

# Troubleshooting Your Design

with the TDS3000C Series Oscilloscopes





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# Getting Started

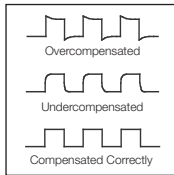
To optimize your measurements, it is important to start at the beginning – by compensating your probes and returning your oscilloscope to a known state.

To compensate your probe, follow these simple steps:

1. Connect the probe to channel 1.
2. Attach the probe tip and reference lead to the **Probe Comp** connectors. If using the probe hook-tip, ensure a proper connection by firmly twisting the tip onto the probe.

3. Push **Autoset**.

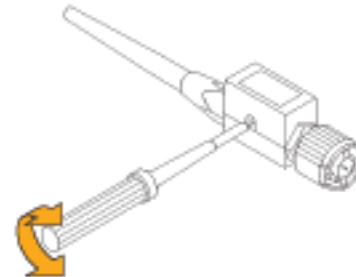
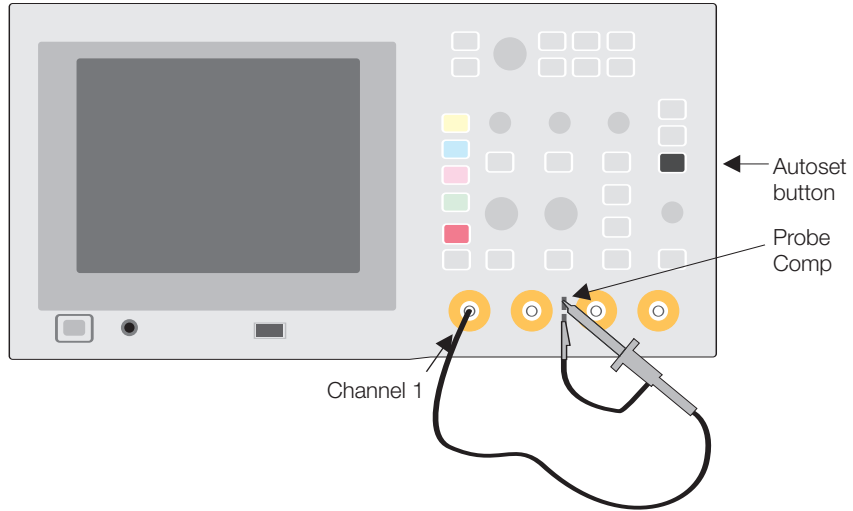
4. Check the shape of the displayed waveform to determine if your probe is compensated correctly.



5. If necessary, adjust your probe. Repeat as needed.

To return your oscilloscope to a known state, follow these simple steps:

1. Press the front panel **Save/Recall** menu button.
2. Press the **Recall Factory Setup** bottom screen menu button.
3. Press the **OK Confirm Factory INIT** side screen menu button.
4. Press the front panel **Autoset** button.



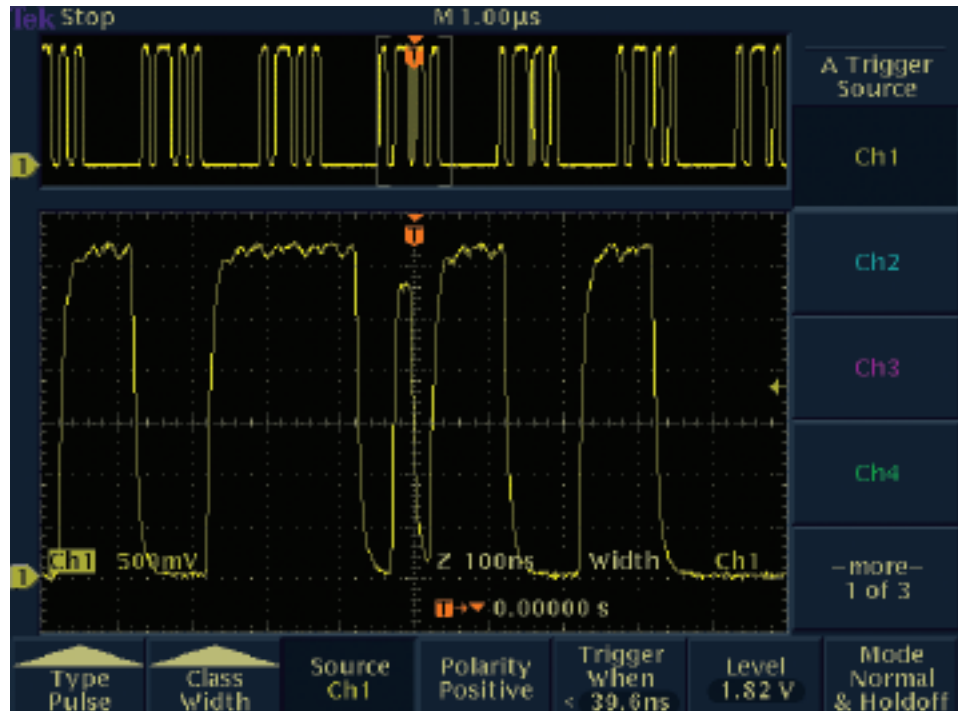
Adjusting Probe P6139A

## Debug Digital Timing Problems

Digital designers need to quickly find and analyze a wide range of circuit timing problems. For example, race conditions and transients can cause circuits to perform inaccurately. The TDS3000C Series' pulse width trigger can help troubleshoot such situations by triggering when a signal pulse width is less than, greater than, equal to or not equal to a specified pulse width.

To use the pulse width trigger to capture a glitch:

1. In the **Trigger** section, press the **Menu** button.
2. In the bottom menu, press **Type** until **Pulse** is selected.
3. In the bottom menu, press **Class** to select **Width**.
4. Select, as desired, **Source**, **Polarity**, **Trigger When**, **Level** and **Mode & Holdoff**.



