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Agilent Technologies 16533A 1-GSa/s and 16534A 2-GSa/s Oscilloscope Programmer's Guide

Insert this package in the back of either Programmer's Guide binder included with the Agilent Technologies 16500B Logic Analysis System.

Programmer's Guide

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Agilent Technologies 16533A 1-GSa/s and 16534A 2-GSa/s Digitizing Oscilloscope

In This Book

This guide, combined with the *Agilent Technologies 16500B/16501A Programmer's Guide*, provides you with the information needed to program the Agilent Technologies 16533/34A oscilloscope module. Each module has its own reference to supplement the mainframe manual since not all mainframes will be configured with the same modules.

Chapter 1 contains:

- Mainframe system commands that are frequently used with the oscilloscope module
- 16533/34A Oscilloscope command tree
- Alphabetic command-to-subsystem directory

Chapter 2 contains module level commands.

Chapters 3 through 10 contain the subsystem commands for the oscilloscope.

Chapter 11 contains program examples of actual tasks that show you how to get started in programming the 16533/34A oscilloscope. These examples are written in HP BASIC 6.2; however, the program concepts can be used in any other popular programming language that allows communications with either the GPIB or RS-232C buses.

Error messages for the 16533/34A are included in generic system error messages and are in the *Agilent Technologies 16500B/16501A Programmer's Guide*.

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Programming the 16533/34A Oscilloscope Module

Introduction

This chapter introduces you to the basic command structure used to program the oscilloscope. Also included is an example program that displays a waveform and makes automatic parametric measurements. Additional program examples are in chapter 11.

Selecting the Module

Before you can program the oscilloscope, you must first "select" it, otherwise, there is no way to direct your commands to the oscilloscope.

To select the module, use the system command :SELect followed by the numeric reference for the slot location of the oscilloscope (1...10 refers to slot A...J respectively). For example, if the oscilloscope card is in slot E, then the command:

```
:SELect 5
```

would select this module. For a multi-card configuration you would select the topmost card slot of the multi-card configuration. For more information on the select command, refer to the *Agilent Technologies 16500B/16501A Programmer's Guide*.

Setting up an Oscilloscope

The easiest and fastest way to set up the oscilloscope is to use the AUTOSCALE command. The AUTOSCALE command causes the oscilloscope to automatically select the vertical sensitivity, vertical offset, trigger source, trigger level and timebase settings for optimum viewing of any input signals. The trigger source is the lowest channel on which the trigger was found. If no signal is found, the oscilloscope defaults to auto-trigger.

To demonstrate a quick oscilloscope setup, we will use the AC CAL signal available at the rear panel of the card. This square wave is normally used for calibration and probe compensation.

Connect the CAL OUTPUT signal from the rear panel output connector to CHAN 1, also on the rear panel. Ensure that the mainframe is connected to a controller. Enter the program listed on the next page and execute it.

Example

```
10 OUTPUT XXX;":SELECT 5"
20 OUTPUT XXX;":AUTOSCALE"
25 WAIT 5
30 DIM Me$[200]
40 OUTPUT ;":MEASURE:SOURCE CHANNEL1;ALL?"
50 ENTER XXX;Me$
60 PRINT Me$
70 END
```

The three Xs (XXX) after the OUTPUT and ENTER statements in the above example refer to the device address required for programming over either GPIB or RS-232-C. Refer to your controller manual and programming language reference manual for information on initializing the interface.

Program Comments

Line 10 selects the oscilloscope in slot E.

Line 20 causes the oscilloscope to execute the AUTOSCALE command.

Line 25 causes the oscilloscope to wait 5 seconds (the time you allow for the measurement to be complete).

Line 30 dimensions and reserves memory for the string array.

Line 40 causes the oscilloscope to make all the parametric measurements of the Measure subsystem. The source for the measurements is channel 1.

Line 50 enters data from the oscilloscope.

Line 60 causes the data to be printed either on controller screen or hardcopy, depending on the output device chosen.

For more information on the specific oscilloscope commands, refer to chapters 2 through 10 of this manual.

Mainframe Commands

These commands are part of the Agilent Technologies 16500B/16501A mainframe system and are mentioned here only for reference. For more information on these commands, refer to the *Agilent Technologies 16500B/16501A Programmer's Guide*.

CARDcage?

The CARDcage query returns a series of integers which identify the modules that are installed in the mainframe. The returned string is in two parts. The first five two-digit numbers identify the card type. The identification number for the both the 16533A and the 16534A oscilloscope is 14. Use the VARiation query to identify the card. A "-1" in the first part of the string indicates no card is installed in the slot.

The five single-digit numbers in the second part of the string indicate which slots have cards installed, which card has the controlling software for the module, and where the master card is located.

Example

For a 16500B Mainframe without the 16501A Expander:

```
1,14,-1,-1,31,0,2,0,0,5
```

The first five numbers of the returned string of -1,14,-1,-1,31,0,2,0,0,5 means:

Slot A is empty (-1).
The oscilloscope (ID number 14) is loaded in slot B.
The next two slots (C and D) are empty (-1).
Slot E contains a logic analyzer module (ID number 31).

The next group of numbers (0,2,0,0,5) mean:

Either Slot A is empty (0), the module software is not recognized, or the module software is not loaded.
A single card module is installed in slot B.
Either slots C and D (0) are empty, the module software is not recognized, or the module software is not loaded.
The last digit (5) in this group indicates that a single module card is loaded in slot E.

Complete information for the CARDcage query is in the *Agilent Technologies 16500B/16501A Programmer's Guide*.

MENU

The MENU command selects the menu to be displayed on the screen. The first parameter specifies the desired module. The optional second parameter specifies the desired menu in the module (defaults to 0 if not specified).

For the 16533/34A Oscilloscope:

- X,0 - Channel Menu
- X,1 - Trigger Menu
- X,2 - Display Menu
- X,3 - Auto-Measure Menu
- X,4 - Marker Menu
- X,5 - Calibration Menu

X = slot number that contains the oscilloscope card

MENU?

The MENU query returns the currently selected (and displayed) menu.

SELect

The SELect command selects which module or intermodule will have parser control. SELect 0 selects system/intermodule, and assuming the Agilent Technologies 16501B extender is being used, SELect 1 through 10 selects modules A through J respectively. Parameters -1 and -2 select software options 1 and 2.

SELect ?

The SELect query returns the currently selected module.

STARt

The STARt command starts the selected module or intermodule. If the selected module is configured for intermodule, STARt will start all modules configured for intermodule.

STOP

The STOP command stops the selected module or intermodule. If the selected module is configured for intermodule, STOP will stop all modules configured for intermodule.

RMODe

The RMODe command specifies the run mode (either single or repetitive) for a module or intermodule. If the selected module is configured for intermodule, the intermodule run mode will be set by this command.

RMODe?

The RMODe query returns the current setting.

SYSTem:ERRor?

The SYSTem:ERRor query returns the oldest error in the error queue. In order to return all the errors in the error queue, a simple FOR/NEXT loop can be written to query the queue until all errors are returned. Once all errors are returned, the queue will return zeros.

SYSTem:PRINt

The SYSTem:PRINt command initiates a print of the screen or listing buffer over the current printer communication interface.

SYSTem:PRINt?

The SYSTem:PRINt query sends the screen or listing buffer data over the current controller communication interface.

MMEMory Subsystem

The MMEMory Subsystem commands provide access to both internal disc drives for loading and storing configurations.

INTermodule Subsystem

The INTermodule Subsystem commands are used to specify intermodule arming between multiple modules.

Table 1-1. Alphabetical Command to Subsystem Directory

COMMAND	WHERE USED
AVOLt	MARKer
ABVOLt	MARKer
ACCumulate	DISPlay
AUToscale	MODULE LEVEL
ALL	MEASure
BVOLt	MARKer
CENTer	MARKer
CONDition	TRIGger
CONNect	DISPlay
COUNt	ACQuire
	WAVeform
COUPling	CHANnel
DATA	WAVeform
DELay	TIMebase
	TRIGger
DIGitize	MODULE LEVEL
ECL	CHANnel
FALLtime	MEASure
FORMat	WAVeform
FREQuency	MEASure
INSert	DISPlay
LABel	DISPlay
LEVel	TRIGger
LOGic	TRIGger
MINus	DISPlay
MODE	TIMebase
	TRIGger
MSTats	MARKer
NWIDth	MEASure
OAUTo	MARKer
OFFSet	CHANnel
OTIMe	MARKer
OVERlay	DISPlay
OVERshoot	MEASure
PATH	TRIGger
PERiod	MEASure
PLUS	DISPlay
POINts	WAVeform
PREamble	WAVeform
PRESHoot	MEASure
PROBe	CHANnel
PWIDth	MEASure
RANGe	CHANnel
	TIMebase
RECord	WAVeform
REMove	DISPlay
RISetime	MEASure
RUNtil	MARKer
SHOW	MARKer
SLOPe	TRIGger
SOURce	MEASure
	TRIGger
	WAVeform
SPERiod	WAVeform
TAVerage	MARKer
TMAXimum	MARKer
TMINimum	MARKer
TMODe	MARKer
TTL	CHANnel
TYPE	ACQuire
	WAVeform
VALid	WAVeform
VAMPlitude	MEASure
VARiation	Module Level
VBASe	MEASure
VMAX	MEASure
VMIN	MEASure
VMODe	MARKer
VOTime	MARKer
VPP	MEASure
VRUNs	MARKer
VTOP	MEASure
VXTime	MARKer
XAUTo	MARKer
XINCrement	WAVeform
XORigin	WAVeform
XREFerence	WAVeform
XOTime	MARKer
XTIMe	MARKer
YINCrement	WAVeform
YORigin	WAVeform
YREFerence	WAVeform

16534B01

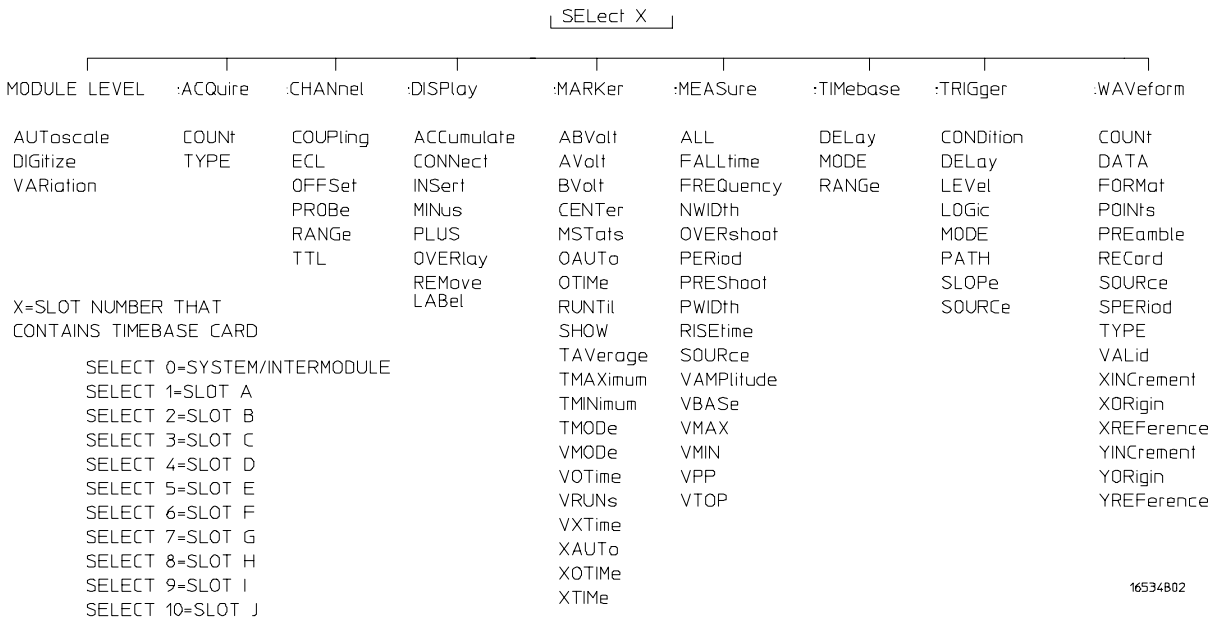
Command Set Organization

The command set for the 16533/34A is divided into module level commands and subsystem commands. Module level commands are listed in Chapter 2 and each of the subsystem commands are covered in their individual chapters starting with Chapter 3.

Each of these chapters contain a description of the subsystem, syntax diagrams and the commands in alphabetical order. The commands are shown in longform and shortform using upper and lowercase letters. For example, TRIGger indicates that the longform of the command is TRIGGER and the shortform is TRIG. Each of the commands contains a description of the command and its arguments, the command syntax, and a programming example.

Figure 1-1 is the command tree for the 16533/34A oscilloscope module.

Figure 1-1



16533/34A Command Tree

Module Status Reporting

Each module reports its status to the Module Event Status Register (MESR) which in turn reports to the Combined Event Status Register (CESR) in the Agilent Technologies 16500B/16501A mainframe (see *Agilent Technologies 16500B/16501A Programmer's Guide*, Chapter 6). The Module Event Status Register is enabled by the Module Event Status Enable Register (MESE).

The following descriptions of the MESE and MESR commands provide the module specific information needed to enable and interpret the contents of the registers.

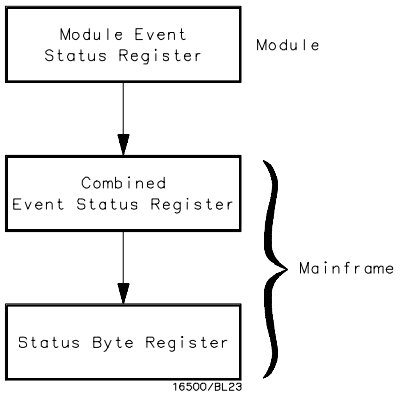


Figure 1-2

Module Status Reporting

MESE <N>

Command `:MESE<N> <enable_mask>`

The MESE <N> command sets the Module Event Status Enable register bits. The MESE register contains a mask value for the bits enabled in the MESR register. A one in the MESE register will enable the corresponding bit in the MESR, a zero will disable the bit.

