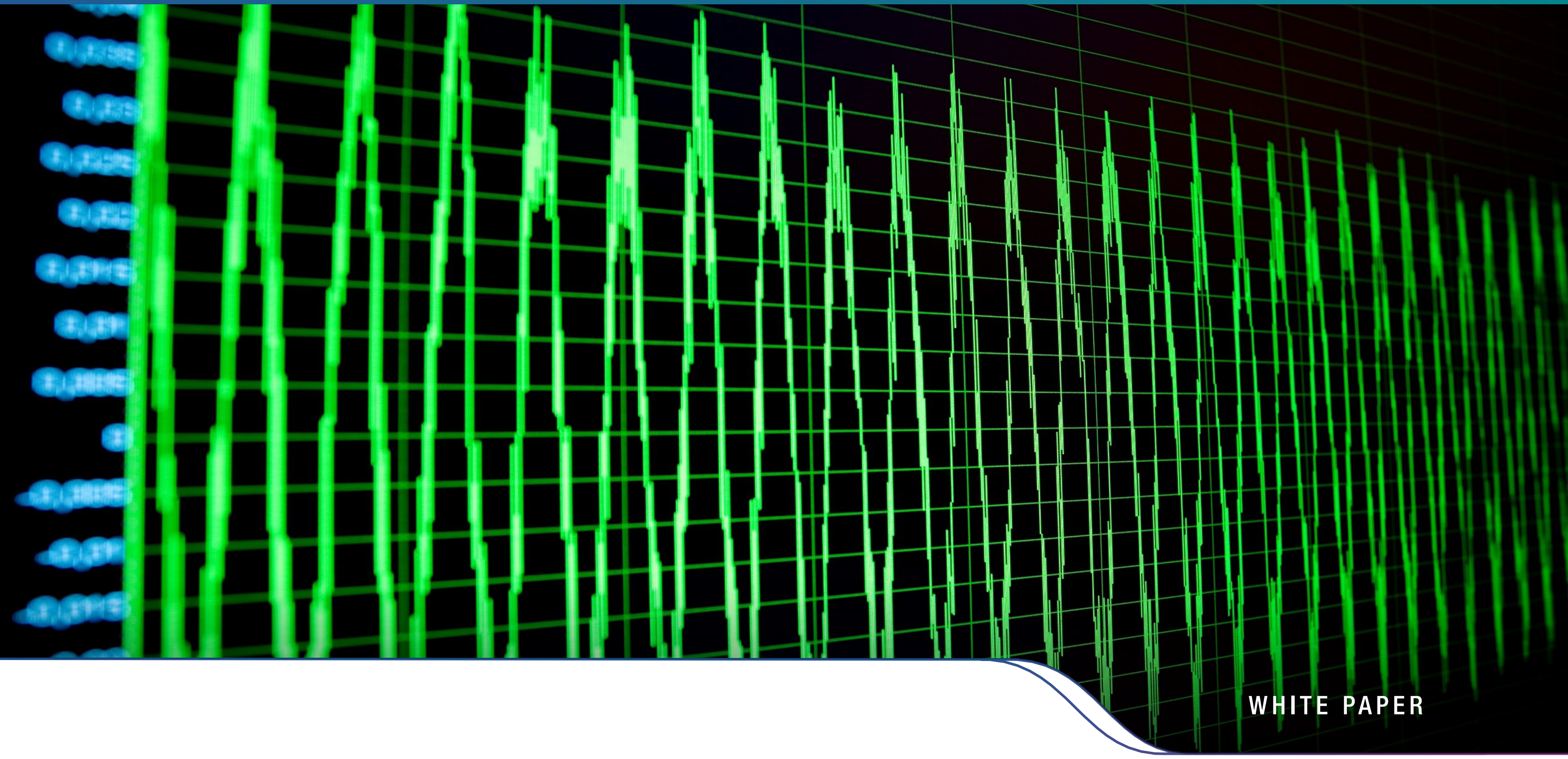

The Oscilloscope of the Future

More Than Just an Oscilloscope

The test engineering team has an extremely challenging job to perform. Along with numerous technical issues, engineers are continuously facing time and schedule time constraints. In most cases, they are also in an environment where their test equipment is inadequate in capacity or performance, if not both. Some standard test instruments on the engineer's bench are an oscilloscope, spectrum analyzer, function generator, frequency response analyzer, logic analyzer, protocol analyzer, counter, and digital voltmeter (DVM). Engineers use these tools for different test requirements — you can imagine the crowded appearance of the test bench area. Now imagine yourself as an engineer who owns the oscilloscope of the future — all test instruments within a single box.

