User's Reference

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This book applies directly to firmware revision code 2.XX.

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

HP 54520C and HP 54540C Series Oscilloscopes

HP 54520C and HP 54540C Series Oscilloscopes

The HP 54520C and HP 54540C series are high-performance, portable oscilloscopes. Each channel provides 8 bits, 32K maximum acquisition memory, and 500-MHz bandwidth. Firmware modularity is provided by a 3-1/2 inch disk drive and flash ROMs, which allows for upgrades of the system firmware features in the oscilloscopes. Each of the oscilloscopes has an auxiliary trigger input on the rear panel. The sample rate and channel count depends on the model number.

- HP 54542C has 4 channels with 2-GSa/s maximum sample rate on each channel.
- HP 54522C has 2 channels with 2-GSa/s maximum sample rate on each channel, and there is an external trigger input on the front panel.
- HP 54540C has four channels with 2-GSa/s maximum sample rate when one channel is turned on, 1-GSa/s maximum sample rate when two channels are turned on, and 500 MSa/s when four channels are turned on.
- HP 54520C has two channels with 1-GSa/s maximum sample rate when one channel is turned on, and 500 MSa/s when two channels are turned on, and there is an external trigger input on the front panel.

This oscilloscope has many powerful features, and each of them is described in this book. Your key to unlocking power of the oscilloscope depends how you combine its features for your application, and your knowledge of how each feature effects the operation of the oscilloscope.

All calibration and repair information is contained in the Service Guide, and all programming information is contained in the Programmer's Reference.

Accessories Supplied

The following accessories are supplied with the oscilloscope.

- 2 HP 10441A 10:1, 1MΩ, passive probes on the 2-channel models, and 4 passive probes on the 4-channel models.
- This User's Reference
- One Quick Start Guide
- One Programmer's Reference
- One Service Guide
- One 2.3 meter (7.5 feet) power cord

See Also The Service Guide for available power cords.

Accessories Available

The following accessories are available for use with the oscilloscope.

- HP 10430A 10:1, 1MΩ, 1 meter, passive probe
- HP 10437A 1:1, 50 Ω, 2 meter, passive probe
- HP 10438A 1:1, 1 meter, passive probe
- HP 10439A 1:1, 2 meter, passive probe
- HP 10441A 10:1, 1MΩ, 2 meter, passive probe
- HP 10442A 10:1, 500Ω, 2 meter, passive probe
- HP 10443A 20:1, 1000Ω, 2 meter, passive probe
- HP 10450A SMT probe accessory kit
- HP 10072A SMT probe accessory kit
- HP 10002A 50:1, 9MΩ, 1000 V peak, passive probe
- HP 10020A resistive divider probe kit
- HP 1137A 1000:1, high voltage divider probe
- HP 1141A 200-MHz, differential probe
- HP 1142A probe power for HP 1141 probe
- HP 1143A probe power for HP 54701A probe
- HP 1144A 800 MHz, 2 pF, 1MΩ, active probe
- HP 54701A 2.5 GHz, 0.6 pF active probe
- HP 10211A 24-pin IC clip
- HP 10024A 16-pin IC clip
- HP 1250-1454 BNC to miniature probe adapter
- HP 1250-2427 horizontal, PC board, mini-probe socket

- HP 1250-2428 vertical, PC board, mini-probe socket
- HP 01144-61604 1:2 probe power fanout
- HP 10240B BNC blocking capacitor
- HP 11094B 75 Ω feedthrough termination
- HP 5062-7379 rackmount kit
- HP 1494-0015 rackmount slide kit
- HP 1540-1066 Soft carrying case
- HP 1180A tilt-tray testmobile
- HP 92199B power strip for test mobile
- HP 540 Centronics printer
- HP 560C Centronics printer
- Color Pro HPIB, plotter
- HP 7470A HPIB, plotter
- HP 7475A option 002 HPIB, plotter
- HP 7550A option 005 HPIB, plotter

Options

- 090 Delete probes
- 908 Rackmount kit
- 910 Additional manuals
- 001 Telecom Mask Test Software (Downloaded)
- 002 HP 1145A 2-ch 750 MHz, SMT Active Probe
- 003 HP 1144A 800 MHz Active Probe

In this book

This book consists of 14 chapters, a glossary, and an index. Most of the chapters describe the various menus in the oscilloscope. These chapters contain the word "Menu" as part of their title. For example, "Display Menu" discusses the various softkey menus that come up on the display when you press the Display key on the front panel. Other chapters, like Vertical, discuss the softkey menu and knobs associated with the control of the vertical portion of the front panel. The remaining chapters contain additional information about the oscilloscope. For example, "Measurements" discusses how the oscilloscope calculates the measurement results when you select an automatic measurement.

You will find it easier to use this reference book if you are at least a little familiar with how to use the front panel. The best way to learn how to use the front panel is by reading the User's Quick Start Guide that is supplied with the oscilloscope.

Glossary

Index

Contents

4 Horizontal

5 Trigger

6 Display Menu

7 Marker Menu

8 Define Measure Menu

9 Waveform Save Menu

10 Math/FFT Menu

11 Utility Menu

12 Disk Menu

13 Measurements

14 Specifications and Characteristics

Setting Up the Oscilloscope

Setting Up the Oscilloscope

This chapter contains information for unpacking, applying power, and connecting optional accessories to the oscilloscope For safe and troublefree operation, follow the instructions and advisories in this chapter. You may also want to read the safety summary at the end of the book.

Initial Inspection

Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, keep it until the contents of the shipment are checked. Check the shipment for completeness and check the instrument electrically and mechanically.

If the contents are incomplete, if there is mechanical damage, or if the oscilloscope does not power up correctly, notify the Hewlett-Packard Sales Office. Keep the shipping materials for the carrier's inspection. The Hewlett-Packard Sales Office will arrange for repair or replacement at HP's option without waiting for a claim settlement.

Operating Environment

The environmental conditions that you need to be aware of when operating, storing, or shipping the oscilloscope are listed in chapter 16 under "General Characteristics." Because condensation in the instrument cabinet can cause poor operation or malfunction, make sure you avoid temperature extremes which can cause condensation.

If you are shipping the oscilloscope to a Hewlett-Packard Service Center for service or repair, attach a tag to the oscilloscope that identifies the owner, address of the owner, model number, serial number, and a description of the service work that is required.

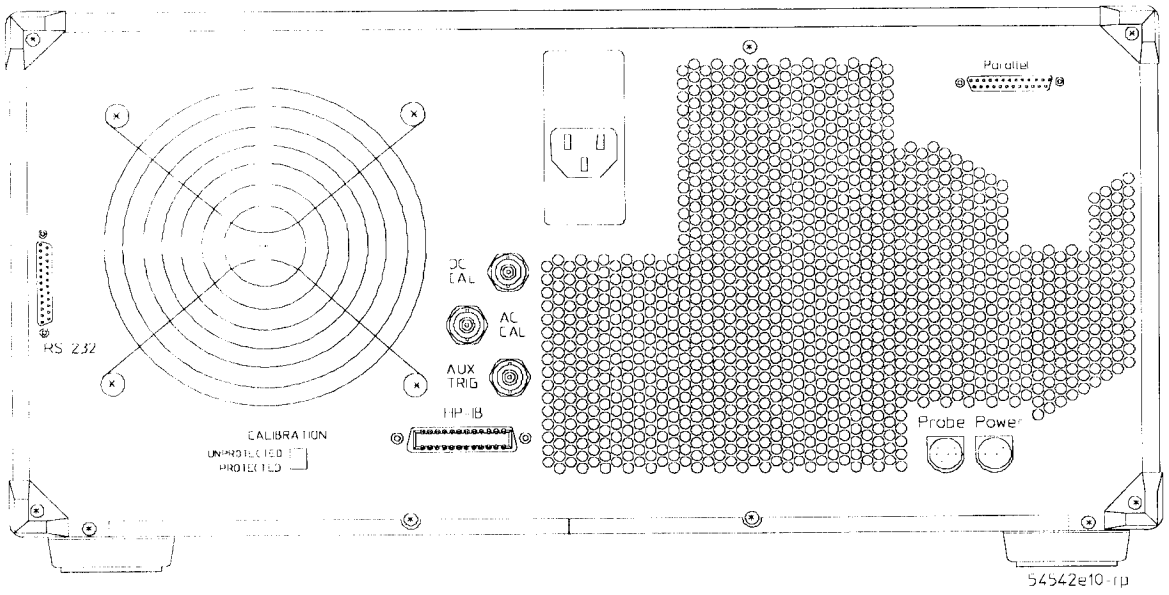
If the original packaging material is no longer available, identical packing material is available through your local Hewlett-Packard Sales office. Mark the container FRAGILE to ensure careful handling. In any correspondence, refer to the oscilloscope by the model and serial number.

THE 54540A WITH CENTRONICS PORT AND 660 DRIVER WILL INTERFACE PROPERLY WITH THE DESKJET 670 C PRINTER

Rear Panel

The rear panel of the oscilloscope contains the power input, voltage selector module, external connectors, intensity adjustment, and calibrator protection switches

Figure 1–1



Rear-panel of the oscilloscope

Power Requirements

The oscilloscope requires a power source of either 115 or 230 volts ac, –25% to +15%; single phase, 48 to 440 Hz; 170 W maximum .

Power Cord

This oscilloscope is a Safety Class 1 instrument with an exposed chassis that is directly connected to earth through the power cord that meets IEC Standard 1010. The oscilloscope is provided with a three-wire power cord. When connected to an appropriate ac power outlet, the cord grounds the instrument cabinet. The type of power-cord plug shipped depends on the country of destination.

See also The Service Guide for a listing of the power cords that are available for the oscilloscope.

WARNING SHOCK HAZARD! Before connecting the oscilloscope to the power line or connecting to circuits that are connected to the power line, make sure the protective earth terminal of the oscilloscope is connected to the protective conductor of the power cord. Failure to do so could result in electrical shock.

Also, make sure you insert the power plug into an outlet that contains a protective earth contact. Do not use an extension cord without a protective earth conductor (grounding). The grounding of one conductor on a two-conductor outlet is not sufficient for grounding purposes to prevent the possibility of electrical shock.

Line Voltage Selection

The fuse module is set at Hewlett-Packard to the line voltage used in the country of destination. Check the setting of the fuse module to verify it is in the correct position for the voltage you are using.

CAUTION ⚠ INSTRUMENT DAMAGE! Before applying power to the oscilloscope, make sure that the fuse module is set to the correct line voltage position. Damage to the oscilloscope can occur if the line voltage is not set correctly.

To change the line voltage selection.

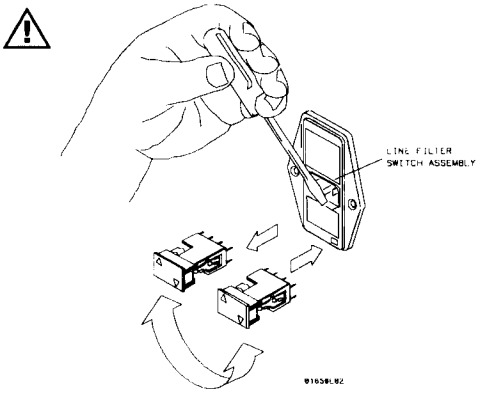
1 Unplug the oscilloscope.

2 Carefully pry at the top center of the fuse module until you can pull it out.

3 Insert the fuse module with the arrow for the line voltage you want aligned with the arrow below the fuse module.

4 Plug-in the oscilloscope.

Figure 1–2

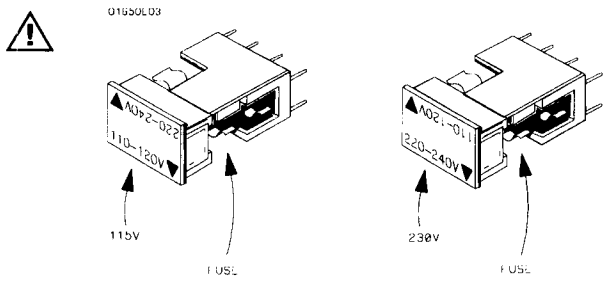


Removing and installing the fuse module.

Verifying the Fuse

If it is necessary to check or change fuses, remove the fuse module and check each fuse for its amperage and voltage ratings.

Figure 1–3



Fuse location on fuse module

Air Flow Requirements

Make sure the oscilloscope has unrestricted air flow for the fan and ventilation openings in the rear panel. You can stack the oscilloscope under, over, or between other instruments provided the other instruments are adequately cooled.

Connecting External Equipment

The oscilloscope is equipped with an HP-IB connector on the rear panel. This allows direct connection to an HP-IB compatible printer, plotter, or external controller. Make sure you tighten the captive screws of the HP-IB cable to ensure a good electrical connection. If you do not have an HP-IB printer, you can use the Centronics port.

You have to set the HP-IB address of the oscilloscope in order to communicate with the connected device. The oscilloscope's HP-IB address is set in the Utility menu.

See also

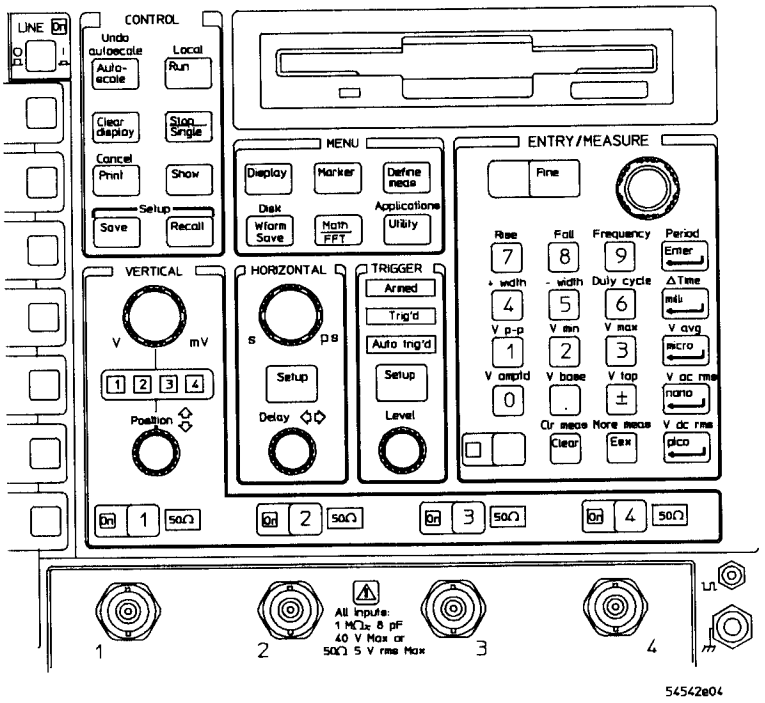
"HP-IB/RS-232/CENT Menu" in Chapter 11 for information on the HP-IB menu selections.

Front-Panel Overview

Front-Panel Overview

This chapter describes the various areas of the front panel and an explanation of each areas function.

The front panel is separated into nine functional areas:display, control, disk drive, menu, entry/measure, vertical, horizontal, trigger, and probe compensation terminals. All of these areas, except for the last three, are discussed in this chapter. The vertical, horizontal, and trigger sections are discussed in other chapters in this book.



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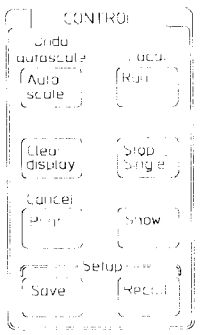
There are two types of keys: front-panel keys and softkeys. A front-panel key has text or numbers printed on it, or it is blue in color. Softkeys are to the right side of the display, and the labels for the softkeys are displayed on the screen next to each softkey. These labels are referred to as menus, and which menu is displayed depends on the front-panel key you press. Not all front-panel keys cause softkey menus to display on the screen.

In this book, *key* is used when referring to front-panel keys, and *softkey* is used when referring to softkeys.

Control



The area of the front-panel marked Control is located at the top of the oscilloscope and to the right of the display.

Autoscale Key

Pressing the Autoscale key causes the oscilloscope to quickly analyze the signal. Then, it sets up the vertical, horizontal, and trigger to best display that signal. The autoscale function can find repetitive signals with a frequency greater than or equal to 50 Hz, a duty cycle greater than one percent, and an amplitude of 50 mV p-p or greater.