The first parameter specifies the module, and the second parameter specifies the enable value. 1...10 refers to the module in slot A...J.

Refer to table 1-2 for information about the Module Event Status Enable register bits, bit weights, and what each bit masks for the module.

`<N>` {1|2|3|4|5|6|7|8|9|10} number of slot where the module resides

`<enable_mask>` integer 0 to 255

Example:

```
OUTPUT XXX;":MESE5 2"
```

Query `:MESE<N>?`

The MESE query returns the current setting.

Returned Format: `[MESE]<enable_mask><NL>`

Example:

```
10 OUTPUT XXX;":MESE5?"
20 ENTER XXX; Mes
30 PRINT Mes
40 END
```

Table 1-2. Module Event Status Register

Bit	Weight	Enables
7	128	Not used
6	64	Not used
5	32	Not used
4	16	Number of averages met
3	8	Auto triggered
2	4	Trigger received
1	2	RNT-Run until satisfied
0	1	MC-Measurement complete

The Module Event Status Enable Register contains a mask value for the bits to be enabled in the Module Event Status Register (MESR). A one in the MESE enables the corresponding bit in the MESR, a zero disables the bit.

MESR <N>?

Query `:MESR<N> ?`

The MESR query returns the contents of the Module Event Status register.

Table 1-3 shows each bit in the Module Event Status Register and their bit weights for this module. When you read the MESR, the value returned is the total bit weights of all bits that are high at the time the register is read.

The parameter 1...10 refers to the module in slot A...J respectively.

> Reading the register clears the Module Event Status Register.

Returned Format: `[MESR<N>]<status><NL>`

`<N>` {1|2|3|4|5|6|7|8|9|10} number of slot where the module resides

`<status>` integer 0 to 255

Example:

```
10 OUTPUT XXX;":MESR5?"
20 ENTER XXX; Mer
30 PRINT Mer
40 END
```

Table 1-3.

Module Event Status Register

Bit	Weight	Condition
7	128	Not used
6	64	Not used
5	32	Not used
4	16	1=Number of averages satisfied 0=Number of averages not satisfied
3	8	1=Auto triggered received 0=Auto triggered not received
2	4	1=Trigger received 0=Trigger not received
1	2	1=Run until satisfied 0=Run until not satisfied
0	1	1=Measurement complete 0=Measurement not complete

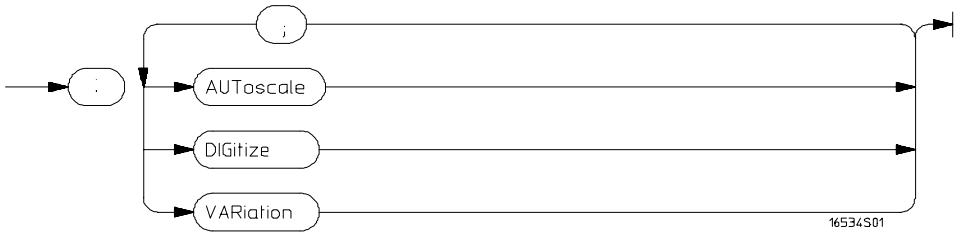
Module Level Commands

Introduction

Oscilloscope Module Level commands control the basic operation of the oscilloscope. Refer to figure 2-1 for the module level syntax command diagram. The 16533/34A Module Level commands are:

- AUToscale
- DIGitize
- VARiation

Figure 2-1



Module Level Command Syntax Diagram

AUToscale

Command

```
:AUToscale
```

The AUToscale command causes the oscilloscope to automatically select the vertical sensitivity, vertical offset, trigger source, trigger level and timebase settings for optimum viewing of any input signals. The trigger source is the lowest channel on which the trigger was found. If no trigger is found, the oscilloscope defaults to auto-trigger. The display window configuration is not altered by AUToscale.

Example:

```
OUTPUT XXX;":AUTOSCALE"
```

DIGitize

Command

```
:DIGitize
```

The DIGitize command is used to acquire waveform data for transfer over GPIB. The command initiates the Repetitive Run for the oscilloscope and any modules that are grouped together in Group Run through the Intermodule Bus. If a RUNtil condition has been specified in any module, the oscilloscope and the grouped modules will acquire data until the RUNtil conditions have been satisfied.

The Acquire subsystem commands may be used to set up conditions such as acquisition type and average count for the DIGitize command. See the Acquire subsystem for the description of these commands.

When a count number in the average acquisition type has been specified, the oscilloscope and all grouped modules will acquire data until these conditions have been satisfied.

When both the RUNtil and the ACQuire:COUNt have been satisfied, the acquisition will stop.

For a faster data transfer rate over the interface bus, diaplay a menu that has no waveforms on screen.

> The DIGitize command is an overlap command, thus ensure that all data has been acquired and stored in the channel buffers before executing any other commands. The MESE command and the MESR query may be used to check for run complete or a WAIt instruction may be inserted after the DIGitize command to ensure enough time for command execution.

Example

```
OUTPUT XXX;":DIGITIZE"
```

> An example using the DIGitize command can be found in Chapter 11, "Programming Examples."

VARiation

Query

```
:VARiation?
```

The VARiation query is used to return the specific 32K sample scope board variation at this cardslot location. The return value is a string with the scope model number.

Recall that the Mainframe Query, CARDcage? is used to determine the card type installed in a specific card slot (see section 1 of this manual). The card type for both the 16533A and the 16534A is 14.

If multiple scope cards are connected together to create a scope module with greater than two channels, only the master card (top-most card) variation is returned.

Returned Format

[:VARiation] {16533 | 16534}

Example

```
OUTPUT XXX;":VARiation?"
```

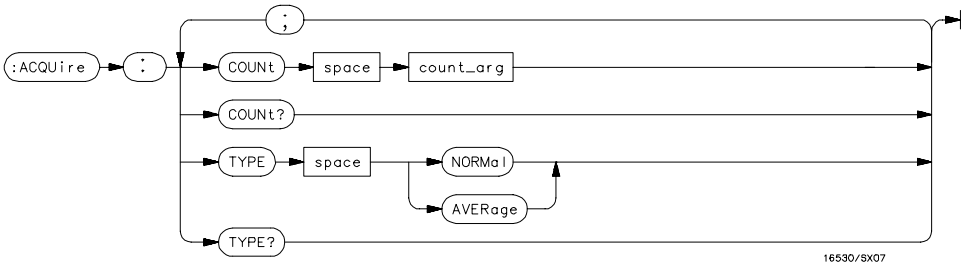
ACQuire Subsystem

Introduction

The Acquire Subsystem commands are used to set up acquisition conditions for the DIGitize command. The subsystem contains commands to select the type of acquisition and the number of averages to be taken if the average type is chosen. Refer to Figure 3-1 for the ACQuire Subsystem Syntax Diagram. The ACQuire Subsystem commands are:

- COUNt
- TYPE

Figure 3-1



ACQuire Subsystem Syntax Diagram

Table 3-1 **ACQuire Parameter Values**

Parameter	Value
count_arg	An integer that specifies the number of averages to be taken of each time point. The choices are 2, 4, 8, 16, 32, 64, 128, or 256.

Acquisition Type Normal

In the Normal mode, with the ACCumulate command OFF, the oscilloscope acquires waveform data and then displays the waveform. When the oscilloscope makes a new acquisition, the previously acquired waveform is erased from the display and replaced by the newly acquired waveform. When the ACCumulate command is ON, the oscilloscope displays all the waveform acquisitions without erasing the previously acquired waveform.

Acquisition Type Average

In the Average mode, the oscilloscope averages the data points on the waveform with previously acquired data. Averaging helps eliminate random noise from the displayed waveform. In this mode the ACCumulate command is OFF. When Average mode is selected, the number of averages must also be specified using the COUNt command. Previously averaged waveform data is erased from the display and the newly averaged waveform is displayed.

COUNt

Command `:ACQuire:COUNt <count>`

The COUNt command specifies the number of acquisitions for the running weighted average. This command generates an error if Normal acquisition mode is specified.

`<count>` {2|4|8|16|32|64|128|256}

Example

```
OUTPUT XXX;":ACQUIRE:COUNT 16"
```

Query `:ACQuire:COUNt?`

The COUNt query returns the last specified count.

Returned Format `[:ACQuire:COUNt] <count><NL>`

Example

```
OUTPUT XXX;":ACQ:COUN?"
```

TYPE

Command

```
:ACQuire:TYPE {NORMal|AVERage}
```

The TYPE command selects the type of acquisition that is to take place when a DIGitize or STARt command is executed. One of two acquisition types may be chosen: the NORMal or AVERage mode.

Example

```
OUTPUT XXX;":ACQUIRE:TYPE NORMAL"
```

Query

```
:ACQuire:TYPE?
```

The TYPE query returns the last specified type.

Returned Format

```
[:ACQuire:TYPE] {NORMal|AVERage}<NL>
```

Example

```
OUTPUT XXX;":ACQUIRE:TYPE?"
```

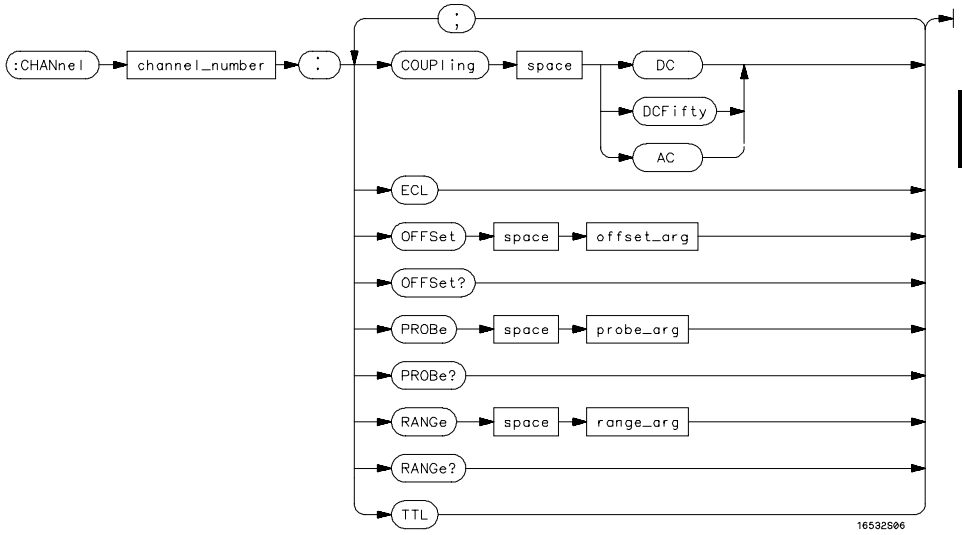
CHANnel Subsystem

Introduction

The Channel Subsystem commands control the channel display and the vertical axis of the oscilloscope. Each channel must be programmed independently for all offset, range and probe functions. When ECL or TTL commands are executed, the vertical range, offset and trigger levels are automatically set for optimum viewing. Refer to figure 4-1 for the CHANnel Subsystem Syntax Diagram. The CHANnel Subsystem commands are:

- COUPling
- ECL
- OFFSet
- PROBe
- RANGe
- TTL

Figure 4-1



CHANnel Subsystem Syntax Diagram

Table 4-1 CHANnel Parameter Values

Parameter	Value
channel_number	An integer from 1 through 8, depending on how many oscilloscope cards are installed as a single unit (chained together).
offset_arg	a real number defining the voltage at the center of the display. The offset range is as follows (for a 1:1 probe setting):

Vertical Sensitivity	Vertical Range	Offset Voltage
4 mV - 100 mV/div	16 mV - 400 mV	±2 V
>100 mV - 400 mV/div	>400 mV - 1.6 V	±10 V
>400 mV - 2.5 V/div	>1.6 V - 10 V	±50 V
>2.5 V - 10 V/div	>10 V - 40 V	±250 V

probe_arg	an integer from 1 through 1000, specifying the probe attenuation with respect to 1.
range_arg	a real number specifying vertical sensitivity. The allowable range is 16 mV to 40 V for a probe attenuation of 1. The specified range is equal to 4 times Volts/Div.

COUPling

Command `:CHANnel<N>:COUPling {DC|AC|DCFifty}`

The COUPling command sets the input impedance for the selected channel. The choices are 1M Ohm DC (DC), 1M Ohm AC (AC), or 50 Ohms DC (DCFifty).

<N> 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2.

Example

```
OUTPUT XXX;":CHANNEL1:COUPLING DC"
```

Query `:CHANnel<N>:COUPling?`

The COUPling query returns the current input impedance for the specified channel.

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

Example

```
OUTPUT XXX;":CHANNEL1:COUPLING?"
```

ECL

Command

```
:CHANnel<N>:ECL
```

The ECL command sets the vertical range, offset, and trigger levels for the selected input channel for optimum viewing of ECL signals. The set ECL: values are:

Range: 2.0 V (500 mV per division)

Offset: -1.3 V

Trigger level: -1.3 V

<N> An integer from 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2.

Example

```
OUTPUT XXX;":CHANNEL1:ECL"
```

To return to "Preset User", change the CHANnel:RANGe, CHANnel:OFFSet, or TRIGger:LEVel value.

OFFSet

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

The OFFSet command sets the voltage that is represented at center screen for the selected channel. The allowable offset voltage <value> is shown in the table below. The table represents values for a Probe setting of 1:1. The offset value is recompensated whenever the probe attenuation factor is changed.

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2.

`<value>` allowable offset voltage value shown in the table below.

Vertical Range	Offset Voltage
16 mV - 400 mV	±2 V
>400 mV - 1.6 V	±10 V
>1.6 V - 10 V	±50 V
>10 V - 40 V	±250 V

Example

```
OUTPUT XXX;":CHAN1:OFFS 1.5"
```

Query `:CHANnel<N>:OFFSet?`

The OFFSet query returns the current value for the selected channel.

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2.

