Troubleshooting Your Design

with the TDS1000B and TDS2000B Series Oscilloscopes

Tektronix

Enabling Innovation

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Troubleshooting Your Design with the TDS1000B and TDS2000B Series Oscilloscope

Today's engineers and technicians face increasingly complex and critical troubleshooting tasks. New digital designs often challenge designers with new problems to find: race conditions, transients, signal aberrations, bus contention problems, etc. And, of course, competitive time-to-market pressures dictate that troubleshooting must be completed quickly and accurately.

The TDS1000B and TDS2000B Series delivers the perform-ance, affordability and portability that enable engineers and technicians to tackle these challenges – quickly and easily. More than just a matter of basic bandwidth, these oscilloscopes enable users to solve problems quickly, helping them to establish that a problem exists, allowing them to capture the problem accurately, and enabling them to analyze it to determine the root cause.

The tips on the following pages are designed to further simplify your troubleshooting tasks. But if you need more help, there is plenty available. Simply contact your local Tektronix representative, authorized distributor, or visit www.tektronix.com/oscilloscopes

▶ 40, 60, 100, and 200 MHz models

▶ Up to 2 GS/s sample rate on all channels

▶ Built-in USB host and device ports standard

▶ Easy documentation and analysis with PC connectivity software

▶ Lifetime warranty*

* Limitations apply. For terms and conditions,
  visit www.tektronix.com/lifetimewarranty

Getting Started

To optimize your troubleshooting task at hand, it is important to start at the beginning – with proper probe compensation and attenuation, default setup, and automatic instrument setup.

PROBE COMP   AUTOSET button

Overcompensated

Undercompensated

CH 1

Compensated Correctly

P2220
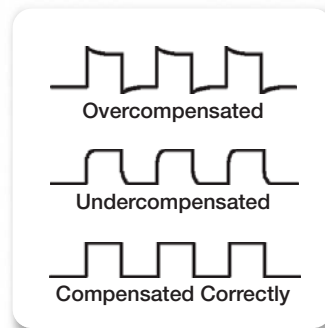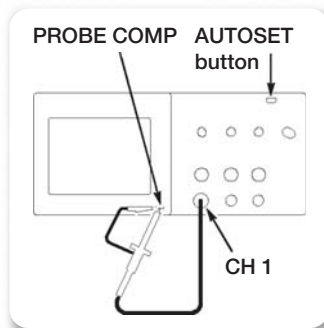
To properly compensate and attenuate your probe, follow these simple steps:

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 **PROBE CHECK**.

4. The oscilloscope will automatically check the probe attenuation and check the shape of the displayed waveform to determine if your probe is compensated correctly.

5. If necessary, it will instruct you to adjust your probe compensation.

To ensure that you begin with factory initialization settings, follow these simple steps:

1. Press the front panel **DEFAULT SETUP** button.

2. Press the front panel **AUTOSET** button.

Capture Elusive Glitches

In today's high-speed digital designs, elusive glitches and random anomalies can cause circuits to fail. While finding these glitches has never been easy, the TDS1000B and TDS2000B Series simplifies this task with its peak detect feature. Peak detect can capture narrow glitches, even on low-frequency signals.
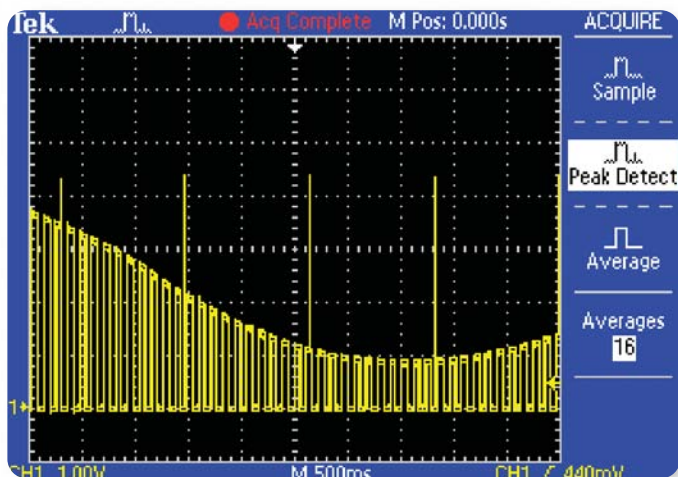