The Autoscale function looks for signals on all channels, even if they are turned off. On two-channel models, the scope looks for a trigger signal on the external trigger input; then, it consecutively looks at the channel inputs starting with channel 1. The scope consecutively looks for a trigger signal at the channel inputs starting with channel 1.

When the Autoscale key is pressed, the following conditions are set:

- Vertical sensitivity — To best display signals on active channels
- Vertical offset — To best display signals on active channels
- Trigger — Edge mode, positive slope, and trigger level on the found source
- Display — To minimum persistence when in normal display and repetitive acquisition modes (single persistence in real-time acquisition mode)
- Time base delay — 0.0 seconds
- Time base reference — Center
- Time per division — To best display the signal

Autoscale also includes a partial reset which performs the following:

- Turns off markers
- Turns off all measurements
- Sets measurements to screen instead of markers
- Turns off measurement limit test
- Turns off waveform compare test
- Turns off sequential single shot
- Turns off waveform math functions
- Turns off waveform/pixel/multiple memory display
- Turns off connect-the-dots
- Turns off peak detect
- Sets holdoff to 40 ns (minimum value)

The previous oscilloscope settings are stored in setup memory 0. You can either press Recall 0 or undo autoscale to restore the previous settings.

Undo Autoscale Key

You can access the undo autoscale key by pressing the blue shift key on the keypad, followed by pressing the Autoscale key again.

You may find situations where you have pressed the Autoscale key unintentionally. When this happens, you can use the Undo Autoscale key to return the oscilloscope to the settings prior to pressing the Autoscale key.

Run Key

The Run key causes the oscilloscope to resume acquiring data. If the oscilloscope is stopped, it starts acquiring data on the next trigger event. If the oscilloscope is already in the run mode, it continues to acquire data on successive trigger events.

If pressing the Run key does not cause waveform data to display on the screen, try the following hints:

- Press the Autoscale key (unless the signal is single-shot).
- Make sure that a signal is connected to one of the channels and that the display for that channel is turned on.
- Make sure that the offset does not have the trace clipped off the display.
- Check the trigger setup conditions to make sure that the trigger conditions are valid for the signal.
- Set the trigger sweep mode to auto. Auto sweep forces the oscilloscope to trigger, which may allow you to see enough of the signal, so that you can set up the front panel controls.

Local Key

You can access the Local key by pressing the blue shift key on the keypad, followed by pressing the Run key. The Local key sets the oscilloscope to return control to the front panel. This is the only active key when the oscilloscope is under remote control. The exception occurs when the controller sends a local lockout command. The local lockout command prevents the local key from returning control of the oscilloscope to the front panel.

Clear Display Key

The Clear Display key erases all waveform data from the graticule area, clears waveform math functions, and it resets all associated measurements and measurement statistics. Pressing the Clear Display key does not affect the waveform memories.

When the oscilloscope is stopped If the oscilloscope is stopped, the display remains cleared of waveform data until the trigger circuit is rearmed and the oscilloscope is triggered. Then, the new data is displayed and measurements are recalculated.

When the oscilloscope is running If the oscilloscope is running, new waveform data is displayed on the next acquisition and all measurements are recalculated.

Stop/Single Key

Pressing the Stop/Single key causes the oscilloscope to stop acquiring data. The status area of the screen displays the message "Stopped." In the auto-trigger mode, the next press of the Stop/Single key arms the trigger circuit. If no trigger occurs, the scope triggers itself. In the triggered mode, the next press of the Stop/Single key arms the trigger circuit. If a trigger event is not immediately present, the Armed light on the front-panel lights and the message "running-awaiting trigger" is displayed. If the trigger event is immediately present, you may not see the arm light turn on or the message "running-awaiting trigger." The next trigger event causes the oscilloscope to make a single acquisition, the trig'd (triggered) light briefly lights, the message "stopped" is displayed, and any measurements are recalculated. Each subsequent press of the Stop/Single key rearms the trigger circuit. If all of the channels are turned off or if a trigger event can not be found, the oscilloscope will not acquire any data.

Capturing single-shot events

Single-shot events are waveforms that occur only once or infrequently. Some examples of single-shot events are a switch closure, a power supply turning on, the impact of an object on the floor, or an errant pulse that causes your system to fail.

In order to capture a single-shot event, you need to have some knowledge of the waveform you are trying to capture. Before you can set up the trigger, vertical, and horizontal controls to capture and display the event, you must know the approximate amplitude, duration, and dc offset of the signal. For example, if you are using a logic family, the two common trigger levels you can use to capture an intermittent glitch are VIH minimum and VIL maximum.

To capture a single-shot event

1 Connect the signal to the oscilloscope.

2 Set the Display softkey to on for that channel. Then, select the appropriate vertical scale and position settings to display the signal.

3 Select the appropriate horizontal scale and delay settings to display the signal.

4 Press the trigger setup key. Then, set up the trigger menu to best capture the signal. Set the triggering mode to trig'ed (triggered).

5 Press the horizontal setup key. Then, set the Sampling mode to real time and select the desired record length.

6 Press the Stop/Single key.

This stops the oscilloscope from acquiring any additional data.

7 Press the Clear display key.

This erases any previously acquired data from the display and resets any measurement results.

8 Press the Stop/Single key again.

This rearms the trigger circuit. The next event that meets the trigger criteria specified in step 4 is captured by the oscilloscope. If the channel and horizontal controls are set correctly, the signal will be displayed on the screen and any measurement results will be recalculated.

To capture another set of data, press the Stop/Single key again. Depending on your application, you can press the Clear display key between acquisitions, or you can allow the display to build a waveform.

To allow the waveform to build on the display, set the display persistence to infinite and do not press the Clear display key between acquisitions.

Print

Pressing the Print key causes the oscilloscope to immediately print the currently displayed data on a compatible plotter or graphics printer, and it stops all other oscilloscope functions while printing. Also, the message "hardcopy active" is displayed.

The oscilloscope must be in the talk only mode, and the printer or plotter must be in the listen always mode. Setup of the printer or plotter options is accessed in the HP-IB/RS-232/CENT menu. If a printer or plotter is not connected to the oscilloscope or if the oscilloscope cannot communicate with them, the oscilloscope stops the printing process after an amount of time set by the time out softkey in the Utility menu.

See also

"HP-IB/RS-232/CENT Softkey" in chapter 11 for information on setting up the oscilloscope to print to a printer or plotter.

Cancel

You can access the cancel print function by pressing the blue shift key on the keypad, followed by pressing the Print key again. Pressing Cancel print stops the printing process to the printer or plotter.

Show Key

The Show key gives you quick access to channel, function, and trigger information with the show screen. Pressing the Show key toggles between the currently selected menu and the show screen. The show screen displays the following information about channels, memories, or functions that are on:

- Channel scaling
- Channel offset
- Channel coupling
- Channel impedance
- Probe attenuation
- Trigger mode
- Trigger source
- Trigger level
- Math function operation
- Math function scaling
- Math function offset
- Memories
- Waveform memory scaling

Save Key

The Save key allows you to save the current front-panel setup to one of the nine non-volatile setup memories. When you press the Save key, the message "select digit 1-9 for setup save" is displayed. Simply use the keypad to select one of the nine waveform memories. After you select a setup memory, the message "setup #*n* saved" is displayed. The oscilloscope uses memory 0 to store the current configuration before executing an autoscale, recall, or ECL/TTL preset.

Recall Key

The Recall key has three functions.

First, you can use the Recall key to retrieve a front-panel setup from one of the nine setup memories (providing that you previously saved a setup to that memory). If a setup was previously saved to that memory, the scope is immediately configured to match that setup, and the message "setup #*n* recalled" is displayed. If a setup is not stored in that memory, the configuration of scope is left alone, and the message "bad data no recall done" is displayed.

Second, you can use the Recall key to retrieve the previous configuration by pressing Recall 0.

Third, you can use the Recall key to set the oscilloscope to a default operating condition by pressing Recall clr (clear key on the keypad). The default settings are shown in table 2-1.

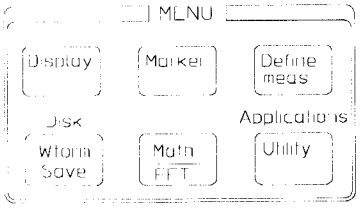
Table 2-1 **Default Settings**

Horizontal Menu		**Display Menu**	
Time/Div	100 µs/div	Mode	Normal
Delay	0.00000 s	Persistence	Single
Reference	Cntr (center)	# of screens	1
Repetitive/real time	Real time	Off/frame/axes/grid	Axes
Sequential	Off	Connect dots	Off
Record length	512		
Sample clock	Auto		
Vertical Menu		**Math/FFT Menu**	
Channel 1	On	f1	Off
Channel 2	Off	f2	Off
Channel 3 *	Off	f3	Off
Channel 4 *	Off	f4	Off
Volts/Div	500 mV	Chan/mem	Chan 1
Offset	0.00000 V	Operator	+
Coupling	dc	Chan/mem	Chan 1
Impedance	1 MΩ	Function sensitivity	1.00 V/div
Probe attenuation	1.000:1	Function offset	0.0 V
Trigger Menu		**Waveform Save Menu**	
Trigger	Auto	Waveform/pixel	Waveform
Mode	Edge	Nonvolatile	m1
Source	Channel 1	Display	Off
Slope	Positive	Source	Chan 1
Noise reject	Off	Protect	Off
Holdoff	40 ns		
Level	0.00 V		
Define Meas Menu		**Utility Menu, System Submenu**	
Meas/def/limit/compare	Measure		
Continuous	On	AC BNC	Probe comp
Measure window	Screen	Interpolation	On
Statistics	Off	Probe comp freq	496.484 Hz
Extended analysis	Off		
Marker menu		**Utility Menu System Util Submenu**	
Markers	Off	Clicker	On
		Gnd markers	On
		Chan labels	Off
		Chan factors	On
		Power up	Run
		FP ontime hrs	6

*On 4-channel models only

Menus

The menu section of the front panel has six keys, two of which have shifted functions: disk and applications. Each of these menu keys, except applications, has its own chapter in this book. When you purchase an application from Hewlett-Packard, the documentation you need comes with that application.



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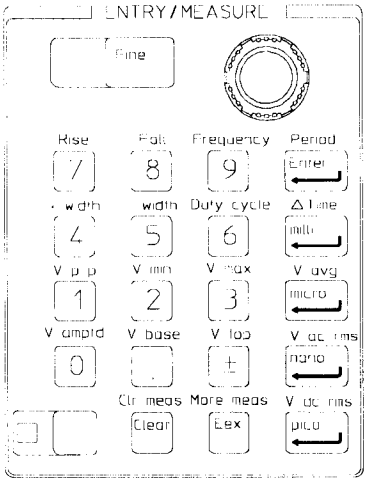
- Display Menu — Chapter 6
- Marker Menu — Chapter 7
- Define meas Menu — Chapter 8
- Wform save Menu — Chapter 9
- Math/FFT Menu — Chapter 10
- Utility Menu — Chapter 11
- Disk Menu (a shifted function) — Chapter 12

The channel, time base, and trigger menus are found in the following chapters:

- Vertical menu — Chapter 3
- Horizontal menu — Chapter 4
- Trigger Menu — Chapter 5

Entry/Measure

The entry/measure portion of the front-panel has a multifunctional numeric keypad, a selection knob, and fine key.



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Numeric Keypad

The keypad is for direct numeric input. To input known values directly, press the associated softkey to activate the desired field on screen, and then select the units with the numeric keys. For example, to set the vertical sensitivity to 500 mV, select V/div in the vertical menu to ensure it is the active field (displayed in full-bright). Then, press 5, 0, 0, milli in sequence.

When pressed, the blue key on the numeric keypad allows you to select the alternate (shifted) functions. The shifted function above the keys (blue text) are automatic measurement functions. The clear key erases any selections made for the active field. The shift clr meas key erases all measurements and markers.

Entry Knob

The entry knob changes values within each function. It increments, decrements, or toggles the selection in the active field or function. The current selection is displayed yellow in the softkey menu area.

Fine Key

The Fine key changes the increment and decrement sequence. Instead of sequencing in the normal sequence, the values increment or decrement in more precise values. You can use this feature when the normal sequence is too coarse for precision measurements or settings. When the oscilloscope is operating in the fine mode, the word "fine" is displayed in the lower right corner of the display, and the LED next to the fine key is illuminated.

Blue Shift Key

The blue shift key allows you to access the functions that are written in blue above the other keys on the front panel. When you press the blue shift key, the message "select shift function" is displayed, and the LED next to the blue shift key is illuminated.

Probe Terminal

The probe terminal provides a square wave used for probe compensation. You can vary the frequency of the probe compensation signal from about 250 mHz to 32 kHz. The default setting is about 500 Hz. The signal is present when the AC BNC softkey is set to probe compensation in the System Submenu of the Utility Menu.

See also

"System Menu" in Chapter 11 for more information on the probe compensation softkey and the probe compensation signal.

Line Switch

The line switch is located on the front panel. You turn on the oscilloscope by pressing the switch in. The green LED illuminates when the oscilloscope is turned on. The switch position is labeled 1 and 0, corresponding to on and off, respectively.

Display

The display section contains the screen and the labels for the softkeys. The vertical column on the right side of the display show the labels for the softkeys. Each label corresponds to a softkey.

Numeric fields, when highlighted yellow, are changed by either numeric keys on the keypad or by one of the knobs. The numeric fields are displayed in highlighted white when inactive and in yellow when active.

Nonnumeric fields are displayed in highlighted white and are changed by toggling the corresponding softkey.

When the acquisition mode in the horizontal menu is set to the real-time mode, a memory bar is displayed above the graticule area. The graticule area, also referred to as the waveform viewing area, is where all the waveform data and markers are displayed. Below the graticule area are the measurement results, marker settings, and statistical results.

There is a ground marker on the left side of the display for each channel that is turned on. The ground markers give you a visual indication of where the

ground reference point is for each channel that is turned on. When a channel is turned on, the ground marker is displayed. When channel markers is selected, the channel # is displayed. If the ground reference for a channel is positioned vertically off the screen, the ground marker turns into an arrow that points in the direction of the ground reference. Ground markers are printed with hardcopy prints. You can turn the ground markers on or off with the **GND MARKERS** softkey in the Utility/system menu/system util menu.

When selected, there is a channel marker on the right side of the display for each channel that is turned on. The channel markers help you keep track of the source channel for each displayed waveform. The channel labels are printed with hardcopy prints. You can turn the channel lables on and off with the **CHAN LABELS** softkey in the Utility/system menu/system util menu.

The volts/div and offset (channel factors) settings for each channel that is turned on are displayed on the screen. If measurements are turned off, the channel factors are displayed below the graticule area. If measurements are turned on, the channel factors are displayed near the bottom of the graticule area. You can turn on or off the display of the channel factors with the **CHAN FACTORS** softkey in the Utility/system menu/system util menu. You can also press the Show front-panel key to see the complete setup of any channels that are turned on. The channel factors are printed with hardcopy prints.

