PASSMARK® SOFTWARE

# USB Power Delivery Tester PRO

# User's Guide

**Model PM240**


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# Introduction

The USB Power Delivery Tester PRO is a tool designed to diagnose and troubleshoot the power delivery capabilities of USB ports and the charging behaviour of USB devices. The unit has two ports for testing: Sink and Source. The Sink port allows you to test USB devices that supply power, such as USB wall chargers or PC USB ports, to see how they perform when providing power to other devices. The Source port, on the other hand, emulates different types of chargers, enabling you to test how devices respond to various charging technologies and determine if they charge as expected. With the USB Power Delivery Tester PRO, you can:

- Test the power delivery capability of USB ports, Thunderbolt ports, USB chargers, and USB power banks by dissipating up to 240W continuously from these devices using the sink port.
- Check if a USB host can deliver its maximum specified wattage and its output voltage levels remain within specification under high load.
- Detect the wattage a USB charger (wall-wart) claims to support, which in turn controls the charging speed of mobile phones and other USB connected battery devices.
- Display and select a specific charging profiles to use, from 5 to 48Volts
- Test USB Type-C cables for voltage drops by measuring the voltage across the cable, the power rating of the cable and the maximum speed supported. Thus, also checking if the cable is E-Marked correctly.
- Determine the actual capacity of power banks by discharging them at your specified load.
- Emulate USB chargers with a configurable 100W source port to check if a device can be powered or charged with different type of chargers. You can create your own list of charging profiles to emulate any power supply (5V to 20V, up to 100W).
- Accurately measures the current consumption or the power usage of USB devices such as smartphones or power banks.
- Use it with the USB 3.0 loopback Plug, to test communication speed, data integrity, and power delivery of USB ports simultaneously. For example, does data corruption occur under high electrical load.
- View voltage graphs to measure and monitor ripple/noise of USB ports and USB chargers, with a range up to 3V peak to peak and a maximum frequency of 1 MHz for noise/ripple measurement.
- Display an FFT graph of the sink voltage, allowing for in-depth analysis of noise up to 1MHz.
- Records and displays the power delivery messages sent to and from the USB charger using the protocol tracer feature.
- Create your own power delivery protocol messages to send to the device under test
- Automate testing via an API with example source code

# Warnings – Important – Please read.

- Do not block the air vents or restrict airflow. Ensure adequate clearance of at least 15cm around the device for proper fan operation and cooling of the unit. Also ensure there is airflow under the device.
- Some USB power supplies are known to not fully comply with the USB standards. Some also do not comply with relevant electrical standards in the countries where they are sold. Faulty or poorly designed devices can be dangerous! The USB PD Tester PRO may expose design and manufacturing flaws in the device when putting the device under high load. The result can be catastrophic failure of the device under test. Which in turn can lead to **fire**, **melting** of the device under test, **smoke, electrical shorts** and even destruction of the USB PD tester PRO itself.
- The unit should not be turned off during high load testing, as the fan needs to operate to cool down the heatsink and the internal components.
- The device under test connected to the sink or source port, should be unplugged before turning off the unit. This is because some of the built-in protections depend on the main power.
- Only use the USB PD Tester PRO with devices that claim compliance with the USB standards. A catastrophic failure of the device under test can result in the shorting of mains power to the USB cable. Which can both destroy the USB PD Tester PRO and present a serious **electrocution hazard**.
- Always have someone monitor the testing in case the device under test suddenly fails. Do not start a test and walk away.
- Do not draw more current from the device than it claims to support. The port might be damaged as a result, or over current protection might lead to the port shutting down.
- The USB PD Tester PRO is not a consumer device. It was designed for use by qualified electrical engineers.
- Do not use with damaged cables or connectors. Replace the cable if required.
- Keep away from liquids

# Power over USB background information

## *USB History*

Universal Serial Bus (USB) is a standard interface for connecting peripheral devices to a host computer. The USB system was originally devised by a group of companies including Compaq, Digital Equipment, IBM, Intel, Microsoft, and Northern Telecom to replace the existing mixed connector system with a simpler architecture. The main goal of USB was to make the addition of peripheral devices quick and easy (although it could be argued that USB is in fact vastly more complex than the interfaces it replaced).

To ensure maximum interoperability the USB standard defines all aspects of the USB system from the physical layer (mechanical and electrical) all the way up to the software layer. The USB standard is maintained and enforced by the USB Implementers Forum (USB-IF).

USB 1.0 was first introduced in 1996 but was not adopted widely until 1998 with USB 1.1. In 2000, USB 2.0 was released and has since become the de facto standard for connecting devices to computers and beyond. In 2008, the USB specification was expanded with USB 3.0, also known as SuperSpeed USB. USB 3.0 represents a significant change in the underlying operation of USB. USB 3.0 adds SuperSpeed, which is a new transfer mode with transfer speeds of up to 5 Gbps. This is more than 10x faster than the top speed of USB 2.0, which is only 480 Mbps.

Another area of evolution for USB was sidelined earlier in its development—power delivery. With the focus on speed, power delivery was not initially the priority for USB. In fact, the first time a specification was made specifically for power delivery occurred only in 2010: The Battery Charging Specification – BC 1.2 increased USB power delivery from 4.5W to 7.5W. This specification introduced a mode called CDP (charging downstream port) and DCP (dedicated charging port) that allowed for higher charging current (up to 1.5A) compared to traditional SDP ports (standard downstream port).

However, this specification was only a precursor for what was to come. Almost at the same time as the USB 3.1 release, the USB Implementers Forum (USB-IF) released the USB Power Delivery Specification. This new USB power delivery specification allows power transfers of up to 100W, along with other features and benefits. Using the new protocol, devices negotiate what power they need, thus ensuring that a device doesn't draw too much current, which would cause things to fail, catch on fire, melt or explode. Programmable Power Supply (PPS) was introduced in 2017 as part of USB PD 3.0. It aimed to improve charging efficiency and reduce heat by allowing devices to dynamically request specific voltages and currents. Another such protocol introduced by Qualcomm was Quick Charge (QC) for fast-charging smartphones. It evolved from QC1 with 10W to QC4 and QC5 over the years.

At the same time specifications for “intelligent” cables were introduced. Older cables, with thin wires, were a safety risk, so higher wattage cables (above 3Amps) were E-Marked by adding a capability chip inside of the cable.

The original USB PD specification allowed sources to deliver up to 100W. This mode of operation is referred as the Standard Power Range (SPR). Another optional higher power mode referred to as the Extended Power Range (EPR) where the Source is allowed to deliver up to 240W was added in the PD specification revision 3.1 in 2021. The EPR mode can only be entered from the SPR mode. The entry process is designed to prevent accidental entry into this higher power mode. It can be entered only when an Explicit SPR contract is in place and both source and sink ports as well as the cable supports EPR. The EPR sources are capable of both Fixed and Adjustable Voltage Supply (AVS) operation. This AVS protocol allows specifying the voltage from a range of 15V to 48V in 100mV steps.

## *Power capability in different USB standards*

In the USB 1.0 specification, a standard downstream port can deliver up to 100mA at 5Volts, over 4 wires. (Two data wires, +5V and ground).

In the USB 2.0 specification, a standard downstream port can deliver up to 500mA at 5Volts, again over 4 wires. (2.5 Watts) once a device is enumerated. The limit is just 100mA prior to enumeration.

USB 3.0 ports add an additional row of five pins to make a total of nine wires. The power limit was also increased which allowed USB devices to draw up to 900mA after being enumerated.

There are three types of USB ports specified by the Battery Charging Specification, BC1.1 and then BC1.2):

1. A standard downstream port (SDP): Found on most computers, with a current limit of 500mA before enumeration and 900mA after enumeration.
2. A charging downstream port (CDP): Found on some computers, 1500mA (1.5A, 7.5W)
3. A dedicated charging port (DCP): for "dumb" wall chargers, also allowing 1500mA (1.5A, 7.5W)

In the Power Delivery specification, power transfers of up to 100W at varying voltages and an optional higher power mode (EPR) where the Source is allowed to deliver up to 240W is possible. The below table shows different types of chargers/ports, their current ratings and acceptable voltage ranges.

| Charger/Port Type | Voltage Range | Max Current | Power Rating |
|---|---|---|---|
| **USB2/USB3 Type-A ports/chargers** | | | |
| USB 2.0 | 4.75V – 5.5V | 500mA | 2.5W |
| USB 3.0 | 4.75V – 5.5V | 900mA | 4.5W |
| **Proprietary Chargers** | | | |
| Apple (Divider Mode) | 5V | 3A | 15W |
| Samsung 2A (1.2V/1.2V Mode) | 5V | 2A | 10W |
| **Battery Charging BC 1.2 (Legacy Charging)** | | | |
| BC-SDP | 4.75V – 5.5V | 500mA | 2.5W |
| BC-CDP | 4.75V – 5.5V | 1.5A | 7.5W |

| | | | |
|---|---|---|---|
| BC-DCP | 4.75V – 5.5V | 1.5A | 7.5W |
| **Quick Charge** | | | |
| QC 1 | 4.75V – 5.5V | 2A | 10W |
| QC 2 | 5V, 9V, 12V | 3A | 10W – 18W |
| QC 3 | 3.6V – 20V | 3A | Up to 36W |
| QC 4 | 3.3V – 20V | 5A | Up to 100W |
| QC 5 | 3.3V – 20V | 5A | Over 100W |
| **USB Type C** | | | |
| USBC Default | 4.75V – 5.5V | 500 mA for USB 2.0 ports; 900 mA or 1,500 mA for USB 3.2 ports operating in single-lane or dual-lane, respectively | Up to 7.5W |
| USBC 1.5A | 4.75V – 5.5V | 1.5A | 7.5W |
| USBC 3A | 4.75V – 5.5V | 3A | 15W |
| **Power Delivery** | | | |
| PD-FIX | 5V, 9V, 12V, 15V, 20V | 5A | Up to 100W |
| PD-BAT | 5V – 20V | 5A | Up to 100W |
| PD-VAR | 3.3V – 21V | 5A | Up to 100W |
| PD-APDO (PPS) | 3.3V – 21V | 5A | Up to 100W |
| PD-AVS | 9V – 20V | 5A | Up to 100W |
| **EPR chargers** | | | |
| EPR-FIX | 28V, 36V, 48V | 5A | Up to 240W |
| EPR-APDO | 15V – 48V | 5A | Up to 240W |

Table 1

# Device Operation

The unit has two separate ports for testing: **Sink** and **Source**, and they can work independently for different tasks. The Sink port simulates a device that consumes power, such as a phone during charging, while the Source port provides power, like a wall adapter that charges a smartphone.

