Errata

Title & Document Type: 16532A 1-GSa/s Digitizing Oscilloscope User's Reference (Jul93)

Manual Part Number: 16532-97003

Revision Date: July 1993

HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

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User's Reference

HP 16532A
1-GSa/s Digitizing Oscilloscope

HP 16532A Digitizing Oscilloscope

User's Reference

Publication Number 16532-97003
First Edition, July 1993

For Safety Information, Warranties, and Regulatory Information, see the pages behind the index

HP 16532A
1 GSa/s Oscilloscope Module

In This Book

This book provides a detailed description of the features of the HP 16532A 1 GSa/s Oscilloscope Module. It identifies the different menus available on the oscilloscope, and shows what options are available in the menus. It then explains what each of these options mean and what they do. The book is divided into the following chapters:

Chapter 1 describes the options for running and stopping the oscilloscope and explains single and repetetive modes of operation.

Chapter 2 describes the Autoscale function—what is does, what trigger it selects to trigger on, and what fields and menus are affected by the algorithm.

Chapter 3 describes the Channel menu options—input identification, vertical sensitivity and position, probe attenuation factor, coupling field selection, and preset values.

Chapter 4 describes time base functions—sweep speed, horizontal position, pan and zoom, and sample period display.

Chapter 5 describes time marker functions—both manual and automatic. It describes the capabilities of both manual and automatic time markers and the fields available in each, then describes the function of each of these fields. It also decribes voltage markers, the fields available to them, and the function of each of these fields.

Chapter 6 describes trigger options available—immediate, pattern, and edge. It describes their use, configurations available, and the fields controlling each option.

Chapter 7 describes the display options—normal, average, and accumulate. It then explains when each is used, and what the results are when each is used.

Chapter 8 describes the Auto-Measure feature and explains the algorithm for each of the nine automatic measurements taken. The measurements taken using this feature are: frequency, period, peak-to-peak voltage, positive pulse width, negative pulse width, rise time, fall time, preshoot, and overshoot.

Chapter 9 describes the Waveform Selection menu. This menu lets you select the following modes of operation: single channel, overlay, Chan + Chan, or Chan−Chan. It also allows you to insert, replace, or delete channels from the display.

Chapter 10 gives you the specifications and characteristics for the oscilloscope.

The Glossary defines some of the common terms you will find throughout this book.

The Index is an alphanumeric listing of the subject matter contained in this book.

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5 The Marker Menu

Run/Stop Options

Run/Stop Options

When you first turn on the Logic Analysis System, all of the modules installed in the mainframe are inactive (that is, not running). Making the module inactive at system start-up prevents any unwanted interaction between the modules.

This chapter describes how to manually start the oscilloscope running. You can cause the oscilloscope to run automatically in an intermodule measurement setup. For information on intermodule measurements, refer to the "InterModule Measurements" chapter in the *HP 16500B Logic Analysis User's Guide.*

Manually running or stopping the oscilloscope is controlled by the Run/Stop field. All of the run and stop options are explained in this chapter. The Run/Stop field is in the upper-right corner of all oscilloscope menus.

There are two ways you can manually cause the oscilloscope to run. One way is to touch the Autoscale field on the screen, then select Continue from the pop-up menu. The more obvious way to cause the oscilloscope to run (or stop) is to use the Run/Stop field options.

In addition to the run and stop options available with the Run/Stop field, the Run field allows you to choose the acquisition mode of the run you want to make. The acquisition modes available are single mode and repetitive mode.

Remember, when the Run/Stop field displays Run, the oscilloscope is stopped. You touch the Run field to start the oscilloscope running. Likewise, when the Run/Stop field displays Stop, the oscilloscope is running. You touch the Stop field to stop the oscilloscope. In short, the Run/Stop field displays your next option—not the action taking place.

Autoscale Run

You can use the autoscale feature to cause the oscilloscope to run. You may want to use this method when you have changed one or more of the signal input parameters and want to get back to a basic screen presentation of your waveform. Just touch the Autoscale field on the screen, then select Continue from the pop-up menu. When autoscaling is complete, the oscilloscope automatically starts running. It will run in the mode (single or repetitive) that was last selected using the Run field menu options. If no run mode is selected prior to selecting autoscale, the run mode defaults to single mode.

Run Field

When the green Run field is displayed, the oscilloscope is stopped. Touching the Run field, then removing your finger from the screen, starts the oscilloscope running. The oscilloscope runs using the parameters that are currently set. Additionally, it runs in the mode (single or repetitive) that was last selected. If no run mode is selected prior to selecting a run, the run mode defaults to single mode.

When you touch and hold your finger on the Run field, a pop-up menu appears. The pop-up contains the selections Single, Repetitive, and Cancel. To select one of the options, slide your finger down the screen until it is over the option you want to select, then remove your finger from the screen. These options are described in the following paragraphs.

Single Mode Option

When the system is turned on, the oscilloscope defaults to the Single mode. Single mode acquisition fills acquisition memory once with 8000 samples of the input waveform, automatically stops running, then displays the contents of acquisition memory. Each 8000-sample waveform record is acquired in a single acquisition.

To start the oscilloscope running in the single-shot mode after it has been running in repetitive mode, touch the green Run field. Slide your finger down to the Single field in the pop-up until the Single field turns white, then remove your finger from the screen. This starts the oscilloscope running in the Single mode. When single-shot acquisition is in process, the Run/Stop field will display Stop. When the acquisition is complete, the field display changes to Run. In Single mode, the oscilloscope makes a single acquisition and displays the results. The oscilloscope then waits until the Run field is touched again before making another acquisition.

Repetitive Mode Option

Repetitive mode acquisition fills acquisition memory with 8000 samples of the input waveform on continuing acquisitions. The display is updated each time a new acquisition is made. Repetitive mode continues acquiring data in this manner until you touch the Stop field. As in single mode, each 8000-sample waveform record is acquired in a single acquisition.

To start the oscilloscope running in the repetitive mode after it has been running in single mode, touch the green Run field. Slide your finger down to the Repetitive field in the pop-up until the Repetitive field turns white, then remove your finger from the screen. This starts the oscilloscope running in the Repetitive mode. While the real-time repetitive acquisitions are being made, the Run/Stop field will display Stop. When you want to stop making repetitive acquisitions, touch the Stop field. To resume making repetitive acquisitions, touch the Run field again.

Cancel Option

If you select the Cancel field in the pop-up, the oscilloscope returns to the state it was in before the Run field was touched. That is, it is stopped in either single or repetitive mode, whichever mode was selected last.

Stop Field

When the red Stop field is displayed, the oscilloscope is running. Touch the Stop field to cause the oscilloscope to stop running.

Autoscale

Autoscale

Autoscale is an algorithm built into the oscilloscope that automatically optimizes the display of one or more waveforms. When you touch the Autoscale field and select Continue, the autoscale algorithm starts, and the screen displays the advisory message "Autoscale is in progress."

This chapter discusses how the autoscale algorithm works. It also discusses what fields are affected by the autoscale algorithm.

Autoscale Field Options

The Autoscale field is displayed in the top row of menu fields on every oscilloscope menu.

When you touch the Autoscale field, a pop-up appears that allows you to cancel or continue the autoscale.

Cancel

If you accidentally touch the Autoscale field, you can touch the Cancel field in the pop-up menu to cancel the autoscale process. The cancel feature keeps you from inadvertently changing your oscilloscope setup.

Continue

When you touch the Continue field, the autoscale algorithm starts, and the screen displays the advisory message "Autoscale is in progress." Once the autoscale operation begins, it cannot be cancelled.

Autoscale Algorithm

This section describes what the autoscale algorithm does when a signal, or signals, is present at the oscilloscope inputs. It also describes what occurs when signals are not present at the oscilloscope inputs.

What the Autoscale Algorithm Does When a Signal is Found

The autoscale algorithm first checks all input channels to determine whether or not there are any signals present. The vertical scaling is then set as required for each channel. Next the time base is scaled for a single input channel. Finally, the trigger channel is selected and the waveforms are displayed.

Finding the Vertical Settings The autoscale algorithm first checks all input channels to determine whether or not there are any signals present. Starting at the lowest numbered channel in the oscilloscope module, the autoscale algorithm checks for activity on that channel. It then sets the vertical scaling (V/Div and offset) appropriate to that input signal. This process is repeated for each input channel. If no activity is found on an input channel, the original (pre-autoscale) vertical settings are restored.

When all input signals have been vertically scaled, the time base settings (s/Div and delay) are scaled. The time base settings are determined based on the input signal for a single channel.

Finding the Time Base Settings The time base settings (s/Div and delay) are determined based on the input signal of the lowest numbered input channel that has been determined to have a signal present.

For example, if signals are present on both CHAN 1 and CHAN 2 inputs, the autoscale algorithm selects the signal on CHAN 1 input as the time base scaling source. Similarly, if a signal is present only on the CHAN 4 input, then the CHAN 4 input is selected as the time base scaling source.

The time base is scaled so that between two and five complete cycles of the time base scaling source input signal can be seen on the screen. If signals of significantly different frequencies are probed by the oscilloscope, and the time base scaling is based on a slow signal, you should be aware of the possibility that the faster signals may be under-sampled and incorrectly displayed on the screen.

Displaying the Waveform When the autoscale algorithm is complete, the oscilloscope automatically starts running, and displays waveforms for the inputs that have been selected. The run mode (single or repetitive) that was selected prior to running autoscale is the run mode executed when autoscale is completed. If a run mode has not been selected prior to running autoscale, the single mode run is executed.

The channel and time base fields are updated (if necessary) to reflect any changes made by the autoscale algorithm. The trigger settings are also changed by the autoscale algorithm and an edge mode trigger with CHAN 1 or CHAN 2 is selected. If the time base scaling is based on CHAN 1 or CHAN 2, that channel is selected as the trigger source. If there is no activity on CHAN 1 or CHAN 2, but there is activity on some other channel, the trigger source will be set to CHAN 1.

The trigger point on the waveform is determined by the trigger level set by the autoscale algorithm. The trigger point is displayed as a dotted vertical red line at the center of the screen when Delay = 0 s.

What the Autoscale Algorithm Does When a Signal Cannot be Found

When a signal cannot be found on any of the vertical inputs, the oscilloscope displays the advisory messages "No signal found" and "Original setup restored." The autoscale algorithm toggles the Auto-Trig field to On, which places the oscilloscope in the automatic trigger mode. The oscilloscope then displays the message "Auto triggered." The automatic trigger mode allows the oscilloscope to sweep automatically and to display a baseline anytime a trigger signal is not present.

Menus and Fields Changed by the Autoscale Algorithm

The following table shows the menus and their fields that are changed by the autoscale algorithm.

Settings Changed by Autoscale

Menu	Field	Autoscale Action
Channel	V/Div	Scaled - depending on amplitude of input signal.
	Offset	Scaled - depending on offset of input signal.
Trigger	Mode	Defaults to Edge.
	Source	Set to lowest numbered input with signal present.
	Level	Scaled - depending on amplitude of lowest numbered input with signal present.
	Slope	Defaults to Positive.
	Count	Defaults to 1.
	Auto-Trig	Defaults to On.
		NOTE: Trigger source must be either CHAN 1 or CHAN 2, even if no signal exists on either channel. If no input signal exists for CHAN 1 or CHAN 2, the source and level remain the same as before autoscale was run.
All Applicable	s/Div	Scaled - depending on frequency of lowest numbered input with signal present.
	Delay	Defaults to 0 s.

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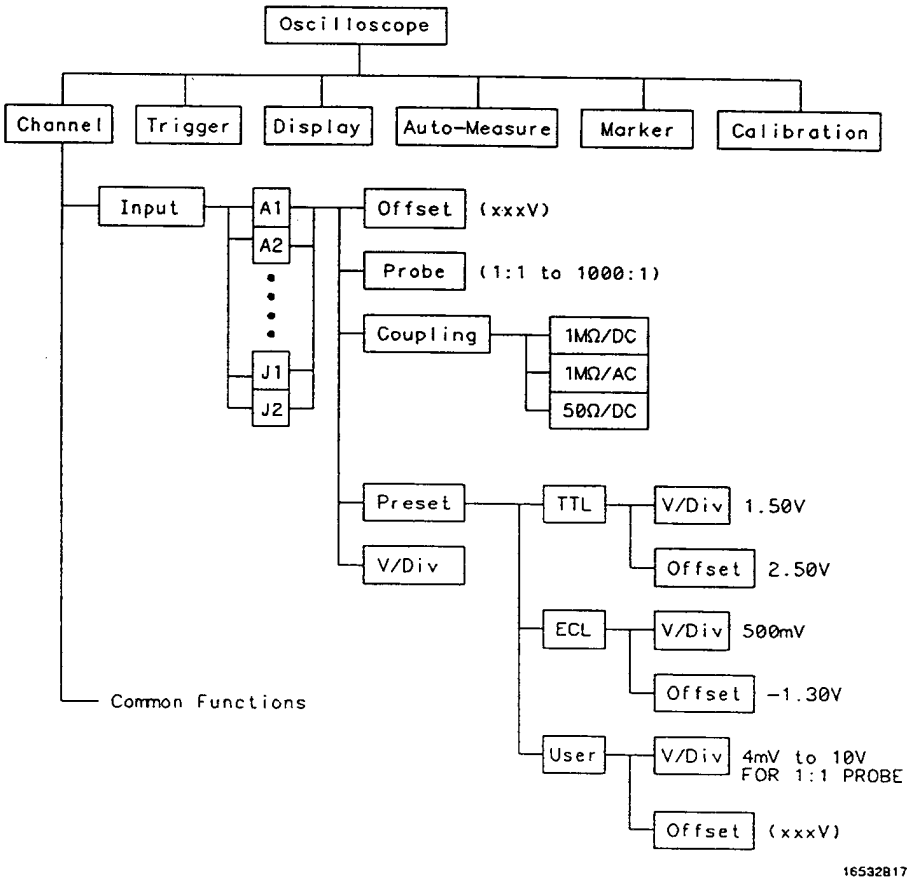
The Channel Menu

The Channel Menu

The Channel menu lets you select the channel input for the module currently displayed in the module field. It lets you select values that control the vertical sensitivity, offset, probe attenuation factor, input impedance, and coupling of the input channel currently shown in the Input field. The Channel menu also gives you preset vertical sensitivity, offset, and trigger level values for ECL and TTL logic levels.

Channel Menu Map

The menu map on the next page illustrates all fields and the available options for the Channel menu. The menu map will help you get an overview as well as provide you with a quick reference of what the Channel menu contains.



Channel Field Menu Map

Input Field

You use the Input field to select the input source for the channel parameters displayed on the Channel menu. Each channel may be set independent of all other channels.

Input Identification

When you touch the Input field, a pop-up appears that shows the input channels for the module that is currently displayed in the module field. The input channels are shown as a letter/number combination: A1, for example. The letter A identifies the slot number in the mainframe which contains the module. The number 1 identifies the input connector on the rear of the module. For the 1 GSa/s Oscilloscope Module, A1 identifies the module location as slot A and the input location as CHAN 1. Likewise, A2 identifies the module location as slot A and the input location as CHAN 2.

For 1 GSa/s Oscilloscope Modules installed in an HP 16500B Logic Analysis System mainframe, two inputs are available for each of the slots A, B, C, D, and E. If the HP 16501B Logic Analysis System expansion frame is used, additional slots F, G, H, I, and J are also available.