Figure 2–1

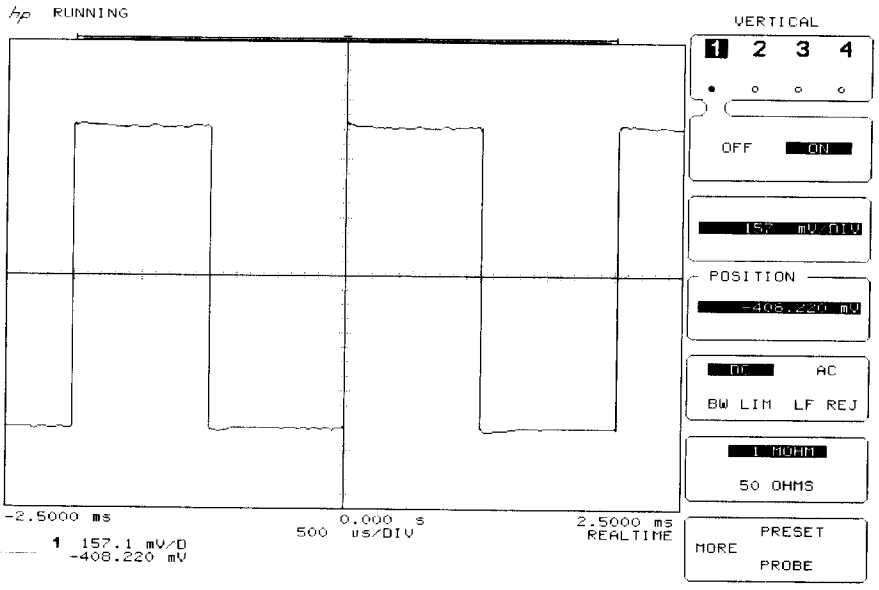
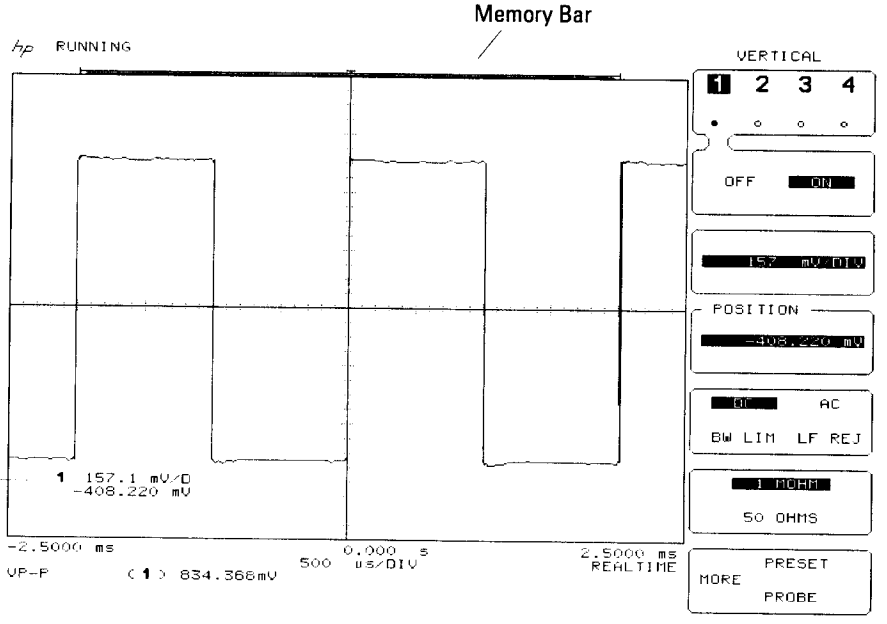


Figure 2–2



Instrument Reset

The oscilloscope has two methods of instrument reset: key-down power up or Recall clr.

Key-Down Powerup A key-down power up is a hard reset of the oscilloscope. It is done by pressing and holding any front-panel key while cycling power.

The oscilloscope powers up displaying a baseline, the show screen, and the front-panel configuration is set to the default settings. Except for the following additions, the default settings are the same as those in table 2-1.

Utility Menu (HP-IB menu)

Address/talk	Address
Address	7

Recall Clr (Clear) Recall clr (clear) is a soft reset that sets the scope to the default conditions in table 2-1. Performing a recall clear is similar to a key-down power-up except the previous menu selections are retained.

Disk Drive

The oscilloscope has a high-density, 3-1/2 inch, MS-DOS® compatible disk drive. In the disk menu you can save and recall waveforms, save and recall front-panel setups, delete files from a disk, format a disk, or obtain a directory listing of a disk. You can also use the disk drive to load new system firmware into the flash ROMs or you can load applications.

See also Chapter 12, "Disk Menu" for information about the disk menu and its features.

MS-DOS® is a US registered trademark of Microsoft Corporation.

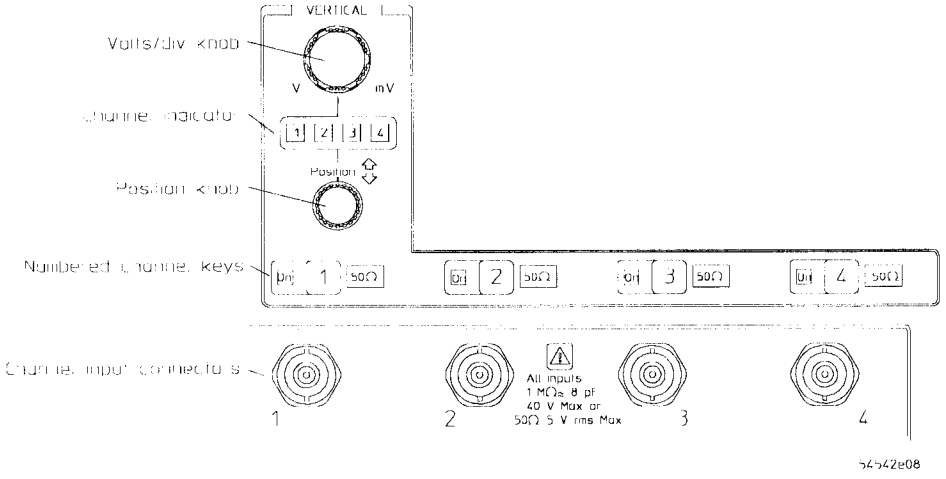
Vertical

Vertical

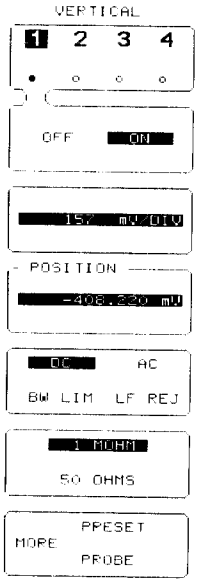
This chapter describes the portion of the oscilloscope that controls the vertical display of waveforms and the acquisition parameters. On the portion of the front panel marked VERTICAL are the volts/division knob, position knob, and the numbered front-panel keys for the channel menu for each channel.

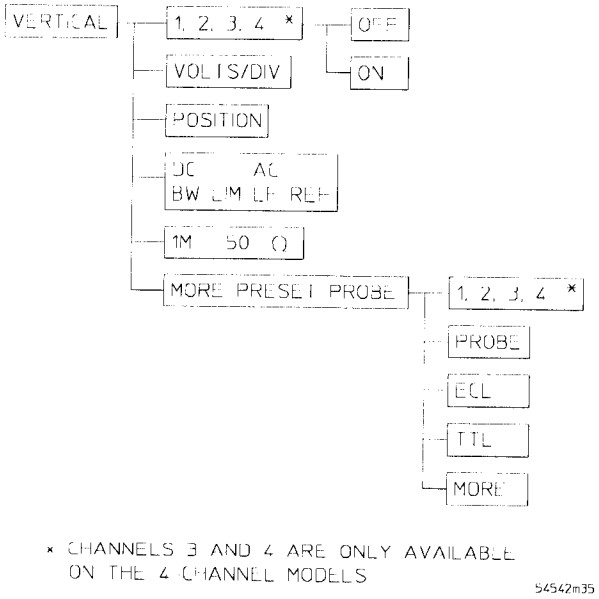
The volts/div knob changes the vertical scaling for the selected channel. The channel indicator tells you which channel's parameters you are changing with the vertical menu or the knobs. The position knob moves displayed waveforms vertically on the display. The numbered channel keys bring up the vertical menu on the display and turns the channel on or off. The On indicator is lit when a channel is turned on, and the 50 Ω indicator is lit when the channel input impedance is set to 50 Ω.

The 2-channel models have two input channels and an external trigger input. The 4-channel models have four input channels and no external trigger input. Each channel is shunted by about 7 pF at the input BNC with a maximum input voltage of 250 V.



When you press a numbered channel key on the front panel, the vertical menu that corresponds to the key you pressed is displayed on the right hand portion of the screen. The vertical menu and menu map are shown below.





* CHANNELS 3 AND 4 ARE ONLY AVAILABLE ON THE 4 CHANNEL MODELS

54542m35

Channel Softkey

The top key in the vertical menu is for channel selection. This key toggles between channels. You can use the channel softkey to select a channel or you can use the numbered channel keys on the front panel to select a channel. When a channel is selected (highlighted), you can turn that channel on or off. When a channel is turned on, the small circle immediately below the channel number is highlighted, and the LED is turned on. When you turn a channel off, the channel menu automatically switches to the lowest numbered active channel.

Because you may have a channel turned on while being in the vertical control menu of a different active channel, make sure you that you are changing the functions for the channel you intend to change. You can tell which channel you are affecting by checking which number is lit directly below the volts/div knob, or by noting which channel is in inverse video in the vertical menu.

Vertical Sensitivity Softkey

The **VERTICAL SENSITIVITY** softkey is the third softkey from the top in the channel menu. The current volts/division is displayed with the units of the currently selected channel. You can use the volts/div knob to change the vertical scaling at any time, even if you are in a different menu or even when the **VOLTS/DIV** softkey is not the active function. However, when the **VOLTS/DIV** softkey is the active function, you can use the volts/div knob, the entry knob, or the keypad to change the vertical scaling of the selected channel.

When the probe attenuation is set to 1:1, the vertical sensitivity range is from 1 mV/division to 5 V/division, and it changes in a 1-2-5 sequence. You can use the keypad to enter values not in the normal 1-2-5 sequence. When the Fine key is selected, you can make fully calibrated vernier adjustments using the entry knob. When the Show key is pressed, the current vertical sensitivity is shown at the right of the waveform display for channels that are turned on.

Position Softkey

The **POSITION** softkey is the fourth softkey. Selecting position assigns position as the active function. You can use the position knob to change the position setting at any time, even if you are in a different menu or when position is not the active function. When position is the active function, you can use either the position knob or the entry knob to change the position setting of the selected channel.

position moves the trace vertically up or down similar to the vertical position adjustment on an analog oscilloscope. However, because digital oscilloscopes have a true dc offset at the front end, they provide a much wider offset range. When the Show key is pressed, the position voltage is shown at the right of the waveform display. The position value is the voltage level at the vertical center of the screen.

Coupling Softkey

The **COUPLING** softkey has several selections: dc, dc BW lim (dc bandwidth limited), ac, ac BW lim (ac bandwidth limited), and ac LF reject (ac low-frequency reject).

CAUTION 

Because the 50 Ω selection sinks more current than the 1MΩ setting, make sure you do not exceed the maximum rated input of the channel when switching from 1MΩ to 50 Ω.

When dc is selected, 1 MΩ and 50 Ω dc input impedances are available as choices for input impedance. When ac is selected, only 1 MΩ is available for input impedance. Bandwidth limit is switchable for both ac and dc coupling. Bandwidth limit, LF reject, and ac coupling filter both the vertical and trigger paths.

- dc — The dc bandwidth of the scope, which is 500 MHz.
- dc bandwidth limit — Adds a 30 MHz low-pass filter.
- ac — Adds a 10 Hz high-pass filter.
- ac bandwidth limit — Band-pass filter that consists of a 10 Hz high-pass filter and a 30 MHz low-pass filter.
- LF reject — Adds a 400 Hz, high-pass filter.

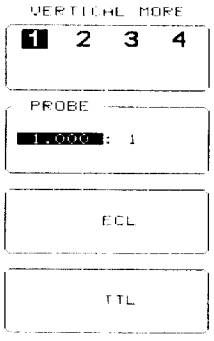
See Also

"Edge Trigger Mode" in chapter 5 for information about ac coupling or adding LF reject to the trigger path separately from the vertical path.

Input Impedance Softkey

The **INPUT IMPEDANCE** softkey allows you to select the input coupling impedance. The choices are 1 MΩ for ac coupling and selectable 1 MΩ or 50 Ω dc when dc coupling is selected in the coupling function. When 50 Ω is selected, the 50 Ω indicator LED on the front panel is lit for that channel.

More Preset Probe Softkey



The **MORE PRESET PROBE** softkey gives you access to a second-level channel menu.

Probe Softkey

The **PROBE** softkey allows you to select a probe attenuation from 0.9000:1 to 1000:1. Attenuation is adjusted by either the entry knob or keypad. When the entry knob is in coarse mode, adjustments are incremented or decremented in the 1-2-5 sequence. When in the fine mode, adjustments are in 0.1 increments.

Probe attenuation affects scaling factors for the display, not the sensitivity at the input connector. Also, the attenuation factors are saved with the front panel setups. You can let the oscilloscope calibrate (calculate) the probe or cable attenuation for you in the utility menu.

See Also

"Probe Cal Menu" in Chapter 11 for information on probe calibration.

ECL Softkey

The **ECL** softkey sets the oscilloscope to levels optimized for ECL circuits:

- V/Div 200 mV/div (400 mV/div if the number of screens is 2, and 800 mV/div if the number of screens is 4)
- Offset −1.3 V
- Coupling dc
- Trigger level −1.3 V
- Trigger slope No change

Recall 0 returns the menu to the previous settings.

TTL Softkey

The **TTL** softkey sets the oscilloscope to levels optimized for TTL circuits:

- V/Div 1 V/div (2 V/div if number of screens is 2, and 4 V/div if number screens is 4)
- Offset 2.5 V
- Coupling dc
- Trigger level 1.4 V
- Trigger slope No change

Recall 0 returns the menu to the previous settings.

More Softkey

The **MORE** softkey returns you to the vertical menu.

Horizontal

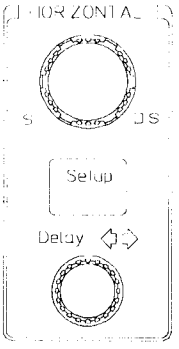
This chapter contains a description of the portion of the oscilloscope that controls the horizontal display of waveforms and the acquisition parameters. You may notice that the front panel is divided into several areas. On the area of the front panel marked HORIZONTAL are the time/division knob, delay knob, and the setup key for the horizontal menu.

The time/div knob changes the horizontal scaling for displayed waveforms. The setup key brings up the horizontal menu on the display. The delay knob moves displayed waveforms horizontally across the display.

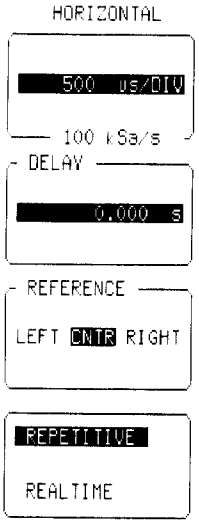
Time/div knob

Setup key

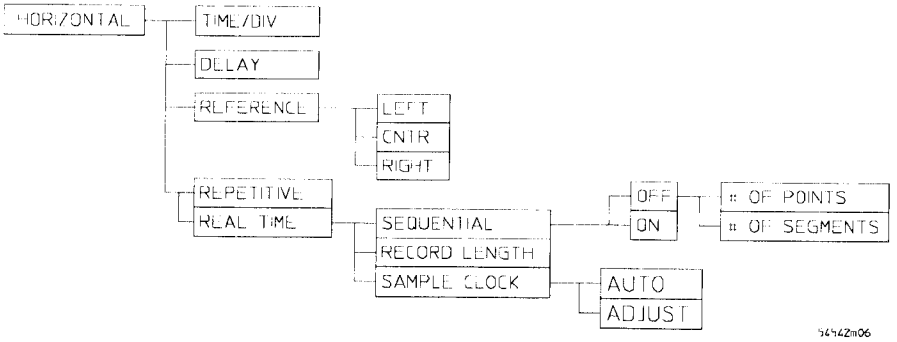
Delay knob

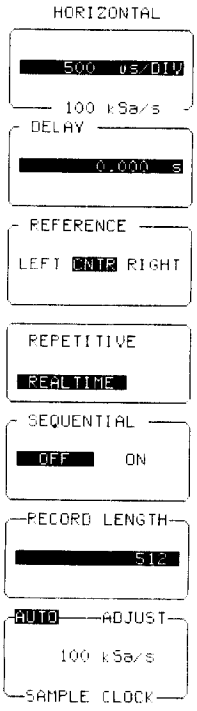


54542L23



When you press the horizontal Setup key on the front panel, the horizontal menu is displayed on the right hand portion of the screen. The horizontal softkey menu and menu map are shown below. When the real-time mode is selected, three additional softkeys are added to the softkey menu.





When real time is selected, these three keys are available.

