

User's
Guide

HP 53310A Option 031
Modulation Domain Analyzer

User's Guide

This guide describes how to use the Digital RF Communications Analysis/High Resolution 2.5 GHz Input option for the HP 53310A Modulation Domain Analyzer. This information applies to instruments having HP 53310A firmware revision: 3234.

The firmware revision number is listed on the Utility Menu at the bottom of the display.

If the number on this page does not match your firmware revision number, refer to the Manual Updating Changes included with this guide.

HP 53310A Option 031
Modulation Domain Analyzer

Notice

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Introduction

Introduction

A better way to measure for digital RF communications system designers

A better way to measure for digital RF communications system designers

The HP 53310A Modulation Domain Analyzer's Option 031 provides the following automatic measurements:

- Synthesizer settling time.
- Frequency Shift Keyed (FSK) center frequency.
- FSK peak deviation.

Option 031 also includes:

- An internal downconverter for higher resolution measurements.
- Increased sampling rate for fast data rate systems.

Introduction
In this book

In this book

This user's guide is organized into four parts:

- **Chapter 1** demonstrates how to use the Option 031 digital RF analysis features.
- **Chapter 2** describes the Option 031 downconverter and some details about using an external LO.
- **Chapter 3** explains the Option 031 advisory messages that appear on the display.
- **Chapter 4** provides the programming commands to help automate the Option 031 measurement sequences.

Refer to other HP 53310A documentation for important additional information:

- *Quick Start Guide* A step-by-step approach for first-time users of the HP 53310A.
- *Operating Reference Manual* The details of operating the HP 53310A.
- *Programming Reference Manual* The details of programming the HP 53310A.
- *Programming Quick Reference* A summary of programming commands.
- *Service Manual* The performance tests, retrofitting instructions, and troubleshooting help.

Introduction
Specifications

Specifications*

Both warranted specifications and operating characteristics of the HP 53310A are discussed in this section. To distinguish warranted specifications from operating characteristics, *specifications are highlighted throughout in italics.*

Input Conditions

Range: 200 MHz to 2.5 GHz
Sensitivity:
-13 dBm 50 MHz to 200 MHz
-17 dBm 200 MHz to 2 GHz
-12 dBm 2 GHz to 2.5 GHz

Maximum Input Level:
+20 dBm
Damage Level: *+23 dBm*
Impedance: 50 Ω
Coupling: ac
Pulse Width: 50 μ s to CW

External Local Oscillator Input

Level: +6dBm (\pm 1dB)
Impedance: 50 Ω
Frequency Range: 150 MHz to 2.5 GHz

Maximum Measurement Rate

Fast Histogram: 1.5 MHz
Other Modes: 1 MHz
Fast Sampling: 8 MHz (repetitive)

RF Envelope Trigger

Level: Adjustable in 100 steps (e.g., -25 dBm to 0 dBm @1 GHz)

Output: 0 to 0.4 volt into 50 Ω or TTL level into high impedance

* Consult the HP 53310A Technical Data Sheet (pub# 5091-2596EUS) for further product information and specifications.

Introduction
Specifications

Resolution

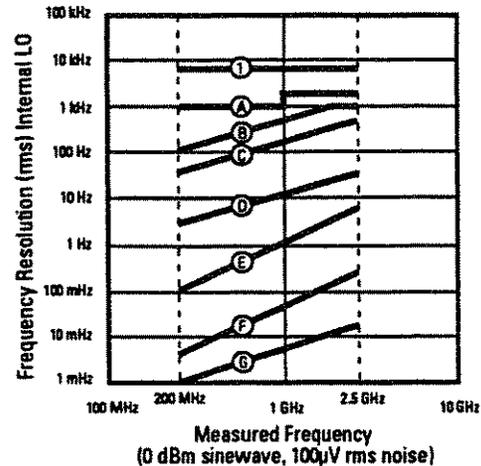
Maximum available measurement resolution or display resolution, whichever is greater.

Maximum Available Measurement Resolution (Auto Sampling): *see graph A*

Display Resolution:
vs Time or Histogram of vs Time
Window Off: Display Span/256
Window On: Display Span/224
Fast Histogram:
Display Span/450

Accuracy: $\pm [Resolution + (Frequency \times Reference Error^*)]$

Maximum Available Frequency Resolution



	Timebase Setting Interval @ center: Auto	Interval @ Center Setting (Interval @ Center: Manual)	Frequency Resolution (Ext. LO)†
①		125 ns††	7 kHz
A	≤ 20 μs/Div	1 μs	1 kHz
B	200 μs/Div	10 μs	20 Hz
C	2 ms/Div	100 μs	5 Hz
D	20 ms/Div	1 ms	2 Hz
E	200 ms/Div	10 ms	50 mHz
F		100 ms	5 mHz
G		0.5 s	2 mHz

† Typical resolution over the 200 MHz to 2.5 GHz range using an HP 8663A Synthesizer as an external LO.

†† Fast Sampling mode

Graph A

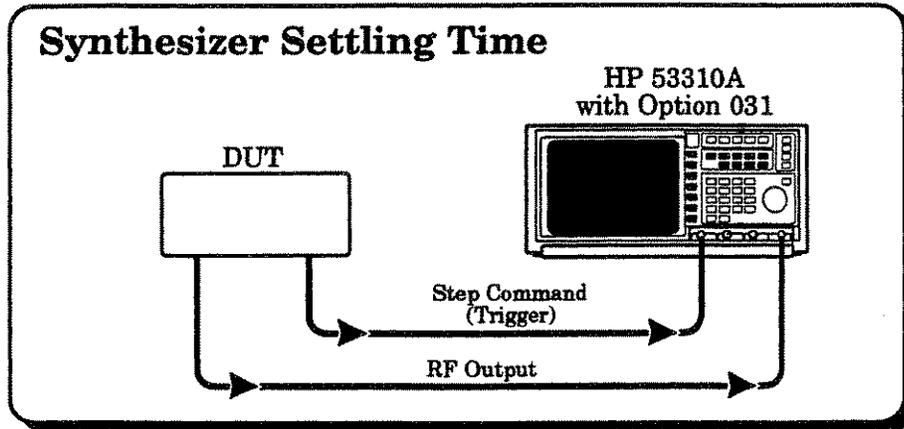
Maximum available frequency resolution for Option 031 Channel C. Larger timebase setting and averaging will reduce the effects of random noise and improve resolution. Please refer to graph 2 of the HP 53310A Technical Data Sheet for resolution over the 50 MHz - 200 MHz band.

Introduction
 Settling Time Quick Reference

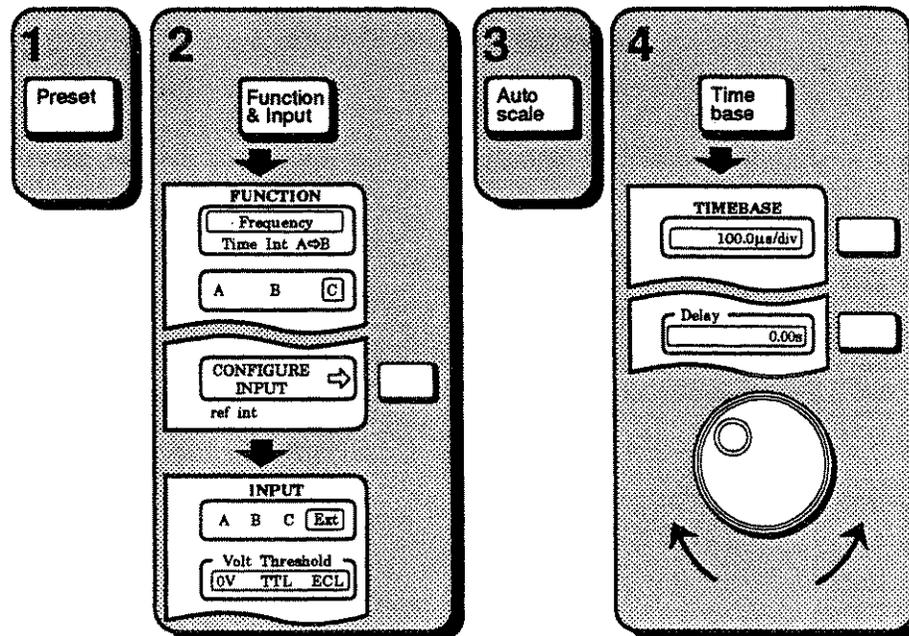
Settling Time Quick Reference

Use this visual guide as a quick reference for how to make this measurement. Chapter 1 describes each step in detail.

Instructions:
 Follow the numbered steps to make a settling time measurement. Text in this column indicates where you need to provide input. It is referenced to a step by number.

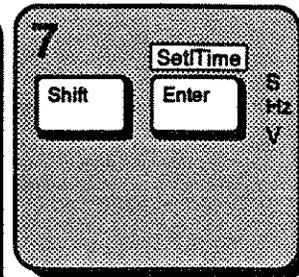
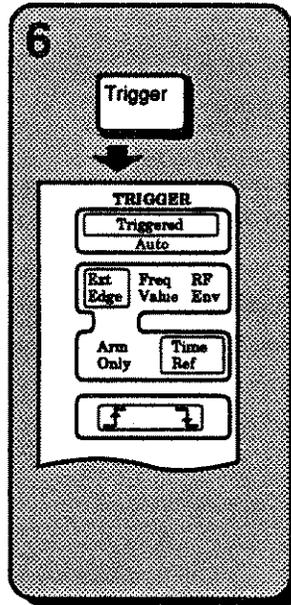
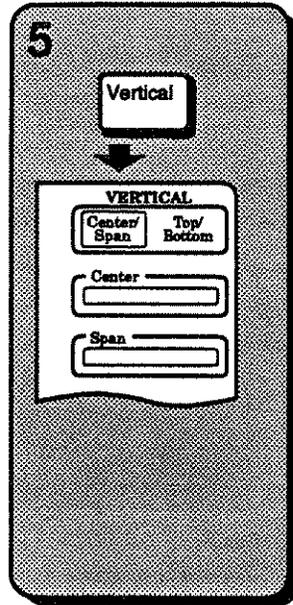


4 Adjust the time/div and Delay values as needed.

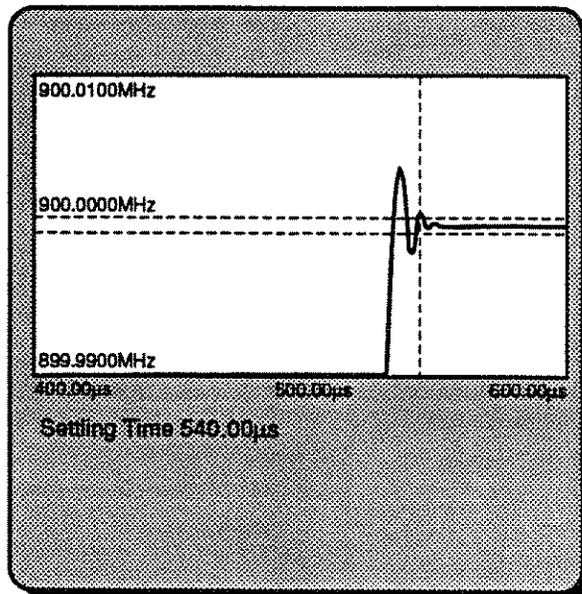
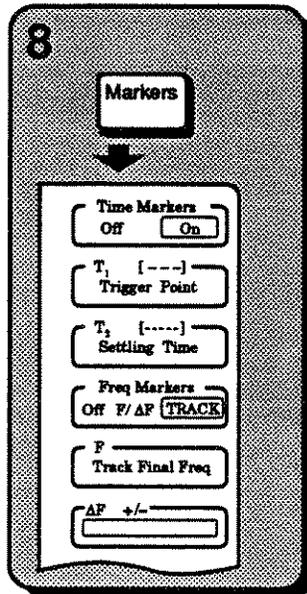


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Settling Time Quick Reference

5 Enter the Center and Span values appropriate for your measurement.



8 Enter the $\pm \Delta F$ value appropriate for your measurement.

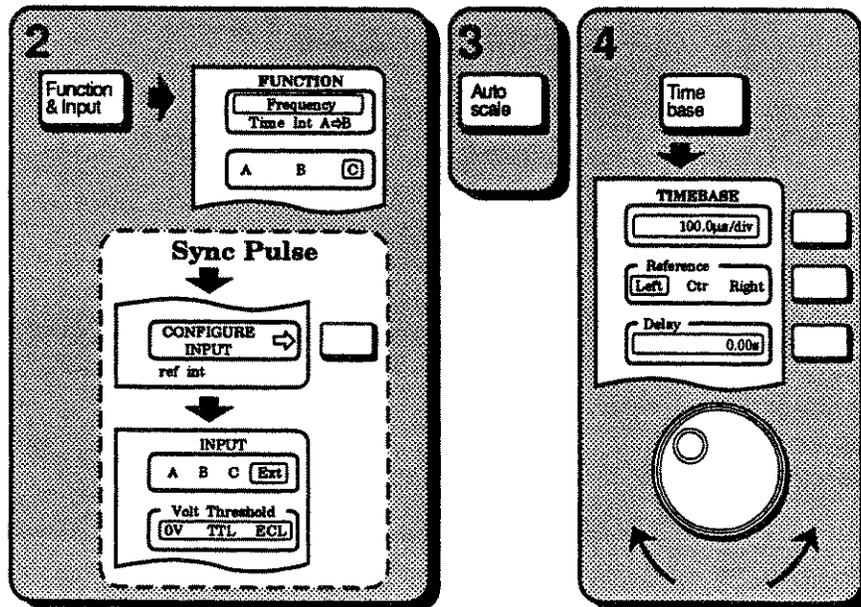
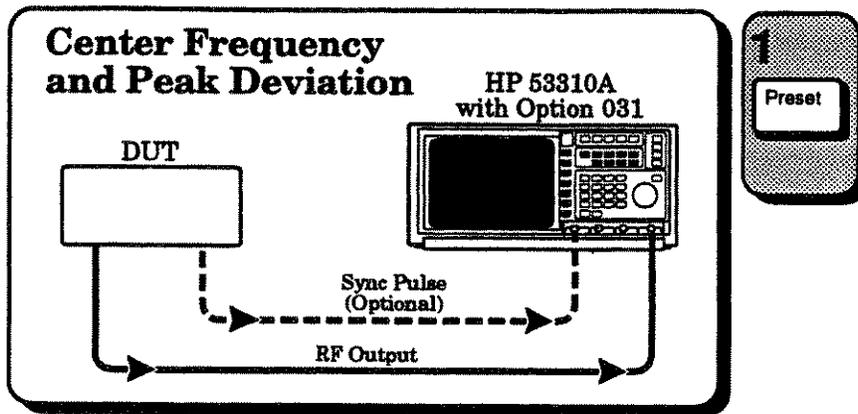


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Center Frequency and Peak Deviation Quick Reference

Center Frequency and Peak Deviation Quick Reference

Use this visual guide as a quick reference for how to make this measurement. Chapter 1 describes each step in detail.

