Keysight E6963A
Automotive Ethernet Link Segment Compliance Solution
Harness and Connector testing made easy for your 100BASE-T1 components

Data Sheet
The Keysight Technologies, Inc. E6963A automotive Ethernet link segment compliance software provides you with an easy and accurate way to verify and debug BroadR-Reach and/or 100BASE-T1 harness and connector designs and components.

Autonomous vehicles promise to change the nature of commercial and passenger transportation over the roadways. The future requirements for data speed and bandwidth demand the next-generation performance of automotive Ethernet. 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 buses used before, the IEEE standard for automotive Ethernet demands rigorous compliance verification with test cases that cover Tx, Rx and harness/connector assemblies. Keysight's full suite of automotive Ethernet solutions automate testing and validation across Tx, Rx and link segment for 100 Mb/s and 1000 Mb/s automotive Ethernet.

The E6963A automotive Ethernet link segment test software lets you automatically execute Ethernet physical-layer (PHY) electrical tests for harness and connector compliance using IEEE 802.3bw specifications. The E6963A 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 E6963A automotive Ethernet link segment test software provides five test modes for testing and validating the complete communication channel. The Whole Communications Channel represents the complete wired connection between two transmit/receive modules with an Ethernet interface using a two-wire twisted pair cable. To meet signal quality requirements, your product must successfully pass conformance testing. Performing these tests is not only required but will give you confidence in your design/s. The Keysight E6963A link segment software will save you hours of valuable time with configuration, instrument setup, calculations and report generation.

Using the Keysight E6963A link segment compliance application (100BASE-T1 compliant) software greatly simplifies automotive ethernet harness and connector compliance testing.

The E6963A link segment compliance application is available in the following license variations.
- E6963A-1FP Fixed to E5071C vector network analyzer
- E6963A-1TP Server-based transportable license

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Features

Using the Keysight E6963A link segment application software greatly simplifies compliance testing of your harness and connectors using automotive Ethernet.

The Keysight link segment compliance software offers several features to simplify the validation of automotive Ethernet harness and connector designs:

The E6963A software:
- Guides you how to make connections to the device under test
- Automatically checks for proper configuration
- Sets up the ENA for each test
- Produces an automated test result calculation including correction for impedance profile slope and summing of all four S-parameters
- Creates a simple Pass/Fail judgement for each test
- Complies with link segment testing per BroadR-Reach V3.2 (OPEN alliance PMA test suite version 2) as well as IEEE 802.3bw (100BASE-T1) specifications

E6963A Link Segment Compliance Software

The E6963A link segment test software saves you time by setting the stage for automatic execution of 100BASE-T1 harness and connector tests. Some of the difficulties of performing tests for 100BASE-T1 link segments are properly connecting to the vector network analyzer, loading the proper setup files, and then analyzing the measured results by comparing them to limits published in the specification. The 100BASE-T1 link segment application does much of this work for you.

There are two different governing bodies of these automotive ethernet standards. The specifications from IEEE 802.3bw issued on October 2015 defines electrical specifications for 100BASE-T1. The OPEN Alliance test suite for BroadR-Reach (OABR) physical layer transceiver specification for automotive applications V3.2 dated June 24th, 2014 in addition to other things, establishes the communication channel in version 2.0 that sets the test procedure of wire harnesses and connectors. Keysight E6963A BroadR-Reach Link segment test software incorporates both the specification and the test suite so that you do not need to be an expert on either.

The automotive Ethernet standard is designed to operate over a one-pair balanced cabling system. The one pair UTP (Unshielded Twisted Pair) cable supports an effective data rate of 100 Mb/s in each direction simultaneously. The link segment for a BroadR-Reach PHY system is defined as one pair 15m UTP balanced copper cabling, two inline connectors and two end connectors. The transmission parameters of the link segment include insertion loss, return loss and characteristic impedance of the cable, the connector and the cable plus the connector (the whole communication channel).

The Keysight E6963A link segment software has a total of 5 tests to cover all the required tests and parameters.

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1. As listed on their website, the OPEN Alliance (One-Pair Ether-Net) Special Interest Group (SIG) is a non-profit, open industry alliance of mainly automotive industry and technology providers collaborating to encourage wide scale adoption of Ethernet-based networks as the standard in automotive networking applications.
2. As per the OPEN Alliance test suite for BroadR-Reach (OABR) V3.2.
Harness and Connector Specifications for Automotive Applications

The E6963A BroadR-Reach Link segment test software automatically configures the network analyzer for each test and provides an informative results report that includes margin analysis indicating how close your product is to passing or failing that specification. See Tables 1 to 3 for a list of the measurements and specifications tested in the E6963A.

