# Thunderbolt Cable Power Controller

User Manual

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# Introduction

This user's guide documents the Thunderbolt Cable Power Controller (TBT-TPA-CPC) as used with Thunderbolt cable test products. The Thunderbolt Cable Power Controller, when paired with two TBT-TPA-ER (Receptacle) TPAs, can be used for testing Thunderbolt cables. The CPC can set-up the necessary test modes, set the Power-in and Power-out voltages, and set load currents. The Power-in and Power-out is fully programmable over the low and high voltages ranges. The load current can be programmed over the full load range of a Thunderbolt cable. The CPC is programmed via USB. It comes with a +9Vdc, 5A universal power supply, to supply power for testing.

Software is used to support testing of Thunderbolt cables. The software is detailed in the section: Thunderbolt Cable Power Controller Software.

Figure 1. The Thunderbolt Cable Power Controller.

Provided with each TBT-TPA-CPC Thunderbolt Cable Power Controller are the following supporting materials.

- (1) Universal +9Vdc Power Supply.
- (1) NEMA 5-15P Power Cord.
- (1) USB Cable, Type A to Type B, 3 ft.
- (1) CD or USB Memory Containing CPC Software



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# Product Inspection

Upon receiving the Thunderbolt Cable Power Controller from Wilder Technologies, perform the following product inspection:

- Inspect the outer shipping container, foam-lined instrument case, and product for damage. Retain the outer cardboard shipping container until the contents of the shipment have been inspected for completeness and the product has been checked mechanically and electrically. Use the foam-lined instrument-case for secure storage of the Wilder Technologies Thunderbolt Cable Power Controller when not in use.

- Locate the shipping list and verify that all items ordered were received.

- In the unlikely event that the product is defective or incomplete, the “Limited Warranty” section discusses how to contact Wilder Technologies for technical assistance and/or how to package the product for return.

# The Thunderbolt Cable Power Controller Care and Handling Precautions

When using the Thunderbolt Cable Power Controller with Thunderbolt Receptacle test adapters careful handling is required to avoid damage. Improper handling techniques, or using too small a cable bend radius, can damage the coaxial cable connections within the adapter housing or the cables themselves. This can occur at any point along the cable. To achieve optimum performance and to prolong the Thunderbolt Cable Power Controller and Thunderbolt TPA's life, observe the following handling precautions:

- **CAUTION 1: Avoid Torque Forces** (Twisting)
  While individual coaxial cables within the test adapter have some rotational freedom, twisting the Thunderbolt TPA as a unit, with one end held stationary, in excess of +/- 90° may damage or severely degrade performance. Adherence to Caution 5 (below) helps to avoid exceeding twist limits.

- **CAUTION 2: Avoid Sharp Cable Bends**
  Never bend coaxial cables into a radius of 26 mm (1-inch) or less. Never bend cables greater than 90°. Single or multiple cable bends must be kept within this limit. Bending the Thunderbolt TPA cables less than a 26mm (1-Inch) radius will permanently damage or severely degrade test adapter performance.

- **CAUTION 3: Avoid Cable Tension** (Pull Forces)
  Never apply tension (pull forces) to an individual coaxial cable that is greater than 2.3 kg (5 lbs.). To avoid applying tension, always place accessories and equipment on a surface that allows adjustment to eliminate tension on the Thunderbolt TPA and cables. Use adjustable elevation stands or apparatus to accurately place and support the Thunderbolt TPA.

- **CAUTION 4: Connect the Thunderbolt Receptacle TPAs First**
  To prevent twisting, bending, or applying tension to the coaxial cables when connecting a Thunderbolt TPA, always attach the Thunderbolt TPA to the device under test (DUT) or cable under test before attaching any SMA connectors. Carefully align the Thunderbolt connectors and then gently push the connectors together until fully seated.

  If the Thunderbolt TPA must be turned or twisted to make connection to the DUT, avoid using the Thunderbolt TPA housing alone to make this occur. Try to distribute the torque forces along the length of the test setup and cabling. If this is not possible, it is recommended to first loosen or disconnect the SMA connections at the Thunderbolt TPA, make the connection to the DUT and then re-tighten or attach the test equipment leads.

**NOTE: Only grip the test adapter housing when inserting or extracting the Thunderbolt TPA to or from the DUT. Pulling directly on the Thunderbolt TPA cables or using them to insert the Thunderbolt TPA may cause damage.**

- **CAUTION 5: Carefully Make SMA Connections**

  To connect the Thunderbolt TPA SMA connectors, follow these steps:

  1. Hold the cable stationary by grasping the cable at the black heat-shrink section near the SMA connector.

  2. Insert the mating SMA barrel and hand-tighten the free-spinning SMA nut onto the connector while avoiding pulling, bending, or twisting the Thunderbolt TPA coaxial cable.

  3. The Thunderbolt Cable Power Controller and Thunderbolt TPA SMA connectors have flats that accept an open-end 1/4-inch or 6.5mm wrench. When attaching instrument cables to these test adapters, it is recommended that the SMA connectors be mechanically held and the test leads be tightened to the equipment manufacturer's torque recommendations, normally 5 in-lbs, using a 5/16-inch open-end wrench.

If the test set-up requires repositioning, first loosen or disconnect the SMA connections to avoid twisting, bending, or tension.

**NOTE: A drop in signal amplitude by half or 6db during the testing of a lane may indicate that a cable has been mechanically pulled free of coaxial cable connections internal to the assembly. This could be determined by checking if the cable has any lateral play relative to the TPA. This would only occur when the TPA has exceeded the pull force as specified within the mechanical specification. If the cable cannot be re-seated, the test adapter will need to be sent back to the factory for service.**

- **CAUTION 6: Independently Support Instrument Cables or Accessories**

  Excessive weight from instrument cables and/or accessories connected to the Thunderbolt Cable Power Controller or Thunderbolt TPA can cause damage or affect the test adapter performance. Be sure to provide appropriate means to support and stabilize all test set-up components.

# General Thunderbolt Cable Power Controller, Test Adapter, Cable, and Connector

Observing simple precautions can ensure accurate and reliable measurements.

## Handling and Storage

Before each use of the Thunderbolt Cable Power Controller, ensure that all connectors are clean. Handle all cables carefully and store the test adapter in the foam-lined instrument case when not in use, if possible. For Thunderbolt test adapters, do not set connectors contact end down. Install the SMA protective end caps when the test adapter is not in use.

## Visual Inspection

Be sure to inspect all cable connectors carefully before making a connection. Inspect all cables for metal particles, scratches, deformed threads, dents, or bent, broken, or misaligned SMA connector center conductors. Do not use damaged cables.

## Cleaning

If necessary, clean the connectors using low-pressure (less than 60 PSI) compressed air or nitrogen with an effective oil-vapor filter and condensation trap. Clean SMA connector threads, if necessary, using a lint-free swab or cleaning cloth moistened with isopropyl alcohol. Always completely dry a connector before use. Do not use abrasives to clean the connectors. Re-inspect connectors, making sure no particles or residue remains.

## Making Connections

Before making any connections, review the “Care and Handling Precautions” section. Follow these guidelines when making connections:

- Align cables carefully
- Make preliminary connections lightly
- To tighten SMA connections, turn connector nut only
- Do not apply bending force to coaxial cables
- Do not over-tighten preliminary connections
- Do not twist or screw-in cables
- For SMA connections, use an appropriately sized torque wrench, and do not tighten past the “break” point of the torque wrench



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# Electrostatic Discharge Information

Protection against electrostatic discharge (ESD) is essential while connecting, inspecting, or cleaning the Thunderbolt Cable Power Controller and connectors when attached to a static-sensitive circuit (such as those found in test sets).

Electrostatic discharge can damage or destroy electronic components. Be sure to perform all work on electronic assemblies at a static-safe work station, using two types of ESD protection:

- Conductive table-mat and wrist-strap combination
- Conductive floor-mat and heel-strap combination

When used together, both of these types provide a significant level of ESD protection. Used alone, the table-mat and wrist-strap combination provide adequate ESD protection. To ensure user safety, the static-safe accessories must provide at least 1 MΩ of isolation from ground. Acceptable ESD accessories may be purchased from a local supplier.

