

Automotive Ethernet Transmitter Compliance Test Application

100 and 1000 Mbit/s

The Keysight AE6910T Automotive Ethernet Transmitter Compliance Test Application provides you with an easy and accurate way to verify and debug the physical layer of your Automotive Ethernet designs.

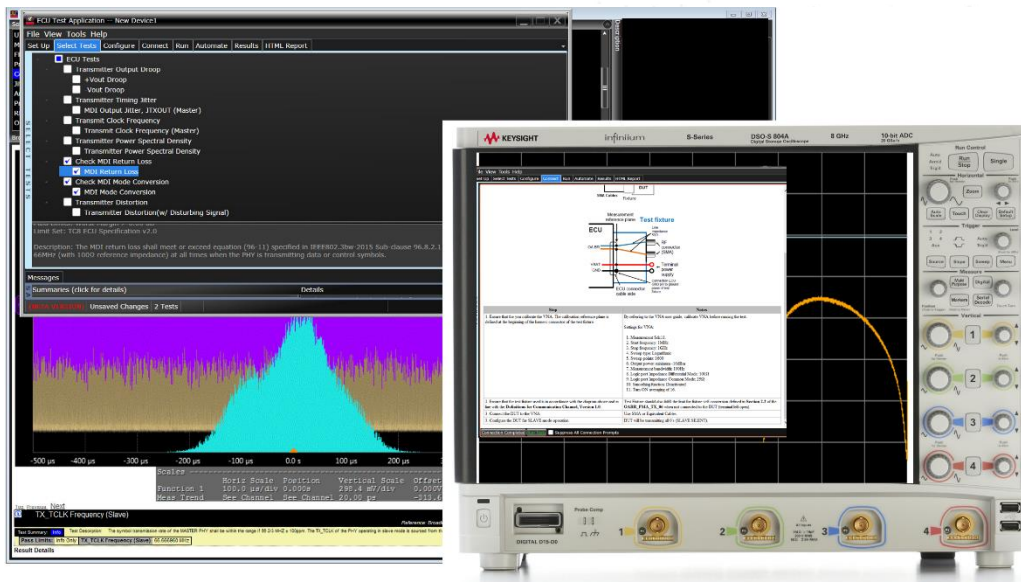


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Compliance Testing of Transmitters

Advanced driver assistance systems (ADAS), connected cars and autonomous vehicles (AVs) are transforming commercial and passenger transportation. Every leap in performance demands more and faster data, and this is driving a transition to Automotive Ethernet for in-vehicle networks.

Unlike CAN, LIN or MOST, the IEEE standard for Automotive Ethernet demands rigorous compliance verification using test cases that cover transmitters (Tx), receivers (Rx), and harness/connector assemblies (e.g., IEEE 802.3bw, IEEE 802.3bp, and OABR 3.2). The requirements include complex measurements that, until recently, have been uncommon in the auto industry: vector network analysis with S-parameters, bit error rate (BER) testing, and protocol analysis of high-speed digital signals.

To help you save time and effort, Keysight offers solutions that automate the testing and validation of Automotive Ethernet devices. Our engineers have invested thousands of hours in learning the standards and creating automated, repeatable compliance tests. These proven applications help you ensure proper test configuration and valid measurement results. Ultimately, you'll have greater confidence that your device is compliant with the IEEE standard.

The Keysight AE6910T Automotive Ethernet Transmitter Compliance Test Application lets you automatically execute physical-layer (PHY) electrical tests for transmitter compliance verification. The AE6910T software displays the results in a flexible report format. In addition to the measurement data, the report provides a margin analysis that shows how closely your device passed or failed each test.

The AE6910T software performs a wide range of electrical tests required to meet the 100BASE-T1, 1000BASE-T1 and TC8 specification requirements all in one install. The application helps you execute a wide subset of the conformance tests performed with a variety of Keysight equipment.

The AE6910T Automotive Ethernet Transmitter Compliance Test Application allows you to select the reference specification and the test plan depending on the selected specification and currently supports the following sub-applications and standards:

- 1000BASE-T1 with the reference to the IEEE specification 802.3pb
- 100BASE-T1^{*} with the reference to the IEEE specification 802.3bw
- 100BASE-T1 ECU test with the reference to OPEN Alliance TC8 specification

Note: The software is installed and runs on a Keysight Infiniium 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.

^{*} Also supports BroadR-Reach

Features

Using the AE6910T software greatly simplifies compliance testing. The software automatically configures all the required test equipment, reducing the overall test time. This automotive Ethernet electrical performance validation and conformance software offers several features to simplify the validation of automotive Ethernet designs:

- Setup wizard for quick and clear setup, configuration and testing
- Wide range of tests enabling standards conformance for both 100BASE-T1, 1000BASE-T1 and TC8 ECU test cases.
- Accurate and repeatable results with Keysight Infiniium oscilloscopes
- Setup instructions and calibration cues for all required test equipment.
- Detailed information on each test that has been run
- Automated reporting in a comprehensive pass/fail HTML format with margin analysis



Outlining the Transmitter Specifications

The AE6910T electrical test software saves you time by setting the stage for automatic execution of electrical tests. Some of the difficulties of performing electrical tests for Automotive Ethernet are properly connecting to the oscilloscope, loading the proper setup files, and then analysing the measured results by comparing them to limits published in the specification. The AE6910T does much of this work for you.

The AE6910T test software automatically configures the oscilloscope for each test and provides an informative report with results that includes margin analysis, indicating how close your product is to passing or failing the specification.

There are three different governing bodies and conformance tests set by those bodies. Below is a table that compares the different test requirements cross those test cases.

