



GRL Platform Solutions

USB4® Version 2.0 Transmitter Test Method of Implementation (MOI) Using High-Performance Real Time Oscilloscopes and GRL-USB4-V2-TX Automation Software

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1 Introduction

This documentation describes how to use the GRL-USB4-V2-TX automation software to test an electrical transmitter (Tx) unit for USB4® Version 2.0 (or USB4 Gen 4) certification using the Keysight or Tektronix High-Performance Real Time Oscilloscope.

This documentation starts off by explaining how to set up and use the GRL-USB4-V2-TX automation software as the main body followed by an Appendix describing the SMA cable transfer function setup procedure on the Scope.

The GRL-USB4-V2-TX automation software provides Tx equalization tests and waveform processing for USB4 Gen 4 router assemblies and captive devices. GRL-USB4-V2-TX also supports the SigTest post-processing analysis application to ensure signal quality compliance. When combined with a satisfactory level of interoperability testing, these tests provide a reasonable level of confidence that the devices-under-test (DUT's) will function properly in many USB4 V2 Tx environments.

In summary, below are the main topics that are covered in this documentation:

- GRL-USB4-V2-TX automation software installation and setup.
- USB4 V2 Tx test setup and report generation.
- Appendix on SMA cable transfer function setup procedure for cable de-embedding.

2 Resource Requirements

2.1 Equipment Requirements

TABLE 1. EQUIPMENT REQUIREMENTS – SYSTEMS

System	Qty.	Description	Key Specification Requirement
Oscilloscope	1	High Performance Real-time Oscilloscope	• ≥ 25 GHz bandwidth^[a] • Sampling rate ≥ 80 Gs/s • Sample clock jitter/intrinsic jitter < 100 fs rms within the acquired time range of 10 to 50 μsec/div • Intrinsic vertical noise < 3 mV rms within the acquired voltage range of 10 to 100 mV/div • SNDR ≥ 38.5 dB measured using common test methodology for ADC, by applying high quality/low noise sine wave (3 sine-wave test frequencies: 6,10,12.8 GHz, magnitude 800 mV p-p differential) at scope input and measuring the output signal-to-noise-and-distortion ratio while compensating scope intrinsic noise as defined by USB4 V2 standard • 16 GB or above memory RAM • Scope measurement software, e.g. Keysight InfiniiSim for Keysight scope or Tektronix DPOJET for Tektronix scope
Control Computer/ PC	1 or 2	High-performance computer with SigTest application installed For automation control (running GRL-USB4-V2-TX software) GRL Platform Solutions' distributed process licensing allows users to perform testing using two PC's—one for capturing waveforms and the other for analyzing them—thereby reducing testing time (refer to Section 9 for details)	• Windows 11 OS and above • High-performance CPU with Multicore • Minimum system requirements: 32GB RAM memory • Recommended system requirements: 48GB RAM memory

^[a] Oscilloscope with scope bandwidth as specified in vendor specific MOI's.

TABLE 2. EQUIPMENT REQUIREMENTS – ACCESSORIES

Accessory	Qty.	Description	Key Specification
USB Microcontroller	1	USB4 Gen 4 Microcontroller	
Plug Test Fixture	1	USB4 Gen 4 Plug Test Fixture	
Receptacle Test Fixture	2	USB4 Gen 4 Receptacle Test Fixture	
Matched Cable Pairs	2 pairs	Rosenberger UFC142A 2.92m (x2), 1m SMA cable	Phase matched $\pm 5^\circ$ at 40 GHz Insertion loss 1.5 dB max in 10 GHz
USB Type-C Passive Cable	1	For connecting USB4 Gen 4 microcontroller and test fixture	
USB Type-A to Type-B Cable	1	For connecting USB4 Gen 4 microcontroller and control PC	

2.2 Software Requirements

TABLE 3. SOFTWARE REQUIREMENTS

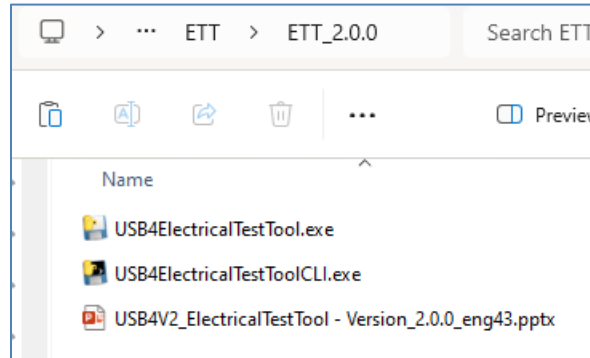
Software	Source
GRL-USB4-V2-TX	GRL Platform Solutions USB4 Version 2.0 Transmitter Test Automation Software – www.grlps.com
VISA (Virtual Instrument Software Architecture) API Software	VISA Software is required to be installed on the host PC running GRL-USB4-V2-TX software. GRL Platform Solutions' software framework has been tested to work with all three versions of VISA available on the Market: 1. NI-VISA: http://www.ni.com/download/ni-visa-17.0/6646/en/ 2. Keysight IO Libraries: www.keysight.com (Search on IO Libraries) 3. Tektronix TekVisa: www.tek.com (Downloads > Software > TekVisa)
USB4 V2 Electrical Test Tool (ETT)	ETT Version 2.0.0 is required. Downloadable from USB-IF's website. See Section 3 for more details.
USB Microcontroller Drivers	USB4 Gen 4 Microcontroller Drivers
MATLAB MCR R2024a (24.1)	Downloadable from MATLAB's website. (Note: This is required to run the USB4 Gen 4 SigTest.)
SigTest Application	SigTest Version 0.9 or above is required. Downloadable from USB-IF's website. (Note: Approval and NDA as a USB-IF Adopter is required to gain access to USB-IF products.)

3 Download and Install USB4 V2 Electrical Test Tool (ETT)

Download the USB4 V2 ETT Version 2.0.0 or above from the USB-IF official website:

<https://www.usb.org/usb4tools>.

Before running ETT, configure the control PC's environment using the instructions in **USB4V2_ElectricalTestTool – Version_2.0.0_eng43.pptx** from the ETT package downloaded from USB-IF.



For USB4 V2 Host Testing:

- The ETT can be loaded on the control PC with the GRL-USB4-V2-TX software. In this case, the USB4 Gen 4 microcontroller is required. The DUT is controlled using a 0.8m USB Type-C passive cable from the microcontroller to the USB4 V2 test fixture.

For USB4 V2 Device Testing:

- **Upstream Facing Port (UFP):** The ETT can be loaded on the control PC with the GRL-USB4-V2-TX software. In this case, the USB4 Gen 4 microcontroller is required. The DUT is controlled using a 0.8m USB Type-C passive cable from the microcontroller to the USB4 V2 test fixture.
- **Downstream Facing Port (DFP):** Connect the DUT's UFP to any USB4 V2 Host via the USB4 Type-C cable. The ETT tools can be loaded on the control PC with the GRL-USB4-V2-TX software. In this case, the USB4 Gen 4 microcontroller is required. The DUT is controlled using a 0.8m USB Type-C passive cable from the microcontroller to the USB4 V2 test fixture. *Take note for the device DUT, if the port under test is a Downstream Facing Port (DFP), a USB4 V2 Host will be required to connect to the DUT's Upwards Facing Port (UFP).*

4 Install and Set Up GRL-USB4-V2-TX Software

This section provides the procedures for installing, configuring and verifying the operation of the GRL-USB4-V2-TX software. It also helps you familiarize with the basic operation of the GRL Platform Solutions software.

The software installer automatically creates shortcuts in the Desktop and Start Menu. To open the software, follow the procedure in the following section.

4.1 Download GRL-USB4-V2-TX Software

Install, launch and set up the GRL-USB4-V2-TX software on the Scope or control PC.

1. If using a control PC, install VISA (Virtual Instrument Software Architecture) on the control PC where the GRL-USB4-V2-TX software is to be used.
2. Download the software ZIP file package from the GRL Platform Solutions support site.

The ZIP file contains:

- **USB4V2TxTestApplicationxxxxxxxxSetup** – Run this on the control PC or Scope to install the GRL-USB4-V2-TX application.
 - **USB4V2TxTestScopeSetupFilesInstallationxxxxxxxxSetup** – Run this on the Scope to install the proper Scope setup files.
3. Launch and set up the GRL-USB4-V2-TX software as follows:
 - a) Open the **GRL** folder from the Windows Start Menu. Click on **GRL – Automated Test Solutions** within the GRL folder to launch the GRL Platform Solutions software framework.

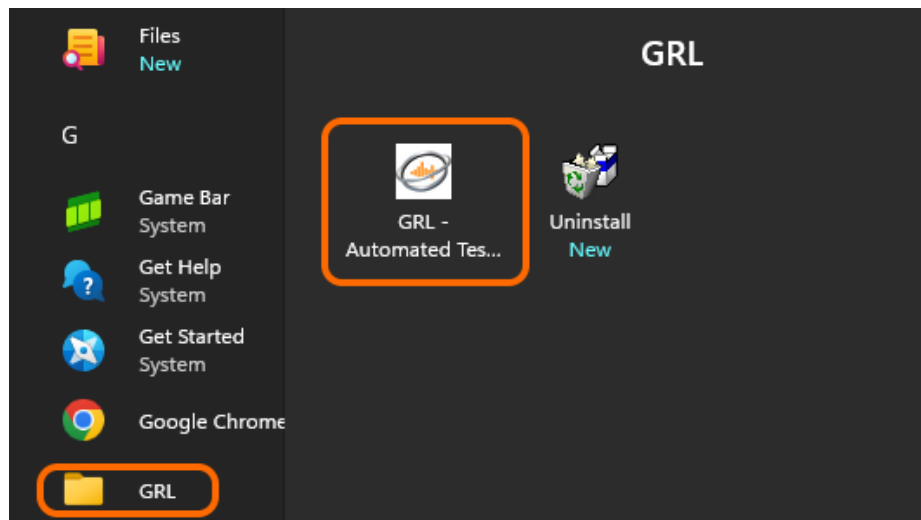


FIGURE 1. LAUNCHING GRL PLATFORM SOLUTIONS SOFTWARE FRAMEWORK

- b) From the **Application → Framework Test Solution** drop-down menu, select **USB4 V2 Tx Test**. If the selection is grayed out, it means that your license has expired.

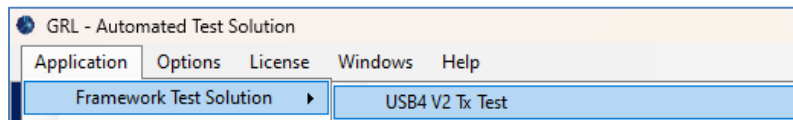


FIGURE 2. LAUNCHING USB4 V2 TX TEST APPLICATION

c) To enable license, go to License → License Info.

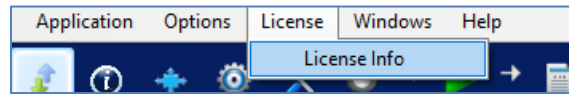


FIGURE 3. LICENSE DETAILS

d) Check the license status for the installed application.

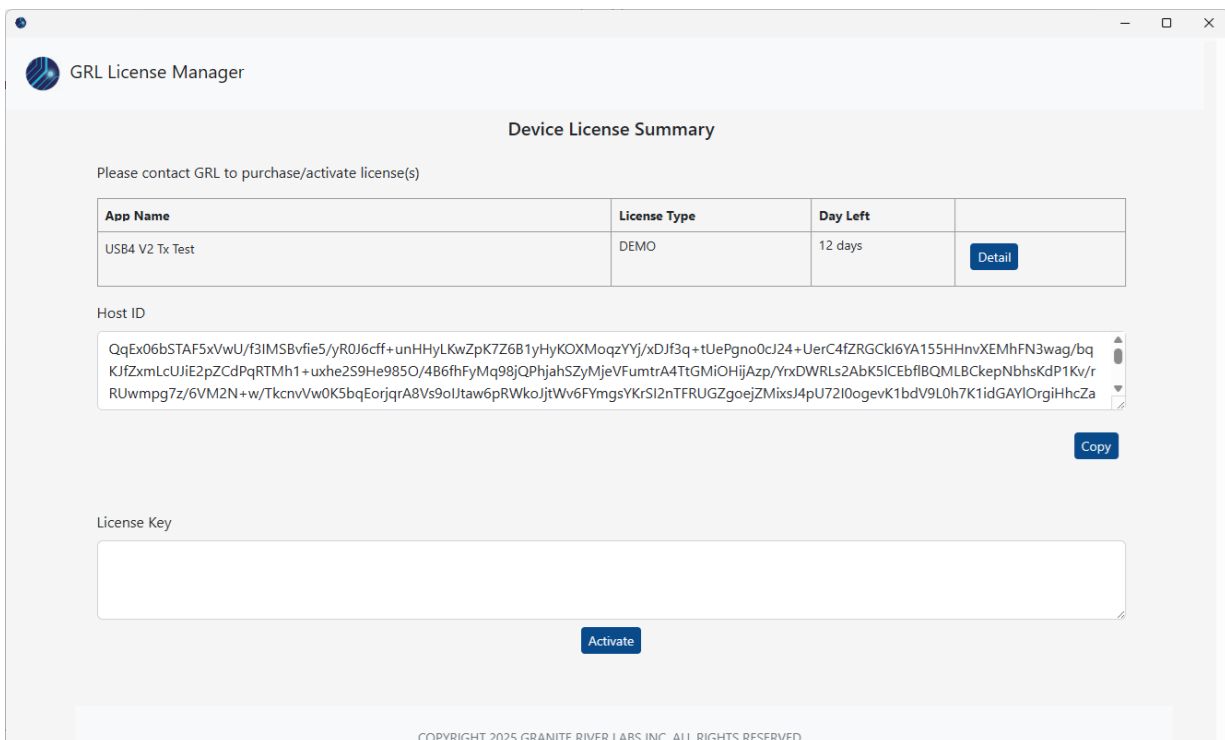


FIGURE 4. CHECK LICENSE FOR INSTALLED APPLICATION

e) Activate License:

- If you have an Activation Key, enter it in the **License Key** field provided and select **Activate**. The installed application is ready for use upon successful activation.
- If you do not have an Activation Key, close the above window to use a demo version of the application over a free 12-day trial period.

Note: Once the 12-day trial period ends, you will need to request an Activation Key to continue using the application on the same computer by contacting support@grlps.com.

4.2 Connect Oscilloscope with Control PC

4.2.1 Connect Keysight Oscilloscope

Connect the Keysight Scope with the control PC through GPIB, USB or LAN.

1. Download the latest version of the Keysight IO Libraries Suite software from the Keysight website and install it on your control PC.
2. When installed successfully, the IO icon () will appear in the taskbar notification area of your control PC.
3. Select the IO icon to launch the **Keysight Connection Expert**.
4. Click Rescan.

