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# Programming Reference

## HP 54510A 1 GSa/s Digitizing Oscilloscope

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## Printing History

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## List of Effective Pages

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**Quick Reference Guide**

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## Introduction

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The HP 54510A 1 GSa/s Digitizing Oscilloscope is a general purpose repetitive and realtime oscilloscope. Full HP-IB programmability is incorporated into the HP 54510A and may be used in a broad range of HP-IB applications, from high-speed ATE to device characterization in research and development environments. This manual explains how to program the HP 54510A over HP-IB and lists the commands and queries associated with this instrument.

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### How to Use This Manual

This manual is divided into 22 chapters. The first two chapters introduce you to the programming syntax and some basic programming concepts to help get you started programming.

Chapter 3 describes the interface functions and some general concepts of HP-IB.

Chapter 4 covers the conventions which are used to program the instrument as well as conventions used in the remainder of this manual. This chapter also includes a complete **command tree** and **alphabetic command cross-reference**.

Chapter 5 contains **example programs** using the command set from the HP 54510A.

Chapters 6 through 18 list the commands and queries associated with the HP 54510A, including their corresponding arguments and returned formats.

Chapter 19 describes the **status reporting** features of the HP 54510A that are available over the HP-IB.

Chapter 20 lists the **error messages** that are returned by the parser on the HP 54510A.

Chapter 21 provides details on how automatic measurements are calculated and offers some tips on how to improve results.

Chapter 22 describes the operation of instruments that operate in compliance with the **IEEE 488.2** standard.

At the end of the manual is **Quick Reference Guide** that lists the commands and queries with their corresponding arguments and returned formats. Also, at the end of the manual is a complete **index** for easy reference of commands and functions.

## Introduction to Programming an Instrument

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### Introduction

Chapters 1 and 2 introduce you to the basics of remote programming. The programming instructions explained in this manual conform to the IEEE 488.2 Standard Digital Interface for Programmable Instrumentation. These programming instructions provide a means of remotely controlling the HP 54510A. There are four basic operations that can be done with a controller and an oscilloscope via HP-IB. You can:

- Set up the instrument and start measurements.
- Retrieve setup information and measurement results.
- Digitize a waveform and pass the data to the controller.
- Send measurement data to the instrument.

Other more complicated tasks are accomplished with a combination of these four basic functions.

This chapter introduces you to the basic concepts of HP-IB communication and provides information and examples to get you started programming. The exact mnemonics for the commands are listed in chapters 6 through 18.

Chapter 2 deals mainly with how to set up the instrument, how to retrieve setup information and measurement results, how to digitize a waveform, and how to pass data to the controller. Refer to chapter 15, "Measure Subsystem" for information on sending measurement data to the instrument.

**Note** 

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The programming examples in this manual are written in HP BASIC 5.0 for an HP 9000 Series 200/300 Controller.

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## Talking to the Instrument

In general, computers acting as controllers communicate with the instrument by sending and receiving messages over a remote interface. Instructions for programming the HP 54510A normally appear as ASCII character strings embedded inside the output statements of a "host" language available on your controller. The input statements of the host language are used to read in responses from the HP 54510A.

For example, HP 9000 Series 200/300 BASIC uses the OUTPUT statement for sending commands and queries to the HP 54510A. After a query is sent, the response is usually read in using the ENTER statement.

Messages are placed on the bus using an output command and passing the device address, program message, and terminator. Passing the device address ensures that the program message is sent to the correct interface and instrument.

The following BASIC statement sends a command which turns the command headers on:

```
OUTPUT < device address > ;":SYSTEM:HEADER ON"<terminator>
```

The < device address > represents the address of the device being programmed. Each of the other parts of the above statement are explained in the following pages.

## Program Message Syntax

To program the instrument remotely, you must have an understanding of the command format and structure expected by the instrument. The IEEE 488.2 syntax rules govern how individual elements such as headers, separators, program data, and terminators may be grouped together to form complete instructions. Syntax definitions are also given to show how query responses are formatted. Figure 1-1 shows the main syntactical parts of a typical program statement.

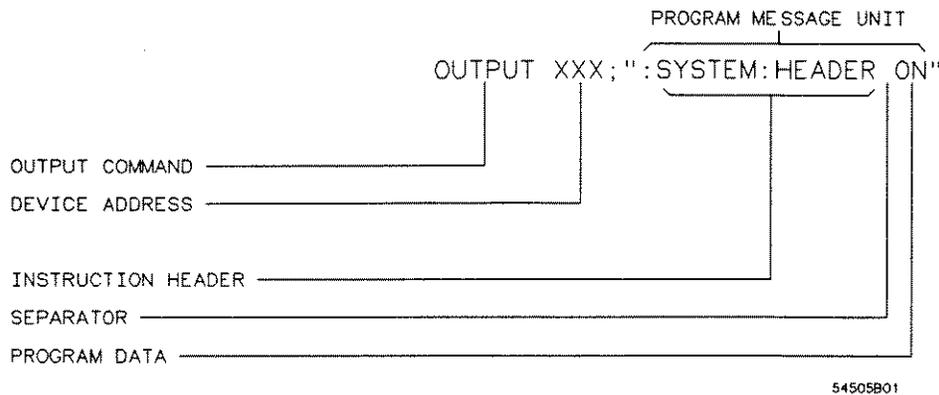


Figure 1-1. Program Message Syntax

## Output Command

The output command is entirely dependent on the language you are using. Throughout this manual HP 9000 Series 200/300 BASIC 5.0 is used in the programming examples. If you are using another language, you will need to find the equivalents of BASIC commands like OUTPUT, ENTER, and CLEAR in order to convert the examples. The instructions listed in this manual for the HP 54510A are always shown between quotes in the example programs.

**Device Address** The location where the device address must be specified is also dependent on which host language you are using. In some languages, this may be specified outside the output command. In BASIC, this is always specified after the keyword OUTPUT. The examples in this manual assume the HP 54510A is at device address 707. When writing programs, the address you use varies according to how you have configured the bus for your application.

**Instructions** Instructions (both commands and queries) normally appear as a string embedded in a statement of your host language, such as BASIC, Pascal, or C. The only time a parameter is not meant to be expressed as a string is when the instruction's syntax definition specifies <block data>. There are only a few instructions which use block data.

Instructions are composed of two main parts:

- The header, which specifies the command or query to be sent.
- The program data, which provide additional information needed to clarify the meaning of the instruction.

**Instruction Header** The instruction header is one or more mnemonics separated by colons (:) that represent the operation to be performed by the instrument. The command tree in figure 4-1 illustrates how all the mnemonics can be joined together to form a complete header (see chapter 4, "Programming and Documentation Conventions").

The example in figure 1-1 shows a command. Queries are indicated by adding a question mark (?) to the end of the header. Many instructions can be used as either commands or queries, depending on whether or not you have included the question mark. The command and query forms of an instruction usually have different program data. Many queries do not use any program data.

**White Space  
(Separator)**

White space is used to separate the instruction header from the program data. If the instruction does not require any program data parameters, you do not need to include any white space. In this manual, white space is defined as one or more spaces. ASCII defines a space to be character 32 (in decimal).

**Program Data**

Program data are used to clarify the meaning of the command or query. They provide necessary information, such as whether a function should be on or off, or which waveform is to be displayed. Each instruction's syntax definition shows the program data, as well as the values they accept. The section "Program Data Syntax Rules" in this chapter has all of the general rules about acceptable values.

When there is more than one data parameter, they are separated by commas (.). Spaces can be added around the commas to improve readability.

**Header Types**

There are three types of headers:

- Simple Command headers.
- Compound Command headers
- Common Command headers.

**Simple Command Header**

Simple command headers contain a single mnemonic. AUTOSCALE and DIGITIZE are examples of simple command headers typically used in this instrument. The syntax is:

```
<program mnemonic><terminator>
```

When program data must be included with the simple command header (for example, :DIGITIZE CHAN1), white space is added to separate the data from the header. The syntax is:

```
<program mnemonic><separator><program data><terminator>
```

### Compound Command Header

Compound command headers are a combination of two or more program mnemonics. The first mnemonic selects the subsystem, and the last mnemonic selects the function within that subsystem. Additional mnemonics may appear between the subsystem mnemonic and the function mnemonic when there are additional levels within the subsystem that must be traversed. The mnemonics within the compound message are separated by colons. For example:

To execute a single function within a subsystem:

```
:<subsystem>:<function><separator><program data><terminator>
```

(For example :SYSTEM:LONGFORM ON)

To traverse down a level of a subsystem to execute a subsystem within that subsystem:

```
:<subsystem>:<subsystem>:<function><separator><program data><terminator>
```

(For example :TRIGGER:DELAY:SOURCE CHAN1)

### Common Command Header

Common command headers control IEEE 488.2 functions within the instrument (such as clear status, etc.). Their syntax is:

```
*<command header><terminator>
```

No space or separator is allowed between the asterisk (\*) and the command header. \*CLS is an example of a common command header.

---

## Combining Commands from the Same Subsystem

To execute more than one function within the same subsystem a semi-colon (;) is used to separate the functions:

```
:<subsystem>:<function><separator><data>;<function><separator><data>  
<terminator>
```

(For example :SYSTEM:LONGFORM ON;HEADER ON)

---

## Duplicate Mnemonics

Identical function mnemonics can be used for more than one subsystem. For example, the function mnemonic RANGE may be used to change the vertical range or to change the horizontal range:

```
:CHANNEL1:RANGE .4
```

- sets the vertical range of channel 1 to 0.4 volts full scale.

```
:TIMEBASE:RANGE 1
```

- sets the horizontal time base to 1 second full scale.

CHANNEL1 and TIMEBASE are subsystem selectors and determine which range is being modified.

---

## Query Command

Command headers immediately followed by a question mark (?) are queries. After receiving a query, the instrument interrogates the requested function and places the answer in its output queue. The answer remains in the output queue until it is read or another command is issued. When read, the answer is transmitted across the bus to the designated listener (typically a controller). For example, the query `:TIMEBASE:RANGE?` places the current time base setting in the output queue. In BASIC, the controller input statement:

```
ENTER < device address > ;Range
```

passes the value across the bus to the controller and places it in the variable `Range`.

Query commands are used to find out how the instrument is currently configured. They are also used to get results of measurements made by the instrument, with the query actually activating the measurement. For example, the command `:MEASURE:RISETIME?` instructs the instrument to measure the rise time of your waveform and place the result in the output queue.

The output queue must be read before the next program message is sent. For example, when you send the query `:MEASURE:RISETIME?` you must follow that query with an input statement. In BASIC, this is usually done with an `ENTER` statement immediately followed by a variable name. This statement reads the result of the query and places the result in a specified variable.

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### Note

Sending another command or query before reading the result of a query causes the output buffer to be cleared and the current response to be lost. This also generates an error in the error queue.

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## Program Header Options

Program headers can be sent using any combination of uppercase or lowercase ASCII characters. Instrument responses, however, are always returned in uppercase.

Program command and query headers may be sent in either long form (complete spelling), short form (abbreviated spelling), or any combination of long form and short form. Either of the following examples turn the headers on.

```
:SYSTEM:HEADER ON - long form
```

```
:SYST:HEAD ON - short form
```

Programs written in long form are easily read and are almost self-documenting. The short form syntax conserves the amount of controller memory needed for program storage and reduces the amount of I/O activity.

### Note

---

The rules for the short form syntax are shown in chapter 4, "Programming and Documentation Conventions."

---

---

## Program Data Syntax Rules

Program data is used to convey a variety of types of parameter information related to the command header. At least one space must separate the command header or query header from the program data.

```
<program mnemonic><separator><data><terminator>
```

When a program mnemonic or query has multiple program data a comma separates sequential program data.

```
<program mnemonic><separator><data>,<data><terminator>
```

For example, :TRIGGER:DELAY TIME,1.23E-01 has two program data: TIME and 1.23E-01.

There are two main types of program data which are used in HP 54510A commands: character and numeric program data.

### Character Program Data

Character program data is used to convey parameter information as alpha or alphanumeric strings. For example, the TIMEBASE:MODE command can be set to auto, trigger, or single. The character program data in this case may be AUTO, TRIGGER, or SINGLE. :TIMEBASE:MODE SINGLE sets the time base mode to single.

The available mnemonics for character program data are always included with the instruction's syntax definition. When sending commands, either the long form or short form (if one exists) may be used. Upper-case and lower-case letters may be mixed freely. When receiving responses, upper-case letters are used exclusively. The use of long form or short form in a response depends on the setting you last specified with the SYSTEM:LONGform command.

## Numeric Program Data

Some command headers require program data to be expressed numerically. For example, `:TIMEBASE:RANGE` requires the desired full scale range to be expressed numerically.

For numeric program data, you have the option of using exponential notation or using suffix multipliers to indicate the numeric value. The following numbers are all equal:

$$28 = 0.28E2 = 280e-1 = 28000m = 0.028K = 28e-3K.$$

When a syntax definition specifies that a number is an integer, that means that the number should be whole. Any fractional part would be ignored, truncating the number. Numeric data parameters which accept fractional values are called real numbers. For more information see chapter 22, "Message Communication and System Functions."

All numbers are expected to be strings of ASCII characters. Thus, when sending the number 9, you would send a byte representing the ASCII code for the character "9" (which is 57). A three-digit number like 102 would take up three bytes (ASCII codes 49, 48, and 50). This is taken care of automatically when you include the entire instruction in a string.

## Embedded Strings

Embedded strings contain groups of alphanumeric characters which are treated as a unit of data by the HP 54510A. For example, the line of text written to the advisory line of the instrument with the `:SYSTEM:DSP` command. Embedded strings may be delimited with either single (') or double (") quotes. These strings are case-sensitive and spaces act as legal characters just like any other character.

---

## Program Message Terminator

The program instructions within a data message are executed after the program message terminator is received. The terminator may be either an NL (New Line) character, an EOI (End-Of-Identify) asserted, or a combination of the two. All three ways are equivalent with the exact encodings for the program terminators listed in chapter 22, "Message Communication and System Functions." Asserting the EOI sets the EOI control line low on the last byte of the data message. The NL character is an ASCII linefeed (decimal 10).



The NL (New Line) terminator has the same function as an EOS (End Of String) and EOT (End Of Text) terminator.

---

---

## Selecting Multiple Subsystems

You can send multiple program commands and program queries for different subsystems on the same line by separating each command with a semicolon. The colon following the semicolon enables you to enter a new subsystem. For example:

```
<program mnemonic><data>;<program mnemonic><data><terminator>  
:CHANNEL1:RANGE 0.4;:TIMEBASE:RANGE 1
```



Multiple commands may be any combination of compound and simple commands.

---

## Programming an Instrument

---

### Introduction

This chapter deals mainly with how to set up the instrument, how to retrieve setup information and measurement results, how to digitize a waveform, and how to pass data to the controller. Refer to chapter 15, "Measure Subsystem" for information on sending measurement data to the instrument.



The programming examples in this manual are written in HP BASIC 5.0 for an HP 9000 Series 200/300 Controller.

---

### Initialization

To make sure the bus and all appropriate interfaces are in a known state, begin every program with an initialization statement. BASIC provides a CLEAR command which clears the interface buffer. For example:

```
CLEAR 707 ! initializes the interface of the instrument.
```

When you are using HP-IB, CLEAR also resets the HP 54510A's parser. The parser is the program which reads in the instructions which you send it.

After clearing the interface, initialize the instrument to a preset state. For example:

```
OUTPUT 707;"*RST" ! initializes the instrument to a preset state.
```

---



The actual commands and syntax for initializing the instrument are discussed in chapter 6, "Common Commands."

Refer to your controller manual and programming language reference manual for information on initializing the interface.

---

---

## Autoscale

The AUTOSCALE feature of Hewlett-Packard digitizing oscilloscopes performs a very useful function on unknown waveforms by setting up the vertical channel, time base, and trigger level of the instrument.

The syntax for Autoscale is:

```
:AUTOSCALE<terminator>
```

---

## Setting Up the Instrument

A typical oscilloscope setup would set the vertical range and offset voltage, the horizontal range, delay time, delay reference, trigger mode, trigger level, and slope. A typical example of the commands sent to the oscilloscope are:

```
:CHANNEL1:RANGE 0.64;OFFSET 0.25<terminator>
```

```
:TIMEBASE:RANGE 1E-6;DELAY 20E-9;MODE TRIGGERED <terminator>
```

```
:TRIGGER:LEVEL 0.25;SLOPE POSITIVE<terminator>
```

This example sets the vertical to 0.64 volts full-scale (80 mV/div) centered at 0.25 V. The horizontal time is set to 1 ms full-scale with 20 ns delay. The time base mode is set to triggered, and the trigger circuit is set to trigger at 0.25 volts on a positive slope.

## Example Program

This program demonstrates the basic command structure used to program the HP 54510A. It assumes that the AC CAL signal from the rear panel of the instrument is connected to channel 1 through a 10:1 probe.

```
10  CLEAR 707                ! Initialize instrument interface
20  OUTPUT 707;"*RST"        ! Initialize instrument to preset state
30  OUTPUT 707;"BNC PROBE"  ! BNC output to probe mode
40  OUTPUT 707;"SYSTEM:HEADER ON" ! Turn headers on
50  OUTPUT 707;"SYSTEM:LONGFORM ON" ! Turn long form on
60  OUTPUT 707;"TIMEBASE:MODE TRIGGERED" ! Triggered time base mode
70  OUTPUT 707;"TIMEBASE:RANGE SE-4" ! Time base to 50 us/div
80  OUTPUT 707;"TIMEBASE:DELAY 0" ! Delay to zero
90  OUTPUT 707;"TIMEBASE:REFERENCE CENTER" ! Display reference at center
100 OUTPUT 707;"CHANNEL1:PROBE 10" ! Probe attenuation to 10:1
110 OUTPUT 707;"CHANNEL1:RANGE 1.6" ! Vertical range to 1.6 V full scale
120 OUTPUT 707;"CHANNEL1:OFFSET -.4" ! Offset to -0.4
130 OUTPUT 707;"CHANNEL1:COUPLING DC" ! Coupling to DC
140 OUTPUT 707;"TRIGGER:MODE EDGE" ! Edge triggering
150 OUTPUT 707;"TRIGGER:LEVEL -.4" ! Trigger level to -0.4
160 OUTPUT 707;"TRIGGER:SLOPE POSITIVE" ! Trigger on positive slope
170 OUTPUT 707;"ACQUIRE:TYPE NORMAL" ! Real time acquisition
180 OUTPUT 707;"DISPLAY:CONNECT ON" ! Connect-the-dots function on
190 OUTPUT 707;"DISPLAY:GRATICULE GRID" ! Grid on
200 OUTPUT 707;"RUN"        ! Acquire data
210  END
```

---

## Program Overview

**Line 10** initializes the instrument interface to a known state.  
**Line 20** initializes the instrument to a preset state.  
**Line 30** selects the Probe mode for the BNC output on the rear panel.  
**Lines 40 and 50** turn the headers and long form on.  
**Lines 60 through 90** set the time base mode to triggered with the horizontal time at  $50 \mu\text{s}/\text{div}$  with 0 s of delay referenced at the center of the graticule.  
**Lines 100 through 130** set the vertical range to 1.6 volts full scale centered at -0.4 volts with 10:1 probe attenuation and DC coupling.  
**Lines 140 through 160** configures the instrument to trigger at -0.4 volts on a positive edge.  
**Line 170** configures the instrument for real time acquisition.  
**Line 180** turns the connect-the-dots function on.  
**Line 190** turns the grid on.  
**Line 200** runs the measurement and acquires the data.

---

## Using the Digitize Command

The Digitize command is a macro that captures data satisfying the specifications set up by the acquire subsystem. When the digitize process is complete, the acquisition is stopped. The captured data can then be measured by the instrument or transferred to the controller for further analysis. The captured data consists of two parts: the waveform data record and the preamble.

---

### Note



After changing the oscilloscope configuration, the waveform buffers are cleared. Before doing a measurement, the Digitize command must be sent to ensure new data has been collected.

---

When the DIGITIZE command is sent to an instrument, the specified channel signal is digitized with the current ACQUIRE parameters. To obtain waveform data, you must specify the WAVEFORM parameters for the waveform data prior to sending the :WAVEFORM:DATA? query.

The number of data points comprising a waveform varies according to the number requested in the ACQUIRE subsystem. The ACQUIRE subsystem determines the number of data points, type of acquisition, and number of averages used by the DIGITIZE command. This allows you to specify exactly what the digitized information contains. The following program example shows a typical setup:

```
OUTPUT 707;":TIMEBASE:SAMPLE REPETITIVE"<terminator>
OUTPUT 707;":ACQUIRE:TYPE AVERAGE"<terminator>
OUTPUT 707;":ACQUIRE:COMPLETE 100"<terminator>
OUTPUT 707;":WAVEFORM:SOURCE CHANNEL1"<terminator>
OUTPUT 707;":WAVEFORM:FORMAT ASCII"<terminator>
OUTPUT 707;":ACQUIRE:COUNT 4"<terminator>
OUTPUT 707;":ACQUIRE:POINTS 500"<terminator>
OUTPUT 707;":DIGITIZE CHANNEL1"<terminator>
OUTPUT 707;":WAVEFORM:DATA?"<terminator>
```

This setup places the instrument into the averaged mode with four averages and defines the data record to be 500 points. This means that when the DIGITIZE command is received, the waveform is not stored into memory until 500 points have been averaged at least four times.

After receiving the :WAVEFORM:DATA? query, the instrument will start passing the waveform information when addressed to talk.

Digitized waveforms are passed from the instrument to the controller by sending a numerical representation of each digitized point. The format of the numerical representation is controlled with the :WAVEFORM:FORMAT command and may be selected as ASCII, WORD, BYTE, or COMPRESSED.

The easiest method of entering a digitized waveform from the instrument is to use the ASCII format and place the information in an integer array. Each data point is represented by signed six-digit integers whose values range from 0 to 32,640. You must scale the integers to determine the voltage value of each point. These integers are passed starting with the leftmost point on the instrument's display. For more information, refer to chapter 18, "Waveform Subsystem."

**Note**

A digitize operation may be aborted by pressing the "LOCAL" key, then any other key on the front panel, or by sending a Device Clear over the bus. Digitize operations with :ACQUIRE:TYPE RAWDATA can only be aborted with a Device Clear.

## Receiving Information from the Instrument

After receiving a query (command header followed by a question mark), the instrument interrogates the requested function and places the answer in its output queue. The answer remains in the output queue until it is read or another command is issued. When read, the answer is transmitted across the bus to the designated listener (typically a controller). The input statement for receiving a response message from an instrument's output queue typically has two parameters; the device address, and a format specification for handling the response message. For example, to read the result of the query command `:SYSTEM:LONGFORM?` you would execute the BASIC statement:

```
ENTER <device address> ;Setting$
```

where `<device address>` represents the address of your device. This would enter the current setting for the `LONGFORM` command in the string variable `Setting$`.

All results for queries sent in a program message must be read before another program message is sent. For example, when you send the query `:MEASURE:RISETIME?`, you must follow that query with an input statement. In BASIC, this is usually done with an `ENTER` statement.

Sending another command before reading the result of the query causes the output buffer to be cleared and the current response to be lost. This also causes an error to be placed in the error queue.

Executing an input statement before sending a query causes the controller to wait indefinitely.

The format specification for handling response messages is dependent on both the controller and the programming language.

## Response Header Options

The format of the returned ASCII string depends on the current settings of the **SYSTEM HEADER** and **LONGFORM** commands. The general format is:

```
<header><separator><data><terminator>
```

The header identifies the data that follows and is controlled by issuing a **:SYSTEM:HEADER ON/OFF** command. If the state of the header command is **OFF**, only the data is returned by the query.

The format of the header is controlled by the **:SYSTEM:LONGFORM ON/OFF** command. If long form is **OFF**, the header is in its short form and the header varies in length depending on the particular query. The separator between the header and the data always consists of one space.

The following examples show some possible responses for a **:MEASURE:FREQUENCY?** frequency measurement query:

```
<data><terminator> (with HEADER OFF )
:MEAS:FREQ<separator><data><terminator> (with HEADER ON/LONGFORM OFF )
:MEASURE:FREQUENCY<separator><data><terminator> (with HEADER ON/LONGFORM ON )
```

### Note

A command or query may be sent in either long form or short form, or in any combination of long form and short form. The **HEADER** and **LONGFORM** commands only control the format of the returned data and have no effect on the way commands are sent.

Refer to chapter 8, "System Subsystem" for information on turning the **HEADER** and **LONGFORM** commands on and off.

---

## Response Data Formats

Both numeric and character data are returned as a series of ASCII characters, as described in the following sections. Mnemonics in the program data are returned in the same format as the header, as specified by the LONGform command. Like the headers, the mnemonics are always in upper-case.

The following examples are possible responses to the :TRIGGER:SLOPE? query:

:TRIGGER:SLOPE POSITIVE <terminator>	(with HEADER ON/LONGFORM ON)
:TRIG:SLOP POS<terminator>	(with HEADER ON/LONGFORM OFF)
POSITIVE<terminator>	(with HEADER OFF/LONGFORM ON)
POS<terminator>	(with HEADER OFF/LONGFORM OFF)

---

### Note



Refer to the individual commands in this manual for information on the format (alpha or numeric) of the data returned from each query.

---

## String Variables

If you want to observe the headers for queries, you must bring the returned data into a string variable. Reading queries into string variables is simple and straightforward, requiring little attention to formatting. For example:

```
ENTER <device address>;Result$
```

places the output of the query in the string variable Result\$.



In HP BASIC 5.0, string variables are case sensitive and must be expressed exactly the same each time they are used.

The output of the instrument may be numeric or character data depending on what is queried. Refer to the specific commands for the formats and types of data returned from queries.



For the example programs, assume that the device being programmed is at device address 707. The actual address varies according to how you have configured the bus for your own application.

The following example shows the data being returned to a string variable with headers off:

```
10 DIM Rang$[30]
20 OUTPUT 707;"SYSTEM:HEADER OFF"
30 OUTPUT 707;"CHANNEL1:RANGE?"
40 ENTER 707;Rang$
50 PRINT Rang$
60 END
```

After running this program, the controller displays:

```
+8.00000E-01
```

## Numeric Variables

If you do not need to see the headers when a numeric value is returned from the instrument, then you can use a numeric variable. When you are receiving numeric data into a numeric variable, turn the headers off.

### Note



When you are receiving numeric data into numeric variables, the headers should be turned off. Otherwise the headers may cause misinterpretation of returned data.

The following example shows the data being returned to a numeric variable:

```
10 OUTPUT 707;":SYSTEM:HEADER OFF"  
20 OUTPUT 707;":CHANNEL1:RANGE?"  
30 ENTER 707;Rang  
40 PRINT Rang  
50 END
```

After running this program, the controller displays:

.8

## Definite-Length Block Response Data

Definite-length block response data allows any type of device-dependent data to be transmitted over the system interface as a series of 8-bit binary data bytes. This is particularly useful for sending large quantities of data or 8-bit extended ASCII codes. The syntax is a pound sign ( # ) followed by a non-zero digit representing the number of digits in the decimal integer. After the non-zero digit is the decimal integer that states the number of 8-bit data bytes being sent. This is followed by the actual data.

For example, for transmitting 80 bytes of data, the syntax would be:

NUMBER OF DIGITS  
THAT FOLLOW

ACTUAL DATA

#800000080<eighty bytes of data><terminator>

NUMBER OF BYTES  
TO BE TRANSMITTED

16500B03

**Figure 2-1. Definite-Length Block Response Data**

The "8" states the number of digits that follow, and "00000080" states the number of bytes to be transmitted.

---

## Multiple Queries

You can send multiple queries to the instrument within a single program message, but you must also read them back within a single program message. This can be accomplished by either reading them back into a string variable or into multiple numeric variables. For example, you could read the result of the query `:TIMEBASE:RANGE?;DELAY?` into the string variable `Results$` with the command:

```
ENTER 707;Results$
```

When you read the result of multiple queries into string variables, each response is separated by a semicolon. For example, the response of the query `:TIMEBASE:RANGE?;DELAY?` with `HEADER` and `LONGFORM` on would be:

```
:TIMEBASE:RANGE <range_value>;:TIMEBASE:DELAY <delay_value>
```

If you do not need to see the headers when the numeric values are returned, read the result of the query into numeric variables. For example, use the following program message to read the query `:TIMEBASE:RANGE?;DELAY?` into multiple numeric variables:

```
ENTER 707;Result1,Result2
```



When you are receiving numeric data into numeric variables, the headers should be turned off. Otherwise the headers may cause misinterpretation of returned data.

---

---

## Instrument Status

Status registers track the current status of the instrument. By checking the instrument status, you can find out whether an operation has been completed, whether the instrument is receiving triggers, and more. Chapter 19, "Status Reporting" explains how to check the status of the instrument.

## Interface Functions

---

### Introduction

This section describes the interface functions and some general concepts of the HP-IB. In general, these functions are defined by IEEE 488.1. They deal with general bus management issues, as well as messages which can be sent over the bus as bus commands.

---

### Interface Capabilities

The interface capabilities of the HP 54510A, as defined by IEEE 488.1, are SH1, AH1, T5, L4, SR1, RL1, PP1, DC1, DT1, C0, and E2.

---

### Command and Data Concepts

The HP-IB has two modes of operation:

- command mode.
- data mode.

The bus is in the command mode when the ATN line is true. The command mode is used to send talk and listen addresses and various bus commands, such as a group execute trigger (GET).

The bus is in the data mode when the ATN line is false. The data mode is used to convey device-dependent messages across the bus. The device-dependent messages include all of the instrument commands and responses found in chapters 6 through 18 of this manual.

---

## Addressing

By using the front-panel controls, the instrument can be placed in either the talk-only mode or addressed (talk/listen) mode (see your front-panel reference). Talk-only mode should be used when you want the instrument to talk directly to a printer without the aid of a controller. Addressed mode is used when the instrument operates in conjunction with a controller. When the instrument is in the addressed mode, the following is true:

- Each device on the HP-IB resides at a particular address, ranging from 0 to 30.
- The active controller specifies which devices talk and which listen.
- An instrument may be talk addressed, listen addressed, or unaddressed by the controller.

If the controller addresses the instrument to talk, the instrument remains configured to talk until it receives an interface clear message (IFC), another instrument's talk address (OTA), its own listen address (MLA), or a universal untalk command (UNT).

If the controller addresses the instrument to listen, the instrument remains configured to listen until it receives an interface clear message (IFC), its own talk address (MTA), or a universal unlisten command (UNL).

---

## Communicating Over the Bus (HP 9000 Series 200/300 Controller)

Since HP-IB can address multiple devices through the same interface card, the device address passed with the program message must include not only the correct interface select code, but also the correct instrument address.

### Interface Select Code (Selects Interface)

Each interface card has a unique interface select code. This code is used by the controller to direct commands and communications to the proper interface. The default is typically "7" for HP-IB controllers.

### Instrument Address (Selects Instrument)

Each instrument on an HP-IB bus must have a unique instrument address between decimal 0 and 30. The device address passed with the program message must include not only the correct instrument address, but also the correct interface select code.

DEVICE ADDRESS = (Interface Select Code \* 100) + (Instrument Address)

For example, if the instrument address for the HP 54510A is 4 and the interface select code is 7, when the program message is passed, the routine performs its function on the instrument at device address 704.

For the HP 54510A, the instrument address is typically set to "7" at the factory. This address can be changed in the HP-IB menu of the Utility menu.

#### Note

The examples in this manual assume the HP 54510A is at device address 707.

### Remote, Local and Local Lockout

The remote, local, and remote with local lockout modes may be used for various degrees of front-panel control while a program is running. The instrument accepts and executes bus commands while in local mode, and the front panel is entirely active. If the HP 54510A is in the remote mode, all controls (except the power switch and the LOCAL key) are entirely locked out. Local control can only be restored by the controller or pressing the front-panel LOCAL key.

#### Note

Cycling the power also restores local control, but this also resets certain HP-IB states.

The instrument is placed in the remote mode by setting the REN bus control line true, and then addressing the instrument to listen. The instrument is placed in the local lockout mode by sending the local lockout command (LLO). The instrument can be returned to the local mode by either setting the REN line false, or sending the go-to-local command (GTL) to the instrument.

---

**Bus Commands**

The following commands are IEEE 488.1 bus commands (ATN true). IEEE 488.2 defines many of the actions which are taken when these commands are received by the instrument.

**Device Clear**

The device clear (DCL) or selected device clear (SDC) commands clear the input and output buffers, reset the parser, and clear any pending commands. If either of these commands is sent during a digitize operation, the digitize operation is aborted.

**Group Execute Trigger (GET)**

The group execute trigger (GET) command arms the trigger which is the same action produced by sending the RUN command.

**Interface Clear (IFC)**

The interface clear (IFC) command halts all bus activity. This includes unaddressing all listeners and the talker, disabling serial poll on all devices, and returning control to the system controller.

---

**Status Annunciators**

The HP 54510A displays the HP-IB status on the screen. The message indicates whether the instrument is in the remote mode, whether talk or listen is addressed, and whether the instrument has requested service. When the instrument is in the local mode only the SRQ annunciator is displayed.

## Programming and Documentation Conventions

### Introduction

This chapter covers conventions which are used in programming the instrument, as well as conventions used in the remainder of this manual. This chapter contains a detailed description of the command tree and command tree traversal. For more information on command syntax refer to chapter 22, "Message Communication and System Functions."

### Truncation Rules

The truncation rule for the mnemonics used in headers and alpha arguments is:

**The mnemonic is the first four characters of the keyword unless:**

**The fourth character is a vowel, then the mnemonic is the first three characters of the keyword.**

**This rule is not used if the length of the keyword is exactly four characters.**

Some examples of how the truncation rule is applied to various commands are shown in table 4-1.

**Table 4-1. Mnemonic Truncation**

Long Form	Short Form
RANGE	RANG
PATTERN	PATT
TIME	TIME
DELAY	DEL

## Front Panel to Command Cross-Reference

Table 4-2 lists the front-panel functions for the HP 54510A in alphabetical order with their corresponding programming commands.

**Table 4-2. Front-Panel Function to Command Cross-Reference**

Front-Panel Function	Location	Command
1 2 EXT	Channel menu	:BLANk
1 2 EXT	Channel menu	:VIEW
1 2 EXT	Delay Trigger menu (edge)	:TRIGger:DELay:SOURce
1 2 EXT	Edge Trigger menu	:TRIGger:SOURce
1 2 EXT	State Trigger menu	:TRIGger:SOURce
1 M $\Omega$  50 $\Omega$ DC	Channel menu	:TRIGger:COUPling
525 625 lines	TV Trigger menu	:TRIGger:LINE
$\Delta$ t $\Delta$ V	$\Delta$ t $\Delta$ V menu	:MEASure:TDELta
$\Delta$ t $\Delta$ V	$\Delta$ t $\Delta$ V menu	:MEASure:VDELta
$\Delta$ t $\Delta$ V	front-panel key	:MENU:DELTA
$\Delta$ t markers	$\Delta$ t $\Delta$ V menu	:DISPlay:TMARker
$\Delta$ t markers	$\Delta$ t $\Delta$ V menu	:MEASure:ESTArt
$\Delta$ t markers	$\Delta$ t $\Delta$ V menu	:MEASure:ESTOp
$\Delta$ t markers	$\Delta$ t $\Delta$ V menu	:MEASure:TSTArt
$\Delta$ t markers	$\Delta$ t $\Delta$ V menu	:MEASure:TSTOp
$\Delta$ V markers	$\Delta$ t $\Delta$ V menu	:DISPlay:VMARker
$\Delta$ V markers	$\Delta$ t $\Delta$ V menu	:MEASure:VSTArt
$\Delta$ V markers	$\Delta$ t $\Delta$ V menu	:MEASure:VSTOp
- subtract	Waveform Math menu	:FUNCTion:SUBTRact
- WIDTH	front-panel key	:MEASure:NWIDth
# of avg	Display menu (avg)	:ACQuire:COUNT
# of screens	Display menu	:DISPlay:FORMat
% volts	Define Meas menu (meas def)	:MEASure:UNITs
+ add	Waveform Math menu	:FUNCTion:ADD
+ WIDTH	front-panel key	:MEASure:PWIDth
$\uparrow$  X X	Delay Trigger menu (state)	:TRIGger:LOGic
$\uparrow$  X X	State Trigger menu	:TRIGger:LOGic
AC BNC	Utility menu	:BNC
ac dc	Channel menu	:CHANnel:COUPling

Table 4-2. Front-Panel Function to Command Cross-Reference

Front-Panel Function	Location	Command
add   +	Waveform Math menu	:FUNCTION:ADD
address	Utility menu (HP-IB menu)	(front panel only)
addressed   talk only	Utility menu (HP-IB menu)	program language specific
add to memory	Waveform Save menu (pixel)	:MERGe
adjust	Edge Trigger menu	:TRIGger:LEVel
after fail	Define Meas menu (meas limit)	:MEASure:POSTfailure
attenuation	Utility menu (probe cal menu)	(front panel only)
AUTOSCALE	front-panel key	:AUToscale
auto   trig'd	Trigger menu	:TIMEbase:MODE
avg   env   norm	Display menu	:ACQuire:TYPE
axes   grid   off   frame	Display menu	:DISPlay:GRATicule
BW lim	Channel menu	:CHANnel:HFReject
center	Edge Trigger menu	:TRIGger:CENTERed
CHAN	front-panel key	:MENU:CHANnel
channel	Utility menu (probe cal menu)	:CALibrate:TNUlI
CLEAR DISPLAY	front-panel key	:ERASe 0
clear memory	Waveform Save menu (pixel)	:ERASe
clicker	Utility menu	:BEEPper
clock	Delay Trigger menu (state)	:TRIGger:DELay:SOURce
clock	State Trigger menu	:TRIGger:SOURce
CLR MEAS	front-panel key	:MEASure:SCRatch
color	Utility menu (HP-IB menu)	:HARDcopy:PLOT:COLor
connect dots	Display menu	:DISPlay:CONNect
continuous	Define Meas menu (meas)	(see specific measurement)
count	Delay Trigger menu	:TRIGger:OCCurrence
dc   ac	Channel menu	:CHANnel:COUPLing
DEFINE MEAS	front-panel key	:MENU:MEASure
delay   + width   - width	Define Meas menu (meas def)	:MEASure:DEFine
DELAY	front-panel key	:MEASure:DELay
delay	Timebase menu	:TIMEbase:DELay
delay	Delay Trigger menu	:TRIGger:DELay
delay   tv   edge   pattern   state	Trigger menu	:TRIGger:MODE
delta t delta v   $\Delta t \Delta V$	$\Delta t \Delta V$ menu	:MEASure:TDELta
delta t delta v   $\Delta t \Delta V$	$\Delta t \Delta V$ menu	:MEASure:VDELta
delta t delta v   $\Delta t \Delta V$	$\Delta t \Delta V$ menu	:MENU DELTa
delta t markers	$\Delta t \Delta V$ menu	:DISPlay:TMARker
delta t markers	$\Delta t \Delta V$ menu	:MEASure:ESTArt

Table 4-2. Front-Panel Function to Command Cross-Reference

Front-Panel Function	Location	Command
delta t markers	$\Delta t \Delta V$ menu	:MEASure:ESTOp
delta t markers	$\Delta t \Delta V$ menu	:MEASure:TSTArt
delta t markers	$\Delta t \Delta V$ menu	:MEASure:TSTOp
delta V markers	$\Delta t \Delta V$ menu	:DISPlay:VMARker
delta V markers	$\Delta t \Delta V$ menu	:MEASure:VSTArt
delta V markers	$\Delta t \Delta V$ menu	:MEASure:VSTOp
device mode	Utility menu (HP-IB menu)	:HARDcopy:MODE
device mode	Utility menu	:PLOT
device mode	Utility menu	:PRINt
diff	Waveform Math menu	:FUNCTion:DIFF
DISPLAY	front-panel key	:MENU DISPlay
display off	Waveform Math menu	:BLANk
display off	Waveform Save menu	:BLANk
display on	Waveform Math menu	:VIEW
display on	Waveform Save menu	:VIEW
DUTY CY	front-panel key	:MEASure:DUTYcycle
ECL	Channel menu	:CHANnel:ECL
edge   pattern   state   delay   tv	Trigger menu	:TRIGger:MODE
env   norm   avg	Display menu	:ACQuire:TYPE
fail if >	Define Meas menu (meas limit)	:MEASure:COMPare
FALLTIME	front-panel key	:MEASure:FALLtime
field	TV Trigger menu	:TRIGger:FIELD
FINE	front-panel key	(front panel only)
f1   f2	Waveform Math menu	:FUNCTion < n >
form feed	Utility menu (HP-IB menu)	:HARDcopy:PAGE
frame   axes   grid   off	Display menu	DISPlay:GRATICule
FREQ	front-panel key	:MEASure:FREQuency
from	Define Meas menu (meas def)	:MEASure:DEFine
grid   off   frame   axes	Display menu	DISPlay:GRATICule
HARDCOPY	front-panel key	:PLOT
HARDCOPY	front-panel key	:PRINt
H   X   X	Delay Trigger menu (pattern)	:TRIGger:LOGic
H   X   X	Pattern Trigger menu	:TRIGger:LOGic
holdoff	Edge Trigger menu	:TRIGger:HOLDoff
holdoff	Pattern Trigger menu	:TRIGger:HOLDoff
holdoff	State Trigger menu	:TRIGger:HOLDoff
holdoff	TV Trigger menu	:TRIGger:HOLDoff

Table 4-2. Front-Panel Function to Command Cross-Reference

Front-Panel Function	Location	Command
HP-IB menu	Utility menu	(see specific functions)
initialize	Utility menu (HP-IB menu)	:HARDcopy:PLOT:INITialize
int	Waveform Math menu	:FUNCTion:INTegrate
invs	Waveform Math menu	:FUNCTion:INVert
level	Edge Trigger menu	:TRIGger:LEVel
level	TV Trigger menu	:TRIGger:LEVel
LF rej	Channel menu	:CHANnel:LFReject
line	TV Trigger menu	:TRIGger:OCCurrence
LOCAL	front-panel key	:SYSTem:KEY
lower threshold	Define Meas menu (meas def)	:MEASure:LOWer
meas	Define Meas menu	(see specific functions)
meas def	Define Meas menu	:MEASure:DEFine
meas limit	Define Meas menu	:MEASure:COMPare
measurements	Define Meas menu (meas def)	(see specific measurements)
multiply   X	Waveform Math menu	:FUNCTion:MULTiply
noise reject	Edge Trigger menu	:TRIGger:SENSitivity
nonvolatile	Waveform Save menu	:STORE
	(waveform)	
norm   avg   env	Display menu	:ACQuire:TYPE
off   frame   axes   grid	Display menu	DISPlay:GRATicule
offset	Channel menu	:CHANnel:OFFSet
offset	Waveform Math menu	:FUNCTion:OFFSet
only	Waveform Math menu	:FUNCTion:ONLY
or if <	Define Meas menu (meas limit)	:MEASure:COMPare
paper length	Utility menu (HP-IB menu)	:HARDcopy:LENGth
pattern   state   delay   tv   edge	Trigger menu	:TRIGger:MODE
PERIOD	front-panel key	:MEASure:PERiod
persistence	Display menu (norm)	:DISPlay:PERStence
pixel	Waveform Save menu	:MERGe
polarity	TV Trigger menu	:TRIGger:POLarity
plot	Utility menu (HP-IB menu)	:HARDcopy:PLOT:AREA
present	State Trigger menu	:TRIGger:CONDition
probe	Channel menu	:CHANnel:PROBe
probe cal menu	Utility menu	(see specific functions)
qualify on	Delay Trigger menu	:TRIGger:QUALify
qualify on	TV Trigger menu	:TRIGger:QUALify
realtime   repetitive	Timebase menu	:TIMEbase:SAMPle

Table 4-2. Front-Panel Function to Command Cross-Reference

Front-Panel Function	Location	Command
RECALL	front-panel key	*RCL
RECALL / CLEAR	front-panel keys	*RST
reference	Timebase menu	:TIMEbase:REFErence
repetitive   realtime	Timebase menu	:TIMEbase:SAMPle
RISETIME	front-panel key	:MEASure:RISetime
rms	Define Meas menu (meas)	:MEASure:VACRms
rms	Define Meas menu (meas)	:MEASure:VDCRms
rms	Define Meas menu (meas)	:MEASure:VRMS
RUN/STOP	front-panel key	:RUN
RUN/STOP	front-panel key	:STOP
SAVE	front-panel key	*SAV
save to	Define Meas menu (meas limit)	:MEASure:DESTination
scale-delay	Waveform Save menu	front panel only
scale-timebase	Waveform Save menu	front panel only
s/div	Timebase menu	:TIMEbase:RANGE
seconds   s	Utility menu (probe cal menu)	:CALibrate:TNULI
seconds per division	Timebase menu	:TIMEbase:RANGE
self cal menu	Utility menu	(front panel only)
selftest menu	Utility menu	*TST
sensitivity	Waveform Math menu	:FUNctIon:RANGE
service menu	Utility menu	(front panel only)
set	Define Meas menu (meas limit)	(see specific measurements)
SHOW	front-panel key	:MENU SHOW
SINGLE	front-panel key	:TIMEbase:MODE
slope	Delay Trigger menu	:TRIGger:DELAy:SLOPe
slope	Edge Trigger menu	:TRIGger:SLOPe
source	Edge Trigger menu	:TRIGger:SOURce
source	TV Trigger menu	:TRIGger:SOURce
source	Waveform Save menu	:STORE
	(waveform)	
standard	Define Meas menu (meas def)	:MEASure:MODE
start cal	Utility menu (probe cal menu)	(front panel only)
start marker	$\Delta t$ $\Delta V$ menu	:MEASure:ESTArt
start marker	$\Delta t$ $\Delta V$ menu	:MEASure:TSTArt
state   delay   tv   edge   pattern	Trigger menu	:TRIGger:MODE
statistics	Define Meas menu (meas)	:MEASure:STATistics
stop marker	$\Delta t$ $\Delta V$ menu	:MEASure:ESTOp

Table 4-2. Front-Panel Function to Command Cross-Reference

Front-Panel Function	Location	Command
stop marker	$\Delta t \Delta V$ menu	:MEASure:TSTOp
store	Waveform Save menu (waveform)	:STORe
subtract   -	Waveform Math menu	:FUNction:SUBTRact
talk only   addressed	Utility menu (HP-IB menu)	(program language specific)
test	Define Meas menu (meas limit)	:MEASure:LIMittest
test all	Utility menu (selftest menu)	*TST
threshold	Define Meas menu (meas def)	:MEASure:DEFine
thresholds	Define Meas menu (meas def)	:MEASure:LOWer
thresholds	Define Meas menu (meas def)	:MEASure:UPPer
TIMEBASE	front-panel key	:MENU TIMEbase
time null	Utility menu (probe cal menu)	:CALibrate:TNULI
to	Define Meas menu (meas def)	:MEASure:DEFine
TRIG	front-panel key	:MENU:TRIGger
trig'd   auto	Trigger menu	:TIMEbase:MODE
trigger on	Delay Trigger menu	:TRIGger:OCCurrence
trigger on	Delay Trigger menu	:TRIGger:OCCurrence:SLOPe
trigger on	Delay Trigger menu	:TRIGger:OCCurrence:SOURce
trigger on	TV Trigger menu	:TRIGger:OCCurrence
trigger on	TV Trigger menu	:TRIGger:OCCurrence:SLOPe
TTL	Channel menu	:CHANnel:TTL
tv   edge   pattern   state   delay	Trigger menu	:TRIGger:MODE
upper threshold	Define Meas menu (meas def)	:MEASure:UPPer
user defined	Define Meas menu (meas def)	:MEASure:MODE
UTIL	front-panel key	:MENU UTILity
V AMP	front-panel key	:MEASure:VAMPlitude
V AVG	front-panel key	:MEASure:VAVerage
V BASE	front-panel key	:MEASure:VBASe
V/div	Channel menu	:CHANnel:RANGe
versus   vs (WFORM MATH)	Waveform Math menu	:FUNction:VERSus
V marker 1	$\Delta t \Delta V$ menu	:MEASure:VSTArt
V marker 2	$\Delta t \Delta V$ menu	:MEASure:VSTOp
V MAX	front-panel key	:MEASure:VMAX
V MIN	front-panel key	:MEASure:VMIN
volatile	Waveform Save menu (pixel)	:MERGe
volts   %	Define Meas menu (meas def)	:MEASure:UNITs
volts per division	Channel menu	:CHANnel:RANGe

Table 4-2. Front-Panel Function to Command Cross-Reference

Front-Panel Function	Location	Command
V P-P	front-panel key	:MEASure:VPP
V RMS	front-panel key	:MEASure:VRMS
V TOP	front-panel key	:MEASure:VTOP
waveform	Waveform Save menu	:STORE
when	Delay Trigger menu	:TRIGger:LOGic
when	Pattern Trigger menu	:TRIGger:CONDition
when	State Trigger menu	:TRIGger:LOGic
WFORM MATH	front-panel key	:MENU MATH
WFORM SAVE	front-panel key	:MENU SAVE
X multiply	Waveform Math menu	:FUNCTION:MULTiply

## The Command Tree

The command tree in figure 4-1 shows all of the commands in the HP 54510A and the relationship of the commands to each other. The IEEE 488.2 common commands are not listed as part of the command tree since they do not affect the position of the parser within the tree. When a program message terminator (<NL>, linefeed - ASCII decimal 10) or a leading colon (:) is sent to the instrument, the parser is set to the "root" of the command tree.

**Command Types** The commands for this instrument can be placed into three types:

- Common commands.
- Root level commands.
- Subsystem commands.

### Common Commands

The common commands are the commands defined by IEEE 488.2. These commands control some functions that are common to all IEEE 488.2 instruments.

Common commands are independent of the tree, and do not affect the position of the parser within the tree. These commands differ from root level commands in that root level commands place the parser back at the root of the command tree.

Example:

```
*RST.
```

### Root Level Commands

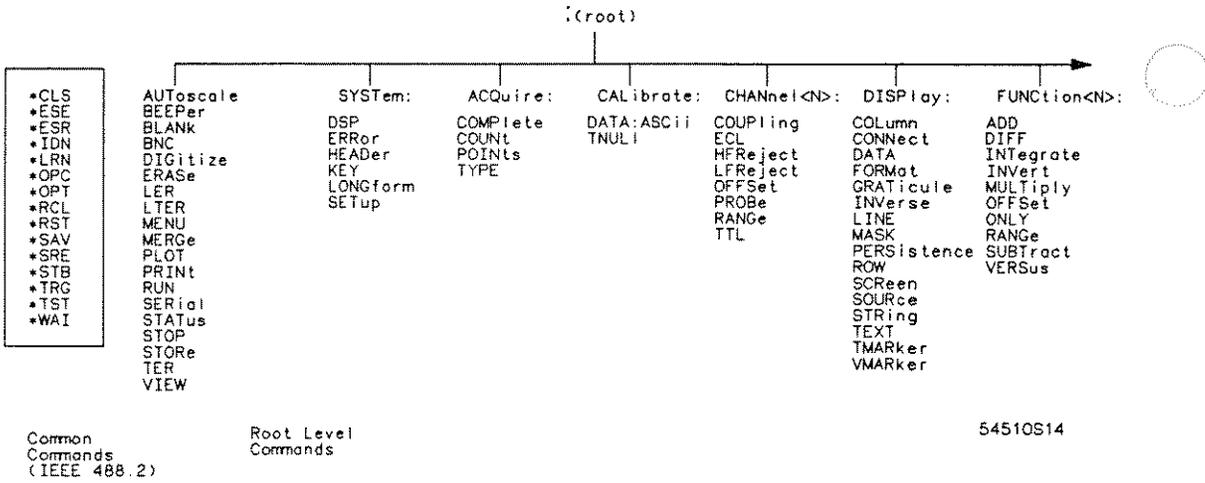
The root level commands control many of the basic functions of the instrument. These commands reside at the root of the command tree. Root level commands are always parsable if they occur at the beginning of a program message, or are preceded by a colon.

Example:

```
:AUTOSCALE
```

### Subsystem Commands

Subsystem commands are grouped together under a common node of the command tree, such as the TIMEBASE commands. Only one subsystem may be selected at any given time. When the instrument is initially turned on, the command parser is set to the root of the command tree, therefore, no subsystem is selected.



This instrument contains two identical channel subsystems and two identical function subsystems. The "N" in the Channel header must be 1 or 2 and the Function header must be 1 or 2.

Figure 4-1. The HP 54510A Command Tree

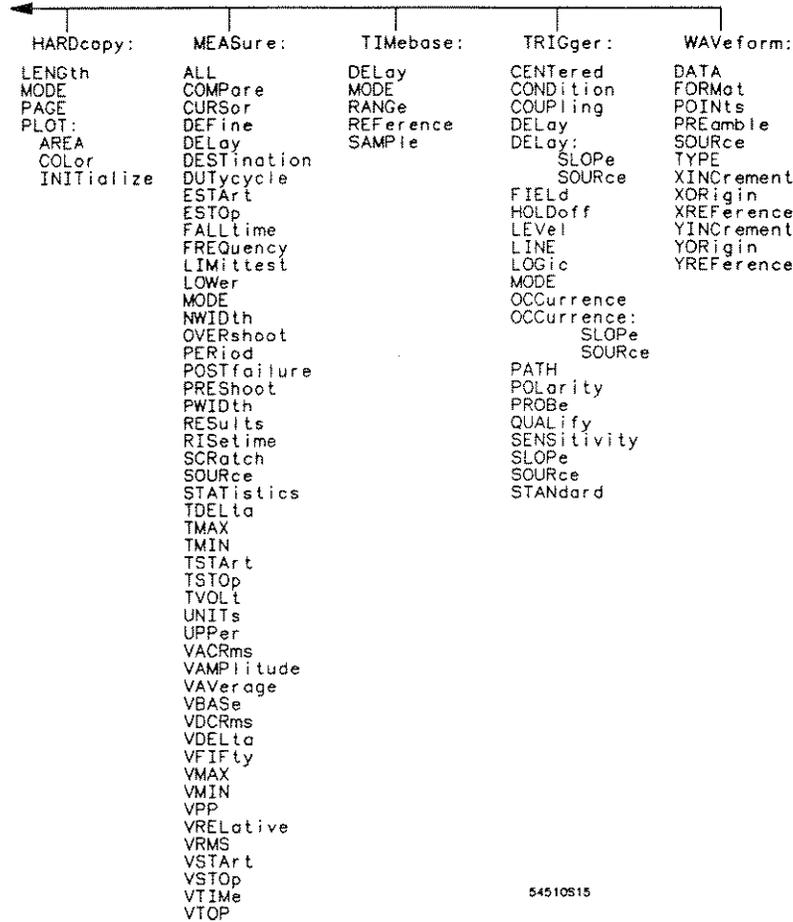


Figure 4-1. The HP 54510A Command Tree (continued)

## Tree Traversal Rules

Command headers are created by traversing down the command tree. A legal command header from the command tree in figure 4-1 would be :CHANNEL1:RANGE. This is referred to as a compound header. A compound header is a header made of two or more mnemonics separated by colons. The mnemonic created contains no spaces. The following rules apply to traversing the tree:

- A leading colon or a < program message terminator > (either an <NL> or EOI true on the last byte) places the parser at the root of the command tree. A leading colon is a colon that is the first character of a program header.
- Executing a subsystem command places you in that subsystem until a leading colon or a < program message terminator > is found. In the Command Tree, figure 4-1, use the last mnemonic in the compound header as a reference point (for example, RANGE). Then find the last colon above that mnemonic (CHANNEL<N>:). That is the point where the parser resides. Any command below that point can be sent within the current program message without sending the mnemonics which appear above them (for example, OFFSET).

## Examples

The OUTPUT statements in the examples are written using HP BASIC 5.0 on a HP 9000 Series 200/300 Controller. The quoted string is placed on the bus, followed by a carriage return and linefeed (CRLF).

### Example 1:

```
OUTPUT 707;" :CHANNEL1:RANGE 0.5 ;OFFSET 0"
```

### Comments:

The colon between CHANNEL1 and RANGE is necessary because CHANNEL1:RANGE is a compound command. The semicolon between the RANGE command and the OFFSET command is the required program message unit separator. The OFFSET command does not need CHANNEL1 preceding it, since the CHANNEL1:RANGE command sets the parser to the CHANNEL1 node in the tree.

**Example 2:**

```
OUTPUT 707;":TIMEBASE:REFERENCE CENTER ; DELAY 0.00001"
```

or

```
OUTPUT 707;":TIMEBASE:REFERENCE CENTER"  
OUTPUT 707;":TIMEBASE:DELAY 0.00001"
```

**Comments:**

In the first line of example 2, the "subsystem selector" is implied for the DELAY command in the compound command. The DELAY command must be in the same program message as the REFERENCE command, since the program message terminator places the parser back at the root of the command tree.

A second way to send these commands is by placing TIMEBASE: before the DELAY command as shown in the second part of example 2.

**Example 3:**

```
OUTPUT 707;":TIMEBASE:REFERENCE CENTER ; :CHANNEL1:OFFSET 0"
```

**Comments:**

The leading colon before CHANNEL1 tells the parser to go back to the root of the command tree. The parser can then see the CHANNEL1:OFFSET command.

---

## Infinity Representation

The representation of infinity is  $9.99999E + 37$ . This is also the value returned when a measurement cannot be made.

The infinity value may also be returned by queries that are not implemented in the HP 54510A, but are parsed for compatibility with other Hewlett-Packard instruments. Nonimplemented queries also place an error 13, "Not a 54510A command," in the error queue. A list of the commands that are not implemented on the HP 54510A are included at the end of this chapter.

---

## Sequential and Overlapped Commands

IEEE 488.2 makes the distinction between sequential and overlapped commands. Sequential commands finish their task before the execution of the next command starts. Overlapped commands run concurrently. Commands following an overlapped command may be started before the overlapped command is completed. All of the commands of the HP 54510A are sequential.

---

## Response Generation

As defined by IEEE 488.2, query responses may be buffered for the following conditions:

- When the query is parsed by the instrument.
- When the controller addresses the instrument to talk so that it may read the response.

The HP 54510A buffers responses to a query when the query is parsed.

## Notation Conventions and Definitions

The following conventions and definitions are used in this manual in descriptions of remote HP-IB operation:

### Conventions

**< >** Angle brackets enclose words or characters that symbolize a program code parameter or an HP-IB command.

**::=** "is defined as." For example, **<A> ::= <B>** indicates that **<A>** can be replaced by **<B>** in any statement containing **<A>**.

**|** "or." Indicates a choice of one element from a list. For example, **<A> | <B>** indicates **<A>** or **<B>**, but not both.

**...** An ellipsis (trailing dots) indicates that the preceding element may be repeated one or more times.

**[ ]** Square brackets indicate that the enclosed items are optional.

**{ }** When several items are enclosed by braces, one, and only one of these elements must be selected.

### Definitions

**d ::=** A single ASCII numeric character, 0-9.

**n ::=** A single ASCII non-zero, numeric character, 1-9.

**<NL> ::=** Newline or Linefeed (ASCII decimal 10).

**<sp> ::=** <white space>

**<white space> ::=** 0 through 32 (decimal) except linefeed (decimal 10).

---

## Syntax Diagrams

Chapters 6 through 18 contain syntax diagrams showing the proper syntax for each command. All characters contained in a circle or oblong are literals, and must be entered exactly as shown. Words and phrases contained in rectangles are names of items used with the command and are described in the accompanying text of each command. Each line can only be entered from one direction as indicated by the arrow on the entry line. Any combination of commands and arguments that can be generated by following the lines in the proper direction is syntactically correct. An argument is optional if there is a path around it. Where there is a rectangle which contains the word "space," a white space character must be entered. White space is optional in many other places.

---

## Program Examples

The program examples given for each command in chapters 5 through 18 were written on an HP 9000 Series 200/300 controller using the HP BASIC 5.0 programming language. The programs always assume the oscilloscope is at address 707. If a printer is used, it is always assumed to be at address 701.

In these examples, pay special attention to the ways in which the command or query can be sent. The way the instrument is set up to respond to a command or query has no bearing on how you send the command or query. That is, the command or query can be sent using the long form or short form, if a short form exists for that command. You can send the command or query using upper case (capital) letters or lower case (small) letters. Also, the data can be sent using almost any form you wish. If you are sending a channel 1 range value of 100 mV, that value could be sent using a decimal (.1), or an exponential (1e-1 or 1.0E-1), or a suffix (100 mV or 100MV).

As an example, set channel 1 range to 100 mV by sending one of the following:

- Commands in long form using the decimal format.

```
OUTPUT 707;":CHANNEL1:RANGE .1"
```

- Commands in short form using an exponential format.

```
OUTPUT 707;":CHAN1:RANG 1E-1"
```

- Commands using lower case letters, short forms, and a suffix.

```
OUTPUT 707;":chan1:rang 100 mV"
```



---

In these examples, the colon as the first character of the command is optional. The space between RANGE and the argument is required.

---

If you want to observe the headers for the queries, you must bring the returned data into a string variable. Generally, you should dimension all string variables before reading the data.

If you do not need to see the headers and a numeric value is returned from the HP 54510A, then you should use a numeric variable. In this case the headers should be turned off.

---

## Command Set Organization

The command set for the HP 54510A is divided into common commands, root level commands and 11 sets of subsystem commands. Each of the 13 groups of commands is described in the following chapters. Each of the chapters contain a brief description of the subsystem, a set of syntax diagrams for the commands, and the commands for each subsystem in alphabetic order.

The commands are shown in the long form and short form using upper and lowercase letters. As an example, AUToscale indicates that the long form of the command is AUTOSCALE and the short form of the command is AUT. Each command listing contains a description of the command and its arguments, the command syntax, and a programming example.

The eleven subsystems in the HP 54510A are listed below:

**SYSTEM** - controls some basic functions of the oscilloscope.

**ACQUIRE** - sets the parameters for acquiring and storing data.

**CALIBRATE** - sets the time nulls (channel-to-channel skew) and returns the instrument's calibration data.

**CHANNEL** - controls all Y-axis oscilloscope functions.

**DISPLAY** - controls how waveforms, voltage and time markers, graticule, and text are displayed and written on the screen.

**FUNCTION** - controls the waveform math functions of the oscilloscope.

**HARDCOPY** - controls the parameters used during the plotting or printing of waveforms.

**MEASURE** - selects the automatic measurements to be made.

**TIMEBASE** - controls all X-axis oscilloscope functions.

**TRIGGER** - controls the trigger modes and parameters for each trigger mode.

**WAVEFORM** - provides access to waveform data, including active data from channels and functions as well as static data from waveform memories.

Table 4-3 lists the commands for the HP 54510A in alphabetical order with their corresponding subsystem or command type.

