

Agilent 1000B Series Oscilloscopes

User's Guide



Agilent Technologies

Notices

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See also [Appendix A](#), “Safety Notices,” starting on page 149.

Agilent 1000B Series Oscilloscopes—At a Glance

The Agilent 1000B Series oscilloscopes are low-cost portable digital storage oscilloscopes (DSOs) that deliver these powerful features:

- Channel counts, input bandwidths, sample rates, and memory depths shown in the following table:

Table 1 Agilent 1000B Series Oscilloscope Models

Model	Channels	Input Bandwidth	Sample Rate (2 channels on-1 channel on)	Memory (2 channels on-1 channel on)
DSO1052B	2	50 MHz	500 MSa/s-1 GSa/s	8-16 kpts
DSO1072B	2	70 MHz	500 MSa/s-1 GSa/s	8-16 kpts
DSO1102B	2	100 MHz	500 MSa/s-1 GSa/s	8-16 kpts
DSO1152B	2	150 MHz	500 MSa/s-1 GSa/s	8-16 kpts

- Bright 5.7 inch QVGA (320 x 240) TFT color LED display and small footprint (to save bench space).
- Up to 400 wfms/s refresh rate.
- Automatic voltage and time measurements (22) and cursor measurements.
- Powerful triggering (edge, pulse width, video, and alternate modes) with adjustable sensitivity (to filter noise and avoid false triggers).
- Math function waveforms: add, subtract, multiply, FFT.
- USB ports (host and device) for easy printing, saving, and sharing of waveforms, setups, screen BMP files, and CSV data files.
- Internal storage for 10 waveforms and 10 setups.
- Special digital filter and waveform recorder.
- Built-in 6-digit hardware frequency counter.
- Multi-language (11) user interface menus and built-in help.

In This Book

This guide shows how to use the Agilent 1000B Series oscilloscopes.

1 Getting Started

Describes the basic steps to take when first using the oscilloscope.

2 Displaying Data

Describes how to use the horizontal and vertical controls, channel settings, math waveforms, reference waveforms, and display settings.

3 Capturing Data

Describes acquisition modes and how to set up triggers.

4 Making Measurements

Describes voltage, time, and cursor measurements.

5 Saving, Recalling, and Printing Data

Describes how to save, recall, and print data.


6 Oscilloscope Utility Settings

Describes other oscilloscope settings found in the Utility menu.

7 Reference

Contains reference information for the 1000B Series oscilloscopes.

Contents

Agilent 1000B Series Oscilloscopes—At a Glance	3
In This Book	4
Figures	13
Tables	15
1 Getting Started	17
Step 1. Inspect the package contents	18
Step 2. Turn on the oscilloscope	19
Step 3. Load the default oscilloscope setup	22
Step 4. Input a waveform	23
	23
Step 5. Use Auto Scale	24
Step 6. Compensate probes	26
Low Frequency Compensation	26
High Frequency Compensation	27
Step 7. Become familiar with the Front Panel Controls	28
Front Panel Overlays for Different Languages	29
Step 8. Become familiar with the oscilloscope display	30
Using the Oscilloscope Softkey Menus	31
Step 9. Use the Run Control keys	33
Step 10. Access the built-in help	34

Securing the Oscilloscope 35

2 Displaying Data 37

Using the Horizontal Controls 38

To adjust the horizontal scale 39

To adjust the horizontal position 40

To display the zoomed time base 41

To change the horizontal time base (Y-T, X-Y, or Roll) 42

To view the sample rate 44

Using the Vertical Controls 45

To turn waveforms on or off (channel, math, or reference) 46

To adjust the vertical scale 46

To adjust the vertical position 47

To specify channel coupling 47

To specify a bandwidth limit 49

To specify the probe attenuation 50

To use a digital filter 51

To change the Volts/Div control sensitivity 51

To invert a waveform 52

Using Math Function Waveforms 54

To add, subtract, or multiply waveforms 55

To display the frequency domain using FFT 55

Using Reference Waveforms 58

To save a reference waveform 58

To export or import reference waveforms 58

To return the reference waveform to its default scale 59


Changing the Display Settings	60
To display waveforms as vectors or dots	61
To clear the display	61
To set waveform persistence	61
To adjust waveform intensity	62
To change the grid	62
To adjust the grid brightness	62
To invert screen colors	62
To change the menu display time	63
3 Capturing Data	65
Overview of Sampling	66
Sampling Theory	66
Aliasing	66
Oscilloscope Bandwidth and Sample Rate	67
Oscilloscope Rise Time	69
Oscilloscope Bandwidth Required	70
Memory Depth and Sample Rate	71
Choosing the Sampling Mode	72
To select the real-time sampling mode	72
To select the equivalent-time sampling mode	73
Choosing the Acquisition Mode	75
To select the Normal acquisition mode	76
To select the Average acquisition mode	76
To select the Peak Detect acquisition mode	77
To turn OFF/ON sine(x)/x interpolation	79
Recording/Playing-back Waveforms	80
To record waveforms	80
To play-back waveforms	81
To store recorded waveforms	83

Contents

Adjusting the Trigger Level	85
To adjust the trigger level	85
To force a trigger	86
Choosing the Trigger Mode	87
To set up edge triggers	87
To set up pulse width triggers	88
To set up video triggers	89
To set up alternate triggers	92
Setting Other Trigger Parameters	93
To set the trigger sweep	93
To set the trigger coupling	93
To set the trigger high-frequency reject coupling	94
To change the trigger sensitivity	95
To specify a trigger holdoff	96
Using the External Trigger Input	97
4 Making Measurements	99
Displaying Automatic Measurements	100
To display an automatic measurement	101
To clear automatic measurements from the display	101
To display or hide all automatic measurements	101

Voltage Measurements	102
Vmax (Maximum Voltage)	102
Vmin (Minimum Voltage)	103
Vpp (Peak-to-Peak Voltage)	103
Vtop (Top Voltage)	103
Vbase (Base Voltage)	103
Vamp (Amplitude Voltage = Vtop - Vbase)	103
Vavg (Average Voltage)	103
Vrms (Root-Mean-Square Voltage)	104
Overshoot	104
Preshoot	104
Time Measurements	105
Period	105
Frequency	106
Rise Time	106
Fall Time	106
Positive Pulse Width	107
Negative Pulse Width	107
Positive Duty Cycle	107
Negative Duty Cycle	107
Delay Between Rising Edges	108
Delay Between Falling Edges	108
Phase Between Rising Edges	109
Phase Between Falling Edges	109
Counter (Frequency)	110
Making Cursor Measurements	111
To use manually adjustable cursors	113
To use tracking cross-hair cursors	114
To display cursors for automatic measurements	115

5	Saving, Recalling, and Printing Data	117
	Saving and Recalling Data	118
	To save and recall waveforms	118
	To save and recall oscilloscope setups	119
	To save screens to BMP or PNG format files	120
	To save data to CSV format files	121
	Using the Disk Manager	122
	To switch between files, path, and directory panes	123
	To navigate the directory hierarchy	123
	To create new folders	123
	To edit folder/file names	124
	To delete folders	125
	To rename folders	125
	To delete files	125
	To recall files	126
	To rename files	126
	To display disk information	126
	Printing Screens	127
	To choose a PictBridge printer	128
	To print with inverted screen colors	129
	To choose color or grayscale printing	129
	To copy a screen to the printer	130
6	Oscilloscope Utility Settings	131
	Displaying System Information	133
	Turning Sound ON or OFF	133
	Setting the Language (Menu and Help)	134

Performing Mask Tests	135
To enable/disable mask tests	135
To select the source channel for mask tests	135
To run/stop a mask test	136
To turn on/off the mask test message display	136
To set the mask test output condition	137
To stop a mask test on the output condition	138
To set up masks	139
Setting Preferences	142
To set up the screen saver	142
To select the vertical scale reference level	142
To select the USB device port function	143
Running Self-Calibration	144
7 Reference	145
Environmental Conditions	146
Overvoltage Category	146
Pollution Degree	146
Pollution Degree Definitions	146
Measurement Category	147
Measurement Category Definitions	147
Transient Withstand Capability	148
	148
Specifications and Characteristics	148
Cleaning the Oscilloscope	148
Contacting Agilent	148
A Safety Notices	149
Warnings	149

Contents

Safety Symbols 150

Index 151

Figures

Figure 1. Power Switch	21
Figure 2. [Default Setup] Key	22
Figure 3. [Auto Scale] Key	24
Figure 4. Low Frequency Probe Compensation	26
Figure 5. High Frequency Probe Compensation	27
Figure 6. Front Panel	28
Figure 7. Oscilloscope Display	30
Figure 8. Softkey Menus	31
Figure 9. Run Control Keys	33
Figure 10. Securing the Instrument	35
Figure 11. Horizontal Controls	38
Figure 12. Status Bar, Trigger Position, and Horizontal Scale Control Indicators	39
Figure 13. Zoomed Time Base Window	42
Figure 14. X-Y Display Format Showing Out-of-Phase Waveforms	43
Figure 15. Vertical Controls	45
Figure 16. DC Coupling Control	48
Figure 17. AC Coupling Control	48
Figure 18. BW Limit Control OFF	49
Figure 19. BW Limit Control ON	50
Figure 20. Waveform Before Inversion	52
Figure 21. Waveform After Inversion	53
Figure 22. Math Scale Setting Value	54
Figure 23. FFT Waveform	57
Figure 24. [Display] Key	60
Figure 25. Alaising	67
Figure 26. Theoretical Brick-Wall Frequency Response	68
Figure 27. Sample Rate and Oscilloscope Bandwidth	69

Figures

Figure 28. Real-Time Sampling Mode	72
Figure 29. Equivalent-Time (Repetitive) Sampling Mode	73
Figure 30. [Acquire] Key	75
Figure 31. Noisy Waveform Without Averaging	76
Figure 32. Noisy Waveform With Averaging	77
Figure 33. Peak Detect Waveform	78
Figure 34. Trigger Controls	85
Figure 35. Line Synchronization	91
Figure 36. Field Synchronization	91
Figure 37. Alternate Triggers	92
Figure 38. Trigger Holdoff	96
Figure 39. [Meas] Key	100
Figure 40. Voltage Measurement Points	102
Figure 41. Period and Frequency Measurements	105
Figure 42. Rise Time and Fall Time Measurements	106
Figure 43. Positive Pulse Width and Negative Pulse Width Measurements	107
Figure 44. Delay Measurements	108
Figure 45. Phase Measurements	109
Figure 46. [Cursors] Key	112
Figure 47. USB Host Port on Front Panel	117
Figure 48. [Save/Recall] Key	118
Figure 49. Disk Manager	122
Figure 50. Editing Folder/File Names in Disk Manager	124
Figure 51. USB Device Port	127
Figure 52. [Print] Key	128
Figure 53. [Utility] Key	132
Figure 54. Mask Test Display	136
Figure 55. Schematic Diagram of Mask Pass/Fail out	137
Figure 56. Mask Pass/Fail out	138
Figure 57. Mask Test Mask Setting	139
Figure 58. Calibration Screen	144

Tables

Table 1. Agilent 1000B Series Oscilloscope Models	3
Table 2. Power Requirements	19
Table 3. Environmental Characteristics	20
Table 4. Auto Scale Default Settings	25
Table 5. Front Panel Controls	29
Table 6. FFT Window Characteristics	56

Tables



1 Getting Started

- Step 1. Inspect the package contents 18
- Step 2. Turn on the oscilloscope 19
- Step 3. Load the default oscilloscope setup 22
- Step 4. Input a waveform 23
- Step 5. Use Auto Scale 24
- Step 6. Compensate probes 26
- Step 7. Become familiar with the Front Panel Controls 28
- Step 8. Become familiar with the oscilloscope display 30
- Step 9. Use the Run Control keys 33
- Step 10. Access the built-in help 34
- Securing the Oscilloscope 35

This chapter describes the basic steps to take when first using the oscilloscope.



Step 1. Inspect the package contents

1 Inspect the shipping container for damage.

Keep a damaged shipping container or cushioning material until you have inspected the contents of the shipment for completeness and have checked the oscilloscope mechanically and electrically.

2 Verify that you received the following items in the oscilloscope packaging:

- Oscilloscope.
- Power cord.
- N2862A 10:1 10 M Ω passive probes, quantity = 2.
- Documentation CD.
- Front panel overlay (if language option other than English is chosen).

If anything is missing, or if you need to order additional probes, power cords, etc., contact your nearest Agilent Technologies sales office.

3 Inspect the oscilloscope.

- If there is mechanical damage or a defect, or if the oscilloscope does not operate properly or does not pass performance tests, notify your Agilent Technologies sales office.
- If the shipping container is damaged, or the cushioning materials show signs of stress, notify the carrier; then, contact your nearest Agilent Technologies sales office.

Keep the shipping materials for the carrier's inspection.

The Agilent Technologies sales office will arrange for repair or replacement at Agilent's option without waiting for claim settlement.

Step 2. Turn on the oscilloscope

The next few steps (turning on the oscilloscope, loading the default setup, and inputting a waveform) will provide a quick functional check to verify the oscilloscope is operating correctly.

- 1 Connect the power cord to a power source.

Use only power cords designed for your oscilloscope.

Use a power source that delivers the required power.

Table 2 Power Requirements

Name	Typical Value
Line rating:	~Line 50 W max 100-120 V/50/60/400 Hz, $\pm 10\%$ 100-240 V/50/60 Hz, $\pm 10\%$

WARNING

To avoid electric shock, be sure the oscilloscope is properly grounded.

Table 3 Environmental Characteristics

Name	Typical Value
Ambient temperature:	Operating 0 °C to +50 °C Non-operating –20 °C to +60 °C
Humidity:	Operating 80% RH (non-condensing) at +40 °C for 24 hr Non-operating 60% RH (non-condensing) at +60 °C for 24 hr
Altitude:	Operating to 3,000 m (9,842 ft) Non-operating to 15,000 m (49,213 ft)
Vibration:	Agilent class GP and MIL-PRF-28800F; Class 3 random
Shock:	Agilent class GP and MIL-PRF-28800F; (operating 30 g, 1/2 sine, 11-ms duration, 3 shocks/axis along major axis. Total of 18 shocks)
Pollution degree 2:	Normally only dry non-conductive pollution occurs. Occasionally a temporary conductivity caused by condensation must be expected.
Indoor use:	Rated for indoor use only.

2 Turn on the oscilloscope.

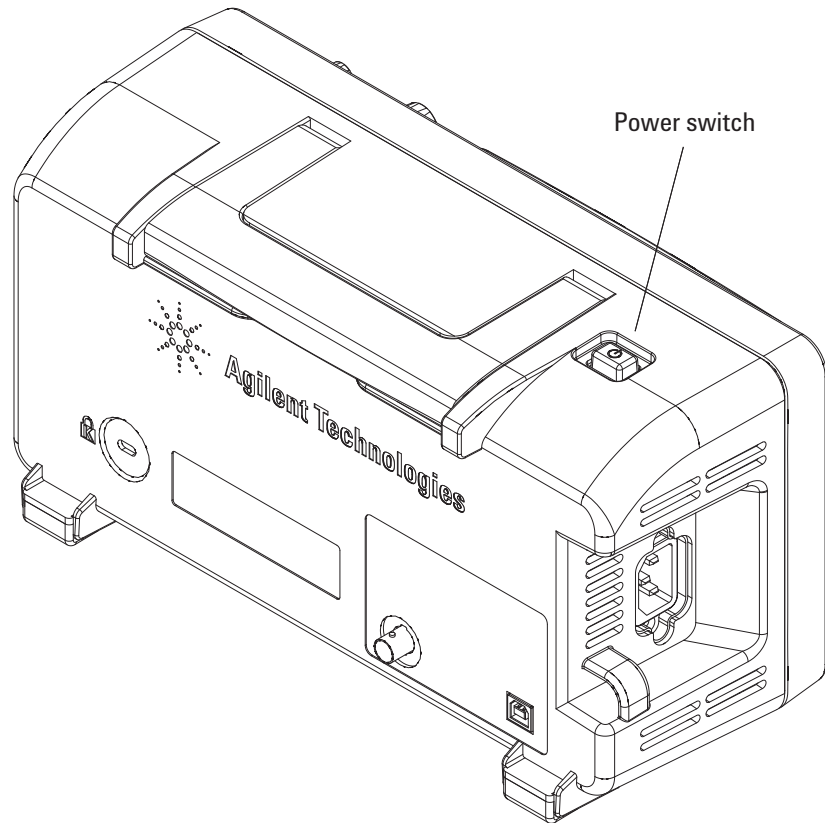


Figure 1 Power Switch

Step 3. Load the default oscilloscope setup

You can recall the factory default setup any time you want to return the oscilloscope to its original setup.

- 1 Press the front panel **[Default Setup]** key.

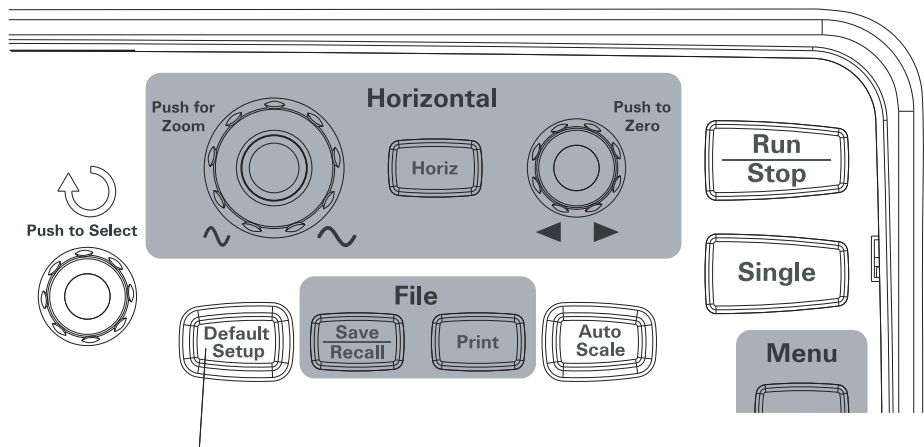


Figure 2 [Default Setup] Key

- 2 When the Default menu appears, press **[Menu On/Off]** to turn off the menu.
(The **Undo** softkey in the Default menu lets you cancel the default setup and go back to the previous setup.)

Step 4. Input a waveform

- 1 Input a waveform to a channel of the oscilloscope.

Use one of the supplied passive probes to input the Probe Comp signal from the front panel of the oscilloscope.

CAUTION

To avoid damage to the oscilloscope, make sure that the input voltage at the BNC connector does not exceed the maximum voltage (300 Vrms, CAT I).



Step 5. Use Auto Scale

The oscilloscope has an auto scale feature that automatically sets the oscilloscope controls for the input waveforms present.

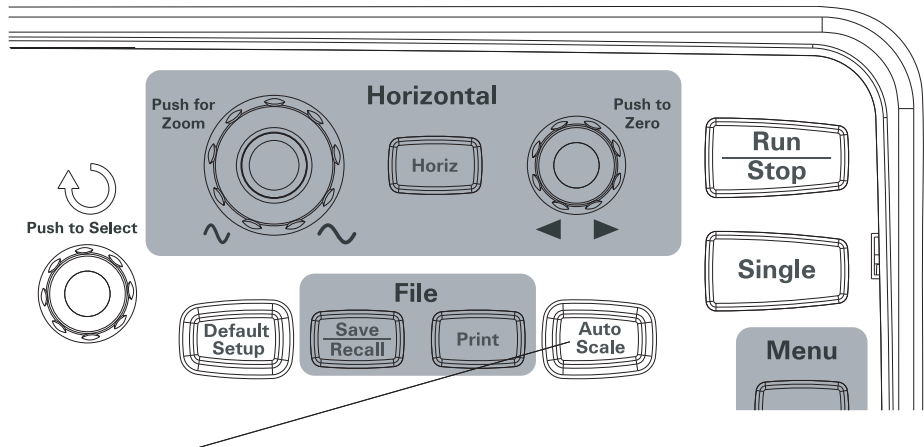


Figure 3 [Auto Scale] Key

Auto scale requires waveforms with a frequency greater than or equal to 50 Hz and a duty cycle greater than 1%.

- 1 Press the front panel [**Auto Scale**] key.
- 2 When the AUTO menu appears, press [**Menu On/Off**] to turn off the menu.

The oscilloscope turns on all channels that have waveforms applied and sets the vertical and horizontal scales appropriately. It also selects a time base range based on the trigger source. The trigger source selected is the highest-numbered channel that has a waveform applied.

(The **Undo** softkey in the AUTO menu lets you cancel the auto scale and go back to the previous setup.)

The oscilloscope is configured to the following default control settings:

Table 4 Auto Scale Default Settings

Menu	Setting
Horizontal time base	Y-T (amplitude vs. time)
Acquisition mode	Normal
Vertical coupling	Adjusted to AC or DC according to the waveform.
Vertical "V/div"	Adjusted
Volts/Div	Coarse
Bandwidth limit	OFF
Waveform invert	OFF
Horizontal position	Center
Horizontal "s/div"	Adjusted
Trigger type	Edge
Trigger source	Measure the channel with input waveform automatically.
Trigger coupling	DC
Trigger voltage	Midpoint setting
Trigger sweep	Auto

Step 6. Compensate probes

Compensate probes to match your probe to the input channel. You should compensate a probe whenever you attach it for the first time to any input channel.

Low Frequency Compensation

For the supplied passive probes:

- 1 Set the Probe menu attenuation to 10X. If you use the probe hooktip, ensure a proper connection by firmly inserting the tip onto the probe.
- 2 Attach the probe tip to the probe compensation connector and the ground lead to the probe compensator ground connector.
- 3 Press the **[Auto Scale]** front panel key.

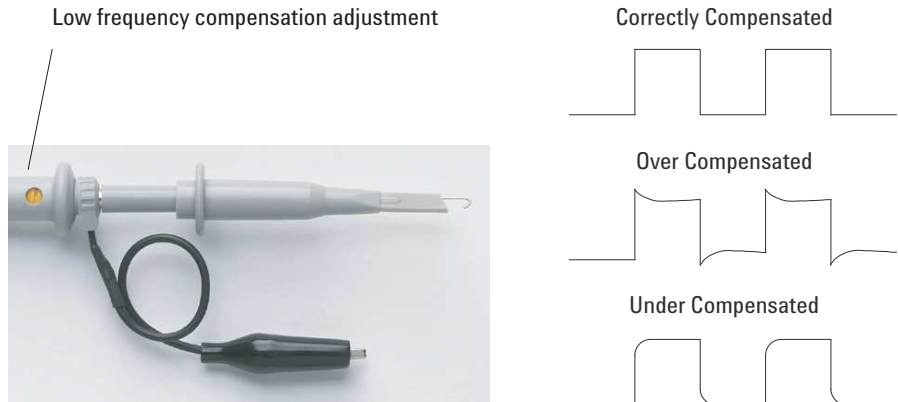


Figure 4 Low Frequency Probe Compensation

- 4 If waveform does not appear like the Correctly Compensated waveform shown in [Figure 4](#), then use a nonmetallic tool to adjust the low frequency compensation adjustment on the probe for the flattest square wave possible.