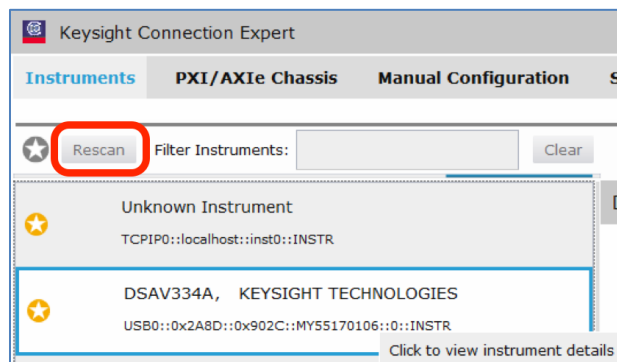


FIGURE 5. KEYSIGHT CONNECTION EXPERT

5. Refresh the system. The Keysight oscilloscope is shown on the left pane and the VISA address is shown on the right pane.

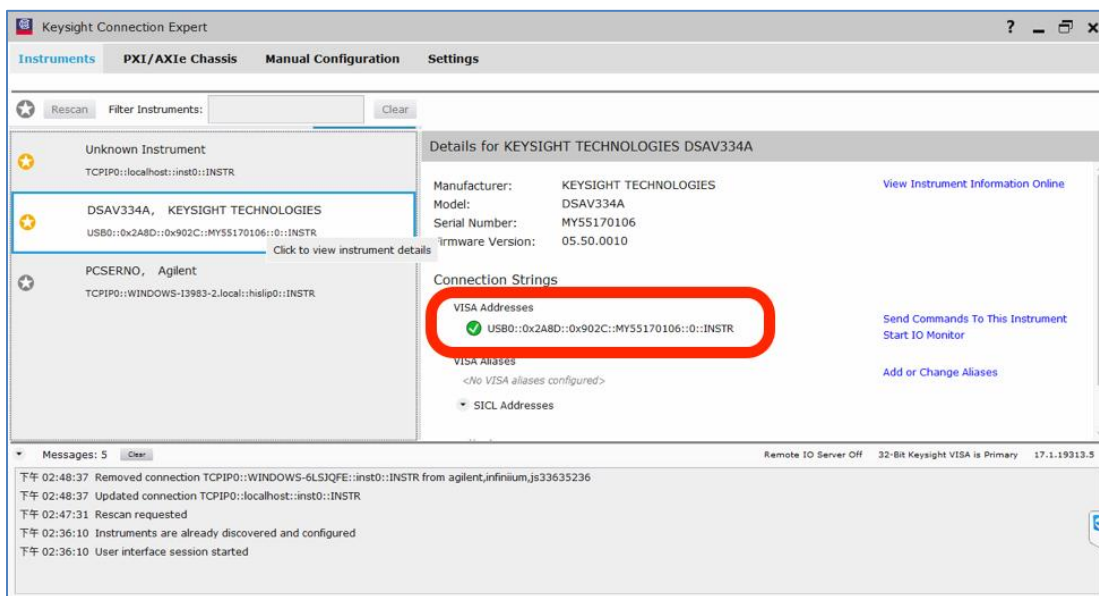


FIGURE 6. OSCILLOSCOPE'S VISA ADDRESS

6. When connecting the Keysight Scope to the controller PC through GPIB/USB, type in the VISA address into the 'Address' field on the Equipment Setup page of the GRL Platform Solutions USB4 V2 Tx Test Application. If the GRL Platform Solutions software is installed on the Keysight Scope, type in the Scope IP address, for example "TCPIP0::127.0.0.1::inst0::INSTR". If the GRL Platform Solutions software is installed on the control PC to control the Scope via LAN, type in the Scope IP address, for example "TCPIP0::192.168.0.100::inst0::INSTR". Note to **omit** the Port number from the address.

If there is error in connection, type in the Scope IP address as "TCPIP0::192.168.0.100::5025::SOCKET".

7. If the GRL Platform Solutions USB4 V2 Tx Test Application is installed on the PC to control the Scope, set up the Remote File Server as described in Section 4.3.1.

4.2.2 Connect Tektronix Oscilloscope

Connect the Tektronix DPOJET Series Scope with the control PC through GPIB, USB or LAN.

1. Download the latest version of the Tektronix TekVISA software from the Tektronix website and install it on the control PC.
2. When installed successfully, open the OpenChoice Instrument Manager application.

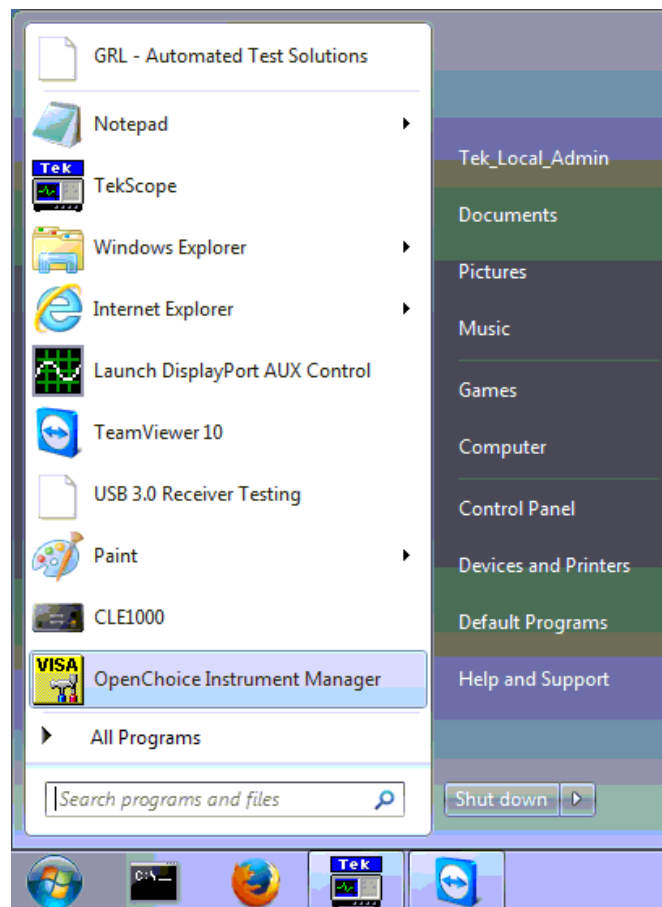


FIGURE 7. OPENCHOICE INSTRUMENT MANAGER IN START MENU

3. The left “Instruments” panel on the OpenChoice Instrument Manager will display all connected instruments. The functional buttons below the “Instruments” panel – “Instrument List Update”, “Search Criteria”, “Instrument Identify” and “Properties” can be used to detect the Scope in case it does not initially appear under “Instruments”.
 - a) “Instrument List Update”: Select to refresh the instrument list and locate new instruments connected to the control PC.
 - b) “Search Criteria”: Select to configure the instrument search function.
 - c) “Instrument Identify”: Select to use a supported programming language to send a query to identify the selected instrument.
 - d) “Properties”: Select to display and view the selected instrument properties.

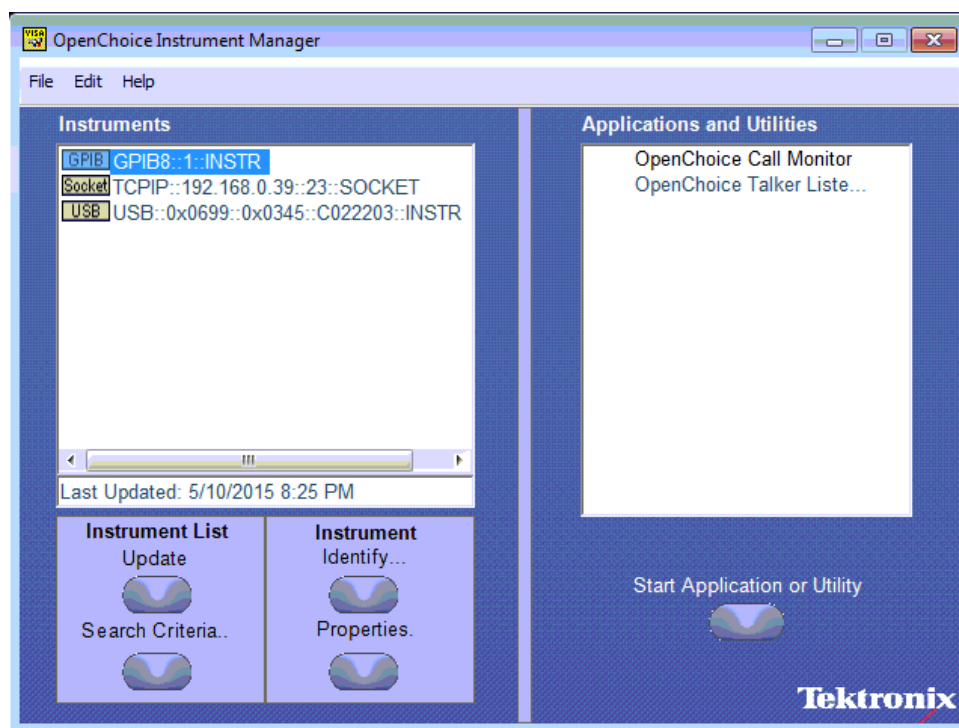


FIGURE 8. OPENCHOICE INSTRUMENT MANAGER MENU

4. If connecting the Tektronix Scope to the control PC via USB, select the “Search Criteria” function to ensure that USB connection is enabled, and then select the “Instrument List Update” function. When the Scope appears on the “Instruments” panel, select it and then go to the “Instrument Identify” function. This will display the model and serial number of the Scope once detected. Select the “Properties” function to view the Scope address.
5. If connecting the Tektronix Scope to the control PC via LAN, the Scope IP address must be pre-determined beforehand. Then select the “Search Criteria” function to ensure that LAN connection is enabled and type in the Scope IP address. When the Scope shows up in the list, select it followed by “Search”. The Scope should then appear on the “Instruments” panel. Select it and access the “Instrument Identify” function to view the Scope model and serial number as well as the “Properties” function to view the Scope address.

6. On the Equipment Setup page of the GRL Platform Solutions USB4 V2 Tx Test Application, type in the Scope address into the 'Address' field. If the GRL Platform Solutions USB4 V2 Tx Test Application is installed on the Tektronix Scope, ensure the Scope is connected via GPIB and type in the GPIB network address, for example "GPIB8::1::INSTR". If the application is installed on the control PC to control the Scope, type in the Scope IP address, for example "TCPIP0::192.168.0.100::inst0::INSTR". Note to **omit** the Port number from the address.
7. If the GRL Platform Solutions USB4 V2 Tx Test Application is installed on the PC to control the Scope, set up the Remote File Server as described in Section 4.3.1.

4.3 Launch and Set Up GRL-USB4-V2-TX Software

1. Launch the GRL Platform Solutions Host Application from the **Start Menu** → **GRL** → **GRL – Automated Test Solutions**.
2. Select **Application** → **Framework Test Solution** → **USB4 V2 Tx Test**.
3. Select the Equipment Setup icon  on the GRL Platform Solutions USB4 V2 Tx Test Application menu.
4. If the oscilloscope is connected to control the PC using LAN, type in the IP Address

of the scope into the "Address" field and click on the "lightning" button . The "lightning" button should turn green  if successfully connected to the Scope.

(Note: If the GRL Platform Solutions software is installed on the **Keysight Scope**, type in the Scope IP address, for example "TCPIP0::127.0.0.1::inst0::INSTR".)

(Note: If the GRL Platform Solutions software is installed on the **Keysight Scope**, and if there is error in connection, type in the Scope IP address as "TCPIP0::192.168.0.35::5025::SOCKET".)

(Note: If the GRL Platform Solutions software is installed on the **Tektronix Scope**, ensure the Scope is connected via GPIB and type in the GPIB network address, for example "GPIB8::1::INSTR".)

If the GRL Platform Solutions software is installed on the PC to control the Scope, type in the Scope IP address, for example "TCPIP0::192.168.0.100::inst0::INSTR". Note to **omit** the Port number from the address. Refer to Section 4.2.1 and 4.2.2 for more information on how to connect the Keysight and Tektronix scopes respectively.

5. The "lightning" button should turn green if successfully connected to the Scope.

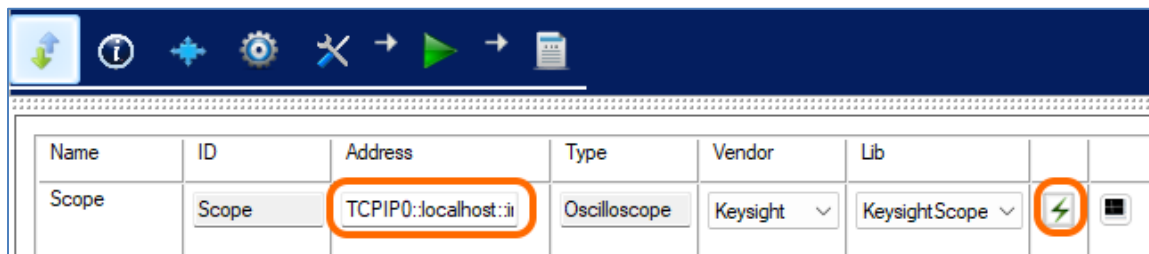


FIGURE 9. CONNECT GRL-USB4-V2-TX SOFTWARE WITH SCOPE

4.3.1 Set Up Remote File Server

1. The **GRLRemoteProxyServer.exe** will also be installed along with the **USB4V2TxTestScopeSetupFilesInstallationxxxxxxxxSetup** on the Scope. The GRLRemoteProxyServer.exe is installed under the C:\GRL\GRLRemoteProxyServer directory.