Test name	IEEE 100BASE-T1	OPEN Alliance ECU	IEEE 1000BASE-T1
Transmitter output droop	96.5.4.1	2.2 OABR_PMA_TX_01	97.5.3.1
Transmitter distortion	96.5.4.2	2.2 OABR_PMA_TX_08	97.5.3.2
Transmitter timing jitter (master and slave)	96.5.4.3/ 96.5.4.5	2.2 OABR_PMA_TX_02	97.5.3.3
Transmitter power spectral density	96.5.4.4	2.2 OABR_PMA_TX_04	97.5.3.4
Transmitter peak differential	96.5.6 (IEEE test only)	N/A	97.5.3.5
Transmit clock frequency	96.5.4.5	2.2 OABR_PMA_TX_03	97.5.3.6
MDI return loss	96.8.2.1	2.2 OABR_PMA_TX_05	97.7.2.1
MDI mode conversion	N/A	2.2 OABR_PMA_TX_06	N/A
MDI common mode emission	N/A	2.2 OABR_PMA_TX_07	N/A

An oscilloscope is used as the main testing tool for the above tests. There are a few additional instruments needed for distortion, MDI return loss/mode conversion, and power spectral density (PSD) tests. The following tables identify those differences with a recommendation. The AE6910T software is installed onto an Infiniium oscilloscope – all tests require an oscilloscope, but in addition, a network analyzer is used for the MDI return loss test. While, an arbitrary waveform generator (or function generator) is required for transmitter distortion test.

Test name	100BASE-T1	ECU	1000BASE-T1	Measurement equipment
Transmitter output droop	96.5.4.1	2.2 _01	97.5.3.1	Oscilloscope 2.5 GHz* or better
Transmitter distortion	96.5.4.2	2.2 _08	97.5.3.2	Oscilloscope + function generator†
Transmitter timing jitter (master and slave)	96.5.4.3/ 96.5.4.5	2.2 _02	97.5.3.3	Oscilloscope 2.5 GHz or better
Transmitter power spectral density	96.5.4.4	2.2 _04	97.5.3.4	Oscilloscope 2.5 GHz or better (or spectrum analyzer 2 GHz or higher)
Transmitter peak differential	96.5.6 (IEEE test only)	N/A	97.5.3.5	Oscilloscope 2.5 GHz or better
Transmit clock frequency	96.5.4.5	2.2 _03	97.5.3.6	Oscilloscope 2.5 GHz or better
MDI return loss	96.8.2.1	2.2 _05	97.7.2.1	Oscilloscope + network analyzer
MDI mode conversion	N/A	2.2 _06	N/A	Oscilloscope + network analyzer
MDI common mode emission	N/A	2.2 _07	N/A	Oscilloscope 2.5 GHz or better

* 2.5 GHz oscilloscope will meet all specifications. If only 100Mb is required a 1GHz oscilloscope will be adequate.

† 125 MHz signal from function generator is required as a disturbing signal for 1G. For only 100Mb 12 MHz will be adequate.

There are some slight variations in test description naming across the different standards. To be clear you can compare the below tables and see a complete list of the measurements made by the test software across 1000BASE-T1, 100BASE-T1 and Open Alliance TC8. All these standards are accessible from one software application in the AE6910T.

1000BASE-T1 with reference to the IEEE 802.3pb

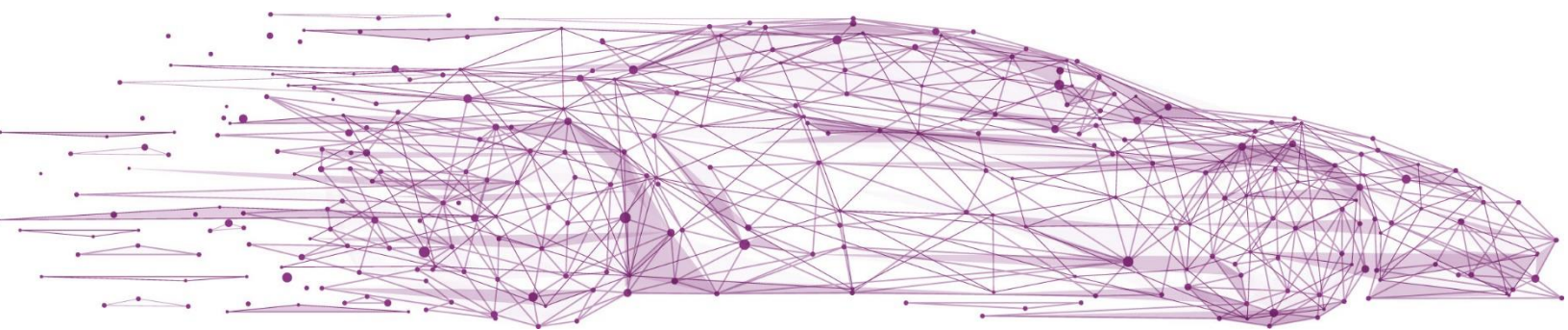
Standard test number	Description
97.5.3.1	Transmitter output positive droop
97.5.3.1	Transmitter output negative droop
97.5.3.2	Transmitter distortion
97.5.3.3	Transmitter timing jitter (master & slave)
97.5.3.3	Transmitter MDI jitter
97.5.3.4	Transmitter power spectral density (PSD)
97.7.2.1	MDI return loss
97.5.3.6	Transmit clock (TX_TCLK125) frequency

100BASE-T1 with reference to the IEEE 802.3bw specification (also supports BroadR-Reach)

Standard test number	Description
96.5.4.1	Transmitter output positive droop
96.5.4.1	Transmitter output negative droop
96.5.4.2	Transmitter distortion
96.5.4.3	Transmitter timing jitter (master & slave)
96.5.4.4	Transmitter power spectral density
96.5.4.5	Transmit clock frequency (master & slave)
96.5.6	Transmitter peak differential output

100BASE-T1 ECU Test with the reference to OPEN Alliance TC8 ECU test specification

Standard test number	Description
IEEE 96.5.4.1 & 2.2 OABR_PMA_TX_01	Transmitter output droop
IEEE 96.5.4.2 & 2.2 OABR_PMA_TX_08	Transmitter distortion
IEEE 96.5.4.3/ 96.5.4.5 & 2.2 OABR_PMA_TX_02	Transmitter timing jitter (master and slave)
IEEE 96.5.4.4 & 2.2 OABR_PMA_TX_04	Transmitter power spectral density
IEEE 96.5.4.5 & 2.2 OABR_PMA_TX_03	Transmit clock frequency
IEEE 96.8.2.1 & 2.2 OABR_PMA_TX_05	MDI return loss
2.2 OABR_PMA_TX_06	MDI mode conversion
2.2 OABR_PMA_TX_07	MDI common mode emission



Saving Time with the AE6910T Software

The AE6910T Automotive Ethernet Transmitter compliance Test Application extends the ease-of-use advantages of Keysight's Infiniium oscilloscopes to testing Automotive Ethernet designs. The Keysight automated test engine quickly walks you through the steps required to define the tests you want to make, set up the tests, perform the tests, and view the results. A setup page lets you quickly make decisions from the outset regarding the choice of tests and perform functions that affect the testing.

