Tektronix®

TekExpress Automotive Ethernet Compliance Analysis Solution for 5 and 6 Series MSO Oscilloscopes

Printable Application Help

077-1460-02

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www.tek.com
077-1460-02

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- In North America, call 1-800-833-9200.
- Worldwide, visit *www.tek.com* to find contacts in your area.

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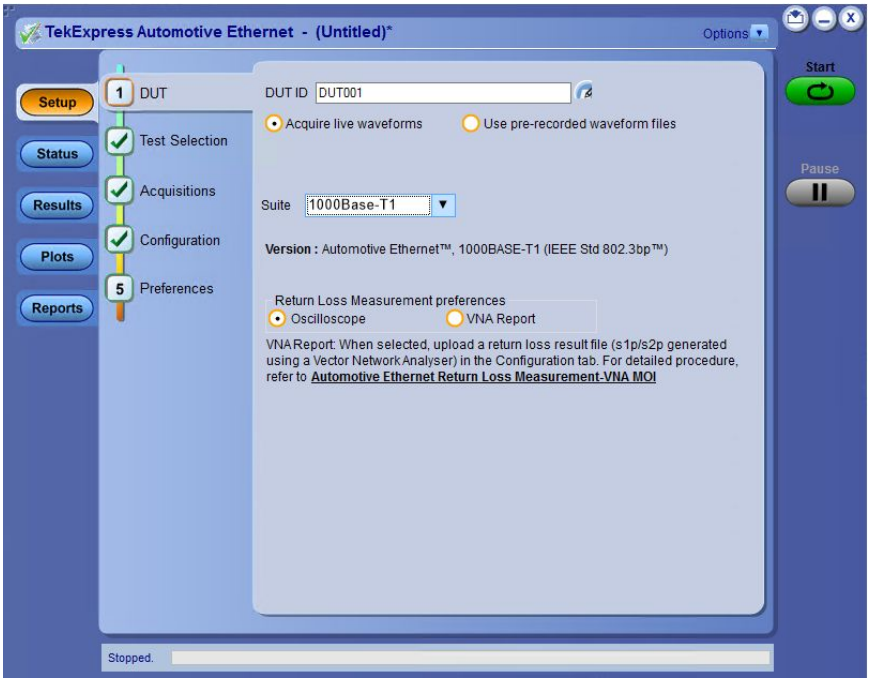
Welcome

The TekExpress Automotive Ethernet (100/1000Base-T1) is a compliance test solution for performing Transmitter electrical specification tests and MDI electrical specification Return Loss test of the transmitter as per OPEN Alliance BroadR-Reach (OABR) specification version 3.2. and IEEE P802.3bw™ D3.3 for 100 Base-T1 and IEEE P802.3bp™ for 1000Base-T1. These specifications have a stated objective to provide electrical interoperability for 100/1000 Mbps client and the same electrical test requirements to the Physical Medium Attachment (PMA) transmitter electrical specifications.

The Automotive Ethernet (100/1000Base-T1) is an Ethernet-based point-to-point technology for automotive applications.



Key features

- Fully automated application with setup wizard, to perform compliance testing as per the Automotive Ethernet 1000Base-T1™ (802.3bp) and IEEE P802.3bw™ (100Base-T1) standards.
- Compliance testing to perform signal qualification
- Automated report generation with Pass/Fail results along with screenshot of the waveform(s).
- The 100/1000Base-T1 specification defines Return Loss measurement that requires a Vector Network Analyzer (VNA). TekExpress Automotive Ethernet application offers you a patented Return Loss measurement, which allows you to perform the measurement without using a VNA.
- Transmitter Timing Jitter-MDI Jitter measurement for 1000Base-T1

- Transmit distortion measurement without need of external hardware clock divider unit, using software signal correction method.
- Run the measurement(s) for the user specified number of iterations.

Getting help and support

Conventions

Help uses the following conventions:

- The term "Application" and "Software" refers to the TekExpress Automotive Ethernet Solution application.
- The term “DUT” is an abbreviation for Device Under Test.
- The term “select” is a generic term that applies to the different methods of choosing a screen item (button, control, list item): using a mouse or using the touch screen.

Table 1: Icon descriptions

Icon	Meaning
	This icon identifies important information.
	This icon identifies conditions or practices that could result in loss of data.
	This icon identifies additional information that will help you use the application more efficiently.

Related documentation

The following documentation is available as part of the TekExpress® Automotive Ethernet Solution application.

Table 2: Product documentation

Item	Purpose	Location
Help	Application operation and User Interface help	
PDF of the help	Printable version of the compiled help	 PDF file that ships with Automotive Ethernet Solution software distribution (*TekExpress Automotive-Ethernet-Automated-Test-Solution-Software-Printable-Help-EN-US.pdf*). You can download the PDF version of the manual from the Tektronix website. *www.tek.com*
Automotive Ethernet Return Loss Measurement-VNA.pdf (MOI)		The PDF file contains method of implementation for return loss measurement using a vector network analyzer. You can access this file at C:\Program Files \Tektronix\TekExpress\TekExpress Automotive-Ethernet\

See also: *Technical support*

Technical support

Tektronix values your feedback on our products. To help us serve you better, please send us your suggestions, ideas, or comments on your application or oscilloscope. Contact Tektronix through mail, telephone, or the website.

When you contact Tektronix Technical Support, please include the following information (be as specific as possible):

General information

- All instrument model numbers
- Hardware options, if any
- Probes used
- Your name, company, mailing address, phone number, FAX number
- Please indicate if you would like to be contacted by Tektronix about your suggestion or comments.

Application specific information

- Software version number
- Description of the problem such that technical support can duplicate the problem
- If possible, save the setup files for all the instruments used and the application
- If possible, save the TekExpress setup files, log.xml, *.TekX (session files and folders), and status messages text file
- If possible, save the waveform on which you are performing the measurement as a .wfm file

Getting started

Minimum system requirements

The following table shows the minimum system requirements to install and run the TekExpress Automotive Ethernet application.

Component	Description	
Oscilloscope	**Supported Oscilloscopes** ■ MSO54, MSO56, MS058, and MSO64 (Windows 10 only)	
Signal Generators	AFG3022C, AFG3052C, AFG3102, AFG3252/C, AFG31102, AFG31152, AFG31252	100Base-T1
	AWG5002B/C, AWG5012B/C, AWG5014, AWG50B, AWG5202, AWG5204, AWG7082/B/C, AWG7102 (Option 2), AWG7122B/C	
	AFG3152C, AFG3252C, AFG3252, AFG31152, AFG31252	1000Base-T1
	AWG5202, AWG5204, AWG5208	
Processor	Same as the oscilloscope	
Operating System	Windows 10	
Memory	Same as the oscilloscope	
Hard Disk	Same as the oscilloscope	
Display	Super VGA resolution or higher video adapter (800 x 600 minimum video resolution for small fonts or 1024 x 768 minimum video resolution for large fonts). The application is best viewed at 96 dpi display settings ***NOTE.*** *If TekExpress is running on an instrument that has a video resolution less than 800x600, connect and configure a second monitor to the instrument.*	
Firmware	■ TekScope 1.20 and above	

Component	Description
Software	■ IronPython 2.7.3 installed ■ PyVisa 1.0.0.25 installed ■ Microsoft .NET 4.0 Framework ■ Microsoft Internet Explorer 7.0 SP1 or greater, or other Web browser for viewing reports ■ Adobe Reader software 7.0 or greater for viewing portable document format (PDF) files
Other Devices	■ Microsoft compatible mouse or compatible pointing device. ■ Two USB ports (four USB ports recommended).

NOTE.

- *Use AWG automation for Return Loss and Transmitter Distortion with Disturbing Signal measurements.*
- *Return Loss measurement is supported only on AWG5202, AWG5204, and AWG5208 with High Power option (AWG5200-2HV/AWG5200-4HV: High Amplitude DC coupled outputs) for AWG5200 S/N B020000 and above.*
- *For 1000Base-T1, use the Signal Generator, which can generate the 1.8 Volts Peak-to-peak.*

See also

Instruments and accessories required

Instruments and accessories required

Table 3: Instruments and accessories required

Instrument/ Accessories	Model / Accessories	
Probes	100Base-T1	TDP1500, P6248, P6247 and TDP3500 differential probes. TDP7700 (TDP7704/6/8) Series TriMode™ with P77STCABL and P77C292MM [1] adapter for MSO6 series oscilloscopes.
	1000Base-T1	TDP3500 ±15 V DC + pk AC input voltage differential probe. TDP7700 (TDP7704/6/8) Series TriMode™ with P77STCABL and P77C292MM[1] adapter for MSO6 series oscilloscopes.
Test fixtures: TF-XGbT	Not applicable	
Frequency divider	**100Base-T1** The TF-BRR-CFD test fixture allows to phase lock frequency between DUT Transmitter Clock, oscilloscope, and AWG/AFG sources. Converts DUT Transmitter Clock from 66.666 MHz to 10 MHz.	
	1000Base-T1 The TF-BRR-CFD fixtures allows to phase lock frequency between DUT Transmitter Clock, oscilloscope, and AWG/AFG sources. Converts DUT Transmitter Clock from 125 MHz to 10 MHz.	
Cables	**100Base-T1** Six same length BNC cables/SMA cables with BNC to SMA connectors: one TCA-BNC or TCA-SMA	
	1000Base-T1 Six same length BNC cables/SMA cables with BNC to SMA connectors: one TCA-BNC or TCA-SMA	

[1] P77C292MM supports all tests except Transmitter Distortion and Return Loss.

See also *Minimum system requirements*

Install the software

Complete the following steps to download and install the latest TekExpress Automotive Ethernet application. See Minimum system requirements for compatibility.

1. Close all applications (including the TekScope application).
2. Go to the www.tek.com.
3. Click **Downloads**. In the Download menu, select DOWNLOAD TYPE as Software and enter TekExpress Automotive Ethernet in the MODEL OR KEYWORD field and click **SEARCH**
4. Select the latest version of software and follow the instructions to download. Copy the executable file to the oscilloscope
5. Double-click the executable and follow the on-screen instructions. The software is installed at C:\Program Files\Tektronix\TekExpress\TekExpress Automotive-Ethernet\
6. Select **Application**>**TekExpress Automotive Ethernet** from the TekScope menu to launch the application.

See also

Minimum System Requirements

Activate the license

Follow the steps to activate the TekExpress Automotive Ethernet license:

- From the MSO 5/6 Series Oscilloscope menu bar, click **Help** > **About**.
- Click **Install License**, and then select the license file (*.Lic).
- Follow the application instructions in the oscilloscope to activate the license.
- After successful activation of the license, reboot the oscilloscope.

NOTE. *Check the Oscilloscope help for the steps to activate the license. Click F1 key to open the Option Installation topic and follow the steps to activate the license.*

See also

View Version and License Information

View version and license information

Use the following instructions to view application version information and license information for the application modules such as the Programmatic Interface and the Programmatic Interface Client.

To view version information, click in the TekExpress application and select **About TekExpress**.

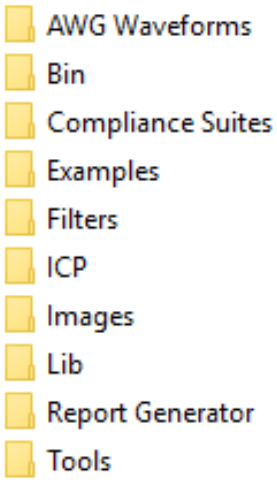
See also *Activate the license*

Options menu

Application directories and usage

The TekExpress Automotive Ethernet application files are installed at the following location:

C:\Program Files\Tektronix\TekExpress\TekExpress Automotive-Ethernet\.



The following table lists the default directory names and their usage.

Table 4: Application directories and usage

Directory names	Application specific information
AWG Waveforms	It contains AWG waveforms (AWG 5K, 7K and AFG waveforms) that get used in return loss and distortion with disturbing signal .
Bin	It contains miscellaneous TekExpress Automotive-Ethernet libraries.
Compliance Suites	It contains compliance-specific files and filter files.
Examples	It contains various support files.
Filters	Filters that are applicable for 100 and 1000Base-T1 Jitter and Power Spectral Density measurements.
ICP	It contains instrument and TekExpress Automotive-Ethernet-specific interface libraries.
Images	It contains images required for the application.
Lib	It contains utility files specific to the TekExpress Automotive-Ethernet.
Report Generator	It contains style sheets for report generation.
Tools	It contains instrument and TekExpress Automotive-Ethernet-specific files.

See also

View test-related files

File name extensions

The TekExpress Automotive Ethernet software uses the following file name extensions:

Table 5: File name extensions

File name extension	Description
.TekX	Session files are saved in this format but the extensions may not be displayed
.py	The test sequence file
.xml	The encrypted XML file that contains the test-specific configuration information The log file extension is also xml
.wfm	The test waveform file
.mht .pdf .csv	Test result reports are saved in MHTML format by default. Test reports can also be saved in CSV and PDF format. Test result reports are saved in MHTML format by default. Test reports can also be saved in MHTML format and .pdf.
.cal	Calibration file used with transmitter tests

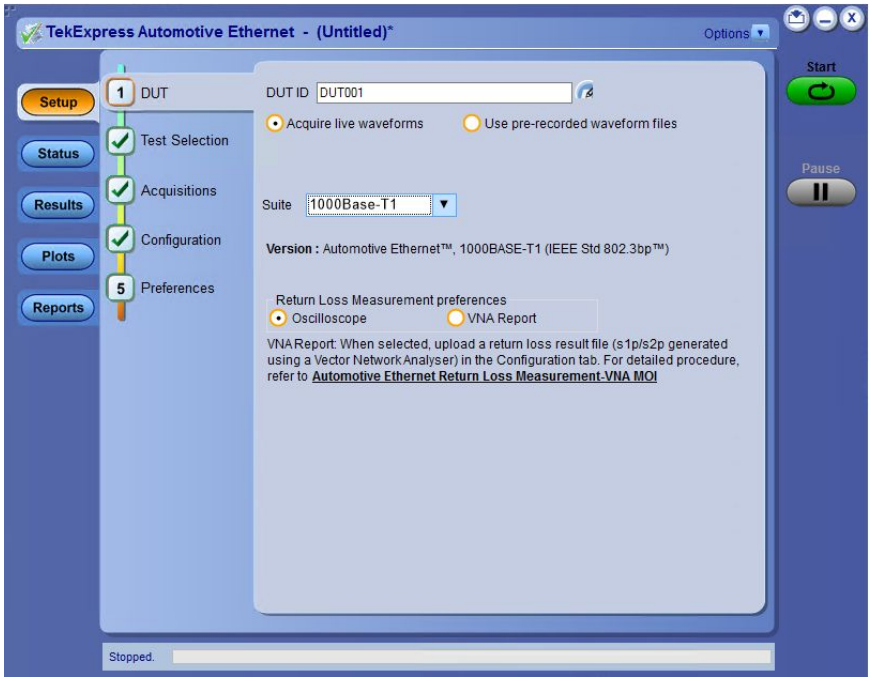
See also *Application directories and usage*

Operating basics

Start the application

To launch the TekExpress Automotive Ethernet application, select **Application** > **TekExpress Automotive Ethernet** from the oscilloscope menu.

The oscilloscope opens the **TekExpress Automotive Ethernet** application:



When you run the application for the first time after installation, the application checks for Resources.xml located in the C:\Users\<username>\Documents\My TekExpress\TekExpress Automotive-Ethernet\ folder. The Resources.xml file gets mapped to the X: drive when the application launches. Session files are then stored inside the X:\TekExpress Automotive-Ethernet\ folder. The Resources.xml file contains information about available network-connected instruments. If the application does not find the file, it runs an instrument discovery program to detect connected instruments before launching TekExpress Automotive Ethernet.

To keep the TekExpress Automotive Ethernet application window on top, select **Keep On Top** from the *Options menu*. If the application goes behind the oscilloscope application, click **Application > TekExpress Automotive Ethernet** to bring the application to the front.

See also *Application controls*

Application basics

TekExpress Automotive Ethernet uses panels to group related configuration, test, and results settings. You can open any panel by clicking on it. A panel may have one or more tabs that lists all the options applicable. Options in a panel can change depending on the settings made in that panel or another panel.

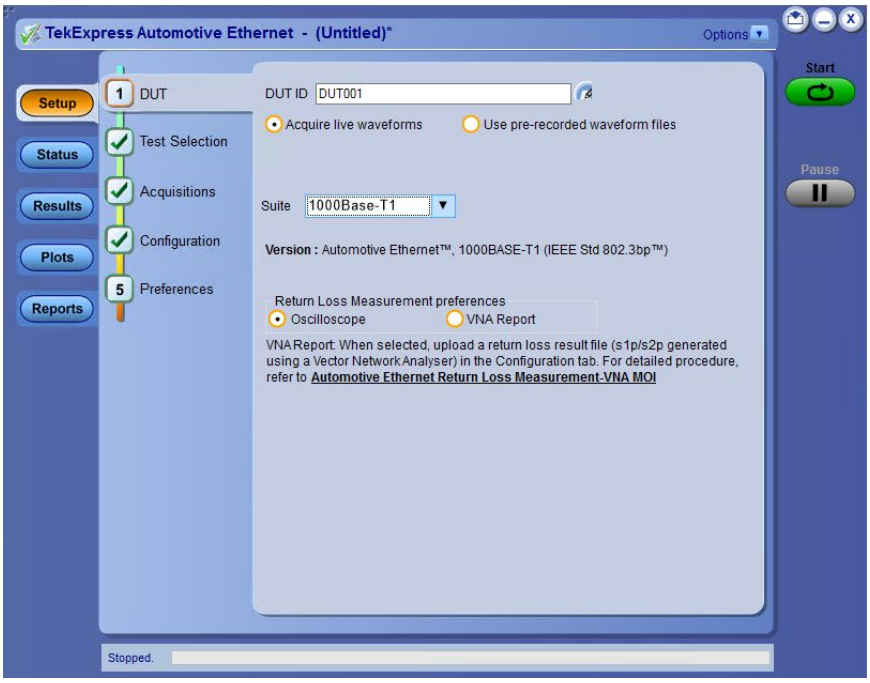


Table 6: Application panels overview

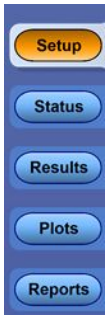
Panel Name	Purpose
Setup	The Setup panel shows the test setup controls. Click the **Setup** button to open this panel. Use this panel to: ■ *Set DUT tab parameters*. ■ *Selecting tests*. ■ *Selecting acquisition tab parameters* for selected tests. ■ *Set preferences tab*.
Status	View the progress and analysis status of the selected tests, and view test logs.
Results	View a summary of test results and select result viewing preferences.
Reports	Browse for reports, save reports as specific file types, specify report naming conventions, select report content to include (such as summary information, detailed information, user comments, setup configuration, application configuration) and select report viewing options.
Plots	View a summary of plot generated during run.

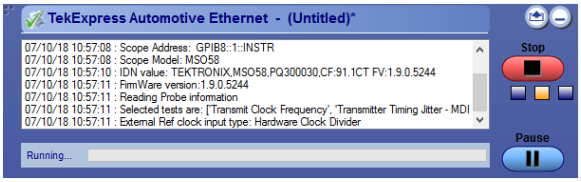
See also *Application controls*

Global application controls

Application controls

Table 7: Application controls descriptions

Item	Description
Options menu 	Menu to display global application controls.
Test Panel buttons 	Controls that open panels for configuring test settings and options.
Start / Stop button  	Use the **Start** button to start the test run of the measurements in the selected order. If prior acquired measurements have not been cleared, the new measurements are added to the existing set. The button toggles to the Stop mode while tests are running. Use the **Stop** button to abort the test.
Pause / Continue button  	Use the **Pause** button to temporarily interrupt the current acquisition. When a test is paused, the button name changes to “Continue.”

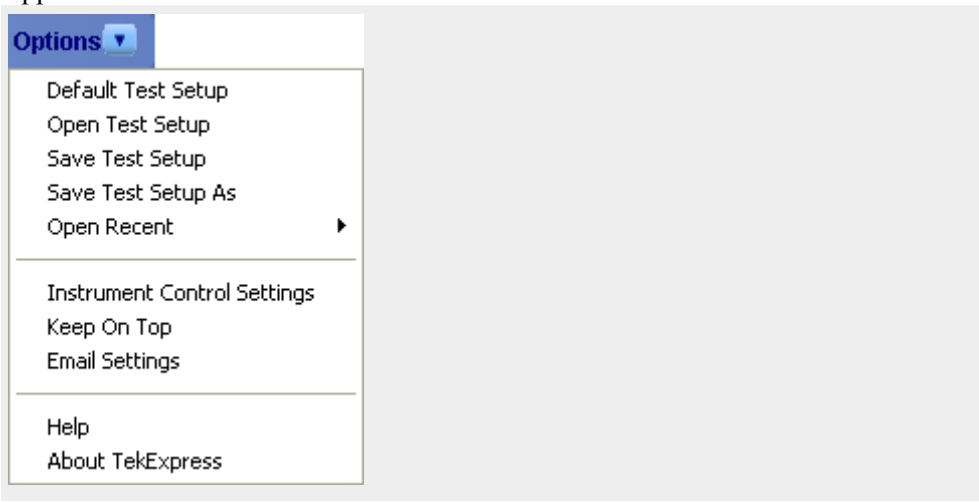
Item	Description
Clear button 	Use the **Clear** button to clear all existing measurement results. Adding or deleting a measurement, or changing a configuration parameter of an existing measurement, also clears measurements. This is to prevent the accumulation of measurement statistics or sets of statistics that are not coherent. This button is available only on the *Results* panel.
Application window move icon 	Place the cursor over the three-dot pattern in the upper left corner of the application window. When the cursor changes to a hand, drag the window to the desired location.
Minimize button 	Minimizes the application.
Close button 	Closes the application.
Mini view / Normal view  	Toggles the application between mini view and normal view. Mini view displays the run messages with the time stamp, progress bar, Start / Stop button, and Pause / Continue button. The application automatically moves to the mini view when you click the Start button. 

See also

Options menu

Options menu

Options menu. The Options menu is located in the upper right corner of the application.



It has the following selections:

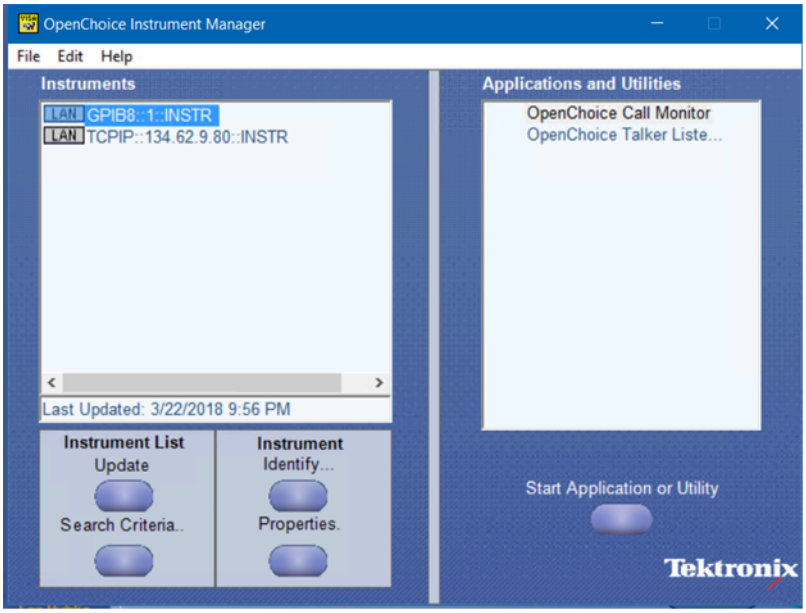
Table 8: Options menu

Menu	Function
Default Test Setup	Opens an untitled test setup with defaults selected.
Open Test Setup	Opens a saved test setup.
Save Test Setup	Saves the current test setup selections.
Save Test Setup As	Creates a new test setup based on an existing one.
Open Recent	It displays a menu of recently opened test setups to select from.
Instrument Control Settings	It shows the list of instruments connected to the test setup and allows you to locate and refresh connections to connected instruments.
Keep On Top	It keeps the TekExpress Automotive Ethernet application on top of other open windows on the desktop.
Email settings	It configures email options for test run and results notifications.
Help	It displays TekExpress Help.
About TekExpress	■ It displays application details such as software name, version number, and copyright. ■ It provides access to *license information* for your TekExpress Automotive Ethernet application installation. ■ It provides a link to the Tektronix Website.

Instrument configuration using TekVISA

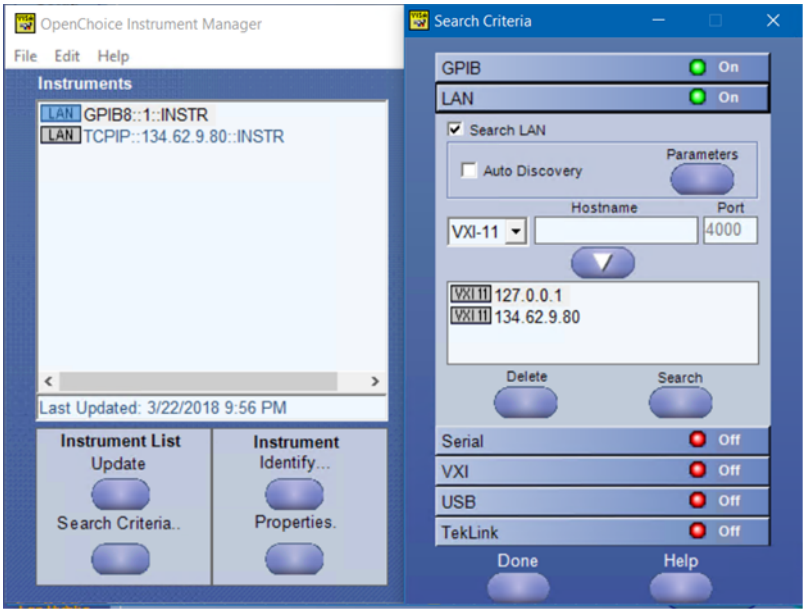
To configure the instrument using TekVISA, use the following steps.

1. Select oscilloscope window menu and click **OpenChoice Instrument Manager**.



2. Click the Update button and wait to update the list. The AWG which is connected to LAN displays the Instruments connected list. If the list is not displayed follow the steps.
   - Click **Search Criteria** and select LAN.
   - Turn it ON, if the LAN is Off.
   - Enter the AWG IP address in **Hostname** field and Press  button.
   - Click **Search** button and wait for your AWG instrument to discover and display the list.
   - Click **Done**.

- Click **Update**. It refreshes the instruments discovered and displays the list.



TekExpress instrument control settings

Use the Instrument Control Settings dialog box to view or search for connected instruments required for the tests. The application uses TekVISA to discover the connected instruments.

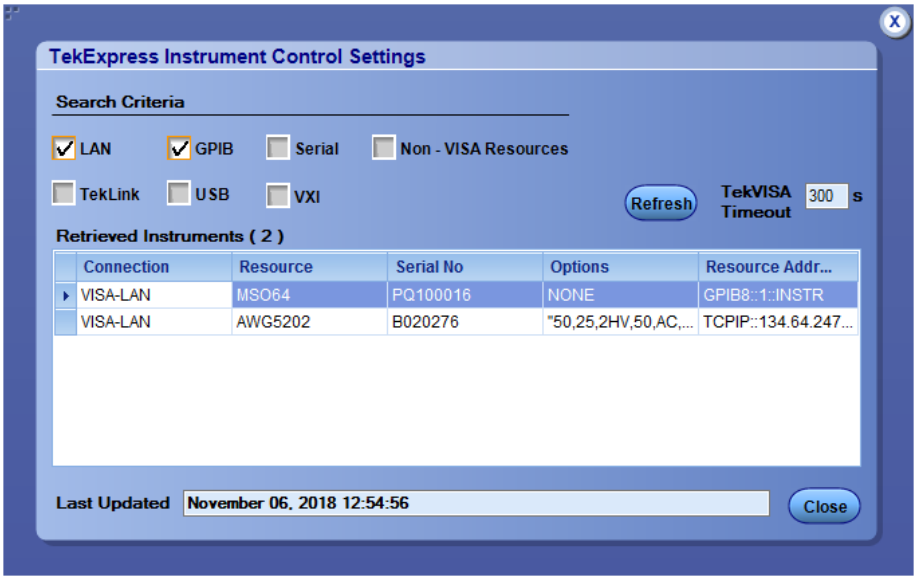


Figure 1: Instrument Control Settings

To refresh the list of connected instruments:

1. From the Options menu, select **Instrument Control Setting**.
2. In the Search Criteria section of the Instrument Control Settings dialog box, select the connection types of the instruments to search.

   Instrument search is based on the VISA layer but different connected cables determine the resource type, such as LAN, GPIB, USB. For example, if you choose LAN, you can search for all the instruments supported by TekExpress that are communicating over the LAN. If the search does not find any instruments that match a selected resource type, a message appears telling you that no such instruments were found. Click **OK** to close the message window.

   NOTE. *Ensure that the GPIB option is enabled to detect the real time oscilloscope in the Global Settings tab.*

3. Click **Refresh**.

   TekExpress searches for connected instruments.

4. After discovery, the dialog box lists the instrument-related details based on the search criteria you selected. For example, if you have selected LAN and GPIB as the search criteria, the application checks for the availability of instruments over LAN, then GPIB.

   The details of the instruments are displayed in the Retrieved Instruments table. The time and date of instrument refresh is displayed in the Last Updated field.

Configure email notification

Set up these email settings if you want the application to notify you by email when a test completes or produces an error. Configure email from the Options menu.

1. From the Options menu in the upper right corner, select Email Settings to open the Email Settings dialog box, or click the Preferences tab on the Setup panel.

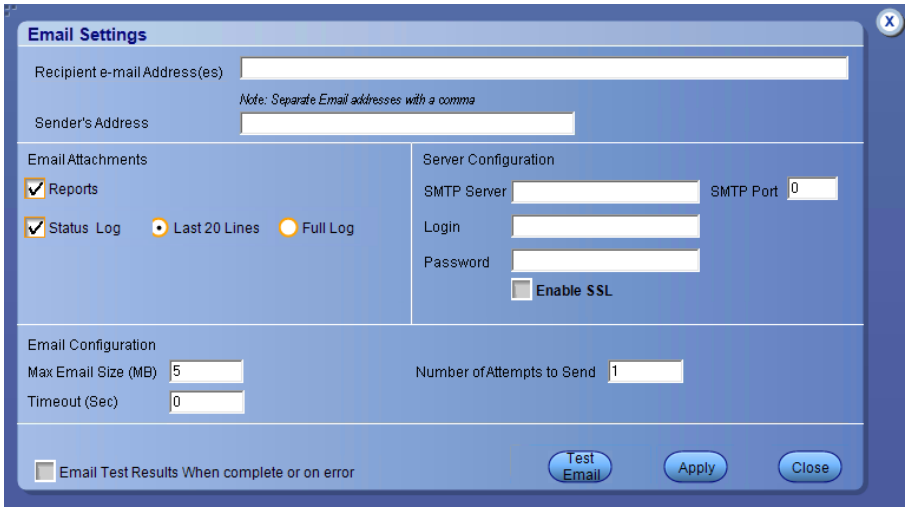


Figure 2: Email Settings dialog box

2. (Required) For Recipient email Address(es), enter your email address. You can include multiple addresses as long as you separate the addresses with commas.
3. (Required) For Sender's Address, enter the email address used by the instrument. This address consists of the instrument name, followed by an underscore, followed by the instrument serial number, the @ symbol, and the email server used. For example: DPO72004C_B130099@yourcompany.com.
4. (Required) In the Server Configuration section, type the SMTP Server address of the Mail server configured at the client location, and the SMTP Port number, in the corresponding fields.

   If this server requires password authentication, enter a valid login name, password, and host name in the corresponding fields.

   NOTE. *If any of the above required fields are left blank, the settings will not be saved and email notifications will not be sent.*

5. In the Email Attachments section, select from the following options:
   - Reports: Select to receive the test report with the notification email.

- Status Log: Select to receive the test status log with the notification email. If you select this option, then also select whether you want to receive the full log or just the last 20 lines.

NOTE. *The ScoreCard and Analysis Screenshot options are not available in Automotive Ethernet.*

6. In the Email Configuration section, select as desired:
   - Enter a maximum file size for the email message. Messages with attachments larger than this limit will not be sent. The default is 5 MB.
   - To limit the number of attempts the system makes to send a notification, enter the number in the Number of Attempts to send field. The default is 1. You can also specify a timeout.
7. Select the **Email Test Results when complete or on error** check box. Use this check box to quickly enable or disable email notifications.
8. To test your email settings, click **Test Email**.
9. To apply your settings, click **Apply** button.
10. Click **Close** button to exit the Email Settings dialog box.

See also. *Before you click start*

Pre-run check list

Running the tests and viewing their progress

Setup panel

Setup panel overview

The Setup panel contains sequentially ordered tabs that help you guide through the test setup and execution process.

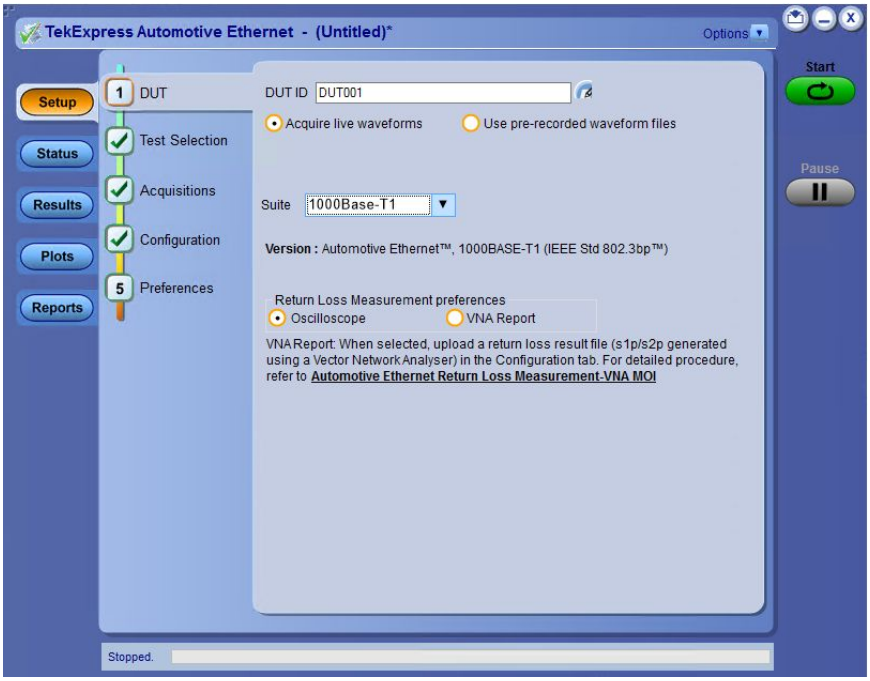


Figure 3: Setup panel

See also. *Saving a test setup*

Running the tests and viewing their progress in the Status Panel

Viewing test results in the Results Panel

Set DUT tab parameters

Use the DUT tab to select parameters for the device under test. These settings are global and apply to all tests for the current session. DUT settings also affect the list of available tests in the Test Selection tab.

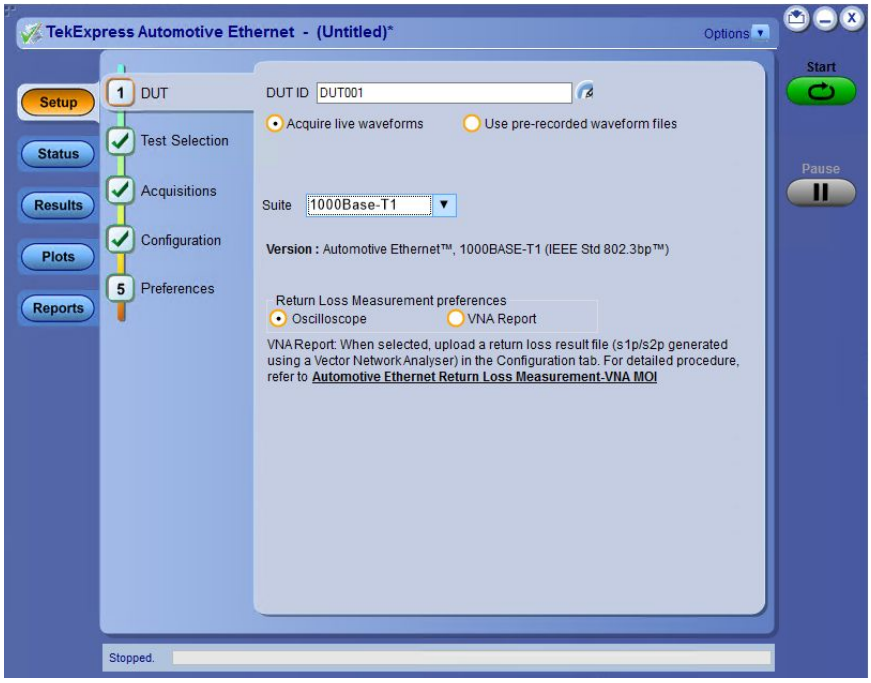


Figure 4: Setup panel

Click **Setup > DUT** to access the DUT parameters:

Table 9: DUT tab settings

Setting	Description
DUT ID	Adds an optional text label for the DUT to reports. The default value is DUT001. The maximum number of characters is 32. You cannot use the following characters in an ID name: (.,..,...,\,/:?"<>|*)
 Comments icon (to the right of the DUT ID field)	Opens a Comments dialog box in which you can enter optional text to add to a report. Maximum size is 256 characters. To enable or disable comments appearing on the test report. See *Select report options* for details.
Acquire live waveforms	Perform analysis on live waveforms.
Use pre-recorded waveform files	Perform analysis on pre-recorded waveforms.

Setting	Description
Suite	■ 1000Base-T1 ■ 100Base-T1
Return Loss measurement preferences	■ Oscilloscope: Fully automated oscilloscope based method ■ VNA Report: Select to run the return loss measurement with a VNA report file (S-Parameter). For steps to run the return loss measurement by VNA Report file method, *click here*. Only available, when **Return Loss** measurement is selected in the Test Selection tab.

See also. *Setup panel overview*

Selecting tests

Setting configuration tab parameters

Selecting tests

Use the Test Selection tab to select one or all the tests. The tests that you select here impact the parameters available in the Acquisitions tab.

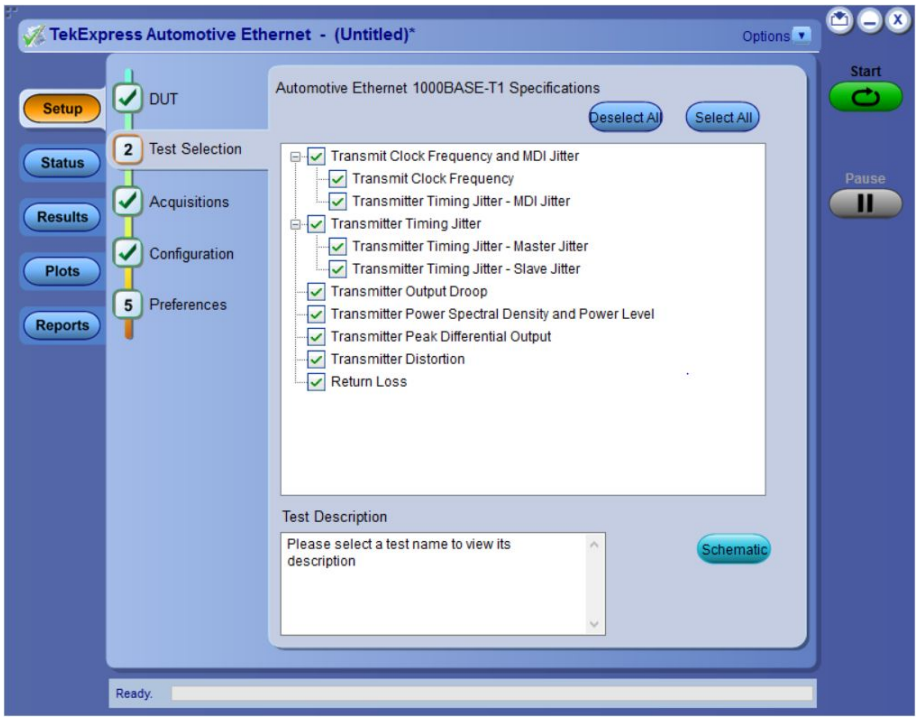


Figure 5: Test Selection tab

Table 10: Test selection tab settings

Setting	Description
Tests	Click on a test to select or unselect. Highlight a test to show details in the Test Description pane.
Test Description	Shows a brief description of the highlighted test in the test field.
Select All	Click to select all the tests in the list.
Deselect All	Click to deselect all the tests in the list.
Schematic	Click to view the connection diagram for the selected test.

See also. *Setup panel*

Configuration tab

Status panel

Selecting acquisition tab parameters

Use the Acquisitions tab to view test acquisition parameters. The contents displayed on this tab depend on the pre-recorded or live mode selected.

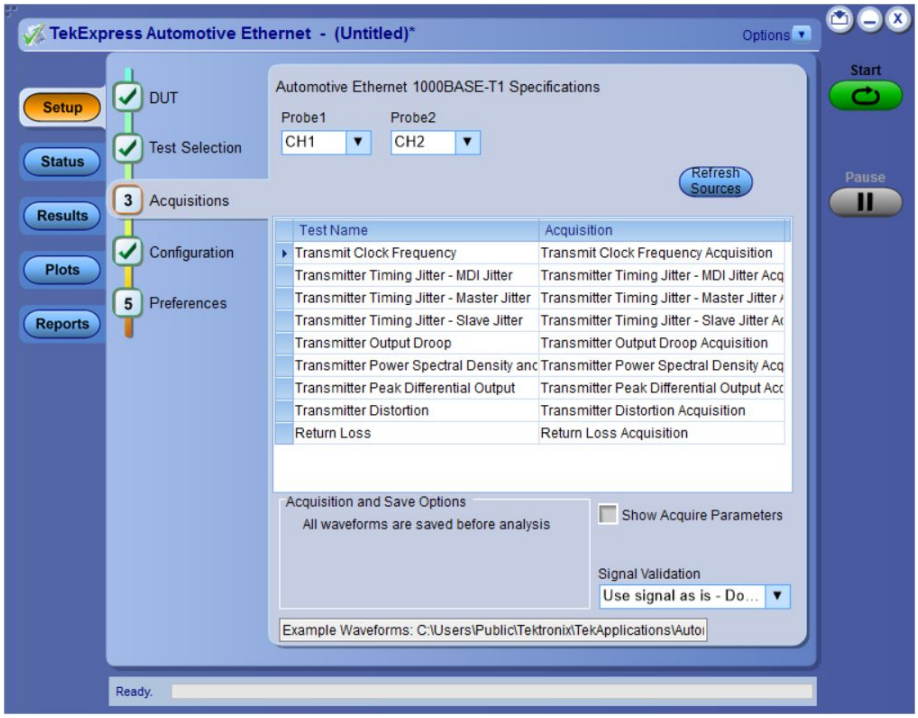


Table 11: Acquisition tab settings

Setting	Description
Probe<X>	Select the channel connected to the probe.
Refresh Sources	Click to refresh the selected resources.
Show Acquire Parameters	Select to view the acquisition parameters.
Signal Validation	Select the signal validation type ■ Prompt me if Signal Validation Fails ■ Skip test if Signal Validation Fails ■ Use signal as is - Don't Validate

TekExpress Automotive Ethernet saves all acquisition waveforms to files by default. Waveforms are saved in a unique folder for each session (a session starts when you click the Start button). The folder path is X:\Automotive-Ethernet \Untitled Session \<dutid>\<date>_<time>. Images created for each analysis, CSV files with result values, reports and other information specific to that particular execution are also saved in this folder.

Saving a session moves the session file contents from the Untitled Session folder to the specified folder name, and changes the session name to the specified name.

Acquire live waveforms for analysis. Select **Acquire Live Waveforms** on the DUT tab, to perform live acquisitions.