# Debug Rise Time and Fall Time Problems

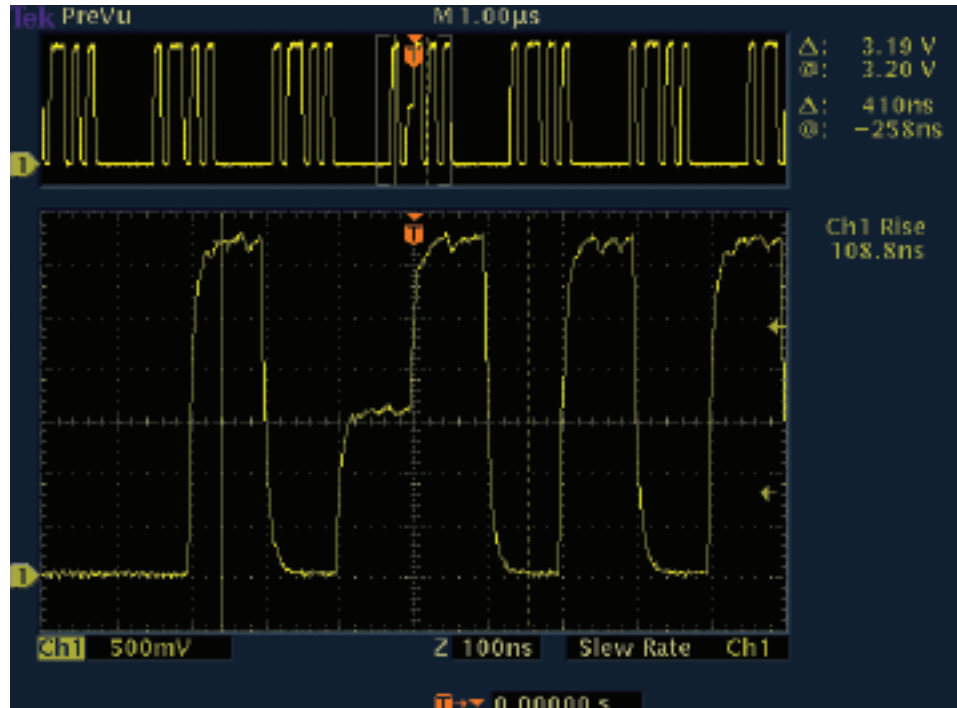
Both analog and digital electronics designers face problems related to slow edges (the rate of change of volts over time), as measured by the rise or fall time. The signal's edge speed, known as the slew rate, can affect the operation of digital bus transceivers, transmission lines and op-amp circuits. The TDS3000C Series' slew rate trigger can help troubleshoot such situations by capturing waveforms where the slew rate is less than, greater than, equal to, or not equal to a specified rate. Automatic measurements can supply supporting data.

## To use the slew rate triggers:

1. In the **Trigger** section, press the **Menu** button.
2. In the bottom menu, press **Type** until **Pulse** is selected.
3. In the bottom menu, press **Class** to select **Slew Rate**.
4. Select, as desired, **Source**, **Polarity**, **Trigger When**, **Thresholds**, and **Mode & Holdoff**.

## To run automatic measurements:

1. Press the front panel **Measure** button.
2. Press the **Select Measurement** bottom menu button.
3. Select the desired measurements from the side menu.

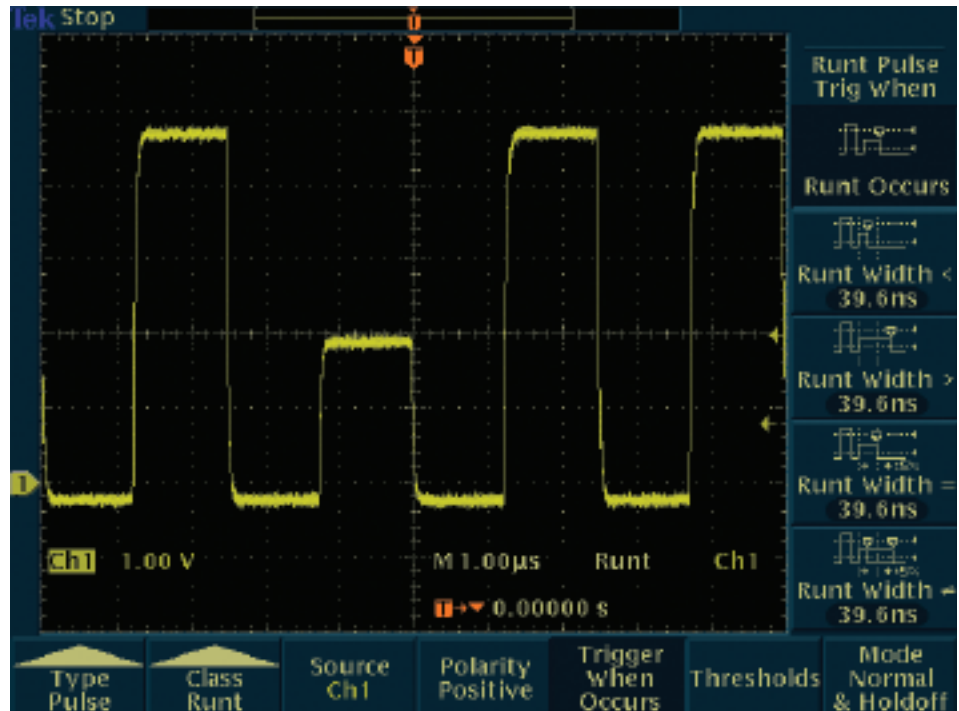


## Debug Threshold Problems

Digital designers must quickly find and analyze bus contention and other threshold problems. The runt pulse trigger is useful to troubleshoot such situations. A runt pulse is an illegal digital signal that re-crosses a first threshold level before crossing a second threshold level. A positive runt pulse is a signal that first re-crosses the low threshold level; a negative runt pulse is a signal that first re-crosses the high threshold level.

To use the runt pulse triggers:

1. In the **Trigger** section, press the **Menu** button.
2. In the bottom menu, press **Type** until **Pulse** is selected.
3. In the bottom menu, press **Class** to select **Runt**.
4. Select, as desired, **Source**, **Polarity**, **Trigger When**, **Thresholds**, and **Mode & Holdoff**.

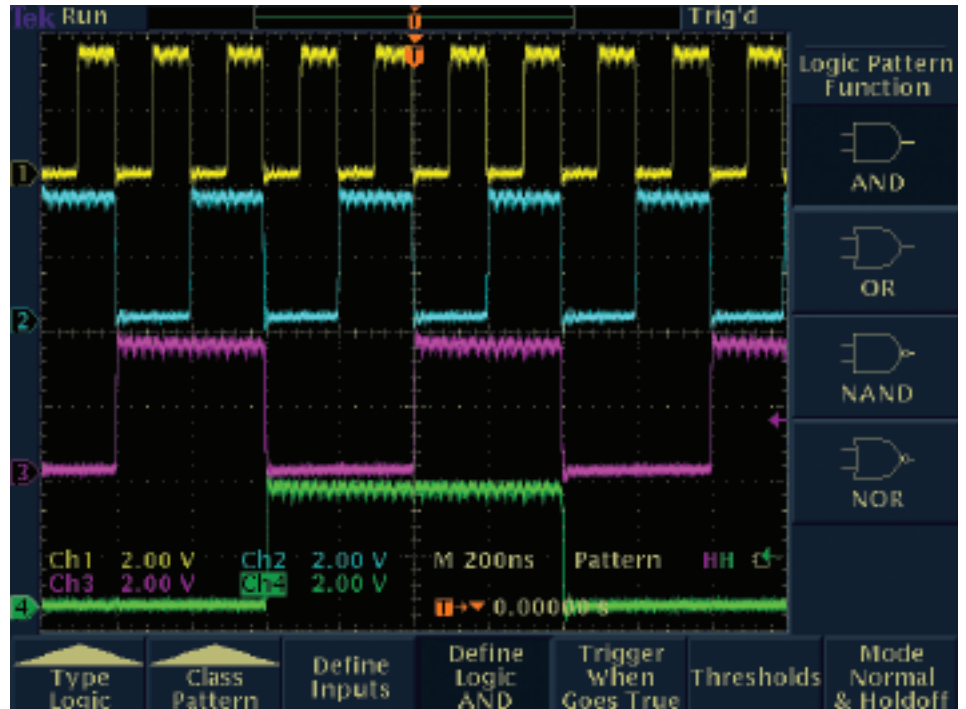


# Debug Digital Logic Problems

Digital designers must troubleshoot logic conditions on digital circuits. They may need to determine what happens when, or if, two signals meet a Boolean trigger condition. They may want to evaluate conditions when two signals become logically true or false, such as from the output of a two-input AND, OR, NAND, or NOR logic gate. When troubleshooting digital logic synchronous state machines, designers may want to determine if a state signal is true or false at the time a clock signal transition is true. The TDS3000C Series' logic triggers, such as its pattern and state triggers, can be used to tackle these problems.

