Keysight AE6910R Automotive Ethernet Rx Compliance Test Software

KEYSIGHT

INSTALLATION & USER GUIDE

Notices

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	Alternating current (AC)		

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1 Introduction

Overview

The BitifEye “ValiFrame” Test Automation software is globally marketed and supported by Keysight Technologies as AE6910R for the Automotive Ethernet Receiver Test solution. This document describes the calibrations and test procedures conducted by ValiFrame for Automotive Ethernet in detail.

The AE6910R software implements the compliance tests according to the requirements defined by the OPEN Alliance in the “1000BASE-T1 Interoperability Test Suite”, “IEEE 1000BASE-T1 Physical Media Attachment Test Suite”, “100BASE-T1 Interoperability Test Suite”, and “IEEE 100BASE-T1 Physical Media Attachment Test Suite” documents. It also offers additional custom characterization tests to provide more details of the DUT (Device Under Test) behavior beyond the limits of compliance testing.

The software runs on a standard Windows PC and controls the hardware test resources through appropriate interfaces such as LAN (Local Area Network).

NOTE

AE6910R Valiframe v1.4 or higher will support new version of APM1000E/-CLK media converter (S/N RN0000 models) only.

The Valiframe v1.3 or below supports old APM1000E/-CLK with RM0000 only.

The future AE6910R SW updates will only be relevant to new APM1000E/-CLK with S/N RN0000 only.

2 Installation

Overview

The AE6910R software consists of different SW components:

1. Test Automation for the automated receiver compliance tests consist of the following:
   - Station Configurator.
   - ValiFrame.
   - Frame Generator.
2. Keysight APM1000E/-CLK serial protocol driver SW.

All of these parts are installed by three different installer files. Station Configurator and Valiframe are in one installer. This can be downloaded from here.

Installation

NOTE

Before installing the Automotive Ethernet software, you need to first install the Keysight Serial Protocol Driver package for accessing the APM1000E/-CLK Media Converter.

In addition to ValiFrame, the FrameGenerator software is also available. The FrameGenerator software allows you to control and debug the DUTs behavior under stressed conditions with a wide range of configurations.

You can separately install the three installers, namely, the Keysight driver package, ValiFrame/Configurator, and FrameGenerator.

Installer

1 Download all the installers from here. The installers are:

– the Keysight driver package.

– ValiFrame/Configurator.

– FrameGenerator.

2 Save it on the hard drive of your PC.

3 Right click and select **Run as administrator** for the following files:

– AutomotiveEthernet_Frame Generator_AE6910R_1.4.0.x_Beta_Installer.exe

– AutomotiveEthernet_ValiFrame_AE6910R_1.4.0.x_Beta_Installer.exe

– SerialProtocolDriver_2_0_0_x.exe

4 Accept and proceed with the steps.

5 After clicking **Install**, each selected installer will start to install. You may have to confirm several dialogs, check boxes, or other similar prompts.

Upon installing the AE6910R Automotive Ethernet Rx Compliance Test Software, three icons are added to the desktop as shown in Figure 2-1.

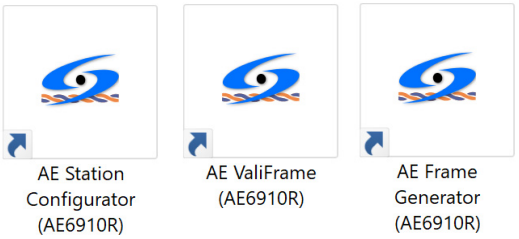

Figure 2-1 Desktop Shortcuts to the Components of the AE6910R Automotive Ethernet Rx Compliance Test Software

Licensing

You must obtain and activate your license before using the software. Refer to the related video tutorials or related manual on steps to activate your license here.

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3 ValiFrame Automotive Ethernet Software

Overview

After installing the ValiFrame software, two icons are added to the desktop as shown in Figure 3-1 for the AE Station Configurator and Figure 3-8 for the AE ValiFrame.

AE Station Configurator

Test Station Selection

The set of test instruments used for a specific application are referred to in the following as “Test Station” or in short “Station”. You can control the test station by using a suitable PC and the AE6910R Test Automation Software Platform.

You must start the ValiFrame Automotive Ethernet Station Configuration before launching ValiFrame. It allows you to select the required set of instruments. Double-click the AE Station Configurator icon (see Figure 3-1) to launch the software. Alternatively, to access the ValiFrame Station Configuration on a Windows-based PC:

Click  > **BitifEye AE AE6910R** > **AE Station Configurator (AE6910R)**

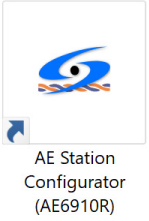

Figure 3-1 AE Station Configurator

Upon launching the AE Station Configurator, the ValiFrame Configuration Wizard appears as shown in Figure 3-2.

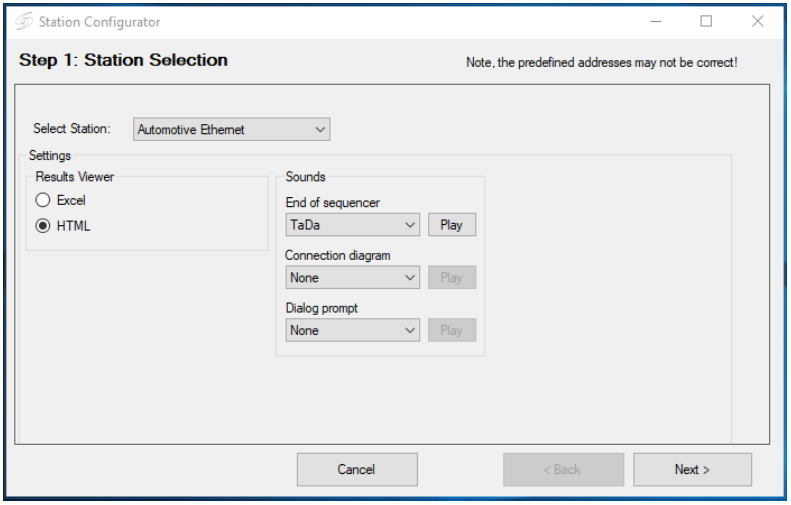

Figure 3-2 Station Selection Window

You may also select either (Microsoft) **Excel** or **HTML** (recommended) as the viewer for test results.

Next, you may optionally assign sounds that would mark the attainment of different states of the program.

- **End of sequencer** plays the selected sound at the end of a sequence.
- **Connection diagram** plays the selected sound every time a connection diagram pops up.
- **Dialog prompt** plays the selected sound at each dialog prompt.

Select a sound tone from the following options available in the drop-down options for **End of sequencer**, **Connection diagram**, and **Dialog prompt**. The option "None" disables the sound for the respective action.

- None
- Car Brakes
- Feep Feep
- Ringing
- TaDa
- Tut

After selecting the Automotive Ethernet Station for **Select Station**, click **Next** to continue.

Test Station Configuration

Figure 3-3 shows the Station Configuration stage of the wizard. It shows the various options for instruments used for Automotive Ethernet testing. The options are as follows:

- Media Converter
- Noise Source

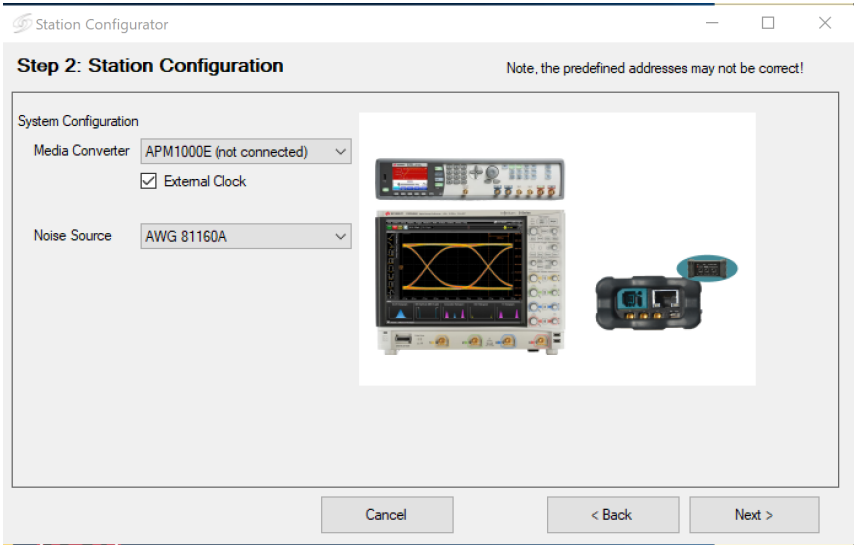

Figure 3-3 Station Configuration Window

Media Converter

A Gigabit Ethernet port of a PC or laptop or a suitable adapter USB-to-Gigabit-Ethernet generates the frames to test. A data converter that converts the Gigabit standard Ethernet to Automotive Ethernet is required. The available option is as follows:

- APM1000E

Note that the Valiframe version 1.4 is only for use with the newer version APM1000E/-CLK with the serial number 'RN0000'. While configuring the APM1000E, connecting old versions of APM1000E with the serial number 'SN RM0000' should pop up an invalid connection message as shown on Figure 3-4.

Newer versions of the APM1000E can operate with an adjustable clock frequency. Select the checkbox **External Clock** to add the clock source to the setup.

If you connect several APM1000E to the PC, select the one to use as a data converter by its serial number, displayed in brackets.

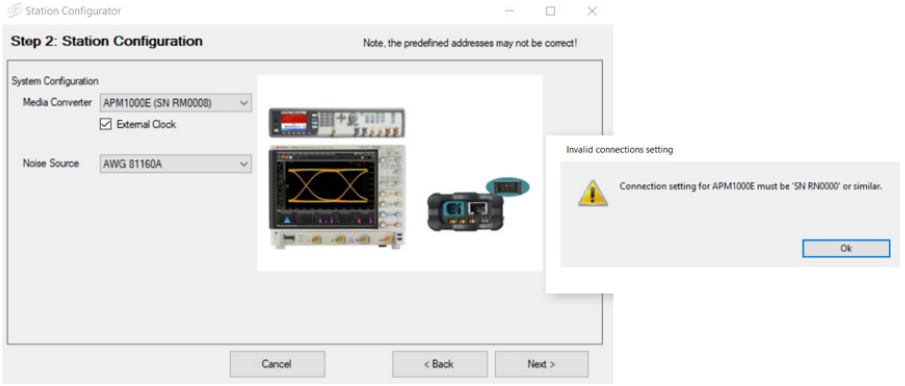

Figure 3-4 Step 2 : Station Configuration Warning Message

Noise Source

A noise source is required. ValiFrame supports the following sources:

– AWG 81160A Pulse Function Arbitrary Noise Generator

Test Instrument Configuration

Once you configured the Automotive Ethernet station, you must set the instrument addresses. Figure 3-5 shows an example of setting the instrument configuration whereas Figure 3-7 shows an example of a failed instrument setting when the older version of APM1000E is being used as instrument.

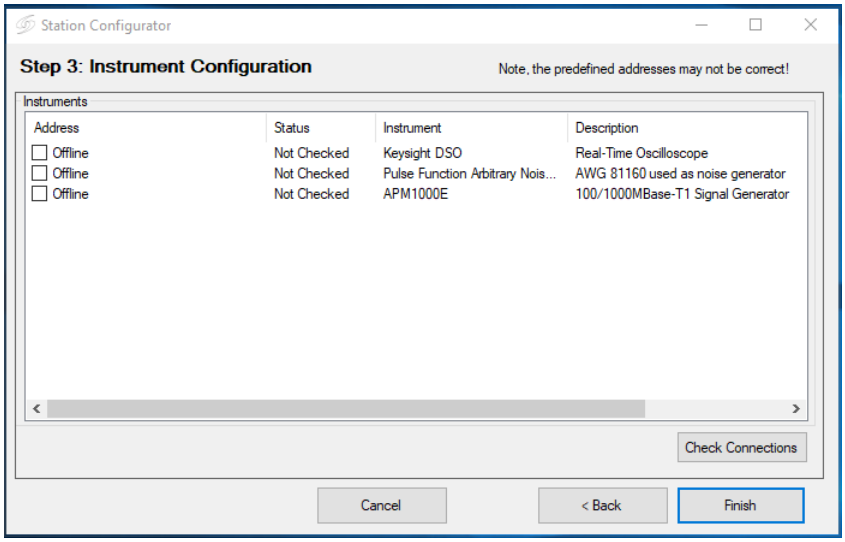

Figure 3-5 Instrument Configuration Window

After the installation process, the configuration of all instruments by default is in the **Offline** mode. In the simulation mode, you need not physically connect the hardware to the test controller PC. The ValiFrame software cannot connect to any instrument in this mode. To control the instruments connected to the PC, enter the instrument address. The address depends on the bus type used for the connection, for example, GPIB (General Purpose Interface BUS) or LAN (Local Area Network). Most of the instruments used in the Automotive Ethernet station require a VISA (Virtual Instrument System Architecture) connection.

To determine the VISA address, run the **Keysight Connection Expert**. Refer to "Keysight Connection Expert" on page 100 for details.

Copy the address string for each instrument from the Connection Expert entries and paste it as the instrument address in the **Station Configuration** wizard. After entering the address strings, click **Check Connections** to verify that the connections for the instruments are correct. If there are any errors in the instrument address configuration, the Wizard displays a prompt to indicate so.

Control the Instruments Connected to the PC

1 Check the respective **Address** check box of the **Step 3: Instrument Configuration** wizard as shown in Figure 3-6.

2 Copy the address string for each instrument from the **Keysight Connection Expert** entries as shown in Figure A-3 and paste it as the **Instruments** > **Address** column in the **Step 3: Instrument Configuration** wizard.

3 After entering the address strings, click **Check Connections** to verify that the connections for the instruments are correct. If there is an error in the instrument address configuration, the Wizard displays a prompt to indicate so.

