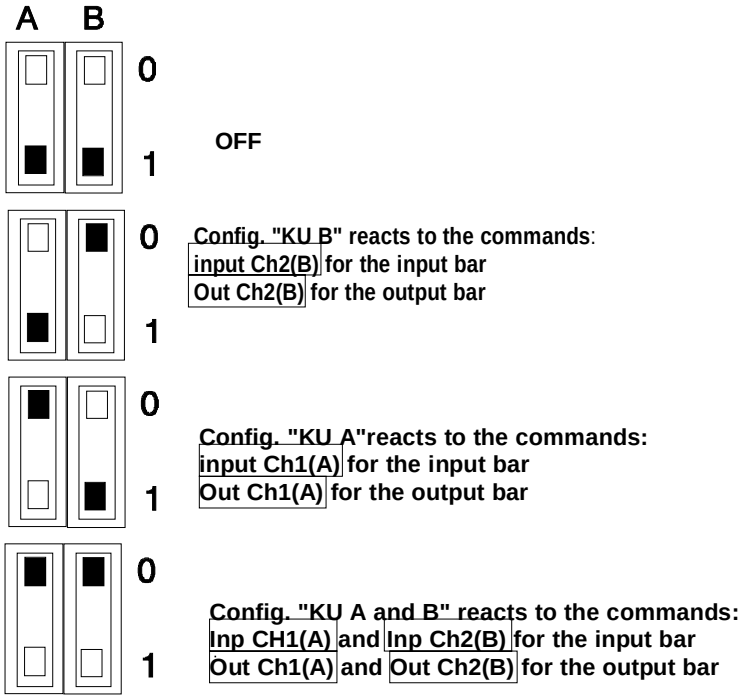

Fig. 2-2 Assignment of routing switcher to command lines in the OPTIONS panel

For stereo measurements, two KUs can be used in the configuration "KU A and B" so that the relay contacts (see Fig. 22-5) are connected in mirror-inverted form, irrespective of whether a Ch1A) or Ch2(B) command is set. The relays of the input bar react to the commands Inp **Ch1(A)** and Inp **Ch2(B)** in the same way. The relays of the output bar react to the commands Out **Ch1(A)** and Out **Ch2(B)**. If KUs in the configuration "KU A" and "KU B" are used for stereo measurements, the relays can be switched independently of each other.

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2.15.6.12 Pin Assignment of Parallel Interface Switchers

(For position of female connector see Fig. 2-2 Rear view)

25-contact D-sub connector of
Option UPD-B5
Monitor Output/Parallel I/O

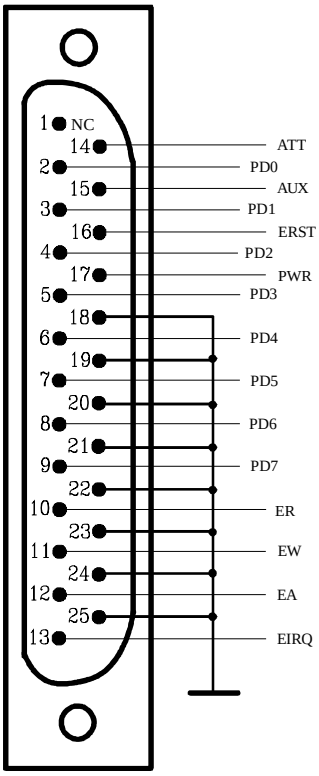

Fig. 2-3 Pin assignment for switcher control

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2.15.7 Calibration

Calibration ANL

Zero Auto

Dynamic offset calibration

OFF

DC offset calibration of the ADC board is OFF; the calibration factors most recently valid are used.

Note: *Calibration should be switched off for short periods only (eg for execution of a sweep), as otherwise relatively significant measurement errors may occur.*

ON

Cyclic calibration of the DC offset of the ADC board and, if necessary, of the zero offset of analog DC measurements. A calibration is also made whenever an instrument is changed.

Note: *A cyclic calibration is not performed while a sweep is running; it is delayed until the sweep is terminated or stopped.*

ONCE

Immediate offset calibration of the ADC board and (with DC selected as function) of all DC measurement ranges. Then the setting changes to the previously selected item.

Calibration GEN

Low Dist

Displayed only when the low-distortion generator is built-in.
Permits automatic calibration of low-distortion generator.

OFF

Calibration of low-distortion generator inactive.

ONCE

Starts the automatic calibration. Subsequently the setting changes to OFF.
Permissible only after an operation time of at least one hour.

Calibration DIG

PhaseToRef

Displayed only if the Jitter option UPD-B22 is built-in.
Permits automatic calibration of digital Phase to Ref measurement and generation.

OFF

Calibration of digital Phase to Ref measurement inactive.

ONCE

Starts the automatic calibration. Subsequently the setting changes to OFF.

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2.15.8 Version Display and Service Functions

The version numbers of software, analog and digital hardware and of options are displayed in the OPTIONS panel. As these menu items cannot be edited, they cannot be selected by the cursor.

VERSIONS

SOFTWARE ----------

Software	<version number>
Setup	<version number>
IEC	<version number>

HARDWARE ANALOG ----------

Analy Ch1	<version number>
Analy Ch2	<version number>
Motherbrd	<version number>
Output Cir	<version number>
DAC Board	<version number>

HARDWARE DIGITAL ----------

Digl board	<version number>
Generator	<version number>

OPTIONS ----------

Low Dist	<version number>
IEC board	<version number>
AES/EBU	<version number>
SPK/SWI	<version number>
Highsp Anl	<version number>
Highsp Dig	<version number>
Noname GEN	<version number>
Noname ANL	<version number>

Any software, hardware or option which is not installed is marked by the letters -NA- (Not Available). They are displayed instead of the version number.

Also the service functions are in the OPTIONS panel. They are given under menu item SERVICE PSWD, protected by a password and thus not available to the user.

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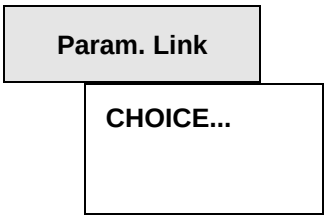
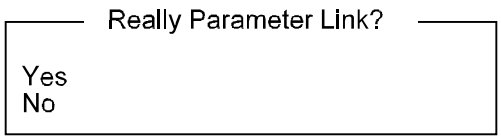
2.15.9 Transfer of Parameters (Parameter Link Function)



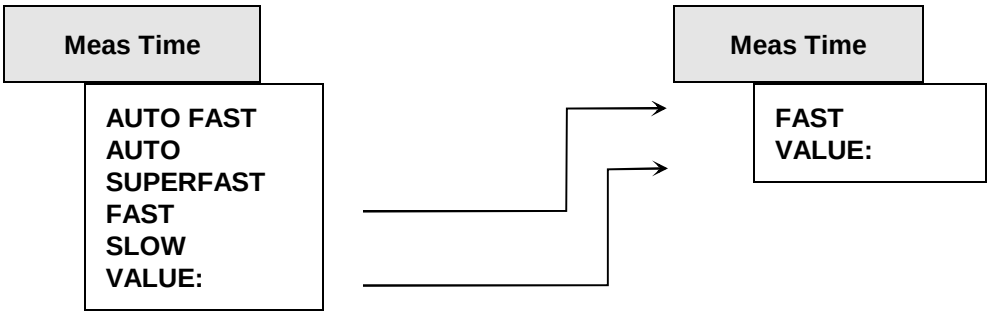
Parameter Link offers the possibility to transfer generator and analyzer settings to another signal or measurement function or to another instrument. The corresponding selection box is opened by pressing the SELECT key. The selected options are to be marked by a tick, see next page.

If a setting is made in UPD that enables the transfer of parameters in accordance with the options selected (marked with a tick), the user is prompted to confirm the transfer:



If YES is entered, the parameter setting is transferred to the new signal function when the signal function is changed. For the transfer, a corresponding command line must exist and the setting to be transferred must be selectable for the old and the new function.

Example:
Parameter Link with switchover from
RMS measurement function to DC measurement function



When switching from the RMS to the DC measurement mode, the settings FAST and VALUE can be transferred. Transfer of the settings AUTO FAST, AUTO, SUPERFAST and SLOW is not possible as these are not available for the DC measurement function.
Numerical values are transferred only if a corresponding command line exists and if the unit for a value in question is available for the new function or instrument. Transferring values from an analog to a digital instrument and vice versa is therefore not possible, and nor is it useful. If the new function or instrument has a range of values assigned that does not include the value to be transferred (while allowing for the associated unit), the value to be transferred is set to the upper or lower limit value of this range.

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Explanation of menu items of parameter link box

Changing Gen Function keeps
FUNCTION parameters

When the signal function is changed, the settings of the old function are transferred to the new function.

Changing Gen Instrument keeps
Output Config.

When an instrument is changed, the configuration settings (those relating to the generator outputs) are transferred to the new instrument. No settings will be transferred for changeovers made between analog and digital instruments.

Changing Gen Instrument keeps
FUNCTION + Parameters

When an instrument is changed, the signal function and associated settings are transferred to the new instrument provided the signal function and settings are permissible for the new instrument.

Changing Anl Instrument keeps
FUNCTION parameters

When the measurement function is changed, the settings of the old function are transferred to the new function.

Changing Anl Instrument keeps
Input Config.

When an instrument is changed, the configuration settings (settings relating to the analyzer inputs) are transferred to the new instrument. No settings will be transferred for changeovers made between analog and digital instruments.

Changing Anl Instrument keeps
START COND

When an instrument is changed, the START COND settings are transferred to the new instrument.

Changing Anl Instrument keeps
INPUT DISP

When an instrument is changed, the INPUT DISP settings are transferred to the new instrument.

Changing Anl Instrument keeps
FREQ/PHASE

When an instrument is changed, the FREQ/PHASE settings are transferred to the new instrument.

Changing Anl Instrument keeps
MONITOR

When an instrument is changed, the MONITOR settings are transferred to the new instrument

Changing Anl Instrument keeps
FUNCTION + Parameters

When an instrument is changed, the measurement functions and associated settings are transferred to the new instrument provided the measurement function and settings are permissible for the new instrument.

Function tracking Gen → Anl
MDIST, DFD, DIM, POL, FM → W&F

When the signal function of the generator is changed, the appropriate measurement function for the analyzer is set.

If any of the signal functions, measurement functions or configuration settings cannot be transferred, a warning will be output.

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2.16 Macro-Operation

With the UPD, setting and measurement sequences can be written as BASIC programs or else recorded via the built-in program generator. Option UPD-K1 (Automatic Sequence Control) is required to do this. The generated BASIC programs can be stored (preferred file extension: .BAS) and called and used in various ways:

1. Call from BASIC user interface:

Once the BASIC user interface has been activated by pressing F3 (on the external keyboard) or BACKSP (on the UPD keyboard), the program can be loaded with LOAD (softkey or F11) and then started with RUN (softkey or F6). The program name needs to be typed during loading. After the program has been quit, the UPD user interface is reactivated with F3 or the LOCAL key.

2. Automatic start of a BASIC program on switch-on:

The UPD can be configured to load and execute (once) a particular program at switch-on. After the program has been quit, the UPD user interface is reactivated with F3 or the LOCAL key. The BASIC program can be either of the following:

- the program INIT.BAS under C:\UPD\USER\, if the power-up mode has been set to 2 with the aid of utility programs BASSET or UPDSET.
- any program whose name is entered with "-bn<filename>" as a call parameter when UPD is started.

3. Call from UPD user interface:

Via the menu item "Exec Macro" on the OPTIONS panel, a BASIC file name can be selected with the aid of the standard file box. In the file box, all files with the extension .BAS are listed as standard. The selected BASIC program is loaded and started automatically. After the program has been quit, the UPD user interface is automatically reactivated.

Advantages of this method:

- All BAS files (macros) available in the selected directory are displayed in the file box.
- Faster and more convenient file handling: the file can be selected directly from the UPD file box and does not need to be typed (possibly plus path) after activating the BASIC user interface.
- As no file name needs to be typed, a macro of this type can also be started without an external keyboard (which is required for typing text into a BASIC user interface).

4. Call from an external control program via IEC/IEEE-bus interface:

Any BASIC program can be loaded and started with the IEC/IEEE-bus command SYST:PROG:EXEC. After the program has been quit, a 1->0 transition is generated in the RUN bit (#14) of the operation register. This is communicated to the controller via SRQ or serial poll so that it can fetch the measurement results. Data exchange between the external control program and the BASIC program can be performed via the measurement-result displays and the measurement-result buffers.

Advantages of this method:

- Modular measurement tasks; the controller is not directly involved with *how* the sequence of measurement is executed in UPD.
- Reduction of controller workload; once the macro has been started, the controller can handle other tasks.
- The measurement algorithms implemented in the BASIC programs of UPD-K1 also be called with a single keystroke in manual mode (see above).

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Exec Macro

The file bearing the name shown here is loaded and executed as a BASIC file. It is essential this file was generated with the Rohde&Schwarz BASIC, eg in the autocontrol option of either UPD or UPL (UPD-K1 or UPL-B10).

Recommended file extension: .BAS

If the file cannot be opened or if it contains invalid BASIC lines, a BASIC error message is issued.

For infor about entering file names, see 2.3.2.5

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2.17 Connecting External Devices

Important:
Using shielded cables for connection of external devices is recommended!
Otherwise spurious emissions may slightly increase, adversely affecting a very sensitive DUT.

All connectors below are located on the UPD rear panel (see 2.1.2, Rear-panel View).

IEC/IEEE-bus
Option: UPD-B4 (IEC-625/IEEE-488 interface)
Applications:

- Remote control of UPD from a host computer; select the address in the OPTIONS panel: "UPD IECadr" (see 2.15.1, IEC/IEEE-bus Address).
- SCREEN HARD COPY on a plotter connected to the IEC/IEEE bus; settings in the OPTIONS panel: "Destin → PLOTTER", "Plot on→IEC BUS", "IEC-Adr" (see 2.14.1 Printing, Plotting, Storing Screen Contents).

For IEC/IEEE-bus operation, see Section 3, Remote Control

RS-232 (COM1, COM2)

2 serial interfaces

Standard configuration of serial interfaces COM1 and COM2:

transmission rate 9600 baud,
even parity,
7 data bits,
1 stop bit,
none retry.

Applications COM1 (free for user-defined devices):

- Connecting a mouse or a roll key; offers an alternative way of operating panels and softkeys. (See Sections 1.1.7, Connecting a Mouse, and 2.3, General Instructions for Use

Applications COM2 (reserved for device software):

- SCREEN HARD COPY on a plotter connected to COM2; settings in the OPTIONS panel Destin → PLOTTER, Plot on → COM1/2 (see 2.14.1, Printing, Plotting and Storing Screen Copies).

The interfaces can be reconfigured at the operating system level using the DOS command MODE (change to DOS with the SYSTEM key), or automatically upon switch-on by modifying the AUTOEXEC.bat file, via the universal sequence controller or, alternatively, also after execution of the SHELL command.

SYNTAX

mode com*m* [:] [b[,b[,d[,s[,r]]]]]
mode com*m* [:] [**baud**=*b*] [**parity**=*p*] [**data**=*d*] [**stop**=*s*] [**retry**=*r*]

Parameter

com*m*

Denotes the number of the pin for asynchronous data transmissions (COM). Valid values for m are 1 or 2.

If one of the following five parameters is omitted, mode uses the last setting of the omitted parameter. If the short form of the syntax is used (without the words **baud =, parity =, data** etc.), the **mode** command identifies the parameters by their position. If no value is entered for a particular parameter, the comma preceding the next parameter must be entered.

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baud=*b*

Denotes the first two positions of the transmission rate in bits per second. The following list contains the valid values for b and the corresponding transmission rates:

11	110 baud
15	150 baud
30	300 baud
60	600 baud
12	1200 baud
24	2400 baud
48	4800 baud
96	9600 baud

This parameter can be abbreviated by omitting **baud =** and entering a value for *b*.

parity: =*p*

Determines how the parity bit is used by the system to check transmission errors. *p* may assume one of the following values: **n** (none), **e** (even) or **o** (odd). The standard value is **e**. This parameter can be abbreviated by simply omitting **parity =** and specifying a value *p*.

data: =*d*

Denotes the number of data bits per character: Valid values for *d* are 7 or 8. The standard value is 7 data bits. This parameter can be abbreviated by simply omitting **data =** and specifying a value for *d*.

stop: =*s*

Denotes the number of stop bits defining the end of a character: 1 or 2. If the transmission rate 110 has been set, 2 stop bits are used as standard. Otherwise, the standard value is 1. This parameter can be abbreviated by simply omitting **stop =** and entering a value for *s*.

retry: =*r*

Determines what is to happen in the case of a time-exceeded error if **mode** attempts to send data to a serial printer. The option causes a part of **mode** to remain resident in the working memory. The following list contains the valid values for r and a short description of their meaning.

e	Output an error following a status check of a busy pin
b	Indicate "busy" following a status check of a busy pin
p	Try until the interface accepts the output.
r	Indicate "busy" following a status check of a busy pin
n	Do not try again (standard). **none** can also be indicated for this value.

This parameter can be abbreviated by omitting **retry** = and specifying a value for *r*.

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Serial interface:
Typical connections to external device with 9-pin connector (PC) using the acknowledge signal lines.

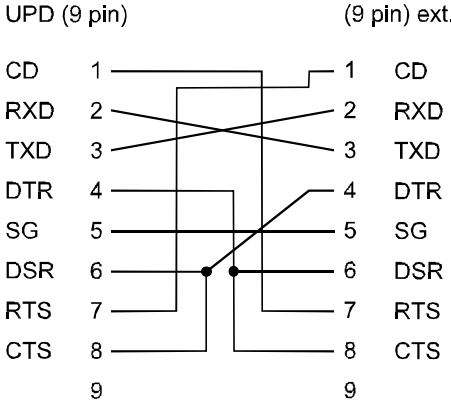

Fig. 2-66 9-contact serial interface

Typical connections to external device with 25-pin serial connector using the acknowledge signal lines.

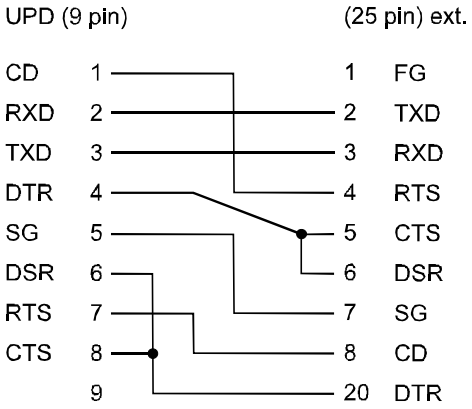

Fig. 2-67 25-pin serial interface

25-pin serial interface, connection without acknowledge signal lines.

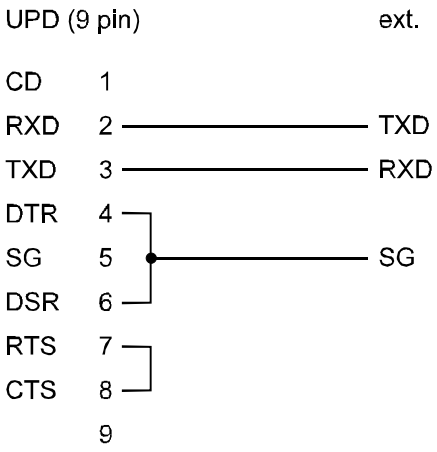

Fig. 2-68 25-pin serial interface

FG: Frame Ground, **TXD:** Transmitted Data, **RXD:** Received Data, **RTS:** Request to Send, **CTS:** Clear to Send, **DSR:** Data Set Ready, **SG:** Signal Ground, **CD:** Carrier Detect, **DTR:** Data Terminal Ready.

Note: *The connection cable between UPD (9-pin plug) and the external device (eg plotter) should be configured as described in the instrument manual (of the plotter eg). The UPD side can be connected up as in the case of connection of an ISA (IBM-PC)-compatible computer.*

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Centronics
Parallel interface for connecting a printer (see 2.14.2, Printing Traces and Lists)

VGA (external CRT monitor)
CRT interface for connecting a (colour or monochrome) VGA monitor
Advantages:

- Larger screen size
- Coloured trace representation possible even on UPDs with monochrome monitor

Switchover to external monitor in the OPTIONS panel using the menu item "Extrn disp → BOTH..." (see 2.15.5, Setting, Switching Off the Displays)

Note: *When connecting an external monochrome VGA monitor, the 'C:\CONFIG.SYS file has to be modified (for more details see comment in this file).*

Monitor 1/2
Monitoring outputs channel 1 and 2 for the unfiltered (analog) input signal; active for analog analyzers only; switching on and level attenuation in the ANALYZER panel (MONITOR → ON and "Atten", see 2.6.6 Monitor Output.

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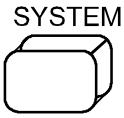
2.18 UPD Used as Computer

The UPD software uses the MS-DOS operating system from Microsoft. MS-DOS commands and programs are available when the UPD software is quit. For operation refer to the MS-DOS user manual supplied.



The UPD software is quit with the SYSTEM key (or the key combination CTRL+F9 on the external keyboard). A dialog box is then displayed in which the command must be confirmed in order to avoid the inadvertent call of the MS-DOS operating system.

***Note**:* *The key combinations Ctrl+C or Ctrl+Pause (of the external keyboard) have the same function as the SYSTEM key. . Therefore, an inadvertent use of these key combinations will not lead to an uncontrolled program abort.*

At the operating system level, the user is wholly responsible for not the files required by the UPD, it that they are not modified or deleted. The directory structure used must also be maintained (see 1.3, Software Re-installation). The CONFIG.SYS and AUTOEXEC.BAT files required for starting the UPD should be modified by experienced users only.

The UPD software can be restarted in the following three ways:

1. Call the UPD.BAT batch file by way of >UPD (where ">" is the input request of MS-DOS and need not be entered).
2. Press the CTRL, ALT and DEL keys simultaneously in order to trigger a warm start.
3. Switch the UPD off and (after a few seconds) on again.

2.18.1 Setting the Realtime Clock

If the time or date display in the UPD is no longer correct, the AT realtime clock must be set. This is done at the operating system level using the DOS commands TIME and DATE. To do so quit the current mode by accessing the operating system by means of the SYSTEM key (see **2.18 UPD Used as Computer**).

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3 Remote Control

3.1 Introduction

The UPD may be optionally equipped with an IEC/IEEE interface according to standard IEC 625.1/IEEE 488.2 .

Note:

If the remote-control option UPD-B4 was not originally ordered with the UPD, it may be obtained via the local sales engineer (for Order No. see data sheet). After entering an enable code as described in the supplied instructions, the IEC/IEEE-bus option is ready for use without any additional hardware installations being required.

Note:

If the remote-control option UPD-B4 is not enabled, the UPD should not be connected to other instruments via the IEC/IEEE bus as proper function cannot be guaranteed in this case.

The connector is located at the rear of the instrument and allows a controller to be connected for remote control. The instrument supports SCPI version 1993.0 (Standard Commands for Programmable Instruments). The SCPI standard is based on standard IEEE 488.2 and aims at the standardization of device-specific commands, error handling and status registers (see section 3.5.1 SCPI Introduction).

Note:

In the IEC/IEEE-bus command lists below, all commands confirmed or approved by the SCPI committee are written in normal characters.
Other innovative commands or commands required for general measurements are in italics and in the form and style as specified by SCPI (not part of SCPI definition).

This section assumes a basic knowledge of IEC/IEEE-bus programming and controller operation. A description of the interface commands is to be obtained from the relevant manuals.
The requirements of the SCPI standard placed on command syntax, error handling and configuration of status registers are explained in detail in the respective sections. Tables provide a fast overview of the bit assignment in the status registers. The tables are supplemented by a comprehensive description of the status registers. For detailed program examples of the main functions see **3.15 Examples of IEC/IEEE-Bus Programming**. The program examples are written in Quick BASIC.

Note:

R&S BASIC and the R&S IEC/IEEE-bus interface board may be ordered from your local sales engineer under the designation: ***PAT-B1, Order No. 1007115002****.*

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3.2 Brief Instructions (Read-out of Measured Values)

The short and simple operating sequence given below permits fast putting into operation of the instrument and setting of its basic functions. A condition is, however, that the **IEC/IEEE-bus address**, which is factory-set to **20, is not changed.**

1. Interconnect instrument and controller using the IEC/IEEE-bus cable.

2. Write the following program on the controller and start it with RUN (F2):

```
10 IEC TERM 10: ’     Controller expects LF as a delimiter of an UPD reply
20 IEC TIME 5000:  ’Controller waits for a maximum of 5 s for a reply from
30 ’                        the UPD before sending an IEC/IEEE-bus timeout
40 IEC OUT 20,"*RST": ’                                  UPD default setup
45 IEC OUT 20,"INP:TYPE GEN1": ’Internal connection to generator channel 1
50 IEC OUT 20,"*CLS": ’                Resets IEC/IEEE-bus status register
60Loop:
70 IEC OUT 20,"INIT:CONT OFF;*WAI":  ’        Triggers a single measurement
80 IEC OUT 20,"SENS:DATA?": ’                Request for measurement result
90 IEC IN 20,M$: ’                            Readout of measurement result
100 PRINT M$: ’                                Output of measurement result
110 Goto Loop
120 END
```

As a result of the default setup with *RST (see annex A UPD Default Setup in the UPD manual), the UPD generator produces a 1-kHz sinewave signal with a level of 0.5 V.
Command `INP:TYPE GEN1` establishes an internal connection between generator and analyzer channel 1 so that no cabling of outputs and inputs is required for this first test. The UPD analyzer carries out an RMS measurement, indicates the measurement result in the display and outputs it continuously on the controller display.

Note:

A measurement must be triggered before a result can be displayed, a measurement must be triggered. (line 70). The settled measurement result available after triggering can be requested (line 80), read in (line 90) and output to the controller (line 100).

3. To return to manual operation press the [LOCAL] key on the front panel.

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3.3 Switchover to Remote Control

After power-on, the instrument is always in the manual operating state (LOCAL state) and can be operated from the front panel or the keyboard. It is switched to remote control control (REMOTE state shown by REMOTE caption in the screen center) as soon as it receives an addressed command from a controller.

If the UPD has been set to the manual status from REMOTE with the LOCAL key, then each command via

R&S BASIC switches the UPD to the REMOTE status, because R&S BASIC sends each command in addressed form to the UPD. If the

NI GPIB device driver is used, the first IEC/IEEE command should be send addressed. This addressing for board-specific programming is for example the command ibcmd (`board address, 20, 1`) or for device-specific programming the **repeat addressing** setting in the NI GPIB device driver – or `ibloc(0)` before the first IEC/IEEE command. If the UPD in the LOCAL state is sent a non-addressed command, the latter will be carried out but the screen will show the old manual settings and not the expected empty screen with the REMOTE caption.

During remote control, operation from the front panel is disabled. The instrument remains in the remote state until it is reset to manual operation via the front panel or the IEC/IEEE bus (see section 3.3.3 Return to Manual Operation). Switching from manual operation to remote control and vice versa has no effect on the instrument setup.

3.3.2 Setting the Device Address

The IEC/IEEE-bus address of the instrument is factory-set to 20. It can be changed manually under UPD IECadr in the OPTIONS panel or via IEC/IEEE bus.

Manually: Enter the required address under UPD **IECadr** in the OPTIONS panel.

Via IEC/IEEE bus:

```
IECOUT 20,"SYST:COMM:GPIB:ADDR 30":'                    Set new address 30
HOLD 500:'          Wait approx. 500 ms before new commands are effected
```

3.3.3 Indications During Remote Control

- The remote-control status is signalled by the word REMOTE in the display center and by the REM LED on the UPD front panel.
- Measurement results (active) are indicated in the upper part of the display.
- Error messages occurring during IEC/IEEE-bus control are displayed in plain text in the lower part of the UPD display (see also section **3.14 List of Error Messages**).

3.3.4 Return to Manual Operation

Return to manual control can be made from the front panel or via the IEC/IEEE bus.

Manual: Press the [LOCAL] key, the REM LED goes out.

Prior to the switchover, command processing must be completed as otherwise remote control is immediately switched on again.

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Note: LLO state (Local Lockout):

The [LOCAL] key can be locked by the universal command LLO in order to prevent inadvertent switchover:

R&S-BASIC:
R&S BASIC command `IECLLO`

NI-GPIB-Treiber:
NI command `SendLLO(0)`

This state can be cancelled only by switching the "REN" line of the IEC/IEEE bus from 0 to 1:

R&S-BASIC:
R&S BASIC commands IECNREN, followed by IECREN.

NI-GPIB-Treiber:
NI commands ibsre(0,0); followed by ibsre(0,1);.

Via IEC/IEEE bus:

R&S-BASIC:

```
   :
IECLAD 20:'                Sets device to manual operation
IECGTL
   :
```

NI-GPIB-Treiber:

```
ibloc (0);
```

To switch UPD from LOCAL state to REMOTE state, see 3.3 Switchover to Remote Control

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3.4 IEC/IEEE-Bus Messages

The messages transmitted on the data lines of the IEC/IEEE bus can be subdivided into two groups:
- **interface messages** and
- **device-dependent messages**

3.4.1 Interface Messages

Interface messages are transmitted on the data lines of the IEC/IEEE bus, with the control line "ATN" being active. They are used for communication between the controller and the instrument and can only be sent by a controller with controller function on the IEC/IEEE bus.
There are two groups of interface messages:
- **common commands** and
- **addressed commands**

Common commands affect all devices connected to the IEC/IEEE bus without any addressing being required, whereas addressed commands only affect devices addressed as a listener. The relevant interface messages for the UPD are listed in annex A.

3.4.2 Device-Dependent Messages (Commands and Responses)

The device-dependent messages are transmitted on the data lines of the IEC/IEEE bus, with the control line ATN being not active. The ASCII code is used for data transmission. Device-dependent messages are differentiated according to the direction in which they are sent via the IEC/IEEE bus:

- **Commands** are messages sent by the controller to the UPD. They control the device functions and request information.
  The commands are subdivided according to two criteria:

  1. According to the effect they have on the device:
     Setting commands cause device settings to be made, e.g. the resetting of the UPD or the setting of the output level to 1 Volt.

     Queries cause data to be provided for output via the IEC/IEEE bus, eg for device identification or query of the active input.

  2. According to their definition in the IEEE 488.2 standard:
     Common commands are precisely defined in their function and notation in the IEEE 488.2 standard. They refer to functions as for instance the management of the standardized status registers, resetting and selftest

     Device-specific commands refer to functions that depend on the device characteristics, such as frequency setting. A large number of these commands has also been standardized by the SCPI Consortium (see section 3.5.1 SCPI Introduction)

- **Responses** are messages sent by the UPD to the controller following a query. They may contain results, device settings or information on the device status (see section 3.5.4 Responses to Queries).

The section below describes structure and syntax of device-dependent messages. As from section **3.10 IEC-bus Commands** onwards, the commands are listed independent of their function, described in brief and listed in alphabetical order.

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3.5 Structure and Syntax of Device-Dependent Messages

3.5.1 SCPI Introduction

SCPI (Standard Commands for Programmable Instruments) describes a standardized command set for the programming of instruments regardless of the type of instrument or manufacturer. The goal of the SCPI Consortium is to standardize device-specific commands to a large extent. For this purpose an instrument model has been developed which defines identical functions within an instrument or of different instruments. Command systems have been generated and assigned to these functions so that it is possible to address identical functions by the same commands. The command systems have a hierarchical structure. Fig. 3-1 shows this tree structure, using a detail from the SOURce command system for controlling the signal sources of the instrument. The other examples of syntax and structure of the commands are taken from this command system.
SCPI is based on the IEEE 488.2 standard, ie it uses the same syntax elements as well as the "common commands" defined therein. The syntax of the responses is partly subjected to stricter rules than laid down in the IEEE 488.2 standard).

3.5.2 Command Structure

The commands consist of a so-called header and usually one or several parameters. Header and parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, eg space). The headers may be composed of several keywords. The query form is generated by appending a question mark directly to the header.

Common Commands

Common commands consist of a header preceded by an asterisk "*" and one or several parameters.

Examples	`"*RST"`	RESET, resets the UPD
	`"*ESE 253"`	EVENT STATUS ENABLE, sets the bits of the Event Status Enable Registers
	`"*ESR?"`	EVENT STATUS QUERY, queries the contents of the Event Status Register.

Device-specific commands

Hierarchy

Device-specific commands have a hierarchical structure (see Fig. 3-1). The various levels are represented by compound headers. Headers of the highest level (root level) have one keyword only. This keyword stands fro a whole command system.

Example: `SENSe` This keyword denotes the command system SENSe (see section 3.5.7 Programming Model of UPD Generator)

For lower-level commands the full path has to be specified, starting with the highest level in the left-most position. The individual keywords are separated by a colon ":".

Example: `"SENSe:FUNCtion:SETTling:MODE EXPonential"`
(exponential settling of function test results)

This command is at the fourth level of the SENSe system. It selects the function settling mode.

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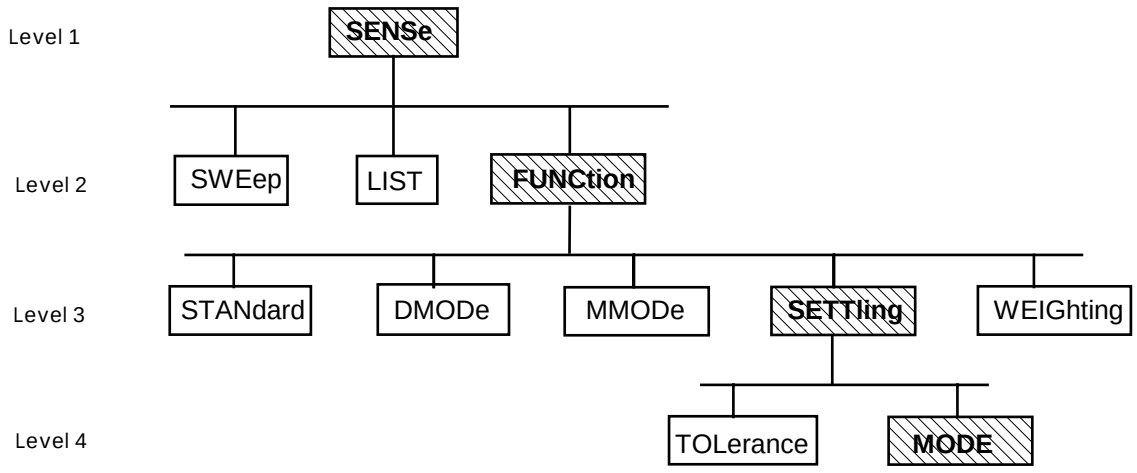

Fig. 3-1 Tree structure of SCPI command system, SENSe being shown as an example

Optional keywords: Some command systems permit certain keywords to be optionally inserted into the header or omitted. In the manual these keywords are marked by square brackets. For reasons of compatibility with the SCPI standard, the instrument must be able to recognize the full command length. Some of the commands become considerably shorter when the optional keywords are omitted.
Example: "`DISPlay[:WINDow]:TEXT[:DATA] 'String'`"
The following command has the same effect:
"`DISPlay:TEXT 'String'`" (text in graphic display)

Long and short form: The keywords have a long and a short form. The short form or the long form can be entered, other abbreviations are not permissible
Example: "`STATus:QUEStionable:ENABle 1`"
The following command has the same effect:
"`STAT:QUES:ENAB 1`" (0 bit of Status Questionable Register enabled)

Note:

The short form uses uppercase characters, the long form gives the whole keyword. Uppercase and lowercase letters are used for identification in the manual, the UPD itself does not differentiate between uppercase and lowercase characters.

Parameter: The parameter must be separated from the header by a "white space". If a command contains several parameters, they have to be separated by a comma ",". Some of the queries permit the parameters MINimum and MAXimum to be entered. For a description of the various types of parameter see section 3.5.5 Types of Parameters.
Example: "`SENSe:FREQuency:STARt? MAXimum`"
Response: `21641.8`
(query requesting the maximum value for starting a frequency sweep)

Numeric suffix: If a device has several identical functions or features, eg inputs, the desired function can be selected by a suffix added to the command.
Example: "`SENSe2:Voltage:REFerence 1V`"
(reference value for a relative INPUT peak measurement

Note:

Entries without suffix are interpreted like entries with suffix 1

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3.5.3 Structure of a Command Line

All commands and data sent to the UPD are temporarily stored in a 1024-byte input buffer. Longer command lines can also be processed, the previously received part of the line being internally processed. A command line may take up more than one line on the controller display. The end of a line is determined by a delimiter.

Delimiters for a command set to the UPD:
A command line to the UPD may contain one or several commands. It is terminated by a <New Line> (ASCII code, 10 decimal) or <EOI> (EOI line active) together with the last useful character of the command line or by <New Line>. Since a <Carriage Return> character (ASCII code, 13 decimal) as a filler before the delimiter has no effect, the combination <Carriage Return><New Line> is permissible.

Example for generating the various delimiter combinations:

<**Carriage Return**>+<**New Line**>+<**EOI**> (default setting of IEC/IEEE-bus controller):

```
10 IECEOI
20 IECOUT 20,"XYZ"
```

If no **';'** is sent at the line end, <CR><NL> is added.

<**New Line**>+<**EOI**>**:**

```
10 IECEOI
20 IECOUT 20,"XYZ"+CHR$(10);
```

';' ensures that no <CR><NL> is added.

<**EOI**>**:**

```
10 IECEOI
20 IECOUT 20,"XYZ";
```

';' ensures that no <CR><NL> is added.

<**New Line**>**:**

```
10 IECNEOI
20 IECOUT 20,"XYZ"+CHR$(10);
```

';' ensures that no <CR><NL> is added.

<**Carriage Return**>+<**New Line**>**:**

```
10 IECNEOI
20 IECOUT 20,"XYZ"
```

If no **';'** is sent at the line end, <CR><NL> is added.

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Command string:

Several commands in a command line are separated by a semicolon **";"**. If the next command belongs to a different system, the semicolon is followed by a colon **":"**

Example:

```
IECOUT 20,"SOUR:FREQ:STAR 20Hz;:SYST:BEEP:STAT ON"
```
(switches on beeper for error messages)

This command line contains two commands. The first command belongs to the SOURce system and is used to set the start frequency for a generator sweep. The second command is part of SYSTem and switches on an acoustic alarm in the case of errors.

If the successive commands belong to the same system and therefore have one or several common levels, the command line may be shortened. The second command following the semicolon then starts at the level that is below the common levels (see also Fig. 3-1). The colon after the semicolon has to be omitted.

Example:

```
IECOUT 20,"SOUR:FREQ:STAR 20Hz;:SYST:BEEP:STAT ON"
```
(Start- and stop command for sweep)

This command line is shown in full length and contains two commands separated by a semicolon. Both commands belong to the SOURce command system, FREQency subsystem, ie they have two common levels.
In the shortened command line the second command starts at the level below SOURce:FREQ. The colon after the semicolon has to be omitted.

The abbreviated form of the command line is:

```
IECOUT 20,"SOURce:FREQ:STAR;STOP 15kHz"
```

A new command line always begins with the complete path.

Example:
```
IECOUT 20,"SOUR:FREQ:START 20Hz"
IECOUT 20,"SOUR:FREQ:STOP 15 kHz
```
(Start- and stop command for sweep)

When common commands starting with an asterisk '*' are linked in a command string, they are preceded by a semicolon ';' and not by ';:' as is the case with linked UPD commands.

Example:
```
IECOUT 20,"INIT;*WAI;:SENS:DATA1?"
                  ↑
```
(triggers measurement, selects result of function measurement on channel 1 and sends `next command only` after completion of the measurement!)

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3.5.4 Responses to Queries

Delimiters of responses sent by the UPD:

All responses sent by the UPD to the IEC/IEEE-bus controller are terminated by <New Line> (ASCII code, 10 decimal) and <EOI> (EOI line active). With the aid of the `IECTERM` command, the IEC/IEEE-bus controller can be set to various delimiters, but only the setting

`IECTERM 10` is useful.

- `IECTERM 10`, causes the IEC/IEEE-bus controller to respond to the delimiter <New Line>. With
- `IECTERM 1` (EOI only), the response string from the UPD displayed on the monitor of the IEC/IEEE-bus controller is followed by an empty line, as <New Line> before <EOI> is interpreted as part of the response string.
- `IECTERM 0` (<Carriage Return>+<New Line>), the response string from the UPD displayed on the monitor of the IEC/IEEE-bus controller will again be followed by an empty line, as the <Carriage Return> is interpreted as part of the response string and changed into a line feed command by the IEC/IEEE-bus controller.

All other settings cause a TIMEOUT.

Possible queries

Unless explicitly specified otherwise, a query is defined for each setting command. The query is generated by appending a question mark to the associated setting command. Some of the SCPI rules imposed on the query responses are stricter than those of the IEEE 488.2 standard:

1. The requested parameter is sent without header.
   Example: **Setting:** `"INPut:TYPE BAL"`
   Query: `"INPut:TYPE?"` **Response:** BAL
   (input BAL for analog analyzer)

2. Maximum and minimum values requested by the special text MAXimum and MINimum are returned as numeric values
   Example: **Setting:** `"SENSe:FREQuency MAX|MIN|`any value"
   Query: `"SENSe:FREQuency? MAX"` **Response:** `21641.8`
   Query: `"SENSe:FREQuency? MIN"` **Response:** `2.0`
   (maximum or minimum value depend on current setting)

3. Numeric values with floating decimal point are output with the same unit as entered.
   Example: **Setting:** "`SENSe:FREQuency:STARt 20kHz?`"
   Query: `"SENSe:FREQuency:STARt?"` **Response:** 20.0 kHz
   (sweep start frequency)

4. Integral values are returned as such.
   Example: **Setting:** "INST:NSEL 1"
   Query: "INST:NSEL?" **Response:** 1
   (enables display of measurement results)

5. Text (character data) are returned in short form (see sections 3.5.1 and 3.5.4).
   Example: **Setting:** "OUTPut: TYPE BALanced"
   Query: "OUTput:TYPE?" **Response:** BAL
   (generator output channel 1 XLR balanced)

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6. Character strings are output in the same way as they are input, ie the simple and double quotation marks are also output (see section 3.5.6 Overview of Syntax Elements).

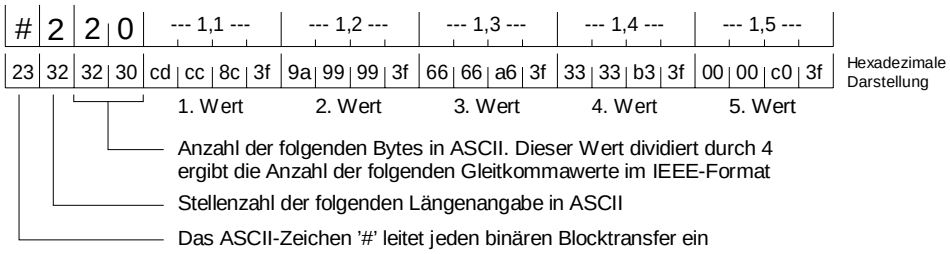
   Example: **Setting:** `"MEMory:STORe:STATe 2,'LASTSAVE.SCO'"`
   Query: `"MMEMory:STORe:STATe? 2"` **Response:** `'LASTSAVE.SCO'`
   (storage of UPD setting under 'LASTSAVE.SCO'

7. Data strings are output as ASCII characters or in binary form depending on IEC/IEEE-bus commands FORM ASC and FORM REAL.
   Example:
   5 floating-point values are available as a trace following a completed sweep.

   Setting: `"FORM ASC"`
   Query: `"TRACe? TRACe"` **Response:** `1.1,1.2,1.3,1.4,1.5`
   (load Y values of A trace into UPD)

   Setting: `"FORM REAL"`
   Query: `"TRACe? TRACe"`

   The **response** is in the form of a binary data stream. Floating-point values are output with a length of 4 byte each in IEEE format (LSB first):



   To receive the binary data stream in full length, set the **end character EOI** (in R&S BASIC: **IEC TERM 1**) in the controller program and not LF (0Ah = 10d) (in R&S-BASIC: IEC TERM 10) which would normally be set for the reception of ASCII strings. This is to avoid the binary data stream being prematurely interrupted if the bit combination OAh occurs.

3.5.5 Types of Parameters

Most commands require the specification of a parameter. The parameters must be separated from the header by a "white space" (ASCII code, 0 to 9, 11 to 32 decimal, generally a blank). Parameters may be specified as numeric values, Boolean parameters, character data, character strings and block data. The type of parameter required for the specific command as well as the permitted range of values are described together with the commands (see section **3.10 IEC-bus Commands**).

Numeric values

Numeric values may be entered in any customary form, ie with sign, decimal point and exponent. If the values exceed the resolution of the UPD, they will be rounded off. The number including the exponent may comprise up to 20 characters. The number of digits of mantissa and exponent is only limited by this condition. The exponent is denoted by an "E" or "e". The exponent alone must not be used. Physical quantities may be stated with the unit. Permissible prefixes for the unit (also called engineering) are M (Mega), K (Kilo), m (milli) and u (micro). The units for which these prefixes may be used can be seen from the tables in section **2.4 Unit** in the UPD manual. With no unit stated, the basic unit is assumed (see section 3.10 IEC-bus Commands column Basic unit of UPD manual).

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Examples:

```
"SOURce:FREQuency 1.5 kHz"    1500 Hz
                  1.5E3       1.5E+3
                  1.5E 3      1.5E 03
                  +1.5E3      001.5E3
```

Special numeric values

The parameters MINimum, MAXimum, UP and DOWN are interpreted as special numeric values.

MIN/MAX

MINimum and MAXimum denote the minimum and maximum value.
Upon a query the numeric value will be returned.

Example: Setting command: `"SOURce:VOLTage MAXimum"`
Query: `"SOURce:VOLTage?"` **Response:** `24`
(maximum generator level)

UP/DOWN

UP increments, DOWN decrements the current numeric value by 0.001%.

NAN

Not **A** **N**umber represents the value 9,91E37, is only sent as a device response and denotes missing or illegal values.

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Boolean parameters Boolean parameters represent two states. The ON state (true condition) is represented by ON, the OFF state (false condition) by OFF.

Example: Setting command: `"SENS:FUNC:WEIG ON"`
Query: `"SENS:FUNC:WEIG?"` **Response:** `ON`
(W&F weighting filter on)

Character data Character data follow the syntax rules for keywords, ie they also have a short and a long form. Like any other parameter, they must be separated from the header by a 'white space'. A query returns the short form of the character data.

Example: Setting command: `"DISPlay:MODE COLB"`
Query: `"DISPlay:MODE?"` **Response:** `COLB`
(representation in colour on internal and external display)

Character string According to SCPI strings must always be given in single or double quotation marks. Normally single quotes are used as the double quotes are used for identifying the total IEC/IEEE-bus command as a string.

Example: `"MMEMory:DELete 'C:\UPD\USER\MYSETUP.SCO'"`
(clearing of specified file)

Data strings Numeric values are to be separated by commas, decimal digits by a '.'.

Example: `"TRAC LIST1, 100.0,1000.0,5000.0,15000.0"`
(setting the X values in a graphics display)
`"SOUR:LIST:FREQ 1.1,1.2,1.3,1.4,1.5"`
(setting the frequencies for a frequency sweep)

Whether the data strings start with a comma or a blank depends on the command and is defined by SCPI.

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3.5.6 Overview of Syntax Elements

The following list provides an overview of the syntax elements..

:	The colon separates the keywords of a command. In a command line, the colon following a semicolon identifies the highest command level.
;	The semicolon separates two commands in a command line. It does not change the path.
,	The comma separates several parameters of a command.
?	The question mark forms a query.
*****	The asterisk identifies a common command.
"	Quotation marks denote the beginning of a character string and terminate it.
#	The double cross denotes the beginning of block data.
	A "white space" (ASCII code 0 to 9, 11 to 32 decimal, eg space) separates header and parameter.
.	Decimal point of numeric values.

3.5.7 Programming Model of UPD Generator

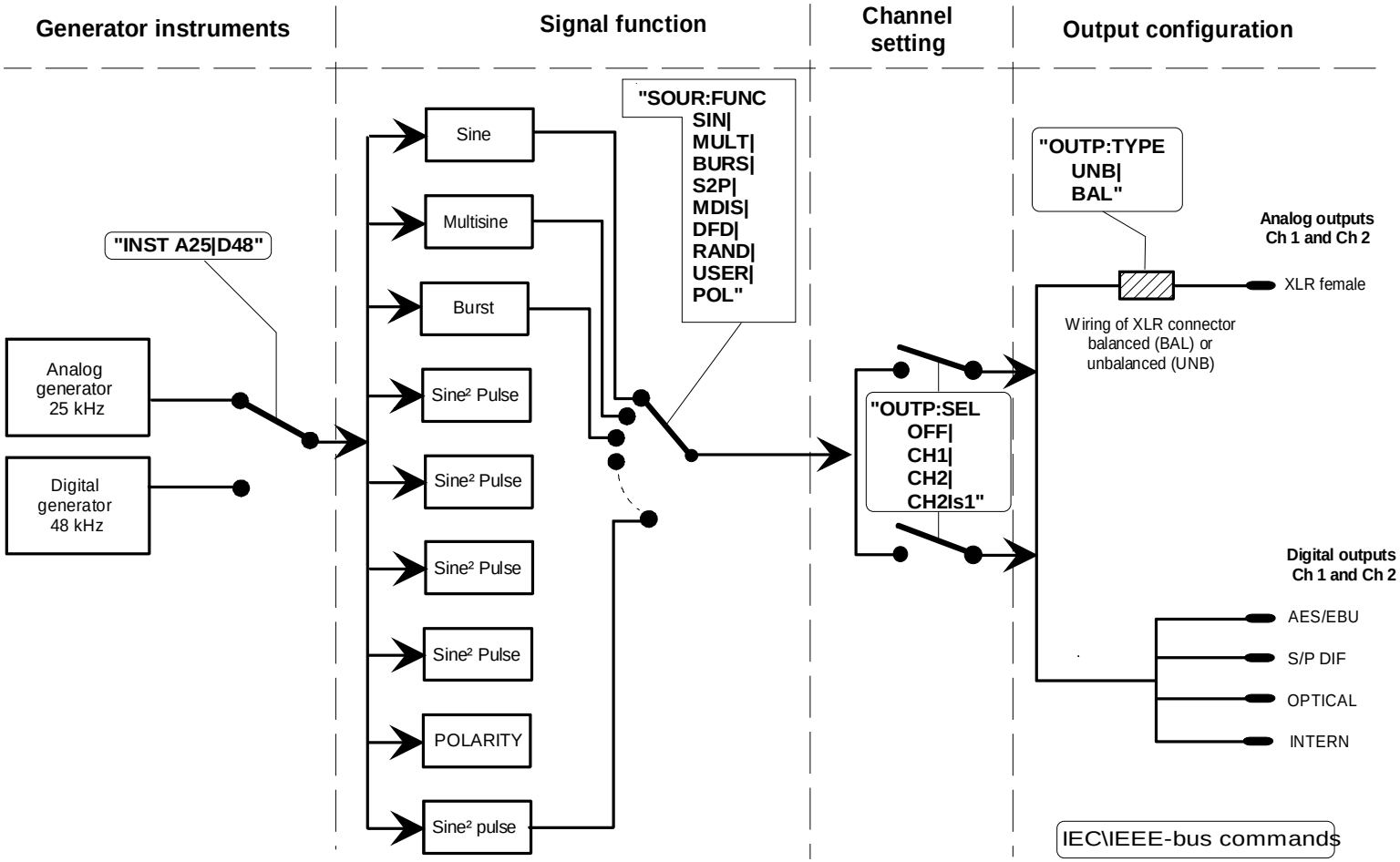

Fig. 3-2 Instruments and signal functions of UPD generator

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3.5.8 Programming Model of UPD Analyzer

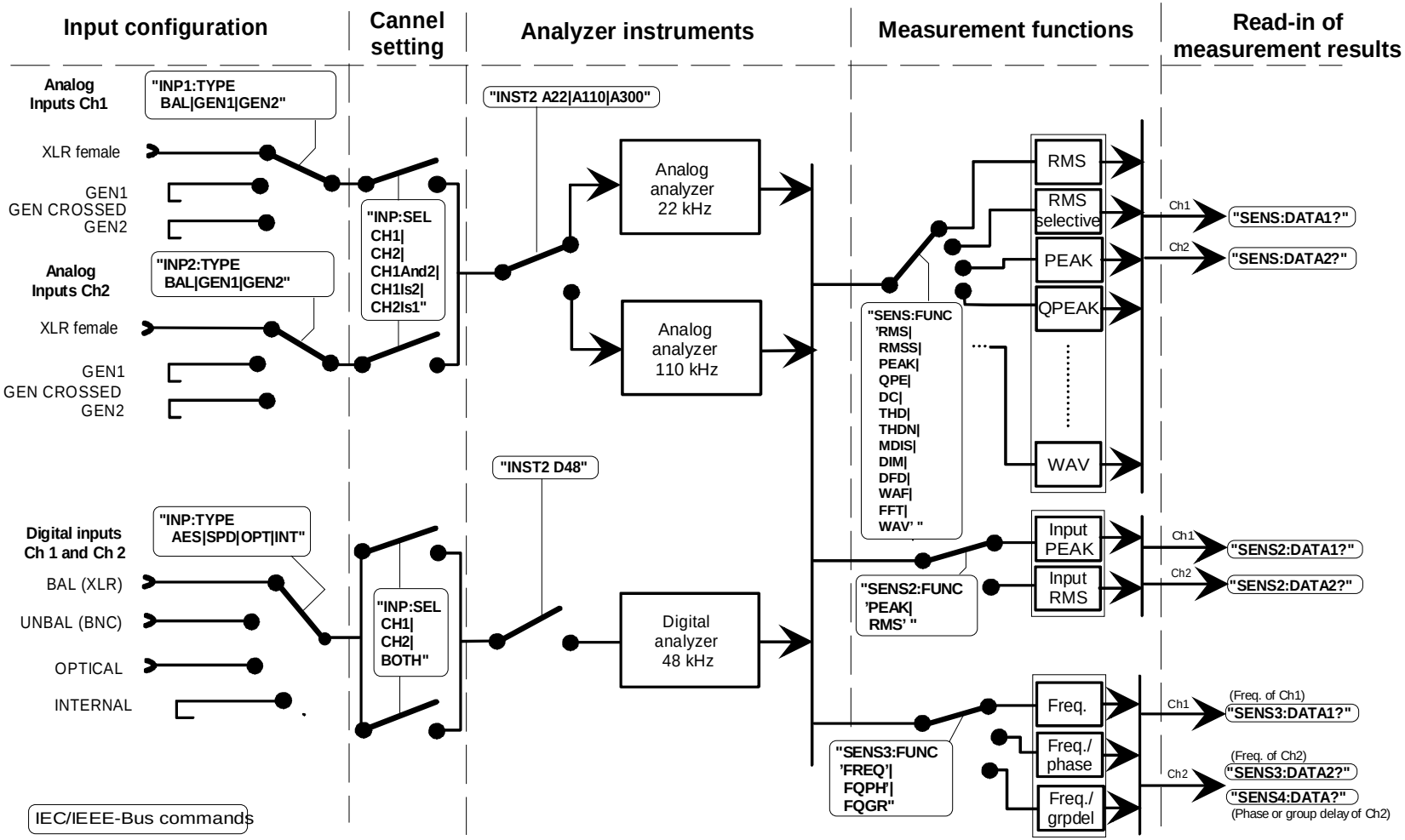

Fig. 3-3 Instruments and measurement functions of UPD analyzer

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3.6 Instrument Model and Command Processing

The instrument model shown in Fig. 3-4 has been configured under the aspect of processing IEC/IEEE-bus commands. The individual components operate independently of each other and simultaneously. They communicate with each other by means of so-called messages.

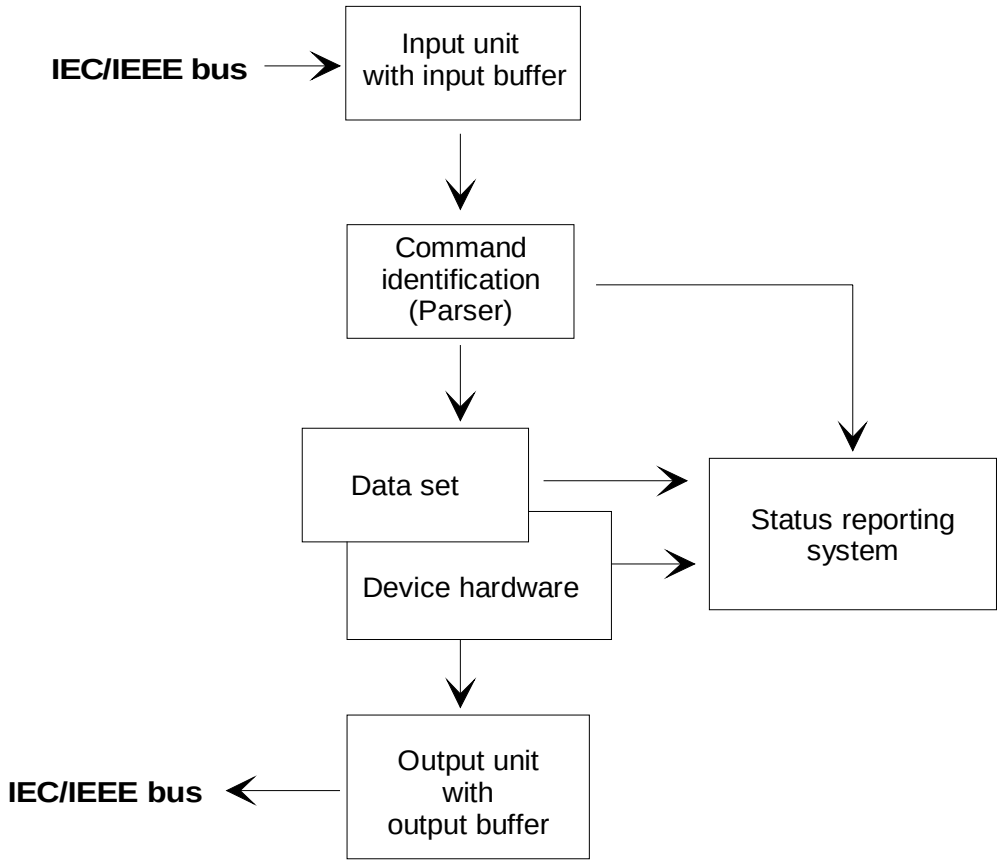

Fig. 3-4 Instrument model with remote control via IEC/IEEE-bus

3.6.1 Input Unit

The input unit receives the commands in the form of characters from the IEC/IEEE bus and collects them in the input buffer. The input buffer has a capacity of 1024 characters. As soon as the input buffer is full or receives the interface message DCL, transfer on the IEC/IEEE bus is stopped and the received data are sent to the parser where the commands are checked for syntax and semantic errors and the hardware is set in the sequence in which the commands arrived. Data transfer on the IEC/IEEE bus is then continued. However, if the buffer is not yet full when a terminator is received, the input unit can receive the next command while the previous command is identified and executed. Reception of a DCL clears the input buffer.

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3.6.2 Parser

The parser (to parse = grammatically analyze) analyzes the data received from the input unit proceeding in the order in which the data are received. A GET (Group Execute Trigger), for example, is only processed when the previously received commands are executed. A DCL command will be given priority. Each command identified as correct will immediately be executed and causes a hardware setting.
Syntax and semantic errors are recognized and passed on to the status reporting system. The remaining part of a command line after the syntax error will be further analyzed as far as possible and processed.

While the parser is setting the hardware, the input unit can collect new commands in the input buffer. This means that further commands can already be processed while settings are being made in the hardware ("overlapping execution").

3.6.3 Setting the Device Hardware

The term "device hardware" refers to that part of the UPD which performs the instrument function proper: signal generation, measurements, etc. This does not include the controller.

An IEC/IEEE-bus command line which may contain several setting commands is sent to the parser, which checks the IEC/IEEE-bus commands for syntax and semantic errors. If a command is identified as correct, a check is made with the aid of the current settings whether the command is permissible. Permissible commands are taken over into the UPD data set (corresponds to hardware settings) and the device hardware is set. If it turns out that the command is illegal because of the existing settings, as for example a generator level of 20 V on the unbalanced outputs, an "execution error" message is sent to the status reporting system and no new settings will be made in the device hardware for this command. Subsequent commands which prove to be permissible are executed as described in the following section.
This strictly hierarchical sequence ensures that at no time illegal device states will be set.

3.6.4 Why is a Specific Operating Sequence Sometimes Required?

- Each IEC/IEEE-bus command received by the UPD is immediately checked whether it is permissible. This check can only be carried out if the UPD knows which instrument or function the command is intended for, ie if the addressed instrument or command has been activated **before.**

  Example1:
  Selecting an input impedance of 600 Ohm is permissible for the balanced input, not for the unbalanced one.

  If this check and the respective error messages were to be omitted, measurements would be carried out with incorrect instrument settings or would not be possible at all and the user would not even know about it.

  Example2:
  Setting: generator, unbalanced outputs.
  Remote programming of 20 V generator level.
  This is not possible, however, as the balanced output allows only 12 V to be set.

  – Should the UPD accept this incorrect setting without signalling an error because the user might afterwards select unbalanced outputs which can handle 20 V.
  – What will happen when this subsequent selection is not made?
  – Should the incorrect voltage be output?
  – Or, should an error message be output when the switchover is not performed?
  – And **when** should this error be signalled?

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These conflicts can be avoided by observing the required operating sequence!

- Since similar menu items of different instruments or functions are addressed with the same command in remote control, they can only be distinguished by a reference to the currently used instrument or function.

  Example:
  Command `"INPut:SELect CH1"` may be used for all 3 analyzer units.

  To provide the possibility for presetting also parameters of non-active functions, information on the instrument or function to be addressed would have to be added to each IEC/IEEE-bus command. Thus the internal address management of UPD commands would have to be carried out by the IEC/IEEE-bus programmer. This would make programming unnecessarily difficult and the number of commands would increase by many times. The UPD uses approx. 6000 menu items which would then have to be "called up" separately by the user.

- An important operational feature of the UPD is its capability to note the settings for the individual generator and analyzer functions and to restore all required parameters when one of these functions is selected.

  This eliminates the need to reset each parameter when a new function is selected.

  Example:
  Settings: Generator, MOD DIST function with frequencies 400 Hz and 7 kHz.
  Switchover to DFD function
  The frequency pair 11 and 12 kHz, which was set when the DFD function was used last, is automatically reset.

  This function of the UPD is also available for operation via IEC/IEEE bus, ie even in the case of remote control a function switchover triggers an **automatic** reset of all pertaining parameters. This is a much quicker and more reliable than a reset of each parameter every time by the user via IEC/IEEE bus.
  If settings for non-active instruments would be permissible as well, this automatic function could no longer be used, as in this case already set parameters would also be overwritten.

- As the same internal data sets are used for manual and remote control (combined manual and remote control should be possible), the same method of internal parameter processing can only be allowed for the two modes. Since automatic parameter restoration is indispensable for manual control, it must also be used in the case of remote operation.

To relieve the user from having to pay attention to such not so obvious conditions, the following applies for manual and remote control of the UPD:

Any setting that is not permissible cannot become effective in the UPD

This has sometimes the disadvantage that a certain sequence has to be observed even in the case of remote-control. However, this is more than compensated for by the fact that setting errors are immediately signalled.

Note:

The command logging capability offered by the Universal Sequence Controller for UPD, option UPD-K1, minimized the risk of incorrect settings (see 3.15.3 Command Logging - Converting K1-Commands into IEC/IEEE-Bus Commands*)*

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3.6.5 Status Reporting System

The status reporting system collects information on the device status and makes it available to the output unit on request. Structure and function are described in detail in section **3.7 Status Reporting System**.

3.6.6 Output Unit

The output unit collects the information requested by the controller. It processes such information in line with the SCPI rules and makes it available in the 1024-character output buffer. If the requested information is longer it will be made available in blocks in a way that is not noticeable to the controller.
If the UPD is addressed as a talker and the output buffer does not contain any data or expect data from the data set management, the output unit sends the error message "Query UNTERMINATED" to the status reporting system. No data will be sent on the IEC/IEEE bus and the controller waits for the set time limit. This procedure is prescribed by SCPI.

3.6.7 Triggering a Measurement/Sweep

A measurement or a sweep can be triggered in three different ways:

- With the SCPI-specific command `IEC OUT 20,"INIT"`
- With the Common Command `IEC OUT 20,"*TRG"`
- With the addressed command "**G**roup **E**xecute **T**rigger" `IEC LAD 20: IEC GET`

The three trigger modes take about the same execution time.

Another three commands are available for waiting for a triggered measurement result. They are described in section 3.6.8.3 Comparison of Synchronization Capabilities. The synchronization command **`"*WAI"`** is used in the program examples below and in 3.15.15.1 Command Synchronization with *WAI for demonstrating the three trigger modes for a single measurement.

3.6.8 Command Synchronization

There are two events in the UPD, which have to be waited for before the next command can be executed to make sure that subsequent commands meet clear conditions:

- End of a calibration
- End of a measurement (measurement result ready to be fetched)

Through programming, the controller can be forced to wait for the end of a calibration or measurement (see table 3-2). Commands `"*OPC"`, `"*OPC?"` or `"*WAI"` are used to ensure that a calibration or measurement is completed before a new command is sent (see section 3.6.8.3 Comparison of Synchronization Capabilities).
In the examples below synchronization by means of the *WAI command is described.

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3.6.8.1 Wait for End of Calibration

Wait for the calibration to be completed before sending the next setting command:

When analog analyzer instruments are called up with commands
```
IECOUT 20,"INSTrument2 A22;*WAI"
IECOUT 20,"INSTrument2 A110;*WAI"
```

with calibration switched on in the current setup ("CALibrate:ZERO:AUTO ON")
or upon loading a setup with commands

```
IECOUT 20,"MMEMory:LOAD:STATe 0, 'filename';*WAI"
          (current setup)
IECOUT 20,"MMEMory:LOAD:STATe 2, 'filename';*WAI"
          (complete setup)
IECOUT 20,"*RST;*WAI"
          (default setup)
```

with calibration switched on in the setup to be loaded ("CALibrate:ZERO:AUTO ON")
or after calling up a calibration with commands

```
IECOUT 20,"CALibrate:LDG:AUTO ONCE;*WAI"  or "CALibrate LDG;*WAI"
IECOUT 20,"CALibrate:ZERO:AUTO ON;*WAI"   or "CALibrate AUTO;*WAI"
IECOUT 20,"CALibrate:ZERO:AUTO ONCE;*WAI" or "CALibrate DCC;*WAI"
```

Without this forced synchronization, a subsequent generator or analyzer setting command would trigger a new calibration procedure.

3.6.8.2 Wait for End of Measurement/Sweep

Note:

In the explanations below the term measurement result denotes either a single measurement result or a sequence of results obtained in a single sweep.

A measurement or a sweep can be triggered by means of INIT , *TRG or GET (see section 3.6.8.2 Wait for End of Measurement/Sweep).
INIT will be used in the examples below.

With IEC/IEEE-bus commands assuming a settled measurement result, synchronization with *WAI, *OPC? or *OPC must be effected by means of an SRQ. The use of the three synchronization methods is described in section 3.6.8.3 Comparison of Synchronization Capabilities.
*WAI will be used in the examples below.

The effect of the various combinations of measurement or sweep trigger with a synchronization command is described in the table below.

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Table 3-1 Trigger command with/without synchronization

Trigger command with/without synchronization	Description
`"INIT:CONT OFF;*WAI"`	A single measurement or sweep is triggered. Subsequent commands are processed after the measurement or sweep is completed. Generator and analyzer setting commands **do not** trigger a new measurement. A new measurement has to be triggered with `IECOUT 20,"INIT;*WAI"`. **This command is the simplest to use and should preferably be used for triggering a measurement**.
`"INIT:CONT OFF"` **without** `*WAI`	When a generator or analyzer setting command is sent **during a single measurement**, ie before the measurement is completed, the measurement is restarted to avoid incorrect results (incorrect results could be obtained, for instance, when the generator voltage is varied during the measurement). Generator or analyzer setting commands sent **after the single measurement has been terminated** will **not** trigger a new measurement. A new measurement has to be triggered with `IECOUT 20,"INIT"` .
`"INIT:CONT ON;*WAI"`	Generator and analyzer setting commands will only be processed when the measurement is terminated. They will **not** trigger a new measurements. A new measurement has to be triggered with `IECOUT 20,"INIT;*WAI"` .
`"INIT:CONT ON"` **without** `*WAI`	Each generator or analyzer setting command restarts a measurement to avoid incorrect measurement results (incorrect results could be obtained, for instance, when the generator voltage is varied during the measurement).

Note*:*

A synchronization of commands other than analyzer, generator, INIT, status loading or calibration commands is ineffective and should be avoided considering that synchronization commands are .

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3.6.8.3 Comparison of Synchronization Capabilities

Table 3-2 Comparison of synchronization capabilities

Command	Action after hardware settling	Controller programming
*OPC?	Upon completion of the calibration or after a measurement result has been obtained, command *OPC? causes 1 to be entered into the output buffer. The 1 is irrelevant however; the method is based on the fact that command IECIN 20,A$ stops the program run until the 1 is in the output buffer. **This method is therefore not suitable to wait for a 1 in the control loop. This is possible with *OPC.**	IECOUT 20,"INST2 A22" IECOUT 20,"*OPC? IECIN 20,A$
*WAI	Upon completion of the calibration or after a measurement result has been obtained, the next command is executed.	IECOUT 20,"INST2 A22;*WAI"
*OPC	Upon completion of the calibration or after a measurement result has been obtained, the Operation Complete bit in the Event Status Register (ESR) is set which triggers an SRQ if bit 5 in the Status Enable Register is set.	- Set bit 0 in the ESE - Set bit 5 in the SRE - Wait for Service Request (SRQ) **Advantage over "*OPC?" and "*WAI"**: While waiting for SRQ with the Operation Complete bit in the Event Status Register set, the program may carry out other tasks.

Detailed examples for command synchronization are given in section 3.15.15 Command Synchronization.

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3.7 Status Reporting System

The status reporting system (see Fig. 3-6) stores all information on the current operating status of the UPD, eg AUTORANGE being performed, and on errors. Such information is stored in the status registers and in the error queue. The contents of the status registers and of the error queue can be queried via the IEC/IEEE bus.

The information is hierarchically structured. The topmost level is formed by the Status Byte Register (STB) defined by IEEE 488.2 and the associated mask register Service Request Enable (SRE). The STB receives its information from the Standard Event Status Register (ESR) also defined in IEEE 488.2 and the associated mask register Standard Event Status Enable (ESE) as well as from the SCPI-defined STATus:OPERation and STATus:QUEStionable registers which contain detailed information on the UPD.

The status reporting system also includes the IST flag (Individual STatus) and the Parallel Poll Enable Register (PPE) assigned to it. The IST flag, just as SRQ, combines the complete device status in a single bit. The PPE for the IST flag has an analog function like the SRE has for the Service Request.

3.7.1 Structure of SCPI Status Register

The STATus:OPERation Register and the STATus:QUEStionable Register (see section 3.7.3.4 STATus:OPERation Register and) consists of five registers of 16 bits each with different functions (see Fig. 3-5). The individual bits are independent of each other, ie each hardware status is assigned a bit number which is the same for all five registers. Bit 5 of the STATus OPERation-Registers, for instance, is assigned in all five registers to the hardware status "wait for trigger". Bit 15 (the most significant bit) is set to zero in all registers. Thus the contents of the registers can be processed by the controller as a positive integer.

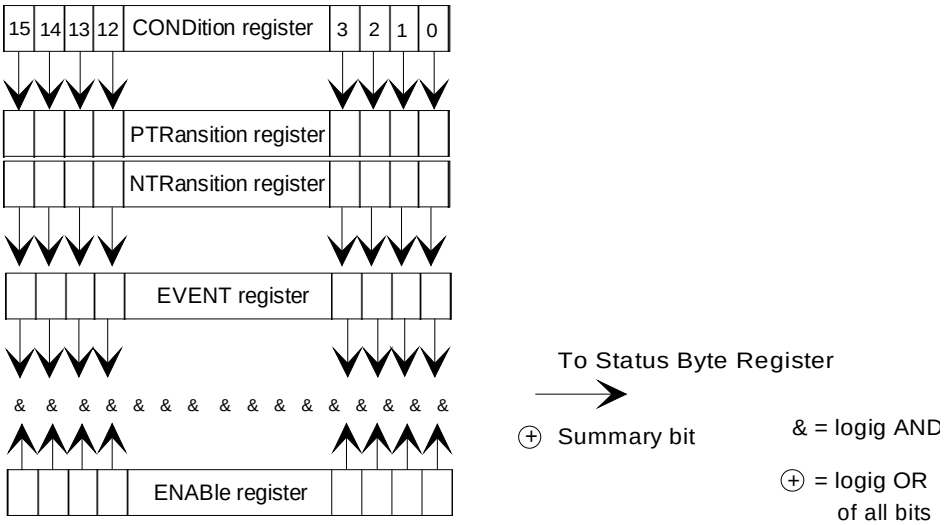

Fig. 3-5 Status register model

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CONDition register

The CONDition register is directly written to by the hardware or the summary bit of the next lower register. Its content reflects the current device status. This register can only be read, but neither written nor cleared. After an SRQ has occurred as a result of an entry in one of the status registers, reading the CONDition register does **not** trigger another SRQ. Further SRQs are only possible when the EVENT register of the status register is read.
Reading the register does not change its contents.

PTRansition register

The Positive TRansition register acts as a transition filter. Upon transition of a bit of the CONDition register from 0 to 1, the associated PTR bit decides whether the EVENt bit will be set to 1
PTR bit = 1: the EVENt bit is set.
PTR bit = 0: the EVENt bit is not set.
This register can be written and read.
Reading the register does not change its contents.

NTRansition register

The Negative TRansition register also acts as a transition filter. Upon transition of a bit of the CONDition register from 1 to 0, the associated NTR bit decides whether the EVENt bit is set to 1.
NTR bit = 1: the EVENt bit is set.
NTR bit = 0: the EVENt bit is not set.
This register can be written and read.
Reading the register does not change its contents.

With the aid of these two transition filter registers the user can define the status change of the CONDition register (none, 0 to 1, 1 to 0 or both) that is to be reported in the EVENt register.

EVENt register

The EVENt register reports whether an event has occurred since its last reading, it is the "memory" of the CONDition register. It only registers events that have been reported by the transition filters. The EVENt register is continuously updated by the instrument. It can only be read by the user. **Reading this register clears its contents.** After an SRQ has occurred as a result of an entry in a status register, another SRQ is only possible when the EVENt register of the status register is read. Reading the CONDition register does **not** trigger another SRQ.

This register is frequently referred to as the overall register.

ENABle register

The ENABle register determines whether the EVENt bit affects the summary bit (see below). Each bit of the EVENt register is ANDed (symbol '&') with the associated ENABle bit. The events of all logical operations of this register are ORed (symbol '+') and passed on to the summary bit.
ENAB bit = 0: the associated EVENt bit does not affect the summary bit.
ENAB bit = 1: if the associated EVENt is "1", the summary bit is also set to "1".
This register can be written and read by the user.
Reading the register does not change its contents.

Summary bit

As stated above, the summary bit for each register is derived from the EVENt and the ENABle registers. The result is entered into a bit of the CONDition register of the next higher register.
The instrument automatically generates the summary bit for each register. An event, eg a non-locking PLL, may thus cause a service request through all hierarchical levels.

Note:

The Service Request Enable Register SRE defined in IEEE 488.2 may be considered as the ENABle register of the STB provided that the STB is configured in conformance with SCPI. Accordingly, the ESE may be considered as the ENABLe register of the ESR.

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3.7.2 Overview of Status Register

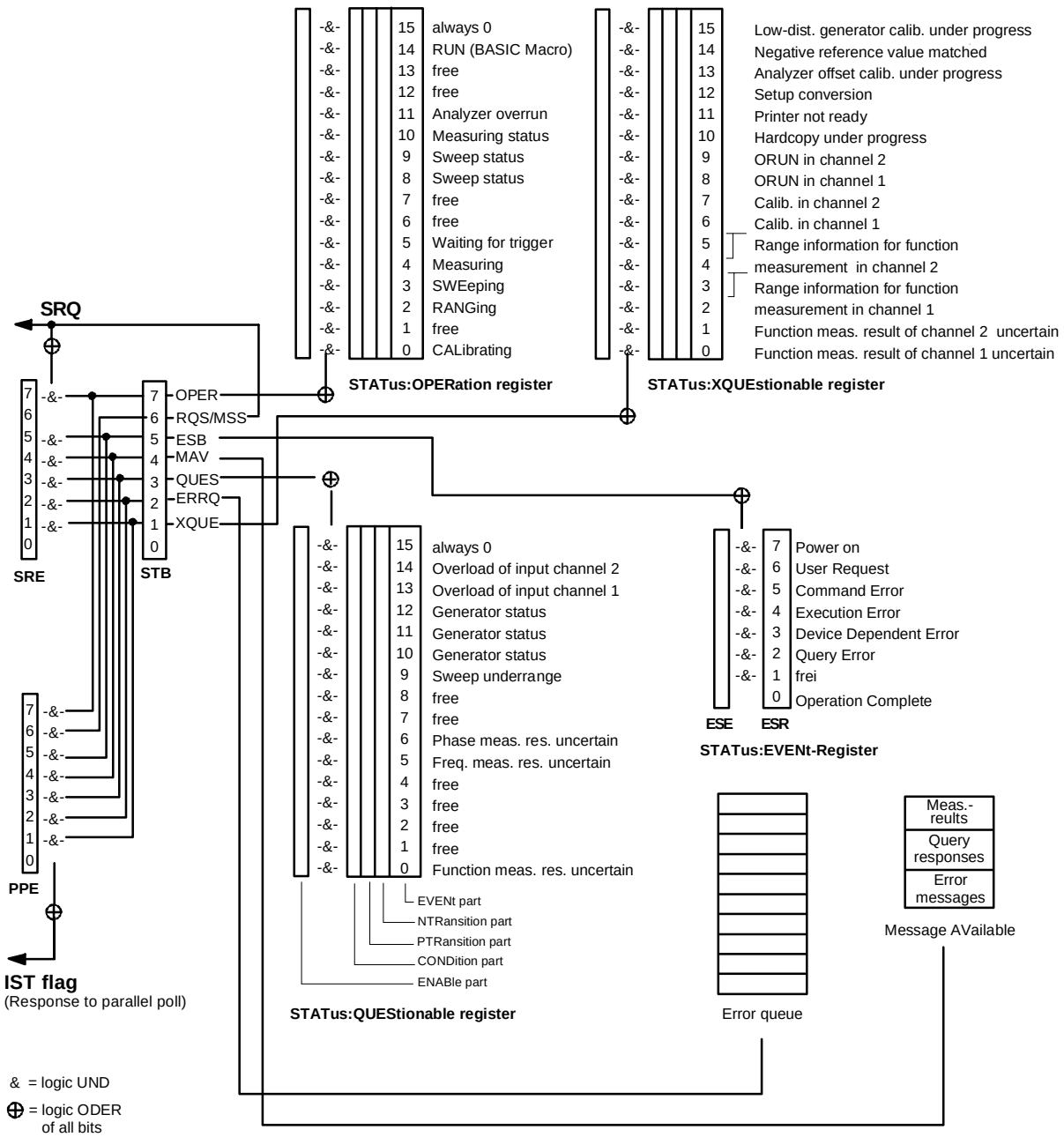

Fig. 3-6 Overview of Status Register

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3.7.3 Description of Status Registers

3.7.3.1 Status Byte (STB) and Service Request Enable Register (SRE)

The STB is already defined in IEEE 488.2. It provides a rough overview of the UPD status, collecting information from the lower-level registers. It is comparable with the CONDition register of a SCPI-defined register and is at the highest level of the SCPI hierarchy. Its special feature is that bit 6 acts as the summary bit of all other bits of the Status Byte Register.
The Status Byte Register is read out by the query *STB? or a Serial Poll .

The SRE is associated with the STB. The function of the SRE corresponds to that of the ENABle register of the SCPI registers. Each bit of the STB is assigned a bit in the SRE. Bit 6 of the SRE is ignored. If a bit is set in the SRE and the associated bit in the STB changes from 0 to 1, a Service Request (SRQ) will be generated on the IEC/IEEE bus, which triggers an interrupt in the controller configured for this purpose, and can be further processed by the controller.
The SRE can be set by the command *SRE and read out by the query *SRE?.
Its contents are <u>not</u> set to zero during reading.
If the EVENt part of a status register is read, the associated bit in the status byte register is deleted (eg STAT:OPER:EVEN? deletes the OPER bit (d7) in the OPERation register).

Table 3-3 Definition of bits used in the Status Byte Register

Bit No.	Definition
0	**Free**
1	**Free**
2	**Free**
3	**QUEStionable Status summary bit** This bit is set if in the QUEStionable Status Register an EVENt bit is set and the associated ENABle bit is set to 1. A set bit denotes a questionable device status which can be specified in greater detail by querying the QUEStionable Status Registers with "STATus:QUEStionable:CONDition?" or "STATus:QUEStionable[:EVENt]?"
4	**Free**
5	**ESB bit** Summary bit of the Event Status Register. This bit is set if one of the bits in the Event Status Register is set and enabled in the Event Status Enable Register. Setting of this bit denotes a serious error which can be specified in greater detail by querying the Event Status Registers with "*ESR?".
6	**MSS bit** (master status summary bit) This bit is set if the UPD triggers a service request. This is the case if one of the other bits of this register is set together with its mask bit in the Service Request Enable Register SRE.
7	**OPERation Status Register summary bit** This bit is set if an EVENt bit is set in the OPERation Status Register and the associated ENABle bit is set to 1. A set bit denotes that an action is just being performed by the UPD. Information on the type of the action can be obtained by querying the OPERation Status Register with "STATus:OPERation:CONDition?" or "STATus:OPERation[:EVENt]?".

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3.7.3.2 IST Flag and Parallel Poll Enable Register (PPE)

Similar to the SRQ, the IST flag (**I**ndividual **St**atus Flag) combines the complete status information in a single bit. It can be queries by parallel poll (see section 3.7.4.3 Parallel Poll, and 3.15.16.1 SRQ Interrupt Routine with Serial Poll or with "*IST?".

The Parallel Poll Enable Register (PPE) determines which bits of the STB affect the IST flag. The bits of the STB are ANDed with the corresponding bits of the PPE, bit 6 - in contrast to the SRE - being used too. The IST flag is obtained by ORing all results together. The PPE can be set by the command *PRE and read by the query *PRE?.

3.7.3.3 Definition of bits used in the Event Status Register

The ESR is already defined in the IEEE 488.2 standard. It is comparable to the EVENt register of an SCPI register. The Event Status Register can be read out by the query *ESR?.
The ESE forms the associated ENABle register. It can be set by the command *ESE and read out by the query *ESE?.

Table 3-4 Definition of bits used in the Event Status Register

Bit No.	Definition
0	**Operation Complete** Upon reception of the "*OPC" command this bit is set exactly when all previous commands have been executed.
1	**Free**
2	**Query Error** This bit is set if the controller wants to read data from the instrument but has not sent a data request command, or if the controller does not fetch the requested data but sends instead a new command to the instrument. A frequent cause is a faulty query which cannot be executed.
3	**Device-dependent Error** This bit is set if a device-dependent error occurs. An error message with a positive number denoting the error in greater detail in plain text (see **3.14 List of Error Messages**) will be entered into the Error Queue.
4	**Execution Error** This bit is set if the syntax of the command received is correct but the command cannot be executed due to various marginal conditions. An error message with a number between -200 and -300 describing the error in greater detail (see **3.14 List of Error Messages**) will be entered into the Error Queue.
5	**Command Error** This bit is set if an undefined command or a command with incorrect syntax is received. An error message with a number between -100 and -200 describing the error in greater detail (see **3.14 List of Error Messages**) will be entered into the Error Queue.
6	**User Request** This bit is set upon pressing the [LOCAL] key, ie when the instrument is switched to manual control.
7	**Power On** This bit is set upon power on of the instrument.

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3.7.3.4 STATus:OPERation Register

The CONDition part of this register contains information on the operations currently performed by the UPD and the EVENt part on the operations performed by the UPD since the last readout of the register. The register can be read by the commands
`"STATus:OPERation:CONDition?"` or
`"STATus:OPERation[:EVENt]?"`.

Table 3-5 Definition of bits used in the STATus:OPERation register

Bit No.	Definition
0	**CALibrating** This bit is set as long as a calibration is performed by the UPD.
1	**Free**
2	**RANGing** This bit is set as long as the UPD performs a range change (eg. autorange).
3	**SWEeping** This bit is set while the UPD is performing a sweep. Bits 8 and 9 inform on the current sweep state.
4	**MEASuring** This bit is set while the UPD is performing a measurement. Bit 10 informs on the current measurement state.
5	**WAIT for TRIGGER** This bit is set while the UPD waits for a trigger event.
6 - 7	**Free**
8 and 9	**Sweep Status** Bit 3, 9, 8 0 0 0 = Sweep OFF — No sweep performed 0 0 1 = Sweep TERMINATED — Single sweep completed 0 1 0 = Sweep STOPPED — Sweep has been stopped and may be continued 0 1 1 = Sweep INVALID — Sweep invalid as not yet started 1 0 0 = Sweep MANU RUNNING — Manual sweep running 1 0 1 = Sweep SNGL RUNNING — Single sweep running 1 1 0 = Sweep CONT RUNNING — Continuous sweep running 1 1 1 = Sweep OFF
10	**Measuring Status** Bit 4, 10 0 0 = Measuring TERM — Single measurement completed 0 1 = Measuring STOP — Measurement stopped 1 0 = Measuring SNGL — Single measurement running 1 1 = Measuring CONT — Continuous measurement running

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Bit No.	Definition
11	**Analyzer Overrun** The sampling rate applied to the external input is too high for the digital meter selected. Remedy: - Select a lower external sampling rate and set function again - Select a fast digital meter.
12,13	**Free**
14	**RUN** **(BASIC-Macro)** If a BASIC macro (see **2.16 Makro Operation**) is started with the command SYST:PROG:EXEC 'filename.bas', this bit is set to 1. This bit is set to 0 when the program has been quit. This 1→0 transition can be queried via serial poll or initiate an SRQ, eg to fetch measurement data (for a detailed example see **3.15.18 Call a BASIC-Macro**
15	**Free**

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3.7.3.5 STATus QUEStionable Register

This register contains information on questionable device states. These may for instance occur if the UPD is operated out of specifications. The register can be read by the commands "`STATus:QUEStionable:CONDition?`" or "`STATus:QUEStionable[:EVENt]?`".