The test selections available in the following steps are then filtered according to the choices made in the setup page. While selecting tests, you can select a category of tests all at once or specify individual tests. You can save tests and configurations as project files and recall them later for quick testing and review of previous test results. Straightforward menus let you perform tests with a minimum amount of mouse clicks.

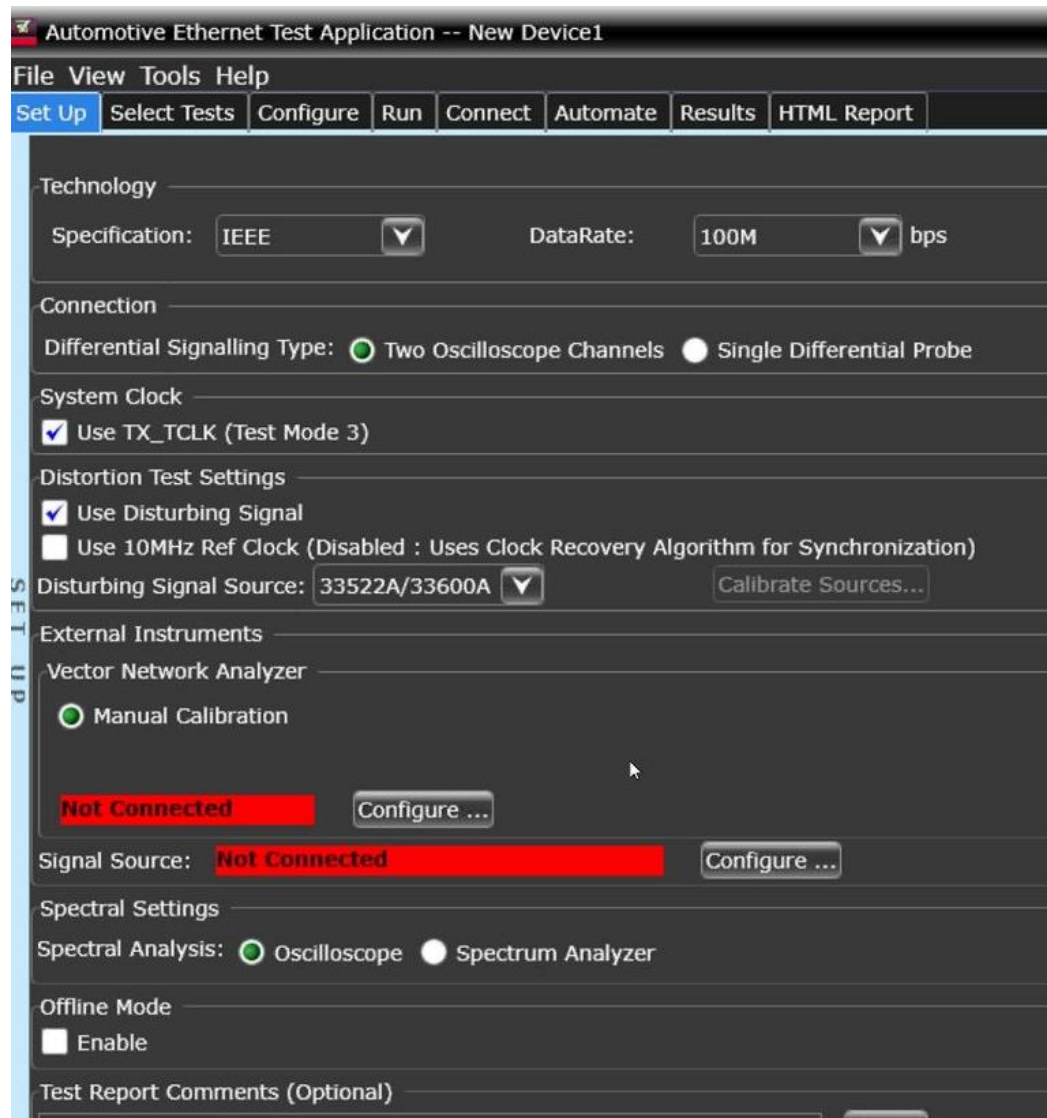


Figure 1. The clean interface allows you to select different test plans according to the selected specification.

To select between the specifications and data rates there are drop-down menus on the first two selections as shown below.

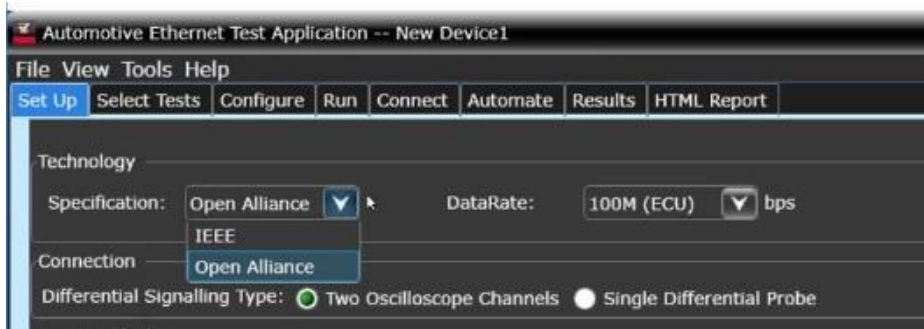


Figure 2. The drop-down menu to select which specification you want to test against.