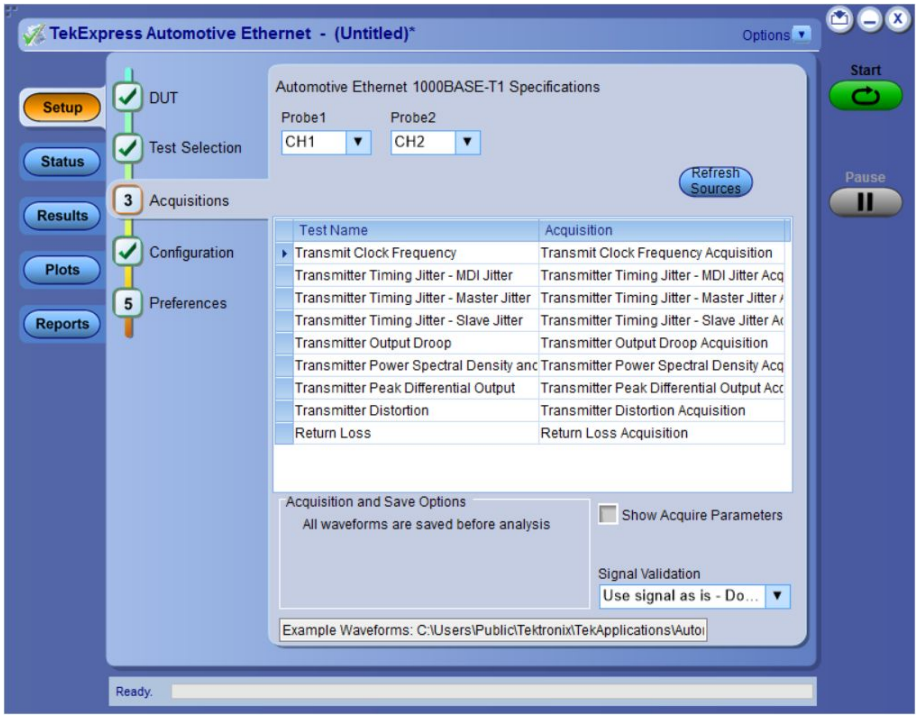
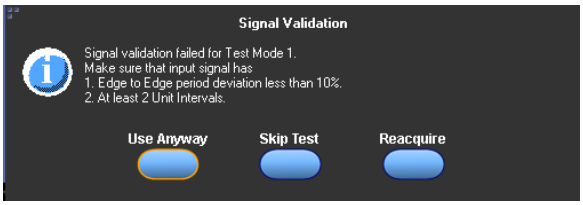


Figure 6: Acquisitions tab with Acquire live waveforms selected

Table 12: Acquisitions tab settings for Acquire Live Waveforms

Column name	Description
Probe<x>	Select the probe source channel for each listed signal in the Probe selection drop-down menu.
Refresh Sources	Click to refresh the sources.
Show Acquire Parameters	Select to view the acquisition parameters for the selected tests in the results table.

Column name	Description
Signal validation	■ **Prompt me if signal fails**: Select to prompt if signal fails.  ■ **Use Anyway**: Click to Run the test on the current acquired signal in spite of failed signal. ■ **Skip Test**: Click to skip the current test after signal validation fails. ■ **Reacquire**: Click to reacquire the signal for the test being Run. ■ **Use signal as is-Don't check**: Select to perform the test without signal validation. ■ **Skip test if signal fails**:Select to skip the test for which signal validation fails.

See also. *Selecting configuration tab parameters*

Use pre-recorded waveforms for analysis

Use pre-recorded waveforms for analysis. Select **Use pre-recorded waveform files** on the DUT tab, to use pre-recorded waveforms for analysis. Click  for the selected measurement and select the waveform file (.wfm).

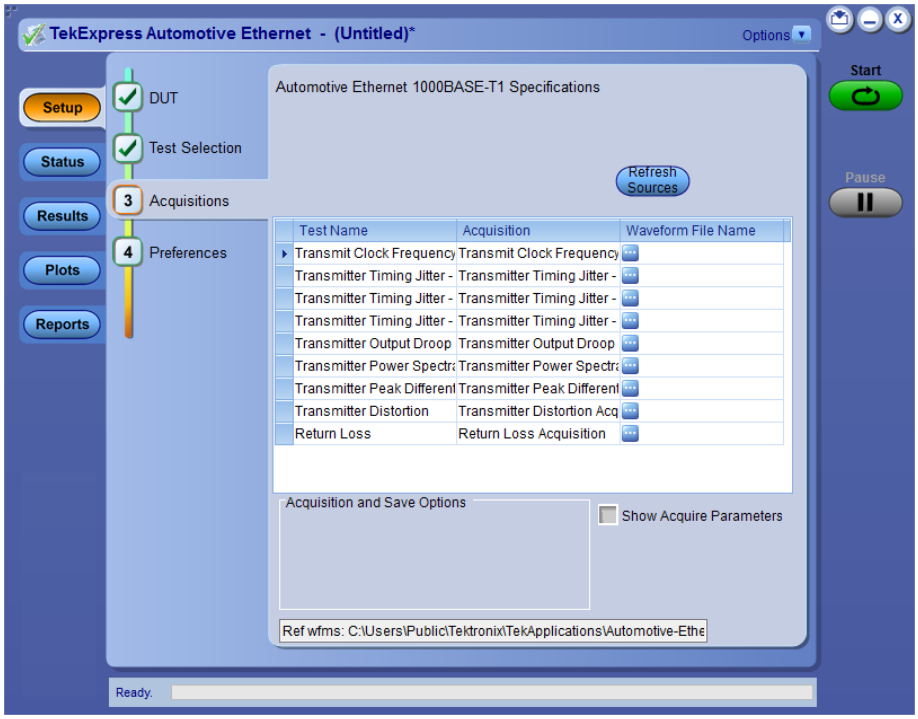


Figure 7: Acquisitions tab with Use pre-recorded waveform files selected

Table 13: Acquisitions tab settings for Use pre-recorded waveform files

Column name	Description
Refresh Sources	Click to refresh the sources.
Show Acquire Parameters	Select to view the acquisition parameters for the selected tests in the results table.

NOTE. *Tektronix recommends to use a Tektronix oscilloscope to capture the waveform files.*

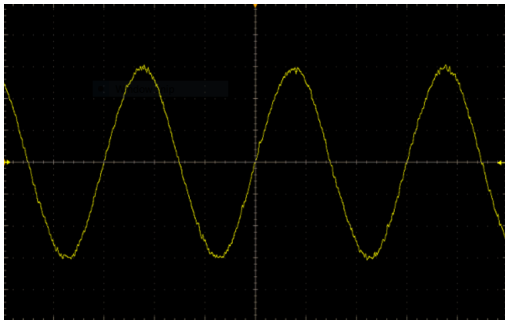
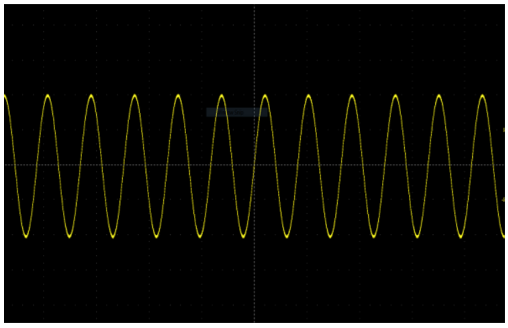
See also. *Acquire live waveforms for analysis*

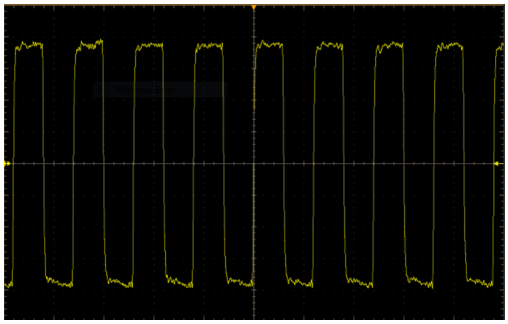
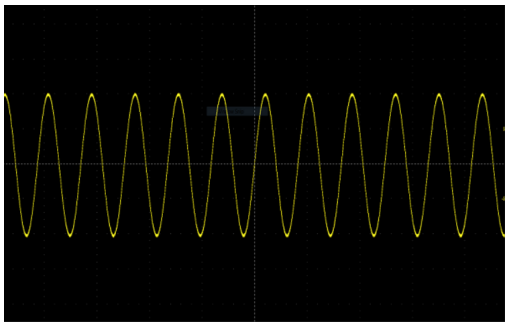
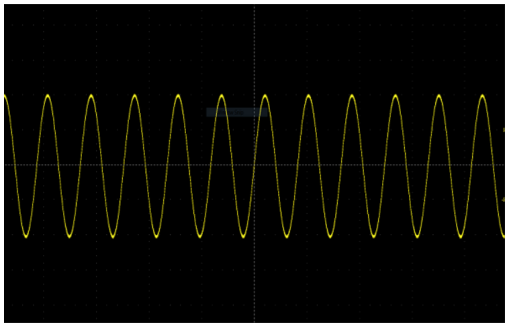
Acquire step by step. The Acquire Step By Step option is available in the Acquisitions panel. This is a global parameter that is applied to all tests when selected. By default, this option is deselected.

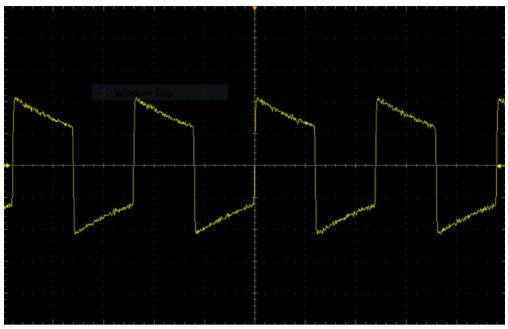
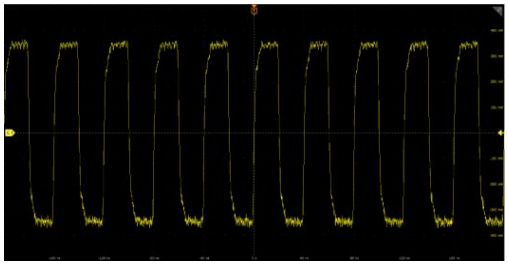
When selected, this parameter allows for display of the reference input waveform of the selected measurement. This helps to compare the input waveform coming from DUT with the typical reference waveform (snap shot), allowing you to change the setup before acquiring the waveforms. The following table gives different reference waveform snap shots that appear for different tests.

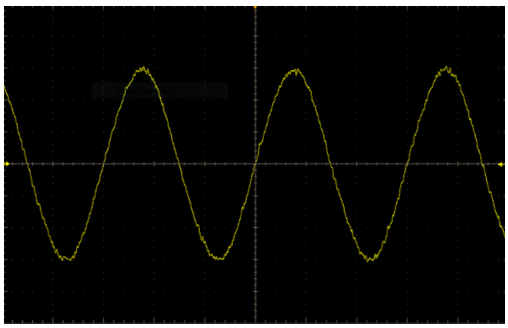
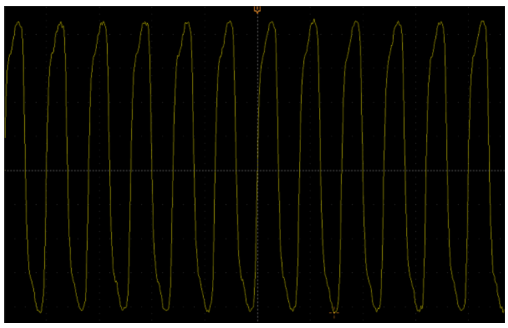
NOTE. *When using prerecorded waveform files, the* ***Acquire Step By Step*** *option is not available.*

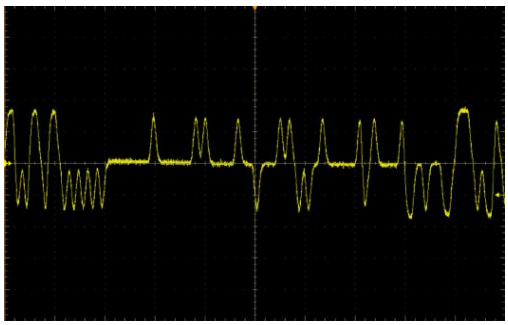
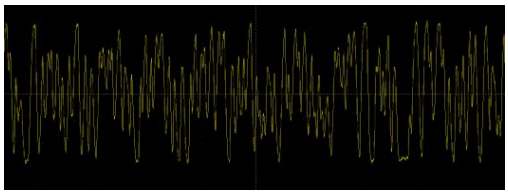
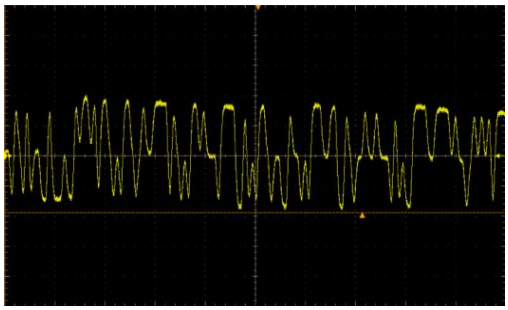
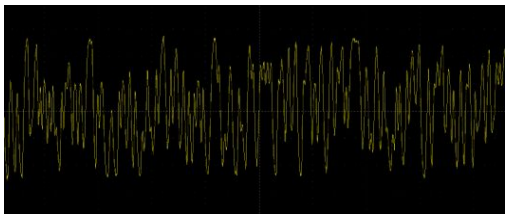
Table 14: Reference waveforms

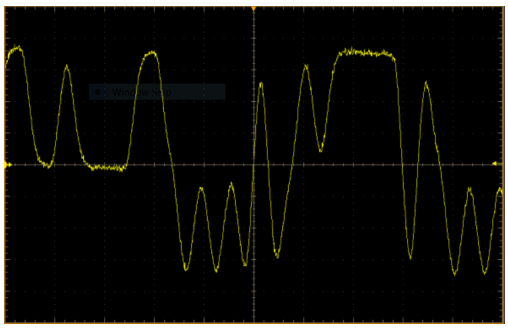
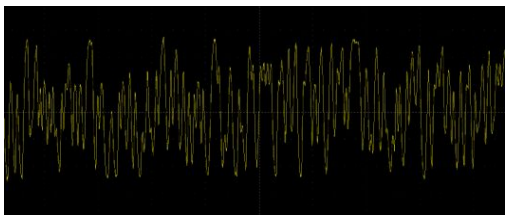
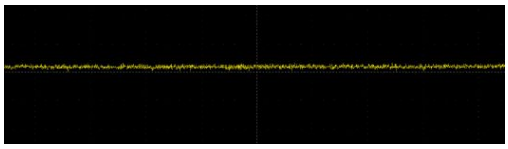
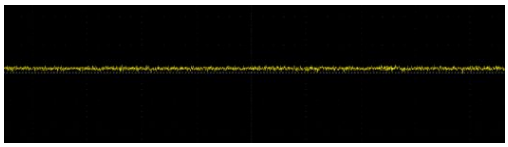
Test name	Reference waveform
Transmit Timing Jitter – Master Jitter	100Base-T1  1000Base-T1 

Test name	Reference waveform
Transmit Timing Jitter – Slave Jitter	100Base-T1  1000Base-T1 
Transmit Timing Jitter – MDI Jitter	1000Base-T1 

Test name	Reference waveform
Transmitter Output Droop	100Base-T1  1000Base-T1 

Test name	Reference waveform
Transmit Clock Frequency	100Base-T1  1000Base-T1 

Test name	Reference waveform
Transmitter Distortion	100Base-T1  1000Base-T1 
Transmitter Power Spectral Density	100Base-T1  1000Base-T1 

Test name	Reference waveform
Transmitter Peak Differential Output	100Base-T1  1000Base-T1 
Return Loss	100Base-T1  1000Base-T1 

Setting configuration tab parameters

Use the Configuration tab to view the instruments detected, set measurement parameters and perform calibration for the measurements.

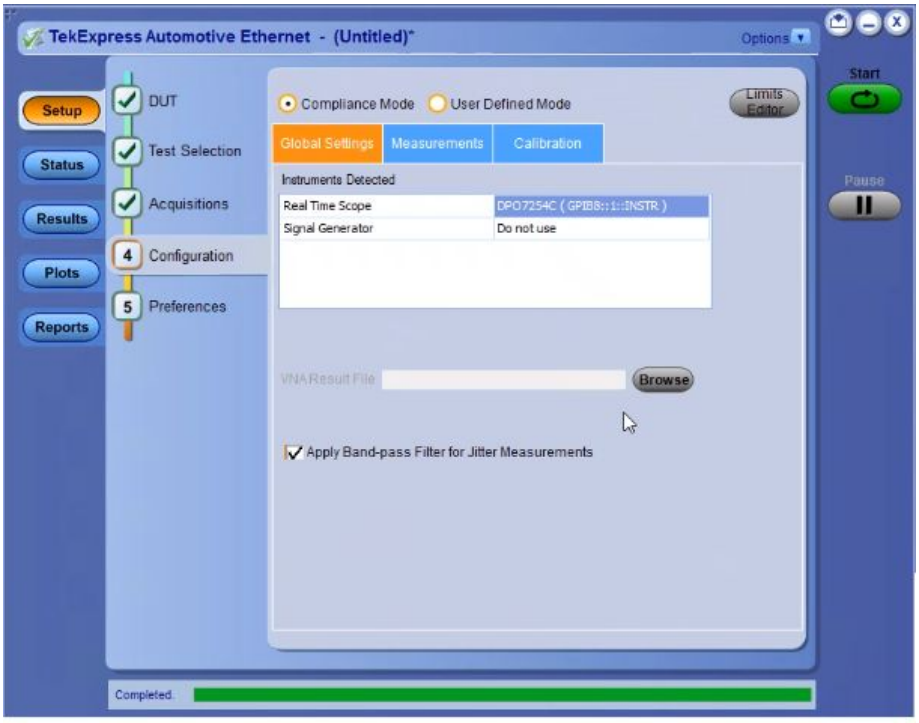


Figure 8: Configure tab settings for 1000Base-T1

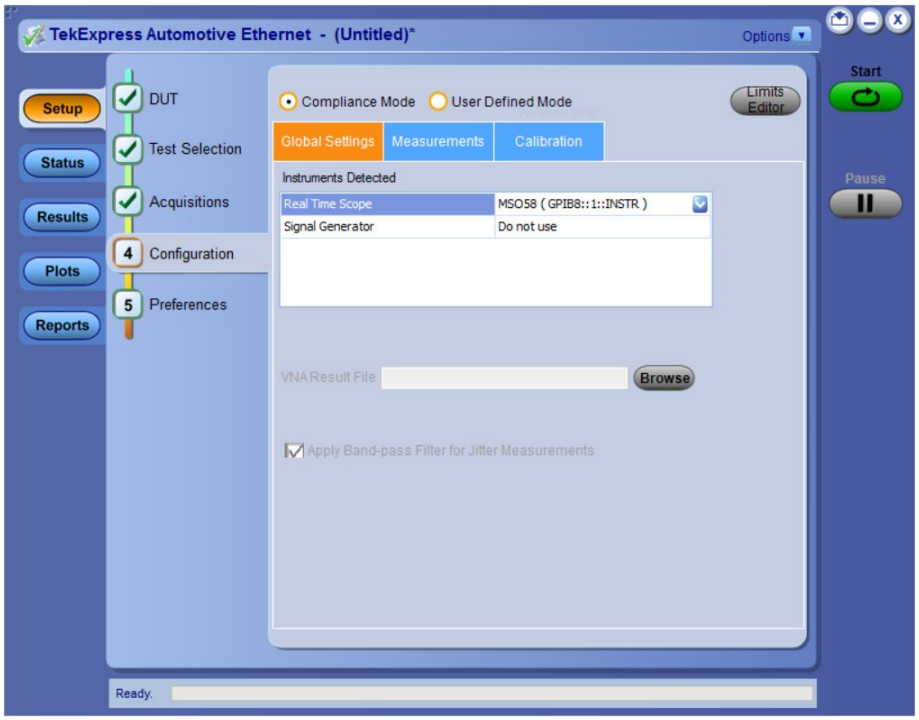


Figure 9: Configure tab settings for 100Base-T1

Table 15: Configuration tab settings

Setting	Description
Compliance Mode	Select to use Compliance Mode values. You cannot change any test parameters in Compliance Mode, but you can view the compliance parameters. By default Compliance Mode is selected.
User Defined Mode	Select to run tests using custom parameters.
Limits Editor	Shows the upper and lower limits for the applicable measurement using different types of comparisons. In Compliance Mode, use the Limits Editor to view the measurement high and low limits used for selected tests. In User Defined Mode, use the Limits Editor to edit the limit settings.  To edit a value, click that field and either select from the displayed list or enter a new value. Use the bottom scroll bar to view all available fields.
Global Settings	
Instruments Detected	Displays the instruments connected to this application. Click on the instrument name to open a list of available (detected) instruments. Select **Options > Instrument Control Settings** and click Refresh to update the instrument list. ***NOTE.*** *Verify that the **GPIB/LAN** search criteria (default setting) in the Instrument Control Settings is selected when using TekExpress Automotive Ethernet application.*
VNA Result File	Click Browse. Navigate to the folder path and select a return loss result file (s1p/s2p) generated using a Vector Network Analyser. Only available, when **Return Loss** measurement is selected in the Test Selection tab.
Apply Band-pass Filter for Jitter Measurements	Select to apply the Band pass filter for the selected jitter measurements. Only available, either when one among **Transmitter Timing Jitter - MDI Jitter, Transmitter Timing Jitter - Master Jitter or Transmitter Timing Jitter - Slave Jitter** measurements or all these measurements are selected in the Test Selection tab. ***NOTE.*** *Band pass filter is applicable only for 1000Base-T1 Jitter Measurements and it is disabled for 100Base-T1.*

The Configuration screen shows Global parameters, which are common for all tests, and Measurement parameters, which are specific to selected tests, including acquisition, analysis, and limit parameters.

NOTE. *You cannot change the Test parameters that are greyed out.*

See Also. *Setup panel overview*

Set DUT tab

Selecting tests

Selecting configuration tab

About saving and recalling test setups

Measurement parameter descriptions. You can view or change the measurement parameters in the Configuration tab of the Setup panel. Configuration parameters are displayed for the measurement selected, in the Test Selection tab. The parameters listed are enabled based on the measurement selected and if the measurements are running tests in User Defined Mode. You cannot change the parameters in Compliance Mode.

1000Base-T1

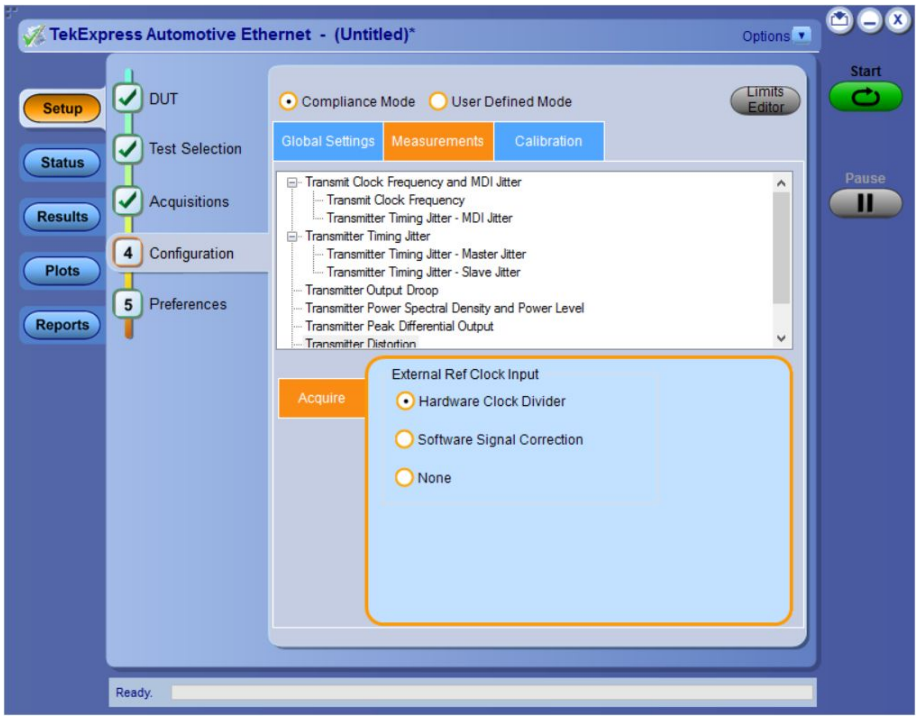


Figure 10: Measurements tab

Table 16: 1000Base-T1 measurement configurations

Name	Unit	Range/ Allowable values	Default	Description	Applies to
Record Length	M Samples	1 to 20	2.75	Sets the record length to use.	Transmit Clock Frequency
			13		Transmitter Timing Jitter-MDI Transmitter Timing Jitter (Master Jitter) Transmitter Timing Jitter (Slave Jitter)

Name	Unit	Range/ Allowable values	Default	Description	Applies to
Averages	NA	2 to 100	2	Sets the number of averages (number of acquisitions) for average mode acquisition.	Transmitter Output Droop
		2 to 1000	500		Return Loss
No of Acquisitions	NA	1 to 100	5	Sets the number of acquisitions	Transmitter Peak Differential Output
Hardware Clock Divider	NA	NA	Hardware Clock Divider	Select to use the external hardware clock divider unit (125 MHz Tx_CLK to 10 MHz) to synchronize the DUT, disturber signal source (AWG/ AFG), and the oscilloscope.	Transmitter Distortion
Software Signal Correction	NA	NA	NA	When Software Signal correction method is selected, the software computes Tx distortion for TM4 signal with disturber source without using hardware CDU synchronizatio n.	Transmitter Distortion
None	NA	NA	NA	Select to check the behavior of the DUT without any Ref clock (External or Internal).	Transmitter Distortion

Name	Unit	Range/ Allowable values	Default	Description	Applies to
Unit of Measurement ■ dBm ■ dBm/Hz	NA	NA	dBm	Selects the unit of measurement on which Transmitter Power Spectral Density will be displayed.	Transmitter Power Spectral Density and Power Level
Edge ■ Falling ■ Rising	NA	NA	Rising	Used to select the type of edges on which RMS Jitter and Peak-to-Peak Jitter will be calculated.	Transmitter Timing Jitter-MDI Jitter Transmitter Timing Jitter (Master Jitter) Transmitter Timing Jitter (Slave Jitter)
Hysteresis	%	1 to 10	5	Sets the hysteresis in percentage that gets used during edge finding.	Transmitter Timing Jitter (Master Jitter) Transmitter Timing Jitter (Slave Jitter) Transmitter Timing Jitter - MDI Jitter
Smooth	NA	0 to 10	7	Sets the number of samples that will be used while smoothing the return loss waveform; sets the averaging filter length.	Return Loss

100Base-T1

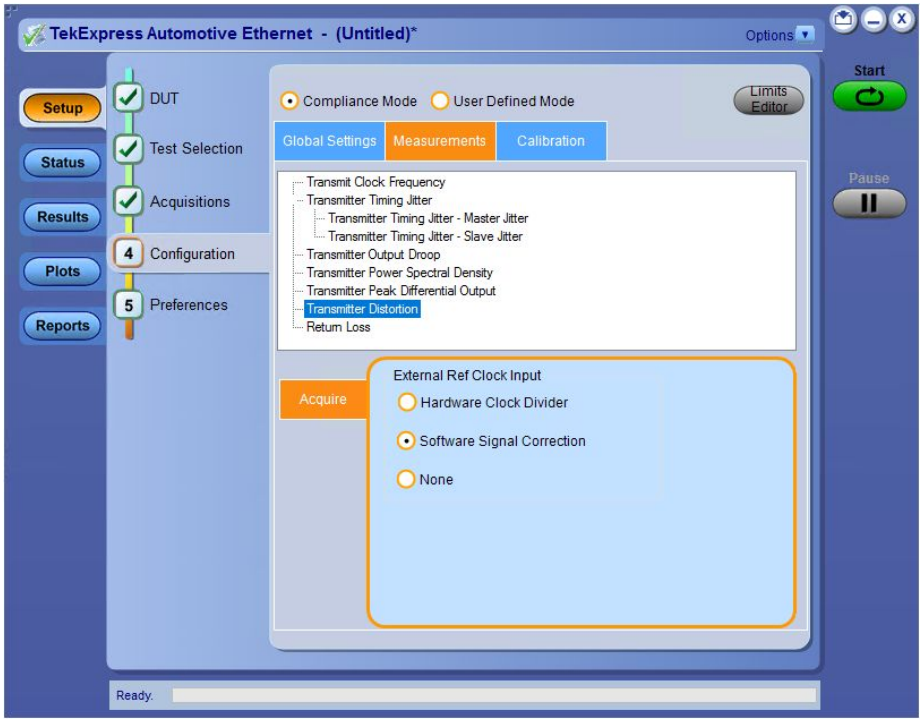


Table 17: 100Base-T1 measurement configurations

Name	Unit	Range/ Allowable values	Default	Description	Applies to
Record Length	M Samples	1 to 20	0.5	Sets the record length to use.	Transmit Clock Frequency
			12.5		Transmitter Timing Jitter (Master Jitter) Transmitter Timing Jitter (Slave Jitter)
Averages	NA	2 to 100	16	Sets the number of averages (number of acquisitions) for average mode acquisition.	Transmitter Output Droop
		2 to 1000	500		Return Loss
Spectral Average	NA	2 to 256	2	Sets the number of spectral averages	Transmitter Power Spectral Density

Name	Unit	Range/ Allowable values	Default	Description	Applies to
Hardware Clock Divider	NA	NA	NA	Select to use the external hardware clock divider unit (66.66 MHz Tx_CLK to 10 MHz) to synchronize the DUT, disturber signal source (AWG/ AFG), and the oscilloscope.	Transmitter Distortion
Software Signal Correction	NA	NA	NA	When Software Signal correction method is selected, the software computes Tx distortion for TM4 signal with disturber source without using hardware CDU synchronizatio n.	Transmitter Distortion
None	NA	NA	NA	Select to check the behavior of the DUT without any Ref clock (External or Internal).	Transmitter Distortion
Edge ■ Falling ■ Rising	NA	NA	Rising	Used to select the type of edges on which RMS jitter will be calculated.	Transmitter Timing Jitter (Master Jitter) Transmitter Timing Jitter (Slave Jitter)
Hysteresis	%	1 to 10	5	Sets the hysteresis in percentage that gets used during edge finding.	Transmitter Timing Jitter (Master Jitter) Transmitter Timing Jitter (Slave Jitter)

Name	Unit	Range/ Allowable values	Default	Description	Applies to
RBW	KHz	1 to 100	10	Sets the resolution bandwidth. This controls the bandwidth of the spectral analyzer filters.	Transmitter Power Spectral Density
Center Frequency	MHz	50 to 500	100.5	Sets the center of the frequency span over which spectral analysis is done.	Transmitter Power Spectral Density
Frequency Span	MHz	100 to 500	201	Sets the range of frequencies over which spectral analysis is done	Transmitter Power Spectral Density
Unit of Measurement ■ dBm ■ dBm/Hz	NA	NA	dBm	Selects the unit of measurement on which Transmitter Power Spectral Density will be displayed.	Transmitter Power Spectral Density
Smooth	NA	0 to 10	7	Sets the number of samples that will be used while smoothing the return loss waveform; sets the averaging filter length.	Return Loss

See also. *Setting configuration tab parameters*

Calibration. Calibration step is done to calibrate the disturber signal source amplitude and frequency. It measures the DUT signal level at defined PIN points on the test fixture. You can perform calibration on live DUT signal and disturber source signal connected as mentioned in the calibration connection diagram.

NOTE. *It is recommended to do calibration of the waveforms for Transmitter Distortion and Return Loss measurements.*

Calibration for transmitter distortion measurement

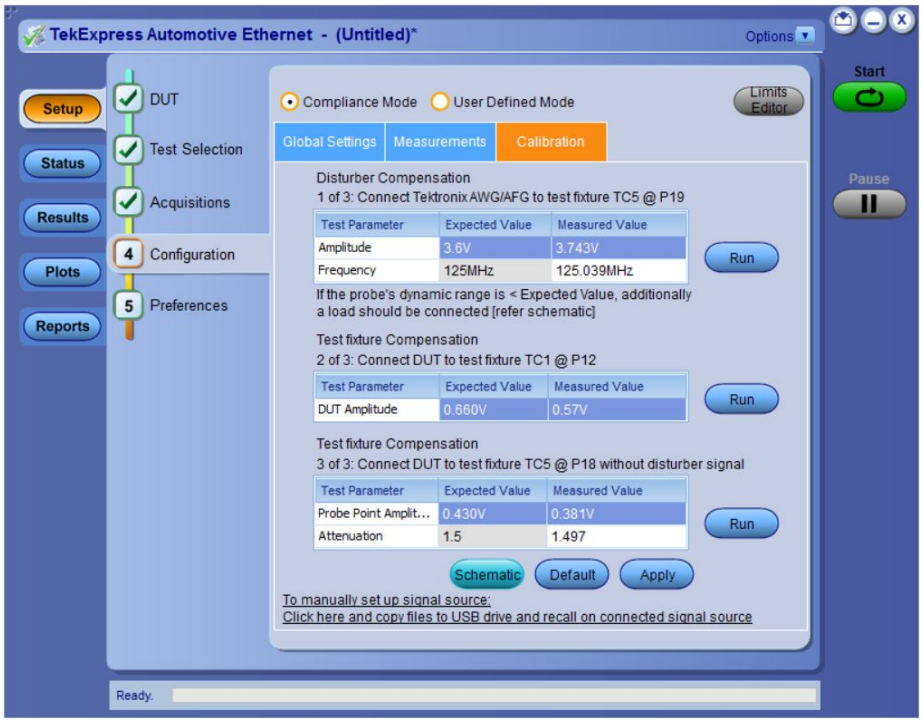


Figure 11: Calibration tab for 1000Base-T1 transmitter distortion measurement

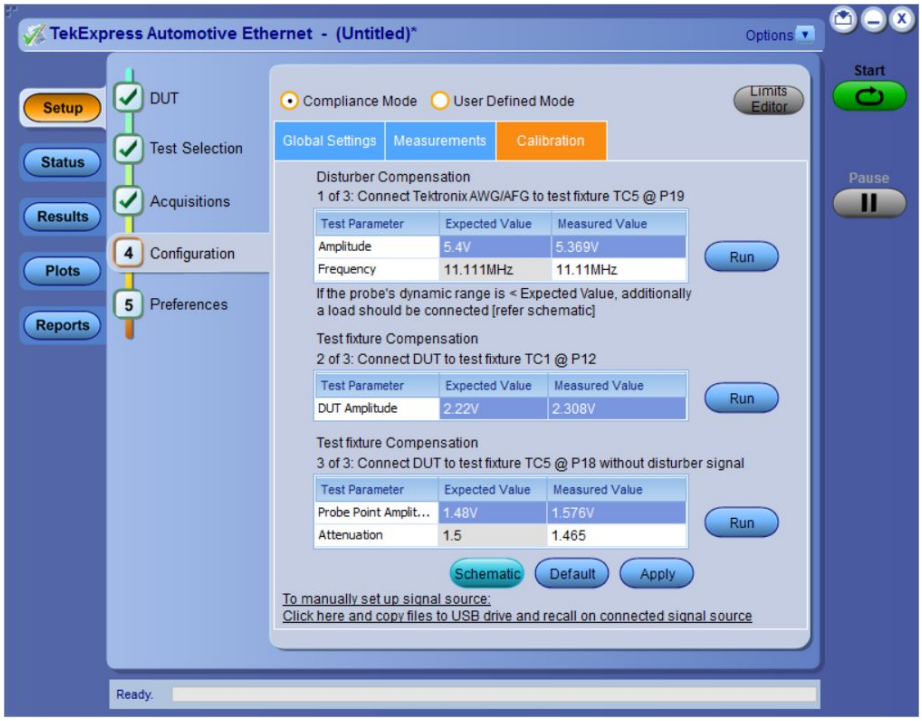


Figure 12: Calibration tab for 100Base-T1 transmitter distortion measurement

Calibration for return loss measurement

Figure 13: Calibration tab for return loss measurement

Table 18: Calibration settings

Parameter	Description
Live Calibration	Sets the live calibration process. The live Calibration files are saved in X:\Automotive Ethernet\Calibration folder.
Use Pre-recorded Calibration	Sets the calibration process with prerecorded calibrated waveforms and allows you to browse and select the calibrated waveforms. The path for selecting the calibrated waveforms is C:\Users\Public\Tektronix\TekApplications\Automotive-Ethernet.
Channel drop down	Allows you to select relevant channel and probes. ***NOTE.*** *when you change the input sources (Channel) other than calibrated sources, you need to re-calibrate with latest sources.*
Cal Type	Displays the type of calibration: Load, Open, and Short.
Cal Status	Displays the status of the calibration: Pending, Done.
Cal Time	Displays the previous calibration time: Date, Month, and Year.
Schematic	Click to view the schematic.
Plot	Click to view the plot.
Apply	Click to apply the configured parameters to calibration.
Run	Click to run the process of calibration.
Default button	Click to perform calibration by using default values. ***NOTE.*** *This button is applicable only for Transmitter distortion. The expected and measured values for Transmitter distortion on Calibration tab will be initially empty, when you launch the application for the first time and they get populated once you click the* ***Default*** *button.*
To manually set up signal source: Click here and copy files to USB drive and recall on connected signal source.	In case of manual signal source (AFG/AWG) setup, click the link and copy the relevant folder and recall the setup on connected signal source.

Compliance mode or User defined mode. From the Configuration screen, you will have the option to select either Compliance Mode or User Defined Mode.

- **Compliance Mode**: Select to use Compliance Mode values. You cannot change any test parameters in Compliance Mode, but you can view the compliance parameters.
- **User Defined Mode**: Select to run tests using custom parameters. You may change parameters that are not grayed out.

Set preferences tab parameters

Use the Preferences tab to set the application action on completion of a measurement.

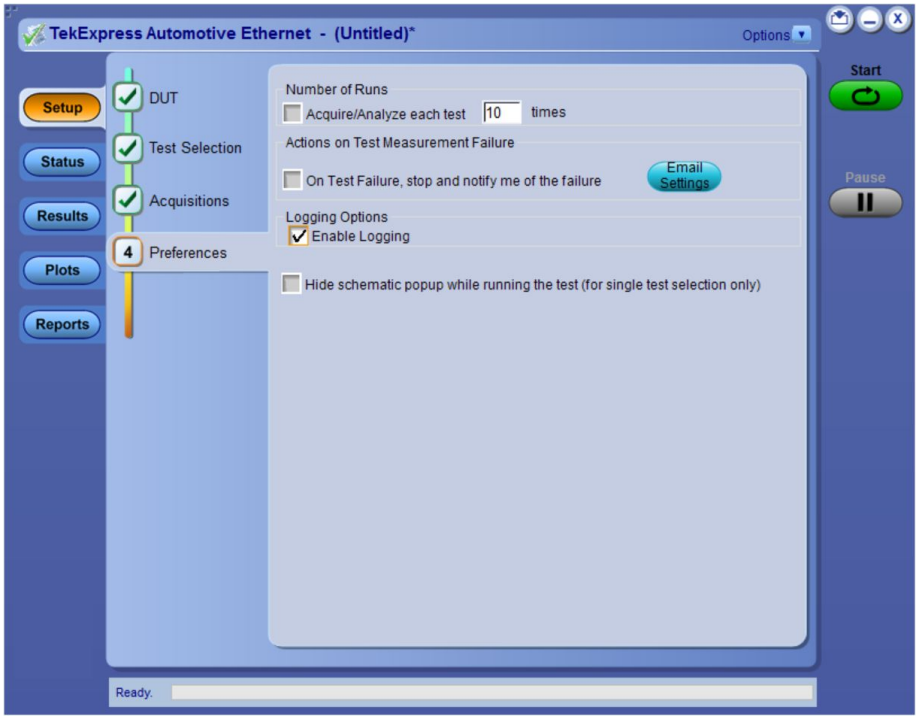
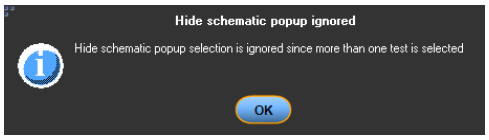


Table 19: Preferences tab settings

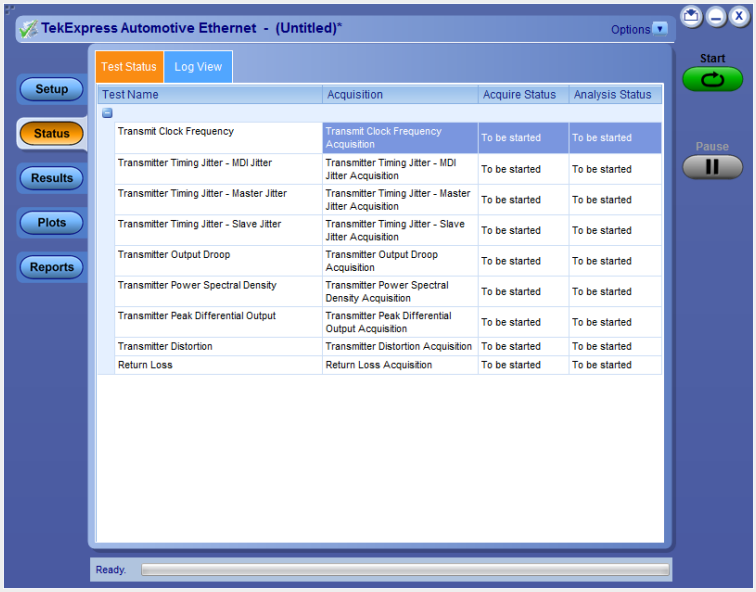
Setting	Description
Number of Runs	
Acquire/Analyze each test	Select to run the same selected test(s), specified number of times. Minimum is two. Maximum is 30.
Actions on Test Measurement Failure	
On Test Failure, stop and notify me of the failure	Select to stop the test run on Test Failure, and to get notified via email. By default, it is unselected. Click **Email Settings** to configure.
Logging Options	
Enable Logging	Select to enable/disable the logging feature. When enabled the application records the actions of the user. By default, it is selected.

Setting	Description
Hide schematic popup while running the test (for single test selection only)	When selected the schematic popup is displayed. ***NOTE.*** *When more than one test is selected, a warning message will be displayed and the enabled check box will be ignored. The schematics will be displayed for the selected measurements. Does not apply for exceptions, VISA-connection timeout pop-ups.* 

Status panel overview

The Status button accesses the Test Status and Log View tabs, which provide status on test acquisition and analysis (Test Status tab) and a listing of test tasks performed (Log View tab). The application opens the Test Status tab when you start a test run. You can select the Test Status or the Log View tab to view these items while tests are running.

Test status view



Log view

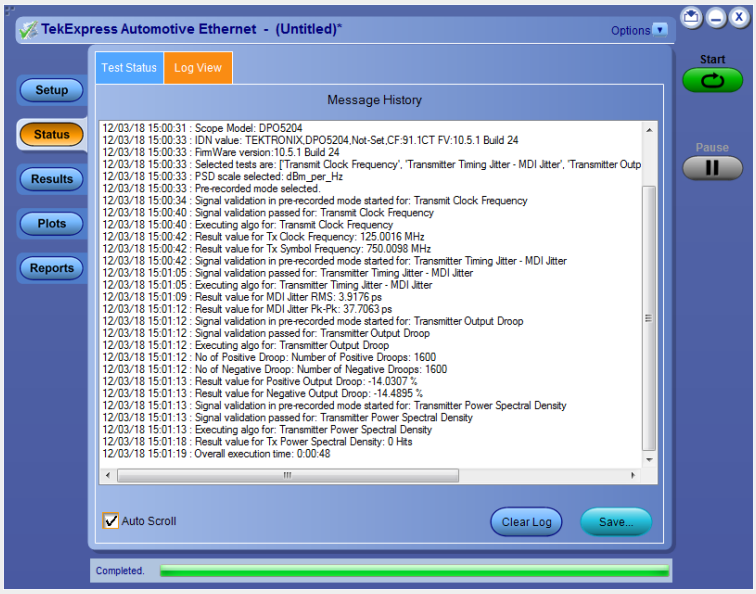


Table 20: Status panel Log View controls

Control	Description
Message History	Lists all executed test operations and timestamp information.
Auto Scroll	Enables automatic scrolling of the log view as information is added to the log during the test.
Clear Log	Clears all messages from the log view.
Save	Saves the log file to a text file. Use the standard Save File window, to navigate and specify the folder and file name and then save the log file.