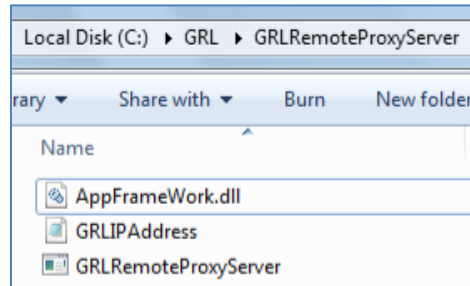


FIGURE 10. INSTALLED GRLREMOTEPROXYSERVER.EXE FILE DIRECTORY

2. If the GRL-USB4-V2-TX software is installed on the PC to control the Scope and SigTest is selected as the test method to be used (refer Section 6.2), the GRLRemoteProxyServer.exe must be run on the Scope to move large waveform files back to the control PC. The GRL Platform Solutions software will then perform post-processing and analysis of these waveforms using SigTest.
3. When running the GRLRemoteProxyServer.exe, make sure that the control PC and Scope are connected to the same network, using IP addresses as in following example:
 - Control PC IP address: 192.168.100.8
 - Scope IP address: 192.168.100.35

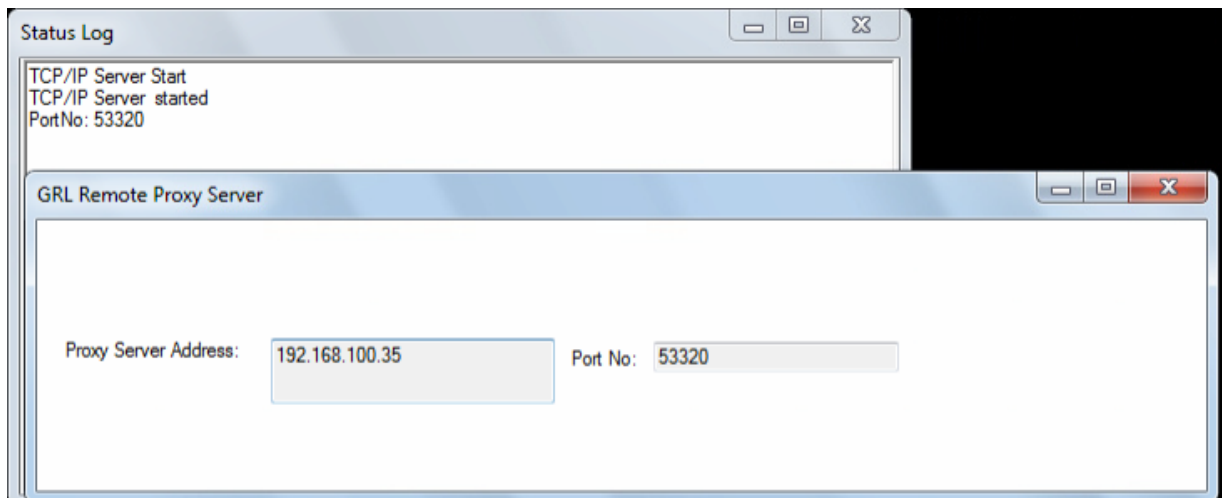


FIGURE 11. VERIFY PROXY SERVER CONNECTION FOR CONTROL PC AND SCOPE

4. On the GRL Platform Solutions USB4 V2 Tx Test Application, configure the “Remote File Server IP Address” and “Remote File Server Port” parameters on the Setup Configuration  page to match the network settings of the GRL Platform Solutions Remote Proxy Server as shown in the example below:

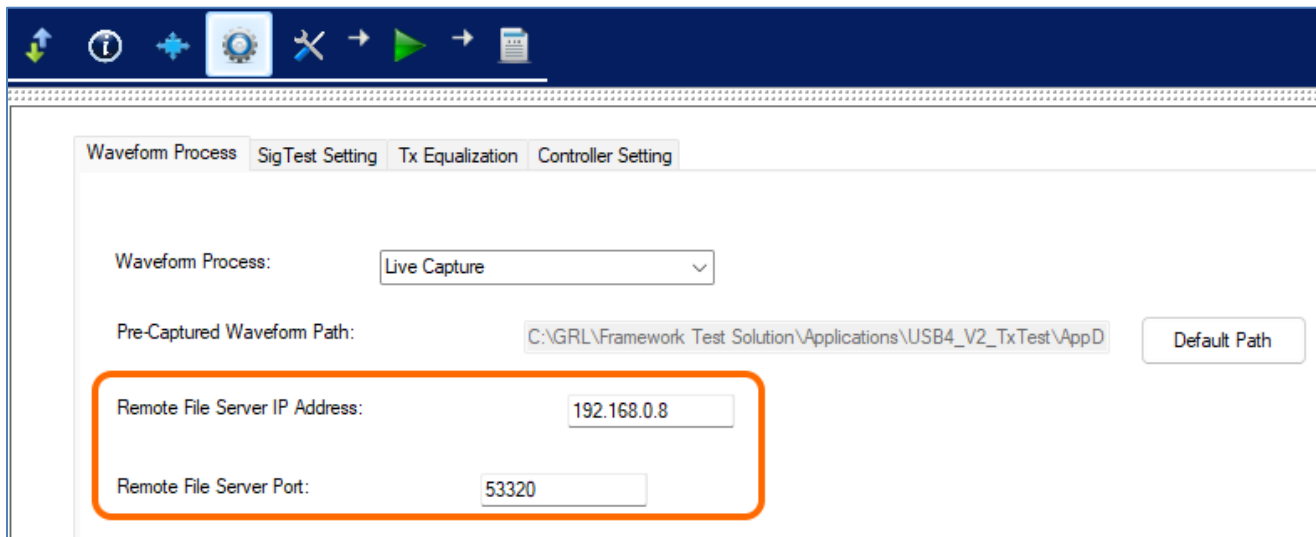


FIGURE 12. CONFIGURE REMOTE PROXY SERVER NETWORK SETTINGS ON GRL PLATFORM SOLUTIONS SOFTWARE

Refer Section 6.2 for more details on parameters available on the Setup Configuration page.

4.3.2 Session Info

Select the  button in the main software menu to access the Test Session Info page. The information provided will be included in the report.

- The **DUT Info** and **Test Info** are input by the user.
- The **Software Info** is automatically populated.

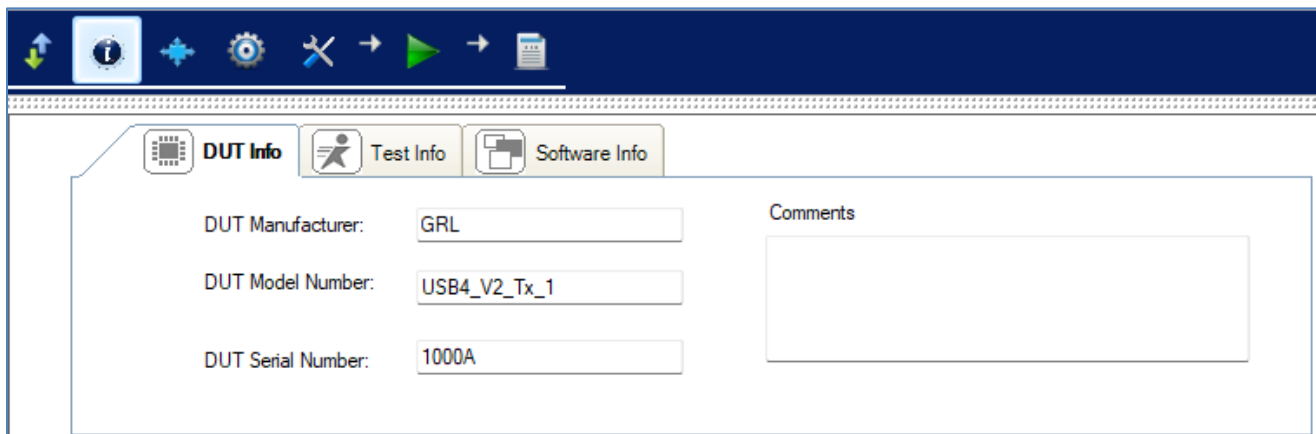


FIGURE 13. SESSION INFO

4.3.3 Test Conditions

Select the  button in the main software menu to access the Test Conditions page.

- a) **Port Option tab:** Select the USB4 Symmetric/Asymmetric test ports of the device under test (DUT).

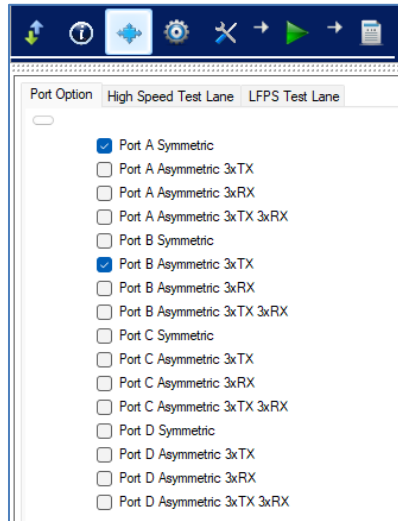


FIGURE 14. SELECT DUT TEST PORT(S)

- b) **High Speed Test Lane tab:** For the above selected test port(s), select the Tx test Lane(s) & configuration (straight/reversed insertion of the USB Type-C connector).

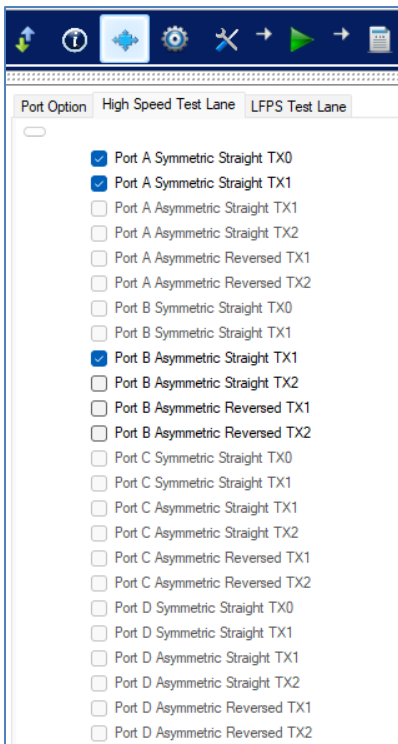


FIGURE 15. SELECT HIGH SPEED TX TEST LANE(S) & CONFIGURATION

- c) **LFPS Test Lane tab:** For the above selected test port(s), select the LFPS test Lane(s) & configuration (straight/reversed insertion of the USB Type-C connector).

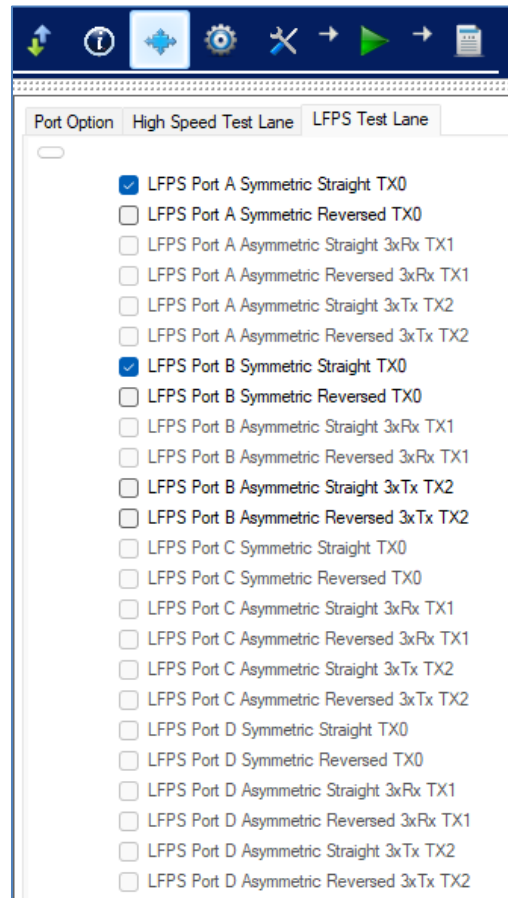


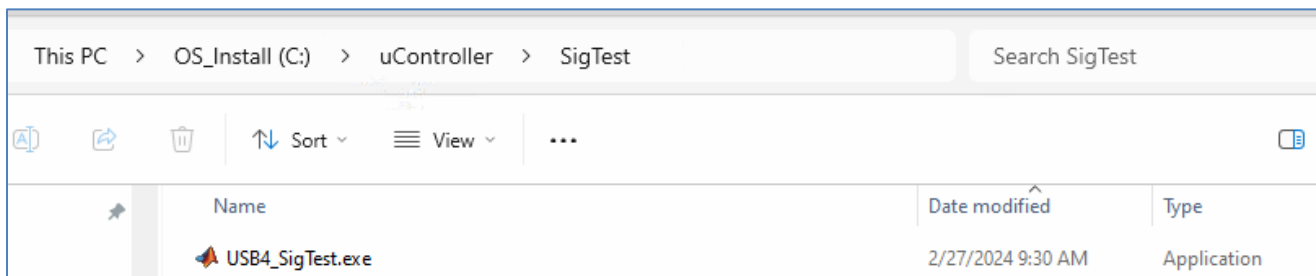
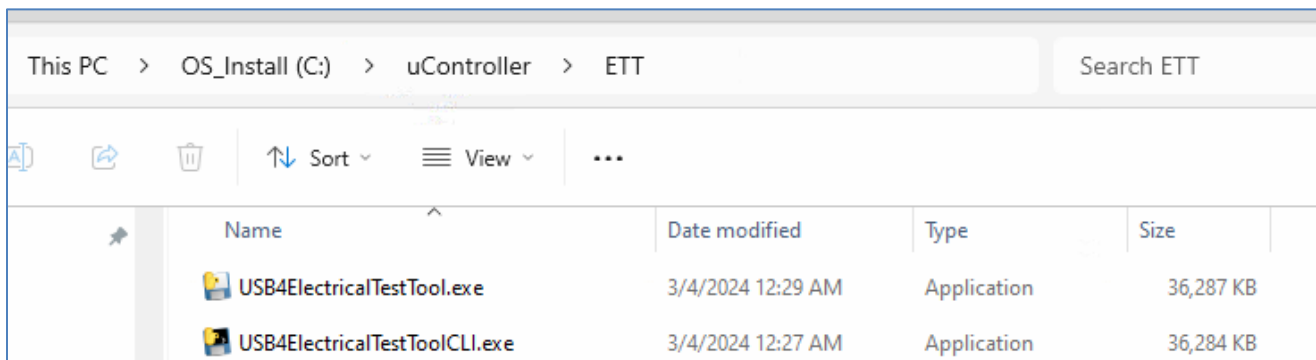
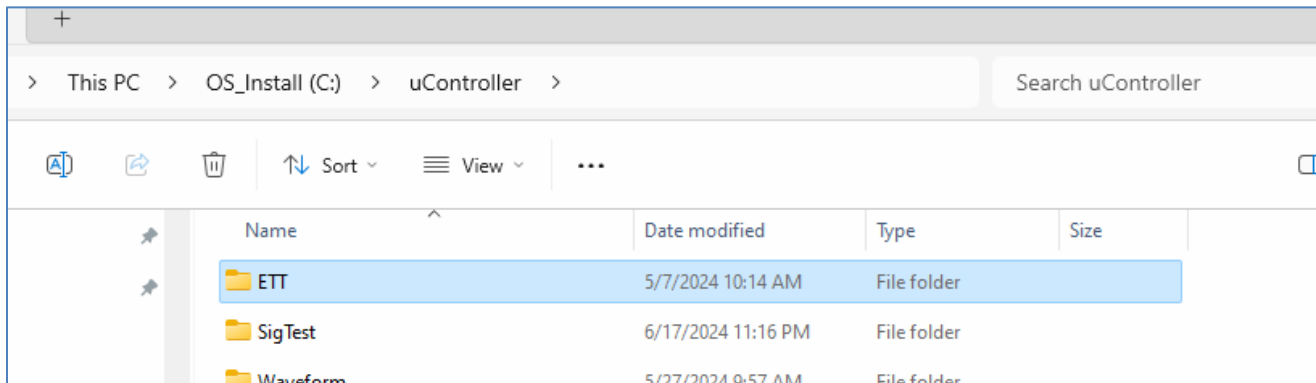
FIGURE 16. SELECT LFPS TEST LANE(S) & CONFIGURATION

5 USB4 V2 Transmitter Test Connection Setups

This section describes the test connection setups for the USB4 Gen 4 Tx DUT using the microcontroller and plug/receptacle test fixture (depending on the DUT configuration). The USB4 V2 ETT is required to run the Tx tests. The ETT can be loaded on the control PC.

