

# Granite River Labs

## USB Power Suite Pro (GRL-PSP) Test Software User Guide with GRL USB Type-C™ Power Delivery Tester and Analyzer (GRL-USB-PD-C2) and GRL USB Power Performance Tester (GRL-USB-PD-F1)



This material is provided as a reference to install and use the v3.2.1x of Granite River Labs (GRL) USB Power Suite Pro (GRL-PSP) software.

For software support, contact [support@graniteriverlabs.com](mailto:support@graniteriverlabs.com).

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# 1 Scope of this User Guide and GRL Power Suite Pro

This User Guide serves as the primary user documentation for the GRL Power Suite Pro (GRL-PSP) software that is used with the GRL-USB-PD-C2 USB Type-C Test Controller Hardware / GRL-USB-PD-F1 USB Power Performance Tester. The GRL-PSP software supplements the GRL-USB-PD-C2 / F1 Controller by providing USB Power Delivery emulation, analysis, functional performance benchmarking and sample testing for USB devices as follows:

- Perform emulation for a USB Power Delivery Source or Sink device through capture of different USB Power Delivery device behavior.
- Verify performance of various USB Type-C devices such as power adapters, power banks, phones, tablets, PC's, hubs, multi-port adapters, docks, monitors, and cables. Also determine the capabilities of the device being tested and identify potential problems.
- Automate testing with result reporting and detailed protocol traces.

GRL-PSP supports major USB based charging technologies such as USB Power Delivery and Qualcomm Quick Charge for testing to standard test specifications.

The subsequent sections in this User Guide describe each feature provided by the GRL-PSP.

***Note:** The test case applications and features outlined in this document are tests required by various technology adoptions of the USB Type-C or other USB Connectors. Specifications that have adopted the USB Connector and may be referenced in this document include, but are not limited to, current specification versions. In order to have access to all specifications, it may be required that you are a member of an industry group and have attained the proper permissions.*

## 1.1 GRL-PSP Features and Capabilities

Below is a summary of what GRL-PSP can offer:

- Provide Dual Sink Ports for testing Source devices with multiple connectors such as multi-port chargers
- Provide a Single Sink Port for testing Source devices as follows:
  - Create custom USB Power Delivery Sinks
  - Capture and save Source device capabilities
  - Emulate Sink to functionally test with Source devices
  - Verify Source device IV Curves and Over Current Protection Behavior
  - Test Source device Power Efficiency
- Provide a Single Source Port for testing Sink devices as follows:
  - Create custom USB Power Delivery Sources
  - Load and emulate Source device capabilities
  - Characterize Sink power capabilities
- Provide a Source/Sink Port for performing battery cycling test on devices with dual role power capability such as power banks
- Provide both Sink and Source Ports for testing devices with individual Source and Sink connectors such as passthrough hubs and cables

## 1.2 PRO and Basic Versions of GRL-PSP

The PRO version of GRL-PSP (GRL Power Suite Pro) enables additional features that are not available in the Basic version. The PRO version allows you to connect external/third party test equipment and applications that are required for running certain tests, e.g., power efficiency, battery monitoring or thermal analysis with the GRL-PSP. You can also perform automated Source/Sink emulation using the PRO version for various mobile devices and laptop PC's. More details on these additional features are provided in subsequent sections of this User Guide.

The GRL Power Suite PRO requires licensing upon purchase which you can contact [support@graniteriverlabs.com](mailto:support@graniteriverlabs.com) for more information.

The following table summarizes the differences in features between the PRO and Basic versions of the GRL-PSP:

TABLE 1. GRL-PSP PRO AND BASIC VERSIONS – FEATURE DIFFERENCES

Feature	GRL-PSP PRO (Requires Licensing)	GRL-PSP Basic (No Licensing)
<b>Third Party Tools</b> - Allows configuration of external/third party test equipment to be used with the GRL-PSP <i>See Section 4 in this User Guide for more details.</i>	<i>Available</i>	<i>Not Available</i>
<b>Test Cases &amp; Operation</b> - Allows setting up and running multiple tests for the Units Under Test or UUT's <i>See Section 5 in this User Guide for more details.</i>	<i>Available</i>	<i>Available (excluding Power Efficiency &amp; Sniffer Mode Test Cases)</i>
<b>Sniffer Mode</b> - Allows validation of USB Power Delivery communications between Source and Sink devices <i>See Section 5.10 in this User Guide for more details.</i>	<i>Available</i>	<i>Not Available</i>
<b>Sequencer</b> - Allows setting up and running test sequences for the UUT's <i>See Section 6 in this User Guide for more details.</i>	<i>Available</i>	<i>Not Available</i>
<b>Emulator</b> - Allows automation of USB Power Delivery Source/Sink emulation and testing for the UUT <i>See Section 7 in this User Guide for more details.</i>	<i>Available</i>	<i>Not Available</i>
<b>Global Settings</b> - Allows configuration of trace plot acquisition parameters <i>See Section 2.2 in this User Guide for more details.</i>	<i>Available</i>	<i>Available</i>
<b>Results</b> - Displays test reports generated from all test runs <i>See Section 2.2 in this User Guide for more details.</i>	<i>Available</i>	<i>Available</i>

## 2 Getting Started with GRL-PSP

This section describes in detail how to get started with the GRL-PSP software. If you are installing for the first time, please make sure to follow all the steps in this section to verify your setup prior to testing a USB device. The procedure is as follows:

1. Install the latest version of GRL-PSP on the computer (laptop or desktop) connected to the GRL-USB-PD-C2 / F1 Controller.
2. Make sure the GRL-USB-PD-C2 / F1 Controller Firmware has been updated to the latest version. Refer to the GRL-USB-PD-C2 user documentation in <http://graniteriverlabs.com/download-center/> for firmware update procedure.

If this procedure is followed and any issues arise, please contact [support@graniteriverlabs.com](mailto:support@graniteriverlabs.com).

### 2.1 Install GRL-PSP

1. Download the GRL-PSP software from: <http://graniteriverlabs.com/download-center/>. For general information about the GRL-USB-PD-C2 / F1 Controller, go to: <http://graniteriverlabs.com/usb-pd-c2/> or <https://graniteriverlabs.com/grl-usb-power-performance-tester-grl-usb-pd-f1/>.

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Download GRL software, user manuals and other detailed product information

PD 3.0 & QC4+ Solution – USB Power Delivery and Type-C™ Tester and Analyzer (GRL-USB-PD-C2)		
GRL USB PD/Type-C Compliance Test Software	1.3.12.5	Download
User Documentation	1.3.12	Download

GRL USB PD/Type-C Test Software Suite		
GRL Power Suite Pro (GRL-PSP)	3.2.1	Download
GRL USB PD/Type-C Production Test Software	1.0.0.25	Download
GRL USB PD API documentation	0.8.5	View

*Note: This software suite works on the USB Power Delivery and Type-C™ Tester and Analyzer (GRL-USB-PD-C2), GRL USB Power Performance Tester (GRL-USB-PD-F1), and GRL Intelligent USB Power ATX (GRL-USB-PD-M4).*

FIGURE 2.1: GRL SUPPORT DOWNLOAD PAGE

2. On the Win7 (or above) computer to be used for running the GRL-PSP, create a folder and download the software installer compressed archive (zip file). On the Download Center page, select the “Download” button associated with the latest GRL-PSP version. Enter the required information and select the “Download” button:

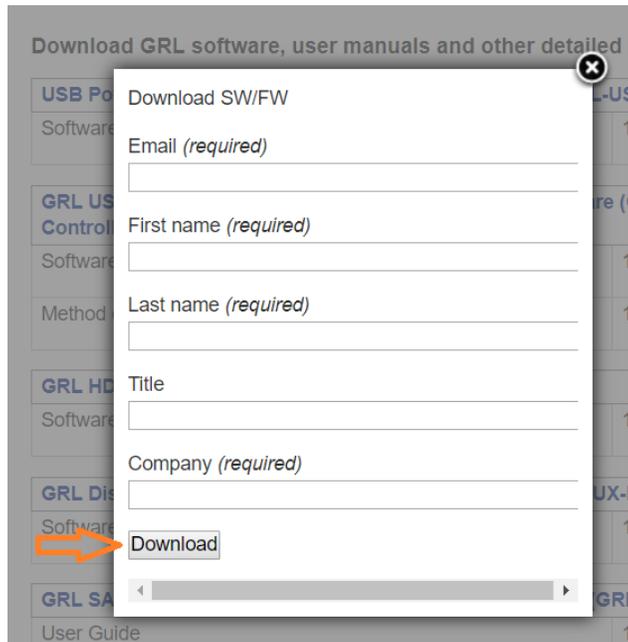


FIGURE 2.2: DOWNLOAD INFORMATION

3. Save the zip archive in a convenient folder and extract the GRL-PSP installer by right-clicking the downloaded archive and selecting "Extract All":

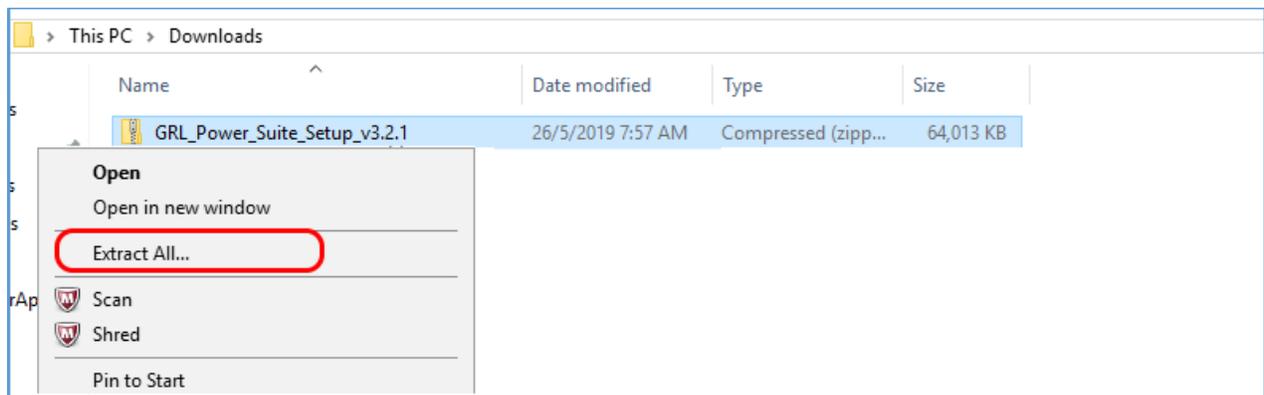


FIGURE 2.3: EXTRACT INSTALLER FROM ZIP ARCHIVE

4. Run the installer by double clicking the extracted executable:

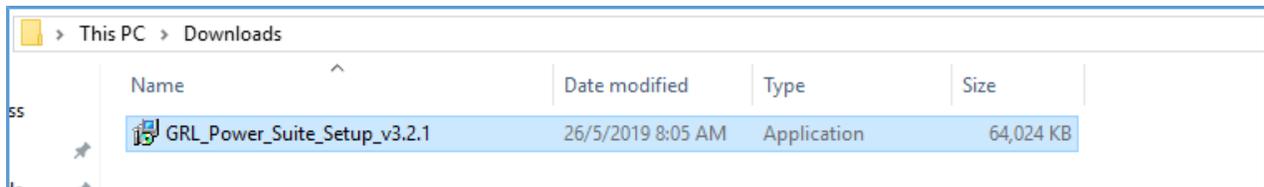


FIGURE 2.4: DOUBLE CLICK EXECUTABLE TO START APP INSTALLATION

5. Make sure to click "Yes" when the system prompt asks if you want to allow the installer to make changes to your system. Then follow the on-screen instructions to complete installation for the GRL-PSP.

## 2.2 Start Up and Navigate GRL-PSP

Once installed, launch the GRL-PSP to access the main screen as follows:

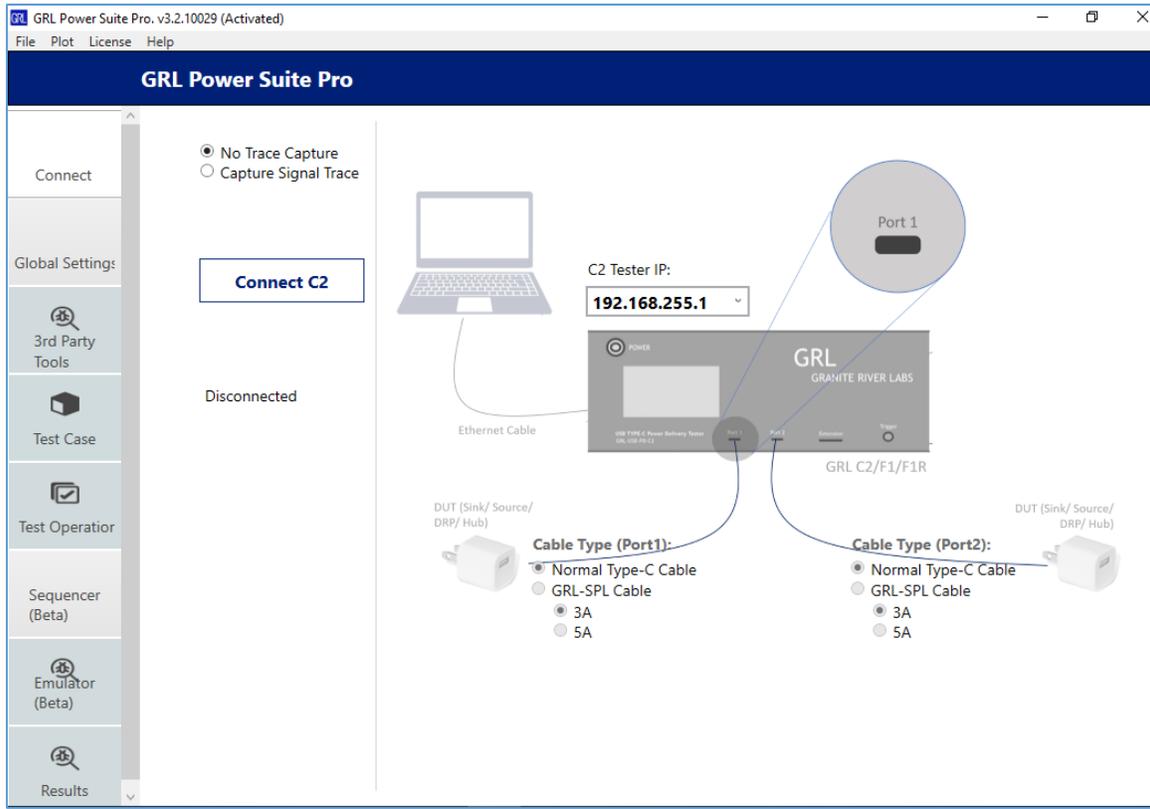


FIGURE 2.5: GRL-PSP MAIN SCREEN

- From the **License** drop-down menu above the main screen, select 'License Info' to enable licensing for the GRL-PSP. You can also opt to pay a monthly or yearly subscription fee for the GRL-PSP by selecting 'Subscribe Now', which will direct you to the GRL Payment webpage.

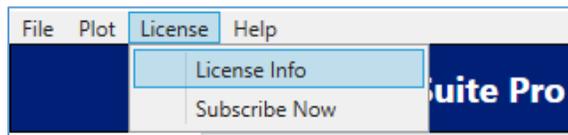


FIGURE 2.6: GRL-PSP LICENSE DETAILS

- a) Once you select 'License Info', enter your email address and password to log in.

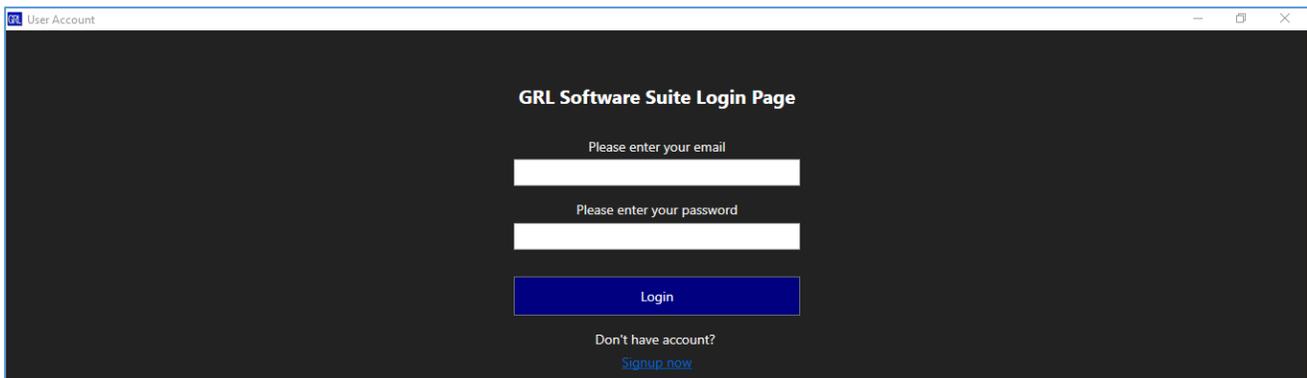


FIGURE 2.7: LOG IN TO CHECK LICENSE FOR INSTALLED APPLICATION

b) Check the license status for the installed software.

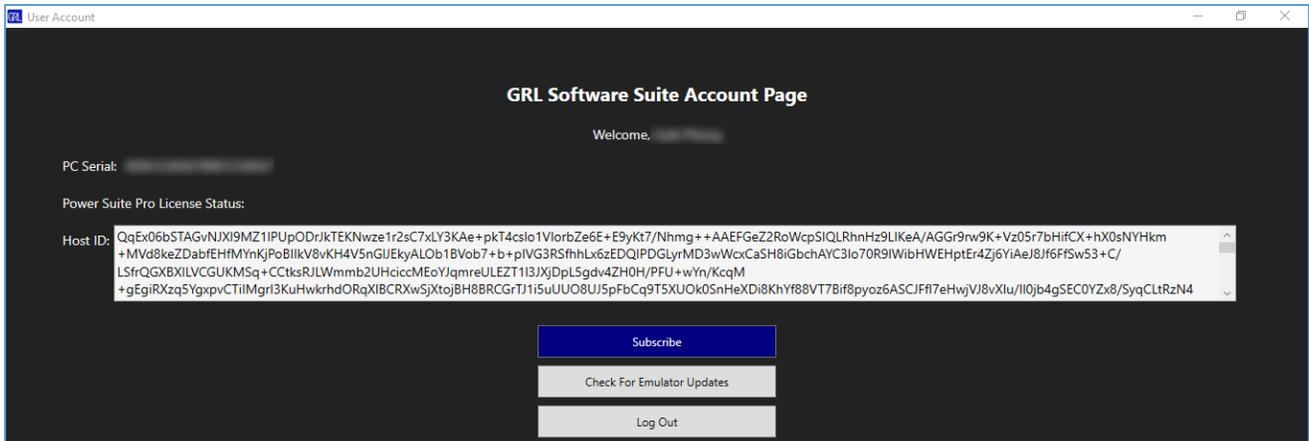


FIGURE 2.8: CHECK LICENSE FOR INSTALLED APPLICATION

c) Subscribe to GRL-PSP:

- By selecting the 'Subscribe' button, you will be directed to the GRL Payment webpage where you can choose to pay a monthly or yearly subscription fee for the GRL-PSP.

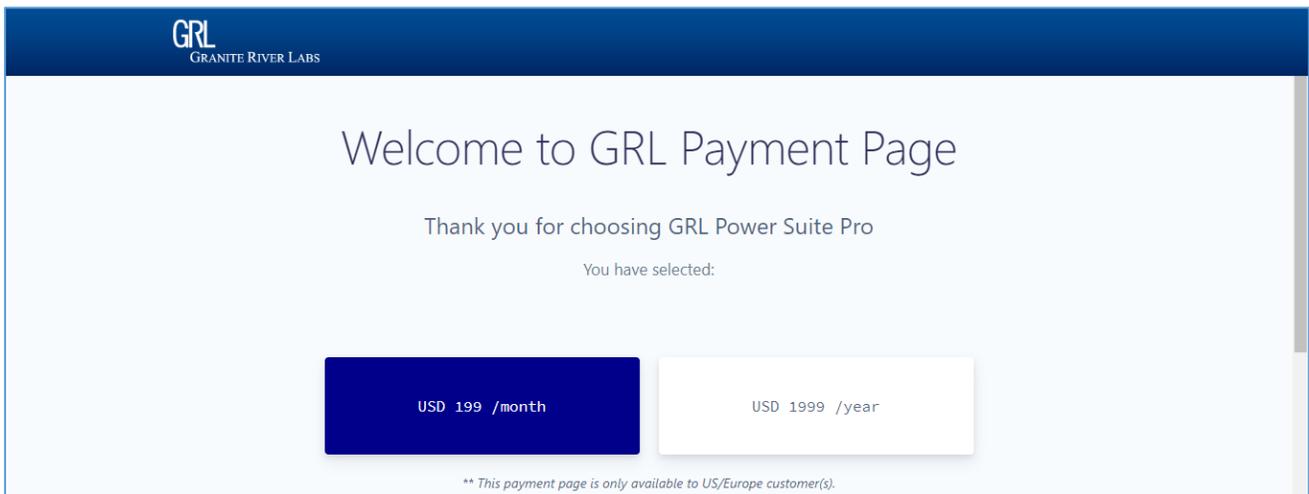


FIGURE 2.9: SUBSCRIBE TO GRL-PSP

d) Check for any software updates by selecting the 'Check For Emulator Updates' button.

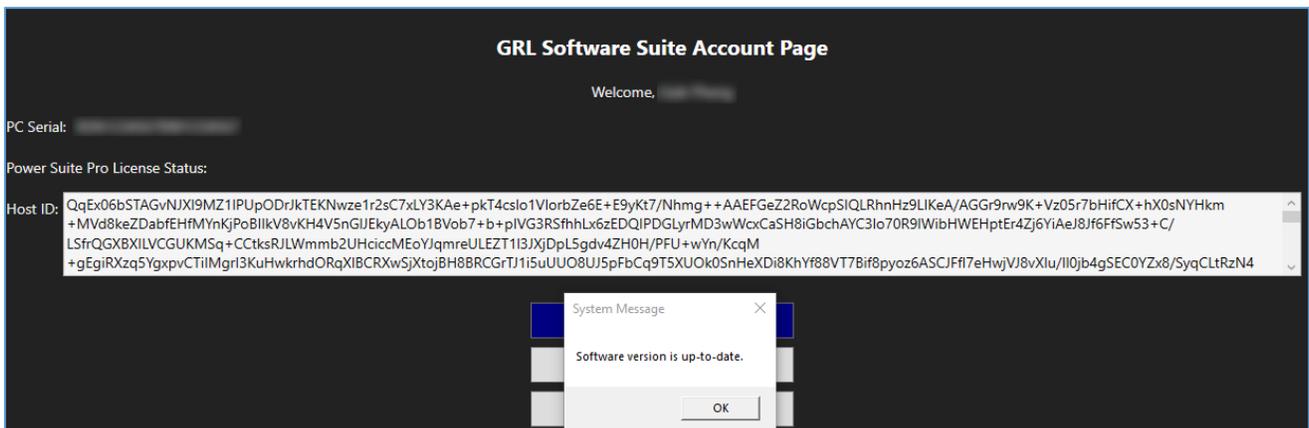


FIGURE 2.10: CHECK UPDATES FOR INSTALLED APPLICATION

**Note:** Once the 30-day trial period ends, you will need to request an Activation Key to continue using the GRL-PSP on the same computer. The demo software is also limited in its capability in that it will not enable access to some features. Thus the full functionality of the demo version cannot be utilized by the user.

- e) Request an Activation Key by selecting the ‘Request for Activation’ button. The button will then display ‘Processing your request’ while awaiting confirmation from GRL.

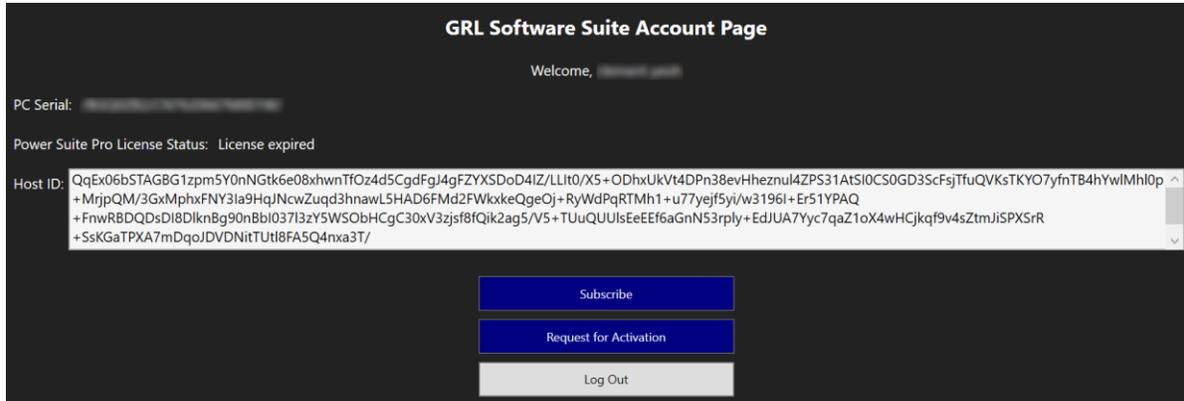


FIGURE 2.11: REQUEST ACTIVATION KEY FOR INSTALLED APPLICATION

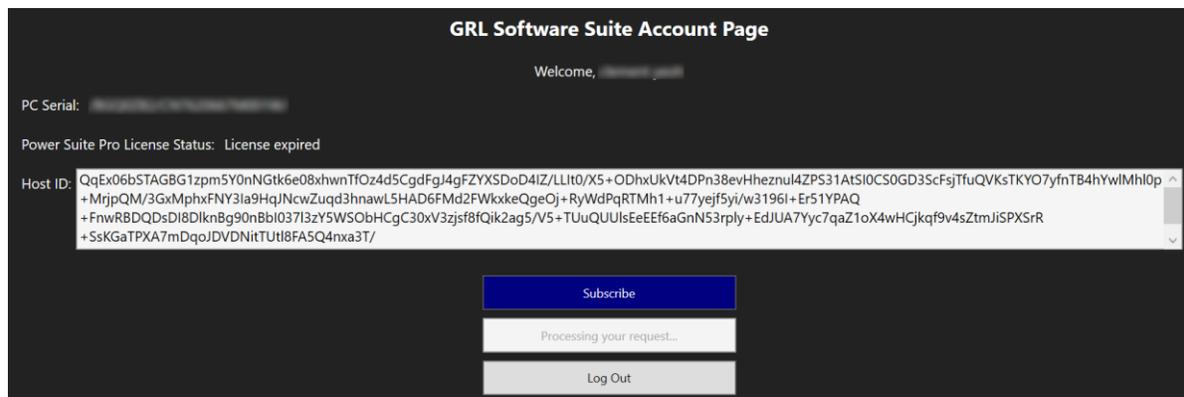


FIGURE 2.12: ACTIVATION REQUEST PENDING CONFIRMATION

- f) Activate a License:

- Once Activation is confirmed, select the ‘Activate’ button and confirm the Activation key in the field by selecting the ‘Activate’ button again.

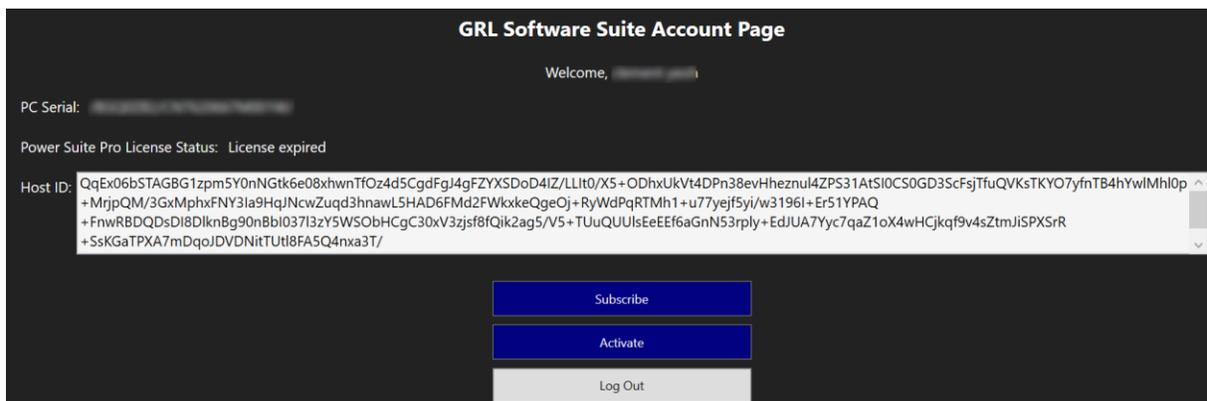


FIGURE 2.13: ACTIVATE LICENSE FOR INSTALLED APPLICATION

- Upon successful activation you should see the following screen:

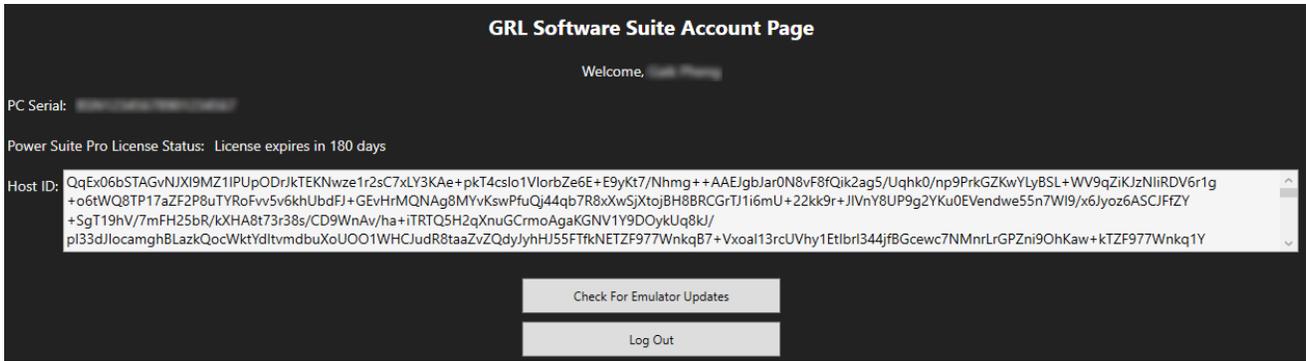


FIGURE 2.14: INSTALLED APPLICATION READY FOR USE UPON SUCCESSFUL ACTIVATION

- You can also select other drop-down menus above the main screen of the GRL-PSP to access the following:
  - a. Select the **File** drop-down menu to load an existing saved test report, save reports for tests currently being run on specific test ports, or exit the GRL-PSP.

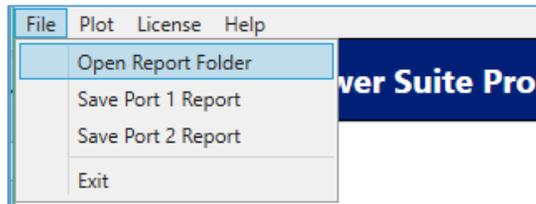


FIGURE 2.15: GRL-PSP FILE MENU

- b. Select the **Plot** drop-down menu to enable the advanced power trace plot from the GRL-USB-PD-C2 or a standalone basic power trace plot. See page 20 for more details.