**WARNING: These techniques for a static-safe work station should not be used when working on circuitry with a voltage potential greater than 500 volts.**



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# Mechanical and Environmental Specifications

**NOTE: All specifications in this manual are subject to change.**

**Table 1. General Specifications**

| ITEM | DESCRIPTION |
|---|---|
| Usage Environment | Controlled indoor environment |
| TBT-TPA-CPC Length x Width x Height | 150.1 mm (5.91 in) x 80.3 mm (3.16 in) x 57.1 mm (2.25 in) |
| Operating Temperature | 0°C to +55°C (32°F to +131°F) (Characteristic) |
| Storage Temperature | -40°C to +70°C (-40°F to +158°F) (Characteristic) |
| Power Dissipation | 20 Watts max |

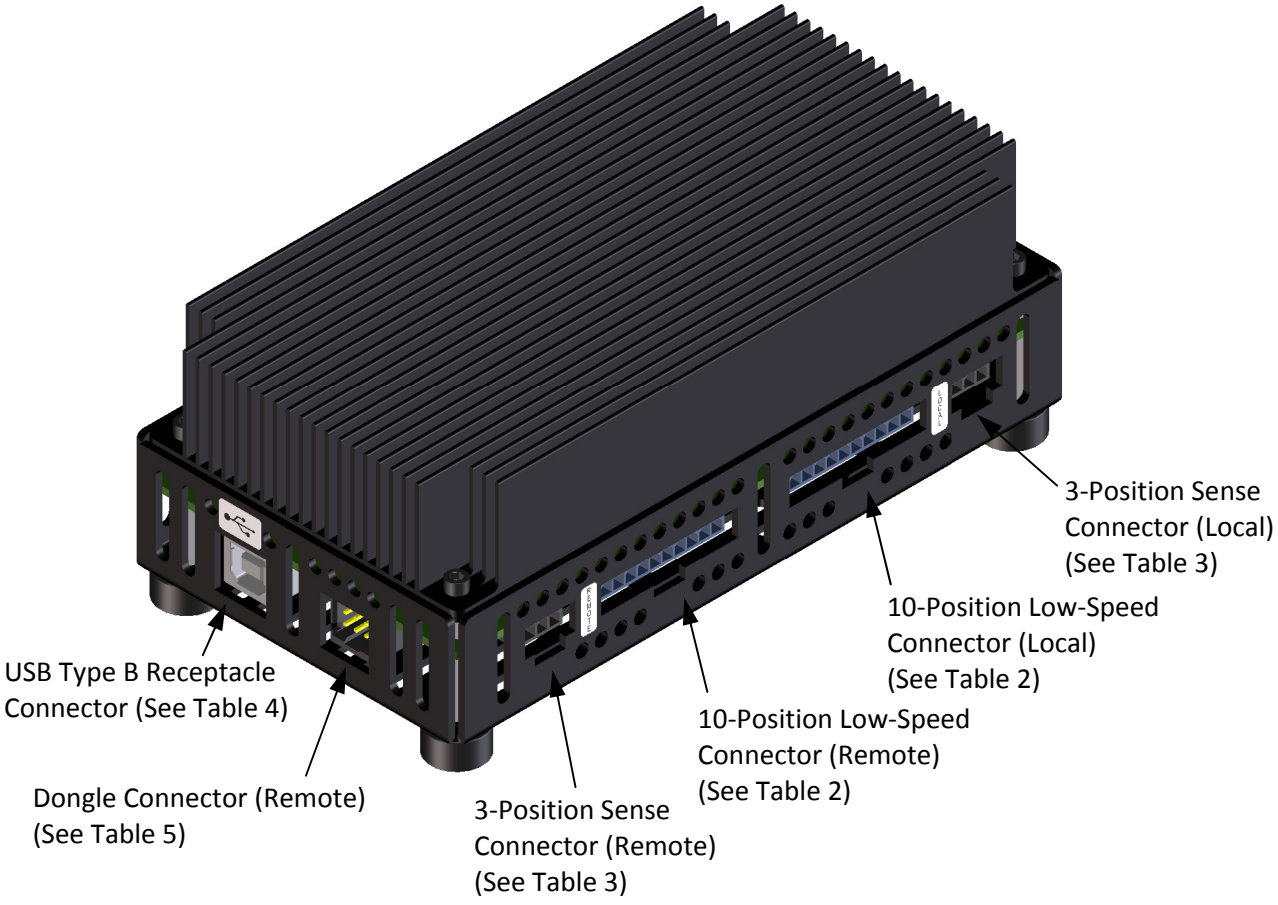


Figure 2. Connectors (Thunderbolt Cable Power Controller shown)



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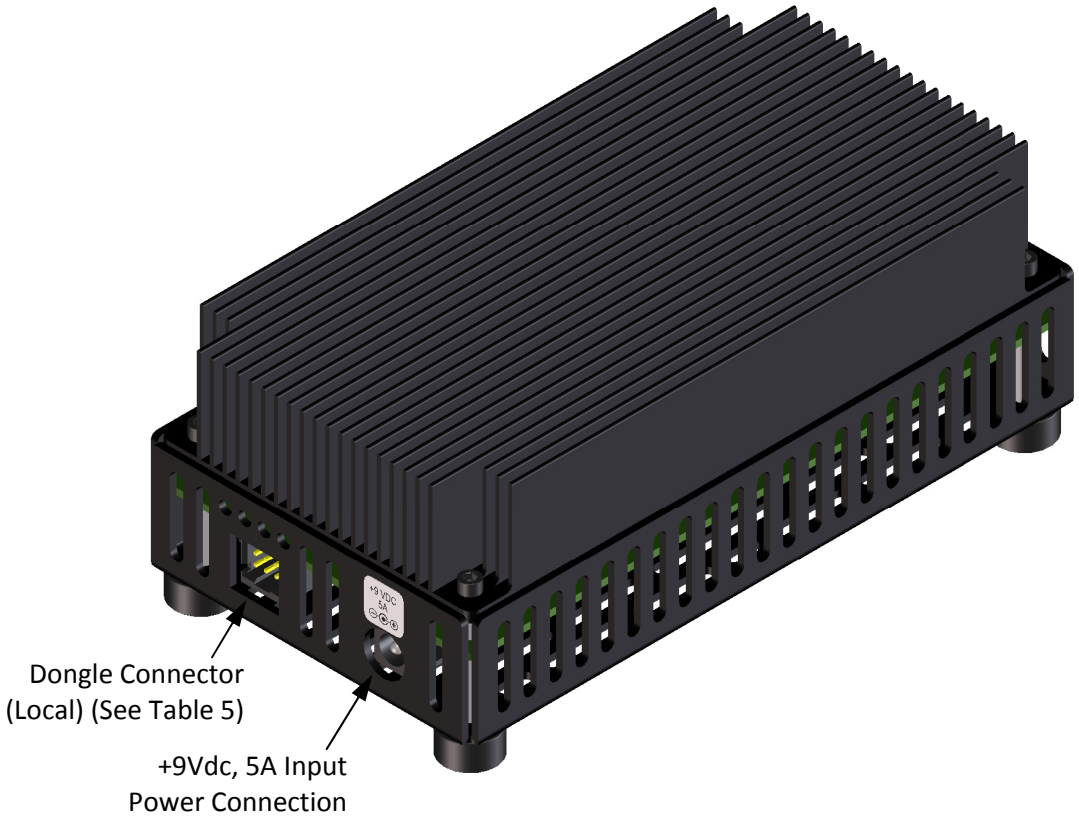



Figure 3. Dongle and Input Power Connectors (Thunderbolt Cable Power Controller shown)

**Thunderbolt Cable Power Controller Pin-out**

The Thunderbolt Cable Power Controller has six low-speed connectors, a USB connector, and a power jack. Of the six low-speed connectors, four are for connection of the Thunderbolt TPAs, two are for back-up low-speed transmit and receive connections to the Thunderbolt TPA (not normally used). Labels clearly mark each position of four low-speed connectors. The USB connector provides power to the LDO for local generation of digital 3.3V for control. The power jack provides analog power for programmable voltage and load generation. Figures 2 and 3, above, refer to pin-description tables for each of the connector types.