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

Example

```
OUTPUT XXX;":CHANNEL1:OFFSET?"
```

PROBe

Command `:CHANnel<N>:PROBe <atten>`

The PROBe command specifies the attenuation factor for an external probe connected to a channel. The command changes the channel voltage references such as range, offset, trigger level and automatic measurements. The actual sensitivity is not changed at the channel input. The allowable probe attenuation factor is an integer from 1 to 1000.

`<N>` An integer from 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2.

`<atten>` An integer from 1 to 1000

Example

```
OUTPUT XXX;":CHAN1:PROB 10"
```

Query `:CHANnel<N>:PROBe?`

The PROBe query returns the probe attenuation factor for the selected channel.

Returned Format `[:CHANnel<N>:PROBe]<atten><NL>`

Example

```
OUTPUT XXX;":CHANNEL1:PROBE?"
```

RANGe

Command

```
:CHANnel<N>:RANGe <range>
```

The RANGe command defines the full-scale (4 times the Volts/Div) vertical axis of the selected channel. The values for the RANGe command are dependent on the current probe attenuation factor for the selected channel. The allowable range for a probe attenuation factor of 1:1 is 16 mV to 40 V. For a larger probe attenuation factor, multiply the range limit by the probe attenuation factor.

`<N>` An integer from 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2.

`<range>` 16 mV to 40 V for a probe attenuation factor of 1:1

Example

```
OUTPUT XXX;":CHANNEL1:RANGE 4.8"
```

Query

```
:CHANnel<N>:RANGe?
```

The RANGe query returns the current range setting.

Returned Format

```
[:CHANnel<N>:RANGe] <range><NL>
```

Example

```
OUTPUT XXX;":CHANNEL1:RANGE?"
```

TTL

Command `:CHANnel<N>:TTL`

The TTL command sets the vertical range, offset, and trigger level for the selected input channel for optimum viewing of TTL signals. The set TTL values are:

Range: 6.0 V (1.50 V per division)

Offset: 2.5 V

Trigger Level: 1.62 V

<N> An integer 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2.

Example

```
OUTPUT XXX;":CHANNEL1:TTL"
```

To return to "Preset User" change the CHANnel:RANGe, CHANel:OFFSet, or TRIGger:LEVel value.

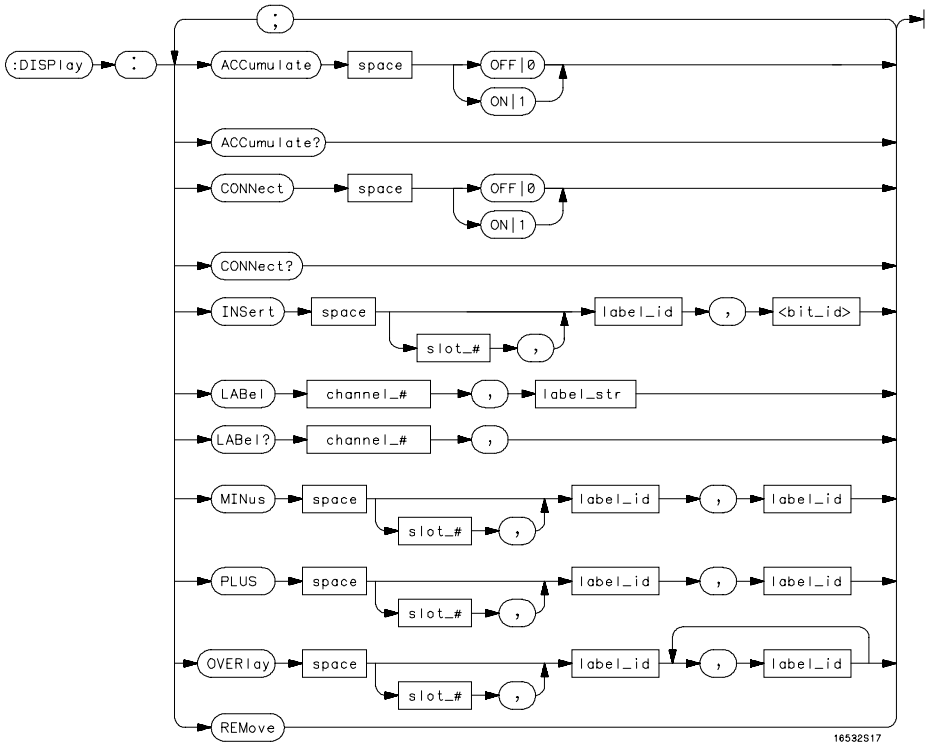
DISPlay Subsystem

Introduction

The Display Subsystem is used to control the display of data. Refer to Figure 5-1 for the DISPlay Subsystem Syntax Diagram. The DISPlay Subsystem commands are:

- ACCumulate
- CONNect
- INSert
- LABel
- MINus
- OVERlay
- PLUS
- REMove

Figure 5-1



DISPlay Subsystem Syntax Diagram

Table 5-1 **DISPlay Parameter Values**

Parameter	Value
slot_#	a number from 1 through 10 identifying the oscilloscope card slot.
bit_id	an integer from 0 to 31.
channel_#	an integer from 1 through 8 depending on how many oscilloscope modules are installed as a single unit.
label_str	up to five characters enclosed in single quotes making up a label name.
label_id	a string of 1 alpha and 1 numeric character for the oscilloscope, or 6 characters for the timing modules.

ACCumulate

Command

```
:DISPlay:ACCumulate {{ON|1}|{OFF|0}}
```

The ACCumulate command works in conjunction with the commands in the Acquisition Subsystem. In the Normal mode, the ACCumulate command turns the infinite persistence on or off.

Example

```
OUTPUT XXX;":DISPLAY:ACC ON"
```

Query

```
:DISPLAY:ACCumulate?
```

The ACCumulate query reports if accumulate is turned on or off.

Returned Format

```
[:DISPlay:ACCumulate] {1|0}<NL>
```

Example

```
OUTPUT XXX;":DISPLAY:ACCUMULATE?"
```

CONNect

Command

```
:DISPlay:CONNect {{ON|1}|{OFF|0}}
```

The CONNect command sets the Connect Dots mode. When ON, each displayed sample dot will be connected to the adjacent dot by a straight line. The waveform is easier to see in this mode. When OFF, only the sampling points will be displayed.

Example

```
OUTPUT XXX;":DISPLAY:CONNECT ON"
```

Query `:DISPlay:CONNect?`

The CONNect query reports if connect is on or off.

Returned Format `[:DISPlay:CONNect] {1|0}<NL>`

Example

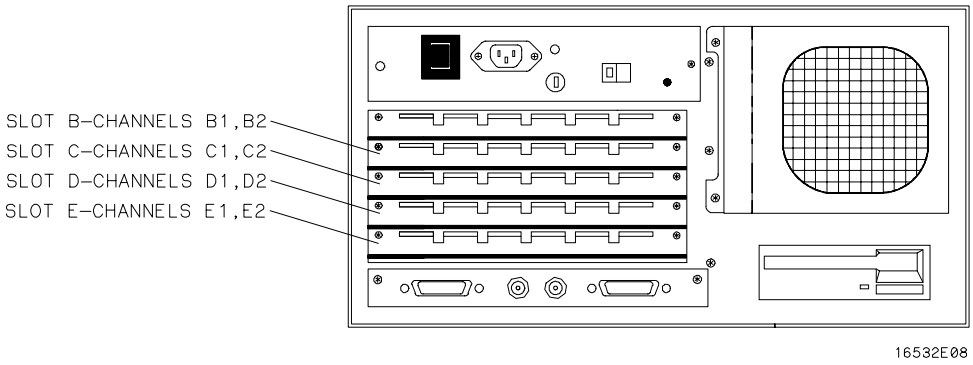
```
OUTPUT XXX;":DISPLAY:CONNECT?"
```

INSert

The INSert command inserts waveforms into the current display. Time-correlated waveforms from another oscilloscope module, logic analyzer or high speed timing module may also be added to the current display. The waveforms are added just below any currently displayed signals. Only eight oscilloscope waveforms can be displayed at any time.

The first parameter is optional and specifies the module from where the waveform is to be taken. The module number is the same as the slot number in which the master card is installed. If a module is not specified, the current module is assumed. The second parameter is the label of the waveform that is to be added to the current display. The label names depend on the slot in which the acquisition cards are installed. The example of figure 5-2 shows the labeling scheme for eight oscilloscope channels (four oscilloscope cards).

Figure 5-2



Oscilloscope Label Identification

To insert a waveform from the oscilloscope to the oscilloscope display:

Command

```
:DISPlay:INSert [<module number>,]<label>
```

`<module number>` slot in which oscilloscope master card is installed

`<label>` string of 1 alpha and 1 numeric character enclosed by single quotes

Example

```
OUTPUT XXX;":DISPLAY:INSERT 'C1'"
```

To insert a waveform from a logic analyzer or high speed timing module to the oscilloscope display:

Command

```
:DISPlay:INSert <slot no>,<label>,<bit-id>
```

`<slot no>` card slot number of the module from which waveform is to be taken

`<label>` string of up to 6 alphanumeric characters enclosed by single quotes

`<bit-id>` integer from 0 to 31

Example

```
:OUTPUT XXX;":DISPLAY:INSERT 4,'WAVE',10"
```

For a complete explanation of the label name and the <bit-id>, refer to the Programmer's Guide of the logic analyzer or timing analyzer being used.

LABel

Command `:DISPlay:LABel CHANnel<N>,<label_string>`

The LABel command is used to assign a label string to an oscilloscope channel. For single channel traces, the label string (up to five characters) appears on the left of the waveform area of the display. Note that the label string cannot be used in place of the channel number when programming the oscilloscope module.

`<N>` an integer from 1 to 8 depending on the number of oscilloscope modules installed as a single unit

`<label_str>` a string of up to five characters enclosed in single quotes

Example

```
OUTPUT XXX;":DISPLAY:LABEL CHANNEL1,'CLK'"
```

Query `:DISPlay:LABel? CHANnel<N>`

The LABel query returns the label string assigned to the specified channel. If no label has been assigned, the default channel identifier (single character and single number) is returned.

Returned Format `[:DISPlay:LABel] CHANnel<N>,<label_str><NL>`

Example

```
OUTPUT XXX;":DISPLAY:LABEL? CHANNEL2"
```

MINus

Command `:DISPlay:MINus [<module_number>,]<label>,<label>`

The MINus command algebraically subtracts one channel from another and inserts the resultant waveform to the display. Note that both channels must in the same oscilloscope module. The first parameter is an optional module specifier. The module is identified by the slot number that contains the oscilloscope master card. If a module is not specified, the current module is assumed. The next two parameters are the label of the waveform selected to be added to the display. The label names are defined in the same manner as the INSert command.

`<module_number>` slot number in which oscilloscope master card is installed

`<label>` string of 1 alpha and 1 numeric character enclosed by single quotes

Example

```
OUTPUT XXX;":DISPLAY:MINUS 3,'C1','C2'"
```

OVERlay

Command `:DISPlay:OVERlay <label>,<label>[,<label>...]`

The OVERlay command overlays oscilloscope waveforms. The syntax parameters are the labels of the waveforms that are to be overlaid. Only waveforms sharing a common master card can be overlaid. A label may be used only once with each OVERlay command.

<label> string of 1 alpha and 1 numeric character enclosed by single quotes

Example

```
OUTPUT XXX;":DISPLAY:OVERLAY 'C1','C2'"
or
OUTPUT XXX;":DISPLAY:OVERLAY 'C1','C2','B1','B2'"
```

PLUS

Command `:DISPlay:PLUS [<module_number>,]<label>,<label>`

The PLUS command algebraically adds two channels and inserts the resultant waveform to the current display. Note that both channels must in the same oscilloscope module. The first parameter is an optional module specifier and needs to be used only if another module is displayed. The next parameters are the labels of the waveform that are to be added.

`<module_number>` slot number in which oscilloscope master card is installed

`<label>` string of 1 alpha and 1 numeric character enclosed by single quotes

Example

```
OUTPUT XXX;":DISPLAY:PLUS 2,'B1','B2'"
```

REMove

Command `:DISPlay:REMove`

The REMove command removes all displayed waveforms from the current display.