At system turn on, the Input field defaults to the lowest lettered and numbered input for the module selected. For example, if a module is installed in mainframe slot A, the Input field will display A1.

V/Div Field

You use the V/Div field to set the vertical sensitivity for the waveform on the screen. It is set for the channel currently displayed in the Input field. Vertical sensitivity determines the vertical size of a waveform displayed on the screen and it is measured in volts per division. Each waveform display area is divided into four vertical divisions. The divisions are marked by small tan-colored tick marks at the left and right sides of the waveform display area.

When you select the V/Div field, you can change the vertical sensitivity by turning the knob. Turning the knob clockwise causes the waveform to expand vertically in both directions from the center of the display. Turning the knob counterclockwise causes the waveform to compress vertically in both directions toward the center of the display. As you turn the knob, the vertical sensitivity changes in a 1-2-4 sequence from 4 mV/Div to 10 V/Div (1:1 probe).

Vertical sensitivity can also be entered from the pop-up keypad. The keypad appears when you touch the V/Div field when the field is light blue. Any valid value from 4 mV/Div to 10 V/Div (1:1 probe) can be entered from the keypad. The vertical sensitivity value is set to the two most significant digits of the value entered. For example, if you enter a value of 154 mV, the value is rounded and then truncated to 150 mV.

If acquisitions have been stopped (either by touching the Stop field or by a completed measurement), vertical sensitivity changes will not be reflected on the waveform until Run is touched and the next acquisition is displayed. Changes to V/Div during a repetitive run will be seen on the next displayed acquisition because the hardware is reprogrammed between acquisitions.

The default value for the V/Div field is 1.5 V (TTL preset value).

Offset Field

You use the Offset field to set the vertical position of the waveform on the screen. It is set for the channel currently displayed in the Input field. Vertical position determines the vertical placement of the waveform. Offset is measured in volts. Each waveform display area is divided into four vertical divisions. The divisions are marked by small tan-colored tick marks at the left and right sides of the waveform display area.

Offset is the voltage represented at the center vertical tick mark in the waveform display. It is a dc voltage that is added to or subtracted from the input signal so that the waveform can be centered on the waveform display. Offset range and resolution are dependent on vertical sensitivity (V/Div) as shown in the table below. The table values are based on a 1:1 probe setting.

Offset Range and Resolution

V/Div Setting	Offset Range	Offset Resolution
4 mV - 100 mV/Div	±2 V	1 mV
>100 mV - 500mV/Div	± 10 V	1 mV
>500mV - 2.5 V/Div	± 50 V	1 mV
>2.5 V - 10 V/Div	± 250 V	2 mV

When you select the Offset field, the offset value of the channel currently displayed in the Input field can be changed by turning the knob. As you turn the knob, the value in the Offset field changes, and the position of the waveform moves up or down on the waveform display. Offset works similar to the vertical position control of an analog oscilloscope, but offset is calibrated.

Any valid offset value can also be entered from the keypad. The keypad will appear when you touch the Offset field when the field is light blue. The default value for the Offset field is 2.5 V (TTL preset value).

If acquisitions have been stopped (either by touching the Stop field or by a completed measurement), offset changes will not be reflected on the waveform until Run is touched and the next acquisition is displayed. Changes to Offset during a repetitive run will be seen on the next displayed acquisition because the hardware is reprogrammed between acquisitions.

Probe Field

You use the Probe field to set the probe attenuation factor for the input channel currently displayed in the Input field.

Probe Attenuation Factor

The probe attenuation factor can be set from 1:1 to 1000:1 in increments of one. When you select the Probe field, the probe attenuation factor can be changed by turning the knob or by entering a value from the pop-up keypad.

When you select a probe attenuation factor, the actual sensitivity at the input does not change. The voltage values shown on the display (V/div, offset, trigger level) are automatically adjusted to reflect the attenuation factor. The marker and automatic measurement voltage values change when Run is touched and the next acquisition is displayed

The default value for the Probe field is 10:1 for 10:1 divider probes.

Coupling Field

You use the Coupling field to set the input impedance for the channel currently displayed in the Input field.

Coupling Field Selections

When you touch the Coupling field, a pop-up appears that shows the input impedance values available for selection. The selectable values are as follows:

- 1MΩ / DC
- 1MΩ / AC
- 50Ω / DC.

The default value for the Coupling field is 1MΩ / DC.

CAUTION The maximum input voltage for the 50Ω / DC Coupling field selection is 5 Vrms.

Preset Field

When you touch the Preset field, a pop-up appears. TTL, ECL, and User are the options available. The Preset field automatically sets offset, V/div, and trigger level values to properly display TTL and ECL logic levels. Trigger level is in the Trigger menu and can be changed only when edge trigger is the selected trigger mode.

Preset Field Values

When you select TTL or ECL, the parameters are preset to the values shown in the following table:

Preset Values

Parameter	ECL	TTL
V/Div	500 mV	1.5 V
Offset	-1.300 V	2.5 V
Trigger Level	-1.300 V	1.620 V

When any of the ECL or TTL preset values are changed from the preset values listed above, the Preset field will change to User and the new values become the new User values. The User values remain the same until you manually change the User values or you change the ECL or TTL preset values while in ECL or TTL Preset.

The default value for the Preset field is TTL.

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Time Base Functions

Time Base Functions

The s/Div and Delay time base fields control the horizontal display on the oscilloscope. There are three rows of fields displayed on the oscilloscope. The s/Div and Delay fields are located in the bottom row of fields. These two fields are displayed on all of the oscilloscope menus, except for the Calibration menu.

s/Div Field

The s/Div field allows you to set the sweep speed (time scale) on the horizontal axis of the display. Sweep speed is measured in seconds per division.

Selecting Sweep Speed

The waveform display is divided into 10 horizontal divisions. The divisions are marked by small tan-colored tick marks at the top and bottom of the waveform display area.

If you have a multimodule oscilloscope configuration, the s/Div field is set on the master card. All other modules in the multimodule configuration will use the same s/Div setting as the master card.

When you select the s/Div field, you can change the sweep speed for the next acquisition by turning the knob. Turning the knob clockwise a small amount expands the displayed waveform horizontally in both directions from the center of the display. Turning the knob counter-clockwise a small amount compresses the displayed waveform horizontally in both directions toward the center of the display. As you turn the knob, the sweep speed changes in a 1-2-5 sequence (10.0 ns, 20.0 ns, 50.0 ns, etc.) from 1 ns/div to 5 s/div.

Sweep speed can also be entered from the pop-up keypad. The keypad appears when you touch the light-blue s/Div field. Any value from 1 ns/div to 5 s/div can be entered from the keypad. Sweep speed values are rounded and then truncated to the three most significant digits. For example, if you enter a value of 15.45 ns, the value is rounded and then truncated to 15.5 ns.

At sweep speeds of 100 ms/div and slower, the time to acquire the 8000 sample points for acquisition memory is greater than 1 second. At these sweep speeds the screen displays the message "Waiting for Prestore" when acquiring the sample points prior to the trigger. It displays the message "Waiting for Poststore" when acquiring the sample points after the trigger. These messages advise you that the oscilloscope is still actively acquiring data. Acquisition time and sample rate, as they compare to sweep time, are shown in the table at the end of this chapter.

The default value for the s/Div field is 500 ns.

Zooming (Acquisition Stopped)

When acquisitions are stopped, the oscilloscope displays the sample points stored in acquisition memory on the screen. When you change the sweep speed, the new screen display is a different presentation of the data retained in acquisition memory when acquisitions were stopped. Presenting the same data in a different form (zooming) is normally used on a waveform acquired in Single mode.

Zooming while in repetitive mode will change the sample rate and the display because the hardware is reprogrammed between acquisitions in response to the new timebase settings. Zooming is done by adjusting the value in the s/Div field. It causes the waveform to either expand horizontally (decrease sweep time value) or compress horizontally (increase sweep time value).

When used in conjunction with panning (see "Delay Field"), zooming is very useful in displaying waveforms.

Delay Field

The Delay field allows you to set the horizontal position of the displayed waveform in relation to the trigger. Delay time is measured in seconds.

Setting Horizontal Position

Delay time zero is always at the trigger point of the waveform. A delay time value is the time difference measured from before or after the trigger point on the waveform (delay time zero), to the center point of the screen. In other words, delay time is always measured from the trigger point on the waveform to the center of the screen. The vertical dotted red line on the screen is the trigger point. When delay time is zero, the trigger point will be at the center of the screen.

If you have a multimodule oscilloscope configuration, the Delay field is set on the master card. All other modules in the multimodule configuration will use the same Delay setting as the master card.

When you select the Delay field, delay time can be changed by turning the knob. Remember that the trigger point is always delay time zero and is marked by the vertical dotted red line. When you set the delay such that the trigger point is on the right side of the screen, delay time is negative. What you will see at the center of the screen will be the result of samples taken before the trigger point. They have occurred in what is referred to as negative time.

When you set the delay such that the trigger point is on the left side of the screen, delay time is positive. What you will see at the center of the screen will be the result of samples taken after the trigger point. They have occurred in what is referred to as positive time.

Delay time resolution is equal to 2% of the sweep speed setting when using the knob. When using the pop-up keypad, resolution is 10 ps at sweep speeds of 99.99 ns/div and faster, and can be set to 5-digit resolution at sweep speeds of 100 ns/div and slower.

When run mode is set to Repetitive, the valid Delay range is:

Pre-trigger delay range = 4000 X sample period
Post-trigger delay range is equal to the following:

Time/Div Setting	Available Delay
100 ms to 5 s/Div	2.5 ks
1 μs to 50 ms/Div	33,500 X (s/Div)
1 ns to 500 ns/Div	16.7 ms

Pre- and post-trigger delay time ranges, as they compare with sweep speeds, are shown in the table at the end of this chapter.

The default value for the Delay field is 0 s.

Panning (Acquisition Stopped)

When acquisitions are stopped, the Delay field can be used to control what portion of acquisition memory will be displayed on screen. Acquisition memory is comprised of the following sections:

Pre-trigger delay range = delay time setting – (4000 X sample period)
Post-trigger delay range = delay time setting + (4000 X sample period)

This shows that one-half of the data stored in acquisition memory was stored before the delay time setting and one-half of the data in memory was stored after the delay time setting. Panning allows you to view the entire waveform record by adjusting the Delay field. Normally, using the delay function to view all of the acquired waveform (panning) is done on a waveform acquired in Single (single-shot) mode.

Using the Center Screen field that appears in the Marker Menu (refer to chapter 5) is another way to shift/pan the display to center it on specific time markers.

Sample Period Field

Any time the Time and Voltage Markers field are both Off, the sample period of the acquired waveform is displayed in the bottom row of the menu fields.

Sample period is the time period between acquired sample points and is the inverse of sample rate (digitizing rate). Sample period is a function of sweep speed and can only be changed by changing the s/Div field. Sample period and sample rates, as they compare with sweep speed, are shown in the following table.

There are two fields to the right of the Sample Period field which pertain to the sample rate. These fields are the Data acquired at field and the Next acquisition field.

Data acquired at Field

When acquisitions are stopped, the Data acquired at field shows the sample rate at which the last acquisition was taken. When the s/Div field is light-blue, you can turn the knob to change the time base setting.

During a repetitive run, the Data acquired at field and the Next acquisition field will display the same value on the first acquisition following a s/Div setting change. This happens because the hardware is reprogrammed between acquisitions in response to the new time base setting.

Next acquisition Field

When you change the time base setting (see above paragraph), the value in the Next acquisition field changes to reflect the sample rate at which the next acquisition will be taken if the Run field is touched.

During a repetitive run, the Data acquired at field and the Next acquisition field will display the same value on the first acquisition following a s/Div setting change. This happens because the hardware is reprogrammed between acquisitions in response to the new time base setting.

Sample Period Value Display

Any time the markers (either voltage and/or time) are turned on, the current marker settings may be displayed on the channel, trigger, display and auto-measure menus by using the Display Options field located to the right of the time base Delay field. The Display Options field is also used to access the channel labeling field. Refer to the Display Menu chapter for channel labeling details. Refer to the Marker Menu chapter for further details about the Marker Value display.

On the marker menu, if time markers are turned off, the Sample Period display will appear on the marker menu. If time markers are selected as either On or Auto, the Sample Period display is not visible on the Marker menu.

The Display Options field never appears on the Marker menu.

Sample Period Field

s/Div	Sample Rate	Sample Period	Trace Length	Percent on Screen
5 s	100 Sa/s	10 ms	80.000 s	62%
2 s	250 Sa/s	4 ms	32.000 s	62%
1 s	500 Sa/s	2 ms	16.000 s	62%
500 ms	1 KSa/s	1 ms	8.000 s	62%
200 ms	2.5 KSa/s	400 µs	3.200 s	62%
100 ms	5 KSa/s	200 µs	1.600 s	62%
50 ms	10 KSa/s	100 µs	800.0 ms	62%
20 ms	25 KSa/s	40 µs	320.0 ms	62%
10 ms	50 KSa/s	20 µs	160.0 ms	62%
5 ms	100 KSa/s	10 µs	80.000 ms	62%
2 ms	250 KSa/s	4 µs	32.000 ms	62%
1 ms	500 KSa/s	2 µs	16.000 ms	62%
500 µs	1 MSa/s	1 µs	8000 µs	62%
200 µs	2.5 MSa/s	400 ns	3200 µs	62%
100 µs	5 MSa/s	200 ns	1600 µs	62%
50 µs	10 MSa/s	100 ns	800.0 µs	62%
20 µs	25 MSa/s	40 ns	320.0 µs	62%
10 µs	50 MSa/s	20 ns	160.0 µs	62%
5 µs	100 MSa/s	10 ns	80.000 µs	62%
2 µs	250 MSa/s	4 ns	32.000 µs	62%
1 µs	500 MSa/s	2 ns	16.000 µs	62%
500 ns	1 GSa/s	1 ns	8000 ns	62%
200 ns	1 GSa/s	1 ns	8000 ns	25%
100 ns	1 GSa/s	1 ns	8000 ns	12%
50 ns	1 GSa/s	1 ns	8000ns	6%
20 ns	1 GSa/s	1 ns	8000 ns	2%
10 ns	1 GSa/s	1 ns	8000 ns	1%
5 ns	1 GSa/s	1 ns	8000 ns	0.6%
2 ns	1 GSa/s	1 ns	8000 ns	0.2%
1 ns	1 GSa/s	1 ns	8000 ns	0.1%

Notes:

Sa/s = Samples per second.