To use the Peak Detect feature:

1. Display the waveform on the screen.

2. Press the **ACQUIRE** front panel menu button.

3. Press the Peak Detect menu button.

4. Notice that the oscilloscope captures several very narrow glitches, even at slow sweep speeds. Without peak detect, you would not have seen many of these glitches.

Capture Elusive Glitches (continued)

Intermittent signal anomalies can also be a challenge to see. The TDS1000B and TDS2000B Series provides variable- and infinite-persistence display capabilities to provide you with information about the signal variations over time, making it easier to understand the characteristics of the transients you've captured.
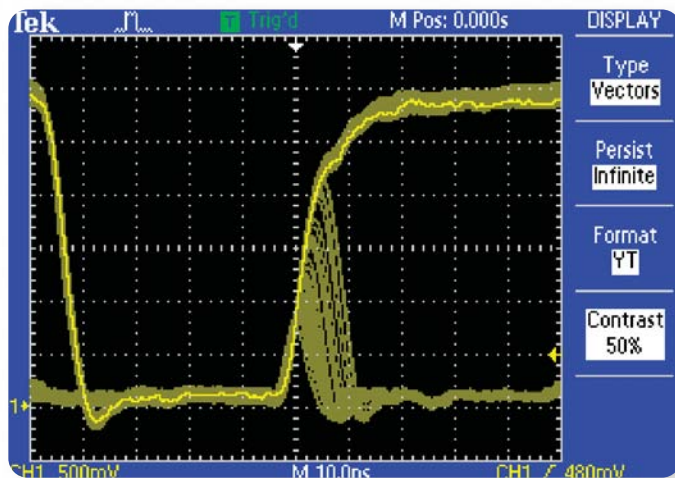

To use Display Persistence:

1. Display the waveform on the screen.

2. Press the **DISPLAY** front panel menu button.

3. Press the **Persist** menu button until the desired amount of persistence is selected.

4. Notice that the most recent signal is highlighted in the display. By monitoring the screen updates, you can judge the relative frequency-of-occurrence of the signal anomalies.

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 TDS1000B and TDS2000B 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.
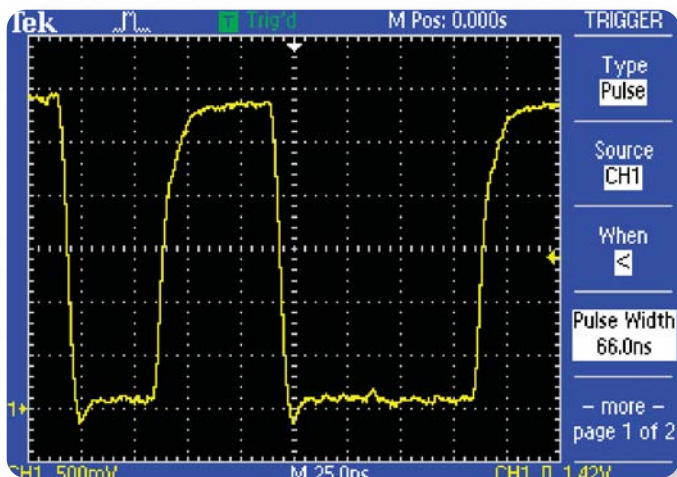

To use the pulse width trigger:

1. Press the **TRIG MENU** front panel button.

2. In the side menu, press **Type** until **Pulse** is selected.

3. Press the **When** side menu button until **<** is selected.

4. Use the multipurpose knob to set the desired minimum pulse width.

5. Select, as desired, **Source, Polarity, Mode, and Coupling**.

Verify Timing Relationships

Electronics engineers often need to verify that their circuits are working as designed. One of the most common types of oscilloscope measurements is timing measurements, such as pulse width, period, and frequency. The TDS1000B and TDS2000B Series' cursors can be used to make such measurements quickly and easily.
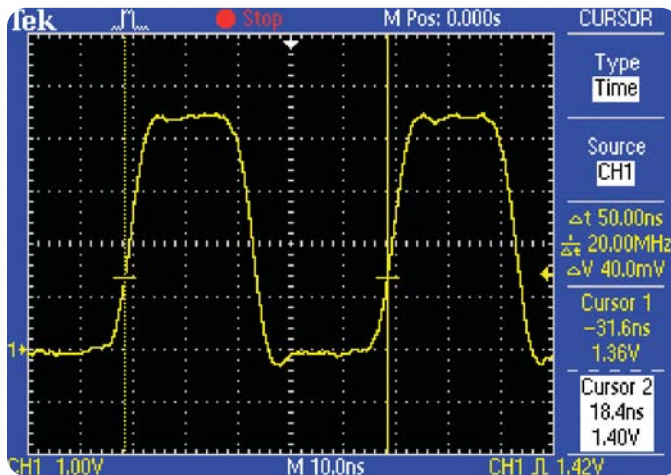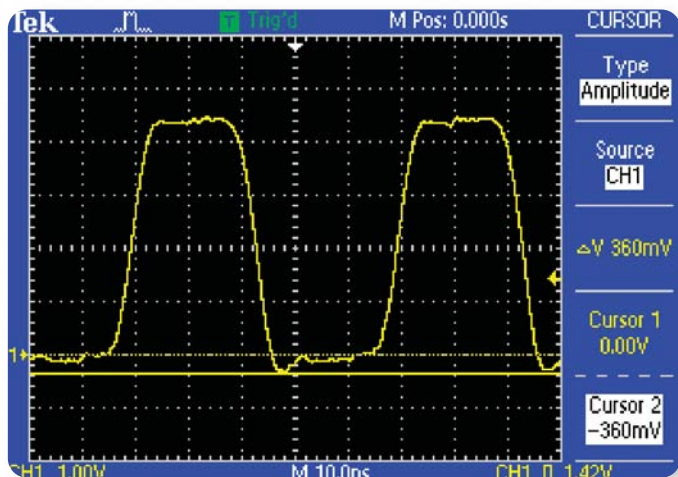

To make timing measurements using cursors:

1. Press the **CURSOR** button.

2. Press the **Type** menu button until the **Time** cursor type is selected.

3. Press the **Cursor 1** menu button.

4. To measure the timing relationship between two signals, place cursor 1 on the first edge of interest, using the multipurpose knob.

5. Press the **Cursor 2** button and place cursor 2 on the second edge of interest, at approximately the same Voltage.

6. The cursor readouts indicate the timing of the cursors relative to the trigger point. In this example, the Δt readout indicates the period of the waveform, and the 1/Δt is the frequency of the signal.

Check 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 TDS1000B and TDS2000B Series' cursors can be used to make such measurements.
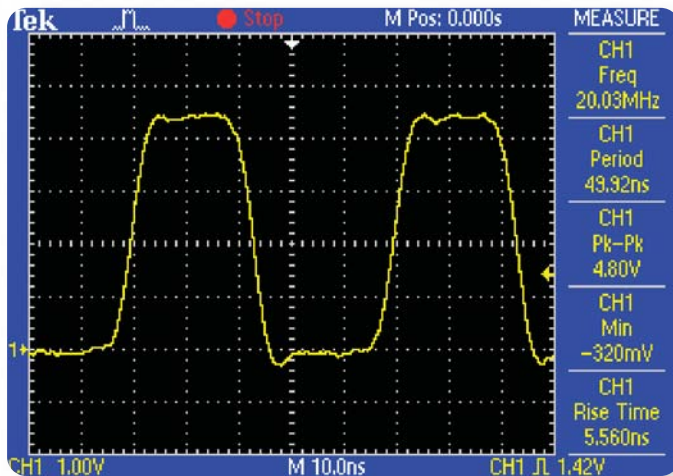