High Frequency Compensation

For the supplied passive probes:

- 1 Using the BNC adapter, connect the probe to a square wave generator.
- 2 Set the square wave generator to a frequency of 1 MHz, an amplitude of 3 V_{p-p}, and an output termination of 50Ω.
- 3 Press the **[Auto Scale]** front panel key.

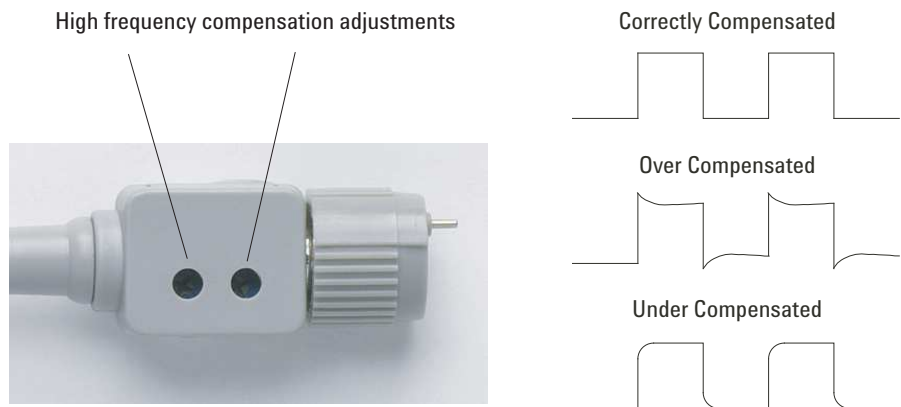


Figure 5 High Frequency Probe Compensation

- 4 If waveform does not appear like the Correctly Compensated waveform shown in [Figure 5](#), then use a nonmetallic tool to adjust the 2 high frequency compensation adjustments on the probe for the flattest square wave possible.

Step 7. Become familiar with the Front Panel Controls

Before using the oscilloscope, familiarize yourself with the front panel controls.

The front panel has knobs, keys, and softkeys. Knobs are used most often to make adjustments. Keys are used for run controls and to change other oscilloscope settings via menus and softkeys.

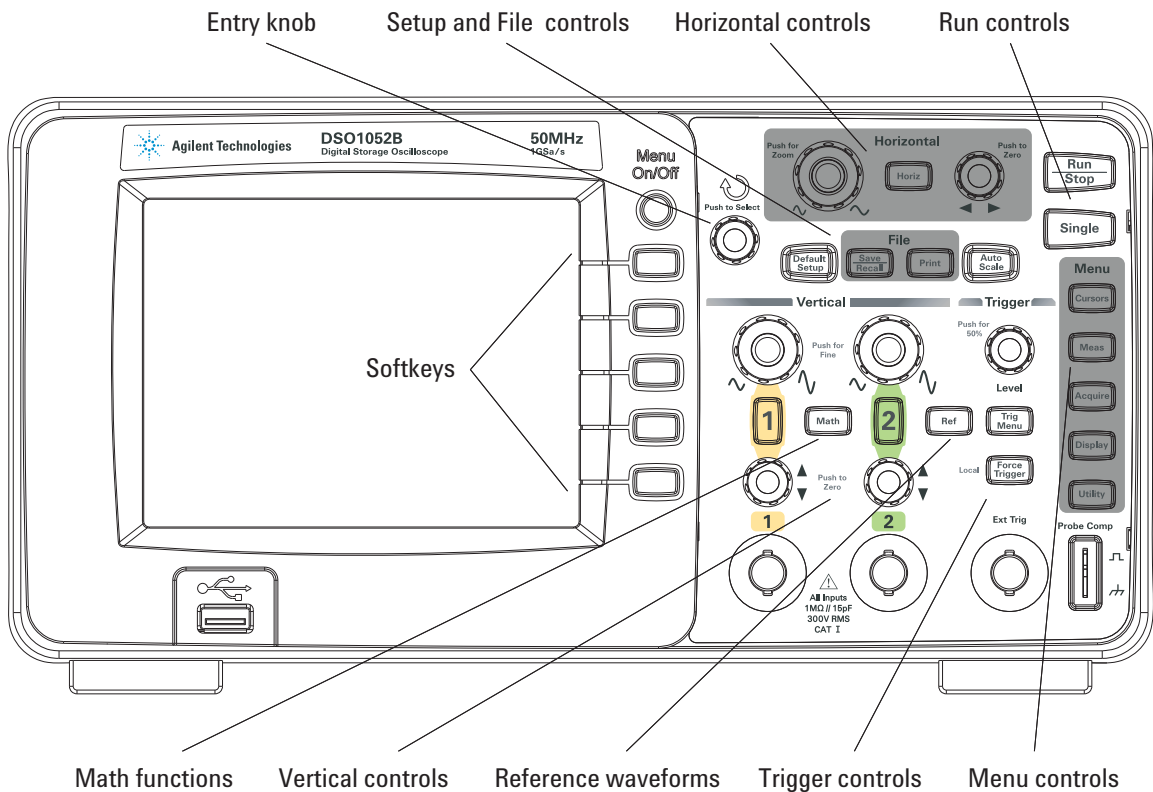


Figure 6 Front Panel

The definitions of the front panel knobs, keys, and softkeys are as follows:

Table 5 Front Panel Controls

Controls	Consists of these knobs and keys
↻ Entry knob	For the adjustment of defined controls.
Setup controls	[Auto Scale] and [Default Setup] front panel keys.
File controls	[Save/Recall] and [Print] front panel keys.
Horizontal controls	Position knob, [Horiz] front panel key, and scale knob.
Run controls	[Run/Stop] and [Single] front panel keys.
Menu controls	[Cursors] , [Meas] , [Acquire] , [Display] , and [Utility] front panel keys.
Trigger controls	Trigger [Level] knob, [Menu] , and [Force Trigger] front panel keys.
Vertical controls	Vertical position knobs, vertical scale knobs, channel ([1] , [2] , etc.) [Math] , and [Ref] front panel keys.
Softkeys	Five gray keys from top to bottom on the right-hand side of the screen, which select the adjacent menu items in the currently displayed menu.

Front Panel Overlays for Different Languages

If you choose a language option other than English, you get a front panel overlay for your language option.

To install a front panel overlay:

- 1 Insert the tabs on the left side of the overlay into the appropriate slots on the front panel.
- 2 Gently press the overlay over the knobs and buttons.
- 3 When the overlay is against the front panel, insert the tabs on the right side of the overlay into the slots on the front panel.
- 4 Let the overlay flatten out. It should remain secure on the front panel.

Step 8. Become familiar with the oscilloscope display

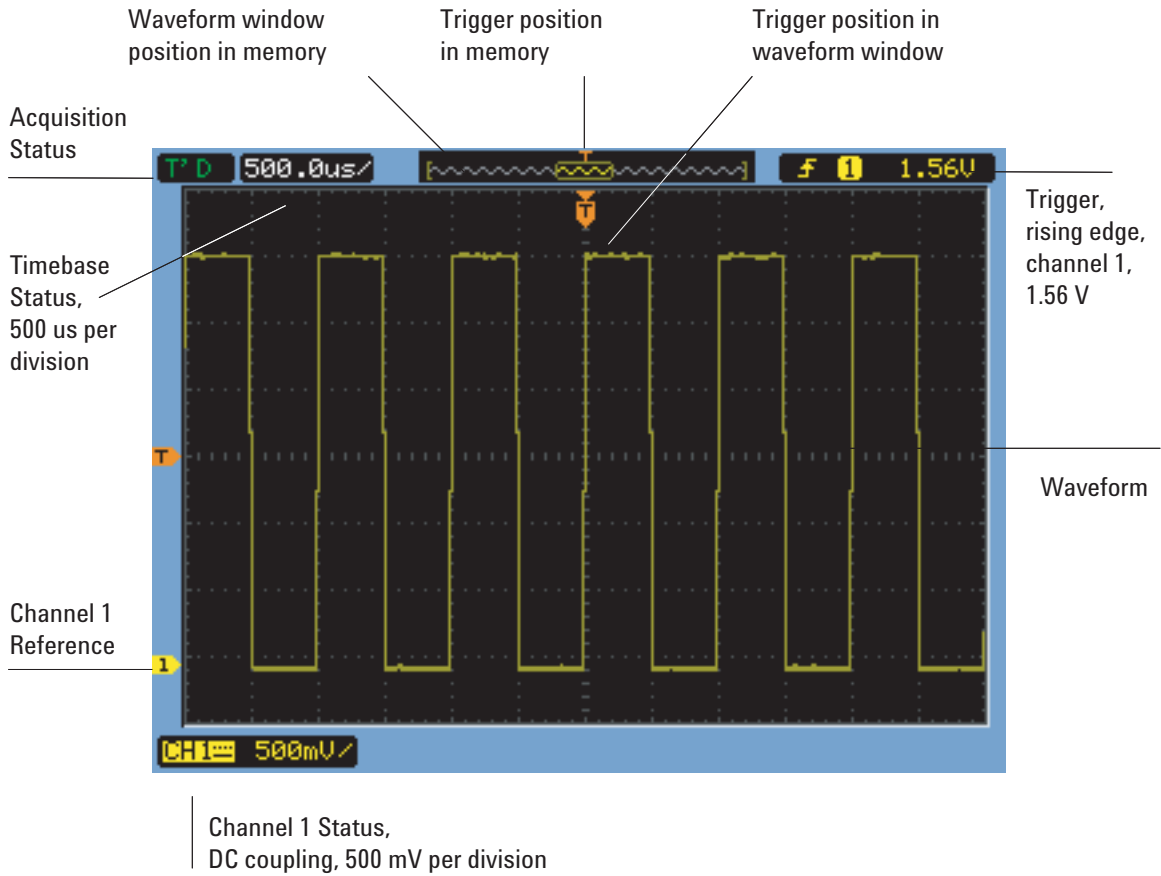


Figure 7 Oscilloscope Display

Using the Oscilloscope Softkey Menus

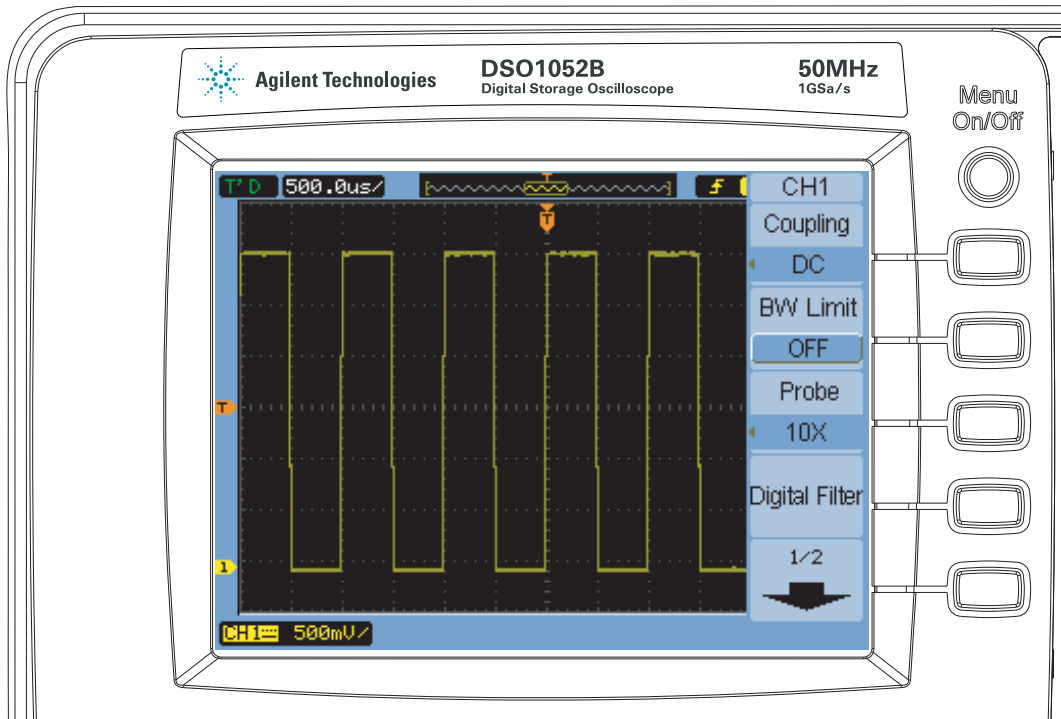


Figure 8 Softkey Menus

When one of the oscilloscope front panel keys turns on a menu, you can use the five softkeys to choose items from the menu.

Some common menu item choices are:



Accesses the next page of items in the menu.



Accesses the previous page of items in the menu.



Returns to the previous menu in the hierarchy.

The [**Menu On/Off**] front panel key turns off the menu or turns on the last accessed menu on again. The **Menu Display** item in the Display menu lets you select the amount of time menus are displayed (see “[To change the menu display time](#)” on page 63).

Step 9. Use the Run Control keys

There are two front panel keys for starting and stopping the oscilloscope's acquisition system: **[Run/Stop]** and **[Single]**.

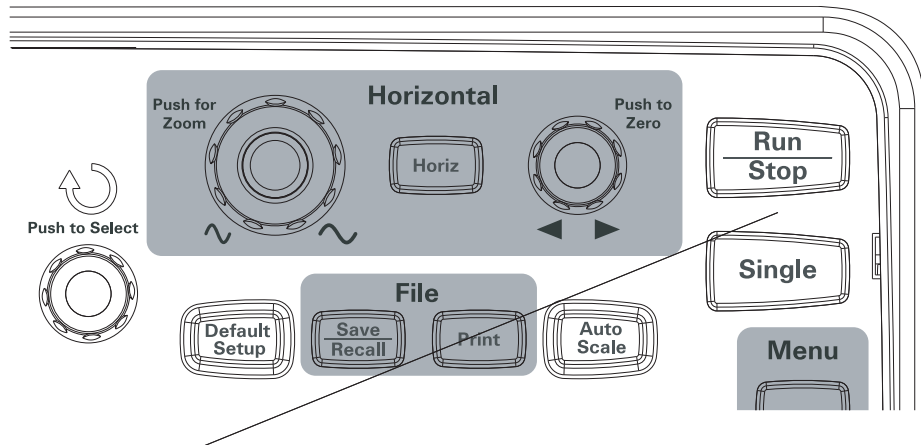


Figure 9 Run Control Keys

- When the **[Run/Stop]** key is green, the oscilloscope is acquiring data. To stop acquiring data, press **[Run/Stop]**. When stopped, the last acquired waveform is displayed.
- When the **[Run/Stop]** key is red, data acquisition is stopped. To start acquiring data, press **[Run/Stop]**.
- To capture and display a single acquisition (whether the oscilloscope is running or stopped), press **[Single]**. After capturing and displaying a single acquisition, the **[Run/Stop]** key is red.

Step 10. Access the built-in help

The oscilloscope has built-in quick help information. To access the built-in help:

- 1 Press and hold the front panel key, softkey, or pushable knob on which you would like quick help information.

The built-in help is available in 11 different languages (see [“Setting the Language \(Menu and Help\)”](#) on page 134).

Securing the Oscilloscope

To secure a 1000B Series oscilloscope to its location, you can use a Kensington lock or the security loop.

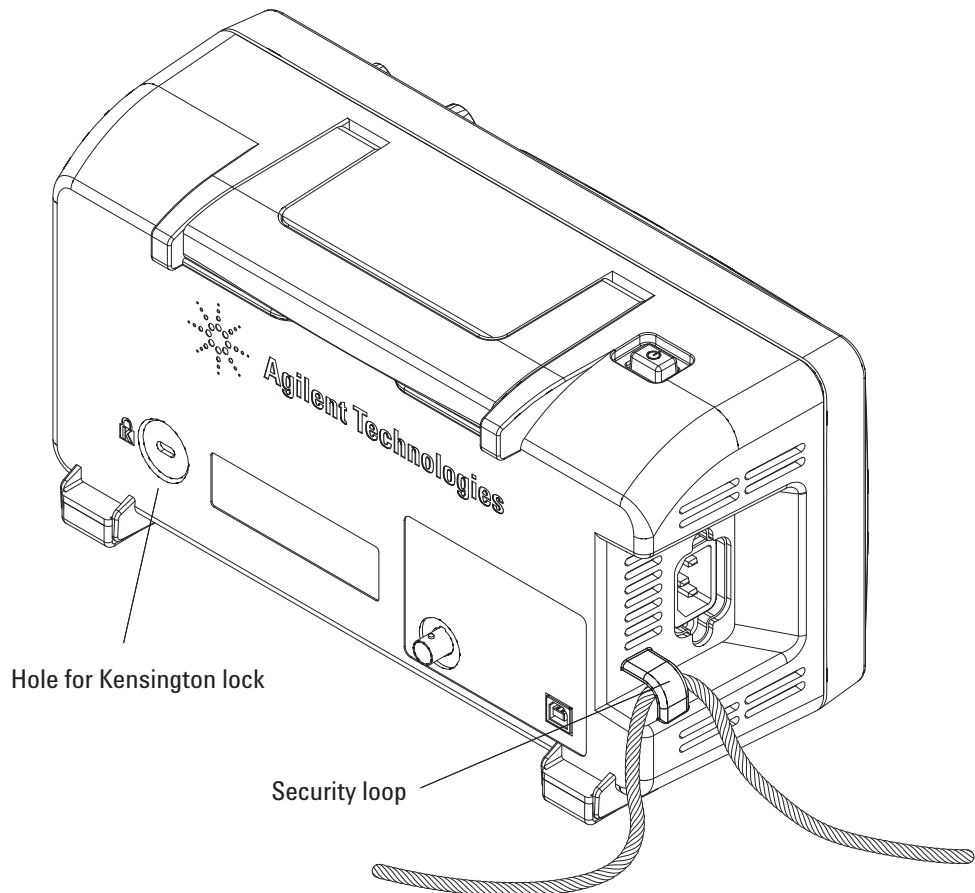
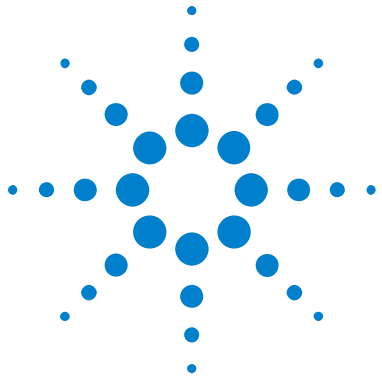


Figure 10 Securing the Instrument



2 Displaying Data

Using the Horizontal Controls	38
Using the Vertical Controls	45
Using Math Function Waveforms	54
Using Reference Waveforms	58
Changing the Display Settings	60

This chapter describes how to use the horizontal and vertical controls, channel settings, math waveforms, reference waveforms, and display settings.



Using the Horizontal Controls

The horizontal controls consist of:

- The horizontal scale knob – changes the oscilloscope’s time per division setting using the center of the screen as a reference.
- The horizontal position knob – changes the position of the trigger point relative to the center of the screen.
- The [Horiz] key – displays the Horizontal menu which lets you display the zoomed (delayed) time base, change the time base mode, and display the sample rate.

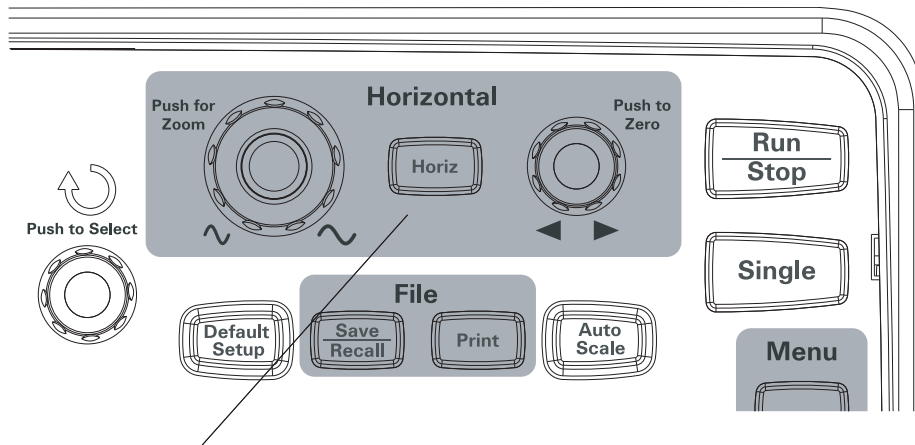


Figure 11 Horizontal Controls

Figure 12 shows the screen icon descriptions and control indicators.

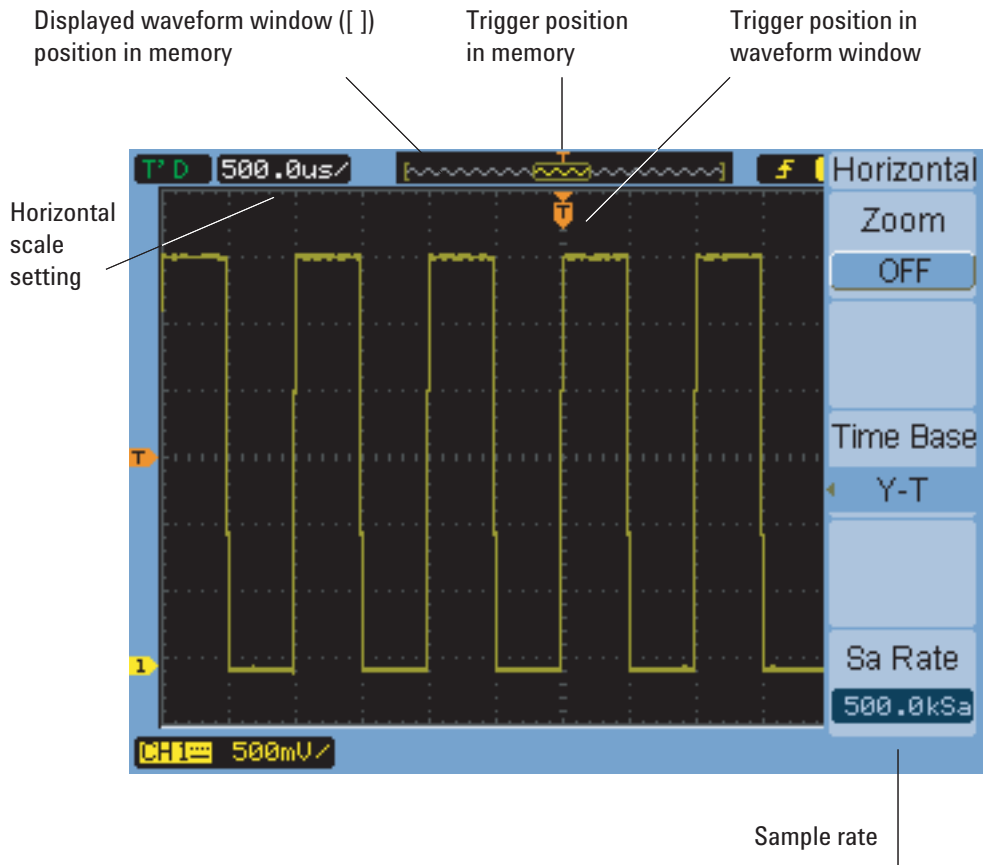


Figure 12 Status Bar, Trigger Position, and Horizontal Scale Control Indicators

To adjust the horizontal scale

- Turn the horizontal scale knob to change the horizontal time per division (time/div) setting (and the oscilloscope’s sample rate – see “Memory Depth and Sample Rate” on page 71).

