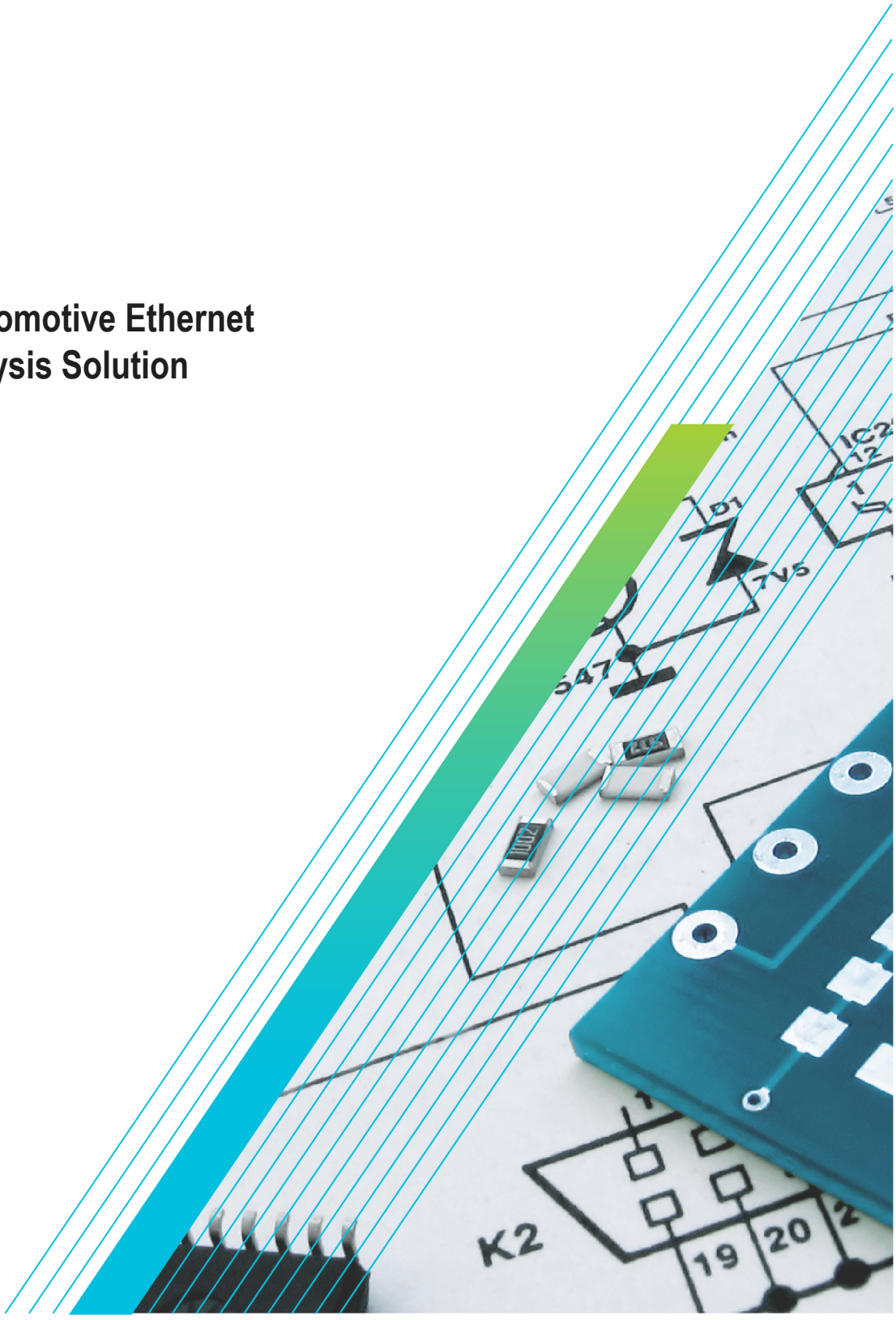
Tektronix®

TekExpress® Automotive Ethernet Compliance Analysis Solution

Application Help



077-1679-04

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TekExpress® Automotive Ethernet Compliance Analysis Solution

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Contacting Tektronix

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Beaverton, OR 97077

USA

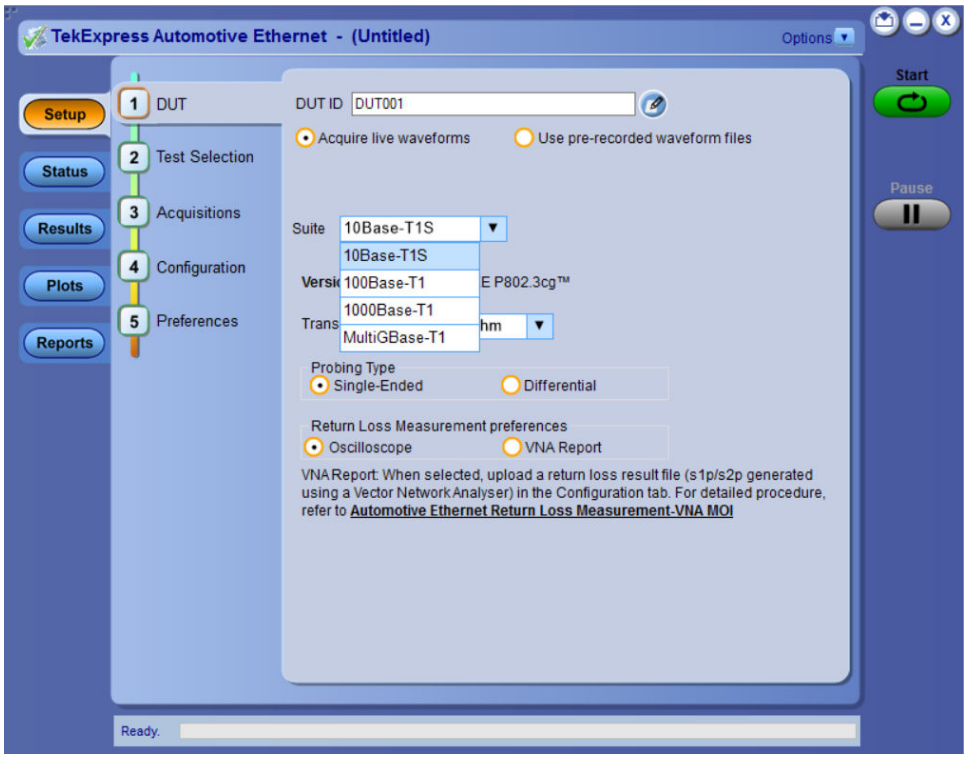
For product information, sales, service, and technical support:

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

Table of Contents

Welcome

The TekExpress Automotive Ethernet application is a compliance test solution to perform transmitter electrical specification measurements and MDI return loss measurements in accordance to IEEE. Supports an OPEN Alliance PMA test suites for the Automotive Ethernet technologies; 10BASE-T1S, 100BASE-T1, 1000BASE-T1, and MultiGBASE-T1. The IEEE specifications for 10BASE-T1S, 100BASE-T1, 1000BASE-T1, and MultiGBASE-T1 technologies are IEEE Std 802.3cg™-2019, IEEE P802.3bw™/D3.3 , IEEE P802.3bpTM-2016 and IEEE Std 802.3ch™ -2020 respectively.



Key features

- Fully automated setup wizard to perform transmitter electrical specification measurements and MDI electrical specification return loss measurements.
- Comprehensive reports of results with Pass/Fail status along with plots
- Offers full coverage of test measurements
- An instrument offers full coverage of measurements. Return Loss measurement is offered as a patented approach and requires an oscilloscope only, without the need of an additional instrument (VNA).
- Power Spectral Density (PSD) is an oscilloscope-based measurement and Spectrum analyzer is not required.
- TekExpress Automotive Ethernet application offers you a patented Return Loss measurement, which allows you to perform the measurement without using a VNA.
- Transmit distortion measurement without need of external hardware clock divider unit, using software signal correction method.
- Validates Test Mode signals before performing measurements.
- Ability to run the measurements multiple times and generate result statistics across runs.

Getting help and support

Product documents

Use the product documents for more information on the application functions, understand the theory of operation, how to remotely program or operate the application, and do other tasks.

Table 1: TekExpress Application documents

To learn about	Use this document
How to use the application How to remotely control the instrument	TekExpress <Application Name> Help PDF version of this document can be downloaded from *www.tek.com/downloads* Compiled HTML (CHM) version is integrated with the application. Press **F1** key from the keyboard to start the help. Tektronix Part Number: 077-xxxx-xx

Conventions

This application help uses the following conventions:

- The term "Application," and "Software" refers to the TekExpress Application.
- The term “DUT” is an abbreviation for Device Under Test.
- The term “select” is a generic term that applies to the two methods of choosing a screen item (button control, list item): using a mouse or using the touch screen.
- A **Note** identifies important information.

Table 2: Icons used in the help

Icon	Description
	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.

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 Web site. See *Contacting Tektronix* at the front of this document for contact information.

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
- Modules 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

Getting started

Required instruments and applications

Required instruments and applications for 10Base-T1S Suite

The table below lists the recommended/minimum configuration for 10Base-T1S Suite:

Table 3: Required instruments and applications for 10Base-T1S Suite

Category	Description	Model/Part number
Instrument	MSO 5/6/6B or DPO/MSO 5K/7K/70K Series Oscilloscope with bandwidth ≥ 350 MHz	• MSO54 with 5-BW-350, 5-WIN (Windows 10 only) • DPO/MSO 5K/7K/70K Series Oscilloscope
Software option	TekExpress Automotive Ethernet - 10BASE-T1S Compliance Solution	• CMAUTOEN10 For MSO 5/6 Series • AUTOEN10 For DPO/MSO 5K/7K/70K Series Oscilloscope
Instrument	Signal Generator to test return loss 2-Channel AFG with a frequency range of ≥100 MHz	AFG31102
Probing Type : Differential	50 Ω TekVPI to TekConnect adapter	TDP1500 Quantity = 2
Probing Type : Single-Ended	Matched pair SMA cables	Quantity = 1 pair
Probe adapter for DPO/MSO 5K/7K/70K Series Oscilloscope	50 Ω TekVPI to TekConnect adapter	TCA-VPI50 Quantity = 2
Cable	Same length SMA cable for Signal source connections	Quantity = 3
Accessory	Adapter, SMA female to BNC male	Part number: 015-0572-00 Quantity = 4
	TF-XGbT Compliance Test Fixture and Calibration Board	TF-XGbT
	ETH-TPA-AW-CBL (Automotive Ethernet, Open Solder Cable)	Part number: 640-1028-000

Table continued…

Category		Description	Model/Part number
Accessory	SMA-T M to 2F	SMA male to 2 SMA female RF coaxial adapter connector with 3 way splitter	Quantity = 2
	SMA F-F	SMA female to female adapter	Quantity = 2
	SMA M-M	SMA Male to SMA Male RF coaxial cable adapter	Quantity = 2
	50 Ω SMA M	Terminator cap	Quantity = 6

Note:

1. Recommended oscilloscope firmware version v1.22 or later.
2. A short RJ45 cable recommended for return loss calibration and measurement.
3. To connect the DUT, fixture and oscilloscope to common ground, use the minigator clip to the staking banana plug (part number : 3220-12-2) to connect the ground point on the oscilloscope.
4. External PC monitor/display recommended.
5. For the list of all supported oscilloscope modes refer *List of supported instrument models for 10Base-T1S* on page 19.

Required instruments and applications for 100Base-T1 Suite

The table below lists the recommended/minimum configuration for 100Base-T1 Suite:

Table 4: Required instruments and applications for 100Base-T1 Suite

Category	Description	Model/Part number
Instrument	Oscilloscope with bandwidth ≥ 1 GHz (Windows 10 only)	• For MSO 5/6 Series MSO54 with 5-BW-1000, 5-WIN • For DPO/MSO 5K/7K/70K Series Any of the DPO/MSO 5K/7K/70K Series Oscilloscope with bandwidth ≥ 1 GHz
Software option	Serial compliance testing packages - TekExpress Automotive Ethernet	• For MSO 5/6 Series CMAUTOEN • For DPO/MSO 5K/7K/70K Series Option BRR
Instrument	Signal Generator to test distortion and return loss. 2-Channel AFG with a frequency range of ≥ 100 MHz	AFG31102
Probing Type : Differential	Differential probes and accessories 50 Ω TekVPI to TekConnect adapter for DPO/MSO 70K Series Oscilloscopes	TDP1500 (For MSO 5/6 Series) TDP1500 + TCA-VPI50 Quantity = 2
Probing Type : Single-Ended	Matched pair SMA cables	Quantity = 1 pair

Table continued…

Category	Description	Model/Part number
Accessory	TF-XGbT Compliance Test Fixture and Calibration Board.	TF-XGbT
	ETH-TPA-AW-MN (Automotive Ethernet, MateNet, Tyco)	Part number: 640-1026-000
	ETH-TPA-AW-CBL (Automotive Ethernet, Open Solder Cable)	Part number: 640-1028-000
	ETH-TPA-AW-D (Automotive Ethernet, Distortion Card)	Part number: 640-1029-000
Accessory	Clock frequency divider to synchronize oscilloscope and Signal source with DUT clock. Converts DUT Transmitter Clock from 66.666 MHz to 10 MHz. (Required for Hardware clock for Distortion measurement)	TF-BRR-CFD
Cable	Same length **SMA** cables for signal source connections.	Quantity = 6
Accessory	Adapter, SMA female to BNC male	015-0572-00 Quantity = 4

Note:

1. Recommended oscilloscope firmware version 1.34.xx or later for MSO5/6 Series.
2. Recommended oscilloscope firmware version 10.12.0.xx or later for DPO/MSO 5K/7K/70K Series.
3. A short RJ45 cable recommended for return loss calibration and measurement.
4. To connect the DUT, fixture and oscilloscope to common ground, use the minigator clip to the staking banana plug (part number : 3220-12-2) to connect the ground point on the oscilloscope.
5. External PC monitor/display recommended.
6. For the list of all supported oscilloscope modes refer *List of supported instrument models for 100Base-T1* on page 20.

Required instruments and applications for 1000Base-T1 Suite

The table below lists the recommended/minimum configuration for 1000Base-T1 Suite:

Table 5: Required instruments and applications for 1000Base-T1 Suite

Category	Description	Model/Part number
Instrument	Oscilloscope with bandwidth ≥ 2 GHz. (Windows 10 only)	• For MSO 5/6 Series MSO54 with 5-BW-2000, 5-WIN • For DPO/MSO 5K/7K/70K Series Any of the DPO/MSO 5K/7K/70K Series Oscilloscope with bandwidth ≥ 2 GHz

Table continued…

Category	Description	Model/Part number
Software option	Serial compliance testing packages - TekExpress Automotive Ethernet	• For MSO 5/6 Series CMAUTOEN • For DPO/MSO 5K/7K/70K Series Oscilloscope Option BRR
Instrument	Signal Generator to test distortion and return loss. AWG includes below mentioned options: • [250]5 GS/s (10 GS/s interpolated) • [HV] High Voltage outputs	AWG5202/5204/5208 option 250 and HV
Probing Type : Differential	Differential probes and accessories 50 Ω TekVPI to TekConnect adapter for DPO/MSO 70K Series Oscilloscopes	• For MSO 5/6 Series TDP3500 • For DPO/MSO 5K/7K/70K Series Oscilloscope TDP3500 + TCA-VPI50 Each quantity = 2
Probing Type : Single-Ended	Matched pair SMA cables	Quantity = 1 pair
Cable	Same length **SMA** cables for Signal source connections.	Quantity = 6
Accessory	TF-XGbT Compliance Test Fixture and Calibration Board.	TF-XGbT
	ETH-TPA-AW-MN (Automotive Ethernet, MateNet, Tyco)	Part number: 640-1026-000
	ETH-TPA-AW-CBL (Automotive Ethernet, Open Solder Cable)	Part number: 640-1028-000
	ETH-TPA-AW-D (Automotive Ethernet, Distortion Card)	Part number: 640-1029-000
	Clock frequency divider to synchronize oscilloscope and Signal source with DUT clock. Converts DUT Transmitter Clock from 125 MHz to 10 MHz. (Required for Hardware clock for Distortion measurement)	TF-BRR-CFD
	Adapter, SMA female to BNC male	015-0572-00 Quantity = 4

Note:

1. Recommended oscilloscope firmware version 1.34.xx or later for MSO5/6 Series.
2. Recommended oscilloscope firmware version 10.12.0.xx or later for [DPO/MSO 5K/7K/70K Series].
3. A short RJ45 cable recommended for return loss calibration and measurement.

4. To connect the DUT, fixture and oscilloscope to common ground, use the minigator clip to the staking banana plug (part number : 3220-12-2) to connect the ground point on the oscilloscope.
5. External PC monitor/display recommended.
6. For the list of all supported oscilloscope modes refer *List of supported instrument models for 1000Base-T1* on page 21.

Required instruments and applications for MultiGBase-T1 Suite

The recommended/minimum instruments of MultiGBase-T1 Suite for DPO/MSO70K (*Table 6* on page 17) and MSO6/6B (*Table 7* on page 18) Series Oscilloscope are listed in the tables below:

Table 6: For DPO/MSO 70K Series Oscilloscope

Category	Description	Model/Part number
Instrument	MSO or DPO70000 Series Oscilloscope with bandwidth ≥13 GHz	DPO71304SX
Software option	Jitter, Noise and Eye Diagram Analysis tool	AUTOEN10G
	Jitter, Noise and Eye Diagram Analysis tool	DPOJET Opt. DJA
Probe (Data Line)	Differential Probe Optional, if the DUT does not support SMA/coaxial interface for the MDI output	P7713 Quantity = 1
	Probe Tip Differential probe Accessory- SMA Coaxial adapter with TekFlex connector technology	P77C292MM Quantity = 1
Probe (CLK Line)	Differential Probe Optional, if the DUT does not support SMA/coaxial interface for the TX_TCLK output. You can also use the data line probe.	TDP 1500 Quantity = 1
	Probe Adapter 50 Ω TekVPI to TekConnect adapter	TCA-VPI50 Quantity = 1
Cable	Matched length SMA matched pair cables	Quantity = 1
Accessory	Test Fixture: H-MTD Connector to SMA Adapter Optional, if the DUT does not support SMA/coaxial interface for the MDI output. H-MTD Connector to SMA Adapter (3rd party item, Customer need to purchase directly from Rosenberger)	PCB S3401 SB 396373 Quantity = 1

Table 7: For MSO6/6B Series Oscilloscope

Category	Description	Model/Part numbe
Instrument	MSO 6/6B Series Oscilloscope with bandwidth ≥ 8 GHz	MSO64B/66B/68B with 6-BW-8000, 6-WIN
Software option	Jitter Analysis	6-CMAUTOEN10G
	Jitter Analysis	DJA
Probe (Data Line)	Differential Probe Optional, if the DUT does not support SMA/coaxial interface for the MDI output	TDP7708 Quantity = 1
	Probe Tip Differential probe accessory - SMA coaxial adapter with TekFlex connector technology	P77C292MM Quantity = 1
Probe (CLK Line)	Differential Probe Optional, if the DUT does not support SMA/coaxial interface for the TX_TCLK output. You can use data line probe also.	TDP 1500 Quantity = 1
Cable	SMA matched pair cables	Quantity = 1 pair
Accessory	BNC-to-SMA adapter	103-0503-xx Quantity = 2
	Test Fixture: H-MTD Connector to SMA Adapter. Optional, if the DUT does not support SMA/coaxial interface for the MDI output (3rd party item, Customer need to purchase directly from Rosenberger)	PCB S3401 SB 396373 Quantity = 1

List of supported instrument models

List of supported instrument models for 10Base-T1S

The table below lists all the supported oscilloscopes, signal sources, and probe models for 10Base-T1S.

Table 8: List of supported instrument models for 10Base-T1S

Category	Description	Model/Part number
Instrument	Oscilloscope MSO 5/6/6B series oscilloscope with bandwidth 350 MHz or above. (Windows 10 only)	• MSO54 with 5-BW-350, 5-WIN • MSO56 with 5-BW-350, 5-WIN • MSO58 with 5-BW-350, 5-WIN • MSO64 with 6-BW-1000, 6-WIN • MSO64B • MSO66B • MSO68B • DPO/MSO 5K/7K/70K
Instrument	Signal Generator to test return loss. 2-Channel AFG with a frequency range of 100 MHz or above	• AFG31102 • AFG31152 • AFG31252
Probing Type : Differential	Differential probe (MSO 5/6 Series Oscilloscope)	• TDP1500 • P6248 (with TPA-BNC adapter) • P6247 (with TPA-BNC adapter)
	DPO/MSO 5K/7K/70K Series Oscilloscope	• TDP1500 + TCA-VPI50 • P6248 + TCA-BNC • P6247 + TCA-BNC
Probing Type : Single-Ended	Matched pair SMA cables	Quantity = 1 pair

List of supported instrument models for 100Base-T1

The table below lists all the supported oscilloscopes, signal sources, and probe models for 100Base-T1.

Table 9: List of supported instrument models for 100Base-T1

Category	Description	Model/Part number
Instrument	Oscilloscope, with bandwidth 1 GHz or above.	For MSO 5/6 Series • MSO54/56/58 with 5-BW-1000, 5-WIN • MSO64 with 6-BW-1000, 6-WIN • MSO64B/66B /68B with 6-BW-1000, 6-WIN For DPO/MSO 5K/7K/70K Series Any of the below with bandwidth 1 GHz or more. • DPO/MSO 5000B Series • DPO 7000 Series • DPO/MSO 70000C Series • DPO/MSO 70000DX Series • DPO 70000SX Series (up to 33 GHz Model)
Instrument	Signal Generator to test distortion and return loss. AWG includes options • [250]5 GS/s (10 GS/s interpolated) • [HV] High Voltage outputs	• AFG31102 /31152/31252 • AWG5202 /5204/5208 option 250 and HV
Probing Type : Differential	Differential Probes	For MSO 5/6 Series • TDP1500/3500 • P6247/6248 (with TPA-BNC adapter) For DPO/MSO 5K/7K/70K Series • TDP1500/3500 + TCA-VPI50 • P6247/6248 (with TPA-BNC adapter) TBD • TDP7704/7706/7708 + P77C292MM[1]
Probing Type : Single-Ended	Matched pair SMA cables	Quantity = 1 pair

Note: For a detailed list of all oscilloscope models [DPO/MSO 5K/7K/70K series] see *List of 5K/7K/70K Series Oscilloscope models for 10S/100/1000BASE-T1* on page 22.

[1] This does not support - Reurn loss and Distortion measurement.

List of supported instrument models for 1000Base-T1

The table below lists all the supported oscilloscopes, signal sources, and probe models for 1000Base-T1.

Table 10: List of supported instrument models for 1000Base-T1

Category	Description	Model/Part number
Instrument	MSO 5/6 Series oscilloscope with bandwidth 2 GHz or above. (Windows 10 only)	For MSO 5/6 Series • MSO54/56/58 with 5-BW-2000, 5-WIN • MSO64 with 6-BW-2500, 6-WIN • MSO64B/66B/68B with 6-BW-2500, 6-WIN For DPO/MSO 5K/7K/70K Series Any of the below with bandwidth 2 GHz or more) • DPO/MSO 5000B Series • DPO 7000 Series • DPO/MSO 70000C Series • DPO/MSO 70000DX Series • DPO 70000SX Series (up to 33 GHz model)
Instrument	Signal Generator (Distortion Test)	• AFG31152/31252 • AWG5202/5204/5208 option 250 and HV
	Signal Generator (Distortion and Return Loss Test) AWG includes options • [250]5 GS/s (10 GS/s interpolated) • [HV] High Voltage outputs	AWG5202/5204/5208 option 250 and HV
Probing Type : Differential	Differential Probes	For MSO 5/6 Series • TDP 3500 For DPO/MSO 5K/7K/70K Series • TDP 3500 + TCA-VPI50 • TDP7704/ 7706/ 7708 + P77C292MM[2]
Probing Type : Single-Ended	Matched pair SMA cables	Quantity = 1 pair

Note: For a detailed list of all oscilloscope models [DPO/MSO 5K/7K/70K series] see *List of 5K/7K/70K Series Oscilloscope models for 10S/100/1000BASE-T1* on page 22.

[2] This does not support - Return loss and Distortion measurement.

List of 5K/7K/70K Series Oscilloscope models for 10S/100/1000BASE-T1

5000 Series	DPO5104B, DPO5204B, MSO5104B, MSO5204B
7000 C Series	DPO7104C, DPO7254C, DPO7354C
70000 C Series	DPO70604C, DPO70804C, DPO70404C, DPO71254C, DPO71604C, DPO72004C DSA70404C, DSA70604C, DSA70804C, DSA71254C, DSA71604C, DSA72004C MSO70404C, MSO70604C, MSO70804C, MSO71254C, MSO71604C, MSO72004C
70000 D/DX Series	DPO72504D, DPO73304D, DSA72504D, DSA73304D DPO72304DX, DPO72504DX, DPO73304DX, MSO72304DX, MSO72504DX, MSO73304DX
70000 SX Series	DPO71304SX, DPO71604SX, DPO72304SX, DPO73304SX

List of supported instrument models for MultiGBase-T1

The tables below lists all the supported oscilloscopes and probe models for MultiGBase-T1:

Table 11: For DPO/MSO 70K Series

Category	Description	Models/Part Numbers
Instrument	MSO or DPO70000 Series Oscilloscope with bandwidth ≥ 13 GHz	DPO71304SX, DPO71604SX, DPO72304SX, DPO73304SX, MSO72304DX, MSO72504DX, MSO73304DX, DPO72304DX, DPO72504DX, DPO73304DX, DPO72304DX with Opt 5XL, DPO72504DX with Opt 5XL, DPO73304DX with Opt 5XL [for DPO70K series - Opt 5XL would be a pre-requisite]
Probe (Data Line)	Differential probes and accessory	• P7713 + P77C292 MM • P7716 + P77C292 MM • P7720 + P77C292 MM
Probe (CLK Line)	Differential probes and adapter	• TDP 1500 + TCA-VPI50 • TDP 3500 + TCA-VPI50 • TDP 4000 + TCA-VPI50

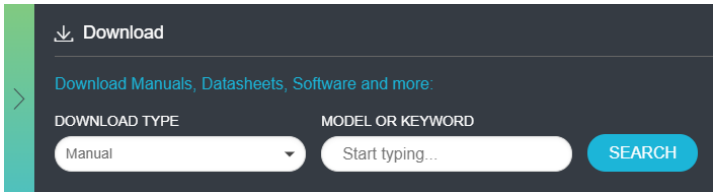
Table 12: For MSO6/6B

Category	Description	Models/Part Numbers
Instrument	MSO 6/6B Series Oscilloscope with bandwidth ≥ 8 GHz	• MSO64 with 6-BW-8000, 6-WIN • MSO64B/66B/68B with 6-BW-8000, 6-WIN
Probe (Data Line)	Differential probes and accessory	TDP7708 + P77C292 MM
Probe (CLK Line)	Differential probes and adapter	• TDP 1500 • TDP 3500 • TDP 4000

Downloading and installing the software

Complete the following steps to download and install the latest TekExpress <Application Name> application.

1. Go to *www.tek.com*.
2. Click **Downloads**. In the Downloads menu, select DOWNLOAD TYPE as Software and enter the application name in the MODEL OR KEYWORD field and click **SEARCH**.



3. Select the latest version of software and follow the instructions to download the software. Copy the executable file into the oscilloscope.
4. Double-click the executable and follow the on-screen instructions.

   The software is installed at `C:\Program Files\Tektronix\TekExpress\TekExpress <Application Name>`.
5. Select from the Oscilloscope menu, to open the application.

Activate the license

For DPO/MSO 70K Series Oscilloscope

Activate the license using the **Option Installation** wizard in the TekScope application:

1. In the **TekScope** application menu bar, click **Utilities** > **Option Installation**. The TekScope Option Installation wizard opens.
2. Push the **F1** key on the oscilloscope keyboard to open the Option Installation help topic.
3. Follow the directions in the help topic to activate the license.

For MSO6/6B Series Oscilloscope

Activate the license using the **Click Install License** wizard in the TekScope application:

1. In the **TekScope** application menu bar, click **Help** > **About** > **Install License**. The TekScope Install License wizard opens, select the license file (*.Lic).
2. Follow the application instructions in the oscilloscope to activate the license.
3. Reboot the oscilloscope, after successfully activating the license.

View software version and license key details

To view version information of the application, click **Options > About TekExpress**.

Setting up the test environment

Calibrate the Oscilloscope

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* on page 122 and *Return Loss measurement* on page 116.

Calibration for transmitter distortion measurement

Figure 1: Calibration tab for 1000Base-T1 transmitter distortion measurement

Figure 2: Calibration tab for 100Base-T1 transmitter distortion measurement

Calibration for return loss measurement

Figure 3: Calibration tab for return loss measurement for 100/1000Base-T1

Figure 4: Calibration tab for return loss measurement for 10Base-T1S

Table 13: 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 diagram for the selected measurement.
Plot	Click to view the plot.
Apply	Click to apply the configured parameters to calibration.
Run	Click to run the process of calibration.

Table continued…

Parameter	Description
Default button	Click to perform calibration by using default values. **Note:** This button is applicable only for Transmitter distortion measurement. 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.

Search instruments connected to the application

Use the TekExpress Instrument Control Settings dialog box to search the instruments (resources) connected to the application. The application uses TekVISA to discover the connected instruments.

Note: The instruments required for the test setup must be connected and detected by the application, before running the test.

To refresh the list of connected instruments:

1. Select **Options > Instrument Control Settings**.
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 connections determine the resource type, such as LAN, GPIB, and USB. For example, if you choose LAN, the search will include all the instruments supported by the TekExpress that are communicating over the LAN.
3. Click **Refresh**. The TekExpress application searches for the connected instruments.

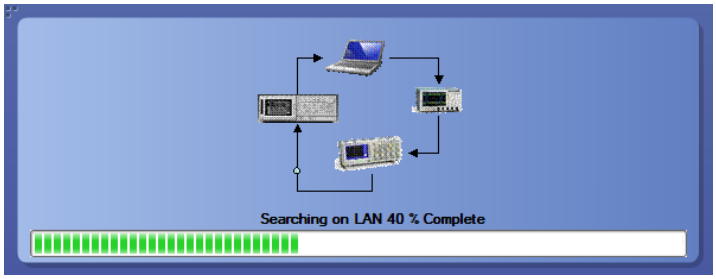


Figure 5: Search status of the instruments connected to LAN

4. When the search is complete, a dialog box lists the instrument-related details based on the search criteria. For example, for the Search Criteria as LAN and GPIB, the application displays all the LAN and GPIB instruments connected to the application.

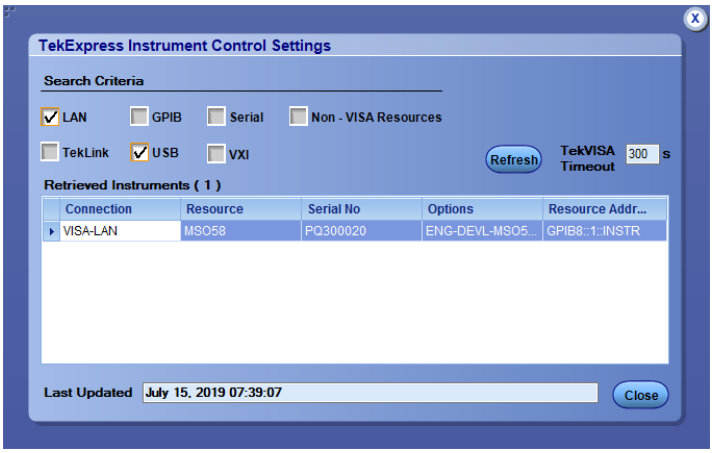


Figure 6: TekExpress Instrument Control Settings window

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.

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* on page 122: AWG/AFG is used to transmit a disturbing signal. CH1 and CH1_inverted are used.
- *Return Loss measurement* on page 116: 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**.

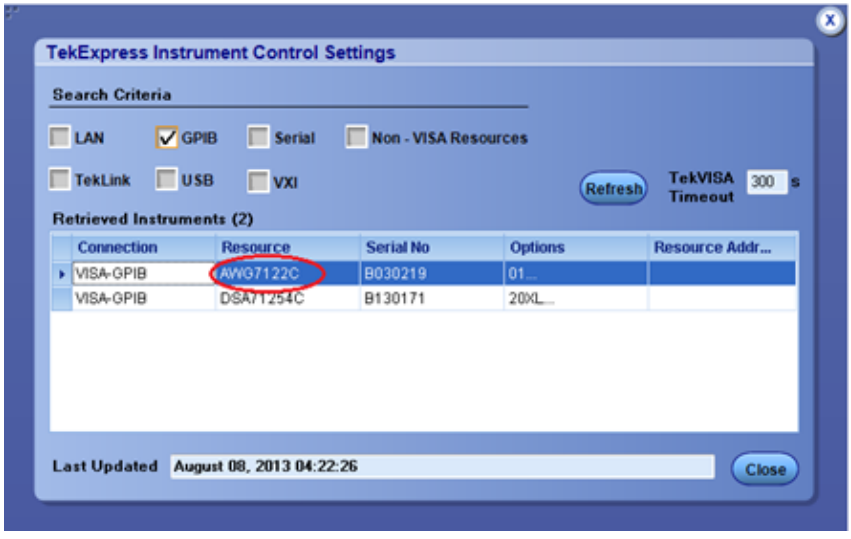


Figure 7: Instrument Control Settings

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.

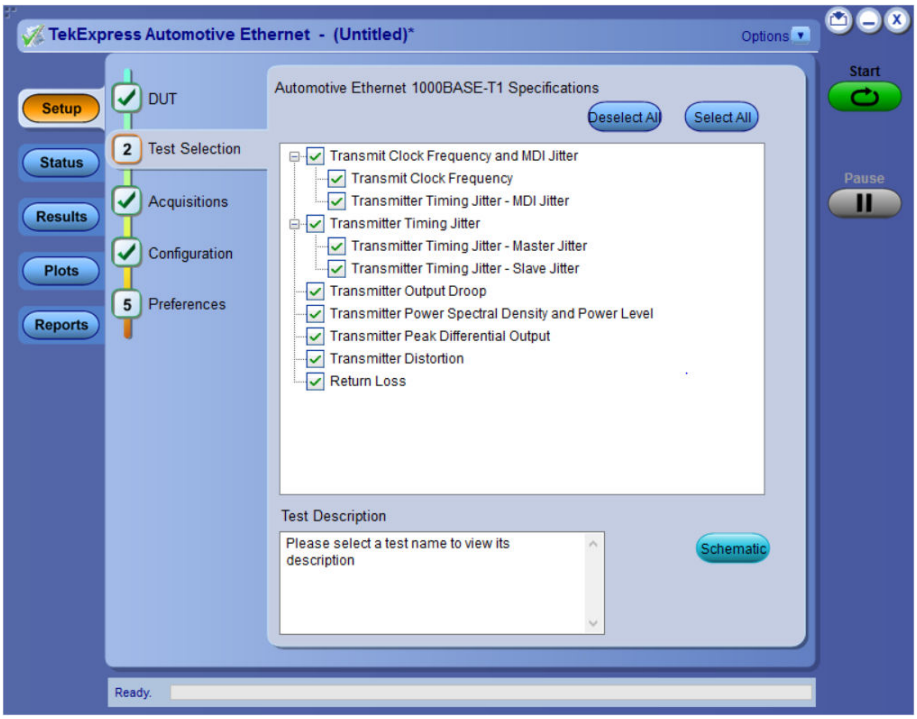


Figure 8: Test Selection tab

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

Before running any test

1. Review the *Pre-run check list* on page 32.
2. Configure the *email setting* 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 on page 32

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).
3. If any signal path differences are present, enter de-skew values to align the signals perfectly.
4. Ensure that the application is able to find the DUT. If it cannot, perform a *Search instruments connected to the application* on page 29.

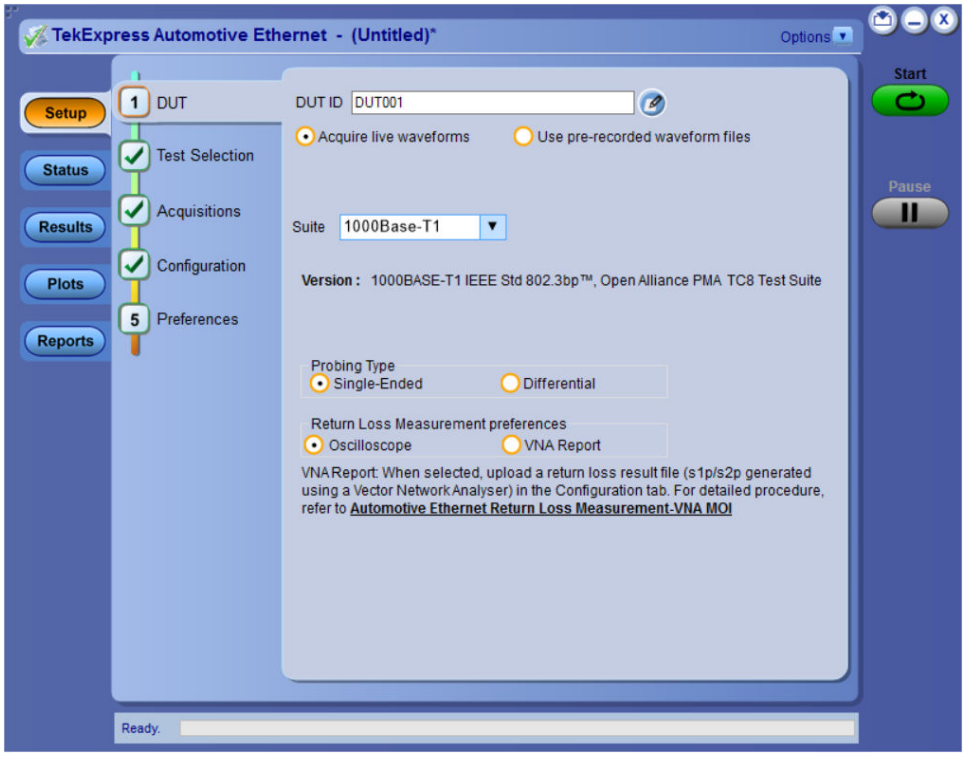
See also

Before you click start

Configure email notification

Starting the application

To start the TekExpress , select from the oscilloscope menu bar.



During start, a "My TekExpress" folder is created in the Documents folder of the current user and gets mapped to "X" drive. When the application is closed properly, the "X" drive gets unmapped. Session files are then stored inside the folder. If this file is not found, the application runs an instrument discovery program to detect connected instruments before starting TekExpress .

To keep the TekExpress application on top of any application, select **Keep On Top** from the *options menu*. If the application goes behind the oscilloscope application, select to bring the application to the front.

Application controls

This section describes the application controls with functionality and its details.

Table 14: Application control description

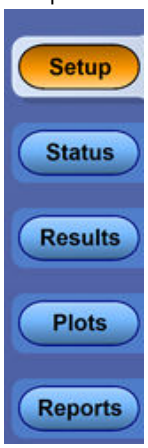
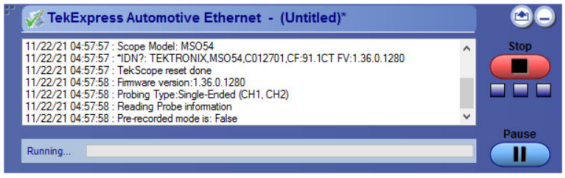
Item	Description
Options menu 	Menu to display global application controls.
Test panel 	Controls that open tabs for configuring test settings and options.
Start / Stop button  	Use the **Start** button to start the test run of the measurements in the selected order. If prior acquired measurements are not cleared, then 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 pause the acquisition. When a test is paused, this button changes as **Continue**.
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 *Results panel*.  **Note:** This button is visible only when there are results data on the panel.
Application window move icon 	Place the cursor over the top of the application window to move the application window to the desired location
Minimize icon 	Minimizes the application.

Table continued…

Item	Description
Close icon 	Close the application.
Mini view / Normal view  	Mini view displays the run messages with the time stamp, progress bar, Start / Stop button, and Pause / Continue button. The application moves to mini view when you click the **Start** button. 

Options menu functions

To access the **Options** menu, click in the upper-right corner of the application. It has the following selections:

Options menu

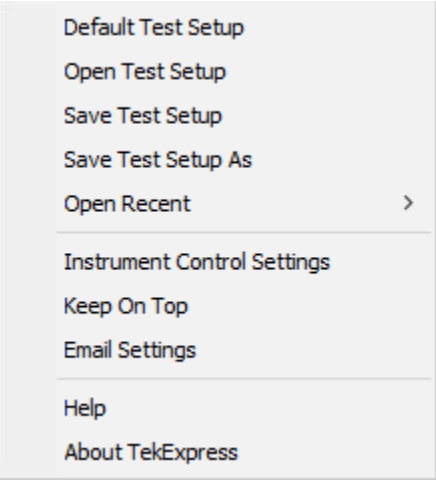


Figure 10: Options menu

Table 15: Options menu settings

Menu	Function
Default Test Setup	Opens a new test setup with default configurations.
Open Test Setup	Opens a previously saved test setup. Displays the list of previously saved test setup file names. Make the selection and click **OK** to open the test setup.
Save Test Setup	Saves the current test configurations with the specified file name.
Save Test Setup As	Saves the current test setup with a different file name or file type.
Open Recent	Displays the recently opened test setup file names. Make the selection and click **OK** to open the test setup.
Instrument Control Settings	Detects, lists, and refreshes the connected instruments found on the specified connections (LAN, GPIB, USB, Serial, Non-VISA Resources, TekLink, and VXI).
Keep On Top	Always keeps the TekExpress application on top of all the applications.
Email Settings	Configures email options for test run and result notifications.
Help	Displays the TekExpress help.
About TekExpress	Displays the application name, version, and hyperlink to end the user license agreement.

Configure email settings

Use the **Email Settings** utility to get notified by email when a measurement completes or produces any error condition. Follow the steps to configure email settings:

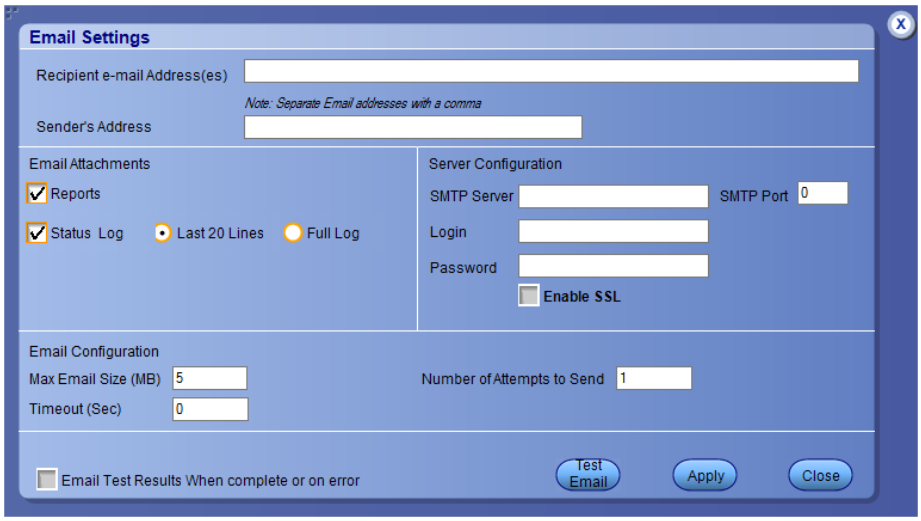


Figure 11: Email settings window

1. Select **Options > Email Settings** to open the Email Settings dialog box.
2. (Required) For **Recipient email Address(es)**, enter one or more recipient email addresses. To include multiple addresses, 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, then the @ symbol, and the email server ID. For example: user@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.

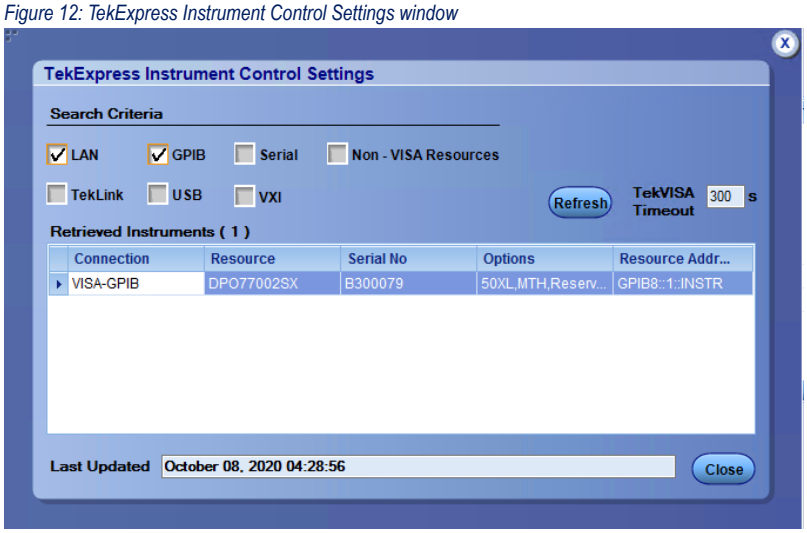
   Note: If any of the above required fields are left blank, the settings will not be saved, and email notifications will not be sent.
5. In the **Email Attachments** section, select from the following options:
   - **Reports**: Select to receive the test report with the notification email.
   - **Status 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.
6. In the **Email Configuration** section:
   - 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.
   - Enter the number in the Number of Attempts to Send field, to limit the number of attempts that the system makes to send a notification. The default is 1. You can also specify a timeout period.
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**.
10. Click **Close** when finished.

TekExpress instrument control settings

Use the **TekExpress Instrument Control Settings** dialog box to search the instruments (resources) connected to the application. You can use the **Search Criteria** options to search the connected instruments depending on the connection type. The details of the connected instrument is displayed in the Retrieved Instruments window.

To access, click **Options** > **Instrument Control Settings**. Select **USB** and **LAN** as search criteria for TekExpress application and click **Refresh**. The connected instruments displayed in the Retrieved Instruments window and can be selected for use under Global Settings in the test configuration section.

Figure 12: TekExpress Instrument Control Settings window



See also

Options menu functions on page 36

Setup panel: Configure the test setup

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

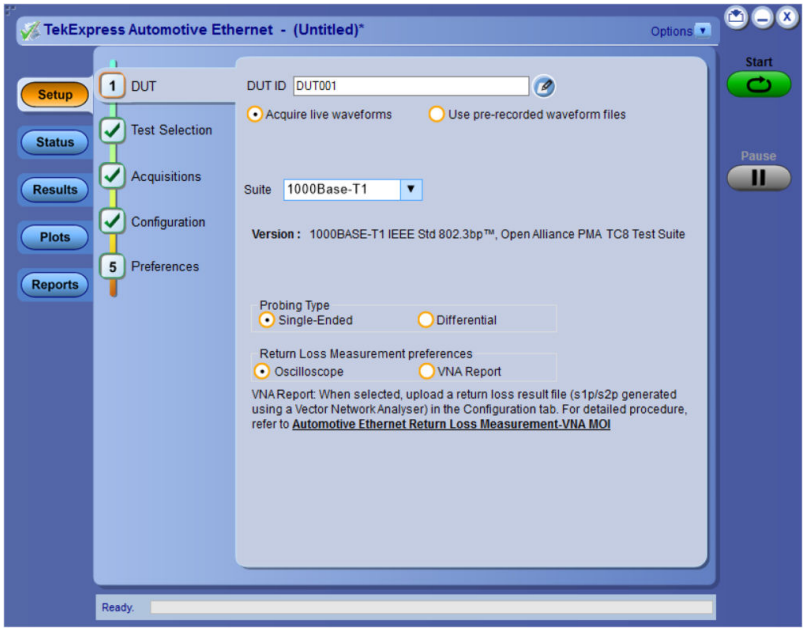


Figure 13: DUT tab for 100/1000Base-T1

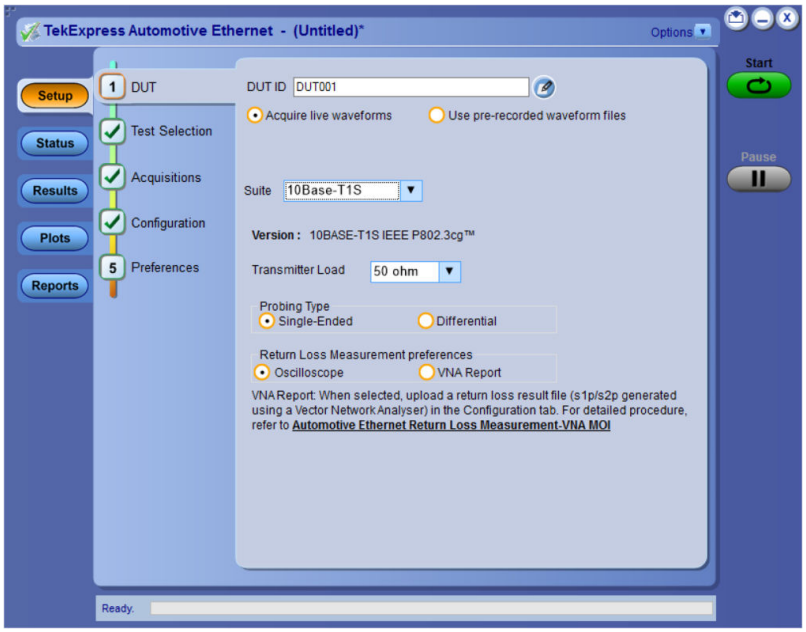


Figure 14: DUT tab for 10Base-T1S

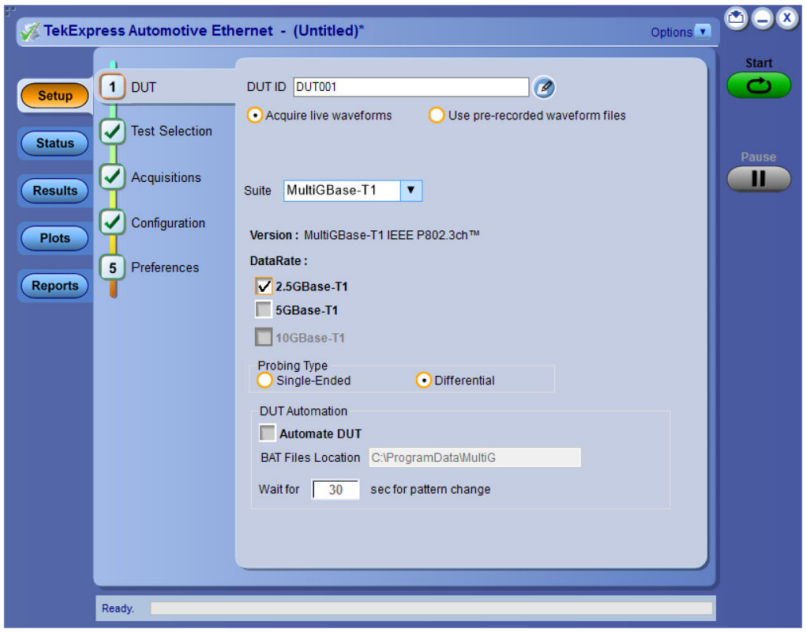


Figure 15: Setup panel of MultiGBase-T1 on MSO6/6B Series Oscilloscope

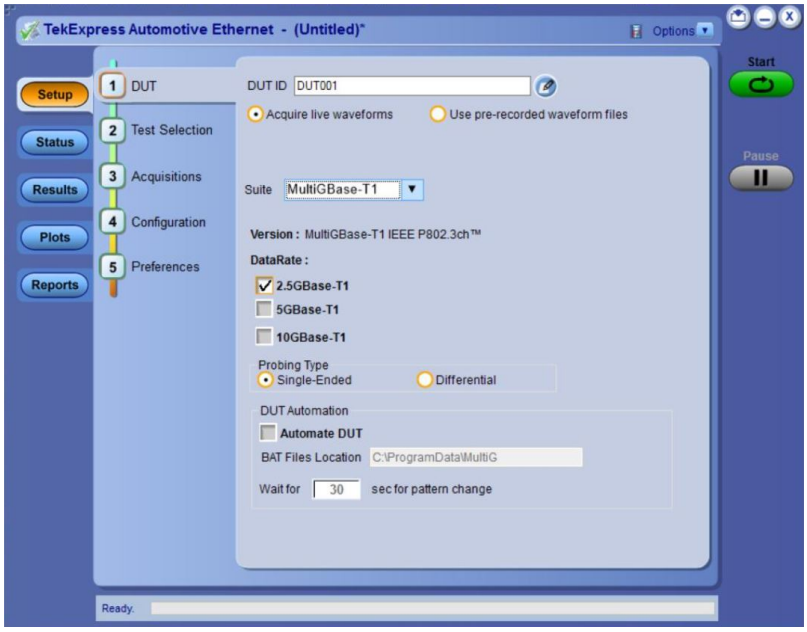


Figure 16: Setup panel of MultiGBase-T1 on DPO/MSO 70K Series Oscilloscope

See also

Save the configured test setup on page 85

DUT: Set DUT settings

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

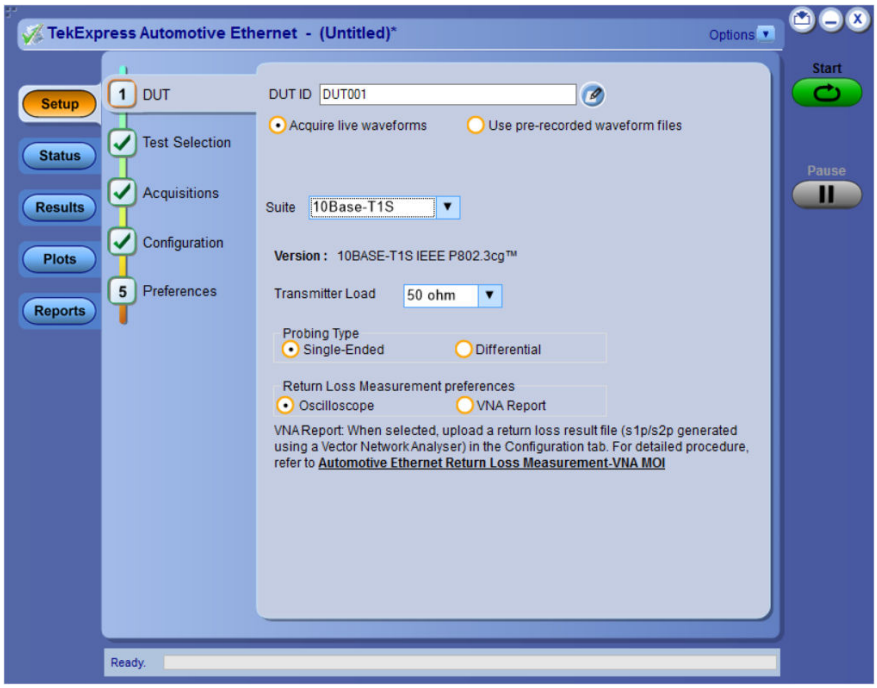


Figure 17: DUT tab for 10Base-T1S

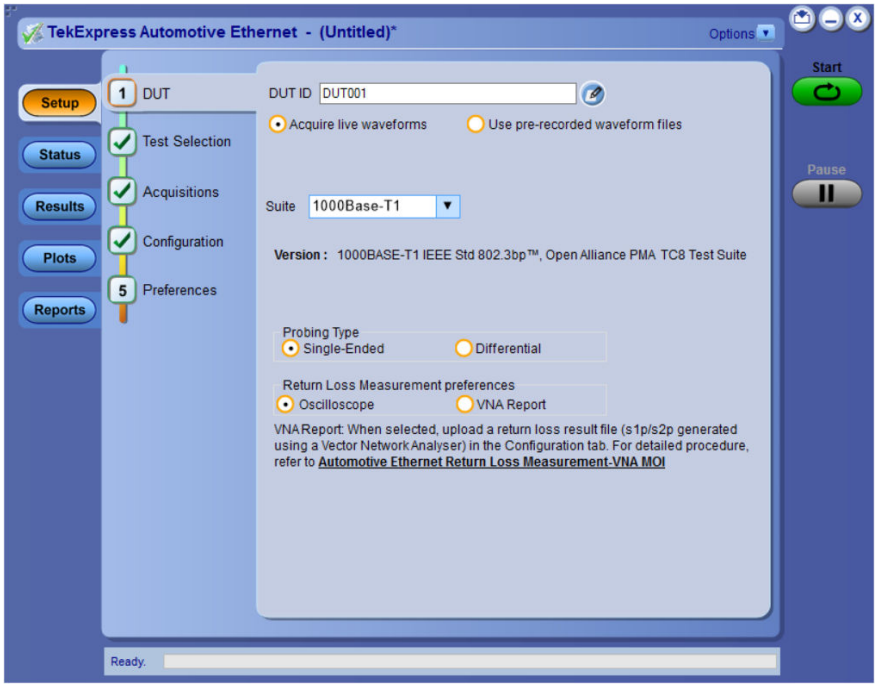


Figure 18: DUT tab for 100/1000Base-T1

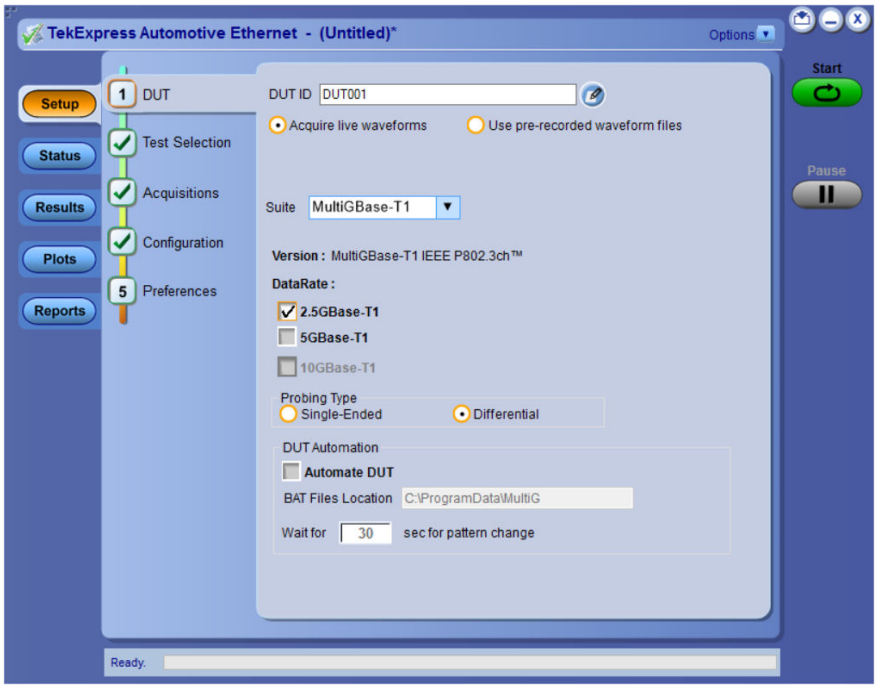


Figure 19: DUT tab of MultiGBase-T1 on MSO6/6B Series Oscilloscope

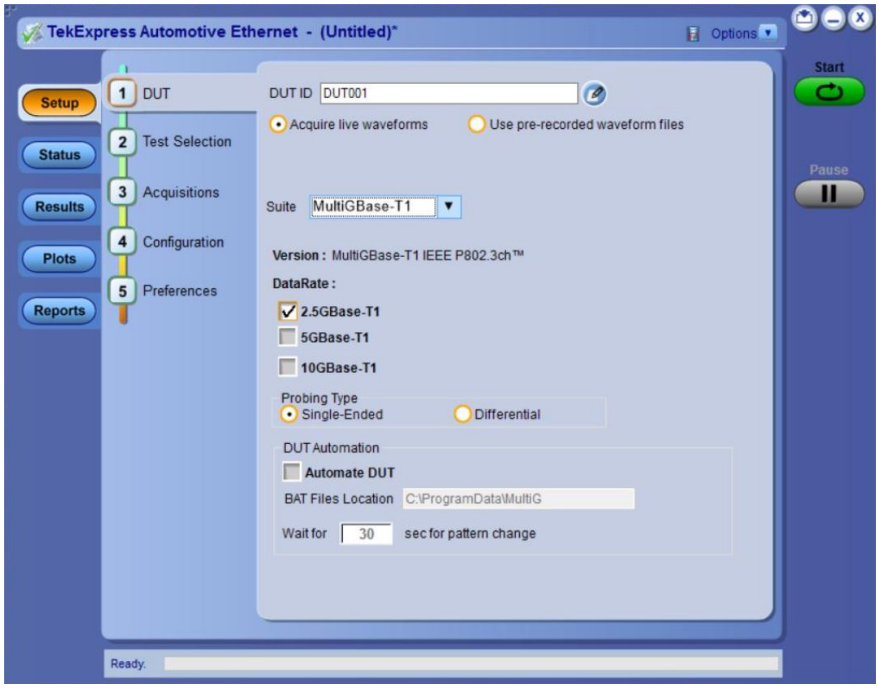


Figure 20: DUT tab of MultiGBase-T1 on DPO/MSO 70K Series Oscilloscope

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

Table 16: 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.
Suite	• 10Base-T1S • 100Base-T1 • 1000Base-T1 • MultiGBase-T1
Version	Displays the CTS specification for the selected suite.
Transmitter load	Select the operating mode from the drop-down list. The available values are 100 Ω, 50 Ω, Both.
Return Loss Measurement preferences	Available only, when **Return Loss measurement** is selected in the Test Selection tab. • 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, refer *Return Loss measurement using VNA Result File* on page 120 **Note:** You cannot run the batch file for the Return Loss Measurement when, the **DUT Automation** is enabled.
DataRate	(Available only when **Suite=MultiGBase-T1**) Select the data rate from drop down: • 2.5GBase-T1 • 5GBase-T1 • 10GBase-T1 **Note:** MSO6/6B Series Oscilloscope supports the data rate 2.5GBase-T1 and 5GBase-T1 only.
Probing Type	Select the probing type from drop down: • Differential • Single-Ended

Table continued…

Setting	Description
DUT Automation	Available only, when **Suite**=**MultiGBase-T1** Automates the DUT configuration for Test Mode signal with selected data rate and measurement.
Automate DUT	Set or clear to enable/disable the **DUT automation** check box for the test session.
BAT Files Location	This is the predefined path C:\ProgramData\MultiG\ with admin privileges to access.
Wait for 30 sec for pattern change	Specifies the maximum wait time for the execution of a BAT file. Allows an unknown time execution of the batch file and any other delay in DUT configuration. Essentially the feature accounts the time needed for the BAT file to execute the setup of the DUT to transmit the Test Mode signal. Expect you to determine the particular DUTs BAT files and set the time in TekExpress Automotive Ethernet application. **Note:** Do not **Pause** while executing BAT file, the application have no control over the completion of the BAT file in this case.