## To use these logic triggers:

1. In the **Trigger** section, press the **Menu** button.
2. In the bottom menu, press **Type** until **Logic** is selected.
3. In the bottom menu, press **Class** to select either **Pattern** or **State**.
4. Select, as desired, **Inputs**, **Trigger When**, **Thresholds**, and **Mode & Holdoff**.
5. For pattern triggers, also define whether to trigger on **AND**, **OR**, **NAND**, or **NOR** conditions.





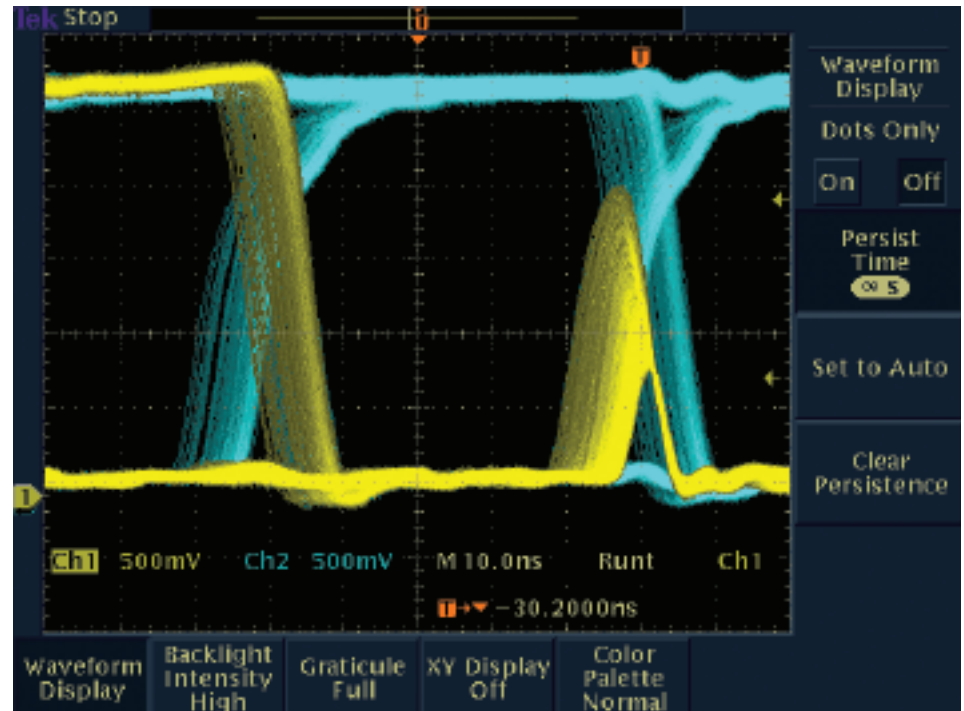
## Capture Elusive Glitches and Waveform Anomalies

In today's high-speed digital designs, elusive glitches and random anomalies can cause circuits to fail. The TDS3000C Series speeds anomaly detection with its digital phosphor technology and patented WaveAlert waveform anomaly detection feature.

The TDS3000C Series employs digital phosphor technology to capture and display infrequent waveforms or waveform variations. Its real-time intensity-grading provides you with information about the frequency of occurrence of signal amplitudes and widths, making it easier to understand the characteristics of the transients you've captured.

To fully utilize the TDS3000C Series' digital phosphor technology:

1. Press the **Display** button to show the display menu.
2. Press **Waveform Display** on the bottom menu.
3. Confirm that **Persist Time** on the side menu is set to **Auto**.
4. Press the **Clear Persistence** side menu button.
5. As desired, select the **Backlight Intensity** and **Graticule** settings.
6. As desired, rotate the **Waveform Intensity** front panel knob to adjust the persistence of the anomalous waveform.

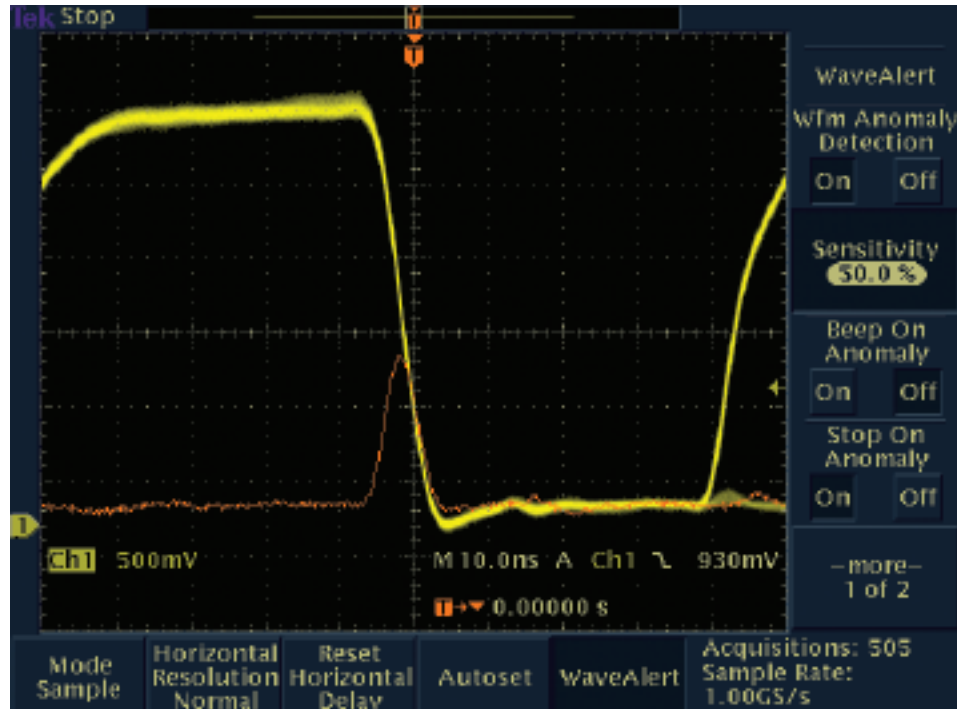


## Capture Elusive Glitches and Waveform Anomalies (continued)

The TDS3000C Series' WaveAlert waveform anomaly detection feature speeds your troubleshooting task by helping you find elusive problems faster. WaveAlert monitors the incoming signals on all channels and will detect and highlight any waveform that deviates from the "normal" waveform being acquired. You have full control over how sensitive WaveAlert is to changes, and you can select from several actions for the oscilloscope to take when it finds a problem – stop the acquisition, sound a beep, print the problem waveform and/or save the problem waveform to disk.

