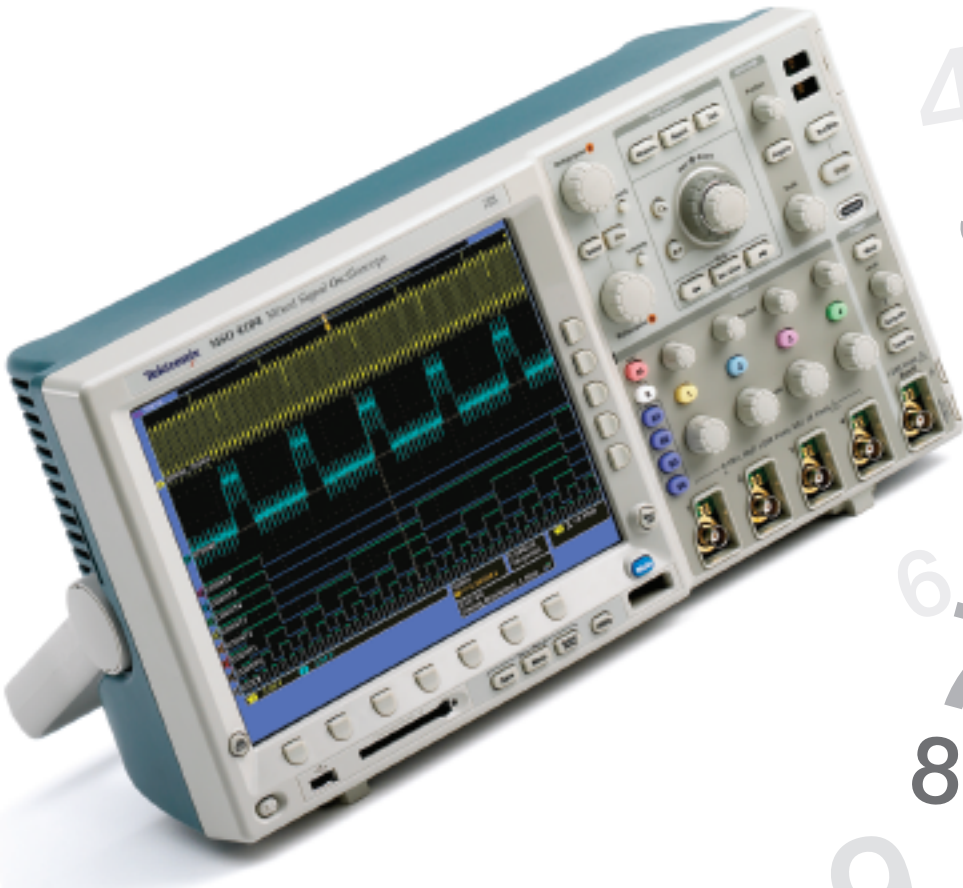
Ten Reasons Why

You Have Never Seen a Mixed Signal Oscilloscope Like This!



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2
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Tektronix

Enabling Innovation

Tektronix MSO4000 Series Mixed Signal Oscilloscopes - Ten Reasons Why You Have Never Seen A Mixed Signal Oscilloscope Like This!

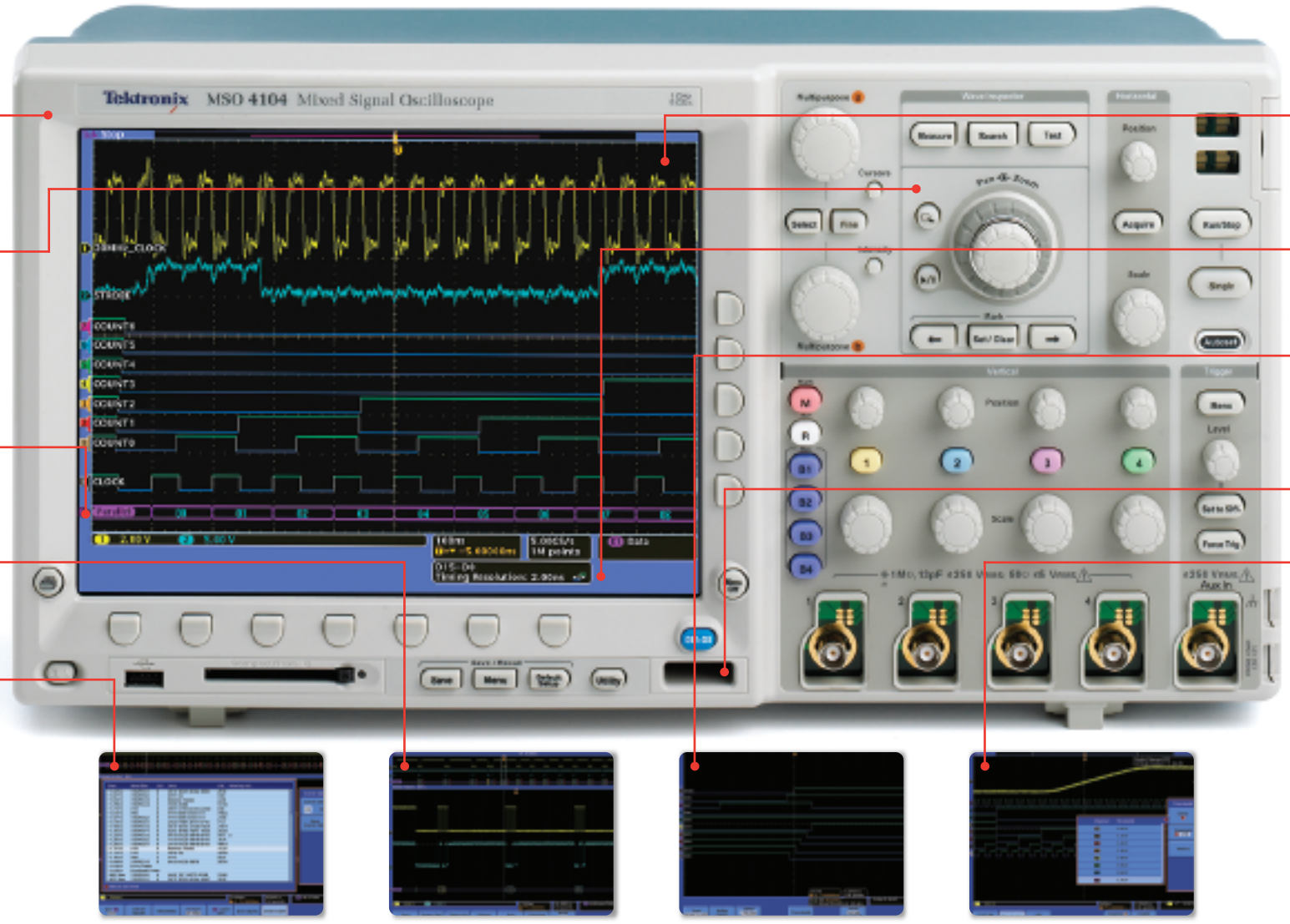
① Design
Designed with attention to detail.

② Wave Inspector®
- Zoom/Pan
- Play/Pause
- User Marks
- Search Marks

③ Parallel bus
triggering & analysis

④ Serial bus
triggering & analysis

⑤ Decoded data
view data in a listing format



⑥ Display
Endless combinations

⑦ MagniVu
60.6 ps timing

⑧ Multi-Channel
Setup and Hold triggering

⑨ P6516 Probe

⑩ Per channel thresholds

Oscilloscopes are found in virtually every electronics lab worldwide. Many would say the oscilloscope is the electronic design engineer's tool of choice. Engineers are confident in the way they operate and trust the results. However, oscilloscopes are limited to typically two or four analog channels. Engineers are commonly faced with needing more channels than their oscilloscope offers.

The following examples are looking at the input of an A/D converter while monitoring the 8-bit output or wanting to observe the address and data lines of a microprocessor. In both cases, the oscilloscope has an inadequate number of channels to get the job done. Engineers are faced with the decision of hunting around the lab to find a couple more scopes or using a logic analyzer. In either case, measurement

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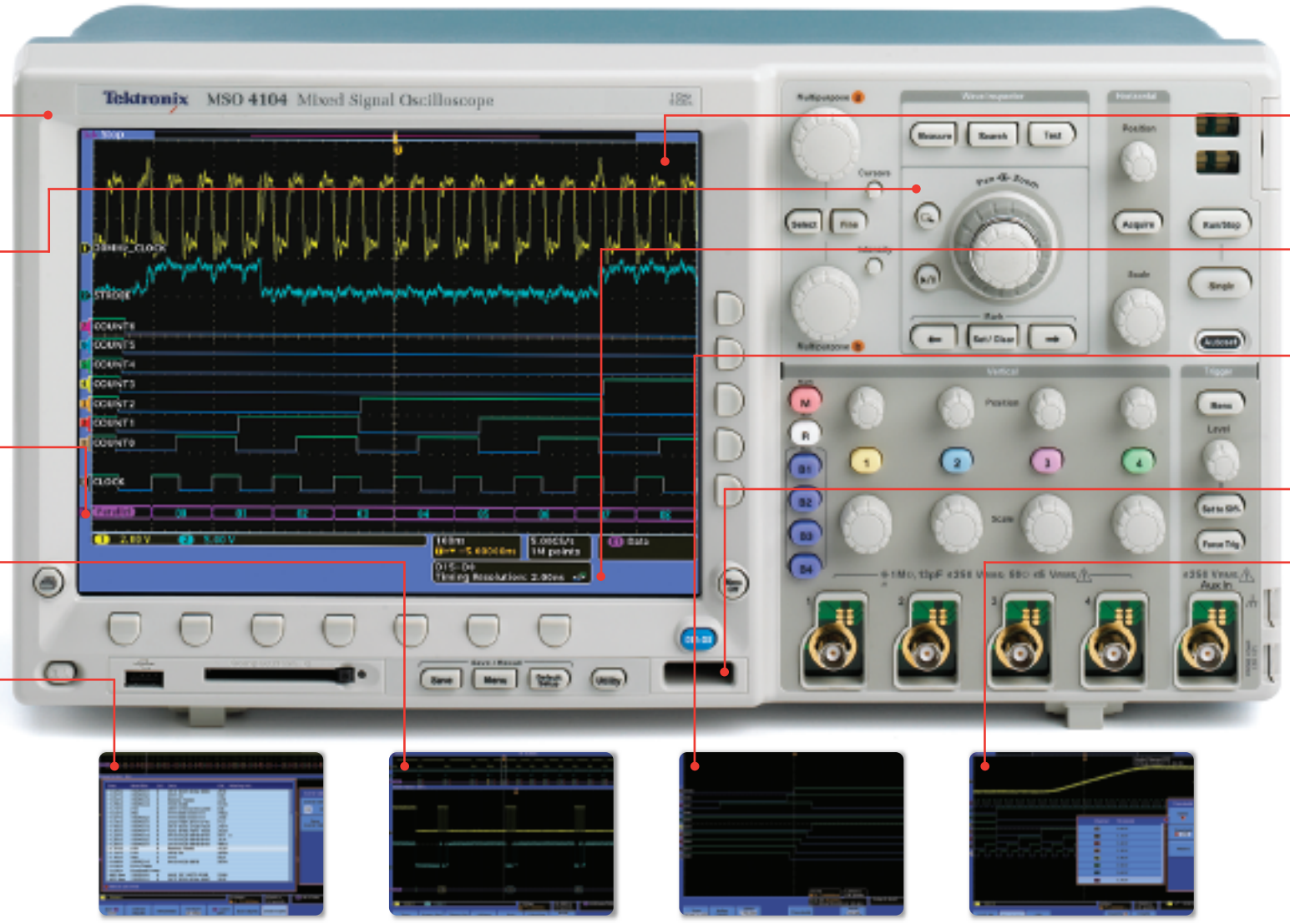