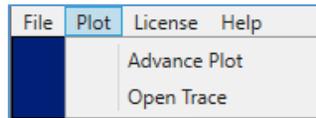


FIGURE 2.16: GRL-PSP PLOT MENU

- c. Select the **Help** drop-down menu to access the User Guide (this document) and software information of the GRL-PSP.

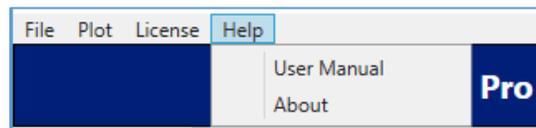


FIGURE 2.17: GRL-PSP HELP MENU

- On the main screen, you can navigate the left menu buttons to access the corresponding screens:
  - a. **Connect** – This screen allows you to connect the control computer running the GRL-PSP with the GRL-USB-PD-C2 / F1 Controller. There are also additional options to select the types and current capabilities of cable connectors that are used to link up the Unit Under Test (UUT) to the GRL-USB-PD-C2.

- b. **Global Settings** – This screen allows you to change the default settings of the GRL-PSP trace acquisition plots to match your test requirements.
- **Port One/Two X Axis Time Config** – To set the X axis time parameters for the trace plot in the **Test Operation** screen. Select the time in seconds, minutes or hours for the trace plot X axis of the respective USB Type-C test ports of the GRL-USB-PD-C2 / F1 Controller. See “**Port One, Test Operation**” on page 18 and Section 5, **Performing Tests with GRL-PSP** for more details on the Test Operation trace plots.
  - **Advanced Plot Sub Sampling Ratio Value & Sub Sample Resolution** – To set the sub sampling ratio value and sub sample resolution for the **Advance Plot** feature from the **‘Plot’ drop-down menu** above the GRL-PSP. Set the Advance Plot to acquire samples when running tests using a sub sampling ratio value from 1 to 3000 with a low, medium or high sub sample resolution. See Figure 2.24 on page 21 for more details on the Advance Plot feature.

Once configured, select the **Apply Changes** button to implement the new settings.

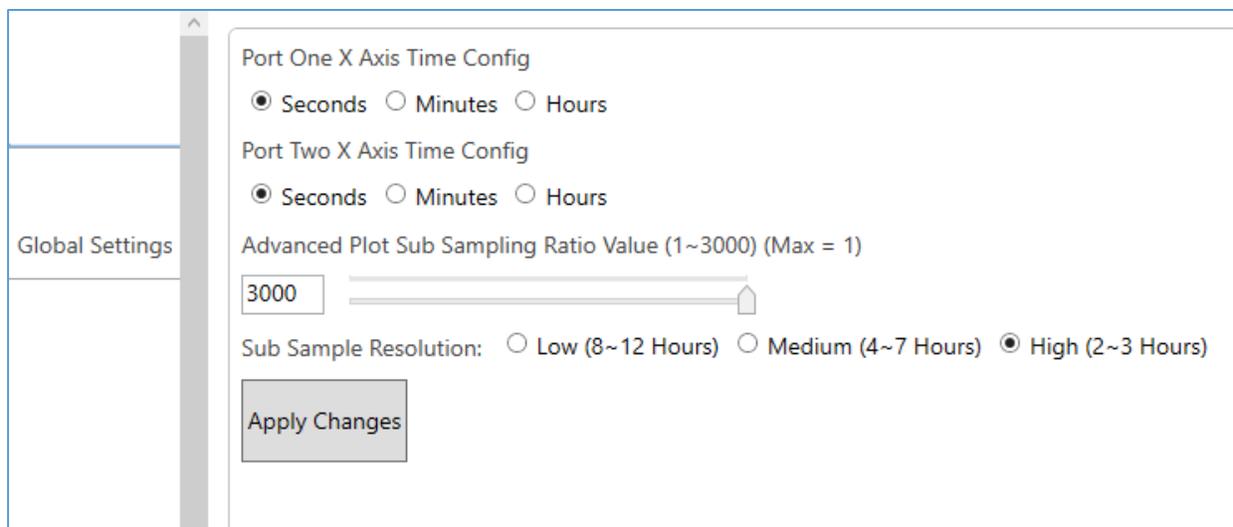


FIGURE 2.18: GRL-PSP GLOBAL SETTINGS SCREEN

- c. **3rd Party Tools** (*only available with PRO version of the GRL-PSP*) – For performing tests/measurements such as power efficiency, battery monitoring, thermal analysis, RF switching and short circuiting that require using external test equipment, this screen allows you to connect to those equipment or applications and make configurations. The GRL-PSP currently supports the following third party equipment and applications:
- GW Instek APS-7100 programmable AC power supply
  - GW Instek GPM-8213 power meter
  - FLIR C2 compact thermal camera
  - GRL Battery Monitor application (phone based and Web based)
  - GRL 5-Port RF Switch
  - GRL Type-C VBUS & VCONN Shorting Board (GRL-USB-PD-PWR)

An example display screen for connecting to the GW Instek APS-7100 is shown below. You can set up the network connectivity of the power supply as well as the AC voltage and line frequency range to be used for measurements.

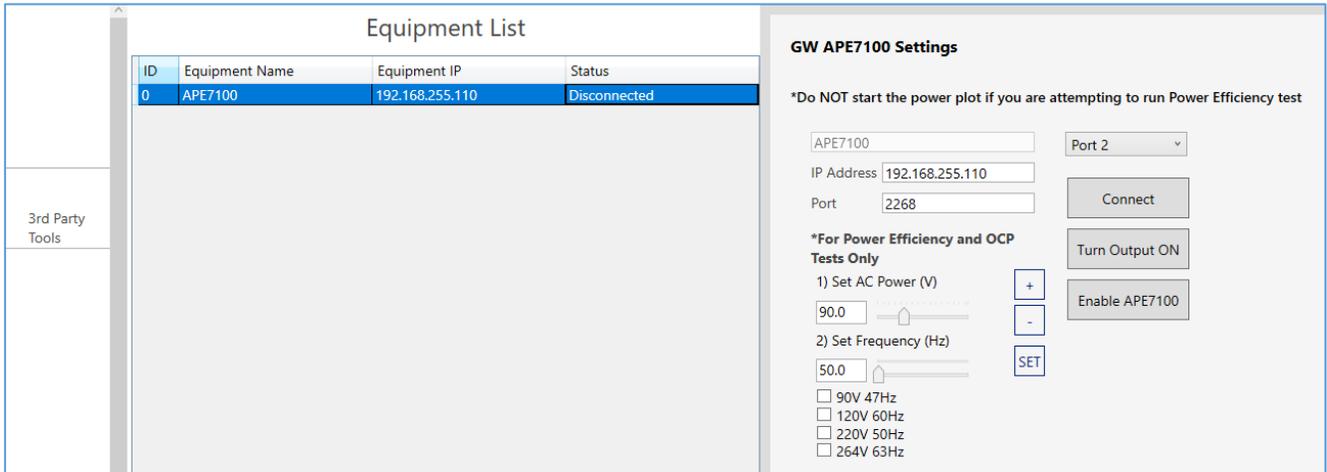


FIGURE 2.19: GRL-PSP 3RD PARTY TOOLS SCREEN EXAMPLE

For more details on the third party tools feature, refer to Section 4, Using Third Party Tools with GRL.

- d. **Test Case** – This screen contains the list of available test cases supported by the GRL-PSP for different DUT types and port connections. You can select a test case to configure and run in the Test Operation screen. Note for the Power Efficiency test you will need to connect and set up a external AC power supply in the 3rd Party Tools screen as described above in order to enable this test selection.



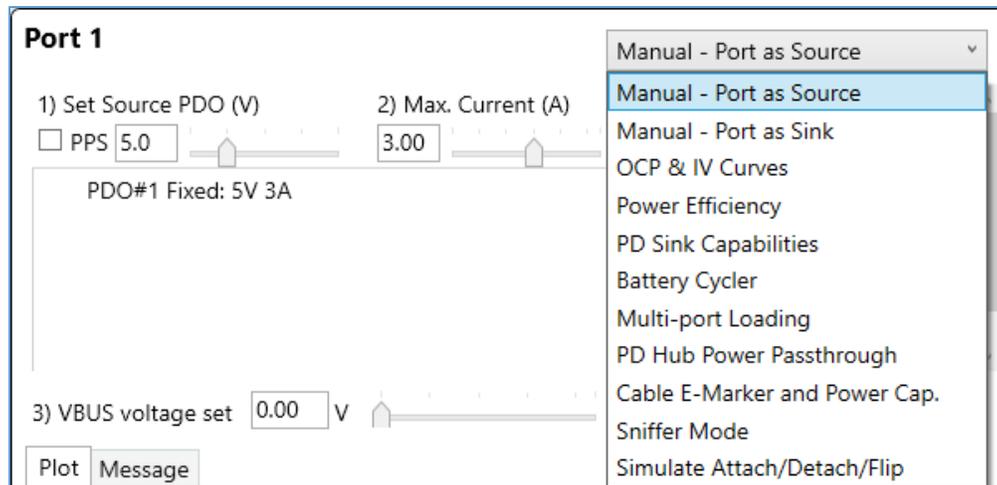
FIGURE 2.20: GRL-PSP TEST CASE SCREEN

- e. **Test Operation** – This screen displays the test case selected from the Test Case screen and allows you to configure and run automated tests for devices connected to the respective USB Type-C test ports of the GRL-USB-PD-C2 / F1 Controller.



FIGURE 2.21: GRL-PSP TEST OPERATION SCREEN EXAMPLE

You can also quickly select a test case from the top drop-down menu of the Test Operation screen.



- f. **Emulator** (only available with PRO version of the GRL-PSP) – This screen provides the Emulator function which automates PD Source/Sink emulation and testing for the appropriate UUT that is connected to USB Test Port 1 of the GRL-USB-PD-C2 / F1 Controller. This function requires the use of previously saved PD source/sink capabilities data files for emulation.

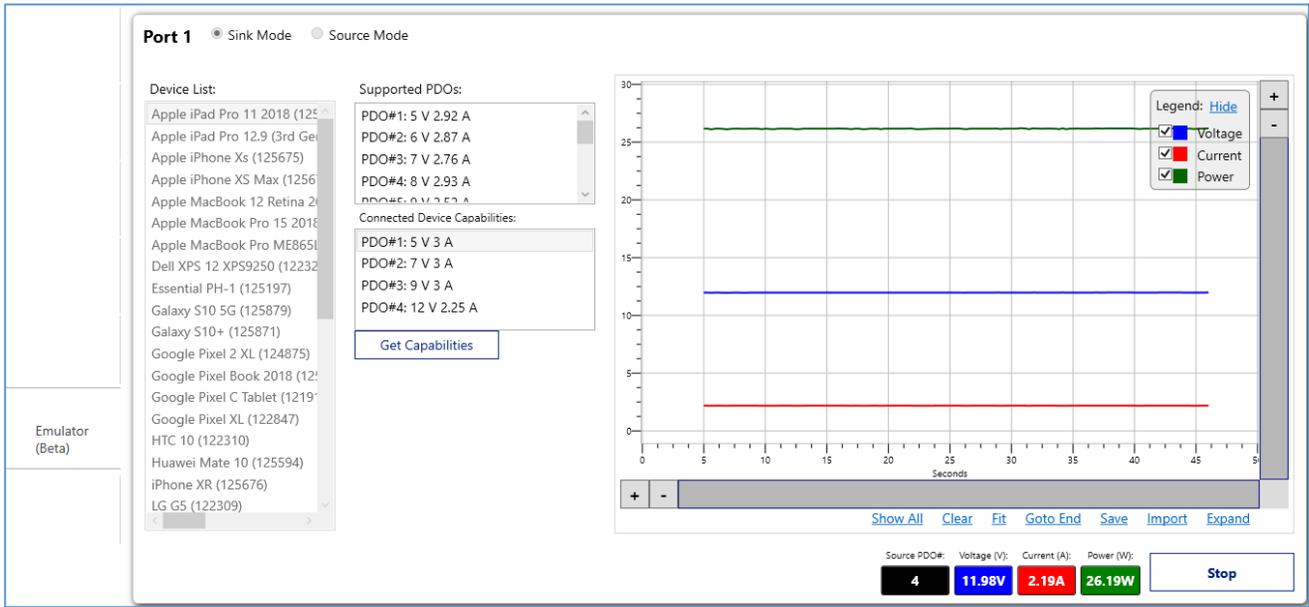


FIGURE 2.22: GRL-PSP EMULATOR SCREEN EXAMPLE

- g. **Results** – This screen displays information of the hardware/software being used for testing along with a summary of results generated after a test case has been run along with detailed protocol traces where applicable. You can move the cursor along the traces to view the readings at different points as well as configure the trace plot using the graph function tools above the plot.

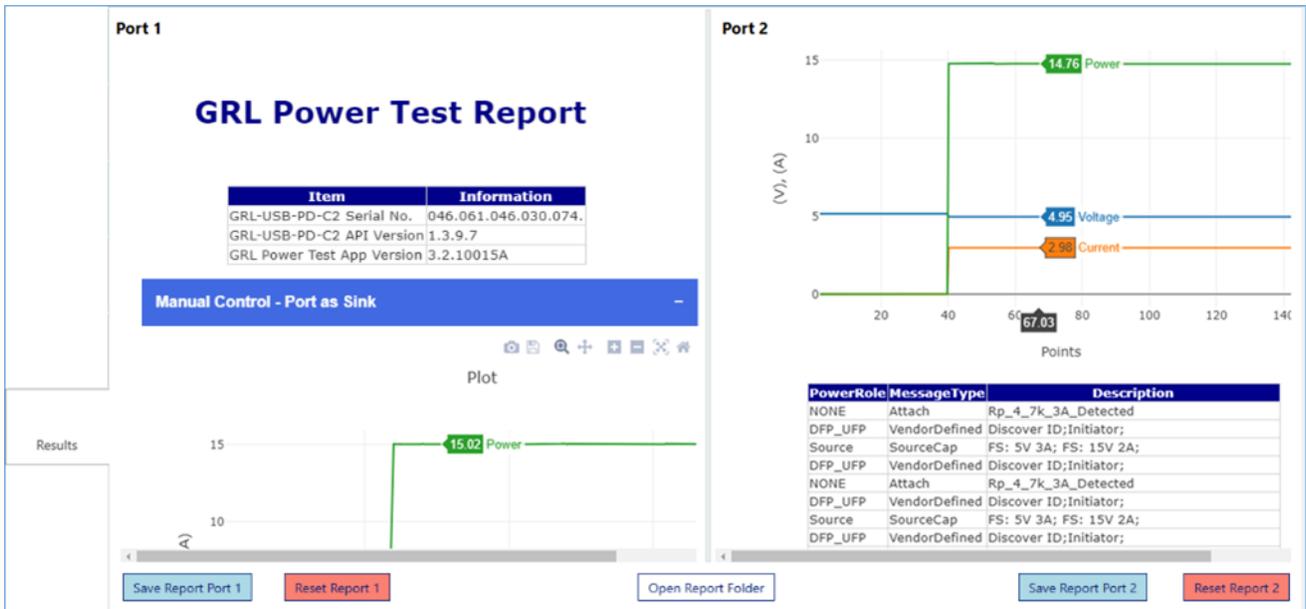
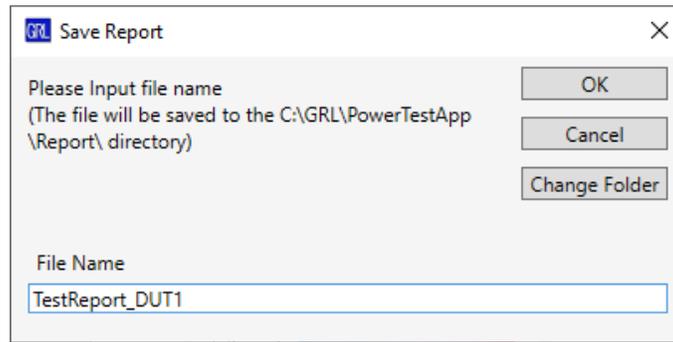
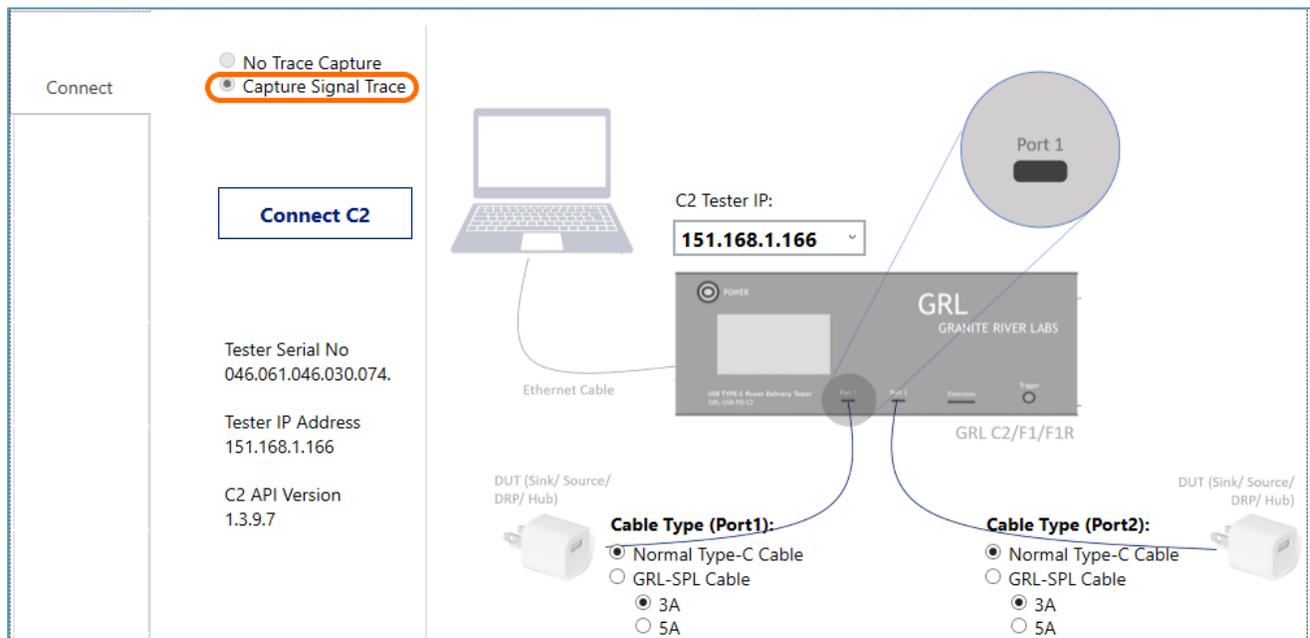


FIGURE 2.23: GRL-PSP RESULTS SCREEN EXAMPLE

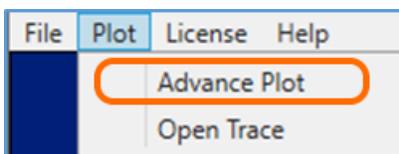
You can select “Save Report Port #” to save the test results for Port 1 or Port 2 as a test report to the designated file directory. To clear the existing results, select “Reset Report #”. To access the saved report file, select “Open Report Folder”.



- To generate additional USB Power Delivery protocol trace plot for the test being run, select from the 'Plot -> Advance Plot' drop-down menu of the GRL-PSP. Note that this is only enabled when the "Capture Trace Signal" option is selected from the *Connect* screen:



After selecting the "Capture Trace Signal" option, the 'Advance Plot' feature will be available in the 'Plot' drop-down menu of the GRL-PSP:



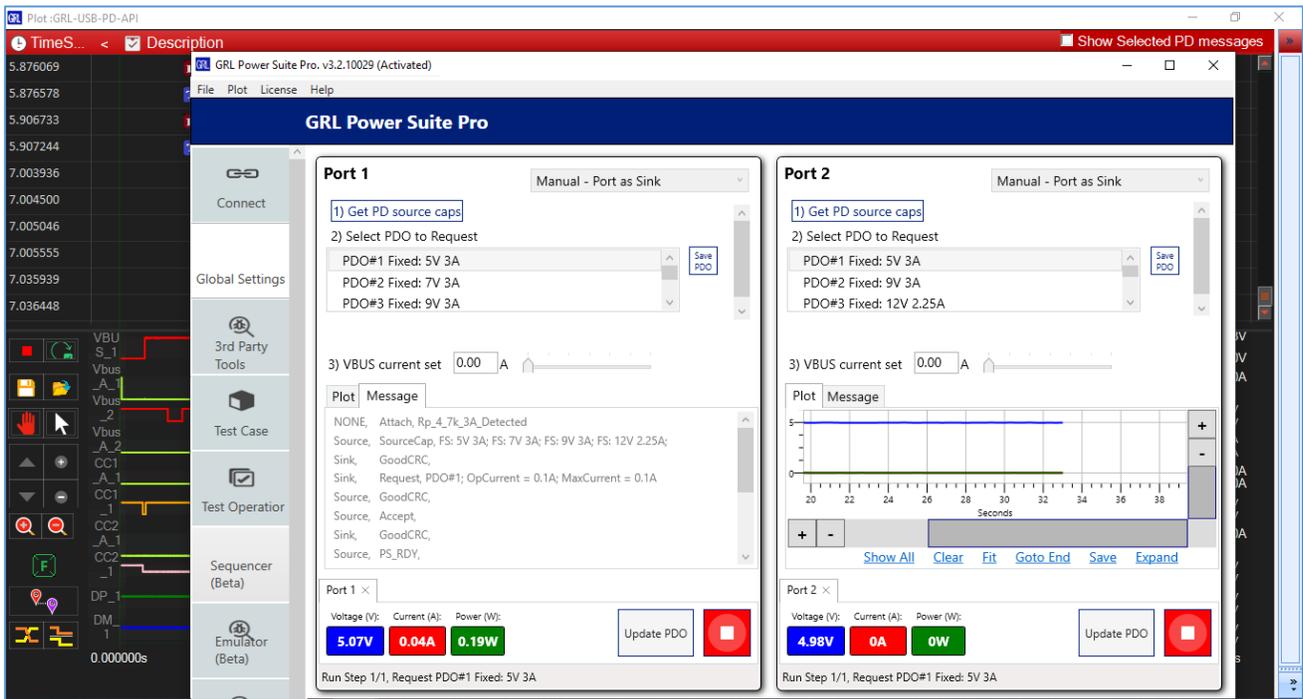


FIGURE 2.24: GRL-PSP ADVANCE PLOT VIEW EXAMPLE

The power trace plot allows you to validate USB Power Delivery (USB-PD) communications between the GRL-USB-PD-C2 / F1 Controller and the UUT. It displays a USB-PD sniffer function utility which allows you to view the PDO negotiations while running sub sampling of USB-PD data packets and generating the PDO communications exchange protocol.

Select the **Start Streaming**  button to generate the PDO communications exchange protocol.

When the protocol is running, select the **Stop Streaming**  button or the **Pause Live Update**  button at any time to end or pause the process respectively.

Select the **Save**  button to save the power trace plot to a file and the **Open**  button to open and use an existing saved power trace file.

The other common plot specific buttons can be used to control the power trace view as desired which includes panning, resetting the cursor, moving or scaling the trace up/down, zooming in/out of the trace view, fitting the trace within the chart area, and combining the chart areas into one. The  button in particular can be selected to enable cursors which the user can right-click on the plot to turn on markers at certain areas of the plot.

The right navigation side pane of the trace plot enables decoding of USB-PD messages from the PDO power negotiations that were generated. This allows for analysis and debugging of USB-PD signals such as evaluating Type-C CC lines or detecting errors by breaking down each protocol line to view extended message details. Select the “Show Selected PD messages” checkbox or click the “>>” symbol to access the decoder pane.

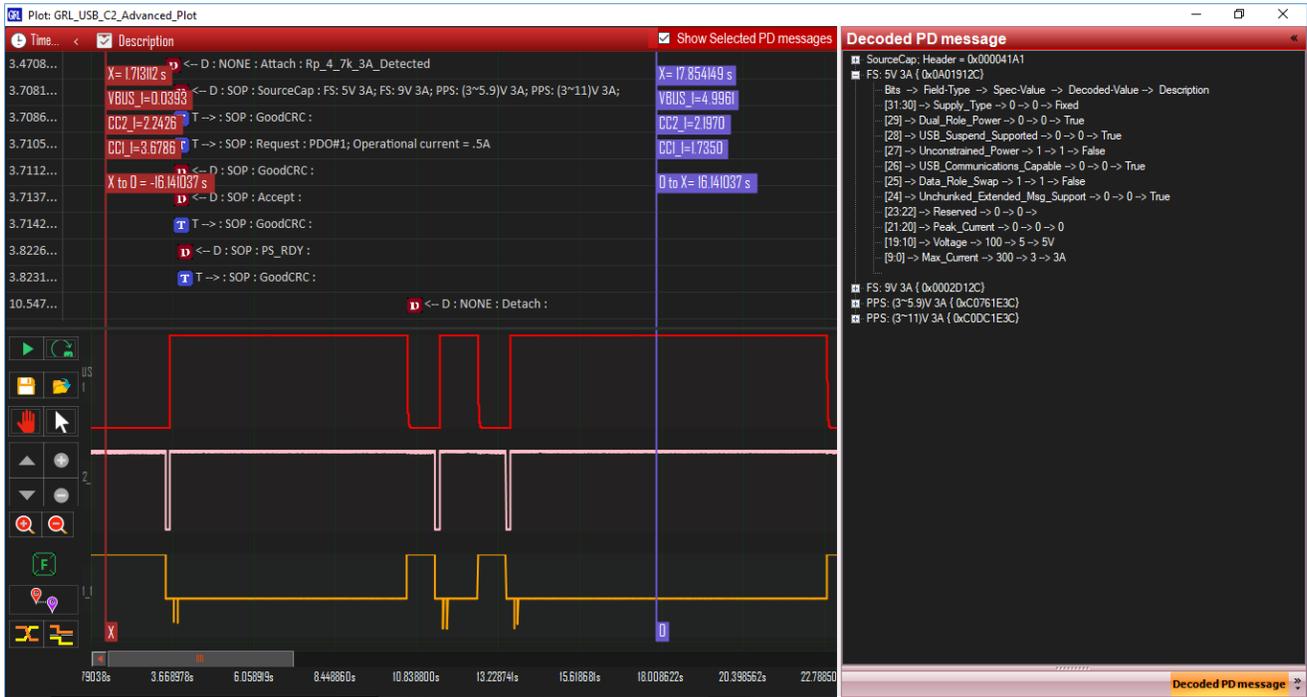


FIGURE 2.25: USB-PD ADVANCED PLOT MESSAGE DECODER FUNCTION

- You can also view the power trace plot from an existing saved configuration file during offline mode (not having connected to hardware setup) by selecting the ‘Plot -> Open Trace’ drop-down menu of the GRL-PSP. Note that this is enabled when the “No Trace Capture” option is selected from the *Connect* screen:

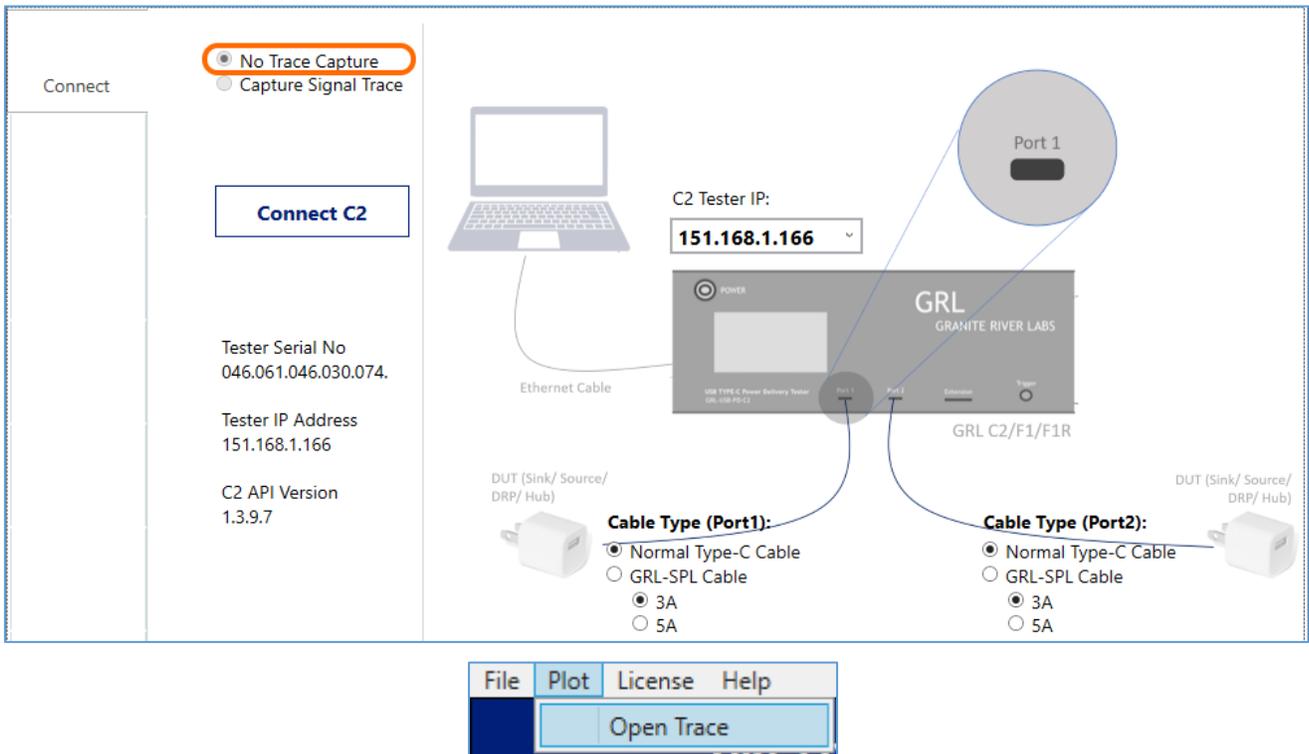


FIGURE 2.26: GRL-PSP OFFLINE POWER TRACE PLOT FEATURE

Click on the “Import” button below the graph and select any of the saved configuration files to open it. The power trace plot corresponding to the selected file will be displayed as shown in the example below. You can use the horizontal and vertical scroll bars of the graph to zoom in/out and navigate across the length of the trace plot. Additional function buttons below the bar allow you to control the graph view, clear/reset the graph, save the current test configuration to a file or load another trace plot from a different saved configuration file.