Trace length = 8000 × *sample period.*

Percent on screen assumes zero delay and is calculated by $\frac{10 \times s/Div}{trace\ length}$. It is the percentage of the total acquired samples that are seen on screen when the acquired data is displayed.

s/Div	Sample Period	*Max. Negative Delay at Acquisition	**Max. Positive Delay at Acquisition	Max. Negative Delay	Max. Positive Delay
5 s	10 ms	−40 s	2.5 Ks	−55.0 s	2.5 Ks
2 s	4 ms	−16 s	2.5 Ks	−70.0 s	2.5 Ks
1 s	2 ms	−8 s	2.5 Ks	−75.0 s	2.5 Ks
500 ms	1 ms	−4 s	2.5 Ks	−77.5 s	2.5 Ks
200 ms	400 µs	−1.6 s	2.5 Ks	−79.0 s	2.5 Ks
100 ms	200 µs	−800 ms	2.5 Ks	−79.5 s	2.5 Ks
50 ms	100 µs	−400 ms	1.675 Ks	−79.7 s	2.5 Ks
20 ms	40 µs	−160 ms	670 s	−79.9 s	2.5 Ks
10 ms	20 µs	−80 ms	335 s	−79.9 s	2.5 Ks
5 ms	10 µs	−40 ms	167.5 s	−79.9 s	2.5 Ks
2 ms	4 µs	−16 ms	67.0 s	−79.9 s	2.5 Ks
1 ms	2 µs	−8 ms	33.5 s	−79.9 s	2.5 Ks
500 µs	1 µs	−4 ms	16.75 s	−79.9 s	2.5 Ks
200 µs	400 ns	−1.6 ms	6.70 s	−79.9 s	2.5 Ks
100 µs	200 ns	−800 µs	3.35 s	−79.9 s	2.5 Ks
50 µs	100 ns	−400 µs	1.67 s	−79.9 s	2.5 Ks
20 µs	40 ns	−160 µs	671 ms	−79.9 s	2.5 Ks
10 µs	20 ns	−80 µs	335 ms	−79.9 s	2.5 Ks
5 µs	10 ns	−40 µs	167 ms	−79.9 s	2.5 Ks
2 µs	4 ns	−16 µs	67.0 ms	−79.9 s	2.5 Ks
1 µs	2 ns	−8 µs	33.5 ms	−79.9 s	2.5 Ks
500 ns	1 ns	−4 µs	16.7 ms	−79.9 s	2.5 Ks
200 ns	1 ns	−4 µs	16.7 ms	−79.9 s	2.5 Ks
100 ns	1 ns	−4 µs	16.7 ms	−79.9 s	2.5 Ks
50 ns	1 ns	−4 µs	16.7 ms	−79.9 s	2.5 Ks
20 ns	1 ns	−4 µs	16.7 ms	−79.9 s	2.5 Ks
10 ns	1 ns	−4 µs	16.7 ms	−79.9 s	2.5 Ks
5 ns	1 ns	−4 µs	16.7 ms	−79.9 s	2.5 Ks
2 ns	1 ns	−4 µs	16.7 ms	−79.9 s	2.5 Ks
1 ns	1 ns	−4 µs	16.7 ms	−79.9 s	2.5 Ks

Notes:

@ Acquisition = maximum ± delay when you press Run.

Maximum negative delay = 80.0 $s - \frac{1}{2} SD$ where 1/2 SD (1/2 screen diameter) = 5 × *s/Div*.

*Maximum negative delay @ acquisition = −(4000 × *sample period*)

**Maximum positive delay without a sample rate change = 2^{24} × *sample period*.

The Marker Menu

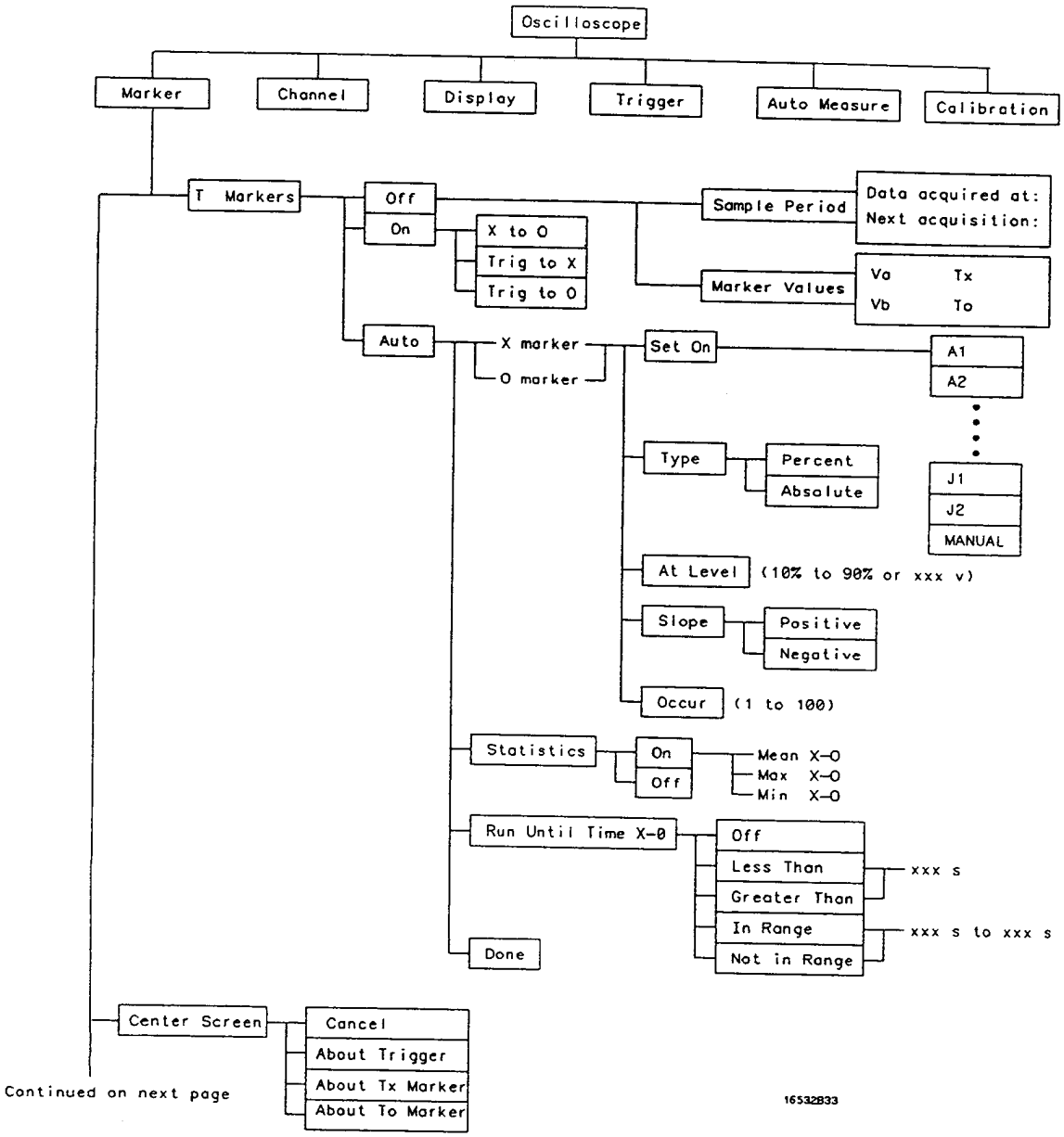
The Marker Menu

The oscilloscope has two sets of markers that allow you to make time and voltage measurements. These measurements can be made either manually (voltage and time markers) or automatically (time markers only). The markers are accessed when you touch the Markers choice on the oscilloscope menu pop-up.

The default selection for both the time and voltage Marker fields is Off.

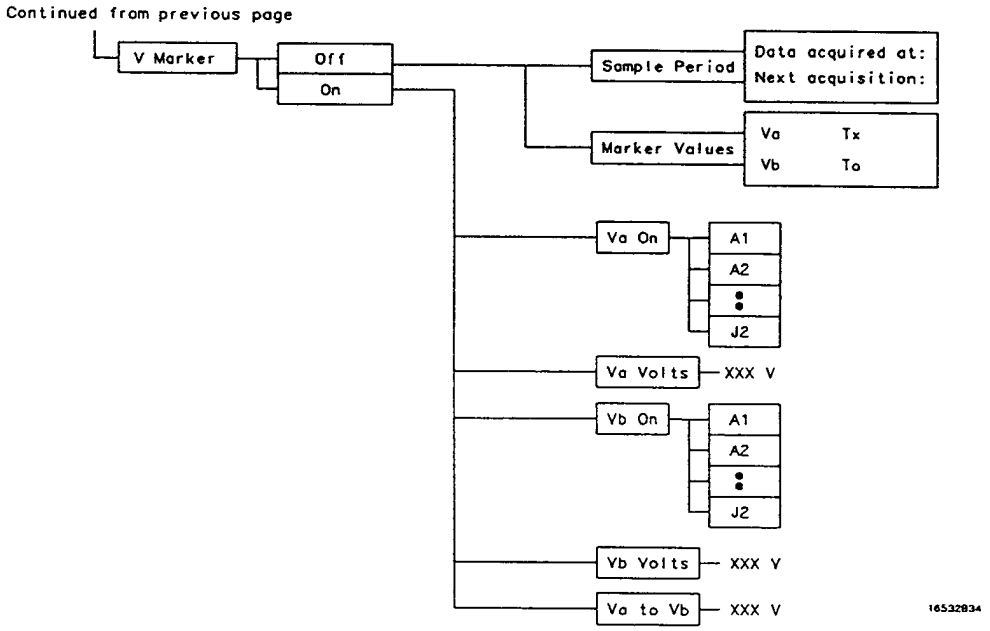
Markers Menu Map

The menu map on the next page illustrates all fields and the available options in the Markers menu. The menu map will help you get an overview as well as provide you with a quick reference of what the Marker menu contains.



Markers Field Menu Map

Marker Menu



Markers Field Menu Map (Continued)

When you touch the T Markers field on the display, a pop-up menu appears. When you touch the On field in the pop-up to turn T Markers On, you can manually move the Tx and To markers to make time measurements.

When you touch the On field in the T Markers menu, three new fields appear to the right of the T Markers field: Tx to To, Trig to X, and Trig to O fields. These fields allow you to position the Tx marker and the To marker by entering time values for these markers. When time markers are turned on and voltage markers are turned off, the channel label field displays voltage values for the Tx and To markers except for waveforms where Overlay mode has been selected in the Waveform Selection menu.

Tx to To Field

The Tx to To field displays the time difference (delta time) between the Tx marker and the To marker. When you select the Tx to To field, turning the knob moves both the Tx and To markers across the display without changing the value in the Tx to To field. However, the values in the Trig to X and Trig to O fields will change to reflect the movement of the Tx and To markers.

You can change the value in the Tx to To field by changing the Trig to X or Trig to O values, or by changing the Tx to To value from the pop-up keypad. The keypad appears when you touch the Tx to To field when the field is light blue.

When you change the time value of Tx to To by using the keypad, the difference between the new value and old value is divided in half. Each half is then either added to or subtracted from the Tx marker while the other half is either added to or subtracted from the To marker, depending on one of four possibilities.

- If the Tx marker is to the left of the To marker and you are increasing the time between markers, subtract one half from the Tx marker value and add the other half to the To marker value.
- If the Tx marker is to the left of the To marker and you are decreasing the time between markers, add one half to the Tx marker value and subtract the other half from the To marker value.
- If the To marker is to the left of the Tx marker and you are increasing the time between markers, subtract one half from the To marker value and add the other half to the Tx marker value.
- If the To marker is to the left of the Tx marker and you are decreasing the time between markers, add one half to the To marker value and subtract the other half from the To marker value.

If, for example:

The Tx marker is to the left of the To marker

The Tx to To marker is originally set to 352 μs

The Trig to X field is originally 8 μs

The Trig to O field is originally 360 μs

Then, using the keypad, decrease the value of Tx to To to 200 μs. The difference between the original value (352) and the new value (200) is 152. Half that value is 76. Adding 76 to the old Trig to X value (76 + 8) = 84. Subtracting 76 from the old Trig to O value (360 - 76) = 284.

Trig to X Field

The Tx marker is shown on the waveform display as a vertical dashed green line. The border around the Trig to X field is also green so that you can correlate the value in that field to the green Tx marker. The time displayed in the Trig to X field is measured from the trigger point to the Tx marker. The trigger point is shown as a vertical dotted red line at the center of the waveform display when Delay equals zero. The trigger point is always time 0.

When you select the Trig to X field, you can change the time value by turning the knob or by entering a time value from the pop-up keypad. The keypad appears when you touch the Trig to X field when the field is light blue.

Resolution for Trig to X time values is 2% of the sweep speed setting. The default value for the Trig to X field is 0 s.

Trig to O Field

The To marker is shown on the waveform display as a vertical dashed yellow line. The border around the Trig to O field is also yellow so that you can correlate the value in that field to the yellow To marker. The time displayed in the Trig to O field is measured from the trigger point to the To marker.

When you select the Trig to O field, you can change the time value by turning the knob or by entering a time value from the pop-up keypad. The keypad appears when you touch the Trig to O field when the field is light blue.

Resolution for Trig to O time values is 2% of the sweep speed setting. The default value for the Trig to O field is 0 s.

Channel Label Field

The channel label field is the dark blue field to the left of the waveform display. When you turn time markers on with voltage markers off, the voltage values where the Tx and To markers intersect each waveform are displayed under each channel label.

When you touch the Trig to X field and turn the knob, the Tx marker (green) will move across the display. As you move the marker, the time value in the Trig to X field changes. A negative time value indicates the marker is placed before the trigger point, and a positive time value indicates the marker is placed after the trigger point.

As you turn the knob when either the Trig to X or Trig to O field is selected, the time value in the Tx to To field also changes, showing the time difference between the Tx and To markers. If the time displayed in the Tx to To field is negative, the To marker is to the left of the Tx marker.

As you move the Tx marker from a low portion on the waveform to a high portion, the x voltage value under the input label in the channel label field also changes.

When you touch the Trig to O field and turn the knob, the To marker (yellow) will move, and the time and voltage values will change just as they did for the Tx marker.

When you touch the Tx to To field and turn the knob, the Tx and To markers will move in unison and maintain the preset Tx to To time value.

You can also change the Tx to To, Trig to X, and Trig to O fields with the pop-up keypad. Refer to the earlier paragraph entitled "Tx to To Field" for a description and results of keypad entries in the Tx to To field.

T Marker Value Display

Any time the markers (either voltage and/or time) are turned on, the current marker settings may be displayed on the channel, trigger, display and auto-measure menus by using the Display Options field located to the right of the time base Delay field. The Display Options field provides a pop-up menu that allows you to either select to set channel labels or to view the Sample Period display or the Marker Value display.

The Marker Value display consists of two blocks. One contains settings for the voltage markers, the second contains settings for the time markers. If only one set of markers is turned on, only one of the two blocks will appear on the screen.

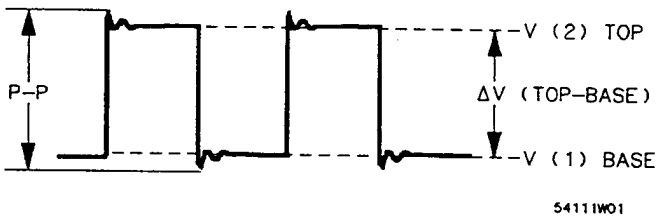
On the Marker menu, if time markers are turned off, the Sample Period display will appear on the marker menu. If time markers are selected as either On or Auto, the Sample Period display is not visible on the Marker menu.

The Display Options field never appears on the Marker menu.

Automatic Time Marker Options

When you touch the T Markers field a pop-up menu appears. When you touch the Auto field in the pop-up, a pop-up menu for automatic time marker measurements is displayed.