Table 4-3. Alphabetic Command Cross-Reference

Command	Where Used
ADD	FUNCTION Subsystem
ALL	MEASURE Subsystem
AUTOScale	Root Level Command
BEEPer	Root Level Command
BLANK	Root Level Command
BNC	Root Level Command
CENTERed	TRIGGER Subsystem
*CLS	Common Command
COLUMN	DISPLAY Subsystem
COMPARE	MEASURE Subsystem
COMPLETE	ACQUIRE Subsystem
CONDITION	TRIGGER Subsystem
CONNECT	DISPLAY Subsystem
COUNT	ACQUIRE Subsystem
COUPLing	CHANNEL Subsystem
COUPLing	TRIGGER Subsystem
CURSOr	MEASURE Subsystem
DATA	DISPLAY Subsystem
DATA	WAVEform Subsystem
DATA:ASCii	CALibrate Subsystem
DEFine	MEASURE Subsystem
DELay	MEASURE Subsystem
DELay	TIMEbase Subsystem
DELay	TRIGGER Subsystem
DELay:SLOPe	TRIGGER Subsystem
DELay:SOURce	TRIGGER Subsystem
DESTination	MEASURE Subsystem
DIFF	FUNCTION Subsystem
DIGitize	Root Level Command
DSP	SYSTEM Subsystem
DUTYcycle	MEASURE Subsystem
ECL	CHANNEL Subsystem
ERASe	Root Level Command
ERRor	SYSTEM Subsystem
*ESE	Common Command
*ESR	Common Command
ESTArt	MEASURE Subsystem
ESTOp	MEASURE Subsystem

Table 4-3. Alphabetic Command Cross-Reference

Command	Where Used
FALLtime	MEASure Subsystem
FIELD	TRIGger Subsystem
FORMat	DISPlay Subsystem
FORMat	WAVEform Subsystem
FREQuency	MEASure Subsystem
GRATicule	DISPlay Subsystem
HEADer	SYSTEM Subsystem
HFReject	CHANnel Subsystem
HOLDoff	TRIGger Subsystem
*IDN	Common Command
INTegrate	FUNCTion Subsystem
INVerse	DISPlay Subsystem
INVert	FUNCTion Subsystem
KEY	SYSTEM Subsystem
LENGth	HARDcopy Subsystem
LER	Root Level Command
LEVel	TRIGger Subsystem
LFReject	CHANnel Subsystem
LIMittest	MEASure Subsystem
LINE	DISPlay Subsystem
LINE	TRIGger Subsystem
LOGic	TRIGger Subsystem
LONGform	SYSTEM Subsystem
LOWer	MEASure Subsystem
*LRN	Common Command
LTER	Root Level Command
MASK	DISPlay Subsystem
MENU	Root Level Command
MERGE	Root Level Command
MODE	HARDcopy Subsystem
MODE	MEASure Subsystem
MODE	TIMebase Subsystem
MODE	TRIGger Subsystem
MULTiply	FUNCTion Subsystem
NWIDth	MEASure Subsystem
OCCurrence	TRIGger Subsystem
OCCurrence:SLOPe	TRIGger Subsystem
OCCurrence:SOURce	TRIGger Subsystem

Table 4-3. Alphabetic Command Cross-Reference

Command	Where Used
OFFSet	CHANnel Subsystem
OFFSet	FUNcTion Subsystem
ONLY	FUNcTion Subsystem
*OPC	Common Command
*OPT	Common Command
OVERshoot	MEASure Subsystem
PAGE	HARDcopy Subsystem
PATH	TRIGger Subsystem
PERiod	MEASure Subsystem
PERSistence	DISPlay Subsystem
PLOT	Root Level Command
PLOT:AREA	HARDcopy Subsystem
PLOT:COLor	HARDcopy Subsystem
PLOT:INITialize	HARDcopy Subsystem
POINTs	ACQuire Subsystem
POINTs	WAVEform Subsystem
POLarity	TRIGger Subsystem
POSTfailure	MEASure Subsystem
PREamble	WAVEform Subsystem
PREShoot	MEASure Subsystem
PRINt	Root Level Command
PROBE	CHANnel Subsystem
PROBE	TRIGger Subsystem
PWIDth	MEASure Subsystem
QUALify	TRIGger Subsystem
RANGe	CHANnel Subsystem
RANGe	FUNcTion Subsystem
RANGe	TIMEbase Subsystem
*RCL	Common Command
REFerence	TIMEbase Subsystem
RESults	MEASure Subsystem
RISetime	MEASure Subsystem
ROW	DISPlay Subsystem
*RST	Common Command
RUN	Root Level Command
SAMPle	TIMEbase Subsystem
*SAV	Common Command
SCRatch	MEASure Subsystem

Table 4-3. Alphabetic Command Cross-Reference

Command	Where Used
SCReen	DISPlay Subsystem
SENSitivity	TRIGger Subsystem
SERial	Root Level Command
SETup	SYSTem Subsystem
SLOPe	TRIGger Subsystem
SOURce	DISPlay Subsystem
SOURce	MEASure Subsystem
SOURce	TRIGger Subsystem
SOURce	WAVeform Subsystem
*SRE	Common Command
STANdard	TRIGger Subsystem
STATistics	MEASure Subsystem
STATus	Root Level Command
*STB	Common Command
STOP	Root Level Command
STORE	Root Level Command
STRing	DISPlay Subsystem
SUBTRact	FUNCTion Subsystem
TDELta	MEASure Subsystem
TER	Root Level Command
TEXT	DISPlay Subsystem
TMARKer	DISPlay Subsystem
TMAX	MEASure Subsystem
TMIN	MEASure Subsystem
TNULL	CALibrate Subsystem
*TRG	Common Command
*TST	Common Command
TSTArt	MEASure Subsystem
TSTOp	MEASure Subsystem
TTL	CHANnel Subsystem
TVOLt	MEASure Subsystem
TYPE	ACQuire Subsystem
TYPE	WAVeform Subsystem
UNITs	MEASure Subsystem
UPPer	MEASure Subsystem
VACRms	MEASure Subsystem
VAMplitude	MEASure Subsystem
VAVerage	MEASure Subsystem

Table 4-3. Alphabetic Command Cross-Reference

Command	Where Used
VBASe	MEASure Subsystem
VDCRms	MEASure Subsystem
VDELta	MEASure Subsystem
VERSus	FUNCTion Subsystem
VFIFty	MEASure Subsystem
VIEW	Root Level Command
VMARker	DISPlay Subsystem
VMAX	MEASure Subsystem
VMIN	MEASure Subsystem
VPP	MEASure Subsystem
VRELative	MEASure Subsystem
VRMS	MEASure Subsystem
VSTArt	MEASure Subsystem
VSTOp	MEASure Subsystem
VTIMe	MEASure Subsystem
VTOP	MEASure Subsystem
*WAI	Common Command
XINCrement	WAVEform Subsystem
XORigin	WAVEform Subsystem
XREFerence	WAVEform Subsystem
YINCrement	WAVEform Subsystem
YORigin	WAVEform Subsystem
YREFerence	WAVEform Subsystem

## Nonimplemented Commands

The commands and queries listed in table 4-4 are not implemented in the HP 54510A, but the queries are parsed for compatibility with other Hewlett-Packard instruments. Sending one of these commands or queries will produce the error code and string "13, NOT A 54510A COMMAND." The returned values for the queries are also listed in table 4-4.

**Table 4-4. Nonimplemented Commands and Queries**

Command/Query	Returned Value
*IST	9.99999E + 37
*PRE	9.99999E + 37
:EOI	9.99999E + 37
:ACQuire:FiLTeR	9.99999E + 37
:MEASure:PRECiSion	9.99999E + 37
:TiMebase:WiNDoW	9.99999E + 37
:TiMebase:WiNDoW:DELaY	9.99999E + 37
:TiMebase:WiNDoW:RANGe	9.99999E + 37
:WAVeform:COUNt	9.99999E + 37
:WAVeform:RECoRd	9.99999E + 37

### Note

The EOI bus control line is always asserted on the HP 54510A oscilloscope in accordance with IEEE 488.2.

## Example Programs

---

### Introduction

This chapter contains example programs using the command set for the HP 54510A. In general, the programs use the long form of the command with alpha (as opposed to numeric) arguments. Each command has a separate output statement for clarity. To optimize speed, switch to the concatenated short form numerics.

Throughout these examples, the HP 54510A is assumed to be at address 7, the hardcopy devices at address 1, and the system bus at 700. The input signal used is the AC CAL signal from the rear panel of the instrument. This signal is connected to channel 1 through a 10:1 probe.

All programs were developed on an HP Series 200/300 controller using HP BASIC 5.0. Several examples use the BASIC command "ENTER 2." This pauses program execution until the "ENTER" key is pressed on the controller. This is used to separate different blocks in the example to dramatize the features, allow for user interaction, or to wait for the HP 54510A to finish an operation such as a hardcopy output or an acquisition.

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### Order of Commands

The order of the commands in a program may be critical to the task you are trying to accomplish. If your commands do not follow the proper order, later commands may cancel out earlier commands and conditions you thought were setup are no longer valid. Table 5-1 lists the order of some commonly used commands in the TIMEbase, CHANnel, TRIGger, ACQuire, and WAVEform subsystems. For more information, refer to the specific commands in this manual.

To use the table, select the appropriate commands you need from one subsystem at a time, working from top to bottom. Then move to the next subsystem, working from left to right. It is not necessary to use all of the commands, but the order in which you use the commands is critical.

Table 5-1. Order of Commands

	First	Second	Third	Fourth	Fifth
<b>Subsystem:</b>	:TIMEbase	:CHANnel {1 2}	:TRIGger	:ACQuire	:WAVeform
<b>First</b>	:MODE AUTO TRIGgered SINGLE	:PROBe (ratio to one: .9 - 1000)	:MODE EDGE PATTern STATE DELay TV	:TYPE NORMAL AVERage ENVELOpe	:FORMat ASCii WORD BYTE COMPressed
<b>Second</b>	:SAMPLing REALtime REPetitive	:RANGE (Volts/screen)	:SOURce CHANnel1 CHANnel2 EXTernal	:COMPLete (0 to 100%)	:SOURce CHANnel1 CHANnel2 WAVeform1 WAVeform2 WAVeform3 WAVeform4
<b>Third</b>	:REFERence LEFT CENTer RIGHT	:OFFSet (Volts @ center screen)	:LEVel (trigger@Volts)	:POINTs (500/8000)	
<b>Fourth</b>	:RANGE (s/screen)	:COUPLing AC DC DCFifty	:SLOPe POSitive NEGative	:COUNT (1 - 2048)	
<b>Fifth</b>	:DELay (delay value)				

## Vertical Channel Setup Program

This sample program demonstrates some of the commands used to set a vertical channel, in this case channel 1. The program assumes that the AC CAL signal from the rear panel of the instrument is connected to channel 1 through a 10:1 probe.

```

10 CLEAR 707 ! Initialize instrument interface
20 OUTPUT 707;"*RST" ! Reset instrument to known state
30 OUTPUT 707;"AUTOSCALE" ! Autoscale the instrument
40 !
50 OUTPUT 707;"BNC PROBE" ! BNC output to probe mode
55 OUTPUT 707;"TIMEBASE:SAMPLE REALTIME" ! Real time acquisition
60 OUTPUT 707;"CHANNEL1:PROBE 10" ! Probe attenuation to 10:1
70 OUTPUT 707;"CHANNEL1:RANGE 0.8" ! Vertical range to 800 mV full scale
80 OUTPUT 707;"CHANNEL1:OFFSET 0.2" ! Offset to 200 mV
90 OUTPUT 707;"CHANNEL1:COUPLING DC" ! DC coupling
100 !
110 REAL Offset,Range ! Set up REAL variables
120 INTEGER J ! Set up INTEGER variable
130 Offset=.20 ! Offset variable to .2 V
140 OUTPUT 707;"BEEPER" ! Sound beeper
150 OUTPUT 707;"SYSTEM:DSP 'PRESS ENTER - OFFSET POSITIONS WAVEFORM ON SCREEN'"
160 ENTER 2
170 OUTPUT 707;"SYSTEM:DSP '"
180 !
190 ! The following lines vary the channel 1 offset
200 !
210 FOR J=1 TO 21
220 OUTPUT 707;"CHANNEL1:OFFSET ";Offset ! Set next offset
230 Offset=Offset-.03
240 WAIT .5
250 NEXT J
260 OUTPUT 707;"BEEPER" ! Sound beeper
270 OUTPUT 707;"SYSTEM:DSP 'PRESS ENTER - VERTICAL RANGE SCALES SIGNAL'"
280 ENTER 2
290 OUTPUT 707;"SYSTEM:DSP '"
300 OUTPUT 707;"CHANNEL1:OFFSET -0.4" ! Center screen at -400 mV
310 OUTPUT 707;"CHANNEL1:RANGE 0.8" ! Vertical range to 800 mV full scale
320 Range=.8 ! Range variable to .8
330 !
340 ! The following lines vary the vertical range
350 !
360 FOR J=1 TO 25
370 OUTPUT 707;"CHANNEL1:RANGE ";Range ! Set new range
380 Range=Range+.16
390 WAIT .8

```

```
400 NEXT J
410 OUTPUT 707;":SYSTEM:DSP 'END OF PROGRAM'"
420 WAIT 6
430 OUTPUT 707;":SYSTEM:DSP '"
440 LOCAL 707 ! Return instrument to local
450 END
```

## Time Base Program

This sample program demonstrates some of the commands in the TIMEBASE subsystem. The program assumes that the AC CAL signal from the rear panel of the instrument is connected to channel 1 through a 10:1 probe.

```

10 CLEAR 707 ! Initialize instrument interface
20 OUTPUT 707;"*RST" ! Reset instrument to known state
30 OUTPUT 707;"AUTOSCALE" ! Autoscale the instrument
40 !
50 OUTPUT 707;"BNC PROBE" ! BNC output to probe mode
60 REAL Sens,Tdelay ! Set up REAL variables
70 INTEGER J ! Set up INTEGER variable
80 OUTPUT 707;"MENU TIMEBASE" ! Select the timebase menu
85 OUTPUT 707;"TIMEBASE:SAMPLE REALTIME" ! Real time acquisition
90 OUTPUT 707;"TIMEBASE:RANGE 5E-4" ! Time base to 50 us/div
100 OUTPUT 707;"TIMEBASE:DELAY 0" ! Set delay to zero
110 OUTPUT 707;"TIMEBASE:REFERENCE CENTER" ! Center reference
111 OUTPUT 707;"CHANNEL1:PROBE 10" ! Probe attenuation to 10:1
120
130 OUTPUT 707;"BEEPER" ! Sound beeper
140 OUTPUT 707;"SYSTEM:DSP 'PRESS ENTER - DELAY FROM TRIGGER EVENT WILL CHANGE'"
150 ENTER 2
160 OUTPUT 707;"SYSTEM:DSP '"
170 Tdelay=-2.4E-4 ! Set variable to 240 us
180 !
190 ! The following lines vary the time base delay
200 !
210 FOR J=1 TO 28
220 OUTPUT 707;"TIMEBASE:DELAY ";Tdelay ! Set new delay
230 Tdelay=Tdelay+2.E-5
240 WAIT .6
250 NEXT J
260 OUTPUT 707;"BEEPER" ! Sound beeper
270 OUTPUT 707;"SYSTEM:DSP 'PRESS ENTER - HORIZONTAL TIME WILL CHANGE'"
280 ENTER 2
290 OUTPUT 707;"SYSTEM:DSP '"
300 Sens=8.0E-2 ! Set variable to 80 ms
310 OUTPUT 707;"TIMEBASE:RANGE 10.0E-2" ! time base to 10 ms/div
320 OUTPUT 707;"TIMEBASE:DELAY 0" ! Set delay to zero
330 !
340 ! The following lines vary the horizontal time base range
350 !
360 FOR J=1 TO 15
370 OUTPUT 707;"TIMEBASE:RANGE ";Sens ! Set new range
380 Sens=Sens/2

```

```
390 WAIT 1
400 NEXT J
410 OUTPUT 707;":SYSTEM:DSP 'END OF PROGRAM'"
420 WAIT 6
430 OUTPUT 707;":SYSTEM:DSP '"
440 LOCAL 707 ! Return instrument to local
450 END
```

## Measurement Setup Program

This sample program demonstrates some of the commands in the MEASURE subsystem. The program assumes that the AC CAL signal from the rear panel of the instrument is connected to channel 1 through a 10:1 probe.

```

10 CLEAR 707 ! Initialize instrument interface
20 OUTPUT 707;"*CLS" ! Clear error queue
30 OUTPUT 707;"*RST" ! Reset instrument to known state
40 DIM Meas$(400) ! Dimension variable
50 OUTPUT 707;"SYSTEM:HEADER ON" ! Headers on for query responses
60 OUTPUT 707;"AUTOSCALE" ! Autoscale the instrument
70 !
80 OUTPUT 707;"BNC PROBE" ! BNC output to probe mode
90 OUTPUT 707;"TIMEBASE:RANGE 5E-3" ! Time base to 500 us/div
100 OUTPUT 707;"TIMEBASE:DELAY 5E-4" ! Delay to 500 us
110 OUTPUT 707;"CHANNEL1:PROBE 10" ! Attenuation to 10:1
120 OUTPUT 707;"CHANNEL1:RANGE 1.2" ! Channel 1 to 1.2 V full scale
130 OUTPUT 707;"CHANNEL1:OFFSET -0.4" ! Channel centered at -0.4 V
140 OUTPUT 707;"TRIGGER:MODE EDGE" ! Edge triggering
150 OUTPUT 707;"TRIGGER:SLOPE POSITIVE" ! Trigger on positive edge
160 OUTPUT 707;"ACQUIRE:TYPE NORMAL" ! Display mode to NORMAL
170 OUTPUT 707;"DISPLAY:FORMAT 1" ! Full screen display
180 OUTPUT 707;"VIEW CHANNEL1"
190 OUTPUT 707;"BLANK CHANNEL2"
200 OUTPUT 707;"DISPLAY:VMARKER ON" ! Turn on voltage markers
210 OUTPUT 707;"DISPLAY:TMARKER ON" ! Turn on time markers
220 OUTPUT 707;"MEASURE:SOURCE CHANNEL1" ! Channel 1 source
230 !
240 ! The following lines set voltage markers to -0.4 V for
250 ! the reference for the edge find function.
260 !
261 OUTPUT 707;"DIGITIZE CHANNEL1" ! Acquire data for measurements
270 OUTPUT 707;"MEASURE:VSTART -0.4"
280 OUTPUT 707;"MEASURE:VSTOP -.4"
290 OUTPUT 707;"BEEPER" ! Sound beeper
300 OUTPUT 707;"SYSTEM:DSP 'PRESS ENTER - TIME MARKERS MOVE TO SIGNAL EDGES'"
310 ENTER 2
320 OUTPUT 707;"SYSTEM:DSP '"
330 INTEGER J ! Set up INTEGER variable
340 !
350 ! The following lines move the time markers between
360 ! the signal edges
370 !
380 FOR J=1 TO 3
390 OUTPUT 707;"MEASURE:ESTART ";J ! Find the Jth positive edge

```

```

400 WAIT .75
410 OUTPUT 707;":MEASURE:ESTOP ";-J           ! Find the Jth negative edge
420 WAIT .75
430 NEXT J
440 OUTPUT 707;":BEEPER"                       ! Sound beeper
450 OUTPUT 707;":SYSTEM:DSP 'PRESS ENTER - INCREMENT VOLTAGE AND TIME MARKERS'"
460 ENTER 2
470 OUTPUT 707;":SYSTEM:DSP '"
480 REAL Tdelay,Voffset                       ! Set up REAL variables
490 Tdelay=0                                  ! Initialize Tdelay variable
500 Voffset=0                                  ! Initialize Voffset variable
510 !
520 ! The following lines move the time and voltage start and
530 ! stop markers.
540 !
550 FOR J=1 TO 21
560 OUTPUT 707;":MEASURE:TSTART ";-1.E-3-Tdelay! Move time start marker
570 OUTPUT 707;":MEASURE:TSTOP ";1.E-3+Tdelay ! Move time stop marker
580 OUTPUT 707;":MEASURE:VSTART ";-.4-Voffset ! Move voltage start marker
590 OUTPUT 707;":MEASURE:VSTOP ";-.4+Voffset ! Move voltage stop marker
600 Tdelay=Tdelay-1.E-4
610 Voffset=Voffset-4.E-2
620 NEXT J
630 OUTPUT 707;":BEEPER"                       ! Sound Beeper
640 OUTPUT 707;":SYSTEM:DSP 'PRESS ENTER TO MAKE AUTOMATIC MEASUREMENTS'"
650 ENTER 2
660 OUTPUT 707;":SYSTEM:DSP '"
670 OUTPUT 707;":MEASURE:ALL?"                 ! Measure all parameters
680 !
690 ! The results of the MEASURE ALL query are displayed on
700 ! the screen, and are available over HP-IB. The error
710 ! "Questionable horizontal scaling" will be placed in the
720 ! error queue to indicate that the horizontal is not set for
730 ! maximum accuracy.
740 !
750 ENTER 707 USING "-K";Meas$
760 PRINT USING "K";Meas$
770 WAIT 3
780 DIM Err${50}                               ! Dimension variable
790 OUTPUT 707;":SYSTEM:ERROR? STRING"         ! Check for errors
800 ENTER 707;Err$
810 PRINT Err$
820 OUTPUT 707;":BEEPER"                       ! Sound beeper
830 OUTPUT 707;":SYSTEM:DSP 'PRESS ENTER TO ACCURATELY MEASURE RISETIME'"
840 ENTER 2
850 OUTPUT 707;":SYSTEM:DSP '"
860 OUTPUT 707;":TIMEBASE:DELAY 0"             ! Center rising edge
870 OUTPUT 707;":TIMEBASE:RANGE 2E-8"         ! Expand the display
880 OUTPUT 707;":DIGITIZE CHANNEL1"           ! Acquire new data
890                                           ! after changing the time base

```

```
900  OUTPUT 707;""*CLS"           ! Clear status data structures
910  OUTPUT 707;":MEASURE:RISETIME?" ! Measure rise time
920  ENTER 707;Meas$
930  PRINT Meas$
940  OUTPUT 707;":SYSTEM:ERROR? STRING" ! Check for errors
950  ENTER 707;Err$
960  PRINT Err$
970  OUTPUT 707;":SYSTEM:DSP 'END OF PROGRAM'"
980  WAIT 6
990  OUTPUT 707;":SYSTEM:DSP '"
1000 LOCAL 707                   ! Return instrument to local
1010 END
```

## Digitize Program

This sample program demonstrates some of the commands used to digitize a waveform. The program assumes that the AC CAL signal from the rear panel of the instrument is connected to channel 1 through a 10:1 probe.

```

10  CLEAR 707                ! Initialize instrument interface
20  OUTPUT 707;"*RST"        ! Reset instrument to known state
30  OUTPUT 707;"AUTOSCALE"  ! Autoscale the instrument
40  OUTPUT 707;"BNC PROBE"  ! BNC output to probe mode
50  OUTPUT 707;"TIMEBASE:SAMPLE REPETITIVE" ! Repetitive time base mode
60  OUTPUT 707;"TIMEBASE:RANGE 1E-8" ! Time base to 1 ns/div
70  OUTPUT 707;"CHANNEL1:PROBE 10" ! Attenuation to 10:1
80  OUTPUT 707;"CHANNEL1:RANGE 1.6" ! Vertical to 1.6 V full scale
90  OUTPUT 707;"CHANNEL1:OFFSET -.4" ! Offset to -0.4 V
100 OUTPUT 707;"CHANNEL1:COUPLING DC" ! DC coupling
110 OUTPUT 707;"ACQUIRE:TYPE NORMAL" ! Display mode to NORMAL
120 OUTPUT 707;"ACQUIRE:COMPLETE 30" ! 30% completion criteria
130 OUTPUT 707;"ACQUIRE:POINTS 500" ! 500 points per record
140 OUTPUT 707;"WAVEFORM:SOURCE CHANNEL1" ! Channel 1 as waveform source
150 OUTPUT 707;"DIGITIZE CHANNEL1" ! Acquire data
160 REAL Cmp                ! Set up REAL variable
170 INTEGER J               ! Set up INTEGER variable
180 OUTPUT 707;"BEEPER"    ! Sound beeper
190 OUTPUT 707;"SYSTEM:DSP 'PRESS ENTER - CHANGE COMPLETION CRITERIA'"
200  ENTER 2
210 OUTPUT 707;"SYSTEM:DSP '"
220  Cmp=100                ! Initialize Cmp variable
230  !
240  ! The following lines reduce the completion criteria
250  ! for each acquisition
260  !
270  FOR J=1 TO 11
280  OUTPUT 707;"ACQUIRE:COMPLETE ";Cmp ! Set new completion criteria
290  PRINT Cmp              ! Print current completion criteria
300  OUTPUT 707;"DIGITIZE CHANNEL1"
310  Cmp=Cmp-10
320  WAIT 4
330  NEXT J
340  OUTPUT 707;"SYSTEM:DSP 'END OF PROGRAM'"
350  WAIT 6
360  OUTPUT 707;"SYSTEM:DSP '"
370  LOCAL 707             ! Return instrument to local
380  END

```

## Using \*OPC to Detect the End of an Operation

This sample program uses the \*OPC to detect the end of a digitize operation. The program assumes that the AC CAL signal from the rear panel of the instrument is connected to channel 1 through a 10:1 probe.

```

10  CLEAR 707                                ! Initialize instrument interface
20  OUTPUT 707;"*RST"                        ! Reset instrument to known state
30  OUTPUT 707;"*CLS"                        ! Clear status data structures
40  OUTPUT 707;"BNC PROBE"                  ! BNC output to probe mode
50  OUTPUT 707;"CHANNEL1:PROBE 10"         ! Probe attenuation to 10:1
60  OUTPUT 707;"*SRE 32"                   ! Set up service request
70  OUTPUT 707;"*ESE 1"
80  ON INTR 7 GOSUB Service
90  ENABLE INTR 7;2
100 Operation_done=0
110 OUTPUT 707;"AUTOSCALE;*OPC"            ! Set OPC bit at end of Autoscale
120 LOOP
130 EXIT IF Operation_done
140 END LOOP
150 PRINT "AUTOSCALE COMPLETED"
160 Operation_done=0                        ! Reset flag
170 OUTPUT 707;"DIGITIZE CHANNEL1;*OPC"    ! Set OPC bit at end of Digitize
180 LOOP
190 EXIT IF Operation_done
200 END LOOP
210 PRINT "DIGITIZE COMPLETED"
220 STOP
230 Service:Operation_done=0                ! Interrupt routine
240 S=SPOLL(707)
250 PRINT "SERIAL POLL RETURN = ";S
260 IF BIT(S,5) THEN                        ! Complete?
270   OUTPUT 707;"*ESR?"
280   ENTER 707;Esr
290   PRINT "EVENT STATUS REGISTER = ";Esr
300   IF BIT(Esr,0) THEN
310     Operation_done=1
320   END IF
330 END IF
340 ENABLE INTR 7;2
350 RETURN
360 END

```

## Transferring Data

This sample program moves waveform data from the HP 54510A to the controller and then back to the HP 54510A with the WAVEFORM:DATA query and command. The program assumes that the AC CAL signal from the rear panel of the instrument is connected to channel 1 through a 10:1 probe.

```

10  CLEAR 707                                ! Initialize instrument interface
20  OUTPUT 707;":BNC PROBE"                  ! BNC output to probe mode
30  OUTPUT 707;":CHANNEL1:PROBE 10"         ! Probe attenuation to 10:1
31  OUTPUT 707;":TIMEBASE:SAMPLE REPETITIVE" ! Select sample mode
40  OUTPUT 707;":ACQUIRE:TYPE NORMAL"      ! Display mode to NORMAL
50  OUTPUT 707;":ACQUIRE:COUNT 1"
60  OUTPUT 707;":ACQUIRE:POINTS 500"
70  OUTPUT 707;":DIGITIZE CHANNEL1"        ! Acquire data
80  OUTPUT 707;":SYSTEM:HEADER OFF"        ! Headers off
90  OUTPUT 707;":WAVEFORM:SOURCE CHANNEL1" ! Channel 1 as waveform source
100 OUTPUT 707;":WAVEFORM:FORMAT WORD"     ! WORD format
110 OUTPUT 707;":WAVEFORM:DATA?"
120 ENTER 707 USING "#,2A,8D";Headers$,Bytes
130 Length=Bytes
140 Length=Length/2
150 ALLOCATE INTEGER Waveform(1:Length)
160 ENTER 707 USING "#,W";Waveform(*)
170 ENTER 707 USING "-K,B";End$
180 DIM Preamble$[200]                       ! Dimension variable
190 OUTPUT 707;":WAVEFORM:PREAMBLE?"
200 ENTER 707 USING "-K";Preamble$
210 OUTPUT 707;":WAVEFORM:SOURCE,WMEMORY4" ! Waveform memory 4 as source
220 OUTPUT 707 USING "#,K";":WAVEFORM:PREAMBLE ";Preamble$
230 OUTPUT 707 USING "#,K";":WAVEFORM:DATA #800001000"
240 OUTPUT 707 USING "W";Waveform(*)
250 OUTPUT 707;":BLANK CHANNEL1"
260 OUTPUT 707;":VIEW WMEMORY4"
270  END

```



### Note

In program line 220, the space after :WAVEFORM:PREAMBLE and before the quotation mark is required.

## Transferring Unfiltered Data

This sample program acquires ten fifty-point records of unfiltered data and reads them into the controller. It then prints out the XORIGIN and first three data points of each acquisition. The program assumes that the AC CAL signal from the rear panel of the instrument is connected to channel 1 through a 10:1 probe.

```

10  OPTION BASE 1
20  ASSIGN @Scope TO 707                ! Assign 707 to @Scope
30  ASSIGN @Fast TO 707;FORMAT OFF      ! Assign 707 to @Fast
40                                     ! with Format off for
50                                     ! fast data transfers.
60  CLEAR @Scope                        ! Initialize instrument interface
70  OUTPUT @Scope;":BNC PROBE"         ! BNC output to probe mode
80  OUTPUT @Scope;":CHANNEL1:PROBE 10" ! Probe attenuation to 10:1
90  OUTPUT @Scope;":SYSTEM:HEADER OFF" ! Headers off
100 OUTPUT @Scope;":ACQUIRE:TYPE RAWDATA,50,10"
110 OUTPUT @Scope;":DIGITIZE CHANNEL1" ! Start acquisition
120 OUTPUT @Scope;":WAVEFORM:SOURCE CHANNEL1" ! Channel 1 as source
130 OUTPUT @Scope;":WAVEFORM:DATA?"
140 ALLOCATE REAL Xorgs(1:10)           ! Assign REAL variable
150 ALLOCATE INTEGER Waveforms(1:500)  ! Assign INTEGER variable
160 ENTER @Scope USING "#,1A,D,8D";Header$,Bytes,Length
170 ENTER @Fast;Xorgs(*)                ! Enter Xorg value for each record
180 ENTER @Fast;Waveforms(*)           ! Enter ten 50-point records
190 ENTER @Scope;A$
200 !
210 ! The following lines print the Xorg value and first 3 points
220 ! for each of the ten records.
230 !
240 FOR I=1 TO 10
250   PRINT Xorgs(I)
260   FOR J=1 TO 3
270     PRINT Waveforms((I-1)*50+J),
280   NEXT J
290   PRINT
300 NEXT I
310 OUTPUT @Scope;":ACQUIRE:TYPE NORMAL" ! Exit the RAWDATA mode
320 END

```

## Hardcopy Program (Service Request using \*OPC)

This sample program demonstrates some of the commands in the **HARDCOPY** subsystem. The service request is used to detect when the printing is complete. The program assumes that a graphics printer is used and its address is set to 1.

```

10  CLEAR 707                                ! Initialize instrument interface
20  ON INTR 7,5 GOTO 160                      ! Exit printing routine after SRQ
30  ENABLE INTR 7;2                          ! Enable SRQ on bus #7
40  OUTPUT 707;"*CLS"                        ! Clear status data structures
50  OUTPUT 707;"*ESE 1"                      ! Enable OPC
60  OUTPUT 707;"*SRE 32"                     ! Enable Event Status Register Interrupt
70  OUTPUT 707;":HARDCOPY:PAGE AUTOMATIC"
80  OUTPUT 707;":HARDCOPY:LENGTH 12"
90  OUTPUT 707;":PRINT?;*OPC"                ! Set OPC when print is complete
100 SEND 7;UNT UNL                            ! Clear bus
110 SEND 7;TALK 7                             ! Scope to talk mode
120 SEND 7;LISTEN 1                          ! Printer to listen mode
130 SEND 7;DATA                              ! Lower ATN line @ controller
140 GOTO 140                                 ! Loop until printing is
150                                           ! complete, then generate interrupt
160 A=SPOLL(707)                              ! Clear service request
170 OUTPUT 707;":SYST:DSP 'PRINT IS COMPLETE'"
180 WAIT 6
190 OUTPUT 707;":SYST:DSP '"
200  END

```

## Waveform Template Program

This sample program demonstrates how to use some of the commands in the HP 54510A to make a waveform template for comparing waveforms. This program assumes that the AC CAL signal from the rear panel of the instrument is connected to channel 1 through a 10:1 probe.

```

10  CLEAR 707                ! Initialize instrument interface
20  OPTION BASE 0            ! Select default option base
30  OUTPUT 707;"*RST"        ! Reset instrument to known state
40  OUTPUT 707;":BNC PROBE"  ! BNC output to probe mode
50  OUTPUT 707;":AUTOSCALE"  ! Autoscale the instrument
60  OUTPUT 707;":TIMEBASE:SAMPLE REPETITIVE" ! Repetitive time base mode
70  DIM Preamble$(200)      ! Dimension variable
80  DIM Preamb(1:10)        ! Dimension variable
90  OUTPUT 707;":TIMEBASE:MODE TRIGGERED"  ! Triggered time base mode
100 OUTPUT 707;":TIMEBASE:RANGE 5E-4"      ! 50 us per division
110 OUTPUT 707;":TIMEBASE:DELAY 0"         ! Zero delay
120 OUTPUT 707;":TIMEBASE:REFERENCE CENTER" ! Center display reference
130 OUTPUT 707;":CHANNEL1:PROBE 10"        ! Probe attenuation to 10:1
140 OUTPUT 707;":CHANNEL1:RANGE 1.6"      ! Vertical range to 1.6 V full scale
150 OUTPUT 707;":CHANNEL1:OFFSET -0.4"    ! Offset to -0.4 V
160 OUTPUT 707;":CHANNEL1:COUPLING DC"    ! DC coupling
170 OUTPUT 707;":TRIGGER:MODE EDGE"       ! Edge triggering
180 OUTPUT 707;":TRIGGER:LEVEL -0.4"      ! Trigger level to -0.4
190 OUTPUT 707;":ACQUIRE:TYPE AVERAGE"   ! Display mode to AVERAGE
200 OUTPUT 707;":ACQUIRE:COMPLETE 100"   ! 100% completion criteria
210 OUTPUT 707;":ACQUIRE:POINTS 500"     ! 500 points per acquisition
220 OUTPUT 707;":ACQUIRE:COUNT 4"       ! 4 values averaged
230 OUTPUT 707;":DISPLAY:GRATICULE FRAME"  ! Frame on
240  !
250 OUTPUT 707;":CHANNEL1:RANGE?"         ! Save the range for later.
260 ENTER 707;Range_value
270  !
280 OUTPUT 707;":SYSTEM:HEADER OFF"       ! Headers off
290 OUTPUT 707;":WAVEFORM:FORMAT WORD"    ! Word format for data transfers
300 OUTPUT 707;":WAVEFORM:SOURCE CHANNEL1" ! Channel 1 as source
310 OUTPUT 707;":DIGITIZE CHANNEL1"
320 OUTPUT 707;":WAVEFORM:PREAMBLE?"      ! Output waveform preamble
330  ! to controller
340 ENTER 707;Preamb(*)
350 OUTPUT 707;":WAVEFORM:PREAMBLE?"      ! Output waveform preamble
360  ! to controller
370 ENTER 707 USING "-K";Preamble$
380 OUTPUT 707;":WAVEFORM:DATA?"          ! Output waveform record
390  ! to controller

```

```

400 ENTER 707 USING "#,2A,8D";Header$,Bytes
410 Length=Bytes/2
420 ALLOCATE INTEGER Waveform(1:Length),Wavemax(1:Length),Wavemin(1:Length)
430 ENTER 707 USING "#,W";Waveform(*)
440 ENTER 707 USING "-K,B";End$
450 !
460 ! The following lines set the voltage and time tolerance limits
470 ! as a percent of full scale.
480 !
490 Volt_tol=5                                ! 5% of full scale
500 Time_tol=5
510 !
520 Time_tics=INT(512*Time_tol/100)
530 Volt_tics=INT(2*Preamb(10)*Volt_tol/100)
540 MAT Wavemin= Waveform                    ! Copy the waveform into min template memory
550 MAT Wavemax= Waveform                    ! Copy the waveform into max template memory
560 FOR Time_cntr=1 TO Length                ! Time bucket where center of
570                                           ! ellipse is located.
580     PRINT Time_cntr                      ! Counter to show which time bucket the
590                                           ! program is now calculating.
600     FOR Time_pt=(Time_cntr-Time_tics) TO (Time_cntr+Time_tics)
610                                           ! Loop which increments along the time axis
620                                           ! of the ellipse.
630         IF Time_pt>0 AND Time_pt<=Length THEN
640             Volt_pt=Volt_tics*SQR(1-((Time_pt-Time_cntr)/Time_tics)^2)
650             Volt_max=Waveform(Time_cntr)+Volt_pt
660             Volt_min=Waveform(Time_cntr)-Volt_pt
670             IF Wavemax(Time_pt)<Volt_max THEN
680                 Wavemax(Time_pt)=Volt_max
690             END IF
700             IF Wavemin(Time_pt)>Volt_min THEN
710                 Wavemin(Time_pt)=Volt_min
720             END IF
730         END IF
740     NEXT Time_pt
750 NEXT Time_cntr
760 !
770 OUTPUT 707;" :WAVEFORM:SOURCE WMEMORY2"    ! Waveform memory 2 as source
780 OUTPUT 707 USING "#,K";" :WAVEFORM:PREAMBLE ";Preamb$ ! Send waveform
790                                           ! preamble to waveform memory 2
800 OUTPUT 707 USING "#,K";" :WAVEFORM:DATA #800001000" ! Send waveform
810                                           ! record to waveform memory 2
820 OUTPUT 707 USING "W";Wavemin(*)
830 OUTPUT 707;" :VIEW WMEMORY2"
840 OUTPUT 707;" :WAVEFORM:SOURCE WMEMORY1"    ! Waveform memory 1 as source
850 OUTPUT 707 USING "#,K";" :WAVEFORM:PREAMBLE ";Preamb$ ! Send waveform
860                                           ! preamble to waveform memory 1
870 OUTPUT 707 USING "#,K";" :WAVEFORM:DATA #800001000" ! Send waveform
880                                           ! record to waveform memory 1
890 OUTPUT 707 USING "W";Wavemax(*)

```

```
900 OUTPUT 707;":VIEW WMEMORY1"
910 Funct_range=Range_value/2
920 Range$=VAL$(Funct_range)
930 OUTPUT 707;":FUNCTION1:SUBTRACT WMEMORY1, CHANNEL1" ! Set up function 1
940 OUTPUT 707;":FUNCTION1:RANGE ";Range$
950 OUTPUT 707;":FUNCTION2:SUBTRACT CHANNEL1, WMEMORY2" ! set up function 2
960 OUTPUT 707;":FUNCTION2:RANGE ";Range$
970 OUTPUT 707;":VIEW FUNCTION1"
980 OUTPUT 707;":VIEW FUNCTION2"
990 OUTPUT 707;":RUN"
1000 OUTPUT 707;":MEASURE:STATISTICS ON"
1010 OUTPUT 707;":MEASURE:DESTINATION OFF"
1020 OUTPUT 707;":MEASURE:SOURCE FUNCTION1"
1030 WAIT 1
1040 OUTPUT 707;":MEASURE:VMIN"
1050 OUTPUT 707;":MEASURE:SOURCE FUNCTION2"
1060 WAIT 1
1070 OUTPUT 707;":MEASURE:VMIN"
1080 OUTPUT 707;":MEASURE:COMPARE VMIN, 200, 0"
1090 OUTPUT 707;":MEASURE:LIMITTEST MEASURE"
1100 OUTPUT 707;":MEASURE:POSTFAILURE STOP"
1110 END
```

## Burst Capture

This sample program demonstrates how to use the segmentable memories in the HP 54510A to capture burst data. This program assumes that the AC CAL signal from the rear panel of the instrument is connected to channel 1 through a 10:1 probe. The program allows you to set the time span, points, and number of acquisitions that you want to capture.

```

10 RE-STORE "Pulse_cap"
20 OPTION BASE 1
21 GINIT
22 GRAPHICS ON
30 ASSIGN @Scope TO 707
40 ASSIGN @Fast TO 707;FORMAT OFF           ! Fastest word transfer
50 ASSIGN @Prt TO CRT
60 !
70 CLEAR @Scope                           ! Clear the interface
80 CLEAR SCREEN                            ! Clear the screen
90 GCLEAR
100 OUTPUT @Scope;"*RST"                   ! Scope to a known state
110 OUTPUT @Scope;"AUTOSCALE"              ! Find a signal
111 OUTPUT @Scope;"TIMEBASE:MODE TRIGGERED"
120 !
130 DIM Pre$(120)
140 DIM Tim_setup(1:25,1:3)
150 ! _____ Table of possible timebase settings _____
160 ! Sa/s,      Time Sec/div,      Max_span in sec
170 DATA 10,    5.0,                800
180 DATA 25,    2.0,                320
190 DATA 50,    1.0,                160
200 DATA 100,   .5,                 80
210 DATA 250,   .2,                 32
220 DATA 500,   .1,                 16
230 DATA 1000,  .05,                8
240 DATA 2500,  .02,                3.2
241 DATA 5000,  .01,                1.6
250 DATA 10000, .005,               .8
260 DATA 25000, .002,               .32
270 DATA 50000, .001,               .16
280 DATA 100000, .0005,             .08
290 DATA 250000, .0002,             .032
300 DATA 500000, .0001,             .016
310 DATA 1000000, .00005,           .008
320 DATA 2500000, .00002,           .0032
330 DATA 5000000, .00001,           .0016

```

```

340 DATA 10000000, .000005, .0008
350 DATA 25000000, .000002, .00032
360 DATA 50000000, .000001, .00016
370 DATA 100000000, .0000005, .00008
380 DATA 250000000, .0000002, .000032
390 DATA 500000000, .0000001, .000016
400 DATA 1000000000, .00000005, .000008
410 READ Tim_setup(*) ! Put the settings in an array
420 !
430 OUTPUT @Scope;"TIMEBASE:REFERENCE CENTER"
440 Span_tm_query: !
450 BEEP
460 INPUT "Enter time span of capture in nsec? must be > 1 nsec",Span_tm
470 Span_tm=Span_tm*1.E-9
490 IF Span_tm<1.E-9 THEN GOTO Span_tm_query
500 OUTPUT @Prt;"__USER INPUT REQUEST__"
510 OUTPUT @Prt;"Capture time span= ";Span_tm
520 Span_pts_query: !
530 BEEP
540 DISP "Setting points (1..8000) will determine sample density"
550 WAIT 3
560 INPUT "How many points in the capture time span? ",Span_pts
570 IF (Span_pts<1 OR Span_pts>8000) THEN GOTO Span_pts_query
580 OUTPUT @Prt;"Points in time span= ";Span_pts
590 OUTPUT @Prt;"__"
600 OUTPUT @Prt;"__Scope settings ____"
610 !
620 Sample_tm=Span_tm/Span_pts ! Calculate desired delta time
630 Samp_per_sec=1/Sample_tm ! (ie Sa/sec) best guess for now
640 !
650 ! Now go set the timebase to achieve the requested sample density.
660 ! The user has requested a Time span which will be unaltered.
670 ! The user has requested points to indirectly set the sample density.
680 ! Sample density will be set to the nearest timebase range possible.
690 !
691 ! Sample density can only be set by timebase range.
700 ! When necessary, we will round to the fastest range and recalculate
710 ! the number of points to achieve the requested span.
720 !
721 ! Lookup the right timebase setting.
722 ! *****
730 I=25 ! Default to 1 nsec range or
740 LOOP ! loop till pointing to closest
750 EXIT IF I=1
760 EXIT IF Samp_per_sec>Tim_setup(I-1,1) ! clock for time span & points.
770 I=I-1
780 END LOOP ! Pointing to best setup for
790 ! ! time span and points density.
791 ! *****
792 !

```

```

800 OUTPUT @Scope;":TIMEBASE:RANGE ";Tim_setup(I,2)*10
810 OUTPUT @Prt USING "18A,DD.DESZ";"Timebase Sec/div= ";Tim_setup(I,2)
820 OUTPUT @Prt USING "18A,DD.DESZ";"Sa/sec = ";Tim_setup(I,1)
830 Sample_tm=1/Tim_setup(I,1) ! Delta T, Xinc
840 OUTPUT @Prt USING "18A,DD.DESZ";"Sample time = ";Sample_tm
850 !
860 Points=INT(Span_tm/Sample_tm + .5) ! Points set from lookup table
870 IF Points>8000 THEN Points=8000 ! Points is reset to insure covering
871 IF Points<4 THEN Points=4 ! the span time.
880 OUTPUT @Prt;"Adjusted points count is ";Points
890 OUTPUT @Prt;""
900 !
910 Limit=150000/(Points+8) ! 8 bytes for each xorg
920 OUTPUT @Prt;"At ";Points;" points per capture, "
930 OUTPUT @Prt;"the MAX # of waveforms= ";INT(Limit)
940 Acq_query: !
950 INPUT "Number of acquisitions",Acq_number
960 IF (Acq_number>Limit) THEN GOTO Acq_query
970 OUTPUT @Prt;""
980 !
990 !
1000 OUTPUT @Scope;":SYSTEM:HEADER OFF"
1010 OUTPUT @Scope;":ACQUIRE:TYPE RAWDATA ,";Points;",";Acq_number
1020 !
1030 BEEP
1040 T=TIMEDATE
1050 OUTPUT @Scope;":DIGITIZE CHANNEL1;*OPC?" ! Capture and wait till done
1060 ENTER @Scope;Opc
1061 BEEP
1062 !
1070 Lapse=TIMEDATE-T
1071 OUTPUT @Prt USING "#,6/"
1072 OUTPUT @Prt;"acquisition complete, begin data transfer"
1080 OUTPUT @Prt;" _____ RESULTS _____ "
1090 OUTPUT CRT;Acq_number;" waveforms of ";Points;" points spanning ";Span_tm;" sec."
1100 OUTPUT @Prt;" were captured in";Lapse;" sec."
1110 OUTPUT @Prt;" Capture rate was ";Acq_number/Lapse;" waveforms per sec."
1120 !
1130 OUTPUT @Scope;":WAVEFORM:PREAMBLE?"
1140 ENTER @Scope;Pre$
1150 ENTER Pre$;Frmt,Typ,Pnts,Cnt,Xinc,Xorg,Xref,Yinc,Yorg,Yref
1160 !
1170 OUTPUT @Scope;":WAVEFORM:DATA?"
1180 ENTER @Scope USING "#,1A,D,8D,";Header$,Bytes,Length
1190 !OUTPUT @Prt;"Words = ";Length/2
1200 ALLOCATE INTEGER Waveforms(1:Acq_number,1:Points)
1210 ALLOCATE REAL Xorgs(1:Acq_number)
1220 ENTER @Fast;Xorgs(*)
1230 ENTER @Fast;Waveforms(*)
1240 ENTER @Scope;End$

```

```

1250 Total=TIMEDATE-T
1251 !
1252 ! RE-START SCOPE
1253 !
1254 OUTPUT @Scope;" :RUN"
1260 OUTPUT @Prt;" Capture AND transfer time = ";Total
1261 OUTPUT @Prt;" Capture AND transfer rate = ";Acq_number/Total;" waveforms/sec."
1270 !
1300 VIEWPORT 50,130,50,100
1310 Left=MIN(Xorgs(*))
1320 Right=MAX(Xorgs(*))+((Points-1)*Xinc)
1330 WINDOW Left,Right,0,32640
1331 PEN 3
1340 FRAME
1350 FOR I=1 TO Acq_number
1351   DISP "drawing waveform ";I
1352   Xorg=Xorgs(I)
1353   FOR J=1 TO Points
1354     X=Xorg+((J-1)*Xinc)
1355     Y=Waveforms(I,J)
1356     P=I MODULO 7
1357     IF P=0 THEN
1358       P=4
1359     END IF
1360     PEN P
1362     MOVE X,Y
1363     DRAW X,Y
1364   NEXT J
1365 NEXT I
1375 PAUSE
1385 END
1445 SUB Color
1455 Color: !
1465   GINIT
1475   GCLEAR
1485   !
1495   Id$=SYSTEM$("CRT ID")
1505   IF NOT POS(Id$,"C") THEN ! Check for color monitor
1515     SUBEXIT
1525   ELSE
1535     IF POS(Id$,"B") THEN ! Check for bit map
1545       MERGE ALPHA WITH GRAPHICS
1555     END IF
1565   END IF
1575 !
1585 PLOTTER IS CRT,"INTERNAL ";COLOR MAP
1595 SET PEN 0 INTENSITY 0,0,.45
1605 ALPHA PEN 5 ! This sets all alpha colors including editor
1615 KEY LABELS PEN 1 ! White labels color
1625 PRINT CHR$(128); ! Remove all highlights

```

```
1635 DISP CHR$(137)
1645 !
1655 SUBEND
```

! Red disp characters

## Common Commands

---

### Introduction

The common commands are defined by the IEEE 488.2 standard. These commands are common to all instruments that comply with the IEEE 488.2 standard. They control some of the basic instrument functions, such as instrument identification and reset, reading the learn (instrument setup) string, how status is read and cleared, and how commands and queries are received and processed by the instrument.

The following common commands are implemented in the HP 54510A:

- \*CLS (Clear Status)
- \*ESE (Event Status Enable)
- \*ESR (Event Status Register)
- \*IDN (Identification Number)
- \*LRN (Learn)
- \*OPC (Operation Complete)
- \*OPT (Option)
- \*RCL (Recall)
- \*RST (Reset)
- \*SAV (Save)
- \*SRE (Service Request Enable)
- \*STB (Status Byte)
- \*TRG (Trigger)
- \*TST (Test)
- \*WAI (Wait)

Figure 6-1 lists the syntax diagrams for the common commands.

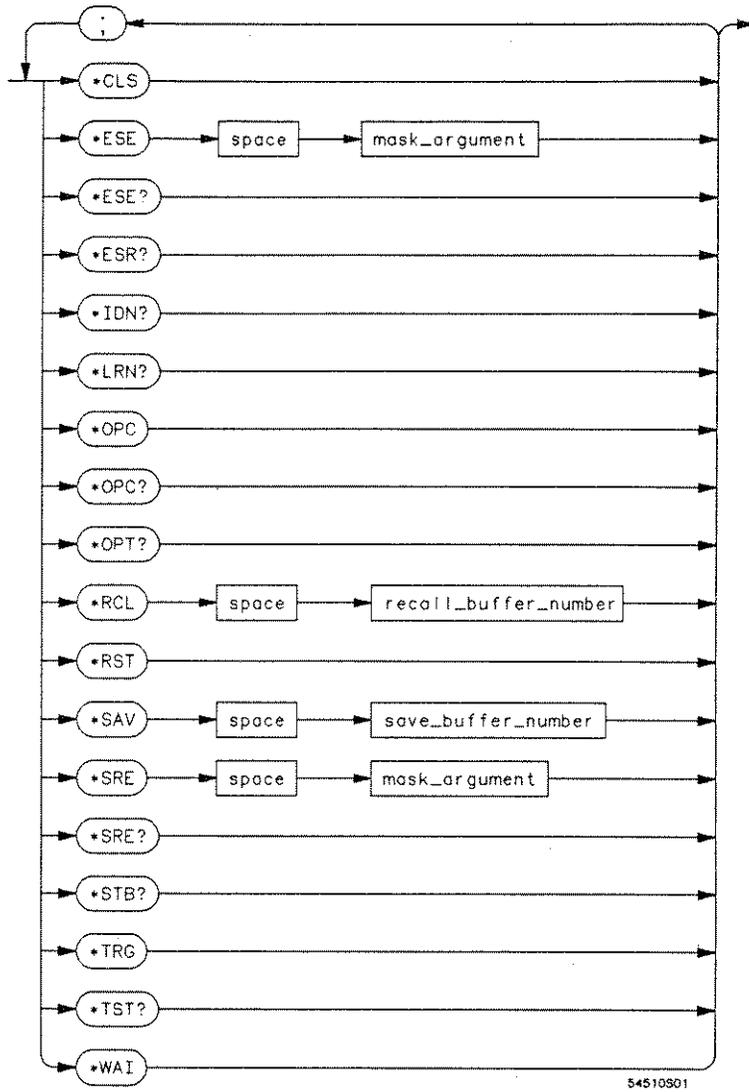


Figure 6-1. Common Commands Syntax Diagram

<b>mask_argument =</b>	An integer, 0 through 255. This number is the sum of all of the bits in the mask corresponding to conditions that are enabled. Refer to *ESE and *SRE commands for bit definitions in the enable registers.
<b>recall_buffer_number =</b>	An integer, 0 through 4.
<b>save_buffer_number =</b>	An integer, 1 through 4.

Figure 6-1. Common Commands Syntax Diagram (continued)

## Common Commands

Common commands can be received and processed by the HP 54510A whether they are sent over the HP-IB as separate program messages or within other program messages. If an instrument subsystem has been selected and a common command is received by the instrument, the instrument remains in the selected subsystem. For example, if the program message ":ACQUIRE:TYPE AVERAGE; \*CLS; COUNT 1024" is received by the instrument, the instrument sets the acquire type and count, then clears the status information without leaving the selected subsystem.

If some other type of command is received within the program message, you must reenter the original subsystem after the command. For example, the program message ":ACQUIRE:TYPE AVERAGE; :AUTOSCALE; :ACQUIRE:COUNT 1024" sets the acquire type, completes the autoscale, then sets the acquire count. In this example, :ACQUIRE must be sent again after the AUTOSCALE command in order to reenter the acquire subsystem and set the count.

### Note

Each of the status registers mentioned in this chapter has an enable (mask) register. By setting the bits in the enable register, you can select the status information you wish to use. For a complete discussion of how to read the status registers and how to use the status information available from this instrument refer to chapter 19, "Status Reporting."

**\*CLS**

---

**\*CLS (Clear Status) command**

The \*CLS (clear status) common command clears the status data structures, including the device-defined error queue. This command also clears the Request-for-OPC flag.

If the \*CLS command immediately follows a program message terminator, the output queue and the MAV (message available) bit are cleared.

**Command Syntax:** \*CLS

**Example:** OUTPUT 707;""CLS"



---

Refer to chapter 19, "Status Reporting" for a complete discussion of status.

---

**\*ESE****\*ESE****(Event Status Enable)****command/query**

The **\*ESE** command sets the bits in the Standard Event Status Enable Register. The Standard Event Status Enable Register contains a mask value for the bits to be enabled in the Standard Event Status Register. A one in the Standard Event Status Enable Register enables the corresponding bit in the Standard Event Status Register. A zero disables the bit. Refer to table 6-1 for information about the Standard Event Status Enable Register bits, bit weights, and what each bit masks.

The **\*ESE** query returns the current contents of the register.

**Command Syntax:** **\*ESE** <mask>

**Where:**

<mask> ::= 0 to 255

**Example:** **OUTPUT 707; \*ESE 64**

In this example, the **\*ESE 64** command enables URQ (user request) bit 6 of the Standard Event Status Enable Register. Therefore, when a front panel key is pressed, the ESB (event summary bit) in the Status Byte Register is also set.

**\*ESE****Query Syntax:** \*ESE?**Returned Format:** <mask><NL>**Where:**

&lt;mask&gt; ::= 0 to 255 (integer - NR1 format)

**Example:** OUTPUT 707;"\*ESE?"  
 ENTER 707;Event  
 PRINT Event

**Table 6-1. Standard Event Status Enable Register**

Event Status Enable Register (High - Enables the ERS bit)		
Bit	Weight	Enables
7	128	PON - Power On
6	64	URQ - User Request
5	32	CME - Command Error
4	16	EXE - Execution Error
3	8	DDE - Device Dependent Error
2	4	QYE - Query Error
1	2	RQC - Request Control
0	1	OPC - Operation Complete

**Note** 

Refer to chapter 19, "Status Reporting" for a complete discussion of status.

**\*ESR****\*ESR****(Event Status Register)****query**

The \*ESR query returns the contents of the Standard Event Status Register.

When you read the Event Status Register, the value returned is the total bit weights of all of the bits that are high at the time you read the byte. Table 6-2 shows each bit in the Event Status Register and its bit weight.

**Note** 

Reading the register clears the Standard Event Status Register.

**Query Syntax:** \*ESR?

**Returned Format:** <status><NL>

**Where:**

<status> ::= 0 to 255 (integer - NR1 format)

**Example:**  
 OUTPUT 707;"\*ESR?"  
 ENTER 707;Event  
 PRINT Event

**\*ESR****Table 6-2. Standard Event Status Register**

Bit	Bit Weight	Bit Name	Condition
7	128	PON	1 = OFF to ON transition has occurred.
6	64	URQ	0 = no front-panel key has been pressed. 1 = a front-panel key has been pressed.
5	32	CME	0 = no command errors. 1 = a command error has been detected.
4	16	EXE	0 = no execution error. 1 = an execution error has been detected.
3	8	DDE	0 = no device dependent errors. 1 = a device dependent error has been detected.
2	4	QYE	0 = no query errors. 1 = a query error has been detected.
1	2	RQC	0 = request control - NOT used - always 0
0	1	OPC	0 = operation is not complete. 1 = operation is complete.
0 = False = Low			1 = True = High

**\*IDN****\*IDN****(Identification Number)****query**

The \*IDN query identifies the instrument type, serial number, and software version by returning the following string:

```
"HEWLETT-PACKARD,54510A,<XXXXAYYYYY>,<MMDD>"
```

Where:

<XXXXAYYYYY> ::= the serial number of the instrument.

<MMDD> ::= the software revision of the instrument. The first two parameters represent the month and the second two parameters represent the day of the month.

An \*IDN query must be the last query in a message. Any queries after the \*IDN query in a program message are ignored.

**Query Syntax:** \*IDN?

**Returned Format:** HEWLETT-PACKARD,54510A,XXXXAYYYYY,MMDD<NL>

**Example:**

```
DIM Id$[50]
OUTPUT 707;"*IDN?"
ENTER 707;Id$
PRINT Id$
```

**\*LRN****\*LRN (Learn) query**

The \*LRN query returns a program message that contains the current state of the instrument.

This query performs the same function as the :SYSTEM:SETUP? query. It allows you to store an instrument setup in the controller. The stored setup can then be returned to the instrument at a later time using the :SYSTEM:SETUP command.



The returned header for the \*LRN query is :SYSTEM:SETUP. The :SYSTEM:HEADER command does not affect this returned header.

**Query Syntax:** \*LRN?

**Returned Format:** :SYSTem:SETup <setup><NL>

**Where:**

<setup> ::= #800001024<learn string><NL>  
< learn string> ::= 1024 data bytes in length.

**Example:**  
DIM Lrn\$[2000]  
OUTPUT 707;"\*LRN?"  
ENTER 707 USING "-K";Lrn\$

**\*OPC****\*OPC****(Operation Complete)****command/query**

The \*OPC (operation complete) command sets the operation complete bit in the Standard Event Status Register when all pending device operations have finished.

The \*OPC query places an ASCII "1" in the output queue when all pending device operations have finished.

**Command Syntax:** \*OPC

**Example:** OUTPUT 707;"\*OPC"

**Query Syntax:** \*OPC?

**Returned Format:** 1<NL>

**Example:** OUTPUT 707;" :AUTOSCALE;\*OPC?"  
ENTER 707;Op\$

**\*OPT**

---

<b>*OPT</b>	<b>(Option)</b>	<b>query</b>
-------------	-----------------	--------------

The \*OPT query reports the options installed in the instrument. This query always returns a zero because the HP 54510A does not have any possible options to report.

**Query Syntax:** \*OPT?

**Returned Format:** 0<NL>

**Example:** OUTPUT 707;""\*OPT?"  
ENTER 707;Va lue  
PRINT Va lue

**\*RCL****\*RCL****(Recall)****command**

The **\*RCL** command restores the state of the instrument from the specified save/recall register. An instrument setup must have been stored previously in the specified register. Registers 1 through 4 are general purpose and can be used with the **\*SAV** command. Register 0 is special because it recalls the state that existed before the last **AUTOSCALE**, **RECALL**, **ECL**, or **TTL** operation.



An error message appears on the screen if nothing has been previously saved in the specified register.

**Command Syntax:** `*RCL {0 | 1 | 2 | 3 | 4}`

**Example:** `OUTPUT 707; *RCL 3`

**\*RST**

**\*RST** (Reset) **command**

The \*RST command places the instrument in a known state. Refer to table 6-3 for the reset conditions.

**Command Syntax:** \*RST

**Example:** OUTPUT 707;""\*RST"

**Table 6-3. Reset Conditions for the HP 54510A**

<b>Timebase Menu</b>	
time/division	100 $\mu$ s
delay	0.00 s
reference	cntr
sample rate	realtime
<b>Channel Menu</b>	
Channel 1	on
Channel 2	off
volts/division	500 mV
offset	0.00
coupling	dc
input resistance	1 M $\Omega$
probe attenuation	1.000:1
<b>Trigger Menu</b>	
triggering	auto
mode	edge
source	Channel 1
level	0.0 V
slope	positive
noise reject	off
holdoff	40 ns

\*RST

Table 6-3. Reset Conditions for the HP 54510A (continued)

<b>Display Menu</b>	
mode	norm
persistence	single
# of screens	1
off/frame/axes/grid	axes
connect dots	off
<b><math>\Delta t/\Delta V</math> Menu</b>	
$\Delta V$ markers	off
$\Delta t$ markers	off
<b>Waveform Math Menu</b>	
f1	off
f2	off
display	off
chan/mem	chan 1
operator	+
chan/mem	chan 1
function sensitivity	1.00 V/div
function offset	0.0 V
<b>Waveform Save Menu</b>	
waveform/pixel	waveform
nonvolatile	m1
display	off
source	chan 1

**\*RST**

---

**Table 6-3. Reset Conditions for the HP 54510A (continued)**

<b>Define Meas Menu</b>	
meas/meas def/meas limit	meas
continuous	on
statistics	off
rms	ac
<b>Utility Menu</b>	
clicker	on
AC BNC	probe comp

**\*SAV**

---

**\*SAV (Save) command**

The **\*SAV** command stores the current state of the device in a save register. The data parameter is the number of the save register where the data will be saved. Registers 1 through 4 are valid for this command.

**Command Syntax:** \*SAV {1 | 2 | 3 | 4}

**Example:** OUTPUT 707;""\*SAV 3"

**\*SRE**


---

**\*SRE** (Service Request Enable) command/query

The \*SRE command sets the bits in the Service Request Enable Register. The Service Request Enable Register contains a mask value for the bits to be enabled in the Status Byte Register. A one in the Service Request Enable Register enables the corresponding bit in the Status Byte Register. A zero disables the bit. Table 6-4 lists the bits in the Service Request Enable Register and what they mask.

The \*SRE query returns the current value.

**Command Syntax:** \*SRE <mask>

Where:

<mask> ::= 0 to 255

Example: OUTPUT 707;""\*SRE 16"

**Note** 

This example enables a service request to be generated when a message is available in the output queue. When a message is available the MAV bit is high.

**Query Syntax:** \*SRE?

**Returned Format:** <mask><NL>

Where:

<mask> ::= sum of all bits that are set - 0 through 255 (integer - NR1 format)

Example: OUTPUT 707;""\*SRE?"  
ENTER 707;Value  
PRINT Value

\*SRE

Table 6-4. Service Request Enable Register

Service Request Enable Register (High - Enables the SRE bit)		
Bit	Weight	Enables
7	128	not used
6	64	RQS - Request Service
5	32	ESB - Event Status Bit
4	16	MAV - Message Available
3	8	LTF - Limit Test Failure
2	4	MSG - Message
1	2	LCL - Local
0	1	TRG - Trigger

**\*STB**

---

**\*STB** (Status Byte) query

The \*STB query returns the current value of the instrument's status byte. The MSS (Master Summary Status) bit is reported on bit 6 instead of the RQS (request service) bit. The MSS indicates whether or not the device has at least one reason for requesting service. Refer to table 6-5 for the meaning of the bits in the status byte.



To read the instrument's status byte with RQS reported on bit 6, use the HP-IB Serial Poll.

**Query Syntax:** \*STB?

**Returned Format:** <value><NL>

**Where:**

<value> ::= 0 through 255 (integer - NR1)

**Example:** OUTPUT 707; "\*\*STB?"  
ENTER 707; Value  
PRINT Value

\*STB

Table 6-5. Status Byte Register

Bit	Bit Weight	Bit Name	Condition
7	128	---	0 = not used.
6	64	RQS/MSS	0 = instrument has no reason for service. 1 = instrument is requesting service.
5	32	ESB	0 = no event status conditions have occurred. 1 = an enabled event status condition has occurred.
4	16	MAV	0 = no output messages are ready. 1 = an output message is ready.
3	8	LTF	0 = no limit test has failed. 1 = limit test has failed.
2	4	MSG	0 = no message has been displayed. 1 = message has been displayed.
1	2	LCL	0 = a remote-to-local transition has not occurred. 1 = a remote-to-local transition has occurred.
0	1	TRG	0 = no trigger has occurred. 1 = a trigger has occurred.
0 = False = Low			1 = True = High

## \*TRG

---

**\*TRG** (Trigger) **command**

The \*TRG command has the same effect as the Group Execute Trigger (GET). That effect is as if the RUN command had been sent.

**Command Syntax:** \*TRG

**Example:** OUTPUT 707;"\*TRG"

**\*TST****\*TST****(Test)****query**

The \*TST query performs a self-test on the instrument. The result of the test is placed in the output queue.

**Note**

Disconnect all front-panel inputs before sending this command.

A zero indicates the test passed and a non-zero value indicates the test failed.

If a test fails, refer to the troubleshooting section of the HP 54510A service manual.

