Automotive Ethernet MultiGBASE-T1 Receiver Test Compliance

2.5/5/10GBASE-T1 design validation for receiver components

The Keysight AE6920R automotive Ethernet receiver compliance solution makes it easy and accurate to verify and debug the receiver characteristics of your 2.5/5/10GBASE-T1 PHYs.

KEYSIGHT

Why Compliance Testing Matters

Next-generation ADAS systems require camera and radar systems with increasingly high resolution. That means new requirements for speed and bandwidth. Automotive Ethernet enables faster data communication to meet the demands of today's vehicles and the connected vehicles of the future.

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. 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 designs. Our engineers have invested countless hours learning the standards and creating automated compliance tests. These proven applications help ensure proper test configuration and valid, repeatable measurement results. The net result: You'll have greater confidence that your device is compliant with the IEEE/Open Alliance standard, has a faster development cycle, is repeatable of testing, and has less human error.

Validating Receiver Compliance

The AE6920R automotive Ethernet MultiGBASE-T1 receiver test solution provides an easy and accurate way to verify and debug Automotive Ethernet modules that use IEEE 2.5/5/10GBASE-T1. The software lets you execute Ethernet Physical-Layer (PHY) electrical tests for receiver compliance. With capabilities that span test configuration, instrument setup, results calculations, and report generation, the AE6920R software will save you hours.

To meet signal-quality requirements, your design must pass conformance testing. When testing and validating the receiver components of your automotive Ethernet module or switch, the software provides three receiver test cases: bit error rate verification, alien crosstalk noise rejection, and receiver clock frequency tolerance. Receiver tests ensure the quality of the digital transmission by measuring the receiver's ability to recover data from an impaired input signal. The primary metric is the Bit Error Rate (BER) - the ratio of bits received in error to the total number received.

The AE6920R displays the results in an HTML or .XLS format. In addition to the measurement data, the report includes pass/fail limits for each test.

The Keysight AE6920R Automotive Ethernet MultiGBASE-T1 Receiver Test Compliance Software greatly simplifies 2.5/5/10GBASE-T1 Automotive Ethernet receiver compliance testing following the IEEE 802.3ch and Open Alliance TC15 PMA specs.

The software is available as part of the overall solution package, AE6000R. It comes as a node-locked perpetual license, including 12 months of support, and additional software support and maintenance are available once the original maintenance period has ended.

The software runs on a standard Windows PC and controls the hardware through appropriate interfaces, such as LAN. The test setup requires an M8195A arbitrary waveform generator, a test fixture, and a media converter.

Save time

The AE6920R Automotive Ethernet MultiGBASE-T1 Receiver Test Compliance Software saves you time by setting the stage for automatic execution of the required 2.5/5/10GBASE-T1 receiver tests. Some of the difficulties in performing these tests are correctly understanding the specification, configuring and running the instruments, and analyzing the measured results by comparing them to limits published in the specification. The AE6920R test software does much of this work for you.

The AE6920R Automotive Ethernet MultiGBASE-T1 Receiver Test Compliance Software automatically configures the M8195A for the test. It provides an informative results report that includes a BER measurement, Receiver Clock Frequency Test, and Alien Crosstalk Noise Rejection with a pass/fail limit. The AE6920R Software:

- Guides you how to make connections to the device under test.
- Helps you to check for proper instrument configuration quickly.
- Enables a quick way to communicate with your DUT.
- Runs the tests automatically.
- Provides detailed information on each test that has been run.
- Creates a printable report of the tests that have been run.

Test selection

The test automation software platform lets you select tests from an intuitive tree structure with multiple levels of detail. A key element of the platform is the test sequencer. This lets you choose the tests you want to run for in-depth product characterization over multiple repetitions (loops).