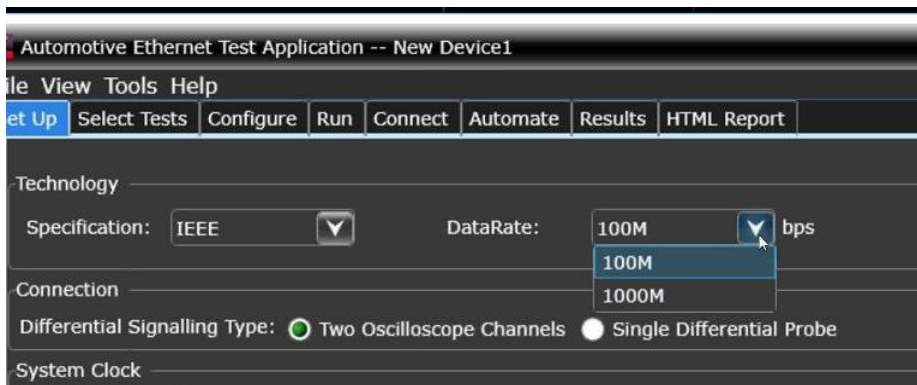


Figure 3. A second drop-down menu allow you to select the data rate you are interested in testing.

You can view all the tests in the GUI under selected test modes or test groups. The easy-to-use GUI also allows:

- Setup wizard for quick and clear setup, configuration and test
- Run single or multiple tests based on your needs
- When a test is highlighted, it will show a description of the test along with pass limits
- Get accurate and repeatable results with the Keysight Infiniium oscilloscopes
- Use automated reporting in a comprehensive HTML format with margin analysis

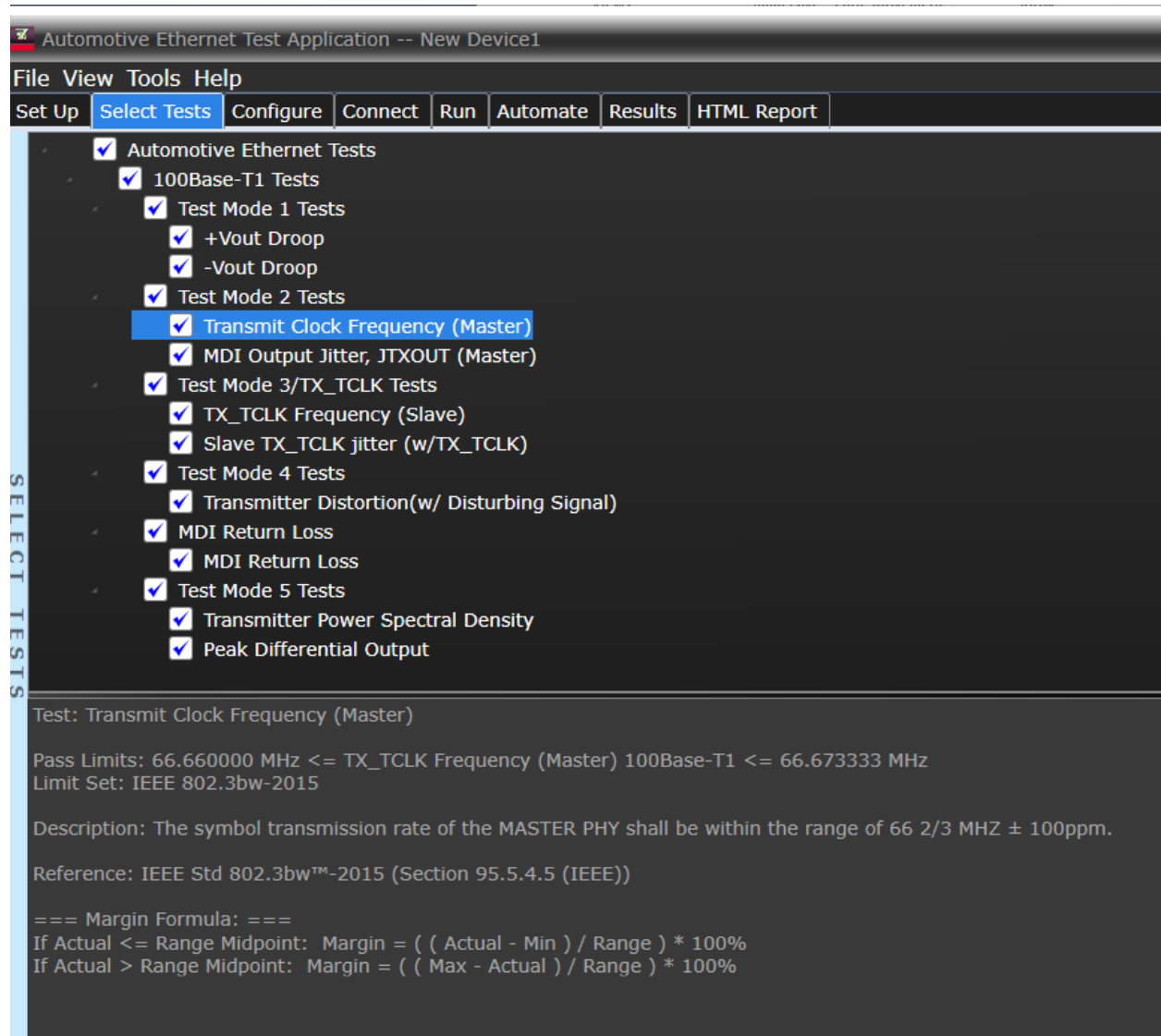


Figure 4. The Keysight automated test engine quickly guides you through selecting and configuring tests, setting up the connection, running tests, and viewing results. You can easily select individual tests or groups of tests with a mouse-click.

Applying Configurability and Guided Connections

The AE6910T test software provides flexibility in your test setup. It guides you to make connection changes with hook-up diagrams when the tests you select require it. In most cases, a connection from the DUT to the oscilloscope will be made through an SMA cable and the Keysight AE6941A automotive Ethernet test fixture. Test connections are clearly identified including additional hardware and cables. When you make multiple tests where the connections must be changed, the software prompts you with a message and appropriate connection diagrams. In addition, in the connection setup, step-by-step instructions along with expected signals are displayed to help make sure you are getting the intended readings.

The screenshot displays the 'Automotive Ethernet Test Application -- New Device1' software interface. The main window is titled 'Test Mode 1 Connection (Differential Signal)'. It features a hook-up diagram showing a 'DUT/ECU' with 'TX+' and 'TX-' outputs connected to an 'Oscilloscope' via 'SMA Cables'. Below the diagram is a table with three steps for connecting the DUT to the oscilloscope. An example waveform is shown at the bottom, and a status bar at the very bottom indicates 'Connection Completed' and provides buttons for 'Run Tests' and 'Suppress All Connection Prompts'.