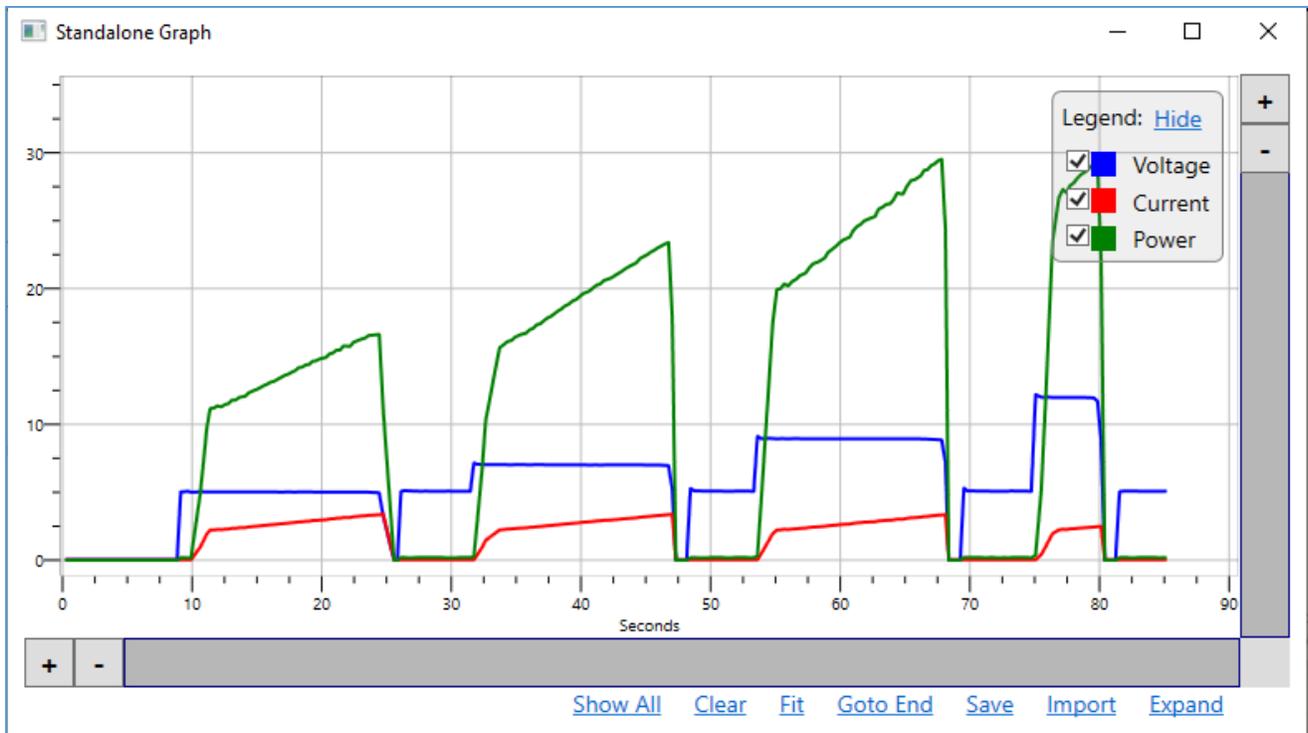


FIGURE 2.27: GRL-PSP BASIC PLOT VIEW EXAMPLE

### 3 Connection Setup of GRL-PSP

Figure 3.1 shows an example hardware setup for testing a USB-PD Provider, Consumer or Dual Role Powered device, or USB Type-C hub or cable using the GRL-PSP running on a control computer and connected via Ethernet to the GRL-USB-PD-C2 / F1 Controller that is attached to the USB device to be tested through one of the two controller USB Type-C test ports.

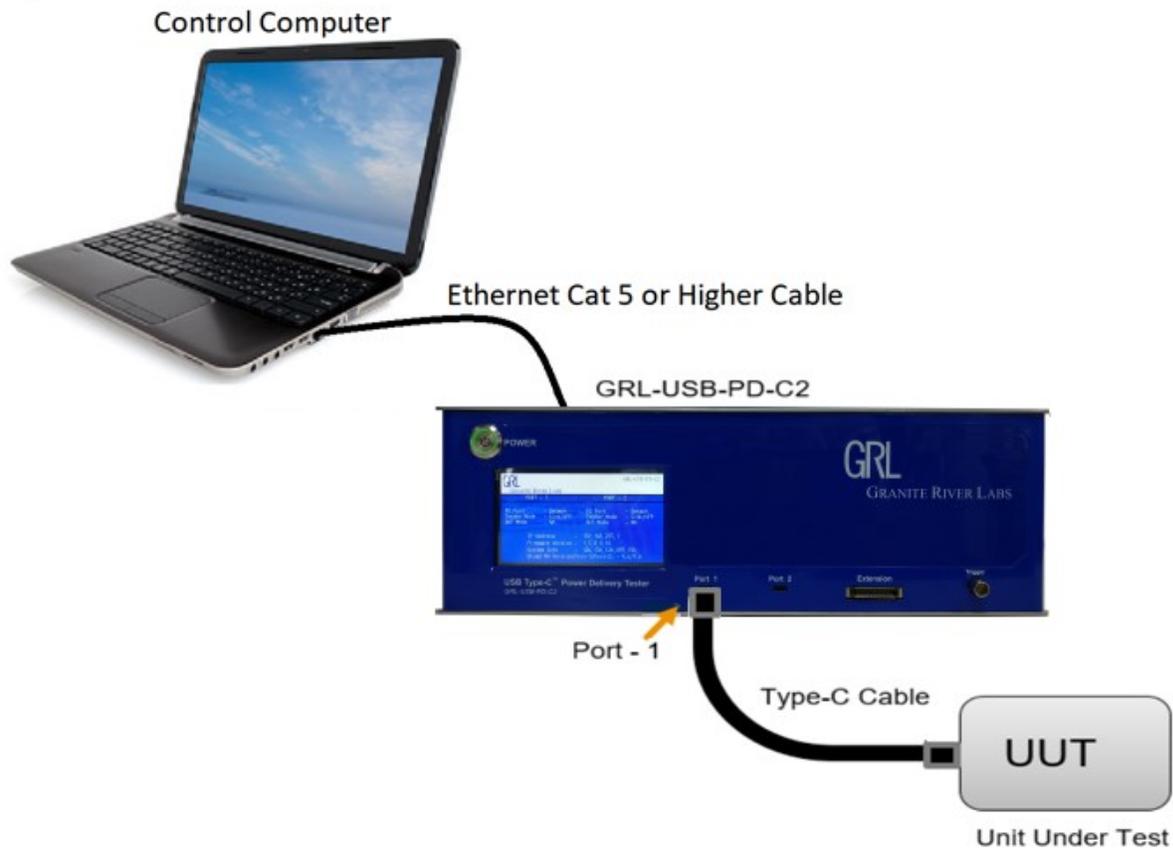


FIGURE 3.1: HARDWARE CONNECTION SETUP FOR DEVICE UNDER TEST

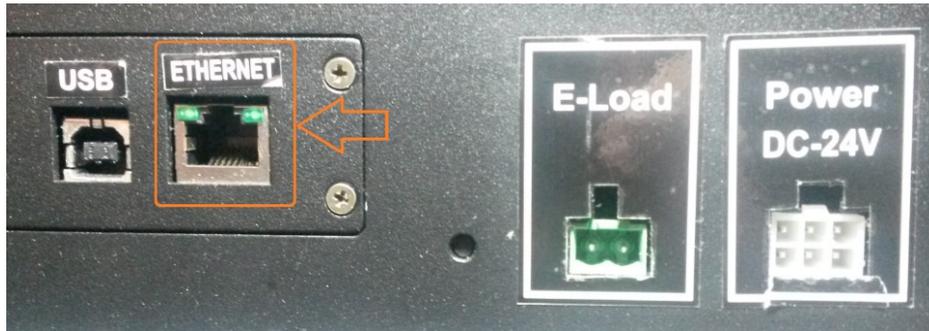
The GRL-PSP loaded on a Windows 7 (or higher) computer automates the testing process (note this will be referred to as the control computer here onwards). Below is a procedure for connecting the hardware and verifying proper hardware connections.

1. Connect a Power Supply to the GRL-USB-PD-C2 / F1 Controller Power Interface using the 24V, 280W Power Brick included with the Controller.
2. Connect the GRL-USB-PD-C2 / F1 Controller to the control computer using a physical Ethernet connection.

*Note: Automation of the UUT Power Supply switching in the GRL-USB-PD-C2 / F1 is handled internally to the Controller. Thus, there is no Ethernet, USB or GPIB connection attached to the Power Supply.*

### 3.1 Connect Ethernet Cable and Turn On Controller

Connect the Ethernet (RJ-45) connector to one of the control computer's Ethernet ports. A USB to Ethernet adapter can be used if there are no native Ethernet ports on the control computer.



Turn on the GRL-USB-PD-C2 / F1 Controller using the Power button on the front of the instrument.



### 3.2 Verify Controller Ethernet Installation

The Ethernet port on the control computer needs to be configured correctly for the GRL-USB-PD-C2 / F1 Controller to recognize the control computer and vice versa.

To make sure the network connection is set up correctly, open the Network Connections panel from the control panel.

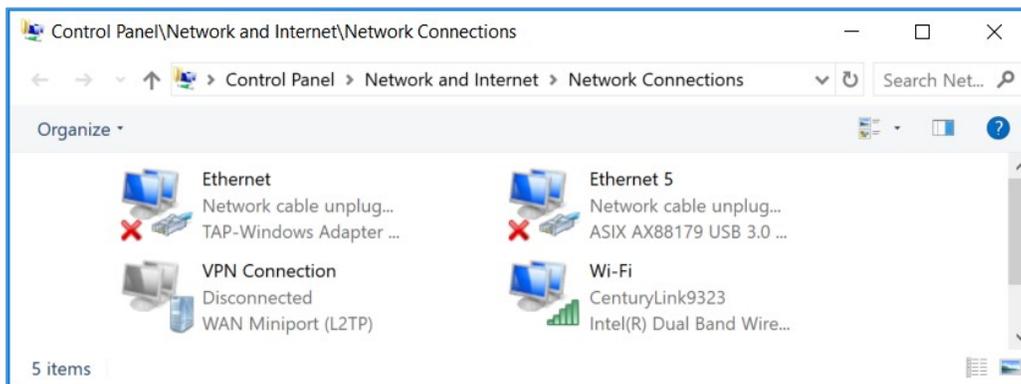


FIGURE 3.2: NETWORK CONNECTIONS BEFORE CONNECTING GRL-USB-PD-C2 / F1 CONTROLLER

Open the Ethernet panel for the Ethernet port that will connect to the GRL-USB-PD-C2 / F1 Controller, select “Internet Protocol Version 4 (TCP/IPv4)” and click on the “Properties” button below and to the right.

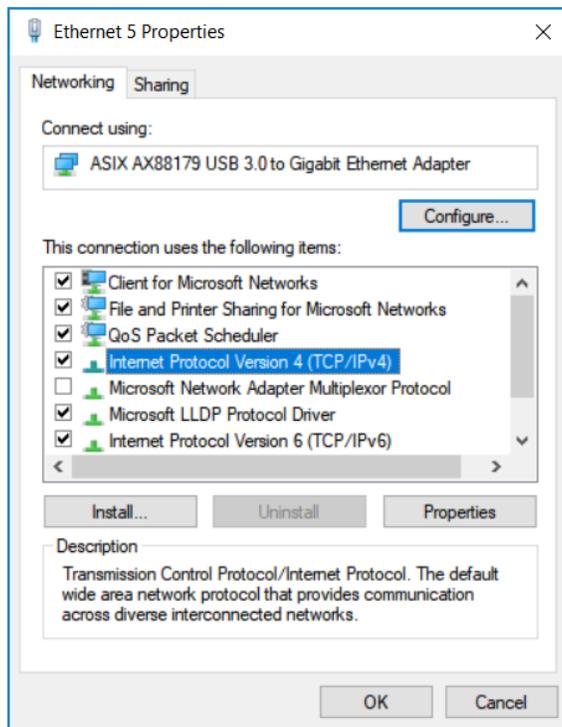


FIGURE 3.3: ETHERNET PROPERTIES

Set up the TCP/IPv4 properties as shown below.

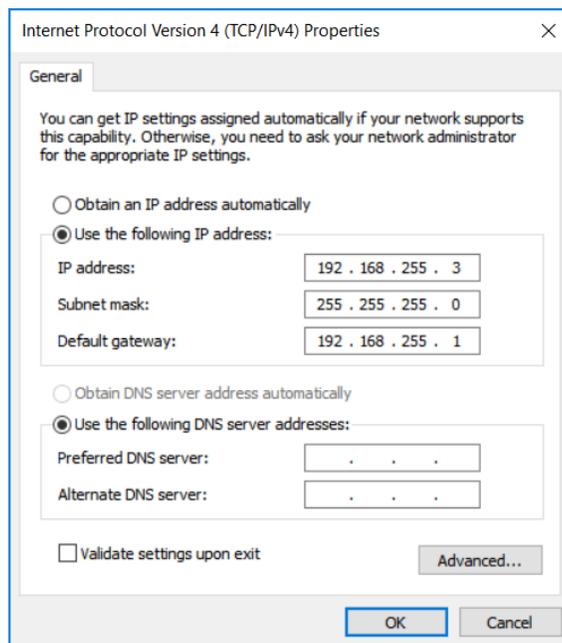


FIGURE 3.4: ETHERNET PROPERTIES WITH TCP/IPv4 SELECTED

Select a static IP address (“Use the following IP address:”) which should be 192.168.255.*n* where *n* is any number between 2 and 255. The subnet mask should be 255.255.255.0 and the default gateway should be 192.168.255.1. The rest of the items should remain unchanged.

Click the ‘OK’ button on the Internet Protocol Properties and close the Ethernet Properties. Make sure the GRL-USB-PD-C2 / F1 Controller is powered on and completely booted up (front panel display showing firmware version number), then connect the Ethernet cable from the GRL-USB-PD-C2 / F1 Controller to the control computer’s Ethernet port that was just set up. The network connections panel should now look as pictured in Figure 3.5 below:

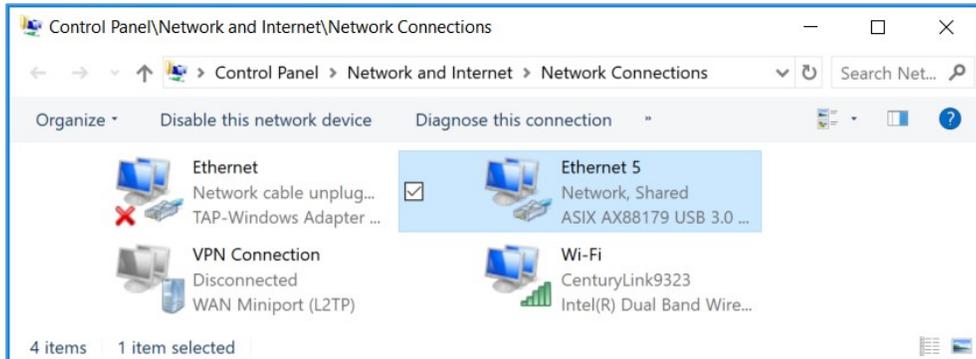


FIGURE 3.5: NETWORK CONNECTIONS AFTER SETUP AND CONNECTION OF GRL-USB-PD-C2 / F1 CONTROLLER

The GRL-USB-PD-C2 / F1 Controller is now set up and ready for use.

### 3.3 Set Up Control Computer Connection

To connect the GRL-PSP from the control computer, do the following:

1. On the GRL-PSP main screen, enter the correct IP address of the connected GRL-USB-PD-C2 / F1 Controller and select the **Connect C2** button.

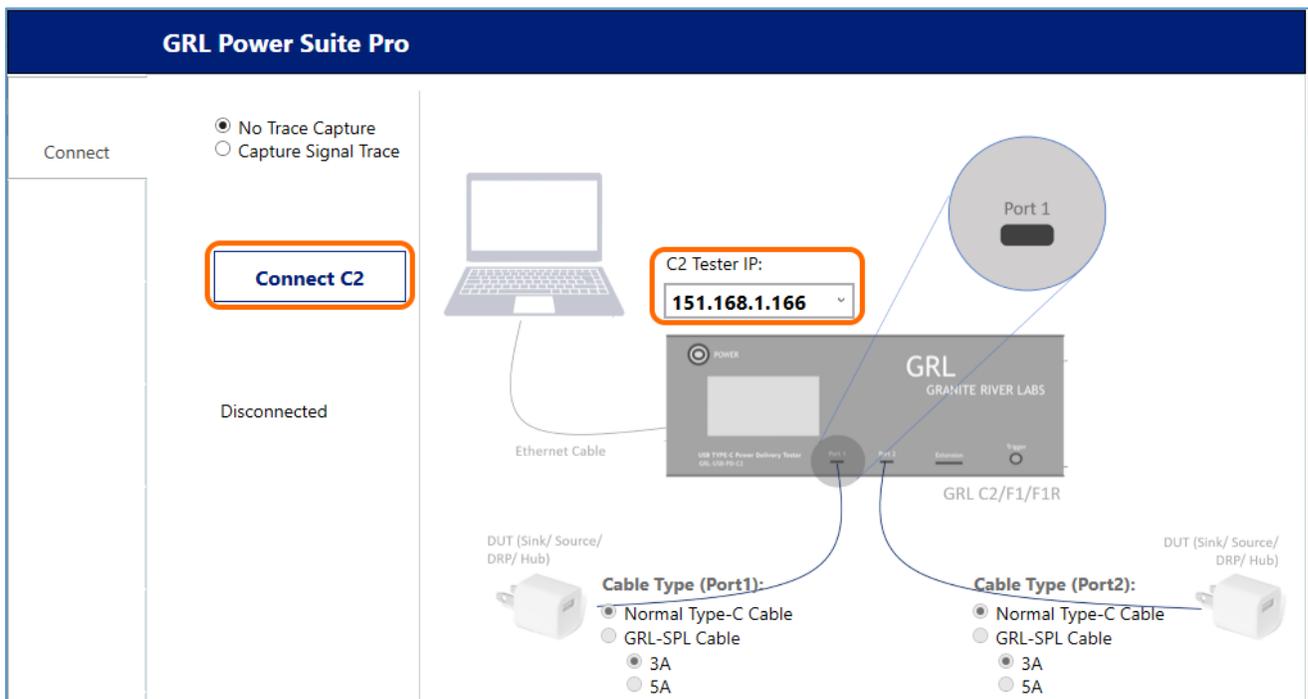


FIGURE 3.6: INITIAL CONNECTION CONFIGURATION SCREEN

- The GRL-USB-PD-C2 / F1 Controller and control computer are now set up and connected as indicated by the Controller information display.

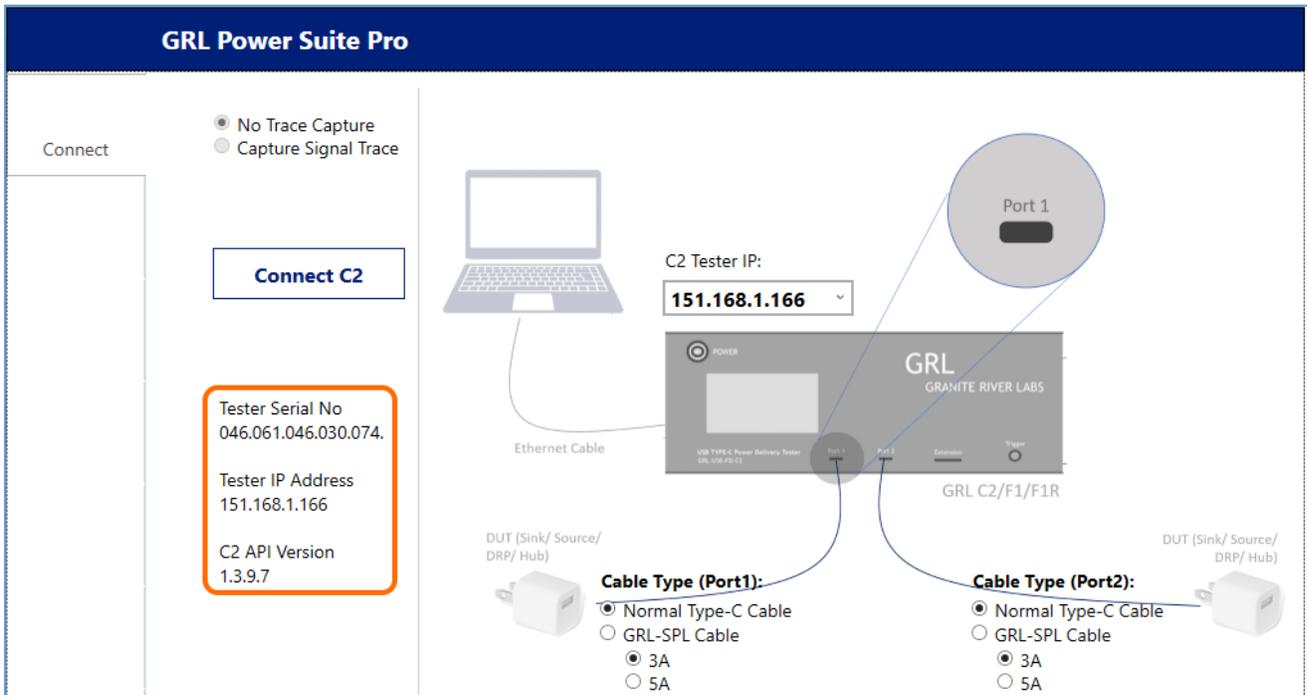


FIGURE 3.7: CONNECTION CONFIGURATION SCREEN AFTER SUCCESSFUL CONNECTION

### 3.4 Connect to Unit Under Test (UUT)

Once the GRL-USB-PD-C2 / F1 Controller has been successfully connected to the control computer, the UUT needs to be connected to the GRL-USB-PD-C2 / F1 Controller.

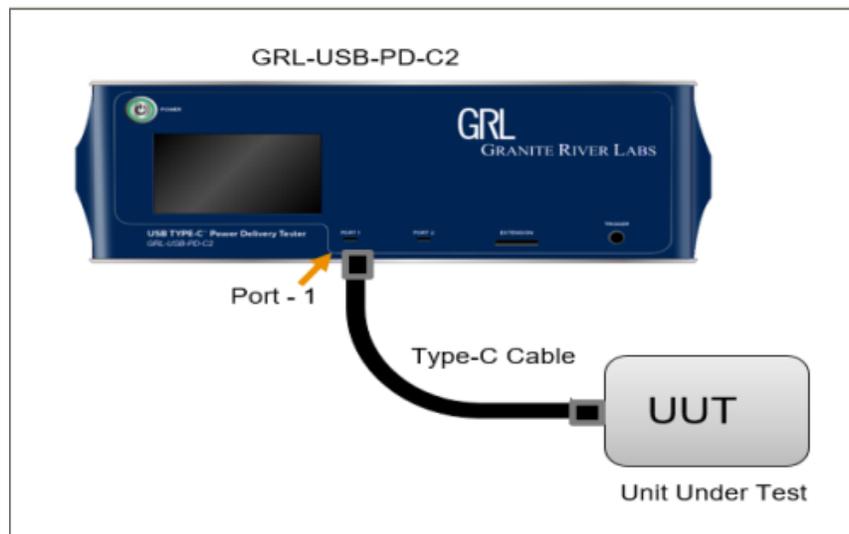


FIGURE 3.8: UUT CONNECTION TO GRL-USB-PD-C2 / F1 CONTROLLER

- Connect the UUT to either USB Port 1 or Port 2 or both ports of the GRL-USB-PD-C2 / F1 Controller using the USB Type-C cable provided by Granite River Labs or a compliant Type-C cable.

2. The GRL-PSP allows you to specify what cable connects the UUT to the specific USB Port on the GRL-USB-PD-C2 / F1 Controller. The ‘Normal Type-C Cable’ option indicates the standard USB Type-C cable with or without eMarker capability, while the ‘GRL-SPL Cable’ option indicates the special Type-C VCONN passthrough test cable provided with the GRL-USB-PD-C2 / F1 Controller which has been characterized specifically for compliance testing. The special cable does not have an eMarker since, under very specific circumstances, an eMarker cable response can be confused with the UUT response during compliance testing. For these cables, you can also select minimum 3 amps ‘3A’ current or maximum 5 amps ‘5A’ current depending on which current capability is supported by the cable being used.

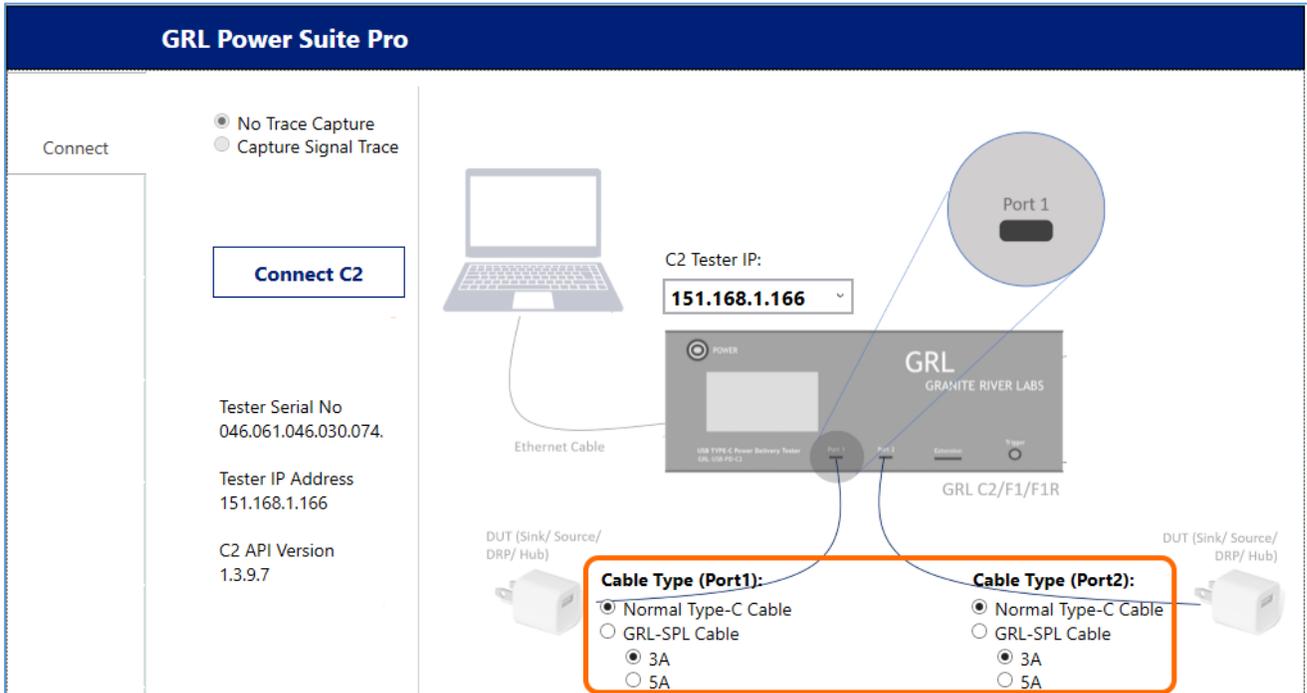


FIGURE 3.9: TEST CABLE TYPE SELECTION

## 4 Using Third Party Tools with GRL-PSP

The PRO version of the GRL-PSP allows you to connect and configure external/third party test equipment and applications as required to perform certain tests through the 3rd Party Tools screen.

*Note: Make sure the third party test equipment or applications to be used are all connected to the same local network as the GRL-PSP.*

1. On the 3rd Party Tools screen, select the **Add New** button at the bottom of the screen.
2. When the Create New Equipment dialog appears, select any of the supported equipment or applications to be used and click on the **Create** button.

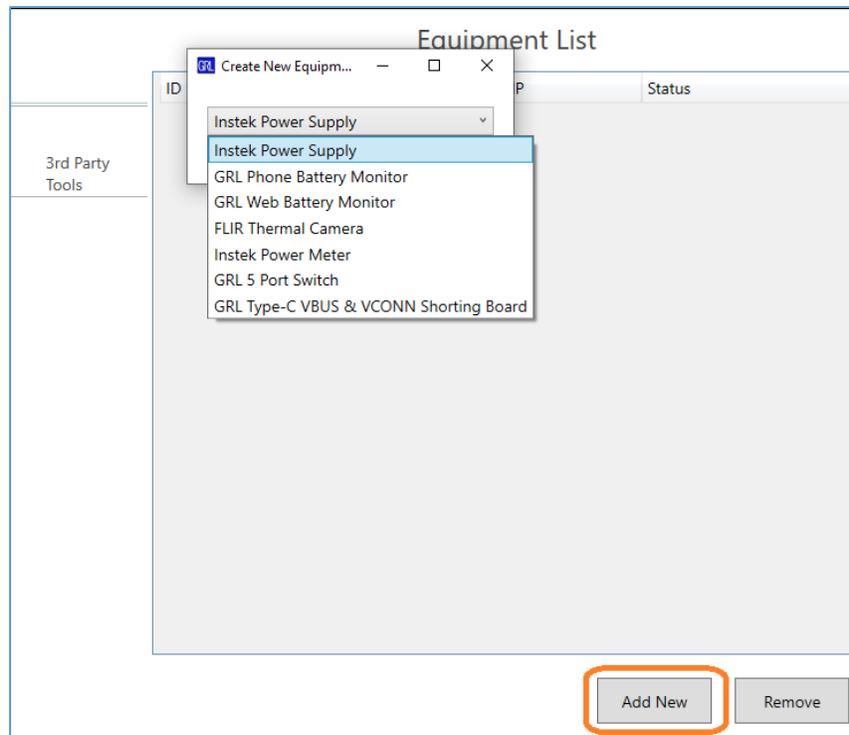


FIGURE 4.1: ADD 3RD PARTY TOOLS TO CONNECT TO GRL-PSP

### 4.1 Set Up Instek Power Supply

If the **Instek Power Supply** is selected, it will be listed in a row along with IP address under Equipment List.

- To make configurations to the network connectivity or set up the power supply for measurements, select the row to display the configuration section on the right panel. Otherwise select the **Connect** button to link up the power supply with the GRL-PSP.
- In the configuration panel, you can assign whether the power supply is connected to which test port of the GRL-USB-PD-C2 / F1 Controller or as a standalone unit, as well as IP address and port number.
- Upon successful connection, you can set up the AC power ratings for the power supply by selecting from the default values or adding new values.
- To use the default AC values, select the appropriate check boxes. To add new values, set the AC voltage and line frequency using the **1) Set AC Power (V)** and **2) Set Frequency (Hz)**

sliders or type in the values. Select the ‘Set’ button on the right to apply or the ‘+’ button to add on the new values under the list of default values. You can also remove any of the added values by selecting their check boxes followed by the ‘-’ button.

- Finally, click on the **Enable APE7100** button to start data acquisition. If you set to run the data acquisition on the Port 1 or Port 2 trace plot, then go to the Test Operation screen to access it. If you set to run on a separate trace plot, the standalone graph window will appear which is similar to the Port 1 or Port 2 graph. You can then select the ‘Turn Output ON / OFF’ button to control the power supply output.

**Caution:** For safety precautions, it is highly advised not to run both data acquisition and power efficiency test at the same time.

Note: The Instek Power Supply setup is used for testing power efficiency and over current protection (OCP) only.