See also

Test Selection: Select the tests on page 45

Configuration: Set measurement limits for tests on page 54

Test Selection: Select the tests

Use the Test Selection tab to select one or all the tests. The test measurements available depends on the settings selected in the DUT tab.

The tests that you select here impact the parameters available in the Acquisitions tab.

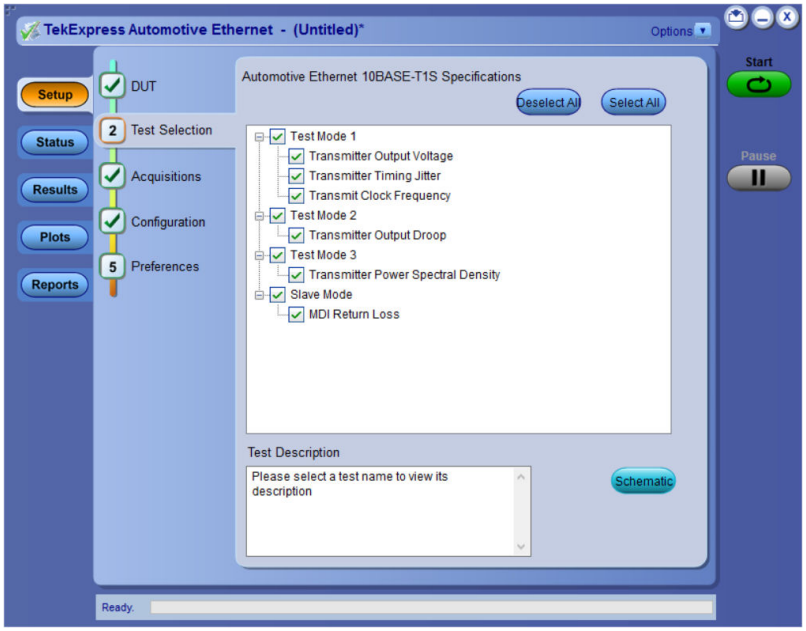


Figure 21: Test Selection tab for 10Base-T1S

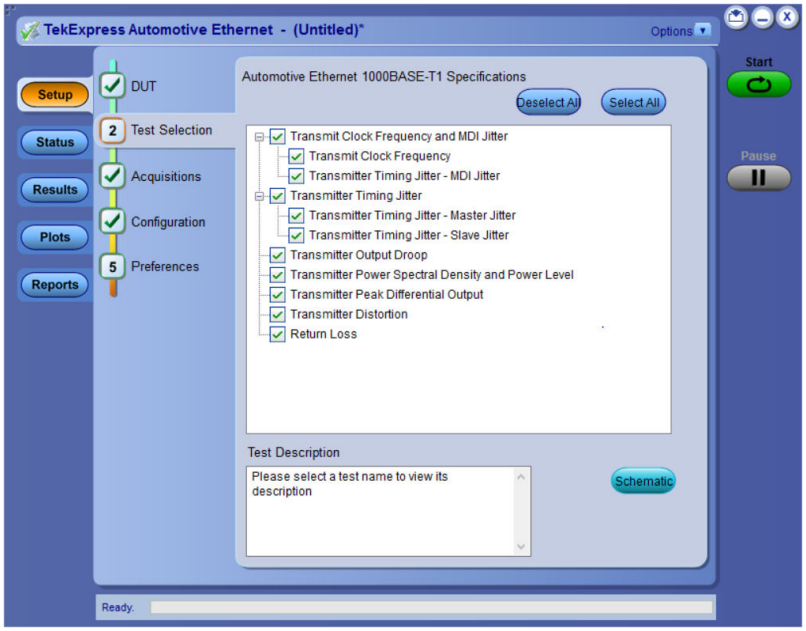


Figure 22: Test Selection tab for 100/1000Base-T1

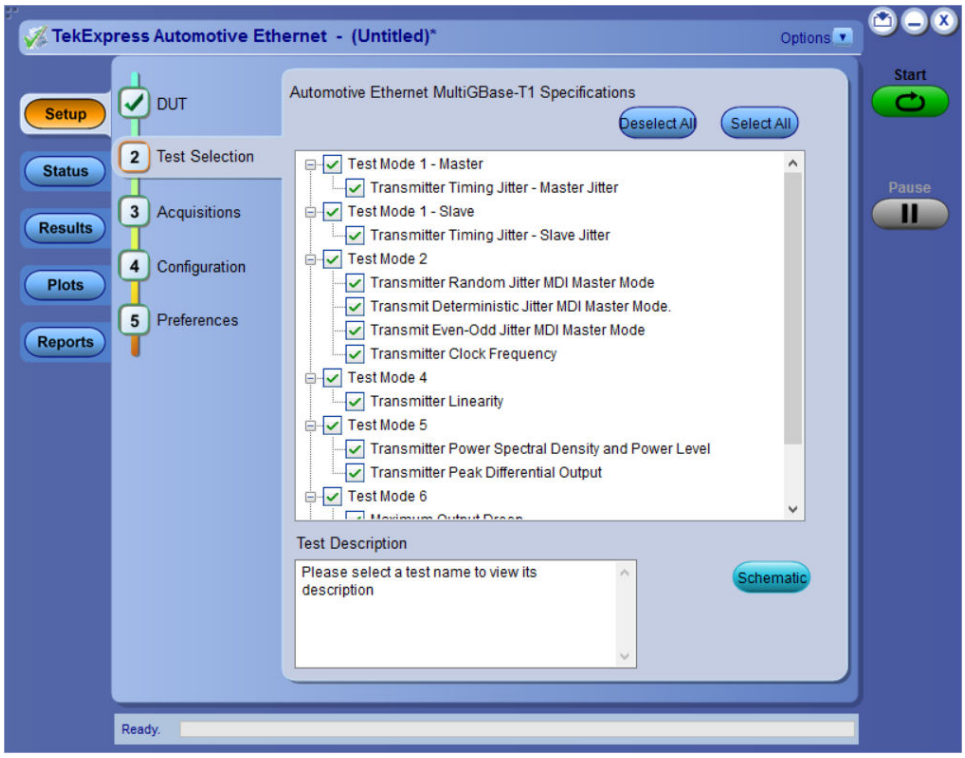


Figure 23: Test Selection tab for MultiGBase-T1

Table 17: 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

DUT: Set DUT settings on page 41

Configuration: Set measurement limits for tests on page 54

Status panel: View the test execution status on page 71

Acquisitions: Set waveform acquisition settings

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

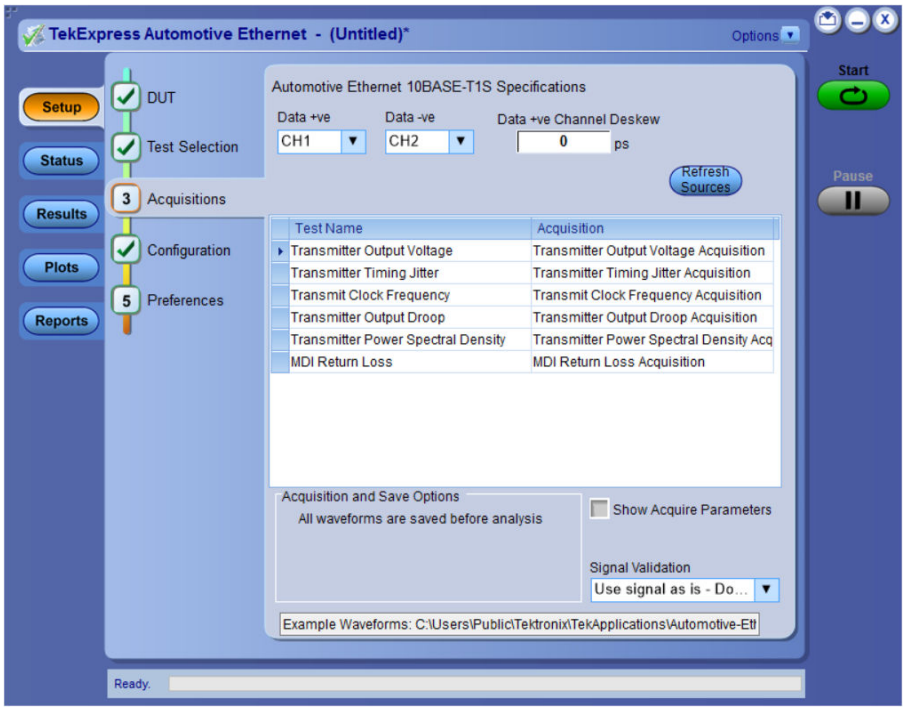


Figure 24: Acquisitions tab for 10Base-T1

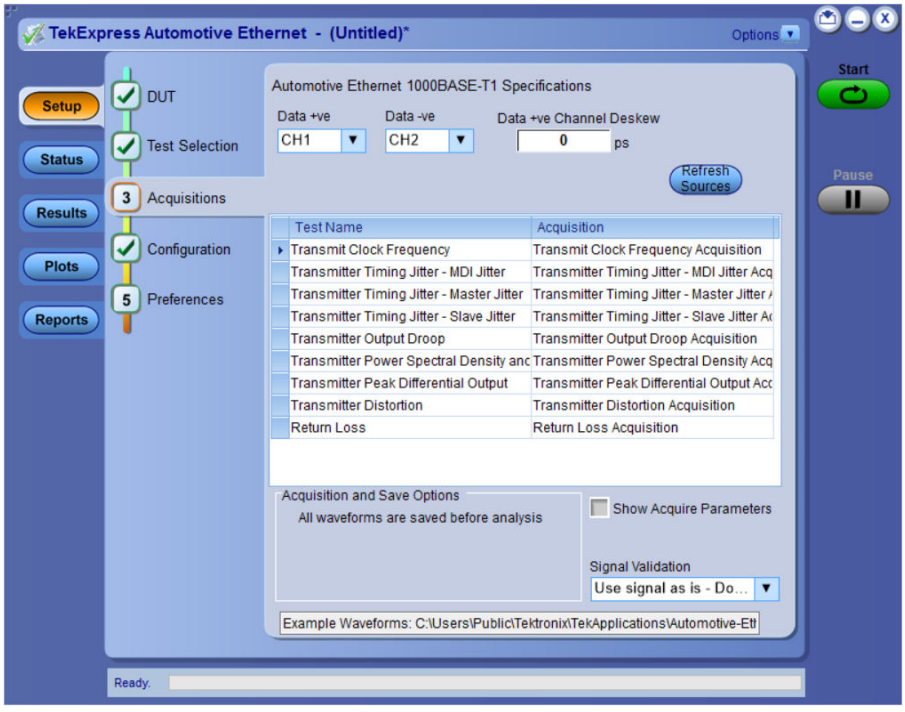


Figure 25: Acquisitions tab for 100/1000Base-T1

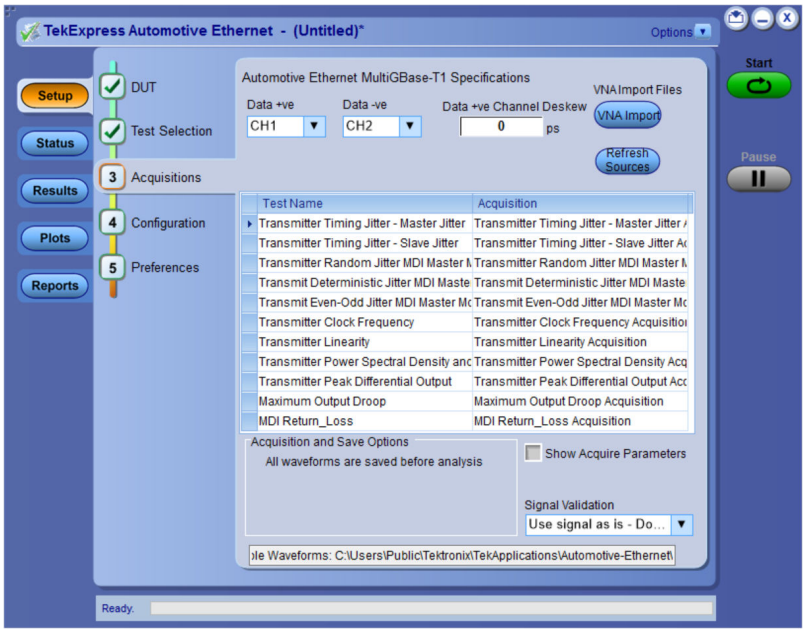


Figure 26: Acquisitions tab for MultiGBase-T1

Table 18: Acquisition tab settings

Setting	Description
Data +ve, Data -ve	Available only when **Probe Type=Single-Ended** Oscilloscope channels to which the positive and negative signal of the DUT is connected.
Data +ve Channel Deskew	Available only when **Probe Type=Single-Ended** Compensates the skew between the positive and negative channels of the oscilloscope
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
VNA Import	(Available only when **Suite=MultiGBase-T1**) Imports a VNA result file (s-parameter) to the application for return loss measurement

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.

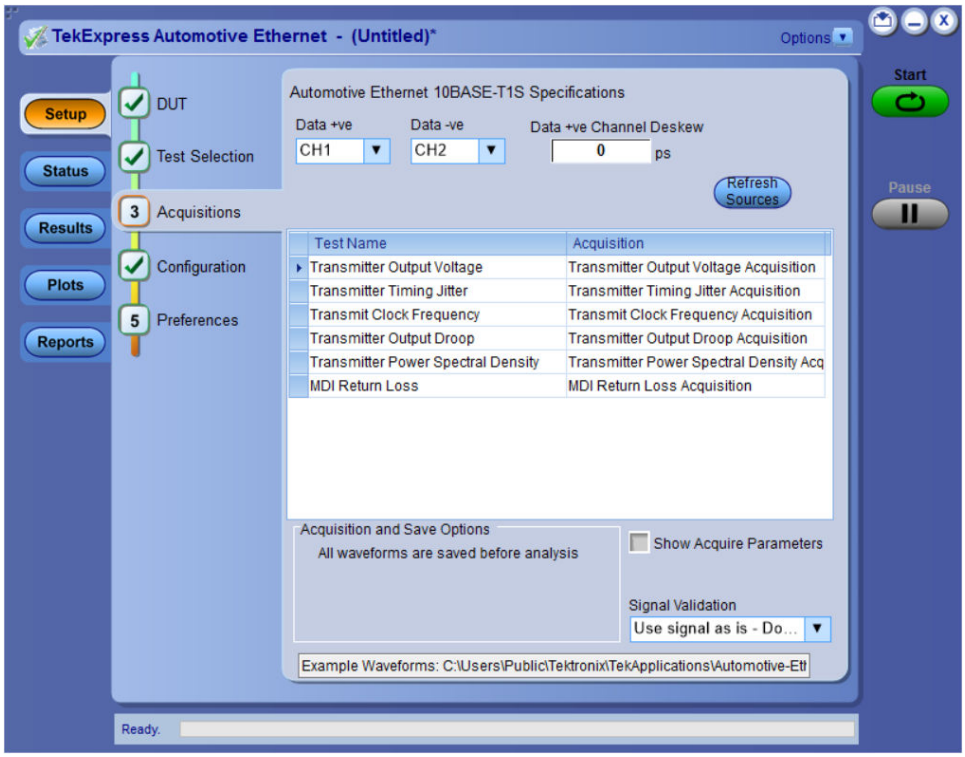


Figure 27: Acquisitions tab with Acquire live waveforms selected for 10Base-T1S

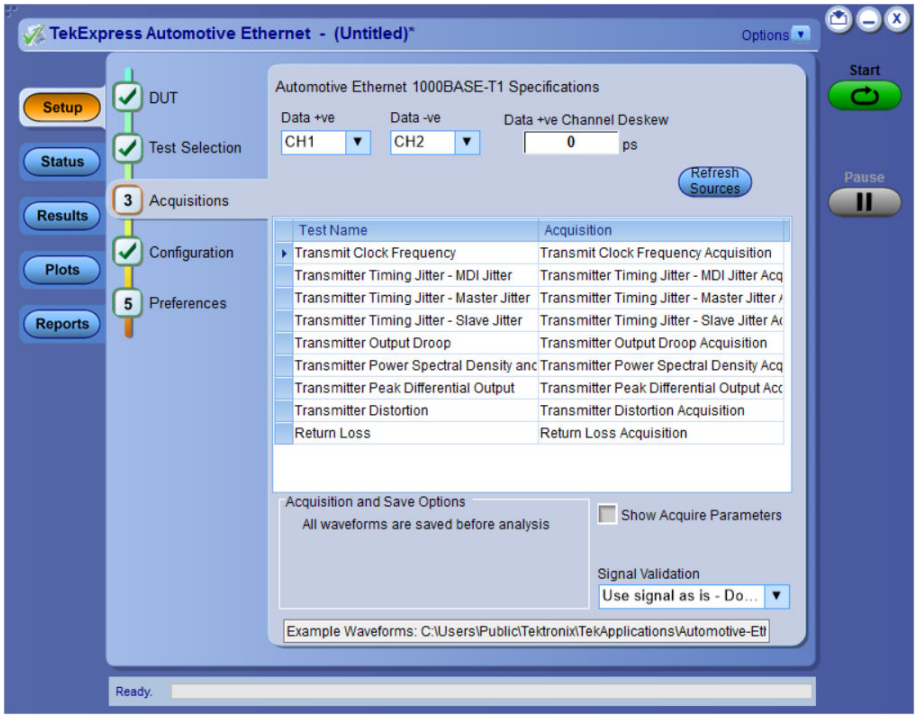


Figure 28: Acquisitions tab with Acquire live waveforms selected for 100/1000Base-T1

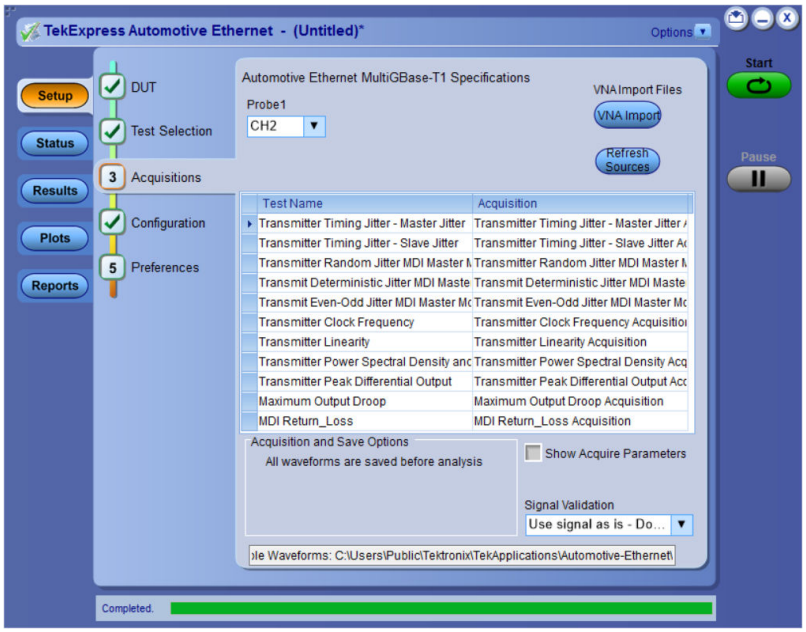
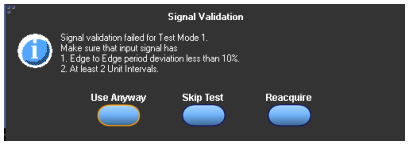


Figure 29: Acquisitions tab with Acquire live waveforms selected for MultiGBase-T1

Table 19: 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.

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.

VNA Import	(Available only when **Suite=MultiGBase-T1**) Imports a VNA result file (s-parameter) to the application for return loss measurement.

See also

Configuration: Set measurement limits for tests on page 54

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).

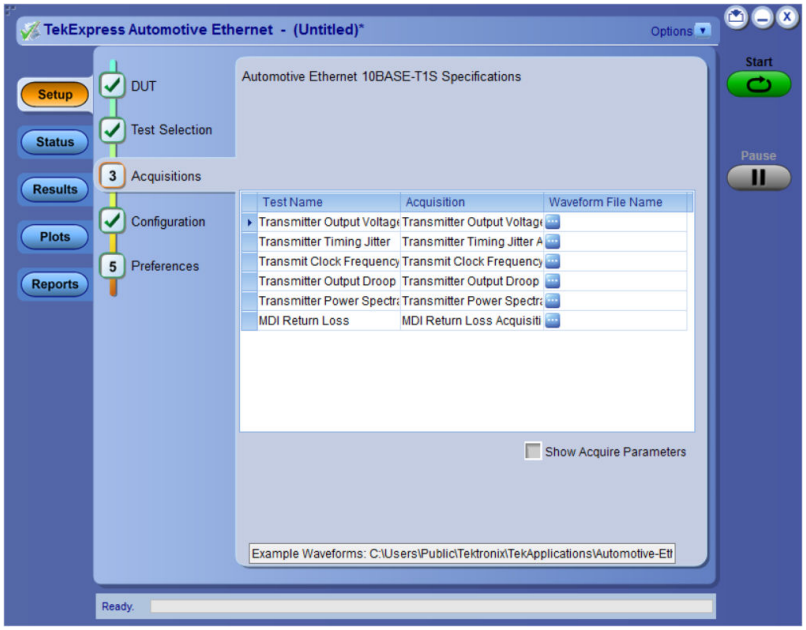


Figure 30: Acquisitions tab with Use pre-recorded waveform files selected for 10Base-T1S

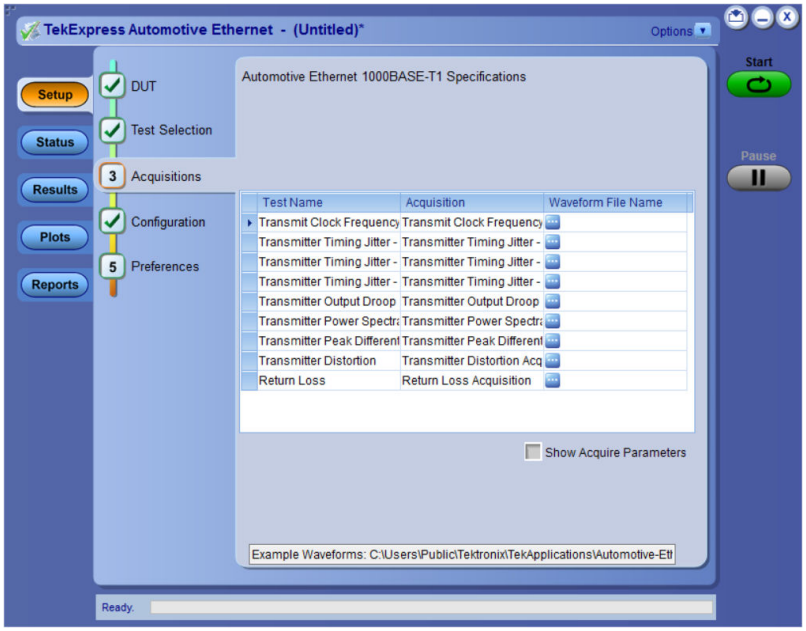


Figure 31: Acquisitions tab with Use pre-recorded waveform files selected for 100/1000Base-T1

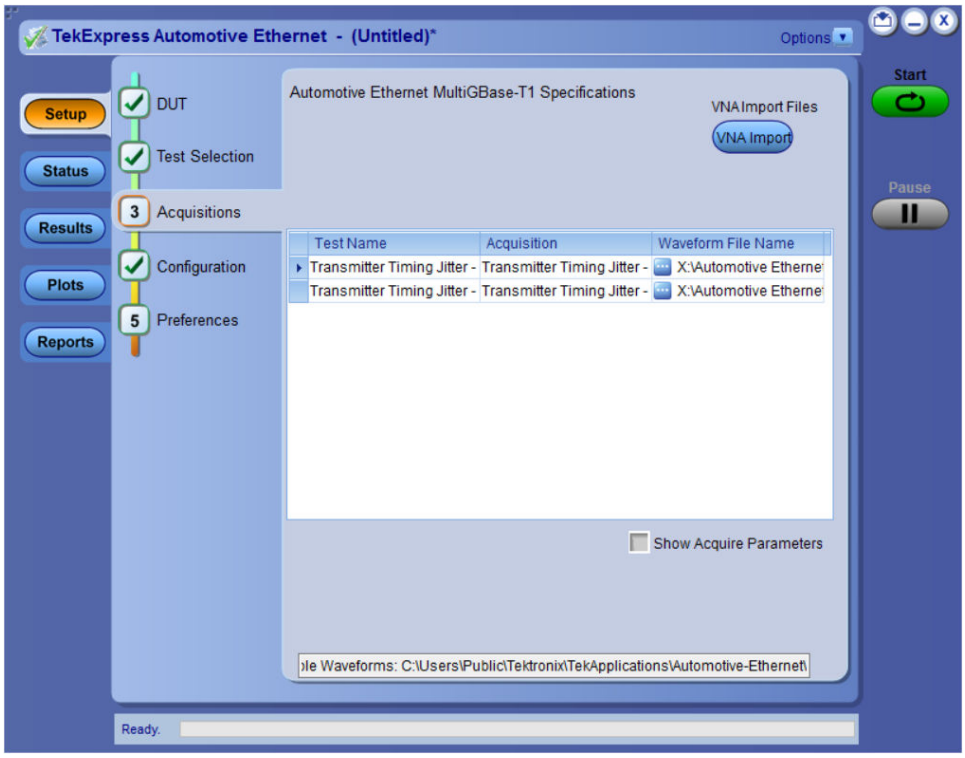


Figure 32: Acquisitions tab with Use pre-recorded waveform files selected for MultiGBase-T1

Table 20: 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.
VNA Import	(Available only when **Suite=MultiGBase-T1**)

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 (snapshot), allowing you to change the setup before acquiring the waveforms.

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

Naming convention of Pre-recoded mode

Follow the naming convention for single-ended and differential waveforms which are saved in the session. Use the same naming convention to save the waveform for pre-recorded mode analysis as shown in the below points:

- The naming convention for differential 5GBASE-T1 waveform will be `_DataRate_5G_Run1_Diff_`

`5G`	Conveys the data rate of the waveform.
`Run1`	Indicates the iteration index, which is helpful for the Muti-Run Session feature in the DUT panel.
`Diff`	Refers to the probing selection on the DUT panel as differential.

- The naming convention for single ended 2.5G BASE-T1 waveform will be `_DataRate_2Dot5_Run1_P` for positive and `_DataRate_2Dot5_Run1_N` for negative waveforms.

`2Dot5G`	Conveys the data rate of the waveform.
`Run1`	Indicates the iteration index, which is helpful for the Muti-Run Session feature in the DUT panel.
`Pos and Neg`	Refers to the probing selection on the DUT panel as single-ended.

Configuration: Set measurement limits for tests

Use Configuration tab to view and configure the Global Settings and the measurement configurations. The measurement specific configurations available in this tab depends on the selections made in the DUT panel and Test Selection panel.

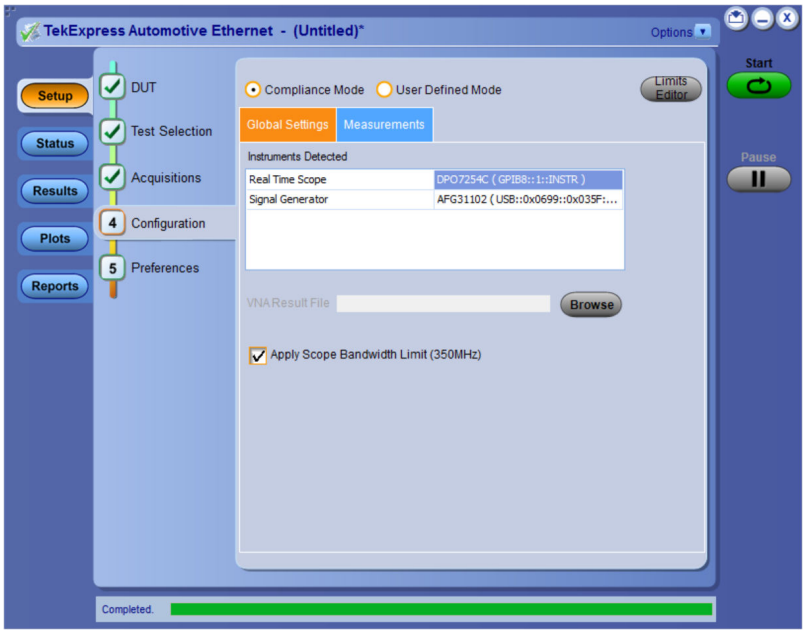


Figure 33: Configure tab settings for 10Base-T1S

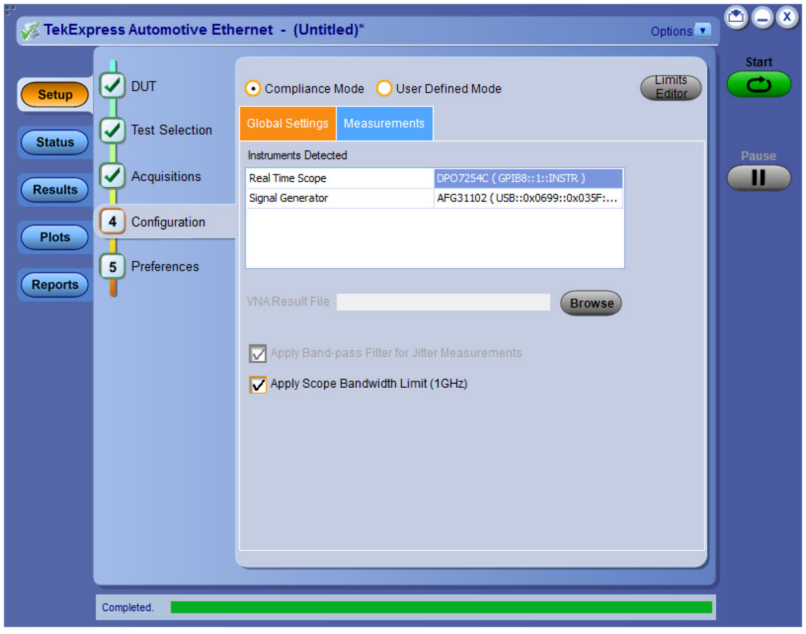


Figure 34: Configure tab settings for 100Base-T1/1000Base-T1

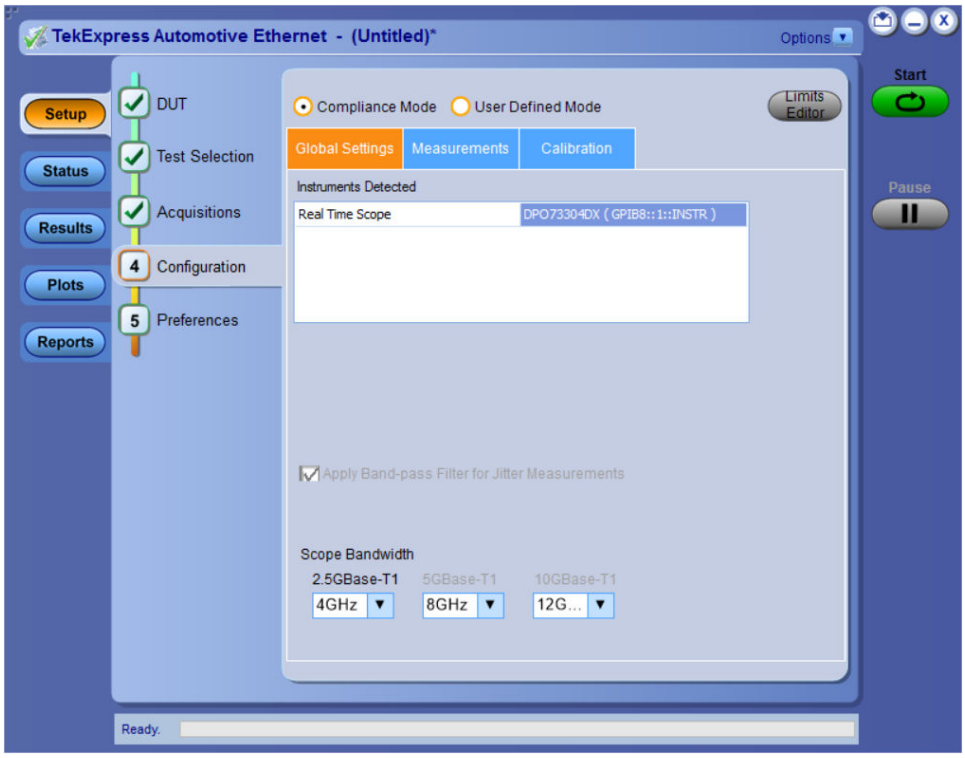


Figure 35: Configure tab settings for MultiGBase-T1

Table 21: Configuration tab settings

Setting	Description
Mode	Determines whether test parameters are in compliance or can be edited. • **Compliance**: Select to run the tests using compliance mode values. The measurement specific parameters are set to optimal values. • **User Defined**: Select to run the tests using custom values. All test parameters and global parameters are editable.

Table continued…

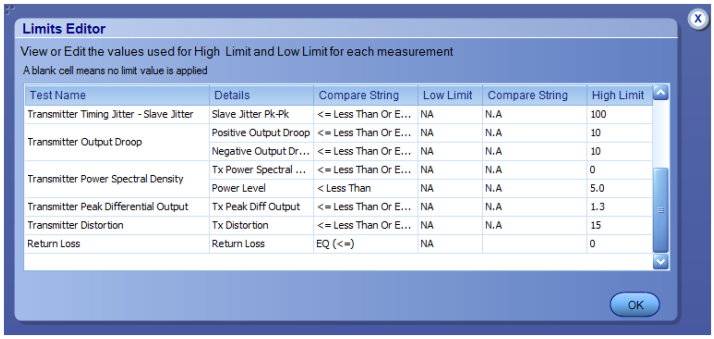
Setting	Description
Limits Editor	Displays the upper and lower limits for the applicable measurement using different types of comparisons. In Compliance Mode, use the Limits Editor to view the measurement high and low limits used for selected tests. In User Defined Mode, use the Limits Editor to edit the limit settings.  *Figure 36: Limits editor* 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 Analyzer. Available only, 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. Available only, 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 and MultiGBase-T1.
Apply Scope Bandwidth Limit(25GHz)	When enabled, applies the bandwidth limit filter of 350 MHZ for 10BASE-T1S, 1 GHz for 100BASE-T1 and 2 GHz for 1000BASE-T1. This bandwidth limiting feature is applicable to all the measurements except 100/1000BASE-T1 Return loss. A 100 MHz filter is applied for 10BASE-T1S Return loss. In the case of MSO5/6 series, in pre-recorded mode this feature will not have an impact on the measurement execution.

Table continued…

Setting	Description
Scope Bandwidth	Select to limit the effect of high frequency noise by limiting the oscilloscope bandwidth appropriately for each data rate. (Available only when **Suite**=**MultiGBase-T1**) • 2.5GBase-T1 • 5GBase-T1 • 10GBase-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

DUT: Set DUT settings on page 41

Test Selection: Select the tests on page 45

Acquisitions: Set waveform acquisition settings on page 47

Saving and recalling test setup on page 85

Measurement parameters

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.

10Base-T1S

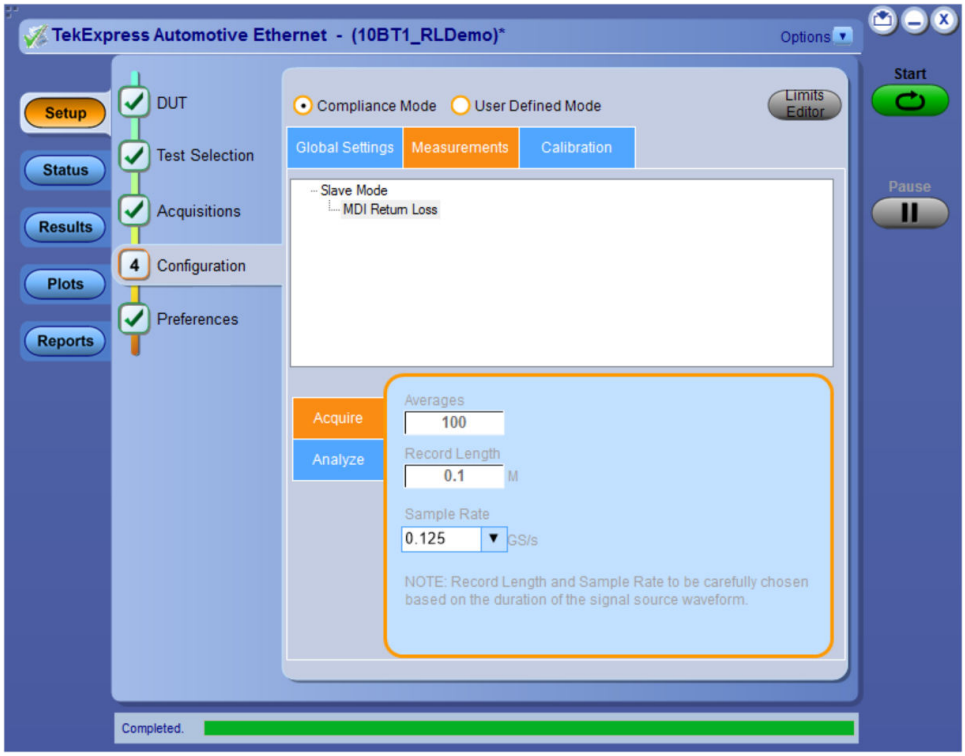


Figure 37: Configuration tab: Measurement for 10Base-T1S

Table 22: Configuration tab: Measurement settings for 10Base-T1S

Measurements	Group	Settings	Default Value
Test Mode 1			
Transmitter Output Voltage	Acquire	Record Length (M)	0.03
		Sample Rate (GS/s)	0.625
Transmitter Timing Jitter	Acquire	Record Length (M)	0.65
		Sample Rate (GS/s)	0.625
	Analyze	Edge	Both
		Hysteresis (%)	5 %
Transmitter Clock Frequency	Acquire	Record Length (M)	0.03
		Sample Rate (GS/s)	0.625
Test Mode 2			

Table continued…

Measurements	Group	Settings	Default Value
Transmitter Output Droop	Acquire	Averages	8
		Record Length (M)	0.04
		Sample Rate (GS/s)	0.625
Test Mode 3			
Transmitter Power Spectral Density	Acquire	Spectral Averages	2
		Record Length (M)	2.5
		Sample Rate (GS/s)	1.25
	Analyze	RBW (KHz)	1
		Start Frequency (MHz)	0.3
		Stop Frequency (MHz)	40
Slave Mode			
MDI Return Loss	Acquire	Averages	100
		Record Length (M)	0.1
		Sample Rate (GS/s)	0.625
	Analyze	Smooth	7

100Base-T1

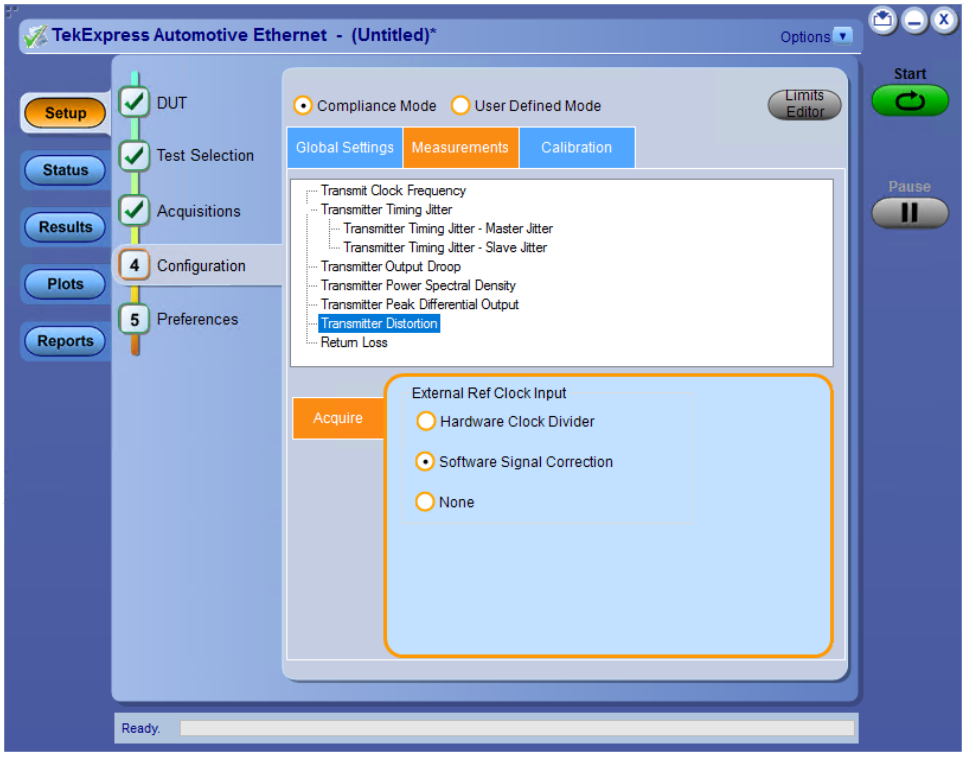


Figure 38: Configuration tab: Measurement for 100Base-T1

Table 23: Configuration tab: Measurement settings for 100Base-T1

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
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 synchronization.	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)

Table continued…

Name	Unit	Range/Allowable values	Default	Description	Applies to
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)
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

1000Base-T1

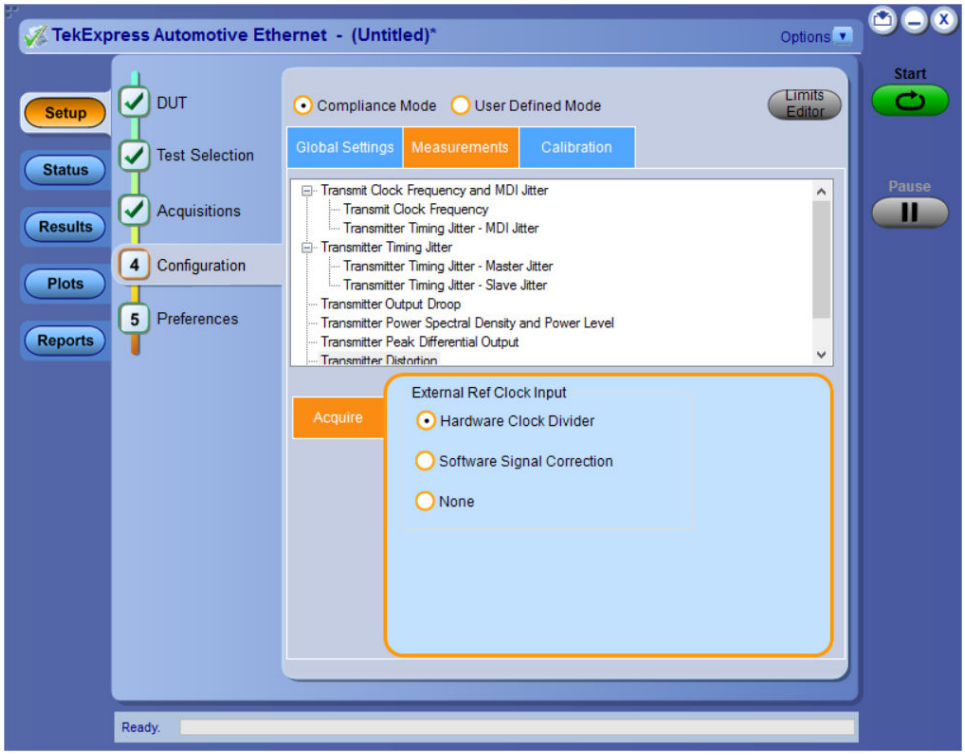


Figure 39: Configuration tab: Measurement for 1000Base-T1

Table 24: Configuration tab: Measurement settings for 1000Base-T1

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)
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

Table continued…

Name	Unit	Range/Allowable values	Default	Description	Applies to
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 synchronization.	Transmitter Distortion
None	NA	NA	NA	Select to check the behavior of the DUT without any Ref clock (External or Internal).	Transmitter Distortion
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

Table continued…

Name	Unit	Range/Allowable values	Default	Description	Applies to
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

MultiGBase-T1

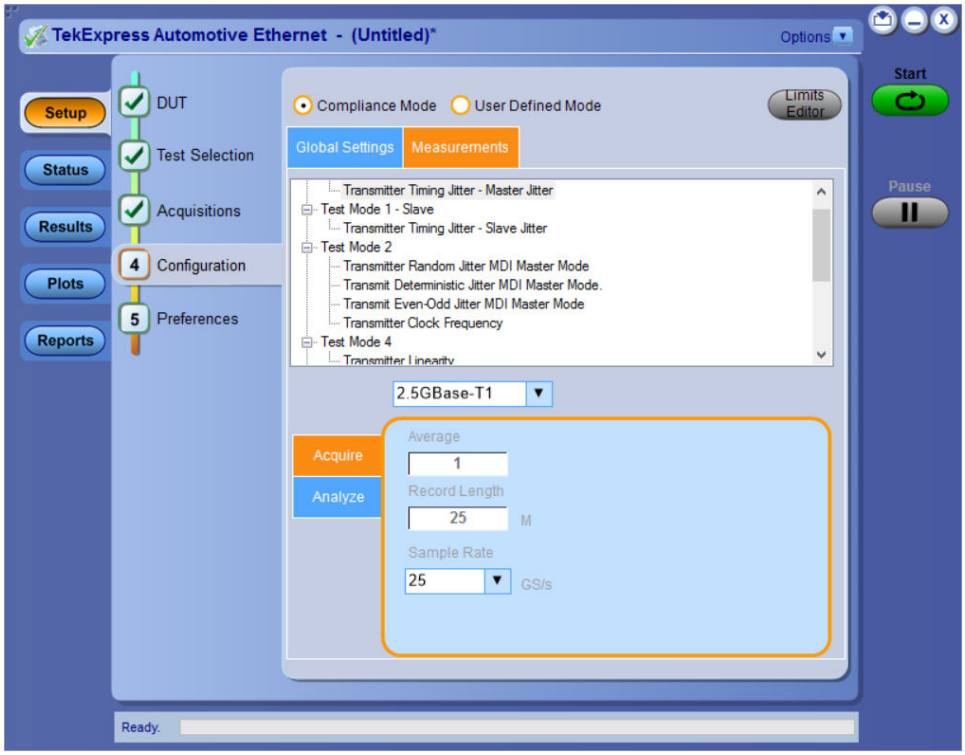


Figure 40: Configuration tab: Measurement for MultiGBase-T1

Table 25: Configuration tab: Measurement settings for MutiGBase-T1

Name	Unit	DataRate	Range/Allowable values	Default	Description	Applies to
Record Length	M Samples	2.5GBase-T1	0.2 to 50	12.5	Specifies the waveform record length.	Transmitter Timing Jitter - Master Jitter
		5GBase-T1				
		10GBase-T1				
		2.5GBase-T1	0.2 to 50	12.5		Transmitter Timing Jitter - Slave Jitter
		5GBase-T1				
		10GBase-T1				

Table continued…

Name	Unit	DataRate	Range/Allowable values	Default	Description	Applies to
		2.5GBase-T1	0.2 to 50	12.5		Transmitter Random Jitter MDI Master Mode
		5GBase-T1				
		10GBase-T1				
		2.5GBase-T1	2.3 to 150	89		Transmit Deterministic Jitter MDI Master Mode
		5GBase-T1				
		10GBase-T1				
		2.5GBase-T1	0.005 to 50	0.002		Transmit Even-Odd Jitter MDI Master Mode
		5GBase-T1				
		10GBase-T1				
		2.5GBase-T1	0.005 to 50	0.1		Transmitter Clock Frequency
		5GBase-T1				
		10GBase-T1				
		2.5GBase-T1	0.3 to 50	0.6		Transmitter Linearity
		5GBase-T1				
		10GBase-T1				
		2.5GBase-T1	0.125 to 50	0.350		Transmitter Power Spectral Density
		5GBase-T1				
		10GBase-T1				
		2.5GBase-T1	0.1 to 50	0.1		Transmitter Peak Differential Output
		5GBase-T1				
		10GBase-T1				
		2.5GBase-T1	0.1 to 50	0.1		Maximum Output Droop
		5GBase-T1				
		10GBase-T1				
Average	NA	2.5GBase-T1	1 to 256	1	Sets the number of averages (number of acquisitions) for average mode acquisition.	Transmitter Timing Jitter - Master Jitter
		5GBase-T1				
		10GBase-T1				
		2.5GBase-T1	1 to 256	1		Transmitter Timing Jitter - Slave Jitter
		5GBase-T1				
		10GBase-T1				
		2.5GBase-T1	1 to 256	1		Transmitter Random Jitter MDI Master Mode
		5GBase-T1				
		10GBase-T1				
		2.5GBase-T1	1 to 256	1		Transmit Deterministic Jitter MDI Master Mode
		5GBase-T1				
		10GBase-T1				

Table continued…

Name	Unit	DataRate	Range/Allowable values	Default	Description	Applies to
		2.5GBase-T1	1 to 256	1		Transmit Even-Odd Jitter MDI Master Mode
		5GBase-T1				
		10GBase-T1				
		2.5GBase-T1	1 to 256	1		Transmitter Clock Frequency
		5GBase-T1				
		10GBase-T1				
		2.5GBase-T1	1 to 256	2		Maximum Output Droop
		5GBase-T1				
		10GBase-T1				
Sample Rate	GS/s	2.5GBase-T1	• 3.125 • 6.25 • 12.5 • 25 • 50	12.5	Specifies the oscilloscope's sample rate for all tests.	Transmitter Timing Jitter - Master Jitter
		5GBase-T1				
		10GBase-T1				
		2.5GBase-T1	• 3.125 • 6.25 • 12.5 • 25 • 50	12.5		Transmitter Timing Jitter - Slave Jitter
		5GBase-T1				
		10GBase-T1				
		2.5GBase-T1	• 3.125 • 6.25 • 12.5 • 25 • 50	12.5		Transmitter Random Jitter MDI Master Mode
		5GBase-T1				
		10GBase-T1				
		2.5GBase-T1	• 6.25 • 12.5 • 25 • 50	12.5		Transmit Deterministic Jitter MDI Master Mode
		5GBase-T1	• 12.5 • 25 • 50	25		
		10GBase-T1	• 25 • 50	50		
		2.5GBase-T1	• 6.25	12.5		Transmit Even-Odd Jitter MDI Master Mode
		5GBase-T1		25		

Table continued…

Name	Unit	DataRate	Range/Allowable values	Default	Description	Applies to
		10GBase-T1	• 12.5 • 25 • 50	50		
		2.5GBase-T1	• 6.25 • 12.5 • 25 • 50	12.5		Transmitter Clock Frequency
		5GBase-T1		25		
		10GBase-T1		50		
		2.5GBase-T1	• 12.5 • 25 • 50	12.5		Transmitter Linearity
		5GBase-T1	• 25 • 50	25		
		10GBase-T1	50	50		

Name	Unit	DataRate	Range/Allowable values	Default	Description	Applies to
		2.5GBase-T1	• 3.125 • 6.25 • 12.5 • 25 • 50	3.125		Transmitter Power Spectral Density
		5GBase-T1	• 6.25 • 12.5 • 25 • 50	12.5		
		10GBase-T1	• 12.5 • 25 • 50	25		
		2.5GBase-T1	• 3.125 • 6.25 • 12.5 • 25 • 50	6.25		Transmitter Peak Differential Output
		5GBase-T1	• 6.25 • 12.5 • 25 • 50	12.5		
		10GBase-T1	• 12.5 • 25 • 50	25		
		2.5GBase-T1 5GBase-T1 10GBase-T1	• 0.625 • 3.125 • 6.25 • 12.5 • 25 • 50	3.125		Maximum Output Droop

Table continued…

Name	Unit	DataRate	Range/Allowable values	Default	Description	Applies to
Edge	NA	2.5GBase-T1	• Falling • Raising • Both	Both	Used to select the type of edges on which RMS Jitter and Peak-to-Peak Jitter will be calculated.	Transmitter Timing Jitter - Master Jitter
		5GBase-T1				
		10GBase-T1				
		2.5GBase-T1		Both		Transmitter Timing Jitter - Slave Jitter
		5GBase-T1				
		10GBase-T1				
Test Pattern		2.5GBase-T1	• JP03A • JP03B	JP03A	Selects the input test mode pattern	Transmitter Clock Frequency
		5GBase-T1				
		10GBase-T1				
		2.5GBase-T1		JP03A		Transmit Deterministic Jitter MDI Master Mode
		5GBase-T1				
		10GBase-T1				
Apply Band-pass Filter					Select to apply the Band pass filter for the selected jitter measurements	Transmitter Timing Jitter - Master Jitter
						Transmitter Random Jitter MDI Master Mode
						Transmitter Timing Jitter - Slave Jitter
RBW		2.5GBase-T1	2 to 400	100	Sets the resolution bandwidth. This controls the bandwidth of the spectral analyzer filters.	Transmitter Power Spectral Density
		5GBase-T1				
		10GBase-T1				
Start Frequency		2.5GBase-T1	0 to 1365	0	Specifies the start frequency of the capture for PSD	
		5GBase-T1	0 to 2470			
		10GBase-T1	0 to 5490			
Stop Frequency		2.5GBase-T1	10 to 1375	1375	Specifies the stop frequency of the capture for PSD	
		5GBase-T1	10 to 2750	2750		
		10GBase-T1	10 to 5500	5500		

Note: MSO6/6B Series Oscilloscope supports the data rate 5GBase-T1 and 2.5GBase-T1 only.