Prior to DUT testing, the oscilloscope intrinsic noise measurement shall be performed to capture and save the intrinsic noise waveforms for SigTest processing.

Note: Ensure that the ETT and SigTest software have already been installed to their respective ETT and SigTest folders in the specified directory. Examples as below:



While running tests, the GRL-USB4-V2-TX software will guide the user through each of the selected tests by providing step-by-step instructions. When testing is completed, the GRL-USB4-V2-TX software will generate a test report detailing all results obtained from the test.

Before proceeding with the following sections, first make sure to de-skew SMA cables through the Scope using a Power Divider:

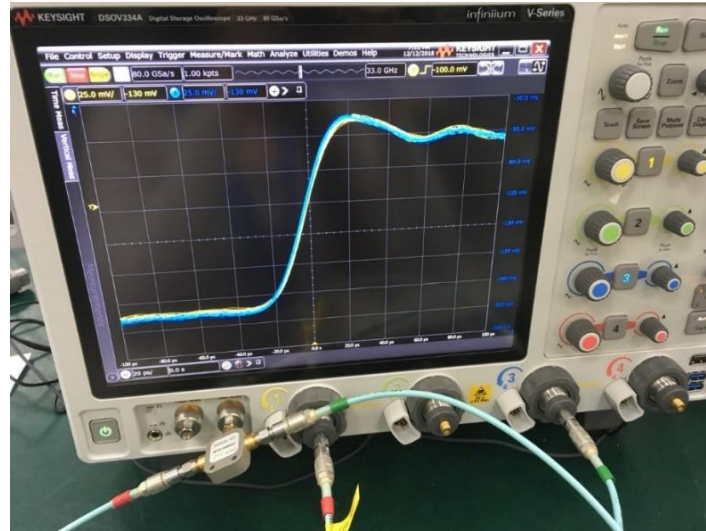


FIGURE 17. PERFORMING SMA CABLE DESKEW

5.1 Connection Setup for Scope Intrinsic Noise Measurement (Pre-Test)

Figure 18 below shows the setup diagram to measure the intrinsic noise generated by the oscilloscope with no external signal applied. The intrinsic noise waveforms will be captured and saved for SigTest processing.

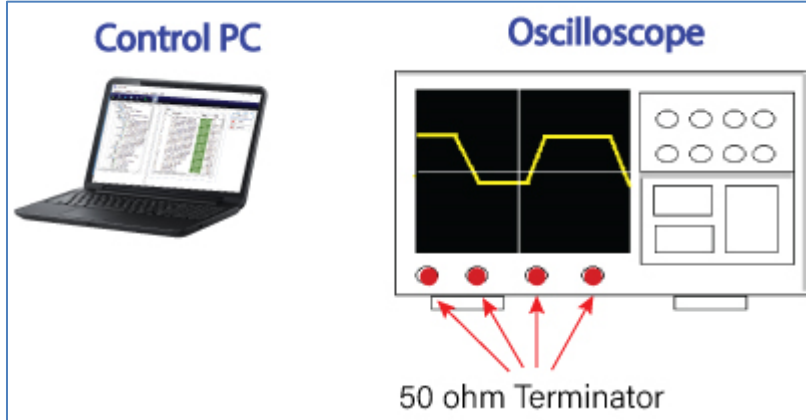


FIGURE 18. SETUP FOR SCOPE INTRINSIC NOISE MEASUREMENT

Connection Step:

Connect 50-ohm terminators to all of the oscilloscope channels (1, 2, 3 and 4).

5.2 Connection Setup for Host DUT

If testing a Host DUT, and the ETT's have been loaded on the Control PC, follow the below procedure:

1. Connect the equipment as follows:

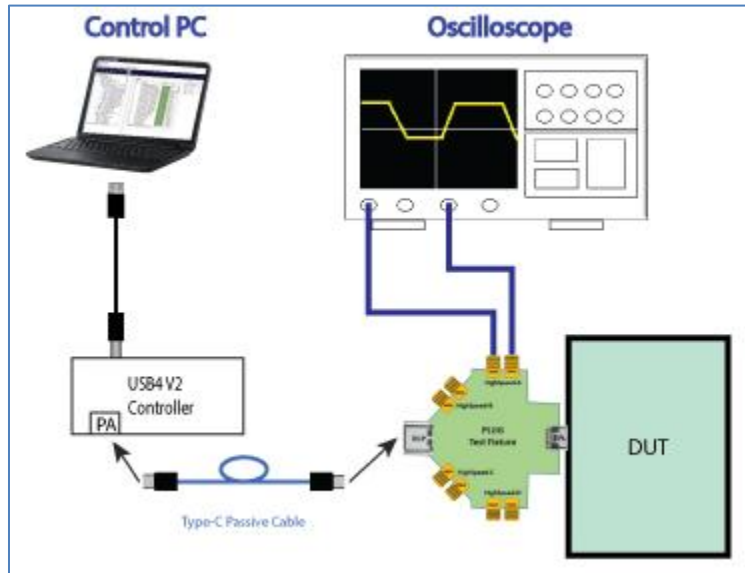


FIGURE 19. TEST SETUP FOR HOST DUT

2. Connect a USB Type-C passive cable in between the USB4 V2 microcontroller and the plug test fixture's receptacle port.
3. Connect the plug test fixture to the DUT's test port.
4. Based on the test port configuration from Test Conditions (under Section 4.3.3), connect cables from the oscilloscope Port 1 and 3 to the first test lane pair on the test fixture's connectors.
5. For 2-lane testing, connect another set of cables from the oscilloscope Port 2 and 4 to the second test lane pair on the test fixture's connectors, according to the test port configuration from Test Conditions.
6. Connect a USB Type-A to Type-B cable from the USB4 V2 microcontroller to the control PC.

5.3 Connection Setup for DUT Symmetric Lanes

If the Host/Device DUT supports the symmetric link type, and the ETT's have been loaded on the Control PC, follow the below procedure.

1. Connect the equipment as follows:

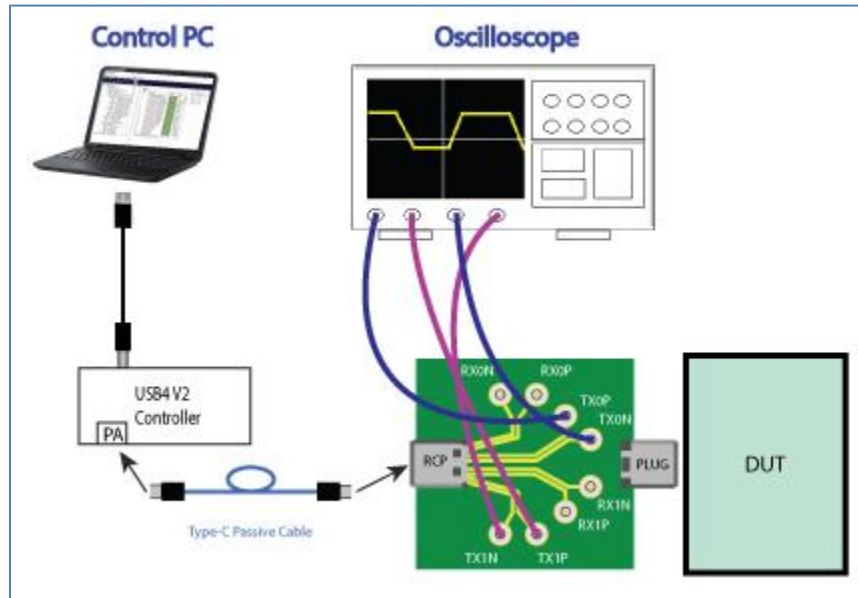


FIGURE 20. TEST SETUP FOR DUT SYMMETRIC LANES

2. Connect a USB Type-C passive cable in between the USB4 V2 microcontroller and the receptacle test fixture.
3. Connect the plug port of the test fixture to the DUT's test port.
4. Based on the test port configuration from Test Conditions (under Section 4.3.3), connect cables from the oscilloscope Port 1 and 3 to the TX0 test lane pair on the test fixture's connectors.
5. For 2-lane testing, connect another set of cables from the oscilloscope Port 2 and 4 to the TX1 test lane pair on the test fixture's connectors, according to the test port configuration from Test Conditions.
6. Connect a USB Type-A to Type-B cable from the USB4 V2 microcontroller to the control PC.

5.4 Connection Setup for DUT Asymmetric Lanes

5.4.1 Asymmetric Straight Insertion Lanes

If the Host/Device DUT supports the asymmetric link type with straight insertion of the USB Type-C connector, and the ETT's have been loaded on the Control PC, follow the below procedure.

1. Connect the equipment as follows:

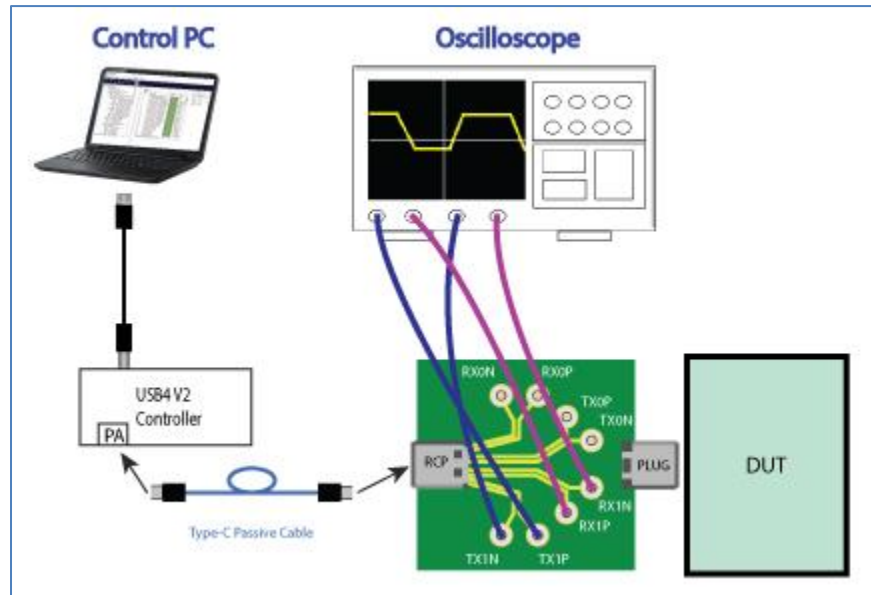


FIGURE 21. TEST SETUP FOR DUT ASYMMETRIC STRAIGHT INSERTION LANES

2. Connect a USB Type-C passive cable in between the USB4 V2 microcontroller and the receptacle test fixture.
3. Connect the plug port of the test fixture to the DUT's test port.
4. Based on the test port configuration from Test Conditions (under Section 4.3.3), connect cables from the oscilloscope Port 1 and 3 to the TX1 test lane pair on the test fixture's connectors.
5. For 2-lane testing, connect another set of cables from the oscilloscope Port 2 and 4 to the RX1 test lane pair on the test fixture's connectors, according to the test port configuration from Test Conditions.
6. Connect a USB Type-A to Type-B cable from the USB4 V2 microcontroller to the control PC.

5.4.2 Asymmetric Reversed Insertion Lanes

If the Host/Device DUT supports the asymmetric link type with reversed insertion of the USB Type-C connector, and the ETT's have been loaded on the Control PC, follow the below procedure.

1. Connect the equipment as follows:

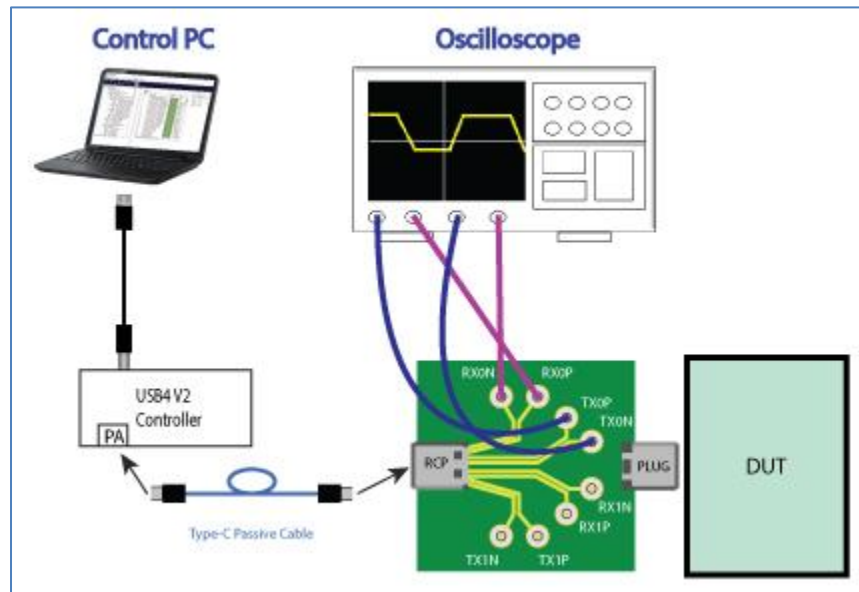


FIGURE 22. TEST SETUP FOR DUT ASYMMETRIC REVERSED INSERTION LANES

2. Connect a USB Type-C passive cable in between the USB4 V2 microcontroller and the receptacle test fixture.
3. Connect the plug port of the test fixture to the DUT's test port.
4. Based on the test port configuration from Test Conditions (under Section 4.3.3), connect cables from the oscilloscope Port 1 and 3 to the TX0 test lane pair on the test fixture's connectors.
5. For 2-lane testing, connect another set of cables from the oscilloscope Port 2 and 4 to the RX0 test lane pair on the test fixture's connectors, according to the test port configuration from Test Conditions.
6. Connect a USB Type-A to Type-B cable from the USB4 V2 microcontroller to the control PC.

6 DUT Testing with GRL-USB4-V2-TX Software

6.1 Select DUT Tests

The tests selection panel allows tests that need to be performed to be selected.