Results panel

Viewing test results: the Results panel

When a test completes running, the application switches to the Results Panel.

Set result viewing preferences from the Preferences menu in the upper right corner.

Each test result occupies a row in the Results table. By default, results are displayed in summary format, with the measurement details collapsed, and with the Pass/Fail column visible. You can change the display view.

- To expand all test rows listed, from the **Preferences** menu in the upper right corner, select **View Results Details**.
- To expand a collapsed test row, click the plus button ( ) to the left of the test row.
- To collapse all expanded test rows, select **Preferences > View Results Summary**.
- To collapse a single expanded test row, click the minus button ( ) to the left of the test row.
- To remove or restore the Pass/Fail column, select **Preferences > Show Pass/Fail**.
- To enable or disable the wordwrap feature, select **Preferences > Enable Wordwrap**.
- To expand the width of a column, place the cursor over the vertical line that separates the column from the one to the right. When the cursor changes to a double-ended arrow, hold down the mouse button and drag the column to the desired width.
- To sort the test information by column, click the column head. When sorted in ascending order, a small up arrow is displayed. When sorted in descending order, a small down arrow is displayed.
- To clear all test results displayed, click **Clear** 

button.

Results preferences

Figure 14: Results preferences

See also. *Setup panel*

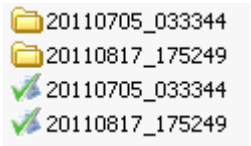
Running tests and viewing their progress: the Status panel

View test-related Files

Files related to TekExpress Automotive Ethernet tests are stored in the X:\Automotive Ethernet\Untitled Session shared folder. In the Automotive Ethernet folder, each test setup has a test setup file and a test setup folder, both with the test setup name. The test setup file is preceded by the Automotive Ethernet icon and usually has no file extension displayed.

Inside the test setup folder is another folder named for the DUT ID used in the test sessions (the default is DUT001).

Inside the DUT001 folder are the session folders and files. Each session has a folder and file pair, both named for the test session using the naming convention (date)_(time). Each session file is stored outside of its matching session folder.



Each session folder contains image files of any plots generated by the test session and any waveform files if prerecorded waveform files were used during the session.

The first time you run a new, unsaved session, the session files are stored in the X:\Automotive Ethernet\Untitled Session folder. Once you name and save the session, the Untitled Session folder name is changed to the one you specified.

NOTE. *By default, test report files are saved in the session folder. You can change the report file location for a specific test.*

See also. *File name extensions*

Plots panel

Viewing plots

The Plots panel displays a summary of plot generated during run. The plots have zoom, cursors, save, dock/undock, and select test features.

Types of plots

Following are different plots generated during run, based on the measurement(s) selected.

Transmit Clock Frequency

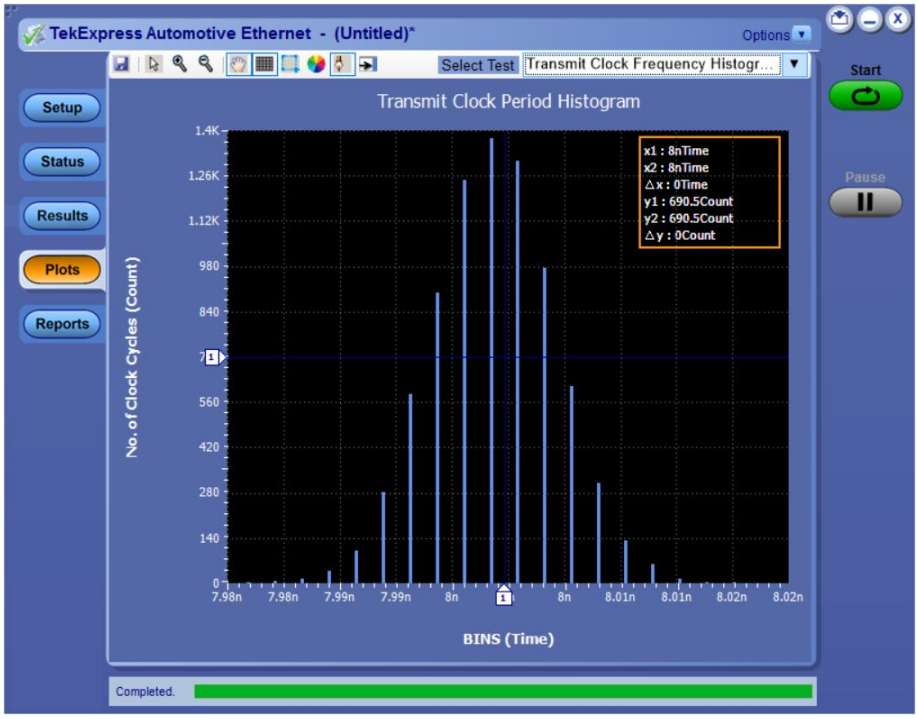


Figure 15: Transmit Clock Frequency - 1000Base-T1 Histogram Plot

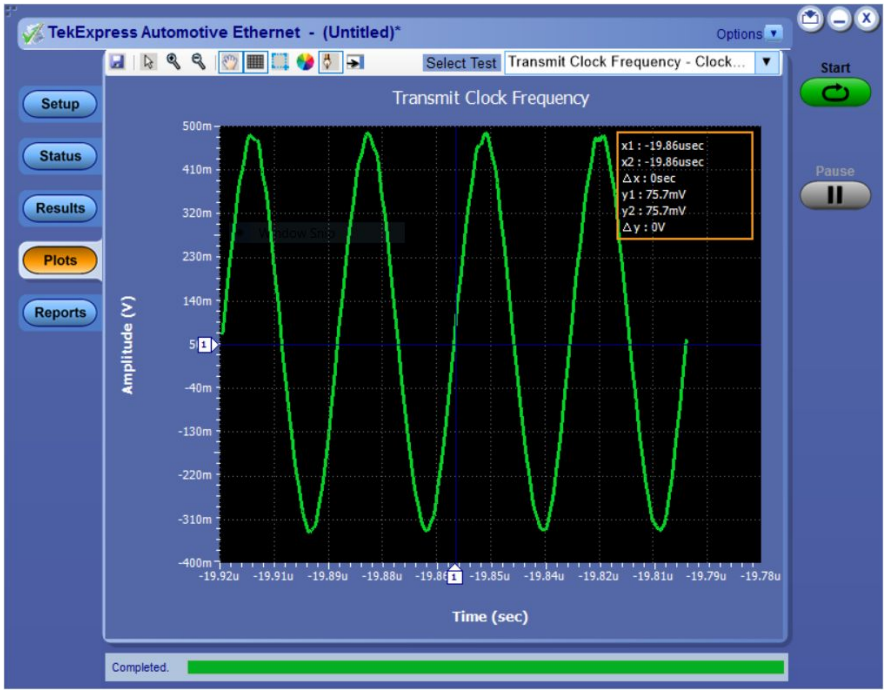


Figure 16: Transmit Clock Frequency - 1000Base-T1

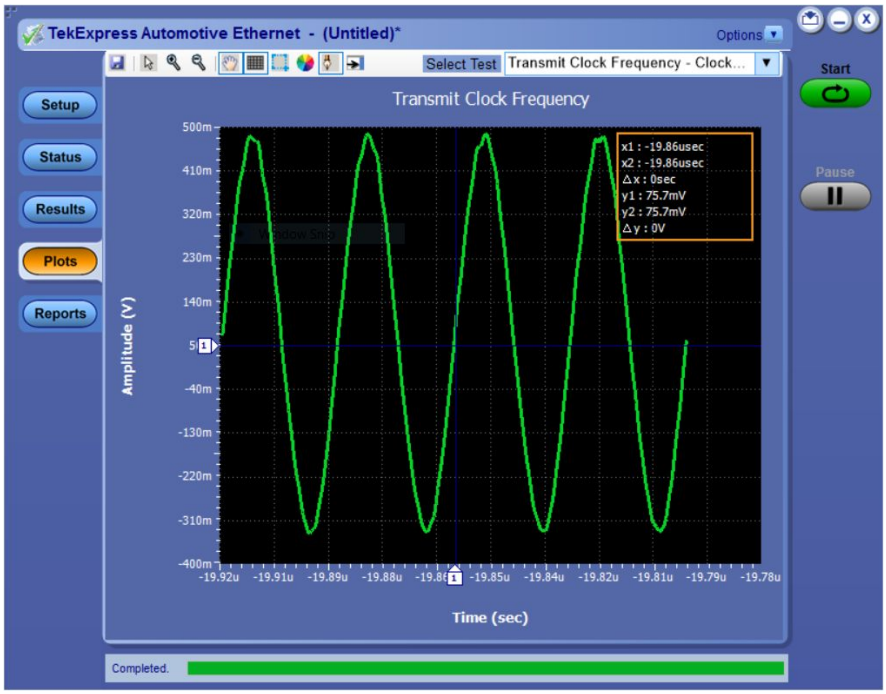


Figure 17: Transmit Clock Frequency - 100Base-T1

Transmitter Timing Jitter (Master and Slave)