The time/div setting changes in a 1-2-5 step sequence.

The time/div setting is also known as the *sweep speed*.

When the time/div is set to 50 ms/div or slower, the oscilloscope enters Slow Scan mode (see “[Slow Scan Mode](#)” below).

When the horizontal scale is set to 20 ns or faster, the oscilloscope uses sine(x)/x interpolation to expand the horizontal time base.

- Push the horizontal scale knob to toggle between the zoomed time base and the normal time base display (see “[To display the zoomed time base](#)” on page 41).

The time/div setting is displayed in the status bar at the top left of the screen. Because all channels are displayed in the same time base (except in the Alternate trigger mode), the oscilloscope displays one time/div setting for all channels.

Slow Scan Mode

When the horizontal scale is set to 50 ms/div or slower, the oscilloscope enters Slow Scan mode.

In the Slow Scan mode, peak detect acquisition is used so that no data is missed (even though the Acquire menu may show a different acquisition mode setting). The oscilloscope acquires sufficient data for the pre-trigger part of the display, then waits for the trigger. When the trigger occurs, the oscilloscope continues to capture data for the post-trigger part of the display.

When using the Slow Scan mode to view low frequency signals, the channel coupling should be set to “DC”.

The Slow Scan mode lets you see dynamic changes (like the adjustment of a potentiometer) on low frequency waveforms. For example, Slow Scan mode is often used in applications like transducer monitoring and power supply testing.

To adjust the horizontal position

- Turn the horizontal position knob to change the position of the trigger point relative to the center of the screen.

The position knob adjusts the horizontal position of all channels, math functions, and reference waveforms.

- Push the horizontal position knob to “zero” the trigger point (in other words, move it to the center of the screen).

To display the zoomed time base

The zoomed time base (also known as delayed sweep time base), magnifies a portion of the original waveform display (now on the top half of the screen) and displays it in a zoomed time base on the bottom half of the screen.

- 1 To toggle the zoomed time base “ON” or “OFF”, either push the horizontal scale knob or press [**Horiz**] key followed by the **Zoom** softkey in the Horizontal menu.
- 2 When the zoomed time base is “ON”:
 - The top half of the display shows the original waveform and the portion being magnified.
 - The horizontal scale knob changes the magnification (widens or narrows the area of magnification).
 - The horizontal position knob moves the area of magnification forward and backward on the original waveform.
 - The bottom half of the display shows the magnified data in the zoomed time base.

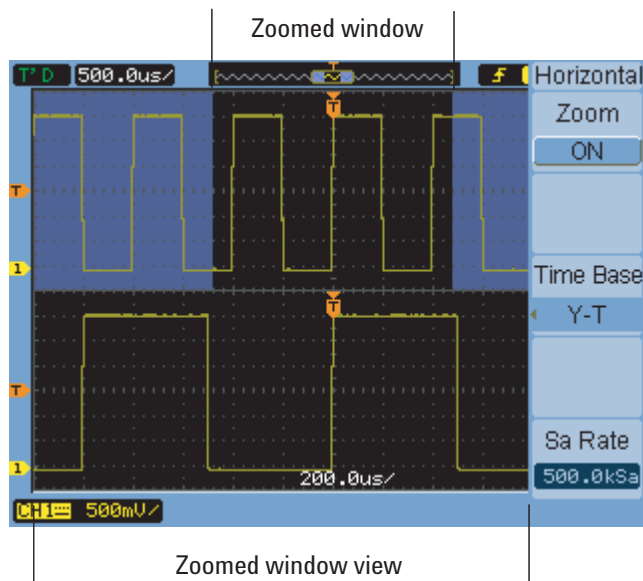



Figure 13 Zoomed Time Base Window

To change the horizontal time base (Y-T, X-Y, or Roll)

- 1 Press [**Horiz**].
- 2 In the Horizontal menu, press **Time Base**.
- 3 Continue pressing the **Time Base** softkey or turn the  entry knob to select between:

Y-T	Amplitude vs. time. This is the typical horizontal time base setting.
X-Y	Channel 2 (X-axis) vs. Channel 1 (Y-axis), see “ X-Y Format ” on page 43.

Roll In Roll mode, the waveform display rolls from right to left, and the minimum horizontal scale setting is 500 ms/div. No trigger or horizontal position control is available. Roll mode is used in applications similar to the ones for which Slow Scan mode is used (see “[Slow Scan Mode](#)” on page 40).

X-Y Format

This format compares the voltage level of two waveforms point by point. It is useful for studying phase relationships between two waveforms. This format only applies to channels 1 and 2. Choosing the X-Y display format displays channel 1 on the horizontal axis and channel 2 on the vertical axis.

The oscilloscope uses the untriggered sample acquisition mode and waveform data is displayed as dots. The sampling rate can vary from 4 kSa/s to 100 MSa/s, and the default sampling rate is 1 MSa/s.

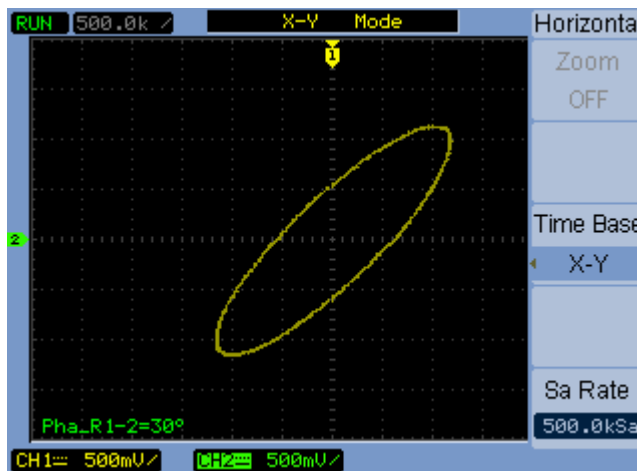


Figure 14 X-Y Display Format Showing Out-of-Phase Waveforms

The following modes or functions are not available in X-Y format:

- Automatic voltage or time measurements.
- Cursor measurements.
- Mask testing.
- Math function waveforms.
- Reference waveforms.
- Zoomed time base display.
- Displaying waveforms as vectors.
- Horizontal position knob.
- Trigger controls.

To view the sample rate

- 1 Press [**Horiz**].
- 2 In the Horizontal menu, the **Sa Rate** menu item displays the sample rate used for the current horizontal scale setting.

See Also [“Memory Depth and Sample Rate”](#) on page 71.

Using the Vertical Controls

The vertical controls consist of:

- The channel ([1], [2], [3], and [4]), [Math], and [Ref] front panel keys – turn waveforms on or off (and display or hide their menus).
- The vertical scale knobs – change the amplitude per division setting for a waveform, using either ground or the center of the screen as a reference (depending on a preference setting).
- The vertical position knobs – change the vertical position of the waveform on the screen.

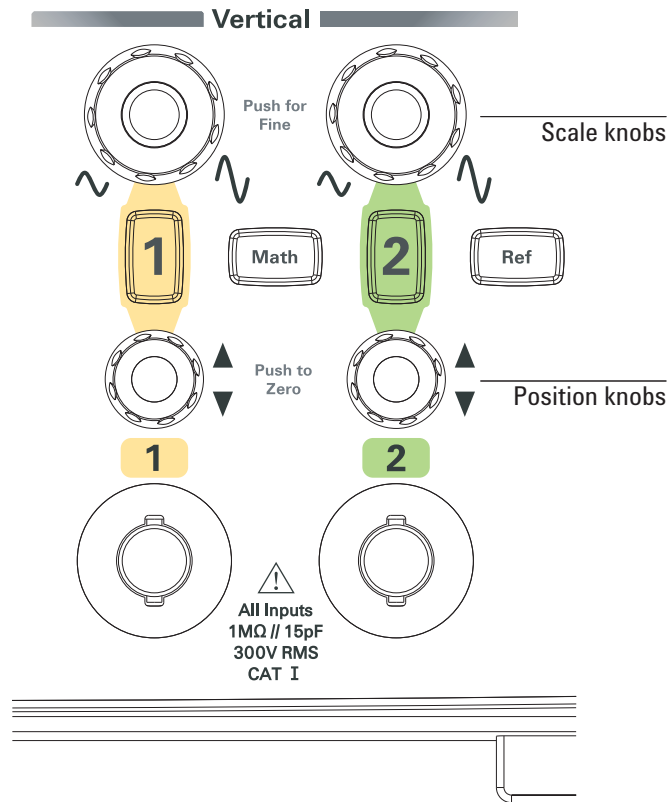


Figure 15 Vertical Controls

To turn waveforms on or off (channel, math, or reference)

Pressing the channel ([1], [2], [3], and [4]), [Math], and [Ref] front panel keys have the following effect:

- If the waveform is off, the waveform is turned on and its menu is displayed.
- If the waveform is on and its menu is not displayed, its menu will be displayed.
- If the waveform is on and its menu is displayed, the waveform is turned off and its menu goes away.

To adjust the vertical scale

When an input channel waveform is on:

- Turn its vertical scale knob to change the amplitude per division setting.

The amplitude/div setting changes in a 1-2-5 step sequence from 2 mV/div to 10 V/div (with “1X” probe attenuation).

Either ground or the center of the screen is used as a reference, depending on the “Expand Reference” preference setting (see “[To select the vertical scale reference level](#)” on page 142). The “center of screen” reference is not available for math function or reference waveforms.

- Push its vertical scale knob to toggle between vernier (fine scale) adjustment and normal adjustment.

With vernier adjustment, the amplitude/div setting changes in small steps between the normal (coarse scale) settings.

The **Volts/Div** item in a channel’s menu also toggles between vernier and normal adjustment (see “[To change the Volts/Div control sensitivity](#)” on page 51).

Vernier adjustment is not available for math function or reference waveforms.

The amplitude/div setting is displayed in the status bar at the bottom of the screen.

To adjust the vertical position

Adjusting their vertical position lets you compare waveforms by aligning them above one another or on top of each other.

When an input channel waveform is on:


- Turn the vertical position knob to change the vertical position of the waveform on the screen.

Notice that the ground reference symbol on the left side of the display moves with the waveform.

- Push the vertical position knob to “zero” the ground reference (in other words, move it to the center of the screen).

Notice that, as you adjust the vertical position, a message showing the position of the ground reference relative to the center of the screen is temporarily displayed in the lower left-hand corner of the screen.

To specify channel coupling

- 1 If the channel’s menu is not currently displayed, press the channel key ([1], [2], [3], or [4]).
- 2 In the Channel menu, press **Coupling**.
- 3 Continue pressing the **Coupling** softkey or turn the  entry knob to select between:

DC	Passes both DC and AC components of the input waveform to the oscilloscope. See Figure 16 . You can quickly measure the DC component of the waveform by simply noting its distance from the ground symbol.
AC	Blocks the DC component of the input waveform and passes the AC component. See Figure 17 . This lets you use greater sensitivity (amplitude/div settings) to display the AC component of the waveform.
GND	The waveform is disconnected from the oscilloscope input.

2 Displaying Data

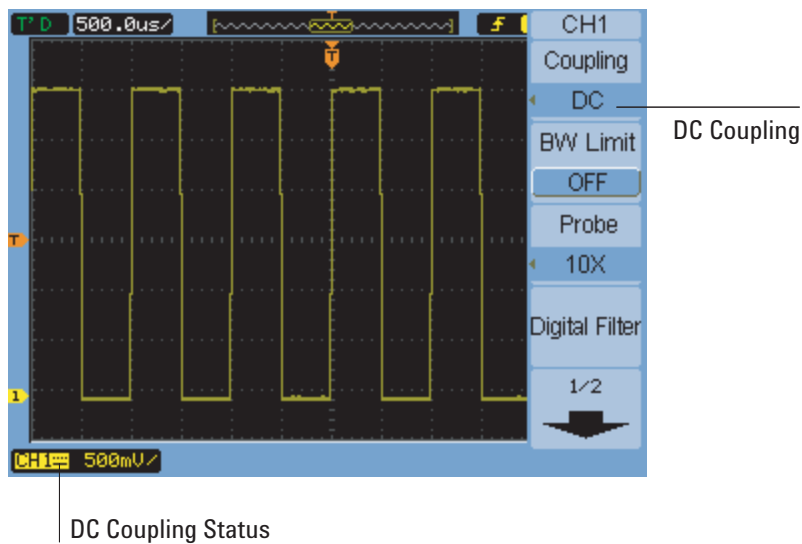


Figure 16 DC Coupling Control

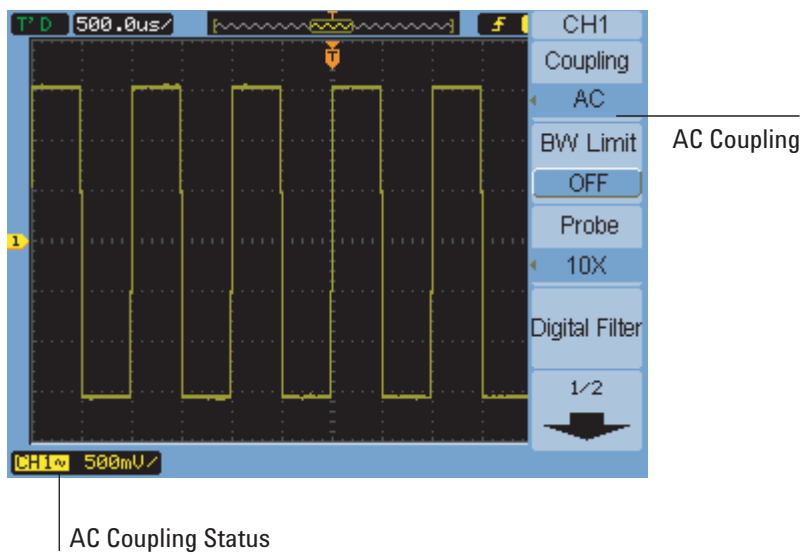


Figure 17 AC Coupling Control

To specify a bandwidth limit

When high frequency components of a waveform are not important to its analysis, the bandwidth limit control can be used to reject frequencies above 20 MHz. See [Figure 19](#) and [Figure 18](#).

- 1 If the channel's menu is not currently displayed, press the channel key ([1], [2], [3], or [4]).
- 2 In the Channel menu, press **BW Limit** to toggle the bandwidth limit setting "ON" and "OFF".

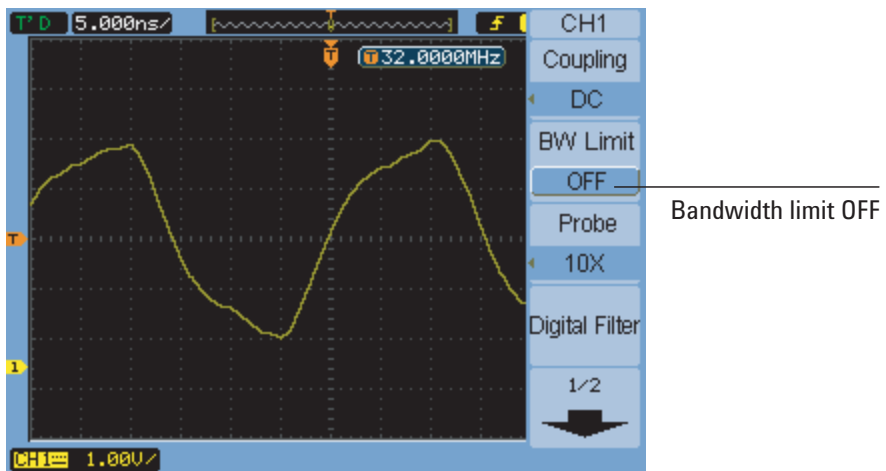


Figure 18 BW Limit Control OFF

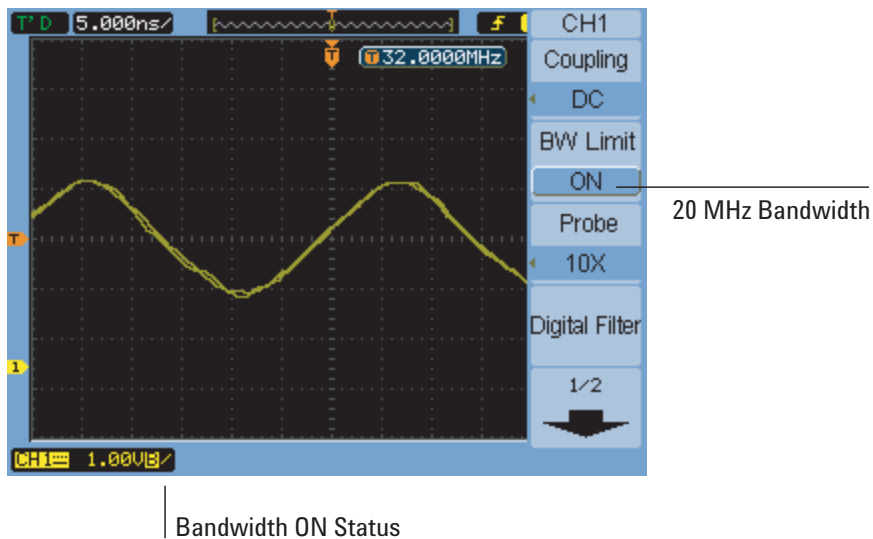


Figure 19 BW Limit Control ON

To specify the probe attenuation


For correct measurements, you must match the oscilloscope's probe attenuation factor settings with the attenuation factors of the probes being used.

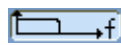
The probe attenuation factor setting changes the vertical scaling of the oscilloscope so that the measurement results reflect the actual voltage levels at the probe tip.

- 1 If the channel's menu is not currently displayed, press the channel key ([1], [2], [3], or [4]).
- 2 In the Channel menu, press **Probe**.
- 3 Continue pressing the **Probe** softkey or turn the ↻ entry knob to select the appropriate attenuation factor.

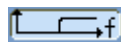
To use a digital filter

You can apply a digital filter to the sampled waveform data.

- 1 If the channel's menu is not currently displayed, press the channel key ([1], [2], [3], or [4]).
- 2 In the Channel menu, press **Digital Filter**.
- 3 In the Filter menu, press **Filter Type**, and continue pressing the **Filter Type** softkey or turn the  entry knob to select between:



LPF (Low Pass Filter).




HPF (High Pass Filter).



BPF (Band Pass Filter).



BRF (Band Reject Filter).

- 4 Depending on the type of filter selected, press **Upper Limit** and/or **Lower Limit**, and turn the  entry knob to adjust the limit.

The horizontal scale control sets the maximum value for the upper and lower limits.

Digital filters are not available when:

- The horizontal scale is 20 ns/div or lower.
- The horizontal scale is 50 ms/div or higher.

To change the Volts/Div control sensitivity

When you need to adjust the amplitude/div setting in smaller increments, you can change the sensitivity of the vertical scale control.

- 1 If the channel's menu is not currently displayed, press the channel key ([1], [2], [3], or [4]).
- 2 In the Channel menu, press **Volts/Div** to toggle between:

Coarse	The vertical scale knob changes the amplitude/div setting in a 1-2-5 step sequence from 2 mV/div to 10 V/div (with “1X” probe attenuation).
Fine	Also known as vernier, the vertical scale knob changes the amplitude/div setting in small steps between the normal (coarse scale) settings.

You can also toggle between coarse and fine settings by pushing the vertical scale knob (see [“To adjust the vertical scale”](#) on page 46).

To invert a waveform

You can invert a waveform with respect to the ground level.

- 1 If the channel’s menu is not currently displayed, press the channel key ([1], [2], [3], or [4]).
- 2 In the Channel menu, press **Invert** to toggle between “ON” and “OFF”.

[Figure 20](#) and [Figure 21](#) show the changes before and after inversion.

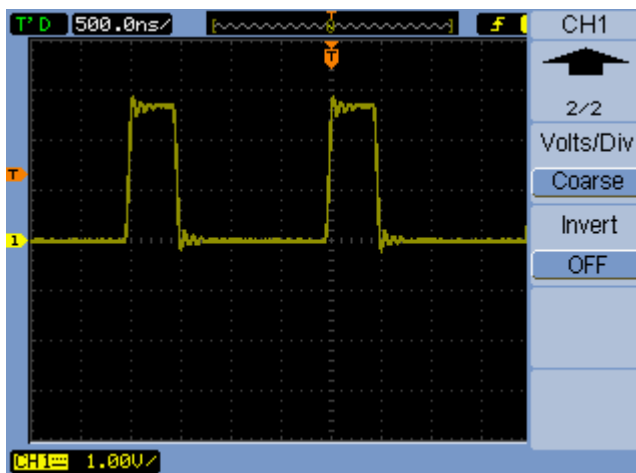


Figure 20 Waveform Before Inversion

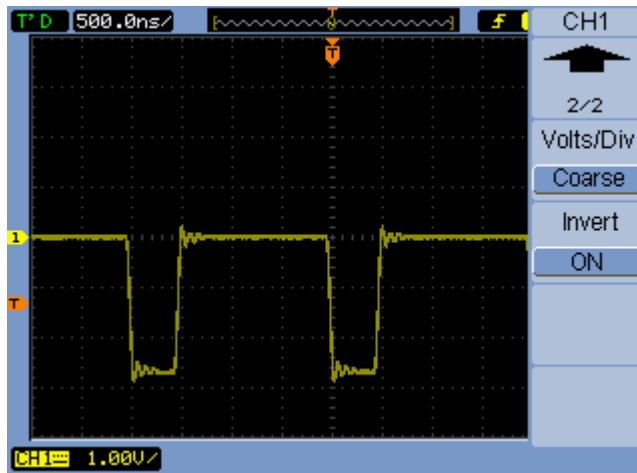



Figure 21 Waveform After Inversion

Using Math Function Waveforms

The math functions control allows the selection of the math functions:

- Add.
- Subtract.
- Multiply.
- FFT (Fast Fourier Transform).

The mathematical result can be measured using the grid and cursor controls.

The amplitude of the math waveform can be adjusted using a menu item selection in the Math menu and the  entry knob. The adjustment range is in a 1-2-5 step from 0.1% to 1000%.

The math scale setting is shown at the bottom of the display.

