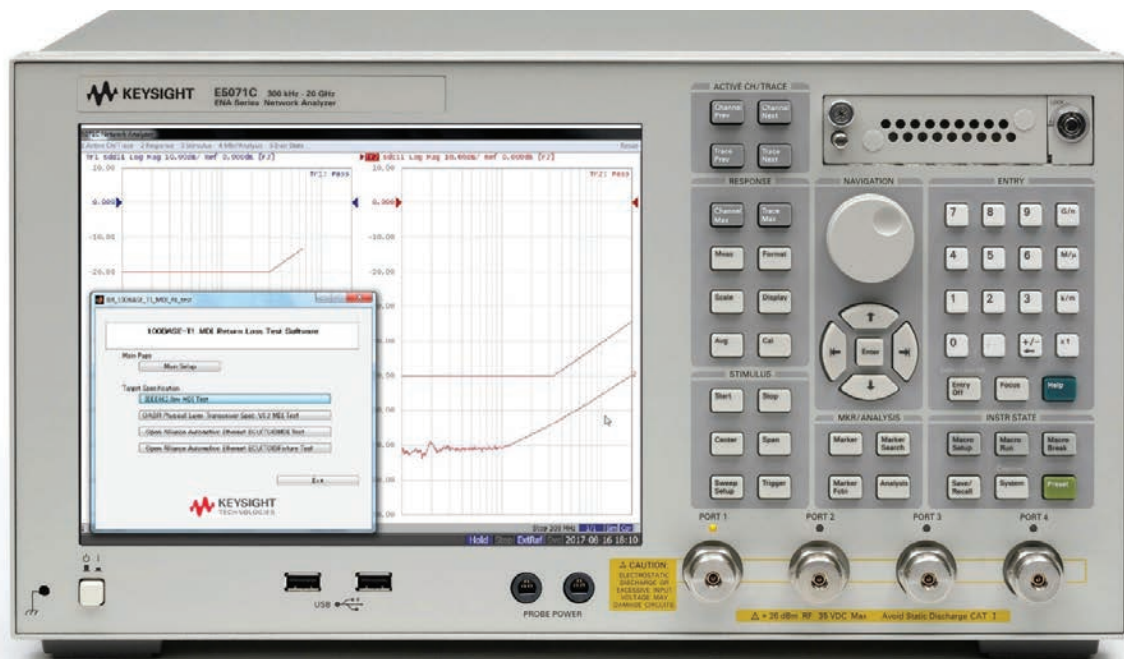# Keysight E6964A
Automotive Ethernet MDI S-parameter Compliance Solution

Medium Dependent Interface (MDI) S-parameter testing made more accurate for components being tested for 100BASE-T1 or BroadR-Reach transmission compliance.

Data Sheet

KEYSIGHT
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Introduction

The Keysight Technologies, Inc. E6964A automotive Ethernet MDI S-parameter software provides you with an accurate way to verify BroadR-Reach and/or 100BASE-T1 designs and components.

Most R&D teams believe they're ready for automotive Ethernet because they've mastered low-speed buses like CAN or LIN. However, with automotive Ethernet you can't glance at a few bits on the bus and quickly understand what's happening. Next-generation Advanced Driver Assistance Systems (ADAS) require cameras and radar systems with increasingly high resolution. That means new requirements for speed and bandwidth—and automotive Ethernet provides much faster transfer of ADAS-related data. 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, link segment and unique MDI S-parameters solution for 100 Mb/s automotive Ethernet.

The E6964A automotive Ethernet MDI S-parameter test software lets you quickly execute Ethernet physical-layer (PHY) electrical tests for transmission compliance using the IEEE 802.3bw standard. In addition to the measurement data, the report provides a pass/fail analysis. The E6964A displays the results in a text format.

Using the Keysight E6964A MDI S-parameter application (100BASE-T1 compliant) software increases confidence and repeatability of automotive Ethernet S-parameter testing.

The E6964A MDI S-parameter application is available in the following license variations

– E6964A-1FP Fixed to one E5071C vector network analyzer
– E6964A-1TP Server-based transportable license to move from a lab or company to different E5071C vector network analyzers

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Features

Using the Keysight E6964A MDI S-parameter application (100BASE-T1 compliant) software increases confidence and repeatability of automotive Ethernet S-parameter testing.