To make signal integrity measurements using cursors:

1. Press the **CURSOR** button.

2. Press the **Type** menu button until the **Amplitude** cursor type is selected.

3. Press the **Cursor 1** menu button.

4. To measure the peak ringing below ground, place cursor 1 at 0 Volts, using the multipurpose knob.

5. Press the **Cursor 2** menu button and place cursor 2 on the negative peak, using the multipurpose knob.

6. View the absolute Voltage measurements on the cursor readouts at the side of the display. The Δ readout indicates the difference between the cursor positions.

Check Signal Integrity (continued)

The TDS1000B and TDS2000B Series' automatic measure-
ment system can also be used to make such measurements
quickly and automatically.

**To make signal integrity measurements
using automatic measurement system:**

1. Press the **MEASURE** front panel button.

2. Press a **CH1** side menu button to add an automatic
   measurement.

3. Press the **Type** side menu button until you find the
   desired measurement, and then press **Back**.

4. Repeat steps 2 and 3 to select and display up to 5
   measurements.

5. View the selected measurements on the right side of
   the display.

Debugging Digital System Lock-up

One common cause of digital system lock-ups is an intermittent clock. The TDS1000B and TDS2000B Series trigger system can quickly and easily identify unexpected interruptions in the clock signal.
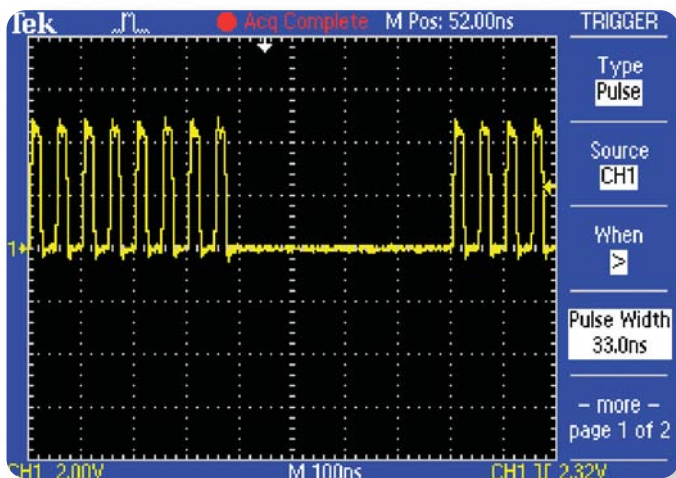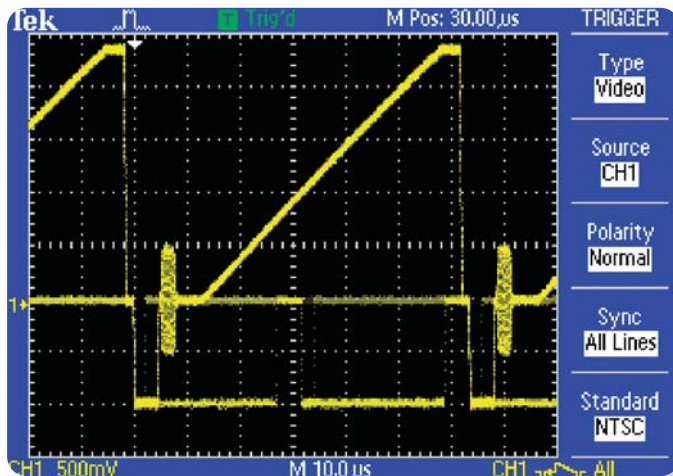