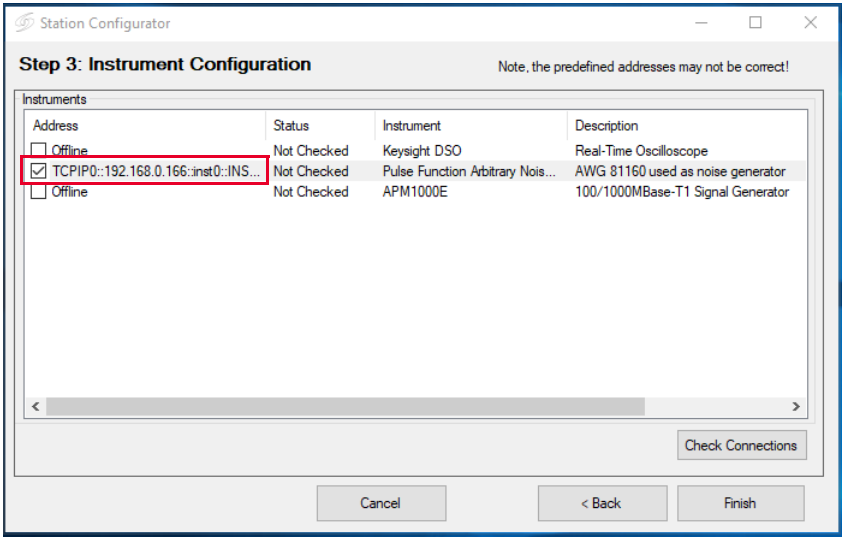

Figure 3-6 Change Address

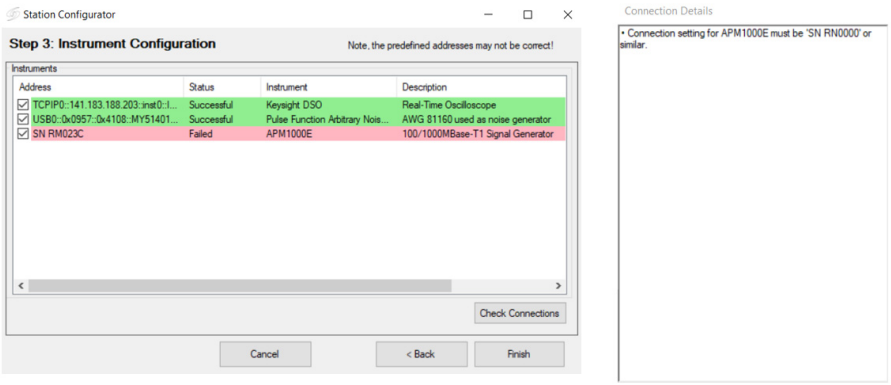

Figure 3-7 Failed Instrument Configuration Window

NOTE When starting a specific test station configuration for the first time, set all instruments to the **Offline** mode. In this mode the test automation software does not connect to any instrument. Use this mode for demonstrations or checks only.

AE ValiFrame

After configuring the AE Station Configurator you can now double click the AE ValiFrame icon on the desktop, as shown in Figure 3-8 to launch it.

Alternatively, click > **BitifEye AE AE6910R** > **AE ValiFrame AE6910R**.

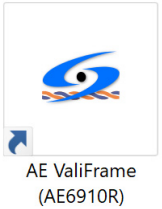

Figure 3-8 AE ValiFrame

Starting the AE ValiFrame opens the following window in Figure 3-9.

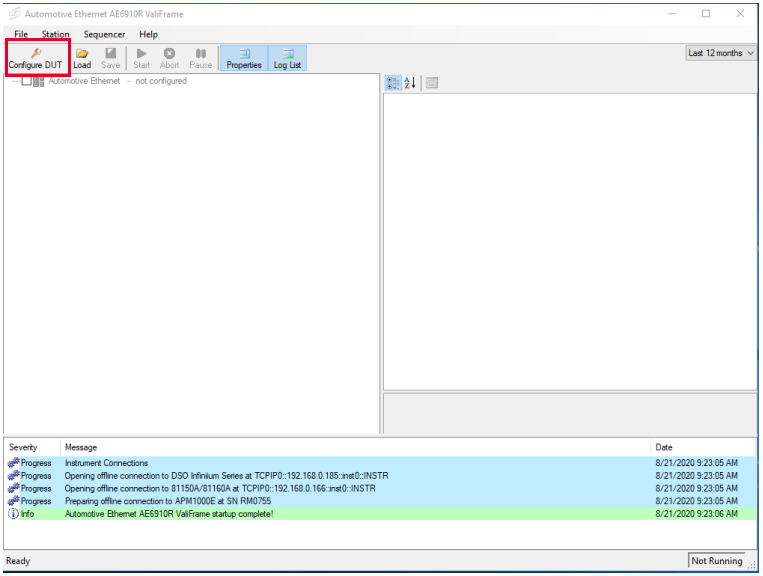

Figure 3-9 ValiFrame Automotive Ethernet User Interface

Configure the test parameters before running any test or calibration procedure. Click the **Configure DUT** button to open the Automotive Ethernet Configuration window shown in Figure 3-10. Alternatively, you may select **File** > **Configure DUT...** from the File menu.

Configuring the DUT

The Automotive Ethernet Configuration window allows you to select the DUT parameters, such as **Data rate** or **Spec Version**, as well as test parameters, which are related to the receiver test configuration. These parameters shall be used later in several calibrations and test procedures.

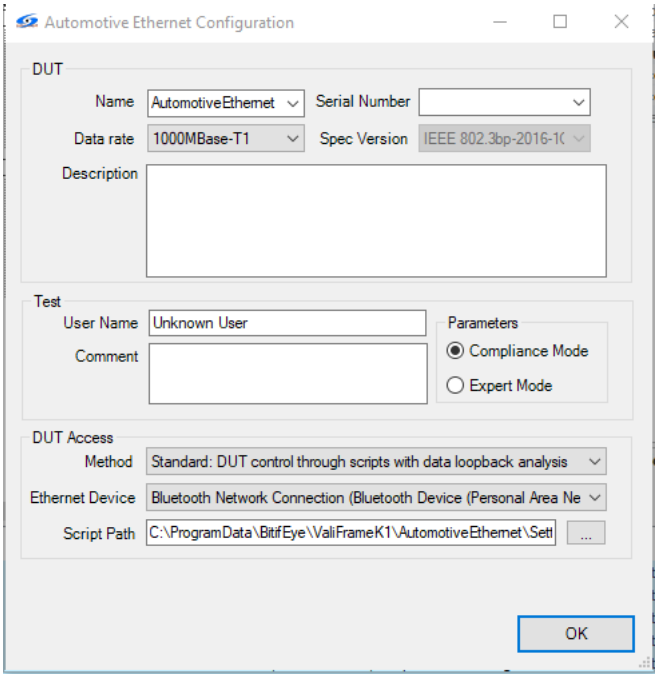

Figure 3-10 Configure DUT Panel

Configuration Parameters

In Figure 3-10, various parameters, such as **Data rate**, **Spec Version**, and **Compliance Mode** or **Expert Mode**, can be selected. Table 3-1 lists the description for all such parameters.

Table 3-1 DUT Parameter List

Parameter Name	Parameter Description
DUT (Product Parameter)	
Name	Product name
Serial Number	Product serial number
Data rate	Select the data rate as follows: – 100MBASE-T1 – 1000MBASE-T1
Spec Version	The calibrations and tests are defined according to the selected spec version. The options are as follows: – IEEE 802.3bw-2015-10 when 100MBASE-T1 is selected – IEEE 802.3bp-2016-10 when 1000MBASE-T1 is selected
Description	Product description
Test (Test Parameter)	
User Name	User name text field.
Comment	User comments text area.
Compliance Mode	Test are conducted as mandated by the CTS. The parameters that are shown in the calibration and test procedures cannot be modified by the user.
Expert Mode	Calibrations and tests can be conducted beyond the limits and constraints of the CTS. The parameters that are shown in the calibrations and test procedures can be modified by the user.

Table 3-1 DUT Parameter List

Parameter Name	Parameter Description
DUT Access	
Method	– Scripting: The DUT access is implemented by using scripts to read or set the relevant registers of the DUT. The BER is measured by reading the error counters. If scripting is selected, it is necessary to provide and specify the path of the scripts. ValiFrame provides batch script templates (such as enable loopback, read BER register...) that can be filled with any kind of script (e.g. calling itself a tool or a python script). They can be found in the path: "C:\ProgramData\BitifEye\ValiFrameK1\AutomotiveEthernet\Settings\OfflineScripts" **IMPORTANT NOTE:** The scripts have to be adapted to the specific needs of your DUT. The following options are only available in Expert Mode: – Manual: In manual mode it is necessary to set up the device and read the register through any tool to control the DUT. ValiFrame will interactively ask for the required actions. The BER is measured with loopback analysis. – Standard: In this case, the scripts are used to set up the device and the BER is measured with loopback analysis.
Ethernet Device	Keysight recommends that you use a USB to Ethernet gigabit adapter to easily recognize which port needs to be chosen.
Script Path	It is the path of the script files used to access the DUT.

NOTE To be able to perform automated tests, the DUT must have the capability to reset and configure its PHY as well as looping back the received Ethernet data packages.

Configuring the Ethernet Port

For performing BER tests based on a data loopback analysis, it is necessary to configure the used Ethernet port of your PC (or the USB-to-Ethernet-adapter) in the right way:

- The conversion by the APM1000E from Standard Ethernet to Automotive Ethernet will fail if there is a change of the device speed or duplex setting in the data flow.
- For tests at 100 Mbps, you must set the PC's Ethernet device (or the used USB-to-Ethernet-adapter) to 100 Mbps Full Duplex:

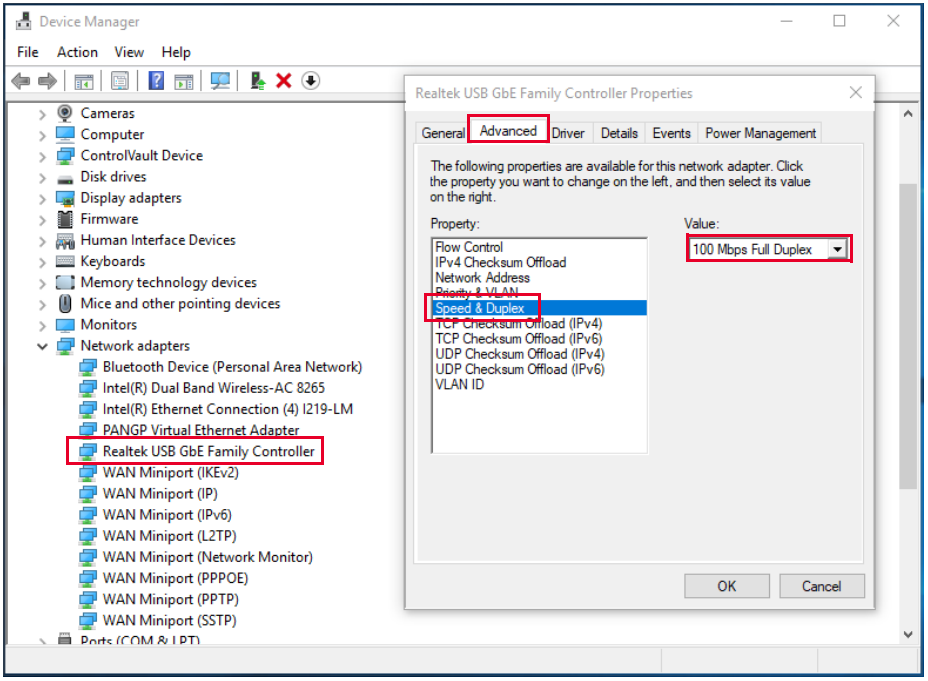

Figure 3-11 Configuring the PC's Ethernet Device for Tests at 100 Mbps

- In the same way, set the Ethernet device to **Auto Negotiation** for the tests at 1000 Mbps:

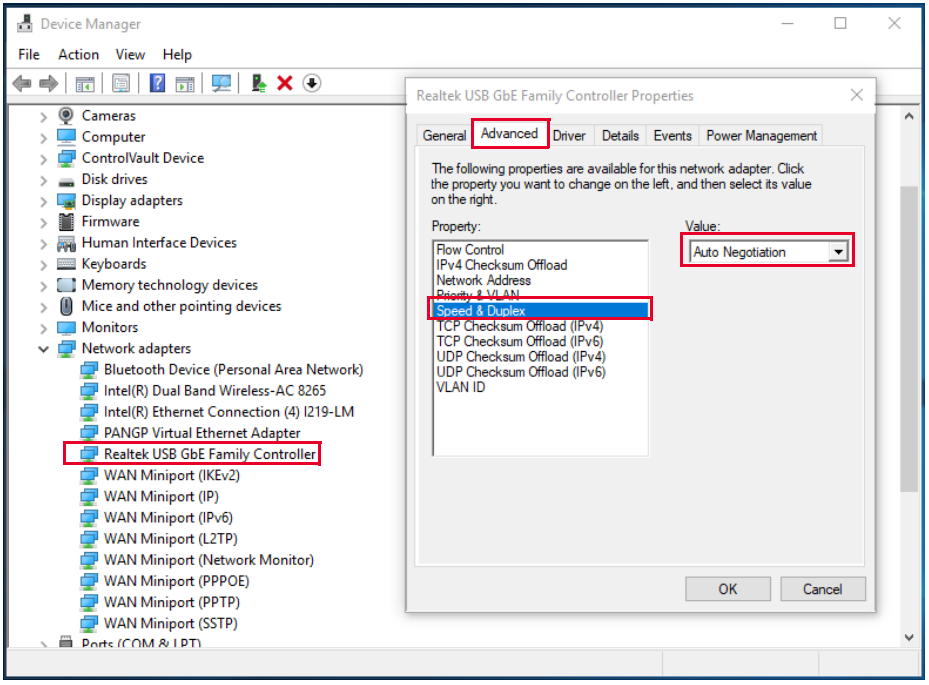

Figure 3-12 Configuring the PC's Ethernet Device for Tests at 1000 Mbps

NOTE

If the device is currently at 1000 Mbps and you want to switch it to 100 Mbps, then you need to change the device's Speed & Duplex to **100 Mbps Full Duplex** and press the Master/Slave button at the device until flash light change to yellow. Next, you need to reconnect the USB cable of the device to ensure it works properly on data loopback analysis.

Configuring Data Rate and Link Role of the APM1000E

The APM1000E has to be configured correctly, depending on the chosen data rate and link role of the DUT.

If ValiFrame detects a wrong configuration, it displays a dialog with the direction of the button to press. The dialog will appear again for as long as the configuration of the APM1000E is incorrect.

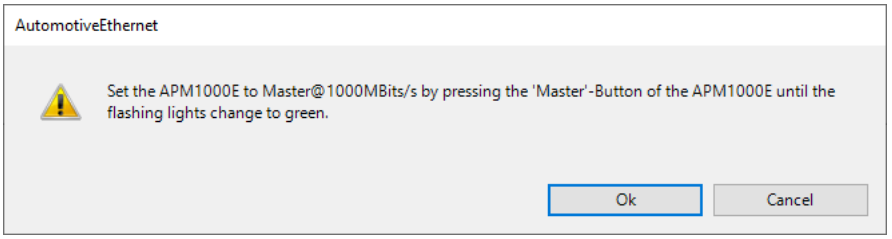

Figure 3-13 Ensuring the Correct Data Rate and Link Role of the APM1000E

Using an APM1000E with Variable Clock Frequency

The internal clock of the APM1000E is only correctly working if the external reference clock provided by the 81160A generator is present during startup. A repowering step ensures this at the beginning of a test run and after changing the clock frequency.

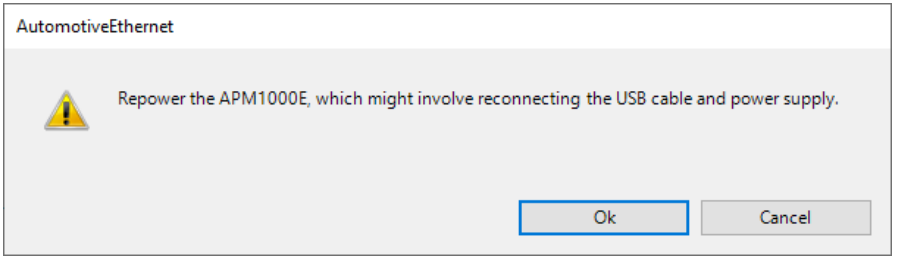

Figure 3-14 Ensuring the Initialization of the Internal Clock

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4 Using the Software

Overview

Once the DUT has been configured as stated in the “Configuring the DUT” on page 30, press the **OK** button in **Configure DUT** panel. All the calibration and test procedures are in their respective groups, organized in a similar way as in the CTS.