Step	Notes
1. Connect the (+) output of the PHY to CHAN1* .	Use an SMA cable to connect the (+) output to the scope.
2. Connect the (-) output of the PHY to CHAN3* .	Use an SMA cable to connect the (-) output to the scope.
3. Configure the DUT to transmit Test Mode 1 .	Use the software supplied by your PHY manufacturer to control the DUT.

*If probing using a differential probe, please select the single-ended signalling type.

Example waveform:

Connection Completed Suppress All Connection Prompts

Figure 5. The software will guide you to set up tests, to define the device to test, its configuration, and how the oscilloscope is connected to it.

Automotive Ethernet Test Application -- New Device1

File View Tools Help

Set Up Select Tests Configure **Connect** Run Automate Results HTML Report

Test Mode 4 Connection w/Disturbing Signal

Step	Notes
1. Connect the DUT to the Ethernet Test Fixture, Section 11 using a pair of SMA cables.	Connect the DUT to the SMA connectors labeled " DUT "
2. Connect the Function Generator(s) to the Ethernet Test Fixture, Section 11 using of BNC cable(s).	Please calibrate the Function Generator(s) before running the test.
3. Connect the output of the Ethernet Test Fixture, Section 11 to the oscilloscope.	Connect the oscilloscope to the SMA connectors labeled " Scope "
4. If frequency/clock divider available, connect the 10 MHz output(s) of the clock/frequency divider to the 10 MHz Ref In Input(s) of the oscilloscope and function gen for clock synchronization.	Please ensure the 10 MHz output(s) are identical and phase locked to the input clock.
5. Configure the DUT to transmit Test Mode 4 .	Use the software supplied by your PHY manufacturer to control the DUT.

Example waveform:

Connection Completed Run Tests Suppress All Connection Prompts

Figure 6. When you make multiple tests where the connections must be changed, the software prompts you with connection diagrams. In the connection setup, step-by-step instructions along with expected signals are displayed to help with the test setup.

Generating Pass/Fail Reports

In addition to giving you measurement results, the AE6910T software also provides a report format that shows you not only where your product passes or fails but also reports how close you are to the limits specified for a particular test. You can select the margin test report parameter, which means you can specify the level at which warnings are issued to alert you to electrical tests where your product is operating close to the official test limit defined by the 100BASE-T1/1000BASE-T1/TC8 specification. 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.

Automotive Ethernet Test Application -- TI 100Mbps

File View Tools Help

Set Up Select Tests Configure Connect Run Automate Results HTML Report

Test Name	Actual Value	Margin %	Pass Limits	# Trials
Transmitter +Vout Droop	6.00 %	86.7	VALUE < 45.00 %	1
Transmitter -Vout Droop	6.05 %	86.6	VALUE < 45.00 %	1
Transmit Clock Frequency (Master)	66.670660 MHz	20.0	66.660000 MHz <= VALUE <= 66.673333 MHz	1
MDI Output Jitter, JTXOUT (Master)	17.968 ps	64.1	VALUE < 50.000 ps	1
Transmitter Distortion(w/o Disturbing Signal)	5.523 mV	63.2	VALUE <= 15.000 mV	1
Transmitter Power Spectral Density	275 mdBm	275.0	Overall = Pass	2
Transmitter Peak Differential Output	1.701 V	22.7	VALUE < 2.200 V	1
Transmitter Distortion(w/ Disturbing Signal)	6.847 mV	54.4	VALUE <= 15.000 mV	3

Parameter Value

Transmitter +Vout Droop (100Base-T1) 6.00 %

---Additional Info---

Vd 50 mV

Vpk 837 mV

Transmitter +Vout Droop (100Base-T1)

249 mV 3.0 V

0:00 ns 300.0000 ns

Messages

Summaries (click for details)

2019-05-08 02:29:38:142 PM Opening project

2019-05-08 02:29:39:374 PM Project opened

2019-05-08 02:29:46:629 PM Refreshing HTML Report

2019-05-08 02:29:46:993 PM HTML Report Refreshed

Details

The HTML report now reflects the results shown on the Results tab.

1 Test

Figure 7. The test software results screen shows a summary of the tests performed, pass/ fail status, and margin. Clicking on a specific test also shows the test specification and a measurement waveform, if appropriate.

Test Report

Overall Result: **FAIL**

Test Configuration Details	
Device Description	
Disturbing Signal Source	81150A/60A
Spectral Analysis	Oscilloscope
Test Session Details	
Infinium SW Version	06.10.00538
Infinium Model Number	DSO90804A
Infinium Serial Number	No Serial
Application SW Version	0.00.6450
Debug Mode Used	No
Compliance Limits (official)	802.3bp-2016 Specification - Amendment 4
Last Test Date	2017-08-28 18:47:52 UTC -06:00

Summary of Results

Test Statistics	
Failed	1
Passed	3
Total	4

Margin Thresholds	
Warning	< 2 %
Critical	< 0 %

Pass	Failed	# Trials	Test Name	Worst Actual	Worst Margin	Pass Limits
X	2	2	Transmitter Peak Differential Output	2.144 V	-64.9 %	VALUE < 1.300 V
0	2	2	Transmit Clock Frequency (Master)	124.997300 MHz	39.2 %	124.987500 MHz <= VALUE <= 125.012500 MHz
0	1	1	MDI Output Jitter, RMS (Master)	2.272 ps	54.6 %	VALUE < 5.000 ps
0	1	1	MDI Output Jitter, Peak-to-Peak (Master)	32.754 ps	34.5 %	VALUE < 50.000 ps

Report Detail

Next

Transmitter Peak Differential Output
 Reference: Physical Layer Transceiver 802.3bp-2016 Specification - Amendment 4 (Section 97.5.3.5)
 Test Summary: **Fail** Test Description: The Peak Differential Voltage obtained must conform to the requirements specified in IEEE802.3bp-2016 Sub-clause 97.5.3.5
 Pass Limits: < 1.300 V | Transmitter Peak Differential Output (Worst of 2 Trials) 2.144 V | #Trials Run: 2 | Worst Trial: Trial 2