The automatic time marker measurements are made by setting the time markers to levels that are either a percentage of the top-to-base voltage value of a waveform or that specify voltage levels. The top-to-base voltage value of a waveform is typically not the same as the peak-to-peak voltage value. The oscilloscope determines the top and base voltages by finding the flattest portions of the top and bottom of the waveform. The top and base values do not typically include preshoot or overshoot of the waveform. The peak-to-peak voltage is the difference between the minimum and maximum voltages found on the waveform.



If the signal is clipped, the time markers will not be automatically placed.

When searching for the marker patterns, the search will occur only on that part of the waveform that is displayed, not the entire stored waveform.

The default Auto markers pop-up menu options are discussed in the following paragraphs.

Done Field

You touch the Done field when you are done entering data in the auto-markers pop-up and want to return to the waveform display.

Set on Field

The Set on field assigns an input waveform to the Tx or To marker, or allows the marker to be set manually (with the MANUAL selection in the pop-up). When you touch the Set on field, a pop-up appears showing all waveform sources available.

What is displayed on the pop-up depends on how many oscilloscope boards are installed in the mainframe and in which slots they are installed.

The default selection for the Set on field is the lowest letter and number combination. For example, if oscilloscope boards are installed in mainframe slots C and D, the Set on field will default to C1 for both the Tx and To markers.

Type Field

The Type field selects the units in which an automatic time marker level will be specified. The automatic time marker can have a level expressed as either a percentage of the waveform top-base voltage (Percent) or as an absolute voltage level (Absolute).

The default selection is Percent.

at Level Field

When the marker Type is Percent, the at Level field sets the Tx or To marker to a percentage level (from 10% to 90%) of the top-base voltage on the waveform selected by the Set on field. When you select the at Level field, you can change the percentage by turning the knob or by entering a value from the pop-up keypad. The keypad appears when you touch the at Level field when the field is light blue. You can enter any percentage from 10% to 90% in increments of 1%.

The default value for the at Level field is 50%.

When the marker Type is Absolute, the at Level field sets the Tx or To marker to the specific voltage level. The allowable voltage range that can be selected is the vertical range for the selected channel (that is: offset ± 2 times v/div)). You can change the voltage level by either turning the knob or by entering a value from the pop-up keypad. The keypad appears when you touch the at Level field when the field is light blue. You can enter any voltage from -12V to 4V in increments of 30mV.

The power up default value for at Level field is the selected channel offset value. If the vertical range parameters (for example: v/div, offset, probe factor) of a channel are changed such that the current at Level voltage is no longer valid, the at Level voltage will track the limit of the vertical range.

Slope Field

The Slope field sets the Tx or To marker on either the positive or negative edge of the selected occurrence of a waveform. When you touch the Slope field, the slope toggles between Positive and Negative.

The default selection for the Slope field is Positive.

Occur Field

The Occur field sets the Tx or To marker on a specific occurrence of a displayed edge on the waveform. You can define the edge to be displayed all the way from the 1st edge up to the 100th edge. The count of edge occurrences is made starting with the first edge displayed on the screen.

Auto-marker measurements are made with data that is displayed on the screen. Make sure the data of interest is fully displayed on the screen.

When the Occur field is selected, you can change the occurrence by turning the knob or by entering a new value from the pop-up keypad. The keypad appears when you touch the Occur field when the field is light blue. Any number from 1 to 100 in increments of 1 can be entered.

The default value for the Occur field is 1.

Statistics Field

The Statistics field allows you to make minimum, maximum, and mean time interval measurements from marker Tx to marker To. When you touch the Statistics field, it toggles between On and Off. The default selection for the Statistics field is On.

On

When Statistics is set to On, Min X-O, Max X-O, and Mean X-O appear together in a tan-colored field to the right of the T Markers field on the marker menu.

When Statistics is set to On, the minimum, maximum, and mean (average) Tx to To marker time interval data is accumulated and displayed until one of the following happens:

- Auto is deselected as the T Marker option.
- Auto-marker parameters are changed.
- Statistics is set to Off.
- Run Repetitive mode is stopped.

Off

When Statistics is set to Off, the Tx to To, Trig to X, and Trig to O fields appear next to the Markers field on the Marker menu.

The marker statistics (minimum, maximum, and mean) are reset to zero only when you touch the Done field on the auto-markers pop-up after making a change to one of the auto-marker placement specification fields (Set On, Type, Level, Slope, or Occur).

Other oscilloscope menu changes do not reset marker statistics, but may have an impact on the values computed for the marker statistics.

Run Until Time X-O Field

This field allows you to set up a stop condition for the time interval between the Tx marker and To marker. When the stop condition is met, the oscilloscope stops making acquisitions and displays the message "Stop condition satisfied." You define the stop conditions with selections you make after you touch the Run Until Time X-O field. The default selection for this field is Off.

The Run Until Time X-O feature is only valid if the Run field is set to Repetitive.

Less Than Field

When you select this field from the pop-up, a time value field appears next to the Run Until Time X-O Less Than field. The time value field default value is 0 s.

When you select the time value field, you can enter the time by turning the knob or by entering a value from the pop-up keypad. The keypad appears when you touch the time value field when the field is light blue. For keypad entries, resolution is 10 ps at times up to ±99.99 ns and can be set to 5-digit resolution for other times up to ±100 megaseconds. Positive times are used when the Tx marker is displayed before the To marker, and negative times are used when the To marker is displayed before the Tx marker.

When you select Less Than, the oscilloscope runs until the Tx-To time interval is less than the value entered for the Less Than time field. When the condition is met, the oscilloscope stops making acquisitions and displays the message "Stop condition satisfied."

Greater Than Field

When you select this field from the pop-up, a time value field appears next to the Run Until Time X-O Greater Than field. The time value field default value is 0 s. When you select the time value field, you can enter the time in the same manner as for the Less Than field.

When you select Greater Than, the oscilloscope runs until the Tx-To time interval is greater than the value entered for the Greater Than time field. When the condition is met, the oscilloscope stops making acquisitions and displays the message "Stop condition satisfied."

In Range Field

When you select this field from the pop-up, two time value fields appear next to the Run Until Time X-O In Range field. You need to enter the time range values for the stop condition in these two time fields. Select each time value field, in turn, and enter the time value in the same manner as for the Less Than field.

When you select In Range, the oscilloscope runs until the Tx-To time interval is in the range of the time values entered for the In Range time fields. When the condition is met, the oscilloscope stops making acquisitions and displays the message "Stop condition satisfied."

Not In Range Field

When you select this field from the pop-up, two time value fields appear next to the Run Until Time X-O Not In Range field. You need to enter the time range values for the stop condition in these two time fields. Select each time value field, in turn, and enter the time values in the same manner as for the Less Than field.

When Not In Range is selected, the oscilloscope runs until the Tx-To time interval is not in the range of the time values entered for the Not In Range time fields. When the condition is met, the oscilloscope stops acquisitions and displays the message "Stop condition satisfied."

Manual/Automatic Time Markers Option

The manual/automatic combination allows you to have one marker set to automatic mode and one marker set to be controlled manually with the knob.

Setting the Manual/Automatic Time Markers Option

To set the manual/automatic option you touch the T Markers field and select the Auto field from the pop-up. You then touch the Set on field for either the Tx or To marker, and then select MANUAL from the pop-up menu.

When you touch Done in the auto-markers pop-up menu, you return to the waveform display. Now when you touch the T Markers field again and select On from the pop-up menu, the marker you selected with the MANUAL field is set to the manual mode and the other marker is set to fall on the parameters you set while in the automatic mode.

For example:

While in Auto markers mode set the conditions to:

Tx>: X1, positive slope, occur 1
To>: MANUAL

Now set the T Marker Mode to On and Run Repetitively. You can now control the To marker with the knob, but the Tx marker is controlled by the setup you made in Auto Markers (that is, it will fall on the leading edge of the first displayed positive pulse).
If you move the Tx marker, it will default to MANUAL mode and will no longer be set automatically.

Voltage Markers Options

When you touch the V Markers field on the display, a pop-up menu appears. When you touch the On field in the pop-up to turn Voltage Markers On, you can manually move the Va and Vb markers to make voltage measurements.

When you touch the On field in the V Markers menu, five new fields appear to the right of the V Markers field: Va On, Va Volts, Vb On, Vb Volts, and Va to Vb fields. These fields allow you to position the Va marker and the Vb marker by entering channel numbers and voltage levels for these markers.

If you turn the voltage markers on while the time markers are also turned on, the voltage levels that correspond to the time marker waveform crossings will be deleted from the channel label field. If you turn the voltage markers off while the time markers are turned on, the voltage levels that correspond to the time marker waveform crossings will appear in the channel label field.

Va On Field

The Va marker is shown on the waveform display as a horizontal dashed green line. The border around the Va On field is also green so you can more easily correlate the value in this field to the green Va marker.

When you select the Va On field, you are able to assign the Va marker to one of the oscilloscope acquisition channels. A pop-up menu appears that lists all possible channels for assignment of the Va marker. The default channel is the lowest numbered channel in the oscilloscope.

The channel selected for assignment to the Va marker does not have to be displayed in the waveform area. If the selected waveform is not in the waveform area of the screen, the Va marker will not be displayed. If there are multiple occurrences of the selected waveform in the waveform area of the screen, only the uppermost occurrence of the waveform will display the Va marker.

Overlay and waveform math traces cannot be selected for voltage marker placement.

Va Volts Field

The Va marker is shown on the waveform display as a horizontal dashed green line. The border around the Va Volts field is also green so you can more easily correlate the value in this field to the green Va marker.

The voltage displayed in the Va Volts field is measured relative to the zero-volt reference for this channel.

When you select the Va Volts field, you can change the voltage value by turning the knob or by entering a voltage value from the pop-up keypad. The keypad appears when you touch the Va Volts field when the field is light blue.

The range of voltage levels for the Va Volts field is ±2 times maximum range for the selected channel. The maximum range value is affected by the probe factor and v/div settings.

Vb On Field

The Vb marker is shown on the waveform display as a horizontal dashed yellow line. The border around the Vb On field is also yellow so you can more easily correlate the value in this field to the yellow Vb marker.

When you select the Vb On field, you are able to assign the Vb marker to one of the oscilloscope acquisition channels. A pop-up menu appears that lists all possible channels for assignment of the Vb marker. The default channel is the lowest numbered channel in the oscilloscope.

The channel selected for assignment to the Vb marker does not have to be displayed in the waveform area. If the selected waveform is not in the waveform area of the screen, the Vb marker will not be displayed. If there are multiple occurrences of the selected waveform in the waveform area of the screen, only the uppermost occurrence of the waveform will display the Vb marker.

Overlay and waveform math traces cannot be selected for voltage marker placement.

Vb Volts Field

The Vb marker is shown on the waveform display as a horizontal dashed yellow line. The border around the Vb Volts field is also yellow so you can more easily correlate the value in this field to the yellow Vb marker.

The voltage displayed in the Vb Volts field is measured relative to the 0v reference for this channel.

When you select the Vb Volts field, you can change the voltage value by turning the knob or by entering a voltage value from the pop-up keypad. The keypad appears when you touch the Vb Volts field when the field is light blue.

The range of voltage levels for the Vb Volts field is ±2 times maximum range for the selected channel. The maximum range value is affected by the probe factor and v/div settings.

Va to Vb Field

This field displays the difference between the Va and Vb markers. This value is dependent on channel selections and represents Vb minus Va.

Center Screen Field

The Center Screen field appears on the right side of the Marker menu. The Center Screen field is used to modify the horizontal (time base) position of the waveform display.

When you select the Center Screen field, a pop-up menu appears that lets you chose a time marker for use as the center point of the display. You also have the option of cancelling the center screen function.

If time markers are turned off, the only marker choice available on the Center screen pop-up will be the trigger marker. If time markers are turned on, the Tx and To markers will also appear in the Center Screen pop-up menu. If the auto time markers are enabled, only the trigger marker appears in the Center Screen pop-up menu.

Selecting one of the possible time markers for centering the waveform data will cause the time base delay value to be changed such that the selected marker is positioned at the center of the screen. All acquisition channels are shifted when the trace data is centered. The time base delay field value will be updated when the centering operation is performed.

V Marker Value Display

Any time the markers (either voltage and/or time) are turned on, the current marker settings may be displayed on the channel, trigger, display and auto-measure menus by using the Display Options field located to the right of the time base Delay field. The Display Options field provides a pop-up menu that allows you to select to set channel labels or to view the Sample Period display or the Marker Value display.

The Marker Value display consists of two blocks. One contains settings for the voltage markers, the second contains settings for the time markers. If only one set of markers is turned on, only one of the two blocks will appear on the screen.

On the marker menu, if time markers are turned off, the Sample Period display will appear on the Marker menu. If time markers are selected as either On or Auto, the Sample Period display is not visible on the Marker menu.

The Display Options field never appears on the Marker menu.

6

The Trigger Menu

The Trigger Menu

When you are set up in a multimodule configuration, only the master card input channels are recognized as the trigger source. The oscilloscope will not trigger on inputs from the other boards in a multimodule setup.

This chapter discusses how triggering works in a single module configuration or in the master card in a multimodule configuration.

You access the trigger options through the Mode field which is located at the leftmost position of the middle row of fields in the Trigger menu. The Mode field allows you to select the method you want to use to trigger the oscilloscope for a particular application. When you touch the Mode field, a pop-up menu appears, showing the three modes that are available:

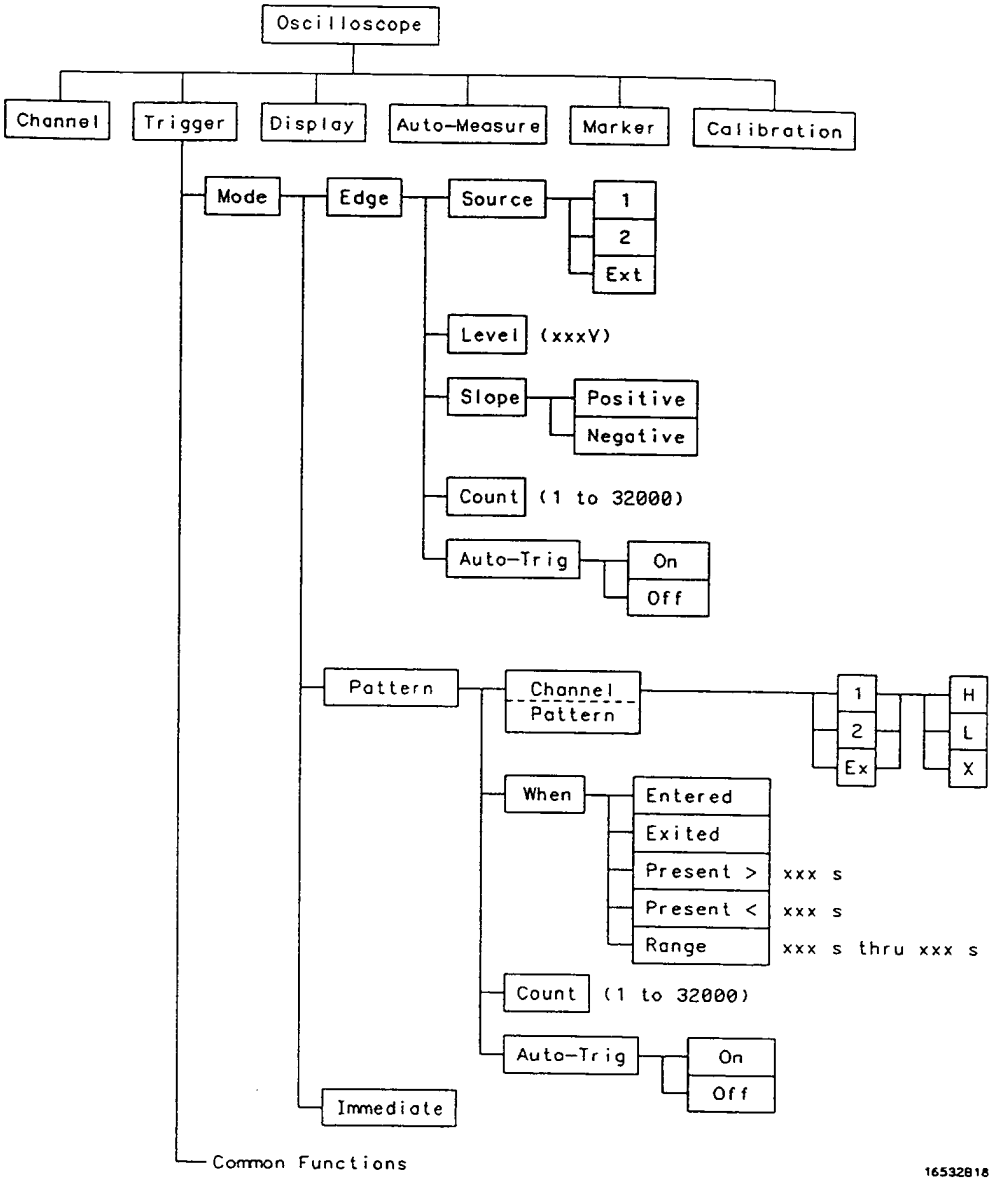
- Edge
- Pattern
- Immediate

This chapter explains what the trigger marker is, how to access the different trigger modes, and what each trigger mode does.