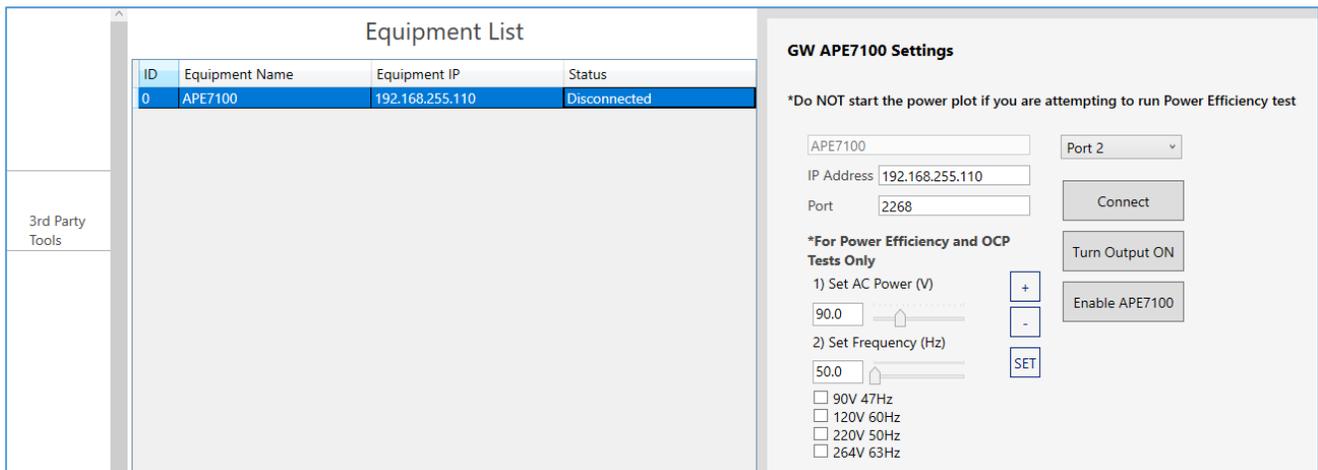


FIGURE 4.2: ADD 3RD PARTY TOOLS – INSTEK POWER SUPPLY

## 4.2 GRL Battery Monitor Apps

GRL has its own phone and Web based Battery Monitor App’s which can be used with the GRL-PSP, allowing you to evaluate battery charging performance for a Android/iOS phone/tablet or for a laptop computer through the Web. The GRL-PSP when linked up with the mobile device running the GRL Battery Monitor App will generate a more detailed test run and test report for further analysis. For more information on the GRL Battery Monitor App along with licensing details, please contact [support@graniteriverlabs.com](mailto:support@graniteriverlabs.com).

### 4.2.1 Set Up GRL Phone Battery Monitor App

GRL Phone Battery Monitor App for both Android and iOS platforms can also be downloaded at:

- IOS: <https://apps.apple.com/us/app/grl-battery-monitor/id1482758036?platform=iphone>
- Android: <https://play.google.com/store/apps/details?id=com.graniteriverlabs.batterymonitor&hl=en>

The GRL Phone Battery Monitor App when installed on the Android/iOS phone will show the following user interfaces. You can choose to turn on options such as brightness, flashlight and vibration when measuring battery performance on the phone. Select **Get Battery Info** to acquire the

battery charging data of the phone. Also note the IP address that will be used to connect this App with the GRL-PSP.

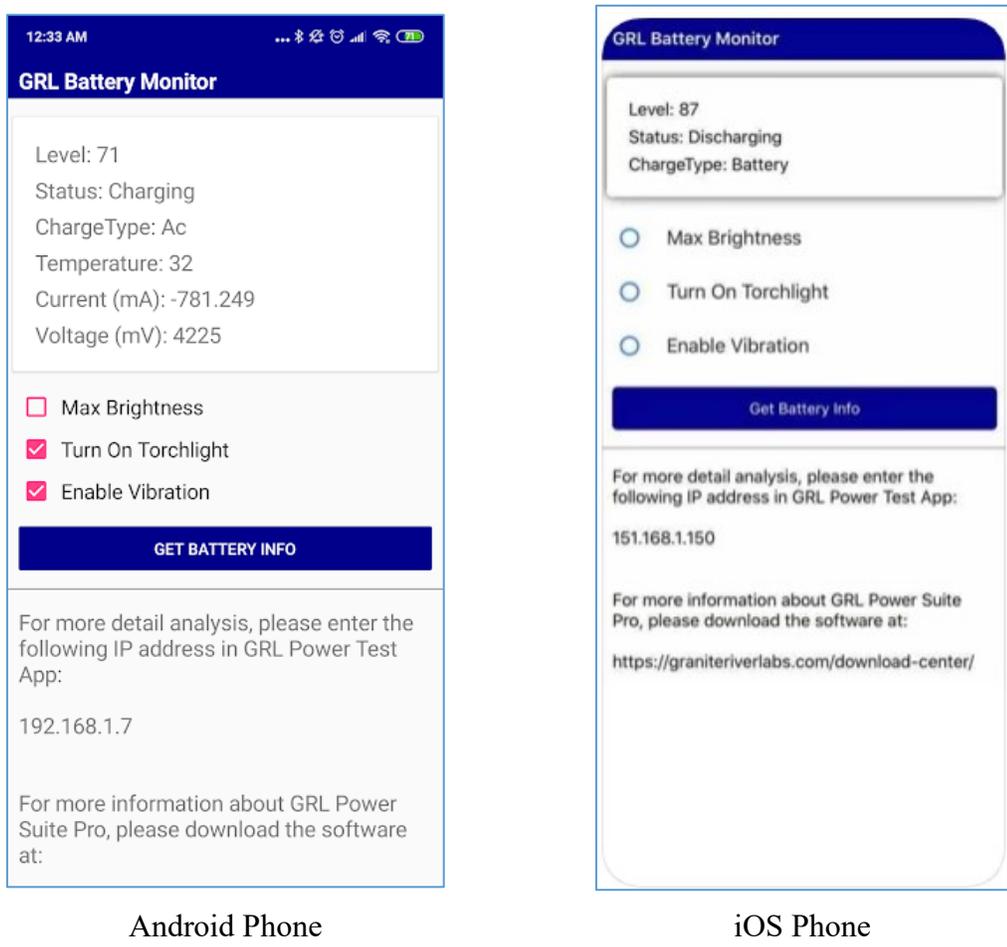


FIGURE 4.3: GRL PHONE BATTERY MONITOR APP UI ON PHONE

If the **GRL Phone Battery Monitor** is selected, it will be listed in a row along with IP address under Equipment List.

- To make configurations to the IP address or set up the parameters for measurements, select the row to display the configuration section on the right panel.
- In the configuration panel, you can set the **IP address** and whether to acquire data on either the Port 1 or Port 2 trace plot of the Test Operation screen or on a separate trace plot.
- Select the operating system (OS) that the phone runs on; either **Android** or **iOS**. You can then select **Show Advance Setup** to choose which trace data items to be shown on the plot and set up the acquisition interval and the unit of current.
- Finally, click on the **Enable Battery Monitor** button at the bottom of the configuration panel to establish connection with GRL Phone Battery Monitor. If you set to run the data acquisition on the Port 1 or Port 2 trace plot, then go to the Test Operation screen to access it. If you set to run on a separate trace plot, the standalone graph window will appear which is similar to the Port 1 or Port 2 graph.

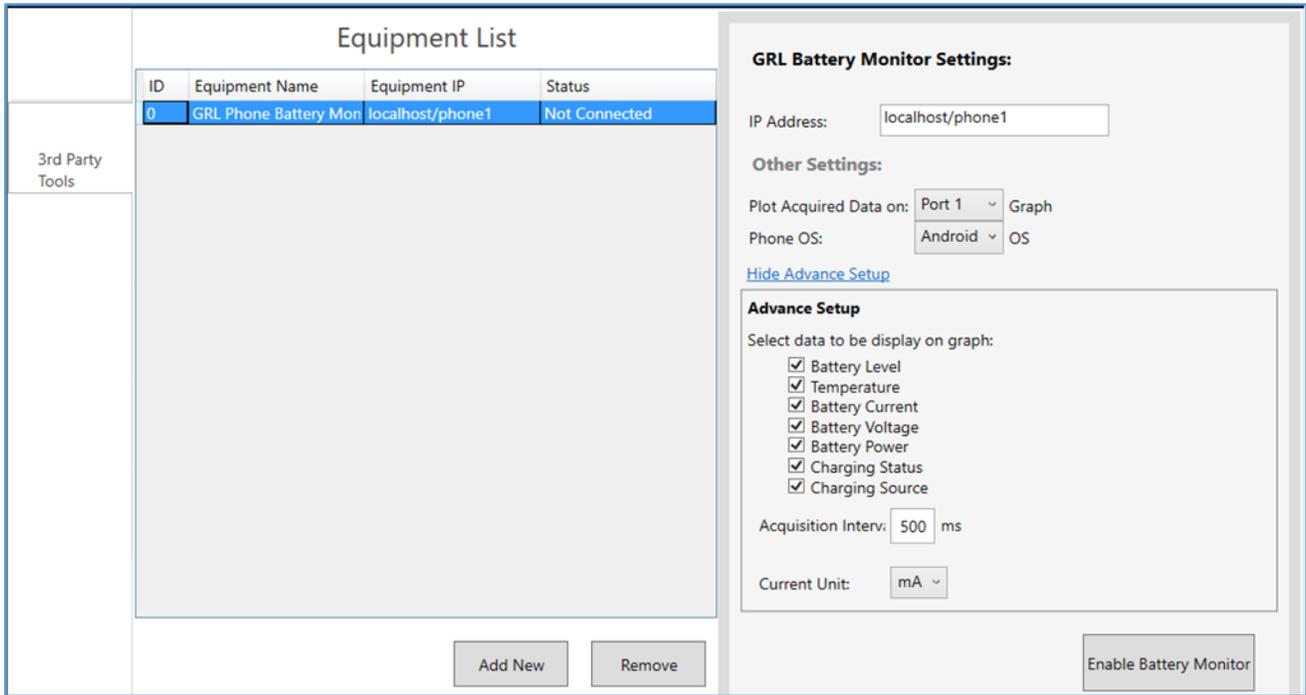


FIGURE 4.4: ADD 3RD PARTY TOOLS – GRL PHONE BATTERY MONITOR APP

- If running the data acquisition on the Port 1 or Port 2 trace plot, on the Test Operation screen the ‘GRL Phone Battery Monitor’ tab is added to the existing Port 1 or Port 2 tab below the graph. Click on the **Start** button to start running data acquisition which will generate the readings for the selected trace data items as well as the trace plot. To stop the test run, select the ‘**Stop**’ button.

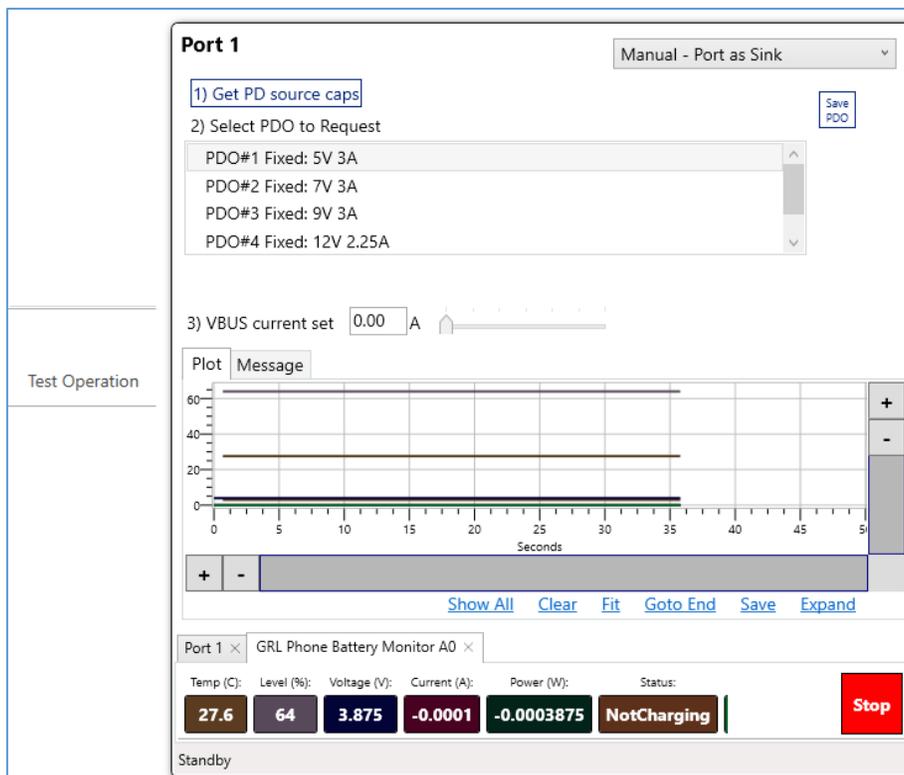


FIGURE 4.5: ADD 3RD PARTY TOOLS – GRL PHONE BATTERY MONITOR TEST AT PORT 1 OR 2 EXAMPLE

## 4.2.2 Set Up GRL Web Battery Monitor App

The GRL Web Battery Monitor App when run on the Google Chrome browser of the laptop PC will display the following user interface example. You can easily track the current status of battery charging on the PC through this App. Make sure to use the same connection ID to link up this App with the GRL-PSP for more detailed analysis.

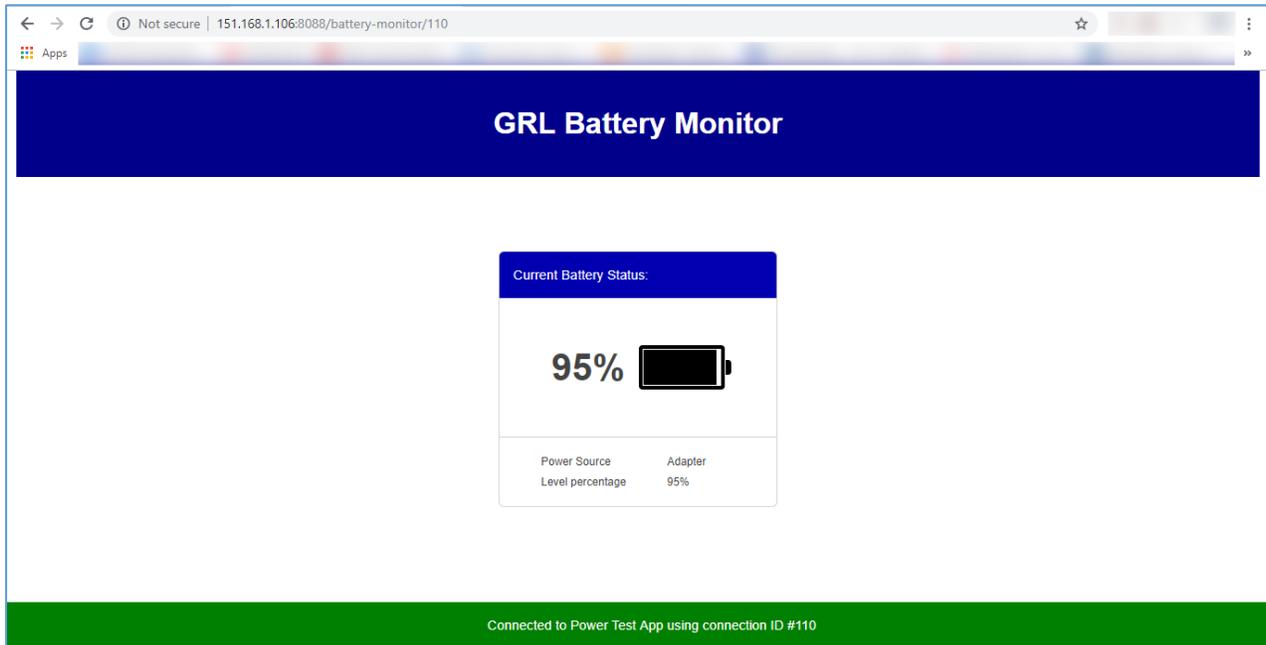


FIGURE 4.6: GRL WEB BATTERY MONITOR APP UI ON PC EXAMPLE

If the **GRL Web Battery Monitor** is selected, it will be listed in a row under Equipment List.

- To make configurations to the HTML connection ID or set up the parameters for measurements, select the row to display the configuration section on the right panel. Follow the instructions to open the Google Chrome browser on the PC to be tested and enter the address as listed. This will launch and initiate the GRL Web Battery Monitor App.
- In the configuration panel, you can set the **Connection ID** and whether to acquire data on either the Port 1 or Port 2 trace plot of the Test Operation screen or on a separate trace plot.
- You can select **Show Advance Setup** to choose which trace data items to be shown on the plot and set up the acquisition interval.
- Then click on the **Enable Battery Monitor** button at the bottom of the configuration panel to establish connection with the GRL Web Battery Monitor App. If you set to run the data acquisition on the Port 1 or Port 2 trace plot, then go to the Test Operation screen to access it. If you set to run on a separate trace plot, the standalone graph window will appear which is similar to the Port 1 or Port 2 graph.

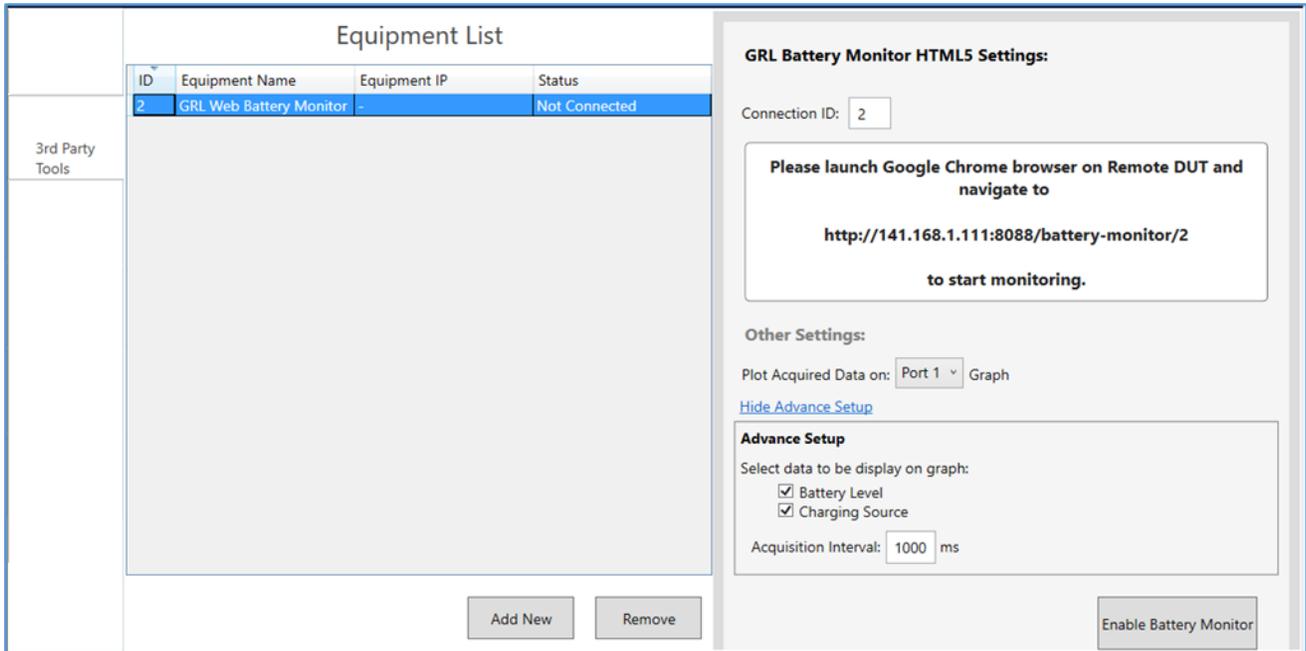


FIGURE 4.7: ADD 3RD PARTY TOOLS – GRL WEB BATTERY MONITOR APP

- If running the data acquisition on the Port 1 or Port 2 trace plot, on the Test Operation screen the 'GRL Web Battery Monitor' tab is added to the existing Port 1 or Port 2 tab below the graph. Click on the **Start** button to start running data acquisition which will generate the readings for the selected trace data items as well as the trace plot. To stop the test run, select the **Stop** button.

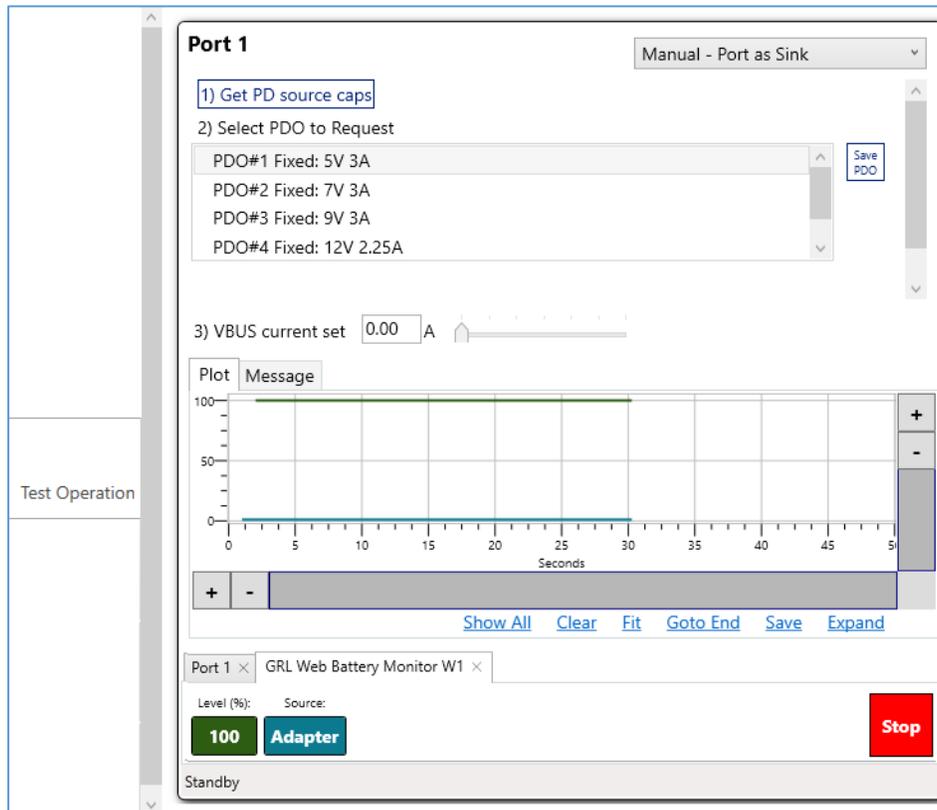


FIGURE 4.8: ADD 3RD PARTY TOOLS – GRL WEB BATTERY MONITOR TEST AT PORT 1 OR 2 EXAMPLE

### 4.3 Set Up FLIR Thermal Camera

If the **FLIR Thermal Camera** is selected, it will be listed in a row under Equipment List.

*Note: Make sure to open the FLIR Tools software first before proceeding with enabling the FLIR thermal camera function in the GRL-PSP.*

*Note: Saving images of the thermal camera while it is running will consume more system memory.*

- To set up the thermal camera for measurements, select the row to display the configuration section on the right panel.
- In the configuration panel, you can assign whether to acquire data on either the Port 1 or Port 2 trace plot of the Test Operation screen or on a separate trace plot.
- You can also select which trace data items to be shown on the plot, set up the acquisition interval and choose to save or remove image captures.
- Your connected thermal camera should show up in the list if connected properly. Select the camera and click on the **Select** button.
- When done, click on the **Enable FLIR** button at the bottom of the configuration panel to establish connection with the thermal camera.
- If you set to run the data acquisition on the Port 1 or Port 2 trace plot, then go to the Test Operation screen to access it. If you set to run on a separate trace plot, the standalone graph window will be displayed. While data acquisition is running, you also have the option to view real time hot spot imaging on a separate window.

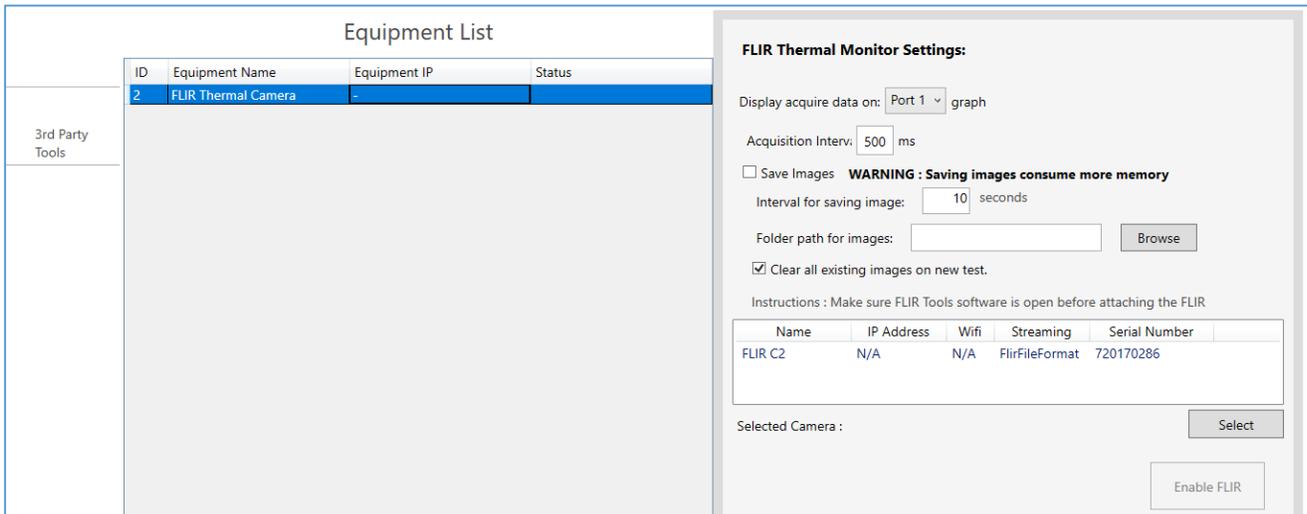


FIGURE 4.9: ADD 3RD PARTY TOOLS – FLIR THERMAL CAMERA

- If running the data acquisition on the Port 1 or Port 2 trace plot, on the Test Operation screen the ‘FLIR Thermal’ tab is added to the existing Port 1 or Port 2 tab below the graph. Click on the **Start** button to start running data acquisition which will generate the readings for the selected trace data items as well as the trace plot. To view real time hot spot imaging on a separate window, click on the ‘**Show Cam**’ button. To stop the test run, select the ‘**Stop**’ button.

Note: The FLIR image functionality can support and record up to five thermal points, in which three of them can easily be created and has their own detection position modified by simply clicking on the live image itself.

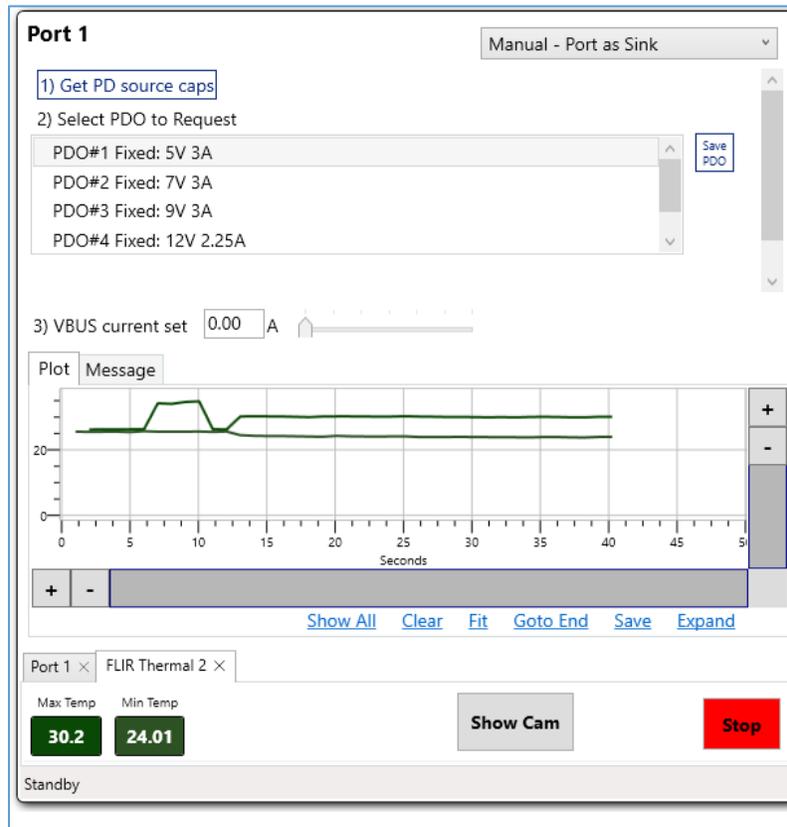


FIGURE 4.10: ADD 3RD PARTY TOOLS – FLIR THERMAL MEASUREMENTS AT PORT 1 OR 2 EXAMPLE

- Below is an example if running the data acquisition as a standalone graph.

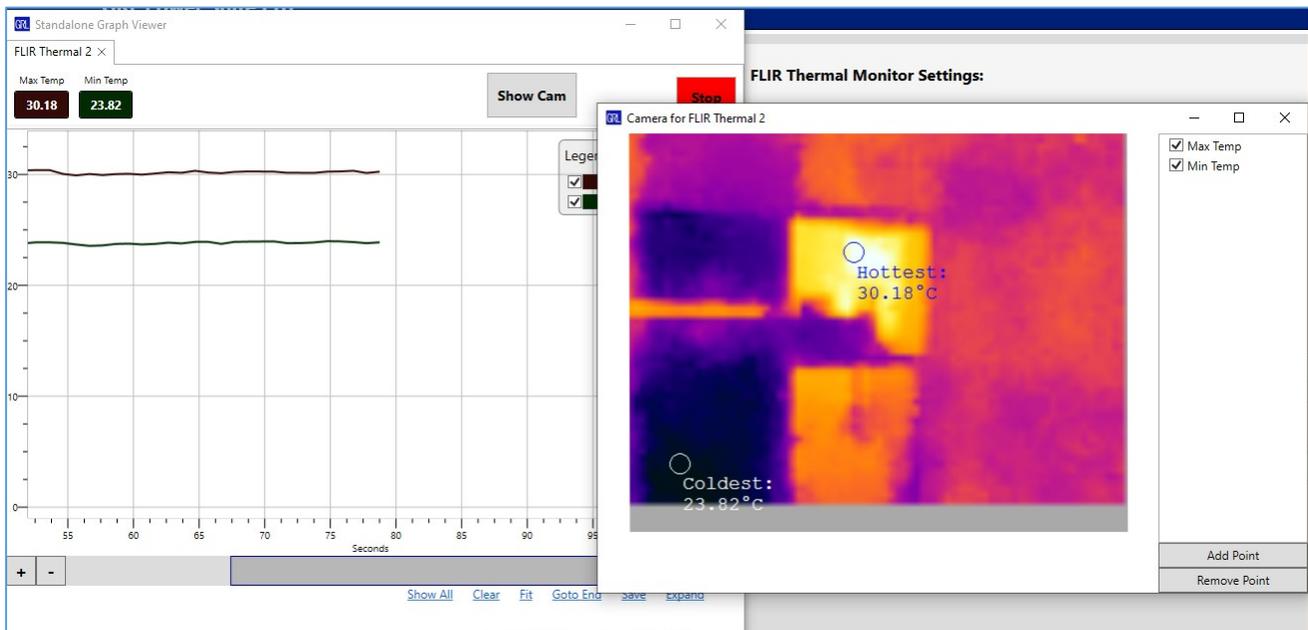


FIGURE 4.11: ADD 3RD PARTY TOOLS – FLIR MEASUREMENTS IN STANDALONE GRAPH VIEW EXAMPLE

## 4.4 Set Up Instek Power Meter

If the **Instek Power Meter** is selected, it will be listed in a row along with IP address under Equipment List.

- To make configurations to the network connectivity or set up the power meter for measurements, select the row to display the configuration section on the right panel. Otherwise select the **Connect** button to link up the power meter with the GRL-PSP.
- In the configuration panel, you can assign whether the power meter is connected to which test port of the GRL-USB-PD-C2 / F1 Controller or as a standalone unit, as well as IP address and port number.
- Upon successful connection, you can set up the AC power ratings for the power meter using the default values or by setting new values. To set new values, set the AC voltage and line frequency using the **1) Set AC Power (V)** and **2) Set Frequency (Hz)** sliders or type in the values.
- Finally, click on the **Enable GPM8213** button to start data acquisition. If you set to run the data acquisition on the Port 1 or Port 2 trace plot, then go to the Test Operation screen to access it. If you set to run on a separate trace plot, the standalone graph window will appear which is similar to the Port 1 or Port 2 graph.

