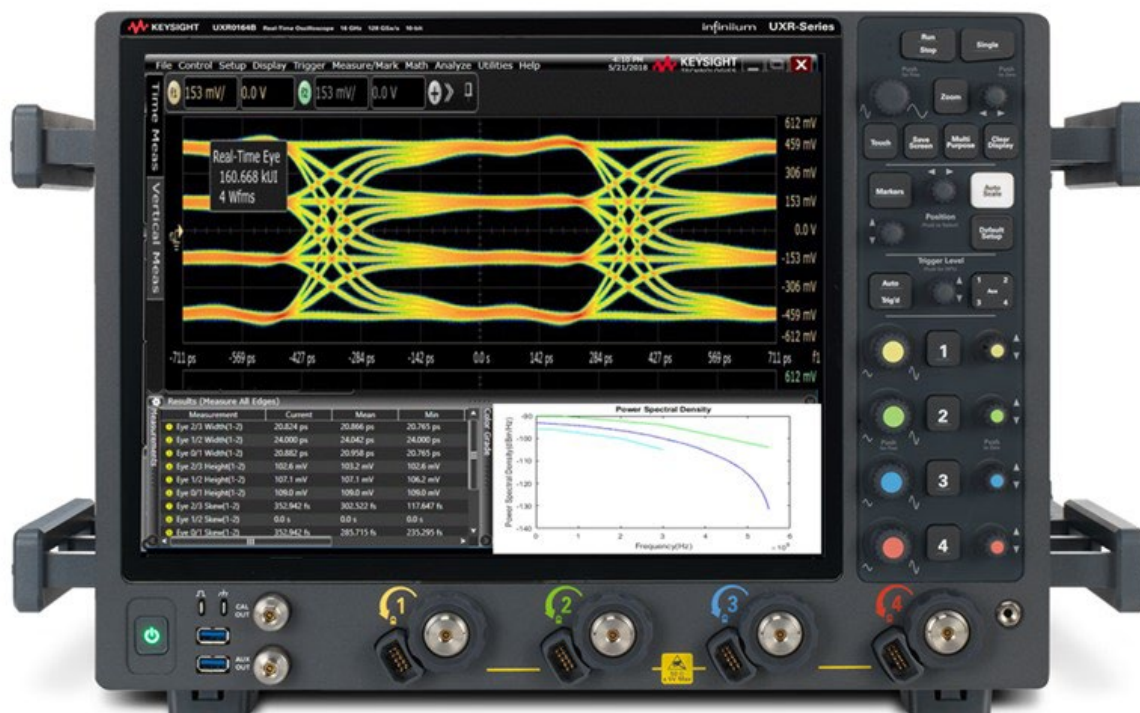


Automotive SerDes Transmit Test

MIPI A-PHY, ASA, GMSL2*

Ensure Interoperability and Data Integrity

Dealing with the generated data and adjusting to new technologies can be very difficult. You can benefit from those quick changes with the support and expertise of Keysight. Simply verification testing with Keysight SerDes transmit test software.



Test, Debug, and Characterize

High-speed serializer/deserializers (SerDes) help transport data streams, making in-vehicle video, audio, and communication possible. The high bandwidth, reliability, and performance of the SerDes serial links are key requirements in automotive applications that enable advanced infotainment and Advanced Driver Assistance Systems (ADAS) in modern vehicles. The tests performed by the AE2010T software include verification tests of SerDes-based protocols, including MIPI A-PHY and ASA. The application covers crucial measurements such as frequency, distortion, jitter, and droop, as well as MDI Return Loss. The test application offers a user-friendly setup wizard and a comprehensive report with margin analysis.

Advanced Driver Assistance Systems (ADAS) connected cars and Autonomous Vehicles (AVs) are transforming vehicles. Many of these new features delivered through a mix of sensors, cameras, and networks require faster data rates with each iteration.