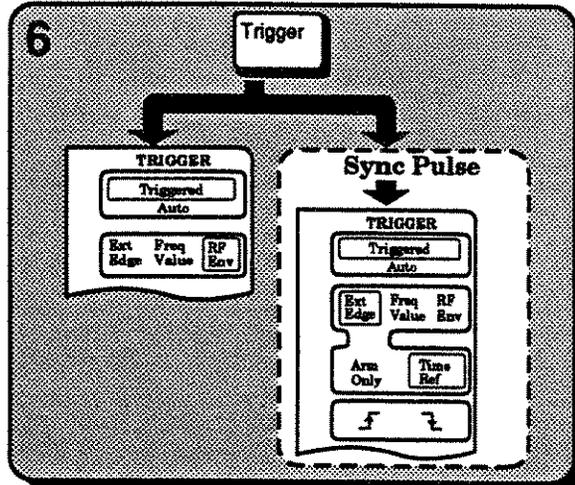
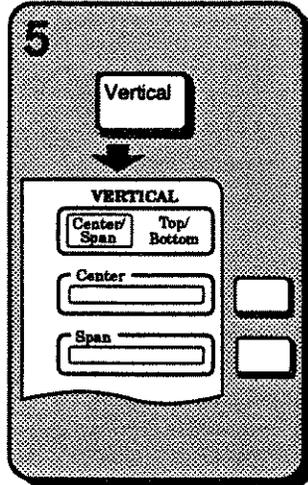
Instructions:
Follow the numbered steps to make a center frequency and peak deviation measurement. Text in this column indicates where you need to provide input. It is referenced to a step by number.



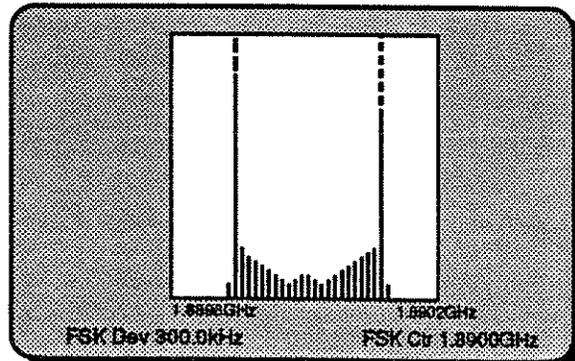
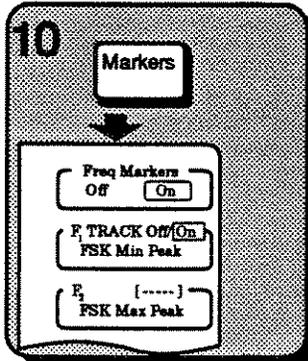
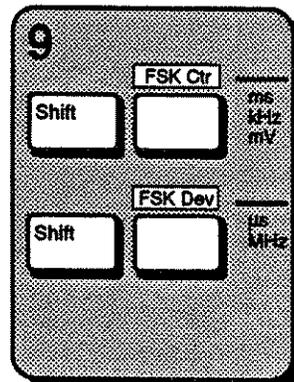
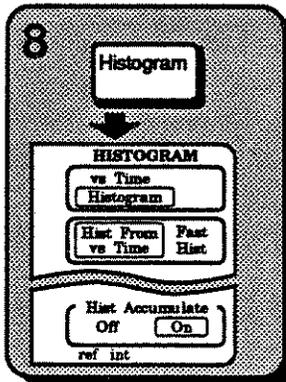
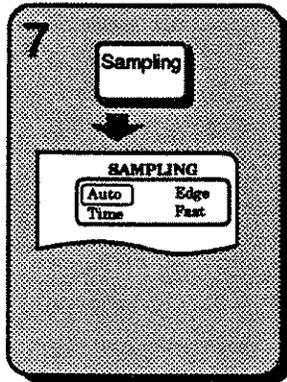
4 Adjust the time/div and Delay values as needed.

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Center Frequency and Peak Deviation Quick Reference

5 Enter the Center and Span values appropriate for your measurement.



7 For fast data rate systems, such as DECT, use Fast Sampling.



Introduction
Center Frequency and Peak Deviation Quick Reference



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1

**Using Digital RF Communications
Analysis**

**Using Digital RF Communications Analysis
In this chapter**

In this chapter

Option 031 adds digital RF analysis features to help a designer of digital RF communication systems. These features include measuring synthesizer settling time, and characterizing center frequency and peak deviation of radio systems such as CT-2, CT-3, GSM, and DECT.

This chapter presents step-by-step procedures for the option 031 measurements. The procedures include CT-2, DECT, and GSM signals as examples.

The following measurements are described in this chapter:

- **Synthesizer settling time**
- **Transmitter turn on/off frequency transients**
- **Center frequency and peak deviation**
- **Eye diagram of FSK modulation on RF carrier**

Using Digital RF Communications Analysis To measure synthesizer settling time

To measure synthesizer settling time

Radio manufacturers use synthesizer settling time as a way to evaluate how the performance of a synthesizer compares to internal design needs. The HP 53310A Option 031 measures settling time by displaying the changing frequency of the synthesizer and the time it takes to reach a settled frequency. The following procedure shows how to make this measurement. Information is also included about making averaged measurements on a synthesizer that is being repetitively stepped.

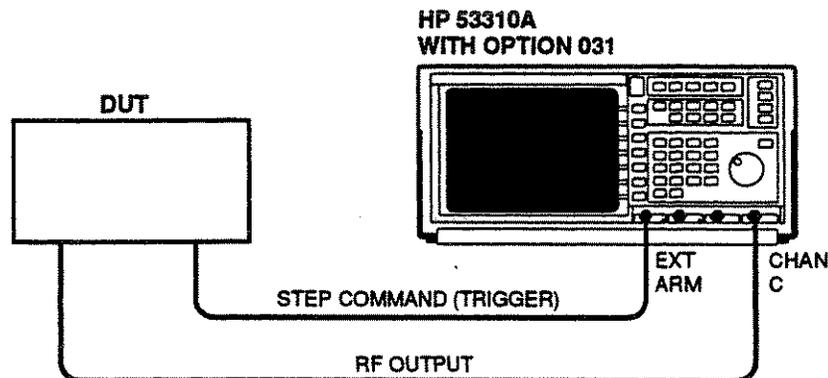
Note

An abbreviated version of this measurement procedure is in the introduction. Use it as a guide after you become familiar with this procedure.

Overview and equipment setup

A settling time measurement consists of a frequency measurement with a time record. Typically the synthesizer step command is used to specify the start of the measurement. The equipment setup is shown below.

This is a typical setup for a settling time measurement. The step command is connected to the Ext Arm input. The measurement determines the time from the occurrence of the step command to when the synthesizer settles.



Using Digital RF Communications Analysis
To measure synthesizer settling time

Settling time measurement

The following steps demonstrate how to measure settling time using a DECT signal as an example.

Preset the HP 53310A.

- 1 Press the Preset key.

Select the channel and input settings.

- 1 Select the C channel.

The Frequency measurement function is selected by Preset.

- 2 Press the CONFIGURE INPUT softkey.

- 3 Select the Ext input.

This is where you set the voltage level at which the step command signal triggers a measurement.

- 4 Select the Volt Threshold setting appropriate for your Ext Arm input signal.

You are setting the voltage threshold for your step command signal. The HP 53310A will sense a signal that passes through the voltage level selected: 0 volts, 1.5 volts (TTL), or -1.3 volts (ECL). A signal transition from low to high or from high to low can be detected and will mark the start of the synthesizer switching time.

Note

The rising or falling edge of the step command signal is selected on the Trigger menu. This is described under "Set the trigger controls" later in this section.

Using Digital RF Communications Analysis
To measure synthesizer settling time

- 5 **If you are using a 10:1 probe at the Ext Arm input, select the HP 53310A's 10:1 probe setting.**

Autoscale the HP 53310A.

If you have a single-shot measurement situation, skip over this step.

- 1 **Press the Autoscale key.**

The autoscale feature will usually "find" repetitive signals. This is an easy way to have the instrument adjust itself to display your signal.

Set the timebase controls.

- 1 **Press the Timebase key.**
- 2 **Press the top softkey to select the time/div field.**
- 3 **Enter a value that is approximately one tenth the amount of time over which you want to measure.**

The measurement time should exceed the expected settling time to ensure that the HP 53310A can properly measure it.

Hint: If your synthesizer settles in 500 μs , set the time/div so your signal will be measured for double or triple that length of time. To measure for 1.5 ms, enter a time/div value of 150 μs .

Use this example as a guide. You can readjust this value for subsequent measurements as needed.

Using Digital RF Communications Analysis
To measure synthesizer settling time

4 Set Reference to Left.

This moves the 0.0s x-axis reference point to the left edge of the display. If you want to modify the time range on the display, select the Delay feature and adjust the knob to show the time range of interest.

Set the vertical controls.

1 Press the Vertical key.

2 Enter the expected settled frequency as the Center value.

3 Enter a Span value.

The span value is the frequency range that will be shown on the vertical axis of the HP 53310A display. A wide span (larger value) will show the entire synthesizer step. A narrow span (smaller value) will display the settling transient with greater resolution.

Hint: Enter a Span value that is approximately thirty times the tolerance band of the settled result. For example, if you want to measure the time it takes the synthesizer to settle to ± 10 kHz, set the span to 300 kHz. This should provide a reasonable resolution for your measurement.

Use this example as a guide. You can readjust this value for subsequent measurements as needed.

Using Digital RF Communications Analysis
To measure synthesizer settling time

Set the trigger controls.

- 1 Press the Trigger key.**
- 2 Select Triggered.**
- 3 Select Ext Edge.**
- 4 Select Time Ref.**

The settling time result will be referenced to the occurrence of the step command at the Ext Arm input.

Note

No pre-trigger data is available when using the time reference trigger. You may need to readjust the timebase delay feature to center your data display after selecting Ext Edge trigger.

- 5 Select the rising or falling edge as appropriate for your step command signal.**

**Using Digital RF Communications Analysis
To measure synthesizer settling time**

Measuring Repetitively

If all the steps have been followed and the synthesizer is being repetitively stepped, the HP 53310A is displaying each sweep of data as it is acquired.

Averaging Multiple Acquisitions

The HP 53310A can average the results from multiple measurements of a synthesizer that is being repetitively stepped. This may be useful when you want to average out the short-term measurement-to-measurement variations and increase resolution.

1 Press the Display key.

2 Select Repetitive.

3 Set Averaging to On.

The HP 53310A will accumulate multiple acquisitions and provide a running average of synthesizer steps, all referenced to the step command edge.

Using Digital RF Communications Analysis
To measure synthesizer settling time

Measuring Single-Shot

1 Press the Stop/Single key once or twice until you see the word "stopped" at the top of the display.

2 Press the Stop/Single key once to start a new acquisition.

The HP 53310A is now waiting for the step command signal.

3 Send the step command signal.

4 The HP 53310A captures and displays the synthesizer settling response.

Enable the settling time feature.

1 Press the blue Shift key and then the Setl Time key.

This enables the settling time feature. The measured settling time will not be displayed until you set the markers in the next step.

Set the markers.

1 Press the Markers key.

2 Set Time Markers to On.

3 Set Freq Markers to F/ Δ F.

Using Digital RF Communications Analysis
To measure synthesizer settling time

- 4 Enter the settled frequency for the synthesizer as the F value.

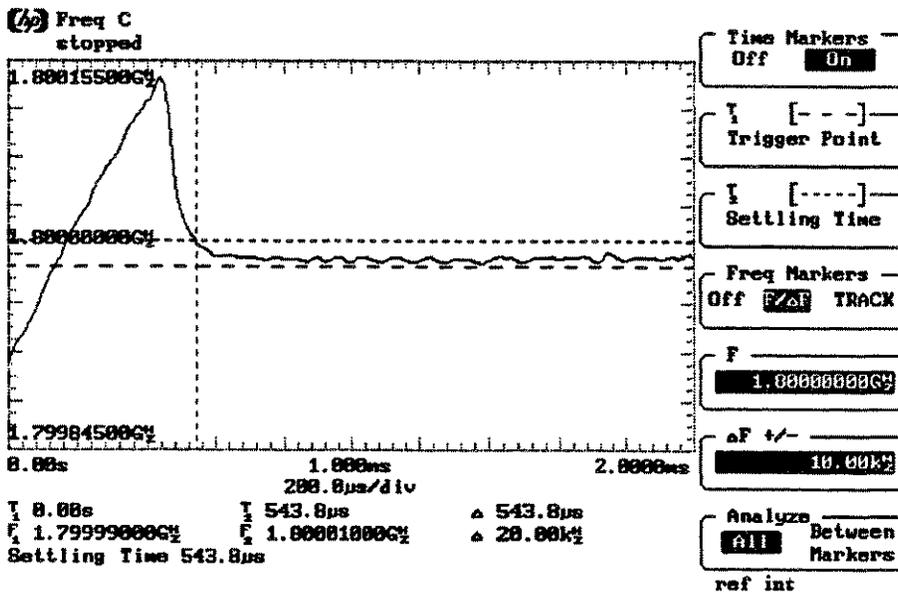
If the settled frequency is drifting, or the final value is not known, the instrument can track this value for you. Go to "Track the settled frequency" later in this section.

