MDO3000 Series
Mixed Domain Oscilloscopes

User Manual

Tektronix

Front Panel Menus and Controls

The front panel has buttons and controls for the functions that you use most often. Use the menu buttons to access more specialized functions.

Using the Menu System

To use the menu system:

1. Push a front panel menu button to display the menu that you want to use.

*NOTE. The **B1** and **B2** buttons support up to two different serial or parallel buses.*

3249-013

2. Push a lower menu button. If a pop-out menu appears, turn **Multipurpose a** to select the desired choice. If a pop-up menu appears, push the button again to select the desired choice.

3249-026

3. Push a side menu button.

If the menu item contains more than one choice, push the side button repeatedly to cycle through the choices.

If a pop-out menu appears, turn **Multipurpose a** to select the desired choice.

0968-011

**4.** To remove a side menu, push the lower button again or push **Menu Off**.

0968-012

5. Certain menu choices require you to set a numeric value to complete the setup. You can use the upper and lower multipurpose knobs **a** and **b** to adjust values. You can also set many numerical values with the 10-digit keypad on the front panel.

6. Push **Fine** to turn off or on the ability to make smaller adjustments.

0968-013

Using the Menu Buttons

Use the menu buttons to perform many functions in the oscilloscope.


3249-015
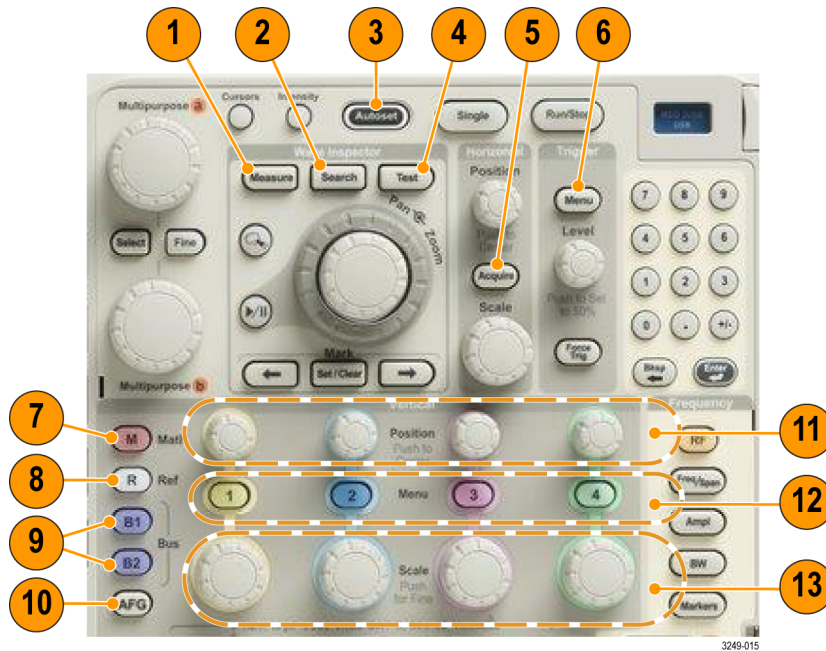
1. Measure. Push to perform automated measurements on waveforms and to access the digital voltmeter (DVM) and waveform histogram functions.

2. Search. Push to perform an automated search through an acquisition for user-defined events/criteria.

3. Autoset. Push to perform an automatic setup of oscilloscope settings.

4. Test. Push to activate advanced or application-specific testing features.

5. **Acquire**. Push to set the acquisition mode and adjust the record length.

6. **Trigger Menu**. Push to specify trigger settings.

7. **M**. Push to manage the math waveform, including the display or removal of the math waveform from the display.

8. **R**. Push to manage reference waveforms, including the display or removal of each reference waveform from the display.

9. **B1** or **B2**. Push to define and display a serial bus if you have the appropriate application modules. Parallel bus support is available on MDO3000 products with the MDO3MSO option installed. Also, push the **B1** or **B2** button to display or remove the corresponding bus from the display.

10. **AFG**. Push to enable the arbitrary function generator output and access the AFG menu.

11. **Vertical Position**. Turn to adjust the vertical position of the corresponding waveform. Push to center the waveform baseline indicator.

12. Channel **1**, **2**, **3**, or **4 Menu**. Push to set vertical parameters for input waveforms and to display or remove the corresponding waveform from the display.

13. **Vertical Scale**. Turn to adjust the vertical scale factor of the corresponding waveform (volts/division). Push the front-panel **Fine** button to make smaller adjustments.

Below the display buttons

Use the buttons below the display to perform many functions in the oscilloscope.

1. **Save / Recall Menu**. Push to define the **Save** button to save and recall setups, waveforms, or screen images to internal memory, a USB flash drive, or a mounted network drive.
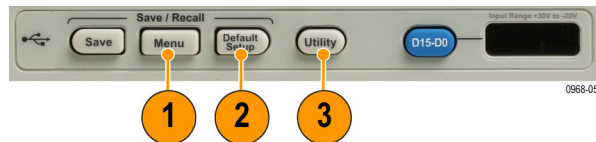
2. **Default Setup**. Push to perform an immediate restore of the oscilloscope to the default settings.

3. **Utility**. Push to activate the system utility functions, such as selecting a language or setting the date/time.

Get Acquainted with the Instrument

4. **B1** or **B2**. Push to define and display a bus if you have the appropriate module application keys.

  ■ MDO3AERO supports MIL-STD-1553 buses.

  ■ MDO3AUDIO supports I2S, Left Justified (LJ), Right Justified (RJ), and TDM buses.

  ■ MDO3AUTO supports CAN and LIN buses.

  ■ MDO3EMBD supports I2C and SPI buses.

  ■ MDO3COMP supports RS-232, RS-422, RS-485, and UART buses.

  ■ MDO3FLEX supports FlexRay buses.

  ■ MDO3USB supports USB 2.0 buses.

  Also, push the **B1** or **B2** button to display or remove the corresponding bus from the display.

5. **R**. Push to manage reference waveforms and traces, including the display or removal of each reference waveform or trace from the display.

6. **M**. Push to manage the math waveform or trace, including the display or removal of the math waveform or trace from the display.


0968-050

Using Spectral Analysis Controls

These buttons configure the acquisition and display of the RF input.

1. **RF**. Push to bring up the frequency domain display and menu. The RF menu provides access to the Spectrogram display.

2. **Freq/Span**. Push to specify the portion of the spectrum to view on the display. Set the center frequency and the span – or set the start and stop frequency.

3. **Ampl**. Push to set the reference level.

4. **BW**. Push to define the resolution bandwidth.

5. **Markers**. Push to set automatic or manual markers.
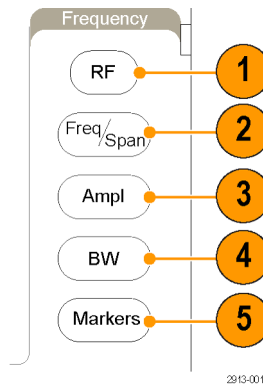

Using Other Controls
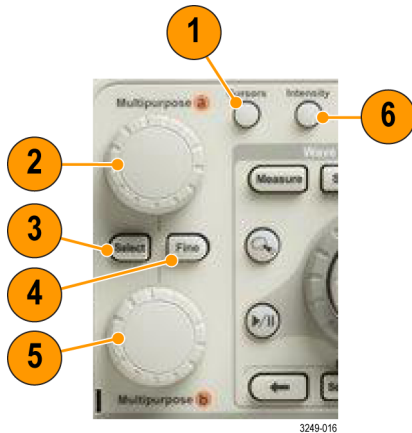
1. **Cursors**. Push once to activate the two vertical cursors. Push again to turn off all cursors. Push and hold to bring up the cursor menu. Use the menu to select the cursor features, such as type, source, orientation, linked status, and units.

   When the cursors are on, you can turn the multipurpose knobs to control their position.

2. Turn the upper multipurpose knob **a**, when activated, to move a cursor, to set a numerical parameter value for a menu item, or to select from a pop-out list of choices. Push the **Fine** button to toggle between coarse and fine adjustment.

   Screen icons tell you when **a** or **b** are active.

3. **Select**. Push to activate special functions.

For example, when using the two vertical cursors (and no horizontal ones are visible), you can push this button to link or unlink the cursors. When the two vertical and two horizontal cursors are both visible, you can push this button to make either the vertical cursors or the horizontal cursors active.

4. **Fine**. Push to toggle between making coarse and fine adjustments with the many operations of multipurpose knobs **a** and **b**

5. Turn the lower **Multipurpose b** knob, when activated, to move a cursor or set a numerical parameter value for a menu item. Push **Fine** to make adjustments more slowly.

6. **Intensity**. Push to enable **Multipurpose a** to control waveform display intensity and knob **b** to control graticule intensity.
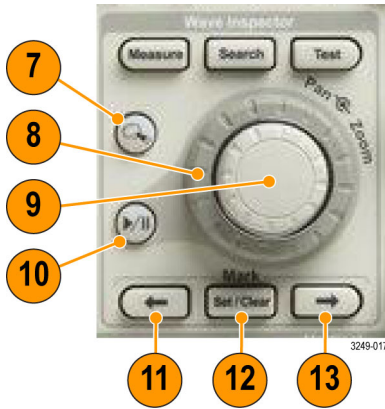

7. **Zoom** button. Push to activate zoom mode.

8. **Pan** (outer knob). Turn to scroll the zoom window through the acquired waveform.

9. **Zoom-scale** (inner knob). Turn to control the zoom factor. Turning it clockwise zooms in further. Turning it counterclockwise zooms out.

10. **Play-pause** button. Push to start or stop the automatic panning of a waveform. Control the speed and direction with the pan knob.

11. ← **Prev**. Push to jump to the previous waveform mark.

12. **Set/Clear Mark**. Push to establish or delete a waveform mark.

13. → **Next**. Push to jump to the next waveform mark.

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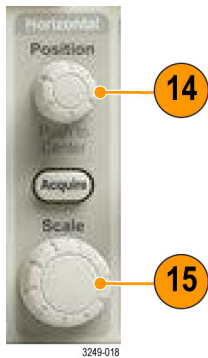
14. **Horizontal Position**. Turn to adjust the trigger point location relative to the acquired waveforms. Push to center when delay is on. Push to set to 10% when delay is off.

15. **Horizontal Scale**. Turn to adjust the horizontal scale (time/division).
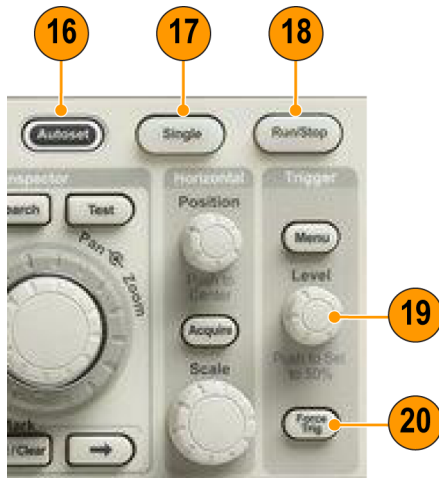
16. **Autoset**. Push to automatically set the vertical, horizontal, and trigger controls for a usable, stable display.

17. **Single**. Push to make a single sequence acquisition.

18. **Run/Stop**. Push to start or stop acquisitions.

19. **Trigger Level**. Turn to adjust the trigger level.

   **Push Level to Set 50%**. Push the Trigger level knob to set the trigger level to the midpoint of the waveform.

20. **Force Trig**. Push to force an immediate trigger event.

0968-060

21. **Print**. Push to print to the selected printer.

22. **Power** switch. Push to power on or off the oscilloscope.

23. **USB 2.0 Host port**. Insert a USB peripheral to the oscilloscope, such as a keyboard or a flash drive.

24. **Save**. Push to perform an immediate save operation. The save operation uses the current save parameters, as defined in the Save / Recall menu.

25. **Save / Recall Menu**. Push to save and recall setups, waveforms, and screen images to internal memory, or a USB flash drive.

26. **Default Setup**. Push to perform an immediate restore of the oscilloscope to the default settings.

27. **Utility**. Push to activate the system utility functions, such as selecting a language or setting the date/time.

28. **D15 - D0**. Push to display or remove the digital channels from the display, and to access the digital channel setup menu (with option MDO3MSO only).

29. **Menu Off**. Push to clear a displayed menu from the screen.

Identifying Items in the Time Domain Display

The items shown in the graphic below may appear in the display. Not all of these items are visible at any given time. Some readouts move outside the graticule area when menus are turned off.
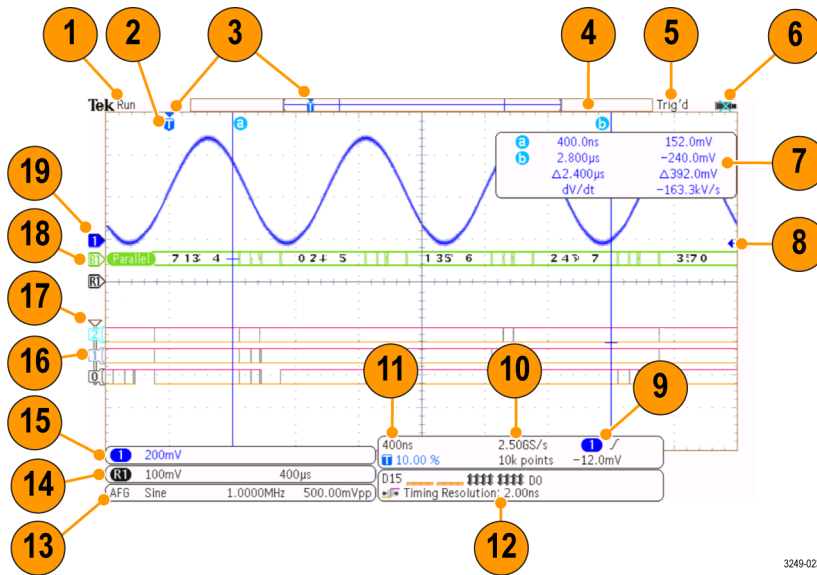

3249-023

1. The acquisition readout shows when an acquisition is running, stopped, or when acquisition preview is in effect. Run = acquisitions enabled. Stop = Acquisitions not enabled. Roll = roll mode (40 ms/div or slower). PreVu = The oscilloscope is stopped or between triggers. You can change the horizontal or vertical position or scale to see approximately what the next acquisition will look like. A/B = When using the average acquisition mode, B shows the total number of acquisitions to be averaged (set this using the Acquisition Mode side menu), and A shows the current progress towards this total number.