**Caution:** For safety precautions, it is highly advised not to run both data acquisition and power efficiency test at the same time.

Note: The Instek Power Meter setup is used for testing power efficiency and over current protection (OCP) only.

The screenshot displays a software interface with two main panels. The left panel, titled 'Equipment List', contains a table with the following data:

ID	Equipment Name	Equipment IP	Status
3	GPM8213	192.168.255.110	Disconnected

The right panel, titled 'GW GPM8213 Settings', contains the following configuration options:

- A warning: **\*Do NOT start the power plot if you are attempting to run Power Efficiency test**
- Equipment ID: GPM8213
- Connection Mode: Standalone (dropdown menu)
- IP Address: 192.168.255.110
- Port: 23
- Buttons: Connect, Enable GPM8213
- Section: **\*For Power Efficiency and OCP Tests Only**
- 1) Set AC Power (V): 240.0 (with a slider)
- 2) Set Frequency (Hz): 50.0 (with a slider)
- Checkbox:  240V 50Hz

FIGURE 4.12: ADD 3RD PARTY TOOLS – INSTEK POWER METER

## 4.5 Set Up GRL 5-Port Switch

If the **GRL 5-Port Switch** is selected, it will be listed in a row under Equipment List.

**Note:** This switch function requires the GRL 5-Port Switch Board (GRL-USB-PD-MULT option) to be used which is provided as a separate accessory for the GRL-PSP. The GRL 5-Port Switch Board consists of a five ports switch extension fixture that is plugged in to the GRL-USB-PD-C2 / F1 Controller and used to connect up to five Unit Under Tests or UUT's to perform switching during tests. For more information on the GRL 5-Port Switch Board, please contact [support@graniteriverlabs.com](mailto:support@graniteriverlabs.com).

- To set up the switch for measurements, select the row to display the configuration section on the right panel. Otherwise select the **Connect** button to link up the switch with the GRL-PSP.
- In the configuration panel, you can assign which **COM Port** and **Port path** to be used on the switch. Upon successful connection, you can then perform switching as required in the test setup after clicking on the **Enable Automation** button. If you set to perform switching on the Port 1 or Port 2 trace plot, then go to the Test Operation screen to access it.

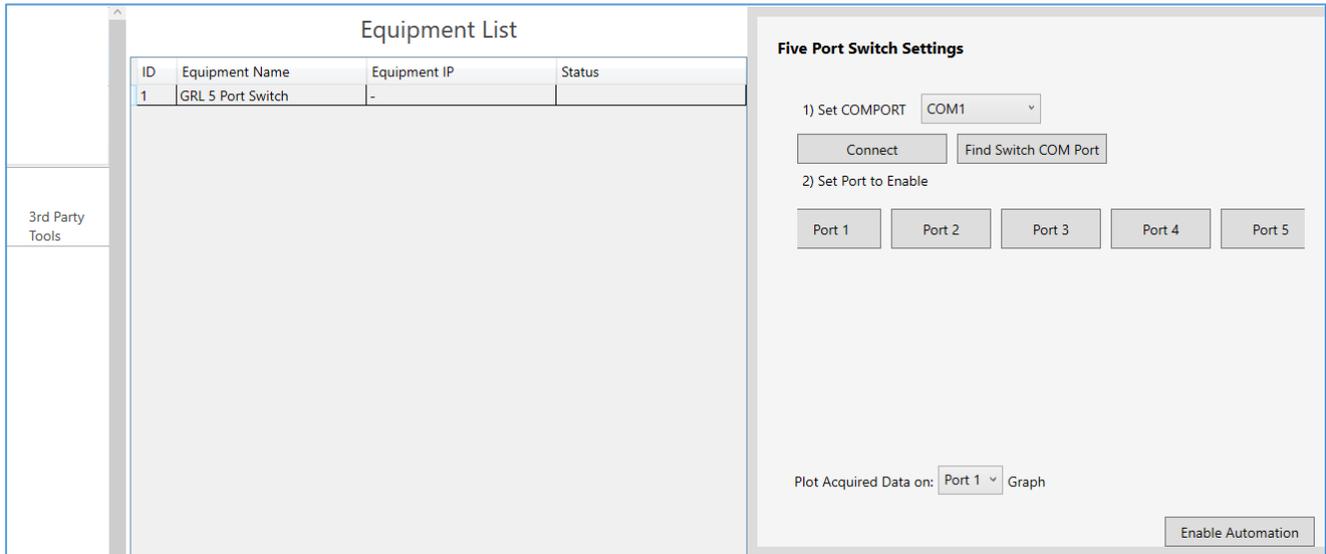


FIGURE 4.13: ADD 3RD PARTY TOOLS – GRL 5-PORT SWITCH

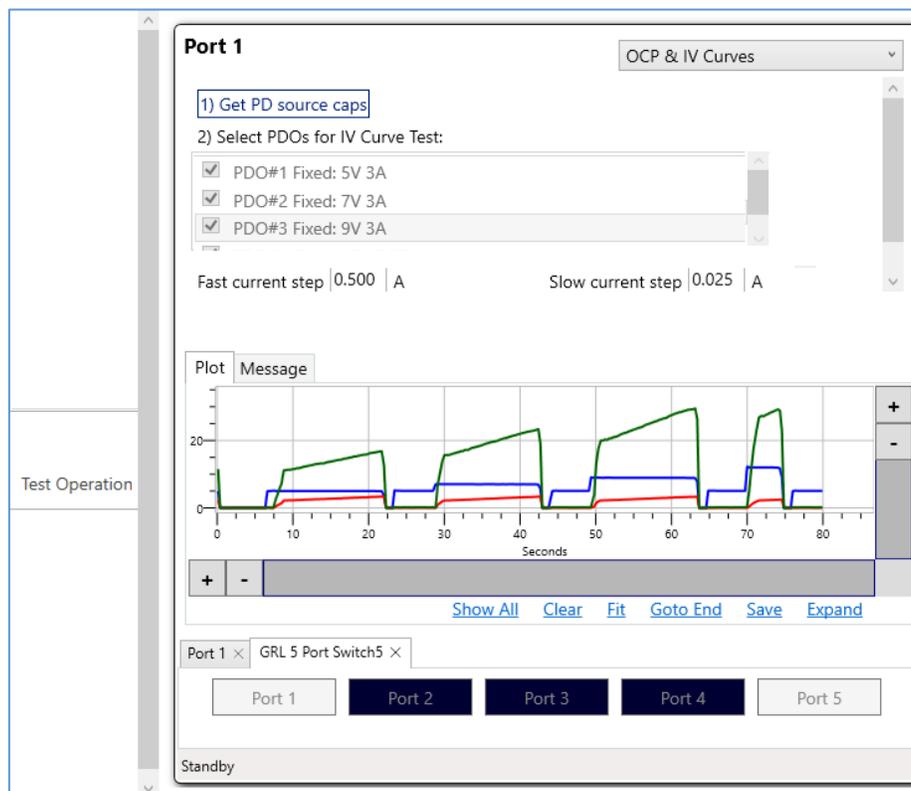


FIGURE 4.14: ADD 3RD PARTY TOOLS – GRL 5-PORT SWITCH AT PORT 1 OR 2 EXAMPLE

## 4.6 Set Up GRL Type-C VBUS & VCONN Shorting Board

If **GRL Type-C VBUS & VCONN Shorting Board** is selected, it will be listed in a row under Equipment List.

*Note: This function requires the GRL Type-C VBUS & VCONN Shorting Board (GRL-USB-PD-PWR option) to be used which is provided as a separate accessory for the GRL-PSP. The GRL Type-C VBUS & VCONN Shorting Board comprises the following fixtures and cable:*



- **GRL-C2-EXT5 Extension Board** – EXT5 extension fixture for the GRL-USB-PD-C2 / F1 Controller, used to:
  - Control inputs/outputs from the controller.
  - Control the GRL-USB-PD-SHT2 Extension Fixture.



- **GRL-USB-PD-SHT2** – Extension fixture for the GRL-USB-PD-C2 / F1 Controller, used to connect to the controller's Port 1 and Port 2 to perform external short circuit for VBUS and VCONN to ground using control signals from the GRL-C2-EXT5 extension board.



- **F1R-IO-TBT-Cable** – Thunderbolt input/output test cable, used for connecting the GRL-C2-EXT5 extension board with the GRL-USB-PD-SHT2 extension fixture.
- Support for Thunderbolt power testing using the GRL-USB-PD-C2 / F1 Controller (VBUS and VCONN shorting to ground).

*Note: Additional "GRL-USB-PD-PSP" licensing is required for testing with the above fixtures; please contact [support@graniteriverlabs.com](mailto:support@graniteriverlabs.com) for purchase orders or more information.*

Below is an example to connect the GRL Type-C VBUS & VCONN Shorting Board with the GRL-USB-PD-C2 / F1 Controller and Unit Under Tests (UUT's).



- Ensure that the GRL Type-C VBUS & VCONN Shorting Board is connected properly to both Port 1 and Port 2 and the Extension port on the GRL-USB-PD-C2 / F1 Controller as shown in the above example before making any setup configuration.
- To set up the GRL Type-C VBUS & VCONN Shorting Board on the GRL-PSP for measurements, select the row to display the configuration section on the right panel. If the GRL Type-C VBUS & VCONN Shorting Board is connected to the GRL-USB-PD-C2 / F1 Controller, the **Short** and **Open** buttons will be enabled for both Port 1 and Port 2.
- In the configuration panel, you can select the **Short** button to perform VBUS and VCONN shorting to ground or the **Open** button to reset the operation when running a test case. For example, if you are running the ‘Manual Control – Port as Sink’ test case in the Test Operation screen using a 5 V charger UUT, pressing the **Short** button will cause the voltage to immediately drop to 0 V. If the **Open** button is pressed, the voltage will be reset to 5 V.

ID	Equipment Name	Equipment IP	Status
1	GRL-USB-PD-PWR	-	

3rd Party Tools

**GRL Type-C VBUS & VCONN Shorting Board Settings**

(\*) C2 must be connected first in order to access the commands below

**Port 1**

Short Open

---

**Port 2**

Short Open

FIGURE 4.15: ADD 3RD PARTY TOOLS – GRL TYPE-C VBUS & VCONN SHORTING BOARD

## 5 Performing Tests with GRL-PSP

GRL-PSP supports multiple test applications and features as listed in Section 1.1 when used with the GRL-USB-PD-C2 / F1 Controller.

The various Test Cases presented by the GRL-PSP allow you to select, configure, run and generate reports from these tests for a variety of devices (Units Under Test or UUT's). Some of these test cases also allow you to perform analysis for specific UUT features and capabilities. More details on these are provided in the following subsections.

### 5.1 Create Custom Power Delivery (PD) Source/Sink

The 'Manual Control – Port as Source' or 'Manual Control – Port as Sink' Test Case allows you to create or emulate a PD Source/Sink for the appropriate UUT that is connected to either USB Test Port 1 or Port 2 or both of the GRL-USB-PD-C2 / F1 Controller.

1. On the Test Case screen, select **Manual Control – Port as Source** if testing a PD Sink UUT or **Manual Control – Port as Sink** if testing a PD Source UUT.

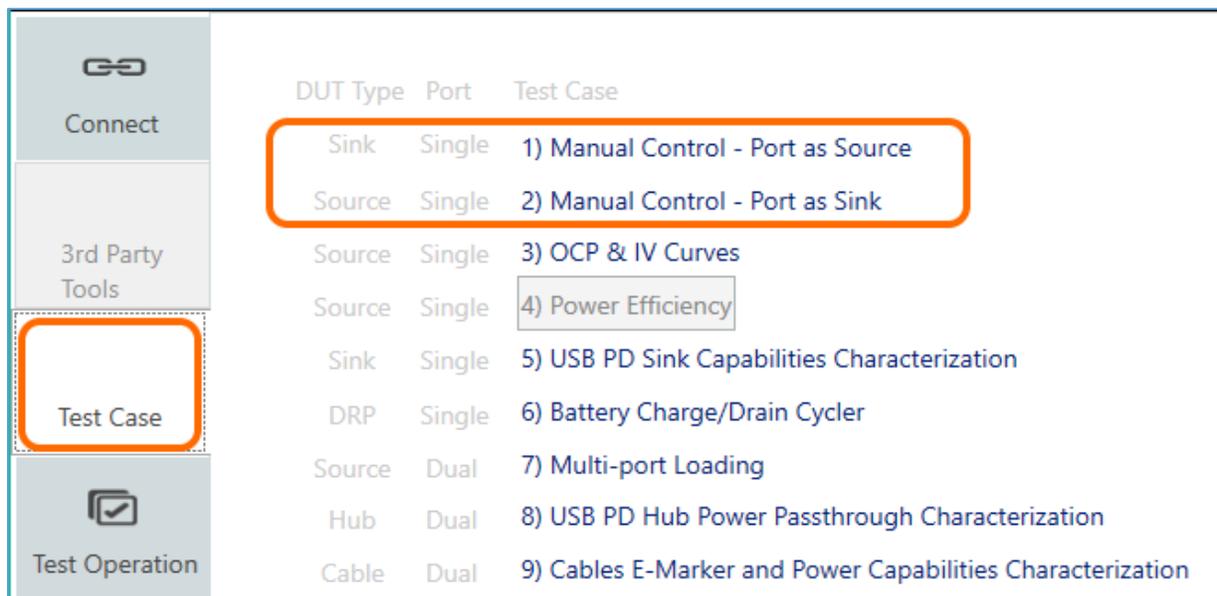


FIGURE 5.1: SELECT TEST CASE – MANUAL CONTROL – PORT AS SOURCE/SINK

2. If **Manual Control – Port as Source** is selected:
  - a. Go to the Test Operation screen and set the Source PDO using the voltage (1) and current (2) sliders or type in the values. If the UUT supports Programmable Power Supply power profiles, select the 'PPS' check box and enter the APDO's values. To add more than one PDO with different voltages/current, select the '+' button on the right and similarly set the voltage/current values for each added PDO.

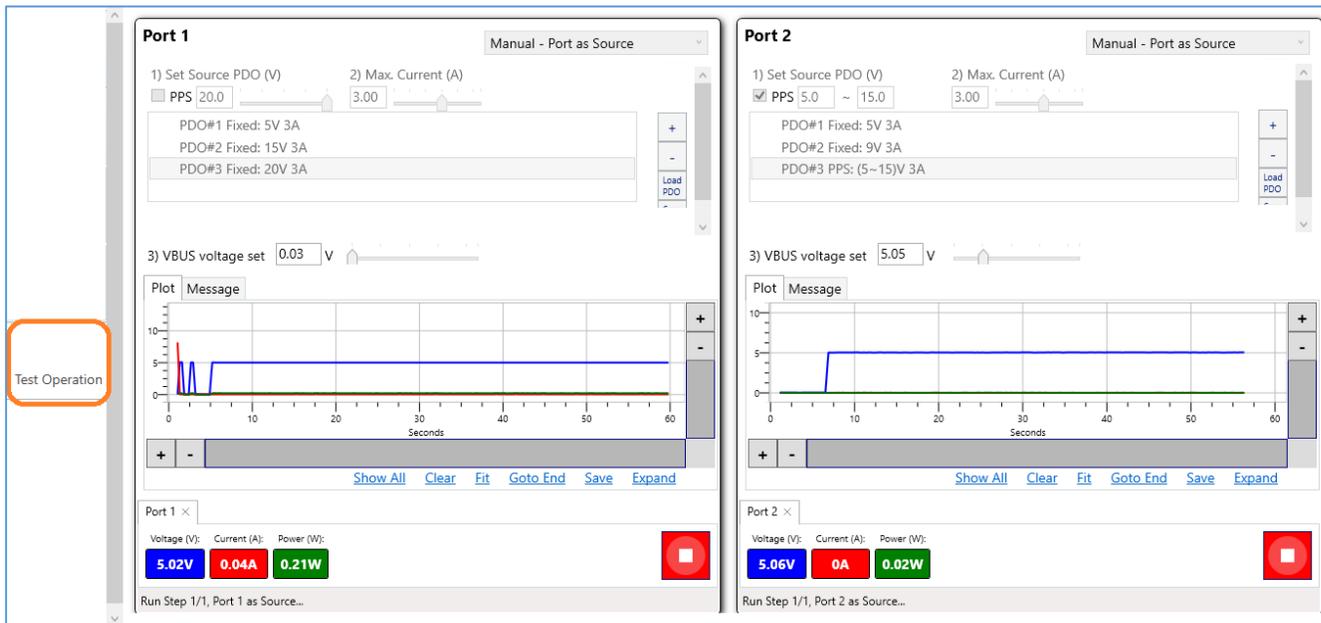


FIGURE 5.2: PERFORM MANUAL CONTROL – PORT AS SOURCE TEST FOR PD SINK UUT

- b. In case you want to remove an added PDO from the list, select the specific PDO followed by the ‘-’ button on the right. To remove all added PDO’s from the list, select the ‘Clear All’ button on the right.
- c. You can also configure VBUS voltage using the VBUS voltage (3) slider or type in the value.
- d. Connect a PD Sink UUT(s) to either USB Test Port 1 or Port 2 or both of the GRL-USB-PD-C2 / F1 Controller where the Source is being emulated and then select the bottom  button to start running virtual connection to the emulated Source. *Note: You can right-click this button to access more ‘Play’ or ‘Stop’ functionality as desired.*
- e. As the test is being run, it will generate the VBUS and trace plot along with values for voltage, current and power while displaying the test status at the bottom of the screen. *Note: You can right-click on the voltage, current or power value box to toggle visibility, change line color and offset of each graph line.*
- f. You can select the ‘Message’ tab to switch from the graph view to a simplified PD protocol negotiation view.
- g. You can use the horizontal and vertical scroll bars of the graph to zoom in/out, navigate across the length of the trace plot or pause the running trace. Additional function buttons below the bar allow you to control the graph view, clear/reset the graph, save the current test configuration to a file or display the graph on a separate window.
- h. At any time you want to stop the test run, select the  button.
- i. To save the emulated PD Source capabilities, select the ‘Save PDO’ button on the right. To load previously saved emulated PD Source capabilities, select the ‘Load PDO’ button on the right.

- j. When test is completed, the Results screen will display the USB Power Delivery negotiation along with a voltage, current trace plot for the respective test Port(s) as shown in the example below. To save as a test report, select the ‘Save Report’ button at the bottom.

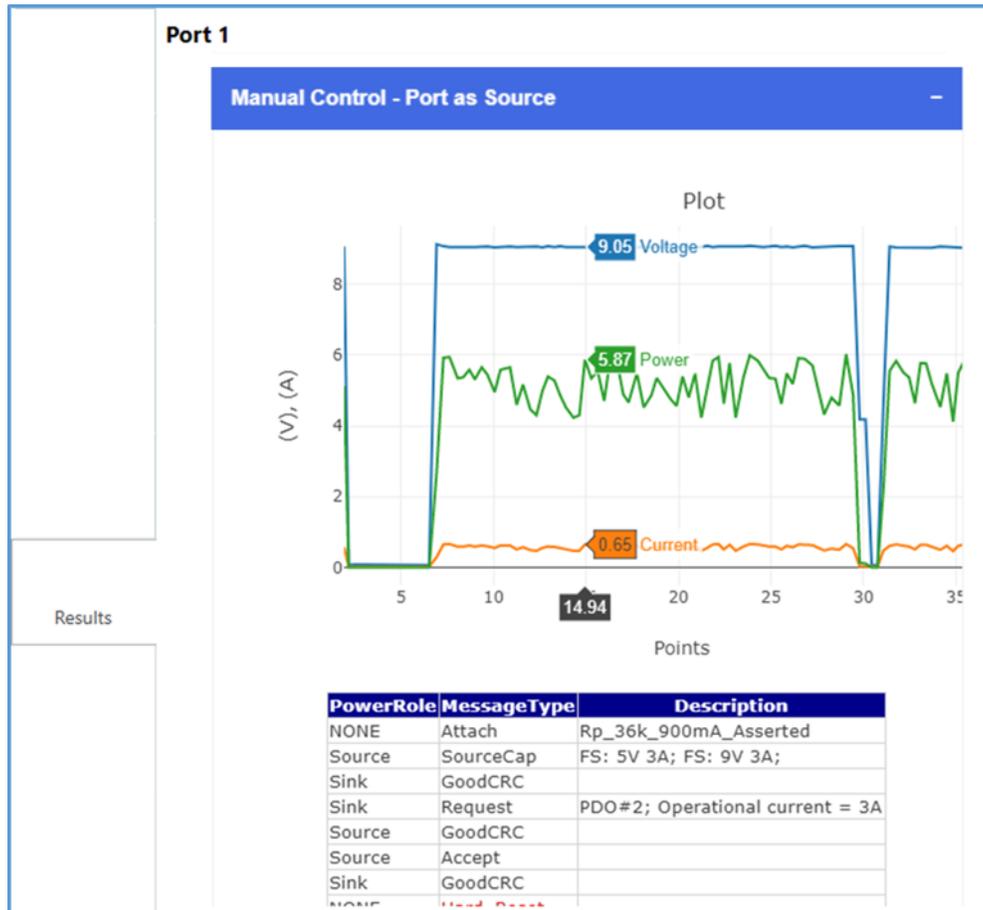


FIGURE 5.3: MANUAL CONTROL – PORT AS SOURCE TEST RESULTS EXAMPLE

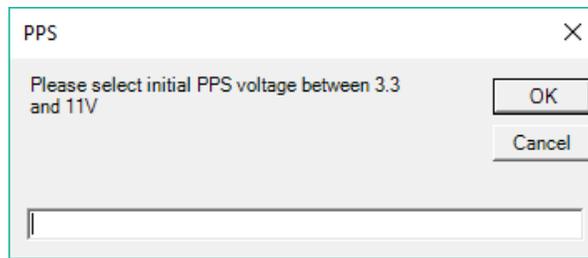
### 3. If **Manual Control – Port as Sink** is selected:

- a. Connect a PD Source UUT(s) to either USB Test Port 1 or Port 2 or both of the GRL-USB-PD-C2 / F1 Controller and go to the Test Operation screen.
- b. Select the ‘1) Get PD source caps’ button to acquire Source PDO’s supported by the connected UUT.
- c. When the Source PDO’s are listed, select any of these PDO’s to request from the UUT.
- d. You can also configure VBUS current using the VBUS current (3) slider or type in the value.
- e. Select the  button for the Test Port emulating the Sink to start running virtual connection of the Source UUT to the emulated Sink. *Note: You can right-click this button to access more ‘Play’ or ‘Stop’ functionality as desired.*



FIGURE 5.4: PERFORM MANUAL CONTROL – PORT AS SINK TEST FOR PD SOURCE UUT

- f. As the test is being run, it will generate the VBUS and trace plot along with values for voltage, current and power while displaying the test status at the bottom of the screen. *Note: You can right-click on the voltage, current or power value box to toggle visibility, change line color and offset of each graph line.*
- g. If you decide to switch to another PDO while test is running, click on the ‘Update PDO’ button or the ‘Update PPS’ button if the UUT supports Programmable Power Supply power profiles and a APDO is selected.
- h. You can select the ‘Message’ tab to switch from the graph view to a simplified PD protocol negotiation view.
- i. You can use the horizontal and vertical scroll bars of the graph to zoom in/out, navigate across the length of the trace plot or pause the running trace. Additional function buttons below the bar allow you to control the graph view, clear/reset the graph, save the current test configuration to a file or display the graph on a separate window.
- j. At any time you want to stop the test run, select the  button.
- k. If the UUT supports Programmable Power Supply power profiles and a APDO is requested from the UUT, you need to enter an initial APDO voltage of within the range limit when prompted as shown in the example below.



- l. To save the PD Source capabilities of the UUT, select the ‘Save PDO’ button on the top right.
- m. When test is completed, the Results screen will display the USB Power Delivery negotiation along with a voltage, current trace plot for the respective test Port(s) as shown in the example below. To save as a test report, select the ‘Save Report’ button at the bottom.

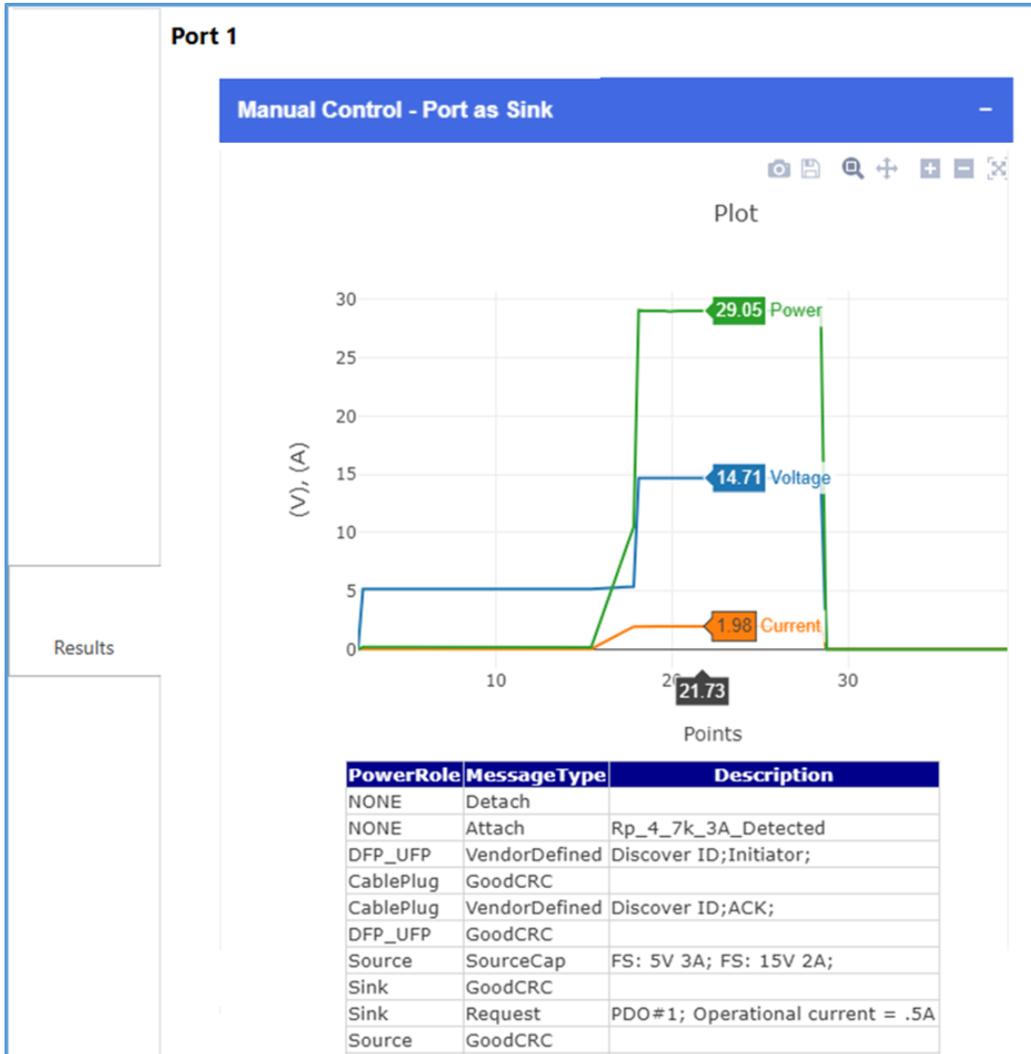


FIGURE 5.5: MANUAL CONTROL – PORT AS SINK TEST RESULTS EXAMPLE

- n. If you want to test another UUT using the same PDO that you have selected, you can select the ‘Auto PDO Reselect’ checkbox. The GRL-PSP will automatically run the test using the same PDO selected previously.

## 5.2 Save/Load Power Delivery (PD) Source Emulation

When running the ‘Manual Control – Port as Source’ or ‘Manual Control – Port as Sink’ Test Case, you can save or load PD Source emulation to be applied for the appropriate UUT that is connected to either USB Test Port 1 or Port 2 or both of the GRL-USB-PD-C2 / F1 Controller.

1. On the Test Case screen, select **Manual Control – Port as Source** if testing a PD Sink UUT or **Manual Control – Port as Sink** if testing a PD Source UUT.

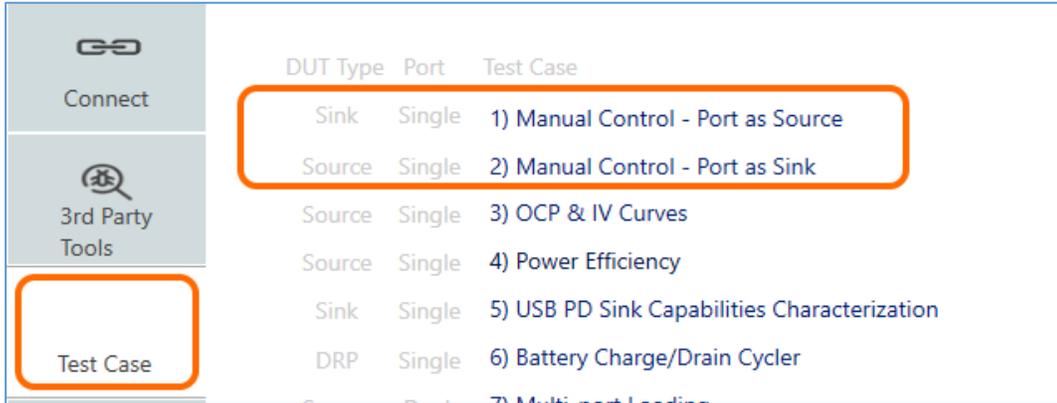


FIGURE 5.6: SELECT TEST CASE – MANUAL CONTROL – PORT AS SOURCE/SINK

2. Assuming the PD Source UUT is connected to Test Port 1 of the GRL-USB-PD-C2 / F1 Controller, select the **Manual Control – Port as Sink** Test Case and perform these steps:
  - a. Go to the Test Operation screen and on the **Port 1** panel, select the ‘1) Get PD source caps’ button to acquire Source PDO’s supported by the connected UUT.



FIGURE 5.7: PORT AS SINK TEST – ACQUIRE PD SOURCE CAPS

- b. Save the PD Source capabilities of the UUT to a file by selecting the ‘Save PDO’ button on the top right.

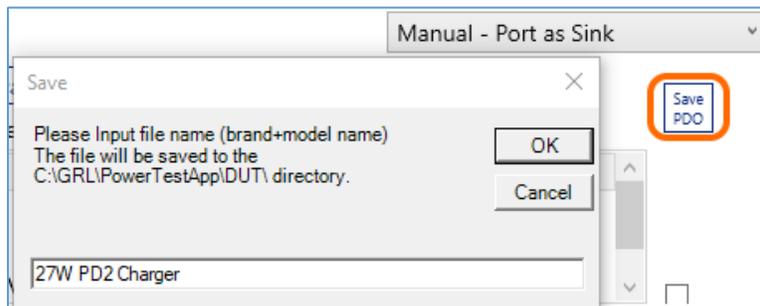


FIGURE 5.8: PORT AS SINK TEST – SAVE PD SOURCE CAPS

3. On **Port 2** panel of the Test Operation screen, select the **Manual Control – Port as Source** Test Case from the top drop-down menu and perform the following steps:
  - a. On the **Port 2** panel, select the ‘Load PDO’ button on the right to load the UUT’s PD Source capabilities that was saved in step 2 (b).