Today, SerDes links drive many in-vehicle cameras and display connections. The emergence of MIPI A-PHY and the Automotive SerDes Alliance (ASA) allows chipsets to be implemented by many different silicon vendors, making interoperability a vital requirement.

The Keysight AE2010T Automotive SerDes Transmitter Test Application lets you automatically configure the oscilloscope for each test and provides informative test results, including margin and statistical analysis. The AE2010T software performs a wide range of electrical tests required to meet the current Automotive SerDes specifications all in one installation. The application helps you execute a wide subset of the conformance tests performed with various Keysight equipment.

The AE2010T Automotive SerDes Transmitter Test Application allows you to select the reference specification and the test plan depending on the selected specification. Currently, it supports the following data rates and standards:

- MIPI A-PHY
- ASA
- GMSL2 6 Gbps Coaxial TX Eye Mask test
- Configurable LVDS tests

Comprehensive Test Coverage

Using the AE2010T software simplifies testing with the following features.

- Automatic configuration of all the required test equipment, reducing overall test time.
- Execution speed and proven test algorithm which minimizes test time.
- Wide range of tests for standards conformance of MIPI A-PHY and ASA, saving the hassle of multiple installations and licenses while reducing cost.
- Be confident in the test setup, with setup instructions and calibration cues for all required test equipment.
- Trust the results, accurate and repeatable results with Keysight oscilloscopes.
- Test framework that reports multi trial results with full array of statistics for each measurement with worst case measurement result.
- Detailed information on each test that ran in case you need to follow up and debug.

Note:

The software is installed and runs on a Keysight Infiniium UXR oscilloscope and is available with a node-locked, transportable, floating and USB dongle license type. Each license can be purchased with 6-, 12-, 24-, or 36 -months of support. Please see the ordering information for additional details on software license types.

Transmitter specifications

The AE2010T Automotive SerDes Tx test software saves you time by setting the stage for the automatic electrical test execution. Some of the difficulties of performing electrical tests for these SerDes protocols are properly connecting to the oscilloscope, loading the proper setup files, and analyzing the measured results by comparing them to limits. The AE2010T software does much of this work for you.

The AE2010T software automatically configures the oscilloscope for each test. It provides an informative report with results that include margin analysis, indicating how close your product is to passing or failing the specification.

An oscilloscope is the main testing tool for the above tests. All tests require an oscilloscope, though a network analyzer will also be needed for a return loss test.

Specification	Oscilloscope Minimum Bandwidth	Additional Equipment Required
MIPI A-PHY	10 GHz ¹	VNA, Signal Generator
ASA	20 GHz ¹	VNA
GMSL2 6 Gbps Coaxial TX Eye Mask	13 GHz	

MIPI A-PHY 1.0 CTS version 1.0

PMD Transmitter Electrical Test for Source

2.1.1	TX Power Spectral Density Mask
2.1.2	TX Maximum Output Droop
2.1.3	TX Timing Jitter
2.1.4	TX Symbol Rate Accuracy
2.1.5	NRZ Downlink TX Eye Opening
2.1.6	PAM-X Transmitter Linearity
2.1.7	Downlink TX Return Loss
x.x	Common Mode PSD (beta for A-PHY 1.1)

PMD Transmitter Electrical Test for Sink

2.3.1	TX Power Spectral Density Mask
2.3.2	TX Maximum Output Droop
2.3.3	TX Timing Jitter
2.3.4	TX Symbol Rate Accuracy
2.3.5	Uplink TX Return Loss

ASA 1.1 CTS version 0.2

4.4	PMA electrical parameters
4.54	MDI return loss

GMSL2

1	GMSL2 6Gbps Coaxial TX Eye Mask
2.3.2	TX Maximum Output Droop

¹ Based on the baud rate of the different speed gears of MIPI A-PHY, and speed grades within ASA different oscilloscope bandwidths are possible, we have estimated the min bandwidth based on the fastest gear/grade.