**Table 2. TBT-TPA-CPC 10-position Cable Connector, J2, Remote, and J3, Local (Low-Speed)**

| LABEL | PIN NO. | DESCRIPTION |
|---|---|---|
| HPD | Pin 1 | Hot Plug Detect |
| 1-F (PIF) | Pin 2 | Main connector pin 1 force, was Power-In Force |
| 20F (POF) | Pin 3 | Main connector pin 20 force, was Power-Out Force |
| LST | Pin 4 | Low-speed Transmit |
| CF1 | Pin 5 | Configure 1 |
| LSR | Pin 6 | Low-speed Receive |
| CF2 | Pin 7 | Configure 2 |
| GND | Pin 8 | Ground |
| NC | Pin 9 | No-Connect |
| NC | Pin 10 | No-Connect |

**Table 3. TBT-TPA-CPC 3-position Cable Connectors, J1, Remote, and J4, Local (Sense)**

| LABEL | PIN NO. | DESCRIPTION |
|---|---|---|
| 20S (POS) | Pin 1 | Main connector pin 20 sense, was Power-Out Sense |
| GDS | Pin 2 | Ground Sense |
| 1-S (PIS) | Pin 3 | Main connector pin 1 sense, was Power-In Sense |

**Table 4. TBT-TPA-CPC Pin Assignments for USB Connector J18**

| SIGNAL IDENTIFICATION | PIN NO. | DESCRIPTION |
|---|---|---|
| Vbus | Pin 1 | +5V power supply |
| D- | Pin 2 | Data (n), not connected |
| D+ | Pin 3 | Data (p), not connected |
| RTN | Pin 4 | Return, (connected to Ground) |
| None | Connector Shell | NC |

**Table 5. TBT-TPA-CPC Pin Assignments for Dongle Connectors (J9 Remote, J11 Local)**

| SIGNAL IDENTIFICATION | PIN NO. | DESCRIPTION |
|---|---|---|
| LSTX External | Pin 1 | Output from the cable under test (internally jumpered to pin 4). |
| GND | Pin 2 | Ground |
| LSRX External | Pin 3 | Input from the cable under test (internally jumpered to pin 6). |
| LSTX Internal | Pin 4 | Output from the cable under test (internally jumpered to pin 1). |
| GND | Pin 5 | Ground |
| LSRX Internal | Pin 6 | Input from the cable under test (internally jumpered to pin 3). |

# Electrical Specifications

**NOTE: All specifications in this manual are subject to change.**

**Table 6. Thunderbolt Cable Power Controller Electrical Specifications**

| SPECIFICATION | MINIMUM | TYPICAL | MAXIMUM | NOTES |
|---|---|---|---|---|
| Low Voltage, programmable range, (V) | 3.0 | | 3.6 | As applied to 20F Local and/or Remote |
| Low Voltage, LSB, (mV) | | 1.6 | | As applied to 20F Local and/or Remote |
| High Voltage, programmable range, (V) | 10 | | 16.3 | As applied to 20F Local and/or Remote |
| High Voltage, LSB, (mV) | | 0.8 | | As applied to 20F Local and/or Remote |
| Load Current Range (A) | 0 | | 1.5 | As applied to 1-F Local and/or Remote |
| Load Current, LSB, (mA) | | 0.4 | | |
| Voltage measurement gain error (%) | | +/-1.1 | +/-1.5 | |
| Voltage measurement offset error (mV) | | +/-1 | +/-2.5 | |
| Load Current measure-ment gain error (%) | | +/-1.1 | +/-1.5 | |
| Load Current measure-ment offset error (mA) | | +/-1 | | |
| Maximum power dissipation (W) | | | 20 | As calculated = (20F Local Voltage)*(1-F Remote Load current) + (20F Remote Voltage)*(1-F Local Load current) |
| HPD current (mA), Vhpd = 3.3V | | | 3.1 | |

# Thunderbolt Cable Power Controller User Model

The figure, below, shows an example of a Thunderbolt Cable Power Controller and two Thunderbolt Receptacle Test Adapters used to test a typical Thunderbolt interface cable.

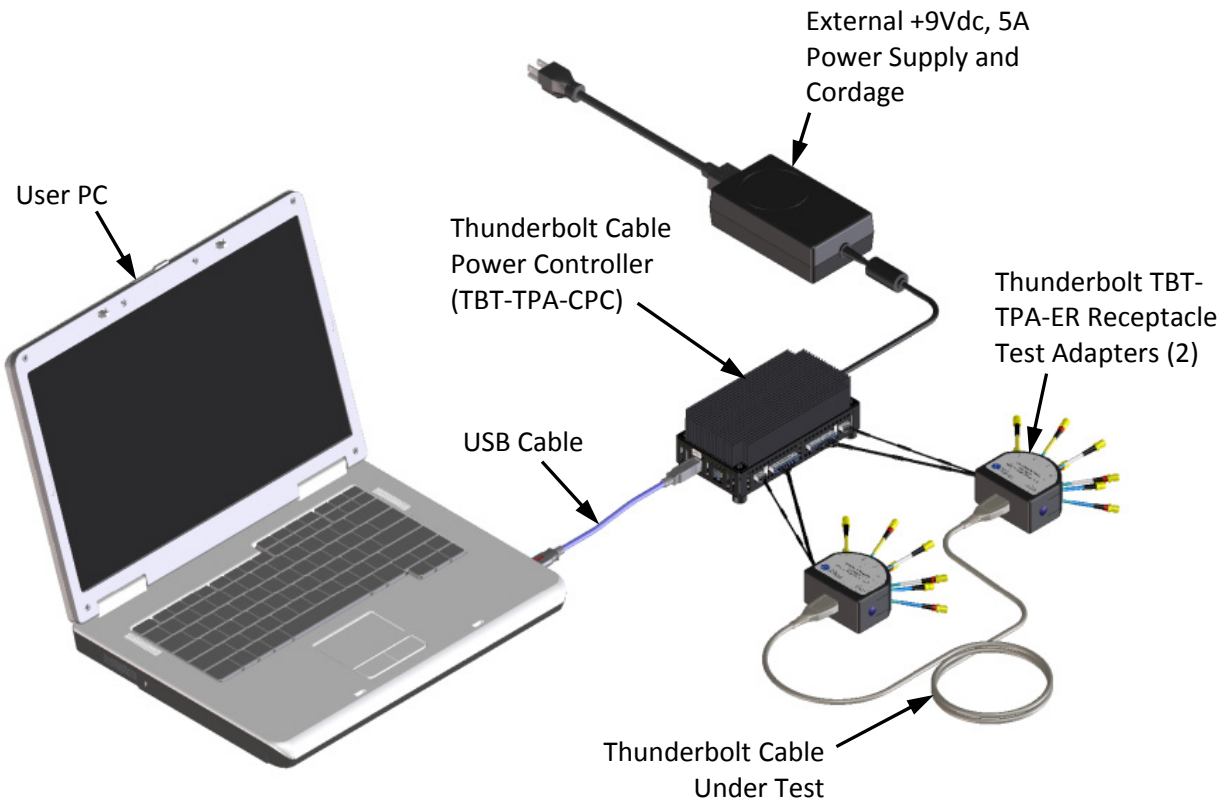



Figure 4. Two TBT-TPA-ERs (Receptacle Test Adapters) mated to a TBT-TPA-CPC (Thunderbolt Cable Power Controller)

# Thunderbolt Cable Power Controller Software

## Introduction

The included Software (SW) operates the Wilder Technologies Thunderbolt Cable Power Controller (CPC) via a USB connection from a PC. The User Interface (UI) provides Screens that allow direct interaction with the CPC and semi-automated testing via Test Plans created with Microsoft Excel. The SW will run on most PCs with Vista, Windows 7 or Windows 8. A powered USB port is required.

## File List

These files are included in the SW distribution.

| | |
|---|---|
| FTD2XX.dll | The FTD files support the USB operations |
| FTD2XX_NET.dll | |
| FTD2XX_NET.xml | |
| Wilder_CPC.exe | The Wilder CPC UI executable |
| Wilder_DSN.exe | Displays the Disk Serial Number. Required to get a License |
| Wilder_TBT_Test_Plan_Starter_V106.xlsx | Starter Excel file for creating Test Plans |
| *.docx | Documentation Files |

## Installation

The SW will run on Windows Vista, 7 and 8.

Unzip the distribution file into the folder from which the SW is to be run. All of the files must be kept together except for the documents which may be moved.

Run the Wilder_CPC.exe program. The start screen should report that its version is 1.06 (or greater) and the API version is 1.01 (or greater). The SW will not further operate without a license.

## Licensing

A license file WilderCore.Key must be installed in the same folder as WilderCore.dll. The file is created from the Disk Serial number. Run the program Wilder_DSN.exe to get the serial number and follow the instructions to get the license file.

## Release Notes

The CPC Firmware (FW) Version must be 1.00 (or greater). The FW version is reported on the start screen after a successful connect (which requires a license).

## UI SW Start Screen

The Start Screen comes up when Wilder_CPC.exe is run. Version information, one enabled button and several disabled buttons will appear. The disabled buttons are enabled by a successful connection to the CPC Hardware.

(NOTE: The Start Screen, shown below, is for reference only and may be slightly different than the Start Screen that appears in the most current version of the CPC software.)


## UI SW Connection to CPC Hardware

Before the UI can be operated, the SW must connect to the CPC HW. This is initiated by pushing the "Connect to TBT CPC HW" button on the start screen. For a successful connection to be made, the SW must be licensed and the CPC HW must have the +9Vdc supply connected, and the CPC USB must be connected to a powered USB connector on the PC.

After a successful connection the version of the Firmware (FW) in the CPC Hardware will be displayed.

Error messages assist with debugging connection problems.