**Sink Port:**
The Sink port can be used to test USB ports that provide power, such as USB wall chargers or PC USB ports. It acts like an active load, letting you check how much power the source can deliver. You can simulate different devices by adjusting the voltage and power levels and test how stable the voltage is across its full range. The Sink port can draw up to 240W, with a maximum current of 5A.

**Source Port:**
The Source port is designed to emulate different types of chargers. You can create up to 5 virtual chargers, each with up to 10 charging profiles, to test how USB devices handle various charging technologies. It can deliver up to 100W and is perfect for testing devices that draw power, such as phones or tablets.

**Loopback Operation:**
Loopback mode is used to enable the USB Power Delivery Tester PRO to be used in conjunction with a PassMark USB Loopback Plug, allowing for simultaneous testing

of communication speed, data integrity, and power delivery of USB ports. When loopback mode is activated, the power and data lines from the device connected to the Sink port are routed through to the Source / Loopback port. This type of testing allows for worse-case testing of USB ports, where the data and power can be stress tested up to the maximum load.

In this configuration, the PC or tablet to be tested must be connected to the Sink port. The Source / Loopback port must be connected to the PassMark USB Loopback Plug or other loopback device.

**Important note**: The device connected to the Source / Loopback port is responsible for negotiating the selected profile and voltage level. In Loopback mode, manually selecting the voltage level is disabled, as adjusting the voltage manually can damage the device connected to the Source / Loopback port.

**Note:** Both Sink and Source ports can be operated independently and simultaneously unless loopback mode is enabled.

**Analysis Port:**
The unit also includes a third port, a micro-B USB port, for connecting the unit to your PC. This port is for remotely controlling the unit, running automated tests, viewing graphs, and logging data when using the standalone test application. This port should be connected to the PC running the stand alone test application and is not intended for use with the device under test. For a full list of supported commands and their responses in the API, refer to the separate document, "Communication Protocol Guide."

## *User Interface*

The USB Power Delivery Tester PRO has a 3.5” TFT LCD screen with capacitive touch and a rotary dial. The touch screen makes it easy to view and select profiles and options, while the rotary dial provides more precise control, especially for adjusting voltage and current. Since there are multiple readings for each port, the Port Viewer allows you to view information for each port individually. You can switch between Sink and Source views using the slider at the bottom left corner of the main screen. The PC test application, however, can display all information from both ports simultaneously.

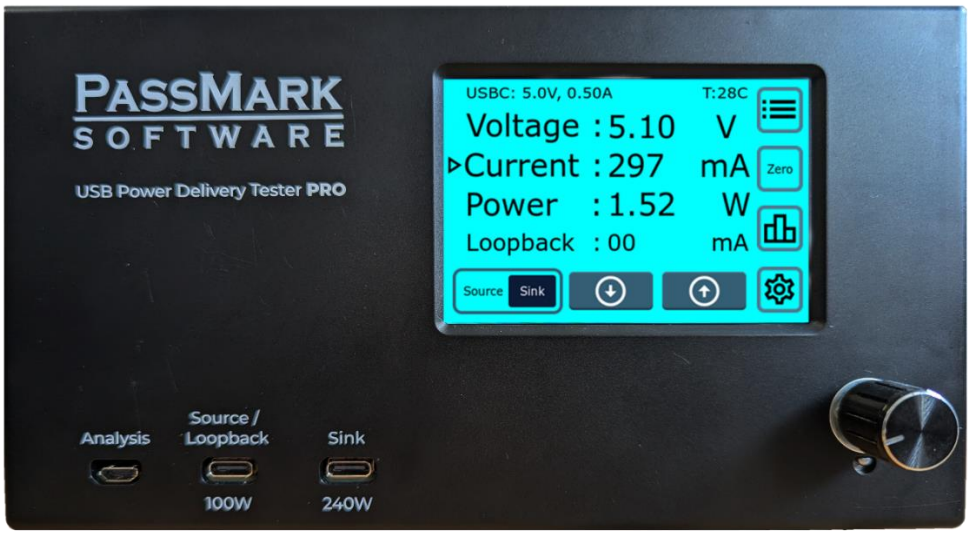



Figure 1

## Main Screen

The main screen shows important information such as active profile, voltage, current and power. From here, you can easily navigate through different options to change the profile, adjust current, modify settings, and access graphs. Below is an example of the main screen when a device is connected to the Sink port, and the unit is drawing current from a device under test.

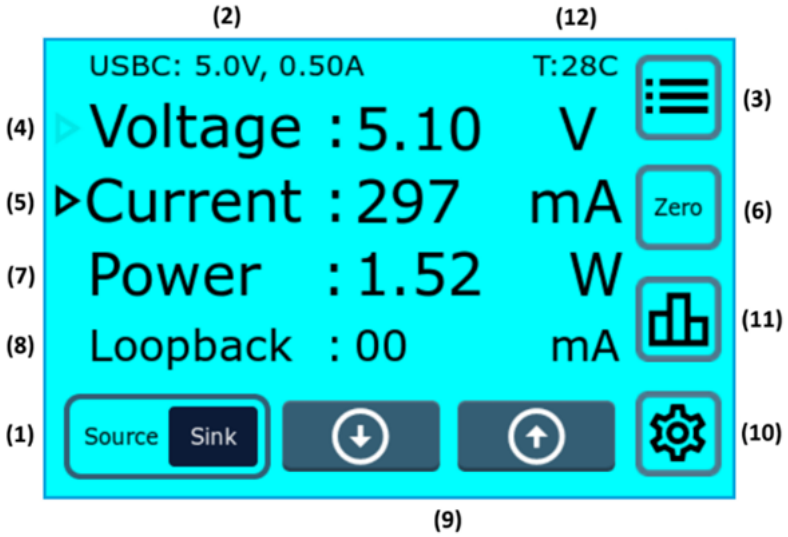



Figure 2

**(1) Port Viewer:** The Port Viewer lets you select which port's readings to be displayed.
**(2) Active Profile:** This displays the currently active profile. In Sink view, it shows the profile that the unit has requested from the device connected to the Sink port. In Source view, it indicates the profile requested by the device under test connected to the Source port.
**(3) Profile List:** Tapping this icon displays a list of available profiles and allow you to select a new one. A new screen will appear for this purpose, which will be explained later in this document.
**(4) Voltage:** In Sink view, this displays the voltage (in volts) supplied by the device connected to the Sink port. In Source view, it shows the voltage being supplied to the

device connected to the Source port. When in Sink view, if the connected charger or port supports adjustable profiles (e.g., PPS, QC Variable, or AVS), you can change the voltage by tapping “Voltage” on the screen. The voltage can then be adjusted using either the knob or the UP/DOWN buttons.

**(5) Current:** In Sink view, this shows the current (in milliamps) drawn by the tester from the device under test on sink port. This can be changed by turning the rotary dial or using the UP / DOWN buttons. When source port is selected, it shows the current drawn by the device under test on source port.

**(6) Zero:** Instantly sets the sink current to zero. By tapping again, you can restore the previously set value.

**(7) Power:** Power (in watts) dissipated by the unit or the device connected to source port.

**(8) Loopback Current:** When loopback mode is enabled, this shows the current drawn from the loopback port (in milliamps).

**(9) Up/Down buttons:** These buttons are active only in Sink view and allow you to adjust the current or voltage. The small arrow next to "Voltage" or "Current" indicates which one will be adjusted using the knob or Up/Down buttons. To switch between voltage and current adjustment, simply touch the "Voltage" or "Current" labels on the screen.

**(10) Settings:** This allows you to change the device settings. Some settings can only be modified using the standalone test application.

**(11) Graphs:** This allows you to view the real-time voltage ripple (AC) graph or the FFT graph of the voltage on the Sink port. The test application provides additional graph types which are not all available on the device screen. These graphs will be explained later in this document.

**(12) Heatsink Temperature:** Shows the internal heatsink temperature in Celsius.

### Changing Profile

To change the active profile, tap the **Profile List** icon on the main screen. This will display a new screen showing the list of available profiles advertised by the charger/port. Users can view the supported profiles as shown below.

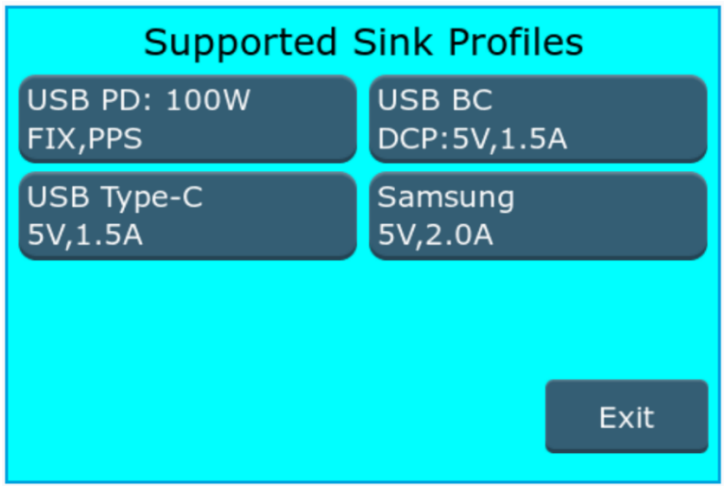



Figure 3

If there are more sub-profiles under a power profile like USB PD, they can be viewed by clicking on the corresponding button. A new screen will appear with the list of

supported sub-profiles as shown below. Tap on any button to select and activate the new profile or click on Back button to go back to previous screen.