Time/Div Softkey

The top softkey in the horizontal menu is the **TIME/DIV** softkey, which displays the horizontal scaling factor. When the scope is running, this softkey also displays the current sample rate. You can use the horizontal knob to change the time base scaling at any time, even if you are in a different menu or when the time/div softkey is not the active function. However, when the time/div softkey is the active function, you can use either the horizontal knob, keypad, or the entry knob to change the horizontal scaling.

Horizontal scaling changes in a 1-2-5 sequence from 500 ps/div to 5 s/div. When the HP 54540C is samping at 1 GSa/s in the real-time mode, the 500 ps setting is not available. When the HP 54540C and HP 54520C are sampling at 500 MSa/s in the real-time mode, the 500 ps and 1 ns setting are not available. The fine key does not affect the time base sequence while the acquisition is running, unless the auto adjust softkey is set to adjust.

The horizontal scale setting affects the sample rate at which the oscilloscope acquires data, except when the sample clock softkey is set to adjust in the real-time mode. When the scope is running, the current sample rate is displayed below the time/div setting in the time base menu.

In the real-time mode and with the acquisition stopped, the time/div knob also controls the zoom feature. By observing the memory bar, you can tell what portion of the memory is being displayed.

An acquisition is not displayed on the screen until all data is available. The data is available when the waveform record is full. The advisory "running" is displayed after the scope triggers.

When the sample clock and record length are set such that it takes two seconds or longer to collect the data, the advisory "*n* sec (prestore)" is displayed while pretrigger data is collected, and "*n* sec (poststore)" is displayed while posttrigger data is collected. These messages indicate the time needed to complete an acquisition, where *n* is the remaining time in seconds, and continues to count down until the time has elapsed.

The total time acquired and the sample rate are dependent on the sample clock setting and the selected record length of the acquisition (as per table 4-1).

See Also

"Repetitive/Real-Time Softkey" in this chapter for information on sampling modes.

Delay Softkey

Selecting delay assigns delay as the active function. You can use the delay knob to change the delay setting at any time, even if you are in a different menu or when delay is not the active function. However, when delay is the active function, you can use either the delay knob, keypad, or the entry knob to change the delay setting.

The trigger event always occurs at time zero. When delay is set to 0, the trigger point occurs at the delay reference point. Positive delay indicates time after trigger (posttrigger) and negative delay indicates time before trigger (pretrigger). For example, a delay setting of –50 ns indicates that the trigger event occurs 50 ns after the delay reference point. Viewing pretrigger information is a useful feature because you can see the events that led up to the trigger event.

In the real-time mode and with the acquisition stopped, delay also controls the pan feature. If you watch the memory bar just above the waveform area, you can see what portion of the memory you are panning across.

Pan and Zoom

The normal running mode displays 500 points on the screen. But when the scope is stopped, you can observe any portion or all of the waveform record by using pan and zoom. The pan and zoom feature performs the same function as the time base windowing feature used in many digitizing oscilloscopes. The pan and zoom feature is available in the real-time acquisition mode and is operable only when the acquisition is stopped. Applications that require precise evaluation of low-repetition-rate signals, such as radar and transponder pulse trains, are simplified by zooming and panning on single-shot data.

Zooming either expands or compresses the acquired waveform on the horizontal axis of the display. It is controlled by the time/div controls, and it is used for expansion or compression of a single-shot waveform in the real-time mode. Increasing time/div compresses the waveform and is referred to as "zooming out." Because you can acquire record lengths up to 32,768 and the display is limited to 500 points when the scope is running, you may find situations when zooming out that up to 65 sample points can be mapped to one pixel column. Decreasing time/div expands the waveform and is referred to as "zooming in."

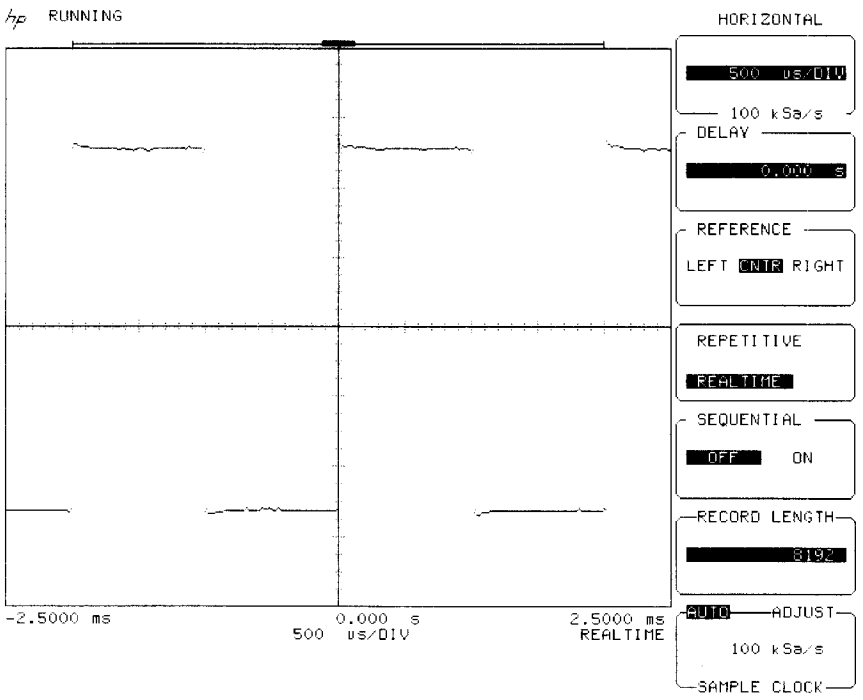
Panning is moving the acquired waveform horizontally on the display. It is controlled by the time base delay controls. Increasing delay moves the waveform to the left and decreasing delay moves the waveform to the right. By observing the memory bar, you can tell what portion of the memory is being displayed.

Pan and Zoom Exercise

This exercise shows how to use the time base to zoom in and to zoom out on a single-shot waveform. Then, you use delay to pan the waveform horizontally on the display.

1. Press the Recall key. Then, press the Clr key.
2. Connect a coaxial cable between the rear-panel AC connector and channel 1.
3. Press the Autoscale key.
4. Use the time/div knob to change the time base to 500 µs/div.
5. Press the Horizontal Setup key. Then, select the **REAL-TIME** mode.
6. Press the **RECORD LENGTH** softkey. Then, use the entry knob to set the record length to 8192 points.

Figure 4–1



7 Press the Stop/Single key. Then, press the Clear display key.

8 Press the Stop/Single key to perform a single-shot acquisition.

9 While watching the display, rotate the time/div knob. Then, rotate the delay knob.

Selecting slower time/div settings zooms out (displays more of the acquired waveform on the screen), while selecting faster time/div settings zooms in on the acquired waveform. You may notice that when zooming in or out on a waveform, the memory bar indicates what portion of the waveform record is currently displayed on the screen.

Changing the delay setting pans across the data in the waveform memory. You may notice that the memory bar moves to the left or right as the acquisition is panned. You can use both panning and zooming to examine an acquisition.

10 Use the time/div knob to change the time base to 10 ms/div. Then, use the delay knob to set the delay to 0.00 s.

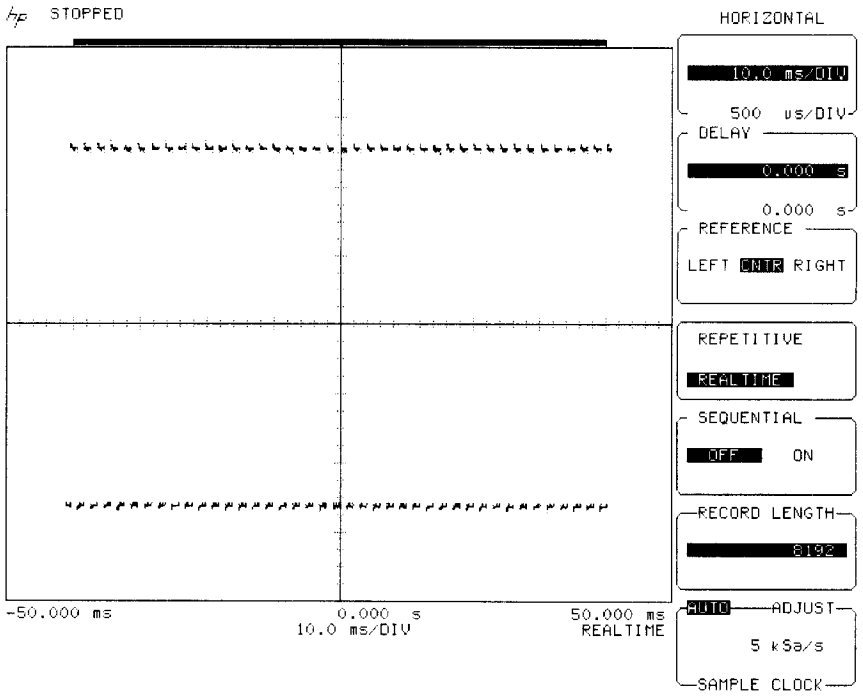
All of the data in the waveform record is displayed on the screen. Because the sample rate is 100 kSa/s and the record length is 8192, you can use the following formula to calculate the amount of captured data.

$$\frac{1}{Sample\ Rate}\ (Record\ Length) = Time\ Duration\ of\ the\ Record$$

$$\frac{1}{100\ ^{kSa}/_{s}}\ (8192) = 81.92\ ms$$

There are 81.92 ms of data in the waveform record, and indeed, figure 4-2 shows 81.92 ms of data. That is why the waveform does not fill the screen. The memory bar also indicates that the entire waveform memory is on the screen.

Figure 4–2



11 Set the time base back to 500 µs/div, and set the waveform record to 512 points.

12 Press the Clear display key. Then, press the Stop/Single key.

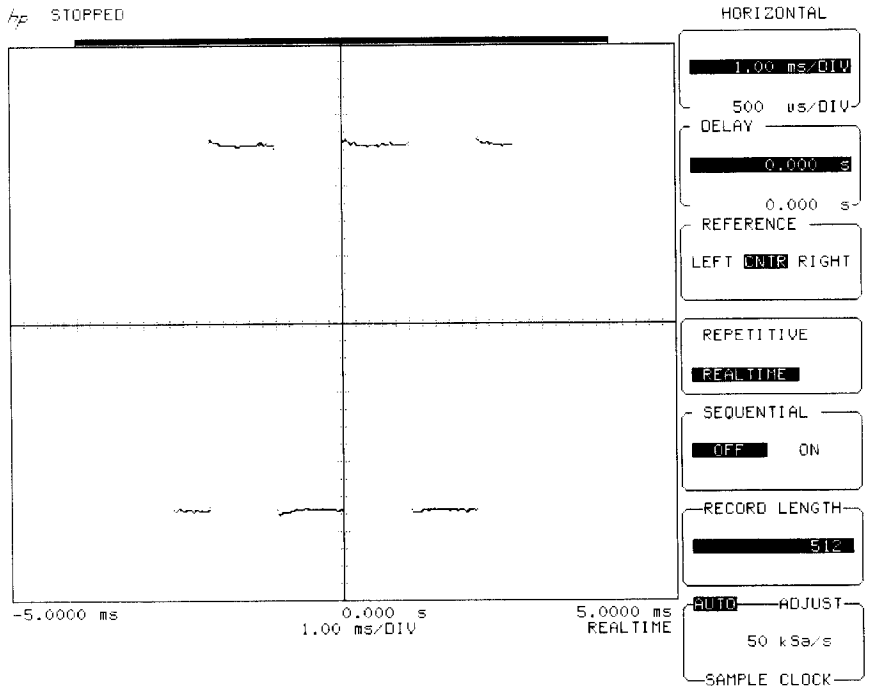
13 Use the time/div knob to change the time base to 1 ms/div.

Because of the shorter record length, there is now only 5.12 ms of data in the waveform record.

$$\frac{1}{100\ ^{kSa}/_{s}}(512) = 5.12\ ms$$

Because there is less data in the waveform record, you only need to zoom out to 1 ms/div to have the entire waveform record on the display.

Figure 4–3



Reference Softkey

The **REFERENCE** softkey changes the delay reference point to one of three reference points: left, cntr (center), or right. The time from the trigger changes with the delay setting, and is displayed below the waveform area at the left, center, and right of the display. If delay is set to 0 and reference is set to center, pretrigger data is to the left of the reference point and posttrigger data is to the right of the reference point.

Center

The data is acquired evenly on both sides of the reference point. The data in the waveform record is centered around the reference point, and changing the scale expands or contracts the signal about the reference point.

Left

The data is acquired starting at the reference point, and the data in the waveform record is all posttrigger data.

Right

The data is acquired before the reference point, and the data in the waveform record is all pretrigger data.

Repetitive/Real Time Softkey

The **REPETITIVE/REAL TIME** softkey selects one of the two acquisition modes used by the oscilloscope: repetitive and real time.

Repetitive

The repetitive mode (also known as equivalent time) sets the oscilloscope to acquire data in the repetitive acquisition mode. In this mode, the data from many acquisitions may be interleaved, which can result in a greater effective sample rate. At 50 ns/div and slower, enough data is acquired on each acquisition that interleaving acquisitions is not required. In the repetitive mode, the sample rate is dependent on the time/div setting. The sample rate from 500 ps/div to 50 ns/div is 1 GSa/s. At settings slower than 50 ns/div, the sample rate is reduced, depending on the selected time/div setting. For example, at 50 ns/div the sample rate is 1 GSa/s, and at 50 µs/div the sample rate is 1 MSa/s. You can calculate the number of points captured on one trigger and plotted to the screen in both the real-time and repetitive modes with the following formula.

Number of points = sample rate × time/div setting × 10

The repetitive mode is typically used on repetitive signals. You can still use the repetitive mode for single-shot applications. However, because the interpolation filter is turned off in the repetitive mode, the maximum single-shot frequency you can reasonably view and also avoid aliasing is about one-tenth the current sample rate. Also, the record length is the size of the screen.

Because the oscilloscope is in the repetitive mode, the sample rate is dependent on the time base setting. To ensure a full screen display of 500 points on the slower time base ranges, as the time base is slowed down the sample rate is also slowed down.

You can view the data using the normal, averaged, and envelope display modes. You can average data from multiple acquisitions by selecting averaging in the display menu, or you can choose to display data for a definable period of time (persistence) by using normal in the display menu.

See also

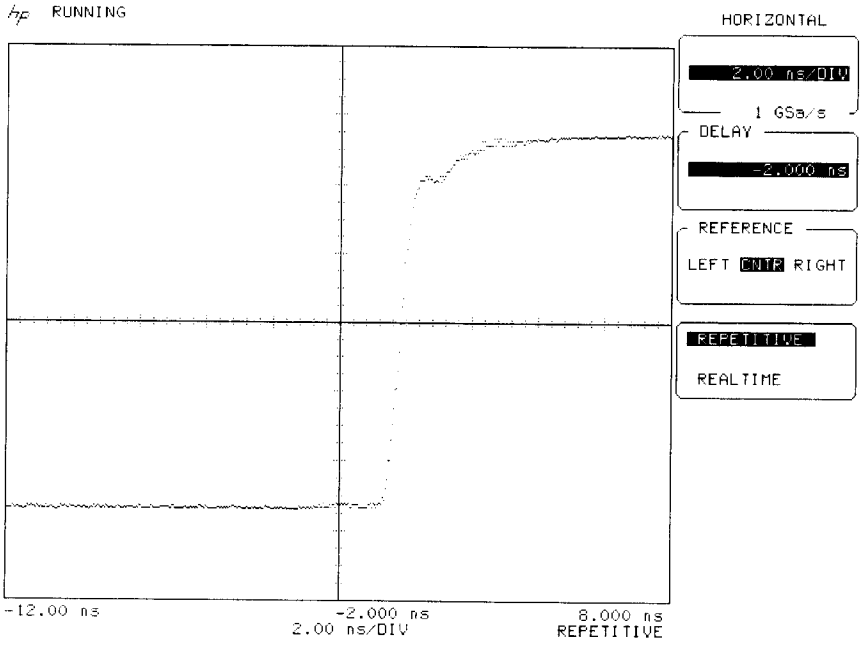
Chapter 7, "Display Menu," for information on acquisition modes.

Repetitive Single-Shot Exercise

This exercise shows the single-shot capabilities of the oscilloscope in the repetitive mode. The exercise uses single-shot acquisitions in the repetitive mode to build a waveform while displaying the 1-GSa/s sample rate.