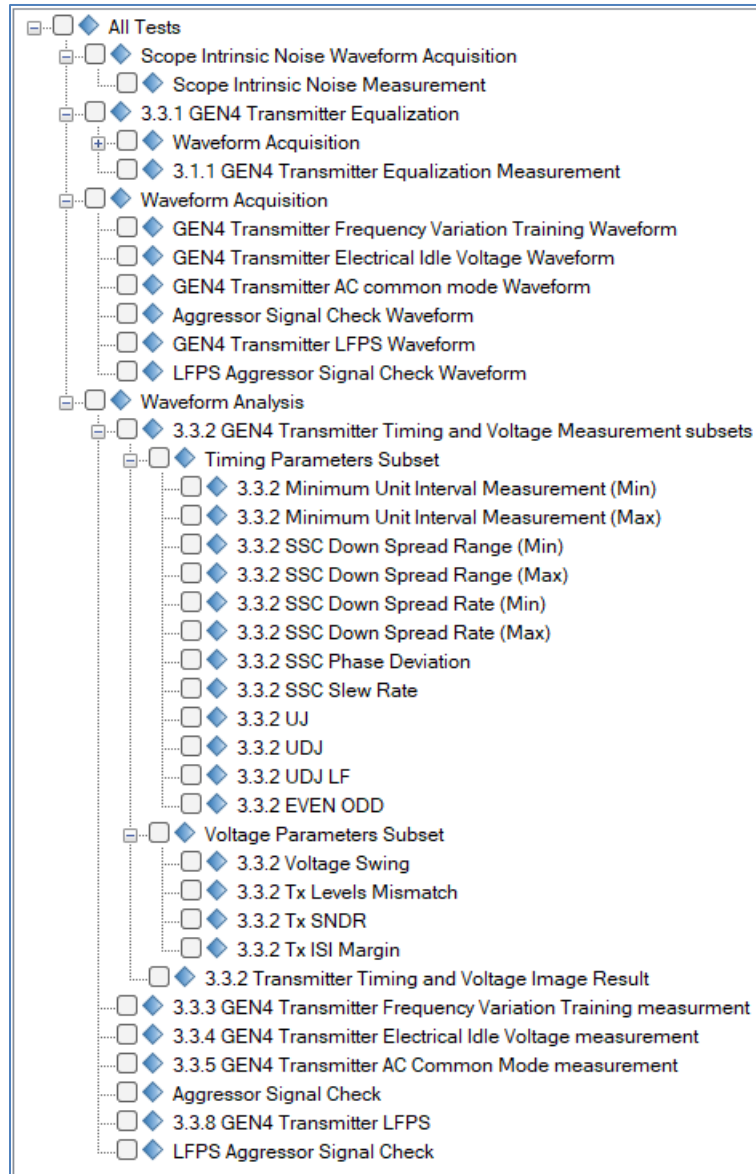


FIGURE 23. SELECT DUT TESTS

The GRL-USB4-V2-TX software will walk through the user step by step while tests are being run.

Note: The marking shown on the left of each calibration/test parameter indicates the status of the calibration/test result of the parameter. In the above example,  indicates that calibration/testing has not been run for the specific calibration/test parameter. When calibration/testing has been run and completed successfully for the specific calibration/test parameter with a Pass result, this will be indicated with .

6.2 Setup Configuration

Select the  button in the main software menu to access the Setup Configuration page.

6.2.1 Select Test Mode

Select the checkbox to run tests in compliance mode for the DUT to meet the USB4 V2 Tx CTS compliance.

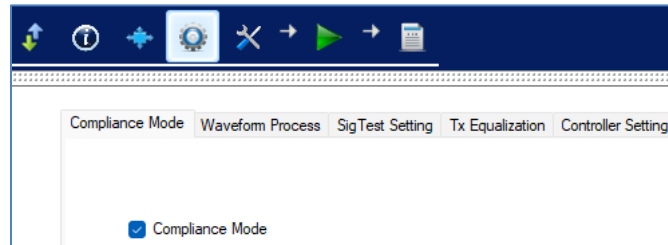


FIGURE 24. SELECT TEST MODE

6.2.2 Set Up Tx Waveform Processing and Remote File Server

Select the **Waveform Process** tab and make the following configuration:

- Select **Live Capture** to acquire USB4 Gen 4 Tx waveforms using the GRL-USB4-V2-TX software, or select **Process Pre-captured waveforms** to use existing waveforms that have been previously captured and saved for analysis. *Note that selecting “Process Pre-captured waveforms” will remove the “Waveform Acquisition” group from the test selection panel.*
- If “Process Pre-captured waveforms” is selected, enter the directory of the saved waveform file in the **Pre-Captured Waveform Path** field.
- Enter the **Remote File Server IP Address** and **Port** number for the GRL Platform Solutions Remote Proxy Server. See Section 4.3.1 on how to set up the remote file server.
- Select either two or four oscilloscope channels are being connected under **Scope Channel Count**.

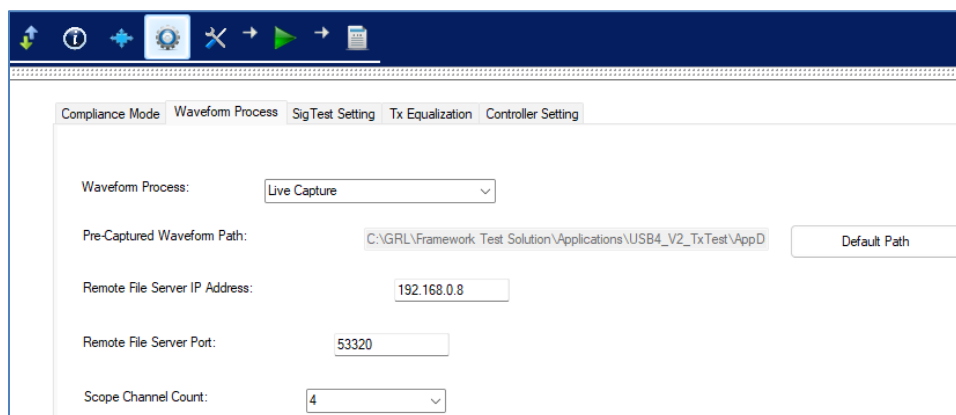


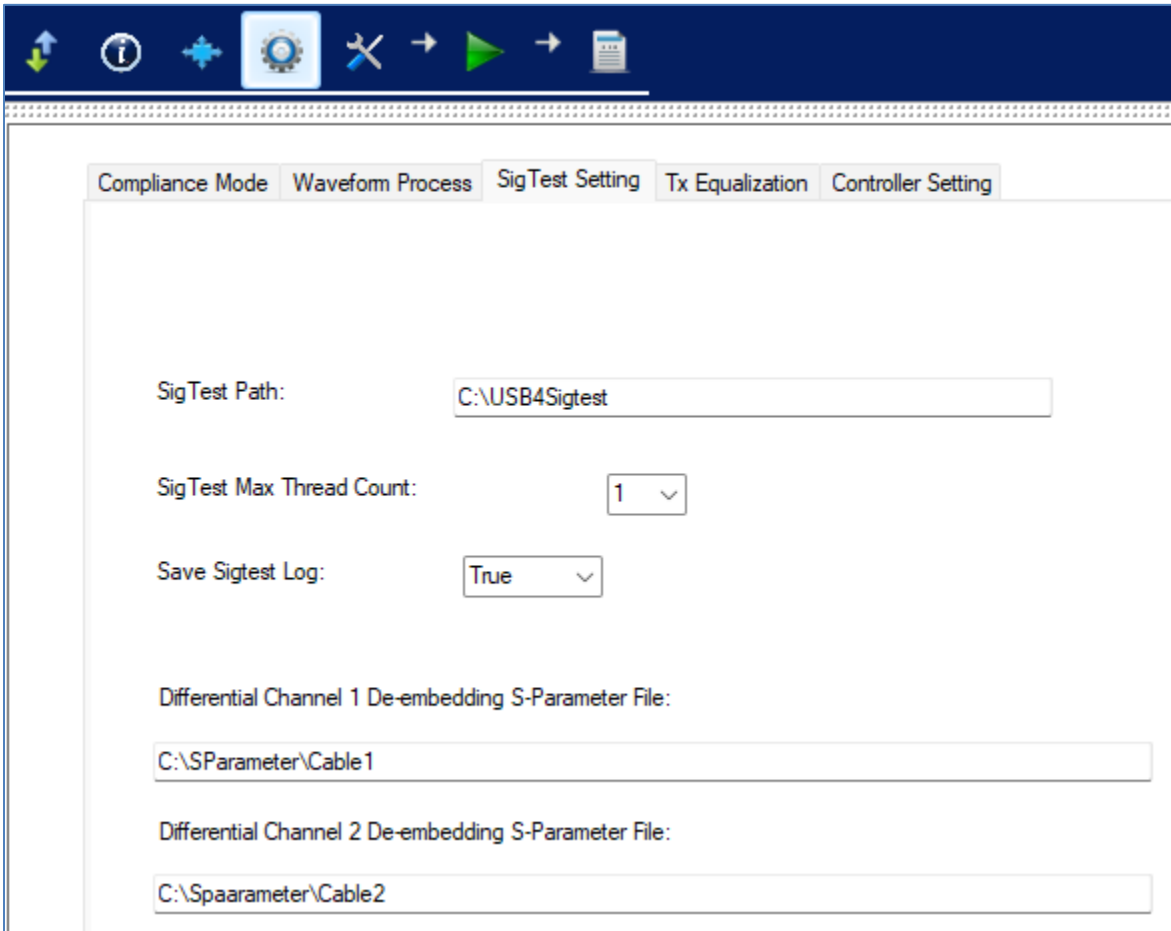
FIGURE 25. SET UP TX WAVEFORM PROCESSING AND REMOTE FILE SERVER

6.2.3 Set Up SigTest Environment

SigTest allows waveforms captured with the oscilloscope to be analyzed and checked against the specified pass/fail criteria.

Select the **SigTest Setting** tab to set up the SigTest components as described below:

Note: Make sure that the SigTest application is already installed in the test controller system.



The screenshot shows the 'SigTest Setting' tab in a software application. The interface includes a toolbar at the top with icons for navigation and execution. Below the toolbar, there are five tabs: 'Compliance Mode', 'Waveform Process', 'SigTest Setting' (which is active), 'Tx Equalization', and 'Controller Setting'. The 'SigTest Setting' tab contains several configuration fields:

- SigTest Path:** A text box containing 'C:\USB4Sigtest'.
- SigTest Max Thread Count:** A dropdown menu set to '1'.
- Save Sigtest Log:** A dropdown menu set to 'True'.
- Differential Channel 1 De-embedding S-Parameter File:** A text box containing 'C:\SParameter\Cable1'.
- Differential Channel 2 De-embedding S-Parameter File:** A text box containing 'C:\Spaarameter\Cable2'.

FIGURE 26. CONFIGURE SIGTEST

- Enter the full **SigTest Path** in the test controller system. Ensure that the SigTest file name is "USB4_SigTest.exe".
- Select the **SigTest Max Thread Count** to generate the maximum process threads for checking the Rx device functionality when running SigTest.
- Set the **Save SigTest Log** to "True" to generate a detailed log of all activities during the SigTest run.
- Enter the **SMA Cable De-embedding S-Parameter File** paths for the oscilloscope differential channels 1 & 2.

6.2.4 Set Up Tx Equalization

Select the **Tx Equalization** tab and make the following configuration:

Select from the preset coefficient range of 0 to 41 to be applied when executing the “3.3.1 GEN4 Transmitter Equalization” test case. This is to ensure that the transmitter equalization Pre-shoot/ De-emphasis falls within the limits of the USB4 V2 specification. This will also locate the best preset of the test lane upon resetting of the test.

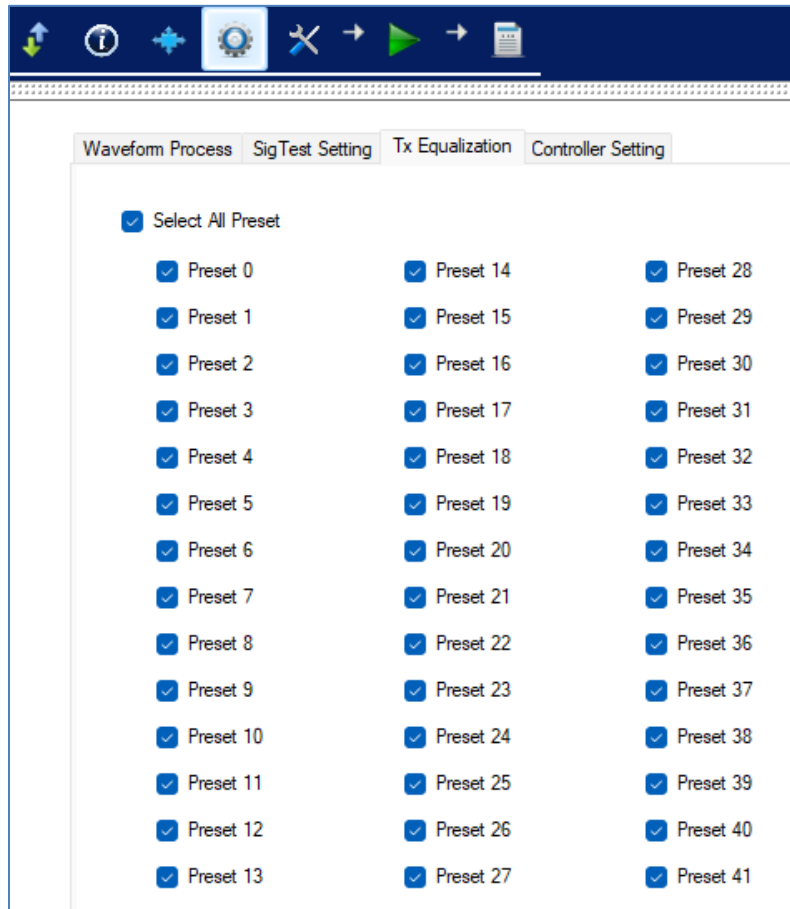


FIGURE 27. SELECT TX EQUALIZATION PRESET COEFFICIENT

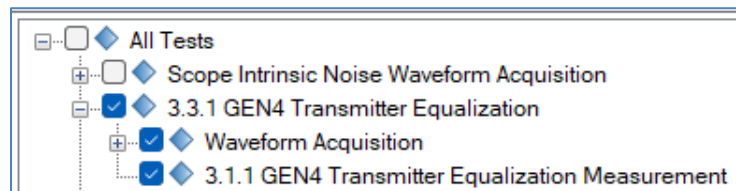


FIGURE 28. SELECT 3.3.1 GEN4 TRANSMITTER EQUALIZATION TEST CASE

6.2.5 Set Up USB4 V2 Controller

Select the **Controller Setting** tab to call the USB4 V2 ETT script from a remote host or use a manual control method as described below:

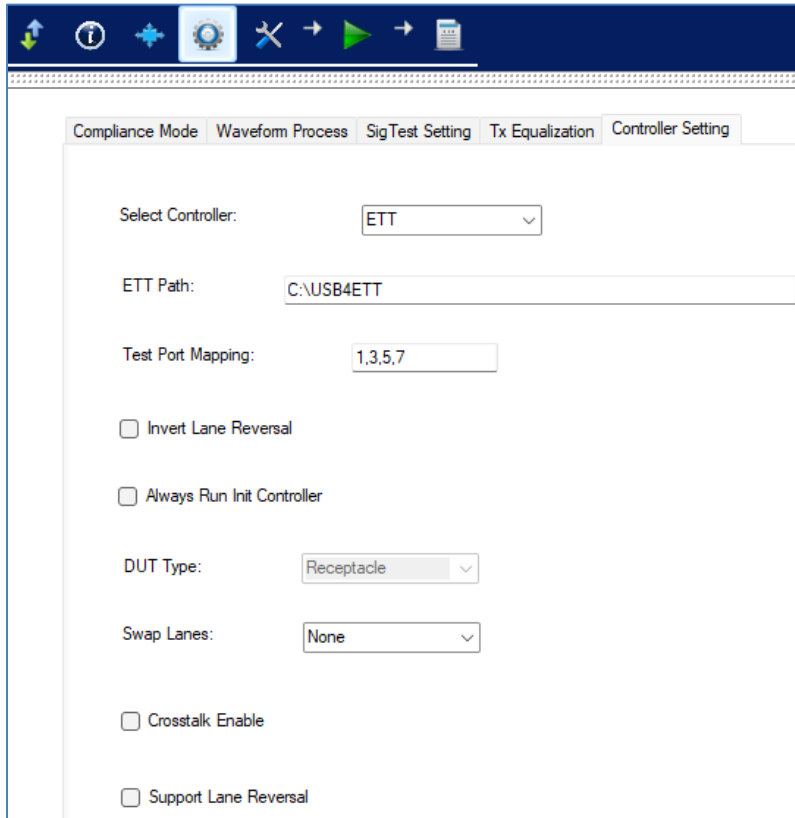


FIGURE 29. CONFIGURE USB4 V2 CONTROLLER

- Select the **Controller** mode as ETT or Manual (using manual control).
- If **ETT** is selected, set the **ETT Path** to the location where the ETT script is installed on the host PC.
- If the Device DUT is being used, specify the ETT API argument “-Dp”(DUT Test Port), {PortA,PortB,PortC,PortD} in the **Test Port Mapping** field.
- Select the **Invert Lane Reversal** checkbox to enable reversed insertion of the USB Type-C connector.
- Select the **Always Run Init Controller** checkbox to enable the selected USB4 V2 controller to be always running.
- Select the **DUT Type** to map to the ETT DUT Type configuration.
- To perform lane switching for the DUT, select the router and/or re-timer setup in the **Swap Lanes** field.
- Set the controller option to enable the crosstalk setting by selecting the **Crosstalk Enable** checkbox.
- Select the **Support Lane Reversal** checkbox to enable reverse insertion of the USB Type-C connector.

6.3 Configure Test Parameters

Select the  button in the main software menu to access the Configurations page. Set the parameters required for the test setup.

To return all parameters to their default values, select the ‘Set Default’ button.

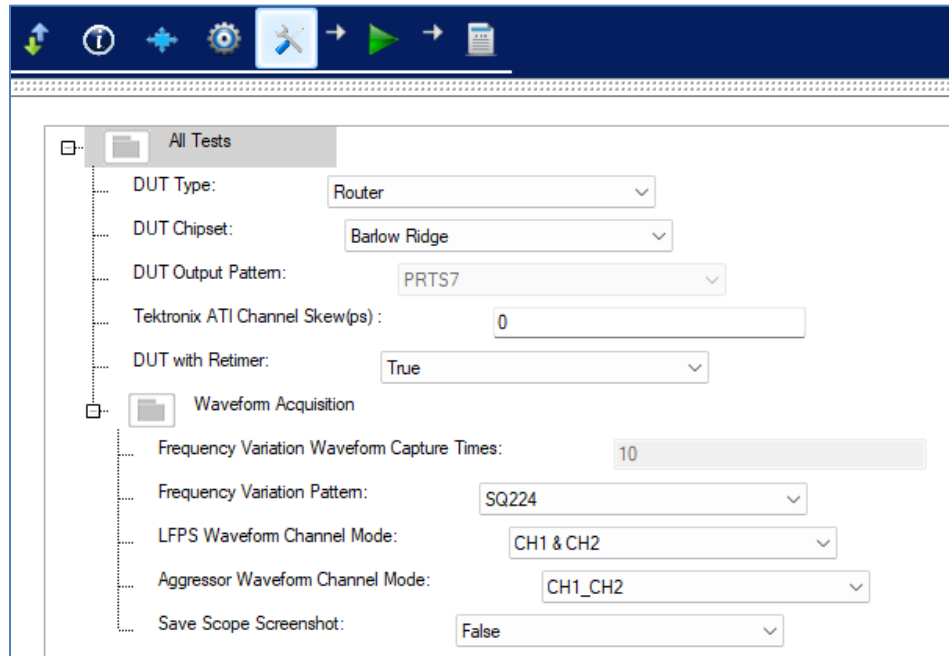


FIGURE 30. TEST CONFIGURATION PAGE

TABLE 4. TEST PARAMETERS

Parameter	Description
DUT Type	Select “Router” or “Captive Device” as supported by the transmitter DUT.
DUT Chipset	If the Intel chipset model is selected as Barlow Ridge, the ETT will not enable the crosstalk command.
DUT Output Pattern	PRTS7 (random stress pattern for eye/jitter/BER measurements) will be used as the compliance pattern output by the DUT.
Tektronix ATI Channel Skew (ps)	If using the Tektronix ATI based scope, enter the channel skew or timing to perform alignment of the scope channels.
DUT with Retimer	Select “True” if the DUT has a re-timer on board.
Frequency Variation Waveform Capture Times	Frequency variation is set to be performed over the signal transmitted by the re-timer for 10 times.
Frequency Variation Pattern	Select the square-wave (SQ) frequency variation patterns of either SQ224 (PAM3 based) or SQ128 (legacy NRZ based).
LFPS Waveform	Select whether the LFPS waveform measurements are taken as

Channel Mode	a single-ended channel 1 (CH1) / channel 2 (CH2)-only capture or in differential mode (CH1 & CH2 or CH2 & CH1 pair).
Aggressor Waveform Channel Mode	Select whether the oscilloscope is using independent single-ended Channel 1 (CH1) or Channel 2 (CH2) or Channel 1 and Channel 2 as a differential pair (CH1_CH2 / CH2_CH1) to observe the aggressor lane signal.
Save Scope Screenshot	Select “True” to capture and save the screenshot of each waveform acquisition on the oscilloscope to a file.

6.4 Perform Tx Tests

The following example describes how to use the GRL-USB4-V2-TX software to run a typical automation test on the Tx DUT lanes.

Note: Before running measurements, make sure that the proper test setups for the DUT as described in Section 5 have been completed.

1. Select the required DUT port(s) and lane configuration to be tested under Test Conditions . Refer Section 4.3.3.
2. Set up the waveform capture/processing method and remote file server under Setup Configuration . Refer Section 6.2.2.
3. Set up SigTest for post-processing analysis of the captured waveforms under Setup Configuration . Refer Section 6.2.3.
4. Set up the presets for Tx Equalization under Setup Configuration . Refer Section 6.2.4.
5. Set up the USB4 V2 ETT or manual test controller under Setup Configuration . Refer Section 6.2.5.
6. Select the Tx tests to be run. Refer Section 6.1.
7. Set up the test parameters for the selected tests under Configurations . Refer Section 6.3.
8. Go to the Run Tests  page and click on the **Run Tests** button to begin testing. Refer Section 6.5.
9. Follow the software instructions step by step to set up the connections and perform the selected tests.
10. Once tests have completed, the test results will be saved automatically and populated on the Report  page. Select the **Generate report** button to view the details of each result. Refer Section 7.

6.5 Run Tests

Select the  button in the main software menu to access the Run Tests page.

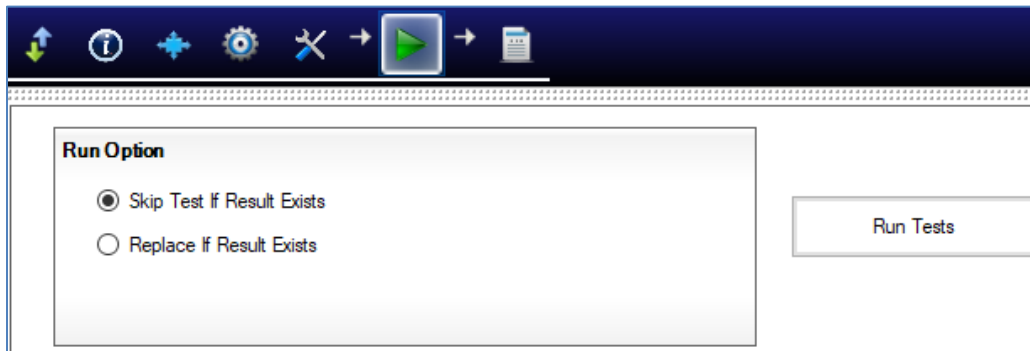


FIGURE 31. RUN TESTS PAGE

TABLE 5. RUN OPTIONS

Run Option	Description
Skip Test If Result Exists	If previous test or calibration results exist, then the software will <i>skip</i> the tests/calibration steps that have existing reports.
Replace If Result Exists	If previous test or calibration results exist, then the software will replace each step in the test/calibration with new results.

If you need to re-run only certain calibration/tests on certain conditions, delete these calibration/tests from the Report page and Run with **Skip Test If Result Exists**. The GRL-USB4-V2-TX software will keep track and only perform the calibration/tests that are missing in the report. See figure example below.

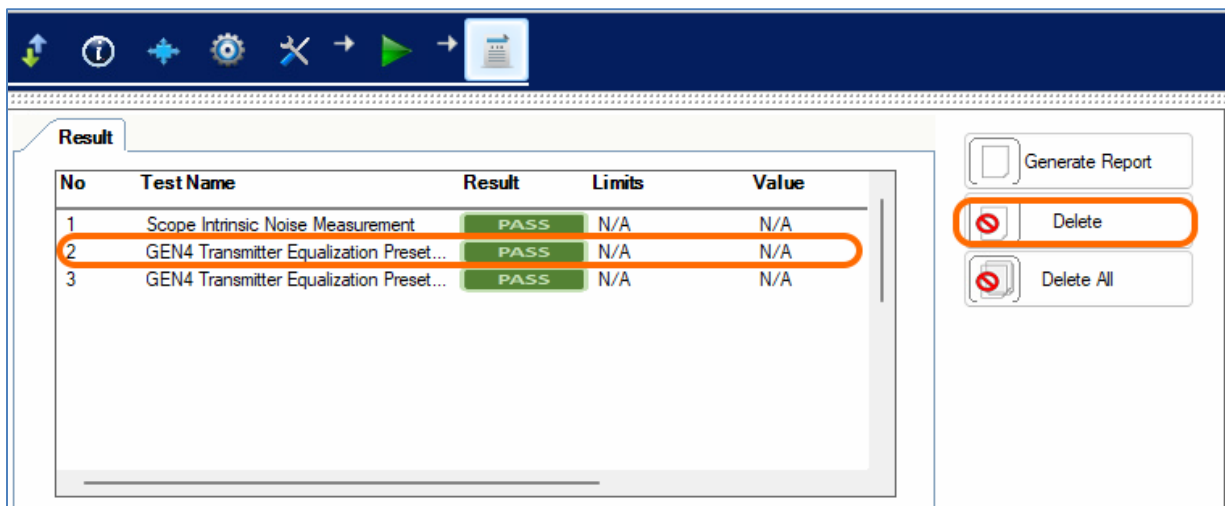


FIGURE 32. DELETE CALIBRATION/TEST RESULTS EXAMPLE

7 Test Results and Reports with GRL-USB4-V2-TX Software

The **Report**  page displays the results from all calibration and test runs. If some of the results are not desired, they can be individually deleted by selecting the **Delete** button. Also for a PDF report, select the **Generate report** button.

7.1 Generate Test Report

Select the **Generate report** button for the detailed calibration and tests report.

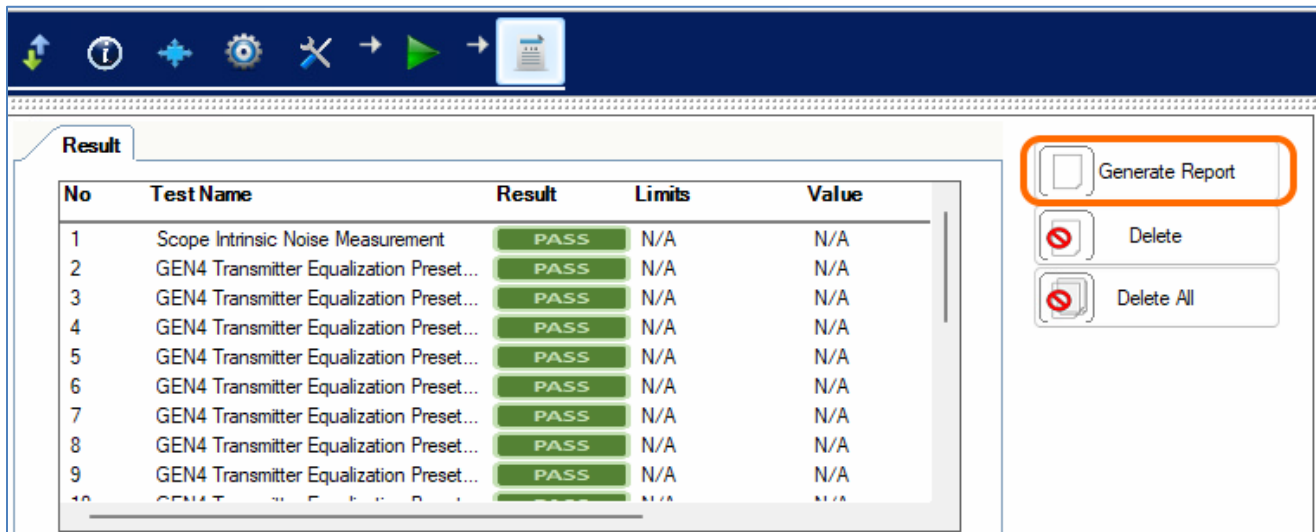


FIGURE 33. GENERATE REPORT PAGE

7.1.1 Test Session Information

This portion is populated from the information entered in the **Session Info** page (refer Section 4.3.2).

USB4 V2 Tx Test Report	
DUT Information	
DUT Manufacturer	: GRL
DUT Model Number	: USB4_V2-Tx_1
DUT Serial Number	: 1000A
DUT Comments	:
Test Information	
Test Lab	: Granite River Labs
Test Operator	: David
Test Date	: 25 August 2024
Software Version	
Software Revision	: 1.00.18

FIGURE 34. TEST SESSION INFORMATION

7.1.2 Test Results Summary Table

This portion is populated from the tests and calibration performed and their results. This gives a summarized view of all the results and test conditions.