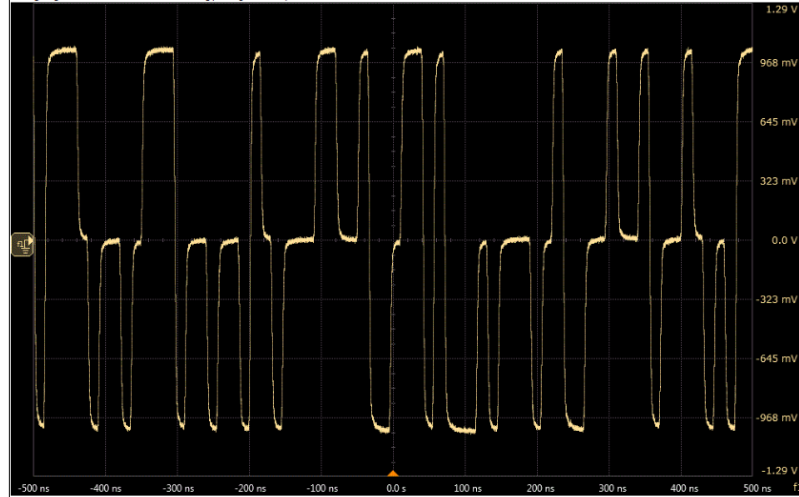
Overall Summary + details of 1 worst trials

Pass	Trial	Actual Value	Margin
	Avg	2.144 V	-64.88 %
	StdDev	636.4 μV	54.39 m%
	Range	900.0 μV	76.92 m%
	Min	2.143 V	-64.92 %
	Max	2.144 V	-64.85 %
	Sum	4.287 V	-129.8 %
X	Trial 2 (Worst)	2.144 V	-64.9 %

Trial 2

Trial 2: Transmitter Peak Differential Output

Keysight Infinium : Thursday, August 24, 2017 12:54:36 PM



Top Previous Next

Transmit Clock Frequency (Master)
 Reference: Physical Layer Transceiver 802.3bp-2016 Specification - Amendment 4 (Section 97.5.3.6 / Section 97.5.2)
 Test Summary: **Pass** Test Description: PHY shall transmit a continuous pattern of three (+) symbols followed by three (-) symbols, with the transmitted symbols timed from its local clock source of 750 MHz. The transmitter output is a 125 MHz signal. Hence the accuracy of the transmit clock frequency is also within 125 MHz ±100 ppm.
 Pass Limits: [124.987500 MHz to 125.012500 MHz] | Transmit Clock Frequency (Master) (Worst of 2 Trials) 124.997300 MHz | #Trials Run: 2
 Worst Trial: Trial 1

Overall Summary + details of 1 worst trials

Pass	Trial	Actual Value	Margin
0	Trial 1	124.997300 MHz	39.2 %

Figure 8. The test software HTML report documents your tests and indicates the pass/fail status, test specification range, measured values, and margin. Additional details are available for each test, including the test limits, test description, and test results, including waveforms, if appropriate.

Minimum Requirements: Instruments and Accessories

The AE6910T is software that is installed directly onto a Keysight Infiniium class oscilloscope. The table below attempts to capture the minimum requirements of the specifications and lists the corresponding equipment that Keysight offers for that measurement type.

Test requirement	Min Instrument requirement	Available Keysight models
Basic compliance tests	A 1 GHz oscilloscope, 2 channel (100BASE-T1)	Infiniium S-Series*, 90000, V-Series, Z-Series, UXR
	A 2.25 GHz oscilloscope, 2 channel (1000BASE-T1)	
Transmitter distortion test	A 2-channel function generator with a minimum bandwidth of 12 MHz (100BASE-T1)	33512A/B, 33522A/B,
	A 2-channel function generator with a minimum bandwidth of 125 MHz (1000BASE-T1)	33622A, 81150/60A
MDI return loss and mode conversion tests	A network analyzer (VNA) with the start and stop frequency range 1 MHz - 66 MHz (100BASE-T1), 2-port configuration and a calibration kit	E5080B, E5071C†
	A network analyzer (VNA) with the start and stop frequency range 2 MHz - 600 MHz (1000BASE-T1), 2-port configuration and a calibration kit	
Power spectral density (PSD)‡	A spectrum analyzer (SA) with a minimum frequency range up to 1 GHz (100BASE-T1)	Any X-series analyzer
	A spectrum analyzer (SA) with a minimum frequency range up to 2 GHz (1000BASE-T1)	

* The Infiniium S-Series also has hardware trigger system which can be used the protocol decoding. Decode and compliance test can run on any Infiniium oscilloscope.

† Currently the E5071C has accredited calibration. Accredited calibration for the E5080B is expected in late 2020. Both E5071C & E5080B support differential measurement simulation (Sdd11 & Sdc11) with a fixture simulator option.

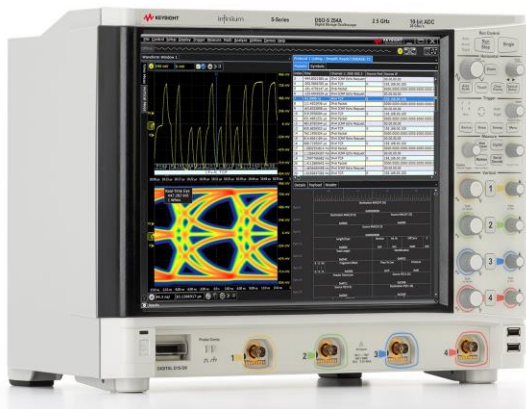
‡ The power spectral density test can be run directly from the oscilloscope with variable number of averages, using a spectrum analyzer is a secondary and optional method

Hardware

Option	Description	Test Enabled
AE6900T-160	81160A Pulse Function Arbitrary Noise Generator, 2 channels, 500 MHz sine waveform output	
AE6900T-150	81150A Pulse Function Arbitrary Noise Generator, 2 channels, 240 MHz sine waveform output	Transmitter distortion test (choose 1)
AE6900T-622	33622A Trueform Series Waveform/Function Generator, 2 channels, 120 MHz	
AE6900T-80B	E5080B ENA vector network analyzer, options 440,181,182	MDI return loss and mode conversion with S-parameters
AE6900T-254	DSOS254A oscilloscope: 2.5 GHz, 4 analog channels	
AE6900T-M25	MSOS254A oscilloscope: 2.5 GHz, 4 analog, 16 digital channels	
AE6900T-D04	DSOS104A oscilloscope: 1 GHz, 4 analog channels	
AE6900T-M10	MSOS104A oscilloscope: 1 GHz, 4 analog, 16 digital channels	Used for basic compliance setup (choose 1)
AE6900T-404	DSOS404A oscilloscope: 4 GHz, 4 analog channels	
AE6900T-M04	MSOS404A oscilloscope: 4 GHz, 4 analog, 16 digital channels	
AE6900T-804	DSOS804A oscilloscope: 8 GHz, 4 analog channels	
AE6900T-M80	MSOS804A oscilloscope 8 GHz, 4 analog, 16 digital channels	