Preferences: Set the test run preferences

Use **Preferences** tab to set the application action on completion of a measurement. The **Preferences** tab has the feature to enable or disable certain options related to the measurement execution.

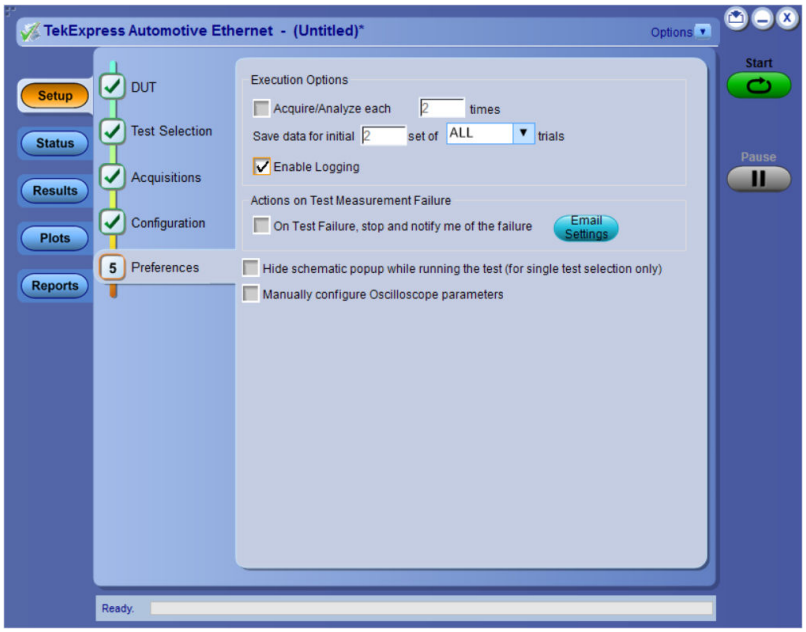


Figure 41: Preferences tab

Refer the below table for the options available in the **Preferences** tab:

Table 26: Preferences tab settings

Setting	Description
Execution Options	
Acquire/Analyze each test <no> times (not applicable to Custom Tests)	Select to repeat the test run by setting the number of times. By default, the check box is disabled. Upon enabling, the default value is 10. Refer *Multi-Run description* on page 215 to perform the measurements for a user defined number of iterations.
Save data for initial <no> set of <type> waveforms	Saves the set(s) of Pass/Fail waveforms to the session path.
Enable Logging	Select to record the actions of the user by the application. By default, it is selected.
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 the email settings to receive notifications.
Hide schematics popup while running the test (for single test selection only)	Enable to hide schematics popup while running the single test.
Manually configure Oscilloscope parameters	Available only when **Suite=MultiGBase-T1** The feature allows you to configure the oscilloscope settings manually such as Horizontal, Vertical and Trigger settings to capture a waveform. In general TekExpress application configures the oscilloscope optimally for each measurement as per the needs of the specification. If you want to debug using different settings, then select this feature.

Status panel: View the test execution status

The Status panel contains the **Test Status** and **Log View** tabs, which provides status on the test acquisition and analysis (Test Status) and listing of test tasks performed (Log View tab). The application opens the **Test Status** tab when you start to execute the test. Select the **Test Status** or the **Log View** tab to view these items while the test execution is in progress.

View test execution status

The tests are grouped and displayed based on the Clock and Data lane. It displays the tests along with the acquisition type, acquire, and analysis status of the tests. In pre-recorded mode, **Acquire Status** is not valid.

The **Test Status** tab presents a collapsible table with information about each test as it is running. Use the symbols to expand (+) and collapse (−) the table rows.

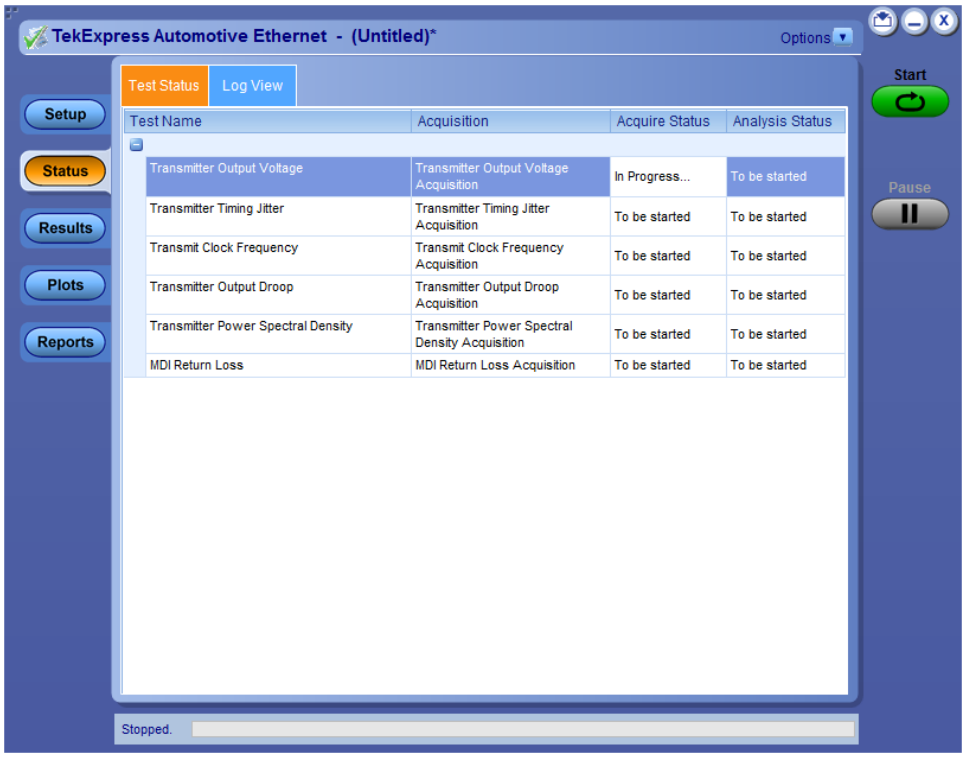


Figure 42: Test execution status view in Status panel

Table 27: Test execution status table headers

Table Header	Description
Test Name	Displays the measurement name.
Acquisition	Describes the type of data being acquired.

Table continued…

Table Header	Description
Acquire Status	Displays the progress state of the acquisition: • To be started • In Progress • Completed
Analysis Status	Displays the progress state of the analysis: • To be started • In Progress • Completed • Aborted

View test execution logs

The Test Status tab displays the detailed execution status of the tests. Also, displays each and every execution step in detail with its timestamp information. The log details can be used to troubleshoot and resolve any issue/bug which is blocking the test execution process.

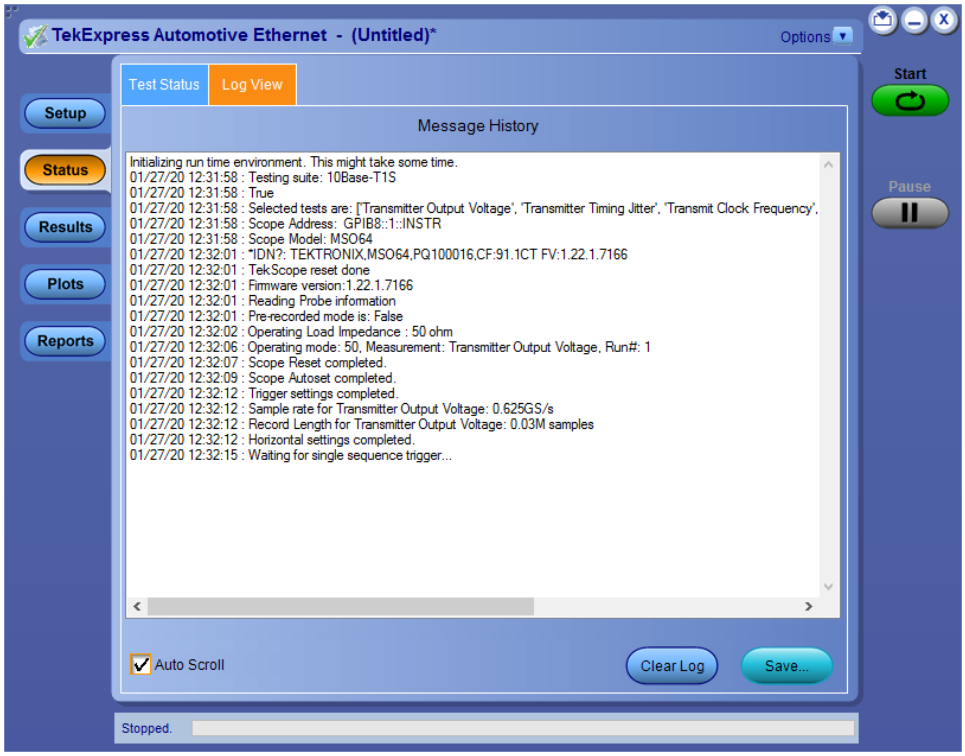


Figure 43: Log view in Status panel

Table 28: Status panel settings

Control	Description
Message History	Lists all the executed test operations and timestamp information.

Table continued…

Control	Description
Auto Scroll	Enables automatic scrolling of the log view as information is added to the log during the test execution.
Clear Log	Clears all the messages from the log view.
Save	Saves the log file into a text file format. Use the standard Save File window to navigate to and specify the folder and file name to save the log text.

Results panel: View summary of test results

Figure 44: Results panel with measurement results

Click icon on each measurement in the row to expand and to display the minimum and maximum parameter values of the measurement.

Filter the test results

Each column in the result table can be customized and displayed by enabling or disabling any column as per your requirement. You can change the view in the following ways:

- To remove or restore the Pass/Fail column, select **Preferences** > **Show Pass/Fail**.
- To collapse all expanded tests, select **Preferences** > **View Results Summary**.
- To expand all the listed tests, select **View Results Details** from the **Preferences menu** in the upper right corner.
- To enable or disable the wordwrap feature, select **Preferences** > **Enable Wordwrap**.
- To view the results grouped by lane or test, select the corresponding item from the **Preferences** menu.
- To expand the width of a column, place the cursor over the vertical line that separates the column from the column 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 clear all test results displayed, click **Clear**.

Plots panel: Plots panel overview

The Plots panel displays the result as a two-dimensional plot for additional measurement analysis. The plots are displayed only during run and only for the measurements which supports plots.

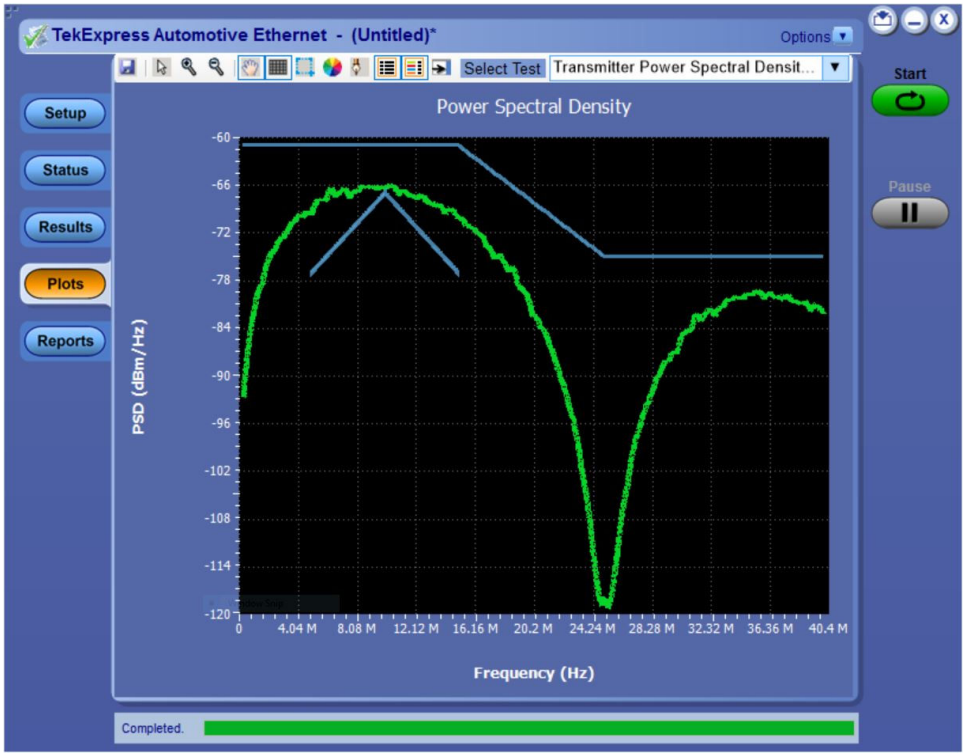


Figure 45: Plots panel

Toolbar functions in plot windows

The Plot Toolbar window includes the following functions:

Icon	Functions
Save	Saves the plot.
Select & Zoom	Expands the selected plot area. Left-click and drag the mouse to mark the region on the plot to zoom.
Zoom In	Expands part of the plot (Horizontal and Vertical); the data appears in more detail.
Zoom Out	Contracts part of the plot (Horizontal and Vertical); the data appears in less detail.
Pan	Moves the plot anywhere within the scale.
Hide Gridlines	Hides the gridlines.

Table continued…

Icon	Functions
Reset	Resets the zoom to 100%.
Choose Waveform Colors	Sets the plot color. Click and select the color in the Color window and click **OK**. Click in the plot area to apply the color.
Show/Hide Markers	Displays or hides the markers.
UnDock/Dock	Click to undock/dock the plot window.
	Select the measurement.

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. An Example of the plot generated during run, based on the measurement(s) selected is as shown:

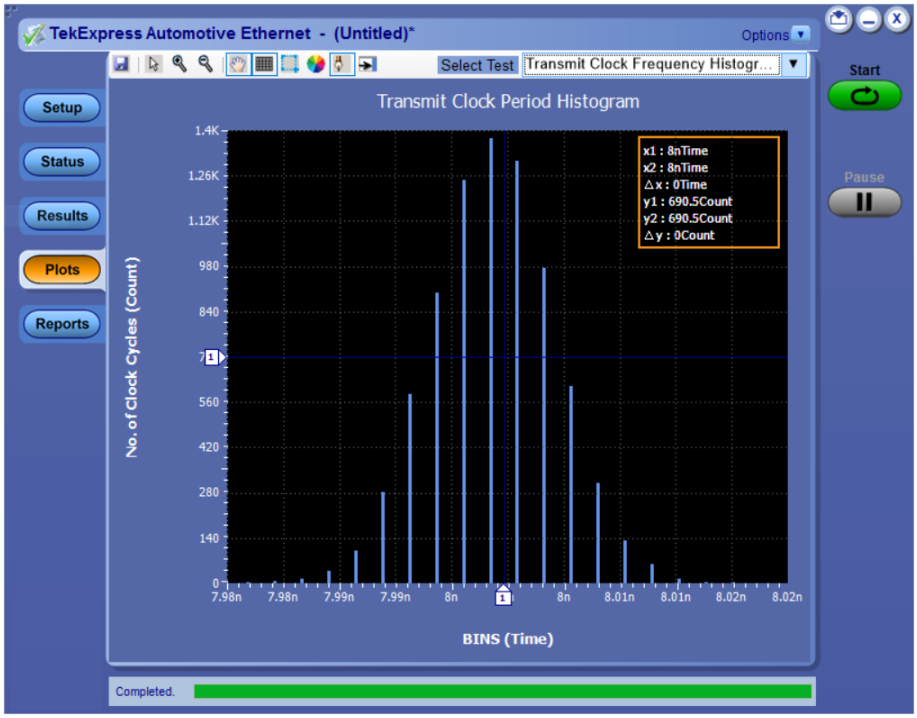


Figure 46: Transmit Clock Frequency - 1000Base-T1 Histogram Plot

Reports panel: Configure report generation settings

The **Report** panel contains the **Configuration** and **View Settings** tabs to configure the report generation settings and select the test result information to include in the report. You can use the Reports panel to configure report generation settings, select test content to include in reports, generate the report, view the report, browse for reports, name and save reports, and select report viewing options.

Report configuration settings

The Configuration tab describes the report generation settings to configure the Reports panel. Select report settings before running a test or when creating and saving test setups. Report settings configured are included in saved test setups.

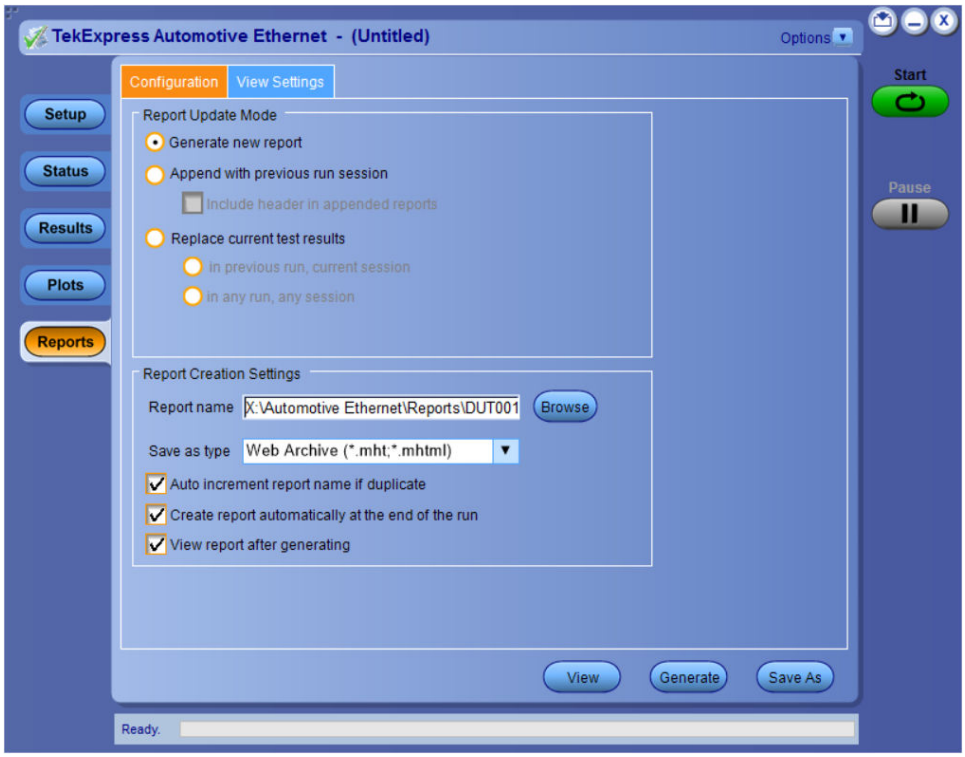


Figure 47: Report panel- Configuration tab

Table 29: Report configuration panel settings

Control	Description
View	Click to view the most current report.
Generate	Generates a new report based on the current analysis results.
Save As	Specify a name for the report.
Report Update Mode Settings	
Generate new report	Each time when you click **Run** and when the test execution is complete, it will create a new report. The report can be in either .mht, .pdf, or .csv file formats.
Append with previous run session	Appends the latest test results to the end of the current test results report. Each time when you click this option and run the tests, it will run the previously failed tests and replace the failed test result with the new pass test result in the same report.

Table continued…

Control	Description
Include header in appended reports	Select to include header in appended reports.
Replace current test results	Replaces the previous test results with the latest test results. Results from newly added tests are appended to the end of the report.
In previous run, current session	Select to replace current test results in the report with the test result(s) of previous run in the current session.
In any run, any session	Select to replace current test results in the report with the test result(s) in the selected run session's report. Click and select test result of any other run session.
Report Creation Settings	
Report name	Displays the name and path of the <Application Name> report. The default location is at `\My Documents>\My TekExpress\<Application Name>\Reports`. 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. **To change the report name or location, do one of the following:** • In the Report Path field, type the current folder path and name. • Double-click in the Report Path field and then make selections from the popup keyboard and click **Enter**. 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\<Application Name> \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. The report is saved in .csv, .pdf, or .mht. **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	Select to create the report with the settings configured, at the end of run.
View report after generating	Automatically opens the report in a Web browser when the test execution is complete. This option is selected by default.

Configure report view settings

The **View Settings** tab describes the report view settings to configure the Reports panel. Select report view settings before running a test or when creating and saving test setups. Report settings configured are included in saved test setups.

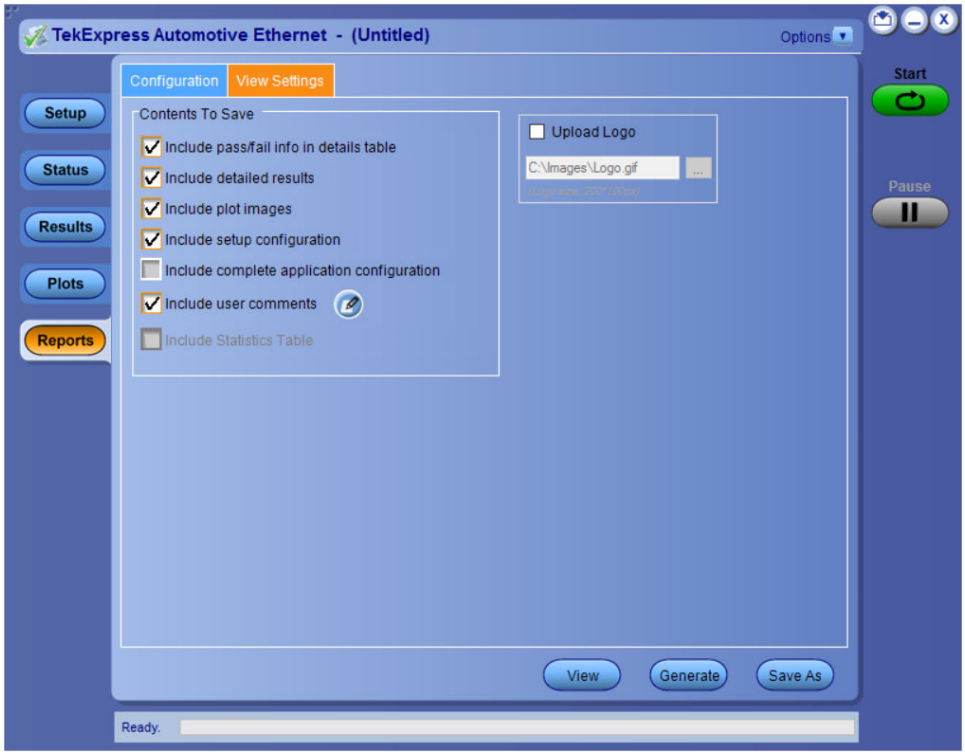


Figure 48: Report panel-View settings tab

Table 30: Report panel view settings

Control	Description
Contents To Save Settings	
Include pass/fail info in details table	Select to include pass/fail information in the details table of the report.
Include detailed results	Select to include detailed results in the report.
Include plot images	Select to include the 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	Select to include the complete application configuration in the report.
Include user comments	Select to include any comments about the test that you or another user have added in the DUT tab of the Setup panel. Comments appear in the Comments section, below the summary box at the beginning of each report.
Include statics table	Select to include test run statistics in the report. This is enabled when you run any test for more than once. Set **Acquire/Analyze each test** in the Preferences tab to more than one, to run any test for multiple times.

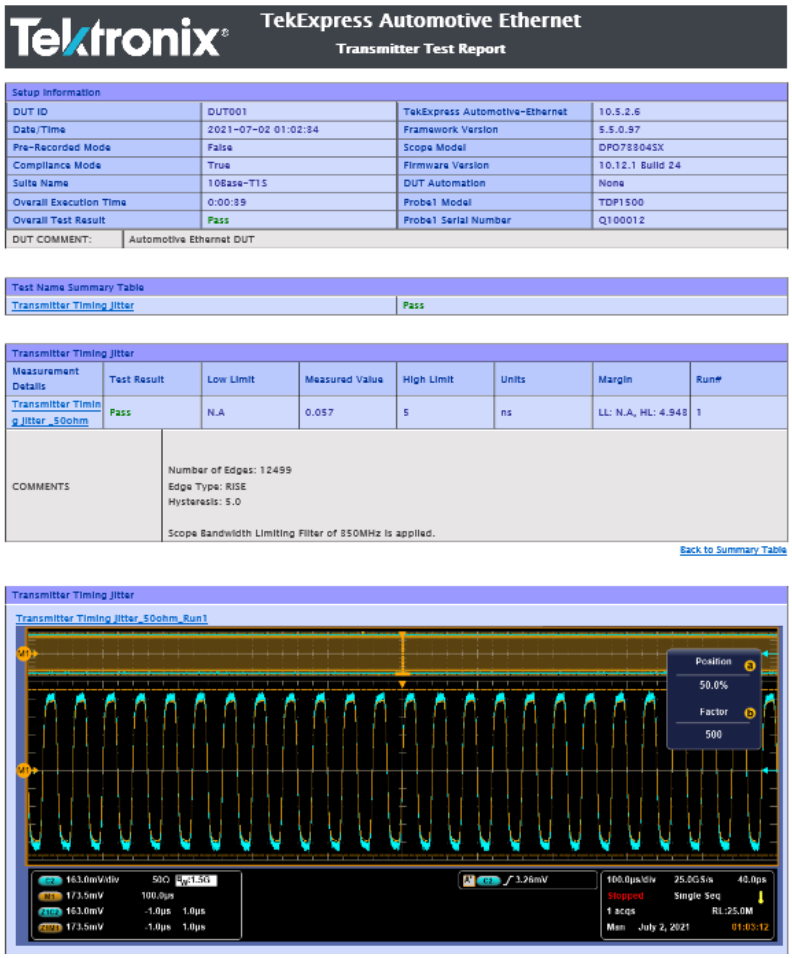
Table continued…

Control	Description
Include user logo	Select to add your logo in the generated report. When selected, specify the logo file path in the Image file path option. Click **browse** and select the logo image.

View a generated report

Sample report and its contents

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



TekExpress Automotive Ethernet
Transmitter Test Report

Setup Information

DUT ID	DUT001	TekExpress Automotive-Ethernet	10.5.2.6
Date/Time	2021-07-02 01:02:34	Framework Version	5.5.0.97
Pre-Recorded Mode	False	Scope Model	DPO78304SX
Compliance Mode	True	Firmware Version	10.12.1 Build 24
Suite Name	10Base-T1S	DUT Automation	None
Overall Execution Time	0:00:39	Probe1 Model	TDP1500
Overall Test Result	Pass	Probe1 Serial Number	Q100012
DUT COMMENT:	Automotive Ethernet DUT		

Test Name Summary Table

Transmitter Timing Jitter	Pass

Transmitter Timing Jitter

Measurement Details	Test Result	Low Limit	Measured Value	High Limit	Units	Margin	Run#
Transmitter Timing Jitter_50ohm	Pass	N.A	0.057	5	ns	LL: N.A, HL: 4.948	1

COMMENTS

Number of Edges: 12499
Edge Type: RISE
Hysteresis: 5.0

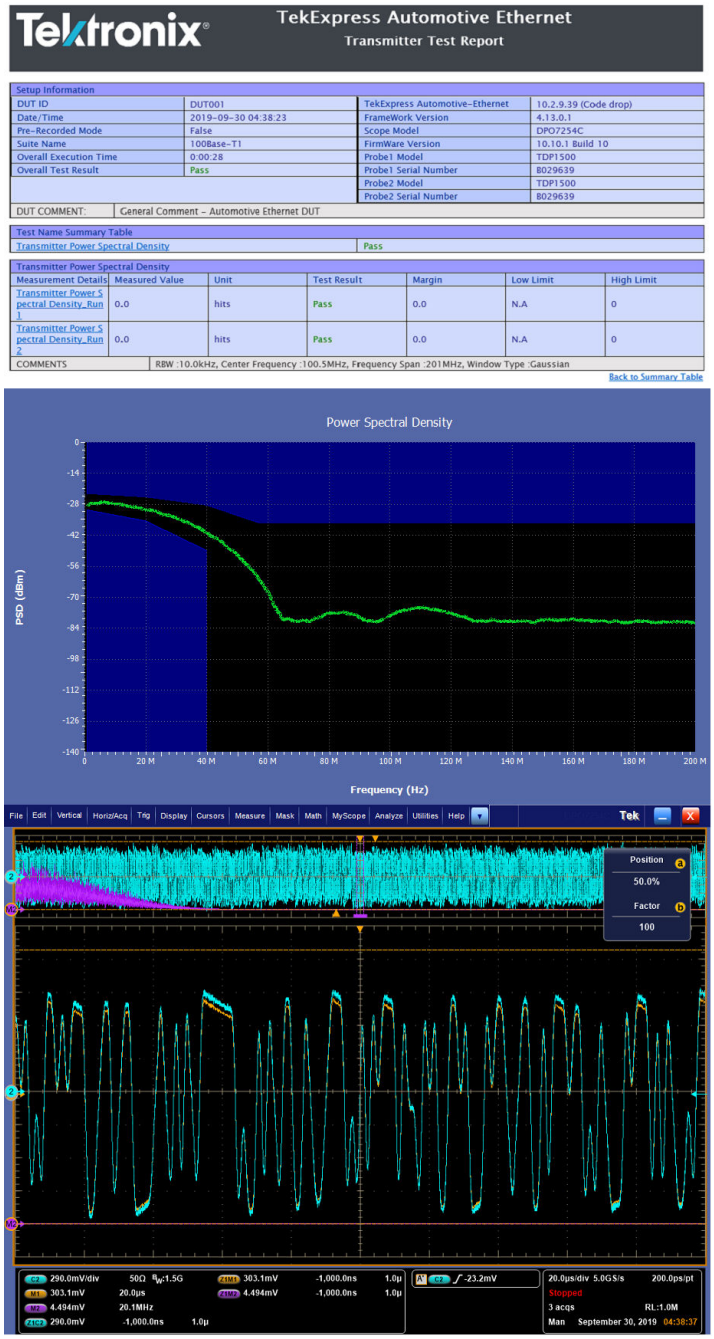
Scope Bandwidth Limiting Filter of 850MHz is applied.

Back to Summary Table

Transmitter Timing Jitter

Transmitter Timing Jitter_50ohm_Run1

Figure 49: Report of 10Base-T1S probing type Differential



TekExpress Automotive Ethernet
Transmitter Test Report

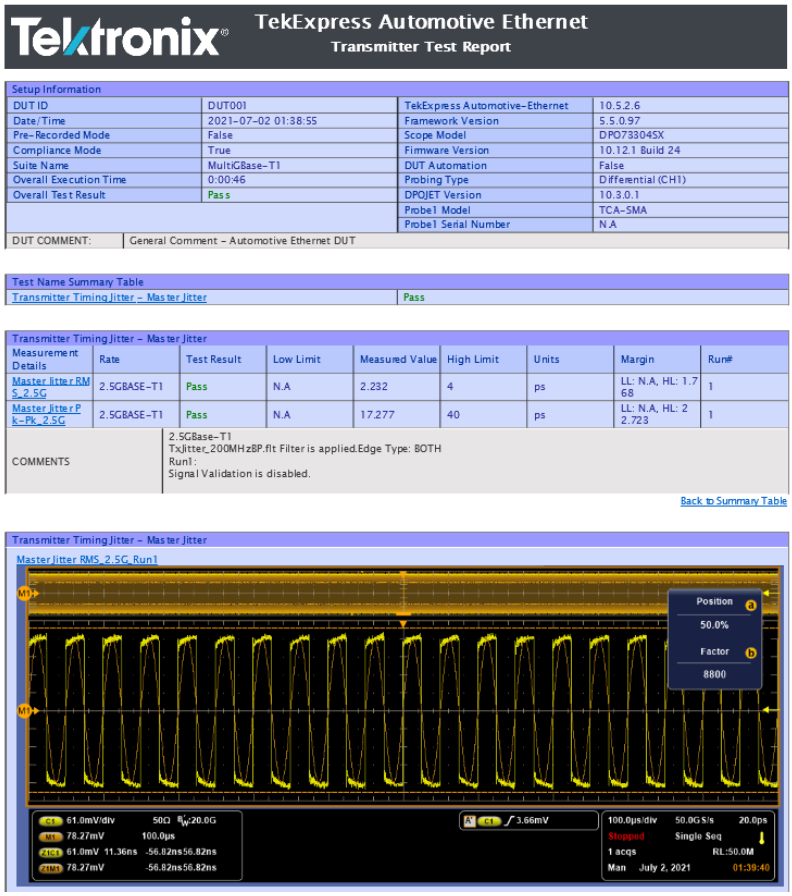
Setup Information			
DUT ID	DUT001	TekExpress Automotive-Ethernet	10.2.9.39 (Code drop)
Date/Time	2019-09-30 04:38:23	FrameWork Version	4.13.0.1
Pre-Recorded Mode	False	Scope Model	DPO7254C
Suite Name	100Base-T1	FirmWare Version	10.10.1 Build 10
Overall Execution Time	0:00:28	Probe1 Model	TDP1500
Overall Test Result	Pass	Probe1 Serial Number	B029639
		Probe2 Model	TDP1500
		Probe2 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
COMMENTS	RBW :10.0kHz, Center Frequency :100.5MHz, Frequency Span :201MHz, Window Type :Gaussian					

Back to Summary Table

Figure 50: Report of 100/1000Base-T probing type Differential



TekExpress Automotive Ethernet
Transmitter Test Report

Setup Information

DUT ID	DUT001	TekExpress Automotive-Ethernet	10.5.2.6
Date/Time	2021-07-02 01:38:55	Framework Version	5.5.0.97
Pre-Recorded Mode	False	Scope Model	DPO73304SX
Compliance Mode	True	Firmware Version	10.12.1 Build 24
Suite Name	MultiGBase-T1	DUT Automation	False
Overall Execution Time	0:00:46	Probing Type	Differential (CH1)
Overall Test Result	Pass	DPOJET Version	10.3.0.1
		Probe1 Model	TCA-SMA
		Probe1 Serial Number	N.A
DUT COMMENT:	General Comment - Automotive Ethernet DUT		

Test Name Summary Table

Transmitter Timing Jitter - Master Jitter	Pass

Transmitter Timing Jitter - Master Jitter

Measurement Details	Rate	Test Result	Low Limit	Measured Value	High Limit	Units	Margin	Run#
Master Jitter RMS_2.5G	2.5GBASE-T1	Pass	N.A	2.232	4	ps	LL: N.A, HL: 1.768	1
Master Jitter Pk-Pk_2.5G	2.5GBASE-T1	Pass	N.A	17.277	40	ps	LL: N.A, HL: 22.723	1
COMMENTS	2.5GBase-T1 TxJitter_200MHzBP.flt Filter is applied.Edge Type: BOTH Run1: Signal Validation is disabled.							

Back to Summary Table

Transmitter Timing Jitter - Master Jitter

Master Jitter RMS_2.5G_Run1

Figure 51: Report of MultiGBase-T1 probing type Differential

TekExpress Automotive Ethernet
Transmitter Test Report

Setup Information			
DUT ID	DUT001	TekExpress Automotive-Ethernet	1.5.3.42
Date/Time	2021-11-27 02:03:41	Framework Version	5.7.0.33
Pre-Recorded Mode	False	Scope Model	MSO66B (10.0GHz)
Compliance Mode	True	Firmware Version	1.36.3.1522
Suite Name	100Base-T1	DUT Automation	None
Overall Execution Time	0:01:23	Probing Type	Single-Ended (CH1, CH2)
Overall Test Result	Pass	Probe1 Model	TCA-SMA
		Probe1 Serial Number	N.A
DUT COMMENT:	Automotive Ethernet DUT		

Test Name Summary Table	
Transmitter Timing Jitter – Master Jitter	Pass

Transmitter Timing Jitter – Master Jitter

Measurement Details	Test Result	Low Limit	Measured Value	High Limit	Units	Margin	Run#
Transmitter Timing Jitter – Master Jitter(ps)	Pass	NA	21.124	50	ps	LL: N.A, HL: 28.876	1
Transmitter Timing Jitter – Master Jitter(ps)	Pass	NA	21.216	50	ps	LL: N.A, HL: 28.784	2
COMMENTS	Signal Validation : Use signal as is – Don't Check Number of Edges: 33327 Scope Bandwidth Limiting Filter of 1GHz is applied.						

Back to Summary Table

Transmitter Timing Jitter – Master Jitter

Transmitter Timing Jitter – Master Jitter_Run1

Figure 52: Report of 100/1000Base-T1 probing type Single-Ended

Setup 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.
Test Name Summary Table	The test summary table lists all the tests which are executed with its result status.
Measurement	The measurement table displays the measurement related details with its parameter value.
User comments	If you had selected to include comments in the test report, any comments you added in the DUT tab are shown at the top of the report.

Saving and recalling test setup

Test setup files overview

Saved test setup information (such as the selected oscilloscope, general parameters, acquisition parameters, measurement limits, waveforms (if applicable), and other configuration settings) are saved under the setup name at X:\<Application Name>.

Use test setups to:

- Run a new session, acquire live waveforms, using a saved test configuration.
- Create a new test setup using an existing one.
- View all the information associated with a saved test, including the log file, the history of the test status as it executed, and the results summary.
- Run a saved test using saved waveforms.

Save the configured test setup

You can save a test setup before or after running a test. You can create a test setup from already created test setup or using a default test setup. When you save a setup, all the parameters, measurement limits, waveform files (if applicable), test selections, and other configuration settings are saved under the setup name. When you select the default test setup, the parameters are set to the application's default value.

Select **Options** > **Save Test Setup** to save the opened setup.

Select **Options** > **Save Test Setup As** to save the setup with different name.

Load a saved test setup

To open (load) a saved test setup, do the following:

- Select **Options** > **Open Test Setup**.
- Select the setup from the list and click **Open**. Setup files are located at X:\<Application Name>.

Select a pre-run session from the loaded test setup

Complete the following steps to load a test setup from a pre-run session:

1. Select **Options > Open Test Setup**.
2. Select a setup from the list and then click **Open**. Setup files are located at `X:\<Application Name>\`.
3. Switch the mode to **Pre-recorded waveform files** in the DUT panel.
4. Select the required waveforms from the selected setup in the Acquisition tab and **Run** the required test.

Save the test setup with a different name

To create a test setup with a different name, follow the steps:

1. Select **Options > Open Test Setup**.
2. Select a setup from the list and then click **Open**.
3. Click application setup and modify the parameters.
4. Click application reports and modify the report options.
5. Select **Options > Save Test Setup As**.
6. Enter the test setup name and click **Save**.

Automotive Ethernet measurements

10Base-T1S Measurements

10Base-T1S Measurement list

Reference specification

Refer Section 147.5.4 and section 147.9.2 in IEEE Std 802.3cg™-2019.IEEE Standard for Ethernet Amendment 5: Physical Layers Specifications and Management Parameters for 10 Mb/s Operation and Associated Power Delivery over a Single Balanced Pair of Conductors.

The table below lists the measurements and its reference section for a detailed test procedure:

Measurement Name	Test Mode Signal	Reference section for Test Procedure
Transmitter Output Droop	Test Mode 2	*Measurement procedure using TC1 differential coupon and the single-ended test fixture.* on page 103
Transmitter Timing Jitter	Test Mode 1, TX_TCLK line	*Measurements using symbol rate clock (TX_TCLK) of DUT* on page 101
Transmitter Power Spectral Density	Test Mode 3	*Measurement procedure using TC1 differential coupon and the single-ended test fixture.* on page 103
Transmitter Output Voltage	Test Mode 1	
Transmit Clock Frequency (Informative)	Test Mode 1, TX_TCLK line	
MDI Return Loss	Slave Idle Mode	*Return Loss measurement* on page 116

10Base-T1S Test limits

The below table lists the 10Base-T1S test measurement limits:

Measurements	Operating Mode	Low	High	Unit
Transmitter Output Droop (Positive an Negative)	Both		30	%
Transmitter Timing Jitter	Both		5	ns
Transmitter Power Spectral Density (Mask)	Both		0	Mask Hits
Power Level (Informative)	100Ω	NA	NA	dBm
	50Ω	NA	NA	dBm
Transmitter Clock Frequency (Informative)	Both	NA	NA	MBd
Transmitter Peak Differential Output		0.8	1.2	V

10Base-T1S Example Test Mode waveforms

Plots of Testmode 1 and Testmode 3 signals are given below:

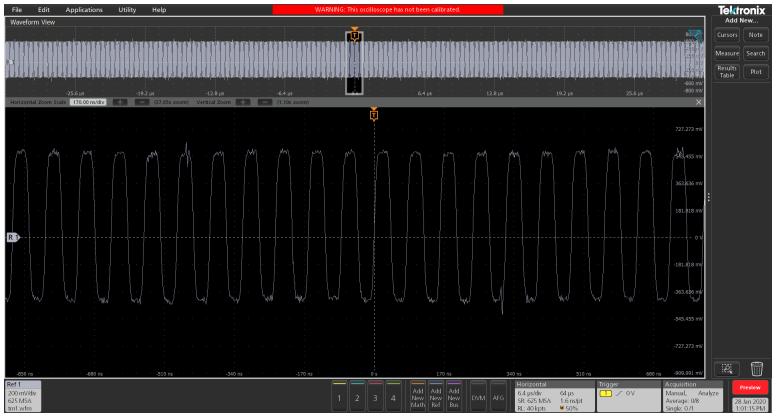


Figure 53: Test mode 1 signal

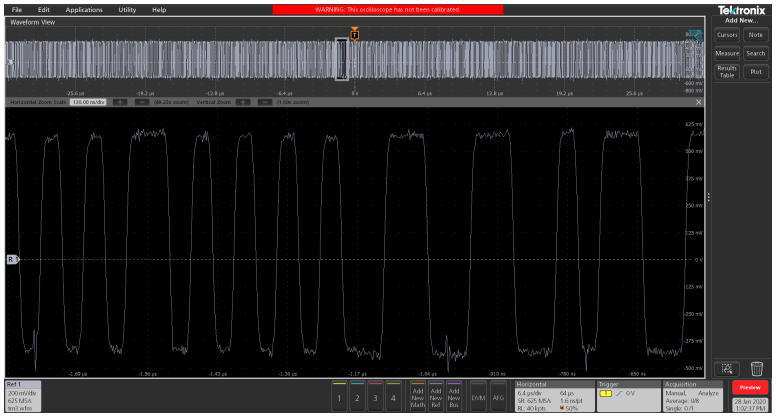


Figure 54: Test mode 3 signal

100Base-T1 Measurements

100Base-T1 Measurement list

Reference specification

Refer section 96.5.4 and section 96.8.2.1 in IEEE P802.3bw™/D3.3 Standard for Ethernet Amendment: Physical Layer Specifications and Management Parameters for 100 Mb/s Operation over a Single Balanced Twisted Pair Cable.

The table below list the measurements and its reference section for a detailed test procedure:

Measurement Name	Test Mode Signal	Reference section for Test Procedure
Maximum Transmitter Output Droop	Test Mode 1	*Measurement procedure using TC1 differential coupon and the single-ended test fixture.* on page 103
Transmitter Distortion	Test Mode 4	*Transmitter Distortion* on page 122
Transmitter Timing Jitter- Master and Slave	Test Mode 2, TX_TCLK	*Measurements using symbol rate clock (TX_TCLK) of DUT* on page 101

Table continued…

Measurement Name	Test Mode Signal	Reference section for Test Procedure
Transmitter Power Spectral Density	Test Mode 5	*Measurement procedure using TC1 differential coupon and the single-ended test fixture.* on page 103
Transmit Clock Frequency	Test Mode 2	
MDI Return Loss	Slave Idle Mode	*Return Loss measurement* on page 116
Transmitter Peak Differential Output	Slave Idle Mode	*Measurement procedure using TC1 differential coupon and the single-ended test fixture.* on page 103

100Base-T1 Test limits

Measurement Name	Low Limit	High Limit
Maximum Transmitter Output Droop (Positive/Negative Droop)	NA	45%
Transmitter Distortion	NA	15 mV
Transmitter Timing Jitter - Master (RMS)	NA	50 ps
Transmitter Timing Jitter - Slave (RMS)	NA	150 ps
Transmitter Power Spectral Density	NA	0 Mask Hits
Transmit Clock Frequency	66.6603 MHz	66.6736 MHz
Transmitter Peak Differential Output	NA	2.2 V
MDI Return Loss	NA	0 Mask Hits

100Base-T1 Example Test Mode waveforms

Given below are the example test mode waveforms for 100Base-T1.

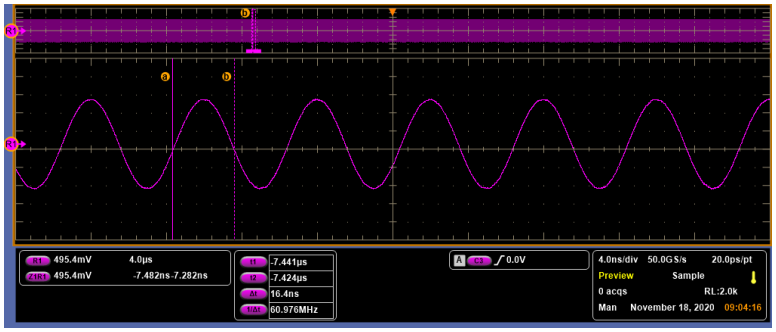


Figure 55: Example TestMode 2, Clock waveform for probing type differential

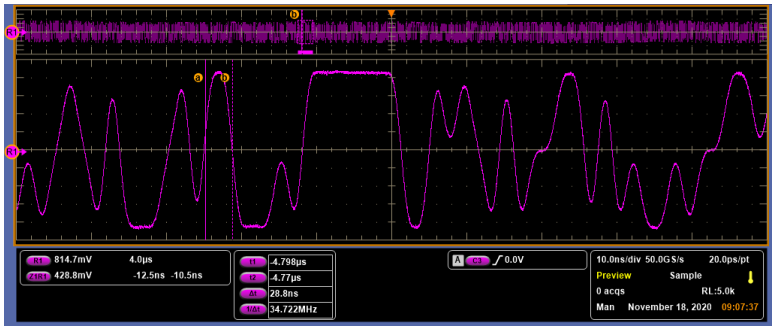


Figure 56: Example TestMode 5, PAM3 waveform for probing type differential

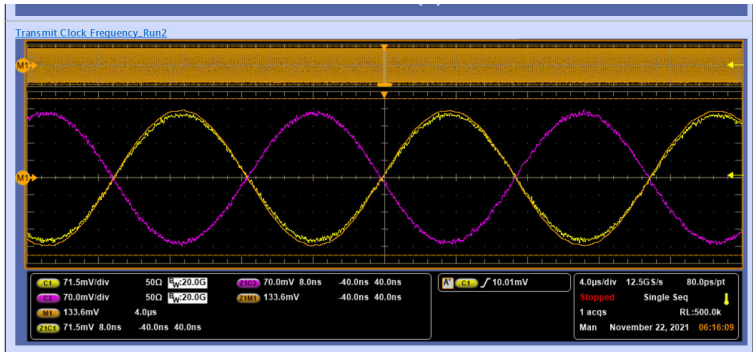


Figure 57: Example TestMode 2, Clock waveform for probing type single-ended

1000Base-T1 Measurements

1000Base-T1 Measurement list

Reference specification

Refer section 97.1 and section 97.3.1 in IEEE P802.3bpTM-2016, IEEE Standard for Ethernet Amendment 4: Physical Layer Specifications and Management Parameters for 1 Gb/s Operation over a Single Twisted-Pair Copper Cable.

The table below list the measurements and its reference section for a detailed test procedure:

Measurement Name	Test Mode Signal	Reference section for Test Procedure
Maximum Transmitter Output Droop	Test Mode 6	*Measurement procedure using TC1 differential coupon and the single-ended test fixture.* on page 103
Transmitter Distortion	Test Mode 4	*Transmitter Distortion* on page 122
Transmitter Timing Jitter - Master and Slave	Test Mode 1, TX_TCLK line	*Measurements using symbol rate clock (TX_TCLK) of DUT* on page 101
Transmitter Timing Jitter - MDI	Test Mode 2	*Measurement procedure using TC1 differential coupon and the single-ended test fixture.* on page 103
Transmitter Power Spectral Density	Test Mode 5	
Transmit Clock Frequency	Test Mode 2	
MDI Return Loss	Slave Idle Mode	*Return Loss measurement* on page 116
Transmitter Peak Differential Output	Test Mode 5	*Measurement procedure using TC1 differential coupon and the single-ended test fixture.* on page 103
MDI Mode Conversion Loss	Slave Idle Mode	

1000Base-T1 Test limits

Measurement Name	Low Limit	High Limit
Maximum Transmitter Output Droop (Positive/Negative Droop)	NA	10 %
Transmitter Distortion	NA	15 mV
Transmitter Timing Jitter - Master (RMS)	NA	5 ps
Transmitter Timing Jitter - Master (pk2pk)	NA	50 ps
Transmitter Timing Jitter - Slave (RMS)	NA	10 ps
Transmitter Timing Jitter - Slave (pk2pk)	NA	100 ps
Transmitter Timing Jitter - MDI (RMS)	NA	5 ps
Transmitter Timing Jitter - MDI (pk2pk)	NA	50 ps
Transmitter Power Spectral Density	NA	0 Mask Hits
Transmitter Peak Differential Output	NA	1.3 V
Power Level	NA	5 dBm
Transmit Clock Frequency	749.925 MHz	750.075 MHz
MDI Return Loss	NA	0 Mask Hits

PSD limit is defined by:

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

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

Return loss limit is defined by:

$$\text{Return Loss}(f) \ge \left\{ \begin{array}{ll} 18 - 18\log_{10}\frac{20}{f} & 2 \le f < 20 \\ 18 & 20 \le f < 100 \\ 18 - 16.7\log_{10}\frac{f}{100} & 100 \le f \le 600 \end{array} \right\} \text{dB}$$

where f is the frequency in MHz.

1000Base-T1 Example Test Mode waveforms

Given below are the example test mode waveforms for 1000Base-T1.

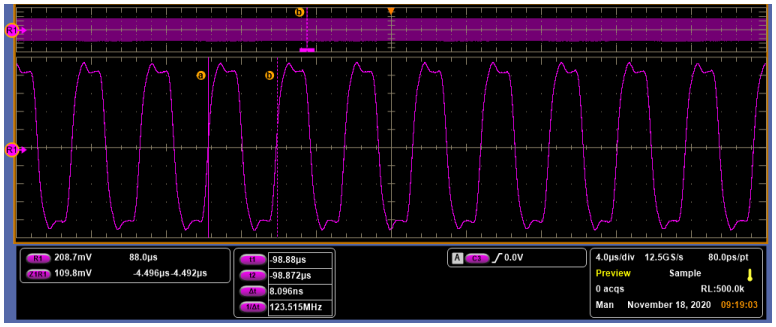


Figure 58: Example TestMode 2, Clock waveform

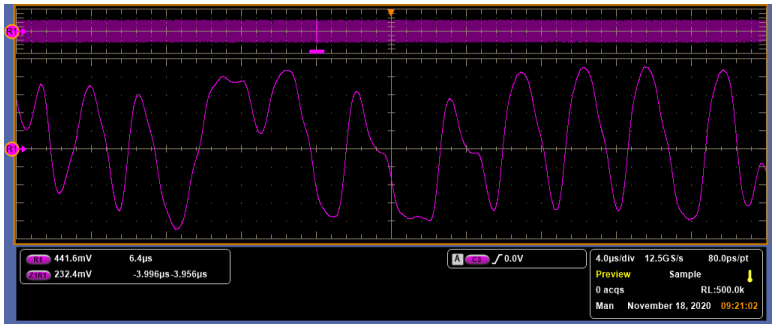


Figure 59: Example TestMode 5 waveform

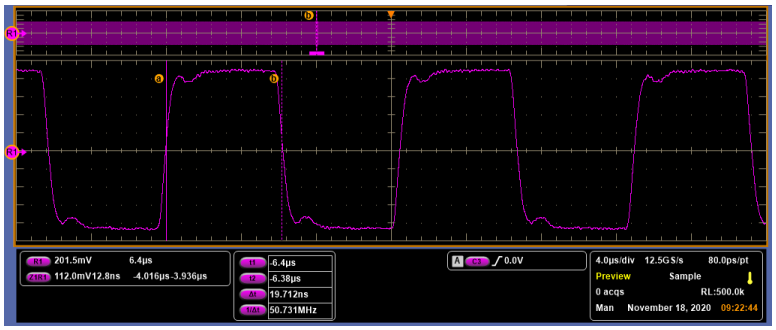


Figure 60: Example TestMode 6, Droop waveform

MultiGBASE-T1 Measurements

MultiGBASE-T1 Measurement List

Reference specification:

Refer Section 149.5.2 in IEEE Std 802.3ch™-2020, IEEE Standard for Ethernet Amendment 4: Physical Layer Specifications and Management Parameters for 1 Gb/s Operation over a Single Twisted-Pair Copper Cable.

Refer section 149.8.2.1 in IEEE Standard for Ethernet Amendment 8: Physical Layer Specifications and Management Parameters for 2.5 Gb/s, 5 Gb/s, and 10 Gb/s Automotive Electrical Ethernet.