1. Press **TRIG MENU** front panel button.

2. Press **Type** side button until **Pulse** is selected.

3. Press **When** until **>** is selected.

4. Using the multipurpose knob, set **Pulse Width** to slightly longer than the clock pulse.

5. Press **–more–** and press Polarity until Negative is selected.

6. You can also adjust the **TRIGGER LEVEL** to capture low-amplitude or "runt" pulses.

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 TDS1000B and TDS2000B Series' video trigger features make this oscilloscope a valuable tool for these technicians.
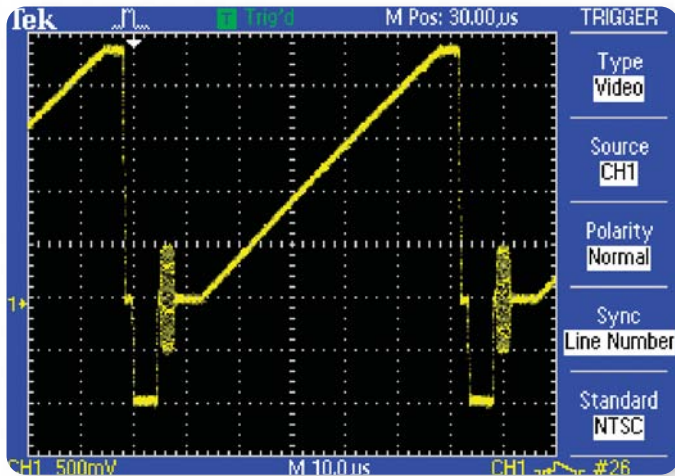

1. Connect the video signal to the oscilloscope using proper adapters and a 75 Ω terminator, if necessary.

2. Press the **AUTOSET** front panel button.

3. Press the **Line/Field** side button to select video line triggering. If a broadcast-standard video waveform is present, the oscilloscope will display a stable video waveform that is triggered on all lines.

4. To add some display persistence, press **DISPLAY** and press **Persist** to select the desired persistence.

5. Adjust vertical position and scale as desired.

6. To adjust trigger setup, press **TRIG MENU** and change **Source**, **Polarity**, and video **Standard**.

7. If desired, reconnect the oscilloscope to other test points. You do not need to change any oscilloscope settings.

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

TDS1000B and TDS2000B Series' video triggers enable technicians to test each line of a video signal.

1. Connect the video signal to the oscilloscope using proper adapters and a 75 Ω terminator, if necessary.

2. Press the **AUTOSET** front panel button.

3. Adjust vertical position and scale as desired.

4. Press the **TRIG MENU** button.

5. Press the **Sync** menu button until **Line Number** is displayed.

6. You can use the multipurpose knob to examine each video line.

Look for Unintentional Circuit Noise

Developers need to check for unintended noise in their prototypes. However, noisy signals can be difficult to analyze in the time domain, as shown below.
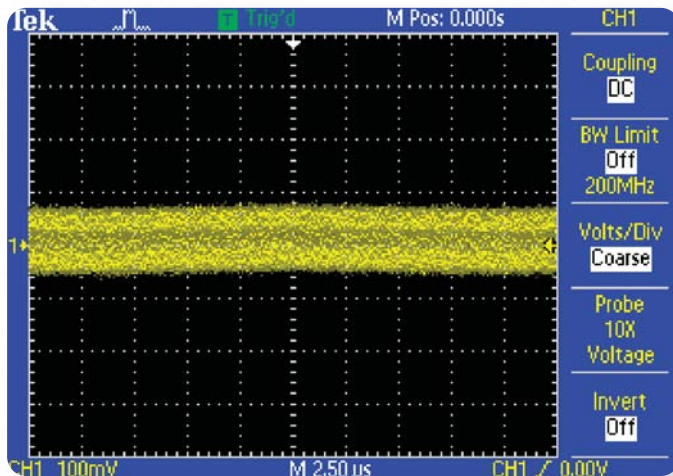
▶ Engineers and technicians can use the Fast Fourier Transform (FFT) to break down signals into component frequencies, which the oscilloscope uses to display a graph of the frequency domain of a signal, as opposed to the oscilloscope's standard time domain graph.

▶ Developers can then associate those frequencies with known system frequencies, such as system clocks, oscillators, read/write strobes, display signals, or switching power supplies.