Easy test definition

The test application enhances the usability of Keysight Infiniium oscilloscopes for testing automotive SerDes devices. The automated test framework guides you through the steps required to define the setup, perform the tests, and view the results. You can select a category of tests or select an individual test. The user interface is designed to minimize unnecessary reconnections, which will help save test time and minimize potential operator error. You can save the tests and configurations as project files, recall them for quick testing, and review previous results.

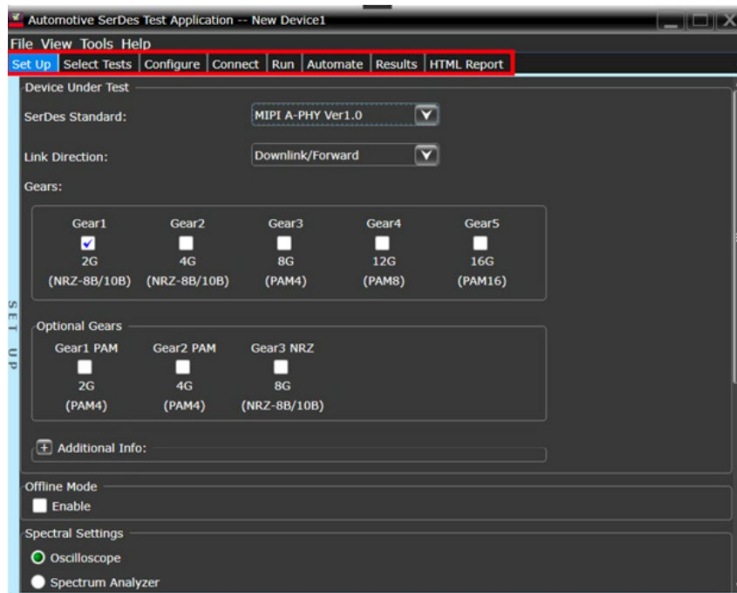


Figure 1. SerDes application test setup screen. Select the speed grade of your device.

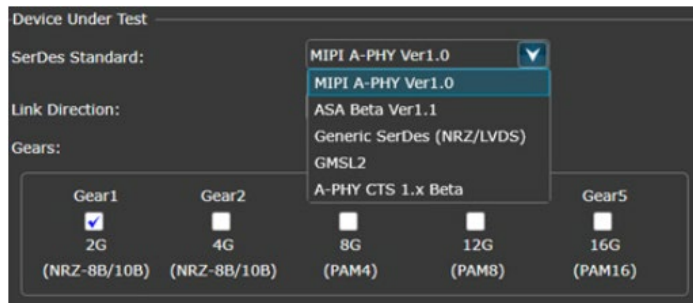


Figure 2. A drop-down menu to select which specification you want to test against.

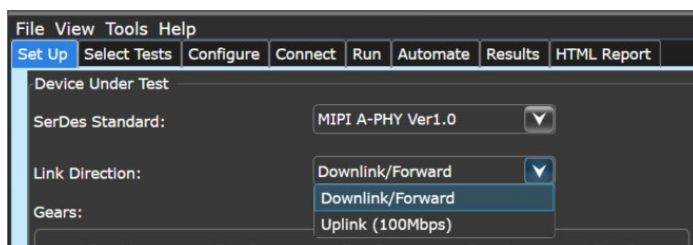


Figure 3. A second drop-down menu allows you to select the link direction you want to test.

Configurable and guided connections

The AE2010T software guides you to make connection changes with diagrams clearly identifying test connections including additional hardware and cables. The connection setup provides, step-by-step instructions along with example signals to help make sure you are getting the intended readings. You can specify the number of test trials and the stop condition. When you select multiple tests where the connections change, the software prompts you with a message and appropriate connection changes.