To use the WaveAlert waveform anomaly detection feature:

1. Display the waveform on the screen.
2. Press the **Acquire** front panel menu button.
3. Press the **WaveAlert** menu button.
4. Press the **WFM Anomaly Detection** side menu button to select **On**.
5. Press the **Highlight Anomalies** button to select **On**.
6. Rotate the general-purpose knob to set the comparison sensitivity value.
7. Use the **Waveform Intensity** front panel button to adjust the persistence of the anomalous waveform.

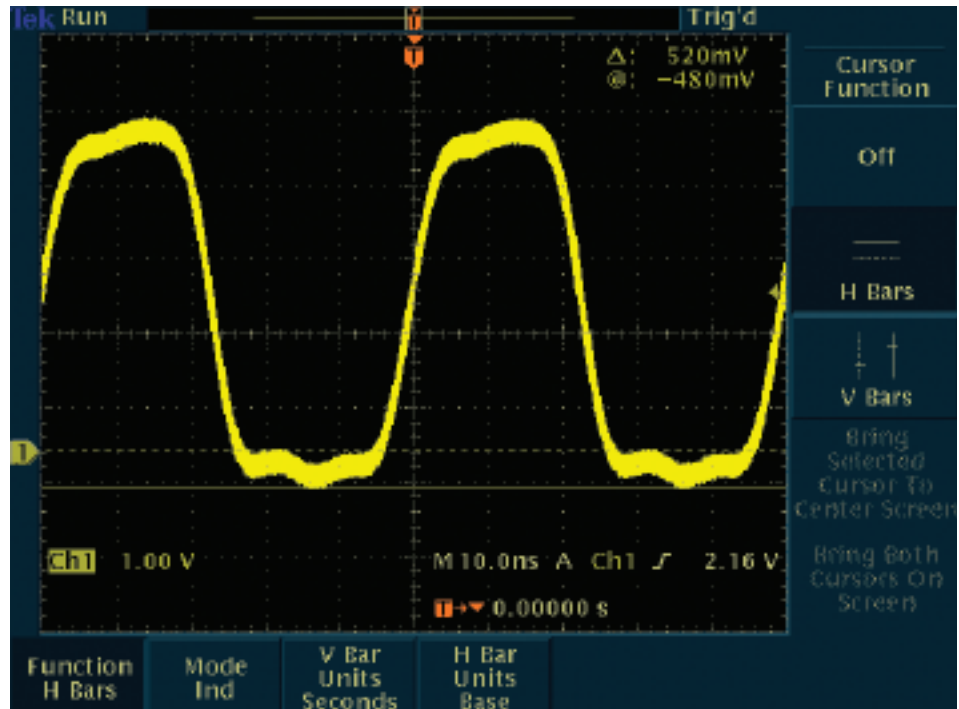


## Checking Signal Integrity

Electronics engineers may discover that a wide array of unintentional electrical events will make a difference in how circuits function in the real world. To characterize these events, engineers can measure criteria such as overshoot, ringing, ground bounce, cross talk, and other signal integrity issues. The TDS3000C Series' cursors and automatic measurements can be used to take such measurements.

### To make signal integrity measurements using cursors:

1. Press the **Cursor** button.
2. Press the **Function** menu button.
3. Press the **H Bar Units** (or **V Bar Units**) menu button to select **H Bar** (or **V Bar**) cursors.
4. Place one cursor, as desired, using the general-purpose knob.
5. Press the **Select** button.
6. Place the other cursor, as desired, using the general-purpose knob.
7. View the measurement (between cursors, or absolute) on the upper right corner of the display.



$\Delta$  readouts indicate the difference between the cursor positions.

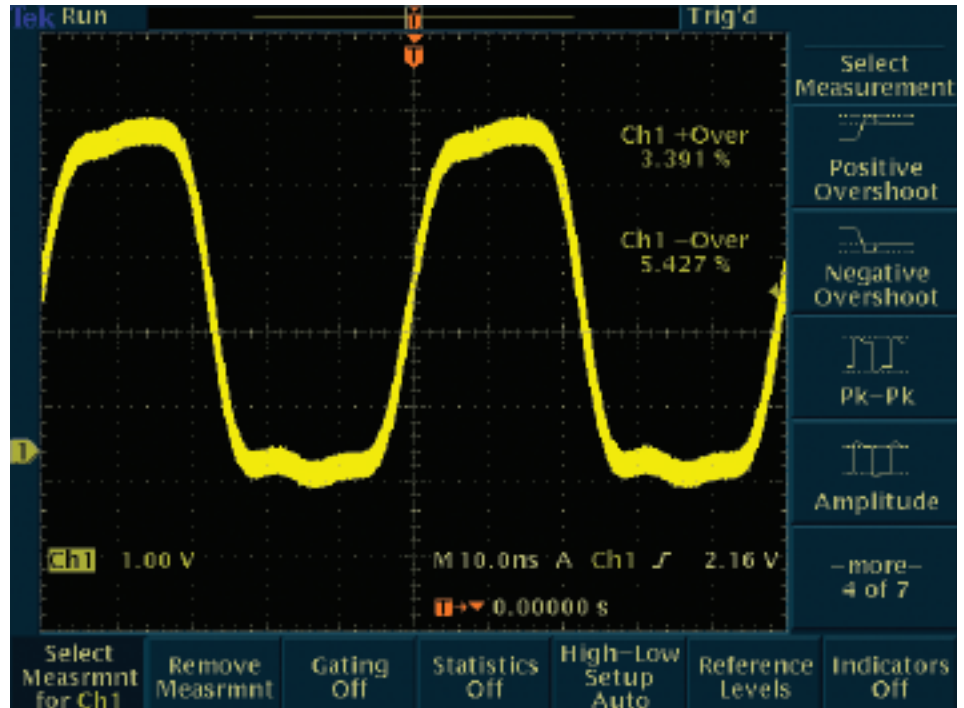
For H Bar cursors, @ readouts indicate the location of the active cursor relative to zero volts.

For V Bar cursors, @ readouts indicate the location of the active cursor relative to the trigger point.

## Checking Signal Integrity (continued)

To make signal integrity measurements using automatic measurements:

1. Press the **Measure** front panel button.
2. Press the **Select Measurement** bottom menu button.
3. Press the **More** side menu button until you find the desired measurements. In this example, look for the positive and negative overshoot measurements.
4. Select **Positive Overshoot** and **Negative Overshoot** from the side menu buttons.
5. View the measurements selected on the right side of the display.