## UI SW CPC Control Screens

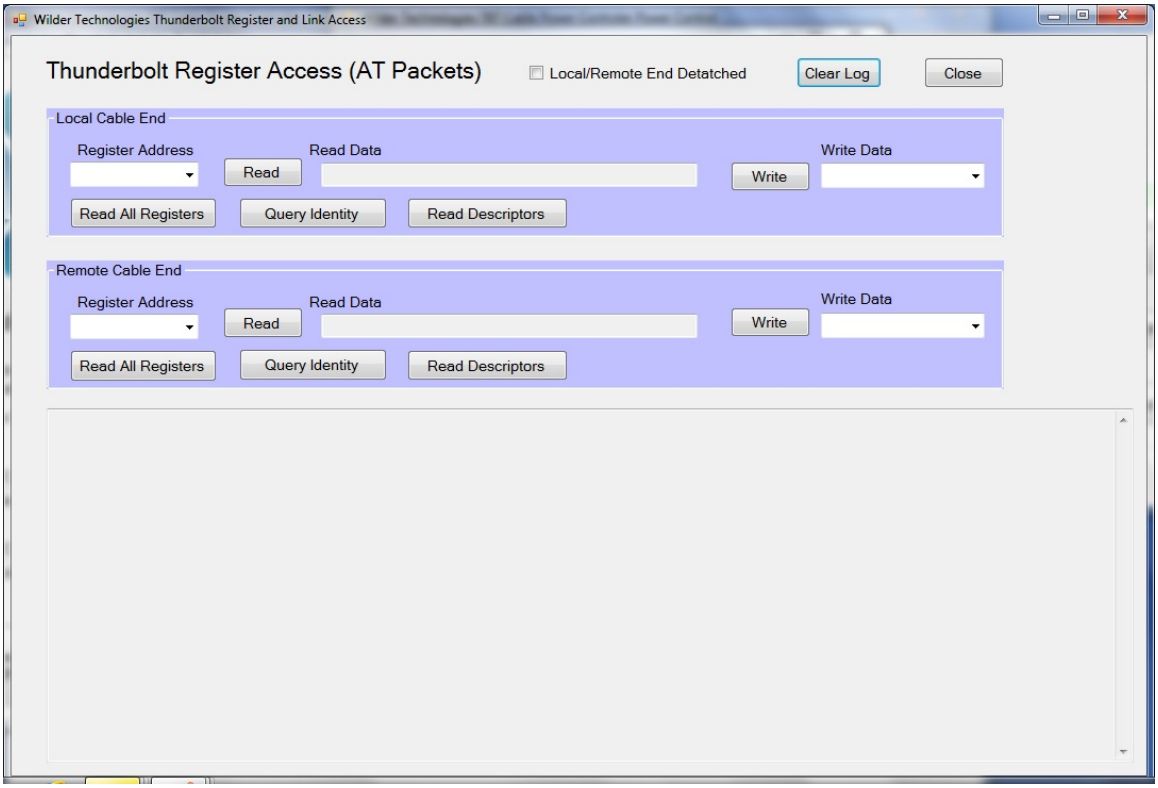
The CPC can be operated directly via three screens:

| | |
|---|---|
| TBT Register Access | TBT AT packets can be Read and written from and to the Cable Microcontroller (CM) in each Cable End. |
| TBT Power Control | Cable Ends can be turned on and off with TBT LT and TBT AT packets. |
| TBT Cable Power Controller Measurements | CPC voltages and current drive can be set.<br>CPC Measurement can be made. |

## TBT Register Access Screen

### Operation Log

This screen allows Cable End AT registers to be read and written. It has a log at the bottom where the results of the supported operations are displayed as they are run. Register addresses are shown in decimal.




### Register address

Enter an AT register address as a decimal or hexadecimal (with 0x prefix) number. It must be between 0 and 255 (0xFF). This address is used for a “Read” or “Write” operation.

## Read

Push the Read button to read the contents of the AT register. The LSRX is first held low for nine microseconds followed by a 70-millisecond wait to turn on the CM. The results are displayed in the "Read Data" box and on the log below. If the register has a documented name in the TBT specification it will be shown in the log, otherwise the name is "unknown". The SW will attempt to read any address between 0 and 255.

## Write

Push the Write button to write the contents of the "Write Data" Box to the AT register. The LSRX is first held low for nine microseconds followed by a 70-millisecond wait to turn on the CM. The data is 32 bits and may be entered as a decimal or hexadecimal (with 0x prefix) number or as four characters enclosed in quotes (for example: "abcd"). The results of the write operation (including the AT return packet if received) are displayed on the log. Note that not all registers are write-able.

## Read All Registers

Push Read All Registers to read all registers defined in the TBT specification and display their contents on the log.

## Query Identity

Push Query Identity to read the registers that contain Cable identifying information and display their contents on the log.

## Read Descriptors

Push Read Descriptors to read all the Descriptor registers that can be found starting with the Descriptor Head (11) register and display the contents on the log.

## Local/Remote End Detached

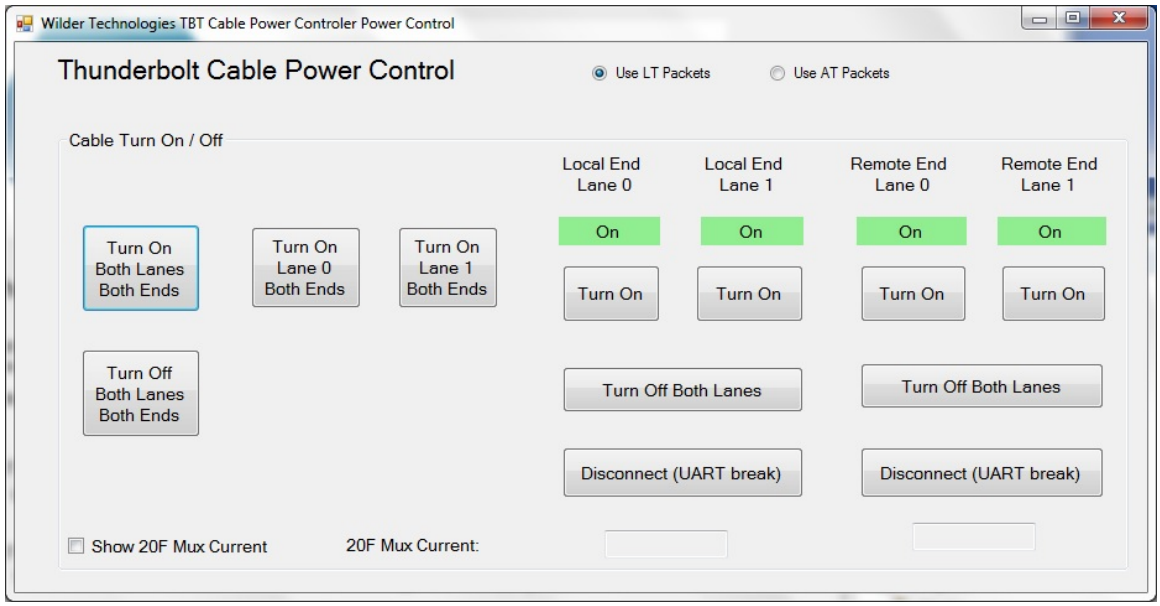
If one TBT cable End is Detached (disconnected) the other (connected) End can still receive AT packets but the CPC can not read the return packets because the LSTX has lost its pull-up. (LSTX is connected to the CPC UART Rx).

Check the ☐ Local/Remote End Detached checkbox to instruct the CPC to add a middle strength pull-up. The pull-up is turned off when the Register Screen is dismissed or the CPC hardware is restarted.

## TBT Power Control Screen

This screen allows Cable Ends and Lanes to be turned off and on using LT packets and AT command packets. The LSRX is first held low for nine microseconds followed by a 70-millisecond wait to turn on the CM. The colored rectangles indicate the state of each Cable End and Lane. There is no query of the power state so when the screen first comes up it shows Unknown.

| Unknown | On | Off | Disconnected |
|---|---|---|---|




Use LT Packets  Use AT Packets

Select the Packet type by clicking the radio button. TBT AT packets are "POxx" command packets (written to register 8) defined by the TBT specification. When LT packets are used to turn on both ends the LSOE high is sent to each end then RESUME is sent to each end.

Turn On  Turn Off

Push Turn On or Turn Off buttons to turn on or off Cable End and Lane combinations.