Challenges for Test Engineers

The project timeline in Figure 1 is an example of an end-to-end plan to complete a project. However, as the project continues, you will see changes for the time taken between tasks in each phase of the project. In most cases, the development, validation, and verification teams may take longer to complete their assignment. Some possible reasons could be due to errors that require correction before the next phase.

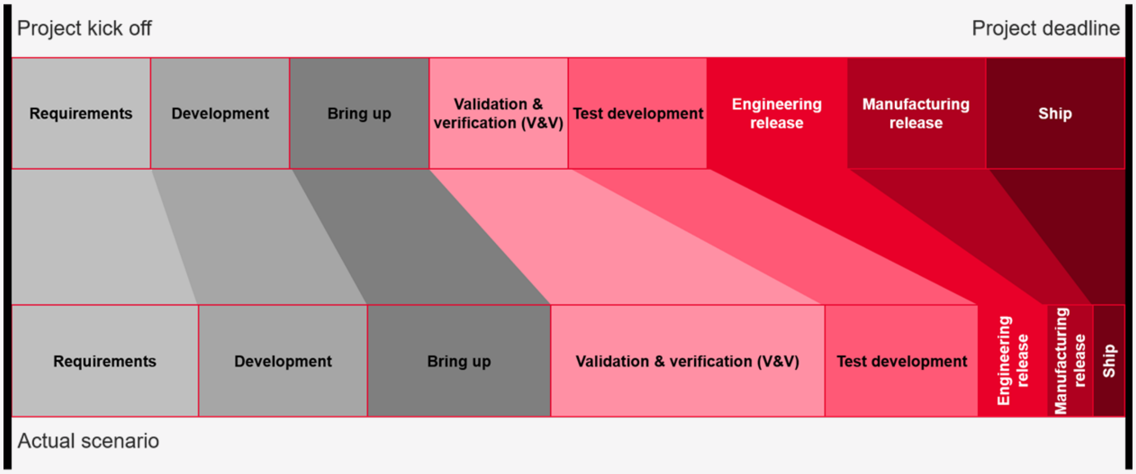

Figure 1. Planned project timeline versus the actual scenario

As a test engineer, the following are key points to think about to help you keep the project on track:

- Reliable instruments because you need quality test data that meets high standards.
- Workbench setup that makes it easy for you to find the tools you need.
- Instrument integration for a single device under test (DUT).
- Software to integrate various code modules in different languages from multiple engineers.
- Legacy test instruments that may have the capacity and performance you need.

Your Future Bench

For a moment, let's imagine an oscilloscope of the future — you will want the following test instruments on your bench.

Digital oscilloscope: 8 channels, 6 GHz, 16 GSa/s

When it comes to time domain signal analysis, an oscilloscope is crucial. An oscilloscope is easily the most used test instrument for many measurement scenarios. Today's test devices require testing multiple inputs and outputs synchronously due to the high-density input / output (I/O) counts in test devices. New technologies such as Wi-Fi 6 and 5G FR1 also require bandwidth beyond 2 GHz. Choosing an 8-analog channel 6 GHz bandwidth digital oscilloscope ensures scalability for current as well as future test requirements, as shown in Figure 2.

Figure 2. Screen view of an 8-analog channel 6 GHz bandwidth digital oscilloscope

Waveform generator: 50 MHz

Most test requirements call for a 50 MHz generator. The waveform generator should have common waveforms preconfigured for ease of use. For example, sine, square, pulse, triangle, ramp, noise, DC, cardiac, sinc, exponential rise / fall, and arbitrary. It must be user-friendly to send command signals, simulate channel noise, and stress test the device with ease.

