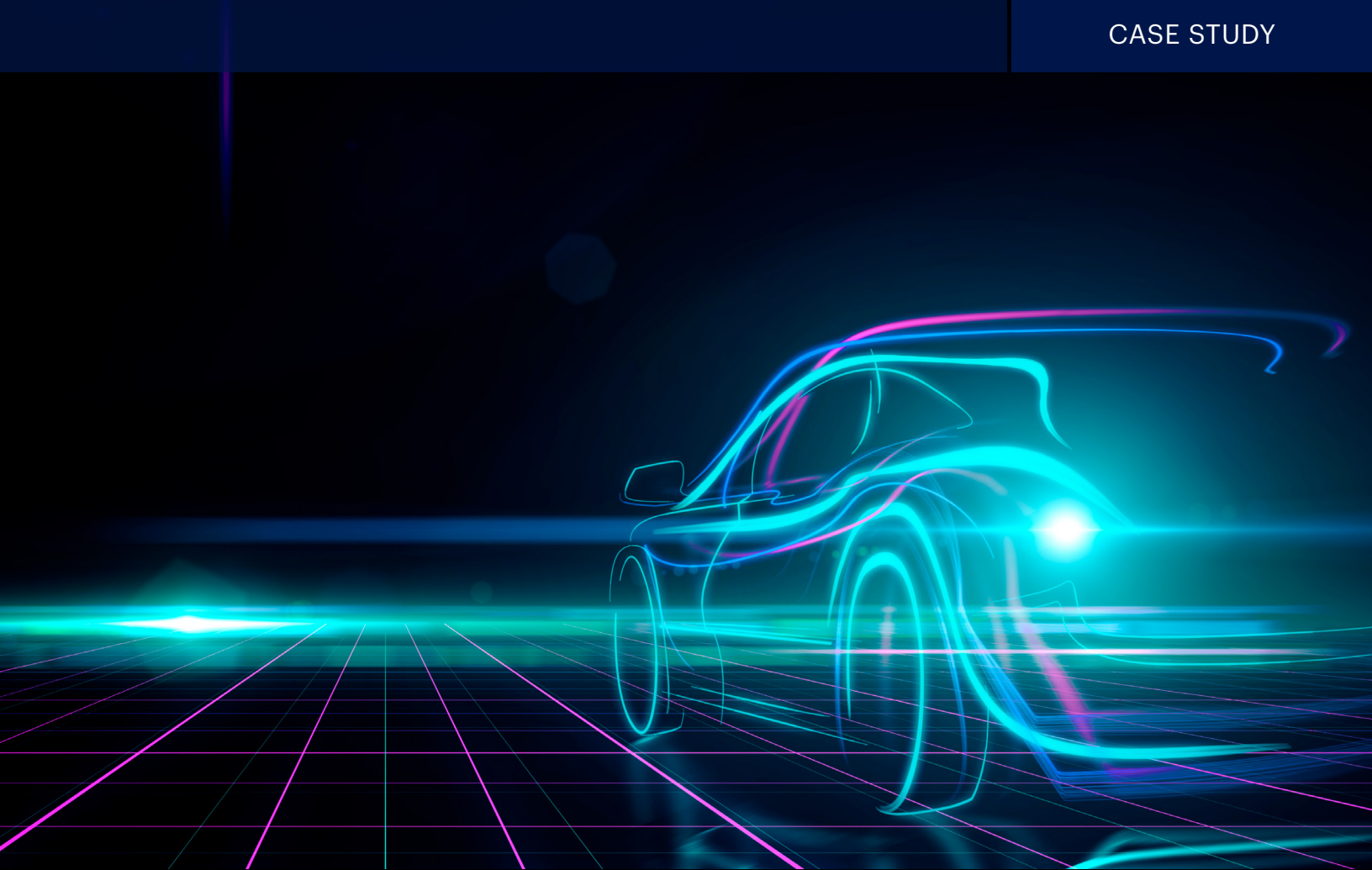




Putting the Future in Motion with Automotive Ethernet

Organization

- Continental AG Interior Division¹

Challenges

- Implement high-speed designs that use automotive Ethernet at two data rates
- Thoroughly test those designs in a reasonable amount of time
- Validate design compliance with relevant IEEE standards

Solutions

- Keysight Infiniium S-Series mixed-signal oscilloscope
- Keysight N6467B Automotive Ethernet 100BASE-T1 electrical compliance application
- Keysight N8847A Automotive Ethernet 100BASE-T1 protocol triggering and decode software
- Keysight E6960A 100BASE-T1 transmitter compliance application

Results

- Deep stress testing enabled designers to achieve 100% of performance targets for its new modules
- Saved 30 percent overall test development time

Automobile innovating is accelerating at a rapid pace. Built-in infotainment systems—information and entertainment—demand higher speed wireless connections. Advanced electronic safety and convenience systems, built with cameras, radar, and lidar, are driving exponential data growth. All this data is traveling on wired networks inside next-generation vehicles.