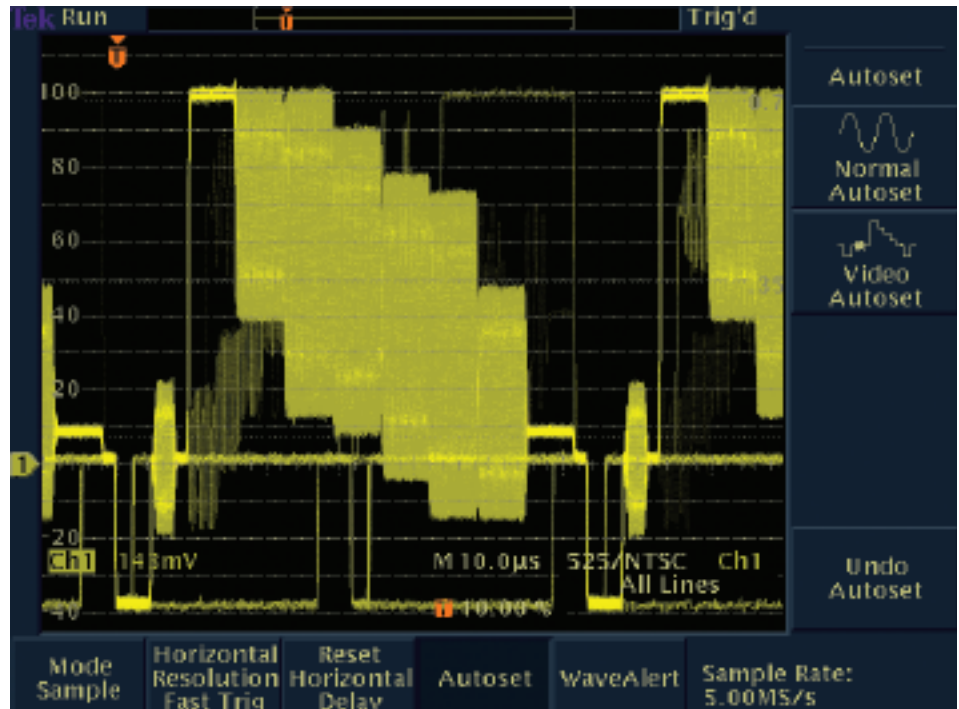
## Test for the Presence of Video Signals

Video technicians must perform a quick check for the presence of a video signal at different test points. If the site is in the field, technicians will need lightweight, portable test equipment gear that they can easily carry to each location. The TDS3000C Series, with its optional battery-powered operation and video trigger features, make this oscilloscope a valuable tool for these technicians.

To use the TDS3000C Series' video trigger to quickly check for the presence of a video signal:

1. Connect the oscilloscope to the video signal using proper adapters and a 75  $\Omega$  terminator, if necessary.
2. Press the **Acquire** menu button.
3. Press the **Autoset** bottom button.
4. Press the **Video Autoset\*** side button. If a broadcast-standard video waveform is present, the oscilloscope will display a stable video waveform that is triggered on all lines.
5. Adjust vertical position and scale as desired.
6. If desired, reconnect the oscilloscope to other test points. You do not need to change any oscilloscope settings.

\*TDS3VID or TDS3SDI video application modules required.  
Otherwise, video triggering must be set up manually.



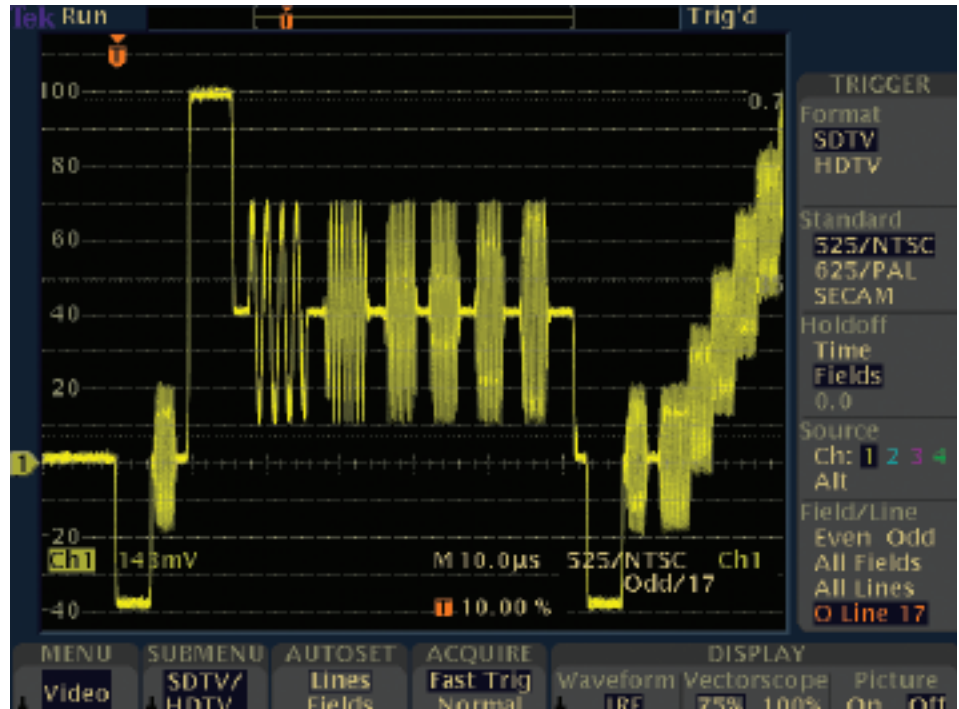
## Test Each Line of a Video Signal

Video technicians may need to check one or more video lines. They may need to search for defective pixels in a Charge-Coupled Device (CCD) video camera. The TDS3000C Series' video triggers enable technicians to test each line of a video signal.

To use the TDS3000C Series' video trigger to check each line of a video signal:

1. Connect the oscilloscope to the video signal using proper adapters and a 75  $\Omega$  terminator, if necessary.
2. Press the **QuickMenu** button.
3. If needed, press the **Menu** bottom button to display **Video**.
4. Press the **Video Autoset\*** bottom button until **Lines** is displayed.
5. Press the **Field/Line** side button to select the proper line type. **Even** and **Odd** signify even and odd lines/fields, respectively. When viewing lines, **Autoset** will select **Fast Trig** for you.
6. If you have selected **Line** in **Field/Line** section, you can now rotate the general-purpose knob to examine each video line.
7. Adjust vertical position and scale as desired.

\*TDS3VID or TDS3SDI video application modules required.  
Otherwise, video triggering must be set up manually.



## Determine if this Video Signal is the Desired Video Signal

Video technicians want to determine if the displayed signal is the desired signal. Is it the news program or the sports program? With the TDS3000C Series, these technicians can make this determination by simply viewing a picture image of the video source.

To apply the TDS3000C Series' video trigger to determine whether or not the video signal is the desired signal by using the video picture mode:

1. Press the **Display** menu button.
2. Press the **Video Picture** menu button.
3. Press the **Picture** menu button to select **On**.

TDS3VID or TDS3SDI video application modules required.