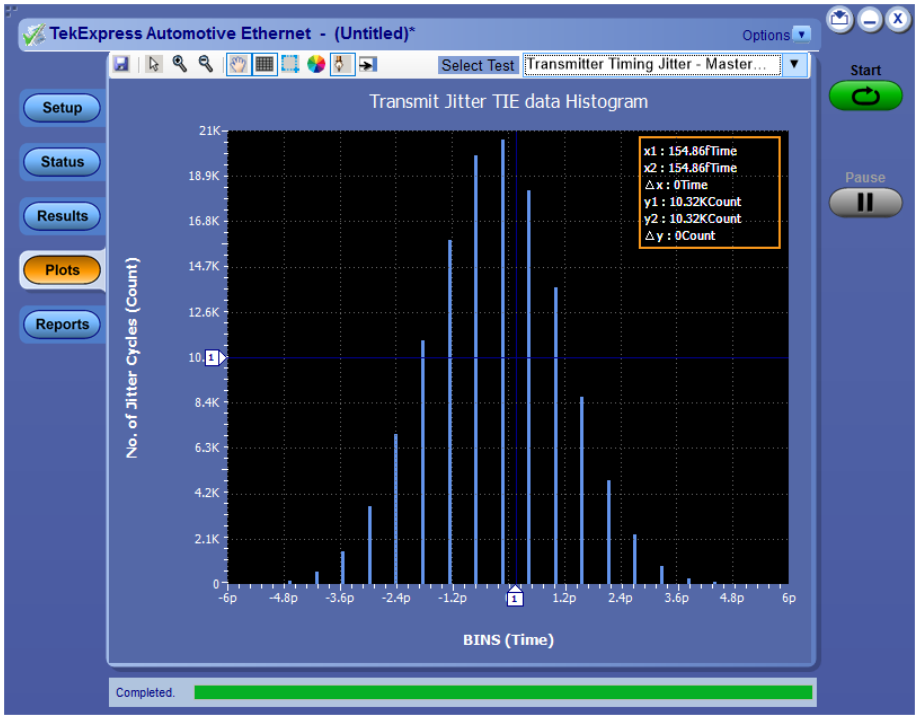


Figure 18: Master Jitter - 1000Base-T1 Histogram plot

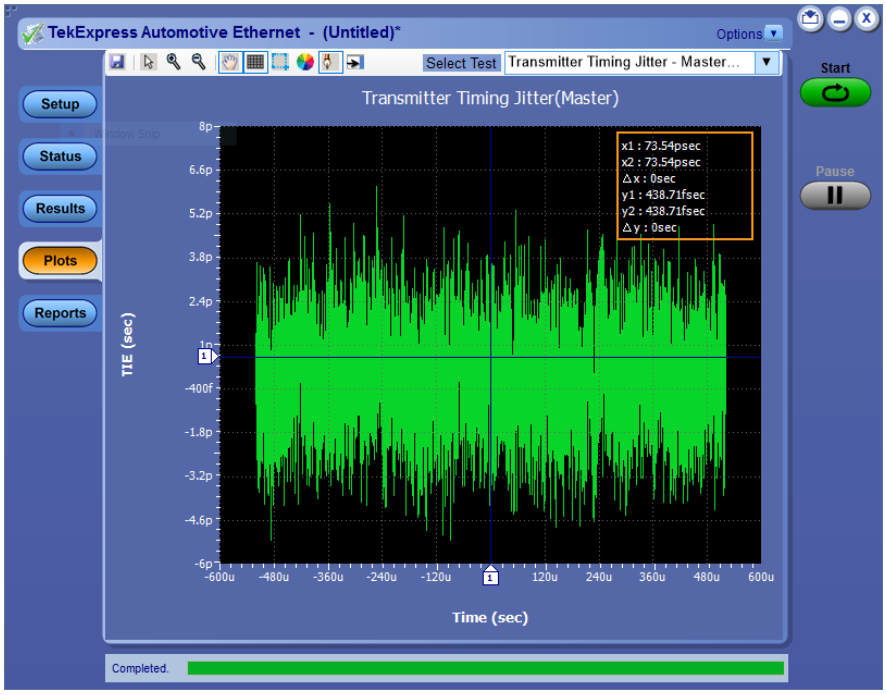


Figure 19: Master Jitter - 1000Base-T1

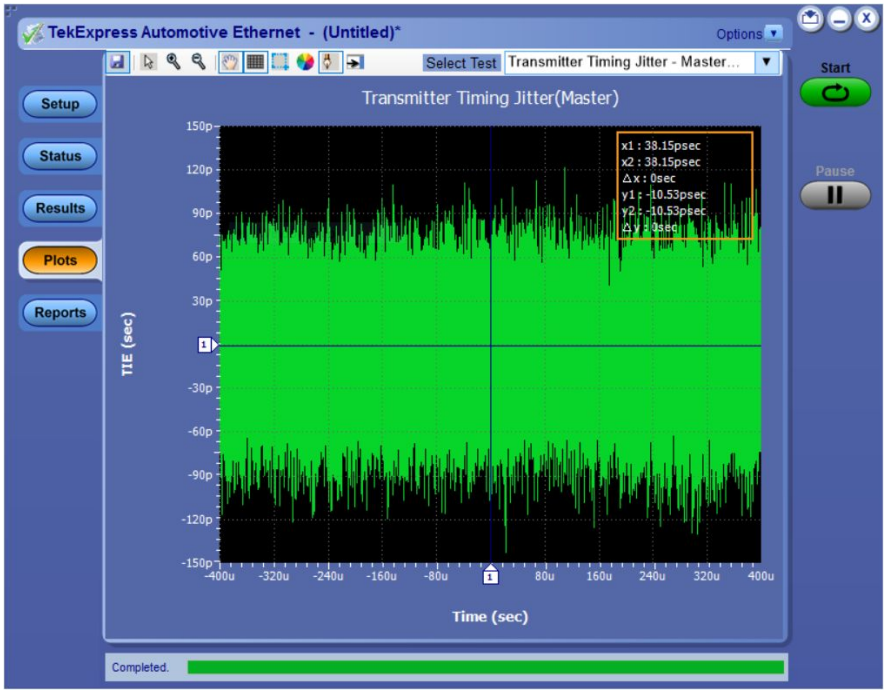


Figure 20: Master Jitter - 100Base-T1

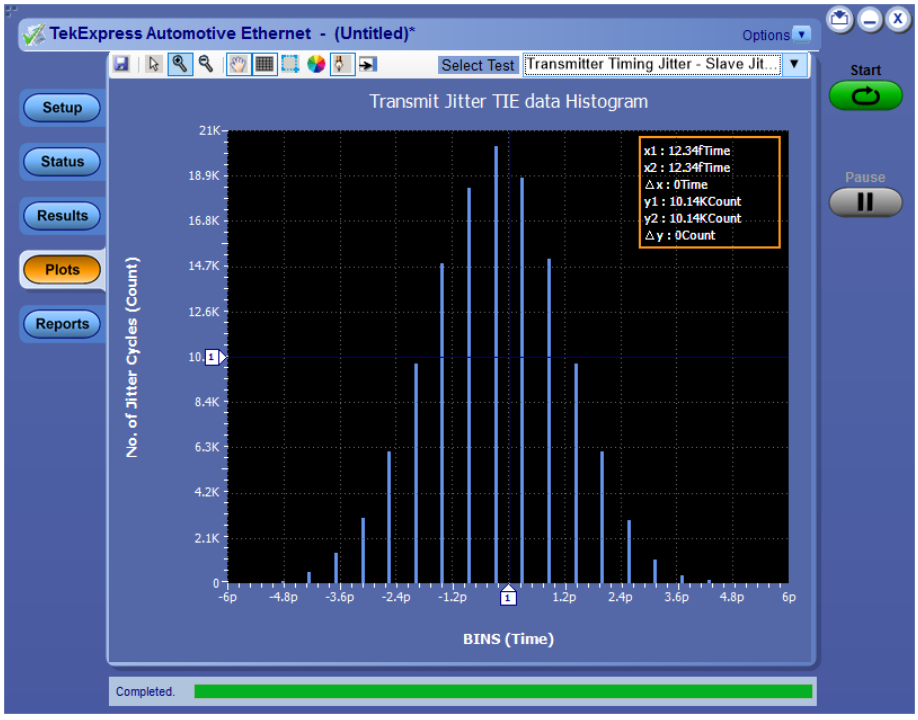


Figure 21: Slave Jitter - 1000Base-T1 Slave Histogram plot

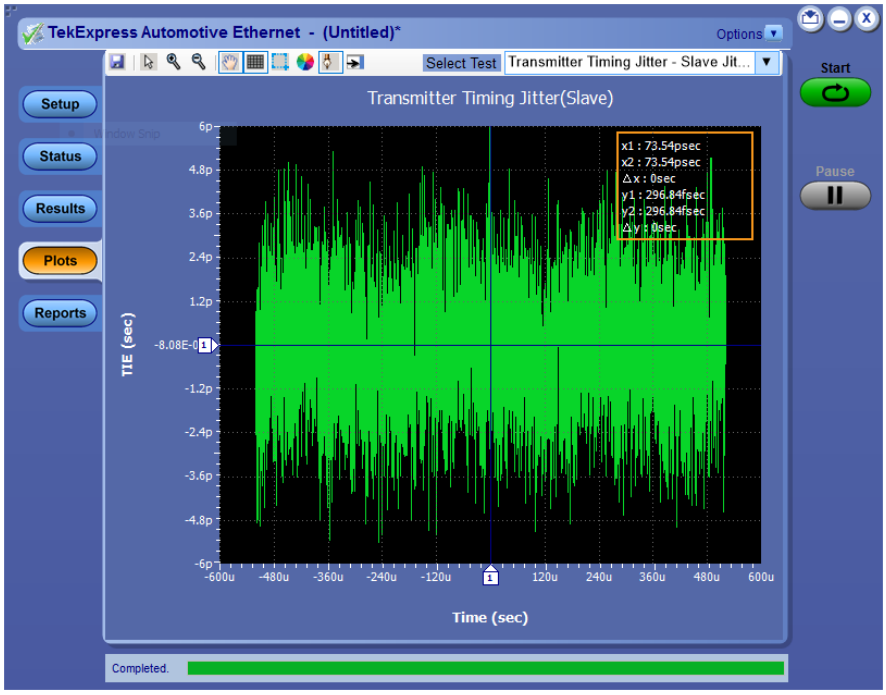


Figure 22: Slave Jitter - 1000Base-T1

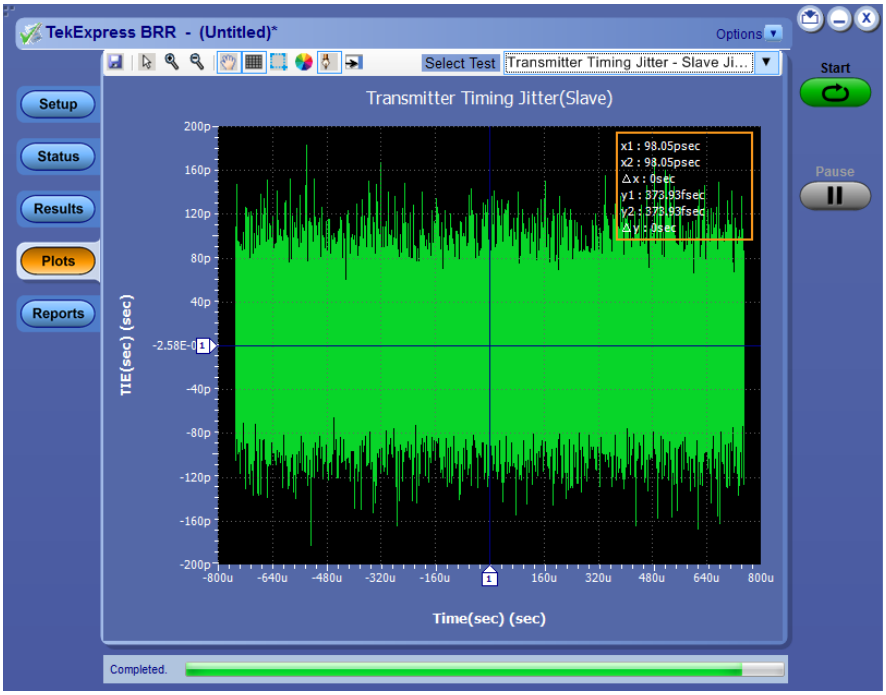


Figure 23: Slave Jitter - 100Base-T1

Transmitter Output Droop

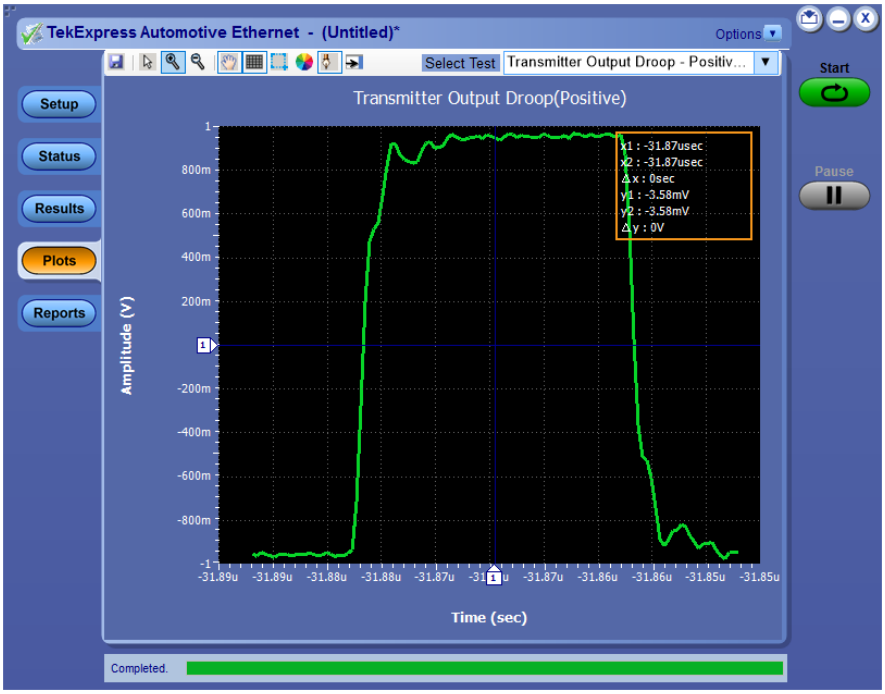


Figure 24: Transmitter Output Droop - 1000Base-T1: Positive

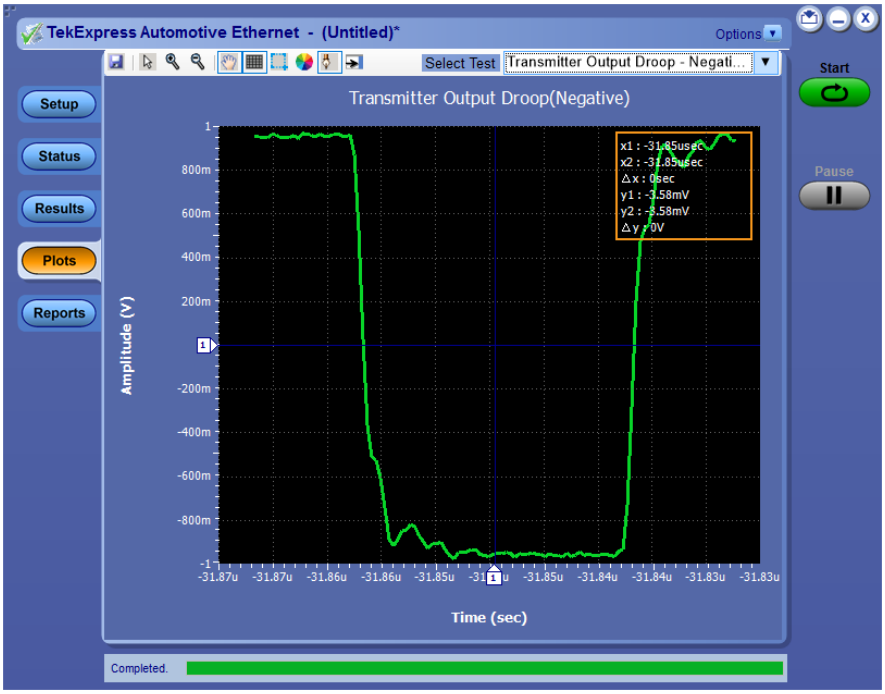


Figure 25: Transmitter Output Droop - 1000Base-T1: Negative

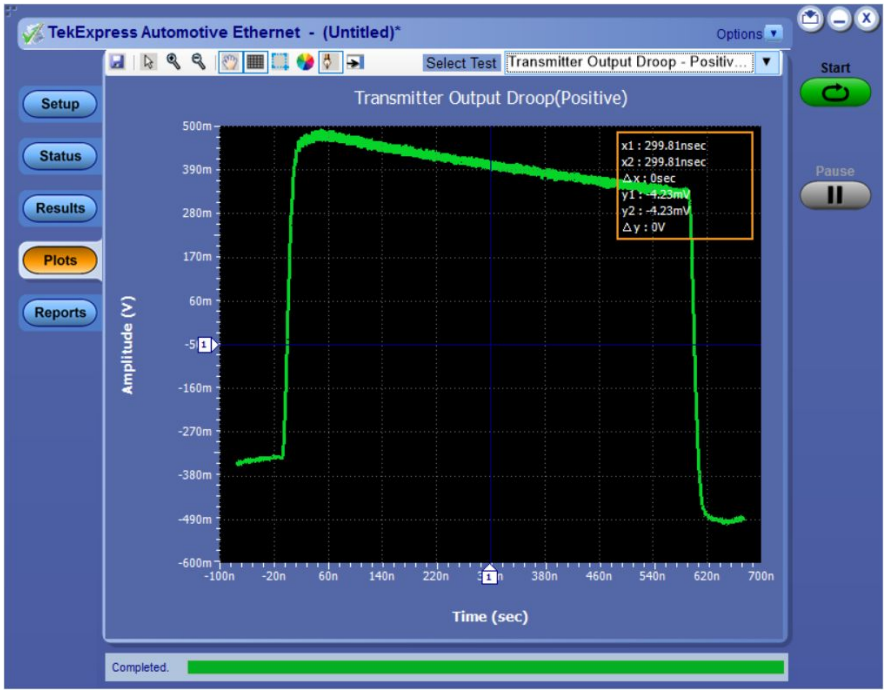


Figure 26: Transmitter Output Droop - 100Base-T1: Positive

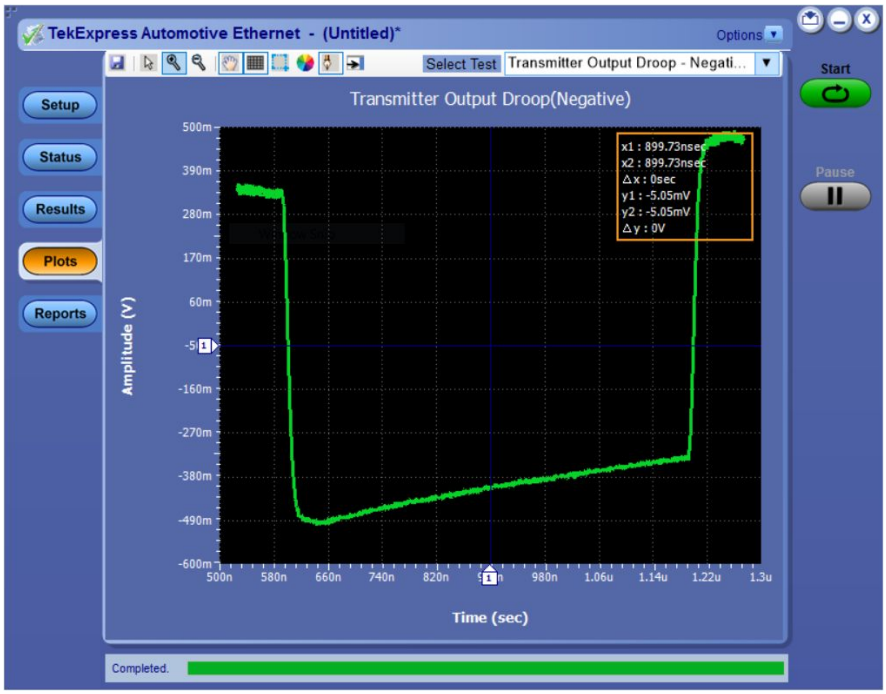


Figure 27: Transmitter Output Droop - 100Base-T1: Negative

Transmitter Power Spectral Density

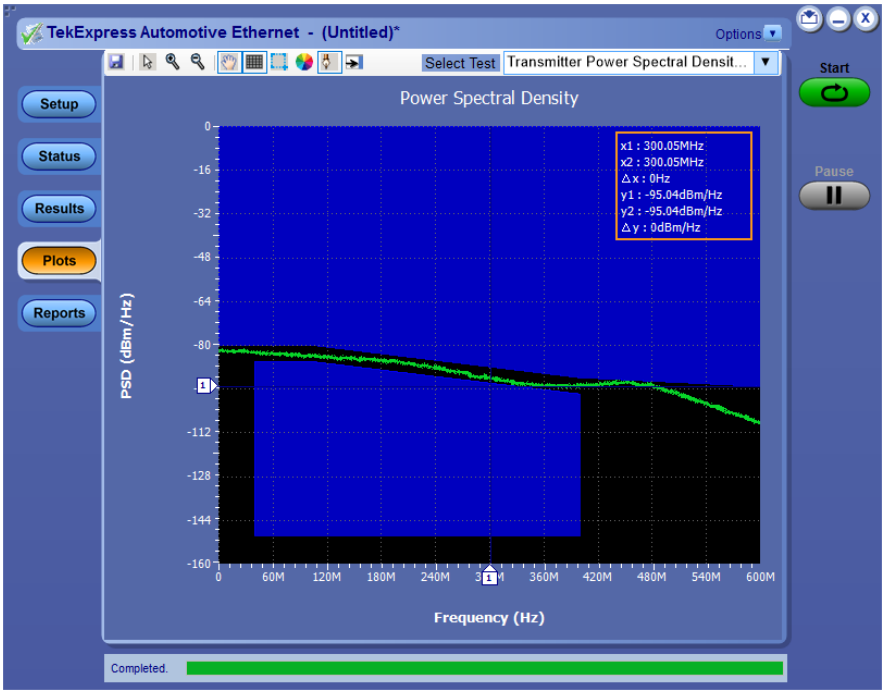


Figure 28: Transmitter Power Spectral Density and Power Level - 1000Base-T1

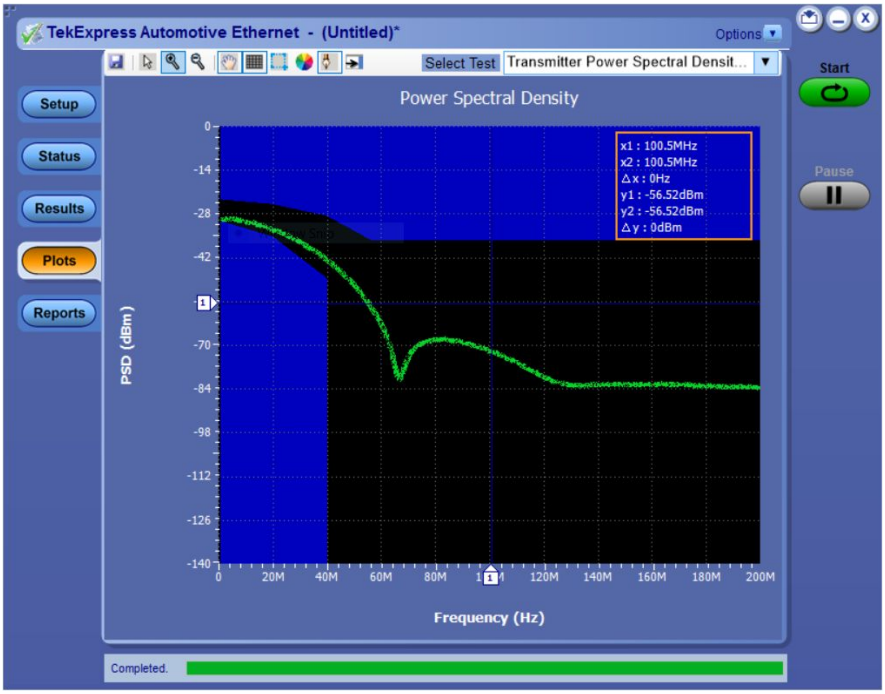


Figure 29: Transmitter Power Spectral Density - 100Base-T1

Transmitter Distortion

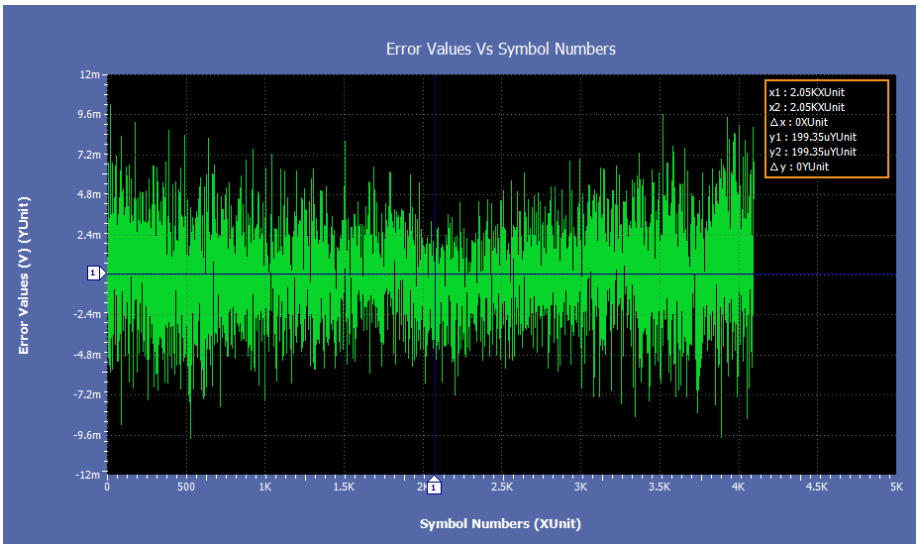


Figure 30: Error Value - 1000Base-T1

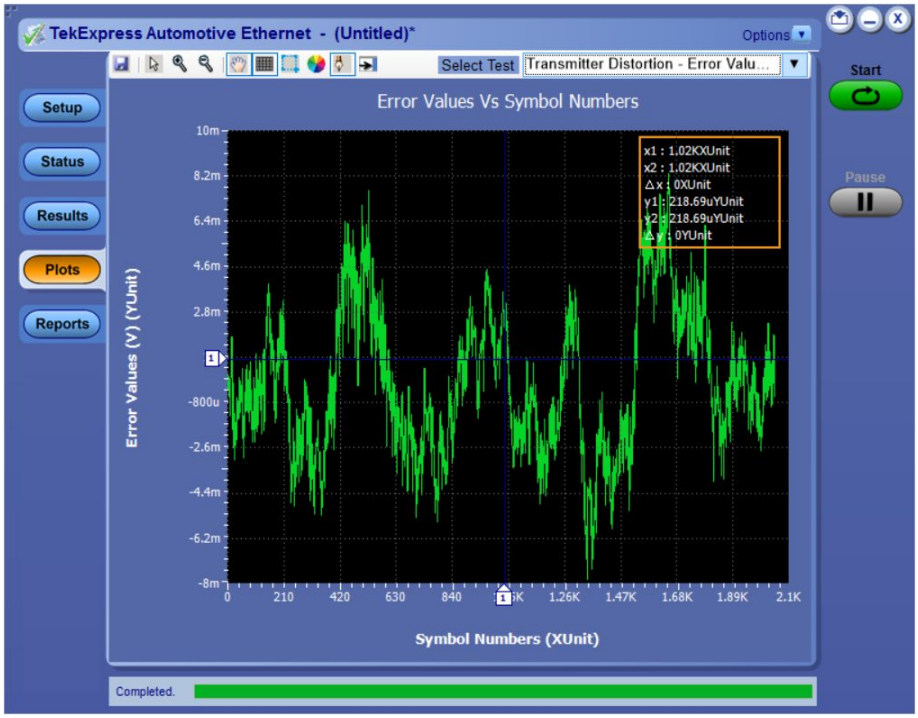


Figure 31: Error Value - 100Base-T1

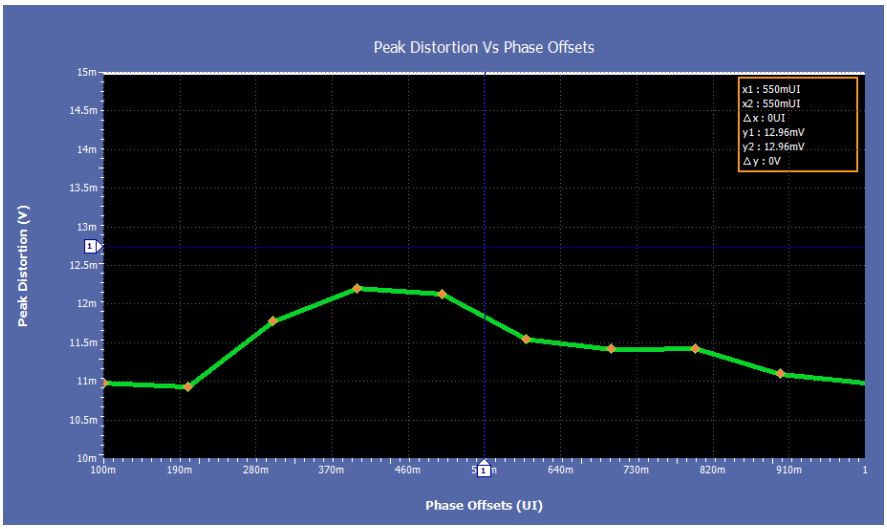


Figure 32: Peak Distortion - 1000Base-T1

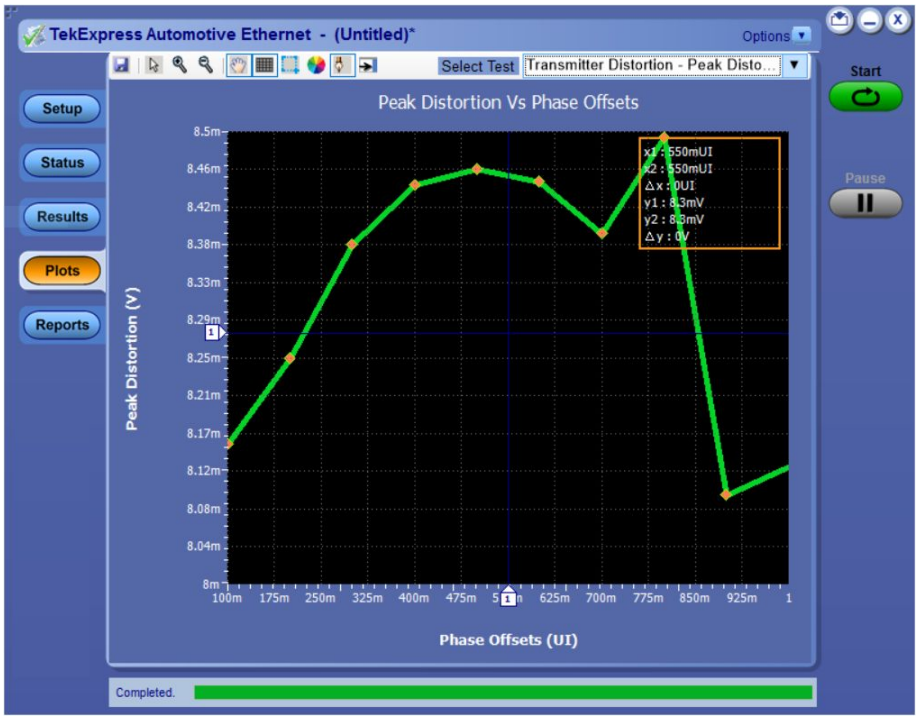


Figure 33: Peak Distortion - 100Base-T1

Return Loss

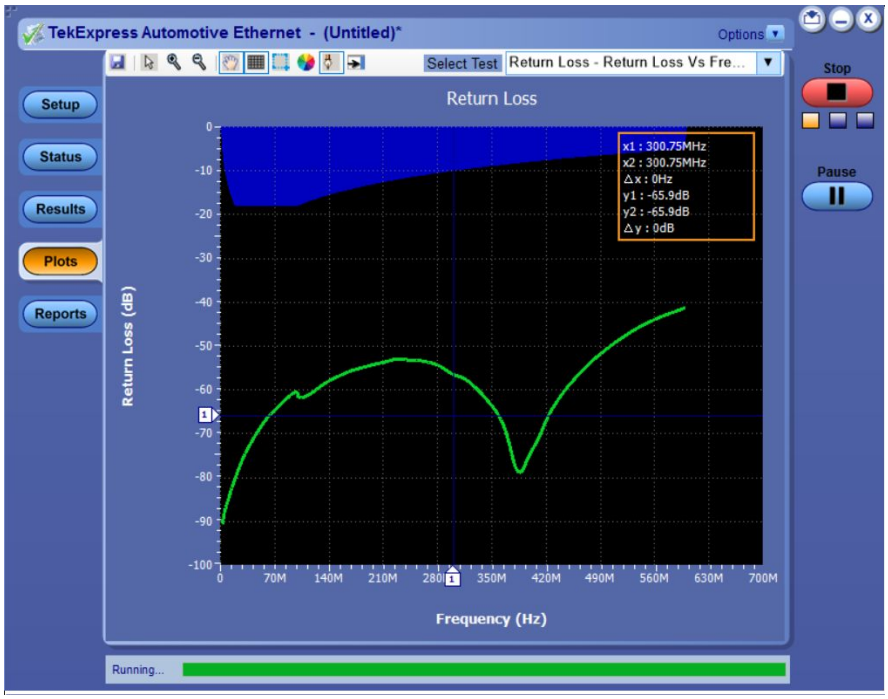


Figure 34: Return Loss - 1000Base-T1

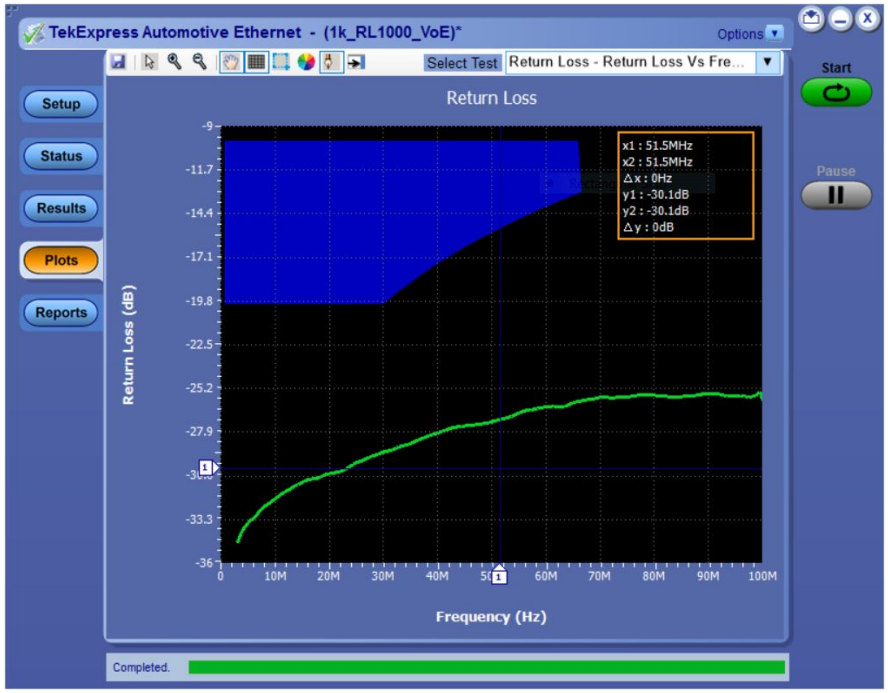


Figure 35: Return Loss - 100Base-T1

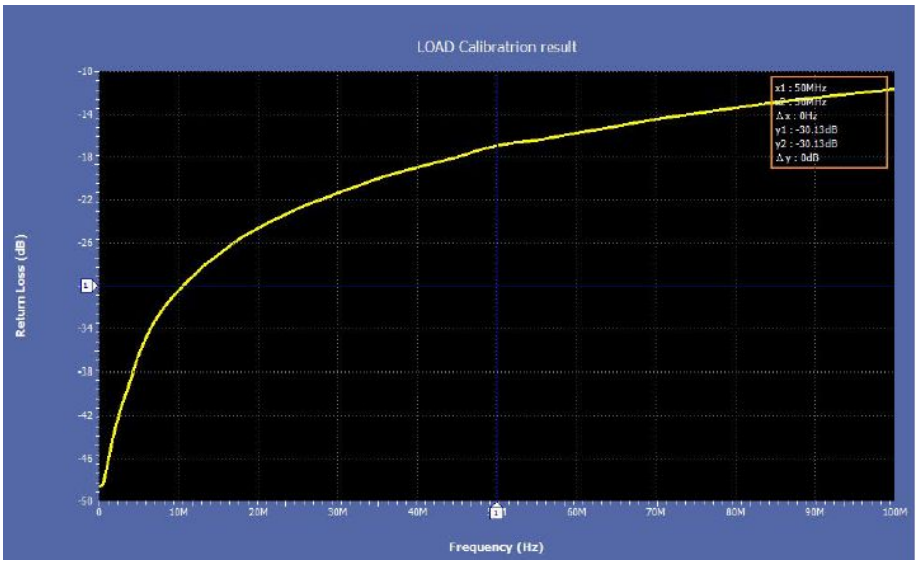


Figure 36: 100Base-T1 Return Loss Load Calibration

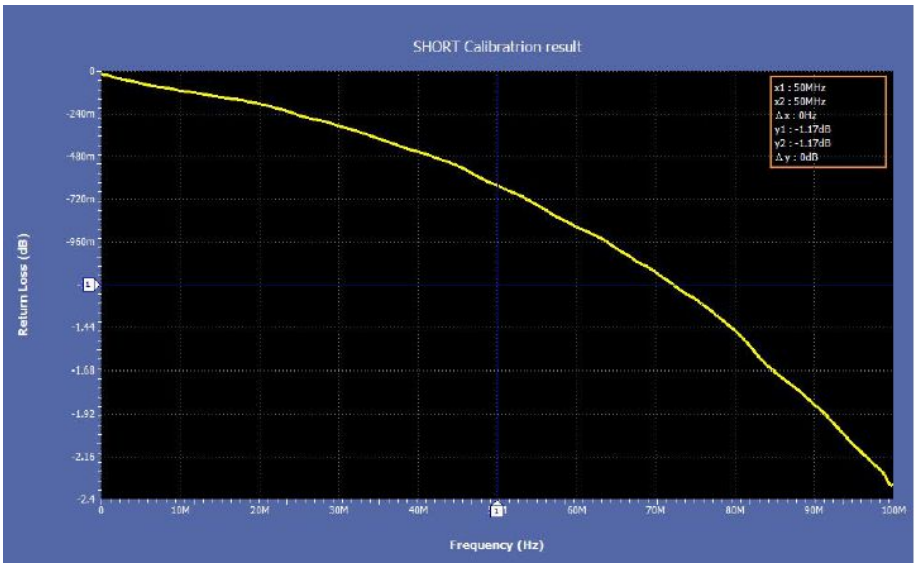


Figure 37: 100Base-T1 Return Loss Short Calibration

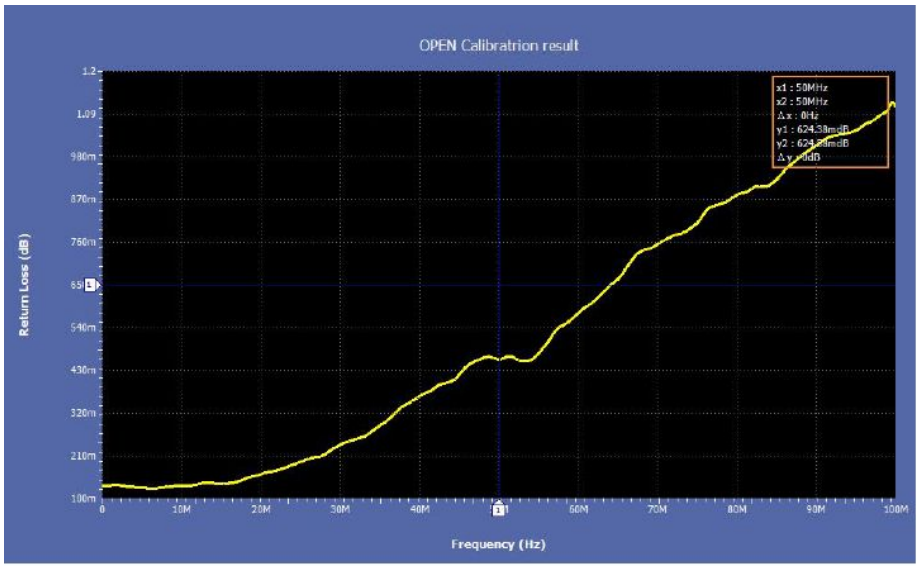


Figure 38: 100Base-T1 Return Loss Open Calibration

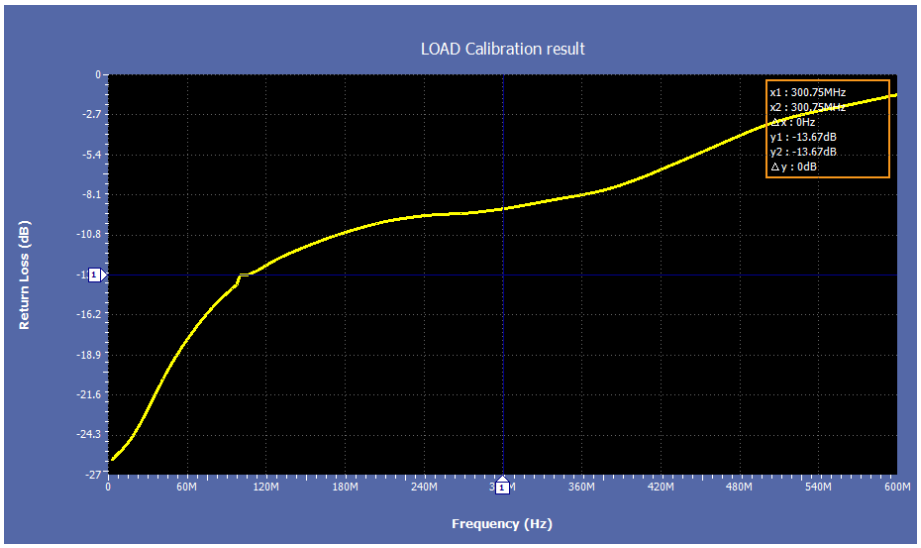


Figure 39: 1000Base-T1 Return Loss Load Calibration

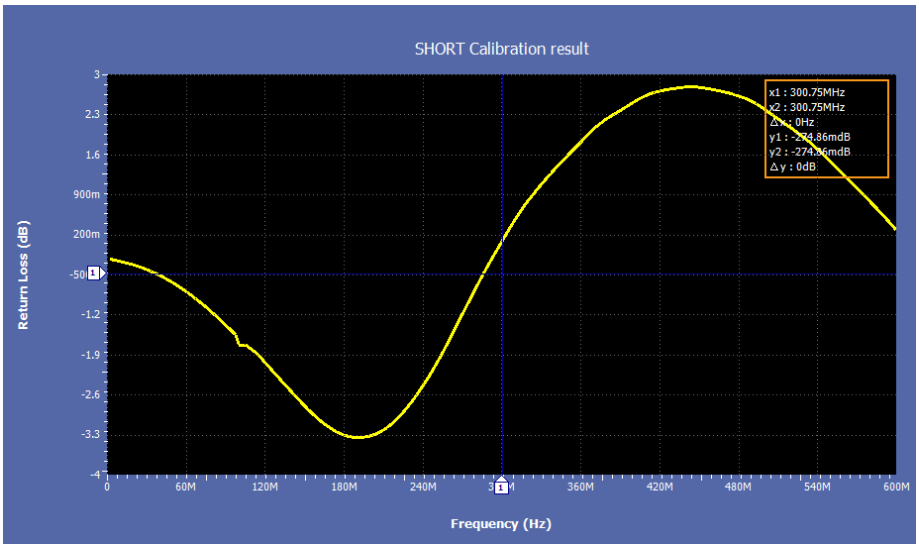


Figure 40: 1000Base-T1 Return Loss Short Calibration

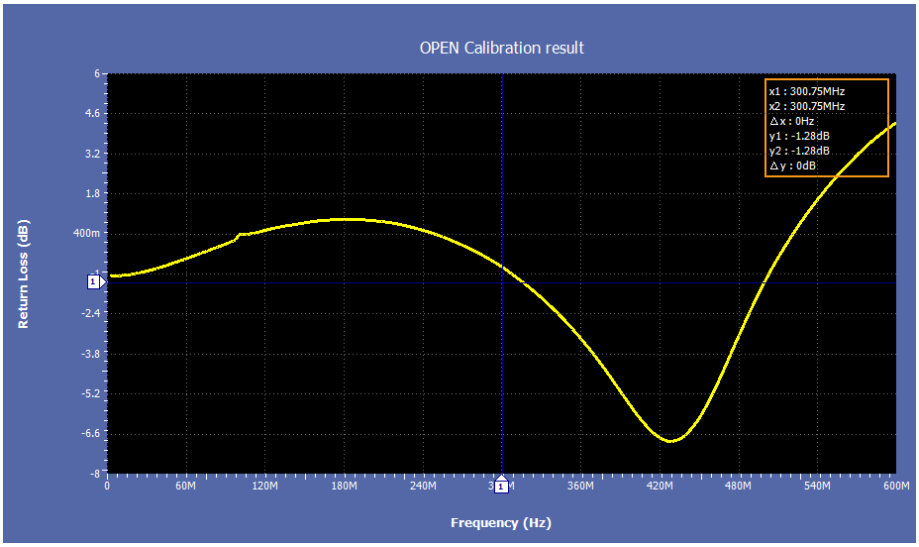


Figure 41: 1000Base-T1 Return Loss Open Calibration

See also. *Known limitations*

Reports panel

Reports panel overview

Use the Reports panel to browse for reports, name and save reports, select test content to include in reports, and select report viewing options.

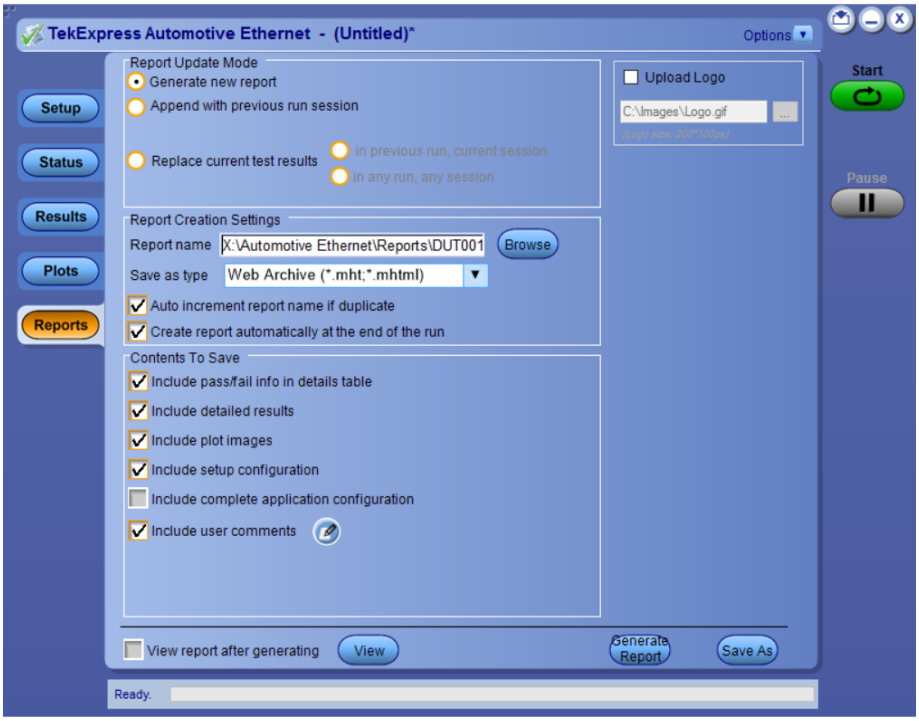


Figure 42: Reports panel

For information on setting up reports, see *Select report options*. For information on viewing reports, see *View a report*.

Report contents

A report shows detailed results and plots, as set in the Reports panel.

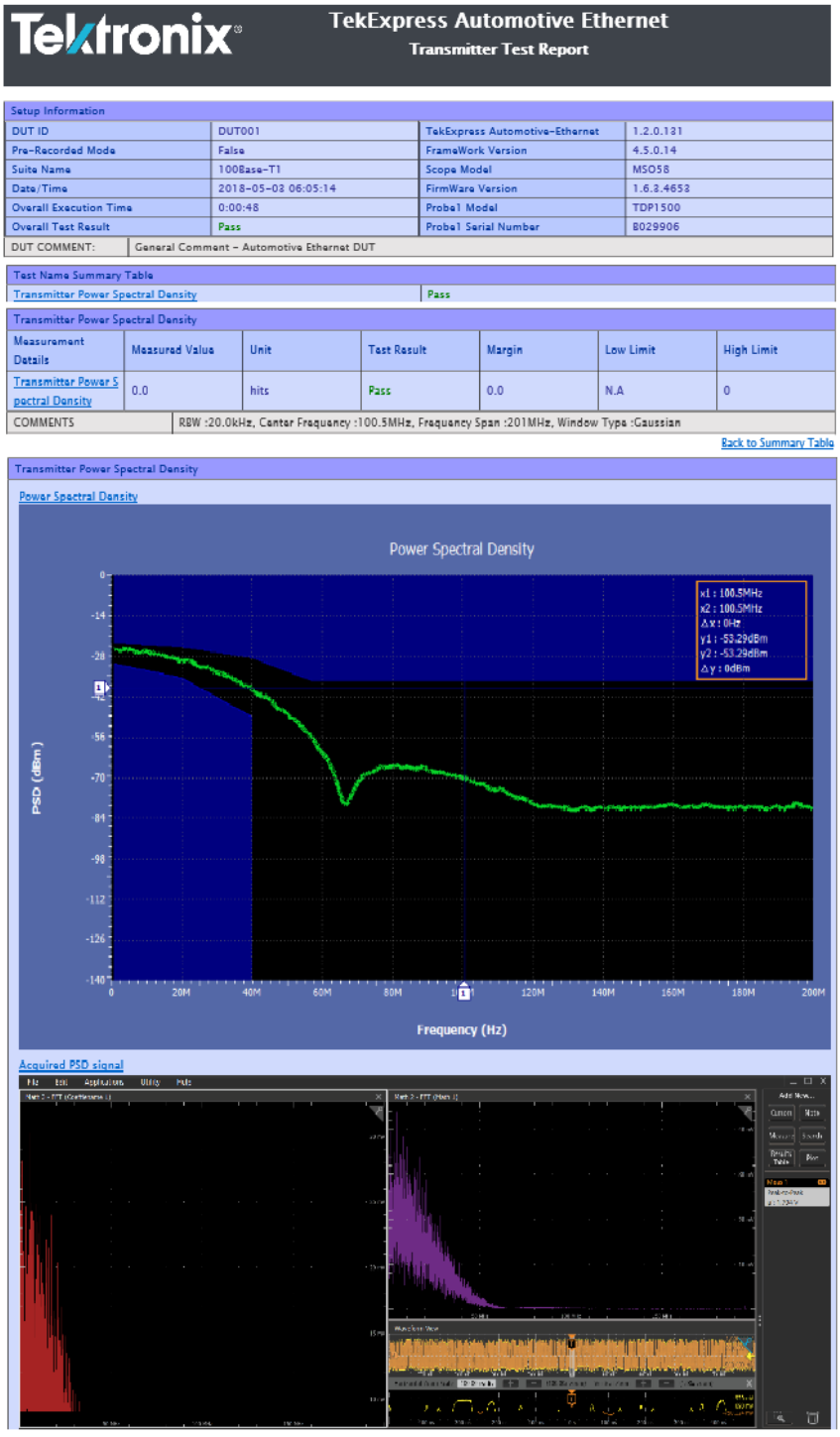


Figure 43: Example report for single run

Tektronix

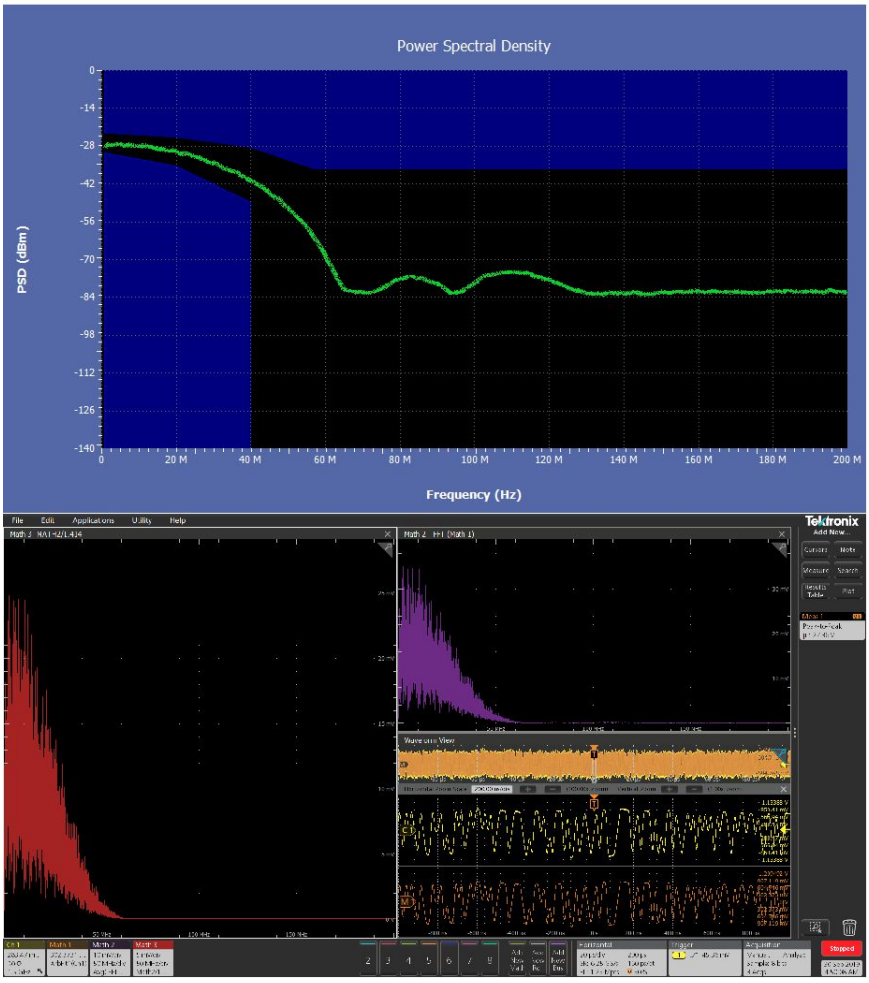
TekExpress Automotive Ethernet
Transmitter Test Report

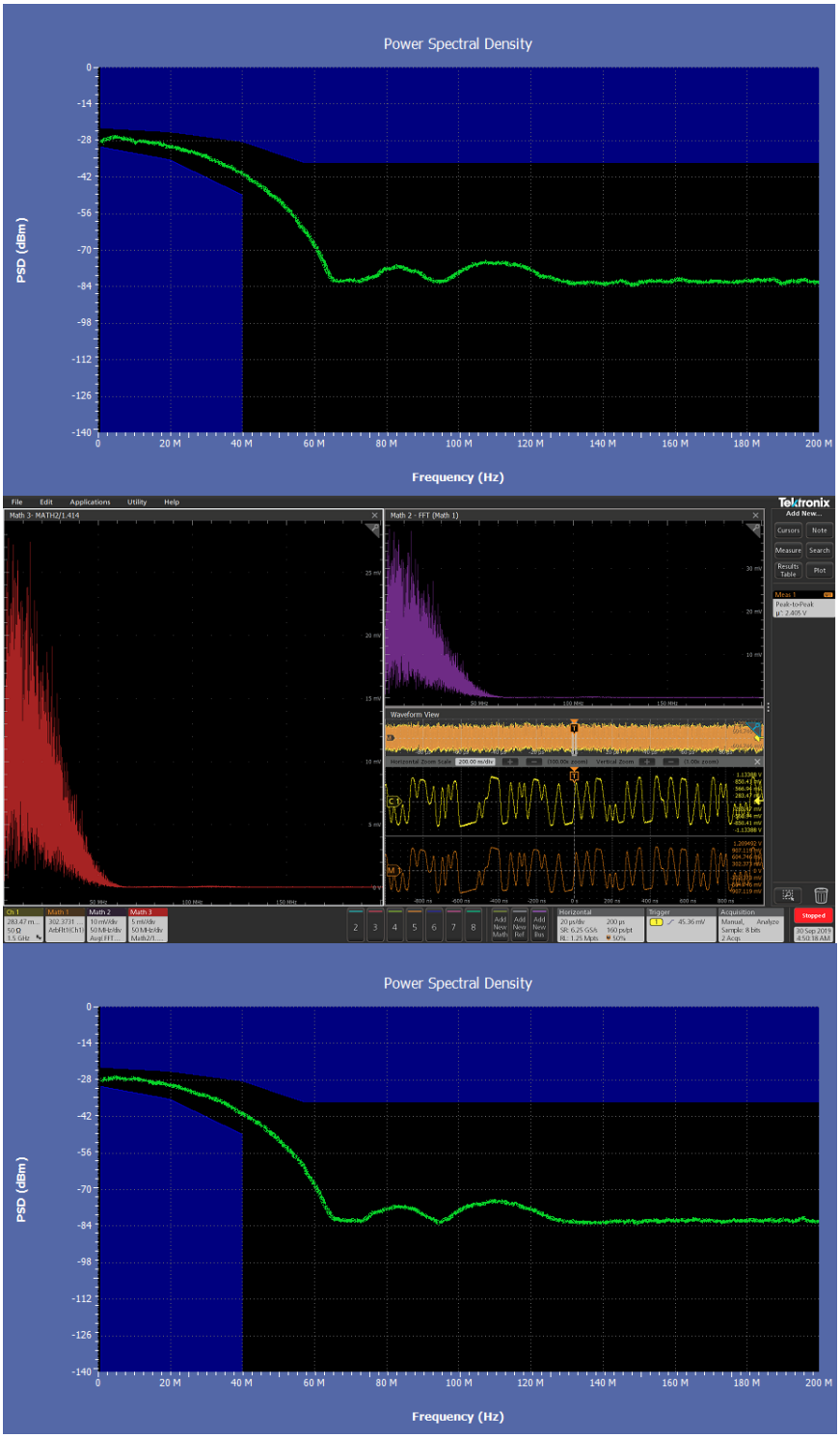
Setup Information			
DUT ID	DUT001	TekExpress Automotive-Ethernet	1.2.9.39 (Code drop)
Date/Time	2019-09-30 04:49:04	FrameWork Version	4.13.0.1
Pre-Recorded Mode	False	Scope Model	MSO58
Suite Name	100Base-T1	FirmWare Version	1.22.1.7166
Overall Execution Time	0:01:32	Probe1 Model	TDP1500
Overall Test Result	Pass	Probe1 Serial Number	B029639
DUT COMMENT:	General Comment - Automotive Ethernet DUT		

Test Name Summary Table	
Transmitter Power Spectral Density	Pass

Transmitter Power Spectral Density						
Measurement Details	Measured Value	Unit	Test Result	Margin	Low Limit	High Limit
Transmitter Power Spectral Density_Run 1	0.0	hits	Pass	0.0	N.A	0
Transmitter Power Spectral Density_Run 2	0.0	hits	Pass	0.0	N.A	0
Transmitter Power Spectral Density_Run 3	0.0	hits	Pass	0.0	N.A	0
COMMENTS	RBW :10.0kHz, Center Frequency :100.5MHz, Frequency Span :201MHz, Window Type :Gaussian					

Back to Summary Table




Power Spectral Density
PSD (dBm)
Frequency (Hz)
Power Spectral Density
PSD (dBm)
Frequency (Hz)

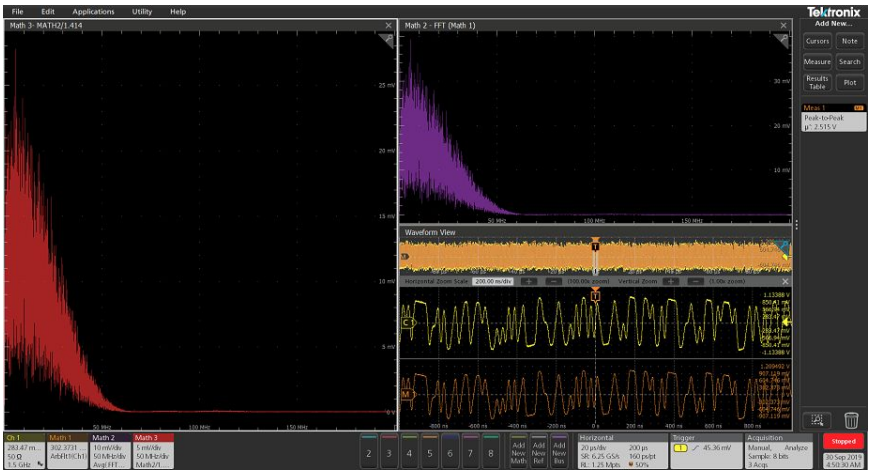


Figure 44: Example report for multi-run

Setup configuration information

The summary box at the beginning of the report lists setup configuration information. This information includes the oscilloscope model and serial number, optical module model and serial number, and software version numbers of all associated applications.

To exclude this information from a report, clear the **Include Setup Configuration** check box in the Reports panel before running the test.

User comments

If you selected to include comments in the test report, any comments you added in the DUT tab are shown at the top of the report.

See also. *Results panel*

View test-related files

Select report options

Click the **Reports** button and use the Reports panel controls to select which test result information to include in the report, and the naming conventions to use for the report. For example, always give the report a unique name or select to have the same name increment each time you run a particular test.

Select report options before running a test or when creating and saving test setups. Report settings are included in saved test setups.

In the Reports panel, select from the following report options:

Table 21: Report options

Setting	Description
Report Update Mode	
Generate new report	Creates a new report. The report can be in either .mht or .pdf or .csv file formats.

Setting	Description
Append with previous run session	Appends the latest test results to the end of the current test results report.
Replace current test in previous run session	Replaces the previous test results with the latest test results. Results from newly added tests are appended to the end of the report.
Report Creation Settings	
Report name	Displays the name and location from which to open a Ethernet Tx report. The default location is at *\My TekExpress\Automotive Ethernet \Untitled Session*. The report file in this folder gets overwritten each time you run a test unless you specify a unique name or select to auto increment the report name. Change the report name or location. Do one of the following: ■ In the Report Path field, type over the current folder path and name. ■ Double-click in the Report Path field and then make selections from the popup keyboard and click the **Enter** button. Be sure to include the entire folder path, the file name, and the file extension. For example: C:\Documents and Settings\your user name\My Documents\My TekExpress\Automotive Ethernet \DUT001.mht. ***NOTE.*** *You cannot set the file location using the Browse button.* Open an existing report. Click **Browse**, locate and select the report file and then click **View** at the bottom of the panel.
Save as type	Saves a report in the specified file type, selected from the drop-down list. ***NOTE.*** *If you select a file type different from the default, be sure to change the report file name extension in the Report Name field to match.*
Auto increment report name if duplicate	Sets the application to automatically increment the name of the report file if the application finds a file with the same name as the one being generated. For example: DUT001, DUT002, DUT003. This option is enabled by default.
Create report automatically at the end of the run	Creates report at the end of the run.
Contents To Save	

Setting	Description
Include pass/fail info in details table	Includes pass/fail info in the details table of the report.
Include detailed results	Includes detailed results in the report.
Include plot images	Includes plot images in the report.
Include setup configuration	Sets the application to include hardware and software information in the summary box at the top of the report. Information includes: the oscilloscope model and serial number, the oscilloscope firmware version, and software versions for applications used in the measurements.
Include complete application configuration	Includes complete application configuration in the report.
Include user comments	Select to include any comments about the test that you or another user added in the DUT tab of the Setup panel. Comments appear in the Comments section, under the summary box at the beginning of each report.
Group Report By	
Test Name	Select to group the tests in the report by test name.
Test Result	Select to group the tests in the report by test results
View report after generating	Automatically opens the report in a Web browser when the test completes. This option is selected by default.
View	Click to view the most current report.
Generate Report	Generates a new report based on the current analysis results.
Save As	Specify a name for the report.

View a report

The application automatically generates a report when test analysis is completed and displays the report in your default Web browser (unless you cleared the **View Report After Generating** check box in the Reports panel before running the test). If you cleared this check box, or to view a different test report, do the following:

1. Click the **Reports** button.
2. Click the **Browse** button and locate and select the report file to view.
3. In the Reports panel, click **View**.

For information on changing the file type, file name, and other report options, see *Select report options*.

Running tests

Automate AWG/AFG signal generation

The TekExpress Automotive Ethernet application allows you to automatically load the pattern files in AWG/AFG and generate the signals. Ensure that the GPIB/LAN/USB connection between the oscilloscope and AWG/AFG is established, before you automate the signal generation. The AWG/AFG automation is supported for the following measurements:

- *Transmitter Distortion with disturbing signal*: AWG/AFG is used to transmit a disturbing signal. CH1 and CH1_inverted are used.
- *Return Loss measurement and calibration*: AWG/AFG is used to transmit a wide band signal. CH1 and CH1_inverted are used for transmission of the signal. A marker signal has to be connected to the auxiliary channel of the oscilloscope (used as trigger source).

How to automate AWG/AFG signal generation

Complete the following steps in the TekExpress application to automate the signal generation from AWG/AFG:

1. Click in the upper right corner of the application and select **Instrument Control Settings**.
2. Select Search Criteria as USB and click **Refresh**; when the Retrieved Instruments table is uploaded with the connected instruments list, click **Close**.

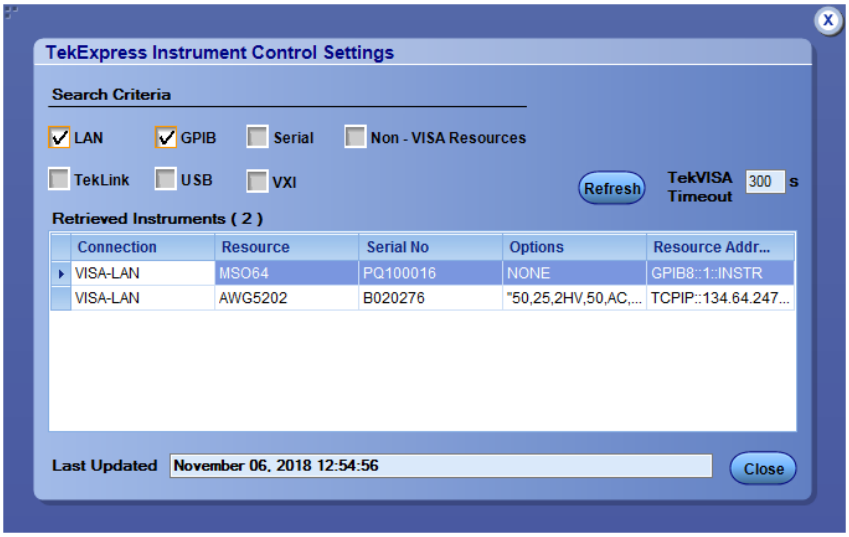


Figure 45: Instrument Control Settings

3. Once the AWG/AFG is listed as shown above, go to the Global Settings tab from the Configuration menu of the Tests. If the AWG/AFG is supported, it will be listed as a drop-down menu option next to the Automate with AWG/AFG label. By default, the application will consider the connected AWG to be used for automation.

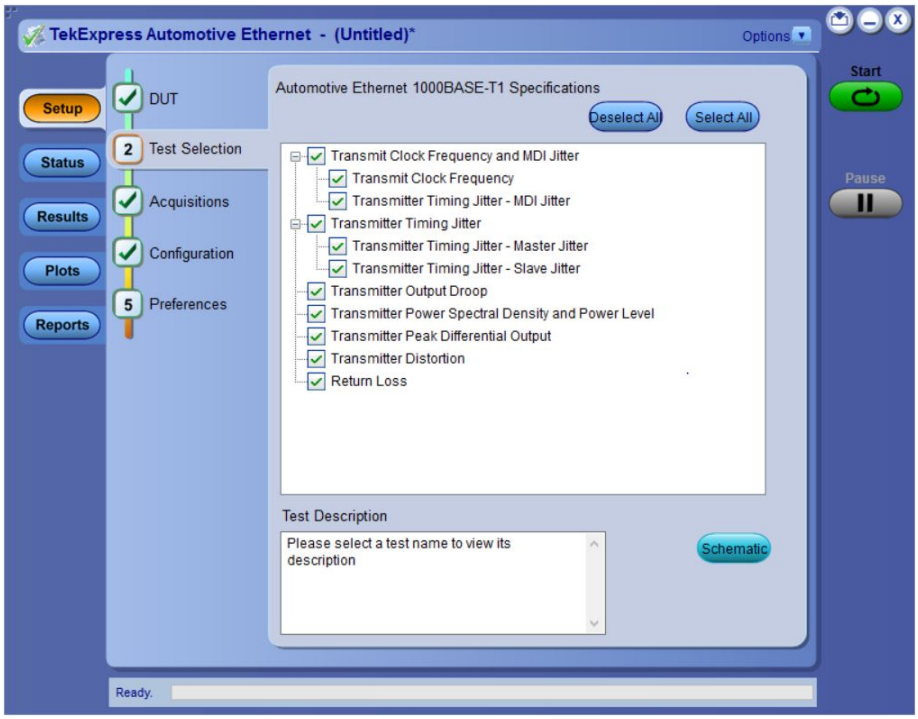


Figure 46: Test Selection tab

NOTE. *If Automate with AWG/AFG is set as Do not use, you must manually copy the AWG/AFG waveforms from the oscilloscope to the AWG/AFG. Waveforms are located at C:\Program Files\Tektronix\TekExpress\TekExpress Automotive-Ethernet\AWG Waveforms\.*

Before you click start

Before running a test for the first time

Before you run a test for the first time, review these steps:

1. Understand where your test files are stored on the instrument.

After you install and launch TekExpress Automotive Ethernet, it creates the following folders on the Oscilloscope:

- \Program Files\Tektronix\TekExpress\TekExpress Automotive-Ethernet
- \My Documents\My TekExpress\Automotive Ethernet
- \My Documents\My TekExpress\Automotive Ethernet\Untitled Session

  Every time you launch TekExpress Automotive Ethernet.exe, an Untitled Session folder is created in the Automotive Ethernet folder. The Untitled Session folder is automatically deleted when you exit the Automotive Ethernet application.

CAUTION. *Do not modify any of the session files or folders because this may result in loss of data or corrupted session files. Each session has multiple files associated with it. When you save a session, a .TekX file, and a folder named for the session that contains the associated files, is created on the oscilloscope X: drive.*

2. Ensure that the **My TekExpress** folder has read and write access, and that the contents are not set to be encrypted:

a. Right-click the folder and select Properties.

b. Select the General tab, and then click Advanced.

c. In the Advanced Attributes dialog box, ensure that the option Encrypt contents to secure data is NOT selected.

Example:

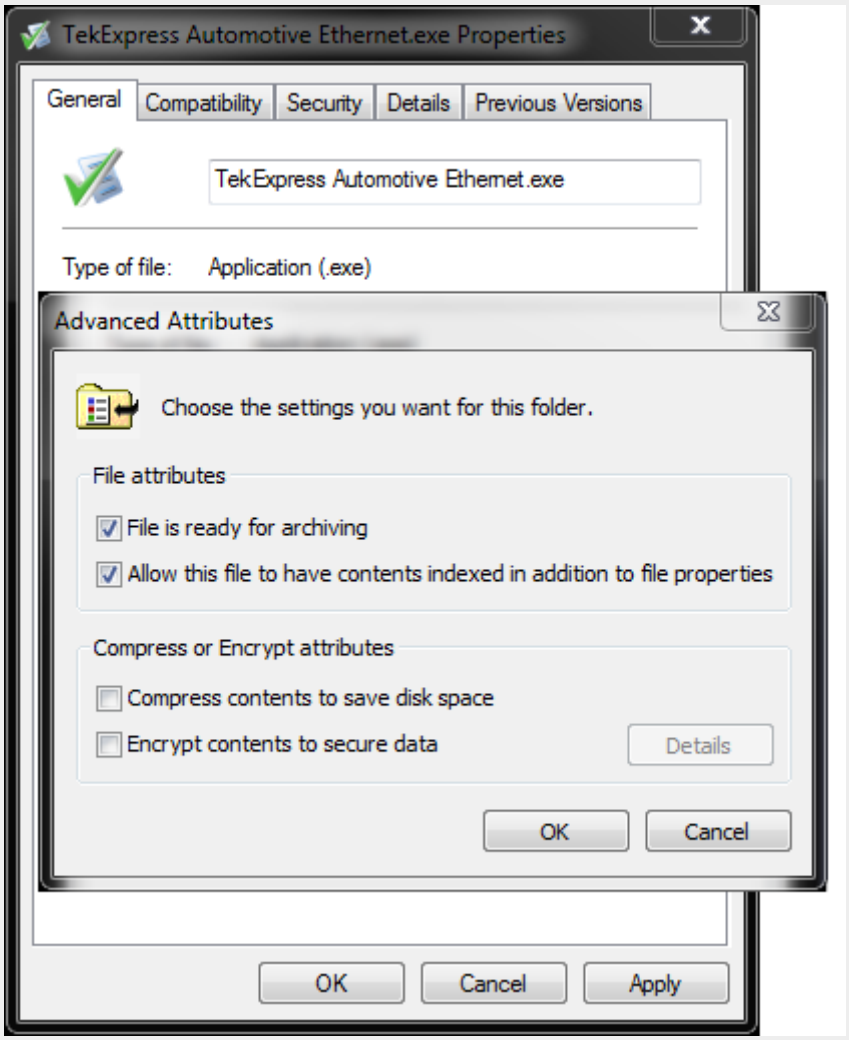


Figure 47: Advanced Attributes dialog box

Before running any test

1. Review the *Pre-run check list*.
2. Configure the *Email notification options* if you want the application to notify you by email when a test completes or produces an error. Access the email options either from the Options menu in the upper right corner, or from the Preferences tab on the Setup panel.
3. Select the Report options.

See Also

Pre-run check list

Pre-run check list

Do the following before you click **Start** to run a test. If this is the first time you are running a test on a setup, then refer also to the guidelines above.

1. Ensure that all the required instruments are properly warmed up (about 20 minutes).
2. Perform the Signal Path Compensation (SPC).

   a. On the oscilloscope main menu, select the **Utilities** menu.

   b. Select **Instrument Calibration**.

3. Deskew any cables.
4. Ensure that the application is able to find the DUT. If it cannot, *perform a search for connected instruments*.

   To find the DUT:

   a. Launch the TekExpress Automotive Ethernet application.

   b. Select the **Setup** panel and then click the **DUT** tab.

   c. Click the **Test Selection** tab. Select any test, and then click **Configure** button.

   d. In the Configuration section, click **Global Settings**.

   e. In the Instruments Detected section, click in the shaded area opposite Real Time Scope and ensure that the oscilloscope with the (GPIB8::1::INSTR) designation is in the drop-down list.

See also

Before you click start

Configure email notification

Running the tests and viewing their progress

Running the tests and viewing their progress: the Status panel

Once you have configured the tests and gone through the *Pre-run check list*, from any screen, click the green **Start** button. The application acquires and analyzes the data, then displays a report when the tests are completed.

While the tests are running, other applications may display windows in the background. The TekScope application takes precedence over other applications, but you can switch to other applications using the Alt+Tab key combination. To keep the TekExpress Automotive Ethernet application on top, select the **Keep On Top** from the Options menu in the upper right corner.

Viewing the progress of analysis

The Status panel displays a record of the test as it is executed. By default, the application switches to this panel after you click the **Start** button to run a test. You can choose from the following two views by selecting the named tab, even while a test is in progress:

Test Status tab

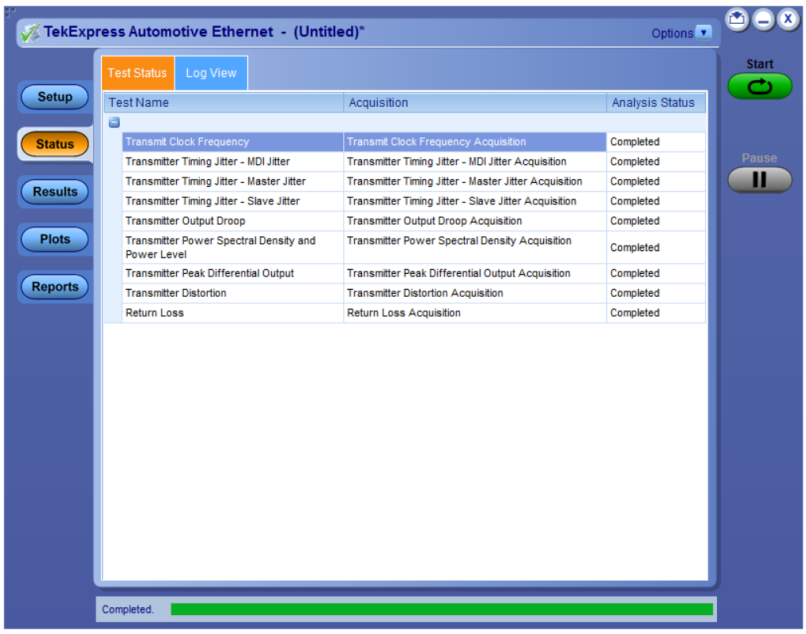


Figure 48: Test status tab

The Test Status tab presents a collapsible table with information about each test as it is running. To collapse and expand the table rows, click the expand (+)/(−) collapse button.