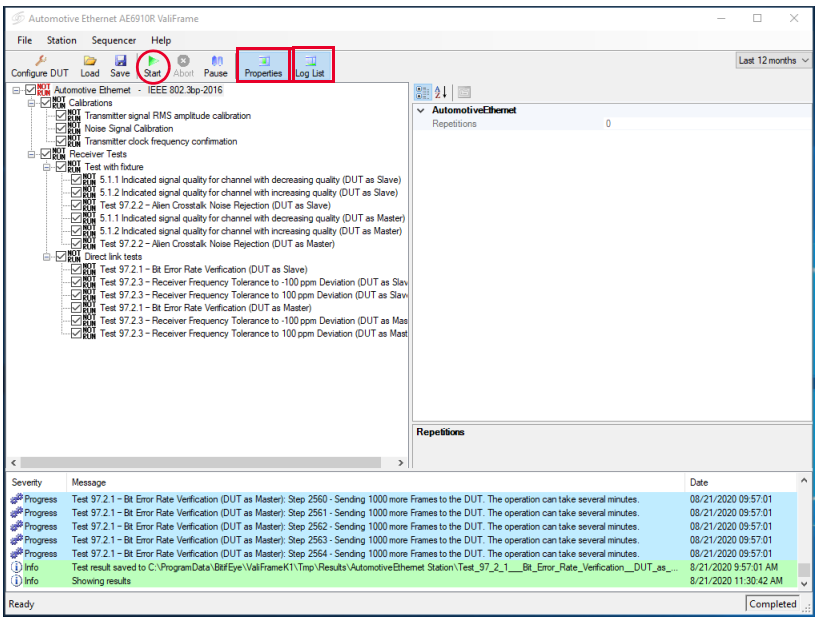

Figure 4-1 Automotive Ethernet Main Window

Use the **Properties** and **Log List** buttons of the main menu (highlighted in Figure 4-1) to display additional information on the right and at the bottom of the AE6910R main window, respectively. The parameter grid on the right side of the window shows the parameters which are related to the selected calibration, test procedure subgroups, or individual procedures. You can set these parameters only before the execution of the procedure subgroup or before starting the procedure. The log list at the bottom of the window shows calibration and test status messages (regular progress updates as well as warnings and error messages).

Upon running all the procedures, the AE6910R configuration can be stored as a single VFP file (.vfp) using the **Save** button and recalled using the **Load** button without configuring the DUT again.

CAUTION Before executing the calibration or test procedures, ensure that you configure the Automotive Ethernet Station Configuration properly with all necessary instruments such as the Infiniium oscilloscope set to online. You can run all calibrations in offline mode, that is, without any instruments connected. The offline mode is for product demonstrations with simulated data. CALIBRATIONS RUN IN OFFLINE MODE DO NOT GENERATE VALID CALIBRATION DATA.

Selecting, Modifying, and Running Test

Selecting Procedures

The calibration, receiver, and transmitter test procedure groups can be selected globally by clicking on the checkbox at the top of the group. Alternatively, you can select an individual test procedure by checking the specific selection boxes in front of the tests. Click on the **Start** button to execute the selected test procedures.

Modifying Parameters

Most calibration and test procedures, as well as the groups containing them, have parameters that control the details of how to run these procedures. In the compliance mode, most of these parameters are read-only. In the expert mode, you can modify almost all parameters. First, select a specific calibration or test procedure or one of the groups containing in the AE6910R procedure tree (see Figure 4-2). The displayed parameters are in a property list on the right side of the screen. If they are not displayed, press the **Properties** button. Your selection on the top left side of the list determines if the list is ordered alphabetically or in categories. The test parameters selected are listed in the MS Excel/HTML test results worksheets.

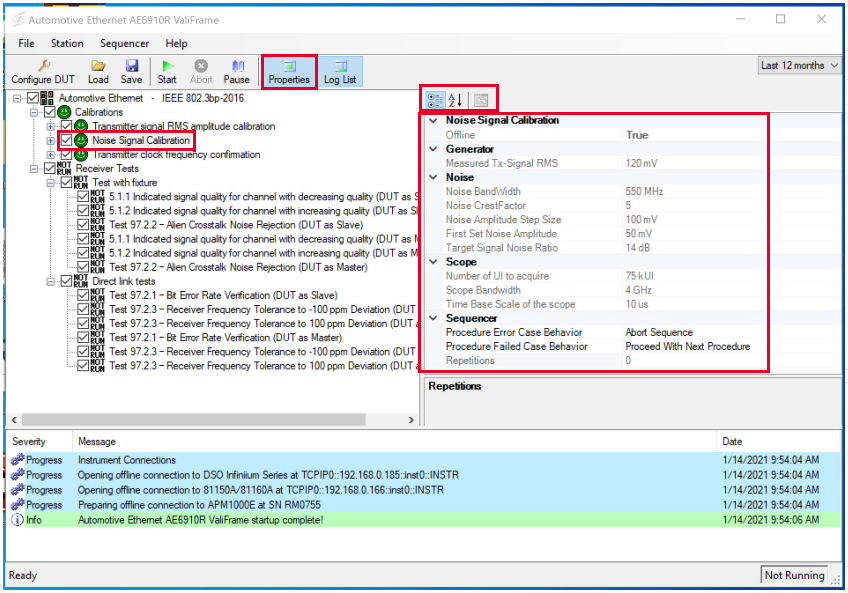

Figure 4-2 Modifying Parameters

Running Procedures

To run the selected procedure or test, press the **Start** button (highlighted in Figure 4-1). The procedures run in the order shown in the procedure selection tree. Some procedures may require user interaction, such as changing cable connections or entering DUT parameters. The required action is prompted in pop-up dialog boxes before the execution.

The connection diagram is also displayed by right-clicking on the desired test or calibration and selecting **Show Connection...**.

Results

Run-Time Data Display

Most procedures generate data output. While the procedure is running, the data displays in a temporary MS Excel worksheet or HTML page (depending on the selected viewer in the Station), which opens automatically for each procedure.

The MS-Excel worksheet or the HTML page opened during the procedure run then are closed once the specific procedure is complete. As long as the AE6910R software is running, you can reopen each worksheet or page by double-clicking on the respective procedure. However, the individual worksheets or pages will be lost when the AE6910R main window is closed unless you saved them.

Results Workbook

You can save all calibration and test data worksheets in a workbook by selecting **File** > **Save Results as Workbook...** at any time. Keysight recommends that this step is carried out at least at the end of each AE6910R run. If the calibration and test procedures are conducted several times during the same AE6910R run, the result worksheets are combined in the workbook. If you conduct a test procedure without prior execution of calibration procedures in the same test run, only the test results will be saved to the workbook.

NOTE

As a safety feature, all calibration and test results are saved by default to the ValiFrame “Tmp” directory. The sub-folder “Results/IEEE Open Station” contains the Excel files of the final results measured at each calibration and test procedure.

In addition to the calibration data worksheets, the calibration data files are generated. These files are saved by default to the ValiFrame calibrations folder. Rerunning these calibrations will overwrite the data file. To save the calibration data files at each configuration, you must copy the files from the directory: “C:\ProgramData\BitifEye\ValiFrameK1\Automotive Ethernet\Calibrations” and save them manually in any folder before rerunning the calibrations.

Test Results

Once you run the selected procedures successfully, a smiley face indicates the results (Pass / Fail / Incomplete), as shown in Table 4-1.

Table 4-1 Test Result Description

Smiley	Description
	Indicates that the procedure passed successfully in the previous run and the results are available.
	Indicates that the procedures passed in offline mode previously, and the results are available.
	Indicates that the procedure passed successfully in the present run.
	Indicates that the procedure did not run completely in the previous run.
	Indicates that the procedure could not run in the present run. Most likely, the DUT failed during initialization, so there was no test conducted.
	Indicates that the procedure failed in the previous run.
	Indicates that the procedure failed in the present run.
	This smiley face displays two results, such as the first half indicating the result of the present run and the second half showing the result of the previous run. In this example, the first half indicates that the procedure passed successfully in the present run and the second half means that it did not completely run in the previous run.

Automotive Ethernet Parameters

Sequencer Parameters

The sequencer parameters control the flow of the test sequencer, not the behavior of individual procedures. They are identical across all versions of ValiFrame. One of them, **Repetitions**, is available for all procedures and groups in the procedure tree. The others are only available for procedures. Like all other parameters, the sequencer parameters are shown on the right side of the ValiFrame user interface, and they can be changed by the user, as illustrated in Figure 4-3.

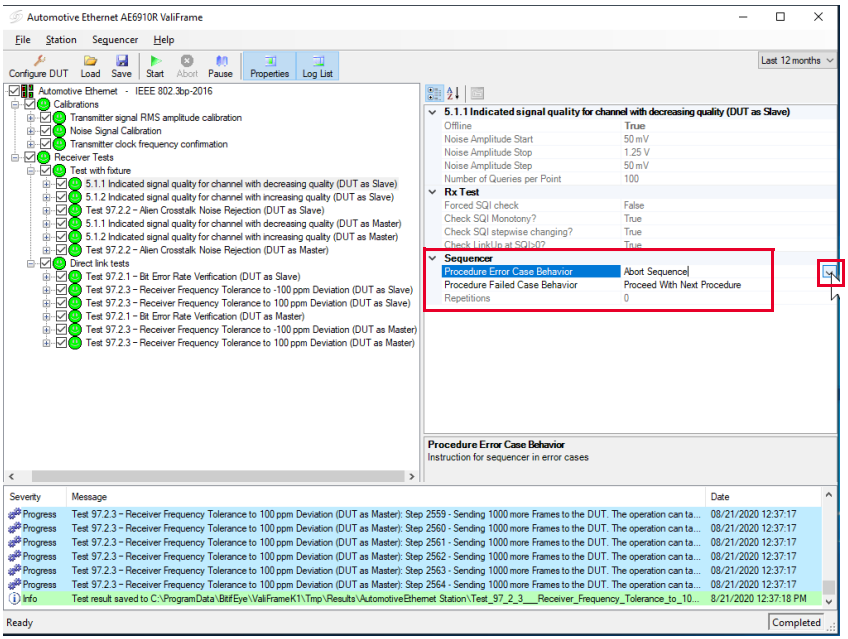

Figure 4-3 Sequencer Parameters

Table 4-2 lists all sequencer parameters in alphabetical order.

Table 4-2 Automotive Ethernet Sequencer Parameters

Parameter Name	Parameter Description
Procedure Error Case Behavior	**Proceed With Next Procedure**: If an error occurs in the current test or calibration procedure, continue by running the next procedure in the sequence. **Abort Sequence**: Abort the execution of the sequence.
Procedure Failed Case Behavior	**Proceed With Next Procedure**: If the current test or calibration procedure fails, continue by running the next procedure in the sequence. **Abort Sequence**: Abort the execution of the sequence.
Repetitions	The number of times the group or procedure is going to be repeated. If the value is set as "0", it runs only once.

Common Parameters

The common parameters are used for several related calibrations or test procedures. They are shown on the right side of the ValiFrame user interface when the selected entry of the procedure tree on the left is a group instead of an individual procedure.

The Automotive Ethernet Receiver Test Software has some group parameters (in addition to **Repetitions**) on the top-level entry of the Receiver procedure tree, as shown Figure 4-4. These will be common for all ValiFrame receiver procedures.

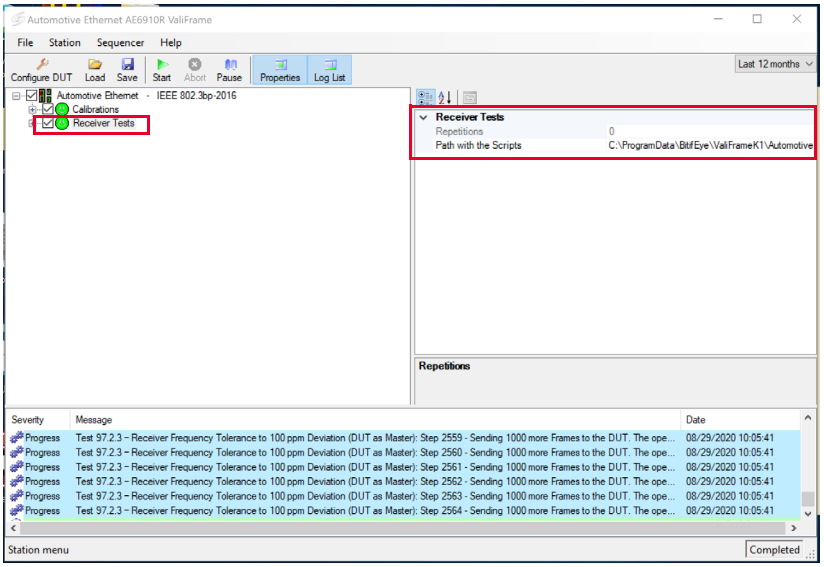

Figure 4-4 Common Parameters

Procedure Parameters

The Procedure Parameters are all parameters that do not fall into one of the previously described categories. They are shown on the right side of the ValiFrame user interface when the selected entry of the procedure tree on the left is an individual procedure. They only change the behavior of that single procedure. Procedures often have parameters with the same name, but set settings always apply to the selected procedure, and the meaning may be slightly different.

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5 Calibrations

Overview

Before running any receiver test procedure, the Automotive Ethernet receiver test system must first be calibrated.

The DUT input ports give the ValiFrame calibration plane. The receiver test signal characteristics are typically affected by the signal transmission between the generator output ports and the DUT input ports. Thus, for any signal output parameter selected by the user (set value), the signal received at the DUT input ports (actual value) deviates from the set value. The ValiFrame calibration procedures compensate these deviations of the relevant signal output parameter actual values from the set values over the required parameter range.

The ValiFrame software includes all calibration procedures required for Automotive Ethernet receiver testing. The implemented ValiFrame calibration procedures are such that the calibration process is conducted as fast as possible and is automated as much as possible; for example, by minimizing the number of reconfigurations of the hardware connections.

NOTE

The LED color of the APM1000E-CLK changes to Magenta if Ext is selected and if it is not connected to the external clock.

To change the LED color to blue, connect the APM1000E-CLK to the external clock and repower the device. If the APM1000E-CLK is not connected to the external clock, ensure the Int is selected and hold Master button while powering up the device.

Transmitter Signal RMS Amplitude Calibration

Purpose and Method

The purpose of this procedure is to measure the voltage amplitude of the APM1000E signal generator.

The test automation sets the signal generator into a defined mode (Testmode5) and measures the RMS amplitude of the output signal after the fixture with a real-time oscilloscope.

Use the measured value in the following calibration (Noise Signal Calibration). Assigned to the **Measured Tx Signal RMS** parameter, use it to calculate the signal to noise ratio (SNR).

