Multi-Port Cable-Wire Harness Test Solution

SOLUTIONS

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SIGLENT TECHNOLOGIES CO.,LTD

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1 OVERVIEW

Next-generation computer and communication systems will handle data rates of several gigabits per second. Many systems will utilize processors and SERDES chip-sets with clock frequencies exceeding gigahertz. As switches, routers, server blades, and storage area network (SAN) equipment advance towards 800 Gbps and 1.6 Tbps data rates, new and challenging input/output (I/O) issues arise. Digital design engineers selecting chip-to-chip, chip-to-module, and backplane technologies for these systems encounter signal integrity challenges previously unseen.

Traditional parallel bus topologies have exhausted their bandwidth. As parallel buses grow wider, the complexity and cost of PCB trace routing increase dramatically. The escalating skew between data and clock lines becomes increasingly difficult to manage within parallel buses. The solution lies in high-speed serial channels. Newer serial bus architectures are rapidly replacing parallel bus structures in high-speed digital systems. Engineers are increasingly adopting multi-gigabit serial interconnect protocols with embedded clocks to achieve simpler routing and greater bandwidth per channel.

2 CHALLENGE

New serial buses require increased data rates. As data rates escalate over serial interconnects, the rise time for data transitions from logic level 0 to 1 becomes shorter. This reduced rise time causes larger reflections at impedance discontinuities and degrades the eye diagram at the channel's end. Consequently, physical layer components such as printed circuit board (PCB) traces, connectors, cables, and IC packages can no longer be neglected.

To maintain signal integrity throughout the channel, engineers are shifting from single-ended circuits to differential circuits. Differential circuits offer good Common-Mode Rejection Ratio (CMRR) and help shield adjacent PCB traces from crosstalk. Well-designed differential transmission lines minimize the detrimental effects of mode conversion and enhance maximum data rate throughput. However, testing for differential signal integrity is less intuitive.

The combination of differential transmission lines and the microwave effects of high-speed data necessitates new design and validation tools for digital engineers. Understanding the fundamental characteristics of signal propagation through measurement and post-measurement analysis is essential for today's cutting-edge telecommunications and computer systems. While the traditional Time Domain Reflectometer (TDR) remains a highly useful tool, a Vector Network Analyzer (VNA) is often required to fully characterize physical layer components. There is a critical need for a test and measurement system capable of simply characterizing the complex microwave behavior emerging in high-speed digital interconnects.

Many high-speed protocols have adopted the SDD21 parameter (differential insertion loss) as a mandatory measurement for ensuring channel compliance. This parameter represents the frequency response of a differential signal propagating through a high-speed serial channel.

3 SOLUTION

Siglent's Vector Network Analyzer (VNA) SNA5000/6000 Series, equipped with the SSM5000A Series Switch Matrix, enables expansion up to 24 ports. Combined with the TDR or TDA option, it facilitates high-speed, precise measurement of various parameters for multi-port wire harnesses, high-speed PCBs, including Time Domain Reflectometry (TDR), characteristic impedance, mixed-mode S-parameters, and more.

Figure1: Siglent Vector Network Analyzer SNA6000 Series equipped with SSM5000A Switch Matrix enabling 24-port expansion

The SSM5000A Series Switch Matrix connects to the SNA5000/6000 VNA via USB cable, enabling "native" port expansion. This means the switch matrix ports appear directly on the SNA5000/6000 main interface, allowing direct testing (e.g., S24,23 for transmission from port 23 to port 24). Furthermore, rapid calibration is achievable using Siglent's 4-port Electronic Calibration Module (Figure 2).

Figure 2: Calibration wizard for multi-port electronic calibration module

The SSM5000A can connect any two of its subordinate ports to the VNA ports, enabling measurement of any Sxx (reflection) or Sxy (transmission) parameter.

Siglent's SNA5000/6000 VNAs offer two time-domain test options: TDR and TDA. The enhanced TDR measurement features a wizard-guided operation for rapid characteristic impedance measurement of transmission lines (Figure 3). It incorporates convenient De-skew functionality to quickly eliminate the effects of fixtures, probes, etc.