Table 3-6 Definition of bits used in the STATus:QUEStionable Register

Bit No.	Definition
0	**Function** This bit is set when the result of a function measurement is questionable.
1 - 4	**Free**
5	**FREQuency** This bit is set when the result of a frequency measurement is questionable.
6	**PHASe** This bit is set when the result of a phase measurement is questionable.
7 - 8	**Free**
9	**Sweep underrange** During the sweep, valid but inaccurate measurement results were obtained because of underranging.
10 - 12	**Generator status** Bit 12, 11, 10 0 0 0 = Generator OFF — Both generator channels are switched off 0 0 1 = Generator OFF 0 1 0 = Generator RUNNING — Generator outputs a signal 0 1 1 = Generator BUSY — Generator DSP computes a waveform 1 0 0 = Generator HALTED — No generator output signal due to incomplete or invalid setting 1 0 1 = Generator OVERRUN — The sampling rate applied to the external input is too high for the digital generator selected Remedy: - Select lower sampling rate, call up function again. - Select faster digital generator 1 1 0 = Generator OFF 1 1 1 = Generator OFF
13 - 15	**Free**

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3.7.3.6 STATus XQUEStionable Register

This register contains additional information for the Status Operation Register and information on rarely occurring states. It can be read by the queries "`STATus:XQUEStionable :CONDition?`" or "`STATus:XQUEStionable[:EVENt]?`".

Table 3-7 Definition of bits used in the STATus:XQUEstionable Register

Bit No.	Definition
0	Bit set: Information of MEASuring bit (d4) and Measuring Status bit (d10) of Status Operation Register refers to **channel 1**. MEASuring bit (d4) Measuring status bit (d10) 0 0 = Measuring TERM — Single measurement terminated on 0 1 = Measuring STOP — Measurement stopped on 1 0 = Measuring SNGL — Single measurement in progress on 1 1 = Measuring CONT — Continuous measurement in progress on
1	Bit set: Information of MEASuring bit (d4) and Measuring Status bit (d10) of Status Operation Register refers to **channel 2**. Analogous to bit No. 0.
2 - 3	Additional range information for **channel 1** d3 d2 0 0 = Measurement result valid 0 1 = Ranging in channel 1. Bit d2 (RANGing) of STATus OPERation Register set simultaneously. 1 0 = Underrange (measurement result inaccurate) in channel 1 1 1 = Overrange (measurement result invalid) in channel 1 Register: Function bit d0 (function measurement result uncertain) of the Status Questionable set simultaneously with underrange and overrange bits.
4 - 5	Additional range information for **channel 2** d3 d2 0 0 = Measurement result valid 0 1 = Ranging in channel 2. Bit d2 (RANGing) of STATus OPERation Register set simultaneously. 1 0 = Underrange (measurement result inaccurate) in channel 2 1 1 = Overrange (measurement result invalid) in channel 2 Register: Function bit d0 (function measurement result uncertain) of the Status Questionable set together with the underrange and overrange bits.
6	Bit set: The calibration denoted in bit 13 or 15 is in progress in **channel 1.** No measurements are performed during this period.
7	Bit set: The calibration denoted in bit 13 or 15 is in progress in **channel 2.** No measurements are performed during this period.
8	Bit set: The sampling rate at the external input of **channel 1** is too high for the digital instrument. Remedy: Set lower rate and recall measurement function.
9	Bit set: Ditto for **channel 2**
10	Bit set: Read-out of screen content to a printer or a file. Operation of UPD is disabled for a few seconds.
11	Bit set: Printer not ready.
12	Bit set: A previous SETUP is converted to the latest status.
13	Bit set: Calibration of analyzer offset in progress. No measurement results are output during this period.
14	Bit set: A negative reference value is limited to $+10^{-10}$ for the dBr calculation.
15	Bit set: Calibration of low-distortion generator in progress. No measurement results are output during this period.

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3.7.4 Use of Status Reporting System

For an efficient use of the status reporting system, the information contained therein has to be transferred to the controller and further processed. There are various methods which are described in the following. Detailed program examples are given in 3.15 Examples of IEC/IEEE-Bus Programming.

3.7.4.1 Service Request, Use of Hierarchical Structure

Under certain conditions, the UPD may send a service request (SRQ) to the controller. This service request usually causes an interrupt at the controller to which the controller program can respond by a suitable action. As shown in Fig. 3-6 (Section 3.7.2 Overview of Status Register), a SRQ will always be triggered if one or several of the bits 3, 5 or 7 have been set in the Status Byte Register and enabled in the SRE. Each of these bits combines the information from a further status register. By setting the ENABle registers of the status registers accordingly, any bit in any status register will be able to trigger a SRQ. To utilize the possibilities of the service request, all bits in the enable registers SRE and ESE should be set to "1".

Examples:
(see also Fig 3-6 , Section 3.7.2 Overview of Status Register):

Use command "*OPC" for generating an SRQ. While waiting for the SRQ, the program may perform other tasks.

- Setting bit 0 (Operation Complete) in the ESE
- Setting bit 5 (ESB) in the SRE

Upon completion of the settings, the UPD generates an SRQ.

Indicating the end of a sweep by an SRQ via bit 3 in the STATus OPERation Register. While waiting for the SRQ the program may perform other tasks.

- Setting bit 7 (summary bit of STATus:OPERation Register) in the SRE
- Setting bit 3 (Sweep Terminated) in the STATus:OPERation:ENABle Register.
- Setting bit 3 in the STATus:OPERation:NTRansition to ensure that the transition of sweeping bit 3 from 1 to 0 (Sweep-Terminated) is also stored in the EVENt register. Calling up the *CLS command causes all bits of the NTRansition and PTRansition to be set to 1 so that any bit change is recorded. Enabling the desired enable bit, in this case bit 3, will normally be sufficient.

After having completed the sweep, the UPD generates an SRQ.

The SRQ is thus the only way for the UPD to become active of its own. A controller program should set the UPD so that a service request will be generated in case of malfunctions. The program should suitably respond to the service request. A detailed example of a service request routine is given in section 3.15.15 Command Synchronization.

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3.7.4.2 Serial Poll

Serial Poll is mainly used for obtaining a quick overview of the status of several devices connected to the IEC/IEEE bus
In the case of a Serial Poll, the status byte of a device can be queried with

```
IECOUT 20,"*STB?"
IEC IN 20,A%
```

However, querying the status byte is normally implemented by interface messages (see 3.4.1 Interface Messages) which means that a single byte is set to the hardware.

The R&S BASIC command for the execution of a Serial Poll is

```
IEC SPL 20,A%
```

It is much quicker than the Common Command "*STB?".

The serial poll method has already been defined in the IEEE 488.1 standard and used to be the only standard method for querying the status byte of several devices. This method also works with instruments which neither conform to SCPI nor to IEEE 488.2.

3.7.4.3 Parallel Poll

In the parallel poll mode up to eight devices are simultaneously requested by a command from the controller to transmit 1 bit of information on the assigned data line, ie to pull the assigned data line to logic 0 or 1. Similar to the SRE register which defines the conditions under which an SRQ will be generated, there is a Parallel Poll Enable Register (PPE), which is also ANDed bit by bit with the STB – taking into account bit 6. The result is ORed and is then returned (may be inverted) as a reply to a parallel poll of the controller. The result can also be read out without parallel poll by the query `*IST`.

The UPD must first be set for the parallel poll using the R&S BASIC command `IEC PCON`.
Example:

`IECPCON 20,1,6`: UPD identifies itself by a 1 on line 6.

This command assigns a data line to the device on which it sends an SRQ. The parallel poll itself is made by `IEC PPL Pp%`.

The parallel poll mode is mainly used to find out quickly which of the devices connected to the IEC/IEEE bus has caused an SRQ. For this purpose SRE and PPE must be set to the same value. A detailed example of parallel poll is given in section 3.15.16.2 SRQ Interrupt Routine with Parallel Poll.

3.7.4.4 Queries

Each individual register of a status register can be read out by queries. The individual queries are given in the detailed description of the registers in Section 3.7.3 Description of Status Registers. The queries always return a number representing the bit pattern of the queried register. This number is evaluated by the controller program.

Queries are mainly used after a SRQ to obtain detailed information on the cause for the SRQ.

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3.7.4.5 Error Queue Query

- Each error condition in the instrument causes an entry in the error queue. The entries in the error queue are detailed error messages in plain text which can be read out via IEC/IEEE bus by the query `SYSTem:ERRor?`. Each query `SYSTem:ERRor?` returns an entry from the error queue. If there are no more error messages in the error queue, **0 = "No error"** is returned by the instrument
- The error queue should be queried in the controller program after each SRQ since the queue entries provide a more precise description of the error cause than the status registers. In particular in the test phase of a controller program the error queue should be queried at regular intervals since it also registers faulty commands from the controller to the UPD.

Note:

In addition to an entry in the Error Queue, each error causes a plain-text message to be output on the UPD display so that the IEC/IEEE-bus control program can be checked in the REMOTE control mode without reading out the Error Queue.

3.7.5 Resetting the Status Reporting Systems

Table 3-8 contains the various commands and events causing a reset of the status reporting system. None of the commands, with the exception of *RST affects the functional device setting. In particular DCL does not clear the device settings.

Table 3-8 Resetting of device functions

Event	Effect			
	DCL,SDC (Device Clear, Selected Device Clear)	***RST or SYSTem:PRESet**	**STATus:PRESet**	***CLS**
Clears STB,ESR	—	—	—	yes
Clears SRE,ESE	—	—	—	—
Clears PPE	—	—	—	—
Clears EVENt registers	—	—	—	yes
Clears ENABle registers of OPERation, QUESTionable and XQUEStionable Register, fills ENABle registers of all other registers with "1".	—	—	yes	—
Fills PTRansition registers with "1", clears NTRansition registers	—	—	yes	—
Clears Error Queue	—	—	—	yes
Clears output buffer	yes	1)	1)	1)
Clears command processing and input buffer	yes	—	—	—

1) Any command that is the first one in a command line clears the output buffer.

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3.8 Notation of Command Table

All commands implemented in the UPD according to the command system are tabulated and described in detail in section 3.10 IEC-bus Commands. The notation is in line with the SCPI standard provided the committee has defined a command for the required function.

Command table in section 3.10 IEC-bus Commands

Command: In this column the complete command without parameters is listed.

Parameter: Here the required parameters and their range of values are stated. If the command is only available in the form of a query, 'Query only' is marked in this column.

Basic unit: Basic unit of physical parameter.

Meaning: Brief description of command.

Section: Reference to the detailed function description in the case of manual operation, mainly section 2 of the UPD manual.

Upper/lower case Upper/lowercase characters are used to differentiate between the long form and the short form of the keywords of a command. The UPD itself does not distinguish between uppercase and lowercase letters.

Special character | For some commands there is a choice of keywords having the same effect. These keywords are stated in the same line and separated by a vertical bar. Only one of these keywords need to be stated in the header of the command. The effect of the command is independent of the keyword selected.

Example: `"SOURce:FREQuency:CW|:FIXed"`
(setting generator to a constant frequency of 1 kHz)

The two commands below have an identical effect
`"SOURce:FREQuency:CW 1E3"≡ "SOURce:FREQuency:FIXed 1E3"`

A vertical bar in the notation of the parameters is used to separate alternative options and is to be seen as "or". The effect of the command differs according to the parameter stated.

Example: Selection of parameters for the command
`"SENSe:VOLTage:UNIT V|DBV|DBU"`
(measurement result may be displayed in Volt, dBV or dBu)

Special characters [ ] Keywords in square brackets may be omitted in compound headers (see section 3.5.3 Structure of a Command Line). For reasons of compatibility with the SCPI standard, the instrument must be able to accept the full length of the command.
Parameters in square brackets may also be optionally inserted in the command or omitted.

Example: `"SENSe[1][:VOLTage|POWer]:REFerence:MODE ..."`
has the same effect as
`"SENSe:REFerence:MODE ..."`
(selecting the method for generating a level reference value)

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Parameters in square brackets
may also be optionally inserted in the command or omitted.

Example: TRACe[1] stands for TRACe and TRACe1

TRACe**[1|2]** denotes that either TRACe1 or TRACe2 can be selected, causing **different settings.**
`DISPlay:TRACe[1|2]:MARKer MODE ...`
(markers for FFT spectrum display may be different for TRACe1 and TRACe2)

TRACe**[ ]** denotes that the command can be used for TRACe1 and TRACe2, causing the **same settings** in both cases.
`DISPlay:TRACe[]:CURSor[1]:MODE ...`
(selected cursor function apply to both traces!)

Special characters { } Parameters in curly brackets may be included in the command as often as required.

Example: `SENSe[1]:LIST:FREQuency <n>{,<n>}`
(frequencies of an RMS-selective sweep)

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3.9 Common Commands

The common commands are based on the IEEE 488.2 (IEC 625.2) standard. A specific command has the same effect in different instruments. The headers of these commands consist of an asterisk "*" followed by three letters. Many common commands refer to the status reporting system described in detail in section **3.7 Status Reporting System**.

Table 3-9 Common Commands

Command	Brief description	Parameter / Notes	Automatic Control of the UPD (UPD-K1)
***CLS**	Resets status byte	no query	Not usable
***ESE**	Sets Event Status Enable Register	0 to 255	Not usable
***ESR?**	Readout of content of Event Status Register	query only	Usable
***IDN?**	Identification query	ROHDE&SCHWARZ, UPD, 0, 2.xx	Usable
***IST?**	Query for content of IST flag	query only	Not usable
***OPC**	Synchronization command		Usable
***OPT?**	Option identification query	query only	Usable
***PCB**	Address for passing back the IEC/IEEE-bus control	0 to 30, no query	Not usable
***PRE**	Sets Parallel Poll Enable Register	0 to 255	Not usable
***RST**	Resets the device to a defined default state. The parameter link (see 2.15.9 Transfer of Parameters) is disabled to maintain the default setting described in Appendix A, UPD Default Setup.	no query	Usable
***SRE**	Sets Service Request Enable Register	0 to 255	Not usable
***STB?**	Query for content of Status Byte	query only	Not usable
***TRG**	Triggers measurement	no query	Usable
***TST?**	UPD selftest	query only	Usable
***WAI**	Synchronization command		Usable

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***CLS**

CLEAR STATUS sets the status byte (STB), the Standard Event Register (ESR) and the EVENt part of the QUEStionable, OPERation and of the XQUEstionable Register to zero. The command has no effect on the mask and transition parts of the register. The output buffer is cleared.

***ESE 0 to 255**

EVENT STATUS ENABLE sets the Event Status Enable Register to the defined value. The query *ESE? returns the content of the Event Status Enable Registers in decimal form.

***ESR?**

EVENT STATUS ENABLE returns the contents of the Event Status Enable Register in decimal form (0 to 255) and clears the register.

***IDN?**

IDENTIFICATION QUERY for identification of the instrument.
The response is for example: "Rohde&Schwarz, UPD, 0, 2.xx"
UPD = instrument designation: 0 = serial number, 2.xx = firmware version

***IST?**

INDIVIDUAL STATUS QUERY returns the contents of the IST flag in decimal form (0 | 1). The IST flag is the status bit sent during a Parallel Poll (see section 3.7.3.2 IST Flag and Parallel Poll Enable Register (PPE)).

***OPC**

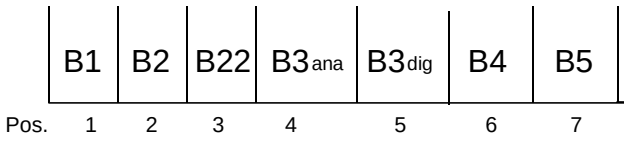
OPERATION COMPLETE sets bit 0 in the Event Status Register if all preceding commands have been executed. This bit may be used to assert a Service Request (see section 3.6.8.3 Comparison of Synchronization Capabilities, 3.7.3.3 Event Status Reg. (ESR) Event Status Enable Reg. (ESE), and section **3.15.15.3 Command Synchronization with** *OPC and SRQ

***OPC?**

OPERATION COMPLETE QUERY places an ASCII character "1" in the output buffer as soon as all preceding commands have been executed (see 3.6.8.3, Comparison of Synchronization Capabilities and section 3.15.15.3 Command Synchronization with *OPC and SRQ.

***OPT?**

OPTION IDENTIFICATION QUERY; a list of the installed options separated by commas is returned in the following sequence.



For an option that is not installed, 0 is returned in the answer string; for an installed option its brief designation possibly together with a version number in brackets.

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Brief designation of option	Option	Position in answer string
B1	Low Distortion Generator	1
B2	AES/EBU Interface	2
B22	Jitter- and Interface Tester	3
$B3_{ana}$	Highspeed analog	4
$B3_{dig}$	Highspeed digital	5
B4	IEC-625/IEEE-488-Bus Interface	6
B5	Monitoring Output, Switcher	7

The following example contains zeros at positions 1, 2, 4 and 5, indicating that options B1, B2, $B3_{ana}$ and $B3_{dig}$ are not installed.

Pos. 1 2 3 4 5 6 7

Example: `*OPT?` Answer: `0,0,B22(0.01),0,0,B4(0.02),B5(0.01)`

***PCB 0 to 30**

PASS CONTROL BACK notifies the address of the controller to which the IEC/IEEE-bus control is to returned.

***PRE 0 to 255**

PARALLEL POLL REGISTER ENABLE sets the Parallel Poll Enable Register to the defined value. The query *PRE? returns the contents of the Parallel Poll Enable Registers in decimal form

***RST**

RESET sets the UPD to a defined default state. The parameter-Link (see 2.15.9 Transfer of Parameters) is switched off to ensure that the default state as described in Annex A UPD Default Setup is maintained after a change of instrument or function.

***SRE 0...255**

SERVICE REQUEST ENABLE sets the Service Request Enable Register to the defined value. Bit 6 (MSS mask bit) remains 0. This command determines the conditions under which a Service Request will be asserted. The query *SRE? outputs the contents of the Service Request Enable Registers in decimal form.
Bit 6 is always 0.

***STB?**

READ STATUS BYTE QUERY outputs the contents of the status byte in decimal form.
Its contents are not set to zero during reading.
If the EVENt part of a status register is read, the associated bit in the status byte register is deleted (eg STAT:OPER:EVEN? deletes the OPER bit (d7) in the OPERation register).

***TRG**

TRIGGER starts all actions waiting for a trigger event.
See sections 3.6.7 Triggering a Measurement/Sweep; Sweep and section 3.15.8.1 Readout of Triggered Measurements.

***TST?**

SELF TEST QUERY causes a brief selftest of the UPD and outputs an error code in decimal form ('0' for ok., '1' for error)

***WAI**

WAIT-to-CONTINUE allows processing of commands only after all preceding commands have been executed, all signals settled and current measurements are terminated (see sections 3.6.8.2 Wait for End of Measurement/Sweep, 3.6.8.3 Comparison of Synchronization Capabilities, and section 3.15.15.1 Command Synchronization with *WAI.

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IEC/IEEE-Bus Commands
Selection of Generator · Configuration of Analog Generators · Configuration of Digital Generators · Generator Sweeps · Generator Functions

IEC/IEEE-Bus Commands for Analyzers
Selection of Analyzer · Configuration of Analog Analyzers · Configuration of Digital Analyzers · Starting the Analyzer, Ext. Sweep · Analyzer Functions

Selection of Analyzer Filter

Units for IEC/IEEE Measurement Results

Loading and Storing
Loading and Storing Instrument Setups · Loading and Storing Traces and Lists

Commands for Graphical Representation of Results

Commands for Printing/Plotting of Screen and Storing in Files

Setting and Display of Auxiliary Parameters
IEC/IEEE-Bus Address · Keyboard Settings · Macro Operating · Display Settings · Setting and Switching Off the Displays · Version Display · Calibration · Transfer of Settings · Parameters of COM2 Interface · Loading Speed for Setups and Analyzer Measurement Functions

Commands for Data Output
Commands for Input/Output of Block Data
Commands for Status and Error Queries
Commands for Synchronization
Settings without Corresponding IEC/IEEE-Bus Command

Alphabetical List of IEC/IEEE-Bus Commands

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3.10 IEC/IEEE-Bus Commands

3.10.1 Generators

3.10.1.1 Selection of Generator

Command	Parameter	Basic unit	Meaning	Section
INSTrument[1][:SELect] corresponding to **INST**rument[1]:**NSEL**ect	***A25*** ***A110*** ***D48*** ***D192*** ***D768*** ***1*** ***2*** ***3*** ***4*** ***5***		→ Analog generator 25 kHz → Analog generator 110 kHz → Digital generator 48 kHz → Digital generator 192 Hz → Digital generator 768 kHz → Analog generator 25 kHz → Analog generator 110 kHz → Digital generator 48 kHz → Digital generator 192 Hz → Digital generator 768 kHz	**2.5.1** **GEN panel** INSTRUMENT → ANLG 25 kHz → ANLG 110 kHz → DIG 48 kHz → DIG 192 kHz → DIG 768 kHz

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3.10.1.2 Configuration of Analog Generators

Command	Parameter	Basic unit	Meaning	Section
OUTPut:***SEL****ect***	***OFF*** ***CH1*** ***CH2*** ***CH2I****s1* ***CH2P****has180*		→ Generator channels switched off → Only generator channel 1 active → Only generator channel 2 active → Both generator channels active → Both generator channels active, channel 2 in phase opposition to channel 1	**2.5.2** **GEN panel** Channel(s) → OFF → 1 → 2 → 2 ≡ 1 → 2 ≡ -1
OUTPut:***TYPE***	***BAL****anced* ***UNB****alanced* ***CTES****t*		→ Balanced output (XLR connector) → Unbalanced output (BNC connector) → Common mode test output	**2.5.2** **GEN panel** Output → BAL XLR → UNBAL BNC → COMTST XLR
OUTPut:**IMP**edance	***R5*** ***R10*** ***R15*** ***R30*** ***R200*** ***R600*** ***USER****defined*		Output impedance → 5 Ω (only UNB) → 10 Ω (only BAL) → 15 Ω (only UNB) → 30 Ω (only BAL) → 200 Ω (only BAL) → 600 Ω (only BAL) → User Defined	**2.5.2** **GEN panel** Impedance → 5 Ω → 10 Ω → 15 Ω → 30 Ω → 200 Ω → 600 Ω → USER DEF
OUTPut:**LOW**	**FLO**at **GRO**und		→ Common floating → Common grounded	**2.5.2** Common → FLOAT → GROUND

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Command	Parameter	Basic unit	Meaning	Section
SOURce:**VOLT**age:**RANG**e:**AUTO**	**ON** **OFF**		Selection of voltage range for setting the generator output voltage. → Full drive of internal signal paths The output voltage is set with the aid of the output amplifier **Advantage:** Optimum noise and THD values for measurements at constant level, eg frequency sweep. With the subsequent command SOUR:VOLT:LIM <nu>, any maximum voltage can be entered; higher voltages are *not permissible*. → The output amplifier is set to the maximum voltage specified with the subsequent command; higher voltages *cannot be set.* The actual output voltage is attained by means of smaller digital values on the D/A converter. No analog hardware settings are required when the output voltage is changed. **Advantage:** Voltage dips upon attenuator switching are avoided. Fast level variations and better settling characteristic for measurements with small level variations, eg. frequency sweep using an equalization file (this setting should be used for loudspeaker measurements). ***Note**:* *This setting is ignored when the low-distortion generator option (UPD-B1) is used. The SOUR:VOLT:RANG:AUTO ON algorithm is used for level control of the low-distortion generator.*	**2.5.2** **GEN panel** Volt Range → AUTO → FIX:
SOURce:**VOLT**age:**LIM**it[:AMPLitude]	**<nu>** 0 to 24 V	V	Limit value for output voltage, prevents inadvertent entry of too high voltage values. The rms value for sinewave signals is entered, ie the peak value of max. Volt is $\sqrt{2}$ times higher.	**2.5.2** GEN panel → Max Volt
SOURce:**FREQ**uency:***REF**erence*	**<nu>** 1 MHz to 1 MHz	Hz	Reference frequency	**2.5.2** **GEN panel** Ref.Freq
SOURce:**VOLT**age:**REF**erence	**<nu>** 1µV to 1 MV	V	Reference voltage	**2.5.2** **GEN panel** Ref.Volt

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Command	Parameter	Basic unit	Meaning	Section
OUTPut	**ON** **OFF**		→ Switches all outputs on. → Switches all outputs off (including clock lines of digital interfaces, see **2.13 Fast Switch-off of Outputs**. The status is indicated by an LED at the top left of the front panel. LED on signals OUTPUT OFF.	**2.13** Key OUTPUT OFF

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3.10.1.3 Configuration of Digital Generators

Common settings

Command	Parameter	Basic unit	Meaning	Section
SOURce:**DIG**ital:**FEED**	**ADAT**a		Specifies what should be generated at the digital interfaces. → Generates digital audio signals without jitter. The audio signal is available at all digital interfaces.	2.5.3.1 **GEN panel** Src Mode → AUDIO DATA → JITTER ONLY → PHASE → COMMON ONLY
	JITTer		→ The audio data stream contains an analog jitter signal. All frequency and level settings refer to the jitter signal. The audio data content can be set in addition with the auxiliary generator AUX GEN (SOUR2:FUNC DIGD). The jitter signal is available only at the digital interfaces AES / S/P DIF / OPTICAL.	
	PHASe		→ Same as with JITTER, but here the frame phase of the audio data stream to the REF output (rear) can be set instead of the audio data content. Restrictions caused by the freely selectable phase: GENERATOR panel: Sync To: GEN CLK only, *not* REF IN (SOUR:DIG:SYNC:SOUR GCL|~~RINP~~) Sync Out: AUDIO IN, REF IN, GEN CLK only, *not* SYNC PLL (OUTP:DIG:SYNC:FEED ANIP|RINP|GCL| Ref Out: REF GEN only, *not* AUDIO OUT, AUDIO IN, AUD IN CLK (OUTP:DIG:REF:FEED RGEN) ANALYZER panel: Jitter Ref: GEN CLK only, *not* VARI (PLL), 32.0 (PLL), 44.1 (PLL), 48.0 (PLL) (SENS:DIG:SYNC:REF GCL)	
	COMMon		→ An analog signal is superimposed onto the audio data stream symmetrically on the two lines of the AES/EBU socket. All frequency and level settings refer to the analog common signal; the audio data are constant. The common mode signal is only available at the AES/EBU digital interface. Available only for generator instrument DIG 48 kHz (INST D48) if the jitter option (UPD-B22) is installed. Without the option only audio data can be generated.	

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OUTPut:***SEL****ect* **OUTP**ut:***TYPE***	***OFF*** ***CH1*** ***CH2*** ***CH2IS1*** ***PAR****allel* ***MPAR****allel* ***SER****ial* ***MSER****ial* ***AES****ebu* ***SPD****if* ***OPT****ical* ***INT****ernal*		→ Generator channels switched off → Only generator channel1 active → Only generator channel2 active → Both generator channels active and in phase Available only when Src Mode AUDIO DATA (SOUR:DIG:FEED ADAT) is active. All other source modes refer to the digital data *stream* and not to the data *contents* so that specifying a channel would be meaningless. → Parallel digital output active (for one-channel generation only, "OUTP:SEL CH1") → Parallel digital output active; multiplex mode → Serial digital output active → Serial digital output active; multiplex mode → AES/EBU output active → S/P DIF output active → Optical digital output active → Digital outputs inactive, generator signal is internally applied to analyzer (for one-channel generation only, "OUTP:SEL CH1") Available only when Src Mode AUDIO DATA (SOUR:DIG:FEED ADAT) is active. In all other source modes only the digital interfaces AES / SPDIF / OPTICAL are active and cannot be separately selected.	**2.5.3.1..** **GEN panel** Channel(s) → OFF → 1 → 2 → 2 ≡ 1 **2.5.3.1..** Output → PARALLEL → PARAL MUX → SERIAL → SERIAL MUX → AES/EBU → S/P DIF → OPTICAL → INTERN
OUTPut:***OSAM****pling***	***N1*** ***N2*** ***N4*** ***N8*** ***N16***		→ Generator oversampling factor 1 → Generator oversampling factor 2 → Generator oversampling factor 4 → Generator oversampling factor 8 → Generator oversampling factor 16 Available in the fast digital generators only (INST D192 | D768)	**2.5.3.1..** Oversamp → 1 → 2 → 4 → 8 → 16
SOURce:**VOLT**age:**LIM**it[:AMPLitude]	**<nu>** 0 to 1 FS	FS	Limit value for output voltage entry; prevents inadvertent entry of impermissibly high voltages. Displayed only when Src Mode AUDIO DATA (SOUR:DIG:FEED ADAT) is active.	**2.5.3.1..** **GEN panel** Max Volt
SOURce:***FREQ****uency:REF****erence***	**<nu>** 1 mHz to 1 MHz	Hz	Reference value for relative frequency units. When the reference frequency is changed, all relative frequency settings are changed as well. The relative frequency of the generator signal remains unchanged.	**2.5.3.1** **GEN panel** Ref.Freq

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SOURce:**VOLT**age:**REF**erece	**<nu>** 10 nFS to 100 FS	FS	Reference value for relative voltage units. When the reference level is changed, all relative voltage entries are changed as well. The relative voltage of the generator signal remains unchanged.	**2.5.3.1** **GEN panel** Ref Volt

3.10.1.3.1 Serial Interfaces (Serial, Serial Mux)

Command	Parameter	Basic unit	Meaning	Section
OUTPut:***TYPE***	***SER**ial* ***MSER**ial*		→ Serial digital output active → Serial digital output active, multiplex operation Available only when Src Mode AUDIO DATA (SOUR:DIG:FEED ADAT) is active. In all other source modes only the digital interfaces AES / S/P DIF / OPTICAL are active and cannot be separately selected.	2.5.3.1 **GEN panel** Output → SERIAL → SERIAL MUX
SOURce:**DIG**ital:**SYNC:SOUR**ce	**GCL**ock **EXT**ern		Specifies the sync source of the digital audio generator. → Synchronization to internal clock generator. → Synchronization to external clock signal applied to the generator via line SCLKIN (pin 4, see Table 2-30). The clock rate of the external signal is to be specified with the next command.	2.5.3.2 Sync TO → GEN CLK → EXTERN:
OUTPut:***SAMP**le*[:FREQuency]:**MODE**	***F32*** ***F44*** ***F48***		If the generator is internally clocked (Sync To = GEN CLK = SOUR:DIG:SYNC:SOUR GCLock) one of the three fixed frequencies can be selected.	2.5.3.2 **GEN panel** Sample Frq → 32 kHz → 44.1 kHz → 48 kHz
OUTPut:***SAMP**le*:**FREQ**uency	**<nu>** 100 Hz to 48 kHz (D48) 100 Hz to 192 kHz (D192) 100 Hz to 768 kHz (D768)	Hz	If the generator is externally clocked, ("Sync To" = EXTERN = SOUR:DIG:SYNC:SOUR EXT) the numerical value of the external clock frequency is entered with this command.	2.5.3.2 **GEN panel**

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Command	Parameter	Basic unit	Meaning	Section
OUTPut:***WLEN**gth*	***L8*** ***L16*** ***L24*** ***L32***		Setting of data bits for each output sample → Word length 8 bits → Word length 16 bits → Word length 24 bits → Word length 32 bits the remaining 4 bits are not used (bits #28 to #30) or are required for the left/right information (bit #31)	**2.5.3.2** **GEN panel** Wordlength → 8 → 16 → 14 → 32
OUTPut:***WOFF**set*	<***n***> -N/2 to +N/2 -1 N = OUTP:WLEN		Word offset	**2.5.3.2** **GEN panel** Wordoffset
OUTPut:***AUD**iobits*	**<n>** Value range depends on word length: with word length = 8: 8 = 16: 8 to 16 = 24: 8 to 24 = 32: 8 to 28		Word width of generated audio samples in bits. If the word width is reduced, the values of the audio samples are rounded to the specified word width. ***Note:*** *With a word length of 32, bits #28 to #30 are not used; bit #31 contains the left/right information (for multiplex operation).*	**2.5.3.2** **GEN panel** Audio Bits
OUTPut:***WSEL**ect*	***LOW*** ***HIGH***		→ Word Select Ch1 has LOW level → Word Select Ch1 has HIGH level Available for the SERIAL MUX output only (OUTP:TYPE MSER)	2.5.3.2 **GEN panel** WordselCh1 → LOW → HIGH
OUTPut:***WCL**ock*	***RIS**ing* ***FALL**ing*		→ Data word is read in on rising / → falling edge Available for the SERIAL output only (OUTP:TYPE SER)	2.5.3.2 **GEN panel** Wordclock → RISING → FALLING

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Command	Parameter	Basic unit	Meaning	Section
OUTPut:***BCL**ock*	***RIS**ing* ***FALL**ing*		→ Bits are output with rising / → falling edge	2.5.3.2 **GEN panel** Bitclock → RISING → FALLING
OUTPut:***BCL**ock:**FREQ**uency**?***	Query only	Hz	Frequency of bit clock	2.5.3.2 **GEN panel** Frq Bitclk
OUTPut:***BITO**rder*	***MSBF**irst* ***LSBF**irst*		→ Data word is sent with MSB first → Data word is sent with LSB first	2.5.3.2 **GEN panel** Bit Order → MSB → LSB

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3.10.1.3.2 Parallel Interfaces (Parallel, Parallel Mux)

Command	Parameter	Unit	Meaning	Section
OUTPut:***TYPE***	***PAR**allel* ***MPAR**allel*		→ Parallel digital output active (for single-channel generation OUTP:SEL CH1 only) → Parallel digital output active, multiplex mode Available only when Src Mode AUDIO DATA (SOUR:DIG:FEED ADAT) is active. In all other source modes only the digital interfaces AES / SPDIF / OPTICAL are active and cannot be separately selected.	2.5.3.1 **GEN panel** Output → PARALLEL → PARAL MUX
SOURce:**DIG**ital:**SYNC:SOUR**ce	**GCL**ock **EXT**ern		Specifies the sync source of the digital audio generator. → Synchronization to external clock generator. → Synchronization to external clock signal applied to the generator via line EXSTRBIN (pin 36, see Table 2-31). The clock rate of the external signal is specified with the next command.	2.5.3.3 **GEN panel** Sync To → GEN CLK → EXTERN
OUTPut:***SAMP**le*[:FREQuency]:**MODE**	***F32*** ***F44*** ***F48***		If the generator is internally clocked (Sync To = GEN CLK = SOUR:DIG:SYNC:SOUR GCLock) one of the 3 fixed frequencies can be selected.	**2.5.3.3** **GEN panel** Sample Frq → 32 kHz → 44.1 kHz → 48 kHz
OUTPut:***SAMP**le*:**FREQ**uency	**<nu>** 100 Hz to 48 kHz (D48) 100 Hz to 192 kHz (D192) 100 Hz to 768 kHz (D768)	Hz	If the generator is externally clocked, ("Sync To" = EXTERN = SOUR:DIG:SYNC:SOUR EXT) the numeric value of the external clock frequency is entered with this command.	**2.5.3.3** **GEN panel**
OUTPut:***AUD**iobits*	**<n>** 8 to 24		Word width of generated audio samples in bits. If the word width is reduced, the values of the audio samples are rounded to the specified word width.	**2.5.3.3** **GEN panel** Audio Bits

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Command	Parameter	Unit	Meaning	Section
OUTPut:***WSEL****ect***	***LOW*** ***HIGH***		Word Select Channel 1 → Data of channel 1 are LOW on line LR. → Data of channel 1 are HIGH on line LR. LR (pin 34) is the control line which distinguishes left and right in multiplex operation. Available only for PARAL MUX (OUTP:TYPE MPAR)	2.5.3.3 Wordsel CH1 → LOW → HIGH
OUTPut:***WCL****ock***	***RIS****ing* ***FALL****ing*		→ Data word read in with rising / → falling edge	2.5.3.3 **GEN panel** Wordclock → RISING → FALLING

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3.10.1.3.3 AES / EBU-, S / P DIF and Optical Interfaces

Command	Parameter	Basic unit	Meaning	Section
OUTPut:***TYPE***	***AES**ebu* ***SPD**if* ***OPT**ical*		→ AES/EBU output active → S/P DIF output active → Optical digital output active	2.5.3.1 **GEN panel** Output → AES/EBU → S/P DIF → OPTICAL
OUTPut:***AUD**iobits*	**<n>** 8 to 24		Word width of generated audio samples in bits. If the word width is reduced, the values of the audio samples are rounded to the specified word width. Available only for Src Mode = AUDIO DATA (SOUR:DIG:FEED ADAT)	2.5.3.4 **GEN panel** Audio Bits
OUTPut:***SIGN**al*:**LEV**el	<**nu**> 20 mV to 5.1 V 10 mV to 1.5 V	V	Signal level of digital data stream OUTPut:TYPE AES OUTPut:TYPE SPD	2.5.3.4 **GEN panel** Dig. Vpp

Configuration *without* jitter option (UPD-B22)

Command	Parameter	Basic unit	Meaning	Section
SOURce:**DIG**ital:**SYNC**:**SOUR**ce	**AINP**ut **WCLock** **GCL**ock		Specifies, the sync source of the digital audio generator. → Synchronization to audio input signal; The clock rate of the analyzer is entered with the next command and updated upon each change. → Synchronization to external wordclock signal applied to the generator via the BNC socket at the rear of the instrument: The clock rate of the external signal is to be specified with the next command. → Synchronization to external clock generator. The fixed rate of the internal clock generator can be selected with the next command.	**2.5.3.4.1** **GEN panel** Sync To → AUDIO IN → WORDCLK INP → GEN CLK

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Command	Parameter	Basic unit	Meaning	Section
OUTPut:***SAMP****le***[:FREQuency]:**MODE**	***F32*** ***F44*** ***F48***		If the generator is internally clocked (Sync To = GEN CLK = SOUR:DIG:SYNC:SOUR GCLock) one of these 3 fixed frequencies can be selected.	**2.5.3.4.1** GEN panel Sample Frq → 32 kHz → 44.1 kHz → 48 kHz
OUTPut:***SAMP****le***:**FREQ**uency	<nu> 30 kHz **to** 52.5 kHz	Hz	If the generator is synchronized to the analyzer ("Sync To" = AUDIO IN = SOUR:DIG:SYNC:SOUR AINP), the numeric value for the analyzer clock frequency is entered here. If the generator is externally clocked ("Sync To" = WORDCLK INP = SOUR:DIG:SYNC:SOUR WCL), the numeric value for the external clock frequency is entered here.	**2.5.3.4.1** GEN panel
OUTPut:**SIGN**al:**LEV**el	**<nu>** 10 mV **to** 1.5 V Resolution 8.33 mV	V	Setting the output voltage of the digital S/P DIF signals. (Peak-to-peak voltage when terminated with a nominal impedance of 75 Ω). With open circuit the voltage is twice as high. Available only for the S/P DIF output (OUTP:TYPE SPD).	**2.5.3.4.1** **GEN panel** S/PDIF Vpp
OUTPut:**SIGN**al:**BAL**anced**:LEV**el**?**	**<nu>** Query only 20 mV **to** 5.1 V	V	Setting the output voltage of the digital AES/EBU signal. (Peak-to-peak voltage when terminated with a nominal impedance of 110 Ω). With open circuit the voltage is twice as high. Available only for the AES/EBU output (OUTP:TYPE AES).	2.5.3.4.1 **GEN panel** AESEBU Vpp

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Configuration *with* jitter option (UPD-B22)

Command	Parameter	Basic unit	Meaning	Section
SOURce:**DIG**ital:**SYNC**:**DEL**ay	**<nu>** -64 UI to +64 UI corresponds to -180º to +180º.	UI see **2.5.3.4** **.3**	Setting the frame phase between digital audio output and REF output (instrument rear). Available only with built-in jitter option (UPD-B22) and Src Mode PHASE (SOUR:DIG:FEED PHAS) selected.	2.5.3.4.2 **GEN panel** PhaseToRef
OUTPut:**DIG**ital:**UNB**alanced:**FEED**	**AOUT**put **AINP**ut		Specifies the signal present at the S/P DIF output. → The *generated* AUDIO data are output (same as at the AES/EBU and optical output) → The digital AUDIO data *received (*from the AES/EBU or S/P DIF input) are present (front panel). An oscilloscope may, for instance, be connected to this output to view the input signal. Available only with built-in jitter option (UPD-B22).	**2.5.3.4.2** **GEN panel** S/PDIF Out → AUDIO OUT → AUDIO IN
OUTPut:**DIG**ital:**CSIM**ulator	**OFF** **SIML**ong **SIMS**hort		A cable length may be simulated at the AES/EBU or S/P DIF output. → Cable simulation switched off. → Simulation of a 100-m-long cable switched on for both electrical outputs. → Simulation of a few meters cable switched on for both electrical outputs. Cable simulation is also active when switched to the S/P DIF output of the AUDIO IN signal. Available only with built-in jitter option (UPD-B22).	**2.5.3.4.2** **GEN panel** Cable Sim → OFF → LONG CABLE → SHORT CABEL

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Command	Parameter	Basic unit	Meaning	Section
SOURce:**DIG**ital:**SYNC**:**SOUR**ce	**AINP**ut **RINP**ut **SINP**ut **GCL**ock		Specifies the sync source of the digital audio generator. Depending on the "Src Mode", some items cannot be selected. → Synchronization to audio input signal; *not* possible with JITTER or PHASE. → Synchronization to REF input signal (XLR socket at instrument rear); *not* possible with PHASE → Synchronization to SYNC input signal (BNC socket at instrument rear) *not* possible with JITTER or PHASE. The mark-to-space ratio can be set with the following command SOUR:DIG:SYNC:MODE ... . → Synchronization to internal clock generator which either generates one of the 3 fixed frequencies or a user-defined frequency. Available only with built-in jitter option (UPD-B22).	**2.5.3.4.2** **GEN panel** Sync To → AUDIO IN → REF IN → SYNC IN → GEN CLK
SOURce:**DIG**ital:**SYNC**:**MODE**	**V50** **V60** **F1024** **WCL**ock **IWCL**ock		Available only with built-in jitter option (UPD-B22) and generator synchronized to the (rear) SYNC input (SOUR:DIG:SYNC:SOUR SINP). → Sample frequency synchronized to 50 Hz refresh rate (Europe). → Sample frequency synchronized to 60 Hz refresh rate (USA). ***Note:*** *With VIDEO 50 and VIDEO 60, a respective composite video signal must be present at the SYNC input.* → Sample frequency synchronized to a 1024 kHz reference signal. → Sample frequency synchronized to the wordclock signal at the SYNC input. → Sample frequency synchronized to the inverted wordclock signal at the SYNC input.	**2.5.3.4.2** **GEN panel** Sync Mode → VIDEO 50 → VIDEO 60 → 1024 kHz → WORD CLK → WRD CLK INV

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Command	Parameter	Basic unit	Meaning	Section
OUTPut:***SAMP**le*[:FREQuency]:**MODE**	***F32*** ***F44*** ***F48*** ***VAL**ue* ***EXT**ern* ***SYNC**hron*		Setting the output clock rate. Depending on the synchronization selected with command "SOUR:DIG:SYNC:SOUR ..." the following rates can be specified: → Sample frequency 32 kHz → Sample frequency 441 kHz → Sample frequency 48 kHz Three fixed frequencies, selectable when the generator is internally clocked or synchronized via the SYNC IN socket, which is selected with command SOUR:DIG:SYNC:SOUR GCL | SIN → The numeric value is entered with the next command when the generator is internally clocked which is be selected with command SOUR:DIG:SYNC:SOUR GCL. → An external clock can be entered as a numeric value with the next command when the generator is synchronized with a (possibly inverted) wordclock signal via the SYNC IN socket, or via the REF IN socket, selectable with commands "SOUR:DIG:SYNC:SOUR SINP | RINP" and "SOURc:DIG:SYNC:MODE WCL | IWCL". → Sample frequency synchronized to analyzer. If the generator is synchronized to the analyzer input signal with the SOUR:DIG:SYNC:SOUR AINP command, only this item can be selected. This means that the command need not be output. In this case the numeric value for the sample frequency is taken from the ANALYZER panel and cannot be changed in the generator. Available only with built-in jitter option (UPD-B22).	**2.5.3.4.2** **GEN panel** Sample Freq → 32 kHz → 44.1 kHz → 48 kHz → VALUE: → EXTERN → SYNCHRON
OUTPut:***SAMP**le*:**FREQ**uency	**<nu>** 30 kHz to 52.5 kHz	Hz	External sample frequency for the above commands: OUTP:SAMP:MODE VAL | EXT	**2.5.3.4.2** **GEN panel**

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Command	Parameter	Basic unit	Meaning	Section
OUTPut:**DIG**ital:**SYNC**:**FEED**	**AIP**ut **RINP**ut **SPLL** **GCL**ock		Defines which clock signal is connected to the SYNC output (rear BNC connector). → Digital AUDIO input signal (front panel). → REF input signal (XLR connector at the rear); → Signal from internal synchronization PLL (eg input signal without jitter) → Internal generator clock. Available only with SOUR:DIG:SYNC:SOUR GCL selected. Available only with built-in jitter option (UPD-B22).	**2.5.3.4.2** **GEN panel** Sync Out → AUDIO IN → REF IN → SYNC PLL → GEN CLK
OUTPut:**DIG**ital:**SYNC**:**TYPE**	**WCL**ock **BCL**ock		Specifies the type of SYNC OUT signal (OUTPut:DIGital:SYNC:FEED .....): → Wordclock signal (sample frequency) → Biphase clock signal (128 times the sample frequency) Available only with built-in jitter option (UPD-B22).	**2.5.3.4.2** **GEN panel** Type → WORD CLK → BIPHASE CLK
OUTPut:**DIG**ital:**REF**erence:**FEED**	**AINP**ut **AINR**eclock **AOUT**put **RGEN**erator		Decides which signal is connected to the REF output (rear XLR connector). → Buffered AUDIO input signal; → AUDIO input signal clocked back via the internal synchronization PLL → Generated AUDIO signal (same as front panel) → Generated reference signal defined as constant low (AZER) or constant high (AONE) using the following SOUR:DIG:REF command. Available only with built-in jitter option (UPD-B22).	**2.5.3.4.2** **GEN panel** Ref Out → AUDIO IN → AUD IN RCLK → AUDIO OUT → REF GEN
SOURce:**DIG**ital:**REF**erence	**AZER**o **AONE**		All data of the reference generator are → 0 → 1 Available only with built-in jitter option (UPD-B22) and with OUTP:DIG:REF:FEED RGEN selected.	**2.5.3.4.2** **GEN panel** Data → ALL ZERO → ALL ONE

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Command	Parameter	Basic unit	Meaning	Section
OUTPut:**SIGN**al:**LEV**el	**<nu>** 0 mV to 2.125 V Resolution 8.33 mV	V	Setting the output voltage of the digital signal at the S/P DIF interface. Peak-to-peak voltage upon termination with nominal impedance (75 Ω); with open circuit the voltage is twice as high. ***Note**:* *The voltage at the AES/EBU interface is always 4 times as high as the voltage selected here.* Available only for the S/P DIF output (OUTP:TYPE SPD).	**2.5.3.4.2** **GEN panel** S/PDIF Vpp
OUTPut:**SIGN**al:**BAL**anced**:LEV**el	**<nu>** 0 mV to 8.5 V	V	Setting the output voltage of the digital AES/EBU signal (peak-to-peak voltage upon termination with nominal impedance 110 Ω). With open circuit the voltage is twice as high. ***Note:*** *The voltage at the S/P DIF interface is always ¼ of the voltage selected here.* Available only for the AES/EBU output (OUTP:TYPE AES).	**2.5.3.4.2** **GEN panel** AESEBU Vpp

3.10.1.3.4 AES / EBU PROTOCOL Definition

Command	Parameter	Basic unit	Meaning	Section
SOURce:**PROT**ocol	**OFF** ***ENH**anced*		Entry of protocol information → No entry of channel status data. The state defined last is retained. After a change to manual control the protocol command display in the GENERATOR panel is switched off. → The whole range of protocol data commands can be entered. After a change to manual control the protocol commands are displayed in the GENERATOR panel.	2.5.3.4.4 **GEN panel** PROTOCOL → PANEL OFF → ENHANCED

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Command	Parameter	Basic unit	Meaning	Section
SOURce:**PROT**ocol	**OFF** ***ENH**anced*		Entry of protocol information → No entry of channel status data. The state defined last is retained. After a change to manual control the protocol command display in the GENERATOR panel is switched off. → The whole range of protocol data commands can be entered. After a change to manual control the protocol commands are displayed in the GENERATOR panel.	2.5.3.4.4 **GEN panel** PROTOCOL → PANEL OFF → ENHANCED
OUTPut:***VAL**idity*	***CH1A**nd2* ***CH1*** ***CH2*** ***NONE***		Sets the validity bits in the AES/EBU data stream. → Valid bit for both channels set. → Validity bit is set for channel 1 only → Validity bit is set for channel 2 only → Valid bit is set for neither of the channels	**2.5.3.4.4** **GEN panel** Validity → 1 & 2 → 1 → 2 → NONE
SOURce:***PROT**ocol:**LCH**annelstatus*	***ZERO*** ***AES3*** ***CRC*** ***RAW***		Specifies how the channel status data for LEFT are to be generated. → All channel status data bits are 0 → UPD generates local timecode and CRC. All other channel status data are defined by the file loaded with command MMEMory:LOAD: LPGC **"filename"**. → Same as AES3, however local timecode is not generated by UPD but set as a fixed value from the file. → Same as AES3, however neither local timecode nor CRC is generated by UPD but set as fixed values from the file.	**2.5.3.4.4** **GEN panel** Ch Sta. L → ZERO → FILE+AES3 → FILE+CRC → FILE
MMEMory:**LOAD:*LPGC***	**"filename"**		Stating a file containing channel status data for LEFT. Preset file type: * · PGC	**2.5.3.4.4** **GEN panel** Filename

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Command	Parameter	Basic unit	Meaning	Section
SOURce:**PROT**ocol	**OFF** ***ENH**anced*		Entry of protocol information → No entry of channel status data. The state defined last is retained. After a change to manual control the protocol command display in the GENERATOR panel is switched off. → The whole range of protocol data commands can be entered. After a change to manual control the protocol commands are displayed in the GENERATOR panel.	2.5.3.4.4 **GEN panel** PROTOCOL → PANEL OFF → ENHANCED
SOURce:***PROT**ocol:**RCH**annelstatus*	**ZERO** **LEQ**ual **AES3** **CRC** **RAW**		Specifies how the channel status data RIGHT are to be generated. → All channel status data bits are 0 → The two sides are identical, all definitions made for left are copied to the right side. The operating mode is defined by Ch. Stat L. → UPD generates local timecode and CRC. All other channel status data are defined by the file loaded with command MMEMory:LOAD:RPGC "filename". → Same as AES3-..., however local timecode not generated by UPD but set as a fixed value from the file. → Same as AES3-..., however neither local timecode nor CRC is generated by UPD but set as fixed values from the file.	**2.5.3.4.4** **GEN panel** Ch Stat. R → ZERO → EQUAL L → FILE+AES3 → FILE+CRC → FILE
MMEMory:**LOAD:*RPGC***	**"filename"**		Stating a file containing channel status data for RIGHT. Preset file type: *.prd	**2.5.3.4.4** **GEN panel** Filename
SOURce:***PROT**ocol:**UMOD**e*	**ZERO** **FILE**		Specifies how user data are to be generated. → All user bits are initialized to be 0. → User bits are output according to the definitions in the file loaded with command MEMory:LOAD:PGU "filename".	**2.5.3.4.4** **GEN panel** User Mode → ZERO → FILE DEF
MMEMory:**LOAD:*PGU***	**'filename'**		Stating a file containing USER data Preset data type: *.prd	**2.5.3.4.4** **GEN panel** Filname

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Command	Parameter	Basic unit	Meaning	Section
SOURce:**PROT**ocol	**OFF** ***ENH**anced*		Entry of protocol information → No entry of channel status data. The state defined last is retained. After a change to manual control the protocol command display in the GENERATOR panel is switched off. → The whole range of protocol data commands can be entered. After a change to manual control the protocol commands are displayed in the GENERATOR panel.	2.5.3.4.4 **GEN panel** PROTOCOL → PANEL OFF → ENHANCED
SOURce:***PROT**ocol:**PAR**ity*	**ON** **FAIL**		Specifies whether the protocol is to be generated with parity errors. All samples with correct parity. Setting the error rate with the commands described below: ...NFCount, to FCOunt and ... FOFFset	**2.5.3.4.4** **GEN panel** Parity → TRUE → WITH ERR
SOURce:***PROT**ocol:**PAR**ity:**NFC**ount*	**<n>** 100 to 10·000·000		Specifies the number of samples with correct parity bit.	**2.5.3.4.4** **GEN panel** No. Trues
SOURce:***PROT**ocol:**PAR**ity:**FCO**unt*	**<n>** 0 to 1000		Specifies the number of samples with false parity bit.	**2.5.3.4.4** **GEN panel** No. False
SOURce:***PROT**ocol:**PAR**ity:**FOFF**set*	**<n>** 0 to 100·000 000		Specifies the number of samples with correct parity bit up to the first parity error.	**2.5.3.4.4** **GEN panel** Offset
SOURce:***PROT**ocol:**FBL**ock*	**<n>** 0 to 100·000		Defines the interval (in blocks) in which errors in the beginning-of-block preamble sequence are generated.	**2.5.3.4.4** **GEN panel** Block Err
SOURce:***PROT**ocol:**FCRC***	**<n>** 0 to 100·000		Defines the interval (in blocks) in which errors in the CRC of the status data are generated.	**2.5.3.4.4** **GEN panel** CRC Error

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Command	Parameter	Basic unit	Meaning	Section
SOURce:**PROT**ocol	**OFF** ***ENH****anced*		Entry of protocol information → No entry of channel status data. The state defined last is retained. After a change to manual control the protocol command display in the GENERATOR panel is switched off. → The whole range of protocol data commands can be entered. After a change to manual control the protocol commands are displayed in the GENERATOR panel.	2.5.3.4.4 **GEN panel** PROTOCOL → PANEL OFF → ENHANCED
SOURce:***PROT****ocol:FSEQ***	**<n>** 0 to 100·000		Defines the interval (in blocks), in which sequence errors in the preamble are generated.	**2.5.3.4.4** **GEN panel** Seq. Err

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3.10.1.3.5 Digital Interface INTERN

Configuration *without* jitter option (UPD-B22)

Command	Parameter	Basic unit	Meaning	Section
OUTPut:***TYPE***	***INT**ern*		→ Digital outputs inactive, generator signal internally applied to analyzer (only in DIG 48 kHz instrument for single-channel generation OUTP:SEL CH1 and with a fixed sample rate of 43619.7917 Hz)	**2.5.3.1** Output → INTERN
OUTPut:***AUD**iobits*	**<n>** 8 to 24		Word width of generated audio samples in bits. If the word width is reduced, the values of the audio samples are rounded to the specified word width.	**2.5.3.5** **GEN panel** Audio Bits

Configuration *with* jitter option (UPD-B22)

The whole set of command described in section 3.10.1.3.3 AES / EBU, S/P DIFF, OPTICAL, **Configuration *with* jitter option (UPD-B22)** is available except for commands OUTPut:SIGNal:LEVel <nu> and OUTPut:SIGNal:BALanced:LEVel <nu> which are assigned to the S/P DIF and AES/EBU outputs only.

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3.10.1.4 Generator Sweeps

Sweep settings for SINusoid, BURSt, S2Pulse, MDISt and DFD

- With a BURSt and S2Pulse sweep the burst frequency and/or the level is swept, likewise Ontime and/or interval (see next section).
- With a SINusoid sweep the sinusoidal frequency and/or the level is swept.
- With a MDISt sweep the upper frequency and/or the total voltage is swept.
- With a DFD sweep the center frequency and/or the total voltage is swept.

Command	Parameter	Basic unit	Meaning	Section
SOURce:**SWE**ep:**MODE**	**MAN**ual **AUTO**		→ Manual sweep switching → Automatic sweep switching	**2.5.4.2** **GEN panel** Sweep Ctrl
SOURce:**SWE**ep:***NEXT****step***	***DWEL****l* ***ASYN****c* ***LIST***		→ Sweep after a certain (fixed) time has elapsed → Sweep after a valid measured value has been obtained → Sweep after a certain time defined by interpolated list value	**2.5.4.2** **GEN panel** Next Step → ANLR SYNC → DWELL VALUE → DWELL FILE
SOURce:**SWE**ep:**DWEL**l	**<nu>** 10 ms to 1000 s	s	Dwell time per sweep	**2.5.4.2** **GEN panel** Dwell
MMEMory:***LOAD:LIST***	**DWEL**l[1]**,'filename'** Query: MMEM:LOAD:LIST? DWEL		Specified file contains the dwell times	**2.5.4.2** **GEN panel** Dwell File
SOURce:**FREQ**uency:**MODE**	**CW**|**FIX**ed **SWE**ep**1** **SWE**ep**2** **LIST1** **LIST2**		→ Frequency setting via entry → Frequency setting via normal sweep; frequency as X axis → Frequency setting via normal sweep; frequency as Z axis → Frequency setting via list sweep; frequency as X axis → Frequency setting via list sweep; frequency as Z axis	**2.5.4.2** **GEN panel** SWEEP CTRL X Axis Z Axis

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Command	Parameter	Basic unit	Meaning	Section
SOURce:**FREQ**uency:**STAR**t	**<nu>** Value range determined by instrument or function	Hz	Start value for frequency sweep	**2.5.4.2** **GEN panel** FREQUENCY → Start
SOURce:**FREQ**uency:**STOP**	**<nu>** Value range determined by instrument or function	Hz	Stop value for frequency sweep	**2.5.4.2** **GEN panel** FREQUENCY → Stop
SOURce:**SWE**ep:***FREQ****uency*:**POIN**ts	**<n>** 2 to 1024		For analog instrument Number of sweep points for frequency sweep	**2.5.4.2** **GEN panel** Points
SOURce:**SWE**ep:***FREQ****uency*:**SPAC**ing	**LIN**ear **LOG**arithmic		Scaling of frequency sweep range → linear → logarithmic	**2.5.4.2** **GEN panel** Spacing
SOURce:**SWE**ep:***FREQ****uency*:**STEP**	**<nu>**	Hz	Step width for frequency sweep	**2.5.4.2** **GEN panel** Step
MMEMory:**LOAD:*LIST***	**FREQ**uency[1],'**filename'** Query: MMEM:LOAD:LIST? FREQ		File containing frequencies	**2.5.4.2** **GEN panel** FREQ FILE
SOURce:**VOLT**age:**MODE**	**CW**|**FIX**ed **SWE**ep**1** **SWE**ep**2** **LIST1** **LIST2**		→ Amplitude setting via entry → Amplitude setting via normal sweep; amplitude as X axis → Amplitude setting via normal sweep; amplitude as Z axis → Amplitude setting via list sweep; amplitude as X axis → Amplitude setting via list sweep; amplitude as Z axis	**2.5.4.2** **GEN panel** SWEEP CTRL X Axis Z Axis

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Command	Parameter	Basic unit	Meaning	Section
SOURce:**VOLT**age:**STAR**t	**<nu>** Value range determined by instrument or function	V FS	Start value for amplitude sweep	**2.5.4.2** **GEN panel** VOLTAGE → Start
SOURce:**VOLT**age:**STOP**	**<nu>** Value range determined by instrument or function	V FS	Stop value for amplitude sweep	**2.5.4.2** **GEN panel** VOLTAGE → Stop
SOURce:**SWE**ep:***VOLT****age*:**POIN**ts	**<n>** 2 to 1024		Number of sweep points for amplitude sweep	**2.5.4.2** **GEN panel** Points
SOURce:**SWE**ep:***VOLT****age*:**SPAC**ing	**LIN**ear **LOG**arithmic		Scaling of amplitude sweep range → linear → logarithmic	**2.5.4.2** **GEN panel** Spacing → LIN → LOG
SOURce:**SWE**ep:***VOLT****age*:**STEP**	**<nu>** Value range determined by instrument or function	V FS	Step width for amplitude sweep	**2.5.4.2** **GEN panel** Step
MMEMory:**LOAD:*LIST***,	**VOLT**age[1],'**filename'** Query: MMEM:LOAD:LIST? VOLT		File containing amplitude values	**2.5.4.2** **GEN panel** VOLT FILE

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Command	Parameter	Basic unit	Meaning	Section
SOURce:***OFF*:MODE	**SWE*ep2*|LIST2**		Switches a Z sweep off which was switched on with one of the following commands. SOURce:FREQuency:MODE SWEep2 / LIST2 or SOURce:VOLTage:MODE SWEep2 / LIST2 or SOURce:ONTime:MODE SWEep2 / LIST2 or SOURce:INTerval:MODE SWEep2 / LIST2 SWEep2 and LIST2 are synonyms in this command	**2.5.4.2** **GEN panel** Z Axis → OFF

Note: Max. 2 sweep parameters can be selected not to equal CW (= FIXed). Combining SWEep and LIST is not permissible. Likewise, assignment of the same selection point (eg SWEep1) to different sweep parameters is not permissible; the selection made most recently is valid, the other sweep parameters are set to FIXed.

A normal sweep (or list sweep) is possible only when exactly 1 sweep parameter is set to SWEep1 (or LIST1).
The sweep system is switched off when all sweep parameters are set to CW (= FIXed).
Value range for "STARt", "STOP": values are specified in the functions section.
Value range for "STEP": the permissible step size is determined by "STARt" and "STOP"

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Sweep settings for BURSt and S2Pulse

Sweep settings same as with SINusoid, but for BURSt and S2Pulse **Ontime** and **Interval** may be swept in addition:

Command	Parameter	Basic unit	Meaning	Section
SOURce:***ONT**ime***:MODE**	**CW**|**FIX**ed **SWE**ep**1** **SWE**ep**2** **LIST1** **LIST2**		→ Burst time setting via entry → Burst time setting via normal sweep; burst time as X axis → Burst time setting via normal sweep; burst time as Z axis → Burst time setting via list sweep; burst time as X axis → Burst time setting via list sweep; burst time as Z axis	**2.5.4.2** **GEN panel** SWEEP CTRL X Axis Z Axis
SOURce:***INT**erval***:MODE**	**CW**|**FIX**ed **SWE**ep**1** **SWE**ep**2** **LIST1** **LIST2**		→ Interval setting via entry → Interval setting via normal sweep; interval as X axis → Interval setting via normal sweep; interval as Z axis → Interval setting via list sweep; interval as X axis → Interval setting via list sweep; interval as Z axis	**2.5.4.2** **GEN panel** SWEEP CTRL X Axis Z Axis
SOURce:***ONT**ime***:STAR**t	**<nu>** Value range determined by instrument or function	s, cyc	Start value for burst time sweep	**2.5.4.2** **2.5.4.5** **2.5.4.6** **GEN panel** Start
SOURce:***ONT**ime***:STOP**	**<nu>** Value range determined by instrument or function	s, cyc	Stop value for burst time sweep	**2.5.4.2** **2.5.4.5** **2.5.4.6** **GEN panel** Stop
SOURce:**SWE**ep:***ONT**ime***:POIN**ts	**<n>** 2 to 1024		Number of sweep points of burst time sweep	**2.5.4.2** **GEN panel** Points

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Command	Parameter	Basic unit	Meaning	Section
SOURce:**SWE**ep:***ONT**ime*:**SPAC**ing	**LIN**ear **LOG**arithmic		Scaling of burst time sweep range → linear → logarithmic	**2.5.4.2** **GEN panel** Spacing → LIN → LOG
SOURce:**SWE**ep:***ONT**ime*:**STEP**	**<nu>** Value range determined by instrument or function	s, cyc	Step size for burst time sweep	**2.5.4.2** **GEN panel** Step
MMEMory:**LOAD:LIST**	**ONT**ime**, 'filename'** Query: MMEM:LOAD:LIST? ONT		File containing burst time values	**2.5.4.5** **2.5.4.6** **GEN panel** ONTIM FILE
SOURce:***INT**erval*:**STAR**t	**<nu>** Value range determined by instrument or function	s	Start value for interval sweep	**2.5.4.2** **2.5.4.5** **2.5.4.6** **GEN panel** Start
SOURce:***INT**erval*:**STOP**	**<nu>** Value range determined by instrument or function	s	Stop value for interval sweep	**2.5.4.2** **2.5.4.5** **2.5.4.6** **GEN panel** Stop
SOURce:**SWE**ep:***INT**erval*:**POIN**ts	**<n>** 2 to 1024		Number of sweep points for interval sweep	**2.5.4.2** **GEN panel** Points

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Command	Parameter	Basic unit	Meaning	Section
SOURce:**SWE**ep:***INT**erval*:**SPAC**ing	**LIN**ear **LOG**arithmic		Scaling of interval sweep range → linear → logarithmic	**2.5.4.2** **GEN panel** Spacing → LIN → LOG
SOURce:**SWE**ep:***INT**erval*:**STEP**	**<nu>** Value range determined by instrument or function	s	Step size for interval sweep	**2.5.4.2** **GEN panel** Step
MMEMory:**LOAD:*LIST***	**INT**erval,**'filename'** Query: MMEM:LOAD:LIST? INT		File containing interval values	**2.5.4.5** **2.5.4.6** **GEN panel** INTV FILE

3.10.1.5 Generator Functions

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion[:SHAPe]	***SIN**usoid* **MULT**isine ***BURS**t* **S2P**ulse **MDIS**t **DFD** ***RAND**om* ***USER*** **POL**arity **FSK** ***FM*** **DC**		Generator signal: → Sinusoidal tone → Multi-tone (up to 17 sine lines) → Sine burst → Sine^2 burst → Double sine (similar to SMPTE) → Double sine (difference frequency distortion method) → Noise → User-defined signals → Polarity test signal → Frequency Shift Keying → Modulated sine → DC Voltage	**2.5.4** **GEN panel** FUNCTION → SINE → MULTISINE → SINE BURST → SINE² BURST → MOD DIST → DFD → RANDOM → ARBITRARY → POLARITY → FSK → MODULATION → DC

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3.10.1.5.1 SINE

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion[:SHAPe]	**SIN**usoid		→ Sinusoidal tone	**2.5.4.3** **GEN panel** FUNCTION → SINE
SOURce:**FREQ**uency:***OFFS**et:**STAT**e*	***ON*** ***OFF***		→ Frequency offset 0.1 % → No frequency offset	**2.5.4.1** **GEN panel** Frq. Offset
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et:**STAT**e	**OFF** **ON**		DC offset permitting a DC voltage to be superimposed on the generator output. → Hardly any DC voltage at the output → DC voltage can be set with the next command. ***Note:*** *This setting cannot be made in the analog generator when a low distortion generator is used.*	**2.5.4.1** **GEN panel** DC Offset → OFF → ON
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	**<nu>** -5 V to 5 V -10 V to 10 V -1FS to 1FS	 V V FS	DC amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	**2.5.4.1** **GEN panel** DC Offset
SOURce:***SIN**usoid:**DITH**er:**STAT**e*	**ON** **OFF**		→ Noise superimposed on signal → Noise superimposition off For digital instrument only	**2.5.4.1** **GEN panel** Dither → ON → OFF
SOURce:***SIN**usoid:**DITH**er*	**<nu>** 0 to 1 FS	FS	Noise amplitude	**2.5.4.1** **GEN panel** Dither

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Command	Parameter	Basic unit	Meaning	Section
SOURce:***RAND**om:**PDF***	**GAUS**sian **TRI**angle **RECT**angle		→ Noise distribution, Gaussian → Noise distribution, triangular → Noise distribution, uniform	**2.5.4.1** **GEN panel** PDF → GAUSS → TRIANGLE → RECTANGLE
SOURce:***LOWD**istortion*	***ON*** ***OFF***		→ Sine signal generated by LDG → Sine signal generated by function generator	**2.5.4.1** **2.5.4.3** **GEN panel** Low Dist → ON → OFF
SOURce:**FREQ**uency[:CW|FIXed]	**<nu>** Value range determined by instrument or function	Hz	Sine frequency	**2.5.4.3** **GEN panel** FREQUENQY
SOURce:**VOLT**age:***EQU**alize*:**STAT**e	**ON** **OFF**		→ Sine signal equalized → Sine signal not dependent on frequency	**2.5.4.3** **GEN panel** Equalizer → ON → OFF
MMEMory:**LOAD:*LIST***	**EQU**alize***,'filename'*** Query: MMEM:LOAD:LIST? EQU		File containing equalizer data	**2.5.4.3** **GEN panel** Equal.File
SOURce:**FREQ**uency:***QUAL**ity*	***PREC**ision* ***FAST***		→ Frequency of the LDG is reset precisely (maximum accuracy) → Frequency of the LDG is set coarsely (maximum speed)	**2.5.4.1** **GEN panel** Settling → PRECISION → FAST

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Command	Parameter	Basic unit	Meaning	Section
SOURce**:VOLT**age[:LEVel|AMPLitude]	**<nu>** 0 to 12 V 0 to 24 V 0 to 1 FS	 V V FS	Sine amplitude Analog range (OUTP:TYPE UNB) Analog range (OUTP:TYPE BAL) Digital range	**2.5.4.3** **GEN panel** VOLTAGE

Note: fmin, fmax depend on generator (2.5.1) .
Caution: SOUR:VOLT is voltage-limited by SCPI command SOUR:VOLT:LIM

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3.10.1.5.2 MULTISINE

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion:SHAPe]	***MULT**isine*		Multi-tone (up to 17 sine lines)	**2.5.4.4** **GEN panel** FUNCTION → MULTISINE
SOURce:**VOLT**age[:LEVel|AMPLitude]:**OFFS**et:**STAT**e	***OFF*** ***ON***		DC offset permitting a DC voltage to be superimposed to the generator output. → Hardly any DC voltage at the output → DC voltage can be set with the next command. ***Note**:* *This setting cannot be made in the analog generator when a low distortion generator is used.*	**2.5.4.1.1** **GEN panel** DC Offset → OFF → ON
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	**<nu>** -5 V to 5 V -10 V to 10 V -1FS to 1FS	V V FS	DC amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	**2.5.4.1.1** **GEN panel** DC Offset
SOURce:***RAND**om*:***SPAC**ing*:**MODE**	**USER**defined **ATR**ack		Setting the frequency spacing for the multisine measurement → The entered value (see next command) is corrected to the next settable value. → The value of the analyzer frequency spacing of FFT is automatically set It can be read out with command CALC:TRAN:FREQ:RES? provided FFT is selected in the analyzer.	**2.5.4.4** **GEN-Panel** Spacing → USER DEF → ANLR TRACK
SOURce:***RAND**om*:***SPAC**ing*:**FREQ**uency	**<nu>** Lower limit value: analog = 2.93 Hz digital = sampling frequency / 16384	Hz	Setting value for frequency spacing for multisine measurement The value range depends on the selected generator and its sampling rate (see 2.5.1 Selecting the Generator	**2.5.4.4** **GEN-Panel** Spacing
SOURce:**FUNC**tion:**MODE** alias **SOUR**ce:***MULT**isine*:**MODE**	***EQU**alvoltage* ***DEF**inedvoltage*		Selection of entry mode for individual multisine voltages: → The same amplitude applies for each sine. It is entered with command SOUR:VOLT1 <nu>. → A separate amplitude can be defined for each sine.	**2.5.4.4** **GEN-Panel** Mode → EQUAL VOLT → DEFINE VOLT

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Command	Parameter	Basic unit	Meaning	Section
SOURce:**VOLT**age:***EQU**alize*:**STAT**e	**ON** **OFF**		→ Sinewave signal equalized → Sinewave signal not frequency-dependent	**2.5.4.4** **GEN panel** Equalizer → ON → OFF
MMEMory:**LOAD:*LIST***	**EQU**alize,***'filename'*** Query: MMEM:LOAD:LIST? EQU		File with equalizer data	**2.5.4.4** **GEN panel** Equal.File
SOURce:***MULT**isine:**COUN**t*	**<n>** 1 to 17		Number of settable frequencies	**2.5.4.4** **GEN panel** No of Sin
SOURce:**VOLT**age:**CRES**tfactor:**MODE**	**MIN**imized **DPH**ase **VAL**ue		→ The crest factor (ratio of peak/rms value) is minimized. → The phase of the lines can be separately set with the next but one command SOURce:PHASe[**<i>**][:ADJust]. The start phase of the sinewave is entered. → The crest factor is set with the next command SOUR:VOLT:CRES <n> so that it closely approaches a settable value.	**2.5.4.4** **GEN-Panel** Crest Fact → OPTIMIZED → DEFINE PHAS → VALUE
SOURce:**VOLT**age:***CRES**tfactor*	**<n>** 1 to 100	Multiplication factor	The specified crest factor is approximated; the more lines are used for optimization the easier the approximation. A crest factor of 4 (= 12 dB) is recommended for the measurement in line with ANSI S3.42.	**2.5.4.4** **GEN panel** Crest Fact
SOURce:**PHAS**e[<i>][:ADJust]	<**i**> 1 to 17 **<nu>** 0 to 360 °	DEG	Phase entry: i-th sine phase; i=2 to 17 The line is output starting with the specified phase. With 0° entered the line starts at 0 and then rises. With 90° entered the line starts at the specified voltage and then goes down. For SOUR:VOLT:CRES:MODE DPHase only	**2.5.4.4** **GEN panel** Phas No1 to 17

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Command	Parameter	Basic unit	Meaning	Section
SOURce:**FREQ**uency[<i>][:CW|FIXed]	**<i>** 1 to 17 **<nu>** Value range determined by instrument or function	Hz	Frequency entry: i-th sine frequency; i = 1 to 17	**2.5.4.4** **GEN panel** Freq No1 to 17
SOURce:**VOLT**age[**<i>**][:LEVel|AMPLitude]	**<nu>** 0 ... 12 V 0 ... 24 V 0 ... 1 FS **<i>,** 1 ... 17	 V FS	i-th sine value Analog range (OUTP:TYPE UNB|CTES) Analog range (OUTP:TYPE BAL) Digital range	**2.5.4.4** **GEN panel** Volt No 1 to 17
SOURce:**VOLT**age:***TOTal:GAIN***	**<nu>**	dB	Subsequent amplification of all sine lines (<0 → attenuation); the upper range limit depends on individual rules for sine and sine frequencies as well as on SOUR:VOLT:LIM	**2.5.4.4** **GEN panel** TOTAL GAIN
SOURce:**VOLT**age:***TOTal***[:LEVel|AMPLitude]**?**	**<nu>** Query only	V FS	Total peak amplitude; query only	**2.5.4.4** **GEN panel** TOTAL PEAK
SOURce:**VOLT**age:***TOTal:RMS?***	**<nu>** Query only	V FS	Total RMS amplitude; query only	**2.5.4.4** **GEN panel** TOTAL RMS

Note: f_{max} depends on generator (see **2.5.4.1 Common Parameters for** the Generator Signals)

The maximum amplitude can be set for SOUR<i>:VOLT only when all other sinewaves have an amplitude of 0. Otherwise, V_{max} must be reduced by the sum of the remaining single voltages.

Caution: SOUR:VOLT:TOT is voltage-limited by SCPI command ”SOUR:VOLT:LIM”
With the single amplitudes being unknown, all sinewaves should be set explicitly to 0 before setting the maximum amplitude.
1. SOUR:MULT:MODE EQU
2. SOUR1:VOLT 0

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3.10.1.5.3 SINE BURST

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion[:SHAPe]	***BURS**t*		→ Sine burst	**2.5.4.5** **GEN panel** FUNCTION → SINE BURST
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et:**STAT**e	**OFF** **ON**		DC offset permitting a DC voltage to be superimposed at the generator output. → Hardly any DC voltage at the output → DC voltage can be set with the next command. ***Note**:* *This setting cannot be made in the analog generator when a low distortion generator is used.*	**2.5.4.1.1** **GEN panel** DC Offset → OFF → ON
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	**<nu>** -5 V to 5 V -10 V to 10 V -1FS to 1FS	V FS	DC amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	**2.5.4.1.1** **GEN panel** DC Offset
SOURce**:SWE**ep ...			For sweep commands see **3.10.1.4 Generator Sweeps**	2.5.4.2 **GEN-Panel**
SOURce:**FREQ**uency[:CW|FIXed]	**<nu>** Voltage range depends on instrument or function	Hz	Sine frequency	2.5.4.5 **GEN-Panel** FREQUENCY
SOURce:**VOLT**age[:LEVel|AMPLitude]	**<nu>** 0 to 12 V 0 to 24 V 0 to 1 FS	V FS	Burst amplitude (amplitude during HIGH phase of signal) Analog instrument (OUTPUP:TYPE UNB) Analog instrument(OUTP:TYPE BAL) Digital instrument	**2.5.4.5** **GEN panel** VOLTAGE

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Command	Parameter	Basic unit	Meaning	Section
SOURce:**VOLT**age:***LOWL****evel***	**<nu>** 0 to SOUR:VOLT	V %on FS %on	Amplitude during LOW phase of signal Analog instrument Digital instrument	**2.5.4.5** **GEN panel** Low Level
SOURce:***ONT****ime***[:CW|FIXed]	**<nu>** 0 to 60 s Value range determined by instrument or function	s, cyc	Burst time	**2.5.4.5** **GEN panel** ON TIME
SOURce:**INT**erval[:CW|FIXed]	**<nu>** Value range determined by instrument or function	s	Interval time	**2.5.4.5** **GEN panel** INTERVAL
SOURce:***ONT****ime:DEL****ay***	**<nu>** 0 to 60 s		Sets a start delay for SINE BURST and SINE^2 BURST.	**2.5.4.5** **2.5.4.6** **GEN panel** BurstOnDel

Note: Clock rate and f_{max} depend on generator (see **2.5.1 Selecting the Generator**).

Caution: SOUR:VOLT is voltage-limited by SCPI command SOUR:VOLT:LIM

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3.10.1.5.4 SINE^2 BURST

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion[:SHAPe]	***S2P**ulse*		Sine^2 burst	**2.5.4.6** **GEN panel** FUNCTION → SINE² BURST
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et:**STAT**e	**OFF** **ON**		DC offset permitting a DC voltage to be superimposed at the generator output. → Hardly any DC voltage at the output → DC voltage can be set with the next command. ***Note**:* *This setting cannot be made in the analog generator when a low distortion generator is used.*	**2.5.4.1.1** **GEN panel** DC Offset → OFF → ON
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	**<nu>** -5 V to 5 V -10 V to 10 V -1FS to 1FS	V FS	DC amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	**2.5.4.1.1** DC Offset
SOURce**:SWE**ep ...			For sweep commands see **3.10.1.4 Generator Sweeps**	2.5.4.2 **GEN panel**
SOURce:**FREQ**uency[:CW|FIXed]	**<nu>** Value range determined by instrument or function	Hz	Burst frequency	**2.5.4.6** **GEN panel** FREQUENCY
SOURce:**VOLT**age[:LEVel|AMPLitude]	**<nu>** 0 to 12 V 0 to 24 V 0 to 1 FS	V FS	Burst amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	**2.5.4.6** **GEN panel** VOLTAGE

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Command	Parameter	Basic unit	Meaning	Section
SOURce:***ONT**ime*[:CW|FIXed]	**<nu>** Value range determined by instrument or function	s ,cyc	Burst time	**2.5.4.6** **GEN panel** ON TIME
SOURce:***INT**erval*[:CW|FIXed]	**<nu>** Value range determined by instrument or function	s	Interval time	**2.5.4.6** **GEN panel** INTERVAL
SOURce:***ONT**ime**:DEL**ay*	**<nu>** 0 to 60 s		Sets a start delay for SINE BURST and SINE^2 BURST.	**2.5.4.5** **2.5.4.6** **GEN panel** BurstOnDel

Note: f_{max} depends on generator (see **2.5.1 Selecting the Generator**)

Caution: SOURC:VOLT is voltage-limited by SCPI command SOUR:VOLT:LIM
When negative amplitudes are entered the pulse is inverted.

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3.10.1.5.5 SQUARE

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion[:SHAPe]	**SQU**are		Square	2.5.4.7 **GEN panel** FUNCTION → SQUARE
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et:**STAT**e	**OFF** **ON**		DC offset permitting a DC voltage to be superimposed to the generator output. → Hardly any DC voltage at the output → DC voltage can be set with the next command. ***Note**:* *This setting cannot be made in the analog generator when a low distortion generator is used.*	**2.5.4.1.1** **GEN panel** DC Offset → OFF → ON
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	**<nu><n>** -5 V to 5 V -10 V to 10 V -1Fs to 1FS	V FS	DC amplitude Analog range (OUTP:TYPE UNB) Analog range (OUTP:TYPE BAL) Digital range	**2.5.4.1.1** DC Offset
SOURce**:SWE**ep ...			For sweep commands see **3.10.1.4 Generator Sweeps**	**2.5.4.2** GEN panel SWEEP CTRL
SOURce:**FREQ**uency[:CW|FIXed]	**<nu>** 2 Hz to 10 kHz 2 Hz to Taktrate/4 50 Hz to Taktrate/4	Hz	Square frequency for INST A25 for INST D48, INST D192 for INST D768	2.5.4.7 **GEN panel** FREQUENCY
SOURce:**VOLT**age[:LEVel|AMPLitude]	<**nu**> 0 to 10 V 0 to 20 V 0 to 1 FS	V FS	Square amplitude Analog range (OUTP:TYPE:UNB|CTES) Analog range (OUTP:TYPE:BAL) Digital range	2.5.4.7 **GEN panel** VOLTAGE

Note: f_{max} depends on generator (see **2.5.1 Selecting the Generator**) **Caution:** SOURC:VOLT is voltage-limited by SCPI command SOUR:VOLT:LIM

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3.10.1.5.6 MOD DIST

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion[:SHAPe]	***MDIS****t*		→ Double sine (similar to SMPTE)	2.6.5.8 **GEN panel** FUNCTION → MOD DIST
SOURce:**FREQ**uency:**OFFS**et:**STAT**e	**ON** **OFF**		→ Frequency offset 0.1 % → No frequency offset	**2.5.4.1.1** **GEN panel** Frq. Offset → +1000 PPM → OFF
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et:**STAT**e	**OFF** **ON**		DC offset permitting a DC voltage to be superimposed at the generator output. → Hardly any DC voltage at the output → DC voltage can be set with the next command. ***Note****:* *This setting cannot be made in the analog generator when a low distortion generator is used.*	**2.5.4.1.1** **GEN panel** DC Offset → OFF → ON
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	**<n>** -5 V to 5 V -10 V to 10 V -1FS to 1FS	V FS	DC amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	**2.5.4.1.1** **GEN panel** DC OFFSET
SOURce:***SIN****usoid:DITH****er:STAT****e***	**ON** **OFF**		→ Noise superimposed onto the signal. → Noise superimposition off For digital instrument only	**2.5.4.1.1** **GEN panel** Dither → ON → OFF
SOURce:***SIN****usoid:DITH****er***	**<nu>** 0 to 1 FS	FS	Noise amplitude	**2.5.4.1.1** **GEN panel** Dither

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Command	Parameter	Basic unit	Meaning	Section
SOURce:***RAND**om:**PDF***	**GAUS**sian **TRI**angle **RECT**angle		→ Noise distribution, Gaussian → Noise distribution, triangular → Noise distribution, equivalent	**2.5.4.1.1** **GEN panel** PDF → GAUSS → TRIANGLE → RECTANGLE
SOURce**:LOWD**istortion	**ON** **OFF**		→ Useful signal generated by LDG → Both sines generated by function generator.	**2.5.4.1** **2.5.4.8** **GEN panel** Low Dist → ON → OFF
SOURce**:SWE**ep ...			For sweep commands see **3.10.1.4 Generator Sweeps**	2.5.4.2 **GEN-Panel**
SOURce:**FREQ**uency:***QUAL**ity*	***PREC**ision* ***FAST***		→ Frequency of the LDG is reset (maximal accuracy) → Frequency of the LDG is coarsely set (maximal rate)	**2.5.4.8** **GEN panel** Settling → PRECISION → FAST
SOURce:**FREQ**uency[1][:CW|FIXed]	**<nu>** Value range determined by instrument or function	Hz	Useful frequency	**2.5.4.8** **GEN panel** UPPER FREQ
SOURce:**FREQ**uency**2**[:CW|FIXed]	**<nu>** 30 to 500 Hz	Hz	Interfering frequency	**2.5.4.8** **GEN panel** LOWER FREQ
SOURce:**VOLT**age:***RAT**io*	**<n>** 1 to 10		Ratio of interfering to useful signal	**2.5.4.8** **GEN panel** VOLT LF:UF

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Command	Parameter	Basic unit	Meaning	Section
SOURce:**VOLT**age:***TOT****al***[:LEVel|AMPLitude]	**<nu>** Value range determined by instrument or function	V FS	Total amplitude	**2.5.4.8** **GEN panel** TOTAL VOLT

Note: f_{max} depends on generator (see **2.5.1 Selecting the Generator**)

Caution: SOUR:VOLT:TOT is voltage-limited by SCPI command SOUR:VOLT:LIM.
In the analog instrument the lower limit SOUR:VOLT:RAT (for high rms voltage specifications) depends on the required total rms voltage (see TOTAL VOLT).