- 5 Enter the plus and minus frequency range for the synthesizer settling as the ΔF +/- value.

- 6 Read the settling time at the lower left of the display.

The settling time is the time from the step command to when the synthesizer settled within the tolerance band. One of the vertical time markers will indicate the settling point. See the example display below.

The time the synthesizer takes to settle within the tolerance band is displayed at the lower left.



Using Digital RF Communications Analysis
To measure synthesizer settling time

Hint: Once a single measurement has been acquired and the HP 53310A is stopped, you can change the ΔF value and see the settling time for different tolerance band values.

Track the settled frequency.

When you want the HP 53310A to follow a drifting frequency, or to find the settled frequency for you, use the tracking feature.

- 1 Perform the preceding tasks in this measurement procedure up to the point where you are asked to enter the settled frequency in the previous task "Set the markers".**

The waveform of the settled frequency must be on the display before you can use the tracking feature.

- 2 Set Freq Markers to TRACK.**
- 3 Enter the plus and minus range for the synthesizer settling as the ΔF +/- value.**

The settled frequency will now be tracked, as long as the frequency stays on the display. If you do not know the settled frequency, this feature will find it for you.

Note

The tracking feature actually follows the last measured value at the right edge of the display. If the waveform drops off before the edge, use Delay on the Timebase menu to position the settled frequency at the edge of the display, or use the time markers (set the Analyze softkey feature to Between Markers) to limit the area of analysis.

Using Digital RF Communications Analysis To measure synthesizer settling time

Synthesizer Pulling

Another consideration is the secondary effect on the synthesizer of the power ramp-up of the amplifier as the transmitter is turned on. In most radio transmissions, the power does not come on until the synthesizer has settled. As the TDMA burst is turned on, the amplifier power ramp can cause a temporary shift in the synthesizer's frequency. Leakage signals from the RF antenna can also be radiated back into the circuit causing a pulling effect. The HP 53310A can show you how far from the settled frequency the synthesizer is pulled and how long it takes to relock.

To check for synthesizer pulling:

- 1. Use the same setup as for synthesizer settling time.**
- 2. Create the condition of power ramp-up in the radio.**
- 3. Monitor the synthesizer response at the point the power comes on.**
- 4. Use the Delay feature on the Timebase menu to look beyond the point where the synthesizer originally settles.**

Once you find the area of interest, you may want to change the time/div setting on the Timebase menu to take a better look at the synthesizer behavior.

Enhance resolution of settling time measurements

If the resolution of your settling time measurement using averaging and the internal local oscillator (LO) is not sufficient, enhanced resolution can be obtained by using a high performance external LO. Refer to chapter 2 for instructions. Typical resolution using an HP 8663A Signal Generator as an external LO is listed in the specifications.

Using Digital RF Communications Analysis
To measure transmitter turn on/off frequency transients

To measure transmitter turn on/off frequency transients

Various international test standards specify that the transmitter turn-on/off behavior be measured. The HP 53310A Option 031 measures the transient frequency response of a transmitter at turn-on or turn-off by measuring the frequency of the transmitter output signal as the power ramps up or down.

The transmitter response is typically referenced to a point on the power ramp, such as -30 dBc. The HP 53310A can be triggered two ways to make this measurement:

- trigger on an external signal that is synchronized to the -30 dBc power level.
- adjust the RF envelope trigger level to trigger at the -30 dBc power level.

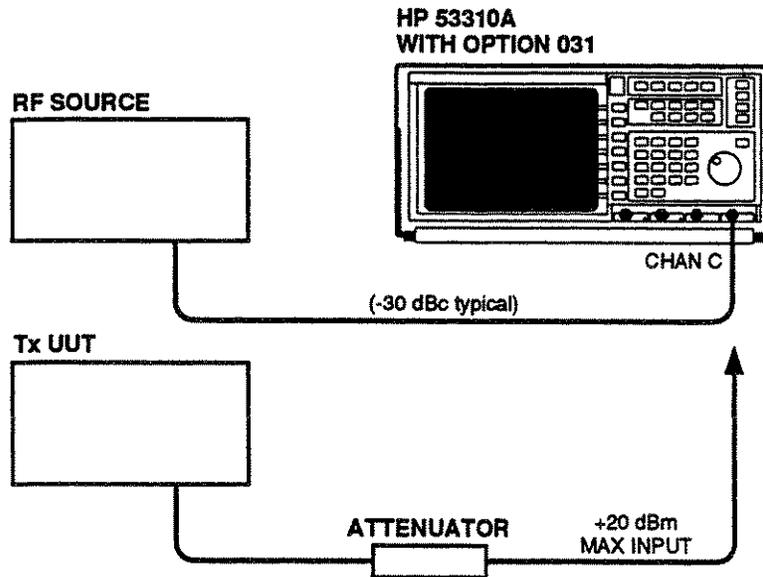
This procedure demonstrates how to use the RF envelope trigger to make this measurement.

**Using Digital RF Communications Analysis
To measure transmitter turn on/off frequency transients**

Overview and equipment setup

The setup for a transient frequency measurement consists of first setting the HP 53310A RF Envelope trigger level at the proper power level and then measuring the transients referenced to the time when this power level occurs. This adjustment requires an RF source that can simulate the attenuated output power level of the transmitter specified for the test. The equipment setup is shown below.

An RF source is used to help adjust the HP 53310A to make this measurement. Use an attenuator to limit power to the Channel C input to less than +20 dBm.



Using Digital RF Communications Analysis
To measure transmitter turn on/off frequency transients

Transient turn on/off measurement

The following steps demonstrate how to measure transient frequency behavior of a transmitter at turn-on and turn-off.

There are four parts to measuring the turn-on and turn-off transients of a transmitter with the HP 53310A:

Part One: Measure the output power of the transmitter.

Part Two: Adjust an RF source to -30 dBc (typical).

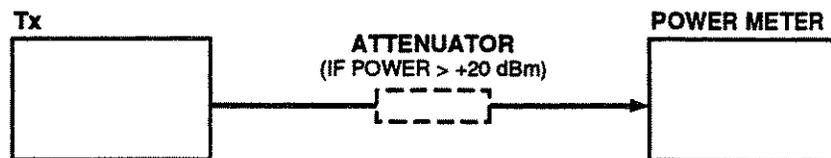
Part Three: Adjust the HP 53310A's RF Envelope trigger level to -30 dBc (typical) using the RF source.

Part Four: Measure the transmitter transients.

Part One: Measure the output power of the transmitter.

The maximum power level that the HP 53310A can accept on the C channel without damage is $+23$ dBm. Use this procedure to establish the attenuation that will be needed between the transmitter and the HP 53310A if your transmitter's output power is greater than $+20$ dBm.

Use an attenuator if the output power of the transmitter exceeds $+20$ dBm.



Using Digital RF Communications Analysis
To measure transmitter turn on/off frequency transients

- 1 Determine the nominal output power of the transmitter under test.**

Use a power meter or similar instrument to measure the transmitter power.

- 2 If the power is greater than +20 dBm, use an attenuator at the output of the transmitter to limit its output power.**

This protects the front-end circuitry of the HP 53310A from damage by power levels exceeding +23 dBm.

Part Two: Adjust the RF source to -30 dBc (typical).

This section helps you determine the power level at which the HP 53310A RF Envelope trigger level should be set for the test.

The test specification used as an example here, specifies that the transient measurements be triggered at a power level 30 dB below the transmitter's nominal power level. For example, if the nominal power level of the transmitter is +15 dBm, the power level test point is -15 dBm.

Any attenuation required (see preceding section) must be factored in when setting the trigger level of the HP 53310A. For example, if 6 dB of attenuation is needed so the HP 53310A can safely accept the transmitter nominal power output level, this attenuation must be added in when calibrating the HP 53310A trigger level.

Using Digital RF Communications Analysis
To measure transmitter turn on/off frequency transients

This step calibrates the RF source for setting the trigger level of the HP 53310A.



- 1 If the nominal output power level is less than +20 dBm, set the RF source to output a level 30 dB below the nominal level and go to the next section.**
- 2 If attenuation is required (+20 dBm maximum level allowed at the channel C input), review the example below and set the RF source to the appropriate level using the power meter.**

Example An example of how to determine the power level of the RF source is as follows:

Transmitter's nominal power level = +30 dBm

Transmitter power level at test trigger point = 0 dBm (30 dB below the nominal power level)

If 15 dB of attenuation is inserted to reduce the power level to the HP 53310A to a maximum of +15 dBm:

Power level at HP 53310A for the adjustment = -15 dBm (+15 dBm - 30 dB)

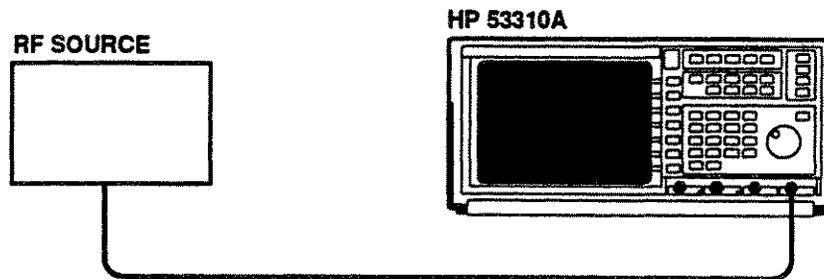
For this example, the RF source should be set to -15 dBm.

Using Digital RF Communications Analysis
To measure transmitter turn on/off frequency transients

Part Three: Adjust the HP 53310A RF Envelope trigger level.

Adjust the RF Envelope trigger level using the known reference. This is done so the HP 53310A will detect the transmitter signal and trigger the start of the measurement at the correct power level (-30 dBc in this example).

Adjust the HP 53310A to trigger at the proper transmitter power level.



- 1 Set the RF source to output a power level 30 dB below the nominal power level of the transmitter (as determined in the previous section) and at the same frequency as the transmitter.**

Note

If you are using an attenuator on the output of the transmitter, add this attenuation to calculated test level of the transmitter. For example, If the nominal transmitter output power level is $+20$ dBm and you added 6 dB of attenuation to protect the input of the HP 53310A, the trigger level needs to be set at a power level of -16 dBm ($+20$ dBm -6 dB -30 dB).

- 2 Connect the RF source to the HP 53310A Channel C.**

Setting the RF source to add FM to the output signal will make the signal easier to see in the following steps.

Using Digital RF Communications Analysis
To measure transmitter turn on/off frequency transients

- 3 **Press the Preset key on the HP 53310A.**
- 4 **Select the C channel on the Function menu.**
- 5 **Press the Autoscale key on the HP 53310A.**

The HP 53310A automatically measures and displays the input signal. The green LED trigger light at the C channel input should be flashing.

Note

If Autoscale cannot find the signal, you may have to increase the power level used for this measurement and begin again at Part One.

- 6 **Press the CONFIGURE INPUT softkey.**
- 7 **Select the C input.**

The envelope trigger level will be adjusted so the HP 53310A will detect the transmitter signal at the proper level.

- 8 **Rotate the knob slowly clockwise until the green LED at the C channel stops flashing.**

The trigger level is now adjusted above the input signal. The next step will make a fine adjustment so the signal will be detected again.

- 9 **Press the Fine key near the knob.**

This step increases the resolution of the trigger level setting by 10 times.

- 10 **Rotate the knob slowly counterclockwise just until the green LED starts flashing again.**

Using Digital RF Communications Analysis
To measure transmitter turn on/off frequency transients

- 11 As a final adjustment check, rotate the knob clockwise until the green LED stops flashing; then rotate the knob counterclockwise just until the LED starts flashing again.

You have set the envelope trigger level of the C channel to detect a signal at the power level of the RF source. The HP 53310A is now adjusted for the correct power level to test the transmitter.

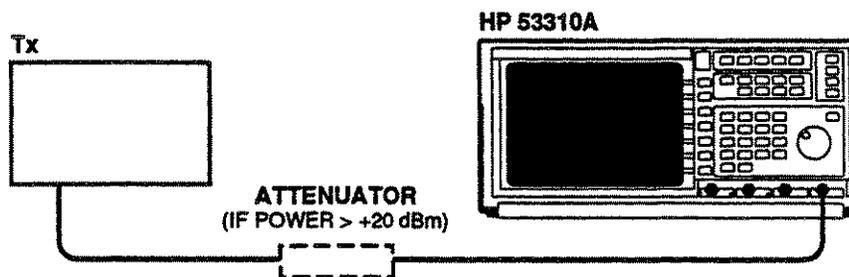
Note

Using Autoscale will reset this trigger level to a default value. If you inadvertently press the Autoscale key, you can recall the previous setup by pressing the Save/Recall key, the Recall Setup softkey, and then the 0 key.

Part Four: Measure the transmitter transient frequency

At this point, the HP 53310A is set to make a frequency measurement on the C channel and the input has been adjusted to the testing level for the transmitter under test.

Remember to protect the input of the HP 53310A, if necessary.



Using Digital RF Communications Analysis
To measure transmitter turn on/off frequency transients

Connect the transmitter.

- 1 **Connect the transmitter under test to the C channel.**

Ensure that any required attenuation is inserted between the transmitter and the HP 53310A. See the procedure "Measure the output power of the transmitter" at the beginning of this procedure for more on attenuation.

Set the timebase controls.

- 1 **Press the Timebase key.**
- 2 **Press the top softkey to select the time/div field.**
- 3 **Set the value to 10 ms/div, or to a value more appropriate for your test.**

A time/div value of 10 ms/div will display 100 ms of data (there are ten divisions across the display left to right).

- 4 **Set the Reference to Left.**

Set the vertical controls.

- 1 **Press the Vertical key.**
- 2 **Set the Center value to the center frequency, if not already done.**
- 3 **Enter a span value that is twice the channel spacing for your radio system.**

Now the top and bottom of the display will be one channel spacing away from the channel under test at the center of the display.

Using Digital RF Communications Analysis
To measure transmitter turn on/off frequency transients

Set the trigger controls.