Look for Unintentional Circuit Noise (continued)

The TDS1000B and TDS2000B Series offers a standard FFT feature, making it an ideal tool for these identifying sources of noise in a circuit. To create and FFT display:
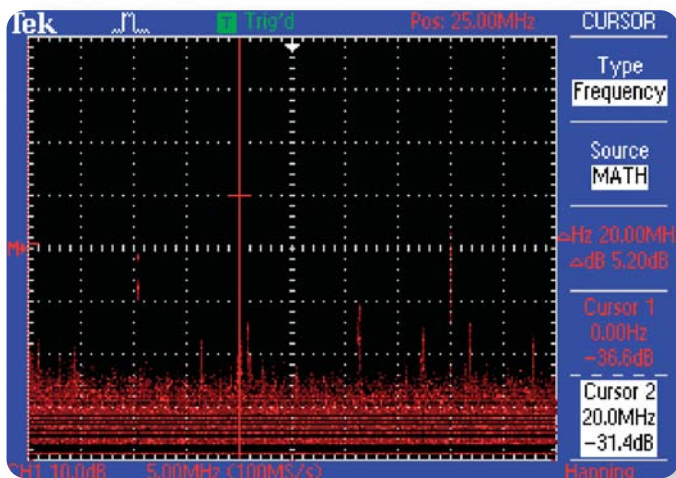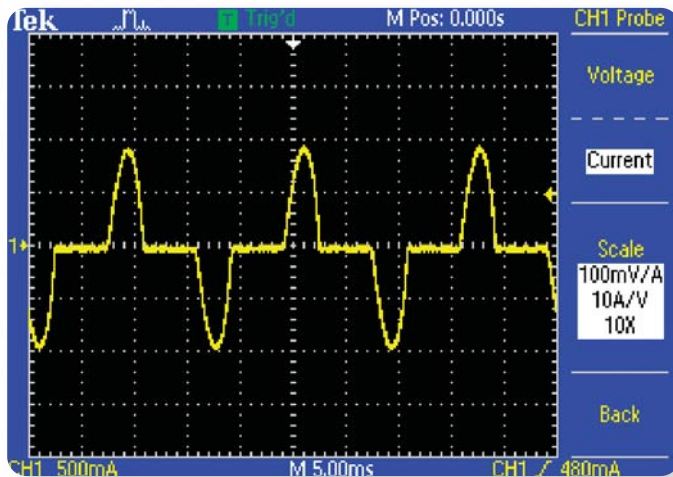

1. Press the front panel **MATH** button.

2. Press the **Operation** menu button until **FFT** is selected.

3. Press the **Window** menu button until the **Hanning** window is selected, which provides the highest frequency resolution.

4. If desired, use the vertical and horizontal **POSITION** and **SCALE** controls to magnify and position the FFT waveform.

5. Cursors can be used to accurately measure the FFT waveform. Press **CURSOR**.

6. Press the **Source** menu button until **MATH** is selected.

7. Press the **Type** menu button until **Frequency** is selected.

8. Press the **Cursor 1** menu button. Using the multipurpose knob, position cursor 1 at the left side of the display.

9. Press the **Cursor 2** menu button. Position cursor 2 on the highest point in the display.

10. The readout indicates one of the sources of noise. In this case, the 20 MHz signal is the system clock, which is coupling into the signal.

Power Line Harmonic Analysis

Power circuit designers often need to analyze the effects of their circuits on the power line. Although an ideal power supply would present a constant load on a power line, real power supply circuits do not, creating harmonics on the power line. The TDS1000B and TDS2000B provide simple tools to measure power supply currents and analyze the harmonics on a power line.