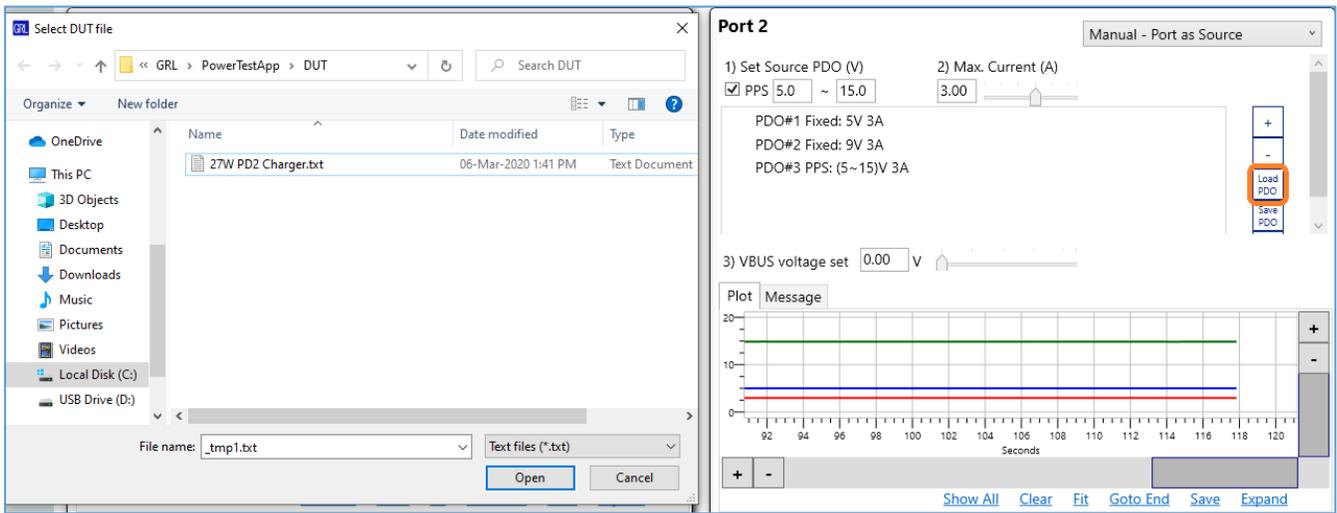


FIGURE 5.9: PORT AS SOURCE TEST – LOAD PD SOURCE CAPS

- b. Connect a PD Sink UUT(s) to Test Port 2 where the Source is being emulated and then select the bottom  button to start running virtual connection to the emulated Source. *Note: You can right-click this button to access more ‘Play’ or ‘Stop’ functionality as desired.*
- c. As the test is being run, it will generate the VBUS and trace plot along with values for voltage, current and power while displaying the test status at the bottom of the screen. *Note: You can right-click on the voltage, current or power value box to toggle visibility, change line color and offset of each graph line.*
- d. You can select the ‘Message’ tab to switch from the graph view to a simplified PD protocol negotiation view.
- e. You can use the horizontal and vertical scroll bars of the graph to zoom in/out, navigate across the length of the trace plot or pause the running trace. Additional function buttons below the bar allow you to control the graph view, clear/reset the graph, save the current test configuration to a file or display the graph on a separate window.
- f. At any time you want to stop the test run, select the  button.

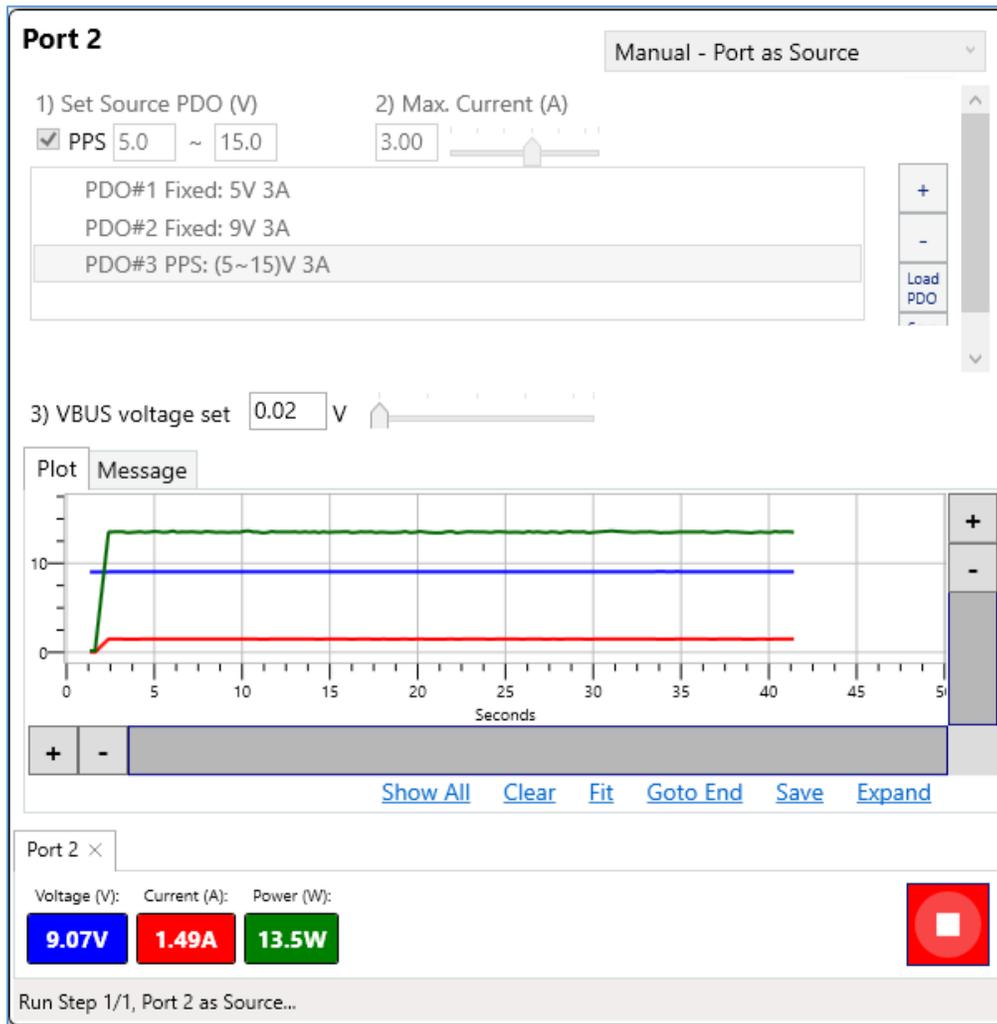


FIGURE 5.10: PORT AS SOURCE TEST – RUN PD SOURCE EMULATION

### 5.3 Search for Source Over Current Protection Thresholds and Identify Voltage-Current Relationship Problems

The ‘IV Curves’ Test Case allows you to determine the Over Current Protection (OCP) thresholds and generate Current-Voltage (I-V) curve plots for the Source UUT that is connected to either USB Test Port 1 or Port 2 or both of the GRL-USB-PD-C2 / F1 Controller.

The GRL-PSP first negotiates a power contract for every PDO supported by the UUT, and increases the load gradually to find the threshold where OCP kicks in and voltage and current start to drop for safety reasons.

1. On the Test Case screen, select **OCP & IV Curves**.



FIGURE 5.11: SELECT TEST CASE – OCP & IV CURVES

2. Connect a Source UUT to either USB Test Port 1 or Port 2 or both of the GRL-USB-PD-C2 / F1 Controller and go to the Test Operation screen.
3. Select the '1) Get PD source caps' button to acquire Source PDO's supported by the connected UUT.
4. When the Source PDO's are listed, select any of these PDO's to request from the UUT to test for I-V curves.
5. You can also manually configure the fast and slow current steps which will be used during the test run to search for the OCP threshold limit.
6. Select the  button for the Test Port(s) attached with the UUT to start the test run. *Note: You can right-click this button to access more 'Play' or 'Stop' functionality as desired.*
7. A OCP prompt will show up where you can configure the starting point of current that will cause the current step size to progressively reduce as it locates the OCP threshold limit.

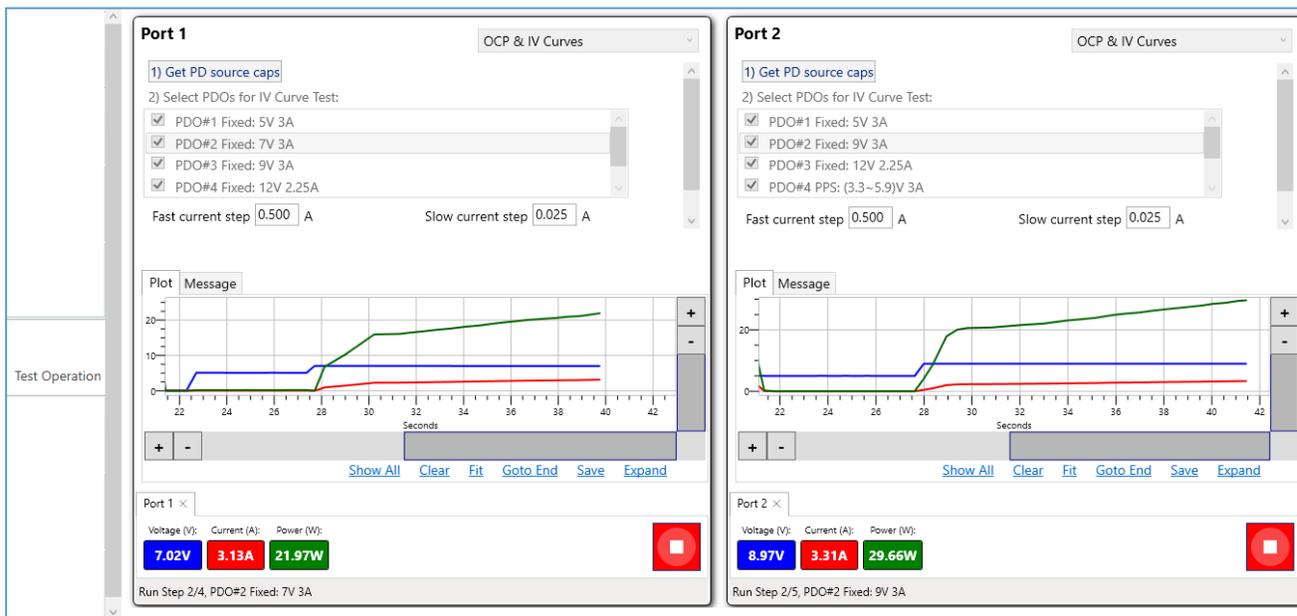
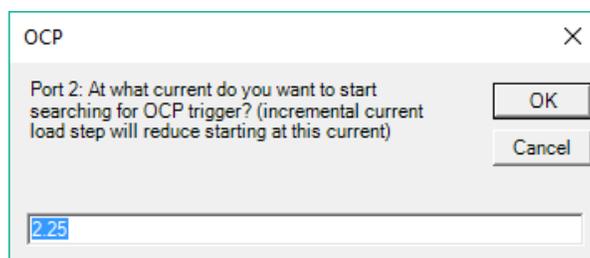


FIGURE 5.12: PLOT IV CURVES AND TEST OCP LIMITS FOR SOURCE UUT

8. As the test is being run, it will generate the trace plot and values for voltage, current and power while displaying the test status at the bottom of the screen. *Note: You can right-click on the voltage, current or power value box to toggle visibility, change line color and offset of each graph line.*
9. You can select the 'Message' tab to switch from the graph view to a simplified PD protocol negotiation view.

10. You can use the horizontal and vertical scroll bars of the graph to zoom in/out, navigate across the length of the trace plot or pause the running trace. Additional function buttons below the bar allow you to control the graph view, clear/reset the graph, save the current test configuration to a file or display the graph on a separate window.

11. At any time you want to stop the test run, select the  button.

12. When test run has completed, it will report out all the PDO's supported by the UUT and their OCP thresholds (under the OCP & IV Curves tab). The test results will also produce an I-V curve which graphically shows the relationship between voltage and current for each PDO. For many UUT's that support PPS (Programmable Power Supply), current fold-back behavior may be reflected through the I-V curve where as the current increases beyond the OCP threshold, the voltage starts to curve/bend down rather than immediately shutting off. For UUT's with non-PPS support, the voltage will most likely shut off immediately once the current increases beyond the OCP threshold. These two scenarios are shown in the following test results example:

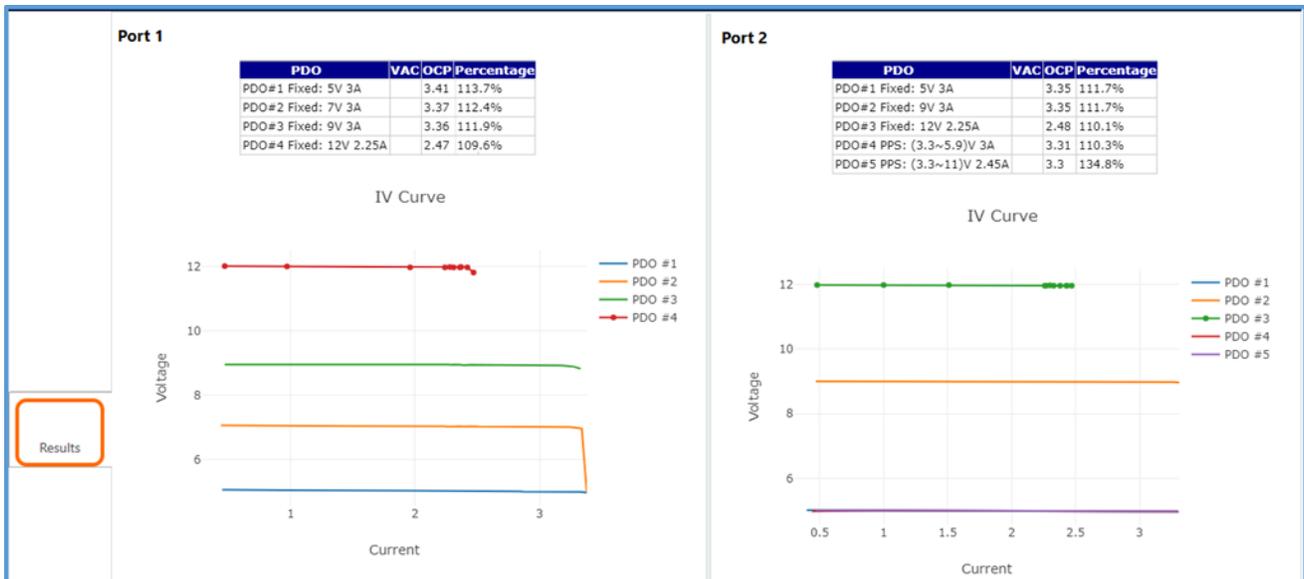
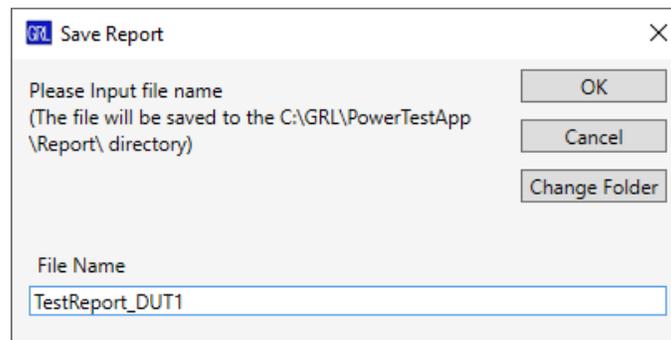


FIGURE 5.13: RESULTS EXAMPLE – IV CURVES AND OCP LIMITS FOR SOURCE UUT

13. To save a report of the test results to the specified file directory, select the ‘Save Report’ button at the bottom the Results screen and enter the file name to save as.



## 5.4 Test Power Efficiency for Source UUT

The ‘Power Efficiency’ Test Case allows you to verify if the Source UUT meets standard requirements for power efficiency test. For this test you will need to connect an external AC power supply or power meter to the setup. The GRL-PSP can use the GRL-USB-PD-C2 / F1 Controller integrated with the GW Instek APS-7100 programmable AC power supply or GPM-8213 power meter to compare the UUT's power output vs power input so that power efficiency can be measured and compared to regulatory limits from United States of Energy (DOE) Level VI or European Union's CoC Tier 2 requirements. The power efficiency tests can be repeated for different PDO's, current load conditions, and different AC input ranges, providing a complete picture of power efficiency ranges across all different usage scenarios.

1. On the 3rd Party Tools screen, set up the connection and configure AC measurements for the external AC power supply (GW Instek APS-7100) or power meter (GW Instek GPM-8213) to be used. An example is as shown below.

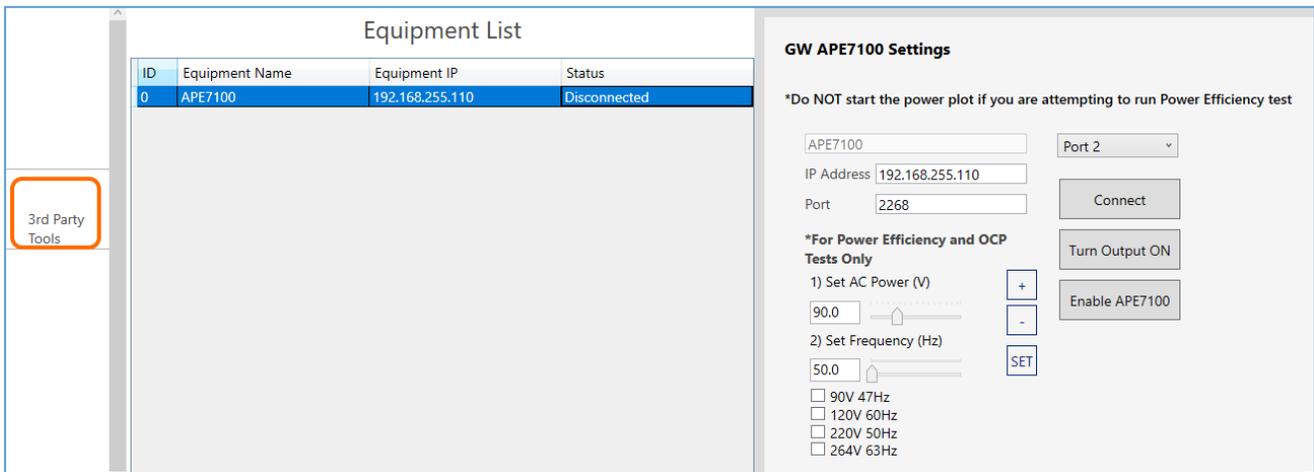


FIGURE 5.14: CONNECT TO AC POWER SUPPLY FOR POWER EFFICIENCY TESTS

2. On the Test Case screen, select **Power Efficiency**.



FIGURE 5.15: SELECT TEST CASE – POWER EFFICIENCY

3. Connect a Source UUT to either USB Test Port 1 or Port 2 or both of the GRL-USB-PD-C2 / F1 Controller and go to the Test Operation screen.
4. You should see all the Source PDO's supported by the UUT being populated in the top panel.
5. Select the  button for the Test Port(s) attached with the UUT to start the test run. *Note: You can right-click this button to access more 'Play' or 'Stop' functionality as desired.*



FIGURE 5.16: TEST FOR POWER EFFICIENCY FOR SOURCE UUT

6. As the test is being run, it will generate the trace plot along with values for voltage, current and power while displaying the test status at the bottom of the screen. *Note: You can right-click on the voltage, current or power value box to toggle visibility, change line color and offset of each graph line.*
7. You can select the 'Message' tab to switch from the graph view to a simplified PD protocol negotiation view.
8. You can use the horizontal and vertical scroll bars of the graph to zoom in/out, navigate across the length of the trace plot or pause the running trace. Additional function buttons below the bar allow you to control the graph view, clear/reset the graph, save the current test configuration to a file or display the graph on a separate window.
9. At any time you want to stop the test run, select the  button.
10. When test run has completed, it will display the power efficiency levels comparing DoE Level VI and CoC Tier 2 limits along with a corresponding trace plot as shown in the test results example below:

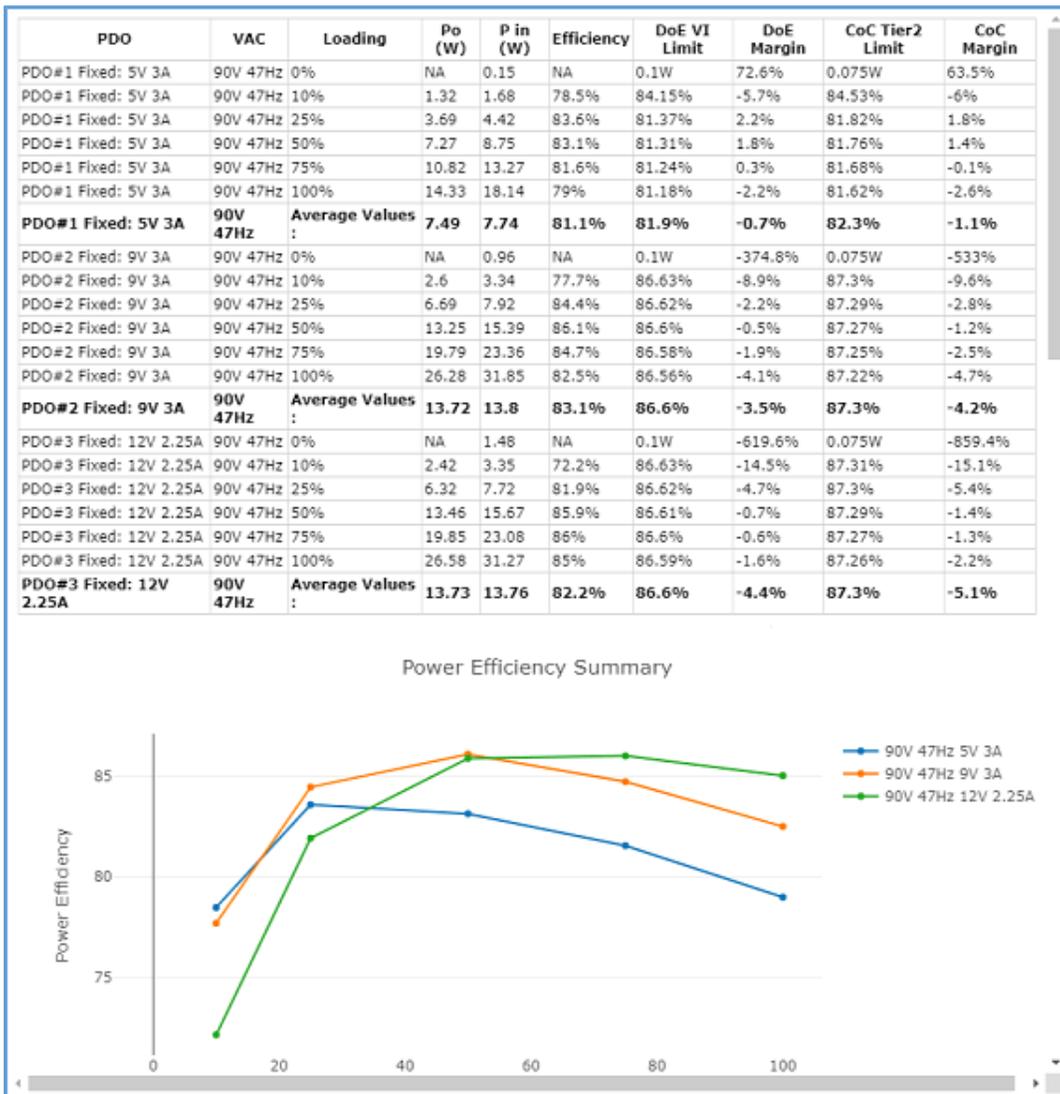


FIGURE 5.17: RESULTS EXAMPLE – POWER EFFICIENCY LEVELS OF SOURCE UUT

### 5.5 Analyze PD Sink Capabilities

The ‘USB PD Sink Capabilities Characterization’ Test Case allows you to verify PD negotiation and power behavior of the PD Sink UUT that is connected to either USB Test Port 1 or Port 2 or both of the GRL-USB-PD-C2 / F1 Controller.

The GRL-PSP first negotiates a power contract emulating the Source to determine the PD Sink capabilities of the UUT. The USB-PSP then reports out the voltage and current supported by the UUT for each of the Source PDO's advertised to the UUT.

1. On the Test Case screen, select **USB PD Sink Capabilities Characterization**.



FIGURE 5.18: SELECT TEST CASE – USB PD SINK CAPABILITIES CHARACTERIZATION

- Go to the Test Operation screen and connect the PD Sink UUT to either USB Test Port 1 or Port 2 or both of the GRL-USB-PD-C2 / F1 Controller. The Controller Test Port will act as the Source provider for the attached Sink UUT.
- The Source will advertise power profiles over a list of PDO's to be requested by the Sink UUT. You can select specific PDO's using their respective checkboxes.
- You can also configure the delay in seconds using the Delay input slider or type in the value.
- Select the  button for the Test Port(s) attached with the UUT to start the test run. *Note: You can right-click this button to access more 'Play' or 'Stop' functionality as desired.*



FIGURE 5.19: ANALYZE PD SINK CAPABILITIES OF PD SINK UUT

- As the test is being run, it will generate a voltage, current and power trace plot which graphically shows the voltage, current and power requested by the UUT for each advertised Source PDO throughout the power negotiation. At the same time values for voltage, current and power will also be generated while the test status is displayed at the bottom of the screen. *Note: You can right-click on the voltage, current or power value box to toggle visibility, change line color and offset of each graph line.*
- You can select the 'Message' tab to switch from the graph view to a simplified PD protocol negotiation view.
- You can use the horizontal and vertical scroll bars of the graph to zoom in/out, navigate across the length of the trace plot or pause the running trace. Additional function buttons below the bar allow you to control the graph view, clear/reset the graph, save the current test configuration to a file or display the graph on a separate window.
- At any time you want to stop the test run, select the  button.
- When test is completed, the test results will indicate which Source PDO's advertised were selected and what current was pulled by the Sink UUT at each voltage level along with a voltage, current trace plot as shown in the example below:

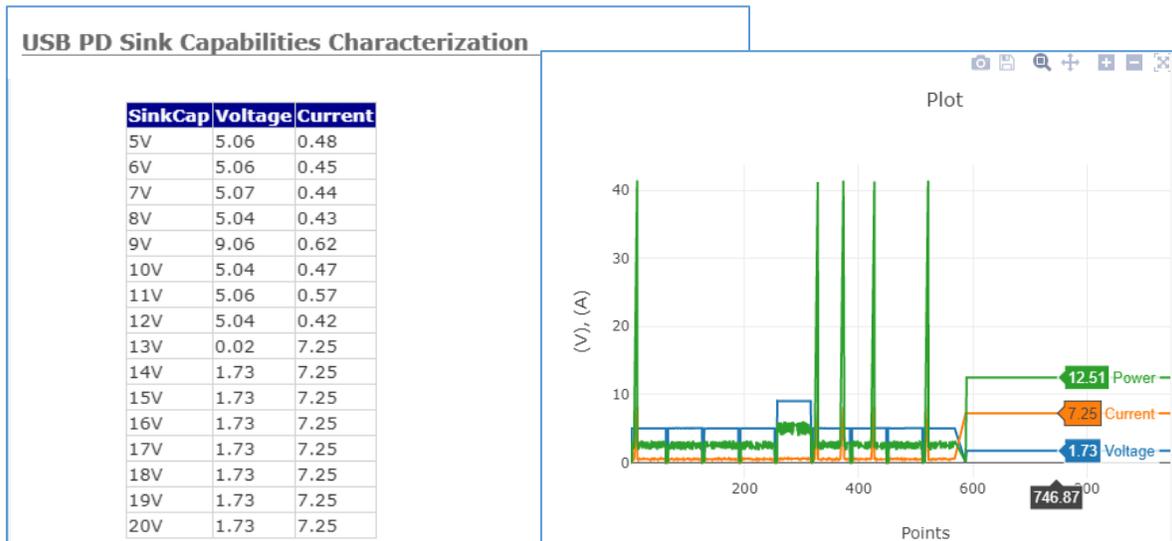


FIGURE 5.20: PD SINK CAPABILITIES TEST RESULTS EXAMPLE

## 5.6 Perform Battery Cycling for Dual Role Power Based Devices

The ‘Battery Charge/Drain Cycler’ Test Case allows you to perform battery charge/drain cycling for battery based devices with dual role power (DRP) capabilities such as power banks or certain phones. A DRP device is able to supply power to other devices as well as consume power for own charging, acting as both a Source and a Sink.

The GRL-PSP can use certain third party thermal imaging tools such as FLIR to measure the heat emitted by the DRP UUT and produce temperature heat map graphs for all PDO's supported by the UUT.

1. On the Test Case screen, select **Battery Charge/Drain Cycler**.



FIGURE 5.21: SELECT TEST CASE – BATTERY CHARGE/DRAIN CYCLER

2. Go to the Test Operation screen and configure the charge/drain cycle change based on reaching time limit.
3. Configure the cycle count based on whether to start off with charging or draining the battery.
4. Connect the battery based DRP UUT to either USB Test Port 1 or Port 2 or both of the GRL-USB-PD-C2 / F1 Controller. The Controller Test Port will act as the Source/Sink for testing the attached Consumer/Provider port of the DRP UUT accordingly.
5. Select the  button for the Test Port(s) attached with the UUT to start the test run. *Note: You can right-click this button to access more ‘Play’ or ‘Stop’ functionality as desired.*



FIGURE 5.22: PERFORM BATTERY CYCLING FOR DRP UUT

6. As the test is being run, it will generate the trace plot along with values for voltage, current and power while displaying the test status at the bottom of the screen. *Note: You can right-click on the voltage, current or power value box to toggle visibility, change line color and offset of each graph line.*
7. You can select the 'Message' tab to switch from the graph view to a simplified PD protocol negotiation view.
8. You can use the horizontal and vertical scroll bars of the graph to zoom in/out, navigate across the length of the trace plot or pause the running trace. Additional function buttons below the bar allow you to control the graph view, clear/reset the graph, save the current test configuration to a file or display the graph on a separate window.
9. At any time you want to stop the test run, select the  button.
10. When test is completed, the test results can be used to detect any abnormal protocol or power behavior from the UUT as well as hot spots through temperature heat map graphs using third party thermal imaging tools (example as below):

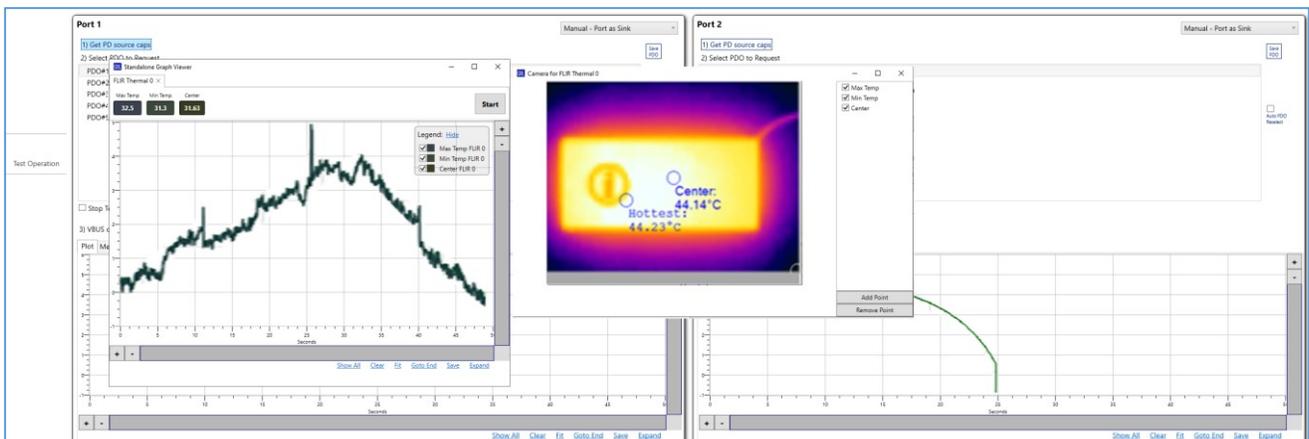


FIGURE 5.23: PERFORM THERMAL ANALYSIS ON DRP UUT EXAMPLE

## 5.7 Test Power Load Per Output Port of Multi-Port Source Devices

The ‘Multi-port Loading’ Test Case allows you to verify that each Source or output port of a UUT with multiple port configuration such as a multi-port charger is able to supply power independently to any connected Sink device. For this test the Source ports of a multi-port UUT will be connected to both USB Test Port 1 and Port 2 of the GRL-USB-PD-C2 / F1 Controller. For every PDO supported by the UUT, the GRL-PSP will increase the load gradually for the connected Source ports to detect any power loss at the highest load limit for each port.