Connection Diagram

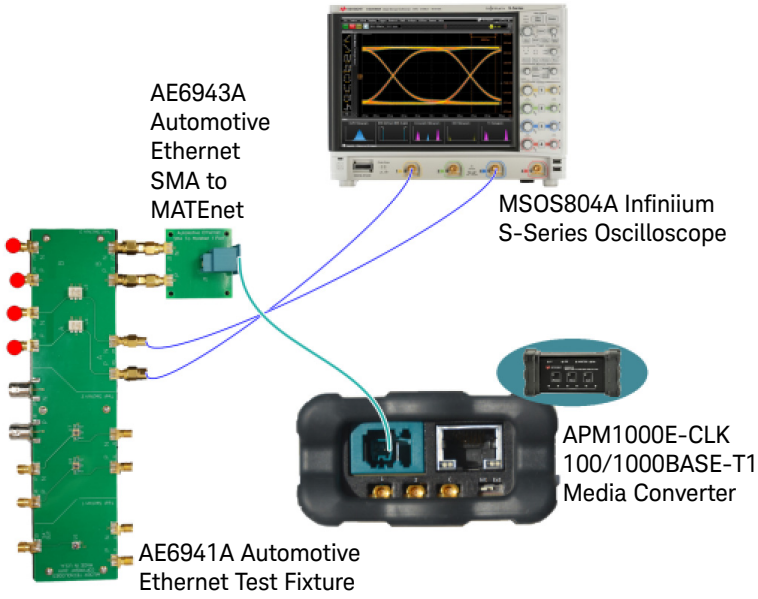


Figure 5-1 Connection Diagram for Transmitter Signal Peak-Peak Calibration

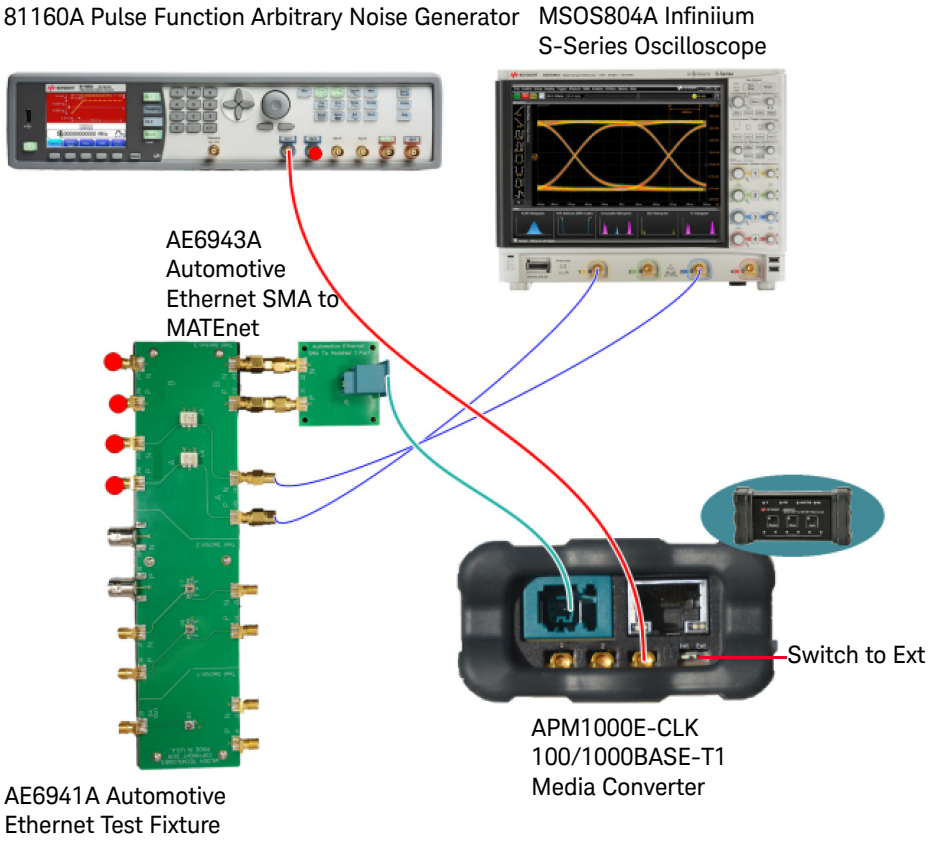


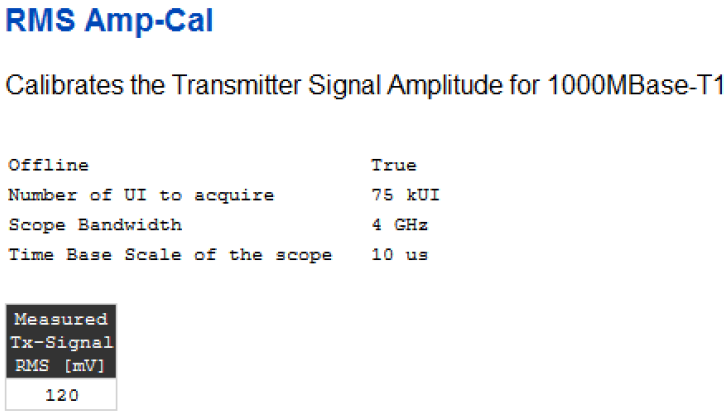
Figure 5-2 Connection Diagram for Transmitter Signal Peak-Peak Calibration (with External Clock)

Parameters in Expert Mode

Scope

- **Number of UI to acquire**: Scope capture length in Unit Intervals.
- **Scope Bandwidth**: Bandwidth set on the scope.
- **Time Base Scale of the scope**: Time base scale set on the scope.

Result Description



RMS Amp-Cal

Calibrates the Transmitter Signal Amplitude for 1000MBase-T1

Offline	True
Number of UI to acquire	75 kUI
Scope Bandwidth	4 GHz
Time Base Scale of the scope	10 us

Measured Tx-Signal RMS [mV]
120

Figure 5-3 Example HTML Viewer for Transmitter Signal Peak-Peak Amplitude Calibration

– **Measured Tx-Signal RMS [mV]**: The RMS voltage amplitude measured on the scope.

Noise Signal Calibration

Purpose and Method

The purpose of this procedure is to calibrate the noise and the signal to noise ratio (SNR) of the setup.

The test automation starts by applying small noise amplitudes and increases them with the defined step size. For every set value, measure the noise amplitude with a real-time oscilloscope and, calculate the SNR for the given **Measured Tx-Signal RMS**. Repeat until you reach the target SNR (or until the maximum capability of the noise generator).

Connection Diagram

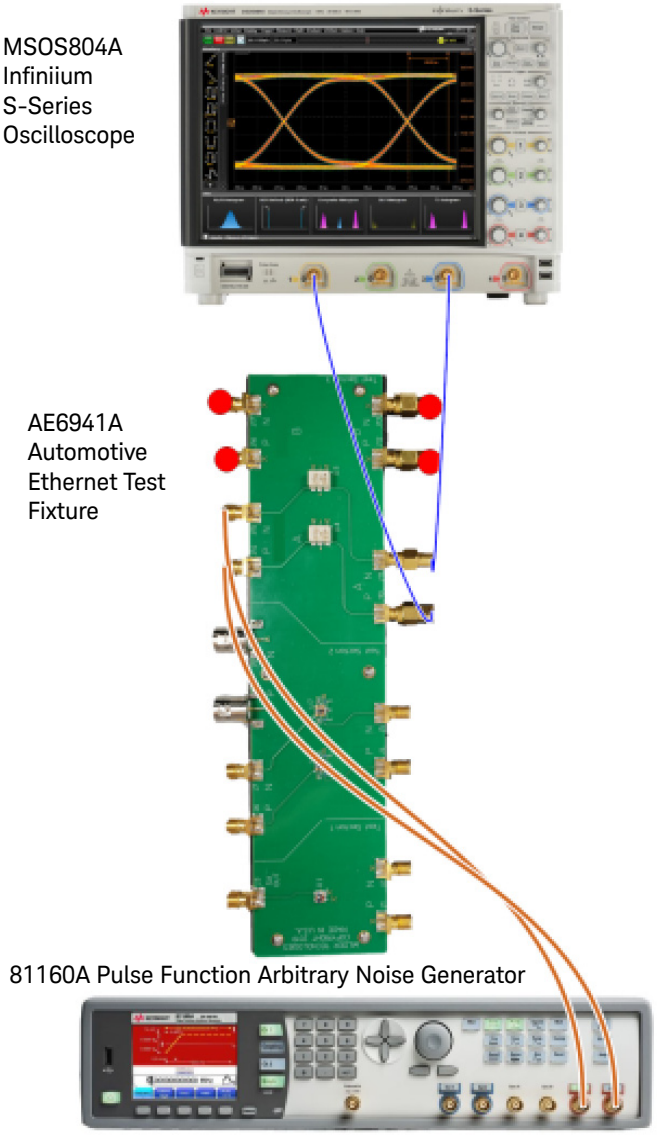


Figure 5-4 Connection Diagram for SNR Calibration

Parameters in Expert Mode

Generator

- **Measured Tx-Signal RMS**: Set to the measured value from the previous calibration.

Noise

- **Noise Bandwidth**: Bandwidth of the noise signal.
- **Noise CrestFactor**: The crest factor of the noise injected to the signal.
- **Noise Amplitude Step Size**: The amount of noise amplitude increased at each step.
- **First Set Noise Amplitude**: The noise amplitude set at the first step.
- **Target Signal Noise Ratio**: The target SNR. The calibration will finish when the measured SNR is smaller than that value.

Scope

- **Number of UI to acquire**: Scope capture length in Unit Intervals.
- **Scope Bandwidth**: Bandwidth set on the scope.
- **Time Base Scale of the Scope**: Time base scale set on the scope.

NOTE

The scope settings are recommended to get quick and reliable measurement results.

The noise settings are defined in the test specifications

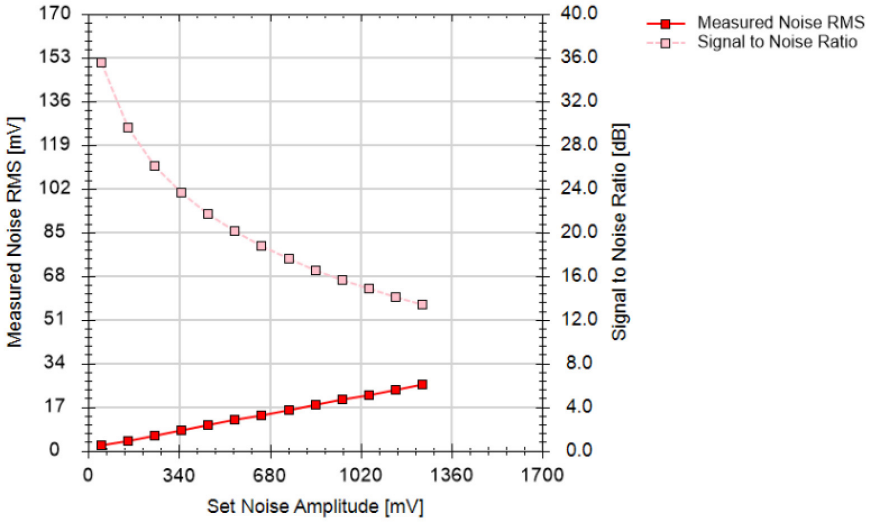
Dependencies

- Transmitter signal RMS amplitude calibration.

Result Description

Noise-Cal

1000MBase-T1



Offline	True
Number of UI to acquire	75 kUI
Scope Bandwidth	4 GHz
Time Base Scale of the scope	10 us
Noise BandWidth	550 MHz
Noise CrestFactor	5
Noise Amplitude Step Size	100 mV
First Set Noise Amplitude	50 mV
Target Signal Noise Ratio	14 dB
Measured Tx-Signal RMS	120 mV

Set Noise Amplitude [mV]	Measured Noise RMS [mV]	Signal to Noise Ratio [dB]
50	2.0	35.6
150	4.0	29.6
250	6.0	26.1
350	7.9	23.6
450	9.9	21.7
550	11.9	20.1
650	13.9	18.7
750	15.9	17.6
850	17.8	16.6
950	19.8	15.6
1050	21.8	14.8
1150	23.8	14.1
1250	25.8	13.4

Figure 5-5 Example HTML Viewer for Signal To Noise Ratio Calibration

- **Set Noise Amplitude [mV]**: The amplitude set on the noise generator.
- **Measured Noise RMS [mV]**: The measured noise in RMS.
- **Signal to Noise Ratio [dB]**: The measured SNR calculated with the measured noise and the calibrated Tx-Signal RMS amplitude.

Transmitter Clock Frequency Confirmation

Purpose and Method

The purpose of this procedure is to calibrate the transmitter clock frequency and its deviation. It is available when you select the **External Clock** option in the Station Configuration.

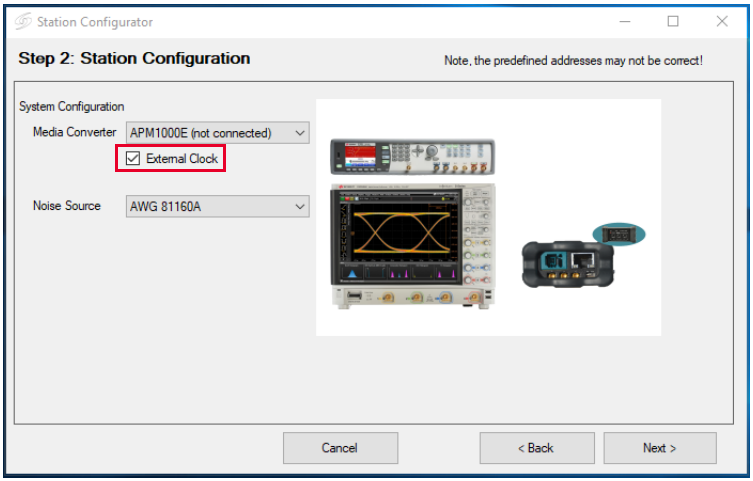


Figure 5-6 Select External Clock in the Station Configuration Window

The test automation does a swept of the crystal clock frequency. For each step, measure the transmitter output frequency with a real-time oscilloscope.

The calibration passes if the output frequency range covers the range defined by the “Mean transmitter out frequency” ± “Clock frequency deviation”.