**Query Syntax:** \*TST?**Returned Format:** <result><NL>**Where:**

&lt;result&gt; ::= 0 or non-zero value

**Where:**

0 indicates the test passed.  
non-zero indicates the test failed.

**Example:** OUTPUT 707; "\*TST?"  
ENTER 707; Result  
PRINT Result

**\*WAI**

---

**\*WAI** (Wait) **command**

The \*WAI command has **no function** in the HP 54510A, but is parsed for compatibility with other instruments.

**Command Syntax:** \*WAI

**Example:** OUTPUT 707;"\*WAI"

## Root Level Commands

---

### Introduction

Root Level commands control many of the basic operations of the oscilloscope. These commands are always recognized by the parser if they are prefixed with a colon, regardless of current command tree position. After executing a root level command, the parser is positioned at the root of the command tree.

The following Root Level commands are implemented in the HP 54510A:

- AUToscale
- BEEPer
- BLANk
- BNC
- DIGitize
- ERASe
- LER
- LTER
- MENU
- MERGe
- PLOT
- PRINt
- RUN
- SERial
- STATus
- STOP
- STORe
- TER
- VIEW

Figure 7-1 lists the syntax diagrams for the Root Level commands.

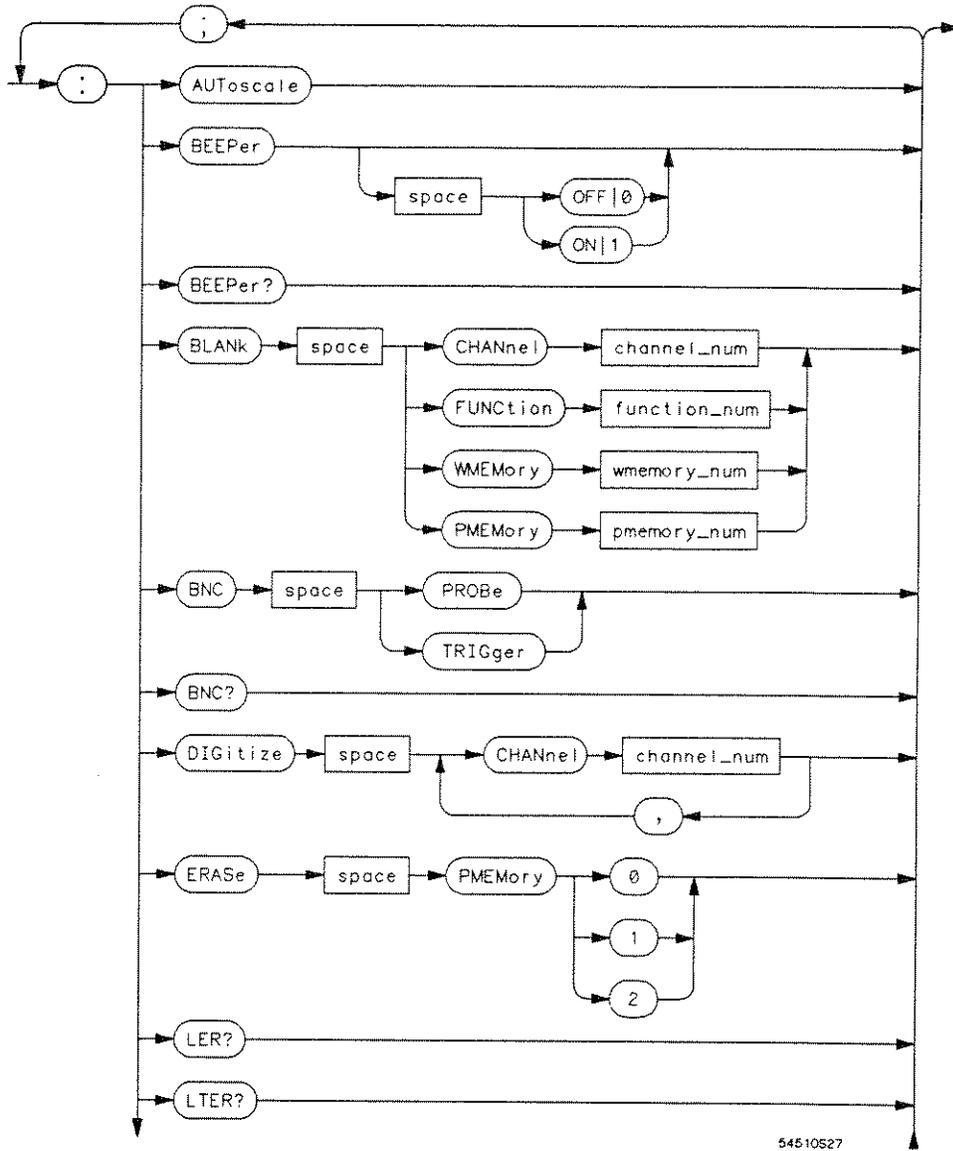


Figure 7-1. Root Level Commands Syntax Diagram

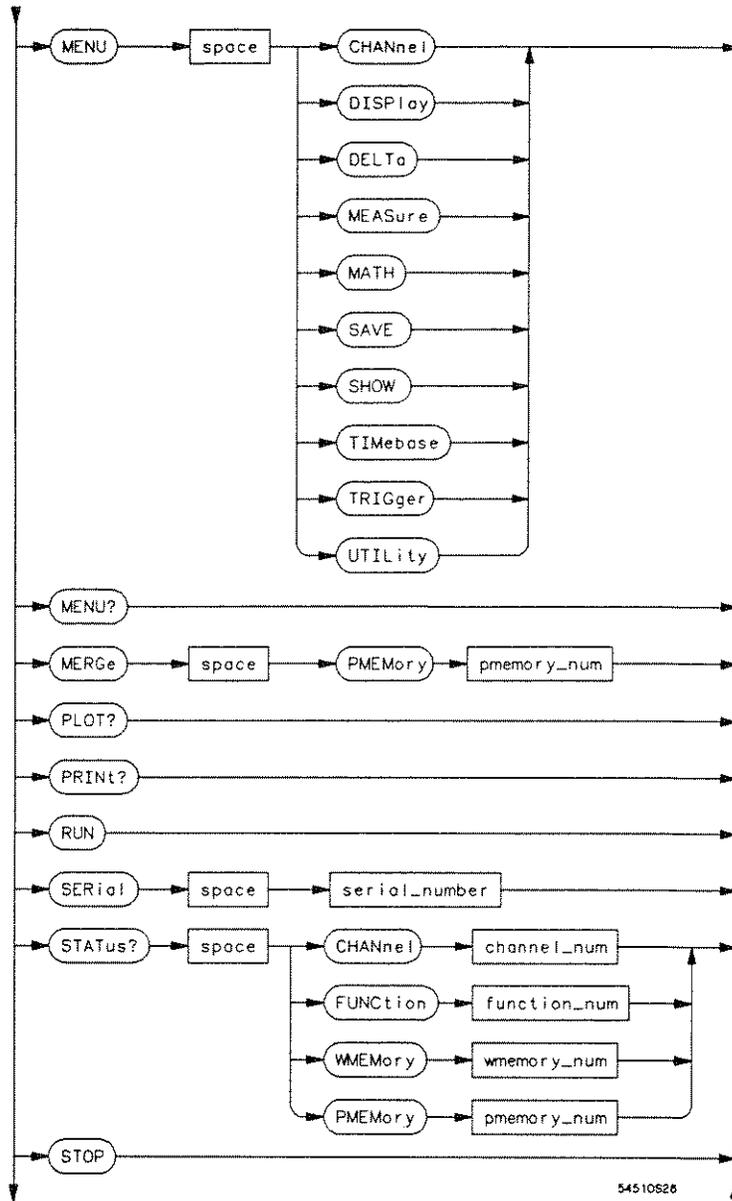
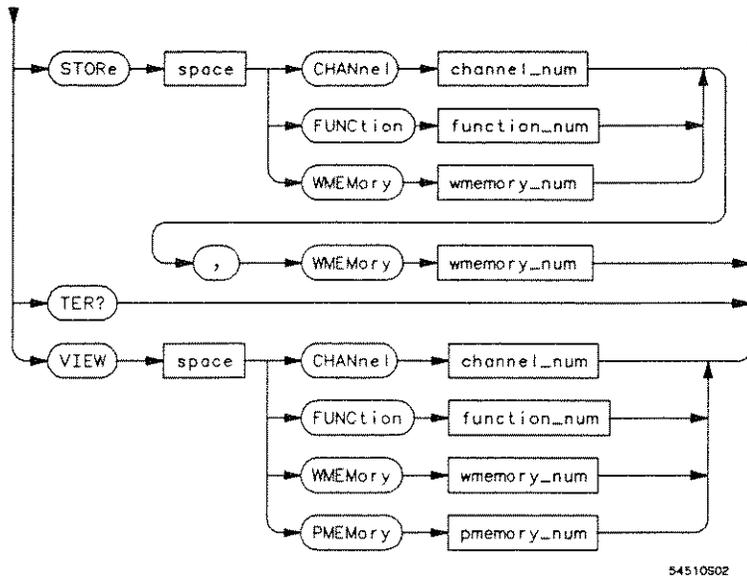


Figure 7-1. Root Level Commands Syntax Diagram (continued)



54510502

- channel\_num** = an integer, 1 or 2.
- function\_num** = an integer, 1 or 2.
- wmemory\_num** = an integer, 1 through 4.
- pmemory\_num** = an integer, 1 or 2.
- serial\_number** = a 10 character quoted string.

Figure 7-1. Root Level Commands Syntax Diagram (continued)

## AUToscale

### AUToscale

### command

The AUTOSCALE command evaluates all input signals and sets the correct conditions to display the signals. When the AUTOSCALE command is sent the following conditions are set:

- The vertical sensitivity.
- The vertical offset.
- The trigger to edge mode with minimum persistence.
- The trigger level, holdoff, and slope.
- The sweep speed of the displayed channel.

In addition, the AUTOSCALE command turns off the following items:

- Markers.
- All measurements.
- Functions.
- Windows.
- Memories.
- Connect the dots.

If input signals are present on more than one vertical input, the sweep is triggered on channel 1 if a signal is present on that channel. If a signal is not present on channel 1 then the oscilloscope is triggered on channel 2 if a signal is present on that channel. If no signals are found on any vertical input, the oscilloscope is returned to its former state.

**Command Syntax:** :AUToscale

**Example:** OUTPUT 707;":AUTOSCALE"

## BEEPer

---

### BEEPer

### command/query

The BEEPER command sets the beeper mode, which controls the sound function of the instrument. The beeper can be set to on or off. If the BEEPER command is sent without an argument the beeper will be sounded without effecting the current mode of the instrument.

The BEEPER query returns the current state of the beeper mode.

**Command Syntax:** :BEEPer [{ON | 1} | {OFF | 0}]

**Example:** OUTPUT 707;":BEEPER 1"

**Query Syntax:** :BEEPer?

**Returned Format:** [:BEEPer] {1 | 0}<NL>

**Example:**  
DIM Click\$ [50]  
OUTPUT 707;":BEEP?"  
ENTER 707;Click\$  
PRINT Click\$

**BLANK****BLANK****command**

The **BLANK** command turns off (stops displaying) the specified channel, function, pixel memory, or waveform memory. To turn off a channel display, use the command **:BLANK CHANNEL{1|2}**. To turn off a waveform memory display, use the command **:BLANK WMEMORY{1|2|3|4}**. To turn off a pixel memory display, use the command **:BLANK PMEMORY{1|2}**. To turn off a function, use the command **:BLANK FUNCTION{1|2}**.

Use the **VIEW** command to turn on (start displaying) an active channel, function, pixel memory, or waveform memory.

**Command Syntax:** `:BLANK <display>`

**Where:**

`<display> ::= {CHANnel{1 | 2} | FUNction{1 | 2} |  
WMEMory{1 | 2 | 3 | 4} | PMEMory{1 | 2}}`

**Example:** `OUTPUT 707;":BLANK CHANNEL1"`

## BNC

---

### BNC

#### command/query

The BNC command sets the output mode of the rear-panel BNC to PROBE or TRIGGER. The PROBE mode outputs a square wave signal. The TRIGGER mode outputs a rising edge when an internal trigger occurs.

The BNC query returns the current mode for the rear-panel BNC.

**Command Syntax:** :BNC {PROBe | TRIGger}

**Example:** OUTPUT 707;":BNC PROBE"

**Query Syntax:** :BNC?

**Returned Format:** [:BNC] {PROBe | TRIGger}<NL>

**Example:**  
DIM Mode\$ [50]  
OUTPUT 707;":BNC?"  
ENTER 707;Mode\$  
PRINT Mode\$

**DIGitize****DIGitize****command**

The DIGITIZE command is used to acquire waveform data for transfer over the HP-IB. Sending the command causes an acquisition to take place on the specified channels with the resulting data being placed in the channel buffer. Sending the DIGITIZE command also turns off any unused channels.

The sources for the :DIGITIZE command are channels 1 and 2.

During a digitize operation, connect the dots, infinite persistence, and variable persistence are disabled so that the screen more accurately reflects the data transferred. Disabling these functions also simplifies and speeds up the digitize operation.

When the digitize operation is complete the instrument is placed in the stopped mode. When the instrument is restarted, with a RUN command or the front panel RUN key, the digitized data stored in the channel buffers is overwritten. Therefore, ensure all operations that require the digitized data are completed before restarting the oscilloscope.

The ACQUIRE subsystem commands are used to set up conditions such as TYPE, number of POINTS, and COUNT for the next DIGITIZE command. See the ACQUIRE subsystem for a description of these commands. To determine the actual number of points that are acquired and how the data is transferred, refer to the WAVEFORM subsystem commands.

To increase the speed of the digitize operations, send two or more DIGITIZE commands without changing other parameters. If you only want data, you can improve the speed by turning the screen off with the command :DISPLAY:SCREEN OFF prior to sending the DIGITIZE command. In this case, nothing is plotted on the screen.

For more information on the DIGITIZE command refer to the section on the DIGITIZE command in chapter 2, "Programming an Instrument."

## DIGitize

---

**Command Syntax:** :DIGitize CHANne1<N>[,CHANne1<N>]

**Where:**

<N> ::= 1 or 2.

**Example:** OUTPUT 707;":DIGITIZE CHANNEL1,CHANNEL2"

**ERASe****ERASe****command**

The ERASE command erases a specified pixel memory.

Erasing pixel memory 0 is a special case, which is the same as pressing the CLEAR DISPLAY key on the front panel. If the scope is running and being triggered and ERASE PMEMORY0 is executed, the instrument momentarily stops acquiring data, clears the screen, then continues with data acquisition.

Erasing pixel memory 1 or 2 clears the specified pixel memory and anything on the display from that pixel memory.

**Note** 

Once you erase pixel memory 1 or 2, there is no way to retrieve the original information.

**Command Syntax:** :ERASe {PMEMory0 | PMEMory1 | PMEMory2}

**Example:** OUTPUT 707;":ERASE PMEMORY1"

**LER**

---

**LER****(Local Event Register)****query**

The LER query reads the LCL (Local) Event Register. After the LCL Event Register is read, it is cleared. A one indicates a remote to local transition has taken place due to the front-panel LOCAL key being pressed. A zero indicates a remote to local transition has not taken place.

Once this bit is set it can only be cleared by reading the Event Register or sending a \*CLS command.

A Service Request (SRQ) can only be generated when the bit transitions from 0 to 1. Therefore, the bit must be cleared each time you want a new Service Request to be generated.

**Query Syntax:** :LER?

**Returned Format:** [:LER] {1 | 0}<NL>

**Example:**  
DIM Event\$[50]  
OUTPUT 707;":LER?"  
ENTER 707;Event\$  
PRINT Event\$

**LTER****LTER****(Limit Test Event Register)****query**

The LTER query reads the Limit Test Event Register. The Limit Test Event Register contains the Limit Test Fail bit. This bit is set when the limit test is active and a limit test has failed. After the Limit Test Event Register is read, it is cleared.

A Service Request (SRQ) can only be generated when the bit transitions from 0 to 1; therefore, the bit must be cleared each time you would like a new Service Request to be generated.

**Query Syntax:** :LTER?

**Returned Format:** [:LTER] {1 | 0}<NL>

**Example:**

```
DIM Lmt$[50]
OUTPUT 707;":LTER?"
ENTER 707;Lmt$
PRINT Lmt$
```

## MENU

---

### MENU

### command/query

The MENU command selects one of the 10 menus on the front panel.

The MENU query returns the name of the currently displayed menu.

**Command Syntax:** :MENU <name>

Where:

<name> ::= {TIMEbase | CHANnel | TRIGger | DISPlay | DELTa | MATH | SAVE | MEASure | UTILity | SHOW}

**Example:** OUTPUT 707;":MENU DISPLAY"

**Query Syntax:** :MENU?

**Returned Format:** [:MENU] <name><NL>

Where:

<name> ::= {TIMEbase | CHANnel | TRIGger | DISPlay | DELTa | MATH | SAVE | MEASure | UTILity | SHOW}

**Example:** DIM Name\$[50]  
 OUTPUT 707;":MENU?"  
 ENTER 707;Name\$  
 PRINT Name\$

**MERGe****MERGe****command**

The MERGE command stores the contents of the active display into the specified pixel memory. The pixel memories are PMEMORY 1 or PMEMORY 2.

The function of this command is similar to the function of the "add to memory" key in the pixel menu of the Waveform Save menu.

**Command Syntax:** :MERGe {PMEMory1 | PMEMory2}

**Example:** OUTPUT 707;":MERGE PMEMORY2"

## PLOT

---

### PLOT

query

The PLOT query outputs a copy of the display as soon as the oscilloscope is addressed to talk. The portion of the waveform to be copied must be placed on the display before sending the PLOT query. The plotter output includes the displayed waveforms, the graticule, time and voltage markers, trigger setup, and measurement results.

**Query Syntax:** :PLOT?

**Example:** OUTPUT 707;":PLOT?"  
SEND 7;UNT UNL  
SEND 7;LISTEN 1 !Assumes the plotter is at address 1  
SEND 7;TALK 7  
SEND 7;DATA

**PRINT****PRINT****query**

The PRINT query outputs a copy of the display as soon as the oscilloscope is addressed to talk. The portion of the waveform to be copied must be placed on the display before sending the PRINT query. The printer output includes the displayed waveforms, the graticule, time and voltage markers, trigger setup, and measurement results.

**Query Syntax:** :PRINT?

**Example:**

```
OUTPUT 707;":HARDCOPY:PAGE AUTOMATIC"  
OUTPUT 707;":PRINT?"  
SEND 7;UNT UNL  
SEND 7;LISTEN 1      !Assumes the printer is at address 1  
SEND 7;TALK 7  
SEND 7;DATA
```

## RUN

---

### RUN

#### command

The RUN command acquires data for the active waveform display. The data is acquired as defined by the time base mode.

If the time base mode is in SINGLE, the RUN command enables the trigger once and displays the acquired data on the screen. This also occurs when the front panel SINGLE key is pressed while the instrument is STOPPED.

If the time base mode is set to AUTO or TRIGGERED, the RUN command enables the trigger repeatedly and displays the data it acquires continuously on the screen. This is the same thing that happens when the front panel RUN key is pressed. For a description of the various modes, see the :TIMEBASE:MODE command in chapter 16, "Timebase Subsystem."

**Command Syntax:** :RUN

**Example:** OUTPUT 707;":RUN"

**SERial****SERial****(Serial Number)****command**

The SERIAL command allows you to enter a serial number in the instrument. The serial number is placed in protected non-volatile RAM, so the protection switch on the rear panel must be in the unprotected position to write a new serial number to the instrument.

A serial number corresponding to the serial number of the board in the HP 54510A is loaded at the factory. Do not use this command unless you need to serialize the instrument for a different application.

The serial number is part of the string returned for the \*IDN query.

**Command Syntax:** :SERial <string>

**Where:**

<string> ::= 10 character alphanumeric serial number within quotes.

**Example:** OUTPUT 707;":SER ""1234A56789""

## STATUS

---

### STATUS

query

The STATUS query indicates whether a channel, function, wmemory, or pmemory is ON or OFF. A one indicates ON and a zero indicates OFF.

**Query Syntax:** :STATUS? <display>

**Where:**

<display> ::= {CHANnel{1 | 2} | FUNction{1 | 2} | WMEMory{1 | 2 | 3 | 4} | PMEMory{1 | 2}}

**Returned Format:** [:STATUS] {0 | 1}<NL>

**Example:**  
DIM Status\${50}  
OUTPUT 707;":STATUS? CHANNEL1"  
ENTER 707;Status\$  
PRINT Status\$

**STOP**

---

**STOP**

**command**

The STOP command stops the data acquisition.

The RUN command must be executed to restart the acquisition.

**Command Syntax:** :STOP

**Example:** OUTPUT 707;":STOP"

## STORE

---

### STORE

### command

The STORE command moves a stored waveform, channel, or function to a waveform memory. This command has two parameters:

- The first parameter is the source of the waveform, which can be specified as any channel, function, or waveform memory.
- The second parameter is the destination of the waveform, which can only be waveform memory 1 through 4.

**Command Syntax:** :STORE <source>,<destination>

where:

<source> ::= {CHANnel{1 | 2} | FUNCTION{1 | 2} | WMemory{1 | 2 | 3 | 4}}  
<destination> ::= WMemory {1 | 2 | 3 | 4}

**Example:** OUTPUT 707;":STORE CHANNEL2,WMEMORY4"

TER

TER

**(Trigger Event Register)**

query

The TER query reads the Trigger Event Register. After the Trigger Event Register is read, it is cleared. A one indicates a trigger has occurred. A zero indicates a trigger has not occurred.

If a trigger event is not found and the sweep is auto-triggering, the Trigger Event Register bit is not set.

A Service Request (SRQ) can only be generated when the Trigger Event Register bit transitions from 0 to 1; therefore, the bit must be cleared each time you would like a new Service Request to be generated.

**Query Syntax:** :TER?

**Returned Format:** [:TER] {1 | 0}<NL>

**Example:**

```
DIM Trg_event$[50]
OUTPUT 707;":TER?"
ENTER 707;Trg_event$
PRINT Trg_event$
```

## VIEW

---

### VIEW

### command

The VIEW command turns on (starts displaying) an active channel, function, pixel memory, or waveform memory.

To display a channel use the command :VIEW CHANnel{1 | 2}. To display a waveform memory, use the command :VIEW WMEMory{1|2|3|4}. To display a pixel memory, use the command :VIEW PMEMory{1 | 2}. To display a function use the command :VIEW FUNCtion{1 | 2}.

Use the BLANK command to turn off (stop displaying) a specified channel, function, pixel memory, or waveform memory.

**Command Syntax:** :VIEW <display>

**Where:**

<display> ::= {CHANnel{1 | 2} | FUNCtion{1 | 2} |  
PMEMory{1 | 2} | WMEMory{1 | 2 | 3 | 4}}

**Example:** OUTPUT 707;":VIEW CHANNEL1"

## System Subsystem

---

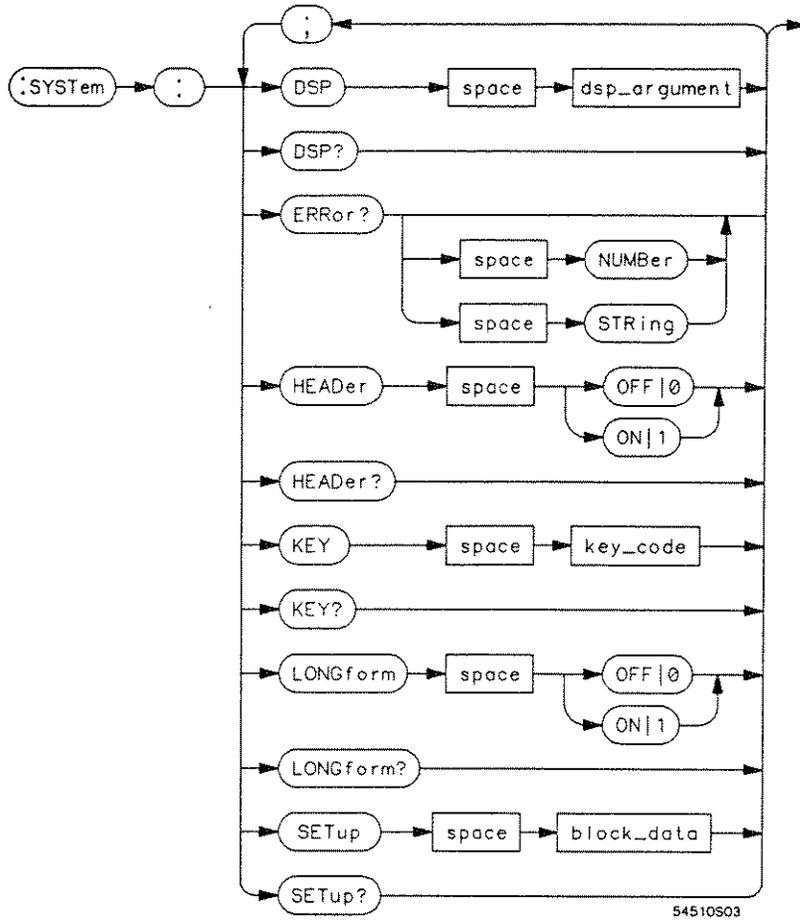
### Introduction

SYSTEM subsystem commands control the way in which query responses are formatted, simulate front panel key presses, and enable reading and writing to the advisory line of the instrument.

The System subsystem contains the following commands:

- DSP
- ERRor
- HEADer
- KEY
- LONGform
- SETup

Figure 8-1 lists the syntax diagrams for the System subsystem commands.



- dsp\_argument =** any quoted string.
- key\_code =** an integer, 1 through 44.
- block\_data =** block data in IEEE 488.2 # format.

Figure 8-1. System Subsystem Commands Syntax Diagram

**DSP****DSP****command/query**

The :SYSTEM:DSP command writes a quoted string, excluding quotes, to the advisory line (line 1) of the screen.

The DSP query returns the last string written to the advisory line. This may be a string written with a DSP command or an internally generated advisory.

The string is actually read from the message queue. The message queue is cleared when it is read. Therefore, the displayed message can only be read once over the bus.

**Command Syntax:** :SYSTem:DSP <quoted ASCII string>

**Example:** OUTPUT 707;":SYSTEM:DSP ""This is a message""

**Query Syntax:** :SYSTem:DSP?

**Returned Format:** [:SYSTem:DSP] <string><NL>

**Where:**

<string> ::= string response data containing the last information written on the advisory line.

**Example:**  
DIM Display\$[100]  
OUTPUT 707;":SYSTEM:DSP?"  
ENTER 707;Display\$  
PRINT Display\$

**ERRor****ERRor****query**

The :SYSTEM:ERROR query outputs the next error number in the error queue over the HP-IB. This instrument has an error queue that is 30 errors deep and operates on a first-in, first-out basis. Repeatedly sending the query :SYSTEM:ERROR? returns the error numbers in the order that they occurred until the queue is empty. Any further queries then return zeros until another error occurs.

When the NUMBER parameter is used in the query, only the numeric error code is output. When the STRING parameter is used, the error number is output followed by a comma and a quoted string. If no parameter is specified, then only the numeric error code is output. Not specifying a parameter is the same as specifying NUMBER.

See table 8-1 for the error numbers and descriptions.

**Query Syntax:** :SYSTEM:ERROR? {NUMBER | STRING | (no\_parameter)}

**Returned Format:** [:SYSTEM:ERRor] <error>[,<quoted string>]<NL>

**Where:**

<error> ::= an integer error code.

<quoted string> ::= an alpha string specifying the error condition.

**Example:**

```
DIM Emsg$[50]
OUTPUT 707;":SYSTEM:ERROR?"
ENTER 707;Emsg$
PRINT Emsg$
```

**ERRor****Table 8-1. Error Messages**

Error Number	Description
11	Questionable horizontal scaling
12	Edges required not found
13	Not a 54510A command
70	RAM write protected
-100	Command error (unknown command)
-101	Invalid character
-102	Syntax error
-103	Invalid separator
-104	Data type error
-105	GET not allowed
-108	Parameter not allowed
-109	Missing parameter
-112	Program mnemonic too long
-113	Undefined header
-121	Invalid character in number
-123	Numeric overflow
-124	Too many digits
-128	Numeric data not allowed
-130	Suffix error
-131	Invalid suffix
-138	Suffix not allowed
-140	Character data error
-141	Invalid character data
-144	Character data too long
-148	Character data not allowed
-150	String data error
-151	Invalid string data
-158	String data not allowed

**ERRor****Table 8-1. Error Messages (Continued)**

Error Number	Description
-160	Block data error
-161	Invalid block data
-168	Block data not allowed
-170	Expression error
-171	Invalid expression
-178	Expression data not allowed
-200	Execution error
-211	Trigger ignored
-221	Settings conflict
-222	Data out of range
-223	Too much data
-310	System error
-350	Too many errors
-400	Query error
-410	Query INTERRUPTED
-420	Query UNTERMINATED
-430	Query DEADLOCKED
-440	Query UNTERMINATED after indefinite response

**HEADeR****HEADeR****command/query**

The `:SYSTEM:HEADER` command turns the command headers for query responses on and off. When the `HEADER` is set to `ON`, query responses include the command header.

The `HEADER` query returns the state of the `HEADER` command.

**Command Syntax:** `:SYSTem:HEADer {{ ON | 1 } | { OFF | 0 }}`

**Example:** `OUTPUT 707;":SYSTEM:HEADER ON"`

**Query Syntax:** `:SYSTem:HEADer?`

**Returned Format:** `[ :SYSTem:HEADer ] { 1 | 0 } <NL>`

**Where:**

1 ::= ON  
0 ::= OFF

**Example:** `DIM Hdr$[20]  
OUTPUT 707;":SYSTEM:HEADER?"  
ENTER 707;Hdr$  
PRINT Hdr$`

The following example shows the response to the query `:CHANNEL1:RANGE?` with the headers on and off.

With headers set to `ON`; long form `ON`:

`:CHANNEL1:RANGE 6.40000E-01`

With headers set to `ON`; long form `OFF`:

`:CHAN1:RANG 6.40000E-01`

With headers set to `OFF`:

`6.40000E-01`

**Note**

Headers should be turned off when returning values to numeric variables. Otherwise, the headers may be misinterpreted as part of returned data.

**KEY****KEY****command/query**

The :SYSTEM:KEY command simulates the pressing of a specified front-panel key. Key commands may be sent over the HP-IB in any order that are legal key presses from the front panel. Make sure the instrument is in the desired state before executing the KEY command.

The KEY query returns the key code for the last key pressed from the front panel or returns the last simulated key press over the HP-IB. Key codes range from 1 to 44. Zero represents no key and is returned after power up.

Refer to table 8-2 for key codes.



The :SYSTEM:KEY 39 command will not return the instrument to the "Local" mode when the instrument is in the "Local Lockout" mode.

**Command Syntax:** :SYSTem:KEY <keycode>

**Where:**

<keycode> ::= 1 to 44

**Example:** OUTPUT 707;":SYSTEM:KEY 2"

**Query Syntax:** :SYSTem:KEY?

**Returned Format:** [:SYSTem:KEY] <keycode><NL>

**Where:**

<keycode> ::= 0 through 44 (integer - NR1 format)

**Example:**  
 DIM Input\$[50]  
 OUTPUT 707;":SYSTEM:KEY?"  
 ENTER 707;Input\$  
 PRINT Input\$

## KEY

Table 8-2. HP 54510A Front-Panel Key Codes

Key	Key Code	Key	Key Code
Menus - TIMEBASE	1	"-" (minus)	24
Menus - CHAN	2	"." (decimal point)	25
Menus - TRIG	3	0	26
Menus - DISPLAY	4	1	27
Menus - $\Delta t \Delta V$	5	2	28
Menus - WFORM MATH	6	3	29
Menus - WFORM SAVE	7	4	30
Menus - DEFINE MEAS	8	5	31
Menus - UTIL	9	6	32
Function Select 1	10	7	33
Function Select 2	11	8	34
Function Select 3	12	9	35
Function Select 4	13	RUN/STOP	36
Function Select 5	14	SINGLE	37
Function Select 6	15	CLEAR DISPLAY	38
Function Select 7	16	LOCAL	39
FINE	17	HARDCOPY	40
s V	18	AUTO-SCALE	41
ms mV	19	RECALL	42
$\mu s$	20	SAVE	43
ns	21	SHOW	44
CLEAR	22	no key	0
Shift (blue key)	23		

**Note**

The function select keys are at the right of the screen and are numbered from the top (10) to the bottom (16).

## LONGform

---

### LONGform

### command/query

The `:SYSTEM:LONGFORM` command sets the long form variable for formatting query responses. If the `LONGFORM` command is set to `OFF`, command headers and alpha arguments are sent from the HP 54510A in the short form. If the `LONGFORM` command is set to `ON`, the whole word is output. This command does not affect the input data messages to the HP 54510A. Headers and arguments may be sent to the HP 54510A in either the long form or short form, regardless of how the `LONGFORM` command is set. For more information, refer to the `HEADER` command in this chapter.

The `LONGFORM` query returns the state of the `LONGFORM` command.

### Note

Even though the Longform command can be sent using an alpha or numeric argument, the response is always a 1 or 0 (1 for ON, 0 for OFF).

**Command Syntax:** `:SYSTEM:LONGform {{ ON | 1 } | { OFF | 0 }}`

**Example:** `OUTPUT 707;":SYST:LONG ON"`

**Query Syntax:** `:SYSTEM:LONGform?`

**Returned Format:** `[:SYSTEM:LONGform] {1 | 0}<NL>`

#### Where:

1 ::= ON  
0 ::= OFF

**Example:** `DIM Long$[30]  
OUTPUT 707;":SYSTEM:LONGFORM?"  
ENTER 707;Long$  
PRINT Long$`

**SETup****SETup****command/query**

The :SYSTEM:SETUP command sets the HP 54510A as defined by the data in the setup (learn) string sent from the controller. The setup string contains 1024 bytes of setup data. The 1024 bytes do not include the header or "#800001024."

The setup string does not change the HP-IB mode, HP-IB address, fine key setting, waveform format, or waveform source.

The SETUP query operates the same as the \*LRN? query. It outputs the current HP 54510A setup in the form of a learn string to the controller.

The setup (learn) string is sent and received as a binary block of data. The format for the data transmission is the # format defined in the IEEE 488.2 specification.

**Command Syntax:** :SYSTEM:SETup <setup>

**Where:**

<setup> ::= #800001024<setup data string>

## SETup

---

**Query Syntax:** :SYSTem:SETup?

**Returned Format:** [:SYSTem:SETup] <setup><NL>

**Where:**

<setup> ::= #800001024<setup data string>

**Example:**

```
10 DIM Set$[2000]
20 !Setup the instrument as desired
30 OUTPUT 707;":SYST:HEAD OFF"
40 OUTPUT 707;":SYSTEM:SETUP?"
50 !Transfer the instrument setup to controller
60 ENTER 707 USING "-K";Set$ !Store the setup
70 PAUSE
80 OUTPUT 707 USING "#,K";":SYST:SETUP ";Set$
90 !Returns the instrument to the first setup
100 END
```

**Note** 

The logical order for this instruction is to send the query, followed by the command, at a time of your choosing. The query causes the learn string to be sent to the controller and the command causes the learn string to be returned to the HP 54510A.

---

## Acquire Subsystem

---

### Introduction

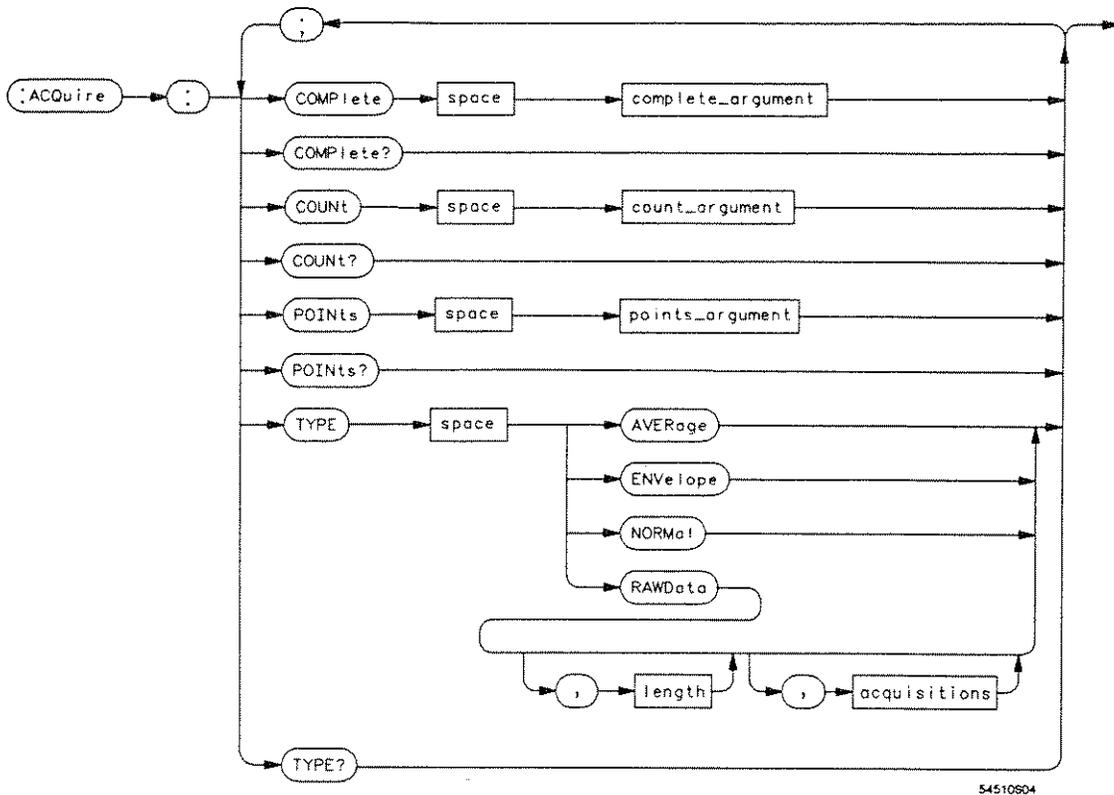
The ACQUIRE subsystem commands set up conditions for executing a DIGITIZE root level command to acquire waveform data.

The Acquire subsystem selects the type of data, the number of averages, and the number of data points.

This subsystem contains the following commands:

- COMPLETE
- COUNT
- POINTS
- TYPE

Figure 9-1 lists the syntax diagrams for the Acquire subsystem commands.



54510604

Figure 9-1. Acquire Subsystem Commands Syntax Diagram

<b>acquisitions =</b>	dependent on the length of the acquisitions and the buffer size.
<b>complete_argument =</b>	an integer, 0 through 100.
<b>count_argument =</b>	an integer, 1 to 2048. It specifies the number of values to average for each time point when in the averaged mode.
<b>length =</b>	an integer, 4 to 8000.
<b>points_argument =</b>	500 in the repetitive mode. 500 or 8000 in the real-time mode.

**Figure 9-1. Acquire Subsystem Commands Syntax Diagram**

---

## Acquire Type and Count

The ACQUIRE subsystem is the only HP-IB control for two display parameters: Display Mode and Number of Averages. There is a coupling between the front panel and the ACQUIRE subsystem parameters. This means that when the HP-IB parameters for ACQUIRE TYPE or COUNT are changed, the front panel changes. Also, when the front-panel parameters are changed, the HP-IB parameters change.

### (Normal) Persistence Mode

The :ACQUIRE:TYPE NORMAL command sets the HP 54510A to the variable persistence mode when the instrument is operating in the repetitive time base mode. You can activate the same mode from the front panel by selecting the Display menu, then setting the display mode to Normal. The persistence time is set over the HP-IB in the DISPLAY subsystem using the :DISPLAY:PERSISTENCE command.

The :ACQUIRE:COUNT can be set in the variable persistence mode, but has no impact on the current display mode or HP-IB acquisition. The :ACQUIRE:COUNT query always returns a 1 when the acquisition type is set to NORMAL.

### Averaging Mode

The :ACQUIRE:TYPE AVERAGE command sets the HP 54510A to the Averaging mode. The averaging mode is available only when the :TIMEBASE:SAMPLE is set to REPETITIVE.

COUNT can be set in the AVERAGE mode by sending the :ACQUIRE:COUNT command followed by the number of averages. In this mode, the value is rounded to the nearest power of two. The COUNT value determines the number of averages that must be acquired.

To activate the averaging mode from the front panel, select the Display menu, then select Average. Changing the number of averages changes the COUNT value.

**Envelope Mode** The `:ACQUIRE:TYPE ENVELOPE` command sets the HP 54510A to the Envelope mode. The envelope mode is only available when the `:TIMEBASE:SAMPLE` is set to `REPETITIVE`.

To activate the Envelope mode from the front panel, select the Display menu, then select the Envelope mode.

**Rawdata Mode** The `:ACQUIRE:TYPE RAWDATA` command is a special command that allows you to get unfiltered, 16-bit binary data over the bus. The `RAWDATA` command has two parameters: `Length` and `Acquisitions`. `Length` specifies the number of points of each acquisition. `Acquisitions` specify the number of acquisitions to be taken in a single digitize operation.

The maximum number of acquisitions is a function of the length of the acquisitions. Buffer size is the limiting factor. The rawdata buffer size is 300,000 bytes per channel. The number of acquisitions must satisfy the following condition:

$$\text{buffer\_size} = [(\text{length} * 2) + 8] * \text{acquisitions}.$$

The data points take up 2 bytes per point, and the time value (`XORIGIN`) associated with each acquisition takes up 8 bytes.

Rawdata can only be acquired with a digitize operation and is only accessible over the bus. Rawdata cannot be stored in memories or measured. Also, the command `:WAVEFORM:FORMAT` has no effect in the rawdata mode. Data is always transferred in the `WORD` format.

The Rawdata mode is exited when either the `RUN` or `SINGLE` key is pressed, or the `:ACQUIRE:TYPE` is changed over the bus.

## COMPLete

---

### COMPLete

### command/query

The `:ACQUIRE:COMPLETE` command specifies the minimum completion criteria for an acquisition. The parameter determines what percentage of the time buckets need to be "full" before an acquisition is considered complete. If you are in the `NORMAL` mode, the instrument only needs one data bit per time bucket for that time bucket to be considered full. In order for the time bucket to be considered full in the `AVERAGE` mode, a specified number of data points (`COUNT`) must be acquired.

The range for the `COMPLETE` command is 0 to 100 and indicates the minimum percentage of time buckets that must be "full" before the acquisition is considered complete. If the complete value is set to 100%, all time buckets must contain data for the acquisition to be considered complete. If the complete value is set to zero, then one acquisition cycle will take place.

### Note

The `:ACQUIRE:COMPLETE` command specifies the minimum completion criteria for an acquisition. In the `realtime` mode, and in the `repetitive` mode at sweep speeds slower than 50 ns per division, 100% of the time buckets are always filled in a single acquisition. This is due to the fast sample rate of the HP 54510A and does not vary with the value specified by the `:ACQUIRE:COMPLETE` command.

The `COMPLETE` query returns the completion criteria for the currently selected mode.

---

**COMPLete**

---

**Command Syntax:** :ACquire:COMPLete <comp>

**Where:**

<comp> ::= 0 to 100 percent

**Example:** OUTPUT 707;":ACQUIRE:COMPLETE 85"

**Query Syntax:** :ACquire:COMPLete?

**Returned Format:** [:ACquire:COMPLete] <comp><NL>

**Where:**

<comp> ::= 0 to 100 (integer - NR1 format)

**Example:**  
DIM Cmp\$[50]  
OUTPUT 707;":ACQUIRE:COMPLETE?"  
ENTER 707;Cmp\$  
PRINT Cmp\$

## COUNT

---

### COUNT

### command/query

In the average mode, the :ACQUIRE:COUNT command specifies the number of values to be averaged for each time bucket before the acquisition is considered complete for that time bucket. The :ACQUIRE:COUNT command is only valid in the repetitive mode.

When the acquisition type is set to ENVELOPE, the count can be any value between 1 and 2048.

When the acquisition type is set to AVERAGE, the count can range from 1 to 2048. Any value can be sent in this mode; however, the value will be rounded to the nearest power of two.

When the acquisition type is set to NORMAL, the count is 1.

The COUNT query returns the currently selected count value.

**Command Syntax:** :ACquire:COUNT <count>

**Where:**

<count> ::= 1 to 2048 (depending on the acquisition type)

**Example:** OUTPUT 707;":TIMEBASE:SAMPLE REPETITIVE !select sampling mode  
 OUTPUT 707;":ACQUIRE:TYPE AVERAGE" !select acquisition type  
 OUTPUT 707;":ACQUIRE:COUNT 1024"

**Query Syntax:** :ACquire:COUNT?

**Returned Format:** [:ACquire:COUNT] <count><NL>

**Where:**

<count> ::= 1 through 2048 (integer - NR1 format)

**Example:** DIM Cnt\${50}  
 OUTPUT 707;":ACQ:COUNT?"  
 ENTER 707;Cnt\$  
 PRINT Cnt\$

## POINTS

## POINTS

## command/query

The :ACQUIRE:POINTS command specifies the number of time buckets for each acquisition record. When operating in the repetitive mode, the legal setting is 500. When operating in the real-time mode, the legal settings are 500 and 8000.

If a value is sent in the repetitive mode that is not a legal value, the value is set to 500. If a value is sent in the real-time mode that is not a legal value, the value is set according to one of the following conditions:

- If the value is less than or equal to 1023, the value is set to 500.
- If the value is greater than or equal to 1024, the value is set to 8000.

The POINTS query returns the number of time buckets to be acquired.

**Note** 

Always query the Waveform Subsystem Points value to determine the actual number of acquired time buckets.

**Command Syntax:** :ACquire:POINTs <points\_argument>

Where:

<points\_argument> ::= 500 in the repetitive mode.  
500 or 8000 in the real-time mode.

**Example:** OUTPUT 707;":TIMEBASE:SAMPLE REPETITIVE" !select sample mode  
OUTPUT 707;":ACQ:POINTS 500"

## POINTs

---

**Query Syntax:** :ACquire:POINTs?

**Returned Format:** [:ACquire:POINTs] <points\_argument><NL>

**Where:**

<points\_argument> ::= 500 in the repetitive mode.  
500 or 8000 in the real-time mode.

**Example:**

```
DIM Pnts$[50]
OUTPUT 707;":ACQUIRE:POINTS?"
ENTER 707;Pnts$
PRINT Pnts$
```

## TYPE

## TYPE

## command/query

The :ACQUIRE:TYPE command selects the type of acquisition that is to take place when a :DIGITIZE root level command is executed. There are four acquisition types: NORMAL, AVERAGE, ENVELOPE, and RAWDATA.

For RAWDATA, you can also select the length and number of acquisitions. Length specifies the number of points in each acquisition. Acquisitions specify the number of acquisitions to be taken.

The maximum number of acquisitions is a function of the length of the acquisitions. Buffer size is the limiting factor. The rawdata buffer size is 300,000 bytes per channel. The number of acquisitions must satisfy the following condition:

$$\text{buffer\_size} = [(\text{length} * 2) + 8] * \text{acquisitions.}$$

The data points take up 2 bytes per point, and the time value (XORIGIN) associated with each acquisition takes up 8 bytes.

The parameters for RAWDATA are optional, but are also dependent on one another. For example, if you specify the number of acquisitions, then you must specify the length. The length parameter can be specified without specifying the number of acquisitions.

## Note



To get a correct PREAMBLE with the corresponding 8000 point realtime acquisition, you must send the DIGITIZE command or STOP the acquisition before sending the WAVEFORM:DATA query.

The :ACQUIRE:TYPE query returns the current acquisition type except in the RAWDATA mode. In the RAWDATA mode it returns the acquisition type, length, and number of acquisitions.

## TYPE

---

**Command Syntax:** :ACquire:TYPE {NORMal | AVERage | ENVELOpe | RAWData  
[,<length>][,<acquisitions>]}

**Where:**

<length> ::= 4 to 8000

<acquisitions> ::= dependent on length of acquisitions and buffer size as shown on previous page.

**Example:** OUTPUT 707;":ACQUIRE:TYPE ENVELOPE"

**Query Syntax:** :ACquire:TYPE?

**Returned Format:** [:ACquire:TYPE] {NORMal | AVERage | ENVELOpe |  
RAWData,<length>,<acquisitions>}<NL>

**Where:**

<length> ::= 4 to 8000 (integer - NR1 format).

<acquisitions> ::= dependent on length of acquisitions and buffer size as shown on previous page.

**Example:** DIM Tpe\$[50]  
OUTPUT 707;":ACQUIRE:TYPE?"  
ENTER 707;Tpe\$  
PRINT Tpe\$

# Calibrate Subsystem

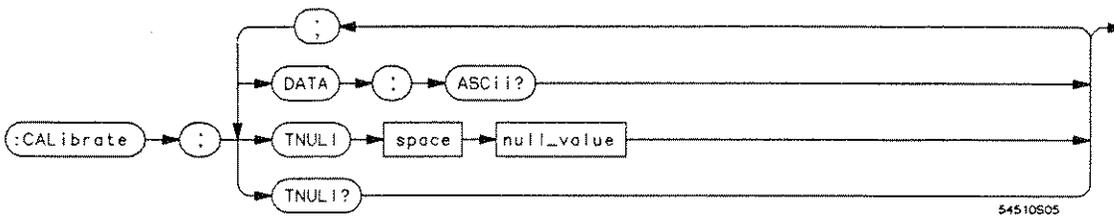
## Introduction

The CALIBRATE subsystem contains only two commands: :DATA:ASCii and TNULI. This subsystem calibrates the instrument for different probes, cables, or setups.



**Note**

The time null is set in the Probe Cal menu of the Utility menus. For more information refer to the *HP 54510A Front-Panel Reference*.



**null\_value =** channel 1 to channel 2 skew.

Figure 10-1. Calibrate Subsystem Commands Syntax Diagram

## DATA:ASCii

---

### DATA:ASCii

query

The :CALIBRATE:DATA:ASCii query returns the instrument's calibration data.

**Query Syntax:** :CALibrate:DATA:ASCii?

**Returned Format:** [:CALibrate:DATA:ASCii] <data>,<data>,...<NL>

**Where:**

<data> ::= calibration data

**Example:**  
DIM Data\$[18000]  
OUTPUT 707;":CAL:DATA:ASCii?"  
ENTER 707;Data\$  
PRINT Data\$

## TNULL

## TNULL

## command/query

The :CALIBRATE:TNULL command sends the time null (channel-to-channel skew) values to the HP 54510A. The time null values should have been obtained from the instrument during a previous setup.

The TNULL query tells the instrument to output the time null values to the controller.

**Command Syntax:** :CALibrate:TNULL <null\_value>

**Where:**

<null\_value> ::= channel 1 to channel 2 skew

**Example:** OUTPUT 707;":CAL:TNULL 5NS

**Query Syntax:** :CALibrate:TNULL?

**Returned Format:** [:CALibrate:TNULL] <null\_value><NL>

**Where:**

<null\_value> ::= channel 1 to channel 2 skew (exponential - NR3 format)

**Example:** DIM N11\$[50]  
OUTPUT 707;":CALIBRATE:TNULL?"  
ENTER 707;N11\$  
PRINT N11\$



## Channel Subsystem

---

### Introduction

The CHANNEL subsystem commands control the channel display and vertical or Y-axis of the HP 54510A. Channels 1 and 2 are independently programmable for all offset, probe, coupling, and range functions. The channel number specified in the command selects the channel that is affected by the command.

The channel displays are toggled on and off with the root level commands VIEW and BLANK.

The Channel subsystem contains the following commands:

- COUPling
- ECL
- HFReject
- LFReject
- OFFSet
- PROBe
- RANGe
- TTL

Figure 11-1 lists the syntax diagrams for the Channel subsystem commands.

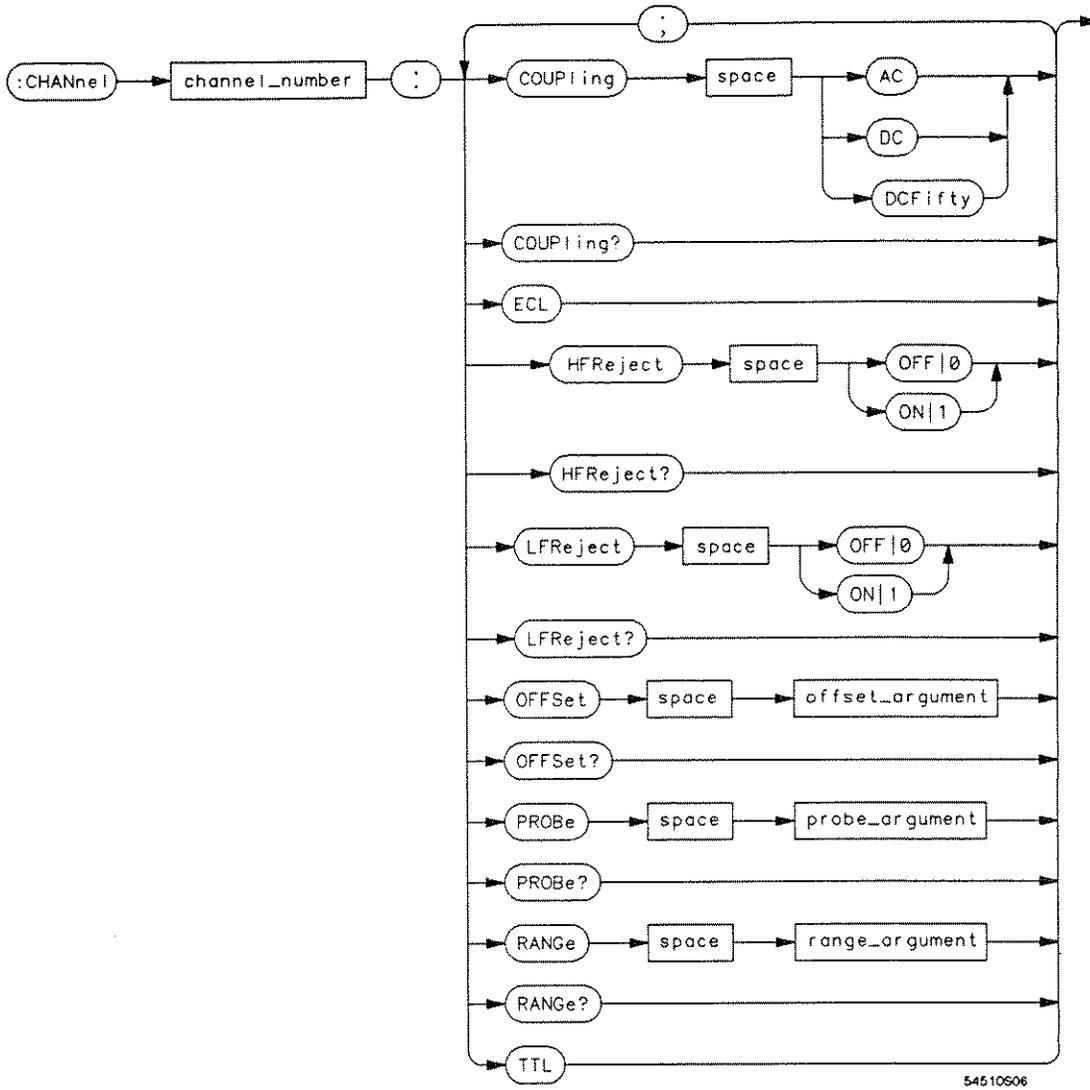


Figure 11-1. Channel Subsystem Commands Syntax Diagram

<b>channel_number =</b>	an integer, 1 or 2.
<b>offset_argument =</b>	a real number defining the voltage at the center of the display range.
<b>probe_argument =</b>	a real number from 0.9 to 1000.0 specifying the probe attenuation with respect to 1.
<b>range_argument =</b>	a real number specifying the size of the acquisition window in volts.

**Figure 11-1. Channel Subsystem Commands Syntax Diagram (Continued)**

## COUPLing

---

### COUPLing

### command/query

The `:CHANNEL<N>:COUPLING` command selects the input coupling for the specified channel. The coupling for each channel can be set to AC, DC, or DCFIFTY. DCFIFTY places an internal 50  $\Omega$  load on the input.

The `COUPLING` query returns the current coupling for the specified channel.

**Command Syntax:** `:CHANnel<N>:COUPLing {AC | DC | DCFifty}`

Where:

`<N>` ::= 1 or 2

**Example:** `OUTPUT 707;":CHAN2:COUP DC"`

**Query Syntax:** `:CHANnel<N>:COUPLing?`

Where:

`<N>` ::= 1 or 2

**Returned Format:** `[:CHANnel<N>:COUPLing] {AC | DC | DCFifty}<NL>`

**Example:**  
`DIM Ch$[50]`  
`OUTPUT 707;":CHAN2:COUPLING?"`  
`ENTER 707;Ch$`  
`PRINT Ch$`

**ECL****ECL****command**

The `:CHANNEL <N> :ECL` command sets the vertical range, offset, channel coupling, and trigger level of the selected channel for optimum viewing of ECL signals. The channel offset and trigger level are set to  $-1.3$  volts and the range is set to 1.6 volts full scale. Channel coupling is set to DC.

There is no query form of this command.

**Command Syntax:** `:CHANne1<N>:ECL`

**Where:**

`<N> ::= 1 or 2`

**Example:** `OUTPUT 707;":CHAN1:ECL"`

## HFReject

---

### HFReject

### command/query

The `:CHANNEL<N>:HFREJECT` command controls an internal low-pass filter. When the filter is ON, the bandwidth of the specified channel is limited to approximately 20 MHz. The bandwidth limit filter may be used when either AC, DC, or DCFIFTY coupling is used.

The HFREJECT query returns the current setting of the command.

**Command Syntax:** `:CHANne1<N>:HFReject {{ON | 1} | {OFF | 0}}`

**Where:**

`<N> ::= 1 or 2`

**Example:** `OUTPUT 707;":CHANNEL2:HFR ON"`

**Query Syntax:** `:CHANne1<N>:HFReject?`

**Where:**

`<N> ::= 1 or 2`

**Returned Format:** `[.:CHANne1<N>:HFReject] {1 | 0}<NL>`

**Example:**  
`DIM HF$[50]  
 OUTPUT 707;":CHAN1:HFR?"  
 ENTER 707;HF$  
 PRINT HF$`

## LFReject

### LFReject

### command/query

The `:CHANNEL<N>:LFREJECT` command controls an internal high-pass filter. When the filter is ON, the bandwidth of the specified channel is limited to approximately 400 Hz. The bandwidth limit filter may be used only when AC coupling is used. Otherwise, the bandwidth limit filter is automatically turned off.

The `LFREJECT` query returns the current setting of the command.

**Command Syntax:** `:CHANne1<N>:LFReject {{ON | 1} | {OFF | 0}}`

**Where:**

`<N> ::= 1 or 2`

**Example:** `OUTPUT 707;":CHANNEL2:COUPLING AC" !select AC coupling`  
`OUTPUT 707;":CHANNEL2:LFREJECT ON"`

**Query Syntax:** `:CHANne1<N>:LFReject?`

**Where:**

`<N> ::= 1 or 2`

**Returned Format:** `[ :CHANne1<N>:LFReject ] {1 | 0}<NL>`

**Example:** `DIM Lf$[50]`  
`OUTPUT 707;":CHAN1:LFREJECT?"`  
`ENTER 707;Lf$`  
`PRINT Lf$`

## OFFSet

### OFFSet

### command/query

The `:CHANNEL<N>:OFFSET` command sets the voltage that is represented at center screen for the selected channel. The range of legal values vary with the value set with the `RANGE` command. If you set the offset to a value outside of the legal range, the offset value is automatically set to the nearest legal value.

The `OFFSET` query returns the current offset value for the selected channel.

**Command Syntax:** `:CHANnel<N>:OFFSet <value>`

**Where:**

`<N>` ::= 1 or 2  
`<value>` ::= offset value

**Examples:** `OUTPUT 707;":CHAN1:OFFS 200M"`  
`OUTPUT 707;":CHAN2:OFFSET 20E-3"`

**Query Syntax:** `:CHANnel<N>:OFFSet?`

**Returned Format:** `[ :CHANnel<N>:OFFSet] <value><NL>`

**Where:**

`<N>` ::= .1 or 2  
`<value>` ::= offset value in volts (exponential - NR3 format)

**Example:** `OUTPUT 707;":SYSTEM:HEADERS OFF"`    !turn headers off  
`OUTPUT 707;":CHANNEL2:OFFSET?"`  
`ENTER 707;Offset`  
`PRINT Offset`

**PROBe****PROBe****command/query**

The `:CHANNEL <N>:PROBE` command specifies the probe attenuation factor for the selected channel. The range of the probe attenuation factor is from 0.9 to 1000.0. This command does not change the actual input sensitivity of the HP 54510A. It changes the reference constants for scaling the display factors, for making automatic measurements, for setting trigger levels, etc.

The `PROBE` query returns the current probe attenuation factor for the selected channel.

**Command Syntax:** `:CHANne1<N>:PROBe <attenuation>`

**Where:**

`<N>` ::= 1 or 2  
`<attenuation>` ::= 0.9 to 1000

**Example:** `OUTPUT 707;":CHANNEL2:PROBE 10"`

**Query Syntax:** `:CHANne1<N>:PROBe?`

**Where:**

`<N>` ::= 1 or 2

**Returned Format:** `[:CHANne1<N>:PROBe] <attenuation><NL>`

**Where:**

`<N>` ::= 1 or 2  
`<attenuation>` ::= 0.9 to 1000 (exponential - NR3 format)

**Example:** `DIM Prb$[50]  
OUTPUT 707;":CHANNEL1:PROBE?"  
ENTER 707;Prb$  
PRINT Prb$`

## RANGe

---

### RANGe

### command/query

The `:CHANNEL<N>:RANGe` command defines the full-scale vertical axis of the selected channel. The RANGE for channels 1 and 2 can be set to any value from 8 mV to 40 V when using 1:1 probe attenuation. If the probe attenuation is changed, the range value is multiplied by the probe attenuation factor.

The RANGE query returns the current full-scale range setting for the specified channel.

**Command Syntax:** `:CHANne1<N>:RANGe <range>`

**Where:**

`<N>` ::= 1 or 2  
`<range>` ::= full-scale range value

**Examples:** `:OUTPUT 707;":CHANNEL1:RANGE 0.64"`  
`:OUTPUT 707;":CHANNEL2:RANGE 1.2 V"`

**Query Syntax:** `:CHANne1<N>:RANGe?`

**Returned Format:** `[[:CHANne1<N>:RANGe] <range><NL>`

**Where:**

`<N>` ::= 1 or 2  
`<range>` ::= full-scale range value (exponential - NR3 format)

**Example:** `DIM Rng$[50]`  
`OUTPUT 707;":CHAN2:RANGE?"`  
`ENTER 707;Rng$`  
`PRINT Rng$`

**TTL****TTL****command**

The `:CHANNEL <N>:TTL` command sets the vertical range, offset, channel coupling, and trigger level of the selected channel for optimum viewing of TTL signals. The channel offset is set to 2.5 volts. The trigger level is set to 1.4 volts and the range is set to 8.0 volts full scale. Channel coupling is set to DC.

There is no query form of this command.

**Command Syntax:** `:CHANne1<N>:TTL`

**Where:**

`<N> ::= 1 or 2`

**Example:** `OUTPUT 707;":CHAN1:TTL"`



## Display Subsystem

---

### Introduction

The DISPLAY subsystem is used to control the display of data, voltage and time markers, text, and graticules.

#### Note



The Display mode can be selected with the :ACQUIRE:TYPE command. The number of averages can be specified with the ACQUIRE:COUNT command.

The Display subsystem contains the following commands:

- COLumn
- CONNect
- DATA
- FORMat
- GRATicule
- INVerse
- LINE
- MASK
- PERSistence
- ROW
- SCReen
- SOURce
- STRing
- TEXT
- TMArker
- VMARker

Figure 12-1 lists the syntax diagrams for the Display subsystem commands.