2. The trigger position icon shows the trigger position in the acquisition.
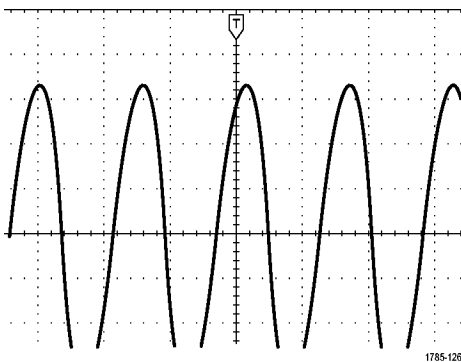
1785-126

3. The expansion point icon (an orange triangle) shows the point that the horizontal scale expands and compresses around. To make the expansion point the same as the trigger point, push **Acquire** and set the lower menu **Delay** item to **Off**.

2121-241
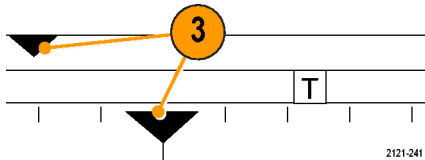
4. The waveform record view shows the trigger location relative to the waveform record. The line color corresponds to the selected waveform color. The brackets show the part of the record currently displayed on the screen.

2121-242
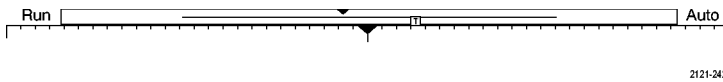
5. The trigger status readout shows trigger status. Status conditions are: PrTrig: Acquiring pretrigger data. Trig? = Waiting for trigger. Trig'd: Triggered. Auto: Acquiring untriggered data.

6. The security icon indicates when the I/O ports are disabled.

7. The cursor readout shows time, amplitude, and delta (Δ) values for each cursor. For FFT measurements, it shows frequency and magnitude. For serial and parallel buses, the readout shows the decoded values.

8. The trigger level icon shows the trigger level on the waveform. The icon color corresponds to the trigger source color.

1785-143
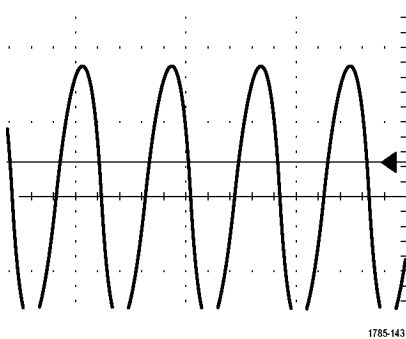
9. The trigger readout shows the trigger source, slope, and level. The trigger readouts for other trigger types show other parameters.

10. The top line of the record length/sampling rate readout shows the sampling rate. You can adjust it with the **Horizontal Scale** knob. The bottom line shows the record length. You can adjust it by pushing **Acquire** and **Record Length** on the lower menu.

```
2.50GS/s
10k points
```

11. The horizontal position/scale readout shows on the top line the horizontal scale (adjust with the **Horizontal Scale** knob). With **Delay Mode** on, the bottom line shows the time from the T symbol to the expansion point icon (adjust with the **Horizontal Position** knob). Use horizontal position to insert added delay between when the trigger occurs and when you actually capture the data. Insert a negative time to capture more pretrigger information. With **Delay Mode** off, the bottom line shows the time location of the trigger within the acquisition, as a percentage.

```
400ns
T 10.00 %
```

12. The Timing Resolution readout shows the timing resolution of the digital channels. Timing resolution is the time between samples. It is the reciprocal of the digital sample rate. When the MagniVu control is on, "MagniVu" appears in the readout.

```
D15 ____ ____ ⬆⬆⬆⬆ ⬆⬆⬆⬆ D0
    ▸⬜◂ Timing Resolution: 2.00ns
```
3249-025

13. Measurement readouts show the selected measurements. You can select up to four measurements to display at one time. A ⚠ symbol appears instead of the expected numerical measurement if a vertical clipping condition exists. Part of the waveform is above or below the display. To obtain a proper numerical measurement, turn the vertical scale and position knobs to make all of the waveform appear in the display.

① Period	995 µs
① Freq	1.004 kHz

1785-144

14. The auxiliary waveform readouts show the vertical and horizontal scale factors of the math and reference waveforms.

```
Ⓜ
```
1785-138

15. The channel readout shows the channel scale factor (per division), coupling, invert, and bandwidth status. Adjust with the **Vertical Scale** knob and in the channel **1**, **2**, **3**, or **4** menus.
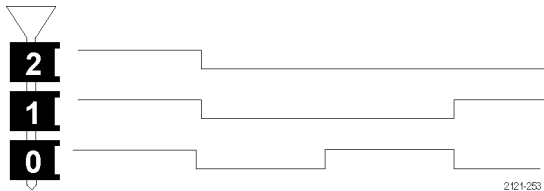
```
①↓ 20.0mV Ω ᴮw
```
2121-243

16. For digital channels, the baseline indicators point to the high and low levels. The indicator colors follow the color code used on resistors. The D0 indicator is black, the D1 indicator is brown, the D2 indicator is red, and so on.

2121-216
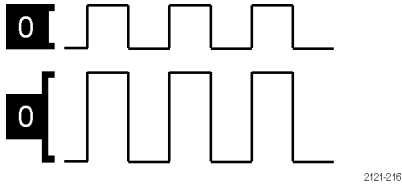
**17.** The group icon indicates when digital channels are grouped.

2121-253

18. The bus display shows decoded packet level information for serial buses or for parallel buses. The bus indicator shows the bus number and bus type.

19. For analog channels, the waveform baseline indicator shows the zero-volt level of a waveform, assuming you have not used any offset. The icon colors correspond to the waveform colors.


1785-125
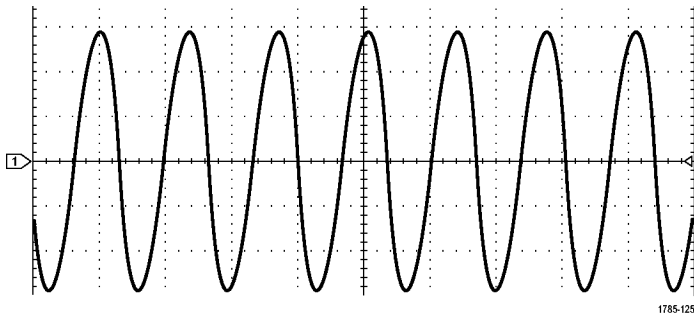
Identifying Items in the Frequency Domain Display

Activate the frequency domain display by pressing the front panel **RF** button.
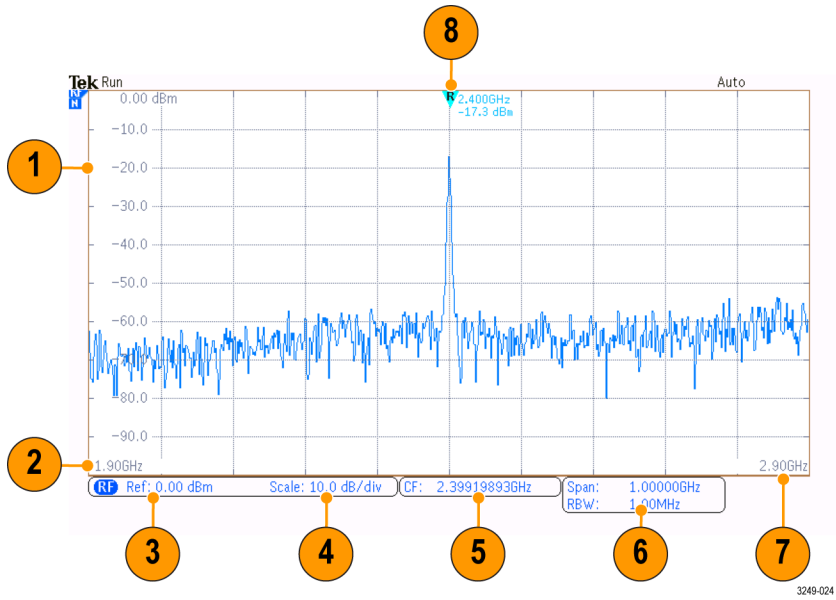
1. Vertical graticule labels

2. Start frequency

3. Reference level

4. Vertical scale

5. Center frequency

6. Span and resolution bandwidth
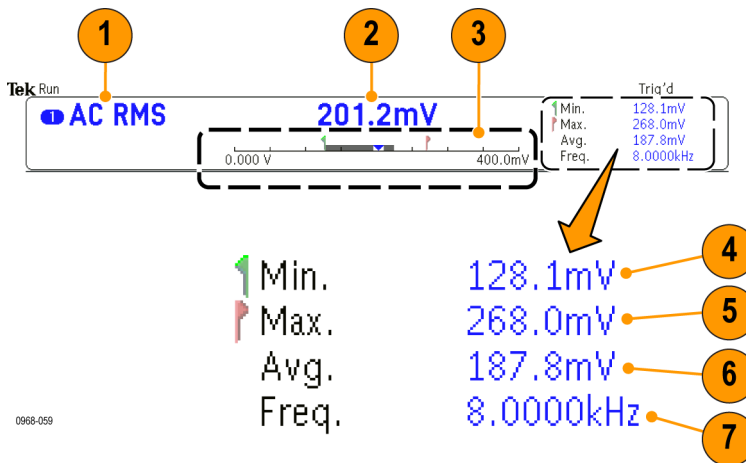
7. Stop frequency

8. Reference marker

Identifying Items in the Arbitrary Function Generator Display
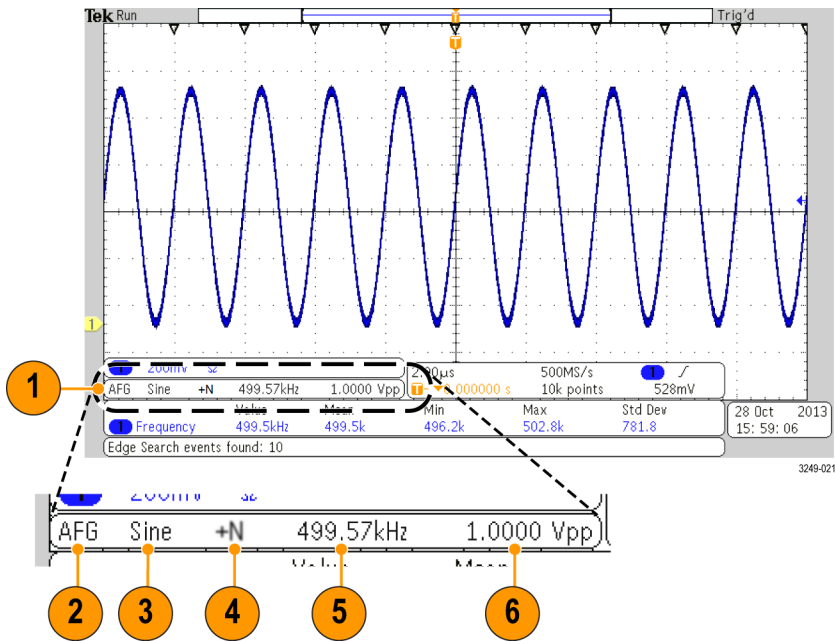
1. If visible, the output is on

2. AFG label

3. Waveform type, e.g. "Sine"

4. Additive Noise icon

5. Frequency

6. Amplitude

(See page 183, *Use the Arbitrary Function Generator.*)

## Identifying Items in the Digital Voltmeter Display

1. Measurement type (AC+DC RMS, DC, AC RMS, or Frequency)

2. Numerical value of the current measurement

3. Graphic (min, max, value, five-second rolling range)

   The number on the left side of the graphic's linear scale is the minimum value of the range (e.g. 0.000 V).

   The number on the right side of the graphic's linear scale is the maximum value of the range (e.g. 400.0 mV).

   The gray bar shows the five second rolling average of measurements.

   The inverted triangle shows the location on the scale of the current measurement value.

4. Minimum measurement value recorded since you powered on the instrument or since you last pushed the **Reset DVM Statistics** menu item.

5. Maximum measurement value recorded since you powered on the instrument or since you last pushed the **Reset DVM Statistics** menu item.

6. Average of all measurement values recorded since you powered on the instrument or since you last pushed the **Reset DVM Statistics** menu item.

7. Frequency

---

*NOTE. An "Over bandwidth" message appears for voltage measurements ≥ 10 kHz. An "Under bandwidth" message appears for voltage measurements ≤ 10 Hz. A "?" message appears next to min or max measurements that have gone out of bounds. Push **Reset DVM Statistics** to remove the "?" from the display.*

(See page 131, *Taking Digital Voltmeter Measurements.*).