The Keysight MDI S-parameter compliance software offers several features to simplify the validation of automotive Ethernet designs.

The E6964A software:
  – Guides you how to make connections to the device under test.
  – Configures the ENA for the 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
  – Complies with MDI S-parameter testing per BroadR-Reach V3.2 (OPEN alliance PMA test suite version 2) as well as IEEE 802.3bw (100BASE-T1) specifications

E6964A MDI S-parameter compliance software

The E6964A MDI S-parameter test software saves you time and gives you confidence by setting the stage for automatic execution of 100BASE-T1 transmitter S-parameter tests. Some of the difficulties of performing tests for 100BASE-T1 return loss measurements 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. Without intimate knowledge of how to use a network analyzer these steps can be intimidating and confusing. The 100BASE-T1 MDI S-parameter application gives you confidence in setting up, executed and analyzing the results.

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 including the MDI return loss that is covered by this software. The OPEN Alliance[1] test suite for BroadR-Reach (OABR) physical layer transceiver specification for automotive applications V3.2, dated June 24th, 2014 specifies the return loss characteristics required. In addition, the Open Alliance Automotive Ethernet ECU (TC8) specifies return loss and mode conversion of the MDI and fixture test.   Keysight E6964A BroadR-Reach Link segment test software incorporates these specifications and the test suites so that you do not need to be an expert on any of them.

Keysight's E6964A BroadR-Reach MDI S-Parameter software provides the same test as the Test Mode 4 Management Data Input (MDI) Return Loss Test in the N6467B Automotive Ethernet TX Compliance Test. The only difference is that this test runs directly from a vector network analyzer and does not require an oscilloscope.

1. 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.

S-Parameter Specifications for Automotive Ethernet Applications

The E6964A BroadR-Reach MDI S-parameter test software automatically configures the network analyzer and provides an informative results report that includes pass/fail analysis.

See Table 1 for the measurements and specifications tested in the E6964A.

Target Specification	Parameter	Measurement Equipment	Keysight Model
IEEE802.3bw MDI Test	96.8.2.1, 96.8.2.2	Vector Network Analyzer	E5071C ENA Series
OABR Physical Layer Transceiver Spec. V3.2 MDI Test	8.2.2		
Open Alliance Automotive Ethernet ECU(TC8)	OABR_PMA_TX_05, OABR_PMA_TX_06		

Table 1. Conformance tests performed by the E6964A MDI S-parameter application software as specified by IEEE 802.3bw, OABR V3.2 and ECU(TC8) physical layer transceiver specification for automotive applications.

E6964A software gives you confidence

It can be time consuming to look up the specifications and then manually setup your network analyzer to run the required return loss test. The domain knowledge of a network analyzer and confidence to know you are doing it correctly can be an added challenge. In addition, you may not need to run all the transmission tests on the oscilloscope. Unlike other vendors, Keysight gives you the confidence to operate the network analyzer and simplicity to run just the S-parameter test stand alone, without an oscilloscope. Ultimately, saving you time in understanding the specifications, setting up the tests and interpreting the results.

The E6964A MDI S-parameter test application extends Keysight's E5071C vector network analyzer to do a complete set of return loss tests as required by IEEE 802.3bw. The Keysight E6964A enables you to:
 – View the MDI S-parameter tests in the GUIs main window
 – Perform quick and clear setup, configuration and test
 – Run single or multiple tests based on your needs
 – Get accurate and repeatable results with Keysight vector network analyzer
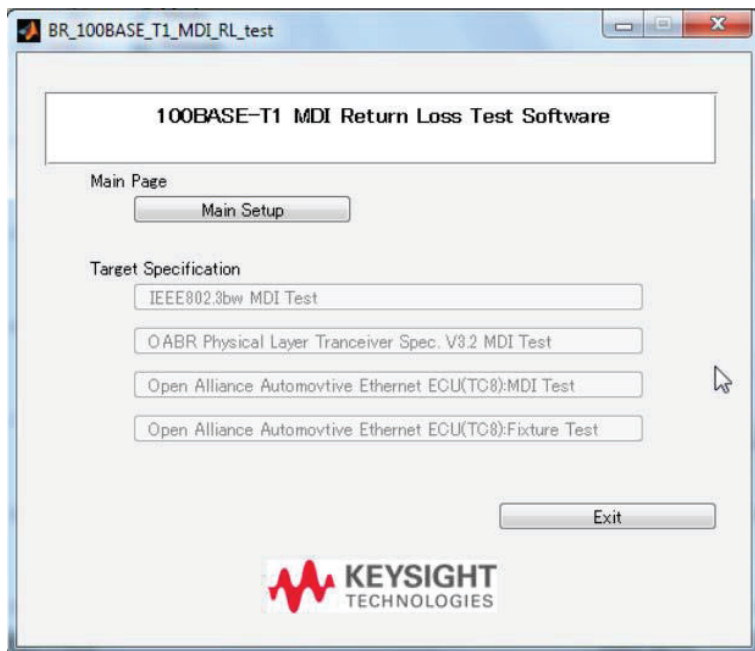 – Obtain test report with pass/fail analysis