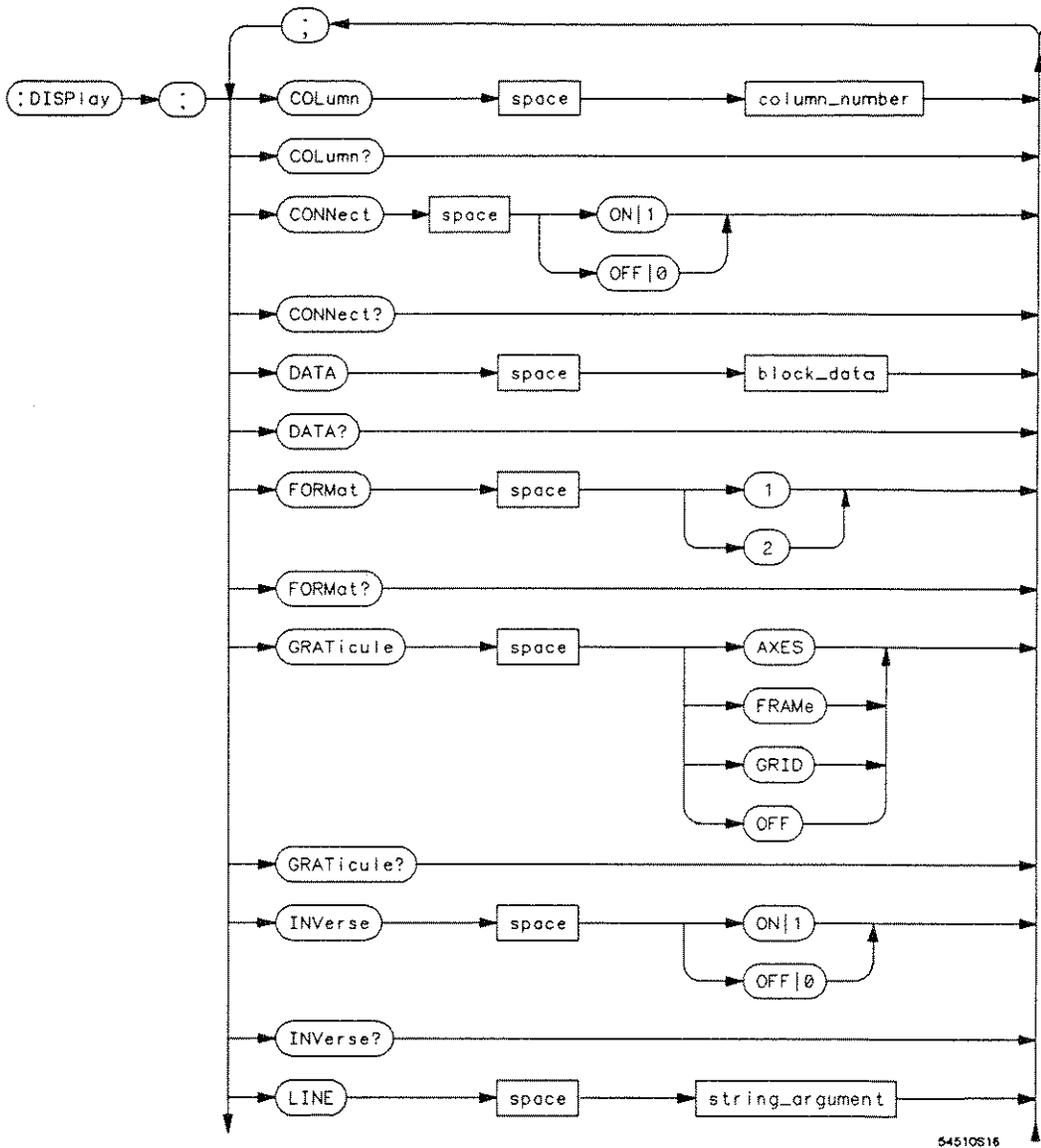
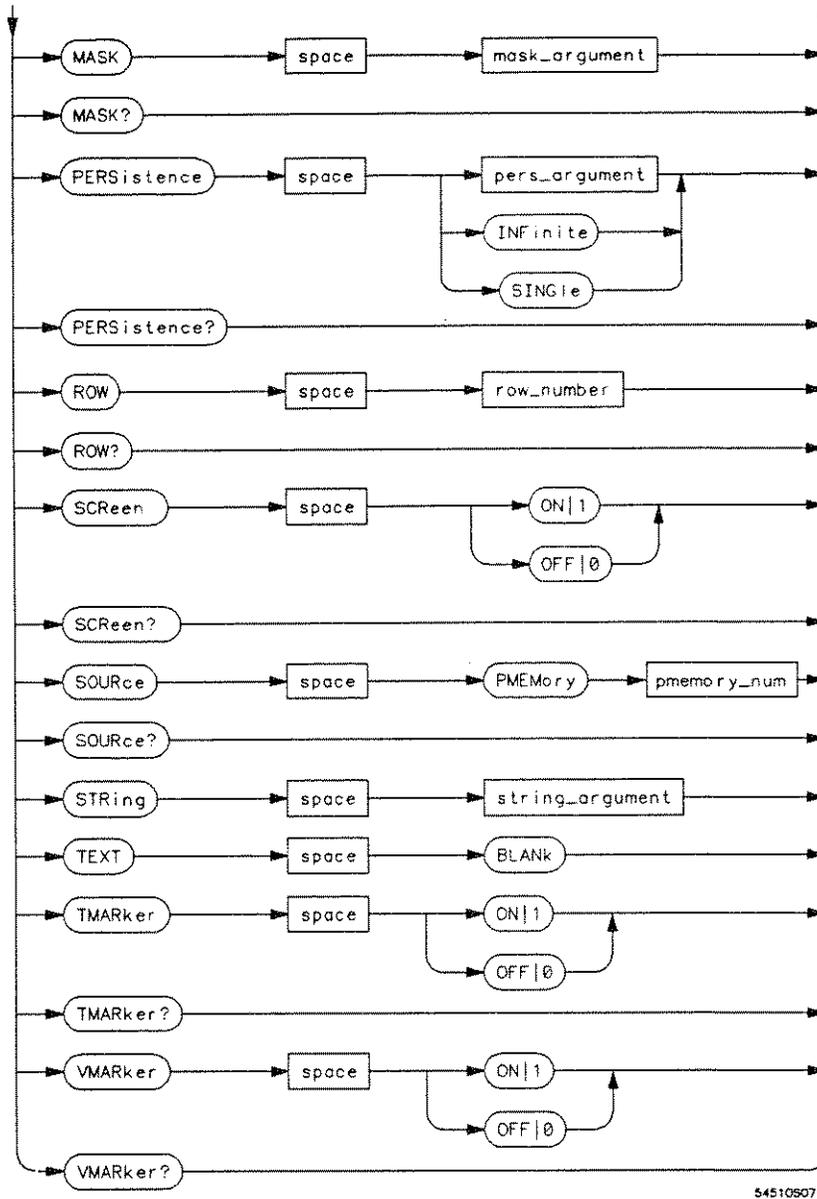


Figure 12-1. Display Subsystem Commands Syntax Diagram



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Figure 12-1. Display Subsystem Commands Syntax Diagram (continued)

<b>column_number =</b>	an integer, 0 through 72.
<b>block_data =</b>	block data in IEEE 488.2 # format.
<b>mask_argument =</b>	an integer, 0 through 255.
<b>pers_argument =</b>	a real number, 0.1 through 11.
<b>pmemory_num =</b>	an integer, 0 through 3.
<b>row_number =</b>	an integer, 0 through 24.
<b>string_argument =</b>	any quoted string.

**Figure 12-1. Display Subsystem Commands Syntax Diagram (continued)**

## COLumn

### COLumn

### command/query

The `:DISPLAY:COLUMN` command specifies the starting column for subsequent `STRING` and `LINE` commands.

The `COLUMN` query returns the column where the next `LINE` or `STRING` will start.

**Command Syntax:** `:DISP lay:COLumn <number>`

**Where:**

`<number>` ::= 0 through 72

**Example:** `OUTPUT 707;":DISPLAY:COLUMN 50"`

**Query Syntax:** `:DISP lay:COLumn?`

**Returned Format:** `[ :DISP lay:COLumn ] <number><NL>`

**Where:**

`<number>` ::= 0 through 72 (integer - NR1 format)

**Example:**

```
DIM C1mn$[30]
OUTPUT 707;":DISPLAY:COLUMN?"
ENTER 707;C1mn$
PRINT C1mn$
```

## CONNECT

---

### CONNECT

### command/query

The `:DISPLAY:CONNECT` command turns the connect-the-dots function on and off.

The `CONNECT` query returns the current setting of the connect-the-dots function. The returned status is indicated by using a 1 for on and a 0 for off.

**Command Syntax:** `:DISP lay:CONNECT {{ON | 1} | {OFF | 0}}`

**Example:** `OUTPUT 707;":DISPLAY:CONNECT ON"`

**Query Syntax:** `:DISP lay:CONNECT?`

**Returned Format:** `[:DISP lay:CONNECT] {1 | 0}<NL>`

**Example:**  
`DIM Cnn$[50]`  
`OUTPUT 707;":DISP:CONNECT?"`  
`ENTER 707;Cnn$`  
`PRINT Cnn$`

**DATA****DATA****command/query**

The `:DISPLAY:DATA` command writes waveform data to one of the pixel planes in the HP 54510A. The `DATA` command is followed by a block of binary data that is transferred from the controller to a specific plane in the HP 54510A. The data can be written to pixel memories 1 and 2. The data is in the IEEE 488.2 definite block form with 16576 bytes of data preceded by seven block header bytes. The block header contains the ASCII characters "#800016576" and is sent prior to the data.

The `:DISPLAY:DATA` query is used to write waveform data from one of the pixel planes in the HP 54510A. The pixel planes available are planes 0 through 3. The `DATA` query causes the HP 54510A to output pixel data from the specified plane. If plane 0 is specified, the HP 54510A transfers the active display. If `PMEMORY1` or `PMEMORY2` is specified that memory is transferred. When `PMEMORY3` is specified the half-bright portion of the display (graticule, markers, and displayed memories) is transferred.

**Note** 

The pixel planes (`PMEMORY0` through `PMEMORY3`) are specified with the `:DISPLAY:SOURCE` command.

**Command Syntax:** `:DISP lay:DATA <binary block>`

**Where:**

`<binary block> ::= block data in IEEE 488.2 # format`

## DATA

---

**Query Syntax:** :DISPlay:DATA?

**Returned Format:** [:DISPlay:DATA] #800016576<16576 bytes of binary data><NL>

**Example:**

```
10 CLEAR 707
20 DIM Plane$ [17000]
30 OUTPUT 707;":SYST:HEAD ON"
40 OUTPUT 707;":DISPLAY:SOURCE PMEMORY;DATA?"
50 ENTER 707 USING "-K";Plane$
60 OUTPUT 707;":DISPLAY:SOURCE PMEM1"
70 OUTPUT 707 USING "#,-K";":DISPLAY:DATA ";Plane$
80 END
```

This example transfers data from the active display memory to the controller, then transfers the data back to pixel memory 1 in the HP 54510A.

**Note**



In program line 70, the space after :DISPLAY:DATA and before the quotation mark is required.

**FORMat****FORMat****command/query**

The `:DISPLAY:FORMAT` command sets the number of display areas on the screen. `FORMAT 1` provides one display area and uses eight divisions for the full-scale range. `FORMAT 2` sets the number of screens to 2 and uses four divisions for the full-scale range.

The `FORMAT` query returns the current display format.

**Command Syntax:** `:DISPlay:FORMat {1 | 2}`

**Example:** `OUTPUT 707;":DISP:FORMAT 1"`

**Query Syntax:** `:DISPlay:FORMat?`

**Returned Format:** `[.:DISP lay:FORMat] {1 | 2}<NL>`

**Example:**  
`DIM Frmt$[30]`  
`OUTPUT 707;":DISPLAY:FORMAT?"`  
`ENTER 707;Frmt$`  
`PRINT Frmt$`

## GRATicule

---

### GRATicule

### command/query

The `:DISPLAY:GRATICULE` command selects the type of graticule that is displayed.

The `GRATICULE` query returns the type of graticule that is currently displayed.

**Command Syntax:** `:DISPlay:GRATicule {OFF | GRID | AXES | FRAMe}`

**Example:** `OUTPUT 707;":DISPLAY:GRATICULE AXES"`

**Query Syntax:** `:DISPlay:GRATicule?`

**Returned Format:** `[:DISP lay:GRATicule] {OFF | GRID | AXES | FRAMe}<NL>`

**Example:**  
`DIM Grt$[30]  
OUTPUT 707;":DISPLAY:GRATICULE?"  
ENTER 707;Grt$  
PRINT Grt$`

**INVerse****INVerse****command/query**

The `:DISPLAY:INVERSE` command determines whether text sent with the `LINE` or `STRING` command in the `DISPLAY` subsystem is to be written with the `INVERSE` attribute. If the inverse attribute is `ON` the text will be written in inverse video.

The `INVERSE` query returns the current state of this command.

**Command Syntax:** `:DISP lay:INVerse {{ON | 1} | {OFF | 0}}`

**Example:** `OUTPUT 707;":DISPLAY:INVERSE OFF"`

**Query Syntax:** `:DISP lay:INVerse?`

**Returned format:** `[ :DISP lay:INVerse ] {1 | 0}<NL>`

**Example:**

```
DIM Iv$[30]
OUTPUT 707;":DISP:INVERSE?"
ENTER 707;Iv$
PRINT Iv$
```

## LINE

---

### LINE

### command

The `:DISPLAY:LINE` command writes a text string to the screen. The text is displayed starting at the location of the current row and column. The row and column can be set by the `:DISPLAY:ROW` and `:DISPLAY:COLUMN` commands prior to sending the `:DISPLAY:LINE` command. Text can be written over the entire screen with the `LINE` command.

If the text string is longer than the available space on the current line, the text wraps around to the start of the same line. In any case, the `ROW` value is incremented by one and the `COLUMN` value remains the same. The next `:DISPLAY:LINE` command will write on the next line of the display starting at the same column as the previous text. After writing line 24, the last line in the display area, `ROW` is reset to 0.

**Command Syntax:** `:DISPlay:LINE <quoted string>`

Where:

`<quoted string>` ::= any series of ASCII characters enclosed in quotes.

**Example:** `OUTPUT 707;":DISPLAY:LINE ""ENTER PROBE ATTENUATION""`

**MASK****MASK****command/query**

The `:DISPLAY:MASK` command inhibits the instrument from writing to selected areas of the screen. Text sent over the HP-IB with the line and string commands, or the `SYSTEM:DSP` command, is not affected by this command. The purpose of the command is to allow HP-IB text to be written anywhere on the screen, and to prevent the instrument from overwriting the text through its normal operation.

The mask parameter is an 8-bit integer in which each bit controls writing to an area of the screen. A zero inhibits writing to the area represented by the bit, and a 1 enables writing to that area.

The `MASK` query returns the current value of the `MASK` command.

**Command Syntax:** `:DISP lay:MASK <value>`

**Where:**

`<value>` ::= 0 to 255 (integer - NR1 format)

**Example:** `OUTPUT 707;":DISPLAY:MASK 67"`

The previous example enables writing to the Menu Area (bit 6), the Status Line (bit 1), and the Advisory Area (bit 0).

**Query Syntax:** `:DISP lay:MASK?`

**Return Format:** `[[:DISP lay:MASK] <value><NL>`

**Where:**

`<value>` ::= 0 to 255 (integer - NR1 format)

**Example:**

```
DIM Msk$[30]
OUTPUT 707;":DISP:MASK?"
ENTER 707;Msk$
PRINT Msk$
```

**MASK**

---

**Table 12-1. Display Mask Byte.**

Bit	Weight	Screen Area Affected
7	128	unused
6	64	Menu Area
5	32	Timebase Information
4	16	Measurement Result Area
3	8	Graticule Area
2	4	unused
1	2	Status Line
0	1	Advisory Area

**PERSistence****PERSistence****command/query**

The `:DISPLAY:PERSISTENCE` command sets the display persistence. The `PERSISTENCE` command is only effective in the Normal display mode.

In the real-time time base mode, the parameters for this command are the keywords `INFINITE` or `SINGLE`.

In the repetitive time base mode, the parameter for this command is the keyword `INFINITE`, or real numbers from 0.5 through 10.0 representing the persistence in seconds. Any value less than 0.45 sets the `PERSISTENCE` to `MINIMUM`. Any value greater than 10 seconds sets the `PERSISTENCE` to `INFINITE`.

When the key word `SINGLE` is sent as the argument for this command, the persistence value is set to minimum.

In the real-time time base mode the `PERSISTENCE` query returns the actual mnemonic: `SINGLE` or `INFinite`.

In the repetitive time base mode the `PERSISTENCE` query returns the current persistence value. When `Minimum` is displayed, the value returned is 0. When `Infinite` is displayed, the value returned is 11.

**Command Syntax:** `:DISPlay:PERSistence {SINGle | INFinite | 0.1 through 11}`

**Example:** `OUTPUT 707;":TIMEBASE:SAMPLE REPETITIVE" !select time base mode`  
`OUTPUT 707;":DISPLAY:PERSISTENCE 3.0"`

## PERSistence

---

**Query Syntax:** :DISP lay:PERSistence?

**Returned Format:** [:DISP lay:PERSistence] <value><NL>

**Where:**

<value> ::= {0 | .5 to 10 | 11} (exponential - NR3 format) in the repetitive mode

**Where:**

1.100E+1 = infinite  
<value> ::= {SINGle | INFinite} in the real-time mode

**Example:** DIM Prs\$[50]  
OUTPUT 707;":DISPLAY:PERSISTENCE?"  
ENTER 707;Prs\$  
PRINT Prs\$

**ROW****ROW****command/query**

The `:DISPLAY:ROW` command specifies the starting row on the screen for subsequent `STRING` and `LINE` commands. The `ROW` number remains constant until another `ROW` command is received, or until it is incremented by the `LINE` command. The `ROW` value can be set to 0 through 24.

The `ROW` query returns the current `ROW` number.

**Command Syntax:** `:DISPlay:ROW <row number>`

**Where:**

`<row number>` ::= 0 through 24

**Example:** `OUTPUT 707;":DISPLAY:ROW 10"`

**Query Syntax:** `:DISPLAY:ROW?`

**Returned Format:** `[[:DISPlay:ROW] <row number><NL>`

**Where:**

`<row number>` ::= 0 through 24 (integer - NR1 format)

**Example:** `DIM Rw$[30]  
OUTPUT 707;":DISPLAY:ROW?"  
ENTER 707;Rw$  
PRINT Rw$`

## SCReen

---

### SCReen

### command/query

The `:DISPLAY:SCREEN` command turns the displayed screen on and off. The status line is the only part of the screen that remains on after the `:DISPLAY:SCREEN OFF` command is executed. The screen can be turned on again with the `ON` parameter.

The `SCREEN` query returns the current setting of this function. The returned status is indicated by using a 1 for on and a 0 for off.

The command `:DISPLAY:TEXT BLANK` removes only the text from the display.

**Command Syntax:** `:DISP lay:SCReen {{ON | 1} | {OFF | 0}}`

**Example:** `OUTPUT 707;":DISPLAY:SCREEN ON"`

**Query Syntax:** `:DISP lay:SCReen?`

**Returned Format:** `[ :DISP lay:SCReen ] {1 | 0} <NL>`

**Example:**  
`DIM Srm$[50]  
OUTPUT 707;":DISP:SCREEN?"  
ENTER 707;Srm$  
PRINT Srm$`

**SOURce****SOURce****command/query**

The :DISPLAY:SOURCE command specifies the source or destination for the :DISPLAY:DATA query and command. The SOURCE command has one parameter which can be set to PMEMORY0 through PMEMORY3.

The SOURCE query returns the currently specified SOURCE.

**Command Syntax:** :DISPlay:SOURce PMemory{0 | 1 | 2 | 3}

Where:

PMemory0 ::= active display  
 PMemory1 ::= pixel memory 1  
 PMemory2 ::= pixel memory 2  
 PMemory3 ::= half-bright portion of the display (graticule, markers, and displayed memories)

**Example:**

```
10 CLEAR 707
20 DIM Plane$[17000]
30 OUTPUT 707;":SYSTEM:HEADER ON"
40 OUTPUT 707;":DISPLAY:SOURCE PMEMORY0;DATA?"
50 ENTER 707 USING "-K";Plane$
60 OUTPUT 707;":DISPLAY:SOURCE PMEM1"
70 OUTPUT 707 USING "#,-K";":DISPLAY:DATA ";Plane$
80 END
```

This example transfers data from the active display to the controller, then transfers it back to pixel memory 1 in the HP 54510A.

**Query Syntax:** :DISPlay:SOURce?

**Returned Format:** [:DISPlay:SOURce] PMemory{0 | 1 | 2 | 3}<NL>

**Example:**

```
DIM Src$[30]
OUTPUT 707;":DISP:SOUR?"
ENTER 707;Src$
PRINT Src$
```

## STRing

---

### STRing

### command

The :DISPLAY:STRING command writes a text string to the screen of the HP 54510A. The text is written starting at the current ROW and COLUMN values. If the column limit is reached (column 72), the excess text is written over the text on the left side of that line. If 90 or more characters are sent, the error -144, "Character data too long" is produced. The STRING command does not increment the ROW value; however, the LINE command does.

**Command Syntax:** :DISPlay:STRing <quoted string>

**Example:** OUTPUT 707;":DISP:STRING 'INPUT SIGNAL TO CHANNEL 2'"

**TEXT****TEXT****command**

The `:DISPLAY:TEXT` command blanks the user text area on the screen. When this command is sent, all text on the entire screen is blanked. This command has only one parameter: `BLANK`.

There is no query form of this command.

The `:DISPLAY:SCREEN ON` command restores the user text to the screen.

**Command Syntax:** `:DISP1ay:TEXT BLANK`

**Example:** `OUTPUT 707;":DISPLAY:TEXT BLAN"`

## TMARker

---

### TMARker

### command/query

The `:DISPLAY:TMARKER` command turns the time markers on and off.

The `TMARKER` query returns the state of the time markers.

**Command Syntax:** `:DISP lay:TMARker {{ON | 1} | {OFF | 0}}`

**Example:** `OUTPUT 707;":DISP:TMAR OFF"`

**Query Syntax:** `:DISP lay:TMARker?`

**Returned Format:** `[ :DISP lay:TMARker ] {1 | 0} <NL>`

**Example:**  
`DIM Tmr$[30]  
OUTPUT 707;":DISP:TMARKER?"  
ENTER 707;Tmr$  
PRINT Tmr$`

### Note



It is a recommended practice to turn the Tmarkers on before attempting to set them using a `:MEASURE:TSTART` or `MEASURE:TSTOP` command.

**VMARker****VMARker****command/query**

The `:DISPLAY:VMARKER` command turns the voltage markers on and off.

The `VMARKER` query returns the state of the Vmarkers.

**Command Syntax:** `:DISPlay:VMARKer {{ON | 1} | {OFF | 0}}`

**Example:** `OUTPUT 707;":DISP:VMARKER ON"`

**Query Syntax:** `:DISPlay:VMARKer?`

**Returned Format:** `[:DISP]ay:VMARKer] {1 | 0}<NL>`

**Example:**  
`DIM Vmrk$[30]  
OUTPUT 707;":DISP:VMARKER?"  
ENTER 707;Vmrk$  
PRINT Vmrk$`

**Note**

It is a recommended practice to turn the Vmarkers on before attempting to set them using a `:MEASURE:VSTART` or `MEASURE:VSTOP` command.



## Function Subsystem

---

### Introduction

The FUNCTION subsystem defines functions using the displayed channels or waveform memories as operands. If a channel or memory that is not on is specified as an operand, then that channel is enabled. Channel 1 and 2, and waveform memories 1 through 4, are available for functions.

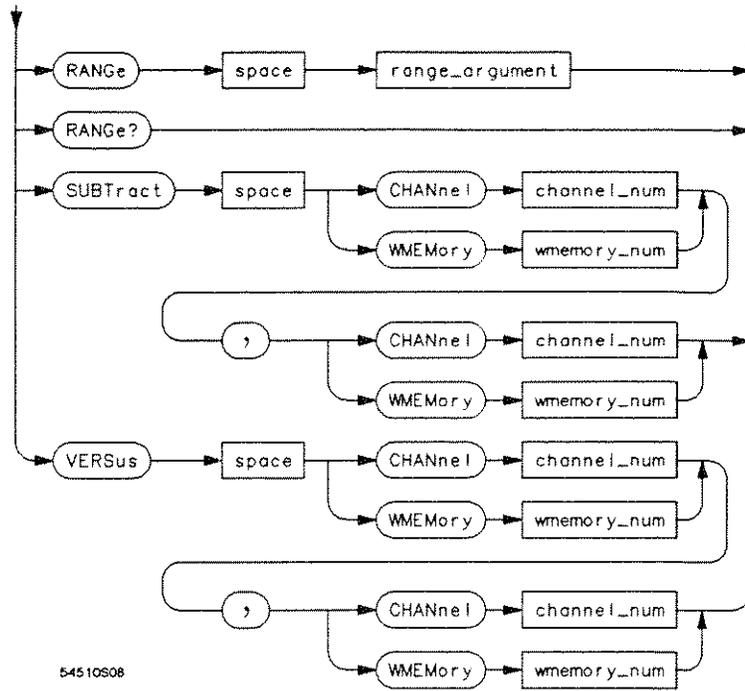
The Function subsystem contains the following commands:

- ADD
- DIFF (differentiate)
- INTegrate
- INVert
- MULTiply
- OFFSet
- ONLY
- RANGe
- SUBTract
- VERSus

Figure 13-1 lists the syntax diagrams for the Function subsystem commands.



Figure 13-1. Function Subsystem Commands Syntax Diagram



- channel\_num =** an integer, 1 or 2.
- function\_num =** an integer, 1 or 2.
- offset\_argument =** 0 to ± voltage full scale.
- range\_argument =** full screen voltage.
- wmemory\_num =** an integer, 1 through 4.

Figure 13-1. Function Subsystem Commands Syntax Diagram (continued)

## ADD

---

### ADD

### command

The :FUNCTION <N>:ADD command algebraically adds the two defined operands.

**Command Syntax:** :FUNct ion<N>:ADD <operand>, <operand>

**Where:**

<N> ::= 1 or 2

<operand> ::= {CHANne11 | CHANne12 | WMemory1 | WMemory2 | WMemory3 | WMemory4}

**Example:** OUTPUT 707;":FUNCTION2:ADD WMEMORY3,WMEMORY4"

## DIFF

## DIFF

## command

The :FUNCTION<N>:DIFF command plots the voltage differences between consecutive points in time divided by the time bucket width,  $\Delta t$ .

$$d_1 = 0$$

$$d_n = \frac{c(n) - c(n-1)}{\Delta t}$$

The equation calculates the differential waveform of the channel, where  $d$  represents the differential waveform and  $c$  represents the channel.

**Note** 

The differential function will magnify signal noise. This noise will be less in the realtime mode.

**Command Syntax:** :FUNction<N>:DIFF <operand>

Where:

<N> ::= 1 or 2

<operand> ::= {CHANne11 | CHANne12 | WMEMory1 | WMEMory2 | WMEMory3 | WMEMory4}

**Example:** OUTPUT 707;":FUNCTION2:DIFF WMEMORY4"

## INTEgrate

---

### INTEgrate

### command

The :FUNCTION<N>:INTEGRATE command plots the integral of the specified waveform. The integral is calculated by adding voltage points multiplied by the time bucket width,  $\Delta t$ .

$$I_n = \sum_{i=0}^{n-1} C_i \Delta t$$

The equation calculates the integral of the channel, where I represents the integral and C represents the channel.

**Command Syntax:** :FUNct ion<N>:INTEgrate <operand>

Where:

<N> ::= 1 or 2

<operand> ::= {CHANne11 | CHANne12 | WMEMory1 | WMEMory2 | WMEMory3 | WMEMory4}

**Example:** OUTPUT 707;" :FUNCTION2:INTEGRATE WMEMORY4"

**INVert****INVert****command**

The :FUNCTION <N>:INVERT command inverts the operand.

**Command Syntax:** :FUNCTION<N>:INVert <operand>

**Where:**

<N> ::= 1 or 2

<operand> ::= {CHANne11 | CHANne12 | WMEMory1 | WMEMory2 | WMEMory3 |  
WMEMory4}

**Example:** OUTPUT 707;":FUNCTION2:INVERT WMEMORY3"

## MULTipty

---

### MULTipty

command

The :FUNCTION <N> :MULTIPLY command algebraically multiplies the two defined operands.

**Command Syntax:** :FUNCTION<N>:MULTIPLY <operand>,<operand>

Where:

<N> ::= 1 or 2

<operand> ::= {CHANne11 | CHANne12 | WMEMory1 | WMEMory2 | WMEMory3 | WMEMory4}

**Example:** OUTPUT 707;" :FUNCTION2:MULTIPLY CHANNEL1,CHANNEL2"

**OFFSet****OFFSet****command/query**

The :FUNCTION<N>:OFFSET command sets the voltage represented at the center of the screen for the selected function. The maximum value of offset is plus or minus volts full screen.

The OFFSET query returns the current offset value for the selected function.

**Command Syntax:** :FUNCTION<N>:OFFSet <offset>

**Where:**

<N> ::= 1 or 2  
<offset> ::= offset value (see above)

**Example:** OUTPUT 707;":FUNCTION1:OFFSET 650E-4"

**Query Syntax:** :FUNCTION<N>:OFFSet?

**Where:**

<N> ::= 1 or 2

**Returned Format:** [:FUNCTION<N>:OFFSet] <offset><NL>

**Where:**

<N> ::= 1 or 2  
<offset> ::= offset value (see above) (exponential - NR3 format)

**Example:** DIM Off\$[50]  
OUTPUT 707;":FUNCTION2:OFFSET?"  
ENTER 707;Off\$  
PRINT Off\$

**ONLY****ONLY****command**

The `:FUNCTION<N>:ONLY` command produces another copy of the operand and places it in the specified function. The `ONLY` command is useful for scaling channels and memories with the `:FUNCTION<N>:RANGE` and `:FUNCTION<N>:OFFSET` commands.

**Command Syntax:** `:FUNCTION<N>:ONLY <operand>`

Where:

`<N> ::= 1 or 2`

`<operand> ::= {CHANne11 | CHANne12 | WMEMory1 | WMEMory2 | WMEMory3 | WMEMory4}`

**Example:** `OUTPUT 707;":FUNCTION2:ONLY WMEMORY4"`

**RANGe****RANGe****command/query**

The `:FUNCTION<N>:RANGE` command defines the full scale vertical axis of the selected function.

The `RANGE` query returns the current range setting for the specified function.

**Command Syntax:** `:FUNCTION<N>:RANGE <range>`

**Where:**

`<N>` ::= 1 or 2  
`<range>` ::= full-scale vertical range

**Example:** `OUTPUT 707;":FUNCTION2:RANGE 400 MV"`

**Query Syntax:** `:FUNCTION<N>:RANGe?`

**Where:**

`<N>` ::= 1 or 2

**Returned Format:** `[:FUNCTION<N>:RANGe] <range><NL>`

**Where:**

`<N>` ::= 1 or 2  
`<range>` ::= current range setting (exponential - NR3 format)

**Example:** `DIM Rng$[50]  
OUTPUT 707;":FUNCTION2:RANGe?"  
ENTER 707;Rng$  
PRINT Rng$`

## SUBTRACT

---

### SUBTRACT

command

The :FUNCTION <N>:SUBTRACT command algebraically subtracts operand 2 from operand 1.

**Command Syntax:** :FUNCTION<N>:SUBTRACT <operand1>,<operand2>

Where:

<N> ::= 1 or 2

<operand1> ::= {CHANne11 | CHANne12 | WMEMory1 | WMEMory2 | WMEMory3 | WMEMory4}

<operand2> ::= {CHANne11 | CHANne12 | WMEMory1 | WMEMory2 | WMEMory3 | WMEMory4}

**Example:** OUTPUT 707;":FUNCTION2:SUBTRACT WMEMORY3,WMEMORY2"

In this example, Waveform Memory 2 is algebraically subtracted from Waveform Memory 3.

**VERSus****VERSus****command**

The `:FUNCTION<N>:VERSUS` command allows X vs Y displays with two operands. The first operand defines the Y-axis and the second defines the X-axis. The Y-axis range and offset is initially equal to that of the first operand, and can be adjusted with the `FUNCTION<N>:RANGE` and `FUNCTION<N>:OFFSET` commands.

The X-axis range and offset is always equal to that of the second operand. They can only be changed by changing the vertical settings of the second operand.

**Command Syntax:** `:FUNCTION<N>:VERSUS <Y_operand>,<X_operand>`

**Where:**

`<N> ::= 1 or 2`

`<Y_operand> ::= {CHANne11 | CHANne12 | WMEMory1 | WMEMory2 | WMEMory3 | WMEMory4}`

`<X_operand> ::= {CHANne11 | CHANne12 | WMEMory1 | WMEMory2 | WMEMory3 | WMEMory4}`

**Example:** `OUTPUT 707;":FUNCTION2:VERSUS CHAN1,CHAN2"`



## Hardcopy Subsystem

---

### Introduction

The HARDCOPY subsystem commands set various parameters for printing and plotting waveforms from the HP 54510A.

To actually make the hardcopy print or plot, refer to the root level commands :PRINT and :PLOT for the sequence of bus commands that actually get the data to the printer or plotter.

The Hardcopy subsystem contains the following commands:

- LENGTH
- MODE
- PAGE
- PLOT:AREA
- PLOT:COLor
- PLOT:INITialize

Figure 14-1 lists the syntax diagrams for the Hardcopy subsystem commands.

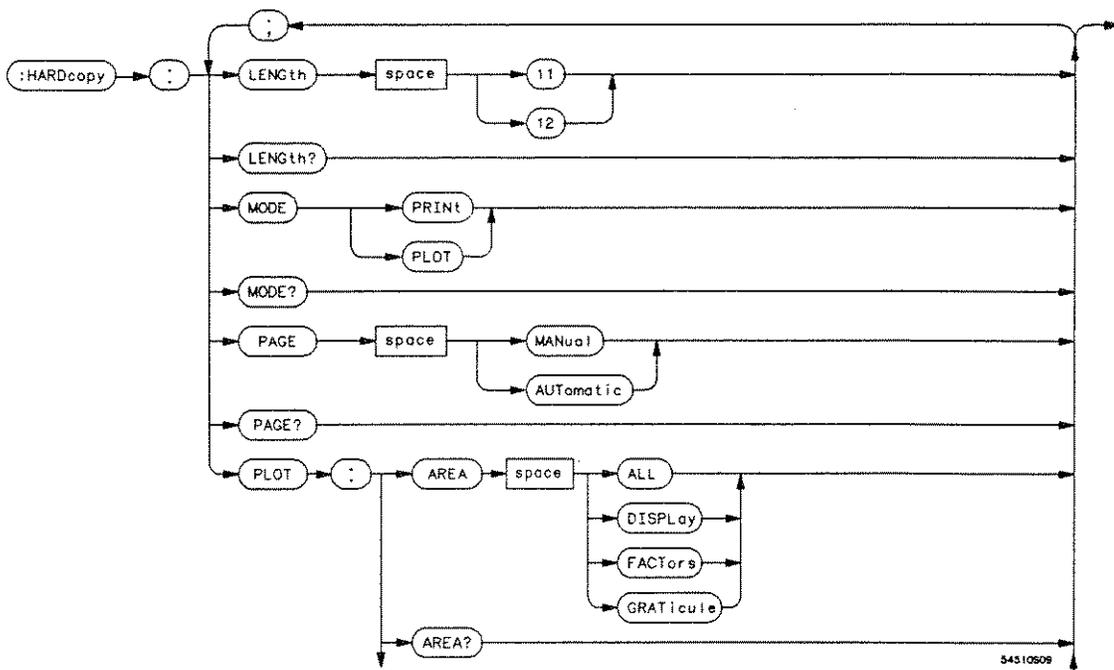
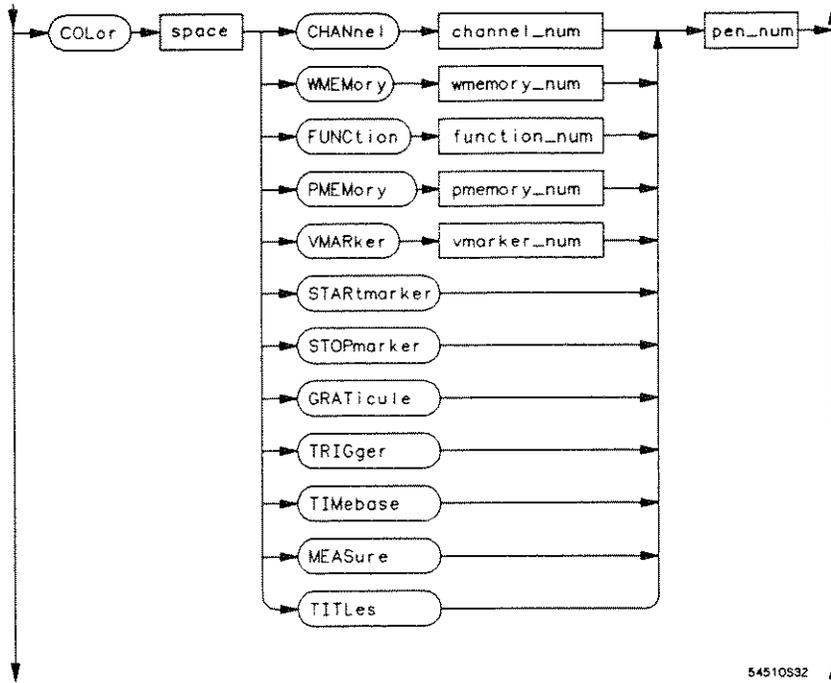
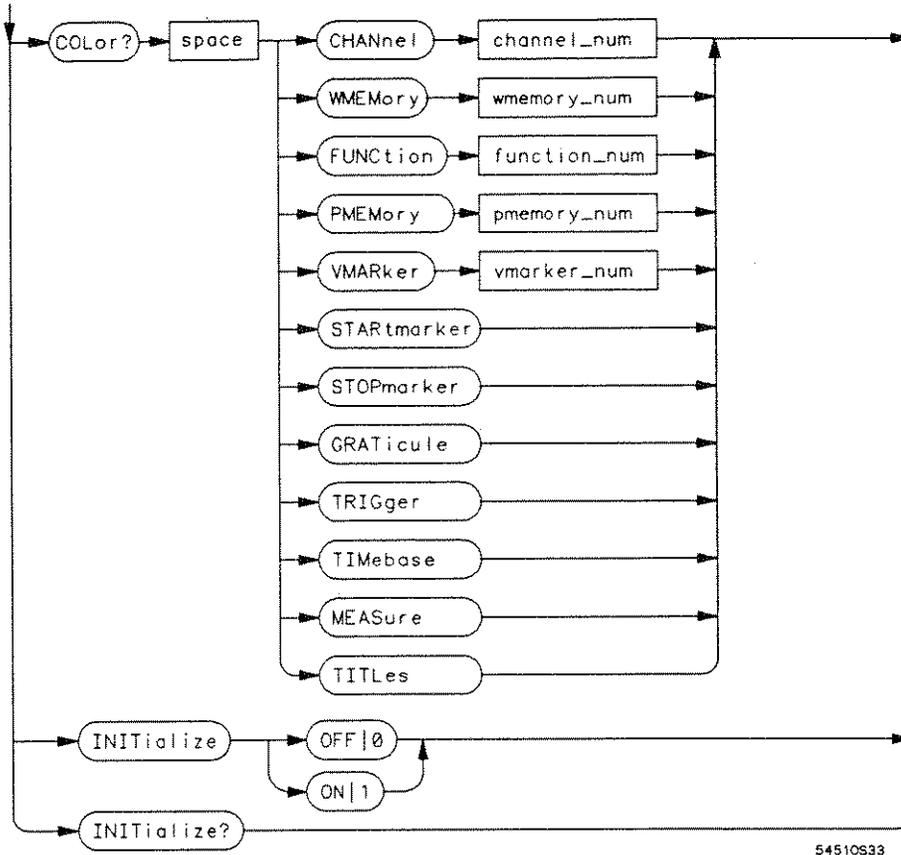


Figure 14-1. Hardcopy Subsystem Commands Syntax Diagram



54510S32

Figure 14-1. Hardcopy Subsystem Commands Syntax Diagram (continued)



54510S33

- channel\_num =** an integer, 1 or 2.
- function\_num =** an integer, 1 or 2.
- pen\_num =** an integer, 0 to 8.
- pmemory\_num =** an integer, 1 or 2.
- vmarker\_num =** an integer, 1 or 2.
- wmemory\_num =** an integer, 1 to 4.

Figure 14-1. Hardcopy Subsystem Commands Syntax Diagram (continued)

**LENGTH****LENGTH****command/query**

The **:HARDCOPY:LENGTH** command sets the length of the page to either 11 inches or 12 inches.

The **LENGTH** query returns the current length setting.

**Command Syntax:** `:HARDCopy:LENGTH {11 | 12}`

**Example:** `OUTPUT 707;":HARDCOPY:LENGTH 12"`

**Query Syntax:** `:HARDCopy:LENGTH?`

**Returned Format:** `[[:HARDCopy:LENGTH] {11 | 12}<NL>`

**Example:**  
`DIM Lgth$[50]  
OUTPUT 707;":HARDCOPY:LENGTH?"  
ENTER 707;Lgth$  
PRINT Lgth$`

## MODE

---

### MODE

### command/query

The `:HARDCOPY:MODE` command sets the HP-IB device mode for a printer or plotter output.

The `MODE` query returns the current setting of the `MODE` command.

**Command Syntax:** `:HARDCopy:MODE {PRINT | PLOT}`

**Example:** `OUTPUT 707;":HARD:MODE PRINT"`

**Query Syntax:** `:HARDCopy:MODE?`

**Returned Format:** `[[:HARDCopy:MODE] {PRINT | PLOT}<NL>`

**Example:**  
`DIM Md$[30]  
OUTPUT 707;":HARDCOPY:MODE?"  
ENTER 707;Md$  
PRINT Md$`

**PAGE****PAGE****command/query**

The `:HARDCOPY:PAGE` command configures the HP 54510A to send a formfeed to the printer after it outputs a hardcopy.

If the `PAGE` command is set to `AUTOMATIC`, a formfeed occurs at the end of the hardcopy; otherwise, the page scrolls up by 4 lines.

The `PAGE` query returns the current state of the `PAGE` command.

**Command Syntax:** `:HARDCOPY:PAGE {MANUAL | AUTOMATIC}`

**Example:** `OUTPUT 707;":HARD:PAGE AUT"`

**Query Syntax:** `:HARDCOPY:PAGE?`

**Returned Format:** `[[:HARDCOPY:PAGE] {MANUAL | AUTOMATIC}<NL>`

**Example:**  
`DIM Pg$[30]`  
`OUTPUT 707;":HARDCOPY:PAGE?"`  
`ENTER 707;Pg$`  
`PRINT Pg$`

## PLOT:AREA

---

### PLOT:AREA

### command/query

The :HARDCOPY:PLOT:AREA command selects the area to be plotted.

The PLOT:AREA query returns the current selection for the PLOT:AREA command.

**Command Syntax:** :HARDCOPY:PLOT:AREA {ALL | DISPLAY | FACTORS | GRATICULE}

**Example:** OUTPUT 707;":HARD:PLOT:AREA ALL"

**Query Syntax:** :HARDCOPY:PLOT:AREA?

**Returned Format:** [:HARDCOPY:PLOT:AREA] {ALL | DISPLAY | FACTORS | GRATICULE}<NL>

**Example:**  
DIM P1\$[50]  
OUTPUT 707;":HARDCOPY:PLOT:AREA?"  
ENTER 707;P1\$  
PRINT P1\$

**PLOT:COLor****PLOT:COLor****command/query**

The **:HARDCOPY:PLOT:COLOR** command selects the plotter pen to plot individual items on the screen. By selecting the appropriate plotter pen, you can plot different items on the screen in different colors to distinguish them from each other. Pen numbers 1 through 8 select the corresponding pins on the plotter. Pen number 0 returns the plotter pen to its carousel without plotting the selected item.

The **PLOT:COLOR** query returns the current pen selection for an individual item on the screen.

**Command Syntax:** `:HARDcopy:PLOT:COLor <item>,<pen_number>`

Where:

`<item> ::= {CHANnel{1 | 2} | WMEMory{1 | 2 | 3 | 4} | FUNction{1 | 2} | PMEMory{1 | 2} | VMARKer{1 | 2} | STARTmarker | STOPmarker | GRATICule | TRIGger | TIMEbase | MEASure | TITLes}`

`<pin_number> ::= 0 through 8`

**Example:** `OUTPUT 707;":HARD:PLOT:COLOR CHANNEL1,2"`

**Query Syntax:** `:HARDcopy:PLOT:COLor? <item>`

**Returned Format:** `[[:HARDcopy:PLOT:COLor] <pen_number><NL>`

Where:

`<item> ::= {CHANnel{1 | 2} | WMEMory{1 | 2 | 3 | 4} | FUNction{1 | 2} | PMEMory{1 | 2} | VMARKer{1 | 2} | STARTmarker | STOPmarker | GRATICule | TRIGger | TIMEbase | MEASure | TITLes}`

`<pen_number> ::= 0 through 8 (integer - NR1)`

**Example:** `DIM P1$[50]  
OUTPUT 707;":HARDCOPY:PLOT:COLOR? CHANNEL1"  
ENTER 707;P1$  
PRINT P1$`

## PLOT:INITialize

---

### PLOT:INITialize

### command/query

The :HARDCOPY:PLOT:INITialize command sets the plotter to a known state. Sending the command :HARDCOPY:PLOT:INITIALIZE ON sends the "IN" command to the plotter which sets P1 and P2 to the default value. Sending the command :HARDCOPY:PLOT:INITIALIZE OFF sends the "DF" command to the plotter and does not set P1 and P2 to the default value.

The PLOT:INITIALIZE query returns the current setting of the command.

**Command Syntax:** :HARDCopy:PLOT:INITiaIize {{ON | 1} | {OFF | 0}}

**Example:** OUTPUT 707;":HARD:PLOT:INITIALIZE ON"

**Query Syntax:** :HARDCopy:PLOT:INITiaIize?

**Returned Format:** [:HARDCopy:PLOT:INITiaIize] {1 | 0}<NL>

**Example:**  
DIM P1\$[50]  
OUTPUT 707;":HARDCOPY:PLOT:INIT?"  
ENTER 707;P1\$  
PRINT P1\$

## Measure Subsystem

### Introduction

The commands in the MEASURE subsystem are used to make parametric measurements on displayed waveforms and to report the settings of the voltage and time markers. Some commands in this subsystem can be used to set the voltage and time markers to specified voltages, times, or events.

The Measure subsystem contains the following commands:

- ALL
- COMPare
- CURSor
- DEFine
- DELay
- DESTination
- DUTYcycle
- ESTart
- ESTop
- FALLtime
- FREQuency
- LIMittest
- LOWer
- MODE
- NWIDth
- OVERshoot
- PERiod
- POSTfailure
- PREShoot
- PWIDth
- RESults
- RISetime
- SCRatch
- SOURce
- STATistics
- TDELta
- TMAX
- TMIN
- TSTart
- TSTop
- TVOLT
- UNITs
- UPPer
- VACRms
- VAMPLitude
- VAVerage
- VBASE
- VDCRms
- VDELta
- VFIFty
- VMAX
- VMIN
- VPP
- VRELative
- VRMS
- VSTart
- VSTop
- VTIMe
- VTOP

Figure 15-1 lists the syntax diagrams for the Measure subsystem commands.

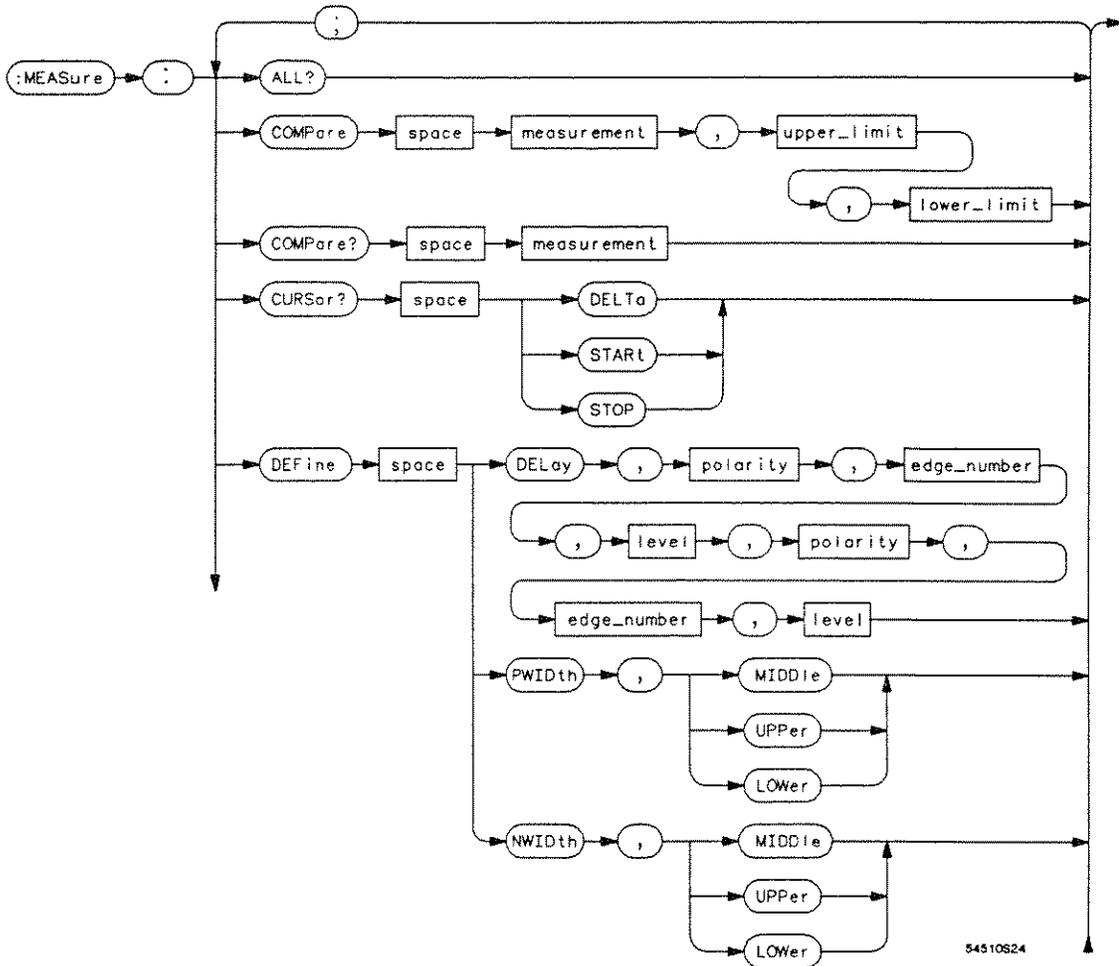


Figure 15-1. Measure Subsystem Commands Syntax Diagram

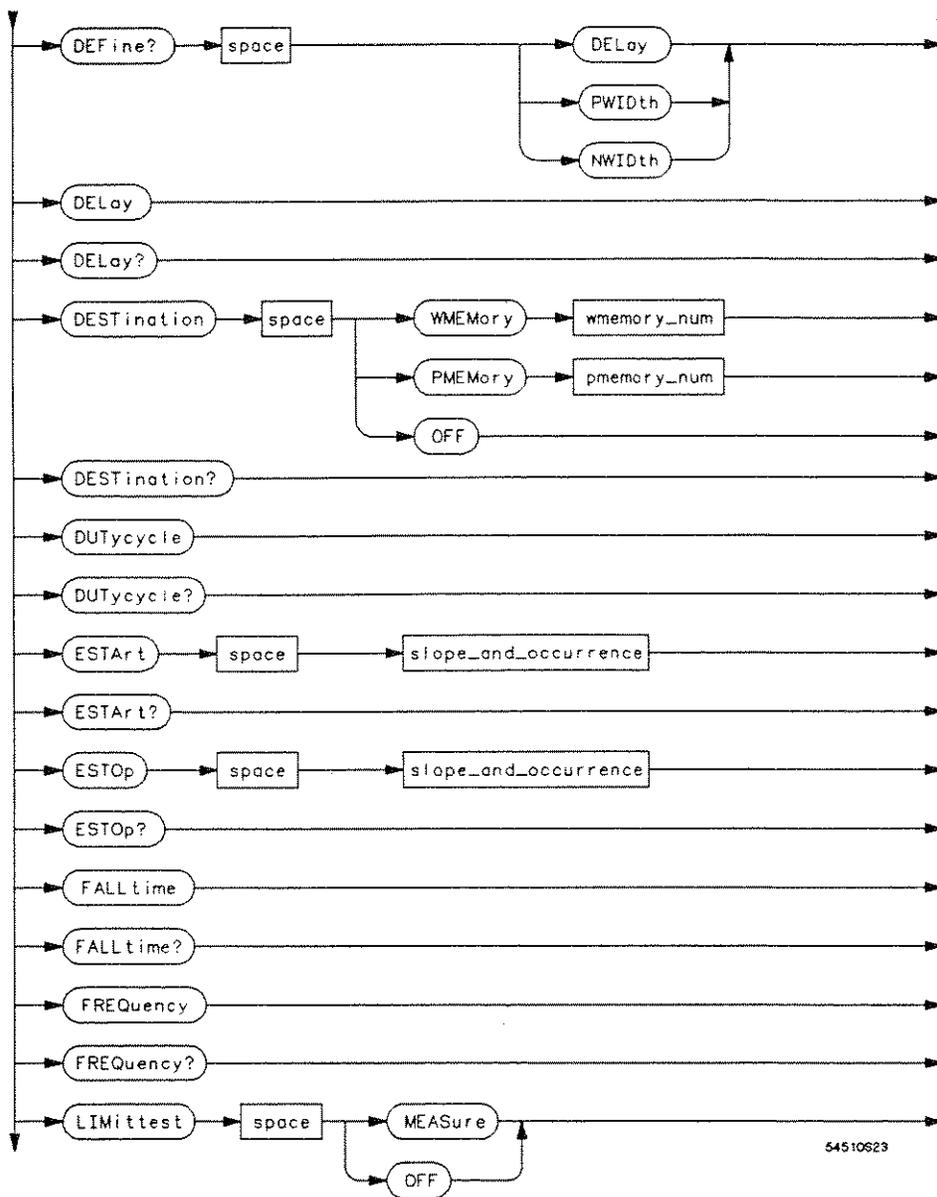


Figure 15-1. Measure Subsystem Commands Syntax Diagram (continued)

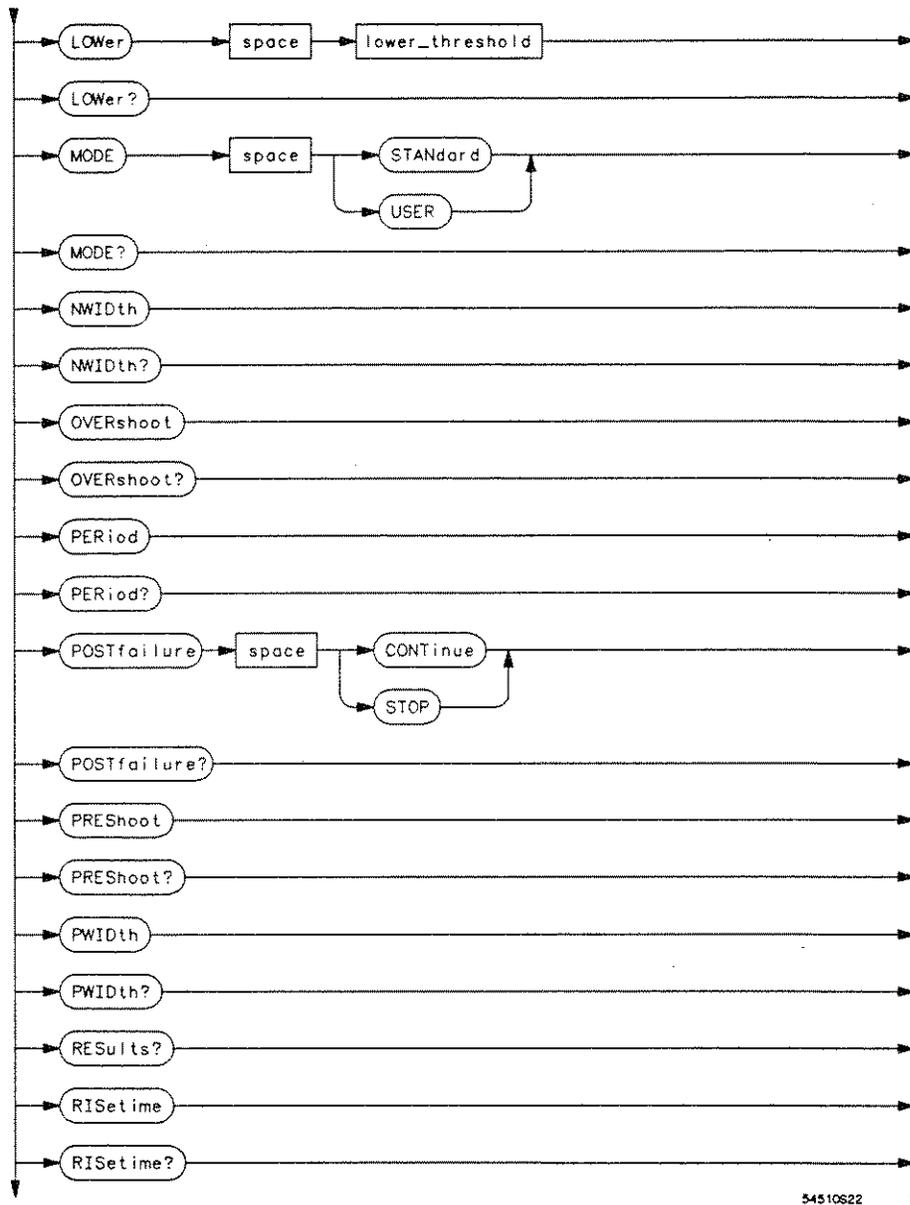


Figure 15-1. Measure Subsystem Commands Syntax Diagram (continued)

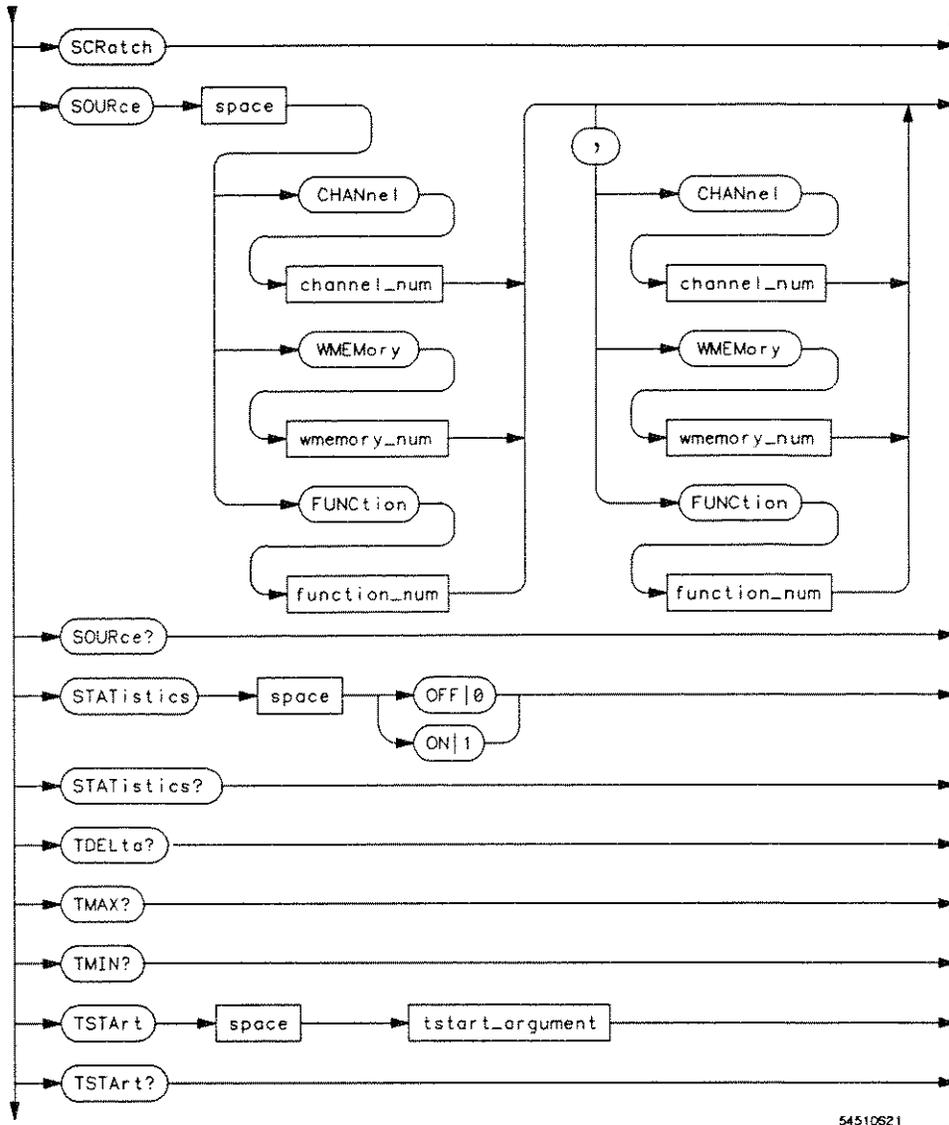


Figure 15-1. Measure Subsystem Commands Syntax Diagram (continued)

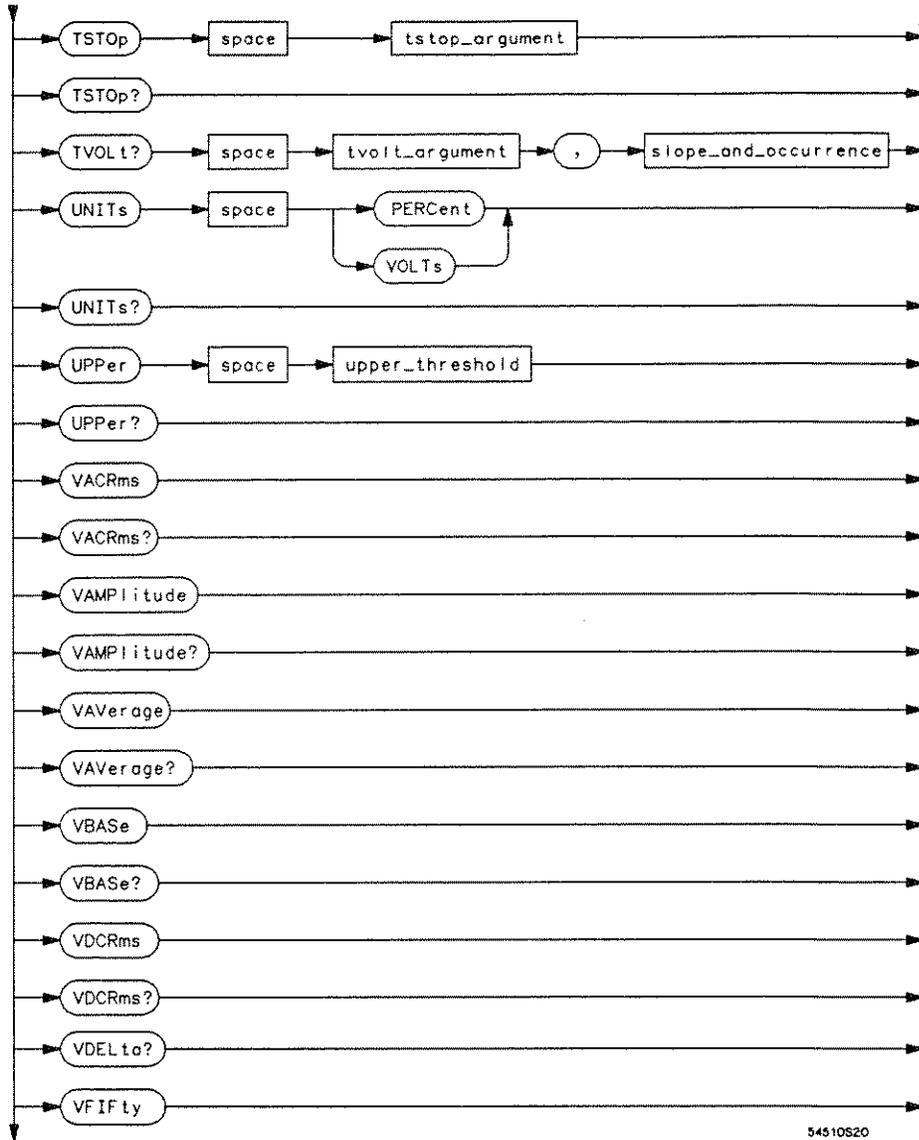


Figure 15-1. Measure Subsystem Commands Syntax Diagram (continued)

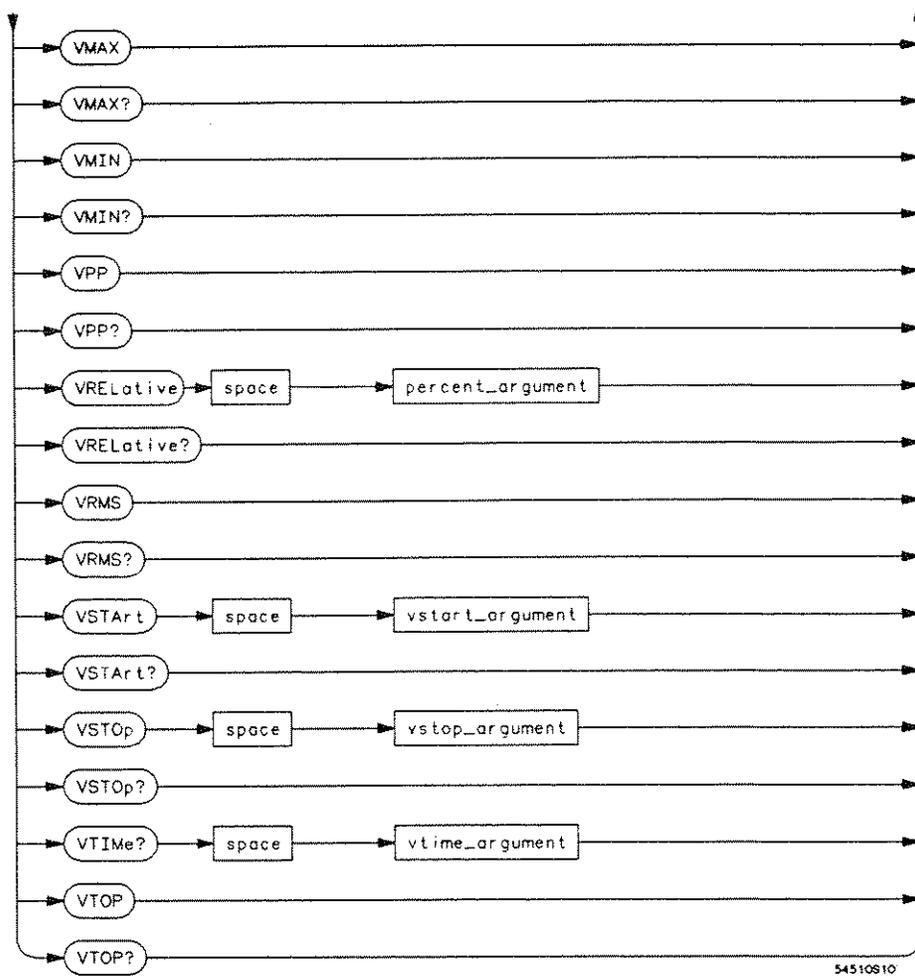


Figure 15-1. Measure Subsystem Commands Syntax Diagram (continued)

<b>channel_num =</b>	an integer, 1 or 2.
<b>edge_number =</b>	an integer, 1 to 4000.
<b>function_num =</b>	an integer, 1 or 2.
<b>level =</b>	MIDDle, UPPer, or LOWer.
<b>lower_limit =</b>	lower limit for compare.
<b>lower_threshold =</b>	lower threshold value in percent or volts.
<b>measurement =</b>	name of the measurement to be compared.
<b>percent_argument =</b>	an integer, 0 to 100.
<b>pmemory_num =</b>	an integer, 1 or 2.
<b>polarity =</b>	POSitive or NEGative.
<b>slope_and_occurrence =</b>	an integer, -4000 to 4000 (excluding 0) specifying a displayed edge.
<b>tstart_argument =</b>	time in seconds from the trigger.
<b>tstop_argument =</b>	time in seconds from the trigger.
<b>tvolt_argument =</b>	a real number specifying voltage.
<b>upper_limit =</b>	upper limit for compare.
<b>upper_threshold =</b>	upper threshold value in percent or volts.
<b>vstart_argument =</b>	a real number within the voltage range.
<b>vstop_argument =</b>	a real number within the voltage range.
<b>vtime_argument =</b>	a real number in the horizontal display window.
<b>wmemory_num =</b>	an integer, 1 through 4.