1. Press the Recall key. Then, press the Clr key.
2. Connect a coaxial cable between the rear-panel AC connector and channel 1.
3. Press the Autoscale key.
4. Use the time/div knob to change the time base to 2 ns/div. Then, use Delay knob to horizontally move the signal so it is slightly to the right of center screen.
5. Press the Horizontal Setup key. Then select the **REPETITIVE** mode.

Figure 4–4



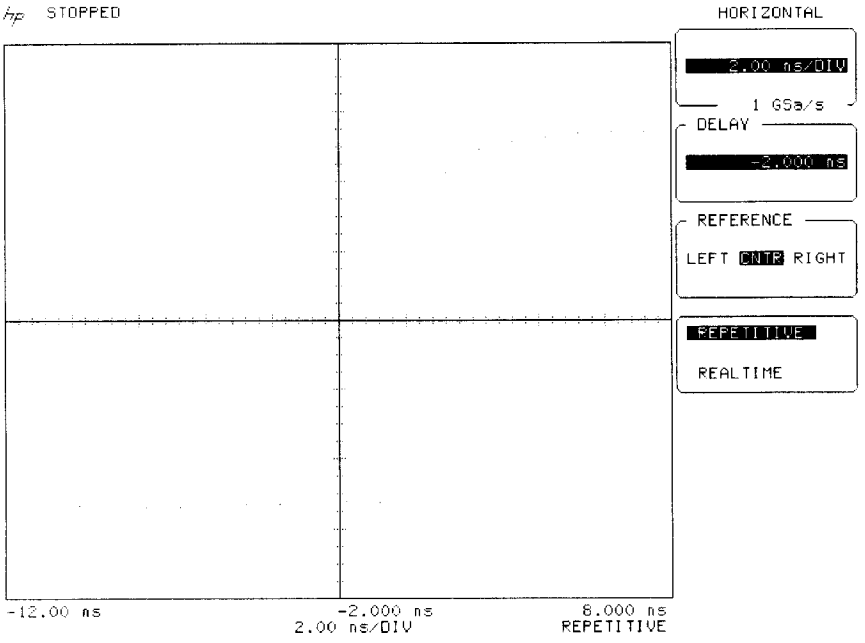
6 Press the Stop/Single key to stop the acquisition. Then, press the Clear display key.

7 Alternately press the Stop/Single and Clear display keys to alternately display and erase the single-shot data.

At 2 ns/div, 20 points are captured. Because interpolation is turned off in the repetitive mode, only 20 points are displayed on the screen with each new acquisition. Because the sample rate is 1 GSa/s, the data points are 1 ns apart. The 20 data points are referred to as raw data because they are the actual data points that are captured.

At 20 ns/div and faster, it may take several acquisitions to fill the screen (all 500 pixel columns). At 50 ns/div and slower, each acquisition contains enough data to fill the screen and the screen is completely refreshed with each acquisition in the minimum persistence mode.

Figure 4–5



8 Press the Stop/Single key repeatedly without pressing the Clear display key.

By not pressing the clear display key, the waveform fills in with each single-shot addition to the waveform. Interpolation is still turned off and 40 points are captured with each acquisition. The waveform fills in because the data from previous acquisitions is retained on the screen and each new acquisition is interleaved with the previous data.

When averaging is off and persistence is set to minimum If newly acquired data points fall into time buckets that are empty, the data points are stored in the time buckets and the display is updated. If a time bucket already contains a data point, the old data is replaced by the new data point. Data stays on screen until you modify the instrument setup or you press the Clear display key.

When averaging is on If newly acquired data points fall into time buckets that are empty, the data points are added to the time buckets and added to the display. If a time bucket already contains a data point, the new data is averaged with the old data point. Depending on how many data points are acquired with each acquisition, it can take multiple acquisitions to meet the number of averages selected. At 50 ns/div and slower, enough data is acquired so that each acquisition corresponds to one average.

Real-Time

The real-time mode sets the oscilloscope to acquire data in the real-time acquisition mode. In this mode, all the data points that make up a waveform come from one trigger event.

The real-time mode is typically used to capture signals that happen either once or infrequently. The oscilloscope can simultaneously capture a single-shot acquisition on all channels at sampling rates up to 2 GSa/s. This allows the capturing of simultaneous, nonrecurring, or low-repetition-rate events at the same time.

In the real-time mode, you can set the sample rate to auto or adjust, and you can vary the record length. When real time is selected, three additional softkeys are displayed: sequential key, record length, sample clock. Each of these keys are discussed later in this chapter. You can calculate the amount of time captured in memory in the realtime mode using the following formula.

Time = record length ÷ sample rate

See also

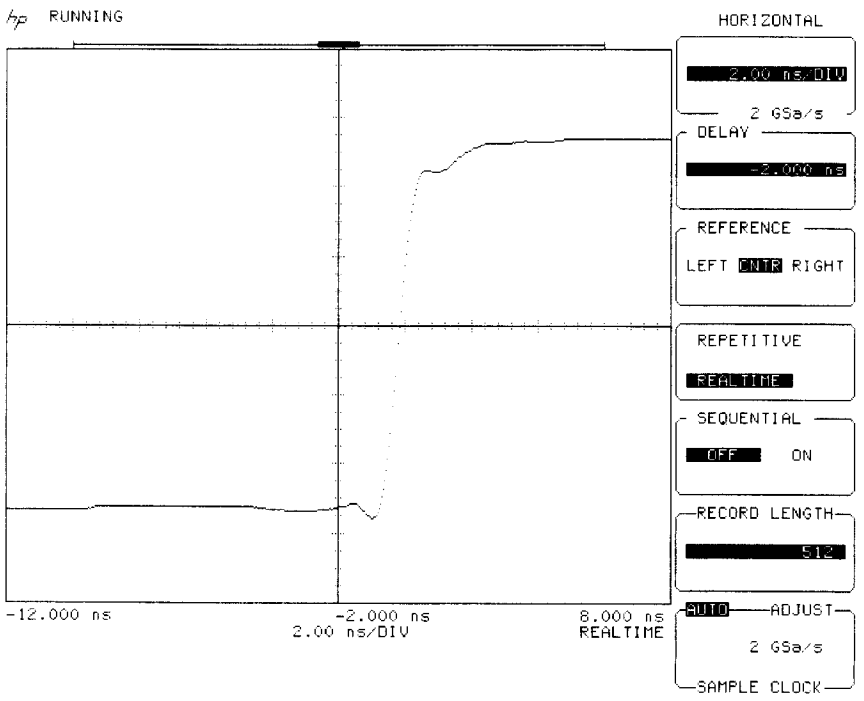
Feeling Comfortable with Digitizing Oscilloscopes, that is supplied with the oscilloscope, for additional information on repetitive and real-time sampling.

Real-Time Single-Shot Exercise

In the real-time mode, data is interpolated (reconstructed) at the faster time base settings for an improved display of the waveform. The 2-GSa/s sampling rate of the oscilloscope allows the capture of very fast nonrecurring events, like a microprocessor start-up sequence, or error-causing glitches that disrupt system performance. This exercise shows you the difference between noninterpolated and interpolated data:

1. Press the Recall key. Then, press the Clr key.
2. Connect a coaxial cable between the rear-panel AC connector and channel 1.
3. Press the Autoscale key.
4. Use the time/div knob to change the time base to 2 ns/div. Then, use the delay knob to horizontally move the signal so it is slightly to the right of center screen.
5. Press the Horizontal Setup key. Then select the **REAL-TIME** mode.

Figure 4–6

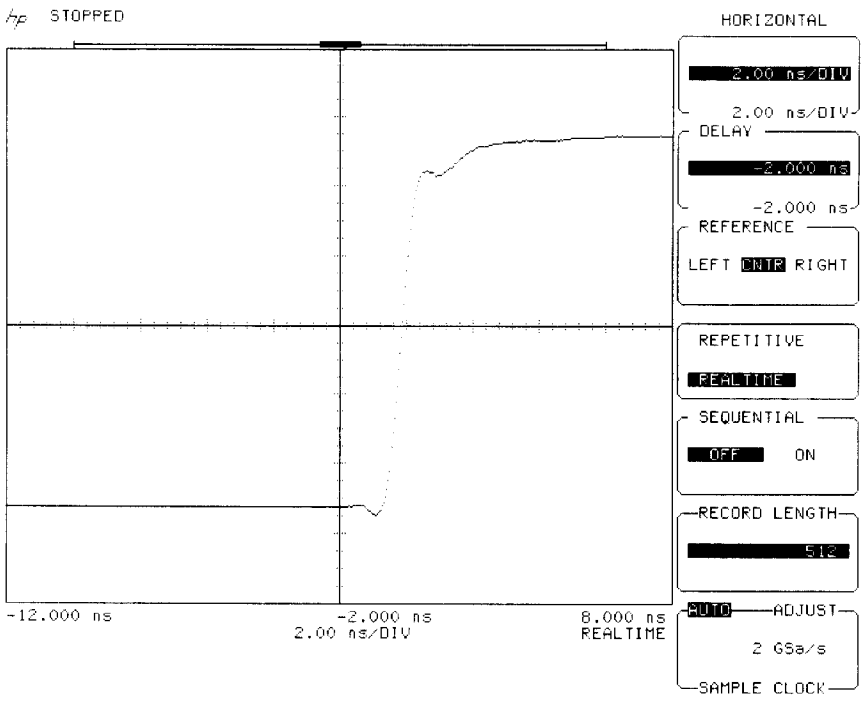


6 Press the Stop/Single key to stop the acquisition. Then, press the Clear display key.

7 Press the Stop/Single key to acquire a single-shot acquisition.

In the Repetitive Single-Shot Exercise, only the 20 raw data points that were captured are displayed at the 2 ns/div sweep speed. Even though 40 points are captured in the real-time mode, the interpolator fills in the remaining 461 points so that 501 points are displayed on the screen.

Figure 4–7



To see the raw data points, turn off the interpolator in the real-time mode.

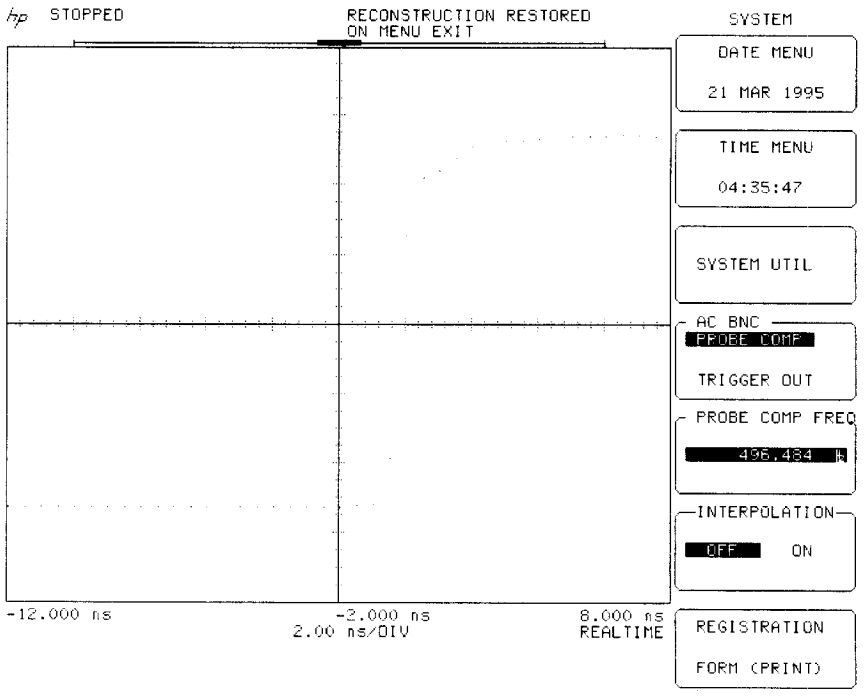
To turn the interpolator off in the real-time mode:

1 Press the **Utility** key.

2 Press the **SYSTEM MENU** softkey.

3 Set the **INTERPOLATION** softkey to **OFF**.
When you exit the utility menu, the interpolator is automatically turned on.

Figure 4–8 **Single-shot acquisition using the real-time sampling mode and with the interpolator turned off.**



Memory Bar

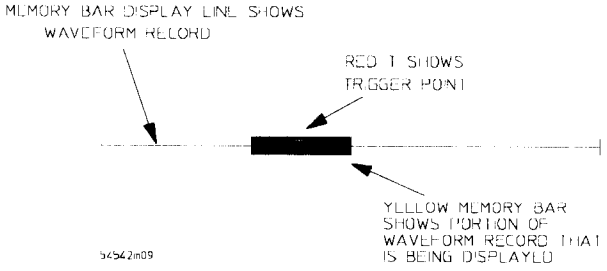
When the real-time mode is selected, the memory bar is displayed above the graticule area, except when the compare mode is active. When the compare mode is active, the memory bar is replaced by the fail bar. Figure 4-9 shows the components of the memory bar.

The memory bar display line represents the entire waveform record. The memory bar represents the displayed portion of the waveform record. The memory bar at the top of the display moves as the delay changes. The "T" indicates the location of the trigger point within the waveform record.

You can view the waveform from three different positions with respect to the trigger point by selecting left, center, or right with the reference softkey.

When the acquisition is stopped, you can place the display at any portion of the waveform record by changing the delay setting. The delay knob moves the acquisition display relative to the trigger point.

Figure 4–9



Memory Bar Exercise

This exercise demonstrates how to use the memory bar to display those captured portions of the waveform that occur before and after the trigger event. The memory bar shows the portion of the waveform record that is being displayed.

1 Press the Recall key. Then, press the Clr key.

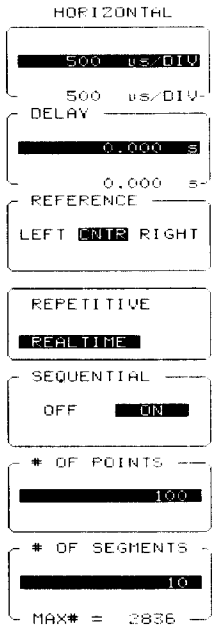
2 Connect a coaxial cable between the rear-panel AC connector and channel 1.

3 Press the Autoscale key. Then, press the Stop/Single key to stop the acquisition.

4 While watching the memory bar, use the delay knob to move the waveform horizontally on the screen.

As the delay value is changed, the memory bar moves to the right or to the left, depending on whether the delay value is positive or negative. Negative delay values show pretrigger events and positive delay values show posttrigger events.

Sequential softkey



Sequential single-shot is a real-time feature that is used to maximize the oscilloscope's data capture rate while improving memory efficiency. You define the number of points the oscilloscope captures on each acquisition and the number of segments (events) that are captured. You can make measurements, calculate waveform math functions, or use pan and zoom on captured segments. Also, a time tag is placed on each captured event. The time tag allows you to determine when a captured segment occurred with respect to the first captured segment.

Normal oscilloscope operation is a 5-step process:

- Acquire new data into high-speed memory.
- Transfer the data to slower, conventional memory.
- Process the data.
- Make measurements on the data.
- Display the data.

The last three steps — processing, measuring, and displaying the data — takes up most of the oscilloscope's time. This time span is also referred to as oscilloscope dead time because the oscilloscope is not acquiring new data at that time. The sequential single-shot mode delays performing the last three steps until after all of the selected events are acquired.

Use the sequential single-shot mode when you need to rapidly capture events by minimizing oscilloscope dead time, or when there is a significant dead time between events and you are interested in the events rather than the time between events. For example, if you have a series of 100-ns pulses that are 10 ms apart, the time between pulses is 100,000 times greater than the width of each pulse. If you are only interested in specific events, you can adjust the triggering and you can set the number of points so only the events you are interested in are captured (pulses, rising edges, or falling edges). Then, you can set the number of segments to capture the number of events you want to analyze. The time tag feature allows you to piece together the captured events in time with respect to the first event.