The following table lists the measurements and its reference section for a detailed test procedure:

Measurement name	Test mode signal	Reference section for test procedure
Maximum output droop	Test Mode 6	*MDI measurements* on page 150
Transmitter linearity	Test Mode 4	
Transmitter timing jitter-Master/Slave	Test Mode 1	*Clock line measurements* on page 148
Transmit MDI random jitter in master mode	Test Mode 2- Square Wave	*MDI measurements* on page 150
Transmit MDI deterministic jitter in master mode	Test Mode 2- JP03B(EOJ)	
Transmit MDI Even Odd jitter in master mode	Test Mode 2- JP03B(EOJ)	
Transmitter Power Spectral Density (PSD) and power level	Test Mode 5	
Transmitter peak differential output	Test Mode 5	
Transmitter clock frequency	Test Mode 2 - JP03A	
MDI return loss	SLAVE IDLE MODE	*Return loss measurement using VNA Result File* on page 155

MultiGBASE-T1 Test Limits

The below table lists the MultiGBase-T1 test measurement limits:

Test name	Data rate	Details/Sub tests	Low	High	Unit
Maximum output droop	2.5/5/10GBase-T1	Positive droop	NA	15	%
		Negative droop			
Transmitter linearity	2.5GBase-T1		36	NA	dB
	5GBase-T1		38	NA	dB
	10GBase-T1		35	NA	dB
Transmitter timing jitter	2.5GBase-T1	RMS MASTER Tx CLK	NA	4	ps
		p2p MASTER Tx CLK	NA	40	ps
		RMS SLAVE Tx CLK	NA	8	ps
		p2p SLAVE Tx CLK	NA	80	ps
	5GBase-T1	RMS MASTER Tx CLK	NA	2	ps
		p2p MASTER Tx CLK	NA	20	ps
		RMS SLAVE Tx CLK	NA	4	ps
		p2p SLAVE Tx CLK	NA	40	ps
	10GBase-T1	RMS MASTER Tx CLK	NA	1	ps
		p2p MASTER Tx CLK	NA	10	ps
		RMS SLAVE Tx CLK	NA	2	ps
		p2p SLAVE Tx CLK	NA	20	ps

Table continued…

Test name	Data rate	Details/Sub tests	Low	High	Unit
Transmit MDI random jitter in master mode	2.5GBase-T1	RMS	NA	4	ps
		p2p	NA	40	ps
	5GBase-T1	RMS	NA	2	ps
		p2p	NA	20	ps
	10GBase-T1	RMS	NA	1	ps
		p2p	NA	10	ps
Transmit MDI deterministic jitter in master mode	2.5GBase-T1	DJ pk-pk	NA	36	ps
		EOJ pk-pk	NA	16	ps
	5GBase-T1	DJ pk-pk	NA	18	ps
		EOJ pk-pk	NA	8	ps
	10GBase-T1	DJ pk-pk	NA	9	ps
		EOJ pk-pk	NA	4	ps
Transmitter Power Spectral Density (PSD)	2.5/5/10GBase-T1	PSD	NA	0	Mask Hits
		Power Level	-1	2	dBm
Transmitter peak differential output	2.5/5/10GBase-T1	pk-pk	NA	1.3	V
Transmitter clock frequency	2.5GBase-T1	mean	1406.1796875	1406.3203125	MHz
	5GBase-T1	mean	2812.359375	2812.640625	MHz
	10GBase-T1	mean	5624.71875	5625.28125	MHz
MDI return loss	2.5/5/10GBase-T1			0	Mask Hits

MultiGBASE-T1 example Test Mode waveforms

Plots of the test mode waveforms from 2.5GBASE-T1 PHY type signals are given below:

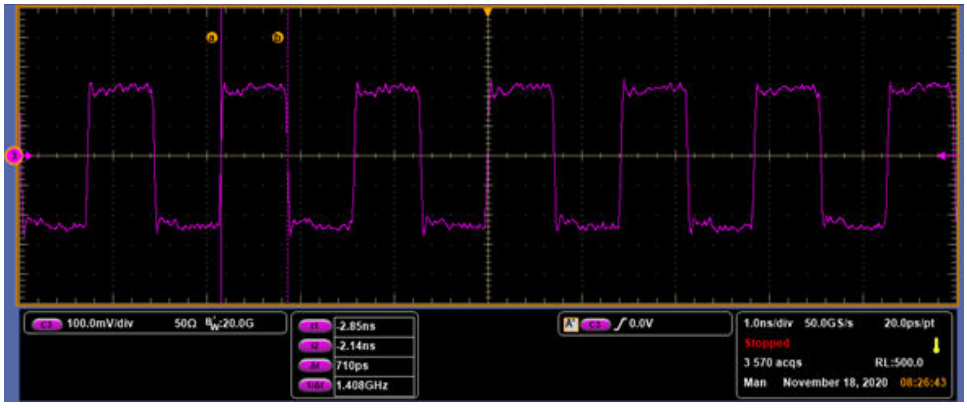


Figure 61: Example TestMode#2, JP03A waveform for 2.5GBASE-T1

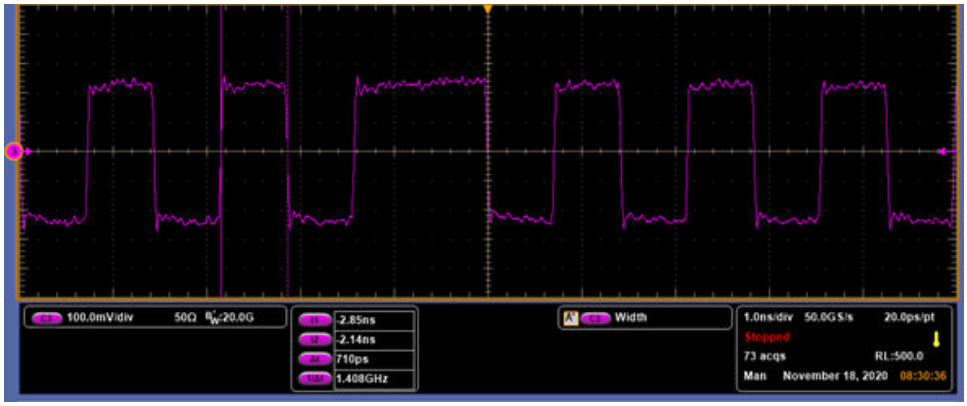


Figure 62: Example TestMode#2, JP03B waveform for 2.5GBASE-T1

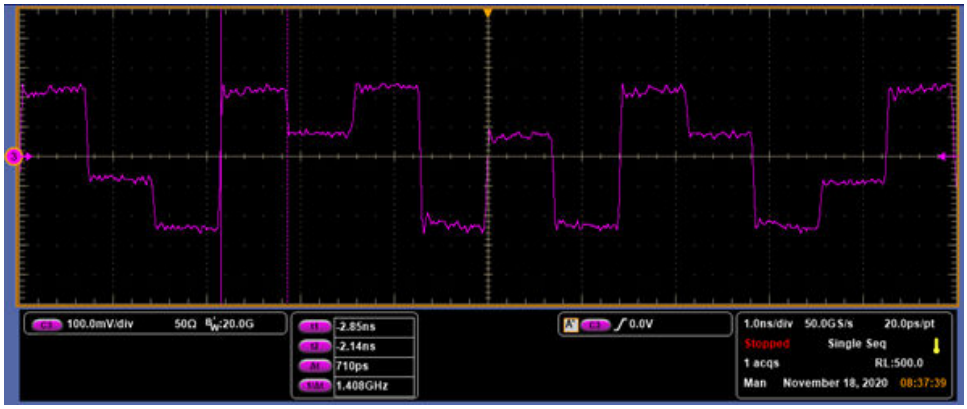


Figure 63: Example TestMode#4, PRBS13Q waveform for 2.5GBASE-T1

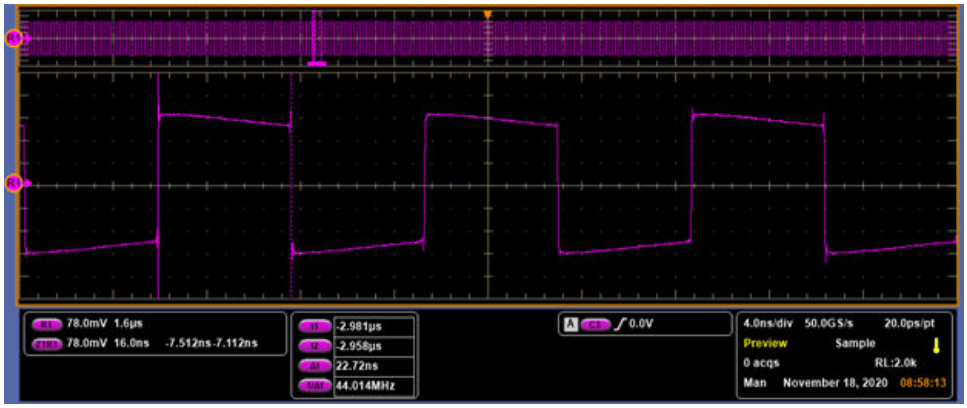


Figure 64: Example TestMode#6, Droop waveform for 2.5GBASE-T1

Test Fixture

10/100/1000Base-T1 Test Fixture: Differential

The differential test fixture for RJ45/Ethernet port Automotive DUT interface.

This section describes the test modes and test fixture employed for different measurements/technologies:

- 10Base-T1S

- 100Base-T1
- 1000Base-T1

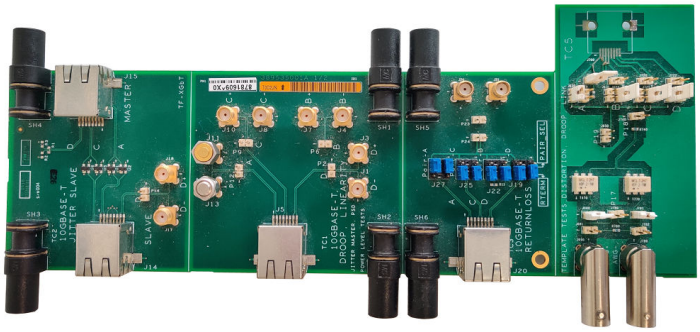


Figure 65: TF-XGbT Fixture

Table 31: 10Base-T1S Measurement list and Test Fixture Coupons

Measurement Name	Coupon/Section of the TF-XGbTtest fixture
Transmitter Output Droop	TC1
Transmitter Timing Jitter	TC1
Transmitter Power Spectral Density	TC1
Transmitter Output Voltage	TC1
Transmit Clock Frequency	TC1
MDI Return Loss	TC3 Return Loss

Table 32: 100Base-T1 Measurement list and Test Fixture Coupons

Measurement Name	Coupon/Section of the TF-XGbTtest fixture
Maximum Transmitter Output Droop	TC1
Transmitter Distortion	TC5 – Distortion
Transmitter Timing Jitter	NA
Transmitter Power Spectral Density	TC1
Transmit Clock Frequency	TC1
MDI Return Loss	TC3 - Return Loss
Transmitter Peak Differential Output	TC1

Table 33: 1000Base-T1 Measurement list and Test Fixture Coupons

Measurement Name	Coupon/Section of the TF-XGbTtest fixture
Maximum Transmitter Output Droop	TC1
Transmitter Distortion	TC5 - Distortion
Transmitter Timing Jitter - Master, Slave	NA
Transmitter Timing Jitter - MDI	TC1
Transmitter Power Spectral Density	TC1

Table continued…

Measurement Name	Coupon/Section of the TF-XGbTtest fixture
Transmitter Peak Differential Output	TC1
Transmit Clock Frequency	TC1
MDI Return Loss	TC3 - Return Loss
MDI Mode Conversion Loss	NA

10/100/1000Base-T1 Test Fixture: Single-Ended

The single-ended test fixture to support the Automotive DUT interface.

This section describes the test modes and test fixture employed for different measurements/technologies:

- 10Base-T1S
- 100Base-T1
- 1000Base-T1

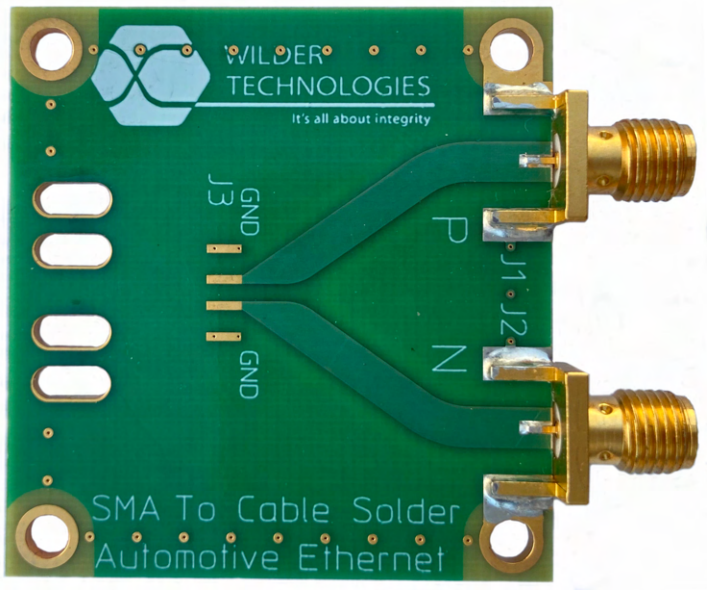


Figure 66: SMA to Cable Solder

Figure 67: SMA to Matenet

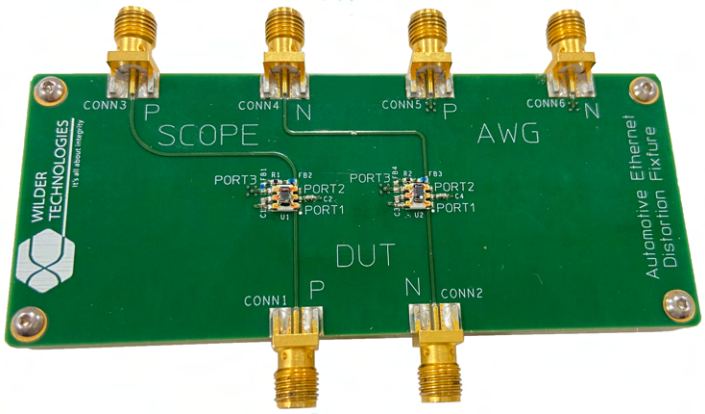


Figure 68: SMA Distortion Fixture

For 10Base-T1S all the test can be performed and excluding the return loss using the soldering fixture. For list of measurement Refer *Table 31* on page 96.

For 100Base-T1/1000Base-T1 all the test can be performed and excluding the return loss using the soldering fixture and Automotive Ethernet MateNet. For list of measurement Refer *Table 32* on page 96 and *Table 33* on page 96.

For 100Base-T1/1000Base-T1 Transmitter distortion test can be performed using Automotive Ethernet Distortion Card and one of the fixture mentioned in above steps.

Table 34: Probing Type Single-Ended: Test Fixture Details Suit Measurement

Test Suit	Measurement Name	Fixture	Part number
10 BaseT1-S	All Test (Exclude Return Loss)	Soldering Fixture	640-1028-000
100/1000Base-T1	All Test (Exclude Return Loss, Tx Dist)	ETH-TPA-AW-MN (Automotive Ethernet, MateNet, Tyco)	640-1026-000
	All Test (Exclude Return Loss, Tx Dist)	Soldering Fixture	640-1028-000
	Tx Distortion	ETH-TPA-AW-D (Automotive Ethernet, Distortion Card)	640-1029-000

10/100/1000Base-T1 Measurement Procedure

Test Mode list for each Technology

Table 35: 10Base-T1S Measurement list and Test Modes

Measurement Name	Test Mode Signal
Transmitter Output Droop	Test Mode 2
Transmitter Timing Jitter	Test Mode 1, TX_TCLK line
Transmitter Power Spectral Density	Test Mode 3
Transmitter Output Voltage	Test Mode 1
Transmit Clock Frequency (Informative)	Test Mode 1, TX_TCLK line
MDI Return Loss	Slave Idle Mode

Table 36: 100Base-T1 Measurement list and Test Modes

Measurement Name	Test Mode Signal
Maximum Transmitter Output Droop	Test Mode 1
Transmitter Distortion	Test Mode 4
Transmitter Timing Jitter - Master and Slave	Test Mode 2, TX_TCLK
Transmitter Power Spectral Density	Test Mode 5
Transmit Clock Frequency	Test Mode 2
Transmitter Peak Differential Output	Test Mode 5
MDI Return Loss	Slave Idle Mode
MDI Mode Conversion Loss	Slave Idle Mode

Table 37: 1000Base-T1 Measurement list and Test Modes

Measurement Name	Test Mode Signal
Maximum Transmitter Output Droop	Test Mode 6
Transmitter Distortion	Test Mode 4
Transmitter Timing Jitter - Master, Slave	Test Mode 1, TX_TCLK line
Transmitter Timing Jitter - MDI	Test Mode 2
Transmitter Power Spectral Density	Test Mode 5
Transmitter Peak Differential Output	Test Mode 5
Transmit Clock Frequency	Test Mode 2
MDI Return Loss	Slave Idle Mode
MDI Mode Conversion Loss	Slave Idle Mode

10Base-T1S: Setting up the different transmitter load conditions with the fixture

This section describes the instructions and the accessories required for setting up the XGBT fixture for two different transmitter load conditions; 50 Ω and 100 Ω, to test a 10Base-T1S device.

1. Transmitter load of 100 Ω.

   The SMA output is terminated by a pair of two 50 Ω caps as shown below:

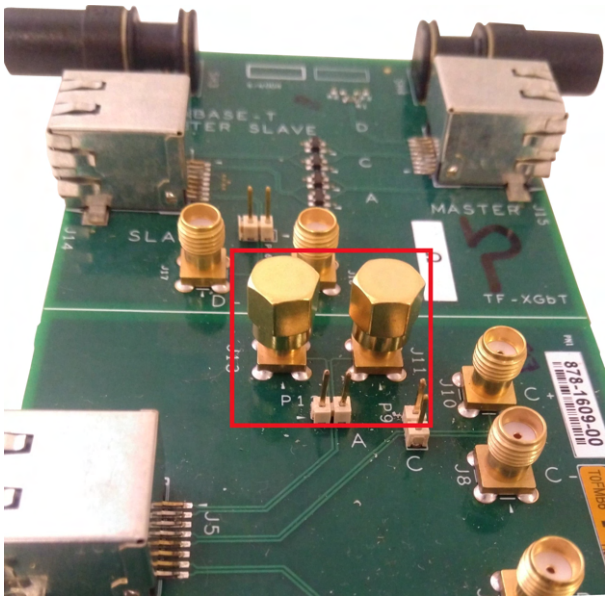
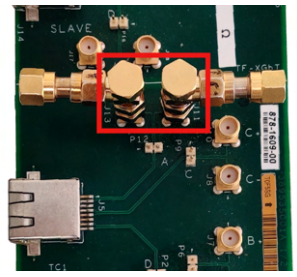


Figure 69: Representation of the connection diagram for the transmitter load of 100 Ω

2. Transmitter load of 50 Ω.

   To achieve differential 50 Ω load at the DUT, connect SMA - T and SMA 50 Ω terminators as shown:



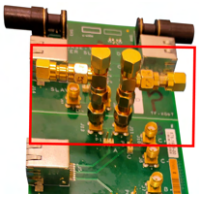


Figure 70: Representation of the connection diagram for the transmitter load of 50 Ω

   The required accessories to achieve differential 50 Ω load at the DUT are listed below:

2 x SMA-T M to 2F	
2 x SMA F-F	
2 x SMA M-M	
4 x 50 Ω SMA M terminator cap	

3. If the DUT offers the necessary termination, a direct connection of the probe (without using the fixture) to the DUT can be used.

Note: The above accessories and setup informations are explained for probing type differential. In case of probing type single-ended respective automotive test fixture need to be terminated as explained above.

Measurements using symbol rate clock (TX_TCLK) of DUT

Discussion

This section describes the equipment connection diagram and test procedure for the following technology/measurements:

- 10Base-T1S
  - Transmitter Timing Jitter
- 100Base-T1
  - Transmitter Timing Jitter - Master and Slave
- 1000Base-T1
  - Transmitter Timing Jitter - Master and Slave

Test Setup

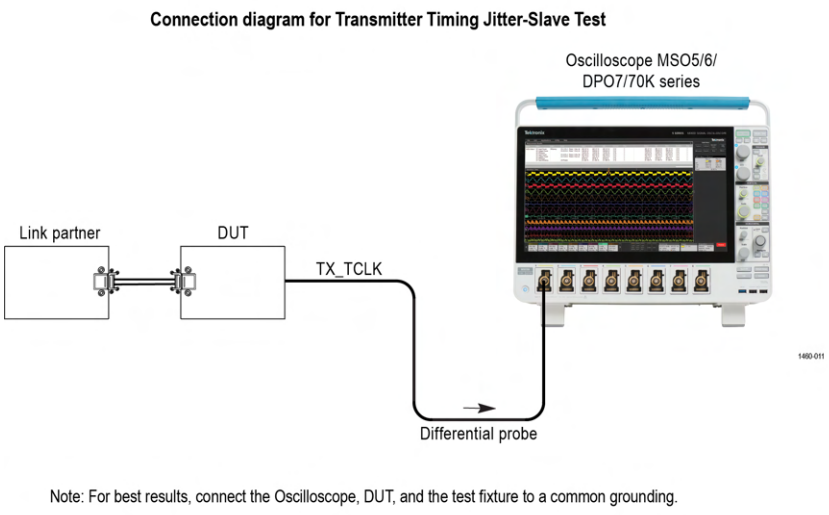


Figure 71: Connection diagram for link mode with probing type differential

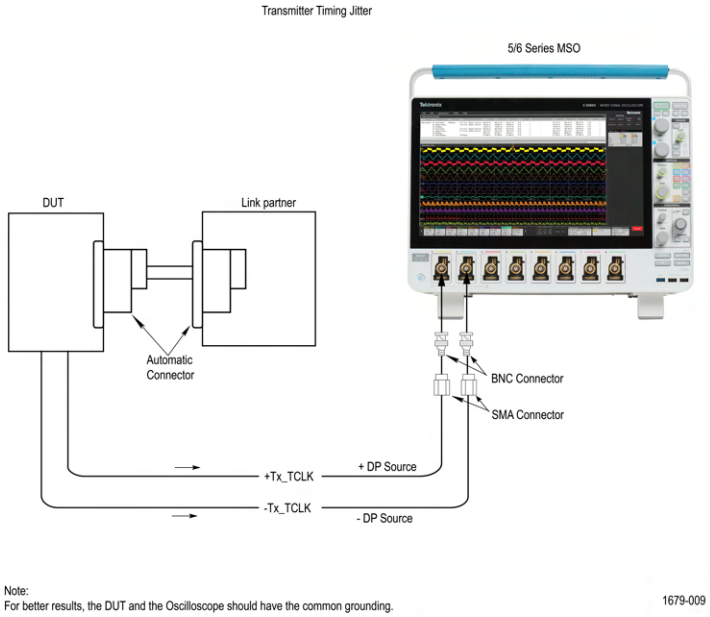


Figure 72: Connection diagram for link mode with probing type single-ended

Test procedure

1. Pre-requisite: DUT must have the provision to access the device clock line TX_TCLK.
2. Test setup connection:
   - Make the connection of the test setup for probing type differential as shown in the *Figure 71* on page 102. *OR*
   - Make the connection of the test setup for probing type single-ended as shown in the *Figure 72* on page 102
3. Probe connection:
   - For probing type differential, connect the DUT positive (+) and negative (-) points available on the DUT to differential probe tip. *OR*

- For probing type single ended, connect the DUT positive (+) and negative (-) points available on the DUT to SMA pair cables.

4. To test the symbol rate of clock line (TX_TCLK) either the slave or master, connect the DUT to the link partner, and set it to slave mode and In case of master TX_TCLK test, set the DUT in master mode.
5. Configure the DUT to transmit the Test Mode signal as per the measurements listed in *Test Mode list for each Technology* on page 99.
6. After running the measurement, a report with result compared against results and necessary plots is generated. Refer *Automotive Ethernet measurements* on page 87 for the list of the measurement limits.

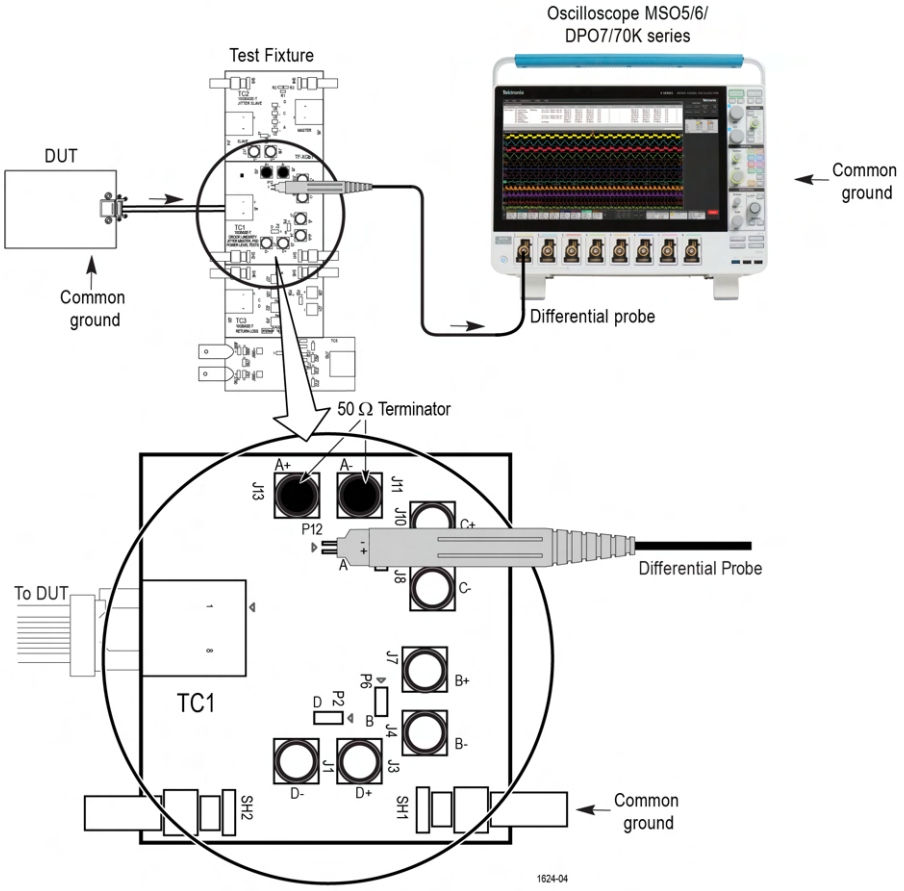
Measurement procedure using TC1 differential coupon and the single-ended test fixture.

Discussion

This section describes the equipment connection diagram and test procedure for the following technology/measurements:

- 10Base-T1S
  - Maximum Output Droop
  - Transmitter Timing Jitter
  - Transmitter Power Spectral Density
  - Transmitter Output Voltage
  - Transmit Clock Frequency
- 100Base-T1
  - Maximum Transmitter Output Droop
  - Transmitter Distortion
  - Transmitter Power Spectral Density
  - Transmit Clock Frequency
  - Transmitter Peak Differential Output
- 1000Base-T1
  - Maximum Transmitter Output Droop
  - Transmitter Timing Jitter - MDI
  - Transmitter Power Spectral Density
  - Transmitter Peak Differential Output
  - Transmit Clock Frequency

Test Setup



Note: For best results, connect the Oscilloscope, DUT, and test fixture to a common ground.
The terminator on the test fixture is setup appropriately based on transmitter load selection.
For 100 Ω transmitter load, connect a 50 Ω SMA M terminator cap on each of the SMA connectors of the lane.
For 50 Ω transmitter load, connect a SMA-T with a two SMA M terminator cap on each of the SMA connectors of the lane

Figure 73: Connection diagram for TC1 coupon test fixture probing type differential

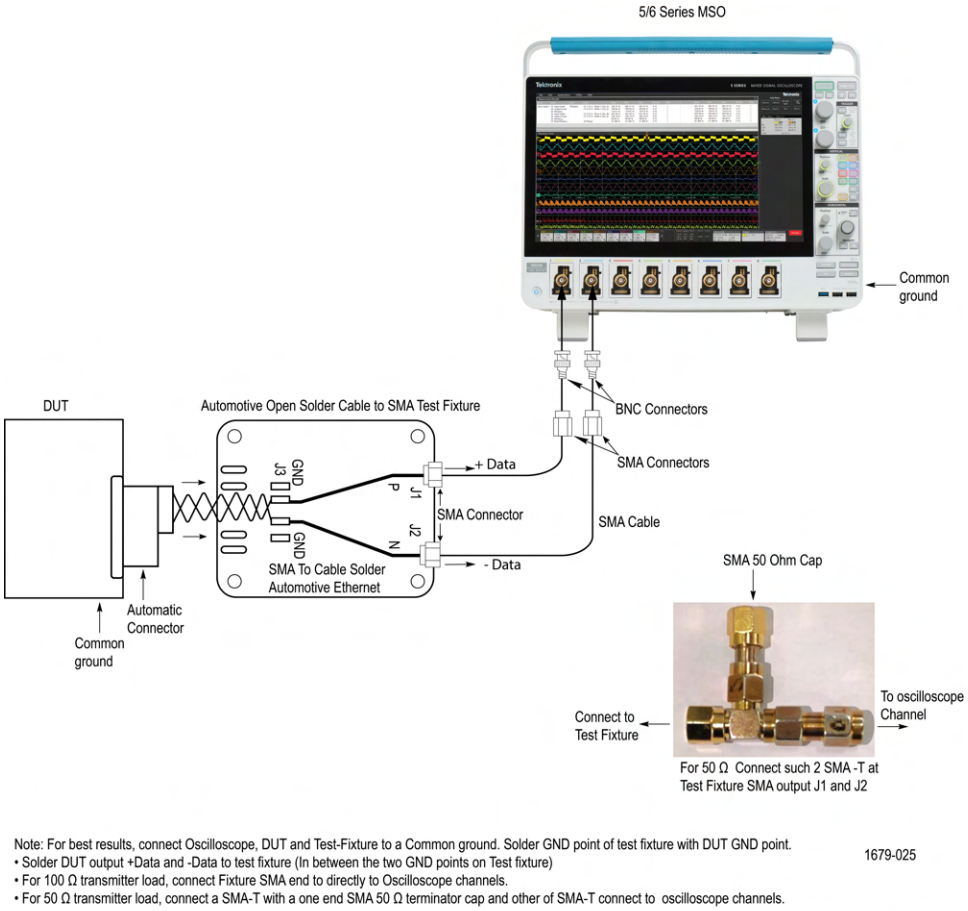


Figure 74: Connection diagram for 10Base-T1S for probing type single-ended

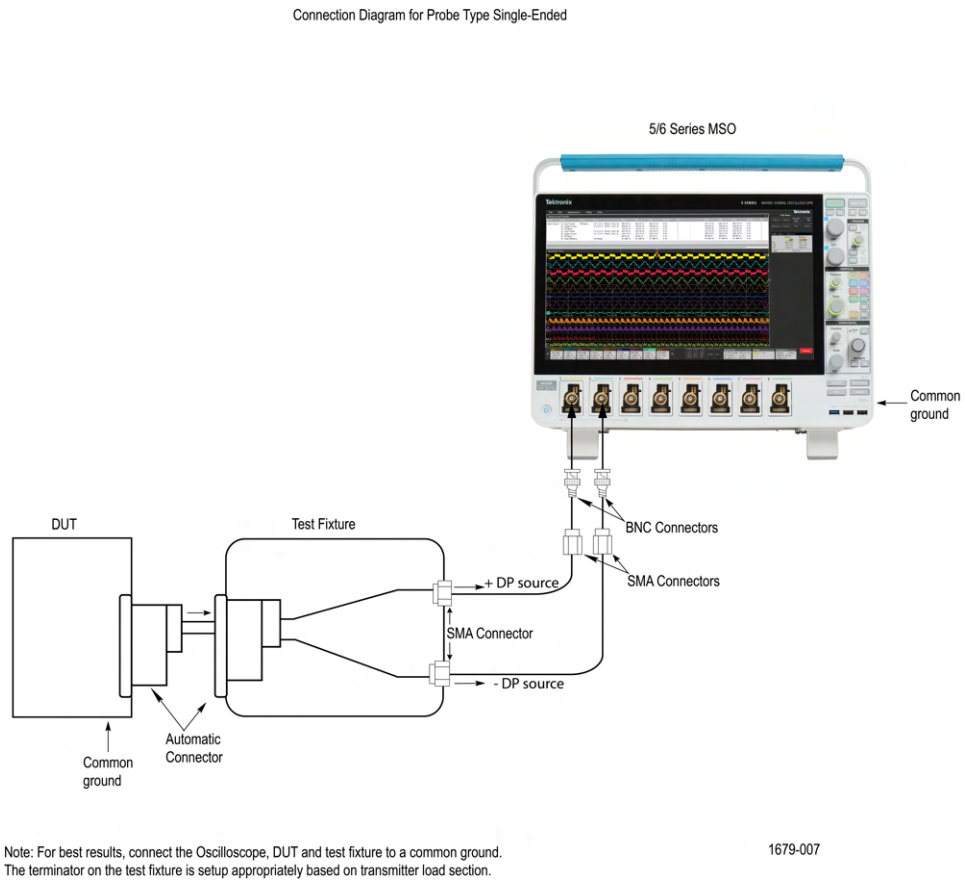


Figure 75: Connection diagram for 100/1000Base-T1 for probing type single-ended

Test Procedure

1. Make the connection of the test setup as shown in the detailed test setup schematic.
2. Setting up the terminations on the fixture:
   a. 100/1000Base-T1:
      - For probing type differential, terminate the SMA pins J11 and J13 with two 50 Ω terminators. (Assuming LANE A of the fixture is selected).
      - For probing type single-ended, terminate the SMA pins of the single-ended test fixture with two 50 Ω terminators.
   b. 10Base-T1S:
      - For probing type differential, it is required with two transmitter load conditions -50 Ω /100 Ω. Based on the transmitter load to be tested against, set up the SMA pins J11 and J13 as described in the section *10Base-T1S: Setting up the different transmitter load conditions with the fixture* on page 100. Select the operating mode (**Transmitter load= 50 Ω/100 Ω/Both**) on the **Setup** panel in the **DUT** tab. (Assuming LANE A of the fixture is selected).
      - For probing type single-ended,

        Connect the fixture SMA end to directly to oscilloscope channels for 100 Ω transmitter load.

        Connect a SMA-T with a one end to SMA 50 Ω terminator cap and connect the other end of SMA-T to oscilloscope channels for 50 Ω transmitter load.
3. Connecting and soldering the test fixture:
   - For probing type differential, connect the DUT Ethernet cable to J5 Ethernet port (TC1 segment) of test fixture.
   - For probing type single-ended,

Solder the DUT output to single-ended test fixture in case of using SMA single-ended test fixture.

Connect the DUT output to the test fixture which converts automotive connector to SMA single-ended test fixture.

Note: Make sure that the grounding connections are connected properly as shown in the respective connection diagram.

4. For probing type differential, connect the differential probe to P12 on the fixture.
5. Connect the positive (+) of the probe tips align with the ▶ symbol marked on the test fixture board to ensure the polarity not being reversed.
6. Configure the DUT to transmit the Test mode signal, as per the *Test Mode list for each Technology* on page 99.
7. Click **Start**.
8. After running the measurement, a report with result compared against results and necessary plots is generated. Refer *Automotive Ethernet measurements* on page 87 for the list of the measurement limits.

10Base-T1S Example results and plots

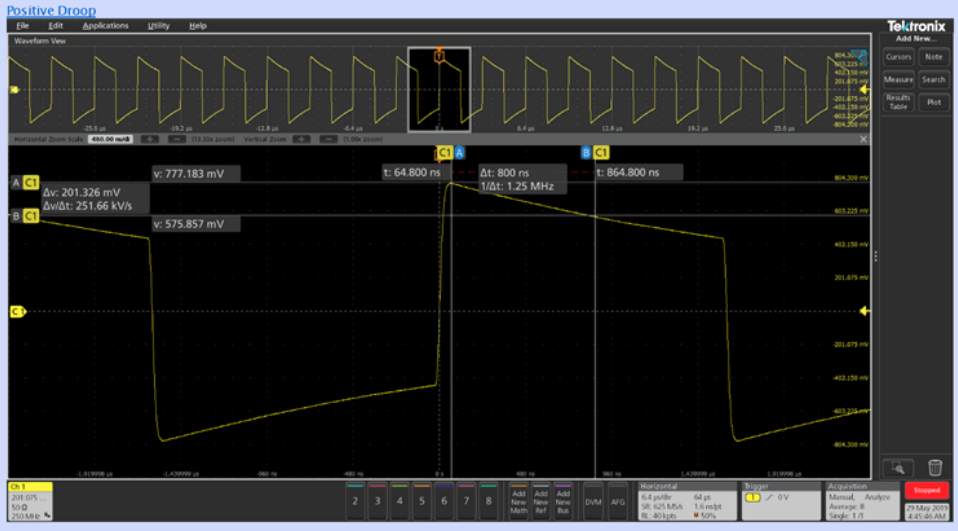


Figure 76: Droop waveform plot with cursors

100Base-T1 Example results and plots

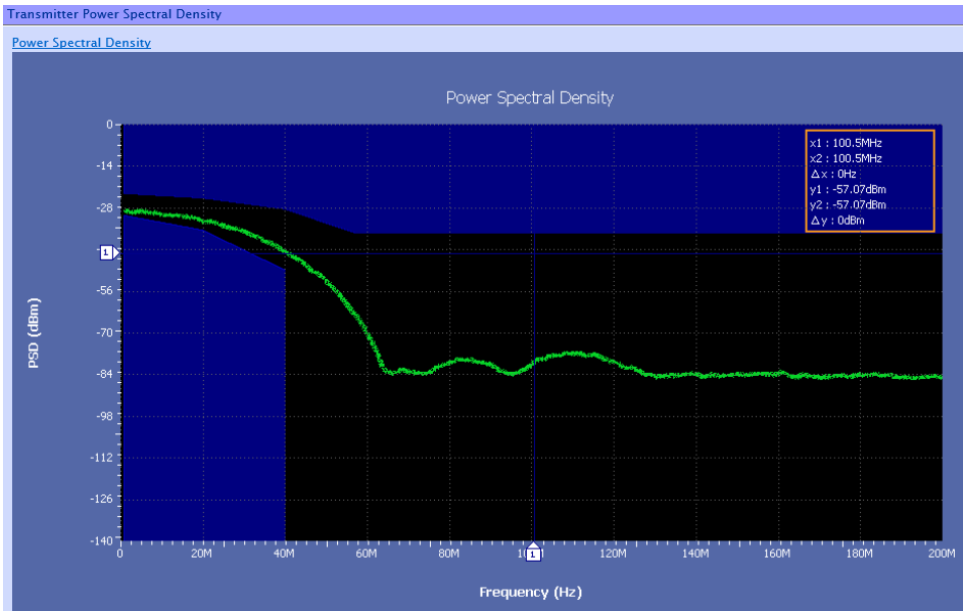


Figure 77: Power spectral density plot

1000Base-T1 Example results and plots

Figure 78: Power spectral density plot

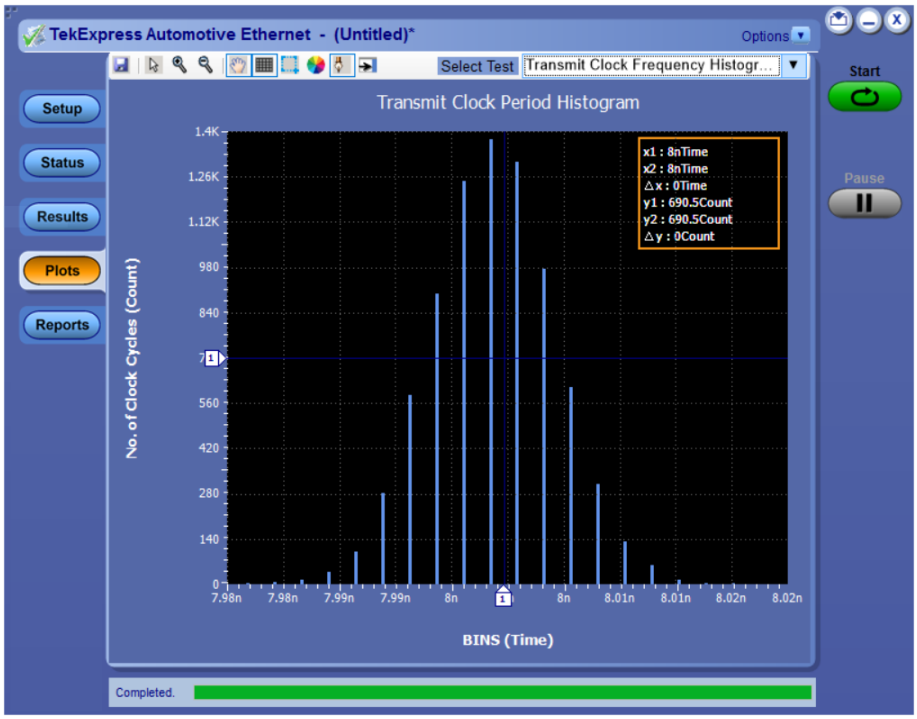


Figure 79: Transmit Clock Frequency - 1000Base-T1 Histogram Plot

Return Loss measurement Calibration

Discussion

This section describes the equipment connection diagram and test procedure for the following technologies:

- 10Base-T1S
- 100Base-T1
- 1000Base-T1

Return Loss Calibration

This section describes the equipment connection diagram and test procedure for the return loss calibration and measurement.

Calibrating the test setup is needed before running the return loss measurement. Calibration has the following steps:

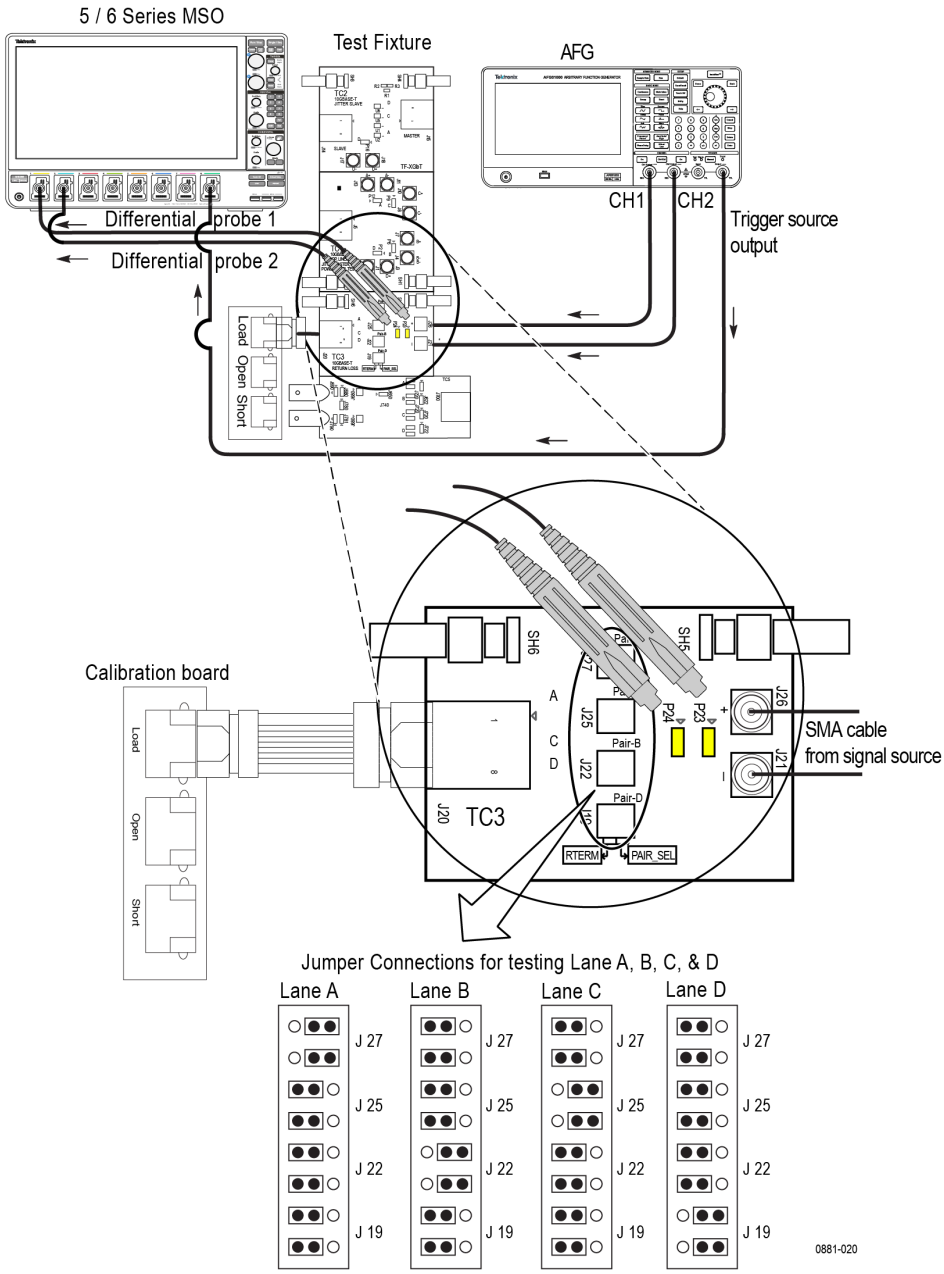
1. Load calibration
2. Open calibration
3. Short calibration

Following are the accessories/fixture needed for the return loss calibration:

- Two supported differential probes. See *List of supported instrument models* on page 19, for the list of supported signal source for the technology.
- Signal Source – either AFG/AWG. See *List of supported instrument models* on page 19, for the list of supported signal source for the technology.
- LAN/USB cable to connect the oscilloscope to Signal source which enables the automation of the signal source by the application.
- One matched pair of SMA cable, to connect signal source output to the fixture.
- Same length SMA cable with two SMA to BNC adapters to connect the trigger input from the signal source.
- One short RJ45 cable.
- TF-XGbT test fixture and calibration board (Open, Short, and Load).

The application also provides an option to read the return loss results captured using a VNA (s1p/s2p files) and compare the results against the measurement limits to determine the test measurement is Pass/Fail. It also generates the report with return loss plot against the limits. Refer *Return Loss measurement using VNA Result File* on page 120 steps to perform return loss measurement using VNA result file.

Test Setup



Note: For best results, connect the Oscilloscope, DUT, and test fixture to a common ground.

Figure 80: Connection diagram for return loss calibration

Test Procedure

1. Make the connections as shown in the *Figure 80* on page 111.
2. Connect two probes from the oscilloscope channel to the fixture. Two oscilloscope channels (say CH1 and CH2) are connected to P23 and P24 respectively on the return loss test coupon (TC3) of the test fixture.
3. Connect a pair of SMA cable (with the BNC and SMA connectors) from CH1 and CH2 of the signal source (AFG) to the J26 and J21 respectively, on the return loss test coupon (TC3) of the test fixture.

4. Connect a trigger signal from the signal source to the oscilloscope.
   a. With AFG 31xxx, connect the trigger output channel of AFG to a oscilloscope channel or Aux trigger (on 6 Series MSO).
5. To enable remote control of the signal source by the oscilloscope, connect the oscilloscope and signal source (AFG) either using LAN/USB.
6. Ensure the DUT, Fixture and Oscilloscope are connected to a common ground.
7. Ensure the jumper setting on the Fixture is as per the schematic in the test setup.
8. To enable remote connections on the TekExpress application:
   a. Click **Options > Instrument Control Settings**.
   b. Select the options from the Search Criteria and click **Refresh**.
   c. Wait for the signal source to be displayed in list. If you are using LAN connect, follow the LAN configuration steps before doing these steps.
   d. Click **Setup > Test Selection > Global Settings** and view the list of detected instruments. For more details refer *Automate AWG/AFG signal generation* on page 30.
9. Setup the return loss calibration board – Connect a short RJ45 cable from J20 of the test fixture to one of the three connectors (LOAD/OPEN/SHORT) on the calibration board, based on the calibration step.
10. Run all the three calibrations one after another, with appropriate connections to the calibration board (Load Calibration, Open Calibration, and Short Calibration). The application screen for calibration is show in the *Figure 81* on page 112
11. Click **Apply** to generate the calibration coefficients using the calibration data. The live calibration data is stored at `X:\Automotive Ethernet\LiveCal \10Base-T1S\`.
12. After successfully completing the above steps, the necessary calibration data is available to run the return loss measurement. Click **Plot** to view the calibration result.

Figure 81: Return loss Calibration

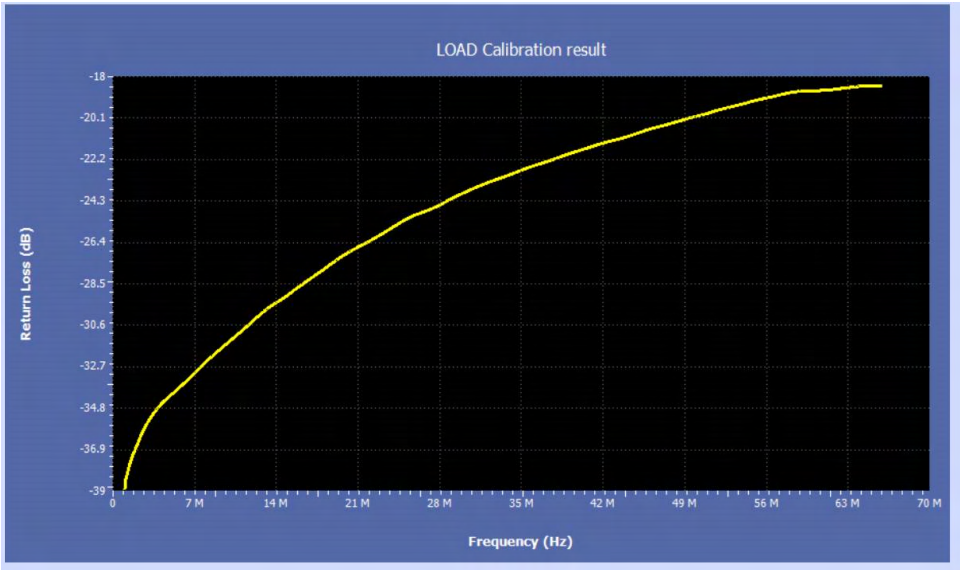


Figure 82: Load calibration result

1000Base-T1 Example results and plots

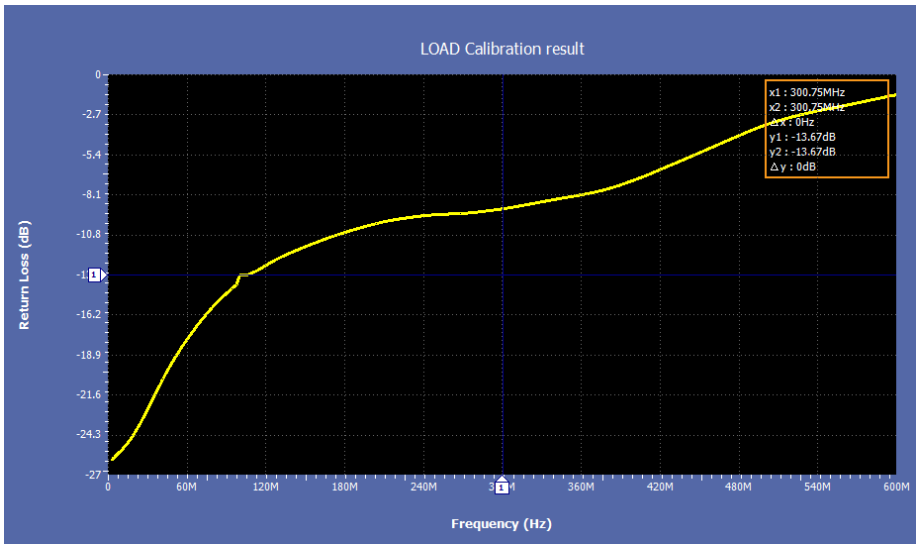


Figure 83: 1000Base-T1 Return Loss Load Calibration

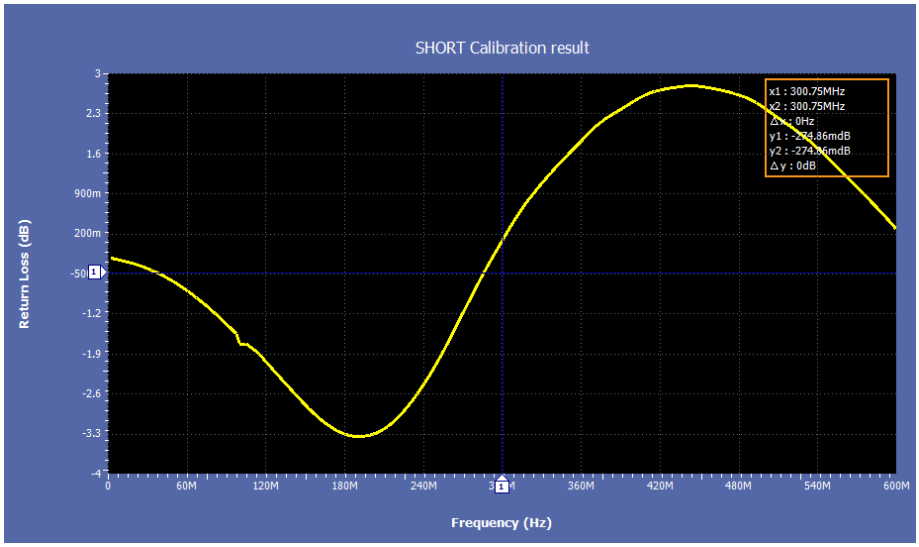


Figure 84: 1000Base-T1 Return Loss Short Calibration

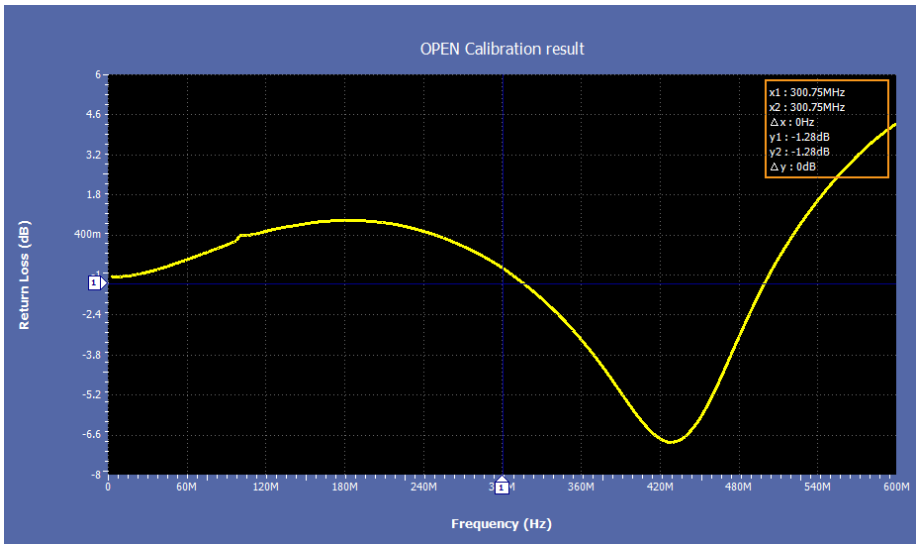


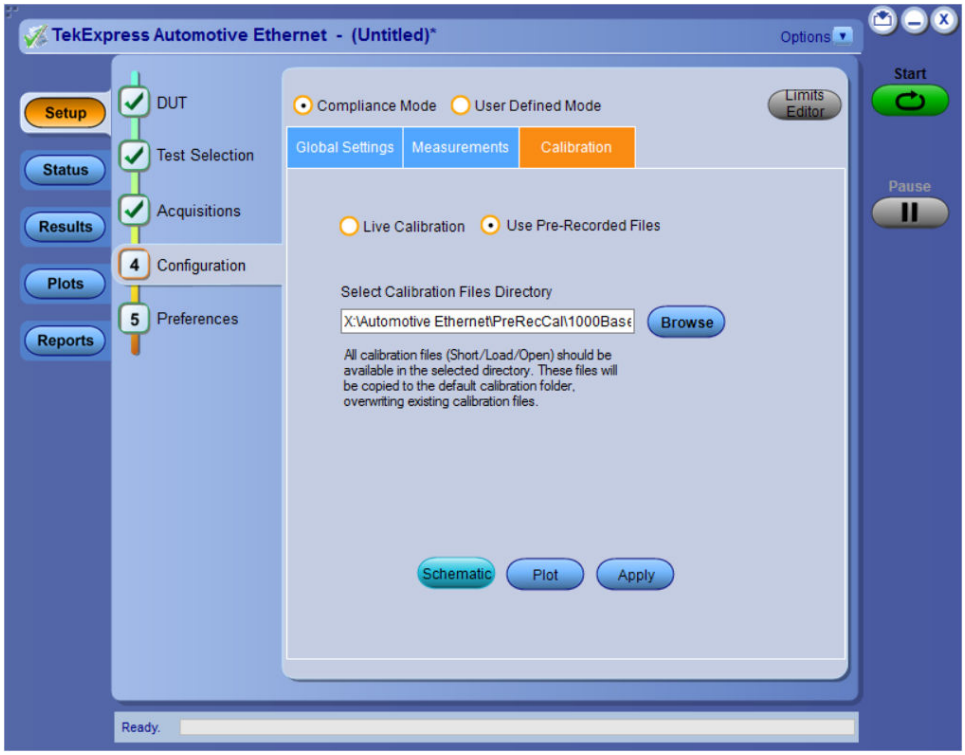
Figure 85: 1000Base-T1 Return Loss Open Calibration

Pre-recorded Calibration

This section describes the equipment connection diagram and test procedure for the following technologies:

- 100Base-T1
- 1000Base-T1

To use previously saved/generated calibration data, use **Use Pre-Recorded Files** and select the file path and click **Apply**.



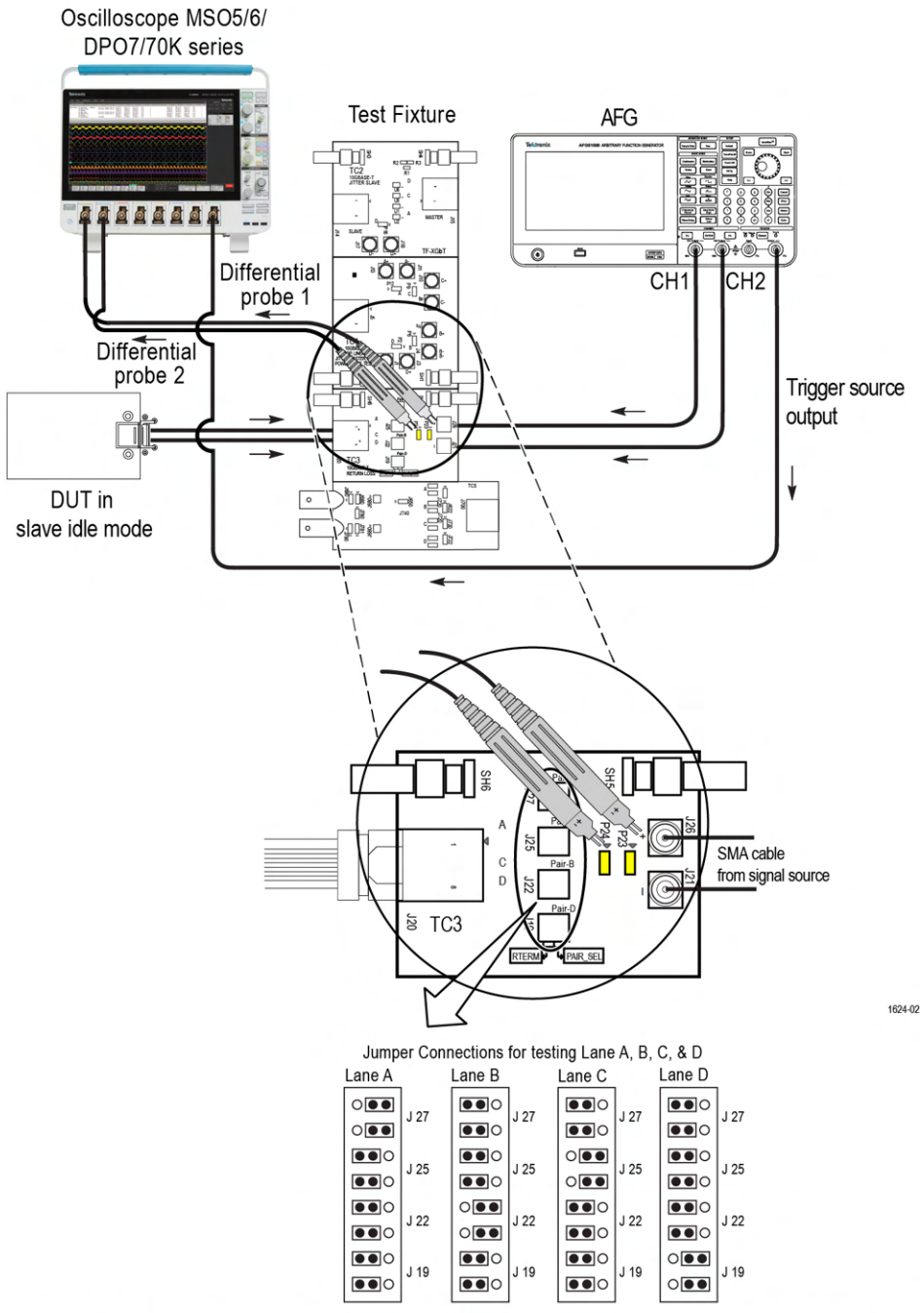
Return Loss measurement

Discussion

This section describes the equipment connection diagram and test procedure for the following technologies:

- 10Base-T1S
- 100Base-T1
- 1000Base-T1

Test Setup



Note: For best results, connect the oscilloscope, DUT, and test fixture to a common ground.