The following tests are available to be run:

	Open Alliance TC15 PMA v0.8	IEEE 802.3ch-2020 PMA electrical specs
Receiver differential input signals (BER)	5.2.1	149.5.3.1 (receiver differential input signals)
Alien crosstalk noise rejection	5.2.2	149.5.3.2 (alien crosstalk noise rejection)
Receiver clock frequency tolerance	5.2.3	149.5.3.1 (receiver differential input signals)

Software user interface

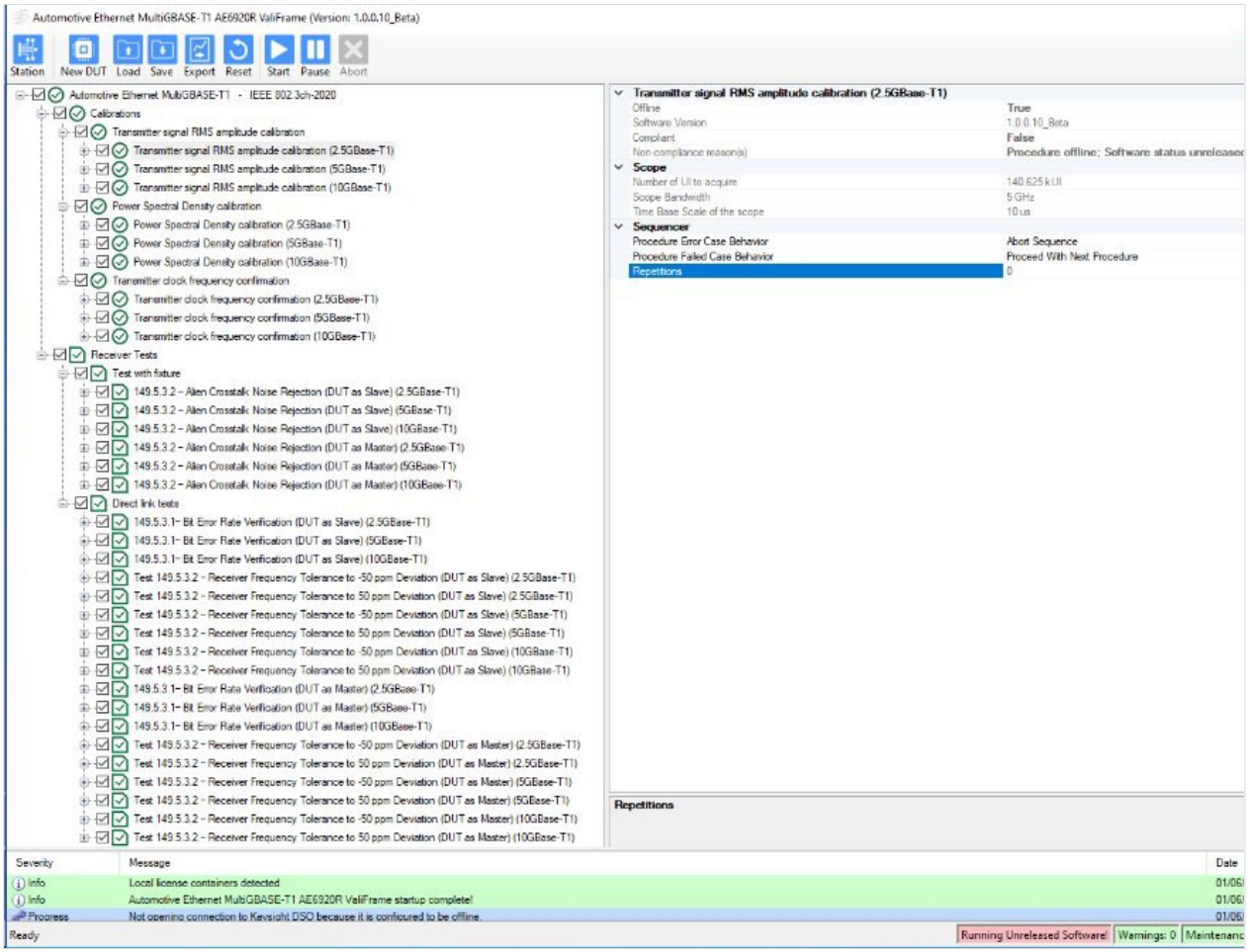

Figure 1. The main screen of the AE6920R ValiFrame environment. The window on the right provides details of the selected test. A window across the bottom provides the status of the tests being run as well as immediate feedback on if a test passed or failed.