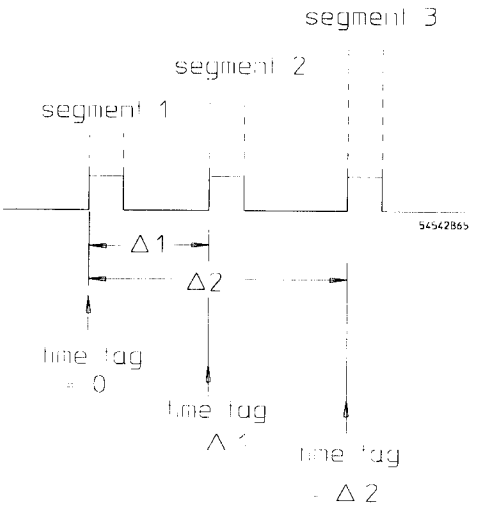
The total sequential memory is 400k words, and it is allocated depending on how many points and segments are selected. A single-channel acquisition can use up to 400k words, while a dual-channel acquisition can use up to 200k words per channel. Acquired data is not lost when the sequential single-shot mode is exited. Sequential data is retained unless one of the following events happen:

- Another sequential single-shot capture is performed.
- Failure data is saved to multiple memories using the limit or compare tests.
- Power is cycled.

To allow the scope to power up in the running mode, sequential signal-shot is turned off when the power is cycled.

Sequential single-shot is only available when the oscilloscope is in the real-time mode. You may notice that this key is initially displayed in the off position (sequential single-shot disabled), allowing for normal real-time mode operation. When the sequential mode is set to on, the # of points (number of points) and # of segments (number of segments) softkeys are displayed

Figure 4–10



When the sequential softkey is set to on, the screen is cleared and the oscilloscope is placed in the stopped state to allow selection of the acquisition parameters (number of points and segments). The sample rate is set by the time/div knob.

Pressing the run key starts data acquisition. While the oscilloscope is acquiring data, the message "ACQUIRING" is displayed. If the oscilloscope is waiting for a trigger, "ACQUIRING # n" is displayed (where n is the segment number the oscilloscope is waiting to acquire). After all of the segments are captured, the message "sequential data captured, processing..." is displayed. After the data is processed, the message "sequential data processed, select DISPLAY menu" is displayed. You can press the Stop/Single key at any time to stop the acquisition process.

See also

Chapter 7, "Display Menu," for information on displaying acquired sequential single-shot data.

of points softkey

The number of points softkey defines how large a segment is, and you can think of a segment as an event. An event can be a piece of a pulse or it can be several pulses. You can specify any number of points from 4 to 32,768. Because 500 points are displayed for a normal screen display, you can use the pan and zoom feature to view segments that are larger than 500 points.

of segments softkey

The number of segments softkey defines how many segments the oscilloscope is to acquire. The maximum number of available segments is displayed at the bottom of the softkey. This number is dependent on the number of points, record length, and the number of active channels. If all of the channels are off, the softkey is disabled.

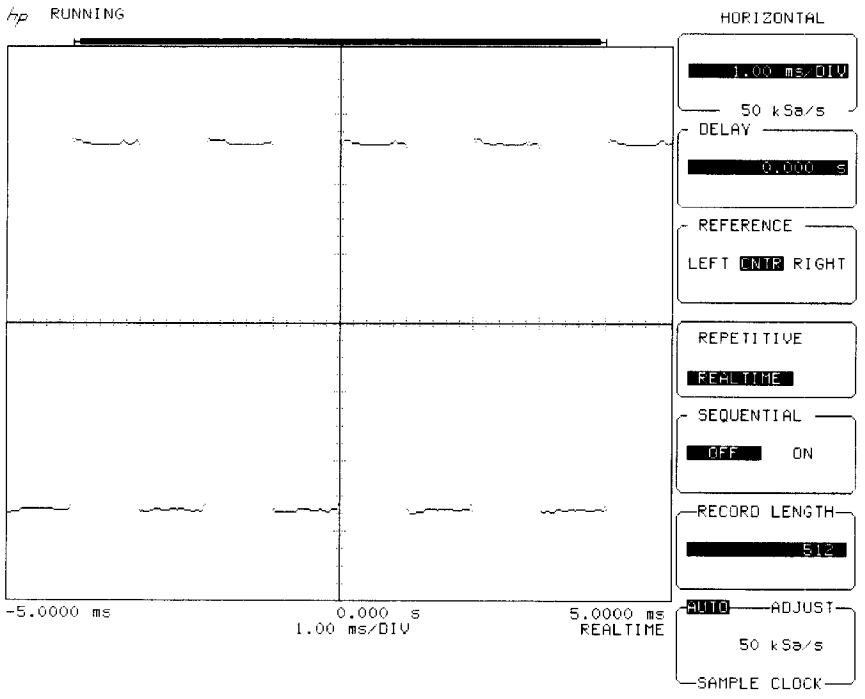
Sequential Single-Shot Exercise

This exercise uses a 500-Hz square wave to demonstrate the sequential single-shot feature. You set up the oscilloscope to capture one pulse on each acquisition, and to capture a total of 10 pulses.

1. Press the Recall key. Then, press the Clr key.
2. Connect the oscilloscope's rear-panel AC CALIBRATOR signal to channel 1 with a coaxial cable.
3. Press the Autoscale key.
4. Use the time/div knob to change the time base to 1 ms/div.

   You may notice that there are five pulses on the screen. Because there are 500 points across the screen, each pulse takes up about 100 points.
5. Press the Horizontal Setup key. Then, select the **REAL-TIME** mode.

Figure 4–11



6 Set the **SEQUENTIAL** softkey to **ON**.

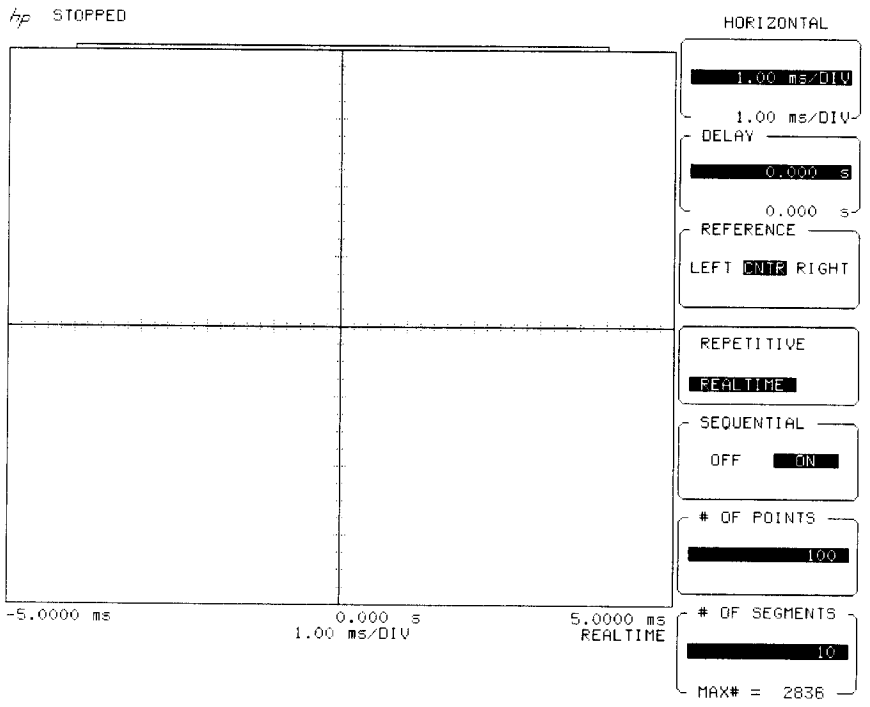
7 Press the **# OF POINTS** softkey, Then, use the keypad or entry knob to set the **# OF POINTS** to 100.

Set the number of points to capture the event of interest. For this exercise, 100 points are used because each pulse takes up about 100 points on the screen, and because this exercise is using a pulse as an event. You could also have used 200 points to capture two pulses, or 25 points to capture part of a pulse. You can also increase the sample rate to use more points to capture the pulse.

8 Press the **# OF SEGMENTS** softkey. Then, use the keypad or entry knob to set the **# OF SEGMENTS** to 10.

Set the number of segments to capture the number of events you are interested in. Below the selected number of segments is the maximum number of segments allowed. You may notice that as you increase the selected number of points, the maximum number of segments the scope can capture decreases. For this exercise, 10 segments were chosen, so that 10 pulses are captured.

Figure 4–12



9 Press the Run key to capture and process data.

You may notice that the oscilloscope captures all of the data before the data is processed.

10 Press the Display key. Then, set the **DISPLAY** softkey to **NORM** (normal).

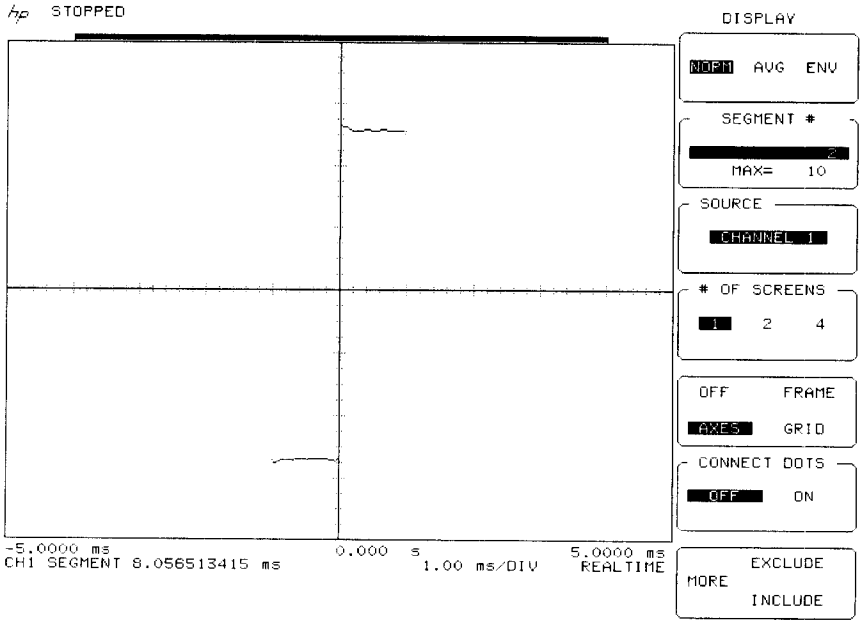
The captured segments are viewed in the display menu.

11 Press the **SEGMENT #** softkey. Then, use the entry knob to display each of the ten segments.

You may notice that below the graticule area a time tag is displayed for each segment. The scope captures only the number of points you specify for each segment. The time tag allows you to determine when the trigger for each subsequent segment occurred in relation to the trigger event for the first segment. You may notice that each of the time tags is about 6 ms apart

The entry knob allows you to scroll through the 10 captured pulses (events). Turning the knob past ten allows you to view all of the segments simultaneously. Because viewing all the segments at once overlays the segments, you can notice if one of the events is radically different than the others. You can also set the display to average (average all the segments) or envelope, and you can use the more key to exclude or include segments.

Figure 4–13



Sample Clock Softkey

The sample clock softkey is available in the real-time mode only. Sample clock (sampling rate) and waveform record length (waveform memory) are closely tied together. Sampling rate determines how often the oscilloscope samples the signal you are measuring. Record length is the amount of memory the oscilloscope fills up before it updates the display and measurement results.

Usually, you use a high sample rate, so there are plenty of data points to better reconstruct the original waveform. For fastest throughput, use a short waveform record because the oscilloscope must fill up the waveform record before it updates the display and measurement results. The higher the sample rate, the faster the waveform record fills up. Therefore, a long waveform record slows down the throughput of the oscilloscope. As a result, you must often make a trade-off between sample rate and record length to achieve a desired throughput, both of which affect the measurement speed and accurate reconstruction of the waveform.

You may prefer to sacrifice measurement throughput by selecting a high sample rate and a long record length, or you may want to have a high sample rate and a short record length to maximize the measurement throughput.

Auto

Auto lets the oscilloscope select the sampling rate for you. The advantage is that the oscilloscope selects a sample rate that optimizes the way the waveform is displayed and the display update rate.

Adjust

Adjust lets you specify a sample rate. The maximum sample rate is always available to you regardless of the time/div setting. However, do not overlook the interaction among sample rate, record length, and measurement throughput. Also, when in the adjust mode, you can use the fine mode to adjust the time base range to values not in the normal 1-2-5 sequence.

Record Length Softkey

The record length softkey is available in the real-time mode only. The record length softkey allows you to sets the memory depth for the waveform record.

The time between the sample points equals 1 divided by the sample rate, and the amount of data in memory equals the time between the points times the number of points. For example, if the sample rate is 2 GSa/s and the record length is 512 points, the time between the sample points is 500 ps; and, 500 ps times 512 points is 256 ns of waveform data stored in the waveform record. Because there are ten horizontal divisions, set the time base to 20 ns/div to display the most of the waveform record. To display the entire waveform record, set the time base to 25 ns/div. To set the time base to 25 ns/div while the scope is running, set the sample rate to the adjust mode and press the Fine key.

$$\frac{1}{Sample\ Rate}\ (Record\ Length) = Time\ Duration\ of\ the\ Record$$

Each channel has its own 32K waveform memory. The default setting is 512. If you specify a 2K record, then each channel uses 2K of its available 32K record. You cannot specify a different record length for each channel. For single-shot applications, you may want to capture as much data as possible by using a 32K record. You can pan and zoom through the data at a later time. If you are not using pan and zoom, use a 512-point record, or use enough memory so all of the data that is acquired on each acquisition is displayed on the screen.

You can specify a record length from 512 points to 32,768 points with the entry knob. Remember that sample rate and record length work together. If you combine a short record length with a high sample rate, you will have a very fast throughput, but very little data in the record.

Because the shortest record length is 512 points and the screen displays 500 of these points, there are 12 data points in the waveform record that are not displayed at sweep speeds of 50 ns/div and faster. You can use pan and zoom to view any data points that are not displayed.

Trigger

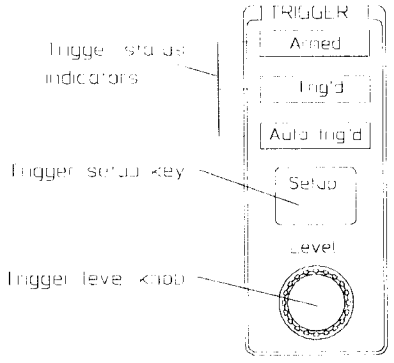
Trigger

The trigger modes of the oscilloscope provide many distinctive techniques for triggering and capturing data. The triggering capabilities range from simple edge triggering to logic triggering on multiple signals.

This chapter contains descriptions of the triggering modes, and explanations on how to use them. The oscilloscope has six triggering modes: edge, pattern, state, delay, TV, and glitch.

The three lights indicate the present status of the trigger circuitry in the oscilloscope.

- Armed — The oscilloscope is waiting for a trigger event to occur.
- Triggered — The oscilloscope triggered on a valid trigger event.
- Auto Triggered — Valid trigger events are not occurring, and the oscilloscope is automatically triggering because it is in the auto sweep trigger mode.



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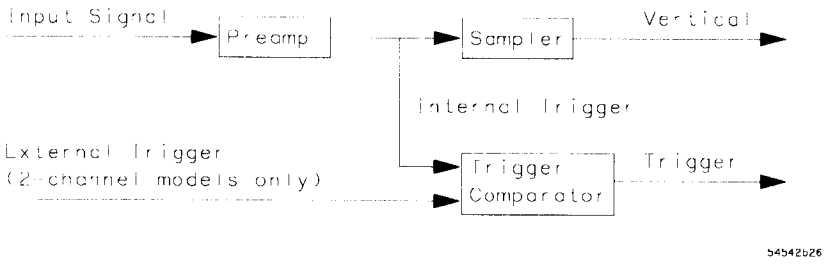
Trigger Basics

A trigger event is defined as an edge of a selected slope (either positive or negative) that transitions through a selected voltage (trigger level). This is referred to as the edge trigger mode. Events leading up to the trigger event are referred to as occurring in negative time, and events that occur after the trigger event are referred to as occurring in positive time. No matter what mode the trigger circuit is in, a valid trigger is always caused by an edge.