The default selection for the Trigger field is Edge.

Trigger Menu Map

The menu map on the next page illustrates all fields and the available options in the Trigger menu. The menu map will help you get an overview as well as provide you with a quick reference of what the Trigger menu contains.



Trigger Field Menu Map

Trigger Marker

The trigger marker is the dotted vertical red line at the center of the waveform display. The point where the waveform from the trigger source crosses the trigger marker is called the trigger point. The trigger point always represents a delay time of zero seconds.

If you set delay time to greater than ±5 times the sweep speed, the trigger marker will move off the screen.

Edge Trigger Mode

When you are set up in a multimodule configuration, only the master card input channels are recognized as the trigger source. The oscilloscope will not edge trigger on inputs from the other boards in a multimodule setup.

This section discusses how edge triggering works in a single module configuration or in the master card in a multimodule configuration.

Edge triggering is the type of triggering found in all oscilloscopes. In the edge trigger mode, the oscilloscope triggers at a specified voltage level on a rising or falling edge of one of the input channels or the external trigger input. In this mode you can specify which input is the trigger source, set a trigger level voltage (except for Ext, which is set to −1.3 V), and specify which edge to trigger on.

When you touch the Mode field, Edge can be selected from the pop-up menu. Menu selections for the edge trigger mode are discussed in the following paragraphs.

Source Field

When you touch the Source field, a pop-up menu appears showing the inputs available as the trigger source. You can set the trigger source to be any one of the input signals for the oscilloscope module. The source can be input X1, X2, or Ext, where X equals the oscilloscope master card mainframe slot letter and Ext equals an ECL level external trigger.

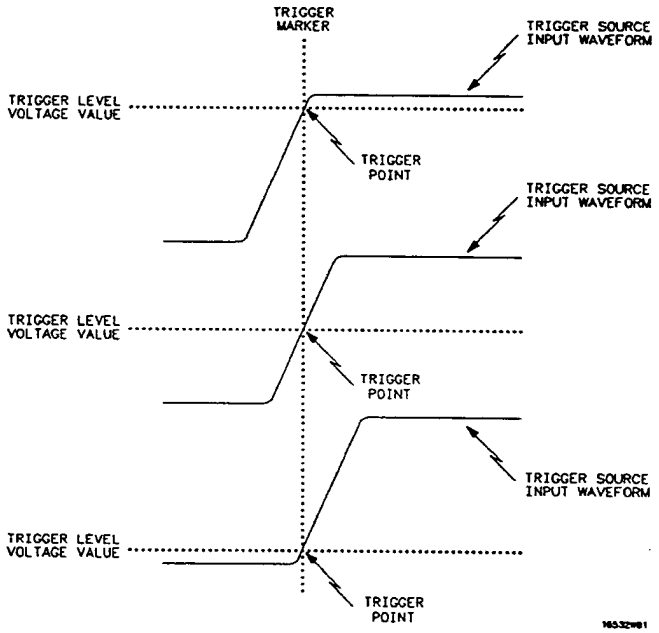
When you have two or more HP 16532A modules connected together, you can only specify the channels on the master HP 16532A module as the trigger source.

At power-up, the default channel input selection for the Source field is the lowest numbered input channel on the selected module. For example, if the oscilloscope module you selected is installed in mainframe slot A and inputs are connected to both channels 1 and 2, the Source field defaults to A1. However, if an input signal is only connected to channel 2, the Source field defaults to A2 when you automatically scale with Autoscale, even though channel 1 is the default at power-up.

Level Field

The Level field shows the trigger level voltage value. When the voltage value on the trigger source input waveform equals the trigger level voltage value, the oscilloscope triggers. The point at which the oscilloscope triggers is called the trigger point (see the illustration below). The trigger point is shown on the screen as a vertical dotted red line, called the trigger marker. At zero delay time, the trigger marker is located at the horizontal center of the screen. At delay time T_d, the trigger point is offset left (positive delay) or right (negative delay) from the horizontal center of the screen by time T_d.

When you change the trigger level voltage value, the waveform moves horizontally on the display to maintain the trigger point. (That is, the point where the waveform voltage value equals the trigger point voltage value.) This is illustrated below.



If the trigger point voltage level is set above or below the waveform amplitude, the trigger point cannot be found. If Auto-Trig is set to On, this causes the waveform display to become unsynchronized and to "float" on the display. If Auto-Trig is set to Off, the message "Waiting for trigger" is displayed.

The trigger point voltage can be set, either by the autoscale function, or by a voltage value set into the Level field. When you touch the Level field and turn it light blue, you can change the value of the trigger level voltage by turning the knob.

The trigger level can be set to any voltage value contained within the waveform display window, in increments of 0.05% of full scale vertical voltage range (V/Div X 4 divisions = full scale). For example, if full scale voltage range were 400 mV, trigger level would be set in increments of 2 mV (V/Div = 100 mV x 4 x 0.005 = 2 mV).

Trigger level values can also be entered with the pop-up keypad. The keypad appears when you select the Level field when the field is white (already selected once). You can enter any value, in 0.05% increments of full scale vertical voltage range. Values entered that are not in this range will be rounded to the nearest 0.05% increment.

Since the trigger level range is limited by the voltage values displayed in the waveform window, the voltage window limits can be easily determined. Turn the knob in both directions until the Level field reads minimum and maximum voltage. These voltage values are the limits of the waveform window. However, if the level is set at the edge of a window and offset for that channel is changed, the trigger level will track that change, thereby changing the window limits.

If the trigger source channel (except EXT) is displayed in the waveform area of the screen, the trigger level marker will appear on the screen as a horizontal dashed red line. The trigger level marker will move up and down on the screen as the trigger level voltage is changed.

If the trigger source channel is not in the waveform area of the screen, the trigger level marker will not be displayed.

If there are multiple occurrences of the trigger source waveform in the waveform area of the screen, only the uppermost occurrence of the trigger source waveform will display the trigger source marker.

The trigger level marker will only appear when the trigger menu is selected.

The default value for the Level field is 1.620 V (TTL preset value).

Slope Field

You can set the trigger slope to trigger on either the positive or negative edge of the trigger source waveform. When you touch the Slope field, the field toggles between Positive and Negative.

The default selection for the Slope field is Positive.

Count Field

In edge trigger mode, you can define a positive or negative edge and the trigger level as a trigger qualifier. When the oscilloscope detects the trigger qualifier, it will trigger at a user-specified number of edges (Count field) on the waveform.

The Count field defines the number of trigger events that must occur after the first trigger qualifier before the oscilloscope will trigger and acquire a waveform.

Count can be set to any integer from 1 to 32,000. When the Count field is selected, the trigger events count can be changed by turning the knob or by entering a value from the pop-up keypad.

This type of triggering is commonly referred to as "events triggering" or "delay-by-events triggering". It is very useful when trying to trigger on a specific pulse in a burst of pulses, with a long time delay, before the next burst occurs.

The default value for the Count field is 1.

Auto-Trig Field

The Auto-Trig field allows you to specify whether or not the acquisitions should wait for the specified trigger condition to occur. When you touch the Auto-Trig field, the field toggles between On and Off. The On and Off fields are discussed below.

The default selection for the Auto-Trig field is On.

On

When you set auto-trigger to On, the oscilloscope waits 50 ms (20-Hz rate) for a trigger to occur. If a trigger does not occur within that time, the current contents of acquisition memory are displayed. The message "Auto triggered" is displayed if one of the following conditions occurs:

- No signal is on the input. In this case, the oscilloscope will display a baseline.
- There is a signal but the specified trigger condition has not been met within 50 ms. In this case, the waveform display will not be synchronized to a trigger point.

Off

When you set auto-trigger to Off, the oscilloscope waits until a trigger is received before the waveform display is updated. If a trigger does not occur, the screen is not updated and the message "Waiting for Trigger" is displayed. Use this mode when:

- The trigger source signal has less than a 20-Hz repetition rate.
- The trigger events counter (refer to Count field, below) is set so that the number of trigger events would not occur before 50 ms.
- When you want to trigger on a specific event only.

When you are set up in a multimodule configuration, only the master card input channels are recognized as the trigger source. The oscilloscope will not pattern trigger on inputs from the other boards in a multimodule setup.

This chapter discusses how pattern triggering works in a single module configuration or in the master card in a multimodule configuration.

Pattern trigger mode allows you to trigger the oscilloscope upon entering or exiting a specified pattern of the trigger channels and the external trigger input or by specifying a pattern duration or range.

When you have two or more HP 16532A modules connected together, you can only specify the channels on the master HP 16532A module as the trigger source.

When you touch the Mode field, Pattern can be selected from the pop-up menu.

Channel/Pattern Field

The Channel/Pattern field is located next to the Mode field. It allows you to enter a pattern for the combination of the input channels and the ECL external trigger.

Channel

The Channel row lists the inputs available on the oscilloscope module being used. Channels are numbered 1, 2, and Ex. Ex is for the ECL external trigger.

Pattern

Each entry in the pattern shown in the Pattern row shows the trigger condition of the input above it in the Channel row.

You must set the trigger level for each input you want to use in the pattern. You set the trigger levels using the knob or keypad to set the value in the Level field in the Edge trigger mode. Setting these levels sets the threshold of each input for high and low levels in the pattern. The trigger level marker does not appear when Pattern mode triggering is selected.

The pattern for each input may be specified as high (H), low (L), or "don't care" (X). H, L, and X conditions are as follows:

- H—the voltage value of this input channel must be greater than the edge trigger level of this input.
- L—the voltage level of this input channel must be less than the edge trigger level of this input.
- X—is a "don't care" condition. The "don't care" means the associated input channel will not be used in the pattern for the trigger qualifier. It does not equate to "trigger on anything."

The default condition for all patterns is X "don't care." To change the pattern, touch the Channel/Pattern field. A pop-up keypad will appear which allows you to assign the pattern conditions.

To enter a pattern, touch either X, L, or H on the pop-up keypad. The entries you make appear at the top of the pop-up keypad as they are entered. If you make a mistake, turn the knob to move the highlight to the entry to be corrected and select the correct entry, or touch CLEAR to change all entries back to X and enter the correct values. If the pattern is correct, touch DONE.

A pattern of XXX says to use NO channels to find the trigger. It does not equate to Immediate Mode when Auto-Trig is set to Off. This event will never occur in the hardware. Do not confuse XXX with "don't care, trigger on anything."

When Field

When you touch this field, a pop-up menu appears that lets you specify the trigger When condition.

Pattern Trigger When Condition Pop-up Menu

The Pattern When pop-up menu is used to specify the trigger when condition for pattern triggering. Once a selection has been made, you touch the Done field to exit the pop-up menu and return to the trigger menu. The trigger condition selected will now appear in the When field.

The default selection for the When field is When Entered.

When Entered When this field is active, the oscilloscope triggers on the first transition that makes the pattern specification true for every input used in the pattern trigger specification. If the count set in the Count field is more than 1, the pattern must be true for the number of times set in the count field.

When Exited When this field is active, the oscilloscope triggers on the first transition that causes the pattern specification to be false for every input used in the pattern trigger specification. If the count set in the Count field is more than 1, the pattern must be true for the number of times set in the count field before turning false.

Present > When this field is active, the scope triggers on the first transition that causes the pattern specification to be false for every input used in the pattern trigger specification if the specified pattern has been true for the time duration specified. If the pattern specification becomes false before the specified duration time has elapsed, the search for a trigger condition starts again. If the pattern specification remains true longer than the specified duration time, the trigger point will be the point at which the pattern specification becomes false.

The pattern duration time can be any value between 20ns and 160ms in 10ns steps.

If the count set in the Count field is one, the trigger event will be the first pattern event that meets both the pattern specification and the duration specification. If the count is greater than one, only the first pattern event must meet the duration specification. Once the pattern duration specification has been met, subsequent pattern events that meet the pattern specification can be of any duration and each such pattern event will contribute to meeting the count specification. For instance: with a pattern specification of HXX, a duration specification of >100ns, and a count of 3; a pulse string with pulse widths 80ns, 150ns, 50ns, 75ns, 20ns, 200ns would trigger on the trailing edge of the 75ns pulse. In this example, the 150ns pulse meets the duration specification and is count 1, the 50ns pulse is count 2, and the 75ns pulse is count 3.

Present < When this field is active, the scope triggers on the first transition that causes the pattern specification to be false for every input used in the pattern trigger specification if the specified pattern has been true for less than the time duration specified. If the pattern specification remains true after the specified duration time has elapsed, the search for a trigger condition starts again the next time the pattern specification becomes true. If the pattern specification becomes false before the specified duration time, the trigger point will be the point at which the pattern specification becomes false.

The pattern duration time can be any value between 20ns and 160ms in 10ns steps.

If the count set in the Count field is one, the trigger event will be the first pattern event that meets both the pattern specification and the duration specification. If the count is greater than one, only the first pattern event must meet the duration specification. Once the pattern duration specification has been met, subsequent pattern events that meet the pattern specification can be of any duration and each such pattern event will contribute to meeting the count specification. For instance: with a pattern specification of HXX, a duration specification of <100ns, and a count of 3; a pulse string with pulse widths 200ns, 80ns, 150ns, 50ns, 75ns, 20ns would trigger on the trailing edge of the 50ns pulse. In this example, the 80ns pulse meets the duration specification and is count 1, the 150ns pulse is count 2, and the 50ns pulse is count 3.