Integrating these technologies is one of the biggest challenges facing the Interior division of Continental Aktiengesellschaft (AG) of Hanover, Germany. Information management in and beyond the vehicle is at the very heart of the Interior division. The product portfolio includes: instrument clusters, multifunctional and head-up displays, control units, access control and tire-information systems, radios, infotainment systems, input devices, control panels, climate control units, software, cockpits as well as services and solutions for telematics and Intelligent Transportation Systems.

The Challenge: Dealing with High-speed Data Buses

With wide deployment of advanced driver-assistance systems for autonomous vehicle features in the industry, Continental's Interior division aspires to achieve a failure rate as close to zero as possible for its products.

Performing thorough testing that stresses each design and reveals potentially risky problems is a key challenge for Continental. Continental must achieve broad and deep test coverage in a reasonable amount of time, initially in R&D and later during mass production.

Stressing systems was relatively simple when working with low-speed buses such as CAN, LIN and MOST. Those legacy buses cannot provide enough speed or bandwidth to handle the data load in next-generation vehicles. Automotive Ethernet is an emerging solution, providing either 100 Mbps or 1,000 Mbps bandwidth.

From an engineering perspective, the next-generation automotive challenge lies in troubleshooting high-speed digital signals that are more sensitive and complex than CAN or LIN. Unlike those buses, automotive Ethernet requires rigorous compliance verification with test cases that cover transmitters, receivers and harness/connector assemblies. Many of these tests are too difficult and time consuming to perform manually.

All these challenges came together with a project that integrated 1000BASE-T1 chips into an automotive system built around a n-port Ethernet gateway. The gateway needed to be capable of supporting 100BASE-T1, 1000BASE-T1, DDR memory, and USB connectivity. The design team searched for a test solution that would help them meet external and internal expectations: ensure transmitter compliance; satisfy the OEM's performance requirements; and meet Continental's in-house goals for efficiency, effectiveness and innovation.



The Solution: Saving Time with Application-specific Tools

Continental selected Keysight solutions based on Keysight's automotive Ethernet leadership. Continental recognized Keysight as the first to deliver an oscilloscope application providing 100BASE-T1 protocol decoding. In addition, Keysight was the first to demonstrate 1000BASE-T1 measurements.

A major benefit of the Keysight solution was the compliance test suite, which automated complex tests and procedures for 100 and 1000BASE-T1. To address Continental's specific needs, Keysight's Application Engineering Organization customized the solution, integrating a switch matrix to incorporate other test setups and drive multiple device connections in sequence. This also provided the ability to activate external test instruments in environmental test chambers. The automated compliance test solution saved Continental over 30 percent in overall test development time.

The solution² included the following key elements:

- Keysight MSOS104A Infiniium S-Series Mixed-Signal Oscilloscope (1 GHz, four channels)
- Keysight N6467B Automotive Ethernet 100BASE-T1 compliance application
- Keysight N8847A Automotive Ethernet 100BASE-T1 protocol triggering and decode software
- Keysight E6960A 1000BASE-T1 transmitter compliance application

These application-specific elements embody Keysight's commitment to the latest standards. The result was an automated, repeatable compliance testing solution that helped Continental engineers understand, integrate and deploy these new technologies successfully (Figure 1).