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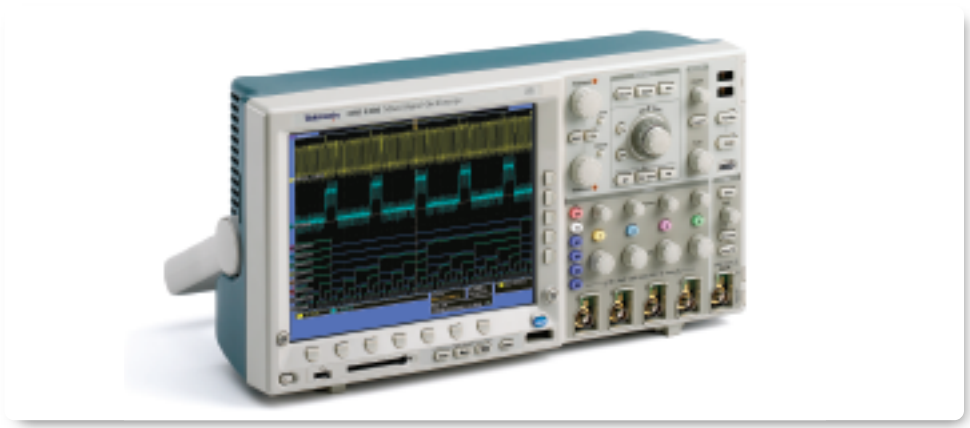

▶ **Figure 1.** *The MSO4000 Series provides the ultimate all-in-one debug tool for embedded design.*

complexity is significantly increased. At this point, the engineer is pondering, *"If only my scope had more channels…"*

Mixed Signal Oscilloscopes are the ideal solution for this measurement challenge. Take the tool engineers already trust and know how to use (the oscilloscope), add 16 digital channels, and you now have the ultimate tool for embedded design. The Tektronix MSO4000 Series drives like a scope, offers both analog and digital channels but without the complexity associated with logic analyzers.

The MSO4000 family shares the same common look and feel of the DPO4000, offering a compact form factor and a large 10.4 inch (264 mm) XGA display.

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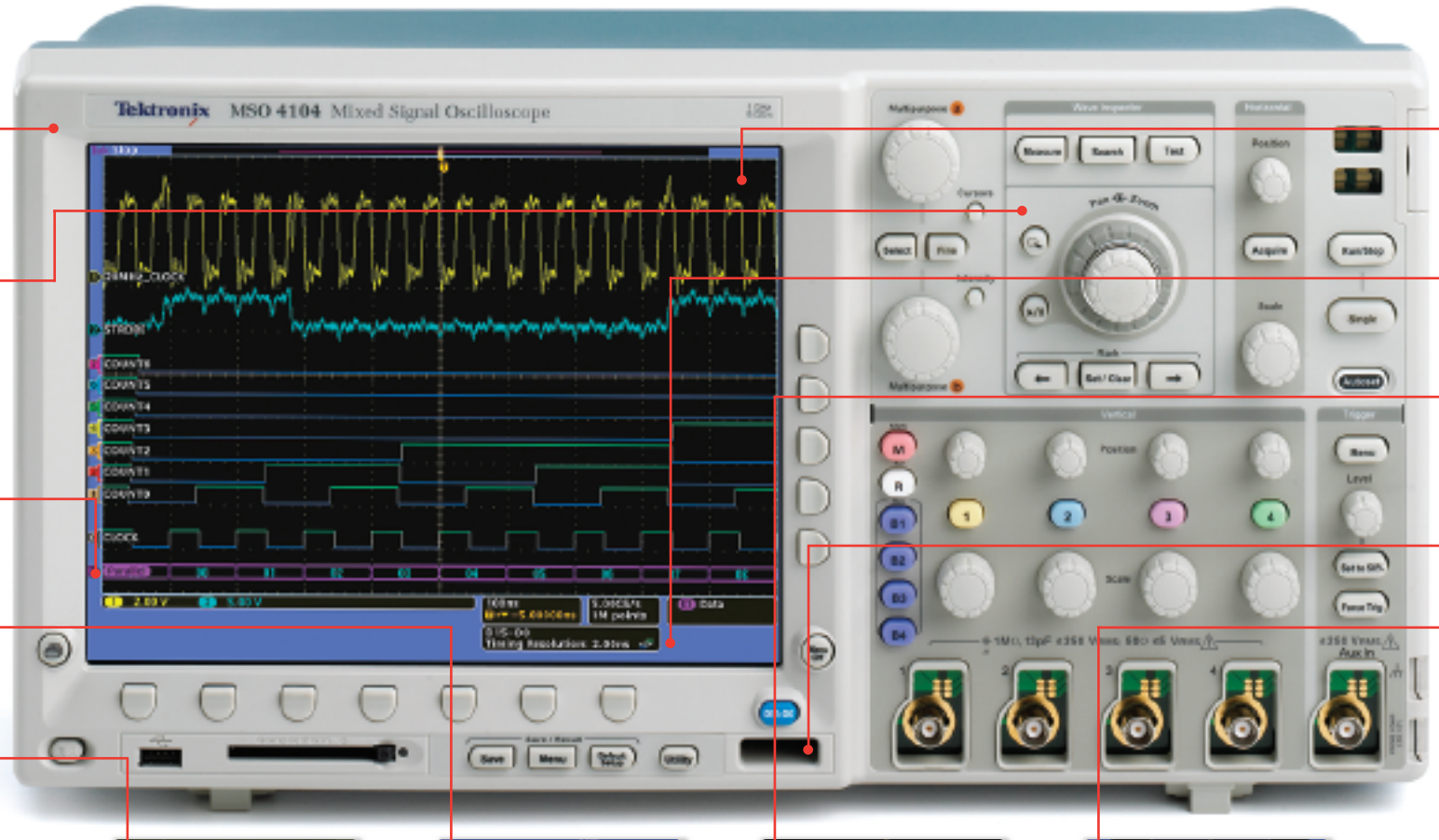

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1 Designed

to make your work easier

The MSO4000 Series is designed with an attention to detail to revolutionize the way you view digital data. An example of this is how digital waveforms are drawn. Color is used to identify the logical state of the digital waveform. When the logical state is high, the waveform is colored green; when low, it's colored blue. This is especially useful when you have zoomed in to the point where a digital channel is the same state all the way across the display, as you can still tell whether it's high or low.

The MSO4000 has multiple-transition detection hardware. When the system detects multiple transitions, you will see a white edge on the display. White edges indicate that more information is available by zooming in or acquiring at faster sampling rates. As shown in Figure 2, zooming in will usually reveal a pulse that was previously invisible. If the white edge is still present after zooming in as far as possible, increasing your sample rate on the next acquisition will reveal higher frequency information than your previous settings could acquire.

Figure 2. *White edges as shown on the MSO4104 informing the user to zoom in for more detail.*

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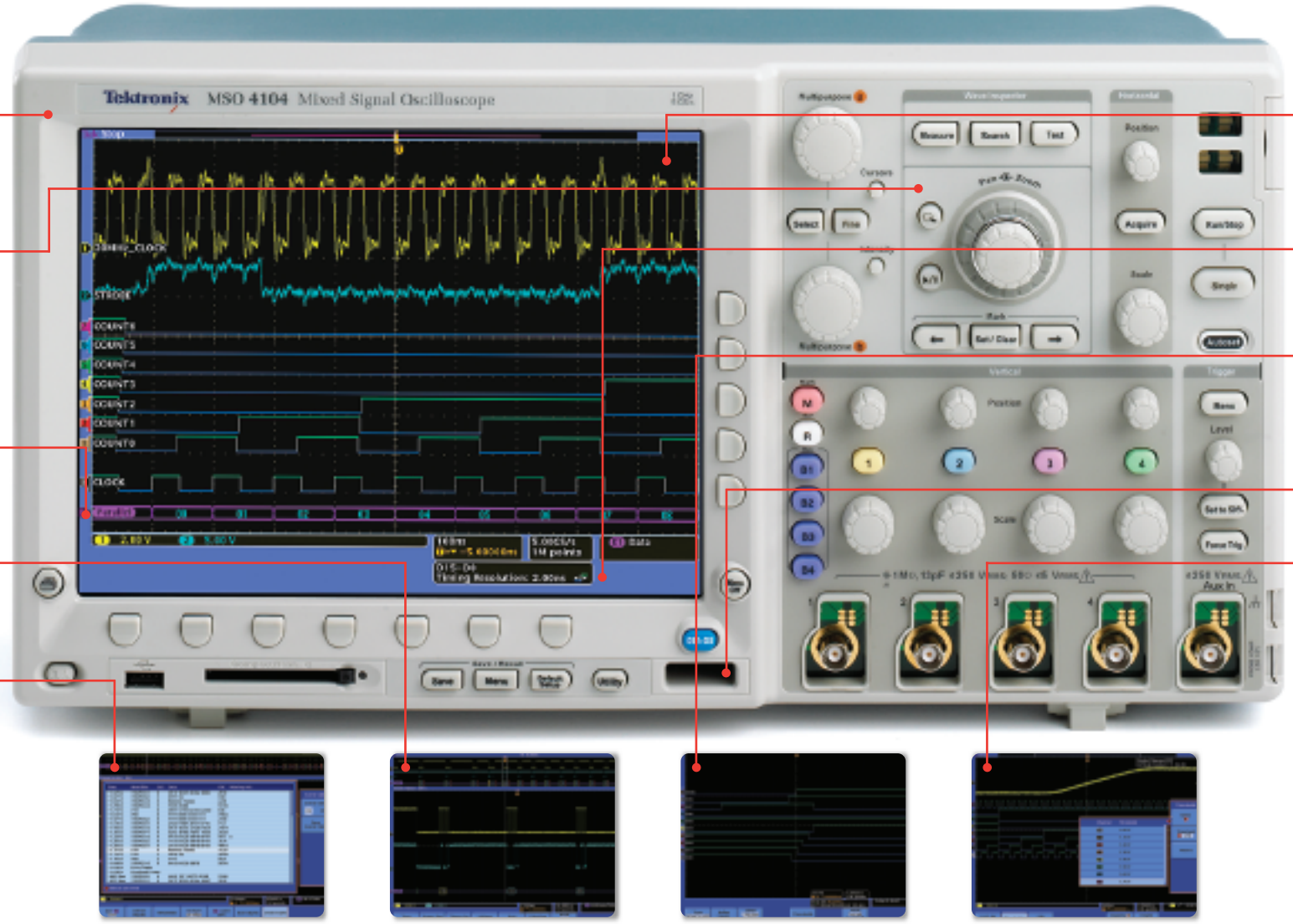

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2 Use Wave Inspector®

to easily find areas of interest in your acquired data

► **Figure 3.** *Intuitive Wave Inspector® Controls.*

The MSO4000 Series can acquire up to 10 million points on each of the 2 or 4 analog channels as well as each of the 16 digital channels. While this long record length is extremely valuable for capturing long time windows with high resolution, it presents its own set of challenges. After all, what is the point in acquiring thousands of screens worth of information if you don't have any useful tools for working with all that data? The MSO4000 Series is the first MSO to offer a complete set of features/tools for working with long record length acquisitions.