Additional trigger features are added, like logic triggering and holdoff, that allow you to further qualify the trigger event. The logic trigger modes are pattern, state, delay by time, and delay by events. Basically you can think of the logic trigger features as adding a 3- or 4-bit logic analyzer to your oscilloscope. The edge trigger mode looks at only one channel, while logic triggering allows you to qualify the trigger across all of the available trigger sources. Rather than clutter up the waveform record with useless data that you have to sift through, you can use logic triggering to pick out the area of the signal you are most interested in viewing. Then, you can use time base delay to view what happened before and after the trigger event.

The trigger circuit and sampler circuit operate in parallel. The sampler samples the input signal at a specific rate. The trigger circuit operates independently of the sampler circuit, and a trigger event does not have to occur at the same time as a sample point. Because the oscilloscope knows when the trigger event happened in relation to the sampled data, the oscilloscope knows where to place the sampled data on the display.

Figure 5–1



Common Trigger Softkeys

The top two softkeys are common to all of the trigger modes. The remaining trigger keys are discussed in the topic for each of the trigger modes.

You set the trigger level for the TV and Glitch trigger modes in the TV and glitch trigger menus.

Trig'd/Auto Softkey

The **TRIG'D** (triggered)/**AUTO** softkey toggles between the two trigger modes. The current selection is displayed in inverse video.

Triggered The oscilloscope displays data only after all of the trigger conditions are met. The triggered mode keeps the oscilloscope from displaying data on the screen before a specific trigger event occurs. After each trigger event, the trigger circuit is rearmed for the next trigger event.

Auto After the trigger circuit is armed, the oscilloscope waits for a trigger to occur. If a trigger does not occur, the oscilloscope triggers itself, and the data that is acquired with the trigger is displayed on the screen. The rate at which auto trigger occurs is dependent upon the sweep speed setting.

Use the Auto mode when you are unsure how to setup the trigger menu to trigger the oscilloscope. This mode forces the oscilloscope to trigger if a trigger event is not found, giving you glimpses of the signal, which then allows you to set up the oscilloscope to display the signal.

Mode Softkey

The second softkey selects the various trigger modes. The oscilloscope has six triggering modes: edge, pattern, state, delay, TV, and glitch. Each of these modes are discussed later in this chapter.

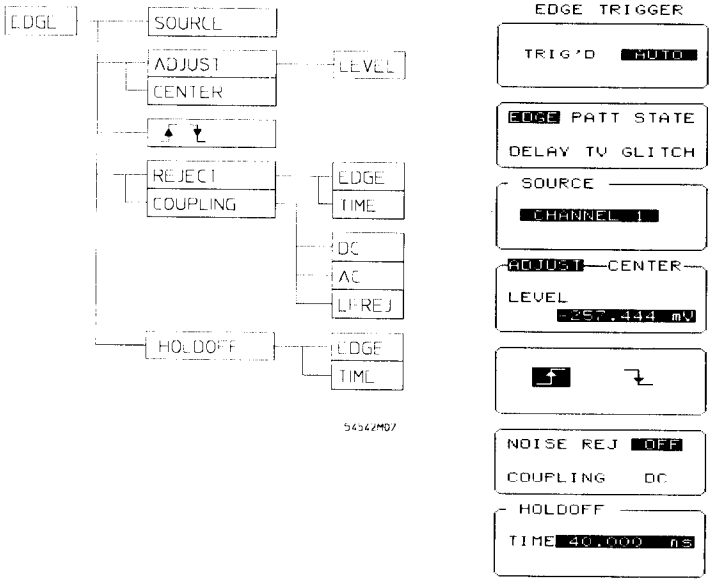
Edge Trigger Mode

Edge is the basic trigger mode, all the other trigger modes are a variation of the edge mode.

The edge trigger mode identifies a trigger point by looking for a specified slope and voltage level on a waveform on one source only. This process is accomplished by arming the trigger on a voltage either slightly higher or slightly lower than the trigger level. The difference between the arming voltage and the trigger level is hysteresis. The arming voltage is set slightly lower than the trigger level for a positive slope and slightly higher than the trigger level for a negative slope. Then, a signal with the correct slope and voltage level triggers the oscilloscope. You can use the edge trigger mode to easily detect logic level transitions.

The trigger level (threshold) for each channel is set in the edge trigger menu and is independent for each channel. It is carried over to all other modes, except for the TV and glitch trigger modes. These levels are important settings because the high and low levels in the pattern, state, and delay modes are defined as being greater than or less than the trigger level.

Figure 5–2



Source Softkey

The **SOURCE** softkey selects the trigger source. The options are any channel input, auxiliary input (on the rear panel), external trigger input (on the 2-channel models only), or line trigger. The current selection is highlighted in inverse video. When line is selected as the source, the oscilloscope uses the power line as the trigger source, and the remaining menu choices are removed. Also, holdoff is not available with line trigger or auxiliary trigger.

Level Softkey

The **LEVEL** softkey has two modes, adjust and center.

Adjust Adjust allows the flexibility of setting exact triggering points and specifies levels used in the other triggering modes. The trigger level range depends on the source.

- Channel inputs — ±12 divisions from the center of the screen.
- Auxiliary input — ±5 V.
- External trigger — There are three ranges:±1 V, ±5 V, and ± 25 V.

Center For the channel inputs, center sets the trigger level to the same value as the channel offset for the selected source, which places the trigger level at the center of the screen. For the auxiliary and external inputs, center sets the trigger level to 0 V.

Slope Softkey

The **SLOPE** softkey is not labeled. However, the available selections are graphic representations of the rising edge and falling edge. The current selection is highlighted in inverse video. You can set the slope for each trigger source except line trigger. Slope applies only to the edge mode.

Reject-Coupling Softkey

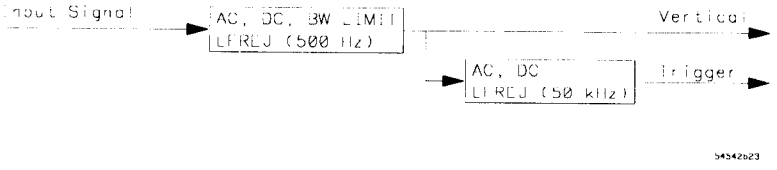
The **REJECT-COUPLING** softkey allows you to turn noise reject on or off, and allows you to select the trigger coupling.

Reject When on, reject increases the trigger hysteresis band, so that it takes a larger trigger signal to trigger the oscilloscope. When noise reject is on, it makes the trigger circuitry less sensitive to noise. You can use noise reject when triggering on noisy signals without the problem of false triggering. You can set noise reject independently for each trigger source, the selection also applies to the logic trigger modes.

Coupling Coupling allows you to further condition the trigger signal independent of the channel conditioning circuitry. Figure 5-3 shows that the input signal goes through the input signal conditioning before the trigger coupling path. For example, you can set the channel path to dc coupling and the trigger path to ac coupling. Coupling applies only to the edge mode.

- dc allows dc and ac signals into the trigger path.
- ac blocks out any dc portion of the trigger signal and allows ac signals greater than 7 Hz into the trigger path.
- lfrej (low frequency reject) adds a 50-kHz, low-pass filter to the trigger path.

Figure 5–3



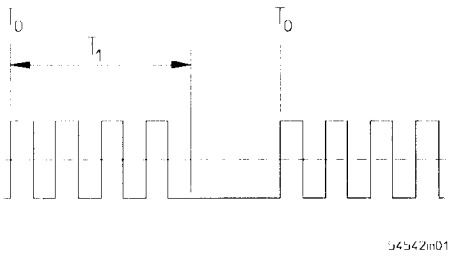
Holdoff Softkey

The **HOLDOFF** softkey disables the trigger circuit for a selectable time period or for a number of events after the trigger event. Holdoff is selected in 20-ns time increments from 40 ns to 320 ms, or by number of events from 2 to 16,000,000. Time and event are toggled with the knob. An events is a pattern, state, or edge. The maximum event counting rate is 70 MHz.

You use holdoff to synchronize a waveform to a trigger signal. Holdoff is used to stabilize the display of complex waveforms, or to trigger on a burst of pulses that are separated by time. Figure 5-4 shows a pulse burst with the holdoff time represented as T_1. You may notice that holdoff keeps the trigger circuit from rearming until after the pulse burst is over. That way, the first pulse in the next burst is the trigger event.

The advantage of digital holdoff is that it is a fixed number. As a result, changing the time base settings does not affect holdoff and the oscilloscope remains triggered. In contrast, the holdoff in analog oscilloscopes is a function of the time base setting, making it necessary to readjust the holdoff each time you change the time base setting. Also, there is no holdoff when edge triggering using auxiliary or line trigger as the source.

Figure 5–4



Pattern Trigger Mode

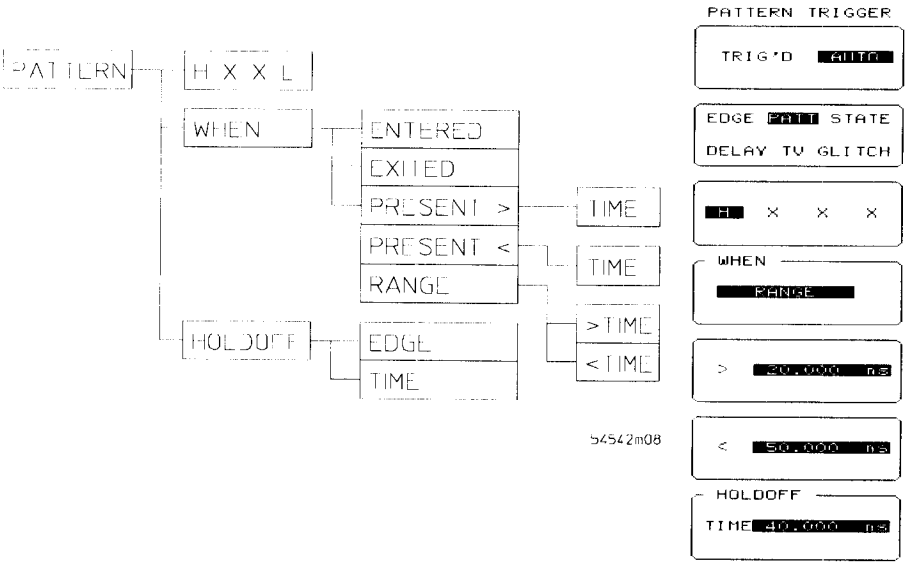
Pattern allows you to have the oscilloscope search for a pattern that you define. You can define a pattern using any channel and external trigger (on the 2-channel models), up to a 4-bit pattern on 4-channel models and up to a 3-bit pattern on 2-channel models. The oscilloscope triggers on the last edge to make the condition true, or the first edge that makes the condition false as set by the when softkey. You define a pattern by assigning each trigger source either as an L, X, or H (L = low, X = don't care, and H = high). A high is a voltage above the trigger level, and a low is a voltage below the trigger level. The thresholds for the channel trigger levels (or H/L levels) are set in the edge trigger menu.

You can use the pattern mode to detect glitches greater than 20 ns wide, however, use the glitch trigger mode to detect glitches less than 20 ns wide.

See also

"Glitch Trigger Mode" later in this chapter for information on capturing and differentiating glitch widths less than 20-ns.

Figure 5–5



Pattern Softkey

The **PATTERN** softkey is not labeled, but it is the third softkey from the top. The pattern softkey defines a 4-bit pattern for which the oscilloscope searches. The positions correspond to the channel or trigger inputs, as shown in figure 5-6. For example, on 4-channel models, the left-most bit corresponds to channel 1 and the right-most bit corresponds to channel 4. On 2-channel models, the left-most bit corresponds to channel 1 and the right-most bit corresponds to the external trigger input.

If the pattern is set to all X's (don't care), a trigger event will not occur because a trigger event is not defined. Any trigger source that you are not using as part of the qualifier pattern should be set to a don't care to make sure that the source does not cause false triggering.

You can set the trigger level and noise reject independently on each source in the edge menu. For example, you can set the trigger level on channel 1 to a TTL high and the trigger level on channel 2 to an ECL low. However, all of the channels are set to dc coupling for all of the trigger modes except for the edge mode.

Figure 5–6

When Softkey

The **WHEN** softkey selects when the trigger is to occur. The choices are listed below:

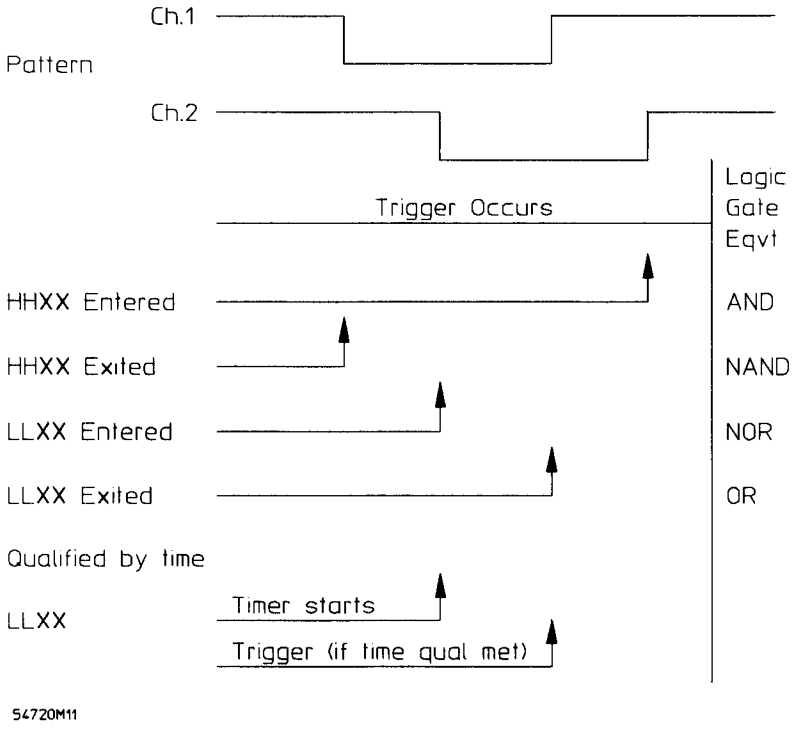
- Entering a pattern — The trigger occurs on the edge of the source that is the last edge to make the pattern true.
- Exiting a pattern — The trigger occurs on the edge of the source that is the first edge to make the pattern false.
- A pattern is present greater than a defined time — A timer starts when the pattern is entered. If the pattern is present greater than the specified time, a trigger occurs on the first edge to exit the pattern.
- A pattern is present less than a defined time — A timer starts when the pattern is entered. If the pattern is present less than the specified time, the trigger occurs when the pattern is exited.
- A time range — When a pattern is present greater than a defined time and less than another defined time. A timer starts when the pattern is entered. If the pattern is present greater than one specified time and less than another specified time, the trigger occurs when the pattern is exited.

Holdoff Softkey

The **HOLDOFF** softkey allows you to select the amount of holdoff. Holdoff disables the trigger circuit for a selectable time period or number of patterns after the pattern is found. Holdoff is selected in time units, from 40 ns to 320 ms and is incremented in 20-ns intervals or by the number of patterns from 2 to 16,000,000. The maximum pattern counting rate is 70 MHz.

Figure 5-7 shows pattern triggering on two channels. The trigger location is indicated on a few examples with an arrow. Also shown is the Boolean equivalent of each pattern.

Figure 5–7



State Trigger Mode

State triggering is similar to pattern triggering, except that you select one channel as a clock edge, and you set the remaining channels to define a pattern. Basically state is a selective pattern trigger. The pattern can occur often, but it is checked for validity only on the selected clock edge. The thresholds for the channel trigger levels (or H/L levels) are set in the edge trigger menu.