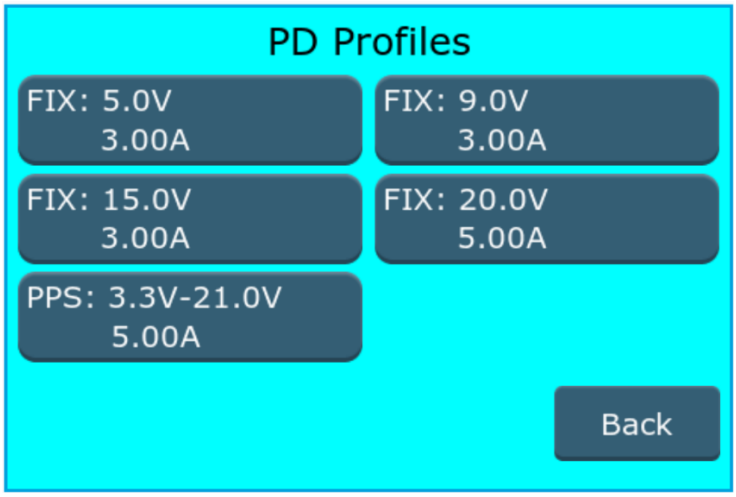



Figure 4

## Graphs

Tap the **Graph** icon on the main screen to view real-time voltage ripple (AC) or FFT graphs. These graphs allow users to monitor sink voltage ripples or noise in real time. Touching the graph enables/disables additional controls for adjusting the time or voltage divisions. When the AC graph is in full-screen mode (additional controls are disabled), the rotary dial can be used to modify the trigger voltage. A slider button located at the bottom left corner enables switching between the voltage ripple and FFT graphs. The figure below shows the graph screen.

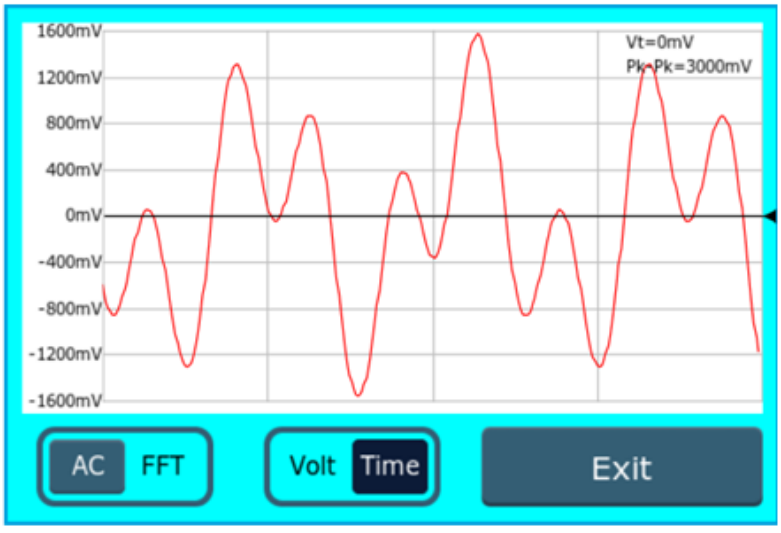



Figure 5

## Settings

Tap **Settings** icon from the main screen to view or change the device settings. The settings screen is shown below.

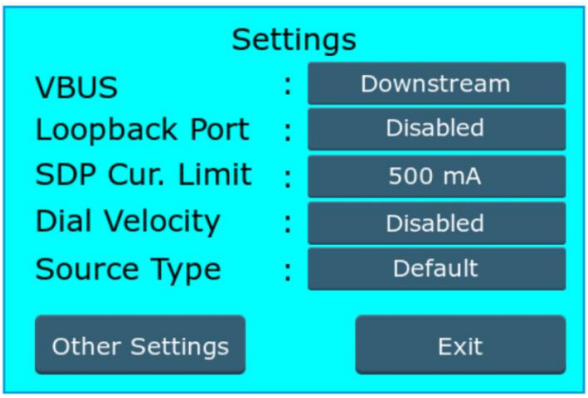



Figure 6

**VBUS:** When "Downstream" is selected, the voltage displayed on the screen is the voltage that is measured on the VBUS line inside the unit. Due to voltage drops from resistance inside the cable and connectors, this voltage is not equal to the voltage that is at the output of the device under test. When "Upstream" is selected, the unit will compensate for these losses and the voltage displayed will instead be an estimate of the voltage at the output of the device under test. This requires knowing the resistance of the cable, which must be set through the standalone test application.
**Loopback Mode:** This option enables or disables the loopback functionality. When loopback mode is activated, the power and data lines from the device connected to the Sink port are routed through to the Source / Loopback port. This setup allows simultaneous testing of communication speed, data integrity, and power delivery of USB ports.
**SDP/USBC Limit:** For SDP and "USB-C Default" ports, the maximum current limit depends on the USB enumeration speed. The unit cannot automatically detect or enforce the maximum available current for these ports. Instead, the current limit must be set manually via the standalone test application.
**Dial Velocity:** Enabling the Dial Velocity option will help to increase or decrease the load faster.
**Active Charger:** Displays the name of the charger currently being emulated by the source port. Users can select from up to five user-defined chargers, configured through the standalone test application.
**Other Settings:** This button allows users to see additional device settings. These settings can only be modified through the standalone test application. The figure below shows the Other Settings screen.

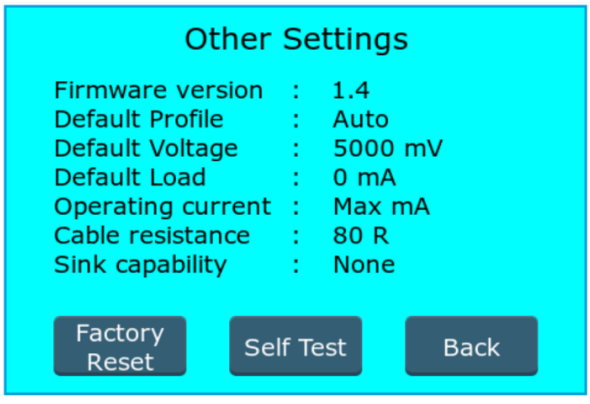



Figure 7

**Firmware version:** This shows the current version number of the firmware programmed on the device.
**Default Profile:** Displays the initial profile index selected when the device under test is connected to the sink port. When set to "Auto," the tester automatically selects the best matching profile for the default voltage.
**Default Voltage:** Displays the default voltage that the unit will request from the device under test connected to sink port upon connection.
**Default Load:** This shows the initial current set when the device under test is connected to sink port.
**Operating current:** This shows the maximum current that can be drawn from the device under test connected to sink port. Set this to “Max” for the maximum current supported by the profile.
**Cable Resistance:** For calculating the estimated voltage at the output of the device under test, the total resistance of the path in milliohms should be specified by the user. The resistance can only be set using the standalone test application. The total resistance can be calculated using the following formula.
$R_{Total} = (R_C*2 + R_W) * 2$
$R_C$ = Mated Connector Resistance
$R_W$ = Cable Resistance
**Sink capabilities:** This shows the second sink capability advertised, alongside the first which is always 5V, 5A. If not required, set to “None”. This value is used when replying to a “Get Sink Capabilities” message.

### Rotary Dial (Load Adj)

The rotary dial lets you adjust the current and voltage and navigate through the menu. It detects how fast you turn it which means slow turns make small changes (e.g., 5mA steps), while fast turns make larger changes (e.g., 100mA steps). You can also use the dial to scroll through profiles and adjust settings on the real-time voltage ripple graph, such as the trigger, voltage, or time scale.

## *Cables*

Each tester comes with 4 cables:

- A 1-meter (39inch) USB A (male) to Micro B (male) cable. This cable is used to connect the tester’s analysis port to a PC.
- A 40cm (15inch), 240W USB TYPE-C to TYPE-C (male) EPR cable. This cable is used to connect the tester to EPR chargers.
- A 40cm (15inch), 100W E-Marked USB Type-C to Type-C cable. This cable is used to connect the tester to a Type-C USB device (USB port or wall charger).
- A 40cm (15inch) USB A to USB TYPE-C cable. This cable is used to connect the tester to USB A devices.

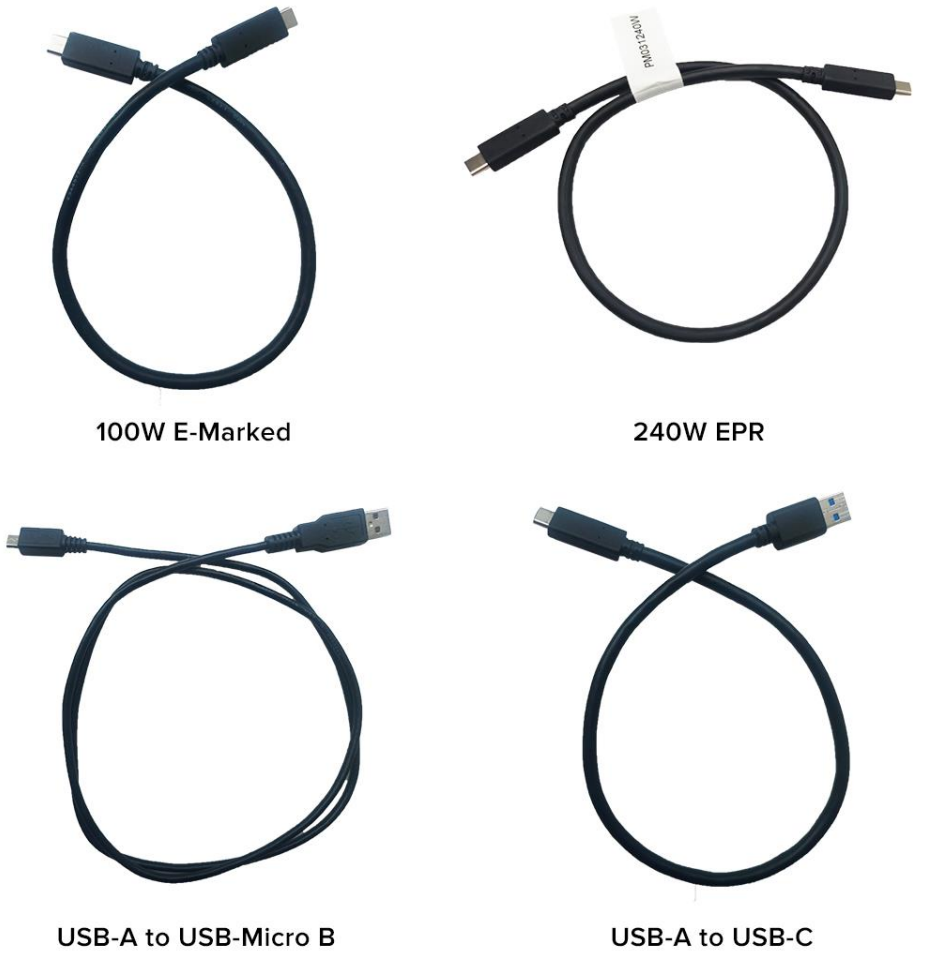



Figure 8

It is recommended to only use the original cables supplied with the tester. Avoid using longer cables as they introduce error in voltage measurement. Moreover, the original E-Marked Type-C cable is qualified for 5A, but not all Type-C cables have this capability.