1. On the Test Case screen, select **Multi-port Loading**.



FIGURE 5.24: SELECT TEST CASE – MULTI-PORT LOADING

2. Go to the Test Operation screen and connect the Source UUT ports to both USB Test Port 1 and Port 2 of the GRL-USB-PD-C2 / F1 Controller. The Controller Test Ports will act as the Sink for the attached Source UUT.
3. You can also configure VBUS current using the VBUS current (3) slider or type in the value.
4. Select the  button to start the test run. *Note: You can right-click this button to access more ‘Play’ or ‘Stop’ functionality as desired.*

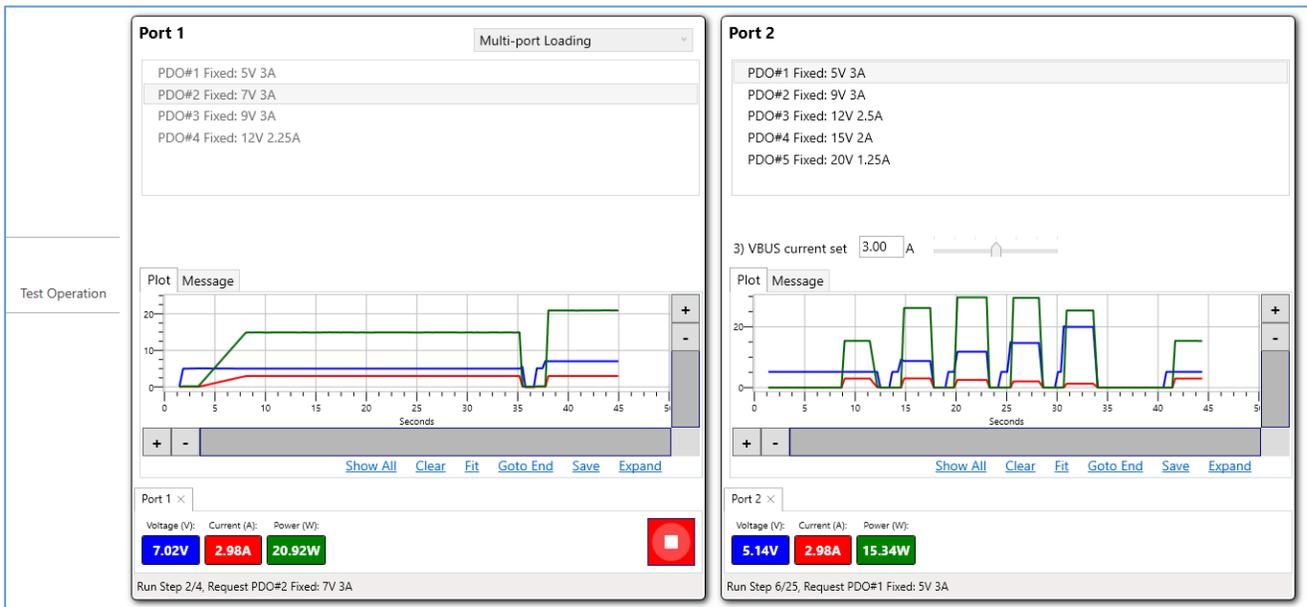


FIGURE 5.25: VERIFY POWER LOAD PER SOURCE PORT OF MULTI-PORT UUT

5. As the test is being run, it will generate the trace plot along with the values for voltage, current and power while displaying the test status at the bottom of the screen. *Note: You can right-click on the voltage, current or power value box to toggle visibility, change line color and offset of each graph line.*

6. You can select the ‘Message’ tab to switch from the graph view to a simplified PD protocol negotiation view.
7. You can use the horizontal and vertical scroll bars of the graph to zoom in/out, navigate across the length of the trace plot or pause the running trace. Additional function buttons below the bar allow you to control the graph view, clear/reset the graph, save the current test configuration to a file or display the graph on a separate window.
8. At any time you want to stop the test run, select the  button.
9. If testing USB Type-A ports on the UUT, make sure to use the USB Type-A to Type-C cable.
10. When test is completed, it will report out the voltage, current and load limits for all the PDO's supported by the UUT along with voltage, current trace plots for each port as shown in the following example:

Port1_PDO	Port2_PDO	Port1_Voltage	Port1_Current	Port1_Loading	Port2_Voltage	Port2_Current	Port2_Loading
PowerApp.listBoxItem		0.05	0.02	100% (0W)			
PDO#1 Fixed: 5V 3A	PDO#1 Fixed: 5V 3A	0.06	0.02	139.05%	4.86	2.99	
PDO#1 Fixed: 5V 3A	PDO#2 Fixed: 9V 3A	0.05	0.02	122.22%	8.86	3	
PDO#1 Fixed: 5V 3A	PDO#3 Fixed: 12V 2.25A	0.05	0.02	122.22%	11.92	2.26	
PowerApp.listBoxItem		8.97	2.98	100% (26.7W)			
PDO#2 Fixed: 9V 3A	PDO#1 Fixed: 5V 3A	8.97	2.99	100.24%	4.87	2.99	
PDO#2 Fixed: 9V 3A	PDO#2 Fixed: 9V 3A	8.97	2.99	100.24%	8.86	2.99	
PDO#2 Fixed: 9V 3A	PDO#3 Fixed: 12V 2.25A	8.97	2.99	100.12%	11.91	2.25	
PowerApp.listBoxItem		11.95	2.24	100% (26.8W)			
PDO#3 Fixed: 12V 2.25A	PDO#1 Fixed: 5V 3A	11.95	2.25	100.11%	4.85	2.98	
PDO#3 Fixed: 12V 2.25A	PDO#2 Fixed: 9V 3A	11.95	2.24	99.94%	8.86	2.99	
PDO#3 Fixed: 12V 2.25A	PDO#3 Fixed: 12V 2.25A	11.95	2.25	100.16%	11.92	2.26	
	PDO#1 Fixed: 5V 3A				4.86	2.98	100% (14.5W)
PDO#1 Fixed: 5V 3A	PDO#1 Fixed: 5V 3A	0.06	0.02		4.86	2.99	100.12%
PDO#2 Fixed: 9V 3A	PDO#1 Fixed: 5V 3A	8.97	2.99		4.87	2.99	100.38%
PDO#3 Fixed: 12V 2.25A	PDO#1 Fixed: 5V 3A	11.95	2.25		4.85	2.98	99.86%
PDO#4 PPS: (3.3~5.9)V 3A	PDO#1 Fixed: 5V 3A	0	0		0	0	0%
PDO#5 PPS: (3.3~11)V 2.45A	PDO#1 Fixed: 5V 3A	0	0		0	0	0%
	PDO#2 Fixed: 9V 3A				8.86	2.99	100% (26.5W)
PDO#1 Fixed: 5V 3A	PDO#2 Fixed: 9V 3A	0.05	0.02		8.86	3	100.24%
PDO#2 Fixed: 9V 3A	PDO#2 Fixed: 9V 3A	8.97	2.99		8.86	2.99	100%
PDO#3 Fixed: 12V 2.25A	PDO#2 Fixed: 9V 3A	11.95	2.24		8.86	2.99	100%
PDO#4 PPS: (3.3~5.9)V 3A	PDO#2 Fixed: 9V 3A	0	0		0	0	0%
PDO#5 PPS: (3.3~11)V 2.45A	PDO#2 Fixed: 9V 3A	0	0		0	0	0%
	PDO#3 Fixed: 12V 2.25A				11.92	2.26	100% (27W)
PDO#1 Fixed: 5V 3A	PDO#3 Fixed: 12V 2.25A	0.05	0.02		11.92	2.26	100%
PDO#2 Fixed: 9V 3A	PDO#3 Fixed: 12V 2.25A	8.97	2.99		11.91	2.25	99.47%
PDO#3 Fixed: 12V 2.25A	PDO#3 Fixed: 12V 2.25A	11.95	2.25		11.92	2.26	99.84%
PDO#4 PPS: (3.3~5.9)V 3A	PDO#3 Fixed: 12V 2.25A	0	0		0	0	0%
PDO#5 PPS: (3.3~11)V 2.45A	PDO#3 Fixed: 12V 2.25A	0	0		0	0	0%

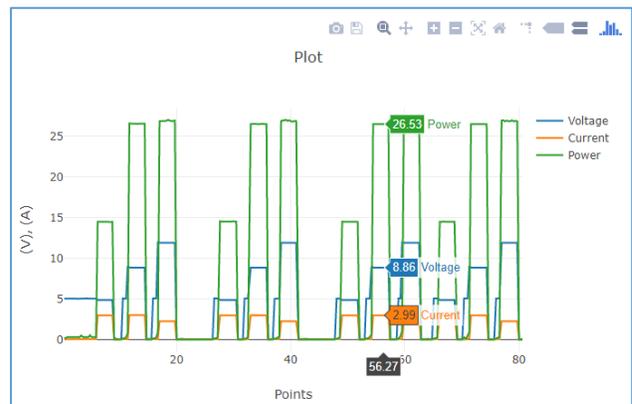
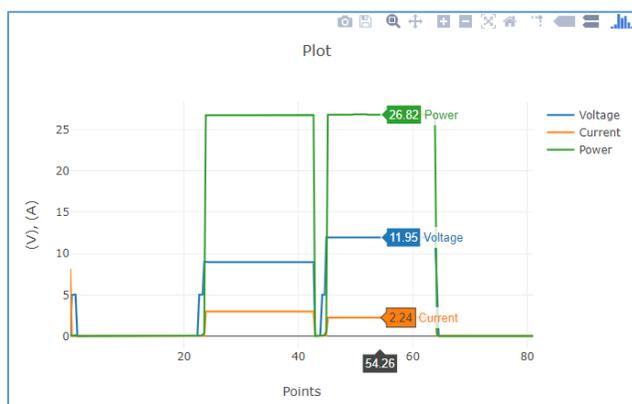


FIGURE 5.26: RESULTS EXAMPLE – MULTI-PORT SOURCE POWER LOAD

## 5.8 Test Capabilities and Power Budget of PD Passthrough Hubs

The ‘USB PD Hub Power Passthrough Characterization’ Test Case allows you to determine the passthrough power for each separate output and input ports of USB Type-C/PD passthrough hub UUT’s. For every PDO advertised into the UUT, the GRL-PSP increases the load gradually for each port to detect any power loss through the voltage and current that were passed through at their corresponding load limits.

1. On the Test Case screen, select **USB PD Hub Power Passthrough Characterization**.



FIGURE 5.27: SELECT TEST CASE – USB PD HUB POWER PASSTHROUGH CHARACTERIZATION

2. Connect the Sink port of a PD passthrough hub UUT to USB Test Port 1 and the UUT Source port to Test Port 2 of the GRL-USB-PD-C2 / F1 Controller and go to the Test Operation screen. The Controller Test Ports will act as the Source and Sink for testing the attached Consumer and Provider ports of the hub UUT accordingly.
3. The Source will advertise power profiles over a list of PDO's to be requested by the Sink.
4. If testing USB Type-A ports on the hub UUT, add loads on the USB Type-A hub.
5. You can also configure the delay in seconds using the Delay input slider or type in the value.
6. Select the  button to start the test run. *Note: You can right-click this button to access more ‘Play’ or ‘Stop’ functionality as desired.*

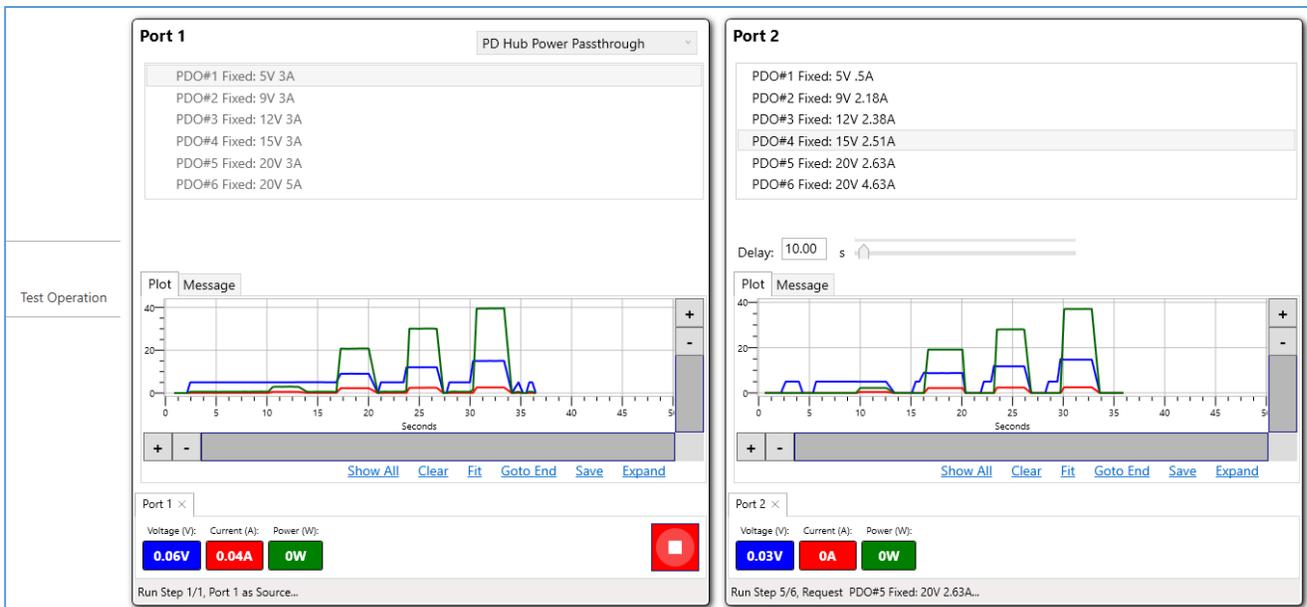


FIGURE 5.28: TEST CAPABILITIES AND POWER BUDGET OF PD PASSTHROUGH HUB UUT

7. As the test is being run, it will generate the trace plot along with the values for voltage, current and power while displaying the test status at the bottom of the screen. *Note: You can right-click on the voltage, current or power value box to toggle visibility, change line color and offset of each graph line.*
8. You can select the ‘Message’ tab to switch from the graph view to a simplified PD protocol negotiation view.
9. You can use the horizontal and vertical scroll bars of the graph to zoom in/out, navigate across the length of the trace plot or pause the running trace. Additional function buttons below the bar allow you to control the graph view, clear/reset the graph, save the current test configuration to a file or display the graph on a separate window.
10. At any time you want to stop the test run, select the  button.
11. When test run has completed, it will report out the voltage, current and load limits for all the PDO's advertised into the UUT for each port with corresponding voltage, current trace plots as shown in the example below:

Port1 PDO	Port2 PDO	Port1 (V)	Port2 (V)	%	Port1 (A)	Port2 (A)	%
PDO#1 Fixed: 5V 3A	PDO#1 Fixed: 5V .5A	5.06	4.89	96.6%	1.01	0.49	48.4%
PDO#2 Fixed: 9V 3A	PDO#2 Fixed: 9V 2.18A	9.02	8.6	95.3%	2.47	2.19	88.7%
PDO#3 Fixed: 12V 3A	PDO#3 Fixed: 12V 2.38A	12.03	11.57	96.2%	2.63	2.38	90.8%
PDO#4 Fixed: 15V 3A	PDO#4 Fixed: 15V 2.51A	15.03	14.55	96.8%	2.72	2.51	92.3%
PDO#5 Fixed: 20V 3A	PDO#5 Fixed: 20V 2.63A	20.02	19.53	97.5%	2.82	2.64	93.5%
PDO#6 Fixed: 20V 5A	PDO#6 Fixed: 20V 2.63A	20.02	19.52	97.5%	2.84	2.64	92.9%

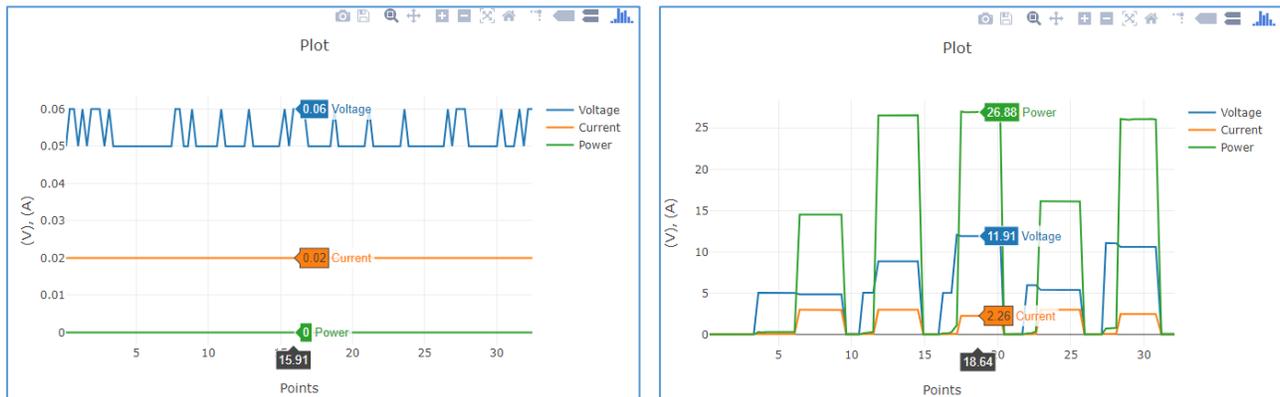


FIGURE 5.29: RESULTS EXAMPLE – POWER PASSTHROUGH AND LOADS OF PD HUB UUT

## 5.9 Test E-Marker and Power Capabilities of USB Type-C Cables

The ‘Cables E-Marker and Power Capabilities Characterization’ Test Case allows you to test capabilities of USB Type-C cable UUT’s that have a USB-PD electronic marking chip on each cable which indicates through USB-PD messaging its capabilities and vendor information. Such cables are known as Electronically Marked or E-Marker cables where you can verify if the advertised data and power capabilities of the cables meet compliance along with vendor information and model versions through this Test Case.

1. On the Test Case screen, select **Cables E-Marker and Power Capabilities Characterization**.

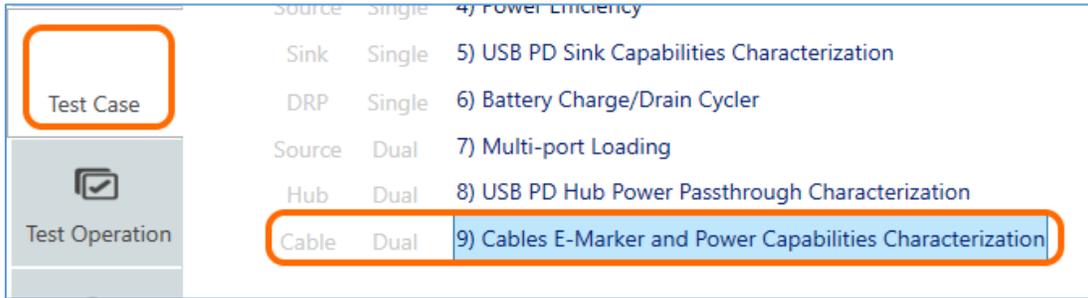


FIGURE 5.30: SELECT TEST CASE – CABLES E-MARKER AND POWER CAPABILITIES CHARACTERIZATION

2. Connect a USB Type-C E-Marker cable UUT in between USB Test Port 1 and Test Port 2 of the GRL-USB-PD-C2 / F1 Controller and go to the Test Operation screen.
3. The Port 1 pane will advertise PDO's of supported power profiles while the Port 2 pane will display vendor information and model version of the cable UUT.
4. You can also configure VBUS voltage/current using the VBUS voltage/current slider or type in the value.
5. Select the  button to start the test run. *Note: You can right-click this button to access more 'Play' or 'Stop' functionality as desired.*

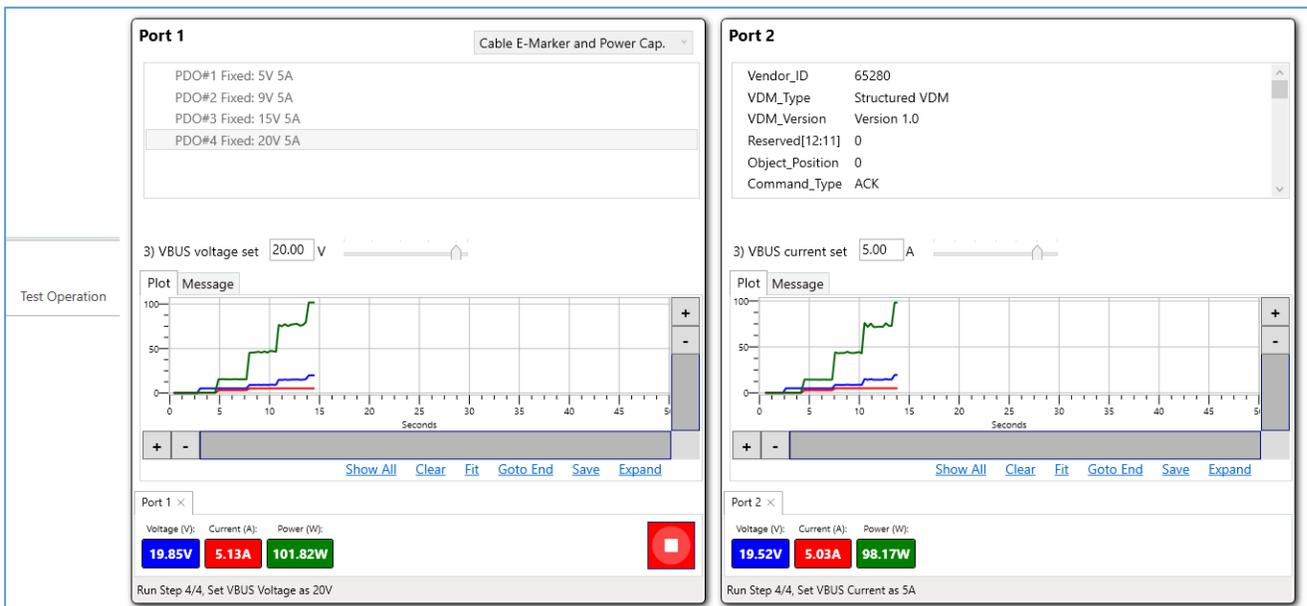


FIGURE 5.31: TEST E-MARKER AND POWER CAPABILITIES OF USB TYPE-C CABLE UUT

6. As the test is being run, it will generate the VBUS and trace plot along with the values for voltage, current and power while displaying the test status at the bottom of the screen. *Note: You can right-click on the voltage, current or power value box to toggle visibility, change line color and offset of each graph line.*
7. You can select the ‘Message’ tab to switch from the graph view to a simplified PD protocol negotiation view.
8. You can use the horizontal and vertical scroll bars of the graph to zoom in/out, navigate across the length of the trace plot or pause the running trace. Additional function buttons below the bar allow you to control the graph view, clear/reset the graph, save the current test configuration to a file or display the graph on a separate window.
9. At any time you want to stop the test run, select the  button.
10. When test run has completed, the Results screen will display what voltage and current were passed through the cable UUT with corresponding loads for both Test Ports against the advertised PDO’s along with resulting IR drop as in below example:

PDO	Port1 (V)	Port2 (V)	%	Port1 (A)	Port2 (A)	%	IR drop (mohm)
PDO#1 Fixed: 5V 5A	5.05	0.04	0.8%	1.5	0	0.2%	3343
PDO#2 Fixed: 9V 5A	9.03	0.04	0.4%	1.55	0	0.2%	5801
PDO#3 Fixed: 15V 5A	15.04	0.04	0.3%	1.54	0	0.2%	9744
PDO#4 Fixed: 20V 5A	20.03	0.04	0.2%	1.6	0	0.2%	12456

FIGURE 5.32: RESULTS EXAMPLE – POWER PASSTHROUGH AND IR DROP OF TYPE-C CABLE UUT

11. Optionally you can view the test report generated by the GRL-USB-PD-C2 / F1 Controller to check support for 3A versus 5A VBUS current and USB 2.0 versus USB 3.1 signaling of the UUT as in below example:

Check for 3A vs 5A and USB 2.0 vs USB 3.1 support

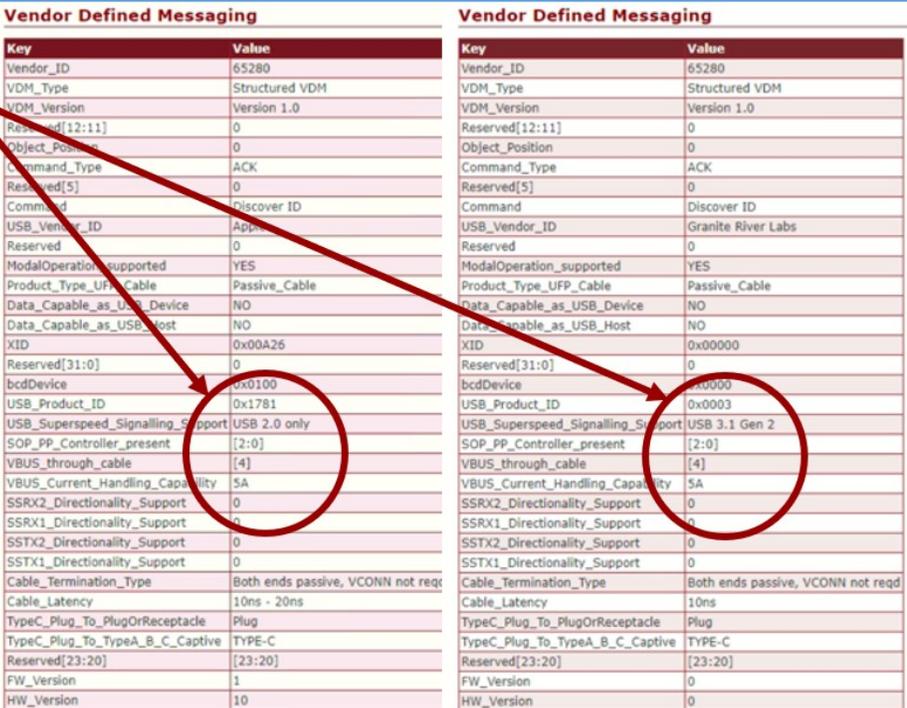


FIGURE 5.33: RESULTS EXAMPLE – VBUS CURRENT AND USB SIGNALING OF TYPE-C CABLE UUT

12. At the same time you can also check for vendor information and model version of the UUT as in below example:

Vendor Defined Messaging	
Key	Value
Vendor_ID	65280
VDM_Type	Structured VDM
VDM_Version	Version 1.0
Reserved[12:11]	0
Object_Position	0
Command_Type	Discover ID
Reserved[5]	0
Command	Discover ID
USB_Vendor_ID	Magic Control Technology Corp.
Reserved	0
ModalOperation_supported	0
Product_Type_UFP_Cable	Passive_Cable
Data_Capable_as_USB_Device	NO
Data_Capable_as_USB_Host	NO
XID	0x00000
Reserved[31:0]	0
bcdDevice	0x0001
USB_Product_ID	0x0999
USB_Superspeed_Signalling_Support	USB 3.1 Gen 2
SOP_PP_Controller_present	[2:0]
VBUS_through_cable	[4]
VBUS_Current_Handling_Capability	3A
SSRX2_Directionality_Support	0
SSRX1_Directionality_Support	0
SSTX2_Directionality_Support	0
SSTX1_Directionality_Support	0
Cable_Termination_Type	Both ends passive, VCONN reqd
Cable_Latency	Reserved
TypeC_Plug_To_PlugOrReceptacle	Plug
TypeC_Plug_To_TypeA_Or_C_Captive	TYPE-C
Reserved[23:20]	[23:20]
FW_Version	1
HW_Version	1

Check for vendor info and model version

FIGURE 5.34: RESULTS EXAMPLE – VENDOR INFO AND MODEL VERSION OF TYPE-C CABLE UUT

### 5.10 Validate PD Communications Between Source and Sink Devices

The GRL-PSP provides a USB Power Delivery (USB-PD) sniffer function utility that allows you to view the PDO negotiations while running sub sampling of USB-PD data packets and generating the PDO communications exchange protocol for the Source/Sink UUT. This sniffer function requires the GRL Type-C Sniffer Board (GRL-USB-PD-SNIF option) to be used which is supplied with the GRL-PSP. The GRL Type-C Sniffer Board consists of a sniffer extension fixture that is plugged in to the GRL-USB-PD-C2 / F1 Controller and used to sniff USB-PD traffic and Qualcomm Quick Charge legacy traffic.

Below shows a simplified diagram on how to set up the equipment connection to start using the sniffer function.