Front Panel Connectors

1. Logic Probe Connector

2. Channel **1**, **2**, **3**, **4**. Channel inputs with TekVPI Versatile Probe Interface.

3. RF input connector.

4. **PROBE COMP**. Square wave signal source to compensate or calibrate probes. Output voltage: 0 – 2.5 V, amplitude ± 1% behind 1 kΩ ±2%. Frequency: 1 kHz.

5. Ground.

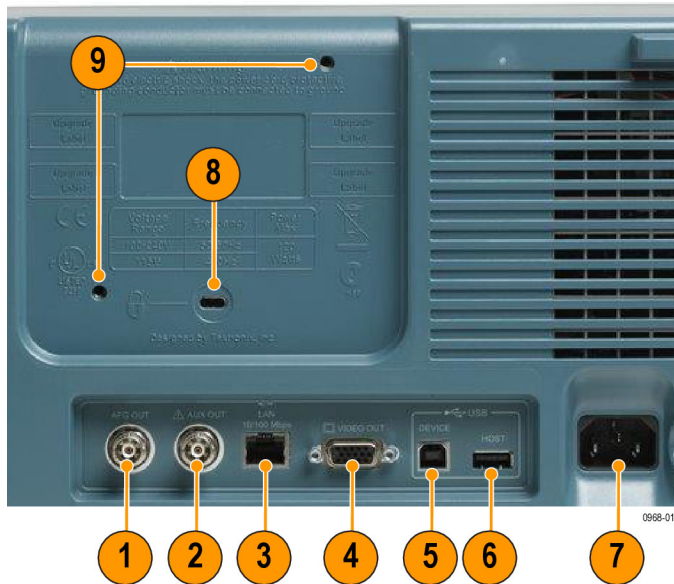6. Application Module Slots.

0968-017
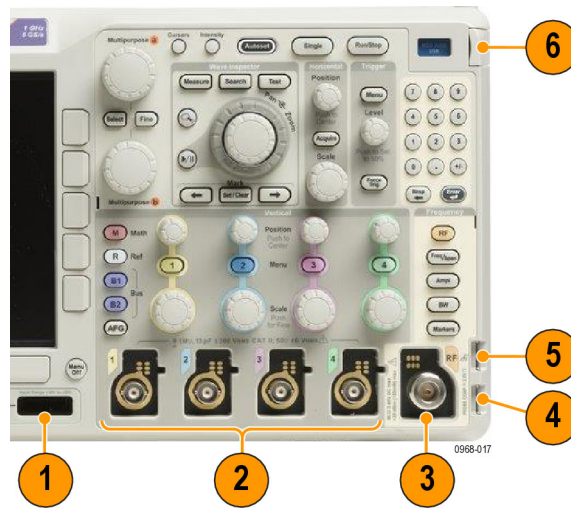
Side-Panel Connector

1. Ground strap connector. This is a receptacle for a grounding strap.

0968-043
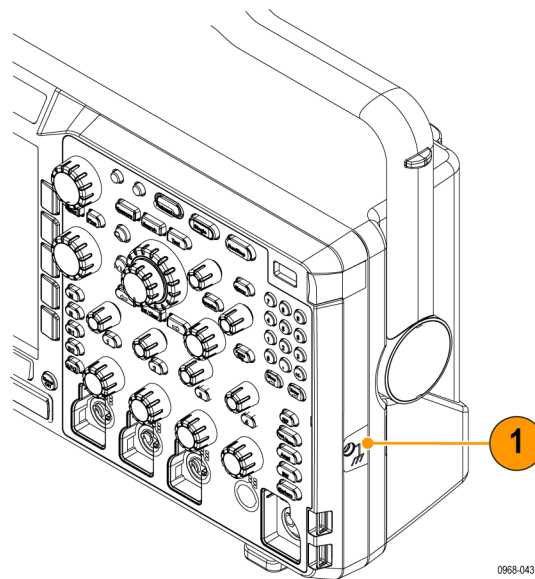
Rear-Panel Connectors

1. **AFG OUT**. Use the AFG OUT port to transmit signals from the arbitrary function generator.

2. **AUX OUT**

3. **LAN**. Use the LAN (Ethernet) port (RJ-45 connector) to connect the oscilloscope to a 10/100 Base-T local area network.

4. **Video Out**. Use the Video Out port (DB-15 female connector) to show the oscilloscope display on an external monitor or projector.

5. **USB 2.0 Device port**. Use the USB 2.0 High Speed Device port to connect a PictBridge compatible printer, or for direct PC control of the oscilloscope using USBTMC protocol.

NOTE. The cable connected from the USB 2.0 Device port to the host computer must meet the USB2.0 specification for high speed operation when connected to a high speed host controller.

6. **USB 2.0 Host port**. Use the USB 2.0 High Speed Host port to connect a USB memory device or USB keyboard.

7. **Power** input. Attach to an AC power line with integral safety ground.

8. **Lock**. Use to secure the oscilloscope.

9. **VESA mount**. 75 mm.

Acquire the Signal

This section describes concepts of and procedures for setting up the oscilloscope to acquire the signal as you want it to.

Setting Up Analog Channels

Use front panel buttons and knobs to set up your instrument to acquire signals using the analog channels.

1. Connect the TPP0250/TPP0500B/TPP1000 or VPI probe to the input signal source.
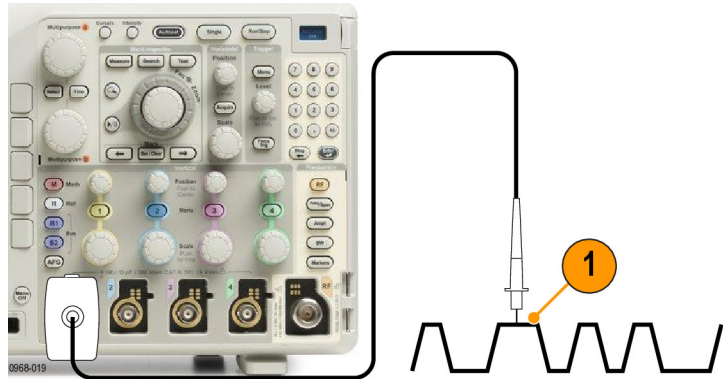
2. Select the input channel by pushing the front panel buttons.

   NOTE. If you are using a probe that does not supply probe encoding, set the attenuation (probe factor) in the oscilloscope vertical menu for the channel to match the probe.

3. Push **Default Setup**.

4. Push **Autoset**.

5. Push the desired channel button. Then adjust the vertical position and scale.

6. Adjust the horizontal position and scale.

The horizontal position determines the number of pretrigger and posttrigger samples.

The horizontal scale determines the size of the acquisition window relative to the waveform. You can scale the window to contain a waveform edge, a cycle, several cycles, or thousands of cycles.
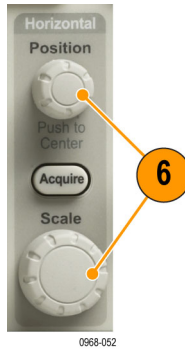
Quick Tip

■ Use the zoom feature to see multiple cycles of your signal in the upper part, and a single cycle in the lower part of the display. (See page 147, *Using Wave Inspector to Manage Long Record Length Waveforms*.)

Labeling Channels and Buses

You can add a label to the channels and buses shown on the display for easy identification. The label is placed on the waveform baseline indicator in the left side of the screen. The label can have up to 32 characters.

To label a channel, push a channel input button for an analog channel.
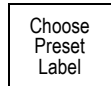
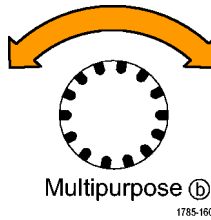**1.** Push a front panel button for an input channel or a bus.

2. Push a lower menu button to create a label, such as for channel 1 or B1.

Label

2
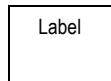
**3.** Push **Choose Preset Label** to view a list of labels.

Choose Preset Label

3

4. Turn **Multipurpose b** to scroll through the list to find a suitable label. You can edit the label after you insert it if necessary.

Multipurpose ⓑ
1785-160

5. Push **Insert Preset Label** to add the label.
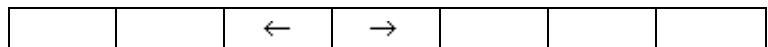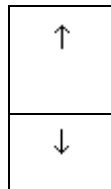
Insert Preset Label

5

If you are using a USB keyboard, use the arrow keys to position the insertion point and edit the inserted label, or type in a new label. (See page 35, *Connecting a USB Keyboard to Your Oscilloscope*.)
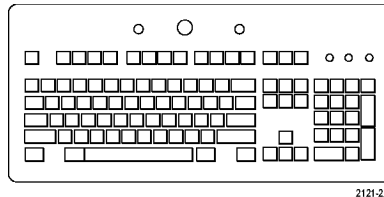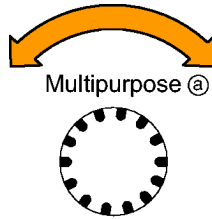
2121-220

6. If you do not have a USB keyboard connected, push the side and lower menu arrow keys to position the insertion point.

↑

↓

←   →

7. Turn **Multipurpose a** to scroll through the list of letters, numbers, and other characters to find the character in the name that you want to enter.

Multipurpose ⓐ

1785-039

ABCDEFGHIJKLMNOPQRSTUVWXYZ

abcdefghijklmnopqrstuvwxyz

0123456789_=+-!@#$%^&*()[]{}<>/~'"\|:,.?

8. Push **Select** or **Enter Character** to let the oscilloscope know that you have picked the proper character to use.

Select

0968-023

You can use the lower menu buttons to edit the label as needed.

Enter Character		←	→	Back Space	Delete	Clear

9. Continue scrolling and pushing **Select** until you have entered all the desired characters.

For another label, push the side and lower menu arrow keys to reposition the insertion point.

10. Push **Display Labels** and select **On** to see the label.

Display Labels

On Off

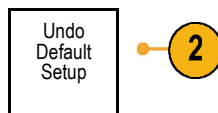10
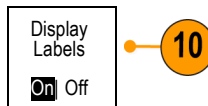
Using the Default Setup

To return the oscilloscope to its default settings:

1. Push **Default Setup**.

Default Setup

3249-008

2. If you change your mind, push **Undo Default Setup** to undo the last default setup.

Undo Default Setup

2

Using Autoset

Autoset adjusts the instrument (acquisition, horizontal, trigger, and vertical controls) such that it displays four or five waveform cycles for analog channels with the trigger near the midlevel, and ten cycles for digital channels.

Autoset works with both the analog and digital channels.

1. To autoset an analog channel, connect the analog probe, and then select the input channel. (See page 54, *Setting Up Analog Channels*.)

    To autoset a digital channel, connect the logic probe and select the input channel. (See page 79, *Setting Up Digital Channels*.)

2. Push **Autoset** to execute an Autoset.

3. If desired, push **Undo Autoset** to undo the last Autoset.

You can also disable the Autoset function. To disable or enable the Autoset function:
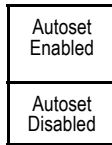
1. Push and hold **Autoset**.

2. Push and hold **Menu Off**.

3. Release **Menu Off**, and then release **Autoset**.

4. Select the desired setting using the side menu.

| Autoset Enabled |
| --- |
| Autoset Disabled |

Quick Tips

- To position the waveform appropriately, Autoset may change the vertical position. Autoset always sets vertical offset to 0 V.

- If you use Autoset when no channels are displayed, the instrument turns on channel 1 and scales it.

- If you use Autoset and the oscilloscope detects a video signal, the oscilloscope automatically sets the trigger type to video and makes other adjustments to display a stable video signal.

Acquisition Concepts

Before a signal can be displayed, it must pass through the input channel where it is scaled and digitized. Each channel has a dedicated input amplifier and digitizer. Each channel produces a stream of digital data from which the instrument extracts waveform records.

Sampling Process

Acquisition is the process of sampling an analog signal, converting it into digital data, and assembling it into a waveform record, which is then stored in acquisition memory.

Input signal   Sampled points

+5.0 V   +5.0 V
0 V   0 V   0 V   0 V
-5.0 V   -5.0 V

Digital values
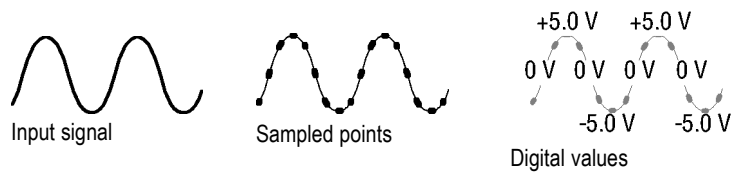
Real-Time Sampling

MDO3000 Series oscilloscopes use real-time sampling. In real-time sampling, the instrument digitizes all of the points it acquires using a single trigger event.

Record points

2121-030

Sampling rate
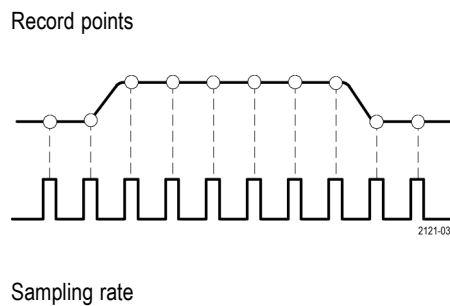
Waveform Record

The instrument builds the waveform record through use of the following parameters:

■ Sample interval: The time between recorded sample points. Adjust this by turning the **Horizontal Scale** knob or pushing **Acquire** and changing the record length in the Acquire menu.