Table 22: Test Status table headers

Column	Description
Test Name	Name of the test
Acquisition	Describes the type of data being acquired
Acquire Status	Progress of the acquisition: ■ To be started ■ Started Acquisition ■ Completed Acquisition
Analysis Status	Progress state of the analysis: ■ To be started ■ In Progress ■ Completed ■ Aborted ■ Skipped

Log View tab

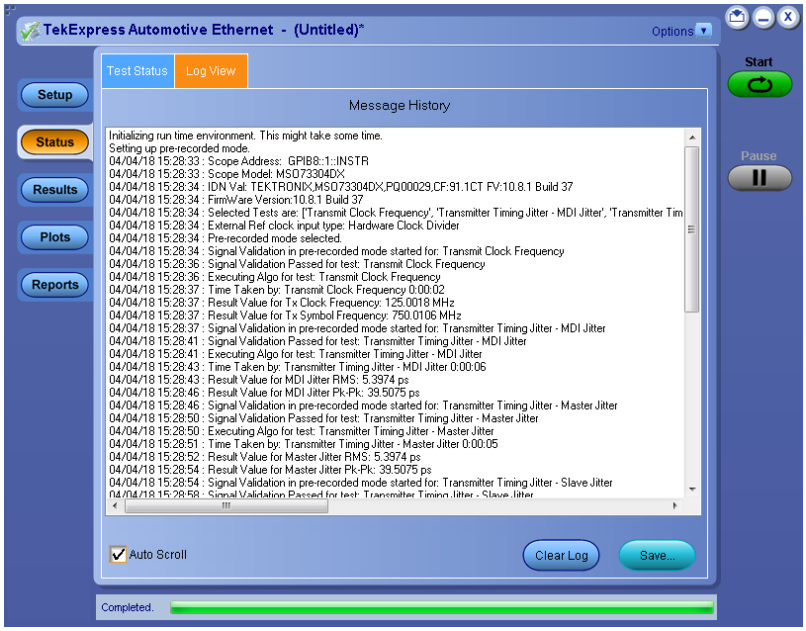


Figure 49: Log view

The Log View tab provides a list of actions that happen as the test executes. You can use this tab to review or troubleshoot tests.

Table 23: Log view options

Item	Description
Message History	This window time-stamps and displays all run messages.
Auto Scroll	Select this check box to have the program automatically scroll down as information is added to the log during test execution.
Clear Log	Click this button to clear all messages in the Message History area.
Save	Use to save the log file as a text file for examination. Displays a standard Save File window and saves the status messages file that you specify.

See also

Before you click start

Pre-run check list

Configure email notification

Saving and recalling test setups

About saving and recalling test setups

TekExpress Automotive Ethernet application opens with the default test setup selected. Any time you want to create a new test setup, you can select the default test setup to clear the previous test setup selections and take the settings back to their defaults.

You can run a test before or after saving a setup. When you save a setup, the selected oscilloscope, general parameters, acquisition parameters, measurement limits, prerecorded waveform files (if applicable), test, and other configuration settings are all saved under the setup name. You can open a setup and click **Start** button without having to do any other setting up except ensuring that the oscilloscope is detected and ready. For details, see *Before you click start*.

See Also

Save a test setup

Recall a saved test setup

Create a new test setup based on an existing one

Delete a test setup

Setup panel overview

Saving a test setup

Save a test setup before or after running a test using the parameters you want to be saved. You can create a new setup from any setup you have open or from the default setup. When you select the default test setup, all parameters are returned to their defaults. The following instructions start from the default setup:

1. From the Options menu, select **Default Test Setup**.
2. Select the desired options in the *Setup panel.*
3. Select the desired report options.
4. If desired, run the test to ensure that it captures the information you want. If it does not, edit the parameters.
5. From the Options menu, select **Save Test Setup**.
6. Name the test and, then click **Save** button.

See Also

About test setups

Recall a saved test setup

Create a new test setup based on an existing one

Delete a test setup

Recalling a saved test setup

These instructions are for recalling saved test setups.

1. From the Options menu, select **Open Test Setup**.
2. In the File Open dialog box, select the desired setup from the list, and then click **Open** button.

See also

About test setups

Save a test setup

Create a new test setup based on an existing one

Delete a test setup

Creating a new test setup based on an existing one

Use this method to create a variation on a test setup without having to create the setup from the beginning.

1. From the Options menu, select **Open Test Setup**.
2. In the File Open dialog box, select the desired setup from the list, and then click **Open**.
3. Modify the parameters as desired.
4. From the Options menu, select **Save Test Setup As**.
5. In the File Save As dialog box, enter a test setup name, and then click **Save**.

See also

About test setups

Save a test setup

Recall a saved test setup

Delete a test setup

Deleting a test setup

If you no longer need a test setup, delete it from the test setup list in the Options menu using these instructions.

Each saved test setup consists of two main parts, the test setup file and the test setup folder, both named for the test session.

1. Ensure the setup you want to delete is not currently selected in TekExpress Automotive Ethernet.
2. Navigate to the Automotive Ethernet folder where test setup files are stored. For example, X:\Automotive Ethernet\(test setup name).
3. Locate the test setup file, and then delete it.

   This removes the setup from the list in the Options menu.
4. Locate the test setup folder. If you want to keep any of the session files, move them out of the test setup folder and then delete the test setup folder.

See also

About test setups

Save a test setup

Recall a saved test setup

Create a new test setup based on an existing one

Automotive Ethernet measurements

Transmitter clock frequency

This measurement verifies that the frequency of the transmit clock is within the conformance limits.

Suite	Description
1000Base-T1	Physical Layer Specifications (IEEE Std 802.3bp™-2016) a parameter for 1 Gb/s Operation over a Single Twisted-Pair Copper Cable section 97.5.3.6 Transmitter clock frequency test.
100Base-T1	BroadR-Reach Physical Layer Transceiver Specification for Automotive Applications, version 3.2, section 5.1.3 or IEEE P802d3bw™ (100 Base T1) section 96.5.4.5 transmitter specifications BroadR-Reach Physical Media Attachment Test Suite version 2.0, section 5.5

Required test equipment

In addition to the DUT and oscilloscope, you need the following:

- One supported differential probe
- Short automotive cable.
- TF-XGbT test fixture

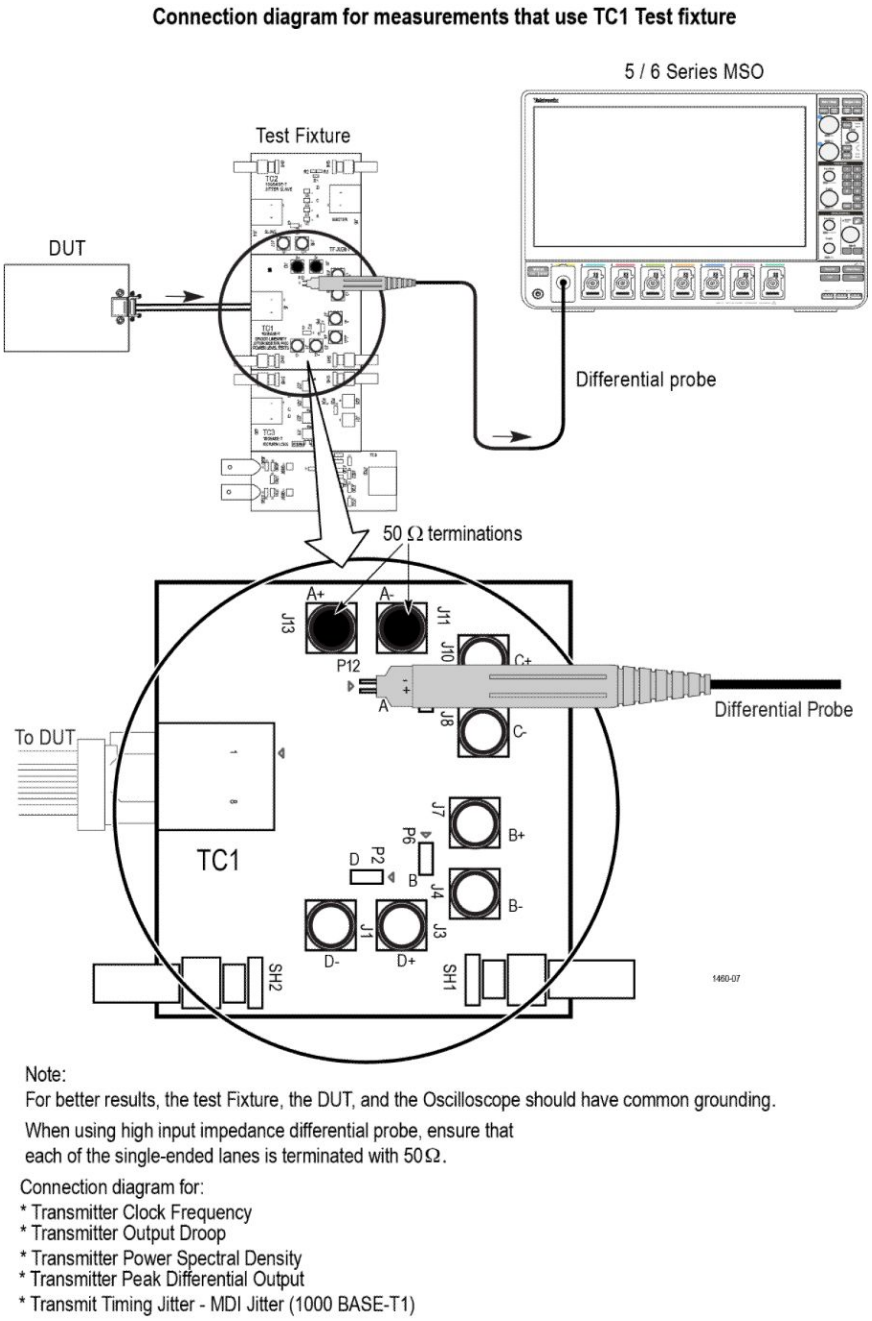


Figure 50: Connection diagram

NOTE. *Ensure that the probe tip (+) is connected to the ▶ on the text fixture board.*

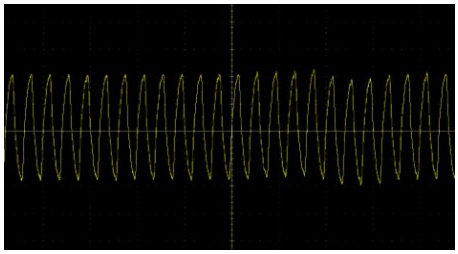
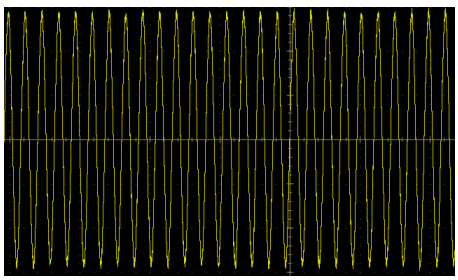
Test setup procedure

1. Make the connection as shown in the above connection diagram.
2. Select the Suite type on the DUT panel.

3. Set the DUT to generate and transmit test mode 2 signal for 1000Base-T1 and 100Base-T1.
4. Connect the DUT Ethernet cable to J5 Ethernet port (TC1 segment) of TF-XGbT test fixture.
5. Connect the differential probe to P12 and the configured channel of the oscilloscope and also terminate the SMA pins J11 and J13 with 50 Ω terminators.
6. Compute and verify the clock frequency between the High and Low limits as shown in below table.

NOTE.

- ***1000Base-T1****: The test mode 2 signal is a clock signal where the PHY shall transmit a continuous pattern of three {+1} symbols followed by three {–1} symbols with the transmitted symbols timed from its local clock source of 750 MHz. 1000Base-T1 PHY shall provide access to a frequency reduced version of the transmit symbol clock or TX_TCLK125. This 125 MHz test clock is one sixth frequency divided version of TX_TCLK that times the transmitted symbols.*
- ***100Base-T1****: The test mode 2 signal is a clock signal where the PHY shall transmit the data symbol sequence (+1, -1) repeatedly on all channels.*

Item	Requirements
Signal type	Test mode 2 for 1000Base-T1 (125 MHz +/- 100 ppm)  Test mode 2 for 100Base-T1(66.667 MHz +/- 100 ppm) 

Measurement output

		Lower limit	Upper limit
100Base-1	Clock frequency	66.6603 MHz	66.6736 MHz
	Number of unit intervals		
1000Base-T1	Transmit clock frequency	124.9875 MHz	125.0125 MHz
	Transmit symbol frequency	749.9250 MHz	750.0750 MHz

See also *Plots*

Transmitter timing Jitter-MDI Jitter

This measurement verifies that the transmitter timing jitter - master of the PMA is within the conformance limits.

Suite	Specification
1000Base-T1	Physical Layer Specifications (IEEE Std 802.3bp™-2016) a parameter for 1 Gb/s Operation over a Single Twisted-Pair Copper Cable section 97.5.3.3 Transmitter Timing Jitter-MDI Jitter.

Required test equipment

In addition to the DUT and oscilloscope, you need the following:

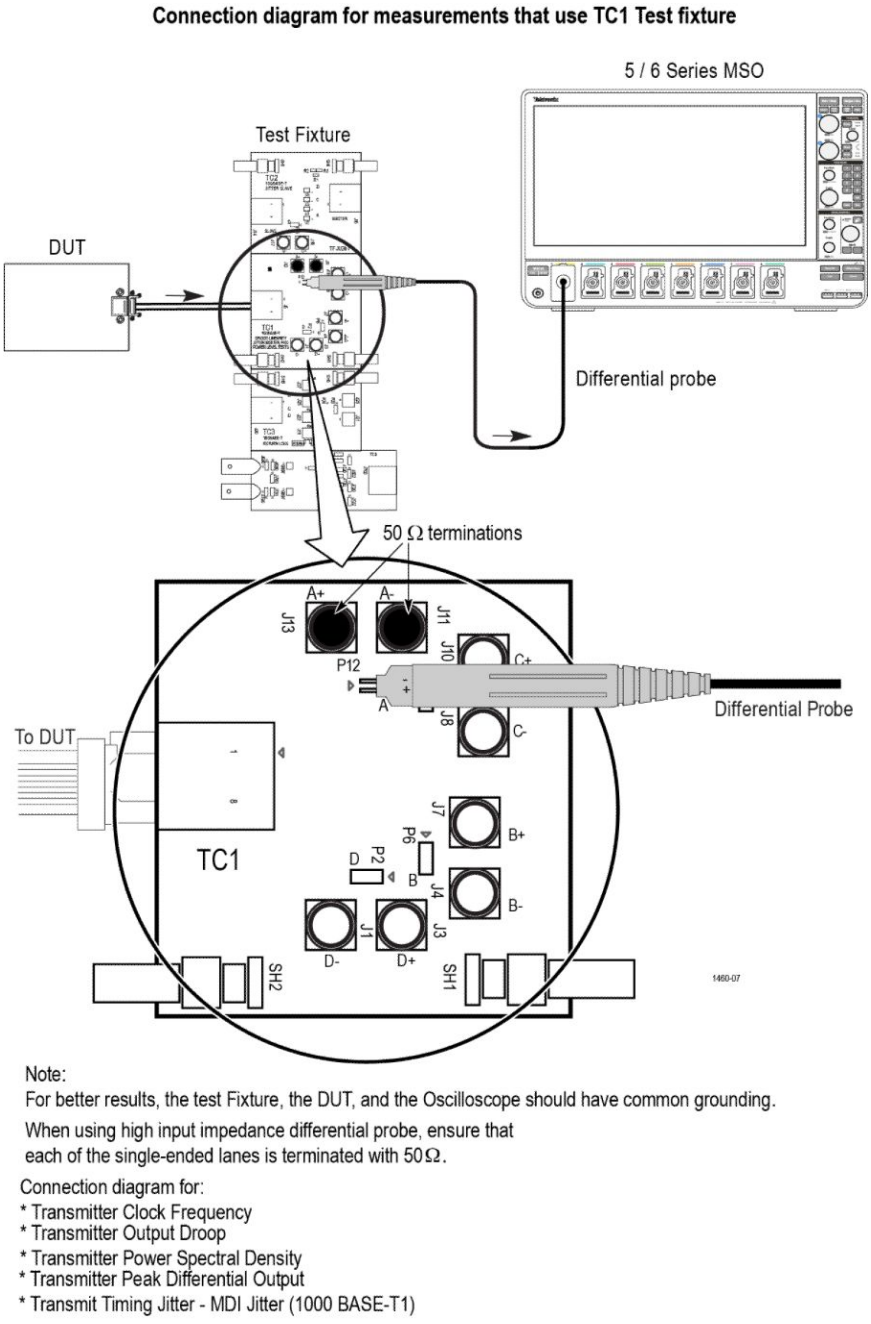
- One supported differential probe
- Short automotive cable.
- TF-XGbT test fixture

Test setup procedure

1. Make the connection as shown in the below connection diagram.
2. Select the Suite type on the DUT panel.
3. Set the DUT to generate and transmit test mode 2 signal for 1000Base-T1.
4. Connect the DUT Ethernet cable to J5 Ethernet port (TC1 segment) of TF-XGbT test fixture.
5. Connect the differential probe to P12 and the configured channel of the oscilloscope and also terminate the SMA pins J11 and J13 with 50 Ω terminators.

NOTE. *Test mode 2 is for Transmitter Jitter testing on MDI when transmitter is in MASTER timing mode. When test mode 2 is enabled, the 1000Base-T1 PHY shall transmit a continuous pattern of three {+1} symbols followed by three {–1} symbols with the transmitted symbols timed from its local clock source of 750 MHz. The transmitter output is a 125 MHz signal.*

Figure 51: Connection diagram



NOTE. *Ensure that the probe tip (+) is connected to the ▶ on the text fixture board.*

		Lower Limit	Upper Limit
1000Base-T1	MDI Jitter RMS	NA	5 pico seconds
	MDI Jitter peak to peak	NA	50 pico seconds

See also *Plots*

Transmitter timing jitter - Master Jitter and Slave Jitter

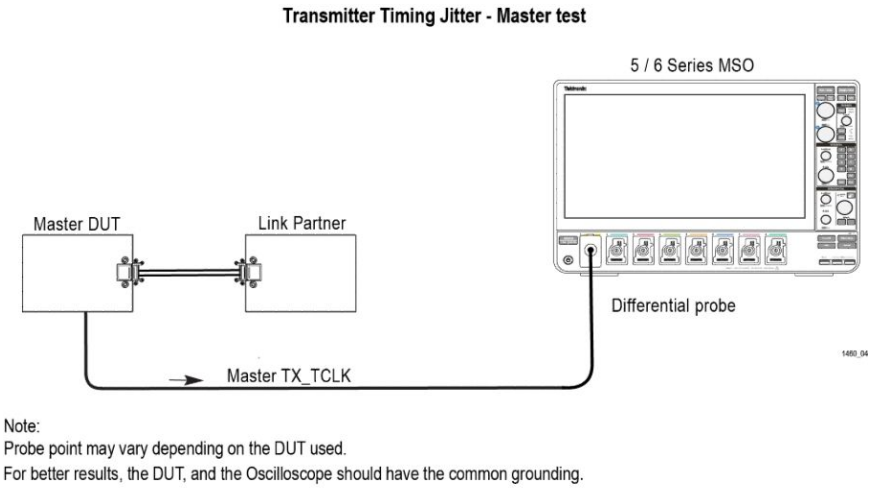
This section verifies that the transmitter timing jitter (master and slave) of the PMA is within the conformance limits.

Suite	Specification
1000Base-T1	Physical Layer Specifications (IEEE Std 802.3bp™-2016) a parameter for 1 Gb/s Operation over a Single Twisted-Pair Copper Cable section 97.5.3.3 Transmitter Timing Jitter-MDI Jitter.
100Base-T1	BroadR-Reach Physical Layer Transceiver Specification for Automotive Applications, version 3.2, section 5.4.3 or IEEE P802d3bwTM (100 Base T1) section 96.5.4.3 transmitter specifications BroadR-Reach Physical Media Attachment Test Suite version 2.0, section 5.3

Required test equipment

In addition to the DUT and oscilloscope, you will need the following:

- One supported differential probe.
- Short automotive cable.
- Test Fixture: TF-XGbT
- Link partner (to put the DUT to slave mode)



NOTE. *Ensure that the "+" on the probe tip aligns with ▶ on the text fixture board. This takes care of the polarity being not reversed.*

Figure 52: Connection diagram for 1000Base-T1 timing jitter (master) test

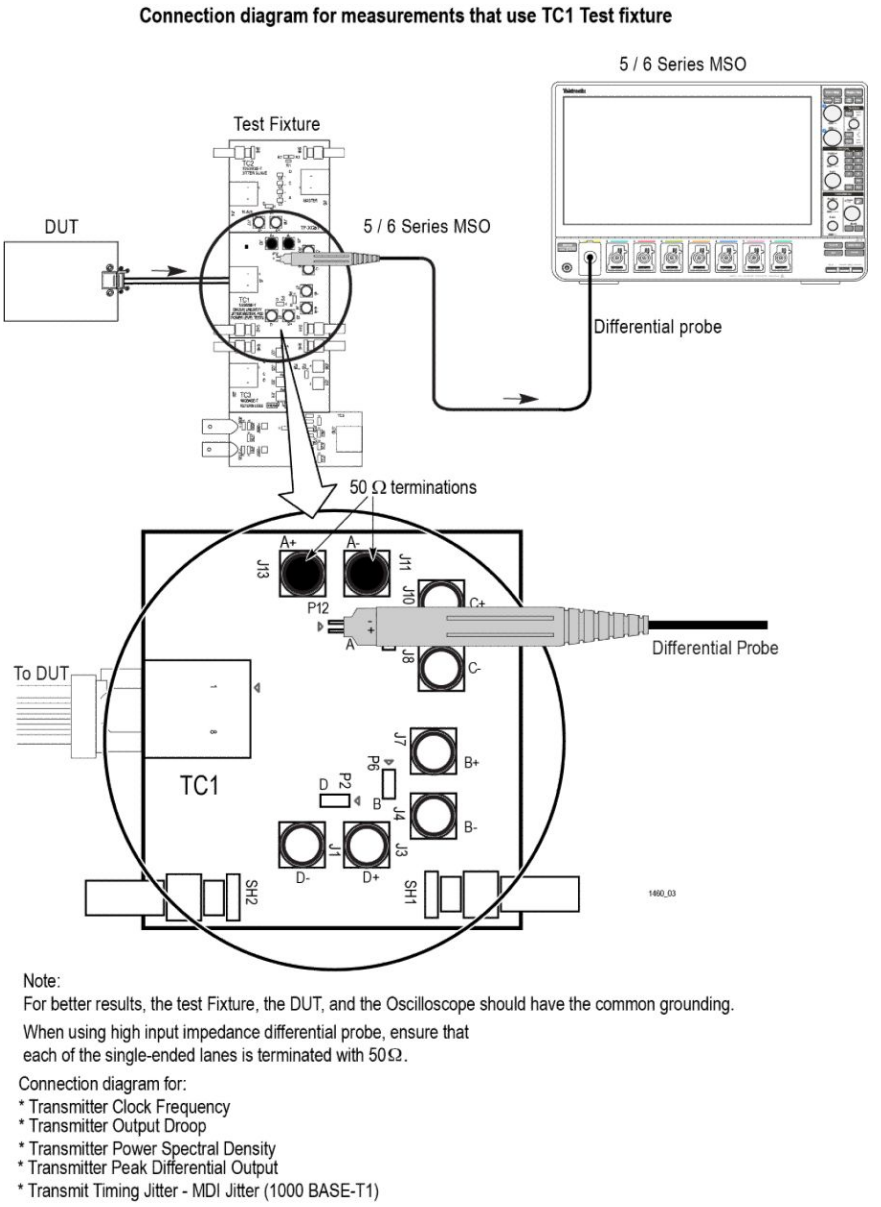


Figure 53: Connection diagram for 100Base-T1 timing jitter (master) test

NOTE. *Ensure that the "+" on the probe tip aligns with ▸ on the text fixture board. This takes care of the polarity being not reversed.*

Test setup procedure for timing jitter (master) test

1. Connect the equipment as shown in the connection diagram for 100/1000Base-T1 timing jitter (master) test.
2. Select the suite type on the DUT panel.
3. Set the DUT to generate and transmit a test mode 2 signal for 100Base-T1 and test mode 1 signal for 1000Base-T1.

For 100Base-T1

- Connect the DUT ethernet cable to J5 ethernet port (TC1 segment) of TF-XGbT test fixture.
- Connect the differential probe to P12 and the configured channel of the oscilloscope.

  Connect the DUT ethernet cable to J5 ethernet port (TC1 segment) of TF-XGbT test fixture.
- Terminate the SMA pins J11 and J13 with 50 Ω terminators.

For 1000Base-T1

- Connect the DUT Master-Slave configuration.
- Connect the SMA/BNC cable from the exposed TX_TCLK125 clock pin to run the measurement with 1000 Base-T1 MASTER TX_TCLK125 signal.

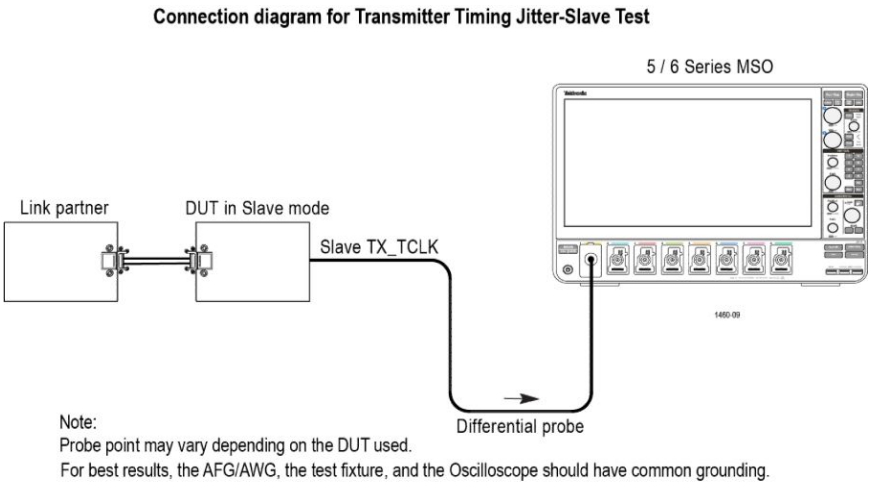


Figure 54: Connection diagram for Jitter (Slave) test

NOTE. *Ensure that the "+" on the probe tip aligns with ▸ on the text fixture board. This takes care of the polarity being not reversed.*

Test setup procedure for timing jitter (slave) test

1. Connect the equipment as shown in the above connection diagram.
2. Select the Suite type on the DUT panel
3. 100Base-T1: The SLAVE transmitter timing jitter can only be performed when the DUTs TX_TCLK is exposed and accessible. For normal operation as the SLAVE, the DUTs reference clock is recovered from a compliant LP PHY operating as MASTER. The RMS TIE jitter of the SLAVE TX_TCLK shall not exceed 0.01 UI (150 ps).

1000Base-T1: When configured for test mode 1 the DUT is in normal operation but a reduced version of the transmit symbol clock (TX_TCLK125) is exposed for testing purposes. The TX_TCLK125 signal is a 125 MHz signal, and the RMS TIE jitter measured on the TX_TCLK125 when the DUT is configured as SLAVE shall be less than 10 ps. Additionally, the Peak-to-Peak TIE jitter measured on the TX_TCLK125 when the DUT is configured as MASTER shall be less than 100 ps. The jitter is measured over an integration time interval of at least 1 ms.

4. Connect the DUT to the link partner and establish a normal Ethernet connection.
5. Use the appropriate cable or probe to run the measurement with the 100Base-T1 DUT SLAVE TX_TCLK or 1000Base-T1 DUT SLAVE TX_TCLK125 signal.

NOTE. *You can perform slave transmitter timing jitter only when the 100Base-T1 DUT SLAVE TX_TCLK or 1000Base-T1 DUT SLAVE TX_TCLK125 is exposed and accessible.*

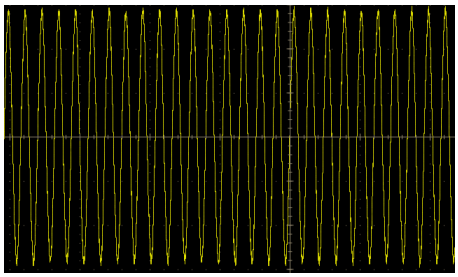
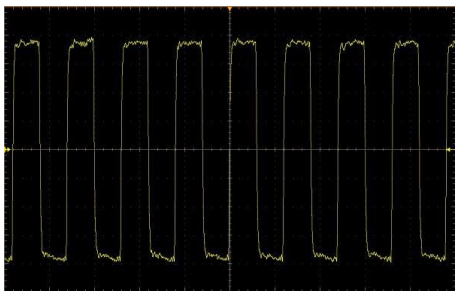
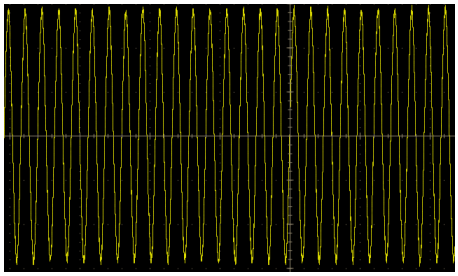
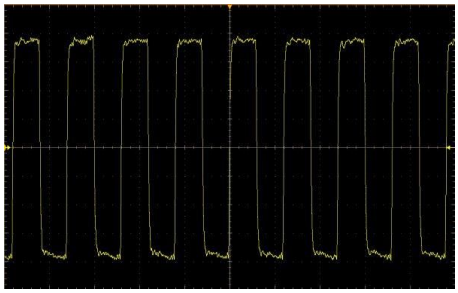
Item	Requirements
Signal type	Test mode 1 (master) and SLAVE TK_TCLK125 (slave) for 1000Base-T1   Test mode 2 (master) and SLAVE TK_TCLK125 (slave) for 100Base-T1  

Table 24: Limits

		Lower limit	Upper limit
1000Base-T1	Master Jitter RMS	NA	5 ps
	Master Jitter peak-to-peak	NA	50 ps
	Slave Jitter RMS	NA	10 ps
	Slave Jitter peak-to-peak	NA	100 ps
100Base-T1	Master Jitter RMS	NA	50 ps
	Slave Jitter RMS	NA	150 ps

See also *Plots*

Transmitter power spectral density

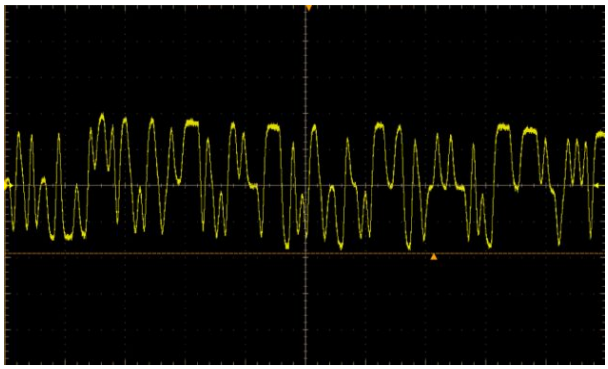
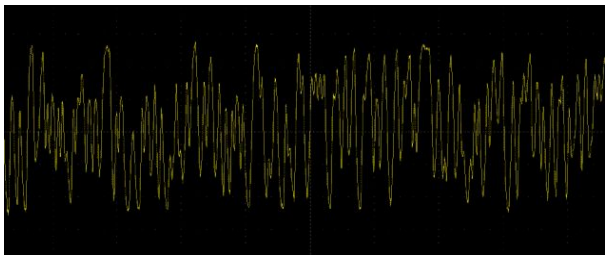
This measurement verifies that the transmitter power spectral density is within the conformance limits.

Suite	Description
1000Base-T1	Physical Layer Specifications (IEEE Std 802.3bp™-2016) a parameter for 1 Gb/s Operation over a Single Twisted-Pair Copper Cable section 97.5.3.4 Transmitter Power Spectral Density and Power Level. The measurement also verifies if the transmit power of the test mode signal is less than 5 dBm.
100Base-T1	BroadR-Reach Physical Layer Transceiver Specification for Automotive Applications, version 3.2, section 5.4.4 or IEEE P802d3bwTM (100 Base T1) section 96.5.4.4 transmitter specifications. BroadR-Reach Physical Media Attachment Test Suite version 2.0, section 5.4.

Required test equipment

In addition to the DUT and oscilloscope, you need the following:

- One supported differential probe
- Short automotive cable.
- TF-XGbT test fixture

Test name	Requirements
Signal type	100Base-T1  1000Base-T1 

Test setup procedure

1. Make the connection as shown in the below connection diagram
2. Select the Suite type on the DUT panel.
3. Set the DUT to generate and transmit test mode 5 signal.
4. Connect the DUT Ethernet cable to J5 Ethernet port (TC1 segment) of TF-XGbT test fixture.
5. Connect the differential probe to P12 and the configured channel of the oscilloscope and also terminate the SMA pins J11 and J13 with 50 Ω terminators.

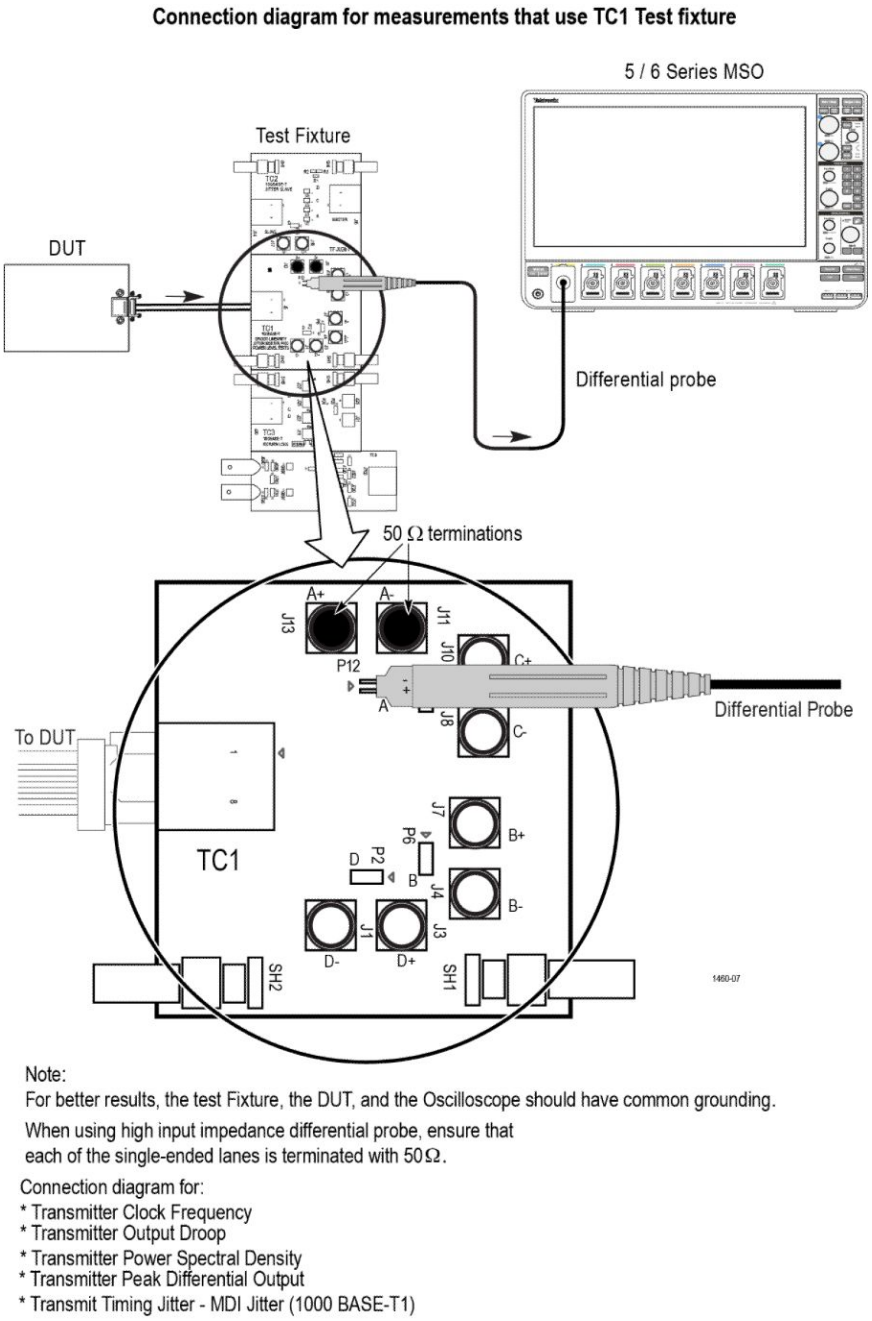


Figure 55: Connection diagram for power spectral density

NOTE. *Ensure that the probe tip (+) is connected to the ▸ on the text fixture board.*

Power spectrum curve mask information

Table 25: Power spectrum curve mask information for 100Base-T1

Frequency	PSD Upper Bound (dBm)	PSD Lower Bound (dBm)
at 1 MHz	–23.3	–30.9
at 20 MHz	–24.8	–35.8
at 40 MHz	–28.5	–40.2
57 MHz - 200 MHz	–36.5	– NA

Power spectrum curve mask information for 1000Base-T1

$$UpperPSD(f) = \begin{cases} -80 & \text{dBm/Hz} \quad 0 < f \le 100 \\ -76 - \frac{f}{25} & \text{dBm/Hz} \quad 100 < f \le 400 \\ -85.6 - \frac{f}{62.5} & \text{dBm/Hz} \quad 400 < f \le 600 \end{cases}$$

$$LowerPSD(f) = \begin{cases} -86 & \text{dBm/Hz} \quad 40 < f \le 100 \\ -82 - \frac{f}{25} & \text{dBm/Hz} \quad 100 < f \le 400 \end{cases}$$

Upper and lower limits/masks are piece-wise linear masks connecting points given in the above table.

Measurement	Suite	Lower limit	Upper limit
Power Level	1000Base-T1	NA	5 dBm

Mask

Figure 56: Mask for 1000Base-T1 PSD

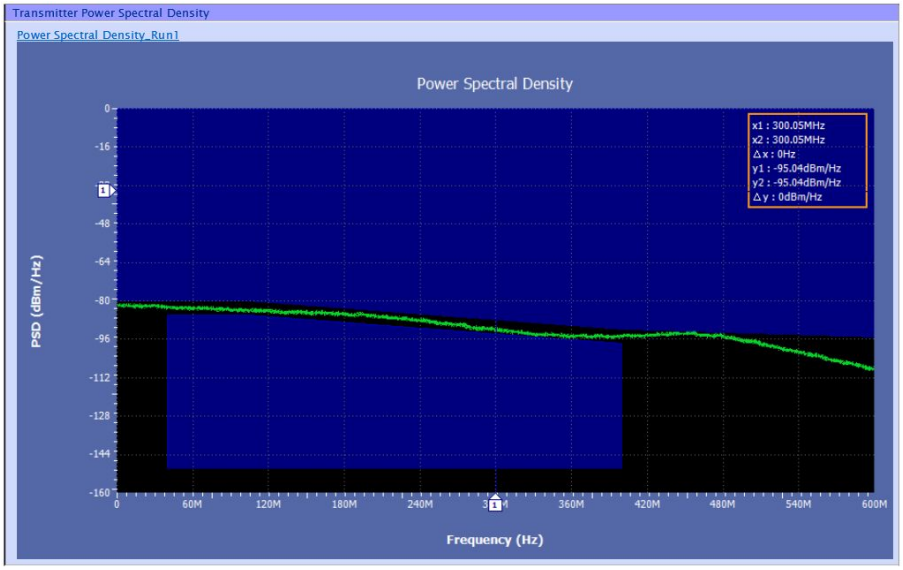
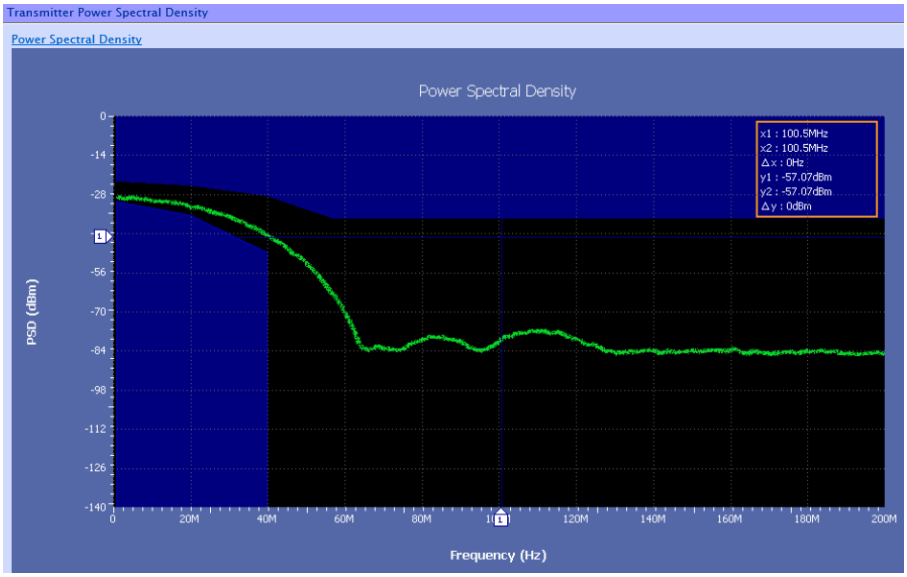


Figure 57: Mask for 100Base-T1 PSD



See also *Plots*

Transmitter output droop

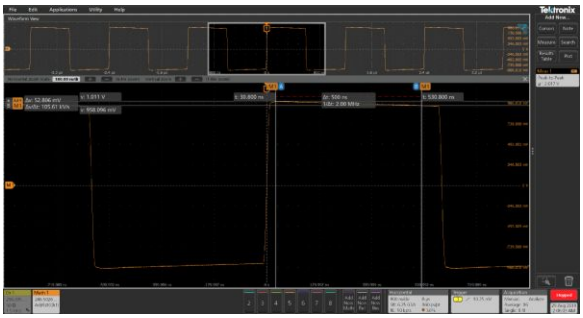
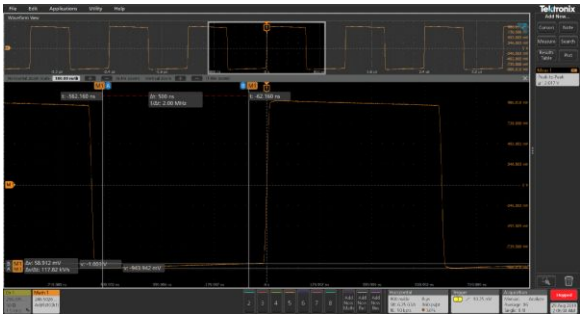
This measurement verifies that the transmitter output level does not decay faster than the maximum specified rate.