## *Setting up the tester*

To power the tester, connect the provided power adapter to the AC supply and plug it into the power connector at the back of the unit. Then, turn on the power switch located at the back to power on the unit. If you wish to use the standalone test application, connect the "Analysis Port" to your computer as well.
Next, connect the Device Under Test (DUT) to either the sink or source port, depending on the DUT type and the test you are performing (See Table 2).

The DUT could be one of the following:

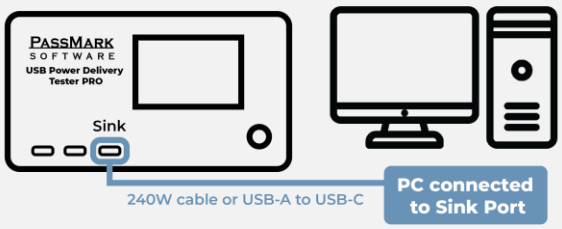
- Desktop or laptop USB port
- Wall charger
- USB Hub
- Portable power bank
- Mobile phone
- USB flash drive

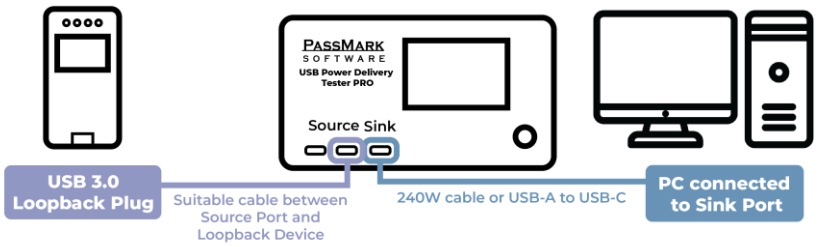
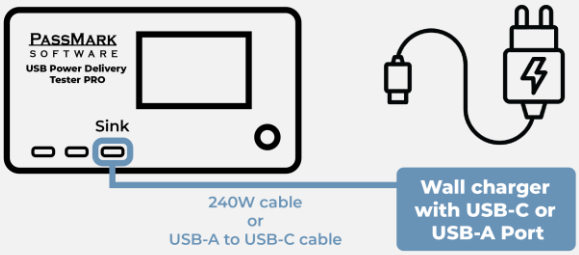
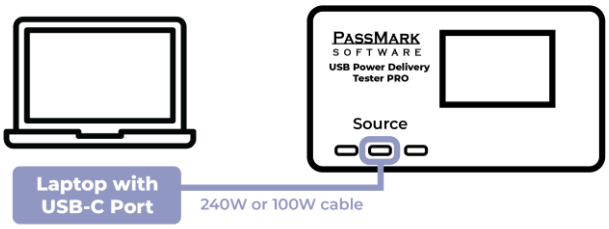
You need the appropriate cables for the DUT:

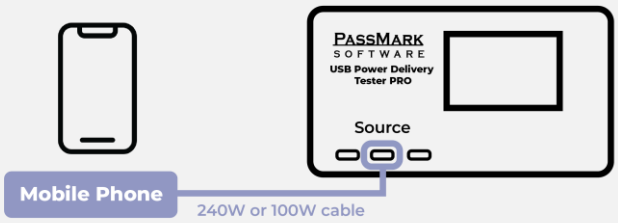
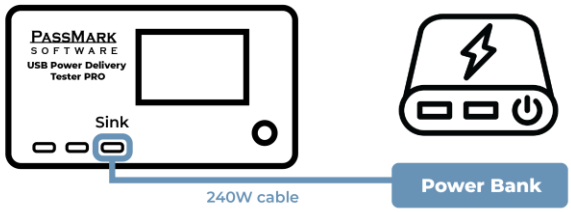
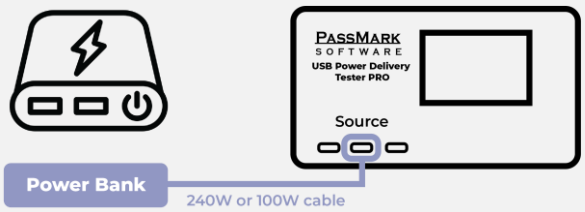
- 240W EPR USB-C to USB-C cable (PM031240W)
- 100W E-Marked USB-C to USB-C cable
- USB-A to USB-C cable

The 240W EPR USB-C cable is a full featured USB-C cable that supports EPR functionality and is the most suitable option for using with Sink port when testing a DUT that has a USB-C port.
The 100W USB-C cable can also be used with Sink port but keep in mind that it is not an EPR cable, so if you're testing a DUT with EPR functionality, some profiles will not be available with this cable. It is recommended to use this cable for connecting devices to Source port or in Loopback mode.
The USB-A to USB-C cable is useful for testing older devices with a Type-A connector.

The table below illustrates how different devices can be connected to the tester for different testing scenarios.

<table>
<tr><th>Usage Scenerio</th><th>Test Scope</th><th>Port to Use</th><th>Cable to Use</th></tr>
<tr><td rowspan="2">❶<br>PC/Laptop<br><br>Testing power delivery functionality as a power source</td><td>- Checking supported charging protocols and profiles as a provider of power to other devices<br>- Testing voltage stability under various load conditions by drawing power.</td><td>Sink Port</td><td>240W cable or USB-A to USB-C depending on PC/Laptop port</td></tr>
<tr><td colspan="3"> 
</td></tr>
<tr><td>❷<br>PC/Laptop<br><br>Testing power delivery functionality as a power source and USB communication simultaneously</td><td>- Checking supported charging protocols and profiles as a provider of power to other devices<br>- Testing voltage stability under various load conditions by drawing power.<br>- Testing power delivery and data simultaneously<br>Note: Loopback mode should be enabled.</td><td>-Sink Port to PC/Laptop<br>-Source Port to loopback device</td><td>-240W cable or USB-A to USB-C (depending on the PC/Laptop port) between PC/Laptop port and Sink Port<br>-Suitable cable between Source port and loopback device (USB2 or USB3 loopback plugs or other loopback devices)</td></tr>
</table>

<table>
<tr><td></td><td colspan="3"> 
</td></tr>
<tr><td rowspan="2">❸<br>Wall charger<br><br>Testing power delivery functionality as a power source</td><td>- Checking supported charging protocols and profiles as a provider of power to other devices<br>- Testing voltage stability under various load conditions by drawing power.</td><td>Sink</td><td>240W cable or USB-A to USB-C (depending on the charger port)</td></tr>
<tr><td colspan="3"> 
</td></tr>
<tr><td rowspan="2">❹<br>Laptop with USB-C Port<br><br>Testing laptop charging behaviour by emulating different chargers</td><td>- Charging/Powering up laptop<br>- Checking the supported charging protocols and that the laptop can correctly negotiate the power it requires.<br>- See what voltages and currents are set by the laptop over the entire charging cycle of the battery.<br>- Test how quickly the laptop charges with different types of chargers.</td><td>Source</td><td>240W or 100W cable</td></tr>
<tr><td colspan="3"> 
</td></tr>
<tr><td>❺<br>Mobile Phone<br><br>Testing phone charging behaviour by emulating different chargers</td><td>- Charging/Powering up phone<br>- Checking the supported charging protocols and that the phone can correctly negotiate the power it requires.<br>- See what voltages and currents are set by the phone over the entire charging cycle of the battery.<br>- Test how quickly the phone charges with different types of chargers.</td><td>Source</td><td>240W or 100W cable</td></tr>
</table>

<table>
<tr><td></td><td colspan="3"> 
</td></tr>
<tr><td rowspan="2">❻<br>Power Bank<br><br>Testing power delivery functionality as a power source</td><td>- Checking supported charging protocols and profiles as a provider of power to other devices<br>- Testing voltage stability under various load conditions by drawing power.</td><td>Sink</td><td>240W cable or USB-A to USB-C (depending on the power bank port)</td></tr>
<tr><td colspan="3"> 
</td></tr>
<tr><td rowspan="2">❼<br>Power Bank<br><br>Testing power bank charging behaviour by emulating different chargers</td><td>- Charging power bank<br>- Checking the supported charging protocols and that the power bank can correctly negotiate the power it requires.<br>- See what voltages and currents are set by the power bank over the entire charging cycle of the battery.<br>- Test how quickly the power bank charges with different types of chargers.<br>- Testing the actual capacity of the power bank.</td><td>Source</td><td>240W cable or USB-A to USB-C (depending on the power bank port)</td></tr>
<tr><td colspan="3"> 
</td></tr>
<tr><td>❽<br>USB-C Hub Pass-through charging<br><br>Testing hub in pass through configuration</td><td>- Testing pass-through charging<br>- Check if hub can correctly negotiate profile via “PD” port. You can emulate different chargers to ensure the hub correctly negotiates power.<br>- Checking how much power the hub reserves for itself and how much it can deliver through USB-C male connector.<br>- Measure any power loss in pass-through mode.</td><td>-Sink Port to hub male USB-C cable<br>-Source Port to hub’s “PD” or “PD IN” port</td><td>240W or 100W cable</td></tr>
</table>