Connection Diagram

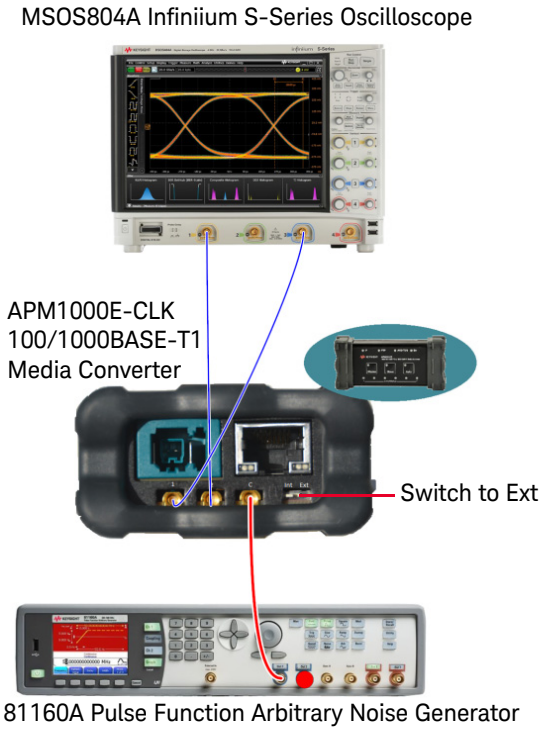


Figure 5-7 Connection Diagram for Transmitter Clock Frequency Confirmation

Parameters in Expert Mode

Generator

- **Mean crystal frequency**: The frequency of the external clock.
- **Mean transmitter out frequency**: The desired frequency for the signal output.
- **Clock frequency deviation**: The desired frequency deviation for the signal output.

Scope

- **Number of UI to acquire**: Scope capture length in Unit Intervals.
- **Scope Bandwidth**: Bandwidth set on the scope.
- **Time Base Scale of the scope**: Time base scale set on the scope.

Result Description

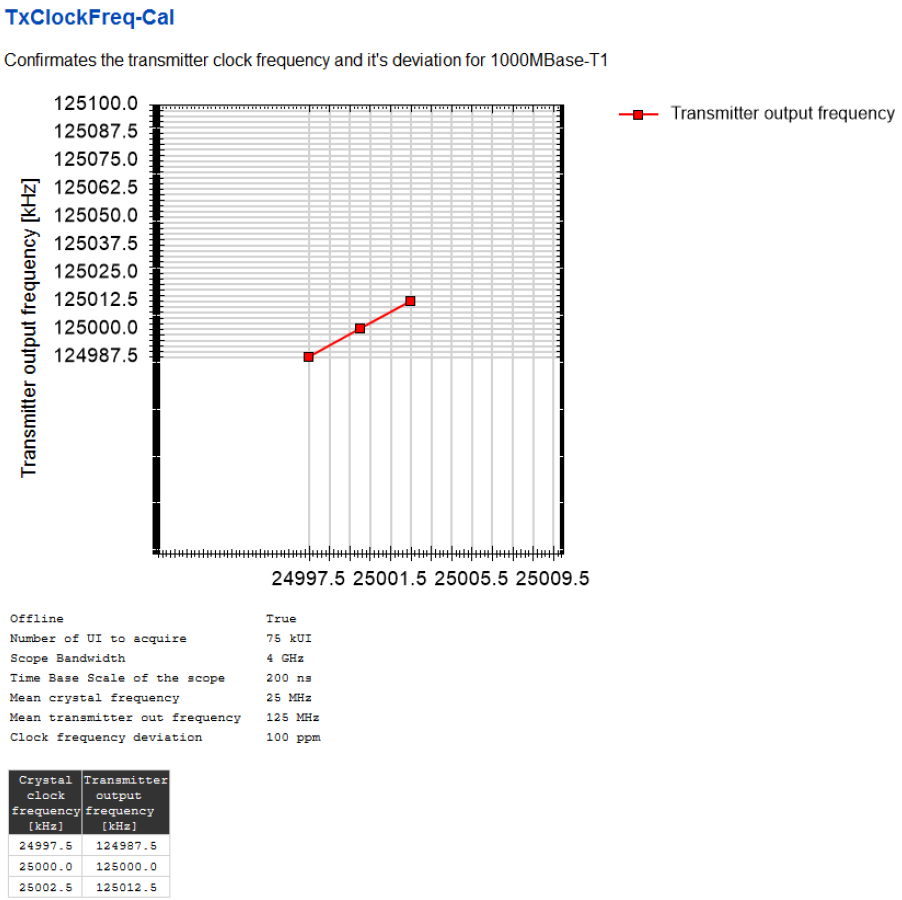


Figure 5-8 Example HTML Viewer for Transmitter Cock Frequency Confirmation

- **Crystal clock frequency [kHz]**: The frequency set in the crystal clock.
- **Transmitter output frequency [kHz]**: The frequency measured on the oscilloscope.

6 Receiver Tests

Overview

Run all tests with the device set as Master and as Slave.

For Rx tests, the real-time oscilloscope is not needed and can stay unconnected.

NOTE The device configuration is not automatic. You are required to implement the bat scripts or set the device manually with an appropriate tool.

NOTE The LED color of the APM1000E-CLK changes to Magenta if Ext is selected and if it is not connected to the external clock.

To change the LED color to blue, connect the APM1000E-CLK to the external clock and repower the device. If the APM1000E-CLK is not connected to the external clock, ensure the Int is selected and hold Master button while powering up the device.

5.1.1 Indicated Signal Quality for Channel With Decreasing Quality

Purpose and Method

The purpose of this test is to ensure that the PHY indicates a signal quality, having decreasing values for a channel with increasing noise.

Either manually or through the scripts, the DUT is soft reset, configured to SLAVE/MASTER and the loopback is enabled. The test automation starts by applying the minimum noise amplitude and increases it at each step until the maximum value. For every set value, the SQI value is measured 100 times and averaged.

The following 3 conditions must be fulfilled to pass the test:

- SQI value steadily and monotonic increases/decreases by one step each (the SQI values are only valid if link-up condition is present)
- Link-up status remains for SQI values higher than 0
- There should be no link instabilities with intermittent link drops for SQI values higher than 0.

The absolute SQI values may be different from the OPEN Alliance recommendation in “Advanced_PHY_features_for_automotive_Ethernet”.

In Expert Mode, there are flags to bypass some of those requirements, if the SQI implementation in the tested DUT differs from the test specification in “OA_1000BASE-T1 InteroperabilityTest Suite” or “OA_100BASE-T1_Interoperability_Test_Suite”.

Connection Diagram

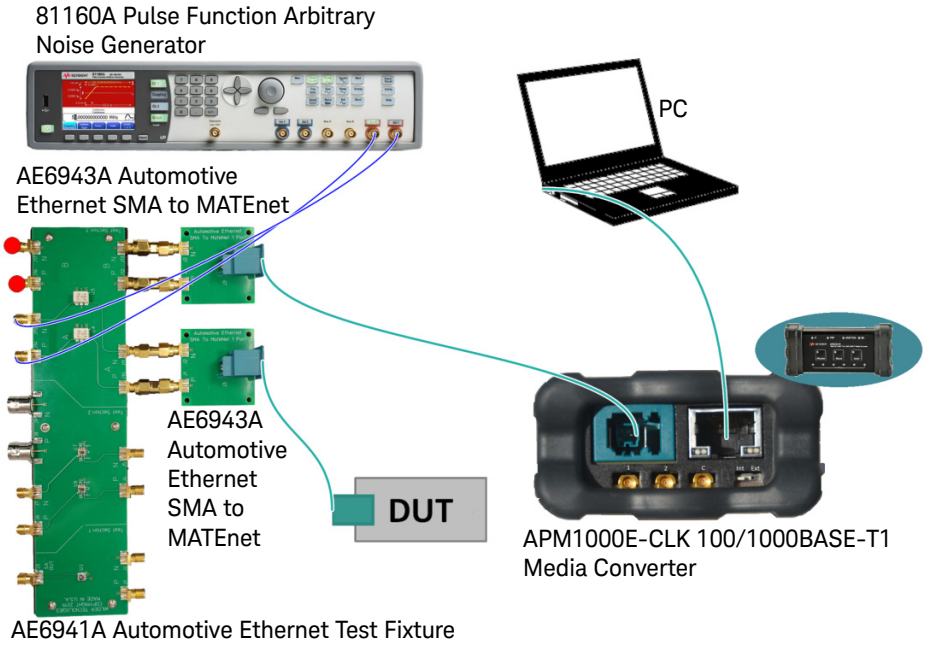


Figure 6-1 Connection Diagram for Receiver Tests with Fixture

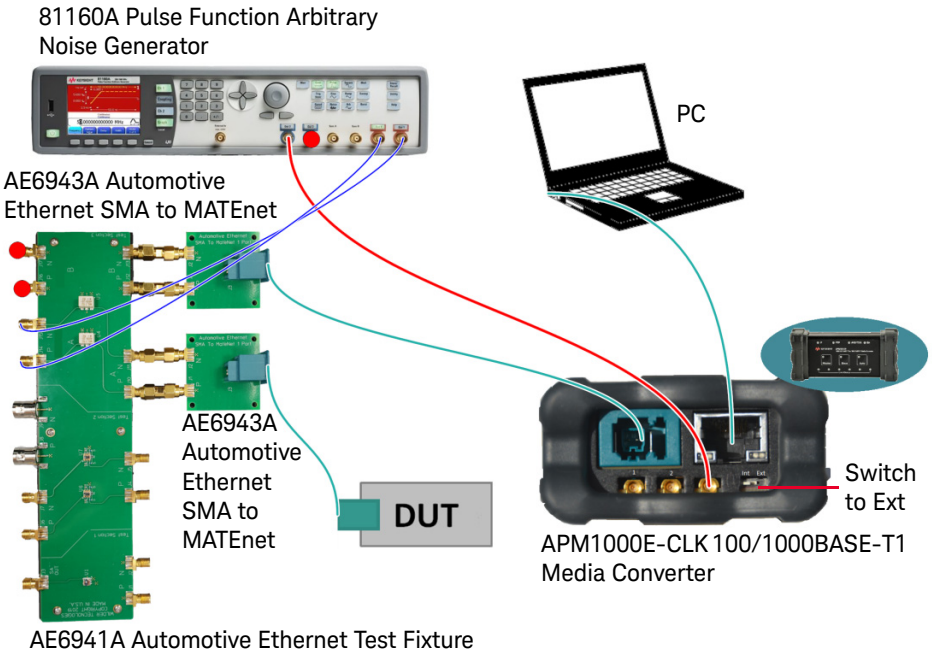


Figure 6-2 Connection Diagram for Receiver Tests with Fixture (with External Clock)

NOTE Refer to Figure 5-6 to enable External Clock in the Station Configuration window.

Parameters in Expert Mode

- **Noise Amplitude Start**: The first noise amplitude value tested.
- **Noise Amplitude Stop**: The last noise amplitude value tested.
- **Noise Amplitude Step**: The amount that the amplitude noise decreases at each step.
- **Forced SQI check**: If set to **False**, the SQI values are not queried from the DUT at Link-Down state. If set to **True**, the SQI values are queried from the DUT 100

times per noise amplitude, even when the link is down. According to the CTS, this is not necessary (and may need significantly extra test time).

- **Check SQI Monotony?**: Check if SQI is steadily and monotonic decreasing.
- **Check SQI stepwise changing?**: Check if SQI values change by one step each.
- **Check LinkUp at SQI >0?**: Check if Link-up status remains for SQI values higher than 0.
- **Number of Queries per Point**: Number of times that the SQI value is requested to the DUT for each noise amplitude tested.

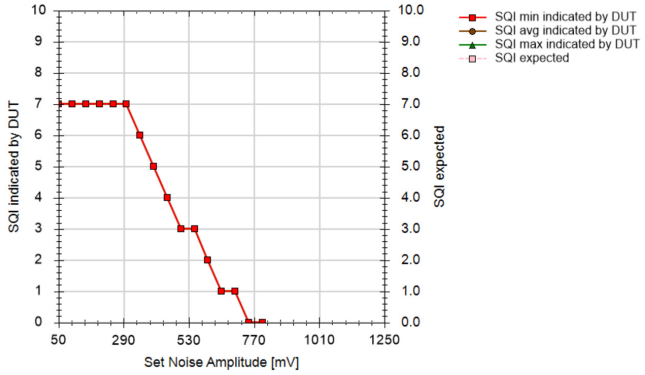
Dependencies

- Transmitter Signal RMS Amplitude Calibration
- Noise Signal Calibration

Result Description

1000MBit_SQI_Slave_Decreasing

AutomotiveEthernet



Report result	Procedure Passed: SQI is steadily and monotonic decreasing by one step each; Link-up status remains for SQI values higher than 0; No link instabilities with intermittently link drops at SQI>0.
Offline	True
Noise Amplitude Start	50 mV
Noise Amplitude Stop	1.25 V
Noise Amplitude Step	50 mV
Forced SQI check	False
Check SQI Monotony?	True
Check SQI stepwise changing?	True
Check LinkUp at SQI>0?	True
Number of Queries per Point	100
Path with the Scripts	C:\ProgramData\BitifEye\ValiFrameM1\AutomotiveEthernet\Settings\OfflineScripts

Set Noise Amplitude [mV]	SQI min indicated by DUT []	SQI avg indicated by DUT []	SQI max indicated by DUT []	SQI expected []	Network Noise level (RMS) [mV]	SNR measured [dB]	Link Status
50	7.0	7.0	7.0	7.0	2.0	35.6	Up
100	7.0	7.0	7.0	7.0	3.0	32.1	Up
150	7.0	7.0	7.0	7.0	4.0	29.6	Up
200	7.0	7.0	7.0	7.0	5.0	27.7	Up
250	7.0	7.0	7.0	7.0	6.0	26.1	Up
300	7.0	7.0	7.0	7.0	6.9	24.8	Up
350	6.0	6.0	6.0	6.0	7.9	23.6	Up
400	5.0	5.0	5.0	5.0	8.9	22.6	Up
450	4.0	4.0	4.0	4.0	9.9	21.7	Up
500	3.0	3.0	3.0	3.0	10.9	20.8	Up
550	3.0	3.0	3.0	3.0	11.9	20.1	Up
600	2.0	2.0	2.0	2.0	12.9	19.4	Up
650	1.0	1.0	1.0	1.0	13.9	18.7	Up
700	1.0	1.0	1.0	1.0	14.9	18.1	Up
750	0.0	0.0	0.0	0.0	15.9	17.6	Up
800	0.0	0.0	0.0	0.0	16.8	17.1	Up
850	N/A	N/A	N/A	N/A	17.8	16.6	Down
900	N/A	N/A	N/A	N/A	18.8	16.1	Down
950	N/A	N/A	N/A	N/A	19.8	15.6	Down
1000	N/A	N/A	N/A	N/A	20.8	15.2	Down
1050	N/A	N/A	N/A	N/A	21.8	14.8	Down
1100	N/A	N/A	N/A	N/A	22.8	14.4	Down
1150	N/A	N/A	N/A	N/A	23.8	14.1	Down
1200	N/A	N/A	N/A	N/A	24.8	13.7	Down
1250	N/A	N/A	N/A	N/A	25.8	13.4	Down

Figure 6-3 Example HTML Viewer for Indicated Signal Quality for Channel With Decreasing Noise

- **Set Amplitude Noise [mV]**: The noise amplitude applied to the signal at each step.
- **SQI min indicated by DUT [ ]**: The minimum SQI archived during that tested point.
- **SQI avg indicated by DUT [ ]**: The averaged SQI indicated by the DUT for the tested point.
- **SQI max indicated by DUT [ ]**: The maximum SQI archived during that tested point.
- **SQI expected [ ]:** The SQI expected for the tested point.
- **Network Noise level (RMS) [mV]**: The noise RMS measured on the Noise Signal Calibration for the tested point.
- **SNR measured [dB]**: The SNR measured in the Noise Signal Calibration.
- **Link Status**: Down/Up.