Example

```
OUTPUT XXX;":DISPLAY:REMOVE"
```

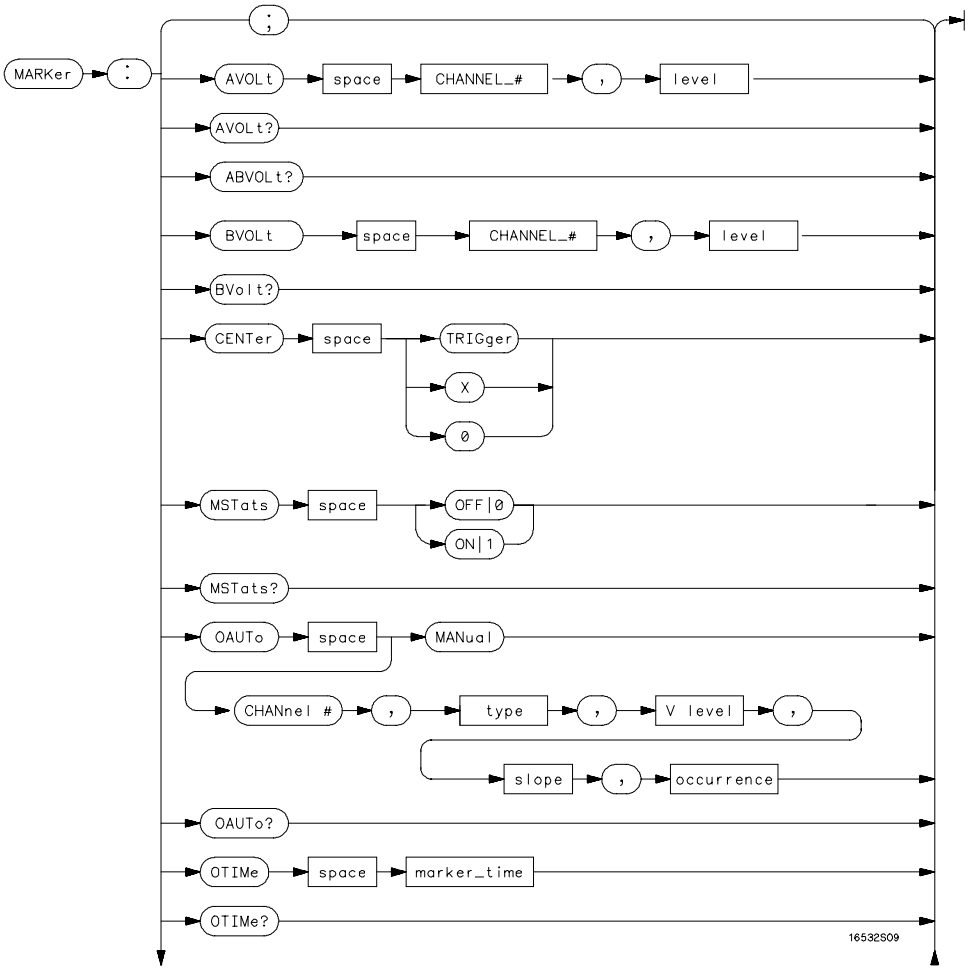
6

MARKer Subsystem

In addition to automatic parametric measurements, the oscilloscope has four markers for making time and voltage measurement. These measurements may be made automatically or manually. Additional features include the centering of trigger or markers in the display area (CENTer) and the run until time (RUNTil) mode. The RUNTil mode allows you to set a stop condition based on the time interval between the X marker and the O marker. When this condition is met, the oscilloscope will stop acquiring data. Refer to Figure 6-1 for the Marker Subsystem Syntax Diagram. The MARKer Subsystem commands are:

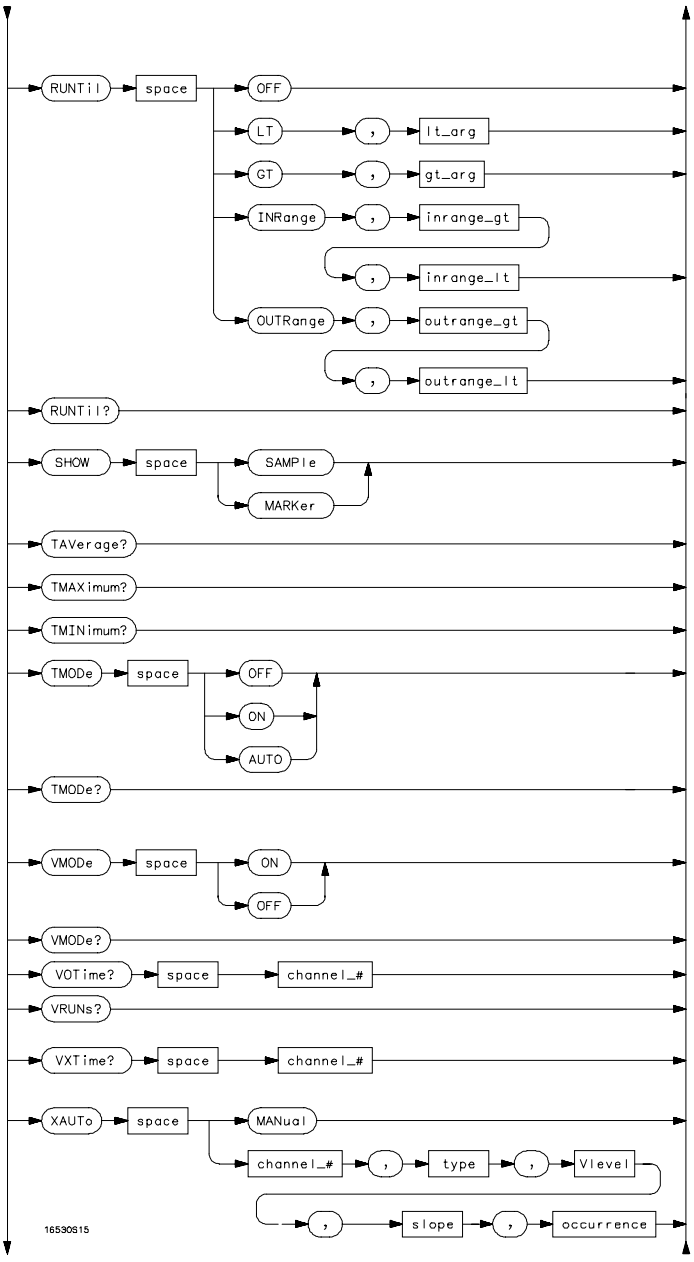
AVOLt	TMAXimum
ABVolt	TMINimum
BVOLt	TMODe
CENTer	VMODe
MSTats	VOTime
OAUTo	VXTime
OTIMe	VRUNs
RUNTil	XAUTo
SHOW	XTIMe
TAVerage	XOTime

Figure 6-1



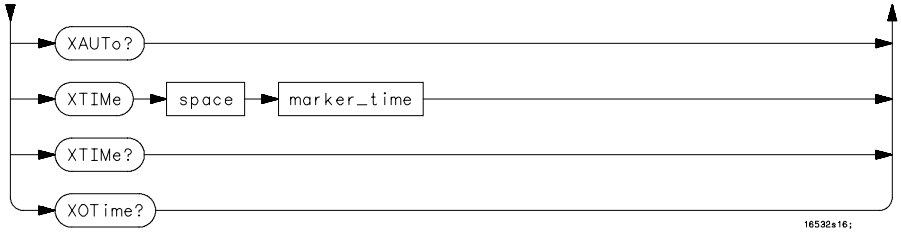
MARKer Subsystem Syntax Diagram

Figure 6-1



MARKer Subsystem Syntax Diagram (Cont'd)

Figure 6-1



MARKer Subsystem Syntax Diagram (Cont'd)

Table 6-1 **MARKer Parameter Values**

Parameter	Value
channel_#	An integer from 1 through 8, depending on how many oscilloscope cards are installed as a single unit (chained together).
marker_time	time in seconds from trigger marker to X or O marker
lt_arg	time in seconds that specifies the less than (lt) RUNTil time
gt_arg	time in seconds that specifies the greater than (gt) RUNTil time
inrange_gt	time in seconds specifying the lower limit of the INRange runtime
inrange_lt	time in seconds specifying the upper limit of the INRange runtime
level	level in volts that specifies marker position
outrange_gt	time in seconds specifying the lower limit of the OUTRange runtime
outrange_lt	time in seconds specifying the upper limit of the OUTRange runtime
V level	percentage of waveform voltage level, ranging from 10 to 90 of the Vtop to Vbase voltage, or a specific voltage level
type	ABSolute or PERCent
slope	positive or negative slope
occurrence	integer from 1 to 100

AVOLt

Command `:MARKer:AVOLt CHANnel<N>,<level>`

The AVOLt command moves the A marker to the specified voltage on the indicated channel.

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

`<level>` the desired marker voltage level, ranging from ±(2 x maximum offset)

Example

```
OUTPUT XXX;":MARKER:AVOLT CHANNEL1,2.75"
```

Query `:MARKer:AVOLt?`

The AVOLt query returns the current voltage and channel selection for the A marker.

Returned Format `[:MARKer:AVOLt]CHANnel<N>,<level><NL>`

Example

```
OUTPUT XXX;":MARKER:AVOLT?"
```

ABVolt?

Query `:MARKer:ABVolt?`

The ABVolt query returns the difference between the A marker voltage and the B marker voltage (Vb - Va).

Returned Format `[:MARKer:ABVolt]<level><NL>`

`<level>` level in volts of the B marker minus the A marker

Example

```
OUTPUT XXX;":MARKER:ABVOLT?"
```

BVOLt

Command `:MARKer:BVOLt CHANnel<N>,<level>`

The BVOLt command moves the B marker to the specified voltage on the indicated channel.

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

`<level>` the desired marker voltage level, ranging from ±(2 x maximum offset)

Example

```
OUTPUT XXX;":MARKER:BVOLT CHANNEL1,2.75"
```

Query `:MARKer:BVOLt?`

The BVOLt query returns the current voltage and channel selection for the B marker.

Returned Format `[:MARKer:BVOLt]CHANnel<N>,<level><NL>`

Example

```
OUTPUT XXX;":MARKER:BVOLT?"
```

CENTer

Command `:MARKer:CENTer {TRIGger|X|O}`

The CENTer command allows you to position the indicated marker (TRIGger, X, or O) at the center of the waveform area on the scope display. The CENTer command adjusts the timebase delay to cause the trace to be centered around the indicated marker (S/DIV remains unchanged).

Example

```
OUTPUT XXX;":MARKER:CENTER X"
```

MSTats

Command `:MARKer:MSTats {{ON|1}|{OFF|0}}`

The MSTats command allows you to turn statistics ON or OFF in the auto marker mode. When statistics is turned on, Min X-O, Max X-O, and Mean X-O times are displayed on screen. When off, X-O, Trig-X, and Trig-O times will be displayed on screen.

Example

```
OUTPUT XXX;":MARKER:MSTATS ON"
```

Query `:MARKer:MSTats?`

The MSTats query returns the current setting.

Returned Format `[:MARKer:MSTats]{1|0}<NL>`

Example

```
OUTPUT XXX;":MARKER:MSTATS?"
```

OAUTo

Command `:MARKer:OAUTo{ MANual|CHANnel<N>,<type>,<level>, <slope>,<occurrence>}`

The OAUTo command specifies the automatic placement specification for the O marker. The first parameter specifies if automarker placement is to be in the manual mode or on a specified channel. If a channel is specified, four other parameters must be included in the command syntax. The four parameters are: marker type, level, the slope, and the occurrence count.

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

`<type>` ABSolute or PERCent

`<level>` percentage of waveform voltage level, ranging from 10 to 90 of the Vtop to Vbase voltage or a voltage level

`<slope>` POSitive or NEGative

`<occurrence>` integer from 1 to 100

Example

```
OUTPUT XXX;":MARKER:OAUTO CHANNEL1,PERCent,50,POSITIVE,5"
```

Query `:MARKer:OAUTo?`

The OAUTo query returns the current settings.

Returned Format
```
[:MARKer:OAUTo] CHANnel<N>,<type>
<level>,<slope>,<occurrence><NL>
```

Example
```
OUTPUT XXX;":MARKER:OAUTO?"
```

If <type> is not specified, the marker type will default to PERCent.

OTIMe

Command `:MARKer:OTIMe <O marker time>`

The OTIMe command moves the O marker to the specified time with respect to the trigger marker.

`<O marker time>` time in seconds from trigger marker to O marker

Example
```
OUTPUT XXX;":MARKER:OTIME 1E-6"
```

Query `:MARKer:OTIMe?`

The OTIMe query returns the time in seconds between the O marker and the trigger marker.

Returned Format `[:MARKer:OTIMe]<O marker time><NL>`

Example
```
OUTPUT XXX;":MARKER:OTIME?"
```

RUNTil

Command

```
:MARKer:RUNTil
{OFF|LT,<time>|GT,<time>|INRange,<time>,
<time>|OUTRange,<time>, <time>}
```

The RUNTil command allows you to set a stop condition based on the time interval between the X marker and the O marker. In repetitive runs, when the time specification is met, the oscilloscope stops acquiring data and the advisory "Stop condition satisfied" will be displayed on screen.

`<time>` a real number specifying the time in seconds between the X and O markers

Example

```
OUTPUT XXX;":MARKER:RUNTIL LT,1MS"
```

Query

```
:MARKer:RUNTil?
```

The RUNTil query will return the current Run Until Time X - O (RUNTil) setting.

Returned Format

```
[:MARKer:RUNTil] {OFF|LT,<time>|GT,<time>|INRange,<time>,
<time>|OUTRange,<time>,<time>}<NL>
```

Example

```
OUTPUT XXX;":MARKER:RUNTIL?"
```

SHOW

Command

```
:MARKer:SHOW {SAMPle|MARKer}
```

The SHOW command allows you to select either SAMPle rate or MARKer data (when markers are enabled) to appear on the oscilloscope menus above the waveform area.

The SAMPle rate or MARKer data appears on the channel, trigger, display, and auto-measure menus. Marker data is always present on the marker menu. While sample rate data is only present on the marker menu when time markers are turned off.

Example

```
OUTPUT XXX;":MARKER:SHOW MARKER"
```

TAVerage?

Query

```
:MARKer:TAVerage?
```

The TAVerage query returns the average time between the X and O markers. If there is no valid data, the query returns 9.9E37.

Returned Format

```
[:MARKER:TAVERAGE] <time value><NL>
```

`<time value>` real number

Example

```
OUTPUT XXX;":MARKER:TAVERAGE?"
```

TMAXimum?

Query `:MARKer:TMAXimum?`

The TMAXimum query returns the value of the maximum time between the X and O markers. If there is no valid data, the query returns 9.9E37.

Returned Format `[:MARKer:TMAXimum] <time value><NL>`

`<time value>` real number

Example

```
OUTPUT XXX;":MARKER:TMAXIMUM?"
```

TMINimum?

Query `:MARKer:TMINimum?`

The TMINimum query returns the value of the minimum time between the X and O markers. If there is no valid data, the query returns 9.9E37.

Returned Format `[:MARKer:TMINimum] <time value><NL>`

`<time value>` real number

Example

```
OUTPUT XXX;":MARKER:TMINIMUM?"
```

TMODe

Command

```
:MARKer:TMODe {OFF|ON|AUTO}
```

The TMODe command allows you to select the time marker mode. The choices are: OFF, ON and AUTO. When OFF, time marker measurements cannot be made. When the time markers are turned on, the X and O markers can be moved to make time and voltage measurements. The AUTO mode allows you to make automatic marker placements by specifying channel, slope, and occurrence count for each marker. Also the Statistics mode may be used when AUTO is chosen. Statistics mode allows you to make minimum, maximum and mean time interval measurements from the X marker to the O marker.

Example

```
OUTPUT XXX;":MARKER:TMODE ON"
```

Query

```
:MARKer:TMODe?
```

The TMODe query returns the current marker mode choice.