■ Record length: The number of samples required to fill a waveform record. Set this by pushing the **Acquire** button and using the lower and side menus.

■ Trigger point: The zero time reference in a waveform record. It is shown on the screen by an orange T.

■ Horizontal position: When **Delay Mode** is on, this is the time from the trigger point to the expansion point. Adjust this by turning the **Horizontal Position** knob.

Use a positive time to acquire the record after the trigger point. Use a negative time to acquire it before the trigger point.

■ Expansion point: The point that the horizontal scale expands and contracts around. It is shown by an orange triangle.
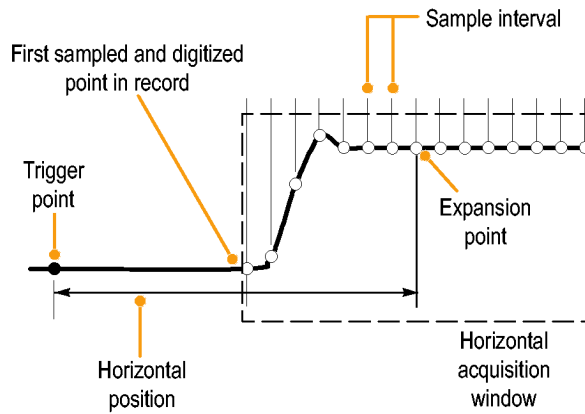
Using FastAcq

FastAcq™ provides high-speed waveform capture. It is helpful in finding elusive signal anomalies. Fast acquisition mode reduces the dead time between waveform acquisitions, enabling the capture and display of transient events such as glitches and runt pulses. Fast acquisition mode can also display waveform phenomena at an intensity that reflects their rate of occurrence.

To use FastAcq:

1. Push **Acquire**.

Mode	Record Length	FastAcq	Delay	Set Horiz. Position to 10%	Waveform Display	XY Display
Sample	10k	Off	On Off			Off

2. Push **FastAcq**.

2

FastACq

Fast Acq
On Off

3

Waveform Palette
a Temper-ature

3. Toggle the **FastAcq** side-menu button to select **On**.

4. Push **Waveform Palette**.

5. Turn the **Multipurpose a** knob to select the desired display palette.

The display palette lets you enhance the visibility of events. This choice uses intensity grading to indicate how often rare transients occur relative to normal signals. The choices are Temperature, Spectral, Normal and Inverted.

Multipurpose ⓐ

1785-039
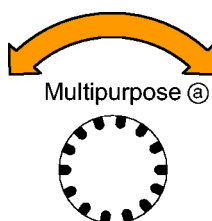
Temperature uses color-grading to indicate frequency of occurrence with hot colors like red/yellow indicating frequently occurring events and colder colors like blue/green indicating rarely occurring events.

Spectral uses color-grading to indicate frequency of occurrence with colder colors like blue indicating frequently occurring events and hot colors like red indicating rarely occurring events.

Normal uses the default channel color (like yellow for channel one) along with gray-scale to indicate frequency of occurrence where frequently occurring events are bright.

Inverted uses the default channel color along with gray scale to indicate frequency of occurrence where rarely occurring events are bright.

These color palettes help highlight the events that over time occur more often or, in the case of infrequent anomalies, occur less often.
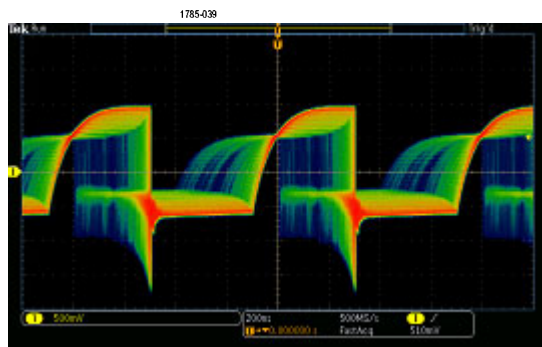
How the Analog Acquisition Modes Work

Sample mode retains the first sampled point from each acquisition interval. Sample is the default mode.

1785-128
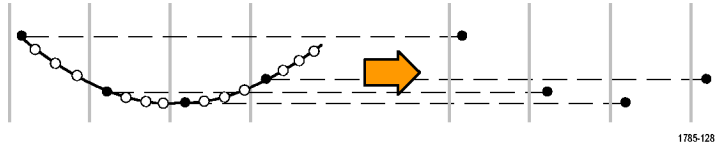
Peak Detect mode uses the highest and lowest of all the samples contained in two consecutive acquisition intervals. This mode only works with real-time, noninterpolated sampling and is useful for catching high frequency glitches.

1785-129
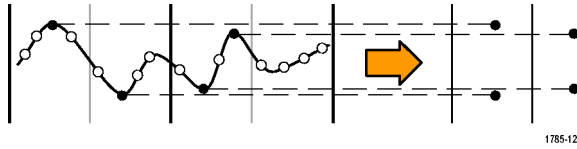
Hi Res mode calculates the average of all the samples for each acquisition interval. This mode also only works with real-time, noninterpolated sampling. Hi-Res provides a higher-resolution, lower-bandwidth waveform.

1785-130
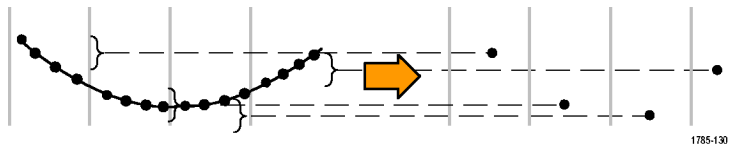
Envelope mode finds the highest and lowest record points over all acquisitions. Envelope uses Peak Detect for each individual acquisition.

1785-131

Average mode calculates the average value for each record point over a user-specified number of acquisitions. Average uses Sample mode for each individual acquisition. Use average mode to reduce random noise.

1785-132

Changing the Acquisition Mode, Record Length, and Delay Time

Use this procedure to change the acquisition mode.

1. Push **Acquire**.

0968-025

2. Push **Mode**.

| Mode	Record Length	FastAcq	Delay	Set Horiz. Position to 10%	Waveform Display	XY Display
Sample	10k	Off	On Off			Off

3. Then choose the acquisition mode from the side menu. You can chose from: Sample, Peak Detect, Hi Res, Envelope, or Average.

Acquisition Mode
∿Л⌐ Sample
∿Л⌐ Peak Detect
Hi Res
∿Л⌐ Envelope
⌐Л⌐ Average 16
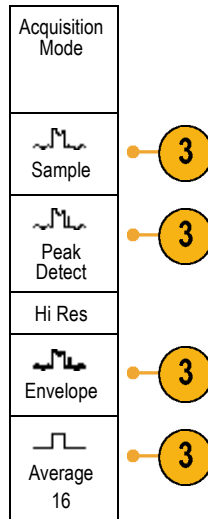
NOTE. *Peak Detect and Hi Res modes take advantage of sample points that the oscilloscope would have discarded at lower sweep speeds. Therefore, these modes only work when the current sample rate is less than the maximum possible sample rate. As soon as the oscilloscope starts to acquire at the maximum sample rate, then the Peak Detect, Hi Res and Sample modes all look the same. You can control the sample rate by setting the Horizontal scale and the Record Length.*

4. If you chose **Average**, turn **Multipurpose a** to set the number of waveforms to average over.

Multipurpose ⓐ

1785-039
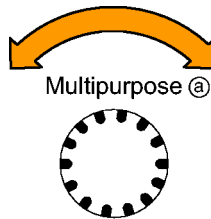
5. Push **Record Length**.

6. Scroll through the available choices. Choose among 1000, 10 k, 100 k, 1 M, 5 M, and 10 M points.

7. Push **Delay** on the lower menu to select **On** when you want to delay the acquisition relative to the trigger event.
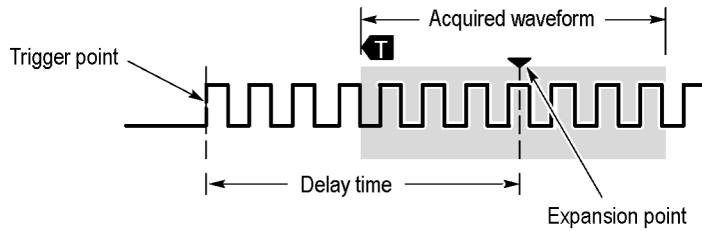
With **Delay** set to **On**, turn the **Horizontal Position** knob counterclockwise to increase the delay. The trigger point will move to the left and ultimately outside of the acquired waveform. Then you can adjust the **Horizontal Scale** knob to acquire more detail around the area of interest at the center of the screen.

When this delay is on, the trigger point separates from the horizontal expansion point. The horizontal expansion point stays at the center of the screen. The trigger point can move off the screen. When this happens, the trigger marker turns to point in the direction of the trigger point.

Use the delay feature when you want to acquire waveform detail that is separated from the trigger event by a significant interval of time. For example, you can trigger on a sync pulse that occurs once every 10 ms and then look at high-speed signal characteristics that occur 6 ms after the sync pulse.

When the delay feature is set to **Off**, the expansion point is tied to the trigger point so that scale changes are centered around the trigger point.

Using Roll Mode

Roll mode gives a display similar to a strip chart recorder for low-frequency signals. Roll mode lets you see acquired data points without waiting for the acquisition of a complete waveform record.

Roll mode is enabled when the trigger mode is auto and the horizontal scale is set to 40 ms/div or slower.

Quick Tips

- Switching to Envelope or Average acquisition mode, using digital channels, using math waveforms, turning on a bus, or switching to Normal trigger will disable Roll mode.

- Roll mode is disabled when you set the horizontal scale to 40 ms per division or faster.

- Push **Run/Stop** to halt Roll mode.

Act on Event

Tell the oscilloscope to perform a defined action after a defined event has occurred. The event can be a trigger or a certain number of acquisitions. The action can be to:

- Stop acquisitions

- Save a waveform or a screen image to a file

- Print

- Send a pulse out the AUX OUT port

- Generate a remote interface SRQ

- Send an e-mail notification

- Display a message on the oscilloscope display

1. Push **Test**.

2. Push **Application** on the lower-menu.

Application Act on Event	Event Acquisition	Action	Repeat Off			
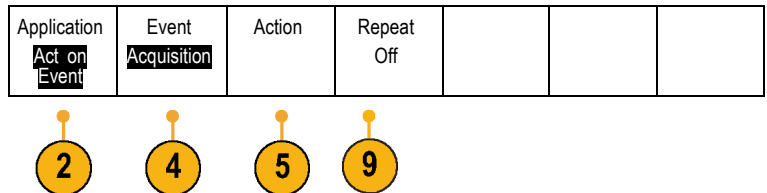
3. Turn **Multipurpose a** to select **Act on Event**
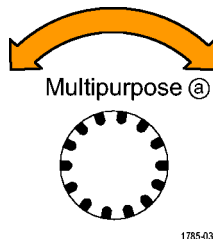
4. Push **Event** on the lower menu.
   This brings up the event type side menu.
   Select the desired event type.

Event Type
None
Trigger
Acquisi- tions (a) 10

5. Push **Actions** on the lower menu.

    This brings up the Actions side menu. Use the menu to select an action to occur on the event.

6. Select the action type from the resulting pop-out menu.

Actions
Select Actions (a) Stop Acq

⬤ 6

7. Select whether or not to enable the action.

Enable Action
On   Off

⬤ 7

8. If you selected **E-mail Notification** from the list of actions above, you can now select **Configure E-mail** from the side menu to define the parameters of the e-mail.

Configure E-mail

⬤ 8

*NOTE. There is a single set of SMTP server settings saved for both **Act on Event** e-mail notification and for the e-mail printer (set through the **Utility** > **Print Setup** > **Select Printer** > **Add E-mail Printer** menus). If you modify the SMTP settings in one of these two locations, they will be similarly modified in the other location.*

9. Push **Repeat**. from the lower menu.

    This lets you set how many times to repeat the selected event and resulting action.

Display Waveform or Trace Data

This section contains concepts and procedures for displaying the acquired waveform or trace.

Adding and Removing a Waveform

1. To add or remove a waveform from the display, push the corresponding front panel channel button or the D15-D0 button.

You can use the channel as a trigger source whether or not it is displayed.
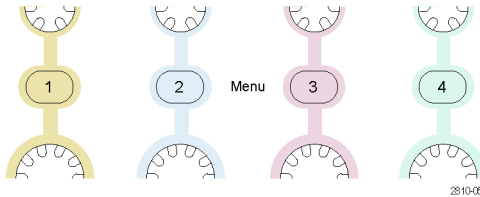
Setting the Display Style and Persistence

1. To set the display style, push **Acquire**.

2. Push **Waveform Display**.

Mode	Record Length	FastAcq	Delay	Set Horiz. Position to 10%	Waveform Display	XY Display
Sample	10k	Off	On Off			On

3. Push **Dots Only On Off** on the side menu. Dots on will display the waveform record points as dots on the screen. Dots off connects the dots with vectors.

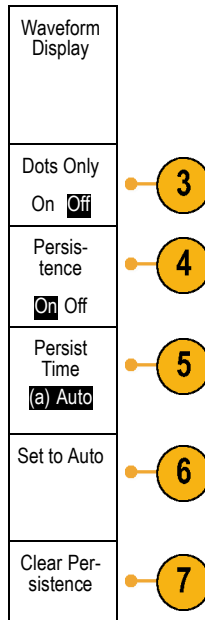| Waveform Display |
| :--- |
| Dots Only
On **Off** |
| Persis-
tence
On Off |
| Persist
Time
(a) Auto |
| Set to Auto |
| Clear Per-
sistence |

4. Push **Persistence** to **Off** to display the display persistence.

5. Push **Persist Time**, and turn **Multipurpose a** to have waveform data remain on screen for a user-specified amount of time.