► **Zoom / Pan** – A dedicated, two-tier front-panel knob provides intuitive control of both zooming and panning.

The inner knob adjusts the zoom factor (or zoom scale); turning it clockwise activates zoom and goes to progressively higher zoom factors, while turning it counter-clockwise results in lower zoom factors and eventually turns zoom off.

The outer knob pans the zoom box across the waveform to quickly get to the portion of the waveform you are interested in. The outer knob also utilizes force-feedback to determine how fast to pan on the waveform. The farther you turn the outer knob, the faster the zoom box moves. Even with 10M record lengths, you can move from one end of the acquisition to the other in seconds!

Pan direction is changed by simply turning the knob the other way. No longer do you need to navigate through multiple menus to adjust your zoom view.

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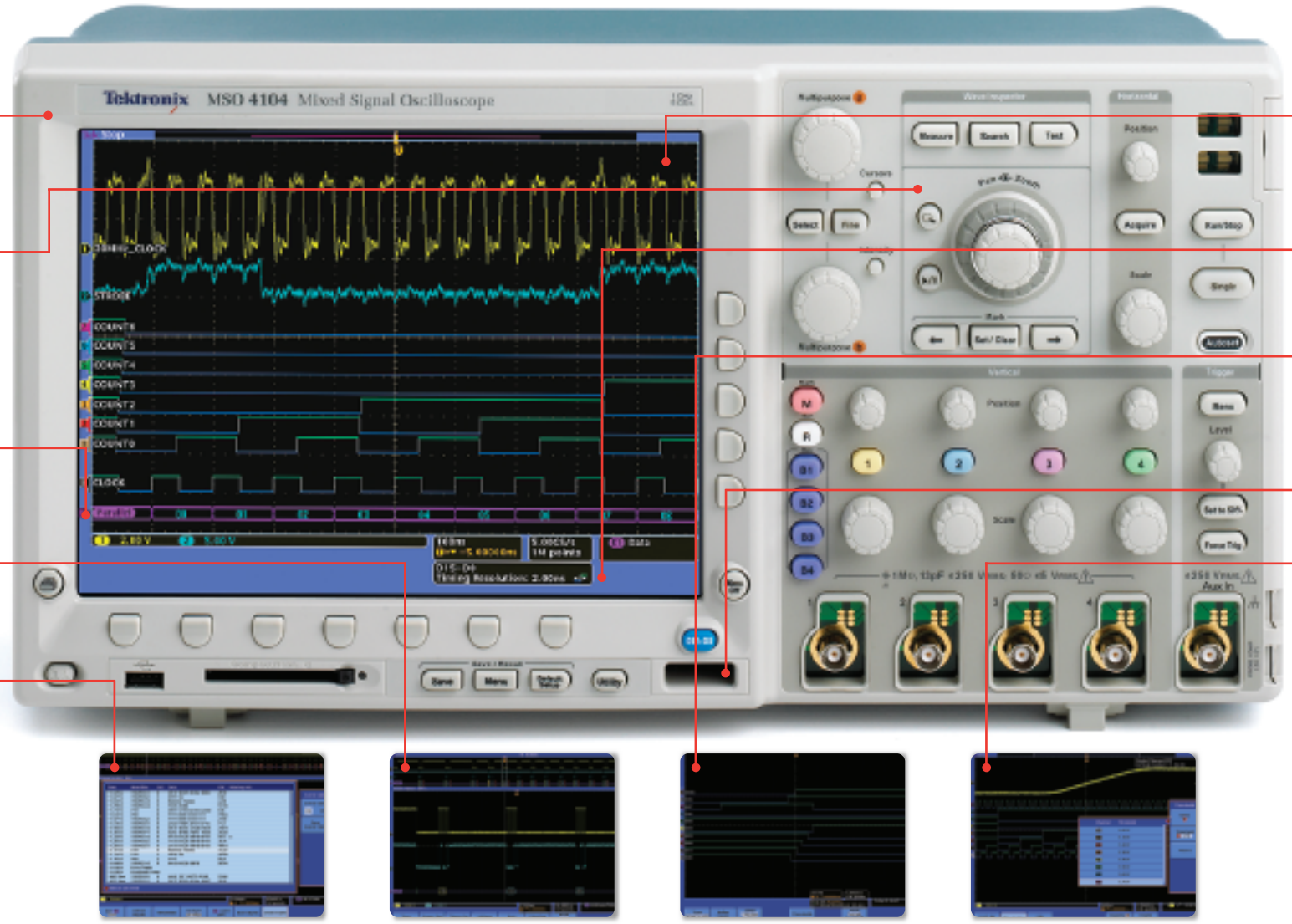

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- **Play / Pause** – A dedicated play/pause button on the front panel makes the MSO automatically scroll the waveform by while you look for anomalies or the event of interest. Playback speed and direction are controlled using the intuitive pan knob. Once again, turning the knob further makes the waveform scroll by faster and changing direction is as simple as turning the knob the other way.
- **User Marks** – See something interesting on your waveform? Press the Set Mark button on the front panel to leave one or more "bookmarks" on the waveform.

Figure 4. *Dedicated front panel controls provide simple and efficient waveform management.*

Navigating between marks is as simple as pressing the Previous and Next buttons on the front panel.

- **Search Marks** – Don't want to take the time to inspect the entire record length to find the event you're looking for? The MSO4000 Series features a robust waveform search feature that allows you to search through your long acquisition based on user-defined criteria such as pulse width, logic state, or even parallel and serial bus content. All occurrences of the event are highlighted with search marks and are easily navigated to using the front panel Previous and Next buttons. This makes comparing multiple occurrences of the search events spread out through a long record length acquisition a trivial task.

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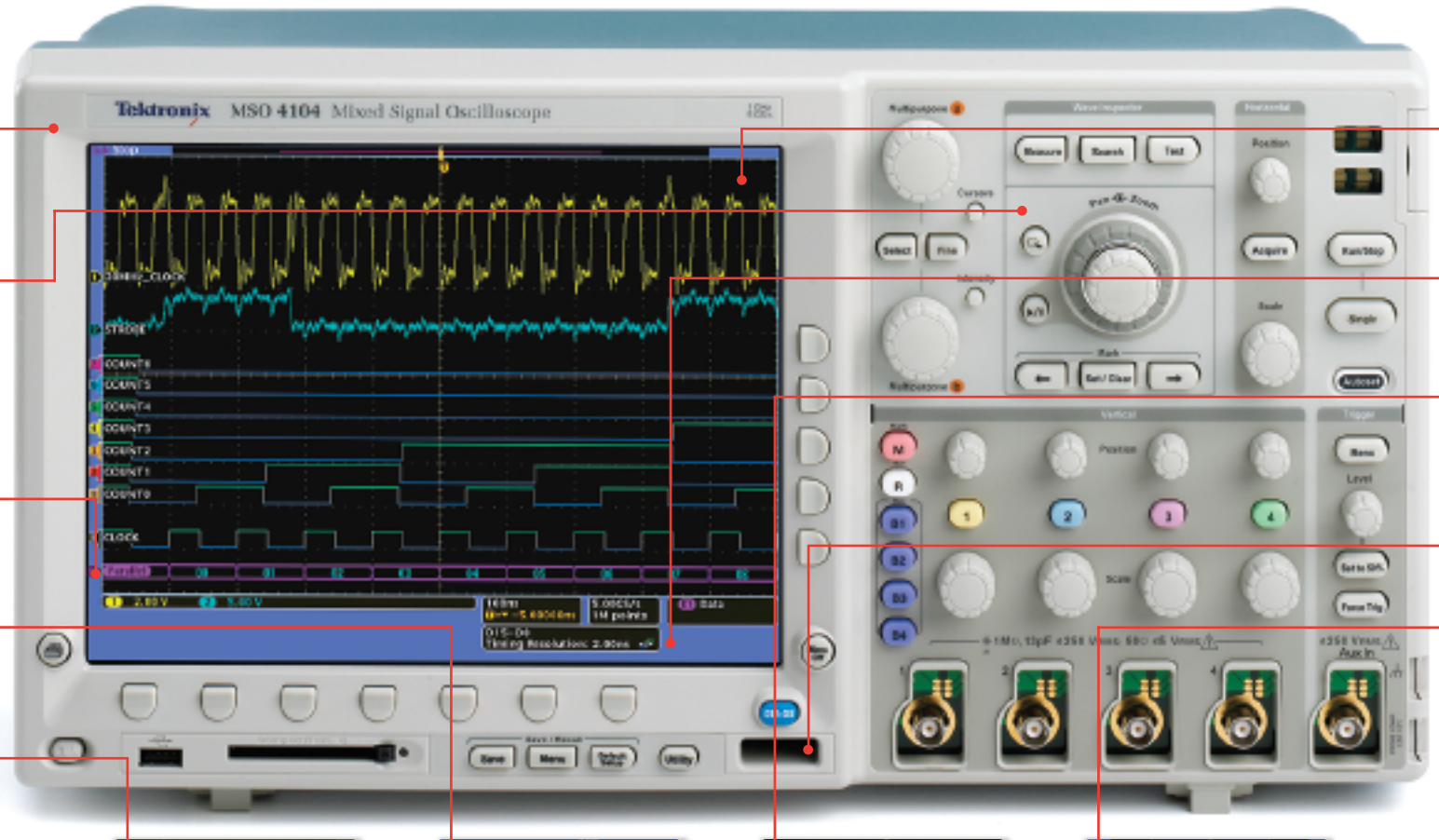