Figure 1. The main screen of the E6964A. The software screens are intuitive and easy to follow.

www.keysight.com/find/E6964A

Configurability and Connections

The E6964A MDI S-parameter 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. 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.
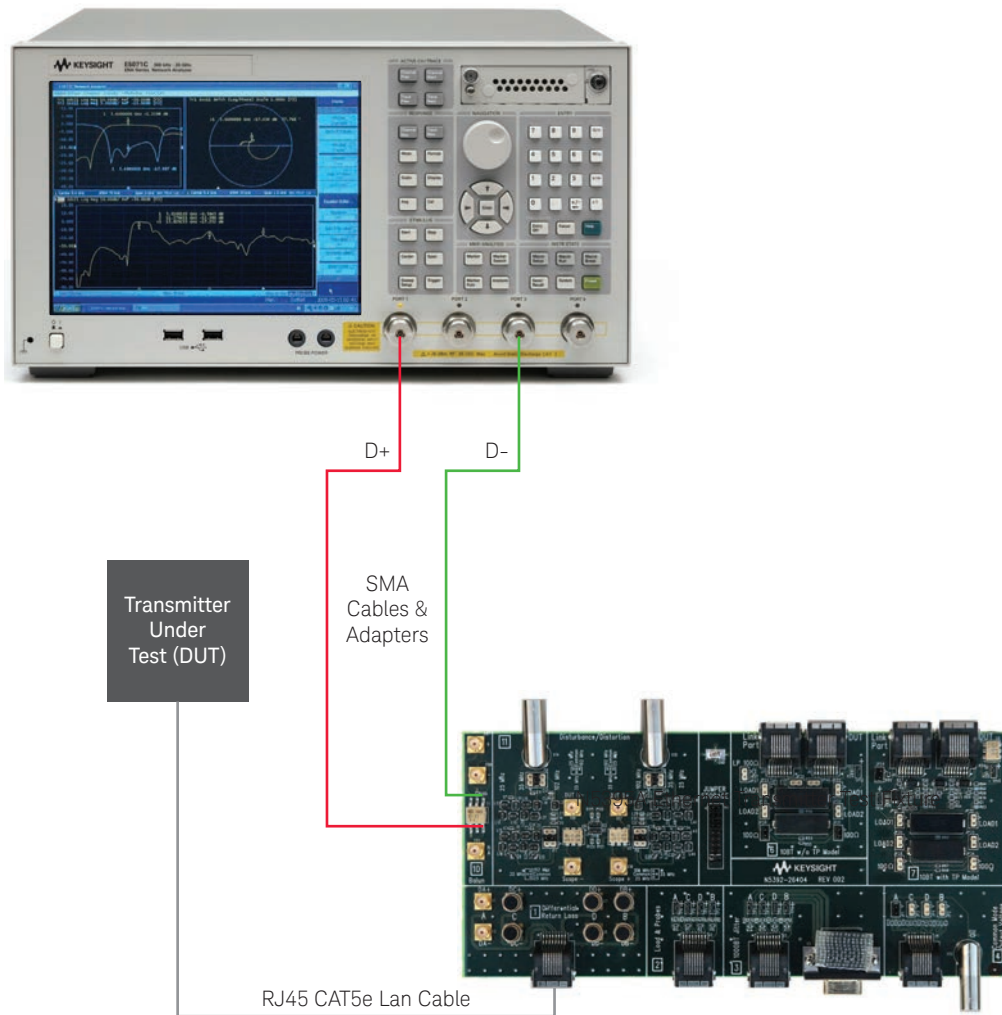

Figure 2. Configuration for general procedure to connect your DUT to the network analyzer.