In TDT (Time Domain Transmission) mode, it can generate the "ideal" eye diagram of a high-speed digital signal after passing through the network under test (Figure 4), supporting data pre-emphasis, equalization, and jitter injection. TDR is suitable for R&D and production testing.

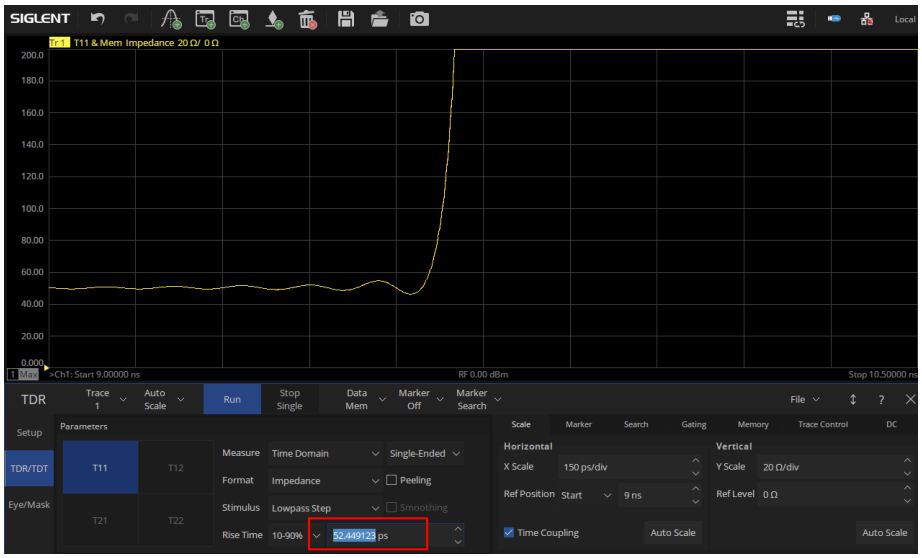

Figure 3: Convenient characteristic impedance testing of a transmission line using the TDR option on Siglent SNA5000/6000 VNA

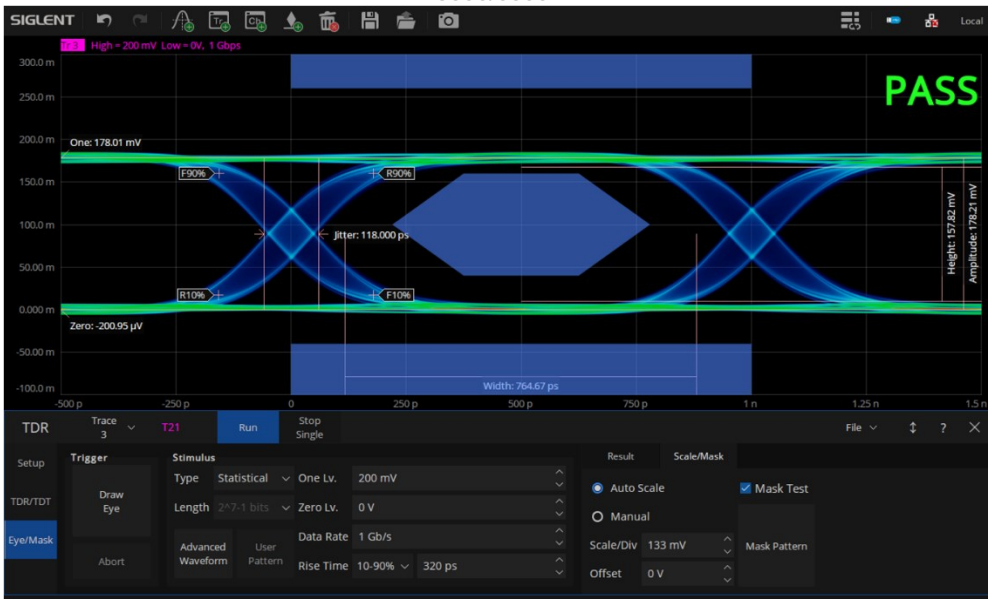

Figure 4: Eye diagram testing in TDT mode

TDA (Time Domain Analysis) is a more streamlined and cost-effective (slightly lower-priced) time-domain test option. It enables measurements like characteristic impedance and can simultaneously display time-

domain and frequency-domain results, but does not generate eye diagrams. The TDA option currently provides full support for the SSM5000A Series Switch Matrix, enabling multi-port cable, wire harness, and PCB testing. It is well-suited for high-volume production line testing.