Suite	Description
1000Base-T1	Physical Layer Specifications (IEEE Std 802.3bp™-2016) a parameter for 1 Gb/s Operation over a Single Twisted-Pair Copper Cable section 97.5.3.1 Transmitter Output Droop.
100Base-T1	BroadR-Reach Physical Layer Transceiver Specification for Automotive Applications, version 3.2, section 5.4.1 or IEEE P802d3bwTM (100 Base T1) section 96.5.4.1 transmitter specifications. BroadR-Reach Physical Media Attachment Test Suite version 2.0, section 5.1

Required test equipment

In addition to the DUT and oscilloscope, you need the following:

- One supported differential probe
- Short automotive cable.
- TF-XGbT test fixture

Item	Requirements
Signal type	100Base-T1  1000Base-T1 

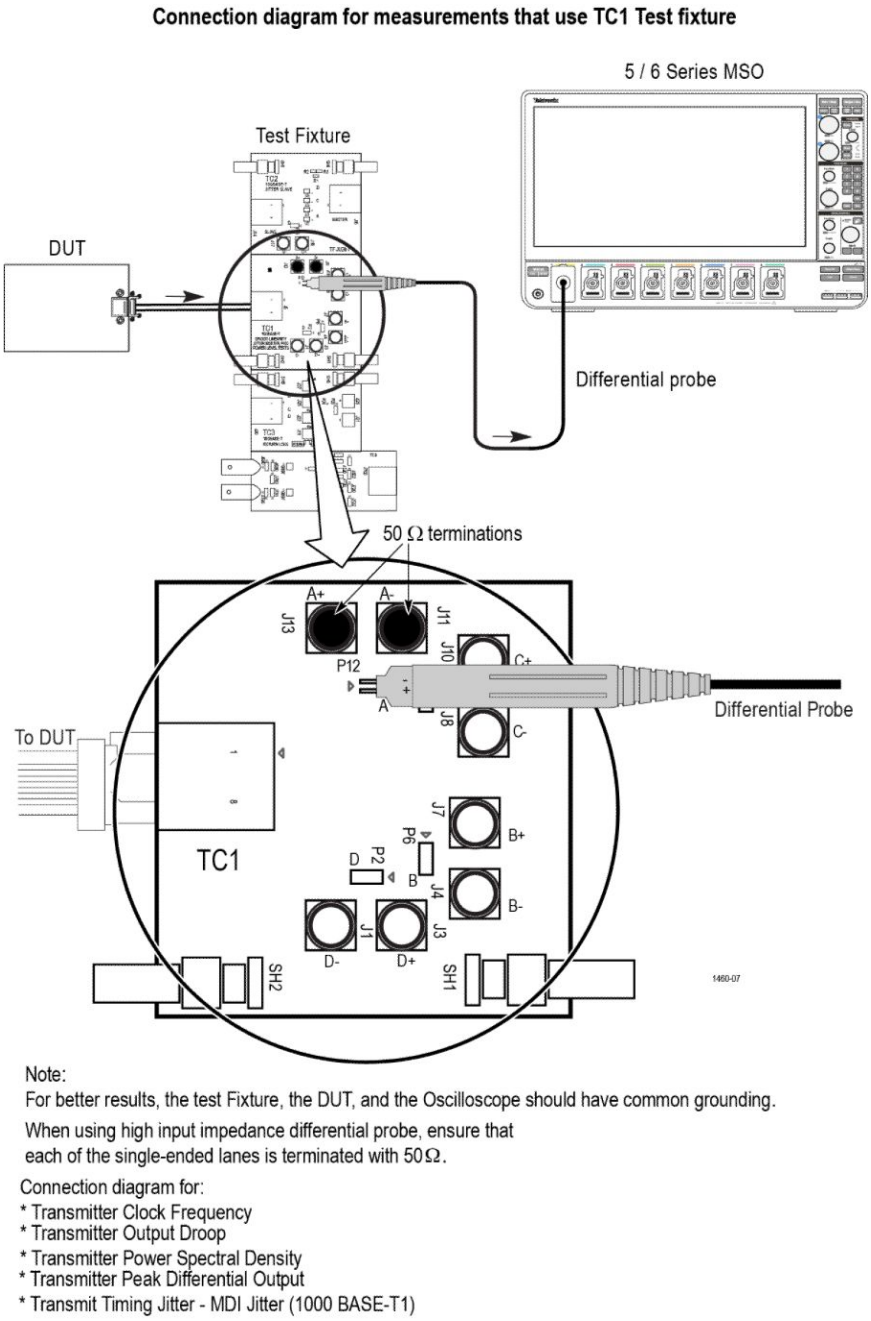


Figure 58: Connection diagram for Transmitter output droop

NOTE. *Ensure that the "+" on the probe tip aligns with ▸ on the text fixture board. This takes care of the polarity being not reversed.*

Test setup procedure

1. Make the connection as shown in the above connection diagram.
2. Select the Suite type on the DUT panel.

3. Set the DUT to generate and transmit test mode 1 for 100Base-T1 and test mode 6 signal for 1000Base-T1.
4. Connect the DUT Ethernet cable to J5 Ethernet port (TC1 segment) of TF-XGbT test fixture.
5. Connect the differential probe to P12 and the configured channel of the oscilloscope and also terminate the SMA pins J11 and J13 with 50 Ω terminators.

Automotive Ethernet standard	Droop type	Lower limit	Upper limit
100Base-T1	Positive Output Droop Percentage	NA	45%
	Negative Output Droop Percentage	NA	45%
1000Base-T1	Positive Output Droop Percentage	NA	10%
	Negative Output Droop Percentage	NA	10%

Transmitter peak differential output

This measurement verifies that the transmitter output level does not decay faster than the maximum specified rate.

1000Base-T1

When measured with 100 Ohm termination, transmit differential signal at MDI shall be less than 1.30 V peak-to- peak. This limit applies to Test Mode 5.

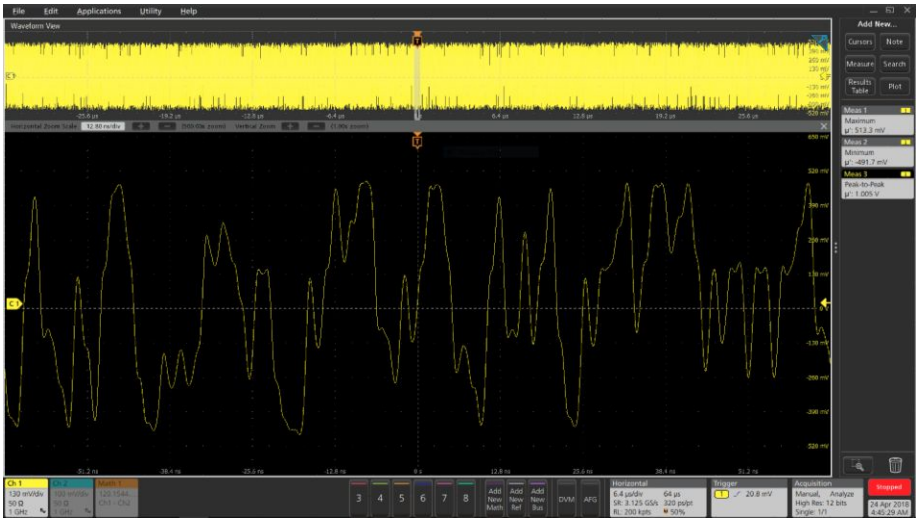
100Base-T1

When measured with 100 Ohm termination, this test confirms that the transmitter peak differential output is within 2.2 V peak-to-peak limits. This limit applies to test mode 5.

1. This measurement uses the test mode 5 signal for Peak Differential Output measurement.
2. Measurement acquires multiple test signals, which are defined on the Configuration tab. You can modify the values in the User Define Mode.

3. This test uses peak-to-peak measurement to compute the peak-to-peak value and average of three peak-to-peak values is computed as results.

1000Base-T1



100Base-T1

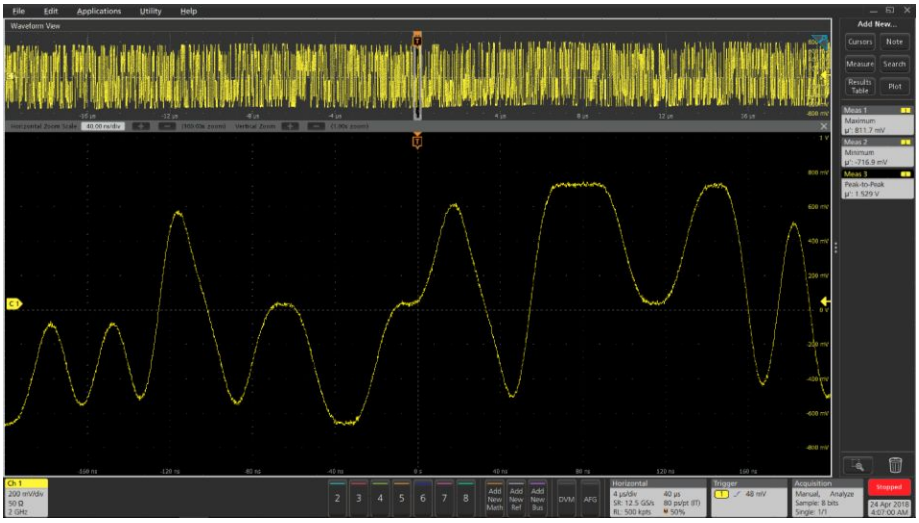


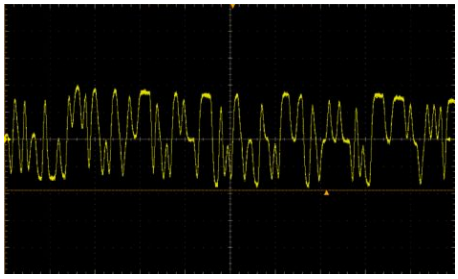
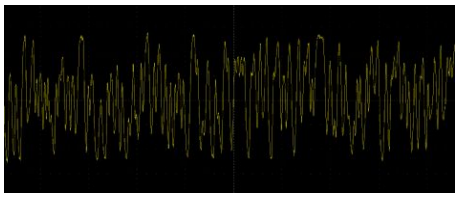
Figure 59: Vertical Histogram for Peak Differential Output

Suite	Description
1000Base-T1	Physical Layer Specifications (IEEE Std 802.3bp™-2016) a parameter for 1 Gb/s Operation over a Single Twisted-Pair Copper Cable section 97.5.3.5 Transmitter Peak Differential Output.
100Base-T1	■ IEEE Draft P802.3bw/ D3.3, section 96.5.6 transmitter specifications ■ BroadR-Reach Physical Media Attachment Test Suite version 1.0, section 5.8

Required test equipment

In addition to the DUT and oscilloscope, you need the following:

- One supported differential probe
- Short automotive cable.
- TF-XGbT test fixture

Test name	Requirements
Signal type	100Base-T1  1000Base-T1 

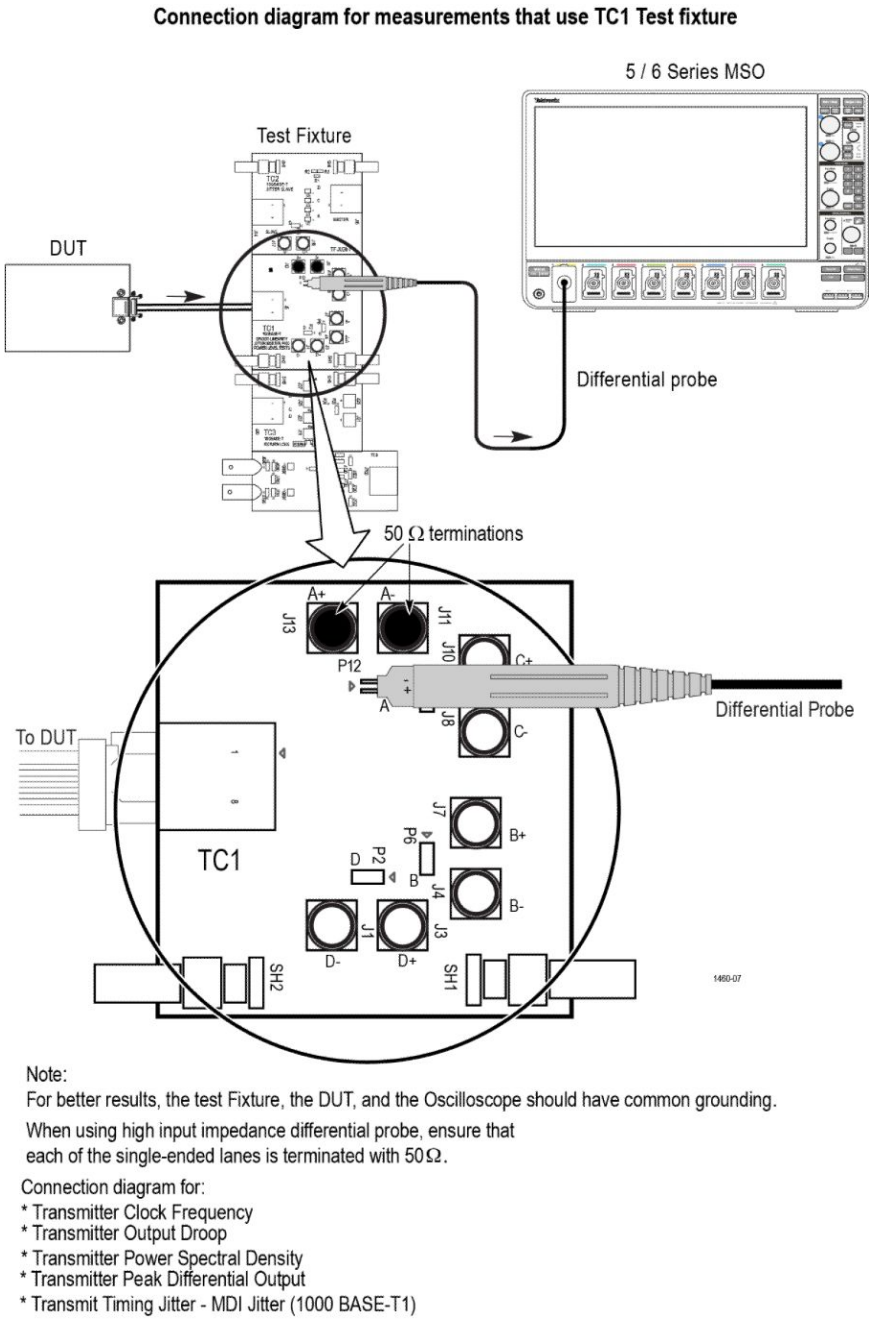


Figure 60: Connection diagram for peak differential output

NOTE. *Ensure that the "+" on the probe tip aligns with ▸ on the text fixture board. This takes care of the polarity being not reversed.*

Test setup procedure

1. Make the connection as shown in the above connection diagram.
2. Select the Suite type on the DUT panel.

3. Set the DUT to generate and transmit test mode 5 signal.
4. Connect the DUT Ethernet cable to J5 Ethernet port (TC1 segment) of TF-XGbT test fixture.
5. Connect the differential probe to P12 and the configured channel of the oscilloscope and also terminate the SMA pins J11 and J13 with 50 terminators.

Table 26: Limits table for 100Base-T1 and 1000Base-T1

	Low Limit	High Limit
100Base-T1	NA	2.2 V (peak-to-peak)
1000Base-T1	NA	1.3 V (peak-to-peak)

Transmitter distortion

This measurement verifies that the peak distortion values, measured at a minimum of 10 equally spaced phases of a single symbol period, shall be less than 15 mV.

Suite	Description
1000Base-T1	Physical Layer Specifications (IEEE Std 802.3bp™-2016) a parameters for 1 Gb/s Operation over a Single Twisted-Pair Copper Cable section 97.5.3.2 Transmitter Distortion test.
100Base-T1	BroadR-Reach Physical Layer Transceiver Specification for Automotive Applications, version 3.2, section 5.4.2 or IEEE P802d3bwTM (100 Base T1) section 96.5.4.2 transmitter specifications BroadR-Reach Physical Media Attachment Test Suite version 2.0, section 5.2.

Required test equipment

In addition to the DUT and oscilloscope, you need the following:

- One supported differential probe
- Four BNC cables (for connecting AFG or AWG5200 to fixture) or two SMA cables with two BNC to SMA connectors [1]
- GPIB/LAN/USB cable (required if you use *AWG automation*, connects AWG and oscilloscope). Refer to *Automate AWG/AFG signal generation* and *Instrument configuration using TekVISA*.
- Short automotive cable.

[1] Use the Signal Generator for 1000Base-T1 which supports the 125 MHz sine wave differential peak to peak 3.6 volts.

- TF-XGbT test fixture
- TF-BRR-CFD (Clock Frequency Divider Unit): This is used to synchronize oscilloscope and signal source with the DUT Transmit_CLK.

NOTE. *You will need to complete the calibration procedure before doing the Transmitter Distortion measurement with disturbing signal. The calibration procedure is used to effectively remove the disturbing signal and compensate for non-linearity in the disturber and test fixture.*

Test setup procedure

The test setup procedure for Transmitter Distortion is divided into two parts as below:

1. **Calibration**
2. **Measurement Run**

Calibration

Calibration step is done to calibrate the disturber signal source amplitude and frequency. It measures the DUT signal level at defined PIN points on the test fixture. You can perform calibration on live DUT signal and disturber source signal connected as mentioned in the calibration connection diagram.

Design of the transmitter to tolerate the presence of the remotely driven signal with acceptable distortion or other changes in performance is a critical issue and must be addressed by the implementer. A disturbing signal is used to simulate the presence of a remote transmitter. The disturbing signal is defined as a sine wave generator that simulates the potential interfering effect of another transmitter.

Automotive Ethernet (1000/100Base T1) measurements that require test mode 4 have to be done with a disturbing signal. Characteristics of disturbing signal are given in the following table.

The calibration has three parts/steps to calibrate the fixture path:

A. Disturber compensation

B. Test fixture compensation

C. Test fixture compensation without disturber signal

Figure 61: Calibration tab for 1000Base-T1 transmitter distortion measurement

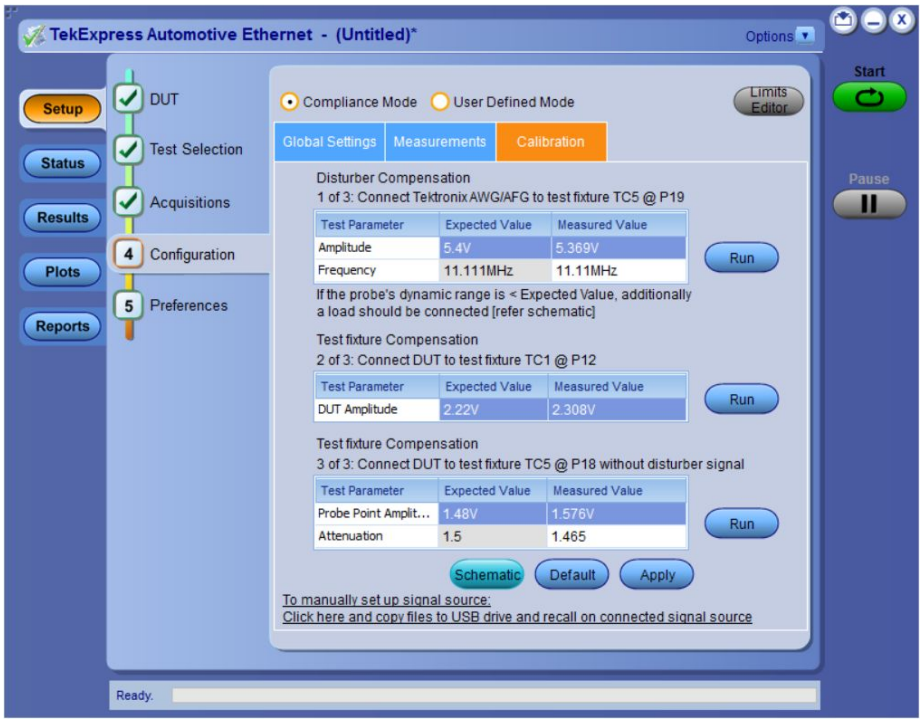
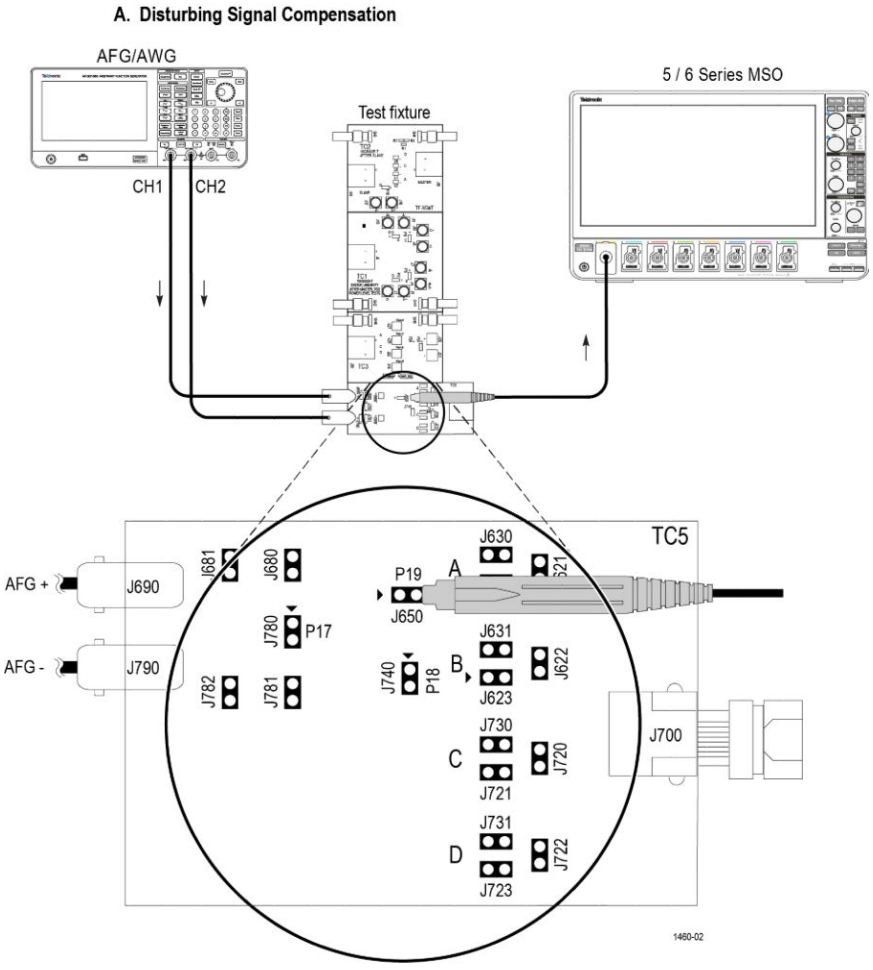


Figure 62: Calibration tab for 100Base-T1 transmitter distortion measurement



Note:
For best results, the AFG/AWG, the test fixture, and the Oscilloscope should have common grounding.
The jumper shorting settings for the lanes are below:
- Lane A - J621, J630, J623, J721, J723, J680, and J781
- Lane B - J620, J631, J622, J721, J723, J680, and J781
- Lane C - J620, J623, J730, J720, J723, J680, and J781
- Lane D - J620, J623, J721, J731, J722, J680, and J781

Figure 63: Disturbing signal compensation with AFG/AWG

NOTE.

- *Ensure that the "+" on the probe tip aligns with ▶ on the text fixture board. This takes care of the polarity being not reversed.*
- *This connection diagram is applicable for the probes whose differential input dynamic range is less than the amplitude of the disturber signal being measured.*
- *For 100Base-T1, the expected value is <= 5.4/2 Volts, as measured across the 100 Ω load.*

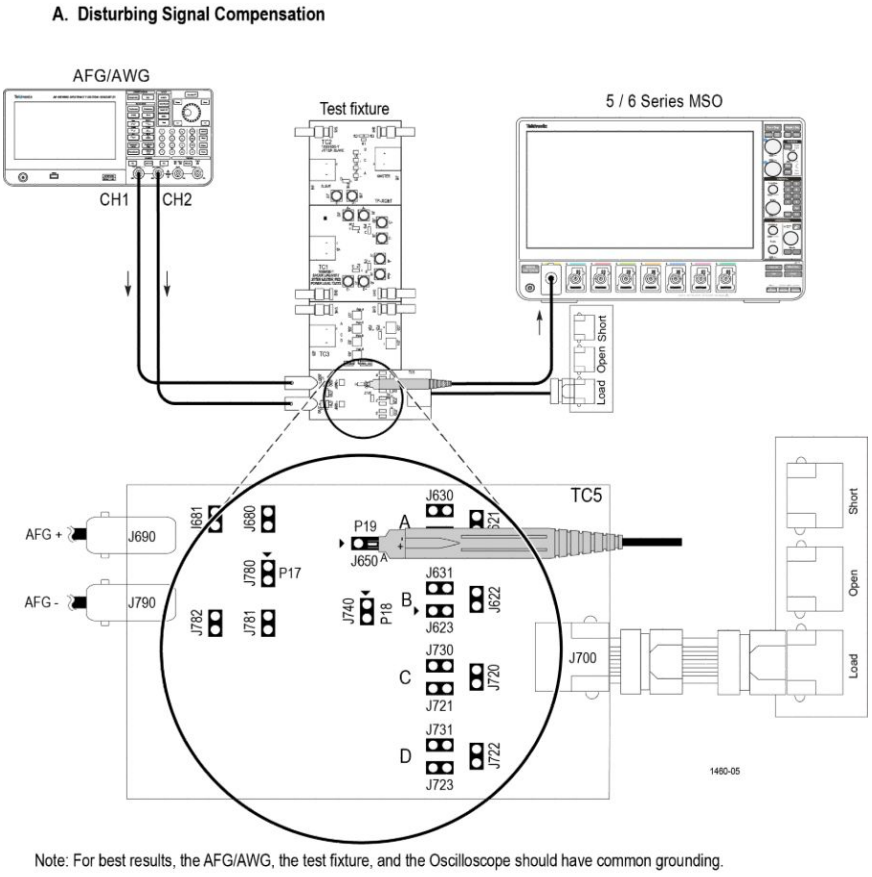


Figure 64: Disturbing signal compensation with AFG/AWG using TDP3500

NOTE.

- *Ensure that the "+" on the probe tip aligns with ▸ on the text fixture board. This takes care of the polarity being not reversed.*
- *This connection diagram is applicable for the probes whose differential input dynamic range is less than the amplitude of the disturber signal being measured.*
- *For 100Base-T1, the expected value is <= 5.4/2 Volts, as measured across the 100 Ω load.*

1. Select the Signal Generator source instrument in Global settings.

   Follow the Instrument step mention on How to connect the Signal Generator to oscilloscope.

   NOTE. *Use the Signal Generator which can generate the (3.6)/2 volte peak-to-peak for 1000Base-T1.*

2. Connect DUT as shown in the above connection diagram.
3. Take two equal length BNC cable.

4. Connect the 1st BNC Cable to (AFG/AWG) + (J690) and the other end to Channel 1 of AFG.
5. Connect the 2nd BNC Cable to (AWG/AFG) – (J790) and other end to Channel 2 of AFG. In case AWG, connect the other end of BNC to CH1_inverted.
6. Make the jumper shorting settings for the lane selected, respectively.
7. Disconnect the DUT from J700, if DUT is connected.
8. If you are using TDP3500 probe (100Base-T1 Tx-Distortion), connect the Load Calibration unit to J700 Port using short RJ45 cable.
9. From the Measurement Configuration tab > Select Calibration tab > Under step 1 of 3 (Disturber Compensation), click **RUN** button.

   The application will automatically configure the selected Signal Generator to the specified frequency and its amplitude level as defined in the specification.

NOTE.

- *For 100Base-T1, set the attenuator factor to 10X on the probe if you are using P6247\6248.*
- *Ensure that the "+" on the probe tip aligns with ► on the text fixture board. This takes care of the polarity being not reversed.*

Test fixture compensation

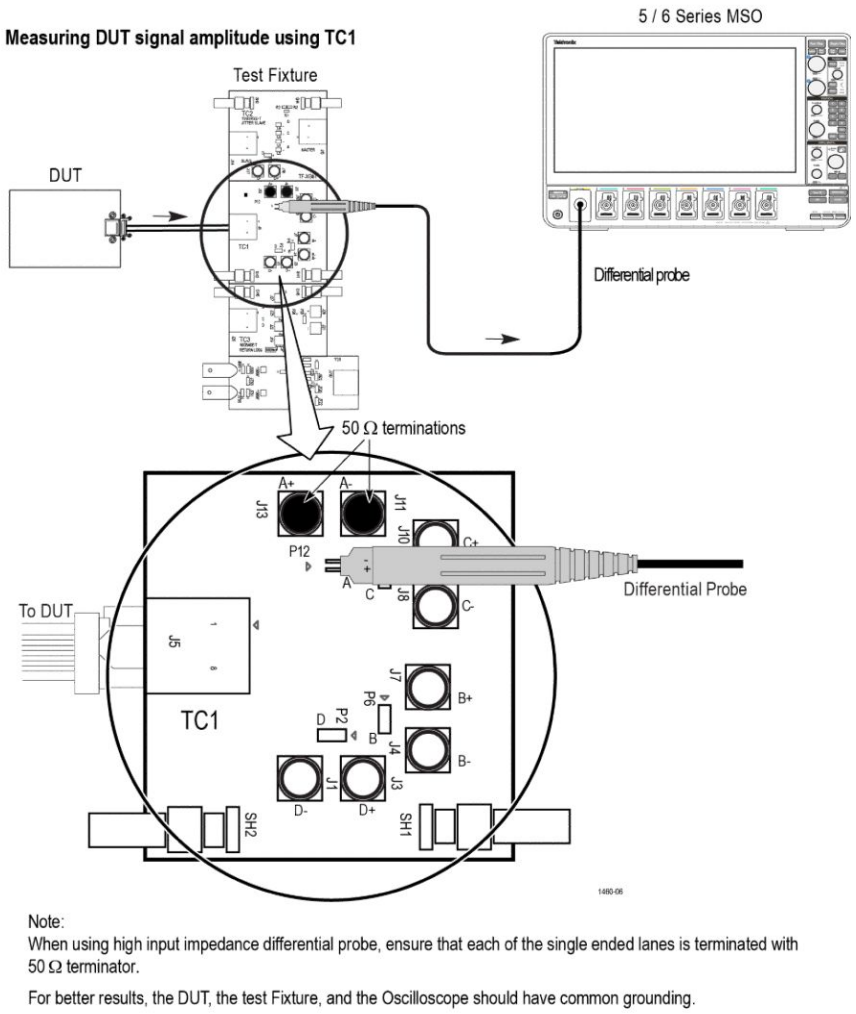


Figure 65: Disturbing signal compensation with AFG/AWG

NOTE.

- *When using high input impedance differential probe, ensure that each of the single ended lanes is terminated with 50 Ω.*
- *Ensure that the "+" on the probe tip aligns with ▸ on the text fixture board. This takes care of the polarity being not reversed.*

1. Connect the DUT to RJ45 of TC1, J5 port.
2. Turn on DUT and set the DUT to run Test Mode 4 signal.

3. Connect the Differential probe tip to P12 pin.

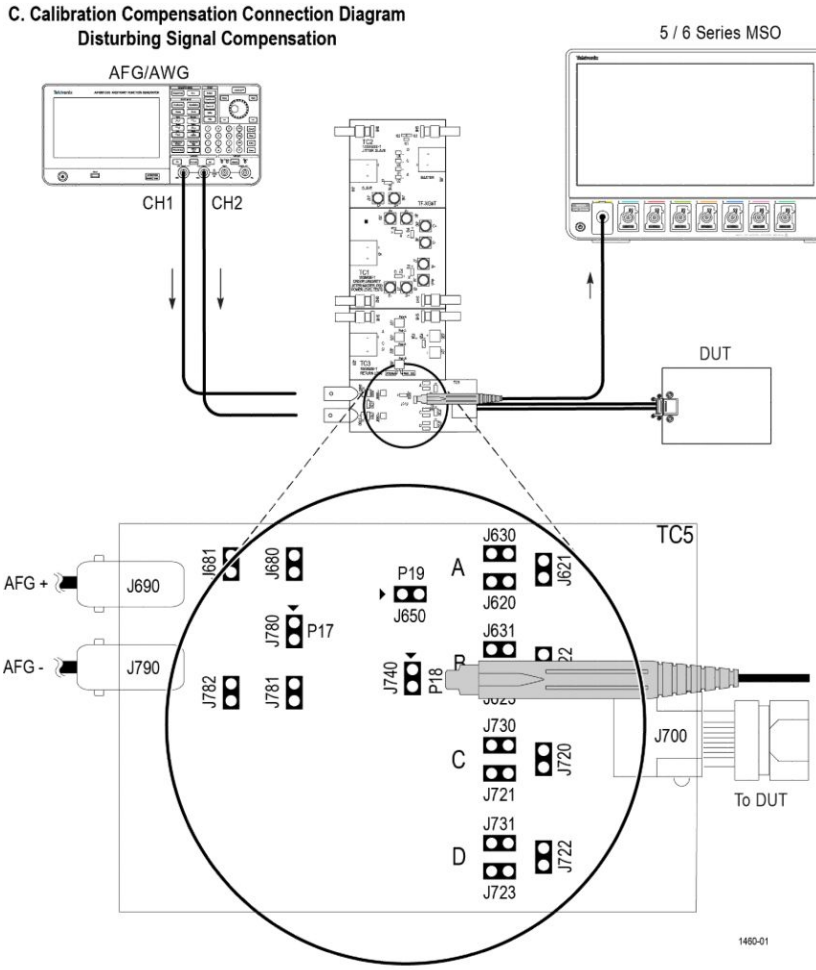
   NOTE. *Indicate the positive probe tip to be connected on test fixture. As per your DUT single twisted pair output, you can get the signal from one of the P2, P6, or P9 pin.*

4. Close J11 and J13 with the 50 Ω terminator cap, which is with respect to P12 pin.
5. From the Measurement Configuration tab > Select Calibration tab > Under step 2 of 3 (Test Fixture Compensation), click **RUN** button and wait to display the measured value in the table.

NOTE.

If the expected and the measured values do not match using the AWG/AFG automation, follow the steps below:

1. *Load the setup file manually on the AWG/AFG.*
2. *In Global Settings for the measurement, set the Signal Generator to 'Do not use'.*
3. *Run the calibration.*
4. *Make changes to frequency/amplitude on the Signal Generator to match the expected values.*
5. *Repeat the steps 3 and 4, until the measured and the expected values closely match.*



Note:
For best results, the AFG/AWG, the test fixture, and the Oscilloscope should have common grounding.
The jumper shorting settings for the lanes are below:
- Lane A - J621, J630, J623, J721, J723, J680, and J781
- Lane B - J620, J631, J622, J721, J723, J680, and J781
- Lane C - J620, J623, J730, J720, J723, J680, and J781
- Lane D - J620, J623, J721, J731, J722, J680, and J781

Figure 66: Disturbing Signal Compensation with AFG/AWG

NOTE. *Ensure that the "+" on the probe tip aligns with ▸ on the text fixture board. This takes care of the polarity being not reversed.*

1. Connect the DUT as shown in the connection above diagram.
2. Make the jumper shorting settings for the lane selected, respectively.
3. Disconnect the BNC cable J790 and J690, if it is connected.

4. From the Measurement Configuration tab > Select Calibration tab > Under step 3 of 3 (Test Fixture Compensation), click **RUN** button.

   The Automotive Ethernet Software Solution will automatically configure the selected Signal Generator to the specified frequency and its amplitude level as defined in the specification.

NOTE. *Ensure "+" on the probe tip aligns with ► on the text fixture board. This takes care of the polarity being not reversed.*

100Base-T1 AFG Configuration The AFG setup happens automatically when you click the **Run** button at Step-1 of Disturber Compensation on Calibration tab.

Use the following steps for AFG:

1. Set amplitude to 5.4 Vpp.
2. Set frequency to 11.111 MHz.
3. Set the external Ref clock.
4. Turn on CH1 and CH2.

Point 1, 2, and 3 are applicable for both CH1 and CH2 and the phase set to CH1 is 0 degrees and for CH2, it is 180 degrees. For more details, refer to connection diagram (Test Fixture Compensation (2 of part 3) and Measuring amplitude with disturbing signal OFF and DUT signal ON (3 of part 3)).

NOTE.

- *Ensure that before clicking the **Start** button the calibration steps are performed.*
- *During calibration, the signal source AFG/AWG will be setup automatically from the application by loading the disturber pattern.*
- *When you click the **Start** button, the AFG/AWG does not setup, only oscilloscope will setup because the application will not disturb the calibration done using AFG/AWG.*

1000Base-T1 AFG Configuration

The AFG/AWG setup happens automatically when you click the **Run** button at Step-1 of Disturber Compensation on Calibration tab.

Use the following steps for AFG:

1. Set amplitude to 3.6 Vpp.
2. Set frequency to 125 MHz.
3. Set the external Ref clock.
4. Turn on CH1 and CH2.

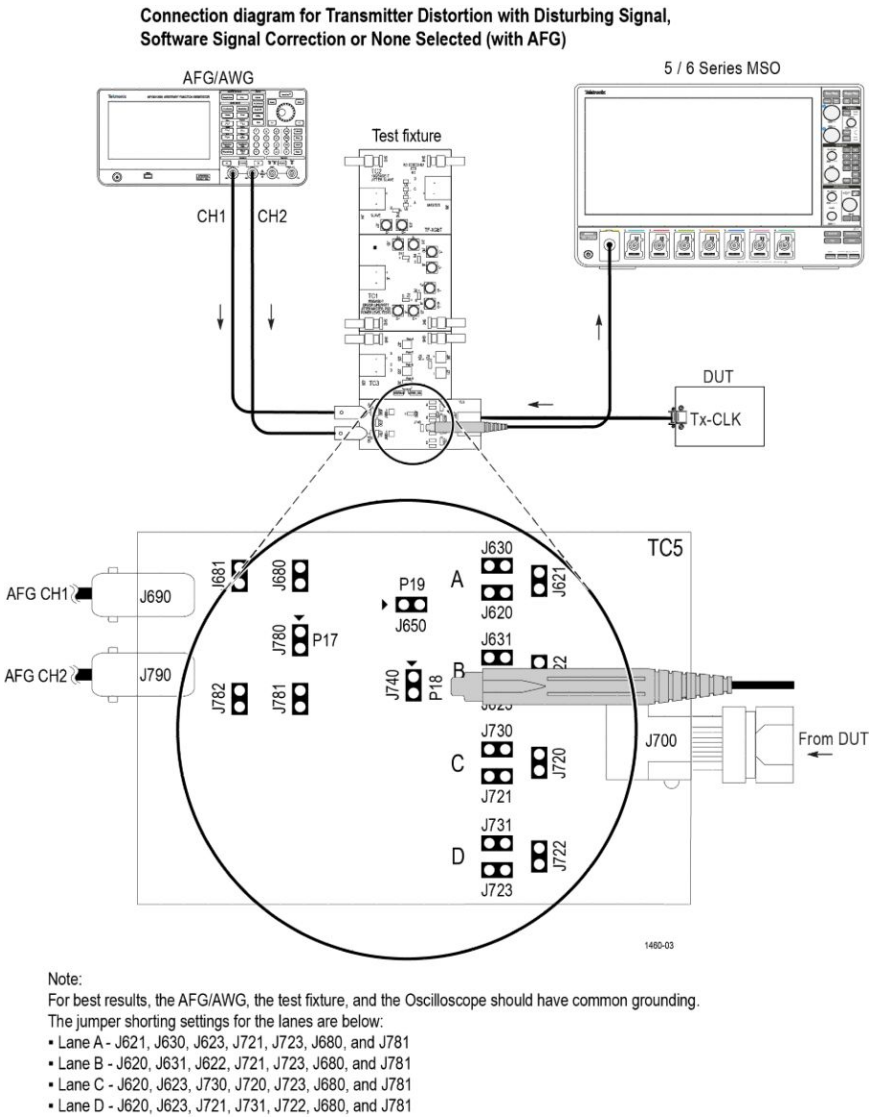
Point 1, 2, and 3 are applicable for both CH1 and CH2 and the phase set to CH1 is 0 degrees and for CH2, it is 180 degrees. For more details, refer to connection diagram (Test Fixture Compensation (2 of part 3) and Measuring amplitude with disturbing signal OFF and DUT signal ON (3 of part 3)).

NOTE.

- *Ensure that before clicking the **Start** button the calibration steps are performed.*
- *During calibration, the signal source AFG/AWG will be setup automatically from the application by loading the disturber pattern.*
- *When you click the **Start** button, the AFG/AWG does not setup, only oscilloscope will setup because the application will not disturb the calibration done using AFG/AWG.*

The application automatically controls the AWG 5202 for 1000Base-T1 and AWG 5K/AWG 7K for 100Base-T1 similarly to that of the AFG configuration.

Measurement: Software signal correction or None method for 1000/100Base-T1



Note:
For best results, the AFG/AWG, the test fixture, and the Oscilloscope should have common grounding.
The jumper shorting settings for the lanes are below:

- Lane A - J621, J630, J623, J721, J723, J680, and J781
- Lane B - J620, J631, J622, J721, J723, J680, and J781
- Lane C - J620, J623, J730, J720, J723, J680, and J781
- Lane D - J620, J623, J721, J731, J722, J680, and J781

Figure 67: Connection diagram for Software Signal Correction or None method-AWG

NOTE. *Ensure that the "+" on the probe tip aligns with ▸ on the text fixture board. This takes care of the polarity being not reversed.*

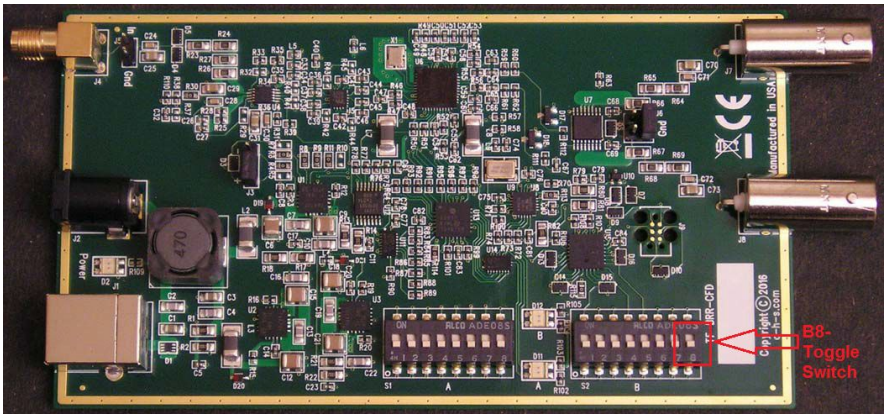
Make the connection as above:

1. Click **Apply** after completing the calibration.
2. Click Measurement tab, and then select one of the options from the Configuration tab.
3. Ensure that the Jumper and the Probe setting as mention in Step 1 of 3 (Refer A. Disturber Signal setup (1 of part 3) (AWG) section). Refer *Calibration* on page 113.
4. Select the Software Signal Correction or None method.

   The Software Signal Correction is selected by default and available for 100Base-T1.
5. Make the connection setup without the clock divider.

   For the Software Signal Correction option, the measurement corrects the acquired signal and adjusts the phase like a hardware clock divider unit, and then performs the peak distortion

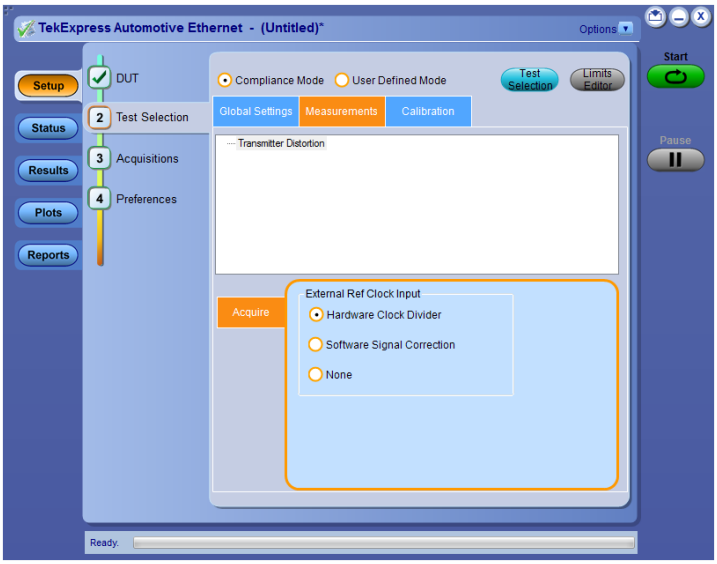
When None option is selected, the Tx distortion measurement is performed without hardware CDU operation or software signal correction method.