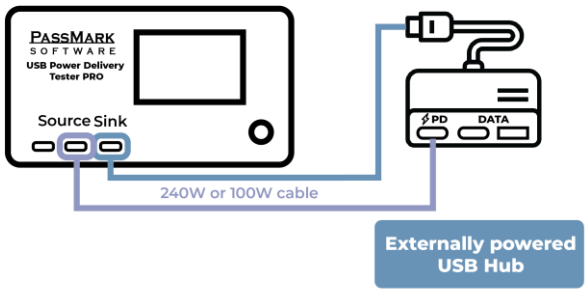
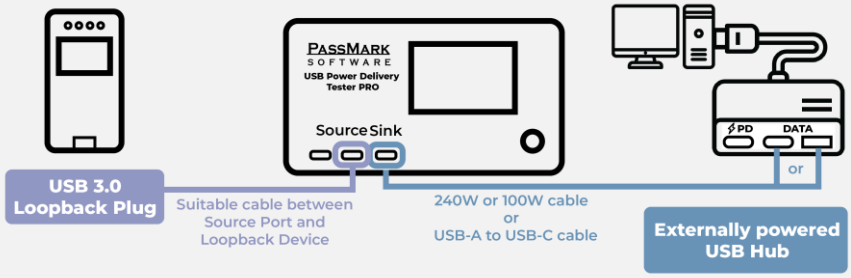
<table>
<tr><td></td><td colspan="3"> 
</td></tr>
<tr><td rowspan="2">❾<br>USB-C Hub<br><br>Testing power delivery functionality as a power source and USB communication simultaneously<br><br>Note: loopback device is optional</td><td>- Testing power delivery and data simultaneously.<br>Note: Loopback mode should be enabled if testing data.</td><td>-Sink Port to hub data port<br>-Source Port to loopback device</td><td>240W cable or USB-A to USB-C (depending on the hub port) between hub port and Sink Port<br>-Suitable cable between Source port and loopback device (USB2 or USB3 loopback plugs or other loopback devices)</td></tr>
<tr><td colspan="3"> 
</td></tr>
</table>

Table 2

# Standalone Test Application

The test comes with free Windows software,
https://www.passmark.com/products/usb-power-delivery-tester-pro/download.php
The USBPDPROTest application window is divided into 5 sections: Select Tester, Sink Port, Source / Loopback Port, Graphs and other control buttons and Log Window.

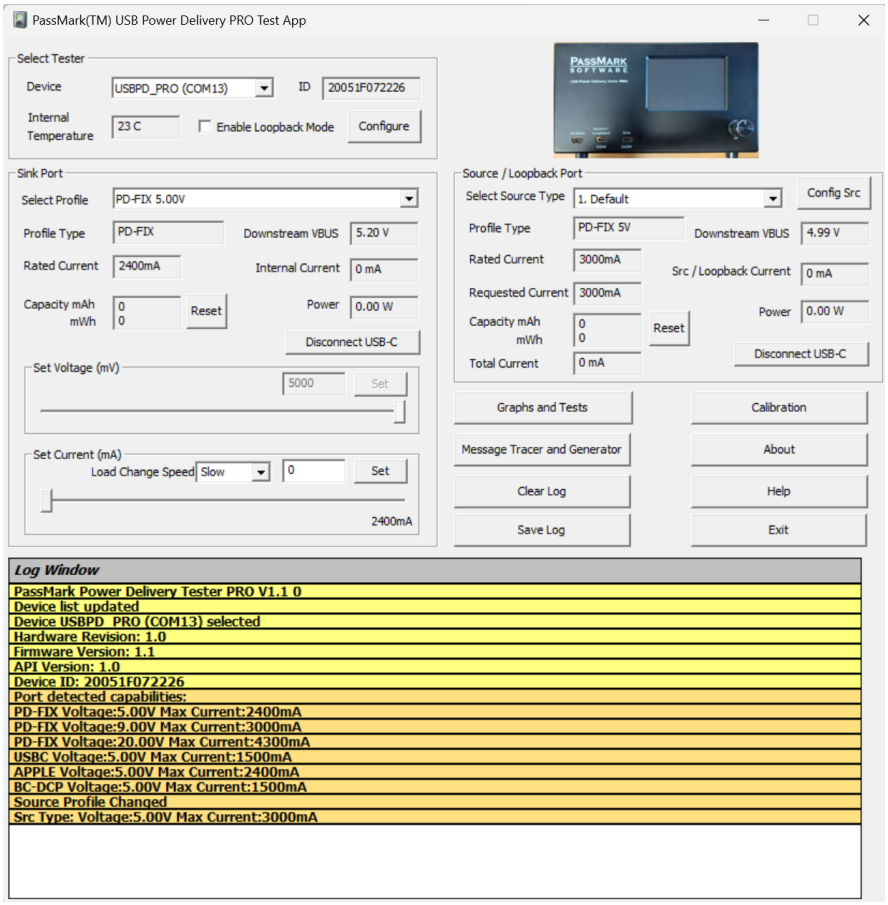



Figure 9

## *Select Tester*

This section contains the following features and options:

### Device

This drop-down list shows all connected PassMark USB Power Delivery PRO devices. If PassMark USB Power Delivery PRO devices are added or removed while the application is running, the drop-down selection list will be automatically updated.

### ID

This displays the unique ID of the PassMark USB Power Delivery PRO device, which is connected to the standalone test application.

### Internal Temperature

This displays the internal heatsink temperature of the connected device in degree Celsius.

### Enable Loopback Mode

This option enables or disables the loopback functionality. When loopback mode is activated, the power and data lines from the device connected to the Sink port are routed through to the Source / Loopback port. This setup allows simultaneous testing of communication speed, data integrity, and power delivery of USB ports.

### Configure

This allows the user to change the configurations of the device. The following options appear in the configuration window:

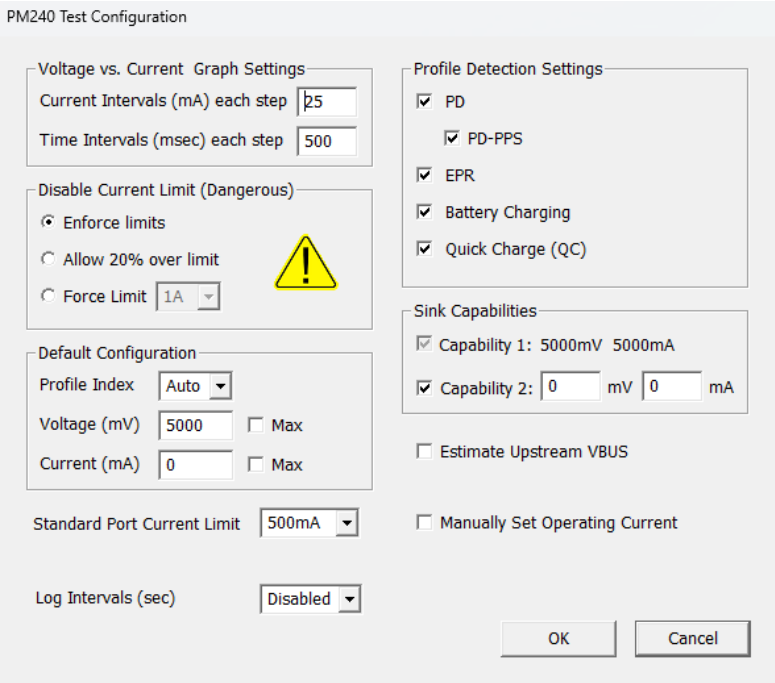



Figure 10

**Voltage vs. Current Graph settings:** This allows to specify the current/time intervals for each step in the Voltage vs. Current graph.
**Disable Current Limit:** This option allows the user to disable the detected current limit and extents the range up to 5A. It is possible to extend the range by 20% or manually force a new limit. Precautions should be taken when disabling the current limit as drawing excessive current could damage the device/port under test.
**Default Configuration:** Sets the initial profile index, voltage and current applied when connecting a device to the sink port and when a new source capability is received for testing devices with dynamically changing profiles. "*Auto*" mode will find the best matching profile based on the settings provided and select it on connecting the device. The "Max" box next to each setting can also be ticked instead if you want to select the maximum voltage or current from the device available as the default configuration.
**Standard Port Current Limit:** The maximum current for standard downstream ports can be defined by this option.
**Estimate Upstream VBUS:** This allows to estimate the VBUS at the output of the device under test.
**Manually Set Operating Current:** This is the maximum current the unit can draw from the device under test connected to the sink port. This can either be manually set or be in automatic mode where it is set to the maximum current allowed by the selected profile.

**Profile Detection Settings:** Sets which profiles will be detected. Disabling profiles will skip the detection step which can lead to quicker connection times. If PD is disabled the USB Power Delivery PRO Tester will appear to not support the Power Delivery Protocol, which can be used to test Quick Charge backwards compatibility on Quick Charge 4+ devices.
**Sink Capabilities:** This contains the capabilities advertised by the device when requested by a source. Capability 1 is required by the PD specifications and Capability 2 can be modified if enabled by ticking the box next to it.

## *Sink Port*

This section contains the statistics and options for the device connected to sink port.

### Select Profile

This drop-down list shows the list of profiles supported by the device connected to sink port. User can select the required power profile using this option.

### Profile Type

This displays the current type of profile selected on the sink port device.

### Downstream VBUS

This displays the measured voltage readings from the device connect to sink port.

### Rated Current

This displays the maximum current allowed by the selected profile.

### Internal Current

This displays the amount of current that is being sinked into the unit, from the device attached to the sink port.

### Power

This displays the amount of power that is being dissipated by the unit, from the device attached to the sink port.

### Capacity / Reset

The tester can be used as a capacity meter to test power banks. The monitoring software accumulates the capacity over the time until the voltage drops below the required voltage limit. The “Reset” button allows users to reset the accumulated capacity.

### Disconnect USB-C

Clicking this button will simulate a physical disconnection of the device from the sink port. This button will then change to *Connect USB-C* which can be used to simulate the reconnection.

### Set Voltage

This allows the user to adjust the voltage when a PPS/APDO or QS profile is selected.

### Set Load

Allow adjusting the variable load. The load can be adjusted by entering the current in mA or by moving the slider. The speed at which the load changes can also be adjusted using the "*Load Change Speed"* drop-down menu.