Figure 15-1. Measure Subsystem Commands Syntax Diagram (continued)

---

## Measurement Setup

To make a measurement, the portion of the waveform required for that measurement must be displayed on the oscilloscope:

- For a period or frequency measurement, at least one complete cycle must be displayed.
- For a pulse width measurement, the entire pulse must be displayed.
- For a rise time measurement, the leading (positive-going) edge of the waveform must be displayed.
- For a fall time measurement, the trailing (negative-going) edge of the waveform must be displayed.

---

## User-Defined Measurements

When User-Defined Measurements are made, the defined parameters must be set before actually sending the measurement command or query.

In User-Defined Measurements, the mid-threshold is the mid point between the upper and lower threshold when the lower threshold value is less than the upper threshold value.

---

## Measurement Error

If a measurement cannot be made (typically because the proper portion of the waveform is not displayed), the value +9.99999E+37 is returned for that parameter.

---

## Making Measurements

If more than one waveform, edge, or pulse is displayed, time measurements are made on the first (left-most) portion of the displayed waveform.

When any of the defined measurements are requested, the oscilloscope first determines the top (100%) and base (0%) voltages of the waveform. From this information, it can determine the other important voltage values (10%, 90%, and 50% voltage values) for making measurements.

The 10% and 90% voltage values are used in the rise time and fall time measurements when standard measurements are selected. The 50% voltage value is used for measuring frequency, period, pulse width, and duty cycle with standard measurements selected.

The measurements can also be made using user-defined parameters instead of the standard measurement values.

When the command form of the preshoot measurement, overshoot measurement, or front-panel measurements is used, the instrument is placed into the continuous measurement mode. When the query form of these measurements is used, the continuous measurement mode is turned off. Then the measurement is made one time, and the measurement result is returned.

Except for VAVERAGE, VRMS, VACRMS, and VDCRMS measurements, which use only one cycle, voltage measurements are made using the entire display. Therefore, if you want to make a measurement on a particular cycle, display only that cycle on the screen.

All voltage values are returned in volts. Returned voltage values are measured with zero volts as the reference. The value returned for the VDELTA? query is the difference between VMarker 1 and VMarker 2 in volts.

All time values are returned in seconds. Returned time values are measured with the trigger point (time 0) as the reference. The value returned for TDELTA? is the time difference between the stop and start markers.

Measurements are made on the displayed waveforms specified by the SOURCE command. The SOURCE command allows two sources to be specified. When two sources are specified, VMarker 1 is assigned to the first specified source and VMarker 2 is assigned to the second specified source.

Most measurements can only be made on a single source. If one of these measurements is made with two sources specified, the measurement is made on the first source specified. VDELTA is the only measurement that uses two sources.

If the horizontal scaling is questionable, an "error 11" is placed in the error queue. In this case, the value returned is the most accurate value that can be made using the current scaling. You might be able to obtain a more accurate measurement by rescaling the horizontal to obtain more data points on the edge.

For more information about measurement algorithms, refer to chapter 21, "Algorithms."

**ALL****ALL****query**

The `:MEASURE:ALL` query makes a set of measurements on the displayed signal and buffers the measurement results for output over the HP-IB.

To make a measurement, the portion of the waveform required for the measurement must be displayed. Time measurements are made on the first (left-most) displayed edges of the waveforms. To obtain the most accurate measurement possible, use proper horizontal scaling.

Refer to the individual commands for information on how the measurements are made and how the measurement results are returned.

**Query Syntax:** `:MEASure:ALL?`

**Returned Format:** `[.MEASure:FREquency] <result>; [PERiod] <result>; [PWIDth] <result>; [NWIDth] <result>; [RISetime] <result>; [FALLtime] <result>; [VAMPplitude] <result>; [VPP] <result>; [PREShoot] <result>; [OVERshoot] <result>; [DUTycycle] <result>; [VRMS] <result>; [VMAX] <result>; [VMIN] <result>; [VTOP] <result>; [VBASe] <result>; [VAverage] <result><NL>`

**Where:**

`<result> ::= individual measurement results (exponential - NR3 format)`

**Example:**

```
DIM A$[500]
OUTPUT 707;" :MEASURE:ALL?"
ENTER 707;A$
PRINT A$
```

**Note** 

These values can be returned to numeric variables instead of the string variables as shown. If numeric variables are used, the headers must be turned off.

**COMPare****COMPare****command/query**

The :MEASURE:COMPARE command specifies the measurement and limits to be used for the measurement comparison (limit test). The first limit is the upper limit, the second is the lower limit.

This command does not start the test, but only sets the test parameters.

The COMPARE query returns the current specification.

**Command Syntax:** :MEASure:COMPare <measurement>,<upper\_limit>,<lower\_limit>

Where:

<measurement> ::= {RISetime | FALLtime | FREQuency | PERiod | PWIDTH |  
MWIDTH | VAMPplitude | VBASe | VTOP | VPP | VAverage | VMAX | VMIN | VRMS |  
DUTYcycle | DELay}

<upper\_limit> ::= high limit value.

<lower\_limit> ::= low limit value.

**Note**

The suffix "HZ" can be used when setting the limits for FREQUENCY.

**Example:** OUTPUT 707;":MEASURE:COMPARE RISETIME,10ns,2ns"

## COMPare

---

**Query Syntax:** :MEASure:COMPare? <measurement>

**Where:**

<measurement> ::= {RISetime | FALLtime | FREQuency | PERiod | PWIDth |  
 NWIDTH | VAMPplitude | VBASe | VTOP | VPP | VAverage | VMAX | VMIN | VRMS |  
 DUTYcycle | DELAY}

**Returned Format:** [:MEASure:COMPare] <measurement>, <upper\_limit>, <lower\_limit><NL>

**Example:**  
 DIM Cmp\$[50]  
 OUTPUT 707;":MEASure:COMPare? VPP"  
 ENTER 707;Cmp\$  
 PRINT Cmp\$

For example, the sequence required to do a limit test on frequency is:

```
OUTPUT 707;":MEASURE:SCRATCH" !clear measurements
OUTPUT 707;":MEASURE:FREQ"!Select measurement
OUTPUT 707;":MEASURE:COMPARE FREQ,1000HZ,10HZ"!Set measurement limits
OUTPUT 707;":MEASURE:LIMITTEST MEASURE"!Start test
OUTPUT 707;":RUN" !start acquisition
```

When a limit test failure occurs, bit 3 of the status byte is set to a 1.

**CURSOR****CURSOR****query**

The :MEASURE:CURSOR query returns the time and voltage values of the specified marker as an ordered pair of time/voltage values.

- If DELTA is specified, the instrument returns the value of delta V and delta T.
- If START is specified, the positions of the start marker and VMarker 1 are returned.
- If STOP is specified, the positions of the stop marker and VMarker 2 are returned.

When the CURSOR query is sent, no measurement is made and the cursors are not moved.

**Query Syntax:** :MEASure:CURSor? {DELTA | START | STOP}

**Returned Format:** [:MEASure:CURSor] <time>,<voltage><NL>

**Where:**

<time> ::= delta time, start time, or stop time

<voltage> ::= delta voltage, VMarker 1 voltage, or VMarker 2 voltage

**Example:** OUTPUT 707;":MEAS:SOURCE CHAN1" !select measurement source  
 OUTPUT 707;":MEAS:CURSOR? START"  
 ENTER 707;Tme,V1t  
 PRINT Tme,V1t

## DEFine

---

### DEFine

### command/query

The `:MEASURE:DEFINE` command defines the setup for a measurement.

The `DEFINE` query returns the current setup.

**Command Syntax:** `:MEASure:DEFine <measurement_spec>`

Where:

`<measurement_spec> ::= {DELAY, <polarity>, <edge_number>, <level>, <polarity>, <edge_number>, <level> | PWIDTH, <level> | MWIDth, <level>}`

Where:

`<polarity> ::= {POSitive | NEGative}`  
`<edge_number> ::= an integer, 1 to 4000 specifying a displayed edge`  
`<level> ::= {MIDDLE | UPPER | LOWER}`

**Example:** `OUTPUT 707;":MEAS:DEFINE DELAY,POSITIVE,1,UPPER,NEGATIVE,2,MIDDLE"`

This example sets the parameters for a time measurement from the first positive edge at the upper threshold level to the second negative edge at the middle threshold. If one source is specified, both parameters apply to that signal. If two sources are specified, the measurement is from the first positive edge on source 1 to the second negative edge on source 2.

---

## DEFine

**Query Syntax:** :MEASure:DEFine? {DELay | PWIDTH | NWIDTH}

**Returned Format:** [:MEASure:DEFine] <measurement\_spec><NL>

**Where:**

<measurement\_spec> ::= {DELay, <polarity>, <edge\_number>, <level>,  
<polarity>, <edge\_number>, <level> | PWIDTH, <level> | NWIDTH, <level>}

**Where:**

<polarity> ::= {POSitive | NEGative}  
<edge\_number> ::= 1 to 4000 (integer - NR1 format)  
<level> ::= {MIDDLE | UPPER | LOWER}

**Example:**

```
DIM Dfn$[100]
OUTPUT 707;" :MEASURE:DEFINE? DELAY"
ENTER 707;Dfn$
PRINT Dfn$
```

## DElAy

---

### DElAy

### command/query

The :MEASURE:DELAY command determines the delay from the first specified edge on one source to the next specified edge on the same source, or to the first specified edge on another source.

One or two sources can be specified with the :MEASURE:SOURCE command.

If user-defined measurement specifications are selected, make sure the defined measurement is displayed.

The DELAY query returns the specified delay value.

**Command Syntax:** :MEASure:DElAy

**Example:** OUTPUT 707;" :MEAS:DEL"

**Query Syntax:** :MEASure:DElAy?

**Returned Format:** [:MEASure:DElAy] <delay\_value><NL>

**Where:**

<delay\_value> ::= time value in seconds (exponential - NR3 format)

**Example:**  
DIM D1y\$[50]  
OUTPUT 707;" :MEASURE:DELAY?"  
ENTER 707;D1y\$  
PRINT D1y\$

**DESTination****DESTination****command/query**

The :MEASURE:DESTINATION command specifies the destination to be used when a comparison violation is found.

If a waveform memory is specified, the memory is overwritten each time a violation is found.

The DESTINATION query returns the destination currently specified.

**Note**

If waveform memories (WMEMORY 1 through 4) are used as the destination, the source must be set up separately using the WAVEFORM:SOURCE command.

**Command Syntax:** :MEASure:DESTination {WMEMory{1 | 2 | 3 | 4} | PMEMory{1 | 2} | OFF}

**Example:** OUTPUT 707;":MEAS:DEST PMEMORY2"

**Query Syntax:** :MEASure:DESTination?

**Returned Format:** [:MEASure:DESTination] {WMEMory{1 | 2 | 3 | 4} | PMEMory{1 | 2} | OFF}<NL>

**Example:** DIM Dst\$[50]  
OUTPUT 707;":MEAS:DEST?"  
ENTER 707;Dst\$  
PRINT Dst\$

## DUTycycle

---

### DUTycycle

### command/query

The `:MEASURE:DUTYCYCLE` command places the instrument in the continuous measurement mode and starts the duty cycle measurement.

The `DUTYCYCLE` query measures and outputs the duty cycle of the signal specified by the `SOURCE` command. The signal must be displayed for the measurement to be made. The value returned for duty cycle is the ratio of the positive pulse width to the period.

The positive pulse width and the period of the specified signal are measured, then the duty cycle is calculated with the following formula:

$$\text{duty cycle} = + \text{pulse width/period}$$

**Command Syntax:** `:MEASure:DUTycycle`

**Example:** `OUTPUT 707;":MEASURE:DUTYCYCLE"`

**Query Syntax:** `:MEASure:DUTycycle?`

**Returned Format:** `[[:MEASure:DUTycycle] <value><NL>`

#### Where:

`<value>` ::= ratio of positive pulse width to period (exponential - NR3 format)

**Example:** `DIM Dc$[50]  
OUTPUT 707;":MEASURE:DUTYCYCLE?"  
ENTER 707;Dc$  
PRINT Dc$`

**ESTArt****ESTArt****command/query**

The :MEASURE:ESTART command positions the start marker on the specified edge and slope of the displayed waveform. All edges must be displayed and are counted from the left edge of the display. The start marker is positioned where VMarker 1 intersects the waveform. The desired edge is specified by sending an integer value after the command name. If a positive integer is sent, the start marker is placed on a positive-going waveform edge. If a negative integer is sent, the start marker is placed on a negative-going waveform edge. If VMarker 1 does not intersect the waveform as specified, the error message "Edges required not found" is displayed.

The ESTART query returns the currently specified edge.

**Note**

The short form of this command, ESTA, does not follow the defined short form convention. The normal short form "EST" is the same for ESTART and ESTOP. Sending EST for the ESTART command produces an error.

**Command Syntax:** :MEASure:ESTArt <edge>

**Where:**

<edge> ::= -4000 to 4000 excluding 0 (if a positive value is sent the + sign may be omitted or a space may be used)

**Example:** OUTPUT 707;":MEASURE:ESTART 2"

This example places the start marker at the second displayed positive-going intersection of the waveform and VMarker 1.

## ESTart

---

**Query Syntax:** :MEASure:ESTart?

**Returned Format:** [:MEASure:ESTart] <edge><NL>

**Where:**

<edge> ::= edge number (integer - NR1 format)

**Example:** OUTPUT 707;":MEAS:ESTART?"  
ENTER 707;Value  
PRINT Value

**ESTOp****ESTOp****command/query**

The :MEASURE:ESTOP command positions the stop marker on the specified edge and slope of the displayed waveform. All edges must be displayed and are counted from the left edge of the display. The stop marker is positioned where VMarker 2 intersects the waveform. The desired edge is specified by sending an integer value after the command name. If a positive integer is sent, the oscilloscope places the stop marker on a positive-going waveform edge. If a negative integer is sent, the stop marker is placed on a negative-going waveform edge.

If VMarker 2 does not intersect the waveform as specified, the error message "Edges required not found" is displayed.

The ESTOP query returns the currently specified edge.

**Note**

The short form of this command, ESTO, does not follow the defined short form convention. The normal short form "EST" is the same for ESTART and ESTOP. Sending EST for the ESTOP command produces an error.

**Command Syntax:** :MEASure:ESTOp <edge>

Where:

<edge> ::= -4000 to 4000 excluding 0 (if a positive value is sent the + sign may be omitted or a space may be used)

**Example:** OUTPUT 707;":MEAS:ESTOP -2"

This example places the stop marker at the second displayed negative-going intersection of the waveform and VMarker 2.

## ESTOp

---

**Query Syntax:** :MEASure:ESTOp?

**Returned Format:** [:MEASure:ESTOp] <edge><NL>

**Where:**

<edge> ::= edge number (integer - NR1 format)

**Example:** OUTPUT 707;":MEASURE:ESTOP?"  
ENTER 707;Value  
PRINT Value

**FALLtime****FALLtime****command/query**

The **:MEASURE:FALLTIME** command places the instrument in the continuous measurement mode and starts a fall time measurement.

The **FALLTIME** query measures and outputs the fall time of the first displayed falling (negative-going) edge. For highest measurement accuracy, set the sweep speed as fast as possible while leaving the falling edge of the waveform on the display. The fall time is determined by measuring the time at the upper threshold of the falling edge, then measuring the time at the lower threshold of the falling edge and calculating the fall time with the following formula:

$$\text{fall time} = \text{time at lower threshold point} - \text{time at upper threshold point.}$$

If the horizontal scaling is questionable when this measurement is made, an "error 11" is placed in the error queue.

**Command Syntax:** `:MEASure:FALLtime`

**Example:** `OUTPUT 707;":MEAS:FALL"`

**Query Syntax:** `:MEASure:FALLtime?`

**Returned Format:** `[ :MEASure:FALLtime ] <value><NL>`

**Where:**

`<value>` ::= time in seconds between lower threshold and upper threshold voltage points (exponential - NR3 format)

**Example:**

```
DIM F11$(50)
OUTPUT 707;":MEASURE:FALLTIME?"
ENTER 707;F11$
PRINT F11$
```

## FREQuency

---

### FREQuency

### command/query

The :MEASURE:FREQUENCY command places the instrument in the continuous measurement mode and starts a frequency measurement.

The FREQUENCY query measures and outputs the frequency of the first complete cycle on the screen. This command uses the 50% levels when Standard measurements are selected and the mid-threshold value when User-Defined measurements are selected.

The algorithm is:

```

if first edge on screen is rising
then
frequency = 1/(time at second rising edge – time at first rising
edge)
else
frequency = 1/(time at second falling edge – time at first falling
edge)

```

**Command Syntax:** :MEASure:FREQuency

**Example:** OUTPUT 707;":MEASURE:FREQ"

**Query Syntax:** :MEASURE:FREQuency?

**Returned Format:** [:MEASure:FREQuency] <va lue><NL>

**Where:**

<value> ::= frequency in Hertz (exponential - NR3 format)

**Example:** DIM Frq\$[50]  
 OUTPUT 707;":MEASURE:FREQUENCY?"  
 ENTER 707;Frq\$  
 PRINT Frq\$

**LIMittest****LIMittest****command**

The `:MEASURE:LIMITTEST` command is used to start or stop a limit test. To perform a limit test, the following conditions must be satisfied:

- The measurement must be selected.
- The measurement comparison must be specified.
- The instrument must be acquiring data.

If `LIMITTEST` is sent with the `MEASURE` parameter, then the instrument starts the test. If the `OFF` parameter is sent, the test is stopped.

The LTF (limit test failure) bit of the status byte is set when a failure is found. This bit can be read with a `*STB?` or `LTER?` query, or by doing an HP-IB Serial Poll. The `*STB?` query does not clear the bit, and the results require some additional evaluation. Where as, the `LTER?` query returns the actual value of the bit and clears the bit so that the next limit test failure can be monitored. For greater speed, the `*SRE` command can be used in conjunction with an HP-IB Serial Poll. For more information, refer to the individual commands, queries, or functions.

**Command Syntax:** `:MEASure:LIMittest {MEASure | OFF}`

**Example:**

```
OUTPUT 707;":MEASURE:RISETIME"      !Select measurement
OUTPUT 707;":MEASURE:COMPARE RISETIME,10NS,2NS" !Specify measurement limits
OUTPUT 707;":RUN"                    !Acquire data
OUTPUT 707;":MEAS:LIM MEAS"
```

## LOWer

---

### LOWer

### command/query

The `:MEASURE:LOWER` command sets the lower measurement threshold. This command sends a value to the instrument in the units selected with the `UNITS` command.



Set the measurement units with the `:MEASURE:UNITS` command prior to sending the lower threshold value.

The `LOWER` query returns the current setting of the lower measurement threshold.

**Command Syntax:** `:MEASure:LOWer <lower_threshold>`

Where:

`<lower_threshold>` ::= user defined lower threshold in percent or volts

**Example:** `OUTPUT 707;":MEASURE:LOWER 47"`

**Query Syntax:** `:MEASure:LOWer?`

**Returned Format:** `[:MEASure:LOWer] <lower_threshold><NL>`

Where:

`<lower_threshold>` ::= user defined lower threshold in percent or volts

**Example:**

```
DIM Lwr$[50]
OUTPUT 707;":MEAS:LOW?"
ENTER 707;Lwr$
PRINT Lwr$
```

**MODE****MODE****command/query**

The **:MEASURE:MODE** command selects standard or user-defined definitions and thresholds for voltage and time measurements.

The **MODE** query returns the current measurement mode setting.

**Command Syntax:** `:MEASure:MODE {STANdard | USER}`

**Example:** `OUTPUT 707;":MEAS:MODE STAN"`

**Query Syntax:** `:MEASure:MODE?`

**Returned Format:** `[ :MEASure:MODE ] {STANdard | USER}<NL>`

**Example:**  
`DIM Md$ [50]  
OUTPUT 707;":MEASURE:MODE?"  
ENTER 707;Md$  
PRINT Md$`

## NWIDth

---

### NWIDth

### command/query

The :MEASURE:NWIDTH command places the instrument in the continuous measurement mode and starts an NWIDTH measurement.

If Standard measurements are selected, the NWIDTH query measures and outputs the width of the first negative pulse on the screen using the 50% levels.

If User Defined measurements are selected, the measurement is made at the mid-threshold value.

The algorithm is:

```

if the first edge on screen is rising
then
width = (time at second rising edge – time at first falling edge)
else
width = (time at first rising edge – time at first falling edge)

```

**Command Syntax:** :MEASure:NWIDth

**Example:** OUTPUT 707;":MEAS:NWIDTH"

**Query Syntax:** :MEASure:NWIDth?

**Returned Format:** [:MEASure:NWIDth] <value><NL>

**Where:**

<value> ::= negative pulse width in seconds (exponential - NR3 format)

**Example:**

```

DIM Nwd$ [50]
OUTPUT 707;":MEASURE:NWIDTH?"
ENTER 707;Nwd$
PRINT Nwd$

```

**OVERshoot****OVERshoot****command/query**

The :MEASURE:OVERSHOOT command places the instrument in the continuous measurement mode and selects the overshoot measurement.

The OVERSHOOT query measures and outputs the overshoot of the first displayed edge of the selected signal. Overshoot is measured with the following algorithm:

```

if the first edge on screen is rising
then
  overshoot = (Vmax - Vtop)/Vamplitude
else
  overshoot = (Vbase - Vmin)/Vamplitude

```

**Command Syntax:** :MEASure:OVERshoot

**Example:** OUTPUT 707;":MEAS:OVER"

**Query Syntax:** :MEASure:OVERshoot?

**Returned Format:** [:MEASure:OVERshoot] <value><NL>

**Where:**

<value> ::= ratio of overshoot to Vamplitude (exponential - NR3 format)

**Example:**  
 DIM Ovr\$[50]  
 OUTPUT 707;":MEASURE:OVERSHOOT?"  
 ENTER 707;Ovr\$  
 PRINT Ovr\$

## PERiod

---

### PERiod

### command/query

The `:MEASURE:PERIOD` command places the instrument in the continuous measurement mode and selects the period measurement.

The `PERIOD` query measures and outputs the period of the first complete cycle on the screen. The period is measured at the 50% point when standard measurements are selected and at the mid-threshold voltage level of the waveform when user-defined measurements are selected.

The algorithm for this measurement is:

```

if the first edge on screen is rising
then
  period = (time at second rising edge – time at first rising edge)
else
  period = (time at second falling edge – time at first falling edge)

```

**Command Syntax:** `:MEASure:PERiod`

**Example:** `OUTPUT 707;":MEAS:PERIOD"`

**Query Syntax:** `:MEASure:PERiod?`

**Returned Format:** `[[:MEASure:PERiod] <value><NL>`

**Where:**

`<value> ::= waveform period in seconds (exponential - NR3 format)`

**Example:**

```

DIM Prd$[50]
OUTPUT 707;":MEASURE:PERIOD?"
ENTER 707;Prd$
PRINT Prd$

```

**POSTfailure****POSTfailure****command/query**

The **:MEASURE:POSTFAILURE** command specifies what the instrument will do after a violation is found by the limit test. If **CONTINUE** is selected, the instrument continues to look for another violation. If **STOP** is selected, the instrument stops the limit test.

If **CONTINUE** is selected and a violation is found, the violation is written to the desired location. If a waveform memory is selected as the destination, then all subsequent violations will overwrite the previous violation. The destination can be specified with the **:MEASURE:DESTINATION** command.

The **POSTFAILURE** query returns the current selection.

**Command Syntax:** `:MEASure:POSTfailure {CONTinue | STOP}`

**Example:** `OUTPUT 707;":MEAS:POST"`

**Query Syntax:** `:MEASure:POSTfailure?`

**Returned Format:** `[[:MEASure:POSTfailure] {CONTinue | STOP}<NL>`

**Example:**  
`DIM PF$[50]  
OUTPUT 707;":MEASURE:POSTFAILURE?"  
ENTER 707;PF$  
PRINT PF$`

## PREShoot

### PREShoot

### command/query

The :MEASURE:PRESHOOT command places the instrument in the continuous measurement mode and starts the preshoot measurement.

The PRESHOOT query measures and outputs the preshoot of the first displayed edge of the selected signal. Preshoot is measured with the following algorithm:

```

if the first edge on screen is rising
then
  preshoot = (Vbase - Vmin)/Vamplitude
else
  preshoot = (Vmax - Vtop)/Vamplitude

```

**Command Syntax:** :MEASure:PREShoot

**Example:** OUTPUT 707;":MEASURE:PRES"

**Query Syntax:** :MEASure:PREShoot?

**Returned Format:** [:MEASure:PREShoot] <value><NL>

**Where:**

<value> ::= ratio of preshoot to Vamplitude (exponential - NR3 format)

**Example:**  
 DIM Prs\$[50]  
 OUTPUT 707;":MEASURE:PRESHOOT?"  
 ENTER 707;Prs\$  
 PRINT Prs\$

**PWIDTH****PWIDTH****command/query**

The :MEASURE:PWIDTH command places the instrument in the continuous measurement mode and starts the Pwidth measurement.

The PWIDTH query measures and outputs the width of the first displayed positive pulse. Pulse width is measured at the 50% voltage level with standard measurements selected and at the mid-level threshold value with user-defined measurements selected. The algorithm for this measurement is:

```

if the first edge on screen is falling
then
  width = (time at second falling edge – time at first rising edge)
else
  width = (time at first falling edge – time at first rising edge)

```

**Command Syntax:** :MEASure:PWIDTH

**Example:** OUTPUT 707;":MEAS:PWIDTH"

**Query Syntax:** :MEASure:PWIDTH?

**Returned Format:** [:MEASure:PWIDTH] <value><NL>

**Where:**

<value> ::= width of positive pulse in seconds (exponential - NR3 format)

**Example:**

```

DIM Pwd$[50]
OUTPUT 707;":MEASURE:PWIDTH?"
ENTER 707;Pwds$
PRINT Pwd$

```

## RESults

---

### RESults

query

The `:MEASURE:RESULTS` query returns the currently active measurements. If statistics are on, the minimum, maximum, and average is returned for each measurement. If the limit test is on and `POSTFAILURE` is set to `CONTINUED`, the pass ratio is returned instead of the average.

If the number of measurements returned is 0, then no measurements are returned.

**Query Syntax:** `:MEASure:RESuIts?`

**Returned Format:** `[[:MEASure:RESuIts] <No. of Meas>[;<measurement>]...<NL>`

**Where:**

`<No. of Meas> ::=` number of measurements displayed on the screen, 0 through 8 (integer - NR1 format)  
`<measurement> ::=` measurement\_name measurement\_result.

**Example:**

```
DIM Mr$[100]
OUTPUT 707;":MEASURE:RESULTS?"
ENTER 707;Mr$
PRINT Mr$
```

## RISetime

### RISetime

### command/query

The `:MEASURE:RISETIME` command places the instrument in the continuous measurement mode and starts a rise time measurement.

The `RISETIME` query measures and outputs the rise time of the first displayed rising (positive-going) edge. For maximum measurement accuracy set the sweep speed as fast as possible while leaving the leading edge of the waveform on the display. The rise time is determined by measuring the time at the lower threshold of the rising edge and the time at the upper threshold of the rising edge, then calculating the rise time with the following formula:

$$\text{rise time} = (\text{time at upper threshold point} - \text{time at lower threshold point})$$

If the horizontal scaling is questionable while making this measurement, an "error 11" is placed in the error queue.

**Command Syntax:** `:MEASure:RISet ime`

**Example:** `OUTPUT 707;":MEAS:RIS"`

**Query Syntax:** `:MEASure:RISet ime?`

**Returned Format:** `[[:MEASure:RISet ime] <value><NL>`

**Where:**

`<value> ::= rise time in seconds (exponential - NR3 format)`

**Example:**

```
DIM Rs$[50]
OUTPUT 707;":MEAS:RIS?"
ENTER 707;Rs$
PRINT Rs$
```

## SCRatch

---

### SCRatch

command

The :MEASURE:SCRATCH command clears the measurement results from the oscilloscope display.

**Command Syntax:** :MEASure:SCRatch

**Example:** OUTPUT 707;":MEASURE:SCRATCH"

**SOURce****SOURce****command/query**

The :MEASURE:SOURCE command selects the sources for the measurements. The specified source becomes the source for the MEASURE subsystem commands.

Two sources can be specified with this command. All measurements except DELAY are made on the first specified source. The DELAY measurement uses two sources if two have been specified. If only one source is specified, the DELAY measurement uses that source for both of its parameters.

The SOURCE query returns the current source selection. If the specified sources are different, both are returned. Otherwise, one source is returned.

**Command Syntax:** :MEASure:SOURce <source1>[,<source2>]

Where:

<source1> and <source2> ::= {CHANne1{1 | 2} | FUNCTION{1 | 2} | WMEMory{1 | 2 | 3 | 4}}

**Example:** OUTPUT 707;":MEASURE:SOURCE CHANNEL1, WMEMORY1"

**Query Syntax:** :MEASure:SOURce?

**Returned Format:** [:MEASure:SOURce] <source1>[,<source2>]<NL>

Where:

<source1> and <source2> ::= {CHANne1{1 | 2} | FUNCTION{1 | 2} | WMEMory{1 | 2 | 3 | 4}}

**Example:** DIM Src\$[50]  
OUTPUT 707;":MEAS:SOUR?"  
ENTER 707;Src\$  
PRINT Src\$

## STATistics

---

### STATistics

### command/query

The :MEASURE:STATISTICS command turns the statistics function on and off. When this mode is on, and the measurements are in the continuous mode, the minimum, maximum, average, and current measurements are shown as the active measurements. If a RESULTS query is executed, all of the displayed data is returned to the controller.

The STATISTICS query returns the current mode.

#### Note

"Average" is replaced by "pass ratio" when the "limit test" is selected and "after failure" is set to continue. Pass ratio lists the percentage of times a certain test passed.

**Command Syntax:** :MEASure:STATistics {{ON | 1} | {OFF | 0}}

**Example:** OUTPUT 707;":MEASURE:STAT ON"

**Query Syntax:** :MEASure:STATistics?

**Returned Format:** [:MEASure:STATistics] {1 | 0}<NL>

**Example:**  
 DIM Stt\$[50]  
 OUTPUT 707;":MEASURE:STAT?"  
 ENTER 707;Stt\$  
 PRINT Stt\$

**TDELta****TDELta****query**

The :MEASURE:TDELTA query returns the time difference between the start and stop time markers:

$$\text{Tdelta} = \text{Tstop} - \text{Tstart}$$

Tstart is the time at the start marker and Tstop is the time at the stop marker

**Query Syntax:** :MEASure:TDELta?

**Returned Format:** [:MEASure:TDELta] <value><NL>

**Where:**

<value> ::= difference between start and stop markers (exponential - NR3 format)

**Example:**

```
DIM Td1$[50]
OUTPUT 707;":MEASURE:TDELTA?"
ENTER 707;Td1$
PRINT Td1$
```

## TMAX

---

### TMAX

query

The `:MEASURE:TMAX` query returns the time at which the first maximum voltage occurred.

**Query Syntax:** `:MEASure:TMAX?`

**Returned Format:** `[[:MEASure:TMAX] <time><NL>`

**Where:**

`<time> ::= time at maximum voltage.`

**Example:**

```
DIM Tmx$[50]
OUTPUT 707;":MEASURE:TMAX?"
ENTER 707;Tmx$
PRINT Tmx$
```

**TMIN****TMIN****query**

The :MEASURE:TMIN query returns the time at which the first minimum voltage occurred.

**Query Syntax:** :MEASure:TMIN?

**Returned Format:** [:MEASure:TMIN] <time><NL>

**Where:**

<time> ::= time at minimum voltage.

**Example:**

```
DIM Tmn$[50]
OUTPUT 707;":MEAS:TMIN?"
ENTER 707;Tmn$
PRINT Tmn$
```

## TSTArt

---

### TSTArt

### command/query

The :MEASURE:TSTART command moves the start marker to the specified time with respect to the trigger time.

The TSTART query returns the time at the start marker.

#### Note

The short form of this command, TSTA, does not follow the defined short form convention. The normal short form "TST" is the same for TSTART and TSTOP. Sending TST for the TSTART command produces an error.

**Command Syntax:** :MEASure:TSTArt <start marker time>

Where:

<start marker time> ::= time at start marker in seconds

**Example:** OUTPUT 707;":MEASURE:TSTART 30 NS"

**Query Syntax:** :MEASure:TSTArt?

**Returned Format:** [:MEASure:TSTArt] <value><NL>

Where:

<value> ::= time at start marker in seconds (exponential - NR3 format)

**Example:**  
 DIM Tst\$  
 OUTPUT 707;":MEASURE:TSTART?"  
 ENTER 707;Tst\$  
 PRINT Tst\$

**TSTOp****TSTOp****command/query**

The :MEASURE:TSTOP command moves the stop marker to the specified time with respect to the trigger time.

The TSTOP query returns the time at the stop marker.

**Note**

The short form of this command, TSTO, does not follow the defined short form convention. The normal short form "TST" is the same for TSTART and TSTOP. Sending TST for the TSTOP command produces an error.

**Command Syntax:** :MEASure:TSTOp <stop marker time>

**Where:**

<stop marker time> ::= time at stop marker in seconds

**Example:** OUTPUT 707;":MEAS:TSTOP 40 NS"

**Query Syntax:** :MEASure:TSTOp?

**Returned Format:** [:MEASure:TSTOp] <value><NL>

**Where:**

<value> ::= time at stop marker in seconds (exponential - NR3 format)

**Example:**  
 DIM Tst\$[50]  
 OUTPUT 707;":MEASURE:TSTOP?"  
 ENTER 707;Tst\$  
 PRINT Tst\$

## TVOLT

---

### TVOLT

### query

When the :MEASURE:TVOLT query is sent, the displayed signal is searched for the defined voltage level and transition. The time interval between the trigger event and this defined occurrence is returned as the response to this query.

The voltage can be specified as a negative or positive voltage. To specify a negative voltage, use a minus (-) sign. The sign of the slope selects a rising (+) or falling (-) edge.

The magnitude of occurrence defines the occurrence to be reported. For example, +3 returns the time for the third time the waveform crosses the specified voltage level in the positive direction. Once this voltage crossing is found, the oscilloscope outputs the time at that crossing in seconds, with the trigger point (time zero) as the reference.

If the specified crossing cannot be found, the oscilloscope outputs +9.99999E+37. This value is returned if the waveform does not cross the specified voltage, or if the waveform does not cross the specified voltage for the specified number of times in the specified direction.

**Query Syntax:** :MEASure:TVOLT? <voltage>, <slope><occurrence>

#### Where:

<voltage> ::= positive or negative voltage level that the waveform must cross.

<slope> ::= direction of the waveform when <voltage> is crossed - rising (sp or +) or falling (-)

<occurrence> ::= number of crossings to be reported (if one - the first crossing is reported, if two - the second crossing is reported, etc.)

---

**TVOLT**

**Returned Format:** [:MEASure:TVOLT] <time><NL>

**Where:**

<time> ::= time in seconds of specified voltage crossing (exponential - NR3 format)

**Example:** DIM Tv1t\$[50]  
OUTPUT 707;":MEASURE:TVOLT? -.250,+3"  
ENTER 707;Tv1t\$  
PRINT Tv1t\$

## UNITS

---

### UNITS

### command/query

The `:MEASURE:UNITS` command sets the measurement threshold units when the user defined measurement mode is selected. The UNITS can be set to PERCENT or VOLTS.

The UNITS query returns the currently selected units.

**Command Syntax:** `:MEASure:UNITS {PERCent | VOLTs}`

**Example:** `OUTPUT 707;":MEASURE:UNITS PERCENT"`

**Query Syntax:** `:MEASure:UNITS?`

**Returned Format:** `[[:MEASure:UNITS] {PERCent | VOLTs}<NL>`

**Example:**  
`DIM Unt$[50]  
OUTPUT 707;":MEASURE:UNITS?"  
ENTER 707;Unt$  
PRINT Unt$`

## UPPer

## UPPer

## command/query

The :MEASURE:UPPER command sets the upper measurement threshold.



Set the measurement units with the :MEASURE:UNITS command prior to sending the upper threshold value.

The UPPER query returns the value of the upper measurement threshold.

**Command Syntax:** :MEASure:UPPer <upper\_threshold>

**Where:**

<upper\_threshold> ::= upper threshold value in percent or volts

**Example:** OUTPUT 707;":MEAS:UPPER 90"

**Query Syntax:** :MEASure:UPPer?

**Returned Format:** [:MEASure:UPPer] <upper\_threshold><NL>

**Where:**

<upper threshold> ::= upper threshold value in percent or volts  
(exponential - NR3 format)

**Example:**  
DIM Up\$ [50]  
OUTPUT 707;":MEAS:UPP?"  
ENTER 707;Up\$  
PRINT Up\$

## VACRms

---

### VACRms

### command/query

The :MEASURE:VACRMS command and query perform the same functions as the VRMS command and query.

The :MEASURE:VACRMS command places the instrument in the continuous measurement mode and starts an ac rms voltage measurement.

The VACRMS query measures and outputs the AC RMS voltage of the selected waveform. The AC RMS voltage is measured on the first cycle of the displayed signal. If a complete cycle is not present, the oscilloscope computes the RMS value on all displayed data points.

### Note

The VACRMS measurement is an AC RMS measurement. This means that the average value of the waveform is subtracted from each data point before the RMS voltage is computed.

**Command Syntax:** :MEASure:VACRms

**Example:** OUTPUT 707;":MEAS:VACRMS"

**Query Syntax:** :MEASure:VACRms?

**Returned Format:** [:MEASure:VACRms] <value><NL>

**Where:**

<value> ::= calculated ac rms voltage (exponential - NR3 format)

**Example:**  
 DIM Vrms\$[50]  
 OUTPUT 707;":MEASURE:VACRMS?"  
 ENTER 707;Vrms\$  
 PRINT Vrms\$

**VAMPLitude****VAMPLitude****command/query**

The **:MEASURE:VAMPLITUDE** command places the instrument in the continuous measurement mode and starts a Vamplitude measurement.

The **VAMPLITUDE** query returns the difference between the top and base voltage of the displayed signal. The **VAMPLITUDE** value is not normally the same as the Vp-p value when the input signal is a pulse.

The Vamplitude value is calculated with the formula:

$$\text{Vamplitude} = V_{\text{top}} - V_{\text{base}}$$

**Command Syntax:** `:MEASure:VAMP1itude`

**Example:** `OUTPUT 707;":MEAS:VAMP"`

**Query Syntax:** `:MEASure:VAMP1itude?`

**Returned Format:** `[[:MEASure:VAMP1itude] <value><NL>`

**Where:**

`<value>` ::= difference between top and base voltages (exponential - NR3 format)

**Example:**

```
DIM Vmp$[50]
OUTPUT 707;":MEASURE:VAMPLITUDE?"
ENTER 707;Vmp$
PRINT Vmp$
```

## VAVerage

---

### VAVerage

### command/query

The :MEASURE:VAVERAGE command places the instrument in the continuous measurement mode and starts a Vaverage measurement.

The VAVERAGE query measures the average voltage of the first cycle of the displayed signal. If a complete cycle is not present, the oscilloscope averages all data points.

**Command Syntax:** :MEASure:VAVerage

**Example:** OUTPUT 707;":MEAS:VAV"

**Query Syntax:** :MEASure:VAVerage?

**Returned Format:** [:MEASure:VAVerage] <average\_voltage><NL>

**Where:**

<average\_voltage> ::= calculated average voltage (exponential - NR3 format)

**Example:**  
DIM Vv\$[50]  
OUTPUT 707;":MEAS:VAV?"  
ENTER 707;Vv\$  
PRINT Vv\$

**VBASE****VBASE****command/query**

The **:MEASURE:VBASE** command places the instrument in the continuous measurement mode and starts a Vbase measurement.

The **VBASE** query measures and outputs the voltage value at the base of the waveform. The base voltage of a pulse is normally not the same as the minimum value.

**Command Syntax:** `:MEASure:VBASe`

**Example:** `OUTPUT 707;":MEAS:VBASE"`

**Query Syntax:** `:MEASure:VBASe?`

**Returned Format:** `[[:MEASure:VBASe] <base_voltage><NL>`

**Where:**

`<base_voltage> ::= voltage at base of selected waveform (exponential - NR3 format)`

**Example:**

```
DIM Vbs$[50]
OUTPUT 707;":MEASURE:VBASE?"
ENTER 707;Vbs$
PRINT Vbs$
```

## VDCRms

---

### VDCRms

### command/query

The :MEASURE:VDCRMS command places the instrument in the continuous measurement mode and starts a dc rms voltage measurement.

The VDCRMS query measures and outputs the RMS voltage of the selected waveform. The RMS voltage is measured on the first cycle of the displayed signal. If a complete cycle is not present, the oscilloscope computes the RMS value on all displayed data points.

### Note

The VDCRMS measurement is a true RMS measurement.

**Command Syntax:** :MEASure:VDCRms

**Example:** OUTPUT 707;":MEAS:VDCRMS"

**Query Syntax:** :MEASure:VDCRms?

**Returned Format:** [:MEASure:VDCRms] <value><NL>

**Where:**

<value> ::= calculated dc rms voltage (exponential - NR3 format)

**Example:**  
 DIM Vrm\$[50]  
 OUTPUT 707;":MEASURE:VDCRMS?"  
 ENTER 707;Vrm\$  
 PRINT Vrm\$

**VDELta****VDELta****query**

The :MEASURE:VDELTA query outputs the voltage difference between VMarker 1 and VMarker 2. No measurement is made when the VDELTA query is received by the oscilloscope. The delta voltage value that is output is the current value. This is the same value as the front panel delta V value.

$$\text{VDELTA} = \text{Voltage at VMarker 2} - \text{Voltage at VMarker 1}$$

**Query Syntax:** :MEASure:VDELta?

**Returned Format:** [:MEASure:VDELta] <value><NL>

**Where:**

<value> ::= delta V value in volts (exponential - NR3 format)

**Example:**

```
DIM Vd1$[50]
OUTPUT 707;" :MEAS:VDELTA?"
ENTER 707;Vd1$
PRINT Vd1$
```

## VFIFty

---

### VFIFty

### command

The :MEASURE:VFIFTY command finds the top and base values of the specified waveforms, then places the voltage markers at the 50% voltage point on the specified sources.

If only one source has been specified with the source command, the VFIFTY command sets both voltage markers (VMarker 1 and VMarker 2) to the 50% voltage level on that source.

If two sources are specified with the source command, VMarker 1 is set to the 50% level of the first specified source and VMarker 2 is set to the 50% level of the second specified source.

There is no query form of this command.

**Command Syntax:** :MEASure:VFIFty

**Example:** OUTPUT 707;":MEASURE:VFIFTY"

**VMAX****VMAX****command/query**

The **:MEASURE:VMAX** command places the instrument in the continuous measurement mode and starts a Vmax measurement.

The **VMAX** query measures and outputs the absolute maximum voltage present on the selected waveform.

**Command Syntax:** `:MEASure:VMAX`

**Example:** `OUTPUT 707;":MEAS:VMAX"`

**Query Syntax:** `:MEASure:VMAX?`

**Returned Format:** `[[:MEASure:VMAX] <value><NL>`

**Where:**

`<value>` ::= maximum voltage of selected waveform (exponential - NR3 format)

**Example:**  
`DIM Vmx$[50]  
OUTPUT 707;":MEASURE:VMAX?"  
ENTER 707;Vmx$  
PRINT Vmx$`

## VMIN

---

### VMIN

### command/query

The `:MEASURE:VMIN` command places the instrument in the continuous measurement mode and starts a VMIN measurement.

The VMIN query measures and outputs the absolute minimum voltage present on the selected waveform.

**Command Syntax:** `:MEASure:VMIN`

**Example:** `OUTPUT 707;":MEAS:VMIN"`

**Query Syntax:** `:MEASure:VMIN?`

**Returned Format:** `[[:MEASure:VMIN] <value><NL>`

#### Where:

<value> ::= minimum voltage value of the selected waveform  
(exponential - NR3 format)

**Example:**

```
DIM Vmn$[50]
OUTPUT 707;":MEASURE:VMIN?"
ENTER 707;Vmn$
PRINT Vmn$
```

**VPP****VPP****command/query**

The `:MEASURE:VPP` command places the instrument in the continuous measurement mode and starts a VPP measurement.

The VPP query measures the maximum and minimum voltages for the selected source, then calculates the peak-to-peak voltage and outputs that value. The peak-to-peak voltage (Vpp) is calculated with the following formula:

$$V_{pp} = V_{max} - V_{min}$$

Vmax and Vmin are the maximum and minimum voltages present on the selected source.

**Command Syntax:** `:MEASure:VPP`

**Example:** `OUTPUT 707;":MEAS:VPP"`

**Query Syntax:** `:MEASure:VPP?`

**Returned Format:** `[[:MEASure:VPP] <value><NL>`

**Where:**

`<value> ::= voltage peak to peak (exponential - NR3 format)`

**Example:**

```
DIM Vp$[50]
OUTPUT 707;":MEAS:VPP?"
ENTER 707;Vp$
PRINT Vp$
```

## VRElative

---

### VRElative

### command/query

The :MEASURE:VRELATIVE command moves the voltage markers to the specified percentage points of their last established position. The last established position is not necessarily on the currently displayed waveform.

For example, after a :MEASURE:VAMPLITUDE? query is sent, VMarker 1 is located at the base (0%) of the signal and VMarker 2 is at the top (100%) of the signal. If the VRELATIVE 10 command is executed, VMarker 1 is moved to the 10% level and VMarker 2 to the 90% level of the signal.

Any value between 0% and 100% can be used. If VRELATIVE 0 is sent, the markers are not moved because the command indicates 0% movement from the current position.

As an example, when the following values are sent, the markers are moved to the following percentage values of their current position:

- 10 moves VMarker 1 to 10% and VMarker 2 to 90%
- 20 moves VMarker 1 to 20% and VMarker 2 to 80%
- 50 moves both markers to 50%
- 80 moves VMarker 1 to 20% and VMarker 2 to 80%
- 90 moves VMarker 1 to 10% and VMarker 2 to 90%

The starting position of the markers must be known for this command to be meaningful. The markers can be set to a known position on the selected waveform using the :MEASURE:VAMPLITUDE? query.

The VRELATIVE query returns the current relative position of VMarker2, which is always in the range of 50% through 100%.



The VRELATIVE command does not affect the upper and lower thresholds selected by the UPPER and LOWER commands.

## VRElative

---

**Command Syntax:** :MEASure:VRElative <percent>

**Where:**

<percent> ::= {0 through 100}

**Example:** OUTPUT 707;":MEASURE:VRELATIVE 20"

**Query Syntax:** :MEASure:VRElative?

**Returned Format:** [:MEASure:VRElative] <value><NL>

**Where:**

<value> ::= Vmarker 2 relative position in percent {50 through 100}  
(integer - NR1 format)

**Example:** DIM Vr1\$[50]  
OUTPUT 707;":MEAS:VREL?"  
ENTER 707;Vr1\$  
PRINT Vr1\$

## VRMS

---

### VRMS

### command/query

The :MEASURE:VRMS command and query perform the same functions as the VACRMS command and query.

The :MEASURE:VRMS command places the instrument in the continuous measurement mode and starts an ac rms voltage measurement.

The VRMS query measures and outputs the RMS voltage of the selected waveform. The RMS voltage is measured on the first cycle of the displayed signal. If a complete cycle is not present, the oscilloscope computes the RMS value on all displayed data points.

### Note

The VRMS measurement is an AC RMS measurement. This means that the average value of the waveform is subtracted from each data point before the RMS voltage is computed.

**Command Syntax:** :MEASure:VRMS

**Example:** OUTPUT 707;":MEAS:VRMS"

**Query Syntax:** :MEASure:VRMS?

**Returned Format:** [:MEASure:VRMS] <value><NL>

**Where:**

<value> ::= calculated ac rms voltage (exponential - NR3 format)

**Example:**  
 DIM Vrm\$ [50]  
 OUTPUT 707;":MEASURE:VRMS?"  
 ENTER 707;Vrm\$  
 PRINT Vrm\$

## VStArt

## VStArt

## command/query

The :MEASURE:VSTART command moves VMarker 1 to the specified voltage. The values are limited to the currently defined channel, function, or memory range.

The VSTART query returns the current voltage level of VMarker 1.



The short form of this command, VSTA, does not follow the defined short form convention. The normal short form "VST" is the same for VSTART and VSTOP. Sending VST for the VSTART command produces an error.

**Command Syntax:** :MEASure:VStArt <voltage>

Where:

<voltage> ::= voltage value for Vmarker 1

**Example:** OUTPUT 707;":MEAS:VSTA -10MV"

**Query Syntax:** :MEASure:VStArt?

**Returned Format:** [:MEASure:VStArt] <value><NL>

Where:

<value> ::= voltage at VMarker 1 (exponential - NR3 format)

**Example:**  
 DIM Vst\${50}  
 OUTPUT 707;":MEASURE:VSTART?"  
 ENTER 707;Vst\$  
 PRINT Vst\$

## VSTOP

---

### VSTOP

### command/query

The :MEASURE:VSTOP command moves VMarker 2 to the specified voltage.

The VSTOP query returns the current voltage level of VMarker 2.

#### Note

The short form of this command, VSTO, does not follow the defined short form convention. The normal short form "VST" is the same for VSTART and VSTOP. Sending VST for the VSTOP command produces an error.

**Command Syntax:** :MEASure:VSTOp <voltage>

Where:

<voltage> ::= voltage value for Vmarker 2

**Example:** OUTPUT 707;":MEAS:VSTO -100MV"

**Query Syntax:** :MEASure:VSTOp?

**Returned Format:** [:MEASure:VSTOp] <value><NL>

Where:

<value> ::= voltage at VMarker 2 (exponential - NR3 format)

**Example:** DIM Vst\$[50]  
OUTPUT 707;":MEASURE:VSTOP?"  
ENTER 707;Vst\$  
PRINT Vst\$

**VTIME****VTIME****query**

The `:MEASURE:VTIME` query returns the voltage at a specified time. The specified time must be on screen and is referenced to the trigger event.

**Query Syntax:** `:MEASure:VTIME? <time>`

**Where:**

`<time>` ::= displayed time from trigger in seconds

**Returned Format:** `[.:MEASure:VTIME] <voltage><NL>`

**Where:**

`<voltage>` ::= voltage at specified time (exponential - NR3 format)

**Example:**

```
DIM Vtm$[50]
OUTPUT 707;":MEASURE:VTIME? .001"
ENTER 707;Vtm$
PRINT Vtm$
```

## VTOP

---

### VTOP

### command/query

The `:MEASURE:VTOP` command places the instrument in the continuous measurement mode and starts a Vtop measurement.

The VTOP query returns the voltage at the top of a waveform.

**Command Syntax:** `:MEASure:VTOP`

**Example:** `OUTPUT 707;":MEASURE:VTOP"`

**Query Syntax:** `:MEASure:VTOP?`

**Returned Format:** `[[:MEASure:VTOP] <value><NL>`

**Where:**

`<value>` ::= voltage at the top of the waveform (exponential - NR3 format)

**Example:**

```
DIM Vtp$[50]
OUTPUT 707;":MEASURE:VTOP?"
ENTER 707;Vtp$
PRINT Vtp$
```

## Timebase Subsystem

---

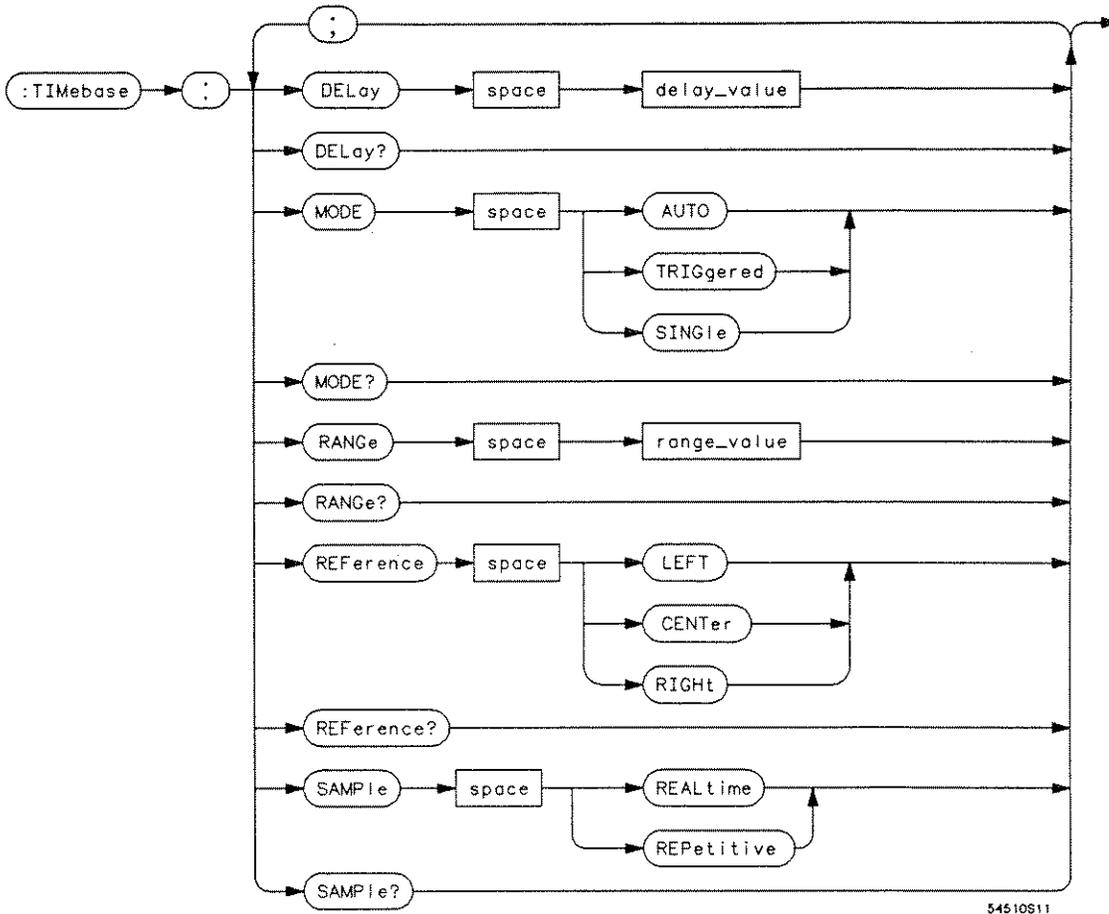
### Introduction

The TIMEBASE subsystem commands control the horizontal or X-axis oscilloscope functions.

The Timebase subsystem contains the following commands:

- DELay
- MODE
- RANGe
- REFerence
- SAMPlE

Figure 16-1 lists the syntax diagrams for the Timebase subsystem commands.



54510S11

**delay\_value =** a real number, the maximum value depends on the sweep range.  
**range\_value =** a real number, 10 ns through 50 s (in a 1, 2, 5 sequence).

Figure 16-1. Timebase Subsystem Commands Syntax Diagram

**DElay****DElay****command/query**

The :TIMEBASE:DElay command sets the time base delay. This delay is the internal time between the trigger event and the on-screen delay reference point. The delay reference point is the left edge of the display, the right edge of the display, or the center of the display, and is set with the :TIMEBASE:REFERENCE command.

The DElay query returns the current delay value.

**Command Syntax:** :TIMebase:DElay <de lay>

**Where:**

<delay> ::= time in seconds from trigger to the on screen delay reference point. The maximum value depends on the time/division setting.

**Example:** OUTPUT 707;":TIM:DEL 2MS"

**Query Syntax:** :TIMebase:DElay?

**Returned Format:** [:TIMebase:DElay] <delay><NL>

**Where:**

<delay> ::= time from trigger to display reference in seconds. Display reference is left, center, or right (exponential - NR3 format)

**Example:** DIM D1\$[50]  
OUTPUT 707;":TIMEBASE:DElay?"  
ENTER 707;D1\$  
PRINT D1\$

## MODE

---

### MODE

### command/query

The `:TIMEBASE:MODE` command selects the time base mode. This function is the same as the Auto/Trig'd key in the trigger menu and the SINGLE key on the front panel.

If the AUTO mode is selected, a baseline is provided on the display in the absence of a signal. If a signal is present but the oscilloscope is not triggered, the unsynchronized signal is displayed instead of a baseline.

If the TRIGGERED mode is selected and no trigger is present, the instrument does not sweep, and the data acquired on the previous trigger remains on the screen.

If the SINGLE mode is selected, the screen is cleared and the instrument is stopped. The RUN command arms the trigger, and data is acquired when the trigger is found. The RUN command must be sent to make a single acquisition.

The MODE query returns the current mode.

**Command Syntax:** `:TIMebase:MODE {AUTO | TRIGgered | SINGle}`

**Example:** `OUTPUT 707;":TIM:MODE TRIGGERED"`

**Query Syntax:** `:TIMebase:MODE?`

**Returned Format:** `[:TIMebase:MODE] {AUTO | TRIGgered | SINGle}<NL>`

**Example:**

```
DIM Mode$[30]
OUTPUT 707;":TIMEBASE:MODE?"
ENTER 707;Mode$
PRINT Mode$
```

**RANGe****RANGe****command/query**

The `:TIMEBASE:RANGE` command sets the full-scale horizontal time in seconds. The RANGE value is ten times the time per division.

The RANGE query returns the current full-scale range value.

**Command Syntax:** `:TIMebase:RANGe <range>`

Where:

`<range> ::= 10 ns to 50 s in a 1,2,5 sequence"`

**Example:** `OUTPUT 707;":TIM:RANG 100 MS"`

**Query Syntax:** `:TIMebase:RANGe?`

**Returned Format:** `[:TIMebase:RANGe] <range><NL>`

Where:

`<range> ::= 10 ns to 50 s (exponential - NR3 format)`

**Example:** `DIM Rng$[50]  
OUTPUT 707;":TIMEBASE:RANGE?"  
ENTER 707;Rng$  
PRINT Rng$`

## REFerence

---

### REFerence

### command/query

The `:TIMEBASE:REFERENCE` command sets the display reference to the left side of the screen, to the right side of the screen, or to the center of the screen.

The `REFERENCE` query returns the current display reference.

**Command Syntax:** `:TIMEbase:REFerence {LEFT | CENTer | RIGHT}`

**Example:** `OUTPUT 707;":TIMEBASE:REFERENCE LEFT"`

**Query Syntax:** `:TIMEbase:REFerence?`

**Returned Format:** `[[:TIMEbase:REFerence] {LEFT | CENTer | RIGHT}<NL>`

**Example:**  
`DIM RF$[30]  
OUTPUT 707;":TIMEBASE:REFERENCE?"  
ENTER 707;RF$  
PRINT RF$`

**SAMPLE****SAMPLE****command/query**

The `:TIMEBASE:SAMPLE` command controls the sampling mode of the instrument. Two sample modes are available: `REALTIME` and `REPETITIVE`. Realtime implies "Single-Shot" capture of data, which means that a complete data record is collected on one trigger event. Repetitive implies that the instrument is in a repetitive or equivalent time mode. In this mode the data record is collected over multiple trigger events.

The `SAMPLE` query returns the current sampling mode.