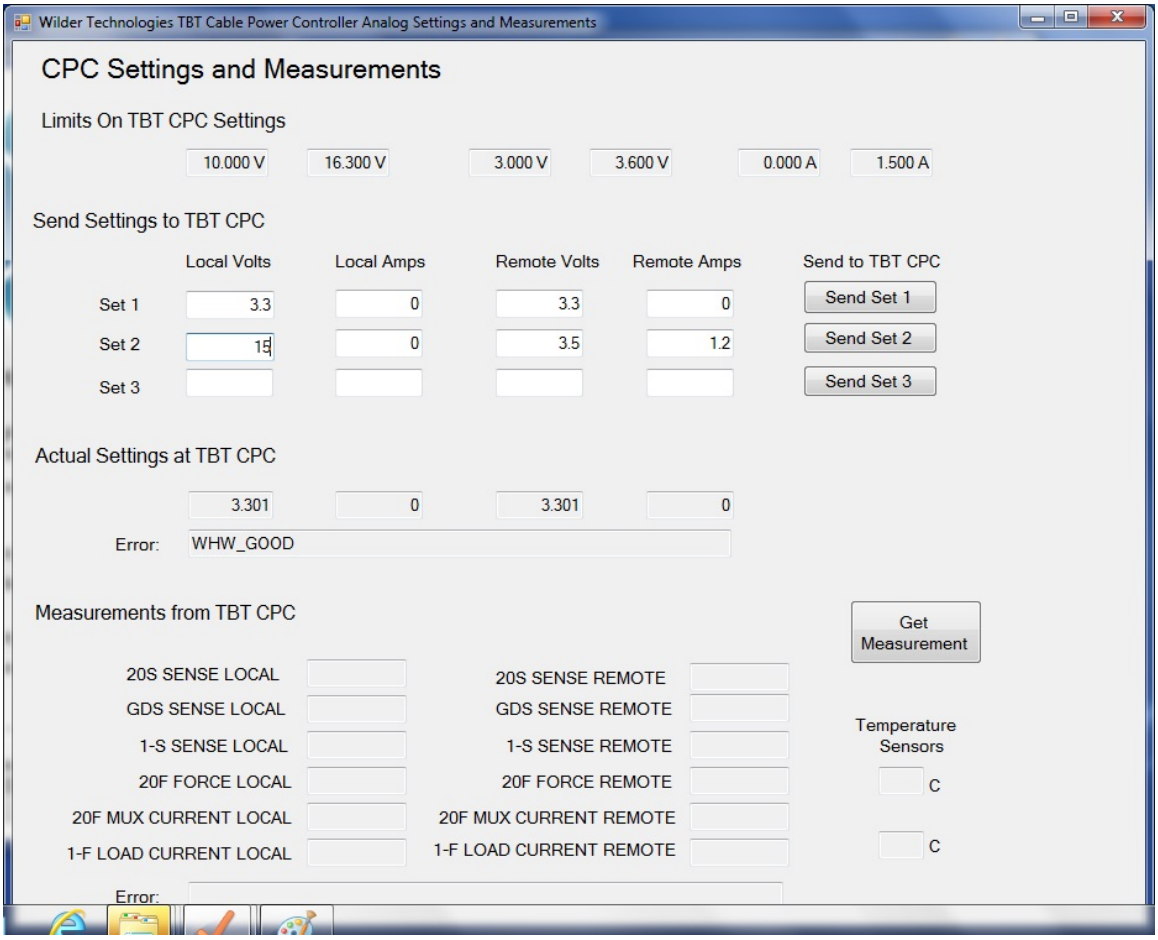
Disconnect

Push Disconnect to turn on the CM and turn off both Lanes. The LSRX is held low for 80-milliseconds.

20F Mux Current

Check the ☐ Show 20F Mux Current check box to enable the display of the Mux current after the TBT cable power state is changed. This current is typically different for On and Off. (This measurement is also shown on the measure screen.)

## TBT Cable Power Controller Settings and Measurements Screen




### Limits on TBT CPC Settings

The CPC hardware supports two ranges of voltage settings and one range of current settings. Displayed are these limits reported by the CPC. Errors will be reported for settings outside of these limits.

### Send Settings to TBT CPC

These settings are the voltage and current drive values for each TBT Cable End. All four must be set together. Three independent sets are provided. Enter settings values in the boxes and push the associated Send Set N button to send the settings to the CPC hardware.

### Actual Settings at TBT CPC

After a set of voltage and current values are sent to the CPC, the Actual Settings will be updated. They may be slightly different than the send setting because the Digital to Analog converters in the CPC hardware are 12 bits.

If the settings were not accepted by the CPC, an Error will appear instead of Actual Settings.

Measurements from TBT CPC

Push the Get Measurements button to get measurements from the CPC.

## Settings

The TBT CPC supports this setting:

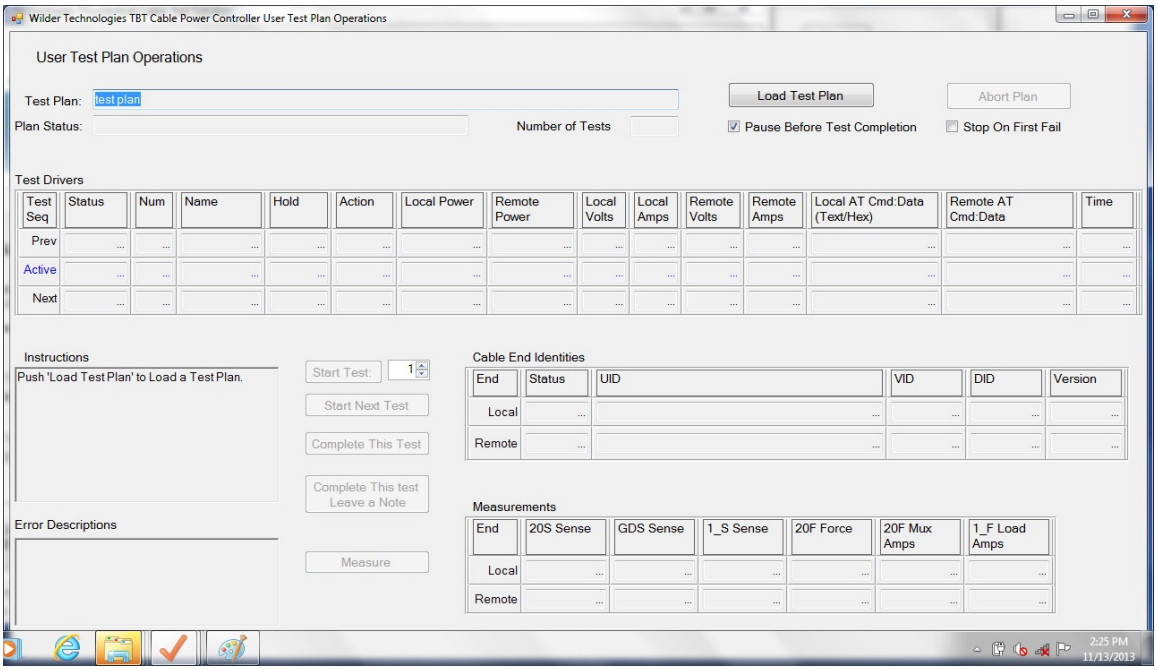
| | |
|---|---|
| ☐ Enter Discovery Mode; Enable Keep Awake | Checking this Box will turn Off the Cable Lanes and enable a low transition on the LSTX every 450-milliseconds. This will cause the TBT Cable to enter Discovery Mode and stay awake (Keep-Awake).<br><br>TBT LT and AT packets may still be sent from the UI. They may cause the TBT Cable to exit Discovery Mode. Since the Cable is always awake in this mode, LT and AT packets are not preceded by a Wake UP.<br><br>The Keep-Awake will continue until the Box is Unchecked.<br><br>This setting is persistent across CPC Power Cycles and SW restarts. |

## UI Test Plan Operation Screen

The screen has controls to operate a Test Plan (sequence of tests) from an input spreadsheet (Excel) that must be created first.

As the tests are run, an output spreadsheet is created with the test settings of the input and measurements. The output spreadsheet has the file name of the input spread sheet, with the date and time appended. The Test Plan is Complete after the last test has been run.

To bring up the UI Test Sequence Screen push the User Test Plan Operation button on the start screen.




Controls near the Top of the Screen

| | |
|---|---|
| Load Test Plan | Push to bring up a File Open dialog for Test Plan (spread sheet) selection. This must be an Excel Spreadsheet prepared with Excel 2010 or later. Test Plans should be created starting with a copy of the Input Starter Spreadsheet. (See below.) |
| Abort Plan | Push to Complete a Test Plan before all of the Tests have been run. The tests that were run are saved to the output spreadsheet. |
| ☐ Pause Before Test Completion | Check to instruct the SW to Pause before each test is completed. The Pause occurs after the Cable Power Voltage and Current settings are made in the CPC hardware and after the AT Command is sent to the TBT. The [Measure] button is active. External tests may also be run. (Specific tests may be Paused independent of this checkbox selection by selecting 'Pause' for the Hold; see "Input Spread Sheet" section). |
| ☐ Stop On First Fail | Check to instruct the SW to Stop when an error occurs. |

Controls near the Lower Left of the Screen

| | |
|---|---|
| Start Next Test | Push to start the Next Test in the spreadsheet sequence. |
| Complete This Test | Push to complete the Test and Save to the output spreadsheet. |
| Complete This Test Leave A Note | Push to Save the Test to the output spreadsheet and receive a prompt to add a Note on the output spreadsheet. |
| Measure | Push to make measurements at the Analog measurement points on the CPC HW. This is only available if the test is Paused. Measurements can be made many times but only the last one before Complete Test is saved in the output spreadsheet. |

## Input Spread Sheet

The Test Plan (test sequence) is driven by test definitions created in a spreadsheet. A test is defined, one per line, via settings in cells. Since only certain values are recognized in each cell it is best to start Test Plan development by copying the Test Plan Starter spreadsheet which is provided with the SW distribution. This has labels for each input (setting) column and dropdown lists for settings that are enumerations.