- 1 Press the Trigger key.**
- 2 Select Triggered.**
- 3 Select RF Env.**
- 4 Select rising or falling edge as appropriate for your measurement.**

Use the rising edge for turn-on transient and the falling edge for the turn-off transient.

Note

When measuring the turn-off transient, set the timebase reference to center or right so you can view the response as the transmitter powers down.

Make the measurement.

- 1. Turn on the transmitter.**

If you have a radio that does not use the Time-Division Multiple Access (TDMA) or Time Division Duplex (TDD) systems, you will need to make the RF output ramp up. This can be done by “keying” the transmitter using the Push-to-Talk button.

Automatically measure the settling time of the transient.

Enable the settling time feature.

- 1 Press the blue Shift key and then the Setl Time key.**

This selects the settling time feature. Your settling time result is not displayed until you set the markers in the next step.

Using Digital RF Communications Analysis
To measure transmitter turn on/off frequency transients

Set the markers.

- 1 Press the Markers key.
- 2 Set Time Markers to On.
- 3 Set Freq Markers to F/ Δ F.
- 4 Enter the settled frequency for the synthesizer as the F value.
- 5 Enter the plus and minus range for the tolerance band as the Δ F +/- value.

If the settled frequency is on the display, you can use the tracking feature instead of entering a frequency value. Select TRACK and the instrument will automatically find this value for you.

The settling time displayed at the lower-left corner of the display is the length of time between the instant when the input signal went through the set power level and when the frequency settled within the tolerance band. One of the vertical markers is positioned at the settling point.

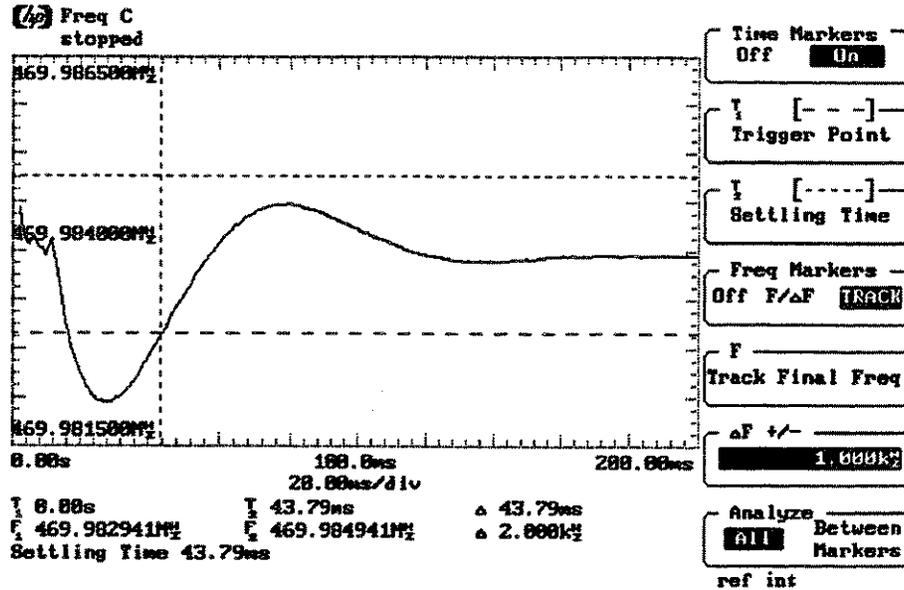
Measure a single transient

- 1 Press the Stop/Single key.
This stops the HP 53310A.
- 2 Press the Stop/Single key again.

Using Digital RF Communications Analysis
To measure transmitter turn on/off frequency transients

3 Apply the RF pulse burst.

The HP 53310A will measure the transient and display the results. The results will be similar to the waveform shown here.



Results

Compare the results from the HP 53310A display with the requirements over the specified times. The test specifications require that the turn-on transient settles to within a specified frequency range within certain time periods. For example, a radio transmitter may need to settle within a one channel spacing 5 ms after the RF output power is switched on. Between 5 ms and 25 ms, the transmitter may have to settle within a 1/2 channel spacing, and thereafter maintain a 1/8 channel spacing.

Using Digital RF Communications Analysis
To measure center frequency and peak deviation

To measure center frequency and peak deviation

The HP 53310A Option 031 automatically calculates center frequency and peak frequency deviation from histogram plots based on thousands of data measurements.

Radio systems, such as CT-2 and DECT, require that radios meet a specification for center frequency and peak deviation in order to guarantee error-free operation.

Note

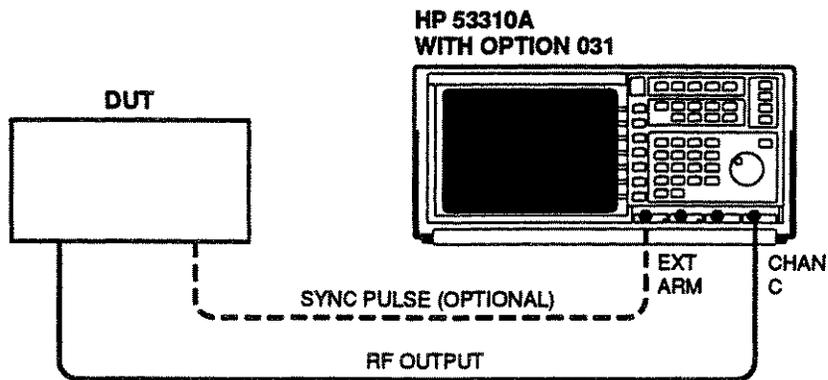
An abbreviated version of this measurement procedure is in the introduction. Use it as a guide after you become familiar with this procedure.

Using Digital RF Communications Analysis To measure center frequency and peak deviation

Overview and equipment setup

The CT-2 radio should be configured to output a TDMA burst. This procedure has you first measure the data and display it as frequency vs. time in order to ensure that you are acquiring the appropriate data. The histogram then shows the distribution of many measurements and the built-in analysis determines the center frequency and peak deviation from the histogram. The start of the measurement can be triggered by a sync pulse or the RF burst envelope. The equipment setup is shown below.

This setup shows the sync pulse as optional. The RF Envelope trigger setting can be used for bursted signals.



Using Digital RF Communications Analysis
To measure center frequency and peak deviation

Center frequency and peak deviation measurement

The following steps demonstrate how to measure center frequency and peak deviation using a CT-2 radio signal as an example.

Preset the HP 53310A.

- 1 Press the Preset key.

Select the channel and input settings.

- 1 Select the C channel.

The Frequency measurement function is already selected by Preset.

- 2 Press the CONFIGURE INPUT softkey.
- 3 If you are using a sync trigger, select the Ext input.
- 4 For your Ext Arm input signal, select the appropriate Volt Threshold setting.

You are setting the voltage threshold for your sync trigger. The HP 53310A will sense a signal that passes through the voltage level selected: 0 volts, 1.5 volts (TTL), or -1.3 volts (ECL). A signal transition from low to high or high to low can be detected and will mark the start of the measurement.

Note

The rising or falling edge of the sync trigger signal is selected on the Trigger menu. This is described under "Set the trigger controls" below.

- 5 If you are using a 10:1 probe at the Ext Arm input, select the 10:1 probe setting.

Using Digital RF Communications Analysis
To measure center frequency and peak deviation

Autoscale the HP 53310A.

If you have a single-shot measurement situation, skip over this step.

- 1 Press the **Autoscale** key.

The autoscale feature will usually “find” repetitive signals. This is an easy way to have the instrument adjust itself to display your signal.

Set the timebase controls.

- 1 Press the **Timebase** key.
- 2 Press the top softkey to select the **time/div** field.
- 3 Use the knob to adjust the amount of data captured, or enter a value appropriate for your measurement.

Hint: For a CT-2 system, try 5 $\mu\text{s}/\text{div}$ to 20 $\mu\text{s}/\text{div}$.

You can use the Delay feature to position the data of interest on the display. The frequency vs. time display shows the FSK modulation on the RF carrier.

Using Digital RF Communications Analysis
To measure center frequency and peak deviation

Collecting more data

Use the Panorama feature to acquire multiple screens of data. The extended measurement memory option (Option 001) captures up to 80 screens of data. The standard memory configuration provides up to 20 screens of data.

When the Panorama feature is enabled, a second display area appears above the main display. This reduced display shows the entire acquisition and uses vertical indicators to highlight the portion of the data visible in the main display.

For example, the panorama display can show an entire time slot of information. The main display can be used to show greater detail (use the Window Timebase feature) and can be positioned anywhere in the panorama by adjustment of the Window Position feature. Analysis results are based on the panorama display data. The "Histogram From vs Time" mode also includes all the panorama data.

4 Set Reference to Left.

This moves the 0.00s time to the left edge of the display.

Set the vertical controls.

1 Press the Vertical key.

2 Adjust the Center and Span values as needed.

Try to adjust the center and span values so the data covers most of the display. This provides results with better resolution than those produced for a larger span.

Using Digital RF Communications Analysis
To measure center frequency and peak deviation

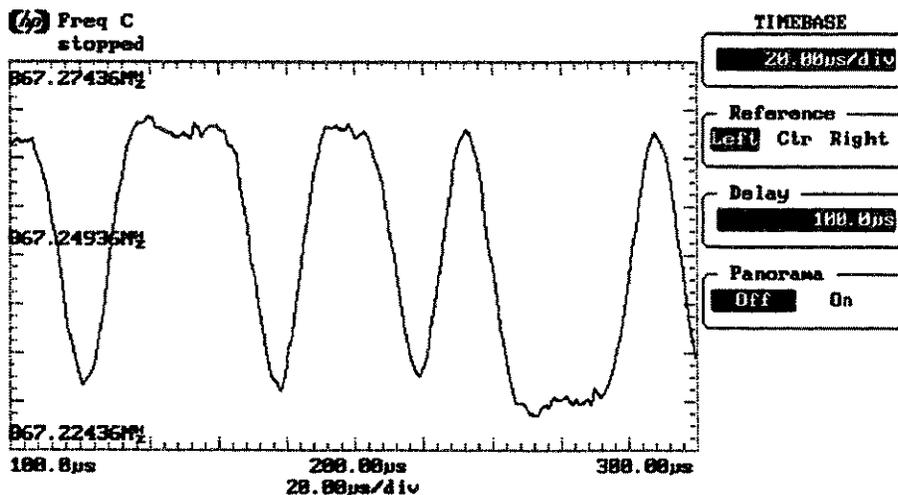
Set the trigger controls.

- 1 Press the Trigger key.
- 2 Select Triggered.
- 3 If you are using a sync trigger, select Ext Edge, Time Ref, and the slope appropriate for your sync trigger signal.
- 4 If you want to trigger on the TDMA burst, select RF Env and the rising edge.

vs Time view of data

At this point, you should see a waveform of the data similar to the one shown below. This is a view of frequency vs. time.

The HP 53310A directly shows the FSK modulation on the signal. Note that the timebase delay is set to 100 μ s to delay into the data.



Using Digital RF Communications Analysis
To measure center frequency and peak deviation

Select the fast histogram mode.

- 1 Press the Histogram key.
- 2 Select Histogram.
- 3 Select Fast Hist.
- 4 Enter 1000 as the # of Measurements, if not already set.
- 5 Set Hist Accumulate to On.

Note

The selection of *Hist From vs Time* will cause approximately 250 measurements per acquisition when not using Panorama (on the Timebase menu). With *Fast Hist*, much larger numbers can be specified, and data is acquired more quickly, because the data is not first acquired in the vs. Time mode.

Enable the center frequency and peak deviation features.

- 1 Press the blue Shift key and then the FSK Ctr key.
- 2 Press the blue Shift key and then the FSK Dev key.

Set the markers.

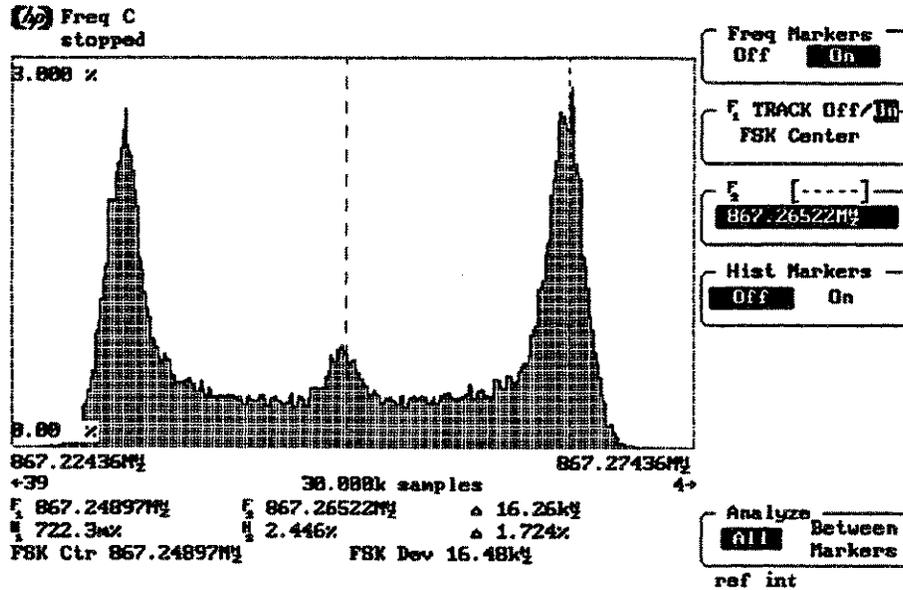
- 1 Press the Markers key.
- 2 Set Freq Markers to On.
- 3 Set Track to On.

The markers automatically go to the minimum and maximum peaks. These are the points used to calculate the center frequency and the peak deviation. Center frequency is defined as the midpoint between the deviation peaks.

Using Digital RF Communications Analysis
To measure center frequency and peak deviation

- To have a marker show the location of center frequency, enable the FSK Ctr feature again.

The data was collected using the Fast Histogram mode. One of the markers is showing the position of the FSK center frequency. The other marker is at the maximum peak deviation.