Refer to Table 6-1 for The expected SQI values are calculated from the applied noise (SNR), according to chapter 6.1.2 in the OpenAlliance specification “Advanced_PHY_features_for_automotive_Ethernet”.

Table 6-1 Recommended correlation from SQI to SNR

SQI Value	SNR Value at MDI-AWG Noise, 80 MHz (Informative)	Recommended BER for AWG Noise Model (Informative)
0	<18 dB	
1	18 dB ≤ SNR < 19 dB	BER > 10^-10
2	19 dB ≤ SNR < 20 dB	
3	20 dB ≤ SNR < 21 dB	
4	21 dB ≤ SNR < 22 dB	
5	22 dB ≤ SNR < 23 dB	BER < 10^-10
6	23 dB ≤ SNR < 24 dB	
7	24 dB ≤ SNR	

5.1.2 Indicated Signal Quality for Channel with Increasing Quality

Purpose and Method

The purpose of this test is to ensure that the PHY indicates a signal quality, having increasing values for a channel with decreasing noise.

Either manually or through the scripts, the DUT is soft reset and configured to SLAVE/MASTER. The test automation starts by applying the maximum noise amplitude and decreases it at each step until the minimum value is reached. For every set value, the SQI value is read from the DUT 100 times and averaged.

To pass the test, the Link Status must change from **Down** at high SNR to **Up** at high SNR values.

The absolute SQI values may be different from the OPEN Alliance recommendation in "Advanced_PHY_features_for_automotive_Ethernet_V1.0_100MBase-T1".

Connection Diagram

Refer to Figure 6-1 and Figure 6-2.

Parameters in Expert Mode

- **Noise Amplitude Start**: The first noise amplitude value tested.
- **Noise Amplitude Stop**: The last noise amplitude value tested.
- **Noise Amplitude Step**: The amount that the amplitude noise increased at each step.
- **Forced SQI check**: If set to **False**, the SQI values are not queried from the DUT at Link-Down state. If set to **True**, the SQI values are queried from the DUT 100 times per noise amplitude, even when the link is down. According to the CTS, this is not necessary (and may need significantly extra test time).
- **Check SQI Monotony?**: Check if SQI is steadily and monotonic decreasing.
- **Check SQI stepwise changing?**: Check if SQI values change by one step each.
- **Check LinkUp at SQI >0?**: Check if Link-up status remains for SQI values higher than 0.
- **Number of Queries per Point**: Number of times that the SQI value is requested to the DUT for each noise amplitude tested.

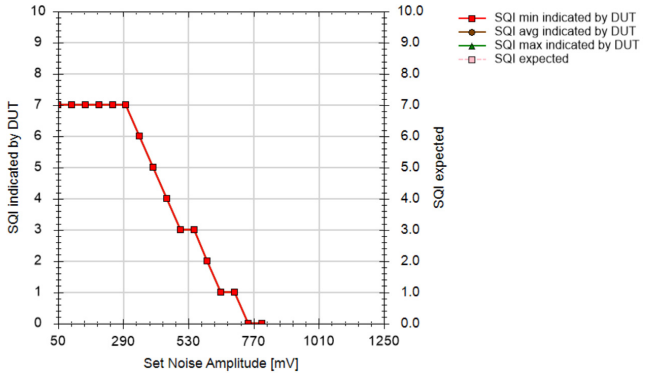
Dependencies

- Noise Signal Calibration

Result Description

1000MBit_SQI_Slave_Increasing

AutomotiveEthernet



Report result	Procedure Passed: SQI is steadily and monotonic increasing by one step each; Link-up status remains for SQI values higher than 0; No link instabilities with intermittently link drops at SQI>0.
Offline	True
Noise Amplitude Start	1.25 V
Noise Amplitude Stop	50 mV
Noise Amplitude Step	50 mV
Forced SQI check	False
Check SQI Monotony?	True
Check SQI stepwise changing?	True
Check LinkUp at SQI>0?	True
Number of Queries per Point	100
Path with the Scripts	C:\ProgramData\BitifEye\ValiFrameK1\AutomotiveEthernet\Settings\OfflineScripts

Set Noise Amplitude [mV]	SQI min indicated by DUT []	SQI avg indicated by DUT []	SQI max indicated by DUT []	SQI expected []	Network Noise level (RMS) [mV]	SNR measured [dB]	Link Status
1250	N/A	N/A	N/A	N/A	25.8	13.4	Down
1200	N/A	N/A	N/A	N/A	24.8	13.7	Down
1150	N/A	N/A	N/A	N/A	23.8	14.1	Down
1100	N/A	N/A	N/A	N/A	22.8	14.4	Down
1050	N/A	N/A	N/A	N/A	21.8	14.8	Down
1000	N/A	N/A	N/A	N/A	20.8	15.2	Down
950	N/A	N/A	N/A	N/A	19.8	15.6	Down
900	N/A	N/A	N/A	N/A	18.8	16.1	Down
850	N/A	N/A	N/A	N/A	17.8	16.6	Down
800	0.0	0.0	0.0	0.0	16.8	17.1	Up
750	0.0	0.0	0.0	0.0	15.9	17.6	Up
700	1.0	1.0	1.0	1.0	14.9	18.1	Up
650	1.0	1.0	1.0	1.0	13.9	18.7	Up
600	2.0	2.0	2.0	2.0	12.9	19.4	Up
550	3.0	3.0	3.0	3.0	11.9	20.1	Up
500	3.0	3.0	3.0	3.0	10.9	20.8	Up
450	4.0	4.0	4.0	4.0	9.9	21.7	Up
400	5.0	5.0	5.0	5.0	8.9	22.6	Up
350	6.0	6.0	6.0	6.0	7.9	23.6	Up
300	7.0	7.0	7.0	7.0	6.9	24.8	Up
250	7.0	7.0	7.0	7.0	6.0	26.1	Up
200	7.0	7.0	7.0	7.0	5.0	27.7	Up
150	7.0	7.0	7.0	7.0	4.0	29.6	Up
100	7.0	7.0	7.0	7.0	3.0	32.1	Up
50	7.0	7.0	7.0	7.0	2.0	35.6	Up

Figure 6-4 Example HTML Viewer for Indicated Signal Quality for Channel with Increasing Quality

- **Set Noise Amplitude [mV]**: The noise amplitude applied to the signal at each step.
- **SQI min indicated by DUT [ ]**: The minimum SQI archived during that tested point.
- **SQI avg indicated by DUT [ ]**: The averaged SQI archived during that tested point.
- **SQI max indicated by DUT [ ]**: The maximum SQI archived during that tested point.
- **SQI expected [ ]**: The SQI expected for the tested point.
- **Network Noise level (RMS) [mV]**: The noise RMS measured on the Noise Signal Calibration for the tested point.
- **SNR measured [dB]**: The SNR measured on the Noise Signal Calibration for the tested point.
- **Link Status**: Down/Up.

Test 97.2.2 - Alien Crosstalk Idle Pattern Rejection

Purpose and Method

The purpose of this procedure is to verify that the DUT can maintain a bit error rate (BER) of less than 10^{-10} in the presence of a crosstalk noise source. For this test, the noise source sends idle symbols. The level of the noise is 100 mV peak-to-peak.

Either manually or through the scripts, configure the DUT to SLAVE/MASTER, and the DUTs loopback is enabled. In case of testing in DUT access mode **Scripting** without loopback, reset the Bit Error Counter and Frame Error Counter. Then the test automation injects noise crosstalk to the signal, and the BER test starts.

The duration of the BER test will be the required time to reach a specified confidence level (default: 95%). It depends on the capabilities of the PC and the Ethernet Port. In very unlikely cases, it may take up to 2 hours.

If the looped back data differ from the sent out data, the faulty data packages are counted as errors (or if the DUT reports transmission errors).

As long as the required amount of transferred bits is not reached, every error causes the test to fail.

Connection Diagram

Refer to Figure 6-1 and Figure 6-2.

Parameters in Expert Mode

- **Crosstalk Reference Amplitude**: The peak-peak level of the crosstalk reference.
- **Target BitErrorRate**: The target BER that determines if the test pass or not
- **Target FrameErrorRate**: The target FER that determines if the test pass or not
- **Confidence Level**: The confidence level used in the BER test
- **Number of Frames per Step**: The total BER measured in several steps. This parameter determines the number of frames tested at each step.
- **Required Number of Bits to send**: The number of bits transmitted.

Dependencies

– Noise Signal Calibration

Result Description

100MBit_xTalk-Pattern_Slave

AutomotiveEthernet

Offline	True
Crosstalk Reference Amplitude	100 mV
Target BitErrorRate	100E-12
Target FrameErrorRate	100E-9
Confidence Level	95 %
Number Of Frames per Step	1000
Required Number of Bits to send	29957322736
Path with the Scripts	C:\ProgramData\BitifEye\ValiFrameK1 \AutomotiveEthernet\Settings\OfflineScripts

Result	Target BitErrorRate	Target FrameErrorRate	Confidence Level [%]	Total sent bits []	Total sent frames []	Total received error bits []	Total received error frames []	BER measured on PHY	FER measured on PHY
pass	1E-10	1E-07	95.0	29959200000	2565000	0	0	<3.3E-11	<3.9E-7

Figure 6-5 Example HTML Viewer for Alien Crosstalk Idle Pattern Rejection

– **Result**: Pass/Fail. A pass means this test succeeded.
– **Target BitErrorRate**: The target BER that determines if the test passes or fails.
– **Target FrameErrorRate**: The target FER that determines if the test passes or fails.
– **Confidence Level [%]**: The confidence level of the BER test.
– **Total sent bits [ ]**: The number of tested bits.
– **Total sent frames [ ]**: The number of tested frames.
– **Total received error bits [ ]**: The total number of bit errors.
– **Total received error frames [ ]**: The total number of frame errors.
– **BER measured on PHY**: The BER indicated by the DUT.
– **FER measured on PHY**: The FER indicated by the DUT.

Test 97.2.2 - Alien Crosstalk Noise Rejection

Purpose and Method

The purpose of this procedure is to verify that the DUT can maintain a bit error rate (BER) of less than 10^{-10} in the presence of a crosstalk noise source. For this test, the noise source sends a Gaussian distribution signal with a bandwidth of 50 MHz and a magnitude of -85 dBm/Hz if you perform the test at a data rate of 100 Mbps. By performing the test at a data rate of 1000 Mbps, the noise bandwidth is 550 MHz, and the magnitude is -100 dBm/Hz.

Either manually or through the scripts, configure the DUT to SLAVE/MASTER, and the DUTs loopback is enabled. In case of testing in DUT access mode **Scripting** without loopback, reset the Bit Error Counter and Frame Error Counter. The test automation then injects noise crosstalk to the signal, and the BER test starts.

The duration of the BER test will be the required time to reach a specified confidence level (default: 95%). It depends on the capabilities of the PC and the Ethernet Port. In very unlikely cases, it may take up to 2 hours.

If the looped back data differ from the sent out data, the faulty data packages are counted as errors (or if the DUT reports transmission errors).

As long as the required amount of transferred bits is not reached, every error causes the test to fail.

Connection Diagram

Refer to Figure 6-1 and Figure 6-2.

Parameters in Expert Mode

- **Noise Bandwidth**: The bandwidth of the noise injected to the signal.
- **Noise CrestFactor**: The crest factor of the noise injected to the signal.
- **Power density in dBm/Hz**: The amount of power of the noise per frequency interval.
- **Target BitErrorRate**: The target BER that determines if the test pass or not.
- **Target FrameErrorRate**: The target FER that determines if the test pass or not.
- **Confidence Level**: The confidence level used in the BER test.

- **Number of Frames per Step**: The total BER measured in several steps. This parameter determines the number of frames tested at each step.
- **Required Number of Bits to send**: The number of bits transmitted.

Dependencies

- Noise Signal Calibration

Result Description

1000MBit_xTalk-Noise_Slave

AutomotiveEthernet

Offline	True
Noise BandWidth	550 MHz
Noise CrestFactor	5
Power density in dBm/Hz	-100
Target BitErrorRate	100E-12
Target FrameErrorRate	100E-9
Confidence Level	95 %
Number Of Frames per Step	1000
Required Number of Bits to send	29957322736
Path with the Scripts	C:\ProgramData\BitifEye\ValiFrameK1 \AutomotiveEthernet\Settings\OfflineScripts

Result	Target BitErrorRate	Target FrameErrorRate	Confidence Level [%]	Total sent bits []	Total sent frames []	Total received error bits []	Total received error frames []	BER measured on PHY	FER measured on PHY
pass	1E-10	1E-07	95.0	29959200000	2565000	0	0	<3.3E-11	<3.9E-7

Figure 6-6 Example HTML Viewer for Alien Crosstalk Noise Rejection

- **Result**: Pass/Fail. A pass means this test succeeded.
- **Target BitErrorRate**: The target BER that determines if the test passes or fails.
- **Target FrameErrorRate**: The target FER that determines if the test passes or fails.
- **Confidence Level [%]**: The confidence level of the BER test.
- **Total sent bits [ ]**: The number of bits tested.
- **Total sent frames [ ]**: The number of frames tested.

- **Total received error bits [ ]**: The total number of bit errors.
- **Total received error frames [ ]**: The total number of frame errors.
- **BER measured on PHY**: The BER indicated by the DUT.
- **FER measured on PHY**: The FER indicated by the DUT.

Test 97.2.1 - Bit Error Rate Verification

Purpose and Method

The purpose of this procedure is to verify that the DUT can maintain a BER of less than 10^{-10}, while having maximum channel length attached.

Either manually or through the scripts, configure the DUT to SLAVE/MASTER, and the DUTs loopback is enabled. In case of testing in DUT access mode **Scripting** without loopback, reset the Bit Error Counter and Frame Error Counter. The test automation then injects noise crosstalk to the signal, and the BER test starts.

The duration of the BER test will be the required time to reach a specified confidence level (default: 95%). It depends on the capabilities of the PC and the Ethernet Port. In very unlikely cases, it may take up to 2 hours.

If the looped back data differ from the sent out data, the faulty data packages are counted as errors (or if the DUT reports transmission errors).

As long as the required amount of transferred bits is not reached, every error causes the test to fail.

Connection Diagram

Run the test with the required cable length (typically 15 m twisted pair, as defined in IEEE Std 802.3bp).