Three of the settings described below are applied to the cable. They are applied in this order: Volts/Amps, Power, and AT Cmd:Data.

Input spread sheet columns:

| | |
|---|---|
| Status | Leave blank; will be included in the output spread sheet |
| Number | Test Number; numeric<br>These do not need to be in sequence order. The tests are executed in the order they appear in the spreadsheet |
| Name | Test Name; text string |
| Hold | Supported Holds are selected via a Drop Down List on the spreadsheet. Click the cell to see the selection Down Arrow.<br><br>None there is no Hold.<br><br>Pause the test will be Paused after the Cable Power, Voltage, and Current settings are made in the CPC hardware and after the AT Command is sent to the TBT. Pause is provided to allow external measurements to be made. Push Complete This Test to exit Pause.<br><br>Delay 0.5 Delay for 0.5 seconds after all settings are made.<br>Delay 1.0 Delay for 1.0 seconds after all settings are made.<br>Delay 1.5 Delay for 1.5 seconds after all settings are made.<br>Delay 2.0 Delay for 2.0 seconds after all settings are made.<br>Delay 2.5 Delay for 2.5 seconds after all settings are made.<br>Delay 3.0 Delay for 3.0 seconds after all settings are made. |

| | |
|---|---|
| Action | Supported Actions are selected via a Drop Down List on the spreadsheet. Click the cell to see the selection Down Arrow.<br><br>None there is no action.<br><br>Measure a measurement is made after the Cable Power, Voltage, and Current settings are made in the CPC hardware and after the AT Command is sent to the TBT. If Hold is Pause the measurement is made after Complete This Test is pushed.<br><br>Discovery On Turn on Discovery Mode. The Cable Lanes are turned Off and LSTX is put low every 450 milliseconds to keep the cable awake. Any Cable Power, Voltage, Current or Register settings on the same row are ignored. This setting is persistent and will remain after the Test Sequence completes.<br><br>Discovery On Turn off Discovery Mode. Recommended to have at the end of the Test Sequence. |
| Local Power | Supported Powers are selected via a Drop Down List on the spreadsheet. Click the cell to see the selection Down Arrow.<br><br>Sets the Local End Cable Power status via LT or AT packets<br>LT_BOTH_OFF Both Lanes turned Off<br>LT_BOTH_ON Both Lanes turned On<br>LT_L0_ON Lane 0 turned On (Lane 1 unchanged)<br>LT_L0_ON_L1_OFF Lane 0 turned On and Lane 1 turned Off<br>LT_L1_ON Lane 1 turned On (Lane 0 unchanged)<br>LT_L1_ON_L0_OFF Lane 1 turned On and Lane 0 turned Off<br>AT_BOTH_OFF Both Lanes turned Off<br>AT_BOTH_ON Both Lanes turned On<br>AT_L0_ON Lane 0 turned On (Lane 1 unchanged)<br>AT_L0_OFF Lane 0 turned Off (Lane 1 unchanged)<br>AT_L0_ON_L1_OFF Lane 0 turned On and Lane 1 turned Off<br>AT_L1_ON Lane 1 turned On (Lane 0 unchanged)<br>AT_L1_OFF Lane 1 turned Off (Lane 0 unchanged)<br>AT_L1_ON_L0_OFF Lane 1 turned On and Lane 0 turned Off |
| Remote Power | Sets the Remote End Cable Power status via TBT LT or AT packets. (Same selections as Local Power.) |
| Local Volts | Sets Local End voltage drive provided by the CPC HW to the TBT Cable. |
| Local Amps | Sets Local End current drive provided by the CPC HW to the TBT Cable. |
| Remote Volts | Sets Remote End voltage drive provided by the CPC HW to the TBT Cable. |
| Remote Amps | Sets Remote End current drive provided by the CPC HW to the TBT Cable. |

| | |
|---|---|
| Local AT Cmd:Data | Writes an AT command to the Local End. The Data is written to AT register 9 and the Cmd is written to register 8.<br><br>Cmd can be written as a hexadecimal number preceded by "0x" or as four characters. The data follows a colon and can be entered as a hexadecimal number preceded by "0x" or as a decimal number.<br><br>Example: "LpBk: 1" Turn off Loopback. |
| Remote AT Cmd:Data | Writes an AT command to the Remote End. The Data is written to AT register 9 and the Cmd is written to register 8.<br><br>(Same Format as Local End.) |

The output spreadsheet will include the settings as well as labels and data for the Time Stamp and measurements.

The CPC HW will reject settings that it cannot support. These will be reported as errors on the User Test Sequence UI.

# Error Messages from the TBT CPC

These Errors can appear from any screen. When Errors occur during UI Test Plan Operations the Error Number is saved to the output spreadsheet. The Host is the PC connected to the TBT CPC.

| | |
|---|---|
| 3 | WHW_CPC_ERROR_Packet_Type_Unknown<br>The CPC does NOT recognize a USB Packet of data that it has received. This could be a corrupted Packet. Try restarting the CPC. |
| 4 | WHW_CPC_ERROR_Packet_CRC_Error<br>The CPC has detected a CRC Error in a Packet of data that it has received; the problem has persisted after several retries. Check the integrity of the Host to CPC USB cable. |
| 5 | WHW_CPC_ERROR_Data_Set_Type_Unknown<br>The CPC has detected an Unknown Data identifier in a Packet of data that it has received. This could be a corrupted Packet. Try restarting the CPC. |
| 6 | WHW_CPC_ERROR_Temperature_Shutdown<br>The CPC internal temperature is greater that 50°C so it has shut down.<br>The CPC must be turned OFF and ON to recover. |
| 34 | WHW_CPC_ERROR_No_HV_Supply<br>The HV supply is Not present or Not connected to the CPC. When the HV supply is connected the CPC will restart and operate. |
| 35 | WHW_CPC_ERROR_Self_Test_Failed<br>The CPC Self Test has Failed. |
| 43 | WHW_CPC_ERROR_Set_Watts_High_GT20<br>The CPC has received Voltage and Current settings that would cause a dissipation of Greater Than 20 Watts.<br>The Settings are Rejected. |
| 44 | WHW_CPC_ERROR_Set_Both_LV_But_NOT_Same<br>The CPC has received Low Voltage settings for each Cable End that are not the same.<br>The Settings are Rejected. |
| 45 | WHW_CPC_ERROR_Set_Both_HV_But_NOT_Same<br>The CPC has received High Voltage settings for each Cable End that are not the same.<br>The Settings are Rejected |
| 52 | WHW_CPC_ERROR_Set_Volts_Low_Local<br>The CPC has received a Voltage setting for the Local Cable End that is Below the supported ranges.<br>The Settings are Rejected. |
| 53 | WHW_CPC_ERROR_Set_Volts_Betw_Local<br>The CPC has received a Voltage setting for the Local Cable End that is Between the supported Low and High ranges.<br>The Settings are Rejected. |

| | |
|---|---|
| 54 | WHW_CPC_ERROR_Set_Volts_High_Local<br>The CPC has received a Voltage setting for the Local Cable End that is Above the supported ranges.<br>The Settings are Rejected. |
| 55 | WHW_CPC_ERROR_Set_Amps_Low_Local<br>The CPC has received a Current setting for the Local Cable End that<br>is Below the supported range.<br>The Settings are Rejected. |
| 56 | WHW_CPC_ERROR_Set_Amps_High_Local<br>The CPC has received a Current setting for the Local Cable End that is Above the supported range.<br>The Settings are Rejected. |
| 57 | WHW_CPC_ERROR_Set_Volts_Low_Remote<br>The CPC has received a Voltage setting for the Remote Cable End that is Below the supported ranges.<br>The Settings are Rejected |
| 58 | WHW_CPC_ERROR_Set_Volts_Betw_Remote<br>The CPC has received a Voltage setting for the Remote Cable End that is Between the supported Low and High ranges.<br>The Settings are Rejected. |
| 59 | WHW_CPC_ERROR_Set_Volts_High_Remote<br>The CPC has received a Voltage setting for the Remote Cable End that is Above the supported ranges.<br>The Settings are Rejected. |
| 60 | WHW_CPC_ERROR_Set_Amps_Low_Remote<br>The CPC has received a Current setting for the Remote Cable End that is Below the supported range.<br>The Settings are Rejected. |
| 61 | WHW_CPC_ERROR_Set_Amps_High_Remote<br>The CPC has received a Current setting for the Remote Cable End that is Above the supported range.<br>The Settings are Rejected. |
| 65 | WHW_CPC_ERROR_LS_AT_Timeout<br>The CPC Sent an AT packet to a Cable End but did not receive a return packet within 300ms. |