Returned Format

```
[:MARKer:TMODe] <state><NL>
```

`<state>` ON or OFF or AUTO

Example

```
OUTPUT XXX;":MARKER:TMODE?"
```

For compatibility with older modules, the MMODe command/query will function the same as the TMODe command/query.

VMODe

Command

```
:MARKer:VMODe {{OFF|0} | {ON|1}}
```

The VMODe command allows you to select the voltage marker mode. The choices are: OFF or ON. When OFF, voltage marker measurements cannot be made. When the voltage markers are turned on, the A and B markers can be moved to make voltage measurements. When used in conjunction with the time markers (TMODe), both "delta t" and "delta v" measurements are possible.

Example

```
OUTPUT XXX;":MARKER:VMODE OFF"
```

Query

```
:MARKer:VMODe?
```

The VMODe query returns the current voltage marker mode choice.

Returned Format

```
[:MARKer:VMODe] <state><NL>
```

`<state>` 1 or 0

Example

```
OUTPUT XXX;":MARKER:VMODE?"
```

VOTime?

Query `:MARKer:VOTime? CHANNEL<N>`

The VOTime query returns the current voltage level of the selected source at the O marker.

Returned Format `[:MARKer:VOTime]<level><NL>`

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

`<level>` level in volts where the O marker crosses the waveform

Example

```
OUTPUT XXX;":MARKER:VOTIME? CHANNEL1"
```

For compatibility with older modules, the OVOLt query will function the same as the VOTime query.

VRUNs?

Query `:MARKer:VRUNs?`

The VRUNs query returns the number of valid runs and the total number of runs made. Valid runs are those where the edge search for both the X and O markers was successful, resulting in valid marker time measurement.

Returned Format `[:MARKer:VRUNs] <valid runs>,<total runs><NL>`

`<valid runs>` positive integer

`<total runs>` positive integer

Example

```
OUTPUT XXX;":MARKER:VRUNS?"
```

VXTime?

Query `:MARKer:XVOLt? CHANnel<N>`

The VXTime query returns the current voltage level of the selected channel at the X marker.

Returned Format `[:MARKer:VXTime]<level><NL>`

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

`<level>` level in volts where the X marker crosses the waveform

Example

```
OUTPUT XXX;":MARKER:VXTIME? CHANNEL1"
```

For compatibility with older modules, the XVOLt query will function the same as the VXTime query.

XAUTo

Command

```
:MARKer:XAUTo{MANual|CHANnel<N>,
<type>,<level>,<slope>,<occurrence>}
```

The XAUTo command specifies the automatic placement specification for the X marker. The first parameter specifies if automarker placement is to be in the Manual mode or on a specified channel. If a channel is specified, four other parameters must be included in the command syntax. The four parameters are: marker type, level, slope and the occurrence count.

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

`<type>` ABSolute or PERCent

`<level>` percentage of waveform voltage level, ranging from 10 to 90 of the Vtop to Vbase voltage or a voltage level

`<slope>` POSitive or NEGative

`<occurrence>` integer from 1 to 100

Example

```
OUTPUT XXX;":MARKER:XAUTO CHANNEL1,ABS,4.75,POSITIVE,5"
```

Query

```
:MARKer:XAUTo?
```

The XAUTo query returns the current settings.

Returned Format

```
[:MARKer:XAUTo] CHANnel
<N>,<type>,<level>,<slope>,<occurrence><NL>
```

Example

```
OUTPUT XXX;":MARKER:XAUTO?"
```

If <type> is not specified, the marker type will default to PERCent.

XOTime?

Query `:MARKer:XOTime?`

The XOTime query returns the time in seconds from the X marker to the O marker. If data is not valid, the query returns 9.9E37.

Returned Format `[:MARKer:XOTime]<time><NL>`

`<time>` real number

Example

```
OUTPUT XXX;":MARKER:XOTIME?"
```

XTIMe

Command `:MARKer:XTIMe <X marker time>`

The XTIMe command moves the X marker to the specified time with respect to the trigger marker.

`<X marker time>` time in seconds from trigger marker to X marker

Example

```
OUTPUT XXX;":MARKER:XTIME 1E-6"
```

Query `:MARKer:XTIMe?`

The XTIMe query returns the time in seconds between the X marker and the trigger marker.

Returned Format `[:MARKer:XTIMe]<xmarker time><NL>`

Example

```
OUTPUT XXX;":MARKER:XTIME?"
```

7

MEASure Subsystem

The commands/queries in the Measure Subsystem are used to make automatic parametric measurements on displayed waveforms. Measurements are made on the displayed waveform(s) specified by the SOURce command. If the source is not specified, the last waveform source specified is assumed. Measurements are made in the following manner:

Frequency

The frequency of the first complete cycle displayed is measured using the 50% level.

Period

The period of the first complete cycle displayed is measured at the 50% level.

Peak-to-Peak

The absolute minimum and the maximum voltages for the selected source are measured.

Positive Pulse Width

Pulse width is measured at the 50% level of the first displayed positive pulse.

Negative Pulse Width

Pulse width is measured at the 50% level of the first displayed negative pulse.

Risetime

The risetime of the first displayed rising edge is measured. To obtain the best possible measurement accuracy, select the fastest sweep speed while keeping the rising edge on the display. The risetime is determined by measuring time at the 10% and the 90%voltage points of the rising edge.

Falltime

Falltime is measured between the 10% and 90% points of the first displayed falling edge. To obtain the best possible measurement accuracy, select the fastest sweep speed possible while keeping the falling edge on the display.

Preshoot and Overshoot

Preshoot and overshoot measure the perturbation on a waveform above or below the top and base voltages.

Preshoot

Is a perturbation before a rising or a falling edge and measured as a percentage of the top-base voltage.

Overshoot

Is a perturbation after a rising or falling edge and is measured as a percentage of the top-base voltage.

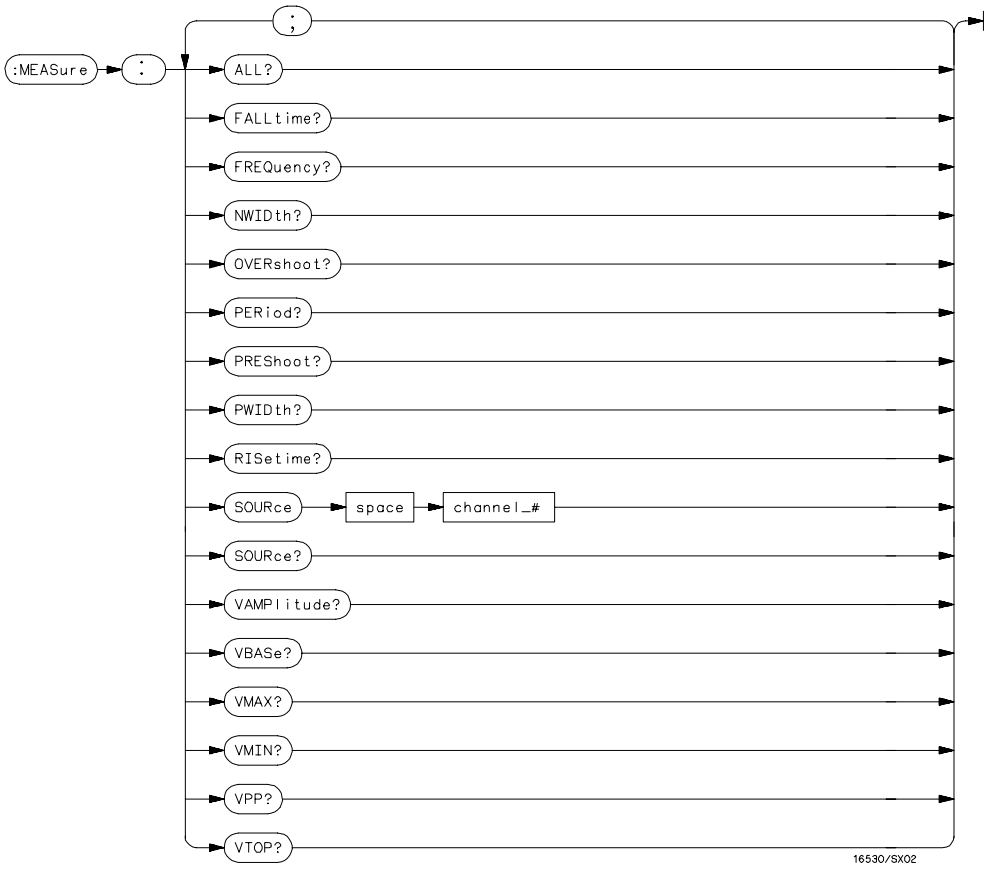
For complete details of the measurement algorithms, refer to the User's Reference Manual.

Refer to Figure 7-1 for the MEASure Subsystem Syntax Diagram

Before using any of the Measure Subsystem queries, note that the SOURce command is part of every query of this subsystem. The SOURce command specifies the channel that is to be used for making the measurements.

If a parameter cannot be measured, the instrument responds with 9.9E37.

Figure 7-1



MEASure Subsystem Syntax Diagram

Table 7-1 MEASure Parameter Values

Parameter	Value
channel_#	An integer from 1 through 8, depending on how many oscilloscope cards are installed as a single unit (chained together).

ALL?

Query

```
:MEASure:[SOURce CHANnel<N>;]ALL?
```

The ALL query makes a set of measurements on the displayed waveform using the selected source.

<N> 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

Returned Format

```
[:MEASure:ALL PERiod] <real number>;
[RISetime] <real number>;
[FALLtime] <real number>;
[FREQuency] <real number>;
[PWIDth] <real number>;
[NWIDth] <real number>;
[VPP] <real number>;
[VAMPlitude] <real number>;
[PREShoot] <real number>;
[OVERshoot] <real number><NL>
```

Example

```
OUTPUT XXX;":MEASURE:SOURCE CHANNEL1;ALL?"
```

FALLtime?

Query `:MEASure:[SOURce CHANnel<N>;]FALLtime?`

The FALLtime query makes a fall time measurement on the selected channel. The measurement is made between the 90% to the 10% voltage point of the first falling edge displayed on screen.

Returned Format `[:MEASure:FALLtime] <value><NL>`

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

`<value>` time in seconds between the 90% and 10% voltage points of the first falling edge displayed on the screen

Example

```
OUTPUT XXX;":MEASURE:SOUR CHAN2;FALLTIME?"
```

FREQuency?

Query `:MEASure:[SOURce CHANnel<N>;]FREQuency?`

The FREQency query makes a frequency measurement on the selected channel. The measurement is made using the first complete displayed cycle at the 50% voltage level.

Returned Format `[:MEASure:FREQuency]<value><NL>`

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

`<value>` frequency in Hertz

Example

```
OUTPUT XXX;":MEASURE:SOUR CHAN1;FREQ?"
```

NWIDth?

Query `:MEASure:[SOURce CHANnel<N>;]NWIDth?`

The NWIDth query makes a negative width time measurement on the selected channel. The measurement is made between the 50% points of the first falling and the next rising edge displayed on screen.

Returned Format `[:MEASure:NWIDth] <value><NL>`

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

`<value>` negative pulse width in seconds

Example

```
OUTPUT XXX;":MEASURE:SOURCE CHAN2;NWID?"
```

OVERshoot?

Query `:MEASure:[SOURce CHANnel<N>;]OVERshoot?`

The OVERshoot query makes an overshoot measurement on the selected channel. The measurement is made by finding a distortion following the first major transition. The result is the ratio of OVERshoot vs. VAMPlitude.

Returned Format `[:MEASure:OVERshoot]<value><NL>`

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

`<value>` ratio of overshoot to Vamplitude

Example

```
OUTPUT XXX;":MEASURE:SOURCE CHAN1;OVER?"
```

PERiod?

Query `:MEASure:[SOURce CHANnel<N>;]PERiod?`

The PERiod query makes a period measurement on the selected channel. The measurement is equivalent to the inverse of the frequency.

Returned Format `[:MEASure:PERiod] <value><NL>`

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

`<value>` waveform period in seconds

Example

```
OUTPUT XXX;":MEASURE:SOURCE CHANNEL1;PERIOD?"
```

PREShoot?

Query `:MEASure:[SOURce CHANnel<N>;]PREShoot?`

The PREShoot query makes the preshoot measurement on the selected channel. The measurement is made by finding a distortion which precedes the first major transition on screen. The result is the ratio of PREshoot vs. VAMPlitude.

Returned Format `[:MEASure:PREShoot] <value><NL>`

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

`<value>` ratio of preshoot to Vamplitude

Example

```
OUTPUT XXX;":MEASURE:SOURCE CHANNEL2;PRES?"
```

PWIDth?

Query `:MEASure:[SOURce CHANnel<N>;]PWIDth?`

The PWIDth query makes a positive pulse width measurement on the selected channel. The measurement is made by finding the time difference between the 50% points of the first rising and the next falling edge displayed on screen.

Returned Format `[:MEASure:PWIDth] <value><NL>`

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

`<value>` positive pulse width in seconds

Example

```
OUTPUT XXX;":MEASURE:SOURCE CHANNEL2;PWIDTH?"
```

RISetime?

Query `:MEASure:[SOURce CHANnel<N>;]RISetime?`

The RISetime query makes a risetime measurement on the selected channel by finding the 10% and 90% voltage levels of the first rising edge displayed on screen.

Returned Format `[:MEASure:RISetime] <value><NL>`

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

`<value>` risetime in seconds

Example

```
OUTPUT XXX;":MEASURE:SOUR CHAN1;RISETIME?"
```

SOURce

Command `:MEASure:SOURce CHANnel<N>`

The SOURce command specifies the source to be used for subsequent measurements. If the source is not specified, the last waveform source is assumed.

<N> 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

Example

```
OUTPUT XXX;":MEASURE:SOURCE CHAN1"
```

Query `:MEASure:SOURce?`

The SOURce query returns the presently specified channel.

Returned Format `[:MEASure:SOURce] CHANnel<N><NL>`

Example

```
OUTPUT XXX;":MEASURE:SOURCE?"
```

VAMPlitude?