**Command Syntax:** `:TIMEbase:SAMPle {REALtime | REPetitive}`

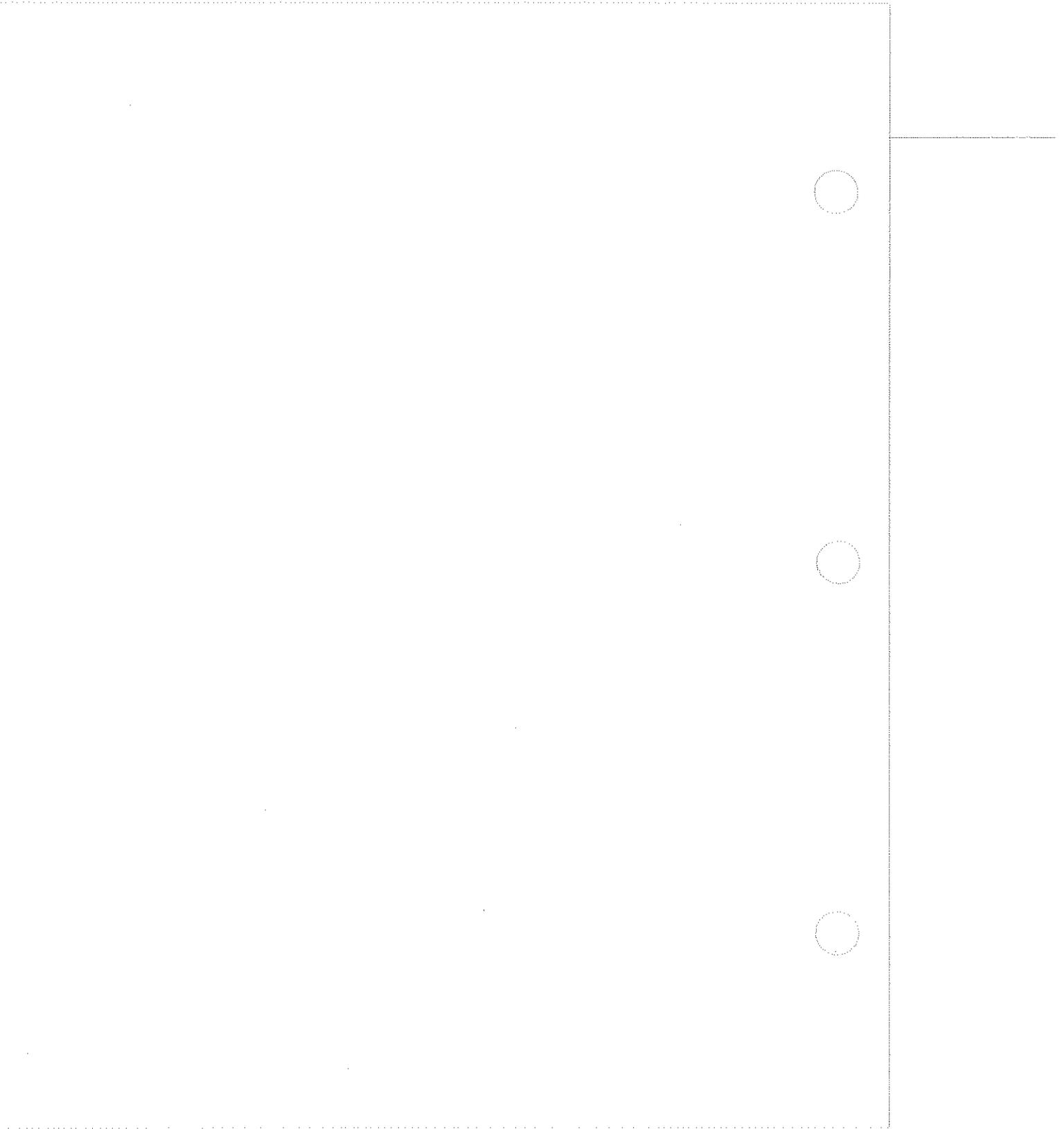
**Example:** `OUTPUT 707;":TIMEBASE:SAMPLE REAL"`

**Query Syntax:** `:TIMEbase:SAMPle?`

**Returned Format:** `[:TIMEbase:SAMPle] {REALtime | REPetitive}<NL>`

**Example:**

```
DIM Smp$ [30]
OUTPUT 707;":TIMEBASE:SAMPLE?"
ENTER 707;Smp$
PRINT Smp$
```



## Trigger Subsystem

---

### Introduction

The commands in the TRIGGER subsystem are used to define the conditions for a trigger. Many of the commands in the Trigger subsystem are valid in more than one of the trigger modes. If the command is a valid command for a trigger mode, that setting is accepted. If the command is not valid for a trigger mode, an error is generated. This subsystem contains the following commands:

- CENTerEd
- CONDition
- COUPLing
- DELay
- DELay:SLOPe
- DELay:SOURce
- FIElD
- HOLDoff
- LEVel
- LINE
- LOGic
- MODE
- OCCurrence
- OCCurrence:SLOPe
- OCCurrence:SOURce
- PATH
- POLarity
- PROBe
- QUALify
- SENSitivity
- SLOPe
- SOURce
- STANdard

Figure 17-1 lists the syntax diagrams for the Trigger subsystem commands.

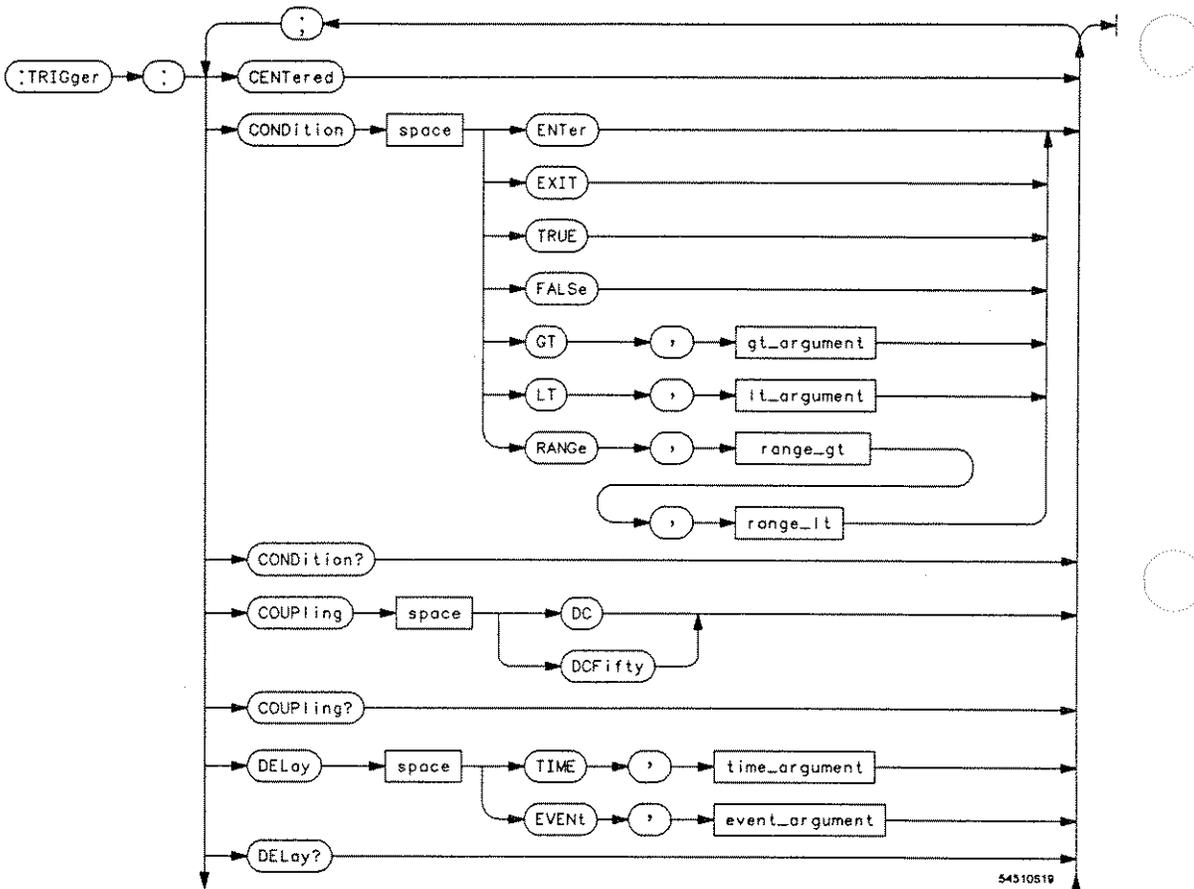


Figure 17-1. Trigger Subsystem Commands Syntax Diagram

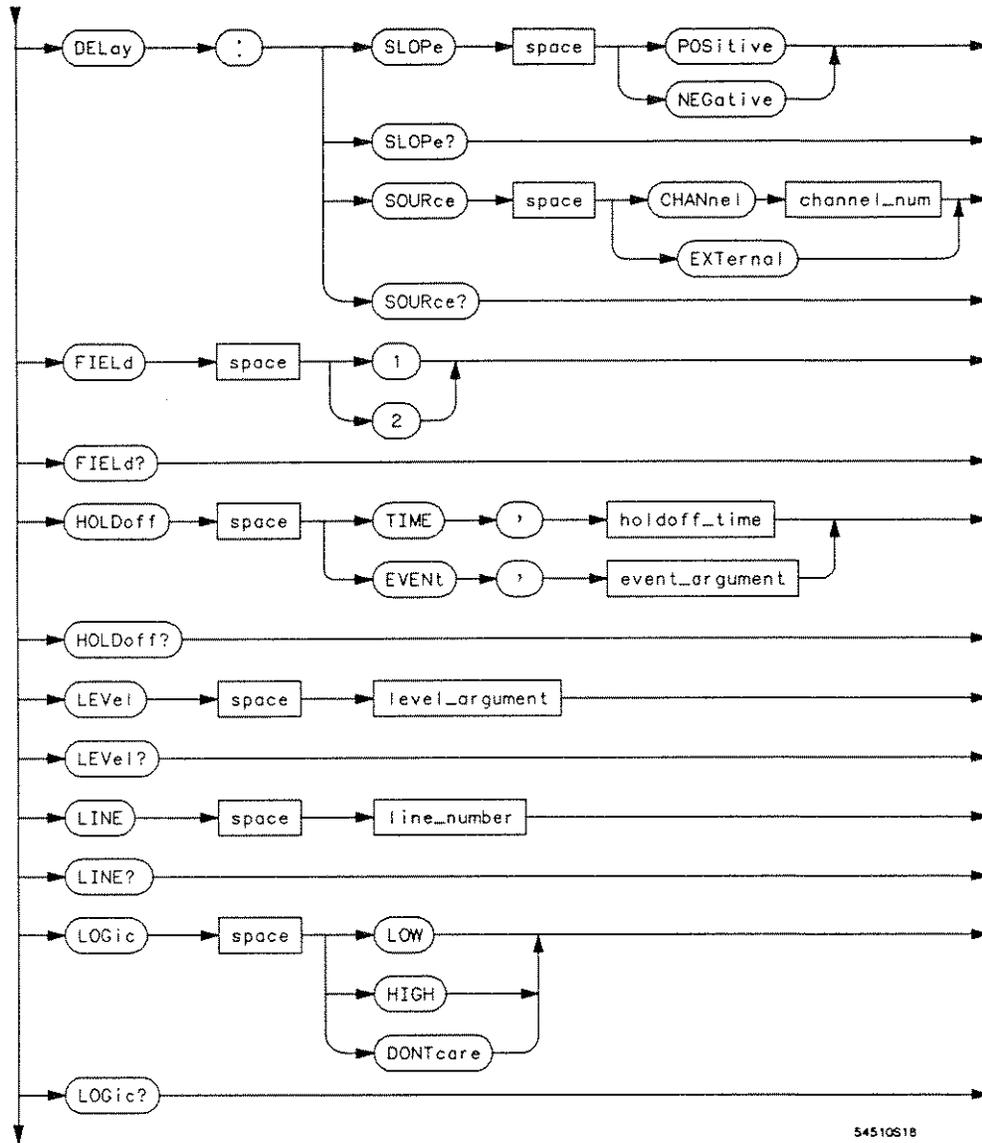


Figure 17-1. Trigger Subsystem Commands Syntax Diagram (continued)

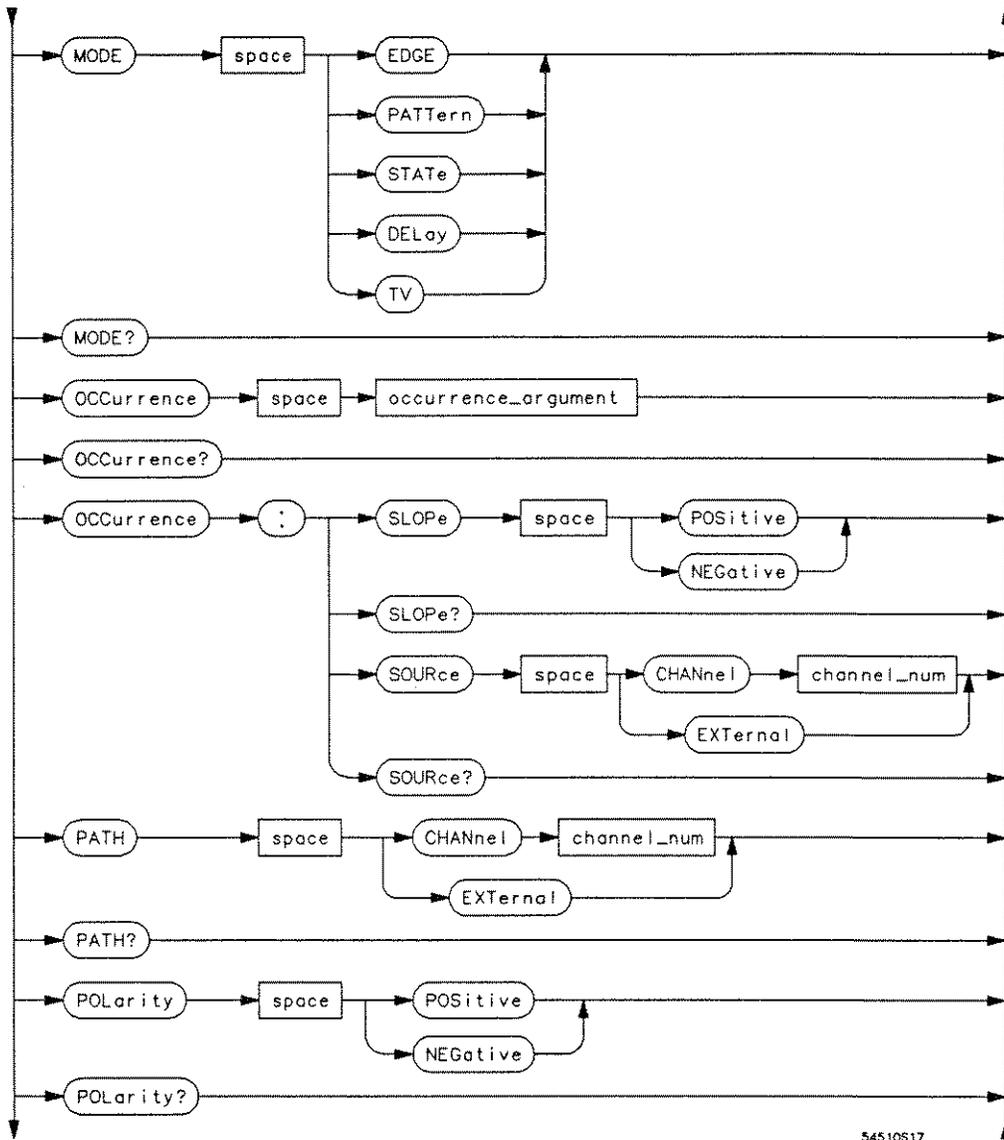
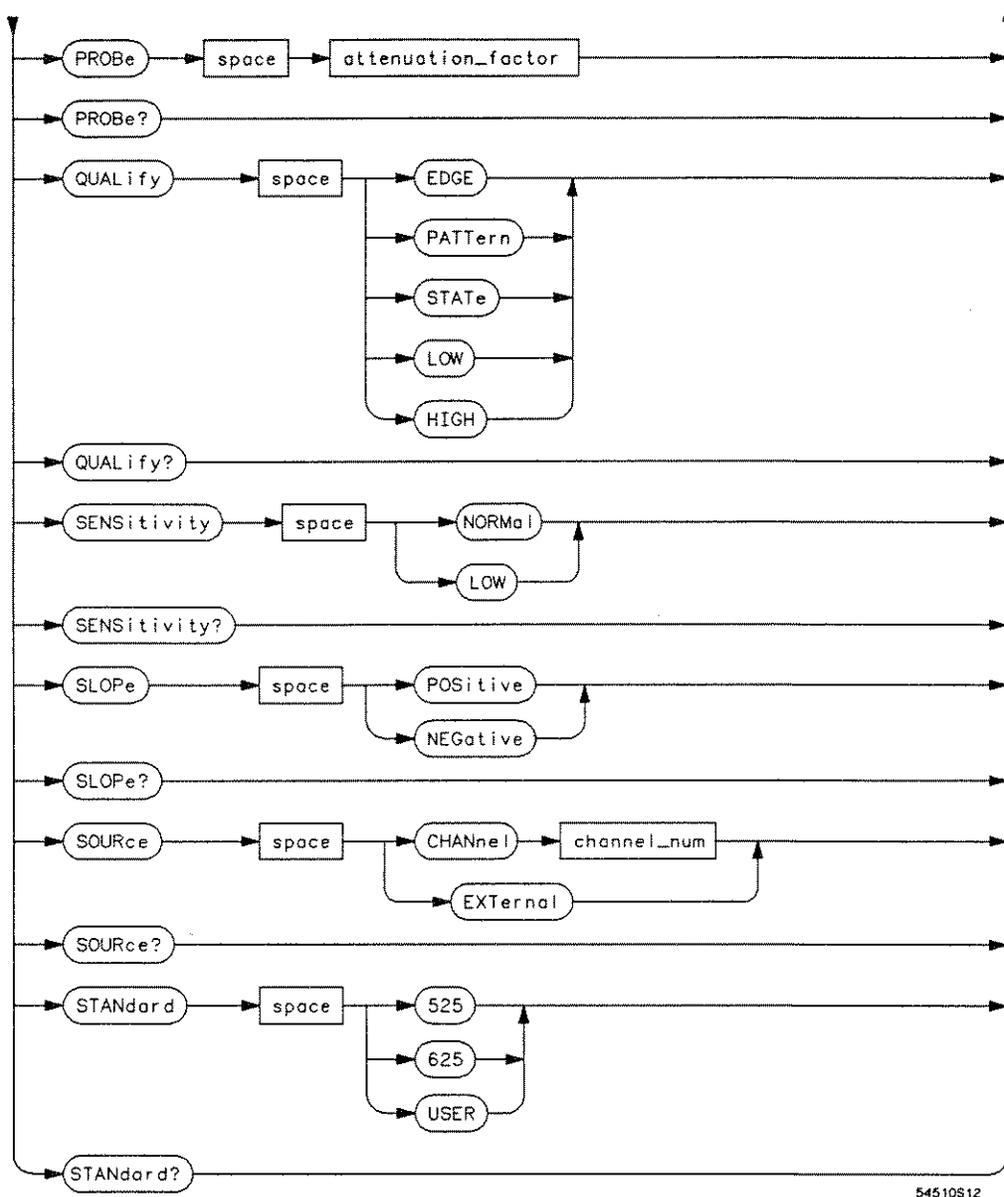


Figure 17-1. Trigger Subsystem Commands Syntax Diagram (continued)



54510S12

Figure 17-1. Trigger Subsystem Commands Syntax Diagram (continued)

<b>attenuation_factor =</b>	a real number, 0.9 to 1000.
<b>channel_num =</b>	an integer, 1 or 2.
<b>event_argument =</b>	an integer, 1 to 16000000.
<b>gt_argument =</b>	a time value, 20 ns to 160 ms.
<b>holdoff_time =</b>	a time value, 40 ns to 320 ms.
<b>level_argument =</b>	a real number specifying the trigger level in volts.
<b>line_number =</b>	an integer, 1 to 625 (depending on the video STANDARD selected).
<b>lt_argument =</b>	a time value, 20 ns to 160 ms.
<b>range_gt =</b>	a time value, 20 ns to 159.999 ms (the value must be less than range_lt).
<b>range_lt =</b>	a time value, 30 ns to 160 ms (the value must be greater than range_gt).
<b>time_argument =</b>	a time value, 30 ns to 160 ms.
<b>occurrence_argument =</b>	an integer, 1 to 16000000.

Figure 17-1. Trigger Subsystem Commands Syntax Diagram (continued)

## Trigger Mode

Make sure the instrument is in the proper trigger mode for the command you want to send. The instrument can be placed in the trigger mode from the front panel or over the HP-IB. One method of insuring the instrument is in the proper trigger mode is to send the :TRIGGER:MODE command in the same program message as the parameter to be set. For example,

```
":TRIGGER:MODE TV;LEVEL 200 MV"
```

places the instrument in the TV Trigger Mode and sets the trigger level to 200 mV. This process is necessary because the LEVEL command is also valid for the other trigger modes.

The trigger modes are described on the next few pages prior to the descriptions of the individual commands. Table 17-1 lists the different TRIGGER subsystem commands that are available for each trigger mode.



Auto or triggered mode is selected with the TIMEBASE:MODE command. For more information, refer to chapter 16, "Timebase Subsystem."

**Table 17-1. Valid Commands for Specific Trigger Modes**

EDGE	PATTERN	STATE	DELAY	TV
CENTERed	CENTERed	CENTERed	CENTERed	CENTERed
COUPLing	CONDition	CONDition	CONDition	CONDition
HOLDoff	COUPLing	COUPLing	COUPLing	COUPLing
LEVel	HOLDoff	HOLDoff	DELay	FIELD
PROBe	LEVel	LEVel	DELay:SLOPe	HOLDoff
SENSitivity	LOGic	LOGic	DELay:SOURce	LEVel
SLOPe	PATH	PATH	LEVel	LINE
SOURce	PROBe	PROBe	LOGic	OCCurrence
	SENSitivity	SENSitivity	OCCurrence	OCCurrence:SLOPe
		SLOPe	OCCurrence:SLOPe	POLarity
		SOURce	OCCurrence:SOURce	PROBe
			PATH	QUALify
			PROBe	SENSitivity
			QUALify	SOURce
			SENSitivity	STANdard
			SLOPe	
			SOURce	

---

## The EDGE Trigger Mode

The Edge Trigger Mode is the easiest trigger mode to understand and use from the front panel or over the HP-IB, because it has the least number of parameters to be set. This explanation of the trigger mode commands follow the front-panel keys very closely. Refer to the *HP 54510A Front-Panel Reference* for further explanations of the trigger operation.

In the Edge Trigger Mode you must set the trigger source using the `:TRIGGER:SOURCE` command. This selects the source that the oscilloscope triggers on. The argument for the `:TRIGGER:SOURCE` command is `channel1`, `channel2`, or `external`.

After setting the trigger source, you need to set the trigger level. This value is set using the `:TRIGGER:LEVEL` command and can be set for each trigger source. The trigger level values that are set in the Edge Trigger Mode are used for all modes except the TV Trigger Mode. Conversely, the levels set in the `PATTERN`, `STATE`, or `DELAY` modes set the levels for the EDGE mode.

The actual edge that creates the trigger is set with the `:TRIGGER:SLOPE` command. This command can be set to `POSITIVE` or `NEGATIVE` for each of the sources.

The last setting in the Edge Trigger Mode is the Trigger Holdoff value. This value is used only for the EDGE mode.

## The Pattern Trigger Mode

This description of the Pattern Trigger Mode follows the front-panel keys very closely. There are additional parameters in this mode that are not used in the Edge Trigger Mode and one parameter that is carried over from the Edge Trigger Mode. The one parameter that carries over is LEVEL. If the level command is used in this mode it also changes the level value for that source in the Edge Trigger Mode. In this trigger mode, the :TRIGGER:LEVEL command defines the voltage that determines if the input voltage is a logic high or logic low for the logic triggers.

The logic pattern for the Pattern Trigger Mode is set using the PATH and LOGIC commands. The PATH command specifies which of the two inputs is selected for the logic pattern. Once the path is selected, the pattern can be set using the LOGIC command. The LOGIC command uses the arguments HIGH, LOW, and DONTCARE to set the "trigger on" bit pattern.

The CONDITION command sets the "when" field on the front panel. This command is used in several of the trigger modes; therefore, it has parameters that are not valid in this mode. The valid parameters for the CONDITION command in the Pattern Trigger Mode are ENTER, EXIT, GT (Greater Than), LT (Less Than), and RANGE.

When the command :TRIGGER:CONDITION ENTER or :TRIGGER:CONDITION EXIT is sent, the Entered or Exited parameter is set on the front panel. When the GT or LT option is used, a time value must be sent to define the limit. When the RANGE option is used, two time values must be sent to define the lower and upper limit. The correct syntax for the RANGE option is :TRIGGER:CONDITION RANGE, <range\_low>, <range\_high>.

The holdoff time is set in the Pattern Trigger Mode with the :TRIGGER:HOLDOFF command.

---

## The State Trigger Mode

When the State Trigger Mode is selected, the `:TRIGGER:SOURCE` command is used to select the clock source. The syntax for selecting channel 2 as the clock source is `:TRIGGER:SOURCE CHANNEL2`.

After the clock source is selected, the correct edge for the clock can be selected using the `:TRIGGER:SLOPE` command, which can be set to `NEGATIVE` or `POSITIVE`.

The `:TRIGGER:PATH` command can be used with the `:TRIGGER:LOGIC` command to set the three bit logic pattern to qualify the clock trigger. These commands can be sent using the syntax `:TRIGGER:PATH CHAN2;:TRIGGER:LOGIC LOW`, or `:TRIGGER:PATH CHAN2; LOGIC LOW`.

In this trigger mode, the `:TRIGGER:LEVEL` command defines the voltage that determines if the input voltage is a logic high or a logic low for the logic triggers.

The `:TRIGGER:CONDITION` command sets the "is/is not present" state using the parameters `TRUE` for "is present" and `FALSE` for "is not present."

In the State Trigger Mode, a holdoff value can be set as in all other modes.

## The Delay Trigger Mode

In the Delay Trigger Mode, the TRIGGER:QUALIFY command can be used to select the EDGE, PATTERN, or STATE mode as a qualifier. When the EDGE qualifier is selected, all Edge parameters and commands can be used to set the Source and Slope. When the PATTERN qualifier is selected, all Pattern commands can be used to set the pattern mode parameters. When the STATE qualifier is selected, all State commands can be used to set the state mode parameters.

The next settings (in front panel order) are the delay settings. The DELAY command is used to set the Time or Count parameter and the amount of delay. To set the delay to time use the command :TRIGGER:DELAY TIME, <time>. To set the delay to count use the command :TRIGGER:DELAY EVENT <number\_events>.

If the trigger delay is set to Event (count) you can then set the delay source and slope. To set the delay source, use the command :TRIGGER:DELAY:SOURCE CHANNEL2. To set the delay slope, use the command TRIGGER:DELAY:SLOPE POSITIVE.

The values within the front-panel "trigger on" field are set with the OCCURRENCE command. To set the number of occurrences to 3333, use the command syntax TRIGGER:OCCURRENCE 3333. To set the source for the number of occurrences to channel 2, use the command syntax :TRIGGER:OCCURRENCE:SOURCE CHANNEL2. To set the slope of the trigger occurrence to negative, use the command syntax :TRIGGER:OCCURRENCE:SLOPE NEGATIVE.

---

## The TV Trigger Mode

The TV Trigger Mode is used for triggering on clamped television signals. This mode allows you to select one of the TV signal frames and one of the lines within that frame.

Once the TV Trigger Mode is selected, the Television Signal Standard can be selected using the `:TRIGGER:STANDARD` command. The three parameters for this command are 525, 625, and USER. Any of these modes allow you to select the trigger level and the source of the trigger signal.

The trigger level is set by sending the command `:TRIGGER:LEVEL <value >`.

The trigger source is set by sending the `:TRIGGER:SOURCE` command. This command allows you to select channel 1 or channel 2 as the trigger source.

With the standard set to 525 or 625, the commands that can be used are POLARITY, FIELD, and LINE. The POLARITY command sets the edge for the trigger. This edge can be set to NEGATIVE or POSITIVE. The FIELD command selects the first or second field of the television signal. The LINE command specifies the horizontal line in which the instrument will trigger on. Refer to the LINE command to determine the correct values.

The HOLDOFF value can also be set in the TV trigger mode, as in all modes.

When the USER (user defined) standard is selected, the source and level are set in the same manner as before.

The QUALIFY command is used to set the "qualify on" field. This command can be set to HIGH or LOW.

The edge defined by the QUALIFY command must occur within the range of time values that are displayed in the front panel field. The TRIGGER:CONDITION RANGE command sets the greater than and less than time values. In order to actually generate a trigger, the qualified conditions must be met within the specified time. To set the time values, send the command :TRIGGER:CONDITION RANGE, <greater\_than\_value>, <less\_than\_value>.

The field, "trigger on," is set with the OCCURRENCE command and OCCURRENCE:SLOPE command. To set the number of occurrences, send the command :TRIGGER:OCCURRENCE <number>. To set the slope for the occurrences, send the command :TRIGGER:OCCURRENCE:SLOPE <slope>. The slope can be set to POSITIVE or NEGATIVE.

The description for each command tells you in which modes that command is valid.

## CENTERed

---

### CENTERed

### command

The `:TRIGGER:CENTERED` command sets the trigger level to the centered mode (at the center of the graph) when the internal source is selected. This command is not valid when the external source is selected.



To return to the ADJUST mode, specify a level with the `TRIGGER:LEVEL` command.

**Command Syntax:** `:TRIGger:CENTerEd`

**Example:** `OUTPUT 707;":TRIGGER:SOURCE CHANNEL1"` !select trigger source  
`OUTPUT 707;":TRIGGER:CENTERED"`

**CONDition****CONDition****command/query**

The `:TRIGGER:CONDITION` command is valid in the `PATTERN`, `STATE`, `DELAY`, and `TV` trigger modes. The time values entered using this command are rounded to the nearest 10 ns.

In the **Pattern Trigger Mode**, the valid arguments for the `CONDITION` command are `ENTER`, `EXIT`, `GT`, `LT`, `RANGE`.

In the **Pattern Trigger Mode**, the `CONDITION` command is used to specify whether the trigger is generated upon entering (`ENTER`) or leaving (`EXIT`) the specified logic pattern. Also, the `CONDITION` command specifies whether the pattern must be present for a specified amount of time. The time in the pattern trigger mode can be greater than a value (`GT`), less than a value (`LT`), or between two values (`RANGE`). These settings can also be specified from the front panel using the "when" key in the **Pattern Trigger Mode**.

In the **State Trigger Mode**, the valid parameters for the `CONDITION` command are `TRUE` (is present) and `FALSE` (is not present).

In the **Delay Trigger Mode**, the `CONDITION` command is valid when `PATTERN` or `STATE` is selected as the qualifier. All arguments for this command that are valid in the **Pattern** or **State Trigger Modes** are valid here.

In the **TV Trigger Mode**, the `CONDITION` command is used to set the range of time values on which the trigger occurs. This command is only valid in the "user defined" mode.

The `CONDITION` query returns the currently selected condition for the currently selected mode.

## CONDition

---

**Command Syntax:** :TRIGger:CONDition <argument>

Where in **PATTERN** or **DELAY:PATTERN** mode:

<argument> ::= {ENTer | EXIT | GT,<value> | LT,<value> |  
RANGe,<range\_gt>,<range\_lt>}

Where in **STATE** or **DELAY:STATE** mode:

<argument> ::= {TRUE | FALSE}

Where in **TV** mode:

<argument> ::= RANGe,<range\_gt>,<range\_lt>

Where:

<value> ::= 20 ns to 160 ms

<range\_gt> ::= 20 ns to 159.999 ms (must be less than range\_lt)

<range\_lt> ::= 30 ns to 160 ms (must be greater than range\_gt)

**Example:** OUTPUT 707;":TRIGGER:MODE PATTERN" !select trigger mode  
OUTPUT 707;":TRIG:COND RANGE,22ms,33ms"

## CONDition

**Query Syntax:** :TRIGger:CONDition?

**Returned Format:** [:TRIGger:CONDition] <argument><NL>

**Where in PATTERN or DELAY PATTERN mode:**

<argument> ::= {ENTer | EXIT | GT,<value> | LT,<value> |  
RANGe,<range\_gt>,<range\_lt>}

**Where in STATE or DELAY STATE mode:**

<argument> ::= {TRUE | FALSE}

**Where in TV mode:**

<argument> ::= RANGe,<range\_gt>,<range\_lt>

**Where:**

<value> ::= 20 ns to 160 ms

<range\_gt> ::= 20 ns to 159.999 ms (must be less than range\_lt)

<range\_lt> ::= 30 ns to 160 ms (must be greater than range\_gt)

**Example:** DIM Con\$[50]  
OUTPUT 707;":TRIGGER:CONDITION?"  
ENTER 707;Con\$  
PRINT Con\$

## COUPLing

---

### COUPLing

### command/query

The `:TRIGGER:COUPLING` command selects the input coupling for the selected external trigger source. The coupling can be set to DC or DCFifty. The DCFifty parameter places a 50  $\Omega$  load on the trigger input.

The COUPLING query returns the current selection.

**Command Syntax:** `:TRIGger:COUPling {DC | DCFifty}`

**Example:** `OUTPUT 707;":TRIGGER:COUPLING DC"`

**Query Syntax:** `:TRIGger:COUPling?`

**Returned Format:** `[ :TRIGger:COUPling ] {DC | DCFifty}<NL>`

**Example:**  
`DIM Mode$[50]`  
`OUTPUT 707;":TRIG:COUP?"`  
`ENTER 707;Mode$`  
`PRINT Mode$`

**DElAy****DElAy****command/query**

The **:TRIGGER:DELAY** command is valid only in the **Delay Trigger Mode**. This command sets a delay value in either time or number of events. In the time delay mode, this command specifies the delay value in seconds. In the events delay mode, this command specifies the delay value in number of trigger events.

The **DELAY** query returns the current delay value.

**Command Syntax:** `:TRIGger:DElAy {TIME,<time_value> | EVENT,<event_value>}`

**Where:**

`<time_value>` ::= amount of delay from 30 ns to 160 ms  
`<event_value>` ::= number of events from 1 to 16000000

**Example:** `OUTPUT 707;":TRIGGER:MODE DELAY" !select trigger mode`  
`OUTPUT 707;":TRIGGER:DELAY TIME,1.23E-01"`

**Query Syntax:** `:TRIGger:DElAy?`

**Returned Format:** `[[:TRIGger:DElAy] {TIME,<time_value> | EVENT,<event_value>}<NL>`

**Where:**

`<time_value>` ::= amount of delay from 30 ns to 160 ms  
`<event_value>` ::= number of events from 1 to 16000000

**Example:** `DIM Value$[50]`  
`OUTPUT 707;":TRIG:DELAY?"`  
`ENTER 707;Value$`  
`PRINT Value$`

## DElay:SLOPe

---

### DElay:SLOPe

### command/query

The :TRIGGER:DELAY:SLOPE command selects the edge that will be counted by the delay command. The parameters for this command are **NEGATIVE** or **POSITIVE**. This command is only valid in the **Delay Trigger Mode**.

The DELAY:SLOPE query returns the current delay slope.

**Command Syntax:** :TRIGger:DElay:SLOPe {POSitive | NEGative}

**Example:** OUTPUT 707;":TRIGGER:MODE DELAY" !select trigger mode  
OUTPUT 707;":TRIG:DEL:SLOP POS"

**Query Syntax:** :TRIGger:DElay:SLOPe?

**Returned Format:** [:TRIGger:DElay:SLOPe] {POSitive | NEGative}<NL>

**Example:** DIM Tos\$[50]  
OUTPUT 707;":TRIGGER:DELAY:SLOP?"  
ENTER 707;Tos\$  
PRINT Tos\$

**DElay:SOURce****DElay:SOURce****command/query**

The **:TRIGGER:DELAY:SOURCE** command selects the source that is counted by the delay command. The parameters for this command are **CHANNEL1**, **CHANNEL2**, or **EXTERNAL**. This command is only valid in the **Delay Trigger Mode**.

The **DELAY:SOURCE** query returns the source of the delay in the **Delay Trigger Mode**.

**Command Syntax:** `:TRIGger:DElay:SOURce {CHANne11 | CHANne12 | EXTerna1}`

**Example:** `OUTPUT 707;":TRIGGER:MODE DELAY" !select trigger mode  
OUTPUT 707;":TRIG:DEL:SOURCE CHANNEL2"`

**Query Syntax:** `:TRIGger:DElay:SOURce?`

**Returned Format:** `[ :TRIGger:DElay:SOURce ] {CHANne11 | CHANne12 | EXTerna1}<NL>`

**Example:** `DIM Tos$[50]  
OUTPUT 707;":TRIGGER:DELAY:SOUR?"  
ENTER 707;Tos$  
PRINT Tos$`

## FIELD

---

### FIELD

### command/query

The `:TRIGGER:FIELD` command is only valid in the **TV Trigger Mode**. This command selects the field of the TV signal when the **STANDARD** is set to 525 or 625. The valid parameters for this command are 1 or 2.

If the `:TRIGGER:FIELD` command is set in any other trigger mode, error -221, "Settings conflict," is placed in the error queue.

The `FIELD` query returns the current setting of the `FIELD` command.

**Command Syntax:** `:TRIGger:FIELD { 1 | 2 }`

**Example:** `OUTPUT 707;":TRIGGER:MODE TV" !select trigger mode`  
`OUTPUT 707;":TRIGGER:FIEL 2"`

**Query Syntax:** `:TRIGger:FIELD?`

**Returned Format:** `[:TRIGger:FIELD] { 1 | 2 }<NL>`

**Example:** `DIM F$ [50]`  
`OUTPUT 707;":TRIG:FIELD?"`  
`ENTER 707:F$`  
`PRINT F$`

**HOLDoff****HOLDoff****command/query**

The **:TRIGGER:HOLDOFF** command is valid in the **Edge, Pattern, State, and TV Trigger Modes**. The **HOLDOFF** command enters a holdoff value in terms of time or events.

The **HOLDOFF** query returns the value of the holdoff for the current mode.

**Command Syntax:** `:TRIGGER:HOLDoff {TIME,<holdoff_value> | EVENT,<event_argument>}`

**Where:**

`<holdoff_value>` ::= 40 ns to 320 ms rounded to nearest 20 ns increment.  
`<event_argument>` ::= 1 to 16000000

**Examples:** `OUTPUT 707;":TRIGGER:HOLDOFF TIME,216 US"`

`OUTPUT 707;":TRIGGER:HOLDOFF EVENT,10"`

**Query Syntax:** `:TRIGGER:HOLDoff?`

**Returned Format:** `[[:TRIGGER:HOLDoff] {TIME,<holdoff_value> | EVENT,<event_argument>}<NL>`

**Where:**

`<holdoff_value>` ::= 40 ns to 320 ms (exponential - NR3 format)  
`<event_argument>` ::= 1 to 16000000 (integer - NR1 format)

**Example:**

```
DIM Ho$[50]
OUTPUT 707;":TRIGGER:HOLD?"
ENTER 707;Ho$
PRINT Ho$
```

**LEVe1****LEVe1****command/query**

The **:TRIGGER:LEVEL** command sets the trigger level voltage of the active trigger. This command can be sent in any mode; however, only two separate levels are stored. One value is kept for the TV Trigger Mode and another value is kept for all other modes. If you are in the Pattern Trigger Mode and set a trigger level value, that level is also used for the Edge, State, and Delay Trigger Modes.

The **LEVEL** query returns the trigger level of the current trigger mode.

**Command Syntax:** `:TRIGger:LEVe1 <level>`

**Where:**

`<level>` ::= for internal triggers,  $\pm 1.5 \times$  full-scale voltage from center screen.  
for external triggers,  $\pm 2$  volts with probe attenuation at 1:1.

**Examples:** `OUTPUT 707;":TRIGGER:LEVEL .30"`

`OUTPUT 707;":TRIGGER:LEV 300MV"`

`OUTPUT 707;":TRIG:LEV 3E-1"`

Refer to chapter 22, "Message Communication and System Functions" for the syntax of using values with multipliers.

**Query Syntax:** `:TRIGger:LEVe1?`

**Returned Format:** `[[:TRIGger:LEVe1] <level><NL>`

**Where:**

`<level>` ::= trigger level in volts (exponential - NR3 format)

**Example:**  
`DIM Tlevel$[30]`  
`OUTPUT 707;":TRIGGER:LEVEL?"`  
`ENTER 707;Tlevel$`  
`PRINT Tlevel$`

**LINE****LINE****command/query**

The **:TRIGGER:LINE** command specifies the horizontal line in which the instrument will trigger on. The **LINE** command is valid in the **TV Trigger Mode** when the **STANDARD** selected is 525 or 625. If one of these standards is selected when the **TV Trigger Mode** is entered, the line value is set in that standard and selected field.

The **LINE** query returns the current line of the selected standard.

**Command Syntax:** `:TRIGger:LINE <line_number>`

**Where:**

`<line_number> ::= 1 to 625 (depends on STANDARD and FIELD selection).`

**Example:**

```
OUTPUT 707;":TRIGGER:MODE TV"      !select trigger mode
OUTPUT 707;":TRIGGER:STANDARD 525" !select TV signal standard
OUTPUT 707;":TRIG:LINE 22"
```

**Query Syntax:** `:TRIGger:LINE?`

**Returned Format:** `[ :TRIGger:LINE ] <line_number><NL>`

**Where:**

`<line_number> ::= 1 to 625 (depends on STANDARD and FIELD selection).  
(integer - NR1 format)`

**Example:**

```
DIM Ln$[50]
OUTPUT 707;":TRIGGER:LINE?"
ENTER 707;Ln$
PRINT Ln$
```

## LOGic

---

### LOGic

### command/query

The :TRIGGER:LOGIC command is valid in the **Pattern** and **State Trigger Modes**, as well as the **DELAY Trigger Mode** when qualifying by **PATTERN** or **STATE**. The **LOGIC** command specifies the relationship between the signal and the defined voltage level that must exist before that part of the pattern is considered valid. If the signal on a selected path is greater than the trigger level, that signal is considered **HIGH**. If the signal is less than the trigger level, it is considered **LOW**.

The **LOGIC** query returns the last specified logic level of the currently enabled path.

**Command Syntax:** :TRIGger:LOGic {HIGH | LOW | DONTcare}

**Example:** OUTPUT 707;":TRIGGER:MODE DELAY" !select trigger mode  
 OUTPUT 707;":TRIGGER:QUALIFY PATTERN" !qualify trigger  
 OUTPUT 707;":TRIG:LOGIC DONT"

**Query Syntax:** :TRIGger:LOGic?

**Returned Format:** [:TRIGger:LOGic] {HIGH | LOW | DONTcare}<NL>

**Example:** DIM L\$[50]  
 OUTPUT 707;":TRIGGER:LOGIC?"  
 ENTER 707;L\$  
 PRINT L\$

**MODE****MODE****command/query**

The `:TRIGGER:MODE` command selects the trigger mode. This command can be sent from any trigger mode.

The `MODE` query returns the currently selected trigger mode.

**Command Syntax:** `:TRIGger:MODE {EDGE | PATtern | STATe | DELay | TV}`

**Example:** `OUTPUT 707;":TRIGGER:MODE PATT"`

**Query Syntax:** `:TRIGger:MODE?`

**Returned Format:** `[[:TRIGger:MODE] {EDGE | PATtern | STATe | DELay | TV}<NL>`

**Example:**  
`DIM Mode${50}`  
`OUTPUT 707;":TRIGGER:MODE?"`  
`ENTER 707;Mode$`  
`PRINT Mode$`

## OCCurrence

---

### OCCurrence

### command/query

The `:TRIGGER:OCCURRENCE` command sets the number of trigger events that must occur before the oscilloscope is actually triggered. This command is valid in the **Delay Trigger Mode** and in the **TV Trigger Mode**.

The `OCCURRENCE` query returns the current value of the `OCCURRENCE` command when the oscilloscope is in the **Delay Trigger Mode**, or in the **TV Trigger Mode** with **USER DEFINED** selected.

**Command Syntax:** `:TRIGger:OCCurrence <occ_number>`

Where:

`<occ_number> ::= 1 to 16000000`

**Example:** `OUTPUT 707;":TRIGGER:MODE DELAY" !select trigger mode`  
`OUTPUT 707;":TRIGGER:OCC 14"`

**Query Syntax:** `:TRIGger:OCCurrence?`

**Returned Format:** `[[:TRIGger:OCCurrence] <occ_number><NL>`

Where:

`<occ_number> ::= 1 to 16000000 (integer - NR1 format)`

**Example:** `DIM 0c$[50]`  
`OUTPUT 707;":TRIGGER:OCCURRENCE?"`  
`ENTER 707;0c$`  
`PRINT 0c$`

## OCCurrence:SLOPe

### OCCurrence:SLOPe

### command/query

The `:TRIGGER:OCCURRENCE:SLOPE` command selects the edge that will be counted by the occurrence command. The parameters for this command are `NEGATIVE` or `POSITIVE`. This command is valid in the **Delay Trigger Mode** and the **TV Trigger Mode**.

The `OCCURRENCE:SLOPE` query returns the slope of the current mode.

**Command Syntax:** `:TRIGger:OCCurrence:SLOPe {POSitive | NEGative}`

**Example:**  
`OUTPUT 707;":TRIGGER:MODE DELAY" !select trigger mode`  
`OUTPUT 707;":TRIG:OCC:SLOP POS"`

**Query Syntax:** `:TRIGger:OCCurrence:SLOPe?`

**Returned Format:** `[:TRIGger:OCCurrence:SLOPe] {POSitive | NEGative}<NL>`

**Example:**  
`DIM Tos$[50]`  
`OUTPUT 707;":TRIGGER:OCCURRENCE:SLOP?"`  
`ENTER 707;Tos$`  
`PRINT Tos$`

## OCCurrence:SOURce

---

### OCCurrence:SOURce

### command/query

The :TRIGGER:OCCURRENCE:SOURCE command selects the source that will be counted by the occurrence command. The parameters for this command are CHANNEL1, CHANNEL2, or EXTERNAL. This command is valid only in the **Delay Trigger Mode**.

The OCCURRENCE:SOURCE query returns the source of the occurrence in the Delay Trigger Mode.

**Command Syntax:** :TRIGger:OCCurrence:SOURce {CHANne11 | CHANne12 | EXTerna1}

**Example:** OUTPUT 707;":TRIGGER:MODE DELAY" !select trigger mode  
OUTPUT 707;":TRIG:OCC:SOURCE CHANNEL2"

**Query Syntax:** :TRIGger:OCCurrence:SOURce?

**Returned Format:** [:TRIGger:OCCurrence:SOURce] {CHANne11 | CHANne12 | EXTerna1}<NL>

**Example:** DIM Tos\$[50]  
OUTPUT 707;":TRIGGER:OCCURRENCE:SOUR?"  
ENTER 707;Tos\$  
PRINT Tos\$

**PATH****PATH****command/query**

The **:TRIGGER:PATH** command is valid in the **Pattern Trigger Mode, State Trigger Mode, and Delay Trigger Mode** when "qualify on" pattern or state is selected. This command selects a pattern bit as the source for future logic commands.

The **PATH** query returns the current trigger source of the present mode.

**Command Syntax:** `:TRIGger:PATH {CHANne11 | CHANne12 | EXTerna1}`

**Example:**

```
OUTPUT 707;":TRIGGER:MODE PATTERN" !select trigger mode
OUTPUT 707;":TRIGGER:PATH CHANNEL2"
OUTPUT 707;":TRIGGER:LOGIC HIGH" !select logic level
```

**Query Syntax:** `:TRIGger:PATH?`

**Returned Format:** `[[:TRIGger:PATH] {CHANne11 | CHANne12 | EXTerna1}<NL>`

**Example:**

```
DIM Tp$[50]
OUTPUT 707;":TRIG:PATH?"
ENTER 707;Tp$
PRINT Tp$
```

## POLarity

---

### POLarity

### command/query

The `:TRIGGER:POLARITY` command is valid only in the **TV Trigger Mode**. This command sets the polarity for the trigger when the **STANDARD** is set to 525 or 625. The valid parameters for this command are **POSITIVE** and **NEGATIVE**.

The **POLARITY** query returns the current polarity setting.

**Command Syntax:** `:TRIGger:POLarity {POSitive | NEGative}`

**Example:**  
`OUTPUT 707;":TRIGGER:MODE TV" !select trigger mode`  
`OUTPUT 707;":TRIGGER:POL NEGATIVE"`

**Query Syntax:** `:TRIGger:POLarity?`

**Returned Format:** `[[:TRIGger:POLarity] {POSitive | NEGative}<NL>`

**Example:**  
`DIM Tp$[50]`  
`OUTPUT 707;":TRIG:POL?"`  
`ENTER 707;Tp$`  
`PRINT Tp$`

**PROBe****PROBe****command/query**

The `:TRIGGER:PROBE` command is valid only for external triggers. It specifies the attenuation factor for the external trigger probe.

The `PROBE` query returns the current setting.

**Command Syntax:** `:TRIGger:PROBe <attenuation_factor>`

**Where:**

`<attenuation_factor> ::= .9 to 1000 (exponential - NR3 format)`

**Example:** `OUTPUT 707;":TRIGGER:SOURCE EXTERNAL" !select trigger source  
OUTPUT 707;":TRIGGER:PROBE 10"`

**Query Syntax:** `:TRIGger:PROBe?`

**Returned Format:** `[:TRIGger:PROBe] <attenuation_factor><NL>`

**Where:**

`<attenuation_factor> ::= .9 to 1000 (exponential - NR3 format)`

**Example:** `DIM Af$[50]  
OUTPUT 707;":TRIG:PROB?"  
ENTER 707;Af$  
PRINT Af$`

## QUALify

---

### QUALify

### command/query

The **:TRIGGER:QUALIFY** command is valid in the **Delay** and **TV Trigger Mode**. When you are in the **Delay Trigger Mode**, the parameters for this command are:

- EDGE
- PATTERN
- STATE

In the **TV Trigger Mode**, the parameters for this command are:

- LOW
- HIGH

The **QUALIFY** query returns the current setting of the **QUALIFY** command in the currently selected mode.

**Command Syntax:** `:TRIGger:QUALify <qualify_parameter>`

**Where in Delay Trigger Mode:**

`<qualify_parameter> ::= {EDGE | PATTern | STATe}`

**Where in TV Trigger Mode:**

`<qualify_parameter> ::= {LOW | HIGH}`

**Example:** `OUTPUT 707;":TRIGGER:MODE DELAY" !select trigger mode  
OUTPUT 707;":TRIGGER:QUALIFY PATT"`

**Query Syntax:** `:TRIGger:QUALify?`

**Returned Format:** `[[:TRIGger:QUALify] {EDGE | PATTern | STATe | LOW | HIGH}<NL>`

**Example:** `DIM Tq$[50]  
OUTPUT 707;":TRIG:QUALIFY?"  
ENTER 707;Tq$  
PRINT Tq$`

**SENSitivity****SENSitivity****command/query**

The `:TRIGGER:SENSITIVITY` command sets the trigger sensitivity for the selected source. `NORMAL` corresponds to noise reject off and `LOW` corresponds to noise reject on.

The `SENSITIVITY` query returns the current sensitivity for the selected source.

**Note** 

Trigger sensitivity cannot be set for the `EXTERNAL` trigger source.

**Command Syntax:** `:TRIGger:SENSitivity {NORMal | LOW}`

**Example:** `OUTPUT 707;":TRIGGER:SOURCE CHANNEL1"` !select trigger source  
`OUTPUT 707;":TRIGGER:SENSITIVITY LOW"`

**Query Syntax:** `:TRIGger:SENSitivity?`

**Returned Format:** `[:TRIGger:SENSitivity] {NORMal | LOW}<NL>`

**Example:** `DIM Sens$[50]`  
`OUTPUT 707;":TRIG:SENS?"`  
`ENTER 707;Sens$`  
`PRINT Sens$`

## SLOPe

---

### SLOPe

### command/query

The `:TRIGGER:SLOPE` command specifies the slope of the edge for the trigger. The `SLOPE` command is valid in the **Edge Trigger Mode**, **State Trigger Mode**, and **Delay Trigger Mode** when `EDGE` or `STATE` is selected as the qualifier.

The `SLOPE` query returns the current slope for the currently selected trigger mode.

**Command Syntax:** `:TRIGger:SLOPe {NEGative | POSitive}`

**Example:**

```
OUTPUT 707;":TRIGGER:MODE DELAY"      !select trigger mode
OUTPUT 707;":TRIGGER:QUALIFY EDGE"    !qualify trigger
OUTPUT 707;":TRIGGER:SLOPE POSITIVE"
```

**Query Syntax:** `:TRIGger:SLOPe?`

**Returned Format:** `[ :TRIGger:SLOPe ] { POSitive | NEGative } <NL>`

**Example:**

```
DIM Ts$[50]
OUTPUT 707;":TRIG:SLOP?"
ENTER 707;Ts$
PRINT Ts$
```

**SOURce****SOURce****command/query**

The **:TRIGGER:SOURCE** command selects the channel that actually produces the trigger. The **SOURCE** command is valid in the **Edge Trigger Mode**, **State Trigger Mode**, **Delay Trigger Mode**, and **TV Trigger Mode**. In the **Delay Trigger Mode** this command is valid when **EDGE** or **STATE** is selected as the qualifier.

The **SOURCE** query returns the current source for the selected trigger mode.

**Command Syntax:** `:TRIGger:SOURce {CHANne11 | CHANne12 | EXTerNa1}`

**Example:** `OUTPUT 707;":TRIGGER:SOURCE CHAN2"`

**Query Syntax:** `:TRIGger:SOURce?`

**Returned Format:** `[[:TRIGger:SOURce] {CHANne11 | CHANne12 | EXTerNa1}<NL>`

**Example:**  
`DIM Src$[30]`  
`OUTPUT 707;":TRIGGER:SOURCE?"`  
`ENTER 707;Src$`  
`PRINT Src$`

## STANdard

---

### STANdard

### command/query

The `:TRIGGER:STANDARD` command selects the television signal standard to be used in the **TV Trigger Mode**. The valid parameters for this command are 525, 625, and USER (user defined).

The `STANDARD` query returns the currently selected standard.

**Command Syntax:** `:TRIGger:STANdard {525 | 625 | USER}`

**Example:** `OUTPUT 707;":TRIGGER:MODE TV" !select trigger mode`  
`OUTPUT 707;":TRIGGER:STANdard USER"`

**Query Syntax:** `:TRIGger:STANdard?`

**Returned Format:** `[:TRIGger:STANdard] {525 | 625 | USER}<NL>`

**Example:** `DIM Ts$[50]`  
`OUTPUT 707;":TRIG:STANDARD?"`  
`ENTER 707;Ts$`  
`PRINT Ts$`

## Waveform Subsystem

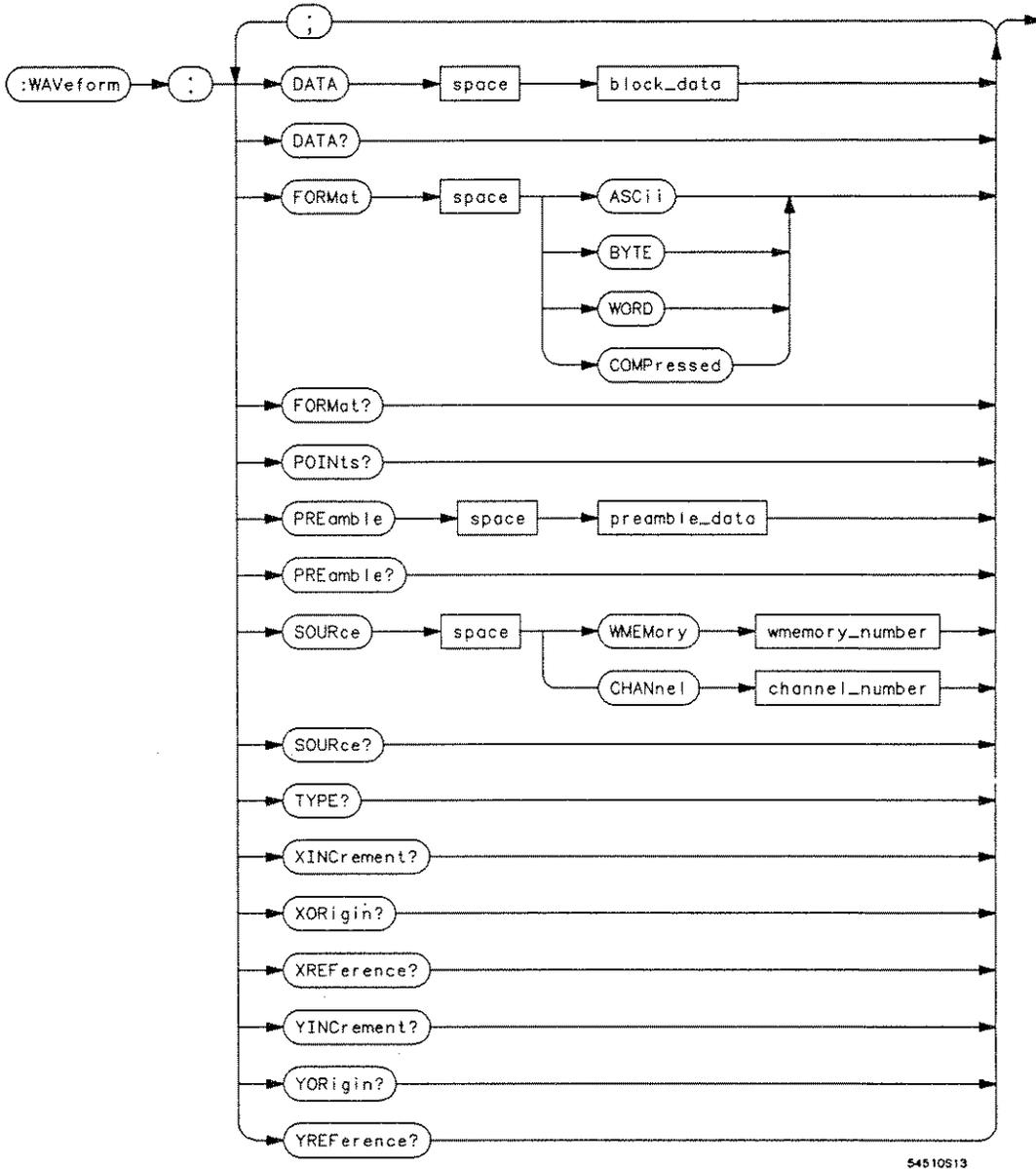
---

### Introduction

The WAVEFORM subsystem is used to transfer waveform data between a controller and the HP 54510A's waveform memories. This subsystem contains the following commands:

- DATA
- FORMat
- POINTs
- PREamble
- SOURce
- TYPE
- XINcrement
- XORigin
- XREFerence
- YINcrement
- YORigin
- YREFerence

Figure 18-1 lists the syntax diagrams for the Waveform subsystem commands.



54510S13

Figure 18-1. Waveform Subsystem Commands Syntax Diagram

<b>channel_number =</b>	an integer, 1 or 2.
<b>block_data =</b>	block data in IEEE 488.2 # format.
<b>preamble_data =</b>	refer to the PREAMBLE command.
<b>wmemory_number =</b>	an integer, 1 through 4.

Figure 18-1. Waveform Subsystem Commands Syntax Diagram (continued)

## Waveform Data and Preamble

The waveform record is actually contained in two portions: the waveform data and the preamble. The waveform data is the actual data acquired for each point in the specified source. The preamble contains the information for interpreting the waveform data, which includes the number of points acquired, format of acquired data, and type of acquired data. The preamble also contains the X and Y increments, origins, and references for the acquired data, so that the raw data can be translated to time and voltage values.

The values set in the preamble are determined when the :DIGITIZE command is executed or when the front-panel STORE key is pressed. The preamble values are based on the settings of variables in the ACQUIRE subsystem, or they are based on the front-panel setup when the STORE key is pressed.

Although the preamble values can be changed with a controller, the way the data is acquired cannot be changed. Changing the preamble values cannot change the type of data that was actually acquired, the number of points actually acquired, etc. Therefore, you must use extreme caution when changing any waveform preamble values to ensure the data is still useful. For example, setting POINTS in the preamble to a value different from the actual number of points in the waveform results in inaccurate data.

The waveform data and preamble must be read by the controller or sent to the HP 54510A with two separate commands, DATA and PREAMBLE.

Sending consecutive :DIGITIZE commands may improve the data throughput. Refer to the Root Level Command :DIGITIZE in chapter 7 for more information.

---

## Data Acquisition Types

There are four types of waveform acquisition that can be selected with the :ACQUIRE:TYPE command: NORMAL, AVERAGE, ENVELOPE, and RAWDATA. When the data is acquired using the DIGITIZE command, the data is placed in the channel buffer of the specified source. However, during a RAWDATA acquisition, data is placed in a special rawdata buffer.

After a DIGITIZE command, the instrument is stopped. If the instrument is restarted, over the HP-IB or the front panel, the data acquired with the DIGITIZE command is overwritten.

With the exception of the rawdata mode, waveforms in the HP 54510A are either 500 or 8000 points long. The 8000 point record is available only in the real-time mode. The 500 point record is available in the repetitive or real-time mode.

### Realtime Mode 8000 Points

A realtime waveform consists of 8000 sample points. If the following conditions are met, all 8000 points are transferred over the bus:

- :ACQUIRE:POINTS is set to 8000.
- :WAVEFORM:DATA is requested.
- The specific channel or waveform memory contains realtime data.

During normal operation, only 500 or less of these 8000 points are displayed on screen. To get the points on screen, send the command :ACQUIRE:POINTS 500.

### 500 Points

When :ACQUIRE:POINTS is set to 500, the on-screen time is divided into 500 time buckets as in the repetitive mode. If less than 500 points of the realtime waveform fall into the on-screen time, an interpolation filter is applied to create exactly 500 points. Pan and zoom, as described in the front-panel reference, can be used to display more than 500 points on screen. In this case, the 500 points are the last points placed in each time bucket.

## Repetitive Modes

In the repetitive mode, the on-screen time is divided into 500 time buckets and all waveforms contain 500 points.

### Normal

Normal data consists of the last data point (hit) in each time bucket. This data is transmitted over HP-IB in a linear fashion starting with time bucket 0 and going through time bucket  $n - 1$ , where  $n$  is the number returned by the WAVEFORM:POINTS query. Only the magnitude values of each data point are transmitted. The first voltage value corresponds to the first time bucket on the left of the screen and the last value corresponds to the next to last time bucket on the right side of the screen. Time buckets that do not have data in them return -1.

The time values for each data point correspond to the position of the data point in the data array. These values are not transmitted.

### Average

Average data consists of the average of the first  $n$  hits in a time bucket, where  $n$  is the value returned by the ACQUIRE:COUNT query. Time buckets that have fewer than  $n$  hits return the average of what data they do have. If the :ACQUIRE:COMPLETE parameter is set to 100%, then each time bucket must contain the number of data hits specified with the :ACQUIRE:COUNT command. If a time bucket does not have any data in it, it returns -1. This data is transmitted over the HP-IB in a linear fashion, starting with time bucket 0 and proceeding through time bucket  $n - 1$ , where  $n$  is the number returned by the WAVEFORM:POINTS query. The first value corresponds to a point at the left side of the screen and the last value corresponds to one point away from the right side of the screen.

## Envelope

Envelope data consists of two arrays of data: one containing the minimum hits in each time bucket, and the other containing the maximum hits in each time bucket. If a time bucket does not have any hits in it, then  $-1$  is returned for both the minimum and maximum values. The two arrays are transmitted one at a time over the HP-IB linearly, starting with time bucket 0 (on the left side of the screen) and proceeding through time bucket  $m-1$ , where  $m$  is the value returned by the WAVEFORM:POINTS query. The array with the minimum values is sent first. The first value of each array corresponds to the data point on the left of the screen. The last value is one data point away from the right side of the screen.

The data is transferred from the channel buffer to a controller using the WAVEFORM:DATA query. Data is transferred into the instrument from a controller using the WAVEFORM:DATA command. Envelope data can be transferred into Waveform Memories 1 and 2, if WMEMORY 1 is specified as the source. If WMEMORY 3 is specified as the source, the envelope data can be transferred into Waveform Memories 3 and 4.

The data is transferred as two arrays. If Waveform Memory 1 is specified as the source, the first array is transferred into Waveform Memory 1 and the second array is transferred into Waveform Memory 2. If Waveform Memory 3 is specified as the source, the first array is transferred into Waveform Memory 3 and the second array is transferred into Waveform Memory 4. The data type is then changed to normal for each of the waveform memories.

**Rawdata** Rawdata is acquired with special routines that are optimized for quick fiso unloading. These routines do not filter the data and do not display the data on screen. As a result, rawdata can only be acquired with a digitize operation. Rawdata cannot be stored in memories or measured.

While acquiring data in the Rawdata mode, data is stored as uncalibrated 8-bit Gray code data in a large buffer. When all acquisitions are complete, the buffer is translated into unfiltered, calibrated 16-bit binary data and sent over the bus in the WORD format. The :WAVEFORM:FORMAT command has no effect in the Rawdata mode.

The RAWDATA command has two parameters: length and acquisitions. Length specifies the number of points of each acquisition. Acquisitions specify the number of acquisitions to be taken in a single digitize operation. The data is transferred from the oscilloscope in a single IEEE 488.2 data block. The number of bytes in the block can be determined with the following equation:

$$\text{Number of Bytes} = \text{Acquisitions} \times (\text{Length} \times 2 + 8)$$

The data block consists of two arrays. The first array consists of double precision 64-bit floating point numbers. This array contains the xorigin values of the waveform records to follow. It can read directly into a double precision real array in a controller allocated by the BASIC command ALLOCATE REAL Xorigins(1:Acquisitions). The xorigin values are also available in ASCII format using the :WAVEFORM:XORIGIN query. These xorigin values are accurate to within the timing resolution of the oscilloscope. A less accurate single xorigin value to within one sample time is supplied in the preamble for the rawdata record. All xorigin values in the array will be greater than or equal to the single xorigin value in the preamble.