<table>
<thead>
<tr>
<th>Target specification</th>
<th>Parameter</th>
<th>Measurement equipment</th>
<th>Keysight model</th>
</tr>
</thead>
<tbody>
<tr>
<td>BroadR Reach Definition for Communication Channel ver 2.0</td>
<td>5.1.1 cable test CIDM, IL, RL, LCL, LCTL</td>
<td>4 port Vector Network Analyzer with opt TDR is required. Both differential reflection and transmission must be measured.</td>
<td>E5071C ENA Series opt TDR</td>
</tr>
<tr>
<td></td>
<td>5.1.2 connector test CIDM, Intra Pair Skew, IL, RL, LCL, LCTL</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.1.3 whole communication channel test CIDM, IL, RL, LCL, LCTL</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.2.2 connector Test for Alien crosstalk ANEXT, AFEXT, ANEXTDC, AFEXTDC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.2.3 whole communication channel test (4 around 1) PSANEXT, PSAACRF, ANEXTDC, AFEXTDC</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Conformance tests performed by the E6963A link segment application software as specified by OABR physical layer transceiver specification for automotive applications V3.2.

<table>
<thead>
<tr>
<th>Test parameters cable, connector and whole communications channel</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time domain measurements</strong></td>
</tr>
<tr>
<td>CIDM Characteristic Impedance Differential Mode</td>
</tr>
<tr>
<td><strong>Frequency domain measurements</strong></td>
</tr>
<tr>
<td>IL: $S_{21}$</td>
</tr>
<tr>
<td>RL: $(S_{411}, S_{422})$</td>
</tr>
<tr>
<td>LCL: $(S_{411}, S_{422})$</td>
</tr>
<tr>
<td>LCTL: $(S_{421}, S_{412})$</td>
</tr>
</tbody>
</table>

Table 2. Test parameter details of the cable, connector and whole communications channel tests.

<table>
<thead>
<tr>
<th>Test parameters connector test for Alien Crosstalk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency domain measurements</strong></td>
</tr>
<tr>
<td>ANEXT_B,C,D,E</td>
</tr>
<tr>
<td>ANEXTDC_B,C,D,E</td>
</tr>
<tr>
<td>AFEXT_B,C,D,E</td>
</tr>
<tr>
<td>AFEXTDC_B,C,D,E</td>
</tr>
<tr>
<td>PSANEXT</td>
</tr>
<tr>
<td>PSAACRF</td>
</tr>
</tbody>
</table>

Table 3. Test parameter details for connector test 5.2.2 and 5.2.3 for alien crosstalk.
E6963A Software Saves you Time

It can be tedious and time-consuming to look up the specifications in the two different documents and manually setup your network analyzer to run each of the required tests. The cable, connector and whole channel each have different requirements and you must also know how to accurately configure your network analyzer for each measurement. Keysight takes the complexity away offering an easy to follow and execute set of steps. Saving you time and hassle in understanding the specifications, setting up the tests and interpreting the results.

The E6963A link segment test application extends Keysight’s E5071C vector network analyzer to do a complete set of tests as required by OABR and IEEE 802.3bw. The Keysight E6963A enables you to

- View all the link segment tests in the GUI’s main window
- Setup wizard for quick and clear setup, configuration and test
- Clearly see all the tests required
- Run single or multiple tests based on your needs
- Accurate and repeatable results with Keysight vector network analyzer
- Automated reporting in a comprehensive text format with pass/fail analysis
Configurability and Guided Connections

The E6963A link segment software provides flexibility in your test setup. In most cases, connection from the DUT to the network analyzer will be made through SMA cables and the device under test as shown in Figure 2 below. 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 appropriate connection diagrams. Because there are no standard automotive wiring harnesses or connectors, you will need to create your own harness and connectors and design your own test fixtures.

Figure 2. Configuration for general procedure to connect your test cable to the network analyzer.

Figure 3. Cable test setup window.
Figure 4. 5.2.2 Connector test window.
Reports with Pass/Fail Analysis

In addition to giving you measurement results, the E6963A BroadR-Reach Link segment test software also provides a report format that shows you if your product passes or fails.

Figure 5. E6963A link segment test report example.
Instruments and Accessory Requirements

To use the E6963A BroadR-Reach link segment compliance software on your E5071C, you will need SMA cables to connect the device to the network analyzer.

The following section describes the recommended connectors.

<table>
<thead>
<tr>
<th>Accessories as options to E6963A</th>
</tr>
</thead>
<tbody>
<tr>
<td>E6963A-APC</td>
</tr>
<tr>
<td>E6963A-SMA</td>
</tr>
</tbody>
</table>

The option listed, when ordered includes the 4 adapters or cables required. These accessories are required to set up the proper test configuration but they do not need to be ordered through the E6963A bundled number.