Configurability and Connections (Continued)

To easily setup and run the return loss measurements The E6964A software stores the settings in a state file for the E5071C ENA. The file includes all the measurement settings for MDI return loss test. Figure 3 and table 2 show loading and describe the contents respectively.
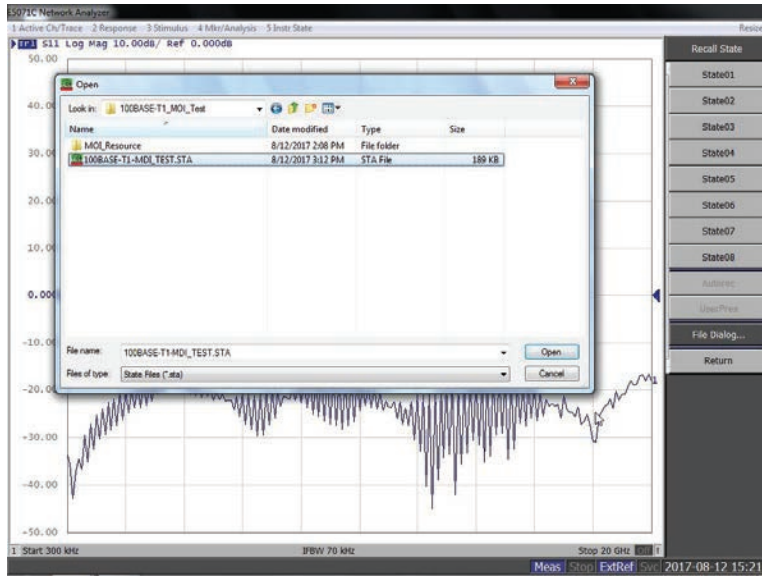

Figure 3. Recalling an ENA state file.

Parameters	Channel 1 (Frequency) Value
Sweep f_{Start}	1 MHz
Sweep f_{Stop}	200 MHz
Sweep points	400
Sweep type	Logarithmic
Output power	-5 dBm
Measurement bandwidth	30 Hz
Logic port impedance differential mode	100 Ω
Logic port impedance common mode	25 Ω

Table 2. The state file measurement conditions.

In addition to providing the state file with the measurement parameters, points of calibration are built into the procedure. It is recommended to calibrate before each measurement to get accurate results, however, user can skip this calibration procedure if they choose.
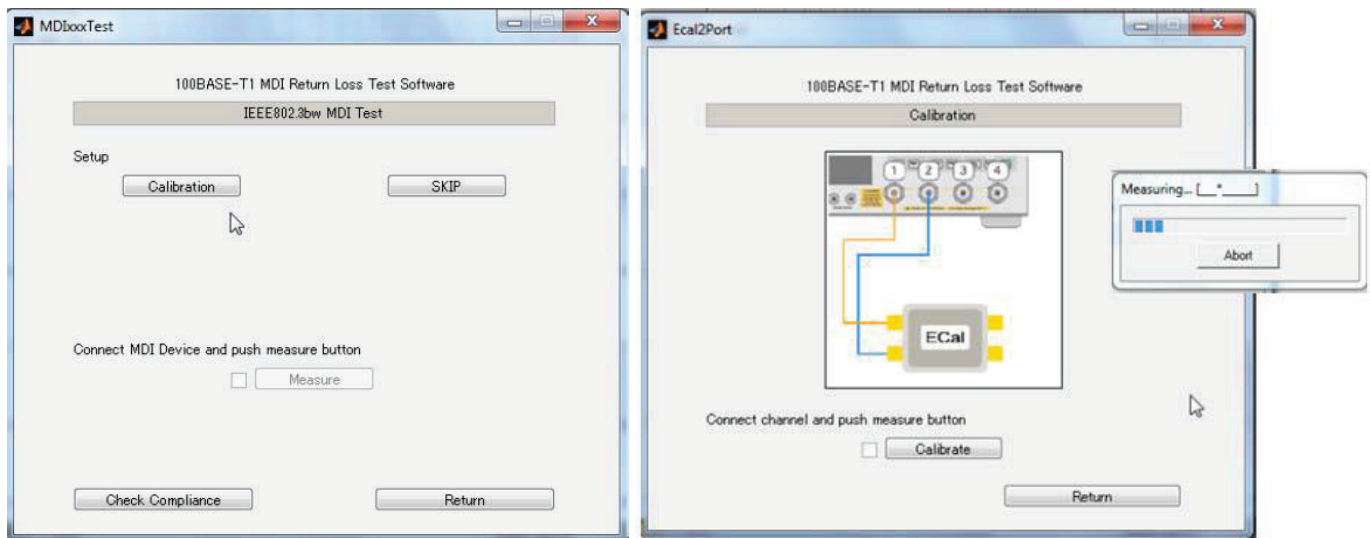