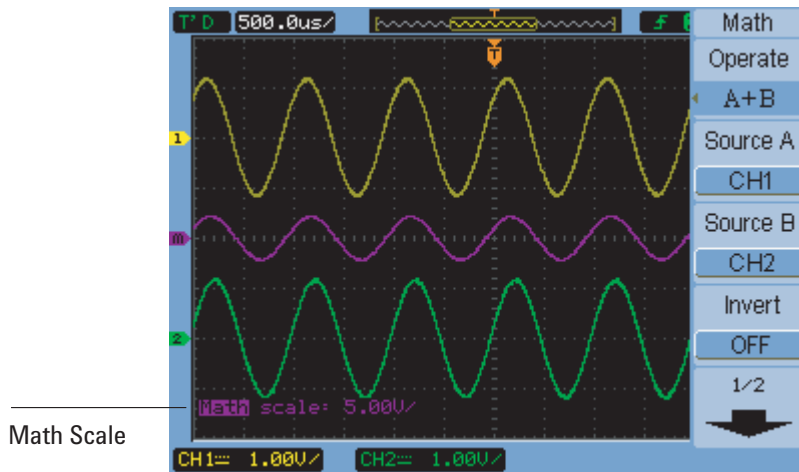



Figure 22 Math Scale Setting Value


To add, subtract, or multiply waveforms

- 1 Press **[Math]**.
- 2 In the Math menu, press **Operate**.
- 3 Continue pressing the **Operate** softkey or turn the  to select “A + B”, “A - B”, or “A x B”.
- 4 Press **Source A**, and continue pressing the softkey to select the desired input channel.
- 5 Press **Source B**, and continue pressing the softkey to select the desired input channel.
- 6 To invert the result of the addition, subtraction, or multiplication (with respect to the reference level), select **Invert** to toggle between “ON” and “OFF”.

To display the frequency domain using FFT

The FFT math function mathematically converts a time-domain waveform into its frequency components. FFT waveforms are useful for finding the harmonic content and distortion in systems, for characterizing noise in DC power supplies, and for analyzing vibration.


To display a waveform's FFT:

- 1 Press **[Math]**.
- 2 In the Math menu, press **Operate**.
- 3 Continue pressing the **Operate** softkey or turn the  to select “FFT”.
- 4 In the FFT menu, press **Source**, and continue pressing the softkey to select the desired input channel.

NOTE

The FFT of a waveform that has a DC component or offset can cause incorrect FFT waveform magnitude values. To minimize the DC component, choose AC Coupling on the source waveform.





To reduce random noise and aliasing components (in repetitive or single-shot waveforms), set the oscilloscope acquisition mode to averaging.

- 5 Press **Window**, and continue pressing the softkey or turn the  entry knob to select the desired window:

There are four FFT windows. Each window has trade-offs between frequency resolution and amplitude accuracy. What you want to measure and your source waveform characteristics help determine which window to use. Use the guidelines in [Table 6](#) to select the best window.

Table 6 FFT Window Characteristics

Window	Characteristics	Best for measuring
Rectangle	Best frequency resolution, worst magnitude resolution. This is essentially the same as no window.	Transients or bursts, the waveform levels before and after the event are nearly equal. Equal-amplitude sine waves with fixed frequencies. Broadband random noise with a relatively slow varying spectrum.
Hanning, Hamming	Better frequency, poorer magnitude accuracy than Rectangular. Hamming has slightly better frequency resolution than Hanning.	Sine, periodic, and narrow-band random noise. Transients or bursts where the waveform levels before and after the events are significantly different.
Blackman	Best magnitude, worst frequency resolution.	Single frequency waveforms, to find higher order harmonics.

- 6 Press **Display** to toggle between a “Split” screen display and a “Full Screen” display.
- 7 Press  and turn the  entry knob to adjust the vertical position of the FFT waveform.
- 8 Press  and turn the  entry knob to adjust the vertical scale of the FFT waveform.
- 9 Press **Scale** to toggle between “ V_{RMS} ” and “ dBV_{RMS} ” units.

NOTE

To display FFT waveforms with a large dynamic range, use the dBV_{rms} scale. The dBV_{rms} scale displays component magnitudes using a log scale.

- 10 Use the horizontal position knob to adjust the frequency per division. The frequency scale is displayed on the screen. Use this to display the frequencies associated with the peaks in the FFT waveform.

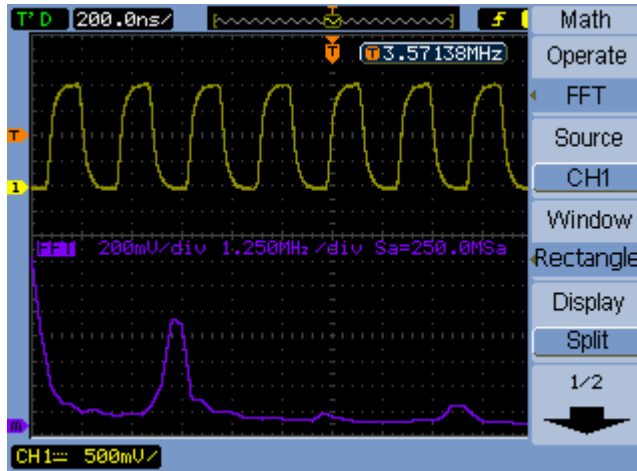


Figure 23 FFT Waveform

NOTE

FFT Resolution

The FFT resolution is the quotient of the sampling rate and the number of FFT points (f_s/N). With a fixed number of FFT points (1024), the lower the sampling rate, the better the resolution.

NOTE

Nyquist Frequency and Aliasing in the Frequency Domain

The Nyquist frequency is the highest frequency that any real-time digitizing oscilloscope can acquire without aliasing. This frequency is half of the sample rate. Frequencies above the Nyquist frequency will be under sampled, which causes aliasing. The Nyquist frequency is also called the folding frequency because aliased frequency components *fold back* from that frequency when viewing the frequency domain.

Using Reference Waveforms

You can save a reference waveform to an internal, nonvolatile memory location and then display it on the oscilloscope along with other captured waveforms.

You can also export/import reference waveforms to/from an external USB drive when it is connected to the front panel USB host port.

Reference waveforms are displayed (that is, turned on/off) just like other waveforms (see [page 46](#)).

NOTE

The reference waveform function is not available in X-Y mode.

To save a reference waveform

- 1 Before saving a waveform as a reference, set the waveform's scale and position as desired.

These settings will become the reference waveform's defaults.

- 2 Press **[Ref]**.
- 3 In the REF menu, press **Source**, and continue pressing the softkey or turn the ↻ entry knob to select the waveform you want to save.
- 4 Press **Location** to choose "Internal".
- 5 Press **Save**.

To export or import reference waveforms

To export or import from external storage (when a USB drive is connected to the front panel USB host port):

- 1 Press **[Ref]**.
- 2 If exporting a waveform, in the REF menu, press **Source**, and continue pressing the softkey or turn the ↻ entry knob to select the waveform you want to export.

- 3 Press **Location** to choose “External”.
- 4 Press **Save** or **Import**.
- 5 Use the disk manager dialog to navigate to the folder where you want to export the file or to select the file you want to import (see “[To navigate the directory hierarchy](#)” on page 123).
- 6 In the Save or Import menu:
 - To export the waveform, press **New File**, enter the filename (see “[To edit folder/file names](#)” on page 124), and press **Save**.
 - To load the selected waveform (.wfm file), press **Import**.

To return the reference waveform to its default scale

- 1 Press [**Ref**].
- 2 In the REF menu, press **Reset**.

The scale and position of the waveform as originally saved are restored.

Changing the Display Settings

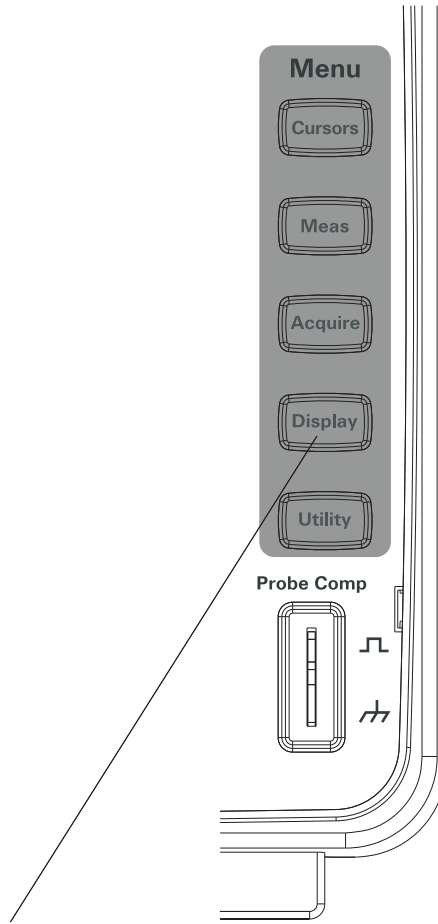


Figure 24 [Display] Key

To display waveforms as vectors or dots

- 1 Press [**Display**].
- 2 In the Display menu, press **Type** to toggle the waveform display between:

Vectors	The oscilloscope connects the sample points by using digital interpolation. Digital interpolation maintains linearity by using a $\sin(x)/x$ digital filter. The digital interpolation is suitable for real time sampling and is most effective at 20 ns or faster horizontal scale settings.
Dots	The sample points are displayed.

To clear the display

- 1 Press [**Display**].
- 2 In the Display menu, press **Clear**.

To set waveform persistence

- 1 Press [**Display**].
- 2 In the Display menu, press **Persist** to toggle the waveform display between:

Infinite	Sample points remain displayed until the display is cleared or persistence is set to “OFF”.
OFF	

To adjust waveform intensity

- 1 Press [**Display**].
- 2 In the Display menu, press **Intensity** and turn the ↻ entry knob to adjust the waveform intensity.

To change the grid

- 1 Press [**Display**].
- 2 In the Display menu, press **Grid**, and continue pressing the softkey or turn the ↻ entry knob to select between:



Display grid and coordinates on the axes.



Displays coordinates on the axes.



Turns off the grid and coordinates.

To adjust the grid brightness

- 1 Press [**Display**].
- 2 In the Display menu, press **GridBright** and turn the ↻ entry knob to adjust the grid brightness.


To invert screen colors

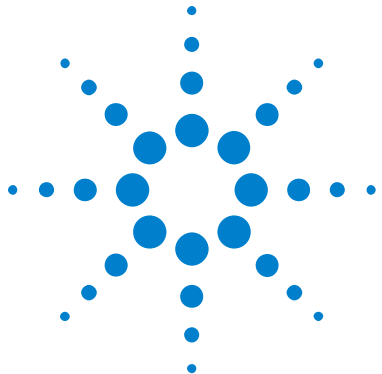
- 1 Press [**Display**] > **Preference**.
- 2 In the Display menu, press **Screen** to toggle the screen between “Normal” or “Inverted” colors.

Inverted screen colors are sometimes useful when printing or saving screens.

To change the menu display time

The menu display time is how long menus remain on the screen after a front panel key or softkey has been pressed.

- 1 Press **[Display]**.
- 2 In the Display menu, press **Menu Display**, and continue pressing the softkey or turn the  entry knob to select “1 s”, “2 s”, “5 s”, “10 s”, “20 s”, or “Infinite” menu display time.



3 Capturing Data

Overview of Sampling	66
Choosing the Acquisition Mode	75
Choosing the Acquisition Mode	75
Recording/Playing-back Waveforms	80
Adjusting the Trigger Level	85
Choosing the Trigger Mode	87
Setting Other Trigger Parameters	93
Using the External Trigger Input	97

This chapter describes sampling and acquisition modes and how to set up triggers.



Overview of Sampling

To understand the oscilloscope's sampling and acquisition modes, it is helpful to understand sampling theory, aliasing, oscilloscope bandwidth and sample rate, oscilloscope rise time, oscilloscope bandwidth required, and how memory depth affects sample rate.

Sampling Theory

The Nyquist sampling theorem states that for a limited bandwidth (band-limited) signal with maximum frequency f_{MAX} , the equally spaced sampling frequency f_S must be greater than twice the maximum frequency f_{MAX} , in order to have the signal be uniquely reconstructed without aliasing.

$$f_{MAX} = f_S/2 = \text{Nyquist frequency } (f_N) = \text{folding frequency}$$

Aliasing

Aliasing occurs when signals are under-sampled ($f_S < 2f_{MAX}$). Aliasing is the signal distortion caused by low frequencies falsely reconstructed from an insufficient number of sample points.

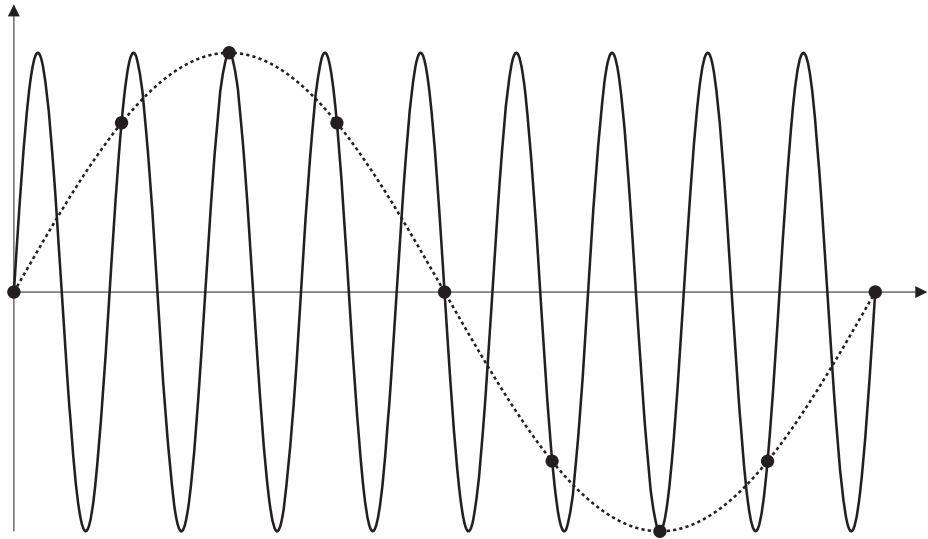


Figure 25 Aliasing

Oscilloscope Bandwidth and Sample Rate

An oscilloscope's bandwidth is typically described as the lowest frequency at which input signal sine waves are attenuated by 3 dB (-30% amplitude error).

At the oscilloscope bandwidth, sampling theory says the required sample rate is $f_S = 2f_{BW}$. However, the theory assumes there are no frequency components above f_{MAX} (f_{BW} in this case) and it requires a system with an ideal brick-wall frequency response.

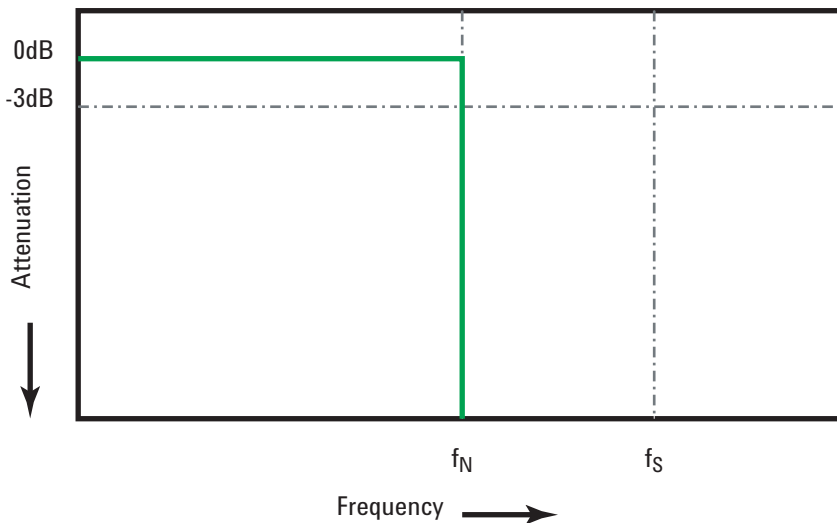
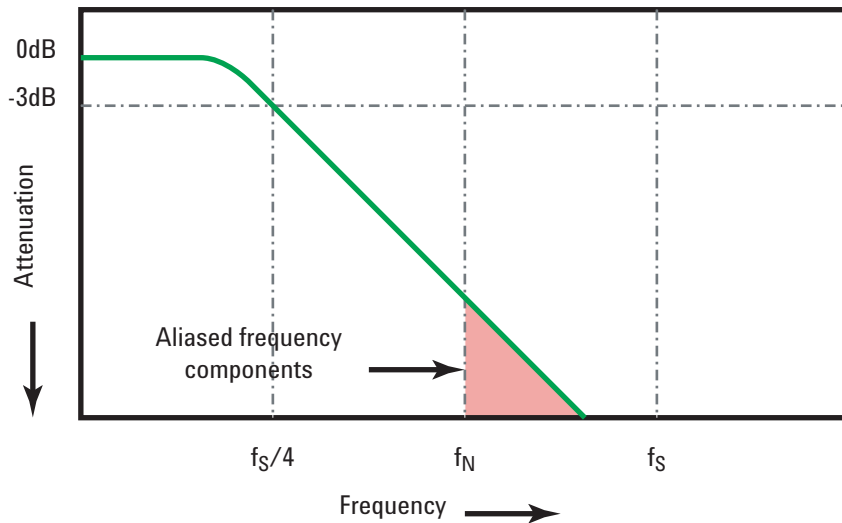


Figure 26 Theoretical Brick-Wall Frequency Response

However, digital signals have frequency components above the fundamental frequency (square waves are made up of sine waves at the fundamental frequency and an infinite number of odd harmonics), and typically, for 1 GHz bandwidths and below, oscilloscopes have a Gaussian frequency response.



Limiting oscilloscope bandwidth (f_{BW}) to 1/4 the sample rate ($f_S/4$) reduces frequency components above the Nyquist frequency (f_N).

Figure 27 Sample Rate and Oscilloscope Bandwidth

So, in practice, an oscilloscope's sample rate should be four or more times its bandwidth: $f_S = 4f_{BW}$. This way, there is less aliasing, and aliased frequency components have a greater amount of attenuation.

See Also *Evaluating Oscilloscope Sample Rates vs. Sampling Fidelity: How to Make the Most Accurate Digital Measurements*, Agilent Application Note 1587 (<http://cp.literature.agilent.com/litweb/pdf/5989-5732EN.pdf>)

Oscilloscope Rise Time

Closely related to an oscilloscope's bandwidth specification is its rise time specification. Oscilloscopes with a Gaussian-type frequency response have an approximate rise time of $0.35/f_{BW}$ based on a 10% to 90% criterion.

An oscilloscope’s rise time is not the fastest edge speed that the oscilloscope can accurately measure. It is the fastest edge speed the oscilloscope can possibly produce.

Oscilloscope Bandwidth Required

The oscilloscope bandwidth required to accurately measure a signal is primarily determined by the signal’s rise time, not the signal’s frequency. You can use these steps to calculate the oscilloscope bandwidth required:

- 1 Determine the fastest edge speeds.

You can usually obtain rise time information from published specifications for devices used in your designs.

- 2 Compute the maximum “practical” frequency component.

From Dr. Howard W. Johnson’s book, *High-Speed Digital Design – A Handbook of Black Magic*, all fast edges have an infinite spectrum of frequency components. However, there is an inflection (or “knee”) in the frequency spectrum of fast edges where frequency components higher than f_{knee} are insignificant in determining the shape of the signal.

$$f_{knee} = 0.5 / \text{signal rise time (based on 10% - 90% thresholds)}$$

$$f_{knee} = 0.4 / \text{signal rise time (based on 20% - 80% thresholds)}$$

- 3 Use a multiplication factor for the required accuracy to determine the oscilloscope bandwidth required.

Required accuracy	Oscilloscope bandwidth required
20%	$f_{BW} = 1.0 \times f_{knee}$
10%	$f_{BW} = 1.3 \times f_{knee}$
3%	$f_{BW} = 1.9 \times f_{knee}$

See Also *Choosing an Oscilloscope with the Right Bandwidth for your Application*, Agilent Application Note 1588 (<http://cp.literature.agilent.com/litweb/pdf/5989-5733EN.pdf>)

Memory Depth and Sample Rate

The number of points of oscilloscope memory is fixed (except when divided between channel pairs), and there is a maximum sample rate associated with oscilloscope's analog-to-digital converter; however, the actual sample rate is determined by the time of the acquisition (which is set according to the oscilloscope's horizontal time/div scale).

$$\text{sample rate} = \text{number of samples} / \text{time of acquisition}$$

For example, when storing 10 ns of data in 10,000 points of memory, the actual sample rate is 1 GSa/s.

Likewise, when storing 1 s of data in 10,000 points of memory, the actual sample rate is 10 kSa/s.

The actual sample rate, is displayed in the Horizontal menu (see [“To view the sample rate”](#) on page 44).

The oscilloscope achieves the actual sample rate by throwing away (decimating) unneeded samples.

Choosing the Sampling Mode

The oscilloscope can operate in real-time or equivalent-time sampling modes.

You can choose the oscilloscope's sampling mode in the Acquire menu (accessed by pressing the **[Acquire]** front panel button).

To select the real-time sampling mode

In the real-time sampling mode, single waveforms are sampled at uniformly spaced intervals. See [Figure 28](#).

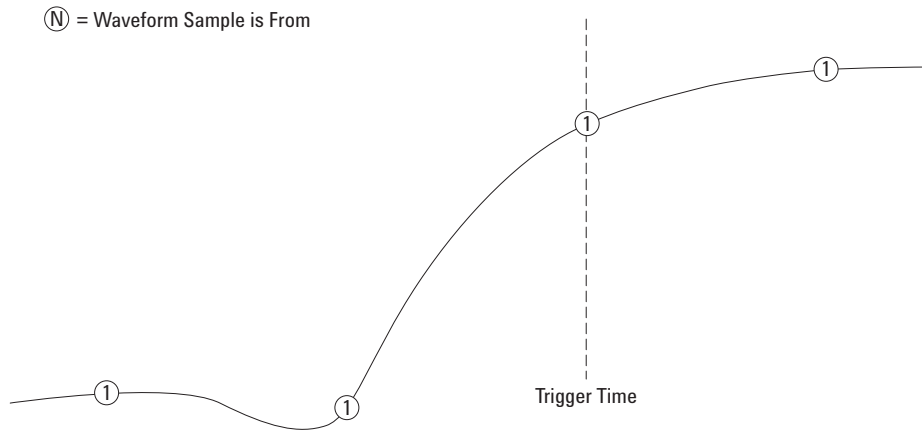


Figure 28 Real-Time Sampling Mode

Use the real-time sampling mode when capturing (non-repetitive) single-shot or pulse waveforms.

The 1000B Series oscilloscopes provide real-time sampling rates up to 500 MSa/s (when two channels are on) or 1 GSa/s (when one channel is on).

To select the Real-Time sampling mode:

- 1 Press [**Acquire**].
- 2 In the Acquire menu, select **Sampling** to choose the “Real Time” sampling mode.

In the real-time sampling mode, when the horizontal scale is set to 20 ns or faster, the oscilloscope uses sine(x)/x interpolation to expand the horizontal time base.

To select the equivalent-time sampling mode

In the equivalent-time sampling mode (also known as repetitive sampling), multiple waveforms are sampled using randomly differing delays from the trigger to yield higher effective sampling rates.