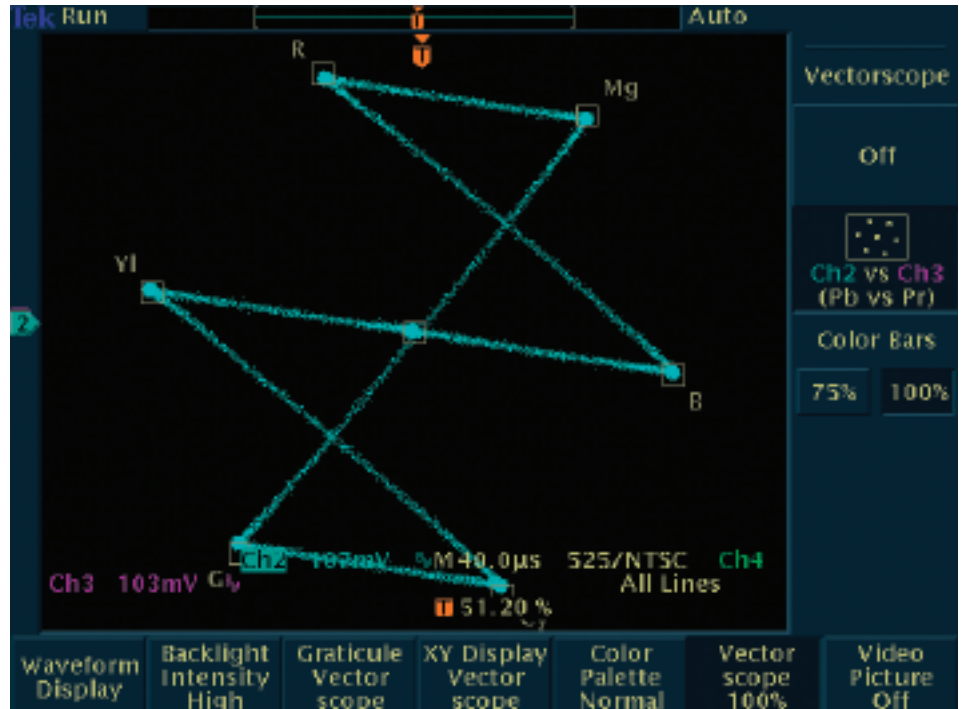


## Check Video Color Signals

Video technicians need to check for chroma (color) level problems and to adjust video equipment to solve any such problems. The TDS3000C Series can function as a vectorscope with built-in graticules for 100% or 75% color bars to enable these technicians to measure chroma levels and view color signal phase and amplitude problems.

To use the TDS3000C Series' vectorscope mode:

1. Connect the Y' signal to Ch1, the P'b signal to Ch2, and the P'r signal to Ch3.
2. Press the **Display** front panel button to show the display menu.
3. Press the **Vector Scope** bottom menu button.
4. Press the **Ch2 vs. Ch3 (P'b vs. P'r)** side menu button.
5. To scale and place the image, adjust the front panel **Vertical Scale** and **Vertical Position** knobs as desired with Ch2 (horizontal) and Ch3 (vertical) selected.
6. To more accurately scale and position the vector display, press the **Vertical Menu** front panel button and the **Fine Scale** bottom button, and rotate the general-purpose knob.



TDS3VID or TDS3SDI video application modules required.



## Check the Quality of a Communications Signal

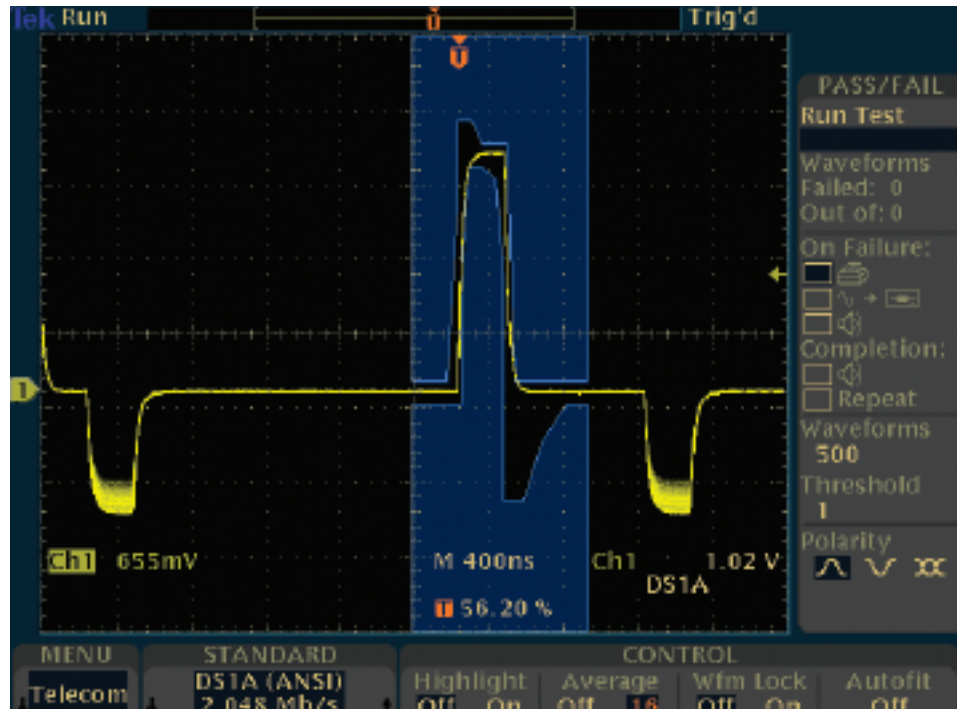
Communications engineers and technicians must test the quality, or performance, of a communications signal. Intense time-to-market pressures require that they do so quickly and efficiently. The TDS3000C Series, with its mask testing capability, constellation diagrams and eye diagrams, is an ideal tool for these developers.

Manufacturing engineers in a telecommunications environment may need to compare the actual performance of equipment on the production line with “masks” of telecommunications standards. The TDS3000C Series’ mask testing capabilities make this oscilloscope an ideal test tool for these manufacturing engineers.

To use the TDS3000C Series’ pass/fail mask testing capabilities:

1. Press the **QuickMenu** front panel button.
2. Press the **Menu** bottom menu button to display **Telecom**.
3. Press the two **Standard** buttons to select and display a mask.
4. Press **Autoset** to position the waveform in the mask and adjust the gain and position settings as necessary.
5. Press the bottom and side menu buttons to set test and pass/fail parameters.
6. Press the **Run Test** side button to run pass/fail testing.

Requires TDS3TMT telecommunications mask testing module.

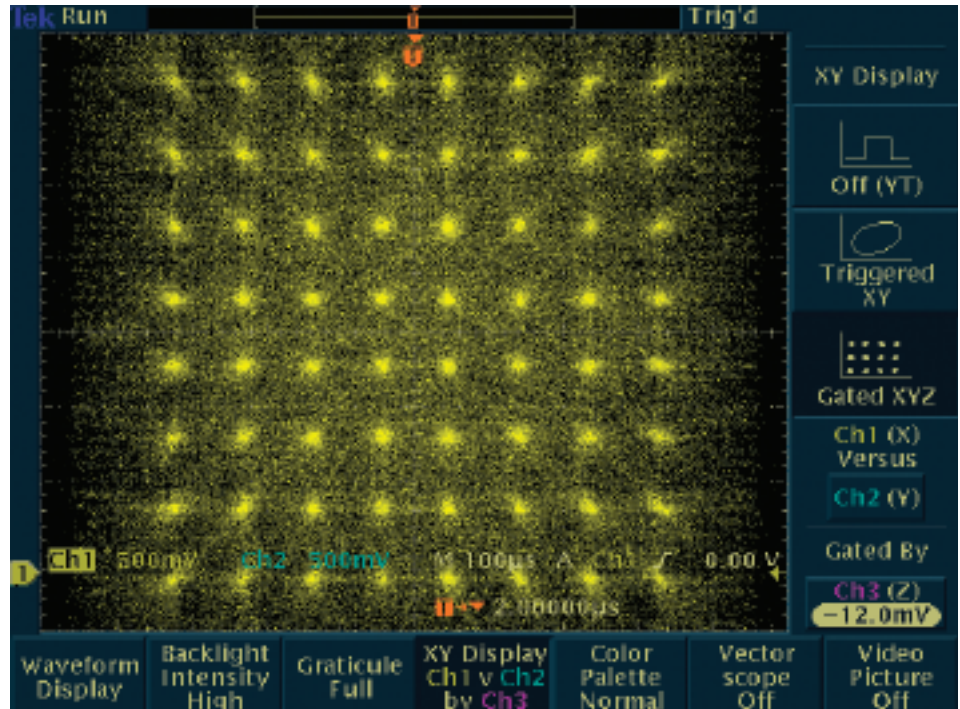


## Check the Quality of a Communications Signal (continued)

Some communications signals are encoded in a Quadrature Amplitude Modulation (QAM) format. To test the distortion of such a signal, engineers can use the TDS3000C Series to generate a constellation diagram and analyze the clarity of the signal's amplitude and phase at discrete times in the diagram.