Hardware clock divider method for 1000/100Base-T1

1. Click **Apply** after completing the calibration.
2. Click **Measurement** tab, and then select one of the options from the Configuration tab.

a. Hardware Clock Divider option



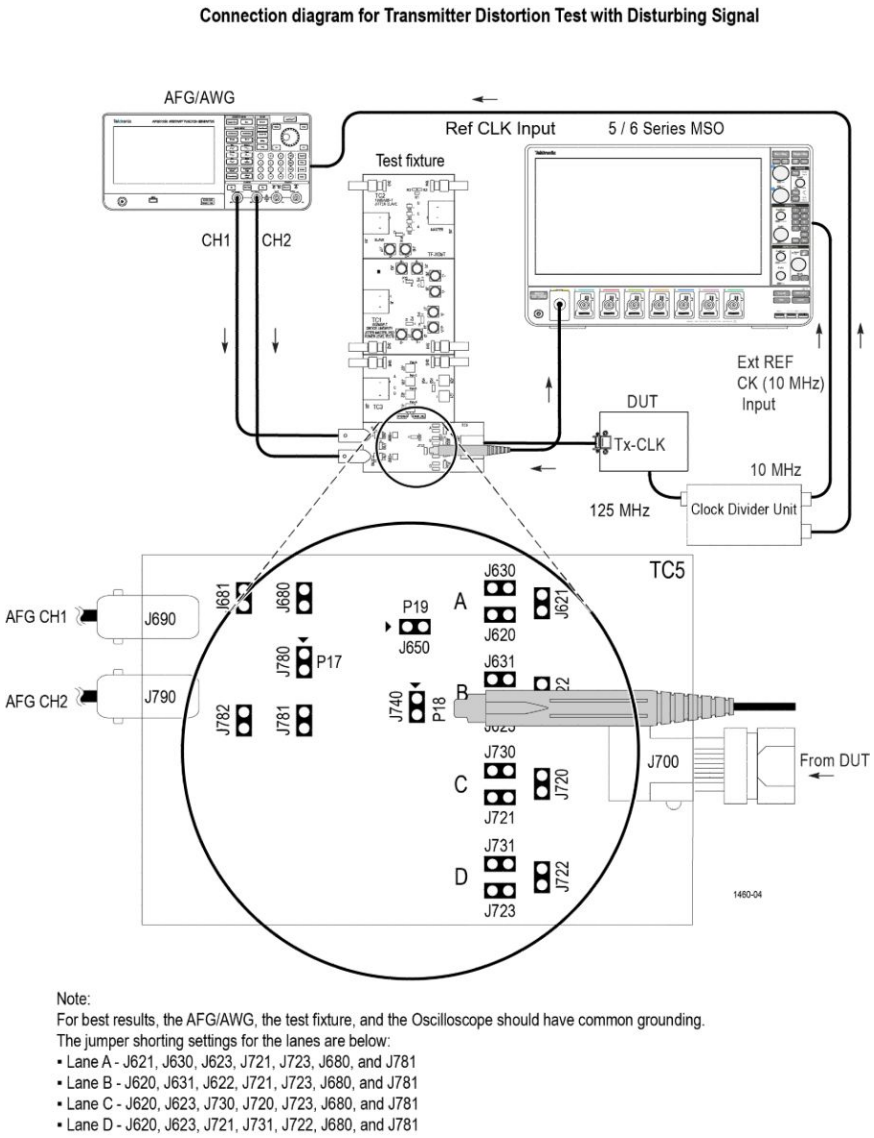


Figure 68: Hardware clock divider

NOTE. *Ensure that the "+" on the probe tip aligns with ▸ on the text fixture board. This takes care of the polarity being not reversed.*

- Select **Hardware Clock Divider**.
- As highlighted in the figure of the Hardware Clock Divider (TF-BRR-CFD) unit the toggle switch B8 should be in:
  - 100 Base-T1: toggle down position for the PLL to lock with 66.666 MHz of transmit clock frequency signal.

- 1000 Base-T1: toggle up position for the PLL to lock with 125 MHz of transmit clock frequency signal.

- Make the connection setup with the clock divider as show above. The clock divider synchronizes the oscilloscope and the disturber source.

NOTE.

- *In case the automation with AFG/AWG is selected in the Global setting tab, the disturber pattern is automatically loaded during the disturber compensation process.*
- *In case of an unstable 10 MHz clock output from the Clock Divider Unit, restart the Clock Divider unit.*
- *Check the amplitude of the 10 MHz clock coming from Clock Divider Unit; it should not exceed the limit mentioned on the oscilloscope and AFG/AFG for 10 MHz reference input signal.*
- *If the External Reference Clock signal is stable (10 MHz), the oscilloscope will phase-lock with the external reference clock. This can be seen in the following image as "XRef", which indicates acquired signal is properly locked. The oscilloscope displays "NoRef", in case of unlocked phase. It indicates that the External Reference Clock is not proper and can result in incorrect results.*

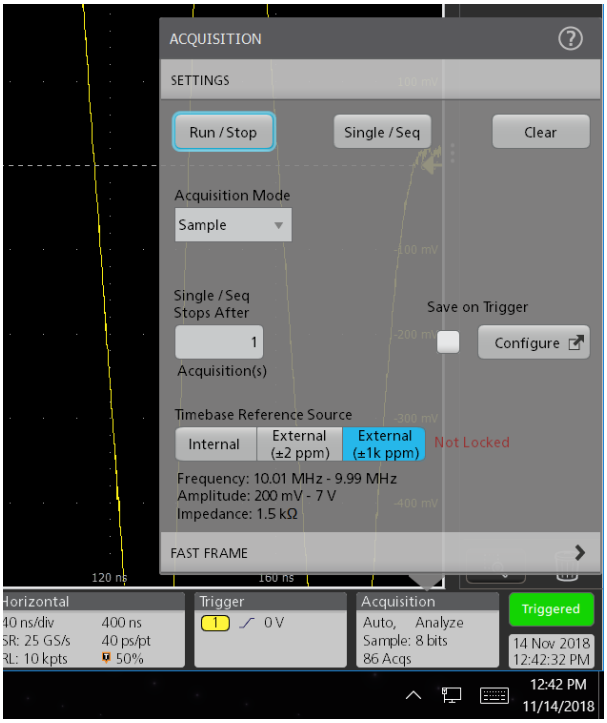
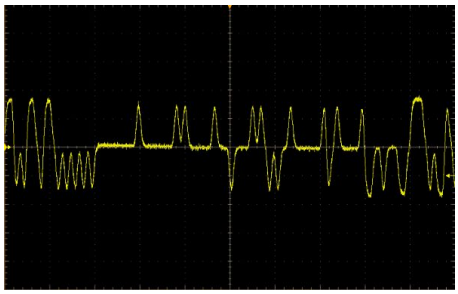
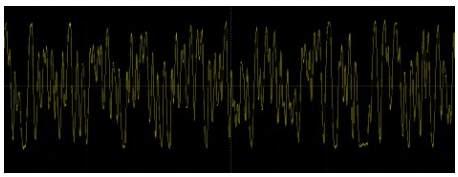


Figure 69: XRef

Item	Requirements
Signal type	Test mode 4 for 100Base-T1  Test mode 4 for 1000Base-T1 
Measurement algorithm outputs	All the computed 10 peaks must be less than 15 mV.
Measurement algorithm inputs	Test mode 4 signal captured in differential form Disturbing Signal. Lower limit is NA. Upper limit is 15 mV.

See also *Plots*

Return loss measurement

This measurement confirms that the return loss of the DUT is within conformance limits. You can perform return loss measurement by oscilloscope method or VNA report method (S-parameter file s1p/s2p).

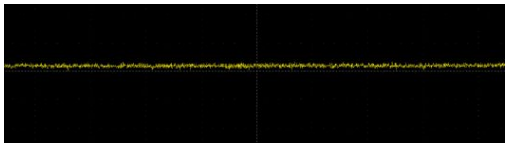
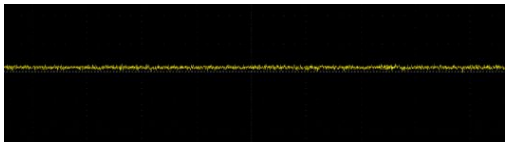
Suite	Description
1000Base-T1	Physical Layer Specifications (IEEE Std 802.3bp™-2016) a parameter for 1 Gb/s Operation over a Single Twisted-Pair Copper Cable section 97.7.2.1 MDI Return Loss not Transmitter Clock Frequency test.
100Base-T1	BroadR-Reach Physical Layer Transceiver Specification for Automotive Applications, version 3.2, section 96.8.2.1 BroadR-Reach Physical Media Attachment Test Suite version 2.0, section 5.6.

Steps to perform return loss measurement by oscilloscope method

Required test equipment

In addition to the DUT and oscilloscope, you need the following:

- Two supported differential probes
- Three BNC cables (for connecting AFG or AWG to fixture) or three SMA cables with two BNC to SMA connectors (for connecting AWG7K to fixture) and TCA-BNC or TCA-SMA adapters (auxiliary)
- AWG with bandwidth >= 600 MHz and high AC voltage option (for 1000Base-T1)
- Short RJ45 connector and short automotive cable.
- GPIB/LAN/USB cable to connect the oscilloscope to AWG and automate signal generation. Refer to *Automate AWG/AFG signal generation* and *Instrument configuration using TekVISA*.
- TF-XGbT test fixture and fixture with loads (Open, Short, and Load)

Test name	Requirements
Signal type	100Base-T1  1000Base-T1 

Test setup procedure

Return Loss measurement has two steps to run the test:

1. Fixture calibration using Open, Load, and Short circuit
2. Perform the return loss test

Steps to perform fixture calibration using Open, Load, and Short circuit

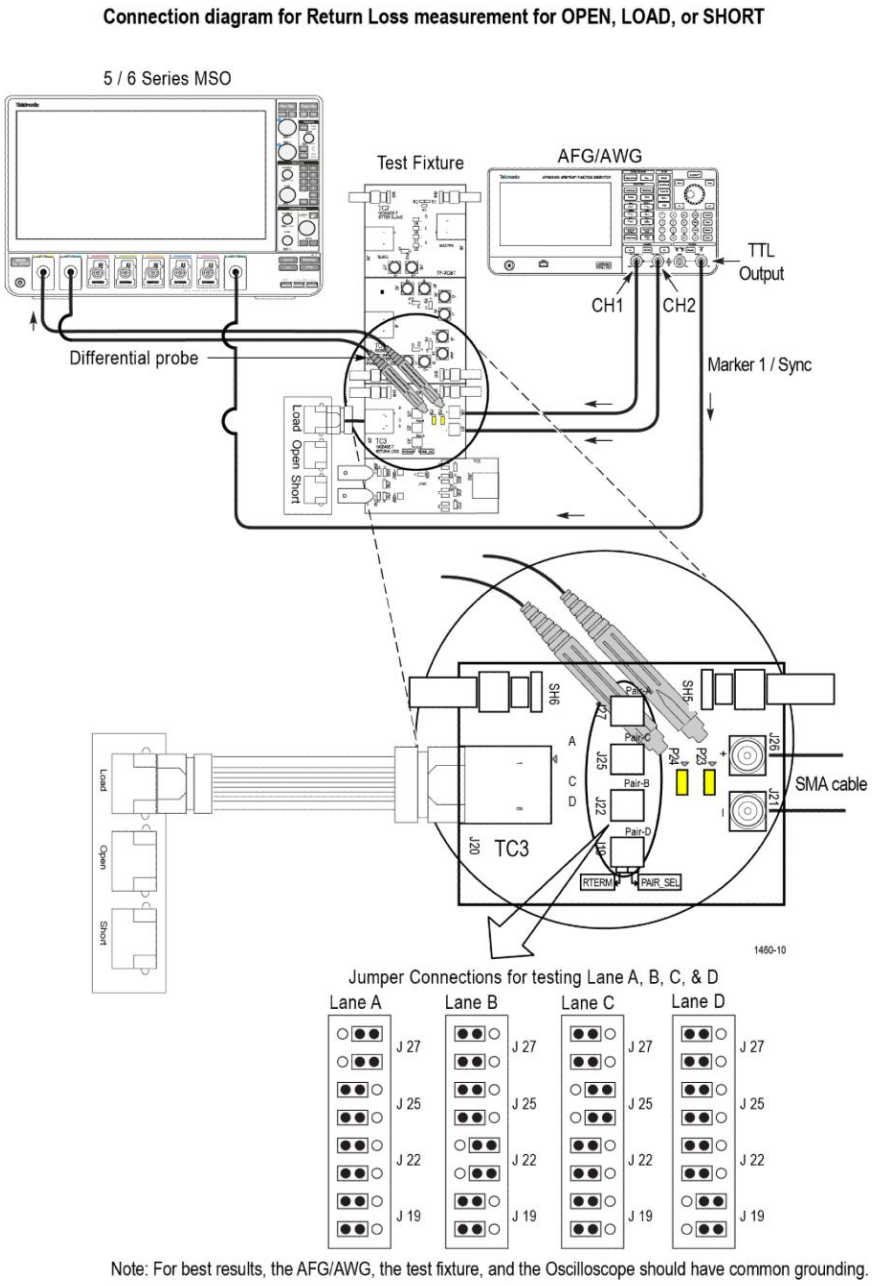


Figure 70: Fixture calibration using Open, Load, and Short circuit

NOTE. *Ensure that the "+" on the probe tip aligns with ▶ on the text fixture board. This takes care of the polarity being not reversed.*

1. Connect the equipment as shown in the connection diagram.
2. Open the Instrument Control settings from the Option menu.
3. Select the options from the Search Criteria and click **Refresh** button.

   Wait for the signal source to display in list. If you are using LAN connect, follow the LAN configuration steps before doing these steps.

4. Click the **Global Settings** tab on the Test selection panel to view the listed instruments.
5. Click **Calibration** tab and then press the RUN button corresponding to Open / Load / Short calibration; then the selected AWG instrument automatically load with calibration pattern.

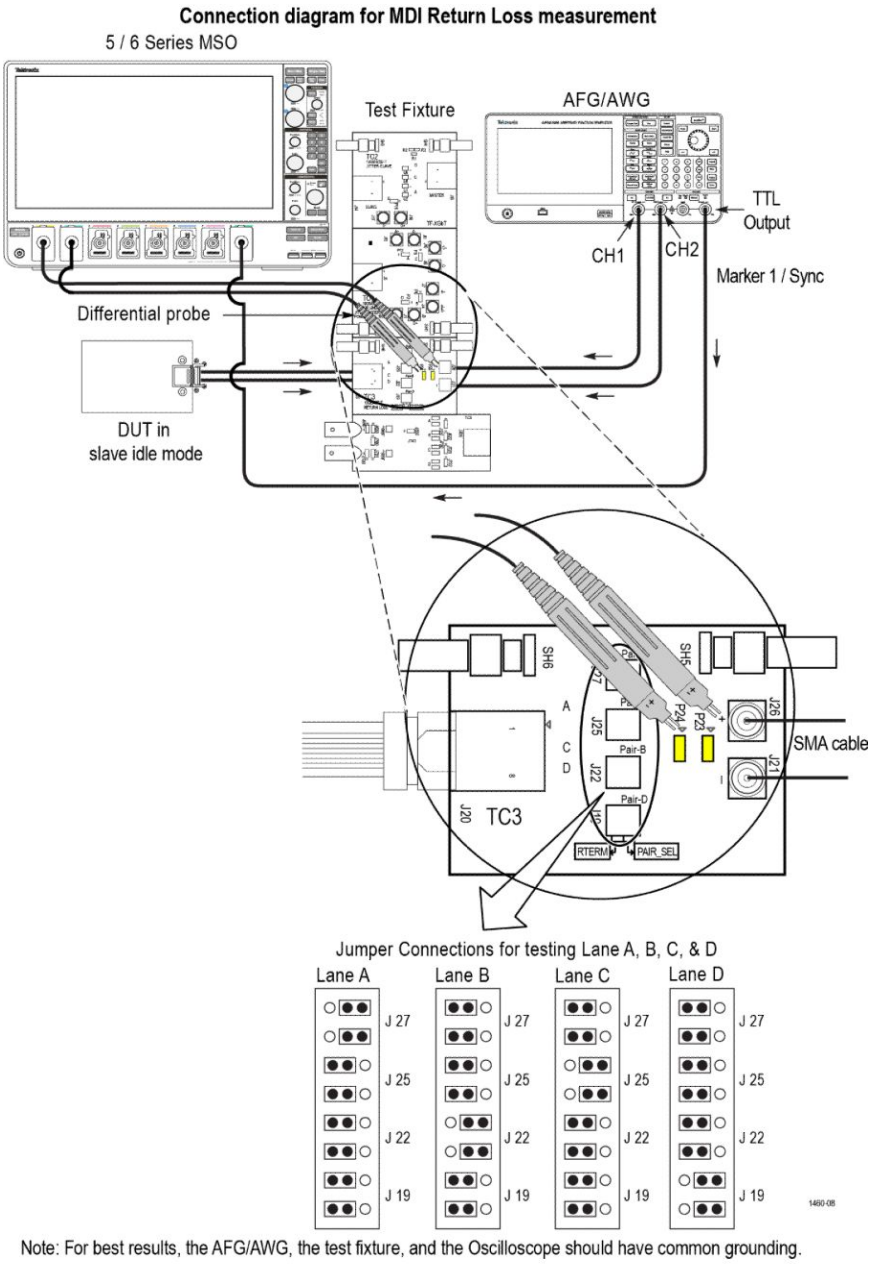
NOTE.

If TF-XGbT is being used, ensure that Channel 1 is connected to P23 of TC3 and Channel 2 to P24 of TC3. Do not reverse Channel 1 to P2 and Channel 2 to P1; this will affect the machine.

If TF-GBE-BTP is being used, ensure that Channel 1 is connected to P1 of TC1 and Channel 2 to P2 of TC1. Do not reverse Channel 1 to P2 and Channel 2 to P1; this will affect the machine.

When you perform Return Loss measurement in 1000BASE-T1 suite, the recommended signal source is AWG5200. Make sure the CH1(+) of AWG is connected to J26(+), CH1(-) of AWG is connected to J21(-) and marker 1:1 is connected to the user selected sync input channel of the oscilloscope.

Steps to perform the return loss test after calibration



Note: For best results, the AFG/AWG, the test fixture, and the Oscilloscope should have common grounding.

Figure 71: Connection diagram for Return Loss test with AFG/AWG

NOTE. *Ensure that the "+" on the probe tip aligns with ▶ on the text fixture board. This takes care of the polarity being not reversed.*

1. After the completion of the Load, Open, and Short calibration in LIVE mode, click the **Apply** button in the Calibration tab. If the Calibration is Run with just near time, use the Use Pre-Recorded Files and select the File path and click **Apply**.
2. Connect the DUT setup as shown in above figure.

3. Configure the DUT for SLAVE IDLE mode of operation.
4. Connect the DUT with one end of 4-inch Automotive Ethernet cable and another end to RJ45 J20 of TC3. Connection for the AWG is as show in below images
5. Click the **Start** button to measure the reflections at the MDI referenced to a 100Ω characteristic impedance.

The measurement will Run and navigate to the Results panel.

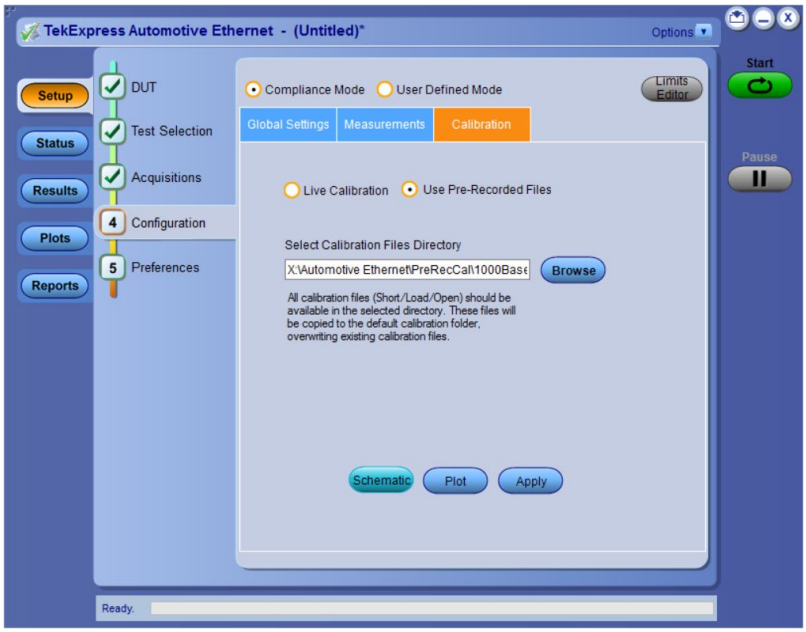
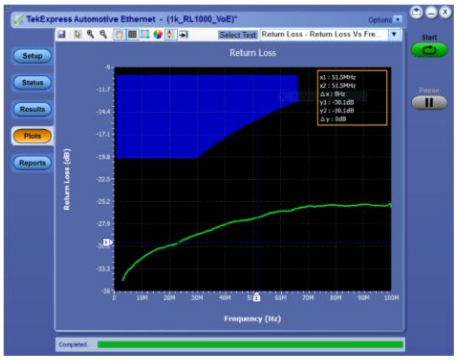
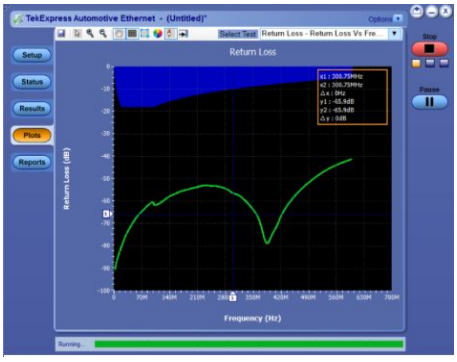


Figure 72: Pre-recorded calibration file

Figure 73: Live Calibration

Table 27: Limits

	Lower limit	Upper limit
100Base-T1	NA	$\text{MDI return loss}\,(f) \geq \begin{cases} 20\ \text{dB} & \text{for}\ \ 1\ \text{MHz} \leq f \leq 30\ \text{MHz} \\ 20 - 20 \times \log_{10}\left(\frac{f}{30}\right)\ \text{dB} & \text{for}\ \ 30\ \text{MHz} \leq f \leq 66\ \text{MHz} \end{cases}$ where MDI return loss(f) is the MDI return loss at frequency f f is the frequency in MHz 
1000Base-T1	NA	$\text{Return Loss}(f) \geq \begin{cases} 18 - 18\log_{10}\frac{20}{f} & 2 \leq f < 20 \\ 18 & 20 \leq f < 100 \\ 18 - 16.7\log_{10}\frac{f}{100} & 100 \leq f \leq 600 \end{cases}\ \text{dB}$ where f is the frequency in MHz. 

Steps to perform return loss measurement by VNA Report

1. Select **Setup** > **DUT**.
2. In the DUT tab:
   a. Select Return Loss Measurement preferences as **VNA Report**.
   b. Select View as **Advanced**.
3. Select **Configuration** > **Global Settings**.
4. Click **Browse** and select the VNA Result file.
5. Click **Start** to run the measurement.
6. Select **Results** panel to view the measurement statistics and Pass/Fail status.
7. After the test execution is complete, the detailed report is displayed.

See also *Plots*

SCPI Commands

About SCPI command

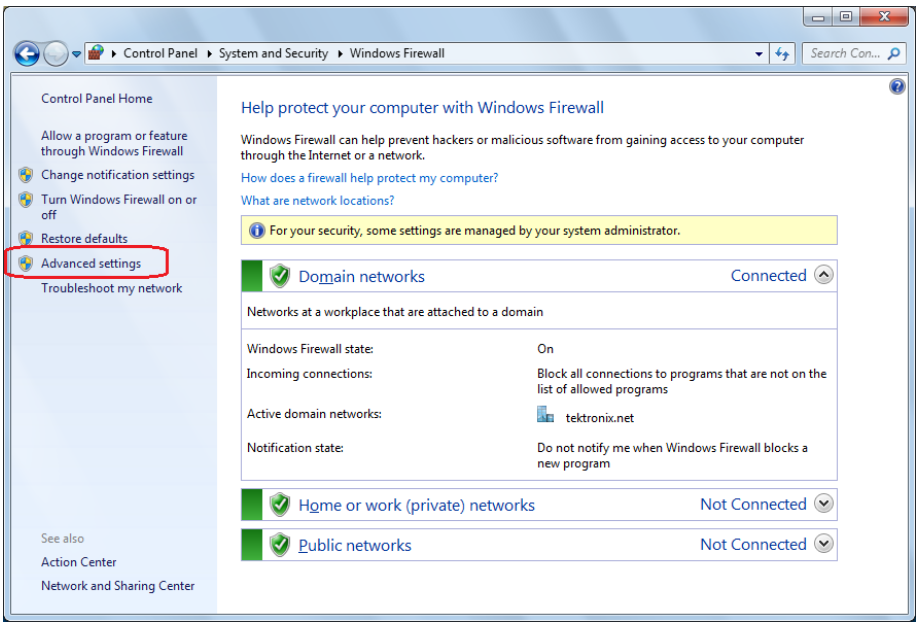
You can use Standard Commands for Programmable Instruments (SCPI) to communicate with the TekExpress application.

Socket configuration for SCPI commands

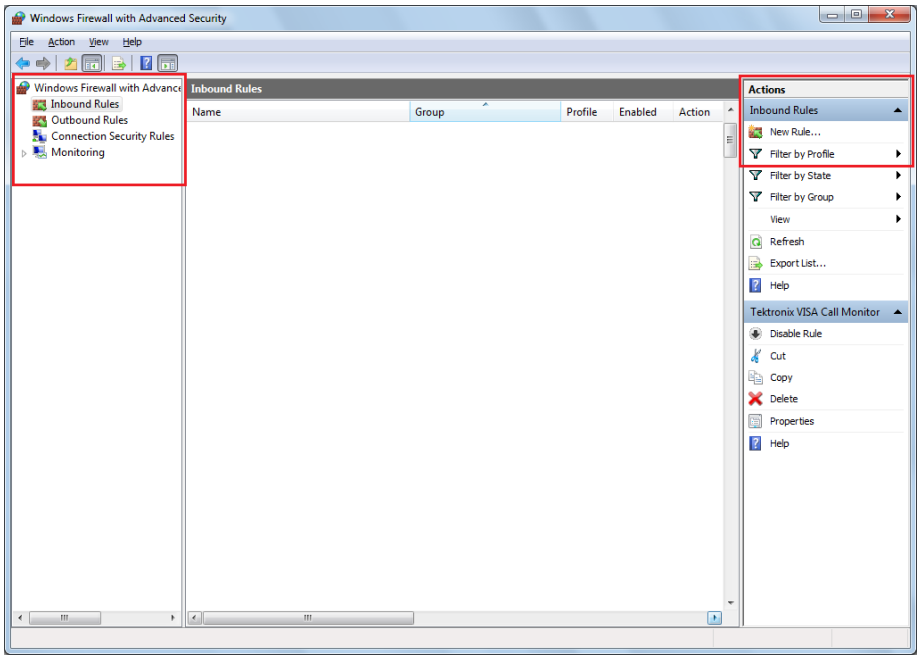
This section describes the steps for TCPIP socket configuration and TekVISA configuration to execute the SCPI commands.

TCPIP socket configuration

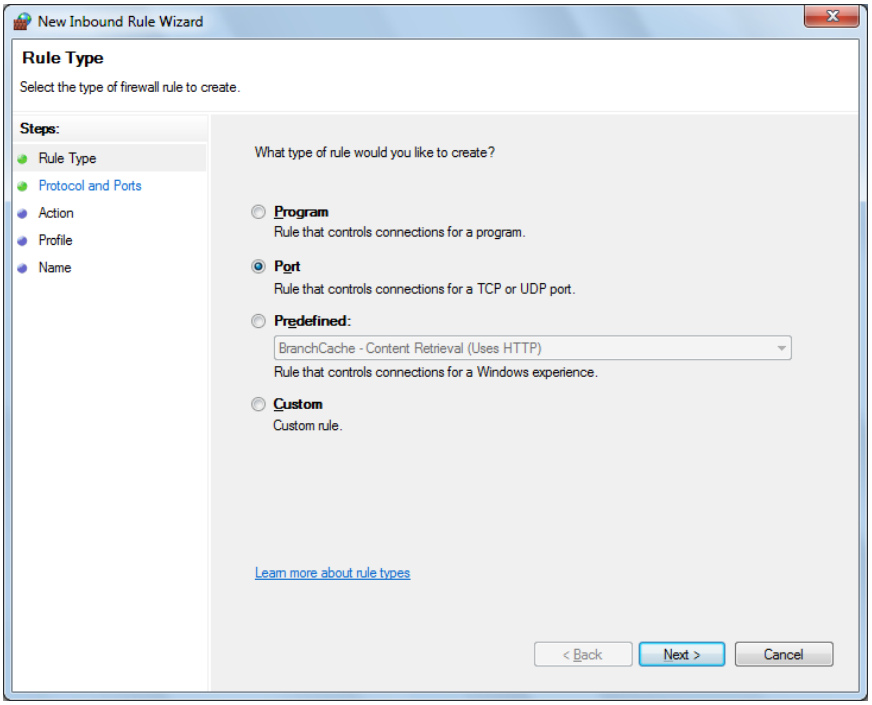
1. Click **Start** > **Control Panel** > **System and Security** > **Windows Firewall** > **Advanced settings**.



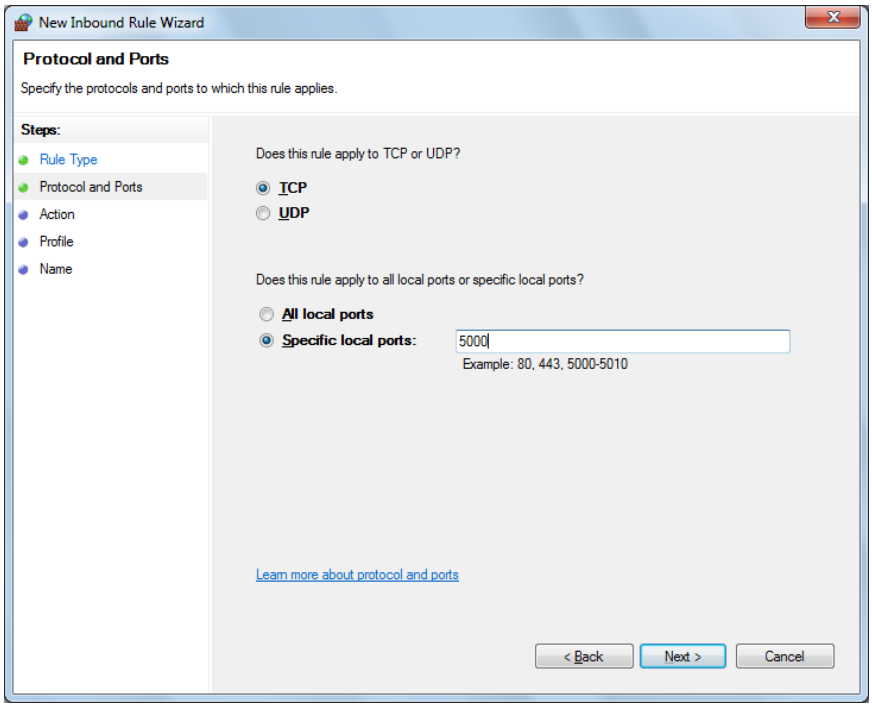
2. In Windows Firewall with Advanced Security menu, select **Windows Firewall with Advanced Security on Local Computer** > **Inbound Rules** and click New Rule…



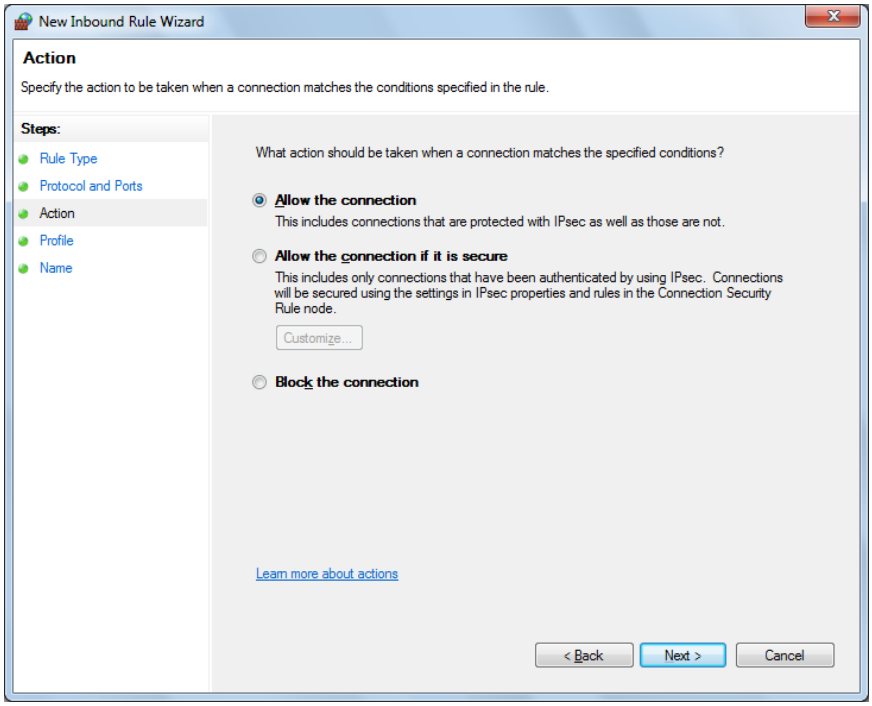
3. In New Inbound Rule Wizard menu
   a. Select **Port** and click **Next**.



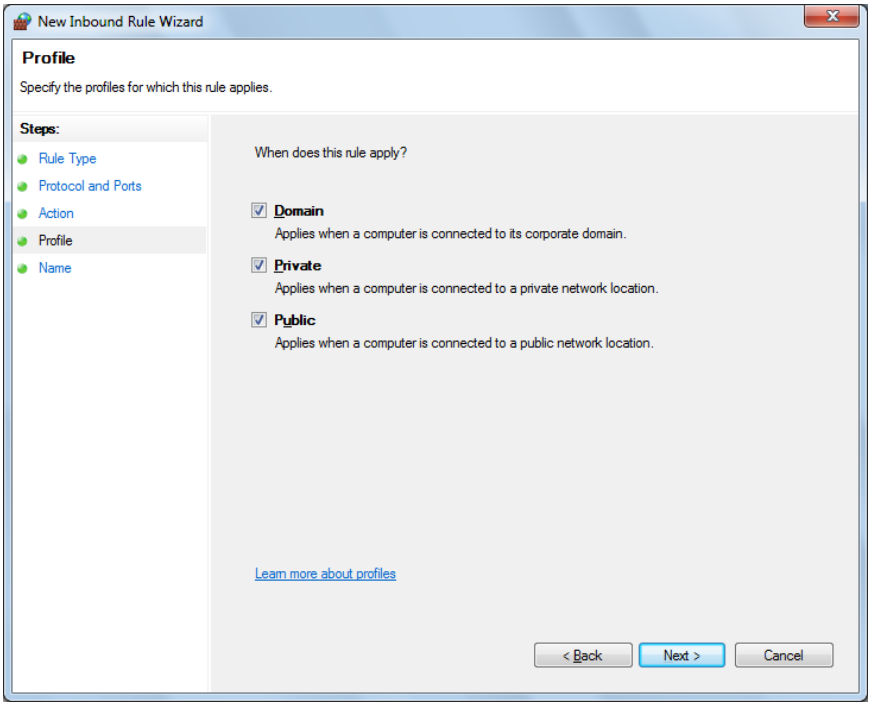
b. Select **TCP** as rule apply and enter 5000 for **Specific local ports** and click **Next**.



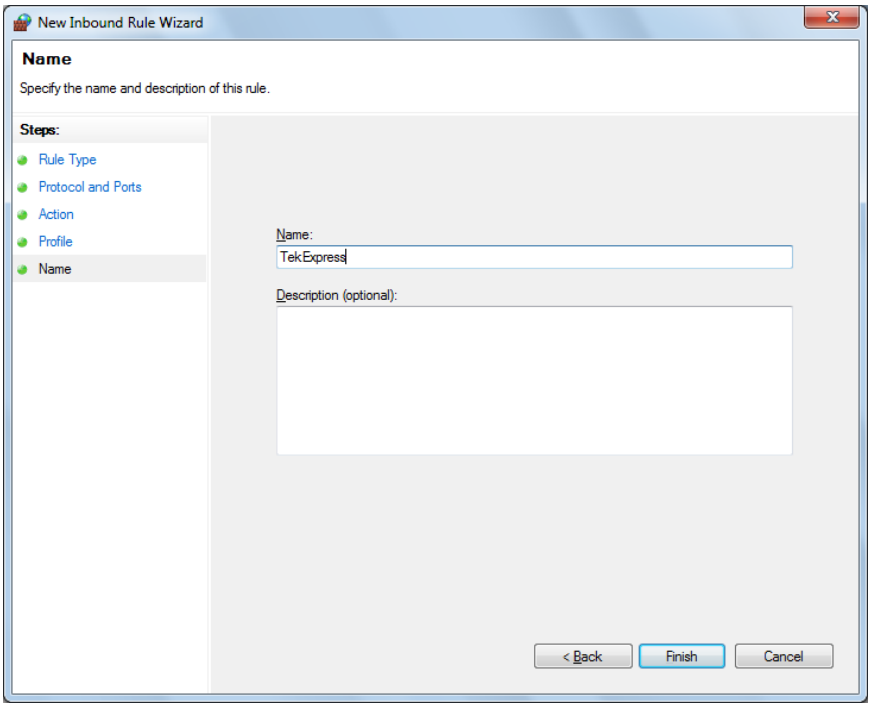
c. Select **Allow the connection** and click **Next**.



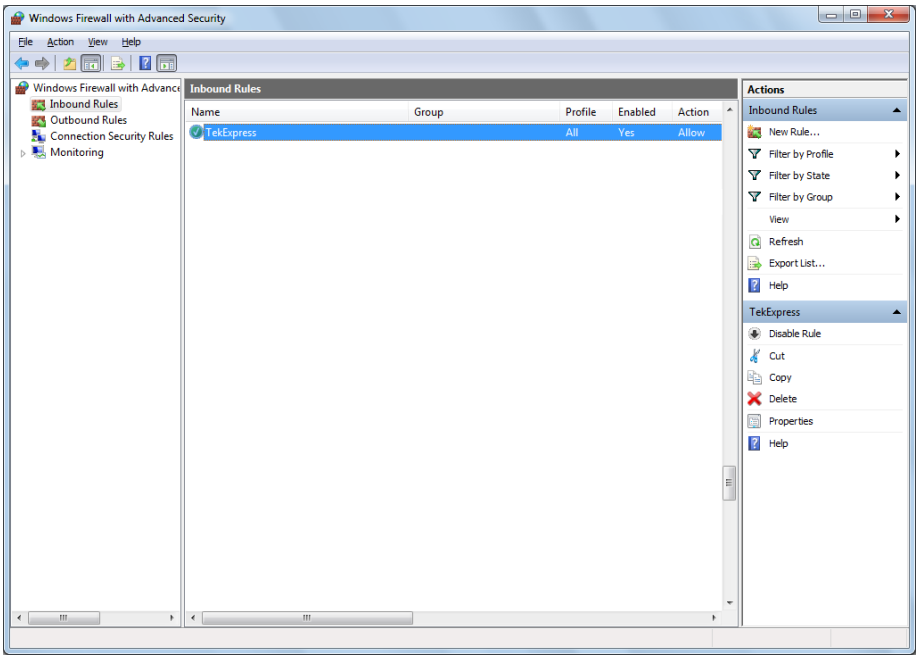
d. Select **Domain, Private, Public** and click **Next**.



e. Enter **Name**, Description (optional), and click **Finish**.

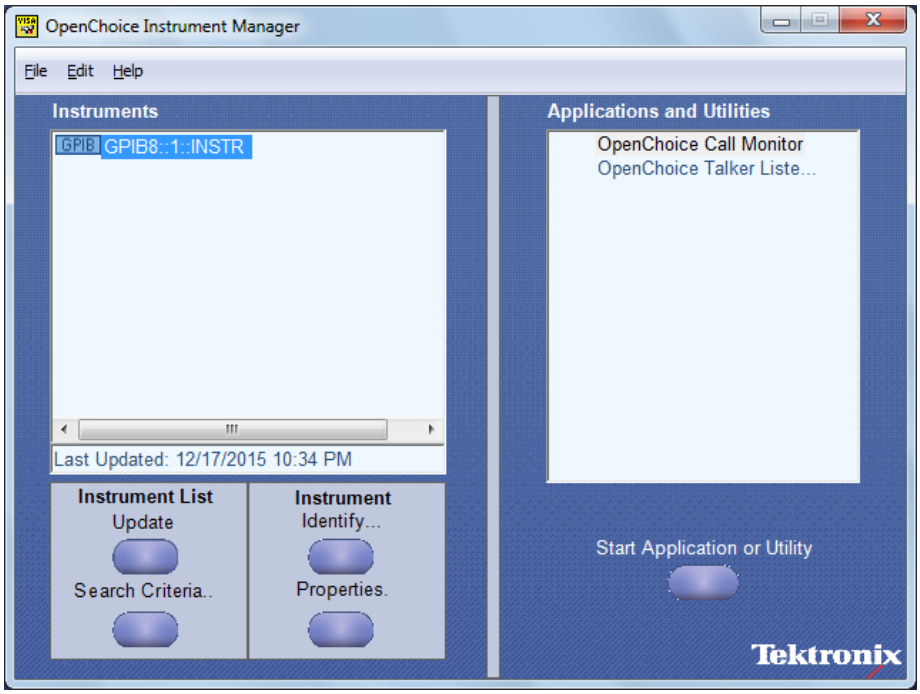


4. Check whether the Rule name is displayed in **Windows Firewall with Advanced Security menu** > **Inbound Rules**.



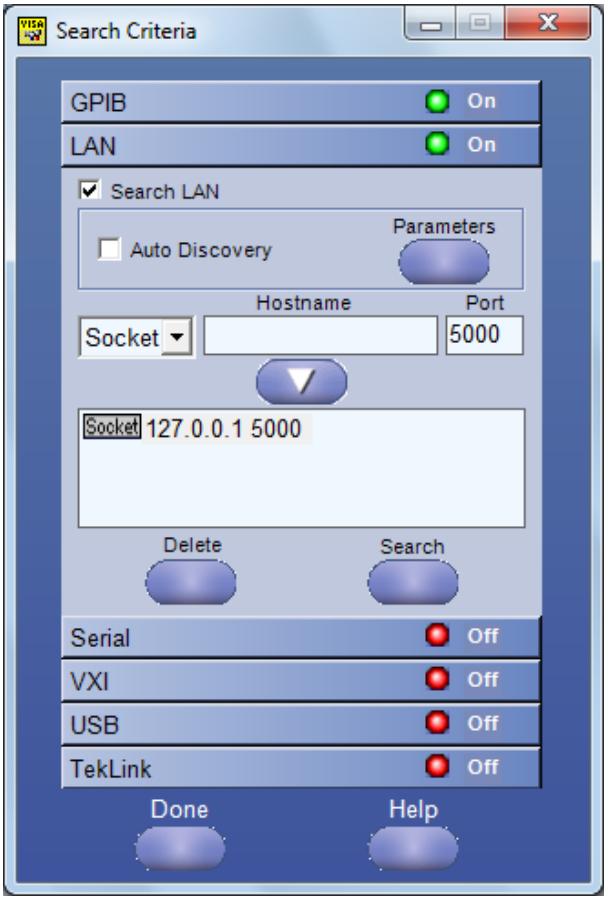
TekVISA configuration

1. Click **Start** > **All Programs** > **TekVISA** > **OpenChoice Instrument Manager**.

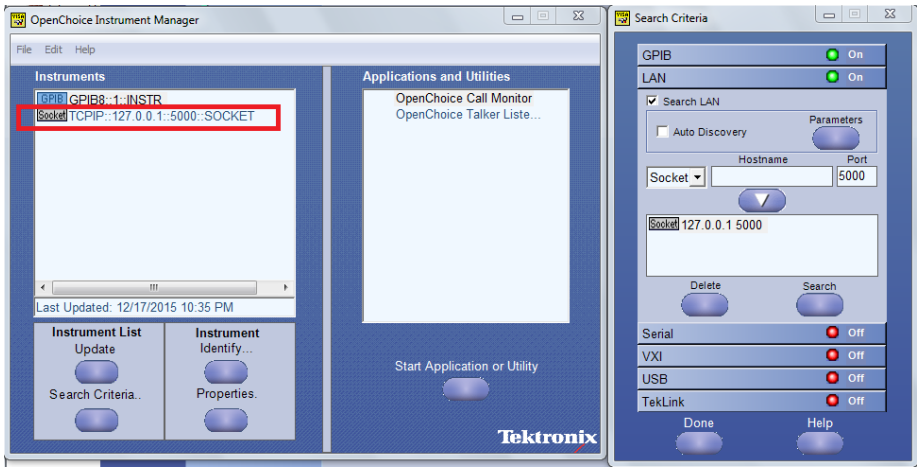


2. Click **Search Criteria**. In Search Criteria menu, click **LAN** to Turn-on. Select **Socket** from the drop-down list, enter the IP address of the TekExpress device in **Hostname** and type **Port** as 5000. Click  to configure the IP address with Port.