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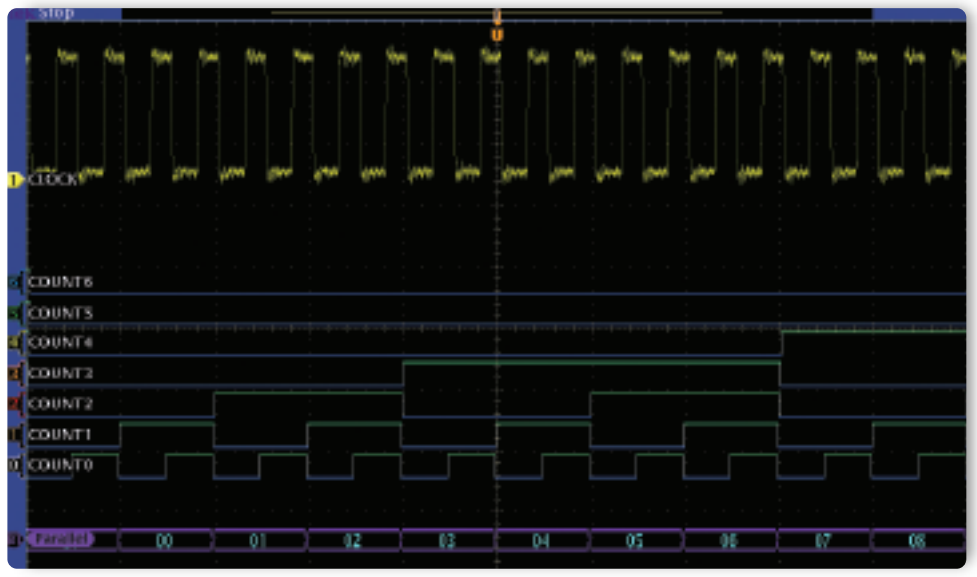
3 Parallel bus triggering and analysis

You have probably spent countless hours decoding system bus activity on your oscilloscope. This typically involves evaluating the state of data and address lines at each clock edge. The MSO4000 Series simplifies this process by providing you the ability to create parallel buses. By specifying which channels are the clock and data lines, you can create a parallel bus display that automatically decodes bus content, as shown in Figure 5.

The MSO4000 Series enables you to define and display up to four parallel buses at one time, allowing you to easily view decoded parallel bus data over time. And, you can trigger the scope on the bus values. Finally, Wave Inspector's search capability has been extended to include searching through long digital acquisitions, simplifying the identification of digital as well as analog events of interest.

The MSO4000 Series Mixed Signal Oscilloscope



▶ **Figure 5.** *MSO4104 Parallel Bus Display.*

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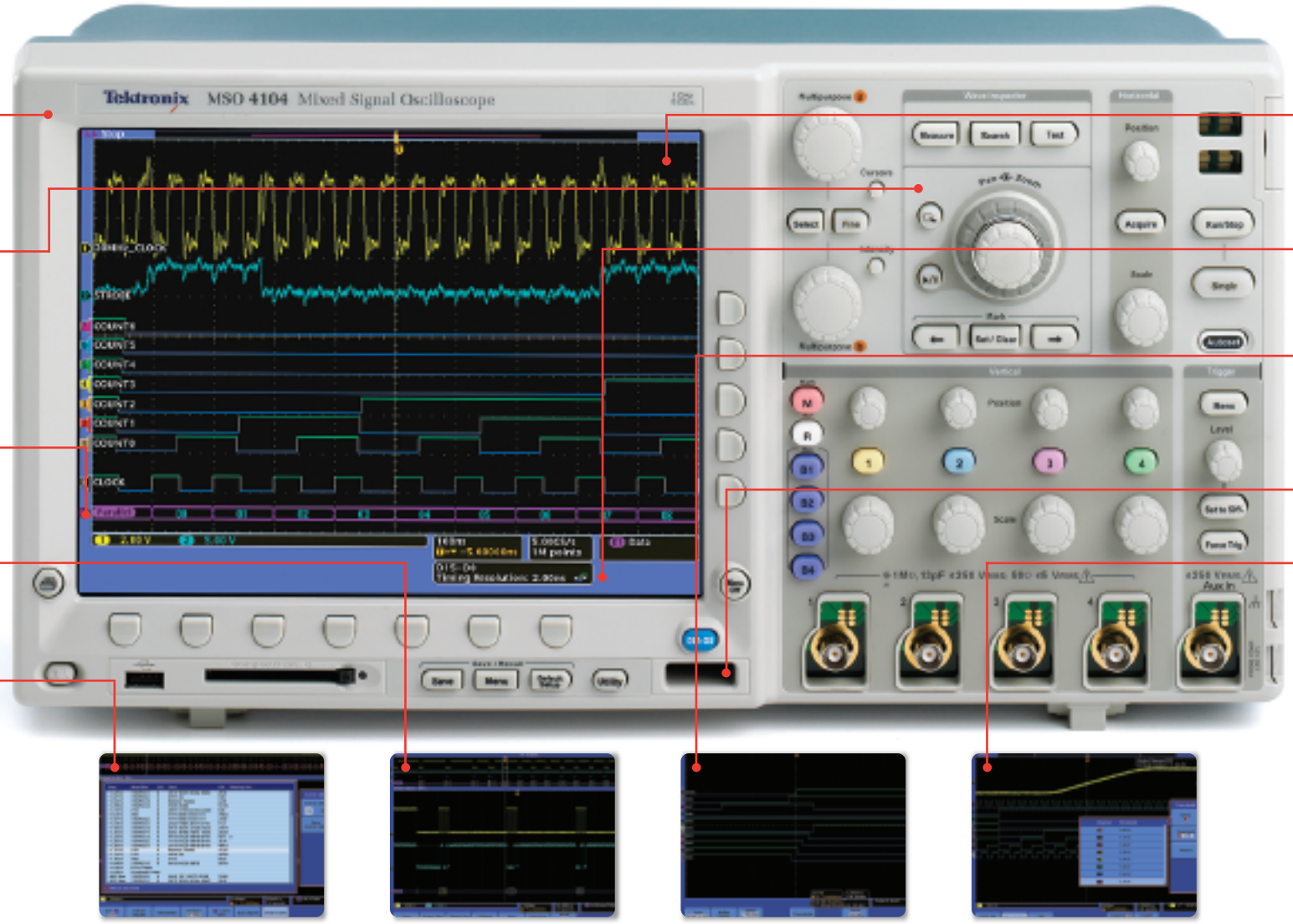

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4 Serial bus
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Serial buses such as I²C, SPI, RS-232 and CAN are virtually everywhere in modern embedded systems. These buses are used to communicate between devices, monitor temperature, control fan speed, and initialize the state of various devices. Debugging system level issues involving one or more serial buses typically takes a long time due to the difficulties in isolating the particular traffic of interest going across the bus and the tedious process of manually decoding messages one bit at a time.

With the MSO4000 Series, you can define the oscilloscope's inputs to be an I²C, SPI, RS-232, or CAN bus. As shown in Figure 6, you can trigger the scope on packet-level information such as specific addresses or data, and automatically display the decoded packet content in an intuitive bus waveform. Wave Inspector's search capability can then be used to search through a long acquisition of serial bus data to immediately find the events of interest you identify.

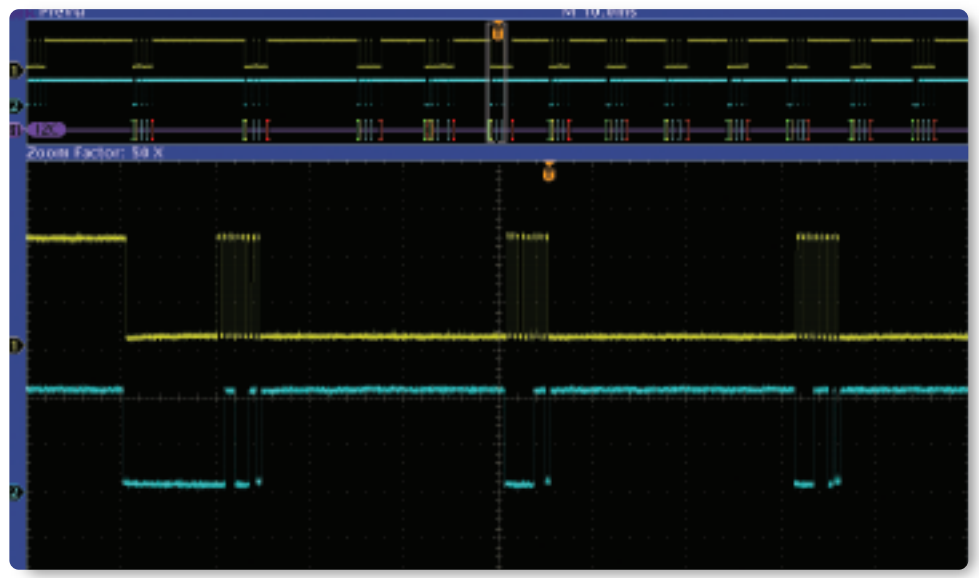
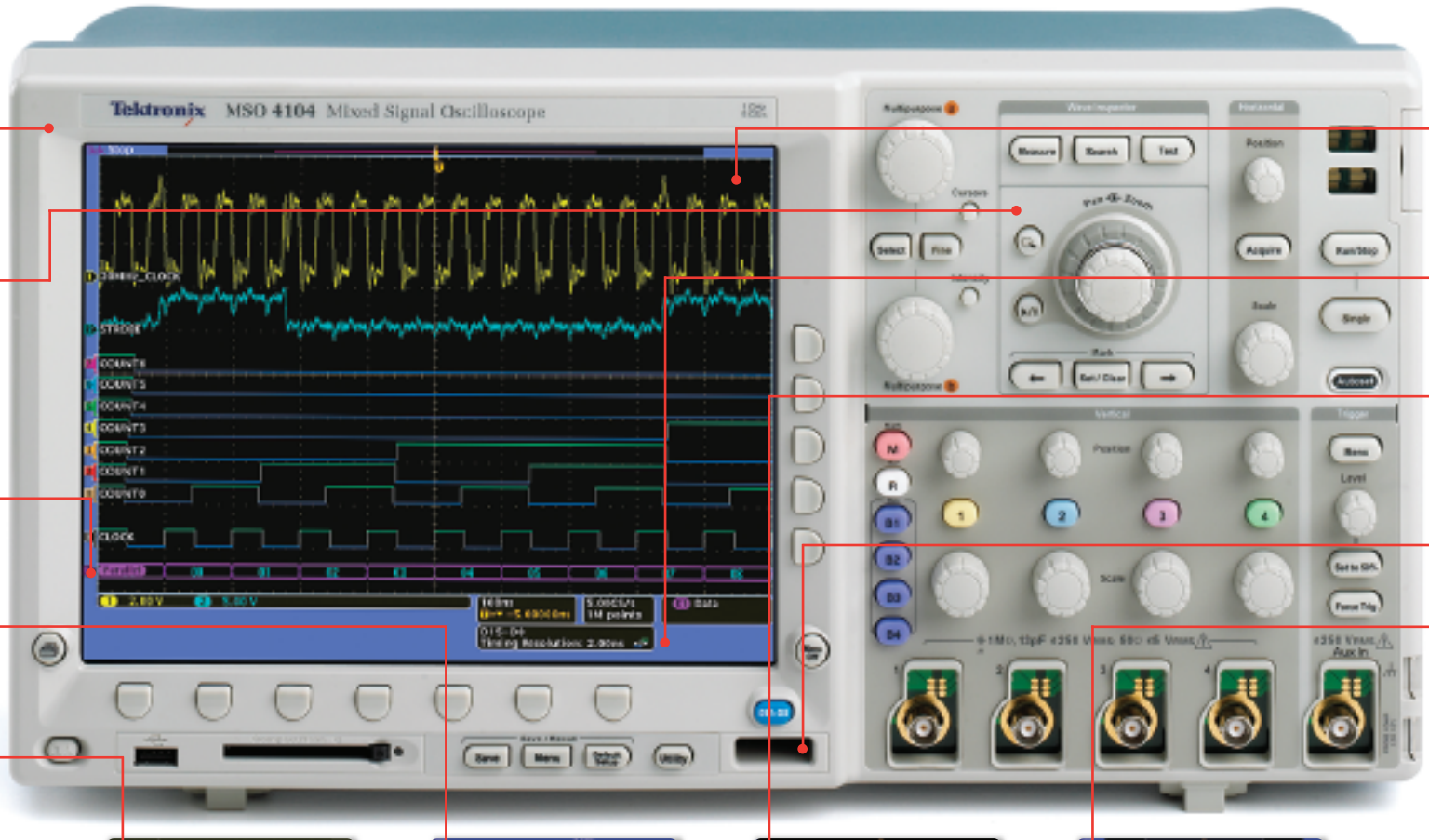