To obtain a constellation diagram using the TDS3000C Series oscilloscope:

1. Connect the three signals to the oscilloscope using proper probe techniques.
2. Press the front panel **Display** button.
3. Press the bottom **XY Display** menu button.
4. Press the side **Gated XYZ** menu button to select the Z (gate) source channel.
5. If needed, press the side Ch1 (x) Versus menu button to select the Y signal (Ch2 is the default).
6. Press the side **Gated By** menu button to select the Z (gate) source channel.
7. Rotate the general-purpose knob to enter a value.
8. To properly place and scale the image, adjust the **Vertical Scale** and **Vertical Position** with Ch1 (horizontal) and Ch2 (vertical) selected.

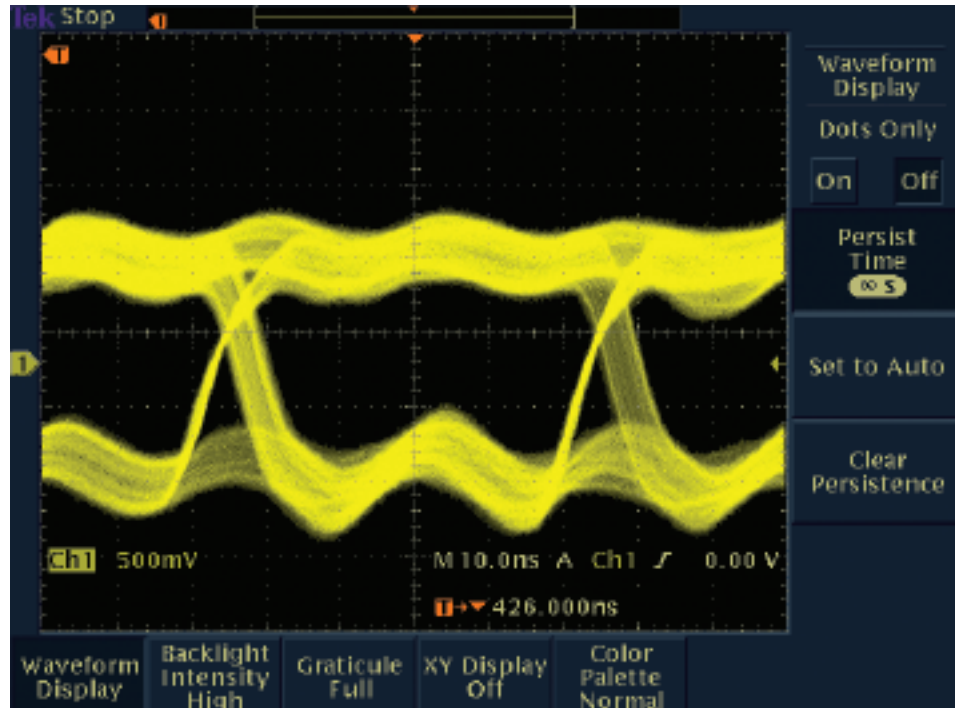


## Check the Quality of a Communications Signal (continued)

Communications technicians must characterize how well a communications signal complies with international standards by determining if the signal's bits are accurately crossing the communications channel. The TDS3000C Series allows these technicians to check the quality of a communications signal using eye diagrams.

To use an eye diagram to check the quality of a communications signal:

1. Press the front-panel **Autoset** button.
2. As desired, adjust the **Horizontal Scale** to adjust the width of the eye.
3. Adjust the front-panel **Horizontal Delay** to view both the positive and negative transitions at the same time.

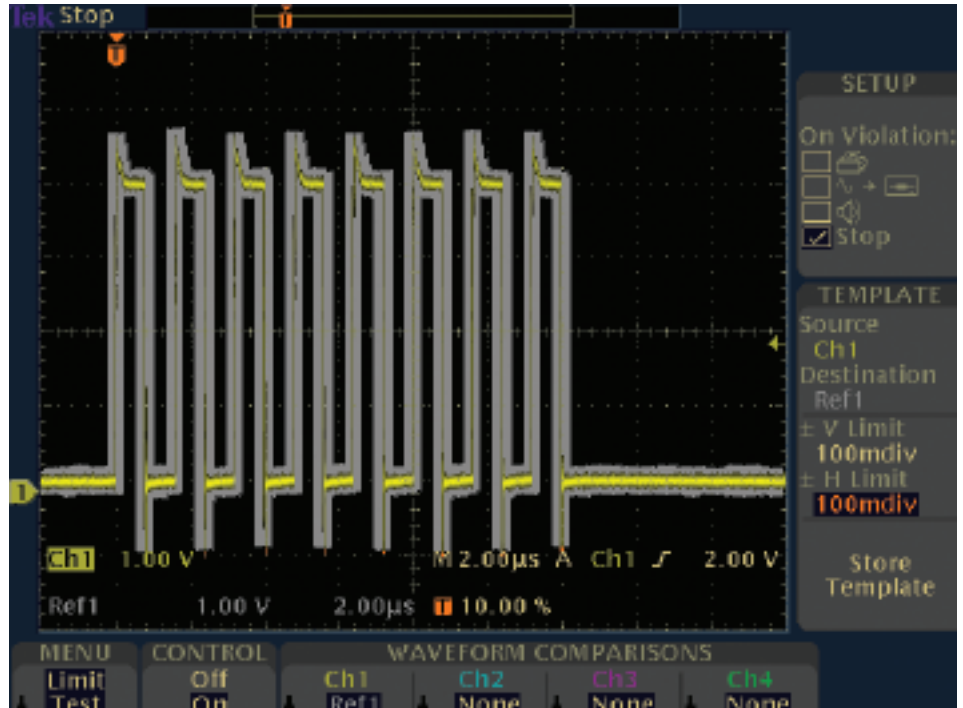


## Make a Quick Pass/Fail Test of a Device-under-test (DUT)

Manufacturing engineers often perform repetitive tests in which they desire quick pass/fail decisions on a DUT. The TDS3000C Series offers quick pass/fail, or limit, tests by comparing active signals of a DUT with template envelope waveforms of a known good device. The oscilloscope can be set up to stop the acquisition, sound a beep, print a hard copy or save the waveform to disk if any part of the active waveform strays outside the reference limits.

