

A shared vision for excellence in signal integrity



In today's digitally connected world, USB cables are far more than simple connectors: they are high-speed data highways and power lifelines. Fast charging, real-time audio streaming and seamless data transfer demand ever more complex performance and reliability standards. Even the slightest signal degradation, whether from cable imperfections or connector faults, can result in device malfunctions and communication errors and, inevitably, customer dissatisfaction. In safety-critical spheres such as emergency services, aviation or construction, reliable communication is vital for safe and coordinated operations. In these environments, interference-free audio signals are indispensable and disruptions can have serious consequences – even personal injury. Intelligent cables – which go beyond simple data transmission and include embedded components and even programmable electronics – are increasingly being used in these safety-critical areas. As a result, testing and validation has become even more complex.

Project challenges

A long-standing MCD customer specializes in the production of communication units. Their existing system uses a custom End-of-Line system from MCD to successfully test controls used in their devices such as buttons, switches and rotary knobs. Their system tests both the electrical contacts and the haptics, ensuring tactile feedback, actuation force and signal continuity meet specifications. As these components are used in critical systems, there are exacting requirements for both functional reliability and traceability. Building on their previous positive experience with MCD, the customer chose to extend the existing test routines, beyond testing individual controls in isolation, to testing the entire assembly and its USB interfaces. The aim: to establish a comprehensive end-of-line test strategy that ensures system-level validation in line with application-critical requirements.

Design requirements

The planned system needed to combine established test routines – logic validation, digital interface checks and HF-sensitive connection checks – with advanced signal integrity analysis, serial protocol decoding and detection of anomalies on USB lines. Since a control PC was already part of the system architecture, and due to the strict industry standards, a USB-based oscilloscope was determined to be the most appropriate solution.

The oscilloscope itself needed to provide high-end measurement capabilities and seamless integration into a test environment, while providing scalability for the future.

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Design requirements (continued from page 1)

The system needs to be able to analyze timing and signal integrity metrics. These metrics include signal-to-noise ratio, voltage levels, rise/fall times and jitter. The ability to draw eye diagrams of the USB data lines (D+/D-) would allow intuitive visual representation of these metrics to enable engineers to quickly assess if requirements had been met.

Joint expertise in action

Pico Technology, with their in-depth oscilloscope knowledge and extensive applications experience, proved to be the ideal partner. In-depth technical discussions highlighted their comprehensive understanding of high-speed signal diagnostics, while their integration-oriented mindset stood out right from the start of development. From early design discussions all the way to implementation, the collaboration between MCD Elektronik and Pico's engineering team was characterized by open communication and technical alignment. Together, MCD and Pico created a solution for holistic USB cable testing, with a particular focus on USB 2.0 Full Speed signal integrity.

The design

The heart of this new test system is the PicoScope 6404E, with 500 MHz bandwidth, 5 GS/s sampling rate and 2 GS deep memory. These specifications allow for testing of the current USB 2.0 cable designs while leaving headroom for future cable performance increases. Meanwhile, the advanced trigger capabilities of the PicoScope 6404E allow targeted signal capture under real production conditions.



Using the flexible PicoSDK software, MCD integrated the oscilloscope into its system. The TestMate interface, one of several sequencers within MCD's TestSuite platform, handled communication between the PicoScope and the test sequence control. MCD's TestSuite platform also includes Comet and TestManager, and these components work in combination with a wide range of Toolmonitors for easy device communication. These software components act as protocol-agnostic interfaces to external instruments, enabling flexible and scalable integration via Ethernet, USB, CAN or even proprietary APIs. The modular software architecture enables the user to configure and adapt the fixture for new cable types with minimal effort, ensuring compatibility with existing production environments as well as supporting future system expansion. Finally, test execution is managed by the integrated StateMachine, which structures the process into clearly defined steps, simplifying operation and diagnostics.

All of these building blocks – the PicoScope 6404E, PicoSDK and MCD's TestSuite – allow for fast, repeatable analysis of USB 2.0 Full speed parameters, improving detection of signal anomalies and raising the quality benchmark for complex cable assemblies.



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Implementing the design

The integration of the PicoScope 6404E into MCD's test environment was the result of close cross-team collaboration, with a shared engineering mindset and clear vision. The comprehensive PicoSDK allowed MCD to incorporate the oscilloscope as a fully integrated measurement module: every feature of the scope was exposed, from advanced trigger control to eye diagram generation and signal evaluation of the USB data lines. For MCD, it was particularly advantageous that the C-based DLLs of the PicoSDK are very powerful libraries that cover a wide range of functions. This was especially helpful when defining the complex trigger conditions. Detailed documentation and support were also helpful in these terms. Meanwhile, the hardware of the PicoScope 6404E, such as advanced triggering and deep memory, proved essential for detecting jitter, reflections and protocol-level anomalies even in real-world test conditions.

Outcomes driving future innovation

This successful collaboration resulted in a comprehensive and powerful, yet compact, test solution. MCD Elektronik and Pico Technology have, with this new system, combined their deep understanding of high-frequency signal analysis and measurement technology.

The key achievements included

- // Seamless integration of the PicoScope 6404E into MCD's TestSuite using PicoSDK
- // Reliable validation of USB 2.0 Full speed signal quality using eye diagram analysis
- // A notable reduction in time-to-validation for complex cable using eye diagram analysis

The system was then taken a step further. MCD's AudioAnalyzer was added to the system to test various audio signals (speaker and microphone). The system was then used to stimulate digital inputs and outputs and check the UART communication system. Finally, the DUT configuration was transferred using the 1-Wire EEPROM communications protocol. Beyond the immediate technical success, the project clearly demonstrated the value of collaborative engineering across company boundaries. By aligning deep oscilloscope expertise with flexible test system design, MCD and Pico have paved the way for future cooperation in the development of testing solutions. Looking ahead, this partnership opens the door to new innovations, such as the joint development of new SmartModuleS oscilloscope modules that can offer scalability, high performance and seamless integration into MCD's platform. The productive teamwork on this project has laid a strong foundation for continued collaboration and shared technical advancement.



About Pico Technology GmbH

Pico Technology is a world leader in the design, development and manufacture of high-performance PC-based oscilloscopes, data loggers, and RF test equipment. With over 30 years of experience, Pico has revolutionized the market by offering compact, cost-effective and reliable solutions across the globe.



About MCD Elektronik GmbH

MCD has been developing and manufacturing customized test systems for electronic production since 1983. The company focuses on zero-error quality assurance for customers in industries such as automotive, energy, sensor technology, aerospace, medical and laboratory applications, and telecommunications.