Frequency response analyzer: 50 MHz, magnitude, and phase

Using a matching 50 MHz frequency response analyzer (FRA) completes the process of any stress test with a 50 MHz waveform generator as an input. While an oscilloscope provides the time domain information, the FRA will provide you with the frequency response information. You should be able to view the bode plot, either in a single or sweep frequency mode. Figure 3 shows it is important to confirm that there are up to 1,000 test points across the test range with an automatic gain / phase margin.

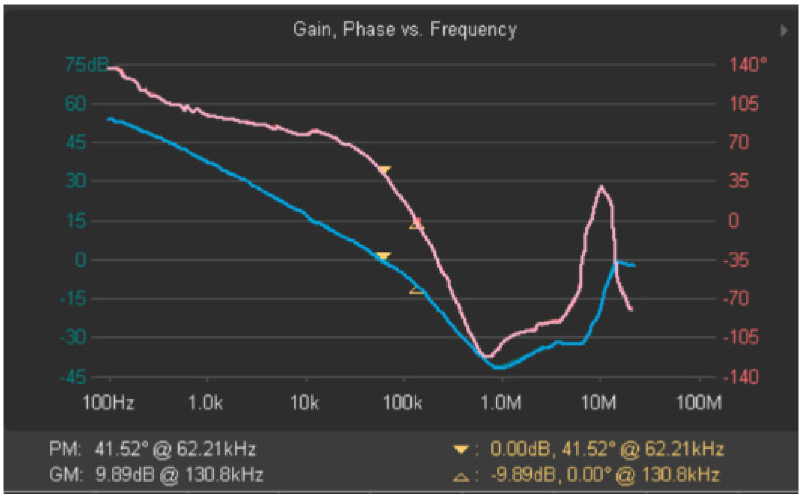

Figure 3. Magnitude and phase bode plot

Real-time spectral analyzer: 320 MHz span

While the FRA gives you the frequency response analysis, a spectrum analyzer is crucial to capture errors in the frequency domain. If you have experienced the challenges of error detection, it's best to choose the real-time spectral analyzer (RTSA) rather than the basic individual Fast Fourier Transform (FFT) method for accurate error detection. Figure 4 displays the RTSA with a 100% probability of detection in the frequency domain, even for asynchronous errors. With the RTSA, you can also detect errors caused by intermittent power supply noise and noise effects, signal crosstalk, and the influences of the environment on the signal.

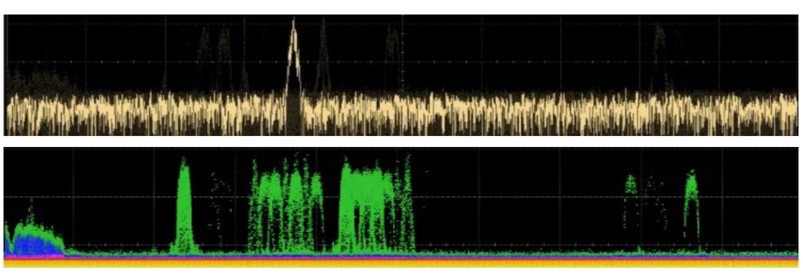

Figure 4. FFT (top) versus RTSA (bottom) for the same *Bluetooth*™ signal providing 400x more information

Logic analyzer and mixed-signal oscilloscope: 16 channels, 2 ns, 8 GSa/s

Almost all devices under test are mixed-signal devices. The convergence of technologies enables devices to have both analog as well as digital I/Os within a single DUT, no matter what the application areas are. You need to correlate the analog as well as the digital domains synchronously during testing. Figure 5 results are from a logic analyzer with mixed-signal oscilloscope (MSO) capabilities with at least 16 channels to connect these different types of signals. Other important requirements are data interpretation, protocol triggering, and decoding capabilities. The logic channels require a high sampling rate of at least 8 GSa/s.