Configurability and guided connections

Building the bit error rate verification system to characterize the receiver signals and get an accurate BER count can be difficult. Keysight removes the complexity and offers a clear objective validation of the BER count. This saves you time and hassle in understanding the specifications, setting up the tests, and interpreting the results.

The AE6920R Automotive Ethernet MultiGBASE-T1 Receiver Test Compliance Software extends the Keysight M8195A and a media converter to enable testing of receiver BER, alien crosstalk noise rejection, and receiver clock frequency tolerance. The software also supports the Multigigabit signal quality index test as an informative test option. The Keysight AE6920R quickly walks you through the steps required to set up the tests, perform them, and view the results.

The IEEE 802.3ch/Open Alliance TC15 PMA spec suggests using the Test Mode 7 normal mode with zero data pattern for the BER and alien crosstalk noise rejection test. On the receiver side, after PCS FEC decoding processing, a zero data sequence is expected with no errors. For the Multigigabit receiver test, the BER is expected to be less than 10^{-12} to pass the test.

Electrical systems that operate inside the automobile must overcome the presence of several different noise sources. Specific environmental noise sources are always present and are modeled as broadband, spectrally shaped noise profiles; other noise sources are dynamic, transient events operating in specific frequency bands for finite periods of time. The combined effect of these noise sources must not overwhelm the receiver's ability to interpret incoming data.

In addition to running the specified tests with limits described in the standard, the software offers the ability to customize the frequency and amplitude of the AWG output outside of specification to characterize the operational boundaries of your device under test truly.

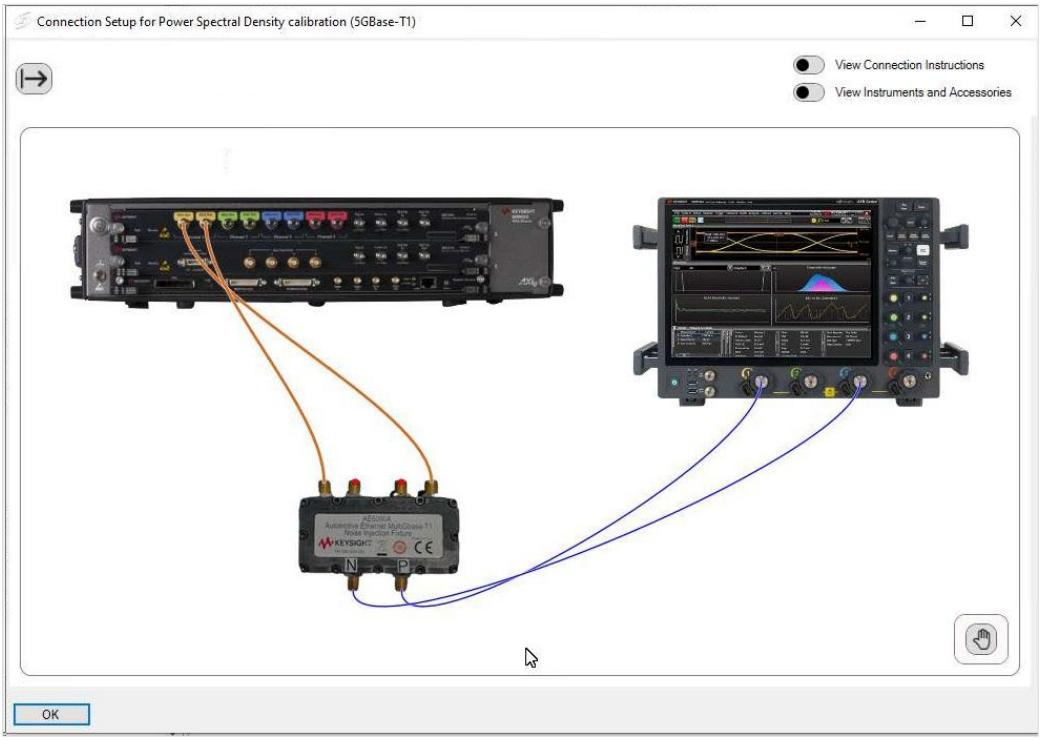

Figure 2. Test Setup of the AE6920R for receiver test with fixture and oscilloscope for calibration.