The second array consists of 16-bit integer numbers. This data is transmitted in a linear fashion over HP-IB. It starts with sample zero of the first acquisition and continues through sample length-1 of the this acquisition. Then it continues in a similar fashion with sample zero through sample length-1 of the each following acquisition through the last acquisition. This array can be read directly into a two dimensional integer array allocated by the BASIC command ALLOCATE INTEGER Waveforms(1:Acquisitions, 1:Points).

---

## Data Conversion

Data sent from the HP 54510A must be scaled for useful interpretation. The values used to interpret the data are the X and Y references, X and Y origins, and X and Y increments. These values are read from the waveform preamble.

### Conversion from Data Value to Voltage

The following formula converts a data value from waveform memories 1 through 4, or channels 1 or 2, to a voltage value:

$$\text{voltage} = [(\text{data value} - \text{yreference}) * \text{yincrement}] + \text{yorigin}.$$

### Conversion from Data Value to Time

The time value of a data point can be determined by the position of the data point. As an example, the fourth data point sent with XORIGIN = 16 ns, XREFERENCE = 0, and XINCREMENT = 2 ns can be calculated using the following formula:

$$\text{time} = [(\text{data point number} - \text{xreference}) * \text{xincrement}] + \text{xorigin},$$

This would result in the following calculation:

$$\text{time} = [(3 - 0) * 2 \text{ ns}] + 16 \text{ ns} = 22 \text{ ns}.$$

---

## Data Format for HP-IB Transfer

There are four formats for transferring waveform data over the HP-IB: WORD, BYTE, COMPRESSED, and ASCII.

WORD, BYTE, and COMPRESSED formatted waveform records are transmitted using the arbitrary block program data format specified in IEEE 488.2. ASCII format block data does not use a block header.

When you use the block data format, the ASCII character string "#8<DD...D>" is sent prior to sending the actual data. The 8 indicates how many D's follow. The D's are ASCII numbers which indicate how many data bytes follow.

For example, if 500 points were acquired and the BYTE format was specified, the block header "#800000500" would be sent. The 8 indicates that eight length bytes follow, and 500 indicates that 500 binary data bytes follow.

### WORD Format

In the WORD format, the number of data bytes is twice the number of words (data points). The number of data points is the value returned by the :WAVEFORM:POINTS? query. The number of data bytes is followed by a sequence of bytes representing the data points, with the most significant byte of each word transmitted first. In this format the data is shifted so that the most significant bit after the sign bit contains the most significant bit of the data. If there is a hole in the data, the hole is represented by the 16-bit value of -1. The range of data in the WORD format is from 0 to 32640.

WORD format is useful in applications where the information is read directly into an integer array in a controller.

WORD and ASCII formatted data returns the most accurate data values.

**BYTE Format** The BYTE format allows only seven bits to be used to represent the voltage values, with the first bit being the sign bit. If there is a hole in the data, the hole is represented by a value of  $-1$ .

The BYTE-formatted data transfers over the HP-IB faster than WORD-formatted data, since one byte per point is transferred in BYTE format and two bytes per point are transferred in WORD format. The BYTE-formatted data has less resolution than WORD-formatted data.

**COMPRESSED Format** The number of bytes transmitted when the format is COMPRESSED is the same as the value returned by the WAVEFORM:POINTS? query.

Eight bits of resolution are retained in the COMPRESSED format. So that a hole in the data may be represented, a data value of 255 is mapped to 254, and 255 is used to represent a hole. This mode gives greater vertical precision than BYTE-formatted data, with faster transfer times than WORD-formatted data. On the other hand, the COMPRESSED mode probably requires more time after the transfer for data to be unpacked.

**ASCII Format** Waveform records in the ASCII format are transmitted one value at a time, separated by a comma. The data values transmitted are the same as the values sent in the WORD FORMAT except that they are converted to an integer ASCII format (six or less characters) before being sent over the HP-IB.

ASCII values cannot be used to transfer data into a controller.

**DATA****DATA****command/query**

The :WAVEFORM:DATA command transfers a waveform data record to the instrument over the HP-IB and stores it in the previously specified waveform memory. The waveform memory is specified with the :WAVEFORM:SOURCE command. Only waveform memories can have waveform data sent to them.

**Note** 

The HP 54510A only accepts 500 or 8000 point records. If you try to send variable length records (RAWDATA acquisition type) back into the HP 54510A, an error message appears on the screen.

The format of the data being sent must match the format previously specified by the waveforms preamble for the destination memory. The :WAVEFORM:DATA command does not accept ASCII data. However, the ASCII format can be specified for data output.

The DATA query outputs a waveform record to the controller over the HP-IB that is stored in a waveform memory or channel buffer previously specified with the :WAVEFORM:SOURCE command.

**Command Syntax:** :WAVEform:DATA <binary block data in # format>

**Query Syntax:** :WAVEform:DATA?

**Returned Format:** [:WAVEform:DATA] <binary block length bytes><binary block><NL>

## DATA

---

**Example:** The following program moves data from the HP 54510A to the controller and then back to the HP 54510A with the :WAVEFORM:DATA query and command.

```

10  CLEAR 707                                ! Initialize instrument interface
20  OUTPUT 707;":TIMEBASE:SAMPLE REPETITIVE" ! Select sample mode
30  ! Setup the Acquire subsystem
40  OUTPUT 707;":ACQUIRE:TYPE NORMAL"      ! Display mode to NORMAL
50  OUTPUT 707;":ACQUIRE:COUNT 1"
60  OUTPUT 707;":ACQUIRE:POINTS 500"
70  OUTPUT 707;":DIGITIZE CHANNEL1"        ! Acquire data
80  OUTPUT 707;":SYSTEM:HEADER OFF"        ! Headers off
90  OUTPUT 707;":WAVEFORM:SOURCE CHANNEL1" ! Channel 1 as waveform source
100 OUTPUT 707;":WAVEFORM:FORMAT WORD"     ! WORD format
110 OUTPUT 707;":WAVEFORM:DATA?"
120 ENTER 707 USING "#,2A,8D";Headers$,Bytes ! Read length byte
130 Length=Bytes
140 Length=Length/2
150 ALLOCATE INTEGER Waveform(1:Length)
160 ENTER 707 USING "#,W";Waveform(*)      ! Enter waveform data to integer array
170 ENTER 707 USING "-K,B";End$
180 DIM Preamble$[200]                     ! Dimension variable
190 OUTPUT 707;":WAVEFORM:PREAMBLE?"      ! Output waveform preamble to controller
200 ENTER 707 USING "-K";Preamble$
210 OUTPUT 707;":WAVEFORM:SOURCE WMEMORY4" ! Waveform memory 4 as source
220 OUTPUT 707 USING "#,K";":WAVEFORM:PREAMBLE ";Preamble$! Send preamble
221                                     ! from controller to WMEMORY 4
230 OUTPUT 707 USING "#,K";":WAVEFORM:DATA #800001000"! Send header
240 OUTPUT 707 USING "W";Waveform(*)      ! Send waveform data to WMEMORY 4
250 OUTPUT 707;":BLANK CHANNEL1"         ! Turn channel 1 off
260 OUTPUT 707;":VIEW WMEMORY4"         ! Turn WMEMORY 4 on
270  END

```

### Note



In program line 220, the space after :WAVEFORM:PREAMBLE and before the quotation mark is required.

**FORMat****FORMat****command/query**

The `:WAVEFORM:FORMAT` command sets the data transmission mode for waveform data output. This command controls how the data is formatted on the HP-IB when sent from the HP 54510A.

When the ASCII mode is selected, the data consists of ASCII digits with each data value separated by a comma. The ASCII mode cannot be used to transfer data into a controller.

WORD formatted data transfers as 16-bit binary integers in two bytes, with the most significant byte of each word sent first.

BYTE and COMPRESSED formatted data is transferred as 8-bit bytes.

The `FORMAT` query returns the current output format for the transfer of waveform data.

**Note**

The `:WAVEFORM:FORMAT` command has no effect in the Rawdata mode. In this mode, data is always transferred in the WORD format.

**Command Syntax:** `:WAVEform:FORMat {ASCIi | WORD | BYTE | COMPressed}`

**Example:** `OUTPUT 707;":WAVEFORM:FORMAT WORD"`

**Query Syntax:** `:WAVEform:FORMat?`

**Returned Format:** `[:WAVEform:FORMat] {ASCIi | WORD | BYTE | COMPressed}<NL>`

**Example:**

```
DIM Fmt$[30]
OUTPUT 707;":WAV:FORMAT?"
ENTER 707;Fmt$
PRINT Fmt$
```

## POINTs

---

### POINTs

### query

The `:WAVEFORM:POINTS` query returns the points value in the currently selected waveform preamble. The points value is the number of time buckets contained in the waveform selected with the `WAVEFORM:SOURCE` command.

**Query Syntax:** `:WAVEform:POINTs?`

**Returned Format:** `[:WAVEform:POINTs] {500 | 8000}<NL>`

**Example:**  
Dim Pts\$[50]  
OUTPUT 707;":WAV:POINTS?"  
ENTER 707;Pts\$  
PRINT Pts\$

## PREamble

### PREamble

### command/query

The `:WAVEFORM:PREAMBLE` command sends a waveform preamble to a previously selected waveform memory in the instrument.

The `PREAMBLE` query sends a waveform preamble to the controller from the waveform source.

In the Rawdata mode, the format is always 2 for `WORD`, and the number of acquisitions is returned by the count parameter. The count parameter returns 1 in all other modes.

**Command Syntax:** `:WAVEform:PREamble <preamble block>`

**Where:**

`<preamble block> ::= <format NR1>,<type NR1>,<points NR1>,<count NR1>,<xincrement NR3>,<xorigin NR3>,<xreference NR3>,<yincrement NR3>,<yorigin NR3>,<yreference NR3>`

**Query Syntax:** `:WAVEform:PREamble?`

**Returned Format:** `[ :WAVEform:PREamble ] <preamble block><NL>`

**Where:**

`<preamble block> ::= <format NR1>,<type NR1>,<points NR1>,<count NR1>,<xincrement NR3>,<xorigin NR3>,<xreference NR1>,<yincrement NR3>,<yorigin NR3>,<yreference NR1>`

**Where:**

`<format> ::=`

- 0 for ASCII format
- 1 for BYTE format
- 2 for WORD format
- 4 for COMPRESSED format

## PREamble

---

```
<type> ::=      0 for INVALID type
                 1 for Repetitive NORMAL type or Realtime
                 2 for Repetitive AVERAGE type
                 3 for Repetitive ENVELOPE type
                 4 for RAWDATA type
```

**Example:** This example program uses both the command and query form of the **PREAMBLE** command. First the preamble is queried (output to the controller). Then, the preamble is returned to a previously selected waveform memory.

```
10 OUTPUT 707;":ACQUIRE:TYPE NORMAL"
20 DIM Pre$[120]
30 OUTPUT 707;":SYSTEM:HEADER OFF"
40 OUTPUT 707;":WAVEFORM:PREAMBLE?"
50 ENTER 707 USING "-K";Pre$
60 OUTPUT 707 USING "#,K";":WAVEFORM:PREAMBLE ";Pre$
70 END
```

### Note



In line 60 of the program example, a space is inserted between the word "PREAMBLE " and the closed quotation mark. This space must be inside the quotation mark because in this format (#,K) the data is packed together. Failure to add the space produces a word that is not a proper command word.

**Example:** The following program example places the preamble in a numeric array.

```
10 OUTPUT 707;":ACQUIRE:TYPE NORMAL"
20 DIM Preamble(1:10)
30 OUTPUT 707;":SYSTEM:HEADER OFF"
40 OUTPUT 707;":WAVEFORM:PREAMBLE?"
50 ENTER 707 ;Preamble(*)
60 OUTPUT 707;":WAVEFORM:PREAMBLE ";Preamble(*)
70 END
```

**SOURCE****SOURCE****command/query**

The `:WAVEFORM:SOURCE` command selects the channel or waveform memory to be used as the source for the waveform commands.

The `SOURCE` query returns the currently selected source for the waveform commands.

**Command Syntax:** `:WAVEform:SOURCE {CHANne1{1 | 2} | WMEMory{1 | 2 | 3 | 4}}`

**Example:** `OUTPUT 707;":WAV:SOURCE WMEMORY3"`

**Query Syntax:** `:WAVEform:SOURCE?`

**Returned Format:** `[[:WAVEform:SOURCE] {CHANne1{1 | 2} | WMEMory{1 | 2 | 3 | 4}}<NL>`

**Example:**  
`DIM Src$[30]  
OUTPUT 707;":WAVEFORM:SOURCE?"  
ENTER 707;Src$  
PRINT Src$`

## TYPE

---

### TYPE

query

The :WAVEFORM:TYPE query returns the data type for the previously specified waveform source.

**Query Syntax:** :WAVEform:TYPE?

**Returned Format:** [:WAVEform:TYPE] {INValid | AVERage | ENVelope | NORMa1 | RAWData}<NL>

**Example:**  
DIM Typ\$[30]  
OUTPUT 707;":WAVEFORM:TYPE?"  
ENTER 707;Typ\$  
PRINT Typ\$

## XINCrement

### XINCrement

### query

The `:WAVEFORM:XINCREMENT` query returns the current x-increment value in the preamble for the current specified source. This value is the time difference between consecutive data points for `NORMAL`, `AVERAGE`, `ENVELOPE`, or `RAWDATA`.

For a 500 point waveform, the xincrement pixel width is in seconds. For 8000 point waveforms and `RAWDATA` waveforms, the xincrement value is the sample period. Therefore, these waveforms never contain the interpolated data points.

**Query Syntax:** `:WAVEform:XINCrement?`

**Returned Format:** `[:WAVEform:XINCrement] <value><NL>`

**Where:**

`<value>` ::= x-increment in the current preamble (exponential - NR3 format)

**Example:**

```
DIM Xin$[50]
OUTPUT 707;":WAV:XINCREMENT?"
ENTER 707;Xin$
PRINT Xin$
```

## XORigin

---

### XORigin

query

The :WAVEFORM:XORIGIN query returns the current x-origin value in the preamble for the current specified source. For a 500 point record, the x-origin value is the time of the first data point in the memory with respect to the trigger point. For an 8000 point record, the x-origin value is the point referenced by x-reference.

In the RAWDATA mode, the :WAVEFORM:XORIGIN query may return multiple values depending on the number of acquisitions specified. In this mode, the x-origin value is the time of the first data point in each acquisition.

#### Note

In the rawdata mode, the x-origin value returned by the preamble is the minimum time of the first point in memory that occurs in any acquired data record.

**Query Syntax:** :WAVEform:XORigin?

**Returned Format:** [:WAVEform:XORigin] <value>[,<value>]...<NL>

**Where:**

<value> ::= x-origin value in the current preamble (exponential - NR3 format)

**Example:**

```
DIM Xr$[50]
OUTPUT 707;":WAV:XORIGIN?"
ENTER 707;Xr$
PRINT Xr$
```

## XREFerence

### XREFerence

query

The :WAVEFORM:XREFERENCE query returns the current x-reference value in the preamble for the current specified source. This value specifies the number of the first point on the screen. For 500 point waveforms and the rawdata mode, xreference is zero. For 8000 point waveforms, xreference is the number of the first data point appearing on screen. This xreference value is between zero and 7999. The exact number depends on the sweep speed; left, center, or right reference; and the pan and zoom if the waveform is stopped.

**Query Syntax:** :WAVeform:XREFerence?

**Returned Format:** [:WAVeform:XREFerence] <value><NL>

**Where:**

<value> ::= x-reference value in the current preamble (integer - NR1 format)

**Example:**

```
DIM Xrf$[50]
OUTPUT 707;":WAV:XREFERENCE?"
ENTER 707;Xrf$
PRINT Xrf$
```

## YINCrement

---

### YINCrement

query

The :WAVEFORM:YINCREMENT query returns the current y-increment value in the preamble for the current specified source. This value is the voltage difference between consecutive data points.

**Query Syntax:** :WAVEform:YINCrement?

**Returned Format:** [:WAVEform:YINCrement] <value><NL>

**Where:**

<value> ::= y-increment value in the current preamble (exponential - NR3 format)

**Example:**

```
DIM Yin$[50]
OUTPUT 707;":WAV:YINCREMENT?"
ENTER 707;Yin$
PRINT Yin$
```

**YORigin****YORigin****query**

The :WAVEFORM:YORIGIN query returns the current y-origin value in the preamble for the current specified source. This value is the voltage at the center of the screen.

**Query Syntax:** :WAVEform:YORigin?

**Returned Format:** [:WAVEform:YORigin] <value><NL>

**Where:**

<value> ::= y-origin in the current preamble (exponential -NR3 format)

**Example:**

```
Dim Yr$[50]
OUTPUT 707;":WAV:YORIGIN?"
ENTER 707;Yr$
PRINT Yr$
```

## YREFerence

---

### YREFerence

query

The :WAVEFORM:YREFERENCE query returns the current y-reference value in the preamble for the current specified source. This value specifies the data point where the y-origin occurs.

**Query Syntax:** :WAVeform:YREFerence?

**Returned Format:** [:WAVeform:YREFerence] <value><NL>

**Where:**

<value> ::= y-reference value in the current preamble (integer - NR1 format)

**Example:**

```
DIM Yrf$[50]
OUTPUT 707;":WAV:YREFERENCE?"
ENTER 707;Yrf$
PRINT Yrf$
```

## Status Reporting

---

### Introduction

IEEE 488.2 defines data structures, commands, and common bit definitions for status reporting. There are also instrument-defined structures and bits.

The bits in the status byte act as summary bits for the data structures residing behind them. In the case of queues, the summary bit is set if the queue is not empty. For registers, the summary bit is set if any enabled bit in the event register is set. The events are enabled with the corresponding event enable register. Events captured by an event register remain set until the register is read or cleared. Registers are read with their associated commands. The \*CLS command clears all event registers and all queues except the output queue. If \*CLS is sent immediately following a program message terminator, the output queue is also cleared.



- Bit Definitions**
- MAV - message available.** Indicates whether there is a response in the output queue.
  - ESB - event status bit.** Indicates if any of the conditions in the Standard Event Status Register are set and enabled.
  - MSS - master summary status.** Indicates whether the device has a reason for requesting service. This bit is returned for the \*STB? query.
  - RQS - request service.** Indicates if the device is requesting service. This bit is returned during a serial poll. RQS is set to 0 after it is read via a serial poll (MSS is not reset by \*STB?).
  - MSG - Message.** Indicates whether there is a message in the message queue.
  - PON - power on.** Always 0 in the HP 54510A.
  - URQ - user request.** Indicates whether a front-panel key has been pressed.
  - CME - command error.** Indicates whether the parser detected an error.
  - EXE - execution error.** Indicates whether a parameter was out of range, or inconsistent with the current settings.
  - DDE - device specific error.** Indicates whether the device was unable to complete an operation for device dependent reasons.
  - QYE - query error.** Indicates whether the protocol for queries has been violated.
  - RQC - request control.** Indicates whether the device is requesting control. The HP 54510A never requests control.
  - OPC - operation complete.** Indicates whether the device has completed all pending operations.
  - LCL - local.** Indicates whether a remote-to-local transition has occurred.
  - TRG - trigger.** Indicates whether a trigger has been received.
  - LTF - limit test failure.** Indicates whether a limit test failure has occurred.

**Operation Complete (\*OPC)**

The IEEE 488.2 structure provides one technique which can be used to find out if any operation is finished. The \*OPC command, when sent to the instrument after the operation of interest, sets the OPC bit in the Standard Event Status Register when all pending device operations have finished. If the OPC bit and the RQS bit have been enabled, a service request is generated.

```
OUTPUT 707;"*SRE 32 ; *ESE 1" !enables an OPC service request
OUTPUT 707;"DIG CHAN1 ; *OPC" !initiates data acquisition, and
!generates a SRQ when the
!acquisition is complete
```

**Trigger Bit (TRG)**

The Trigger (TRG) bit indicates if the device has received a trigger. The TRG event register will stay set after receiving a trigger until it is cleared by reading it or using the \*CLS command. If your application needs to detect multiple triggers, the TRG event register must be cleared after each one.

If you are using the Service Request to interrupt a program or controller operation when the trigger bit is set, then you must clear the event register after each time it has been set.

```
OUTPUT 707;"*SRE 1" ! enables a trigger service request.
! the next trigger will generate an SRQ.

OUTPUT 707;" :TER?" ! queries the TRG event register, thus
ENTER 707;A$ ! clearing it.
! the next trigger can now generate an
! SRQ
```

**Status Byte**

If the device is requesting service (RQS set), and the controller serial polls the device, the RQS bit is cleared. The MSS bit (read with \*STB?) is not cleared by reading it. The status byte is not cleared when read, except for the RQS bit.

---

## Serial Poll

The HP 54510A supports the IEEE 488.1 serial poll feature. When a serial poll of the instrument is requested, the RQS bit is returned on bit 6 of the status byte.

### Using Serial Poll

This example shows how to use the service request by conducting a serial poll of all instruments on the bus. In this example, assume that there are two instruments on the bus: an oscilloscope at address 7 and a printer at address 1. These address assumptions are made throughout this manual. It is also assumed that you are operating on Interface Select Code 7.

The program command for serial poll using HP BASIC 5.0 is `Stat = SPOLL(707)`. The address 707 is the address of the oscilloscope in this example. The command for checking the printer is `Stat = SPOLL(701)` because the address of that instrument is 01 on bus address 7. This command reads the contents of the HP-IB Status Register into the variable called Stat. At that time bit 6 of the variable Stat can be tested to see if it is set (bit 6 = 1).

The serial poll operation can be conducted in the following manner:

1. Enable interrupts on the bus. This allows the controller to "see" the SRQ line.
2. If the SRQ line is high (some instrument is requesting service) then check the instrument at address 1 to see if bit 6 of its status register is high.
3. Disable interrupts on the bus.

4. To check whether bit 6 of an instrument's status register is high, use the following command line.

IF BIT (Stat, 6) then

5. If bit 6 of the instrument at address 1 is not high, then check the instrument at address 7 to see if bit 6 of its status register is high.
6. As soon as the instrument with status bit 6 high is found, check the rest of the status bits to determine what is required.

The S POLL(707) command causes much more to happen on the bus than simply reading the register. This command clears the bus, automatically addresses the talker and listener, sends SPE (serial poll enable) and SPD (serial poll disable) bus commands, and reads the data. For more information about serial poll, refer to your controller manual and programming language reference manuals.

After the serial poll is completed, the RQS bit in the HP 54510A Status Byte Register is reset if it was set. Once a bit in the Status Byte Register is set, it remains set until the status is cleared with a \*CLS command, or the instrument is reset. If these bits do not get reset, they cannot generate another SRQ.

## Error Messages

This chapter lists the error messages that are returned by the parser on the HP 54510A digitizing oscilloscope.

Error Number	Description
11	Questionable horizontal scaling
12	Edges required not found
13	Not a 54510A command
70	RAM write protected
-100	Command error (unknown command)
-101	Invalid character
-102	Syntax error
-103	Invalid separator
-104	Data type error
-105	GET not allowed
-108	Parameter not allowed
-109	Missing parameter
-112	Program mnemonic too long
-113	Undefined header
-121	Invalid character in number
-123	Numeric overflow
-124	Too many digits
-128	Numeric data not allowed
-130	Suffix error
-131	Invalid suffix
-138	Suffix not allowed
-140	Character data error
-141	Invalid character data
-144	Character data too long
-148	Character data not allowed

<b>Error Number</b>	<b>Description</b>
-150	String data error
-151	Invalid string data
-158	String data not allowed
-160	Block data error
-161	Invalid block data
-168	Block data not allowed
-170	Expression error
-171	Invalid expression
-178	Expression data not allowed
-200	Execution error
-211	Trigger ignored
-221	Settings conflict
-222	Data out of range
-223	Too much data
-310	System error
-350	Too many errors
-400	Query error
-410	Query INTERRUPTED
-420	Query UNTERMINATED
-430	Query DEADLOCKED
-440	Query UNTERMINATED after indefinite response

## Algorithms

---

### Introduction

One of the primary features of the HP 54510A is its ability to make automatic measurements on displayed waveforms. This chapter provides details on how automatic measurements are calculated and offers some tips on how to improve results.

---

### Measurement Setup

Measurements typically should be made at the fastest possible sweep speed for the most accurate measurement results. The entire portion of the waveform that is to be measured must be displayed on the oscilloscope:

- At least one complete cycle must be displayed for period or frequency measurements.
  - The entire pulse must be displayed for width measurements.
  - The leading edge of the waveform must be displayed for rise time measurements and all other edge measurements.
  - The trailing edge of the waveform must be displayed for fall time measurements and all other edge measurements.
- 

### Making Measurements

If more than one waveform, edge, or pulse is displayed, the measurements are made on the first (leftmost) portion of the displayed waveform that can be used. If there are not enough data points, the oscilloscope displays  $\leq$  with the measurement results. This is to remind you that the results may not be as accurate as possible. It is recommended that you re-scale the displayed waveform and make your measurement again.

When any of the standard measurements are requested, the HP 54510A first determines the top-base voltage levels at 100%-0%. From this information, it can determine the other important voltage values (10%, 90%, and 50%) needed to make the measurements. The 10% and 90% voltage values are used in the rise time and fall time measurements, as well as in all other edge measurements. The 10% and 90% values are also used to determine the 50% value. The 50% voltage value is used for measuring frequency, period, pulse width, and duty cycle.

---

## Automatic Top-Base

Top-Base is the heart of most automatic measurements. It is used to determine  $V_{top}$  and  $V_{base}$ , the 0% and 100% voltage levels at the top and bottom of the waveform. From this information the oscilloscope can determine the 10%, 50%, and 90% points, which are also used in most measurements. The top or base of the waveform is not necessarily the maximum or minimum voltage present on the waveform. Consider a pulse that has slight overshoot. It would be wrong to select the highest point of the waveform as the top since the waveform normally rests below the perturbation.

Top-Base performs a histogram on the waveform and finds the most prevalent point above and below the waveform midpoint. The most prevalent point is one that represents greater than approximately 5% of the total display points (501) and is considered to be either the top or base. If no point accounts for more than 5% of the total, then the top is chosen as the absolute maximum and the base is chosen as the absolute minimum.

---

## Edge Definition

Both rising and falling edges are defined as transitional edges that must cross three thresholds.

A rising edge must cross the lower threshold in a positive direction (defining it as a rising edge), cross the mid threshold (any number of crossings, both positive and negative are permissible) and then cross the upper threshold without any additional crossing of the lower threshold.

A falling edge must cross the upper threshold in a negative direction, cross the mid threshold (any number of times), and then cross the lower threshold without any additional crossing of the upper threshold.

**Note** 

Most time measurements are made based on the position of the first crossing of the middle threshold.

## Algorithm Definitions

This section lists the definitions that the measurements in the HP 54510A are based on.

**delay** There are three types of delay measurements:

- Jitter.
- Standard.
- User-defined.

Jitter occurs only under the following circumstances:

- The standard/user-defined key is set to standard.
- Two delay parameters are the same.
- The display mode is set to envelope.

**if**

**first edge on minimum waveform is rising**

**then**

**delay = mid-threshold of first rising edge of max waveform minus  
mid-threshold of first rising edge on min waveform**

**else**

**delay = mid-threshold of first falling edge on min waveform minus  
mid-threshold of first falling edge on max waveform**

The standard delay measurement occurs in the standard mode (not user-defined) and is not a jitter measurement.

**standard delay = mid-threshold of the first edge of the second parameter minus the mid-threshold of the first edge of the first parameter**

**Note** 

Negative delay is possible.

**User defined delay = second channel edge minus first channel edge**

**+ width** The + width algorithm has standard and user-defined considerations.

if

first edge is rising

then

**+ width = mid-threshold crossing of first falling edge minus mid-threshold crossing of first rising edge**

else

**+ width = mid-threshold crossing of second falling edge minus mid-threshold crossing of first rising edge**

The user-defined definition is the same as the standard definition except for the user-defined threshold.

**- width** The - width algorithm has standard and user-defined considerations:

if

first edge is rising

then

**- width = second rising edge minus first falling edge**

else

**- width = first rising edge minus first falling edge**

**Period**    **if**  
                   **first edge is rising**  
**then**  
                   **period = second rising edge minus first rising edge**  
**else**  
                   **period = second falling edge minus first falling edge**

**Frequency**    **frequency = 1/period**

**Duty Cycle**    **duty cycle = (+ width/period) \* 100**

---

**Note**  The + width for duty cycle is always calculated using the mid-threshold.

---

**Rise time**    **rise time = time at upper threshold minus time at lower threshold**

**Fall time**    **fall time = time at lower threshold minus time at upper threshold**

**V<sub>max</sub>**    **V<sub>max</sub> = voltage of the maximum point on the screen**

**V<sub>min</sub>**    **V<sub>min</sub> = voltage of the minimum point on the screen**

**V<sub>p-p</sub>**    **V<sub>p-p</sub> = V<sub>max</sub> minus V<sub>min</sub>**

**V<sub>top</sub>**    **V<sub>top</sub> = most prevalent point above waveform midpoint**

**V<sub>base</sub>**    **V<sub>base</sub> = most prevalent point below waveform midpoint**

**V<sub>amp</sub>**    **V<sub>amp</sub> = V<sub>top</sub> minus V<sub>base</sub>**

**Vavg** The average voltage of the first cycle of the displayed signal is measured. If a complete cycle is not present, the oscilloscope averages all data points.

**Vrms (ac)** The ac rms voltage of the first cycle of the displayed signal is measured. If a complete cycle is not present, the measurement computes ac rms on all data points.

$$V_{\text{rms(ac)}} = \left[ \frac{1}{n} \sum_{j=0}^{n-1} (V_n - \frac{1}{m} \sum_{i=0}^{m-1} V_m) \right]^2 \frac{1}{2}$$

**Vrms (dc)** The true rms voltage of the first cycle of the displayed signal is measured.

$$V_{\text{rms(dc)}} = \left[ \frac{1}{n} \sum_{j=0}^{n-1} (V_n) \right]^2 \frac{1}{2}$$

**Integrate**

$$I_n = \sum_{i=0}^{n-1} C_i \Delta t$$

The equation is the integral of the channel, where I represents the integral and C represents the channel. The integral is calculated by adding the voltage points multiplied by the time bucket width,  $\Delta t$ .

**Differentiate**  $d_1 = 0$

$$d_n = \frac{c(n) - c(n-1)}{\Delta t}$$

The equation is the differential waveform of the channel, where d represents the differential and c represents the channel. The differential is the voltage differences between consecutive points in time divided by the time bucket width,  $\Delta t$ .

## Message Communication and System Functions

### Introduction

This chapter describes the operation of instruments that operate in compliance with the IEEE 488.2 standard. Instruments that are compatible with IEEE 488.2 must also be compatible with IEEE 488.1; however, IEEE 488.1 compatible instruments may or may not conform to the IEEE 488.2 standard. The IEEE 488.2 standard defines the message exchange protocols by which the instrument and the controller communicate. It also defines some common capabilities, which are found in all IEEE 488.2 instruments. This chapter also contains a few items which are not specifically defined by IEEE 488.2, but deal with message communication or system functions.

### Protocols

The protocols of IEEE 488.2 define the overall scheme used by the controller and the instrument to communicate. This includes defining when it is appropriate for devices to talk or listen, and what happens when the protocol is not followed.

### Functional Elements

Before proceeding with the description of the protocol, a few system components should be understood.

#### Input Buffer

The input buffer of the instrument is the memory area where commands and queries are stored prior to being parsed and executed. It allows a controller to send a string of commands to the instrument which could take some time to execute, and then proceed to talk to another instrument while the first instrument is parsing and executing commands. The HP 54510A's input buffer holds 300 characters or bytes of data.

### **Output Queue**

The output queue of the instrument is the memory area where all output data (response messages) are stored until read by the controller. The HP 54510A's output queue holds 300 characters; however, the instrument will handle block data of greater than 300 characters where appropriate.

### **Parser**

The instrument's parser is the component that interprets the commands sent to the instrument and decides what actions should be taken. "Parsing" refers to the action taken by the parser to achieve this goal. Parsing and executing of commands begins when either the instrument sees a program message terminator (defined later in this chapter) or the input buffer becomes full. If you wish to send a long sequence of commands to be executed and then talk to another instrument while they are executing, you should send all the commands before sending the program message terminator.

### **Protocol Overview**

The instrument and controller communicate using program messages and response messages. These messages serve as the containers into which sets of program commands or instrument responses are placed. Program messages are sent by the controller to the instrument, and response messages are sent from the instrument to the controller in response to a query message. A "query message" is defined as being a program message which contains one or more queries. The instrument only talks when it has received a valid query message, and therefore has something to say. The controller should only attempt to read a response after sending a complete query message, but before sending another program message. The basic rule to remember is that the instrument only talks when prompted to, and it then expects to talk before being told to do something else.

**Protocol  
Operation**

When the instrument is turned on or when it receives a device clear command, the input buffer and output queue are cleared, and the parser is reset to the root level of the command tree.

The instrument and the controller communicate by exchanging complete program messages and response messages. This means that the controller should always terminate a program message before attempting to read a response. The instrument terminates response messages except during a hardcopy output.

If a query message is sent, the next message passing over the bus should be the response message. The controller should always read the complete response message associated with a query message before sending another program message to the same instrument.

The instrument allows the controller to send multiple queries in one query message. This is referred to as sending a "compound query." Multiple queries in a query message are separated by semicolons. The responses to each of the queries in a compound query are also separated by semicolons.

Commands are executed in the order they are received. This also applies to the group execute trigger (GET) bus command. The group execute trigger command should not be sent in the middle of a program message.

**Protocol  
Exceptions**

If an error occurs during the information exchange, the exchange may not be completed in a normal manner. Some of the protocol exceptions are shown below.

**Addressed to talk with nothing to say**

If the instrument is addressed to talk before it receives a query, the instrument will indicate a query error and will not send any bytes over the bus. If the instrument has nothing to say because queries requested were unable to be executed due to an error, the device does not indicate a query error, but simply waits to receive the next message from the controller.

**Addressed to talk with no listeners on the bus**

If the instrument is addressed to talk and there are no listeners on the bus, the instrument will wait for a listener to listen, or for the controller to take control.

**Command Error**

A command error is reported if the instrument detects a syntax error or an unrecognized command header.

**Execution Error**

An execution error is reported if a parameter is found to be out of range, or if the current settings do not allow execution of a requested command or query.

**Device-Specific Error**

A device-specific error is reported if the instrument is unable to execute a command for a strictly device dependent reason.

**Query Error**

A query error is reported if the proper protocol for reading a query is not followed. This includes the interrupted and unterminated conditions described below.

**Unterminated Condition**

If the controller attempts to read a response message before terminating the program message, a query error is generated. The parser resets itself, and the response is cleared from the output queue of the instrument without being sent over the bus.

**Interrupted Condition**

If the controller does not read the entire response message generated by a query message and then attempts to send another program message, the device generates a query error. The unread portion of the response is then discarded by the instrument. The interrupting program message is not affected.

### Buffer Deadlock

The instrument may become deadlocked if the input buffer and output queue both become full. This condition can occur if a very long program message is sent containing queries that generate a great deal of response data. The instrument cannot accept any more bytes, and the controller cannot read any of the response data until it has completed sending the entire program message. Under this condition the instrument breaks the deadlock by clearing the output queue, and continuing to discard responses until it comes to the end of the current program message. The query error bit is also set.

---

## Syntax Diagrams

The syntax diagrams in this chapter are similar to the syntax diagrams in the IEEE 488.2 specification. Commands and queries are sent to the instrument as a sequence of data bytes. The allowable byte sequence for each functional element is defined by the syntax diagram that is shown with the element description.

The allowable byte sequence can be determined by following a path in the syntax diagram. The proper path through the syntax diagram is any path that follows the direction of the arrows. If there is a path around an element, that element is optional. If there is a path from right to left around one or more elements, that element or those elements may be repeated as many times as desired.

---

## Syntax Overview

This overview is intended to give a quick glance at the syntax defined by IEEE 488.2. It should allow you to understand many of the things about the syntax you need to know. This chapter also contains details of the IEEE 488.2 defined syntax.

IEEE 488.2 defines the blocks used to build messages which are sent to the instrument. A whole string of commands can therefore be broken up into individual components.

Figure 22-1 shows a breakdown of an example program message. There are a few key items to notice:

1. A semicolon separates commands from one another. Each program message unit serves as a container for one command. The program message units are separated by a semicolon.
2. A program message is terminated by an `< NL >` (new line), an `< NL >` with EOI asserted, or EOI being asserted on the last byte of the message. The recognition of the program message terminator, or PMT, by the parser serves as a signal for the parser to begin execution of commands. The PMT also affects command tree traversal (see chapter 4, "Programming and Documentation Conventions").
3. Multiple data parameters are separated by a comma.
4. The first data parameter is separated from the header with one or more spaces.
5. The header `:MEAS:SOURCE` is a compound header. It places the parser in the measure subsystem until the `< NL >` is encountered.

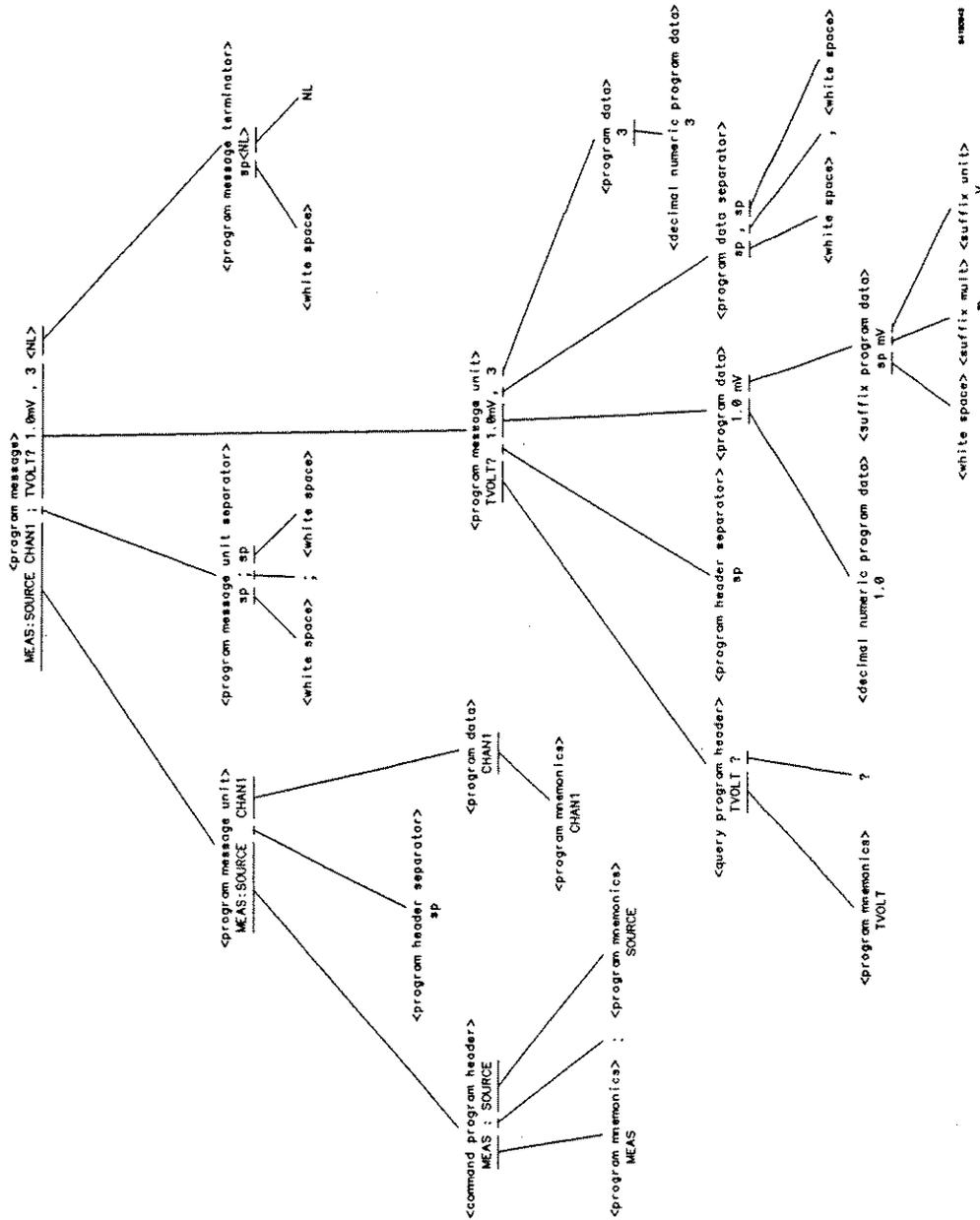


Figure 22-1. Program Message Tree

## Device Listening Syntax

The listening syntax of IEEE 488.2 is designed to be more forgiving than the talking syntax. This allows greater flexibility in writing programs, as well as allowing them to be easier to read.

### Upper/Lower Case Equivalence

Upper and lower case letters are equivalent. The mnemonic **RANGE** has the same semantic meaning as the mnemonic **range**.

### White Space

White space is defined to be one or more characters from the ASCII set of 0 - 32 decimal, excluding 10 decimal (NL). White space is used by several instrument listening components of the syntax. It is usually optional, and can be used to increase the readability of a program.

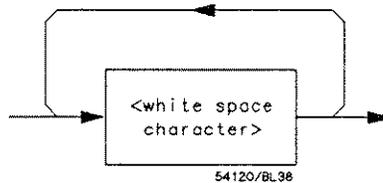


Figure 22-2. White Space

### Program Message

The program message is a complete message to be sent to the instrument. The instrument will begin executing commands once it has a complete program message, or when the input buffer becomes full. The parser is also repositioned to the root of the command tree after executing a complete program message. For more information, refer to the Tree Traversal Rules in chapter 4, "Programming and Documentation Conventions."

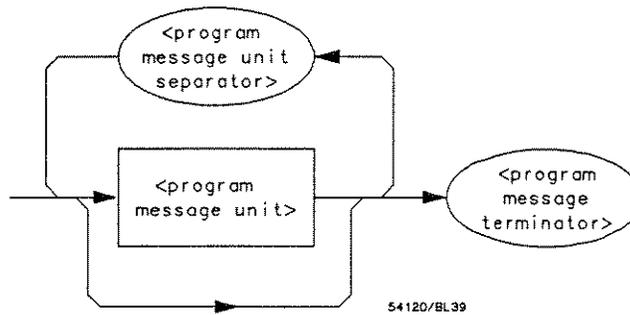


Figure 22-3. Program Message

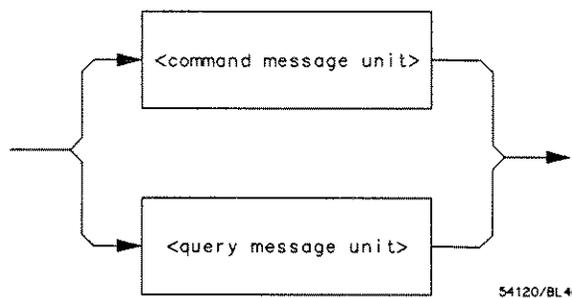
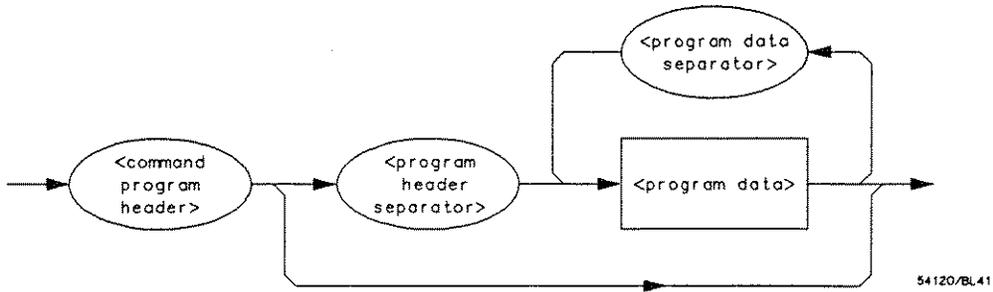
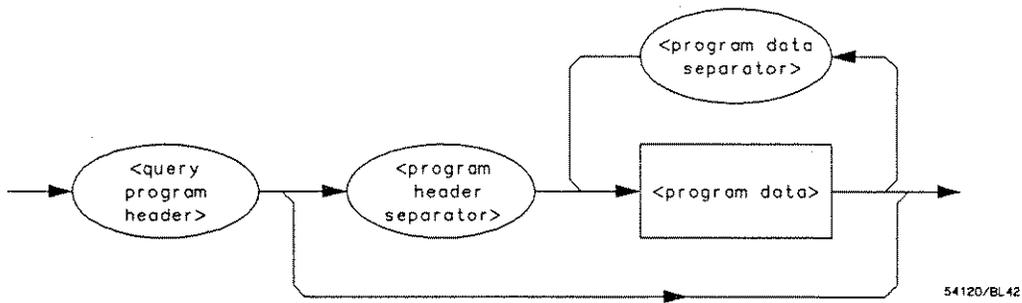


Figure 22-4. Program Message Unit



**Figure 22-5. Command Message Unit**



**Figure 22-6. Query Message Unit**

**Program Message Unit**

The program message unit is the container for individual commands within a program message.

### Program Message Unit Separator

A semicolon separates program message units, or individual commands.

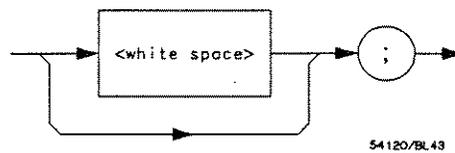


Figure 22-7. Program Message Unit Separator

### Command Program Header/Query Program Header

These elements serve as the headers of commands or queries. They represent the action to be taken.

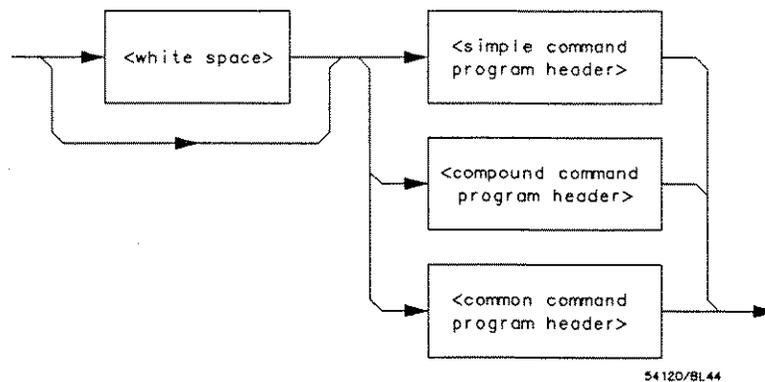
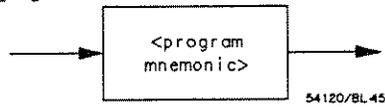
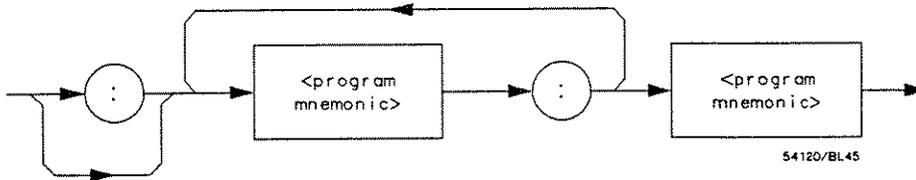


Figure 22-8. Command Program Header

Where simple command program header is defined as



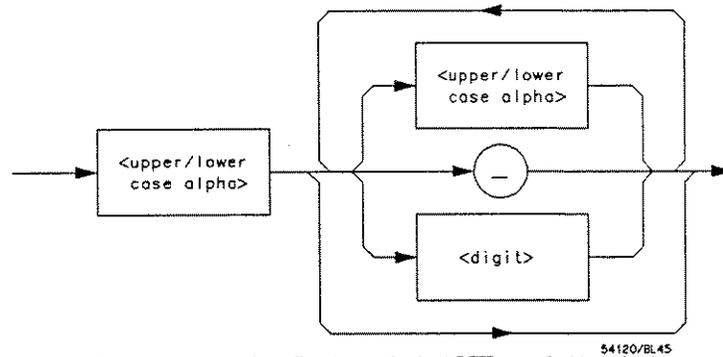
Where compound command program header is defined as



Where common command program header is defined as



Where program mnemonic is defined as

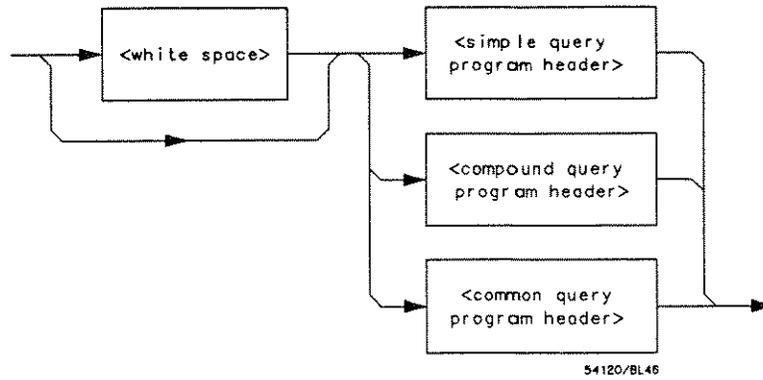


Where upper/lower case alpha is defined as a single ASCII encoded byte in the range 41 - 5A, 61 - 7A (65 - 90, 97 - 122 decimal).

Where digit is defined as a single ASCII encoded byte in the range 30 - 39 (48 - 57 decimal).

Where ( - ) represents an "underscore," a single ASCII-encoded byte with the value 5F (95 decimal).

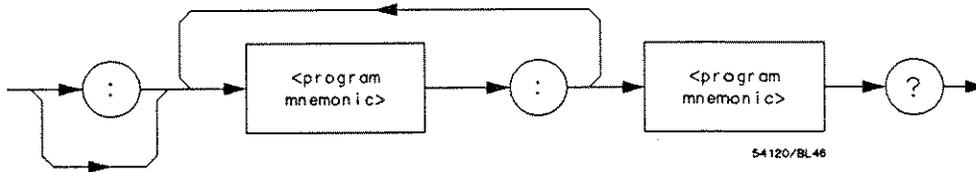
Figure 22-8. Command Program Header (continued)



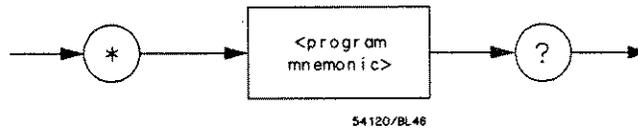
Where simple query program header is defined as



Where compound query program header is defined as



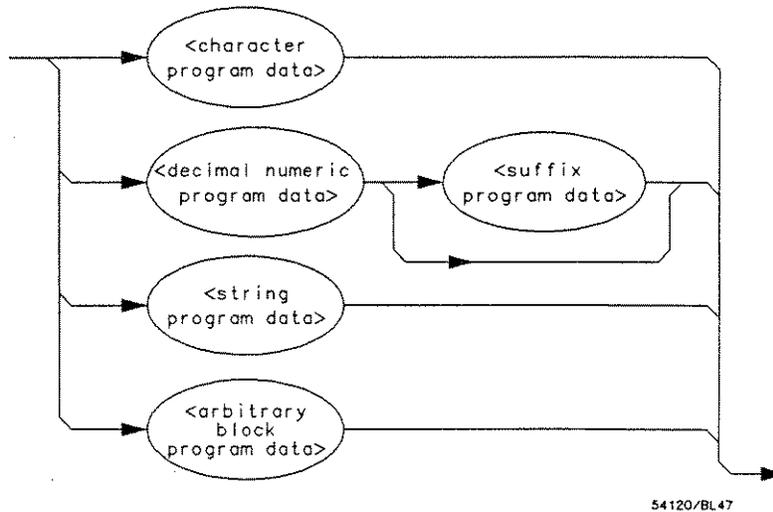
Where common query program header is defined as



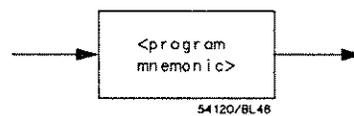
**Figure 22-9. Query Program Header**

**Program Data**

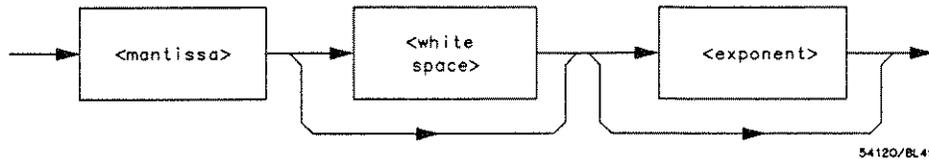
The program data element represents the possible types of data which may be sent to the instrument. The HP 54510A accepts the following data types: character program data, decimal numeric program data, suffix program data, string program data, and arbitrary block program data.



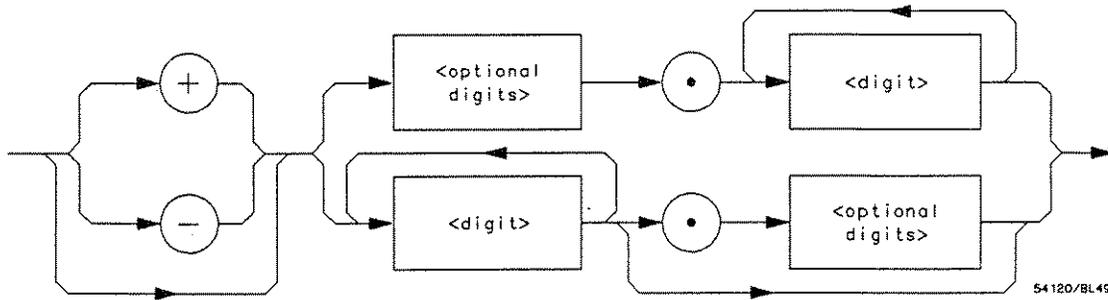
**Figure 22-10. Program Data**



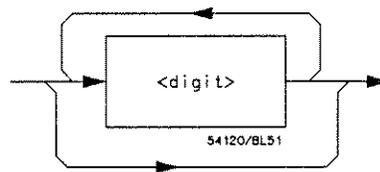
**Figure 22-11. Character Program Data**



Where mantissa is defined as



Where optional digits is defined as



Where exponent is defined as

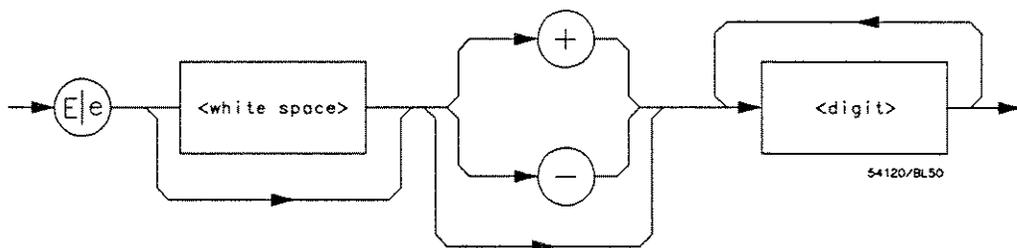


Figure 22-12. Decimal Numeric Program Data

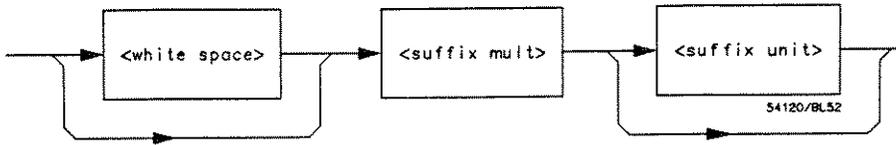


Figure 22-13. Suffix Program Data

**Suffix Multiplier**

The suffix multipliers that the instrument accepts are shown in table 22-1.

Table 22-1. Suffix Multiplier

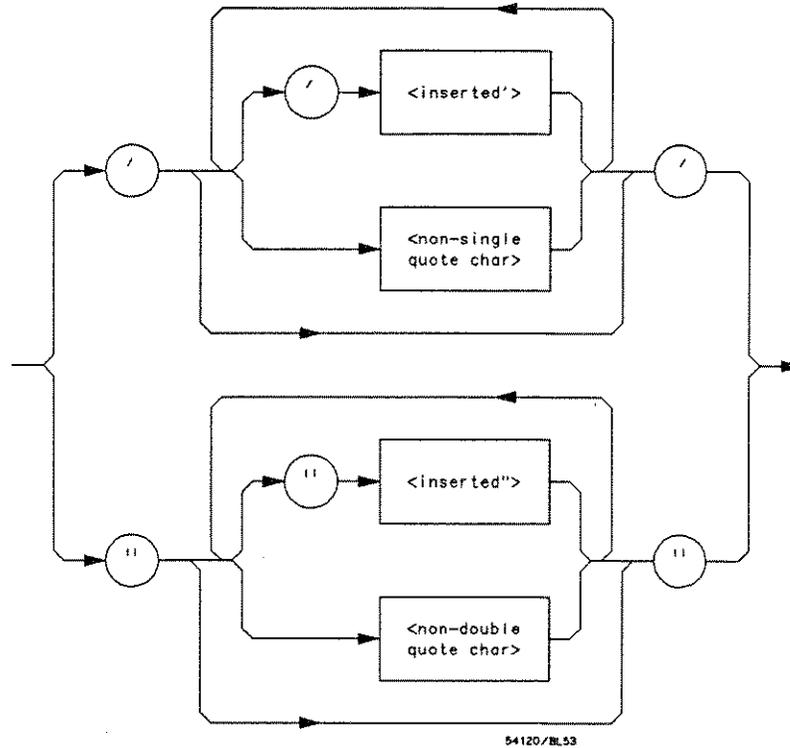
Value	Mnemonic
1E18	EX
1E15	PE
1E12	T
1E9	G
1E6	MA
1E3	K
1E-3	M
1E-6	U
1E-9	N
1E-12	P
1E-15	F
1E-18	A

**Suffix Unit**

The suffix units that the instrument accepts are shown in table 22-2.

Table 22-2. Suffix Unit

Suffix	Referenced Unit	Suffix	Reference Unit
V	Volt	HZ	Hertz
S	Second	PCT	Percent



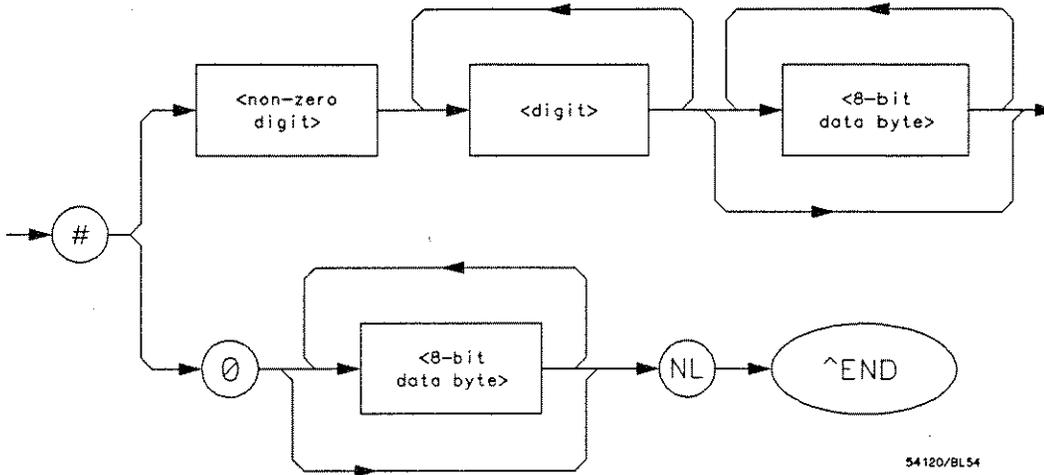
Where `<inserted'>` is defined as a single ASCII character with the value 27 (39 decimal).

Where `<non-single quote char>` is defined as a single ASCII character of any value except 27 (39 decimal).

Where `<inserted\">` is defined as a single ASCII character with the value 22 (34 decimal).

Where `<non-double quote char>` is defined as a single ASCII character of any value except 22 (34 decimal).

Figure 22-14. String Program Data



Where < non-zero digit > is defined as a single ASCII encoded byte in the range 31 - 39 (49 - 57 decimal).

Where < 8-bit byte > is defined as an 8-bit byte in the range 00 -ff (0 - 255 decimal).

Figure 22-15. Arbitrary Block Program Data

### Program Data Separator

A comma separates multiple data parameters of a command from one another.

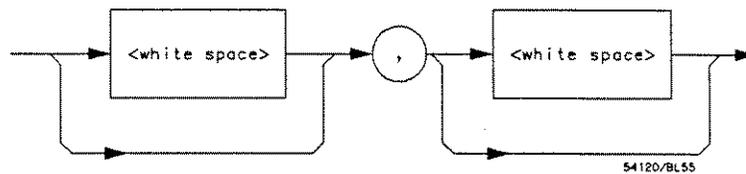


Figure 22-16. Program Data Separator

### Program Header Separator

A space (ASCII decimal 32) separates the header from the first or only parameter of the command.

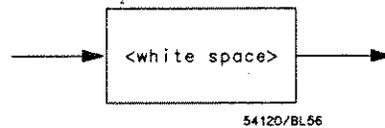
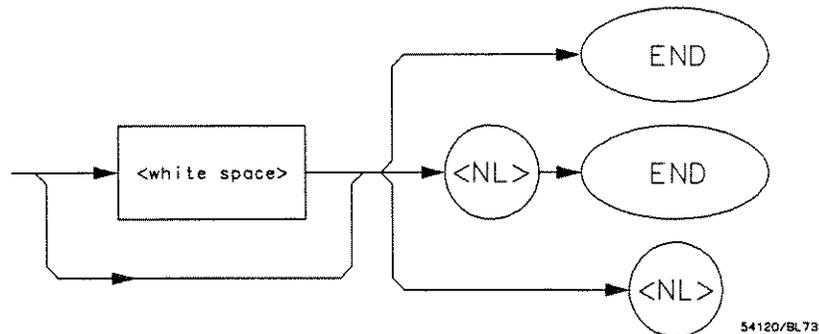


Figure 22-17. Program Header Separator

### Program Message Terminator

The program message terminator or PMT serves as the terminator to a complete program message. When the parser sees a complete program message it begins execution of the commands within that message. The PMT also resets the parser to the root of the command tree.



Where <NL> is defined as a single ASCII-encoded byte 0A (10 decimal).

Figure 22-18. Program Message Terminator

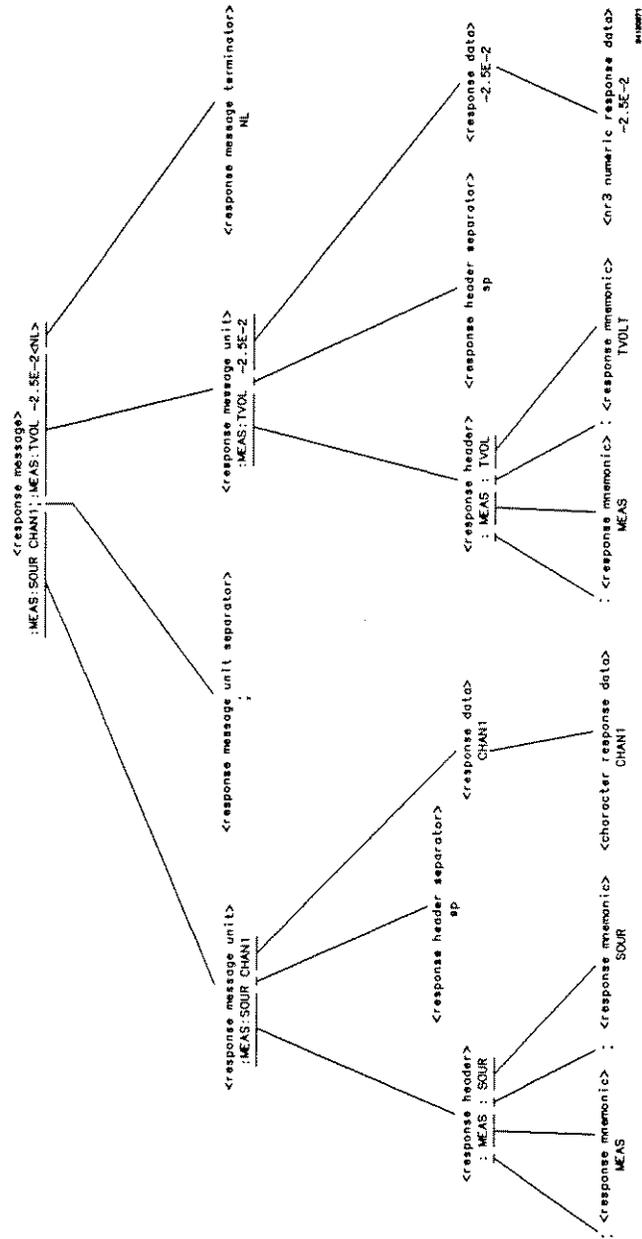


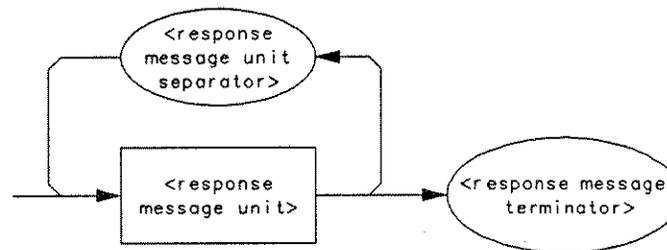
Figure 22-19. Response Message Tree

## Device Talking Syntax

The talking syntax of IEEE 488.2 is designed to be more precise than the listening syntax. This allows the programmer to write routines which can easily interpret and use the data the instrument is sending. One of the implications of this is the absence of white space in the talking formats. The instrument does not pad messages which are being sent to the controller with spaces.