Range When this field is active, the scope triggers on the first transition that causes the pattern specification to be false for every input used in the pattern trigger specification if the specified pattern has been true for greater than the first time value and less than the second time value that make up the pattern duration range.

If the pattern specification remains true for longer than the maximum duration range limit or becomes false before the minimum duration range limit, the search for a trigger condition starts again the next time the pattern specification becomes true. If the pattern specification becomes false within the specified duration time range, the trigger point will be the point at which the pattern specification becomes false.

The minimum pattern duration time can be any value between 20ns and 160ms in 10ns steps. The maximum pattern duration time must be at least 10ns greater than the minimum time value.

If the count set in the Count field is one, the trigger event will be the first pattern event that meets both the pattern specification and the duration specification. If the count is greater than one, only the first pattern event must meet the duration specification. Once the pattern duration specification has been met, subsequent pattern events that meet the pattern specification can be of any duration and each such pattern event will contribute to meeting the count specification. For instance: with a pattern specification of HXX, a duration specification of >60ns & <100ns, and a count of 3; a pulse string with pulse widths 200ns, 80ns, 150ns, 50ns, 75ns, 20ns would trigger on the trailing edge of the 50ns pulse. In this example, the 80ns pulse meets the duration specification and is count 1, the 150ns pulse is count 2, and the 50ns pulse is count 3.

Count Field

In pattern trigger mode, you can define a pattern as a trigger qualifier. When the oscilloscope detects the trigger qualifier, it will trigger when a user-specified number of patterns have occurred (Count field) on all inputs.

The Count field defines the number of events that must occur after the first trigger qualifier before the oscilloscope will trigger and acquire a waveform.

Count can be set to any integer from 1 to 32,000. When the Count field is selected, the events count can be changed by turning the knob or by entering a value from the pop-up keypad.

The default value for the Count field is 1.

Auto-Trig Field

The Auto-Trig field allows you to specify whether or not the acquisitions should wait for the specified pattern condition to occur. When you touch the Auto-Trig field, the field toggles between On and Off.

On

When you set auto-trigger to On, the oscilloscope waits for 50 ms (20 Hz rate) for a trigger to occur. If a trigger does not occur within that time, the current contents of acquisition memory are displayed. The message "Auto triggered" is displayed if one of the following conditions occurs:

- If no signal is on the input. In this case, the oscilloscope will display a baseline.
- If there is a signal but the specified pattern condition is not met within 50 ms. In this case, the waveform display is not synchronized to a trigger point.

Off

When you set auto-trigger to Off, the oscilloscope waits until a trigger is received before the waveform display is updated. If a trigger does not occur, the screen is not updated and the message "Waiting for Trigger" is displayed. Use this mode when:

- The trigger source signal has less than a 20-Hz repetition rate.
- The trigger events counter (refer to Count field, below) is set so that the number of trigger pattern events would not occur before 50 ms.
- When you want to trigger on a specific event only.
- When using pattern duration triggering and the events that meet the duration specification occur infrequently.

The default selection for the Auto-Trig field is On.

Immediate Trigger Mode

When you are set up in a multimodule configuration, only the master card input channels are recognized as the trigger source. The oscilloscope will not trigger on inputs from the other boards in a multimodule setup.

This section discusses how immediate triggering works in a single module configuration or in the master card in a multimodule configuration.

Immediate trigger mode causes the oscilloscope to trigger by itself. When you touch the Mode field, Immediate can be selected from the pop-up menu.

Immediate trigger mode can be used for dual timebase (intermodule) applications where, for instance, one oscilloscope module arms another oscilloscope module, or another module (such as a logic analyzer) arms the oscilloscope.

This mode is very similar to Auto-Trig On, but immediate mode does not wait for a specified event to occur.

If you set the oscilloscope module to Group Run in the Intermodule module menu, the oscilloscope waits until it is armed by the input port or by another module before it begins to search for its own trigger condition. By using the Group Run option you can time-correlate the measurements from various modules (for example, the oscilloscope and a timing analyzer) and display data from several modules on one display.

If you set the oscilloscope module to Independent in the Intermodule Menu, the oscilloscope will be in the free-run mode and the waveform display will not be synchronized with the other measurement modules in your system.

Pattern duration trigger cannot be used when the oscilloscope is armed by another module or by BNC PORT IN as set up on the IMB menu.

More information about intermodule applications can be found in the *HP 16500B/16501A Logic Analysis System User's Reference.*

The Display Menu

The Display Menu

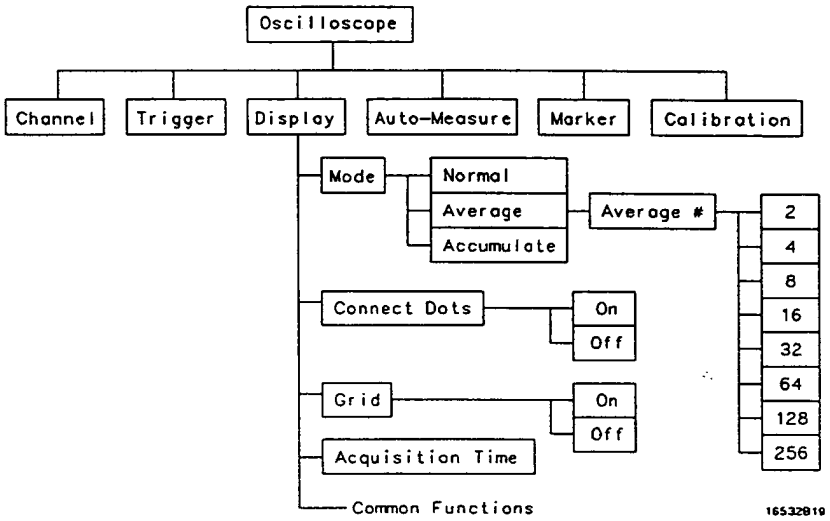
The Display options control how the oscilloscope acquires and displays waveforms. You can cause the oscilloscope to acquire and display the waveforms in one of the following modes:

- Normal
- Average
- Accumulate

The Display options also control the connect-the-dots display and grid display features.

Display Menu Map

The menu map on the next page illustrates all fields and the available options in the Display menu. The menu map will help you get an overview as well as provide you with a quick reference of what the Display menu contains.



Display Field Menu Map

Mode Field

The Mode field determines how waveform information is acquired and displayed. When you touch the Mode field, a pop-up menu appears. You can select Normal, Average, or Accumulate from the pop-up. The default selection for the Mode field is Normal.

Normal Mode

In Normal mode, the oscilloscope acquires waveform data and displays the waveform acquired from that data. When the oscilloscope makes a new acquisition, it erases the previously acquired waveform from the display, and displays the newly acquired waveform. This is an on-going process for as long as the oscilloscope is running repetitively, or whenever you make a single mode run. That is; acquire data, erase display, display new data, acquire data, erase display, display new data, etc.

Average Mode

In Average mode, the oscilloscope averages the most recently acquired data points on a waveform with previously acquired data. Averaging helps eliminate random noise from your displayed waveforms.

When you select Average mode, a new field appears next to the Mode field which allows you to select the number of waveform acquisitions to average. When you touch the Average # field, the field will turn a light-blue color. When the field is light blue, you can change the number in the field by turning the knob. The number of averages can be set to 2, 4, 8, 16, 32, 64, 128, or 256. The default value for the Average # field is 8.

You can also change the value in the Average # field with the pop-up keypad. The keypad appears when you touch the Average # field when that field is light blue. The numbers you can enter are the same as with the knob (any power of two from 2 to 256). Any value entered from the keypad that is not a power of two will be rounded to the nearest power of two (from the choices available).

As an example of average mode usage, assume the Average # field is set to 16 and the Run mode is set to Repetitive. When you touch the Run field, the oscilloscope starts acquiring waveform data and averaging it. After the initial 16 waveforms are acquired, the oscilloscope momentarily displays the advisory message "Number of averages has been met." Once the initial 16 waveforms are acquired, all new data is weighed at 1/N and is averaged with the previous data. All data is retained.

If you set the Run mode to Single, acquisitions are not made until you touch the Run field. If Average # is set to 16, as in the previous example, the "Number of averages has been met" message will not be displayed until you have touched the Run field 16 times.

If you bring a waveform that is being averaged in the oscilloscope into the waveform display of another time correlated module, such as another oscilloscope or a timing analyzer, the waveform will not continue to average. Only the most recent acquisition, not the average trace data, will appear on the screen. To view an averaged mode trace with other time correlated waveforms, bring those other waveforms into the display of the oscilloscope that is setup for average mode (only oscilloscope signals acquired by that oscilloscope will be averaged on the display).

Accumulate Mode

In Accumulate mode, the oscilloscope accumulates all waveform acquisitions and displays them on the screen without erasing the previously acquired waveforms. This is similar to infinite persistence on an analog storage oscilloscope. These acquisitions will stay on the display until Mode is changed, or until the waveform is adjusted by a control that causes the display to change, such as s/Div, Delay, or Connect Dots from On to Off.

When in Accumulate mode, the operation of the display grid follows special rules when turned on or off (refer to the Grid Field paragraph later in this chapter).

Connect Dots Field

The oscilloscope display can optionally be enhanced to show a better picture of a waveform. This is done by using the Connect Dots On or Connect Dots Off feature of the display. The default setting for the Connect Dots field is Off.

If an edge is fast enough (relative to the sample rate), the signal may begin to look like dots scattered around the display. This is because each sample is displayed as a single dot.

To give you a better idea of what the waveform looks like, the oscilloscope has a feature that connects the sample dots together. Touching the Connect Dots field will toggle the field between On and Off.

On

With Connect Dots On, each displayed sample is connected to the adjacent sample. The waveform displayed with Connect Dots set to On is better defined and easier to see.

Off

With Connect Dots Off, each sample is displayed separately; that is, it is not connected to the adjacent sample. The waveform displayed with Connect Dots set to Off is the default mode of operation.

Grid Field

The oscilloscope display can optionally be divided into horizontal and vertical grids by using the Grid On or Grid Off feature of the display. Touching the Grid field will toggle the field between On and Off. The default setting for the Grid field is Off.

On

Touching the Grid field when it reads Off will toggle the field to On, and will cause the screen to display a horizontal and vertical grid pattern.

In either Normal or Average modes, the grid can be turned On when the oscilloscope is not currently running and the grid will appear on screen immediately. If the oscilloscope is currently acquiring data, the grid will be drawn when the acquisition is completed. In Accumulate mode, the grid can be turned on at any time, but it will not be drawn until the next acquisition is completed or some change is made to the display screen that would cause the display to be erased and redrawn (that is: s/div, etc).

Off

Touching the Grid field when it reads On will toggle the field to Off, and will remove the grid pattern from the screen.

In either Normal or Average modes, the grid can be turned Off when the oscilloscope is not currently running and the grid will be erased from the screen immediately. If the scope is currently acquiring data, the grid will be erased when the current acquisition is completed. In Accumulate mode, the grid can be turned off at any time, but it will not be erased from the screen until some change is made to the display screen that would cause the display to be erased and redrawn (that is: s/div, etc).

Acquisition Time Field

The Acquisition Time field time stamps each data acquisition. It is controlled by the real time system clock which is set up in the System Utility Menu. The real time clock cannot be modified from the Display menu. Refer to the *HP 16500B User's Reference Manual* for details for setting the real time clock.

The Acquisition Time field will be blank at system power-up. It will show the date and time of any acquisition when you touch the Run field and make the first data acquisition. The Acquisition Time field is displayed to the right of the Grid field once data has been acquired.

Display Options Field

The Display Options field allows you to display either sample period information or marker value information on the oscilloscope menus. It is also the means by which you access the scope channel labeling menu.

The Display Options field appears on the Channel, Trigger, Display and Auto-Measure menus. The number of selections that appear when you touch the Display Options field will vary depending on whether or not any of the markers are enabled. If no markers are enabled, the oscilloscope menus will always display sample period information and touching the Display Options field will yield a single possible selection, Set Channel Labels. If either voltage or time markers are enabled, touching the Display Options field will reveal three possible selections, Set Channel Labels, Display Sample Period, and Display Marker Values.

Set Channel Labels

Selecting Set Channel Labels from the Display Options pop-up will take you to the Scope Channel Labels menu. This menu allows you to assign labels to each of the oscilloscope channels. These labels will subsequently appear in the channel label area to the left of the waveform display area. The oscilloscope channel labels appear on single trace waveforms only. The default scope labels are used for overlay and waveform math displays. Channel selections on the channel, trigger, marker, and auto-measure menus always appear as the default oscilloscope channel labels.

To specify a Scope Channel Label, touch the field corresponding to the oscilloscope input you wish to label. The default Scope Channel Labels are the cardslot and input number you see elsewhere on the oscilloscope menus. When you touch one of the channel label fields, an alpha-numeric keypad will appear on screen. If you need to change a character in the Scope Channel Label, you can use the knob to move the cursor to the desired position. Scope Channel Labels are limited to five characters in length. The Clear field will erase the entire label. When you are finished specifying the label, touch Done to exit the keypad.

When all channels have been labeled, touch the Done field to return to the oscilloscope menu. Any oscilloscope channels you don't label will retain their default label (cardslot and input number). To erase all scope channel labels for the oscilloscope, and return to the default oscilloscope channel labels, simply touch the Default field on the Scope Channel Labels menu.

Display Sample Period

Selecting the Display Sample Period option will cause the sample period information (see Sample Period Display in the Time Base Functions chapter) to be displayed on the scope menus. Sample period information is the default display option and is always displayed when markers are turned off.

Display Marker Values

Selecting the Display Marker Values option will cause the marker value information (see Marker Value Display in the Marker Options chapter) to be displayed on the oscilloscope menus. Marker values can only be selected when at least one of the markers have been enabled.

The Auto-Measure Menu

The Auto-Measure Menu

One of the primary features of the oscilloscope is its ability to make parametric measurements on displayed waveforms. This chapter provides details on how automatic measurements are performed and gives some tips on how to improve automatic measurement results.

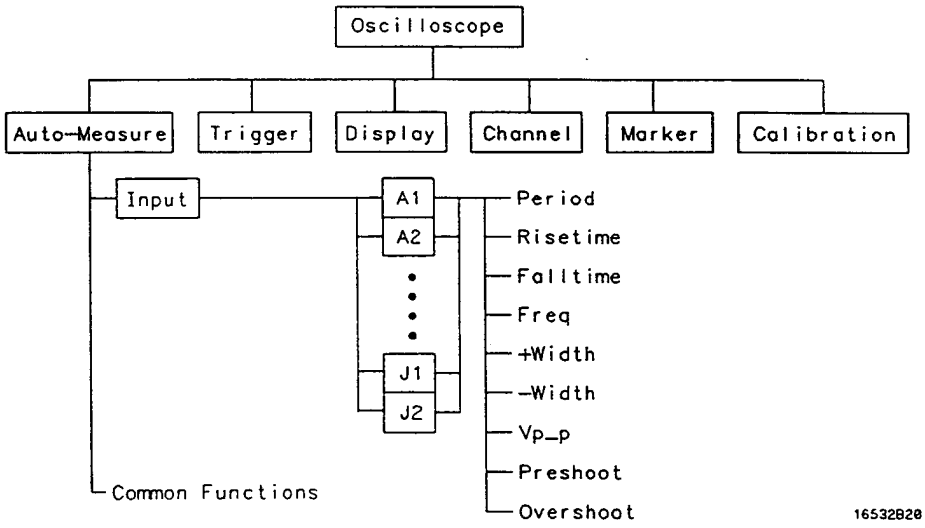
You access the Auto-Measure menu by touching the menu field (top row, second from the left), then by selecting Auto-Measure from the pop-up menu that appears.