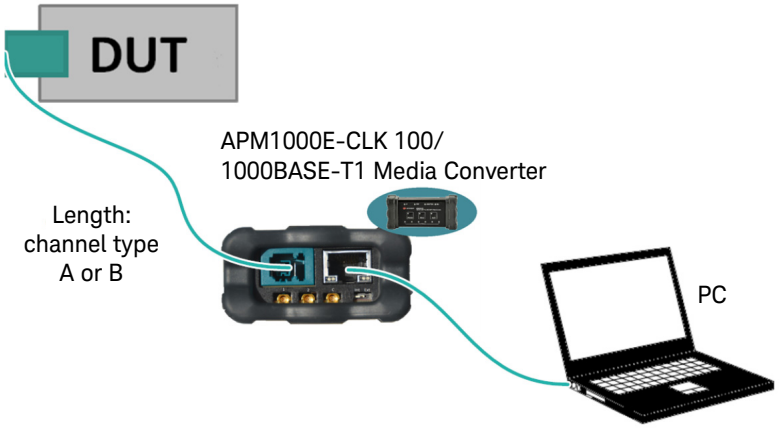


Figure 6-7 Connection Diagram for Receiver Tests with Direct Link

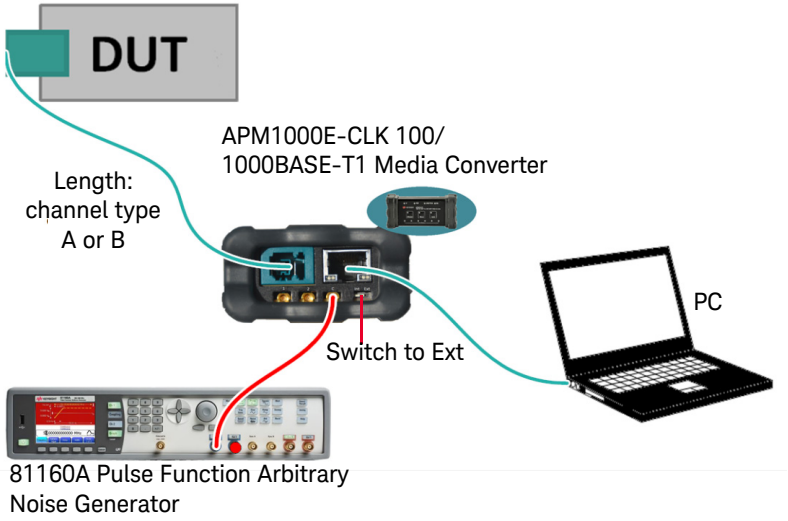


Figure 6-8 Connection Diagram for Receiver Tests with Direct Link (with External Clock)

NOTE Refer to Figure 5-6 to enable External Clock in the Station Configuration window.

Parameters in Expert Mode

- **Target BitErrorRate**: The target BER that determines if the test passes or not.
- **Target FrameErrorRate**: The target FER that determines if the test passes or not.
- **Confidence Level**: The confidence level used in the BER test.
- **Number of Frames per Step**: The total BER is measured in several steps. This parameter determines the number of tested frames at each step.
- **Required Number of Bits to send**: The number of bits transmitted.

Result Description

1000MBit_BER_Slave

AutomotiveEthernet

Offline	True
Target BitErrorRate	100E-12
Target FrameErrorRate	100E-9
Confidence Level	95 %
Number Of Frames per Step	1000
Required Number of Bits to send	29957322736
Path with the Scripts	C:\ProgramData\BitifEye\ValiFrameK1 \AutomotiveEthernet\Settings\OfflineScripts

Result	Target BitErrorRate	Target FrameErrorRate	Confidence Level [%]	Total sent bits []	Total sent frames []	Total received error bits []	Total received error frames []	BER measured on PHY	FER measured on PHY
pass	1E-10	1E-07	95.0	29959200000	2565000	0	0	<3.3E-11	<3.9E-7

Figure 6-9 Example HTML Viewer for Bit Error Rate Verification

- **Result**: Pass/Fail. A pass means this test succeeded.
- **Target BitErrorRate**: The target BER that determines if the test passes or fails.
- **Target FrameErrorRate**: The target FER that determines if the test passes or fails.
- **Confidence Level [%]**: The confidence level of the BER test.
- **Total sent bits [ ]**: The number of tested bits.
- **Total sent frames [ ]**: The number of tested frames.
- **Total received error bits [ ]**: The total number of bit errors.
- **Total received error frames [ ]**: The total number of frame errors.
- **BER measured on PHY**: The BER indicated by the DUT.
- **FER measured on PHY**: The FER indicated by the DUT.

Test 97.2.3 - Receiver Frequency Tolerance to ±100ppm Deviation

NOTE This test will only be available if you select the **External Clock** option on the Station Configuration. Refer to Figure 5-6 to enable External Clock in the Station Configuration window.

NOTE The 100BASE-T1 only has test procedures for 97.2.3 - Receiver Frequency Tolerance to ±100ppm Deviation for DUT as Slave.

Purpose and Method

The purpose of this procedure is to verify that the DUT can properly accept incoming data at a symbol rate deviation of ±100 ppm.

Either manually or through the scripts, configure the DUT to SLAVE/MASTER, and the DUTs loopback is enabled. In case of testing in DUT access mode **Scripting** without loopback, reset the Bit Error Counter and Frame Error Counter. The test automation then injects noise crosstalk to the signal, and the BER test starts.

The duration of the BER test will be the required time to reach a specified confidence level (default: 95%). It depends on the capabilities of the PC and the Ethernet Port. In very unlikely cases, it may take up to 2 hours.

If the looped back data differ from the sent out data, the faulty data packages are counted as errors (or if the DUT reports transmission errors).

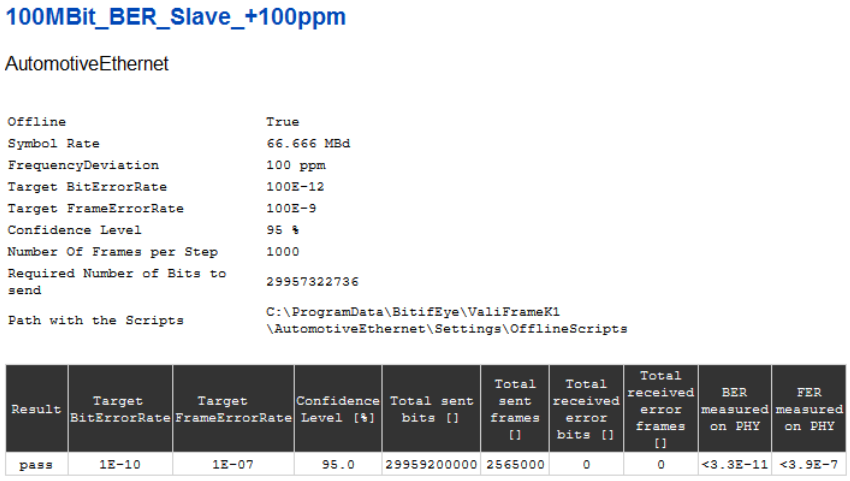
As long as the required amount of transferred bits is not reached, every error causes the test to fail.

Connection Diagram

Refer to Figure 6-7 and Figure 6-8.

Parameters in Expert Mode

- **Symbol Rate**: The symbol rate of the data output signal.
- **FrequencyDeviation**: The deviation added to the symbol rate of the data output signal.
- **Target BitErrorRate**: The target BER that determines if the test pass or not.
- **Target FrameErrorRate**: The target FER that determines if the test pass or not.
- **Confidence Level**: The confidence level used in the BER test.
- **Number of Frames per Step**: The total BER measured in several steps. This parameter determines the number of frames tested at each step.
- **Required Number of Bits to send**: The number of bits transmitted.



100MBit_BER_Slave_+100ppm

AutomotiveEthernet

Offline	True
Symbol Rate	66.666 MBd
FrequencyDeviation	100 ppm
Target BitErrorRate	100E-12
Target FrameErrorRate	100E-9
Confidence Level	95 %
Number Of Frames per Step	1000
Required Number of Bits to send	29957322736
Path with the Scripts	C:\ProgramData\BitifEye\ValiFrameK1 \AutomotiveEthernet\Settings\OfflineScripts

Result	Target BitErrorRate	Target FrameErrorRate	Confidence Level [%]	Total sent bits []	Total sent frames []	Total received error bits []	Total received error frames []	BER measured on PHY	FER measured on PHY
pass	1E-10	1E-07	95.0	29959200000	2565000	0	0	<3.3E-11	<3.9E-7

Figure 6-10 Example HTML Viewer for Bit Error Rate Verification for Receiver Frequency Tolerance to +100ppm Deviation

- **Result**: Pass/Fail. It passes if the measured BER is less than the Target BER. Otherwise, it fails.
- **Target BitErrorRate**: The target BER that determines if the test passes or fails.
- **Target FrameErrorRate**: The target FER that determines if the test passes or fails.

- **Confidence Level [%]**: The confidence level of the BER test.
- **Total sent bits [ ]**: The number of bits tested.
- **Total sent frames [ ]**: The number of frames tested.
- **Total received error bits [ ]**: The total number of bit errors.
- **Total received error frames [ ]**: The total number of frame errors.
- **BER measured on PHY**: The BER indicated by the DUT.
- **FER measured on PHY**: The FER indicated by the DUT.

7 Scripting

Scripting Details

To run all the tests automatically, ValiFrame controls the DUT by calling batch scripts. These scripts are called at special points of the test sequence. Each script has a specific name reported in ValiFrame Logging-Window.

Some scripts are used to set the DUT into a specific state (e.g. Enable_LoopBack.bat or Set_LinkRole_Master.bat). Others are expected to return a value (e.g. Read_SQI.bat), which is read out of the DUT's PMA control registers.

We offer script examples located in the specified directory.

Upon installing AE ValiFrame, user may access the script located at:

C:\ProgramData\BitifEye\ValiFrameK1\AutomotiveEthernet\Settings\OfflineScripts.

These script examples are customizable by users to incorporate various functionalities, such as calling executables, Python, or Tcl scripts, enabling ValiFrame to access the DUT.

The called scripts for data rate 1000 Mbps are as follows:

Table 7-1 Scripts for 1000 Mbps

Procedure	Standard-Method	Script-Method	Loopback-Method
SQI-Test	– Read_SQI.bat – Reset_DeviceSoft.bat – Set_LinkRole_Slave.bat – Set_LinkRole_Master.bat	– Read_SQI.bat – Reset_DeviceSoft.bat – Set_LinkRole_Slave.bat – Set_LinkRole_Master.bat	
Alien-Crosstalk Noise	– Set_LinkRole_Master.bat – Set_LinkRole_Slave.bat – Enable_Loopback.bat – Disable_Loopback.bat	– Set_LinkRole_Master.bat – Set_LinkRole_Slave.bat – Reset_ErrorCounter.bat – Read_ErrorCounter.bat	
Alien-Crosstalk Idle			
BER test			
Frequency Deviation test			

For data rate 100 Mbps, different scripts are used, since the register addresses may differ from those in 1000 Mbps mode:

Table 7-2 Scripts for 100 Mbps

Procedure	Standard-Method	Script-Method	Loopback-Method
SQI-Test	– Read_SQI_100M.bat – Reset_DeviceSoft_100M.bat – Set_LinkRole_Slave_100M.bat – Set_LinkRole_Master_100M.bat	– Read_SQI_100M.bat – Reset_DeviceSoft_100M.bat – Set_LinkRole_Slave_100M.bat – Set_LinkRole_Master_100M.bat	
Alien-Crosstalk Noise	– Set_LinkRole_Master_100M.bat – Set_LinkRole_Slave_100M.bat – Enable_Loopback_100M.bat – Disable_Loopback_100M.bat	– Set_LinkRole_Master_100M.bat – Set_LinkRole_Slave_100M.bat – Reset_ErrorCounter_100M.bat – Read_ErrorCounter_100M.bat	
Alien-Crosstalk Idle			
BER test			
Frequency Deviation test			

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8 Frame Generator

Overview

The AE Frame Generator is a flexible tool for troubleshooting and debugging, that complements the ValiFrame Station. It allows you to observe the response of the DUT after sending frames with noise signal injected.

The AE Frame Generator controls the DUT automatically through calling the required batch scripts (see “Scripting Details” on page 88).

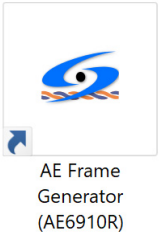


Figure 8-1 AE Frame Generator

Connecting to the Instruments

After starting the Automotive Ethernet FrameGenerator, the software is in “offline” mode. This mode means that the user input has no effect on the software until connected to the instruments. Click the **Instrument Connections** button (see Figure 8-2) to open the connection dialog. This action allows all the necessary parameters entered to establish the connections to the signal generator and complementary instruments.

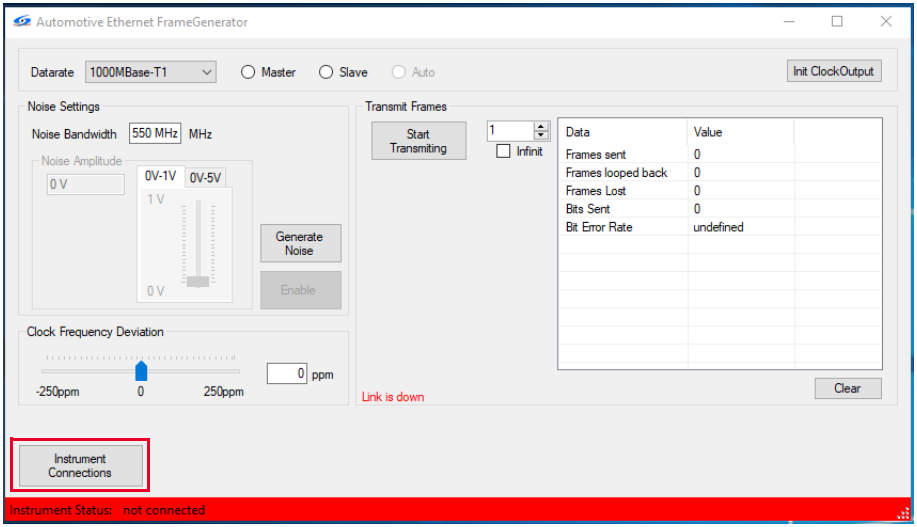


Figure 8-2 Main Window (Instruments Disconnected)

In the **ConnectionDialog** window (see Figure 8-3), configure the test instrument setup.

Media Converter

Generate the Frames to test from a Gigabit Ethernet port of a CPU or laptop. A media converter is required to convert the Gigabit standard Ethernet to Automotive Ethernet.

The Automotive Ethernet FrameGenerator uses the APM1000E as a media converter. The media converter is always connected to a local USB3 port of the PC.

Select the **External Clock** option to operate with an adjustable clock frequency.

In the Data Connection option, select the Ethernet Device used to generate the Gigabit Ethernet frames.

Noise Source

Select the instrument to inject noise into the channel and set the address. The software supports the following sources:

– AWG 81160A

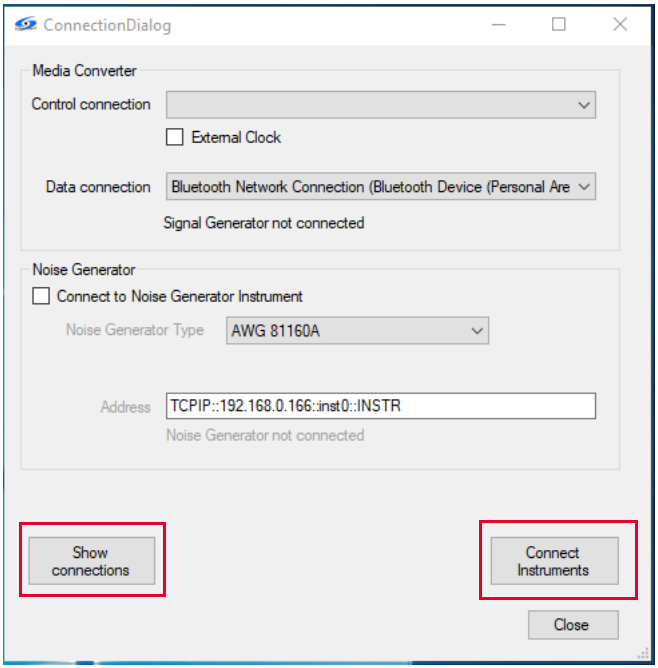


Figure 8-3 Instrument Connection Dialog

Once the configuration settings are done, click the **Connect Instruments** button. If the connections are successful, the **Connect** button will become a **Disconnect** button.