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3.10.1.5.7 DFD

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion[:SHAPe]	***DFD***		→ Double sine (difference frequency method)	**2.5.4.9** **GEN panel** FUNCTION → DFD
SOURce:**FREQ**uency:***OFFS**et:**STAT**e*	**ON** **OFF**		→ Frequency offset 0.1 % → No frequency offset	**2.5.4.1** **GEN panel** Frq. Offset → + 1000 PPM → OFF
SOURce**:LOWD**istortion	**ON** **OFF**		→ 1st sine generated by LDG → Both sines generated by function generator	**2.5.4.1** **2.5.4.9** **GEN panel** Low Dist → ON → OFF
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et:**STAT**e	**OFF** **ON**		DC offset permitting a DC voltage to be superimposed at the generator output. → Hardly any DC voltage at the output → DC voltage can be set with the next command. ***Note**:* *This setting cannot be made in the analog generator when a low distortion generator is used.* *With the offset switched on, the S/N ratio of the analog DFD signal is poorer by 30 dB.*	**2.5.4.1** **GEN panel** DC Offset → OFF → ON
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	**<nu>** -5 V to 5 V -10 V to 10 V -1FS to 1FS	V V FS	DC amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	**2.5.4.1.1** **GEN panel** DC OFFSET

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Command	Parameter	Basic unit	Meaning	Section
SOURce:***SIN**usoid:**DITH**er:**STAT**e*	**ON** **OFF**		→ Noise superimposed onto the signal. → Noise superimposition off For digital instrument only	**2.5.4.1.1** **GEN-Panel** Dither → ON → OFF
SOURce:***SIN**usoid:**DITH**er*	**<nu>** 0 to 1 FS	FS	Noise amplitude	**2.5.4.1.1** **GEN panel** Dither
SOURce:***RAND**om:**PDF***	**GAUS**sian **TRI**angle **RECT**angle		→ Noise distribution, Gaussian → Noise distribution, triangular → Noise distribution, uniform	**2.5.4.1.1** **GEN panel** PDF → GAUSS → TRIANGLE → RECTANGLE
SOURce:**FUNC**tion:**MODE**	**IEC2**68 **IEC1**18		→ Entry of center frequency (MEAN FREQ) and difference frequency (DIFF FREQ) to IEC 268 with commands SOUR:FREQ:MEAN <nu> and SOUR:FREQ:DIFF <nu> If a frequency sweep is selected (for the X or Z axis), the center frequency is swept. → Entry of upper DFD frequency (UPPER FREQ) and of difference frequency (DIFF FREQ) to IEC 118 with commands SOUR:FREQ <nu> and SOUR:FREQ:DIFF <nu> If a frequency sweep is selected (for the X or Z axis), the UPPER FREQ is swept.	**2.5.4.9** **GEN panel** **Mode** → IEC 268 → IEC 118
SOURce:**VOLT**age:***EQU**alize*:**STAT**e	**ON** **OFF**		→ Equalizer switched on. → Equalizer switched off.	**2.5.4.9** **GEN panel** Equalizer → ON → OFF

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Command	Parameter	Basic unit	Meaning	Section
MMEMory:**LOAD:*LIST***	***EQU**alize,'**filename'*** Query: MMEM:LOAD:LIST? EQU		File with equalizer data	**2.5.4.9** **GEN panel** Equal.File
SOURce:**SWE**ep...			**For sweep commands see** 3.10.1.4 Generator Sweeps	
SOURce:**FREQ**uency:***MEAN***	<**nu**> Value range determined by instrument or function	Hz	Mean frequency	**2.5.4.11** **GEN panel** MEAN FREQ
SOURce:**FREQ**uency:***DIFF**erence***	**<nu>** Value range determined by instrument or function	Hz	Difference frequency	**2.5.4.9** **GEN panel** DIFF FREQ
SOURce:**FREQ**uency:***QUAL**ity***	***PREC**ision* ***FAST***		→ Frequency of the LDG is reset (maximal accuracy) → Frequency of the LDG is coarsely set (maximal rate)	2.5.4.9 **GEN panel** Settling → PRECISION → FAST
SOURce:**VOLT**age:***TOT**al*[:LEVel|AMPLitude]	**<nu>** Value range determined by instrument or function	V FS	Total amplitude	**2.5.4.9** **GEN panel** TOTAL VOLT

Note: Clock rate, f_{min}, f_{max} depend on generator (see **2.5.1 Selecting the Generator**)

Caution: SOUR:VOLT:TOT is voltage-limited by SCPI command SOUR:VOLT:LIM

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3.10.1.5.8 DIM

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion[:SHAPe]	***DIM***		→ Sine and square (DIM standards)	2.5.4.10 **GEN panel** FUNCTION → DIM
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et:**STAT**e	**OFF** **ON**		DC offset permitting a DC voltage to be superimposed at the generator output. → Hardly any DC voltage at the output → DC voltage can be set with the next command. ***Note***: *This setting cannot be made in the analog generator when a low distortion generator is used.*	**2.5.4.1.1** **GEN panel** DC Offset → OFF → ON
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	**<nu><n>** -5 V to 5 V -10 V to 10 V -1Fs to 1FS	V FS	DC amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	**2.5.4.1.1** DC Offset
SOURce:***DIM***	***DIMA*** ***DIMB***		→ Frequency square/sine 3.15/15 kHz → Frequency square/sine 2.96/14	2.5.4.10 **GEN panel** Square/Sin → 2.96/14 kHz → 3.15/15 kHz
SOURce:***BAND**width* **SOUR**ce:***BWID**th*	***F30*** ***F100***		Band limitation of analog square → to 30 kHz → to 100 kHz	2.5.4.10 **GEN panel** → 30 kHz → 100 kHz
SOURce**:SWE**ep ...			For sweep commands see **3.10.1.4 Generator Sweeps**	**2.5.4.2** **GEN panel**

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Command	Parameter	Basic unit	Meaning	Section
SOURce:**FREQ**uency:***QUAL****ity***	***PREC****ision* ***FAST***		→ Frequency of the LDG is reset (maximal accuracy) → Frequency of the LDG is coarsely set (maximal rate)	2.5.4.10 **GEN panel** Settling → PRECISION → FAST
SOURce:**VOLT**age:***TOT****al*[:LEVel|AMPLitude]	<**nu**> 0 to 21.2 V 0 to 10.6 V 0 to 1 FS	 V V FS	Total amplitude Analog instrument (OUTP:TYPE UNB|CTES) Analog instrument (OUTP:TYPE BAL) Digital instrument	2.5.4.10 **GEN panel** → TOTAL VOLT

Caution: *SOUR:VOLT:TOT is voltage-limited by SCPI-Command SOUR:VOLT:LIM*

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3.10.1.5.9 RANDOM

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion[:SHAPe]	**RAND**om		→ Noise	**2.5.4.11** **GEN panel** FUNCTION → RANDOM
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et:**STAT**e	**OFF** **ON**		DC offset permitting a DC voltage to be superimposed at the generator output. → Hardly any DC voltage at the output → DC voltage can be set with the next command. *Note:* *This setting cannot be made in the analog generator when a low distortion generator is used.*	**2.5.4.1.1** **GEN panel** DC Offset → OFF → ON
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	**<nu>** -5 V to 5 V -10 V to 10 V -1FS to 1FS	V FS	DC amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	**2.5.4.1.1** **GEN panel** DC OFFSET
SOURce:***RAND**om**:DOM**ain*	***FREQ**uency* ***TIME***		→ Frequency domain → Time domain	**2.5.4.11** **GEN panel** Domain → FREQ → TIME
SOURce:**VOLT**age:***TOT**al*[:LEVel|AMPLitude]	**<nu>** 0 to 12 V 0 to 24 V 0 to 1 FS	V FS	Noise peak amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	**2.5.4.11** **GEN panel** VOLT PEAK
SOURce:**VOLT**age:***TOT**al**:RMS***	**<nu>**	V FS	Queries the noise RMS amplitude	**2.5.4.11** **GEN panel** VOLT RMS

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Further commands for frequency domain only:

Command	Parameter	Basic unit	Meaning	Section
SOURce:***RAND**om:**SPAC**ing*:**MODE**	***ATR**ack* ***USER**defined*		→ Analyzer frequency spacing synchronous → Frequency spacing acc. to user entry	**2.5.4.11** **GEN panel** Spacing → ANLR TRACK → USER DEF
SOURce:***RAND**om:**SPAC**ing:**FREQ**uency*	**<nu>** Value range determined by instrument or function	Hz	Entry of frequency spacing	**2.5.4.11** **GEN panel** Spacing
SOURce:***RAND**om:**SHAPe***	***WHIT**e* ***PINK*** ***TOCT**ave* ***ARB**itrary*		→ White noise → Pink noise → 1/3 octave noise. The center frequency is selected with command SOUR:FREQ:MEAN <nu> further down. → File-defined noise	**2.5.4.11** **GEN panel** Equalizatn → WHITE → PINK → THIRD OCT → FILE
MMEMory:**LOAD:LIST**	***ARB**itrary*, **'filename'** Query: MMEM:LOAD:LIST? ARB ***RAND**om*, **'filename'** Query: MMEM:LOAD:LIST? RAND		File with data for file-defined noise. ARBitrary and RANDom are synonyms.	**2.5.4.11** **GEN panel** Shape File
SOURce:***RAND**om:**FREQ**uency:**LOW**er* **SOUR**ce:***RAND**om:**FREQ**uency:**UPP**er*	**<nu>** Value range determined by instrument or function	Hz	Lower/upper frequency limit for white and pink noise	**2.5.4.11** **GEN panel** Lower Freq Upper Freq

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Command	Parameter	Basic unit	Meaning	Section
SOURce:**VOLT**age:***EQU*alize**:STAT**e	**ON** **OFF**		→ Equalizer switched on. → Equalizer switched off.	**2.5.4.11** **GEN panel** Equalizer → ON → OFF
MMEMory:**LOAD:*LIST***	***EQU*alize,'filename'** Query: MMEM:LOAD:LIST? EQU		File with equalizer data.	**2.5.4.11** **GEN panel** Equal.File
SOURce:**VOLT**age:***CRES*tfactor:MODE**	**MIN**imized **VAL**ue		→ Automatic *minimization* of crest factor by an internal optimization of individual phases. → The crest factor is set as close as possible to a settable value using the following command SOURce:VOLTage:CREStfactor <n>".	**2.5.4.11** **GEN panel** Crest Fact → OPTIMIZED → VALUE
SOURce:**VOLT**age:***CRES*tfactor**	**<n>** 1 to 100	Multiplication factor	A crest factor as close as possible to the specified value is set in the UPD.	**2.5.4.11** **GEN panel** Crest Fact
SOURce:**FREQ**uency:***MEAN***	**<nu>** Value range determined by instrument or function	Hz	Center frequency for 1/3 octave noise with SOUR:RAND:SHAP TOCT selected**.**	**2.5.4.11** **GEN panel** MEAM FREQ

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Further commands for time domain only:

Command	Parameter	Basic unit	Meaning	Section
SOURce:***RAND**om**:PDF***	***GAUS**sian* ***TRI**angle* ***RECT**angle*		→ Noise distribution, Gaussian → Noise distribution, triangular → Noise distribution, uniform	**2.5.4.11** **GEN panel** PDF → GAUSS → TRIANGLE → RECTANGLE

Note: Clock rate depends on generator (see 2.5.1 Selecting the Generator)
Caution: SOUR:VOLT:TOT is voltage-limited by SCPI command SOUR:VOLT:LIM.

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3.10.1.5.10 ARBITRARY

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion[:SHAPe]	**USER**		→ User-defined waveforms	**2.5.4.12** **GEN panel** FUNCTION → ARBITRARY
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et:**STAT**e	**OFF** **ON**		DC offset permitting a DC voltage to be superimposed at the generator output. → Hardly any DC voltage at the output → DC voltage can be set with the next command. ***Note**:* *This setting cannot be made in the analog generator when a low distortion generator is used.*	**2.5.4.1.1** **GEN panel** DC Offset → OFF → ON
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	**<n>** -5 V to 5 V -10 V to 10 V -1FS to 1FS	V FS	DC amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	**2.5.4.1.1** **GEN panel** DC Offset
MMEMory:**LOAD:*LIST***	***ARB**itrary*,**'filename'** Query: MMEM:LOAD:LIST? ARB		File with data for waveform	**2.5.4.12** **GEN panel** Filename
SOURce:**VOLT**age:***TOT**al*[:LEVel|AMPLitude]	**<nu>** 0 to 12 V 0 to 24 V 0 to 1 FS	V FS	Peak amplitude of signal Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	**2.5.4.12** **GEN panel** VOLT PEAK

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Command	Parameter	Basic unit	Meaning	Section
SOURce:**VOLT**age:***TOT**al:**RMS?***	**<nu>** Query only	V FS	RMS signal amplitude Analog instrument Digital instrument	**2.5.4.12** **GEN panel** VOLT RMS

Caution: SOUR:VOLT:TOT is voltage-limited by SCPI command SOUR:VOLT:LIM.

3.10.1.5.11 POLARITY

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion[:SHAPe]	***POL**arity*		→ Polarity test signal	**2.5.4.13** **GEN panel** FUNCTION → POLARITY
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et:**STAT**e	**OFF** **ON**		DC offset permitting a DC voltage to be superimposed at the generator output. → Hardly any DC voltage at the output → DC voltage can be set with the next command. *Note:* *This setting cannot be made in the analog generator when a low distortion generator is used.*	**2.5.4.1.1** **GEN panel** DC Offset → OFF → ON
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	**<nu>** -5 V to 5 V -10 V to 10 V -1FS to 1FS	V FS	DC amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	**2.5.4.1.1** **GEN panel** DC Offset

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Command	Parameter	Basic unit	Meaning	Section
SOURce:**VOLT**age[:LEVel|AMPLitude]	**<nu>** 0 to 12 V 0 to 24 V 0 to 1 FS	V FS	Pulse amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	**2.5.4.13** **GEN panel** VOLTAGE

Caution: SOURC:VOLT is voltage-limited by SCPI command SOUR:VOLT:LIM.

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3.10.1.5.12 FSK

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNCtion**[:SHAPe]	***FSK***		Frequency-coded signal for Automatic Measuring System option UPD-K33	2.5.4.14 FUNCTION
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et:**STAT**e	**OFF** **ON**		DC offset permitting a DC voltage to be superimposed at the generator output. → Hardly any DC voltage at the output → DC voltage can be set with the next command. ***Note**:* *This setting cannot be made in the analog generator when a low distortion generator is used.*	**2.5.4.1.1** **GEN panel** DC Offset → OFF → ON
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	**<nu>** -5 V to 5 V -10 V to 10 V -1FS to 1FS	 V FS	DC amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	**2.5.4.1.1** **GEN panel** DC Offset
SOURce:**VOLT**age[:LEVel|AMPLitude]	**<nu>** 0 to 12 V 0 to 1 FS	V FS	Signal amplitude	2.5.4.14 **GEN panel** Volt No1
SOURce:**O33**	'**O33-Kennung**'		Sends the code for line measurements. The data coded in this way can only be sent from option UPD-B33 or UPD-K1 (universal sequence controller).	**No manual operation**

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3.10.1.5.13 MODULATION (FM or AM signal)

Command	Parameter		Meaning	Section
SOURce:**FUNC**tion	**FM**		Setting a modulated sinewave signal. Either FM or AM can be used.	2.5.4.15 **GEN-Panel** FUNCTION → FM
SOURce:**VOLT**age[:LEVel|AMPLitude]:**OFFS**et:**STAT**e	**OFF** **ON**		DC offset permitting a DC voltage to be superimposed to the generator output. → Hardly any DC voltage at the output → DC voltage can be set with the next command. ***Note**:* *This setting cannot be made in the ANALOG generator when a low-distortion generator is used.*	2.5.4.15 **GEN-Panel** DC Offset → OFF → ON
SOURce:**VOLT**age[:LEVel|AMPLitude]:**OFFS**et	**<nu>** -5 V to 5 V -1 FS to 1 FS	 V FS	DC amplitude Analog Instrument ANLG 25 kHz Digital instrument DIG 48 kHz	2.5.4.15 **GEN-Panel** DC OFFSET
SOURce:**FUNC**tion:**MODE**	 **FM** **AM**		Determines the type of modulation. → Frequency modulation; output of a frequency-modulated sinewave signal. → Amplitude modulation; output of amplitude-modulated sinewave signal.	2.5.4.15 **GEN-Panel** **Mode** → FM → AM
SOURce:**FREQ**uency[:CW|FIXed]	**<nu>** Value range determined by instrument and sample frequency	Hz	Setting the modulation frequency	2.5.4.15 **GEN-Panel** Mod Freq oder Freq Ch1

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Command	Parameter		Meaning	Section
SOURce:**VOLT**age[:LEVel|AMPLitude]	**<nu>** 0 to 100 %	PCT	Modulation deviation / depth With SOUR:FUNC:MODE FM: Setting the deviation in %. With SOUR:FUNC:MODE AM: Setting of modulation depth in %	2.5.4.15 **GEN-Panel** Bei FM: Deviation Bei AM: Mod Depth
SOURce:**FREQ**uency**2**[:CW|FIXed]	**<nu>** Value range determined by instrument and sample frequency	Hz	Setting the carrier frequency	2.5.4.15 **GEN-Panel** Carr Freq
SOURce:**VOLT**age**2**	**<nu>** 0 to 6V 0 to 0.5 FS	 V FS	Setting the carrier amplitude Analog Instrument ANLG 25 kHz Digital instrument DIG 48 kHz	2.5.4.15 **GEN-Panel** Carr Volt

3.10.1.5.14 DC voltage

Command	Parameter		Meaning	Section
SOURce:**FUNC**tion	**DC**		DC voltage	2.5.4.16 **GEN-Panel** FUNCTION → DC
SOURce:**SWE**ep ...			For sweep commands see 3.10.1.4 Generator Sweeps	
SOURce:**VOLT**age:***TOTal***[:LEVel|AMPLitude]	**<nu>** - 5 V to 5 V -1 FS to 1 FS	 V FS	Entry of DC amplitude; may be used as sweep parameter. Is voltage-limited by SOUR:VOLT:LIM see 3.10.1.2 and 3.10.1.3	2.5.4.16 **GEN-Panel** VOLTAGE

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3.10.1.5.15 Auxiliary Generator

Command	Parameter	Basic unit	Meaning	Section
SOURce**2:FUNC**tion	**OFF** ***DIGD**ata*		Activation of auxiliary generator for generating an audio data stream with sine-shaped data content. → Auxiliary generator switched off. An audio data stream with the content 0 is generated. → The auxiliary generator produces sine-shaped data.	**2.5.5** **GEN panel** AUX GEN → OFF → DIG DATA
OUTPut**2:SEL**ect	**OFF** ***CH1*** ***CH2*** ***CH2**Is1* ***CH2P**has180*		Channel setting for sine-shaped audio data stream. → Both channels off, (frame transfer signal available, data content of both channels 0) → Channel 1 contains sine-shaped data, channel 2 contains 0 → Channel 2 contains sine-shaped data, channel 1 contains 0 → Sine-shaped data on both channels → Sine-shaped data on channel 2 shifted by 180° against those of channel 1.	**2.5.5** **GEN panel** Channel(s) → OFF → 1 → 2 → 2 ≡ 1 → 2 ≡ -1
SOURce**2:FREQ**uency[:CW|FIXed]	<**nu**> Resolution ... 21.75 kHz Resolution: sample rate / 192; corresp. to 250 Hz at 48 kHz	Hz	Entry of frequency for sine-shaped data of audio signal.	**2.5.5** **GEN panel** Data Freq
SOURce**2:VOLT**age[:LEVel][AMPLitude]	<**nu**> 0 FS to 1 FS	FS	Entry of amplitude for sine-shaped data of audio signal.	**2.5.5** **GEN panel** Data Ampl

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3.10.2 IEC/IEEE-Bus Commands for Analyzers

3.10.2.1 Selection of Analyzer

Command	Parameter	Basic unit	Meaning	Section
INSTrument**2**[:**SEL**ect] equivalent to **INST**rument**2**:**NSEL**ect	**A22** **A100** **A300** **D48** **D192** **D768** **1** **2** **3** **4** **5** **6**		→ Analog analyzer 22 kHz → Analog analyzer 100 kHz → Analog analyzer 300 kHz → Digital analyzer 48 kHz → Digital analyzer 192 kHz → Digital analyzer 768 kHz → Analog analyzer 22 kHz → Analog analyzer 100 kHz → Analog analyzer 300 kHz → Digital analyzer 48 kHz → Digital analyzer 192 kHz → Digital analyzer 768 kHz	**2.6.1** **ANLR panel** INSTRUMENT → ANLG 22 kHz → ANLG 100 kHz → ANLG 300 kHz → DIG 48 kHz → DIG 192 kHz → DIG 768 kHz

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3.10.2.2 Configuration of Analog Analyzers

Command	Parameter	Basic unit	Meaning	Section
INPut[]:**FILT**er[:LPASs]**:FREQ**uency	**<nu>** Query only 2 Hz|10 Hz	Hz	Lower limit frequency for analyzer instruments A22 and D48.	**2.6.2** **ANLR panel** Min Freq
SENSe[]:**POW**er:**REF**erence:***RES**istance*	**<nu>** 1 mΩ to 100 kΩ	Ohm	Reference resistance for power units	**2.4** (RREF) **2.6.2** **ANLR panel** Imped
INPut[]:***SEL**ect*	***CH1*** ***CH2*** ***CH1A**nd2* ***CH1I**s2* ***CH2I**s1*		→ Only channel 1 active → Only channel 2 active → Channel 1 and 2 active, settings may be different → Channel 1 and 2 active, identical settings Data of channel 1 adopted for channel 2. → Channel 1 and 2 active, identical settings Data of channel 2 adopted for channel 1.	**2.6.2** **ANLR panel** CHANNEL(s) →1 →2 →1 & 2 →1 ≡ 2 →2 ≡ 1
INPut[1|**2**]:***TYPE***	***BAL**anced* ***UNB**alanced* ***GEN1*** ***GEN2***		→ Balanced input (XLR connector), see Fig. 2-23. For analog instruments only. → Unbalanced input (BNC connector), see Fig. 2-22. For analog instruments only. → Internal connection to generator channel 1. For analog instruments only. → Internal connection to generator channel 2. For analog instruments only.	**2.6.2** **ANLR panel** Input →BAL XLR → UNBAL BNC → GEN1 → GEN2
INPut[1|**2**]:**IMP**edance	 ***R300*** ***R600*** ***R200K*** ***USER**defined*		Input impedance for unbalanced input → 300 Ω → 600 Ω → 200 kΩ → User-defined Input impedance for Unbalanced input.	**2.6.2** **ANLR panel** Imped →300 Ω →600 Ω →200 Ω → USER DEF

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Command	Parameter	Basic unit	Meaning	Section
INPut[1|**2**]:**LOW**	**FLO**at **GRO**und		→ Outer conductor of unbalanced. input not connected to instrument ground (PE conductor). → Outer conductor of unbalanced. input connected to instrument ground (PE conductor)	**2.6.2 ANLR panel** Common →FLOAT →GROUND
SENSe[]:**VOLT**age:**RANG**e[1|**2**]:**LOW**er	**<nu>** For value range see **2.6.2 Configuration of the** Analog Analyzers	V	Sets a range containing the specified level value. No underrange but higher ranges may be selected.	**2.6.2 ANLR panel** Range →LOWER
SENSe[]:**VOLT**age:**RANG**e[1|**2**]:**AUTO**	**ON** **OFF**		→ Autoranging → The current range is accepted and retained as :UPPer. Corresponds to SENSe[]:VOLTage:RANGe[1|**2**][:UPPer]<current range>	2.6.2 **ANLR panel** Range →Auto
SENSe[]:**VOLT**age:**RANG**e[1|**2**][:**UPP**er]	**<nu>** For value range see **2.6.2 Configuration of the** Analog Analyzers	V	Sets a range containing the specified level value and holds it unconditionally.	**2.6.2 ANLR panel** Range →FIX

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3.10.2.3 Configuration of Digital Analyzers

Command	Parameter	Basic unit	Meaning	Section
SENSe:**DIG**ital:**FEED**	***ADAT**a* ***JPH**ase* ***CINP**ut*		Specifies what should be measured at the digital interfaces. → Measurement of digital audio data (audio content). → Measurement of jitter of selected digital audio input and phase offset to reference signal (REF IN at instrument rear). → Measurement of COMMON signals (common mode signal) at AES/EBU connector and of digital input amplitude at AES/EBU and S/P DIF connectors.	**2.6.3.1** **ANLR panel** Meas Mode → AUDIO DATA → JITTER/PHAS → COMMON/INP
INPut**:FILT**er[:LPASs]**:FREQ**uency	**<n>** Query only **10** Hz|**20** Hz	Hz	Lower frequency limit of analyzer. For SENS:DIG:FEED ADAT only.	**2.6.1** **ANLR panel** Min Freq
INPut[]:***SEL**ect*	***CH1*** ***CH2*** ***BOTH***		For SENS:DIG:FEED ADAT only → Only channel 1 active → Only channel 2 active → Channel 1 and 2 active, identical setting	**2.6.2** **2.6.3** **ANLR panel** CHANNEL(s) →1 →2 → BOTH

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Command	Parameter	Basic unit	Meaning	Section
INPut[1|**2**]:***TYPE***	***MSER**ial* ***SER**ial* ***MPAR**allel* ***PAR**allel* ***AES**ebu* ***SPD**if* ***OPT**ical* ***INT**ern*		Selection of input interface: → Serial universal input, multiplexed, displayed only with Meas Mode AUDIO DATA active. → Serial universal input, displayed only with Meas Mode AUDIO DATA active. → Parallel input, multiplexed, displayed only with Meas Mode AUDIO DATA active. → Parallel input, displayed only with Meas Mode AUDIO DATA active. → Balanced digital input, XLR; only with built-in AES/EBU Interface option UPD-B2. → Unbalanced digital input, BNC; only with built-in AES/EBU Interface option UPD-B2. → Optical digital input, TOSLINK; only with built-in AES/EBU Interface option UPD-B2. → Digital input, from internal generator. *Without* Jitter option UPD-B22, the generator must be set to INTERN for an internal measurement. *With* Jitter option UPD-B22, an internal measurement can be performed even if the generator is set to AES/EBU, S/P DIF or OPTICAL.	**2.6.3.1** **ANLR panel** Input → SERIAL MUX → SERIAL → PARAL MUX → PARALLEL → AES/EBU → S/P DIF → OPTICAL → INTERN

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3.10.2.3.1 Serial Interfaces

Command	Parameter	Basic unit	Meaning	Section
INPut[1|**2**]:***TYPE***	***MSER**ial* ***SER**ial*		Selection of input interface: → Serial universal input, multiplexed, displayed only with Meas Mode AUDIO DATA active. → Serial universal input, displayed only with Meas Mode AUDIO DATA active.	**2.6.3.1** **ANLR panel** Input → SERIAL MUX → SERIAL
INPut[]:***SAMP**le:**FREQ**uency*:**MODE**	***F32*** ***F44*** ***F48*** ***VAL**ue*		Setting the signal clock rate. Available only for Meas Mode AUDIO DATA (SENS:DIG:FEED ADAT). When the sample frequency is selected, (numerical entry or selection of preset value), the analyzer is informed on the sample frequency of the test signal so that the audio frequency can be correctly measured. This information is irrelevant for analyzer synchronization. → *Without jitter option* and for inputs SERIAL, SERIAL MUX, PARALLEL and PARAL MUX, an internal clock is generated when one of the 3 fixed frequencies is selected. The clock is available at the interfaces for driving an external circuit. Otherwise the (generated) clock has no function for the measurement. → When VALUE is selected, the applied frequency can be entered with the next command. Clocks are not generated at the interface.	**2.6.3.1** **ANLR panel** Sample Frq → 32 kHz → 44.1 kHz → 48 kHz → VALUE: → AUTO → CHAN STATUS
INPut[]:***SAMP**le:**FREQ**uency*	**<nu>** 100 Hz to 52.5 kHz	Hz	Value of applied sample frequency. Only for SENS:DIG:FEED ADAT with INP:SAMP:FREQ:MODE VAL	**2.6.3.1** **ANLR panel** Sample Frq → VALUE:

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Command	Parameter	Basic unit	Meaning	Section
INPut[]:***OSAM***pling*	***N1*** ***N2*** ***N4*** ***N8*** ***N16***		Clock multiplier depending on instrument, see **2.6.1 Selecting the Analyzer**	**2.6.3.1** **ANLR panel** Oversamp → 1 → 2 → 4 → 8 → 16
INPut[]:***WLEN***gth*	***L8*** ***L16*** ***L24*** ***L32***		Data bits per input sample for interfaces SERial and MSERial	**2.6.3.2** **ANLR panel** Word lngth → 8 → 16 → 24 → 32
INPut[]:***WOFF***set*	<**n**>= -16 to 16		Position of sync pulse for interfaces SERial and MSERial	**2.6.3.2** **ANLR panel** Word offset
INPut[]*:**AUD**iobits*	**<n>** Value range depends on word length: With word length = 8: 8 = 16: 8 to 16 = 24: 8 to 24 = 32: 8 to 28		Word width of analyzed audio samples in bits. If the word width is reduced, the values of the audio samples are cut to the specified word width. For SENS:DIG:FEED ADAT only.	**2.6.3.2** **ANLR panel** Audio Bits
INPut[]:***WSEL***ect*	***LOW*** ***HIGH***		Marks CH1 on line LR for interface MSERial	**2.6.3.2** **ANLR panel** WordselCh1 → LOW → HIGH

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Command	Parameter	Basic unit	Meaning	Section
INPut[]:***WCL**ock*	***RIS**ing* ***FALL**ing*		Polarity of sync pulse for interface SERial	**2.6.3.2** **ANLR panel** Wordclock → RISING → FALLING
INPut[]:***BCL**ock*	***RIS**ing* ***FALL**ing*		Polarity of bit clock for interfaces SERial and MSERial	**2.6.3.2** **ANLR panel** Bitclock → RISING → FALLING
INPut[]:***BITO**rder*	***MSBF**irst* ***LSBF**irst*		Bit sequence for interfaces SERial and MSERial	**2.6.3.2** **ANLR panel** Bit order → MSB FISRT → LSB FISTS

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3.10.2.3.2 Parallel Interfaces

Command	Parameter	Basic unit	Meaning	Section
INPut[1|**2**]:***TYPE***	***MPAR**allel* ***PAR**allel*		Selection of input interface: → Parallel input, multiplexed, displayed only with Meas Mode AUDIO DATA active. → Parallel input, displayed only with Meas Mode AUDIO DATA active.	**2.6.3.1 ANLR panel** Input → PARAL MUX → PARALLEL
INPut[]:***SAMP**le:**FREQ**uency*:**MODE**	***F32*** ***F44*** ***F48*** ***VAL**ue*		Setting the signal clock rate. Not available for Meas Mode AUDIO DATA (SENS:DIG:FEED ADAT). When the sample frequency is selected, (numerical entry or selection of preset value), the analyzer is informed on the sample frequency of the test signal so that the audio frequency can be correctly measured. This information is irrelevant for analyzer synchronization. → *Without jitter option* and for inputs SERIAL, SERIAL MUX, PARALLEL and PARAL MUX, an internal clock is generated when one of the 3 fixed frequencies is selected. The clock is available at the interfaces for driving an external circuit. Otherwise the (generated) clock has no function for the measurement. → When VALUE is selected, the applied frequency can be entered with the next command. Clocks are not generated at the interface.	**2.6.3.1 ANLR panel** Sample Frq → 32 kHz → 44.1 kHz → 48 kHz → VALUE:
INPut[]:***SAMP**le:**FREQ**uency*	**<nu>** 100 Hz to 52.5 kHz	Hz	Value of applied sample frequency For SENS:DIG:FEED ADAT only	**2.6.3.1 ANLR panel** Sample Frq → VALUE:
INPut[]:***OSAM**pling*	***N1*** ***N2*** ***N4*** ***N8*** ***N16***		The clock multiplier is instrument-dependent, see **2.6.1 Selecting the Analyzer**	**2.6.3.1 ANLR panel** Oversamp → 1 → 2 → 4 → 8 → 16

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Command	Parameter	Basic unit	Meaning	Section
INPut[]*:**AUD**iobits*	**<n>** 8 to 28		Word width of analyzed audio samples in bits. If the word width is reduced, the values of the audio samples are rounded to the specified word width. For SENS:DIG:FEED ADAT only.	**2.6.3.3** **ANLR panel** Audio Bits
INPut[]:***WSEL**ect*	***LOW*** ***HIGH***		Marks CH1 on line LR for interface MPARallel.	**2.6.3.3** **ANLR panel** WordselCh1 → LOW → HIGH
INPut[]:***WCL**ock*	***RIS**ing* ***FALL**ing*		Polarity of sync pulse for interfaces PARallel and MPARallel	**2.6.3.3** **ANLR panel** Wordclock → RISING → FALLING

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3.10.2.3.3 Digital Interface AES / SPDIF / OPTICAL

Command	Parameter	Basic unit	Meaning	Section
INPut[1|**2**]:***TYPE***	***AES**ebu* ***SPD**if* ***OPT**ical*		Selection of input interface: → Balanced digital input, XLR, only with built-in AES/EBU Interface option UPD-B2. → Unbalanced digital input, BNC, only with built-in AES/EBU Interface option UPD-B2. → Optical digital input, TOSLINK; only with built-in AES/EBU Interface option UPD-B2.	**2.6.3.3 ANLR panel** Input → AES/EBU → S/P DIF → OPTICAL
INPut[]:***SAMP**le:**FREQ**uency*:**MODE**	***F32*** ***F44*** ***F48*** ***VAL**ue* ***AUTO*** ***CHST**atus*		Setting the signal clock rate. Available only for Meas Mode AUDIO DATA (SENS:DIG:FEED ADAT). When the sample frequency is selected, (numerical entry or selection of preset value), the analyzer is informed on the sample frequency of the test signal so that the audio frequency can be correctly measured. This information is irrelevant for analyzer synchronization. → *Without jitter option* and for inputs SERIAL, SERIAL MUX, PARALLEL and PARAL MUX, an internal clock is generated when one of the 3 fixed frequencies is selected. The clock is available at the interfaces for driving an external circuit. Otherwise the (generated) clock has no function for the measurement. → When VALUE is selected, the applied frequency can be entered with the next command. Clocks are not generated at the interface. → The measured sample rate is automatically entered as sample freq. The sample rate is updated once every second when the value varies by more than 0.01%. → To determine the sample freq, the respective channel status bits in the AES/EBU protocol are decoded. Depending on the format (consumer or professional), different bits are interpreted (24 to 27 or 6 to 7). The sample rate is updated as soon as the channel status bits show another sample rate. If no information is obtained from the channel status bits ("not indicated") or when protocol analysis is switched off, the sample rate determined last remains set but can be changed by the user.	**2.6.3.3 ANLR panel** Sample Frq → 32 kHz → 44.1 kHz → 48 kHz → VALUE: → AUTO → CHAN STATUS

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Command	Parameter	Basic unit	Meaning	Section
INPut[]:***SAMP**le:**FREQ**uency*	**<nu>** 100 Hz to 52.5 kHz	Hz	Value of applied sample frequency For SENS:DIG:FEED ADAT|JPH only.	**2.6.3.1** **ANLR panel** Sample Frq → VALUE:
INPut[]:***OSAM**pling*	***N1*** ***N2*** ***N4*** ***N8*** ***N16***		The clock multiplier is instrument-dependent, see **2.6.1 Selecting the Analyzer**	**2.6.3.1** **ANLR panel** Oversamp → 1 → 2 → 4 → 8 → 16
SENSe:**DIG**ital:**SYNC:REF**erence	***GCL**ock* ***PLLV**ari* ***PLL32*** ***PLL44*** ***PLL48***		Indicates the signal to which the jitter measurement should be referenced. → The generator clock is used as reference signal. This is only possible if the generator is synchronized to the internal generator clock with command SOUR:DIG:SYNC:SOUR GCL. → The sample signal derived from the input signal via the internal synchronization PLL is used as reference signal. Synchronization is performed via the VCO with maximum capture range (sample frequency 30 kHz to 52.5 kHz). → The sample signal derived from the input signal via the internal synchronization PLL is used as reference signal. Synchronization is performed via the fixed-frequency VCXO. PLLVari, PLL32, PLL44 and PLL48 cannot be used when Src Mode JITTER/PHASE is selected in the generator (SOUR:DIG.FEED JITT), since in this case the internal PLL is needed for phase generation. Available only with built-in jitter option (UPD-B22) and SENS:DIG:FEED JPH selected.	2.6.3.4 **ANLR panel** Jitter Ref → GEN CLK → VARI (PLL) → 32.0 (PLL) → 44.1 (PLL) → 48.0 (PLL)

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Command	Parameter	Basic unit	Meaning	Section
INPut[1|**2**]:**IMP**edance	***R110*** ***R10K***		Selection of input impedance → 110 Ω: correct termination with nominal impedance → 10 kΩ: high-impedance termination to allow signal monitoring to the UPD. Only possible *without* jitter option and with AES/EBU selected as input.	2.6.3.4 **ANLR panel** Ch1 Imped → 110 Ω → 10 KΩ
INPut[]*:**AUD**iobits*	**<n>** 8 to 24		Word width of analyzed audio samples in bits. If the word width is reduced, the values of the audio samples are rounded to the specified word width. Available only for Meas Mode AUDIO DATA. (SENS:DIG:FEED ADAT).	**2.6.3.4** **ANLR panel** Audio Bits
SENSe[]:**VOLT**age:**RANGe:AUTO** **SENS**e[]:**VOLT**age:**RANGe FIXM**ax	**ON** **FIXM**ax		*Allows optimum range setting depending on the jitter or common mode signal.* *→ Automatic selection of measurement range* *→ The highest possible measurement range of this Meas Mode is set and held. Setting FIXM internally corresponds to the analog 3 V range of the 100 kHz analyzer.* Available only with jitter option (UPD-B22) fitted and SENS:DIG:FEED JPH | CINP selected.	**2.6.3.4** **ANLR panel** Range → AUTO → FIX (MAX)

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3.10.2.3.4 Digital Interface INTERN

Configuration *without* jitter option (UPD-B22)

Command	Parameter	Basic unit	Meaning	Section
INPut[1|**2**]:***TYPE***	***INT**ern*		Selection of input interface: → Digital input, from internal generator. For an internal measurement *without* built-in jitter option UPD-B22, also the generator must be set to INTERN.	**2.6.3.1** **ANLR panel** Input → INTERN
INPut:***AUD**iobits*	**<n>** 8 to 24		Word width of analyzed audio samples in bits. If the word width is reduced, the values of the audio samples are rounded to the specified word width. Available only for Meas Mode AUDIO DATA. (SENS:DIG:FEED ADAT).	**2.6.3.6** **GEN panel** Audio Bits

Configuration *with* jitter option (UPD-B22)

Command	Parameter	Basic unit	Meaning	Section
INPut[1|**2**]:***TYPE***	***INT**ern*		Selection of input interface: → *With* built-in Jitter option UPD-B22 an internal measurement can be performed even if AES/EBU, S/P DIF or OPTICAL is selected on the generator. Available for Sens:DIG:FEED ADAT|JPH only.	**2.6.3.1** **ANLR panel** Input → INTERN

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Command	Parameter	Basic unit	Meaning	Section
INPut[]:***SAMP**le:**FREQ**uency*:**MODE**	***F32*** ***F44*** ***F48*** ***VAL**ue* ***AUTO*** ***CHST**atus*		Same as in section 3.10.2.3.3 Available for Sens:DIG:FEED ADAT only	**2.6.3.1** **ANLR panel** Sample Frq → 32 kHz → 44.1 kHz → 48 kHz → VALUE: → AUTO → CHAN STATUS
INPut[]:***SAMP**le:**FREQ**uency*	**<nu>** 100 Hz to 52.5 kHz	Hz	Applied sample frequency For SENS:DIG:FEED ADAT and INP:SAMP:FREQ:MODE VAL|AUTO|CHST only.	**2.6.3.1** **ANLR panel** Sample Frq → VALUE:
SENSe**:DIG**ital**:SYNC:REF**erence	***GCL**ock* ***PLLV**ari* ***PLL32*** ***PLL44*** ***PLL48***		Same as in section 3.10.2.3.3 Available for Sens:DIG:FEED JPH only	2.6.3.4 **ANLR panel**Jitter Ref → GEN CLK → VARI (PLL) → 32.0 (PLL) → 44.1 (PLL) → 48.0 (PLL)
SENSe[]:**VOLT**age:**RANGe:AUTO** **SENS**e[]:**VOLT**age:**RANGe**	**ON** **FIXM**ax		Allows optimum range setting depending on the jitter or common mode signal. → Automatic selection of measurement range → The highest possible range of this Meas Mode is set and held. Setting FIXM OFF internally corresponds to the analog 3 V range of the 100 kHz analyzer. Available only with built-in jitter option (UPD-B22) and SENS:DIG:FEED JPH|CINP selected.	**2.6.3.4** **ANLR panel** Range → AUTO → FIX (MAX)

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Command	Parameter	Basic unit	Meaning	Section
INPut:***AUD****iobits***	**<n>** 8 to 24		Word width of analyzed audio samples in bits. If the word width is reduced, the values of the audio samples are rounded to the specified word width. Available for Meas Mode AUDIO DATA. (SENS:DIG:FEED ADAT) only.	**2.6.3.6** **GEN panel** Audio Bits

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3.10.2.4 Starting the Analyzer, Ext. Sweep

Command	Parameter	Basic unit	Meaning	Section
TRIGger:**SOUR**ce	**IMM**ediate **TIM**er **CH1F**req|**CH2F**req **CH1L**evel|**CH2L**evel **CH1T**rigger|**CH2T**rigger **TCH**art **CH1R**apidfreq **CH2R**apidfreq **CH1E**dgetrigger **CH2E**dgetrigger		→ Continuous measurement mode w i t h o u t trigger condition → Storing measured values in the buffer at regular intervals. → Collection of measured values due to a variation in frequency found at the ANALYZER input, channel 1 or channel 2. → Collection of measured values due to a variation in level found at the ANALYZER input, channel 1 or channel 2. → Triggers a single measurement as soon as the level is within the range specified by ARM:VOLT:STAR and ARM:VOLT:STOP. → Measured values from the ongoing continuous measurement are entered into a timing diagram at the time interval selected by means of command TRIG:TIM **<nu>**. → External frequency sweep with fast frequency measurement in channel 1 → and channel 2 → Edge-sensitive triggering; a measurement is triggered as soon as the level → enters the interval between ARM:VOLT:START and ARM:VOLT:STOP **for the first time**.	**2.6.4** **ANLR panel** START COND →AUTO →TIME →CH1Freq | CH2Freq →CH1Level| CH2Level →LEV TRG CH1| LEV TRG CH2 →TIME CHART → FRQ FST CH1 → FRQ FST CH2 → EDG TRG CH1 → EDG TRG CH2
TRIGger:**DEL**ay	**<nu>** 0 s to 10 s	s	Waiting time after the measurement (settling time for DUT).	**2.6.4** **ANLR panel** Delay
TRIGger:**TIM**er	**<nu>** 10 ms to 2000 s	s	Interval between recordings of measured values.	**2.6.4** **ANLR panel** Timetick
TRIGger:**COUN**t	**<n>** 2 to 1024		Number of measured values entered into the buffer.	**2.6.4** **ANLR panel** Points

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Command	Parameter	Basic unit	Meaning	Section
ARM:**LEV**el:**MIN**	**<nu>** Analog instruments 10 µV to 300 V Digital instrument 1µFS to 1.0 FS	V FS	Minimum voltage required for triggering a measurement with external frequency sweep.	**2.6.4** **ANLR panel** Min VOLT
ARM:**FREQ**uency**:STAR**t **ARM:FREQ**uency**:STOP**	**<nu>** Analog instruments 10 µV to 300 V Digital instrument UG (lower limit) to 1.0 FS UG: the lower limit for the start/stop level values depends on the number of audio bits (see **2.6.3**) but is at least 1µFS and calculated as follows: UG = $2^{-\text{audio bits}}$	Hz	The input frequency must be within the start/stop frequency for triggering the measurement.	**2.6.4** **ANLR panel** Start|Stop
ARM:VOLTage**:STAR**t **ARM:VOLT**age:**STOP**	**<nu>** Analog instruments 10 µV to 1000 V Digital instrument 1 µFS to 1.0 FS	V FS	The input level must be within the start/stop voltage limits for triggering a measurement.	**2.6.4** **ANLR panel** Start|Stop
TRIGger**:FREQ**uency**:VAR**iation	**<nu>** LL to 50%	PTC	Minimum percentage by which the input frequency must vary for triggering a measurement. LL: The lower limit for the entry of variation is not less than 0.1% and is output such that not more than 1024 measured values are generated (depending on the spacing between start and stop values).	**2.6.4** **ANLR panel** Variation

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Command	Parameter	Basic unit	Meaning	Section
TRIGger**:VOLT**age**:VAR**iation	**<nu>** LL to 900% or LL to 20 dB	PTC	Minimum percentage by which the input voltage must vary for triggering a measurement. LL: The lower limit for the entry of variation is not less than 0.1% or 0,01 dB and is output such that not more than 1024 measured values are generated (depending on the spacing between start and stop values).	**2.6.4** **ANLR panel** Variation

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3.10.2.5 Analyzer Functions

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]**:FUNC**tion	***'OFF'*** ***'RMS'*** ***'RMSS****electiv'* ***'PEAK'*** ***'QREak'*** ***'DC'*** ***'THD'*** ***'THDN****sndr'* ***'MDIS****t'* ***DIM'*** ***'DFD'*** ***'WAF'*** ***'POL****arity'* ***'FFT'*** ***'FILT****ersimulation'* ***'WAV****eform'* *'**COH**erence'* ***'DIGI****npampl'* '***PHAS****etoref'*		→ Function measurement off → RMS measurement **'** → RMS selective measurement → Peak measurement → Quasi-peak measurement → DC measurement → THD measurement → THD+N measurement → MOD DIST measurement → DIM measurement → DFD measurement → Wow & flutter measurement → Polarity measurement → FFT display → Filter simulation → Waveform display → Measurement of transfer function and coherence of two signals, see **2.6.5.16 Coherence Measurement and** Transfer Function → Measurement of digital input amplitude → Measurement of phase between digital input and reference input	**2.6.5** **ANLR panel** FUNCTION → OFF → RMS & S/N → RMS SELECT → REAK & S/N → Q PK & S/N → DC → THD → THD+N/SINAD → MOD DIST → DFD → DIM → WOW & FL → POLARITY → FFT → FILTER SIM. → WAVEFORM → COHERENCE → DIG INP AMP → PHAS TO REF

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3.10.2.5.1 Common Parameters for Analyzer Functions

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**TRIG**ger:**SETTl**ing:**MODE** **SENS**e[1]:**FUNC**tion:**SETTl**ing:**MODE** **SENS**e**3**:**FREQ**uency:**SETT**ling:**MODE** **SENS**e**3**:**PHAS**e:**SETTl**ing:**MODE**	**OFF** **EXP**onential **FLAT** **AVER**age		SENS:TRIG:SETT = settling process for external triggering SENS:FUNC:SETT = settling process for measurement function SENS3:FREQ:SETT = settling process for frequency measurement SENS3:PHAS:SETT = settling process for phase measurement → OFF → Settling with exponential tolerance and resolution characteristic → Settling with tolerance and resolution band → Arithmetic averaging (not for settling with external triggering)	**2.6.5.1** **ANLR panel** Settling → OFF → EXPONENTIAL → FLAT → AVERAGE
SENSe[1]:**TRIG**ger:**SETTl**ing:**COUN**t **SENS**e[1]:**FUNC**tion:**SETTl**ing:**COUN**t **SENS**e**3**:**FREQ**uency:**SETTl**ing:**COUN**t **SENS**e**3**:**PHAS**e:**SETTl**ing:**COUN**t	**<n>** for EXP|FLAT: 2 to 6 for AVER: 2 to 100		Number of test points considered in settling. 3 means that the currently measured value is compared with the two preceding results.	**2.6.5.1** **ANLR panel** Samples
SENSe[1]:**TRIG**ger:**SETTl**ing:**TOL**erance **SENS**e[1]:**FUNC**tion:**SETTl**ing:**TOL**erance **SENS**e**3**:**FREQ**uency:**SETTl**ing:**TOL**erance	**<n>** 0.001 to 10 %	%	Starting value of exponential tolerance characteristic or tolerance band.	**2.6.5.1** **ANLR panel** Tolerance
SENSe[1]:**TRIG**ger:**SETTl**ing:**RES**olution **SENS**e[1]:**FUNC**tion:**SETTl**ing:**RES**olution **SENS**e**3**:**FREQ**uency:**SETTl**ing:**RES**olution **SENS**e**3**:**PHAS**e:**SETTl**ing:**RES**olution	**<nu>** Value range and units are determined by instrument and function see **2.6.5.1**	V FS % dB Hz DEG(°)	Starting value of exponential resolution characteristic or resolution band.	**2.6.5.1** **ANLR panel** Resolution
SENSe[1]:**FUNC**tion:**SETTl**ing:**TOUT** **SENS**e**3**:**FREQ**uency:**SETTl**ing:**TOUT** **SENS**e**3**:**PHAS**e:**SETTl**ing:**TOUT**	**<nu>** 0.001 to 10 s	s	Maximum settling time If no settled measurement result is achieved within this time, the measurement is aborted and an invalid result is signalled.	**2.6.5.1** **ANLR panel** Timeout

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Command	Parameter	Basic unit	Meaning	Section
SYSTem:**SPE**aker:**SOUR**ce	**OFF** **INP1** **INP2** **IN1A**nd2 **FNC1** **FNC2** **FN1A**nd2 **AES1** **AES2** **AE1A**nd2		→ Loudspeaker and headphones output switched off. → Aural monitoring of input signal of analog analyzers A22 and A110 on channel 1. The signal is available at both output channels. → to on channel 2. → ...on both channels (stereo). With channel 1 or 2 selected as analyzer input, only the left or, the right headphones output can be used for monitoring. → Aural monitoring of function output of analog analyzer A22 for all measurement functions (except THD+N) for channel 1. → ... for channel 2. → ... for both channels (stereo). → Aural monitoring of left channel of AES/EBU interface of digital analyzer D48 (Option: Digital Audio Protocol Analysis and Generation UPD-B2). → ... of right channel ... → ... of both channels (stereo) ...	**2.6.7** **ANLR panel** SPEAKER → OFF → INPUT Ch1 → INPUT Ch2 → INPUT Ch1&2 → FUNCT Ch1 → FUNCT Ch2 → FUNCT Ch1&2 → AES Ch1 → AES Ch2 → AES Ch1&2
SYSTem:**SPE**aker:**GAIN**	**<nu>** -120 to 120 dB	dB	Amplification or attenuation of function output.	**2.6.7** **ANLR panel** Pre Gain
SYSTem:**SPE**aker:**VOL**ume	**<nu>** 0 to 100 %	%	Volume of monitor output	**2.6.7** **ANLR panel** Skp Volume
SYSTem:**PHON**e	**SPKC** **PERM**		→ Phones output conforms to loudspeaker setting. → Headphones output permanently switched on.	**2.6.7** **ANLR panel** Phone Out → SPKPhone → PERMANENT
SYSTem:**SPE**aker[:STATe]	**ON** **OFF**		→ Loudspeaker on → Loudspeaker off Command has no effect if option UPD-B5 is not fitted.	**2.6.7** **ANLR panel** LOCAL key

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3.10.2.5.2 RMS Measurement incl. S/N

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]**:FUNC**tion	***"RMS"***		→ RMS measurement	2.6.5.2 **ANLR panel** FUNCTION → RMS & S/N
SENSe[1]:**FUNC**tion:**DCS**uppression	**ON** **OFF**		Suppression of DUT DC in the digital analyzer. → DC not considered; corresponds to AC coupling → DC considered in the measurement and displayed; corresponds to DC coupling	**2.6.5.1** ANLR-Panel DC Suppres → ON → OFF
SENSe[1]**:FUNC**tion**:*SNS**equence***	***ON*** ***OFF***		→ S/N (signal-to-noise) measurement on → S/N (signal- to-noise) measurement off	**2.6.5.1** **ANLR panel** S/N Sequ
SENSe[1][:VOLTage|POWer]:**UNIT**[1|**2**]	**V|DBV|*DBU*|*FS*|DBM|W|*DPCTV*|*DV*|*VVR*|*PCTVVR*|*DPCTW*|*DW*|*PPR*|*PCTPPR*|*PCTFS*|*DBFS*|*DPCT*|*DBR***		Display units for RMS measurement	**2.4** **ANLR panel** Unit Ch1/CH2

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Command	Parameter	Basic unit	Meaning	Section
SENSe[1]**:VOLT**age**:APER**ture**:*MODE***	***AFAS**t* ***AUTO*** ***SFAS**t* ***FAST*** ***SLOW*** ***GENT**rack* ***TRIG**gered* ***VAL**ue*		AFASt and AUTO match the measurement time to the signal frequency by taking the signal period into account. The measurement time is matched as far as possible to the input signal. Maximum algorithmic error: → 1% → 1‰ → 50 ms ⎫ → 200 ms ⎬ fixed integration time → 1000 ms ⎭ → Measurement for (at least) 1 whole period of the generator signal. If required, the generator frequency is matched to the sample frequency of the analyzer. To increase the measurement accuracy at high frequencies, the measurement time may be extended to several periods. Particularly suitable for the measurement of very noisy or distorted signals and for extremely fast sweeps. → A special mode is available for **RMS measurements,** permitting a single **delay-free** measurement with selectable measurement time to be carried out as soon as the signal exceeds a set trigger threshold for the first time. In conjunction with the burst signal generator this measurement mode permits the first period of a signal to be measured and is particularly suitable for echo-free measurements on loudspeakers. → Numerical entry of measurement time. For entry of values see next command.	**2.6.5.2** **ANLR panel** Meas Time → AUTO FAST → AUTO → FIX 50ms → FIX 200ms → FIX 1000ms → GEN TRACK → TRIGGERED → VALUE:
SENSe[1]**:VOLT**age**:APER**ture	**<nu>** 1 ms ... For value range see **2.6.5.2** Meas Time	s	Numerical entry of measurement time. Measurement time for steadying the display.	**2.6.5.2** **ANLR panel** Meas Time

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Command	Parameter	Basic unit	Meaning	Section
SENSe[1][:VOLTage|POWer]**:REF**erence**:MODE**	***CH1S**tore* ***CH2S**tore* ***CH1M**eas* ***CH2M**eas* ***STOR**e* ***VAL**ue*		→ For a two-channel measurement, the current measurement result of channel 1 is stored as a reference. → For a two-channel measurement, the current measurement result of channel 2 is stored as a reference. → The value measured in channel 1 is used as a reference for the output of results in reference-related units. → The value measured in channel 2 is used as a reference for the output of results in reference-related units. → For a single-channel measurement, the current measurement result is stored as a reference. → The reference value is entered using the following command.	**2.6.5.1** **ANLR panel** Reference
SENSe[**1**][:VOLTage|POWer]**:REF**erence	**<nu>** Analog instrument 100 pV to 1000 V Digital instrument 0.0 to 1.0 FS	V FS	Numerical entry of reference value.	**2.6.5.1** **ANLR panel** Reference
SENSe[1]:***NOTCh***[:STATe]	**DB0** **DB12** **DB30** **OFF**		→ Analog notch filter on; no gain → Analog notch filter on; gain 12 dB → Analog notch filter on; gain 30 dB → Analog notch filter off;	**2.6.5.1** **ANLR panel** Anlg. Notch → 0 dB → 12 dB → 30 dB → OFF
SENSe[1]:***NOTCh:FREQ**uency***:MODE	***AUTO*** ***FIX**ed* ***GENT**rack*		→ The notch-filter center frequency tracks the measured frequency. → For numerical entry of notch-filter center frequency see next command. → The notch-filter center frequency tracks the generator frequency.	**2.6.5.1** **ANLR panel** Notch Freq → AUTO → VALUE: → GEN TRACK
SENSe[1]:***NOTCh:FREQ**uency:**FIX**ed*	**<nu>** for analog instr. 10 Hz to 22.5 kHz	HZ	Numerical center frequency of notch filter. For analog instrument only.	**2.6.5.1** **ANLR panel** Notch Freq → VALUE:

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Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FILT**er<i>:.....	<i> 1 to 4		See **3.10.3 Selecting the Analyzer** Filters	**2.7.1 ANLR panel** Filter
CALCulate:**TRAN**sform:**FREQ**uency:**STAT**e	**OFF** **ON**		→ No POST-FFT for the selected measurement function → POST-FFT for selected measurement function: see **2.6.5.13 FFT** with the following settings available: CALCulate:TRANsform:FREQuency:FFT S256 to S8K CALCulate:TRANsform:FREQuency:WINDow RECT to KAIS CALCulate:TRANsform:FREQuency:STARt ? CALCulate:TRANsform:FREQuency:STOP ? CALCulate:TRANsform:FREQuency:RESolution? If the group-delay measurement is selected with command SENSe3:FUNCtion FQGRoupdelay, POST-FFT is always active as the frequency information is obtained from FFT.	**2.6.5.1 ANLR panel** POST FFT → OFF → ON
SENSe[1]:**TRIGger**:**SETTling**:**.....**			For settling commands see **3.10.2.5.1 Common Parameters for** Analyzer Functions	**2.3.4.2 ANLR panel** Fnct Settl

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3.10.2.5.3 Selective RMS Measurement incl. Sweep

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	"***RMSS****electiv***"		Selective RMS measurement	2.6.5.3 **ANLR panel** FUNCTION → RMS SELECT
SENSe[1]:**FUNC**tion:**DCS**uppression	**ON** **OFF**		Suppression of DUT DC in the digital analyzer. → DC not considered; corresponds to AC coupling → DC considered in the measurement and displayed; corresponds to DC coupling	2.6.5.1 ANLR-Panel DC Suppres → ON → OFF
SENSe[1][:VOLTage|POWer]:**UNIT**[1|**2**]	**V|DBV|*DBU*|*FS*|DBM|W|*DPCTV*|*DV*|*VVR*|*PCTVVR*|*DPCTW*|*DW*|*PPR*|*PCTPPR*|*DBR*|*PCTFS*|*DBFS*|*DPCT***		Display units for results of selective RMS measurement	**2.4** **ANLR panel** Unit Ch1/CH2
SENSe[1]:**VOLT**age:**APER**ture**:MODE**	***AFAS****t* ***AUTO*** ***SFAS****t* ***FAST*** ***SLOW*** ***GENT****rack* ***VAL****ue*		AFASt and AUTO: Automatic matching of measurement time to the signal frequency taking the signal period into account. The measurement time is matched as far as possible to the input signal. Maximum algorithmic error → 1%, → 1‰. → 50 ms ⎫ → 200 ms ⎬ fixed integration time → 1000 ms ⎭ → Measurement for (at least) 1 whole period of the generator signal. If required, the generator frequency is matched to the sample frequency of the analyzer. To increase the measurement accuracy at high frequencies, the measurement time may be extended to several periods. Particularly suitable for the measurement of very noisy or distorted signals and for extremely fast sweeps. → Numerical entry of measurement time. For entry of value see next command.	**2.6.5.3** **ANLR panel** Meas Time → AUTO FAST → AUTO → FIX 50ms → FIX 200ms → FIX 1000ms → GEN TRACK → VALUE

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Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**VOLT**age:**APER**ture	**<nu>** 10 µs to 10s	s	Numerical entry of measurement time. Measurement time for steadying the display.	**2.6.5.3** **ANLR panel** Meas Time
SENSe[1]:**BWID**th[**:**RESolution]**:MODE** gleichbedeutend mit **SENS**e[1]:**BAND**wid**t**h[**:**RESolution]**:MODE**	***PPCT1*** ***PPCT3*** ***PTOC**t* ***POCT1**2* ***PFIX*** ***PFAS**t* ***SPCT1*** ***SPCT3*** ***STOC**t* ***SOCT1**2* ***SFIX*** ***SFAS**t*		Bandwidth of bandpass or bandstop of selective RMS filter. Parameter starting with P ... = bandpass S ... = bandstop **PFASt** **SFASt:** Bandstop filter with only 40 dB attenuation, third-octave bandwidth and particularly short settling time.	**2.6.5.3** **ANLR panel** Bandwidth → BP 1% → BP 3 % → BP 1/3 OCT → BP 1/12 OCT → BP FIX: → BP FAST → BS 1% → BS 3 % → BS 1/3 OCT → BS 1/12 OCT → BS FIX: → BS FAST
SENSe[1]:**BWID**th[**:**RESolution] equivalent to **SENS**e[1]:**BAND**width[**:**RESolution]	**<nu>** Value range determined by instrument or function	Hz	Numerical entry of arithmetically symmetrical bandwidth.	**2.6.5.3** **ANLR panel** Bandwidth
SENSe[1][:VOLTage|POWer]:**REF**erence**:MODE**	***CH1S**tore* ***CH2S**tore* ***CH1M**eas* ***CH2M**eas* ***STOR**e* ***VAL**ue*		→ For a two-channel measurement, the current measurement result of channel 1 is stored as a reference. → For a two-channel measurement, the current measurement result of channel 2 is stored as a reference. → The value measured in channel 1 is used as a reference for the output of results in reference-related units. → The value measured in channel 2 is used as a reference for the output of results in reference-related units. → For a single-channel measurement, the current measurement result is stored as a reference. → The reference value is entered using the next command.	**2.6.5.1** **ANLR panel** Reference → STORE CH1 → STORE CH2 → MEAS CH1 → MEAS CH2 → STORE → VALUE:

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Command	Parameter	Basic unit	Meaning	Section
SENSE[1][:VOLTage|POWer]:**REF**erence	**<nu>** Analog instruments 100 pV to 1000 V Digital instrument 0.0 to 1.0 FS	V FS	Numerical entry of reference value.	**2.6.5.1** **ANLR panel** Reference

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Sweep for selective RMS measurement

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FREQ**uency**:MODE**	FIXed | CW SWEep LIST *MULTisine* *GENTrack* *CH1* *CH2*		→ Presetting for fixed frequency of selective RMS measurement. Numerical entry with SENSe[1]:FREQuency[:FIXed|:CW]**<nu>** → Frequency sweep of selective RMS measurement. The sweep parameters are determined by the following user specifications: SENSe[1]:FREQuency:STARt|STOP **<nu>** SENSe[1]:SWEep:SPACing LINear|LOGarithmic SENSe[1]:SWEep:STEP **<nu>** SENSe[1]:SWEep:POINts <n> → List sweep of frequency of selective RMS measurement. The sweep parameters are read from the file specified under MMEMory:LOAD:LIST FREQuency, "filename" For format of block/list files see 2.9.1.3 Format of Block/Listen Data. → The frequency of the selective RMS measurement is set consecutively to the multisine frequencies specified in the generator panel (see 2.5.4.4 MULTISINE). The sweep is similar to a LIST sweep. → The frequency of the selective RMS measurement tracks the current generator frequency. The frequency of the selective RMS measurement tracks the frequency measured in → channel 1 → channel 2.	**2.6.5.3** **ANLR panel** SWEEP CTRL → OFF → AUTO SWEEP MANU SWEEP → AUTO LIST MANU LIST → GEN MLTSINE FREQ MODE → GEN TRACK → FREQ CH1 → FREQ CH2
SENSe:**FREQ**uency:**FACT**or	<nu> MLT 1...20		Factor by which the tracking bandpass filter is higher than the generator frequency with setting GENTRACK (SENS:FREQ:MODE GENT). For analog instruments only.	**2.6.5.3** **ANLR-Panel** FREQ MODE → Factor
SENSe[1]:***NOTCh***[:STATe]	**DB12** **DB30** **DB0** **OFF**		→ Analog notch filter on; gain 12 dB → Analog notch filter on; gain 30 dB → Analog notch filter on; no gain → Analog notch filter off. The notch filter can only be set in the analog instruments when a bandstop filter has been selected for SENS:BWID:MODE.	**2.6.5.1** **ANLR panel** Anlg. Notch → 12 dB Auto → 30 dB Auto → 0 dB → OFF

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Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FILT**er**2**:.....			See **3.10.3 Selecting the Analyzer** Filters Particularly when monitoring weak residual signals amplified by means of Pre Gain, a highpass filter should be used for DC suppression to avoid the signal to be distorted or suppressed altogether. In conjunction with a selective RMS measurement **filter No. 2 must** be selected as filter No. 1 is already used in the UPD as a selective RMS bandpass or bandstop filter. **3.10.3 Selecting the Analyzer** Filters	**2.7.1** **ANLR panel** Filter
SENSe[1]:**FREQ**uency[:FIXed|:CW]	**<nu>** Value range determined by instrument or function	Hz	Numerical entry of frequency for selective RMS measurement.	**2.6.5.3** **ANLR panel** FREQ MODE → FIX
SENSe[1]:**SWE**ep:**MODE**	**AUTO** **MAN**ual		Automatic sweep → This command in conjunction with command SENSe[1]:FREQuency:MODe SWEep sets the AUTO SWEEP mode. → This command in conjunction with command SENSe[1]:FREQuency:MODe SWEep sets the MANU SWEEP mode. Pressing the LOCAL key activates the spinwheel.	**2.6.5.3** **ANLR panel** SWEEP CTRL → AUTO SWEEP → MANU SWEEP
SENSe[1]:**LIST**:**MODE**	**AUTO** **MAN**ual		Automatic list sweep → This command in conjunction with command SENSe[1]:FREQuency:MODe LIST sets the AUTO LIST mode. → This command in conjunction with command SENSe[1]:FREQuency:MODe SWEep sets the MANU LIST mode. Pressing the LOCAL key activates the spinwheel.	**2.6.5.3** **ANLR panel** SWEEP CTRL → AUTO LIST → MANU LIST
SENSe[1]:**FREQ**uency:**STAR**t **SENS**e[1]:**FREQ**uency:**STOP**	**<nu>** Value range determined by instrument or function	Hz	Start and stop frequency for frequency sweep of selective RMS measurement.	**2.6.5.3** **ANLR panel** SWEEP CTRL →Start|Stop

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Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**SWE**ep:**SPAC**ing	**LIN**ear **LOG**arithmic		→ Linear sweep spacing → Logarithmic sweep spacing	**2.6.5.3** **ANLR panel** Spacing → LIN → LOG
SENSe[1]:**SWE**ep:**POIN**ts	**<n>** 2 to 1024		Number of sweep steps. Depending on the selected SPACing (SENSe[1]:SWEep:SPACing LINear|LOGarithmic), the sweep frequency range between STARt and STOP is divided into <n> linear or logarithmic sweep points.	**2.6.5.3** **ANLR panel** Points
SENSe[1]:**SWE**ep:**STEP**	**<nu>|<n>** The selected step size should be so wide that not more than 1023 single steps (= 1024 sweep points) are obtained. It should not exceed the absolute difference between STOP and STARt.	→	Sweep step size Depending on selected SPACing SENSe[1]:SWEep:SPACing LINear|LOGarithmic, the sweep frequency range between STARt and STOP is divided into linear steps in Hz or logarithmic steps in the form of a multiplier. SENSe[1]:SWE:SPAC LIN: Hz SENSe[1]:SWE:SPAC LOG: No unit because of multiplication factor.	**2.6.5.3** **ANLR panel** Steps
MMEMory:**LOAD:*LIST***	**FREQ**uency,**'filenam e'** Query: MMEM:LOAD:LIST? FREQ = path and filename of frequency list for a LIST sweep of a selective RMS measurement, eg "c:\UPD\ref\swpflst.lst "		Loading a frequency list for the list sweep.	**2.6.5.3** **2.9.1.3** **ANLR panel** SWEEP CTRL → Filename

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Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion:**SETT**ling:.....			For settling commands see 3.10.2.5.1 Common Parameters for Analyzer Functions	**2.3.4.2 ANLR panel** Fnct Settl

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3.10.2.5.4 Peak and Quasi-Peak Measurement incl. S/N

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	"***PEAK***"		→ Peak measurement	2.6.5.4 **ANLR panel** FUNCTION →PEAK & S/N
SENSe[1]:**FUNC**tion	"***QPE****ak*"		→ Quasi-peak measurement	2.6.5.4 **ANLR panel** FUNCTION → QPK & S/N
SENSe[1][:VOLTage|POWer]:**UNIT**[1|**2**]	**V|DBV|*DBU*|*FS*|DBM|W|*DPCTV*|*DV*|*VVR*|*PCTVVR*|*DPCTW*|*DW*|*PPR*|*PCTPPR*|*DBR*|*PCTFS*|*DBFS*|*DPCT***		Display units for peak and quasi-peak measurement results.	**2.4** **ANLR panel** Unit Ch1/Ch2
SENSe[1]:**FUNC**tion:***SNS****equence*	**ON** **OFF**		→ S/N (signal-to-noise) measurement on. → S/N (signal-to-noise) measurement off.	**2.6.5.1** **ANLR panel** S/N Sequ → ON → OFF
SENSe[1]:**FUNC**tion:***MMOD****e*	***PPE****ak* ***NPE****ak* ***PTOP****eak* ***PABS****olut*		→ PK+ value → PK- value → Peak-to-peak value → Absolute peak value	**2.6.5.4** **ANLR panel** Meas Mode → PK + → PK - → PK to PK → PK abs

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Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**VOLT**age:***INTV**time*:**MODE**	***SFAS**t* ***FAST*** ***SLOW*** ***FIX**ed* ***VAL**ue*		→ 50 ms → 200 ms monitoring interval for **peak** search → 1000 ms → s monitoring interval for **quasi-peak** search → Numerical entry of interval time. For entry of values see next command.	**2.6.5.4** **ANLR panel** Intv Time → FIX 50ms → FIX 200ms → FIX 1000ms → FIX 3 SEC → VALUE:
SENSe[1]:**VOLT**age:***INTV**time*	**<nu>** 20 ms to 100 s	s	Numerical entry of interval time. Monitoring interval for peak search	**2.6.5.4** **ANLR panel** Intv Time
SENSe[1][:VOLTage|POWer]:**REF**erence**:MODE**	***CH1S**tore* ***CH2S**tore* ***CH1M**eas* ***CH2M**eas* ***STOR**e* ***VAL**ue*		→ For a two-channel measurement, the current measurement result of channel 1 is stored as a reference. → For a two-channel measurement, the current measurement result of channel 2 is stored as a reference. → The value measured of channel 1 is used as a reference for the results in reference-related units. → The value measured of channel 2 is used as a reference for the results in reference-related units. → For a single-channel measurement, the current measurement result is stored as a reference. → The reference value is entered using the next command.	**2.6.5.1** **ANLR panel** Reference → STORE CH1 → STORE CH2 → MEAS CH1 → MEAS CH2 → STORE → VALUE:
SENSE[1][:VOLTage|POWer]**:REF**erence	**<nu>** Analog instrument 100 pV to 1000V Digital instrument 0.0 to 1.0 FS	V FS	Numerical entry of reference value.	**2.6.5.1** **ANLR panel** Reference

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Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:***NOTCh***[:STATe]	**DB0** **DB12** **DB30** **OFF**		→ Analog notch filter on; no gain → Analog notch filter on; gain 12 dB → Analog notch filter on; gain 30 dB → Analog notch filter off;	**2.6.5.1** **ANLR panel** Anlg. Notch → 0 dB → 12 dB → 30 dB → OFF
SENSe[1]:***NOTCh:FREQ****uency*:**MODE**	***AUTO*** ***FIX****ed* ***GENT****rack*		→ Notch filter center frequency tracks the measured frequency. → For numerical entry of notch-filter center frequency see next command. → The center frequency of the notch filter tracks the generator frequency.	**2.6.5.1** **ANLR panel** Notch Freq → AUTO → VALUE: → GEN TRACK
SENSe[1]:***NOTCh:FREQ****uency:FIX****ed*	**<nu>** for analog instr. 10 Hz to 22.5 kHz	Hz	Numerical center frequency of notch filter.	**2.6.5.1** **ANLR panel** Notch Freq → VALUE:
SENSe[1]:**FILT**er<i>:.....	<i> 1 to 4		See **3.10.3 Selecting the Analyzer** Filters	**2.7.1** **ANLR panel** Filter
SENSe[1]:**FUNC**tion:**SETTl**ing:.....			For settling commands see **3.10.2.5.1 Common Parameters for** Analyzer Functions	**2.3.4.2** **ANLR panel** Fnct Settl

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3.10.2.5.5 DC Measurement

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	***"DC"***		→ DC measurement	2.6.5.5 **ANLR panel** FUNCTION → DC
SENSe[1][:VOLTage|POWer]**UNIT**[1|**2**]	**V|DBV|*DBU*|*FS*|DBM|W|*DPCTV*|*DV*|*VVR*|*PCTVVR*|*DPCTW*|*DW*|*PPR*|*PCTPPR*|*DBR*|*PCTFS*|*DBFS*|*DPCT***		Display units for DC measurement results.	**2.4** **ANLR panel** Unit Ch1/Ch2
SENSe[1]:**VOLT**age:**APER**ture**:MODE**	***FAST*** ***VAL**ue*		→ 200 ms integration time for steadying the display. → Numerical entry of integration time. For entry of values see next command.	**2.6.5.5** **ANLR panel** Meas Time → FIX 200ms → VALUE:
SENSe[1]:**VOLT**age:**APER**ture	**<nu>** 100 µs to 1.5 s	s	Numerical entry of measurement time. Measurement time for steadying the display.	**2.6.5.5** **ANLR panel**
SENSe[1][:VOLTage|POWer]**:REF**erence**:MODE**	***CH1S**tore* ***CH2S**tore* ***CH1M**eas* ***CH2M**eas* ***STOR**e* ***VAL**ue*		→ For a two-channel measurement, the current measurement result of channel 1 is stored as a reference. → For a two-channel measurement, the current measurement result of channel 2 is stored as a reference. → The value measured of channel 1 is used as a reference for the results in reference-related units. → The value measured of channel 2 is used as a reference for the results in reference-related units. → For a single-channel measurement, the current measurement result is stored as a reference. → The reference unit is specified by the next command.	**2.6.5.1** **ANLR panel** Reference → STORE CH1 → STORE CH2 → MEAS CH1 → MEAS CH2 → STORE → VALUE:

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Command	Parameter	Basic unit	Meaning	Section
SENSE[1][:VOLTage|POWer]**:REF**erence	**<nu>** Analog instrument - 1000 V to 1000 V	V	Numerical entry of reference value.	**2.6.5.1** **ANLR panel** Reference
SENSe[1]:**FUNC**tion:**SETTl**ing:.....			For settling commands see **3.10.2.5.1 Common Parameters for** Analyzer Functions	**2.3.4.2** **ANLR panel** Fnct Settl

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3.10.2.5.6 THD Measurement

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	**"*THD*"**		THD measurement	2.6.5.6 **ANLR panel** FUNCTION → THD
SENSe[1]:**FUNC**tion:***MMOD***e	***SEL**ectdi* ***LSEL**ectdi* ***DALL*** ***LDAL**l* ***DODD*** ***LDOD**d* ***DEV**en* ***LDEV**en*		→ Any combination of harmonics from d2 to d9 can be set with the → following command. Result in dB Result in V (analog) or FS (digital) → Selection of harmonics to be measured: → All harmonics from d2 to d9 Result in dB Result in V (analog) or FS (digital) → All uneven harmonics: → d3, d5, d7, d9 Result in dB Result in V (analog) or FS (digital) → All even harmonics: → d2, d4, d6, d8 Result in dB Result in V (analog) or FS (digital)	**2.6.5.6** **ANLR panel** Meas Mode → SELECT di → LEV SEL di → All di → LEV All di → All odd di → LEV odd di → All even di → LEV even di
SENSe[1]:**FUNC**tion:***DIST**ortion*	**<n>** *)		Decimal equivalent of integer <n> for any combination of harmonics, eg d2, d4, d6, d9, is desired; binary: 10010101; decimal equivalent <n> = 149	**2.6.5.6** **ANLR panel** → di2468
SENSe[1]:**FUNC**tion:**DMOD**e	**FAST** **PREC**ision		→ Analog notch switched off. → Analog notch switched on when the applied signal is of good quality.	**2.6.5.6** **ANLR panel** Dyn Mode → FAST → PRECISION
SENSe[1]:**UNIT**	**PCT**|**DB**		Display units for results of THD measurements.	**2.4** **ANLR panel** Unit

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Command	Parameter	Basic unit	Meaning	Section
SENSE[1][:VOLTage|POWer]**:REF**erence	**<nu>** Value range determined by instrument or function	V FS	Numerical entry of reference value.	**2.6.5.1** **ANLR panel** Reference
SENSe[1]:**VOLT**age:***FUND**amental*:**MODE**	***AUTO*** ***GENT**rack* ***VAL**ue*		Determining the fundamental frequency: → Automatically by frequency measurement. → Depends on generator frequency → Numerical entry of fundamental frequency. For entry of values see next command.	**2.6.5.6** **ANLR panel** Fundamentl → AUTO → GEN TRACK → VALUE:
SENSe[1]:**VOLT**age:***FUND**amental*	**<nu>** Value range determined by instrument or function	Hz	Numerical entry	**2.6.5.6** **ANLR panel** Fundamentl
SENSe[1]:**FUNC**tion:**SETTl**ing:.....			For settling command see **3.10.2.5.1 Common Parameters for** Analyzer Functions	**2.3.4.2** **ANLR panel** Fnct Settl

Example: di1, di3, di5 and di7
Data word: 10101010
Weighting = 2+8+32+128
Decimal equivalent: =170
*)

MSB							LSB	Data bit
di9	di8	di7	di6	di5	di4	di3	di2	Harmonics
128	64	32	16	8	4	2	1	Weighting

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3.10.2.5.7 THD + N / SINAD Measurement

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	"***THDN****sndr*"		→ THD+N measurement	2.6.5.7 **ANLR panel** FUNCTION →THD+N/SINAD
SENSe[1]:**FUNC**tion:***MMOD****e*	***THDN*** ***LTHD****n* ***SNDR****atio* ***NOIS****e* ***LNO****ise*		Result display as → THD+N value in dB → THD+N RMS value in V (analog) or FS (digital) → SINAD value in negative dB → Same as THD+N but without harmonics weighting, in dB → Same as THD+N RMS value but without harmonics weighting, in V (analog) or FS (digital)	**2.6.5.7** **ANLR panel** Meas Mode → THD+N → LEVEL THD+N → SINAD → NOISE → LEVEL NOISE
SENSe[1]:**FUNC**tion:**DMOD**e	**FAST** **PREC**ision		→ Analog notch filter switched off. → Analog notch filter switched on when the applied signal is of good quality.	**2.6.5.7** **ANLR panel** Dyn Mode → FAST → PRECISION
SENSe[1]:**FUNC**tion:**APER**ture**:MODE**	***SLOW*** ***FAST*** ***SFAS****t*		Selection of measurement speed → Measurement using FFT size 8192 → Measurement using FFT size 2048 → Measurement using FFT size 512	**2.6.5.7** **ANLR-Panel** Meas Time → SLOW → FAST → SUPERFAST
SENSe[1]:***THDN***:***REJ****ection*	***NARR****ow* ***WIDE***		Sets the characteristic of the notch filter in the digital instrument. → The noise is measured close to the carrier. → An two-pole notch filter is additionally taken into account to evaluate attenuated harmonics in the vicinity of the carrier.	**2.6.5.7** **ANLR panel** Rejection → NARROW → WIDE

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Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**UNIT**[]	**PCT**|**DB**		Display units for results of THD+N measurement	**2.4** **ANLR panel** Unit
SENSe[1]:**VOLT**age:***FUND****amental*:**MODE**	***AUTO*** ***GENT****rack* ***VAL****ue*		Determining the fundamental frequency: → Automatically by frequency measurement. → Depending in generator frequency → Numerical entry of fundamental frequency. For entry of values see next command.	**2.6.5.7** **ANLR panel** Fundamentl → AUTO → GEN TRACK → VALUE:
SENSe[1]:**VOLT**age:***FUND****amental*	**<nu>** ANLG22 kHz: 10.0 Hz to 21.9 kHz ANLG 100 kHz: 20.0 Hz to 125 kHz ANLG 300 kHz: 70.0 Hz to 350 kHz DIG 48k Hz: DIG 192 kHz: DIG 768 kHz: 12∗sample freq./(8∗8192) to useful bandwidth	Hz	Numerical entry of fundamental frequency	**2.6.5.7** **ANLR panel** Fundamentl
SENSe[1]:**FILT**er1:.....			See **3.10.3 Selecting the Analyzer** Filters	**2.7.1** **ANLR panel** Fnct Settl
SENSe[1]:**FREQ**uency:***LIMit:LOW****er***	**<nu>** See section 2.6.5.7, FrqLim Low	Hz	Lower band limit for THD+N measurement function	**2.6.5.7** **ANLR panel** → Frq Lim Low
SENSe[1]:**FREQ**uency:***LIMit:UPP****er***	**<nu>** Same as with SENS:VOLT:FUND <nu>	Hz	Upper band limit for THD+N measurement function	**2.6.5.7** **ANLR panel** → Frq Lim Upp

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Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion:**SETTl**ing:.....			For settling commands see **3.10.2.5.1 Common Parameters for** Analyzer Functions	**2.7.1** **ANLR panel** Fnct Settl
CALCulate:**TRAN**sform:**FREQ**uency:**STAT**e	**OFF** **ON**		→ No POST-FFT for selected measurement function → POST-FFT for selected measurement function (see **3.10.2.5.13 FFT**) CALC:TRAN:FREQ:FT S256 to S8K CALC:TRAN:FREQ:WIND RECT to KAIS CALC:TRAN:FREQ:STAR? CALC:TRAN:FREQ:STOP? CALCe:TRAN:FREQ:RES?	**2.6.5.1** **ANLR panel** POST FFT → OFF → ON
CALCulate:**TRAN**sform:**FREQ**uency:***FFT***	***S512*** ***S1K*** ***S2K*** ***S4K*** ***S8K***		FFT size → 512 lines → 1024 lines → 2048 lines → 4096 lines → 8192 lines	**2.6.5.7** **ANLR panel** FFT Size → 512 → 1024 → 2048 → 4096 → 8192

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3.10.2.5.8 MOD DIST

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	"***MDISt***"		MOD-DIST measurement. Measurement with double-sine (similar to SMPTE)	2.6.5.8 **ANLR panel** FUNCTION → MODDIST
SENSe[1]:**FUNC**tion:**DMOD**e	**FAST** **PREC**ision		→ Analog notch filter switched off. → Analog notch filter switched on if the applied signal is of good quality.	**2.6.5.8** **ANLR panel** Dyn Mode → FAST → PRECISION
SENSe[1]:**UNIT**[]	**PCT**|**DB**		Display units for results of MOD-DIST measurement.	**2.4** **ANLR panel** Unit
SENSe[1]:**FUNC**tion:**SETTl**ing:.....			For settling commands see **3.10.2.5.1 Common Parameters for** Analyzer Functions	**2.3.4.2** **ANLR panel** Fnct Settl

3.10.2.5.9 DFD

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	***"DFD"***		→ Difference frequency distortion measurement	2.6.5.10 **ANLR panel** FUNCTION → DFD

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Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion:***MMOD****e***	**D2_268** alias **D2** **D3_268** alias **D3** **D2_118** **D3_118**		→ Measurement and display of 2nd order intermodulation product referred to twice the "upper frequency" (to IEC 268) → Measurement and display of 3rd order intermodulation product referred to twice the "upper frequency" (to IEC 268) → Measurement and display of 2nd order intermodulation product referred to the "upper frequency" (to IEC 118) → Measurement and display of lower 3rd order intermodulation product referred to the "upper frequency" (to IEC 118)	**2.6.5.10** **ANLR panel** Meas Mode → d2 (IEC268) → d3 (IEC268) → d2 (IEC118) → d3 (IEC118)
SENSe[1]:**FUNC**tion:**DMOD**e	**FAST** **PREC**ision		→ Analog notch filter switched off. → Analog notch filter switched on if the applied signal is of good quality.	**2.6.5.10** **ANLR panel** Dyn Mode → FAST → PRECISION
SENSe[1]:**UNIT**[]	**PCT**|**DB**		Display units for results of DFD measurement	**2.4** **ANLR panel** Unit
SENSe[1]:**FUNC**tion:**SETT**ling:.....			For settling commands see **3.10.2.5.1 Common Parameters for** Analyzer Functions	**2.3.4.2** **ANLR panel** Fnct Settl

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3.10.2.4.10 DIM

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	"***DIM***"		DIM measurement	2.6.5.9 **ANLR panel** FUNCTION → DIM
SENSe[1]:**UNIT**[]	**PCT**|**DB**		Display units for results of DIM measurement	**2.4 ANLR panel** Unit
SENSe[1]:**FREQ**uency**:MODE**	**FIXed**|**CW** ***GENT****rack*		→ Setting the reference frequency pair using the following command. → Setting the reference frequency pair using the signal function DIM in the generator.	2.6.5.9 **ANLR panel** FREQ MODE → FIX: → GEN TRACK
SENSe[1]:**FREQ**uency:***SQRS****in***	***DIMA*** ***DIMB***		→ Square = 2.96 kHz, sine = 14 kHz → Square = 3.15 kHz, sine = 15 kHz	2.6.5.9 **ANLR panel** FREQ MODE → 2.96/14kHz → 3.15/15kHz
SENSe[1]:**FUNC**tion:**SETTl**ing:xxxx			Settling commands see **3.10.2.5.1 Common Parameters for** Analyzer Functions	**2.3.4.2 ANLR panel** Fnct Settl

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3.10.2.4.11 Wow & Flutter

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	***"WAF"***		→ Wow & flutter measurement	2.6.5.11 **ANLR panel** FUNCTION → WOW & FL
SENSe[1]:**FUNC**tion:***STAN****dard*	***NAB*** ***JIS*** ***DIN****iec* ***SI05*** ***SI10***		→ W&F acc. to NAB → W&F acc. to JIS → W&F acc. to DIN/IEC → W&F, 2-sigma, 5 s. → W&F, 2-sigma, 10 s	**2.6.5.11** **ANLR panel** Rule → NAB → JIS → DIN/IEC → 2 Sigma 5 s → 2 Sigma 10s
SENSe[1]:**FUNC**tion:***WEIG****hting*	***ON*** ***OFF***		→ W&F weighting filter on → W&F weighting filter off	**2.6.5.11** **ANLR panel** Weighting → ON → OFF
SENSe[1]:**UNIT**[]	**PCT**		No further display unit selectable.	**2.4** **ANLR panel** Unit
CALCulate:**TRAN**sform:**FREQ**uency:**STAT**e	**OFF** **ON**		→ No POST-FFT for selected measurement function → POST-FFT for selected measurement function (see **3.10.2.5.13 FFT**) CALC:TRAN:FREQ:FFT S256 to S8K CALC:TRAN:FREQ:WIND RECT to KAIS CALC:TRAN:FREQ:STAR? CALC:TRAN:FREQ:STOP? CALC:TRAN:FREQ:RES?	**2.6.5.1** **ANLR panel** POST FFT → OFF → ON
SENSe[1]:**FUNC**tion:**SETT**ling:.....			For settling commands see **3.10.2.5.1 Common Parameters for** Analyzer Functions	**2.3.4.2** **ANLR panel** Fnct Settl

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3.10.2.4.12 POLARITY

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	"***POL**arity*"		→ Polarity test of DUT.	2.6.5.12 **ANLR panel** FUNCTION → POLARITY