Figure 6. *MSO4104 I²C Trigger and Decode.*



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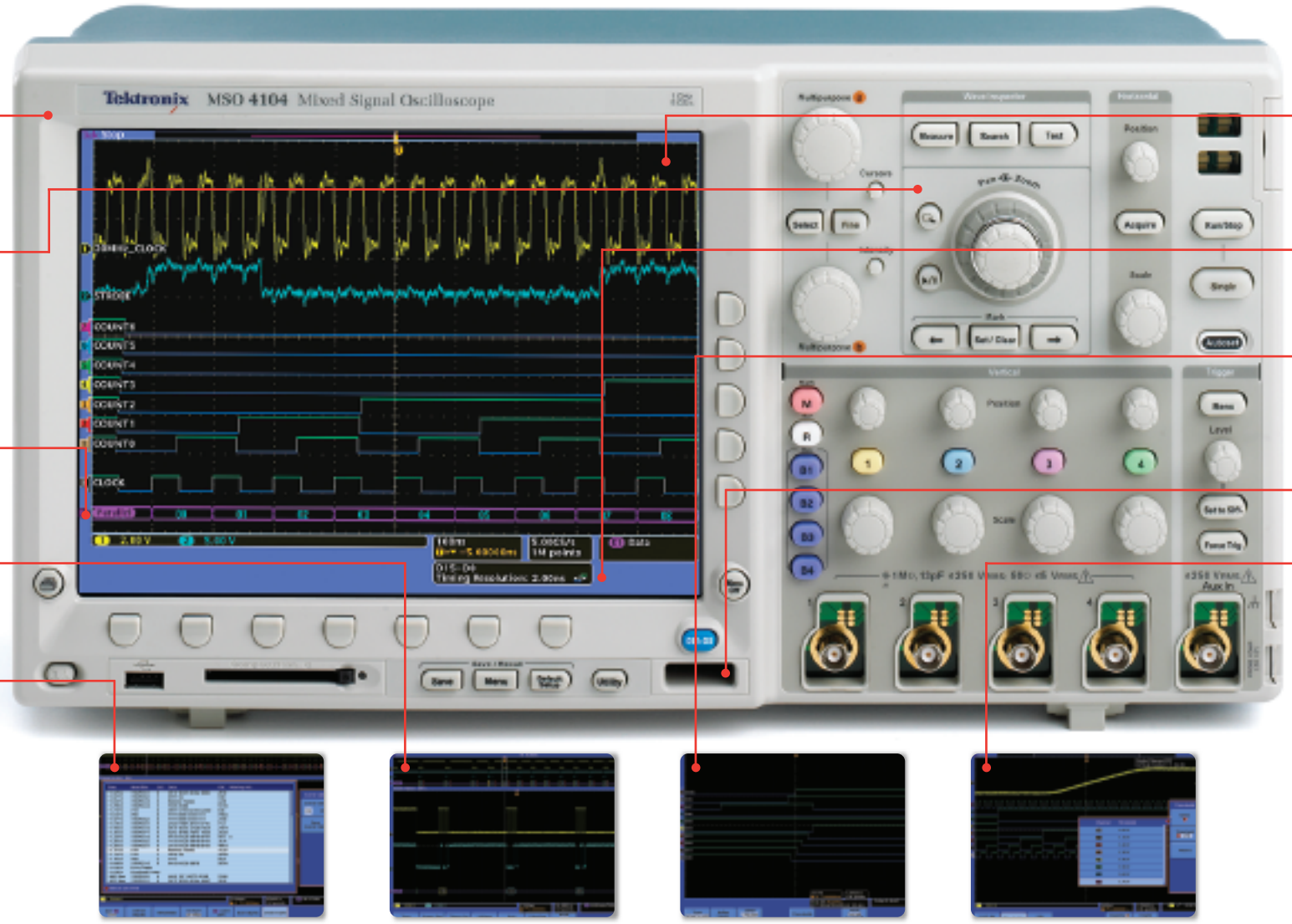
5 View decoded data in an event table

Event tables offer the ability to view decoded parallel or serial bus data in a listing format. Anytime you have a bus displayed on the instrument, you can turn on event tables to view the bus in a listing format.

Figure 7 shows an example of a CAN bus acquisition including decoded Identifiers, Data Length Codes (DLC), Data, CRC, and Missing Acknowledges. In addition, each packet is time stamped for easy timing measurements.

▶ **Figure 7.** *MSO4104 CAN Event Table showing decoded bus traffic.*



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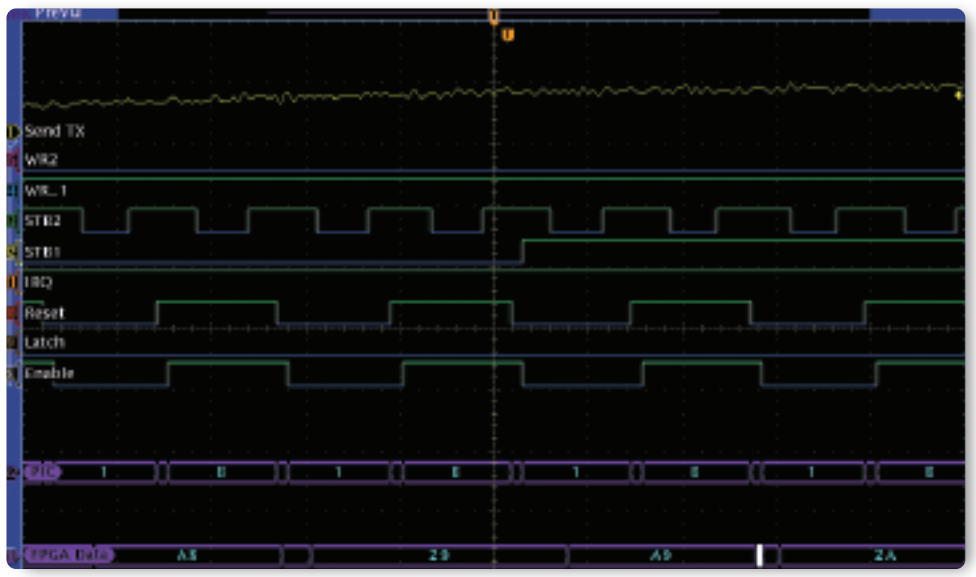
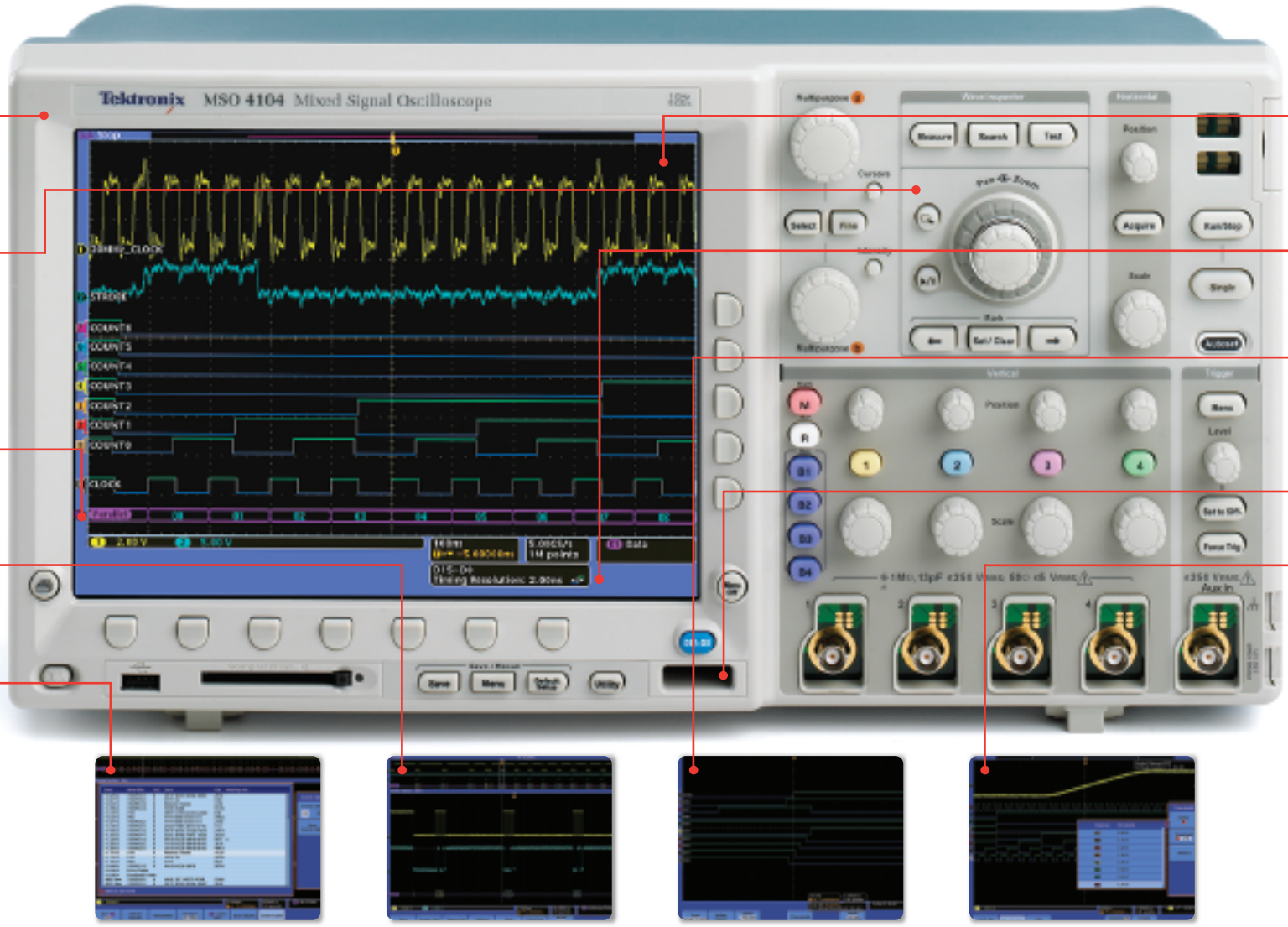
6 Display
a combination of up to four serial or parallel buses