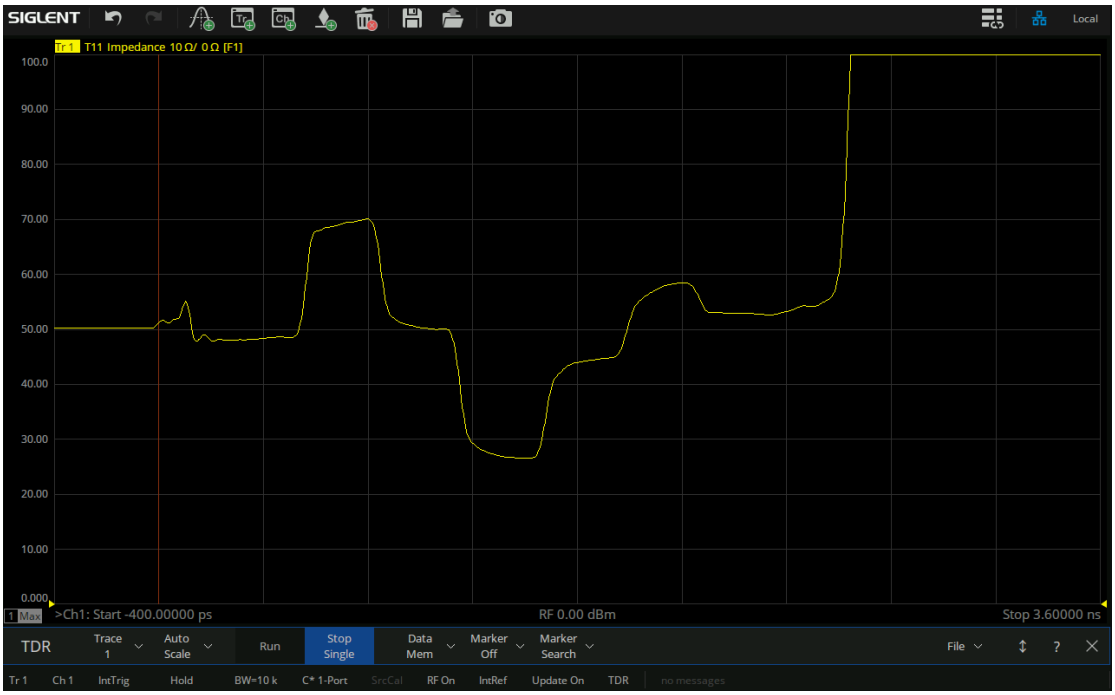

Figure 5: Characteristic impedance testing in TDA mode

Siglent oscillators equipped with analysis software and probes can automatically record all required multi-domain data and analyze the most common serial buses such as I2C, SPI, and UART. This solution supports protocol analysis using the segmented memory acquisition function.

About SIGLENT

SIGLENT is an international high-tech company, concentrating on R&D, sales, production and services of electronic test & measurement instruments.

SIGLENT first began developing digital oscilloscopes independently in 2002. After more than a decade of continuous development, SIGLENT has extended its product line to include digital oscilloscopes, isolated handheld oscilloscopes, function/arbitrary waveform generators, RF/MW signal generators, spectrum analyzers, vector network analyzers, digital multimeters, DC power supplies, electronic loads and other general purpose test instrumentation. Since its first oscilloscope was launched in 2005, SIGLENT has become the fastest growing manufacturer of digital oscilloscopes. We firmly believe that today SIGLENT is the best value in electronic test & measurement.

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