Figure 4. Calibration is extremely important for S-parameter measurements on an VNA. The E6964A builds the procedure into the test setup.

Report with Pass/Fail Analysis

The E6964A BroadR-Reach MDI S-parameter test software gives you measurement results and provides a report format that shows you if your product passes or fails.

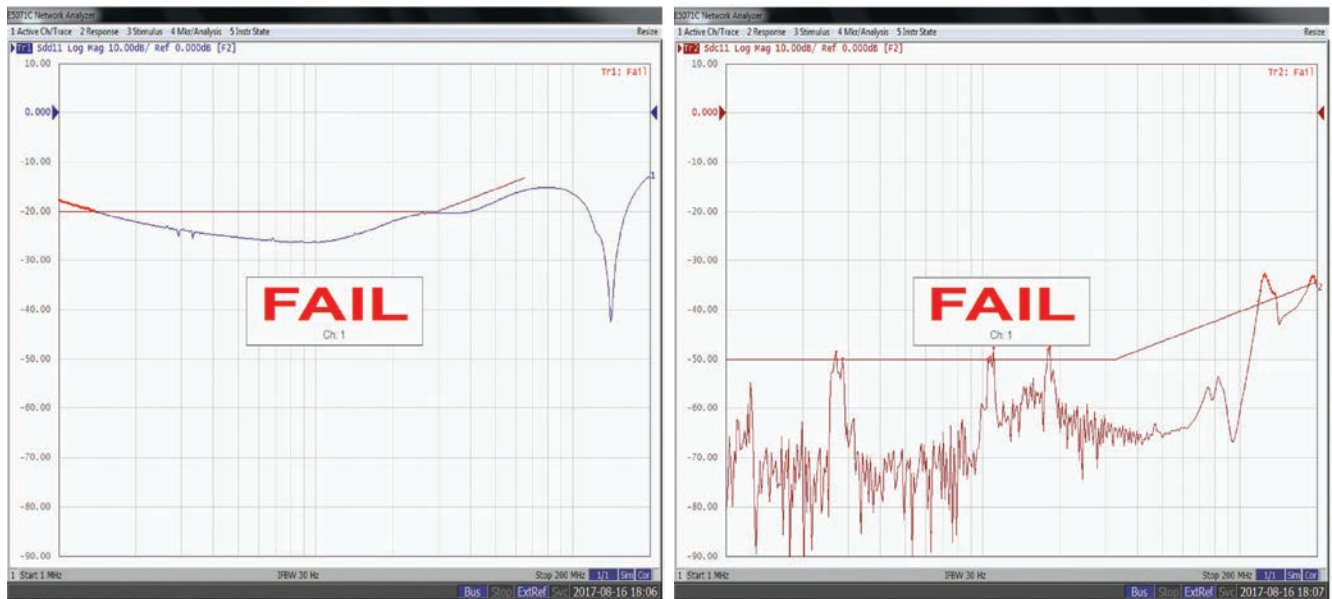Figure 5. E6964A MDI S-parameter typical display.

Figure 6. Sdd11 and Sdc11 Test Result Examples.

Instruments and Accessory Requirements

To use the E6964A BroadR-Reach MDI S-parameter 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.