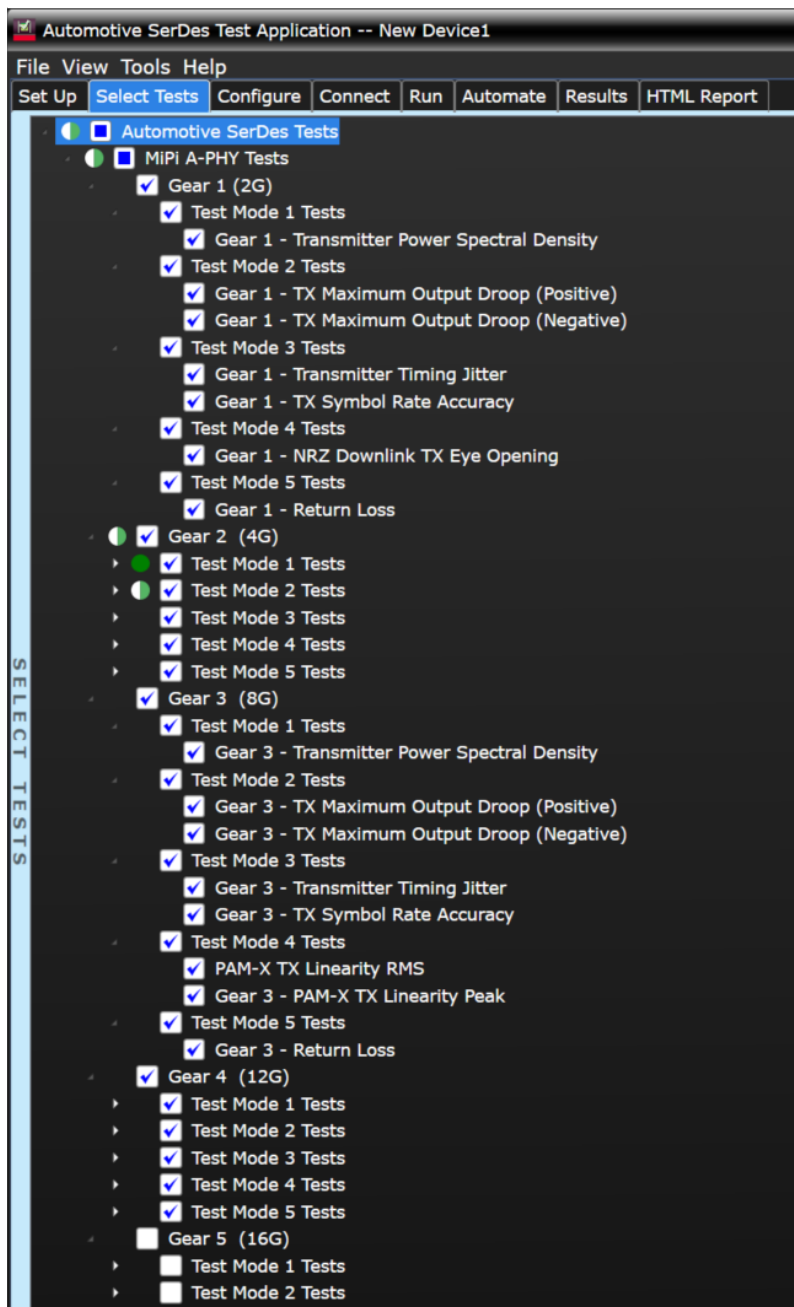


Figure 4. The select tab list all the tests available in your setup. Select an individual or a group of tests.