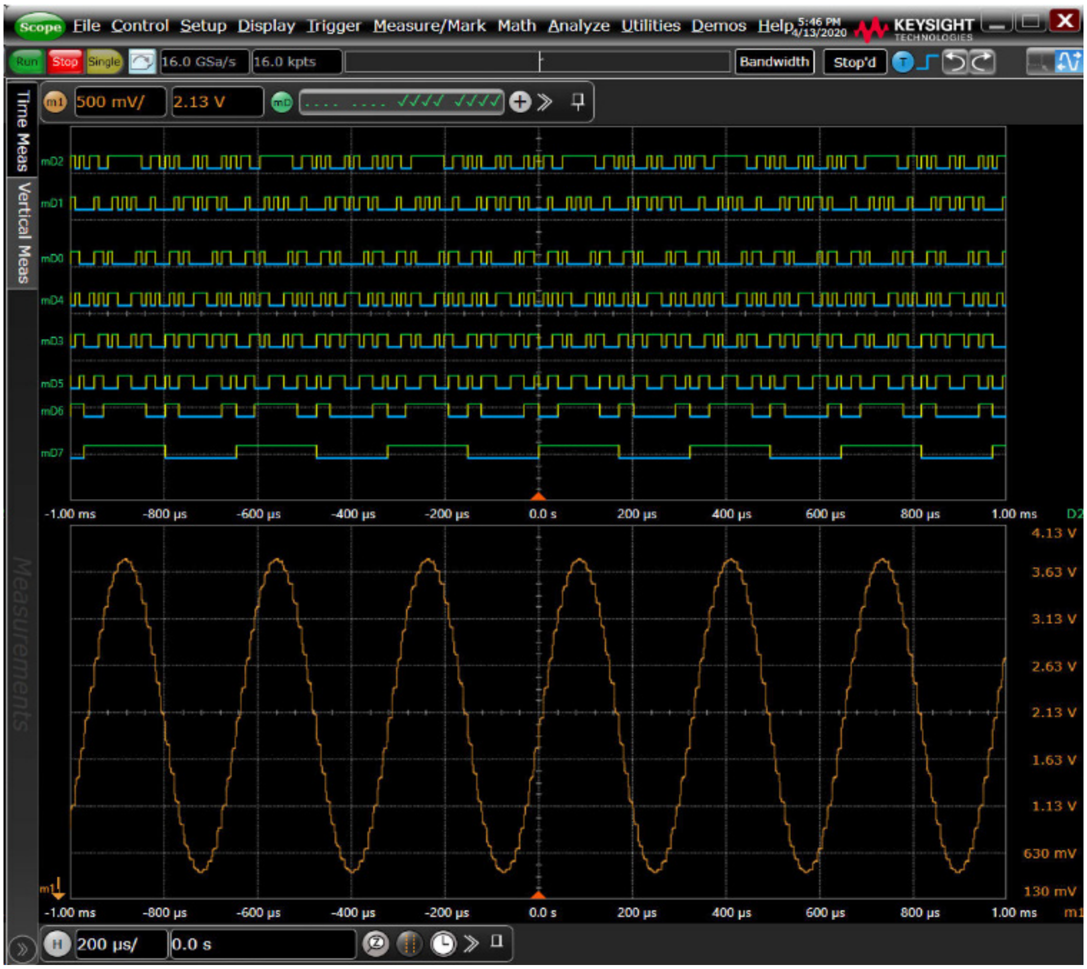

Figure 5. Synchronous analog and digital domain correlation with MSO capabilities

Protocol analyzer: Dozens of protocols

Logic analyzers will help you perform digital domain signal analysis. However, consider all layers of the physical anomalies to ensure accurate test results. A protocol analyzer is essential for hardware triggering as well as analog data synchronization. Commonly used protocol triggers and decodes are necessary for test implementation. Some widely used protocols depending on the application areas are:

- Low-speed: I2C, SPI, Quad SPI, eSPI, Quad eSPI, RS232 / UART, I2S, SVID, JTAG, Manchester, and 10 / 100 Ethernet
- MIPI: RFEE, I3C, and SPMI
- USB: USB 2, USB 3, USB-PD, and eUSB2
- Automotive: CA / CAN FD, LIN, SENT, and 100Base-T1
- Military / aeronautics: ARINC, MIL-STD 1553, and SpaceWire

You can perform this analysis manually with the use of a logic analyzer, but that will take hours of your time just developing the protocol triggers and decodes. You would probably prefer to use the limited time available for actual testing and debugging, instead of preliminary code development.

Digital voltmeter: 4 digits and 10-digit counter

Engineers need a digital voltmeter (DVM) and a counter for quick general test measurements. You will see these two basic instruments on most workbenches shown below in Figure 6:

- Working with a DVM of at least four digits of resolution with AC_{RMS}, DC, and DC_{RMS} to take quick measurements.
- Using a 10-digit counter, primary modes are frequency, period, totalize, trigger qualified, and A / B ratio.