There are nine automatic measurements available in the automatic measurement menu:

Period
Risetime
Falltime
Frequency
+Width
−Width
Vp_p
Preshoot
Overshoot

Auto-Measure Menu Map

The menu map on the next page illustrates all fields and the available options in the Auto-Measure menu. The menu map will help you get an overview as well as provide you with a quick reference of what the Auto-Measure menu contains.



Auto-Measure Menu Map

Automatic-Measurement Fields

There are two Automatic-Measurement fields. They are the Input field and the actual automatic measurement display. These fields are discussed in the following paragraphs.

Input Field

The Input field allows you to select the source of the waveform to be measured. When you touch this field, a pop-up menu appears which shows the input sources. Make sure the proper source is selected for the input you are using.

The options displayed in the Input pop-up is dependent upon how many 1 GSa/s oscilloscope modules are installed in the mainframe and in which slots they are installed.

The default selection for the Input field is the lowest lettered and numbered input channel of the module you select to use to make a measurement. For example, if oscilloscope modules are installed in mainframe slots A, C, and E, the Input field defaults to A1 when you select the module in slot A as the module you will use. Similarly, if you select the module in slot E, the Input field defaults to E1.

Automatic Measurements Display

The tan-colored field in the middle row of the menu is called the automatic measurements display. This display shows the nine automatic measurements that you can make. The measurements that this display shows are:

Period,	+Width,
Risetime,	−Width,
Falltime,	Vp_p,
Freq,	Preshoot, and
	Overshoot

See Also "Automatic Measurement Algorithms" at the end of this chapter for an explanation of each of these fields.

Automatic Measurement Prerequisites

This section gives you some helpful pointers to help you make automatic measurements easier.

Measurement Setup Requirements

Measurements typically should be made at the fastest possible sweep speed in order to obtain the most accurate measurement possible. You can only make automatic measurements with data that is currently being displayed in the waveform display area. Keep the following in mind when making measurements:

- At least one full cycle of the waveform, with at least two like edges, must be displayed for Period and Freq measurements.
- A complete positive pulse must be displayed to make a +Width measurement.
- A complete negative pulse must be displayed to make a −Width measurement.
- The leading (rising) edge of the waveform must be displayed for Risetime, and rising edge Preshoot and Overshoot measurements.
- The trailing (falling) edge of the waveform must be displayed for Falltime, and falling edge Preshoot and Overshoot measurements.
- Risetime, Falltime, Preshoot, and Overshoot measurements will be more accurate if you expand the edge of the waveform by selecting a faster sweep speed.
- If the signal is clipped, the automatic measurements cannot be made.

Criteria Used for Making Automatic 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. 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% voltage, 90% voltage, and 50% voltage) required to make the measurements. The 10% and 90% voltage values are used in the rise time and fall time measurements. The 50% voltage value is used for measuring frequency, period, and pulse width.

This section explains top and base voltages, then defines the measurement algorithms.

Top and Base Voltages

All measurements except Vp_p are calculated using the V_{top} (100% voltage) and V_{base} (0% voltage) levels of the displayed waveform. The V_{top} and V_{base} levels are determined from an occurrence density histogram of the data points displayed on the screen.

The digitizing oscilloscope displays 8-bit vertical voltage resolution. That is, the vertical axis of the display is divided into 2^8 voltage levels. Each of these 256 levels is called a quantization level. Each waveform has 500 data points displayed on the horizontal axis of the screen. Each of these 500 data points has one quantization level assigned to it. The histogram is calculated by adding the number of occurrences of each quantization level of the 500 displayed points on the displayed waveform.

The quantization level with the greatest number of occurrences in the top half of the waveform corresponds to the V_{top} level. The quantization level with the greatest number of occurrences in the bottom half of the waveform corresponds to the V_{base} level.

If V_{top} and V_{base} do not contain at least 5% of the 500 data points displayed on screen, V_{top} defaults to the maximum voltage ($V_{maximum}$) and V_{base} defaults to the minimum voltage ($V_{minimum}$) found on the display. An example of this case would be measurements made on sine or triangle waves.

From this information, the instrument can determine the 10%, 50%, and 90% points, which are used in most automatic measurements. The V_{top} or V_{base} of the waveform is not necessarily the maximum or minimum voltage present on the waveform. If a pulse has a slight amount of overshoot, it would be wrong to select the highest peak of the waveform as the top because the waveform proper rests below the perturbation.

Measurement Algorithms

Frequency (Freq)

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

If the first edge on the display is rising, then

$$\textbf{Freq} = \frac{1}{t_{\textit{rising edge 2}} - t_{\textit{rising edge 1}}}.$$

If the first edge on the display is falling, then

$$\textbf{Freq} = \frac{1}{t_{\textit{falling edge 2}} - t_{\textit{falling edge 1}}}.$$

Period

The period is measured at the 50% voltage level of the waveform.

If the first edge on the display is rising, then

$$\textbf{Period} = t_{\textit{rising edge 2}} - t_{\textit{rising edge 1}}.$$

If the first edge on the display is falling, then

$$\textbf{Period} = t_{\textit{falling edge 2}} - t_{\textit{falling edge 1}}.$$

Peak-to-Peak Voltage (Vp_p)

The maximum and minimum voltages for the selected source are measured:

$$\textbf{Vp\_p} = V_{\textit{maximum}} - V_{\textit{minimum}},$$

where $V_{maximum}$ and $V_{minimum}$ are the maximum and minimum voltages present on the selected source.

Positive Pulse Width (+Width)

Pulse width is measured at the 50% voltage level.

If the first edge on the display is rising, then

+Width = $t_{falling\ edge\ 1} - t_{rising\ edge\ 1}$.

If the first edge on the display is falling, then

+Width = $t_{falling\ edge\ 2} - t_{rising\ edge\ 1}$.

Negative Pulse Width (−Width)

Negative pulse width is the width of the first negative pulse on screen using the 50% levels.

If the first edge on the display is rising, then

−Width = $t_{rising\ edge\ 2} - t_{falling\ edge\ 1}$.

If the first edge on the display is falling, then

−Width = $t_{rising\ edge\ 1} - t_{falling\ edge\ 1}$.

Rise time

The rise time of the first displayed rising edge is measured. To obtain the best possible measurement accuracy, set the sweep speed as fast as possible while leaving the full leading edge of the waveform on the display. The rise time is determined by measuring time at the 10% and 90% voltage points on the rising edge:

Rise time = $t_{90\%} - t_{10\%}$.

Fall time

Fall time is measured between the 10% and 90% points of the falling edge. To obtain the best possible measurement accuracy, set the sweep speed as fast as possible while leaving the falling edge of the waveform on the display:

Fall time = $t_{10\%} - t_{90\%}$.

Preshoot and Overshoot

Preshoot and Overshoot measure the perturbation on a waveform above or below the top and base voltages (see the "Top and Base Voltages" section earlier in this chapter). These measurements use all data displayed on the screen; therefore, it is very important that only the data of interest be displayed. If you want to measure preshoot and overshoot on one edge of a waveform, then only display that edge. If you want to measure the maximum preshoot and overshoot on a waveform, then display several cycles of the waveform.

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

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

If the measured edge is rising, then

$$\textbf{Preshoot} = [\frac{V_{base} - V_{minimum}}{V_{top} - V_{base}}] \times 100$$

and,

$$\textbf{Overshoot} = [\frac{V_{maximum} - V_{top}}{V_{top} - V_{base}}] \times 100.$$

If the measured edge is falling, then

$$\textbf{Preshoot} = [\frac{V_{maximum} - V_{top}}{V_{top} - V_{base}}] \times 100$$

and,

$$\textbf{Overshoot} = [\frac{V_{base} - V_{minimum}}{V_{top} - V_{base}}] \times 100.$$

9

The Waveform Selection Menu

The Waveform Selection Menu

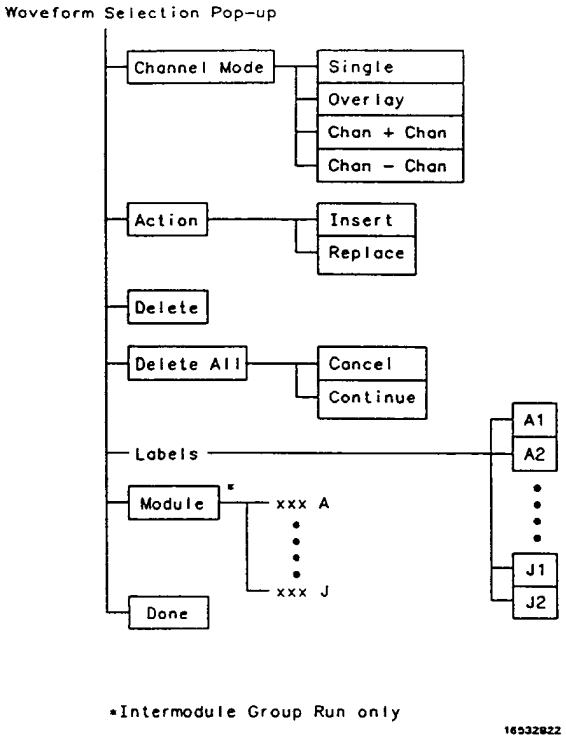
This chapter shows you how to insert, replace, and delete input channels on the waveform display, and how to perform waveform math and overlay functions. Any of these operations can be performed from any of the oscilloscope menus except calibration.

The dark-blue channel label field to the left of the waveform display area shows the input channels that are being displayed. To access the Waveform Selection pop-up menu, you touch the channel label field twice (once to turn it light-blue then once more to access the menu). The menu lets you insert, delete, or replace an input channel, and choose channel modes. It also lets you select to view a waveform from another module when you are making intermodule measurements.

The oscilloscope module has the capability to display 96 waveforms—eight at any one time. When you have made more than eight waveforms accessible for display, some of them will not be in the waveform display area. To display them you touch the dark-blue channel label field once to turn it light-blue then use the knob to scroll through all of the waveforms and select the ones you want displayed.

Waveform Selection Menu Map

The menu map on the next page illustrates all fields and the available options in the Waveform Selection menu. The menu map will help you get an overview as well as provide you with a quick reference of what the Waveform Selection menu contains.



Waveform Selection Menu Map

Module Field

The Module field in the waveform selection menu lets you select to view waveforms from more than one module when you are making intermodule measurements.

Selecting a Module in the Module Field

If you are running your modules in the mainframe independently, and you touch the Module field, the name of the module you are currently running will be displayed as the only option in the pop-up menu. When you touch that field, the message "Data correlatable only for modules under group run" is displayed. This will remind you that this field is only used in intermodule measurements.

If you are running intermodule measurements between modules in the mainframe, and you touch the Module field, the name of the modules you are running as part of the intermodule measurement will be displayed as options in the pop-up menu. The input labels for the module that you select from the pop-up menu will appear in the Labels field. Using the Action options (Replace and Insert) and the Delete option, you can select the input, or inputs, you wish to view, and where you wish to place them on the screen.

You can select up to 96 waveforms or combinations of waveforms for viewing on the display. You can view up to eight waveforms in the display area at any one time. To view selected waveforms that are off the screen, you touch the field to the left of the waveform display area to turn it light-blue. Then use the knob to scroll through the waveforms to find the one you want displayed.

Channel Mode Field

Touching the Channel Mode field in the Waveform Selection field causes a pop-up menu to appear. This pop-up shows the channel mode selections available. The Channel Mode field lets you select how the waveform will be displayed. The options are Single mode, Overlay mode, Chan+Chan mode, and Chan−Chan mode.

Single Mode

This mode displays a single input channel in each waveform display area for which it is selected. It is the default mode for the oscilloscope module.

Overlay Mode

This is a waveform mode that lets you take the signal from one channel input and compare it to the signal from another (or several other) channel input. It lets you put multiple waveforms on the same waveform display area—or overlay the waveforms.

Waveforms from separate modules cannot be overlaid when making an intermodule measurement.

For example, to overlay the waveform on Input 1 with the waveform on Input 2:

Touch the Channel Mode field on the display, then when the pop-up appears, touch the Overlay field.

Turn the knob so that the bottom input in the channel label field is highlighted in white.

Then touch the Action field until Insert is displayed.

Next, touch the Input 1 label in the Labels field, then touch Input 2 in the Labels field.

Input 1 and Input 2 waveforms, shown as X1,X2 (where X is the slot letter of the module) are then displayed in the top channel label field.

After you have touched the Done key in the pop-up, you may need to touch the s/Div field and change the sweep speed in order to more easily see differences in the overlaid waveforms.

Input 1 will now be overlaid on Input 2 in the waveform display area.

No voltage values for the overlaid waveforms will appear in the channel label field to the left of the waveform display area.

Overlaid waveforms are scaled and offset (respectively), or in relationship to each other, but the value in the V/Div field does not necessarily correlate to the overlay waveform display tick marks.

Waveform Math (Chan+Chan Mode)

This is a waveform mode that lets you take the signal from one channel input and add it to the signal from another channel input.

Waveforms from separate modules cannot be added together when making an intermodule measurement.

For example, to add the waveform on Input 1 to the waveform on Input 2:

Touch the Channel Mode field on the display, then when the pop-up appears, touch the Chan+Chan field.

Turn the knob so that the bottom input in the channel label field is highlighted in white.

Then touch the Action field until Insert is displayed.

Touch the Input 1 label in the Labels field, then touch Input 2 in the Labels field.

Input 1 and Input 2 waveforms, shown as X1+X2 (where X is the slot letter of the module) are then displayed in the channel label field.

Now touch the Done key in the pop-up to display the waveform. The display now shows input 2 added to input 1. The resultant waveform is displayed in white in the waveform display.

If T Markers are turned on and V Markers are turned off, voltage values for this waveform will appear in the channel label field to the left of the waveform display area.

Waveform Math (Chan–Chan Mode)

This is a waveform math mode that lets you take the signal on one channel and subtract it from the signal on the other channel.

Waveforms from separate modules cannot be subtracted from each other when making an intermodule measurement.

For example, to subtract the waveform on Input 2 from the waveform on Input 1:

Touch the Channel Mode field on the display, then when the pop-up appears, touch the Chan–Chan field.

Turn the knob so that the bottom input in the channel label field is highlighted in white.

Then touch the Action field until Insert is displayed.

Next touch the Input 1 label in the Labels field, then touch Input 2 in the Labels field.

Input 1 and Input 2 waveforms, shown as X1–X2 (where X is the slot letter of the module) are then displayed in the channel label field.

Touch the Done key in the pop-up to display the waveform. The display now shows input 2 subtracted from input 1. The resultant waveform is displayed in white in the waveform display.

If T Markers are turned on and V Markers are turned off, voltage values for this waveform will appear in the channel label field to the left of the waveform display area.

Action Field

The Action field is a toggle field that toggles between Replace and Insert. These options let you choose to replace or to insert an input channel in the waveform display area.

Replacing a Channel

Touching the Action field in the Waveform Selection pop-up causes the Action field to toggle between Insert and Replace. To replace a channel, you touch the Action field to toggle it to Replace.