6. Push **Set to Auto** to have the oscilloscope automatically determine a persistence time for you.

7. Push **Clear Persistence** to reset the persistence information.

8. To display the amplitude from one waveform against the amplitude from another, push **XY Display**. Then push **Triggered XY** from the side menu.

    A data point from the first waveform specifies the horizontal location while the corresponding data point from the second waveform specifies the vertical location for each displayed point.

    You can optionally view both the YT and XY displays simultaneously on the same screen.

Quick Tips

- Variable persistence accumulates record points for a specified time interval. Each record point decays independently according to the time interval. Use variable persistence for displaying infrequently appearing signal anomalies, such as glitches.

- Infinite persistence continuously accumulates record points until you change one of the acquisition display settings. Use infinite persistence for displaying unique signal anomalies, such as glitches.

- The XY Display mode graphs the data in fixed pairs of waveforms against one another.

Setting the Graticule Style

1. To set the graticule style, push **Utility**.

3249-012

2. Push **Utility Page**.

> Utility
> Page

2

3. Turn **Multipurpose a** and select **Display**.

> Display

4. Push **Graticule** on the lower menu.

| Utility Page Display	Backlight Intensity High	Graticule Full	Screen Annotation	Trigger Frequency Readout		

3 **4**

5. Select the desired style on the side menu.

The **Frame** graticule provides a clean screen on which you can most easily read automatic measurement results and other screen text.

The **Full** graticule can help you make cursor measurements on hard copies.

The **Grid**, **Solid**, and **Cross Hair** graticules provide compromises between **Frame** and **Full**.
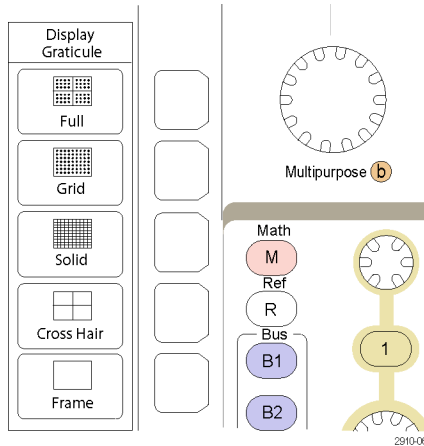
Quick Tips

■ You can display IRE and mV graticules. To do this, set the trigger type to video and set the vertical scale to 114 mV/division. (The 114 mV/division selection is available in the fine vertical scale settings for the channel when you set the trigger type to video.) The oscilloscope will automatically display the IRE graticule for NTSC signals, and the mV graticule for other video signals (PAL, SECAM, HDTV, and custom).

Setting the LCD Backlight Brightness and Dimming Settings
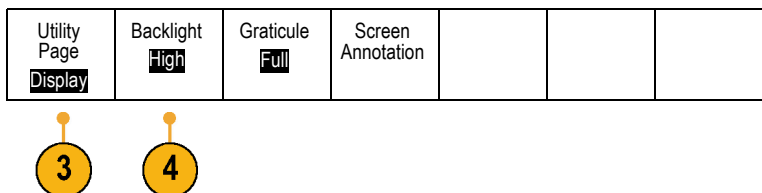
1. Push **Utility**.

2. Push **Utility Page**.

3. Turn **Multipurpose a** and select **Display**.

4. Push **Backlight** .

5. Select the intensity level on the side menu. Choices are: **High**, **Medium**, and **Low**.

Backlight
Backlight Intensity   **High**
Auto-Dim   **On** Off
Time   **60min**

6. Enabling **Auto-Dim** will turn down the screen lighting after a set time. Using it may help prolong the LCD life.

Setting Waveform Intensity

1. Push **Intensity** on the front panel.

Intensity

0968-033

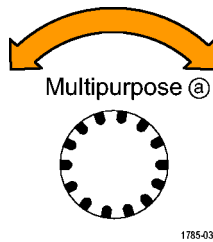This will bring up the intensity readout on the display.

ⓐ Waveform Intensity: 35%
ⓑ Graticule Intensity: 75%

2121-245

2. Turn **Multipurpose a** to select the desired waveform intensity.


Multipurpose ⓐ

1785-039

3. Turn **Multipurpose b** to select the desired intensity for the graticule.

4. Push **Intensity** again to clear the intensity readout from the display.


Intensity

0968-033

Scaling and Positioning a Waveform

Use the horizontal controls to adjust the time base, adjust the trigger point, and to examine waveform details more closely. You can also use the Wave Inspector Pan and Zoom controls to adjust the display of waveforms. (See page 147, *Using Wave Inspector to Manage Long Record Length Waveforms*.)

If you push the **Horizontal Position** knob and **Delay** is set to **On**, the horizontal position is set to 0 seconds. If you push it and **Delay** is set to **Off**, the horizontal position is set to 10%.
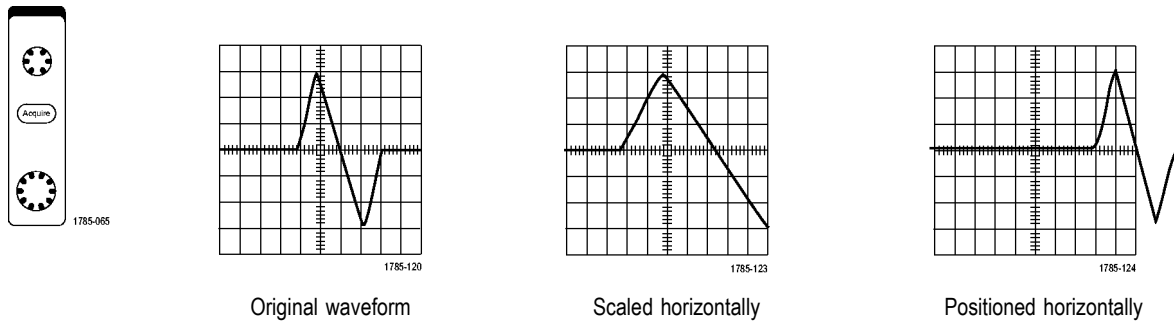
Original waveform	Scaled horizontally	Positioned horizontally

Use the vertical controls to select waveforms, adjust the waveform vertical position and scale, and set input parameters. Push a channel menu button (**1**, **2**, **3**, or **4**), button as many times as needed and the associated menu items to select, add, or remove a waveform.

Original waveform	Scaled vertically	Positioned vertically
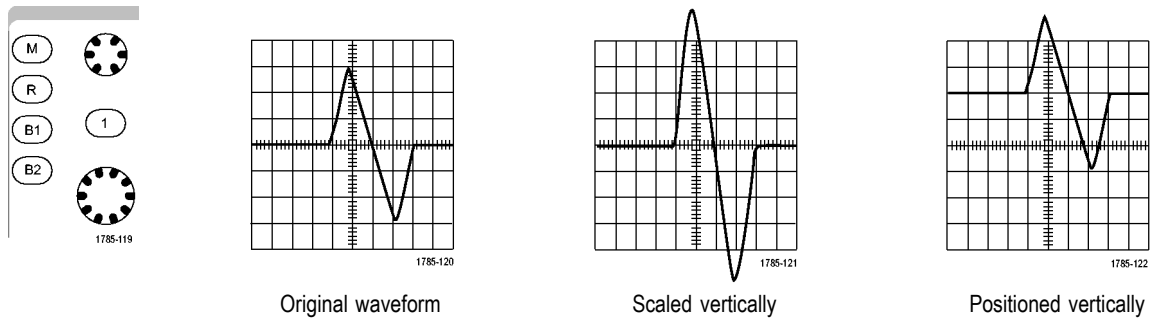
Quick Tips

■ **Preview.** If you change the Position or Scale controls when the acquisition is stopped or when it is waiting for the next trigger, the oscilloscope rescales and repositions the relevant waveforms in response to the new control settings. It simulates what you will see when you next push the **RUN** button. The oscilloscope uses the new settings for the next acquisition.

You may see a clipped waveform if the original acquisition went off the screen.

The math waveform, cursors, and automatic measurements remain active and valid when using preview.

Setting Input Parameters

Use the vertical controls to select waveforms, adjust the waveform vertical position and scale, and set input parameters.

1. Push a channel menu button **1**, **2**, **3**, or **4** to bring up the vertical menu for the designated waveform. The vertical menu only affects the selected waveform.
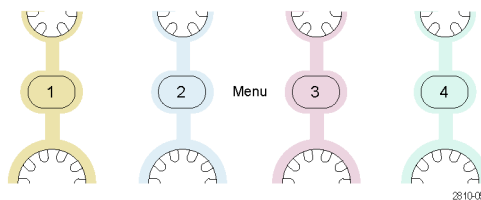
   Pushing a channel button will also select or cancel that waveform selection.

2. Push **Coupling** repeatedly to select the coupling to use.

   Use DC coupling to pass both AC and DC components.

   Use AC coupling to block the DC component and show only the AC signal.
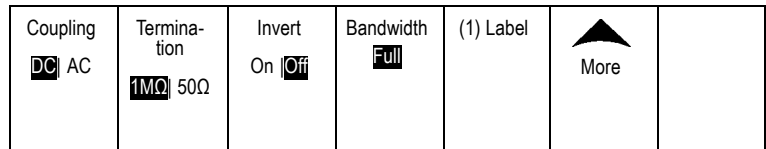
3. Push **Termination** repeatedly to select the input impedance to use.

   Set the input impedance (termination) to 50 Ω or 1 MΩ if using DC coupling. Input impedance is automatically set to 1 MΩ when using AC coupling.

   75 Ω is available on models ≤ 500 MHz.

   For more information on input impedance, see **Quick Tips**. (See page 110, *Quick Tips.*)

4. Push **Invert** to invert the signal.

   Select **Off** for normal operation and **On** to invert the polarity of the signal in the preamplifier.

5. Push **Bandwidth**, and select the desired bandwidth on the side menu.

The set choices are: Full, 250 MHz, and 20 MHz. Additional choices may appear, depending on the probe that you use.

Select **Full** to set the bandwidth to the full oscilloscope bandwidth.

Select **250 MHz** to set the bandwidth to 250 MHz.

Select **20 MHz** to set the bandwidth to 20 MHz.

NOTE. 100 MHz and 200 MHz model oscilloscopes do not include a 250 MHz option on the menu.

6. Push **Label** to create a label for the channel. (See page 55, *Labeling Channels and Buses*.)

7. Push **More** to access a pop-up menu of additional features. These are described below.

8. Select **Fine Scale** to enable **Multipurpose a** to make fine vertical scale adjustments.

Fine Scale	**8**
Offset	**9**
Position	
Probe Setup	**10**
Deskew	**11**
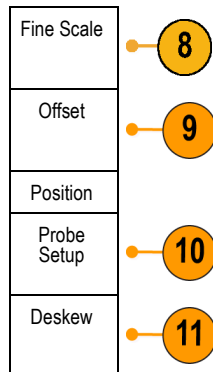
9. Select **Offset** to enable **Multipurpose a** to make vertical offset adjustments.

Push **Set to 0 V** on the side menu to set the vertical offset to 0 V.

For more information on offset, see **Quick Tips**. (See page 110, *Quick Tips*.)

10. Select **Probe Setup** to define probe parameters.

On the side menu:

■ Select **Voltage** or **Current** to set the probe type for probes that do not have a TekProbe Level 1, TekProbe II (requires a TPA-BNC adapter) or TekVPI interface.

■ For probes that do not have a Tek interface, when **Probe Type** is set to **Voltage**, turn **Multipurpose a** to set **Attenuation** to match the probe

■ For probes that do not have a Tek interface, when **Probe Type** is set to **Current**, turn **Multipurpose a** to set the Amps/Volts ratio (Attenuation) to match the probe.

■ If you are measuring current by probing the voltage drop across a resistor, set **Measure Current** to **Yes**. Push **A/V** ratio on the side menu and turn **Multipurpose a** to set the Amps/Volts or Volts/Amp ratio of your setup. For example, if you are measuring the drop across a 2 Ω resistor, set the V/A ratio to 2.

■ For some types of probes, you can push this button to instruct the oscilloscope to perform an AC calibration on the entire signal path from the probe tip to the specific oscilloscope channel. This can result in a flatter frequency response over the entire frequency range.

11. Select **Deskew** to make display and measurement adjustments for probes that have differing propagation delays. This is especially important when using a current probe in conjunction with a voltage probe.

For best results, use a deskew fixture, such as the Tektronix 067-1686-xx.

If you do not have a deskew fixture, you can use the controls in the Deskew menu to set the oscilloscope's deskew parameters to recommended values, based on the nominal propagation delay of each probe. The oscilloscope automatically loads the nominal propagation delay values of TekVPI and TekProbe II (requires use of a TPA-BNC adaptor) probes. For other common probes, first push **Select** on the side menu, and select the channel to which the probe is attached. Then push **Probe Model** on the side menu, and select the probe model. If your probe is not in the list, set probe model to **Other**, and push **Propagation Delay** on the side menu and dial in its propagation delay with **Multipurpose a**.

To display the recommended deskew values calculated by the oscilloscope, set **Show rec. deskews** on the side menu to **Yes**.

To set the deskew values of each channel to the recommended values, push **Set all deskews to recommended values** on the side menu.

Quick Tips

■ **Using Probes with the TekProbe II and TekVPI Interfaces.** When you attach a probe with the TekProbe II or the TekVPI interface, the oscilloscope sets the channel sensitivity, coupling, and termination resistance automatically to match the probe requirements. Tek Probe II probes require use of the TPA-BNC Adapter.