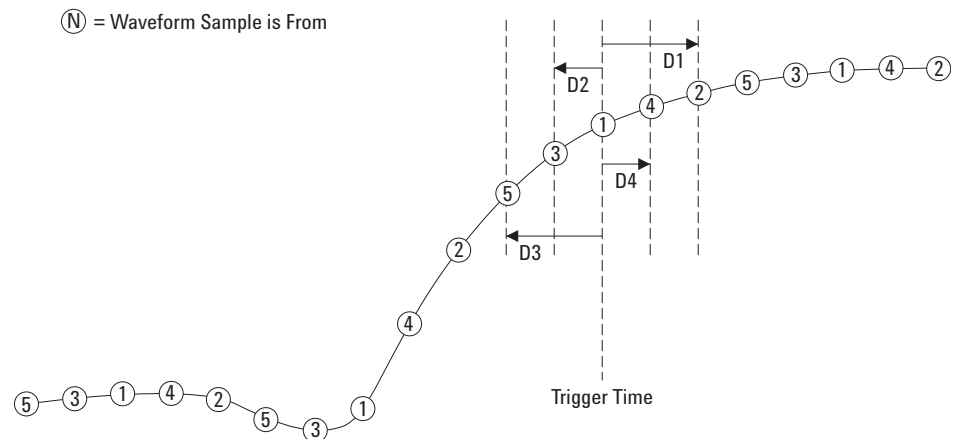


Figure 29 Equivalent-Time (Repetitive) Sampling Mode

In the equivalent-time sampling mode, the *effective sample rate* can be greater because the time between samples in the acquisition is shorter.

Equivalent-time sampling mode requires a repetitive waveform with a stable trigger.

Use the equivalent-time sampling mode to capture repetitive high-frequency signals at greater sample rates than are available in the real-time sampling mode.

Do not use the equivalent-time mode for single-shot events or pulse waveforms.

The benefits of the equivalent-time sampling mode are negligible when sample rates are the same as available in the real-time sampling mode.

In the 1000B Series oscilloscopes, the equivalent time sampling mode can achieve up to 40 ps of horizontal resolution (equivalent to 25 GSa/s).

To select the Equivalent-Time sampling mode:

- 1 Press [**Acquire**].
- 2 In the Acquire menu, select **Sampling** to choose the “Equ-Time” sampling mode.

Choosing the Acquisition Mode

The oscilloscope can operate in normal, average, or peak detect acquisition modes.

You can choose the oscilloscope's acquisition mode in the Acquire menu (accessed by pressing the **[Acquire]** front panel key).

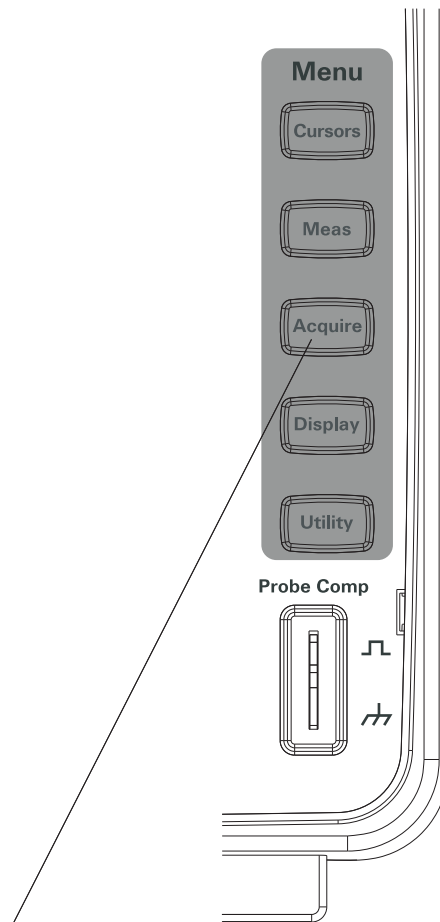



Figure 30 [Acquire] Key

To select the Normal acquisition mode

In the Normal acquisition mode, acquisitions are made and displayed one after the other.

To select the Normal acquisition mode:

- 1 Press [**Acquire**].
- 2 In the Acquire menu, press **Acquisition**.
- 3 Continue pressing the **Acquisition** softkey or turn the  to select “Normal”.

To select the Average acquisition mode

In the Average acquisition mode, acquisitions are made, and the running average over the specified number of acquisitions is displayed.

Use the Average acquisition mode to remove random noise from the waveform and to improve measurement accuracy.

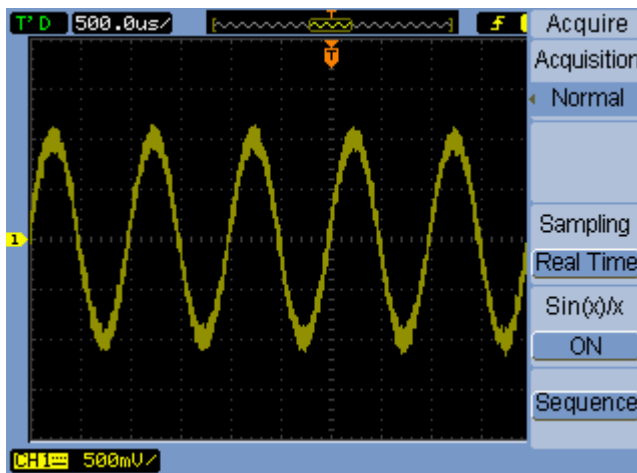


Figure 31 Noisy Waveform Without Averaging

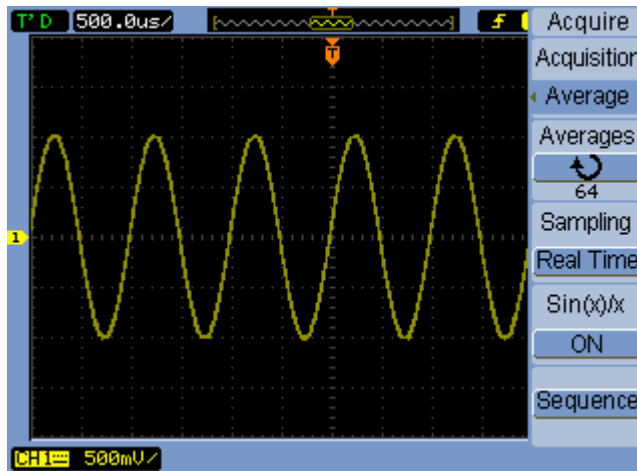




Figure 32 Noisy Waveform With Averaging

The Average acquisition mode decreases the screen refresh rate.

To select the Average acquisition mode:

- 1 Press [**Acquire**].
- 2 In the Acquire menu, press **Acquisition**.
- 3 Continue pressing the **Acquisition** softkey or turn the  entry knob to select “Average”.
- 4 Press **Averages** and turn the  entry knob to select the desired number (2, 4, 8, 16, 32, 64, 128, or 256).

To select the Peak Detect acquisition mode

In Normal or Average acquisition modes, at longer horizontal time/div settings, the oscilloscope’s analog-to-digital converter samples at a rate that yields more samples than can be stored in a limited amount of oscilloscope memory. Consequently, samples are thrown away (decimated), and you can miss narrow excursions on a signal.

3 Capturing Data

However, in the Peak Detect acquisition mode, acquisitions are made at the fastest sample rate, and the minimum and maximum values for the period associated with the actual sample rate are stored. This way, you can capture narrow excursions on a signal at longer horizontal time/div settings.

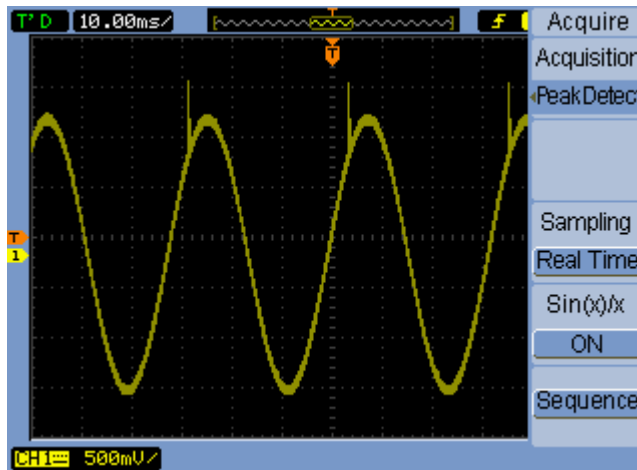


Figure 33 Peak Detect Waveform

Because minimum and maximum values for a sample period are stored, you can use the Peak Detect acquisition mode to avoid waveform aliasing.

To select the Peak Detect acquisition mode:

- 1 Press [**Acquire**].
- 2 In the Acquire menu, press **Acquisition**.
- 3 Continue pressing the **Acquisition** softkey or turn the ↻ entry knob to select “Peak Detect”.

To turn OFF/ON sine(x)/x interpolation

When sample points are displayed as vectors (instead of dots) and sine(x)/x interpolation is on, curved lines are drawn between sample points. When sine(x)/x interpolation is off, straight lines are drawn.

The effects of sine(x)/x interpolation are only noticeable when the horizontal scale is set to 20 ns or faster.

- 1 Press [**Acquire**].
- 2 In the Acquire menu, press **Sinx/x** to turn sine(x)/x interpolation “OFF” or “ON”.


Recording/Playing-back Waveforms

You can record waveforms from input channels or from the mask test output, with a maximum acquisition depth of 1000 frames.


The ability to record mask test output is especially useful for capturing abnormal waveforms over a long period of time.

To record waveforms

To record waveforms:


- 1 Press **[Acquire]**.
- 2 In the Acquire menu, press **Sequence**.
- 3 In the Sequence menu, press **Mode**.
- 4 Continue pressing the **Mode** softkey or turn the  entry knob to select Record.

To select the source channel for recording

- 1 In the Sequence menu (**[Acquire]** > **Sequence** > **Mode=Record**), press **Source**.
- 2 Continue pressing the **Source** softkey or turn the  entry knob to select the desired input channel or the mask test output.

To specify the mask test output, see “[To set the mask test output condition](#)” on page 137.

To select the number of frames to record

- 1 In the Sequence menu (**[Acquire]** > **Sequence** > **Mode=Record**), press **End Frame**.
- 2 Turn the  entry knob to select a number from 1 to 1000.

To start/stop recording

- 1 In the Sequence menu ([**Acquire**] > **Sequence** > **Mode=Record**), press **Operate** to start or stop recording.



Appears on the menu when not recording; press **Operate** to start recording.



Appears on the menu when recording; press **Operate** to stop recording.

To select the interval between recorded frames

- 1 In the Sequence menu ([**Acquire**] > **Sequence** > **Mode=Record**), press **Interval**.
- 2 Turn the ↻ entry knob to select an interval from 1 ms to 1000 s.

To play-back waveforms

To play-back waveforms:

- 1 Press [**Acquire**].
- 2 In the Acquire menu, press **Sequence**.
- 3 In the Sequence menu, press **Mode**.
- 4 Continue pressing the **Mode** softkey or turn the ↻ entry knob to select “Play back”.

To play-back/stop the recording

- 1 In the Sequence menu ([**Acquire**] > **Sequence** > **Mode=Play back**), press **Operate** to play-back or stop the recording.



Appears on the menu when not playing-back; press **Operate** to start playing-back the recording.



Appears on the menu when playing-back; press **Operate** to stop playing-back.

To select continuous or one-time play-back

- 1 In the Sequence menu ([**Acquire**] > **Sequence** > **Mode=Play back**), press **Play Mode** to toggle between:



Continuous play-back.



One-time play-back.

To select the interval between played-back frames

- 1 In the Sequence menu ([**Acquire**] > **Sequence** > **Mode=Play back**), press **Interval**.
- 2 Turn the ↻ entry knob to select an interval from 1 ms to 20 s.

To select the start frame

- 1 In the Sequence menu ([**Acquire**] > **Sequence** > **Mode=Play back**), press **Start Frame**.
- 2 Turn the ↻ entry knob to select a number from 1 to 1000.

To select the current frame

- 1 In the Sequence menu ([**Acquire**] > **Sequence** > **Mode=Play back**), press **Current Frame**.
- 2 Turn the ↻ entry knob to select a number from 1 to 1000.

To select the end frame

- 1 In the Sequence menu ([**Acquire**] > **Sequence** > **Mode=Play back**), press **End Frame**.
- 2 Turn the ↻ entry knob to select a number from 1 to 1000.

To store recorded waveforms

To store recorded waveforms:

- 1 Press **[Acquire]**.
- 2 In the Acquire menu, press **Sequence**.
- 3 In the Sequence menu, press **Mode**.
- 4 Continue pressing the **Mode** softkey or turn the ↻ entry knob to select “Storage”.

To select the start frame

- 1 In the Sequence menu (**[Acquire]** > **Sequence** > **Mode=Storage**), press **Start Frame**.
- 2 Turn the ↻ entry knob to select a number from 1 to 1000.

To select the end frame

- 1 In the Sequence menu (**[Acquire]** > **Sequence** > **Mode=Storage**), press **End Frame**.
- 2 Turn the ↻ entry knob to select a number from 1 to 1000.

To select internal/external recording storage location

- 1 In the Sequence menu (**[Acquire]** > **Sequence** > **Mode=Storage**), press **Location** to toggle between Internal and External.

Internal	Recordings are saved and loaded from oscilloscope internal memory.
External	Recordings are saved, loaded, exported, and imported from an external USB drive.

To save a recording

- 1 In the Sequence menu (**[Acquire]** > **Sequence** > **Mode=Storage**), press **Save**.
- 2 If the External location has been selected, use the Disk Manager to name and save the waveform recording file. See “[Using the Disk Manager](#)” on page 122.

To load a recording

- 1 In the Sequence menu (**[Acquire]** > **Sequence** > **Mode=Storage**), press **Load**.
- 2 If the External location has been selected, use the Disk Manager to select and load the waveform recording file. See [“Using the Disk Manager”](#) on page 122.

To import/export recordings

- 1 Because you can only export and import waveform recordings from an external drive, select the External location. See [“To select internal/external recording storage location”](#) on page 83.
- 2 In the Sequence menu (**[Acquire]** > **Sequence** > **Mode=Storage**), press **Imp./Exp..**
- 3 Use the Disk Manager to select the file and import or export the waveform recording. See [“Using the Disk Manager”](#) on page 122.

Adjusting the Trigger Level

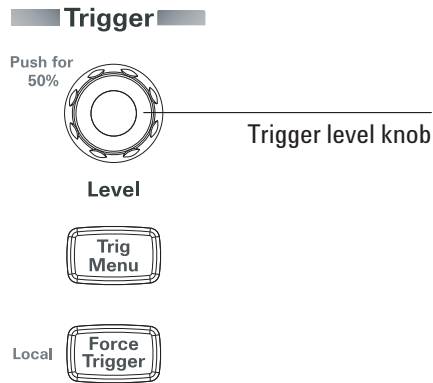


Figure 34 Trigger Controls

To adjust the trigger level

- Turn the trigger **[Level]** knob.

Two things happen:

- The trigger level value is displayed at the lower left-hand corner of the screen.
- A line is displayed showing the location of the trigger level with respect to the waveform (except when using AC coupling or LF reject coupling modes).
- Push the trigger **[Level]** knob to set the level at 50% of the signal's vertical amplitude.

To force a trigger

To make an acquisition even if no valid trigger has been found:

1 Press [**Force Trigger**].

Forcing a trigger is useful, for example, when you want to display the DC voltage of a level signal.

The [**Force Trigger**] key has no effect if the acquisition is already stopped.

When the oscilloscope's front panel is locked by a remote program (shown by a red "Rmt" on the upper-right part of the display), pressing the [**Force Trigger**] key returns the front panel to Local control.

Choosing the Trigger Mode

The trigger determines when captured data should be stored and displayed.



When a trigger is set up properly, it can convert unstable displays or blank screens into meaningful waveforms.

When the oscilloscope starts to acquire a waveform, it collects enough data so that it can draw the waveform to the left of the trigger point. The oscilloscope continues to acquire data while waiting for the trigger condition to occur. After it detects a trigger, the oscilloscope continues to acquire enough data so that it can draw the waveform to the right of the trigger point.

The oscilloscope provides these trigger modes:

Edge	Can be used with analog and digital circuits. An edge trigger occurs when the trigger input passes through a specified voltage level with the specified slope.
Pulse	Is used to find pulses with certain widths.
Video	Is used to trigger on fields or lines for standard video waveforms.
Alternate	Is used to trigger on non-synchronized signals.

To set up edge triggers

- 1 Press **[Menu]**.
- 2 In the Trigger menu, press **Mode**.
- 3 Continue pressing the **Mode** softkey or turn the  entry knob to select "Edge".
- 4 Then, either push the  entry knob or press **Mode** again.

- 5 Press **Source** and continue pressing the softkey or turn the ↻ entry knob to select the waveform to trigger on:

CH1 - CH2 The oscilloscope input channel.

EXT The external trigger input.

AC Line The AC power line.

- 6 Press **Slope** and continue pressing the softkey or turn the ↻ entry knob to select the edge to trigger on:



Rising edge.



Falling edge.



Both rising and falling edges.

To set up pulse width triggers

A pulse width trigger occurs when a pulse that matches the pulse definition is found in a waveform.

The width setting can be adjusted from 20 ns to 10 s.

- 1 Press **[Menu]**.
- 2 In the Trigger menu, press **Mode**.
- 3 Continue pressing the **Mode** softkey or turn the ↻ entry knob to select “Pulse”.
- 4 Then, either push the ↻ entry knob or press **Mode** again.
- 5 Press **Source** and continue pressing the softkey or turn the ↻ entry knob to select the waveform to trigger on:

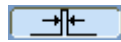
CH1 - CH2 The oscilloscope input channel.

EXT The external trigger input.

- 6 Press **When** and continue pressing the softkey or turn the ↻ entry knob to select the type of pulse to trigger on:



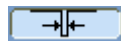
Positive pulse greater than the width setting.



Positive pulse less than the width setting.



Negative pulse greater than the width setting.



Negative pulse less than the width setting.

- 7 Press **Setting** and turn the ↻ entry knob to adjust the width setting.

To set up video triggers

Video triggering is used to trigger on fields or lines of NTSC, PAL, or SECAM standard video waveforms.

When the video trigger mode is selected, the trigger coupling is set to AC.

- 1 Press [**Menu**].
- 2 In the Trigger menu, press **Mode**.
- 3 Continue pressing the **Mode** softkey or turn the ↻ entry knob to select “Video”.
- 4 Then, either push the ↻ entry knob or press **Mode** again.
- 5 Press **Polarity** to toggle between:




Normal polarity – trigger on the negative edge of the sync pulse.




Inverted polarity – trigger on the positive edge of the sync pulse.

NOTE

Normal Polarity Sync triggers always occur on negative-going horizontal sync pulses. If the video waveform has positive-going horizontal sync pulses, use the Inverted Polarity selection.

- 6 Press **Sync** and continue pressing the softkey or turn the  entry knob to select what to trigger on:

All Lines	Trigger on all lines.
------------------	-----------------------

Line Num	Trigger on a selected line. If you select “Line Num”, press the following Line Num menu item and turn the  entry knob to select the line number.
-----------------	---

Odd Field	Trigger on an odd field.
------------------	--------------------------

Even Field	Trigger on an even field.
-------------------	---------------------------

- 7 Press **Standard** to toggle between:

NTSC	Trigger on an NTSC video waveform.
-------------	------------------------------------

PAL/ SECAM	Trigger on a PAL or SECAM video waveform.
-----------------------	---

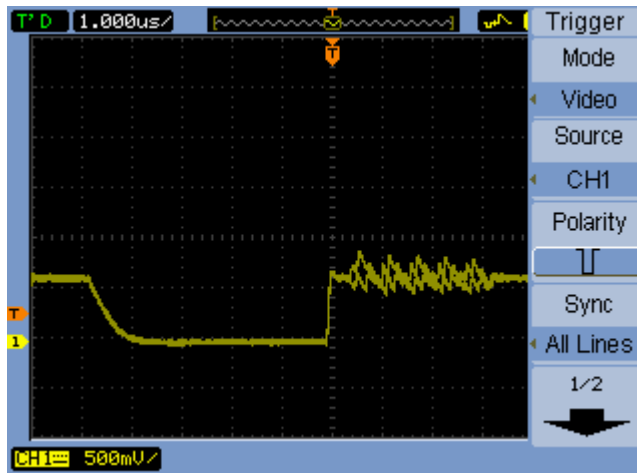


Figure 35 Line Synchronization

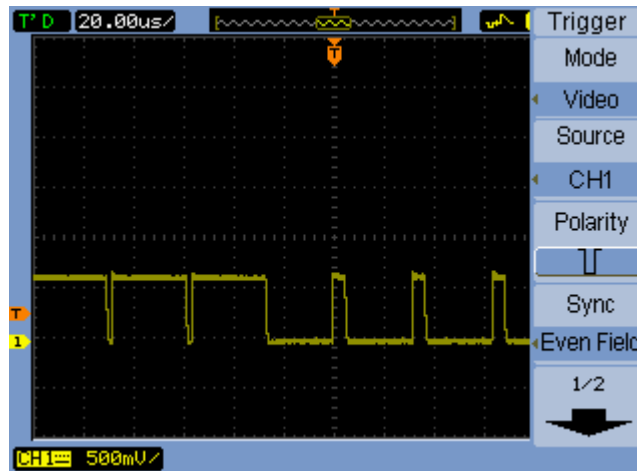


Figure 36 Field Synchronization

To set up alternate triggers

The Alternate trigger mode splits the display horizontally and lets you trigger on two, non-synchronized signals.

- 1 Press **[Menu]**.
- 2 In the Trigger menu, press **Mode**.
- 3 Continue pressing the **Mode** softkey or turn the ↻ entry knob to select “Alternate”.
- 4 Then, either push the ↻ entry knob or press **Mode** again.
- 5 Press **Select** to select the channel to set up triggering on, either “CH1” or “CH2”.

At this point, the remaining items in the Trigger menu let you set up independent triggers for the selected channel.

For each source, you can set up edge, pulse width, or video triggering. You can also specify other trigger setup options, except trigger sweep.

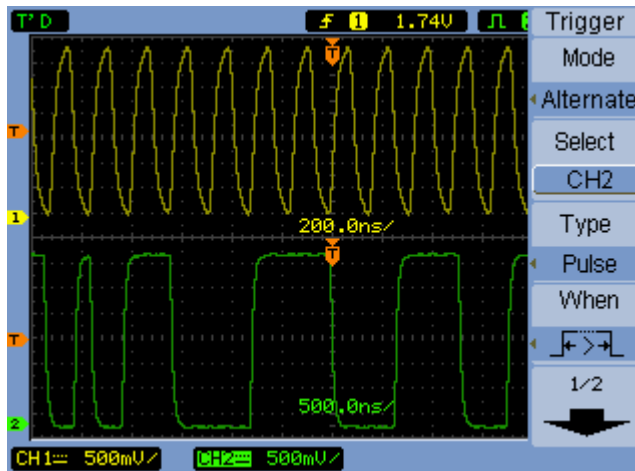



Figure 37 Alternate Triggers

Setting Other Trigger Parameters

These are trigger system parameters that apply in all trigger modes.

To set the trigger sweep

Trigger sweep specifies whether acquisitions occur without a trigger or only with a trigger.