Using Digital RF Communications Analysis
To measure center frequency and peak deviation

Measuring Fast Data Rate Systems

The example in this section uses a CT-2 radio signal. The modulation data rate, or bit rate, for this system is 72 kbits/s. This is well under the default 1 MHz sampling rate of the HP 53310A. If you are measuring a faster data rate system, such as DECT with a 1.152 Mbits/s rate, a 1 MHz sampling rate is no longer adequate. The sample rate needs to be at least 2.304 MHz in order to characterize the modulation on the signal. A faster sampling rate is needed.

For measuring fast data rate systems, use the sampling mode called "Fast". It provides an effective sampling rate up to 8 MHz. Use Fast sampling for any radio system with a bit rate over 300 kbits/s.

Follow these steps to use Fast sampling:

- 1 Press the Sampling key.**
- 2 Select Fast sampling.**

Turn the page for more about Fast sampling.

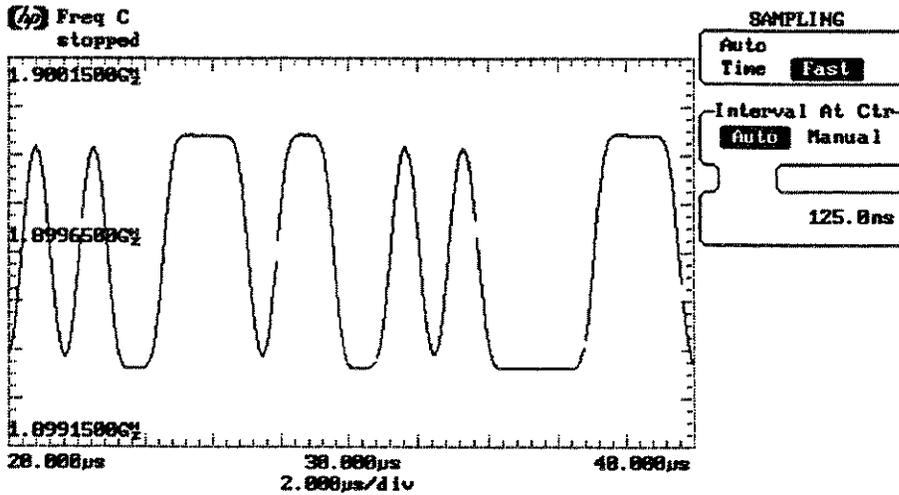
Using Digital RF Communications Analysis
 To measure center frequency and peak deviation

Fast Sampling

When set to Fast sampling, the HP 53310A makes consecutive acquisitions of 16 measurement samples until enough data is collected to fill the display. This can be up to 225 measurements across the vs. Time display representing 14 separate acquisitions. Each of these acquisitions requires a trigger. For example, if 225 measurements were needed and the trigger condition was an edge at the External Arm input, 14 trigger edges, along with the signal being measured, would be needed before enough measurement data would be acquired and displayed. This sampling scheme produces an effective sampling rate of up to 8 MHz.

In the display below, the gaps in the waveform identify the individual acquisitions.

A DECT signal was acquired using the Fast sampling mode. Connect Data is on showing the individual groups of samples.



ref int

**Using Digital RF Communications Analysis
To measure center frequency and peak deviation**

Operating Characteristics

Fast sampling increases the effective sampling rate up to 8 MHz. But when using Fast sampling there are certain behaviors you need to understand.

- Because of how Fast sampling operates, it is recommended that you do not use Fast sampling to search for an unknown signal. Use Auto sampling to first find and display the signal, then switch to Fast sampling.
- Use the triggered mode (see Trigger menu) when using Fast sampling. This provides a reference for the multiple acquisitions collected as part of the Fast sampling mode.
- When Connect Data is on (see Display menu), you can see which samples are grouped together in each sampling group separated by a gap.
- The Fast sampling mode is not able to show pre-trigger data.

Using Digital RF Communications Analysis
To check transmitter performance using an eye diagram

To check transmitter performance using an eye diagram

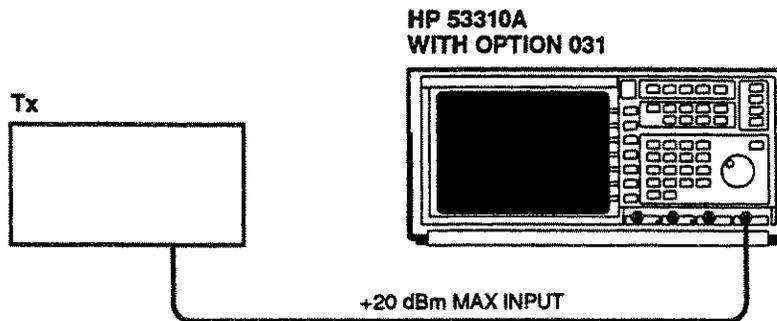
Eye diagrams are often used to characterize baseband modulating signals. The diagram gives a quick qualitative view of the modulation.

The HP 53310A Option 031 produces an RF eye diagram by repetitively measuring the modulated data stream on the RF carrier, and overlaying multiple acquisitions using the infinite persistence feature. The measurement is made at the transmitter's output on random data streams and the resulting eye pattern provides a qualitative view of transmitter performance.

Overview and equipment setup

Set the equipment so the radio is transmitting data. Connect the RF output to the HP 53310A (+20 dBm max input).

Note: Limit the RF power to the Channel C input to less than +20 dBm.



Using Digital RF Communications Analysis
To check transmitter performance using an eye diagram

Eye diagram measurement

The following steps demonstrate how to produce an eye diagram using a GSM radio signal.

Preset the HP 53310A.

- 1 Press the Preset key.**

Select the channel and input settings..

- 1 Select the C channel.**

The Frequency measurement function is already selected by Preset.

Autoscale the HP 53310A.

- 1 Press the Autoscale key.**

The autoscale feature will usually “find” repetitive signals. This is an easy way to have the instrument adjust itself to display your signal.

Should autoscale fail to properly display the modulated RF carrier, adjust the time/div on the Timebase menu, the Center value and the Span value on the Vertical menu until the modulation on the carrier is displayed.

Using Digital RF Communications Analysis
To check transmitter performance using an eye diagram

Set the trigger controls.

- 1 Press the Trigger key.
- 2 Select Triggered.
- 3 If you are using a trigger, such as a data clock, select Ext Edge, Time Ref, and the slope.
- 4 If you can trigger on the TDMA burst, select RF Env and the rising edge.

Set the timebase controls.

- 1 Press the Timebase key.
- 2 Set the Reference to Left.
- 3 Press the top softkey to select the time/div field.
- 4 Use the knob to adjust the amount of data captured, or enter a value appropriate for your measurement.

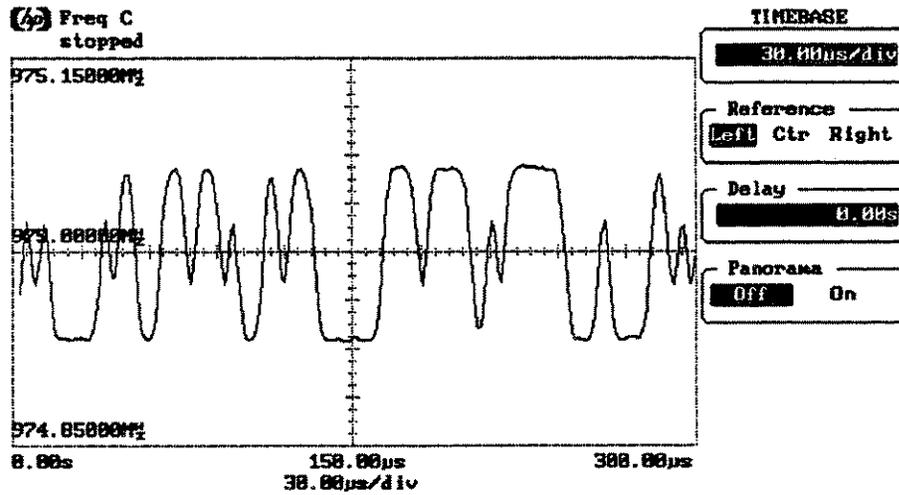
Using Digital RF Communications Analysis
To check transmitter performance using an eye diagram

Set the vertical controls.

1. Press the Vertical key.
2. Adjust the Span value, if necessary, so the data covers at least half of the display.

At this point, you should see a waveform of your data similar to the one shown below.

This is the first step in producing an eye diagram.



ref int

Using Digital RF Communications Analysis
To check transmitter performance using an eye diagram

Measuring Fast Data Rate Systems

This example uses a GSM radio signal. The modulation data rate, or bit rate, for this system is 270.833 kbits/s. This data rate can be adequately measured using the default 1 MHz sampling rate of the HP 53310A.

For measuring fast data rate systems, use the sampling mode called "Fast". It provides an effective sampling rate up to 8 MHz. Use Fast sampling for any radio system with a bit rate over 300 kbits/s.

Overlay many acquisitions.

- 1 Press the Display key.**
- 2 Set Persistence to Infinite.**

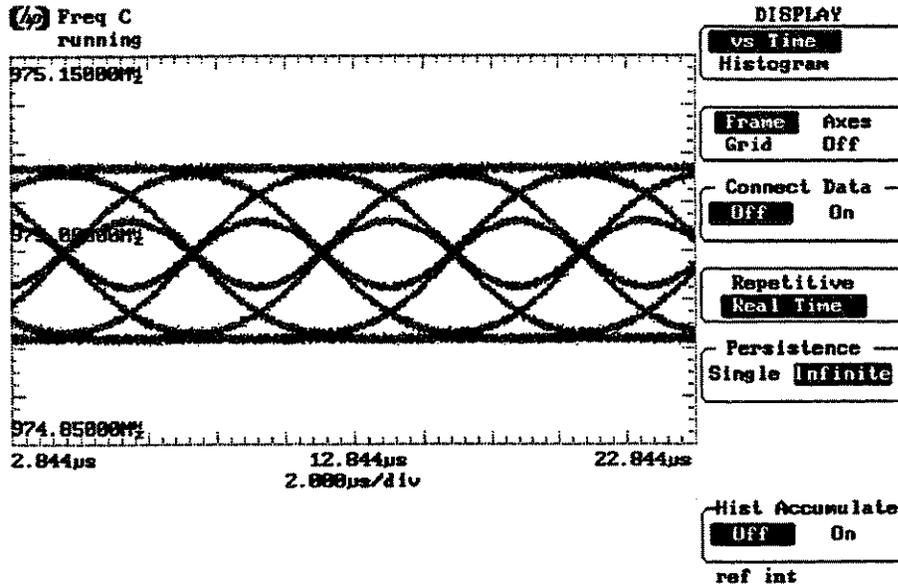
Adjust the timebase controls.

- 1 Press the Timebase key.**
- 2 Adjust the time/div value until the familiar eye diagram pattern appears.**

For this GSM example, the time/div value was decreased (from 30 μ s to 2 μ s) to produce the display shown on the next page.

Using Digital RF Communications Analysis
 To check transmitter performance using an eye diagram

RF eye diagram of a GSM radio signal.



Results

The eye diagram gives you a quick, qualitative view of modulation. Eye closure in the horizontal (time) direction is often due to timing jitter. Eye closure in the vertical (frequency) direction is often due to Inter Symbol Interference (ISI) or filtering problems. Use the markers to measure the amount of jitter or ISI.

**Using Digital RF Communications Analysis
To check transmitter performance using an eye diagram**



2

Using the Downconverter

Using the Downconverter In this chapter

In this chapter

The HP 53310A with option 031 has an internal downconverter for making high resolution measurements on channel C. It is a fundamental-frequency downconverter. This means the input signal and a local oscillator (LO) are mixed together to produce an intermediate frequency (IF). This is the downconverted signal and is equal to the RF input frequency minus the LO. The downconverted signal is then measured by the HP 53310A. This chapter describes how to use the downconverter with both the internal LO, or an external LO that you provide.

Prescaled or downconverted measurements

The HP 53310A is able to measure frequencies on channel C from 50 MHz to 2.5 GHz without downconversion. This is accomplished with a divide-by-64 prescaler that divides down the input frequency so the HP 53310A can count it. The measured frequency is then multiplied by 64 and displayed as a measurement result. Option 031 adds the ability to make higher resolution frequency measurements using an internal downconverter that measures the frequency range 200 MHz to 2.5 GHz.

Do I use the prescaler or the downconverter?

In most cases, you do not need to think about it. When using the internal LO, the HP 53310A will switch automatically between prescaled or downconverted measurements for channel C as necessary for the current instrument settings.

In general, prescaled measurements satisfy most situations where you are measuring wide changes of frequency in the MHz range. Downconversion is more appropriate for making stability measurements or those measurements where you are trying to characterize a narrow frequency change in the kHz range.

**Using the Downconverter
In this chapter**

When in doubt, use Auto Select

Auto Select is the default operating condition. On the LO menu (press Utility key, then LO MENU), there is a softkey option for selecting between Auto Select and Prescale Only. If you are using the internal LO, Auto Select will automatically configure the HP 53310A to select the most appropriate method, prescale or downconvert, for your measurement based on the settings of center frequency, timebase, and vertical span (on the Vertical menu or in the LO menu). For frequencies below approximately 200 MHz, prescale is always used.

If you are using an external LO, you can still use Auto Select but you will need to enter the LO frequency on the LO menu for each new frequency measurement. An LO frequency will be suggested for you based upon the center frequency and the frequency span settings.

Hint: The HP 53310A displays at the top of the screen whether it is making a prescaled or downconverted measurement whenever the LO menu is selected.

Using the Downconverter Downconverter

Downconverter

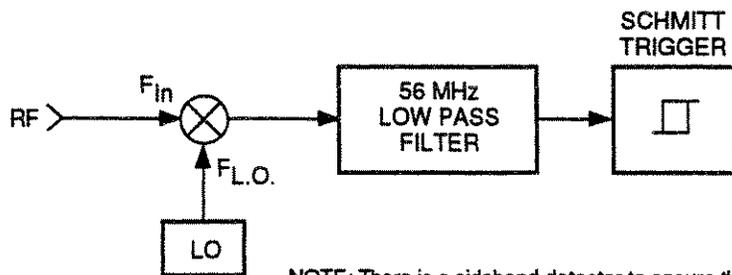
The most common reason for downconversion is to bring the input signal into range of the instrument being used to measure the signal. But there are other reasons to downconvert.