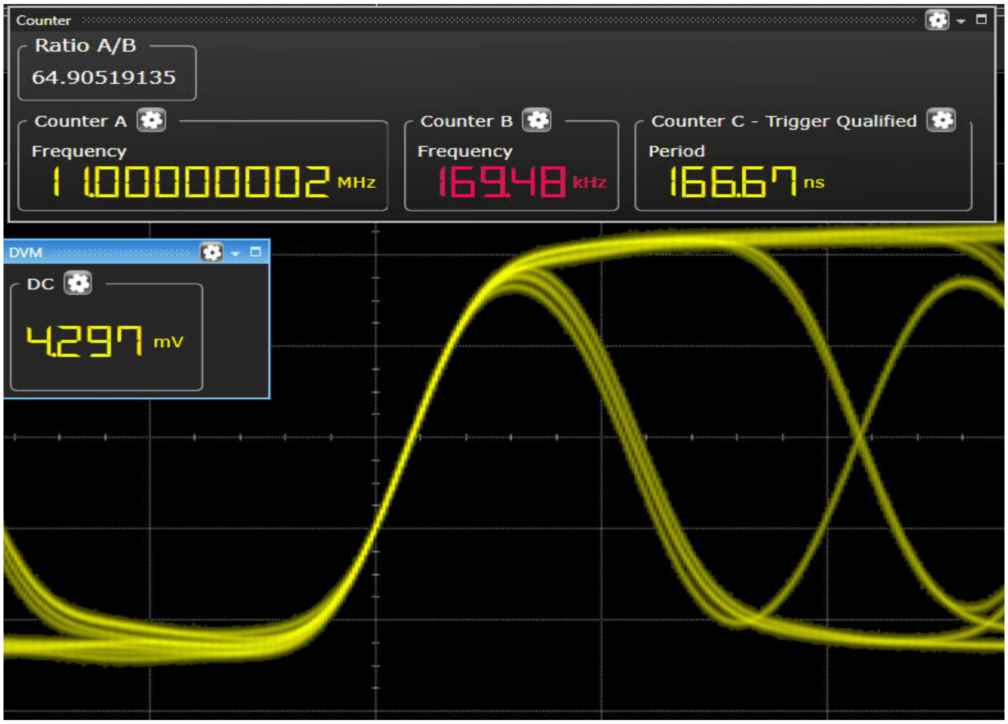

Figure 6. DVM and counter with multiple modes

With these test instruments, everything from instrument sourcing, managing space, cabling and interconnects, hardware / software integration, to actual test, measurement, data storing and results replication are challenges for many test engineers.

The Oscilloscope of the Future

What exactly is the oscilloscope of the future? Imagine your test bench having your test equipment in a single platform. Visualize a single-box instrument that helps you to reduce your test bench and workflow complexity to achieve higher performance accuracy and multi-channel measurement repeatability. That is the oscilloscope of the future.

Reduce bench clutter, setup, and test time

Eight powerful instruments in one platform help you to reduce your bench clutter, setup, and test time while minimizing crosstalk challenges. Because multiple power sources or batteries on your bench to power up your test instruments are no longer necessary, you reduce your expenses. You no longer need to spend most of your time setting up your devices for each DUT. Efficiently perform data visualization, capturing, analysis, and recording on a single view screen, instead of multiple individual instruments. This capability reduces the background processes you must follow before performing tests, further decreasing the test time. Figure 7 is a visualization of today's setup versus an oscilloscope of the future.