3.10.2.4.13 FFT

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	"***FFT***"		→ FFT measurement function	**2.6.5.13 ANLR panel** Function → FFT
SENSe[1][:VOLTage|POWer]:**UNIT**[1|**2**]	**V|DBV|*DBU*|*FS*|DBM|W|*DPCTV*|*DV*|*VVR*|*PCTVVR*|*DPCTW*|*DW*|*PPR*|*PCTPPR*|*PCTFS*|*DBFS*|*DPCT*|*DBR***		Display unit for results of RMS measurement	**2.4 ANLR panel** Unit Ch1/Ch2

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Command	Parameter	Basic unit	Meaning	Section
SENSe[1][:VOLTage|POWer]**:REF**erence**:MODE**	***CH1S**tore* ***CH2S**tore* ***CH1M**eas* ***CH2M**eas* ***STOR**e* ***VAL**ue*		→ For a two-channel measurement, the current measurement result of channel 1 is stored as a reference. → For a two-channel measurement, the current measurement result of channel 2 is stored as a reference. → The value measured of channel 1 is used as a reference for the output of results in reference-related units. → The value measured of channel 2 is used as a reference for the output of results in reference-related units. → For a single-channel measurement, the current measurement result is stored as a reference. → The reference value is entered using the next command.	**2.6.5.1** **ANLR panel** Reference → STORE CH1 → STORE CH2 → MEAS CH1 → MEAS CH2 → STORE → VALUE:
SENSe[**1**][:VOLTage|POWer]**:REF**erence	**<nu>** Value range determined by instrument or function	V FS	Numerical entry of reference value.	**2.6.5.1** **ANLR panel** Reference
SENSe[1]:***NOTCh***[:STATe]	**DB12** **DB30** **DB0** **OFF**		→ Analog notch filter on; gain 12 dB → Analog notch filter on; gain 30 dB → Analog notch filter on; no gain → Analog notch filter off;	**2.6.5.1** **ANLR panel** Anlg. Notch → 0 dB → 12 dB → 30 dB → OFF
SENSe[1]:***NOTCh*:*FREQuency*:MODE	***AUTO*** ***FIXed*** ***GENTrack***		→ Notch filter center frequency tracks the measured frequency. → For numerical entry of notch-filter center frequency see next command. → Center frequency of notch filter tracks the generator frequency.	**2.6.5.1** **ANLR panel** Notch Freq → AUTO → VALUE: → GEN TRACK
SENSe[1]:***NOTCh*:*FREQuency*:***FIXed***	**<nu>** Value range determined by instrument or function	HZ	Numerical entry of notch-filter center frequency.	**2.6.5.1** **ANLR panel** Notch Freq → VALUE:

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Command	Parameter	Basic unit	Meaning	Section
CALCulate:**TRAN**sform:**FREQ**uency :***FFT***	***S256*** ***S512*** ***S1K*** ***S2K*** ***S4K*** ***S8K***		FFT size → 256 lines → 512 lines → 1024 lines → 2048 lines → 4096 lines → 8192 lines	**2.6.5.13** **ANLR panel** FFT Size → 256 → 512 → 1024 → 2048 → 4096 → 8192
CALCulate:**TRAN**sform:**FREQ**uency***AVER****age*	**<n>** 1 to 256		Number of averaging procedures for optimum noise suppression.	**2.6.5.13** **ANLR panel** Average
CALCulate:**TRAN**sform:**FREQ**uency**:AVER**age:**TCON**trol	**NORM**al **EXP**onential		→ The specified number of FFTs is performed, intermediate results are added and then divided by this number. → Averaging is performed continuously.	**2.6.5.13** **ANLR panel** Avg Mode → NORMAL → EXPONENTIAL
CALCulate:**TRAN**sform:**FREQ**uency:**STAR**t**?** **CALC**ulate:**TRAN**sform:**FREQ**uency:**STOP?**	**<nu>** Query only		Queries the beginning and end of FFT, depending on CENTer and SPAN. The response is **<nu>** in Hz.	**2.6.5.13** **ANLR panel** Start / Stop
CALCulate:**TRAN**sform:**FREQ**uency:**CENT**er	**<nu>** Value range determined by instrument or function	Hz	Center frequency for FFT calculation	**2.6.5.13** **ANLR panel** Center
CALCulate:**TRAN**sform:**FREQ**uency:***ZOOM***	**<n>** = 1 **<n>** for instr. A22 a. D48 = 2,4,8 to 256 A100 a. A300 2,4,8,16 D192 a. D768=2,4,8		Zoom FFT off (standard FFT) FFT zoom factor Contrary to the manual mode, the zoom factor instead of the SPAN is entered in the IEC/IEEE-bus mode. The SPAN being a function of the zoom factor it can be determined by the following query.	**2.6.5.13** **ANLR panel** Zoom-FFT

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Command	Parameter	Basic unit	Meaning	Section
CALCulate:**TRAN**sform:**FREQ**uency:**SPAN?**	**<nu>** Query only		Queries the frequency range around the center frequency as a function of the zoom factor. The response is **<nu>** in Hz. Contrary to the manual mode, SPAN can only be read in but not entered in the IEC/IEEE-bus mode. The SPAN value can be changed by changing the zoom factor and modifying the sampling frequency and the oversampling factor.	**2.6.5.13** **ANLR panel** Span
CALCulate:**TRAN**sform:**FREQ**uency:***RES**olution***?**	**<nu>** Query only		Queries the frequency resolution of FFT, depending on CENTer and SPAN. The response is **<nu>** in Hz.	**2.6.5.13** **ANLR panel** Resolution
CALCulate:**TRAN**sform:**FREQ**uency:***MTIM**e***?**	**<nu>** Query only		Queries the measurement time of FFT, depending on FFT size. The response is **<nu>** in s.	**2.6.5.13** **ANLR panel** Meas Time
CALCulate:**TRAN**sform:**FREQ**uency:**WIND**ow	**RECT**angular **HANN**ing ***BLAC**kman_harris* ***RIF1*** ***RIF2*** ***RIF3*** **HAMM**ing **FLAT**top ***KAIS**er*		→ Fast and frequency-accurate → High spectral resolution, wide, bell-shaped curve → Steep slope of bell lobe → Excellent suppression of distant interference → Excellent suppression of distant interference → Excellent suppression of distant interference → Implemented for the sake of completeness → Amplitude read from graphic diagram → Characteristics determined by ß factor	**2.6.5.13** **ANLR panel** Window → RECTANG... → HANN → BLACKMAN H → RIFE VINC 1 → RIFE VINC 2 → RIFE VINC 3 → HAMMING → FLAT TOP → KAISER
CALCulate:**TRAN**sform:**FREQ**uency:**WIND**ow:***BETA**factor*	**<n>** = 1 to 20	no Unit	ß factor for KAISer window	**2.6.5.13** **ANLR panel** ß-Factor

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3.10.2.4.14 Filtersimulation

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	**'FILT**ersim**'**		→ Display of total frequency response using SENS:FILT... Filters to be selected on the UPD display, eg SENS:FILT:AWE ON SESN:FILT2:UFIL5 ON SENS:FUNC 'FILT' IEC LAD 20 IEC GTL	**2.6.5.14** **ANLR panel** Function → FILTER SIM.
SENSe[1][:VOLTagePOWer]**:UNIT**[1|**2**]	**PCT** **DB** See section **3.10.4** **Units for IEC** Measurement Results		Unit of Y axis for the display of curves for filters selected with the subsequent command	**2.4** **ANLR panel** Unit Ch1/Ch2
SENSe[1]:**FILT**er**<i>**:.....	**<i>** 1 to 3		See section **3.10.3 Selecting the Analyzer** Filters	**2.7.1** **ANLR panel** Filter

3.10.2.4.15 WAVEFORM

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	**"WAV**eform**"**		→ Waveform display of applied signal	**2.6.5** **ANLR panel** Function → WAVEFORM

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Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion:***MMOD**e*	***STAN**dard* ***ENH**anced* ***COMP**ressed* ***USAM**pl*		→ Standard display of samples, max. trace length is 7488 samples. Interpolation can be switched on. → Trace length up to 64k samples, however only one curve is possible. Interpolation cannot be switched on. → To allow measurements over longer periods of time only peaks are displayed. With command SENSe:WAVeform:COMPression <n> (see below) the number of peak-weighted samples is determined. Available only for instruments A22 and D48. Interpolation cannot be switched on. → Undersampling of signal to record longer periods; the number of samples specified under "SENS:WAV:COMP" is arithmetically combined (without detection).	**2.6.5.15** **ANLR panel** Meas Mode → STANDARD → ENHANCED → COMPRESSED → UNDERSAMP
SENSe[1]:***WAV**eform**:COMP**ression*	**<n>** 2 to 1024		Number of peak-weighted samples of WAVeform mode SENSe:FUNCtion:MMODe COMPressed.	**2.6.5.15** **ANLR panel** Comp Fact
SENSe[1][:VOLTage|POWer]:**UNIT**[1|**2**]	**V|DBV|*DBU*|*FS*|DBM|W|*DPCTV*|*DV*|*VVR*|*PCTVVR*|*DPCTW*|*DW*|*PPR*|*PCTPPR*|*DBR*|*PCTFS*| *DPCT*|*LSBs***		Display unit for results of DC measurement.	**2.4** **ANLR panel** Unit
SENSE[1][:VOLTage|POWer]**:REF**erence	**<nu>** Analog instrument - 1000 V to 1000 V Digital instrument - 1 kFS to 1 kFS	V FS	Numerical entry of reference value.	**2.6.5.1** **ANLR panel** Reference
TRIGger:**LEV**el	**<nu>** Analog instruments -50V to 50V Digital instrument -1FS to 1FS	V FS	Sets the voltage for the trigger threshold.	**2.6.5.15** **ANLR panel** Trig Level

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Command	Parameter	Basic unit	Meaning	Section
TRIGger**:SLOP**e	**POS**itive alias **RIS**ing **NEG**ative alias **FALL**ing		Sets the trigger edge.	**2.6.5.15** **ANLR panel** Trig Slope → RISING → FALLING
SENSe[1]:**SMO**othing**:APER**ture	**N1** **N2** **N4** **N8** **N16** **N32**		Selects the interpolation stages for smoothing the display of the traced waveform. N1 to N32 = factor 1 to 32	**2.6.5.15** **ANLR panel** Interpol → 1 → 2 → 4 → 8 → 16 → 32
SENSe[1]:***WAV**eform**:DUR**ation*	**<nu>** see **2.6.5.15** **WAVEFORM**	s	Sets the period for which the signal is traced. The max. settable Trace Len is a function of the sampling rate and the interpolation value.	**2.6.5.15** **ANLR panel** Trace Len

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3.10.2.4.16 Coherence Measurement (COHERENCE)

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	"***COHE**rence*"		Coherence and transfer function Condition: • Analog instrument 22 kHz (INST2 A22) • Two-channel measurement (INP:SEL CH1A|CH2I|CH1I) • High-speed option required • Output of digital generator (INST D48) must not be set to AES/EBU|S/P DIF|OPTICAL (not OUTP:TYPE AES|SPD|OPT)	**2.6.5.16** **ANLR panel** FUNCTION → COHERENCE
SENSe[1][:VOLTage|POWer]**:UNIT**[1]	***PCT*** ***DB***		Unit for result display of transfer function (ratio channel2/channel1) obtained in the COHERENCE measurement provided TRACE B is selected with DISP:TRAC2:FEED 'SENS:DATA2'.	**2.6.5.16** **ANLR panel** Unit Ch2
CALCulate:**TRAN**sform:**FREQ**uency:***FFT***	***S256*** ***S512*** ***S1K*** ***S2K*** ***S4K*** ***S8K***		FFT sizes → 256 lines → 512 lines → 1024 lines → 2048 lines → 4096 lines → 8192 lines	**2.6.5.16** **ANLR panel** FFT Size → 256 → 512 → 1024 → 2048 → 4096 → 8192
CALCulate:**TRAN**sform:**FREQ**uency:**WIND**ow	**RECT**angular **HANN**ing ***BLAC**kman_harris* ***RIF1*** ***RIF2*** ***RIF3*** **HAMM**ing **FLAT**top ***KAIS**er*		→ Fast and frequency-accurate → High selectivity, wide bell → Steep bell slope → Excellent suppression of far-off interference → Excellent suppression of far-off interference → Excellent suppression of far-off interference → For reasons of completeness → Amplitude readable from graphics display → Characteristics determined by ß factor	**2.6.5.16** **ANLR panel** Window → RECTANG... → HANN → BLACKMAN H → RIFE VINC 1 → RIFE VINC 2 → RIFE VINC 3 → HAMMING → FLAT TOP → KAISER

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Command	Parameter	Basic unit	Meaning	Section
CALCulate:**TRAN**sform:**FREQ**uency:**WIND**ow:***BETA****fact* *o*	**<n>** 1 to 20	No unit	ß factor for KAISer window	**2.6.5.16** **ANLR panel** ß-Factor
CALCulate:**TRAN**sform:**FREQ**uency:***AVER****age*	**<n>** 2 to 2048		Number of averaging procedures to increase the accuracy of the coherence measurement.	**2.6.5.16** **ANLR panel** Average
CALCulate:**TRAN**sform:**FREQ**uency:**STAR**t**?** **CALC**ulate:**TRAN**sform:**FREQ**uency:**STOP?**	**<nu>** Query only		Query for beginning and end of FFT, depending on CENTer and SPAN. Return of **<nu>** in Hz.	**2.6.5.16** **ANLR panel** Start / Stop
CALCulate:**TRAN**sform:**FREQ**uency:***RES****olution***	**<nu>** Query only		Query for frequency resolution of FFT, depending on CENTer and SPAN. Return of **<nu>** in Hz.	**2.6.5.16** **ANLR panel** Resolution

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3.10.2.4.17 Input Level of Digital Signal (DIG INP AMP)

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	*'**DIGI**npampl'*		Measurement of digital input amplitude (physical level) at the AES/EBU or S/P DIF interface. Available only with instrument DIG 48kHz (INST2 D48), measurement mode COMMON/INP (SENS:DIG:FEED CINP) and built-in jitter option (UPD-B22).	**2.6.5.17** **ANLR panel** FUNCTION → DIG INP AMP
SENSe[1]**:VOLT**age**:APER**ture**:MODE**	***FAST*** ***VAL**ue*		By selecting a long integration time, interfering pulses can be eliminated through averaging to reduce their effect on the measurement result. → Measurement time 200 ms → Numerical entry of measurement time with the following command.	**2.6.5.17** **ANLR panel** Meas Time → FIX 200ms → VALUE:
SENSe[1]**:VOLT**age**:APER**ture	**<nu>** Value range: 100 µs to 1.5 s	s	Numerical entry of measurement time.	**2.6.5.17** **ANLR panel** Meas Time
SENSe[1]:**UNIT**[]	**V|DBV|DBU|DBM|W|DPCTV|DV|VVR|PCTVVR|DPCTW|DW|PPR|PCTPPR|DBR**		Unit for result display of digital input amplitude.	**2.6.5.17** **ANLR panel** Unit
SENSe[1][:VOLTage|POWer]**:REF**erence**:MODE**	***VAL**ue* ***STOR**e* ***GENT**rack*		Reference value for result display in relative units provided a referenced unit is selected. → Reference value specified with the following command. → The current measurement result is stored as reference value. → The currently valid and each newly set generator voltage is stored as reference value.	**2.6.5.1** **ANLR panel** Reference
SENSe[**1**][:VOLTage|POWer]**:REF**erence	**<nu>** 100 pV to 1000 V	V	Numerical entry of reference value.	**2.6.5.1** **ANLR panel**

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3.10.2.4.18 Phase Measurement (PHAS TO REF)

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	'***PHAS****etoref* '		Phase measurement between selected digital input and reference input (REF IN) at the instrument rear. Available only with instrument DIG 48kHz (INST2 D48), measurement mode JITTER/PHAS (SENS:DIG:FEED JPH) and built-in jitter option (UPD-B22).	**2.6.5.18** **ANLR panel** FUNCTION → PHAS TO REF
SENSe[1]**:VOLT**age**:APER**ture**:MODE**	***FAST*** ***VAL****ue*		By selecting a long integration time, interfering pulses can be eliminated through averaging to reduce their effect on the measurement result. → Measurement time 200 ms → Numerical input of measurement time with the subsequent command.	**2.6.5.18** **ANLR panel** Meas Time → FIX 200ms → VALUE:
SENSe[1]**:VOLT**age**:APER**ture	**<nu>** Wertebereich: 100 µs .. 1.5 s	s	Numerical entry of measurement time.	**2.6.5.18** **ANLR panel** Meas Time
SENSe[1]:**UNIT**[]	**UI**|**PCTFRM**|**DEGFRM**|**NS**		Unit for result display of phase.	**2.6.5.18** **ANLR panel** Unit

3.10.2.4.19 Input Disp

Command	Parameter	Basic unit	Meaning	Section
SENSe**2**:**FUNC**tion	**"OFF"** **"PEAK**voltage" "**RMS**"		→ Input peak measurement off → Input peak measurement on → Input RMS measurement for THD and THD+N functions.	**2.6.5.19** **ANLR panel** INPUT DISP → OFF → PEAK → RMS

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Command	Parameter	Basic unit	Meaning	Section
SENSe**2**[:VOLTage|POWer]:**UNIT**[1|**2**]	**V**|**DBV**|**DBU**|***FS***|**HEX**|**DBM**|**W**|***DPCTV***|***DV***|***VVR***|***PCTVVR***|***DPCTW***|***DW***|***PPR***|***PCTPPR***|***DBR***|***PCTFS***|***DBFS***|***DPC*T**		Display units for results of input peak measurement.	**2.4** **ANLR panel** Unit Ch1/Ch2
SENSe**2**:**VOLT**age:**REF**erence**:MODE**	***CH1****Store* ***CH2****Store* ***STOR****e* ***CH1M****eas* ***CH2M****eas* ***GENT****rack* ***VAL****ue*		→ For a two-channel measurement, the current measurement result of channel 1 is stored as a reference. → For a two-channel measurement, the current measurement result of channel 2 is stored as a reference. → The value measured of channel 1 is used as a reference for the results in reference-related units. → The value measured of channel 2 is used as a reference for the results in reference-related units. → For a single-channel measurement, the current measurement result is stored as a reference. → The currently set generator output level is used as a reference. → The reference value is entered using the next command.	**2.6.5.1** **ANLR panel** Reference → STORE CH1 → STORE CH2 → MEAS CH1 → MEAS CH2 → STORE → GEN TRACK → VALUE:
SENSe**2**:**VOLT**age:**REF**erence	**<nu>** Analog instrument 1µV to 1000V Digital instrument 0.0 to 1.0 FS	V FS	Numerical entry of reference value.	**2.6.5.1** **ANLR panel** Reference

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3.10.2.4.20 Frequency Measurement

Command	Parameter	Basic unit	Meaning	Section
SENSe3:**FUNC**tion	**"OFF"** **"FREQ**uency"		→ Frequency measurement off → Frequency measurement on	**2.6.5.20** **ANLR panel** FREQ/PHAS → OFF → FREQ
SENSe3:**FREQ**uency:**UNIT**[1|**2**]	**HZ**|**DHZ**|**DPCTHZ**| **TOCT**|**OCT**|**DEC**| **F**|**FR**		Display units for results of frequency measurement.	**2.4** **ANLR panel** Unit Ch1/Ch2
SENSe3:**FREQ**uency:**APER**ture**:MODE**	***SFAS**t* ***FAST*** ***SLOW*** ***VAL**ue*		→ 50 ms → 200 ms Minimum frequency-measurement time → 1000 ms → Numerical entry of measuring time; for entry of values see next command;	**2.6.5.20** **ANLR panel** Meas Time → FIX 50ms → FIX 200ms → FIX 1000ms → VALUE:
SENSe3:**FREQ**uency:**APER**ture	<**nu**> 1 msto 10 s	s	Numerical entry of measurement time	**2.6.5.20** **ANLR panel**
SENSe3:**FREQ**uency:**REF**erence**:MODE**	***CH1S**tore* ***CH2S**tore* ***CH1M**eas* ***CH2M**ea* ***STOR**e* ***GENT**rack* ***VAL**ue*		→ For a two-channel measurement, the current measurement result of channel 1 is stored as a reference. → For a two-channel measurement, the current measurement result of channel 2 is stored as a reference. → The value measured of channel 1 is used as a reference for the output of results in reference-related units. → The value measured of channel 2 is used as a reference for the output of results in reference-related units. → For a single-channel measurement, the current measurement result is stored as a reference. → The currently set generator output level is used as a reference. → The reference value is entered using the next command.	**2.6.5.20** **ANLR panel** Ref Freq → STORE CH1 → STORE CH2 → MEAS CH1 → MEAS CH2 → STORE → GEN TRACK → VALUE:

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Command	Parameter	Basic unit	Meaning	Section
SENSe**3**:**FREQ**uency:**REF**erence	**<nu>** - 1 MHz to 1 MHz	Hz	Numerical entry of reference value.	**2.6.5.20** **ANLR panel** Ref Freq
SENSe**3**:**FREQ**uency:**SETT**ling:.....			For settling commands see **3.10.2.5.1 Common Parameters for** Analyzer Functions	**2.3.4.2** **ANLR panel** Freq Settl

3.10.2.4.21 Combined Frequency- Phase- and Group Delay-Measurement

Combined Frequency- and Phase-Measurement

Command	Parameter	Basic unit	Meaning	Section
SENSe**3**:**FUNC**tion	"**OFF"** **"FQPH**ase"		→ Combined frequency and phase measurement off. → Combined frequency and phase measurement on.	2.6.5.21 **ANLR panel** FREQ/PHASE → OFF → FREQ&PHASE
SENSe**3**:**FREQ**uency:**UNIT**[1]	**HZ**|**DHZ**|**DPCTHZ**| **TOCT**|**OCT**|**DEC**| **FFR**		Display units for results of frequency measurement.	**2.4** **ANLR panel** Unit Ch1
SENSe**3**:**PHAS**e:**UNIT2**	**DEG**|**RAD**|**DDEG**| **DRAD**|		Display units for results of phase measurement.	**2.4** **ANLR panel** Unit Ch2

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Command	Parameter	Basic unit	Meaning	Section
SENSe**3**:**FREQ**uency:**REF**erence**:MODE**	***STOR****e* ***VAL****ue* ***GENT****rack*		→ The current frequency measurement result is stored as reference value. → The reference value is entered using the following command. → The currently set generator frequency is used as a reference.	**2.6.5.1** **ANLR panel** Ref Freq → STORE → VALUE: → GEN TRACK
SENSe**3:FREQ**uency:**REF**erence	**<nu>** - 1 MHz to 1 MHz	Hz	Numerical entry of reference value.	**2.6.5.1** **ANLR panel** Reference
SENSe**3**:***PHAS****e*:***FORM***at	***POS****itive* ***POSN****egative* ***NEG****ative* ***RAD*** ***RADB****ipolar* ***RADN****egative*		Display format for phase measurement → 0 to 360° → - 180° to -180° → - 360° to 0 ° → 0 to 2 π → - π to + π → -2 π to 0	2.6.5.21 **ANLR panel** Format Pha → 0 .. 360° → -180° .. 180° → - 360° .. 0° → 0 .. 2 π → - π .. + π → -2 π .. 0
SENSe**3**:***PHAS****e*:**REF**erence**:MODE**	***STOR****e* ***VAL***ue		→ The current phase measurement result is stored as a reference value. → The reference value is entered using the following command.	**2.6.5.1** **ANLR-Panel** Reference → STORE → VALUE:
SENSe**3**:***PHAS****e*:**REF**erence	**<nu>** -360° to +360°.	DEG	Numerical entry of reference value.	**2.6.5.1** **ANLR-Panel** Reference
SENSe**3**:**FREQ**uency:**SETTl**ing:.....			For settling commands see **3.10.2.5.1 Common Parameters for** Analyzer Functions	**2.3.4.2** **ANLR-Panel** Freq Settl

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Command	Parameter	Basic unit	Meaning	Section
SENSe**3**:***PHAS****e*:**SETTl**ing:.....			For settling commands see **3.10.2.5.1 Common Parameters for** Analyzer Functions	**2.3.4.2 ANLR-Panel** Phas Settl

Combined Frequency- and Group-Delay-Measurement

Command	Parameter	Basic unit	Meaning	Section
SENSe**3**:**FUNC**tion	"**OFF**" "**FQGR**oupdelay"		→ Combined frequency and group-delay measurement off → Combined frequency and group-delay measurement on. With RSM measurements, POST-FFT is automatically switched on as the frequency information is obtained from FFT.	2.6.5.21 **ANLR panel** FREQ/PHASE → FREQ&GRPDEL
SENSe**3**:**FREQ**uency:**UNIT**[1]	**HZ**|**DHZ**|**DPCTHZ**| **TOCT**|**OCT**|**DEC**| **FFR**		Display units for results of frequency measurement	**2.4 ANLR panel** Unit Ch1
SENSe**3**:**PHAS**e:**UNIT2**	**S** **DS** **DEG** **RAD**		Display units for results of group-delay measurement ***Note****:* *If DEG or RAD is selected, the continuous phase (beyond ±360°) is determined.*	2.6.5.21 **ANLR panel** Unit Ch2
SENSe**3**:**FREQ**uency:**REF**erence**:MODE**	***STOR****e* ***VAL****ue* ***GENT****rack*		→ The current frequency measurement result is stored as reference value. → The reference value is entered using the following command. → The currently set generator frequency is used as a reference value.	**2.6.5.1 ANLR panel** Ref Freq → STORE → VALUE: → GEN TRACK
SENSe**3:FREQ**uency:**REF**erence	**<nu>** -1 MHz to 1 MHz	Hz	Numerical entry of reference value.	**2.6.5.1 ANLR panel** Ref Freq

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Command	Parameter	Basic unit	Meaning	Section
SENSe3:***PHAS***e**:REF**erence**:MODE**	***STOR***e ***VAL***ue		→ The current phase measurement result is stored as reference value. → The reference value is entered using the following command.	**2.6.5.1** **ANLR panel** Ref Phase → STORe → VALUE:
SENSe3:***PHAS***e**:REF**erence	**<nu>** -360 s to +360 s	s	Numerical entry of reference value	**2.6.5.1** **ANLR panel** Ref Phase
SENSe3:**FREQ**uency:**SETTL**ing:.....			For settling commands see **3.10.2.5.1 Common Parameters for** Analyzer Functions	**2.3.4.2** **ANLR panel** Freq Settl

3.10.2.4.22 Measurement of Analyzer Sampling Frequency

Command	Parameter	Basic unit	Meaning	Section
SENSe3:**FUNC**tion	'**OFF'** **'SFRE**quency'		→ Off → Sampling frequency on switched-on channels Available for all digital analyzer instruments	2.6.5.22 **ANLR panel** FREQUENCY → SAMPLE FREQ
SENSe3:**FREQ**uency:**UNIT**[1]	**HZ**|**DHZ**|**DPCTHZ**| **TOCT**|**OCT**|**DEC**| **FFR**		Display units for results of frequency measurement	**2.4** **ANLR panel** Unit Ch1
SENSe3:**FREQ**uency:**UNIT2**	**HZ**|**DHZ**|**DPCTHZ**| **TOCT**|**OCT**|**DEC**| **FFR**		Display units for results of frequency measurement	**2.4** **ANLR panel** Unit Ch2

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Command	Parameter	Basic unit	Meaning	Section
SENSe**3**:**FREQ**uency:**REF**erence**:MODE**	***CH1S**tore* ***CH2S**tore* ***STOR**e* ***CH1M**eas* ***CH2M**eas* ***GENT**rack* ***VAL**ue*		→ With dual-channel measurements, the current result of channel 1 is stored as reference value. → With dual-channel measurements, the current result of channel 2 is stored as reference value. → With single-channel measurements, the current measurement result is stored as reference value. → The measurement result of channel 1 is used as a reference for result output with relative units. → The measurement result of channel 2 is used as a reference for result output with relative units. → The currently set generator frequency is used as reference value. → The reference value is entered using the following command.	**2.6.5.20** **ANLR panel** Ref Freq → STORE CH1 → STORE Ch2 → STORE → MEAS CH1 → MEAS CH2 → GEN TRACK → VALUE:
SENSe**3:FREQ**uency:**REF**erence	**<nu>** -1 MHz to 1 MHz	Hz	Numerical entry of reference value.	**2.6.5.1** **ANLR panel** Ref Freq
SENSe**3**:**FREQ**uency:**SETTl**ing:.....			For settling commands see section **3.10.2.5.1 Common Parameters for** Analyzer Functions	**2.3.4.2** **ANLR panel** Freq Settl

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3.10.2.4.23 Monitor

Command	Parameter	Basic unit	Meaning	Section
SYSTem:***MON****itor*:**STAT**e	**ON** **OFF**		→ Analog headphones input on → Analog headphones input off	2.6.6 Monitor → ON → OFF
SYSTem:***MON****itor:****ATT****enuation***	<**nu**> 0 to 70 dB	dB	Attenuation for analog headphones input 70 dB = max. attenuation	2.6.6 Attenuat.

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3.10.3 Selection of Analyzer Filter

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FILT**er<i>	<**i**>*) 1 to 4 **OFF**		Switches off the filter in the analyzer measurement functions RMS, PEAK, QPE or THD+N.	**2.7.1** **FILTER panel** Filter
SENSe[1]:**FILT**er<i>:***UFIL**ter1*...:***UFIL**ter9*[:STATe]	<**i**>*) 1 to 4 **ON**|**OFF**		A HPASs, LPASs, BPASs, BSTOp, NOTCh, TERZ, OCTav or FILE filter with freely selectable parameters (see SENSe:FILTer<n>:HPASs|:LPASs to and subsequent commands) can be assigned to each of the 9 user filters (UFILter). When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.1** **FILTER panel** Filter
SENSe[1]:**FILT**er<i>:**CCIT**t[:STATe]	<**i**>*) 1 to 4 **ON**|**OFF**		For psophometric measurements When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.1** **FILTER panel** Filter → CCITT
SENSe[1]:**FILT**er<i>:***CCIU**nweight*[:STATe]	<**i**>*) 1 to 4 **ON**|**OFF**		Bandpass filter 20 Hz to 20 kHz When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.1** **FILTER panel** Filter → CCIR unwtd
SENSe[1]:**FILT**er<i>:**CCIR**[:STATe]	<**i**>*) 1 to 4 **ON**|**OFF**		For RFI voltage measurements When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.1** **FILTER panel** Filter → CCIR wtd
SENSe[1]:**FILT**er<i>:**AWE**ighting[:STATe]	<**i**>*) 1 to 4 **ON**|**OFF**		For RFI voltage measurements When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.1** **FILTER panel** Filter → A Weighting
SENSe[1]:**FILT**er<i>:**CMES**sage[:STATe]	<**i**>*) 1 to 4 **ON**|**OFF**		For transmission measurements When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.1** **FILTER panel** Filter → C MESSAGE

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Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FILT**er<i>:***DEMP**hasis**50***[:STATe]	<i>*) 1 to 4 **ON**|**OFF**		For unweighted and weighted noise measurements When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.1** **FILTER panel** Filter → DEEMPH 50
SENSe[1]:**FILT**er<i>:***DEMP**hasis**75***[:STATe]	<i>*) 1 to 4 **ON**|**OFF**		For unweighted and weighted noise measurements When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.1** **FILTER panel** Filter → DEEMPH 75
SENSe[1]:**FILT**er<i>:***DEMP**hasis**17***[:STATe]	<i>*) 1 to 4 **ON**|**OFF**		For unweighted and weighted noise measurements When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.1** **FILTER panel** Filter → DEEMPH J.17
SENSe[1]:**FILT**er<i>:***DEMP**hasis**5015***[:STATe]	<i>*) 1 to 4 **ON**|**OFF**		For unweighted and weighted noise measurements When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.1** **FILTER panel** Filter → DEEM 50/15
SENSe[1]:**FILT**er<i>:***WRUM**ble*[:STATe]	<i>*) 1 to 4 **ON**|**OFF**		Weighted noise measurement for testing tape recorders When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.1** **FILTER panel** Filter → RUMBLE wtd
SENSe[1]:**FILT**er<i>:***URUM**ble*[:STATe]	<i>*) 1 to 4 **ON**|**OFF**		Unweighted noise measurement for testing tape recorders When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.1** **FILTER panel** Filter → RUMBLE unw
SENSe[1]:**FILT**er<i>:***DCN**oise* [:STATe]	<i>*) 1 to 4 **ON**|**OFF**		Highpass filter for measuring the DC noise When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.1** **FILTER panel** Filter → DC NOISE HP

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Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FILT**er<i>:***CARM***[:STATe]	<i>*) 1 to 4 **ON**|**OFF**		Filter for weighted noise measurements in line with older regulations. When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.1** **FILTER panel** Filter → CCIR ARM
SENSe[1]:**FILT**er<i>:***IECTuner***[:STATe]	<i>*) 1 to 4 **ON**|**OFF**		Filter for tuner measurements to DIN/IEC 315	**2.7.1** **FILTER panel** Filter → IEC Tuner
SENSe[1]:***UFIL**ter*<i>:**HPAS**s[:STATe]	<i> 1 to 9 **ON**		Highpass When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.2** **FILTER panel** FILTER 01 to 09
SENSe[1]:***UFIL**ter*<i>:**LPAS**s[:STATe]	<i> 1 to 9 **ON**		Lowpass When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.2** **FILTER panel** FILTER 01 to 09
SENSe[1]:**UFIL**ter<i>:***BPAS**s*[:STATe]	<i> 1 to 9 **ON**		Bandpass When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.2** **FILTER panel** FILTER 01 to 09
SENSe[1]:***UFIL**ter*<i>:***BSTOp***[:STATe]	<i> = 1 to 9 **ON**		Bandpass When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.2** **FILTER panel** FILTER 01 to 09
SENSe[1]:***UFIL**ter***<i>:NOTCh***[:STATe]	<i> 1 to 9 **ON**		Notch filter When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.2** **FILTER panel** FILTER 01 to 09

*) <i> stands for the filter of analyzer measurement functions RMS, PEAK, QPE and THDN, which has been assigned the specified filter function.
Example:
" SENS: FUNC ' RMS ' "
" SENS: FILT1:DEMP5015 ON"
" SENS: FILT3:CCIT ON"
causes the following setting in the ANALYZER panel in the RMS & S/N measurement function

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:
| • Notch (Gain) OFF |
| • Filter DEEM 50/15 | i = 1
| • Filter OFF | i = 2
| • Filter CCITT | i = 3
| • Func Settl OFF |
:

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:***UFIL**ter*<i>:***TOCT**ave*[:STATe]	<**i**> 1 to 9 **ON**		Third-octave filter (Third Octave) When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.2** **FILTER panel** FILTER 01 to 09
SENSe[1]:***UFIL**ter*<i>:***OCT**av*[:STATe]	<**i**> 1 to 9 **ON**		Octave filter When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.2** **FILTER panel** FILTER 01 to 09
SENSe[1]:***UFIL**ter*<i>:***FILE**[:STATe]	<**i**> 1 to 9 **ON**		User-defined filter When a filter is switched ON the previously active filter is automatically switched OFF.	**2.7.2** **FILTER panel** FILTER 01 to 09
SENSe:**UFIL**ter[1**...9**]:**ORD**er	***N4*** ***N8***		Selection of order for highpass and lowpass filters → Order 4 → Order 8	2.7.2 **FILTER-Panel** Order → 4 → 8
SENSe[1]:***UFIL**ter*<i>:***PASS**b*	<**i**> = 1 to 9 **<nu>** = LL*) For MB limit see **2.6.1 Selecting the Analyzer**	Hz	Passband of HPASs and LPASs	**2.7.2.2** **FILTER panel** FILTER 0x → Passband
SENSe[1]:***UFIL**ter*<i>:***STOP**b?*	<**i**> 1 to 9 Query only		Queries the stopband of HPASs and LPASs	**2.7.2.2** **FILTER panel** FILTER 0x → Stopband

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Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:***UFIL***ter<i>:***PASS***b:***LOW***er	<i> = 1 to 9 **<nu>** = LL*) For MB limit see **2.6.5.1 Common Parameters of** Functions	Hz	Lower passband of BPASs and BSTOp	**2.7.2.3** **FILTER panel** FILTER 0x → Passb low
SENSe[1]:***UFIL***ter<i>:***PASS***b:***UPP***er	<i> = 1 to 9 **<nu>** = LL*) For MB limit see **2.6.1 Selecting the Analyzer**	Hz	Upper passband of BPASs and BSTOp	**2.7.2.3** **FILTER panel** FILTER 0x → Passb upp
SENSe[1]:***UFIL***ter<i>:***STOP***b:***LOW***er?*	<i> 1 to 9 Query only		Queries the lower stopband of BPASs and BSTOp	**2.7.2.3** **FILTER panel** FILTER 0x → Stopb low
SENSe[1]:***UFIL***ter<i>:***STOP***b:***UPP***er?*	<i> 1 to 9 Query only		Queries the upper stopband of BPASs and BSTOp	**2.7.2.3** **FILTER panel** FILTER 0x → Stopb upp
SENSe[1]:***UFIL***ter<i>:***CENT***er	<i> = 1 to 9 **<nu>** = LL*) For MB limit see **2.6.1 Selecting the Analyzer**	Hz	Center frequency of NOTCh, TOCT OCTAv	**2.7.2.4** **2.7.2.5** **FILTER panel** FILTER 0x → Center Frq
SENSe[1]:***UFIL***ter<i>:***WIDT***h	<i> = 1 to 9 **<nu>** = LL*) For MB limit see **2.6.1 Selecting the Analyzer**	Hz	Center frequency of NOTCh, TOCT OCTAv	**2.7.2.4** and **2.7.2.5** **FILTER panel** FILTER 0x → Width

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Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:***UFIL**ter*<i>**:*ATT**enuation***	<**i**> 1 to 9 **<nu>** 3 to 120 dB	dB	Attenuation of all filters except FILE Def. The value may be corrected in the UPD and queried.	**2.7.2.1** **FILTER panel** FILTER 0x → Atten
SENSe[1]:***UFIL**ter*<i>**:*DEL**ay***	Query only for all filters except for file-defined filters <**i**> = 1 to 9 **<nu>** = 0 to 1 s	s	Settling time of FILE-defined filters	**2.7.2.7** **FILTER panel** FILTER 0x → Delay
SENSe[1]:***UFIL**ter*<i>**:*DEL**ay?***	<**i**> 1 to 9 Query only		Queries the settling time of filters HPASs, LPASs, BPASs, BSTOp, NOTCh, TOCT OCTav	**2.7.2.1** **FILTER panel** FILTER 0x → Delay
SENSe[1]:***UFIL**ter*<i>**:*FILE***	**"filename"** <**i**> 1 to 9		Path and file name of file-defined filter data z. B. "C:\UPD\USER\MYFILT.ZPZ"	**2.7.2.7** **FILTER panel** FILTER 0x → Filename

*) LL = Lower limit value for instruments 22: 24 Hz
A110: 171 Hz
D48: Sample Freq*Oversamp/2000 (see 2.6.3 Configuration of the Digital Analyzer)

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3.10.4 Units for IEC/IEEE Measurement Results

Command	Parameter	Basic unit	Meaning	Section
SENSe[1|**2**][:VOLTage|POWer]:**UNIT**[1|**2**]	**V** ***MV*** (For SENS[1]... only) ***UV*** (For SENS[1]... only) **DBV** ***DBU*** **W** **DBM**		V mV µV dBV dBu W dBm } Absolute units for analog level measurements	**2.4** **ANLR panel** Unit Ch1/Ch2
	DV ***DPCTV*** ***VVR*** ***PCTVVR*** ***DW*** ***DPCTW*** ***PPR*** ***PCTPPR*** ***DBR***		ΔV Δ%V V/VR $\%V/V_r$ ΔW Δ%W P/P_r $\%P/P_r$ dB_r } Relative units for analog level measurements	

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Command	Parameter	Basic unit	Meaning	Section
SENSe[1|**2**][:VOLTage|POWer]:**UNIT**[1|**2**]	***DB*** (For SENS[1]... only) ***PCT*** (For SENS[1]... only) ***FS*** ***LSBS*** ***DBFS*** ***BITS*** ***DPCT*** ***PCTFS*** ***UI*** ***NS***		dB % } Relative units for intermodulation measurements and W&F FS LSBs dBFS bits } Absolute units for digital level measurements Δ% %FS } Relative units for digital level measurements UI ns } Absolute units for digital jitter and phase measurement	**2.4** **ANLR panel** Unit Ch1/Ch2
SENSe[1|**2**][:VOLTage|POWer]:**UNIT**[1|**2**]	***PPMUI*** ***DBUI*** ***UIR*** ***PCTUI*** ***PCTFRM*** ***DEGFRM***		ppm DBUI } Absolute units for digital jitter measurements Uir %UI } Relative units for digital jitter measurements %FRM °FRM } Absolute units for digital phase measurements	**2.4** **ANLR panel** Unit Ch1/Ch2

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Command	Parameter	Basic unit	Meaning	Section
Command	**Parameter**	**Basic unit**	**Meaning**	**Section**
SENSe**3**:**FREQ**uency:**UNIT**[1|**2**]	**HZ** ***DHZ*** ***DPCTHZ*** ***TERZ*** ***OCT*** ***DEC*** ***FFR***		Absolute and relative units for frequency measurements Hz ΔHz Δ%Hz Terz Oct Dec f/fr	**2.4** **ANLR panel** Unit Ch1/Ch2
SENSe**3**:**PHAS**e:**UNIT**	**DEG** **RAD** ***DDEG*** ***DRAD*** ***S*** ***DS***		Absolute and relative units for phase measurements RAD Δ° ΔRAD s (for group delay) Δs (for group delay)	**2.4** **ANLR panel** Unit Ch1/Ch2

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Selectable units:

Units of measurements

SENSe[1][:VOLTage][:POWer]**:UNIT**[1|**2**]:

Instrument	Measurement function	Selectable units
"INST2 A22 | A110 | A300" "INST2 A22 | A110 | A300" "INST2 A22" "INST2 A22" "INST2 A22 | A110| A300" "INST2 A22 | A110| A300"	"SENS:FUNC 'RMS' | 'RMSS' | 'PEAK' | 'QPE' | 'DC' | 'FFT' "	"SENS:UNIT[1|**2**] V | DBV | DBU | DBM | W | DPCTV | DV | VVR | PCTVVR | DPCTW | DW | PPR | PCTPPR | DBR"
"INST2 A22 | A110| A300"	"SENS:FUNC 'THDN'" and "SENS:FUNC:MMOD LNOI | NOIS "	
"INST2 A22 | A110| A300"	"SENS:FUNC 'WAV'" and "SENS:FUNC:MMOD COMP"	
"INST2 A22 | A110| A300"	"SENS:FUNC 'THD' | 'MDIS' | 'DFD' "	"SENS:UNIT[1|**2**] DB | PCT"
"INST2 A22 | A110| A300"	"SENS:FUNC 'THDN'" and "SENS:FUNC:MMOD THDN | NOIS"	
"INST2 A22"	"SENS:FUNC 'WAF'"	"SENS:UNIT[1|**2**] PCT"
"INST2 A22 | A110| A300"	"SENS:FUNC 'WAV'" and "SENS:FUNC:MMOD STAN"	"SENS:UNIT[1|**2**] V | MV | UV | DPCTV | DV | VVR | PCTVVR"
"INST2 A22 | A110| A300"	"SENS:FUNC 'THDN'" and "SENS:FUNC:MMOD SNDR"	"SENS:UNIT[1|**2**] DB"

Instrument	Measurement function	Selectable units
"INST2 D48" and "SENS:DIG:FEED ADAT" or "INST2 D192 | D768"	"SENS:FUNC 'RMSS' | 'PEAK' | 'QPE' " "SENS:FUNC 'THDN'" and "SENS:FUNC:MMOD LNOI | NOIS " "SENS:FUNC 'WAV'" and "SENS:FUNC:MMOD COMP"	"SENS:UNIT[1|**2**] FS | PCTFS | DBFS | DPCT | DBR | LSBS | BITS"
	"SENS:FUNC 'THD' | 'MDIS' | 'DFD' "	"SENS:UNIT[1|**2**] DB | PCT"

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	"SENS:FUNC 'THDN'" and "SENS:FUNC:MMOD THDN | NOIS	
	"SENS:FUNC 'WAF'"	"SENS:UNIT[1|**2**] PCT"
	"SENS:FUNC 'DC'" "SENS:FUNC 'WAV'" and "SENS:FUNC:MMOD STAN"	"SENS:UNIT[1|**2**] FS | PCTFS | DPCT | LSBS"
	"SENS:FUNC 'THDN'" and "SENS:FUNC:MMOD SNDR"	"SENS:UNIT[1|**2**] DB"

Instrument	Measurement function	Selectable units
"INST2 D48" and "SENS:DIG:FEED JPH"	"SENS:FUNC 'RMS' | 'RMSS' | 'PEAK' | FFT" "SENS:FUNC 'WAV'" and "SENS:FUNC:MMOD COMP"	"SENS:UNIT[1|**2**] UI | PCTUI | PPMUI | NS | UIR | DBR | DBUI"
	"SENS:FUNC 'WAV'" and "SENS:FUNC:MMOD STAN"	"SENS:UNIT[1|**2**] UI | PCTUI | PPMUI | NS | UIR"
"INST2 D48" and "SENS:DIG:FEED CINP"	"SENS:FUNC 'RMS' | 'RMSS' | 'PEAK' | FFT" "SENS:FUNC 'WAV'" and "SENS:FUNC:MMOD COMP"	"SENS:UNIT[1|**2**] V | DBV | DBU | DBM | W | DPCTV | DV | VVR | PCTVVR | DPCTW | DW | PPR | PCTPPR | DBR"
	"SENS:FUNC 'WAV'" and "SENS:FUNC:MMOD STAN"	"SENS:UNIT[1|**2**] V | MV | UV | DPCTV | DV | VVR | PCTVVR"

Units of Input Peak, RMS and Phase masurements

SENSe2[:VOLTage][:POWer]:**UNIT**[1|**2**]:

Instrument	Measurement function	Selectable units
"INST2 A22 | A110"	"SENS2:FUNC 'PEAK' | 'RMS'"	"SENS2:UNIT[1|**2**] V | DBV | DBU | DBM | W | DPCTV | DV | VVR | PCTVVR |

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		DPCTW | DW | PPR | PCTPPR | DBR"
"INST2 D48" and "SENS:DIG:FEED ADAT"	"SENS2:FUNC 'PEAK'"	"SENS2:UNIT[1|**2**] FS | PCTFS | DBFS | DPCT | DBR | LSBS | BITS"
"INST2 D48" and "SENS:DIG:FEED JPH"	"SENS2:FUNC 'PEAK'"	"SENS2:UNIT[1|**2**] UI | PCTUI | PPMUI | NS | UIR | DBR | DBUI"
"INST2 D48" and "SENS:DIG:FEED JPH"	"SENS2:FUNC 'PHAS'"	"SENS2:UNIT UI | PCTFRM | DEGFRM | NS"
"INST2 D48" and "SENS:DIG:FEED CINP"	"SENS2:FUNC 'PEAK' | 'DIGI'"	"SENS2:UNIT[1|**2**] V | DBV | DBU | DBM | W | DPCTV | DV | VVR | PCTVVR | DPCTW | DW | PPR | PCTPPR | DBR"

Units for frequency, phase and group delay measurements

SENSe**3**:**FREQ**uency:**UNIT**[1|**2**] and **SENS**e**3**:**PHAS**e:**UNIT2**:

Instrument	Measurement function	Selectable units
"INST2 A22 | A110 | D48"	"SENS3:FUNC 'FREQ'"	"SENS3:FREQ:UNIT[1|**2**] HZ | DHZ | DPCTHZ | TOCT | OCT | DEC | FFR"
"INST2 A22"	"SENS3:FUNC 'FQPH'"	"SENS3:FREQ:UNIT HZ | DHZ | DPCTHZ | TOCT | OCT | DEC | FFR" "SENS3:PHAS:UNIT DEG | RAD | DDEG | DRAD"
"INST2 A22"	"SENS3:FUNC 'FQGR'"	"SENS3:FREQ:UNIT HZ | DHZ | DPCTHZ | TOCT | OCT | DEC | FFR" "SENS3:PHAS:UNIT S | DS"

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3.10.5 Loading and Storing

3.10.5.1 Loading and Storing Instrument Setups

Command	Parameter	Basic unit	Meaning	Section
SYSTem:**INFO**text**:STAT**e	**ON** **OFF**		→ When scrolling through the selection window of the file box, the "Info text" for a setup is displayed in the user info line (of minor importance for IEC/IEEE-bus control). → "Info text" not displayed.	2.9.1.1 **FILE panel** Info Displ → ON → OFF
MMEMory:**LOAD:STAT**e	**0** | **2** | **4**, **"filename"** Query: MMEM:... LOAD:STAT? 0 LOAD:STAT? 2 LOAD:STAT? 4		0: Load current setup with filename extension .SAC 2: Load complete instrument setup with filename extension .SCO. Use command *RST for loading the R&S default setup under C:UPD \ SETUP \ DEFAULT.SET. Switch off the parameter link (see **2.15.9 Transfer of Parameters**) to ensure that the default setup described under Annex **A UPD Default Setup**, remains unchanged even after an instrument or function change. 4: Display of (4 bit-) PCX pictures on 1:1 scale on the screen of UPD. It is thus possible to view under program control PCX files stored in UPD (eg for demos). As long as a PCX picture is displayed on the screen, UPD is not ready to receive further IEC/IEEE-bus commands. The PCX picture remains on display until the UPD is set to the LOCAL state with the SYST:COMM:GTL command. Subsequently the UPD is ready to receive IEC/IEEE-bus commands. To make sure that the UPD still displays nothing but the text REMOTE in the center of the screen, the UPD has to be readdressed after switchover to LOCAL and before the next IEC/IEEE-bus command **is sent or received** (for example the command ibcmd with the NI-488.2 GPIB device driver or for device-specific programming the repeat addressing setting in the NI GPIB device driver).	**2.9.1.1** **FILE panel** Mode / → ACTUAL → COMPLETE → DEFAULT
MMEMory**:STOR**e**:INFO**text	**'string'**		Entry of a comment of max. 39 characters for a detailed description of measurement task, DUT or the like. Provided SYST:INFO:STAT ON is selected, this comment is displayed in the user info line when a setup is loaded during scrolling through the selection window of the file box. .	**2.9.1.1** FILE panel Info Text

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Command	Parameter	Basic unit	Meaning	Section
MMEMory:**STOR**e**:STAT**e	0|1|2,**'filename'** Query: MMEM:STOR:STAT? 0 MMEM:STOR:STAT? 1 MMEM:STOR:STAT? 2		0: Store current setup in a file with the extension **.SAC** 1: Store current setup with measurement results and traces in a file with the extension **.SAC.** The memory required by these setups depends on the size of the active trace. 2: Store total instrument setup in a file with the extension **.SCO.**	**2.9.1.1** **FILE panel** Mode → ACTUAL → ACTUAL+DATA → COMPLETE
MMEMory:**STOR**e**:STAT**e:***RONL**y*	**ON** **OFF**		→ File is write-protected → File is not write-protected	**2.9.1.1** **FILE panel** Attrib → REAN ONLY → READ/WRITE

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3.10.5.1.1 Loading and Storing Traces and Lists

Command	Parameter	Basic unit	Meaning	Section
MMEMory:**STOR**e:***FORM**at*	***BIN*** ***ASC**ii* ***EXP**ort*		→ Data stored in binary format → Data stored in ASCII format → Daten werden im Textformat in Tabellenform ohne Zusatzinformation mit der Dateierweiterung .EXP gespeichert. Vorteil: Dateien im EXP-Format können von jedem Texteditor oder anderen Programmen problemlos gelesen und weiterverarbeitetwerden. Nachteil: Da die Zusatzinformationen fehlen, können die Dateien vom UPD nicht mehr eingelesen werden. Informationen über den Inhalt der Dateien siehe 2.9.1.2 Loading and Storing of Series of Measured Values and Block/List Data und 2.9.1.3 Format of Block/Listen Data.	2.9.1.2 **FILE panel** Format → REAL → ASCII → EXPORT
MMEMory:**STOR**e:**TRAC**e	**TRAC**e**1**,**"filename"** **TRAC**e**2**,**"filename"** **TR1A**nd2,**"filename"** Query: MMEM:STOR:TRAC? TRAC[1|**2**] MMEM:STOR:TRAC? TR1A		→ Store trace A buffer under "filename" → Store trace B buffer under "filename" → Store trace pair under "filename"	**2.9.1.2** **FILE panel** Store → TRACE A → TRACE B → TRACE A+B
MMEMory:**STOR**e:***LIST***	***LIST1*****,"filename"** ***LIST2*****,"filename"** **DWEL**l**,"filename"** Query: MMEM:STOR:LIST? LIST[1|**2**] MMEM:STOR:LIST? DWEL		→ Store X-axis list under "filename" → Store Z-axis list under "filename" → Store dwell-time list under "filename"	**2.9.1.2** **FILE panel** Store → X-Axis → Z-Axis → DWEL VALUE

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3.10.5.1.2 Storing Limit Violations (Error Reports)

Command	Parameter	Basic unit	Meaning	Section
MMEMory:**STOR**e:***FORM**at*	***BIN*** ***ASCii***		→ Data stored in binary format → Data stored in ASCII format	**2.9.1.2** **FILE panel** Format → REAL → ASCII
MMEMory:**STOR**e:**LIST**	***ERR**ors*,**"filename"** ***LIMU**pper*,**"filename"** ***LIML**ower*,**"filename"** Query: MMEM:STOR:LIST? ERR MMEM:STOR:LIST? LIMU MMEM:STOR:LIST? LIML		→ Store limit error under "filename" → Store upper tolerance curve under "filename" → Store lower tolerance curve under "filename"	**2.9.1.2** **FILE panel** Store → LIM REPORT → LIM UPPER → LIM LOWER

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3.10.5.1.3 Storing Equalization Files

Command	Parameter	Basic unit	Meaning	Section
MMEMory:**STOR**e:***FORM**at*	***BIN*** ***ASC**ii*		→ Data stored in binary format → Data stored in ASCII format	**2.9.1.2** **FILE panel** Format → REAL → ASCII
CALCulate:***EQU**alize:**FEED***	***TRAC**e1* ***TRAC**e2*		→ Amplitude data read from → Trace buffer A/B	**2.9.1.2** **FILE panel** Volt Source → TRACE A → TRACE B
CALCulate:***EQU**alize:**NORM**freq*	**<nu>** f_{min} to f_{max}	Hz	Frequency to the level at which is normalized	**2.9.1.2** **FILE panel** Norm Freq
CALCulate:***EQU**alize:**INV**ert*	**ON** **OFF**		→ Frequency stored in inverted form → Frequency stored without inversion	**2.9.1.2** **FILE panel** Invert 1/n → ON → OFF
MMEMory:**STOR**e:***LIST***	***EQU**alize*,**"filename"** Query: MMEM:LOAD:LIST? EQU		Store equalization file under "filename"	**2.9.1.2** **FILE panel** Store → EQUALIZATN

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3.10.5.2 Commands for Editing Files and Directories

Command	Parameter	Basic unit	Meaning	Section
MMEMory:**DEL**ete	**"filename"**		Deletes a file.	2.9.2 **FILE panel** Delete
MMEMory:**CDIR**ectory	**"pathname"**		Selects a directory for file operation.	**2.9.2** **FILE panel** Work Dir
MMEMory:**COPY**	**"filename1","filename2"**		Selects the file to be copied. Specifies the name of the target file (with drive and directory, if required) to which a copy should be made.	**2.9.2** **FILE panel** Copy + To

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3.10.6 Commands for Graphical Result Display

In the following, TRACe1 and TRACe2 serve for differentiating between displayed curves (trace A and trace B), bargraphs and result lists.

Command	Parameter	Basic unit	Meaning	Section
DISPlay[:WINDow]**:TRAC**e[]**:*OPER*ation**	***CURV***eplot ***LIST*** ***ERR***ors ***BARG***raph ***SPEC***trum ***FFTL***ist ***FFTE***rrors ***PROT***ocol ***AUT***oprotocol alias ***AUTO***protocol		The parameters below determine the form for the graphics display of measurement results. → Line chart in Cartesian coordinates. → List of numeric values. → List of out-of-tolerance values. In this case the limit check function must be active. → Bargraph display in analog form. → Display of FFT or, in the case of THD, DFD or MOD-DIST, in the form of a schematic spectrum display. → FFT data in tabular form. → FFT limit violation data in tabular form. Limit check function must be active. → Protocol data of the digital AES/EBU interface displayed in the graphics window. → Protocol data of the digital interface displayed in the graphics window. Automatic decoding of the channel status bits irrespective of the professional bit value (see 2.10.8 PROTOCOL Analysis).	2.10 **DISP panel** OPERATION → CURVE PLOT **2.10.2** → SWEEP LIST **2.10.4** → SWP LIM REP **2.10.4** → BARGRAPH **2.10.2** → SPECT LIST **2.10.8** → SPC LIM REP **2.10.6** → PROTOCOL 2.10 2.10.8 → PROTO AUTO
DISPlay[:WINDow]**:TRAC**e[]**:MODE**	***DELete_bef_wr*** ***WAT***erfall|***CASC***ade ***MAXH***old		→ Selects a single trace or a pair of traces. Each new X sweep overwrites the previous trace. → Shifts a single trace (trace pairs not possible) on the Z axis for obtaining a spatial presentation (with FFT-SPECtrum only). → Maximum hold function for FFT SPECtrum for FFT-AVERage = 1.	**2.10** **DISP panel** Mode → DEL BEF WR → WATERFAL → MAX HOLD
DISPlay[:WINDow]**:TRAC**e[]**:*COUNt***	**<n>** Recorded: 1 to 100 000 Stored: max. 17 traces		Specifies the number of single traces and trace pairs to be recorded together and stored. Automatically sets the number of Z values in the case of a Z sweep.	**2.10** **DISP panel** Scan Count

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Command	Parameter	Basic unit	Meaning	Section
DISPlay[:WINDow]**:TRAC**e[1|**2**]**:FEED**	**"SENS**e**1**:**DATA1"** **"SENS**e**1**:**DATA2"** **"SENS**e**2**:**DATA1"** **"SENS**e**2**:**DATA2"** **"SENS**e**3**:**DATA1"** **"SENS**e**3**:**DATA2"** **"SENS**e**4**:**DATA"** **"HOLD"** **"FILE"** **"DFILE"** **"OFF"**		Selects the result to be displayed as TRACe1 (or TRACe2). → Measurement function specified by SENSe1:FUNCtion "<>". Value from channel 2 (CH1). → Measurement function specified by SENSe1:FUNCtion "<>2. Value from channel 2 (CH2). → Result of input RMS measurement of channel 1 (CH1) for THD and THD+N functions. → Result of input RMS measurement of channel 2 (CH2) for THD and THD+N functions. → Measured value from frequency meter, channel 1 (CH1). → Measured value from frequency meter, channel 2 (CH2) if SENS3:FUNC FREQ is selected. → Measured value from phase meter, channel 2 (CH2) if SENS3:FUNC FQPH Measured value from group delay measurement, channel 2 (CH2) if SENS:FUNC FQGR is selected → Retains previously displayed values (no collection of new values). → Displays measured values from a file using the command described below. → Loads a trace pair with scale and reference values or reference trace using the command described below. → Switch-off	**2.10.1** **DISP panel** TRACE A/B → FUNC CH1 → FUNC CH2 → INP RMS CH1 → INP RMS CH2 → FREQ CH1 → FREQ CH2 → PHASE → GROUP DEL → HOLD → FILE → DUAL FILE → OFF
MMEMory:**LOAD:TRAC**e	**TRAC**e[1|**2**], "**filename**" Query: MMEM:LOAD:TRAC? TRAC[1|**2**]		Loads a trace from a file for display.	**2.10.1** **DISP panel** TRACE A/B → FILE + Filename
TRACe:**DATA?**	**TRAC**e[1|**2**] Query only Query-Form: TRAC? TRAC[1|**2**]		The trace (block data!) can be read from the UPD to the controller.	**2.10.1** **DISP panel**

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Command	Parameter	Basic unit	Meaning	Section
DISPlay[:WINDow]:**TRAC**e[]**:Y**[:SCALe]:**UNIT**	<**u**> see **3.10.4 Units for IEC** Measurement Results	1)	Determines the units for results displayed in numerical form.	**2.10.1** **DISP panel** Unit
DISPlay[:WINDow]:**TRAC**e[1|**2**]**:Y**[:SCALe]:**RLEV**el**:MODE**	***VAL**ue* ***MAX**imum* ***CURS**or[1]* ***CURS**or 2* ***FILE*** ***HOLD*** ***OTRA**ce* ***CH1M**eas* ***CH2M**eas* ***GENT**rack* ***IFIL**e* ***REF9**97* ***REF1**000*		A reference value is required for all relative units of TRACe1 or TRACe2. → The subsequently entered value is used as a reference. → Uses the maximum value of the trace once. → The value pointing to the o-cursor is stored as a reference. → The value pointing to the *-cursor is stored as a reference. → Reference for reference-related units is a file indicated by MMEMory:LOAD:TRACe[1|**2**]REFTrace,"name.TRC". → The reference-trace memory is no longer filled with new (sweep) values. Stored values are retained. → Reference for reference-related units is another trace. → Reference for reference-related units is the value measured in channel 1 or 2 pertaining to the respective reference point (depending on the display measured frequency, function or input result). → The reference trace is erased and reloaded for each measurement using the respective generator setting. → When a trace with the associated reference trace (Internal reference FILe) is loaded, IFILe activates this internal reference file again when another reference has been selected before. →The value measured at 997 Hz or 1 kHz is taken once as a reference → Value for a single sweep run. With FFT traces, the nearest bin (actually measured frequency line) is taken, with frequency sweeps interpolation is made between the two neighbouring points.If the X axis is not the frequency axis (for example in the case of level sweeps or waveform traces), an error message is output and the reference value remains unchanged.	**2.10.1** **DISP panel** Reference → VALUE → MAX → oCURSOR → *CURSOR → FILE → HOLD → OTHER TRACE → MEAS CH1 → MEAS CH2 → GEN TRACK → FILE INTERN → REF 997 Hz → REF 1000 Hz
DISPlay[:WINDow]:**TRAC**e[]**:Y**[:SCALe]:**RLEV**el	**<nu>**	1)	Entry of reference value for relative units.	**2.10.1** **DISP panel** Reference → VALUE

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Command	Parameter	Basic unit	Meaning	Section
MMEMory:**LOAD:TRAC**e[1|**2**]	**REFT**race**,"filename"** Query: MMEM:LOAD:TRAC[1|2? REFT		→ File containing the reference-trace data for trace A. Default extension = .TRC	**2.10.1** **DISP panel** Reference → FILE + Reference
DISPlay[:WINDow]:**TRAC**e**2:Y**[:SCALe]:***EQU**al*	***ON*** ***OFF***		→ TRACe2 may be displayed on the same axis as TRACe1. In this case no values can be entered for: UNIT,: RLEVel,:SCALe:AUTO,:TOP,:BOTTom and :SPACing for the second axis. → Independent of trace 1.	**2.10.1** **DISP panel** Scale B → EQUAL A → NOT EQUAL A
DISPlay[:WINDow]:**TRAC**e[1|**2**]**:Y**[:SCALe]:**AUTO**	**ONCE** **OFF**		→ Uses the minimum and maximum values of the present trace for scaling the display once. The new scale data are set after DISP:TRAC:Y:TOP <n> and DISP:TRAC:Y:BOTT <n>. → Leaves scaling to the user with the aid of the following two commands.	**2.10.1** **DISP panel** Scale → AUTO ONCE → MANUAL ONCE via Softkey F7 (AUTOSCALE) → F7 (A) → F8 (B)

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Command	Parameter	Basic unit	Meaning	Section
DISPlay[:WINDow]:**TRAC**e[1|**2**]**:Y**[:SCALe]:**NORM**alize **:MODE**	**CURS**or[1] (**o**-Cursor) **CURS**or**2** (*****-Cursor) **VAL**ue		With normalize the reference curve can be multiplied so that a specific Y value is obtained at the desired Y position. → The multiplier is obtained from the measured value at the cursor position divided by the reference value at this position. Thus the new reference corresponds to the value measured at this position (= 0 dBr). → Entry of a fixed multiplier using the following command: Presettings required: DISP:TRAC[1|**2**]:OPER CURV and DISP:TRAC[1|**2**]:FEED 'SENS1:DATA1'|'SENS1:DATA2'|'HOLD' and DISP:TRAC[1|**2**]:Y:UNIT VVRPCTVVR|PPR|PCTPPR|DBR and DISP:TRAC[1|**2**]:Y:RLEV:MODE GENT or DISP:TRAC[1|**2**]:OPER CURV and DISP:TRAC[1|**2**]:FEED 'SENS3:DATA1'|'SENS3:DATA2'|'HOLD' and DISP:TRAC[1|**2**]:Y:UNIT TOCT|OCT|DEC|FFR and DISP:TRAC[1|**2**]:Y:RLEV:MODE GENT	**2.10.1** **DISP panel** Normalize → **o**-Cursor → *****-Cursor → VALue
DISPlay[:WINDow]:**TRAC**e[1|**2**]**:Y**[:SCALe]:**NORM**alize	**<nu>** 10^{-12} to 10^{6} or -200 dB to 120 dB	Multiplier | dB	The specified number is multiplied to obtain the reference value. This allows the reference of a trace to be defined as required.	**2.10.1** **DISP panel** Normalize
DISPlay[:WINDow]**:TRAC**e[1|**2**]**:Y:SPAC**ing	**LIN**ear **LOG**arithmic		→ Linear spacing of Y axes → Logarithmic	**2.10.1** **DISP panel** Spacing → LIN → LOG
DISPlay[:WINDow]:**TRAC**e[1|**2**]**:Y**[:SCALe]:**TOP**	**<nu>**	1)	Sets the upper value of the Y axis (of the dependent value) in the case of DISPlay:TRACe[1|**2**]:Y:AUTO OFF	**2.10.1** **DISP panel** Top
DISPlay[:WINDow]:**TRAC**e[1|**2**]**:Y**[:SCALe]:**BOTT**om	**<nu>**	1)	Sets the lower value of the Y axis (of the dependent value) in the case of DISPlay:TRACe[1|**2**]:Y:AUTO OFF.	**2.10.1** **DISP panel** Bottom

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Command	Parameter	Basic unit	Meaning	Section
DISPlay[:WINDow]**:TRAC**e[]**:X**[:SCALe]***:UNIT*	<**u**> see **3.10.4 Units for IEC** Measurement Results		Defines the units for the numeric results displayed on the X axis. If remote data, ie data transferred to the UPD by means of block transfer commands, are loaded as X axis for the graphics display and the sweep is switched off, the X axis can be selected with command **DISP:TRAC:X:UNIT V|Hz|s| ...** by entering the desired unit of the X axis. The only condition is that the selected **display mode** is **not** DISP:TRAC:OPER **BARGraph** (corresponding manual control in the DISPLAY panel: **Not** OPERATION = BARGRAPH). The long way of selecting sweep parameters in the GENERATOR panel is no longer required.	**2.10.1** **DISP panel** Unit
DISPlay[:WINDow]**:TRAC**e[]**:X**[:SCALe]**:RLEV**el	**<nu>**	2)	Entry of reference value for relative units.	**2.10.1** **DISP panel** Reference
DISPlay[:WINDow]**:TRAC**e[]**:X**[:SCALe]**:AUTO**	**ON** **OFF**		→ Uses the minimum and maximum values of the present trace for scaling the X axis (once). → Leaves scaling to the user with the aid of the following two commands.	**2.10.1** **DISP panel** Scale → AUTO → MANUAL or **Softkey** F7 (AUTOSCALE) → F9 (X)
DISPlay[:WINDow]**:TRAC**e[]**:X:SPAC**ing	**LIN**ear **LOG**arithmic		→ Linear spacing of X axis → Logarithmic	**2.10.1** **DISP panel** Spacing → LIN → LOG
DISPlay[:WINDow]**:TRAC**e[]**:X**[:SCALe]**:LEFT**	**<nu>**	2)	Sets the left-hand value of the X axis (of the independent value) in the case of DISPlay:TRACe[1|**2**]:X:AUTO OFF.	**2.10.1** **DISP panel** Left

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Command	Parameter	Basic unit	Meaning	Section
DISPlay[:WINDow]**:TRACe[]:X**[:SCALe]**:RIGHT**	**<nu>**	2)	Sets the right-hand value of the X axis (of the independent value) in the case of DISPlay:TRACe[1|**2**]:X:AUTO OFF. The lower value of LEFT and RIGHT is used as left-hand value.	**2.10.1** **DISP panel** Right
DISPlay[:WINDow]**:TEXT**[:DATA]	**"string"**		Permits a text to be entered that will be displayed within the trace display in the case of DISPlay:TRACe[1|**2**]:OPERation CURVeplot.	**2.10.1** **DISP panel** COMMENT
DISPlay[:WINDow]**:TEXT:LOC**ate	<**ny**>[,<**nx**>]		Determines the X and Y position of the text. X and Y are the relative distance from the 0 point of the coordinates in % (0 to 100).	**2.10.1** **DISP panel** X Pos, Y Pos
DISPlay[:WINDow]**:TRACe[]:ACT**ive	***CURS**or*[*1*|***2***]		Switches the cursors alternately on and off. This only affects the display. CURSor1 is marked with o, CURSor2 with *.	**2.10.2** **DISP panel** Softkey, 1st level F8
DISPlay[:WINDow]**:TRACe[]:*CURS**or*[*1*]**:MODE**	***N12*** ***D12*** ***OFF***		Parameters used for selecting the cursor function and the type of the displayed numeric cursor values. → Display of measured values A and B and of associated X value. → Display of difference value of A and B at the cursor position and of X value. → The deactivated cursor is no longer displayed.	**2.10.2** **Softkey** F8: selects O-CURS. F9: (O-CURSOR) → F6 (A,B) → F7 (A-B) → F11 (ON/OFF)

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Command	Parameter	Basic unit	Meaning	Section
DISPlay[:WINDow]**:TRAC**e[]**:*CURS*or*2*:MODE**	***N12*** ***D12*** ***C12*** ***HL1*** ***HL2*** ***HLD1*** ***HLD2*** ***OFF***		→ Display of measured values A and B and of associated X value. → Display of difference value of A and B at the cursor position and of X value. → Difference of trace and X values of curves A and B which are marked by the two cursors. → The *-cursor is switched to horizontal line. Its Y value and intersections with TRACe1 (if any) are displayed. → Intersections with TRACe2 are displayed. → The *-cursor is switched to horizontal line. The difference between its Y value and the Y value of the o-cursor are displayed. Intersections with TRACe1 are displayed as well. → Same as with HLD1, but the intersections with TRACe2 are displayed. → The deactivated cursor is no longer displayed.	**2.10.2** **Softkey** F8 selects o-cursor F9 selects ***-cursor → F6 (A,B) → F7 (A-B) → F8 (* - O) → F9 (HLINE) → A → F9 (HLINE) → B → F9 (HLINE) → ΔA → F9 (HLINE) → ΔB → F11 (ON/OFF)
DISPlay[:WINDow]**:TRAC**e[]**:*CURS*or[*1*/*2*]*:POS*ition**:MODE**	***MIN1*** ***MIN2*** ***I MAX1*** ***MAX1*** ***I MAX2*** ***MAX2*** ***MARK****er1* ***NEXT****marker* ***VAL****ue*		Changes the position of the specified cursor. → Sets cursor to the minimum of TRACe1. → Sets cursor to the maximum of TRACe2. → Sets cursor to calculated maximum of TRACe1 (with FFT only) → Sets cursor to maximum of TRACe1. → Sets cursor to calculated maximum of TRACe2 (with FFT only) → Sets cursor to maximum of TRACe2. → Sets cursor to value of 1st marker (FFT only). → Sets cursor to the next marker value (FFT only). → Sets cursor to the value specified with the command below.	**2.10.2** **Softkey** F8 selects O-CURS or *-CURS. → F10 (SET TO) → ---- → ---- → F6 (I MAX A) → F7 (MAX A) → F8 (I MAX B) → F9 (MAX B) → F10 (MARKER) → F11(NXTHARM)
DISPlay[:WINDow]**:TRAC**e[]**:CURS**or[*1*/*2*]*:POS*ition	**<nu>**	3)	Sets specified cursor to the value of the X axis if DISPlay:TRACe[]:CURSor[1|**2**]:POSition:MODE VALue is set.	**2.10.2** not via softkey

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Command	Parameter	Basic unit	Meaning	Section
DISPlay[:WINDow]**:TRAC**e[1|**2**]**:*CURV**e***	**OFF** **ON**		→ TRACe1: trace A on/off → TRACe2: trace B on/off	**2.10.2** **Softkey** → F6 (CURVE) → F6 (A ON/OFF) → F7 (B ON/OFF)
DISPlay[:WINDow]**:TRAC**e[]**:*ZOOM***	**<n>** **0** **1** **-1** **2** **3** **4**		 → Restores the original X axis defined by X AXIS LEFT and RIGHT. → Expands the display on the X axis by the factor 2 (can be repeated). → Reduces the display on the X axis by the factor 2 (repeated actions possible). → Shifts the center of the X axis of the new coordinates to the value of the o-cursors (CURSor1) without expanding the X axis. → The end points of the expanded X axis are determined by the X values of the two cursors → Cancels the last action.	**2.10.2** **Softkey** F10 (ZOOM) → F10 (UNZOOM) → F6 (AT o UP) → F7 (AToDOWN) → F8 (CEN TO o) → F9 (o TO *) → F11 (UNDO)
DISPlay[:WINDow]:**TRAC**e[1|**2**]:***MARK**er*:**MODE**	 ***MAX**imum* ***CURS**or* ***OFF***		Markers for FFT spectrum display → Sets the first marker to the maximum of TRACe1 or TRACe2. → Sets the first marker to the value defined by the o-cursor. TRACe1 or TRACe2 is used. → No markers	**2.10.2** **Softkey** F11 (MARKER) F6 (TRACE A) or F7 (TRACE B). → MAX → CURSOR → VIEW OFF
DISPlay[:WINDow]:**TRAC**e[1|**2**]:***MARK**er:**HARM**onics***	**ON** **OFF**		→ Sets markers for harmonics (frequency multiples) of MARKer1 (FFT only). Values marked in TRACe1 or TRACe2. → No harmonics markers.	**2.10.2** **Softkey** F11 (MARKER) F6 (TRACE A) or F7 (TRACE B) → F10 (HARM) on/off

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Command	Parameter	Basic unit	Meaning	Section
DISPlay[:WINDow]:**TRAC**e[]:***AUT**oscale alias* ***AUTO**scale*			Rescales the X and the TRACe1 axis. When active also the axis of TRACe2.	**2.10.2** **Softkey** F7 (AUTOSCALE) F6 (ALL)
DISPlay[:WINDow]**:TRAC**e[]**:*LAB**el***	**ON** **OFF**		→ Activates user title and units. → Deactivates user title and units.	**2.10.2** **DISP panel** User Label → ON → OFF
DISPlay[:WINDow]**:TRAC**e**:X:*LAB**el***	**"string"**		Specification of a string determining a user-definable label (unit and title) for the X axis.	**2.10.2** **DISP panel** Unit/Label
DISPlay[:WINDow]**:TRAC**e[**1I2**]**:Y:*LAB**el***	**"string"**		Specification of a string determining a user-definable label (unit and title) for the Y1 axis.	**2.10.2** **DISP panel** Unit/Label
DISPlay[:WINDow]**:TRAC**e[]**:IND**ex	**<n>** 1 to 17		Selects the n-th single trace or curve pair. In the graphics display a circle marks the intersection of the vertical cursor line and the selected trace.	**2.9.3.3** **Keys** PAGE UP / PAGE DOWN

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Command	Parameter	Basic unit	Meaning	Section
DISPlay:***CONF**iguration*	***P*** ***SP*** ***AP*** ***GP*** ***FP*** ***DP*** ***OP*** ***GAT*** ***GAO*** ***GAD*** ***FAT*** ***FAO*** ***FAD*** ***SHON*** ***SHOF**f*		Configuration of screen display after switchover to LOCAL: → Full-screen graphics display (plot) → Status panel and graphics window → Analyzer panel and graphics window → Generator panel and graphics window → File panel and graphics window → Display panel and graphics window → Options panel and graphics window → Generator, analyzer and filter panel → Generator, analyzer and options panel → Generator-, analyzer and display panel → File, analyzer and filter panel → File, analyzer and options panel → File, analyzer and display panel → Show I/O graphics on → Show I/O graphics off	**2.3.1** Keys Ext. UPD keyboard GEN ALT+G ANLR ALT+A FILT ALT+T FILE ALT+F DISP ALT+D GRAPH ALT+R ZOOM ALT+Z SHOW I/O ALT+I OPTIONS ALT+O
DISPlay[:WINDow]**:TRAC**e[]**:*CURS**or*[]*:DATA1*?** **DISP**lay[:WINDow]**:TRAC**e[]**:*CURS**or*[]*:DATA2*?** **DISP**lay[:WINDow]**:TRAC**e[]**:*CURS**or*[]*:DATA3*?**	**<nu>** Query only		Return the values of the cursor position. Depending on DISPlay:TRACe[]:CURSor[1|**2**]:MODE and DISPlay:TRACe:CURSor[1|**2**]ACTive the following values are available: DATA1 DATA2 DATA3 with CURSor1 and CURSor2 ACTive N12 A X B D12 A-B X - OFF - - - only with CURSor2 ACTive: C12 A-oA X-oX B-oB HL1 XAL y XAR HL2 XBL Y XBR HLD1 XAL A-Y XAR HLD2 XBL B-Y XBR	**2.10.2 Display in graphics window**

1) Depending on DISPlay:TRACe:FEED and (with SENSe1) of SENSe1:FUNCtion
2) Depending on the sweep selected for generator and analyzer
3) Same units as with DISPlay:TRACe[]:X:UNIT permitted.

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3.10.6.1 Commands for Limit Check

See also Sections **2.10.7 Limit Check** and **3.10.9 Commands for Input/Output** of Data, for the transfer of limit curves and limit check results in the form of block data.