33622A Trueform series Waveform/Function Generator, 2 channels, 120 MHz



DSOS254A High-Definition Oscilloscope: 20 GSa/s, 2.5 GHz, 4 analog channels



E5080B ENA-Series Vector Network Analyzer

Figure 9. An example of the instruments in the AE6900T Automotive Ethernet Solution.

Accessories

Option name	Description	Used for what test
AE6900T-104	SMA cable: SMA(m) -SMA(m) x 2	Needed for basic compliance setup *
AE6900T-102	Adapter: BNC (m) to SMA (f) x2	
AE6900T-FXT	Automotive Ethernet test fixture AE6941A	
AE6900T-MOL†	SMA to Molex/Mini-50 adapter board AE6942A	
AE6900T-MAT†	SMA to MATEnet adapter board AE6943A	
AE6900T-FDB‡	Frequency Divider Board AE6950A	Needed for the transmitter distortion test
AE6900T-109	BNC cable: BNC(m) to BNC(m) cable x 2	Needed to connect to a function generator for the disturbing signal in the distortion test
AE6900T-103	RF Electronic calibration module, N4431B (ECal), 9 kHz to 13.5 GHz, N4431-010	Needed for calibration of a network analyzer for MDI return loss/mode conversion tests
AE6900T-101	Cable: N-type(m) to 3.5 mm (m) x2	Needed for connection to a network analyzer for MDI return loss/mode conversion tests

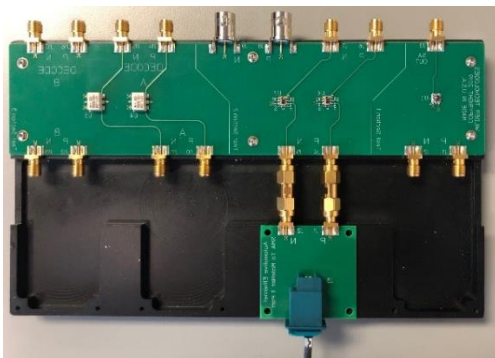


Figure 10. The Keysight AE6941A automotive Ethernet test fixture is used for many of the tests.

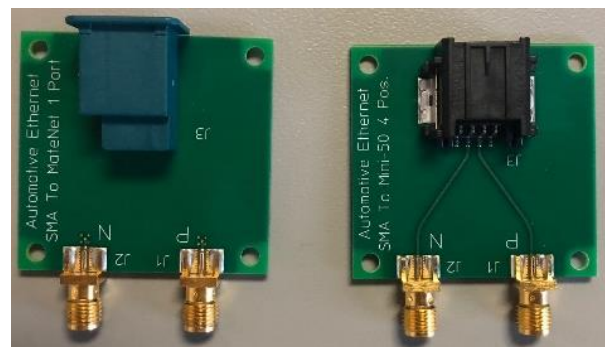


Figure 11. Adapter boards to use with Automotive Ethernet test fixture. The AE6942A SMA to Molex/Mini-50 and AE6943A SMA to MATEnet adapter boards.

* For protocol decode 2 additional SMA cables and 2 additional adapter boards are required.

† IEEE 802.3bw does not specify a connector, users may have different means to connect D+ and D- signals to the oscilloscope. For DUTs that use Molex/Mini50 or MATEnet connections, Keysight's adapter boards can be used with the automotive Ethernet test fixture AE6941A with SMA cables. Alternatively, a differential probe or SMA cables can be used to access D+ and D- signals on a board.

‡ The frequency divider board is required for the IEEE standard but there is a software algorithm available in the AE6910T if your Tx CLK is either not pinned out or you want a minimum configuration.



Figure 12. The Keysight AE6950A frequency divider board is used for the distortion test with disturbing signal to synchronize references of an oscilloscope and a function generator with a transmitter clock.

Ordering Information

	Description	Option through AE6900T	Standalone part number
Required	Automotive Ethernet Transmitter Compliance Test Application		AE6910T
	Automotive Ethernet Protocol Trigger & Decode		D9020AUTP
Optional*	Frequency converter board	AE6900T-FDB	AE6950A
	Automotive Ethernet compliance test fixture	AE6900T-FXT	AE6941A
Qty 2 †	SMA to Molex/Mini-50 adapter board	AE6900T-MOL	AE6942A
	SMA to MATenet adapter board	AE6900T-MAT	AE6943A
Qty 2‡	SMA cable SMA (m) – SMA (m)	AE6900T-104	8121-3118
Qty 2§	BNC to SMA adapter	AE6900T-102	54855-67604
Qty 2	Cable, type-N(m) to 3.5 mm (m)**	AE6900T-101	N4417AK20
Qty 2	BNC to BNC cable	AE6900T-109	8120-2582
Optional to calibrate ENA	Ecal 4 ports and connectors used to calibrate the ENA	AE6900T-103	N4431B-010
Primary tool – order one	Infiniium S-Series oscilloscope	2.5 GHz, 4 analog channels	AE6900T-254 DSOS254A
		2.5 GHz, 4 analog, 16 digital channels	AE6900T-M25 MSOS254A
		1 GHz, 4 analog channels	AE6900T-D04 DSOS104A
		1 GHz, 4 analog, 16 digital channels	AE6900T-M10 MSOS104A
		4 GHz, 4 analog channels	AE6900T-404 DSOS404A
		4 GHz, 4 analog, 16 digital channels	AE6900T-M04 MSOS404A
		8 GHz, 4 analog channels	AE6900T-804 DSOS804A
		8 GHz, 4 analog, 16 digital channels	AE6900T-M80 MSOS804A
	33622A Trueform Series Waveform/ Function Generator, 2- channel, 120 Hz	AE6900T-622	33622A
For distortion test order one	81150A Pulse Function Arbitrary Noise Generator, 2 channels, 240 MHz sine waveform output	AE6900T-150	81150A
	81160A Pulse Function Arbitrary Noise Generator, 2 channels, 500 MHz sine waveform output	AE6900T-160	81160A
MDI return loss/mode conversion	ENA vector network analyzer, 4-port test set, 9 kHz to 4.5 GHz without bias tees	AE6900T-80B	E5080B opt 440,181,182

* A frequency divider board is still required for the IEEE standard but there is a software algorithm available in the AE6910T if your Tx CLK is either not pinned out or you want a minimum configuration.