Downconversion also improves the resolution of frequency measurements. More specifically, the resolution improves by the ratio of the RF (the original frequency) to the IF (the downconverted frequency). In addition, the phase is preserved for the signal being downconverted.

A block diagram is included here for your information. This diagram is intended to give you a view of the major elements of the internal fundamental-frequency downconverter.

Block Diagram of Downconverter

The downconverter consists of a mixer, low pass filter and a Schmitt trigger.



NOTE: There is a sideband detector to ensure that F_{in} is greater than $F_{L.O.}$ to 2.5 GHz.

Using the Downconverter
Using the Internal LO

Using the internal LO

Downconversion using the internal LO is automatically selected when Auto Select is enabled on the LO menu and certain instrument settings such as a small vertical span and time/div indicate a need for high resolution frequency results.

The internal LO is intended to make your life easier. Use it whenever you can. You may want to switch to an external LO if you find the performance of the internal LO limits your measurement performance. This will be exhibited by noise on your measurements at very narrow spans and short time/div values.

Hint: When you suspect that you are running up against the noise of the internal LO, substitute an external LO and see if the performance improves. For a comparison of internal to external LO resolution, refer to the specifications in the introduction. The procedure for using an external LO is described in the next section.

Using the Downconverter
Using the internal LO

To use the internal LO for downconversion.

- 1. Connect the jumper cable at the rear panel between the LO In and LO Out connectors.**
- 2. Switch on the HP 53310A.**
- 3. Press the Preset key.**
- 4. Select channel C on the Function menu.**
- 5. Connect your RF input signal and press Autoscale.**

For downconversion, the center frequency must be between 200 MHz and 2.5 GHz, the vertical span needs to be 20 MHz or less, and the timebase setting must be 400 μ s or less. These values can be adjusted in the Vertical and Timebase menus.

- 6. Refer to chapter 1 for measurement examples.**

Using the Downconverter
Using an external LO

Using an external LO

If you need resolution beyond what the internal LO can provide, use a high-performance external LO. For a comparison of internal to external LO resolution, refer to the specifications in the introduction.

To use an external LO for downconversion.

1. **Connect your external LO at the rear-panel LO In connector.**
2. **Set the output power of the external LO to +6 dBm \pm 1 dB.**
3. **Switch on the HP 53310A.**
4. **Press the Preset key.**
5. **Select channel C on the Function menu.**
6. **Connect your RF input signal.**
7. **Press the Utility key and then the LO Menu softkey.**
8. **Select Ext LO.**
9. **Set the Vertical Center and Vertical Span values.**
10. **Set the external LO frequency based on the suggested value.**

This value appears on the display when downconversion is compatible with vertical settings. For best results, follow this suggestion.

11. **Enter the frequency of your LO.**

Enter this value on the LO menu as the LO Frequency.

12. **Refer to chapter 1 for measurement examples.**

Using the Downconverter
To disable downconversion

To disable downconversion

In those situations when you do not want the HP 53310A to use downconversion, you can force the instrument to only make prescaled measurements.

1. **Select channel C on the Function menu.**
2. **Press the Utility key and then the LO Menu softkey.**
3. **Select Prescale Only.**

3

Messages

Messages In this chapter

In this chapter

Messages appear at the top of the display to advise of the current operating state of the instrument and, when appropriate, to recommend an action in order to continue using the instrument.

The advisory messages in this chapter are specific to Option 031. Refer to the *HP 53310A Operating Reference Manual* for messages not found here.

Other Information

- Many of the messages are related to LO operation. The LO menu is located under the Utility key. To select the LO menu:
 1. **Select Frequency and Channel C on the Function menu.**
 2. **Press the Utility key and then the LO MENU softkey.**
- When using an external LO, proper operation of the downconverter requires that the frequency of the LO be specified on the LO menu.
- The prescaler is able to measure frequencies on channel C from 50 MHz to 2.5 GHz. This is accomplished with a divide-by-64 prescaler that divides down the input frequency so the HP 53310A can count it. The measured frequency is then multiplied by 64 and displayed as a measurement result. The downconverter adds the ability to make higher resolution frequency measurements over the range of 200 MHz to 2.5 GHz.

Messages
Message Descriptions

Message Descriptions

The messages are in alphabetical order determined by the first words of the messages.

Changed to AUTO SELECT of Prescale or Down Convert.

The Auto Select mode on the LO menu is enabled. Prescale Only was set, but the internal LO is connected with the rear-panel LO jumper cable.

Changed to Internal LO.

The LO function changes from Ext LO to Int LO. Ext LO was selected on the LO menu, but the rear panel LO jumper cable for internal LO operation is connected.

Checking External LO... passed.

On power-up, with Ext LO selected on the LO menu, the Analyzer checks for an LO signal at the rear-panel LO In connector. The test passes if a signal is detected at the same frequency as the LO Frequency value entered on the LO menu.

Checking Internal LO... passed.

On power-up, with Int LO selected on the LO menu, the Analyzer checks for the presence of the rear-panel LO jumper cable and that the internal LO appears to be operating normally.

Messages
Message Descriptions**Env Trigger is no longer selectable.**

This message occurs when the RF Envelope trigger mode is selected (available only for channel C frequency measurements), and the Analyzer is set to a configuration that is not compatible with this trigger mode. For example, the channel selection is changed to A or B. The trigger mode will default to Freq Value trigger (triggering on a measured frequency value).

Ext LO freq differs from value on UTILITY:LO Menu.

On power-up, with Ext LO selected on the LO menu, the Analyzer checks for an LO signal at the rear-panel LO In connector. The Analyzer also checks that the frequency of the signal is the same as the LO Frequency value entered on the LO menu. This message appears when the specified LO frequency does not match that of the signal at the rear-panel LO In connector. To ensure proper external LO operation, either adjust the external LO frequency or enter the correct value on the LO menu.

Ext LO frequency wrong. See UTILITY:LO Menu.

The Autoscale operation found that the frequency of the LO signal at the rear-panel LO In connector was different from the LO frequency value entered on the LO menu. They should be the same.

Note

As a result of setting the vertical center and vertical span values on the LO menu, if the setup supports downconversion an LO frequency will be suggested on the display. For best results, enter this value as the LO Frequency, and set your external LO to this frequency.

Messages
Message Descriptions

Ext LO problem. Left in PRESCALE ONLY mode.

The LO menu settings are Ext LO and Prescale Only. With Prescale Only selected on the LO menu, it does not matter that there seems to be a problem with the external LO. If you should want to use an external LO, determine that the external LO is operating properly and that the correct LO frequency is entered on the LO menu.

Int LO not found. Left in PRESCALE ONLY mode.

The internal LO is selected on the LO menu, but it appears that an external LO is attached at the rear-panel LO In connector. All measurements will be made using the prescaler. If the rear-panel LO jumper cable is in fact connected, this message may indicate a failure of the internal LO.

Int LO not found. Suggest UTIL:LO Menu:PRESCALE ONLY.

The internal LO is selected on the LO menu, but no signal was found at the LO input on the rear panel. This may indicate that the rear-panel LO jumper cable is not connected, or that the internal LO has failed. Select Prescale Only on the LO menu to bypass downconversion and use the prescaler to make measurements.

Internal LO failed test.

On power-up, with Int LO selected on the LO menu, the Analyzer checks for the rear-panel LO jumper and that the internal LO appears to be operating normally. This failure message indicates that the rear-panel LO jumper seems to be connected, because several of the frequency tests were passed, but the internal LO failed other frequency tests.

Messages
Message Descriptions**LO appears to be external. Check UTILITY:LO Menu.**

On power-up, the Analyzer checks the LO setting. It appears that an external LO is connected at the rear panel although Int LO is selected on the LO menu. If you want to use the internal LO, connect the rear-panel LO jumper cable. If you intend to use an external LO, select the Ext LO option on the LO menu. If this message appears when the rear-panel LO jumper cable is already connected, it may indicate a failure of the internal LO.

LO not found. Check LO & rear panel connections.

On power-up, the Analyzer checks the LO setting. Although Ext LO is selected on the LO menu, no LO signal was found. Check that an external LO is connected and operating. If you want to use the internal LO, select Int LO and connect the rear-panel LO jumper cable.

LO signal not present. Check rear panel jumper.

On power-up, no LO signal was detected with Int LO selected on the LO menu.

Measurements made using down-conversion

Channel C measurements are made using the downconverter. The use of the downconverter is based upon the settings of the Vertical menu (narrow span), Timebase menu, Sampling menu, and Utility:LO menu.

Measurements made using pre-scaler

Channel C measurements are made using the pre-scaler. The use of the pre-scaler is based upon the settings of the Vertical menu (wide span), Timebase menu, Sampling menu, and Utility:LO menu.

Messages
Message Descriptions

No Envelope detected. Trying without Envelope.

This message can occur when using RF Envelope trigger (available only for channel C frequency measurements) and the Find Center or Find Center And Span features (on the Vertical menu). If the Analyzer fails in its attempt to use an envelope to characterize the signal, another attempt is made while ignoring any envelope trigger. This message could occur if the input is a CW signal.

No LO found. Left in PRESCALE ONLY mode.

With Prescale Only selected on the LO menu, no LO signal was found at the LO input on the rear panel.

No LO found. Suggest UTIL:LO Menu:PRESCALE ONLY.

With Auto Select set on the LO menu, no LO signal was found at the LO input on the rear panel. If you have no intention of using an LO, select Prescale Only on the LO menu.

PRESCALE ONLY mode. See UTILITY:LO Menu to change.

With Ext LO selected and an external LO connected at the rear panel, Prescale Only is selected on the LO menu. If you want to measure using the external LO, choose Auto Select and correctly set LO Frequency on the LO menu.

Note

Proper operation of the downconverter when using an external LO requires that the frequency of the LO be specified on the LO menu. The specified LO frequency should match that of the signal at the rear-panel LO In connector.

Messages
Message Descriptions

Switching to Internal LO. Internal LO test passed.

On power-up, the Analyzer determined that the rear-panel LO jumper cable is connected for internal LO operation, but Ext LO is selected on the LO menu. The Analyzer switches to the Int LO setting.

Trying without Envelope

This message can occur when using RF Envelope trigger (available only for channel C frequency measurements) and the Find Center or Find Center And Span features (on the Vertical menu). If the Analyzer fails in its attempt to use an envelope to characterize the signal, another attempt is made while ignoring any envelope trigger.

Using Envelope Trigger

This message simply advises that when set to RF Envelope trigger (available only for channel C frequency measurements) and the Find Center or Find Center And Span features (on the Vertical menu) are enabled, the Analyzer is using the envelope to characterize the signal.

4

Programming Information

**Programming Information
In this chapter**

In this chapter

This chapter describes the commands used to program the Digital RF Communications Analysis and High Resolution Input capabilities of the HP 53310A with option 031.

The information is organized as follows:

- Overview of the new commands.
- A detailed description of each command.

Conventions used in this chapter

- All the programming examples assume that the HP-IB controller interface is set to a select code of 7 and the HP 53310A is set to a device address of 12 (OUTPUT 712).
- The short form of the SCPI commands are used in all the example program strings.

Hint: An easy way to set the HP 53310A to a particular configuration is to manually save the setup in one of nine memory registers (Save/Recall key). Then use the *RCL command in your program to restore the desired setup needed for your measurement.

Programming Information
In this chapter

Other information

- This manual does not contain all the programming information you will need. Refer to the *HP 53310A Programming Reference Manual* for information you do not find here about programming the HP 53310A.
- Information on reading the error queue is in appendix F of the *HP 53310A Programming Reference Manual*.

Hint: All other front-panel features are mapped to the equivalent SCPI commands in chapter 1 of the *HP 53310A Programming Reference Manual*. Use those pages to quickly find the SCPI command to control a front-panel feature.

Programming Information
Overview of Programming Commands

Overview of Programming Commands

The commands for option 031 are most easily understood by relating them to the front-panel features they control. This chapter uses this approach. The commands can be categorized as those controlling analysis features, the Input menu, the LO menu, the Markers menu, the Sampling menu, and the Trigger menu.

This chapter assumes that you understand how to program with Standard Commands for Programmable Instruments (SCPI). If not, please review the *HP 53310A Programming Reference Manual*.

Table 4-1. Features in brief

FEATURE	PURPOSE	PAGE REFERENCE
ANALYSIS FEATURES		
FSK Center	Display the center frequency.	4-9
FSK Deviation	Display the peak deviation.	4-10
Settling Time	Display the settling time.	4-11
INPUT MENU		
Envelope Trigger Level	Set the envelope trigger level for channel C.	4-13
LO MENU		
Internal or External LO	Select the internal LO or the external LO mode.	4-15
Auto Select or Prescale Only	Prescale Only disables the downconverter.	4-16
Suggested LO Frequency	When external LO is selected and downconversion is possible, the recommended LO frequency is returned by this query.	4-18
LO Frequency	Specify for the HP 53310A the LO frequency of an external LO.	4-17

Programming Information
Overview of Programming Commands

Table 4-1. Features in brief (continued)

FEATURE	PURPOSE	PAGE REFERENCE
MARKERS MENU		
Settling Time Markers	Position the markers and track the settled frequency.	4-20, 4-21, 4-22, 4-24
SAMPLING MENU		
Fast Sampling	Increase the sampling rate for repetitive signals.	4-25
Fast Sampling Interval at Center	Manually set the Interval at Center value.	4-28
TRIGGER MENU		
Time Reference Trigger for Frequency Measurement	Measure frequency starting from an edge on the external arm input.	4-30
Time Reference Trigger for Time Interval Measurement	Measure time intervals starting from an edge on the external arm input.	4-33
Envelope Trigger	Select envelope trigger mode for a pulsed signal on channel C.	4-31
Envelope Trigger Slope	Trigger on the positive or negative slope of a pulsed signal on channel C.	4-32

Programming Information
Option 031 Commands Summary

Option 031 Commands Summary

Table 4-2. Option 031 Subsystem Commands Summary.