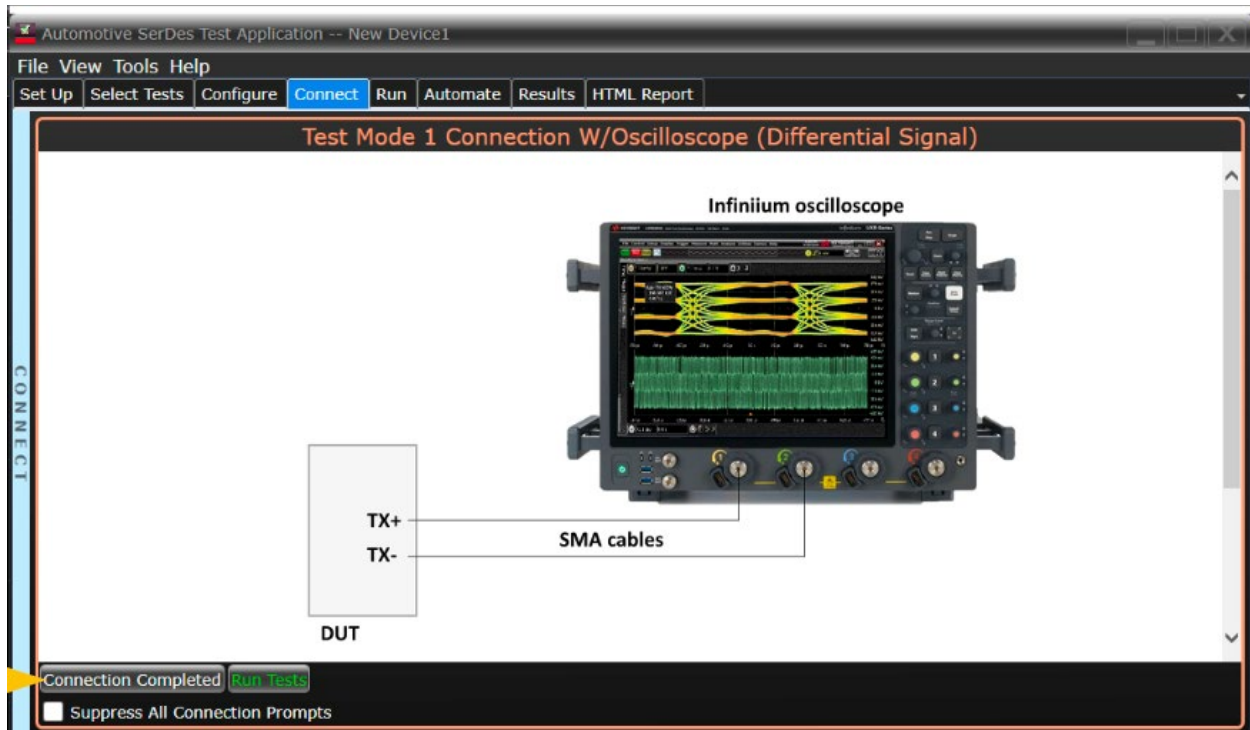


Figure 5. The software will guide you in setting up each test, including oscilloscope configuration and probing. Step-by-step instructions, along with example signals, are displayed to help with the test setup.

Generating pass/fail reports

In addition to giving measurement results, the AE2010T software also provides a report format showing where your product passes or fails and how close you are to the limits specified for a particular test. The application will save the worst-case test result to help you track down the anomalies in your signals. How close your device comes to passing or failing a test is indicated as a percentage in the margin field. A result highlighted in yellow or red indicates that your device has tripped the margin threshold level for a warning or failure.

Debugging tools

What if one of these transmit test fails?

To look deeper and gain insight into the causes of signal jitter, we recommend Keysight's D9020JITA EZJIT Complete jitter and vertical noise analysis and phase noise analysis software. It can help you identify and quantify jitter margins that affect the reliability of your design. The time correlation of the jitter to the real-time signal makes it easy to trace jitter components to their sources. Additional compliance views and a measurement setup wizard simplify and automate RJ/DJ separation for testing against industry standards. EZJIT Complete automatically detects embedded clock frequencies and repetitive data patterns on the oscilloscope inputs and calculates the level of Data-Dependent Jitter (DDJ) that is contributed to the Total Jitter (TJ) PDF by each transition in the pattern, a feature not available on any other real-time oscilloscope today.