- 1 Press **[Menu]**.
- 2 In the Trigger menu, press **Sweep**.
- 3 Continue pressing the **Sweep** softkey or turn the  entry knob to select one of these trigger sweep settings:

Auto	Acquire waveform even when no trigger occurs.
Normal	Acquire waveform when trigger occurs.

To set the trigger coupling

Trigger coupling is used to filter low frequency signal components or DC offsets from the trigger path when they interfere with achieving stable triggers.

Trigger coupling is similar to channel coupling (see [page 47](#)), but it only affects the triggering system and does not change how the signal is displayed.

To set the trigger coupling:

- 1 Press **[Menu]**.
- 2 In the Trigger menu, press **Set Up**.
- 3 In the Set Up menu, press **Coupling**.

- 4 Continue pressing the the **Coupling** softkey or turn the ↻ entry knob to select one of these trigger coupling settings:

DC	Sets the trigger coupling to DC.
AC	Sets the trigger coupling to AC – use for waveforms greater than 50 Hz.
LF Reject	Sets the trigger coupling to low frequency reject (10 kHz cutoff).

To set the trigger high-frequency reject coupling

Trigger high-frequency reject coupling (100 kHz cutoff) is used to filter high frequency signal components from the trigger path when they interfere with achieving stable triggers.

To set the trigger high-frequency reject coupling:


- 1 Press [**Menu**].
- 2 In the Trigger menu, press **Set Up**.
- 3 In the Set Up menu, press **HF Reject** to toggle between “ON” and “OFF”.

To change the trigger sensitivity

Trigger sensitivity specifies the vertical change that must occur in order for a trigger to be recognized. In the 1000B Series oscilloscopes, you can adjust the trigger sensitivity.

For example, to reduce the influence of noise, you can lower the trigger sensitivity (by increasing the vertical change required to trigger).

To change the trigger sensitivity:

- 1 Press **[Menu]**.
- 2 In the Trigger menu, press **Set Up**.
- 3 In the Set Up menu, press **Sensitivity** and turn the  entry knob to adjust the sensitivity setting.

The trigger sensitivity can be adjusted from 0.1 div to 1 div.

To specify a trigger holdoff

Trigger holdoff can be used to stabilize a waveform. The holdoff time is the oscilloscope's waiting period before starting a new trigger. The oscilloscope will not trigger until the holdoff time has expired.

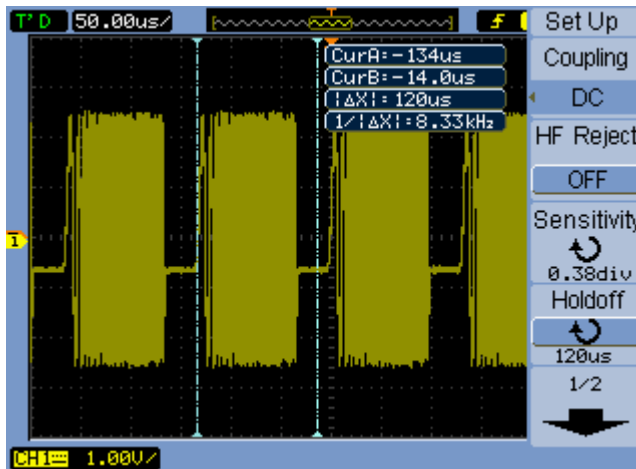



Figure 38 Trigger Holdoff

To specify a trigger holdoff:

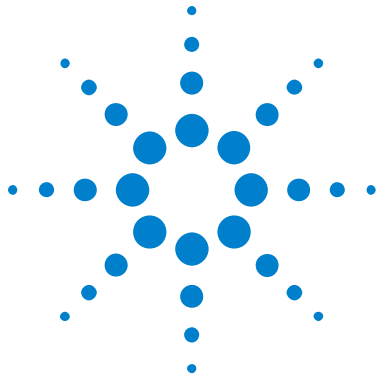
- 1 Press [**Menu**].
- 2 In the Trigger menu, press **Set Up**.
- 3 In the Set Up menu, press **Holdoff** and turn the  entry knob to adjust the holdoff setting.

To reset the trigger holdoff

- 1 In the Set Up menu, select the **Holdoff Reset** menu item to return the trigger holdoff setting to the 100 ns minimum value.

Using the External Trigger Input

You can trigger on external inputs by selecting “EXT” as the trigger source in all trigger modes except Alternate.



4 Making Measurements

Displaying Automatic Measurements	100
Voltage Measurements	102
Time Measurements	105
Counter (Frequency)	110
Making Cursor Measurements	111

This chapter shows how to make automatic voltage measurements, automatic time measurements, and cursor measurements.



Displaying Automatic Measurements

You can use the [Meas] key to display automatic measurements. The oscilloscope has 22 automatic measurements and a hardware frequency counter (see “Voltage Measurements” on page 102 and “Time Measurements” on page 105).

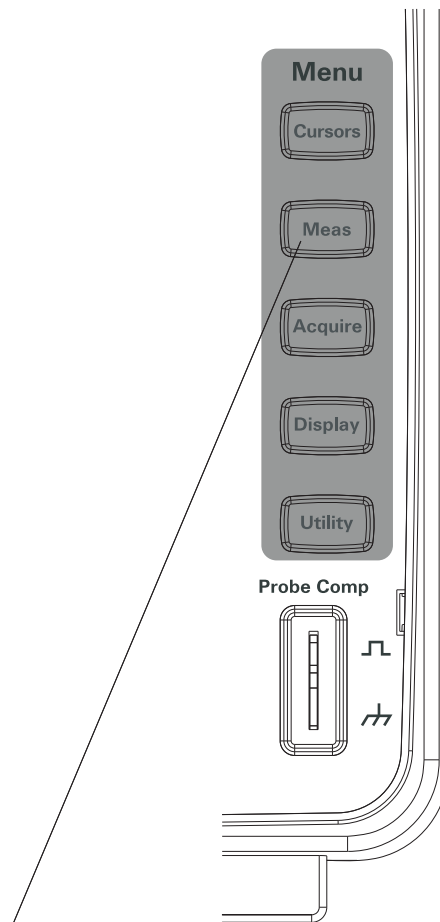


Figure 39 [Meas] Key

To display an automatic measurement

- 1 Press [**Meas**].
- 2 In the Measure menu, press **Source** to select the input channel on which to make the automatic measurement.
- 3 Press **Voltage** (for voltage measurements) or **Time** (for time measurements) and turn the ↻ entry knob to select the desired measurement.
- 4 Then, either push the ↻ entry knob or press **Voltage** or **Time** again to add the measurement to the bottom of the display.

If the measurement result is displayed as "*****", the measurement cannot be performed with the current oscilloscope settings.

A maximum of three measurements can be displayed at the bottom of the display. When three measurements are displayed and you add a new one, the measurements shift to the left, pushing the first measurement result off screen.

See Also [“To display cursors for automatic measurements”](#) on page 115.

To clear automatic measurements from the display

- 1 Press [**Meas**].
- 2 In the Measure menu, press **Clear** to clear all automatic measurements from the display.

To display or hide all automatic measurements

- 1 Press [**Meas**].
- 2 In the Measure menu, press **Display All** to toggle the display of all automatic measurements “ON” or “OFF”.

Voltage Measurements

There are 10 automatic voltage measurements:

- Vmax (Maximum Voltage).
- Vmin (Minimum Voltage).
- Vpp (Peak-to-Peak Voltage).
- Vtop (Top Voltage).
- Vbase (Base Voltage).
- Vamp (Amplitude Voltage = $V_{top} - V_{base}$).
- Vavg (Average Voltage).
- Vrms (Root-Mean-Square Voltage).
- Overshoot.
- Preshoot.

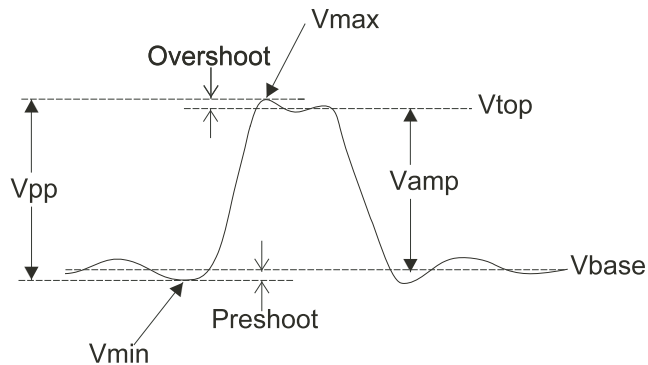


Figure 40 Voltage Measurement Points

Vmax (Maximum Voltage)

The maximum amplitude. The most positive peak voltage measured over the entire waveform. See [Figure 40](#) on page 102.

Vmin (Minimum Voltage)

The minimum amplitude. The most negative peak voltage measured over the entire waveform. See [Figure 40](#) on page 102.

Vpp (Peak-to-Peak Voltage)

Peak-to-peak voltage. See [Figure 40](#) on page 102.

Vtop (Top Voltage)

Voltage of the waveform's flat top, useful for square and pulse waveforms. See [Figure 40](#) on page 102.

Vbase (Base Voltage)

Voltage of the waveform's flat base, useful for square and pulse waveforms. See [Figure 40](#) on page 102.

Vamp (Amplitude Voltage = Vtop - Vbase)

Voltage between Vtop and Vbase of a waveform. See [Figure 40](#) on page 102.

Vavg (Average Voltage)

The arithmetic mean over the entire waveform.

Vrms (Root-Mean-Square Voltage)

The true root-mean-square voltage over the entire waveform.

$$RMS = \sqrt{\frac{\sum_{i=1}^n x_i^2}{n}}$$

Where:

x_i = value at i^{th} point.

n = number of points.

Overshoot

Defined as $(V_{\text{max}} - V_{\text{top}}) / V_{\text{amp}}$, useful for square and pulse waveforms. See [Figure 40](#) on page 102.

Preshoot

Defined as $(V_{\text{min}} - V_{\text{base}}) / V_{\text{amp}}$, useful for square and pulse waveforms. See [Figure 40](#) on page 102.

Time Measurements

There are 12 automatic time measurements plus the hardware frequency counter:

- Period.
- Frequency.
- Rise Time.
- Fall Time.
- + Pulse Width.
- - Pulse Width.
- + Duty Cycle.
- - Duty Cycle.
- Delay A-B, rising edges.
- Delay A-B, falling edges.
- Phase A-B, rising edges.
- Phase A-B, falling edges.

Period

Measures the period of a waveform.

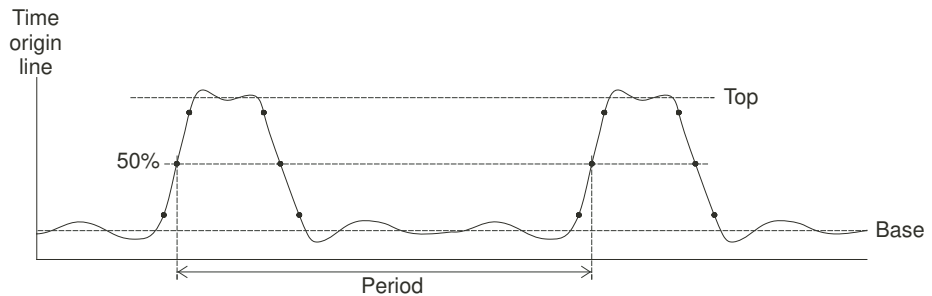


Figure 41 Period and Frequency Measurements

Frequency

Measures the frequency of a waveform. See [Figure 41](#) on page 105.

Rise Time

Measures the rise time of a waveform.

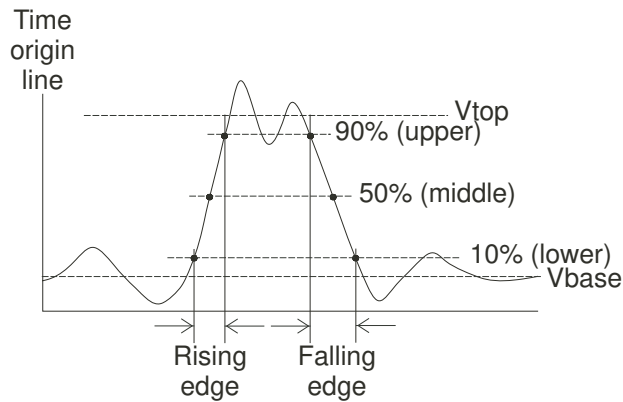


Figure 42 Rise Time and Fall Time Measurements

Fall Time

Measures the fall time of a waveform. See [Figure 42](#) on page 106.

Positive Pulse Width

Measures the positive pulse width of a waveform.

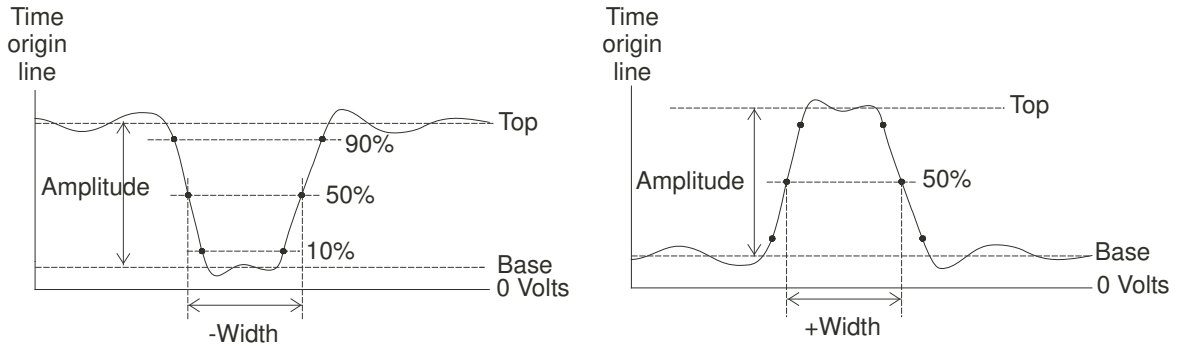


Figure 43 Positive Pulse Width and Negative Pulse Width Measurements

Negative Pulse Width

Measures the negative pulse width of a waveform. See [Figure 43](#) on page 107.

Positive Duty Cycle

Measures the positive duty cycle of a waveform.

Negative Duty Cycle

Measures the negative duty cycle of a waveform.

Delay Between Rising Edges

Measures the delay between two waveforms using the rising edges.

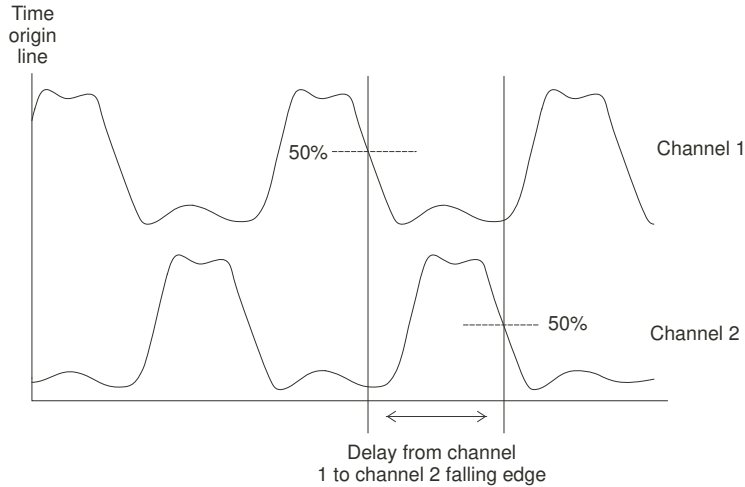


Figure 44 Delay Measurements

Delay Between Falling Edges

Measures the delay between two waveforms using the falling edges. See [Figure 44](#) on page 108.

Phase Between Rising Edges

Measures the phase between two waveforms using the rising edges.

Phase is the calculated phase shift from source 1 to source 2, expressed in degrees. Negative phase shift values indicate that the rising edge of source 1 occurred after the rising edge of source 2.

$$\text{Phase} = \frac{\text{Delay}}{\text{Source 1 Period}} \times 360^\circ$$

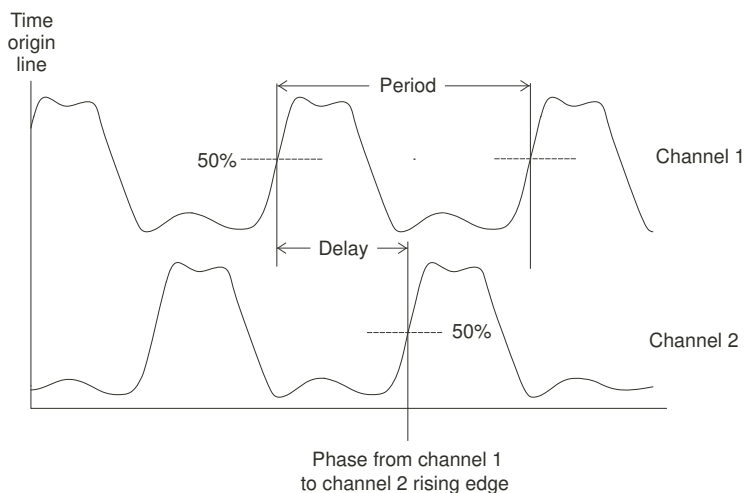


Figure 45 Phase Measurements

Phase Between Falling Edges

Measures the phase between two waveforms using the falling edges. See [Figure 45](#) on page 109.

Counter (Frequency)

The 1000B Series oscilloscopes have an integrated 6-digit hardware frequency counter.

The counter operates on the currently selected trigger source and can measure frequencies from 5 Hz to the bandwidth of the oscilloscope.

The counter uses the trigger comparator to count the number of cycles within a period of time (known as the gate time), so the trigger level must be set correctly.

The frequency counter is not available in the Alternate trigger mode.

To turn the hardware frequency counter on or off:

- 1 Press [**Meas**].
- 2 In the Measure menu, press **Counter** to toggle the frequency counter display “ON” or “OFF”.

Making Cursor Measurements

You can use the **[Cursors]** front panel key to select between these cursor measurement modes:

Manual	Gives you manually adjustable, parallel cursors for measuring time or amplitude between cursors.
Track	Gives you one or two manually adjustable, cross-hair cursors that track the points of a waveform, measuring time and amplitude.
Auto	Gives you automatically adjusted cursors for the most recently displayed voltage or time measurement.
OFF	Cursors are tuned off.

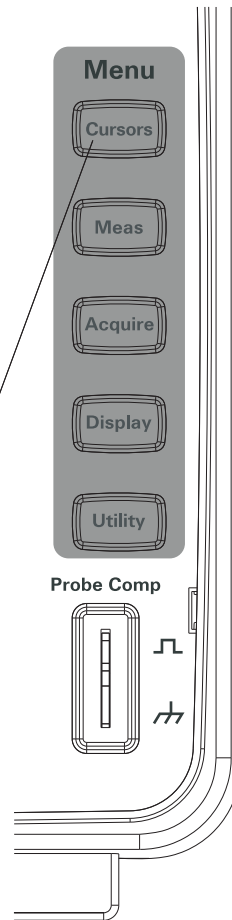







Figure 46 [Cursors] Key

To use manually adjustable cursors

You can set up two parallel, manually adjustable cursors to make amplitude (vertical) or time (horizontal) measurements on a selected waveform.

- 1 Press [**Cursors**].
- 2 In the Cursors menu, press **Mode**.
- 3 Continue pressing the **Mode** softkey or turn the  entry knob to select “Manual”.
- 4 Press **Type** to toggle between:

Time	To use cursors to measure time parameters.
Amplitude	To use cursors to measure amplitude parameters.

- 5 Press **Source**, and continue pressing the softkey or turn the  entry knob to select the channel or math waveform on which to make the measurement.
- 6 To adjust the cursors:
 - Press **CurA** and turn the  entry knob to adjust the “A” cursor.
 - Press **CurB** and turn the  entry knob to adjust the “B” cursor.
 - Press **CurA** and **CurB** and turn the  entry knob to adjust both cursors at the same time.

The cursor values displayed are:

- CurA.
- CurB.
- ΔX or ΔY – difference between CurA and CurB values.
- $1/\Delta X$ – when measuring time parameters, shows the frequency associated with the time period.

To use tracking cross-hair cursors

You can set up one or two manually adjustable, tracking cross-hair cursors to make amplitude (vertical) and time (horizontal) measurements at different points of a selected channel's waveform.

- 1 Press [**Cursors**].
- 2 In the Cursors menu, press **Mode**.
- 3 Continue pressing the **Mode** softkey or turn the ↻ entry knob to select "Track".
- 4 Press **Cursor A**, and continue pressing the softkey or turn the ↻ entry knob to select the channel on which to make the measurement (or "None" to turn off the cursor).
- 5 Press **Cursor B**, and continue pressing the softkey or turn the ↻ entry knob to select the channel on which to make the measurement (or "None" to turn off the cursor).
- 6 To adjust the cursors:
 - Press **CurA** and turn the ↻ entry knob to adjust the "A" cursor.
 - Press **CurB** and turn the ↻ entry knob to adjust the "B" cursor.

The A cursor values displayed are:

- A->X
- A->Y.

The B cursor values displayed are:

- B->X.
- B->Y

If both A and B cursors are used, these values are also displayed:

- ΔX – difference between CurA and CurB time values.
- $1/\Delta X$ – shows the frequency associated with the time value difference.
- ΔY – difference between CurA and CurB amplitude values.

To display cursors for automatic measurements

- 1 Press [**Cursors**].
- 2 In the Cursors menu, press **Mode**.
- 3 Continue pressing the **Mode** softkey or turn the ↻ entry knob to select “Auto”.

In the “Auto” cursors mode:

- Cursors appear for the most recently displayed automatic measurement (see “[To display an automatic measurement](#)” on page 101).
- No cursors are displayed if there are no automatic measurements.



5 Saving, Recalling, and Printing Data

Saving and Recalling Data 118

Using the Disk Manager 122

Printing Screens 127

This chapter describes how to save, recall, and print data.

The oscilloscope has internal, nonvolatile memory locations for saving and recalling waveforms and setups.

The oscilloscope also has a rectangular USB host port on its front panel to which you can connect a USB drive (for saving and recalling data).

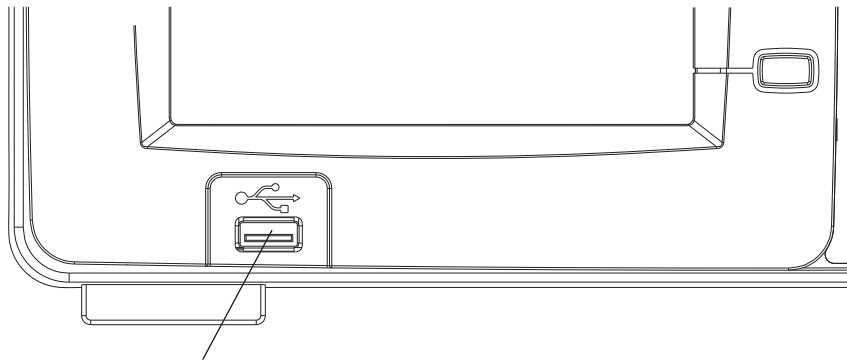


Figure 47 USB Host Port on Front Panel



Saving and Recalling Data

Using the oscilloscope's **[Save/Recall]** key, you can save and recall oscilloscope waveforms and setups, and you can save oscilloscope display screens and data.

