TDS3000B DPO Keeps Pace with Changing Digital Troubleshooting Needs

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Digital circuits are everywhere...

Digital circuitry was once confined to expensive, high-end products. But today, digital circuitry is the mainstay of most electronic designs, used extensively in products from toys to household appliances to automobiles. But along with this wide-spread use has come new troubleshooting challenges which require powerful test equipment.

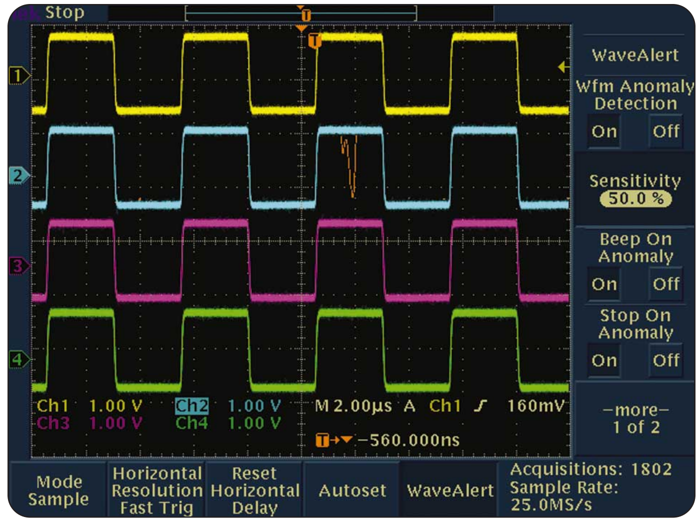
Today's engineers and technicians developing common consumer and industrial products face increasingly complex and critical troubleshooting tasks. New digital designs often confront designers with new problems to find: race conditions, transients, signal aberrations, bus contention problems, etc. And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

It's a scenario that calls for measurement and troubleshooting tools, particularly oscilloscopes, that can meet the challenges of new digital-intensive products. More than just a matter of basic bandwidth, these oscilloscopes must help the engineer solve problems quickly. In other words, they must first help the user establish that a problem exists, then capture the problem accurately, and then analyze it to determine the root cause.

The TDS3000B Digital Phosphor Oscilloscope (DPO) Family Eases Digital Troubleshooting

The TDS3000B digital phosphor oscilloscope (DPO) Family brings important new capabilities to the task of digital troubleshooting. The TDS3000B's digital phosphor technology gives it superior ability to acquire and accurately represent digital signals and intermittent faults with real-time intensity-graded detail, much like an analog oscilloscope. WaveAlert™, a patented waveform anomaly detection feature unique to the TDS3000B, further enhances your ability to find those elusive, intermittent events that are key to eliminating troubleshooting nightmares. WaveAlert monitors the incoming signal on all channels and alerts you to any waveform that deviates from the "normal" input. You have full control over how sensitive WaveAlert is to changes and you can select from several actions for the TDS3000B to take when it finds a problem:

- stop acquisition
- sound a beep
- print the problem waveform
- save the problem waveform to disk



▶ ***Figure 1.*** *WaveAlert waveform anomaly detection screen.*

The TDS3000B Family's bandwidth (models range from 100 MHz to 500 MHz) provides ample headroom for working with today's commodity microprocessors.

▶ The Technology Behind WaveAlert™ Waveform Anomaly Detection

The WaveAlert™ feature builds on a key feature of Tektronix' patented digital phosphor oscilloscope architecture; its ability to keep a running record of every pixel on the screen. Each pixel has a "history" that determines whether its intensity is sustained (If the trace passes through the pixel again), or dimmed with each successive acquisition. WaveAlert technology detects and highlights pixels *new* since the last acquisition, exposing anomalous events that might otherwise go unnoticed. The user determines the number of pixels that must be affected before WaveAlert technology responds.

Getting the signal to the oscilloscope is the first important step in any measurement. The TDS3000B carries its performance all the way to the unit-under-test by means of the versatile TekProbe® interface. The interface mates to a broad selection of active high-frequency probes, current and differential probes.

