

# **Power Distribution Panel**

## **User's Guide**

Revision 1.5



Cross The Road Electronics

[www.crosstheroadelectronics.com](http://www.crosstheroadelectronics.com)

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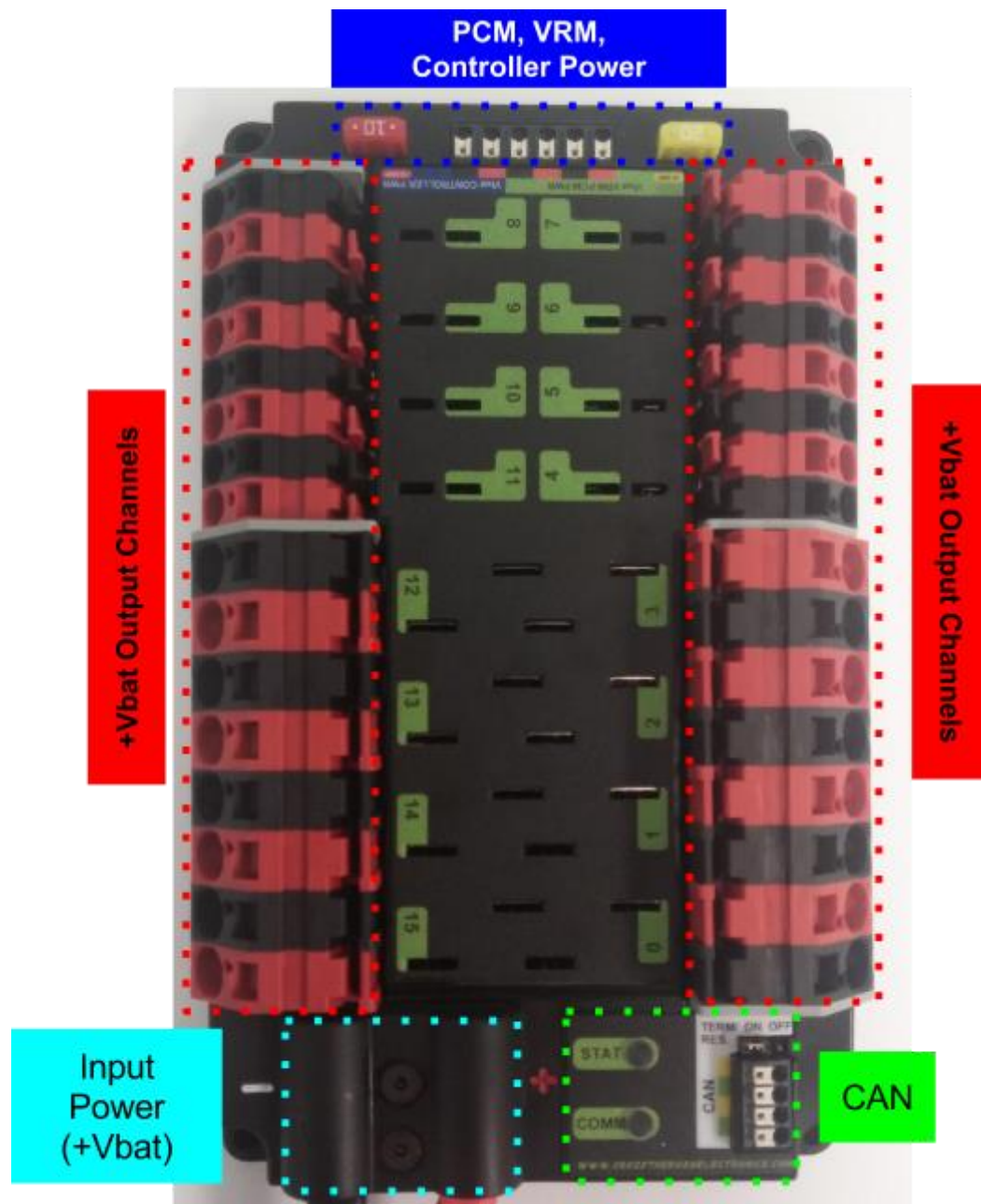
#### TO OUR VALUED CUSTOMERS

It is our intention to provide our valued customers with the best documentation possible to ensure successful use of your CTRE products. To this end, we will continue to improve our publications, examples, and support to better suit your needs.