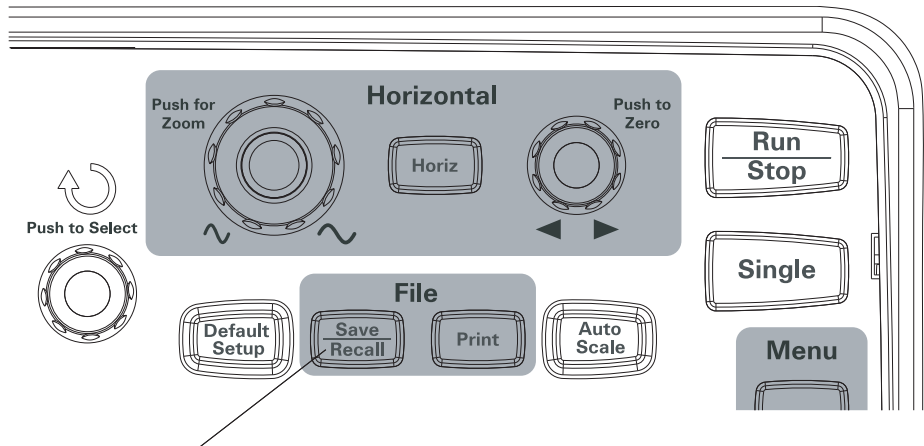


Figure 48 [Save/Recall] Key


When turning off the oscilloscope after saving or recalling data from an external USB drive, allow at least five seconds for the data transfer to complete.

To save and recall waveforms


You can save/recall oscilloscope waveforms and setups to/from 10 internal, nonvolatile memory locations in the oscilloscope.

You can also save/recall waveforms and setups to an external USB drive when it is connected to a rectangular USB host port.

- 1 Press **[Save/Recall]**.
- 2 In the Storage menu, press **Storage**.

- 3 Continue pressing the **Storage** softkey or turn the  entry knob to select “Waveform”.

To save to or recall from internal storage:

- a Press **Internal**.
- b In the Internal menu, press **Location**.
- c Continue pressing the **Location** softkey or turn the  entry knob to select the desired internal storage location.

The “(N)” suffix shows that nothing has been saved to the location.
The “(S)” suffix shows waveforms have been previously saved to the location.

- d Press **Save** or **Recall**.

To save to or recall from external storage (when a USB drive is connected to the front panel USB host port):

- a Press **External**.
- b Use the disk manager dialog to navigate to the folder where you want to save the file or to select the file you want to load (see [“To navigate the directory hierarchy”](#) on page 123).
- c In the External menu:


To save the waveform, press **New File**, enter the filename (see [“To edit folder/file names”](#) on page 124), and press **Save**.

To load the selected waveform (.wfm file), press **Recall**.

To save and recall oscilloscope setups

You can save/recall oscilloscope setups to/from 10 internal, nonvolatile memory locations in the oscilloscope.

You can also save/recall setups to an external USB drive when it is connected to the front panel USB host port.

- 1 Press [**Save/Recall**].
- 2 In the Storage menu, press **Storage**.
- 3 Continue pressing the **Storage** softkey or turn the  entry knob to select “Setups”.

To save to or recall from internal storage:

- a Press **Internal**.
- b In the Internal menu, press **Location**.
- c Continue pressing the **Location** softkey or turn the ↻ entry knob to select the desired internal storage location.

The “(N)” suffix shows that nothing has been saved to the location. The “(S)” suffix shows waveforms have been previously saved to the location.

- d Press **Save** or **Recall**.

To save to or recall from external storage (when a USB drive is connected to the front panel USB host port):

- a Press **External**.
- b Use the disk manager dialog to navigate to the folder where you want to save the file or to select the file you want to load (see [“To navigate the directory hierarchy”](#) on page 123).
- c In the External menu:

To save the setup, press **New File**, enter the filename (see [“To edit folder/file names”](#) on page 124), and press **Save**.

To recall the selected setup (.stp file), press **Recall**.

To save screens to BMP or PNG format files

You can save oscilloscope display screens (in BMP or PNG format) to an external USB drive when it is connected to a rectangular USB host port.


- 1 Press [**Save/Recall**].
- 2 In the Storage menu, press **Storage**.
- 3 Continue pressing the **Storage** softkey or turn the ↻ entry knob to select one of:

8-Bitmap	8-bit BMP format.
24-Bitmap	24-bit BMP format.
PNG	Portable Network Graphics format.

- 4 To specify whether oscilloscope parameters be saved along with the screen, press **Para Save** to toggle between on and off.
- 5 Press **External**.
- 6 Use the disk manager dialog to navigate to the folder where you want to save the file (see [“To navigate the directory hierarchy”](#) on page 123).
- 7 In the External menu, press **New File**, enter the filename (see [“To edit folder/file names”](#) on page 124), and press **Save**.

To save data to CSV format files

You can save captured data (in CSV, comma-separated value format) to an external USB drive when it is connected to the front panel USB host port.

- 1 Press [**Save/Recall**].
- 2 In the Storage menu, press [**Storage**].
- 3 Continue pressing the **Storage** softkey or turn the  entry knob to select “CSV”.
- 4 To specify the amount of data to be saved, press **Data Depth** to toggle between “Displayed” and “Maximum”.
- 5 To specify whether oscilloscope parameters be saved along with the data, press **Para Save** to toggle between “ON” and “OFF”.
- 6 Press **External**.
- 7 Use the disk manager dialog to navigate to the folder where you want to save the file (see [“To navigate the directory hierarchy”](#) on page 123).
- 8 In the External menu, press **New File**, enter the filename (see [“To edit folder/file names”](#) on page 124), and press **Save**.

Using the Disk Manager

When a USB drive is connected to the front panel USB host port, you can use the Disk Manager to select and name files and folders.

To access the Disk Mana. menu:

- 1 Press [**Save/Recall**].
- 2 In the Storage menu, press **Disk Mana.**

The Disk Manager screen appears. It looks similar to:

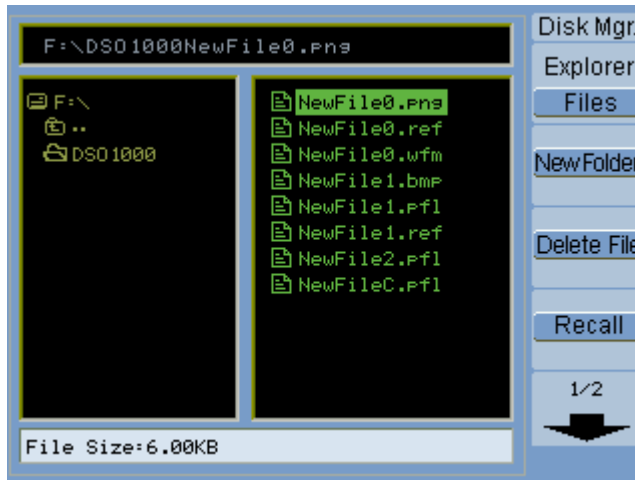



Figure 49 Disk Manager

To switch between files, path, and directory panes



- 1 In the Disk Mana. menu ([**Save/Recall**] > **Disk Mana.**), press **Explorer** to switch between:

Files	Places the cursor in the files pane.
Path	Places the cursor in the path pane.
Directories	Places the cursor in the directories pane.

In each of these panes, the  entry knob is used to select items.

To navigate the directory hierarchy

In the directory pane (see “[To switch between files, path, and directory panes](#)” on page 123):

- Turn the  entry knob to select folders.
- Push the  entry knob to navigate into the selected folder.

To create new folders





- 1 In the Disk Mana. menu ([**Save/Recall**] > **Disk Mana.**), press **New Folder**.
- 2 Use the folder/file naming dialog to enter the folder name. See “[To edit folder/file names](#)” on page 124.
- 3 In the New Folder menu, press **Save**.

To edit folder/file names



Figure 50 Editing Folder/File Names in Disk Manager

In the folder/file name edit dialog:

- Select the  menu item to move the cursor between fields in the dialog.
- Turn the  entry knob to select:
 - A character in the filename (when the cursor is in the name field).
 - A key (when the cursor is in the keypad field).
- When the cursor is in the keypad field, push the  entry knob to:
 - Choose an alphanumeric character for the name (and move to the next name character).
 - On “Aa”, change from upper to lower case characters on the keypad.
 - On “En”, change from single-byte to multi-byte character entry fields.
- Select the  menu item to delete a character from the name.

To delete folders

In the directory pane (see “[To switch between files, path, and directory panes](#)” on page 123):

- 1 Turn the ↻ entry knob to select folders.
- 2 Press **Del Folder** to delete the selected folder.
- 3 Press **Ok** to confirm the deletion.

To rename folders

In the directory pane (see “[To switch between files, path, and directory panes](#)” on page 123):

- 1 Turn the ↻ entry knob to select the folder.
- 2 Press **Rename**.
- 3 Use the folder/file naming dialog to edit the folder name. See “[To edit folder/file names](#)” on page 124.
- 4 In the Rename menu, press **Ok**.

To delete files

In the files pane (see “[To switch between files, path, and directory panes](#)” on page 123):

- 1 Turn the ↻ entry knob to select the file.
- 2 Press **Delete File** to delete the selected file.
- 3 Press **Ok** to confirm the deletion.

To recall files

In the files pane (see “To switch between files, path, and directory panes” on page 123):

- 1 Turn the ↻ entry knob to select the file.
- 2 Press **Recall** to load the selected file.

To rename files

In the files pane (see “To switch between files, path, and directory panes” on page 123):

- 1 Turn the ↻ entry knob to select the file.
- 2 Press **Rename**.
- 3 Use the folder/file naming dialog to edit the file name. See “To edit folder/file names” on page 124.
- 4 In the Rename menu, press **Ok**.

To display disk information

- 1 In the Disk Mana. menu ([**Save/Recall**] > **Disk Mana.**), press **Disk info**.

Printing Screens

You can print oscilloscope display screens to:

- A PictBridge compliant printer connected to the (square) USB device port on the oscilloscope's back panel.

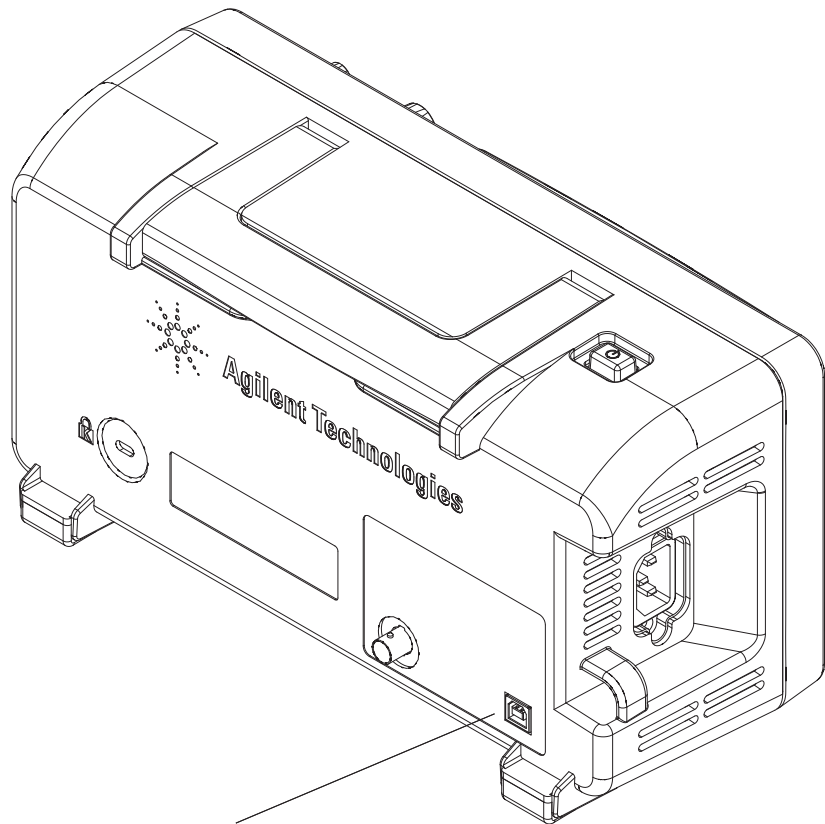


Figure 51 USB Device Port

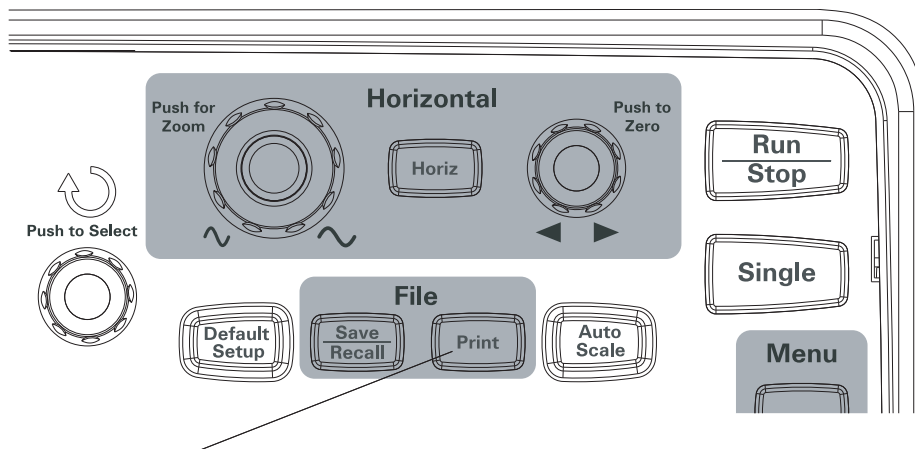


Figure 52 [Print] Key

To choose a PictBridge printer

You can print to a PictBridge compliant printer connected to the (square) USB device port on the oscilloscope's back panel.

- 1 Press **[Print]**.
- 2 Press **Paper Size** and turn the ↻ entry knob to select the desired paper size.
- 3 Press **File Type** and turn the ↻ entry knob to select the desired file type.
- 4 Press **Copies** and turn the ↻ entry knob to select the desired number of copies.
- 5 Press **Print Quality** and turn the ↻ entry knob to select the desired print quality.
- 6 Press **Date Print** to turn date printing on the image "ON" or "OFF".

NOTE

The back panel's (square) USB device port is also used for remote control of the oscilloscope, so the PictBridge compliant printing and remote control features cannot be used at the same time.

If there are problems when connecting the USB device port to a PictBridge compliant printer or remote computer, see ["To select the USB device port function"](#) on page 143.

To print with inverted screen colors

- 1 Press **[Print]**.
- 2 In the Print menu, press **Inverted** to choose between:

ON	This option changes the black background of display image to white. This can be used to reduce the amount of black ink that takes to print the oscilloscope display images.
OFF	This option prints the display image as shown on the screen.

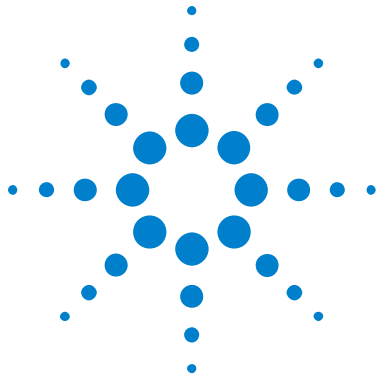
To choose color or grayscale printing

- 1 Press **[Print]**.
- 2 Press **Palette** to choose between:

Grayscale	When this option is selected, the traces are printed in shades of gray rather than in color.
Color	When this option is selected, the traces are printed in color.

To copy a screen to the printer

- 1 Press [**Print**].
- 2 In the Print menu, press the **Print** softkey.



6 Oscilloscope Utility Settings

Displaying System Information	133
Turning Sound ON or OFF	133
Setting the Language (Menu and Help)	134
Performing Mask Tests	135
Setting Preferences	142
Running Self-Calibration	144

This chapter describes oscilloscope settings found in the Utilities menu.



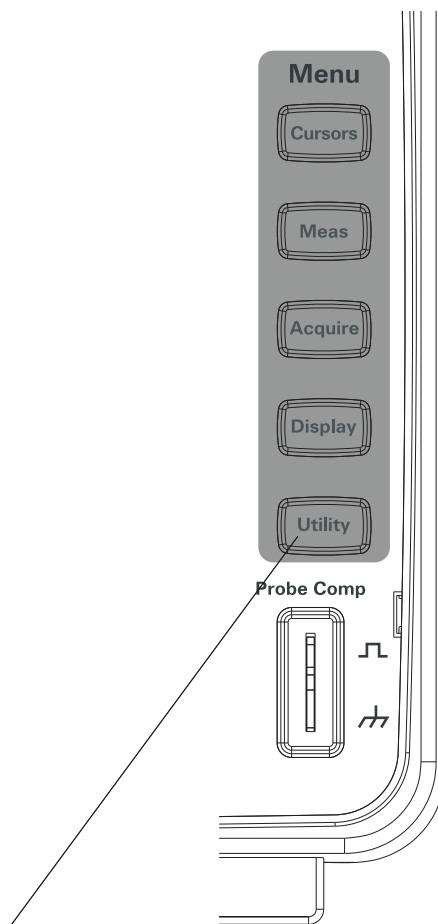


Figure 53 [Utility] Key

Displaying System Information

To display the oscilloscope's system information:

- 1 Press [**Utility**].
- 2 In the Utilities menu, press **System Info**.

The system information contains:

- Model number.
- Serial number.
- Software version.
- Installed module information.

To exit, press **Run/Stop**.

Turning Sound ON or OFF

To turn the oscilloscope's beeper sound on or off:

- 1 Press [**Utility**].
- 2 In the Utilities menu, press **Sound** to toggle between on and off.




Appears on the menu when sound is off; press **Sound** to run the test.



Appears on the menu when sound is on; press **Sound** to stop the test

Setting the Language (Menu and Help)

To set the language used in menus and quick help:

- 1 Press [**Utility**].
- 2 In the Utilities menu, press **Language**.
- 3 Continue pressing the **Language** softkey or turn the  entry knob to select the desired language.

You can select from the following languages:

- Simplified Chinese.
- Traditional Chinese.
- Korean.
- Japanese.
- English.
- German.
- French.
- Portuguese.
- Spanish.
- Italian.
- Russian.

If quick help is unavailable in a particular language, English is displayed.

Performing Mask Tests

The mask test function monitors waveform changes by comparing the waveform to a predefined mask.

NOTE

The Mask Test function is not available in the X-Y horizontal timebase mode.


To access the Mask Test menu:

- 1 Press **[Utility]**.
- 2 In the Utilities menu, press **Mask Test**.

To enable/disable mask tests

- 1 In the Mask Test menu (**[Utility]** > **Mask Test**), press **Enable Test** to toggle between OFF and ON.

To select the source channel for mask tests

- 1 In the Mask Test menu (**[Utility]** > **Mask Test**), press **Source**.
- 2 Continue pressing the **Source** softkey or turn the  entry knob to select the desired input channel.

To run/stop a mask test

- 1 In the Mask Test menu ([Utility] > Mask Test), press **Operate** to run or stop the test.



Appears on the menu when the test is stopped; press **Operate** to run the test.



Appears on the menu when the test is running; press **Operate** to stop the test

To turn on/off the mask test message display

- 1 In the Mask Test menu ([Utility] > Mask Test), press **Msg Display** to toggle between OFF and ON.

The message display shows the failed, passed, and total number of waveforms.

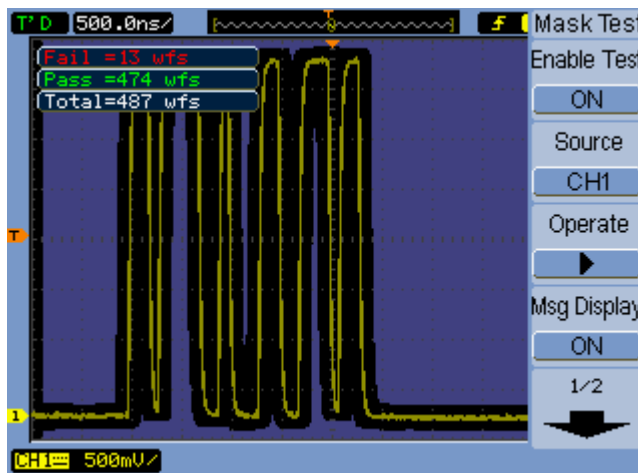




Figure 54 Mask Test Display

To set the mask test output condition

- 1 In the Mask Test menu ([Utility] > Mask Test), press **Output**.
- 2 Continue pressing the **Output** softkey to select the desired output condition:

Fail	A mask failure sets the output.
Fail + 	A mask failure sets the output and causes a beep.
Pass	A passing waveform sets the output.
Pass + 	A passing waveform sets the output and causes a beep.

The output condition can be used:

- To stop a running mask test.
- As a source for the waveform recording function (see “Recording/Playing-back Waveforms” on page 80).
- As a signal on the oscilloscope back panel’s isolated **Mask Pass/Fail out** BNC.

The Mask Pass/Fail out circuit uses optical isolation. An external circuit is required to use the signal. Before connecting to an external circuit, make sure the maximum voltage/current does not exceed 400 V/100 mA. The output device has no polarity limit and can be connected arbitrarily.