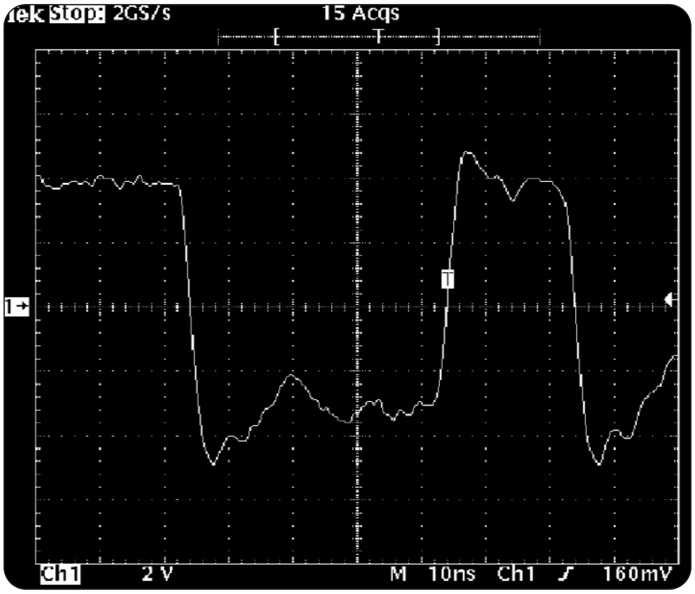
After discovering a digital design problem with the help of the DPO's real-time intensity grading, the engineer can use the TDS3000B's advanced triggers to isolate the fault and track down its origins. An optional user-installed module adds a wealth of advanced triggers to the TDS3000B, including runt triggers, state triggers, width triggers, and more.

To Solve a Problem, First You Need to See It

Many oscilloscopes lack the performance and features to stay abreast of digital evolution. Consider, for example, a common digital design problem: a narrow, occasional transient that affects circuit operation. The analog oscilloscope is unable to display it with sufficient brightness, and is prone to flickering; the (much brighter) main waveform obscures it. Moreover, the analog oscilloscope provides no means of storing and analyzing the waveform, or capturing the glitch alone. The digital storage oscilloscope (DSO) may capture the transient, but cannot display it in real-time distinctly from the main, repetitive waveform. The transient looks like it occurs as often as the main trace.

The TDS3000B DPO brings a new dimension to signal viewing with a digitizing oscilloscope. First, its waveform capture rate is 50 times faster than that of a DSO with comparable performance. This provides advantages when looking for transients. Its acquisition system is active much more of the time, so the DPO has hundreds of times more opportunities to capture glitches and infrequent events.

Secondly, the TDS3000B's real-time intensity grading exposes the details about the "history" of a signal's activity as they accumulate. The digital phosphor display makes it easier to understand the characteristics of the transients you've captured. It intensifies the areas where the signal trace crosses more frequently, much like an analog oscilloscope. An infrequent transient is dimmer than the main waveform that repeats continuously, yet it's still very visible and distinguishable. Changes are seen as they occur. Working with DPO, the TDS3000B's WaveAlert waveform anomaly detection feature makes finding those changes even easier.



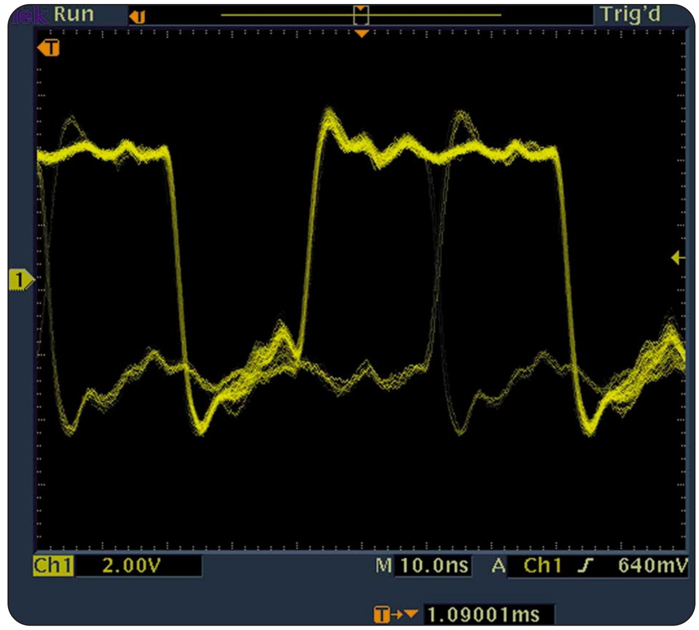
▶ ***Figure 2.*** *Typical DSO can only display one event at a time.*

Figure 2 shows a typical DSO display; compare this to the DPO display in Figure 3 which shows how intensity grading can help you understand what's going on in your circuit.

Extending DPO Performance to the Unit-Under-Test

An often-overlooked aspect of any digital measurement is the oscilloscope probe's effect on the signal. A properly-chosen probe is essential for high-speed measurements on digital circuits, since it minimizes circuit loading and ensures that the signal is not distorted by the probe itself.

As clock speeds and edge rates increase, ordinary passive probes begin to degrade the signal, adding overshoot to transitions, and slowing down edges. Moreover, passive probes can load down the circuit. "Problems" appear that aren't really problems at all, while the real problem – a glitch or a delayed edge – may go unnoticed.



▶ ***Figure 3.*** *DPO reveals what the signal really looks like.*

Often, the best solution is an active probe. An active, or FET, probe has a buffer circuit built into the tip to isolate the signal from the inductive and capacitive effects of the probe cable and oscilloscope input. Active probes require DC power, which is supplied directly by the TDS3000B's own probe interface.