■ **The Difference Between Vertical Position and Offset.** Adjust the vertical position to place the waveforms where you want to see them. The waveform baseline indicators indicate the zero Volts (or Amps) level for each waveform. If you adjust the channel's Vertical Scale, the waveform expands or contracts around the waveform's baseline indicator.

When you use the Channel<x> > **More** >**Offset** > **Vertical Offset** control to move a waveform, the baseline indicator no longer represents zero. Instead, it represents the level of the offset. If you adjust the channel's Vertical Scale, the waveform expands or contracts around the waveform's baseline indicator.

■ **50 Ω Protection.** If you select 50 Ω termination, the maximum vertical scale factor is limited to 1 V/div, except that with a 10X probe the scale factor is 10 V. If you apply excessive input voltage, the oscilloscope automatically switches to 1 MΩ termination to protect the internal 50 Ω termination. For more details, refer to the specifications in the *MDO3000 Series Oscilloscopes Technical Reference.*

Analyze Waveform or Trace Data

After having properly set up the acquisition, triggering, and display of your desired waveform or trace, you can analyze the results. Select from features such as cursors, automatic measurements, statistics, waveform histograms, math, and FFT.

Using Markers in the Frequency Domain

1. Push **Markers**. This brings up the **Markers** side menu.

0968-034

Markers
Peak Markers
(a) 5
On Off

2. Push **Peak Markers** and turn **Multipurpose a** to select how many peaks to label on the display.

   NOTE. This is the maximum number of peaks that will be marked. If there are more peaks that meet the threshold and excursion criteria than the specified number of Peak Markers identified in this control, then only the specified number of highest amplitude peaks will be marked.

3. Push

   To Center to set the center frequency to the frequency indicated by the Reference Marker. The Reference Marker is automatically placed on the highest amplitude peak.

To Center

4. Push **Threshold** and turn **Multipurpose a** to define the threshold of the peak markers. Turn **Multipurpose b** to define their excursion value.

Threshold
-50.0 dBm
Excursion
30.0 dB

5. Push **Manual Markers** to activate manual markers. Use manual markers to measure non-peak areas of interest in the spectrum.

Manual Markers
On Off

6. Push **Readout** to choose between Absolute and Delta readouts. Delta readouts are relative to the Reference Marker.

Readout
Absolute
Delta

Automatic Peak Markers

Automatic peak markers are on by default and assist with quickly identifying the frequency and amplitude of peaks in the spectrum.

1. The Reference Marker is placed on the highest amplitude peak. It is marked with a red R in a triangle.

2. The automatic markers indicate frequency and amplitude.

3. Absolute readouts show the actual frequency and amplitude of the automatic markers.

4. Delta readouts show the frequency and amplitude of the automatic markers relative to the reference marker.
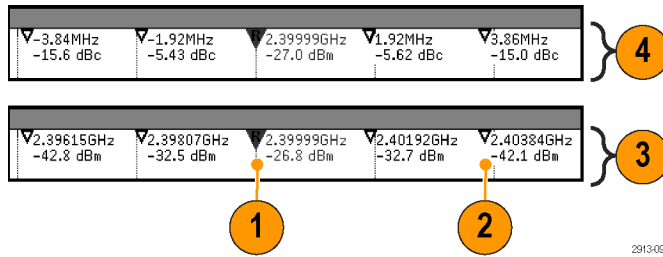
In the screen shot shown below, a marker has been placed on each of the obvious peaks in the display. The Reference Marker is the highest peak. It is marked with the red R in a triangle, and its readout is shown in red text.

1. Reference marker

2. Automatic markers
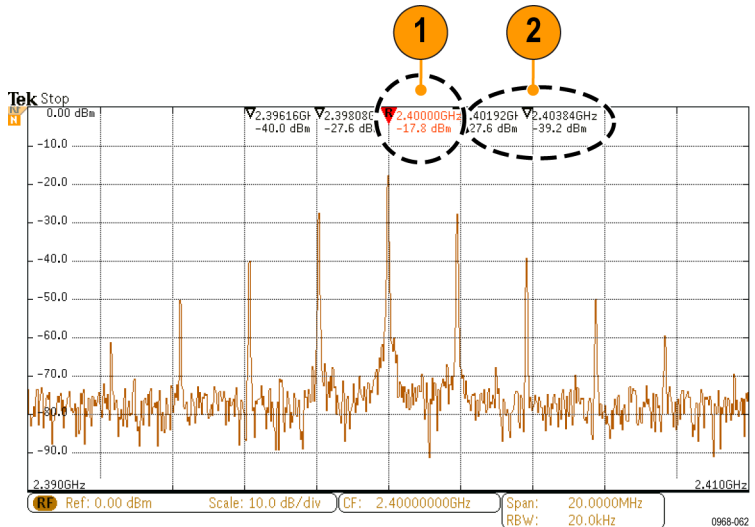
Use **Threshold** and **Excursion** to define which peaks are marked.

The threshold is a minimum amplitude that a signal must cross to be a valid peak. If the threshold is lower, more peaks will tend to qualify to have markers. If the threshold is higher, fewer peaks tend to qualify to have markers.

The excursion is how far a signal needs to fall in amplitude between marked peaks to be another valid peak. If the excursion is low, more peaks will tend to qualify to have associated markers. If the excursion is high, fewer peaks will tend to qualify to have associated markers.

Each automatic marker has a readout associated with it. These can be absolute or delta readouts. An absolute marker readout shows the actual frequency and amplitude of the associated marker. A delta marker readout shows the frequency and amplitude differences from the Reference Marker. The Reference Marker's readout indicates absolute frequency and amplitude, regardless of the readout type.

Manual Markers

Two manual markers are provided for you to measure non-peak areas of the spectrum and to measure Noise Density and Phase Noise. When the manual markers are turned on, the Reference Marker is no longer automatically attached to the highest amplitude peak. It is now assigned to the **Multipurpose a** knob and can be moved to any location you desire. This enables easy measurement of any part of the spectrum as well as delta measurements to any part of the spectrum. This also lets you measure non-peak spectral content of interest. The readouts for manual markers indicate frequency and amplitude, just like automatic marker readouts.

As with automatic peak marker readouts, the manual marker readouts can show either absolute or delta values.

1. One manual marker is controlled by **Multipurpose a**.

2. The other manual marker is controlled by **Multipurpose b**.
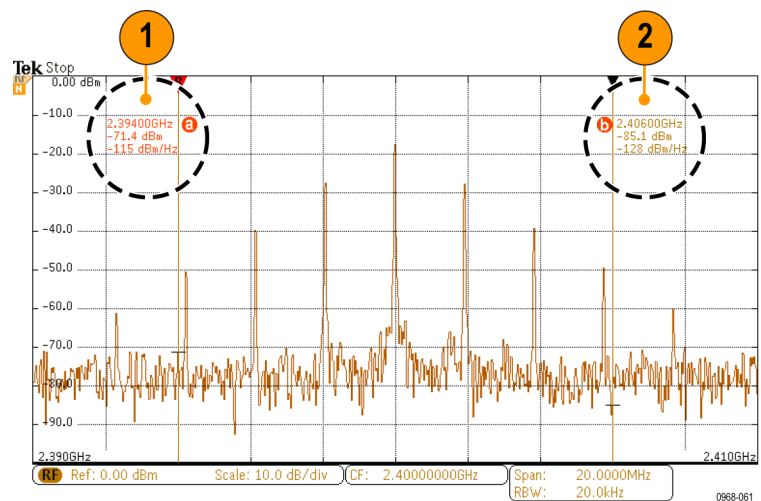
3. Delta readouts for frequency and amplitude are shown at the top of the display.

4. The third line of the manual marker **a** always shows the noise density (dBm/Hz).

5. The third line of manual marker **b** always shows noise density when you choose absolute markers. It shows phase noise when you choose delta markers (dBc/Hz).
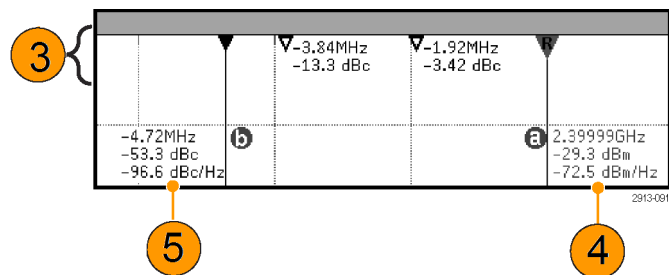
Taking Automatic Measurements in the Time Domain
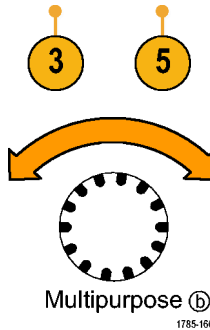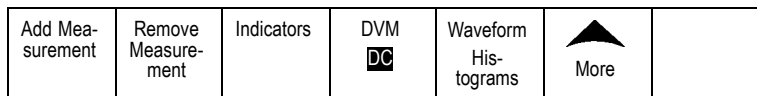
To take an automatic measurement in the time domain:

1. If the instrument is in the frequency domain, push channel **1**.

2. Push **Measure**.

3. Push **Add Measurement**.

Add Mea-surement	Remove Measure-ment	Indicators	DVM DC	Waveform His-tograms	More	

4. Turn the **Multipurpose b** knob to select the specific measurement. If needed, then turn **Multipurpose a** to select the channel to measure on.

    Multipurpose ⓑ
    1785-160

5. To remove a measurement, push **Remove Measurement**, turn **Multipurpose a** to select the specific measurement, and push **OK Remove Measurement** on the side menu.
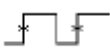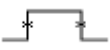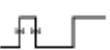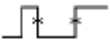
Quick Tips

■ To remove all measurements, select **Remove All Measurements**.

■ A ⚠ symbol appears instead of the expected numerical measurement if a vertical clipping condition exists. Part of the waveform is above or below the display. To obtain a proper numerical measurement, turn the vertical scale and position knobs to make all of the waveform appear in the display.

■ If the oscilloscope displays a **Low Resolution** message, increase the record length of the acquisition so that the oscilloscope has more points from which to calculate the measurement.

Selecting Automatic Measurements in the Time Domain

The following tables list each automatic measurement by category: time or amplitude. (See page 122, *Taking Automatic Measurements in the Time Domain*.)

Time measurements

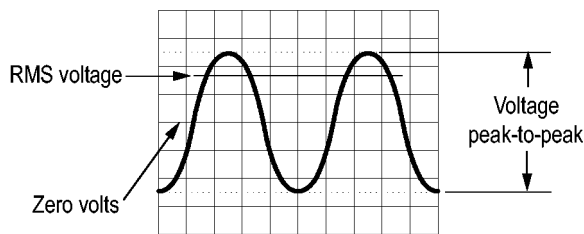| Measurement		Description
Frequency		The first cycle in a waveform or gated region. Frequency is the reciprocal of the period; it is measured in hertz (Hz) where one Hz is one cycle per second.
Period		The time required to complete the first cycle in a waveform or gated region. Period is the reciprocal of frequency and is measured in seconds.
Rise Time		The time required for the leading edge of the first pulse in the waveform or gated region to rise from the low reference value (default = 10%) to the high reference value (default = 90%) of the final value.
Fall Time		The time required for the falling edge of the first pulse in the waveform or gated region to fall from the high reference value (default = 90%) to the low reference value (default = 10%) of the final value.
Delay		The time between the mid reference (default 50%) amplitude point of two different waveforms. See also *Phase*.
Phase		The amount of time that one waveform leads or lags another waveform, expressed in degrees where 360° makes up one waveform cycle. See also *Delay*.
Positive Pulse Width		The distance (time) between the mid reference (default 50%) amplitude points of a positive pulse. The measurement is made on the first pulse in the waveform or gated region.
Negative Pulse Width		The distance (time) between the mid reference (default 50%) amplitude points of a negative pulse. The measurement is made on the first pulse in the waveform or gated region.
Positive Duty Cycle		The ratio of the positive pulse width to the signal period expressed as a percentage. The duty cycle is measured on the first cycle in the waveform or gated region.
Negative Duty Cycle		The ratio of the negative pulse width to the signal period expressed as a percentage. The duty cycle is measured on the first cycle in the waveform or gated region.
Burst Width		The duration of a burst (a series of transient events) and is measured over the entire waveform or gated region.

Amplitude measurements

| Measurement		Description
Peak-to-peak		The absolute difference between the maximum and minimum amplitude in the entire waveform or gated region.
Amplitude		The high value less the low value measured over the entire waveform or gated region.
Max		The most positive peak voltage. Max is measured over the entire waveform or gated region.
Min		The most negative peak voltage. Min is measured over the entire waveform or gated region.
High		This value is used as 100% whenever high reference, mid reference, or low reference values are needed, such as in fall time or rise time measurements. Calculate using either the min/max or histogram method. The min/max method uses the maximum value found. The histogram method uses the most common value found above the midpoint. This value is measured over the entire waveform or gated region.
Low		This value is used as 0% whenever high reference, mid reference, or low reference values are needed, such as in fall time or rise time measurements. Calculate using either the min/max or histogram method. The min/max method uses the minimum value found. The histogram method uses the most common value found below the midpoint. This value is measured over the entire waveform or gated region.
Positive Overshoot		This is measured over the entire waveform or gated region and is expressed as: Positive Overshoot = (Maximum – High) / Amplitude x 100%.
Negative Overshoot		This is measured over the entire waveform or gated region and is expressed as: Negative Overshoot = (Low – Minimum) / Amplitude x 100%.
Total overshoot		This is the summation of the positive overshoot and the negative overshoot.