If you have any questions or comments regarding this document, or any CTRE product, please contact [support@crosstheroadelectronics.com](mailto:support@crosstheroadelectronics.com)

To obtain the most recent version of this document, please visit [www.ctr-electronics.com](http://www.ctr-electronics.com).

## 1. Power Distribution Panel at a Glance



## 1.1. Connection Specifications

- **Battery**
  - Bushings Lugs x 2
  - Thread M6x1 (10mm Length)
- **Power Channels (All Channels provide battery power)**
  - WAGO Connectors
    - 8 Red Channels 4-11
      - 30 Amp
    - 8 Red Channels 0-3, 12-15
      - 40 Amp
    - Black terminals are common
  - 6 Position Weidmuller Connector
    - PCM, VRM Supply
      - 20 Amp fused (ATM blade mini fuse)
    - roboRIO Supply
      - 10 Amp fused (ATM blade mini fuse)
    - **Max:** 16 AWG
    - **Min:** 24 AWG

See [Section 2.3. Weidmuller Connectors](#) for wire insert instructions.

- **CAN**
  - 4 Position Weidmueller Connector
    - Yellow CAN High x 2
    - Green CAN Low x 2

## 1.2. Electrical Specifications

<b>Input Voltage (Vbat)</b>	5.5-16 V
<b>Absolute Max Input Voltage<sup>(1)</sup></b>	0 - 20 V
<b>Output Voltage</b>	
• <b>Channels 0-3, 12-15</b>	Vbat - 40 A
• <b>Channels 4-11</b>	Vbat - 20 or 30 A
• <b>VRM, PCM Weidmuller</b>	Vbat - 20 A <b>fused</b>
• <b>Controller Weidmuller</b>	Vbat - 10 A <b>fused</b>

Note 1: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

## 1.3. Mechanical Specifications

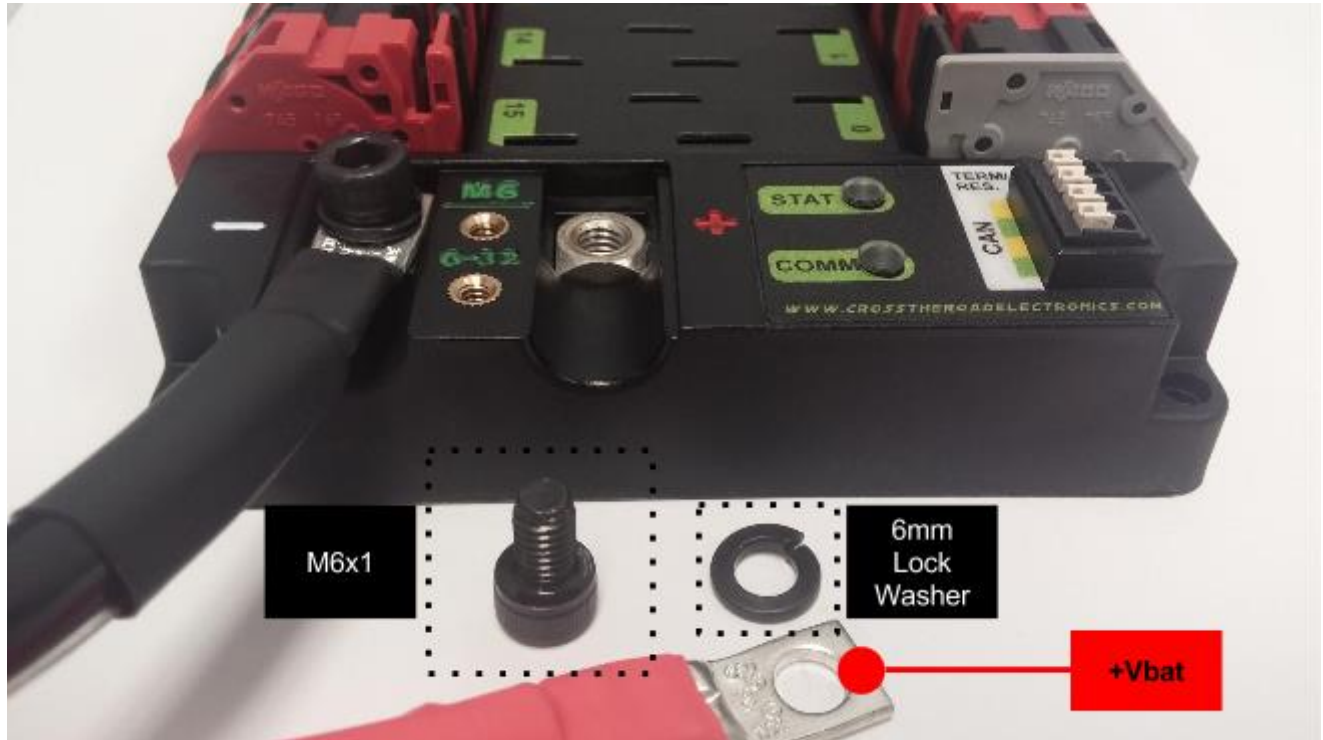
<b>Length</b>	7.586 in.
<b>Width</b>	4.748 in.
<b>Height</b>	1.422 in.
<b>Weight</b>	1 lb. 5.3 oz.