Click on the **Show connections** button to see the details of the required connection diagram.

User to take note that using the older version of APM1000E for control connection may trigger an error message as shown in Figure 8-4.

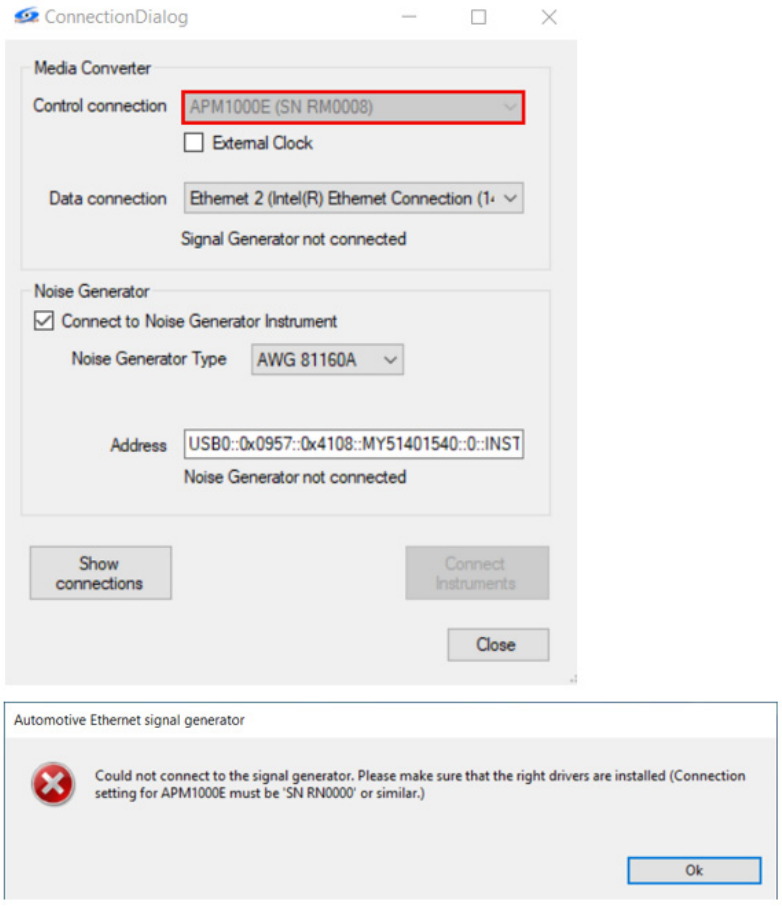


Figure 8-4 Instrument Connection Error for Older Version of APM1000E

Main User Interface

After the successful connection to the instruments, go back to the main window (see Figure 8-2).

The window consists of the following sections:

- **Data Rate**
- **Noise Settings**
- **Clock Frequency Deviation**
- **Transmit Frames**

Data Rate

Select the data rate to test. 100MBASE-T1 and 1000MBASE-T1 are supported.

Select the product type as Master or Slave.

Noise Settings

This section allows you to define the noise signal injected to the DUT.

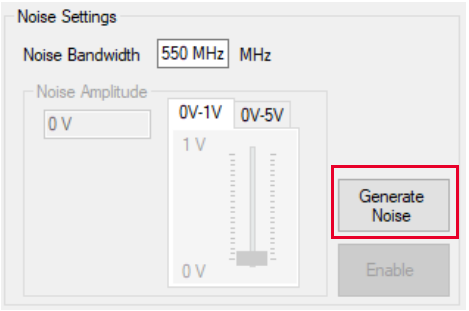


Figure 8-5 Noise Settings

Click the **Generate Noise** button to initialize and configure the noise generator instrument according to the selected noise bandwidth and amplitude.

You can choose the fine-scaled slider to control the noise amplitude more precisely.

The **Enable/Disable** button will enable/disable the output of the noise generator.

Clock Frequency Deviation

This section allows you to add clock frequency deviation to the data output signal.

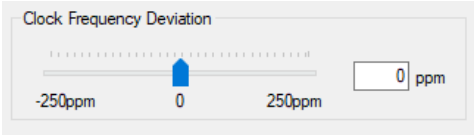


Figure 8-6 Clock Frequency Deviation

Transmit Frames

This section shows the response of the DUT to the sent frames.

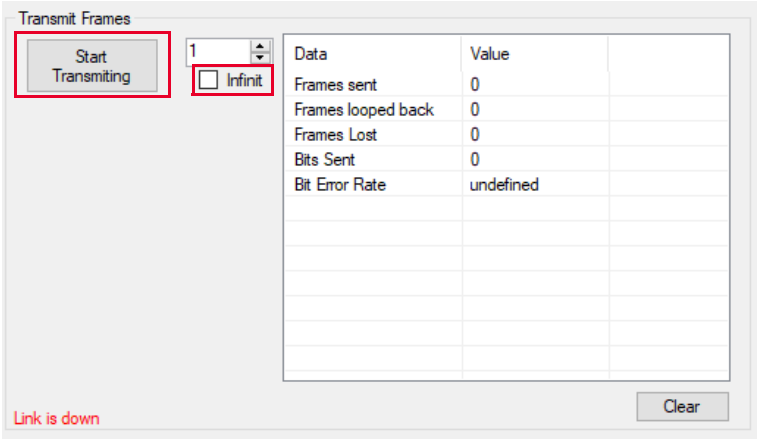


Figure 8-7 Transmit Frames

By clicking on the **Start Transmitting** button, the data generator will start generating and sending the Ethernet frames to the DUT. The selector on the right allows you to set the number of frames to send. For sending an unlimited number of frames, check the **Infinit** option.

Upon transmitting the frames, the following items are shown:

– **Frames sent**: The number shows, how many Gigabit frames are emitted, and thus, should be received by the DUT.

- **Frames looped back**: The number indicates how many frames are looped back by the DUT. Each frame has a unique tag and identified as a looped back one.
- **Frames Lost**: The difference between the sent and received frames.
- **Bits Sent**: The amount of sent frames multiplied with the frame size. It is needed to calculate the BitErrorRate.
- **Bit Error Rate**: The number of properly received bits divided by the total amount of sent bits.

A label on the bottom of the result table shows if the link is **up** or **down**.

It is possible to send a limited amount of frames per transmission step or to run the transmission continuously until you click the transmission button again.

During the transmission of frames, the **Start Transmitting** button becomes **Stop Transmitting** button. Press the **Stop Transmitting** button to complete the transmission.

A Appendix

Keysight Connection Expert

The following steps detail how to obtain the VISA address of an instrument through the Keysight Connection Expert.

If you have not installed the Keysight Connection Expert, download the Keysight Connection Expert here. Follow the installation steps to complete the installation.

The icon for the Keysight Connection Expert will be available on the bottom-right of your taskbar on your PC as show in Figure A-1.

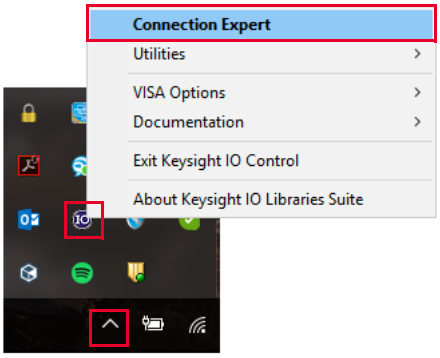


Figure A-1 Launching the Keysight Connection Expert

1. Click the **Connection Expert** to launch the Keysight Connection Expert.
2. The Keysight Connection Expert auto-detects USB instruments, refer to step 6 on how to obtain the VISA address for an instrument connected via USB. If you are adding LAN instruments, refer to step 3 till step 6 on how to obtain the VISA address for an instrument connected via LAN.

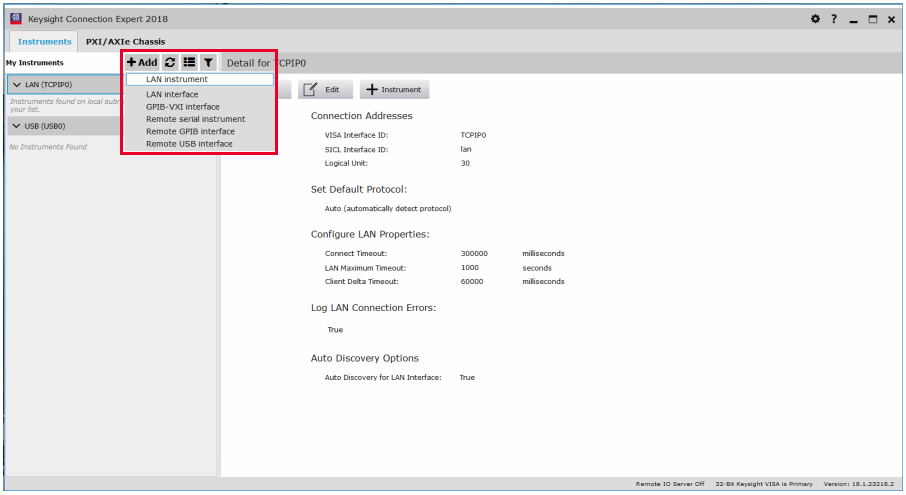
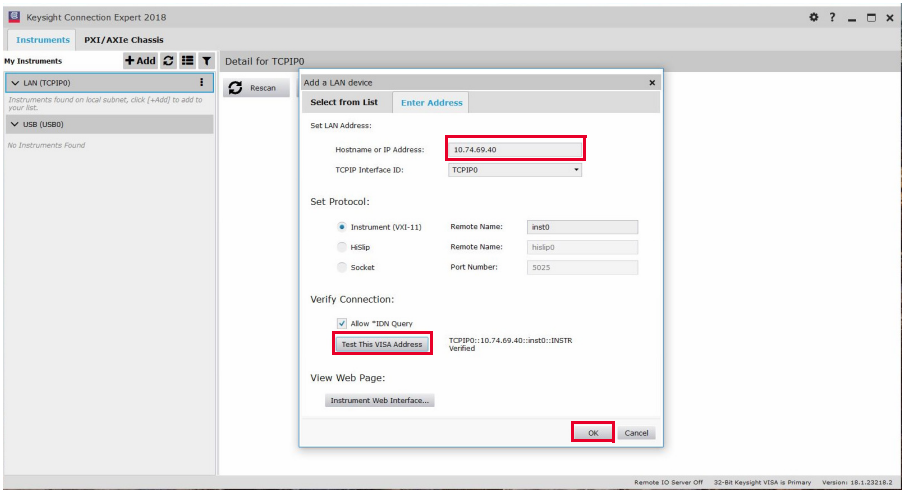


Figure A-2 Adding LAN Instrument

3 Click the **+ Add** > **LAN instrument** shown in Figure A-2.



4 Enter the **Hostname or IP Address** of the instrument.

5 Click **Test This Visa Address**, then click **OK**.

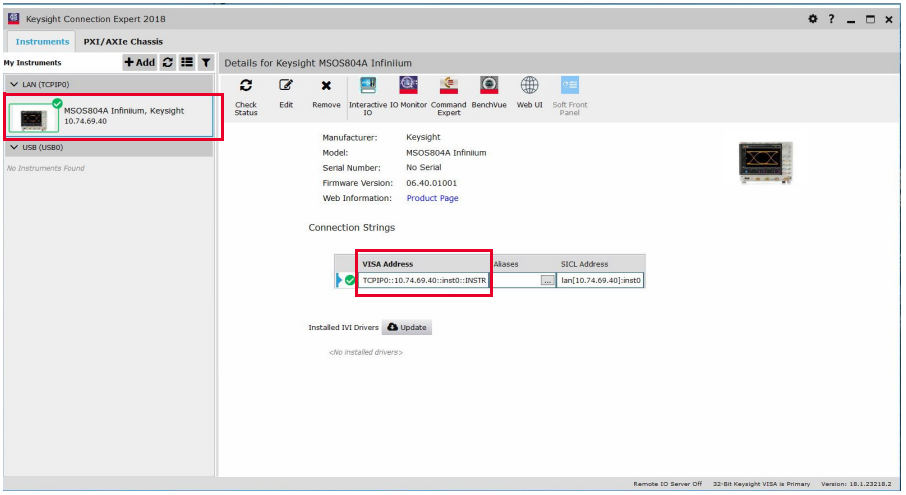


Figure A-3 VISA Address

6 Click the instrument on the left panel to display the instrument details including the **VISA Address** as show in Figure A-3.

B Appendix

List of Abbreviations

Table B-1 Abbreviation and Definition

Abbreviation	Definition
A	
AE	Automotive Ethernet
AWG	Arbitrary Waveform Generator
B	
BER	Bit error rate
C	
CPU	Central Processing Unit
CTS	Compliance Test Specification
D	
DUT	Device under test
G	
GUI	Graphical User Interface
I	
IEEE	Institute of Electrical and Electronic Engineers
L	
LAN	Local Area Network
M	
MDI-AWG	Media Dependant Interface - Arbitrary Waveform Generator
P	
PC	Personal computer
PHY	Physical Layer
PMA	

Table B-1 Abbreviation and Definition

Abbreviation	Definition
S	
SMA	SubMiniature version A
SNR	Signal to noise ratio
SQI	Signal Quality Index
U	
UI	Unit Interval
USB	Universal Serial Bus
V	
VISA	Virtual Instrument Software Architecture

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C Appendix

Service and Support

Americas		
Brazil 55 11 3351 7010	Canada (877) 894 4414	Mexico 001 800 254 2440
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Asia Pacific		
Australia 1 800 629 485	India 1 800 112 929	Malaysia 1 800 888 848
China 800 810 0189	Japan 0120 (421) 345	Singapore 1 800 375 8100
Hong Kong 800 938 693	Korea 080 769 0800	Taiwan 0800 047 866
Other Asian Countries: (65) 6375 8100 www.keysight.com/find/contactus		

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Austria 0800 00 11 22 Belgium 0800 58 580 Finland 0800 523 252 France 0805 980 333 *0.125 €/minute Germany 0800 6270 999	Ireland 1800 832 700 Israel 1 809 343 051 Italy 800 599 100 Luxembourg +32 800 58580 Netherlands 0800 0233 200	Russia 8800 5009 286 Spain 0800 00 01 54 Sweden 0200 88 22 55 Switzerland 0800 80 53 53 United Kingdom 0800 0260 637
Other Unlisted Countries: www.keysight.com/find/contactus		

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