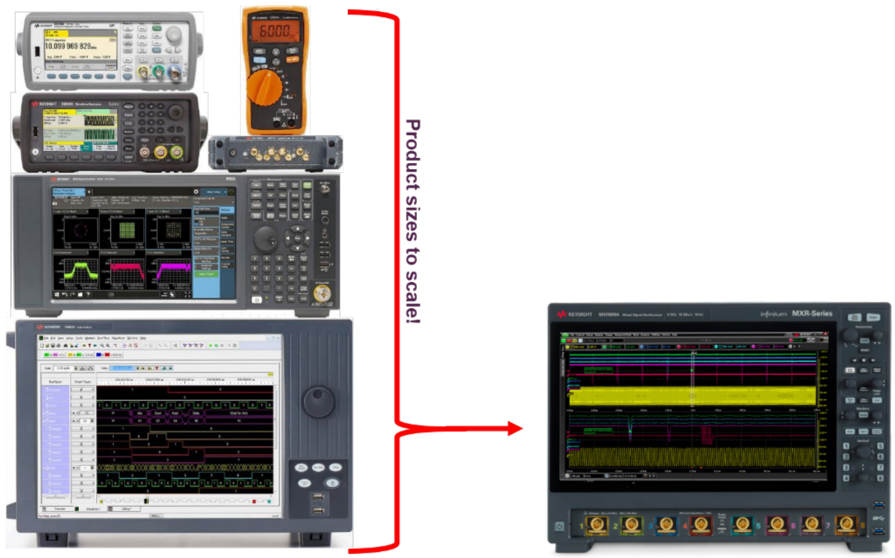

Figure 7. Bench clutter and space issues solved by the oscilloscope of the future

Solve signal faults and errors faster

The oscilloscope of the future should help you save engineering time by accelerating the signal fault and error detection. The data should also have a proper correlation with all other signals that may contribute to the error. Having a “fault hunter” function that learns the “normal” signal and compares it over a specific period to locate any “abnormal” signals automatically will greatly reduce the test time. You can compare data from over the weekend and understand quickly when and where the error occurred and what caused it. The fault hunter function enables you to determine the solution to the error quickly, demonstrated in Figure 8 below.

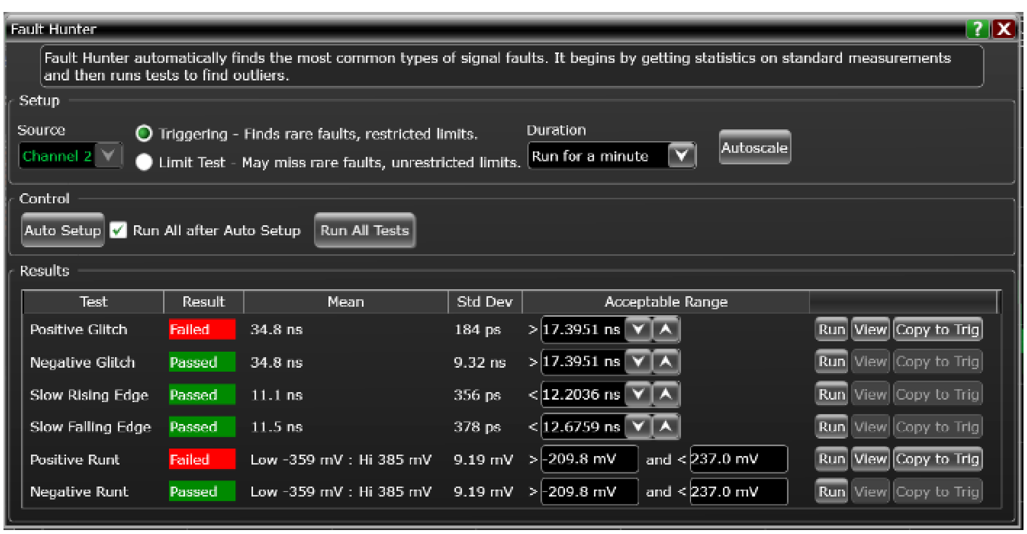

Figure 8. Setup and results page for automated fault hunter capabilities

Requirements for digital and IoT engineers

Digital / IoT engineers must test the DUT for frequency domain characteristics in correlation with power density using a spectrum view. As shown in Figure 9, up to eight channels are necessary to perform synchronous frequency measurements on multiple channels along with capturing fleeting or transient signals with a gap-free real-time spectrum analyzer (RTSA). Some cases require digital down-conversion of I/Q data streams up to 2 GHz. Signal isolation using flexible frequency mask triggering is useful for troubleshooting. It is also necessary to perform advanced signal analysis from multiple source codes, including MATLAB, to extract signal features.