USB4 V2 Tx Test Report					
No	TestName	Limits	Value	Results	Lane
1	GEN4 Transmitter Equalization Preset 0 Waveform Acquisition	N/A	N/A	Pass	L0
2	GEN4 Transmitter Equalization Preset 1 Waveform Acquisition	N/A	N/A	Pass	L0
3	GEN4 Transmitter Equalization Preset 2 Waveform Acquisition	N/A	N/A	Pass	L0
4	GEN4 Transmitter Equalization Preset 3 Waveform Acquisition	N/A	N/A	Pass	L0
5	GEN4 Transmitter Equalization Preset 4 Waveform Acquisition	N/A	N/A	Pass	L0
6	GEN4 Transmitter Equalization Preset 5 Waveform Acquisition	N/A	N/A	Pass	L0
7	GEN4 Transmitter Equalization Preset 6 Waveform Acquisition	N/A	N/A	Pass	L0
8	GEN4 Transmitter Equalization Preset 7 Waveform Acquisition	N/A	N/A	Pass	L0
9	GEN4 Transmitter Equalization Preset 8 Waveform Acquisition	N/A	N/A	Pass	L0
10	GEN4 Transmitter Equalization Preset 9 Waveform Acquisition	N/A	N/A	Pass	L0
11	GEN4 Transmitter Equalization Preset 10 Waveform Acquisition	N/A	N/A	Pass	L0
12	GEN4 Transmitter Equalization Preset 11 Waveform Acquisition	N/A	N/A	Pass	L0
13	GEN4 Transmitter Equalization Preset 12 Waveform Acquisition	N/A	N/A	Pass	L0
14	GEN4 Transmitter Equalization Preset 13 Waveform Acquisition	N/A	N/A	Pass	L0
15	GEN4 Transmitter Equalization Preset 14 Waveform Acquisition	N/A	N/A	Pass	L0
16	GEN4 Transmitter Equalization Preset 15 Waveform Acquisition	N/A	N/A	Pass	L0
17	GEN4 Transmitter Equalization Preset 16 Waveform Acquisition	N/A	N/A	Pass	L0
18	GEN4 Transmitter Equalization Preset 17 Waveform Acquisition	N/A	N/A	Pass	L0

FIGURE 35. TEST RESULTS SUMMARY TABLE EXAMPLE

7.1.3 Test Result Details

This portion is populated from each of the test and calibration results. Here the results are explained in depth with supporting data points and screenshots.

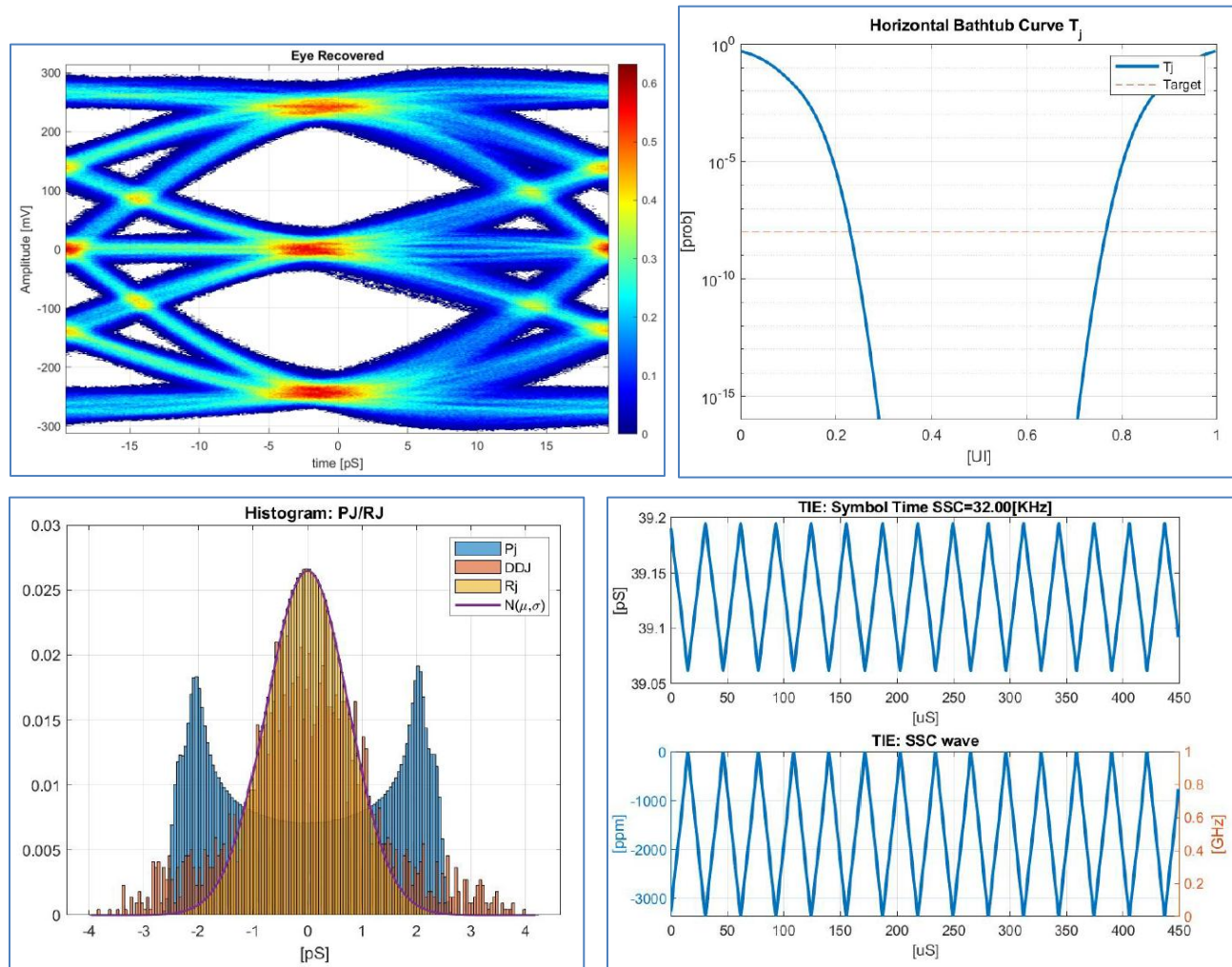


FIGURE 36. TEST RESULT DETAILS EXAMPLE

7.2 Delete Reports

If some of the results are not desired, they can be individually deleted by selecting the **Delete** button.

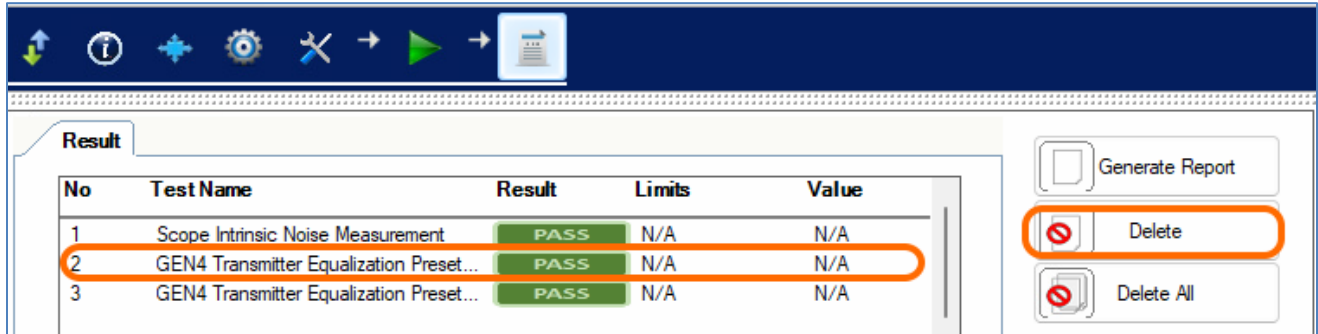


FIGURE 37. DELETE INDIVIDUAL CALIBRATION/TEST RESULTS EXAMPLE

To remove all results, select the **Delete All** button.

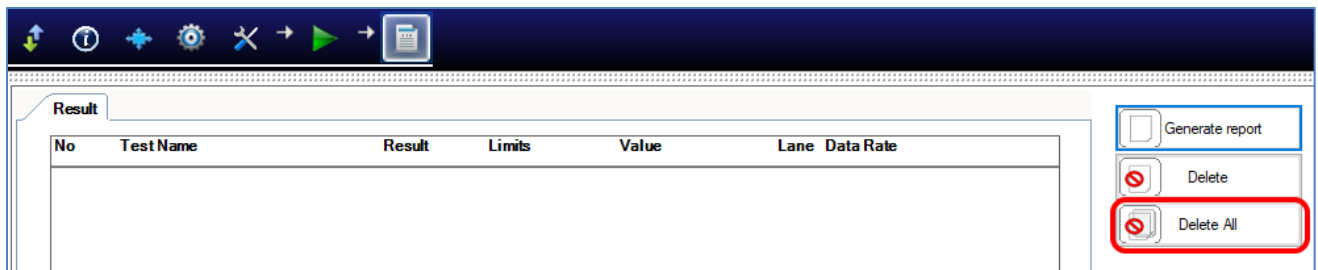


FIGURE 38. DELETE ALL RESULTS

8 Saving and Loading Test Sessions

The usage model for the GRL-USB4-V2-TX automation software is that Calibration and Test Results are created and maintained as a 'Live Session' in the software. This allows you to Quit the software and return later to continue where you left off.

Save and Load Sessions are used to Save a Test Session that you may want to recall later. You can 'switch' between different sessions by Saving and Loading them when needed.

To Save a session, with all of the parameter information, test results, and any waveforms, select **Options** on the menu bar and select **Save Session**.

To Load a session back into the software, including the saved parameter settings, select **Options** on the menu bar and select **Load Session**.

To create a New session and return the software to the default configuration, select **Options** on the menu bar and select **New Session**.

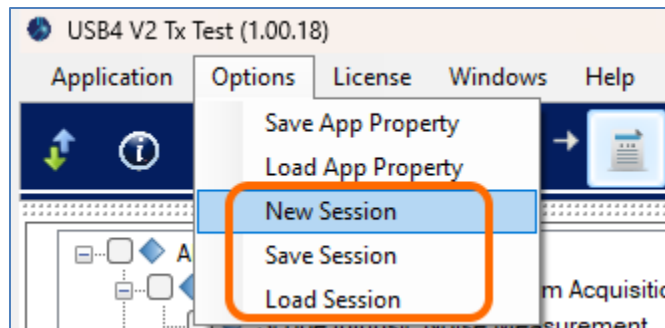


FIGURE 39. SAVING AND LOADING CALIBRATION AND TEST SESSIONS

The configuration and session results are saved in a file with the extension '.ses', which is a compressed zip-style file, containing a variety of information.

9 GRL Platform Solutions Distributed Processing Method

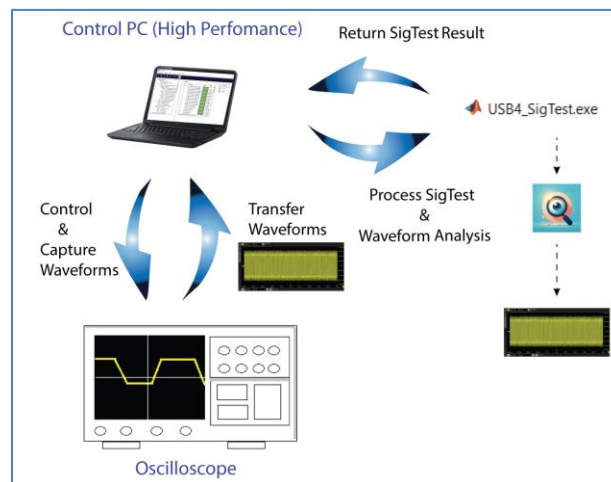
This section describes how to perform the GRL Platform Solutions distributed processing method to reduce testing time by up to 40% efficiency.

9.1 Overview

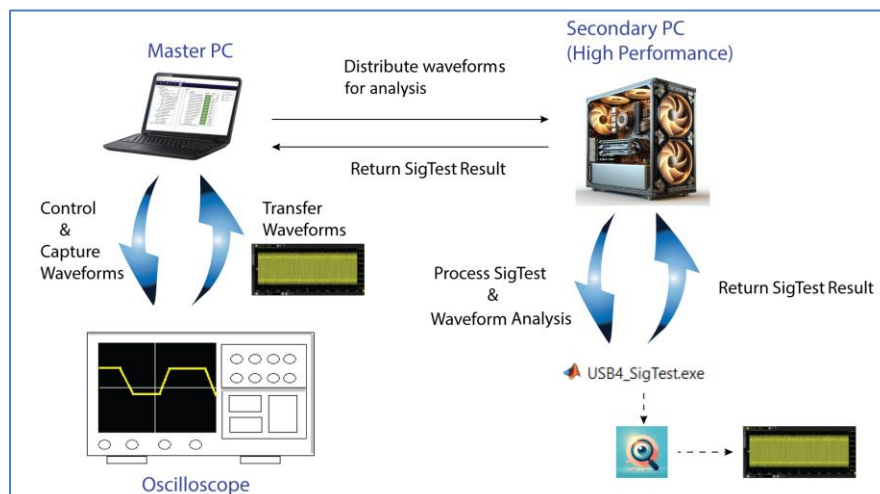
The user will need to connect two control PC's in the test setup to divide the workload. One PC (acting as the Master PC) is used to capture waveforms on the oscilloscope while the other PC (acting as the Secondary PC) analyzes the captured waveforms in parallel using SigTest. This method of process distribution by GRL Platform Solutions will significantly reduce testing time.

Below shows the comparison between the single processing architecture (using a single control PC) and the GRL Platform Solutions distributed processing architecture (using two control PC's).