Accessories		
Quantity	Keysight part number	Description
4	SMA (f) to SMA (m) cables	For E5071C Option 4D5 for 14 GHz or option 4K5 for 20 GHz
4	E6961-20001 SMA (m) to SMA (m) cables	For E5071C Option 480 or 485 for 8.5 GHz
4	1250-1250 N-type (m) to SMA (f) adapter	
1	N5395C standard ethernet test fixture	When using standard RJ45 connectors, use the Keysight Technologies N5395C Standard Ethernet Test Fixture. For custom connectors, the user needs to provide the fixture
1	4-port ECal module N4431B (for E5071C-480/485) N4433A (for E5071C-4D5/4K5)	Required to calibrate E5071C Vector Network Analyzer

Hardware Requirements

Keysight part number	Description
E5071C ENA Series Network Analyzer	E5071C ENA Series Network Analyzer Option 480 (4.5 GHz) *Higher frequency can be used but is not necessary* *485 (8.5 GHz), 4D5 (14 GHz), or 4K5 (20 GHz)*

Please note the following:	
Keysight E5071C ENA analyzer with firmware revision B.13.30 or higher.	For E5071C with earlier revisions, free upgrade software is available here: **www.keysight.com/find/ena_firmware**

Ordering Information

As the MDI return loss test is part of the transmission requirements of Automotive Ethernet PHY compliance testing the hardware and accessories can be ordered through the E6961A.

– The E6961A offers a single part number for a complete solution.
– Order software and accessories through the E6961A, and order hardware separately through the standalone model number.
– Or order all components standalone; the software as E6964A.

See required part numbers and examples below.

Single part number inclusive of all applicable hardware and software

Required for compliance	Description	Option number through E6961A	Stand alone model/part number
Required	BroadR-Reach MDI S-parameter Compliance application license	E6961A-OC-SWLICENSE E6964A-1FP	E6964A
Required	Cable , SMA(m) -SMA(m) x 2		E6961A-SMA
Required	Cable , SMA(m) -SMA(m) x 2		E6961A-SMA
Required	Adapter, coaxial straight APC-N(m)-APC-3.5 Cable x 4	E6961A-MDI	E6961A-ADC
Required	4-port ECal Module - to calibrate E5071C Vector Network Analyzer	E6961A-ECL	N4431B (for E5071C-480/485) N4433A (for E5071C-4D5/4K5)
Required	Vector Network Analyzer	E6961A-ENA	E5071C ENA Vector Network Analyzer with option 440, 820 and 810

A quantity of 4 SMA cables and 4 adapters are required to test the S-parameters in the E6964A, please order E6961A-MDI plus qty 2 E6961A-SMA.

For example, a completely configured order for full compliance with one part number

Qty(1) E6961A
   opt Qty(1) E6964A-1FP
Qty(2) E6961A-SMA
Qty(1) E6961A-MDI
Qty(1) E6961A-ECL
Qty(1) E6961A-ENA

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

Qty(1) E6964A
   opt Qty(1) E6964A-1FP
Qty(4) E6961A-ADC Adapter, coaxial straight APC-N(m)-APC-3.5 Cable
Qty(4) E6961A-SMA SMA Cable SMA(m) -SMA(m)
Qty(1) N4431B Ecal for VNA
    opt Qty(1) 010 4 port
Qty(1) E5071C ENA Vector Network Analyzer
   opt Qty(1) E5071C-440 4-port Test Set, 9 kHz to 4.5 GHz without Bias Tees
   opt Qty(1) E5071C-810 Add keyboard
   opt Qty(1) E5071C-820 Add mouse

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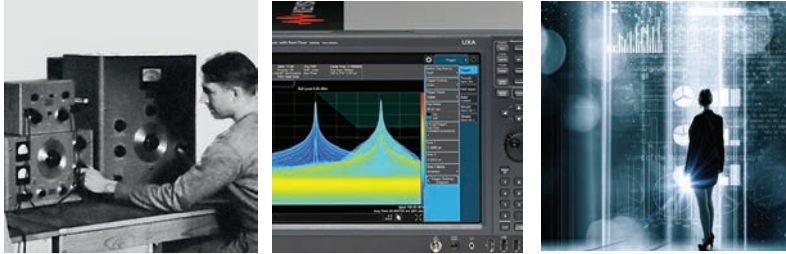– Productivity software

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