Query `:MEASure:[SOURce CHANnel<N>;]VAMPlitude?`

The VAMPlitude query makes a voltage measurement on the selected channel. The measurement is made by finding the relative maximum (VTOP) and minimum (VBASe) points on screen.

Returned Format `[:MEASure:VAMPlitude] <value><NL>`

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

`<value>` difference between top and base voltage

Example

```
OUTPUT XXX;":MEASURE:SOURCE CHANNEL2;VAMP?"
```

VBASe?

Query `:MEASure:[SOURce CHANnel<N>;]VBASe?`

The VBASe query returns the base voltage (relative minimum) of a displayed waveform. The measurement is made on the selected source.

Returned Format `[:MEASure:VBASe] <value><NL>`

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

`<value>` voltage at base (relative minimum) of selected waveform

Example

```
OUTPUT XXX;":MEASURE:SOURCE CHAN1;VBAS?"
```

VMAX?

Query `:MEASure:[SOURce CHANnel<N>;]VMAX?`

The VMAX query returns the absolute maximum voltage of the selected source.

Returned Format `[:MEASure:VMAX] <value><NL>`

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

`<value>` maximum voltage of selected waveform

Example

```
OUTPUT XXX;":MEASURE:SOURCE CHAN2;VMAX?"
```

VMIN?

Query `:MEASure:[SOURce CHANnel<N>;]VMIN?`

The VMIN query returns the absolute minimum voltage present on the selected source.

Returned Format `[:MEASure VMIN] <value><NL>`

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

`<value>` minimum voltage of selected waveform

Example

```
OUTPUT XXX;":MEASURE:SOURCE CHAN1;VMIN?"
```

VPP?

Query

```
:MEASure:[SOURce CHANnel<N>;]VPP?
```

The VPP query makes a peak to peak voltage measurement on the selected source. The measurement is made by finding the absolute maximum (VMAX) and minimum (VMIN) points on the displayed waveform.

Returned Format

```
[:MEASure:VPP]<value><NL>
```

<N> 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

<value> peak to peak voltage of selected waveform

Example

```
OUTPUT XXX;":MEASURE:SOURCE CHAN1;VPP?"
```

VTOP?

Query

```
:MEASure:[SOURce CHANnel<N>;]VTOP?
```

The VTOP query returns the voltage at the top (relative maximum) of the waveform on the selected source.

Returned Format

```
[:MEASure:VTOP] <value><NL>
```

<N> 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

<value> voltage at the top (relative maximum) of the selected waveform

Example

```
OUTPUT XXX;":MEASURE:SOURCE CHAN2;VTOP?"
```



TIMebase Subsystem

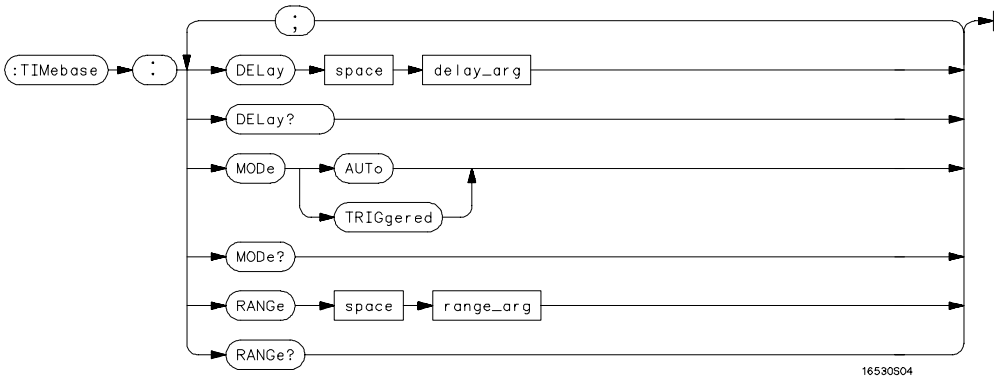
Introduction

The commands of the Timebase Subsystem control the Timebase, Trigger Delay Time, and the Timebase Mode. If TRIGgered mode is to be used, ensure that the trigger specifications of the Trigger Subsystem have been set.

Refer to Figure 8-1 for the TIMebase Subsystem Syntax Diagram. The TIMebase Subsystem commands are:

- DELay
- MODe
- RANGe

Figure 8-1



TIMebase Subsystem Syntax Diagram

Table 8-1 **TIMebase Parameter Values**

Parameter	Value
delay_arg	delay time in seconds, from -2500 seconds through +2500 seconds. The full range is available for panning the waveform when acquisition is stopped. Refer to the User's Reference Manual for a list of the available Delay Pre-trigger and Delay Post-trigger ranges while running and making acquisitions.
range_arg	a real number from 500 ps through 5 s (16534). a real number from 1.0 ns through 5 s .(16533)

DELay

Command `:TIMebase:DELay <delay time>`

The DELay command sets the time between the trigger and the center of the screen.

`<delay time>` delay time in seconds, from -2500 seconds through +2500 seconds. The full range is available for panning the waveform when acquisition is stopped. Refer to the oscilloscope's User's Reference manual for a list of the available Delay Pre-trigger and Delay Post-trigger ranges while running and making acquisitions.

Example

```
OUTPUT XXX;":TIM:DEL 2US"
```

Query `:TIMebase:DELay?`

The DELay query returns the current delay setting.

Returned Format `[:TIMebase DELay] <delay_time><NL>`

Example

```
OUTPUT XXX;":TIM:DEL?"
```

MODE

Command

```
:TIMebase:MODE {TRIGgered|AUTO}
```

The MODE command sets the oscilloscope timebase to either Auto or Triggered mode. When the AUTO mode is chosen, the oscilloscope waits approximately 50 ms for a trigger to occur. If a trigger is not generated within that time, then auto trigger is executed. If a signal is not applied to the input, a baseline is displayed. If there is a signal at the input and the specified trigger conditions have not been met within 50 ms, the waveform display will not be synchronized to a trigger.

When the TRIGgered mode is chosen, the oscilloscope waits until a trigger is received before data is acquired. The TRIGgered mode should be used when the trigger source signal has less than a 20 Hz repetition rate, or when the trigger events counter is set so that the number of trigger events would not occur before 50 ms.

The Auto-Trig On field in the trigger menu is the same as the AUTO mode over GPIB or RS-232-C. The TRIGgered command is the same as the Auto-Trig Off on the front panel.

Example

```
OUTPUT XXX;":TIM:MODE AUTO"
```

Query

```
:TIMebase:MODE?
```

The MODE query returns the current Timebase mode.

Returned Format

```
[:TIMebase:MODE] {AUTO|TRIGgered}<NL>
```

Example

```
OUTPUT XXX;":TIMebase:MODE?"
```

RANGe

Command

```
:TIMebase:RANGe <range>
```

The RANGe command sets the full-scale horizontal time in seconds. The RANGE value is ten times the value in the s/Div field.

`<range>` time in seconds

Example

```
OUTPUT XXX;":TIMEBASE:RANGE 2US"
```

Query

```
:TIMebase:RANGe?
```

The RANGe query returns the current setting.

Returned Format

```
[:TIMebase:RANGe] <range><NL>
```

Example

```
OUTPUT XXX;":TIMEBASE:RANGE?"
```

9

TRIGger Subsystem

Introduction

The commands of the Trigger Subsystem allow you to set all the trigger conditions necessary for generating a trigger. Many of the commands in the Trigger subsystem may be used in either the EDGE or the PATTern trigger mode. If a command is a valid command for the chosen trigger mode, then that setting will be accepted by the oscilloscope. However, if the command is not valid for the trigger mode, an error will be generated. None of the commands of this subsystem (except Mode) are used in conjunction with Immediate trigger mode.

See Figure 9-1 for the TRIGger Subsystem Syntax Diagram.

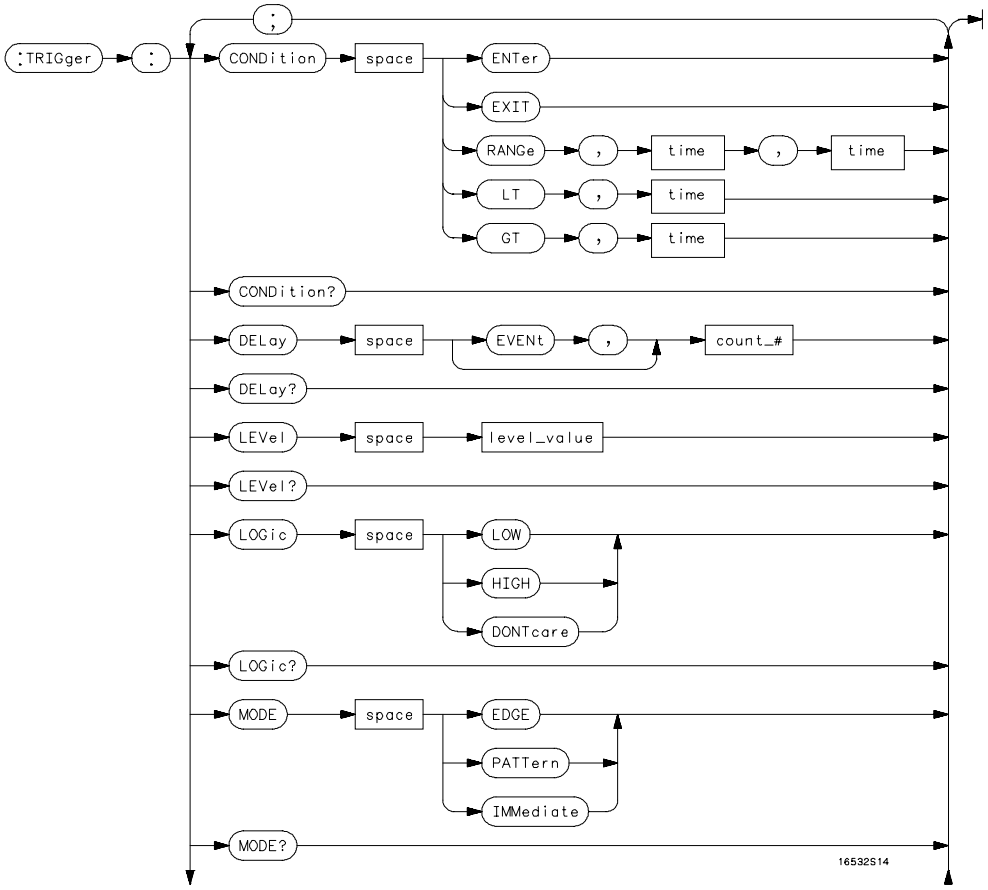
The EDGE Trigger Mode

In the EDGE trigger mode, the oscilloscope triggers on an edge of a waveform, specified by the SOURce, DELay, LEVel, and SLOPe commands. If a source is not specified, then the current source is assumed. If EXTERNAL source is specified, the input signal is assumed to be ECL. The DELay value corresponds to the Count field displayed on the TRIGger menu.

The PATTern Trigger Mode

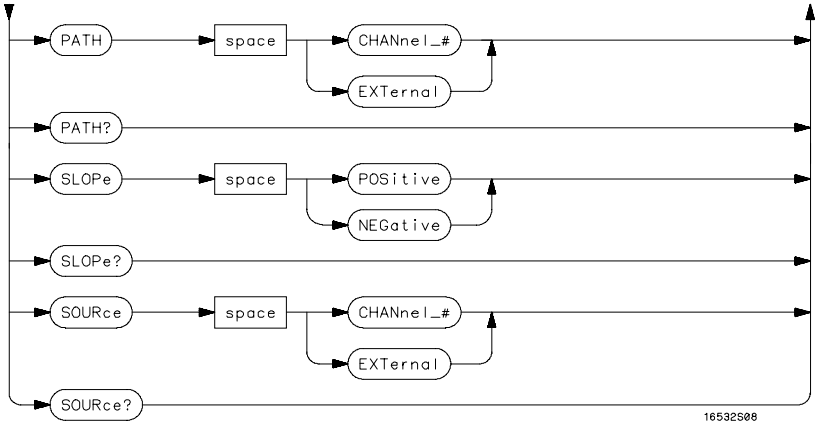
In the pattern trigger mode, the oscilloscope triggers when a pattern is generated using the CONDition, DELay, LEVel, LOGic and PATH commands. The CONDition command allows the oscilloscope to trigger when entering the specified pattern or exiting the pattern. The DELay value corresponds to the Count field displayed on the TRIGger menu. The LOGic command defines the pattern. The PATH command is used to change the trigger pattern and level. The path consists of two channels and the external trigger input.

Figure 9-1



TRIGger Subsystem Syntax Diagram

Figure 9-1



TRIGger Subsystem Syntax Diagram (Cont'd)

Table 9-1 **TRIGger Parameter Values**

Parameter	Value
channel_#	an integer from 1 through 8 depending on how many oscilloscope cards are installed in the mainframe
count_#	an integer from 1 through 32000
time	a real number from 20 ns through 160 ms

CONDition

Command

```
:TRIGger:[MODE PATTern;]CONDition
{ENTer|EXIT|GT,<time>|LT,<time>|RANGe,<time>,<time>
}
```

The CONDition command specifies if a trigger is to be generated on entry (ENTer) to a specific logic pattern, when exiting (EXIT) the specified pattern, or if a specified pattern duration (LT, GT, RANGe) is met. The specified pattern is defined by using the LOGic command.

When ENTer is chosen, the oscilloscope will trigger on the first transition that makes the pattern specification true for every input the number of times specified by the trigger event count (DELay command).

When EXIT is selected, the oscilloscope will trigger on the first transition that causes the pattern specification to be false after the pattern has been true for the number of times specified by the trigger event count (DELay command).

When RANge is selected, the oscilloscope will trigger on the first transition that causes the pattern specification to be false, after the pattern has been true for the number of times specified by the trigger event count (DELAY command). The first event in the sequence will occur when the specified pattern is true for a time greater than that indicated by the first duration term, and less than that indicated by the second duration term. All other pattern true occurrences in the event count are independent of the pattern duration range time.