Figure 9. In-depth signal analysis with RTSA

Requirements for high-speed digital engineers

High-speed digital engineers will have different test requirements. A key critical task is to perform hardware triggering to capture physical layer anomalies. The oscilloscope of the future requires high-processing power using state-of-the-art application-specific integrated circuit (ASIC) to improve decoding speed for effective and efficient test results. The trigger function is essential to achieve precise signal characterization, as it synchronizes the horizontal sweep of the oscilloscope to the appropriate point of the signal. The trigger control enables engineers to stabilize repetitive waveforms as well as capture single-shot waveforms. The oscilloscope will need a selection of protocol triggers, decodes, as well as automated compliance built-in testing capabilities, shown below in Figure 10. Cable or fixture effects require easy removal using internal de-embedding capabilities.

Jitter analysis will require further enhancements to have the capabilities to analyze, measure, deconstruct, and plot the different components of the jitter. The oscilloscope of the future needs widened eyes insight capabilities by removing the effects of channel noise and inter-symbol interference (ISI). It should also help you by providing a secure method to simulate and eliminate the impact of aggressors on signals.

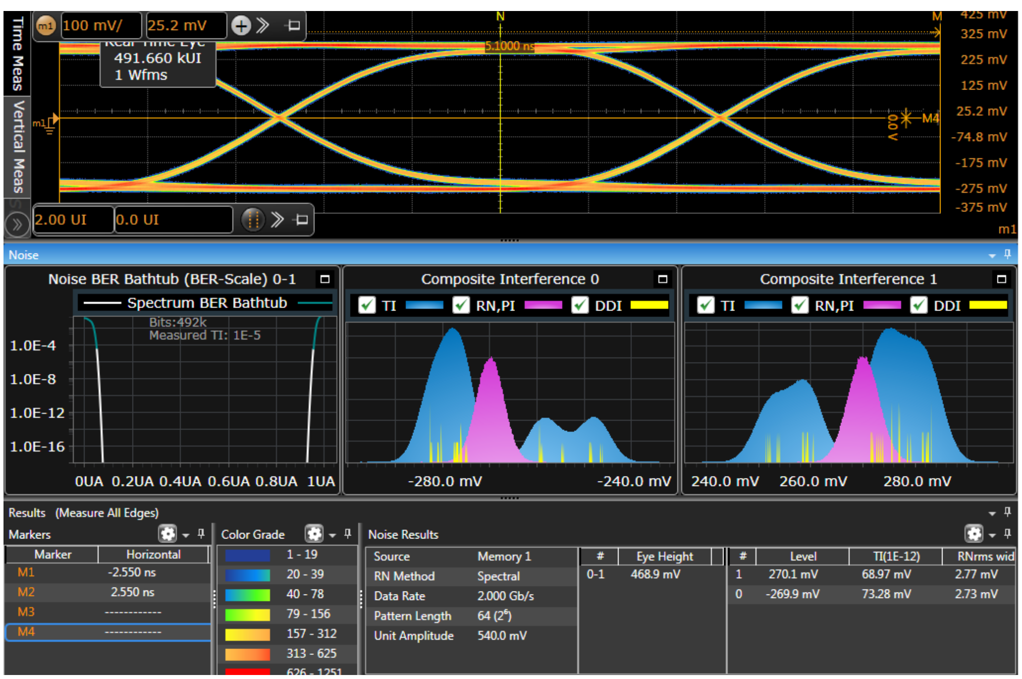

Figure 10. Hardware and visual triggering to capture physical layer anomalies

Requirements for power integrity engineers

An added benefit for the “what if” analysis is the assessment of the effective current state versus potential improvement state, shown in Figure 11 below. A power sequencing evaluation for power management ICs (PMICs) enables automatic timing measurements to help you save time and effort to reduce any human errors. This measurement is achievable using a frequency mask option that tests on every channel to remove any manual marker placements effectively. Another enhancement gives you the capability to improve battery life and energy efficiency by correlating product functions with power consumption.