Command	Parameter	Basic unit	Meaning	Section
CALCulate:**LIM**it:***ON***	***TRAC**e1* ***TRAC**e2* ***TR1A**nd2*		→ TRACe1 or bargraph 1 monitored. → TRACe2 or bargraph 2 monitored. → Both traces (bargraphs) monitored together.	**2.10.7** **DISP panel** Check → TRACE A → TRACE B → TRACE A+B
CALCulate:**LIM**it:**UPP**er:**STAT**e	**ON** **OFF**		→ Upper limit monitoring switched on. → Upper limit monitoring switched off.	**2.10.7** **DISP panel** LIMIT CHECK Mode → LIM UPPER Mode → OFF
CALCulate:**LIM**it:**UPP**er:**VAL**ue	**<nu>**	*)	Specifies a single upper limit value.	**2.10.7** **DISP panel** Lim Upper → VALUE:
MMEMory:**LOAD:*LIST***	***LIMU**pper*, **"filename"** Query: MMEM:LOAD:LIST? LIMU		→ Defines a file containing the upper limit curve.	**2.10.7** **DISP panel** Lim Upper → FILE + filenam"

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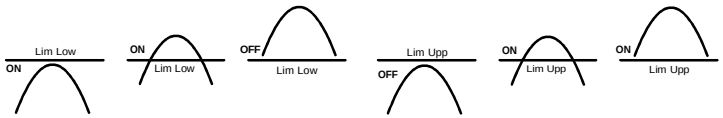
Command	Parameter	Basic unit	Meaning	Section
CALCulate:**LIM**it:**LOW**er:**STAT**e	**ON** **OFF**		→ Lower limit monitoring switched on. → Lower limit monitoring switched off.	**2.10.7** **DISP panel** LIMIT CHECK Mode → LIM LOWER Mode → OFF
CALCulate:**LIM**it:**LOW**er:**VAL**ue	**<nu>**	*)	Specifies a single lower limit value.	**2.10.7** **DISP panel** Lim Lower → VALUE:
MMEMory:**LOAD:*LIST***	***LIML**ower,* **"filename"** Query MMEM:LOAD:LIST? LIML		→ Defines a file containing the lower limit curve.	**2.10.7** **DISP panel** Lim Lower → FILE + filename"
CALCulate:**LIM**it:**FAIL?**	**<n>** Query only		Returns ON if Lim Upper values are exceeded or Lim Lower values are not attained, otherwise OFF. 	**2.10.7** **No manual control**

***) Same units as with DISPlay:TRACe[1|2]:Y:UNIT permitted.**

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3.10.6.2 PROTOCOL Analysis

Command	Parameter	Basic unit	Meaning	Section
DISPlay:***PROT**ocol**:SEL**ect*	**LCHannel**status **RCHannel**status **LUS**erdata **RUS**erdata		Selects the protocol data of the AES/EBU interface to be displayed. → Left channel: status data → Right channel: status data → Left channel: user data → Right channel: user data	**2.10.8** **DISP panel** Source → CHAN STAT L → CHAN STAT R → USER DATA L → USER DATA R
DISPlay:***PROT**ocol**:FORM**at*	**BIN**ary **HEX**adecimal **ASCii** **FILE**		Format selects the interpretation mode for user data. → User data displayed as 0101 sequence. → User data displayed as hexadecimal figures → User data displayed as plain text → Interpretation file for user data loaded with MMEMory:LOAD:PAU "filename".	**2.10.8** **DISP panel** Format → BIN → HEX → ASCII → FILE DEF
MMEMory:**LOAD:*PAU***	**"filename"**		Selects the interpretation file for user data if DISPlay:PROTocol:FORMat FILE has been set.	**2.10.8** **DISP panel** Proto File
MMEMory:**LOAD:*PAC***	**"filename"**		Selects the interpretation file for channel status data.	**2.10.8** **DISP panel** Proto File
DISPlay:***PROT**ocol:**ERR**or:**GEN**eral**?***	Query only Response: UBB SQB NSYN PRMB SQLR RERR NONE		Query only Indicates errors occurred. UBB : unexpected preamble for beginning of block (too early) SQB : no preamble (blank) for beginning of block NSYN : no preamble for beginning of block PRMB : preamble invalid SQLR : error in the channel sequence (L/R) RERR : measured and set rate differ by more than 200 ppm NONE : no error	**2.10.8** **GRAPH panel** **Display**

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Command	Parameter	Basic unit	Meaning	Section
DISPlay:***PROT***ocol:***ERR***or:***PAR***ity**?**	Query only		Query only Displays the sum of all occurred parity errors. Zero reset by reselecting the analyzer or pressing the start key.	**2.10.8 GRAPH panel Display**
DISPlay:***PROT***ocol:***ERR***or:***LCRC?***	Query only		Query only Internal counter of CRC errors (left)	**2.10.8 GRAPH panel Display**
DISPlay:***PROT***ocol:***ERR***or:***RCRC?***	Query only		Query only Internal counter of CRC errors (right)	**2.10.8 GRAPH panel Display**
DISPlay:***PROT***ocol:***CHST***atus**?**	Query only NO LTC YES		Query only Indicates changes in the channel status data. NO : No changes LTC : Changes in local-time-code only (bits 112 to 143) and CRC (bits 184 to 191). YES : Changes at another bit position.	**2.10.8 GRAPH panel Display**
DISPlay:***PROTocol:LR***?**	Query only EQUAL DIFF		Query only Channel status data between left and right channel are ... EQUAL : same DIFF : different	**2.10.8 GRAPH panel Display**
DISPlay:***PROT***ocol:***LVAL***bit**?**	Query only Y0 N1		Query only Indicates the position of the validity bit in the left channel.	**2.10.8 GRAPH panel Display**
DISPlay:***PROT***ocol:***RVAL***bit**?**	Query only Y0 N1		Query only Indicates the position of the validity bit in the right channel.	**2.10.8 GRAPH panel Display**

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3.10.7 Commands for Printing/Plotting of Screen and Storing in Files

Command	Parameter	Basic unit	Meaning	Section
HCOPy:**DEST**ination	PRSPc alias PRINter PLHPgl alias PLOTter PRPS PRHPgl FIPCx, 'filename.PCX' alias PCXFile, 'name.PCX' FIHPgl, 'filename.GL' alias HPGLfile, 'name.GL' FIPS, 'filename.PS' FIEPs, 'filename.EPS' Die Queryantworten lauten: PRIN PLOT PRHP PRPS PCXF HPGL FIPS FIEP		Screen copy → to printer in the specified printer format (PR**SPC** = **SP**e**C**ial printer format) → to plotter in HPGL format → to printer in PostScript format → to printer in HPGL format taking into account the content of the prolog file C:\UPD\REF\GL_PRO.LOG and the epilog file C:\UPD\REF\GL_EPI.LOG. → to file in PCX format → to file in HPGL format → to file in PostScript format → to file in Encapsulated PostScript format	2.14 **OPTIONS-Panel** Destin (**destination/format**) → PRINTR/SPC → PLOTTR/HPGL → PRINTR/HPGL → PRINTR/PS → FILE/PCX → FILE/HPGL → FILE/PS → FILE/EPS
HCOPy:**DEV**ice:**COL**or	**ON** **OFF**		→ PCX information stored in colours in the file specified by HCOP:DEST PCXFile, 'filename'. → PCX information stored in black/white in the file specified by HCOP:DEST PCXFile, 'filename'.	2.14 **OPTIONS panel** COLOR → ON → OFF

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Command	Parameter	Basic unit	Meaning	Section
HCOPy:**ITEM**	***ALL*** ***GRAT**icule* ***TRAC**e*		Effective only with HCOPy:DESTination PLOTter|HPGLfile → The complete screen is output, ie all labels and cursors as well as traces/bargraphs with scales. In the case of graphics windows the result display and a panel are output in addition. → Stores the traces/bargraphs with scales and scale labels but not the cursors and other labelling. → Only the trace(s) displayed is (are) transferred.	2.14 **OPTIONS panel** Copy → SCREEN → CURVE/GRID → CURVE
HCOPy:**ITEM:LAB**el**:STAT**e	**ON** **OFF**		→ Hardcopy with comment → Hardcopy without comment	2.14 **Key** H COPY or Ctrl F8
HCOPy**:DEV**ice**:*PRIN**ter***	**<n>**		Effective only with HCOPy:DESTination PRINter Selects a printer driver. The number <n> to be specified for the desired printer driver can be obtained from the printer-driver box "List of installable Printers" opened under "Printname" in the OPTIONS panel.	2.14 **OPTIONS panel** Printname
HCOPy:**ITEM**:**FRAM**e	***WHITe*** ***FDEF**ined*		Selection of background colour of GRAPH panel frame and result panel for hardcopies on a printer or storage in a .PCX file. WHITE should be selected when the characters cannot be clearly distinguished on the grey background. → White → Colour defined via file For HCOP:DEST PRSPc|FIPCx: Colour No. 2 (backgrnd frames) defined in files \UPD\REF\PRN_BW.PLT (BW printer) and \UPD\REF\PRN_CL.PLT (colour printer) is used. For HCOP:DEST PRPS|FIPS|FIEPs: The colour information for the frames of the GRAPH panel is taken from the PostScript configuration file \UPD\REF\PS.CFG, key word "Background Color" "Frame:" and "Plane:" and available as RGB information for colour PostScript pictures and as shades of grey for black/white PostScript pictures. Examples in file PS.CFG show the RGB combination for different background colours.	2.14 **OPTIONS panel** Frame → WHITE → FILE DEF

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Command	Parameter	Basic unit	Meaning	Section
HCOPy:***PLP**ort*	**COM1** **COM2** **LPT1** **IEC**		Effective only with HCOPy:DESTination PLOTter → Hardcopy via serial interface 1. → Hardcopy via serial interface 2. → Hardcopy via parallel printer interface. → Hardcopy via IEC/IEEE-bus interface.	2.14 **OPTIONS panel** Plot on → COM 1 → COM 2 → LPT 1 → IEC BUS
HCOPy:***PLAD**dress*	**<n>**		Sets the IEC/IEEE-bus address of the plotter when HCOPy:DESTination PLOTer and HCOPy:PLPort IEC has been selected.	2.14 **OPTIONS panel** → IEC Adr
HCOPy:**PAGE**:**LMAR**gin	**<n>** 0 to 80		Margin of hardcopy (number of spaces)	2.14 **OPTIONS panel** LEFT MRGN
HCOPy:**DEV**ice**:RES**olution	***HIGH*** ***MED**ium* ***LOW***		Sets the printer resolution. Whether a resolution can be set and which one depends on the printer used. → High resolution (eg 300 dpi) → Medium resolution (eg 150 dpi) → Low resolution (eg 75 dpi)	2.14 **OPTIONS panel** Prn Resol → HIGH → MEDIUM → LOW
HCOPy:**PAGE**:**SCAL**e**:X**	**<n>** 0.1 to 10		Scaling of X axis of hardcopy	2.14 **OPTIONS panel** X-SCALING
HCOPy:**PAGE**:**SCAL**e**:Y**	**<n>** 0.1 to 10		Scaling of Y axis of screen hardcopy	2.14 **OPTIONS panel** Y-SCALING
HCOPy:**PAGE**:**ORI**entation	**LAND**scape **PORT**trait		→ Hardcopy in upright format → Hardcopy in landscape format	2.14 **OPTIONS panel** ORIENTATION → LANDSCAPE → PORTRAIT

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Command	Parameter	Basic unit	Meaning	Section
HCOPy**:PAGE:WIDT**h**?**	Query only		Indicates the hardcopy width in cm. The width of a hardcopy depends on the following settings: - HCOPy:DEVice:PRINter (selected printer) - HCOPy:PAGE:SCALe:X (X scaling) - HCOPy:DEVice:RESolution (resolution)	2.14 **OPTIONS panel** Prn Width,
HCOPy**:PAGE:LENG**th**?**	Query only		Indicates the hardcopy length in cm. The length of a hardcopy depends on the following settings: - HCOPy:DEVice:PRINter (selected printer) - HCOPy:PAGE:SCALe:Y (Y scaling) - HCOPy:DEVice:RESolution (resolution)	2.14 **OPTIONS panel** Prn Height
HCOPy:**SIZE**	***A4*** ***LETT****er*		Only for HCOPy:DESTination PRPS|FIPS|FIEPs Form feed for a screen copy in PostScript format → UPD images are optimally positioned on format A4 (21 cm * 29.6 cm). → UPD images are optimally positioned on format LETTER (21.6 cm * 27.9 cm).	2.14 **OPTIONS-Panel** Paper Size → A4 → LETTER
HCOPy:**PLOT**s	**<n>** 1 ... 6		Only for HCOPy:DESTination PRPS|FIPS|FIEPs Number of UPD plots to be printed on a PostScript page.	2.14 **OPTIONS-Panel** Plots/Page

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Command	Parameter	Basic unit	Meaning	Section
SYSTem:***PRIN****t* ***TRAC****e1* ***TRAC****e2* ***EQU****alize* ***ERR****ors* ***DWEL****l* ***LIML****ower* ***LIMU****pper* ***LIST1*** ***LIST2*** ***TR1A****nd2* ***OFF***		Printout of numerals in ASCII code (including X axis). → Printout of TRACe1. → Printout of TRACe2. → Printout of equalization values → Printout of values violating limits → Printout of timing values → Printout of lower limit values → Printout of upper limit values → X axis (eg sweep) → Z axis (eg sweep) → Printout of both traces → Switched off	2.14.5 **OPTIONS-Panel** PRINT------ Type → TRACE A → TRACE B → EQUALIZATN → LIM REPORT → DWELL VALUE → LIM LOWER → LIM UPPER → X AXIS → Z AXIS → TRACE A+B → OFF

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Command	Parameter	Basic unit	Meaning	Section
HCOPy[:IMMediate]	Without parameter		Starts printout of the screen content Depending on command HCOP:DEST ... the current screen content is printed, plotted, or stored in a PCX or HPGL file or as a PostScript file, In the case of IEC/IEEE-bus control, only the result window and REMOTE are printed. A **remedy** is a HCOPY command with specified parameters which permits a hardcopy with preceding screen configuration to be printed.	**HCOPy** command via IEC/IEEE bus or Universal Sequence Controller UPD-K1

	CNF
	CF
	NCNF
	NCF
	CONF*ig*
			With setting
			HCOPy:DESTination PRINter
			One of the four parameters CNF, CF, NCNF or NCF can be added to the HCOP command for printing the screen content with a comment:
			CNF: Hardcopy with comment*, without form feed
			CF: Hardcopy with comment*, with form feed
			NCNF: Hardcopy without comment, without form feed
			NCF: Hardcopy without comment, with form feed
			Thus a specific screen configuration (3-panel, split-screen or full-screen display) can be output to the printer via IEC/IEEE bus or through UPD-K1 control.
			The desired screen configuration has to be selected before with command DISP:CONF ... (see end of section 3.10.6, Commands for Graphical Display of Results).
			The HCOP command with one of the 4 parameters switches the UPD from REMOTE to manual control, builds up the screen with the selected configuration, scans the screen content and starts the hardcopy.
			The next IEC/IEEE-bus command switches the UPD back to the REMOTE mode.
			Program example:
			`:`
			`IECOUT 20,"HCOPy:DESTination PRINter"`
			`IECNREN:' Inhibits the LOCAL key ...`
			`IECREN:'... releases key blocking.`
			`IECOUT 20,"DISP:CONF GAT":' GEN, ANLR and FILTER panel`
			`IECOUT 20,"HCOP CF":' Triggers a hardcopy with comment`
			`'  and form feed`
			`IECLLO:' Reactivates blocking of the LOCAL key.`
			`:`	

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Command	Parameter		Meaning	Section
Cont'd **HCOPy**[:IMMediate]	***CONF**ig*		Cont'd: **HCOPy:DESTination PRINter** If a screen copy without comment is output (HCOP:ITEM:LAB:STAT OFF), the desired screen configuration is first set with command DISP:CONF and then the HCOP command with parameter **CONF** is given. Program example: : **IECOUT 20,"HCOPy:DESTination PRINter"** **IECNREN**:' Inhibits the LOCAL key ... **IECREN**:'... releases key blocking. **IECOUT 20,"DISP:CONF GAT"**:' GEN, ANLR and FILTER panel **IECOUT 20,"HCOP CONF"**:' Trigg. a hcopy without comment **IECLLO**:' Reactivates blocking of the LOCAL key. :	**HCOPy** command via IEC/IEEE bus or Universal Sequence Controller UPD-K1
	***CONF**ig*		**With setting** **HCOPy:DESTination PCXFile,'filename':** The desired screen configuration has to be selected first with command DISP:CONF ... see end of section 3.10.6, Commands for Graphics Display of Results). The HCOP command with parameter **CONF** switches the UPD from REMOTE to manual control, builds up the screen with the selected configuration, scans the screen content and starts a hardcopy into the file. The next IEC/IEEE-bus command reset the UPD to the REMOTE mode. Program example: : **IECOUT 20,"HCOPy:DESTination PCXFile,'filename'"** **IECNREN**:' Inhibits the LOCAL key ... **IECREN**:'... releases key blocking **IECOUT 20,"DISP:CONF GAT"**:' GEN, ANLR and FILTER panel **IECOUT 20,"HCOP CONF"**:' Triggers a hardcopy without comment **IECLLO**:' Reactivates blocking of the LOCAL key. :	

*) The comment is stored in file C:\UPD\REF\COMMENT.TXT where it may be modified in the DOS operating system using an ASCII editor.

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Command	Parameter		Meaning	Section

Cont'd
HCOPy[:IMMediate]
	***TITL**e*
	***SUPP**lement*
			With settings
			HCOPy:DESTination PRPS
			HCOPy:DESTination FIPS, 'filename.PS'
			HCOPy:DESTination FIEPs, 'filename.EPS'
			
			A comment* can be added to the PostScript plot as a **TITLe** or caption (**SUPP**lement).
			
			Thus a specific screen configuration (3-panel, split-screen or full-screen display) can be output to the PostScript printer or a PostScript file via IEC/IEEE bus or through UPD-K1 control.
			A selection can be made with command HCOPy:ITEM ALL|GRAT|TRAC whether the whole screen content (ALL), only traces and scales (GRAT) or only traces (TRAC) are output as PostScript plot or stored in a PostScript file.
			When a hardcopy of traces is to be made (HCOP:ITEM GRAT|TRAC) make sure that the screen configuration selected with
			DISP:CONF P|SP|AP|GP|FP|DP|OP allows traces to be plotted.
			The HCOP command with one of the three parameters
			switches the UPD from the REMOTE to the manual control mode,
			builds up the selected configuration,
			scans the screen content and starts the hardcopy.
			The next IEC/IEEE-bus command resets the UPD to REMOTE.
			
			Program example:
			`:`
			`IECOUT 20,"HCOPy:DESTination FIPS, 'filename.PS'"`
			`IECNREN:' Inhibits the LOCAL key ...`
			`IECREN:'... disables key blocking.`
			`IECOUT 20,"DISP:CONF GAT":' GEN, ANLR and FILTER panel`
			`IECOUT 20,"HCOP TITL":' Triggers a hardcopy with a comment as a title`
			`IECLLO:' Reactivates blocking of the LOCAL key.`
			`:`
				HCOPy command via IEC/IEEE bus or Universal Sequence Controller UPD-K1

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Command	Parameter		Meaning	Section

Cont'd
HCOPy[:IMMediate]
	CONFig		Cont'd:
			With settings
			HCOPy:DESTination PRPS
			HCOPy:DESTination FIPS, 'filename.PS'
			HCOPy:DESTination FIEPs, 'filename.EPS'
			
			If a screen copy without comment (HCOP:ITEM:LAB:STAT OFF) is output, the desired screen configuration is first set with command DISP:CONF and then the HCOP command with parameter CONF is triggered.
			
			Program example:
			`:`
			`IECOUT 20," HCOPy:DESTination FIPS, 'filename.PS' "`
			`IECNREN:' Inhibits the LOCAL key ...`
			`IECREN:'... disables key blocking.`
			`IECOUT 20,"DISP:CONF GAT":' GEN, ANLR and FILTER panel`
			`IECOUT 20,"HCOP CONF":' Trigg. a hcopy without comment`
			`IECLLO:' Reactivates blocking of the LOCAL key.`
			`:`
				HCOPy command via IEC/IEEE bus or Universal Sequence Controller UPD-K1

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Command	Parameter		Meaning	Section

Cont'd
HCOPy[:IMMediate]
	***CONF**ig*		**With settings**
			HCOPy:DESTination PLOTter and
			HCOPy:DESTination PRHPgl
			HCOPy:DESTination HPGLfile,'filename':
			
			The default parameter **CONF** triggers a hardcopy to a plotter, a HPGL-compatible printer or a HPGL file with preceding screen configuration.
			A comment cannot be output.
			In addition to the screen configuration selected with DISP:CONF ... a selection can be made with command HCOPy:ITEM ALL|GRAT|TRAC whether the total screen content (ALL), only traces with scales (GRAT) or only traces (TRAC) are plotted or transferred to the HPGL file. When traces are to be plotted (HCOP:ITEM GRAT|TRAC) make sure that a screen configuration allowing traces to be plotted has been selected with DISP:CONF P|SP|AP|GP|FP|DP|OP.
			
			The HCOP command with one of the three parameters switches the UPD from REMOTE control to manual control, builds up the screen with the selected configuration,
			scans the screen content and starts the hardcopy.
			The next IEC/IEEE-bus command resets the UPD to REMOTE control.
			
			Program example:
			`:`
			`IECOUT 20,"HCOPy:DESTination PLOTter"`
			`IECNREN:' Inhibits the LOCAL key ...`
			`IECREN:'... releases key blocking.`
			`IECOUT 20,"DISP:CONF GAT":' GEN, ANLR and FILTER panel`
			`IECOUT 20,"HCOP CONF":' Triggers a hardcopy`
			`IECLLO:' Reactivates blocking of the LOCAL key.`
			`:`
			
			Note:
			No further HCOP command may be given while a hardcopy is being executed (printed), since a command would abort the printout.
				HCOPy command via IEC/IEEE bus or Universal Sequence Controller UPD-K1

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Command	Parameter		Meaning	Section
HCOPy**:ABOR**t			Aborts the hardcopy.	2.14 **Key** H COPY or CTRL F8
HCOPy:**WAIT**			This command is only suitable for the Universal Sequence Controller UPD-K1, as screen configuration and hardcopy output to a printer, plotter or a PCX or HPGL file are only possible with the controller program. In contrast to the HCOP command, with HCOP:WAIT the next command is only executed when the high-speed printout in the background is completed. Consequently, several HCOP:WAIT commands can be given successively without the current printout being aborted as would be the case with the HCOP command.	**No manual control**

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3.10.8 Setting and Display of Auxiliary Parameters

3.10.8.1 IEC/IEEE-Bus Address

Command	Parameter	Basic unit	Meaning	Section
SYSTem:**COMM**unicate:**GPIB:ADDR**ess	**<n>** 0 to 31		IEC/IEEE bus address of UPD	**2.15.1** **OPTIONS panel** UPD IECadr

3.10.8.2 MAKRO-Betrieb

Command	Parameter	Basic unit	Meaning	Section
SYSTem:**PROG**ram:**EXEC**ute	**'filename'**		By means of this command any BASIC program with the name <filename> (preferred file extension: *.BAS) can be loaded and started. After the program has been quit, a 1→0 transition is generated in the RUN bit (#14) of the operation register. This is communicated to the controller via SRQ or serial poll so that it can fetch the measurement results. Data exchange between the external control program and the BASIC program can be performed via the measurement-result displays, the measurement-result buffers or the block data input/output by adding on the command SYST:PROG **<n>**{,**<n>**}. For a detailed example see **3.15.18 Call a BASIC-Macro**. Only in IEC/IEEE-bus or RS232-remote-control mode can a BASIC macro be started with this command. A program supplied by the Universal Autorun Control UPD-K1 **cannot** start a BASIC macro.	2.16 **OPTIONS-Panel** Exec Macro <filename>
SYSTem:**PROG**ram[:DATA]	**<n>**{,**<n>**}		Up to 1024 various floating-point values can be transferred to the external control program from a BASIC macro. To do this, the values are written to the block buffer by the BASIC macro and then read by the external control program. For a detailed example see **3.15.18 Call a BASIC-Macro**.	3.15.18 **No manual control**
SYSTem:**PROG**ram:**POIN**ts?	**<n>** 0 ... 1024 Query only		Number of the available block-data values written to the block buffer by the BASIC macro.	3.15.18 **No manual control**

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3.10.8.3 Switching the Beeper On/Off

Command	Parameter	Basic unit	Meaning	Section
SYSTem:**BEEP**er:**STAT**e	**ON** **OFF**		→ Beeper on → Beeper off	**2.15.2** **OPTIONS panel** Beeper → ON → OFF

3.10.8.4 Parameter Link

Command	Parameter	Basic unit	Meaning	Section
SYSTem:***PAR**ameter**:LINK***	**<n>** *) 0 to 2047		Permits generator or analyzer settings to be transferred to another signal or measurement function or another instrument.	2.15.9 **OPTIONS panel** Param. Link

MSB										LSB	
d10	d9	d8	d7	d6	d5	d4	d3	d2	d1	d0	Data bit
1024	512	256	128	64	32	16	8	4	2	1	Weighting

Example: Function of d0, d3, d9 and d10 required
Data word: 11000001001
Weighting = 1+8+512+1024 = 1545
n =1545

d0: Function settings are retained when the signal function changes.
d1: Output configuration is retained when the generator changes.
d2: Functions and their settings are retained when the generator changes.
d3: Function settings are retained when the measurement function changes.
d4: Input settings are retained when the analyzer changes.
d5: START COND settings are retained when the analyzer changes.
d6: INPUT DISP settings are retained when the analyzer changes.
d7: FREQ/PHASE settings are retained when the analyzer changes.
d8: not used
d9: Functions and their settings are retained when the analyzer changes.
d10: A suitable measurement function is set when the signal function changes.

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3.10.8.5 Parameters of COM2 Interface

The parameters to be set here are valid for a plotter hardcopy (HCOP:DEST PLHPgl), a HPGL printer (HCOP:DEST PRHPgl) ar a PostScript printer (HCOP:DEST PRPS) when the COM2 interface is selected

Command	Parameter	Basic unit	Meaning	Section
SYSTem:**COMM**unicate:**SER**ial2:**FEED**:**BAUD**	**<n>** n = **2400** **3600** **4800** **7200** **9600** **19200** **38400** **56000**		Transmission rate in baud (bits/s) (Default setting: 9600)	**2.15.1** **OPTIONS panel** Baud Rate → 2400 baud → 3600 baud → 4800 baud → 9600 baud → 19200 baud → 38400 baud → 56000 baud
SYSTem:**COMM**unicate:**SER**ial**2**:**FEED**:**PAR**ity[:TYPE]	**NONE** **EVEN** **ODD**		Parity check → Parity check switched off → Check for *even* parity (default setting) → Check for *odd* parity	**2.15.1** **OPTIONS panel** Parity → NONE → EVEN → ODD
SYSTem:COMMunicate:SERial**2**:**FEED:BITS**	**<n>** n = 7|8		Number of data bits (default setting: 7)	**2.15.1** **OPTIONS panel** Data Bits → 7 → 8
SYSTem:**COMM**unicate:**GTL**			Return to manual operation.	**LOCAL keystroke**

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Command	Parameter	Basic unit	Meaning	Section
SYSTem:**COMM**unicate:**SER**ial**2**:**FEED:SBIT**s	**<n>** n = 1|2		Number of stop bits (default setting: 1)	**2.15.1** **OPTIONS panel** Stop Bits → 1 → 2
SYSTem:**COMM**unicate:**SER**ial**2**:**CONT**rol	**RTS** **XON**		Type of synchronization → Hardware handshake via RTS and CTS lines (default setting) → Software handshake	**2.15.1** **OPTIONS panel** Handshake → RTS/CTS → XON/XOFF

3.10.8.6 Keyboard Settings

Command	Parameter	Basic unit	Meaning	Section
SYSTem:**KEY:*RRAT***e	**<nu>** 0 to 20 Hz	Hz	Repetition rate of UPD and AT keyboard	**2.15.3** **OPTIONS panel** Reptn Rate
SYSTem:**KEY:*RDEL***ay	**<nu>** 0.25 to 1.0 s	s	Response delay of UPD and AT keyboard	**2.15.3** **OPTIONS panel** Rep Delay

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3.10.8.7 Setting and Switching Off the Displays

Command	Parameter	Basic unit	Meaning	Section
DISPlay**:MODE**	***INT**ern* ***COLB**oth* ***BWB**oth*		→ Display on internal LCD → Additional display on external colour monitor → Additional display on external monochrome monitor	**2.15.5** **OPTIONS panel** Extrn Disp → INTERN ONLY → BOTH COLOR → BOTH B/W
DISPlay**:*ANN**otation**[*:ALL*]**	***ON*** ***OFF***		→ Display of measurement results and status → Result and status display cleared (FFT, sweep and IEC/IEEE-bus operation speeded up).	**2.15.5** **OPTIONS panel** Meas Disp → ON → OFF Ext. Keyboard: CTRL D
DISPlay:***ACT**ualize*	***ON*** ***OFF***		This command may be called from Universal Autorun Control UPD-K1 or via the IEC/IEEE bus remote control. → Updates the graphics panel and repeats the update every time commands are output which change the graphics display in the UPD, eg DISPlay[:WINDow]:TRACe[]:X :[SCALe]:AUTO ON. → The graphics panel is not updated not even after commands changing the graphics display in the UPD. ***Note:*** *To enhance speed, it is best to **turn off the graphic when the remote-control mode is selected**. Graphics should only be activated when traces are to be displayed.*	**No manual control**
DISPlay:***ENAB**le*	***ON*** ***OFF***		→ LCD active → Switch off LCD to reduce interference from the high-frequency magnetic field of the LCD lighting.	**2.1.1** **Taste** OFF LCD or CTRL F10

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Command	Parameter	Basic unit	Meaning	Section
SYSTem:*DISP*lay*:READ*ing*:RATE	***MAXS*peed** **FSTS**peed **MEDS**peed **SLWS**peed		Presetting for manual control. Determines the rate for the output of measured values in the result windows. The setting is only effective in the continuous measurement mode. In the case of sweeps and triggered measurements as well as with all measurements via IEC/IEEE bus, results are always output at maximum speed. → Max. output speed → 6 results/second → 3 results/second → 1 result/second	**2.15.5** **OPTIONS panel** Read Rate → MAX SPEED → 6/s → 3/s → 1/s
SYSTem:*DISP*lay*:READ*ing*:RES*olution	**<n>**		Presetting for manual control. Sets the number of decimal digits for the display of measured values in the result windows. With measurements via IEC/IEEE bus results are always displayed with maximum resolution. Decimal digits for the 6 result windows are specified by 6 numbers between 0 and 6 (higher numbers are interpreted as 6). 0 Automatic display of decimal digits 1... 6 1 to 6 decimal digits Each number is assigned to a result window: Function / Input peak / Frequency CH1: Window 1 / Window 3 / Window 5 CH2: Window 2 / Window 4 / Window 6 SYSTem:DISPlay:READing:RESolution 112244 Window 6 Window 5 Window 4 Window 3 Window 2 Window 1 Leading zeros may be omitted so that for <n> = 34, for example, the result in window 6 is displayed with 4 decimal digits, the result in window 5 with 3 and the results in windows 1 to 4 without any decimal digits at all.	**2.15.5** **OPTIONS panel** Read Resol

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Command	Parameter	Basic unit	Meaning	Section
SYSTem:**DISP**lay:**TRAC**e[]:**LOAD**	**MAN**ual **DEF**ault **ACOL**or **ALIN**e		→ For each scan of a trace group (to be selected with the subsequent command SYST:DISP:TRAC[1|**2**]:SEL <n>) a colour and the line pattern can be selected for the display. → Automatic assignment of colour and line pattern to max. 17 scans for Trace A and Trace B. All scans of Trace A are green, those of Trace B yellow with thin continuous lines. → Automatic assignment of colour to 17 scans for Trace A and Trace B. → Automatic assignment of line pattern to 17 scans of Trace A and Trace B.	**2.15.5.4** **OPTIONS panel** Scan conf → MANUAL → DEFAULT → AUTO COLOR → AUTO LINE
SYSTem:**DISP**lay:**TRAC**e[1|**2**]:**SEL**ect	**<n>** 1 to17		Scan number of trace group to which a colour or line pattern is to be assigned with the two subsequent commands SYST:DISP:TRAC[1|**2**]:COL and SYST:DISP:TRAC[1|**2**]:LINE for screen display.	**2.15.5.4** **OPTIONS panel** Scannr.(A) Scannr.(B)
SYSTem:**DISP**lay:**TRAC**e[1|**2**]:**COL**or	**GRE**en **YELL**ow **BLUE** **CYAN** **MAG**enta **WHIT**e **BLAC**k **DGR**ay **LGR**ay		Assignment of colour to the scan number specified with command SYST:DISP:TRAC[1|**2**]:SEL <n> when colour display is selected. Shades of grey with monochrome display selected. Newly assigned colours are only visible on the screen after the LOCAL mode has been restored.	**2.15.5.4** **OPTIONS panel** Color (A) / (B) → GREEN → YELLOW → BLUE → CYAN → MAGENTA → WHITE → BLACK → DARK GRAY → LIGHT GRAY

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Command	Parameter	Basic unit	Meaning	Section
SYSTem**:DISP**lay**:TRAC**e[1|**2**]**:LINE**	**SSOL**id **SD** **SP** **SPD** **DSOL**id **DD** **DP** **DPD**		Line patterns for the scan number specified with command SYST:DISP:TRAC[1|**2**]:SEL <n>. → thin continuous line → dashed line → dotted line → dash-dot line → three-times-wide continuous line → dashed line → dotted line → dash-dot line The newly assigned line pattern is only visible on the screen after the LOCAL mode has been restored.	**2.15.5.4 OPTIONS panel** Line (A) / (B) → —————— → - - - - - - → . . . . . . → . - . - . - → ═══════ → ====== → : : : : : : → : = : = : =

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3.10.8.8 Version Display

Command	Parameter	Basic unit	Meaning	Section
SYSTem:***SOFT***ware:***VERS***ion**?**	Query only ***UI*** ***HW*** ***IEC*** The response is the number of a version (eg 3.05).		Version number → software for user interface → software for hardware module → software for IEC/IEEE-bus module (Option UPD-B4)	2.15.7 **OPTIONS panel** UI HW IEC
SYSTem:***AHAR***dware:***VERS***ion**?**	Query only ***ACH1*** ***ACH2*** ***MBO***ard ***GEN***erator ***DAC*** The response is either the number of a version (eg 0.01) or -NA- (Not Available) if the board is not installed.		Version number → Analog analyzer channel 1, with DAC board, only → Analog analyzer channel 2, with or without DAC board → Analog analyzer motherboard → Analog generator output circuit → Analog generator DAC board	2.15.7 **OPTIONS panel** Anlg Board → Analy Ch1 → Analy Ch2 → Motherbrd → Output Cir → DAC Board
SYSTem:***DHAR***dware:***VERS***ion**?**	Query only ***ANAL***ysator ***GEN***erator The response is the number of a version (eg 0.05).		Version number → Digital analyzer → Digital generator	2.15.7 **OPTIONS panel** Digl Board → Analyzer → Generator

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Command	Parameter	Basic unit	Meaning	Section
SYSTem:***OPT***ions:***VERS***ion**?**	Query only ***LDG*** ***IECB***oard ***AES***ebu ***SPKS***witcher ***AHSP***eed ***DHSP***eed ***GNON*** ***JITT***er The response is either the number of an option (eg 0.01), INST or -NA- (Not Available) if the board or option are not installed.		Option number → Low-distortion generator (option) → IEC-625/IEEE-488 interface (option) → AES/EBU interface (option) → Audio monitor/parallel I/O → Highspeed option, analog → Highspeed option, digital → Spare generator board → Option Jitter	2.15.7 **OPTIONS panel** → Low Dist → IEC Board → AES/EBU → SKP/SWI → Highsp Anl → Highsp Dig → Noname GEN → Jitter Opt

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3.10.8.9 Switcher

Command	Parameter	Basic unit	Meaning	Section
***SWITcher*:STATe**	**ON** **OFF**		→ Switcher control on → Switcher control off	2.15.6 **OPTIONS panel** Switcher → ON → OFF
SWITcher*:*TRACking	**ON** **OFF**		→ Switcher control with automatic channel offset → Switcher control without automatic channel offset	2.15.6.7.2 2.15.6.7.1 **OPTIONS panel** Tracking → ON → OFF
***SWITcher*:OFFSet:*CH2V*1**	<**n**> -192 to 192		Offset of channel B (Ch2) compared with channel A (Ch1) between input and output switch.	2.15.6.7 **OPTIONS panel** Ch2 vs Ch1
SWITcher*:*OVI	<**n**> -192 to 192		Offset between the through-connected channels of an output switch compared with those of an input switch.	2.15.6.7 **OPTIONS panel** Out vs Inp
***SWITcher*:INPut[1]**	<**n**> 0 to 192		Channel through-connected on the A-rail of the input switch.	2.15.6.7 **OPTIONS panel** Inp Ch1 (A)
***SWITcher*:INPut2**	<**n**> 0 to 192		Channel through-connected on the B-rail of the input switch.	2.15.6.7 **OPTIONS panel** Inp Ch2 (B)
***SWITcher*:OUTPut[1]**	<**n**> 0 to 192		Channel through-connected on the A-rail of the output switch.	2.15.6.7 **OPTIONS panel** Out Ch1 (A)

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Command	Parameter	Basic unit	Meaning	Section
***SWITcher*:OUTPut2**	<**n**> SWIT:TRAC **OFF**: –1 to 192 SWIT:TRAC **ON**: 0 to 192		Channel through-connected on the B-rail of the output switch. If -1 is specified and - SWIT:OUTP 0 is set, all channels of the B-rail of the output switch are through-connected. - SWIT:OUTP ≠ 0 is set, all channels of the B-rail of the output switch are through-connected except the one specified.	2.15.6.7 **OPTIONS panel** Out Ch2 (B)

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3.10.8.10 Calibration

Command	Parameter	Basic unit	Meaning	Section
CALibrate:**LDG**:**AUTO**	**OFF** **ONCE**		→ No calibration of low-distortion generator → Triggers an automatic calibration of the low-distortion generator. This should be after one hour of operation at the earliest.	2.15.6.7 **OPTIONS panel** CALIBR. GEN LDG Auto → OFF → ONCE
CALibrate:**ZERO**:**AUTO**	**OFF** **ON** **ONCE**		→ No offset calibration → Offset calibration cyclic and after a change of analyzer/instrument. → Manual triggering of offset calibration; then reset to ON	2.15.6 **OPTIONS panel** CALIBR. ANL Zero Auto → OFF → ON → ONCE
CALibrate	**OFF** **AUTO** **DCC** **LDG**		→ No offset calibration. Equivalent to CALibrate:ZERO:AUTO OFF. → Offset calibration cyclic and after a change of analyzer/instrument. Equivalent to CALibrate:ZERO:AUTO ON. → Manual triggering of offset calibration; then reset to AUTO. Equivalent to CALibrate:ZERO:AUTO ONCE. → Automatic calibration of low-distortion generator. This should be after one hour of operation at the earliest. Equivalent to CALibrate LDG:AUTO ONCE.	2.15.6 Alias for CAL:LDG:AUTO, CAL.ZERO:AUTO
CALibrate:**JITT**er:**AUTO**	**OFF** **ONCE**		→ No calibration of digital Phase to Ref measurement → Manual trigger of automatic calibration of digital Phase to Ref measurement, then reset to OFF.	2.15.6 **OPTIONS panel** CALIBR. DIG PhaseToRef → OFF → ONCE

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3.10.8.11 Speed for Loading Setups and Analyzer Measurement Functions

Command	Parameter	Basic unit	Meaning	Section
SYSTem:**LSP**eed	**FAST**		Speed for loading setups and analyzer measurement functions → While **FAST** is active, loading of setups and analyzer measurement functions can be speeded up (considerably compared to SLOW) if the following minor limitations are accepted: • When setups are loaded and analyzer measurement functions changed, the graphics system is not initialized and IEC/IEEE-bus commands have no effect and are rejected with an error message. The K1 commands UPDGTLU and UPDGTLG cannot be used for the graphics display (see section 3.16.4.3, Basic Extensions). • When analyzer measurement functions are changed, the current function is not stored, ie on switching back to the previous function the parameters valid in the slower mode (SYST:LSP SLOW) are restored. • While *RST is executed, the result output is suppressed as if command DISP:ANN OFF was given. When the IEC/IEEE-bus mode is quit (with LOCAL key or IEC/IEEE-bus command GTL), the slower load mode is automatically set without the above limitations.	**No manual control**
	SLOW		→ Without limitations, therefore slower than FAST (default setting).	

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3.10.9 Commands for Data Output

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]**:DATA**1|2**?**	**<nu>**	Depending on FUNC	Returns the measured value of the 1st analyzer for RMS, RMSS, PEAK, QPE, DC, THD, THDN, MDIST, DFD and WAF functions. DATA1 selects input channel 1 DATA2 selects input channel 2.	**3.15.8** **No manual control** **Result display**
SENSe**2:DATA**1|2**?**	**<nu>**	V/FS	Returns the measured value of the 2nd analyzer (peak voltage meter). DATA1 selects input channel 1 DATA2 selects input channel 2.	**3.15.8** **No manual control** **Result display**
SENSe**3:DATA**1|2**?**	**<nu>**	Hz	Returns the measured value of 3rd analyzer (frequency counter). DATA1 selects input channel 1 DATA2 selects input channel 2.	**3.15.8** **No manual control** **Result display**
SENSe**4:DATA?**	**<nu>**	DEG	Returns the measured value of the 4th analyzer (phase meter).	**3.15.8** **No manual control** **Result display**

Write access to the measurement-result buffers is also possible with Universal Autorun Control (UPD-K1) or remote control (IEC/IEEE bus interface). This is of particular interest for operation with BASIC macros:

- The measurement results calculated by a BASIC macro can be displayed in the usual measurement-result window.
- Any floating-point parameters and measurement results may be exchanged between the BASIC macro and the controller via the measurement-result buffers.

For a detailed example see **3.15.18 Call a BASIC-Macro**.

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3.10.10 Commands for Input/Output of Block Data

Command	Parameter	Basic unit	Meaning	Section
FORMat[:DATA]	**ASCI**i **REAL**		→ Determines the numeric format for block data only. Output of numbers with sign, point and exponent, if any (default). → Determines the numeric format for block data only. Output in binary form.	**2.9.1.2** **No manual control**
SENSe[1]:**LIST:FREQ**uency **SOUR**ce[1]:**LIST:FREQ**uency	**<n>**{,**<n>**} **<n>**{,**<n>**}	Hz	These two commands are identical and specify the block data for a frequency sweep or frequencies for a sequence of measurements. When limit or equalization curves are specified, the frequencies are to be sorted in ascending or descending order.	**2.9.1.3** **No manual control**
SENSe[1]:**LIST:FREQ**uency:**POIN**ts**?** **SOUR**ce[1]:**LIST:FREQ**uency:**POIN**ts**?**	**<n>** 0 to 1024 Query only		The two commands are identical and return the number of currently available block data for the frequency axis.	**2.9.1.3** **No manual control**
SOURce[1]:**LIST:VOLT**age	**<n>**{,**<n>**}	V	Specifies the block data for a voltage sweep or the output voltage for a sequence of measurements.	**2.9.1.3** **No manual control**
SOURce[1]:**LIST:VOLT**age:**POIN**ts**?**	**<n>** 0 to 1024 Query only		Returns the number of currently available block data for the voltage axis.	**2.9.1.3** **No manual control**
SOURce[1]:**LIST:*ONT****ime***	**<n>**{,**<n>**}	S	Specifies the block data for a sweep of the on-time and off-time ratio of the burst signal or of a sequence of measurements.	**2.9.1.3** **No manual control**
SOURce[1]:**LIST:*ONT****ime*:POIN**ts**?**	**<n>** 0 to 1024 Query only		Returns the number of currently available block data for the on-time axis.	**2.9.1.3** **No manual control**
SOURce[1]:**LIST:*INT****erval***	**<n>**{,**<n>**}		Specifies the block data for a sweep of the on-time to off-time ratio of the burst signal or a sequence of measurements.	**2.9.1.3** **No manual control**

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Command	Parameter	Basic unit	Meaning	Section
SOURce[1]:**LIST:DWEL**l	**<n>**{,**<n>**}	s	Specifies the block data for the dwell time of a sweep or a measurement sequence.	**2.9.1.3 No manual control**
SOURce[1]:**LIST:DWEL**l:**POIN**ts**?**	**<n>** 0 to 1024 Query only		Returns the number of currently available block data for the dwell time.	**2.9.1.3 No manual control**
SOURce[1]:**LIST:DWEL**l:**CONT**rol[:DATA]	**<n>**{,**<n>**}		X axis for the dwell time.	**2.9.1.3 No manual control**
SOURce[1]:**LIST:DWEL**l:**CONT**rol:**POIN**ts**?**	**<n>** 0 to 1024 Query only		Returns the number of currently available block data for the dwell time.	**2.9.1.3 No manual control**
SOURce[1]:**VOLT**age:**EQU**alize[:DATA]	**<n>**{,**<n>**}		Specifies the block data for the voltage axis of the equalization curve.	**2.9.1.3 No manual control**
SOURce[1]:**VOLT**age:**EQU**alize:**POIN**ts**?**	**<n>** 0 to 1024 Query only		Returns the number of currently available block data for the voltage equalization list.	**2.9.1.3 No manual control**
SOURce[1]:**EQU**alize:**CONT**rol[:DATA]	**<n>**{,**<n>**}		Specifies the block data for the frequency axis of the equalization curve.	**2.9.1.3 No manual control**
SOURce[1]:**EQU**alize:**CONT**rol:**POIN**ts**?**	**<n>** 0 to 1024 Query only		Returns the number of currently available block data for the frequency axis of the equalization curve.	**2.9.1.3 No manual control**
CALCulate:**LIM**it**:UPP**er[:DATA]	**<n>**{,**<n>**}	1)	Returns the block data for the Y axis of the upper limit curve.	**2.9.1.3 No manual control**

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Command	Parameter	Basic unit	Meaning	Section
CALCulate:**LIM**it:**UPP**er:**TRAC**e	**<n>**{,**<n>**}		Returns the block data for the y axis of the **upper** limit trace interpolated along the x axis. The command `trac:points? list1` gives the number of x values, which were used for interpolation. It is the same as the number of interpolated y values for the **upper** limit trace.	2.9.1.3 **No manual control**
CALCulate:**LIM**it**:UPP**er:**POIN**ts**?**	**<n>** 0 to 1024 Query only		Returns the number of currently available block data for the Y axis of the upper limit curve.	**2.9.1.3** **No manual control**
CALCulate:***LIMit:UPPer:CONTrol***[**:DATA]	**<n>**{,**<n>**}		Returns the block data for the X axis of the limit curves	**2.9.1.3** **No manual control**
CALCulate:**LIM**it**:UPP**er:**CONT**rol:**POIN**ts**?**	**<n>** 0 to 1024 Query only		Returns the number of currently available block data for the X axis of the limit curves.	**2.9.1.3** **No manual control**
CALCulate:**LIM**it**:LOW**er[:DATA]	**<n>**{,**<n>**}	1)	Returns the block data for the Y axis of the lower limit curve.	**2.9.1.3** **No manual control**
CALCulate:**LIM**it:**LOW**er:**TRAC**e	**<n>**{,**<n>**}		Returns the block data for the y axis of the **lower** limit trace interpolated along the x axis. The command `trac:points? list1` gives the number of x values, which were used for interpolation. It is the same as the number of interpolated y values for the **lower** limit trace.	2.9.1.3 **No manual control**
CALCulate:**LIM**it**:LOW**er:**POIN**ts**?**	**<n>** 0 to 1024 Query only		Returns the number of currently available block data for the Y axis of the lower limit curve.	**2.9.1.3** **No manual control**
CALCulate:**LIM**it**:LOW**er:**CONT**rol[:DATA]	**<n>**{,**<n>**}		Returns the block data for the X axis of the limit curves.	**2.9.1.3** **No manual control**

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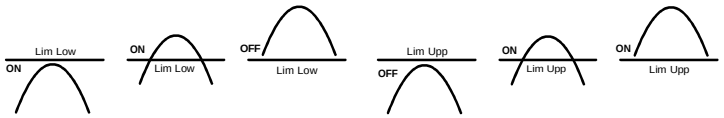
Command	Parameter	Basic unit	Meaning	Section
CALCulate:**LIM**it:**LOW**er:**CONT**rol:**POIN**ts**?**	**<n>** Query only		Returns the number of currently available block data for the X axis of the limit curves.	**2.9.1.3** **No manual control**
CALCulate:**LIM**it:**FAIL?**	Query only		Returns ON if Lim Upper values are exceeded or Lim Lower values are not attained, otherwise OFF. 	**2.9.1.3** **No manual control**
CALCulate:**LIM**it:**REP**ort[:DATA]**?**	**<n>**{,**<n>**}Query only		Returns the block data of limit violations.	**2.9.1.3** **No manual control**
CALCulate:**LIM**it:**REP**ort:**POIN**ts**?**	**<n>** 0 to 1024 Query only		Returns the number of currently available block data of limit violations.	**2.9.1.3** **No manual control**
TRACe[:DATA]**TRAC**e**1,**	**<n>**{,**<n>**} Query: TRACe[:DATA]? TRACe1	1)	Returns the block data of the first measurement sequence (Y1 axis).	**2.9.1.3** **No manual control**
TRACe:**POIN**ts**? TRAC**e**1**	**<n>** 0 to 1024 Query only		Returns the number of currently available block data of the first measurement sequence (Y1 axis).	**2.9.1.3** **No manual control**
TRACe[:DATA]**TRAC**e**2,**	**<n>**{,**<n>**} Query: TRACe[:DATA]? TRACe2	1)	Returns the block data of the second measurement sequence (Y2 axis).	**2.9.1.3** **No manual control**
TRACe:**POIN**ts? **TRAC**e**2**	**<n>** 0 to 1024 Query only		Returns the number of the currently available block data of the second measurement sequence (Y2 axis).	**2.9.1.3** **No manual control**

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Command	Parameter	Basic unit	Meaning	Section
TRACe[:DATA]**LIST1,**	**<n>**{,**<n>**} Query: TRACe[:DATA]? LIST1	2)	Returns the block data of the first sweep list (X axis).	**2.9.1.3** **No manual control**
TRACe**:POIN**ts**? LIST1**	**<n>** 0 to 1024 Query only		Returns the number of the currently available block data of the first sweep list (X axis).	**2.9.1.3** **No manual control**
TRACe[:DATA]**LIST2,**	**<n>**{,**<n>**} Query: TRACe[:DATA]? LIST2	2)	Returns the block data of the second (convoluted, nested) sweep list (Z axis).	**2.9.1.3** **No manual control**
TRACe**:POIN**ts**? LIST2**	**<n>** 0 to 1024 Query only		Returns the number of the currently available block data of the second (convoluted, nested) sweep list (Z axis).	**2.9.1.3** **No manual control**
TRACe[:DATA]**REF**erence**1**,	**<n>**{,**<n>**} Query: TRACe[:DATA]? REF1		Loads the running reference values for the Y axis.	**2.9.1.3** **No manual control**
TRACe:**POIN**ts**? REF**erence**1**	**<n>** 0 to 1024 Query only		Returns the number of the currently available block data for the Y axis of trace A.	**2.9.1.3** **No manual control**
TRACe[:DATA]**REF**erence**2**,	**<n>**{,**<n>**} Query: TRACe[:DATA]? REF2		Loads the running reference values for the Y axis of trace B	**2.9.1.3** **No manual control**
TRACe:**POIN**ts**? REF**erence**2**	**<n>** 0 to 1024 Query only		Returns the number of the currently available block data for the Y axis of trace B.	**2.9.1.3** **No manual control**

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Command	Parameter	Basic unit	Meaning	Section
TRACe[:DATA]**CREF**erence1,	**<n>**{,**<n>**} Query: TRACe[:DATA]? CREF1		Loads the running reference values for the X axis of trace A.	**2.9.1.3** **No manual control**
TRACe:**POIN**ts**? CREF**erence1	**<n>** 0 to 1024 Query only		Returns the number of the currently available block data for the X axis of trace A.	**2.9.1.3** **No manual control**
TRACe[:DATA]**CREF**erence**2**,	**<n>**{,**<n>**} Query: TRACe[:DATA]? CREF2		Loads the running reference values for the X axis of trace B	**2.9.1.3** **No manual control**
TRACe:**POIN**ts**? CREF**erence**2**,	**<n>** 0 to 1024 Query only		Returns the number of the currently available block data for the X axis of trace B.	**2.9.1.3** **No manual control**

1) Depending on DISPlay:TRACe:FEED and (with SENSe1:DATA) of SENSe1:FUNCtion
2) Depending on sweep selected for generator and analyzer.

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3.10.11 Commands for Status and Error Queries

Command	Parameter	Basic unit	Meaning	Section
STATus:**PRES**et			Resets the Enable registers of the OPERation, QUEStionable and XQUEstionable registers to 0. See **3.7.5 Resetting the Status** Reporting Systems.	**3.7.5 No manual control**
STATus:**OPER**ation:**COND?**	**<n>** Query only		Outputs the contents of the CONDition register as a decimal number (current value of Operating Status of UPD). For the weighting of the individual bits see **3.7.3.4 STATus:OPERation Register** Reading out does not clear the register.	**3.7.3.4 No manual control**
STATus:**OPER**ation[:EVENt]**?**	**<n>** Query only		Outputs the content of the EVENt register as a decimal number. A bit set in the EVENt register indicates a change of the corresponding bit in the CONDition register. The entry in the PTRansition and NTRansition registers determines whether a bit transition from 0 to 1 or from 1 to 0 causes an entry in the EVENt register. Reading out clears the register!	**3.7.3.4 No manual control**
STATus:**OPER**ation:**ENAB**le	**<n>** .... 0 0 **1** 0 0 **1** 0 0 ... .d7 d6 d5 d4 d3 d2 d1 d0 Beispiel: d2 und d5 gesetzt: **<n>** = 36 (4 + 32)		Sets the ENABle mask which validates a bit in the EVENt register. Example: When d5 is set in the ENABle mask, the "Waiting for Trigger" event is set in the EVENt register provided the bit has changed. Default setting: every bit reset (0)	**3.7.3.4 No manual control**
STATus:**OPER**ation:**PTR**ansition	**<n>**		If a bit is set in the PTRansition register, the transition from 0 to 1 of the corresponding bit in the CONDition register causes 1 to be entered in the corresponding bit of the EVENt register provided the corresponding bit in the ENABle mask is set. Default setting: every bit reset (65535 or 0xFFFF)	**3.7.3.4 No manual control**

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Command	Parameter	Basic unit	Meaning	Section
STATus:**OPER**ation:**NTR**ansition	**<n>**		If a bit is set in the NTRansition register, a transition from 1 to 0 of the corresponding bit in the CONDition register causes 1 to be entered in the corresponding bit of the EVENt register provided the corresponding bit in the ENABle mask is set. Default setting: every bit reset (65535 or 0xFFFF)	**3.7.3.4** **No manual control**
STATus:**QUES**tionable:**COND?**	**<n>** Query only		Outputs the status of the CONDition register (current value of Questionable Status of UPD) as a decimal number. For the weighting of the individual bits see **3.7.3.5 STATus:QUEStionable Register**. Reading out does not clear the register.	**3.7.3.5** **No manual control**
STATus:**QUES**tionable[:EVENt]**?**	**<n>** Query only		Outputs the contents of the EVENt register as a decimal number. A bit set in the EVENt register indicates a change of the corresponding bit in the CONDition register. The entry in the PTRansition and NTRansition registers determines whether a bit transition from 0 to 1 or from 1 to 0 causes an entry in the EVENt register. Reading out clears the register!	**3.7.3.5** **No manual control**
STATus:**QUES**tionable:**ENAB**le	**<n>**		See above.	**3.7.3.5** **No manual control**
STATus:**QUES**tionable:**PTR**ansition	**<n>**		See above.	**3.7.3.5** **No manual control**
STATus:**QUES**tionable:**NTR**ansition	**<n>**		See above.	**3.7.3.5** **No manual control**
STATus**:XQUE**stionable:**COND?**	**<n>** Query only		Outputs the content of the CONDition register as a decimal number (current value of XQuestionable Status of UPD). For the weighting of individual bits see 3.7.3.6 STATus:XQUEStionable Register. Reading out does not clear the register.	3.7.3.6 **No manual control**

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Command	Parameter	Basic unit	Meaning	Section
STATus:**XQUE**stionable[:EVENt]**?**	**<n>** Query only		See above.	3.7.3.6 **No manual control**
STATus:**XQUE**stionable:**ENAB**le	**<n>**		See above.	3.7.3.6 **No manual control**
STATus:**XQUE**stionable:**PTR**ansition	**<n>**		See above.	3.7.3.6 **No manual control**
STATus:**XQUE**Stionable:**NTR**ansition	**<n>**		See above.	3.7.3.6 **No manual control**
SYSTem:**VERS**ion**?**	**<n>** Query only		Returns the number of the associated SCPI version by specifying the year with decimal point and one decimal digit.	**2.15.7** **No manual control**
SYSTem:**ERR**or**?**	**<string>** Query only		Returns the last error message out of the error message queue. Error messages consist of a number followed by text. Negative error numbers are SCPI-defined, positive numbers are device-specific. If no error occurred, the output is **0, "No error"** If the queue gets too long, the error message: -**350, "Queue overflow"** is output. With *CLS and upon power-on of the device, all error messages are cleared.	3.3.2 **No manual control**

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3.10.12 Commands for Synchronization

Command	Parameter	Basic unit	Meaning	Section
INITiate:**CONT**inuous	**ON** **OFF**		→ Presetting of continuous measurement. → Presetting of a single measurement which is triggered with INITiate[:IMMediate] (see next command)!	**2.11** **START key** **SINGLE key**
INITiate[:IMMediate]			Starts a single measurement. Command INITiate:CONTinuous ON|OFF determines whether it is a continuous or a single measurement (see previous command). The two INITiate commands simulate the function of the START or SINGLE key. The following commands are to be entered: START key: INITiate:CONTinuous ON, INITiate[:IMMediate] SINGLE key: INITiate:CONTinuous OFF, INITiate[:IMMediate]	**2.11** **START key** **SINGLE key**
INITiate:***FORC***e	***STAR***t ***SING***le ***STOP*** ***CONT***inuous		→ • A measurement in progress is immediately aborted. • Trailing pointer, average and peak values are reset. • A new continuous measurement is started. (identical with command "INIT:CONT ON") → • A measurement in progress is immediately aborted. • A new measurement is started. (identical with command INIT:CONT OFF) → An ongoing measurement is stopped as if the STOP/CONT key was pressed during the measurement. (identical with command ABORt). The measurement is continued with INIT:FORC CONT. → • A new continuous measurement is started. • Trailing pointer, average and peak values are **not** reset. This is only effective if the measurement was interrupted with INIT:FORC STOP or ABOR or if the measurement was started with INIT:FORC SING or INIT:CONT OFF and completed.	**2.11** → **Taste START** → **Taste SINGLE** → STOP function of toggel key **STOP/CONT** → CONT function of toggel key **STOP/CONT**
ABORt			Simulation of STOP/CONT key	**2.11** **STOP/CONT key**

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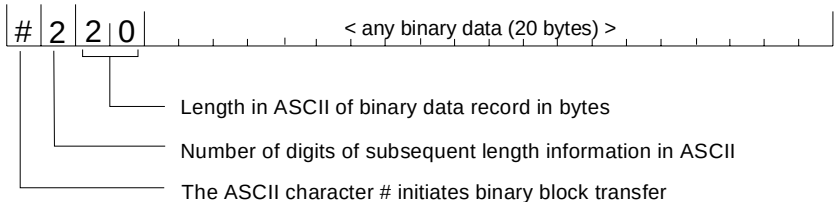
3.10.13 Binary Data via IEC/IEEE-Bus Interface

Command	Parameters	Meaning	Section
MMEMory:**DATA**	**'filename', #<lele><le><binary data>** <lele>: Length of subsequent length information of binary data <le>: Length of subsequent binary data <Binary data>: Any binary codes of any length	If 'filename' contains no path information, the command stores the subsequent binary data in the current working directory of the UPD. The current working directory of the UPD is the directory specified under `Work Dir` in the FILE Panel of the UPD. If 'filename' contains a path that exists in the UPD, the binary data are stored in this path. If 'filename' contains a path that does not exist in the UPD, the error message "Could not write to file" is output. This command therefore allows the transfer of any files of any length from the process controller to the UPD. If a data record to be transferred to the UPD is in the form of a file, its precise length can be determined by means of the DOS command DIR. The value thus obtained is to be specified in the command MMEM:DATA under "Length of subsequent binary data". To allow file transfer from a process controller to the UPD not only for experienced C- and IEC/IEEE-bus programmers, the DOS programs IEC_BT.EXE and UPMD5.EXE will be supplied with the UPD as from UPD software version 3.07 (see „Initial Steps“, „Transfer of File to UPD“ and following). Example: MMEM:DATA 'MYSETUP.SAC',#48561<any binary data> MMEM:DATA '\UPD\USER\MYSETUP.SAC',#48561<any binary data>	3.10.13 Binary Data via IEC/IEEE-Bus Interface No manual control

Example:

:MMEM:DATA 'filename', 

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Command	Parameters	Explanation	Section
MMEMory:**CHEC**k**?**	**'filename'** **Query only**	This command determines the MD5 signature of a file. If `'filename'` contains no path information, the command determines the MD5 signature of the specified file in the current working directory of the UPD. The current working directory of the UPD is the directory specified under `Work Dir` in the FILE Panel of the UPD. If `'filename'` contains a path that exists in the UPD, the MD5 signature of the associated file is determined. If `'filename'` contains a path that does not exist in the UPD, the error message "Execution error" is output. A 32-digit signature of the specified file is returned in response to the query. To check whether the contents of a file were transferred error-free from the process controller to the UPD, the MD5 signature method can be used to generate, from the UPD path C:\UPD\IEC_EXAM and prior to the transfer, a digital signature of the file on the process controller using the program UPMD5.EXE. After the transfer of the file to the UPD via the IEC/IEEE bus, a digital signature of the transferred file is generated by means of the command `MMEMory:CHECk? 'filename'`. If the two signatures agree, it can be assumed that the file contents are identical and the transfer was therefore error-free. Moreover, it can be determined in this way whether any subsequent modifications have been made to a file. **Example:** `MMEM:CHEC?, '\UPD\USER\MYSETUP.SAC'` Reply (for example): `"4edb9481dc7b1fb27393c10c950cf9c1"`	3.10.13 Binary Data via IEC/IEEE-Bus Interface **No manual control**

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Command	Parameter	Basic unit	Section
ABORt			**2.11 STOP/CONT key**
ARM:**FREQ**uency:**STAR**t	**<nu>**	Hz	**2.6.4 ANLR panel** Start
ARM:**FREQ**uency:**STOP**	**<nu>**	Hz	**2.6.4 ANLR panel** Stop
ARM:**LEV**el:**MIN**	**<nu>**	V FS	**2.6.4 ANLR panel** Min VOLT
ARM:**VOLT**age:**STAR**t	**<nu>**	V FS	**2.6.4 ANLR panel** Start
ARM:**VOLT**age:**STOP**	**<nu>**	V FS	**2.6.4 ANLR panel** Stop
CALCulate:**EQU**alize:**FEED**	**TRAC**e**1** **TRAC**e**2**		**2.9.1.2 FILE panel** Volt Source → TRACE A → TRACE B
CALCulate:**EQU**alize:**INV**ert	**ON** **OFF**		**2.9.1.2 FILE panel** Invert 1/n → ON → OFF
CALCulate:**EQU**alize:**NORM**freq	**<nu>**	Hz	**2.9.1.2 FILE panel** Norm Freq
CALCulate:**LIM**it:**FAIL?**	**<n>** Query only		**2.10.7** **2.9.1.3** **No manual control**
CALCulate:**LIM**it:**LOW**er:**CONT**rol:**POIN**ts**?**	**<n>** Query only		**2.9.1.3 No manual control**
CALCulate:**LIM**it:**LOW**er:**CONT**rol[:DATA]	**<n>**{,**<n>**}		**2.9.1.3 No manual control**
CALCulate:**LIM**it:**LOW**er:**POIN**ts**?**	**<n>** Query only		**2.9.1.3 No manual control**

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Command	Parameter	Basic unit	Section
CALCulate:**LIM**it:**LOW**er:**STAT**e	**ON** **OFF**		**2.10.7** **DISP panel** LIMIT CHECK Mode → LIM LOWER Mode → OFF
CALCulate:**LIM**it:**LOW**er:**TRAC**e	**<n>**{,**<n>**}		**2.9.1.3** **No manual control**
CALCulate:**LIM**it:**LOW**er:**VAL**ue	**<nu>**		**2.10.7** **DISP panel** Lim Lower → VALUE:
CALCulate:**LIM**it:**LOW**er[:DATA]	**<n>**{,**<n>**}		**2.9.1.3** **No manual control**
CALCulate:**LIM**it:**ON**	**TRAC**e**1** **TRAC**e**2** **TR1A**nd2		**2.10.7** **DISP panel** Check → TRACE A → TRACE B → TRACE A+B
CALCulate:**LIM**it:**REP**ort:**POIN**ts**?**	**<n>** Query only		**2.9.1.3** **No manual control**
CALCulate:**LIM**it:**REP**ort[:DATA]**?**	**<n>**{,**<n>**} Query only		**2.9.1.3** **No manual control**
CALCulate:**LIM**it:**UPP**er:**CONT**rol:**POIN**ts**?**	**<n>** Query only		**2.9.1.3** **No manual control**
CALCulate:**LIM**it:**UPP**er:**CONT**rol[:DATA]	**<n>**{,**<n>**}		**2.9.1.3** **No manual control**
CALCulate:**LIM**it:**UPP**er:**POIN**ts**?**	**<n>** Query only		**2.9.1.3** **No manual control**
CALCulate:**LIM**it:**UPP**er:**STAT**e	**ON** **OFF**		**2.10.7** **DISP panel** LIMIT CHECK Mode → LIM UPPER Mode → OFF
CALCulate:**LIM**it:**UPP**er:**TRAC**e	**<n>**{,**<n>**}		2.9.1.3 **No manual control**

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Command	Parameter	Basic unit	Section
CALCulate:**LIM**it:**UPP**er:**VAL**ue	**<nu>**		**2.10.7** **DISP panel** Lim Upper → VALUE:
CALCulate:**LIM**it:**UPP**er[:DATA]	**<n>**{,**<n>**}		**2.9.1.3** **No manual control**
CALCulate:**TRAN**sform:**FREQ**uency:**AVER**age	**<n>**		**2.6.5.16** **ANLR panel** Average
CALCulate:**TRAN**sform:**FREQ**uency:**AVER**age:**TCON**trol	**NORM**al **EXP**onential		**2.6.5.13** **ANLR panel** Avg Mode → NORMAL → EXPONENTIAL
CALCulate:**TRAN**sform:**FREQ**uency:**CENT**er	**<nu>**	Hz	**2.6.5.13** **ANLR panel** Center
CALCulate:**TRAN**sform:**FREQ**uency:**FFT**	**S256** **S512** **S1K** **S2K** **S4K** **S8K**		**2.6.5.13** **ANLR panel** FFT Size → 256 → 512 → 1024 → 2048 → 4096 → 8192
CALCulate:**TRAN**sform:**FREQ**uency:**FFT**	**S512** **S1K** **S2K** **S4K** **S8K**		**2.6.5.7** **ANLR panel** FFT Size → 512 → 1024 → 2048 → 4096 → 8192
CALCulate:**TRAN**sform:**FREQ**uency:**FFT**	**S256** **S512** **S1K** **S2K** **S4K** **S8K**		**2.6.5.16** **ANLR panel** FFT Size → 256 → 512 → 1024 → 2048 → 4096 → 8192
CALCulate:**TRAN**sform:**FREQ**uency:**MTIM**e**?**	**<nu>** Query only		**2.6.5.13** **ANLR panel** Meas Time
CALCulate:**TRAN**sform:**FREQ**uency:**RES**olution**?**	**<nu>** Query only		**2.6.5.13** **ANLR panel** Resolution

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Command	Parameter	Basic unit	Section
CALCulate:**TRAN**sform:**FREQ**uency:**RES**olution**?**	**<nu>** Query only		**2.6.5.16** **ANLR panel** Resolution
CALCulate:**TRAN**sform:**FREQ**uency:**SPAN?**	**<nu>** Query only		**2.6.5.13** **ANLR panel** Span
CALCulate:**TRAN**sform:**FREQ**uency:**STAR**t**?** **CALC**ulate:**TRAN**sform:**FREQ**uency:**STOP?**	**<nu>** Query only		**2.6.5.13** **ANLR panel** Start / Stop
CALCulate:**TRAN**sform:**FREQ**uency:**STAR**t**?** **CALC**ulate:**TRAN**sform:**FREQ**uency:**STOP?**	**<nu>** Query only		**2.6.5.16** **ANLR panel** Start / Stop
CALCulate:**TRAN**sform:**FREQ**uency:**STAT**e	**OFF** **ON**		**2.6.5.1** **ANLR panel** POST FFT → OFF → ON
CALCulate:**TRAN**sform:**FREQ**uency:**STAT**e	**OFF** **ON**		**2.6.5.1** **ANLR panel** POST FFT → OFF → ON
CALCulate:**TRAN**sform:**FREQ**uency:**STAT**e	**OFF** **ON**		**2.6.5.1** **ANLR panel** POST FFT → OFF → ON
CALCulate:**TRAN**sform:**FREQ**uency:**WIND**ow	**RECT**angular **HANN**ing **BLAC**kman_harris **RIF1** **RIF2** **RIF3** **HAMM**ing **FLAT**top **KAIS**er		**2.6.5.13** **2.6.5.16** **ANLR panel** Window → RECTANG... → HANN → BLACKMAN H → RIFE VINC 1 → RIFE VINC 2 → RIFE VINC 3 → HAMMING → FLAT TOP → KAISER
CALCulate:**TRAN**sform:**FREQ**uency:**WIND**ow:**BETA**facto	**<n>**	No unit	**2.6.5.13** **2.6.5.16** **ANLR panel** ß-Factor
CALCulate:**TRAN**sform:**FREQ**uency:**ZOOM**	**<n>**		**2.6.5.13** **ANLR panel** Zoom-FFT

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Command	Parameter	Basic unit	Section
CALCulate:**TRAN**sform:**FREQ**uency**AVER**age	**<n>**		**2.6.5.13** **ANLR panel** Average
CALibrate	**OFF** **AUTO** **DCC** **LDG**		**2.15.6** Alias for CAL:LDG:AUTO, CAL.ZERO:AUTO
CALibrate:**JITT**er:**AUTO**	**OFF** **ONCE**		**2.15.6** **OPTIONS panel** CALIBR. DIG PhaseToRef → OFF → ONCE
CALibrate:**LDG**:**AUTO**	**OFF** **ONCE**		**2.15.6.7** **OPTIONS panel** CALIBR. GEN LDG Auto → OFF → ONCE
CALibrate:**ZERO**:**AUTO**	**OFF** **ON** **ONCE**		**2.15.6** **OPTIONS panel** CALIBR. ANL Zero Auto → OFF → ON → ONCE
DISPlay:**ACT**ualize	**ON** **OFF**		**No manual control**
DISPlay:**ANN**otation[:ALL]	**ON** **OFF**		**2.15.5** **OPTIONS panel** Meas Disp → ON → OFF Ext. Keyboard: CTRL D
DISPlay:**CONF**iguration	**P** **SP** **AP** **GP** **FP** **DP** **OP** **GAT** **GAO** **GAD** **FAT** **FAO** **FAD** **SHON** **SHOF**f		**2.3.1** Keys Ext. UPD keyboard GEN ALT+G ANLR ALT+A FILT ALT+T FILE ALT+F DISP ALT+D GRAPH ALT+R ZOOM ALT+Z SHOW I/O ALT+I OPTIONS ALT+O

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Command	Parameter	Basic unit	Section
DISPlay:**ENAB**le	**ON** **OFF**		**2.1.1** **Taste** OFF LCD or CTRL F10
DISPlay:**MODE**	**INT**ern **COLB**oth **BWB**oth		**2.15.5** **OPTIONS panel** Extrn Disp → INTERN ONLY → BOTH COLOR → BOTH B/W
DISPlay:**PROT**ocol:**CHST**atus**?**	Query only Response: NO LTC YES		**2.10.8** **GRAPH panel** **Display**
DISPlay:**PROT**ocol:**ERR**or:**GEN**eral**?**	Query only Response: UBB SQB NSYN PRMB SQLR RERR NONE		**2.10.8** **GRAPH panel** **Display**
DISPlay:**PROT**ocol:**ERR**or:**LCRC?**	Query only		**2.10.8** **GRAPH panel** **Display**
DISPlay:**PROT**ocol:**ERR**or:**PAR**ity**?**	Query only		**2.10.8** **GRAPH panel** **Display**
DISPlay:**PROT**ocol:**ERR**or:**RCRC?**	Query only		**2.10.8** **GRAPH panel** **Display**
DISPlay:**PROT**ocol:**FORM**at	**BIN**ary **HEX**adecimal **ASCii** **FILE**		**2.10.8** **DISP panel** Format → BIN → HEX → ASCII → FILE DEF
DISPlay:**PROT**ocol:**LR?**	Query only Response: EQUAL DIFF		**2.10.8** **GRAPH panel** **Display**
DISPlay:**PROT**ocol:**LVAL**bit**?**	Query only Response: Y0 N1		**2.10.8** **GRAPH panel** **Display**

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Command	Parameter	Basic unit	Section
DISPlay:**PROT**ocol:**RVAL**bit**?**	Query only Response: Y0 N1		**2.10.8** **GRAPH panel** **Display**
DISPlay:**PROT**ocol:**SEL**ect	**LCHannel**status **RCHannel**status **LUS**erdata **RUS**erdata		2.10.8 **DISP panel** Source → CHAN STAT L → CHAN STAT R → USER DATA L → USER DATA R
DISPlay[:WINDow]:**TEXT**:**LOC**ate	<**ny**>[,<**nx**>]		**2.10.1** **DISP panel** X Pos, Y Pos
DISPlay[:WINDow]:**TEXT**[:DATA]	**"string"**		**2.10.1** **DISP panel** COMMENT
DISPlay[:WINDow]:**TRAC**e:**X**:**LAB**el	**"string"**		**2.10.2** **DISP panel** Unit/Label
DISPlay[:WINDow]:**TRAC**e[]:**ACT**ive	**CURS**or[1|**2**]		**2.10.2** **DISP panel** Softkey, 1st level F8
DISPlay[:WINDow]:**TRAC**e[]:**AUT**oscale alias **AUTO**scale			**2.10.2** **Softkey** F7 (AUTOSCALE) F6 (ALL)
DISPlay[:WINDow]:**TRAC**e[]:**COUNt**	**<n>**		**2.10** **DISP panel** Scan Count
DISPlay[:WINDow]:**TRAC**e[]:**CURS**or[]:**DATA1?** **DISP**lay[:WINDow]:**TRAC**e[]:**CURS**or[]:**DATA2?** **DISP**lay[:WINDow]:**TRAC**e[]:**CURS**or[]:**DATA3?**	**<nu>** Query only		**2.10.2** **Display in graphics window**
DISPlay[:WINDow]:**TRAC**e[]:**CURS**or[1]:**MODE**	**N12** **D12** **OFF**		**2.10.2** **Softkey** F8: selects O-CURS. F9: (O-CURSOR) → F6 (A,B) → F7 (A-B) → F11 (ON/OFF)
DISPlay[:WINDow]:**TRAC**e[]:**CURS**or[1|**2**]:**POS**ition	**<nu>**		**2.10.2** not via softkey

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Command	Parameter	Basic unit	Section
DISPlay[:WINDow]:**TRAC**e[]:**CURS**or[1|**2**]:**POS**ition:**MODE**	**MIN1** **MIN2** **I MAX1** **MAX1** **I MAX2** **MAX2** **MARK**er1 **NEXT**marker **VAL**ue		**2.10.2** **Softkey** F8 selects O-CURS or *-CURS. → F10 (SET TO) → ---- → ---- → F6 (I MAX A) → F7 (MAX A) → F8 (I MAX B) → F9 (MAX B) → F10 (MARKER) → F11(NXTHARM)
DISPlay[:WINDow]:**TRAC**e[]:**CURS**or**2**:**MODE**	**N12** **D12** **C12** **HL1** **HL2** **HLD1** **HLD2** **OFF**		**2.10.2** **Softkey** F8 selects o-cursor F9 selects *-cursor → F6 (A,B) → F7 (A-B) → F8 (* - O) → F9 (HLINE) → A → F9 (HLINE) → B → F9 (HLINE) → ΔA → F9 (HLINE) → ΔB → F11 (ON/OFF)
DISPlay[:WINDow]:**TRAC**e[]:**IND**ex	**<n>**		**2.9.3.3** **Keys** PAGE UP / PAGE DOWN
DISPlay[:WINDow]:**TRAC**e[]:**LAB**el	**ON** **OFF**		**2.10.2** **DISP panel** User Label → ON → OFF
DISPlay[:WINDow]:**TRAC**e[]:**MODE**	**DELete_bef_wr** **WAT**erfall|**CASC**ade **MAXH**old		**2.10** **DISP panel** Mode → DEL BEF WR → WATERFAL → MAX HOLD

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Command	Parameter	Basic unit	Section
DISPlay[:WINDow]:**TRAC**e[]:**OPER**ation	**CURV**eplot **LIST** **ERR**ors **BARG**raph **SPEC**trum **FFTL**ist **FFTE**rrors **PROT**ocol **AUT**oprotocol alias **AUTO**protocol		**2.10** **DISP panel** OPERATION → CURVE PLOT **2.10.2** → SWEEP LIST **2.10.4** → SWP LIM REP **2.10.4** → BARGRAPH **2.10.2** → SPECT LIST **2.10.8** → SPC LIM REP **2.10.6** → PROTOCOL **2.10** **2.10.8** → PROTO AUTO
DISPlay[:WINDow]:**TRAC**e[]:**X**:**SPAC**ing	**LIN**ear **LOG**arithmic		**2.10.1** **DISP panel** Spacing → LIN → LOG
DISPlay[:WINDow]:**TRAC**e[]:**X**[:SCALe]:**AUTO**	**ON** **OFF**		**2.10.1** **DISP panel** Scale → AUTO → MANUAL or **Softkey** F7 (AUTOSCALE) → F9 (X)
DISPlay[:WINDow]:**TRAC**e[]:**X**[:SCALe]:**LEFT**	**<nu>**		**2.10.1** **DISP panel** Left
DISPlay[:WINDow]:**TRAC**e[]:**X**[:SCALe]:**RIGHT**	**<nu>**		**2.10.1** **DISP panel** Right
DISPlay[:WINDow]:**TRAC**e[]:**X**[:SCALe]:**RLEV**el	**<nu>**		**2.10.1** **DISP panel** Reference
DISPlay[:WINDow]:**TRAC**e[]:**X**[:SCALe]:**UNIT**	<**u**>		**2.10.1** **DISP panel** Unit
DISPlay[:WINDow]:**TRAC**e[]:**Y**[:SCALe]:**RLEV**el	**<nu>**		**2.10.1** **DISP panel** Reference → VALUE

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Command	Parameter	Basic unit	Section
DISPlay[:WINDow]:**TRAC**e[]:**Y**[:SCALe]:**UNIT**	<u>		**2.10.1** **DISP panel** Unit
DISPlay[:WINDow]:**TRAC**e[]:**ZOOM**	**<n>** **0** **1** **-1** **2** **3** **4**		**2.10.2** **Softkey** F10 (ZOOM) → F10 (UNZOOM) → F6 (AT o UP) → F7 (AToDOWN) → F8 (CEN TO o) → F9 (o TO *) → F11 (UNDO)
DISPlay[:WINDow]:**TRAC**e[1|**2**]:**CURV**e	**OFF** **ON**		**2.10.2** **Softkey** → F6 (CURVE) → F6 (A ON/OFF) → F7 (B ON/OFF)
DISPlay[:WINDow]:**TRAC**e[1|**2**]:**FEED**	**"SENS**e**1**:**DATA1"** **"SENS**e**1**:**DATA2"** **"SENS**e**2**:**DATA1"** **"SENS**e**2**:**DATA2"** **"SENS**e**3**:**DATA1"** **"SENS**e**3**:**DATA2"** **"SENS**e**4**:**DATA"** **"HOLD"** **"FILE"** **"DFIL**e**"** **"OFF"**		**2.10.1** **DISP panel** TRACE A/B → FUNC CH1 → FUNC CH2 → INP RMS CH1 → INP RMS CH2 → FREQ CH1 → FREQ CH2 → PHASE → GROUP DEL → HOLD → FILE → DUAL FILE → OFF
DISPlay[:WINDow]:**TRAC**e[1|**2**]:**MARK**er:**HARM**onics	**ON** **OFF**		**2.10.2** **Softkey** F11 (MARKER) F6 (TRACE A) or F7 (TRACE B) → F10 (HARM) on/off
DISPlay[:WINDow]:**TRAC**e[1|**2**]:**MARK**er:**MODE**	**MAX**imum **CURS**or **OFF**		**2.10.2** **Softkey** F11 (MARKER) F6 (TRACE A) or F7 (TRACE B). → MAX → CURSOR → VIEW OFF

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Command	Parameter	Basic unit	Section
DISPlay[:WINDow]:**TRAC**e[1|**2**]:**Y**:**SPAC**ing	**LIN**ear **LOG**arithmic		**2.10.1** **DISP panel** Spacing → LIN → LOG
DISPlay[:WINDow]:**TRAC**e[1|**2**]:**Y**[:SCALe]:**AUTO**	**ONCE** **OFF**		**2.10.1** **DISP panel** Scale → AUTO ONCE → MANUAL ONCE via Softkey F7 (AUTOSCALE) → F7 (A) → F8 (B)
DISPlay[:WINDow]:**TRAC**e[1|**2**]:**Y**[:SCALe]:**BOTT**om	**<nu>**		**2.10.1** **DISP panel** Bottom
DISPlay[:WINDow]:**TRAC**e[1|**2**]:**Y**[:SCALe]:**NORM**alize	**<nu>**	Multiplier | dB	**2.10.1** **DISP panel** Normalize
DISPlay[:WINDow]:**TRAC**e[1|**2**]:**Y**[:SCALe]:**NORM**alize:**MODE**	**CURS**or[1] (**o**-Cursor) **CURS**or**2** (*****-Cursor) **VAL**ue		**2.10.1** **DISP panel** Normalize → **o**-Cursor → *****-Cursor → VALue
DISPlay[:WINDow]:**TRAC**e[1|**2**]:**Y**[:SCALe]:**RLEV**el:**MODE**	**VAL**ue **MAX**imum **CURS**or[1] **CURS**or 2 **FILE** **HOLD** **OTRA**ce **CH1M**eas **CH2M**eas **GENT**rack **IFIL**e **REF9**97 **REF1**000		**2.10.1** **DISP panel** Reference → VALUE → MAX → oCURSOR → *CURSOR → FILE → HOLD → OTHER TRACE → MEAS CH1 → MEAS CH2 → GEN TRACK → FILE INTERN → REF 997 Hz → REF 1000 Hz
DISPlay[:WINDow]:**TRAC**e[1|**2**]:**Y**[:SCALe]:**TOP**	**<nu>**		**2.10.1** **DISP panel** Top
DISPlay[:WINDow]:**TRAC**e[**1**|**2**]:**Y**:**LAB**el	**"string"**		**2.10.2** **DISP panel** Unit/Label

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Command	Parameter	Basic unit	Section
DISPlay[:WINDow]:**TRAC**e**2**:**Y**[:SCALe]:**EQU**al	**ON** **OFF**		**2.10.1** **DISP panel** Scale B → EQUAL A → NOT EQUAL A
FORMat[:DATA]	**ASCI**i **REAL**		**2.9.1.2** **No manual control**
HCOPy:**ABOR**t			**2.14** **Key** H COPY or CTRL F8
HCOPy:**DEST**ination	PRSPc alias PRINter PLHPgl alias PLOTter PRPS PRHPgl FIPCx, 'filename.PCX' alias PCXFile, 'name.PCX' FIHPgl, 'filename.GL' alias HPGLfile, 'name.GL' FIPS, 'filename.PS' FIEPs, 'filename.EPS' Response: PRIN PLOT PRHP PRPS PCXF HPGL FIPS FIEP		**2.14** **OPTIONS-Panel** Destin (**destination/format**) → PRINTR/SPC → PLOTTR/HPGL → PRINTR/HPGL → PRINTR/PS → FILE/PCX → FILE/HPGL → FILE/PS → FILE/EPS
HCOPy:**DEV**ice:**COL**or	**ON** **OFF**		**2.14** **OPTIONS panel** COLOR → ON → OFF
HCOPy:**DEV**ice:**PRIN**ter	**<n>**		**2.14** **OPTIONS panel** Printname
HCOPy:**DEV**ice:**RES**olution	**HIGH** **MED**ium **LOW**		**2.14** **OPTIONS panel** Prn Resol → HIGH → MEDIUM → LOW
HCOPy:**ITEM**	**ALL** **GRAT**icule **TRAC**e		**2.14** **OPTIONS panel** Copy → SCREEN → CURVE/GRID → CURVE

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Command	Parameter	Basic unit	Section
HCOPy:**ITEM**:**FRAM**e	**WHITe** **FDEF**ined		**2.14** **OPTIONS panel** Frame → WHITE → FILE DEF
HCOPy:**ITEM**:**LAB**el:**STAT**e	**ON** **OFF**		**2.14** **Key** H COPY or Ctrl F8
HCOPy:**PAGE**:**LENG**th**?**	Query only		**2.14** **OPTIONS panel** Prn Height
HCOPy:**PAGE**:**LMAR**gin	**<n>**		**2.14** **OPTIONS panel** LEFT MRGN
HCOPy:**PAGE**:**ORI**entation	**LAND**scape **PORT**trait		**2.14** **OPTIONS panel** ORIENTATION → LANDSCAPE → PORTRAIT
HCOPy:**PAGE**:**SCAL**e:**X**	**<n>**		**2.14** **OPTIONS panel** X-SCALING
HCOPy:**PAGE**:**SCAL**e:**Y**	**<n>**		**2.14** **OPTIONS panel** Y-SCALING
HCOPy:**PAGE**:**WIDT**h**?**	Query only		**2.14** **OPTIONS panel** Prn Width,
HCOPy:**PLAD**dress	**<n>**		**2.14** **OPTIONS panel** → IEC Adr
HCOPy:**PLOT**s	**<n>**		**2.14** **OPTIONS-Panel** Plots/Page
HCOPy:**PLP**ort	**COM1** **COM2** **LPT1** **IEC**		**2.14** **OPTIONS panel** Plot on → COM 1 → COM 2 → LPT 1 → IEC BUS
HCOPy:**SIZE**	**A4** **LETT**er		**2.14** **OPTIONS-Panel** Paper Size → A4 → LETTER

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Command	Parameter	Basic unit	Section
HCOPy:**WAIT**			**No manual control**
HCOPy[:IMMediate]	Without parameter **CNF** **CF** **NCNF** **NCF** **CONF**ig **CONF**ig **TITL**e **SUPP**lement		**HCOPy** command via IEC/IEEE bus or Universal Sequence Controller UPD-K1
INITiate:**CONT**inuous	**ON** **OFF**		**2.11** **START key** **SINGLE key**
INITiate:***FORC**e*	***STAR**t* ***SING**le* ***STOP*** ***CONT**inuous*		**2.11** → **Taste START** → **Taste SINGLE** → STOP function of toggel key **STOP/CONT** → CONT function of toggel key **STOP/CONT**
INITiate:**NEXT**	**<n>**		**2.11** **Spinwheel**
INITiate[:IMMediate]			**2.11** **START key** **SINGLE key**
INPut:**AUD**iobits	**<n>**		**2.6.3.6** **GEN panel** Audio Bits
INPut:**FILT**er[:LPASs]:**FREQ**uency	**<n>** Query only	Hz	**2.6.1** **ANLR panel** Min Freq
INPut[]:**AUD**iobits	**<n>**		**2.6.3.2** **2.6.3.3** **2.6.3.4** **ANLR panel** Audio Bits
INPut[]:**BCL**ock	**RIS**ing **FALL**ing		**2.6.3.2** **ANLR panel** Bitclock → RISING → FALLING
INPut[]:**BITO**rder	**MSBF**irst **LSBF**irst		**2.6.3.2** **ANLR panel** Bit order → MSB FISRT → LSB FISTS

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Command	Parameter	Basic unit	Section
INPut[]:**FILT**er[:LPASs]:**FREQ**uency	**<nu>** Query only	Hz	**2.6.2** **ANLR panel** Min Freq
INPut[]:**OSAM**pling	**N1** **N2** **N4** **N8** **N16**		**2.6.3.1** **ANLR panel** Oversamp → 1 → 2 → 4 → 8 → 16
INPut[]:**SAMP**le:**FREQ**uency	**<nu>**	Hz	**2.6.3.1** **ANLR panel** Sample Frq → VALUE:
INPut[]:**SAMP**le:**FREQ**uency:**MODE**	**F32** **F44** **F48** **VAL**ue **AUTO** **CHST**atus		**2.6.3.1** **2.6.3.3** **ANLR panel** Sample Frq → 32 kHz → 44.1 kHz → 48 kHz → VALUE: → AUTO → CHAN STATUS
INPut[]:**SEL**ect	**CH1** **CH2** **CH1A**nd2 **CH1I**s2 **CH2I**s1 **BOTH**		**2.6.2** **2.6.3** **ANLR panel** CHANNEL(s) →1 →2 →1 & 2 →1 ≡ 2 →2 ≡ 1 → BOTH
INPut[]:**WCL**ock	**RIS**ing **FALL**ing		**2.6.3.2** **2.6.3.3** **ANLR panel** Wordclock → RISING → FALLING
INPut[]:**WLEN**gth	**L8** **L16** **L24** **L32**		**2.6.3.2** **ANLR panel** Word lngth → 8 → 16 → 24 → 32
INPut[]:**WOFF**set	<**n**>		**2.6.3.2** **ANLR panel** Word offset

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Command	Parameter	Basic unit	Section
INPut[]:**WSEL**ect	**LOW** **HIGH**		**2.6.3.2** **2.6.3.3** **ANLR panel** WordselCh1 → LOW → HIGH
INPut[1|**2**]:**IMP**edance	**R300** **R600** **R200K** **USER**defined		**2.6.2** **ANLR panel** Imped →300 Ω →600 Ω →200 Ω → USER DEF
INPut[1|**2**]:**IMP**edance	**R110** **R10K**		**2.6.3.4** **ANLR panel** Ch1 Imped → 110 Ω → 10 KΩ
INPut[1|**2**]:**LOW**	**FLO**at **GRO**und		**2.6.2** **ANLR panel** Common → FLOAT → GROUND
INPut[1|**2**]:**TYPE**	**BAL**anced **UNB**alanced **GEN1** **GEN2** **MSER**ial **SER**ial **MPAR**allel **PAR**allel **AES**ebu **SPD**if **OPT**ical **INT**ern		**2.6.2** **ANLR panel** Input →BAL XLR → UNBAL BNC → GEN1 → GEN2 **2.6.3.1** → SERIAL MUX → SERIAL → PARAL MUX → PARALLEL **2.6.3.3** → AES/EBU → S/P DIF → OPTICAL → INTERN
INSTrument[1][:SELect] equivalent to **INST**rument[1]:**NSEL**ect	**A25** **A110** **D48** **D192** **D768** **1** **2** **3** **4** **5**		**2.5.1** **GEN panel** INSTRUMENT → ANLG 25 kHz → ANLG 110 kHz → DIG 48 kHz → DIG 192 kHz → DIG 768 kHz

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Command	Parameter	Basic unit	Section
INSTrument**2**[:**SEL**ect] equivalent to **INST**rument**2**:**NSEL**ect	**A22** **A100** **A300** **D48** **D192** **D768** **1** **2** **3** **4** **5** **6**		**2.6.1** **ANLR panel** INSTRUMENT → ANLG 22 kHz → ANLG 100 kHz → ANLG 300 kHz → DIG 48 kHz → DIG 192 kHz → DIG 768 kHz
MMEMory:**CDIR**ectory	**"pathname"**		**2.9.2** **FILE panel** Work Dir
MMEMory**:CHEC**k**?**	**'filename'**		**3.10.13** No manual control
MMEMory**:COPY**	**"filename1","filename2"**		**2.9.2** **FILE panel** Copy + To
MMEMory:**DATA**	**'filename',** **#<lele><le><Binärdaten>**		**3.10.13** No manual control
MMEMory:**DEL**ete	**"filename"**		2.9.2 **FILE panel** Delete
MMEMory:**LOAD**:**LIST**	**DWEL**l[1]**,'filename'** Query: MMEM:LOAD:LIST? DWEL		**2.5.4.2** **GEN panel** Dwell File
MMEMory:**LOAD**:**LIST**	**FREQ**uency[1],**'filename'** Query: MMEM:LOAD:LIST? FREQ		**2.5.4.2** **GEN panel** FREQ FILE
MMEMory:**LOAD**:**LIST**	**ONT**ime**, 'filename'** Query: MMEM:LOAD:LIST? ONT		**2.5.4.5** **2.5.4.6** **GEN panel** ONTIM FILE
MMEMory:**LOAD**:**LIST**	**INT**erval,**'filename'** Query: MMEM:LOAD:LIST? INT		**2.5.4.5** **2.5.4.6** **GEN panel** INTV FILE
MMEMory:**LOAD**:**LIST**	**EQU**alize,**'filename'** Query: MMEM:LOAD:LIST? EQU		**2.5.4.3** **GEN panel** Equal.File
MMEMory:**LOAD**:**LIST**	**EQU**alize**,'filename'** Query: MMEM:LOAD:LIST? EQU		**2.5.4.4** **GEN panel** Equal.File