When GT (greater than) is selected, the oscilloscope will trigger on the first transition that causes the pattern specification to be false, after the pattern has been true for the number of times specified by the trigger event count (DELAY command). The first event in the sequence will occur when the specified pattern is true for a time greater than that indicated by the trigger specification. All other pattern true occurrences in the event count are independent of the pattern duration time.

When LT (less than) is selected, the oscilloscope will trigger on the first transition that causes the pattern specification to be false, after the pattern has been true for the number of times specified by the trigger event count (DELAY command). The first event in the sequence will occur when the specified pattern is true for a time less than that indicated by the trigger specification. All other pattern true occurrences in the event count are independent of the pattern duration time.

`<time>` real number between 20 ns and 160 ms

Example

```
OUTPUT XXX;":TRIG:COND ENT"
```

The oscilloscope cannot be programmed for a pattern duration (GT, LT, or RANge) trigger if it is being armed by another module via an IMB (Intermodule Bus) measurement.

Query

```
:TRIGger:CONDition?
```

The CONDition query returns the present condition.

Returned Format

```
[:TRIGger CONDition]
{ENTer|EXIT|GT,<time>|LT,<time>|RANGe,<time>,<time>}<NL>
```

Example

```
OUTPUT XXX;":TRIG:COND?"
```

DELay

Command `:TRIGger:DELay [EVENt,]<count>`

The DELay command is used to specify the number of events at which trigger occurs. The time delay (see TIMe:DELay) is counted after the events delay. The DELay command cannot be used in the IMMediate trigger mode.

`<count>` integer from 1 to 32000

Example

```
OUTPUT XXX;":TRIGGER:DELAY 5"
```

Query `:TRIGger:DELay?`

The DELay query returns the current trigger events count.

Returned Format `[:TRIGger:DELay] <count><NL>`

Example

```
OUTPUT XXX;":TRIG:DEL?"
```

LEVel

Command

For EDGE trigger mode:

```
:TRIGger:[MODE EDGE;SOURce
{CHANnel<N>|EXTernal};]LEVel<value>
```

For PATTern trigger mode:

```
:TRIGger:[MODE PATTern;PATH
{CHANnel<N>|EXTernal};]LEVel<value>
```

The LEVel command sets the trigger level voltage for the selected source or path. This command cannot be used in the IMMediate trigger mode. In EDGE trigger mode, the SOURce command is used; in PATTern mode, the trigger PATH is used for the trigger level source. The LEVel command in PATTern trigger mode sets the high/low threshold for the pattern. LEVel for EXT cannot be specified, LEVel is fixed at ECL levels.

`<N>` 1 or 2

`<value>` Trigger level in volts

Example

For EDGE trigger mode:

```
OUTPUT XXX;":TRIG:MODE EDGE;SOUR CHAN1;LEV 1.0"
```

For PATTern trigger mode:

```
OUTPUT XXX;":TRIG:MODE PATTERN;PATH CHANNEL2;LEVEL 1.0"
```

Query

For EDGE trigger mode:

```
:TRIGger:[MODE EDGE;SOUR {CHAN<N>|EXT};]LEVel?
```

For PATTern trigger mode:

```
:TRIGger:[MODE PATT;PATH {CHAN<N>|EXT};]LEVel?
```

The LEVel query returns the trigger level for the current path or source.

Returned Format

```
[:TRIGger:LEVel] <value><NL>
```

Example

For EDGE trigger mode:

```
OUTPUT XXX;":TRIGGER:SOURCE CHANNEL1;LEVEL?"
```

For PATTern trigger mode:

```
OUTPUT XXX;":TRIGGER:PATH CHANNEL1;LEVEL?"
```

LOGic

Command

```
:TRIGger:[MODE PATTern;PATH
{CHANnel<N>|EXTernal};] LOGic {HIGH|LOW|DONTcare}
```

The LOGic command sets the logic for each trigger path in the PATTern trigger mode. The choices are HIGH, LOW and DONTcare. The trigger level set by the LEVel command determines logic high and low threshold levels. Any voltage higher than the present edge trigger level is considered a logic high for that trigger path; any voltage lower than the trigger level is considered a logic low for that trigger path.

<N> 1 or 2

Example

```
OUTPUT XXX;":TRIG:PATH CHAN1;LOG HIGH"
```

Query

```
:TRIGger:LOGic?
```

The LOGic query returns the current logic of the previously selected trigger or path.

Returned Format

```
[:TRIGger:LOGic] {HIGH|LOW|DONTcare}<NL>
```

Example

```
OUTPUT XXX;":TRIG:MODE PATT;PATH CHAN1;LOG?"
```

MODE

Command

```
:TRIGger:MODE {EDGE|PATTern|IMMediate}
```

The MODE command allows you to select the trigger mode for the oscilloscope. The EDGE mode will trigger the oscilloscope on an edge whose slope is determined by the SLOPe command at a voltage set by the LEVel command. The PATTern mode will trigger the oscilloscope on entering or exiting a specified pattern of the two internal channels and external trigger. In the IMMediate trigger mode, the oscilloscope goes to a freerun mode and does not wait for a trigger. Generally, the IMMediate mode is used in intermodule applications.

Example

```
OUTPUT XXX;":TRIGGER:MODE PATTERN"
```

Query

```
:TRIGger:MODE?
```

The MODE query returns the current trigger mode selection.

Returned Format

```
[:TRIGger:MODE] {EDGE|PATTern|IMMediate}<NL>
```

Example

```
OUTPUT XXX;":TRIGGER:MODE?"
```

PATH

Command

```
:TRIGger:[MODE PATTern;]PATH {CHANnel<N>|EXTernal}
```

The PATH command is used to select a trigger path for the subsequent LOGic and LEVel commands. This command can only be used in the PATTern trigger mode.

<N> 1 or 2

Example

```
OUTPUT XXX;":TRIGGER:PATH EXTERNAL"
```

Query

```
:TRIGger:PATH?
```

The PATH query returns the current trigger path.

Returned Format

```
[:TRIGger PATH] {CHANnel<N>|EXTernal}<NL>
```

Example

```
OUTPUT XXX;":TRIGGER:PATH?"
```

SLOPe

Command

```
:TRIGger:[MODE EDGE;SOURce
{CHANnel<N>|EXTernal};]SLOPe {POSitive|NEGative}
```

The SLOPe command selects the trigger slope for the specified trigger source. This command can only be used in the EDGE trigger mode.

<N> 1 or 2

Example

```
OUTPUT XXX;":TRIG:SOUR CHAN1;SLOP POS"
```

Query

```
:TRIGger:SLOPe?
```

The SLOPe query returns the slope of the current trigger source.

Returned Format `[:TRIGger:SLOPe] {POSitive|NEGative}<NL>`

Example

```
OUTPUT XXX;":TRIG:SOUR CHAN1;SLOP?"
```

SOURce

Command `:TRIGger:[MODE EDGE;]SOURce {CHANnel<N>|EXTernal}`

The SOURce command is used to select the trigger source and is used for any subsequent SLOPe and LEVel commands. This command can only be used in the EDGE trigger mode. It is the equivalent to the PATH command for the PATTern trigger mode.

<N> 1 or 2

Example

```
OUTPUT XXX;":TRIG:SOUR CHAN1"
```

Query `:TRIGger:SOURce?`

The SOURce query returns the current trigger source.

Returned Format `[:TRIGger:SOURce] {CHANnel<N>|EXTernal}<NL>`

Example

```
OUTPUT XXX;":TRIGGER:SOURCE?"
```



10

WAVeform Subsystem

Introduction

The commands of the Waveform subsystem are used to transfer waveform data from the oscilloscope to a controller. The waveform record is actually contained in two portions; the waveform data and preamble. The waveform data is the actual data acquired for each point when a DIGitize command is executed. The preamble contains the information for interpreting waveform data. Data in the preamble includes number of points acquired, format of acquired data, average count and the type of acquired data. The preamble also contains the X and Y increments, origins, and references for the acquired data for translation to time and voltage values.

The values set in the preamble are based on the settings of the variables in the Acquire, Waveform, Channel, and Timebase subsystems. The Acquire subsystem determines the acquisition type and the average count, the Waveform subsystem sets the number of points and format mode for sending waveform data over the remote interface and the Channel and Timebase subsystems set all the X - Y parameters.

Refer to Figure 10-3 for the Waveform Subsystem Syntax Diagram.

Data Acquisition Types

The two acquisition types that may be chosen are Normal or Average.

Normal Mode

In the Normal mode, with ACCumulate command OFF, the oscilloscope acquires waveform data and then displays the waveform. When the oscilloscope takes a new acquisition, the previously acquired waveform is erased from the display and replaced by the newly acquired waveform.

When the ACCumulate is set ON, the oscilloscope displays all the waveform acquisitions without erasing the previously acquired waveform.

Average Mode

In the Average mode, the oscilloscope averages the data points on the waveform with previously acquired data. Averaging helps eliminate random noise from the displayed waveform. In this mode ACCumulate is set to OFF. When Average mode is selected the number of averages must also be specified using the COUNt command. Previously displayed waveform data is erased from the display and the newly averaged waveform is displayed.

Format for Data Transfer

There are three formats for transferring waveform data over the remote interface. These formats are WORD, BYTE, or ASCII.

WORD and BYTE formatted waveform records are transmitted using the arbitrary block program data format specified in IEEE-488.2. When you use this format, the ASCII character string "#8 <DD...D>" is sent before the actual data.

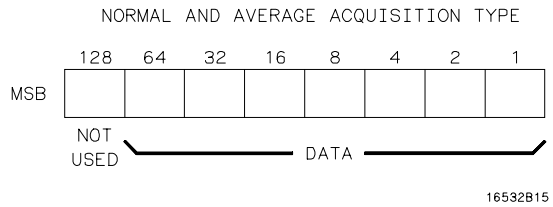
The <D>'s are eight ASCII numbers which indicate how many data bytes will follow.

For example, if 8192 points of data are to be transmitted, the ASCII string #800008192 would be sent.

BYTE Format

In BYTE format, the seven least significant bits represent the waveform data. This means that the possible range of data is divided into 128 vertical increments. The most significant bit is not used. If all "1"s are returned in the seven least significant bits, the waveform is clipped at the top of the screen. If all "0"s are returned, the waveform is clipped at the bottom of the screen (see figure 10-1).

Figure 10-1



Byte Data Structure

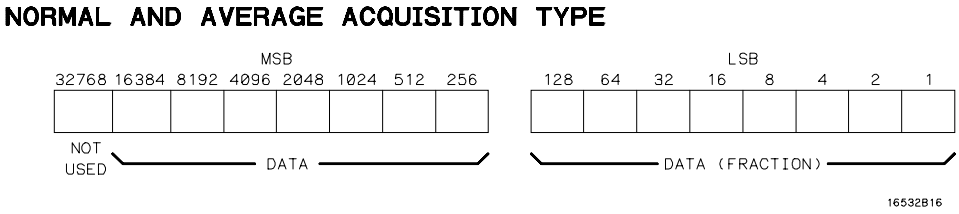
The data returned in BYTE format is the same for either Normal or Average acquisition types. The data transfer rate in this format is faster than the other two formats.

WORD Format

Word data is two bytes wide with the most significant byte of each word being transmitted first. In WORD format, the 15 least significant bits represent the waveform data. The possible range of data is divided into 32768 vertical increments. The WORD data structure for normal and average acquisition types are shown in figure 10-2. If all "1's are returned in the 15 least significant bits, the waveform is clipped at the top of the screen. If all "0's are returned in the 15 least significant bits, the waveform is clipped at the bottom of the screen.

WORD (and ASCII) format data is more accurate than BYTE format data. BYTE format simply truncates the 8 least significant bits of WORD format data.

Figure 10-2



Word Data Structure

ASCII Format

ASCII formatted waveform records are transmitted one value at a time, separated by a comma. The data values transmitted are the same as would be sent in the WORD format except that they are converted to an integer ASCII format (six or less characters) before being transmitted. The header before the data is not included in this format.

Data Conversion

Data sent from the oscilloscope is raw data and 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 (see the PREamble command) or by the queries of these values.

Conversion from Data Value to Voltage

The formula to convert a data value returned by the instrument to a voltage is:

voltage = [(data value - yreference) * yincrement] + 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 third data point sent with XORIGIN = 16ns, XREFERENCE = 0 and XINCREMENT = 2ns. Using the formula:

time = [(data point number - xreference) * xincrement] + xorigin

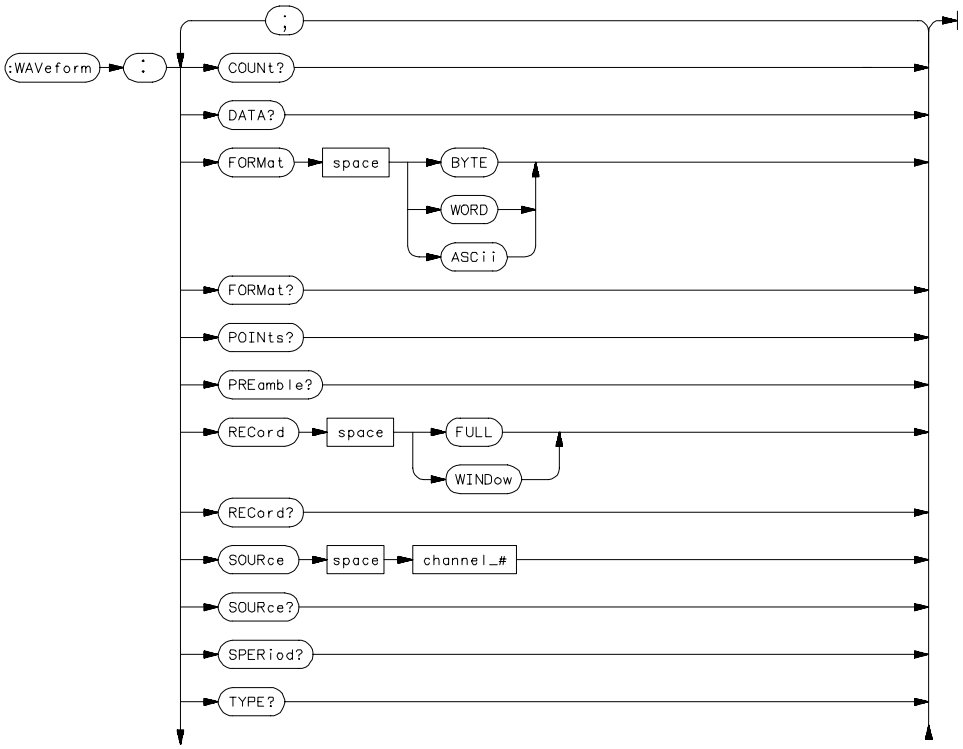
would result in the following calculation:

time = [(3 - 0) * 2ns] + 16ns = 22ns.