KEYWORD	PARAMETER FORM	STD/ NEW	COMMENTS AND RESET VALUES (*RST=)
:CALCulate		Std	Subsystem. Post acquisition data processing.
:ANALysis		New	Subtree.
:FSKCenter		New	Subtree. FSK Center Frequency function.
[:STATe]	ON 1 OFF 0	New	Maximum of 4 analysis functions enabled at a time. *RST=OFF.
:RESult?		New	Query Only. State must be ON to query results.
:FSKDeviation		New	Subtree. FSK Peak Deviation function.
[:STATe]	ON 1 OFF 0	New	Maximum of 4 analysis functions enabled at a time. *RST=OFF.
:RESult?		New	Query Only. State must be ON to query results.
:STIMe		New	Subtree. Settling Time function. Use with Frequency markers.
[:STATe]	ON 1 OFF 0	New	Enabling Settling Time disables all other analysis functions. Enabling any other analysis function disables Settling Time. *RST=OFF.
:RESult?		New	Query Only. State must be ON to query results.
:MARKer		Std	Subsystem.
:FREQUency		New	Subtree. Frequency markers. Use with Settling Time function.
[:STATe]	ON 1 OFF 0	New	Enables Frequency markers. *RST=OFF.
:POSition[1 2]	<numeric value> [HZ]	New	Set F and ΔF values by setting POS1 and POS2. POS1=F-ΔF. POS2=F+ΔF. *RST=POS1 is 85 MHz and POS2 is 115 MHz.
:AUTO	ON 1 OFF 0	New	ON=Selects frequency tracking if Frequency markers are on. *RST=ON.

Programming Information
Option 031 Commands Summary

Table 4-2. Option 031 Subsystem Commands Summary. (Continued)

KEYWORD	PARAMETER FORM	STD/ NEW	COMMENTS,RELATED FIGURES, AND RESET VALUES (*RST=)
[[:SENSe] :EVENT3		Std New	Subsystem. Subtree. Channel C envelope trigger level.
:AMPLitude :RELative	<numeric value>	New New	Subtree. 0 to 100. *RST=8.
:FREQuency :ARM :FCFInterval[1 2 3]	<numeric value> [S]	Std New New	Subtree. Subtree. Frequency sampling. Sampling interval at Center Frequency for FREQ:ARM:SOUR FAST.*RST=5E-6.
:AUTO	ON 1 OFF 0	New	ON couples interval to SWEp:TIME :SPAN. *RST=ON.
:SOURce	AUTO EXTernal FAST LINK TIMer	New	LINK specifies sampling on edge of A or B (frequency A or B, respectively), or external (frequency C). *RST=AUTO.
:CMODE?		New	Query Only. Returns prescaler or downconverter mode for channel C.
:LOScillator :LEVel :MODE	<numeric value> [HZ] AUTO PONLy	New New New	Subtree. Local Oscillator. Specify frequency of External LO. Auto select between prescaler and downconverter or prescaler only. *RST=AUTO
:SLEVel?		New	Query Only. Suggested External LO frequency.
:SOURce	ELOScillator ILOScillator	New	Select internal or external local oscillator

Programming Information
Option 031 Commands Summary

Table 4-2. Option 031 Subsystem Commands Summary. (Continued)

KEYWORD	PARAMETER FORM	STD/ NEW	COMMENTS, RELATED FIGURES, AND RESET VALUES (*RST=)
:TRIGger		Std	Subsystem. Used to synchronize vs. Time measurements.
:FREQuency		New	Subtree.
:EEMode[1 2 3]	AONLY TREReference	New	External edge arm only or time reference. TRIG:SOUR EXT required. *RST=AONLY.
:MODE	ENVELOpe LEVel	New	RF Envelope or frequency value trigger. Channel C only. *RST=FREQ value.
:SLOPe	POSitive NEGative	New	Trigger on rising or falling edge of RF envelope. TRIG:FREQ:MODE ENV required. *RST=POS.
:TINTerval		New	Subtree.
:EEMode	AONLY TREReference	New	External edge arm only or time reference. TRIG:SOUR EXT required. *RST=AONLY.

Analysis Features

The analysis features are part of the SCPI :CALCulate subsystem. Place these commands in your program after those that will initiate the measurement.

FSK Center On/Off

Once data is acquired into a histogram, this command will cause the value midway between the lower and upper statistical modes of the data to be calculated and displayed.

Command syntax :CALCulate:ANALysis:FSKCenter[:STATe] ON|1|OFF|0

Example OUTPUT 712;"CALC:ANAL:FSKC ON"

- Comments**
- This is similar to pressing the blue Shift key and then the FSK Ctr key on the front panel.
 - Put this command in your program after commands to acquire data into a histogram.
 - This command will disable the Settling Time feature if it is enabled.

Programming Information Analysis Features

Query for FSK Center Result

Use this query to return the FSK center frequency result.

Query syntax :CALCulate:ANALysis:FSKCenter:RESult?

Example OUTPUT 712;"CALC:ANAL:FSKC:RES?"

- Comments**
- This query will operate correctly only on histogram data after FSK Center has been enabled.
 - If the HP 53310A is not set to a histogram mode before sending this query, a value of 9.91E+37 will be returned indicating invalid data. An error message will be displayed and put into the error queue.

FSK Deviation On/Off

Once data is acquired into a histogram, this command will cause one half the difference between the lower and upper statistical modes of the data to be calculated and displayed. This value is commonly referred to as "peak deviation".

Command syntax :CALCulate:ANALysis:FSKDeviation[:STATe] ON|1|OFF|0

Example OUTPUT 712;"CALC:ANAL:FSKD ON"

- Comments**
- This is similar to pressing the blue Shift key and then the FSK Dev key on the front panel.
 - Put this command in your program after commands to acquire data into a histogram.
 - This command will disable the Settling Time feature if it is enabled.

Query for FSK Deviation Result

Use this query to return the FSK peak deviation result.

Query syntax :CALCulate:ANALysis:FSKDeviation:RESult?

Example OUTPUT 712;":CALC:ANAL:FSKD:RES?"

- Comments**
- This query will operate correctly only on histogram data after FSK Deviation has been enabled.
 - If the HP 53310A is not set to a histogram mode before sending this query, a value of 9.91E+37 will be returned indicating invalid data. An error message will be displayed and put into the error queue.

Settling Time On/Off

This command will enable the Settling Time feature. The frequency markers must be set correctly before a settling time result will be calculated and displayed. Review the procedure in chapter 1 for making a settling time measurement if you need to study the sequence of steps.

Command syntax :CALCulate:ANALysis:STIME[:STATe] ON|1|OFF|0

Example OUTPUT 712;":CALC:ANAL:STIM ON"

- Comments**
- This is similar to pressing the blue Shift key and then the Setl Time key on the front panel.
 - Put this command in your program after commands to acquire the data on the display and set the settled frequency and the tolerance band values on the Marker menu. (See marker commands later in this chapter for how to set the markers for a settling time measurement.)
 - This command disables all other analysis features.

Programming Information
Analysis Features

Query for Settling Time Result

Use this query to return the settling time result.

Query syntax :CALCulate:ANALysis:STIMe:RESult?

Example OUTPUT 712;"CALC:ANAL:STIM:RES?"

- Comments**
- This query will operate correctly only on vs Time data after Settling Time has been enabled.
 - If the HP 53310A is not set to the frequency function and the vs Time mode, a value of 9.91E+37 will be returned indicating invalid data. This value will also be returned if a settling time measurement cannot be made because the waveform is not displayed properly on the screen or marker values are not set appropriately. An error message will be displayed and put into the error queue.

Input Menu

The only Input menu feature added for option 031 is an envelope trigger feature for setting the trigger level on pulsed signals. The commands are part of the SCPI :SENSE subsystem. Place these commands in your program where the input channels are being configured prior to making a measurement.

Envelope Trigger Level for Channel C

This feature provides the ability to position the trigger level on the envelope of a pulsed signal at channel C. This feature is used together with the RF Envelope setting on the Trigger menu. It is a relative adjustment with no units and a range of 0 to 100. The larger the number, the higher on the voltage amplitude of the envelope the HP 53310A will trigger.

Command syntax [:SENSE]:EVENT3:AMPLitude:RELative <numeric value>

Example OUTPUT 712;"EVEN3:AMPL:REL 50"

- Comments**
- This command sets the trigger level value to the middle of the range.
 - From the front panel, you would press the Function & Input key, the CONFIGURE INPUT softkey, select channel C and use the knob to set a relative value between the minimum and the maximum values. Use the Fine key to change the step increment from 10 to 1.
 - The numeric value range is 0 to 100, with no suffix allowed. The value has no units.

Programming Information Input Menu

Comments (continued)

- When you Preset the instrument, send a Reset command, or autoscale a signal on channel C, the trigger value is set to a default value of 8.
- Substituting "MINimum" in place of a numeric value sets the value to 0. Using "MAXimum" sets a value of 100.
- A negative entry results in a 0 value being set and the HP-IB error -222 (Data out of range) will be displayed and put into the error queue.
- A positive entry exceeding 100 results in a value of 100 being set and the HP-IB error -222 (Data out of range) will be displayed and put into the error queue.

Query for Envelope Trigger Level

Use this query to return the value set for the envelope trigger level.

Query syntax [:SENSe]:EVENT3:AMPLitude:RELative?

Example OUTPUT 712;"EVEN3:AMPL:REL?"

Comments

- This query is used to determine the current setting of the envelope trigger level.

LO Menu

The Local Oscillator (LO) commands are part of the SCPI :SENSe subsystem. They control the LO parameters found on the LO menu. This menu is only available when channel C is selected on the Function menu. The LO menu is accessed on the front panel by pressing the Utility key and then the LO MENU softkey.

Query for Channel C Mode

This command will return whether the measurements are made using the prescaler or the downconverter.

Query syntax [:SENSe]:FREQuency:CMODE?

Example OUTPUT 712;"FREQ:CMOD?"

- Comments**
- "PRES" is returned if the prescaler is used. "DOWN" is returned if the downconverter is used.
 - This information is shown on the display when the LO menu is selected.

Internal LO or External LO

Use this command to select the internal LO or select for an external LO.

Command syntax [:SENSe]:FREQuency:LOSCillator:SOURce ELOScillator | ILOScillator

Example OUTPUT 712;"FREQ:LOSC:SOUR ELOS"

- Comments** To do this from the front panel, you would press the Utility key, the LO MENU softkey, and then the top softkey to select between internal or external LO.

Programming Information
LO Menu

Query for Internal LO or External LO

This query returns the local oscillator setting, internal or external.

Query syntax [:SENSe]:FREQuency:LOSCillator:SOURce?

Example OUTPUT 712;"FREQ:LOSC:SOUR?"

- Comments**
- "ELOS" is returned when external LO is selected.
 - "ILOS" is returned when internal LO is selected.

Auto Select or Prescale Only

This command is used to set Auto Select or Prescale Only on the LO menu. The default condition is Auto Select, and this is also the recommended mode of operation. In this mode, the HP 53310A selects the most appropriate mode for the particular measurement being made.

Command syntax [:SENSe]:FREQuency:LOSCillator:MODE AUTO|PONLy

Example OUTPUT 712;"FREQ:LOSC:MODE PONL"

- Comments**
- "PONL" will override downconversion forcing all measurements to be made using the prescaler.
 - "AUTO" will let the HP 53310A switch between prescaled and downconverted measurements, as appropriate for the measurement.

Query for Auto Select or Prescale Only

Use this query to return whether Auto Select or Prescale Only is selected.

Query syntax [:SENSe]:FREQuency:LOSCillator:MODE?

Example OUTPUT 712;"FREQ:LOSC:MODE?"

- Comments**
- "AUTO" is returned if Auto Select is set.
 - "PONL" is returned if Prescale Only is set.

External LO Frequency

Use this query to specify for the HP 53310A what the external LO frequency is when you are using an external LO.

Command syntax [:SENSe]:FREQuency:LOSCillator:LEVel <numeric value> [HZ]

Example OUTPUT 712;"FREQ:LOSC:LEV 1.793E+9"

- Comments**
- Use this command to specify for the HP 53310A the frequency setting of your external LO. It is critical that this value is the same as the external LO frequency.
 - It is also important that the external LO be set at least close to the value suggested by the HP 53310A. The suggested value is designed to provide the best results. Use the value displayed after the vertical center value and vertical span values are set and confirmed as being compatible with downconversion. Use the query for suggested LO frequency to return this value over the HP-IB.
 - The allowed frequency range for an external LO is 150 MHz to 2.5 GHz, but the LO frequency must be close to the RF input frequency to make downconversion possible.

Programming Information
LO Menu

Query for External LO Frequency

Use this query to return the value set for the LO frequency.

Query syntax [:SENSe]:FREQuency:LOSCillator:LEVel?

Example OUTPUT 712;"FREQ:LOSC:LEV?"

Comments

- Use this query to return the LO frequency value currently set.

Query for Suggested LO Frequency

Use this query to return the LO frequency suggested by the HP 53310A based on vertical center and span values.

Query syntax [:SENSe]:FREQuency:LOSCillator:SLEVel?

Example OUTPUT 712;"FREQ:LOSC:SLEV?"

Comments

- Use this query after you have set the vertical center frequency and the vertical span value. These settings will determine whether downconversion is possible, and if so, the suggested frequency for the external LO.
- A value of 9.91E+37 is returned when downconversion is not possible. The vertical center or vertical span values then need to be modified to make downconversion possible. HP-IB error 2012 ("Vert data out of range") will be displayed and put into the error queue.
- This command is only compatible with external LO operation. See chapter 2 for more on how to use an external LO to make measurements with downconversion.
- To enable downconversion, set vertical center between 200 MHz and 2.5 GHz, set vertical span less than 20 MHz.