Figure 86: Connection diagram for return loss measurement

Test Procedure

1. Perform the test setup calibration. Refer to *Return Loss measurement Calibration* on page 110 section for the steps.
2. Make the connections as shown in the *Figure 86* on page 117.
3. Setup the DUT – Connect a short RJ45 cable from J20 of the fixture to the DUT.

4. Configure the DUT to SLAVE IDLE mode of operation.
5. Click **Start**.
6. Once the test execution is complete, a report with the plots of the calibration and return loss against the mask limits will be generated.

Example results and plots

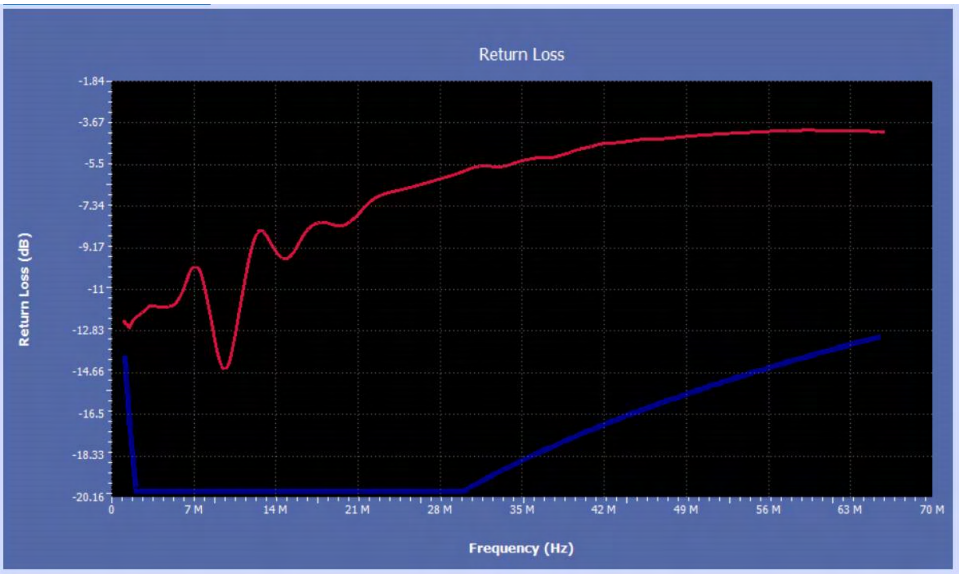


Figure 87: 10Base-T1S Return loss

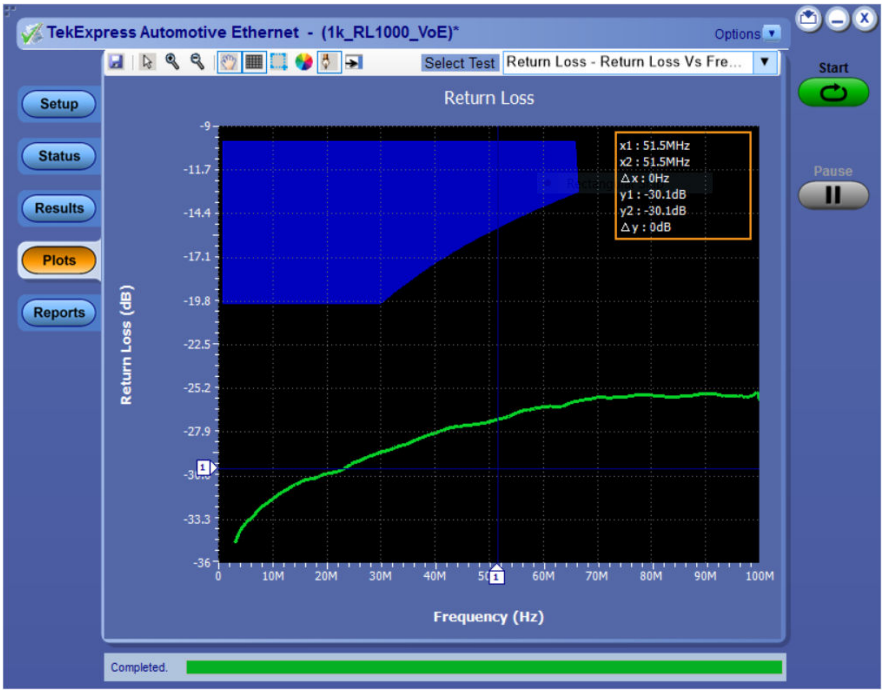


Figure 88: Return Loss - 100Base-T1

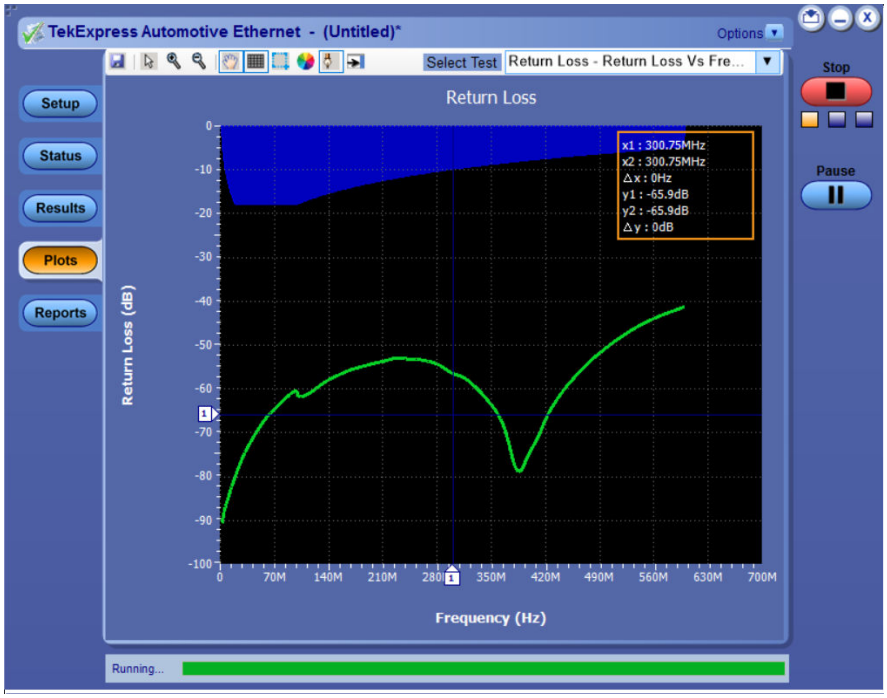


Figure 89: Return Loss - 1000Base-T1

Return Loss measurement using VNA Result File

Discussion

This section describes the equipment connection diagram and test procedure for return loss of the following technologies:

- 10Base-T1S
- 100Base-T1
- 1000Base-T1

The application also provides an option to read the return loss results captured using a VNA (s1p/s2p files) and compare the results against the measurement limits to determine the test measurement is Pass/Fail. It also generates the report with return loss plot against the limits.

Test Procedure

Steps to perform return loss measurement using **VNA Result File**:

1. Select **Setup > DUT**.
2. In the **DUT** tab > Select **Return Loss Measurement preferences** as **VNA Report**.
3. Select **Configuration > Global Settings**. Click **Browse** to select the **VNA Result File**.
4. Click **Start** to run the measurement.
5. Select **Results** panel to view the measurement statistics and Pass/Fail status. Once the test execution is complete, displays the detailed test report as shown.

Tektronix®

TekExpress Automotive Ethernet
Transmitter Test Report

Setup Information			
DUT ID	DUT001	TekExpress Automotive-Ethernet	1.3.0.115
Date/Time	2020-02-07 10:11:08	Framework Version	4.16.0.20
Pre-Recorded Mode	True	Scope Model	MSO54
Compliance Mode	True	Firmware Version	1.22.4.7207
Suite Name	10Base-T1S	VNA Model	TTR503A
Overall Execution Time	0:00:03		
Overall Test Result	Pass		
DUT COMMENT:	General Comment - Automotive Ethernet DUT		

Test Name Summary Table	
MDI Return Loss	Pass

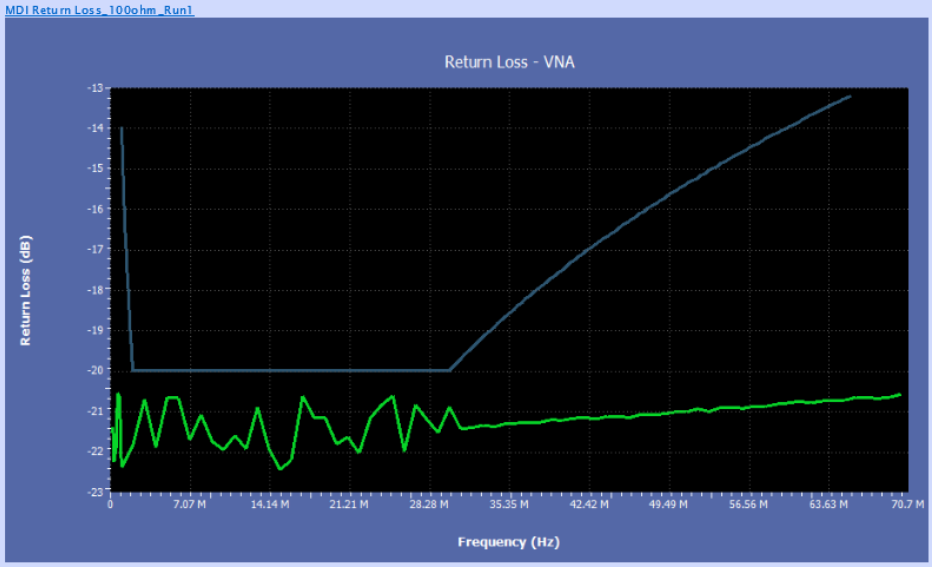
Statistics						
Measurement Details	Run Count	Min	Max	Average	Units	Standard Deviation
MDI Return Loss_100ohm	1	0	0	0	Hits	0

MDI Return Loss							
Measurement Details	Test Result	Low Limit	Measured Value	High Limit	Units	Margin	Run#
MDI Return Loss_100ohm	Pass	NA	0	0	Hits	0	1
COMMENTS	The result is extracted from the S-parameter file provided (C:\Users\sqeind\Desktop\Sample SnP Files\Testcase_10BT1S_Ex1.s1p).						

Back to Summary Table

MDI Return Loss

MDI Return Loss_100ohm_Run1



Transmitter Distortion

Discussion

This section describes the equipment connection diagram and test procedure for the following technologies:

- 100Base-T1
- 1000Base-T1

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

Required test equipment

In addition to the DUT and Oscilloscope, the following equipments are required:

- One supported differential probe
- Four BNC cables (for connecting AFG or AWG5200 to fixture) or two SMA cables with two BNC to SMA connectors [3]
- GPIB/LAN/USB cable (required if you use *AWG automation*, connects AWG and oscilloscope). Refer to *Automate AWG/AFG signal generation*.
- Short automotive cable.
- TF-XGbT test fixture for probing type differential.
- ETH-TPA-AW-MN, ETH-TPA-AW-CBL, and ETH-TPA-AW-D test fixtures for probing type single-ended.
- TF-BRR-CFD (Clock Frequency Divider Unit): Used to synchronize oscilloscope and signal source with the DUT Transmit_CLK.

Note: You need to complete the calibration procedure before doing the Transmitter Distortion measurement with disturbing signal. The calibration procedure effectively removes 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.

Designing of the transmitter is 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:

- Disturber Compensation, Measure Disturber Source Voltage
- Test Fixture Compensation, Measure DUT Output Voltage
- Test Fixture Compensation, Measure DUT Output Voltage @Disturber fixture

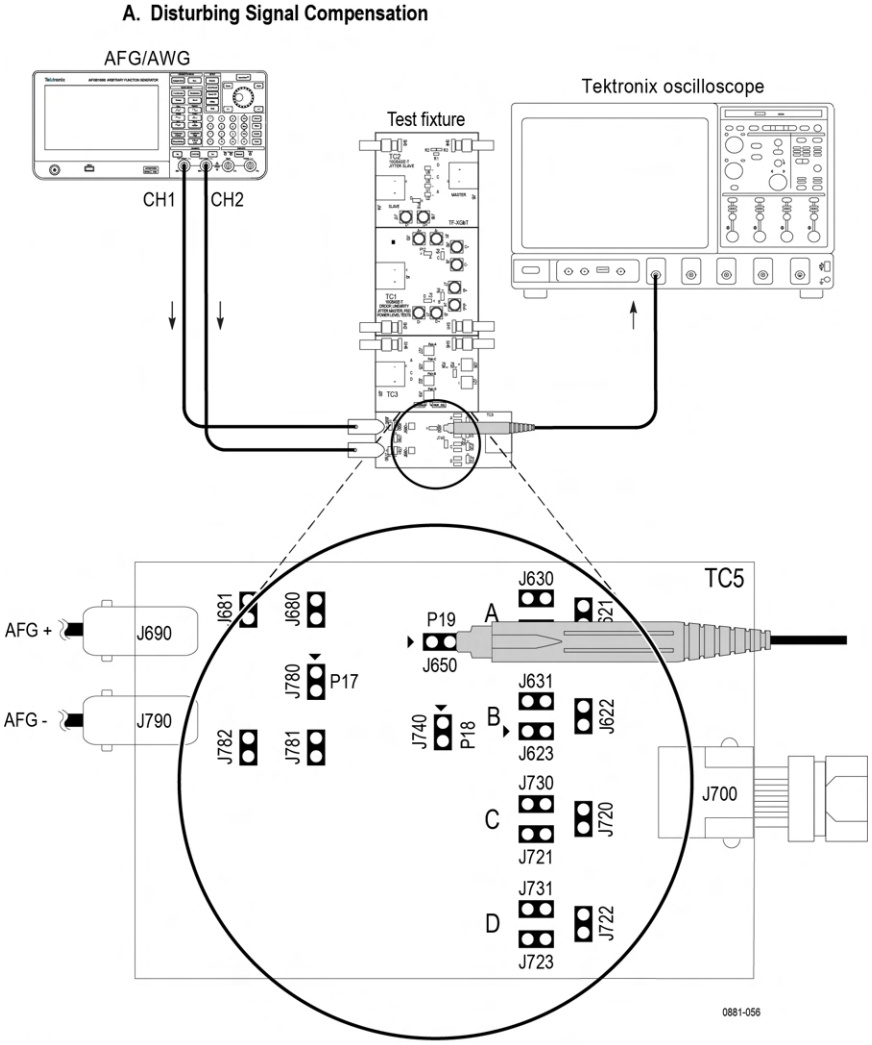
[3] Use the Signal Generator for 1000Base-T1 which supports the 125 MHz sine wave differential peak to peak 3.6 volts.

Figure 90: Calibration tab for 100Base-T1 transmitter distortion measurement

Figure 91: Calibration tab for 1000Base-T1 transmitter distortion measurement

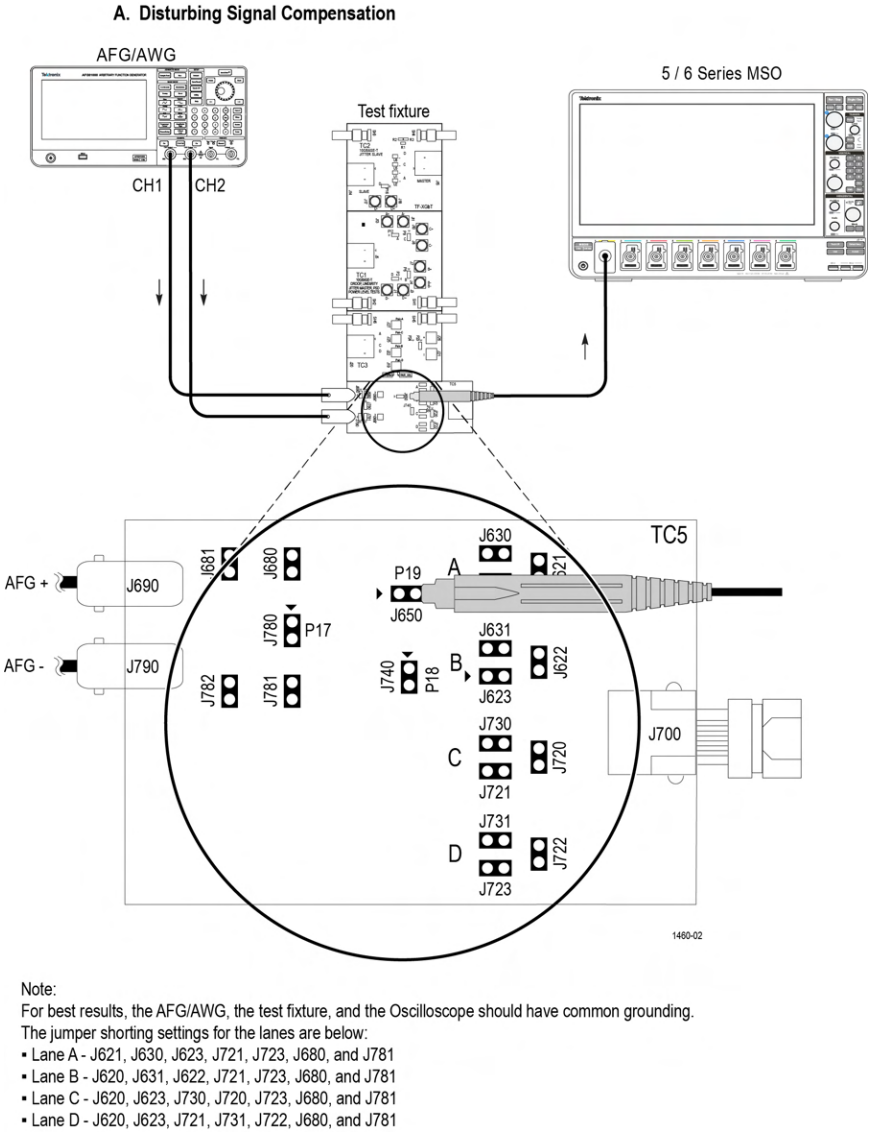
Disturber Compensation, Measure Disturber Source Voltage

Probing type differential



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



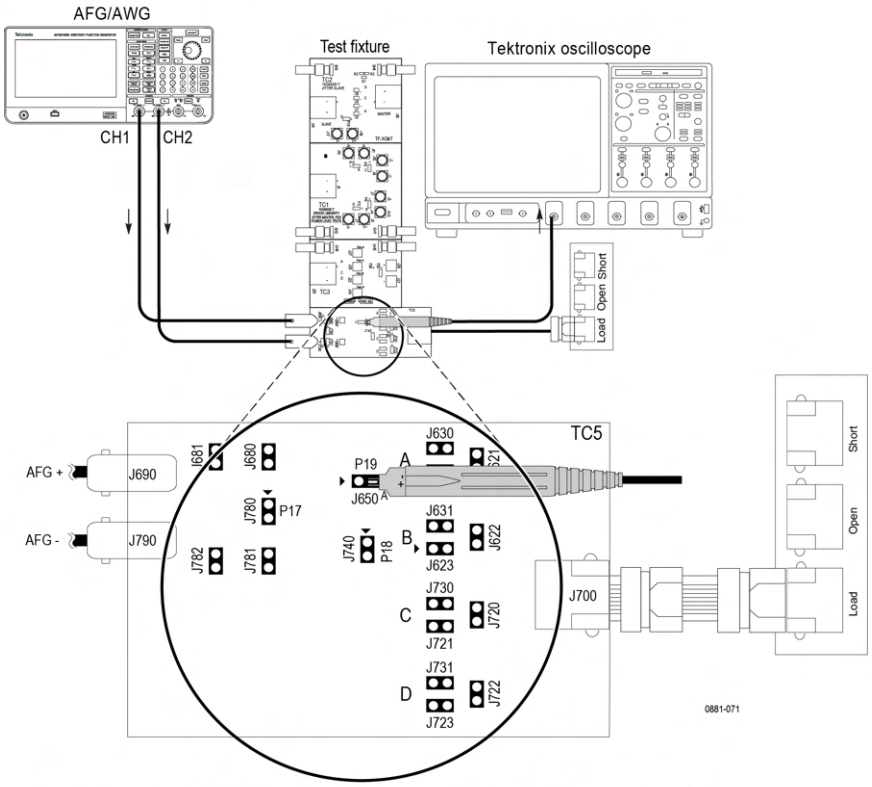
Note:
For best results, the AFG/AWG, the test fixture, and the Oscilloscope should have common grounding.
The jumper shorting settings for the lanes are below:
- Lane A - J621, J630, J623, J721, J723, J680, and J781
- Lane B - J620, J631, J622, J721, J723, J680, and J781
- Lane C - J620, J623, J730,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

Figure 92: Disturbing signal compensation with AFG/AWG

Note:

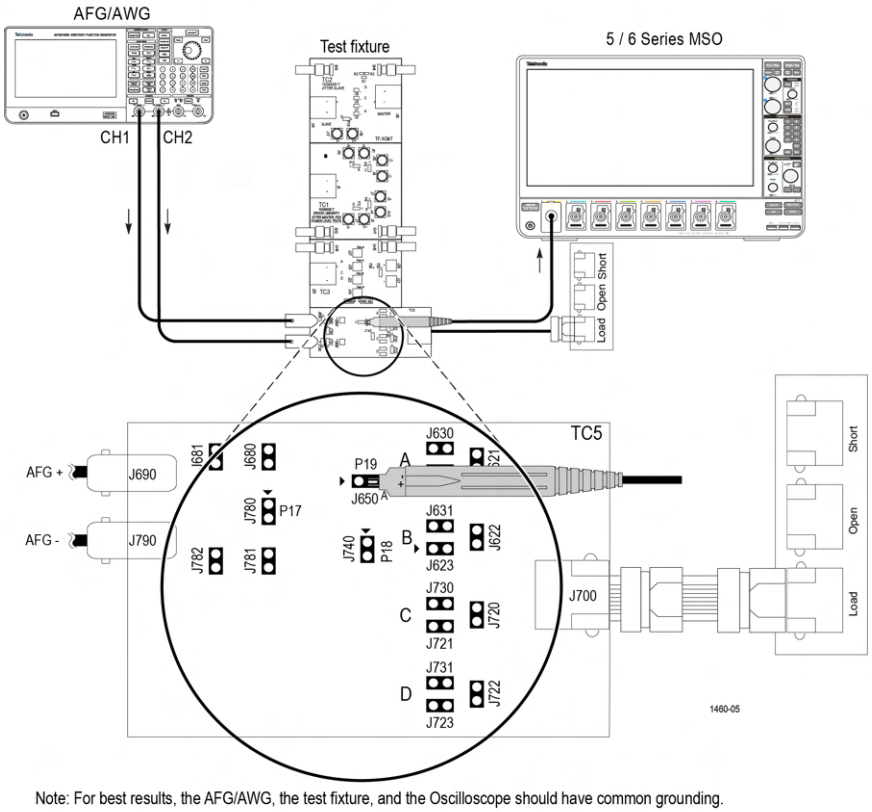
- Connect the positive (+) of the probe tips align with the ▶ symbol marked on the test fixture board to ensure the polarity not being reversed.
- This connection diagram is applicable for the probes whose differential input dynamic range is less than the amplitude of the disturber signal being measured.
- For 100Base-T1, the expected value is ≥ 5.4/2 Volts, as measured across the 100 Ω load.

A. Disturbing Signal Compensation



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

A. Disturbing Signal Compensation



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

Figure 93: Disturbing signal compensation with AFG/AWG

Note:

- Connect the positive (+) of the probe tips align with the ▶ symbol marked on the test fixture board to ensure the polarity not being 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 from the **Global settings** in the **Configuration** panel.

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

   Note: Use the Signal Generator which can generate the (3.6)/2 V_{Pk-Pk} for 1000Base-T1.

2. Connect DUT as shown in the 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. For 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.
- Connect the positive (+) of the probe tips align with the ▶ symbol marked on the test fixture board to ensure the polarity not being reversed.

Probing type single-ended

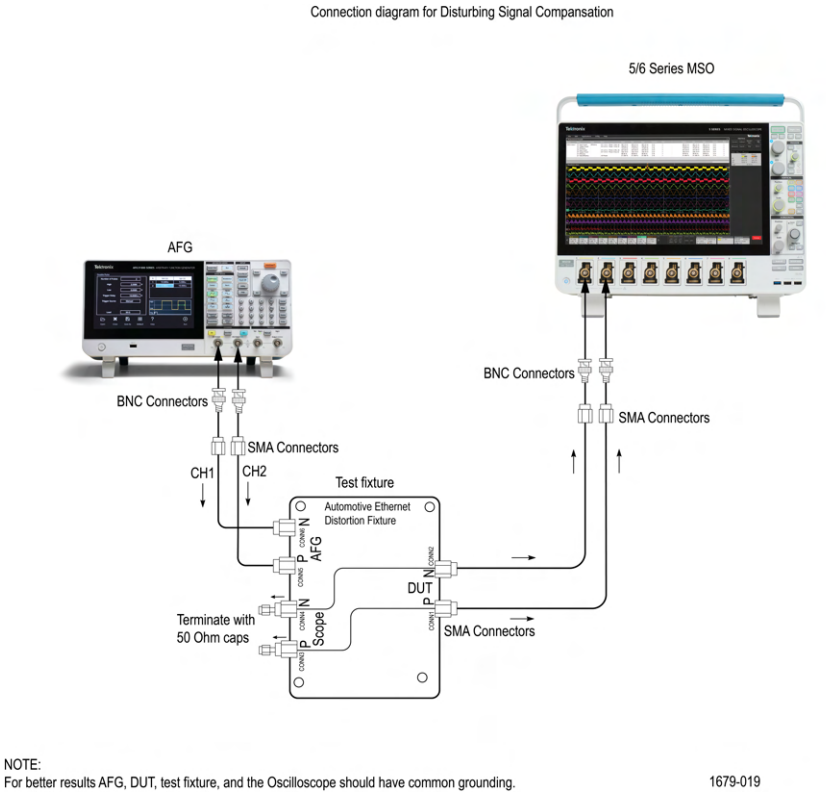


Figure 94: Disturbing signal compensation with AFG using TDP3500

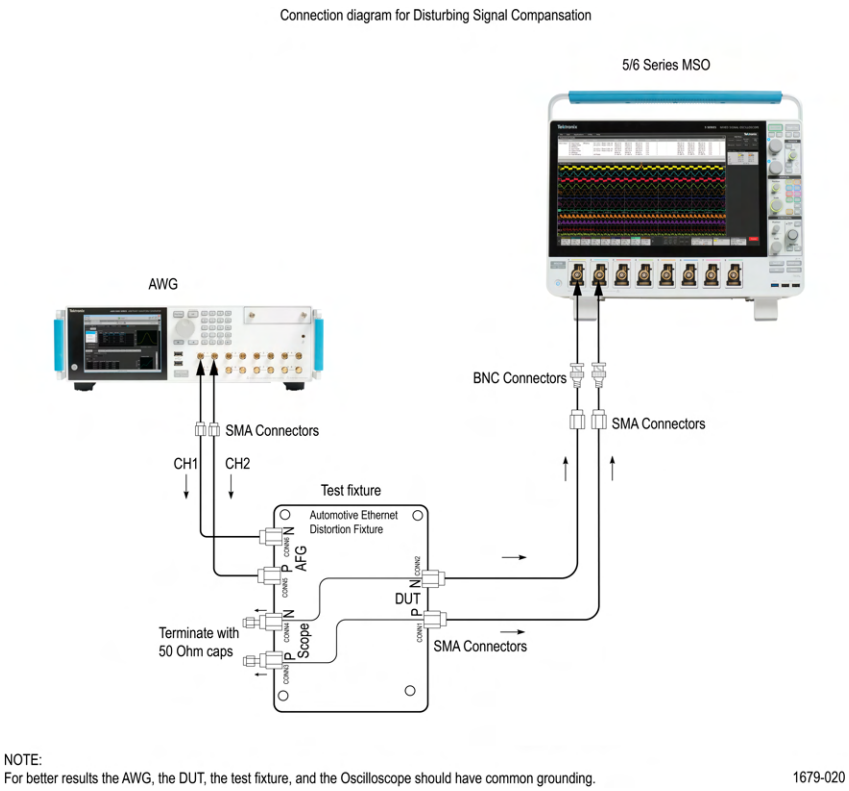


Figure 95: Disturbing signal compensation with AWG using TDP3500

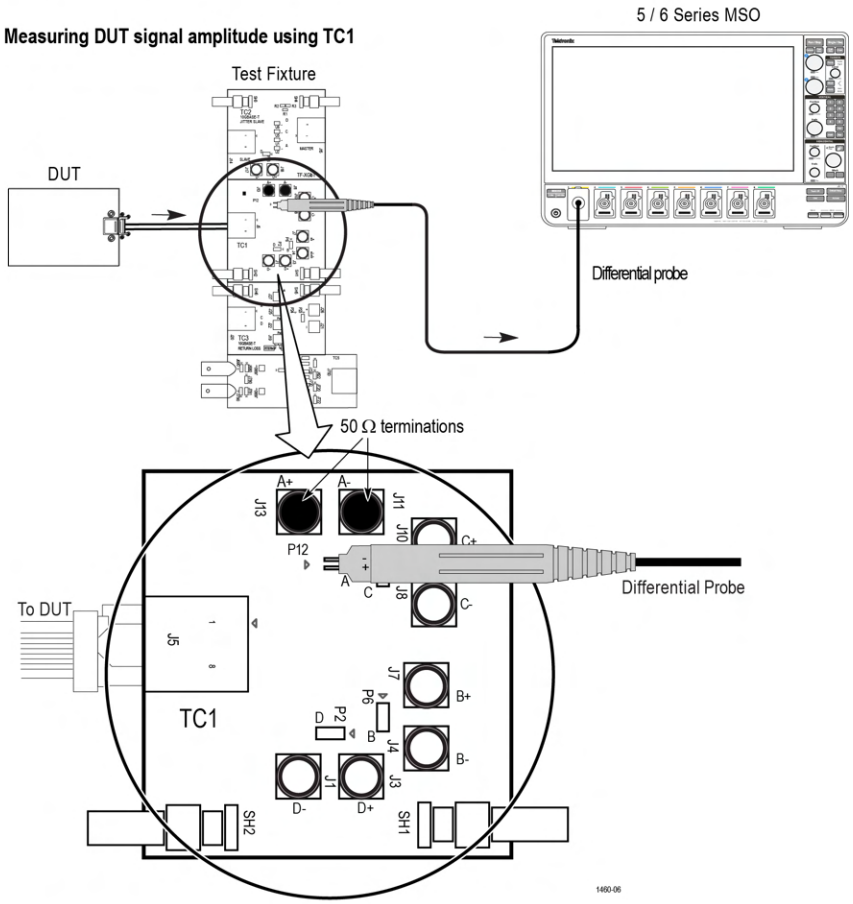
1. Connect the disturber source to AFG/AWG P and N of the test fixture as shown in the above figure.
2. Terminate the test fixture scope output P and N with 50 Ω termination caps.
3. Connect the test fixture DUT output P and N to the SMA pair cable.
4. Connect the SMA pair cable to the oscilloscope.
5. Click the **Run** button from the TekExpress application **Configuration** > **Calibration** tab and wait for the value to be updated in the **Measured Value** column of the Disturber Compensation.

Test Fixture Compensation, Measure DUT Output Voltage

Probing type differential

Test fixture compensation

B. Text Fixture Compensation



Note:
When using high input impedance differential probe, ensure that each of the single ended lanes is terminated with 50 Ω terminator.

For better results, the DUT, the test Fixture, and the Oscilloscope should have common grounding.

B. Text Fixture Compensation

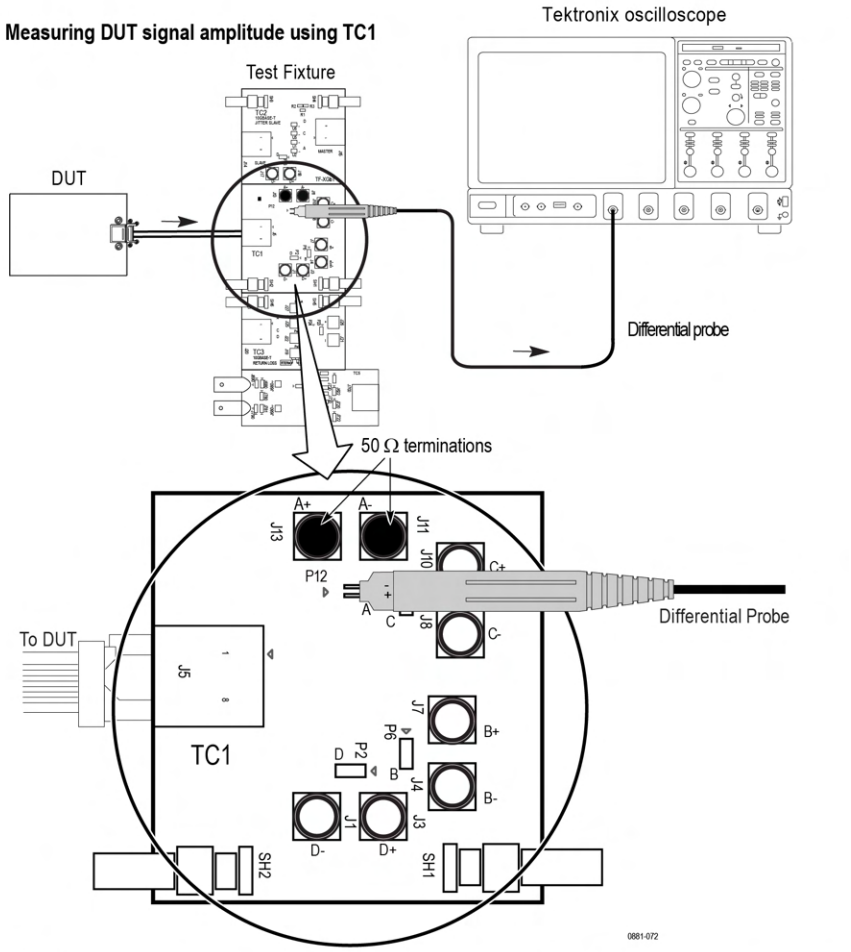


Figure 96: Disturbing signal compensation with AFG/AWG

Note:

- When using high input impedance differential probe, ensure that each of the single ended lanes is terminated with 50 Ω.
- Connect the positive (+) of the probe tips align with the ▶ symbol marked on the test fixture board to ensure the polarity not being 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 > **Calibration** tab > **Test Fixture Compensation**.

6. 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.

Probing type single-ended

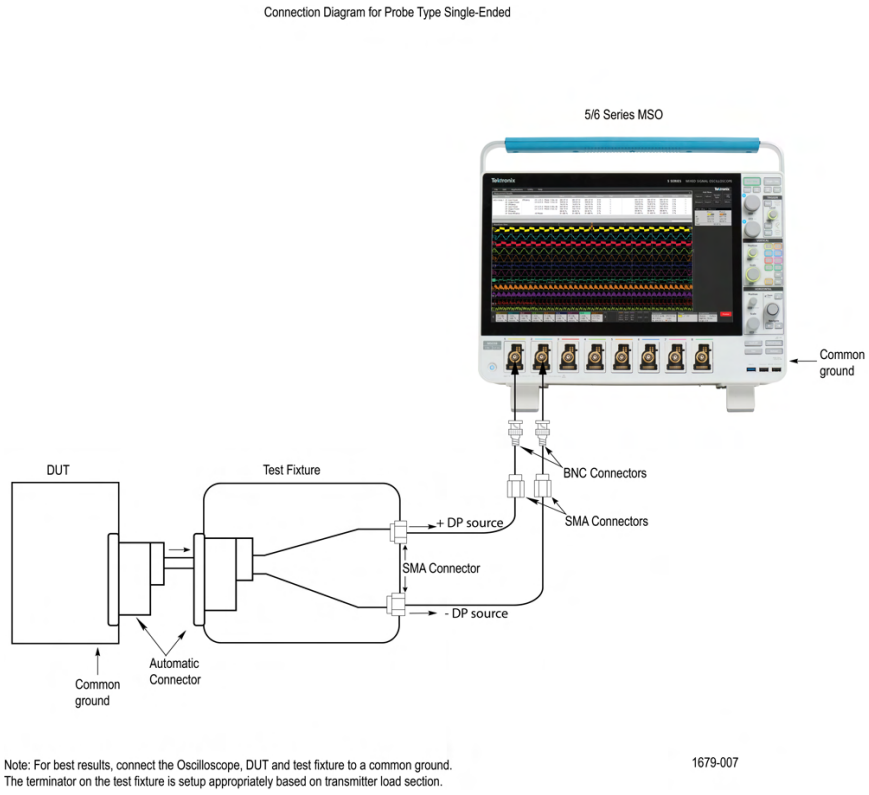
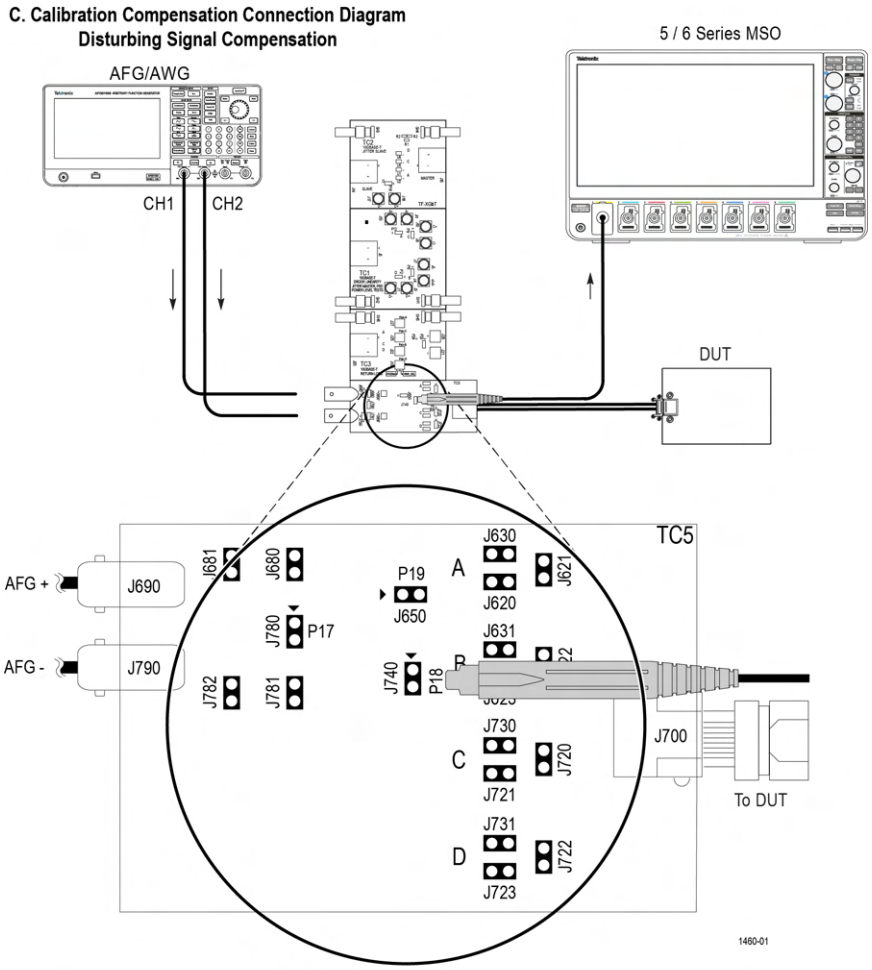


Figure 97: Disturbing signal compensation

1. Connect the DUT to the test fixture.
2. Connect the test fixture positive (+) and negative (-) source to the SMA pair cable.
3. Connect the SMA pair cable to the oscilloscope.
4. Click the **Run** button from the TekExpress application **Configuration** > **Calibration** tab and wait for the value to be updated in the **Measured Value** column of the Test Fixture Compensation.

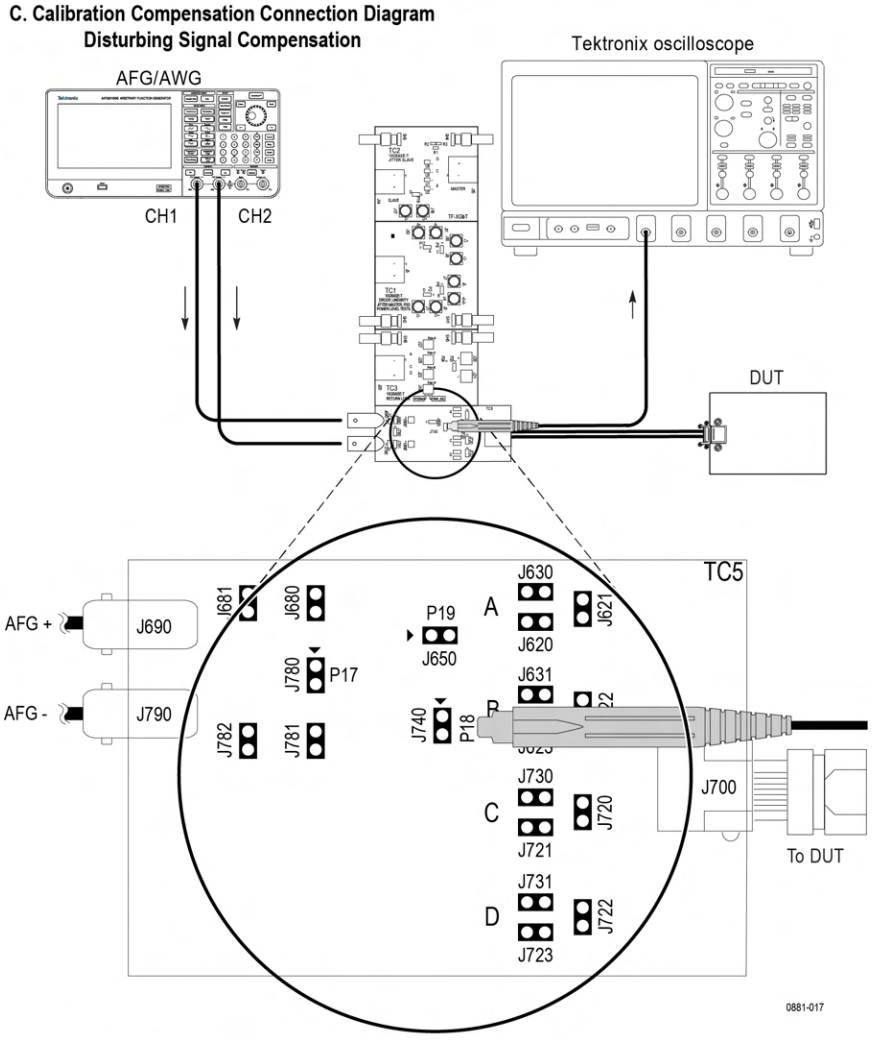
Test Fixture Compensation, Measure DUT Output Voltage @Disturber fixture

Probing type differential



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



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 98: Disturbing signal compensation with AFG/AWG

Note: Connect the positive (+) of the probe tips align with the ▶ symbol marked on the test fixture board to ensure the polarity not being 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)
5. 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: Connect the positive (+) of the probe tips align with the ▶ symbol marked on the test fixture board to ensure the polarity not being reversed.

Probing type single-ended

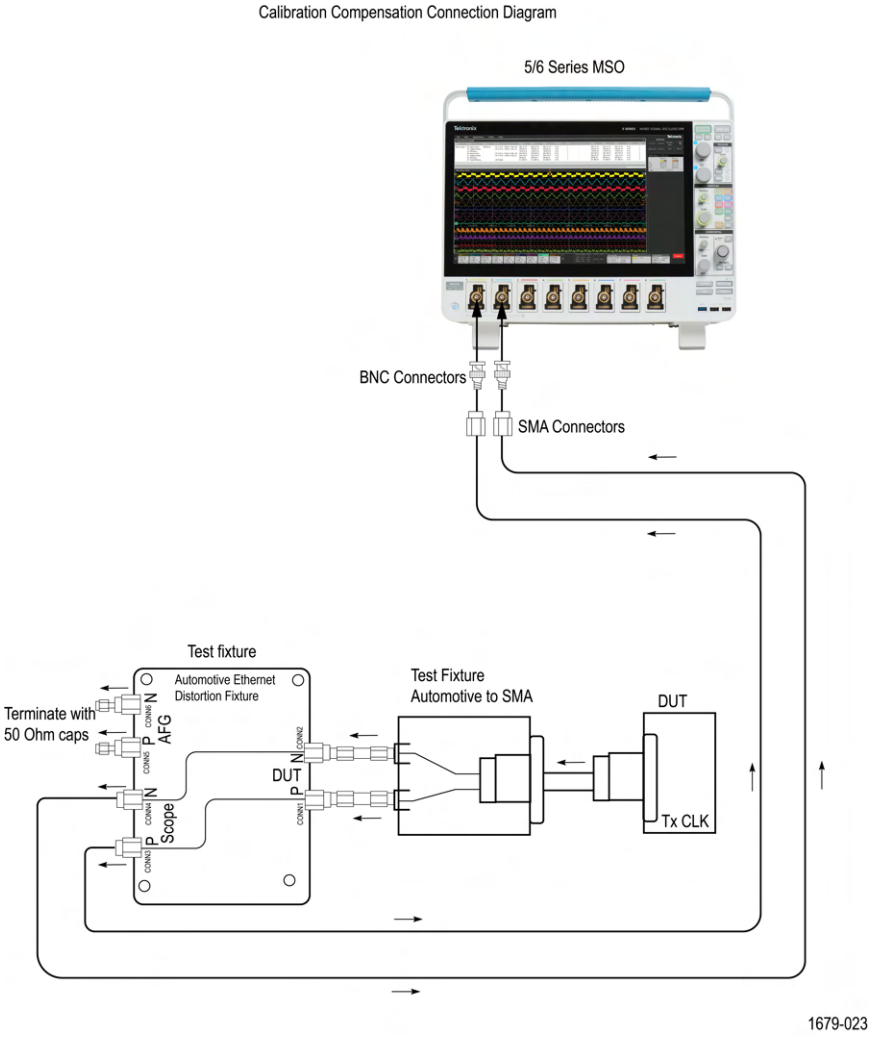


Figure 99: Disturbing signal compensation

1. On the test fixture AFG P and N terminate with 50 Ω impedance.
2. Connect the DUT to the test fixture DUT P and N using appropriate automotive to SMA test fixture.
3. On the test fixture Scope P and N connect the SMA pair cable.
4. Connect the SMA pair cable to the oscilloscope.
5. Click the **Run** button from the TekExpress application **Configuration** > **Calibration** tab and wait for the value to be updated in the **Measured Value** column of the Test Fixture Compensation.

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 and Measuring amplitude with disturbing signal OFF and DUT signal ON.

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 and Measuring amplitude with disturbing signal OFF and DUT signal ON.

Note:

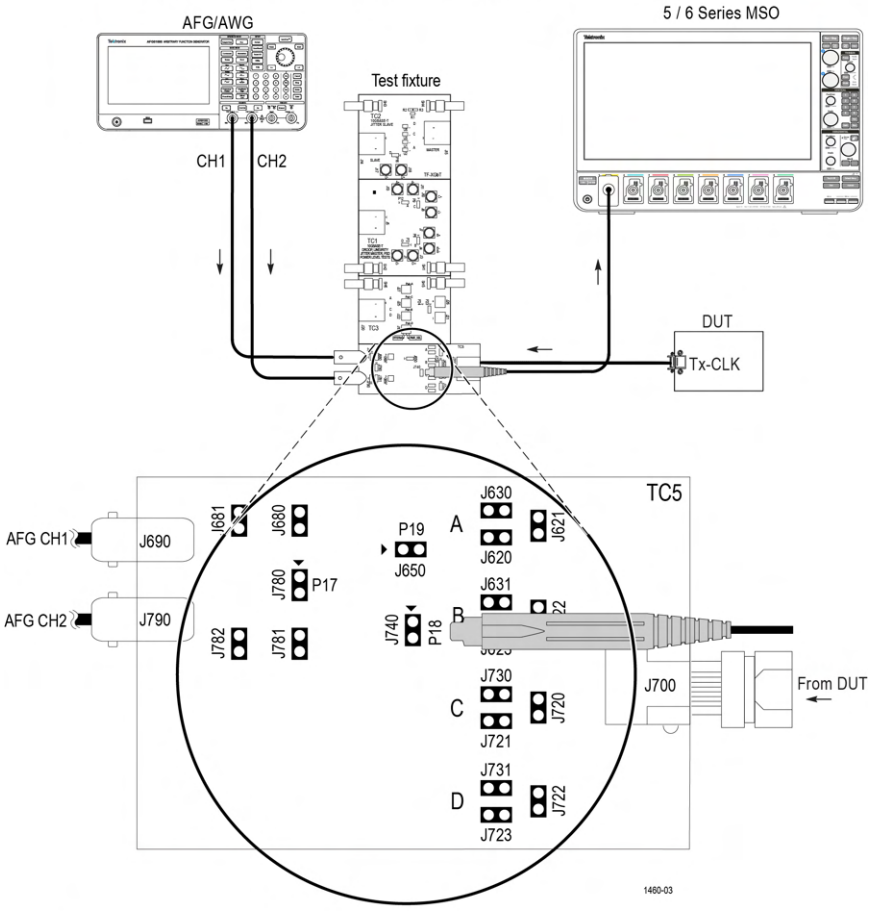
- Ensure that before clicking the **Start** button the calibration steps are performed.
- During calibration, the signal source AFG/AWG will be setup automatically from the application by loading the disturber pattern.
- When you click the **Start** button, the AFG/AWG does not setup, only oscilloscope 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 100/1000Base-T1

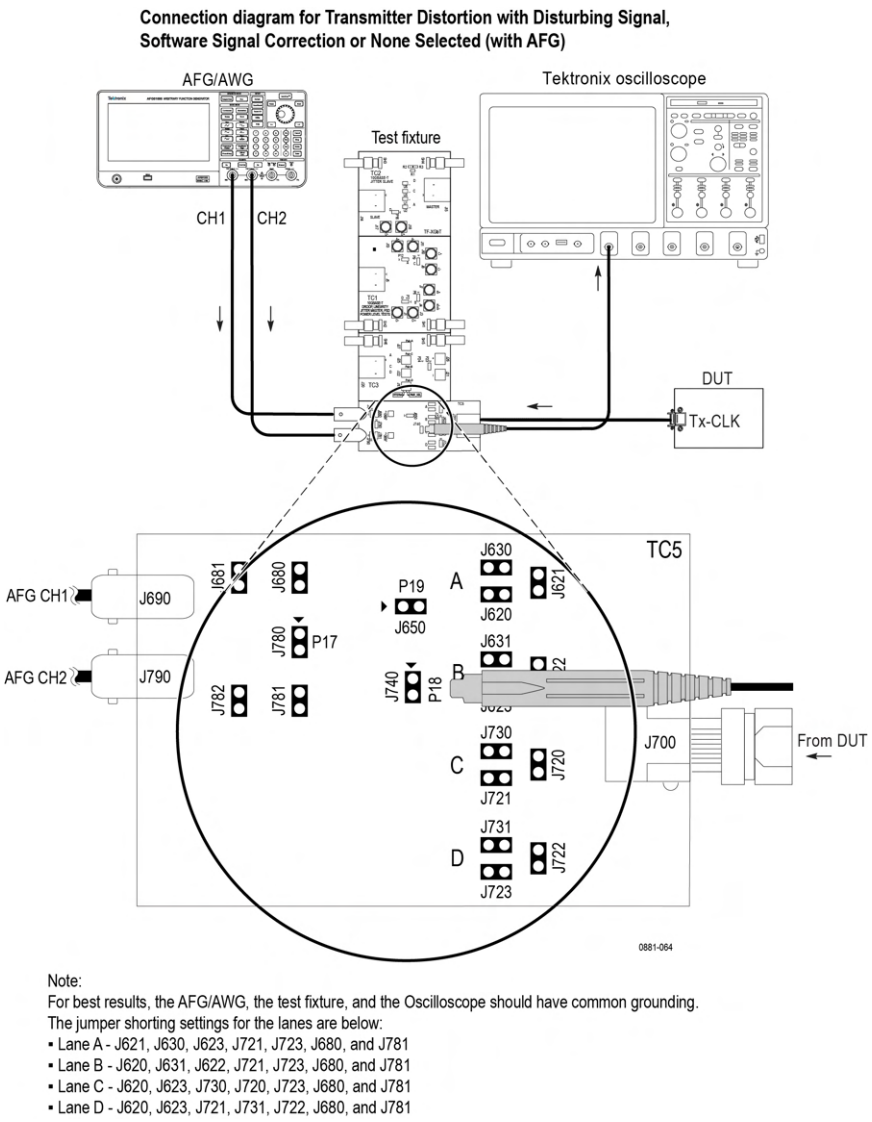
Probing type differential

Connection diagram for Transmitter Distortion with Disturbing Signal, Software Signal Correction or None Selected (with AFG)



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



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

Note: Connect the positive (+) of the probe tips align with the ▶ symbol marked on the test fixture board to ensure the polarity not being reversed.

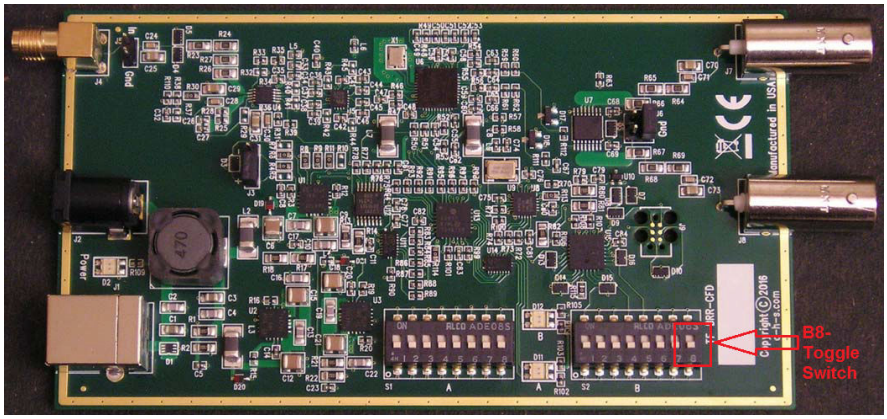
Make the connection as above:

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 mentioned in Step 1 of 3 (Refer A. Disturber Signal setup (1 of part 3) (AWG) section). Refer *Calibration* on page 122.
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.