Conversion from Data Value to Trigger Point

The trigger data point can be determined by calculating the closest data point to time 0.

Figure 10-3



WAVeform Subsystem Syntax Diagram

Figure 10-3



WAVeform Subsystem Syntax Diagram (Cont'd)

Table 10-1 **WAVeform Parameter Values**

Parameter	Value
channel_#	an integer from 1 through 8 depending on how many oscilloscope cards are installed in the mainframe

COUNt?

Query `:WAVeform:COUNt?`

The COUNt query returns the count last specified in the ACQuire Subsystem.

Returned Format `[:WAVeform:COUNt] <count><NL>`

`<count>` {2|4|8|16|32|64|128|256}

Example

```
OUTPUT XXX;":WAVEFORM:COUNT?"
```

DATA?

Query `:WAVeform:[SOURce CHANnel<N>;]DATA?`

The DATA query returns the waveform record stored in a specified channel buffer. The WAVeform:SOURce command is used to select the specified channel. The data is transferred based on the FORMAT (BYTE, WORD or ASCII) chosen and the RECORD specified (FULL or WINDOW). Since WAVeform:DATA is a query, it cannot be used to send a waveform record back to the scope from the controller. If a waveform record is saved for later reloading into the oscilloscope, the SYSTem:DATA command should be used.

Returned Format `[:WAVeform:DATA]#800032768 <block data><NL>`

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

Example

```
OUTPUT XXX;":WAVEFORM:DATA?"
```

An example using the DATA command can be found in Chapter 11, Programming Examples.

FORMat

Command

```
:WAVeform:FORMat {BYTE|WORD|ASCii}
```

The FORMat command specifies the data transmission mode of waveform data over the remote interface.

Example

```
OUTPUT XXX;":WAV:FORM WORD"
```

Query

```
:WAVeform:FORMat?"
```

The FORMat query returns the currently specified format.

Returned Format

```
[:WAVeform:FORMat]{BYTE|WORD|ASCii}<NL>
```

Example

```
OUTPUT XXX;":WAVEFORM:FORMAT?"
```

POINts?

Query

```
:WAVeform:POINts?
```

When WAVeform RECord is set to FULL, the POINts query always returns a value of 32768 points. When WAVeform RECord is set to WINdow, then the query returns the number of points displayed on screen.

Returned Format

```
[:WAVeform:POINts] <points><NL>
```

`<points>` number of points depending on the setting of the WAVeform RECord command

Example

```
OUTPUT XXX;":WAVEFORM:POINTS?"
```

PREamble?

Query

```
:WAVeform[:SOURce CHANnel<N>;]PREamble?
```

The PREamble query returns the preamble of the specified channel. The channel is specified using the SOURCE command.

Returned Format

```
[:WAVeform:PREamble]
<format>, (0 = ASCII, 1 = BYTE, 2 = WORD,)
<type>, (1 = Normal, 2 = Average)
<points >,
<count >,
<Xincrement >,
<Xorigin >,
<Xreference >,
<Yincrement >,
<Yorigin >,
<Yreference ><NL>
```

<N> 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

Example

```
OUTPUT XXX;":WAVEFORM:PREAMBLE?"
```

For more information on the fields in PREamble, see the commands which query the individual fields. For example, see the FORmat command for an explanation of the format field.

RECord

Command

```
:WAVeform:RECord {FULL|WINDow}
```

The RECord command specifies the data you want to receive over the bus. The choices are FULL or WINdow. When FULL is chosen, the entire 32768 point record of the specified channel is transmitted over the bus. In WINdow mode, only the data displayed on screen will be returned.

Example

```
OUTPUT XXX;":WAV:SOUR CHAN1;REC FULL"
```

Query

```
:WAVeform:RECord?
```

The RECord query returns the present mode chosen.

Returned Format

```
[:WAVeform:RECord] {FULL|WINDow}<NL>
```

Example

```
OUTPUT XXX;":WAVEFORM:RECORD?"
```

SOURce

Command

```
:WAVeform:SOURce CHANnel<N>
```

The SOURce command specifies the channel that is to be used for all subsequent waveform commands.

<N> 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels), otherwise the maximum number of channels is 2

Example

```
OUTPUT XXX;":WAVEFORM:SOURCE CHANNEL1"
```

Query

```
:WAVeform:SOURce?
```

The SOURce query returns the presently selected channel.

Returned Format `[:WAVeform:SOURce] CHANnel<N><NL>`

Example

```
OUTPUT XXX;":WAVEFORM:SOURCE?"
```

SPERiod?

Query :WAVeform:SPERiod?

The SPERiod query returns the present sampling period. The sample period is determined by the DELay and the RANGe commands of the TIMEbase subsystem.

Returned Format `[:WAVeform:SPERiod] <period><NL>`

`<period>` time in seconds

Example

```
OUTPUT XXX;":WAVEFORM:SPERIOD?"
```

TYPE?

Query `:WAVeform:TYPE?`

The TYPE query returns the presently acquisition type (normal or average). The acquisition type is specified in the ACQuire Subsystem using the ACQuire TYPE command.

Returned Format `[:WAVeform:TYPE]{NORMal|AVERage}<NL>`

Example

```
OUTPUT XXX;":WAVEFORM:TYPE?"
```

VALid?

Query `:WAVeform:VALid?`

The VALid query checks the oscilloscope for acquired data. If a measurement is completed, and data has been acquired by all channels, then the query reports a 1. A 0 is reported if no data has been acquired for the last acquisition.

Returned Format `[:WAVeform:VALid] {0|1}<NL>`

`0` No data acquired

`1` Data has been acquired

Example

```
OUTPUT XXX;":WAVEFORM:VALID?"
```

XINCrement?

Query `:WAVeform:XINCrement?`

The XINCrement query returns the X-increment currently in the preamble. This value is the time difference between the consecutive data points. X-increment is determined by the RECord mode as follows:

- In FULL record mode, the X-increment equals the time period between data samples (or sample period).
- In WINDow record mode, the X-increment is the time between data points on the Agilent Technologies 16500B front panel. The X-increment for WINDow record data will be less than or equal to the sample period.

Returned Format `[:WAVeform:XINCrement]<value><NL>`

`<value>` X-increment value currently in preamble

Example

```
OUTPUT XXX;":WAVEFORM:XINCREMENT?"
```

XORigin?

Query `:WAVeform:[SOURce CHANnel<N>;]XORigin?`

The XORigin query returns the X-origin value currently in the preamble. The value represents the time of the first data point in memory with respect to the trigger point.

Returned Format `[:WAVeform:XORigin]<value><NL>`

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels)

`<value>` X-origin currently in preamble

Example

```
OUTPUT XXX;":WAV:XOR?"
```

XREFerence?

Query `:WAVeform:XREFerence?`

The XREFerence query returns the current X-reference value in the preamble. This value specifies the X-value of the first data point in memory and is always 0.

Returned Format `[:WAVeform:XREFerence]<value><NL>`

`<value>` X-reference value in the preamble

Example

```
OUTPUT XXX;":WAVEFORM:XREFERENCE?"
```

YINCrement?

Query `:WAVeform:[SOURce CHANnel<N>;]YINCrement?`

The YINCrement query returns the Y-increment value currently in the preamble. This value is the voltage difference between consecutive data values.

Returned Format `[:WAVeform:YINCrement]<value><NL>`

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels)

`<value>` Y-increment value in preamble

Example

```
OUTPUT XXX;":WAVEFORM:YINCREMENT?"
```

YORigin?

Query `:WAVeform:[SOURce CHANnel<N>;]YORigin?`

The YORigin query returns the Y-origin value currently in the preamble. This value is the voltage at center screen.

Returned Format `[:WAVeform:YORigin]<value><NL>`

`<N>` 1 through the number of channels in the oscilloscope connected as one unit (maximum of 8 channels)

`<value>` Y-origin value in preamble

Example

```
OUTPUT XXX;":WAVEFORM:YORIGIN?"
```

YREFerence?

Query `:WAVeform:YREFerence?`

The YREFerence query returns the Y-reference value currently in the preamble. This value specifies the data value at center screen where Y-origin occurs.

Returned Format `[:WAVeform:YREFerence]<value><NL>`

`<value>` Y-reference data value in preamble

Example

```
OUTPUT XXX;":WAVEFORM:YREFERENCE?"
```

11

Programming Examples

Introduction

This chapter contains short, usable, and tested program examples that cover the most asked for examples. The examples are written in HP BASIC 6.2

- Digitizing waveform data
- Using the MEASURE ALL? query
- Combined measurement example

Digitizing Waveform Data

This program sets up the oscilloscope module to digitize a waveform on channel 1 in word format and then moves the data to the computer in.

```
10 CLEAR 707
20 OUTPUT 707;":SELECT 4"
30 OUTPUT 707;":SYSTEM:HEADER OFF; ;EOI ON"
40 OUTPUT 707;":ACQUIRE:TYPE AVERAGE"
50 OUTPUT 707;":WAVEFORM:SOURCE CHANNEL1"
60 OUTPUT 707;":WAVEFORM:FORMAT WORD"
70 OUTPUT 707;":WAVEFORM:RECORD FULL"
80 OUTPUT 707;":AUTOSCALE"
90 DIM Header$[20]
100 OUTPUT 707;":DIGITIZE"
110 WAIT 10
120 Length= 32768
130 ALLOCATE INTEGER Waveform(1:Length)
140 OUTPUT 707;":WAVEFORM:DATA?"
150 ENTER 707 USING "#,10A";Header$
160 ENTER 707 USING "#10,W";Waveform(*)
170 END
```

Using the MEASURE ALL? Query

This program example uses the MEASURE ALL? Query to read in the results of a signal connected to channel 1. Autoscale is used in line 40 to capture the signal and automatically sets the voltage and time settings for a usable display.

```
10 OUTPUT 707;":SYSTEM:HEADER ON"
20 OUTPUT 707;":EOI ON"
30 OUTPUT 707;":SELECT 2"
40 OUTPUT 707;":AUTOSCALE"
50 WAIT 5
60 DIM Me$[200]
70 OUTPUT 707;":MEASURE:SOURCE CHANNEL1;ALL?"
80 ENTER 707 USING "#,200A";Me$
90  PRINT USING "#,200A";Me$
100 END
```

Combined Measurement Example

This program combines three major tasks that you would use when making measurements when controlling the oscilloscope card over the bus. The three major tasks are initializing the interface and oscilloscope card, digitizing the acquired signal, and measuring and printing the frequency and peak-to-peak voltage. This program is written with subroutines in HP BASIC 6.2.

```
10    !                 Combined Measurement Example
20    !
30    !MAIN PROGRAM
40    !    CLEAR SCREEN
60    PRINT "This example program will perform the following tasks:"
70    PRINT "         a.  initialize the interface and oscilloscope"
80    PRINT "         b.  digitize the signal                      "
90    PRINT "         c.  measure and print the frequency          "
100   PRINT
110   PRINT "The program assumes the system is configured as:"
120   PRINT "         GPIB address = 7"
130   PRINT "         Oscilloscope address = 7"
140   PRINT "         Oscilloscope card is in slot B"
150   PRINT "         Signal attached to channel 1"
160   PRINT
170   PRINT "If the addresses are not correct for your configuration, change"
180   PRINT "the ASSIGN statements in the Initialize function."
190   PRINT
200   PRINT "Press Continue when ready to start program, or Shift/Break to
terminate."
210   PAUSE
220   GOSUB Initialize                  !initialize interface and oscilloscope
230   GOSUB Get_waveform                !digitize signal
240   GOSUB Measure                     !measure and print frequency
250   STOP
260   !
270   !INITIALIZE INTERFACE AND OSCILLOSCOPE
280   !
290 Initialize:                         !
300   ASSIGN @Scope TO 707              !system address
310   ASSIGN @Isc TO 7                  !GPIB address
320   CLEAR @Isc                        !clear GPIB interface
330   OUTPUT @Scope;":SELECT 2"         !select the oscilloscope in slot B
```

```
340   OUTPUT @Scope;"*RST"               !set oscilloscope to default config
350   OUTPUT @Scope;":AUTOSCALE"         !AUTOSCALE
360   OUTPUT @Scope;":SYST:HEADER OFF"   !turn headers off
370   CLEAR SCREEN                       !clear screen
380   RETURN
390     !
400     !DIGITIZE waveform to acquire data and stop oscilloscope for further
410     !measurement.  Measurement is NOT displayed on the front panel.
420     !
430 Get_waveform:                                !
440   OUTPUT @Scope;":WAVEFORM:SOURCE CHAN1"  !set source to channel 1
450   OUTPUT @Scope;":DIGITIZE"               !macro to acquire data & stop
460   RETURN
470     !
480     !have oscilloscope do a frequency measurement and read results into
490     !computer.
500     !
510 Measure:                                     !
520   OUTPUT @Scope;":MEASURE:FREQUENCY?"     !FREQUENCY query
530   ENTER @Scope;Value                      !read from oscilloscope
540   PRINT "FREQUENCY = ";Value;"Hz"
550   OUTPUT @Scope;":MEASURE:VPP?"              !Vpp query
560   ENTER @Scope;Value
570   PRINT "Vpp = ";Value;"V"
580   RETURN
590   END
```

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