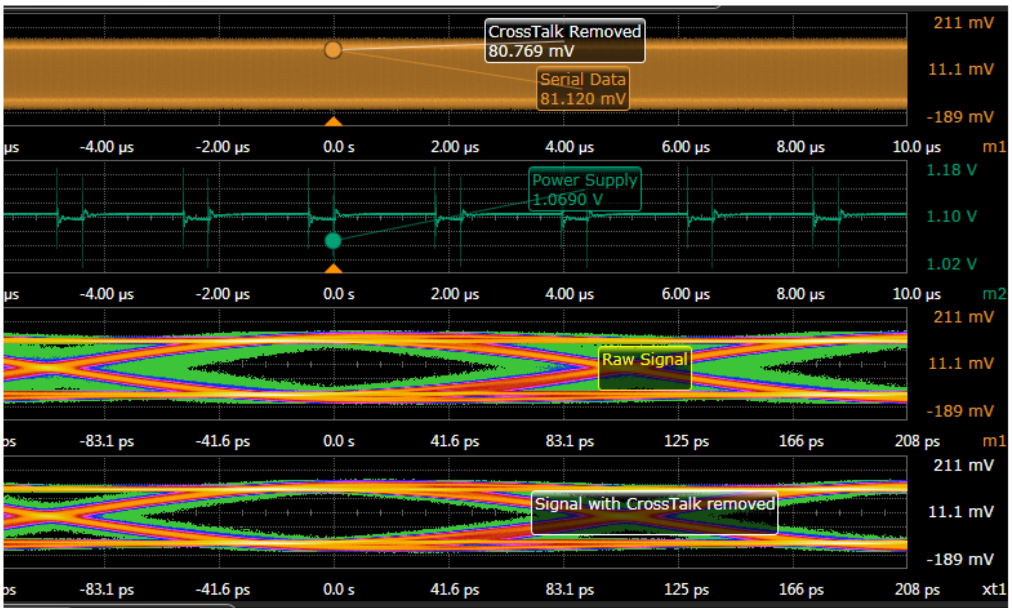

Figure 11. “What if” analysis with additional signal enhancements

Reduced time to market with remote collaboration

The oscilloscope of the future will provide remote collaboration capabilities. The remote collaboration capabilities enable you to perform extensive analysis and data manipulation before, during, and even after the bench measurements are complete. You will have the ability to create an offline experience that completely mirrors the oscilloscope without the hardware. This capability will help the extended team to move from a live test environment with zero training required. Documentation and data sharing among project members will no longer be a tedious process. Global access to critical data will reduce the overall troubleshooting time for random errors to improve the entire test workflow — allowing for a faster time to market.

Summary

The oscilloscope of the future needs to help engineers design and test complex designs and provide insight into more signals. The oscilloscope of the future goes from symptom to root cause to resolution in minutes instead of hours.

The oscilloscope of the future is the newly released Keysight 8-in-1 Infiniium MXR-Series oscilloscope. Add the Infiniium MXR-Series oscilloscope to your bench and deliver designs that impress.

Learn more at www.keysight.com/find/mxr.

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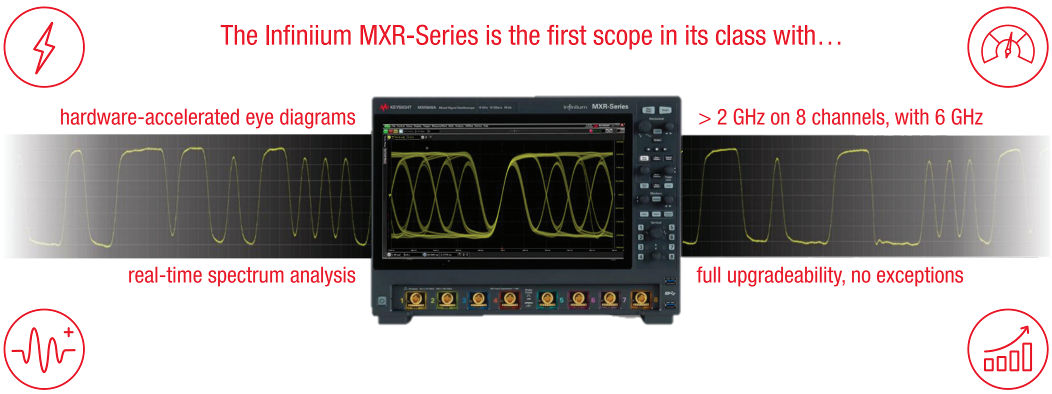

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