Embedded systems commonly have both serial and parallel buses. When system level problems occur, you need to trace the execution of code in hardware. Whether you are a software or hardware engineer, you can use the MSO4000 Series to easily monitor up to four I²C, SPI, RS-232, CAN and Parallel buses to determine the cause of failure. For instance, you can monitor several I²C buses while triggering on data outputted from an FPGA. The combinations are endless. The MSO4000 Series will change the way both software and hardware engineers think about how they will use their oscilloscope in the future.

The MSO4000 Series Mixed Signal Oscilloscope



▶ **Figure 8.** *MSO4104 display showing multiple decoded buses.*



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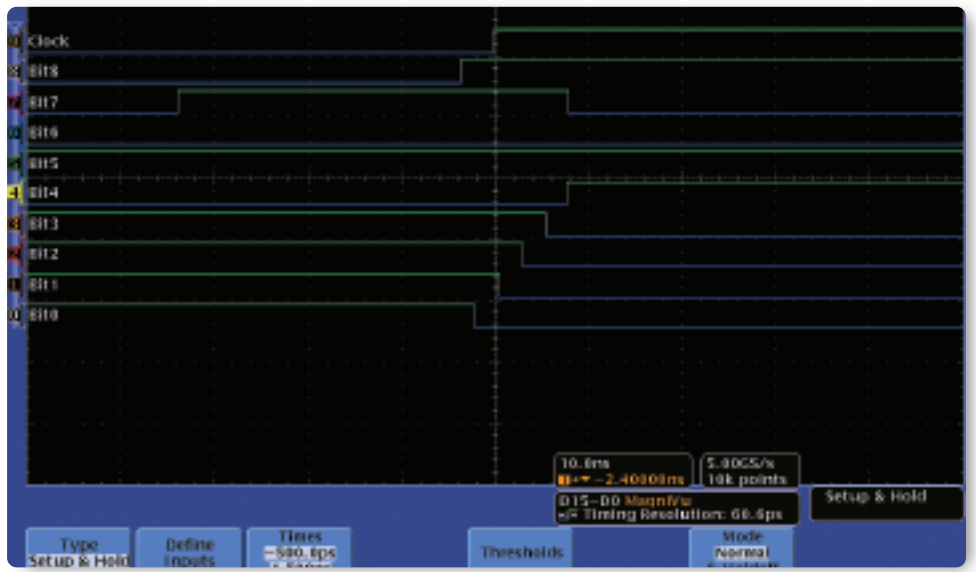
7 MagniVu™

provides ultra-fine 60.6 ps timing resolution

With next-generation microcontrollers achieving clock speeds of 100 MHz or more, it is important to have an instrument with adequate resolution to resolve tight timing issues. The MSO4000 Series is the first mixed signal oscilloscope to offer MagniVu. MagniVu samples all digital channels with resolution as fine as 60.6 ps for 10,000 samples. This ultra-high timing resolution allows designers to move from simply troubleshooting apparent problems to actually verifying tight timing margins. An example of MagniVu timing resolution is shown in Figure 9 where it is being used to verify the setup and hold time violation with very fine timing resolution.



▶ **Figure 9.** *MSO4104 MagniVu™ (at 60.6 ps timing resolution) verifying a setup and hold violation.*

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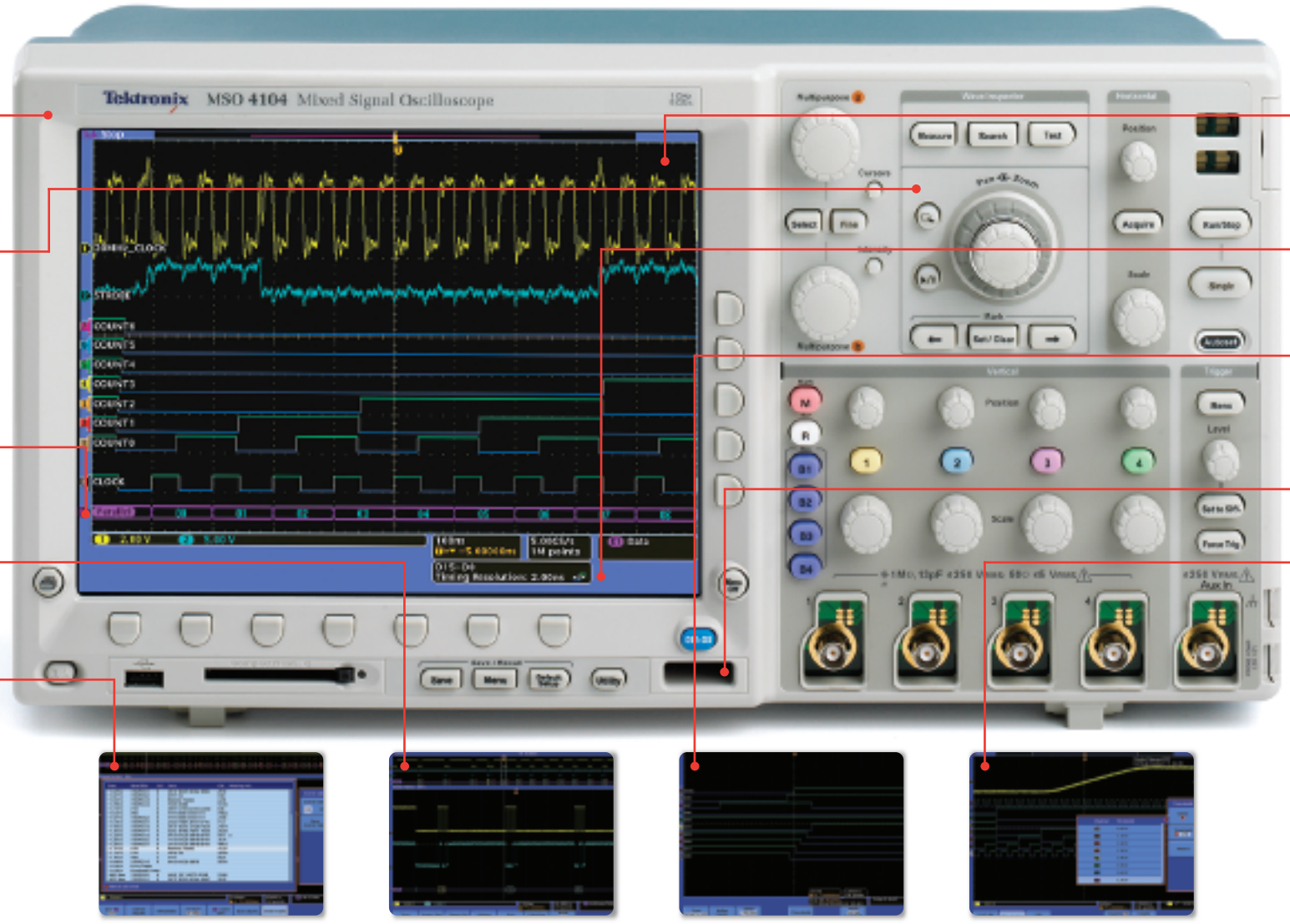

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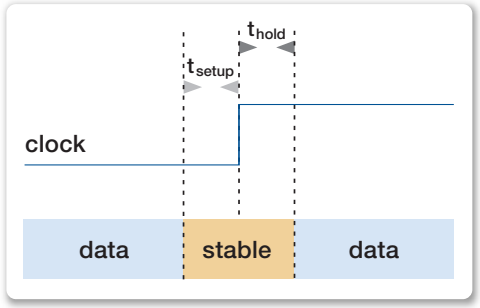
8 Multi-Channel

9 10

Set-up and Hold Triggering

Measuring Setup and Hold times is a common task with modern digital systems.

Setup Time is the amount of time the synchronous input must be stable before the active edge of the clock, while Hold Time is the amount of time the synchronous input must be stable after the active edge of the clock.



▶ **Figure 10.** *Setup and Hold Definition for Digital Signals.*

You will often encounter situations where margins are at their limits, but testing for setup and hold violations can often be a time consuming challenge.

Some oscilloscopes have triggering functions that allow the user to set up a clock and single data line. This may be adequate if you have a simple JK flip-flop, but if you have an 8 or 16-bit bus, it means performing the same task repeatedly to verify each bit of the bus one at a time.

The MSO4000 Series is the first Mixed Signal Oscilloscope to offer multi-channel setup and hold triggering. Now you can monitor, debug and test an entire parallel bus at once (as shown on Page 19, Figure 9) rather than a single bit at a time.