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Command	Parameter	Basic unit	Section
MMEMory:**LOAD**:**LIST**	**EQU**alize,**'filename'** Query: MMEM:LOAD:LIST? EQU		**2.5.4.9** **GEN panel** Equal.File
MMEMory:**LOAD**:**LIST**	**ARB**itrary**, 'filename'** Query: MMEM:LOAD:LIST? ARB **RAND**om**, 'filename'** Query: MMEM:LOAD:LIST? RAND		**2.5.4.11** **GEN panel** Shape File
MMEMory:**LOAD**:**LIST**	**EQU**alize,**'filename'** Query: MMEM:LOAD:LIST? EQU		**2.5.4.11** **GEN panel** Equal.File
MMEMory:**LOAD**:**LIST**	**ARB**itrary,**'filename'** Query: MMEM:LOAD:LIST? ARB		**2.5.4.12** **GEN panel** Filename
MMEMory:**LOAD**:**LIST**	**FREQ**uency**,'filename'** Query: MMEM:LOAD:LIST? FREQ		**2.6.5.3** **2.9.1.3** **ANLR panel** SWEEP CTRL → Filename
MMEMory:**LOAD**:**LIST**	**LIMU**pper**, "filename"** Query: MMEM:LOAD:LIST? LIMU		**2.10.7** **DISP panel** Lim Upper → FILE + filenam"
MMEMory:**LOAD**:**LIST**	**LIML**ower, **"filename"** Query MMEM:LOAD:LIST? LIML		**2.10.7** **DISP panel** Lim Lower → FILE + filenam"
MMEMory:**LOAD**:**LIST**	**VOLT**age[1],**'filename'** Query: MMEM:LOAD:LIST? VOLT		**2.5.4.2** **GEN panel** VOLT FILE
MMEMory:**LOAD**:**LPGC**	**"filename"**		**2.5.3.4.4** **GEN panel** Filename
MMEMory:**LOAD**:**PAC**	**"filename"**		**2.10.8** **DISP panel** Proto File
MMEMory:**LOAD**:**PAU**	**"filename"**		**2.10.8** **DISP panel** Proto File
MMEMory:**LOAD**:**PGU**	**'filename'**		**2.5.3.4.4** **GEN panel** Filname

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Command	Parameter	Basic unit	Section
MMEMory:**LOAD**:**RPGC**	**"filename"**		**2.5.3.4.4** **GEN panel** Filename
MMEMory:**LOAD**:**STAT**e	0 | 2 | 4, **"filename"** Query: MMEM:LOAD:STAT? 0|2|4		**2.9.1.1** **FILE panel** Mode / → ACTUAL → COMPLETE → View PCX
MMEMory:**LOAD**:**TRAC**e	**TRAC**e[1|**2**],"**filename**" Query: MMEM:LOAD:TRAC? TRAC[1|**2**]		**2.10.1** **DISP panel** TRACE A/B → FILE + Filename
MMEMory:**LOAD**:**TRAC**e[1|**2**]	**REFT**race**,"filename"** Query: MMEM:LOAD:TRAC[1|2]? REFT		**2.10.1** **DISP panel** Reference → FILE + Reference
MMEMory:**STOR**e:**FORM**at	**BIN** **ASC**ii **EXP**ort		**2.9.1.2** **FILE panel** Format → REAL → ASCII → EXPORT
MMEMory:**STOR**e:**INFO**text	**'string'**		**2.9.1.1** FILE panel Info Text
MMEMory:**STOR**e:**LIST**	**LIST1**,**"filename"** **LIST2**,**"filename"** **DWEL**l,**"filename"** Query: MMEM:STOR:LIST? LIST[1|**2**] MMEM:STOR:LIST? DWEL		**2.9.1.2** **FILE panel** Store → X-Axis → Z-Axis → DWEL VALUE
MMEMory:**STOR**e:**LIST**	**ERR**ors**,"filename"** **LIMU**pper**,"filename"** **LIML**ower**,"filename"** Query: MMEM:STOR:LIST? ERR MMEM:STOR:LIST? LIMU MMEM:STOR:LIST? LIML		**2.9.1.2** **FILE panel** Store → LIM REPORT → LIM UPPER → LIM LOWER
MMEMory:**STOR**e:**LIST**	**EQU**alize**,"filename"** Query: MMEM:LOAD:LIST? EQU		**2.9.1.2** **FILE panel** Store → EQUALIZATN

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Command	Parameter	Basic unit	Section
MMEMory:**STOR**e:**STAT**e	0|1|2,**'filename'** Query: MMEM:STOR:STAT? 0 MMEM:STOR:STAT? 1 MMEM:STOR:STAT? 2		**2.9.1.1** **FILE panel** Mode → ACTUAL → ACTUAL+DATA → COMPLETE
MMEMory:**STOR**e:**STAT**e:**RONL**y	**ON** **OFF**		**2.9.1.1** **FILE panel** Attrib → REAN ONLY → READ/WRITE
MMEMory:**STOR**e:**TRAC**e	**TRAC**e**1**,**"filename"** **TRAC**e**2**,**"filename"** **TR1A**nd2,**"filename"** Query: MMEM:STOR:TRAC? TRAC[1|**2**] MMEM:STOR:TRAC? TR1A		**2.9.1.2** **FILE panel** Store → TRACE A → TRACE B → TRACE A+B
OUTPut	**ON** **OFF**		**2.13** Key OUTPUT OFF
OUTPut:**AUD**iobits	**<n>**		**2.5.3.2** **2.5.3.3** **2.5.3.4** **2.5.3.5** **GEN panel** Audio Bits
OUTPut:**BCL**ock	**RIS**ing **FALL**ing		**2.5.3.2** **GEN panel** Bitclock → RISING → FALLING
OUTPut:**BCL**ock:**FREQ**uency**?**	Query only	Hz	**2.5.3.2** **GEN panel** Frq Bitclk
OUTPut:**BITO**rder	**MSBF**irst **LSBF**irst		**2.5.3.2** **GEN panel** Bit Order → MSB → LSB
OUTPut:**DIG**ital:**CSIM**ulator	**OFF** **SIML**ong **SIMS**hort		**2.5.3.4.2** **GEN panel** Cable Sim → OFF → LONG CABLE → SHORT CABEL

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Command	Parameter	Basic unit	Section
OUTPut:**DIG**ital:**REF**erence:**FEED**	**AINP**ut **AINR**eclock **AOUT**put **RGEN**erator		**2.5.3.4.2** **GEN panel** Ref Out → AUDIO IN → AUD IN RCLK → AUDIO OUT → REF GEN
OUTPut:**DIG**ital:**SYNC**:**FEED**	**AIP**ut **RINP**ut **SPLL** **GCL**ock		**2.5.3.4.2** **GEN panel** Sync Out → AUDIO IN → REF IN → SYNC PLL → GEN CLK
OUTPut:**DIG**ital:**SYNC**:**TYPE**	**WCL**ock **BCL**ock		**2.5.3.4.2** **GEN panel** Type → WORD CLK → BIPHASE CLK
OUTPut:**DIG**ital:**UNB**alanced:**FEED**	**AOUT**put **AINP**ut		**2.5.3.4.2** **GEN panel** S/PDIF Out → AUDIO OUT → AUDIO IN
OUTPut:**IMP**edance	**R5** **R10** **R15** **R30** **R200** **R600** **USER**defined		**2.5.2** **GEN panel** Impedance → 5 Ω → 10 Ω → 15 Ω → 30 Ω → 200 Ω → 600 Ω → USER DEF
OUTPut:**LOW**	**FLO**at **GRO**und		**2.5.2** Common → FLOAT → GROUND
OUTPut:**OSAM**pling	**N1** **N2** **N4** **N8** **N16**		**2.5.3.1..** Oversamp → 1 → 2 → 4 → 8 → 16
OUTPut:**SAM**Ple:**FREQ**uency	**<nu>**	Hz	**2.5.3.2** **2.5.3.3** **2.5.3.4.1** **2.5.3.4.2** **GEN panel**

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Command	Parameter	Basic unit	Section
OUTPut:**SAMP**le[:FREQuency]:**MODE**	**F32** **F44** **F48** **VAL**ue **EXT**ern **SYNC**hron		**2.5.3.2** **2.5.3.3** **2.5.3.4.1** **2.5.3.4.2** **GEN panel** Sample Freq → 32 kHz → 44.1 kHz → 48 kHz → VALUE: → EXTERN → SYNCHRON
OUTPut:**SEL**ect	**OFF** **CH1** **CH2** **CH2I**s1 **CH2P**has180		**2.5.2** **2.5.3.1..** **GEN panel** Channel(s) → OFF → 1 → 2 → 2 ≡ -1
OUTPut:**SIGN**al:**BAL**anced:**LEV**el	**<nu>**	V	**2.5.3.4.2** **GEN panel** AESEBU Vpp
OUTPut:**SIGN**al:**BAL**anced:**LEV**el**?**	**<nu>** Query only	V	**2.5.3.4.1** **GEN panel** AESEBU Vpp
OUTPut:**SIGN**al:**LEV**el	<**nu**>	V	**2.5.3.4** **GEN panel** Dig. Vpp **2.5.3.4.1** **GEN panel** S/PDIF Vpp **2.5.3.4.2** **GEN panel** S/PDIF Vpp
OUTPut:**TYPE**	**BAL**anced **UNB**alanced **CTES**t		**2.5.2** **GEN panel** Output → BAL XLR → UNBAL BNC → COMTST XLR
OUTPut:**TYPE**	**PAR**allel **MPAR**allel **SER**ial **MSER**ial **AES**ebu **SPD**if **OPT**ical **INT**ernal		**2.5.3.1..** Output → PARALLEL → PARAL MUX → SERIAL → SERIAL MUX → AES/EBU → S/P DIF → OPTICAL → INTERN

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Command	Parameter	Basic unit	Section
OUTPut:**VAL**idity	**CH1A**nd2 **CH1** **CH2** **NONE**		**2.5.3.4.4** **GEN panel** Validity → 1 & 2 → 1 → 2 → NONE
OUTPut:**WCL**ock	**RIS**ing **FALL**ing		**2.5.3.2** **2.5.3.3** **GEN panel** Wordclock → RISING → FALLING
OUTPut:**WLEN**gth	**L8** **L16** **L24** **L32**		**2.5.3.2** **GEN panel** Wordlength → 8 → 16 → 14 → 32
OUTPut:**WOFF**set	<**n**>		**2.5.3.2** **GEN panel** Wordoffset
OUTPut:**WSEL**ect	**LOW** **HIGH**		**2.5.3.2** **2.5.3.3** **GEN panel** WordselCh1 → LOW → HIGH
OUTPut**2**:**SEL**ect	**OFF** **CH1** **CH2** **CH2**Is1 **CH2P**has180		**2.5.5** **GEN panel** Channel(s) → OFF → 1 → 2 → 2 ≡ 1 → 2 ≡ -1
SENSe:**DIG**ital:**FEED**	**ADAT**a **JPH**ase **CINP**ut		**2.6.3.1** **ANLR panel** Meas Mode → AUDIO DATA → JITTER/PHAS → COMMON/INP
SENSe:**DIG**ital:**SYNC**:**REF**erence	**GCL**ock **PLLV**ari **PLL32** **PLL44** **PLL48**		**2.6.3.4** **ANLR panel** Jitter Ref → GEN CLK → VARI (PLL) → 32.0 (PLL) → 44.1 (PLL) → 48.0 (PLL)

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Command	Parameter	Basic unit	Section
SENSe:**FREQ**uency:**FACT**or	<nu>	MLT	**2.6.5.3** **ANLR-Panel** FREQ MODE → Factor
SENSe:**UFIL**ter[1**...9**]:**ORD**er	**N4** **N8**		**2.7.2** **FILTER-Panel** Order → 4 → 8
SENSe[]:**POW**er:**REF**erence:**RES**istance	**<nu>**	Ohm	**2.4** (RREF) **2.6.2** **ANLR panel** Imped
SENSe[]:**VOLT**age:**RANGe**:**AUTO** **SENS**e[]:**VOLT**age:**RANGe**	**ON** **FIXM**ax		**2.6.3.4** **ANLR panel** Range → AUTO → FIX (MAX)
SENSe[]:**VOLT**age:**RANG**e[1|**2**]:**AUTO**	**ON** **OFF**		**2.6.2** **ANLR panel** Range → Auto
SENSe[]:**VOLT**age:**RANG**e[1|**2**]:**LOW**er	**<nu>**	V	**2.6.2** **ANLR panel** Range → LOWER
SENSe[]:**VOLT**age:**RANG**e[1|**2**][:**UPP**er]	**<nu>**	V	**2.6.2** **ANLR panel** Range → FIX
SENSe[1]:**BWID**th[:RESolution] equivalent to **SENS**e[1]:**BAND**width[:RESolution]	**<nu>**	Hz	**2.6.5.3** **ANLR panel** Bandwidth
SENSe[1]:**BWID**th[:RESolution]:**MODE** equivalent to **SENS**e[1]:**BANDwid**th[:RESolution]:**MODE**	**PPCT1** **PPCT3** **PTOC**t **POCT1**2 **PFIX** **PFAS**t **SPCT1** **SPCT3** **STOC**t **SOCT1**2 **SFIX** **SFAS**t		**2.6.5.3** **ANLR panel** Bandwidth → BP 1% → BP 3 % → BP 1/3 OCT → BP 1/12 OCT → BP FIX: → BP FAST → BS 1% → BS 3 % → BS 1/3 OCT → BS 1/12 OCT → BS FIX: → BS FAST

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Command	Parameter	Basic unit	Section
SENSe[1]:**DATA**1|2**?**	**<nu>**	Depending on FUNC	**3.15.8** **No manual control** **Result display**
SENSe[1]:**FILT**er<i>	<i> 1 to 4 **OFF**		**2.7.1** **FILTER panel** Filter
SENSe[1]:**FILT**er<i>:.....	<i> 1 to 4		**2.7.1** **ANLR panel** Filter
SENSe[1]:**FILT**er<i>:**AWE**ighting[:STATe]	<i> 1 to 4 **ON**|**OFF**		**2.7.1** **FILTER panel** Filter → A Weighting
SENSe[1]:**FILT**er<i>:**CARM**[:STATe]	<i> 1 to 4 **ON**|**OFF**		**2.7.1** **FILTER panel** Filter → CCIR ARM
SENSe[1]:**FILT**er<i>:**CCIR**[:STATe]	<i> 1 to 4 **ON**|**OFF**		**2.7.1** **FILTER panel** Filter → CCIR wtd
SENSe[1]:**FILT**er<i>:**CCIT**t[:STATe]	<i> 1 to 4 **ON**|**OFF**		**2.7.1** **FILTER panel** Filter → CCITT
SENSe[1]:**FILT**er<i>:**CCIU**nweight[:STATe]	<i> 1 to 4 **ON**|**OFF**		**2.7.1** **FILTER panel** Filter → CCIR unwtd
SENSe[1]:**FILT**er<i>:**CMES**sage[:STATe]	<i> 1 to 4 **ON**|**OFF**		**2.7.1** **FILTER panel** Filter → C MESSAGE
SENSe[1]:**FILT**er<i>:**DCN**oise [:STATe]	<i> 1 to 4 **ON**|**OFF**		**2.7.1** **FILTER panel** Filter → DC NOISE HP
SENSe[1]:**FILT**er<i>:**DEMP**hasis**17**[:STATe]	<i> 1 to 4 **ON**|**OFF**		**2.7.1** **FILTER panel** Filter → DEEMPH J.17
SENSe[1]:**FILT**er<i>:**DEMP**hasis**50**[:STATe]	<i> 1 to 4 **ON**|**OFF**		**2.7.1** **FILTER panel** Filter → DEEMPH 50

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Command	Parameter	Basic unit	Section
SENSe[1]:**FILT**er<i>:**DEMP**hasis**5015**[:STATe]	<i> 1 to 4 **ON**|**OFF**		**2.7.1** **FILTER panel** Filter → DEEM 50/15
SENSe[1]:**FILT**er<i>:**DEMP**hasis**75**[:STATe]	<i> 1 to 4 **ON**|**OFF**		**2.7.1** **FILTER panel** Filter → DEEMPH 75
SENSe[1]:**FILT**er<i>:**IECTuner**[:STATe]	<i> 1 to 4 **ON**|**OFF**		**2.7.1** **FILTER panel** Filter → IEC Tuner
SENSe[1]:**FILT**er<i>:**UFIL**ter1**...**:**UFIL**ter9[:STATe]	<i> 1 to 4 **ON**|**OFF**		**2.7.1** **FILTER panel** Filter
SENSe[1]:**FILT**er<i>:**URUM**ble[:STATe]	<i> 1 to 4 **ON**|**OFF**		**2.7.1** **FILTER panel** Filter → RUMBLE unw
SENSe[1]:**FILT**er<i>:**WRUM**ble[:STATe]	<i> 1 to 4 **ON**|**OFF**		**2.7.1** **FILTER panel** Filter → RUMBLE wtd
SENSe[1]:**FILT**er1:.....			**2.7.1** **ANLR panel** Fnct Settl
SENSe[1]:**FILT**er**2**:.....			**2.7.1** **ANLR panel** Filter
SENSe[1]:**FREQ**uency:**LIMi**t:**LOW**er	**<nu>**	Hz	**2.6.5.7** **ANLR panel** → Frq Lim Low
SENSe[1]:**FREQ**uency:**LIMi**t:**UPP**er	**<nu>**	Hz	**2.6.5.7** **ANLR panel** → Frq Lim Upp

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Command	Parameter	Basic unit	Section
SENSe[1]:**FREQ**uency:**MODE**	**FIX**ed | **CW** **SWE**ep **LIST** **MULT**isine **GENT**rack **CH1** **CH2**		**2.6.5.3** **2.6.5.9** **ANLR panel** SWEEP CTRL → OFF → AUTO SWEEP MANU SWEEP → AUTO LIST MANU LIST → GEN MLTSINE FREQ MODE → GEN TRACK → FREQ CH1 → FREQ CH2
SENSe[1]:**FREQ**uency:**SQRS**in	**DIMA** **DIMB**		**2.6.5.9** **ANLR panel** FREQ MODE → 2.96/14kHz → 3.15/15kHz
SENSe[1]:**FREQ**uency:**STAR**t **SENS**e[1]:**FREQ**uency:**STOP**	**<nu>**	Hz	**2.6.5.3** **ANLR panel** SWEEP CTRL →Start|Stop
SENSe[1]:**FREQ**uency[:FIXed|:CW]	**<nu>**	Hz	**2.6.5.3** **ANLR panel** FREQ MODE → FIX
SENSe[1]:**FUNC**tion	**'OFF'** **'RMS'** **'RMSS**electiv' **'PEAK'** **'QREak'** **'DC'** **'THD'** **'THDN**sndr' **'MDIS**t' **DIM'** **'DFD'** **'WAF'** **'POL**arity' **'FFT'** **'FILT**ersimulation' **'WAV**eform' '**COH**erence' **'DIGI**npampl' '**PHAS**etoref '		**2.6.5** **ANLR panel** FUNCTION → OFF → RMS & S/N → RMS SELECT → REAK & S/N → Q PK & S/N → DC → THD → THD+N/SINAD → MOD DIST → DFD → DIM → WOW & FL → POLARITY → FFT → FILTER SIM. → WAVEFORM → COHERENCE → DIG INP AMP → PHAS TO REF
SENSe[1]:**FUNC**tion:**APER**ture:**MODE**	**SLOW** **FAST** **SFAS**t		**2.6.5.7** **ANLR-Panel** Meas Time → SLOW → FAST → SUPERFAST

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Command	Parameter	Basic unit	Section
SENSe[1]:**FUNC**tion:**DCS**uppression	**ON** **OFF**		**2.6.5.1** ANLR-Panel DC Suppres → ON → OFF
SENSe[1]:**FUNC**tion:**DIST**ortion	**<n>**		**2.6.5.6** **ANLR panel** → di2468
SENSe[1]:**FUNC**tion:**DMOD**e	**FAST** **PREC**ision		**2.6.5.6** **2.6.5.7** **2.6.5.8** **2.6.5.10** **ANLR panel** Dyn Mode → FAST → PRECISION
SENSe[1]:**FUNC**tion:**MMOD**e	**PPE**ak **NPE**ak **PTOP**eak **PABS**olut		**2.6.5.4** **ANLR panel** Meas Mode → PK + → PK - → PK to PK → PK abs
SENSe[1]:**FUNC**tion:**MMOD**e	**SEL**ectdi **LSEL**ectdi **DALL** **LDAL**l **DODD** **LDOD**d **DEV**en **LDEV**en		**2.6.5.6** **ANLR panel** Meas Mode → SELECT di → LEV SEL di → All di → LEV All di → All odd di → LEV odd di → All even di → LEV even di
SENSe[1]:**FUNC**tion:**MMOD**e	**THDN** **LTHD**n **SNDR**atio **NOIS**e **LNO**ise		**2.6.5.7** **ANLR panel** Meas Mode → THD+N → LEVEL THD+N → SINAD → NOISE → LEVEL NOISE
SENSe[1]:**FUNC**tion:**MMOD**e	**D2_268** alias **D2** **D3_268** alias **D3** **D2_118** **D3_118**		**2.6.5.10** **ANLR panel** Meas Mode → d2 (IEC268) → d3 (IEC268) → d2 (IEC118) → d3 (IEC118)

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Command	Parameter	Basic unit	Section
SENSe[1]:**FUNC**tion:**MMOD**e	**STAN**dard **ENH**anced **COMP**ressed **USAM**pl		**2.6.5.15** **ANLR panel** Meas Mode → STANDARD → ENHANCED → COMPRESSED → UNDERSAMP
SENSe[1]:**FUNC**tion:**SETT**ling:.....			**2.3.4.2** **ANLR panel** Fnct Settl
SENSe[1]:**FUNC**tion:**SETTl**ing:**TOUT** **SENS**e**3**:**FREQ**uency:**SETTl**ing:**TOUT** **SENS**e**3**:**PHAS**e:**SETTl**ing:**TOUT**	**<nu>**	s	**2.6.5.1** **ANLR panel** Timeout
SENSe[1]:**FUNC**tion:**SNS**equence	**ON** **OFF**		**2.6.5.1** **ANLR panel** S/N Sequ → ON → OFF
SENSe[1]:**FUNC**tion:**STAN**dard	**NAB** **JIS** **DIN**iec **SI05** **SI10**		**2.6.5.11** **ANLR panel** Rule → NAB → JIS → DIN/IEC → 2 Sigma 5 s → 2 Sigma 10s
SENSe[1]:**FUNC**tion:**WEIG**hting	**ON** **OFF**		**2.6.5.11** **ANLR panel** Weighting → ON → OFF
SENSe[1]:**LIST**:**FREQ**uency	**<n>**{,**<n>**} **<n>**{,**<n>**}	Hz	**2.9.1.3** **No manual control**
SENSe[1]:**LIST**:**FREQ**uency:**POIN**ts**?**	**<n>** 0 to 1024 Query only		**2.9.1.3** **No manual control**
SENSe[1]:**LIST**:**MODE**	**AUTO** **MAN**ual		**2.6.5.3** **ANLR panel** SWEEP CTRL → AUTO LIST → MANU LIST
SENSe[1]:**NOTC**h:**FREQ**uency:**FIX**ed	**<nu>**	HZ	**2.6.5.1** **ANLR panel** Notch Freq → VALUE:

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Command	Parameter	Basic unit	Section
SENSe[1]:**NOTC**h:**FREQ**uency:**MODE**	**AUTO** **FIX**ed **GENT**rack		**2.6.5.1** **ANLR panel** Notch Freq → AUTO → VALUE: → GEN TRACK
SENSe[1]:**NOTC**h[:STATe]	**DB0** **DB12** **DB30** **OFF**		**2.6.5.1** **ANLR panel** Anlg. Notch → 0 dB → 12 dB → 30 dB → OFF
SENSe[1]:**SMO**othing:**APER**ture	**N1** **N2** **N4** **N8** **N16** **N32**		**2.6.5.15** **ANLR panel** Interpol → 1 → 2 → 4 → 8 → 16 → 32
SENSe[1]:**SWE**ep:**MODE**	**AUTO** **MAN**ual		**2.6.5.3** **ANLR panel** SWEEP CTRL → AUTO SWEEP → MANU SWEEP
SENSe[1]:**SWE**ep:**POIN**ts	**<n>** 2 to 1024		**2.6.5.3** **ANLR panel** Points
SENSe[1]:**SWE**ep:**SPAC**ing	**LIN**ear **LOG**arithmic		**2.6.5.3** **ANLR panel** Spacing → LIN → LOG
SENSe[1]:**SWE**ep:**STEP**	**<nu>|<n>**		**2.6.5.3** **ANLR panel** Steps
SENSe[1]:**THDN**:**REJ**ection	**NARR**ow **WIDE**		**2.6.5.7** **ANLR panel** Rejection → NARROW → WIDE
SENSe[1]:**TRIGger**:**SETTling**:**.....**			**2.3.4.2** **ANLR panel** Fnct Settl
SENSe[1]:**TRIG**ger:**SETTl**ing:**COUN**t **SENS**e[1]:**FUNC**tion:**SETTl**ing:**COUN**t **SENS**e**3**:**FREQ**uency:**SETTl**ing:**COUN**t **SENS**e**3**:**PHAS**e:**SETTl**ing:**COUN**t	**<n>**		**2.6.5.1** **ANLR panel** Samples

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Command	Parameter	Basic unit	Section
SENSe[1]:**TRIG**ger:**SETTl**ing:**MODE** **SENS**e[1]:**FUNC**tion:**SETTl**ing:**MODE** **SENS**e**3**:**FREQ**uency:**SETT**ling:**MODE** **SENS**e**3**:**PHAS**e:**SETTl**ing:**MODE**	**OFF** **EXP**onential **FLAT** **AVER**age		**2.6.5.1** **ANLR panel** Settling → OFF → EXPONENTIAL → FLAT → AVERAGE
SENSe[1]:**TRIG**ger:**SETTl**ing:**RES**olution **SENS**e[1]:**FUNC**tion:**SETTl**ing:**RES**olution **SENS**e**3**:**FREQ**uency:**SETTl**ing:**RES**olution **SENS**e**3**:**PHAS**e:**SETTl**ing:**RES**olution	**<nu>**	V FS % dB Hz DEG(°)	**2.6.5.1** **ANLR panel** Resolution
SENSe[1]:**TRIG**ger:**SETTl**ing:**TOL**erance **SENS**e[1]:**FUNC**tion:**SETTl**ing:**TOL**erance **SENS**e**3**:**FREQ**uency:**SETTl**ing:**TOL**erance	**<n>**	%	**2.6.5.1** **ANLR panel** Tolerance
SENSe[1]:**UFIL**ter<i>:**ATT**enuation	<i> 1 to 9 **<nu>**	dB	**2.7.2.1** **FILTER panel** FILTER 0x → Atten
SENSe[1]:**UFIL**ter<i>:**BPAS**s[:STATe]	<i> 1 to 9 **ON**		**2.7.2** **FILTER panel** FILTER 01 to 09
SENSe[1]:**UFIL**ter<i>:**BSTO**p[:STATe]	<i> 1 to 9 **ON**		**2.7.2** **FILTER panel** FILTER 01 to 09
SENSe[1]:**UFIL**ter<i>:**CENT**er	<i> = 1 to 9 **<nu>**	Hz	**2.7.2.4** **2.7.2.5** **FILTER panel** FILTER 0x → Center Frq
SENSe[1]:**UFIL**ter<i>:**DEL**ay	Query only for all filters except for file-defined filters <i> = 1 to 9 **<nu>**	s	**2.7.2.7** **FILTER panel** FILTER 0x → Delay
SENSe[1]:**UFIL**ter<i>:**DEL**ay?	<i> 1 to 9 Query only		**2.7.2.1** **FILTER panel** FILTER 0x → Delay
SENSe[1]:**UFIL**ter<i>:**FILE**	**"filename"** <i> 1 to 9		**2.7.2.7** **FILTER panel** FILTER 0x → Filename
SENSe[1]:**UFIL**ter<i>:**FILE**[:STATe]	<i> 1 to 9 **ON**		**2.7.2** **FILTER panel** FILTER 01 to 09

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Command	Parameter	Basic unit	Section
SENSe[1]:**UFIL**ter<i>:**HPAS**s[:STATe]	<i> 1 to 9 **ON**		**2.7.2** **FILTER panel** FILTER 01 to 09
SENSe[1]:**UFIL**ter<i>:**LPAS**s[:STATe]	<i> 1 to 9 **ON**		**2.7.2** **FILTER panel** FILTER 01 to 09
SENSe[1]:**UFIL**ter**<i>**:**NOTC**h[:STATe]	<i> 1 to 9 **ON**		**2.7.2** **FILTER panel** FILTER 01 to 09
SENSe[1]:**UFIL**ter<i>:**OCT**av[:STATe]	<i> 1 to 9 **ON**		**2.7.2** **FILTER panel** FILTER 01 to 09
SENSe[1]:**UFIL**ter<i>:**PASS**b	<i> = 1 to 9 **<nu>**	Hz	**2.7.2.2** **FILTER panel** FILTER 0x → Passband
SENSe[1]:**UFIL**ter<i>:**PASS**b:**LOW**er	<i> = 1 to 9 **<nu>**	Hz	**2.7.2.3** **FILTER panel** FILTER 0x → Passb low
SENSe[1]:**UFIL**ter<i>:**PASS**b:**UPP**er	<i> = 1 to 9 **<nu>**	Hz	**2.7.2.3** **FILTER panel** FILTER 0x → Passb upp
SENSe[1]:**UFIL**ter<i>:**STOP**b:**LOW**er?	<i> 1 to 9 Query only		**2.7.2.3** **FILTER panel** FILTER 0x → Stopb low
SENSe[1]:**UFIL**ter<i>:**STOP**b:**UPP**er?	<i> 1 to 9 Query only		**2.7.2.3** **FILTER panel** FILTER 0x → Stopb upp
SENSe[1]:**UFIL**ter<i>:**STOP**b?	<i> 1 to 9 Query only		**2.7.2.2** **FILTER panel** FILTER 0x → Stopband
SENSe[1]:**UFIL**ter<i>:**TOCT**ave[:STATe]	<i> 1 to 9 **ON**		**2.7.2** **FILTER panel** FILTER 01 to 09
SENSe[1]:**UFIL**ter<i>:**WIDT**h	<i> = 1 to 9 **<nu>**	Hz	**2.7.2.4** **2.7.2.5** **FILTER panel** FILTER 0x → Width
SENSe[1]:**UNIT**	**PCT|DB**		**2.4** **ANLR panel** Unit

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Command	Parameter	Basic unit	Section
SENSe[1]:**VOLT**age:**APER**ture	**<nu>**	s	**2.6.5.2** **2.6.5.3** **2.6.5.5** **2.6.5.17** **2.6.5.18** **ANLR panel** Meas Time
SENSe[1]:**VOLT**age:**APER**ture:**MODE**	**AFAS**t **AUTO** **SFAS**t **FAST** **SLOW** **GENT**rack **TRIG**gered **VAL**ue		**2.6.5.2** **ANLR panel** Meas Time → AUTO FAST → AUTO → FIX 50ms → FIX 200ms → FIX 1000ms → GEN TRACK → TRIGGERED → VALUE:
SENSe[1]:**VOLT**age:**APER**ture:**MODE**	**AFAS**t **AUTO** **SFAS**t **FAST** **SLOW** **GENT**rack **VAL**ue		**2.6.5.3** **2.6.5.5** **2.6.5.17** **2.6.5.18** **ANLR panel** Meas Time → AUTO FAST → AUTO → FIX 50ms → FIX 200ms → FIX 1000ms → GEN TRACK → VALUE
SENSe[1]:**VOLT**age:**FUND**amental	**<nu>**	Hz	**2.6.5.6** **ANLR panel** Fundamentl
SENSe[1]:**VOLT**age:**FUND**amental	**<nu>**	Hz	**2.6.5.7** **ANLR panel** Fundamentl
SENSe[1]:**VOLT**age:**FUND**amental:**MODE**	**AUTO** **GENT**rack **VAL**ue		**2.6.5.6** **2.6.5.7** **ANLR panel** Fundamentl → AUTO → GEN TRACK → VALUE:
SENSe[1]:**VOLT**age:**INTV**time	**<nu>**	s	**2.6.5.4** **ANLR panel** Intv Time

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Command	Parameter	Basic unit	Section
SENSe[1]:**VOLT**age:**INTV**time:**MODE**	**SFAS**t **FAST** **SLOW** **FIX**ed **VAL**ue		**2.6.5.4** **ANLR panel** Intv Time → FIX 50ms → FIX 200ms → FIX 1000ms → FIX 3 SEC → VALUE:
SENSe[1]:**WAV**eform:**COMP**ression	**<n>**		**2.6.5.15** **ANLR panel** Comp Fact
SENSe[1]:**WAV**eform:**DUR**ation	**<nu>**	s	**2.6.5.15** **ANLR panel** Trace Len
SENSe[**1**][:VOLTage|POWer]:**REF**erence	**<nu>**	V FS	**2.6.5.1** **ANLR panel** Reference
SENSe[1][:VOLTage|POWer]:**REF**erence:**MODE**	**CH1S**tore **CH2S**tore **CH1M**eas **CH2M**eas **STOR**e **VAL**ue		**2.6.5.1** **ANLR panel** Reference → STORE CH1 → STORE CH2 → MEAS CH1 → MEAS CH2 → STORE → VALUE:

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Command	Parameter	Basic unit	Section
SENSe[1|**2**][:VOLTage|POWer]:**UNIT**[1|**2**]	**V** **MV** (For SENS[1]... only) **UV** (For SENS[1]... only) **DBV** **DBU** **W** **DBM** **DV** **DPCTV** **VVR** **PCTVVR** **DW** **DPCTW** **PPR** **PCTPPR** **DBR** **DB** (For SENS[1]... only) **PCT** (For SENS[1]... only) **FS** **LSBS** **DBFS** **BITS** **DPCT** **PCTFS** **UI** **NS** **PPMUI** **DBUI** **UIR** **PCTUI** **PCTFRM** **DEGFRM**		**2.4** **ANLR panel** Unit Ch1/Ch2
SENSe**2**:**DATA**1|2**?**	**<nu>**	V/FS	**3.15.8** **No manual control** **Result display**
SENSe**2**:**FUNC**tion	**"OFF"** **"PEAK**voltage" "**RMS**"		**2.6.5.19** **ANLR panel** INPUT DISP → OFF → PEAK → RMS
SENSe**2**:**VOLT**age:**REF**erence	**<nu>**	V FS	**2.6.5.1** **ANLR panel** Reference
SENSe**2**:**VOLT**age:**REF**erence:**MODE**	**CH1**Store **CH2**Store **STOR**e **CH1M**eas **CH2M**eas **GENT**rack **VAL**ue		**2.6.5.1** **ANLR panel** Reference → STORE CH1 → STORE CH2 → MEAS CH1 → MEAS CH2 → STORE → GEN TRACK → VALUE:

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Command	Parameter	Basic unit	Section
SENSe3:**DATA**1|2**?**	**<nu>**	Hz	**3.15.8** **No manual control** **Result display**
SENSe3:**FREQ**uency:**APER**ture	<**nu**>	s	**2.6.5.20** **ANLR panel**
SENSe3:**FREQ**uency:**APER**ture:**MODE**	**SFAS**t **FAST** **SLOW** **VAL**ue		**2.6.5.20** **ANLR panel** Meas Time → FIX 50ms → FIX 200ms → FIX 1000ms → VALUE:
SENSe3:**FREQ**uency:**REF**erence	**<nu>**	Hz	**2.6.5.1** **2.6.5.20** **ANLR panel** Ref Freq
SENSe3:**FREQ**uency:**REF**erence:**MODE**	**CH1S**tore **CH2S**tore **CH1M**eas **CH2M**ea **STOR**e **GENT**rack **VAL**ue		**2.6.5.1** **2.6.5.20** **ANLR panel** Ref Freq → STORE CH1 → STORE CH2 → MEAS CH1 → MEAS CH2 → STORE → GEN TRACK → VALUE:
SENSe3:**FREQ**uency:**SETT**ling:.....			**2.3.4.2** **ANLR panel** Freq Settl
SENSe3:**FREQ**uency:**UNIT**[1|**2**]	**HZ** **DHZ** **DPCTHZ** **TERZ** **OCT** **DEC** **FFR**		**2.4** **ANLR panel** Unit Ch1/Ch2
SENSe3:**FUNC**tion	**"OFF"** **"FREQ**uency"		**2.6.5.20** **ANLR panel** FREQ/PHAS → OFF → FREQ
SENSe3:**FUNC**tion	"**OFF"** **"FQPH**ase"		2.6.5.21 **ANLR panel** FREQ/PHASE → OFF → FREQ&PHASE

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Command	Parameter	Basic unit	Section
SENSe**3**:**FUNC**tion	"**OFF"** **"FQGR**oupdelay"		2.6.5.21 **ANLR panel** FREQ/PHASE → FREQ&GRPDEL
SENSe**3**:**FUNC**tion	'**OFF'** **'SFRE**quency'		**2.6.5.22** **ANLR panel** FREQUENCY → SAMPLE FREQ
SENSe**3**:**PHAS**e:**FORM**at	**POS**itive **POSN**egative **NEG**ative **RAD** **RADB**ipolar **RADN**egative		**2.6.5.21** **ANLR panel** Format Pha → 0 .. 360° → -180° .. 180° → - 360° .. 0° → 0 .. 2 π → - π .. + π → -2 π .. 0
SENSe**3**:**PHAS**e:**REF**erence	**<nu>**	s | DEG	**2.6.5.1** **ANLR panel** Ref Phase
SENSe**3**:**PHAS**e:**REF**erence:**MODE**	**STOR**e **VAL**ue		**2.6.5.1** **ANLR-Panel** Reference → STORE → VALUE:
SENSe**3**:**PHAS**e:**SETTL**ing:.....			**2.3.4.2** **ANLR-Panel** Phas Settl
SENSe**3**:**PHAS**e:**UNIT**	**DEG** **RAD** **DDEG** **DRAD** **S** **DS**		**2.4** **ANLR panel** Unit Ch1/Ch2
SENSe**4**:**DATA?**	**<nu>**	DEG	**3.15.8** **No manual control** **Result display**
SOURce:**BAND**width equivalent to **SOUR**ce:**BWID**th	**F30** **F100**		**2.5.4.10** **GEN panel** → 30 kHz → 100 kHz

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Command	Parameter	Basic unit	Section
SOURce:**DIG**ital:**FEED**	**ADAT**a **JITT**er **PHAS**e **COMM**on		**2.5.3.1** **GEN panel** Src Mode → AUDIO DATA → JITTER ONLY → PHASE → COMMON ONLY
SOURce:**DIG**ital:**REF**erence	**AZER**o **AONE**		**2.5.3.4.2** **GEN panel** Data → ALL ZERO → ALL ONE
SOURce:**DIG**ital:**SYNC**:**DEL**ay	**<nu>**.	UI see **2.5.3.4** **.3**	**2.5.3.4.2** **GEN panel** PhaseToRef
SOURce:**DIG**ital:**SYNC**:**MODE**	**V50** **V60** **F1024** **WCL**ock **IWCL**ock		**2.5.3.4.2** **GEN panel** Sync Mode → VIDEO 50 → VIDEO 60 → 1024 kHz → WORD CLK → WRD CLK INV
SOURce:**DIG**ital:**SYNC**:**SOUR**ce	**GCL**ock **EXT**ern		**2.5.3.2** **2.5.3.3** Sync TO → GEN CLK → EXTERN:
SOURce:**DIG**ital:**SYNC**:**SOUR**ce	**AINP**ut **WCLock** **GCL**ock		**2.5.3.4.1** **GEN panel** Sync To → AUDIO IN → WORDCLK INP → GEN CLK
SOURce:**DIG**ital:**SYNC**:**SOUR**ce	**AINP**ut **RINP**ut **SINP**ut **GCL**ock		**2.5.3.4.2** **GEN panel** Sync To → AUDIO IN → REF IN → SYNC IN → GEN CLK
SOURce:**DIM**	**DIMA** **DIMB**		**2.5.4.10** **GEN panel** Square/Sin → 2.96/14 kHz → 3.15/15 kHz

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Command	Parameter	Basic unit	Section
SOURce:**FREQ**uency:**DIFF**erence	**<nu>**	Hz	**2.5.4.9** **GEN panel** DIFF FREQ
SOURce:**FREQ**uency:**MEAN**	<**nu**>	Hz	**2.5.4.11** **GEN panel** MEAN FREQ
SOURce:**FREQ**uency:**MODE**	**CW**|**FIX**ed **SWE**ep**1** **SWE**ep**2** **LIST1** **LIST2**		**2.5.4.2** **GEN panel** SWEEP CTRL X Axis Z Axis
SOURce:**FREQ**uency:**OFFS**et:**STAT**e	**ON** **OFF**		**2.5.4.1** **2.5.4.1.1** **GEN panel** Frq. Offset → +1000 PPM → OFF
SOURce:**FREQ**uency:**QUAL**ity	**PREC**ision **FAST**		**2.5.4.9** **2.5.4.1** **2.5.4.8** **2.5.4.10** **GEN panel** Settling → PRECISION → FAST
SOURce:**FREQ**uency:**REF**erence	**<nu>**	Hz	**2.5.2** **2.5.3.1** **GEN panel** Ref.Freq
SOURce:**FREQ**uency:**STAR**t	**<nu>**	Hz	**2.5.4.2** **GEN panel** FREQUENCY → Start
SOURce:**FREQ**uency:**STOP**	**<nu>**	Hz	**2.5.4.2** **GEN panel** FREQUENCY → Stop
SOURce:**FREQ**uency[:CW|FIXed]	**<nu>**	Hz	**2.5.4.5** **2.5.4.6** **2.5.4.7** **GEN panel** FREQUENQY
SOURce:**FREQ**uency[:CW|FIXed]	**<nu>**	Hz	**2.5.4.15** **GEN panel** Mod Freq
SOURce:**FREQ**uency[<i>][:CW|FIXed]	**<i>** 1 to 17 **<nu>**	Hz	**2.5.4.4** **GEN panel** Freq No1 to 17

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Command	Parameter	Basic unit	Section
SOURce:**FREQ**uency[1][:CW|FIXed]	**<nu>**	Hz	**2.5.4.8** **GEN panel** UPPER FREQ
SOURce:**FREQ**uency**2**[:CW|FIXed]	**<nu>**	Hz	**2.5.4.8** **2.5.4.15** **GEN panel** LOWER FREQ
SOURce:**FREQ**uency**2**[:CW|FIXed]	**<nu>**	Hz	**2.5.4.15** **GEN panel** Carr Freq
SOURce:**FUNC**tion:**MODE**	**IEC2**68 **IEC1**18 **EQU**alvoltage **DEF**inedvoltage **FM** **AM**		**2.5.4.9** **GEN panel** **Mode** → IEC 268 → IEC 118 **2.5.4.4** **GEN-Panel** Mode → EQUAL VOLT → DEFINE VOLT **2.5.4.15** **GEN-Panel** Mode → FM → AM
SOURce:**FUNC**tion:**MODE** equivalent to **SOUR**ce:**MULT**isine:**MODE**	**EQU**alvoltage **DEF**inedvoltage		**2.5.4.4** **GEN-Panel** Mode → EQUAL VOLT → DEFINE VOLT
SOURce:**FUNC**tion[:SHAPe]	**SIN**usoid **MULT**isine **BURS**t **S2P**ulse **SQU**are **MDIS**t **DFD** **DIM** **RAND**om **USER** **POL**arity **FSK** **FM** **DC**		**2.5.4** **GEN-Panel** FUNCTION → SINE →MULTISINE → SINEBURST → SINE²BURST → SQUARE → MODDIST → DFD → DIM → RANDOM → ARBITRARY → POLARITY → FSK → MODULATION → DC
SOURce:**INT**erval:**MODE**	**CW**|**FIX**ed **SWE**ep**1** **SWE**ep**2** **LIST1** **LIST2**		**2.5.4.2** **GEN panel** SWEEP CTRL X Axis Z Axis

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Command	Parameter	Basic unit	Section
SOURce:**INT**erval:**STAR**t	**<nu>**	s	**2.5.4.2** **2.5.4.5** **2.5.4.6** **GEN panel** Start
SOURce:**INT**erval:**STOP**	**<nu>**	s	**2.5.4.2** **2.5.4.5** **2.5.4.6** **GEN panel** Stop
SOURce:**INT**erval[:CW|FIXed]	**<nu>**	s	**2.5.4.5** **2.5.4.6** **GEN panel** INTERVAL
SOURce:**LOWD**istortion	**ON** **OFF**		**2.5.4.1** **2.5.4.3** **2.5.4.8** **2.5.4.9** **GEN panel** Low Dist → ON → OFF
SOURce:**MULT**isine:**COUN**t	**<n>** 1 to 17		**2.5.4.4** **GEN panel** No of Sin
SOURce:**O33**	'**O33-Kennung**'		**No manual operation**
SOURce:**OFF**:**MODE**	**SWEep2** **LIST2**		**2.5.4.2** **GEN panel** Z Axis → OFF
SOURce:**ONT**ime:**DEL**ay	**<nu>**		**2.5.4.5** **2.5.4.6** **GEN panel** BurstOnDel
SOURce:**ONT**ime:**MODE**	**CW|FIX**ed **SWE**ep**1** **SWE**ep**2** **LIST1** **LIST2**		**2.5.4.2** **GEN panel** SWEEP CTRL X Axis Z Axis
SOURce:**ONT**ime:**STAR**t	**<nu>**	s, cyc	**2.5.4.2** **2.5.4.5** **2.5.4.6** **GEN panel** Start

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Command	Parameter	Basic unit	Section
SOURce:**ONT**ime:**STOP**	**<nu>**	s, cyc	**2.5.4.2** **2.5.4.5** **2.5.4.6** **GEN panel** Stop
SOURce:**ONT**ime[:CW|FIXed]	**<nu>**	s, cyc	**2.5.4.5** **2.5.4.6** **GEN panel** ON TIME
SOURce:**PHAS**e[<i>][:ADJust]	<i> 1 to 17 **<nu>**	DEG	**2.5.4.4** **GEN panel** Phas No1 to 17
SOURce:**PROT**ocol	**OFF** **ENH**anced		**2.5.3.4.4** **GEN panel** PROTOCOL → PANEL OFF → ENHANCED
SOURce:**PROT**ocol:**FBL**ock	**<n>**		**2.5.3.4.4** **GEN panel** Block Err
SOURce:**PROT**ocol:**FCRC**	**<n>**		**2.5.3.4.4** **GEN panel** CRC Error
SOURce:**PROT**ocol:**FSEQ**	**<n>**		**2.5.3.4.4** **GEN panel** Seq. Err
SOURce:**PROT**ocol:**LCH**annelstatus	**ZERO** **AES3** **CRC** **RAW**		**2.5.3.4.4** **GEN panel** Ch Sta. L → ZERO → FILE+AES3 → FILE+CRC → FILE
SOURce:**PROT**ocol:**PAR**ity	**ON** **FAIL**		**2.5.3.4.4** **GEN panel** Parity → TRUE → WITH ERR
SOURce:**PROT**ocol:**PAR**ity:**FCO**unt	**<n>**		**2.5.3.4.4** **GEN panel** No. False
SOURce:**PROT**ocol:**PAR**ity:**FOFF**set	**<n>**		**2.5.3.4.4** **GEN panel** Offset
SOURce:**PROT**ocol:**PAR**ity:**NFC**ount	**<n>**		**2.5.3.4.4** **GEN panel** No. Trues

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Command	Parameter	Basic unit	Section
SOURce:**PROT**ocol:**RCH**annelstatus	**ZERO** **LEQ**ual **AES3** **CRC** **RAW**		**2.5.3.4.4** **GEN panel** Ch Stat. R → ZERO → EQUAL L → FILE+AES3 → FILE+CRC → FILE
SOURce:**PROT**ocol:**UMOD**e	**ZERO** **FILE**		**2.5.3.4.4** **GEN panel** User Mode → ZERO → FILE DEF
SOURce:**RAND**om:**DOM**ain	**FREQ**uency **TIME**		**2.5.4.11** **GEN panel** Domain → FREQ → TIME
SOURce:**RAND**om:**FREQ**uency:**LOW**er **SOUR**ce:**RAND**om:**FREQ**uency:**UPP**er	**<nu>**	Hz	**2.5.4.11** **GEN panel** Lower Freq Upper Freq
SOURce:**RAND**om:**PDF**	**GAUS**sian **TRI**angle **RECT**angle		**2.5.4.1** **2.5.4.1.1** **GEN panel** PDF → GAUSS → TRIANGLE → RECTANGLE
SOURce:**RANDom**:**SHAP**e	**WHIT**e **PINK** **TOCT**ave **ARB**itrary		**2.5.4.11** **GEN panel** Equalizatn → WHITE → PINK → THIRD OCT → FILE
SOURce:**RAND**om:**SPAC**ing:**FREQ**uency	**<nu>**	Hz	**2.5.4.4** **2.5.4.11** **GEN-Panel** Spacing
SOURce:**RAND**om:**SPAC**ing:**MODE**	**USER**defined **ATR**ack		**2.5.4.4** **2.5.4.11** **GEN-Panel** Spacing → USER DEF → ANLR TRACK
SOURce:**SIN**usoid:**DITH**er	**<nu>**	FS	**2.5.4.1** **2.5.4.1.1** **GEN panel** Dither

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Command	Parameter	Basic unit	Section
SOURce:**SIN**usoid:**DITH**er:**STAT**e	**ON** **OFF**		**2.5.4.1** **2.5.4.1.1** **GEN panel** Dither → ON → OFF
SOURce:**SWE**ep ...			**2.5.4.2** **GEN panel** SWEEP CTRL
SOURce:**SWE**ep:**DWEL**l	**<nu>**	s	**2.5.4.2** **GEN panel** Dwell
SOURce:**SWE**ep:**FREQ**uency:**POIN**ts	**<n>**		**2.5.4.2** **GEN panel** Points
SOURce:**SWE**ep:**FREQ**uency:**SPAC**ing	**LIN**ear **LOG**arithmic		**2.5.4.2** **GEN panel** Spacing
SOURce:**SWE**ep:**FREQ**uency:**STEP**	**<nu>**	Hz	**2.5.4.2** **GEN panel** Step
SOURce:**SWE**ep:**INT**erval:**POIN**ts	**<n>**		**2.5.4.2** **GEN panel** Points
SOURce:**SWE**ep:**INT**erval:**SPAC**ing	**LIN**ear **LOG**arithmic		**2.5.4.2** **GEN panel** Spacing → LIN → LOG
SOURce:**SWE**ep:**INT**erval:**STEP**	**<nu>**	s	**2.5.4.2** **GEN panel** Step
SOURce:**SWE**ep:**MODE**	**MAN**ual **AUTO**		**2.5.4.2** **GEN panel** Sweep Ctrl
SOURce:**SWE**ep:**NEXT**step	**DWEL**l **ASYN**c **LIST**		**2.5.4.2** **GEN panel** Next Step → ANLR SYNC → DWELL VALUE → DWELL FILE
SOURce:**SWE**ep:**ONT**ime:**POIN**ts	**<n>** 2 to 1024		**2.5.4.2** **GEN panel** Points

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Command	Parameter	Basic unit	Section
SOURce:**SWE**ep:**ONT**ime:**SPAC**ing	**LIN**ear **LOG**arithmic		**2.5.4.2** **GEN panel** Spacing → LIN → LOG
SOURce:**SWE**ep:**ONT**ime:**STEP**	**<nu>**	s, cyc	**2.5.4.2** **GEN panel** Step
SOURce:**SWE**ep:**VOLT**age:**POIN**ts	**<n>** 2 to 1024		**2.5.4.2** **GEN panel** Points
SOURce:**SWE**ep:**VOLT**age:**SPAC**ing	**LIN**ear **LOG**arithmic		**2.5.4.2** **GEN panel** Spacing → LIN → LOG
SOURce:**SWE**ep:**VOLT**age:**STEP**	**<nu>**	V FS	**2.5.4.2** **GEN panel** Step
SOURce:**VOLT**age:**CRES**tfactor	**<n>**	Multipli cation factor	**2.5.4.4** **2.5.4.11** **GEN panel** Crest Fact
SOURce:**VOLT**age:**CRES**tfactor:**MODE**	**MIN**imized **DPH**ase **VAL**ue		**2.5.4.4** **2.5.4.11** **GEN-Panel** Crest Fact → OPTIMIZED → DEFINE PHAS → VALUE
SOURce:**VOLT**age:**EQU**alize:**STAT**e	**ON** **OFF**		**2.5.4.3** **2.5.4.4** **2.5.4.9** **2.5.4.11** **GEN panel** Equalizer → ON → OFF
SOURce:**VOLT**age:**LIM**it[:AMPLitude]	**<nu>**	V FS	**2.5.2** **2.5.3.1..** GEN panel → Max Volt
SOURce:**VOLT**age:**LOWL**evel	**<nu>**	V %on FS %on	**2.5.4.5** **GEN panel** Low Level

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Command	Parameter	Basic unit	Section
SOURce:**VOLT**age:**MODE**	**CW**|**FIX**ed **SWE**ep**1** **SWE**ep**2** **LIST1** **LIST2**		**2.5.4.2** **GEN panel** SWEEP CTRL X Axis Z Axis
SOURce:**VOLT**age:**RANG**e:**AUTO**	**ON** **OFF**		**2.5.2** **GEN panel** Volt Range → AUTO → FIX:
SOURce:**VOLT**age:**RAT**io	**<n>**		**2.5.4.8** **GEN panel** VOLT LF:UF
SOURce:**VOLT**age:**REF**erece	**<nu>**	V FS	**2.5.2** **2.5.3.1** **GEN panel** Ref Volt
SOURce:**VOLT**age:**STAR**t	**<nu>**	V FS	**2.5.4.2** **GEN panel** VOLTAGE → Start
SOURce:**VOLT**age:**STOP**	**<nu>**	V FS	**2.5.4.2** **GEN panel** VOLTAGE → Stop
SOURce:**VOLT**age:**TOT**al:**GAIN**	**<nu>**	dB	**2.5.4.4** **GEN panel** TOTAL GAIN
SOURce:**VOLT**age:**TOT**al:**RMS**	**<nu>**	V FS	**2.5.4.11** **GEN panel** VOLT RMS
SOURce:**VOLT**age:**TOT**al:**RMS?**	**<nu>** Query only	V FS	**2.5.4.4** **GEN panel** TOTAL RMS
SOURce:**VOLT**age:**TOT**al:**RMS?**	**<nu>** Query only	V FS	**2.5.4.12** **GEN panel** VOLT RMS
SOURce:**VOLT**age:**TOT**al[:LEVel|AMPLitude]	**<nu>**	V FS	**2.5.4.8** **2.5.4.10** **2.5.4.12** **2.5.4.16** **GEN panel** TOTAL VOLT
SOURce:**VOLT**age:**TOT**al[:LEVel|AMPLitude]**?**	**<nu>** Query only	V FS	**2.5.4.4** **GEN panel** TOTAL PEAK

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Command	Parameter	Basic unit	Section
SOURce:**VOLT**age[:LEVel|AMPLitude]	**<nu>** 0...12V 0...24V 0...1FS	 V V FS	**2.5.4.3** **2.5.4.5** **2.5.4.6** **2.5.4.7** **2.5.4.13** **GEN panel** **GEN-Panel** VOLTAGE **2.5.4.14** Volt No 1 **2.5.4.15** With FM: Deviation With AM: Mod Depth
SOURce:**VOLT**age[:LEVel|AMPLitude]:**OFFS**et	**<nu>**	 V V FS	**2.5.4.1** **2.5.4.1.1** **GEN panel** DC Offset
SOURce:**VOLT**age[:LEVel|AMPLitude]:**OFFS**et:**STAT**e	**OFF** **ON**		**2.5.4.1** **2.5.4.1.1** **GEN panel** DC Offset → OFF → ON
SOURce:**VOLT**age[**<i>**][:LEVel|AMPLitude]	**<nu>** **<i>**, 1 ... 17	 V FS	**2.5.4.4** **GEN panel** Volt No 1 to 17
SOURce:**VOLT**age**2**[:LEVel|AMPLitude]	**<nu>** 0...12V 0...1FS	 V FS	**2.5.4.15** **GEN panel** Carr Volt
SOURce[1]:**EQU**alize:**CONT**rol:**POIN**ts**?**	**<n>** 0 to 1024 Query only		**2.9.1.3** **No manual control**
SOURce[1]:**EQU**alize:**CONT**rol[:DATA]	**<n>**{,**<n>**}		**2.9.1.3** **No manual control**
SOURce[1]:**LIST**:**DWEL**l	**<n>**{,**<n>**}	s	**2.9.1.3** **No manual control**
SOURce[1]:**LIST**:**DWEL**l:**CONT**rol:**POIN**ts**?**	**<n>** 0 to 1024 Query only		**2.9.1.3** **No manual control**
SOURce[1]:**LIST**:**DWEL**l:**CONT**rol[:DATA]	**<n>**{,**<n>**}		**2.9.1.3** **No manual control**
SOURce[1]:**LIST**:**DWEL**l:**POIN**ts**?**	**<n>** 0 to 1024 Query only		**2.9.1.3** **No manual control**

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Command	Parameter	Basic unit	Section
SOURce[1]:**LIST**:**FREQ**uency	**<n>**{,**<n>**} **<n>**{,**<n>**}	Hz	**2.9.1.3** **No manual control**
SOURce[1]:**LIST**:**FREQ**uency:**POIN**ts**?**	**<n>** 0 to 1024 Query only		**2.9.1.3** **No manual control**
SOURce[1]:**LIST**:**INT**erval	**<n>**{,**<n>**}		**2.9.1.3** **No manual control**
SOURce[1]:**LIST**:**INT**erval:**POIN**ts**?**	**<n>** 0 to 1024 Query only		**2.9.1.3** **No manual control**
SOURce[1]:**LIST**:**ONT**ime	**<n>**{,**<n>**}	S	**2.9.1.3** **No manual control**
SOURce[1]:**LIST**:**ONT**ime:**POIN**ts**?**	**<n>** 0 to 1024 Query only		**2.9.1.3** **No manual control**
SOURce[1]:**LIST**:**VOLT**age	**<n>**{,**<n>**}	V	**2.9.1.3** **No manual control**
SOURce[1]:**LIST**:**VOLT**age:**POIN**ts**?**	**<n>** 0 to 1024 Query only		**2.9.1.3** **No manual control**
SOURce[1]:**VOLT**age:**EQU**alize:**POIN**ts**?**	**<n>** 0 to 1024 Query only		**2.9.1.3** **No manual control**
SOURce[1]:**VOLT**age:**EQU**alize[:DATA]	**<n>**{,**<n>**}		**2.9.1.3** **No manual control**
SOURce**2**:**FREQ**uency[:CW|FIXed]	<**nu**>	Hz	**2.5.5** **GEN panel** Data Freq
SOURce**2**:**FUNC**tion	**OFF** **DIGD**ata		**2.5.5** **GEN panel** AUX GEN → OFF → DIG DATA
SOURce**2**:**VOLT**age[:LEVel][AMPLitude]	<**nu**>	FS	**2.5.5** **GEN panel** Data Ampl
STATus:**OPER**ation:**COND?**	**<n>** Query only		**3.7.3.4** **No manual control**

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Command	Parameter	Basic unit	Section
STATus:**OPER**ation:**ENAB**le	**<n>**		**3.7.3.4 No manual control**
STATus:**OPER**ation:**NTR**ansition	**<n>**		**3.7.3.4 No manual control**
STATus:**OPER**ation:**PTR**ansition	**<n>**		**3.7.3.4 No manual control**
STATus:**OPER**ation[:EVENt]**?**	**<n>** Query only		**3.7.3.4 No manual control**
STATus:**PRES**et			**3.7.5 No manual control**
STATus:**QUES**tionable:**COND?**	**<n>** Query only		**3.7.3.5 No manual control**
STATus:**QUES**tionable:**ENAB**le	**<n>**		**3.7.3.5 No manual control**
STATus:**QUES**tionable:**NTR**ansition	**<n>**		**3.7.3.5 No manual control**
STATus:**QUES**tionable:**PTR**ansition	**<n>**		**3.7.3.5 No manual control**
STATus:**QUES**tionable[:EVENt]**?**	**<n>** Query only		**3.7.3.5 No manual control**
STATus:**XQUE**stionable:**COND?**	**<n>** Query only		3.7.3.6 **No manual control**
STATus:**XQUE**stionable:**ENAB**le	**<n>**		3.7.3.6 **No manual control**
STATus:**XQUE**Stionable:**NTR**ansition	**<n>**		3.7.3.6 **No manual control**
STATus:**XQUE**stionable:**PTR**ansition	**<n>**		3.7.3.6 **No manual control**

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Command	Parameter	Basic unit	Section
STATus:**XQUE**stionable[:EVENt]**?**	**<n>** Query only		3.7.3.6 **No manual control**
SWITcher:**INP**ut[1]	<**n**>		2.15.6.7 **OPTIONS panel** Inp Ch1 (A)
SWITcher:**INP**ut**2**	<**n**>		2.15.6.7 **OPTIONS panel** Inp Ch2 (B)
SWITcher:**OFFS**et:**CH2V**1	<**n**>		2.15.6.7 **OPTIONS panel** Ch2 vs Ch1
SWITcher:**OUTP**ut[1]	<**n**>		2.15.6.7 **OPTIONS panel** Out Ch1 (A)
SWITcher:**OUTP**ut**2**	<**n**> SWIT:TRAC **OFF**: –1 to 192 SWIT:TRAC **ON**: 0 to 192		2.15.6.7 **OPTIONS panel** Out Ch2 (B)
SWITcher:**OVI**	<**n**>		2.15.6.7 **OPTIONS panel** Out vs Inp
SWITcher:**STAT**e	**ON** **OFF**		2.15.6 **OPTIONS panel** Switcher → ON → OFF
SWITcher:**TRAC**king	**ON** **OFF**		2.15.6.7.2 2.15.6.7.1 **OPTIONS panel** Tracking → ON → OFF
SYSTem:**AHAR**dware:**VERS**ion**?**	Query only **ACH1** **ACH2** **MBO**ard **GEN**erator **DAC** The response is either the number of a version (eg 0.01) or -NA- (Not Available) if the board is not installed.		2.15.7 **OPTIONS panel** Anlg Board → Analy Ch1 → Analy Ch2 → Motherbrd → Output Cir → DAC Board

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Command	Parameter	Basic unit	Section
SYSTem:**BEEP**er:**STAT**e	**ON** **OFF**		**2.15.2** **OPTIONS panel** Beeper → ON → OFF
SYSTem:**COMM**unicate:**GPIB**:**ADDR**ess	**<n>** 0 to 31		**2.15.1** **OPTIONS panel** UPD IECadr
SYSTem:**COMM**unicate:**GTL**			**LOCAL keystroke**
SYSTem:**COMM**unicate:**SER**ial**2**:**CONT**rol	**RTS** **XON**		**2.15.1** **OPTIONS panel** Handshake → RTS/CTS → XON/XOFF
SYSTem:**COMM**unicate:**SER**ial2:**FEED**:**BAUD**	**<n>** n = **2400** **3600** **4800** **7200** **9600** **19200** **38400** **56000**		**2.15.1** **OPTIONS panel** Baud Rate → 2400 baud → 3600 baud → 4800 baud → 9600 baud → 19200 baud → 38400 baud → 56000 baud
SYSTem:**COMM**unicate:**SER**ial**2**:**FEED**:**BITS**	**<n>** n = 7|8		**2.15.1** **OPTIONS panel** Data Bits → 7 → 8
SYSTem:**COMM**unicate:**SER**ial**2**:**FEED**:**PAR**ity[:TYPE]	**NONE** **EVEN** **ODD**		**2.15.1** **OPTIONS panel** Parity → NONE → EVEN → ODD
SYSTem:**COMM**unicate:**SER**ial**2**:**FEED**:**SBIT**s	**<n>** n = 1|2		**2.15.1** **OPTIONS panel** Stop Bits → 1 → 2
SYSTem:**DHAR**dware:**VERS**ion**?**	Query only **ANAL**ysator **GEN**erator The response is the number of a version (eg 0.05).		2.15.7 **OPTIONS panel** Digl Board → Analyzer → Generator

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Command	Parameter	Basic unit	Section
SYSTem:**DISP**lay:**READ**ing:**RATE**	**MAXS**peed **FSTS**peed **MEDS**peed **SLWS**peed		**2.15.5** **OPTIONS panel** Read Rate → MAX SPEED → 6/s → 3/s → 1/s
SYSTem:**DISP**lay:**READ**ing:**RES**olution	**<n>**		**2.15.5** **OPTIONS panel** Read Resol
SYSTem:**DISP**lay:**TRAC**e[]:**LOAD**	**MAN**ual **DEF**ault **ACOL**or **ALIN**e		**2.15.5.4** **OPTIONS panel** Scan conf → MANUAL → DEFAULT → AUTO COLOR → AUTO LINE
SYSTem:**DISP**lay:**TRAC**e[1|**2**]:**COL**or	**GRE**en **YELL**ow **BLUE** **CYAN** **MAG**enta **WHIT**e **BLAC**k **DGR**ay **LGR**ay		**2.15.5.4** **OPTIONS panel** Color (A) / (B) → GREEN → YELLOW → BLUE → CYAN → MAGENTA → WHITE → BLACK → DARK GRAY → LIGHT GRAY
SYSTem:**DISP**lay:**TRAC**e[1|**2**]:**LINE**	**SSOL**id **SD** **SP** **SPD** **DSOL**id **DD** **DP** **DPD**		**2.15.5.4** **OPTIONS panel** Line (A) / (B) → ——— → - - - - - - → . . . . . . → . - . - . - → ═══ → ====== → : : : : : : → : = : = : =
SYSTem:**DISP**lay:**TRAC**e[1|**2**]:**SEL**ect	**<n>** 1 to17		**2.15.5.4** **OPTIONS panel** Scannr.(A) Scannr.(B)
SYSTem:**ERR**or**?**	**<string>** Query only		3.3.2 **No manual control**
SYSTem:**INFO**text:**STAT**e	**ON** **OFF**		2.9.1.1 **FILE panel** Info Displ → ON → OFF

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Command	Parameter	Basic unit	Section
SYSTem:**KEY**:**RDEL**ay	**<nu>**	s	**2.15.3** **OPTIONS panel** Rep Delay
SYSTem:**KEY**:**RRAT**e	**<nu>**	Hz	**2.15.3** **OPTIONS panel** Reptn Rate
SYSTem:**LSP**eed	**FAST** **SLOW**		**No manual control**
SYSTem:**MON**itor:**ATT**enuation	<**nu**>	dB	2.6.6 Attenuat.
SYSTem:**MON**itor:**STAT**e	**ON** **OFF**		2.6.6 Monitor → ON → OFF
SYSTem:**OPT**ions:**VERS**ion**?**	Query only **LDG** **IECB**oard **AES**ebu **SPKS**witcher **AHSP**eed **DHSP**eed **GNON** **JITT**er The response is either the number of an option (eg 0.01), INST or -NA- (Not Available) if the board or option are not installed.		2.15.7 **OPTIONS panel** → Low Dist → IEC Board → AES/EBU → SKP/SWI → Highsp Anl → Highsp Dig → Noname GEN → Jitter Opt
SYSTem:**PAR**ameter:**LINK**	**<n>**		2.15.9 **OPTIONS panel** Param. Link
SYSTem:**PHON**e	**SPKC** **PERM**		**2.6.7** **ANLR panel** Phone Out → SPKPhone → PERMANENT

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Command	Parameter	Basic unit	Section
SYSTem:**PRIN**t	**TRAC**e1 **TRAC**e2 **EQU**alize **ERR**ors **DWEL**l **LIML**ower **LIMU**pper **LIST1** **LIST2** **TR1A**nd2 **OFF**		2.14.5 **OPTIONS-Panel** PRINT------ Type → TRACE A → TRACE B → EQUALIZATN → LIM REPORT → DWELL VALUE → LIM LOWER → LIM UPPER → X AXIS → Z AXIS → TRACE A+B → OFF
SYSTem:**PROG**ram:**EXEC**ute	**'filename'**		2.16 **OPTIONS-Panel** Exec Macro <filename>
SYSTem:**PROG**ram:**POIN**ts?	**<n>** 0 ... 1024 Query only		3.15.18 **No manual control**
SYSTem:**PROG**ram[:DATA]	**<n>**{,**<n>**}		3.15.18 **No manual control**
SYSTem:**SOFT**ware:**VERS**ion**?**	Query only **UI** **HW** **IEC** The response is the number of a version (eg 1.30).		2.15.7 **OPTIONS panel** UI HW IEC
SYSTem:**SPE**aker:**GAIN**	**<nu>**	dB	**2.6.7** **ANLR panel** Pre Gain
SYSTem:**SPE**aker:**SOUR**ce	**OFF** **INP1** **INP2** **IN1A**nd2 **FNC1** **FNC2** **FN1A**nd2 **AES1** **AES2** **AE1A**nd2		**2.6.7** **ANLR panel** SPEAKER → OFF → INPUT Ch1 → INPUT Ch2 → INPUT Ch1&2 → FUNCT Ch1 → FUNCT Ch2 → FUNCT Ch1&2 → AES Ch1 → AES Ch2 → AES Ch1&2
SYSTem:**SPE**aker:**VOL**ume	**<nu>**	%	**2.6.7** **ANLR panel** Skp Volume

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Command	Parameter	Basic unit	Section
SYSTem:**SPE**aker[:STATe]	**ON** **OFF**		**2.6.7** **ANLR panel** LOCAL key
SYSTem:**VERS**ion**?**	**<n>** Query only		**2.15.7** **No manual control**
TRACe:**DATA?**	**TRAC**e[1|**2**] Query only Query-Form: TRAC? TRAC[1|**2**]		**2.10.1** **DISP panel**
TRACe:**POIN**ts**? CREF**erence1	**<n>** 0 to 1024 Query only		**2.9.1.3** **No manual control**
TRACe:**POIN**ts**? CREF**erence**2**,	**<n>** 0 to 1024 Query only		**2.9.1.3** **No manual control**
TRACe:**POIN**ts**? LIST1**	**<n>** 0 to 1024 Query only		**2.9.1.3** **No manual control**
TRACe:**POIN**ts**? LIST2**	**<n>** 0 to 1024 Query only		**2.9.1.3** **No manual control**
TRACe:**POIN**ts**? REF**erence**1**	**<n>** 0 to 1024 Query only		**2.9.1.3** **No manual control**
TRACe:**POIN**ts**? REF**erence**2**	**<n>** 0 to 1024 Query only		**2.9.1.3** **No manual control**
TRACe:**POIN**ts**? TRAC**e**1**	**<n>** 0 to 1024 Query only		**2.9.1.3** **No manual control**
TRACe:**POIN**ts? **TRAC**e**2**	**<n>** 0 to 1024 Query only		**2.9.1.3** **No manual control**
TRACe[:DATA]**CREF**erence1,	**<n>**{,**<n>**} Query: TRACe[:DATA]? CREF1		**2.9.1.3** **No manual control**
TRACe[:DATA]**CREF**erence**2**,	**<n>**{,**<n>**} Query: TRACe[:DATA]? CREF2		**2.9.1.3** **No manual control**
TRACe[:DATA]**LIST1,**	**<n>**{,**<n>**} Query: TRACe[:DATA]? LIST1		**2.9.1.3** **No manual control**

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Command	Parameter	Basic unit	Section
TRACe[:DATA]**LIST2,**	**<n>**{,**<n>**} Query: TRACe[:DATA]? LIST2		**2.9.1.3** **No manual control**
TRACe[:DATA]**REF**erence**1**,	**<n>**{,**<n>**} Query: TRACe[:DATA]? REF1		**2.9.1.3** **No manual control**
TRACe[:DATA]**REF**erence**2**,	**<n>**{,**<n>**} Query: TRACe[:DATA]? REF2		**2.9.1.3** **No manual control**
TRACe[:DATA]**TRAC**e**1,**	**<n>**{,**<n>**} Query: TRACe[:DATA]? TRACe1		**2.9.1.3** **No manual control**
TRACe[:DATA]**TRAC**e**2,**	**<n>**{,**<n>**} Query: TRACe[:DATA]? TRACe2		**2.9.1.3** **No manual control**
TRIGger:**COUN**t	**<n>** 2 to 1024		**2.6.4** **ANLR panel** Points
TRIGger:**DEL**ay	**<nu>**	s	**2.6.4** **ANLR panel** Delay
TRIGger:**FREQ**uency:**VAR**iation	**<nu>** UG...50%	PTC	**2.6.4** **ANLR panel** Variation
TRIGger:**LEV**el	**<nu>**	V FS	**2.6.5.15** **ANLR panel** Trig Level
TRIGger:**SLOP**e	**POS**itive alias **RIS**ing **NEG**ative alias **FALL**ing		**2.6.5.15** **ANLR panel** Trig Slope → RISING → FALLING
TRIGger:**SOUR**ce	**IMM**ediate **TIM**er **CH1F**req|**CH2F**req **CH1L**evel|**CH2L**evel **CH1T**rigger|**CH2T**rigger **TCH**art **CH1R**apidfreq **CH2R**apidfreq **CH1E**dgetrigger **CH2E**dgetrigger		**2.6.4** **ANLR panel** START COND →AUTO →TIME →CH1Freq | CH2Freq →CH1Level| CH2Level →LEV TRG CH1| LEV TRG CH2 →TIME CHART → FRQ FST CH1 → FRQ FST CH2 → EDG TRG CH1 → EDG TRG CH2

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Command	Parameter	Basic unit	Section
TRIGger:**TIM**er	**<nu>**	s	**2.6.4** **ANLR panel** Timetick
TRIGger:**VOLT**age:**VAR**iation	**<nu>** UG to 900% or UG to 20 dB	PTC	**2.6.4** **ANLR panel** Variation

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3.12 IEC/IEEE-Bus Interface

UPD is equipped with an IEC/IEEE-bus interface as a standard. The mating 25-pin connector according to standard IEC 625.1/IEEE 488 is at the rear of the instrument. A controller for remote control can be connected via the interface. Interconnection is made via a shielded cable.

3.12.1 Interface Characteristics

- 8-bit parallel data transfer
- bidirectional data transfer
- three-line handshake
- high data transfer rate of max. 350 Kbyte/s
- up to 15 devices can be connected
- maximum length of interconnecting cable 15 m (single connection 2 m)
- wired OR if several instruments are interconnected in parallel.

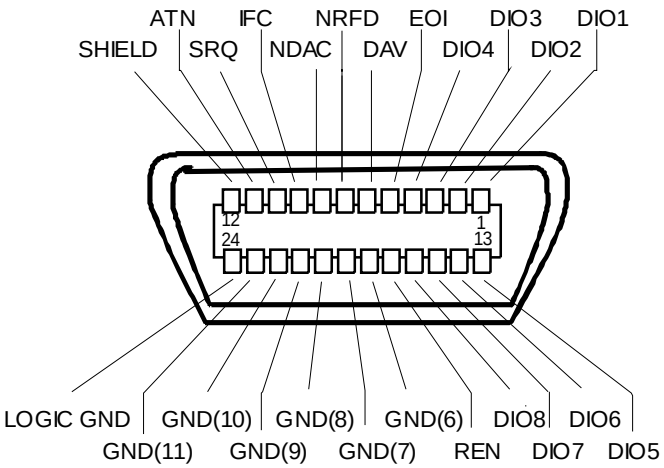

Fig. 3-7 Pin assignment of IEC/IEEE-bus interface

3.12.2 Bus Lines

1. Data bus with 8 lines DIO 1 to DIO 8.
The transmission is bit-parallel and byte-serial in the ASCII/ISO code. DIO1 is the bit of lowest order, DIO8 the bit of highest order.

2. Control bus with 5 lines.
IFC (Interface Clear),
active low resets the interfaces of all connected instruments to the default setting.

ATN (Attention),
active low signals the transmission of interface messages
inactive high signals the transmission of device-dependent messages.
SRQ (Service Request),
active low enables a device connected to send a service request to the controller.

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REN (Remote Enable),
active low permits the switchover to remote control.

EOI (End or Identify),
has two functions in connection with ATN:
active low marks the end of data transmission with ATN = HIGH
active low triggers a parallel poll with ATN = LOW.

3. **Handshake bus with 3 lines.**
DAV (Data Valid),
active low signals a valid data byte on the data bus.

NRFD (Not Ready For Data),
active low signals that one of the devices connected is not ready for data transfer.

NDAC (Not Data Accepted),
active low as long as the instrument connected is accepting the data present on the data bus.

3.12.3 Interface Functions

Instruments which can be remote-controlled via IEC/IEEE bus can be equipped with different interface functions. Table A-1 lists the interface functions appropriate for the UPD.

Table 3-10 Interface functions

Control character	Interface function
SH1	Handshake source function (source handshake)
AH1	Handshake drain function (acceptor handshake)
L3 to L4/LE3 to LE4	Listener function.
T5 to T8/TE5 to TE8	Talker function, ability to respond to serial poll
SR1	Service request function
PP1	Parallel poll function
RL1	Remote/Local switchover function
DC1	Resetting function (Device Clear)
DT1	Trigger function (Device Trigger)
C1 to C27	Controller function (with optional software UPD-K1 only)

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3.13 Interface Messages

Interface messages are transmitted to the UPD on the data lines, with the attention line being active (LOW). They enable the communication between instrument and controller. Since parsing of commands is no longer required a high processing speed is obtained.

3.13.1 Common Commands

The common commands are encoded in the range 10 through 1F hex. They are effective for all instruments connected to the bus without addressing them before.

Table 3-11 Common commands

Command	R&S BASIC command	Effect on UPD
DCL (Device Clear)	`IECDCL`	Aborts the processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument setting.
IFC (Interface Clear)	`IECIFC`	Resets the interfaces to the default setting.
LLO (Local Lockout)	`IECLLO`	The REM/LOCAL key is disabled.
SPE (Serial Poll Enable)	`IECSPE`	Ready for serial poll
SPD (Serial Poll Disable)	`IECSPD`	End of serial poll
PPU (Parallel Poll Unconfigure)	`IECPPU`	End of the parallel-poll state

3.13.2 Addressed Commands

The addressed commands are encoded in the range 00 through 0F hex. They are only effective for instruments addressed as listeners.

Table 3-12 Addressed commands

Command	R&S BASIC command	Effect on UPD
SDC (Selected Device Clear)	`IECLAD 20: IECSDC`	Aborts the processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument setting.
GET (Group Execute Trigger)	`IECLAD 20: IECGET`	Triggers all actions which are waiting for a trigger event. This command is identical with the commands INIT and *TRG.
GTL (Go to Local)	`IECLAD 20: IECGTL`	Transition to the "Local" state (manual control)
PPC (Parallel Poll Configure)	`IEC PCON 20,1,6`	Configure instrument for parallel poll In the command to the left, the UPD with an address of 20 is reporting a 1 on line 6.

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3.14 List of Error Messages

The following list contains error messages which can be obtained via IEC/IEEE bus or in manual operation. Negative error numbers are SCPI-defined. The positive error number "111" marks device-specific errors.

When and how is the error queue output?

If the controller does not succeed in transmitting a command to UPD, an error message appears in the information line on the screen and a short signal can be heard.

This error message can be indicated in the control program by outputting the error queue after every command sent to UPD. This should be controlled by SRQ, i.e. only when bit 3 (Device Dependent Error), bit 4 (Execution Error) or bit 5 (Command Error) of the event status register is set, but can also happen at any location in the control program.
If no error has been detected, the message is
0, "No Error"

Example:

```
1000 Errqueue:
1010 IEC OUT 20,"SYST:ERR?":                    ' Output error queue until it is empty!
1020 IEC IN 20,E$.                              ' Read error information
1030 IF LEFT$(E$,1)="0" THEN RETURN:            ' 0, "No Error", error queue empty!
1040 PRINT "Contents of error queue:"; E$:GOTO Errqueue
```

The table contains the error number in the left-hand column. In the right-hand column, the error text being entered into the error/event queue or being displayed is printed in bold face. Below the error text, there is an explanation as to the respective error.

3.14.1 SCPI-Specific Error Messages

No Error

Error number	**Error query response** Explanation
0	**No error** This message is output if the error queue is completely empty.

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3.14.2 Command Error

Command Error — sets bit 5 in the ESR register.

Error number	**Error query response** Explanation
-100	**Command Error** The command is faulty or invalid.
-101	**Invalid Character** A syntactic element contains a character which is invalid for that type. Example: A header containing an ampersand, "SOURCE&".
-102	**Syntax error** An unrecognized command or data type was received. Example: A string was received when the device does not accept strings.
-103	**Invalid separator** The device was expecting a separator and received an illegal character. Example: The semicolon was omitted after a program message unit.
-104	**Data type error** The device recognized a data element different than one allowed. Example: Numeric or string data are expected but block data was received.
-105	**GET not allowed** A Group Execute Trigger (GET) was received within a program message.
-112	**Program mnemonic too long** The header contains more than 12 characters.
-113	**Undefined header** The header is syntactically correct, but it is undefined for the UPD. Example: *XYZ is not defined for any device.
-114	**Header suffix out of range** A nonheader character has been encountered in the header element parsed by the device. Example: SOURce3 is not defined for any device.
-123	**Exponent too large** The magnitude of the exponent is larger than 320000.
-124	**Too many digits** The mantissa of a decimal numeric data element contains more than 255 digits (excluding leading zeros).
-128	**Numeric data not allowed** A legal numeric data element was received, but the device does not accept one in this position for the header. Example: Command SOURce:FREQuency:MODE requires the indication of a text parameter.
-131	**Invalid suffix** The suffix is inappropriate for this device. Example: nHz is not defined?
-134	**Suffix too long** The suffix contains more than 12 characters.
-138	**Suffix not allowed** A suffix was received after a numeric element which does not allow suffixes. Example: Command *RCL does not permit indicating a suffix.

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-141	**Invalid character data** Either the character data element contains an invalid character or the particular element received is not valid for the header. Example: Write error with parameter indication; `SOURce:FREQuency:MODE FIKSed.`

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Command Error (cont'd)

Error number	**Error query response** Explanation
-144	**Character data too long** The character data element contains more than 12 characters.
-148	**Character data not allowed** A legal character data element was encountered where prohibited by the device. Example: Command *RCL requires the indication of a number.
-151	**Invalid string data** A string data element was expected, but was invalid for some reason. Example: An END message was received before the terminal quote character.
-158	**String data not allowed** A legal string data element was encountered where prohibited by the device.
-161	**Invalid block data** A block data element was expected, but was invalid for some reason. Example: An END message was received before the length was satisfied.
-168	**Block data not allowed** A legal block data element was encountered where prohibited by the device.
-178	**Expression data not allowed** A legal expression data element was encountered where prohibited by the device.

3.14.3 Execution Error

Execution Error — sets bit 4 in the ESR register.

Error number	**Error query response** Explanation
-200	**Execution error** An error occurred when executing a received command.
-220	**Parameter error** A program data element related error occurred.
-221	**Settings conflict** A legal program data element was parsed but could not be executed due to the current device state.
-222	**Data out of range** The received data element was syntactically correct but could not be executed because the value was outside the legal range as defined by the device. Example: Command TRIG:DEL only permits entries in the range of 50 ms to 10 sec.
-241	**Hardware missing** A legal program command or query could not be executed because of missing device hardware; for example, an option was not installed.

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3.14.4 Device-Specific Error

Device-specific Error — sets bit 3 in the ESR register.

Error number	Error query response Explanation
-300	**Device-specific error** Generic device-dependent error for devices that cannot detect more specific errors.

3.14.5 Query Error

Query Error — sets bit 2 in the ESR register.

Error number	Error query response Explanation
-400	**Query error** Generic device-dependent query error for devices that cannot detect more specific errors.
-420	**Query UNTERMINATED** A condition causing an UNTERMINATED query error occurred. Example: The device was addressed to talk and an incomplete program message was received.
-430	**Query DEADLOCKED** A condition causing an DEADLOCKED query error occurred. Example: Both input buffer and output buffer are full and the device cannot continue.

3.14.6 Device-Dependent Error

Device-dependent Error — sets bit 3 in the ESR register.

Error number	Error query response Explanation
111	After the error queue has been output, all device-dependent errors are shown with the code number 111 and a self-explanatory text having a maximum length of 50 characters, e.g. 111, „Device dep. error; Insufficient disk space! Cannot write file".

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3.15 Examples of IEC/IEEE-Bus Programming

The examples illustrate UPD programming and may be taken as a basis for solving more complex programming tasks.

R&S BASIC is the programming language.
If other languages are used for controlling the UPD by means of IEC/IEEE commands, the given sequence of commands may be used but for a few exceptions, as it is independent of the programming language.

3.15.1 R&S BASIC

The following program routines and examples are ready for use provided R&S BASIC and the R&S IEC/IEEE-bus card have been installed in the controller.

Example: C:\UPD\UPD_UI-r <CR>

Note:

*R&S BASIC and the R&S IEC/IEEE-bus interface card may be ordered from your local sales engineer under the designation **PAT-B1, Order No. 1007.1150.02**.*

3.15.2 IEC/IEEE-Bus Control after Power-Up

After UPD power-up, messages may be displayed which have to be acknowledged using the ENTER or the CANCEL key. If the instrument is to be remote-controlled after power-up irrespective of any messages displayed, it is recommended to start the UPD with the aid of the command line parameter "-r". In this case messages do not require to be acknowledged by a keystroke, the UPD is started with a suitable setup and immediately ready for remote control.

Example: C:\UPD\UPD_UI -r <CR>

3.15.3 Command Logging - Converting UPD- K1-Commands into IEC/IEEE-Bus Commands

All commands required for setting the UPD or for measurements are listed in section **3.10 IEC-bus Commands** and section **3.11 Alphabetical List of IEC-bus Commands** of the UPD manual. To avoid a tedious search for the commands required, the Universal Sequence Controller, option UPD- *K1*, which is simply called *K1* below and available as an option, permits all manual setting procedures to be stored as *K1* commands and to be converted into the IEC/IEEE-bus control program.

Note:

*The Universal Sequence Controller option UPD-K1 may be ordered from your local sales engineer under the **Order No. 10314204.02**.*

The procedure is explained by way of a sweep with subsequent display of the sweep curve:

- For setting the UPD- K1 configuration, call up UPDSET at the DOS level and select item 3 (**Run UPD with UPD-K1**..) in the displayed menu.
- Select item 1 (**UPD starts normally** ...) in the subsequent menu. The UPD is restarted!
- Prior to recording the desired command sequence, press key F2 to activate command logging ("**logging on**" displayed at the bottom right). All settings performed subsequently in the UPD are recorded as a sequence of K1 commands.
- When the setting sequence has been completed, disable command logging by pressing the F2 key again ("**logging off**" displayed at the bottom right).