## 1.4. Communication Specifications

<b>Baud Rate</b>	1 MB/s
<b>CAN Termination</b>	120 Ohm (jumper placed in the ON position).  None (jumper missing or placed in the OFF position).
<b>CAN High / Low</b>	2 Ports

## 2. Installing a PDP

### 2.1. Battery harness



- Components
  - QTY 2 - **M6x1** Bolts (10mm Length) Socket Head Cap Screws
  - QTY 2 - **6mm** Split (Lock) Washers
  - Battery Cover
    - QTY 2 - **6-32** (1/2" Length) **Battery Cover** Flat-Head Socket Cap Screw
  - 12 Volt Supply (Battery, Power Supply, etc...)

**Warning:** Do not reverse the battery voltage as this can cause permanent damage to current sense circuitry. Additionally the FRC Control System Components that draw power from PDP may not have reverse battery protection, and can also be damaged in a reverse battery event.

### 2.1.1. Split Washer

**Warning:** Care should be taken to ensure the split washers are installed under the screw head. If this is not done, the robot could exhibit several forms of power/brownout issues as the cable harness loosens over time.





## 2.2. Breakers

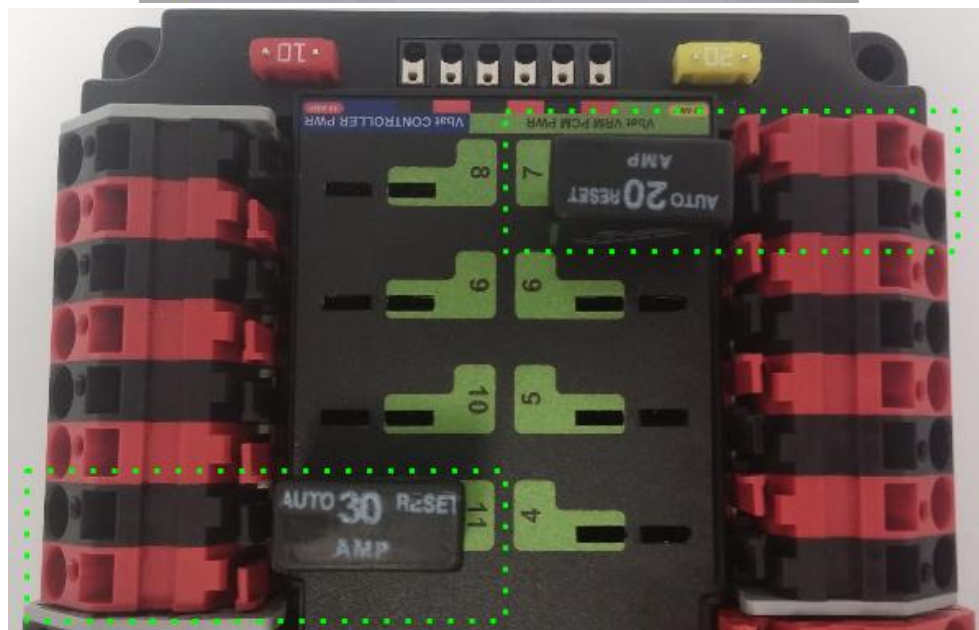
### 2.2.1. Snap Action 40 Amp Breaker



- Channels 0-3, Channels 12-15
  - 40 Amp Breaker
  - Limits Closest Red WAGO
  - Supplies Battery Power

**Warning:** Inductive loads (motor, compressor) must have a power management device (motor controller, PCM, spike) between itself and the PDP. No inductive loads (motor, compressor) may be directly connected to the PDP channels as this can damage current sense circuitry.