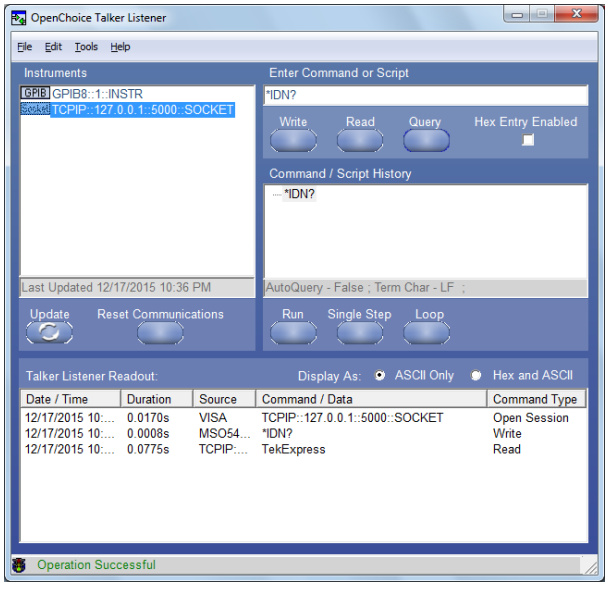
   Enter the Hostname as 127.0.0.1 if the TekVISA and TekExpress application are in the same system, else enter the IP address of the TekExpress application system.



3. Click **Search** to setup the TCPIP connection with the host. Check whether the TCPIP host name is displayed in **OpenChoice Instrument Manager** > **Instruments**.



4. Double-click **OpenChoice Talker Listener** and enter the Command *IDN? in command entry field and click **Query**. Check that the Operation is successful and Talker Listener Readout displays the Command / Data.



TEKEXP:*IDN?

This command queries the active TekExpress application name running on the oscilloscope.

Syntax TEKEXP:*IDN?\n

Inputs NA

Outputs Returns active TekExpress application name running on the oscilloscope.

TEKEXP:*OPC?

This command queries the execution status of the last executed command.

Syntax TEKEXP:*OPC?\n

Inputs NA

Outputs 0 - last command execution is not complete

1 - last command execution is complete

TEKEXP:ACQUIRE_MODE

This command sets the acquire mode as live or pre-recorded.

Syntax TEKEXP:ACQUIRE_MODE {LIVE | PRE-RECORDED}\n

Inputs {LIVE | PRE-RECORDED}

Outputs NA

TEKEXP:ACQUIRE_MODE?

This command queries the acquire mode type.

Syntax TEKEXP:ACQUIRE_MODE?\n

Inputs NA

Outputs {LIVE | PRE-RECORDED}

TEKEXP:EXPORT

This command returns all the bytes of data to the specified file.

Syntax	Outputs
TEKEXP:EXPORT REPORT\n	Returns the report file in bytes
TEKEXP:EXPORT WFM,"<FileName>"\n	Returns the specified waveform file in bytes
TEKEXP:EXPORT IMAGE,"<FileName>"\n	Returns the specified image file in bytes

Inputs FileName - Specifies the file name

TEKEXP:INFO?

This command queries the information about the file(s).

Syntax	Outputs
TEKEXP:INFO? REPORT\n	<ReportFileSize>,"<ReportFileName.mht>"
TEKEXP:INFO? WFM \n	<WfmFile1Size>,"<WfmFileName1.wfm>";<WfmFile2Size>,"<WfmFileName2.wfm>";...
TEKEXP:INFO? IMAGE\n	<Image1FileSize>,"<Image1FileName>";<Image2FileSize>,"<Image2FileName>" ;...

TEKEXP:INSTRUMENT

This command sets the value for the selected instrument type.

Syntax TEKEXP:INSTRUMENT "<InstrumentType>",<Value>"\n

Inputs InstrumentType

Value

TIP. *Check Command parameters list section for InstrumentType and Value parameters.*

Outputs NA

TEKEXP:INSTRUMENT?

This command queries the instrument selected for the specified instrument type.

Syntax TEKEXP:INSTRUMENT? "<InstrumentType>"\n

Inputs InstrumentType

TIP. *Check Command parameters list section for InstrumentType parameters.*

Outputs Returns the instrument selected for the specified instrument type

TEKEXP:LASTERROR?

This command queries the last error string occurred for the current TCP session. If there are no errors since startup, or since the last call to TEKEXP:LASTERROR?\n, this command returns an empty string.

Syntax TEKEXP:LASTERROR?\n

Inputs NA

Outputs <string>

TEKEXP:LIST?

This command queries the list of available device, suite, test, version or instrument.

Syntax	Outputs
TEKEXP:LIST? DEVICE\n	Returns the list of available device(s) as comma separated values.
TEKEXP:LIST? SUITE\n	Returns the list of available suite(s) as comma separated values.
TEKEXP:LIST? TEST\n	Returns the list of available test(s) as comma separated values.
TEKEXP:LIST? VERSION\n	Returns the list of available version(s) as comma separated values.
TEKEXP:LIST? INSTRUMENT,"<InstrumentType>"\n	Returns the list of available instruments' for the given Instrument type as comma separated values.

NOTE. *This command returns the list of items within double quotes (""). Iterate the receive procedure until the list ends with double quotes otherwise the next query commands won't work as expected.*

Inputs InstrumentType

TIP. *Check Command parameters list section for InstrumentType parameters.*

TEKEXP:MODE

This command sets the execution mode as compliance or user defined.

Syntax TEKEXP:MODE {COMPLIANCE | USER-DEFINED}\n

Inputs {COMPLIANCE | USER-DEFINED}

Outputs NA

TEKEXP:MODE?

This command queries the execution mode type.

Syntax TEKEXP:MODE?\n

Inputs NA

Outputs {COMPLIANCE | USER-DEFINED}

TEKEXP:POPUP

This command sets the response to the active popup shown in the application.

Syntax TEKEXP:POPUP “<PopupResponse>”\n

Inputs PopupResponse

Outputs NA

TEKEXP:POPUP?

This command queries the active popup information shown in the application.

Syntax TEKEXP:POPUP?\n

Inputs NA

Outputs Returns the active popup information in the application.

TEKEXP:REPORT

This command generates the report for the current session.

Syntax TEKEXP:REPORT GENERATE\n

Inputs GENERATE

Outputs NA

TEKEXP:REPORT?

This command queries the queried header field value in the report.

Syntax TEKEXP:REPORT? “<HeaderField>”\n

Inputs HeaderField - Specifies to return the measured value for the indicated test.

TIP. *Check* ***Report*** *for HeaderField parameters.*

Outputs Returns the queried header field value in the report

TEKEXP:RESULT?

This command queries the result available in report summary/details table.

Syntax	Outputs
TEKEXP:RESULT? "<TestName>"\n	Return Pass/Fail status of the test.
TEKEXP:RESULT? "<TestName>","<ColumnName>"\n	Returns all the row values of the specified column for the test.
TEKEXP:RESULT? "<TestName>","<ColumnName>",<RowNumber>\n	Returns the column value for the specified row number [1]

Inputs

TestName - Specifies the name of the test for which to obtain the test result value.

ColumnName - Specifies the column name for the measurement

RowNumber - Specifies the row number of the measurement

TIP. *Check* ***Results*** *panel for TestName, ColumnName, and RowNumber parameters.*

[1] Row number starts from zero.

TEKEXP:SELECT

This command selects the device, suite, version, or test.

Syntax

TEKEXP:SELECT <string1>,<string2>,<string4>\n

TEKEXP:SELECT TEST,<string3>,<string4>\n

Inputs

<string1> = {DEVICE | SUITE | VERSION}

<string2> = {DeviceName | SuiteName | VersionName}

<string3> = {"<TestName>"| ALL| REQUIRED }

<string4> = {TRUE | FALSE}

TIP. *Check Command parameters list section for DeviceName, SuiteName, VersionName, and TestName parameters.*

Outputs

NA

TEKEXP:SELECT?

This command queries the name of the selected device, suite, version, or test.

Syntax

TEKEXP:SELECT? {DEVICE | SUITE | TEST | VERSION}\n

Inputs

{DEVICE | SUITE | TEST | VERSION}

Outputs Returns the name of the selected device, suite, version, or test.

TEKEXP:SETUP

This command sets the value of the current setup.

Syntax	Outputs
TEKEXP:SETUP DEFAULT\n	Restore to default Setup
TEKEXP:SETUP OPEN,"<SessionName>"\n	Open the session
TEKEXP:SETUP SAVE\n	Saves the already existing modified session
TEKEXP:SETUP SAVE,"<SessionName>"\n	Save the session

Inputs SessionName - The name of the session

TEKEXP:STATE

This command sets the execution state of the application.

Syntax TEKEXP:STATE {RUN | STOP | PAUSE | RESUME}\n

Inputs {RUN | STOP | PAUSE | RESUME}

Outputs NA

TEKEXP:STATE?

This command queries the current setup state.

Syntax	Outputs
TEKEXP:STATE?	RUNNING | PAUSED | WAIT | ERROR | READY
TEKEXP:STATE? SETUP	SAVED | NOT_SAVED

TEKEXP:VALUE

This command sets the value of parameters of type General, Acquire, Analyze, or DUTID.

Syntax

TEKEXP:VALUE GENERAL,"<ParameterName>",“<Value>”\n

TEKEXP:VALUE ACQUIRE,“<TestName>","<AcquireType>", "<ParameterName>",“<Value>”\n

TEKEXP:VALUE ANALYZE,“<TestName>","<ParameterName>".“<Value>” \n

TEKEXP:VALUE DUTID,“<Value>”\n

TEKEXP:VALUE VERBOSE,{TRUE | FALSE}\n

TEKEXP:VALUE WFMFILE,<Test_Name>,<Aquire_Type>,<FilesName1$FileName2>\n

Inputs

ParameterName - Specifies the parameter name

TestName - Specifies the test name

AcquireType - Specifies the acquire type

Value - Specifes the value to set

FilesName1$FileName2 - Specifies the waveform file name

TRUE - Pop-ups are enabled

FALSE - Pop-ups are disabled

TIP. *Check Command parameters list section for ParameterName, AcquireType, and Value parameters.*

Outputs NA

TEKEXP:VALUE?

This command queries the value of the parameter for type General, Acquire, Analyze, or DUTID.

Syntax	Outputs
TEKEXP:VALUE? GENERAL,"<ParameterName>"\n	Returns the value of Parameter for type GENERAL
TEKEXP:VALUE? ACQUIRE,“<TestName>", "<AcquireType>","<ParameterName>"\n	Returns the value of Parameter for type ACQUIRE
TEKEXP:VALUE? ANALYZE, “<TestName>","<ParameterName>"\n	Returns the value of Parameter for type ANALYZE
TEKEXP:VALUE? DUTID\n	Returns the DUTID value
TEKEXP:VALUE? WFMFILE,<Test_Name>,<Aquire_Type>\n	Returns the waveform file name
TEKEXP:VALUE? VERBOSE	Returns the verbose mode type

Inputs ParameterName - Specifies the parameter name

TestName - Specifies the test name

AcquireType - Specifies the acquire type

TRUE - Pop-ups are enabled

FALSE - Pop-ups are disabled

TIP. *Check Command parameters list section for ParameterName and AcquireType parameters.*

Outputs Returns the value of Parameter for type GENERAL | ACQUIRE | ANALYZE | DUTID.

Command parameters

This section provides the parameters list for the SCPI commands.

ParameterName and Value for DUT, Test selection, Acquisition, Configuration and Preferences tabs

Specifies the ParameterName and Value for DUT, Test selection, Acquisition, Configuration and Preferences tabs

Table 28: ParameterName and Value for DUT tab

Parameters	Description
DUT ID	Specifies the value parameters. ■ For DUTID, valid value is: ■ Comment
Acquiremode	Specifies the acquire mode parameters ■ Acquire live waveforms ■ Use pre-recorded waveform files.
Suite	Sets the suite. ■ 100Base-T1 ■ 1000Base-T1

Table 29: ParameterName and Value for Test selection tab

Parameters	Description
TestName	Specifies the test measurement name. Valid values are: ■ Transmit Clock Frequency ■ Transmitter Timing Jitter-Master Jitter ■ Transmitter Timing Jitter-Slave Jitter ■ Transmitter Output Droop ■ Transmitter Power Spectral Density ■ Transmitter Distortion ■ Return Loss ■ Return Loss Calibration

Table 30: ParameterName and Value for Acquisitions tab

Parameters	Description
Probe1, Probe 2	Specifies the probe source channel for each listed signal. Valid values are: ■ CH1 ■ CH2 ■ CH3 ■ CH4
Show Acquire Parameters	TRUE or FALSE
Acquire Step By Step	TRUE or FALSE
Signal Validation	■ Prompt me if signal fails ■ Use signal as it is-Don't check ■ Skip test if signal fails

Table 31: ParameterName and Value for Preferences tab

Parameters	Description
On Test Failure, stop and notify me of the failure	TRUE or FALSE

ParameterName and Value for General, Acquire and Analyze

Specifies the ParameterName and Value for General, Acquire and Analyze. The configuration parameters available are not same for measurements.

Table 32: ParameterName and Value for General

ParameterName	Value
Report Update Mode	■ New ■ Append ■ Replace
Report Creating Settings	
Report name	X:\BRR\Reports\DUT001.mht
Save As Type	■ Web Archive (*.mht;*.mhtml) ■ PDF (*.pdf;)
Auto increment report name if duplicate	TRUE or FALSE
Create report at the end	■ Included ■ Excluded

ParameterName	Value
Upload logo	Need info
Contents to Save	
Include Pass/Fail Results Summary	TRUE or FALSE
Include Detailed Results	TRUE or FALSE
Include Plot Images	TRUE or FALSE
Include Setup Configuration	TRUE or FALSE
Include Complete Application Configuration	TRUE or FALSE
Include User Comments	TRUE or FALSE

Table 33: ParameterName and Value for Acquire

Test Name	ParameterName	AcquireType	Value
Transmit Clock Frequency	Record Length		1 to 20
TransmitterTiming Jitter-Master Jitter	Record Length		1 to 20
Transmittter Timing Jitter-Slave Jitter	Record Length		1 to 20
Transmitter Output Droop	Averages		2 to 100
Transmitter Power Spectral Density	Averages		2 to 256
Transmitter Distortion	No Configuration Available		NA
Return Loss	Averages		2 to 512

Table 34: ParameterName and Value for Analyze

Test Name	ParameterName	AcquireType	Value
Transmit Clock Frequency	NA		NA
TransmitterTiming Jitter-Master Jitter	Edge ■ Falling ■ Rising		NA
	Hysteresis		Need info
Transmittter Timing Jitter-Slave Jitter	Edge ■ Falling ■ Rising		Need info
	Hysteresis		Need info

Test Name	ParameterName	AcquireType	Value
Transmitter Output Droop	NA		NA
Transmitter Power Spectral Density	RBW		1 to 100
	Center Frequency		1 to 500
	Frequency Span		1 to 500
Transmitter Distortion	No Configuration Available		NA
Return Loss	Smooth		0 to 10

Examples

This section provides the examples for the SCPI commands.

Example	Description
TEKEXP:*IDN?	It returns the active TekExpress application name running on the scope.
TEKEXP:*OPC?	It returns the last command execution status.
TEKEXP:ACQUIRE_MODE PRE-RECORDED	It sets the acquire mode as pre-recorded.
TEKEXP:ACQUIRE_MODE?	It returns LIVE when acquire mode is set to live.
TEKEXP:EXPORT REPORT	It returns the report file in bytes. This can be written into another file for further analysis.
TEKEXP:INFO? REPORT	It returns "100,"ReportFileName.mht"", when 100 is the filesize in bytes for the filename ReportFileName.
TEKEXP:INFO? WFM	It returns "100,"WfmFileName1.wfm"";"200,"WfmFileName2.wfm"" when 100 is the filesize in bytes for the filename WfmFileName1.wfm and 200 is the filesize in bytes for the filename WfmFileName2.wfm.
TEKEXP:INSTRUMENT "Real Time Scope",MSO58 (GPIB8::1::INSTR)	It sets the instrument value as MSO58 (GPIB8::1::INSTR) for the selected instrument type Real Time Scope.
TEKEXP:INSTRUMENT? "Real Time Scope"	It returns "MSO58 (GPIB8::1::INSTR), when MSO58 (GPIB8::1::INSTR)" is the selected instrument for the instrument type Real Time Scope.
TEKEXP:LASTERROR?	It returns ERROR: INSTRUMENT_NOT_FOUND, when no instrument is found.
TEKEXP:LIST? INSTRUMENT,"Real Time Scope"	It returns "MSO58 (GPIB8::1::INSTR),MSO64 (TCPIP::134.64.248.91::INSTR)" when MSO58 (GPIB8::1::INSTR), MSO64 (TCPIP::134.64.248.91::INSTR) are the list of available instruments.
TEKEXP:MODE COMPLIANCE	It sets the execution mode as compliance.
TEKEXP:MODE?	It returns COMPLIANCE when the execution mode is compliance.
TEKEXP:POPUP "OK"	It sets OK as the response to active popup in the application.
TEKEXP:POPUP?	It returns "OK", when OK is the active popup information shown in the application.

Example	Description
TEKEXP:REPORT GENERATE	It generates report for the current session.
TEKEXP:REPORT? "Scope Model"	It returns "MSO58" when MSO58 is the scope model.
TEKEXP:REPORT? "DUT ID"	It returns "DUT001" when DNI_DUT001 is the DUT ID.
TEKEXP:RESULT? "PeakVoltageD_Without_Disturber"	It returns Pass, then the test result is Pass.
TEKEXP:RESULT? "PeakVoltageD_Without_Disturber", "Margin"	It returns list of values then that is 'Margin' column data.
TEKEXP:RESULT? "PeakVoltageD_Without_Disturber", "Units",0	It returns the unit of the first row of result.
TEKEXP:SELECT TEST,"Transmitter Output Droop", TRUE	It selects "Transmitter Output Droop" measurement.
TEKEXP:SETUP DEFAULT	It restores the application to default setup.
TEKEXP:VALUE WFMFILE,"Transmitter Output Droop","Transmitter Output Droop Acquisition","C:\AutoEthernet_SCPI_TestSuite \RefWaveforms\100Base-T1\Transmitter_Output_Droop_TestMode1.wfm	It assigns the pre recorded waveform to the Droop measurement.
TEKEXP:VALUE? WFMFILE,,"Transmitter Output Droop","Transmitter Output Droop Acquisition"	It queries the pre recorded assigned waveform.
TEKEXP:VALUE GENERAL,"ReturnLoss Measurement Method","VNA Report"	It sets the return loss measurement preferences as VNA Report.
TEKEXP:VALUE? GENERAL,"ReturnLoss Measurement Method"	It returns the selection of return loss measurement preferences.
TEKEXP:VALUE GENERAL,"VNA Report File Path","C:\Users \Public\Tektronix\TekApplications\Automotive-Ethernet \ExampleSparamFiles\Example.s2p"	It sets VNA Result File to C:\Users\Public\Tektronix\TekApplications \Automotive-Ethernet\ExampleSparamFiles\Example.s2p.
TEKEXP:VALUE? GENERAL,"VNA Report File Path"	It returns the VNA result file path.

References

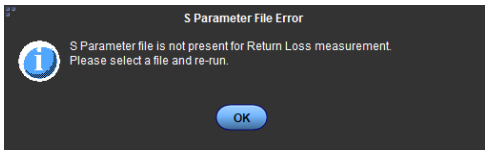
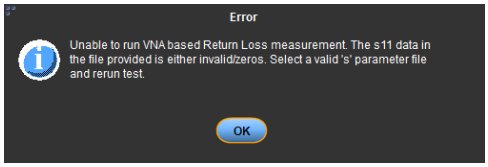
Measurement error messages

The following table lists all of the error messages associated with TekExpress Automotive Ethernet measurements and their definitions.

Table 35: Measurement error messages

Error message	Description
Transmitter Output Droop measurement (Test mode 1)	
Signal Validation failed for test mode 1. Make sure that input signal has: ■ Edge to Edge period deviation is less than 10% ■ At least 2 Unit Intervals	This error occurs if the input signal does not meet the requirements given in specification for test mode 1 signal. Edge to Edge period 33 unit intervals (500 ns)
Signal validation failed for test mode 1.Make sure that input signal has: ■ Rise to Rise period deviation is less than 10%.	This error occurs if the input signal has Rise to Rise period deviation of more than 10%. Rise to Rise period value (500 ns)
Signal validation failed for test mode 1.Make sure that input signal has: ■ Fall to Fall period deviation is less than 10%.	This error occurs if the input signal has Fall to Fall period deviation of more than 10%. Fall to Fall edge period value (500 ns)
Signal validation failed for test mode 1.Make sure that input signal has: ■ Edge to Edge period is greater than 500 nano seconds	This error occurs if the input signal does not meet the Edge to Edge period greater than 500 nano seconds.
Transmitter Clock Frequency measurement and Transmitter Timing Master Jitter measurements (Test mode 2)	
Signal Validation failed for test mode 2. Make sure that: ■ For 100Base-T1: The unit interval/frequency of the signal does not deviate beyond ± 100 ppm from 66(2/3) MHz. ■ For 1000Base-T1: The unit interval/frequency of the signal does not deviate beyond ± 100 ppm from 125 MHz.	For 100Base-T1: This error occurs if the input frequency of the acquired test mode 2 signal is varies beyond 66(2/3) MHz ± 100 ppm. For 1000Base-T1: This error occurs if the input frequency of the acquired test mode 2 signal is varies beyond 125 MHz ± 100 ppm.
Signal Validation failed for test mode 2. Ensure that input signal has: ■ Rise to Rise period deviation is less than 10%.	This error occurs if the input signal has Rise to Rise period deviation of more than 10%.

Error message	Description
Signal Validation failed for test mode 2. Ensure that input signal has: ■ Fall to Fall period deviation is less than 10%.	This error occurs if the input signal has Fall to Fall period deviation of more than 10%.
Signal validation failed for test mode 2.Make sure that input signal has: ■ For 100Base-T1: Edge to Edge period deviation is less than 10% compared to 66(2/3) MHz Tx_Clk. For 1000Base-T1: Edge to Edge period deviation is less than 10% compared to 125 MHz Tx_Clk. ■ At least 2 Unit Intervals, ■ Input is not clock signal (test mode 2).	This error occurs if the input signal has: ■ For 100Base-T1: Edge to Edge period deviation is more than 10% compared to 66(2/3) MHz Tx_Clk. For 1000Base-T1: Edge to Edge period deviation is more than 10% compared to 125 MHz Tx_Clk. ■ More than two cycles are need to execute the measurement. ■ Input signal is not a clock signal (test mode 2).
Transmitter Timing Slave Jitter Measurement (Test mode 3)	
Signal validation failed for TX_TCLK signal. Make sure that: ■ The Edge to Edge deviation is less than 10%.	This error occurs if the input signal does not meet the requirements given in specification for TX_TCLK signal.
Signal validation failed for TX_TCLK signal. Make sure that input signal has: ■ Rise to Rise period deviation is less than 10%.	This error occurs if the input signal does not meet the requirements given in specification for TX_TCLK signal.
Signal validation failed for TX_TCLK signal. Make sure that input signal has: ■ Fall to Fall period deviation is less than 10%.	This error occurs if the input signal does not meet the requirements given in specification for TX_TCLK signal.
Transmitter Distortion and Return Loss Measurement (Test mode 4)	
Signal Validation failed for test mode 4. Ensure that input signal: ■ Is PAM3 modulated ■ Has at least 3 frames of test mode 4 (2047 bits). ■ The common possible cause could be polarity of the probing points being reversed. Ensure Probe tip '+' aligns with '<' on the test fixture board.	This error will occur if the input signal does not meet the requirements given in specification for test mode 4 signal.

Error message	Description
Signal Validation failed for test mode 4. Ensure that: ■ For 100Base-T1: Interval/frequency of the Clock signal does not deviate beyond ± 100 ppm from 66(2/3) MHz. For 1000Base-T1: Interval/frequency of the Clock signal does not deviate beyond ± 100 ppm from 125 MHz.	This error occurs if the input signal does not meet the requirements given in specification for test mode 4 signal. Follow the instruction and step 3. For more information, see *Table 20: Measurement setup and algorithm*.
Return Loss and Power Spectral Density Measurement (Test mode 5)	
Calibration files are not present for return loss measurement. Either Deselect the Measurement or Stop the Execution, Perform Calibration and Re-Run the test.	This error occurs if return loss measurement is executed without calibration files. Always run the calibration and then execute return loss measurement. If calibration is done, return loss measurement uses latest available calibration files.
Return Loss Measurement (Test mode is Slave Idle)	
S parameter file is not present for Return Loss measurement. Please select a file and re-run. 	This error occurs if the VNA Result file is not selected in **Configuration** > **Global Settings**.
Unable to run VNA based Return Loss measurement. The S11 data in the file provided is either invalid/zeros. Select a valid 's' parameter file and rerun test. 	The S11 data in the VNA result file selected for the Return Loss measurement is either invalid or zero. Select a VNA result file with valid 's' parameter and re-run the test.
Error message applicable to all tests	
Not Enough Edges in the Waveform. Acquire the waveform for a longer duration.	This error occurs If the input signal does not have enough rise to fall and fall to rise transitions.
Data points acquired is insufficient for moving average filtering. Set the start frequency, stop frequency and RBW such that (stop frequency - start frequency)/RBW is greater than 3.	User should check the start frequency, stop frequency and RBW setting. This error will occur If the waveform does not have enough frequencies between the start and stop frequency.

Error message	Description
Captured Signal has less than 3 segments, Please increase Record Length.	This error occurs If the input signal has less than three segments of test mode 4 signal (2047 bits).
Unable to run because return loss measurement is not calibrated. Calibrate and apply the return loss measurement, and then click on start.	This error occurs if user tries to execute return loss measurement without applying calibration (computation of error coefficients).
Invalid Signal at CH1. Please check DUT connections and re-run the test.	This error occurs if an invalid signal is fed as input to return loss measurement (wrong connection).
Signal validation failed for Test Mode.Input waveform is not found.	This error occurs when waveform is not found for signal validation.

Measurement algorithms

Return loss

Calibration

The calibration procedure is required to correct for probe and fixture loading in the final measured result. Calibration is done using three loads: open, short, and 100 Ω load.

TekExpress Automotive Ethernet Compliance Solution executes the calculations described below for the return loss calibration:

1. Multiply the acquired signals using Gaussian window (convolving in frequency domain) and then compute the reflected and incident voltages.

   Reflected voltage = (2*P1 – P2)

   Incident voltage = P1

2. Return loss is computed as follows:

   Return loss = FFT(Reflected voltage)/ FFT(Incident voltage)

   This return loss is computed for three types of loads: Open, Short, 100 Ω load. Let the return loss computed be Gamma_Open, Gamma_Short, and Gamma_Load for open, short, and 100 Ω load, respectively. The Gamma_Open, Gamma_Short,and Gamma_Load are dumped in csv files.

3. For plotting purpose, Gamma_Open, Gamma_Short, and Gamma_Load are converted to dB scale, interpolated, and smoothed. Interpolated and smoothed Gamma_Open, Gamma_Short, and Gamma_Load are plotted for visual representation.

Computing error coefficients

Automotive Ethernet Automated Compliance Solution executes the calculations described below for the return loss error coefficient calculation.

1. Gamma_Open, Gamma_Short, and Gamma_Load are used for computing the following three coefficient that are required for computing cable return loss:
   a. b – Gamma_Short + c * Gamma_Short
   b. Gamma_Load
   c. (Gamma_Short + Gamma_Open – 2 * b) / (Gamma_Short – Gamma_Open)

Computing Return Loss

TekExpress Automotive Ethernet Automated Compliance Solution executes the calculations described below for the return loss:

1. Multiply the acquired signals using Gaussian window (convolving in frequency domain) and then compute the reflected and incident voltages.

   Reflected voltage = (2*P1 – P2)

   Incident voltage = P1

2. Return loss is computed as follows:

   Return loss = FFT(Reflected voltage)/ FFT(Incident voltage)

   Let the computed return loss be GammaValue.

3. Read the error coefficients a, b, and c from the dumped csv files. Compute the corrected return loss using a, b, and c.

   Corrected Return loss = (GammaValue – b)/(a – c * GammaValue)

   This return loss is for 100 Ω load. Let this be return_loss_100.

4. For plotting purposes, Return_Loss_100 is converted to dB scale, interpolated, and smoothed. Interpolated and smoothed Return_Loss_100 is plotted for visual representation.

   Return_loss_100 is compared with the specification given limit.

Transmitter clock frequency

TekExpress Automotive Ethernet Compliance Solution automatically executes the calculations described below for the Transmit Clock Frequency measurement.

1000Base-T1

Compute and verify the clock frequency between the High and Low limits as mentioned in the table above.

100Base-T1

1. Configure DUT to Test mode 2. The test mode 2 signal is a clock signal where the PHY shall transmit the data symbol sequence (+1, -1) repeatedly on all channels.
2. Compute and verify the clock frequency between the High and Low limits as mentioned in the table above.

Transmitter distortion

TekExpress Automotive Ethernet Compliance Solution executes the calculations described below for the transmitter distortion measurement:

1. Compute the unit interval of the acquired test mode 4 signal.
2. Determine the number of frames and the start and end of the frames (each frame is 2047 bits long) in the acquired signal. Neglect the residual signal present at both the start and the end of the acquired signal.

   Ensure that all further processing happens from start of the k^{th} frame to end of n^{th} frame.
3. Using the start and end frames information, do averaging across frames and finally get an averaged frame containing 2047 symbols or (2047*k) samples where k is number of samples per symbol.
4. Do single acquisition and collect 2047 samples corresponding to a phase offset. These 2047 samples are picked from 2047 symbols and so each sample represents a symbol.

   The application removes the disturber signal as per the IEEE P802.3bwTM D3.3 for 100 Base-T1 and IEEE P802.3bpTM for 1000Base-T1 MATLAB code.
5. Repeat the previous two steps for phase offsets 0 to 1 UI in steps of 0.1 UI (10 phase offsets). A total of 10 peak errors/peak distortions are obtained.

Transmitter output droop

TekExpress Automotive Ethernet Compliance Solution executes the calculations described as below for the transmitter output droop measurement.

1000Base-T1

1. Check if the input waveform pattern is a square wave test pattern or not.
2. Check the input square wave test pattern, whether positive to negative width is , check whether positive and negative widths are greater than 12ns.
3. From zero crossing 4ns of each rising edge of each rising edge, compute the maximum voltage ($V_{p\_positive}$) and compute the voltage ($V_{droop\_positive}$) 16 ns after that maximum voltage index (12 ns period).

   $V_d = (V_{p\_positive} - V_{droop\_positive})$

Positive Droop = $(V_d/V_{p\_positive}) * 100$

4. From zero crossing 4ns of each falling edge, compute the minimum voltage ($V_{p\_negative}$) and compute the voltage ($V_{droop\_nrgative}$) 16 ns after that maximum voltage index (12 ns period).

   $V_d = (V_{p\_negative} - V_{droop\_negative})$

   Negative Droop = $(V_d/V_{p\_negative}) * 100$

100Base-T1

1. Check if the input waveform pattern is a square wave test pattern or not.
2. If it is square wave test pattern, then check whether positive and negative widths are greater than 33 unit intervals (500 nS).
3. On each rising edge, compute the maximum voltage ($V_{p\_positive}$) and compute the voltage ($V_{droop\_positive}$) 500 ns after that maximum voltage index.

   $V_d = (V_{p\_positive} - V_{droop\_positive})$

   Positive Droop = $(V_d/V_{p\_positive}) * 100$
4. On each falling edge, compute the minimum voltage ($V_{p\_negative}$) and compute the voltage ($V_{droop\_negative}$) 500 ns after that minimum voltage index.

   $V_d = (V_{p\_negative} - V_{droop\_negative})$

   Negative Droop = $(V_d/V_{p\_negative}) * 100$

Transmitter power spectral density

TekExpress Automotive Ethernet Compliance Solution automatically executes the calculations as described below for the power spectral density measurement.

1. The test mode 5 signal feed as input is filtered using a band limiting filter.
2. Spectral functions (SpectralMag) present in the oscilloscope MATH sub system are used for computing the spectrum of the filtered test mode 5 signal.
3. The output of “SpectralMag” is averaged over “Averages” times. “Averages” is an acquisition parameter present in the GUI (No entries in GUI for 1000Base-T1). The default value of this parameter is 64.
4. ”SpectralMag” is executed with the following configuration settings:
   - For 100Base-T1: Center frequency: 100.5 MHz, For 1000Base-T1: Center frequency: 300 MHz
   - For 100Base-T1: Frequency span: 201 MHz, For 1000Base-T1: Frequency span: 600 MHz
   - Window type: Gaussian
   - Vertical axis: scale —> Linear
   - Gating duration: 200 micro seconds

- Gating duration = Record length / sampling rate
  - 2.5 Mega samples / 12.5 GS/sec = 200 micro seconds
- Gating position: 0
- R = 100 Ohm

5. Averaged SpectralMag is saved and used in postprocessing.
6. In postprocessing, the averaged spectral output is filtered using a moving average filter (smoothing).
7. Computed power in dBm is compared with limits given in the specification, which gives limits only at certain frequencies. Linear interpolation is used to find values for intermediate frequencies.

   Power(dBm) = Power (dBm/Hz) + 10 x log 10(BWHz) where, BWHz - Bandwidth resolution

Transmitter timing jitter master and slave

TekExpress Automotive Ethernet Compliance Solution automatically executes the calculations as described below:

1. Edge locations in test mode 2 (100Base-T1) / test mode 1 (1000Base-T1) for Master waveform, SLAVE TX_TCLK (100Base-T1) / SLAVE TX_TCLK125 (1000Base-T1) for Slave waveform, (captured in differential form) are determined with middle level percentage as 50%. Hysteresis and EdgeType are entered by user in GUI.
2. The least square method is used for straight line fit, with Y as the edge locations and X as the edge indices. Only edges that match the EdgeType entered by the user in the GUI are considered for fitting. Slope and intercept are determined as the output of the least square method. Using the intercept and slope, reconstructed edge locations are determined (un-jittered reference).

   reconstructedTime(I) = intercept + I * slope, I = 0 to num_edges(num_edges depend on EdgeType)
3. Compute TIE on EdgeType entered by user in GUI.

   TIE(I) = reconstructedTime(I) – EdgePosition(I), I = 0 to num_edges(num_edges depend on EdgeType).

   Compute rms value of TIE, which is reported as the result.

Transmitter timing jitter-MDI jitter

TekExpress Automotive Ethernet Compliance Solution automatically executes the calculations described below for the measurement Transmitter Timing Jitter-MDI Jitter.

1.

2. Compute and verify the clock frequency between the High and Low limits as mentioned in the above table.

How to load the setup file into AFG31000 for Return Loss measurement (100 BASE-T1)

This section describes the steps to load the setup file into the AFG31000 for return loss measurement (100BASE-T1).

1. Click **Setup** > **DUT**.
2. Select View as **Advanced**.
3. Click **Test Selection** tab and Select **Return Loss** measurement.
4. Click **Configuration** and select Calibration tab.
5. Click the link *Click here and copy files to USB drive and recall on connected signal source*.
6. Plug in a USB drive into the USB port of the oscilloscope and copy the respective AFG setup files.

7. After copying the setup files, unplug the USB drive and plug it into the USB port of the AFG.
8. On AFG:
   a. Press the **Default** button. A confirmation pop-up message appears on the screen.
   b. Press **OK** to recall the default settings.
   c. Press **SAVE/RECALL** button.
   d. Go to the **Save & Recall** tab on the touchscreen and select **Recall**.
   e. Select **USB** and browse to setup file folder.
   f. Select the *.tfs file and click **OK**.
   g. On the touchscreen, swipe the white arrow at the bottom of the screen up.
   h. Go to the **ArbBuilder** tab and click **Open**.
   i. Select USB and browse to the setup file folder.
   j. Select "...Pos.tfw" file and click **OK**.
   k. Click **Send** > **To Ch1** and then click **Exit**.
   l. Go to the **ArbBuilder** tab and click **Open**.
   m. Select USB and browse to the setup file folder.
   n. Select "...Neg.tfw" file and click **OK**.
   o. Click **Send** > **To Ch2** and then click **Exit**.
   p. Select **InterChannel** tab and click **Align Phase**.
   q. Turn ON channels 1 and 2.

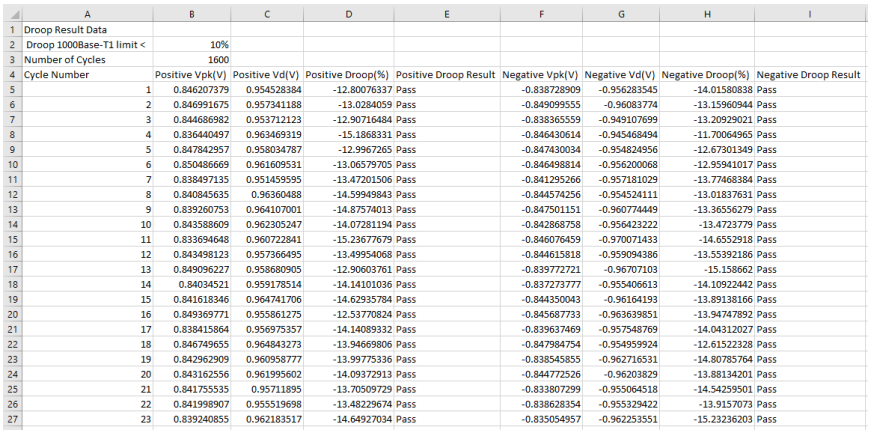
Measurement results in CSV file

Droop measurement

When you save a session, droop measurement results are saved in *DroopAllCycleRes_Run1.csv* file. The file contains the following detailed results for each cycle.

1. Cycle Number
2. Vpk (V) of the positive cycle
3. Vd (V) of the positive cycle
4. Positive Droop Result (%)
5. Positive Droop Result- Pass/Fail with respect to specification limits
6. Vpk (V) of the negative cycle
7. Vd (V) of the negative cycle

8. Negative Droop result (%)
9. Negative Droop result - Pass/Fail result with respect to specification limits



	A	B	C	D	E	F	G	H	I
1	Droop Result Data								
2	Droop 1000Base-T1 limit <	10%							
3	Number of Cycles	1600							
4	Cycle Number	Positive Vpk(V)	Positive Vd(V)	Positive Droop(%)	Positive Droop Result	Negative Vpk(V)	Negative Vd(V)	Negative Droop(%)	Negative Droop Result
5	1	0.846207379	0.954528384	-12.80076337	Pass	-0.838728909	-0.956283545	-14.01580838	Pass
6	2	0.846991675	0.957341188	-13.0284059	Pass	-0.849099555	-0.96083774	-13.15960944	Pass
7	3	0.844686982	0.953712123	-12.90716484	Pass	-0.838365559	-0.949107699	-13.20929021	Pass
8	4	0.836440497	0.963469319	-15.1868331	Pass	-0.846430614	-0.945468494	-11.70064965	Pass
9	5	0.847842957	0.958034787	-12.9967265	Pass	-0.847430034	-0.954824956	-12.67301349	Pass
10	6	0.850486669	0.961609531	-13.06579705	Pass	-0.846498814	-0.956200068	-12.95941017	Pass
11	7	0.838497135	0.951459595	-13.47201506	Pass	-0.841295266	-0.957181029	-13.77468384	Pass
12	8	0.840845635	0.96360488	-14.59949843	Pass	-0.844574256	-0.954524111	-13.01837631	Pass
13	9	0.839260753	0.964107001	-14.87574013	Pass	-0.847501151	-0.960774449	-13.36556279	Pass
14	10	0.843588609	0.962305247	-14.07281194	Pass	-0.842868758	-0.956423222	-13.4723779	Pass
15	11	0.833694648	0.960722841	-15.23677679	Pass	-0.846076459	-0.970071433	-14.6552918	Pass
16	12	0.843498123	0.957366495	-13.49954068	Pass	-0.844615818	-0.959094386	-13.55392186	Pass
17	13	0.849096227	0.958680905	-12.90603761	Pass	-0.839772721	-0.96707103	-15.158662	Pass
18	14	0.84034521	0.959178514	-14.14101036	Pass	-0.837273777	-0.955406613	-14.10922442	Pass
19	15	0.841618346	0.964741706	-14.62935784	Pass	-0.844350043	-0.96164193	-13.89138166	Pass
20	16	0.849369771	0.955861275	-12.53770824	Pass	-0.845687733	-0.963639851	-13.94747892	Pass
21	17	0.838415864	0.956975357	-14.14089332	Pass	-0.839637469	-0.957548769	-14.04312027	Pass
22	18	0.846749655	0.964843273	-13.94669806	Pass	-0.847984754	-0.954959924	-12.61522328	Pass
23	19	0.842962909	0.960958777	-13.99775336	Pass	-0.838545855	-0.962716531	-14.80785764	Pass
24	20	0.843162556	0.961995602	-14.09372913	Pass	-0.844772526	-0.96203829	-13.88134201	Pass
25	21	0.841755535	0.95711895	-13.70509729	Pass	-0.833807299	-0.955064518	-14.54259501	Pass
26	22	0.841998907	0.955519698	-13.48229674	Pass	-0.838628354	-0.955329422	-13.9157073	Pass
27	23	0.839240855	0.962183517	-14.64927034	Pass	-0.835054957	-0.962253551	-15.23236203	Pass

The .CSV file is saved inside X:\Automotive Ethernet\DUT001\<SessionID>\ folder.

PSD measurement

When you save a session, PSD measurement results are saved in *PowerSpectralDensity_PlotData.csv* file. The file contains the measurement results in two columns (Frequency (Hz) and PSD (dBm)).

	A	B	C	D
1	Settings			
2	PlotType	TimeTrend		
3	Labels	Frequency	PSD	
4	title	Power Spectral Density		
5	WFMColor	#d41442		
6	WFMLineWidth	5		
7	Divisions	10	10	
8	Units	Hz	dBm	
9	Data			
10	1000080.006	-20.99076135		
11	1005080.406	-20.98481491		
12	1010080.806	-20.97708028		
13	1015081.206	-20.95886095		
14	1020081.607	-20.94470038		
15	1025082.007	-20.93572495		
16	1030082.407	-20.93154219		
17	1035082.807	-20.9240136		
18	1040083.207	-20.9084374		
19	1045083.607	-20.8934376		
20	1050084.007	-20.8804471		
21	1055084.407	-20.8709122		
22	1060084.807	-20.86492411		
23	1065085.207	-20.85975831		
24	1070085.607	-20.85811006		

The .CSV file is saved inside X:\Automotive Ethernet\DUT001\<SessionID>\ folder.

Return Loss measurement

When you save a session, return loss measurement results are saved for in *plotdata_rl_100.csv* file.

	A	B	C
1	Settings		
2	PlotType	TimeTrend	
3	Labels	Frequency	Return Loss
4	title	Return Loss	
5	WFMColor	#08d529	
6	WFMLineWidth	3	
7	Divisions	10	10
8	Units	Hz	dB
9	Data		
10	100000	-21.15984017	
11	120000	-23.03654746	
12	140000	-24.00810085	
13	160000	-24.94150533	
14	180000	-25.58897894	
15	200000	-26.10648399	
16	220000	-26.55400596	
17	240000	-26.94276006	
18	260000	-27.24907549	
19	280000	-27.4989855	
20	300000	-27.70860594	
21	320000	-27.88259071	
22	340000	-28.0133287	
23	360000	-28.11043029	
24	380000	-28.18085475	
25	400000	-28.23126192	
26	420000	-28.26950884	

The .CSV file is saved in the below listed folders, based on the calibration method used:

- Pre-recorded calibration files: X:\Automotive Ethernet\PreRecCal\100Base-T1\
- Live Calibration: X:\Automotive Ethernet\LiveCal\100Base-T1\

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