## Error Messages from the UI SW

These Errors can appear from any screen. When Errors occur during UI Test Plan Operations the Error Number is saved to the output spreadsheet.

| | |
|---|---|
| 301 | WHW_ERROR_Packet_Not_Received<br>The UI sent a USB Packet of Data to the CPC but did Not receive a Response. This problem has persisted after several retries. Check the integrity of the Host to CPC USB cable. Ensure that the CPC HW is powered On |
| 303 | WHW_ERROR_Cannot_Connect_To_HW<br>Host did not receive a response from the CPC while attempting to Connect. This problem has persisted after several retries. Check the integrity of the Host to CPC USB cable. Ensure that the CPC HW is powered On. |
| 304 | WHW_ERROR_Packet_Receive_CRC<br>A USB packet received from the TBT CPC has a CRC Error |
| 306 | WHW_ERROR_Invalid_License<br>Host can NOT connect to the CPC because the SW License is Not Present or Invalid. |
| 307 | WHW_ERROR_SW_Not_Authorized<br>A UI function or API did not operate because the SW is Not Licensed.<br>(See also error 306.) |
| 309 | WHW_ERROR_AT_Return_Error<br>This is an error in the AT return Packet. |
| 311 | WHW_ERROR_AT_Return_Too_Short<br>The CPC Sent an AT packet to a Cable End but did not receive a complete return packet. |

# Thunderbolt Cable Power Controller Reference Information

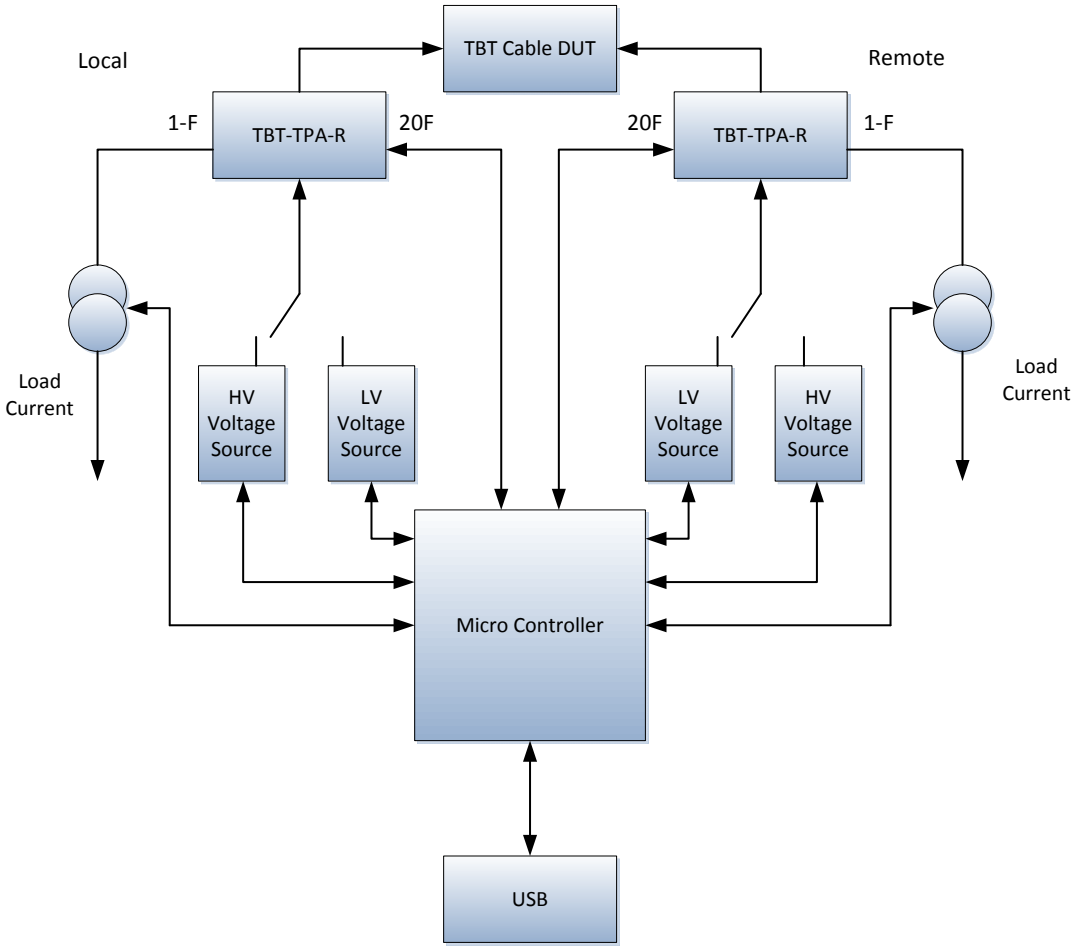



Figure 5. Thunderbolt Cable Power Controller Block Diagram

# Wilder Technologies, LLC – Limited Warranty

Wilder Technologies, LLC warrants that each Test Adapter, 1) is free from defects in materials and workmanship and, 2) conforms to Wilder Technologies specifications for a period of 12 months. **See Consumable and Fragile Material Warranty for exceptions to the 12 month warranty**

The warranty period for a Test Adapter is a specified, fixed period commencing on the date of ship from Wilder Technologies, LLC. If you did not purchase your Test Adapter directly from Wilder Technologies, LLC, the serial number and a valid proof of purchase will be required to establish your purchase date. If you do not have a valid proof of purchase, the warranty period will be measured from the date of ship from Wilder Technologies, LLC.

If, during the warranty period, the Test Adapter is not in good working order, Wilder Technologies, LLC will, at its option, repair or replace it at no additional charge, except as is set forth below. In some cases, the replacement Test Adapter may not be new and may have been previously installed. Regardless of the Test Adapter's production status, Wilder Technologies, LLC appropriate warranty terms apply.

**Consumable and Fragile Material Warranty**
Wilder Technologies, LLC warrants that consumable materials and all fragile materials supplied by Wilder Technologies, LLC either as part of an instrument or system, or supplied separately, will be free from defects in material and workmanship at the time of shipment.

**Extent of Warranty**
The warranty does not cover the repair or exchange of a Test Adapter resulting from misuse, accident, modification, unsuitable physical or operating environment, improper maintenance by you, or failure caused by a product for which Wilder Technologies, LLC is not responsible. The warranty is voided by removal or alteration of Test Adapter or parts identification labels. The initial three months are unconditional; the remaining months excludes plugs, receptacles and SMA connectors. Connectors are wear items and excluded from the warranty after the initial three months.

**These warranties are your exclusive warranties and replace all other warranties or conditions, express or implied, including but not limited to, the implied warranties or conditions or merchantability and fitness for a particular purpose. These warranties give you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction. Some jurisdictions do not allow the exclusion or limitation of express or implied warranties, so the above exclusion or limitation may not apply to you. In that event, such warranties are limited in duration to the warranty period. No warranties apply after that period**.

**Items Not Covered by Warranty**
Wilder Technologies, LLC does not warrant uninterrupted or error-free operation of a Test Adapter.

Any technical or other support provided for a Test Adapter under warranty, such as assistance via telephone with "how-to" questions and those regarding Test Adapter set-up and installation, will be provided **WITHOUT WARRANTIES OF ANY KIND**.

**Warranty Service**
Warranty service may be obtained from Wilder Technologies, LLC by returning a Wilder Technologies, LLC Returns Material Authorization and the Test Adapter to Wilder Technologies, LLC during the warranty period. To obtain RMA number, contact support@wilder-tech.com.

You may be required to present proof of purchase or other similar proof of warranty entitlement. You are responsible for any associated transportation charges, duties and insurance between you and Wilder Technologies, LLC. In all instances, you must ship Test Adapters in Wilder Technologies, LLC approved packaging. Information on packaging guidelines can be found at: www.wilder-tech.com. Wilder Technologies, LLC will ship repaired or replacement Test Adapter Delivery Duty Prepaid (DDP) and will pay for return shipment. You will receive title to the repaired or replacement Test Adapter and you will be the importer of record.

# Wilder Technologies, LLC – Terms & Conditions of Sale

1. **Other Documents:** This Agreement may NOT be altered, supplemented, or amended by the use of any other document(s) unless otherwise agreed to in a written agreement signed by both you and Wilder Technologies, LLC. If you do not receive an invoice or acknowledgement in the mail, via e-mail, or with your Product, information about your purchase may be obtained at support@wilder-tech.com or by contacting your sales representative.