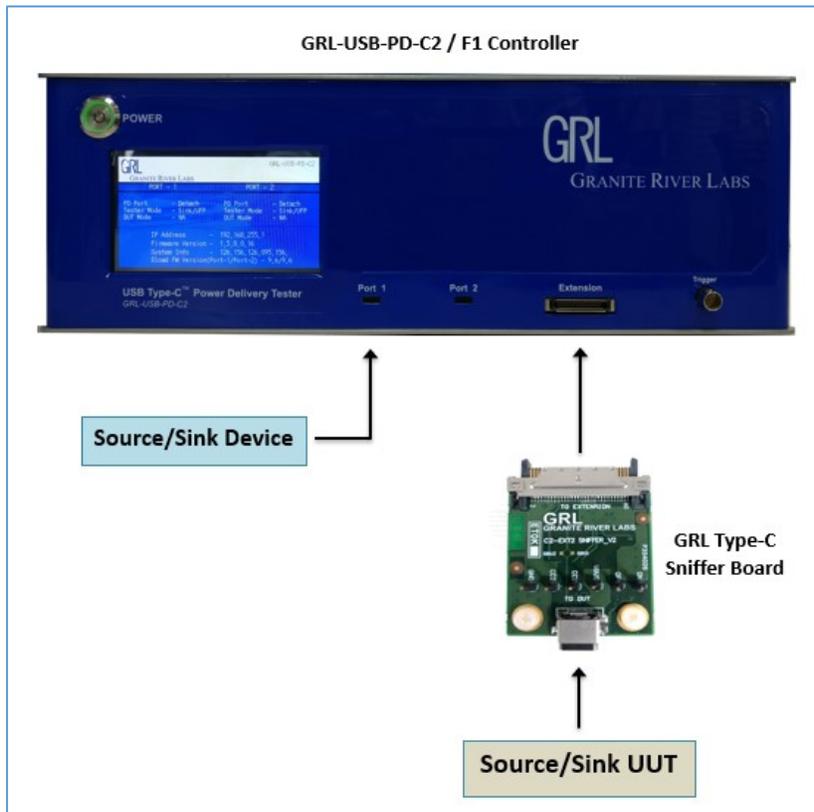


FIGURE 5.35: CONNECTION SETUP FOR SNIFFER FUNCTION TESTING

1. Connect the Source or Sink device (for testing the respective Sink or Source UUT) to the USB Test Port 1 of the GRL-USB-PD-C2 / F1 Controller. The Controller Test Port 1 will act as the Source/Sink for the UUT.
2. Attach the GRL Type-C Sniffer Board to the Extension connector of the GRL-USB-PD-C2 / F1 Controller and then plug in the UUT to the Type-C connector of the GRL Type-C Sniffer Board.
3. On the Test Operation screen, select **Sniffer Mode** from the drop-down menu on the Port 1 pane.

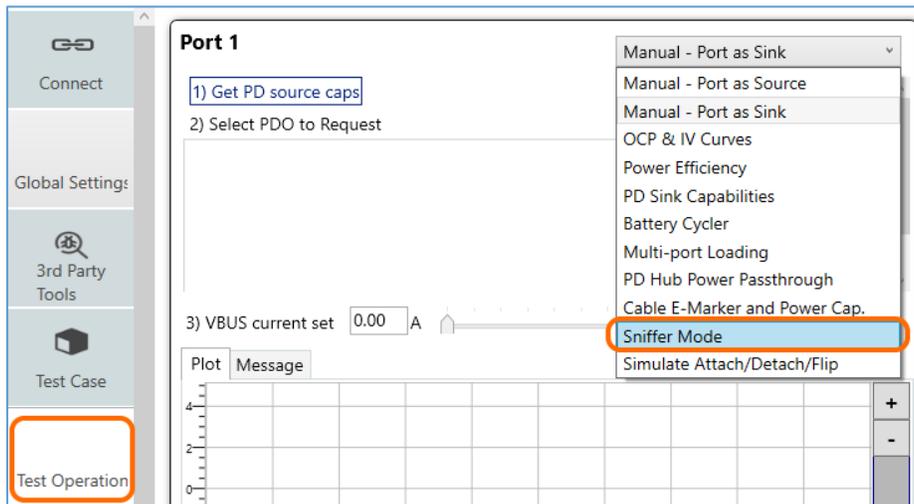


FIGURE 5.36: SELECT SNIFFER MODE FUNCTION

4. Select the  button to start running the sniffer mode. *Note: You can right-click this button to access more 'Play' or 'Stop' functionality as desired.*



FIGURE 5.37: VALIDATE PD COMMUNICATIONS BETWEEN DEVICE AND UUT

5. As the test is being run, it will generate the trace plot along with values for voltage, current, power and D+ and D- voltages while displaying the test status at the bottom of the screen. *Note: You can right-click on the voltage, current or power value box to toggle visibility, change line color and offset of each graph line.*
6. You can select the 'Message' tab to switch from the graph view to a simplified PD protocol negotiation view.
7. You can use the horizontal and vertical scroll bars of the graph to zoom in/out, navigate across the length of the trace plot or pause the running trace. Additional function buttons below the bar allow you to control the graph view, clear/reset the graph, save the current test configuration to a file or display the graph on a separate window.
8. At any time you want to stop the test run, select the  button.

## 5.11 Simulate Attach/Detach/Flip Sequences for Source/Sink UUT

The ‘Simulate Attach/Detach/Flip’ Test Case allows you to verify if the Source/Sink UUT is operating properly during plugging in or out of the test port or when having the cable orientation flipped on the test port when running tests. This simulation test automates the attach/detach/flip sequence of the Source/Sink UUT by repeatedly cycling the sequence while the UUT is attached to the USB Test Port of the GRL-USB-PD-C2 / F1 Controller. The Controller Test Ports will act as the Source and Sink for simulating the attached Consumer and Provider ports of the UUT accordingly. This simulation test will ensure that the UUT is performing the attach/detach/flip sequence correctly throughout the entire cycle duration process.

Note that the flip simulation test applies specifically for the GRL-SPL cable attached to the connected UUT where the orientation of the attached GRL-SPL cable will be automatically flipped or reversed during the simulation test. Make sure to first check the correct cable type is selected on the Connect screen before proceeding.

1. On the Test Case screen, select **Simulate Attach/Detach/Flip**.



FIGURE 5.38: SELECT TEST CASE – SIMULATE ATTACH/DETACH/FLIP

2. Go to the Test Operation screen and connect the Source/Sink UUT to either USB Test Port 1 or Port 2 or both of the GRL-USB-PD-C2 / F1 Controller. The Controller Test Port will act as the Source provider for the attached Sink UUT or the Sink consumer for the attached Source UUT.
3. Configure the cycle count and duration for each cycle to run the simulation test.
4. Select the action to be performed on the UUT (Attach/Detach or Flip) for each cycle. *Note if the Flip action is selected, make sure that the UUT is connected with the GRL-SPL cable.*
5. Select the role for the GRL-USB-PD-C2 / F1 Controller test port (Source or Sink mode) based on the UUT type. If the Source mode is selected, set up the Source PDO's similar to the **Manual Control – Port as Source** Test Case (see Section 5.1). If the Sink mode is selected, the Source UUT will advertise power profiles over a list of PDO's similar to the **Manual Control – Port as Sink** Test Case (see Section 5.1).
6. You can also configure VBUS current using the VBUS current slider or type in the value.
7. Select the  button to start the simulation test run. *Note: You can right-click this button to access more 'Play' or 'Stop' functionality as desired.*

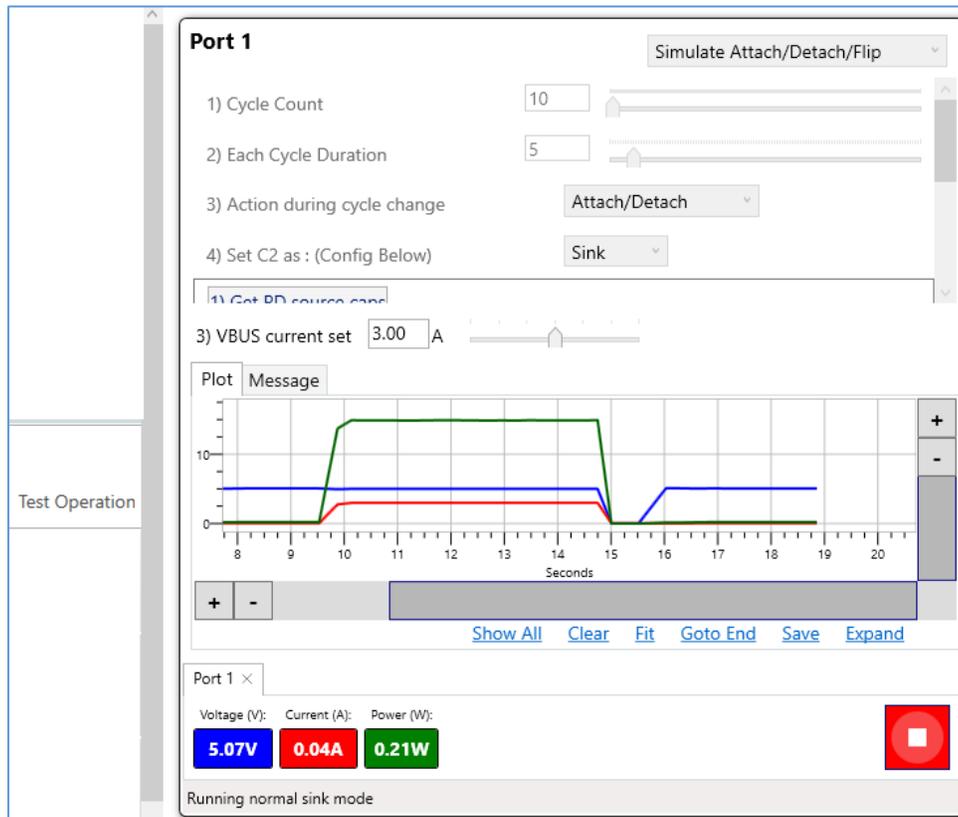


FIGURE 5.39: SIMULATE ATTACH/DETACH SEQUENCE FOR SOURCE UUT EXAMPLE

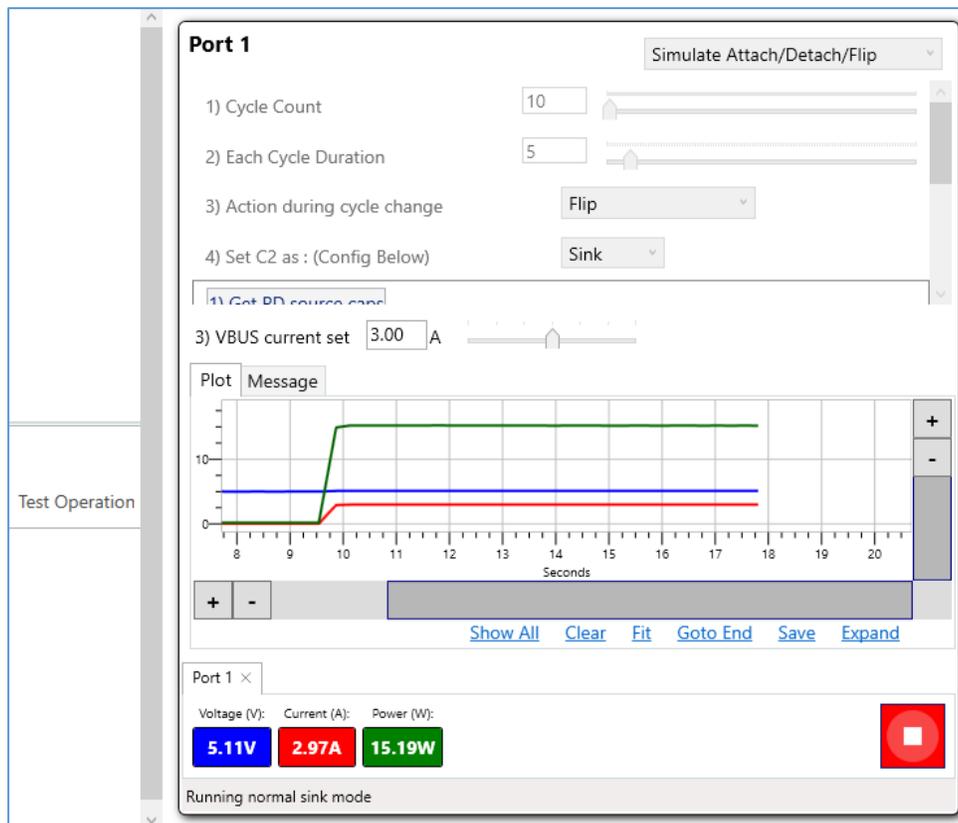


FIGURE 5.40: SIMULATE FLIP SEQUENCE FOR SOURCE UUT WITH GRL-SPL CABLE EXAMPLE

8. As the simulation test is being run, it will generate the VBUS and trace plot along with the values for voltage, current and power while displaying the test status at the bottom of the screen. *Note: You can right-click on the voltage, current or power value box to toggle visibility, change line color and offset of each graph line.*
9. You can select the ‘Message’ tab to switch from the graph view to a simplified PD protocol negotiation view.
10. You can use the horizontal and vertical scroll bars of the graph to zoom in/out, navigate across the length of the trace plot or pause the running trace. Additional function buttons below the bar allow you to control the graph view, clear/reset the graph, save the current test configuration to a file or display the graph on a separate window.
11. At any time you want to stop the simulation test run, select the  button.
12. When the simulation test run has completed, view the test results in the Results screen as shown in below example:

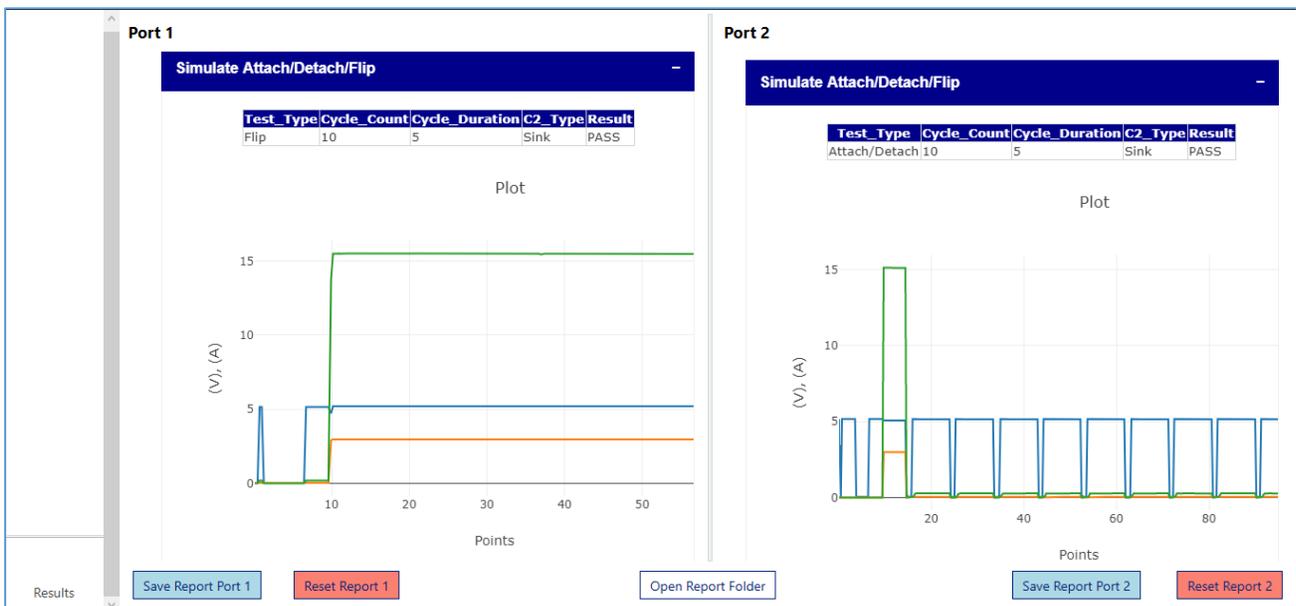


FIGURE 5.41: RESULTS EXAMPLE – ATTACH/DETACH/FLIP SIMULATION FOR SOURCE UUT

## 6 Running Test Sequences with GRL-PSP

The Sequencer function of the GRL-PSP allows you to configure and run test sequences for the UUT that is connected to USB Test Port 1 or Port 2 of the GRL-USB-PD-C2 / F1 Controller.

1. On the Sequencer screen, select the **Port** (that is connected with the UUT) and then select which **Test** to be performed. Select the 'Add Test' button to configure and add the test to the list on the left panel. Repeat this process if there are multiple tests to be added and run. The left panel should display a list of all selected tests for the respective Test Port of the GRL-USB-PD-C2 / F1 Controller.

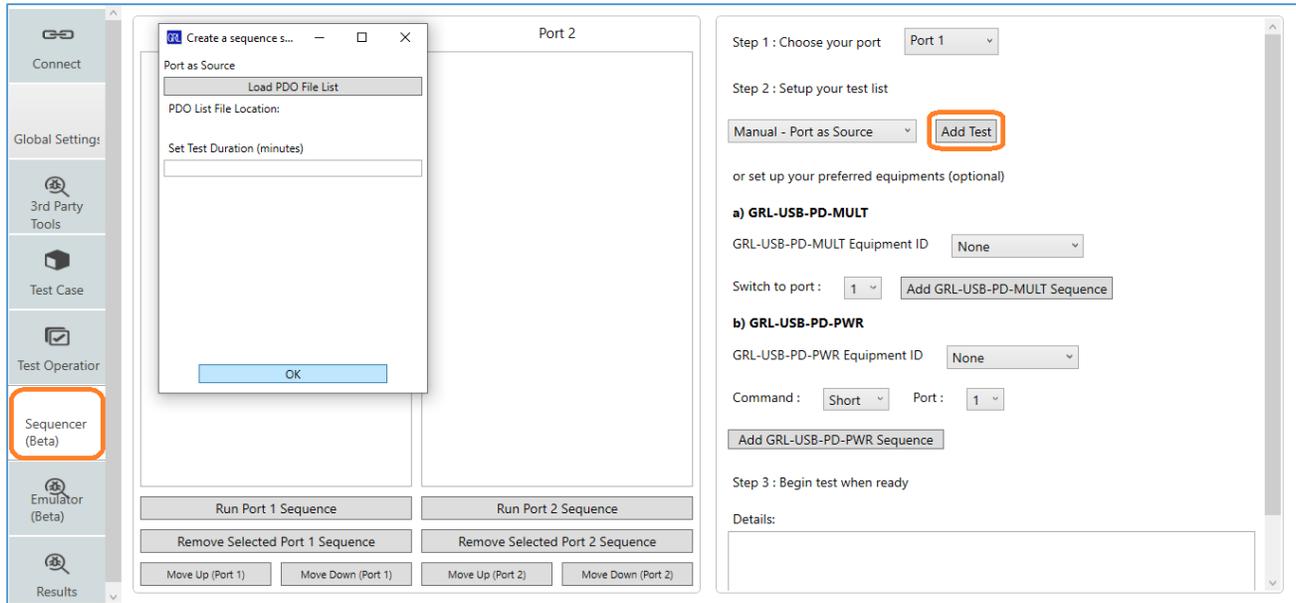


FIGURE 6.1: SEQUENCER – SET UP TEST LIST

2. You can select the following buttons below the test list panels to delete selected tests or rearrange the test sequence for the respective Test Port.

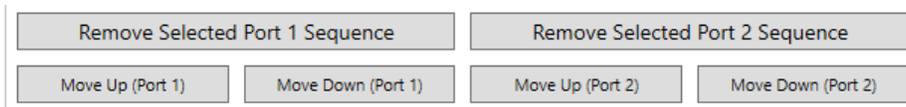


FIGURE 6.2: SEQUENCER – REMOVE OR MOVE SELECTED TESTS IN LIST

3. If you are using an external fixture to control the UUT, select the **Equipment ID** of the fixture and set up the port connected with the UUT. Then select the 'Add <fixture> Sequence' button to create a test sequence for the particular fixture.
4. When done, select the following 'Run Port 1 / 2 Sequence' button below the test list panels to start running the test sequence for the respective Test Port.



FIGURE 6.3: SEQUENCER – START TEST SEQUENCE RUN

5. You can also view details of each test in the sequence by double-clicking on the desired test. The information should be displayed in the **Details** field.

# 7 Performing Emulation with GRL-PSP

The Emulator function of the GRL-PSP provides a convenient way to automate PD Source/Sink emulation and testing for the appropriate UUT that is connected to USB Test Port 1 of the GRL-USB-PD-C2 / F1 Controller.

*Note: Make sure that there are existing PD source/sink capabilities data files that were previously saved into the GRL > PowerAppEmulator folder in C: drive. These data files will be used to emulate the Source or Sink device for testing the UUT.*

## 7.1 Emulate a PD Sink Device for PD Source UUT

1. On the Emulator screen, select **Sink Mode** (if testing a PD Source UUT) and the Device List panel should populate all the Sink devices available from previously saved sink capabilities data files.

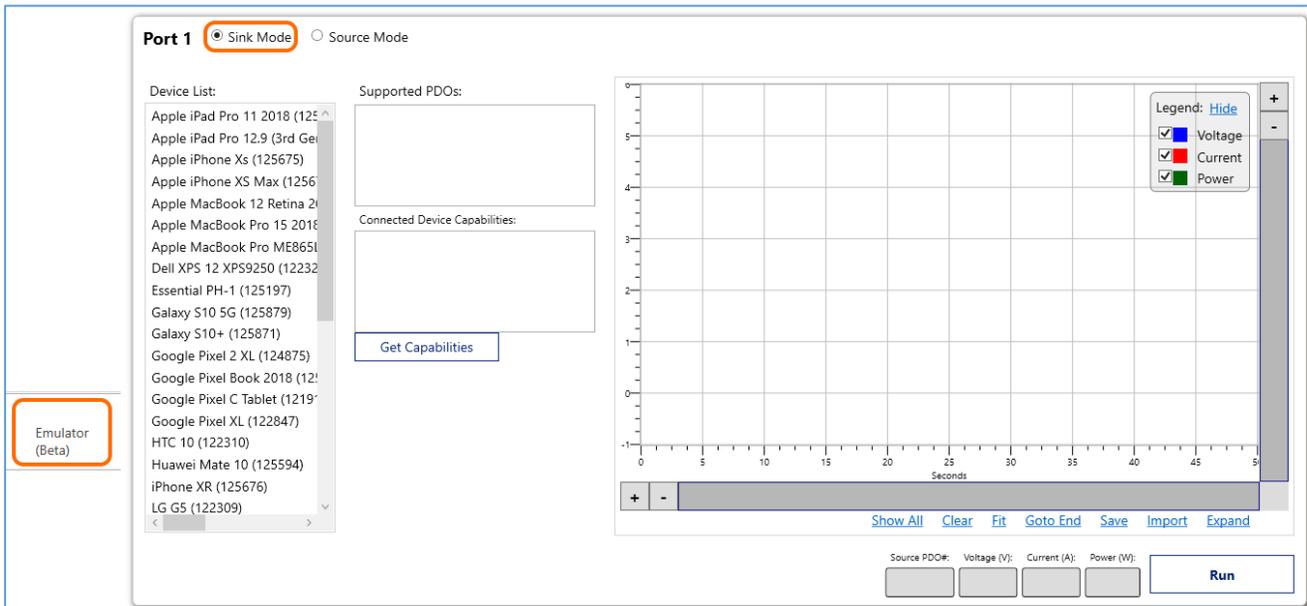


FIGURE 7.1: EMULATOR – SELECT SINK MODE – PORT AS SINK

2. Select a device that appear under the Device List to be used for testing. The Supported PDO’s panel should list out all the power profiles supported by the device.
3. Connect a PD Source UUT to the USB Test Port 1 of the GRL-USB-PD-C2 / F1 Controller where the Sink is being emulated. Select the ‘**Get Capabilities**’ button to acquire the Source PDO’s supported by the UUT in the Connected Device Capabilities panel.

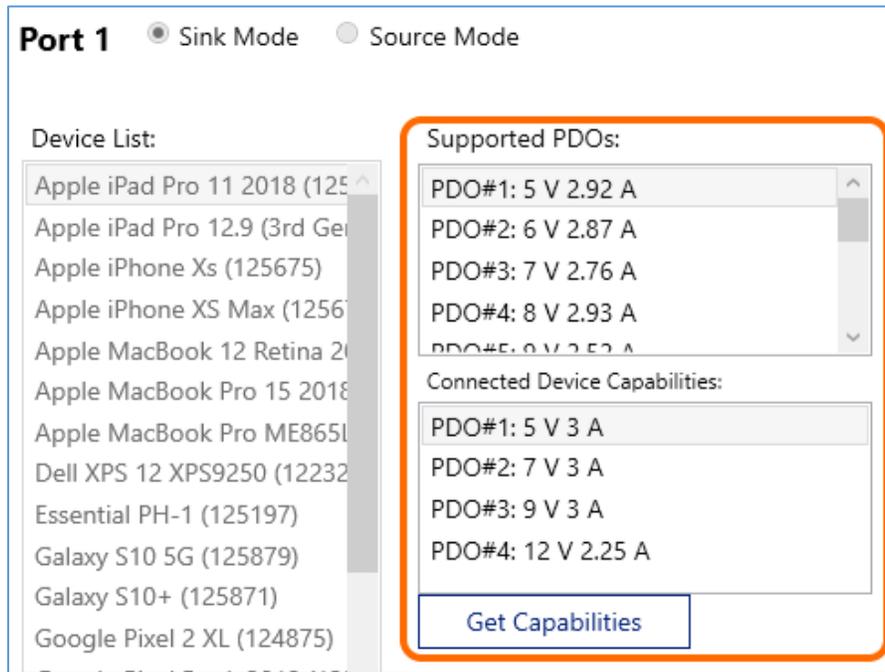


FIGURE 7.2: EMULATOR – ACQUIRE SOURCE PDO’S OF UUT

4. Select the bottom ‘Run’ button to start running virtual connection to the emulated Sink.
5. As the test is being run, it will generate the trace plot along with values for voltage, current and power. At any time you want to stop the test run, select the ‘Stop’ button.

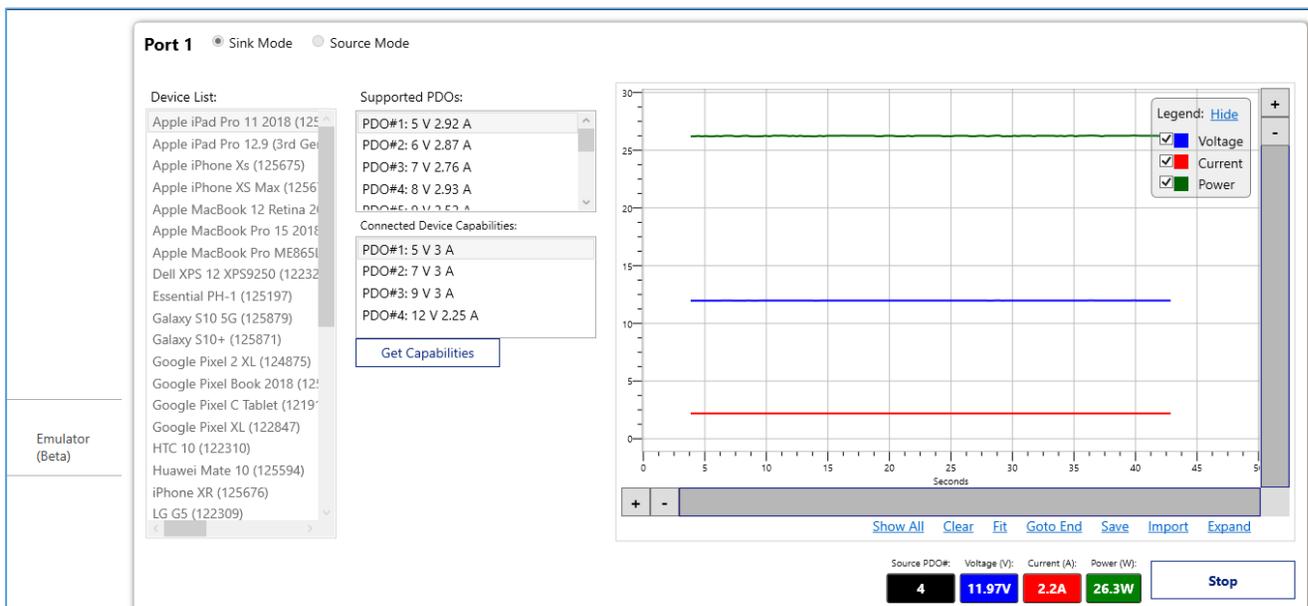


FIGURE 7.3: PERFORM SINK EMULATION AND TESTING FOR PD SOURCE UUT

You can use the horizontal and vertical scroll bars of the graph to zoom in/out, navigate across the length of the trace plot or pause the running trace. Additional function buttons below the bar allow you to control the graph view, clear/reset the graph, save the current test configuration to a file, or display the graph on a separate window.

## 7.2 Emulate a PD Source Device for PD Sink UUT

1. On the Emulator screen, select **Source Mode** (if testing a PD Sink UUT) and the Device List panel should populate all the Source devices available from previously saved source capabilities data files.
2. Select a device that appear under the Device List to be used for testing. The Supported PDO's panel should list out all the power profiles supported by the device.



FIGURE 7.4: EMULATOR – SELECT SOURCE MODE – PORT AS SOURCE

3. Connect a PD Sink UUT to the USB Test Port 1 of the GRL-USB-PD-C2 / F1 Controller where the Source is being emulated.
4. Select the bottom 'Run' button to start running virtual connection to the emulated Source.
5. As the test is being run, it will generate the readings for voltage, current and power and trace plot. At any time you want to stop the test run, select the 'Stop' button. You can use the horizontal and vertical scroll bars of the graph to zoom in/out, navigate across the length of the trace plot or pause the running trace. Additional function buttons below the bar allow you to adjust the graph view, clear/reset the graph, save the current test configuration to a file or display the graph on a separate window.

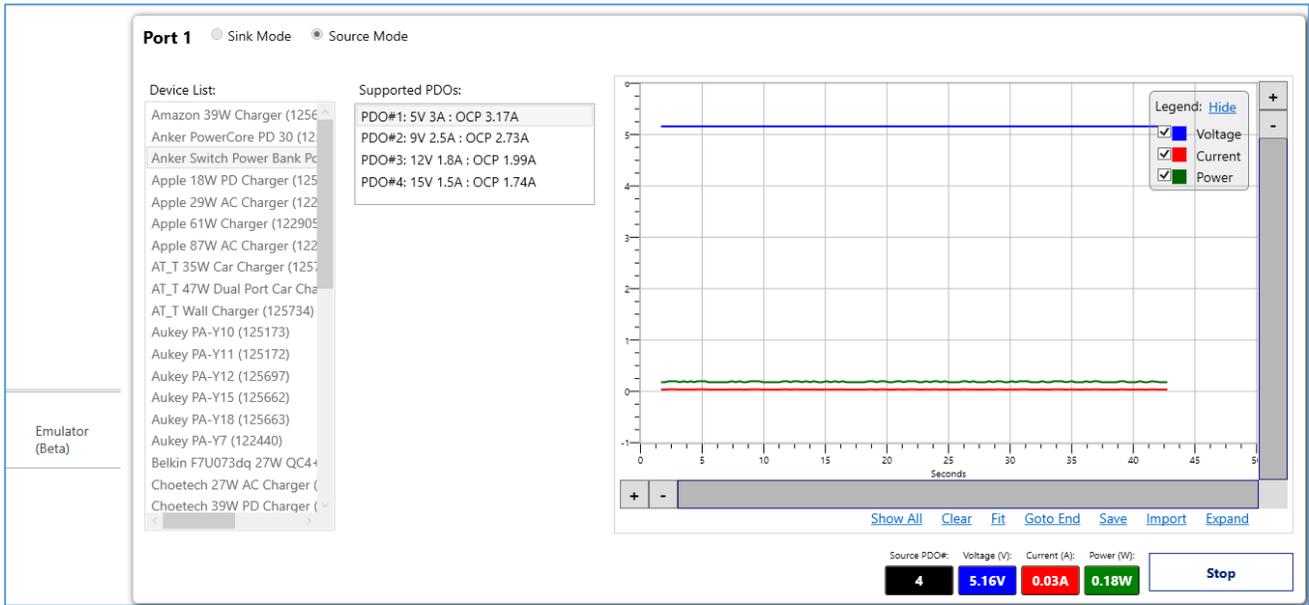


FIGURE 7.5: PERFORM SOURCE EMULATION AND TESTING FOR PD SINK UUT

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