- Single processing architecture:



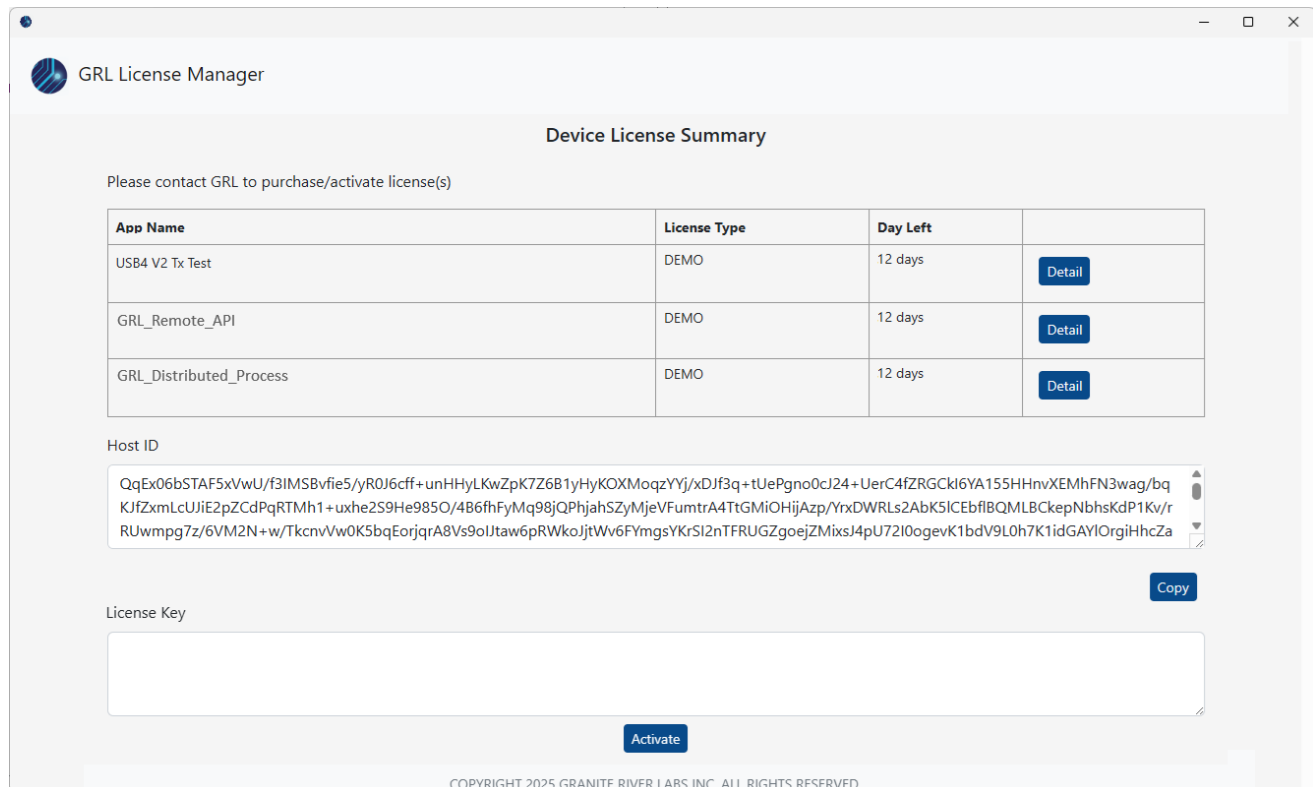
- GRL Platform Solutions distributed processing architecture:



9.2 License Requirements

The GRL Platform Solutions distributed processing method requires three software licenses for each control PC as follows:

- USB4 V2 Tx Test license
- GRL_Remote_API license
- GRL_Distributed_Process license



Once these licenses have been enabled, the Distributed Processing icon  will appear on the menu bar as follows:



9.2.1 Enable Distributed Processing Method

9.2.1.1 Master PC configuration:

1. On the Master PC, select the Distributed Processing icon  on the menu bar.
2. Select the **Enable Distribution Process** checkbox.
3. Select “Current Role” as **Master**.
4. Enter the Secondary PC’s IP address in “Secondary IP”.
5. Enter the Secondary PC’s port number in “Secondary Port”.

- Click on the **Test Connection** button to establish and verify connection to the Secondary PC.

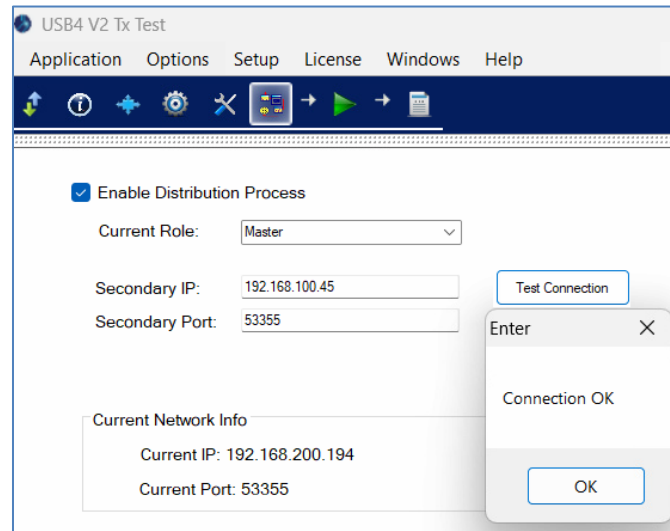


FIGURE 40. ENABLE DISTRIBUTED PROCESSING METHOD ON MASTER PC

9.2.1.2 Secondary PC configuration:

- On the Secondary PC, select the Distributed Processing icon  on the menu bar.
- Select the **Enable Distribution Process** checkbox.
- Select “Current Role” as **Secondary**.
- Enter the Master PC’s IP address in “Master IP”.
- Enter the Master PC’s port number in “Master Port”.
- Click on the **Test Connection** button to establish and verify connection to the Master PC.

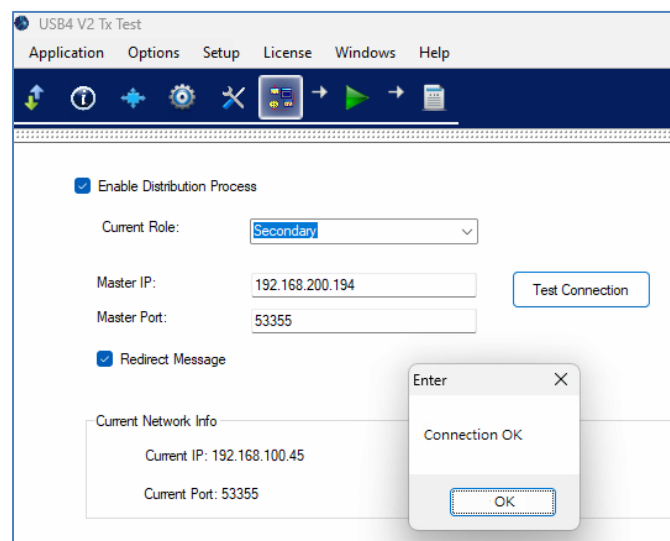


FIGURE 41. ENABLE DISTRIBUTED PROCESSING METHOD ON SECONDARY PC

9.2.2 Run Tests

Once the Master PC and Secondary PC have been configured and successfully verified, select and run the required tests from the test list. This will start the process distribution flow, and a pop-up window will appear during the test run displaying the current test items and status of both the Master and Secondary systems.

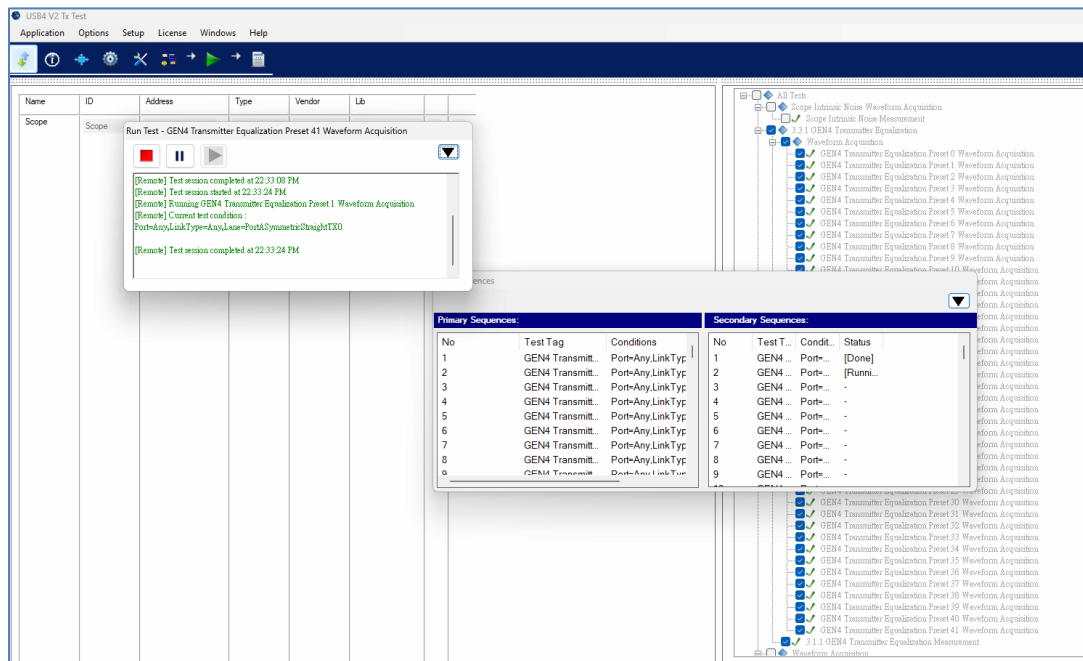


FIGURE 42. EXAMPLE OF TEST EXECUTION WITH DISTRIBUTED PROCESSING METHOD

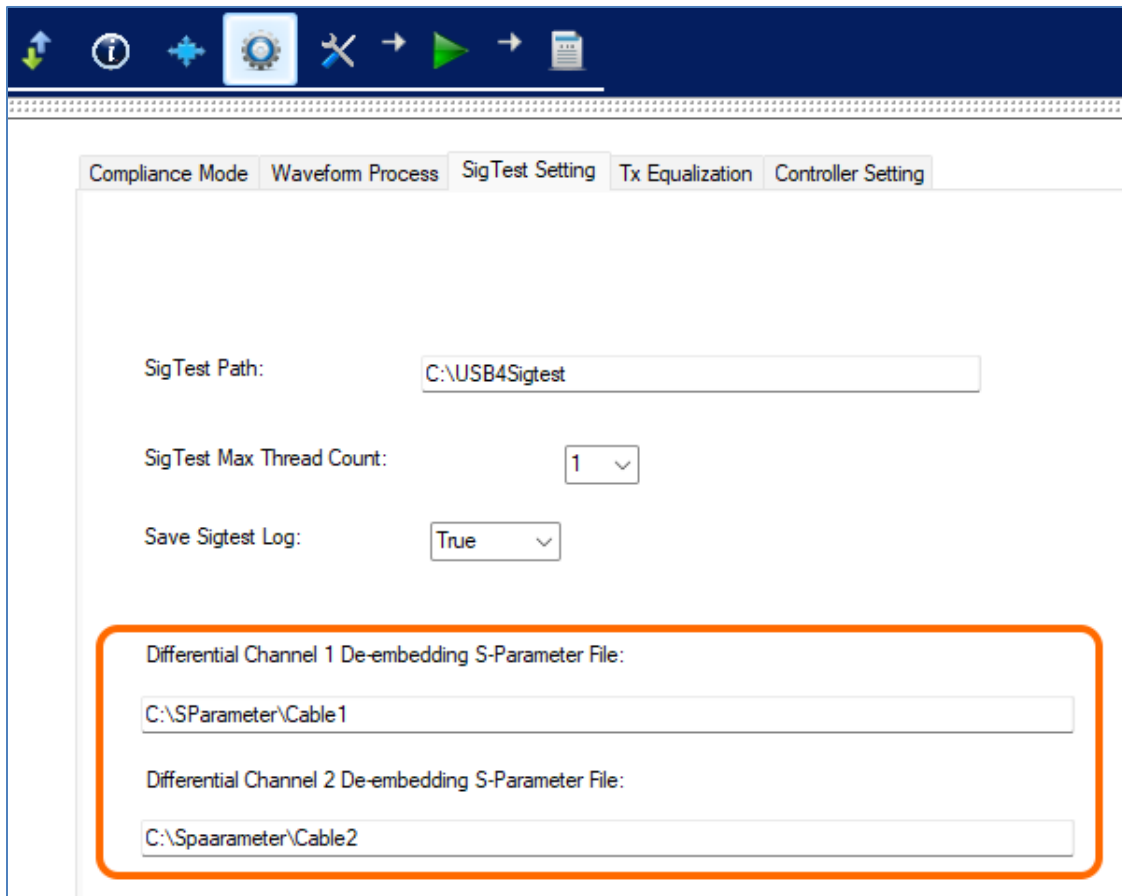
Watch this [example video](#) on how the distributed processing method works.

10 Appendix A: SMA Cable Transfer Function Setup Procedure for Cable De-embedding

This section describes how to create the S-parameter file (S4P) for de-embedding of SMA cables.

The de-embedding files are required to create the S4P file of the SMA cables between the scope and the test fixture.

The software will call the SigTest application and automatically apply the de-embedding of the S4P file.



The GRL-USB4-V2-TX software enables the following S-parameter options:

Differential Channel 1 De-embedding S-Parameter File	Select a S4P file to de-embed the SMA cable on the Scope channels 1 & 3. Type in the S4P file location and file name (file extension is not required).
Differential Channel 2 De-embedding S-Parameter File	Select a S4P file to de-embed the SMA cable on the Scope channels 2 & 4. Type in the S4P file location and file name (file extension is not required).

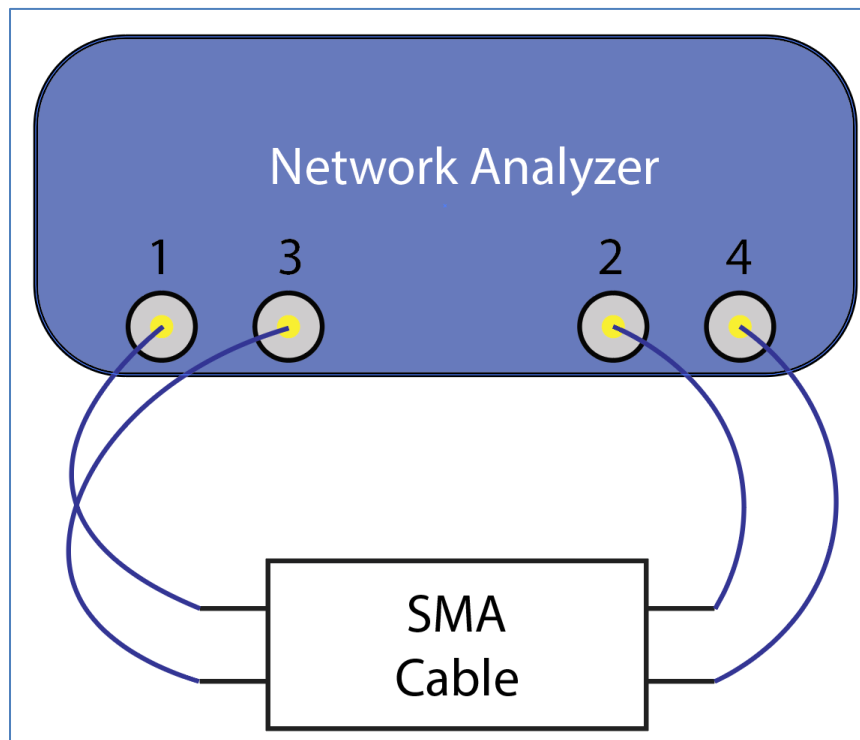
10.1 Network Analyzer Configuration

- Standard class (Single Ended)
- Frequency range of 50 MHz to 20 GHz
- IF bandwidth of 1 kHz
- At least 10000 points
- Save S-parameter file in Normal mode (Single Ended)

Perform calibration on four network analyzer ports using the above configuration.

10.2 Connection Setup

Connect the SMA cables to the network analyzer as shown below:



10.3 Measure SMA Cable and Save S4P File

1. Perform a sweep on the network analyzer once for four ports.
2. Save the S4P file.
3. Repeat the above steps for another differential paired SMA cable.

END_OF_DOCUMENT