## *Source / Loopback Port*

This section contains the statistics and options for the device connected to source port. Some of the statistics are similar to the sink port, but for device connected to source port.

### Select Source Type

This drop-down list shows the list of user defined chargers supported by the source port of the device. The source port of the device will emulate the profiles supported by the selected custom charger.

### Config Src

This allows the user to configure up to 5 custom chargers that the source port can emulate. Each charger supports up to 10 different profiles including USB C (500mA, 1.5A and 3A), Battery Charging (SDP, DCP, QC3 and Samsung), Apple (500mA, 1A, 2.1A, 2.4A and 3A) and up to 7 PD profiles (PD-FIX and PD-APDO).
The below figure shows the source type configurations window.

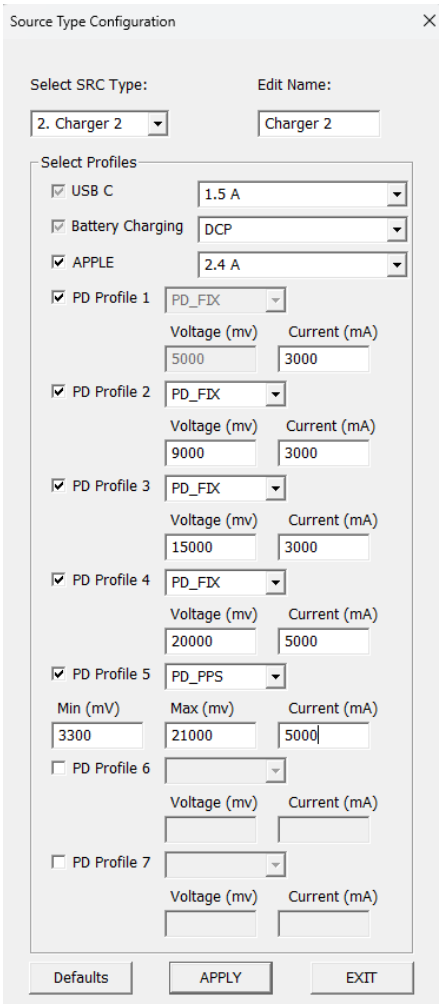



Figure 11

### Requested Current

This displays the current requested by the device connected to source port. The requested current is set by the device under test and is given as part of the request PD message it sends when negotiating a voltage with the unit. Requested Current is only applicable to devices that support PD communication.

### Total Current

This displays the total measured current from the sink and loopback port combined.

## *Graphs and Tests Window*

The controls for running a test are found along the right side of the graph. Within the *Test Graph Configuration* box, the type of tests can be viewed by clicking the drop-down box under *Graph Type* and the test selected by clicking on it. Beneath this, the configuration parameters for that test will be displayed and can be adjusted. When Real-Time graph is selected, the *Signal* drop-down box can be used to select what signal to be used for the test. This can be Voltage, Current or Power for Sink or Source ports. User can also adjust the *Time Division* and *Test Duration* for the Real-Time graph. Hitting the *Run Test* button begins the set test, during the test the Tester will become busy until it is either complete or the *Stop* button is pressed. When a test is complete, the graph can be saved as an image with the *Save Graph* button or exported in the form of a CSV file with the *Export CSV* button.

### Real-time Sink Voltage Graph

The Real-time Sink voltage graph is used to monitor the voltage of the sink port in real-time. A green band is imposed over the output graph to indicate whether the measured voltage falls within the acceptable range. The maximum and minimum voltage measured during the test is also displayed, which is used to determine the ripple voltage.

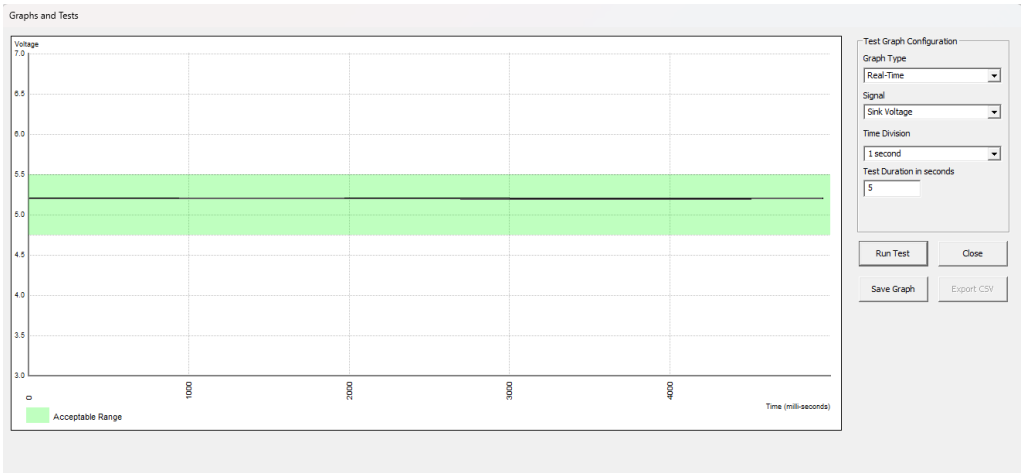



Figure 12

### Real-time Sink Current Graph

The Real-time Sink current graph is used to monitor the current drawn from the DUT connected to sink port in real-time.

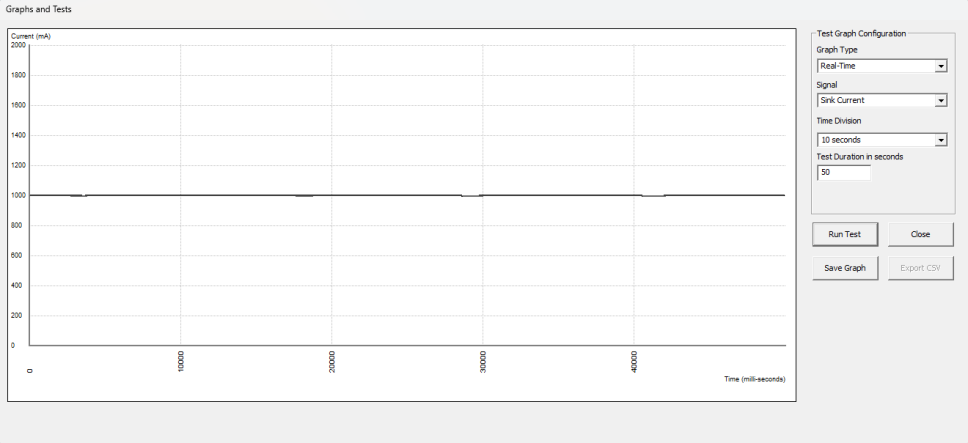



Figure 13

## Real-time Sink Power Graph

The Real-time Sink power graph is used to monitor the power drawn from the DUT connected to sink port in real-time.

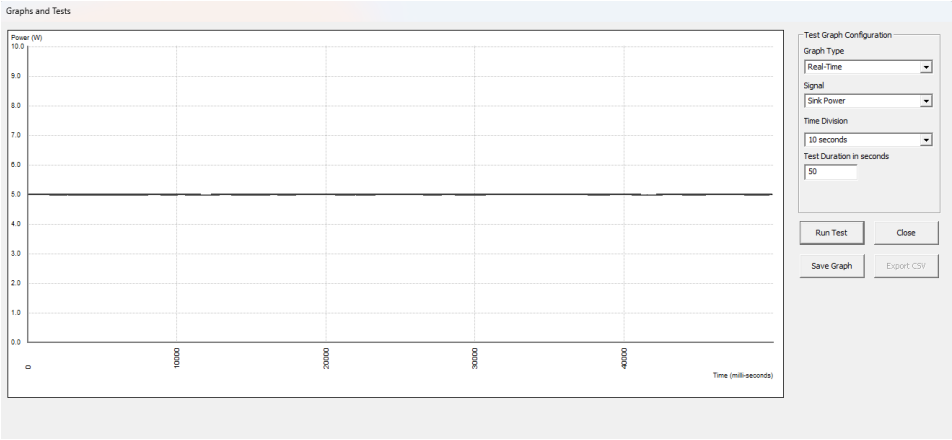



Figure 14

## Real-Time Source Voltage Graph

The Real-time Source voltage graph is used to monitor the voltage of the source port in real-time.

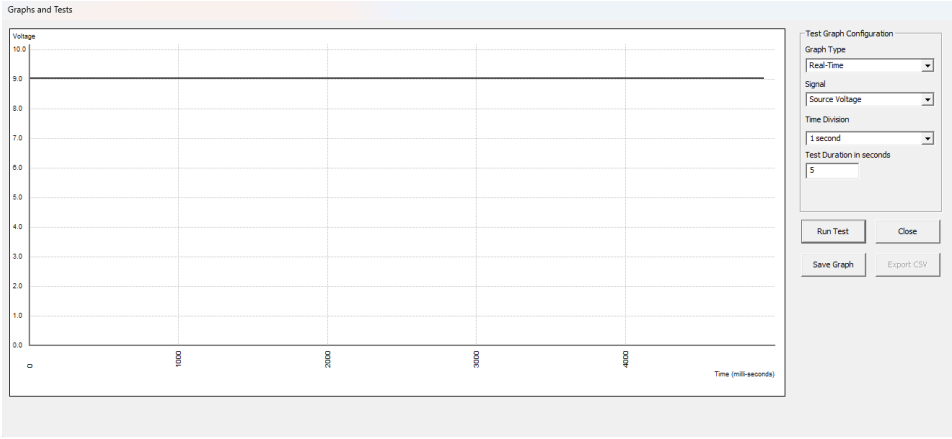



Figure 15

## Real-Time Source Current Graph

The Real-time Source current graph is used to monitor the current drawn from the source port in real-time.