Figure 6. The D9020JITA software can show the jitter histogram, trend, and spectrum.

The Keysight D9010PAMA PAM-N analysis software extends the ease-of-use advantages of the Infiniium oscilloscopes to the analysis of PAM-3 or PAM-4 signals. A wizard walks you quickly through the steps required to set up measurements for a PAM encoded signal, select methods for clock recovery, and then the measurements you wish to have performed on your PAM signal. Our PAM software is also able to accurately set the individual threshold levels of your PAM signal and render each eye.



Figure 7. PAM-4 Noise measurements possible with the D9010PAMA PPAM-N analysis software.

Instrument requirements

The AE2010T is software installed directly onto a Keysight Infiniium class oscilloscope. Additional hardware is required for 100% test coverage. The table below captures the specifications' minimum requirements and lists the corresponding equipment that Keysight offers for that measurement type.

Test Requirement	Minimum Instrument Requirement	Supported Keysight Models
MIPI A-PHY TX Electrical PMD compliance (Normative Gears)	10 GHz oscilloscope, 2 channels ²	Infiniium UXR A and B models, Infiniium V-Series
MIPI A-PHY Linearity	Signal Generator	N5182B-506 RF signal generator
ASA PMA Electrical compliance	20 GHz oscilloscope, 2 channels ²	Infiniium UXR A and B models, Infiniium V-Series
MDI return loss	Network analyzer (VNA) 2-port configuration and a calibration kit with the start and stop frequency range. 5 MHz – 6 GHz (MIPI A-PHY) 5 MHz – 5 GHz (ASA)	P50xxA/B ³ , P9370B ³ , E5071C ⁴ , E5080B ⁴ , PXI M9804A
GMSL2 6Gbps Coaxial TX Eye Mask	13 GHz oscilloscope, 2 channels	

² For lower gears of MIPI APHY or lower speed grades of ASA a lower bandwidth oscilloscope could be used. 2 channels are required for differential measurements.

³ The P5000B Series and P9370B VNA support host PCs with Thunderbolt 3 interface only. Check out the Streamline series VNA configuration guide with Keysight literature number 3121-1254EN for more details.

⁴ Both E5071C & E 5080B support differential measurement simulation (Sdd11 & Sdc11) with a fixture simulator option.