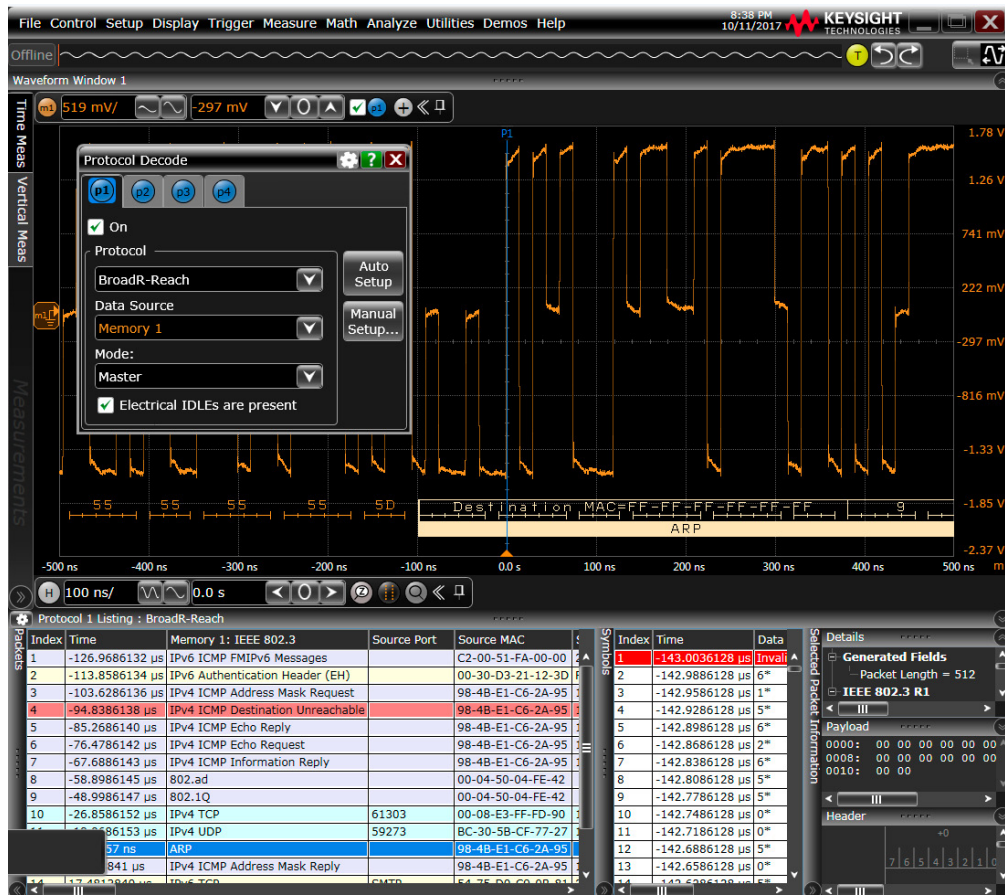


Figure 1. In the Keysight N8847A software, the multi-tab protocol viewer enabled Continental engineers to quickly move between physical- and protocol-layer information using the time-correlated tracking marker.

The Results: Ensuring Performance and Compliance

The Keysight solution enabled Continental to automatically execute tests and display the results in a flexible report format (Figure 2). In addition to measurement data, the reports provided margin analysis that showed how closely a device passed or failed each test.

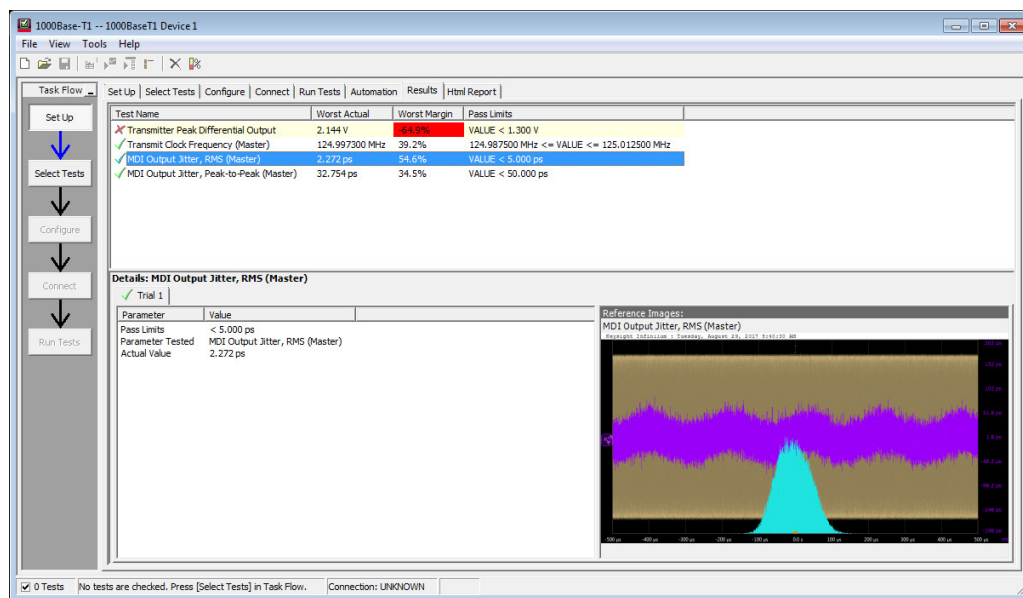


Figure 2. The E6960A application accelerates compliance testing of 1000BASE-T1 automotive Ethernet transmitters. Here, the results screen shows a summary of performed tests, pass/fail status, margin analysis, and an HTML file containing screen shots of completed tests.