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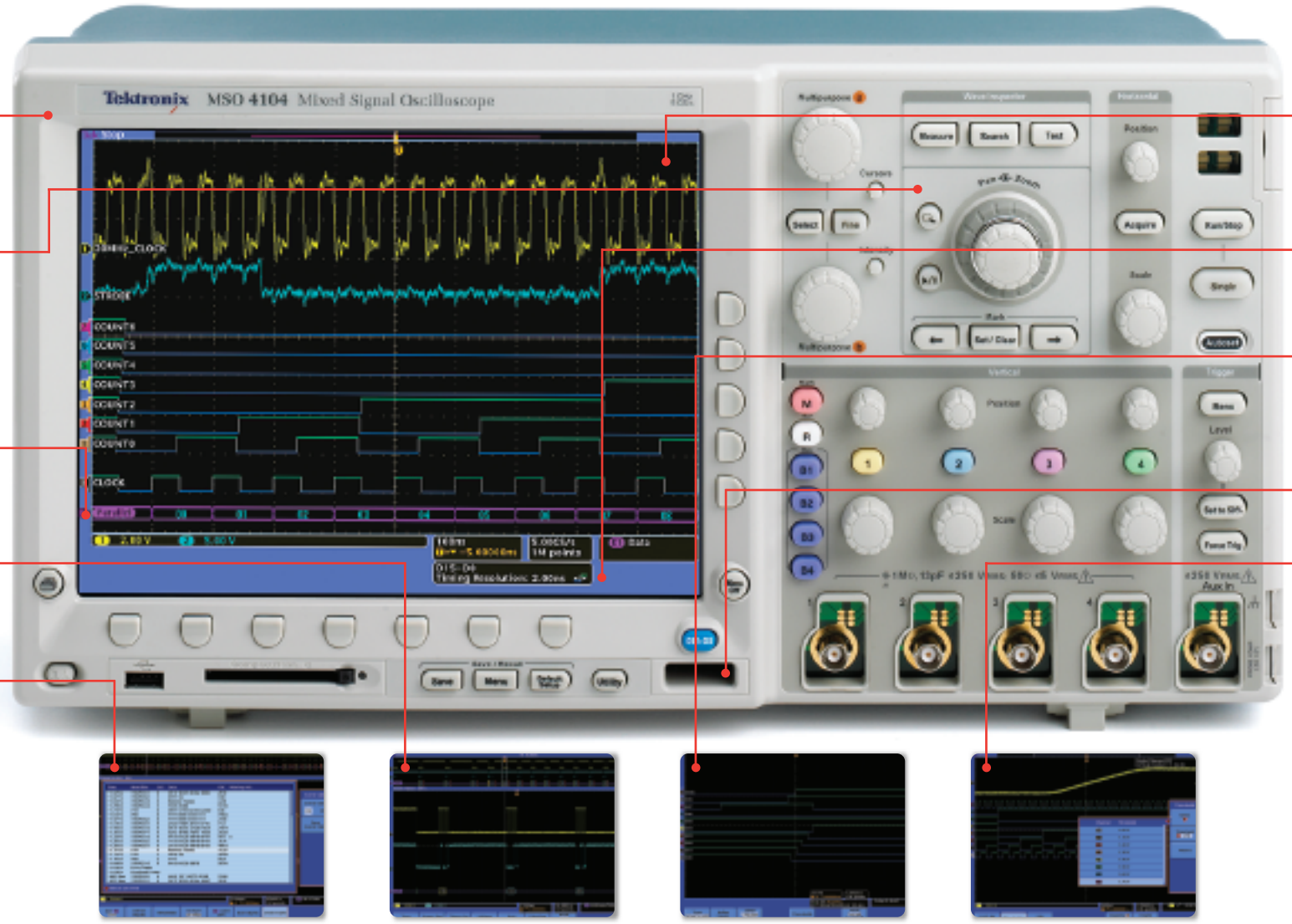

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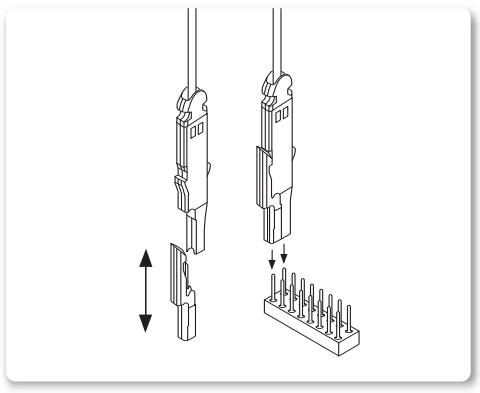
9 P6516 Mixed Signal Oscilloscope Probe

10

▶ **Figure 11.** *P6516 Probe.*

Probing is a crucial step necessary for achieving optimum measurement results. In some cases, circuit board designs include test points, but all too often you have to solder on wires to gain access to critical signals.

The P6516 Mixed Signal Oscilloscope probe has been designed to meet the needs of the mixed signal environment.



▶ **Figure 12.** *P6516 probe head attachment to square-pin header.*

1. The P6516 probe consists of two 3-foot sections which enable easy access to signals in different areas of the circuit board or system.
2. The probe is made up of coax cables that extend from the scope input to the probe tip. This offers the highest level of signal integrity and minimum probe loading at ~3 pF.
3. Each of the inputs to the eight-channel groups ends with a gun barrel tip.

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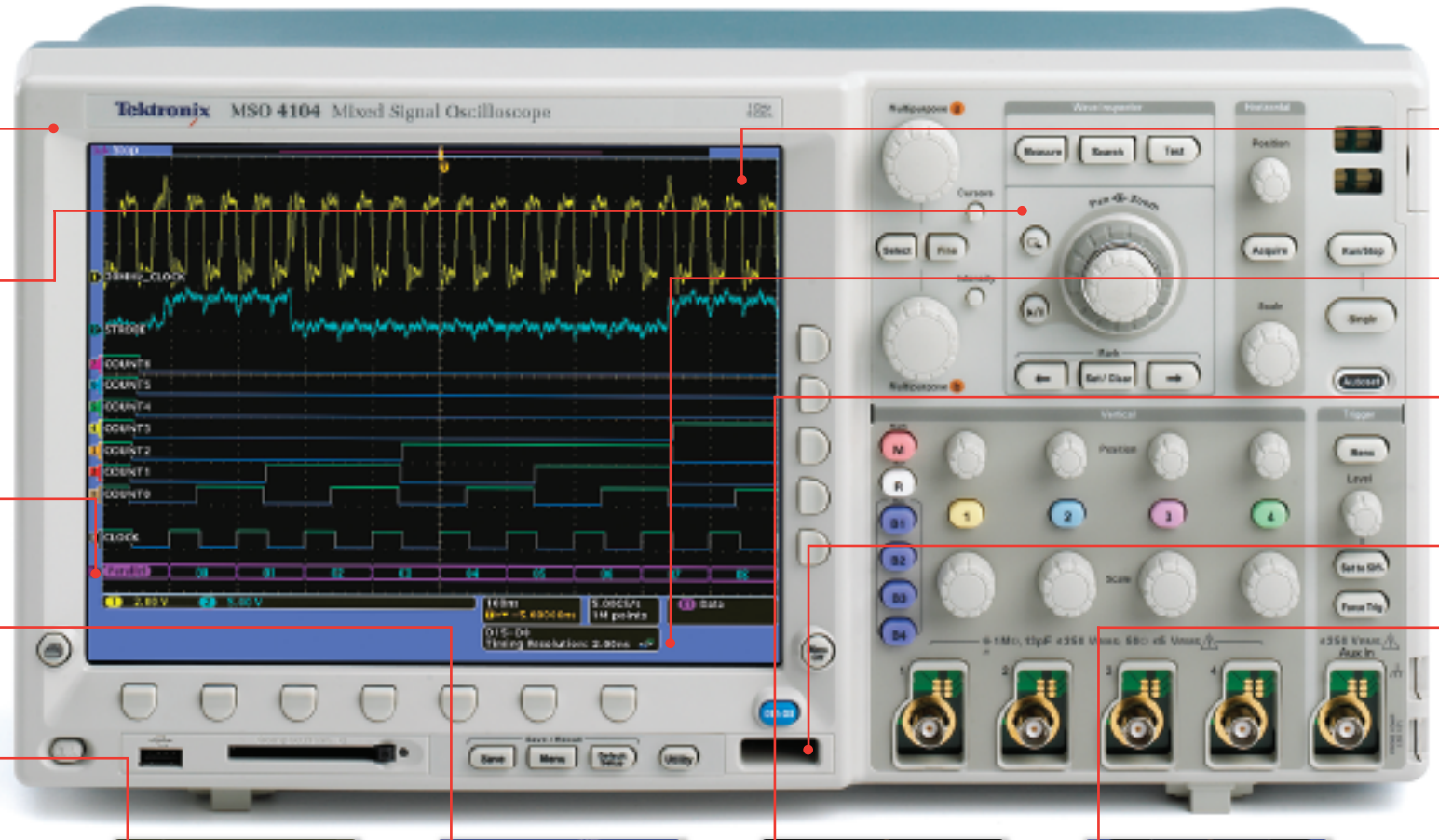

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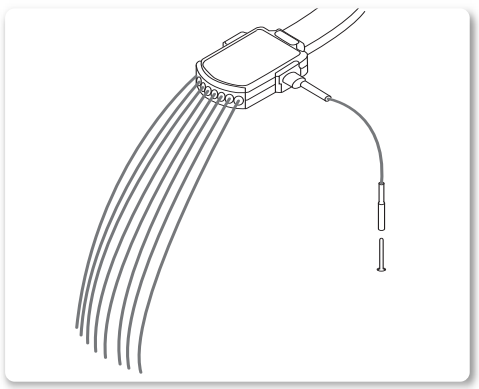
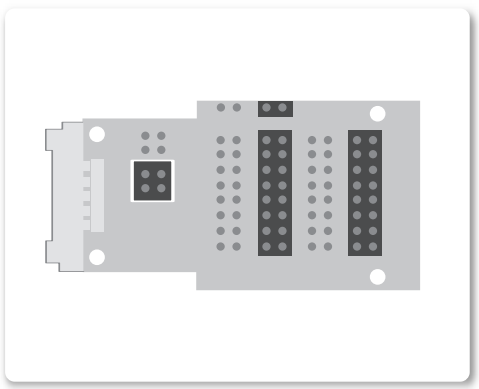


▶ **Figure 13.** *P6516 probe automotive-style ground connector.*

This sleek new probe simplifies the process of connecting to the device under test. The common ground uses an automotive-style connector making it easy to create custom grounds. When connecting to square pins, the P6516 has an adapter that attaches to the probe head extending the probe ground flush with the probe tip so you can attach to a header.



▶ **Figure 14.** *NEX-HD2HEADER adapter.*

If your board has an AMP Mictor connector, the optional NEX-HD2HEADER provides easy access to any of the 34 channels.