Ordering Information

Recommended configuration

Product Number	Description	Notes
AE2010T	AE2010T Automotive SerDes Tx Test Software	Base software
D9020PAMA	Pulse Amplitude Modulation PAM-N Analysis Software	Recommended for ASA
D9020JITA	Jitter, Vertical, and Phase Noise Analysis Software	Required for both MIPI A-PHY and ASA
D9020ASIA	De-embedding Software for correction of a fixture/cable/adaptor	Recommended for both MIPI A-PHY and ASA
UXR0204B	UXR0204B UXR-Series Oscilloscope: 20 GHz, 4 Channels	Required
UXR0104B	UXR0104B UXR-Series Oscilloscope: 10 GHz, 4 Channels	10 GHz minimum bandwidth for MIPI A-PHY Normative Gears
UXR0134B	UXR0134B UXR-Series Oscilloscope: 13GHz, 4 Channels	20 GHz minimum bandwidth for ASA (as well as A-PHY Normative-Optional Gear 3 / 8GBaud) 13 GHz minimum for GMSL2 6 Gbps
81150A / 81160A	Pulse Function Arbitrary Noise Generator	Required for MIPI A-PHY linearity test
33622A	Waveform Generator	Required for MIPI A-PHY linearity test
AP5001A / AP5002A	Analog Signal Generator	Required for MIPI A-PHY linearity test
N5182B Opt 506	RF signal generator	Required for MIPI A-PHY linearity test
Mini-Circuits ZFRSC-42-S+	2 Ways Resistive Power Splitter, DC - 4200 MHz, 50 Ω	Required for MIPI A-PHY linearity test Coax - Qty 1; UTP/STP – Qty 2
Mini-Circuits ZFBT-6GW+	Bias-Tee, 0.1 to 6000 MHz	Required to apply external DC voltage to DUT's that are powered over the data cable. Coax – Qty 1; UTP/STP – Qty 2
N9398C	DC Block, 50 kHz to 26.5 GHz, up to 16V DC	Required to protect the scope input when DC voltage is present on the data line (up to 16 V) Coax – Qty 1; UTP/STP – Qty 2
AE6804A	SMA Cable SMA (m) - SMA (m), 12in	Required to connect to oscilloscope Coax – Qty3; UTP/STP – Qty 6
E5080B Opt 260	Vector network analyzer, 2-port test set, 9 kHz to 6.5 GHz without bias tees	VNA required for MDI return loss measurements; choose 1
P5000A/B Opt 200	USB Vector network analyzer, 9 kHz to 4.5 GHz	
N7552A	Electronic Calibration Module (ECal), DC - 9GHz, 2-port	Calibrate VNA
N4417AK20	Cable: N-type-N (m) to 3.5 mm (m)	Connect to E5080B VNA (Qty 2)
AE6811A	Cable: 3.5 mm (m) to 3.5 mm (m), 26.5 GHz, 36 inches	Connect to P5000A VNA (Qty 2)
Choose an Adapter Type to Match the DUT and Bandwidth Requirement		
AE6960A	Keysight SMA to H-MTD adapter board	Frequency DC – 10 GHz
AE6961A	Rosenberger FAKRA to 2.92	Frequency DC – 6 GHz
AE6962A	Rosenberger HFM (High-speed FAKRA Mini) to 2.92	Frequency DC – 20 GHz
AE6963A	Rosenberger RMC to 2.92 adapter	Frequency DC – 20 GHz
AE6964A	Rosenberger HSD to 2.92 adapter	Frequency DC – 10 GHz
AE6965A	Rosenberger H-MTD to 2.92 Y adapter	Frequency DC – 20 GHz
AE6966A	Rosenberger HFM to 2.92 without plastic cover	Frequency DC – 20 GHz



Figure 8. AE6965A H-MTD to SMA



Figure 9. AE6962A HFM to SMA

Example Order

Coaxial implementation of all MIPI A-PHY gears

Quantity	Part Number to Order	Description
1	AE2010T	Automotive SerDes Tx Test Software
1	D9020JITA	Jitter, Vertical, and Phase Noise Analysis Software
1	D9020ASIA	De-embedding and equalization software
1	AE6962A	Rosenberger HFM to 2.92 adapter
3	AE6804A	SMA Cables to connect the oscilloscope
1	N9398C	DC Block, 50 kHz to 26.5 GHz, up to 16V DC
1	UXR0104B ⁵	UXR 10 GHz oscilloscope
1	E5080B Opt 260	Vector network analyzer, 2-port test set, 9 kHz to 6.5 GHz without bias tees
1	N7551A Ecal	Used to calibrate VNA
2	N4417AK20	Cable: N-type-N (m) to 3.5 mm (m) connects to VNA
1	N5182B Opt 506	RF signal generator for linearity test
1	Mini-Circuits ZFRSC-42-S+	Coupler used for linearity test

⁵ This is a recommendation based on the minimum bandwidth requirement for MIPI A-PHY any higher bandwidth will also work.

For More Information

For more insights on Automotive SerDes testing check the following links

[Keysight website](#) for a free trial of the software

[How to Test automotive SerDes Transmit Conformance](#)

Download [The users guide and methods of implementation](#) for additional detail and specifications

[Advancing the autonomous Vehicle Ecosystem](#) poster can help you see how Automotive SerDes fits with ADAS/AV solutions and technologies.

* GMSL2 6 Gbps Coaxial TX Eye Mask test as defined by Analog Devices