To display the power line harmonics on a current waveform:

1. Press the **CH 1 MENU** front panel button.

2. Press the **Probe** side menu button.

3. Press the **Current** side menu button to select current probe support.

4. Press the **Scale** side menu button to select the appropriate current probe scale factor.

5. Notice the readouts at the bottom of the display, where the waveform's vertical units are now in milliAmps (mA).

6. Press the **MATH** front panel button.

7. Press the **Operation** side menu button until **FFT** is selected.

8. Press the **Window** side menu button until **Flattop** is selected. This window is best for measuring amplitudes accurately.

Power Line Harmonic Analysis (continued)

The FFT display provides a frequency-domain display of the power line signal, including the fundamental power line frequency and the harmonics at integer multiples of the fundamental frequency. The TDS1000B and TDS2000B cursor measurements provide an easy and accurate way to analyze this complex display.
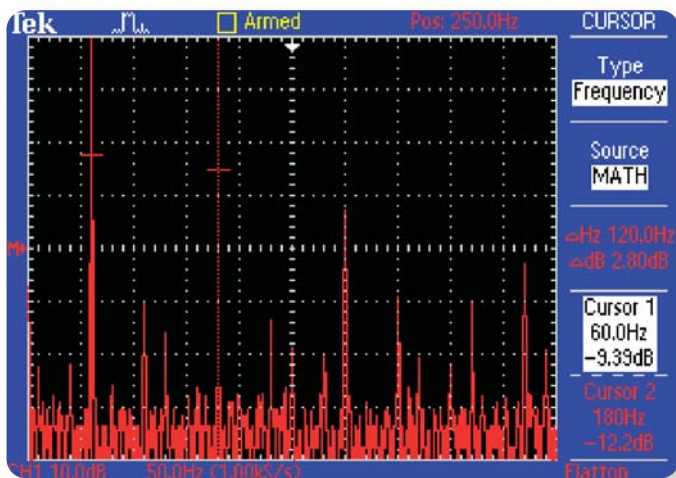

1. Press the **CURSOR** front panel button.

2. Press the **Source** side menu button until **MATH** is selected.

3. Press the **Type** side menu button until **Frequency** is selected.

4. Press the **Cursor 1** side menu button and use the multipurpose knob to align the cross-hair cursor on the left-most peak (the fundamental).

5. Press the **Cursor 2** side menu button and use the multipurpose knob to align the cross-hair cursor on the next-highest peak (the 3rd harmonic, in this case).

6. The readouts at the right of the screen indicated the absolute and relative frequencies and magnitudes.

Documenting Your Results with OpenChoice® Software

Design engineers in the lab and technicians in the field often need to document the work they do with their oscilloscope. They can save screen images to a removable memory device and then manually copy the files to their PC. The easy-to-use OpenChoice Desktop simplifies these documentation tasks by directly transferring screen images to your PC over USB.
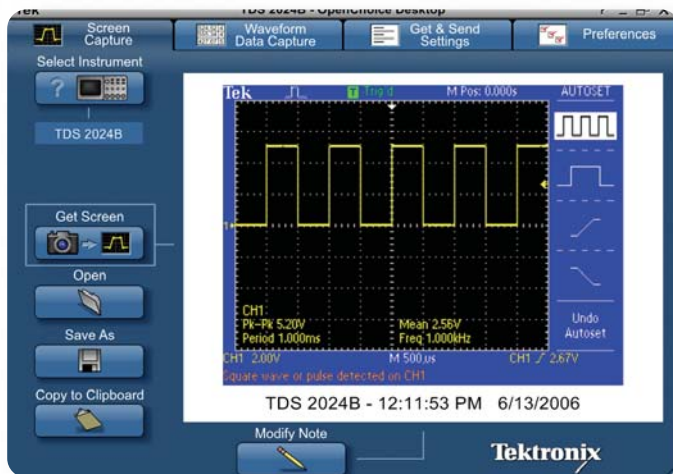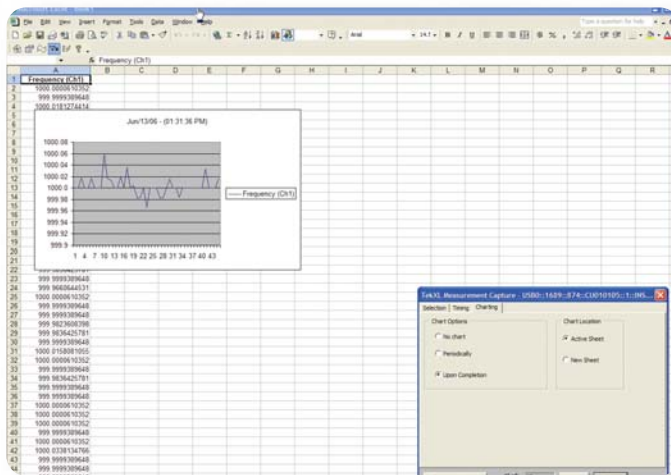