Compliance mode

In compliance mode, you run individual tests specified by the applicable standards. In characterization mode, experienced users have access to test properties such as frequency range, frequency step width, and limits, which makes it easy to perform margin tests.

Automation

Some of the tests require many interactions and steps with the DUT. The AE6920R allows you to run those long-lasting tests unattended overnight. The tests are easily repeated and can be run the same multiple times, enabling them to run under various conditions (climate chamber, EMC, and more).

Integration

AE6920R provides the possibility to programmatically control ValiFrame from another program through the ValiFrame application programming interface (API). For further information, see https://www.keysight.com/us/en/assets/9922-01647/programming-guides/N5991-Remote-Programming-Guide.pdf.

Instrument and accessory requirements

The AE6920R software runs on a separate computer which controls the instruments. The primary hardware in the solution is the Keysight M8195A pulse function arbitrary noise generator and a media converter.

Model	Function	Description
M8195A 	Gaussian noise generation for alien crosstalk noise rejection test, and deviated clock generation into the link partner for receiver clock frequency tolerance test	65 GSa/s arbitrary waveform generator
AE6090A 	Inject gaussian noise for alien crosstalk noise rejection test	Test fixture acts as a coupler between AWG and DUT
APM2000E-CLK 	Multigigabit Media converter acts as a link partner and test pattern transmitter	automotive Ethernet MultiGBASE-T1 to standard Ethernet MultiGBASE-TX media converter with clock access
Infiniium UXR0134B 	calibrating the test signal profile	Infiniium 10 GHz oscilloscope

Ordering information

Model number	Description	Qty	Purpose
AE6920R	Automotive Ethernet MultiGBASE-T1 Receiver Test Compliance Software		
AE6920R-1FP	node-locked perpetual license	Choose 1	Main software[1] license
AE6920R-1TP	transportable perpetual license		
AE6920R-SFM	maintenance for node-locked, 12 months	Choose 1	Maintenance support
AE6920R-STM	maintenance for transportable, 12 months		
M8195A	Arbitrary waveform generator Opt 001 1 ch AWG Opt BU2 2 slot chassis Opt 16G 16GSa memory Opt SEQ Sequencer	1	Noise generation
APM2000E-CLK	MultiGBASE-T1 Media converter with access to clock	1	Link partner and test pattern generator
AE6090A	Noise injection fixture	1	Noise coupler
AE6960A	SMA to H-MTD	2	Adapter to DUT
AE6806A	50-ohm load	2	Terminate unused test ports
AE6952A	HMTD cable	2	Connect to DUT and link partner
AE6804A	Cable: SMA (m) to SMA (m)	2	Connecting AWG to fixture
UXR0134B	UXR 13 GHz 4ch scope	1	Calibration

[1] The initial purchase of AE6920R-1FP or AE6920R-1TP will include a mandatory purchase of AE6920R-SFM or AE6920R-STM for maintenance; renewals for following years are also available.

Example Order

Full compliance of 10GBASE-T1

Quantity	Part number to order	Description
1	AE6920R-1FP	Automotive Ethernet Rx Software node-locked perpetual license
1	AE6920R-1SFM	Automotive Ethernet Rx SW maintenance node-locked, 12 months
2	AE6960A	H-MTD-to-SMA adapters
1	APM2000E-CLK	2.5/5/10G BASE-T1 to 2.5/5/510BASE-T Media converter with clock access
1	AE6090A	Noise injection fixture
2	AE6804A	SMA cable
2	AE6806A	50-ohm load
3		SMA(m) to MMCX (plug) cables for connection to CLK of APM2000E
1	UXR204B	UXR 13 GHz 4 ch oscilloscope for calibration
1	M8195A	2 Channel arbitrary waveform generator

For additional information, please go to:
http://www.keysight.com/find/AE6000R
http://www.keysight.com/find/AE6920R