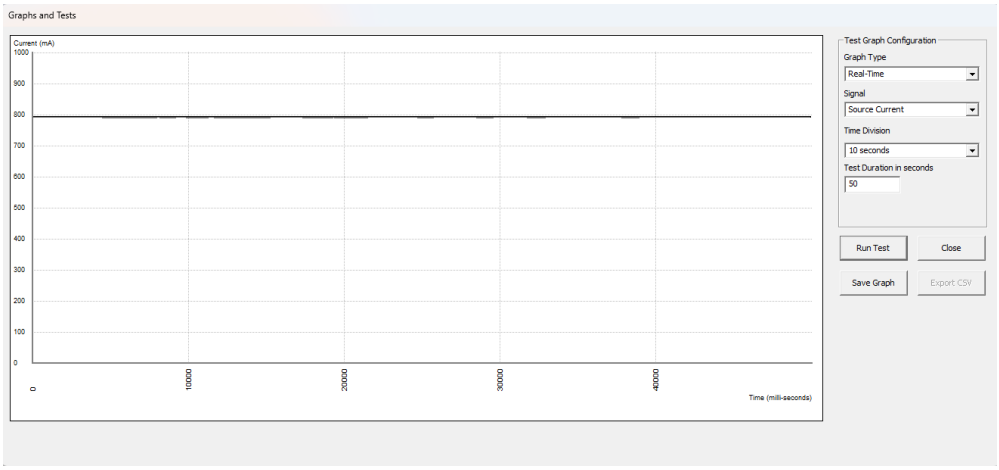



Figure 16

## Real-Time Source Power Graph

The Real-time Source power graph shows the power drawn from the source port over time. This is useful for understanding the charging curve of different devices.

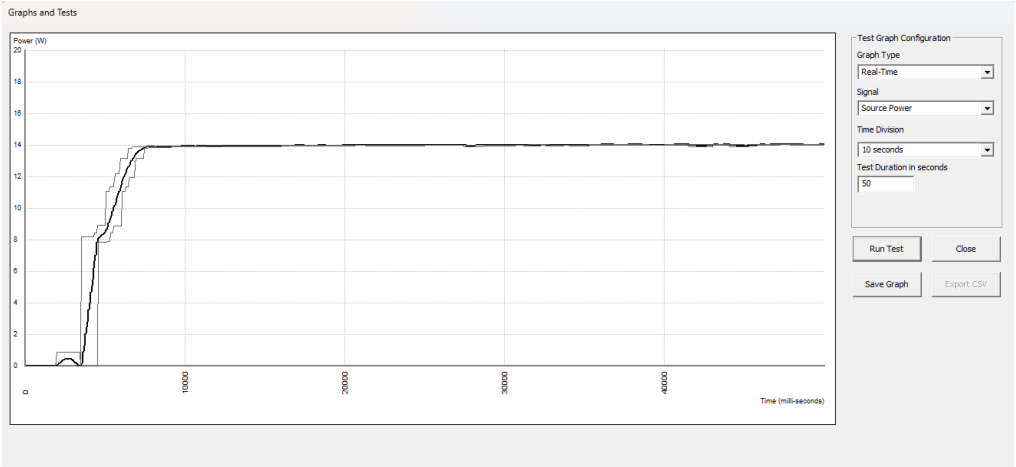



Figure 17

## Sink Voltage vs. Current Graph

The Voltage vs. Current test will sweep the full range of electrical loads to test the voltage stability over the entire output range. A graph of "Voltage vs. Current" will be displayed as a result (figure 12), which provides an easy way to check if voltages remain in spec even under maximum load.

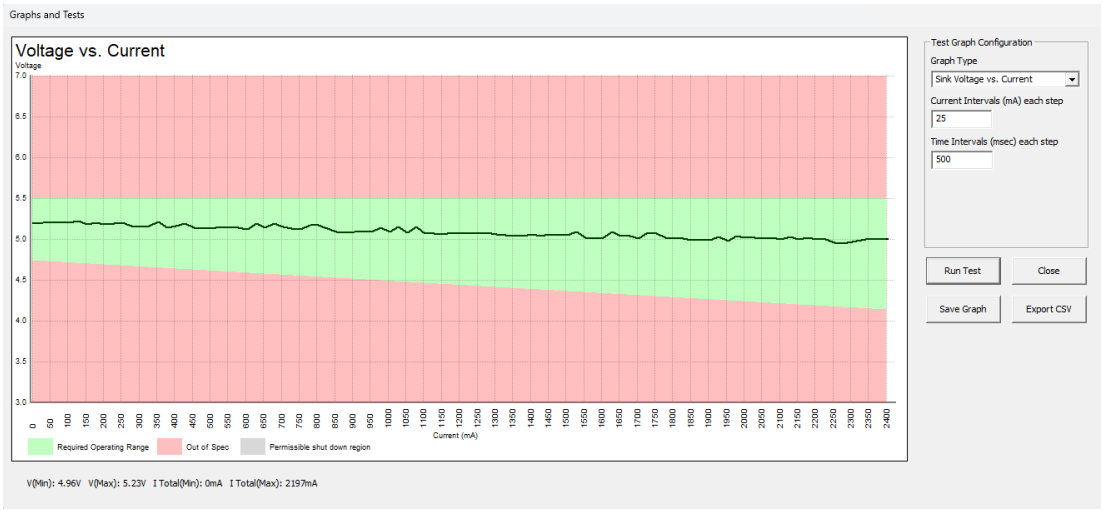



Figure 18

The above graph is divided into three regions:
Required Operating Range (Green area): The voltage vs. current graph for a normal device/port should stay within this area for all currents less than the advertised current by the manufacturer.
Out of Spec (Red area): This means either over voltage or under voltage detected.
Permissible Shutdown Region (Grey area): The device/port under test can shut down when voltage is in this area.
While the graph is being plotted, the voltage measured at each current step will be stored in the Log Window.

### Sink FFT Graph

The Sink FFT graph shows the frequency components in the sink AC signal. It shows the amplitudes in dB up to maximum frequency of 1 MHz.

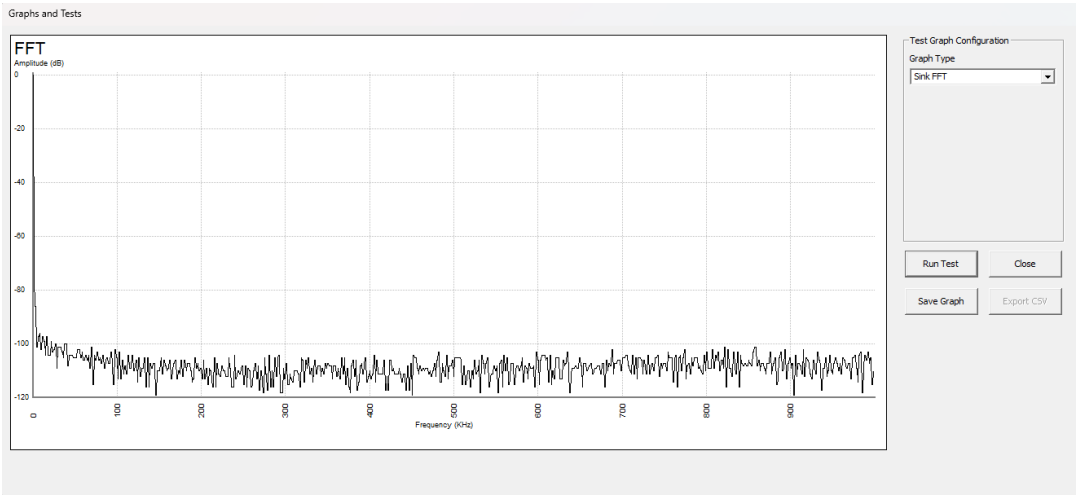



Figure 19

## Message Tracer and Generator Window

The table in the top half of the window displays a log of all the power delivery messages sent and read by the Power Delivery PRO Tester. Below the table, the *Log View Mode* dropdown box can be used to adjust what information is displayed, with the following three options: Default, for a simplified overview; Extended data, for viewing data related to extended type messages; Raw messages, for viewing the raw data sent over the USB cable. Below this, clicking the *Export to CSV* button will save all the log entries to a file, and to the right, clicking the *Clear Log* will reset the log to be empty.
In the bottom left corner of the window is the message generator. Detailed information of each message type and its corresponding data can be found by referring to the Protocol Layer section USB Power Delivery specification. Clicking the send message button will form the power delivery message and send it to the device under test. For generating invalid messages, the Custom type can be used.
<insert screen shot>

## Calibration Window

The unit should provide accurate measurements out of the box, with its default calibration. Typical default accuracy is around 1% for voltage readings and ±10mA for current measurements. So, for most uses, further calibration is not required. However, using an adjustable power supply and a quality multimeter, experienced users can calibrate the tester to improve the voltage & current measurement accuracy.

To calibrate the sink port, two known voltages/loads should be applied for voltage/current calibration. For voltage and current readings, you should split open a USB cable to be able to measure the Volts and Amps with multimeter. This cable should have a 5Kohms pull up resistor between CC line and VBUS to be detected by the tester. The voltage measurement should be done as close as possible to the tester's DUT connector. For current measurement, a multimeter must be inserted in series with VBUS wire. The applied voltage/load should be measured by a multimeter and is called "Applied Value". The PD Tester software also records its own measurement, known as the "Measured Value" and finds the gain and offset required to map this value to the expected value.

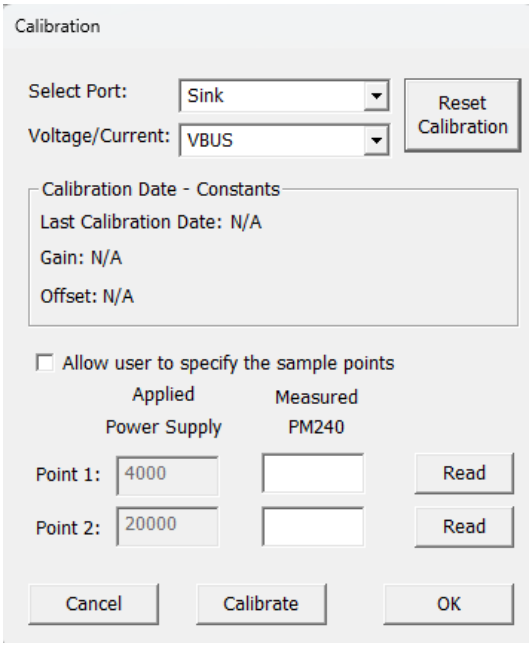



Figure 20

**Sink Voltage measurement calibration:**

- Open the calibration window.
- From the dropdown lists, select Sink and VBUS.
- Click “Reset calibration data” to erase all previous calibration data.
- Apply an external voltage equal or close to Point 1 to VBUS. If you cannot apply the exact voltage, activate the “Allow user to specify the sample points” option, which allows you to specify the exact applied voltage.
- Click “Read” button for the Point 1.
- Apply an external voltage equal or close to Point 2 to VBUS. Again, if you cannot apply the exact voltage, activate the “Allow user to specify the sample points” option, which allows you to specify the exact applied voltage.
- Click “Read” button for the Point 2.
- Click “Calibrate”.