Amplitude measurements (cont.)

Measurement		Description
Mean		The arithmetic mean over the entire waveform or gated region.
Cycle Mean		The arithmetic mean over the first cycle in the waveform or the first cycle in the gated region.
RMS		The true Root Mean Square voltage over the entire waveform or gated region.
Cycle RMS		The true Root Mean Square voltage over the first cycle in the waveform or the first cycle in the gated region.

RMS voltage

Zero volts

Voltage peak-to-peak

1785-083

Miscellaneous measurements

Measurement		Description
Positive Pulse Count		The number of positive pulses that rise above the mid reference crossing in the waveform or gated region.
Negative Pulse Count		The number of negative pulses that fall below the mid reference crossing in the waveform or gated region.
Rising Edge Count		The number of positive transitions from the low reference value to the high reference value in the waveform or gated region.
Falling Edge Count		The number of negative transitions from the high reference value to the low reference value in the waveform or gated region.
Area		Area measurement is a voltage over time measurement. It returns the area over the entire waveform or gated region in volt-seconds. Area measured above ground is positive; area measured below ground is negative.
Cycle Area		A voltage over time measurement. The measurement is the area over the first cycle in the waveform or the first cycle in the gated region expressed in volt-seconds. The area above the common reference point is positive, and the area below the common reference point is negative.

Histogram measurements

Measurement	Description
Waveform Count	Displays the number of waveforms that contributed to the histogram.
Hits in Box	Displays the number of samples within the histogram box or on its boundaries.
Peak Hits	Displays the number of samples in the bin that contains the most hits.
Median	Displays the middle histogram data value, where half of all histogram data points are less than this value and half are greater than this value.
Peak-to-peak	Displays the peak-to-peak value of the histogram. Vertical histograms display the voltage of the highest nonzero bin minus the voltage of the lowest nonzero bin. Horizontal histograms display the time of the right-most nonzero bin minus the time of the left-most nonzero bin.
Histogram Max	Displays the voltage of the highest nonzero bin in vertical histograms or the time of the right most nonzero bin in horizontal histograms.
Histogram Min	Displays the voltage of the lowest nonzero bin in vertical histograms or the time of the left most nonzero bin in horizontal histograms.
Histogram Mean	Measures the average of all histogram data points within or on the histogram box.
Standard Deviation	Measures the standard deviation (Root Mean Square (RMS) deviation) of all histogram data points within or on the histogram box.
Sigma1	Displays the percentage of the hits in the histogram that are within one standard deviation of the histogram mean.
Sigma2	Displays the percentage of the hits in the histogram that are within two standard deviations of the histogram mean.
Sigma3	Displays the percentage of the hits in the histogram that are within three standard deviations of the histogram mean.

Customizing an Automatic Measurement in the Time Domain

You can customize automatic measurements by using gating, modifying measurement statistics, adjusting the measurement reference levels, or taking a snapshot.

Gating

Gating confines the measurement to a certain portion of a waveform. To use:

1. Push **Measure**.

0968-048

2. Push **More** as many times as needed to select **Gating** from the resulting pop-up menu.

Add Mea-surement	Remove Measure-ment	Indicators	DVM DC	Waveform His-tograms	More	

2
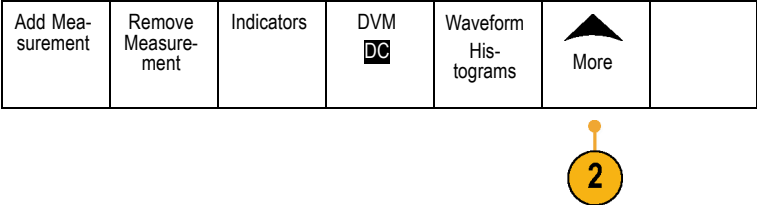
3. Position the gates using the side menu options.

Gating
Off (Full Record)
Screen
Between Cursors
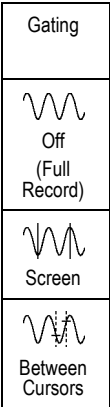
Statistics

Statistics characterize the stability of measurements. To adjust statistics:

1. Push **Measure**.

Measure

0968-048

2. Push **More** as many times as needed to select **Statistics** from the resulting pop-up menu.

Add Mea-surement	Remove Measure-ment	Indicators	DVM DC	Waveform His-tograms	More	

2
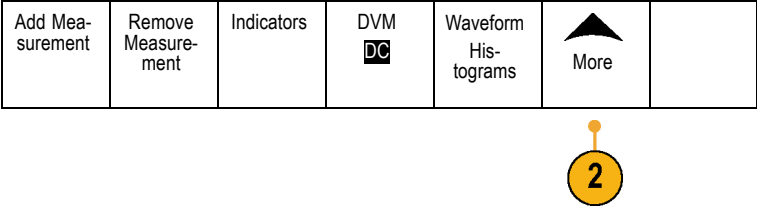
3. Push the side menu options. These include whether to turn statistics on or off and how many samples to use for mean and standard deviation calculations.

Measurement Statistics
On Off

Mean & Std Dev Samples
(a) 32

Reset Statistics

③

③
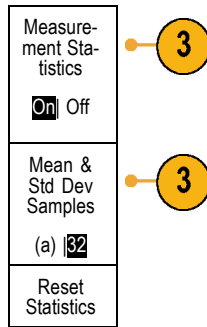
Snapshot

To see all the single-sourced measurements at one moment in time:

1. Push **Measure**.

Measure

0968-048

2. Push **Add Measurement**.

Add Measurement	Remove Measurement	Indicators	DVM **DC**	Waveform Histograms	▲ More	

②
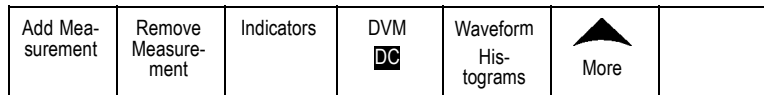
3. Turn **Multipurpose a** to select the desired **Source** channel.

Multipurpose ⓐ

1785-039
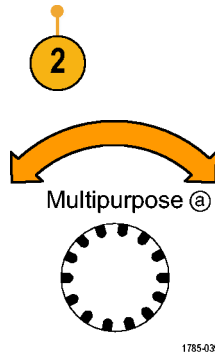
4. Turn **Multipurpose b** to select the **Measurement Type** of **Snapshot**.

Multipurpose ⓑ

1785-160

5. Push **OK Snapshot All Measurements**.

OK
Snapshot
All Mea-
surements

④
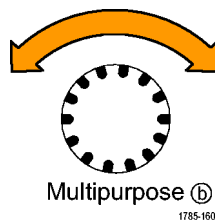
6. View results.

Snapshot on 1

Period	: 312.2µs	Freq	: 3.203 kHz
+Width	: 103.7µs	–Width	: 208.5µs
Burst W	: 936.5µs	Fall	1.144µs
Rise	: 1.452µs	±Over	: 14.286%
+Duty	: 33.23%	–Duty	: 66.77 %
+Over	: 7.143%	–Over	: 7.143 %
High	: 9.200 V	Low	: -7.600 V
Max	: 10.40 V	Min	: -8.800 V
Ampl	: 16.80 V	Pk-Pk	: 19.20 V
Mean	: -5.396 V	CycleMean	: -5.396 V
RMS	: 7.769 V	CycleRMS	: 8.206 V
Area	: -21.58 mVs	CycleArea	: -654.6µVs
+Edges	: 1	-Edges	: 0
+Pulses	: 2	-Pulses	: 2

Reference Levels

Reference levels determine how time-related measurements are taken. For example, they are used in calculating rise and fall times.

Measure

0968-048

1. Push **Measure**.

2. Push **More** as many times as needed to select **Reference Levels** from the resulting pop-up menu.

Add Mea-surement	Remove Measure-ment	Indicators	DVM DC	Wave-form His-tograms	More	

②
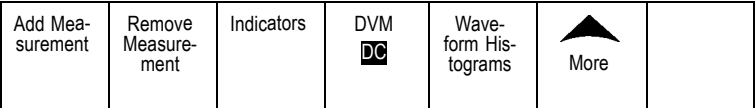
3. Set the levels using the side menu.

Reference Levels
Set Levels in
% | Units
High Ref (a) 90.0 %
Mid Ref 50.0 % 50.0 %
Low Ref 10.0 %
- Set to Defaults

Use High and Low reference to calculate rise and fall times.

Use Mid reference primarily for measurements between edges such as pulse widths.

Taking Automatic Measurements in the Frequency Domain

To take an automatic measurement in the frequency domain:

1. If the instrument is in the time domain, push **RF**.

0968-007

2. Push **Measure**.

0968-048

Select Measure-ment None						

3. Push **Select Measurement**.

③

4. Choose the measurement of interest from the side menu.

Select Measure-ment
None
Channel Power
Adjacent Channel Power Ratio
Occupied Bandwidth

Channel power: The total power within the bandwidth, defined by the Channel Width.

Adjacent channel power ratio: The power in the main channel and the ratio of channel power to main power, for the upper and lower halves of each adjacent channel.

Occupied bandwidth: The bandwidth that contains the specified % of power within the analysis bandwidth.

As you select each frequency measurement, on screen help will appear to explain the purpose of that measurement. A **Configure** item will appear on the lower menu. After you press **Configure** and set the measurement parameters in the resulting side menu, the oscilloscope will automatically set the span. When the RF measurements are on, the Auto detection method will set all frequency domain traces to the **Average** detection method. This provides optimal measurement accuracy.

Taking Digital Voltmeter Measurements

Use the digital voltmeter to measure the potential difference between two points in an electrical circuit.

1. Push channel **1** .

0968-004

2. Push **Measure**.

0968-048

Add Measure-ment	Remove Measure-ment	Indicators Off	DVM Off	Waveform His-tograms	More	

3. Push the bottom-menu button labelled **DVM**.

4. From the side menu, select the desired **Mode**, **Source** and **Display Style**.

Digital Voltmeter
Mode
(a) │
Off
Source
(b) │1
Autorange Unavail- able when Triggering on DVM Source
Display Style
Full
Minimized
Reset DVM Statistics

View the finished results.
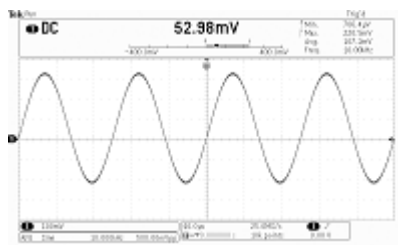
Taking Manual Measurements with Cursors

Cursors are on-screen markers that you position in the waveform display to take manual measurements on acquired data. They appear as horizontal and/or as vertical lines. To use cursors on analog or digital channels:

1. Push **Cursors** to turn cursors on.

*NOTE. A second push turns cursors off. You can also push and hold **Cursors** to display the cursor menu.*

0968-033

In this example, two vertical cursors appear on the selected waveform. As you turn **Multipurpose a**, you move one cursor to the right or left. As you turn knob **Multipurpose b**, you move the other cursor.

0968-054
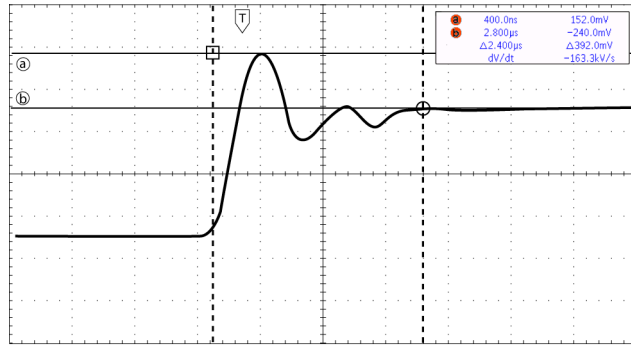
2. With cursors on, push **Select**.

This turns the cursor linking on and off. If linking is on, turning **Multipurpose a** moves the two cursors together. Turning **Multipurpose b** adjusts the time between the cursors.

0968-023

3. Push **Fine** to toggle between a coarse and a fine adjustment for the **Multipurpose a** and **Multipurpose b** knobs.

Pushing **Fine** also changes the sensitivity of other knobs as well.

0968-036

4. Push and hold **Cursors** to display the cursor menu.

5. Push **Cursors** on the lower menu to set the cursors to **Screen**.

In screen mode, two horizontal bars and two vertical bars span the graticule.

Cursors Waveform	Source	Bars	Linked	Bring Cursors	Cursor Units
Screen	Selected Waveform	Horizontal Vertical	On　Off	On Screen	

6. Turn **Multipurpose a** and **Multipurpose b** to move the pair of horizontal cursors.

Multipurpose ⓐ

1785-039

Multipurpose ⓑ

1785-160
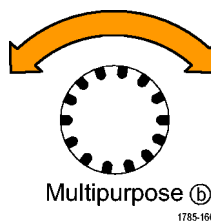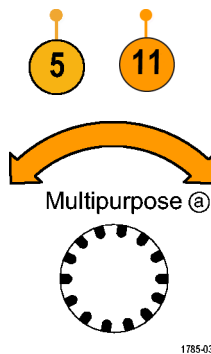
7. Push **Select**.

This makes the vertical cursors active and the horizontal cursors inactive. Now, as you turn the multipurpose knobs, the vertical cursors will move.

Push **Select** to make the horizontal cursors active again.

8. View the cursor and the cursor readout.

NOTE. On digital channels, you can take timing measurements with cursors, but not amplitude measurements.