Probing type single-ended

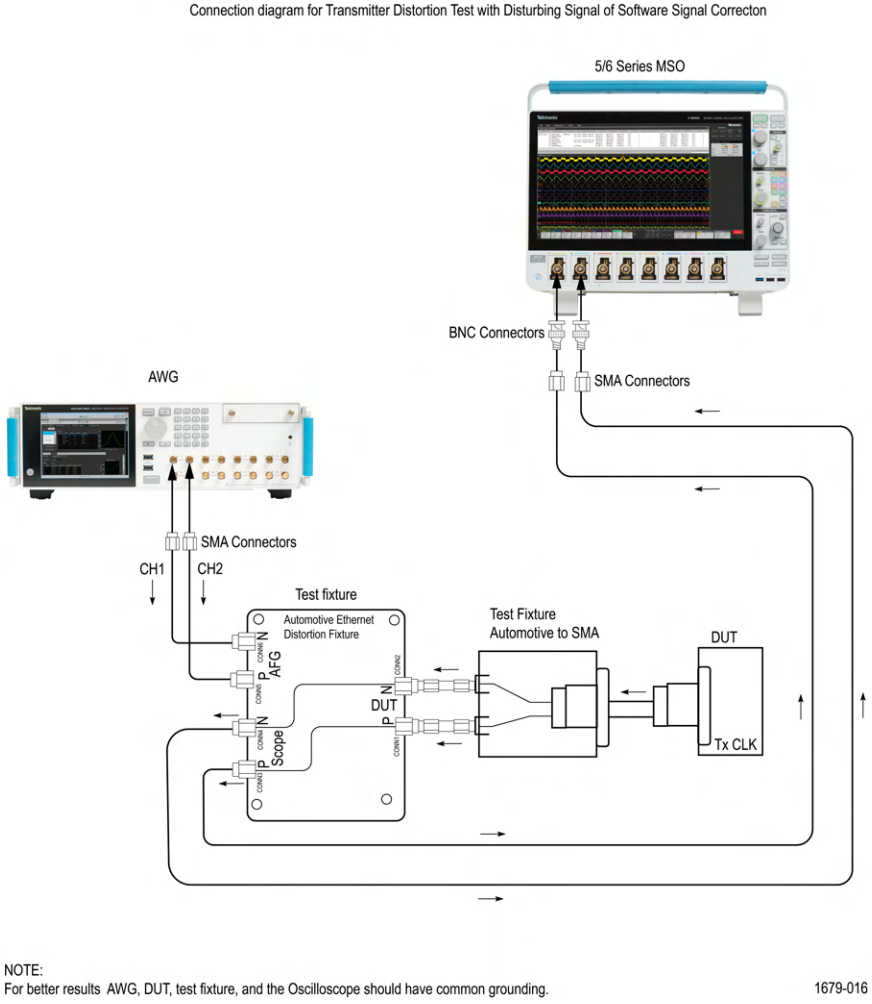


Figure 101: Connection diagram for Software Signal Correction

Make the proper connection as shown in the above connection diagram.

Hardware clock divider method for 100/1000Base-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

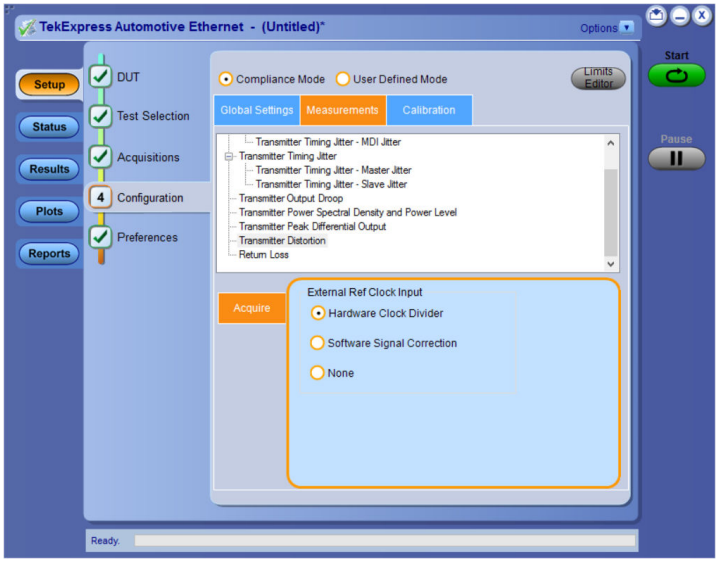
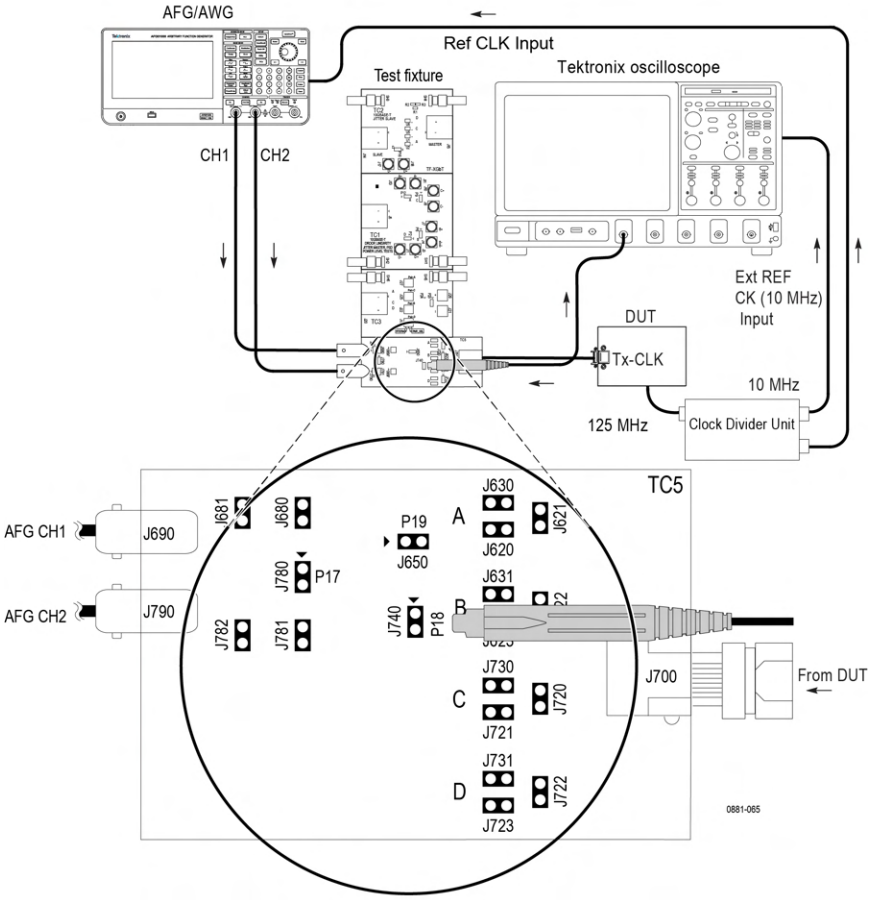


Figure 102: Hardware clock divider

Probing type differential

Connection diagram for Transmitter Distortion Test with Disturbing Signal



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

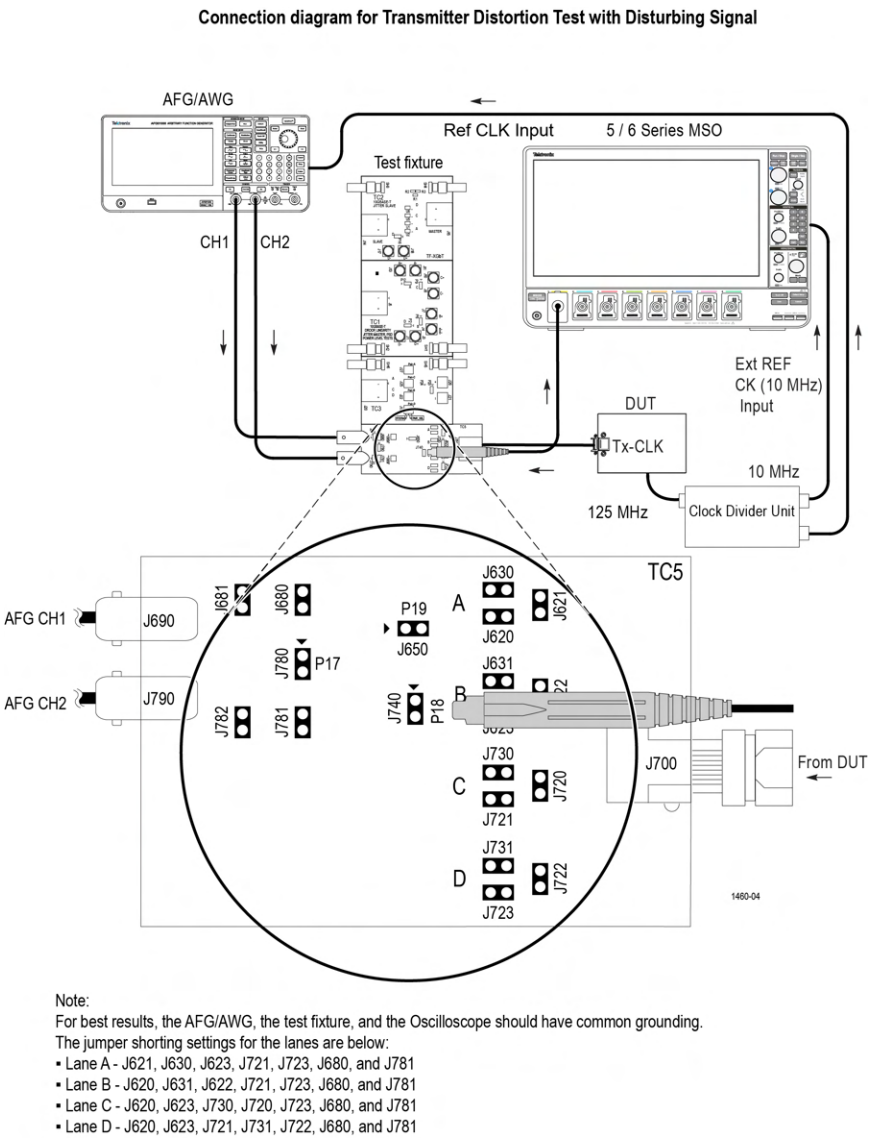


Figure 103: Connection diagram for Hardware Clock Divider

Note: Connect the positive (+) of the probe tips align with the ▶ symbol marked on the test fixture board to ensure the polarity not being 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.

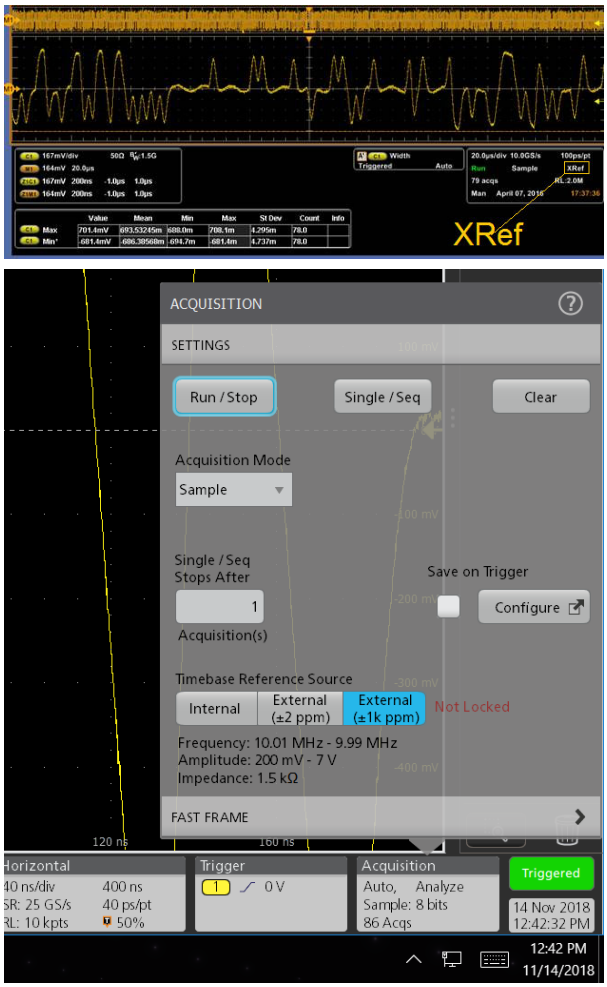
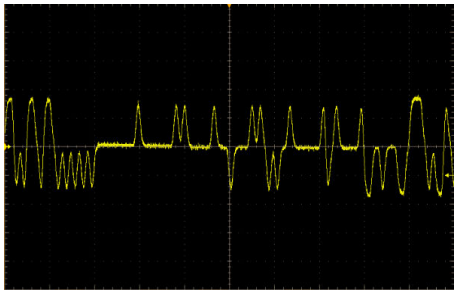
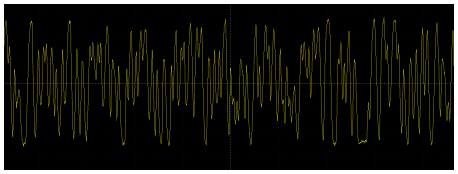


Figure 104: XRef

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.

Probing type single-ended

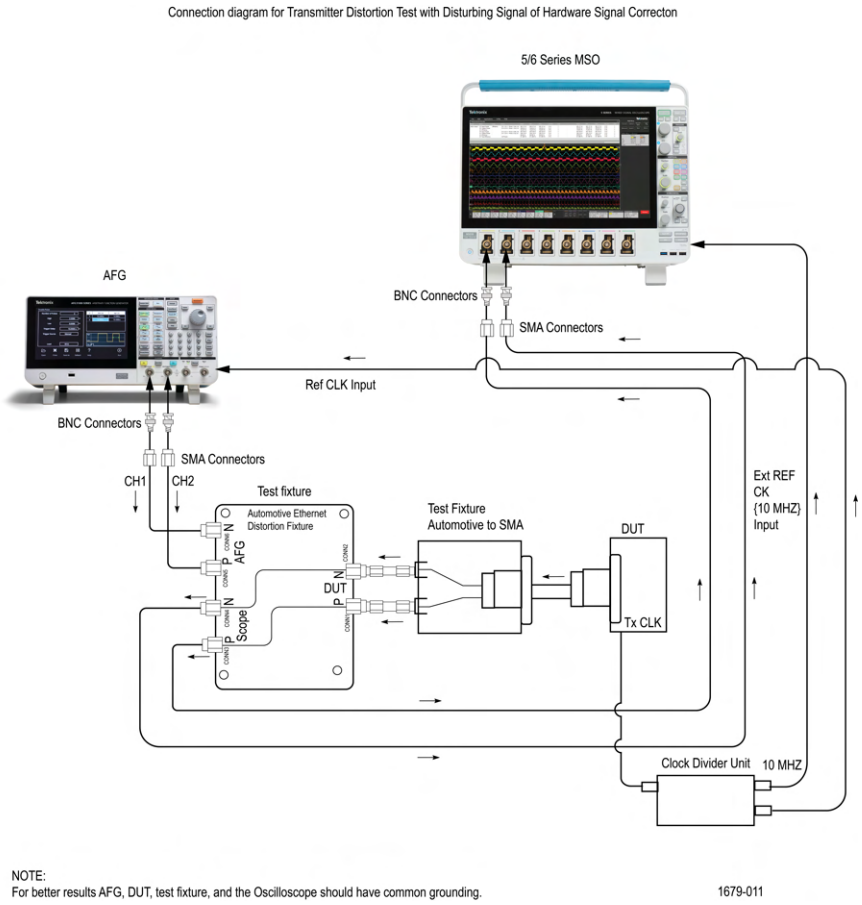


Figure 105: Connection diagram for Hardware Clock Divider

Make the connection as shown in the above connection diagram.

Example results and plots

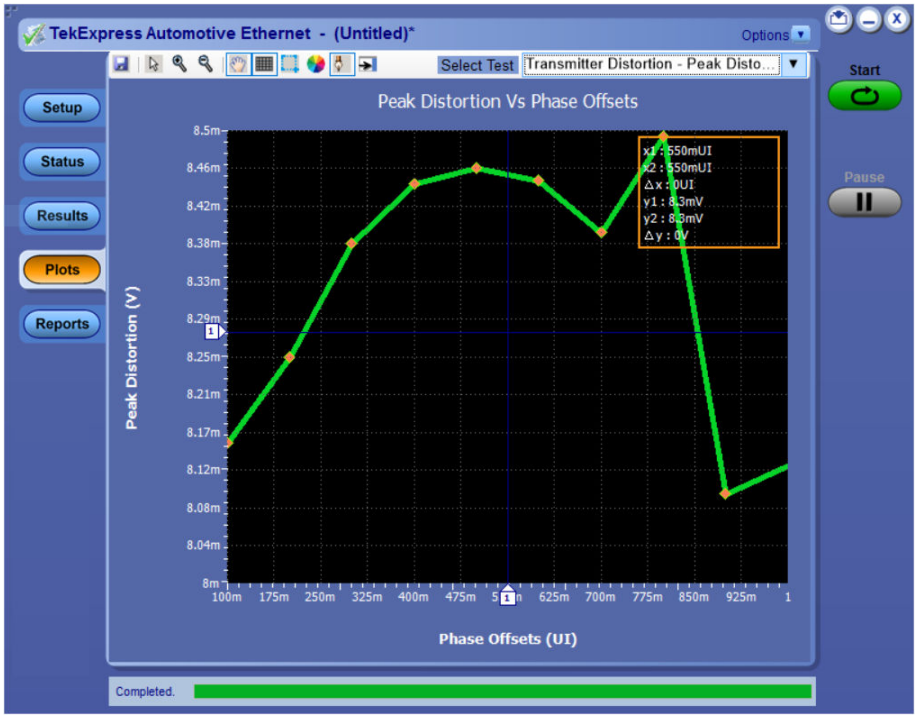


Figure 106: Peak Distortion - 100Base-T1

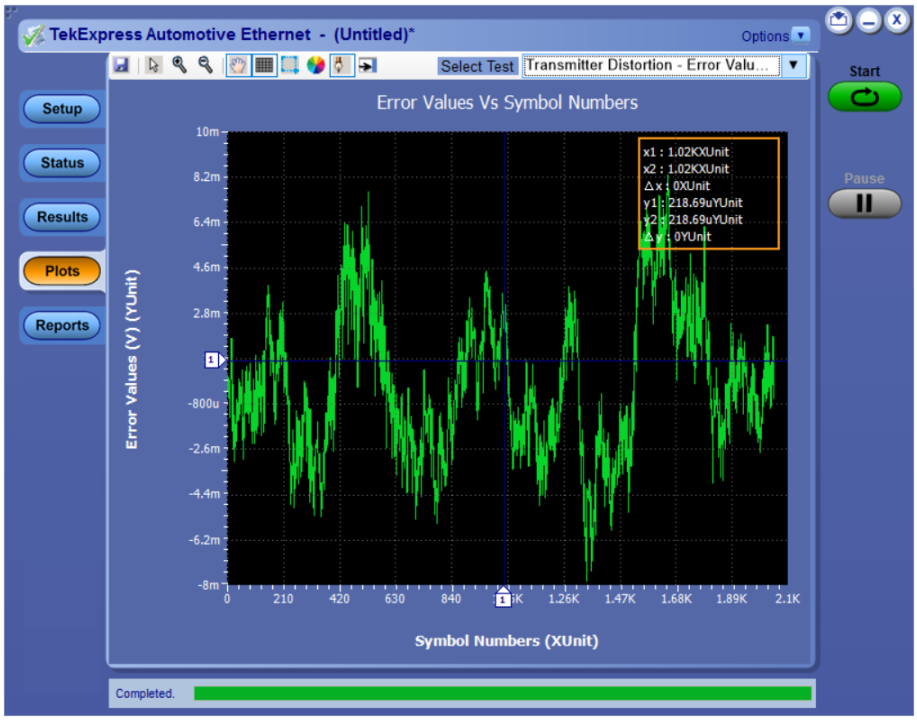


Figure 107: Error Value - 100Base-T1

See also

Plots

MultiGBASE-T1 measurement procedure

Test mode list

Table 38: MultiGBASE-T1 measurement list and test modes

Measurement name	Test mode
Maximum output droop	TM6
Transmitter linearity	TM4
Transmitter timing jitter	TM1
Transmit MDI random jitter in master mode	TM2- Square Wave
Transmit MDI deterministic jitter in master mode	TM2-JP03A
Transmit MDI Even Odd jitter in master mode	TM2 - JP03B
Transmitter Power Spectral Density (PSD) and power level	TM5
Transmitter peak differential output	TM5
Transmitter clock frequency	TM2[JP03A/JP03B]
MDI return loss	SLAVE IDLE MODE

Recommended oscilloscope channels

This section is applicable to MSO6B series of oscilloscope. The channels to be employed while using various models of MSO6B are listed below, to ensure 50 Gsps sample rate and 10G BW on both the channels.

- MSO64B: Ch1/Ch3
- MSO66B: Ch1/Ch4
- MSO68B: Ch1/Ch5

Supported data rates for MultiGBASE-T1

The application supports three data rates 2.5, 5, and 10GBASE-T1 on the SX/DX series of oscilloscopes. MSO6/6B series of oscilloscopes supports 2.5, 5, and 10GBASE-T1 data rate.

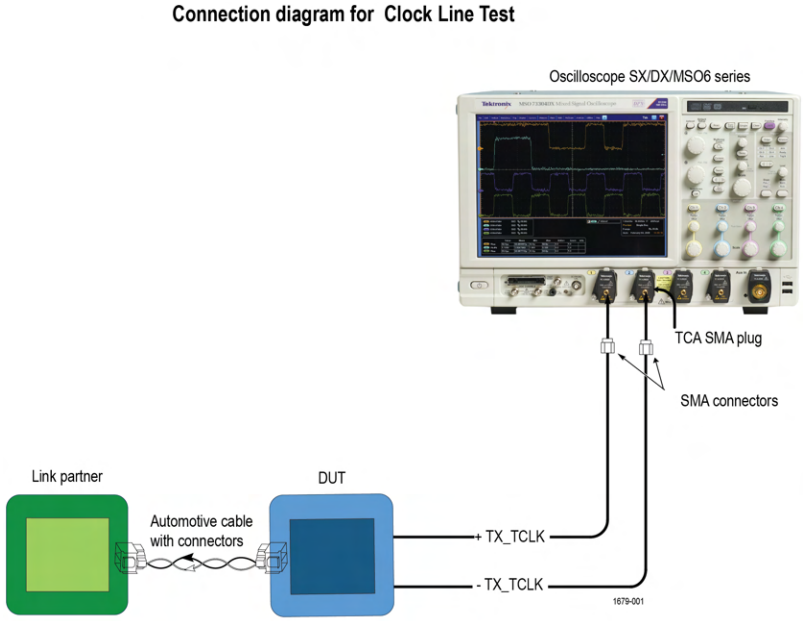
Clock line measurements

Discussion

The following measurements describes the connection diagram and the test procedure for Clock line measurements:

- Transmitter timing jitter - Master
- Transmitter timing jitter - Slave

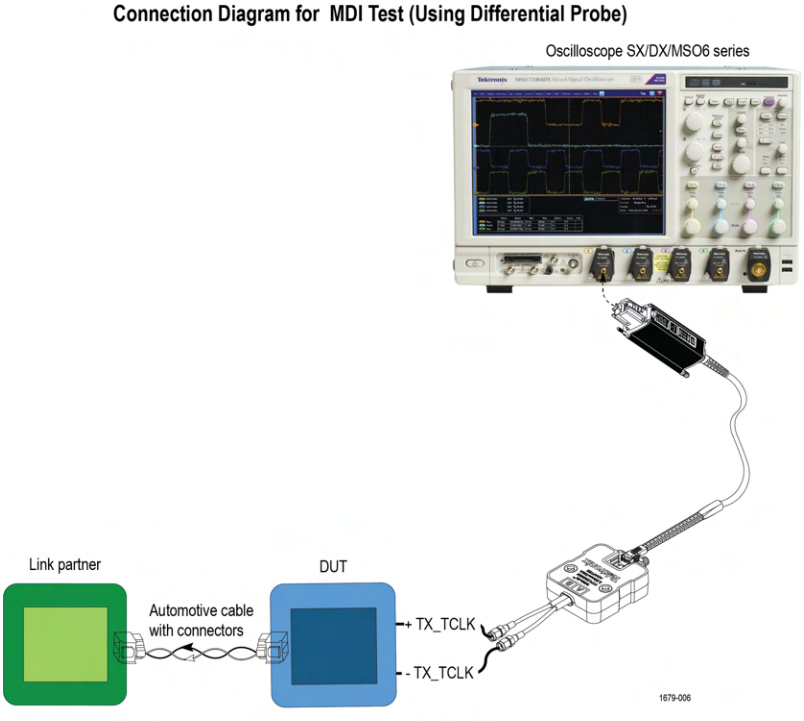
Test setup



Note: For best resuts, connect the oscilloscope, DUT and test fixtures to a common ground.

Figure 108: Connection diagram for Clock line test – Single Ended

Note: MSO6B: For MSO6B, use the recommended oscilloscope channels to ensure 50 Gsps sample rate on the channels. For MSO64B: Ch1/Ch3, MSO66B: Ch1/Ch4, and MSO68B: Ch1/ Ch5.



Note: For best resuts, connect the oscilloscope, DUT and test fixtures to a common ground.

Figure 109: Connection diagram for Clock line test – Differential

Note: MSO6B: For MSO6B, use the recommended oscilloscope channels to ensure 50 Gsps sample rate on the channels. For MSO64B: Ch1/Ch3, MSO66B: Ch1/Ch4, and MSO68B: Ch1/ Ch5.

The DUT clock like TX_TCLK_175 is measured either by using a single ended or differential connection to the oscilloscope. The setup diagram for each of these cases are shown in *Figure 108* on page 149 and *Figure 109* on page 149.

Test procedure

1. Pre-requisite: DUT must have the provision to access the devices' clock line TX_TCLK_175.
2. Based on the type of connection, Single ended (two channels) or differential (single channel) select the **Probing type** configuration in DUT panel in the TekExpress application.
3. Make the connection of the test setup as shown in the detailed Test setup *Figure 108* on page 149 or *Figure 109* on page 149
4. For differential ended connection, use appropriate probe to connect the DUTs TX_TCLK (clock) line to the oscilloscope channel. The probe models with polarity indicators/markings, connect the positive (+) of the probe tip to the DUT positive signal
5. For the single-ended connection, use a matched pair SMA cables to connect the clock positive and negative signals to the two channels of the oscilloscope.
6. To test the symbol rate clock line (TX_TCLK_175) of either the slave or master. Connect the DUT to the link partner and set the DUT in slave mode. In case of master TX_TCLK test, set the DUT in master mode.
7. Configure the DUT to transmit the Test Mode signal, as per the measurements in *Test mode list* on page 148.
8. After running the measurement, a report with result compared against results and necessary plots is generated. Refer *MultiGBASE-T1 Test Limits* on page 93 for the list of measurement limits.

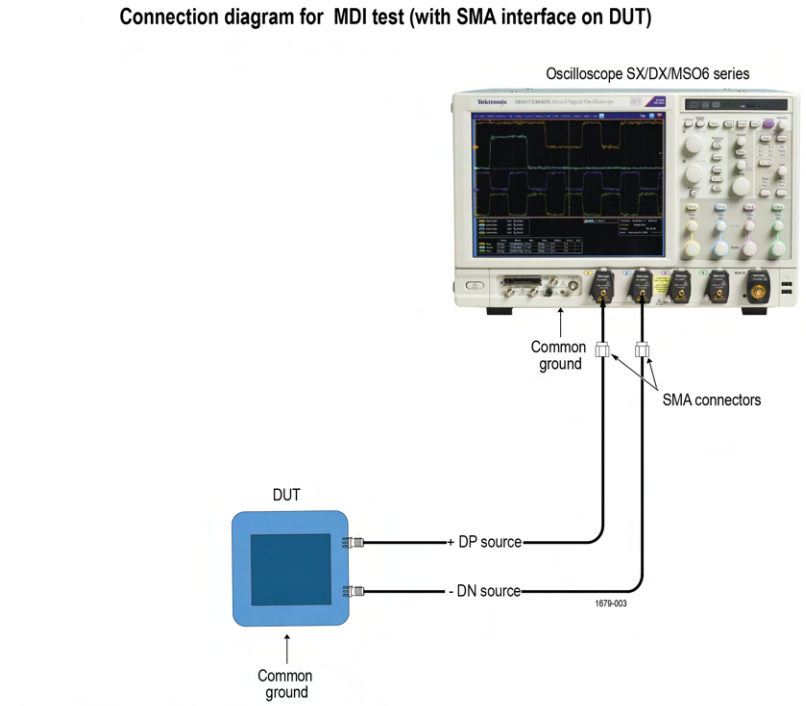
MDI measurements

Discussion

The following measurements describes the connection diagram and the test procedure for MDI measurements: :

- Maximum output droop
- Transmitter linearity
- Transmit MDI random jitter in master mode
- Transmit MDI deterministic jitter in master mode
- Transmit MDI Even Odd jitter in master mode
- Transmitter Power Spectral Density (PSD) and power level
- Transmitter peak differential output
- Transmitter clock frequency

Test setup



Note: For best resuts, connect the oscilloscope, DUT and test fixtures to a common ground.

Figure 110: Connection diagram for MDI test - Single Ended

Note: MSO6B: For MSO6B, use the recommended oscilloscope channels to ensure 50 Gsps sample rate on the channels. For MSO64B: Ch1/Ch3, MSO66B: Ch1/Ch4, and MSO68B: Ch1/ Ch5.

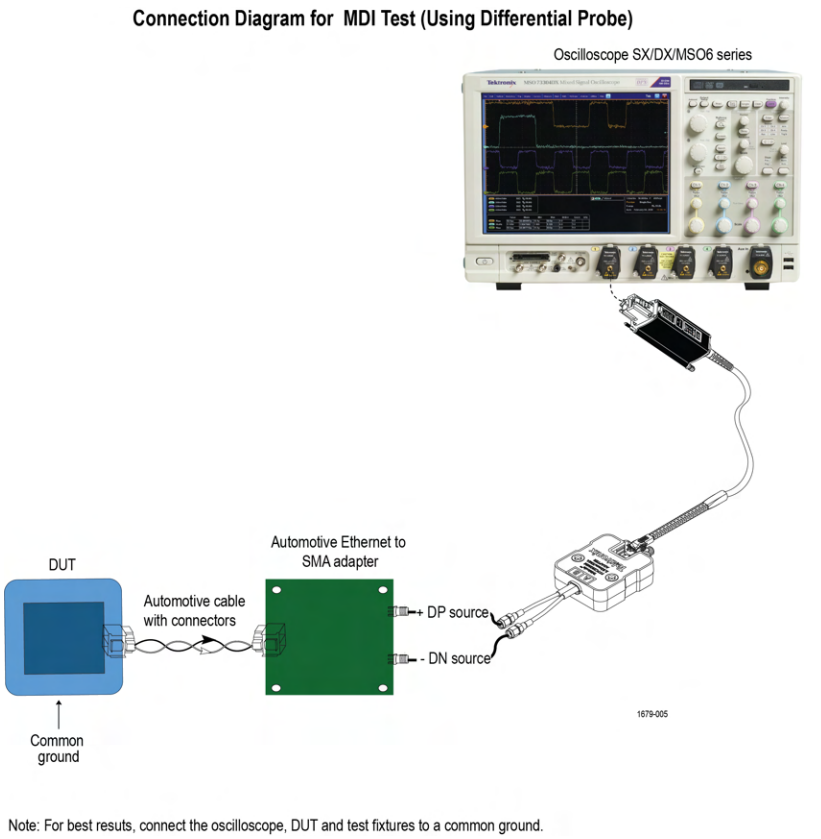


Figure 111: Connection diagram for MDI test - Differential

Note: MSO6B: For MSO6B, use the recommended oscilloscope channels to ensure 50 Gsps sample rate on the channels. For MSO64B: Ch1/Ch3, MSO66B: Ch1/Ch4, and MSO68B: Ch1/ Ch5.

The DUT data line (MDI) is measured by using either a single ended or differential connection to the oscilloscope. Refer *Figure 110* on page 151 and *Figure 111* on page 152 for the setup connection diagram.

Test procedure

1. Based on the setup, select either Differential (single channel) or single ended (two channels) for the configuration DUT Panel->**Probing Type** on the TekExpress application.
2. Make the connection of the test setup as shown in the detailed Test setup *Figure 110* on page 151 or *Figure 111* on page 152.
3. For the differential ended connection, use appropriate probe to connect the DUTs TX_TCLK (clock) line to an oscilloscope channel. Connect the positive(+) of the probe tip to the DUT positive signal.
4. For the single-ended connection, use a match pair SMA cables to connect the clock positive and negative signals to the two channels of the oscilloscope.
5. Configure the DUT to transmit the Test mode signal, as per the measurements *Test mode list* on page 148.
6. Click Start.
7. After running the measurement, a report with result compared against results and necessary plots is generated. Refer *MultiGBASE-T1 Test Limits* on page 93 for the list of measurement limits.

MultiGBASE-T1 Example results and plots

Transmitter Timing Jitter – Master Jitter

Measurement Details	Rate	Test Result	Low Limit	Measured Value	High Limit	Units	Margin	Run#
Master Jitter RMS_2.5G	2.5GBASE-T1	Pass	NA	2.93	4	ps	LL: N.A, HL: 1.07	1
Master Jitter Pk-Pk_2.5G	2.5GBASE-T1	Pass	NA	26.651	40	ps	LL: N.A, HL: 13.349	1
COMMENTS	2.5GBase-T1 TxJitter_200MHzBP.flt Filter is applied. Scope Bandwidth is limited to 4GHz. Edge Type: BOTH Run1: Signal Validation is disabled.							

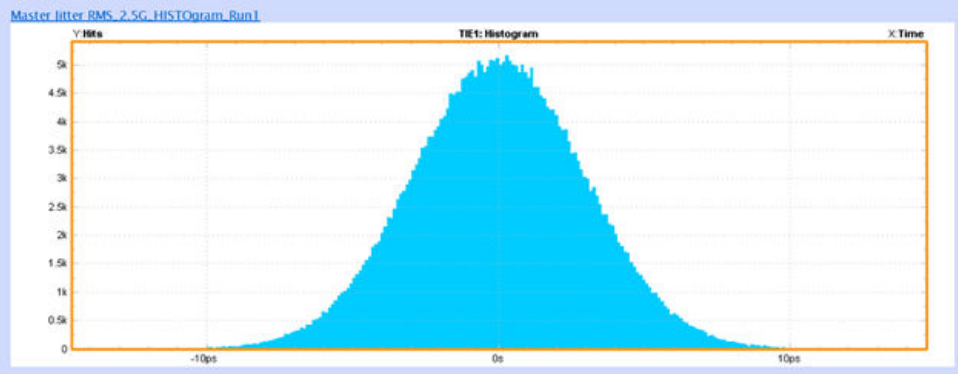


Figure 112: Example Result for 2.5GBASE-T1 - Timing Jitter

Transmitter Linearity

Measurement Details	Rate	Test Result	Low Limit	Measured Value	High Limit	Units	Margin	Run#
SNDR_2.5G	2.5GBASE-T1	Fail	35	32.306	NA	dB	LL: -2.694, HL: N.A	1
COMMENTS	2.5GBase-T1 Scope Bandwidth is limited to 4GHz. Run1: Maximum linear fit pulse response: 492.827 mV Standard Deviation of error: 6.048 mV RMS deviation from the mean voltage: 10.307 mV Signal Validation is disabled.							

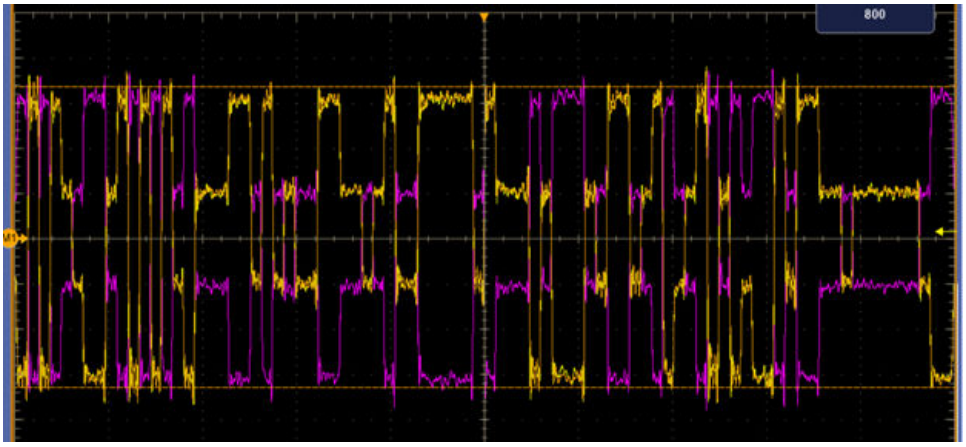


Figure 113: Example Result for 2.5GBASE-T1 - Linearity

Transmitter Clock Frequency

Measurement Details	Rate	Test Result	Low Limit	Measured Value	High Limit	Units	Margin	Run#
Clock Frequency_2.5G	2.5GBASE-T1	Fail	1406.1796875	1406.468699	1406.3203125	MHz	LL: 0.289012, HL: -0.148387	1
COMMENTS	2.5GBase-T1 Scope Bandwidth is limited to 4GHz. Run1: Maximum Frequency: 1457.203481MHz, Minimum Frequency: 1378.604263MHz. Signal Validation is disabled.							

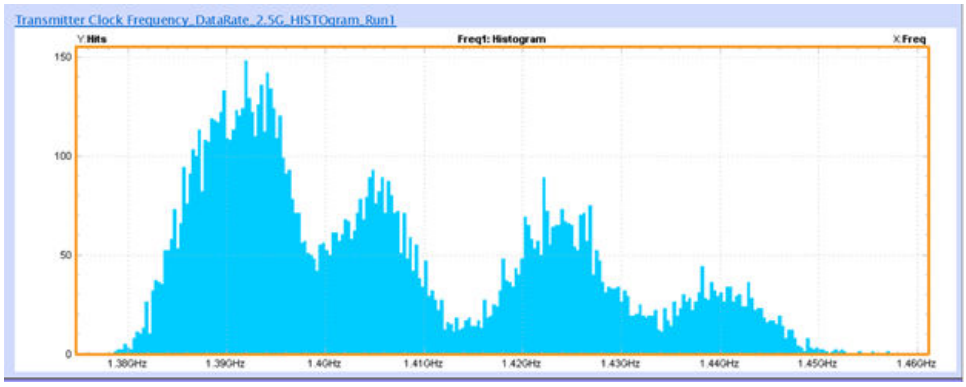


Figure 114: Example Result for 2.5GBASE-T1 – Clock Frequency

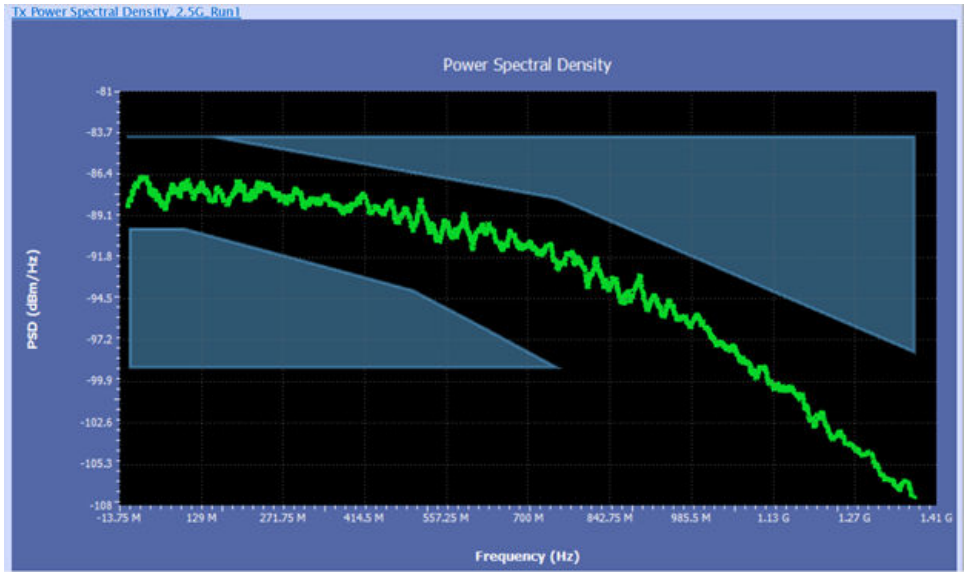


Figure 115: Example Result for 2.5GBASE-T1 – Power Spectral Density

Return loss measurement using VNA Result File

Discussion

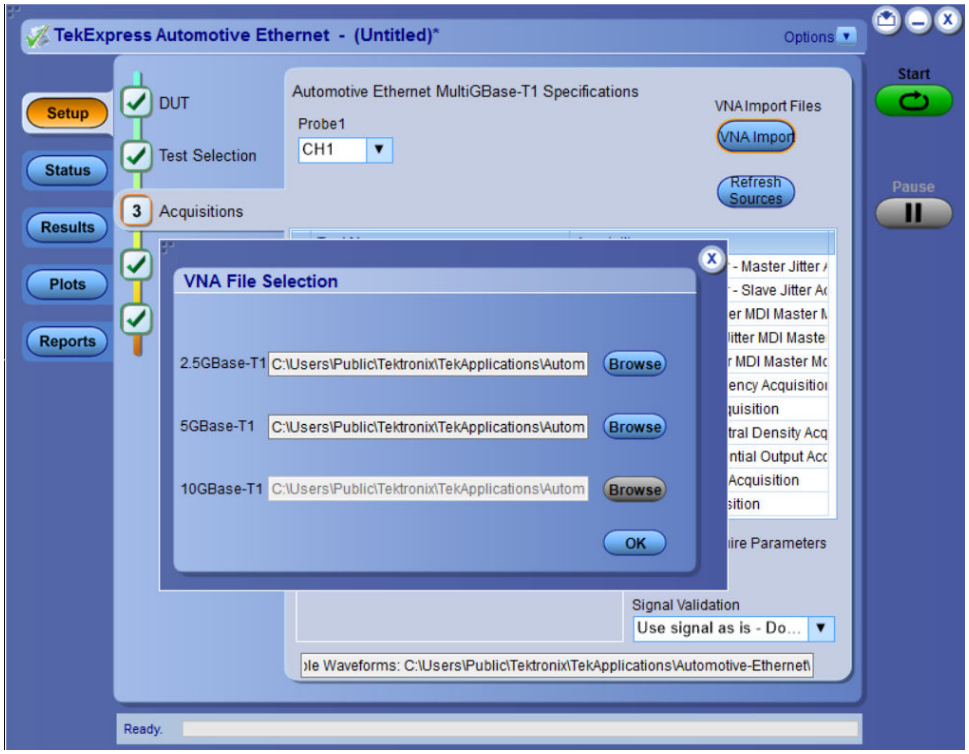
The following measurements describes the connection diagram and the test procedure for Return loss measurement using VNA Result File:

The application also provides an option to read the return loss results captured using a VNA (s1p/s2p files) and compare the results against the measurement limits to determine the test measurement is Pass/Fail and also generates the report with return loss plot against the limits.

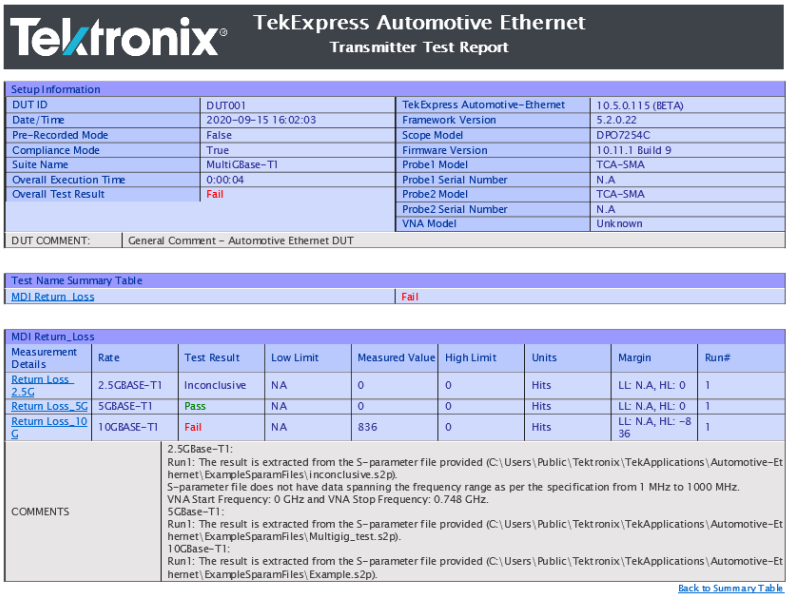
Test procedure

Steps to perform return loss measurement using VNA Result File:

1. Select the Return Loss measurement on the test panel.
2. On the **Acquisition** tab, select **VNA Import** to **Browse** the VNA result file for each rate on the **VNA File Selection** window, based on the PHY type 2.5/5/10GBASE-T1 that is being tested.



3. Click **Start**.
4. Select **Results** panel to view the measurement statistics and Pass/Fail status. Once the test execution is complete, displays the detailed test report as shown.



TekExpress Automotive Ethernet
Transmitter Test Report

Setup Information			
DUT ID	DUT001	TekExpress Automotive-Ethernet	10.5.0.115 (BETA)
Date/Time	2020-09-15 16:02:03	Framework Version	5.2.0.22
Pre-Recorded Mode	False	Scope Model	DPO7254C
Compliance Mode	True	Firmware Version	10.11.1 Build 9
Suite Name	MultiGBase-T1	Probe1 Model	TCA-SMA
Overall Execution Time	0:00:04	Probe1 Serial Number	N.A
Overall Test Result	Fail	Probe2 Model	TCA-SMA
		Probe2 Serial Number	N.A
		VNA Model	Unknown
DUT COMMENT:	General Comment - Automotive Ethernet DUT		

Test Name Summary Table	
MDI Return_Loss	Fail

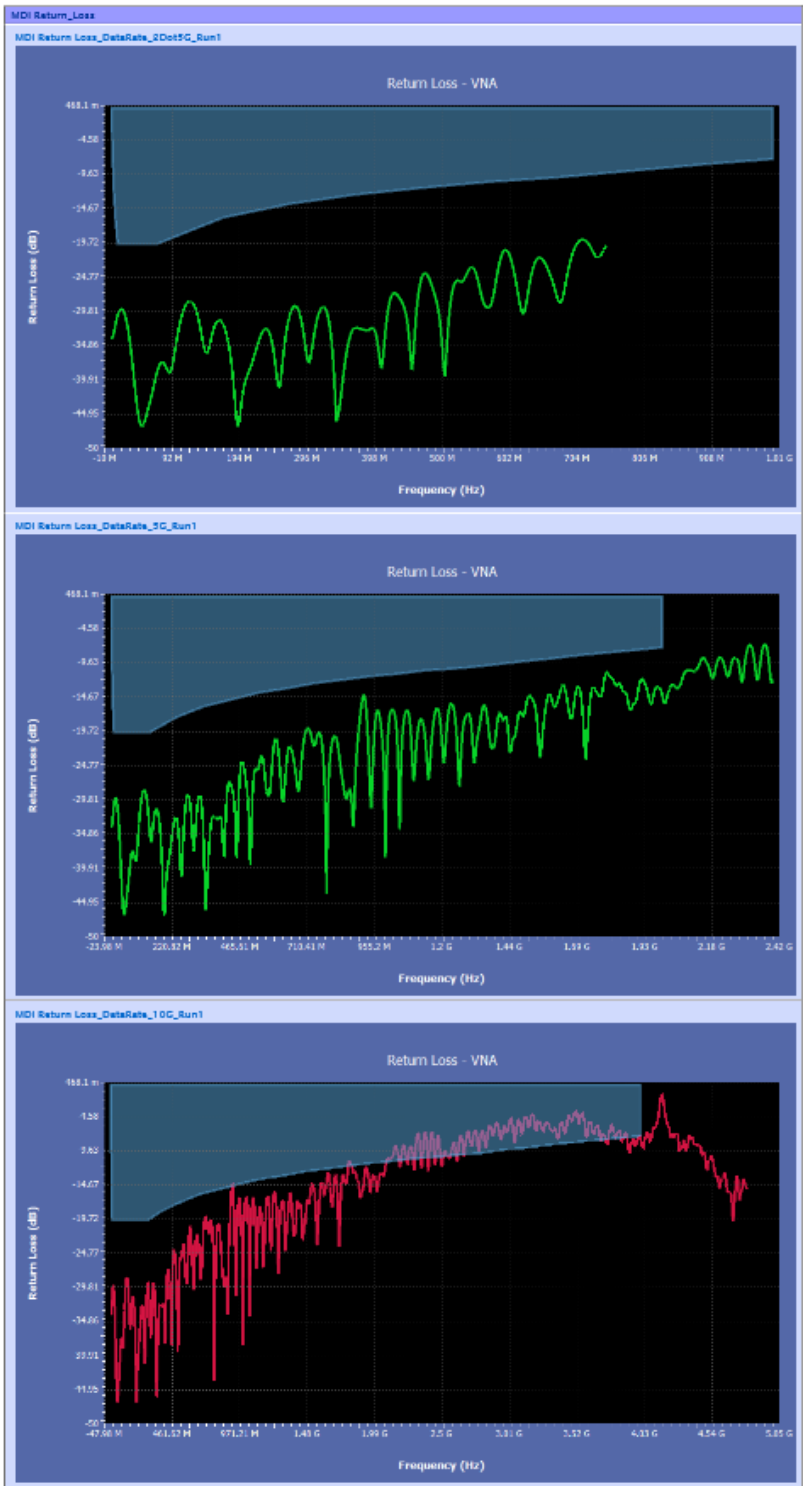
MDI Return_Loss

Measurement Details	Rate	Test Result	Low Limit	Measured Value	High Limit	Units	Margin	Run#
Return Loss_2.5G	2.5GBASE-T1	Inconclusive	NA	0	0	Hits	LL: N.A, HL: 0	1
Return Loss_5G	5GBASE-T1	Pass	NA	0	0	Hits	LL: N.A, HL: 0	1
Return Loss_10G	10GBASE-T1	Fail	NA	836	0	Hits	LL: N.A, HL: -836	1

COMMENTS

2.5GBase-T1:
Run1: The result is extracted from the S-parameter file provided (C:\Users\Public\Tektronix\TekApplications\Automotive-Ethernet\ExampleSparamFiles\inconclusive.s2p).
S-parameter file does not have data spanning the frequency range as per the specification from 1 MHz to 1000 MHz.
VNA Start Frequency: 0 GHz and VNA Stop Frequency: 0.748 GHz.
5GBase-T1:
Run1: The result is extracted from the S-parameter file provided (C:\Users\Public\Tektronix\TekApplications\Automotive-Ethernet\ExampleSparamFiles\Multigig_test.s2p).
10GBase-T1:
Run1: The result is extracted from the S-parameter file provided (C:\Users\Public\Tektronix\TekApplications\Automotive-Ethernet\ExampleSparamFiles\Example.s2p).

Back to Summary Table


MDI Return_Loss
MDI Return Loss_DataRate_2Dot5G_Run1
Return Loss - VNA
Return Loss (dB)
Frequency (Hz)
MDI Return Loss_DataRate_5G_Run1
Return Loss - VNA
Return Loss (dB)
Frequency (Hz)
MDI Return Loss_DataRate_10G_Run1
Return Loss - VNA
Return Loss (dB)
Frequency (Hz)

SCPI Commands

About SCPI command

You can use the Standard Commands for Programmable Instruments (SCPI) to communicate remotely with the TekExpress application. Complete the TCPIP socket configuration and the TekVISA configuration in the oscilloscope or in the device where you are executing the script.

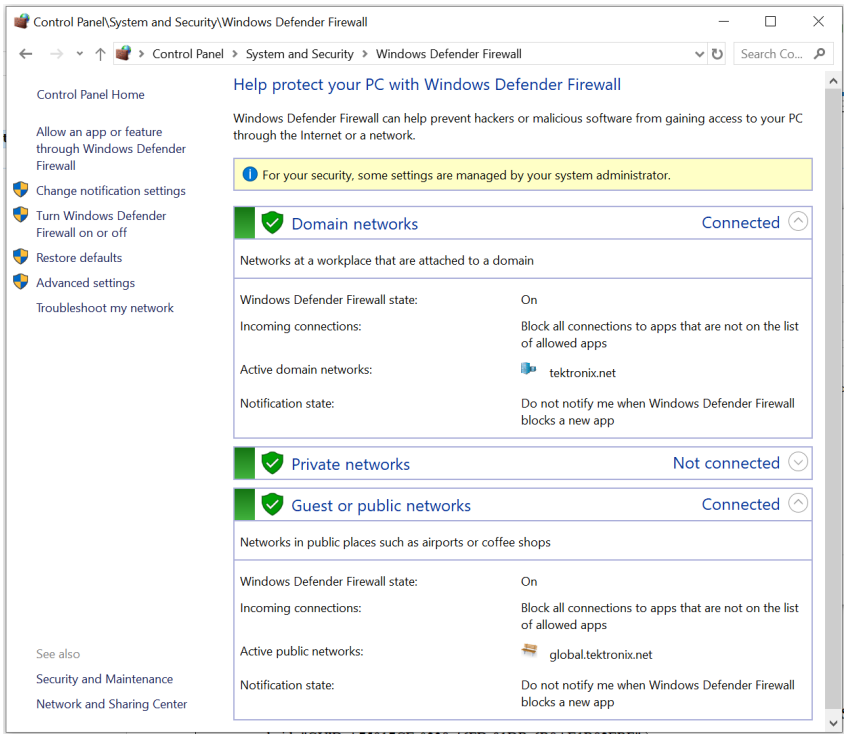
Note: If you are using an external PC to execute the remote interface commands, then install TekVISA in the PC to make the configurations.

Socket configuration for SCPI commands

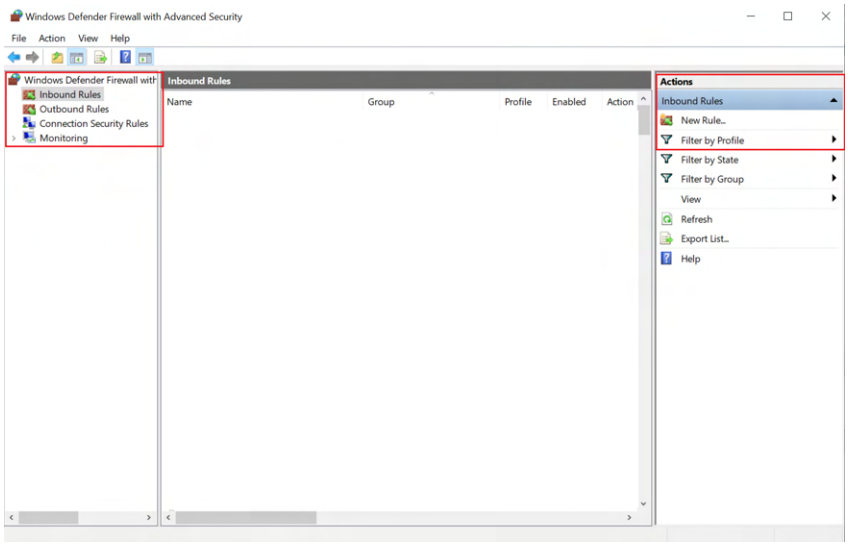
This section describes the steps to configure the TCPIP socket configuration in your script execution device and the steps to configure the TekVISA configuration in the oscilloscope to execute the SCPI commands.