### To create a template for limit testing and perform a limit test:

1. Press the **QuickMenu** front panel button.
2. Press the **Menu** bottom button to select Limit Test.
3. Press the top two side menu buttons to select the **Setup On Violation** options.
4. Select the **Template Source** waveform and the **Template Destination** reference location.
5. Set the vertical and horizontal limits of the template waveform.
6. Store the limit test template.
7. Press **Ref** and select the specified reference memory to display the template.
8. Press **Control** to select **On** and start the test.



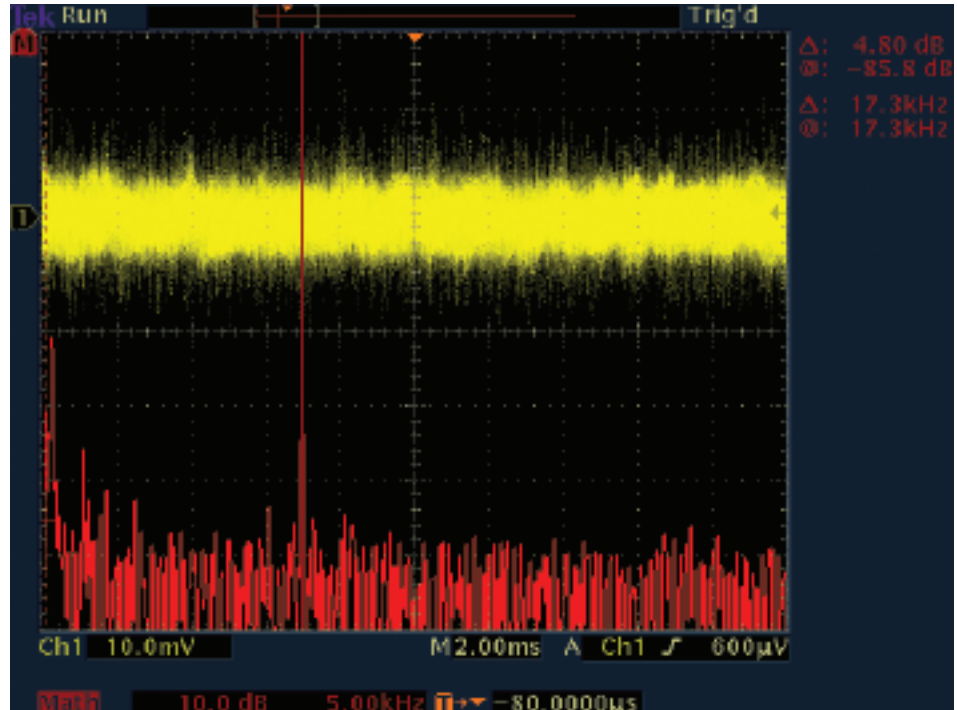
Requires TDS3LIM limit testing module.

## Look for Unintentional Circuit Noise

Developers need to check for unintended noise in their prototypes. To do so, developers can use advanced math, such as Fast Fourier Transform (FFT) displays. The FFT feature breaks down signals into component frequencies, which the oscilloscope uses to display a graph of the frequency domain of a signal, as opposed to the oscilloscope's standard time domain graph. Developers can then associate those frequencies with known system frequencies, such as system clocks, oscillators, read/write strobes, display signals, or switching power supplies. For example, switching power supplies can generate odd-order harmonics, which can enter the power grid and degrade designs. The TDS3000C Series offers a standard FFT feature, making it an ideal tool for these developers.

### To create and run an FFT measurement:

1. Press the vertical **Math** button.
2. Press the **FFT** button.
3. Select the signal source, vertical scale, and FFT window.
4. If desired, use the **Zoom** button along with the horizontal **Position** and **Scale** controls to magnify and position the FFT waveform.

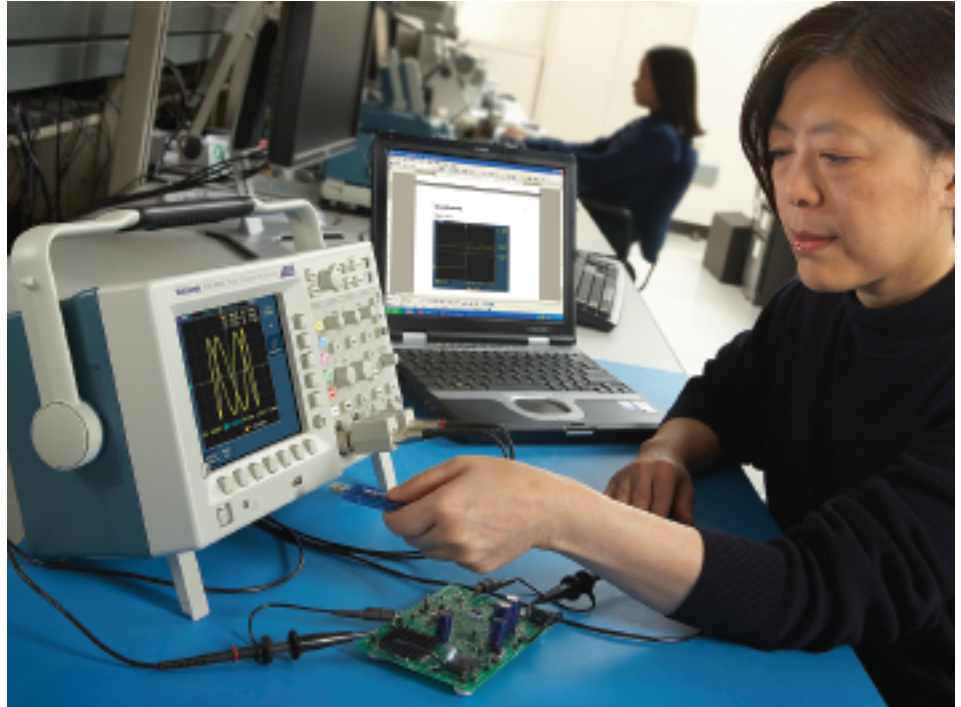


# Remote Troubleshooting Using Your Computer's Browser

A development team on one continent may need to troubleshoot a problem with a circuit board on the production line on another continent. A factory expert may need to personally supervise measurements by a field technician to troubleshoot a customer's problem. Or a team may need to remotely monitor equipment at off-site locations. The TDS3000C Series' unique e\*Scope web-based remote control feature enables these users to access any Internet-connected TDS3000C Series oscilloscope from a browser on workstations or PCs.

To connect your oscilloscope to the network from your PC or work station using the TDS3000C Series' e\*Scope feature, simply:

1. Connect your oscilloscope to the network with an Ethernet cable, or directly to your PC with a cross-over Ethernet cable.
2. Open your **Browser**.
3. In the browser field, enter the **IP Address** of the TDS3000C Series oscilloscope to which you wish to connect.
4. Press **Return**.
5. The browser program will load the oscilloscope's home page and will include an image of the screen's contents.



For more detail about the operation of the TDS3000C Series' e\*Scope feature, please refer to the application note, e\*Scope Remote Control Puts Network-Connected Oscilloscope on Your PC Desktop, located at [www.tektronix.com](http://www.tektronix.com).