9. Display multiple waveforms on the screen by pushing one or more of the channel **1** through **4** buttons or by pushing the **D15 – D0** button.

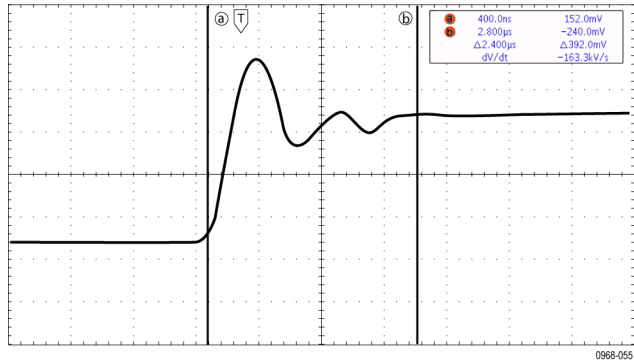**10.** Push and hold **Cursors** to display the cursor menu again.

11. Push **Source** on the lower menu.

A pop-up menu will appear. The default menu selection of **Selected Waveform** will cause the cursors to take measurements on the selected (last used) waveform.

12. Turn **Multipurpose a** to choose a channel to measure other than the one pointed to by **Selected Waveform**.

13. Push **Menu Off** to remove the pop-up menu.

14. Turn **Multipurpose a** and take cursor measurements on the alternate waveform.

15. Push **Cursors** again. This turns off the cursors. The screen no longer displays the cursors and the cursor readout.

Cursors

0968-033

Using Cursor Readouts

Cursor readouts supply textual and numeric information relating to the current cursor positions. The oscilloscope always shows the readouts when the cursors are turned on.

Readouts appear in the upper right corner of the graticule. If Zoom is on, the readout appears in the upper right corner of the zoom window.

When a bus is selected, the readout shows the decoded bus data in the format you have selected from the choices in the bus menu. When a digital channel is selected, the cursors show the values of all displayed digital channels.

NOTE. When serial or parallel buses are selected, the data value at that point is displayed in the cursor readout.

Δ Readout:

The Δ readouts indicate the difference between the cursor positions.

a	400.0ns	152.0mV
b	2.800µs	−240.0mV
	Δ2.400µs	Δ392.0mV
	dV/dt	−163.3kV/s

a Readout:

Indicates that the value is controlled by the **Multipurpose a** knob.

b Readout:

Indicates that the value is controlled by the **Multipurpose b** knob.

The horizontal cursor lines on the display measure the vertical parameters, typically voltage.

The vertical cursor lines on the display measure horizontal parameters, typically time.

The square and circle shapes in the readout map to the multipurpose knobs when both vertical and horizontal cursors are present.

Using XY Cursors

When the XY Display mode is on, the cursor readouts will appear to the right of the lower graticule (XY). They will include rectangular, polar, product, and ratio readouts. The oscilloscope will display vertical-bar waveform cursors in the upper graticule (YT).

Setting Up a Histogram

You can display a vertical (voltage) or horizontal (time) histogram. Use histogram measurements to get statistical measurement data for a section of a waveform along one axis. The sources for a histogram can be any of the four or two analog channels, a math waveform, or any of the four or two reference waveforms.

To Display a Histogram

1. Set up the oscilloscope to show the waveform on which to measure the histogram. Use **Autoset** if appropriate.

2. Push **Measure**.

3. Push **Waveform Histograms** on the lower menu.

Add Mea-surement	Remove Measure-ment	Indicators	DVM DC	Waveform His-tograms	More	

Use the Arbitrary Function Generator

The MDO3000 contains an optional integrated arbitrary function generator (AFG) (option MDO3AFG). This is useful for simulating signals within a design or adding noise to signals to perform margin testing.

The function generator provides output of predefined waveforms up to 50 MHz. Choose between sine, square, pulse, ramp/triangle, DC, noise, sin(x)/x (Sinc), Gaussian, Lorentz, exponential rise/fall, Haversine and cardiac signals.

The AFG can generate up to 131,072 points of an arbitrary waveform. You can create the waveform from any of the four internal ARB memories, the four (or two) analog channels, the four (or two) reference waveforms, the math waveform or the 16 digital channel waveforms. You can also use a .CSV (spreadsheet) file stored externally or a predefined template.

You can modify your arbitrary waveform via an on-screen editor and then replicate it out of the generator. For more involved waveform manipulation, you can use Tektronix' ArbExpress PC-based waveform creation and editing software. It is available for free download from www.tektronix.com/software. Use version 3.1 or later with the MDO3000.

How to access the AFG

To access the AFG output, connect your cable to the port marked **AFG OUT** in the back of the oscilloscope.
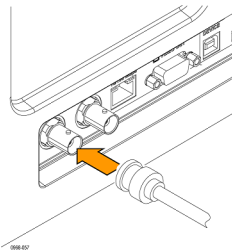
To see the output of the AFG, connect the other end of the cable to one of the input channels on the front of the oscilloscope.
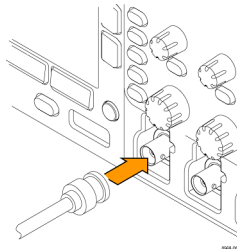
Push the front-panel **AFG** button to turn the AFG output on and off.

The button lights up when the output is on. The light goes out when it is off. The On-Off status is always off when you recall an instrument setup. The AFG will always come up in the off state when you turn the oscilloscope power on.
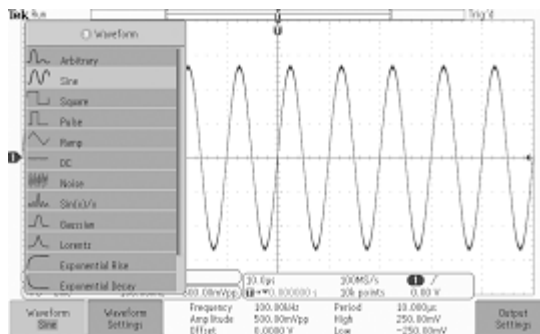
How to change the waveform type

1. Push the **AFG** button to bring up the AFG lower menu.

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| Waveform Sine	Wave– form Settings	Frequency Amplitude Offset	100.00kHz 500.00m- Vpp 0.0000 V	Period High Low	10.000µs 250.00mV −250.00 mV	Output Settings

2   **3**   **4**

2. Push the **Waveform** button on the AFG lower menu and turn the **Multipurpose a** knob to select the waveform type.

3. Push the **Waveform Settings** button on the AFG lower menu to set the frequency, period, amplitude, offset and the high and low levels of the desired waveform.

4. Push the **Output Settings** button on the lower menu to adjust the load impedance and amount of additive noise.

   You can enable the AFG trigger pulse to come out of the rear-panel **AUX OUT** port. This is useful if you want an AUX OUT pulse that is synchronized to your AFG waveform block. To enable this feature, push **AFG** > **Output Settings** > **AUX OUT** > **AFG**.
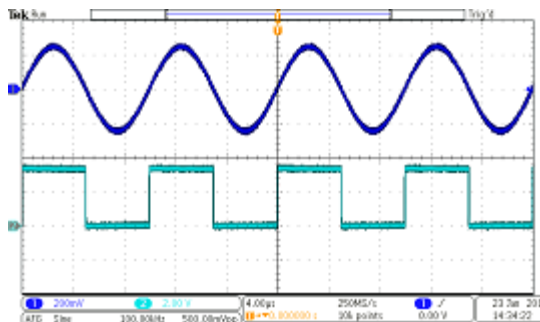
The channel 1 sine wave shows the output of the AFG. The channel 2 square wave show the output of the AFG sync pulse. It comes from the AUX OUT port.

Restrictions. When an output frequency is higher than 4.9 MHz, some restrictions exist. A divided frequency that is lower than 4.9 MHz is output from the AUX OUT port. The AFG trigger frequency will be limited as shown in the table to the right.

The output waveform (MHz) frequency setting.	AFG trigger output frequency (MHz).
≤ 4.9 MHz	Signal frequency
>4.9 MHz to 14.7 MHz	Signal frequency / 3
>14.7 MHz to 24.5 MHz	Signal frequency / 5
>24.5 MHz to 34.3 MHz	Signal frequency / 7
>34.3 MHz to 44.1 MHz	Signal frequency / 9
>44.1 MHz to 50 MHz	Signal frequency / 11

How to create an arbitrary waveform

You can create the waveform from any of the four internal ARB memories, the four (or two) analog channels, the four (or two) reference waveforms, the math waveform or the 16 digital channel waveforms. You can also use a .CSV (spreadsheet) file stored externally or a predefined template (square, sine, ramp, pulse, or noise).

1. Push the **AFG** button to bring up the AFG lower menu.

2. On the lower-menu, push **Waveform** and turn **Multipurpose a** to select **Arbitrary** from the list of waveforms on the resulting pop-up menu.

Waveform Arbitrary	Waveform Settings	Waveform Edit	Freq. Ampl. Offset	100.00kHz 500.00m-Vpp 0.000 V	Period 10.000μV High 250.00mV Low –250.00mV	Output Settings

3. Push **Waveform Settings** to set the frequency, period, amplitude, offset, and high and low levels.

4. Push **Waveform Edit** to bring up the Waveform Edit lower menu. This menu will let you manipulate existing waveform points, as well as to add and delete points, and to edit the voltage level.

   For cases with many points to edit, consider using Tektronix ArbExpress software, which is available for free download from www.tektronix.com/software.

   Also, use the Waveform Edit menu to create new arbitrary waveforms in the instrument. You can do this by loading them from files or from live channels.

Edit Existing	Create New	Load Waveform	Freq. Ampl. Offset	100.00kHz 500.00m-Vpp 0.000 V	Period 10.000 µs High 250.00mV Low –250.00mV	Save Waveform

If needed, push **AFG** > **Waveform Edit** to bring up the waveform edit lower menu.

5. Push **Edit Existing** to change, add, or delete points in a current waveform.

⑤ ⑥ ⑦ ⑧

When you enable the internal editor, the screen splits into a smaller top window and a larger bottom window.

The smaller, top part of the screen becomes an overview, which shows the entire waveform memory. A box shows the zoomed-in portion of the waveform.

The larger, lower part becomes the zoomed-in view of the overview, as defined by the box in the top part of the screen. This lower part shows up to 500 points of the record.
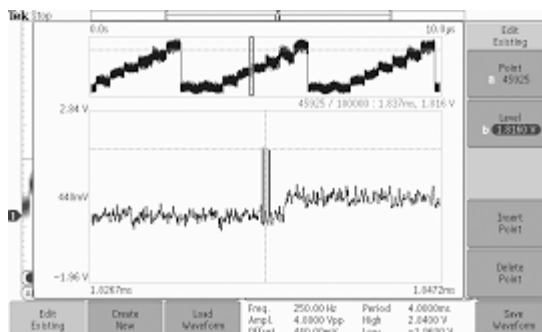
Turn the **Multipurpose a** knob to select a point to edit.

Turn the **Multipurpose b** knob to set the voltage level of that point. The voltage level is a function of the current amplitude and offset settings for the waveform.

Use the side menu items to add or remove points from the waveform.

6. Push **Create New** from the lower-menu to make a fresh arbitrary waveform.

On the resulting side menu, turn **Multipurpose a** or use the keypad to define the number of points in the waveform. Your waveform can have up to 131,072 points. Turn **Multipurpose b** to choose the basic function. Choose between square, sine, ramp, pulse, and noise.

Push **OK Create** to build the new waveform.

7. Push the lower-menu button labeled **Load Waveform**. Turn **Multipurpose a** to choose which of your waveforms to display. Also, you can use the side menu to load a saved waveform from a file. When you have chosen the desired waveform, push **OK Load** from the side menu. Clear the menu by pushing **Menu Off** twice.

Be sure that you have a BNC cable connected from the AUX OUT port on the back to the channel 1 port on the front.

View your arbitrary waveform on the oscilloscope display.
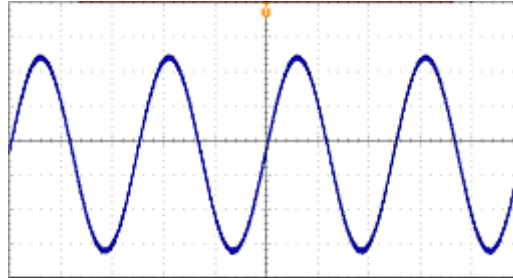
8. On the lower menu, push **Save Waveform**. Turn **Multipurpose a** to select which of the four slots to store your newly created waveform. Push **OK Save**. If you want, push **Edit Labels** and use **Multipurpose a** and the lower menu to assign a name to your new waveform. Clear the label menu by pushing **Menu off**.

Quick Tips

■ You can save arbitrary waveforms in .CSV format. A .CSV file consists of sets of waveform point pairs (voltage, point number).

■ You can load arbitrary waveforms from a variety of active time domain waveform sources: Channel 1 - 4, Ref 1 - 4, MATH, digital channels D0 - D15.

■ The arbitrary waveform memory may be saved to and loaded from one of four arbitrary waveform memory locations. These may only be loaded to the active arbitrary waveform. You cannot save them to files or recall them directly to the arbitrary waveform memory locations.

NOTE. Loading from digital waveform sources will use the main waveform record. MagniVu records are not supported.

NOTE. Load impedance scales the vertical settings to show what the load would see based on the load impedance. Since the AFG is a 50 Ω source, for most accurate operation, set the load impedance to 50 Ω and set the input channel to 50 Ω.

NOTE. Noise range is reduced above 50% of the function Maximum Amplitude according to the function:

Noise Percent Maximum = 100.0 * (Maximum Amplitude / Amplitude – 1.0)