1. Acquire the signal.

2. Connect the oscilloscope to the PC using a USB cable.

3. Launch the **OpenChoice Desktop** program.

4. Click **Select Instrument**, choose the correct USB instrument, and click **OK**.

5. Click **Get Screen** to capture the screen image.

6. Click **Save As** to save the screen image to a file on the PC.

7. Click **Copy to Clipboard**. You can then launch your documentation program and paste the image into the document.

Waveform Measurements Logging

A common task for engineers and technicians is to make measurements on their oscilloscope and then manually record measurements to document circuit performance variations over time. However, this is time-consuming and can lead to inconsistent quality of documentation. The easy-to-use TekXL toolbar simplifies data gathering and documentation tasks inside Excel.
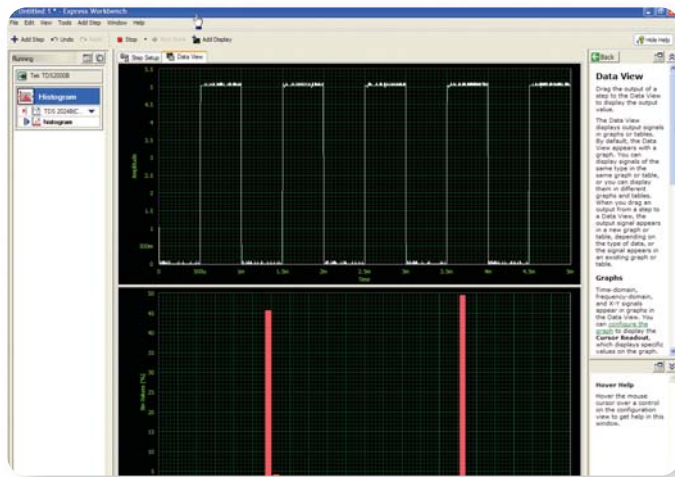

1. Acquire the signal.

2. Connect the oscilloscope to the PC using a USB cable.

3. Launch **Excel** and enable the TekXL toolbar by selecting **Tools ▶ Add-ins…** and checking the box next to **Tekxltoolbar.**

4. Press the **TekXL Connection** icon, select the desired instrument, and press OK.

5. Press the **TekXL Measurements** icon.

6. On the Selection tab, choose **Frequency**.

7. On the Timing tab, select **45** samples.

8. On the Charting tab, choose **Upon Completion**.

Waveform Analysis Using NI SignalExpress™ Tektronix Edition Software

Although the TDS1000B and TDS2000B provide significant on-board analysis capabilities, there are applications where the analysis requirements are better met with PC-based applications. SignalExpress Tektronix Edition provides advanced analysis capabilities with the ease of USB plug-and-play.

1. Acquire the signal.

2. Connect the oscilloscope to the PC using a USB cable.

3. Launch the **SignalExpress TE** program.

4. SignalExpress will open with the instrument automatically connected and transferring data to the PC.

5. To conduct a limit test of the signal against specified limits, select **Add Step ▶ Analog ▶ Test ▶ Limit Test**.

6. To display the histogram of the signal, select **Add Step ▶ Analog ▶ Time-Domain Measurements ▶ Histogram**.

For Further Information

Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit **www.tektronix.com**

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