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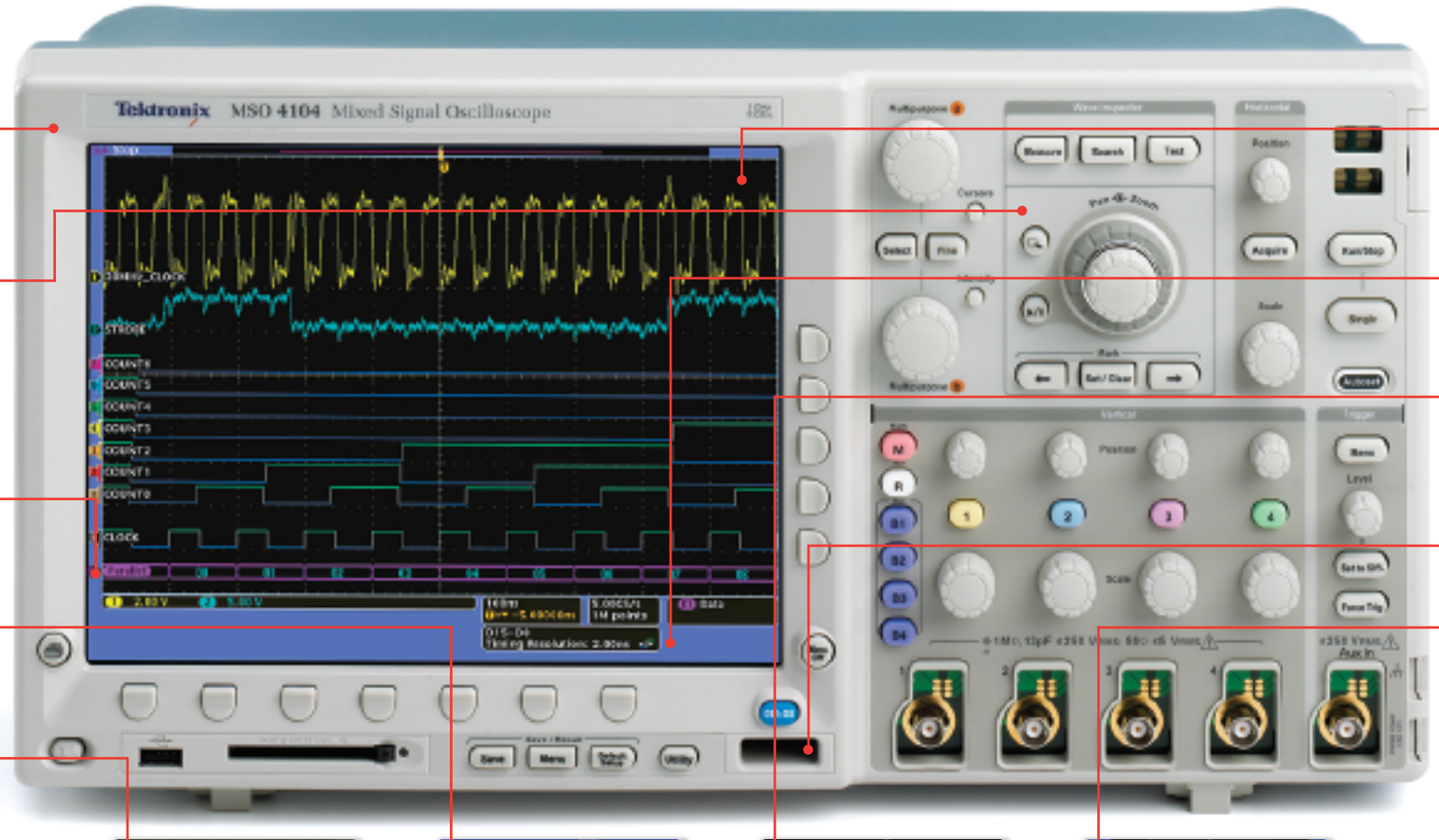

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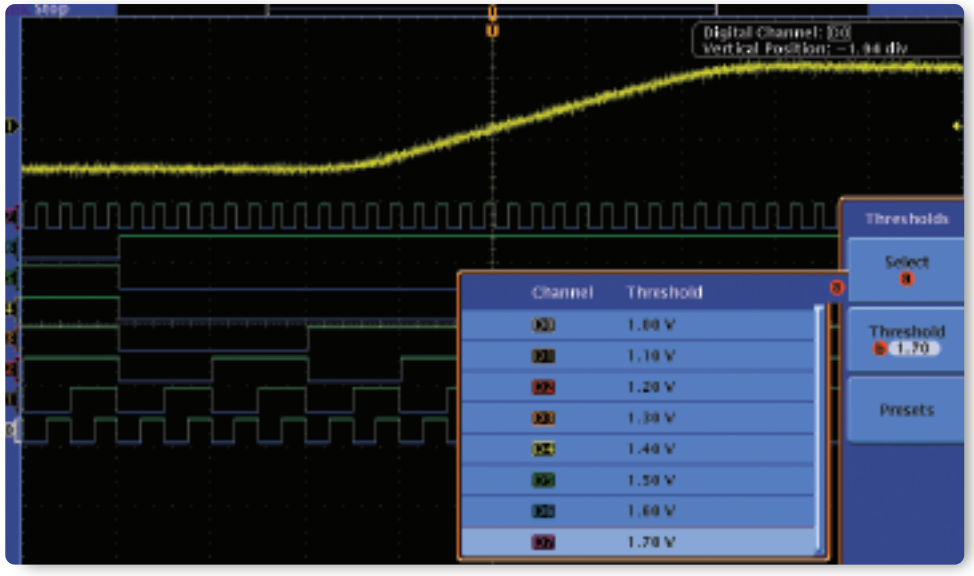
enables true mixed signal design

Typical mixed signal oscilloscopes allow only one logic threshold per 8-digital channels. This means that despite having 16 digital channels, typical MSOs cannot probe more than two areas of interest unless they all use the same logic families.

For instance, your design may use 3.3V and 5V CMOS in addition to TTL. The problem you are tracking down requires you to probe all of these signals.

If you were using a traditional MSO, you would be unable to view all of these signals due to the two-threshold limitation.

With the MSO4000, however you can set an individual threshold per channel allowing you to solve your problem. Per-channel thresholds makes the MSO4000 Series the only true mixed signal oscilloscope on the market.



▶ **Figure 15.** *MSO4104 showing different digital thresholds on each channel.*

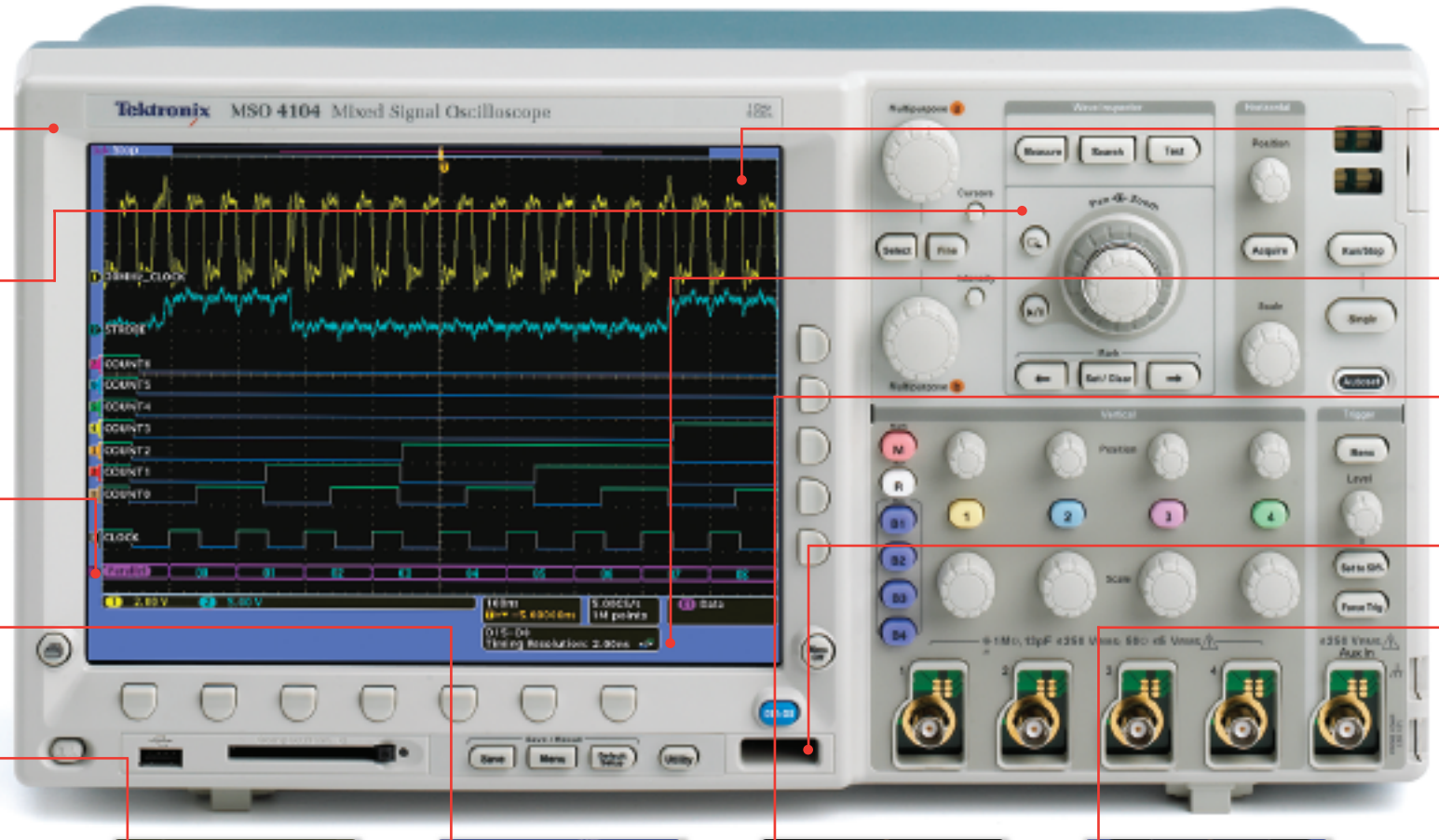
① Design
Designed with attention to detail.

② Wave Inspector®
- Zoom/Pan
- Play/Pause
- User Marks
- Search Marks

③ Parallel bus
triggering & analysis

④ Serial bus
triggering & analysis

⑤ Decoded data
view data in a listing format



⑥ Display
Endless combinations

⑦ MagniVu
60.6 ps timing

⑧ Multi-Channel
Setup and Hold triggering

⑨ P6516 Probe

⑩ Per channel thresholds

The MSO4000 Series Mixed Signal Oscilloscope

Conclusion

The Tektronix MSO4000 Series Mixed Signal Oscilloscopes are the ideal solution for embedded system design. Built on an oscilloscope platform you already know how to use, the MSO4000 Series adds 16 digital channels and bus decoding capabilities to simplify the debug of mixed-signal designs without the complexity associated with the advanced features of logic analyzers. With its compact form factor, large 10.4 inch XGA display, and industry firsts such as MagniVu and setup/hold bus triggering, you truly have never seen a Mixed Signal Oscilloscope like this!

See the MSO4000 Series in action for yourself.
Try out the MSO4000 virtual oscilloscope,
visit: www.tektronix.com/virtualmso

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