### 2.2.2. Snap Action 20/30 Amp Breaker



- Channels 4-11
  - 30 or 20 Amp Breaker
  - Limits Closest Red WAGO
  - Supplies Battery Power

**Warning:** Inductive loads (motor, compressor) must have a power management device (motor controller, PCM, spike) between itself and the PDP. No inductive loads (motor, compressor) may be directly connected to the PDP channels as this can damage current sense circuitry.

## 2.3. Weidmuller Connectors

### Wire Insertion

- Disconnect PDP from Battery before adding or modifying connections
- Strip wire back ~**0.375" (3/8")**
- Press and hold down connector button. Though this isn't necessary, it ensures the stripped wire does not deform and split into "whiskers" after excessive use. A small screwdriver can be used to easily hold down the connector button.
- Insert wire into connector opening
- Release connector button
- Pull wire to ensure wire is locked in connector
- Confirm wire strands are not extruded

### Wire Inspection

- Verify that there are no "whiskers" outside of the connector that may cause a short.
- Verify that the stripped portion of the wire is not excessive enough to cause a short.
- **Tug on the wire and verify wire does not pull out.** If it does then recheck gauge and/or strip the wire back further.

### Wire Removal

- Press and hold down connector button immediately above connector opening
- Pull wire to remove from connector

### Limitations

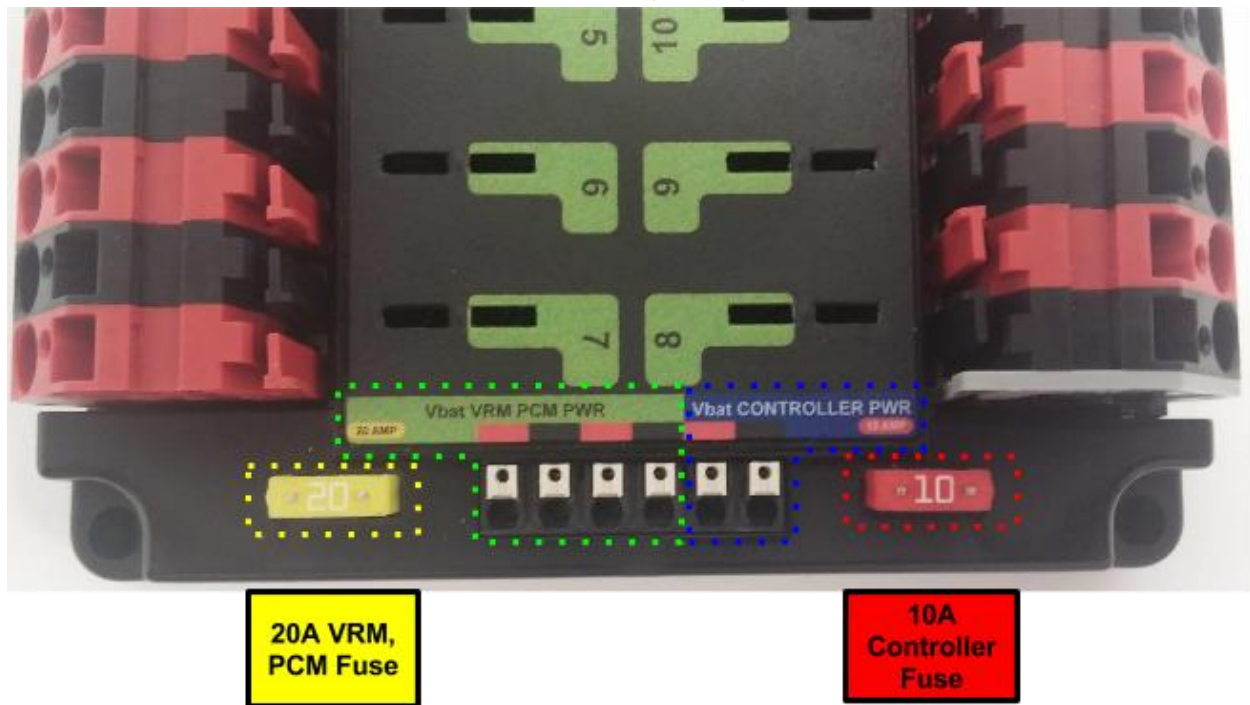
- Wire should **not be frayed** upon insertion. Extruded wire may short to adjacent channels.
- Wire should be **no larger than 16 AWG**, larger gauges will not properly fit in connector
- Wire should be **no smaller than 24 AWG**, smaller gauges will not lock in connector