TCPIP socket configuration

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

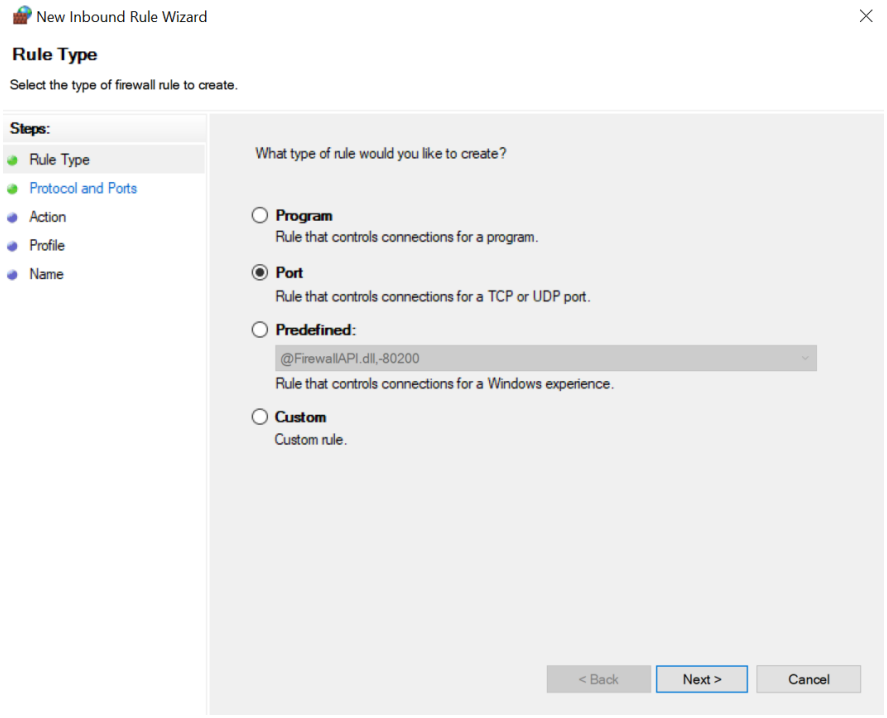


2. In Windows Firewall with Advanced Security menu, select **Windows Firewall with Advanced Security on Local Computer** > **Inbound Rules** and click **New Rule...**

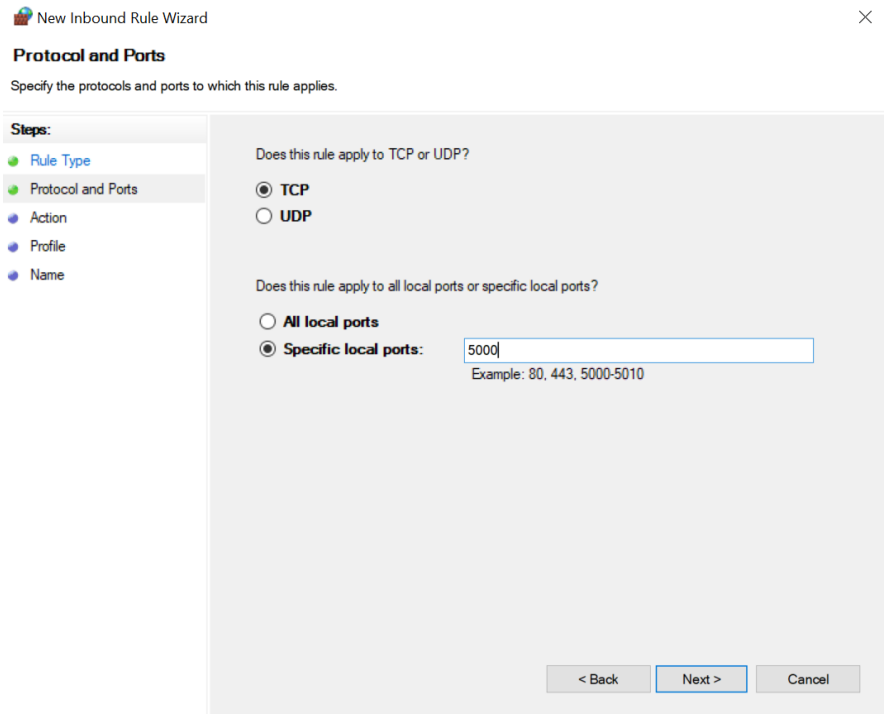


3. In **New Inbound Rule Wizard** menu

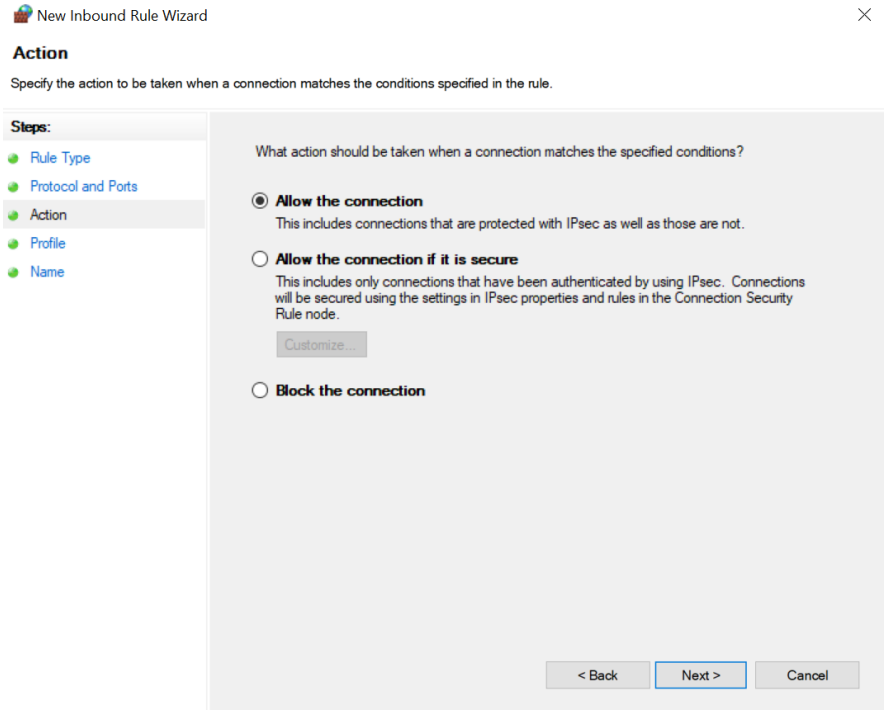
   a. Select **Port** and click **Next**.



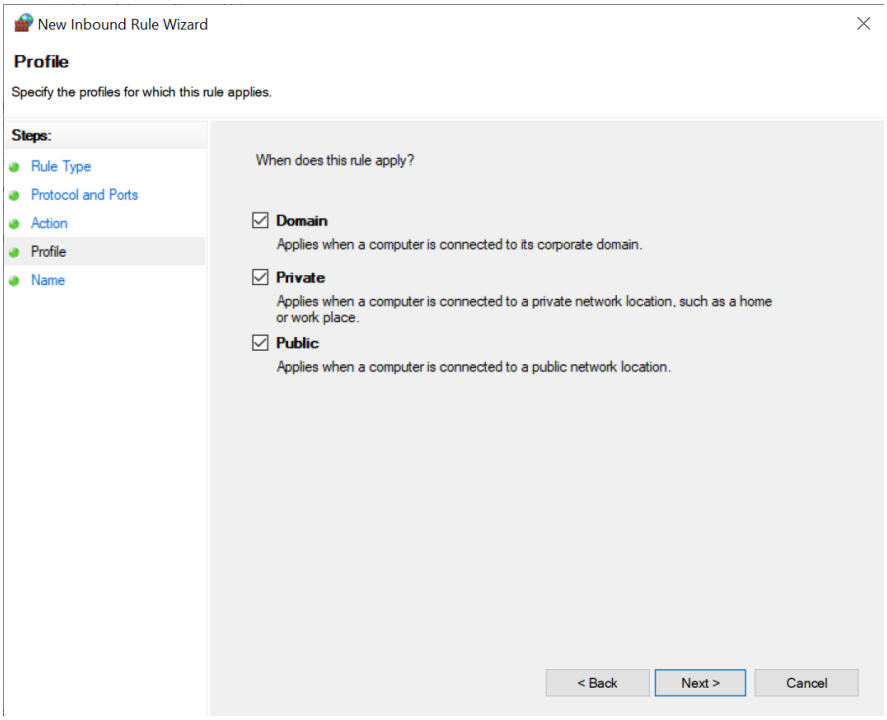
   b. Select **TCP** as rule apply, enter 5000 for **Specific local ports** and click **Next**.



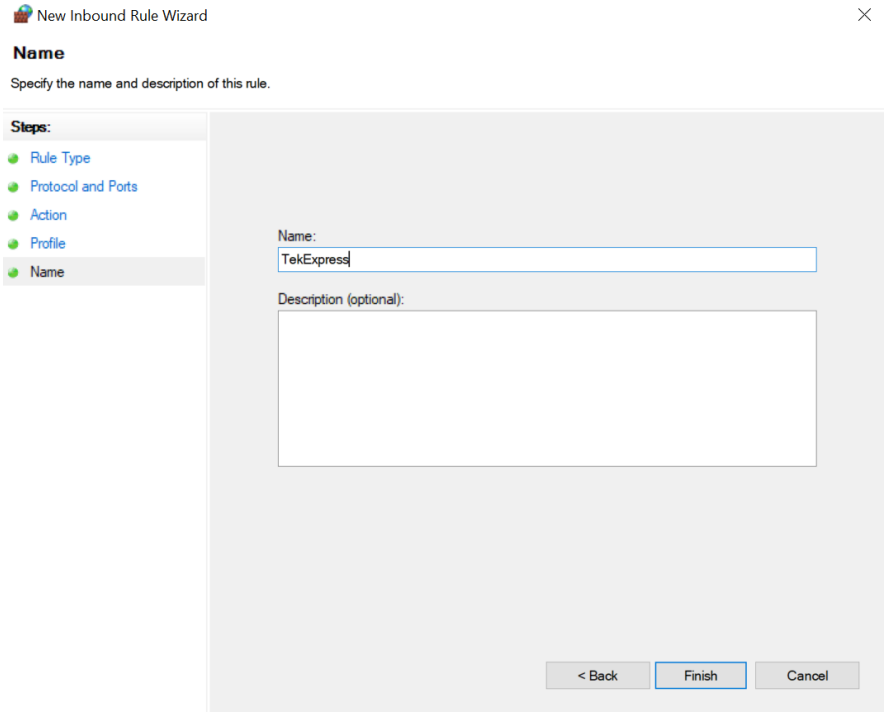
c. Select **Allow the connection** and click **Next**.



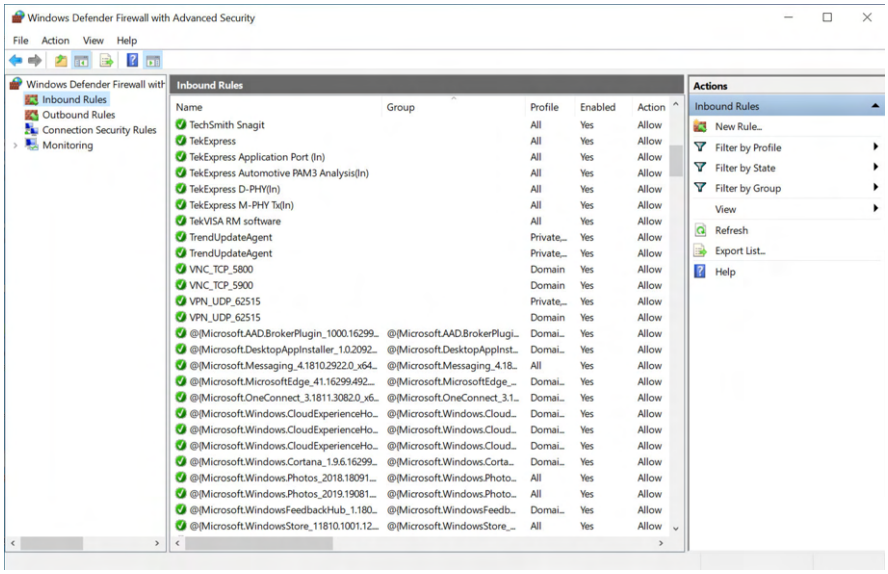
d. Select **Domain, Private, Public** checkbox and click **Next**.



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

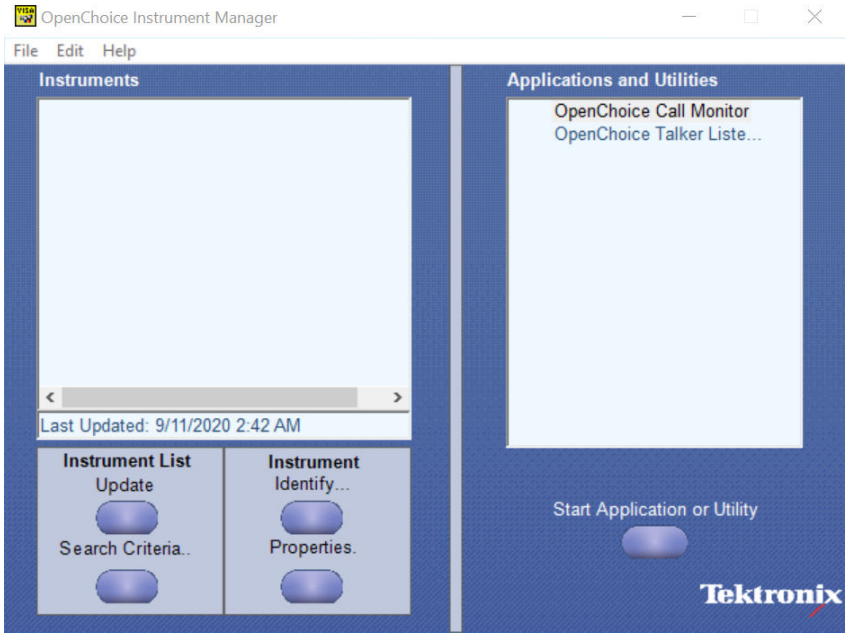


4. Check whether the Rule name is displayed in **Windows Firewall with Advanced Security menu** > **Inbound Rules**.



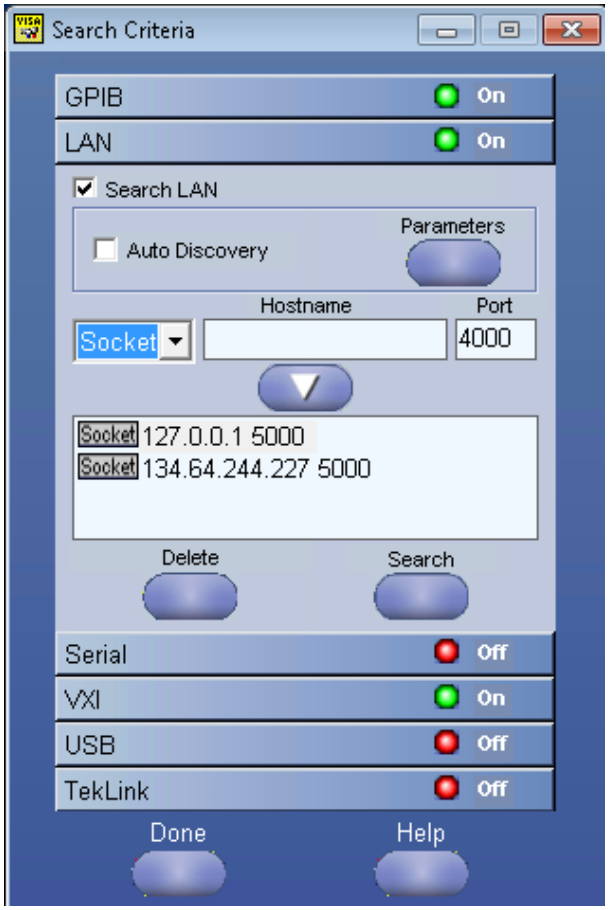
TekVISA configuration

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

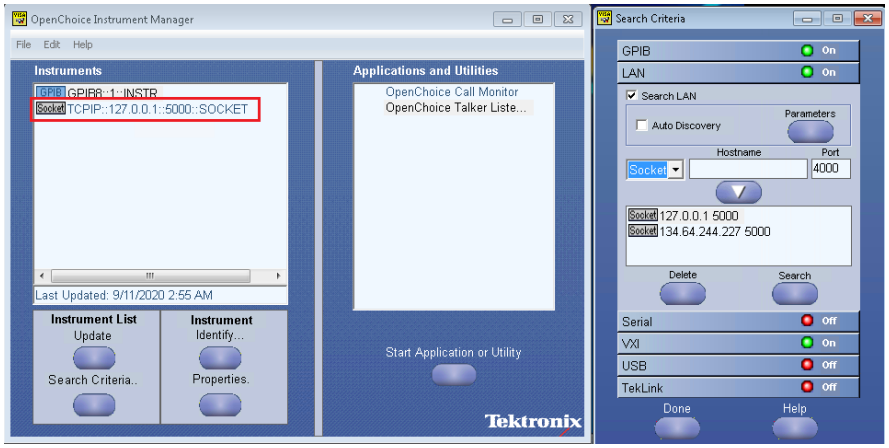


2. Click **Search Criteria**. In **Search Criteria** menu, click **LAN** to Turn-on. Select **Socket** from the drop-down list, enter the IP address of the TekExpress device in **Hostname** and type **Port** as 5000. Click  to configure the IP address with Port.

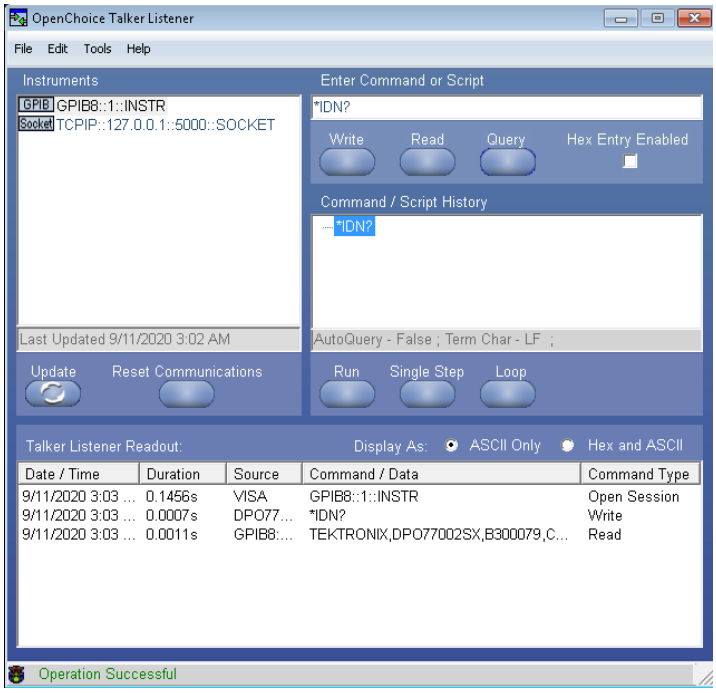
   Enter the Hostname as 127.0.0.1 if the TekVISA and TekExpress application are in the same system, else enter the IP address of the oscilloscope where the TekExpress application is running.



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.



Set or query the device name of application

This command sets or queries the device name of the application.

Syntax

`TEKEXP:SELECT DEVICE,"<DeviceName>"` (Set)

`TEKEXP:SELECT? DEVICE` (Query)

Command arguments

Argument Name	Argument Type
<DeviceName>	<String>

Returns

<String>

Examples

`TEKEXP:SELECT DEVICE,"<DUT001>"` command sets the device name of the application to DUT001.

`TEKEXP:SELECT? DEVICE` command returns the selected device name of the application.

Set or query the suite name of the application

This command sets or queries the suite name of the application.

Syntax

`TEKEXP:SELECT SUITE,"<SuiteName>"` (Set)

`TEKEXP:SELECT? SUITE` (Query)

Command arguments

<SuiteName>
• 10Base-T1S • 100Base-T1 • 1000Base-T1 • MultiGBase-T1

Returns

<String>

Examples

`TEKEXP:SELECT SUITE,"<SuiteName>"` command sets the suite name of the application.

`TEKEXP:SELECT? SUITE` command returns the selected suite of the application.

Set or query the test name of the application

This command selects or deselects the specified test name of the application.

Syntax

`TEKEXP:SELECT TEST,"<TestName>",<Value>` (Set)

`TEKEXP:SELECT TEST,"<ALL>"` (Set)

`TEKEXP:SELECT? TEST` (Query)

Command arguments

<TestName>	<Value>
For **10Base-T1S** • Transmitter Output Voltage • Transmitter Timing Jitter • Transmit Clock Frequency • Transmitter Output Droop • Transmitter Power Spectral Density • MDI Return Loss	{True | False} or {1 | 0} It represents selected or unselected. Where, • True or 1 - Selected • False or 0 - Unselected
For **100Base-T1** • Transmit Clock Frequency • Transmitter Timing Jitter-Master Jitter • Transmitter Timing Jitter-Slave Jitter • Transmitter Output Droop • Transmitter Power Spectral Density • Transmitter Peak Differential Output • Transmitter Distortion • Return Loss	
For **1000Base-T1** • Transmit Clock Frequency • Transmit Timing Jitter - MDI Jitter • Transmitter Timing Jitter-Master Jitter • Transmitter Timing Jitter-Slave Jitter • Transmitter Output Droop • Transmitter Power Spectral Density and Power level • Transmitter Peak Differential Output • Transmitter Distortion • Return Loss	
For **MultiGBase-T1** • Transmitter Power Spectral Density • Transmitter Timing Jitter - Master Jitter • Transmitter Timing Jitter - Slave Jitter • Transmitter Random Jitter MDI Master Mode • Transmitter Linearity • Transmit Deterministic Jitter MDI Master Mode • Transmit Even-Odd Jitter MDI Master Mode • Transmitter Clock Frequency • Transmitter Peak Differential Output • Maximum Output Droop • MDI Return_Loss	

Returns

{True | False} or {1 | 0}

Examples

`TEKEXP:SELECT TEST,"<TestName>",1` command selects the specified test in the Test Panel.

`TEKEXP:SELECT TEST,"<ALL>"` command select all the tests in the Test Panel.

`TEKEXP:SELECT? TEST` command returns the list of selected tests.

Set or query the general parameter values

This command sets or queries the general parameter values of the application.

Syntax

`TEKEXP:VALUE GENERAL,"<ParameterName>","<Value>"` (Set)

`TEKEXP:VALUE GENERAL,"<Probing Type>","<Single-Ended>"` (Set)

`TEKEXP:VALUE GENERAL,"<Probing Type>","<Differential>"` (Set)

`TEKEXP:VALUE? GENERAL,"<ParameterName>"` (Query)

`TEKEXP:VALUE? GENERAL,"<Probing Type>"` (Query)

Command arguments

Table 39: General command parameters

<ParameterName>	<Value>
Transmitter Load **(Only for 10Base-T1S)**	• 50 ohm • 100 ohm • Both
Probe1	CH1 - CH8 (For 10Base-T1S) CH1 - CH4 (For 100/1000Base-T1)
Probe2	CH1 - CH8 (For 10Base-T1S) CH1 - CH4 (For 100/1000Base-T1)
Show Acquire Parameters	{True | False} or {1 | 0} It represents selected or unselected. Where, • True or 1 - Selected • False or 0 - Unselected

Table continued…

<ParameterName>	<Value>
Acquire Step By Step **(Only for 100/1000Base-T1)**	{True | False} or {1 | 0} It represents selected or unselected. Where, • True or 1 - Selected • False or 0 - Unselected
Signal Validation	• Prompt me if signal fails • Use signal as it is-Don't check • Skip test if signal fails
DUT Automation	• True • False
DUT Automation Wait Time	2 to 100
BAT Files Location,<File location>	C:\SCPI-TestSuite\InputCSV
Manual Parameter Configuration	• True • False

Table 40: Report panel command parameters

<ParameterName>	<Value>
On Test Failure, stop and notify me of the failure	{True | False} or {1 | 0} It represents selected or unselected. Where, • True or 1 - Selected • False or 0 - Unselected
Report Update Mode	• New • Append • Replace
Report Path	X:\<application name>\Reports\DUT001.mht
Save As Type	• Web Archive (*.mht;*.mhtml) • PDF (*.pdf;) • CSV (*.csv;)

Table continued…

<ParameterName>	<Value>
Auto increment report name if duplicate	{True | False} or {1 | 0} It represents selected or unselected. Where, • True or 1 - Selected • False or 0 - Unselected
Create report at the end	{True | False} or {1 | 0} It represents selected or unselected. Where, • True or 1 - Selected • False or 0 - Unselected
Upload logo	{True | False} or {1 | 0} It represents selected or unselected. Where, • True or 1 - Selected • False or 0 - Unselected
Include Pass/Fail Results Summary	{True | False} or {1 | 0} It represents selected or unselected. Where, • True or 1 - Selected • False or 0 - Unselected
Include Detailed Results	{True | False} or {1 | 0} It represents selected or unselected. Where, • True or 1 - Selected • False or 0 - Unselected
Include Plot Images	{True | False} or {1 | 0} It represents selected or unselected. Where, • True or 1 - Selected • False or 0 - Unselected

Table continued…

<ParameterName>	<Value>
Include Setup Configuration	{True | False} or {1 | 0} It represents selected or unselected. Where, • True or 1 - Selected • False or 0 - Unselected
Include Complete Application Configuration	{True | False} or {1 | 0} It represents selected or unselected. Where, • True or 1 - Selected • False or 0 - Unselected
Include User Comments	{True | False} or {1 | 0} It represents selected or unselected. Where, • True or 1 - Selected • False or 0 - Unselected
Report Settings:Include Header In Appended Reports	{True | False} or {1 | 0} It represents selected or unselected. Where, • True or 1 - Selected • False or 0 - Unselected
View Report After Generating	{True | False} or {1 | 0} It represents selected or unselected. Where, • True or 1 - Selected • False or 0 - Unselected
Report Group Mode	• Test Name • Test Result • Measurement Group
Append Report	{True | False} or {1 | 0} It represents selected or unselected. Where, • True or 1 - Selected • False or 0 - Unselected

Returns

<NRf> or <String>

Examples

`TEKEXP:VALUE GENERAL,"<ParameterName>","<Value>"` command set the value for the specified general parameter.

`TEKEXP:VALUE GENERAL,"<Probing Type>","<Single-Ended>"` command set the value for the specified general parameter.

`TEKEXP:VALUE GENERAL,"<Probing Type>","<Differential>"` command set the value for the specified general parameter.

`TEKEXP:VALUE? GENERAL,"<ParameterName>"` command returns the value for the specified general parameter.

`TEKEXP:VALUE? GENERAL,"<Probing Type>"` command returns the value for the specified general parameter.

Set or query the acquire parameter values

This command sets or queries the acquire parameter values of the application.

Syntax

`TEKEXP:VALUE ACQUIRE,”<TestName>","”<AcquireType>”,”<ParameterName>","<ParameterValue>"` (Set)

`TEKEXP:VALUE? ACQUIRE,”<TestName>","”<AcquireType>”,”<ParameterName>"` (Query)

Command arguments

Table 41: 10Base-T1S Standard arguments

<TestName>	<AcquireType>	<ParameterName>	<ParameterValue>
Transmitter Output Voltage	Transmitter Output Voltage Acquisition	Record Length	0.01 to 5
		Sample Rate	• 0.3125 • 0.625 • 1.25 • 1.5625 • 3.125
Transmitter Timing Jitter	Transmitter Timing Jitter Acquisition	Record Length	0.0001 to 6.5
		Sample Rate	• 0.3125 • 0.625 • 1.25 • 1.565 • 3.125
Transmit Clock Frequency	Transmit Clock Frequency Acquisition	Record Length	0.01 to 5
		Sample Rate	• 0.3125 • 0.625 • 1.25 • 1.565 • 3.125
Transmitter Output Droop	Transmitter Output Droop Acquisition	Average	1 to 256
		Record Length	0.001 to 10
		Sample Rate	• 0.3125 • 0.625 • 1.25 • 1.565 • 3.125

Table continued…

<TestName>	<AcquireType>	<ParameterName>	<ParameterValue>
Transmitter Power Spectral Density	Transmitter Power Spectral Density Acquisition	Average	2 to 256
		Record Length	0.003125 to 5
		Sample Rate	• 0.3125 • 0.625 • 1.25 • 1.565 • 3.125 • 6.25 • 12.5

Table 42: 100Base-T1 Standard arguments

<TestName>	<AcquireType>	<ParameterName>	<ParameterValue>
Return Loss	Return Loss Acquisition	AcquisitionIncluded	• TRUE • FALSE
		Disturbing Signal	• Included • Excluded
		Average	2 to 1000
Transmit Clock Frequency	Transmit Clock Frequency Acquisition	Record Length	0.1 to 20
Transmitter Distortion	Transmitter Distortion Acquisition	External Ref Clock Input	• Hardware Clock Divider • Software Signal Correction • None
		TX_TCLK	• Included • Excluded
		Average	2 to 100
		Disturbing Signal	• Included • Excluded
		Hi Resolution	0 to 64
		Distortion Amplitude in V	5.4
		Distortion Frequency in MHz	11.111
		DUT Amplitude in V	2.22
		Probe Point Amplitude in V	1.48
		Attenuation	1.5
Transmitter Output Droop	Transmitter Output Droop Acquisition	Average	2 to 100

Table continued…

<TestName>	<AcquireType>	<ParameterName>	<ParameterValue>
Transmitter Peak Differential Output	Transmitter Peak Differential Output Acquisition	No of Acquisition	1 to 100
Transmitter Power Spectral Density	Transmitter Power Spectral Density Acquisition	Average	2 to 256
		Record Length	0.003125 to 25
		Sample Rate	• 0.3125 • 0.625 • 1.25 • 1.5625 • 3.125 • 6.25 • 12.5
Transmitter Timing Jitter - Master Jitter	Transmitter Timing Jitter - Master Jitter Acquisition	Record Length	1 to 20
		Sample Rate	0.0625 to 12.5
Transmitter Timing Jitter - Slave Jitter	Transmitter Timing Jitter - Slave Jitter Acquisition	Record Length	1 to 20
		Sample Rate	0.0625 to 12.5

Table 43: 1000Base-T1 Standard arguments

<TestName>	<AcquireType>	<ParameterName>	<ParameterValue>
Return Loss	Return Loss Acquisition	AcquisitionIncluded	• TRUE • FALSE
		Disturbing Signal	• Included • Excluded
		Average	2 to 1000
Transmit Clock Frequency	Transmit Clock Frequency Acquisition	Record Length	1 to 20

Table continued…

<TestName>	<AcquireType>	<ParameterName>	<ParameterValue>
Transmitter Distortion	Transmitter Distortion Acquisition	External Ref Clock Input	• Hardware Clock Divider • Software Signal Correction • None
		TX_TCLK	• Included • Excluded
		Average	2 to 100
		Disturbing Signal	• Included • Excluded
		Hi Resolution	0 to 64
		Distortion Amplitude in V	3.6
		Distortion Frequency in MHz	125
		DUT Amplitude in V	0.660
		Probe Point Amplitude in V	0.430
		Attenuation	1.5
Transmitter Output Droop	Transmitter Output Droop Acquisition	Average	2 to 100
Transmitter Peak Differential Output	Transmitter Peak Differential Output Acquisition	No of Acquisition	1 to 100
Transmitter Power Spectral Density	Transmitter Power Spectral Density Acquisition	Average	2 to 256
		Record Length	0.003125 to 25
		Sample Rate	• 0.3125 • 0.625 • 1.25 • 1.5625 • 3.125 • 6.25 • 12.5
Transmitter Timing Jitter - Master Jitter	Transmitter Timing Jitter - Master Jitter Acquisition	Record Length	1 to 20
		Sample Rate	0.0625 to 6.25`
Transmitter Timing Jitter - MDI Jitter	Transmitter Timing Jitter - MDI Jitter Acquisition	Record Length	1 to 20
		Sample Rate	0.0625 to 12.5
Transmitter Timing Jitter - Slave Jitter	Transmitter Timing Jitter - Slave Jitter Acquisition	Record Length	1 to 20
		Sample Rate	0.0625 to 12.5

Table 44: MultiGBase-T1

TestName	AcquireType	ParameterName	ParameterValue
Transmitter Timing Jitter - Master Jitter	Transmitter Timing Jitter - Master Jitter Acquisition	Average	For **DataRate=2.5GBaseT1**, **5GBase-T1**, **10GBase-T1** 1 to 256
		Record Length (M)	For **DataRate=2.5GBaseT1**, **5GBase-T1**, **10GBase-T1** 0.2 to 50
		Sample Rate (GS/s)	For **DataRate=2.5GBaseT1**, **5GBase-T1**, **10GBase-T1** • 3.125 • 6.25 • 12.5 • 25 • 50
Transmitter Timing Jitter - Slave Jitter	Transmitter Timing Jitter - Slave Jitter Acquisition	Average	For **DataRate=2.5GBaseT1**, **5GBase-T1**, **10GBase-T1** 1 to 256
		Record Length (M)	For **DataRate=2.5GBaseT1**, **5GBase-T1**, **10GBase-T1** 0.2 to 50
		Sample Rate (GS/s)	For **DataRate=2.5GBaseT1**, **5GBase-T1**, **10GBase-T1** • 3.125 • 6.25 • 12.5 • 25 • 50

Table continued…

TestName	AcquireType	ParameterName	ParameterValue
Transmitter Random Jitter MDI Master Mode	Transmitter Random Jitter MDI Master Mode Acquisition	Average	For **DataRate=2.5GBaseT1**, **5GBase-T1**, **10GBase-T1** 1 to 256
		Record Length (M)	For **DataRate=2.5GBaseT1**, **5GBase-T1**, **10GBase-T1** 0.2 to 50
		Sample Rate (GS/s)	For **DataRate=2.5GBaseT1**, **5GBase-T1**, **10GBase-T1** • 3.125 • 6.25 • 12.5 • 25 • 50
Transmit Deterministic Jitter MDI Master Mode	Transmit Deterministic Jitter MDI Master Mode Acquisition	Average	For **DataRate=2.5GBaseT1**, **5GBase-T1**, **10GBase-T1** 1 to 256
		Record Length (M)	For **DataRate=2.5GBaseT1**, **5GBase-T1**, **10GBase-T1** 2.3 to 150
		Sample Rate (GS/s)	For **DataRate=2.5GBaseT1** • 6.25 • 12.5 • 25 • 50
			For **DataRate=5GBase-T1** • 12.5 • 25 • 50
			For **DataRate=10GBase-T1** • 25 • 50
		Test Pattern	For **DataRate=2.5GBaseT1**, **5GBaseT1**, **10GBase-T1** • JP03A • JP03B

Table continued…

TestName	AcquireType	ParameterName	ParameterValue
Transmit Even-Odd Jitter MDI Master Mode	Transmit Even-Odd Jitter MDI Master Mode Acquisition	Average	For **DataRate=2.5GBaseT1**, **5GBaseT1**, **10GBase-T1** 1 to 256
		Record Length (M)	For **DataRate=2.5GBaseT1**, **5GBaseT1**, **10GBase-T1** 0.005 to 50
		Sample Rate (GS/s)	For **DataRate=2.5GBaseT1**, **5GBaseT1**, **10GBase-T1** • 6.25 • 12.5 • 25 • 50
Transmitter Clock Frequency	Transmitter Clock Frequency Acquisition	Average	For **DataRate=2.5GBaseT1**, **5GBaseT1**, **10GBase-T1** 1 to 256
		Record Length (M)	For **DataRate=2.5GBaseT1**, **5GBaseT1**, **10GBase-T1** 0.005 to 50
		Sample Rate (GS/s)	For **DataRate=2.5GBaseT1**, **5GBaseT1**, **10GBase-T1** • 6.25 • 12.5 • 25 • 50
		Test Pattern	For **DataRate=2.5GBaseT1**, **5GBaseT1**, **10GBase-T1** • JP03A • JP03B

Table continued…

TestName	AcquireType	ParameterName	ParameterValue
Transmitter Linearity	Transmitter Linearity Acquisition	Record Length (M)	For **DataRate=2.5GBaseT1**, **5GBaseT1**, **10GBase-T1** 0.3 to 50
		Sample Rate (GS/s)	For **DataRate= 2.5GBase-T1** • 12.5 • 25 • 50
			For **DataRate=5GBase-T1** • 25 • 50
			For **DataRate= 10GBase-T1** 50
Transmitter Power Spectral Density	Transmitter Power Spectral Density Acquisition	Spectral Average	For **DataRate=2.5GBaseT1**, **5GBaseT1**, **10GBase-T1** 2 to 512
		Record Length (M)	For **DataRate=2.5GBaseT1**, **5GBaseT1**, **10GBase-T1** 0.125 to 50
		Sample Rate (GS/s)	For **DataRate= 2.5GBase-T1** • 3.125 • 6.25 • 12.5 • 25 • 50
			For **DataRate= 5GBase-T1** • 6.25 • 12.5 • 25 • 50
			For **DataRate=10GBase-T1** • 12.5 • 25 • 50

Table continued…

TestName	AcquireType	ParameterName	ParameterValue
Transmitter Peak Differential Output	Transmitter Peak Differential Output Acquisition	Record Length (M)	For **DataRate=2.5GBaseT1**, **5GBaseT1**, **10GBase-T1** 0.1 to 50
		Sample Rate (GS/s)	For **DataRate= 2.5GBase-T1** • 3.125 • 6.25 • 12.5 • 25 • 50
			For **DataRate= 5GBase-T1** • 6.25 • 12.5 • 25 • 50
			For **DataRate=10GBase-T1** • 12.5 • 25 • 50
Maximum Output Droop	Maximum Output Droop Acquisition	Average	For **DataRate=2.5GBaseT1**, **5GBaseT1**, **10GBase-T1** 1 to 256
		Record Length (M)	For **DataRate=2.5GBaseT1**, **5GBaseT1**, **10GBase-T1** 0.1 to 50
		Sample Rate (GS/s)	For **DataRate=2.5GBaseT1**, **5GBaseT1**, **10GBase-T1** • 0.625 • 1.25 • 3.125 • 6.25 • 12.5 • 25 • 50

Returns

<Nrf>

Examples

`TEKEXP:VALUE ACQUIRE,”<TestName>",”<AcquireType>”,"<ParameterName>","<ParameterValue>"` command sets the value for the specified test and its acquire parameter.

`TEKEXP:VALUE? ACQUIRE,”<TestName>",”<AcquireType>”,"<ParameterName>"` command returns the value for the specified test and its acquire parameter.

Set or query the analyze parameter values

This command sets or queries the analyze parameter values of the application.

Syntax

`TEKEXP:VALUE ANALYZE,”<TestName>","<ParameterName>","<ParameterValue>"` (Set)

`TEKEXP:VALUE? ANALYZE,”<TestName>","<ParameterName>"` (Query)

Command arguments

Table 45: 10Base-T1S

<TestName>	<ParameterName>	<ParameterValue>
Transmitter Timing Jitter	Clock Edge	• RISE • FALL • BOTH
	Hysteresis	1 to 5
Transmitter Power Spectral Density	RBW	1 to 200
	Start Frequency	0 to 39.9
	Stop Frequency	0.1 to 40
MDI Return Loss	Average	2 to 512
	Record Length	0.1 to 1.25
	Sample Rate	• 0.125 • 0.3125 • 0.625 • 1.25 • 1.5625

Table 46: 100Base-T1

<TestName>	<ParameterName>	<ParameterValue>
Return Loss	Filter	• Included • Excluded
	Smooth	0 to 10

Table continued…

<TestName>	<ParameterName>	<ParameterValue>
Transmitter Distortion	LP Filter	• Included • Excluded
Transmitter Power Spectral Density	RBW	1 to 200
	Start Frequency	0 to 6249.9
	Stop Frequency	0.1 to 6250
Transmitter Timing Jitter - Master Jitter	Clock Edge	• RISE • FALL
	Hysteresis	1 to 10
Transmitter Timing Jitter - Slave Jitter	Clock Edge	• RISE • FALL
	Hysteresis	1 to 10

Table 47: 1000Base-T1

<TestName>	<ParameterName>	<ParameterValue>
Return Loss	Filter	• Included • Excluded
	Smooth	0 to 10
Transmitter Distortion	LP Filter	• Included • Excluded
Transmitter Power Spectral Density	RBW	1 to 200
	Mask Data	`INSTALL FOLDER\Compliance Suites\BRR\1000Base-T1\PSDMask_1000BaseT1_dBm_per_Hz.csv`
	Start Frequency	0 to 6249.9
	Stop Frequency	0.1 to 6250
Transmitter Timing Jitter - Master Jitter	Clock Edge	• RISE • FALL
	Hysteresis	1 to 10
Transmitter Timing Jitter - MDI Jitter	Clock Edge	• RISE • FALL
	Hysteresis	1 to 10
Transmitter Timing Jitter - Slave Jitter	Clock Edge	• RISE • FALL
	Hysteresis	1 to 10

Table 48: MultiGBase-T1

TestName	ParameterName	ParameterValue
Transmitter Timing Jitter - Master Jitter	Edge	• Falling • Rising • Both
	Apply Band-pass Filter	
Transmitter Timing Jitter - Slave Jitter	Edge	• Falling • Rising • Both
	Apply Band-pass Filter	
Transmitter Random Jitter MDI Master Mode	Apply Band-pass Filter	
Transmitter Power Spectral Density	RBW	2 to 400
	Start Frequency	For **DataRate=2.5GBaseT1** 0 to 1365
		For **5GBaseT1** 0 to 2470
		For **DataRate=10GBaseT1** 0 to 5490
	Stop Frequency	For **DataRate=2.5GBaseT1** 10 to 1375
		For **DataRate=5GBaseT1** 10 to 2750
		For **DataRate=10GBaseT1** 10 to 5500

Returns

<Nrf>

Examples

`TEKEXP:VALUE ANALYZE,”<TestName>","<ParameterName>","<ParameterValue>"` command set the value for the specified test and its analyze parameter.

`TEKEXP:VALUE? ANALYZE,”<TestName>","<ParameterName>"` command returns the value for the specified test and its analyze parameter.

Query the list of available instruments based on the specified instrument type

This command queries the list of available instruments based on the specified instrument type.

Syntax

`TEKEXP:LIST? INSTRUMENT,"<InstrumentType>"` (Query)

Command argument

Argument Name	Argument value
<InstrumentType>	<String>

Returns

<String>

Examples

`TEKEXP:LIST? INSTRUMENT,"Real Time Scope"` command returns the list of available instruments based on the real time scope type.

Set or query the IP address of the instrument based on the specified instrument type

This command sets or queries the IP address of the instrument based on the specified instrument type.

Syntax

`TEKEXP:INSTRUMENT? "<InstrumentType>"` (Query)

`TEKEXP:INSTRUMENT, "<InstrumentType>","<Value>"` (Set)

Command argument

Argument Name	Argument Type
<InstrumentType>	<String>
<Value>	<String> TCPIP::XXX.XX.XXX.XXX::INSTR

Returns

<String>

Examples

`TEKEXP:INSTRUMENT? "<InstrumentType>"` command returns the IP address of the oscilloscope.

`TEKEXP:INSTRUMENT, "<InstrumentType>","<value>"` command sets the oscilloscope to the specified IP address.

Query the information of the generated report file

This command queries the information of the generated report file in the format "<FileSize>","<FileName>".

Pre-requisite

A session should be run earlier and the report should be generated to get the information of the report.

Syntax

`TEKEXP:INFO? REPORT` (Query)

Returns

<FileSize>:: <String>

<FileName>:: <String>

Examples

`TEKEXP:INFO? REPORT` command returns the information of the generated report in the format ("1215","DUT001.mht").

Query the information of the generated waveform files

This command queries the information of the generated waveform files in the format.

<File1Size,"File1Name">.

If there are more than one waveform, the waveform file names are displayed with the comma separated values in the format

<File1Size,"File1Name">,<File2Size,"File2Name">.

Syntax

`TEKEXP:INFO? WFM` (Query)

Returns

<FileSize>:: <String>

<FileName>:: <String>

Examples

`TEKEXP:INFO? WFM` command returns the information of the generated waveform in the format (20000858,"X:\<Application Name>\Untitled Session\DUT001\20200916_041609\Iter1_Short Record-length for SCOPE Period_NoSSC_DIFF.wfm").

Query the information of the generated image files

This command queries the information of the generated image files in the format.

<File1Size,"File1Name">.

If there are more than one image, the image file names are displayed with the comma separated values in the format

<File1Size,"File1Name">,<File2Size,"File2Name">.

Syntax

`TEKEXP:INFO? IMAGE` (Query)

Returns

<FileSize>:: <String>

<FileName>:: <String>

Examples

`TEKEXP:INFO? IMAGE` command returns the information of the generated image in the format (109058, "X:\<Application Name>\Untitled Session\DUT001\20200916_041609\Iter1_Short Record-length for SCOPE Period_NoSSC_DIFF.png";22794,"X:\<Application Name>\UntitledSession\DUT001\20200916_041609\ScopePeriodPlot_Iteration1WithCursor.png").

Query the active TekExpress application name

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

Syntax

`TEKEXP:*IDN?` (Query)

Returns

<String>

Examples

`TEKEXP:*IDN?` command returns the active TekExpress application name running on the oscilloscope.

Sets or query the acquire mode status

This command sets or queries the acquire mode status.

Syntax

`TEKEXP:ACQUIRE_MODE <Mode>` (Set)

`TEKEXP:ACQUIRE_MODE?` (Query)

Command arguments

Argument Name	Argument value
<Mode>	• LIVE • PRE-RECORDED

Returns

LIVE | PRE-RECORDED

Examples

`TEKEXP:ACQUIRE_MODE LIVE` command sets the acquire mode to the Live mode.

`TEKEXP:ACQUIRE_MODE?` command returns the current acquire mode.

Set or query the execution mode status

This command sets or queries the execution mode status.

Syntax

`TEKEXP:MODE <Mode>` (Set)

`TEKEXP:MODE?` (Query)

Command arguments

Argument Name	Argument value
<Mode>	• COMPLIANCE • USER-DEFINED

Returns

COMPLIANCE | USER-DEFINED

Examples

`TEKEXP:MODE COMPLIANCE` command sets the execution mode to the compliance mode.

`TEKEXP:MODE?` command returns the current execution mode.

Generate the report for the current session

This command generates the report for the current session.

Syntax

`TEKEXP:REPORT GENERATE`(Set)

Arguments

N/A

Examples

`TEKEXP:REPORT GENERATE` command generates the report for the current session.

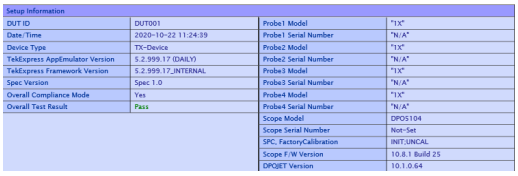
Query the value of specified report header field in the report

This command queries the value of specified report header field in the report.

Syntax

`TEKEXP:REPORT? "<Device Field>"` (Query)

Command arguments

Argument Name	Argument Type
<Device Field> Device field is the header name of each field in the setup information section of the report. 	<String>

Setup Information			
DUT ID	DUT001	Probe1 Model	"1X"
Date/Time	2020-10-22 11:24:39	Probe1 Serial Number	"N/A"
Device Type	TX-Device	Probe2 Model	"1X"
TekExpress AppEmulator Version	5.2.999.17 (DAILY)	Probe2 Serial Number	"N/A"
TekExpress Framework Version	5.2.999.17_INTERNAL	Probe3 Model	"1X"
Spec Version	Spec 1.0	Probe3 Serial Number	"N/A"
Overall Compliance Mode	Yes	Probe4 Model	"1X"
Overall Test Result	Pass	Probe4 Serial Number	"N/A"
		Scope Model	DPO5104
		Scope Serial Number	Not-Set
		SPC, FactoryCalibration	INIT:UNCAL
		Scope F/W Version	10.8.1 Build 25
		DPOJET Version	10.1.0.64

Returns

<String>

Examples

`TEKEXP:REPORT? "DUT ID"` command returns the value of DUT ID field in the report.

Query the value of specified result detail available in report summary/details table

This command queries the value of specified result detail available in report summary/details table.

Syntax

`TEKEXP:RESULT? "<TestName>"` (Query)

`TEKEXP:RESULT? "<TestName>","<ColumnName>"` (Query)

`TEKEXP:RESULT? "<TestName>","<ColumnName>",<RowNumber>` (Query)

Command arguments

Argument Name	Argument Type
<TestName> It is the test name of which the details are required in the report.	<String>
<ColumnName> It is the column header name of which the details are required in the report.	<String>
<RowNumber> It is the row number of which the details are required in the report.	<String>

Returns

<String>

Examples

`TEKEXP:RESULT? "<TestName>"` will return the pass fail status of test.

`TEKEXP:RESULT? "<TestName>","<ColumnName>"` will return all the row values of specific column for the test with comma separated values.

`TEKEXP:RESULT? "<TestName>","<ColumnName>",<RowNumber>` will return the column value of specified row number.

Restore the setup to default settings

This command restores the setup to default settings.

Syntax

`TEKEXP:SETUP Default` (Set)

Arguments

N/A

Examples

`TEKEXP:SETUP Default` command restores the setup to default settings.

Save the setup

This command saves the setup.

Syntax

`TEKEXP:SETUP Save` (Set)

Examples

`TEKEXP:SETUP Save` command saves the setup.

Save the settings to a specified session

This command saves the settings to a specified session.

Syntax

`TEKEXP:SETUP Save,"<SessionName>"`

Command arguments

Argument Name	Argument value
<SessionName>	<String>

Examples

`TEKEXP:SETUP Save,"<SessionName>"` command saves the settings to a specified session.

Open the setup from a specified session

This command opens the setup from a specified session.

Syntax

`TEKEXP:SETUP Open,"<SessionName>"` (Set)

Command arguments

Argument Name	Argument value
<SessionName>	<String>

Examples

`TEKEXP:SETUP Open,"<SessionName>"` command opens the setup from a specified session.

Query the current setup file name

This command queries the current setup file name.

Syntax

`TEKEXP:SETUP? CURRENT` (Query)

Returns

<String>

Examples

`TEKEXP:SETUP? CURRENT` command returns the current setup file name.

Run/stop/pause/resume the selected measurements execution in the application

This command run/stop/pause/resume the selected measurements execution in the application.

Syntax

`TEKEXP:STATE <operation mode>` (Set)

Command arguments

Argument Name	Argument value
<operation mode>	• RUN • STOP • PAUSE • RESUME

Returns

RUN | STOP | PAUSE | RESUME

Examples

`TEKEXP:STATE RUN` command runs the execution for the selected measurements.

Query the current measurement execution status

This command queries the current measurement execution status.

Syntax

`TEKEXP:STATE?` (Query)

Returns

RUNNING | PAUSED | WAIT | ERROR | READY

Examples

`TEKEXP:STATE?` command returns the current measurement execution status.

Query whether the current setup is saved or not saved

This command queries whether the current setup is saved or not saved.

Syntax

`TEKEXP:STATE? SETUP` (Query)

Returns

Saved or Not-Saved

Examples

`TEKEXP:STATE? SETUP` command returns whether the current setup is saved or not saved.

Query the status of the previous command execution

This command queries whether the previous command execution is completed successfully.

Syntax

`TEKEXP:*OPC?` (Query)

Returns

{0 | 1} or {True | False}

1 or True indicates that command execution is successful.

0 or False indicates that command execution is failed.

Examples

`TEKEXP:*OPC?` command returns whether the previous command operation is completed successfully.

Query the last error occurred

This command queries the last error occurred.

Syntax

`TEKEXP:LASTERROR?` (Query)

Returns

<String>

Examples

`TEKEXP:LASTERROR?` command returns the last error occurred.

Set or query the popup details

This command sets or queries the popup details.

Syntax

`TEKEXP:POPUP?` (Query)

`TEKEXP:POPUP "<PopupResponse>"` (Set)

Command arguments

Argument Name	Argument value
<PopupResponse>	• Yes • No

Returns

The pop-up details return in the following format:

"<Tittle>","<message>","<response1>,<response2>".

Where,

<Tittle> :: <String>

<message> :: <String>

<response1>,<response2> :: <String>

Examples

`TEKEXP:POPUP?` command returns the popup details in following format ": "Do you really want to exit TekExpress?";Responses: "Yes, No".

`TEKEXP:POPUP "Yes"` command sets the popup response to Yes.

Set or query the session create option in the continuous run function

This command sets or queries the option for session creation in the continuous run function.

Syntax

`TEKEXP:VALUE? ContinuousRun_RunSessionOptions` (Query)

`TEKEXP:VALUE ContinuousRun_RunSessionOptions,"Value"` (Set)

Arguments

Argument Name	Argument value
<Value>	NewSession | SameSession_ClearResults NewSession - creates new session for each run. SameSession_ClearResults - Clears the test results of the current session and starts the test execution. The session results will be added in the same session, by erasing the previous run results.

Returns

NewSession | SameSession_ClearResults

Examples

`TEKEXP:VALUE? ContinuousRun_RunSessionOptions` command returns the option for session creation in the continuous run function.

`TEKEXP:VALUE ContinuousRun_RunSessionOptions,"Value"` command sets the option for session creation in the continuous run function.

Set or query the View report after generating option status

This command sets or queries the enable/disable status of the View report after generating function.

Syntax

`TEKEXP:VALUE? GENERAL,"View Report After Generating"` (Query)

`TEKEXP:VALUE GENERAL,"View Report After Generating",<value>` (Set)

Arguments

Argument Name	Argument value
<Value>	{True | False} or {1 | 0} It represents enabled or disabled. Where, • True or 1 - enabled • False or 0 - disabled

Returns

{True | False} or {0 | 1}

Examples

`TEKEXP:VALUE? GENERAL,"View Report After Generating"` command returns the enable or disable status of view report after generating option.

`TEKEXP:VALUE GENERAL,"View Report After Generating",<value>` command enable or disable the view report after generating option.

Set or query the waveform file recalled for the specified test name and acquire type

This command set or queries the waveform file recalled for the specified test name and acquire type.

If there are more than one waveform, the waveform file names are displayed with the symbol "$" separated values in the format

<WaveformFileName1$ WaveformFileName2>.

Syntax

`TEKEXP:VALUE WFMFILE,<TestName>,<AcquireType>,<WaveformFileName>` (Set)

`TEKEXP:VALUE? WFMFILE,<TestName>,<AquireType>` (Query)

Returns

<String>

Examples

`TEKEXP:VALUE WFMFILE,<TestName>,<AquireType>,<WaveformFileName>` command recalls the sepcified waveform file for the specified testname and acquire type.

`TEKEXP:VALUE? WFMFILE,<TestName>,<AquireType>` command returns the waveform file name recalled for the specified testname and acquire type.

Sets or query the limit values in the limits editor window

This command sets or queries the limit values in the limits editor window.

Syntax

`TEKEXP:VALUE LIMIT,<TestName>,<LimitHeader>,<Value1>,<CompareString>,<Value2>`(Set)

`TEKEXP:VALUE? LIMIT,<TestName>,<LimitHeader>` (Query)

Returns

<String> or <NRf>

Examples

`TEKEXP:VALUE LIMIT,<TestName>,<LimitHeader>,<Value1>,<CompareString>,<Value2>` command sets the limits value for the specified testname and limit header.

`TEKEXP:VALUE? LIMIT,<TestName>,<LimitHeader>` command returns the limits value for the specified testname and limit header.

Set or query the enable/disable status of Verbose function

This command sets or queries the enable/disable status of Verbose function.

Syntax

`TEKEXP:VALUE VERBOSE,"<Value>"` (Set)

`TEKEXP:VALUE? VERBOSE` (Query)

Arguments

Argument Name	Argument value
<Value>	{True | False} or {1 | 0} It represents enabled or disabled. Where, • True or 1 - enabled • False or 0 - disabled

Returns

{True | False} or {0 | 1}

Examples

`TEKEXP:VALUE VERBOSE,"<Value>"` command enable or disable the Verbose function.

`TEKEXP:VALUE? VERBOSE` command returns the enable or disable status of Verbose function.

Exit or close the application

The command exits or close the application

Syntax

`TEKEXP:EXIT`(Set)

Examples

`TEKEXP:EXIT` command close the application.

Example

A PI example, for the TekExpress Application is given below. A ‘Programmatic_Interface_Example.py’ file is also included as a part of the installer.

```
s#Create an object of Socket
sckt=socket.socket(socket.AF_INET, socket.SOCK_STREAM)
sckt.connect(("localhost", 5000))

#DefaultApp
sckt.sendall('TEKEXP:SETUP DEFAULT'+'\n')
dutid ="BRR"
sckt.sendall("TEKEXP:VALUE DUTID,"+dutid+"\n")
#Selecting the suite
Suite="MultiGBase-T1"
sckt.sendall("TEKEXP:SELECT SUITE,"+""+'MultiGBase-T1'+""+",TRUE"+'\n')
print ("Selecting"+str(Suite))
#Setting Live mode
sckt.sendall('TEKEXP:ACQUIRE_MODE LIVE\n')

# Selecting rate 5GBASE-T1
param=['Transmitter 2.5G Speed','Transmitter 5G Speed']
value=['False','True']

for i in range(0,len(param)):
sckt.sendall('TEKEXP:VALUE GENERAL,'+""+param[i]+""+','+""+value[i]+""+'\n')
time.sleep (2)

#Deselect All Tests
sckt.sendall('TEKEXP:SELECT TEST,ALL,FALSE'+'\n')

#Selecting the specific Test measurement
meas='Transmitter Timing Jitter - Master Jitter'
sckt.sendall('TEKEXP:SELECT TEST,'+meas+'\n')

sckt.sendall('TEKEXP:VALUE GENERAL,'+""+'Run Test More than Once'+""+','+""+'True'+""+'\n')
sckt.sendall('TEKEXP:VALUE GENERAL,'+""+'Number of Runs'+""+','+""+'3'+""+'\n')
sckt.sendall('TEKEXP:STATE?'+'\n')
appStatus = sckt.recv(1024)
time.sleep(2)
appStatus = str(appStatus).strip('\n')
```

```
# 'Run the measurements, and check for completion'
if((appStatus)=='READY'):
sckt.sendall('TEKEXP:STATE RUN'+'\n')
time.sleep(1)
sckt.sendall('TEKEXP:STATE?'+'\n')
appStatus = sckt.recv(1024)
appStatus = str(appStatus).strip('\n')
while (appStatus == "RUNNING" or appStatus == "ERROR" or appStatus=="WAIT"):
print "Application Status..."+appStatus
time.sleep(2)
sckt.sendall('TEKEXP:POPUP "Done"'+'\n')
time.sleep(3)
sckt.sendall('TEKEXP:STATE?'+'\n')
appStatus = sckt.recv(1024)
appStatus = str(appStatus).strip('\n')
#Transfer the reports
sckt.sendall("TEKEXP:INFO? REPORT\n")
status = str(sckt.recv(1024))
fileInfo= status.split(',')
fileLength = long(fileInfo[0])
destinationPath = "X:\\"
sckt.sendall("TEKEXP:EXPORT REPORT\n")
while(len(status) < fileLength):
received = sckt.recv(fileLength)
status = status + received
fileName = fileInfo[1].strip()
fileName = fileName.strip('\"')
time.sleep(15)
f= open(destinationPath+fileName,'wb')
f.write(status)
f.close()
sckt.close()
```

References

Application directories

You can find the application files at *C:\Program Files\Tektronix\<Application Name>*. The application directory and associated files are organized as follows:

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

Table 49: Application directories and usage

Directory names	Usage
Bin	Contains application libraries
Compliance Suites	Contains test suite specific files
Examples	Contains various support files
ICP	Contains instrument and application specific interface libraries
Images	Contains images of the application
Lib	Contains utility files specific to the application
Licenses	Contains all the license files
Report Generator	Contains style sheets for report generation
Tools	Contains instrument and application specific files

File name extensions

The TekExpress <Application Name> software uses the following file name extensions:

Table 50: File name extension

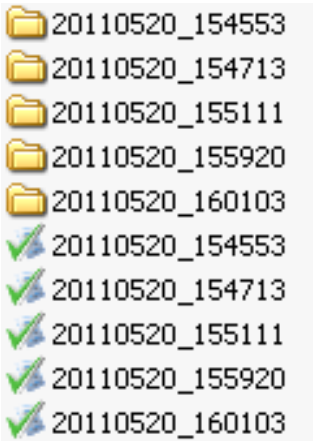
File name extension	Description
*.TekX	Application session files (the extensions may not be displayed)
*.py	Python sequence file.
*.xml	Test-specific configuration information (encrypted) files. Application log files
*.csv	Test result reports Plot data
*.mht	Test result reports (default) Test reports can also be saved in HTML format
*.pdf	Test result reports Application help document
*.xslt	Style sheet used to generate reports
*.png	Captured images

View test-related files

Files related to tests are stored in My Documents\<Application Name>\Untitled session folder. Each test setup in this folder has both a test setup file and a test setup folder, both with the test setup name. The test setup file is preceded by the TekExpress icon.