The P6243 active probe is recommended for high-speed digital measurements with the TDS3000B oscilloscope. The P6243 provides a system bandwidth of 500 MHz when used with the TDS3054B. The TekProbe interface ensures correctly scaled readings from the P6243 and other compatible active probes. The P6243's ≤1 pF input capacitance keeps loading to a minimum, and its small physical size works well with tiny Surface Mount Devices (SMD).

Triggering Helps Isolate Offending Signals

A broad selection of triggering conditions is indispensable when troubleshooting. The TDS3000B offers an optional trigger set that supplements the oscilloscope's basic edge-triggering capabilities. Added triggering functions include State, Pulse Width, Runt Pulse, Slew Rate, and more. With the right trigger setup, you can quickly isolate a problem and perform root-cause analysis.

Race conditions are a common occurrence in new digital designs, especially as clock speeds increase and timing tolerances get more critical. One result of a race condition is a transient, a pulse that's much narrower than the normal data-carrying signals in the circuit. Most digital systems specify a minimum pulse width for valid data, and it's necessary to eliminate pulses narrower than the specifications. The TDS3000B *Pulse Width (PW) trigger* is a powerful tool for finding transients.

The PW trigger allows you to set source, polarity (slope), and level as explained above. In addition, it provides a "Trigger When" menu from which you select one of four timing conditions: Less Than (the specified pulse width), Greater Than, Equal, or Not Equal. Typically you will use the *Less Than* condition. When the oscilloscope triggers, it exposes the pulses that are narrower than the specification. Figure 4 shows a pulse of this type.

State triggering is ideal for tracking events that result (or should result!) from the occurrence of a "clock" pulse. State triggering helps you confirm that the data on synchronous signals is arriving in the proper sequence. The trigger system monitors two inputs: a "state," or data, input, and the clock (which doesn't have to be a clock pulse; just a transition that enables data to move into the device). In Figure 5, for example, the Write Enable (WE) signal is used as the "clock." The TDS3000B is set to trigger when Data is true (1) and Write Enable makes a transition from 0 to 1. Is Write Enable occurring when the

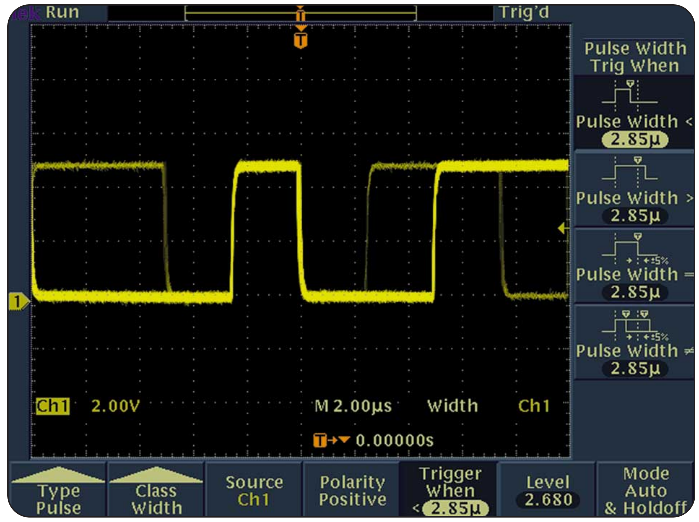


Figure 4. *Pulse Width triggering captures a pulse that is not wide enough to be a valid state.*

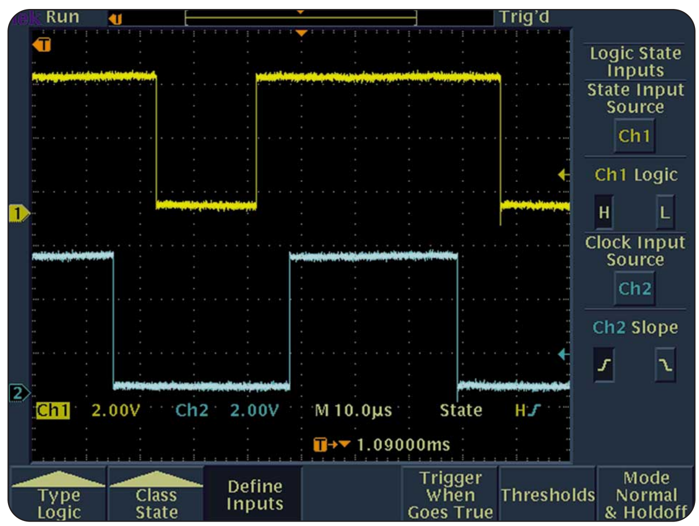


Figure 5. *State triggering confirms that this Write Enable signal (bottom) is occurring when data (top) is valid.*