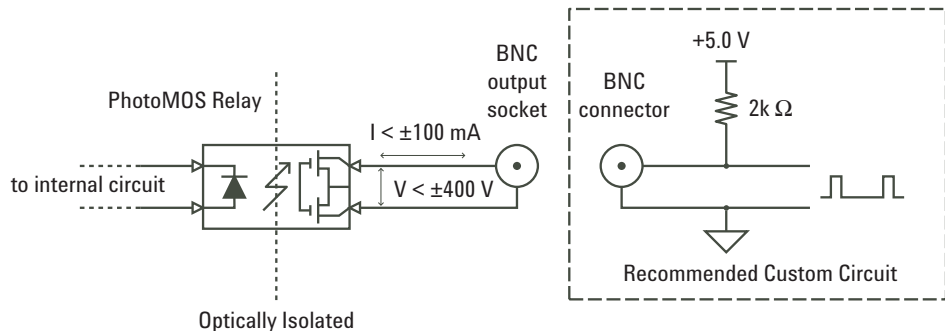


Figure 55 Schematic Diagram of Mask Pass/Fail out

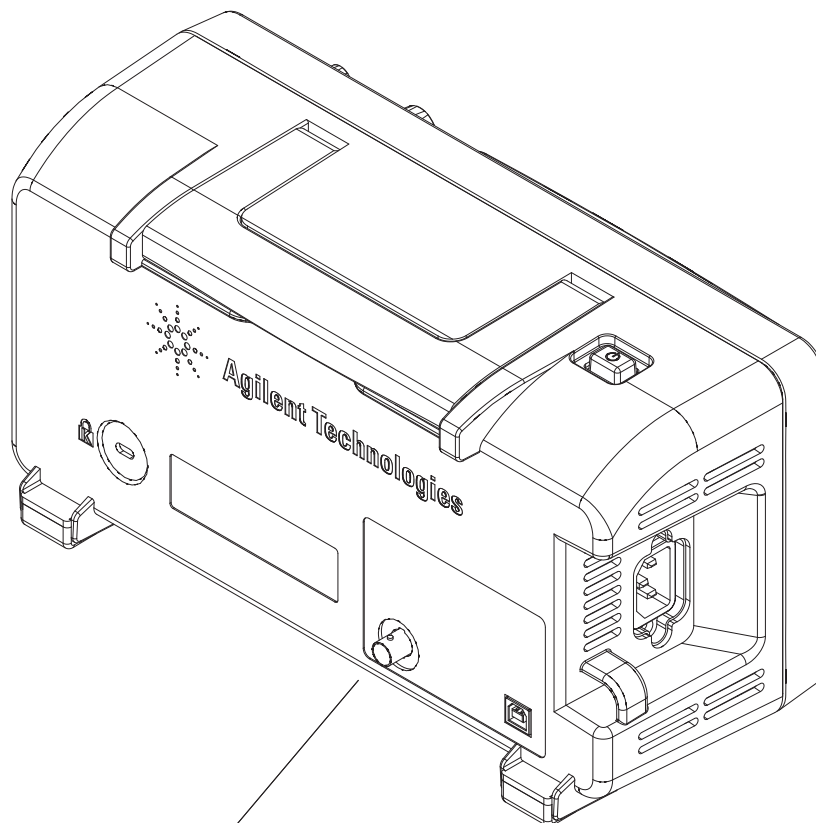


Figure 56 Mask Pass/Fail out

To stop a mask test on the output condition

To turn on/off stopping the mask test when the output condition occurs:

- 1 In the Mask Test menu ([Utility] > Mask Test), press **Stop On Output** to toggle between OFF and ON.

To set up masks

You can create masks by adding horizontal and vertical margins to a signal. You can save and load masks from internal memory or an external USB drive. And you can export and import masks from an external USB drive.

To access the Mask menu:

- 1 Press [**Utility**].
- 2 In the Utilities menu, press **Mask Test**.
- 3 In the Mask Test menu, press **MaskSetting**.

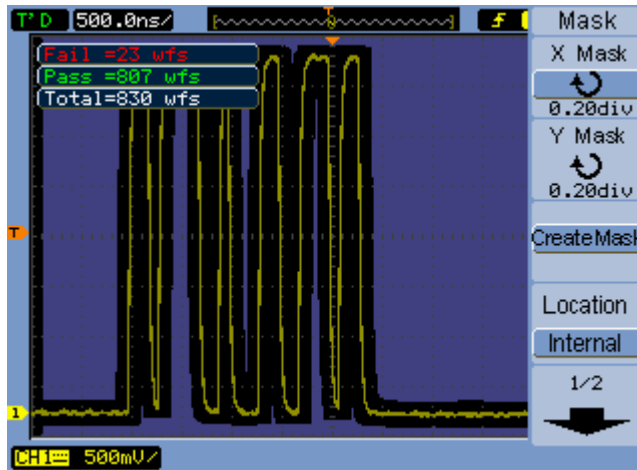


Figure 57 Mask Test Mask Setting

To adjust a mask's horizontal failure margin

- 1 In the Mask menu ([**Utility**] > **Mask Test** > **MaskSetting**), press **X Mask**.
- 2 Turn the ↻ entry knob to adjust the horizontal failure margin.

The margin can be set from 0.04 div to 4.00 div.

To adjust a mask's vertical failure margin

- 1 In the Mask menu ([Utility] > Mask Test > MaskSetting), press **Y Mask**.
- 2 Turn the ↻ entry knob to adjust the vertical failure margin.

The margin can be set from 0.04 div to 4.00 div.

To create a mask using the failure margin settings

- 1 In the Mask menu ([Utility] > Mask Test > MaskSetting), press **Create Mask**.

To select internal/external mask storage location

- 1 In the Mask menu ([Utility] > Mask Test > MaskSetting), press **Location** to toggle between:

Internal	Masks are saved and loaded from oscilloscope internal memory.
External	Masks are saved, loaded, exported, and imported from an external USB drive.

To save a mask

- 1 In the Mask menu ([Utility] > Mask Test > MaskSetting), press **Save**.
- 2 If the External mask storage location has been selected, use the Disk Manager to name and save the mask file. See [“Using the Disk Manager”](#) on page 122.

To recall a mask

- 1 In the Mask menu ([Utility] > Mask Test > MaskSetting), press **Recall**.
- 2 If the External mask storage location has been selected, use the Disk Manager to select and load the mask file. See [“Using the Disk Manager”](#) on page 122.

To export/import masks

- 1 Because you can only export and import masks from an external drive, select the External mask location. See “[To select internal/external mask storage location](#)” on page 140.
- 2 In the Mask menu ([Utility] > **Mask Test** > **MaskSetting**), press **Imp./Exp.**.
- 3 Use the Disk Manager to select the file and import or export the mask. See “[Using the Disk Manager](#)” on page 122.

NOTE

When importing a mask while the **Location** is **Internal** or when importing or recalling a mask while the **Location** is **External**, the mask is imported or recalled to internal memory. To activate the mask, you must set the **Location** to **Internal**, then **Recall** from internal memory.

Setting Preferences


The oscilloscope's Preference menu lets you set screen saver, expand reference, and screen persistence options.

To access the Preference menu:

- 1 Press **[Utility]**.
- 2 In the Utilities menu, press **Preference**.

To set up the screen saver

To set up the screen saver:

- 1 In the Preference menu (**[Utility]** > **Preference**), press **Screen saver**.
- 2 Continue pressing the **Screen saver** softkey or turn the  entry knob to select the desired time or to turn the screen saver off.

Using the screen saver can extend the life of the LED backlight.

To select the vertical scale reference level

When changing the vertical scale of a signal on the display, the expansion (or contraction) takes place about the selected reference level.

To set the expand reference level:

- 1 In the Preference menu (**[Utility]** > **Preference**), press **Expand Refer.** to toggle between:

Ground	Vertical scale changes take place about the signal ground (ground position remains at same display location).
Center	Vertical scale changes take place about the center of the display.

See Also [“To adjust the vertical scale”](#) on page 46.

To select the USB device port function

The (square) USB device port on the oscilloscope's back panel can be used for:

- Connecting to a PictBridge compliant printer.
- Remote programming control of the oscilloscope.

Normally, the USB device port auto-detects the type of host that is connected. However, if there are auto-detect problems, you can manually choose the type of host that is (or will be) connected.

To select the USB device port function:

- 1 In the Preference menu ([Utility] > Preference), press **USB Device** to toggle between:

Computer	Specifies the that the USB device port will be connected to a computer host.
PictBridge	Specifies the that the USB device port will be connected to a PictBridge compliant printer host.

Running Self-Calibration

The automatic calibration routine adjusts the internal circuitry of the oscilloscope for the best measurement accuracy.

The automatic calibration should be run when the ambient temperature changes by 5 °C or more.

NOTE

Before performing the automatic calibration, let the oscilloscope warm-up at least 30 minutes.

To run the oscilloscope's self-calibration:

- 1 Press **[Utility]**.
- 2 In the Utilities menu, press **Self-Cal**.
- 3 Follow the instructions on the Calibration screen.

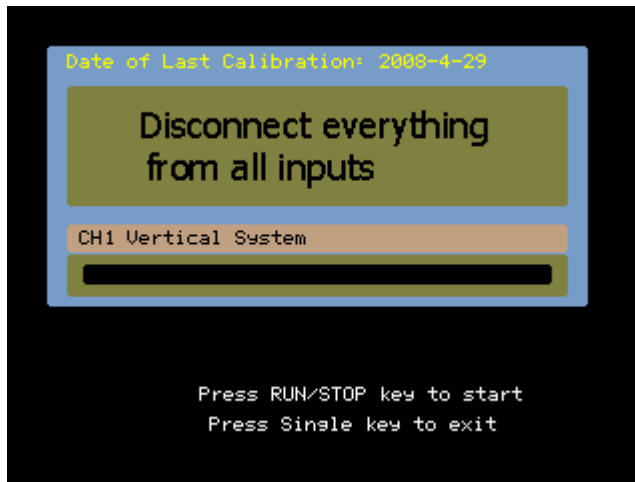


Figure 58 Calibration Screen



7 Reference

Environmental Conditions	146
Measurement Category	147
Specifications and Characteristics	148
Cleaning the Oscilloscope	148
Contacting Agilent	148

This chapter contains reference information for the 1000B Series oscilloscopes.



Environmental Conditions

Overvoltage Category

This product is intended to be powered by MAINS that comply to Overvoltage Category II, which is typical of cord-and-plug connected equipment.

Pollution Degree

The 1000B Series oscilloscope may be operated in environments of Pollution Degree 2 (or Pollution Degree 1).

Pollution Degree Definitions

Pollution Degree 1: No pollution or only dry, non-conductive pollution occurs. The pollution has no influence. Example: A clean room or climate controlled office environment.

Pollution Degree 2. Normally only dry non-conductive pollution occurs. Occasionally a temporary conductivity caused by condensation may occur. Example: General indoor environment.

Pollution Degree 3: Conductive pollution occurs, or dry, non-conductive pollution occurs which becomes conductive due to condensation which is expected. Example: Sheltered outdoor environment.

Measurement Category

The 1000B Series oscilloscope is intended to be used for measurements in Measurement Category I.

WARNING

Use this instrument only for measurements within its specified measurement categories.

Measurement Category Definitions

Measurement category I is for measurements performed on circuits not directly connected to MAINS. Examples are measurements on circuits not derived from MAINS, and specially protected (internal) MAINS derived circuits. In the latter case, transient stresses are variable; for that reason, the transient withstand capability of the equipment is made known to the user.

Measurement category II is for measurements performed on circuits directly connected to the low voltage installation. Examples are measurements on household appliances, portable tools and similar equipment.

Measurement category III is for measurements performed in the building installation. Examples are measurements on distribution boards, circuit-breakers, wiring, including cables, bus-bars, junction boxes, switches, socket-outlets in the fixed installation, and equipment for industrial use and some other equipment, for example, stationary motors with permanent connection to the fixed installation.

Measurement category IV is for measurements performed at the source of the low-voltage installation. Examples are electricity meters and measurements on primary overcurrent protection devices and ripple control units.

Transient Withstand Capability

CAUTION



Maximum input voltage for analog inputs:

- CAT I 300 Vrms, 400 Vpk; transient overvoltage 1.6 kVpk
 - with N2862A/N2863A 10:1 probe: CAT I 600 V (DC + peak AC)
-

Specifications and Characteristics

For complete, up-to-date specifications and characteristics, find the 1000B Series oscilloscopes data sheet at: www.agilent.com

Cleaning the Oscilloscope

If the instrument requires cleaning:

- 1 Remove power from the instrument.
- 2 Clean the external surfaces of the instrument with a soft cloth dampened with a mixture of mild detergent and water.

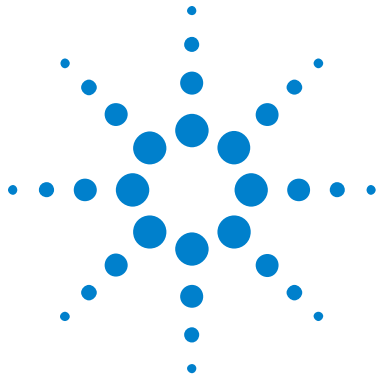
CAUTION

Do not use too much liquid in cleaning the oscilloscope. Water can enter the oscilloscope's front panel, damaging sensitive electronic components.

- 3 Make sure that the instrument is completely dry before reconnecting it to a power source.

Contacting Agilent

Agilent Technologies contact information can be found at: www.agilent.com/find/contactus



A Safety Notices

Warnings 149

Safety Symbols 150

This apparatus has been designed and tested in accordance with UL 61010-1:2004 2nd Edition, and has been supplied in a safe condition. This is a Safety Class I instrument (provided with terminal for protective earthing). Before applying power, verify that the correct safety precautions are taken (see the following warnings). In addition, note the external markings on the instrument that are described under "Safety Symbols."

Warnings

- The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. You must not negate the protective action by using an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two-conductor outlet is not sufficient protection.
- Whenever it is likely that the ground protection is impaired, you must make the instrument inoperative and secure it against any unintended operation.
- Capacitors inside the instrument may retain a charge even if the instrument is disconnected from its source of supply.
- Do not operate the instrument in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.



A Safety Notices

- Do not use the instrument in a manner not specified by the manufacturer, or the protection provided by the equipment may be impaired.

Safety Symbols



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



Hazardous voltage symbol.



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

Index

Numerics

50% trigger level, 85

A

AC channel coupling, 47
AC coupling, 55
AC trigger coupling, 89, 94
accuracy, measurement, 76
acquisition mode, 75
actual sample rate, 71
add math function, 54
add waveforms, 55
aliasing, 57, 66, 78
alternate trigger, 87, 92
Alternate trigger mode, 110
amplitude/div setting, 46
at a glance, 3
attenuation, probe, 50
Auto cursor measurements, 111
automatic calibration, 144
automatic measurements, 100
automatic measurements, clear, 101
automatic measurements, cursors for, 115
automatic measurements, display or hide, 101
automatic time measurements, 105
automatic voltage measurements, 102
Auto-Scale key, 24
Average acquisition mode, 55, 76, 77

B

backlight, LED, 142
band pass filter, 51
band reject filter, 51
bandwidth limit, 49

bandwidth required, oscilloscope, 70
bandwidth, oscilloscope, 67
beeper sound, 133
Blackman FFT window, 56
brick-wall frequency response, 67
brightness, grid, 62
built-in help, 3, 34

C

calibration, 144
center of screen reference, 46, 142
channel coupling, 40, 47
channel pairs, 71
characteristics, 148
cleaning the oscilloscope, 148
clear automatic measurements, 101
clear the display, 61
coarse adjustment, 52
color printing, 129
colors (screen), invert, 62
comma-separated value files, 121
compensate probes, 26
computer host, USB device port setting, 143
coordinates, grid, 62
counter, frequency, 3
counter, hardware frequency, 110
coupling, trigger, 93
cross-hair cursors, 114
CSV format files, save data to, 121
cursor measurements, 3, 44, 111
cursors for automatic measurements, 115
Cursors key, 111

D

dBVrms scale, 56
DC channel coupling, 47
DC trigger coupling, 94
DC voltage of a level signal, 86
decimated samples, 71, 77
default scale, reference waveform, 59
Default Setup key, 22
Delay Between Falling Edges measurement, 108
Delay Between Rising Edges measurement, 108
delayed sweep time base, 41
digital filter, 3, 51
disk information, displaying, 126
Disk Manager, 122
display all automatic measurements, 101
display, clear, 61
distortion, 55
dots waveform type, 61
dynamic range, 56

E

edge speeds, 70
edge trigger, 87
effective sample rate, 73
English language, 134
environmental conditions, 146
equivalent-time sampling mode, 72, 73
Expand Reference preference setting, 46
external trigger input, 97

F

factory default, 22
Fall Time measurement, 106

Index

FFT (Fast Fourier Transform) math function, 54, 55
FFT resolution, 57
FFT windows, 56
field synchronization, 91, 92
file names, editing, 124
files, deleting, 125
files, loading, 126
files, renaming, 126
filter, digital, 51
fine scale adjustment, 46, 52
folder names, editing, 124
folders, creating new, 123
folders, deleting, 125
folders, renaming, 125
folding frequency, 66
force a trigger, 86
French language, 134
frequency counter, hardware, 3, 110
frequency domain, 55
Frequency measurement, 106
frequency scale, 57
frequency, Nyquist, 66
front panel control, 28
functions, math, 54

G

gate time, frequency counter, 110
Gaussian frequency response, 68
German language, 134
GND channel coupling, 47
grayscale printing, 129
grid brightness, 62
grid, changing, 62
ground reference, 46
ground reference level for vertical scaling, 142
ground reference symbol, 47

H

Hanning FFT window, 56
hardware frequency counter, 3, 105, 110

harmonic content, 55
hide all automatic measurements, 101
high frequency probe compensation, 27
high pass filter, 51
high-frequency reject coupling, trigger, 94
holdoff, trigger, 96
horizontal controls, 38
horizontal failure margin (mask), 139
horizontal position knob, 38, 40, 41, 44
horizontal resolution, 74
horizontal scale, 39, 73, 79
horizontal scale controls indicators, 39
horizontal scale knob, 38, 40
horizontal time base, 42
horizontal time/div, 77

I

infinite persistence, 61
input voltage, 23
installed module information, 133
intensity, waveform, 62
internal memory locations, 117
internal storage, 3
invert a waveform, 52
invert screen colors, 62
Italian language, 134

J

Japanese language, 134

K

Korean language, 134

L

language, setting the, 134
LED backlight, 142
LED display, 3
LF reject trigger coupling, 94
line synchronization, 91
loading data, 118
Local function of [FORCE] key, 86

log scale, 56
low frequency probe compensation, 26
low pass filter, 51

M

Manual cursor measurements, 111
manually adjustable cursors, 113
Mask Pass/Fail out BNC, 137
mask test, 44, 135
mask, creating, 140
mask, loading, 140
mask, saving, 140
masks, exporting/importing, 141
masks, setting up, 139
math function waveforms, 3, 44, 54
math scale setting, 54
maximum sample rate, 71
measurement accuracy, 76
measurement category, 147
measurements, cursor, 111
memory, 3
memory depth and sample rate, 71
menu display time, 63
Menu On/Off button, 22, 24, 32
Menu/Zoom key, 38, 41
menus, 31, 134
model number, 133
module information, 133
multiply math function, 54
multiply waveforms, 55

N

N2862A passive probe, 18
N2863A passive probe, 18
Negative Duty Cycle measurement, 107
Negative Pulse Width measurement, 107
noise in DC power supplies, characterizing, 55
non-repetitive waveforms, 72
non-synchronized signals, 92
nonvolatile memory locations, 117
Normal acquisition mode, 76

normal adjustment, 46
 NTSC standard, 89, 90
 Nyquist frequency, 57
 Nyquist sampling theory, 66

O

oscilloscope bandwidth, 67
 oscilloscope bandwidth required, 70
 oscilloscope display, 30
 oscilloscope rise time, 69
 oscilloscope sample rate, 69
 oscilloscope setups, saving and loading, 119
 output condition, mask test, 80, 137
 overshoot measurement, 104
 overvoltage category, 146

P

package contents, 18
 PAL standard, 89, 90
 parallel cursors, 113
 passive probes, 18
 Peak Detect acquisition mode, 77
 Period measurement, 105
 persistence, waveform, 61
 Phase Between Falling Edges measurement, 109
 Phase Between Rising Edges measurement, 109
 PictBridge compliant printer, 127, 128
 PictBridge printer host, USB device port setting, 143
 play-back waveforms, 80, 81
 pollution degree, 146
 Portuguese language, 134
 Positive Duty Cycle measurement, 107
 Positive Pulse Width measurement, 107
 potentiometer adjustment, 40
 power cord, 19
 power source, 19
 power supply testing, 40
 preferences, setting, 142

preshoot measurement, 104
 printing data, 127
 probe attenuation, 50
 Probe Comp signal, 23
 pulse waveforms, 72
 pulse width trigger, 87, 88

Q

quick help, 134

R

random noise, 76
 real-time sampling mode, 72
 recalling data, 118
 record waveforms, 80
 recorded waveforms, storing, 83
 recording waveforms, 80
 Rectangle FFT window, 56
 reference, 46
 reference level for vertical scaling, 142
 reference waveform, saving, 58
 reference waveforms, 44, 58
 reference waveforms, export or import, 58
 refresh rate, 3, 77
 remote program, 86
 repetitive waveforms, 73
 required oscilloscope bandwidth, 70
 Rise Time measurement, 106
 rise time, oscilloscope, 69
 rise time, signal, 70
 Rmt on oscilloscope display, 86
 Roll time base, 43
 Run Control keys, 33
 Run/Stop key, 33
 Russian language, 134

S

safety
 notices, 149
 symbols, 150
 sample rate, 3, 44
 sample rate and memory depth, 71

sample rate, oscilloscope, 67, 69
 sampling mode, 72
 sampling rate, 43
 sampling theory, 66
 sampling, overview, 66
 save data to CSV format files, 121
 save screens to BMP or PNG files, 120
 Save/Recall key, 118
 saving data, 118
 screen colors, invert, 62
 screen refresh rate, 77
 screen saver, 142
 screens, saving to BMP or PNG files, 120
 SECAM standard, 89, 90
 self-calibration, 144
 sensitivity, trigger, 95
 sensitivity, Volts/Div control, 51
 serial number, 133
 setups, saving and loading, 119
 shipping container, 18
 Simplified Chinese language, 134
 sine(x)/x interpolation, 40, 73, 79
 Single key, 33
 single-shot waveforms, 72
 Slow Scan mode, 40
 softkeys, 31
 software version, 133
 sound, turning on/off, 133
 Spanish language, 134
 specifications, 148
 square waves, 68
 status bar, 39
 store recorded waveforms, 83
 subtract math function, 54
 subtract waveforms, 55
 sweep speed, 39
 symbols, safety, 150
 system information, displaying, 133

T

theory, sampling, 66
 time measurements, 3, 44, 105, 111

Index

Track cursor measurements, 111
tracking cross-hair cursors, 114
Traditional Chinese language, 134
transducer monitoring, 40
transient withstand capability, 148
trigger controls, 44
trigger coupling, 93
trigger high-frequency reject coupling, 94
trigger holdoff, 96
trigger holdoff, reset, 96
trigger level, 85, 110
trigger mode, 87
trigger position, 39
trigger sensitivity, 95
trigger sweep, 92, 93
triggering, 3

U

under-sampled signals, 66
untriggered sample acquisition mode, 43
USB device port, 127
USB Device port function, 143
USB ports, 3
Utility key, 131

V

Vamp (amplitude voltage = $V_{top} - V_{base}$)
measurement, 103
Vavg (average voltage) measurement, 103
Vbase (base voltage) measurement, 103
vectors, 44
vectors waveform type, 61
vernier adjustment, 46, 52
vertical failure margin (mask), 140
vertical position, 47
vertical position knob, 45, 47
vertical scale, 46
vertical scale knob, 45, 46, 52
vertical scale reference level, 142
vertical scaling, 50
vibration, analyzing, 55
video trigger, 87, 89

Vmax (maximum voltage)
measurement, 102
Vmin (minimum voltage)
measurement, 103
voltage measurements, 3, 44, 102, 111
Volts/Div control sensitivity, 51
Vpp (peak-to-peak voltage)
measurement, 103
Vrms (root-mean-square voltage)
measurement, 104
Vtop (top voltage) measurement, 103

W

warnings, 149
waveform intensity, 62
waveform math, 54
waveform persistence, 61
waveforms, recording/playing-back, 3, 80
waveforms, turning on or off, 46
window, FFT, 56

X

X-Y format, 43
X-Y time base, 42

Y

Y-T time base, 42

Z

zoomed time base, 41
zoomed time base display, 44