Markers Menu

The syntax for the option 031 marker commands are the same as for a non-option 031 instrument. The difference is in how the results are interpreted when the Settling Time feature is enabled. The commands are part of the SCPI :MARKer subsystem.

When the Settling Time feature is enabled and “Analyze All” is selected, the Time Markers are dedicated to showing positions relevant to the settling time measurement. To have control of the Time Markers, select “Analyze Between Markers”.

Note

For all the marker commands, refer to the *HP 53310A Programming Reference Manual* for a description of marker behavior when the Settling Time feature is not enabled.

Programming Information
Markers Menu

Frequency Markers On/Off

After the Settling Time feature is enabled (see Settling Time On/Off), there are options specific to a settling time measurement available. These options let you specify the settled frequency value and the tolerance band for the measurement.

Command syntax :MARKer:FREQuency[:STATe] ON|1|OFF|0

Example OUTPUT 712;"MARK:FREQ ON"

Comments • When this command is sent while the Settling Time feature is enabled, the following occurs:

Sending "ON" (or 1) enables the frequency markers with settling time parameters.

The center frequency and the tolerance band can be specified for the settling time measurement.

Sending "ON" (or 1) enables the F/ Δ F or Track feature, whichever was selected last.

Query for Frequency Markers On/Off

Use this query to return the status of the frequency markers.

Query syntax :MARKer:FREQuency[:STATe]?

Example OUTPUT 712;"MARK:FREQ?"

Comments • When the Settling Time feature is enabled:

A "1" is returned if the frequency markers are set to F/ Δ F or Track.

A "0" is returned if the frequency markers are set to Off.

Setting Markers for Settled Frequency (F) and ΔF

Once you have enabled the frequency markers, you must set the markers (F_1 and F_2) in order to have your settling time correctly calculated and displayed. You need to specify the settled frequency and the delta value, or tolerance band, although there are no F and ΔF commands for setting the values directly.

The marker position commands can be used to set the desired values for F and ΔF . Set the F_1 marker to the settled frequency $- \Delta F$; set the F_2 marker to the settled frequency $+ \Delta F$. The example below demonstrates this.

Command syntax :MARKer:FREQuency:POSition[1 | 2] <numeric value> [HZ]

Example OUTPUT 712;"MARK:FREQ:POS1 999.975E+6"
OUTPUT 712;"MARK:FREQ:POS2 1.000025E+9"

Comments Using Marker Commands to set F and ΔF :

- The example above shows the two command lines you would use to set the settled frequency (F) to 1 GHz and the delta value (ΔF) to 25 kHz. To calculate the F_1 and F_2 marker values, use these formulas:

$$F_1 = F - \Delta F, \quad F_2 = F + \Delta F$$

To calculate F and ΔF from F_1 and F_2 use these formulas:

$$F = \frac{F_2 + F_1}{2}, \quad \Delta F = \frac{F_2 - F_1}{2}$$

Programming Information Markers Menu

Setting Markers for ΔF with TRACK

TRACK is a convenient way to have the markers follow the settled frequency when it is drifting or to find it when it is not precisely known. One complication is that the marker position commands cannot be used when TRACK is enabled. Two examples here show how to set the ΔF value while using frequency tracking.

Ways to Set ΔF Value

1. Use the marker commands while frequency tracking is disabled.
2. Use the :SYSTem:KEY command to simulate the pressing of individual front-panel keys.

Examples of both methods are included here.

Comments 1. Using Marker Commands to set ΔF

```
OUTPUT 712;"MARK:FREQ:POS:AUTO OFF" !Disable TRACK.  
OUTPUT 712;"MARK:FREQ:POS1 1E+6" !Set  $F_1$  to 1 MHz  
OUTPUT 712;"MARK:FREQ:POS2 1.02E+6" !Set  $\Delta F$  to 10 kHz.  
OUTPUT 712;"MARK:FREQ:POS:AUTO ON" !Enable TRACK again.
```

This example uses the formula:

$$\Delta F = \frac{F_2 - F_1}{2}$$

to set ΔF to 10 kHz. The F_1 value is set arbitrarily since TRACK will automatically find the actual settled frequency. The marker spacing remains constant at 20 kHz (± 10 kHz).

Programming Information
Markers Menu

2. Using Key Commands to set ΔF :

- Another way to set the ΔF value is using the :SYSTem:KEY command. Here is a sample program to set ΔF to 10 kHz:

```
OUTPUT 712;"MARK:FREQ:POS:AUTO ON" !Enables TRACK.
OUTPUT 712;"DISP:MENU MARK" !Selects Marker menu.
OUTPUT 712;"SYST:KEY 33" !Selects  $\Delta F$  +/- field.
OUTPUT 712;"SYST:KEY 50" !Enters a 1.
OUTPUT 712;"SYST:KEY 34" !Enters a 0.
OUTPUT 712;"SYST:KEY 69" !Enters a kHz terminator.
```

- Refer to the :SYSTem:KEY description in the *HP 53310A Programming Reference Manual* for all the front-panel keys and their corresponding number.

Programming Information Markers Menu

Frequency Tracking

After the Settling Time feature is enabled, use this command to enable or disable tracking of the center frequency for settling time measurements. When tracking is enabled, the frequency markers automatically follow the settled frequency.

Note

The frequency being tracked is defined as the last frequency value on the display. When markers are set to "Analyze Between Markers", the last frequency value between the time markers will be tracked.

Command syntax :MARKer:FREQuency:POSition[1|2]:AUTO ON|1|OFF|0

Example OUTPUT 712;"MARK:FREQ:POS:AUTO ON"

- Comments**
- Sending "ON" enables the tracking of the settled frequency.
 - Sending "OFF" disables the tracking feature.
 - To set the ΔF value, refer to "Setting Markers for ΔF with TRACK" on the preceding page.

Query for Frequency Tracking

Use this query to return whether or not the tracking feature is enabled for the Settling Time feature.

Query syntax :MARKer:FREQuency:POSition[1|2]:AUTO?

Example OUTPUT 712;"MARK:FREQ:POS:AUTO?"

- Comments**
- A "1" is returned if tracking is enabled.
 - A "0" is returned if tracking is disabled.

Sampling Menu

The Sampling menu commands are part of the SCPI :SENSE subsystem. The commands control the Fast sampling mode.

Fast Sampling Mode

This command selects the sampling mode for the channel specified with the [:SENSE]:FUNCTION command.

Command syntax [:SENSE]:FREQuency:ARM:SOURce
AUTO|EXTernal|FAST|LINK|TIMer

Example OUTPUT 712;":FREQ:ARM:SOUR FAST"

Comments

- The example command selects the Fast sampling mode. It provides an effective sampling rate of up to 8 MHz for repetitive signals. It should normally be used for repetitive signals.

Note

When set to Fast sampling, the HP 53310A makes consecutive acquisitions of 16 measurement samples until enough data is collected to fill the display. This can be up to 225 measurements across the vs. Time display representing 14 separate acquisitions. Each of these acquisitions requires a trigger. For example, if 225 measurements were needed and the trigger condition was an edge at the External Arm input, 14 trigger edges, along with the signal being measured, would be needed before enough measurement data would be acquired and displayed.

Programming Information Sampling Menu

- Comments (continued)**
- The sampling modes are: Auto, External Edge, Time, Edge of the channel being measured, and Fast.
 - Edge of the channel being measured is available for measurements on channel A or B.
 - Fast sampling is only available for Frequency measurements.
 - External Edge is only available when External Edge is not already selected as the trigger condition on the Trigger menu.

Query for Sampling Mode

Use this query to return the selected sampling mode.

Query syntax [:SENSe]:FREQuency:ARM:SOURce?

Example OUTPUT 712;":FREQ:ARM:SOUR?

- Comments**
- The example query returns the sampling mode for the input channel currently selected.

Fast Sampling Interval at Center On/Off

This command is used to set the Fast sampling Interval at Center control to Auto or Manual.

Command syntax [:SENSe]:FREQuency:ARM:FCFInterval[1|2|3]:AUTO ON|1|OFF|0

Example OUTPUT 712;":FREQ:ARM:FCFI3:AUTO OFF"

- Comments**
- The example command sets the Fast sampling mode Interval at Center control to Manual for channel C.

Query for Fast Sampling Interval at Center On/Off

Use this query to return the control mode of Fast sampling Interval at Center.

Query syntax [:SENSe]:FREQuency:ARM:FCFInterval[1|2|3]:AUTO?

Example OUTPUT 712;":FREQ:ARM:FCFI3:AUTO?"

- Comments**
- The example query returns whether the control mode for Fast sampling Interval at Center for channel C is set to Auto or Manual.
 - A "1" is returned for Auto.
 - A "0" is returned for Manual.

Programming Information
Sampling Menu

Fast Sampling Interval at Center

This command sets the value of the sampling interval at the center frequency. An interval is the time between two adjacent samples and is used in the calculation of frequency measurement results.

Because of the way that the HP 53310A makes frequency measurements in the Auto or Fast sampling modes, the interval at center is partly determined by the center frequency value specified on the Vertical menu. When the input frequency is above or below the center, the actual interval is shorter or longer. The time/div setting on the Timebase menu also helps determine the interval at center value. Use this command when you want to control the value of interval at center so that the value is not affected by changing the center frequency, a changing input frequency, or the time/div setting. Typically, the Auto setting for Interval at Center provides the best results.

Command syntax [:SENSe]:FREQuency:ARM:FCFInterval[1|2|3] <numeric value> [S]

Example OUTPUT 712;":FREQ:ARM:FCFI3 2.5E-6"

- Comments**
- "1" selects channel A, "2" selects channel B, "3" selects channel C.
 - The example command switches the Interval at Center control for Fast sampling to Manual and sets the interval to 2.5 μ s.
 - Unit equals seconds.

Query for Fast Sampling Interval at Center

Use this query to return the value of the Fast sampling interval at center.

Query syntax [:SENSe]:FREQuency:ARM:FCFInterval[1|2|3]?

Example OUTPUT 712;"FREQ:ARM:FCFI3?"

Comments

- The example command will return the sampling interval for the Fast sampling mode on channel C.

Programming Information
Trigger Menu

Trigger Menu

The Trigger menu commands are part of the SCPI :TRIGger subsystem. These commands control external edge and envelope triggering.

External Edge Arm or Time Reference: Frequency Mode

A signal at the External Arm input can be set to simply arm the measurement (AONL) or to provide a time record for the measurement (TREF). This time record is referenced to the instant at which the External Arm input signal occurred.

Command syntax :TRIGger:FREQuency:EEMode[1|2|3] AONLy|TREFerence

Example OUTPUT 712;"TRIG:FREQ:EEM3 TREF"

- Comments**
- The example command sets the external edge trigger mode to Time Reference for a frequency measurement on channel C.
 - Use the command, :TRIG:SOUR EXT, to enable the external edge trigger mode.
 - Use "AONL" for Arm Only or "TREF" for Time Reference.

Query for External Edge Arm or Time Reference: Frequency Mode

Use this query to return the setting of the external edge trigger mode for frequency.

Query syntax :TRIGger:FREQuency:EEMode[1|2|3]?

Example OUTPUT 712;"TRIG:FREQ:EEM3?"

- Comments**
- The example query returns the setting of the external edge trigger mode for channel C.
 - "AONL" is returned for Arm Only or "TREF" is returned for Time Reference.

Envelope Trigger for Channel C

The HP 53310A with option 031 has the ability to trigger on the envelope of a pulsed signal at channel C. This command selects between the Frequency Value trigger and the RF Envelope trigger.

Command syntax :TRIGger:FREQuency:MODE ENVelope | LEVel

Example OUTPUT 712;"TRIG:FREQ:MODE ENV"

- Comments**
- The example command selects the envelope trigger on channel C.
 - Select channel C before sending this command.

Programming Information
Trigger Menu

Query for Trigger Mode

Use this query to return the setting of the trigger mode for the channel currently selected.

Query syntax :TRIGger:FREQuency:MODE?

Example OUTPUT 712;"TRIG:FREQ:MODE?"

Comments

- The example query returns "EXT" for external edge, "ENV" for envelope trigger, or "LEV" for frequency value.

Envelope Trigger Slope

This command allows you to select the slope of the envelope. A positive setting will trigger on the rising edge of the envelope, a negative setting on the falling edge of the envelope.

Command syntax :TRIGger:FREQuency:MODE:SLOPe POSitive|NEGative

Example OUTPUT 712;"TRIG:FREQ:MODE ENV"

OUTPUT 712;"TRIG:FREQ:MODE:SLOP POS"

Comments

- The two example commands select RF envelope trigger and the positive slope as the trigger edge.
- If Fast sampling is selected, the positive slope is used regardless of the slope setting.

Query for Envelope Trigger Slope

Use this query to return the slope setting for the envelope.

Query syntax :TRIGger:FREQuency:MODE:SLOPe?

Example OUTPUT 712;"TRIG:FREQ:MODE:SLOP?"

- Comments**
- The example query returns the slope setting for the envelope trigger, "POS" or "NEG".
 - If Fast sampling is selected, the positive slope is used regardless of the slope setting.

External Edge Arm or Time Reference: Time Interval Mode

A signal at the External Arm input can be set to simply arm the measurement (AONL) or to provide a time record for the measurement (TREF). This time record is referenced to the instant at which the External Arm input signal occurred.

Command syntax :TRIGger:TINTerval:EEMode AONLy | TREFerence

Example OUTPUT 712;"TRIG:TINT:EEM TREF"

- Comments**
- The example command sets the external edge trigger mode to Time Reference for a time interval measurement.
 - Use the command, :TRIG:SOUR EXT, to enable the external edge trigger mode.
 - Use "AONL" for Arm Only or "TREF" for Time Reference.

Programming Information
Trigger Menu

**Query for External Edge Arm or Time Reference:
Time Interval Mode**

Use this query to return the setting of the external edge trigger mode for time interval.

Query syntax :TRIGger:TINTerval:EEMode?

Example OUTPUT 712;"TRIG:TINT:EEM?"

- Comments**
- The example query returns the setting of the external edge trigger mode for time interval.
 - "AONL" is returned for Arm Only and "TREF" is returned for Time Reference.

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