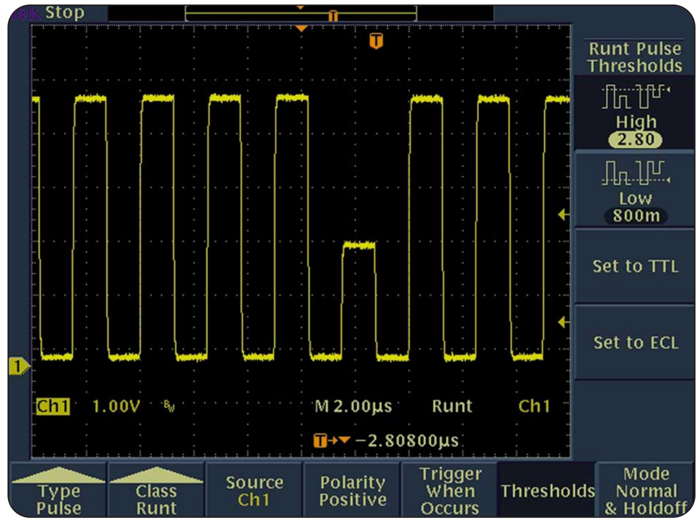
Data signal is valid? In this instance, yes. The arrival of Write Enable prompts the oscilloscope to check the Data input, which is found to be valid at the time of the WE transition. The instrument triggers and displays the two signals.

When two I/O devices are trying to send data across a bus at the same time, erratic conditions can result. One of the transmitters might try to force a "1" at the same time the other is driving a "0." A common effect of this bus contention is a "runt" pulse – a signal that is neither 1 nor 0, but somewhere in between. Unlike the logic problems described previously, the runt pulse is an amplitude problem, not a timing problem.

The TDS3000B's *Runt Pulse* trigger detects attenuated signals immediately. It looks for a pulse that crosses the first of two threshold levels but fails to cross a second threshold. Imagine, for example, setting up to detect a bus contention problem on a GPIB bus. The first threshold is set at 800 millivolts, the second at 2.80 volts. The thresholds can be set to detect either positive-going or negative-going pulses. Pulse width conditions can also be specified. Figure 6 depicts the resulting screen capture. With this triggering method, it's possible to trigger on the bad pulse and use a second channel to track down the logic conditions that caused it.

Voice Control for Critical Measurements

Simultaneously probing multiple measurement points on fine-pitch parts usually means juggling two or more probes and positioning them in critical areas where a slip of the probe tip may result in an incorrect measurement or a damaged component. Once you've positioned the probes, it's a challenge to adjust the oscilloscope, or even to look away and read the results on screen. Probe positioning jigs are expensive, time consuming to set up, and not easy to position in confined areas.



▶ ***Figure 6.*** *Runt Pulse trigger finds attenuated signals on an I/O bus.*

Asking a fellow engineer to adjust the oscilloscope settings is not a cost-effective or time-efficient solution either.

Tektronix' VocalLink™ software allows you to maintain probe contact while controlling your oscilloscope with spoken commands. You can tell your oscilloscope to change settings, measurement parameters, and more. Audible feedback assures you that the command has been implemented correctly. VocalLink software also provides audible feedback of measurement results, allowing you to continue your measurements uninterrupted by the need to read the on-screen results. Because VocalLink software uses a special microphone that filters out background noise and provides feedback via a comfortable earpiece in the headset, you can make your measurements even in noisy environments.

Conclusion

Today's digital circuits present a continuing challenge to conventional measurement tools. Clock speeds, circuit density, and functional complexity are all increasing. Fortunately, the Tektronix TDS3000B Family of digital processing oscilloscopes has advanced with these needs, especially when combined with VocalLink Voice Control Software. The TDS3000B simplifies design and troubleshooting tasks wherever digital measurements are needed.

__Figure 7.__ VocalLink™ voice control software gives you a new measure of control over your oscilloscope

▶ **VocalLink™ Voice Control Software.** Probing today's circuits with their dense packaging and extremely fine pitch parts requires precise probe placement and the use of both hands, making it a challenge to maintain probe contact while operating the oscilloscope. VocalLink software frees your visual attention to focus on making solid probe contact with your test signals to ensure accurate, repeatable measurements. Choose from multiple languages for both on-screen operating menus and voice recognition.

▶ **P6243 Active FET Probe.** The P6243 Active FET Probe provides the high-speed signal acquisition and low circuit loading required for today's digital system designs. It has a probe-only bandwidth of 1 GHz and a 500 MHz system bandwidth when used with the TDS3054B oscilloscope. The P6243 offers superior signal acquisition on surface-mount devices. The P6243 has ≤1 pF capacitive loading, which allows it to measure high-speed signals without affecting the signal or the device under test. No additional power supplies or cables are needed when used with the TDS3054B oscilloscope.

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 "Resources For You" on our Web site at

www.tektronix.com

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