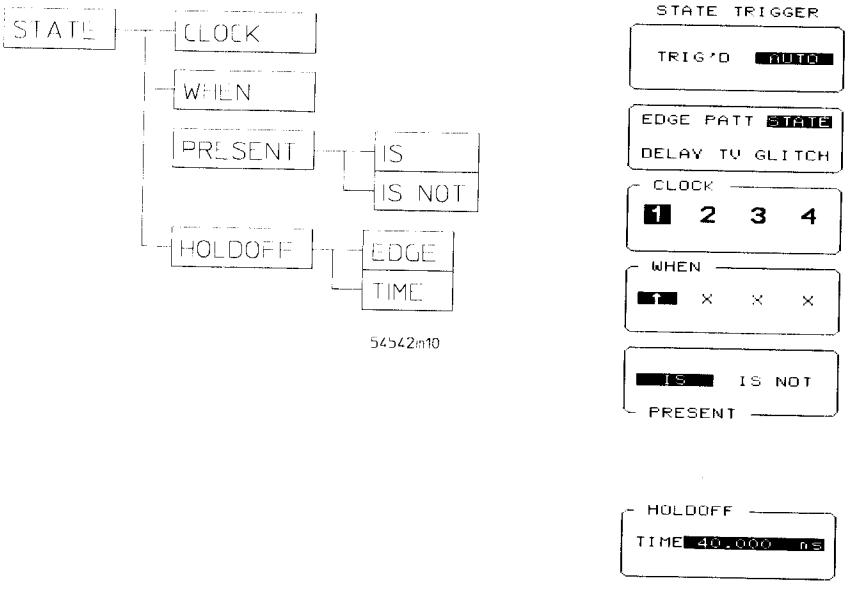
Clock Softkey

The **CLOCK** softkey allows you to select any trigger source as the clock. The trigger source you select as the clock is indicated with an arrow under the when softkey.

When Softkey

The **WHEN** softkey sets the other channels to form a trigger pattern. An arrow indicates which trigger source is the clock, and the direction of the arrow indicates the selected slope. You can select the polarity of the clock edge as either rising or falling, and you can select the pattern on the remaining sources.

Figure 5–8



Present Softkey

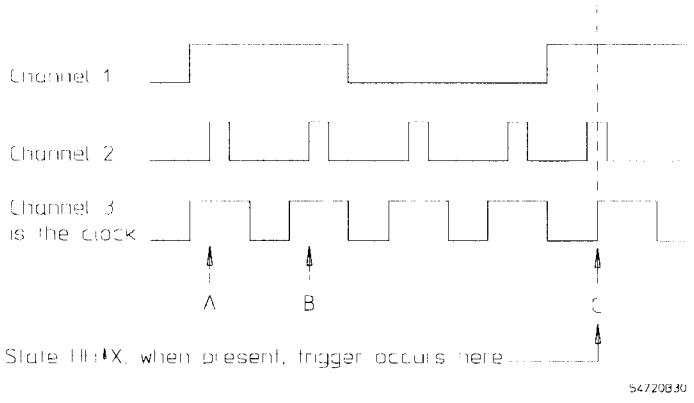
The **PRESENT** softkey sets the oscilloscope to trigger when the pattern is either present or not present. The pattern is checked for only on the designated clock edge.

Holdoff Softkey

The **HOLDOFF** softkey allows you to select the amount of holdoff. Holdoff disables the trigger circuit for a selectable time period after the state event has occurred. Holdoff is selected in 20 ns time increments, from 40 ns to 320 ms, or for events (count of states) 2 to 16,000,000. The maximum state counting rate is 70 MHz.

Figure 5-9 shows a three-channel timing diagram. For this example, the clock is a rising edge on channel 3. The oscilloscope was also set to look for when a pattern is present, and the oscilloscope is looking for a high on channels 1 and 2. You may notice that channels 1 and 2 are both high during clock pulses A, B, and C. In the state mode, the pattern is checked for validity only on the selected clock edge. On the rising edge of clock pulses A and B, channel 2 is a low level. Therefore, the pattern is valid only on the rising edge of clock pulse C.

Figure 5–9



Delay Trigger Mode

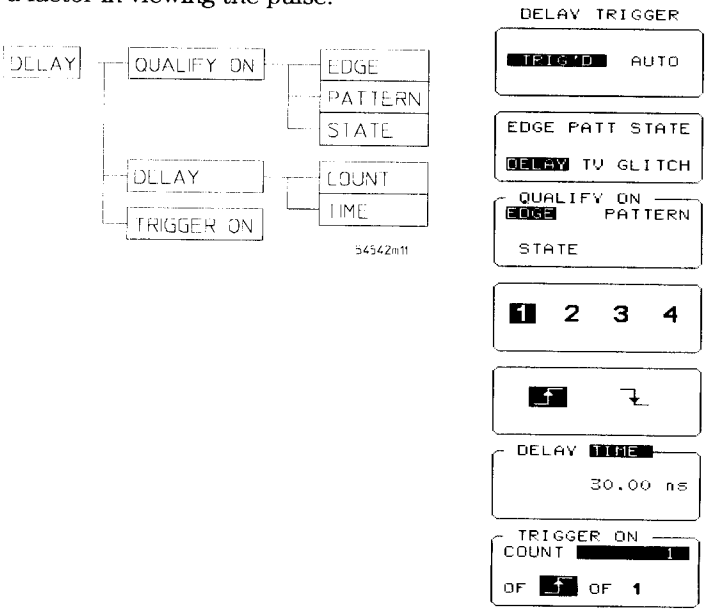
The delay trigger mode qualifies on an edge, pattern, or state from one trigger source, waits for a selected period of time or events, then triggers on the *nth* edge from any of the other trigger sources. Basically you can think of delay as two edge triggers that are separated by a selectable time or event counter.

The traditional method to view events that happen after the trigger event is to use time base position to pan through the data. The problem with this is that the further the point of interest is from the trigger event, the greater the possibility that signal jitter makes it difficult to analyze the point of interest.

Delay by time or events eliminates this problem because it moves the trigger event closer to the point of interest, which reduces any jitter on long delay measurements.

For example, a disk drive motor does not spin at a constant speed all the time. If you use time base delay to look at a pulse separated from the trigger event by a long time period, the jitter on the pulse caused by variations in the motor's speed can make it almost impossible to see the desired pulse. Delay by time allows you to delay out to the pulse of interest, then trigger on that pulse. Because you are triggering on the pulse of interest, signal jitter is not a factor in viewing the pulse.

Figure 5–10



Qualify On Softkey

The **QUALIFY ON** softkey selects which mode to qualify the trigger before a delay is defined. The qualify options are edge, pattern, and state.

Qualify On Edge When you select edge qualify, the next two softkeys allow you to select which trigger source and slope to use for the edge qualification.

Qualify On Pattern When you select pattern qualify, the next softkey allows you to select a pattern to use for qualification, and allows you to select when the qualification occurs: entered, exited, when present greater than a time, when present less than a time, or when present for a range of times. You set the range of times with the next softkey.

Qualify On State When you select state qualify, the next two softkeys allow you to select a clock edge and a pattern to use for qualification. It also allows you to select when the qualification occurs: when entered or when exited.

Delay Softkey

The **DELAY** softkey selects between delay by time and delay by count. Delay time disables the trigger circuit for a selected period of time, from 30 ns to 160 ms after the trigger is qualified.

Time delay is not available in the time qualified pattern settings of when present greater than, when present less than, and when present for a range of times. Delay count (delay by edges) disables the trigger circuit for a selected count from 1 to 16,000,000 after the trigger is qualified. After the selected count is met, the oscilloscope looks for the selected trigger edge.

Trigger On Softkey

The **TRIGGER ON** softkey selects a specific edge to trigger on after the qualification and delay conditions are met. All the other softkeys in this menu dealt with defining qualifying conditions. The **TRIGGER ON** softkey sets the trigger point. You can select the number of counts, slope, and source for the trigger event.

Figure 5-11 shows a delay-by-time timing diagram. You may notice that the qualifying event is channel 1, and the trigger event is channel 2. By changing the amount of delay, you can look at various events in a pulse train without the effects of jitter. After the delay timer times out, the scope triggers on the edge number you select.

Figure 5–11

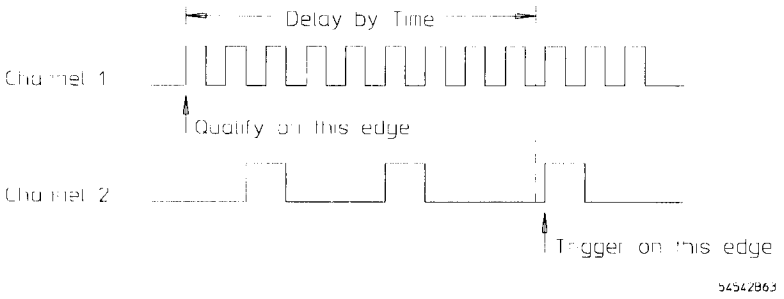
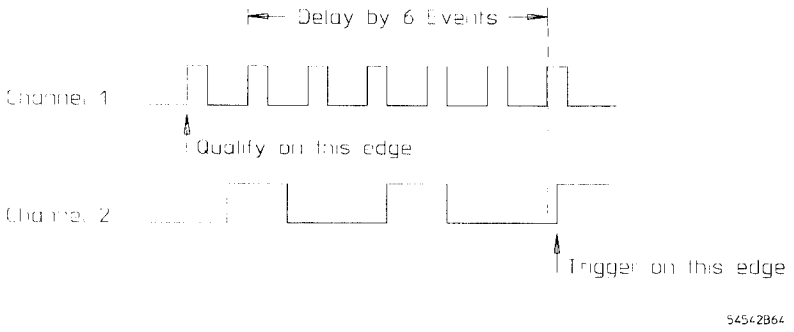


Figure 5-12 shows a delay-by-events timing diagram. You may notice that the qualifying event is channel 1, and the trigger event is channel 2. By changing the number of events, you can consecutively look at pulses in a pulse burst without the effects of jitter. After the number of events are counted, the scope triggers on the edge number you select.

Figure 5–12



TV Trigger Mode

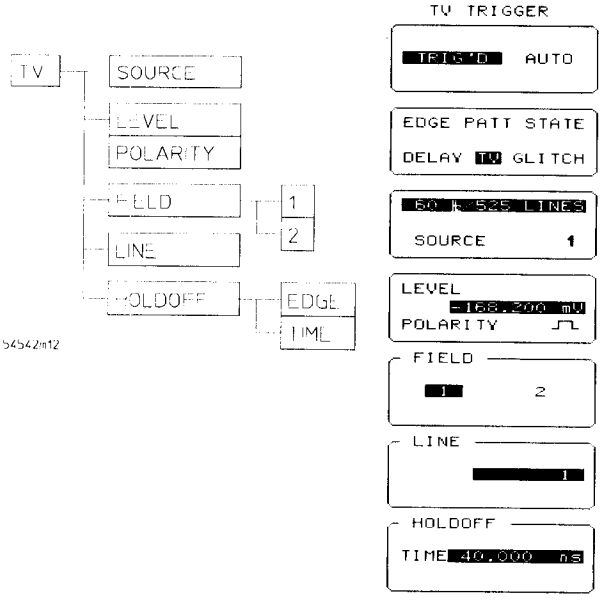
The TV trigger mode enables the oscilloscope to trigger on clamped TV signals. The two most common TV standards are NTSC and PAL. NTSC (60 Hz/525 lines) is the standard used in the United States, and PAL (50 Hz/625 lines) is the standard used in most European countries. This trigger menu also allows for user defined triggering on TV signals that are used in other parts of the world.

Press the softkey to move the highlighted inverse video window, and use the entry knob to change the value displayed in the window.

Standard/Source Softkey

The **STANDARD/SOURCE** softkey is not labeled, but it is the third softkey from the top. The upper portion of the softkey allows you to choose between the NTSC standard TV signal used in the United States (60 Hz/525 lines, or the PAL standard used in most European countries (50 Hz/625 lines). The third option is for user-defined ranges of the TV signal. User-defined ranges are used to trigger on any of the proposed HDTV standards. The lower portion of the softkey allows you to select the trigger source.

Figure 5–13



Level/Polarity Softkey

The **LEVEL** softkey sets the trigger level (in volts) that is applicable only to the TV trigger source.

Field Softkey

The **FIELD** softkey selects field 1 or 2 of the TV video signal.

Line Softkey

The **LINE** softkey selects which line the trigger is generated on. This selection depends upon which field was selected.

If the previous selection is the 60 Hz, 525 line standard (which is compatible with broadcast standard M), the options available depend upon which field is selected. If field 1 is selected, the range of lines is from 1 to 263. If field 2 is selected, the range of lines is from 1 to 262.

If the 50 Hz, 625 line standard is selected (which is compatible with broadcast standards B, C, D, G, H, I, K, K1, L, and N), the options are also dependent upon the field selection. If field 1 is selected, the range of lines is from 1 to 313. If field 2 is selected, the range of lines is from 314 to 625.

Holdoff Softkey

The **HOLDOFF** softkey enables the oscilloscope to hold off the trigger event from 40 ns to 320 ms, and is incremented in 20-ns time frames.

Glitch Trigger Mode

The glitch mode is like the pattern duration triggering, except a single channel defines the pattern, with the additional time selections of 2.5 ns, 5 ns, and 10 ns.

Source--State Softkey

The **SOURCE--STATE** softkey selects the source and glitch polarity used for triggering. The sources available are any channel input and (on the two channel models) external trigger input. You can specify the state for the source selected as either a high or a low, where high is higher than the current trigger level, and low is lower than the current trigger level. You can select only one source or state at a time. The current selection is highlighted in inverse video.

Level Softkey

The **LEVEL** softkey sets the trigger level used by the **SOURCE--STATE** softkey. The choices are adjust or center.

Adjust Adjust allows the flexibility for setting exact triggering points and specifies levels used in the other triggering modes. The trigger level range is ±12 divisions from the center of the screen.

Center Center has the oscilloscope automatically set the trigger level to the same value as the channel offset for the selected source.

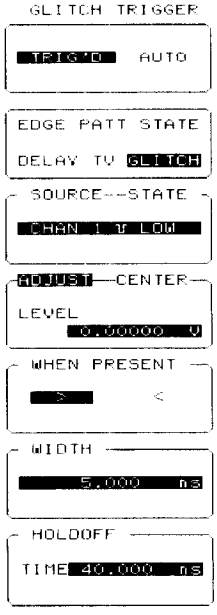
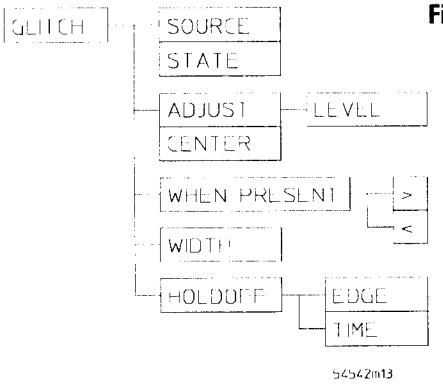


Figure 5–14



When Present Softkey

The **WHEN PRESENT** softkey sets the condition that must be satisfied to generate a trigger event. If **WHEN PRESENT >** is selected, a trigger is generated when the glitch is true longer than a specified width. If **WHEN PRESENT <** is selected, a trigger is generated when the glitch is true less than a specified width. The current selection is highlighted in inverse video.

Width Softkey

The **WIDTH** softkey sets the width of the pulse to generate the trigger on. The oscilloscope can trigger glitches as narrow as 1 ns, even though the width selections are from 2.5 ns to 160 ms.

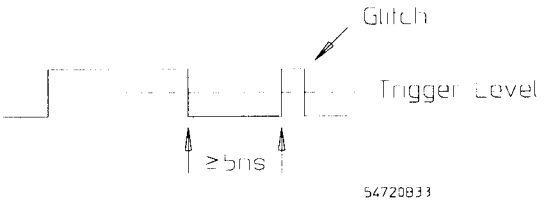
Holdoff Softkey

The **HOLDOFF** softkey sets the holdoff value. Holdoff disables the trigger circuit for a selectable time period after the trigger event. Holdoff is selected in 20-ns time increments, from 40 ns to 320 ms.

Glitch timing requirements

For the oscilloscope to trigger on a glitch, the opposite polarity of the glitch must be present for at least 5 ns. The polarity of the glitch is determined by the trigger level. Voltages above the trigger level are of positive polarity, and voltages below the trigger level are of negative polarity. For example, Figure 5-15 shows a positive polarity glitch. The signal must be below the trigger level for at least 5 ns for the oscilloscope to detect the glitch. If a negative polarity glitch is selected, then the signal must be above the trigger level for at least 5 ns for the oscilloscope to detect the glitch.

Figure 5–15



If the selected glitch width is from 2.5 ns to 20 ns, the time between similar edges must be greater than the selected glitch width. Figure 5-16 illustrates the timing between like edges. For example, if the selected width is 10 ns, then the time from point A to point B must be greater than 10 ns.

Figure 5–16