† Order 2 available adapter boards of your choice for compliance, order 2 additional for protocol decoding (bi-directional link)

‡ 2 SMA cables for compliance are required and 2 additional may be required to decode two directions of the bi-directional link.

§ 2 adapters for compliance tests are required, and 2 additional may be required to decode two directions of the bi-directional link.

** Alternatively, an SMA to N-type adapter could be used such as the 1250-1250.

Software License Types for AE6910T and D9020AUTP

Keysight offers a variety of flexible licensing options to fit your needs and budget. Choose your license term, license type, and KeysightCare software support subscription. Licenses are available either as node-locked, transportable, USB portable or floating and can be purchased with 6-, 12-, 24- or 36-months support.

License Terms

- **Perpetual** – Perpetual licenses can be used indefinitely.
- **Time-based** – Time-based licenses can be used through the term of the license only (6, 12, 24, or 36 months).

License Types

- **Node-locked** – License can be used on one specified instrument/computer.
- **Transportable** – License can be used on one instrument/computer at a time but may be transferred to another using Keysight Software Manager (internet connection required).
- **USB Portable** – License can be used on one instrument/computer at a time but may be transferred to another using a certified USB dongle (available for additional purchase with Keysight part number E8900-D10).
- **Floating (single site)** – Networked instruments/computers can access a license from a server one at a time. Multiple licenses can be purchased for concurrent usage. Three types of floating license are available: **Single Site**: 1-mile radius from the server; **Single Region**¹: Americas; Europe; Asia; **Worldwide** (export restriction identified in End User License Agreement (EULA)).

¹ Americas (North, Central, and South America, Canada); Europe (European Continent, Middle Eastern Europe, Africa, India); Asia (North and South Asia Pacific Countries, China, Taiwan, Japan)

KeysightCare Software Support Subscriptions

Perpetual licenses are sold with a 12 (default), 24, 36, or 60-month software support subscription. Support subscriptions can be renewed for a fee after that.

Time-based licenses include a software support subscription through the term of the license.

KeysightCare Software Support Subscription provides peace of mind amid evolving technologies.

- Ensure your software is always current with the latest enhancements and measurement standards.
- Gain additional insight into your problems with live access to our team of technical experts.
- Stay on schedule with fast turnaround times and priority escalations when you need support.

Selecting your license

- Step 1.** Choose your software product (eg. D9020AUTP).
- Step 2.** Choose your license term: perpetual or time-based.
- Step 3.** Choose your license type: node-locked, transportable, USB portable, or floating.
- Step 4.** Depending on the license term, choose your support subscription duration.

Software configuration Examples

If you selected:	Your quote will look like:	
D9020AUTP node-locked perpetual license with a 12-month support subscription	Part Number	Description
	D9020AUTP	High-Speed Automotive Decode and Trigger Software
	R-B5P-001-A	Node-locked perpetual license
	R-B6P-001-L	KeysightCare software support subscription, node-locked–12 months
D9020AUTP transportable time-based 6-month license	Part Number	Description
	D9020AUTP	High-Speed Automotive Decode and Trigger Software
	R-B4P-001-F	6-months, node-locked KeysightCare software support subscription

Example of a completely configured order for full compliance testing with one part number

The main components required for Transmitter Testing:

- Qty (1) AE6910T Automotive Ethernet compliance software
- Qty (1) AE6900T-FXT automotive Ethernet test fixture
 - Qty (2) adapter board of choice AE6900T-MOL or AE6900T-MAT
- Qty (1) AE6900T-FDB frequency divider board
- Qty (2) AE6900T-104 SMA cable
- Qty (2) AE6900T-102 BNC to SMA adapter
- Qty (1) AE6900T-254 S-series scope
- Qty (1) AE6900T-622 used for transmitter distortion tests
- Qty (1) AE6900T-80B- used for MDI return loss measurements
 - Qty (1) AE6900T-103 used to calibrate ENA
 - Qty (2) AE6900T-101 type N to 3.5mm cable to connect to ENA

Example of a completely configured order for full compliance with standalone part numbers

- Qty (1) DSOS254A 2.5GHz S-Series Infiniium oscilloscope
- Qty (1) AE6910T automotive Ethernet compliance application
- Qty (1) AE6941A Automotive Ethernet test fixture
 - Qty (2) adapter board of choice AE6942A or AE6943A
- Qty (2) 8121-3118 SMA cable SMA (m)
- Qty (1) AE6950A clock frequency divider fixture
- Qty (1) 33622A used for transmitter distortion
- Qty (2) 54855-67604 BNC (m) to SMA (f)
- Qty (1) E5080B vector network analyzer used for MDI return loss measurements
 - opt Qty (1) 240
 - opt Qty (1) 181
 - opt Qty (1) 181
- Qty (1) N4431B Ecal module for VNA
 - opt Qty (1) 010 4 port
- Qty (2) N4417AK20 type N to 3.5mm cable to connect to ENA

Please note the following:

Recommended hardware instrument firmware versions

Keysight Infiniium Series oscilloscopes with operating software revision 6.30 or higher.

For oscilloscopes with earlier revisions, upgrade software is available: www.keysight.com/find/scope-apps-sw

Keysight N9010B EXA analyzer with instrument software version A.21.04 or higher.

For N9010B with earlier revisions, upgrade software is available www.keysight.com/find/exa_software

Keysight E5080B ENA analyzer with firmware revision A.13.70.02 or higher.

For E5080B with earlier revisions, upgrade software is available here: [E5080B Firmware](#)

Learn more at: www.keysight.com

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: www.keysight.com/find/contactus