Turning the knob slightly in each direction controls which input channel in the channel label field is highlighted in white. The channel highlighted in white is the channel that will be replaced. You replace the channel highlighted in white with the channel you touch in the Labels field.

In single module configurations the waveform display shows input 1 as yellow and input 2 as green. If two cards are connected as one unit, the second card input 1 is shown as blue and input 2 is shown as red.

Inserting a Channel

Inserting an input channel works similar to replacing a channel. Touching the Action field in the Waveform Selection pop-up causes the Action field to toggle between Insert and Replace. To insert a channel, you touch the Action field to toggle it to Insert.

Turning the knob slightly in each direction controls which input channel in the channel label field is highlighted in white. The channel you insert will be inserted below the channel highlighted in white. To insert a channel, you touch the channel in the Labels field that you want to insert below the channel highlighted in white.

In single module configurations the waveform display shows input 1 as blue and input 2 as red. If two cards are connected as one unit, the second card input 1 is shown as yellow and input 2 is shown as green.

Delete All Field

The Delete All field in the Waveform Selection pop-up menu lets you delete all of the currently displayed channel inputs from the waveform display area. The pop-up selections for this field are Continue and Cancel

Cancel

Selecting Cancel from the Delete All pop-up menu allows you to change your mind about deleting all currently displayed inputs. Touching this field causes the pop-up to disappear. No changes are made to the display choices made prior to touching the Delete All field.

Continue

Selecting Continue from the Delete All pop-up menu causes all of the currently displayed inputs to be deleted. Touching this field also causes the pop-up to disappear.

Delete Field

The Delete field in the Waveform Selection pop-up menu lets you delete channel inputs from the waveform display area.

Deleting a Channel

You use the knob to highlight the input channel in the channel label field that you want to delete. You then touch the Delete field in the Waveform Selection pop-up to delete the highlighted channel input from the channel label field, and hence, from the waveform display area. The input channel highlighted in white will be deleted when you remove your finger from the Delete field.

Labels Field

The Labels field in the Waveform Selection pop-up menu lets you pick the channels you wish to display on the screen. You use this field in conjunction with the Action and Channel Mode fields to make your display choices when running your mainframe modules independently. For intermodule runs, you also use the Module field to choose the module that contains the input channels you wish to display.

Done Field

When you are finished making all of your selections in the Waveform Selection pop-up menu, you touch the Done field to enter the selections and return to the waveform display. The choices you made while in the Waveform Selection pop-up will be implemented on the screen.

10

Specifications and Characteristics

This chapter lists the specifications and characteristics. The specifications are the performance standard against which the product is tested.

The characteristics are not specifications, but are included as additional information.

For complete information on the test procedures used to verify product performance, refer to the Service Guide.

Specifications

Type: 2-channel simultaneous acquisition

Bandwidth(*,1): dc to 250 MHz (real time, dc-coupled)

Maximum Sample Rate: 1 Gigasample per second

Number of Channels: 2, 4, 6, 8 simultaneous channels using the same time base setting(s)

OR

Up to 10 channels with independent time bases for each pair of channels. Up to 18 channels with the HP 16501A Expansion Frame.

Rise Time(2): 1.4 ns

ADC: 8-bit real time

Vertical Resolution: 8 bits over 4 vertical divisions (± 0.4%)

Waveform Record Length: 8000 points

Time Interval Measurement Accuracy(*,3,6): ±[(0.005% X Δt)+(2 x 10^{-6} x delay setting)+150 ps]

Vertical (dc) Gain Accuracy(4): ±1.5% of full scale

DC Offset Accuracy(*): ±(1.0% of channel offset + 2.0% of full scale)

Voltage Measurement Accuracy(*,5): ± [(1.5% of full scale + offset accuracy) + (0.008 x V/div)]

Trigger Sensitivity(*): dc to 50 MHz: 0.063 x full scale, 50 to 250 MHz: 0.125 x full scale

Input Coupling: 1 MΩ: ac and dc, 50 Ω: dc only

Input R (selectable) (*): 1 MΩ: ±1%, 50 Ω: ±1%

Input C: Approximately 7 pF

NOTES:

* Specifications (valid within ± 10° C of auto-calibration temperature, excluding bandwidth—see note 1 for bandwidth specification.)

1. Upper bandwidth reduces by 2.5 MHz for every degree C above 35° C.

NOTES (cont):

2. Rise time is calculated from the formula: $t_r = \frac{0.35}{bandwidth}$

3. Specification applies to the maximum sampling rate. At lower rates, the specification is: ± [(0.005% x Δt)+(2 x 10^{-6} x delay setting) + (0.15 x sample interval)] for bandwidth limited signals (t_r = 1.4 x sample interval). Sample interval is defined as $\frac{1}{sample\ rate}$

4. Vertical gain accuracy decreases 0.08% per degree C from software calibration temperature.

5. Digitizing level = (#vertical divisions)$(\frac{1}{2})(\frac{1}{LSB})$, where LSB=$2^{\#\text{ bits in ADC}}$

6. The Time Interval Measurement Accuracy deteriorates across multiple modules connected as one unit with each added module.

Operating Characteristics

Vertical (at BNC)

Vertical Sensitivity Range (1:1 Probe): 4 mV/div to 10 V/div in 1-2-4 increments

DC Offset Range (1:1 Probe):

Vertical Sensitivity	Available Offset
4 mV/div to 100 mV/div	±2 V
>100 mV/div to 500 mV/div	±10 V
>500 mV/div to 2.5 V/div	±50 V
>2.5 V/div to 10 V/div	±250 V

Probe Factors:

Any integer ratio from 1:1 to 1000:1

Maximum Safe Input Voltage:

1 MΩ: ±250 V [dc + peak ac (< 10 KHz)]
50 Ω: ±5 VRMS

Channel-to-Channel Isolation:

dc to 50 MHz: 40 dB, 50 MHz to 250 MHz: 30 dB

Timebase

Range: 1 ns/div to 5 s/div

Resolution: 20 ps

Delay Pre-trigger Range:

Time/div Setting	Available Delay
1 μs to 5 s/div	-8 x (s/div)
1 ns to 500 ns/div	-4 μs

Delay Post-trigger Range:

Time/div Setting	Available Delay
100 ms to 5 s/div	2.5 ks
1 μs to 50 ms/div	33,500 x (s/div)
1ns to 500 ns/div	16.7 ms

Triggering

Trigger Level Range: Within display window (full scale and offset)

Trigger Modes:

Immediate: Triggers immediately after arming condition is met.

Edge: Triggers on rising or falling edge of any internal channel or external trigger, count adjustable from 1 to 32,000.

Pattern: Triggers on entering, exiting, duration greater than, duration less than, or duration in range for a specified pattern of both internal channels and external trigger, count adjustable from 1 to 32,000. Duration time range is adjustable from 20 ns to 160 ms in 10 ns increments. Duration accuracy is approximately ±3% ±2ns.

Auto-Trigger: If enabled, the module will self-trigger if no trigger condition is found within approximately 50 ms after arming.

Events Delay: The trigger can be set to occur on the nth edge or pattern, as specified by the user. The number of events (n) can be set from 1 to 32,000 events. Maximum count frequency is 70 MHz.

Intermodule: Arms another measurement module or triggers the rear panel BNC.

External: If enabled, the oscilloscope will trigger on an ECL level signal (-1.3 V).

Digitizer

Resolution: 8 bits (1 part in 256)

Digitizing Rate: Up to 1 Gigasample per second

Digitizing Technique: Real-time digitizing; each 8000 samples are acquired on a single acquisition

Acquisition Memory Size: 8000 samples per channel

Waveform Display

Displayed Waveforms: Eight waveform windows maximum, with scrolling across 96 waveforms.

Display Formats: Waveforms can be displayed in an overlapping and/or non-overlapping format. Display capability of A−B and A+B is also provided.

Display Resolution: 500 points horizontal, 240 points vertical

Display Modes

Normal (Single): New acquisition replaces old acquisition on screen.

Accumulate: New acquisition is displayed in addition to previous acquisitions until screen is erased.

Average: New acquisitions are averaged with old acquisitions, with the updated waveform displayed until erased. Maximum number of averages is 256.

Overlay: Up to 8 acquired waveforms from separate channels can be overlayed in the same display area.

Connect-the-dots: Provides a display of the sample points connected by straight lines.

Waveform Reconstruction: When there is insufficient data to fill every horizontal location, a post acquisition reconstruction filter fills in missing data points for time base < 50 ns/div.

Waveform Math: Display capability of A−B and A+B functions is provided.

Measurement Aids

Time Markers: Two vertical markers, X and O, are provided for measurements of time and voltage. Capabilities are: measure voltage at point where X and O markers cross each analog waveform; measure time from trigger to X, trigger to O, and X to O; automatic marker placement by specifying percentage of edge, edge number, and rising or falling edge type; run until X to O > than, < than, in range, and not in range provides selective event search; X to O statistics (mean, max, and min) provide analysis of time interval deviation.

Voltage Markers: Two horizontal markers, a and b, are provided for voltage measurements. These markers can each be placed on any acquisition channel trace. A delta voltage field is displayed. This field shows the delta voltage between markers on the same channel or between two channels.

Automatic Search: Searches for a percentage or absolute voltage level at a positive or negative edge, count adjustable from 1 to 100.

Auto Search Statistics: Mean, maximum, and minimum values for elapsed time from X to O markers for multiple runs. Number of valid runs and total number of runs available.

Automatic Measurements: The following pulse parameter measurements can be performed automatically:

Frequency	Rise time	+pulse width
Period	Fall time	−pulse width
V p-p	Preshoot	$V_{amplitude}$*
	Overshoot	

(*gives difference between top and base voltages; only available over bus)

Grid: Graticules can be displayed in background of waveform.

Setup Aids

Autoscale: Autoscales the vertical and horizontal ranges, offset, and trigger level to display the input signals. Requires a frequency between 50 Hz and 250 MHz.

Presets: Scales the vertical range, offset, and trigger level to predetermined values for displaying ECL or TTL waveforms.

Calibration: Vertical, trigger, delay, and all defaults. Calibration factors stored in NV-RAM on the circuit board.

Probe Compensation Source: External BNC supplies a square wave approximately 0.0 mV to -800 mV into the open circuit at approximately 1000 Hz.

Operating Environment

Temperature: Instrument, 0° to 55° C (+32° to 131° F). Probes and cables, 0° to 65° C (+32° to 149° F).

Humidity: Instrument, up to 95% relative humidity at +40° C (+104° F). Recommended disk media, 8% to 80% relative humidity at +40° C (+104° F).

Altitude: To 4600 m (15,000 ft).

Vibration

Operation: Random vibration 5-500 Hz, 10 minutes per axis, ~0.3 g (rms).

Non-operating: Random vibration 5-500 Hz, 10 minutes per axis, ~ 2.41 g (rms); and swept sine resonant search, 5-500 Hz, 0.75 g (0- peak), 5 minute resonant dwell @ 4 resonances per axis.

acquisition Denotes one complete cycle of data gathering. One complete cycle gathers 8000 samples of information and stores them in acquisition memory.

attenuation factor *See* probe field

autoscale algorithm An algorithm that, based on the amplitude and period of the signals found, sets the vertical sensitivity in volts per division, offset, horizontal sweep speed in seconds per division, trigger level, and trigger slope for the trigger source input. Its purpose is to provide two to five cycles of a waveform that is displayed on the screen. The waveform is from the lowest numbered and lettered channel with a signal.

cancel autoscale The field that allows you to cancel doing an automatic scaling of the input signals. This is particularly important if you inadvertently touch the Autoscale field when you have your measurement configuration set. Automatically scaling your signals at this point could change your present configuration.

cancel run The field that allows you to cancel making an oscilloscope run for any reason once you have touched the Run field.

coupling field The field that sets the input impedance for the signal applied to channel 1 or channel 2 of the oscilloscope. Selectable values for each channel are 1MΩ / DC, 1MΩ / AC, and 50Ω / DC.

delay field The field that sets the horizontal position of the waveform on the screen. Delay time is measured from the trigger point. It is measured in seconds and is viewed in the Delay field. It can be set by using the knob or the keypad .

don't care Signifies that the state of the signal (high or low) is not pertinent to the measurement being performed.

edge mode The trigger mode that causes a trigger based on a single channel edge (either rising or falling).

high The positive-going portion of a logic signal. Used in pattern trigger measurements, it is represented by an H in the pattern selector.

horizontal position *See* delay field.

horizontal sweep speed The time value that determines the horizontal scaling of the waveform to be displayed on the screen. It is measured in seconds per division and and is viewed in the s/Div field. It is set by using the knob or the keypad.

immediate mode The trigger mode that does not require a specific trigger condition (that is; an edge or a pattern).

input field The field that allows you to select a channel for vertical scaling.

input impedance *See* coupling field.

intermodule menu The menu that lets you set up the instrument to make interactive measurements, either with other modules in the mainframe or with external modules.

low The negative-going portion of a logic signal. Used in pattern trigger measurements, it is represented by an L in the pattern selector.

manual markers mode The marker mode that lets you manually move the markers using the knob or the keypad.

menu field The field to the immediate right of the module field (see below). It allows you to choose the menus related to the module shown in the module field.

module field The field in the upper-left corner of the screen. It allows you to choose any of the modules in the mainframe as your working module. It also allows you to choose system options and intermodule options.

offset field The field that sets the vertical position of the waveform on the screen. Offset is the voltage represented at the center vertical tick mark in the waveform display. It is measured in volts and is viewed in the Offset field. It is set by the using knob or the keypad.

Document Warranty

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Complete product warranty information is given on the last page of this guide.

Safety

This apparatus has been designed and tested in accordance with IEC Publication 348, Safety Requirements for Measuring Apparatus, and has been supplied in a safe condition. This is a Safety Class I instrument (provided with terminal for protective earthing). Before applying power, verify that the correct safety precautions are taken (see the following warnings). In addition, note the external markings on the instrument that are described under "Safety Symbols."

Warning

- Before turning on the instrument, you must connect the protective earth terminal of the instrument to the protective conductor of the (mains) power cord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. You must not negate the protective action by using an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two-conductor outlet is not sufficient protection.
- Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short-circuited fuseholders. To do so could cause a shock of fire hazard.
- Service instructions are for trained service personnel. To avoid dangerous electric shock, do not perform any service unless qualified to do so. Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.
- If you energize this instrument by an auto transformer (for voltage reduction), make sure the common terminal is connected to the earth terminal of the power source.
- Whenever it is likely that the ground protection is impaired, you must make the instrument inoperative and secure it against any unintended operation.
- Do not operate the instrument in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.
- Do not install substitute parts or perform any unauthorized modification to the instrument.
- Capacitors inside the instrument may retain a charge even if the instrument is disconnected from its source of supply.
- Use caution when exposing or handling the CRT. Handling or replacing the CRT shall be done only by qualified maintenance personnel.

Safety Symbols

Instruction manual symbol: the product is marked with this symbol when it is necessary for you to refer to the instruction manual in order to protect against damage to the product.

Hazardous voltage symbol.

Earth terminal symbol: Used to indicate a circuit common connected to grounded chassis.

WARNING

The Warning sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a Warning sign until the indicated conditions are fully understood and met.

CAUTION

The Caution sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a Caution symbol until the indicated conditions are fully understood or met.

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