**Sink Current measurement calibration:**

- Open the calibration window.
- From the dropdown list, select Sink and Current.
- Connect the VBUS to a low noise external power source and insert a multimeter in series with VBUS for current measurement.
- Click “Reset calibration data” to erase all previous calibration data.
- Turn the knob until load measured by multimeter is equal or close to Point 1. If you cannot apply the exact load, activate the “Allow user to specify the sample points” option, which allows you to specify the exact applied load.
- Click “Read” button for the Point 1.
- Turn the knob until load measured by multimeter is equal or close to Point 2. If you cannot apply the exact load, activate the “Allow user to specify the sample points” option, which allows you to specify the exact applied load.
- Click “Read” button for the Point 2.
- Click Calibrate.

**NOTE:**
To calibrate Source port, first Sink port should be calibrated and then connect a USB Type-C cable between Sink and Source ports. Users can now calibrate the source port VBUS and Current using the sink port readings.

### Log Window

The log window displays test results and events logged during operation. It starts with a list of the PassMark USB Power Delivery PRO devices connected.
This includes the:

- The version of USB Power Delivery Test PRO application.
- A list of PassMark USB Power Delivery devices connected.
- Hardware, Firmware and API versions of the connected device.
- Device Unique ID
- The power capabilities (voltage profiles) that the sink port device supports.
- Warnings such as under voltage or over voltage.
- Voltage Sweep results.

# Driver Installation

In most cases, if there is an available Internet connection, Windows will silently connect to the Windows Update website and install the driver automatically. If the automatic installation takes place there is no need to continue with the procedure outlined below.

## *Windows 8, 10 and 11 Installation*

Un-install any previous version of the Virtual COM Port driver before installing a new version.

**Step1 – Connect the device**

With the computer turned on and running, connect the device to the USB port on the computer to be tested. The device should be powered ON.
If the driver was previously installed on the system, the device can be found under the Ports section in the Device Manager.

For Win7 users, the "Installing device driver software" bubble should be displayed as shown below.


Figure 21

**Step2 – Install the device driver**

Download the latest version of STM32 Virtual COM Port driver from the following address and extract the package.
STSW-STM32102 - STM32 Virtual COM Port Driver - STMicroelectronics

Run the correct setup depending on your machine OS.
After successfully installing the setup, start Device Manager by selecting Windows Start and typing "Device Manager".

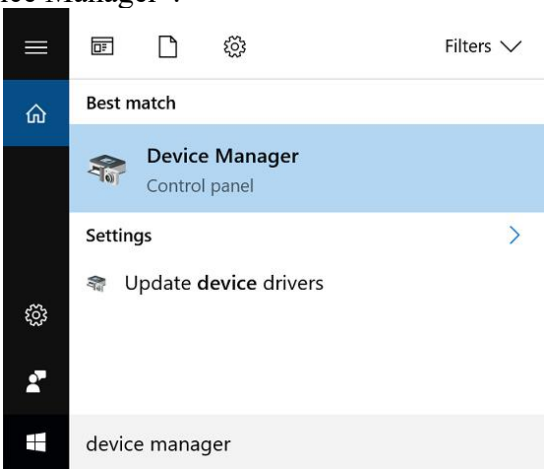



Figure 22

In the Device Manager, check if the device shows up under Ports as "STMicroelectronics Virtual COM Port" to confirm that the device driver was installed correctly.

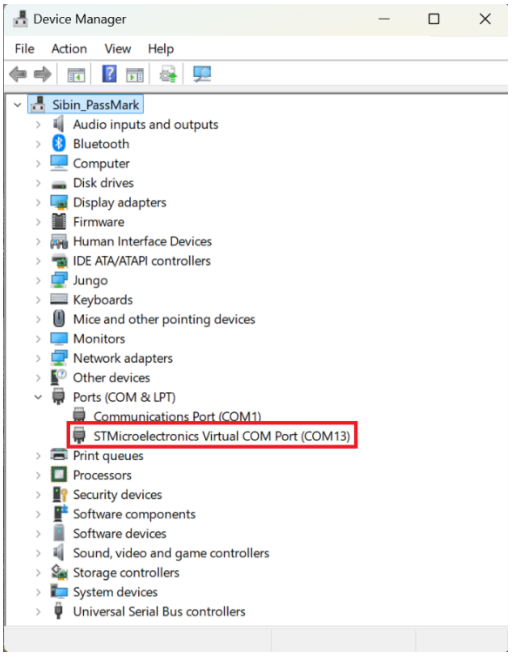



Figure 23

### *Uninstalling in Windows 8, 10 and 11*

From the Windows "Start" option, open Device Manager. From the "Ports (COM & LPT)" branch of the device tree, select the device and right click. Select "Uninstall Device". Now tick "Attempt to remove the driver for this device" and uninstall.

# Technical Specification

| | |
|---|---|
| **Model No** | PM240 |
| **User Interface** | 3.5" TFT LCD, Capacitive touch and Rotary dial |
| **USB standards** | USB Power Delivery Specification Revision 3.1, Battery Charging Specification Revision 1.2 and Quick Charge 5 (including QC1, QC2, QC3, QC4 and QC4+) |
| **Physical connectors** | Monitoring Port (PC): USB Micro B<br>Sink Port: USB-C<br>Source Port: USB-C<br>Power Jack |
| **Operational Voltage** | 24V via the supplied 120W external adapter |
| **Operational Current** | Sink Port in use: 100mA<br>Source Port in use: determined by the power supplied via the source port |
| **Sink Port** | |
| **Port/Charger Detection** | Type-C (non-PD, Fixed, PPS and EPR)<br>DCP, SDP, CDP, QC and Proprietary Chargers (Apple and Samsung) |
| **Maximum Voltage** | 58V |
| **Maximum Load** | 240W Continuous (5A @ 48V) |

| | |
|---|---|
| **Voltage Adjustment for PPS/EPR/QC profiles** | Yes |
| **QC/PPS/EPR Voltage Adjustment Steps** | 200mV/20mV/100mV |
| **Measurement Error (V)** | 1% before calibration, 0.25% after calibration |
| **Measurement Error (A)** | ±10mA for the entire range (0-5A), calibration improves the accuracy to 1% for loads less than 1A |
| **Cable Detection** | Max cable voltage/current detection<br>EPR mode capable<br>Maximum USB speed (E-marked cables)<br>Cable latency (E-marked cables) |
| **Voltage Graph** | AC graph for ripple monitoring (3V Pk-Pk) |
| **FFT Analysis** | Fast Fourier Transform (FFT) of the input signal up to 1MHz |
| **Safety Protections** | Over current protection.<br>ESD Protection on VBUS, CC lines, and USB2 data lines (IEC 61000-4-2 level 4, ±8kV contact discharge, ±15kV air discharge)<br>CC line short-to-VBUS protection up to 58V |
| **Source/Loopback Port** | |
| **Port/Charger Emulation** | Type-C (non-PD, Fixed, PPS)<br>DCP, SDP, CDP, QC and Proprietary Chargers (Apple and Samsung) |
| **Charger Type Selection** | Create up to 5 custom charger configurations. Charger type selected by user or automated. |
| **Maximum Power/Voltage** | 100W/20V |
| **Programable Voltage Steps** | 20mV |
| **Maximum Current** | 5A |
| **Programable Current Limit** | User Programable or Automatic (depends on cable current limit) |
| **Maximum Voltage/Current in Loopback mode** | 20V/5A |
| **Voltage Accuracy** | 1% before calibration, 0.25% after calibration |
| **Measurement Error (A)** | ±10mA for the entire range (0-5A), calibration improves the accuracy to 1% for loads less than 1A |
| **Safety Protections** | Over current protection.<br>ESD Protection on VBUS, CC lines, and USB2 data lines (IEC 61000-4-2 level 4, ±8kV contact discharge, ±15kV air discharge)<br>CC line short-to-VBUS protection up to 24V. |
| **Other Specifications** | |
| **Cooling** | Heatsink with 80x80mm fan |
| **Case** | Carbon Steel - Black Powder Coated |
| **Size** | 170mm x 110mm x 200mm<br>(6.7 x 4.3 x 7.9 inches) |
| **Weight** | 1600g |
| **EMC standards** | AS/NZS 3548:1995, EC |

| | |
|---|---|
| **Electrical Compliance** | CE, UKCA, RCM |
| **PD Protocol Analyzer / PD Message Injection** | Supported |
| **Other Safety Protections** | Isolated USB Monitoring port (2.5KV)<br>Over-Temperature Protection: Dual temperature sensors connected to the heatsink<br>Onboard Temperature Sensor: Monitors the device's internal temperature for additional safety<br>Chassis Grounding: The body of the device is earthed to reduce the risk of electric shock |
| **Storage Temperature** | -30 ºC to + 80 ºC |
| **Usage Temperature** | 0 ºC to + 35 ºC (lower temperature allows longer period of higher loads) |
| **RoHS (Lead free)** | Yes |

Table 3

The USB Power Delivery Tester is software upgradeable.
Most settings and user selections can be automated via the API (console application and example source code in C is provided).

# Software Compatibility

Window 7, 8, 10, 11 are supported.
Windows: USBPDPROTest application is required for Windows.
64bit Windows drivers are available.

# Troubleshooting

Symptom: Voltage and Current readings show zero after connecting the USB cable.
Check the correct port is selected on the display. Make sure appropriate cables are used. There is most likely a fault with the cable or device connected.

Symptom: Monitoring Software shows No device detected or does not show readings.
Make sure the device is connected to the PC and correct device is selected using the "Device" drop-down menu. Check the debug cable is working, and drivers are correctly installed on the PC.

# Disclaimer

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