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 also has a folder and file pair, both named for the test session using the naming convention (date)_(time). Each session file is stored outside its matching session folder:



Each session folder contains image files of any plots generated from running the test session. If you selected to save all waveforms or ran tests using prerecorded waveform files, these are included here.

The first time you run a new, unsaved session, the session files are stored in the Untitled Session folder located at X: \<Application Name>. When you name and save the session, the files are placed in a folder with the name that you specify. A copy of the test files stay in the Untitled Session folder until you run a new test or until you close the application.

Measurement and application error messages

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

Table 51: 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%.
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%.

Table continued…

Error message	Description
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.
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.
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)	

Table continued…

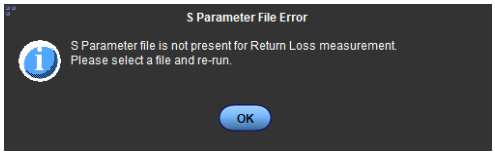
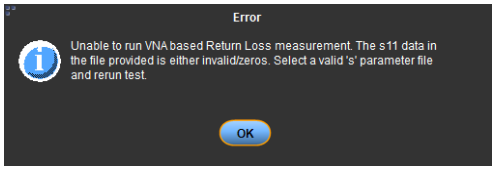
Error message	Description
S parameter file is not present for Return Loss measurement. Please select a file and re-run. 	This error occurs if the VNA Result file is not selected in **Configuration > Global Settings**.
Unable to run VNA based Return Loss measurement. The S11 data in the file provided 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.
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.

Table 52: Application error messages

Type	Error message
Acquisition error	Configured channel source has no signal. Check DUT and channel connections and run the measurement.
Return Loss test is not run	Calibration which is the pre-requisite is incomplete.
Error	Exception occurred while connecting to signal source. Check if signal source is configured correctly.

Table continued…

Type	Error message
Error	Exception occurred while running the calibration. Check if signal source is configured correctly.
Error	Error while saving the waveform. Check if sufficient disk space is available.
Error	Invalid Signal for Return loss - Please check Scope AUX or Sync Input Channel is connected with AFG Trigger output [TTL] and Re-Run.
Error	Return Loss Calibration files are missing. Ensure all calibration steps are performed.
Signal Validation failed for <testname>	Either the waveform record length is too low or it is invalid testmode signal.
Insufficient RBW	Insufficient RBW','RBW value is low for PSD test. Change the RBW value to be.

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 saved in CSV file format

The TekExpress Automotive Ethernet application saves the measurement results for Droop measurement, PSD measurement, and Return Loss measurement (100Base-T1) in a CSV file format. This section describes the file names used for the measurements, result details added in the file, and the file path.

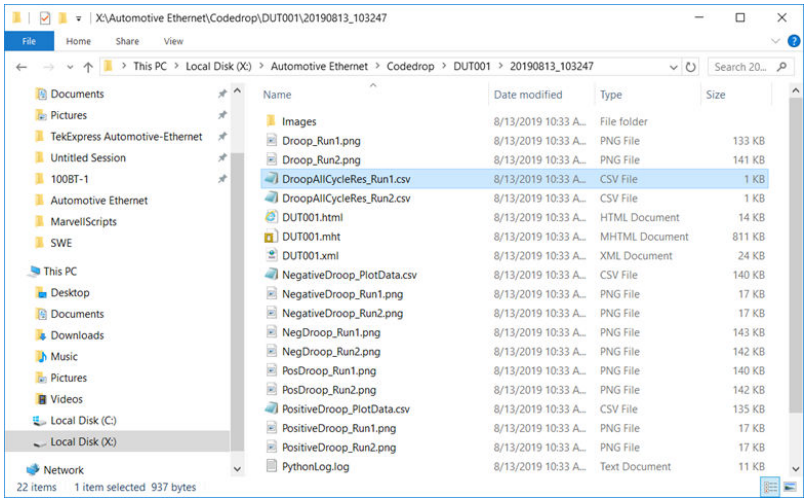


Figure 116: An example of the save session folder

Droop measurement

The Droop measurement is applicable for the following technologies:

- 10BASE-T1S
- 100BASE-T1
- 1000BASE-T1
- MultiGBASE-T1

When you save a session, droop measurement results are saved in the *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

Droop Result Data								
Droop 1000Base-T1 limit <	10%							
Number of Cycles	1600							
Cycle Number	Positive Vpk(V)	Positive Vd(V)	Positive Droop(%)	Positive Droop Result	Negative Vpk(V)	Negative Vd(V)	Negative Droop(%)	Negative Droop Result
1	0.846207379	0.954528384	-12.80076337	Pass	-0.838728909	-0.956283545	-14.01580838	Pass
2	0.846991675	0.957341188	-13.0284059	Pass	-0.849099555	-0.96083774	-13.15960944	Pass
3	0.844686982	0.953712123	-12.90716484	Pass	-0.838365559	-0.949107699	-13.20929021	Pass
4	0.836440497	0.963469319	-15.1868331	Pass	-0.846430614	-0.945468494	-11.70064965	Pass
5	0.847842957	0.958034787	-12.9967265	Pass	-0.847430034	-0.954824956	-12.67301349	Pass
6	0.850486669	0.961609531	-13.06579705	Pass	-0.846498814	-0.956200068	-12.95941017	Pass
7	0.838497135	0.951459595	-13.47201506	Pass	-0.841295266	-0.957181029	-13.77468384	Pass
8	0.840845635	0.96360488	-14.59949843	Pass	-0.844574256	-0.954524111	-13.01837631	Pass
9	0.839260753	0.964107001	-14.87574013	Pass	-0.847501151	-0.960774449	-13.36556279	Pass
10	0.843588609	0.962305247	-14.07281194	Pass	-0.842868758	-0.956423222	-13.4723779	Pass
11	0.833694648	0.960722841	-15.23677679	Pass	-0.846076459	-0.970071433	-14.6552918	Pass
12	0.843498123	0.957366495	-13.49954068	Pass	-0.844615818	-0.959094386	-13.55392186	Pass

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

PSD measurement

The PSD measurement is applicable for the following technologies:

- 10BASE-T1S
- 100BASE-T1
- 1000BASE-T1
- MultiGBASE-T1

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

Settings		
PlotType	TimeTrend	
Labels	Frequency	PSD
title	Power Spectral Density	
WFMColor	#d41442	
WFMLineWidth	5	
Divisions	10	10
Units	Hz	dBm
Data		
1000080.006	-20.99076135	
1005080.406	-20.98481491	
1010080.806	-20.97708028	
1015081.206	-20.95886095	
1020081.607	-20.94470038	
1025082.007	-20.93572495	
1030082.407	-20.93154219	
1035082.807	-20.9240136	
1040083.207	-20.9084374	
1045083.607	-20.8934376	
1050084.007	-20.8804471	
1055084.407	-20.8709122	

Return Loss measurement

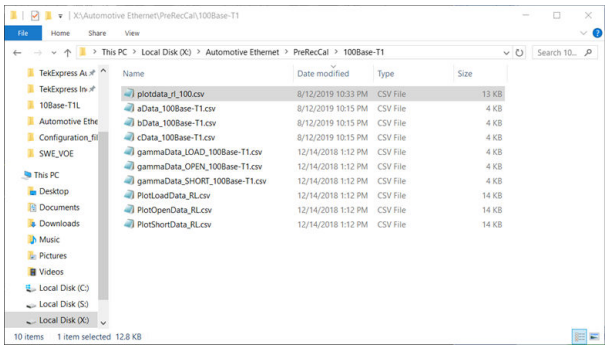
The Return Loss measurement is applicable for the following technologies:

- 10BASE-T1S
- 100BASE-T1
- 1000BASE-T1
- MultiGBASE-T1

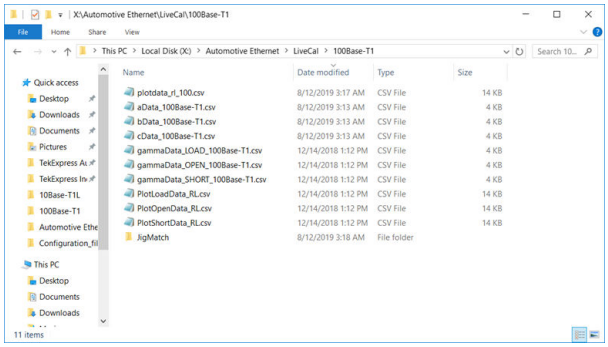
A CSV (plotdata_rl_100.csv, for the 100Base-T1 technology) file with return loss information is saved in the location along the calibration data, and the location is based on the calibration used.

Based on the calibration method, the .CSV files are saved in the below listed folders:

- Pre-recorded calibration files: `X:\Automotive Ethernet\PreRecCal\100Base-T1\`



- Live Calibration: `X:\Automotive Ethernet\LiveCal\100Base-T1\`



The below listed file contains the measurement result of frequency (Hz) and return loss(dB)

Settings		
PlotType	TimeTrend	
Labels	Frequency	Return Loss
title	Return Loss	
WFMColor	#08d529	
WFMLineWidth	3	
Divisions	10	10
Units	Hz	dB
Data		
100000	-21.15984017	
120000	-23.03654746	
140000	-24.00810085	
160000	-24.94150533	
180000	-25.58897894	
200000	-26.10648399	
220000	-26.55400596	
240000	-26.94276006	
260000	-27.24907549	
280000	-27.4989855	
300000	-27.70860594	
320000	-27.88259071	

Even-Odd Measurement details

The Even-odd measurement is applicable for the MultiGBASE-T1 technology.

When you save a session, the Even-odd measurement results are saved in the *Transmit_EOJ_5GBASE_T1_Run1.csv* file for 5GBASE-T1. The file contains the following detailed results for each frame of JP03B pattern:

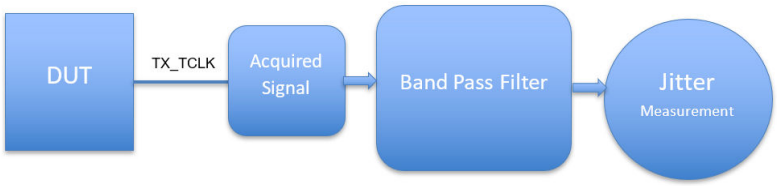
- Frame Number
- Even Jitter(ps)
- Odd Jitter(ps) for each frame
- EOJ pk-pk(ps) for each frame
- Pass/Fail result with respect to specification limits

Trasmitter MDI EOJ Test Result									
Input Signal	Transmit Even-Odd Jitter MDI Master Mode_DataRate_2Dot5_Run1_MATH1.wfm								
Data Rate	2.5	GBASET1							
EoJ Pk-Pk <	16	ps							
Frame No.	Even Jitter	Odd Jitter	EoJ Pk-Pk(	Pass/Fail					
1	710.7788	710.969	0.095062	Pass					
2	710.0022	711.6881	0.842964	Pass					
3	710.5488	710.9961	0.223629	Pass					
4	710.4806	710.9642	0.241784	Pass					
5	710.7939	711.4619	0.33399	Pass					
6	710.5475	712.5305	0.991485	Pass					
7	711.5525	711.7394	0.093439	Pass					
8	712.0104	710.8991	0.555614	Pass					
9	710.7214	711.0327	0.155675	Pass					
10	710.7505	711.1859	0.217706	Pass					
11	710.6732	711.1366	0.231695	Pass					
12	709.5643	712.0178	1.226747	Pass					
13	710.1603	712.2225	1.03109	Pass					
14	710.1428	712.8498	1.353502	Pass					
15	711.1677	712.1265	0.479369	Pass					
16	710.7996	711.8056	0.503009	Pass					

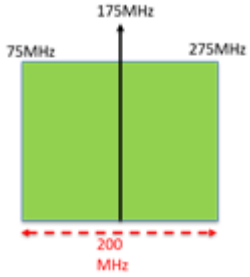
Measurement Details - MultiGBASE-T1

Transmitter Timing Jitter

This measurement requires the use of band pass filtering of the TX_TCLK signal with 200 MHz band with filter. The details of filter is described by the block diagram shown:



Bandpass filter is used to depict as follow:



MDI Random Jitter

The filtering applied in this measurement is same as in Transmitter timing jitter. But this is applied to MDI signal with Test Mode2 (square wave).

Transmit MDI deterministic jitter in master mode

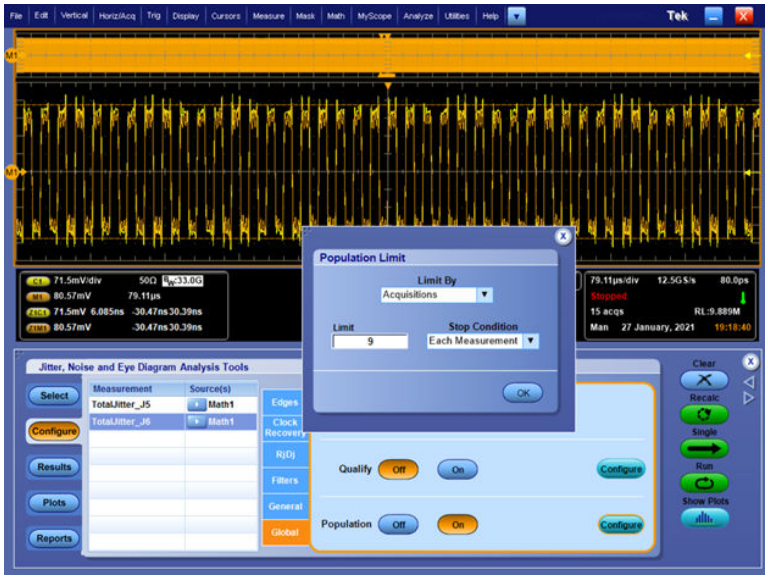
The DJ measurement needs the acquisition of 10^7 symbols, as this result in large record length on the oscilloscope, this is addressed using DPOJET population feature.

DJ population

Measurement is performed with a population of ≥10^7 symbols. For 2.5GBASE-T1, DJ population translates to 7.111 ms.

- Sample rate of 12.5 Gsps, implies a waveform record of ~88 M samples

  The high record length measurement is simplified using DPOJET Population limit as shown:



- A 9.88 M waveform is acquired 9 (limit) times (amounting to 88 Msample accumulation), and the corresponding measurement result is computed by DPOJET.

Pre-recoded mode - DJ limitation

As the waveforms saved in the session is one of the acquisitions. The results of the DJ in pre-recorded mode would not the match the corresponding result in the live measurement case.

Transmit MDI Even-Odd jitter in master mode

This measurement configuration has parameter for waveform averaging and available for two data rates 2.5GBASE-T1 and 5GBASE-T1. For the case of 10GBASE-T1, the averaging is not available for the user. Alternatively the user can use Multi-Run option to perform this measurement for multiple iterations and analyze the result statistics.

Linearity Measurement

This section provides additional details for the measurement procedures.

Procedure

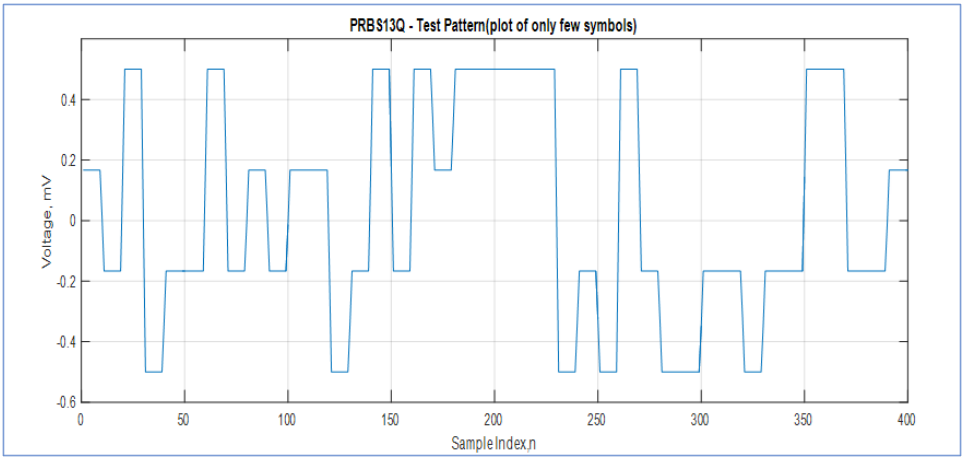


Figure 117: PRBS13Q Test pattern (plot of only few symbols)

1. **Waveform Capture**:

Capture at least one complete cycle of the PRBS13Q waveform. Denote the number of PAM4 symbols in the test pattern as N. The waveform shall be captured with an effective sample rate that is at least 7(say M) times the signaling rate of the transmitter under test. The captured waveform *y(k)* is aligned so that the first M sample represent the first symbol of the PRBS13Q pattern.

2. **Measurement of mean signal levels**:

   The waveform consists of M samples per unit interval(symbol). Reduce the captured waveform to have one sample per unit interval, by retaining only the central sample. The central sample is defined as m^{th}sample in each unit interval where *m,* is the integer closest to M/2. The mean value of all waveform samples that correspond to a symbol level *x*, represent the mean signal level of the symbol V_x.

   V_0, V_1, V_2, and V_3 denote the mean signal levels of the symbols corresponding to the PAM4 symbol levels 0, 1, 2, and 3. The mean signal levels are then normalized, and offset adjusted so that

   a. V_{mid} corresponds to 0

$$V_{mid} = \frac{(V_0 + V_3)}{2}$$

   b. V_0, V_1, V_2, and V_3 correspond to -1, -ES1, ES2 and 1 respectively.

$$ES1 = \frac{(V_1 - V_{mid})}{(V_0 - V_{mid})}$$

$$ES2 = \frac{(V_2 - V_{mid})}{(V_3 - V_{mid})}$$

3. **Aligned symbols**:

   The symbols of the captured waveform, *x(n),* are assigned normalized amplitudes. PAM4 symbol levels 0, 1, 2, and 3 are respectively assigned normalized amplitudes −1, −ES, ES, and 1. ES is defined as follows:

$$ES = \frac{|ES1| + |ES2|}{2}$$

4. Compute the linear fit pulse response *p(k)* and linear fit error *e(k)* using the captured waveform y*(k)* as described in [1] using Np = 200 and Dp = 2. Denote the standard deviation of *e(k)* as σ_e. Denote p_{max} as the maximum value of *p(k)*.
5. Measure the RMS deviation σ_n, from the mean voltage at a fixed low-slope point in runs of at least 6 consecutive identical PAM4 symbols.
6. SNDR is computed as defined below:

$$SNDR = 10Log10\left(\frac{p_{max}^2}{\sigma_e^2 + \sigma_n^2}\right)$$

Debugging Checklist on Measurement Failures

This section describes the equipment connection diagram and test procedure for the following Technologies:

- 10Base-T1S
- 100Base-T1
- 1000Base-T1

Power spectral Density

- Ensure Oscilloscope Signal Path Calibration (SPC) is done.

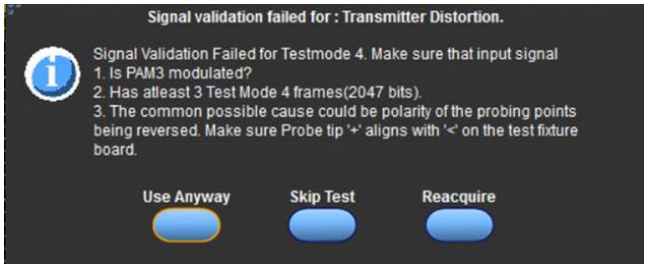
- Each lane on the fixture has SMA outputs and provision to probe. When a probe is being used, terminate the corresponding SMA outputs.
- In some cases, it would help to have a common ground. Connect the DUT ground point to the oscilloscope ground.
- Few DUTs may have a pulse filter and may a have an option to enable it for testing. Try running the measurement by enabling this option on the DUT.

Return loss calibration

- Ensure Oscilloscope Signal Path Calibration (SPC) is done.
- Ensure jumper setting on the fixture as per connection diagram, based on the lane employed.
- Common ground: For best results, connect the test fixture and oscilloscope, DUT to a common ground. Employ the black connector on the Return Loss coupon of the test fixture.
- Debug tip: Try using the same length SMA cables – the one used to connect the AWG output to fixture and the trigger out from AWG to oscilloscope.
- Expected calibration result curves: There is NO one standard result, this would vary depending on various factors including cables/ length.
- Once all the steps (open/load/short) of calibration is complete and applied. Run the return loss measurement, with connection as open (instead of connecting the DUT). In this case we expect the result of return loss to be a horizontal line (constant loss across all frequencies).

Distortion Test Debugging

Incorrect signal or connections would result in the following pop-up:



- Check the connections on the fixture, including probe polarity as per the schematic
- Ensure necessary test mode signal is setup on the DUT - PAM3 signal with at-least 4 frames of 2047 bits.

Return Loss using VNA result file

This section describes the equipment connection diagram and test procedure for the following Technologies:

- 10Base-T1S
- 100Base-T1
- 1000Base-T1

VNA result from the S-parameter file is read and analyzed for test requirement and result with limit check against the specification limit is available in the report. In this measurement, the result can either be marked as PASS/FAIL/INCONCLUSIVE. Inconclusive is a result state, with the data in the provided VNA s-parameter file does not include all the frequencies as per the specification limit.

An example result table and mask plot is shown for MultiGBASE-T1.

Test Name Summary Table	
MDI Return Loss	Fail

MDI Return Loss

Measurement Details	Rate	Test Result	Low Limit	Measured Value	High Limit	Units	Margin	Run#
Return Loss_2.5G	2.5GBASE-T1	Inconclusive	NA	0	0	Hits	LL: N.A, HL: 0	1
Return Loss_5G	5GBASE-T1	Pass	NA	0	0	Hits	LL: N.A, HL: 0	1
Return Loss_10G	10GBASE-T1	Fail	NA	836	0	Hits	LL: N.A, HL: -836	1
COMMENTS	2.5GBase-T1: Run1: The result is extracted from the S-parameter file provided (C:\Users\Public\Tektronix\TekApplications\Automotive-Ethernet\ExampleSparamFiles\inconclusive.s2p). S-parameter file does not have data spanning the frequency range as per the specification from 1 MHz to 1000 MHz. VNA Start Frequency: 0 GHz and VNA Stop Frequency: 0.748 GHz. 5GBase-T1: Run1: The result is extracted from the S-parameter file provided (C:\Users\Public\Tektronix\TekApplications\Automotive-Ethernet\ExampleSparamFiles\Multigig_test.s2p). 10GBase-T1: Run1: The result is extracted from the S-parameter file provided (C:\Users\Public\Tektronix\TekApplications\Automotive-Ethernet\ExampleSparamFiles\Example.s2p).							

Back to Summary Table

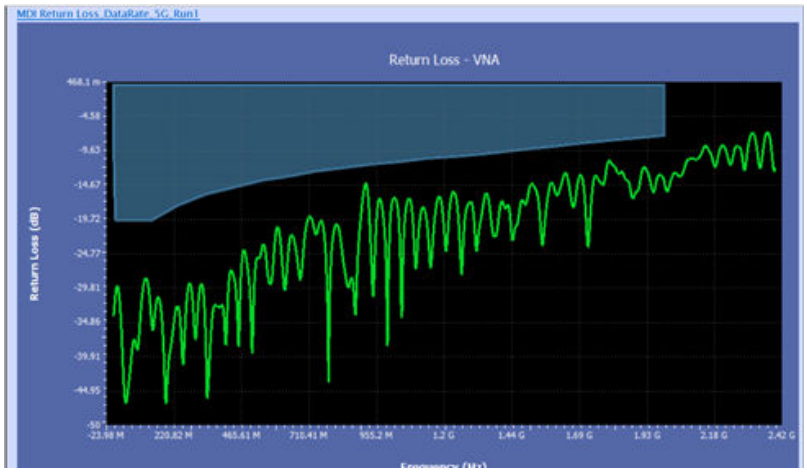


Figure 118: Example of a PASS result

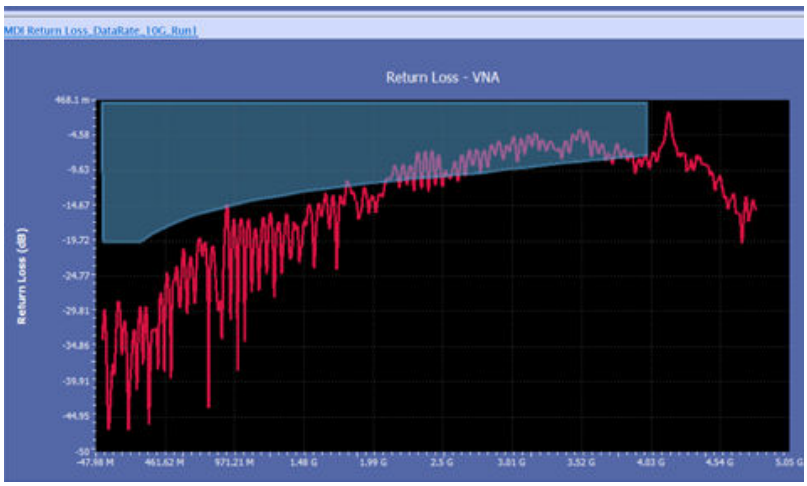


Figure 119: Example of a FAIL result

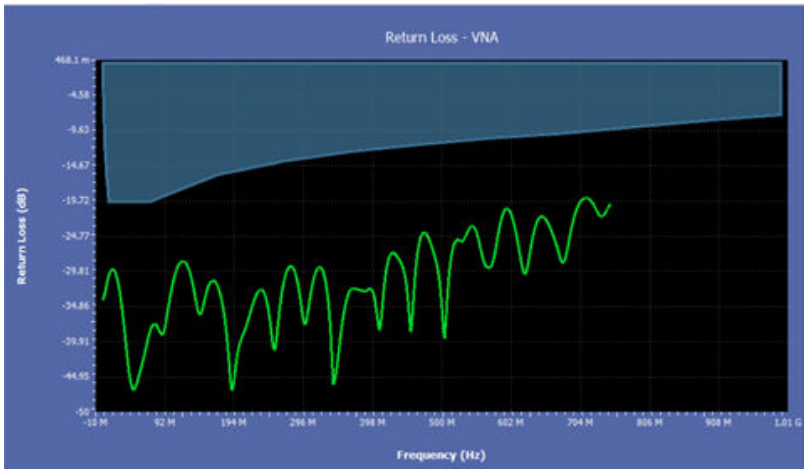


Figure 120: Example of an inconclusive result

Manually Configure Oscilloscope parameters

The feature allows you to configure the oscilloscope settings manually such as Horizontal, Vertical and Trigger settings to capture a waveform. In general, TekExpress application configures the oscilloscope optimally for each measurement as per the needs of the specification. If you want to debug using different settings, then select this feature.

Procedure to Enable Manually configure Oscilloscope parameters feature

1. On the Test Selection panel, Select Tests to run.
2. On the Preference panel, set the **Manually configure Oscilloscope parameters** check box and click **Start**.

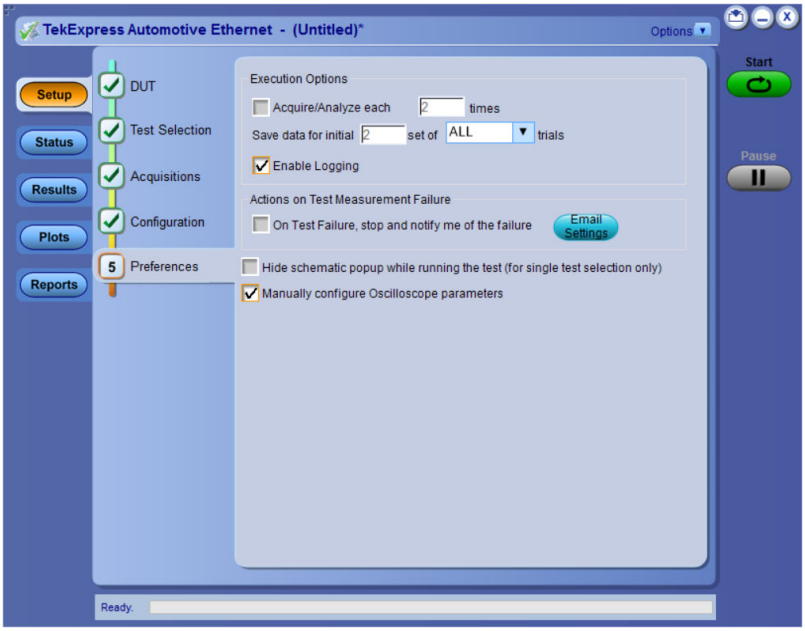


Figure 121: TekExpress Preference Panel

3. Displays the **Configure Setup and Scope Settings for: MultiGBase-T1** window.

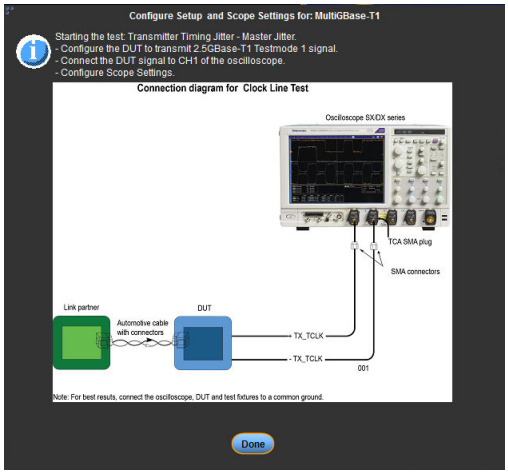


Figure 122: User prompt to configure the settings

4. Click **Configure the oscilloscope** and then click **Done** on the **Configure Setup and Scope Settings for: MultiGBase-T1** window. *Figure 123* on page 214 shows the channel vertical scale is set appropriately.

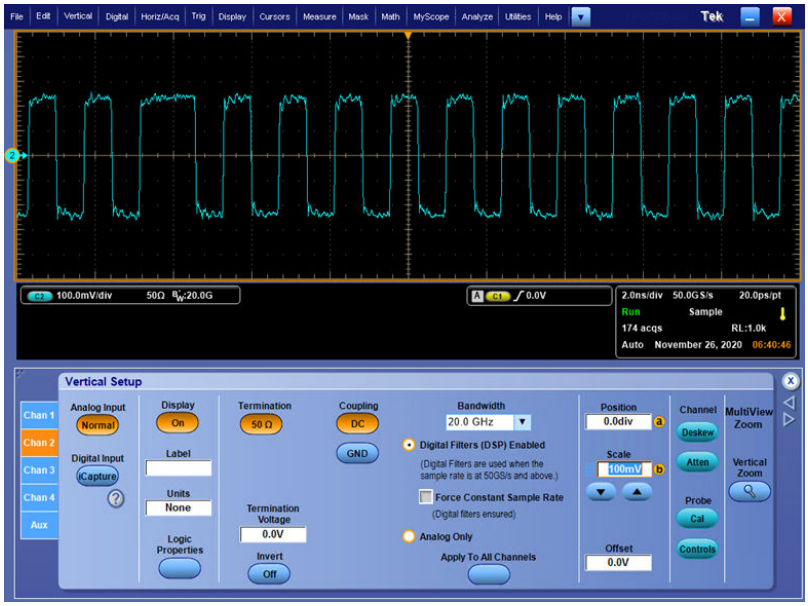


Figure 123: Example for the channel vertical scale configuration

5. Configuring the parameters can also be achieved by recalling the setup file, which has the desired settings for the channels used in TekExpress application.

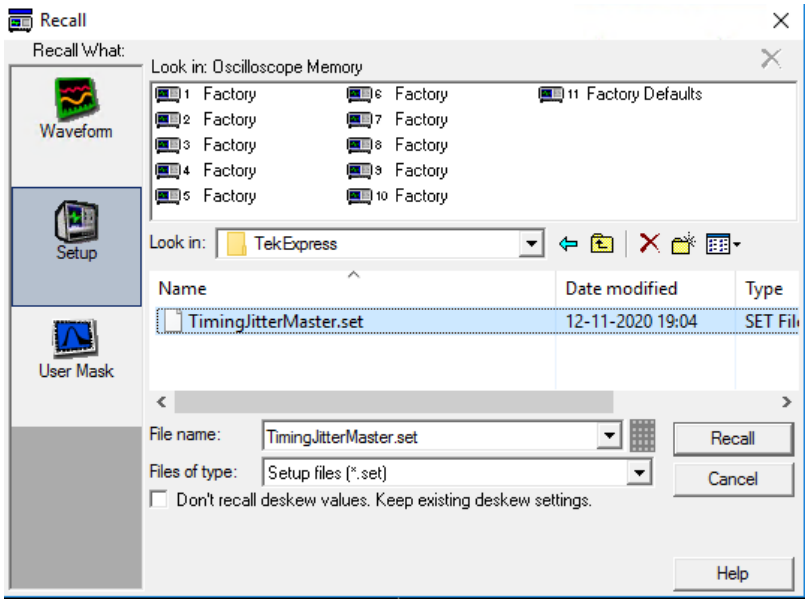
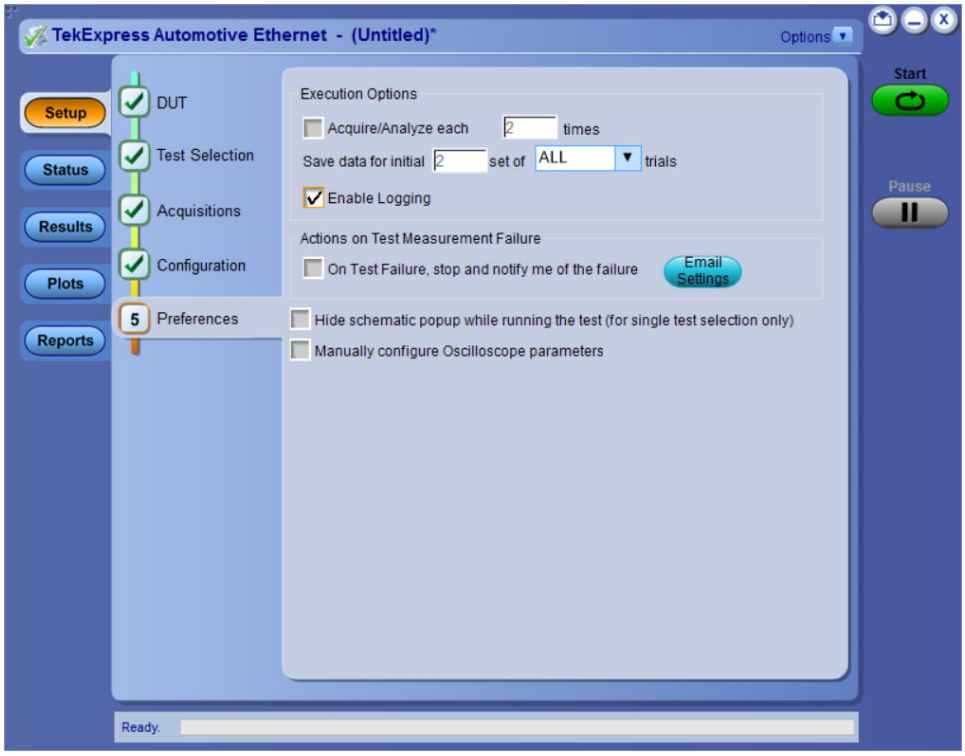


Figure 124: Example for the scope setup recall

Multi-Run description

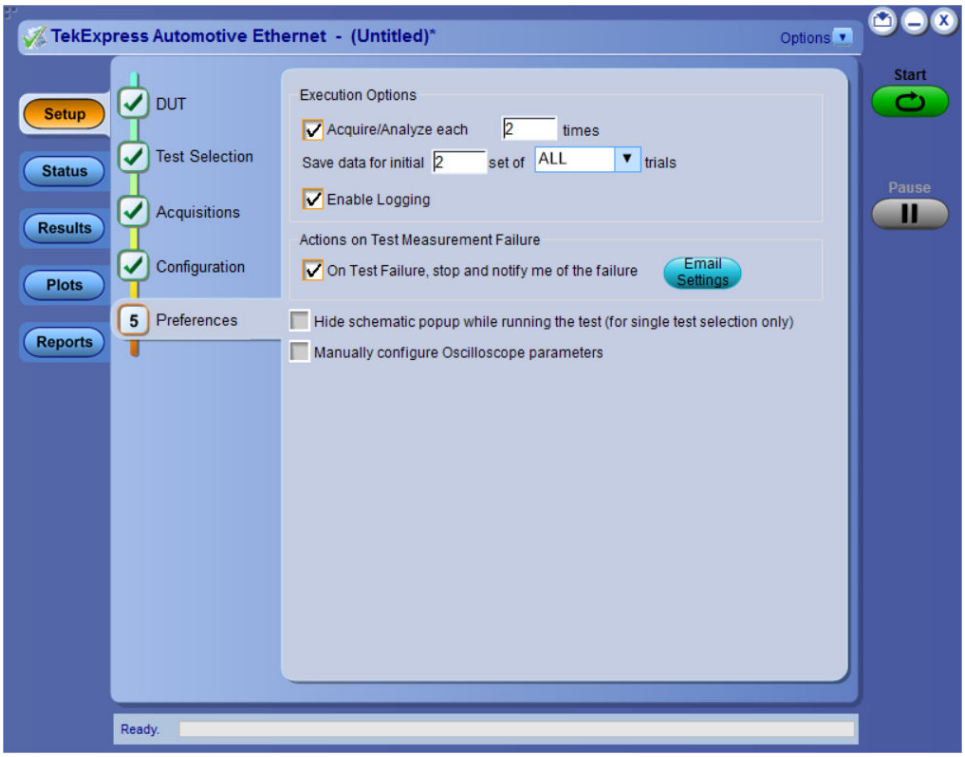
This section is applicable for the MultiGBase-T1 Technologies:

Multi-Run is an option to the user to perform the measurements for a user defined number of iterations. The report would list the results for all the iterations, and the statistics table would additionally compute and report the statistics across the measured values. Multi-Run feature can be enabled from the 'Preference Tab' as shown:



A description of the user configurations are listed below:

- Multi-Run is enabled by selecting the **Acquire/Analyse**.
- Number of times a measurement to be run is specified by the number, which allows a maximum of 1000 iterations
- Saving the date of the iterations/trials has two options:
  - To save initial set of data for N trials, select **All** from the drop-down menu in the save configuration.
  - To save initial set of data for N FAIL trials, select **FAIL** from the drop-down menu in the save configuration.
  - Saving of a maximum of 30 trials is possible.
- Stop on Failure: To stop the execution of multi-Run on a measurement failure, enable **On Test Failure, stop and notify me of the failure** option.



FLT file : Finite Impulse Response (FIR) filter file format

FLT file is used in the Tektronix arbitrary waveform math filter function. The ASCII file format describes the storing filters used in the Tektronix oscilloscope waveform math section. A filter menu function allows you to specify a disk file name that contains the filter. A single file format allows you to select a different set of coefficients for each sample rate at which the filter is allowed to operate. If the sample rate is not in the file list, then that filter is not applied to the data. The file format also allows you to specify the set of filter coefficients is normalized and allows the same set of filter coefficients to operate at all sample rates.

The ASCII file format is specified as follows:

< sampleRate > coef1, coef2, …. coefN
< sampleRate > coef1, coef2, …. coefN
| |
| |
< sampleRate > coef1, coef2, …. coefN

Each set of filter coefficients in a file are specified in one row preceded by the sample rate value at which that set will operate. If you specify the @ symbol for the sample rate then the filter will operate at all sample rates. If the @ symbol is specified, then it should have only one set of filter coefficients in the file. However, the user may have other rows with sample rates specified and they will be ignored.

There will be a separate row for each sample rate the filter will operate at. Each row may have a different number of coefficients with a maximum of 1000. The file may contain up to 20 rows.

An example of a filter that is setup to operate at a specific sample rate is given as follows. This is the contents of a file named 200MHz_mult_sample_rates.flt that is included in the library directory on the oscilloscope.

```
#This is a 4th order Bessel Thomson low pass filter.
#200MHz bandwidth, will operate at any of the following sample rates:
# 40 GS/s, 20 GS/s, 10 GS/s, 5 GS/s
5e8;
1.968e-007,1.008,-0.00978,0.002267,-0.0002208,1.643e-005,-1.397e-006,1.434e-007
1e9; 9.524e-008,0.3899,0.4877,0.1304,-0.004733,-0.004566,.....
2.5e9; 3.868e-008,0.01885,0.1081,0.1982,0.2284,0.1981,.....
5e9; 1.935e008,0.0007332, 0.009428, 0.02874, 0.05408, 0.07921, .....
```

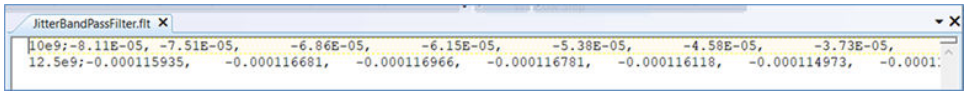


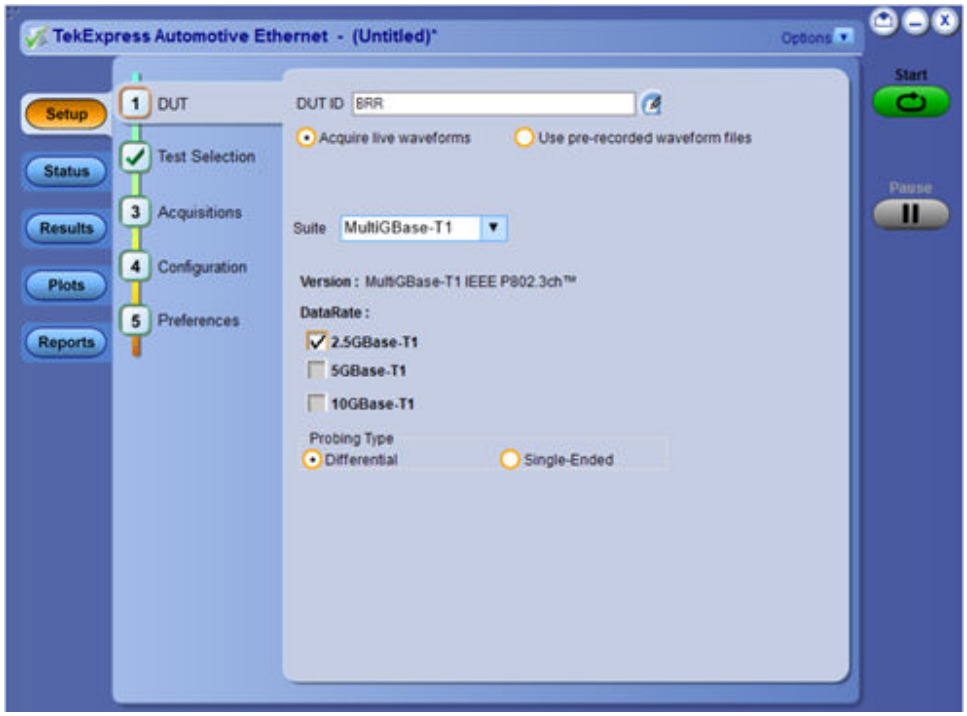
Figure 125: Example format of the FLT file

Oscilloscope noise calculation procedure using Linearity measurement

For DPO/MSO70000 Series Oscilloscopes

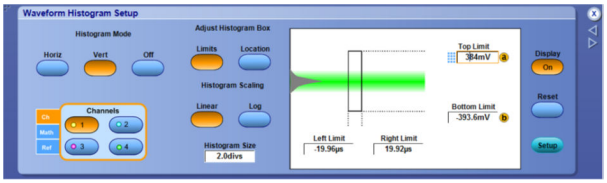
Follow the steps to calculate the Oscilloscope noise for DPO/MSO70000 Series Oscilloscopes:

Select the **Probing Type** in the DUT panel

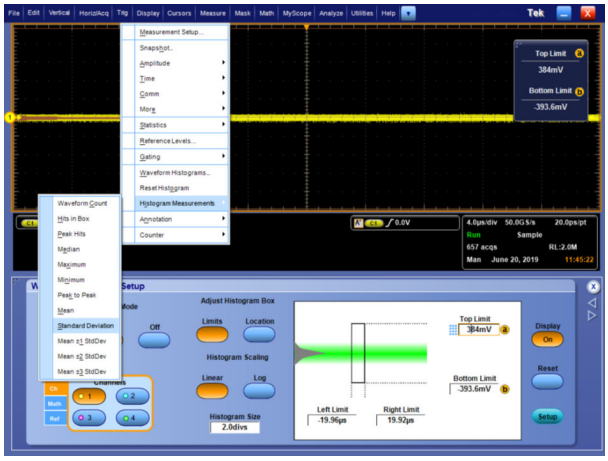


1. Connect the live signal to one of the channels that will be used within the test setup.

2. Run the Linearity measurement with appropriate data rate. Retain the oscilloscope setup, without changing the acquisition parameters. Note-down the Record Length and Sample rate configured on the oscilloscope.
3. Disconnect the live signal from the oscilloscope and switch the live channel connected to the intended live signal.
4. Run the measurement on the TekExpress application. Set the Math for single-ended and differential as given:
   a. For differential, set the **Probing Type** to **Differential** and Math=ScopeBWflt(ch1)
   b. For single-ended, set the **Probing Type** to **Differential** and Math=ScopeBWflt(ch1) – ScopeBWflt(ch3)
5. On the **TekScope** menu, in the **Measure**, select **Waveform Histograms**.
   a. Set **Histogram Mode** to **Vert**.
   b. Set the source to the channel selected in Step 3.
   c. Set the Left, Right, Top, and Bottom limits to cover the entire graticule.

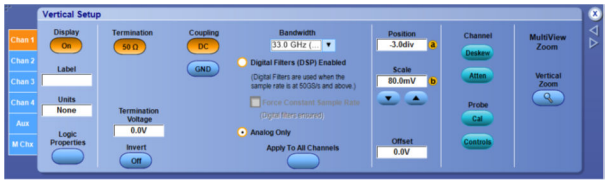


6. On the **TekScope** menu, in the **Measure**, under the **Histogram Measurements**, select **Standard Deviation** to add the **Hs Std Dev** tab in to the **Measurement** badge.



7. The mean value in the **Hs Std Dev** tab is the RMS value of the oscilloscope noise.

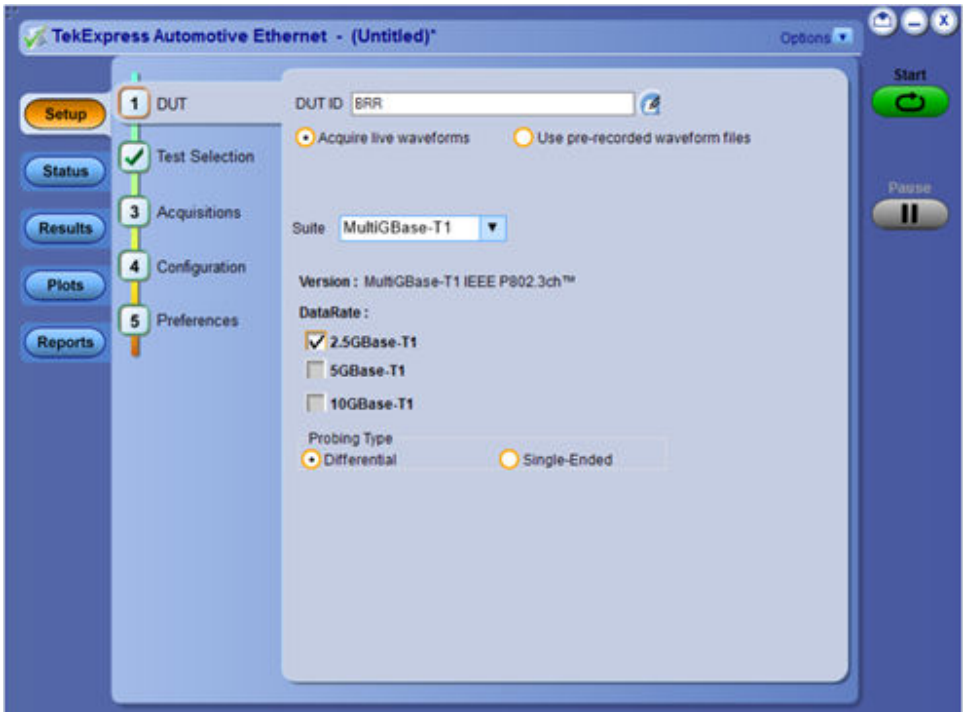
8. Set the **Position** to **-3 div**, On the **TekScope** menu, in the **Vertical** tab for the live channel that are connected to the intended live signal.



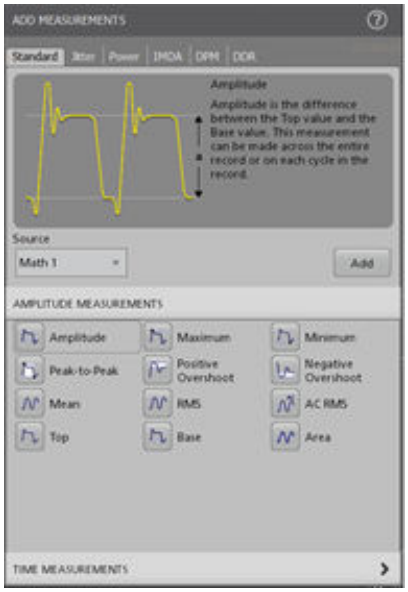
For MSO64/6B Series Oscilloscopes

Follow the steps to calculate the Oscilloscope noise for DPO/MSO70000 series oscilloscopes:

Select the **Probing Type** in the DUT panel as shown:

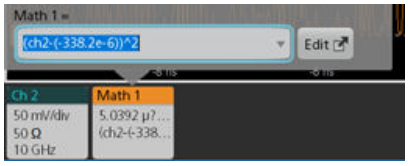


1. Connect the live signal to one/two channels that can be used within the test setup.
   a. You can use Ch1, when **Probe Type** is selected as **Differential**.
   b. Use two channels; Ch1 and Ch3, when **Probe Type** is selected as **Single- Ended**.
2. Run the Linearity measurement with appropriate data rate. Retain the oscilloscope setup, without changing the acquisition parameters. Note-down the Record Length and Sample rate configured on the oscilloscope.
3. Disconnect the DUT live signal from the oscilloscope, by removing the channels which are connected to the oscilloscope.
4. Run the measurement on the TekExpress application. Set the Math for single-ended and differential as given:
   a. For Differential, set the **Probing Type** to **Differential** and Math=ScopeBWflt(ch1)
   b. For single-ended, set the **Probing Type** to **Differential** and Math=ScopeBWflt(ch1) – ScopeBWflt(ch3)
5. Add **Mean** measurement, from the **Amplitude** measurement, on the **Add measurement** menu under the **Standard** tab and configure the **Source** to **Math1**. Note down the mean value of the amplitude; V_{mean}.

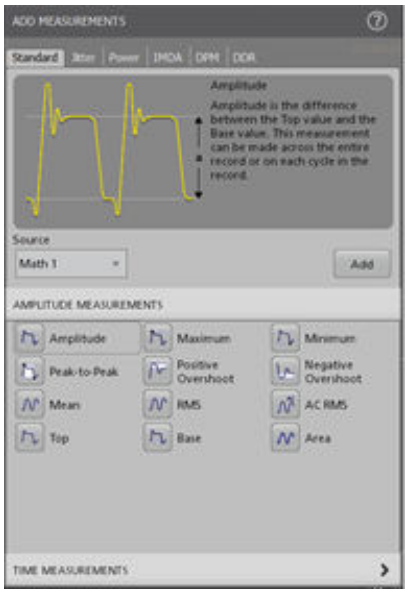


6. Add another Math defined as:

   Math2=Math1-(V_{mean})^2



7. Add **Area** measurement, from the **Amplitude** measurement, on the **Add measurement** menu under the **Standard** tab as shown and configure the **Source** to **Math2**. Note down the mean value of the area; A_{mean}.

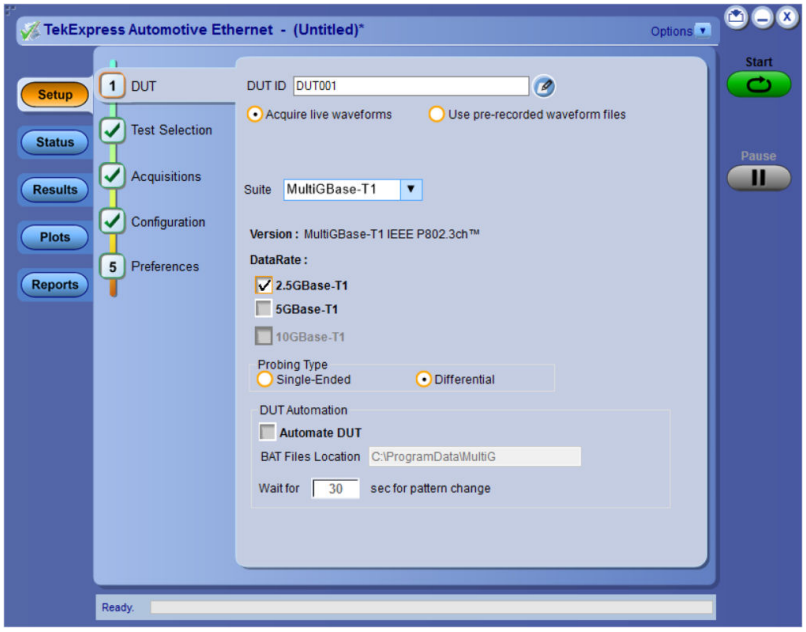


8. The RMS value of the Oscilloscope noise is calculated as:

   Oscilloscope Noise=(A_{mean}*Sample Rate/Record Length)^0.5

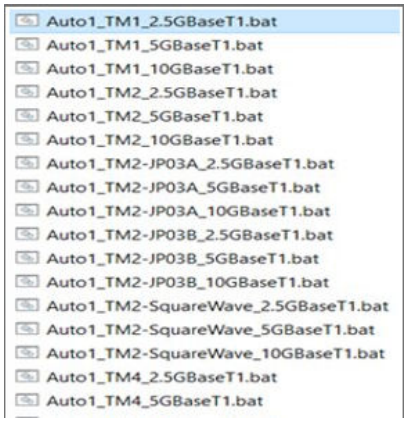
BAT Files Location

This folder is generally a hidden folder. You have to create a subfolder *\MultiG* and copy the BAT file into this location.



MultiGBase-T1 supports 3 data rates (2.5GBase-T1, 5GBase-T1, and 10GBase-T1) and various types of test modes (TM1 to TM6).

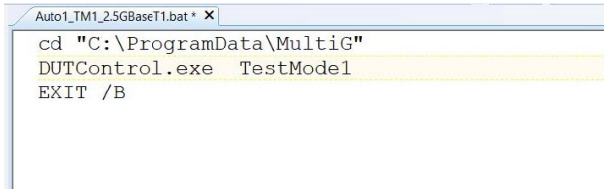
Follow a certain naming convention to allow the application to execute an appropriate file to the test/Data rate as shown:



The file name has 2 strings:

- `2.5G`: Represents the data rate **2.5GBASE-T1**.
- `TM2`: Represents the **Test Mode** signal.

An example is shown for the BAT file:



Copy the DUT control software application; *DUTControl.exe* in to the predefined location. Where, the `TestMode1` is an input parameter to DUTcontrol.exe to set the DUT to the **Test Mode**.

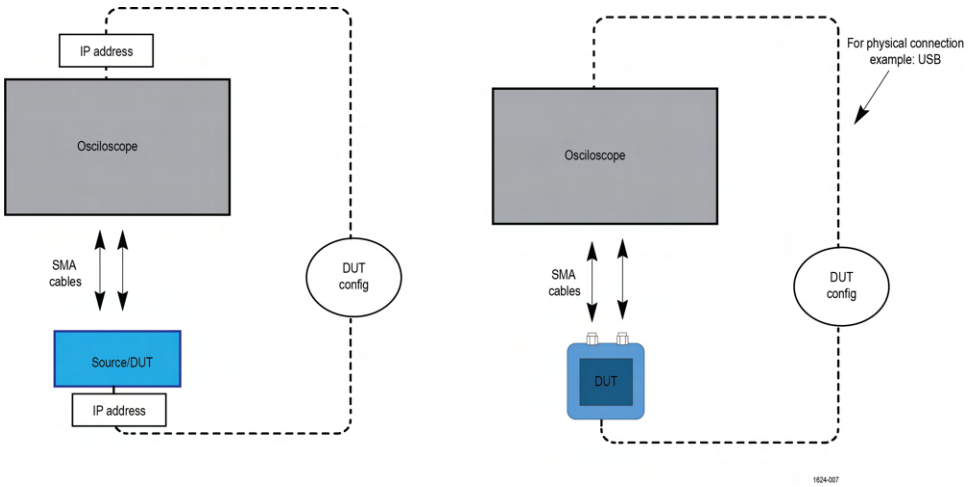


Figure 126: Examples shows the BAT files at predefined location on an oscilloscope

Index

P

R

S

T

V

W