### Response Message

This element serves as a complete response from the instrument. It is the result of the instrument executing and buffering the results from a complete program message. The complete response message should be read before sending another program message to the instrument.



54120/BL57

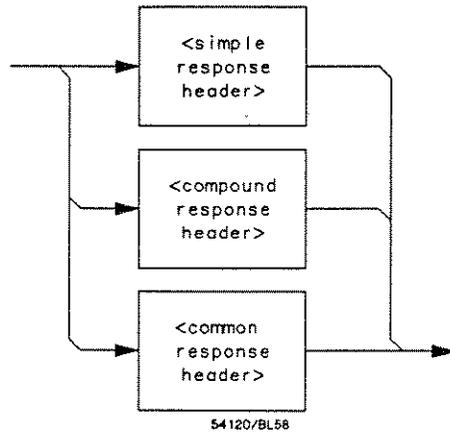
Figure 22-20. Response Message

### Response Message Unit

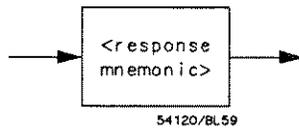
This element serves as the container of individual pieces of a response. Typically a query message unit generates one response message unit, although a query message unit may generate multiple response message units.

### Response Header

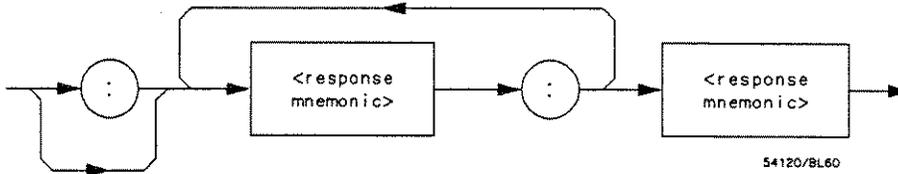
The response header, when returned, indicates what the response data represents.



Where <simple response mnemonic> is defined as



Where <compound response header> is defined as



Where <common response header> is defined as

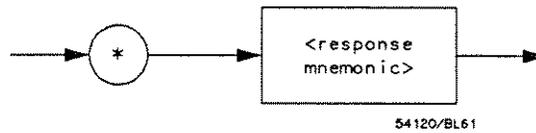
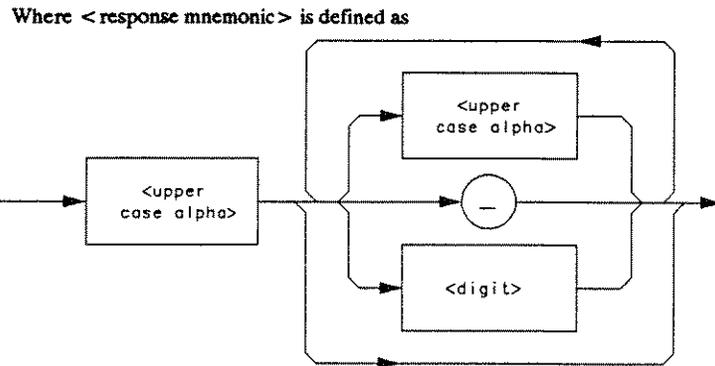


Figure 22-21. Response Message Unit



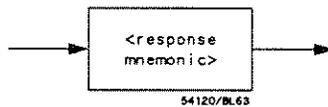
Where < uppercase alpha > is defined as a single ASCII encoded byte in the range 41 - 5A (65 - 90 decimal).

Where (   ) represents an "underscore", a single ASCII encoded byte with the value 5F (95 decimal).

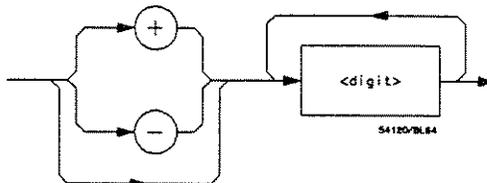
**Figure 22-21. Response Message Unit (continued)**

**Response Data**

The response data element represents the various types of data which the instrument may return. These types include: character response data, nr1 numeric response data (integer), nr3 numeric response data (exponential), string response data, definite length arbitrary block response data, and arbitrary ASCII response data.



**Figure 22-22. Character Response Data**



**Figure 22-23. NR1 Numeric Response Data**

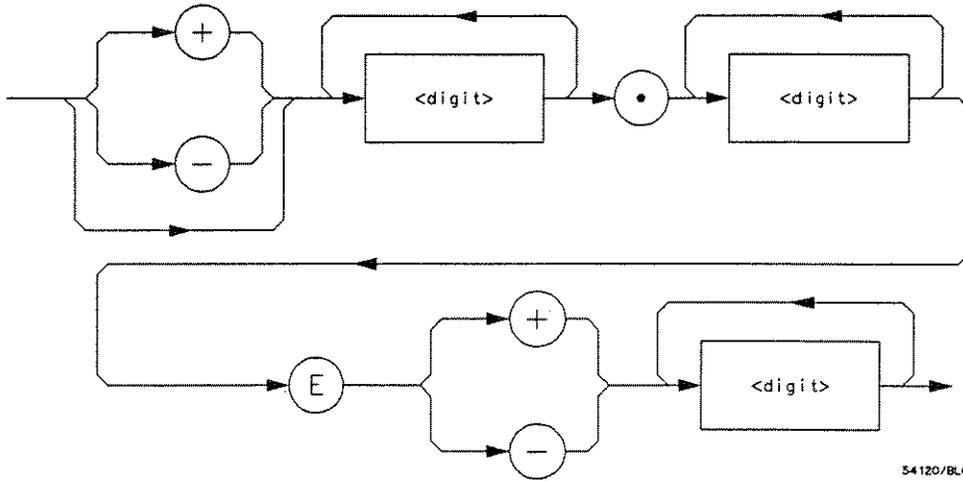


Figure 22-24. NR3 Numeric Response Data

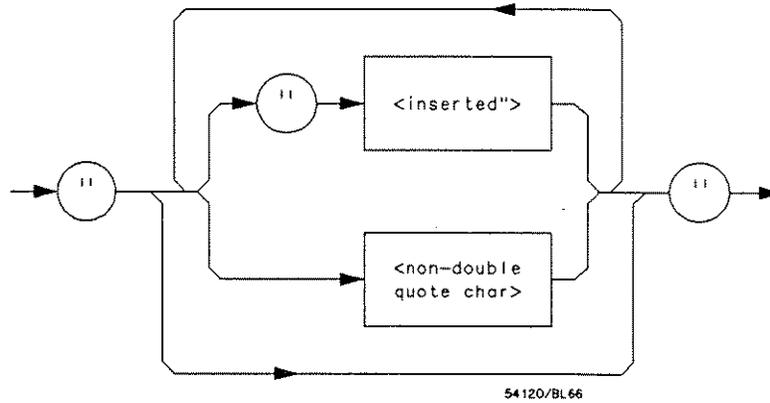
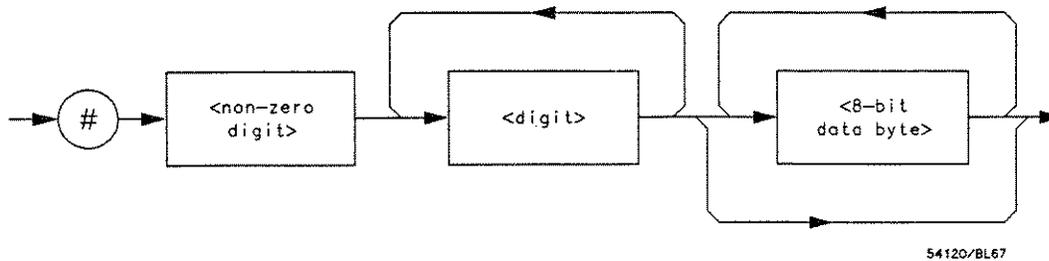
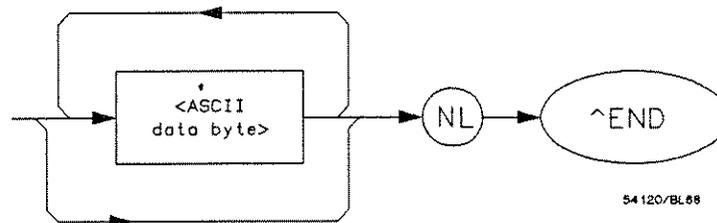


Figure 22-25. String Response Data



**Figure 22-26. Definite Length Arbitrary Block**



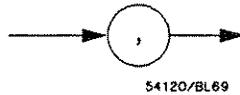
Where <ASCII data type> represents any ASCII-encoded byte except <NL> (0A, 10 decimal).

1. The END message provides an unambiguous termination to an element that contains arbitrary ASCII characters.
2. The IEEE 488.1 END message serves the dual function for terminating this element as well as terminating the <RESPONSE MESSAGE>. It is only sent once with the last byte of the indefinite block data. The NL is presented for consistency with the <RESPONSE MESSAGE TERMINATOR>.

**Figure 22-27. Arbitrary ASCII Response Data**

### Response Data Separator

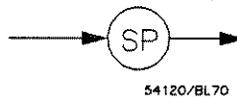
A comma separates multiple pieces of response data within a single response message unit.



**Figure 22-28. Response Data Separator**

#### **Response Header Separator**

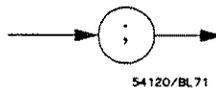
A space (ASCII decimal 32) delimits the response header, if returned, from the first or only piece of data.



**Figure 22-29. Response Header Separator**

#### **Response Message Unit Separator**

A semicolon delimits the response message units if multiple responses are returned.



**Figure 22-30. Response Message Unit Separator**

#### **Response Message Terminator**

A response message terminator (NL) terminates a complete response message. It should be read from the instrument along with the response itself.

**Note** 

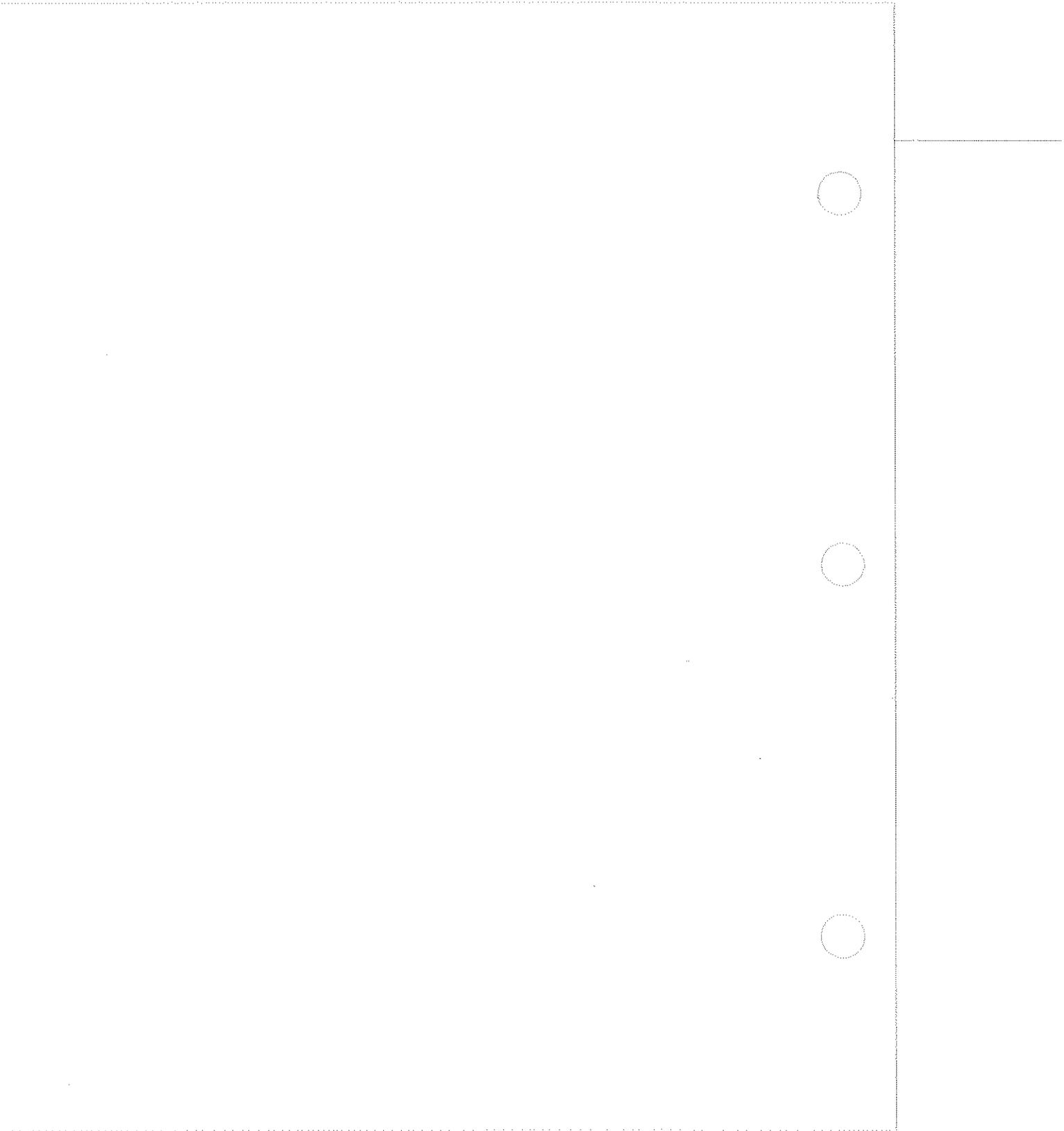
If you do not read the response message terminator, the HP 54510A produces an interrupted error on the next message.

## Common Commands

IEEE 488.2 defines a set of common commands. These commands perform functions which are common to any type of instrument. They can therefore be implemented in a standard way across a wide variety of instrumentation. All the common commands of IEEE 488.2 begin with an asterisk. There is one key difference between the IEEE 488.2 common commands and the rest of the commands found in this instrument. The IEEE 488.2 common commands do not affect the parser's position within the command tree. More information about the command tree and tree traversal can be found in chapter 4, "Programming and Documentation Conventions."

**Table 22-3. HP 54510A's IEEE 488.2 Common Commands**

Command	Command Name
*CLS	Clear Status Command
*ESE	Event Status Enable Command
*ESE?	Event Status Enable Query
*ESR?	Event Status Register Query
*IDN	Identification Query
*LRN?	Learn Device Setup Query
*OPC	Operation Complete Command
*OPC?	Operation Complete Query
*OPT?	Option Identification Query
*RCL	Recall Command
*RST	Reset Command
*SAV	Save Command
*SRE	Service Request Enable Command
*SRE?	Service Request Enable Query
*STB?	Read Status Byte Query
*TRG	Trigger Command
*TST?	Self-Test Query
*WAI	Wait-to-Continue Command



## Quick Reference Guide

### Introduction

The following section lists the commands and queries with their corresponding arguments and returned formats. The arguments for each command list the minimum argument required. The part of the command or query listed in uppercase letters refers to the short form of that command or query. The long form is the combination of uppercase and lowercase letters.

**Conventions** The following conventions are used in this section:

< > Angular brackets enclose words or characters that symbolize a program code parameter or an HP-IB command.

::= "is defined as." For example, <A> ::= <B> indicates that <A> can be replaced by <B> in any statement containing <A>.

| "or." Indicates a choice of one element from a list. For example, <A> | <B> indicates <A> or <B> but not both.

... An ellipsis (trailing dots) indicate that the preceding element may be repeated one or more times.

[] Square brackets indicate that the enclosed items are optional.

{ } When several items are enclosed by braces, one, and only one of these elements may be selected.

**Suffix Multipliers** The suffix multipliers available for arguments are:

EX ::= 1E18	M ::= 1E-3
PE ::= 1E15	U ::= 1E-6
T ::= 1E12	N ::= 1E-9
G ::= 1E9	P ::= 1E-12
MA ::= 1E6	F ::= 1E-15
K ::= 1E3	A ::= 1E-18

For more information on specific commands or queries, refer to chapters 6 through 18 of this manual.

<b>*CLS</b>	<b>(Clear Status)</b>	<b>command</b>
<b>Command Syntax:</b> *CLS		
<b>*ESE</b>	<b>(Event Status Enable)</b>	<b>command/query</b>
<b>Command Syntax:</b> *ESE {0 to 255}		
<b>Query Syntax:</b> *ESE?		
<b>Returned Format:</b> {integer, 0 to 255}<NL>		
<b>*ESR</b>	<b>(Event Status Register)</b>	<b>query</b>
<b>Query Syntax:</b> *ESR?		
<b>Returned Format:</b> {integer, 0 to 255}<NL>		
<b>*IDN</b>	<b>(Identification Number)</b>	<b>query</b>
<b>Query Syntax:</b> *IDN?		
<b>Returned Format:</b> HEWLETT-PACKARD,54510A,XXXXYYYYY,MMDD<NL>		
<b>*LRN</b>	<b>(Learn)</b>	<b>query</b>
<b>Query Syntax:</b> *LRN?		
<b>Returned Format:</b> :SYSTem:SETup #800001024<learn string><NL>		
<b>*OPC</b>	<b>(Operation Complete)</b>	<b>command/query</b>
<b>Command Syntax:</b> *OPC		
<b>Query Syntax:</b> *OPC?		
<b>Returned Format:</b> 1<NL>		
<b>*OPT</b>	<b>(Option)</b>	<b>query</b>
<b>Query Syntax:</b> *OPT?		
<b>Returned Format:</b> 0<NL>		
<b>*RCL</b>	<b>(Recall)</b>	<b>command</b>
<b>Command Syntax:</b> *RCL {0 to 4}		

<b>*RST</b>	<b>(Reset)</b>	<b>command</b>
<b>Command Syntax:</b> *RST		
<b>*SAV</b>	<b>(Save)</b>	<b>command</b>
<b>Command Syntax:</b> *SAV {1 to 4}		
<b>*SRE</b>	<b>(Service Request Enable)</b>	<b>command/query</b>
<b>Command Syntax:</b> *SRE {0 to 255}		
<b>Query Syntax:</b> *SRE?		
<b>Returned Format:</b> <mask><NL>		
<b>Where:</b> <mask> ::= sum of all bits set - integer, 0 to 255		
<b>*STB</b>	<b>(Status Byte)</b>	<b>query</b>
<b>Query Syntax:</b> *STB?		
<b>Returned Format:</b> {integer, 0 to 255}<NL>		
<b>*TRG</b>	<b>(Trigger)</b>	<b>command</b>
<b>Command Syntax:</b> *TRG		
<b>*TST</b>	<b>(Test)</b>	<b>query</b>
<b>Query Syntax:</b> *TST?		
<b>Returned Format:</b> {0 or non-zero value}<NL>		
<b>Where:</b> 0 ::= test passed non-zero ::= test failed		
<b>*WAI</b>	<b>(Wait)</b>	<b>command</b>
<b>Command Syntax:</b> *WAI		
<b>:ACQuire:COMPLete</b>		<b>command/query</b>
<b>Command Syntax:</b> :ACQuire:COMPLete {0 to 100}		
<b>Query Syntax:</b> :ACQuire:COMPLete?		
<b>Returned Format:</b> [:ACQuire:COMPLete] {integer, 0 to 100}<NL>		

**:ACQUIRE:COUNT** **command/query**

**Command Syntax:** :ACQUIRE:COUNT {1 to 2048}  
**Query Syntax:** :ACQUIRE:COUNT?  
**Returned Format:** [:ACQUIRE:COUNT] {integer, 1 to 2048}<NL>

**:ACQUIRE:POINTS** **command/query**

**Command Syntax:** :ACQUIRE:POINTS <points\_argument>  
**Query Syntax:** :ACQUIRE:POINTS?  
**Returned Format:** [:ACQUIRE:POINTS] <points\_argument><NL>  
**Where:** <points\_argument> ::= 500 in repetitive mode  
500 or 8000 in real-time mode

**:ACQUIRE:TYPE** **command/query**

**Command Syntax:** :ACQUIRE:TYPE {NORMAL | AVERAGE | ENVELOPE |  
RAWData[,<length>][,<acquisitions>]}  
**Query Syntax:** :ACQUIRE:TYPE?  
**Returned Format:** [:ACQUIRE:TYPE] {NORMAL | AVERAGE | ENVELOPE |  
RAWData,<length>,<acquisitions>}<NL>  
**Where:** <length> ::= integer, 4 to 8000.  
<acquisitions> ::= dependent on length of acquisitions and buffer size.

**:AUTOSCALE** **command**

**Command Syntax:** :AUTOSCALE

**:BEEPER** **command/query**

**Command Syntax:** :BEEPER [{ON | 1} | {OFF | 0}]  
**Query Syntax:** :BEEPER?  
**Returned Format:** [:BEEPER] {1 | 0}<NL>

**:BLANK** **command**

**Command Syntax:** :BLANK {CHANNEL{1 | 2} | FUNCTION{1 | 2} | MEMORY{1 | 2 | 3 | 4} |  
PMEMORY{1 | 2}}

**:BNC****command/query**

**Command Syntax:** :BNC {PROBe | TRIGger}  
**Query Syntax:** :BNC?  
**Returned Format:** [:BNC] {PROBe | TRIGger}<NL>

**:CALibrate:DATA:ASCii****query**

**Query Syntax:** :CALibrate:DATA:ASCii?  
**Returned Format:** [:CALibrate:DATA:ASCii] <calibration\_data>,<calibration\_data>,...<NL>

**:CALibrate:TNULI****command/query**

**Command Syntax:** :CALibrate:TNULI <null\_value>  
**Query Syntax:** :CALibrate:TNULI?  
**Returned Format:** [:CALibrate:TNULI] <null\_value><NL>  
**Where:** <null\_value> ::= channel 1 to channel 2 skew

**:CHANnel{1 | 2}:COUPling****command/query**

**Command Syntax:** :CHANnel{1 | 2}:COUPling {AC | DC | DCFifty}  
**Query Syntax:** :CHANnel{1 | 2}:COUPling?  
**Returned Format:** [:CHANnel{1 | 2}:COUPling] {AC | DC | DCFifty}<NL>

**:CHANnel{1 | 2}:ECL****command**

**Command Syntax:** :CHANnel{1 | 2}:ECL

**:CHANnel{1 | 2}:HFReject****command/query**

**Command Syntax:** :CHANnel{1 | 2}:HFReject {{ON | 1} | {OFF | 0}}  
**Query Syntax:** :CHANnel{1 | 2}:HFReject?  
**Returned Format:** [:CHANnel{1 | 2}:HFReject] {1 | 0}<NL>

**:CHANnel{1 | 2}:LFReject****command/query**

**Command Syntax:** :CHANnel{1 | 2}:LFReject {{ON | 1} | {OFF | 0}}  
**Query Syntax:** :CHANnel{1 | 2}:LFReject?  
**Returned Format:** [:CHANnel{1 | 2}:LFReject] {1 | 0}<NL>

**:CHANnel{1 | 2}:OFFSet** **command/query**

**Command Syntax:** :CHANnel{1 | 2}:OFFSet <offset value>  
**Query Syntax:** :CHANnel{1 | 2}:OFFSet?  
**Returned Format:** [:CHANnel{1 | 2}:OFFSet] <offset value><NL>

**:CHANnel{1 | 2}:PROBe** **command/query**

**Command Syntax:** :CHANnel{1 | 2}:PROBe {0.9 to 1000}  
**Query Syntax:** :CHANnel{1 | 2}:PROBe?  
**Returned Format:** [:CHANnel{1 | 2}:PROBe] {exponential, 0.9 to 1000}<NL>

**:CHANnel{1 | 2}:RANGe** **command/query**

**Command Syntax:** :CHANnel{1 | 2}:RANGe <full-scale range>  
**Query Syntax:** :CHANnel{1 | 2}:RANGe?  
**Returned Format:** [:CHANnel{1 | 2}:RANGe] <exponential full-scale range><NL>

**:CHANnel{1 | 2}:TTL** **command**

**Command Syntax:** :CHANnel{1 | 2}:TTL

**:DIGitize** **command**

**Command Syntax:** :DIGitize CHANnel{1 | 2}[.CHANnel{1 | 2}]

**:DISPlay:COLumn** **command/query**

**Command Syntax:** :DISPlay:COLumn {0 to 72}  
**Query Syntax:** :DISPlay:COLumn?  
**Returned Format:** [:DISPlay:COLumn] {integer, 0 to 72}<NL>

**:DISPlay:CONNect** **command/query**

**Command Syntax:** :DISPlay:CONNect {{ON | 1} | {OFF | 0}}  
**Query Syntax:** :DISPlay:CONNect?  
**Returned Format:** [:DISPlay:CONNect] {1 | 0}<NL>



---

**:DISPlay:ROW** **command/query**

**Command Syntax:** :DISPlay:ROW {0 to 24}  
**Query Syntax:** :DISPlay:ROW?  
**Returned Format:** [:DISPlay:ROW] {integer, 0 to 24}<NL>

---

**:DISPlay:SCREen** **command/query**

**Command Syntax:** :DISPlay:SCREen {{ON | 1} | {OFF | 0}}  
**Query Syntax:** :DISPlay:SCREen?  
**Returned Format:** [:DISPlay:SCREen] {1 | 0}<NL>

---

**:DISPlay:SOURce** **command/query**

**Command Syntax:** :DISPlay:SOURce PMemory{0 | 1 | 2 | 3}  
**Query Syntax:** :DISPlay:SOURce?  
**Returned Format:** [:DISPlay:SOURce] PMemory{0 | 1 | 2 | 3}<NL>

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**:DISPlay:STRing** **command**

**Command Syntax:** :DISPlay:STRing <quoted string>

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**:DISPlay:TEXT** **command**

**Command Syntax:** :DISPlay:TEXT BLANK

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**:DISPlay:TMARker** **command/query**

**Command Syntax:** :DISPlay:TMARker {{ON | 1} | {OFF | 0}}  
**Query Syntax:** :DISPlay:TMARker?  
**Returned Format:** [:DISPlay:TMARker] {1 | 0}<NL>

---

**:DISPlay:VMARker** **command/query**

**Command Syntax:** :DISPlay:VMARker {{ON | 1} | {OFF | 0}}  
**Query Syntax:** :DISPlay:VMARker?  
**Returned Format:** [:DISPlay:VMARker] {1 | 0}<NL>

---

**:ERASe** **command**

**Command Syntax:** :ERASe PMemory{0 | 1 | 2}

**:FUNCTION{1 | 2}:ADD** **command****Command Syntax:** :FUNCTION{1 | 2}:ADD <operand>,<operand>**Where:** <operand> ::= {CHANnel{1 | 2} | WMEMory{1 | 2 | 3 | 4}}**:FUNCTION{1 | 2}:DIFF** **command****Command Syntax:** :FUNCTION{1 | 2}:DIFF {CHANnel{1 | 2} | WMEMory{1 | 2 | 3 | 4}}**:FUNCTION{1 | 2}:INTEgrate** **command****Command Syntax:** :FUNCTION{1 | 2}:INTEgrate {CHANnel{1 | 2} | WMEMory{1 | 2 | 3 | 4}}**:FUNCTION{1 | 2}:INVert** **command****Command Syntax:** :FUNCTION{1 | 2}:INVert {CHANnel{1 | 2} | WMEMory{1 | 2 | 3 | 4}}**:FUNCTION{1 | 2}:MULTIply** **command****Command Syntax:** :FUNCTION{1 | 2}:MULTIply <operand>,<operand>**Where:** <operand> ::= {CHANnel{1 | 2} | WMEMory{1 | 2 | 3 | 4}}**:FUNCTION{1 | 2}:OFFSet** **command/query****Command Syntax:** :FUNCTION{1 | 2}:OFFSet <offset value>**Query Syntax:** :FUNCTION{1 | 2}:OFFSet?**Returned Format:** [:FUNCTION{1 | 2}:OFFSet] <exponential offset value><NL>**:FUNCTION{1 | 2}:ONLY** **command****Command Syntax:** :FUNCTION{1 | 2}:ONLY {CHANnel{1 | 2} | WMEMory{1 | 2 | 3 | 4}}**:FUNCTION{1 | 2}:RANGe** **command/query****Command Syntax:** :FUNCTION{1 | 2}:RANGe <range setting>**Query Syntax:** :FUNCTION{1 | 2}:RANGe?**Returned Format:** [:FUNCTION{1 | 2}:RANGe] <exponential range setting><NL>

**:FUNCTION{1 | 2}:SUBTRact** **command**

**Command Syntax:** :FUNCTION{1 | 2}:SUBTRact <operand>,<operand>  
**Where:** <operand> ::= {CHANnel{1 | 2} | WMEMory{1 | 2 | 3 | 4}}

**:FUNCTION{1 | 2}:VERSus** **command**

**Command Syntax:** :FUNCTION{1 | 2}:VERSus <operand>,<operand>  
**Where:** <operand> ::= {CHANnel{1 | 2} | WMEMory{1 | 2 | 3 | 4}}

**:HARDcopy:LENGth** **command/query**

**Command Syntax:** :HARDcopy:LENGth {11 | 12}  
**Query Syntax:** :HARDcopy:LENGth?  
**Returned Format:** [:HARDcopy:LENGth] {11 | 12}<NL>

**:HARDcopy:MODE** **command/query**

**Command Syntax:** :HARDcopy:MODE {PRINT | PLOT}  
**Query Syntax:** :HARDcopy:MODE?  
**Returned Format:** [:HARDcopy:MODE] {PRINT | PLOT}<NL>

**:HARDcopy:PAGE** **command/query**

**Command Syntax:** :HARDcopy:PAGE {MANua1 | AUTomatic}  
**Query Syntax:** :HARDcopy:PAGE?  
**Returned Format:** [:HARDcopy:PAGE] {MANua1 | AUTomatic}<NL>

**:HARDcopy:PLOT:AREA** **command/query**

**Command Syntax:** :HARDcopy:PLOT:AREA {ALL | DISPlay | FACTors | GRATICule}  
**Query Syntax:** :HARDcopy:PLOT:AREA?  
**Returned Format:** [:HARDcopy:PLOT:AREA] {ALL | DISPlay | FACTors | GRATICule}<NL>

**:HARDcopy:PLOT:COLor** **command/query**

**Command Syntax:** :HARDcopy:PLOT:COLor <item>,{0 to 8}  
**Query Syntax:** :HARDcopy:PLOT:COLor? <item>  
**Returned Format:** [:HARDcopy:PLOT:COLor] {0 to 8}<NL>  
**Where:** <item> ::= {CHANnel{1 | 2} | WMEMory{1 | 2 | 3 | 4} | FUNCTION{1 | 2} | PMEMory{1 | 2} | VMARker{1 | 2} | STARTmarker | STOPmarker | GRATICule | TRIGger | TIMEbase | MEASure | TITLes}

**:HARDcopy:PLOT:INITialize** **command/query**

**Command Syntax:** :HARDcopy:PLOT:INITialize {{ON | 1} | {OFF | 0}}  
**Query Syntax:** :HARDcopy:PLOT:INITialize?  
**Returned Format:** [:HARDcopy:PLOT:INITialize] {1 | 0}<NL>

**:LER** **(Local Event Register)** **query**

**Query Syntax:** :LER?  
**Returned Format:** [:LER] {1 | 0}<NL>

**:LTER** **(Limit Test Event Register)** **query**

**Query Syntax:** :LTER?  
**Returned Format:** [:LTER] {1 | 0}<NL>

**:MEASure:ALL** **query**

**Query Syntax:** :MEASure:ALL?  
**Returned Format:** [:MEASure:FREquency] <result>;[PERiod] <result>;[PWIDth] <result>;[NWIDth] <result>;[RISetime] <result>;[FALLtime] <result>;[VAMPitude] <result>;[VPP] <result>;[PREShoot] <result>;[OVERshoot] <result>;[DUTycycle] <result>;[VRMS] <result>;[VMAX] <result>;[VMIN] <result>;[VTOP] <result>;[VBASe] <result>;[VAverage] <result><NL>

**:MEASure:COMPare** **command/query**

**Command Syntax:** :MEASure:COMPare <measurement>,<upper\_limit>,<lower\_limit>  
**Query Syntax:** :MEASure:COMPare? <measurement>  
**Returned Format:** [:MEASure:COMPare] <measurement>,<upper\_limit>,<lower\_limit><NL>  
**Where:** <measurement> ::= {RISetime | FALLtime | FREquency | PERiod | PWIDth | NWIDth | VAMPitude | VBASe | VTOP | VPP | VAverage | VMAX | VMIN | VRMS | DUTycycle | DELay}

**:MEASure:CURSor****query**

**Query Syntax:** :MEASure:CURSor? {DELTA | START | STOP}  
**Returned Format:** [:MEASure:CURSor] <time>,<voltage><NL>

**:MEASure:DEFine****command/query**

**Command Syntax:** :MEASure:DEFine <measurement\_spec>  
**Query Syntax:** :MEASure:DEFine? {DELAY | PWIDTH | NWIDTH}  
**Returned Format:** [:MEASure:DEFine] <measurement\_spec><NL>  
**Where:** <measurement\_spec> ::= {DELAY,<polarity>,<edge\_number>,<level>,<polarity>,<edge\_number>,<level> | PWIDTH,<level> | NWIDTH,<level>}  
<polarity> ::= {POSitive | NEGative}  
<edge\_number> ::= integer, 1 to 4000  
<level> ::= {MIDDLE | UPPER | LOWER}

**:MEASure:DELay****command/query**

**Command Syntax:** :MEASure:DELay  
**Query Syntax:** :MEASure:DELay?  
**Returned Format:** [:MEASure:DELay] <delay\_value><NL>

**:MEASure:DESTination****command/query**

**Command Syntax:** :MEASure:DESTination {WMemory{1 | 2 | 3 | 4} | PMEMory{1 | 2} | OFF}  
**Query Syntax:** :MEASure:DESTination?  
**Returned Format:** [:MEASure:DESTination] {WMemory{1 | 2 | 3 | 4} | PMEMory{1 | 2} | OFF}<NL>

**:MEASure:DUTycycle****command/query**

**Command Syntax:** :MEASure:DUTycycle  
**Query Syntax:** :MEASure:DUTycycle?  
**Returned Format:** [:MEASure:DUTycycle] <value><NL>

**:MEASure:ESTart****command/query**

**Command Syntax:** :MEASure:ESTart <edge\_number>  
**Query Syntax:** :MEASure:ESTart?  
**Returned Format:** [:MEASure:ESTart] <edge\_number><NL>

---

**:MEASure:ESTOp** **command/query**

**Command Syntax:** :MEASure:ESTOp <edge\_number>  
**Query Syntax:** :MEASure:ESTOp?  
**Returned Format:** [:MEASure:ESTOp] <edge\_number><NL>

---

**:MEASure:FALLtime** **command/query**

**Command Syntax:** :MEASure:FALLtime  
**Query Syntax:** :MEASure:FALLtime?  
**Returned Format:** [:MEASure:FALLtime] <value><NL>

---

**:MEASure:FREQuency** **command/query**

**Command Syntax:** :MEASure:FREQuency  
**Query Syntax:** :MEASure:FREQuency?  
**Returned Format:** [:MEASure:FREQuency] <value><NL>

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**:MEASure:LIMittest** **command**

**Command Syntax:** :MEASure:LIMittest {MEASure | OFF}

---

**:MEASure:LOWer** **command/query**

**Command Syntax:** :MEASure:LOWer <lower\_threshold>  
**Query Syntax:** :MEASure:LOWer?  
**Returned Format:** [:MEASure:LOWer] <lower\_threshold><NL>

---

**:MEASure:MODE** **command/query**

**Command Syntax:** :MEASure:MODE {STANdard | USER}  
**Query Syntax:** :MEASure:MODE?  
**Returned Format:** [:MEASure:MODE] {STANdard | USER}<NL>

---

**:MEASure:NWIDth** **command/query**

**Command Syntax:** :MEASure:NWIDth  
**Query Syntax:** :MEASure:NWIDth?  
**Returned Format:** [:MEASure:NWIDth] <negative\_width><NL>

**:MEASure:OVERshoot****command/query**

**Command Syntax:** :MEASure:OVERshoot  
**Query Syntax:** :MEASure:OVERshoot?  
**Returned Format:** [:MEASure:OVERshoot] <value><NL>

**:MEASure:PERiod****command/query**

**Command Syntax:** :MEASure:PERiod  
**Query Syntax:** :MEASure:PERiod?  
**Returned Format:** [:MEASure:PERiod] <value><NL>

**:MEASure:POSTfailure****command/query**

**Command Syntax:** :MEASure:POSTfailure {CONTInue | STOP}  
**Query Syntax:** :MEASure:POSTfailure?  
**Returned Format:** [:MEASure:POSTfailure] {CONTInue | STOP}<NL>

**:MEASure:PREShoot****command/query**

**Command Syntax:** :MEASure:PREShoot  
**Query Syntax:** :MEASure:PREShoot?  
**Returned Format:** [:MEASure:PREShoot] <value><NL>

**:MEASure:PWIDth****command/query**

**Command Syntax:** :MEASure:PWIDth  
**Query Syntax:** :MEASure:PWIDth?  
**Returned Format:** [:MEASure:PWIDth] <positive\_width><NL>

**:MEASure:RESults****query**

**Query Syntax:** :MEASure:RESults?  
**Returned Format:** [:MEASure:RESults] {integer, 0 to 8}[:<measurement> <result>]...<NL>

**:MEASure:RISetime****command/query**

**Command Syntax:** :MEASure:RISetime  
**Query Syntax:** :MEASure:RISetime?  
**Returned Format:** [:MEASure:RISetime] <value><NL>

<b>:MEASure:SCRatch</b>	<b>(Clear Results)</b>	<b>command</b>
<b>Command Syntax:</b> :MEASure:SCRatch		
<b>:MEASure:SOURce</b>		<b>command/query</b>
<b>Command Syntax:</b> :MEASure:SOURce <source>[,<source>]		
<b>Query Syntax:</b> :MEASure:SOURce?		
<b>Returned Format:</b> [:MEASure:SOURce] <source>[,<source>]<NL>		
<b>Where:</b> <source> ::= {CHANnel{1   2}   FUNction{1   2}   WMEMory{1   2   3   4}}		
<b>:MEASure:STATistics</b>		<b>command/query</b>
<b>Command Syntax:</b> :MEASure:STATistics {{ON   1}   {OFF   0}}		
<b>Query Syntax:</b> :MEASure:STATistics?		
<b>Returned Format:</b> [:MEASure:STATistics] {1   0}<NL>		
<b>:MEASure:TDELta</b>		<b>query</b>
<b>Query Syntax:</b> :MEASure:TDELta?		
<b>Returned Format:</b> [:MEASure:TDELta] <value><NL>		
<b>:MEASure:TMAX</b>		<b>query</b>
<b>Query Syntax:</b> :MEASure:TMAX?		
<b>Returned Format:</b> [:MEASure:TMAX] <time at maximum voltage><NL>		
<b>:MEASure:TMIN</b>		<b>query</b>
<b>Query Syntax:</b> :MEASure:TMIN?		
<b>Returned Format:</b> [:MEASure:TMIN] <time at minimum voltage><NL>		
<b>:MEASure:TSTArt</b>		<b>command/query</b>
<b>Command Syntax:</b> :MEASure:TSTArt <start marker time>		
<b>Query Syntax:</b> :MEASure:TSTArt?		
<b>Returned Format:</b> [:MEASure:TSTArt] <start marker time><NL>		

**:MEASure:TSTOp** **command/query**

**Command Syntax:** :MEASure:TSTOp <stop marker time>  
**Query Syntax:** :MEASure:TSTOp?  
**Returned Format:** [:MEASure:TSTOp] <stop marker time><NL>

**:MEASure:TVOLT** **query**

**Query Syntax:** :MEASure:TVOLT? <voltage>,<slope><occurrence>  
**Returned Format:** [:MEASure:TVOLT] <time of voltage crossing><NL>

**:MEASure:UNITs** **command/query**

**Command Syntax:** :MEASure:UNITs {PERCent | VOLTs}  
**Query Syntax:** :MEASure:UNITs?  
**Returned Format:** [:MEASure:UNITs] {PERCent | VOLTs}<NL>

**:MEASure:UPPer** **command/query**

**Command Syntax:** :MEASure:UPPer <upper\_threshold>  
**Query Syntax:** :MEASure:UPPer?  
**Returned Format:** [:MEASure:UPPer] <upper\_threshold><NL>

**:MEASure:VACRms** **command/query**

**Command Syntax:** :MEASure:VACRms  
**Query Syntax:** :MEASure:VACRms?  
**Returned Format:** [:MEASure:VACRms] <ac\_rms voltage><NL>

**:MEASure:VAMPLitude** **command/query**

**Command Syntax:** :MEASure:VAMPLitude  
**Query Syntax:** :MEASure:VAMPLitude?  
**Returned Format:** [:MEASure:VAMPLitude] <value><NL>

**:MEASure:VAverage** **command/query**

**Command Syntax:** :MEASure:VAverage  
**Query Syntax:** :MEASure:VAverage?  
**Returned Format:** [:MEASure:VAverage] <average voltage><NL>

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**:MEASure:VBASe** **command/query**

**Command Syntax:** :MEASure:VBASe  
**Query Syntax:** :MEASure:VBASe?  
**Returned Format:** [:MEASure:VBASe] <base voltage><NL>

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**:MEASure:VDCRms** **command/query**

**Command Syntax:** :MEASure:VDCRms  
**Query Syntax:** :MEASure:VDCRms?  
**Returned Format:** [:MEASure:VDCRms] <dc\_rms voltage><NL>

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**:MEASure:VDELta** **query**

**Query Syntax:** :MEASure:VDELta?  
**Returned Format:** [:MEASure:VDELta] <value><NL>

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**:MEASure:VFIFty** **command**

**Command Syntax:** :MEASure:VFIFty

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**:MEASure:VMAX** **command/query**

**Command Syntax:** :MEASure:VMAX  
**Query Syntax:** :MEASure:VMAX?  
**Returned Format:** [:MEASure:VMAX] <maximum voltage><NL>

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**:MEASure:VMIN** **command/query**

**Command Syntax:** :MEASure:VMIN  
**Query Syntax:** :MEASure:VMIN?  
**Returned Format:** [:MEASure:VMIN] <minimum voltage><NL>

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**:MEASure:VPP** **command/query**

**Command Syntax:** :MEASure:VPP  
**Query Syntax:** :MEASure:VPP?  
**Returned Format:** [:MEASure:VPP] <peak-to-peak voltage><NL>

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**:MEASure:VRELative** **command/query**

**Command Syntax:** :MEASure:RELative {0 to 100}  
**Query Syntax:** :MEASure:RELative?  
**Returned Format:** [:MEASure:RELative] {integer, 50 to 100}<NL>

**:MEASure:VRMS (AC RMS)** **command/query**

**Command Syntax:** :MEASure:VRMS  
**Query Syntax:** :MEASure:VRMS?  
**Returned Format:** [:MEASure:VRMS] <ac\_rms voltage><NL>

**:MEASure:VStArt** **command/query**

**Command Syntax:** :MEASure:VStArt <vmarker1 voltage>  
**Query Syntax:** :MEASure:VStArt?  
**Returned Format:** [:MEASure:VStArt] <vmarker1 voltage><NL>

**:MEASure:VStOp** **command/query**

**Command Syntax:** :MEASure:VStOp <vmarker2 voltage>  
**Query Syntax:** :MEASure:VStOp?  
**Returned Format:** [:MEASure:VStOp] <vmarker2 voltage><NL>

**:MEASure:VTIME** **query**

**Query Syntax:** :MEASure:VTIME? <time from trigger>  
**Returned Format:** [:MEASure:VTIME] <voltage at specified time><NL>

**:MEASure:VtOP** **command/query**

**Command Syntax:** :MEASure:VtOP  
**Query Syntax:** :MEASure:VtOP?  
**Returned Format:** [:MEASure:VtOP] <top\_voltage><NL>

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**:MENU** **command/query**

**Command Syntax:** :MENU {TIMEbase | CHANne1 | TRIGger | DISPlay | DELTa | MATH | SAVE | MEASure | UTILity | SHOW}

**Query Syntax:** :MENU?

**Returned Format:** [:MENU] {TIMEbase | CHANne1 | TRIGger | DISPlay | DELTa | MATH | SAVE | MEASure | UTILity | SHOW}<NL>

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**:MERGe** **command**

**Command Syntax:** :MERGe PMemory{1 | 2}

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**:PLOT** **query**

**Query Syntax:** :PLOT?

---

**:PRINT** **query**

**Query Syntax:** :PRINT?

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**:RUN** **command**

**Command Syntax:** :RUN

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**:SERial** **(Serial Number)** **command**

**Command Syntax:** :SERial <string>

**Where:** <string> ::= 10 character alphanumeric serial number within quotes

---

**:STATus** **query**

**Query Syntax:** :STATus? {CHANne1{1 | 2} | FUNction{1 | 2} | WMemory{1 | 2 | 3 | 4} | PMemory{1 | 2}}

**Returned Format:** [:STATus] {0 | 1}<NL>

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**:STOP** **command**

**Command Syntax:** :STOP

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**:STORE****command****Command Syntax:** :STORE <source>,<destination>**Where:** <source> ::= {CHANnel{1 | 2} | FUNCTION{1 | 2} | WMemory{1 | 2 | 3 | 4}}  
<destination> ::= WMemory{1 | 2 | 3 | 4}**:SYSTEM:DSP****command/query****Command Syntax:** :SYSTEM:DSP <quoted ASCII string>**Query Syntax:** :SYSTEM:DSP?**Returned Format:** [:SYSTEM:DSP] <string><NL>**Where:** <string> ::= last information written on the advisory line**:SYSTEM:ERROR****query****Query Syntax:** :SYSTEM:ERROR {NUMBER | STRING | (no\_parameter)}**Returned Format:** [:SYSTEM:ERROR] <error code>[,<quoted string>]<NL>**:SYSTEM:HEADER****command/query****Command Syntax:** :SYSTEM:HEADER {{ON | 1} | {OFF | 0}}**Query Syntax:** :SYSTEM:HEADER?**Returned Format:** [:SYSTEM:HEADER] {1 | 0}<NL>**:SYSTEM:KEY****command/query****Command Syntax:** :SYSTEM:KEY {1 to 44}**Query Syntax:** :SYSTEM:KEY?**Returned Format:** [:SYSTEM:KEY] {integer, 0 to 44}<NL>**:SYSTEM:LONGform****command/query****Command Syntax:** :SYSTEM:LONGform {{ON | 1} | {OFF | 0}}**Query Syntax:** :SYSTEM:LONGform?**Returned Format:** [:SYSTEM:LONGform] {1 | 0}<NL>**:SYSTEM:SETup****command/query****Command Syntax:** :SYSTEM:SETup #800001024<setup data string>**Query Syntax:** :SYSTEM:SETup?**Returned Format:** [:SYSTEM:SETup] #800001024<setup data string><NL>

<b>:TER</b>	<b>(Trigger Event Register)</b>	<b>query</b>
<b>Query Syntax:</b>	:TER?	
<b>Returned Format:</b>	[:TER] {1   0}<NL>	
<b>:TIMEbase:DELAy</b>		<b>command/query</b>
<b>Command Syntax:</b>	:TIMEbase:DELAy <delay time>	
<b>Query Syntax:</b>	:TIMEbase:DELAy?	
<b>Returned Format:</b>	[:TIMEbase:DELAy] <delay time><NL>	
<b>:TIMEbase:MODE</b>		<b>command/query</b>
<b>Command Syntax:</b>	:TIMEbase:MODE {AUTO   TRIGgered   SINGle}	
<b>Query Syntax:</b>	:TIMEbase:MODE?	
<b>Returned Format:</b>	[:TIMEbase:MODE] {AUTO   TRIGgered   SINGle}<NL>	
<b>:TIMEbase:RANGE</b>		<b>command/query</b>
<b>Command Syntax:</b>	:TIMEbase:RANGE {10 ns to 50 s}	
<b>Query Syntax:</b>	:TIMEbase:RANGE?	
<b>Returned Format:</b>	[:TIMEbase:RANGE] {exponential, 10 ns to 50 s}<NL>	
<b>:TIMEbase:REFerence</b>		<b>command/query</b>
<b>Command Syntax:</b>	:TIMEbase:REFerence {LEFT   CENTer   RIGHT}	
<b>Query Syntax:</b>	:TIMEbase:REFerence?	
<b>Returned Format:</b>	[:TIMEbase:REFerence] {LEFT   CENTer   RIGHT}<NL>	
<b>:TIMEbase:SAMPle</b>		<b>command/query</b>
<b>Command Syntax:</b>	:TIMEbase:SAMPle {REALtime   REPetitive}	
<b>Query Syntax:</b>	:TIMEbase:SAMPle?	
<b>Returned Format:</b>	[:TIMEbase:SAMPle] {REALtime   REPetitive}<NL>	
<b>:TRIGger:CENTerEd</b>		<b>command</b>
<b>Command Syntax:</b>	:TRIGger:CENTerEd	

**:TRIGger:CONDition****command/query**

**Command Syntax:** :TRIGger:CONDition <argument>  
**Query Syntax:** :TRIGger:CONDition?  
**Returned Format:** [:TRIGger:CONDition] <argument><NL>  
**Where:** <argument> ::= {ENTER | EXIT | GT,<value> | LT,<value> | RANGE,<range\_greater\_than>,<range\_less\_than> | TRUE | FALSE}

**:TRIGger:COUPling****command/query**

**Command Syntax:** :TRIGger:COUPling {DC | DCFifty}  
**Query Syntax:** :TRIGger:COUPling?  
**Returned Format:** [:TRIGger:COUPling] {DC | DCFifty}<NL>

**:TRIGger:DELAy****command/query**

**Command Syntax:** :TRIGger:DELAy {TIME,<time\_value> | EVENT,<event\_value>}  
**Query Syntax:** :TRIGger:DELAy?  
**Returned Format:** [:TRIGger:DELAy] {TIME,<time\_value> | EVENT,<event\_value>}<NL>  
**Where:** <time\_value> ::= time of delay - exponential, 30 ns to 160 ms  
<event\_value> ::= number of events - integer, 1 to 16000000

**:TRIGger:DELAy:SLOPe****command/query**

**Command Syntax:** :TRIGger:DELAy:SLOPe {POSitive | NEGative}  
**Query Syntax:** :TRIGger:DELAy:SLOPe?  
**Returned Format:** [:TRIGger:DELAy:SLOPe] {POSitive | NEGative}<NL>

**:TRIGger:DELAy:SOURce****command/query**

**Command Syntax:** :TRIGger:DELAy:SOURce {CHANne1{1 | 2} | EXTerna1}  
**Query Syntax:** :TRIGger:DELAy:SOURce?  
**Returned Format:** [:TRIGger:DELAy:SOURce] {CHANne1{1 | 2} | EXTerna1}<NL>

**:TRIGger:FIELD****command/query**

**Command Syntax:** :TRIGger:FIELD { 1 | 2 }  
**Query Syntax:** :TRIGger:FIELD?  
**Returned Format:** [:TRIGger:FIELD] { 1 | 2 }<NL>

**:TRIGger:HOLDoff** **command/query**

**Command Syntax:** :TRIGger:HOLDoff {TIME,<holdoff\_value> | EVENT,<event\_argument>}  
**Query Syntax:** :TRIGger:HOLDoff?  
**Returned Format:** [:TRIGger:HOLDoff] {TIME,<holdoff\_value> | EVENT,<event\_argument>}<NL>  
**Where:** <holdoff\_value> ::= exponential, 40 ns to 320 ms  
 <event\_argument> ::= integer, 1 to 16000000

**:TRIGger:LEVel** **command/query**

**Command Syntax:** :TRIGger:LEVel <level>  
**Query Syntax:** :TRIGger:LEVel?  
**Returned Format:** [:TRIGger:LEVel] <level><NL>  
**Where:** <level> ::= trigger level in volts

**:TRIGger:LINE** **command/query**

**Command Syntax:** :TRIGger:LINE {1 to 625}  
**Query Syntax:** :TRIGger:LINE?  
**Returned Format:** [:TRIGger:LINE] {integer, 1 to 625}<NL>

**:TRIGger:LOGic** **command/query**

**Command Syntax:** :TRIGger:LOGic {HIGH | LOW | DONTcare}  
**Query Syntax:** :TRIGger:LOGic?  
**Returned Format:** [:TRIGger:LOGic] {HIGH | LOW | DONTcare}<NL>

**:TRIGger:MODE** **command/query**

**Command Syntax:** :TRIGger:MODE {EDGE | PATtern | STATe | DELay | TV}  
**Query Syntax:** :TRIGger:MODE?  
**Returned Format:** [:TRIGger:MODE] {EDGE | PATtern | STATe | DELay | TV}<NL>

**:TRIGger:OCCurrence** **command/query**

**Command Syntax:** :TRIGger:OCCurrence {1 to 16000000}  
**Query Syntax:** :TRIGger:OCCurrence?  
**Returned Format:** [:TRIGger:OCCurrence] {integer, 1 to 16000000}<NL>

**:TRIGger:OCCurrence:SLOPe** **command/query**

**Command Syntax:** :TRIGger:OCCurrence:SLOPe {POSitive | NEGative}  
**Query Syntax:** :TRIGger:OCCurrence:SLOPe?  
**Returned Format:** [:TRIGger:OCCurrence:SLOPe] {POSitive | NEGative}<NL>

**:TRIGger:OCCurrence:SOURce** **command/query**

**Command Syntax:** :TRIGger:OCCurrence:SOURce {CHANne1{1 | 2} | EXTerna1}  
**Query Syntax:** :TRIGger:OCCurrence:SOURce?  
**Returned Format:** [:TRIGger:OCCurrence:SOURce] {CHANne1{1 | 2} | EXTerna1}<NL>

**:TRIGger:PATH** **command/query**

**Command Syntax:** :TRIGger:PATH {CHANne1{1 | 2} | EXTerna1}  
**Query Syntax:** :TRIGger:PATH?  
**Returned Format:** [:TRIGger:PATH] {CHANne1{1 | 2} | EXTerna1}<NL>

**:TRIGger:POLarity** **command/query**

**Command Syntax:** :TRIGger:POLarity {POSitive | NEGative}  
**Query Syntax:** :TRIGger:POLarity?  
**Returned Format:** [:TRIGger:POLarity] {POSitive | NEGative}<NL>

**:TRIGger:PROBe** **command/query**

**Command Syntax:** :TRIGger:PROBe {0.9 to 1000}  
**Query Syntax:** :TRIGger:PROBe?  
**Returned Format:** [:TRIGger:PROBe] {exponential, 0.9 to 1000}<NL>

**:TRIGger:QUALify** **command/query**

**Command Syntax:** :TRIGger:QUALify {EDGE | PATTeM | STATE | LOW | HIGH}  
**Query Syntax:** :TRIGger:QUALify?  
**Returned Format:** [:TRIGger:QUALify] {EDGE | PATTeM | STATE | LOW | HIGH}<NL>

**:TRIGger:SENSitivity** **command/query**

**Command Syntax:** :TRIGger:SENSitivity {NORMa1 | LOW}  
**Query Syntax:** :TRIGger:SENSitivity?  
**Returned Format:** [:TRIGger:SENSitivity] {NORMa1 | LOW}<NL>

**:TRIGger:SLOPe** **command/query**

**Command Syntax:** :TRIGger:SLOPe {NEGAtive | POSitive}  
**Query Syntax:** :TRIGger:SLOPe?  
**Returned Format:** [:TRIGger:SLOPe] {POSitive | NEGAtive}<NL>

**:TRIGger:SOURce** **command/query**

**Command Syntax:** :TRIGger:SOURce {CHANne1{1 | 2} | EXTerma1}  
**Query Syntax:** :TRIGger:SOURce?  
**Returned Format:** [:TRIGger:SOURce] {CHANne1{1 | 2} | EXTerma1}<NL>

**:TRIGger:STANdard** **command/query**

**Command Syntax:** :TRIGger:STANdard {525 | 625 | USER}  
**Query Syntax:** :TRIGger:STANdard?  
**Returned Format:** [:TRIGger:STANdard] {525 | 625 | USER}<NL>

**:VIEW** **command**

**Command Syntax:** :VIEW {CHANne1{1 | 2} | FUNCTION{1 | 2} | PMEMory{1 | 2} |  
WMEMory{1 | 2 | 3 | 4}}

**:WAVeform:DATA** **command/query**

**Command Syntax:** :WAVeform:DATA <binary block data in # format>  
**Query Syntax:** :WAVeform:DATA?  
**Returned Format:** [:WAVeform:DATA] <binary block length bytes><binary block><NL>

**:WAVeform:FORMat** **command/query**

**Command Syntax:** :WAVeform:FORMat {ASCii | WORD | BYTE | COMPRESSED}  
**Query Syntax:** :WAVeform:FORMat?  
**Returned Format:** [:WAVeform:FORMat] {ASCii | WORD | BYTE | COMPRESSED}<NL>

**:WAVeform:POINts** **query**

**Query Syntax:** :WAVeform:POINts?  
**Returned Format:** [:WAVeform:POINts] {500 | 8000}<NL>

**:WAVeform:PREAmble****command/query****Command Syntax:** :WAVeform:PREAmble <preamble block>**Query Syntax:** :WAVeform:PREAmble?**Returned Format:** [:WAVeform:PREAmble] <preamble block><NL>**Where:** <preamble block> ::= <format NR1>, <type NR1>, <points NR1>, <count NR1>, <xincrement NR3>, <xorigin NR3>, <xreference NR1>, <yincrement NR3>, <yorigin NR3>, <yreference NR1>

<format> ::= 0 for ASCII format  
 1 for BYTE format  
 2 for WORD format  
 4 for COMPRESSED format

<type> ::= 0 for INVALID type  
 1 for NORMAL type or REALTIME  
 2 for AVERAGE type  
 3 for ENVELOPE type  
 4 for RAWDATA type

**:WAVeform:SOURce****command/query****Command Syntax:** :WAVeform:SOURce {CHANne1{1 | 2} | WMEMory{1 | 2 | 3 | 4}}**Query Syntax:** :WAVeform:SOURce?**Returned Format:** [:WAVeform:SOURce] {CHANne1{1 | 2} | WMEMory{1 | 2 | 3 | 4}}<NL>**:WAVeform:TYPE****query****Query Syntax:** :WAVeform:TYPE?**Returned Format:** [:WAVeform:TYPE] {INVAliD | AVERAge | ENVELOpe | NORMAl | RAWData}<NL>**:WAVeform:XINCrement****query****Query Syntax:** :WAVeform:XINCrement?**Returned Format:** [:WAVeform:XINCrement] <x-increment value><NL>**:WAVeform:XORigin****query****Query Syntax:** :WAVeform:XORigin?**Returned Format:** [:WAVeform:XORigin] <x-origin value>[, <x-origin value>]...<NL>

---

**:WAVeform:XREFerence****query**

**Query Syntax:** :WAVeform:XREFerence?  
**Returned Format:** [:WAVeform:XREFerence] <x-reference value><NL>

---

**:WAVeform:YINCrement****query**

**Query Syntax:** :WAVeform:YINCrement?  
**Returned Format:** [:WAVeform:YINCrement] <y-increment value><NL>

---

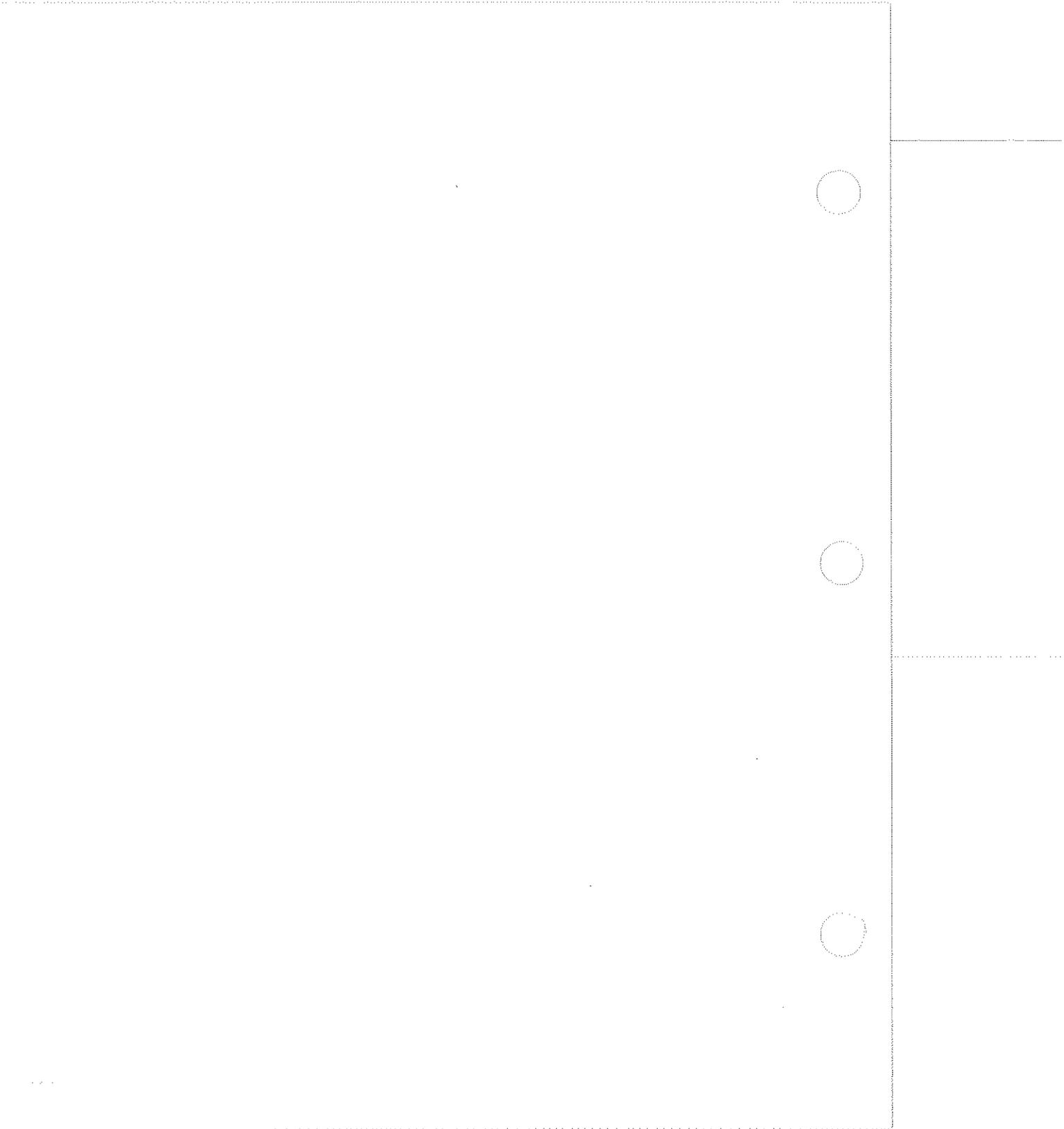
**:WAVeform:YORigin****query**

**Query Syntax:** :WAVeform:YORigin?  
**Returned Format:** [:WAVeform:YORigin] <y-origin value><NL>

---

**:WAVeform:YREFerence****query**

**Query Syntax:** :WAVeform:YREFerence?  
**Returned Format:** [:WAVeform:YREFerence] <y-reference value><NL>



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