When troubleshooting a failed test, the ability to debug at the protocol level made it possible to correlate data in the actual frames and packets with the bytes in the physical layer (Figure 3). Ultimately, this solution enabled the team to perform an array of deep stress tests and ensure the new module could deliver 100% of design performance objectives.

Index	Time	Memory 1: IEEE 802.3	Source Port	Source MAC	Source IP
	-126.9686132 µs	IPv6 ICMP FMIPv6 Messages		C2-00-51-FA-00-00	2001:0DB8:0000:0012:0000:0
	-113.8586134 µs	IPv6 Authentication Header (EH)		00-30-D3-21-12-3D	FE80:0000:0000:0000:0230:D
	-103.6286136 µs	IPv4 ICMP Address Mask Request		98-4B-E1-C6-2A-95	141.121.237.191
	-94.8386138 µs	IPv4 ICMP Destination Unreachable		98-4B-E1-C6-2A-95	141.121.237.191
	-85.2686140 µs	IPv4 ICMP Echo Reply		98-4B-E1-C6-2A-95	141.121.237.191
	-76.4786142 µs	IPv4 ICMP Echo Request		98-4B-E1-C6-2A-95	141.121.237.191
	-67.6886143 µs	IPv4 ICMP Information Reply		98-4B-E1-C6-2A-95	141.121.237.191
	-58.8986145 µs	802.ad		00-04-50-04-FE-42	
	-48.9986147 µs	802.1Q		00-04-50-04-FE-42	
0	-26.8586152 µs	IPv4 TCP	61303	00-08-E3-FF-FD-90	146.208.217.60
1	-18.0686153 µs	IPv4 UDP	59273	BC-30-5B-CF-77-27	141.121.237.244
2	-98.6157 ns	ARP		98-4B-E1-C6-2A-95	
3	8.6913841 µs	IPv4 ICMP Address Mask Reply		98-4B-E1-C6-2A-95	141.121.237.191
4	17.4813840 µs	IPv4 TCP	SMTP	54-75-D0-C9-0B-81	2607:F8B0:400C:0C03:0000:0
5	28.3413837 µs	IPv6 UDP	DHCPv6 Client	B4-B5-2F-E0-64-50	FE80:0000:0000:0000:BCF3:24
5	45.8313834 µs	IPv6 ICMP FMIPv6 Messages		C2-00-51-FA-00-00	2001:0DB8:0000:0012:0000:0

Figure 3. Drilling down on a failed test, the E6960A software helps pinpoint the root problem.

Going Forward

Faster wired and wireless links are crucial to the future success of connected cars and autonomous vehicles, but they must meet performance and reliability targets, even in hard automotive environments. As Continental continues to put the future in motion, solutions from Keysight are helping it stay true to its mission: safety, information, environment and affordable mobility.

Related Information

- Brochure: *Infiniium S-Series Oscilloscopes*, publication [5991-4028EN](#)
- Data sheet: *Infiniium S-Series High-Definition Oscilloscopes*, publication [5991-3904EN](#)
- Data sheet: *N6467B BroadR-Reach Automotive Ethernet Electrical Compliance Application*, publication [5991-1965EN](#)
- Data sheet: *N8847A BroadR-Reach Triggering and Decode*, publication [5992-2682EN](#)
- Data sheet: *E6960A 1000BASE-T1 Tx Automotive Ethernet Compliance Application*, publication [5992-2672EN](#)
- White paper: *Automotive Ethernet: Enabling the Future of Autonomous Driving*, publication [5992-3430EN](#)

www.keysight.com/find/automotive

¹ Continental develops pioneering technologies and services for sustainable and connected mobility of people and their goods. Founded in 1871, the company offers safe, efficient, intelligent and affordable solutions for vehicles, machines, traffic and transportation. In 2017, Continental generated sales of €44 billion and currently employs more than 240.000 people in 61 countries. The Interior division employs more than 46,000 people worldwide and generated sales of €9.3 billion in 2017.

² Solution configurations will vary depending on customers' requirements.