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- Call up the K1 program by pressing F3. Upon pressing F8 (LISTe), a list of commands is displayed - for the time being without comments - which has been generated by means of K1 commands and correspond to the settings just performed (in the example **Settings for a frequency sweep**).

```
10 UPD OUT "*RST"                                   Listing of K1 commands without comments.
20 UPD OUT "DISP:MODE COLB"                         Comments will we added manually later on.
30 UPD OUT "SENS:VOLT:APER:MODE AFAS"
40 UPD OUT "SENS:FILT:AWE ON"
50 UPD OUT "DISP:TRAC:OPER CURV"
60 UPD OUT "DISP:TRAC:X:SPAC LOG"
70 UPD OUT "SOUR:SWE:MODE AUTO;:SOUR:FREQ:MODE SWE1"
```

- Use command ASAVE "A:LOGGING.TXT" to store the listing as ASCII file on a floppy disk.
- Return to the UPD operating level by pressing F3 and quit the UPD (CTRL+F9).
- Using an editor of your own choice at the DOS operating system level, edit the A:LOGGING.TXT file in a form suitable for IEC/IEEE-bus control by replacing |**UPD OUT|** by |**IEC OUT 20,|** and store it on the floppy disk.

```
10 IEC OUT 20,"*RST"                                Listing of IEC/IEEE-bus commands without comments.
20 IEC OUT 20,"DISP:MODE COLB"                      Comments will be added manually later on!
30 IEC OUT 20,"SENS:VOLT:APER:MODE AFAS"
40 IEC OUT 20,"SENS:FILT:AWE ON"
50 IEC OUT 20,"DISP:TRAC:OPER CURV"
60 IEC OUT 20,"DISP:TRAC:X:SPAC LOG"
70 IEC OUT 20,"SOUR:SWE:MODE AUTO;:SOUR:FREQ:MODE SWE1"
```

- To set the UPD IEC/IEEE-bus configuration, call up UPDSET at the DOS level and select item 2 (**Run UPD with UPD-B4 ... IEC/IEEE...**) in the displayed menu. The UPD is restarted.
- Establish connection to IEC/IEEE-bus controller and start R&S BASIC.
- Insert floppy holding the "LOGGING.TXT" file into the controller.
- Load the listing as ASCII file from the floppy with command ALOAD "A:LOGGING.TXT" and extend it as required by IEC/IEEE-bus-specific commands and comments.

```
10 IEC TERM 10:'              Controller waits for Line Feed as terminator
20 IEC TIME 10000:'                          IEC/IEEE-bus timeout 10 s
30 IEC OUT 20,"*RST;*WAI":'                          UPD default setup
40 IEC OUT 20,"DISP:MODE COLB":'                     Changes of colour
50 IEC OUT 20,"SENS:VOLT:APER:MODE AFAS":'         High measurement speed
60 IEC OUT 20,"SENS:FILT:AWE ON":'          Switches on A-weighting filter
70 IEC OUT 20,"DISP:TRAC:OPER CURV":'                Selects trace display
80 IEC OUT 20,"DISP:TRAC:X:SPAC LOG":'                  Logarithmic X axis
0 IEC OUT 20,"SOUR:SWE:MODE AUTO;:SOUR:FREQ:MODE SWE1":'      Autom. Sweep
100 IEC OUT 20,"DISP:CONF AP":'                      Selects graphic window
110 IEC OUT 20,"INIT:CONT OFF;*WAI":'       Starts sweep and waits for end
120 IEC OUT 20,"DISP:TRAC:Y:AUTO ONCE":'                      Autoscaling
130 IEC LAD 20: IEC GTL:'                      Return to manual control
140 END
```

(listing of IEC/IEEE-bus commands with additional commands and comments)

- Start the ready-to-run program with RUN or F2.

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3.15.4 Initialization and Default Status

The controller must be informed that the end character for query replies from the UPD is < Line Feed> and that it has to wait for max. 10 s after a trigger command or an IEC-IN command before it signals a timeout. The IEC/IEEE-bus Status Registers and the UPD are reset to the default state.
For default settings of UPD see annex A UPD Default Setup.

```
10 'Initialization of controller
10 IEC TERM 10:'                Controller waits for Line Feed as terminator
20 IEC TIME 10000:'       After 10 s controller signals IEC/IEEE-bus timeout
10 'Initialization of UPD
20 IECOUT 20,"*CLS":'                                  Resets Status Register
30 IECOUT 20,"*RST:*WAI":'    Resets device and waits for end of calibration
     :
```

3.15.5 Sending Instrument Setting Commands

In this routine, the UPD is set to maximum speed for triggered measurements.

```
10 IEC TERM 10:'                  Terminator for query replies is Line Feed
20 IEC TIME 10000:'             Max. waiting time for query replies is 10 s
30 IEC OUT 20,"*CLS":'                  Resets IEC/IEEE-bus Status Register
40 IEC OUT 20,"*RST;*WAI":'      UPD default setting, *WAI waits for calibr.
50 IEC OUT 20,"DISP:ANN OFF":'                   Switches off result display
60 IEC OUT 20,"SENS2:FUNC 'OFF'":'       Switches off input-peak measurement
70 IEC OUT 20,"SENS3:FUNC 'OFF'":'        Switches off frequency measurement
80 IEC OUT 20,"SENS:VOLT:APER:MODE VAL"
90 IEC OUT 20,"SENS:VOLT:APER 1ms":'        Sets a measurement speed of 1 ms
     :
```

3.15.6 Switchover to Manual Control

```
REM ------ Switching the instrument to manual control -------
     :
100 IEC LAD 20:'  Addresses UPD
110 IEC GTL:'     Sets UPD to local
     :
```

3.15.7 Readout of Instrument Settings

The settings made in section 3.15.5 Sending Instrument Setting Commands, are read out. In this case the short form of the commands is used.

```
     :
110 '------- Readout of instrument settings ---------
120 IEC OUT 20,"DISP:ANN?":'           Query for setting the display Update
130 IEC IN 20,A$: PRINT A$:'                                Displays OFF
140 IEC OUT 20,"SENS2:FUNC?":'             Query for input peak measurement
150 IEC IN 20,A$: PRINT A$:'                                Displays OFF
160 IEC OUT 20,"SENS:VOLT:APER?":'              Query for measurement speed
170 IEC IN 20,A$: PRINT A$:'                                Displays 1.E-3
     :
```

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3.15.8 Readout of Measurement Results

Numeric results of a specific measurement function, ie input peak, input RMS or frequency and phase measurements, can be taken from the UPD in a triggered or non-triggered form.

For triggering measurements and sweeps see section 3.6.7 Triggering a Measurement/Sweep
Waiting for the end of a measurement or sweep is described in section 3.6.8.2 Wait for End of Measurement/Sweep.

The display below gives the IEC/IEEE-bus commands used for selecting and calling up measurement results.

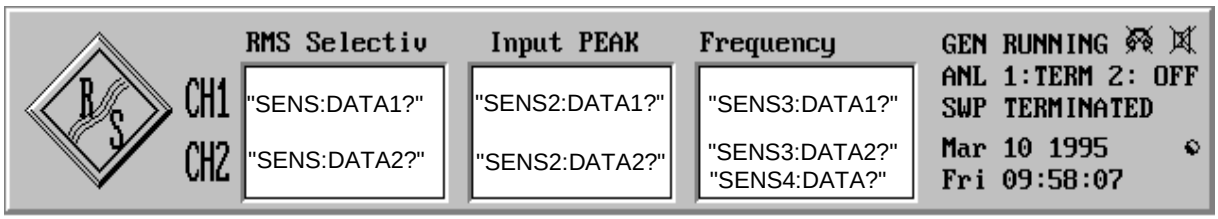

Fig. 3-8 Result display and associated IEC/IEEE-bus commands

Table 3-1 Selecting measurement results

Measurement function	Channel setting	Selection and readout of measurement results
Function IECOUT 20, "SENS:FUNC 'RMS'" "SENS:FUNC 'RMSS'" "SENS:FUNC 'PEAK'" "SENS:FUNC 'QPE'" "SENS:FUNC 'DC'" "SENS:FUNC 'DFD'" "SENS:FUNC 'DIM'" "SENS:FUNC 'MDIST'" "SENS:FUNC 'THD'" "SENS:FUNC 'THDN'" "SENS:FUNC 'WAF'" "SENS:FUNC 'POL'" "SENS:FUNC 'FFT'"	IECOUT 20,"INP:SEL CH1"	IECOUT 20,"SENS:DATA1?":IECIN 20,Func$
	IECOUT 20,"INP:SEL CH2"	IECOUT 20,"SENS:DATA2?":IECIN 20,Func$
	IECOUT 20,"INP:SEL CH1A" or IECOUT 20,"INP:SEL CH1I" or IECOUT 20,"INP:SEL CH2I" or IECOUT 20,"INP:SEL BOTH"	IECOUT 20,"SENS:DATA1?":IECIN 20,FuncA$ IECOUT 20,"SENS:DATA2?":IECIN 20,FuncB$
Function IECOUT 20, "SENS:FUNC 'FILT'" "SENS:FUNC 'WAV'" "SENS:FUNC 'COHE'"	Measurement results cannot be called	Measurement results cannot be called
Input PEAK or Input RMS IECOUT 20, "SENS2:FUNC 'PEAK'" "SENS2:FUNC 'RMS'"	IECOUT 20,"INP:SEL CH1"	IECOUT 20,"SENS2:DATA1?":IECIN 20,Ip$
	IECOUT 20,"INP:SEL CH2"	IECOUT 20,"SENS2:DATA2?":IECIN 20,Ip$
	IECOUT 20,"INP:SEL CH1A" or IECOUT 20,"INP:SEL CH1I" or IECOUT 20,"INP:SEL CH2I" or IECOUT 20,"INP.SEL BOTH"	IECOUT 20,"SENS2:DATA1?":IECIN 20,IpA$ IECOUT 20,"SENS2:DATA2?":IECIN 20,IpB$

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Measurement function	Channel setting	Selection and readout of measurement results
Frequency measurement IECOUT 20, "SENS3:FUNC 'FREQ'"	IECOUT 20,"INP:SEL CH1" IECOUT 20,"INP:SEL CH2" IECOUT 20,"INP:SEL CH1A" or IECOUT 20,"INP:SEL CH1I" or IECOUT 20,"INP:SEL CH2I" or IECOUT 20,"INP.SEL BOTH"	IECOUT 20,"SENS3:DATA1?":IECIN 20,Freq$ IECOUT 20,"SENS3:DATA2?":IECIN 20,Freq$ IECOUT 20,"SENS3:DATA1?":IECIN 20,FreqA$ IECOUT 20,"SENS3:DATA2?":IECIN 20,FreqB$
Frequency and phase measurement IECOUT 20, "SENS3:FUNC 'FQPH'" with two-channel measurements only	IECOUT 20,"INP:SEL CH1A" or IECOUT 20,"INP:SEL CH1I" or IECOUT 20,"INP:SEL CH2I" or IECOUT 20,"INP.SEL BOTH"	IECOUT 20,"SENS3:DATA1?":IECIN 20,Freq$ IECOUT 20,"SENS4:DATA?":IECIN 20,Phas$
Frequency and group delay measurement IECOUT 20, "SENS3:FUNC 'FQGR'" with two-channel measurements only	IECOUT 20,"INP:SEL CH1A" or IECOUT 20,"INP:SEL CH1I" or IECOUT 20,"INP:SEL CH2I" or IECOUT 20,"INP.SEL BOTH"	IECOUT 20,"SENS3:DATA1?":IECIN 20,**Freq$** IECOUT 20,"SENS4:DATA?":IECIN 20,**Grpl$**

3.15.8.1 Readout of Triggered Measurements

Readout of triggered measurement is demonstrated by way of an RMS measurement:

```
    :
100 IEC OUT 20,"SENS:FUNC 'RMS':'                    Sets RMS measurement
110 IEC OUT 20,"INPUT:SELECT CH1":'                        Sets channel 1
    :
210 'One of three trigger modes can be selected
220 INPUT "Select trigger mode INIT [I], GET [G] or *TRG [T]:";Tg$
    :
330 IEC OUT 20,"INIT:CONT OFF;*WAI":'       Selects single-measurement mode
    :
480 IF Tg$="I" THEN IEC OUT 20,"INIT":   GOTO In
490 IF Tg$="G" THEN IEC LAD 20: IEC GET :GOTO In
500 IF Tg$="T" THEN IEC OUT 20,"*TRG":   GOTO In
    :
620In:
630 IEC OUT 20,"*WAI":'          Sends next IEC/IEEE-bus command only after
640 '                                        a result has been obtained.
650 IEC OUT 20,"SENS:DATA1?":'               Selects result of channel 1
660 IEC IN 20,Mwert$:'                       Reads in measurement result
667 PRINT Mwert$:'                            Outputs measurement result
    :
```

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3.15.8.2 Readout of Non-Triggered Measurements

Contrary to triggered measurements, results of non-triggered measurements are read from the buffer at maximum speed without considering settling so that the same value is displayed several times before a new value is output.
Since results of non-triggered measurements are read out as an exception, no detailed description will be given. Reading out triggered measurement results as described in section 3.15.8.1 Readout of Triggered Measurements, is to be preferred in any case.

```
    :
190 IEC OUT 20,"*RST;*WAI": ’                        Sets up RMS measurement
200 IEC OUT 20,"DISP:ANN OFF":’                   Switches off result display
210 IEC OUT 20,"SENS2:FUNC ’OFF’":’             Switches off PEAK measurement
220 IEC OUT 20,"SENS3:FUNC ’OFF’":’       Switches off frequency measurement
230 IEC OUT 20,"SENS:VOLT:APER:MODE AFAS":’   Selects high measurement speed
240 IEC OUT 20,"INIT:CONT ON":’              Selects continuous measurements
250 IEC LAD 20: IEC GET :’             Triggers with Group Executive Trigger
260 ’"*WAI" omitted!
270 IEC OUT 20,"SENS:DATA1?":’               Selects RMS result on channel 1
280 IEC IN 20,Mwert$:’                           Reads in measurement result
    :
```

3.15.9 Sweep Setting/Trigger

3.15.9.1 Generator Sweep

With a generator sweep of the UPD, output frequency, output level, burst duration, etc. are swept between the start/stop values .
A sweep is triggered with `INIT`, `*TRG` or `GET` (see section 3.6.7 Triggering a Measurement/Sweep).

```
    :
50 IEC OUT 20,"SOUR:SWE:MODE AUTO;:SOUR:FREQ:MODE SWE1":’       Freq. sweep
60 IEC OUT 20,"SOUR:FREQ:STAR 100 HZ":’         Sweep start frequency 100 Hz
70 IEC OUT 20,"SOUR:FREQ:STOP 10 KHZ":’          Sweep stop frequency 10 kHz
80 IEC OUT 20,"SOUR:SWE:FREQ:POIN 15":’                    15 sweep points
90 IEC OUT 20,"SENS:FILT:AWE ON": ’              Selects A-weighting filter
100 IEC OUT 20,"DISP:TRAC:OPER CURV": ’               Selects trace display
110 IEC OUT 20,"INIT:CONT OFF;*WAI":’  Triggers single sweep, waits for end
120 IEC OUT 20,"DISP:CONF AP":’ Selects analyzer display with graphic window
130 IEC LAD 20: IEC GTL: ’                            Displays sweep curve
    :
```

See also section 3.15.10.3 Configuration for Maximum Sweep Speed and 3.15.10.3.1 Generator Sweep.

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3.15.9.2 External Sweep

With external sweep of UPD, measurement results are obtained by frequency and level variations at channel 1 or 2 of the analyzer input.
The example below illustrates an external frequency sweep.

```
     :
300 '*** Setting parameters for external sweep
310 IEC OUT 20,"TRIG:SOUR CH1F": '        Setup for external frequency sweep
320 IEC OUT 20,"ARM:LEV:MIN 100 mV": '                  Minimum level 100 mV
330 IEC OUT 20,"ARM:FREQ:STAR 100 Hz": '              Start frequency 100 Hz
340 IEC OUT 20,"ARM:FREQ:STOP 16 kHz": '               Stop frequency 16 kHz
350 IEC OUT 20,"TRIG:FREQ:VAR 4.5": '       Var. just below sweep step width
360 IEC OUT 20,"DISP:CONF AP": '                      Selects graphic window
370 PRINT "External sweep is started - recording is in progress!"
380 IEC OUT 20,"INIT:CONT OFF;*WAI": '         Triggers external single sweep
390 IEC OUT 20,"SYST:BEEP:STAT ON": ' Waits for sweep end with dummy command
400 IEC LAD 20: IEC GTL : '                                    Displays curve
     :
```

See also section 3.15.10.3 Configuration for Maximum Sweep Speed and 3.15.10.3.2 External Sweep.

3.15.9.3 RMS Selective Sweep

With the RMS selective sweep, the center frequency of a bandpass or bandstop filter is swept between the start/stop frequencies and an RMS measurement is carried out after each sweep step.
The sweep is triggered with `"INIT"`, `"*TRG"` or `GET` (see section 3.6.7 Triggering a Measurement/Sweep)

```
     :
100 IEC OUT 20,"SENS:FUNC 'RMSS':'      Setup for RMS selective measurement
110 IEC OUT 20,"SENS:BAND:MODE PPCT1":'     Bandwidth of bandpass filter 1%
120 IEC OUT 20,"SENS:FREQ:MODE SWE;:SENS:SWE:MODE AUTO":'        Sweep setup
130 IEC OUT 20,"SENS:SWE:SPAC LOG;POIN 50":'       Log. sweep with 50 points
140 IEC OUT 20,"SENS:FREQ:STAR 4000Hz;STOP 16000Hz":'       Start/stop freq.
150 IEC OUT 20,"INIT:CONT OFF;*WAI":'       Triggers sweep and waits for end
160 IEC OUT 20,"DISP:TRAC:OPER CURV":'                  Selects trace display
170 IEC OUT 20,"DISP:CONF AP":'   Selects analyzer panel with graphic window
180 IEC LAD 20: IEC GTL:'                                      Displays curve
     :
```

See also section 3.15.10.3 Configuration for Maximum Sweep Speed and 3.15.10.3.3 RMS-selective Sweep.

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3.15.10 Tuning - Setup for Maximum Measurement Speed

3.15.10.1 Configuration for Maximum Measurement Speed

To obtain maximum measurement speed, all unnecessary measurements and result displays are to be avoided. This is demonstrated by way of a fast RMS measurement:

```
    :
190 IEC OUT 20,"*RST;*WAI": ’                        Sets up RMS measurement
200 IEC OUT 20,"DISP:ANN OFF":’                   Switches off result display
210 IEC OUT 20,"SENS2:FUNC ’OFF’":’             Switches off PEAK measurement
220 IEC OUT 20,"SENS3:FUNC ’OFF’":’        Switches off frequency measurement
230 IEC OUT 20,"SENS:VOLT:APER:MODE GENT":’   Selects high measurement speed
240 IEC OUT 20,"INIT:CONT OFF":’                  Selects single measurement
250 IEC LAD 20: IEC GET :’          Triggers sweep with Group Execute Trigger
260 IEC OUT 20,"*WAI":’ *WAI                     Waits for measurement results
270 IEC OUT 20,"SENS:DATA1?":’                Selects RMS results on channel 1
280 IEC IN 20,Mwert$:’                                Reads in measured value
     :
```

3.15.10.2 Adapting Measurement Speed to Signal Frequency

Table 3-2 Hints for matching measurement speed and signal frequency

Automatic adaptation of measurement speed to signal frequency	
IEC/IEEE-bus command	**Used for**
`"SENSe[1]:VOLTage:APERture:MODE AFASt"`	RMS and RMS selective measurements: Automatic matching of measurement time and signal frequency by taking into account the signal period. The measurement time is optimally adapted to the input signal. An algorithmic error of max. 1% may occur
`"SENSe[1]:VOLTage:APERture:MODE AUTO"`	RMS and RMS selective measurements: Same as AFASt but with an algorithmic error of max. 0.1%.
`"SENSe[1]:VOLTage:APERture:MODE GENT"`	For RMS and RMS selective measurement: Measurement over (at least) one whole period of the generator signal; if necessary the generator frequency is matched to analyzer sample rate. To increase the measurement accuracy at high frequencies, the measurement time is extended to several periods. This is particularly suitable for measuring very noise or distorted signals and for extremely fast sweeps.

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Fixed measurement speed	
IEC/IEEE-bus command	**Used for**

`"SENSe[1]:VOLTage:APERture:MODE SFAS`
`"SENSe[1]:VOLTage:APERture:MODE FAST`
`"SENSe[1]:VOLTage:APERture:MODE SLOW`
`"SENSe[1]:VOLTage:APERture:MODE VALue"`
`"SENSe[1]:VOLTage:APERture xxx ms"`
	For RMS, RMS selective and DC measurement
	→ 50 ms ⎫
	→ 200 ms ⎬ fixed measurement time
	→ 1000 ms ⎭
	→ freely selectable, fixed measurement time

VALue is a **fixed integration time** irrespective of the signal period.

RMS and RMS selective measurements:

- If the measurement time is an integral multiple of the signal period, optimum integration and therefore a steady display is obtained.
- If the measurement time is longer and not an integral multiple of the signal period, an integration is obtained with a beat effect in the display.

DC measurements:

If an AC voltage is superimposed on the DC, the measurement time as integration period has different effects with respect to the signal period of the AC voltage shows different effects:

- If the measurement time is an integral multiple of the signal period, optimum integration is obtained. The AC voltage does not influence the DC measurement result and the display is steady.
- If the measurement time is longer and not an integral multiple of the signal period, an integration is obtained with a beat effect in the display. The AC voltage has no effect on the DC measurement result.
- If the measurement time is shorter than the signal period, the measurement result follows the signal curve. The AC voltage affects the DC measurement result.

Fixed monitoring time	
IEC/IEEE-bus command	**Used for**

`"SENSe[1]:VOLTage:INTVtime:MODE SFASt"`
`"SENSe[1]:VOLTage:INTVtime:MODE FAST"`
`"SENSe[1]:VOLTage:INTVtime:MODE SLOW"`
	PEAK measurements
	→ 50 ms ⎫
	→ 200 ms ⎬ Monitoring time
	→ 1000 ms ⎭

`"SENSe[1]:VOLTage:INTVtime:MODE FIXed"`	QPK measurements → time 3000 ms
`"SENSe[1]:VOLTage:INTVtime:MODE VALue"` `"SENSe[1]:VOLTage:INTVtime xxx ms"`	PEAK and QPK measurements → time freely selectable Generally no recommendations can be made as to the most suitable monitoring time for peak values, as it depends on the input signal and the measurement task.

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3.15.10.3 Configuration for Maximum Sweep Speed

3.15.10.3.1 Generator Sweep

To obtain maximum sweep speed, switch off all "slowing-down" settings. Particularly the frequency measurement and settling of the low-distortion generator are very time-consuming. If permitted by the measurement, these functions should be switched off.

The following example illustrates which functions are to be switched on or off to obtain maximum sweep speed.
A typical example is a

- **single-channel linear frequency sweep** on channel 1 of
- **100 points,**
- **200 Hz to 4 kHz** and
- **RMS measurement** in
- **GEN TRACK**.

Each speed-reducing function can be switched off separately by means of a command after the *RST command. In this case a single sweep should be triggered once with "INIT:CONT OFF;*WAI" (program line 230) before sweeping is started to avoid the setting times of this command influencing the sweep time. The sweep performed at maximum speed is then triggered with another INIT command (program line 300).

```
 :
100   IEC OUT 20,"*RST;*WAI"
110   IEC OUT 20,"INP:TYPE GEN1"
120   IEC OUT 20,"OUTP:SEL CH2"
130   IEC OUT 20,"SENS:VOLT:RANG 1V": ’                    Prevent ranging
140   IEC OUT 20,"SOUR:LOWD OFF": ’              Low-distortion generator off
150   IEC OUT 20,"SENS:VOLT:APER:MODE GENT": ’    Measurement speed GEN TRACK
160   IEC OUT 20,"SENS2:FUNC ’OFF’": ’             Input peak measurement off
170   IEC OUT 20,"SENS3:FUNC ’OFF’": ’              Frequency measurement off
180   IEC OUT 20,"DISP:ANN OFF": ’               No display of measured values
190   IEC OUT 20,"SOUR:SWE:MODE AUTO;:SOUR:FREQ:MODE SWE1": ’Frequency sweep
200   IEC OUT 20,"SOUR:FREQ:STAR 200;STOP 4000": ’     Sweep 200 Hz to 4 kHz
210   IEC OUT 20,"SOUR:SWE:FREQ:SPAC LIN": ’                  Linear sweep
220   IEC OUT 20,"SOUR:SWE:FREQ:POIN 100": ’                100 Sweep points
230   IEC OUT 20,"INIT:CONT OFF;*WAI": ’               Triggers single sweep
240   IEC OUT 20,"SYST:BEEP:STAT OFF": ’     Dummy command waits for sweep end
 :
300 IEC OUT 20,"INIT;*WAI": ’         Triggers single sweep with max. speed
310 IEC OUT 20,"SYST:BEEP:STAT OFF":       ’ Dummy command waits for sweep end
 :
```

The fastest way to set a suitable sweep is to load an ACTUAL SETUP in which the required settings have already been made.

```
 :
100 IEC OUT 20,"MMEM:LOAD:STAT 0,’C:\UPD\USER\MAXSWP.SAC’;*WAI"
110 IEC OUT 20,"INIT;*WAI": ’                        Triggers single sweep
120 IEC OUT 20,"SYST:BEEP:STAT OFF": ’     Dummy command waits for sweep end
 :
```

Sweep time of a 100-point sweep with UPD 486, DX4/75 and the above setting: ***0.7 s***

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3.15.10.3.2 External Sweep

The example below demonstrates the setup for a fast external frequency sweep with a sweep-signal sequence obtained, for instance, from a CD or tape.

Matching the external frequency sweep to the signal sequence:

- Set a start value which should corresponds to the expected lowest frequency of the sweep-signal sequence.
- Select a stop value slightly below the expected highest sequence frequency (approx. 0.1%) to provide a safe halt criterion.
- elect a variation that is approx. 5 to 10 % lower than the expected frequency variation of the signal sequence to ensure safe triggering and avoid unwanted intermediate values.

The example below illustrates the settings for matching the external sweep of the UPD to the signal sequence generated by a sweep generator for demonstration purposes.
Connect the sweep generator to UPD input UNBAL Ch1, and set and start a

- continuous logarithmic sweep of 100 Hz to 16.1 kHz,
- with a step width 5%,
- and 120-ms time tick

The external sweep parameters of the UPD are set as recommended above and the external single sweep is started.

- Start frequency of ext. sweep = 100 Hz (expected lowest frequency in this case 100 Hz)
- Stop frequency of ext. sweep = 16 kHz (0.1% below the expected highest frequency, in this case 16.1 kHz)
- Variation of ext. sweep = 4.5% (10% below the expected frequency variation of the sequence, in this case 5 %)

Each time the frequency varies by more than 4.5% on channel 1, UPD carries out an RMS measurement until a frequency greater than 16 kHz is measured. After this the external sweep is terminated and the sweep curve is displayed.

With the speed-increasing settings in lines 270 to 290 and the fast frequency measurement for the external sweep in line 310, a signal sequence with a **minimum time tick of 120 ms** can still be reliably measured. For all other settings a longer time is required.

```
    :
260 '*** Speed-increasing settings
270 IEC OUT 20,"DISP:ANN OFF": '                          Display Update off
280 IEC OUT 20,"SENS3:FUNC 'OFF'": '                 Frequency measurement off
290 IEC OUT 20,"SENS:VOLT:APER:MODE AFAS": '       RMS meas. speed AUTO FAST
300 '*** Setting of external sweep parameters
310 IEC OUT 20,"TRIG:SOUR CH1R": '    Ext. sweep with fast freq. measurement
320 IEC OUT 20,"ARM:LEV:MIN 100 mV": '              Measurement above 100 mV
330 IEC OUT 20,"ARM:FREQ:STAR 100 Hz": '              Start frequency 100 Hz
340 IEC OUT 20,"ARM:FREQ:STOP 16 kHz": '               Stop frequency 16 kHz
350 IEC OUT 20,"TRIG:FREQ:VAR 4.5": '       Var. just below sweep step width
360 IEC OUT 20,"DISP:CONF AP": '                        Selects graphic window
370 PRINT "External sweep is started - recording goes on!"
380 IEC OUT 20,"INIT:CONT OFF;*WAI": '        Triggers external single sweep
390 IEC OUT 20,"SYST:BEEP:STAT ON": '      Dummy command waits for sweep end
400 IEC LAD 20: IEC GTL : '                                  Displays curve
    :
```

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3.15.10.3.3 RMS Selective Sweep

In the example below settings are made for a fast RMS selective sweep. The sweep speed mainly depends on the

- bandwidth of the set bandpass /bandstop filter and the
- center frequency.

The bandpass or bandstop filters are very steep filters with an attenuation of 100 dB. The higher the center frequency the wider the passband range and the faster the settling and therefore the RMS selective measurement.
The example below illustrates a fast RMS selective sweep of a 5-kHz squarewave signal produced by the UPD generator. The narrowband RMS measurement from 4 to 16 kHz yields a spectrum display of the fundamental with the 2nd and 3rd harmonic of the squarewave signal.

```
10 IEC TERM 10: IEC TIME 60000
20 IEC OUT 20,"*RST;*WAI;:DISP:MODE COLB;:INP:TYPE GEN1"
30 IEC OUT 20,"SOUR:FUNC SQU;:SOUR:FREQ 5000Hz;:SOUR:VOLT 1V"
70 IEC OUT 20,"SENS:FUNC 'RMSS':'     Switches on RMS selective measurement
80 '*** Speed-increasing measures
90 IEC OUT 20,"SENS:VOLT:APER:MODE AFAS":'             Fast RMS measurement
100 IEC OUT 20,"SENS2:FUNC 'OFF':'                Input-peak measurement off
110 IEC OUT 20,"SENS3:FUNC 'OFF':'                 Frequency measurement off
120 IEC OUT 20,"DISP:ANN OFF":'                           Display Update off
130 '*** Settings for RMS selective sweep
140 IEC OUT 20,"SENS:BAND:MODE PPCT1":'                   Bandpass filter 1%
150 IEC OUT 20,"SENS:FREQ:MODE SWE;:SENS:SWE:MODE AUTO":'         Auto sweep
160 IEC OUT 20,"SENS:SWE:SPAC LOG;POIN 50":'       Log. sweep over 50 points
180 IEC OUT 20,"SENS:FREQ:STAR 4000Hz;STOP 16000Hz":'   Start/stop frequency
190 '*** Settings for graphics display
200 IEC OUT 20,"DISP:TRAC:OPER CURV"
210 IEC OUT 20,"DISP:TRAC:Y:UNIT DBV;:DISP:TRAC:X:AUTO OFF"
220 IEC OUT 20,"DISP:TRAC:X:LEFT 3000Hz;RIGH 17000Hz":'              X scale
230'Measuring the sweep time
240 Z1=TIME
250 IEC OUT 20,"INIT:CONT OFF;*WAI"
260 IEC OUT 20,"DISP:CONF AP":'   Selects analyzer panel with graphic window
270 Z2=TIME: IEC LAD 20: IEC GTL:'                        Displays spectrum
280 PRINT (Z2-Z1)/100;" Sec pro Sweep": END
```

Speed-increasing measures become more effective towards higher center frequencies (> 5 kHz)!

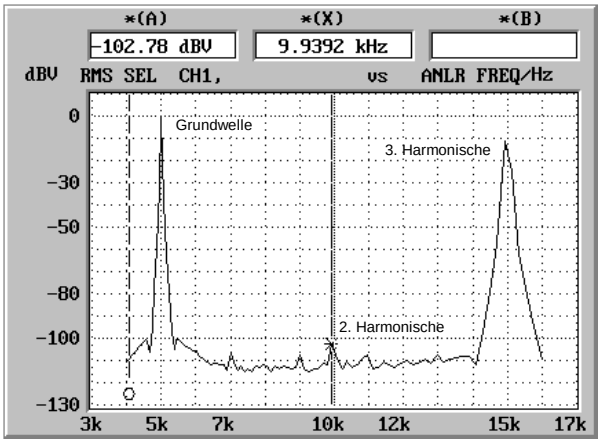

Fig. 3-9 Spectrum of 5-kHz squarewave obtained through RMS selective sweep

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3.15.11 List Management

3.15.11.1 Loading Lists into the UPD

3.15.11.1.1 Loading Sweep Lists into the UPD

Depending on the application, data are loaded into the UPD by a variety of commands that can be looked up in section 3.10.6 Commands for Graphical Representation of Results. Loading the frequency values for a frequency sweep is used as an example for demonstrating the procedure.
Load command:
"SOURce:LIST:FREQuency 100.0,300.0,500.0, ... ,20000"
permits a maximum of 1024 values to be loaded.

Use DATA and READ for handling a greater number of frequency values in program code:

```
     :
8110 DATA 100,300,500,700,800,900,1000,2000,3000,4000,5000,6000,7000
8120 DATA 10000,13000,15000,17000,20000,0
8150 IEC OUT 20,"SOUR:SWE:MODE AUTO":'                              AUTO sweep
8160 IEC OUT 20,"SOUR:FREQ:MODE LIST1":'          LIST sweep of frequencies
8170 Bef$="SOUR:LIST:FREQ": '               Lists block data of frequencies
8180 READ Frq
8190 Loop1:
8200 IF Frq<>0 THEN Bef$=Bef$+STR$(Frq)
8210 READ Frq: IF Frq<>0 THEN Bef$=Bef$+",": GOTO Loop1
8230 IEC OUT 20,Bef$:'                                 Outputs block command
     :
```

3.15.11.1.2 Loading and Display of Several Traces in the UPD

Not only curves generated in the UPD by a sweep or FFT, or those stored in a file can be graphically displayed but also any data sequences loaded into the UPD by the control program. All UPD capabilities for scaling and unit conversion are used for the graphic display.
The following routine demonstrates loading of three traces into the UPD and their graphic display.

```
     :
200 '*********************** Loading traces ***************************
210 IEC OUT 20,"DISP:TRAC:COUN 3":'       Sets number of traces to be loaded
220 IEC OUT 20,"DISP:TRAC:IND 0":'               Selects trace with index 0
230 IEC OUT 20,"TRAC LIST1, 100,1000,5000,15000":'     X values for trace 0
240 IEC OUT 20,"TRAC TRAC1, 0.001,0.01,0.01,0.001":    'Y values for trace 0
250 IEC OUT 20,"DISP:TRAC:IND 1":'               Selects trace with index 1
260 IEC OUT 20,"TRAC LIST1, 100,1500,5500,15000":'     X values for trace 1
270 IEC OUT 20,"TRAC TRAC1, 0.001,0.02,0.02,0.001":    'Y values for trace 1
280 IEC OUT 20,"DISP:TRAC:IND 2":'               Selects trace with index 2
290 IEC OUT 20,"TRAC LIST1, 100,1800,6000,15200":'     X values for trace 2
300 IEC OUT 20,"TRAC TRAC1, 0.001,0.03,0.03,0.001":    'Y values for trace 2
310 IEC OUT 20,"DISP:TRAC:OPER CURV":'             Selects the display mode
320 IEC OUT 20,"DISP:TRAC:Y:AUTO ONCE":'                    Optimizes scale
330 IEC OUT 20,"DISP:CONF AP":'    Activates analyzer panel + graphic window
340 IEC LAD 20:IEC GTL:'                                    Displays curve
     :
```

Note:

If traces are loaded into the UPD under program control and a sweep is subsequently selected, the trace in the display will be erased and the sweep curve displayed.

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3.15.11.1.3 Loading and Display of Trace Pairs in the UPD

The program below demonstrates loading of three trace pairs into the UPD, the graphic display, subsequent selection of another unit, rescaling and changing from linear to logarithmic display on the X axis.

```
     :
290 IEC OUT 20,"DISP:TRAC1:FEED 'SENS:DATA'":'              Enables trace A
300 IEC OUT 20,"DISP:TRAC2:FEED 'SENS:DATA'":'              Enables trace B
310 IEC OUT 20,"DISP:TRAC:COUN 3":'Three trace pairs
320 IEC OUT 20,"DISP:TRAC:IND 0":'          Selects trace pair with index 0
330 IEC OUT 20,"TRAC LIST1, 100,1000,5000,15000":'      X values of trace A
340 IEC OUT 20,"TRAC TRAC1, 0.001,0.01,0.01,0.001":'    Y values of trace A
350 IEC OUT 20,"TRAC LIST2, 100,1100,5100,15000":'      X values of trace B
360 IEC OUT 20,"TRAC TRAC2, 0.001,0.02,0.02,0.001":'    Y values of trace B
370 IEC OUT 20,"DISP:TRAc:IND 1":'          Selects trace pair with index 1
380 IEC OUT 20,"TRAC LIST1, 100,1500,5500,15000":'      X values of trace A
390 IEC OUT 20,"TRAC TRAC1, 0.001,0.03,0.03,0.001":'    Y values of trace A
400 IEC OUT 20,"TRAC LIST2, 100,1600,5600,15000":'      X values of trace B
410 IEC OUT 20,"TRAC TRAC2, 0.001,0.04,0.04,0.001":'    Y values of trace B
420 IEC OUT 20,"DISP:TRAc:IND 2":'          Selects trace pair with index 2
430 IEC OUT 20,"TRAC LIST1, 100,1800,6000,15200":'      X values of trace A
440 IEC OUT 20,"TRAC TRAC1, 0.001,0.05,0.05,0.001":'    Y values of trace A
450 IEC OUT 20,"TRAC LIST2, 100,1900,6100,15200":'      X values of trace B
460 IEC OUT 20,"TRAC TRAC2, 0.001,0.06,0.06,0.001":'    Y values of trace B
470 IEC OUT 20,"DISP:TRAC:OPER CURV":'                  Selects trace display
480 IEC OUT 20,"DISP:TRAC2:Y:EQU ON":'      Scaling of trace B same as for A
490 IEC OUT 20,"DISP:TRAC1:Y:AUTO ONCE":'                       Autoscaling
500 IEC OUT 20,"DISP:CONF DP":'    Selects DISPLAY panel with graphic window
510 IEC LAD 20: IEC GTL: HOLD 5000:'                Result display for 5 s
520 IEC OUT 20,"DISP:TRAC1:Y:UNIT W":'      Conversion of Y values into Watt
530 IEC OUT 20,"DISP:TRAC1:Y:AUTO ONCE":'                       Autoscaling
540 IEC LAD 20: IEC GTL:HOLD 5000:'                 Result display for 5 s
550 IEC OUT 20,"DISP:TRAC:X:SPAC LOG":'             Log display on X scale
560 IEC OUT 20,"DISP:TRAC1:Y:AUTO ONCE":'                       Autoscaling
570 IEC LAD 20: IEC GTL
     :
```

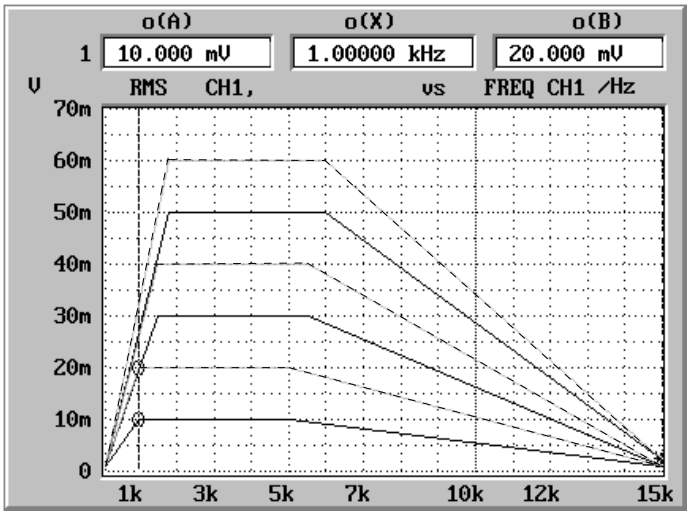

Fig. 3-10 Trace pairs loaded into UPD by control program

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3.15.11.2 Readout of Data Lists from the UPD

When data lists are read from the UPD, in compliance with SCPI values are always transferred in the basic unit even if other units have been selected for the trace display. The table below shows the basic units for transferring data of various functions from the UPD to the controller.

Table 3-3 Basic units of data

Measurement function/sweep settings	Data with basic unit for analog/digital instruments
"SENS:FUNC 'RMS'"	V/FS
"SENS:FUNC 'RMSS'"	V/FS
"SENS:FUNC 'PEAK'"	V/FS
"SENS:FUNC 'QPE'"	V/FS
"SENS:FUNC 'DC'"	V/FS
"SENS:FUNC 'THD'"	%
"SENS:FUNC 'THDN'" "SENS:FUNC:MMOD THDN|NOIS "SENS:FUNC:MMOD SNDR "SENS:FUNC:MMOD LTHD|LNOI	% % % (large values) V/FS
"SENS:FUNC 'DFD'"	%
"SENS:FUNC 'DIM'"	%
"SENS:FUNC 'MDIS'"	%
"SENS:FUNC 'WAF'"	%
"SENS:FUNC 'POL'"	no data
"SENS:FUNC 'FFT'"	V/FS
"SENS:FUNC 'WAV'"	V/FS
"SENS:FUNC 'COHE'"	%
"SENS:FUNC 'FILT'"	%
"SENS2:FUNC 'PEAK'"	V/FS
"SENS2:FUNC 'RMS'"	V/FS
"SENS3:FUNC 'FREQ'"	Hz
"SENS3:FUNC 'FQPH'"	Degree
"SENS3:FUNC 'FQGR'"	s
"SOUR:FREQ:MODE ..."	Hz
"SOUR:VOLT:MODE ..."	V/FS
"SOUR:ONT:MODE ..."	s
"SOUR:INT:MODE ..."	s
"SENS:FREQ:MODE ..."	Hz

Note:
When reading out lists remember that with commands
- "SOUR:LIST:FREQ?"
- "SOUR:LIST:INT?"
- "SOUR:LIST:ONT?"
- "SOUR:LIST:VOLT?"
- "SENS:LIST:FREQ?"

always the X values of the set sweep are read, contrary to commands
- "TRAC? LIST1"
- "TRAC? LIST2"

which cause the X values of the current graphic display to be read.

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*Normally, X values are identical for both command groups. They are only different if **other than the sweep curve** is **subsequently** selected by means of program control or by loading a file while the sweep mode is on .*

3.15.11.2.1 Readout of Lists of up to 1024 Values

A great number of application-specific commands are available for reading out sweep data, FFT data, data loaded from a file or by the control program (see section 3.10.6 Commands for Graphical Representation of Results). The procedure is illustrated by an example for reading out level values of a frequency sweep.
The readout procedure is as follows

"TRAC? TRAC" permits 1024 values to be read.

```
      :
8270 IEC OUT 20,"INIT:CONT OFF;*WAI": ’             Triggers a single sweep
      :
8420 IEC OUT 20,"TRAC? TRAC":’                Reads in level data of trace A
8430 IEC IN 20,S$:’    S$ comprises an ASCII string with level values in the
8440 ’                       form "1.1234E-003,2.3456E-002,3.4567E-001 ..."
      :
```

3.15.11.2.2 Readout of FFT Lists of more than 1024 Values

The number of values that can be transferred is limited to 1024 lines. If more than 1024 lines are to be read, the data have to be divided in blocks of 1024 values. The table in section 2.6.5.13 FFT informs on the number of lines of the selected FFT which are a function of FFT size and zooming.

In the R&S BASIC program below, the 7488 lines of a 8k-zoom FFT with 8 blocks each (7 x 1024 and 1 x 320 lines) are read and stored in the form of a string
(eg "5.50884e-004,4.1273e-004,1.64638e-004,...") in files FFT_Y1.TXT ... FFT_Y8.TXT.

```
       :
500 FOR Blkidx=0 TO 7
510  IEC OUT 20,"DISP:TRAC:IND"+STR$(Blkidx):’    Selects block index 0 to 7
520  ’                      Reads out FFT lines and stores in string Fftdat$
530  IEC OUT 20,"TRAC? TRAC"
540  IEC IN 20,Fftdat$:’                    Reads in FFT data as ASCII string
550  Filename$="FFT_Y"+RIGHT$(STR$(Blkidx+1),1)+".TXT":’   Defines file name
560  OPENO# 1,Filename$: PRINT# 1,Fftdat$: CLOSE# 1
570 NEXT Blkidx
       :
```

FFT line frequencies are read out in the same way with command
"TRAC? LIST1"

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3.15.11.2.3 FFT Lists with Suppressed Noise Floor

Since in most cases the noise floor of an FFT is of no interest, the number of lines can be considerably reduced by including only values exceeding a certain limit in the trace, eg 0.1 V.
To do so set the UPD as described below:

```
                :
100 IECOUT 20,"DISPlay:TRACe:OPERation FFTErrors":'            Sets limits
110 IECOUT 20,"CALCulate:LIMit:UPPer:VALue 0.1V":'..               >0.1 V
                :
510 IEC OUT 20,"DISP:TRAC:IND 0":'                           Block index 0
520 IEC OUT 20,"TRAC? TRAC":'                  Stores FFT lines above 0.1 V
530 IEC IN 20,Fftdat$:'                        as string data under Fftdat$
                :
```

FFT lines frequencies are read out in the same way using command
"TRAC? LIST1"

3.15.11.2.4 Readout of Several Traces from UPD

If several traces are displayed on the UPD (**"DISP:TRAC:COUN > 1"** set), the required trace can be selected with command "**DISP:TRAC:IND 0 to 17"** and read out with commands **"TRAC? LIST1"** and **"TRACE? TRAC"**:

```
     :
200 '***************** Readout of traces ********************
220 IEC OUT 20,"DISP:TRAC:IND 0":'               Selects trace with index 0
230 IEC OUT 20,"TRAC? LIST1":'       Selects X values of trace with index 0
240 IEC IN 20,X0$:'                Stores X values as ASCII string under X0$
250 IEC OUT 20,"TRAC? TRAC":'        Selects Y values of trace with index 0
260 IEC IN 20,Y0$:'                 Stores Y values as ASCII string under Y0
270 IEC OUT 20,"DISP:TRAC:IND 1":'               Selects trace with index 1
280 IEC OUT 20,"TRAC? LIST1":'       Selects X values of trace with index 1
290 IEC IN 20,X1$:'                Stores X values as ASCII string under X1$
300 IEC OUT 20,"TRAC? TRAC":'        Selects Y values of trace with index 1
310 IEC IN 20,Y1$:'                Stores Y values as ASCII string under Y1$
320 IEC OUT 20,"DISP:TRAC:IND 2":'               Selects trace with index 2
330 IEC OUT 20,"TRAC? LIST1":'       Selects X values of trace with index 2
340 IEC IN 20,X2$:'                Stores X values as ASCII string under X1$
350 IEC OUT 20,"TRAC? TRAC":'        Selects Y values of trace with index 2
     :
```

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3.15.11.2.5 Readout of Trace Pairs from UPD

Trace pairs are read out in the way described in section 3.15.11.2.4 Readout of Several Traces from UPD, with the difference
"**TRAC? LIST1**" and "**TRAC? TRAC1**" reads out the X and Y values of trace A
"**TRAC? LIST2**" and "**TRAC? TRAC2**" reads out the X and Y values of trace B

```
     :
200 '******************** Readout of trace pairs**********************
220 IEC OUT 20,"DISP:TRAC:IND 0":'          Selects trace pair with index 0
230 IEC OUT 20,"TRAC? LIST1":'     Selects X values of trace A with index 0
240 IEC IN 20,Xa0$:'              Stores X values as ASCII string under Xa0$
250 IEC OUT 20,"TRAC? TRAC1":'     Selects Y values of trace A with index 0
260 IEC IN 20,Ya0$:'              Stores Y values as ASCII string under Ya0$
270 IEC OUT 20,"TRAC? LIST2":'     Selects X values of trace B with index 0
280 IEC IN 20,Xb0$:'              Stores X values as ASCII string under Xb0$
290 IEC OUT 20,"TRAC? TRAC2":'     Selects Y values of trace B with index 0
300 IEC IN 20,Yb0$:'              Stores Y values as ASCII string under Yb0$
310 '
320 IEC OUT 20,"DISP:TRAC:IND 1":'          Selects trace pair with index 1
330 IEC OUT 20,"TRAC? LIST1":'     Selects X values of trace A with index 1
340 IEC IN 20,Xa1$:'              Stores X values as ASCII string under Xa0$
350 IEC OUT 20,"TRAC? TRAC1":'     Selects Y values of trace A with index 1
360 IEC IN 20,Ya1$:'              Stores Y values as ASCII string under Ya0$
370 IEC OUT 20,"TRAC? LIST2":'     Selects X values of trace B with index 1
380 IEC IN 20,Xb1$:'              Stores X values as ASCII string under Xb0$
390 IEC OUT 20,"TRAC? TRAC2":'     Selects Y values of trace B with index 1
400 IEC IN 20,Yb1$:'              Stores Y values as ASCII string under Yb0$
410 '
420 IEC OUT 20,"DISP:TRAC:IND 2":'          Selects trace pair with index 2
430 IEC OUT 20,"TRAC? LIST1":'     Selects X values of trace A with index 2
440 IEC IN 20,Xa2$:'              Stores X values as ASCII string under Xa0$
450 IEC OUT 20,"TRAC? TRAC1":'     Selects Y values of trace A with index 2
460 IEC IN 20,Ya2$:'              Stores Y values as ASCII string under Xa0$
470 IEC OUT 20,"TRAC? LIST2":'     Selects X values of trace B with index 2
480 IEC IN 20,Xb2$:'              Stores X values as ASCII string under Xa0$
490 IEC OUT 20,"TRAC? TRAC2":'     Selects Y values of trace B with index 2
500 IEC IN 20,Yb2$:'              Stores Y values as ASCII string under Xa2$
     :
```

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3.15.12 Filter Settings

In the case of RMS measurements, the analyzer permits a maximum of 4 filters to be switched into the measurement path, 3 filters with PEAK and QPK measurements and one filter with THDN measurements. Fixed filters like CCITT, CCIR or WRUMble or user-defined filters can be used.
The example below illustrates a customized filters made up of a bandpass filter of 11 to 15 kHz and the two notch filters of 12 and 14 kHz.

```
     :
300 IEC OUT 20,"*RST;*WAI": ’              *WAI waits for end of calibration
310 IEC OUT 20,"DISP:MODE COLB":’                    Coloured user interface
315 ’----- User filter No. 1: Bandpass filter 11 to 15 kHz, Atten. 100 dB
320 IEC OUT 20,"SENS:UFIL1:BPAS ON"
330 IEC OUT 20,"SENS:UFIL1:PASS:LOW 11 KHZ"
340 IEC OUT 20,"SENS:UFIL1:PASS:UPP 15 KHZ"
350 IEC OUT 20,"SENS:UFIL1:ATT 100 DB"
355 ’----- User filter No. 2: 12-kHz notch filter
360 IEC OUT 20,"SENS:UFIL2:NOTC ON"
370 IEC OUT 20,"SENS:UFIL2:CENT 12 KHZ"
380 IEC OUT 20,"SENS:UFIL2:WIDT 500 HZ"
390 IEC OUT 20,"SENS:UFIL2:ATT 100 DB"
395 ’----- User filter No. 3: 14-kHz notch filter
400 IEC OUT 20,"SENS:UFIL3:NOTC ON"
410 IEC OUT 20,"SENS:UFIL3:CENT 14 KHZ"
420 IEC OUT 20,"SENS:UFIL3:WIDT 500 HZ"
430 IEC OUT 20,"SENS:UFIL3:ATT 100 DB"
435 ’The 3 customized filters defined above are used for RMS
436 ’measurements; the bandpass filter for increasing the filter slope
437 ’is used twice.
440 IEC OUT 20,"SENS:FUNC ’RMS’"
450 IEC OUT 20,"SENS:FILT1:UFIL1 ON":’            Two bandpass filters for
460 IEC OUT 20,"SENS:FILT2:UFIL1 ON":’          increasing the filter slope
470 IEC OUT 20,"SENS:FILT3:UFIL2 ON":’                  12-kHz notch filter
480 IEC OUT 20,"SENS:FILT4:UFIL3 ON":’                  14-kHz notch filter
     :
```

Filter curve obtained in a sweep from 9 to 17 kHz:

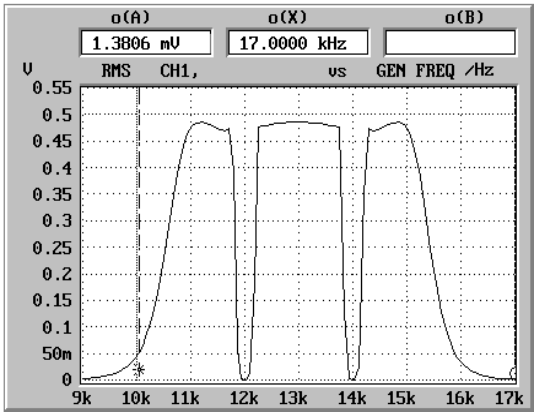

Fig. 3-11 Filter curve: steep bandpass filter + 2 notch filters

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3.15.13 Finding a File

UPD provides no special command to find out whether a file has been stored on the UPD hard disk or on a floppy.
Remedy:
If an attempt to copy the file in a temporary file is not followed by an error message, the file already exists.

```
     :
100 File$ = "'C:\UPD\USER\MY.SCO':' File of interest
110 IECOUT 20,"MMEM:COPY "+File$+",'TMP.TMP'"
120 IECOUT 20,"SYST:ERROR?": IECIN 20,E$
130 IF LEFT$(E$,1)="0" THEN
140   PRINT "File available!"
150 ELSE
160   PRINT "File not available!"
170 ENDIF
     :
```

3.15.14 Readout of Error Queue

The error queue can be read out after each command or by means of an SRQ interrupt routine if an error has occurred (see section 3.6.8 Command Synchronization)
The program below is a routine for reading out the error queue until it is empty.

```
     :
1290Errqueue:
1300 IEC OUT 20,"SYST:ERR?": '    Reads out error queue until queue is empty
1310 IEC IN 20,E$
1320 IF LEFT$(E$,1)="0" THEN RETURN:'                    Quits error routine
1330 PRINT "Contents of error queue: ";E$: GOTO Errqueue
     :
```

3.15.15 Command Synchronization

The synchronization modes realized in the example below are described in section, Command Synchronization.
Use commands *WAI, *OPC? or *OPC with SRQ to terminate a specific action before a new one is executed. Through suitable programming the controller can be made to wait for a specific action to be completed (see section 3.6.8.3 Comparison of Synchronization Capabilities).
There are two events in the UPD which have to be waited for before the next command can be executed:

- End of calibration
- End of measurement

Selection of an instrument with automatic calibration is used as an example for demonstrating the three synchronization methods. The following command should only be sent when the automatic calibration is completed. For more detailed information refer to section 3.6.8.1 Wait for End of Calibration.

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3.15.15.1 Command Synchronization with *WAI

```
IECOUT 20,"INSTrument2 A100;*WAI":'       Selects new analog instrument and
                                        waits with *WAI for end of calibration
```

3.15.15.2 Command Synchronization with *OPC?

```
IECOUT 20,"INSTrument2 A100":'                Selects new analog instrument
IECOUT 20,"*OPC?":'              Sends OPC?. Calibration is terminated when
IECIN 20,A$:'                                 the response "1" is received.
```

3.15.15.3 Command Synchronization with *OPC and SRQ

Command synchronization with *OPC and SRQ is described in advance of section 3.15.16 Service Request, which should best be read through first. Waiting for end of calibration with *OPC and SRQ after an instrument selection is again used as an example.

Procedure:

- set Operation Complete bit (OPC) in the Event Status Register,
- set ESB bit 5 in the Status Byte Register
- activate SRQ handler,
- call up change of instrument with automatic calibration,
- output synchronization command *OPC,
- wait in a loop for SRQ (end of calibration).

```
1057 '***************** Setting up SRQ ******************************
1058 IEC TERM 10:'                                Line Feed as terminator
1059 IEC TIME 10000.'                            IEC/IEEE-bus timeout 10 s
1060 IEC OUT 20,"*CLS"
1061  'Enable OPC (Operation Complete) in the Event Status Register
1062  '                                 +---+---+---+---+---+---+---+---+
1063  '                                 | d7| Event Status Register | d0|
1064  '                                 |POW|USR|CME|EXE|DDE|QUE|   |OPC|
1065  IEC OUT 20,"*ESE 1": '            | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
1066  '                                 +---+---+---+---+---+---+---+---+
1067  'Trigger SRQ through entry in the Event Status Register (d5=1)
1068  '                                 +---+---+---+---+---+---+---+---+
1069  '                                 | d7|  Status Byte Register | d0|
1070  '                                 |SOR|RQS|ESB|   |SQR|   |   |   |
1071  IEC OUT 20,"*SRE 96": '           | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
1072  '                                 +---+---+---+---+---+---+---+---+
1073 ON SRQ1 GOSUB Srqintr:'   Activate SRQ handler of IEC/IEEE bus No. 1
  :
1080 IECOUT 20,"INSTrument2 A100":' Instrument change with autom. calibr.
1090 IECOUT 20,"*OPC":'                          Synchronization command
  :
1100 REPEAT
1110  'Other tasks may be performed as long as no SRQ is appears.
1120  'Signalled by a count on screen.
1130  Count=Count+1: PRINT Count
1140 UNTIL Srqflag=0:'           Flag = 1 when calibration is completed
  :
2000 '** Standard SRQ interrupt routine shown in section 4.15.1.2 ***
2010 Srqintr:
2020 IEC SPL 20,Sb%: '               Reads in Status Byte via Serial Poll
2040                                    :
```

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3.15.16 Service Request

As can be seen from the introduction to the SRQ standard routine below, a Service Request routine requires an extended initialization of the UPD.
The SRQ standard routine uses Serial Poll for processing SRQ . This SRQ routine is used in almost all demo programs but for the sake of clarity it is not listed each time (remark in program code). The program example in section 3.15.16.2 SRQ Interrupt Routine with Parallel Poll, demonstrates SRQ handling by means of Parallel Poll which should be used to speed up identification of the instrument raising the SRQ when several IEC/IEEE-bus instruments are connected.
Same as with all other program examples it is assumed that IEC/IEEE-bus address 20 is set on the UPD to be controlled.

3.15.16.1 SRQ Interrupt Routine with Serial Poll

The examples below for initializing an SRQ and the SRQ interrupt routine are suggestions which can be modified as required by the specific application.
Serial Poll SRQ and the Serial Poll SRQ interrupt routine are initialized in this or a similar form in almost all program examples.

3.15.16.1.1 Initialization of Serial Poll SRQ

```
     :
100 '************ Initializing Serial Poll SRQ ****************
110 IEC TERM 10:' IEC/IEEE-bus terminator = Line Feed
120 IEC TIME 10000: ' IEC/IEEE-bus waiting time 10 s
130 IEC OUT 20,"*CLS":'Resets Status Register
140 'Enables error bits in the Event Status Register
150 '                                +---+---+---+---+---+---+---+---+
160 '                                | d7| Event Status Register | d0|
170 '                                |POW|USR|CME|EXE|DDE|QUE|   |OPC|
180 IEC OUT 20,"*ESE 61": '          | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
190 '                                +---+---+---+---+---+---+---+---+
200 'Enables d5 for SRQ trigger through Event Status Register
210 '                                +---+---+---+---+---+---+---+---+
220 '                                | d7|  Status Byte Register | d0|
230 '                                |SOR|RQS|ESB|   |SQR|   |   |   |
240 IEC OUT 20,"*SRE 96": '          | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
250 '                                +---+---+---+---+---+---+---+---+
260 Srqflag=0
270 ON SRQ1 GOSUB Srqintr: ' Activates SRQ handler
     :
```

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3.15.16.1.2 Serial Poll SRQ Routine

The following standard SRQ interrupt routine is used in almost all the program examples. It displays the reason for the SRQ and the contents of the error queue on the controller monitor and signals to the main program with `Srqflag = 1`, that a SRQ has occurred.

```
1000Srqintr:
1010 ' ********************************************
1020 ' ******* Standard SRQ Interrupt Routine ********
1030 ' ********************************************
1040 IEC SPL 20,Sb%: ' Read-in of Status Byte
1050 IF (Sb% AND 64)=0 THEN GOTO Ret: ' No response in the case of false
alarm
1060 Srqflag=1
1070 PRINT "Status Byte Register = ";Sb%
1080 IF (Sb% AND 1)   THEN PRINT " SRQ->Not used"
1090 IF (Sb% AND 2)   THEN PRINT " SRQ->Not used"
1100 IF (Sb% AND 4)   THEN PRINT " SRQ->Not used"
1110 IF (Sb% AND 8)   THEN PRINT " SRQ->Questionable-status bit"
1120 IF (Sb% AND 16)  THEN PRINT " SRQ->Not used"
1130 IF (Sb% AND 32)  THEN PRINT " SRQ->Event-status bit"
1140 IF (Sb% AND 64)  THEN PRINT " SRQ->Summary bit"
1150 IF (Sb% AND 128) THEN PRINT " SRQ->Operation-status bit"
1160 '
1170 IEC OUT 20,"*ESR?": ' Read-in of Status Register
1180 IEC IN 20,Es$
1190 PRINT "Event Status Register = ";Es$
1200 IF (VAL(Es$) AND 1)   THEN PRINT " ESR->Operation-complete bit"
1210 IF (VAL(Es$) AND 2)   THEN PRINT " ESR->Not used"
1220 IF (VAL(Es$) AND 4)   THEN PRINT " ESR->Query-error bit"
1230 IF (VAL(Es$) AND 8)   THEN PRINT " ESR->Device-dep. error bit"
1240 IF (VAL(Es$) AND 16)  THEN PRINT " ESR->Execution-error bit"
1250 IF (VAL(Es$) AND 32)  THEN PRINT " ESR->Command-error bit"
1260 IF (VAL(Es$) AND 64)  THEN PRINT " ESR->User-request bit"
1270 IF (VAL(Es$) AND 128) THEN PRINT " ESR->Power-on bit"
1280 '
1290Errqueue:
1300 IEC OUT 20,"SYST:ERR?": ' Readout of error queue until queue is empty!
1310 IEC IN 20,E$
1320 IF LEFT$(E$,1)="0" THEN GOTO Ret
1330 PRINT "Contents of Error Queue:"
1340 PRINT " ";E$: GOTO Errqueue
1350 '
1360Ret: ON SRQ1 GOSUB Srqintr: RETURN:' Reactivates SRQ!
```

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3.15.16.2 SRQ Interrupt Routine with Parallel Poll

3.15.16.2.1 Initialization of Parallel Poll SRQ

```
     :
100 '************ Initialization of Parallel Poll SRQ ********************
110 IEC TERM 10:'                          IEC/IEEE-bus terminator = Line Feed
120 IEC TIME 10000: '                           IEC/IEEE-bus waiting time 10 s
130 IEC OUT 20,"*CLS":'                                  Resets Status Register
140 IEC OUT 20,"*ESE 121":' Enables OPC,DDE,EXE,CMD in the Event Status Reg.
150 IEC OUT 20,"*SRE 32":'              Enables Event Status bit as SRQ event
160 IEC OUT 20,"*PRE 255":'                   Enables all Parallel Poll lines
170 IEC PCON 20,1,6:'UPD identifies itself with 1 on line 6
180 IEC PCON 10,1,3:'Device with address 10 ident. itself with 1 on line 3
190 ON SRQ1 GOSUB Srqintr:'                                SRQ handler activated
     :
```

3.15.16.2.2 Parallel Poll SRQ Routine

```
740 '*********************************************************************
750 '******* Standard Parallel-Poll SRQ Interrupt Routine *************
760 '*********************************************************************
770Srqintr:
790 PRINT "SRQ has occurred!"
800 IEC PPL Pp%
810 IF (Pp% AND 32)<>0 THEN GOSUB UPDsrq
820 IF (Pp% AND 4)<>0 THEN GOSUB Adr10srq
825 ON SRQ1 GOSUB Srqintr: RETURN:' Reactivates SRQ
826 '
830UPDsrq:
840 '*********************************************************************
850 '**********         SRQ sent by UPD      ******************
860 '*********************************************************************
1040 IEC SPL 20,Sb%: ' Read-in of Status Byte
1060 Srqflag=1
1070 PRINT "Status Byte Register = ";Sb%
1080 IF (Sb% AND 1)   THEN PRINT " SRQ->Not used"
1090 IF (Sb% AND 2)   THEN PRINT " SRQ->Not used"
1100 IF (Sb% AND 4)   THEN PRINT " SRQ->Not used"
1110 IF (Sb% AND 8)   THEN PRINT " SRQ->Questionable status"
1120 IF (Sb% AND 16)  THEN PRINT " SRQ->Not used"
1130 IF (Sb% AND 32)  THEN PRINT " SRQ->Event Status"
1140 IF (Sb% AND 64)  THEN PRINT " SRQ->Summary"
1150 IF (Sb% AND 128) THEN PRINT " SRQ->Operation Status"
1160 '
```

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```
1170 IEC OUT 20,"*ESR?": ' Read-in of Event Status Register
1180 IEC IN 20,Es$
1190 PRINT "Event Status Register = ";Es$
1200 IF (VAL(Es$) AND 1)   THEN PRINT " ESR->Operation complete"
1210 IF (VAL(Es$) AND 2)   THEN PRINT " ESR->Not used"
1220 IF (VAL(Es$) AND 4)   THEN PRINT " ESR->Query error"
1230 IF (VAL(Es$) AND 8)   THEN PRINT " ESR->Device-dep. error"
1240 IF (VAL(Es$) AND 16)  THEN PRINT " ESR->Execution error"
1250 IF (VAL(Es$) AND 32)  THEN PRINT " ESR->Command error"
1260 IF (VAL(Es$) AND 64)  THEN PRINT " ESR->User request"
1270 IF (VAL(Es$) AND 128) THEN PRINT " ESR->Power on"
1280 '
1290Errqueue:
1300 IEC OUT 20,"SYST:ERR?": ' Read-out of error queue until it is empty
1310 IEC IN 20,E$
1320 IF LEFT$(E$,1)="0" THEN RETURN
1330 PRINT "Contents of error queue:"
1340 PRINT " ";E$: GOTO Errqueue
1250 RETURN
1260 '
1270Adr10srq:
1280 '*****************************************************************
1290 '*******  SRQ sent by device with the address 10   *************
1300 '*****************************************************************
1310 IEC SPL 10,Sb%: '       Reset SRQ conditions for device with address 10
1320 'SRQ evaluation for device with the address 10
1330 '
1340 '
1350 RETURN
```

3.15.17 Readout of Cursor Position and Values

The values of a curve displayed on the UPD can be read by the controller, no matter whether the curve has been generated by a sweep or FFT or loaded into the UPD from a file or the controller. To do so the o- or * cursor has to be positioned as required. The value at the cursor crossing the curve or the difference value can be read out.
The great number of commands available for positioning the cursor are listed below.
To simplify the program examples for the various cursor display modes and the respective intercept points, the cursor position is indicated directly in the form of a value.

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Table 3-4 Positioning the cursor on the displayed curve

Positioning the cursor for curve display	
Positioning the o cursor:	**Positioning the *-cursor:**
"DISP:TRAC:CURS1:POS:MODE MIN1" Sets the horizontal o-cursor to the minimum value of **curve A** on the X axis.	**"DISP:TRAC:CURS2:POS:MODE MIN1"** Sets the horizontal *-cursor for modes "DISP:TRAC:CURS2:POS:MODE N12|D12|C12" to the minimum value of **curve A** on the **X axis .** Sets vertical *-cursor for modes "DISP:TRAC:CURS2:POS:MODE HL1|HL2|HLD1|HLD2" to minimum of **curve A** on the **Y axis.**
"DISP:TRAC:CURS1:POS:MODE MAX1" Sets horizontal o-cursor to maximum of **curve A.**	**"DISP:TRAC:CURS2:POS:MODE MAX1"** Sets horizontal *-cursor for modes ☞ "DISP:TRAC:CURS2:POS:MODE N12|D12|C12" to maximum of **curve A** on the **X axis.** Sets vertical *-cursor for modes "DISP:TRAC:CURS2:POS:MODE HL1|HL2|HLD1|HLD2" to maximum of **curve A** on the **Y axis**.
"DISP:TRAC:CURS1:POS:MODE MIN2" Sets horizontal o-cursor to minimum of **curve B.**	**"DISP:TRAC:CURS2:POS:MODE MIN2"** Sets horizontal *-cursor for modes "DISP:TRAC:CURS2:POS:MODE N12|D12|C12" to maximum of **curve B** on the **X axis.** Sets vertical *-cursor for modes "DISP:TRAC:CURS2:POS:MODE HL1|HL2|HLD1|HLD2" to minimum of **curve B** on the **Y axis.**
"DISP:TRAC:CURS1:POS:MODE MAX2" Sets horizontal o-cursor to maximum of **curve B.**	**"DISP:TRAC:CURS2:POS:MODE MAX2"** Sets horizontal *-cursor for modes "DISP:TRAC:CURS2:POS:MODE N12|D12|C12" to maximum of **curve B** on the **X axis.** Sets vertical *-cursor for modes ☞ "DISP:TRAC:CURS2:POS:MODE HL1|HL2|HLD1|HLD2" to maximum of **curve B** on the **Y axis.**
"DISP:TRAC:CURS1:POS:MODE VALue" **"DISP:TRAC:CURS1:POS 1000kHz"** Sets horizontal o-cursor for modes "DISP:TRAC:CURS1:POS:MODE N12|D12|C12" to specified position on the **X axis.**	**"DISP:TRAC:CURS2:POS:MODE VALue"** **"DISP:TRAC:CURS2:POS 1000kHz"** Sets horizontal *-cursor for modes "DISP:TRAC:CURS1:POS:MODE N12|D12|C12" to specified **X position.** Sets vertical *-cursor for modes ☞ "DISP:TRAC:CURS2:POS:MODE HL1|HL2|HLD1|HLD2 to specified position on the **Y axis.**

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Table 3-5 Positioning the cursor for FFT spectrum display

Positioning the cursor for FFT spectrum display	
Positioning the o-cursor:	**Positioning the *-cursor:**
"DISP:TRAC:CURS1:POS:MODE MARKer1" Sets vertical o-cursor to **X position** of marker if the latter was switched on with "DISP:TRAC1|2:MARK:MODE MAX|CURS".	**"DISP:TRAC:CURS2:POS:MODE MARKer1"** Sets vertical *-cursor to **X position** of marker if the latter was switched on with "DISP:TRAC1|2:MARK:MODE MAX|CURS".
"DISP:TRAC:CURS1:POS:MODE NEXTmarker" Sets vertical o-cursor to **X position** of next harmonic if harmonics display was switched on with DISP:TRAC1|2:MARK:HARM ON.	**"DISP:TRAC:CURS2:POS:MODE NEXTmarker"** Sets vertical *-cursor to **X position** of next harmonic if harmonics display was switched on with "DISP:TRAC1|2:MARK:HARM ON".
"DISP:TRAC:CURS1:POS:MODE IMAX1" Sets vertical o-cursor to **X position** of highest Y value of **FFT curve A.**	**"DISP:TRAC:CURS2:POS:MODE IMAX1"** Sets vertical *-cursor to **X position** of highest Y value of **FFT curve A.**
"DISP:TRAC:CURS1:POS:MODE IMAX2" Sets vertical o-cursor to **X position of** highest Y value of **FFT curve B.**	**"DISP:TRAC:CURS2:POS:MODE IMAX2"** Sets vertical *-cursor to **X position** of highest Y value of **FFT curve B.**

Note:

*Positioning of *-cursor partly depends on the set cursor mode "DISP:TRAC:CURS2:POS:MODE N12|D12|C12|HL1|HL2|HLD1|HLD2". Function and effect of the individual cursor modes can be seen from the following diagrams and the associated program line 110*

Abbreviations used in the diagrams below:

o(A) = Y value at crosspoint of vertical o-cursor on curve A
o(B) = Y value at crosspoint of vertical o-cursor on curve B
o(X) = X value of vertical o-cursor
*(A) = Y value at crosspoint of vertical *-cursor on curve A
*(B) = Y value at crosspoint of vertical *-cursor on curve B
*(X) = X value of vertical *-cursor
*(Y) = Y value of horizontal *-cursor
*(X)AL = X value at left crosspoint of horizontal *-cursor on curve A
*(X)AR = X value at right crosspoint of horizontal *-cursor on curve A
*(X)BL = X value at left crosspoint of horizontal *-cursor on curve B
*(X)BR = X value at right crosspoint of horizontal *-cursor on curve B

Cursor data for traces can be read out without restrictions as from UPD program version 2.10 onwards.!

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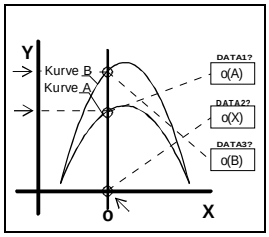
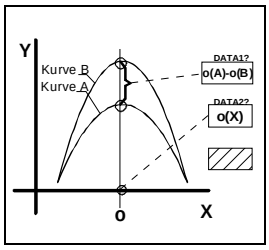



```
100 IEC OUT 20,"DISP:TRAC:CURS1 ACT": ' Activates o-cursor 1
110 IEC OUT 20,"DISP:TRAC:CURS1:MODE N12"
120 IEC OUT 20,"DISP:TRAC:CURS1:POS:MODE VAL": '  at 1000 Hz
130 IEC OUT 20,"DISP:TRAC:CURS1:POS 1000 Hz"
```

Analogously, **CURS2** activates the ***-cursor** yielding the values *(A), *(X) and *(B)

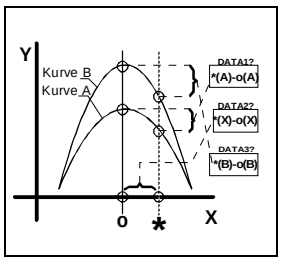
Fig. 3-12 Cursor data o(A), o(X), o(B), *(A), *(X), *(B)




```
100 IEC OUT 20,"DISP:TRAC:CURS1 ACT": ' Activates o-cursor 1
110 IEC OUT 20,"DISP:TRAC:CURS1:MODE D12"
120 IEC OUT 20,"DISP:TRAC:CURS1:POS:MODE VAL": ' at 1000 Hz
130 IEC OUT 20,"DISP:TRAC:CURS1:POS 1000 Hz"
```

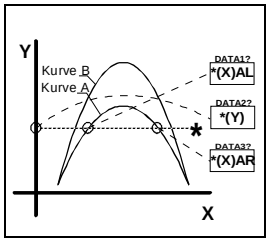
Analogously, **CURS2** activates the ***-cursor** yielding the values *(A) - *(B) and *(X)

Fig. 3-13 Cursor data o(A)-o(B), o(X), *(A)-*(B), *(X)




```
100 IEC OUT 20,"DISP:TRAC:CURS1 ACT;CURS2 ACT": '   Activates
                                                  o- and *-cursors
110 IEC OUT 20,"DISP:TRAC:CURS2:MODE C12"
120 IEC OUT 20,"DISP:TRAC:CURS1:POS:MODE VAL": 'o-cursor 1 kHz
130 IEC OUT 20,"DISP:TRAC:CURS1:POS 1000 Hz"
140 IEC OUT 20,"DISP:TRAC:CURS2:POS:MODE VAL": '*-cursor 2 kHz
150 IEC OUT 20,"DISP:TRAC:CURS2:POS 5000 Hz"
```

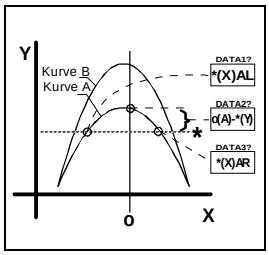
Fig. 3-14 Cursor data *(A)-o(A), *(X)-o(X), *(B)-o(B)




```
100 IEC OUT 20,"DISP:TRAC:CURS2 ACT": ' Activates *-cursor
110 IEC OUT 20,"DISP:TRAC:CURS2:MODE HL1"
120 IEC OUT 20,"DISP:TRAC:CURS2:POS:MODE VAL": ' Positions *-
cursor to
                                        Y value 0.2 V
130 IEC OUT 20,"DISP:TRAC:CURS2:POS 0.2 V"
```

Analogously, cursor ...**CURS2:MODE HL2** yields values *(X)BL, *(Y) and *(X)BR for **curve B.**

Fig. 3-15 Cursor data *(X)AL, *(Y), *(X)AR




```
100 IEC OUT 20,"DISP:TRAC:CURS1 ACT;CURS2 ACT": '   Activates
                                                  o- and *-cursors
110 IEC OUT 20,"DISP:TRAC:CURS2:MODE HLD1"
120 IEC OUT 20,"DISP:TRAC:CURS1:POS:MODE VAL": '   Positions
                                          o-cursor on 1000 Hz
130 IEC OUT 20,"DISP:TRAC:CURS1:POS 1000.0 Hz"
140 IEC OUT 20,"DISP:TRAC:CURS2:POS:MODE VAL": '   Positions
                                       *-cursor on Y value 0,2 V.
150 IEC OUT 20,"DISP:TRAC:CURS2:POS 0.2 V"
```

Fig. 3-16 Cursor data *(X)AL, o(A)-*(Y), *(X)AR

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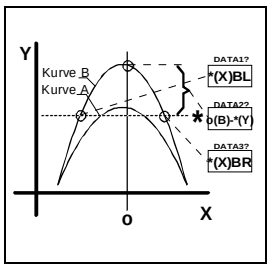


```
100 IEC OUT 20,"DISP:TRAC:CURS1 ACT;CURS2 ACT": ’  Activates
                                                  o- and *-cursors
110 IEC OUT 20,"DISP:TRAC:CURS2:MODE HLD2"
120 IEC OUT 20,"DISP:TRAC:CURS1:POS:MODE VAL": ’   Positions
                                                 o-cursor on 1000 Hz
130 IEC OUT 20,"DISP:TRAC:CURS1:POS 1000.0 Hz"
140 IEC OUT 20,"DISP:TRAC:CURS2:POS:MODE VAL": ’   Positions
                                          *-cursor on Y value 0.2 V
150 IEC OUT 20,"DISP:TRAC:CURS2:POS 0.2 V"
```

Fig. 3-17 Cursor data *(X)BL, o(B)-*(Y), *(X)BR

Readout of cursor values

DATA1?, **DATA2?** and **DATA3?** values are read in with the following commands:

```
IECOUT 20,"DISP:TRAC:CURS:DATA1?":IEC IN 20,"D1$
IECOUT 20,"DISP:TRAC:CURS:DATA2?":IEC IN 20,"D2$
IECOUT 20,"DISP:TRAC:CURS:DATA3?":IEC IN 20,"D3$
```

Values are output with the unit indicated in the display.

3.15.18 Call a BASIC-Macro

With the UPD, setting and measurement sequences can be written as BASIC programs or recorded using the built-in program generator (see **3.15.3 Command Logging -** Converting K1-Commands into IEC/IEEE-Bus Commands). Option UPD-K2 (Universal Autorun Control) is required. The generated BASIC programs can be stored (preferred file extension: .BAS) and called and used in various ways (see **2.16 Makro Operation**)

The following example illustrates how a BASIC macro is called by means of an IEC/IEEE-bus control program in the programming language C and the IEC/IEEE-bus driver GPIB.COM from National Instruments:

Example 1:
BASIC macro transfers a measurement result in a measurement-result buffer to the control program

BASIC macro:

A short program is written under Universal Autorun Control UPD-K1 to trigger a level in channel 1. To demonstrate that any data can be transferred to the IEC/IEEE-bus control program as floating-point values via the measurement-result buffers, the level of channel 1 (line 30) is copied into the measurement-result buffer of channel 2 (line 40), from where it is read with the aid of the IEC/IEEE-bus control program.
This BASIC macro is stored in the UPD under the file name LEV_CH1.BAS.

```
10 UPD OUT "INIT:CONT OFF;*WAI"
20 UPD OUT "*TRG;*WAI"
30 UPD OUT "SENS:DATA?": UPD IN A$: ’ level of channel 1 ...
40 UPD OUT "SENS:DATA2 "+A$: ’... copying into buffer of channel 2
50 END
```

How to proceed:

- Press the F3 key to switch from the UPD user interface to Universal Autorun Control.
- Type the five lines shown above.

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- Store program with SAVE LEV_CH1.BAS.
- Press the F3 key again to return to UPD user interface.

The following IEC/IEEE-bus control program calls the BASIC macro in the UPD with the command `SYST:PROG:EXEC 'LEV_CH1.BAS'`. There is a delay until serial polling indicates that bit 14 (RUN) has changed from 1 to 0 in the OPERation register; this indicates that the BASIC macro has been executed.
The measurement result is read from channel 2's measurement-result buffer and displayed on the screen.

IEC/IEEE-bus control program in controller:

```
/*************************************************************************
* A BASIC program in UPD triggering a level-measurement result in channel 1
* To be started as a BASIC macro from the controller
* Measurement result to be output at the controller
*************************************************************************/
#include <stdio.h>
#include <string.h>
#include <stdlib.h>
#include <conio.h>
#include <bios.h>
#include "C:\NI-GPIB\C\DECL.H"


void report_error(int fd, char *errmsg)
{

   fprintf(stderr, "Error %d: %s\n", iberr, errmsg);
   if (fd != -1) {
      printf("Cleanup: taking board off-line\n");
      ibonl(fd,0);
   }
getch();
exit(1);              /* abort program */
}

void befout (int upd, char *befstr)
{
   ibwrt(upd, befstr,(long)strlen(befstr));
   if (ibsta & ERR)
      report_error (upd, "Could not initialize UPD");
}

void queryin (int upd, char* reading)
{
 ibrd(upd, reading, 20L);
  if (ibsta & ERR)
   report_error (upd, "Could not read data from UPD");
  reading[ibcnt-1] = '\0'; /* Overwrites line feed with string terminator */
}


void main()
{
int    upd;           /* File descriptor for UPD */
int    i;
char   reading[20]; /* UPD measurement results */
long count = 0;
char stb;

if ((upd = ibdev(0, 20, 0, T10s, 1, 0)) < 0)
```

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```
 report_error (upd, "Could not initialize UPD");

befout (upd,"*ESE 0"); //Disables information from event status register
befout (upd,"*SRE 0"); //Disables SRQ

/* The 1 -> 0 transition of bit 14 (RUN) in the OPERation register
   should set bit 7 (OPER) in the STB. The STB is read by means
   of serial poll until the event has occurred. */

befout (upd,"STAT:OPER:NTR 16384");  /* Enables 1->0 transition of bit 14 */
befout (upd,"STAT:OPER:PTR 0");       /* Disables 0->1 transition of bit 14
*/
befout (upd,"STAT:OPER:ENAB 16384"); /* Enables bit 14 for STB */

/* The BASIC program LEV_CH1.BAS in the UPD working directory writes
   the level measured in channel 1 to the measurement-result buffer of
channel 2
   to demonstrate data transfer via the measurement-result buffers. */

for (i=1; i <= 10; i++)
 {/* Reads 10 measurement results via the BASIC macro LEV_CH1.BAS */
  /* Reading the EVENt part of the OPERation register deletes the
     OPER bit in the status byte register! */
  befout (upd,"STAT:OPER:EVEN?");
  queryin (upd,reading);

  befout (upd,"SYST:PROG:EXEC 'LEV_CH1.BAS'"); // Starts the BASIC macro

  /* When the RUN bit (bit 14) in the OPERation register changes from 1 to
     0, the BASIC macro has been executed and the measurement
     result can be read from the measurement-result buffer. */
  stb = 0;
  while ((stb & 0x80) == 0)   // Serial poll is performed until
   {                          // bit 7 (OPER) in the STB is set to 1.
    ibrsp (upd,&stb);         // Serial poll of the status byte register
    if ((count++ % 100) == 0) // Progress counter while
     printf ("+");            // waiting for bit 7 = 1 */
   }

  /* The level of channel 1 can be read from the channel-2 measurement-
      result buffer, where it was stored by the BASIC macro. */
  befout (upd,"SENS:DATA2?");
  queryin (upd,reading);
  printf ("\n%s\n",reading);
 }

printf ("Any key:\n");
getch ();
ibonl(upd, 0);  /* Take UPD off-line */
}
```

Data transfer between BASIC macro and controller via the measurement-result buffers:

The measurement-result buffers can be written to so as to transfer data between the BASIC macro and the controller. The measurement results calculated by the macro can thus then be displayed in the UPD environment, which is familiar to the user.

Furthermore, fast exchange of floating-point parameters and floating-point measurement results between the UPD macro and the controller is possible via the measurement-result buffers. The following commands are available for the data exchange:
SENS1:DATA1, SENS1:DATA2
SENS2:DATA1, SENS2:DATA2
SENS3:DATA1, SENS3:DATA2

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Note:
If the measurement results are not to be overwritten by the UPD measurement task, make sure the measurement task is halted, ie no measurement or sweep is being performed, while the measurement results are being written.

Example 2:
BASIC macro transfers a set of data in a block buffer to the control program

BASIC macro:

A short program is written under Universal Autorun Control UPD-K1. This program writes any set of data into the block buffer specially generated for BASIC macros. The data are then read from this buffer by the IEC/IEEE-bus control program.
This BASIC macro is stored in the UPD under BLK.BAS.

```
10 DIM A(1000): Frq=100: A(0)=X
20 FOR I=1 TO 999: ' 1000 log. frequency values  ...
30 Frq=Frq*1.00503: A(I)=Frq: ' ... 100 Hz to 15 kHz
40 NEXT I
50 UPD BLOCKOUT A(0),1000
60 UPD OUT "SYST:PROG"
70 END
```

Proceed as for example 1.

The following IEC/IEEE-bus control program calls the BASIC macro in the UPD with the command `SYST:PROG:EXEC 'BLK.BAS'`. There is a delay until serial polling indicates that bit 14 (RUN) in the OPERation register has changed from 1 to 0. This shows that the BASIC macro has been executed.
The block data are read from the block buffer and displayed on the screen.