<table>
<thead>
<tr>
<th>Additional and optional accessories</th>
</tr>
</thead>
<tbody>
<tr>
<td>N5395C Standard Ethernet Test Fixture</td>
</tr>
<tr>
<td>4-port ECal Module</td>
</tr>
<tr>
<td>N4431B (for E5071C-480/485)</td>
</tr>
<tr>
<td>N4433A (for E5071C-4D5/4K5)</td>
</tr>
</tbody>
</table>

Hardware Requirements

The E6963A software runs on the E5071C opt TDR. It is optional to order the hardware through the E6963A number, however it is necessary to have this equipment to fully test compliance.

<table>
<thead>
<tr>
<th>Option name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E6963A-ENA</td>
<td>E5071C ENA Series Network Analyzer</td>
</tr>
<tr>
<td></td>
<td>Option 440 (4.5 GHz)</td>
</tr>
<tr>
<td></td>
<td>Higher frequency can be used but is not necessary</td>
</tr>
<tr>
<td></td>
<td>485 (8.5 GHz), 4D5 (14 GHz), or 4K5 (20 GHz)</td>
</tr>
<tr>
<td></td>
<td>Option TDR (Enhanced Time Domain Analysis)</td>
</tr>
</tbody>
</table>

Please note the following:

<table>
<thead>
<tr>
<th>Option name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keysight E5071C ENA analyzer with firmware revision B.13.30 or higher</td>
<td>For E5071C with earlier revisions, free upgrade software is available here: <a href="http://www.keysight.com/find/ena_firmware">www.keysight.com/find/ena_firmware</a></td>
</tr>
<tr>
<td>Option TDR Revision B.02.02 or higher</td>
<td>Earlier revisions, free upgrade available at: <a href="http://www.keysight.com/find/ena-tdr_firmware">www.keysight.com/find/ena-tdr_firmware</a></td>
</tr>
</tbody>
</table>
## Ordering Information

### 3 ways to order

- Single part number for a complete solution – E6963A
- Order just software and accessories E6963A, hardware separately through standalone model number
- Software (E6963A), hardware and accessories through standalone model number

### Single part number inclusive of all applicable hardware and software

<table>
<thead>
<tr>
<th>Required for compliance</th>
<th>Description</th>
<th>Option number through E6963A</th>
<th>Stand alone Model/part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required</td>
<td>BroadR-Reach Link segment Compliance application license</td>
<td>E6963A-1FP Or E6963A-1TP</td>
<td>E6963A</td>
</tr>
<tr>
<td>Required</td>
<td>Adapter-Coaxial straight Male-APC-N Female-APC-3.5 x 4</td>
<td>E6963A-APC</td>
<td>1250-1744</td>
</tr>
<tr>
<td>Required</td>
<td>Cable, SMA(m) -SMA(m) x 4</td>
<td>E6963A-SMA</td>
<td>E6961-20001</td>
</tr>
<tr>
<td>Optional</td>
<td>Standard Ethernet Test Fixture (When using standard RJ45 connectors)</td>
<td>N/A</td>
<td>N5395C</td>
</tr>
<tr>
<td>Optional</td>
<td>4-port ECal Module - to calibrate E5071C Vector Network Analyzer</td>
<td>N/A</td>
<td>N4431B (for E5071C-480/485) N4433A (for E5071C-4D5/4K5)</td>
</tr>
<tr>
<td>Required</td>
<td>Vector Network Analyzer option TDR</td>
<td>E6963A-ENA</td>
<td>E5071C ENA Vector Network Analyzer with option TDR, 440, 820 and 810</td>
</tr>
</tbody>
</table>
For example, a completely configured order for full compliance with one part number

The main components required for 100BASE-T1 Link Segment Testing:
- Qty(1) E6963A
- Qty(1) E6963A-1FP
- Qty(1) E6963A-APC
- Qty(1) E6963A-SMA
- Qty(1) E6963A-ENA
  - Optional: Qty(2) N5395C
  - Optional: Qty(1) N4431B Ecal for VNA
  - Optional: Qty(1) 010 4 port

For example, a completely configured order for full compliance with standalone part numbers

- Qty(1) E6963A
  - Optional: Qty(1) E6963A-1FP
- Qty(4) 1250-1744 Adapter-Coaxial straight Male-APC-N Female-APC-3.5
- Qty(4) E6961-20001 SMA Cable SMA(m) -SMA(m)
  - Optional: Qty(2) N5395C
  - Optional: Qty(1) N4431B Ecal for VNA
  - Optional: Qty(1) 010 4 port
- Qty(1) E5071C ENA Vector Network Analyzer
  - Optional: Qty(1) E5071C-TDR Enhanced Time Domain Analysis
  - Optional: Qty(1) E5071C-440 4-port Test Set, 9 kHz to 4.5 GHz without Bias Tees
  - Optional: Qty(1) E5071C-810 Add keyboard
  - Optional: Qty(1) E5071C-820 Add mouse
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Published in USA, October 8, 2018
5992-2795EN
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