2. **Payment Terms, Orders, Quotes, Interest:** Terms of payment are within Wilder Technologies, LLC's sole discretion, and unless otherwise agreed to by Wilder Technologies, LLC, payment must be received by Wilder Technologies, LLC prior to Wilder Technologies, LLC's acceptance of an order. Payment for the products will be made by credit card, wire transfer, or some other prearranged payment method unless credit terms have been agreed to by Wilder Technologies, LLC. Invoices are due and payable within the time period noted on your invoice, measured from the date of the invoice. Wilder Technologies, LLC may invoice parts of an order separately. Your order is subject to cancellation by Wilder Technologies, LLC, in Wilder Technologies, LLC's sole discretion. Unless you and Wilder Technologies, LLC have agreed to a different discount, Wilder Technologies, LLC's standard pricing policy for Wilder Technologies, LLC-branded systems, which includes hardware, software and services in one discounted price, allocates the discount off list price applicable to the service portion of the system to be equal to the overall calculated percentage discount off list price on the entire system. Wilder Technologies, LLC is not responsible for pricing, typographical, or other errors in any offer by Wilder Technologies, LLC and reserves the right to cancel any orders resulting from such errors.

3. **Shipping Charges; Taxes; Title; Risk of Loss:** Shipping, handling, duties and tariffs are additional unless otherwise expressly indicated at the time of sale. Title to products passes from Wilder Technologies, LLC to Customer on shipment from Wilder Technologies, LLC's facility. Loss or damage that occurs during shipping by a carrier selected by Wilder Technologies, LLC is Wilder Technologies, LLC's responsibility. Loss or damage that occurs during shipping by a carrier selected by you is your responsibility. You must notify Wilder Technologies, LLC within 7 days of the date of your invoice or acknowledgement if you believe any part of your purchase is missing, wrong or damaged. Unless you provide Wilder Technologies, LLC with a valid and correct tax exemption certificate applicable to your purchase of Product and the Product ship-to location, you are responsible for sales and other taxes associated with the order. **Shipping dates are estimates only**.

4. **WARRANTY:** WILDER TECHNOLOGIES, LLC, warrants that the item(s) manufactured under the Buyer's contract shall be free from defects in materials and workmanship furnished by WILDER TECHNOLOGIES, LLC, and shall conform to the applicable drawings and specifications. WILDER TECHNOLOGIES, LLC'S liability herein, for breach of warranty, contract or negligence in manufacturing, shall be limited to repair or replacement. Repair or replacement of defective items will be applicable only if the Buyer notifies WILDER TECHNOLOGIES, LLC, by written notice within 30-days of delivery. All claims shall be addressed to: support@wilder-tech.com or WILDER TECHNOLOGIES, LLC, 6101A East 18th Street, Vancouver, Washington 98661 U.S.A.; ATTENTION: Customer Service Manager. WILDER TECHNOLOGIES, LLC, reserves the right to inspect at the Buyer's plant all items claimed to be defective or nonconforming prior to authorizing their return. WILDER TECHNOLOGIES, LLC, assumes no liability for the results of the use of its components in conjunction with other electric, electronic or mechanical components, circuits and/or systems. The foregoing constitutes the sole and exclusive remedy of the Buyer and the exclusive liability of WILDER TECHNOLOGIES, LLC, and is IN LIEU OF ANY AND ALL OTHER WARRANTIES, STATUTORY, IMPLIED OR EXPRESSED AS TO MERCHANTABILITY, FITNESS FOR THE PURPOSE SOLD, DESCRIPTION, QUALITY, and PRODUCTIVENESS OR ANY OTHER MATTER. Without limiting the foregoing, in no event shall WILDER TECHNOLOGIES, LLC, be liable for loss of use, profit or other collateral, or for special and/or consequential damages.

5. **RETURNED GOODS:** WILDER TECHNOLOGIES, LLC, will accept only those goods for return that have been authorized for return. All goods authorized for return shall be assigned a Returned Material Authorization (RMA) Number. The RMA Number shall be clearly marked on the shipping container(s) and all documentation accompanying the goods authorized for return. The RMA Number shall be assigned by WILDER TECHNOLOGIES, LLC pursuant to the conditions set forth in Paragraph 4, WARRANTY.

6. **UNITED STATES GOVERNMENT CONTRACTS:** In the event this offer is accepted under Government contract, WILDER TECHNOLOGIES, LLC, agrees to accept clauses required by Government regulations and to waive WILDER TECHNOLOGIES, LLC conditions inconsistent therewith. WILDER TECHNOLOGIES, LLC, certifies that it is a regular manufacturer or dealer of the goods and/or services offered herein and that the prices offered do not exceed those charged to any customer for like quantities, services or materials under the same conditions.

# Compliance with Environmental Legislation

Wilder Technologies, LLC, is dedicated to complying with the requirements of all applicable environmental legislation and regulations, including appropriate recycling and/or disposal of our products.

## WEEE Compliance Statement

The European Union adopted Directive 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE), with requirements that went into effect August 13, 2005. WEEE is intended to reduce the disposal of waste from electrical and electronic equipment by establishing guidelines for prevention, reuse, recycling and recovery.

Wilder Technologies has practices and processes in place to conform to the requirements in this important Directive.

In support of our environmental goals, effective January 1st, 2009 Wilder Technologies, LLC has partnered with EG Metals Inc. – Metal and Electronics Recycling of Hillsboro, Oregon, www.egmetalrecycling.com, to recycle our obsolete and electronic waste in accordance with the European Union Directive 2002/96/EC on waste electrical and electronic equipment ("WEEE Directive").

As a service to our customers, Wilder Technologies is also available for managing the proper recycling and/or disposal of all Wilder Technologies products that have reached the end of their useful life. For further information and return instructions, contact support@wilder-tech.com.

# Glossary of Terms (Thunderbolt)

| TERMINOLOGY | DEFINITION |
|---|---|
| Aggressor | A signal imposed on a system (i.e., cable assembly) to measure response on other signal carriers. |
| Daisy-chain | Thunderbolt link between multiple boxes, going from box to box to box, detachable by an end user. A Thunderbolt cable-connector assembly for the box-to-box connection shall have two ports. DisplayPort Sinks can only be at the end of the Daisy-chain. |
| Dual-protocol | Thunderbolt runs PCIe and DisplayPort protocols |
| TBT-TPA | Thunderbolt Test Point Access. A specialized assembly that interfaces to a Thunderbolt receptacle or plug and enables access to signals for measurement or stimulation. |
| Informative | The designation of a test that is not required for compliance but is considered important from a characterization standpoint. It is provided for informational purposes only. |
| Port | Bidirectional channel for isochronous stream transport from Thunderbolt Source to Thunderbolt Sink. Thunderbolt contains two ports in this application. |
| Normative | The designation of a test that is required for compliance. |
| Victim | A signal carrier on a system that has a response imposed on it by other signals in the system. |

# Glossary of Terms (HDMI)

| TERMINOLOGY | DEFINITION |
|---|---|
| Aggressor | A signal imposed on a system (i.e., cable assembly) to measure response on other signal carriers. |
| ARC | Audio Return Channel, used to send an audio stream from the sink to the source or repeater. |
| Box-to-box connection | HDMI Type-A link between two boxes detachable by an end user. An HDMI Type-A cable-connector assembly for the box-to-box connection shall have three TMDS Link lanes. |
| CEC | Consumer Electronics Control |
| DDC | Display Data Channel (VESA) |
| HDMI Ethernet | HDMI Ethernet provides a full duplex connection between HDMI devices which conforms to 100Base-TX IEEE 802.3 standard [4n]. |
| HDMI Type-A Receiver | Circuitry that receives the incoming HDMI Type-A TMDS Link data. Located in Sink Device and the upstream port of Intermediate Device. |
| HDMI Type-A Transmitter | Circuitry that transmits the HDMI Type-A TMDS Link data located in Source Device and in the downstream port of Intermediate Device. |
| HDMI-TPA | HDMI Type-A Test Point Access. A specialized assembly that interfaces to a HDMI Type-A receptacle or plug and enables access of signals for measurement or stimulation. |
| Dual-standard Device Source or Sink | Device that supports both Thunderbolt and DVI/HDMI operating modes. |
| Informative | The designation of a test that is not required for compliance but is considered important from a characterization standpoint. It is provided for informational purposes only. |
| Normative | The designation of a test that is required for compliance. |
| Sink Device | A device that contains A/V stream sinks for display and/or sound. |
| Source Device | A device that contains a stream source and originates an isochronous A/V stream. |
| TMDS | Transition Minimized Differential Signaling |
| Victim | A signal carrier on a system that has a response imposed on it by other signals in the system. |

# Index

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