IEC/IEEE-bus control program in the controller:

```
First part of program as in example 1
            :
            :
befout (upd,"SYST:PROG:EXEC 'BLK.BAS'"); // Starts the BASIC macro
stb = 0;
while ((stb & 0x80) == 0) // Serial poll is performed until
   {                      // bit 7 (OPER) in the STB is set to 1.
    ibrsp (upd,&stb);
    if ((count++ % 100) == 0) // Progress counter while
     printf ("_");            // waiting for bit 7 = 1  */
   }

  /* Determines number of values in the block buffer */
  befout (upd, "SYST:PROG:POIN?");
  queryin (upd,reading);
  points = atoi (reading);
  printf ("\nBlock buffer contains %d values. Display values...\n",points);
  getch();

 /* Read values from block buffer */
  befout (upd,"SYST:PROG?"); /* Fetch contents from block buffer.
                    The values are available as ASCII characters separated
                    by commas */
  ibeos (upd,0x142C); //Stringterminator = ','
  for (i = 0; i < points-1; i++)
   {// Each value is read up to the comma
```

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```
    queryin (upd,reading);
    fltvalfield[i] = atof (reading);
   }
  // Before the last value has been read, the string terminator ...
  ibeos (upd,0x140A); //... is reset to AF.
  queryin (upd,reading);
  fltvalfield[i] = atof (reading);

  // Values are output on the screen.
  for (i = 0; i < points; i++)
    printf ("%d: %f\n", i+1,  fltvalfield[i]);

printf ("Any key:\n");
getch ();
ibonl(upd, 0);  /* Take UPD off-line */
}
```

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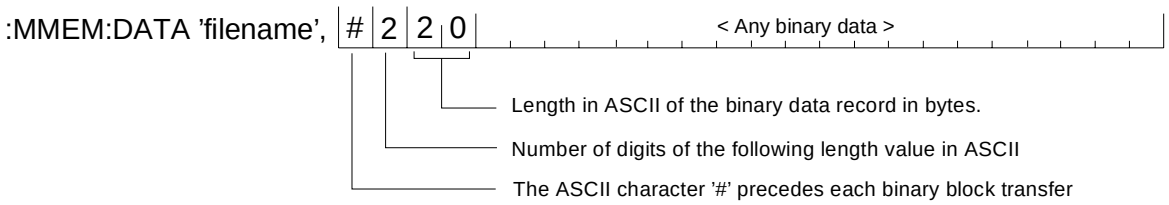
3.15.19 Binary Data via IEC/IEEE-Bus Interface Interface

Using the IEC bus command **MMEMory:DATA 'filename', #<lele><le><Binärdaten>**, it is possible to transfer any binary data and files from the host to the UPD.



Using the IEC bus command **MMEMory:CHECk? 'filename'**, a digital signature can be calculated on the transferred binary data record in order to check whether an error occurred.

To ease the file transfer from host to the UPD not only experienced C- and IEC bus programmers the DOS programs IEC_BT.EXE and UPMD5.EXE are provided from UPD version 3.07.

Initial Steps

After the installation of a new UPD software version 3.07 or higher, the following two EXE files are stored in the **C:\UPD\IEC_EXAM** directory (the EXE files can be run under DOS):

IEC_BT.EXE	(copied by a process controller from a file and transferred to UPD via the IEC/IEEE bus)
UPMD5.EXE	(generates the unique signature of a file)

The associated source code
IEC_BT.C
is stored too.

To be able to transfer a file from a process controller to the UPD via the IEC/IEEE-bus interface, the files IEC_BT.EXE and UPMD5.EXE must be copied to a floppy disk and transferred from the disk to the process controller. The disk can be copied either on the UPD under DOS or, with the UPD measurement software running, from the FILE Panel using the commands 'Copy' and 'To'.

Important:
The program UPMD5.EXE must be in the directory from which IEC_BT.EXE is started, or in a directory specified under PATH.

Transfer of File to UPD via IEC/IEEE-Bus Interface

The program IEC_BT.EXE allow the transfer of any file to the UPD **via the IEC/IEEE-bus interface.**
This is done by transmitting then IEC bus command MMEM:DATA followed by then contents of the file to the UPD. The filename is specified interactively.
The source file IEC_BT.C is written in the programming language C. The source file provides information on the transfer procedure and the call-up of the MD5 signature method. IEC_BT can be adapted to user's requirements.
For the signature method to be executed, an IEC/IEEE-bus driver from National Instruments must be installed in the process controller, and the setting Remote via IEC BUS selected in the OPTIONS Panel of the UPD.
After IEC_BT is called up, the program tries to find

- an UPD connected to the IEC/IEEE bus. When an UPD has been found, measurements on UPD are stopped to obtain maximum transfer speed.
- The path and name of the file to be transferred are requested, as well as the path and name of the target file to be generated in the UPD.

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- The program generates a temporary file with the name TEMP.OUT, which contains the IEC/IEEE-bus command required for the UPD as well as the data record to be transferred.
- TEMP.OUT is transferred to the UPD at a transfer rate between 30 and 100 Kbytes per second depending on the process controller and the UPD configuration. The file TEMP.OUT remains stored in the process controller after it is transferred so that it can be read if necessary by means of an editor capable of handling binary characters.
- At the end of the transfer, a signature is generated both of the original file stored in the process controller and the file generated in the UPD (see MD5 signature method). If the signatures agree, it can be assumed that the two files are completely identical and no transmission errors have occurred.

MD5 Signature Method

MD5 stands for "Message Digest 5" (coding and processing rule), an algorithm recognised world-wide which is used for generating a 128-bit checksum (Signature) of a data record.
To check whether a file was transferred error-free from the process controller to the UPD, the MD5 signature method can be used to generate the digital signature of the file on the process controller prior to the transfer. After the transfer of the file to the UPD via the IEC/IEEE bus, a digital signature is generated on the UPD. If the two signatures agree, it can be assumed that the contents of the files are identical and the transfer was therefore error-free. Moreover, it can be determined in this way whether any subsequent modifications have been made to the file.

The program UPMD5.EXE generates a 16-byte hexadecimal signature of any file. The signature is displayed as a 32-digit ASCII character string on the screen.
Example:
The signature of the file IEC_BT.C is to be generated:
`UPMD5 IEC_BT.C`
ASCII character string displayed on the screen:
0d45494a3e3e262609e20050b5274f58

If the signature of a file is needed for further processing in a program, the signature can be written to a file instead of being displayed on the screen:
Example:
`UPMD5 IEC_BT.C > IEC_BT.CHK`

UPMD5.EXE can conveniently be called up as "child process" from its IEC/IEEE-bus control program in order to evaluate the signature.
As an example, here are the lines of source code IEC_BT.C:

```
// Calculate MD5 checksum of host file. Pipe result to chkfile
sprintf (syststr,"UPMD5.EXE %s > %s",hostfile, chkfile);
// UPMD5.EXE child process prints checksum to chkfile
err = system (syststr); // Call MD5 data security child process
```

To fetch the signature of a file stored on the UPD via the IEC/IEEE bus, the command `"MMEMory:CHECk? 'filename'"`
is to be sent to the UPD.
The 32-digit signature of the requested file will be sent in return.
If `'filename'` is specified without giving the path, the file will be searched in the current working directory of the UPD. The current working directory of the UPD is the directory specified under `Work Dir` in the FILE Panel of the UPD.

The source code for the MD5 signature method is available on the Internet under `www.faqs.org/rfcs/rfc1321.html`

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3.16 Automatic Control of UPD with R&S BASIC

Important:

The software described below is an accessory for UPD and available under the designation UPD-K1. It is not part of the equipment supplied with UPD.

The program examples in the paths C:*UPD**K1*_EXAM\EXAM1.BAS ff of the *UPD* software can be directly run on the *UPD* with Universal Sequence Controller *UPD-K1*. Files with the extension .SAC are setup files required by the examples for setting the *UPD*. Files with the extension .TXT provide the program code of the examples as an ASCII file and can be accessed by any editor.

3.16.1 Use

Executing frequent test sequences in a fast and reproducible way, summing up the results and creating a valuable documentation, these are the applications of the UPD universal sequence controller using R&S BASIC. These automatic measurements, consisting of generator and analyzer functions of the UPD, are used for a full characterization of instruments and components in production or the test shop and for ensuring and monitoring the characteristics of system and transmission devices.

A universal sequence controller for automatic measurements does not only have to control the instrument functions, but must also be able to evaluate the measurement results and branch in the program. Besides, operator prompting with confirmations and indications is expected. Furthermore, synchronization with a time base or external events may be required. Thus, some programming is sometimes required, but it should be as simple as possible. Therefore, a complete BASIC interpreter with optimally integrated commands is used for operation of the measuring instrument. A simple keystroke permits to change between normal operation of the measuring instrument and BASIC. The command extensions for the instrument control feature the same structure as the IEC/IEEE-bus commands, which in turn comply with the international SCPI standard.

3.16.2 Scope of Functions

The UPD provides about 600 elements (ie functions in the programming language) and almost as many keywords as parameters. Therefore, users not wishing to do any programming, but also experts will appreciate the integrated program generator. Every input via front panel or keyboard for setting the UPD is recorded in logging mode and added to the program as a complete program line. Simple test sequences are thus completely programmed without having typed a single line. There is no need to check the correct syntax, the created program can be easily read due to the standard SCPI notation and is thus simple to modify and supplement.

R&S BASIC with easy-to-handle IEC/IEEE-bus commands that are optimally incorporated into the syntax can also control further IEC/IEEE-bus devices without the need for an external controller. (This requires the Remote Control option UPD-B4). Likewise, it is straightforward to operate the serial interface and write and read files for connection with peripheral devices or other programs.

For graphical output, BASIC can fully make use of the UPD software: Graphs with sophisticated scaling and labelling, bargraphs, bargraphs with trailing pointers, all of them also with automatic scaling depending on the measured value, are still available. In addition, the graphics commands belonging to BASIC can also be used.

If the UPD is to be controlled by an external controller in a test system, two REPLACE commands can be used to convert all UPD IN/OUT instructions into IEC/IEEE commands (IEC IN/OUT). This constitutes the basic program for controlling the UPD.

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3.16.3 Preparation for Use

If the Universal Sequence Controller UPD-K1 is ordered together with the UPD it is immediately ready for use. When retrofitted, it has to be enabled by means of an installation key. A key matching the serial number of the UPD is supplied to the user to activate the software.

Subsequently, a memory model for BASIC can be selected by calling UPDSET. The user has to indicate how much memory he wants to reserve for the BASIC program and BASIC data (variables). Since the UPD cannot simultaneously be remote-controlled via the IEC/IEEE bus and the Universal Sequence Controller UPD-K1, the user must choose between the two modes by means of UPDSET. The files CONFIG.SYS and UPD.BAT are thus changed.

UPDSET is called up at system level (prompt C:>), ie UPD must have been quit beforehand by means of the SYSTEM key. After entry of "UPDSET" and "↵" a menu is displayed in which the user can select one of three memory models. Alternatively, the sequence control can be removed from the memory to provide storage capacity (eg for additional drivers) by selection of "1". After selection of one of the memory models a new menu for selecting the "Power-up mode" is displayed. It can be selected whether UPD starts with the known user interface (1), or automatically executes the BASIC program "init.bas" (2). Menu item 2 is especially suitable for automatic applications (eg in production), to avoid operator errors of untrained personnel.

The selected operating mode is maintained even after instrument switch-off.

To estimate the required memory, the following empirical values are given: A typical BASIC line requires about 25 bytes. A 13k program memory is thus sufficient for about 500 lines or 10 pages of program. The remaining empty memory can be polled in BASIC with FRE(1). A variable in BASIC requires about 15 bytes (depending on the length of the name), and a field with floating-point numbers requires 8 bytes for each index. FRE(o) indicates the remaining storage area.

The memory should not be oversized, since the program may be limited in its speed from a certain size onwards (see also Section 3.16.4.11 UPD/BASIC Memory Management). If the preset values are not exceeded, the UPD operates at full speed.

In the case of first installation, the UPD must be booted anew; otherwise this is only necessary when the memory model is changed. UPDSET can also be called in order to poll about the currently active memory allocation.

3.16.4 Operation

In the following, a distinction is made between BASIC and the UPD program, the latter including all routines except BASIC (i.e. the test, readout, graphics output and input routines).

3.16.4.1 Switchover between UPD and BASIC Entry Mode

- **Switchover from UPD to BASIC entry mode**:
  Use function key **F3** on the **external keyboard** or **BACKSP** on the front panel. With BASIC in the entry mode, the fields for reading out measured values are displayed at the upper edge irrespective of whether full graphics display is selected in the UPD or not. The field below down to the softkeys is available to BASIC.
  Possible error messages after pressing the F3 key: When the message "BASIC not installed" is displayed, BASIC has not been installed at all or incorrectly. "Memory not available" indicates that a memory size exceeding the available space has been selected with UPDSET.
- **Entry in the BASIC mode:**
  All characters can be entered from the external keyboard as required. A limited control is also possible from the UPD front panel:
  Keys of the front-panel key blocks DATA/PANEL and EDIT as well as the CURSOR keys have the

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common functions.
Exceptions:
SELECT = blank
+/- = - (minus)
The keys of the CONTROL block as well as HELP, the tabulator and PgUp/Dn keys in the CURSOR/VARIATION block have no function.

Letters cannot be output with the front-panel keys but the entry of numerals opens up plenty of possibilities for controlling a BASIC program without the burden of an external keyboard.

While BASIC waits for a line entry (as after pressing of the "↵"-key), the UPD program continuous to run in the background and the measurement results are displayed. The effects of the settings made by BASIC can thus be observed immediately. However, after the first character has been entered, the UPD program is not called up any more. No measurements are performed and the printer spooler (HCOPY) does not run in the background until the entry is terminated with "↵".

Note:

When the UPD is controlled with BASIC, printing with HCOPY is considerably slowed down as the available computing time must be divided up. There will be more time for the printout if the measurement is stopped using the STOP key on the front panel.

- **Switching back from BASIC to UPD entry mode:**
  Key **F3** on the **external keyboard** or the keys **ENTER** and then **LOCAL** on the **front panel**.
  When switching back to UPD control the panels are completely restored to show the current settings as there may have been changes under BASIC. BASIC is inactive but the last-set status will be retained.

3.16.4.2 First Steps (Readout of Measurement Results)

Program example:
Triggering 10 measurement results and output on the screen.

- Press key F3 of the external keyboard from the UPD user interface. The result display field appears at the top of the screen, the softkey lines at the bottom. "R&S-BASIC version..." is displayed in the screen center.
- Enter the following program (including line numbers 10-90).

```
10 UPD OUT "*RST": ’                                UPD default setting
20 UPD OUT "INP:TYPE GEN2": ’Internal connection to generator channel 2
30 FOR I=1 TO 10
40  UPD OUT "INIT:CONT OFF;*WAI": ’       Triggers a single measurement
50  UPD OUT "SENS:DATA?":  Requests function test result from channel 1
60  UPD IN M$: ’                            Reads in measurement result
70 PRINT M$: ’                                Prints measurement result
80 NEXT
90 END
```

- Start the program with F6:

Due to the default setting made with *RST (see Appendix A UPD Default Setup), the UPD generator produces a 1-kHz sinewave signal with a level of 0.5 V.
Command INP:TYPE GEN2 internally links generator channel 2 and analyzer channel 1 so that cabling between inputs and outputs is not required for this first test. The UPD analyzer performs 10 RMS measurements and the results are displayed on the UPD screen.

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Note:

To display a measurement result on the screen it must first be triggered (line 40). After triggering a settled result is available which can be requested (line 50), read out (line 60) and displayed on the UPD screen (line 70).

- Return to manual operation: Press F3 on the external keyboard or ENTER and then LOCAL on the front panel.

3.16.4.3 Logging Mode

Function key F2 switches the logging mode on or off. The respective mode is indicated in the bottom righthand corner above the softkeys. In the case of "on", all entries used for setting the UPD are appended to the BASIC program as a command line. After switching to the BASIC mode, these new lines are displayed automatically and may be modified.

The BASIC commands for automatic control of the UPD differ only slightly from the commands for remote control via the IEC/IEEE bus. The program can easily be converted into the other commands using the BASIC command REPLACE (eg for controlling the UPD with an external controller). See also UPD-specific modifications of the BASIC manual, paragraph REPLACE. A detailed example is given in section 3.15.3 Command Logging - Converting K1-Commands into IEC/IEEE-Bus Commands.

3.16.4.4 Differences to IEC/IEEE-Bus Remote Control

The differences between the R&S BASIC commands of the universal sequence controller and the R&S BASIC commands of the IEC/IEEE-bus control are illustrated by way of examples:

Delimiters of character strings, Timeout

R&S BASIC command	R&S IEC/IEEE-bus command
A delimiter need not be specified for the transfer of a character string.	**10 IEC TERM 10** Controller expects LF as delimiter for an UPD response
Waits indefinitely for a response. However, in special cases the time can be monitored by querying bit d0 (OPC) of the Event Status Register in a loop until the bit assumes the value 1 which signals that a measurement result is available. The program example is given under "Other differences to IEC/IEEE-bus remote control" further down in this section.	**10 IEC TIME 5000** The controller does not wait longer than 5 s for a response from the UPD before an IEC/IEEE-bus timeout is signalled.

Output of commands

R&S BASIC command	R&S IEC/IEEE bus command
10 **UPD OUT** "SOUR:FREQ 1000Hz" (sets generator frequency) Transfers a character string (constant in quotes, variable denoted with $ or a character string expression) to the UPD program.	10 IEC OUT 20, " SOUR:FREQ 1000Hz "

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Reading in responses

R&S BASIC command	R&S IEC/IEEE-bus command
100 UPD OUT "SENS:DATA2?" 110 **UPD IN** A$ (transfers the measured value of channel 2 to the variable A$ for processing) Takes a character string from the UPD program. This may be a measured value or a queried setting. The information to be taken must first be defined in a query (command with question mark).	100 IEC OUT 20, "SENS:DATA2?" 110 IEC IN 20, A$

Output of block data

R&S BASIC command	R&S IEC/IEEE-bus command

`10 DIM A(20)`
`20 Frqval = 20`
`30 FOR I = 0 TO 19`
`40 A(I) = Frqval`
`50 Frqval = Frqval*1.44`
`60 NEXT I`
`70` **`UPD BLOCKOUT`** `A(0),20`
`80 UPD OUT "sour:list:freq"`
(transfer of 20 values for a frequency list sweep to the UPD)
 	
`UPD BLOCKOUT <array(i)>[,n]`
 	
Stores block data in a reserved communication range of the UPD so that they can be transferred subsequently from BASIC to the UPD with an UPD OUT "...." command. This applies, for instance, to the transfer of lists or values for graphic display. The index **i** indicates the value from which onwards the data field is to be transferred. **n** defines the number of values. If **n** is not specified, the quantity defined with DIM will be used.
	`10 DIM A(20)`
	`20 ' Combines block data to a string`
	`30 Bef$="SOUR:LIST:FREQ"`
	`40 Frqval=20`
	`50 FOR I=0 TO 19`
	`60 Bef$=Bef$+STR$(INT(Frqval))`
	`70 IF I<19 THEN Bef$=Bef$+","`
	`80 Frqval=Frqval*1.44`
	`90 NEXT I`
	`100 IEC OUT 20,Bef$`

Reading out block data

R&S BASIC command	R&S IEC/IEEE-bus command

`10 DIM A(200)`
`20 UPD OUT "TRAC? TRAC"`
`30` **`UPD BLOCKIN`** `A(0)`
`40 UPD OUT "TRAC:POIN? TRAC"`
`50 UPDIN A$:Count = VAL(A$)`
(loads a sweep list in the form of block data from the UPD into field A( ) of BASIC and loads the data into Count)
 	
UPD BLOCKIN <array(i)>
 	
loads block data (ie lists or a measurement sequence) from the
	`10 DIM A (200)`
	`20 IEC OUT 20,"TRAC:POIN? TRAC"`
	`30 IEC IN 20,Count$: Count=VAL(Count$)`
	`40 IEC OUT 20,"TRAC? TRAC"`
	`50 IEC TERM 44: ' Sets string term. to ',' (0x2C = 44d)`
	`60 FOR I=0 TO Count-2: ' Reads in n - 1 values`
	`70 IEC IN 20,A$: DIM(I) = VAL(A$)`
	`80 NEXT I`
	`90 'Reads last value`
	`100 IEC TERM 10: 'Resets string term. to LF`
	`110 IEC IN 20,A$: DIM(Count-1) = VAL(A$)`

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UPD program into a data field (index variable) for further processing. Same as with UPD IN the data to be read must first be defined in a query (`sour:list:freq?`). **i** denotes the index from which the first value of a block is stored. The list is always used in full length, ie a sufficiently large data field has first to be defined with DIM.	

Switchover to UPD user interface

R&S-BASIC-Befehl	R&S-IEC-Bus-Befehl zum Vergleich
UPD GTL (Go To Local) **UPD GTL U** (Go To Local, temporär mit UPD-Bildschirm) **UPD OUT "DISP:ACT ON | OFF"** **UPD GTL B (set BASIC screen)** **UPD GTL G (draw UPD Graphik)** The individual commands are explained on the next page.	`IEC LAD 20` `IEC GTL`

Continue
Switchover to UPD user interface

UPD GTL (Go To Local)

With this command BASIC is quit and the UPD screen is displayed. Control is also transferred to the UPD and entries can be made in the UPD panels. To return to BASIC the F3 key has to be pressed. This means that in the program mode this command has the same function as the F3 key (switchover from BASIC to UPD). If the operator now presses F3, control is switched back and BASIC continues with the command that follows UPD GTL in the program. When entered in the BASIC direct mode, this command has the same function as the F3 key.

Note:
After a BASIC program has been started with RUN, key F3 is disabled. It is enabled again only after END, STOP or abort (with Ctrl/Break)in the BASIC entry mode.

UPD GTL U (Go To Local, temporarily with UPD screen)

This command is required when the UPD display should be used under BASIC. Thus an ongoing sweep or FFT can be monitored (provided a measurement was started before, the display is continuously updated) or values computed in BASIC are to be displayed. (These values have to be transferred first from BASIC to UPD using the UPD BLOCKOUT command).
The panel displayed at the left of the graphics window can be used by BASIC for PRINT outputs. A line must not be longer than 26 characters, however, as otherwise the graphics window will be overwritten. After the UPD GTL U command, the screen scroll is stopped to avoid the graphic display being shifted and destroyed when the first or the last line is reached (in the case of uncontrolled PRINT outputs). Status lines 1 and 2 cannot be used either as this space is occupied by the UPD display.

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With this command the BASIC display is stored and the UPD screen displayed. Control is not transferred to the UPD, however, and entries cannot be made in the UPD panels. Immediately after display of the UPD screen, control is handed back to BASIC without the BASIC display being restored.

Use the GTL B command described below to restore the BASIC display. After an UPD GTL U command and before terminating the program with END, STOP or abort (with Ctrl/Break or in case of a fault) the operator should restore the BASIC display as otherwise no entries can be made, eg in the UPD full-screen mode. As an aid for the operator, the BASIC display is automatically restored when the BASIC entry mode is reached (entry of commands or program instructions) with the consequence that UPD GTL B is performed immediately when UPD GTL U command is entered in the direct mode and the entry has no effect.

UPD OUT "DISP:ACT ON | OFF"

This command is of interest in conjunction with GTL U. The OFF state prevents the graphics display being updated after every control command as this might be disturbing and slow down program execution. With ON the display is completely restored and then continually updated. The OFF and ON commands are to be used together as a pair as otherwise the UPD graphics display is not restored, not even when the UPD is manually controlled.

UPD GTL B (set BASIC screen)

This command is only needed with UPD GTL U. It restores the BASIC screen displayed before the UPD display set up with UPD GTL, UPD GTL U or with the F3 key (change from BASIC to UPD control).

UPD GTL G (draw UPD graphic)

This command is needed when the UPD graphics display is to be used under BASIC. The display is restored but not subsequently updated as is the case with UPD GTL U. Thus values computed in BASIC, for instance, can be displayed (the values have to be transferred first from BASIC to the UPD using the UPD BLOCKOUT command). The operator can make full use of the UPD graphics display with scales and labels.
The graphics display must be switched on of course (with command
UPD OUT "disp:conf ...." using parameters xP or P, or previously in manual control). Note: Upon loading a setup, the 3-panel display may be selected which has the effect of switching off the graphics display. In case of doubt check the setting by changing to the UPD mode.
When the result output has been activated (set to display) using UPDOUT "disp:ann on" also the measurement results in the display field at the screen top are updated.
Contrary to F3, UPD GTL or UPD GTL U, the BASIC screen is not stored and the UPD display set up, but the UPD graphics display is integrated in the BASIC screen. Like any other graphic drawn under BASIC, the display is shifted together with the text when the cursor reaches the top or bottom edge. The graphic may also be overwritten by text (in this case the background is blanked) irrespective of whether this is useful or not.
When the display is shifted, which can always be prevented by adequately positioning the cursor (see section 3.16.4.8 STRINX.SYS Driver for Screen and Keyboard), parts of the graphics display remain visible at the upper or lower edge of the scroll window as the scrolled parts are shifted in multiples of the text size, which do not correspond to the UPD graphic displayed.
Since the UPD graphic has become part of the BASIC screen it is always restored when the UPD display is switched over to BASIC with the F3 key. It is cleared together with the BASIC text screen using the sequence PRINT "Esc[2J". CLEAR also clears the screen or parts thereof (see section 3.16.4.5 UPD-specific Modifications to the BASIC Manual under CLEAR).

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Further differences to IEC/IEEE-bus remote control:

- An SRQ procedure cannot be programmed in R&S BASIC of the Universal Sequence Controller UPD-K1, ie the control program cannot perform other tasks while waiting for measurement results or error messages from the UPD. Error queue or the status registers must be queried cyclically in the control program.
- Since the UPD does not generate an SRQ for the Universal Sequence Controller UPD-K1, there is no need to determine the sender or source of the SRQ by means of a serial or parallel poll. This should not be mixed up with the possibility of using the UPD as an IEC/IEEE-bus controller and to control other instruments on the IEC/IEEE bus from the Universal Sequence Controller UPD-K1 (described in the manual R&S BASIC Interpreter supplied with the UPD-K1 option).
- Line messages like REN, GET, DCL, etc are not possible.
- The line message EOI denoting the end of a binary block cannot be used.
  Binary block data cannot be received. The command " FORMat REAL" is ineffective.
  Block data can only be received with command UPD BLOCKIN described above.
- In R&S BASIC of the Universal Sequence Controller UPD-K1 all common commands referring to SRQ control are not relevant. Respective information can be obtained from the table under 3.9 Common Commands.
  An exception is the *OPC command. Although mainly intended to trigger an SRQ when a measurement result is relevant, under R&S BASIC this command may be used to wait for a measurement result in a loop by querying the bit d0 of the Event Status Register:

  Example:
```
110 UPD OUT "*OPC;*TRG": ’ Triggers measurement result
120 Brk=0: I=0
130 WHILE (Brk=0) AND (I<=100)
140  UPD OUT "*ESR?"
150  I=I+1: UPD IN Esr$: IF (VAL(Esr$) AND 1)<>0 THEN Brk=1: ’ Queries OPC
160 WEND
170 IF I>100 THEN PRINT "Timeout": STOP
180 UPD OUT "SENS:DATA?": ’ Requests measured value
190 UPD IN M$: PRINT M$: ’ Reads and output measured value
```

- Common commands (3.13.1) and addressed commands (3.13.2) are not available for the Universal Sequence Controller UPD-K1.

- All registers and commands of the status reporting system which are not related to SRQ generation can be used:

*STB?	not usable
*SRE	not usable
*PRE	not usable
*IST?	not usable
***ESR?**	**usable**
*ESE	not usable
STATus:**OPER**ation**?**	**usable**
STATus:**QUES**tionable**?**	**usable**
STATus:**XQUE**stionable**?**	**usable**
SYSTem:**ERR**or**?**	**usable**

- ***Note:***

  *If UPD with Universal Sequence Controller UPD-K1 is used as a controller for **other IEC/IEEE-bus devices** (described in the R&S BASIC Interpreter manual supplied with the UPD-K1 option), and should **again** be controlled by another controller as a talker/listener **on the IEC/IEEE bus**, IEC/IEEE-bus control must be released by the Universal Sequence Controller UPD-K1 with command IECRLC (IEC ReLease Control) .*

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3.16.4.5 UPD-Specific Modifications to the BASIC Manual

There are only a few modifications to the supplied standard BASIC manual which result from different conditions. In the part of the manual dealing with process controllers, the BASIC manual of the PSA and PAT controller versions is valid.

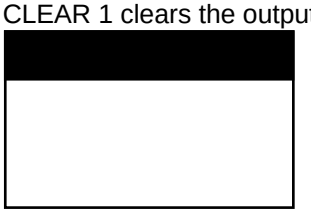
Softkey labelling and function keys
As against the standard BASIC manual, the function keys are shifted by 4 keys as F1 to F4 are assigned different functions in the UPD. The softkey labelling has been adapted accordingly for the UPD. Switchover between alphanumeric and graphics mode (F8) is not provided in the UPD.

BYE
is a synonym for EXIT; description see under EXIT.

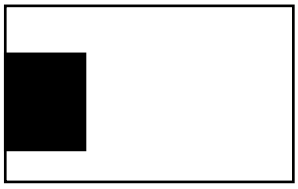
CLEAR [1 | 2 | 3]
This command clears the screen or parts of it. The size of the parts corresponds to the UPD panels or fields. The commands always clear the indicated parts irrespective of whether they are assigned UPD fields or not.

Without parameter specified, the upper part of the screen is cleared, however without the output field for measured values.

CLEAR 1 clears the output field for measured values



CLEAR 2 clears the field at the left of the graphic display.



CLEAR 3 clears the UPD graphics.

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COLOR
should not be modified to avoid changing of the UPD graphics output. The colours are assigned as follows:

Pen	UPD colour mode	UPD b/w mode
0	white	white (background)
1	dark grey	white
2	white	black
3	red	black
4	grey	grey
5	yellow	light grey
6	dark grey	dark grey
7	yellow	dark grey
8	green	grey
9	green	black
10	blue	black
11	green	black
12	yellow	grey
13	cyan	dark grey
14	black	black
15	black	black (preselected colour)

COPYOUT
is not supported. See GSAVE "LPT1".

END
Returns to the BASIC user interface at the end of a K2 BASIC program outputting READY instead of QEND (see QEND).

EXIT (Synonym for BYE)
leaves the BASIC mode and returns to the UPD input mode and not to MS-DOS.

GRAPHIC
The interface name for putting out graphics on the screen is no longer GRAPH but GRAPX with the UPD.

GSAVE on LPT
is not supported. Instead, the HCOP:DEST <> remote-control command should be used for a printout of the display.

HELP
is not supported as a command.

HOLD
Note:

During the wait time the routines are not continued. Therefore, with long times, the wait time should better be implemented with a loop using TIME.

QEND
(Quiet end) returns to the BASIC user interface at the end of a K2 BASIC program without outputting READY.

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REPLACE
To allow also the comma to be contained in the REPLACE command as part of the string (and not as separator between the new and the old string), it has to be preceded by a backslash (\,).

Example 1:
old program: `100 UPD OUT A$`
`REPLACE UPD OUT, IEC OUT 20,`
new program: `100 IEC OUT 20,A$`

Example 2:
old program: `100 IEC IN 20, A$`
`REPLACE IEC IN 20\,, UPD IN`
new program: `100 UPD IN A$`

SCREEN
is not supported; SCREEN 18 (VGA mode with 16 colours/grey shades) is always set.

SET
The colour of the pen is selected from the colours described above under COLOR.

SHELL
is only supported with restrictions, since the remaining memory of approx. 60 Kbytes is too small; the MS-DOS command interpreter together with the program called must not exceed this memory size. However, this is the case with the internal and a few external MS-DOS commands (dir, del, md, cd etc, see MS-DOS manual).

VIEWPORT
The upper limit for y2 should be 294 so that the upper field remains vacant for readout of the measured values. In principal, there are no restrictions to the BASIC graphics commands, it is up to the user whether the area used by the UPD graphics is overwritten.

WINDOW
The preselected values are 0,639,0,**293.**

ZOOM
is not supported

3.16.4.6 BASIC Screen

The screen contains 30 text lines, 5 at the lower edge being reserved for softkeys and two lines for status indication. One status line is used by BASIC, the other is available to the user (see labels of status lines and softkeys).

Two modes are provided for the upper 25 lines: either BASIC uses all lines or the UPD builds up a field for the output of measured values at the top edge, where the measurement results are continuously updated. This field comprises 7 text lines and reduces the BASIC text window to 18 lines. The second mode is activated using UPD OUT "disp:ann on".

Inside the 25/18-line window, the text is scrolled when the cursor reaches the top or bottom edge. If this window contains a graphic, the latter is shifted as well. This also applies to graphics drawn by the UPD software. However, since the graphics are slightly larger than the text window, which is variable in steps of 16 pixels only (text size), they seem to be somewhat "torn". By positioning the text appropriately, the user must ensure not to write outside the text window (which causes a shift).

The command PRINT "Esc (2)" clears the 18- or 25-line window depending on the mode. The CLEAR command (without parameter) only clears the 18-line window (without the area reserved for the output of measured values). The BASIC extensions CLEAR 1 | 2 | 3 clear the panel fields or the output field for measured values irrespective of whether they contain UPD panels or not (see section 3.16.4.5 UPD-specific Modifications to the BASIC Manual).

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If text is entered for BASIC, BASIC does not get the keyboard entries but reads out the screen contents. If graphics are superimposed on this text, it is possible that the character is not identified and BASIC responds with an error message. Even the space between the last character and the right-hand screen edge is significant if it can be interpreted as a blank or character. Therefore, the user should write at a "clean" position, or go to a position by scrolling the text before writing.

3.16.4.7 Control Commands Unsuitable for Logging

The control commands are described in detail in the UPD manual, classified according to their function and then in alphabetical order. Furthermore, almost all commands can be logged in manual operation, the commands being created in the correct notation and added to the program.

Commands for reading out measured values and control commands via the front-panel keys in the CONTROL block cannot be logged. They are briefly summed up in the following.

CONTROL key commands:

START	UPD OUT "init:cont on"
	UPD OUT "init"
SNGL	UPD OUT "init:cont off"
STOP	UPD OUT "abort"
HCOPY	UPD OUT "hcop"
LCD ON/OFF	UPD OUT "disp:enab on" adv. off
OUTPUT ON/OFF	-----
LOCAL	UPD GTL

Commands for reading out single measurement results:

Function CH1:	UPD OUT "sens:data?":UPD IN A¤
Function CH2:	UPD OUT "sens:data2?":UPD IN A¤
Input PEAK CH1:	UPD OUT "sens2:data?":UPD IN A¤
Input PEAK CH2:	UPD OUT "sens2:data2?":UPD IN A¤
Freq CH1:	UPD OUT "sens3:data?":UPD IN A¤
Freq CH2:	UPD OUT "sens3:data2?":UPD IN A¤
Phase:	UPD OUT "sens4:data?":UPD IN A¤
Group Delay	UPD OUT "sens4:data?":UPD IN A$

Commands for reading out block data:

Trace A:	UPD OUT "trac? trac1":UPD BLOCKIN A(0)
Trace B:	UPD OUT "trac? trac2":UPD BLOCKIN B(0)
X values:	UPD OUT "trac? list1":UPD BLOCKIN X(0)
Z values:	UPD OUT "trac? list2":UPD BLOCKIN Z(0)

Command for synchronization:

UPD OUT "*WAI"

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3.16.4.8 Driver for Screen and Keyboard STRINX.SYS

An internationally standardized software interface based on the ANSI standard X 3.41-1774 is provided for addressing the screen. This standard defines all functions required to operate a terminal. The most important functions of this standard as well as certain functions mainly required for operating the BASIC editor are implemented in the STRINX device driver.

This driver is loaded when booting the operating system, if
`DEVICE = C:\UPD\DRIVER\STRINX.SYS`
is contained in the configuration file CONFIG.SYS.

The following function groups are supported:

- Cursor control
- Labelling of status lines and softkeys
- Clearing screen areas
- Editing screen
- Setting the video attributes.

If the appropriate ANSI sequence can be assigned parameters P1; P2 ...; Pn, they must be entered as decimal numbers with one or two digits. The individual parameters are separated by semicolons.

The STRINX.SYS driver is to be used exclusively for programming in R&S BASIC. With this driver, the UPD is largely compatible with the PSA. ANSI.SYS has to be loaded for programs using the control sequences of the ANSI standard.

Cursor Control
The cursor can be set to absolute or relative positions. The output of new characters is continued starting at the set position.

Table 3.19 Cursor Control (UPD-*K1*)

Cursor function	Sequence	Example in BASIC
Free positioning (one parameter may be omitted)	ESC[P_1; P_2H *)	?"E_c[05;32H"; Column Row
Shift cursor by P_n positions ↑ Shift cursor by P_n positions ↓ Shift cursor by P_n positions → Shift cursor by P_n positions ← (P_n with one digit only)	ESC[P_n A ESC[P_n B ESC[P_n C ESC[P_n D	?"E_c[5A"; ?"E_c[3B"; ?"E_c[3C"; ?"E_c[5D";
Shift cursor by one position ↑ ↓ with scrolling	ESC[: A ESC[: B	?"E_c[:A"; ?"E_c[:B";
Store cursor position / recall cursor position	ESC[s ESC[u	?"E_c[s"; ?"E_c[u";
Switch off cursor Switch on cursor	ESC[h ESC[l	?"E_c[h"; ?"E_c[l";

*) ESC means the key "Esc" or the keyboard code 1BH or 27 decimal

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Labelling of Status Lines and Softkeys

Table 3.20 Labelling of Status Lines and Softkeys (UPD-*K1*)

Function	Sequence	Example in BASIC
Label status lines	ESCQP$_n$TEXT	?"E$_c$Q3TEXT"
Label softkeys	ESCRP$_n$TEXT	?"E$_c$R4TEXT"

Note:

The sequences must be terminated by LF (ASCII code 10).

Softkeys 1 to 4 cannot be labelled as they have been assigned important basic functions that must be available in all program states.

Status and softkey lines are labelled as follows:

Table 3.21 Labelling of Softkeys (UPD-*K1*)

Screen lines	VGA graphics mode *)
First	25 Q1 26 Q2, Q 27 Q3 28 Q4, softk.
Last	29 Q5

*) Compatible with PSA mode

If one of the softkeys is labelled, the PSA compatibility mode is switched on (return with sequence "ESC[1j"). The keyboard codes are converted to the corresponding values of the PSA according to the following table:

Table 3.22 Labelling of Softkeys, Conversion table (UPD-K1)

PSA code	PC comp. scan code	Keyboard labels	
		German keyboard	American keyboard
0E0H	3B	F1	F1
0E1H	3C	F2	F2
0E2H	3D	F3	F3
0E3H	3E	F4	F5
0E4H	3F	F5	F4
0E5H	40	F6	F6
0E6H	41	F7	F7
0E7H	42	F8	F8
0E8H	43	F9	F9
0E9H	44	F10	F10
0EAH	45	F11	F11
0EBH	46	F12	F12
0B7H	47	Pos 1 7	Home
0B8H	48	↑ 8	↑
0B9H	49	Bild ↑ 9	Pg Up
0B4H	4B	← 4	←
0B6H	4D	→ 6	→
0B1H	4F	Ende 1	End
0B2H	50	↓ 2	↓
0B3H	51	Bild ↓ 3	Pg Dn
0B0H	52	Einfg 0	Ins
0AEH	53	Entf .	Del

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Editing the screen

Table 3.23 Editing the screen (UPD-K1)

Action	Sequence	Example
Insert blank lines	ESC[P_nL	?"E_c[5L"
Delete lines	ESC[P_nM	?"E_c[3M"

Clearing Screen Area

Table 3.24 Clearing Screen Area (UPD-K1)

Cursor function	Sequence	Example in R&S BASIC
Clear screen, Cursor ↖	ESC[2J	?"E_c[2J"
Clear complete video RAM, Cursor ↖	ESC[3J	?"E_c[3J"
Clear from cursor to end of screen	ESC[J	?"E_c[J"
Clear from cursor to end of line	ESC[K	?"E_c[K"
Clear status and softkey lines **Note:** The sequence must be terminated by LF.	ESC[y	?"E_c[y"

Setting the colours

Colours may be assigned to each character output on the screen. The colours are also set via the ANSI interface.

Table 3.25 Setting the colours (UPD-K1)

Colour	b/w	Sequence	Example in R&S BASIC
light grey	light grey	ESC[91m	?"E_c[91m"
light grey	light grey	ESC[92m	?"E_c[92m"
yellow	white	ESC[93m	?"E_c[93m"
----	----	ESC[94m	?"E_c[94m"
blue	black	ESC[95m	?"E_c[95m"
dark grey	dark grey	ESC[96m	?"E_c[96m"
black	black	ESC[97m	?"E_c[97m"
black	black	ESC[98m	?"E_c[98m"

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3.16.4.9 Operation of Serial Interfaces COM1 and COM2

The transmission rate, parity bit, number of data and stop bits as well as the error handling mode of the serial interfaces can be configured using the MS-DOS MODE program, which is described in section **2.17 Connecting External Devices** or in the DOS manual (DOS commands). Configuration is made either automatically on calling the AUTOEXEC.BAT program, in the operating system by means of an entry via the keyboard, or in BASIC using the SHELL command. Example:

```
10 SHELL "mode com2: baud=24 parity=e data=7 stop=1 retry=n >NUL"
```

The last instruction for rerouting to the NUL device ensures that MODE does not output the response on the screen, but suppresses it.

The serial interface designated COM1 or COM2 is prepared for the output using the PRINT# command. As with every PRINT command, CR and LF are added to the string to be output if the line is not terminated by a comma or semicolon. Example:

```
10 OPENO #1,"com1:"
20 PRINT #1,A$
```

If the acknowledge lines DSR and CTS are not active, the operating system outputs the error message "ERROR 74 IN LINE xx: DOS: write fault".

The interfaces are prepared for reception using the OPEN command. With the subsequent INPUT# command, characters are read in until a CR is received. If the sending device continues to transmit characters, these characters must immediately be read in using the next INPUT# command, otherwise they are lost and an error is signalled. Timing becomes more critical the higher the transmission rates. If no characters are received (timeout), a zero is stored every 100 ms.

Example:

```
10 OPENI #1,"com1:"
20 INPUT #1,A$
```

The entry described above is for line-oriented text as characters are accepted until reception of CR. However, if the number of characters is known, the INPUT$() function ensures that any character and almost any number of characters can be received.

Example:

```
10 OPENI #1, "com2:"
20 A$=INPUT$( 100, #1)
```

Precisely 100 characters are read in. If less characters are received, the device waits 100 ms (specified timeout) for every expected character (and enters zero).

To wait for the start of the transmission, a character can be entered in a loop until the character is no longer zero.

Example:

```
20 REPEAT
30 A$=INPUT( 1, #1)
40 UNTIL ASC( A$) > 0
40 INPUT #1,B$
50 B$=A$+B$
```

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3.16.4.10 UPD-Specific Error Messages From BASIC

ERROR 83: 'Instrument command allowed in this context'

The command is not allowed in this instrument state and depends on other settings. ('Execution error' with IEC/IEEE-bus control)

ERROR 84: 'Instrument param not within valid range'

The value of the command parameter is illegal.

ERROR 85: 'Instrument unit not allowed in this context'

The indicated unit is not allowed (in this state).

ERROR 87: 'Instrument option not installed'

The option required for this command is not fitted.

ERROR 88: 'Instrument ??? user error'

A user-correctable error has occurred during command execution (eg file not found).

ERROR 89: 'Instrument ??? system error'

An error has occurred in the MS-DOS or UPD software during command execution.

ERROR 90: 'Instrument invalid header string'

The actual command was not recognized (possibly because of a notation error).

ERROR 91: 'Instrument invalid parameter string'

The parameter of the command (string) is invalid.

ERROR 92: 'Instrument invalid unit string'

The unit of the command (string) is invalid.

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3.16.4.11 UPD/BASIC Memory Management

The user need not be familiar with all the details, as the user automatically receives the CONFIG.SYS to be used and associated batch files with the program UPDSET described in section 3.16.3.

Since the memory available to MS-DOS programs is limited, the overlay technique is used in the UPD program. Furthermore, BASIC requires memory for the user program and its data (variables). These memory areas are assigned the parameters

-bp<n> for the program memory and
-bd<n> for the data memory.

Example:

```
upd_ui -bp16 -bd8
```

reserves 16k main memory for the program and 8k for the data, BASIC itself needing about 3k for its own management.

The minimum values are about 8k program and 4k data. BASIC can manage a maximum of 64k. However, with a size of about 2 times 32 k, the overlay memory for the UPD program decreases, reducing the program speed. More details cannot be given, since the available total memory, which may be occupied by resident programs and device drivers, may be very different.

The memory management of the UPD program is to be briefly explained in the following so that an experienced user can optimize his own configuration. The program and data memory used for BASIC is first reserved in the UMB area. If this is not possible (because the line DOS=HIGH,UMB is missing in the CONFIG.SYS, or too may other programs have been loaded into this area by LOADHIGH or DEVICEHIGH), the space in the conventional memory (below 640k) is used. If the remaining memory for the UPD program thus becomes too small, no memory is reserved for BASIC at all. The attempt to switch to BASIC then produces the error message "not enough memory for BASIC".

In memory models 64k plus 32k (or 32k plus 64k) also the device drivers are loaded into the UMB area. With 64k plus 64k the upper memory is completely full and the device drivers have to be stored in the conventional memory.

If space is to be used in the conventional memory, the size of the overlay memory is reduced. The UPD program may be restricted in its speed from a certain size onwards, which also depends on the memory required by other resident programs.

When executing BASIC, other instruments can also be controlled via the IEC/IEEE-bus interface. In this case, the UPD is the system controller via BASIC, i.e. it can no longer be remote-controlled by an external controller. The parser program UPD_IEC.EXE is no longer needed and must not be loaded any more when starting the UPD. Instead, BASIC requires the following device drivers:

STRINX.SYS	as BASIC editor
IECX.SYS	as IEC/IEEE-bus controller
GRAPHX.SYS	for the BASIC commands for graphics output
BEEPX.SYS	for audio outputs.

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A UPD Default Setup

The default setup of the UPD is triggered by means of the settings below:

Manual setting in the FILE panel:	IEC/IEEE bus:
LOAD INSTRUMENT STATE Mode DEF SETUP	*RST

A precondition for the validity of this basic settings is that the parameter link is switched off (see 2.15.8 Transfer of Parameters)

A.1 Generator Default Settings

INSTRUMENT ANALOG

```
. Channel(s) 2 = 1
```

With setting GEN. → ANLG 25 kHz (default setting) or ANLG 110 kHz the following applies:

```
. Output      UNBAL BNC
. Impedance   15 Ω
. Common      FLOAT
. Volt Range  AUTO
. Max Volt    12.000 V
. Ref Freq    1000.0 Hz
. Ref Volt    1.0000 V
```

With setting GENERATOR → DIG 48 kHz in Src Mode AUDIO DATA the following applies:

```
. Src Mode    AUDIO DATA
. Channel(s)  2 = 1
. Output      SERIAL
. Sync To     GEN CLK
. Sample Frq  48 kHz
. Oversamp    1
. Wordlength  24              With SERIAL | SERIAL MUX output only
. Wordoffset  0               With SERIAL | SERIAL MUX output only
. Audio Bits  20
. WordselCH1  HIGH            With SERIAL MUX | PARAL MUX output only
. Wordclock   RISING          With SERIAL output only
. Bitclock    RISING          With SERIAL | SERIAL MUX output only
. Frq Bitclk  1152.0 kHz      With SERIAL | SERIAL MUX output only
. Bitorder    MSB FIRST       With SERIAL | SERIAL MUX output only
. Max Volt    1.0000 FS
. Ref Freq    1000.0 Hz
. Ref Volt    1.0000 FS
```

With setting AES/EBU | S/P DIF | OPTICAL the following applies:

```
. S/PDIF Out  AUDIO OUT
. Cable Sim   OFF
. Sync To     GEN CLK
. Sample Frq  48 kHz
. Sync Out    GEN CLK
. Type        WORD CLK
. Ref Out     REF GEN
. Data        ALL ZERO
. Audio Bits  20
. S/PDIF Vpp  1.0000 V        With S/P DIF output only
```

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. AESEBU Vpp	1.0000 V	With AES/EBU output only
. Max Volt	1.0000 FS	
. Ref Freq	1000.0 Hz	
. Ref Volt	1.0000 FS	

PROTOCOL	ENHANCED
· Valid Chan	NONE
· Parity	TRUE
· Block Err	0
· Sequ. Err	0
· Ch Stat. L	ZERO
· Ch Stat. R	ZERO
· User Mode	ZERO

With setting Parity WITH ERR the following applies:

· No Trues	100
· No False	0
· Offset	0

With setting GENERATOR → DIG 48 kHz in Src Mode JITTER | PHASE | COMMON ONLY the following applies:

. PhaseToRef	0.0000 %FRM	With Src Mode PHASE only
. Channel(s)	2 = 1	With Src Mode JITTER ONLY | PHASE only
. S/PDIF Out	AUDIO OUT	
. Cable Sim	OFF	
. Sync To	GEN CLK	
. Sample Frq	48 kHz	
. Sync Out	GEN CLK	
. Type	WORD CLK	
. Ref Out	REF GEN	
. Data	ALL ZERO	
. S/PDIF Vpp	1.0000 V	
. AESEBU Vpp	1.0000 V	
. Ref Freq	1000.0 Hz	
. Ref Volt	1.0000 UI	UI in Src Mode JITTER ONLY | PHASE, V in Src Mode COMMON ONLY

With setting GENERATOR → DIG 192 kHz or DIG 768 kHz the following applies:

. Channel(s)	2 = 1	
. Output	SERIAL	
. Sync To	GEN CLK	
. Sample Frq	48 kHz	
. Oversamp	4	Oversamp 8 for DIG 768 kHz
. Wordlength	24	With SERIAL | SERIAL MUX output only
. Wordoffset	0	With SERIAL | SERIAL MUX output only
. WordselCH1	HIGH	With SERIAL MUX | PARAL MUX output only
. Audio Bits	20	
. Wordclock	RISING	With SERIAL output only
. Bitclock	RISING	With SERIAL | SERIAL MUX output only
. Frq Bitclk	4608.0 kHz	With output SERIAL |SERIAL MUX, 9216.0 kHz for DIG 768 kHz only
. Bitorder	MSB FIRST	With SERIAL | SERIAL MUX output only
. Max Volt	1.0000 FS	
. Ref Freq	1000.0 Hz	
. Ref Volt	1.0000 FS	

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Funktions of all Generators

FUNCTION	**SINE**	
. Frq Offset	OFF	
. Low Dist	ON	Generator ANLG 25 kHz, ANLG 110 kHz. With low-distortion generator option not installed: OFF
. DC Offset	OFF	With ON: 0.0000 FS or 0.0000 V
. Dither	OFF	With generators DIG 48KHz, DIG 192 kHz, DIG 768 kHz
With setting Dither ON the following applies:		
	0.0001 FS	With generators DIG 48KHz, DIG 192 kHz, DIG 768 kHz
. PDF	GAUSS	With generators DIG 48KHz, DIG 192 kHz, DIG 768 kHz
. Equalizer	OFF	
. Equal.File	R&S_EXAM.VEQ	If equalizer ON
. SWEEP CTRL	OFF	
. FREQUENCY	1000.0 Hz	
. Setting	FAST	With generators ANLG 25kHz and ANLG 110 kHz
. VOLTAGE	0.5000 V[FS]	
With setting SWEEP CTRL → AUTO SWEEP or MANU SWEEP the following applies:		
. Next Step	ANLR SYNC	With AUTO SWEEP only
. X Axis	FREQ	
. Z Axis	OFF	
FREQUENCY		With X or Z axis → FREQ selected
. Spacing	LOG POINTS	
. Start	20000 Hz	
. Stop	20.000 Hz	
. Points	30	
. Setting	FAST	
VOLTAGE		With X or Z axis → VOLT selected
. Spacing	LIN POINTS	
. Start	0.0100 V[FS]	
. Stop	0.5000 V[FS]	
. Points	30	
With setting SWEEP CTRL → AUTO LIST or MANU LIST the following applies:		
. Next Step	ANLR SYNC	With AUTO LIST only
. X Axis	FREQ	
. Z Axis	OFF	
. FREQ.FILE	R&S_EXAM.SPF	With X or Z axis → FREQ selected
. Setting	FAST	
. VOLT.FILE	R&S_EXAM.SPV	With X or Z axis → VOLT selected
FUNCTION	**MULTISINE**	
. DC Offset	OFF	With ON: 0.0000 FS or 0.0000 V
. Spacing	USER DEF	
	10.000 Hz	
. Mode	DEFINE VOLT	
. Equalizer	OFF	
. Equal.File	R&S_EXAM.VEQ	If equalizer ON
. Crest Fact	OPTIMIZED	
. No of Sin	2	
. Multisine	CHOICE	Opens multisine box

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With setting No of Sin → 17 *and* Crest Fact → OPTIMIZED *the following applies:*

Multisine

	Frequency	Voltage
1	1000.0 Hz	0.5000 V [FS]
2	40.000 Hz	0.5000 V
3	60.000 Hz	0.0000 V
4	120.00 Hz	0.0000 V
5	250.00 Hz	0.0000 V
6	310.00 Hz	0.0000 V
7	500.00 Hz	0.0000 V
8	1000.0 Hz	0.0000 V
9	2000.0 Hz	0.0000 V
10	4000.0 Hz	0.0000 V
11	6290.0 Hz	0.0000 V
12	8000.0 Hz	0.0000 V
13	10000 Hz	0.0000 V
14	12500 Hz	0.0000 V
15	14000 Hz	0.0000 V
16	16000 Hz	0.0000 V
17	18000 Hz	0.0000 V

Close

With setting No of Sin → 17, *and* Crest Fact → DEFINE PHAS *the following applies:*

Multisine

	Frequency	Phase	Voltage
1	1000.0 Hz	0.0000 °	0.5000 V [FS]
2	40.000 Hz	0.0000 °	0.5000 V
3	60.000 Hz	0.0000 °	0.0000 V
4	120.00 Hz	0.0000 °	0.0000 V
5	250.00 Hz	0.0000 °	0.0000 V
6	310.00 Hz	0.0000 °	0.0000 V
7	500.00 Hz	0.0000 °	0.0000 V
8	1000.0 Hz	0.0000 °	0.0000 V
9	2000.0 Hz	0.0000 °	0.0000 V
10	4000.0 Hz	0.0000 °	0.0000 V
11	6290.0 Hz	0.0000 °	0.0000 V
12	8000.0 Hz	0.0000 °	0.0000 V
13	10000 Hz	0.0000 °	0.0000 V
14	12500 Hz	0.0000 °	0.0000 V
15	14000 Hz	0.0000 °	0.0000 V
16	16000 Hz	0.0000 °	0.0000 V
17	18000 Hz	0.0000 °	0.0000 V

Close

. TOTAL GAIN 0.0000 dB
. TOTAL PEAK 1.0000 V
. TOTAL RMS 1.0000 V

FUNCTION **SINE BURST**
. DC Offset OFF — With ON: 0.0000 FS or 0.0000 V
. SWEEP CTRL OFF
. FREQUENCY 1000.0 Hz
. VOLTAGE 0.5000 V [FS]
. Low Level 0.0000 V [FS]
. ON TIME 0.0100 s
. INTERVAL 1.0000 s
. BurstOnDel 0.0000 s

With setting SWEEP CTRL → AUTO SWEEP or MANU SWEEP the following applies:
. Next Step ANLR SYNC — With AUTO SWEEP only
. X Axis VOLT
. Z Axis OFF

VOLTAGE
. Spacing LIN POINTS
. Start 0.0100 V[FS]
. Stop 0.5000 V[FS]
. Points 30

With X or Z axis → VOLT selected

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FREQUENCY		
. Spacing	LIN POINT	
. Start	20000. Hz	With X or Z axis → FREQ selected
. Stop	20.000 Hz	
. Points	30	
INTERVAL		
. Spacing	LIN POINTS	
. Start	1.0000 s	With X or Z axis → INTERVAL selected
. Stop	0.0200 s	
. Points	30	
ON TIME		
. Spacing	LIN POINTS	
. Start	0.0010 s	With X or Z axis → ON TIME selected
. Stop	0.2000 s	
. Points	30	

With setting SWEEP CTRL → AUTO LIST or MANU LIST the following applies:

. Next Step	ANLR SYNC	With AUTO LIST only
. X Axis	VOLT	
. Z Axis	OFF	
. FREQ FILE	R&S_EXAM.SPF	With X or Z axis FREQ selected
. VOLT FILE	R&S_EXAM.SPV	With X or Z axis VOLT selected
. ONTIM FILE	R&S_EXAM.SPO	With X or Z axis ON TIME selected
. INTV FILE	R&S_EXAM.SPI	With X or Z axis INTERVAL selected

FUNCTION	**SINE^2 BURST**	
· DC Offset	OFF	With ON: 0.0000 FS or 0.0000 V
. SWEEP CTRL	OFF	
. FREQUENCY	1000.0 Hz	
. VOLTAGE	0.5000 V [FS]	
. ON TIME	0.0100 s	
. INTERVAL	1.0000 s	
. BurstOnDel	0.0000 s	

With setting SWEEP CTRL → AUTO SWEEP or MANU SWEEP the following applies:

. Next Step	ANLR SYNC	With AUTO SWEEP only
. X Axis	VOLT	
. Z Axis	OFF	
VOLTAGE		
. Spacing	LIN POINTS	
. Start	0.0100 V[FS]	With X or Z axis → VOLT selected
. Stop	0.5000 V[FS]	
. Points	30	
FREQUENCY		
. Spacing	LIN POINTS	
. Start	20000. Hz	With X or Z axis → FREQ selected
. Stop	20.000 Hz	
. Points	2	
INTERVAL		
. Spacing	LIN POINTS	
. Start	1.0000 s	With X or Z axis → INTERVAL selected
. Stop	0.0200 s	
. Points	2	
ON TIME		
. Spacing	LIN POINTS	
. Start	0.0010 s	With X or Z axis → ON TIME selected
. Stop	0.2000 s	
. Points	30	

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With setting SWEEP CTRL → AUTO LIST or MANU LIST the following applies:

. Next Step	ANLR SYNC	With AUTO LIST only
. X Axis	VOLT	
. Z Axis	OFF	
. FREQ FILE	R&S_EXAM.SPF	With X or Z axis → FREQ selected
. VOLT FILE	R&S_EXAM.SPV	With X or Z axis → VOLT selected
. ONTIM FILE	R&S_EXAM.SPO	With X or Z axis → ON TIME selected
. INTV FILE	R&S_EXAM.SPI	With X or Z axis → INTERVAL selected

FUNCTION	**SQUARE**	
. DC Offset	OFF	With ON: 0.0000 FS or 0.0000 V
. SWEEP CTRL	OFF	
. FREQUENCY	10000 Hz	
. VOLTAGE	0.5000 V	

With setting SWEEP CTRL → AUTO SWEEP or MANU SWEEP the following applies:

. Next Step	ANLR SYNC	With AUTO SWEEP only
. X Axis	FREQ	
. Z Axis	OFF	
FREQUENCY		With X or Z axis → FREQ selected
. Spacing	LIN POINTS	
. Start	10000. Hz	
. Stop	20.000 Hz	
. Points	30	
VOLTAGE		With X or Z axis → VOLT selected
. Spacing	LIN POINTS	
. Start	0.0100 V[FS]	
. Stop	0.5000 V[FS]	
. Points	30	

With setting SWEEP CTRL → AUTO LIST or MANU LIST the following applies:

. Next Step	ANLR SYNC	With AUTO LIST only
. X Axis	FREQ	
. Z Axis	OFF	
. FREQ FILE	R&S_EXAM.SPF	With X or Z axis → FREQ selected
. VOLT FILE	R&S_EXAM.SPV	With X or Z axis → VOLT selected

FUNCTION	**MOD DIST**	
. Frq Offset	OFF	
. Low Dist	ON	
. DC Offset	OFF	With ON: 0.0000 FS or 0.0000 V
. SWEEP CTRL	OFF	
. UPPER FREQ	4000.0 Hz	
. Setting	FAST	
. LOWER FREQ	40.000 Hz	
. Volt LF:UF	4.0000:1	
. TOTAL VOLT	1.0000 V	

With setting SWEEP CTRL → AUTO SWEEP or MANU SWEEP the following applies:

. Next Step	ANLR SYNC	With AUTO SWEEP only
. X Axis	FREQ	
. Z Axis	OFF	
UPPER FREQUENCY		With X or Z axis → FREQ selected
. Spacing	LOG POINTS	
. Start	20000. Hz	
. Stop	4000.0 Hz	
. Points	30	
TOTAL VOLTAGE		With X or Z axis → VOLT selected
. Spacing	LIN POINTS	
. Start	0.0100 V[FS]	

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```
. Stop        0.5000 V[FS]
. Points      30
```

With setting SWEEP CTRL → AUTO LIST or MANU LIST the following applies:

```
. Next Step   ANLR SYNC          With AUTO LIST only
. X Axis      FREQ
. Z Axis      OFF
. UPP F.FILE  R&S_EXAM.SPF       With X or Z axis → FREQ selected
. TOT V.FILE  R&S_EXAM.SPV       With X or Z axis → VOLT selected
```

FUNCTION DFD

```
. Frq Offset    OFF
. Low Dist      ON
. DC Offset     OFF              With ON: 0.0000 FS  or 0.0000 V
. Mode          IEC 268
. Equalizer     OFF
. Equal.File    R&S_EXAM.VEQ     If equalizer ON
. SWEEP CTRL    OFF
. MEAN FREQ     12500. Hz
. DIFF FREQ     80.000 Hz
. Setting       PRECISION
. TOTAL VOLT    1.0000 V
```

With setting SWEEP CTRL → AUTO SWEEP or MANU SWEEP the following applies:

```
. Next Step   ANLR SYNC          With AUTO SWEEP only
. X Axis      VOLT
. Z Axis      OFF

TOTAL VOLTAGE
. Spacing     LIN POINTS
. Start       0.0100 V[FS]       With X or Z axis → VOLT selected
. Stop        0.5000 V[FS]
. Points      30

MEAN FREQUENCY
. Spacing     LIN POINTS
. Start       20000. Hz          With X or Z axis → FREQ selected
. Stop        200.0 Hz
. Points      30
```

With setting SWEEP CTRL → AUTO LIST or MANU LIST the following applies:

```
. Next Step   ANLR SYNC          With AUTO LIST only
. X Axis      VOLT
. Z Axis      OFF
. MEANF.FILE  R&S_EXAM.SPF       With X or Z axis FREQ selected
. TOT V.FILE  R&S_EXAM.SPV       With X or Z axis VOLT selected
```

FUNCTION DIM

```
. DC Offset     OFF              With ON: 0.0000 FS  or 0.0000 V
. Square/Sin    3.15/15kHz
. Bandwidth     30kHz
. SWEEP CTRL    OFF
. Setting       FAST
. TOTAL VOLT    1.0000 V
```

With setting SWEEP CTRL → AUTO SWEEP or MANU SWEEP the following applies:

```
. Next Step   ANLR SYNC          With AUTO SWEEP only
. X Axis      VOLT
. Z Axis      OFF

TOTAL VOLTAGE
. Spacing     LIN POINTS
. Start       0.0100 V[FS]       With X or Z axis → VOLT selected
. Stop        0.5000 V[FS]
```

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```
. Points      30
```

With setting SWEEP CTRL → AUTO LIST or MANU LIST the following applies:

```
. Next Step   ANLR SYNC          With  AUTO LIST only
. X Axis      VOLT
. Z Axis      OFF
. TOT V.FILE  R&S_EXAM.SPV       With X or Z axis VOLT selected
```

FUNCTION RANDOM

```
. DC Offset   OFF                With ON: 0.0000 FS or 0.0000 V
. Domain      TIME
. PDF         GAUSS
. VOLT PEAK   1.0000 V[FS]
. VOLT RMS    0.2550 V           In analog generator only
```

With setting Domain FREQ the following applies:

```
. Spacing     USER DEF
              10.000 Hz
. Shape       WHITE
. Shape File  R&S_EXAM.VEQ       With Shape FILE
. Lower Freq  10.000 Hz          With Shape WHITE | PINK | THIRD OCT
. Upper Freq  20000. Hz          With Shape WHITE | PINK | THIRD OCT
. Equalizer   OFF
. Equal.File  R&S_EXAM.VEQ       If equalizer ON
. Crest Fact  OPTIMIZED
. VOLT PEAK   1.0000 V[FS]
. VOLT RMS    1.0000 V[FS]
```

FUNCTION ARBITRARY

```
. DC Offset   OFF                With ON: 0.0000 FS or 0.0000 V
. Shape File  R&S_EXAM.TTF
. VOLT PEAK   1.0000 V[FS]
. VOLT RMS    1.0000 V           In analog generator only
```

FUNCTION POLARITY

```
. DC Offset   OFF                With ON: 0.0000 FS or 0.0000 V
. VOLTAGE     0.5000 V[FS]
```

FUNCTION FSK Only useful in connection with option UPD-K33

```
. DC Offset   OFF                With ON: 0.0000 FS or 0.0000 V
. VOLTAGE     0.5000 V
```

FUNCTION MODULATION

```
. DC Offset   OFF                with ON: 0.0000 V | FS
. Mode        FM
. Mod Freq    1000.0 Hz
. Deviation   0.5000 %
. Carr Freq   40.000 Hz
. Carr Volt   0.5000 V|FS
```

With setting Mode → AM

```
. Mod Freq    1000.0 Hz
. Mod Depth   0.5000 %
. Carr Freq   40.000 Hz
. Carr Volt   0.5000 V|FS
```

FUNCTION DC

```
. SWEEP CTRL  OFF
. VOLTAGE     1.000 V|FS
```

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With setting SWEEP CTRL → AUTO SWEEP or MANU SWEEP the following applies:

```
. Next Step   ANLR SYNC
. X Axis      VOLT              Only Volt
VOLTAGE
. Spacing     LIN POINTS
. Start       0.0100 V|FS
. Stop        0.5000 V|FS
. Points      30
```

With setting SWEEP CTRL → AUTO LIST or MANU LIST the following applies:

```
. Next Step   ANLR SYNC
. X Axis      VOLT              Only Volt
. VOLT FILE   R&S_EXAM.SPF
```

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A.2 Analyzer Default Settings

INSTRUMENT — ANLG 22kHz

With setting ANALYZER ANLG 22 kHz, ANLG 100 kHz, ANLG 300 Hz the following applies:

. Min Freq	10 Hz	20 Hz for ANLG 100kHz, 50 Hz for ANLG 300kHz
. Ref Imped	600.00 Ω	
. Channel(s)	1	
. Ch1 Input	UNBAL BNC	
. Ch1 Common	FLOAT	The same settings apply to channel 2 (if selected)
. Ch1 Range	AUTO	

With setting ANALYZER DIG 48 kHz the following applies:

. Meas Mode	AUDIO DATA	
. Min Freq	2 Hz	
. Channel(s)	1	
. Input	SERIAL MUX	
. Sample Frq	48 kHz	
. Oversamp	1	
. Wordlength	24	With SERIAL MUX | SERIAL only
. Wordoffset	0	With SERIAL MUX | SERIAL only
. Audio Bits	20	
. Wordclock	RISING	With SERIAL | PARAL MUX | PARALLEL only
. WordselCh1	HIGH	With SERIAL MUX | PARAL MUX only
. Bitclock	RISING	With SERIAL MUX | SERIAL only
. Bit Order	MSB FIRST	With SERIAL MUX | SRIAL only

With setting GENERATOR → DIG 48 kHz in Meas Mode JITTER/PHASE | COMMON/INP the following applies:

. Input	AES/EBU	
. Jitter Ref	GEN CLK	With JITTER/PHASE only
. Range	AUTO	

With setting ANALYZER DIG 192 kHz, DIG 768 kHz the following applies:

. Min Freq	10 Hz	
. Channel(s)	1	
. Input	SERIAL MUX	
. Sample Frq	48 kHz	
. Oversamp	2	8 for DIG 768 kHz
. Wordlength	24	With SERIAL MUX | SERIAL only
. Wordoffset	0	With SERIAL MUX | SERIAL only
. Audio Bits	20	
. Wordclock	RISING	With SERIAL | PARAL MUX | PARALLEL only
. WordselCh1	HIGH	With SERIAL MUX | PARAL MUX only
. Bitclock	RISING	With SERIAL MUX | SERIAL only
. Bit Order	MSB FIRST	With SERIAL MUX | SRIAL only

START COND — AUTO

. Delay	0.0000 s

With setting START COND TIME TICK the following applies:

. Time	1.0000 s
. Points	30

With setting START COND FREQ CH1 / FREQ CH2 the following applies:

. Delay	0.0000 s
. Min Volt	0.0100 V [FS]
. Start	1000.0 Hz
. Stop	10000. Hz

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```
. Variation     10.000 %
. Settling      OFF
```

With setting START COND VOLT CH1 | VOLT CH2 the following applies:

```
. Delay         0.0000 s
. Start         0.0100 V [FS]
. Stop          1.0000 V [FS]
. Variation     10.000 %
. Settling      OFF
```

With setting START COND LEV TRG CH1 | LEV TRG CH2 the following applies:

```
. Delay         0.0000 s
. Start         0.0100 V [FS]
. Stop          1.0000 V [FS]
. Settling      OFF
```

With setting START COND TIME CHART the following applies:

```
. Time          1.0000 s
. Points        30
```

With setting START COND FRQ FST CH1 | FRQ FST CH2 the following applies:

```
. Delay         0.0000 s
. Min Volt      0.0100 V [FS]
. Start         1000.0 Hz
. Stop          10000  Hz
. Variation     10.000 %
. Settling      OFF
```

With setting START COND FREQ CH1|2 | FRQ FST CH1|2 and Settling EXPONENTIAL | FLAT the following applies:

```
. Samples       3
. Tolerance     1.0000 %
. Resolution    0.0010 Hz
```

With setting START COND VOLT CH1|2 | LEV TRG CH1|2 and Settling EXPONENTIAL | FLAT the following applies:

```
. Samples       3
. Tolerance     1.0000 %
. Resolution    0.0010 V [FS]
```

Functions of all Analyzers

```
INPUT DISP      PEAK | RMS
. Unit Ch1      V [dBFS]
. Reference     VALUE:
                1.0000 V[FS]

FREQ/PHASE      FREQ
  Meas Time     FIX 200ms
. Unit Ch1      Hz
. Ref Freq      VALUE:
                1000.0 Hz
. Freq Settl    OFF
```

With setting FREQ/PHASE = FREQ&PHASE (dual-channel measurements only)

```
. Meas Time     FIX 200ms
. Unit Ch1      Hz
. Unit Ch2      °
. Ref Freq      VALUE:
                1000.0 Hz
. Format Pha    -180..+180°
. Ref Phase     VALUE:
                10.000 °
. Freq Settl    OFF
```

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```
. Phas Settl OFF
```

With setting FREQ/PHASE = FREQ&GRPDEL (dual-channel measurements only)

```
. Meas Time   FIX 200ms
. Unit Ch1    Hz
. Unit Ch2    s
. Ref Freq    VALUE:
              1000.0 Hz
. Format Pha  -180..180°
. Ref Phase   VALUE:
              10.000 °
. Freq Settl  OFF
```

With setting Freq Settl EXPONENTIAL / FLAT the following applies:

```
. Samples     3
. Tolerance   0.1000 %
. Resolution  0.1000 Hz
. Timeout     5.0000 s
```

With setting Freq Settl AVERAGE the following applies:

```
. Samples     3
. Timeout     5.0000 s
```

With setting Phas Settl EXPONENTIAL / FLAT the following applies:

```
. Samples     3
. Resolution  0.1000 °
. Timeout     5.0000 s
```

With setting Phas Settl AVERAGE the following applies:

```
. Samples     3
. Timeout     5.0000 s
```

MONITOR OFF

```
. Attenuat.   0.0000 dB        If monitor = ON
```

Default Settings of Measurement Functions:

FUNCTION RMS & S/N

```
. DC Suppres  ON               With DIG 48kHz only
. S/N Sequ    OFF
. Meas Time   AUTO
. Unit Ch1    V   [FS]
. Unit Ch2    V   [FS]         If channel 2 switched on
. Reference   VALUE:
              1.0000 V [FS]
. Notch(Gain)OFF
. Filter      OFF
. Filter      OFF
. Filter      OFF
. Filter      OFF
. Fnct Settl  OFF
. POST FFT    OFF
. SPEAKER     OFF
```

With setting POST FFT = ON the following applies:

```
. FFT Size    4096
. Window      RIFE VINC 2
```

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FUNCTION RMS SELECT

. DC Suppres	ON	With DIG 48kHz only
. Meas Time	AUTO	
. Unit Ch1	V [FS]	
. Unit Ch2	V [FS]	If channel 2 switched on
. Reference	VALUE: 1.0000 V[FS]	
. Bandwidth	BP 1%	With bandwidth BP FIX or BS FIX: 100.00 Hz
. SWEEP CTRL	OFF	
. FREQ MODE	GEN TRACK	With FREQ MODE FIX: 1000.0 Hz
. Factor	1.0000 *	
. Notch(Gain)	OFF	
. Filter	OFF	
. FNCT Settl	OFF	
. SPEAKER	OFF	

With setting SWEEP CTRL AUTO SWEEP, MANU SWEEP the following applies:

. Spacing	LOG POINTS
. Start	100.00 Hz
. Stop	20000. Hz
. Points	30

With setting SWEEP CTRL AUTO LIST, MANU LIST the following applies:

. Filename	R&S_EXAM.SPF

With setting SWEEP CTRL GEN MLTSINE the following applies:

No other parameters

FUNCTION PEAK & S/N

. S/N Sequ	OFF	
. Meas Mode	PK+	
. Intv Time	FIX 200ms	
. Unit Ch1	V [FS]	
. Unit Ch2	V [FS]	If channel 2 switched on
. Reference	VALUE: 1.0000 V[FS]	
. Filter	OFF	
. Filter	OFF	
. Filter	OFF	
. Fnct Settl	OFF	
SPEAKER	OFF	

FUNCTION QPK & S/N

. S/N Sequ	OFF	
. Intv Time	FIX 3 SEC	
. Unit Ch1	V [FS]	
. Unit Ch2	V [FS]	If channel 2 switched on
. Reference	VALUE: 1.0000 V [FS]	
. Notch(Gain)	OFF	
. Filter	OFF	
. Filter	OFF	
. Filter	OFF	
. Fnct Settl	OFF	
. SPEAKER	OFF	

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FUNCTION DC
. Meas Time FIX 200ms
. Unit Ch1 V [FS]
. Unit Ch2 V [FS] If channel 2 switched on
. Reference VALUE:
1.0000 V
. Fnct Settl OFF
. SPEAKER OFF

FUNCTION THD
. Meas Mode All di
. Dyn Mode PRECISION
. Unit dB
. Fundamentl AUTO
. Fnct Settl OFF
. SPEAKER — OFF

FUNCTION THD+N/SINAD
. Meas Mode THD+N
. Dyn Mode PRECISION
. Meas Time SLOW
. Unit dB
. Fundamentl AUTO
. FILTER OFF
. FrqLim Low 100.00 Hz
. FrqLim Upp 21938. Hz
. Fnct Settl OFF
. POST FFT OFF
. FFT Size 8192
. SPEAKER — OFF

With setting POST FFT ON the following applies:
. FFT Size 8192
. Window RIFE VINC 2 Fixed setting

FUNCTION MOD DIST
. Dyn Mode PRECISION
. Unit dB
. Fnct Settl OFF
. SPEAKER — OFF

FUNCTION DFD
. Meas Mode d2 (IEC268)
. Dyn Mode PRECISION
. Unit dB
. Fnct Settl OFF
. SPEAKER — OFF

FUNCTION DIM
. Unit dB
. FREQ MODE FIX:
. Square/Sin 3.15/15kHz
. Fnct Settl OFF
. SPEAKER — OFF

FUNCTION WOW & FL
. Standard DIN/IEC
. Weighting ON
. Unit %
. Fnct Settl OFF
. POST FFT OFF
. SPEAKER — OFF

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With setting POST FFT the following applies:

```
. FFT Size    8192
. Window      RIFE VINC 1
```

FUNCTION POLARITY

No other parameters

FUNCTION FFT

```
. Unit Ch1    dBV
. Reference   VALUE:
              1.0000 V
. Notch (Gain)OFF
. FFT Size    4096
. Window      RIFE VINC 2
. Avg Mode    EXPONENTIAL
. Avg Count   1
. Zooming     OFF
. SPEAKER   – OFF
```

With setting ZOOMING ON (2...256) the following applies:

```
. Zooming     ON (2...256)
. Center      10000  Hz
. Span         21.94 kHz
```

156 kHz for ANLG 110 kHz, 468.0 kHz for ANLG 300kHz
For the digital analyzer the value depends on the selected sample rate.

FUNCTION FILTER SIM.

```
. Unit        %
. Filter      OFF
. Filter      OFF
. Filter      OFF
. Filter      OFF
. SPEAKER   – OFF
```

FUNCTION WAVEFORM

```
  Meas Mode   STANDARD
. Unit        V
. REF VOLT    1.0000 V
. Trig Level  0.0000 V
. Trig Slope  RISING
. Interpol    1
. Trace Len   0.0100 s
. SPEAKER   – OFF
```

FUNCTION COHERENCE

```
. Unit        %
. FFT Size    4096
. Window      RIFE VINC 2
. Avg Count   2
. SPEAKER   – OFF
```

FUNCTION PHAS TO REF

With Meas Mode JITTER/PHAS only

```
. Meas Time   FIX 200ms
. Unit        UI
. SPEAKER   – OFF
```

FUNCTION DIG INP AMP

With Meas Mode COMMON/INP only

```
. Meas Time   FIX 200ms
. Unit        V
. Reference   VALUE:
              1.0000 V
```

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. SPEAKER – OFF

Selectable measurement functions:

Measurement function	Analyzer instruments							
	ANLG 22kHz	ANLG 100kHz	ANLG 300kHz	DIG 48kHz in Meas Mode AUDIO DATA	DIG 48 kHz in Meas Mode JITTER/PHAS	DIG 48 kHz in Meas Mode COMMON/INP	DIG 192kHz	DIG 768kHz
RMS & S/N	√	√	√	√	√	√	√	√
RMS SELECT	√	√	√	√	√	√	√	√
PEAK & S/N	√	—	—	√	√	√	—	—
QPK & S/N	√	—	—	√	—	—	—	—
DC	√	√	√	—	—	—	—	—
THD	√	√	√	√	—	—	√	√
THD+N/SINAD	√	√	√	√	—	—	√	√
MOD DIST	√	√	√	√	—	—	√	√
DFD	√	√	√	√	—	—	√	√
DIM	√	—	—	√	—	—	—	—
WOW & FL	√	—	—	√	—	—	—	—
POLARITY	√	√	√	√	—	—	√	√
FFT	√	√	√	√	√	√	√	√
FILTER SIM.	√	√	√	√	—	—	√	√
WAVEFORM	√	√	√	√	√	√	√	√
COHERENCE	√	—	—	—	—	—	—	—
PHAS TO REF	—	—	—	—	√	—	—	—
DIG INP AMP	—	—	—	—	—	√	—	—

For all measurement functions:

The following applies if SPEAKER is not set to OFF:

```
. Pre Gain    0.0000 dB
. Spk Volume  30.000 %
. Phone Out   = SPEAKER
```

With setting Fnct Settl EXPONENTIAL / FLAT the following applies:

```
. Samples     3
. Tolerance   0.1000 %
. Resolution  0.0010 V
. Timeout     5.0000 s
```

With setting Fnct Settl AVERAGE the following applies:

```
. Samples     3
```

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A.3 Default Settings of FILTER Panel

Default parameters of individual filter types:

Lowpass filter (LOW PASS):
```
. Order       8
. Passband    20000. Hz
. Attenuat.   60.000 dB
. Short Name  1:LP20.0kHz
```

Highpass filter (HIGH PASS):
```
. Order       8
. Passband    400.00 Hz
. Attenuat.   60.000 dB
. Short Name  2:HP400.0Hz
```

Bandpass filter (BAND PASS):
```
. Passb Low   900.00 Hz
. Passb Upp   1100.0 Hz
. Attenuat.   60.000 dB
. Short Name  3:BP900.0Hz
```

Bandstop filter (BAND STOP):
```
. Passb Low   900.00 Hz
. Passb Upp   1100.0 Hz
. Attenuat.   60.000 dB
. Short Name  4:BS900.0Hz
```

Notch (NOTCH FLT):
```
. Center Frq   16000. Hz
. Width        500.00 Hz
. Attenuat.    60.000 dB
. Short Name   5:NO16.0kHz
```

Octave filter (1/3 OCT FLT):
```
. Center Frq   12500. Hz
. Attenuat.    60.000 dB
. Short Name   7:TO12.5kHz
```

Octave filter (OCTAVE FLT):
```
. Center Frq   12500. Hz
. Attenuat.    60.000 dB
. Short Name   8:OC12.5kHz
```

File-defined filter (FILE DEF):
```
. Filename    R&S_EXAM.COE
. Delay       0.1000 s
. Short Name  9:R&S_EXAM
```

Standard filter types:

```
FILTER 01  LOW PASS
FILTER 02  HIGH PASS
FILTER 03  BAND PASS
FILTER 04  BAND STOP
FILTER 05  NOTCH FLT
FILTER 06  1/3 OCT FLT
FILTER 07  OCTAVE FLT
FILTER 08  FILE DEF.
FILTER 09  FILE DEF.
```

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A.4 Default Settings of DISPLAY Panel

OPERATION BARGRAPH
. Scan Count 1
. User Label OFF

BARGRAPH A FUNC CH1

. Unit	V [FS, Hz, dB, %]	Basic unit of selected analyzer or bargraph function (see 2.4 Units)
. Limit Ref	VALUE: 1.0000 V [FS,Hz,dB,%]	Basic unit of selected analyzer or bargraph function (see 2.4 Units)
. Scale	AUTO ONCE	
. Spacing	LIN	

BARGRAPH B OFF

With Scale B → NOT EQUAL A selected:

. Unit	V [FS, Hz, dB, %]	Basic unit of selected analyzer or bargraph function (see 2.4 Units)
. Limit Ref	VALUE: 1.0000 V [FS,Hz,dB,%]	Basic unit of selected analyzer or bargraph function (see 2.4 Units)
. Scale	AUTO ONCE	
. Spacing	LIN	

BARGRAPH X FREQ CH1
. Unit Hz
. Reference 1000.0 Hz
. Scale AUTO
. Spacing LIN

BARGRAPH X VOLT

Displays for FREQ, VOLT, ON TIME and INTERVAL of a generator sweep depend on the X axis setting.

. Unit V[FS]
. Reference 1000.0 V[1.0000 FS]
. Scale AUTO
. Spacing LIN

FREQ is displayed for a center frequency sweep of the RMS selective bandpass filter in the analyzer using measurement function RMS SELECT.

BARGRAPH X ON TIME | INTERVAL
. Unit S
. Scale AUTO
. Spacing LIN

LIMIT CHECK ————————
. Mode OFF

With setting Mode LIM LOWER, LIM UPPER, LIM LOW&UP the following applies:

. Check	TRACE A	
. Lim Upper	VALUE: 0.5000 V	Not with LIM LOWER
. Lim Lower	VALUE: 0.0500 V	Not with LIM UPPER

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A.5 Default Settings of OPTIONS Panel

. UPD IECadr	20	
. Exec Macro	BASIC FILE	
. Beeper	ON	
PARAM.LINK		
. Param Link	CHOICE...	Function tracking Gen → Anl selected
SCREEN HARD COPY		
. Destin	PRINTR/SPC	
. Printname	Default-Printer	
. Frame Col	FILE DEF	
. Comment	OFF	
. Left Mrgn	12 Chars	
. Prn Resol	MEDIUM	
. X Scaling	2.0000	
. Y Scaling	3.0000	
. Orientation	PORTRAIT	
. Color	OFF	with PLOTTR/HPGL, FILE/PCX, FILE/HPGL, PRINTR/HPGL, PRINTR/PS, FILE/PS, FILE/EPS
. Copy	SCREEN	with PLOTTR/HPGL, FILE/HPGL, PRINTR/HPGL, PRINTR/PS, FILE/PS, FILE/EPS
. Comment	OFF	with PRINTR/PS, FILE/PS, FILE/EPS
. Frame Col	FILE DEF	with PRINTR/SPC ,FILE/PCX, PRINTR/PS, FILE/PS, FILE/EPS
. Paper Size	A4	with PRINTR/PS, FILE/PS, FILE/EPS
. Orientatn	PORTRAIT	with PRINTR/PS, FILE/PS, FILE/EPS
. Filename	SCREEN	with FILE/PCX, FILE/HPGL, FILE/PS, FILE/EPS
. Plot on	COM2	with PLOTTR/HPGL, PRINTR/HPGL, PRINTR/PS
. IEC Adr	4	with Plot on IEC BUS
. Plots/Page	1	with PRINTR/PS, FILE/PS, FILE/EPS
PRINT		
. Type	OFF	
COM2 PARAMETER		
. Baud Rate	9600 Baud	These interface parameters are only set after an UPD reset. When a setup or default setup is loaded, the user-selected parameters are maintained to avoid inadvertent overwriting.
. Parity	EVEN	
. Data Bits	7	
. Stop Bits	1	
. Handshake	RTS/CTS	
PANEL KEYS		
. Reptn Rate	10.000 Hz	
. Rep Delay	0.5000 s	
DISPLAY		
. Extrn Disp	BOTH B/W	
. Meas Disp	ON	
. Read Rate	6/s	
. Read Resol	CHOICE ...	Automatic for all 6 displays
TRACES COLOR/LINE		
. Scan conf	MANUAL	
. Scannr.(A)	0	
. Color (A)	BLACK	
. Line (A)	———	
. Scannr.(B)	0	
. Color (B)	BLACK	
. Line (B)	———	
HELP LANGUAGE		
. Language	GERMAN	

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```
SWITCHER ———————————————
. Switcher     OFF

CALIBRATion    ANL ————
. Zero Auto    ON

CALIBRATion    GEN ————
. Low Dist     OFF

CALIBRATion    DIG ————
. PhaseToRef   OFF
```

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A.6 Default Setting of FILE Panel

```
LOAD INSTRUMENT STATE ———
. Applicat   USER DEF
. Mode        ACTUAL
. Info Displ  ON
. Filename    LASTSAVE
STORE INSTRUMENT STATE ——
. Mode        ACTUAL
. Attrib      READ/WRITE
. Info Text   no infotext
. Filename    LASTSAVE
STORE TRACE/LIST ————————
. Store       OFF
UTILS  ——————————————————
. Delete      TO_DELET
. Work Dir    C:\UPD\USER
. COPY        SOURCE
. To          DEST
```

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A

A bar....2.418, 2.420
A WITH *....2.353
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