**Warning:** Tug-testing wires can make the difference between a seamless match and one filled with radio disconnects, roboRIO reboots, bad sensor data, etc... Every inserted wire should be immediately tug-tested to ensure proper operation of the robot.

Additional video and suggestions can be found at:

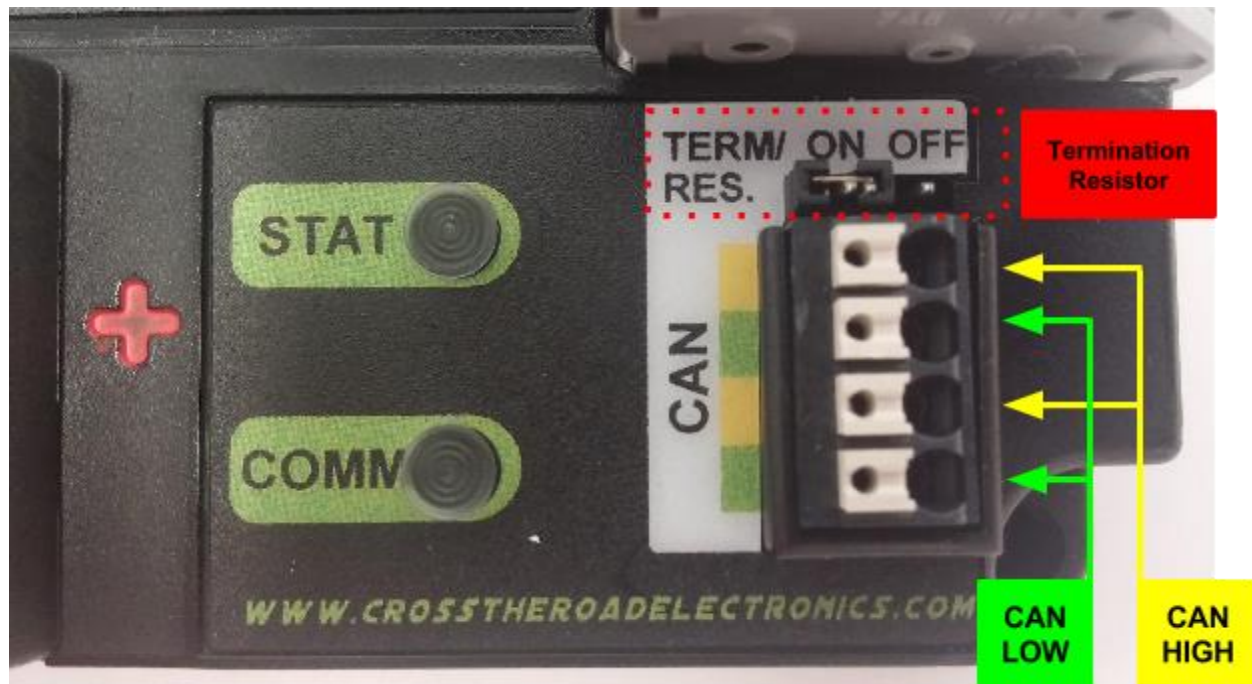
<http://wpilib.screenstepslive.com/s/4485/m/24166/l/144971-wiring-the-2015-frc-control-system>

### 2.3.1. roboRIO, PCM, VRM



Weidmuller Connectors are used for connecting the roboRIO, PCM, and VRM modules to power. See [Section 2.3. Weidmuller Connectors](#) for wire insertion and removal procedures. See [Section 2.4. Blade Fuse Replacements](#) for fuse details.

### 2.3.2. CAN bus



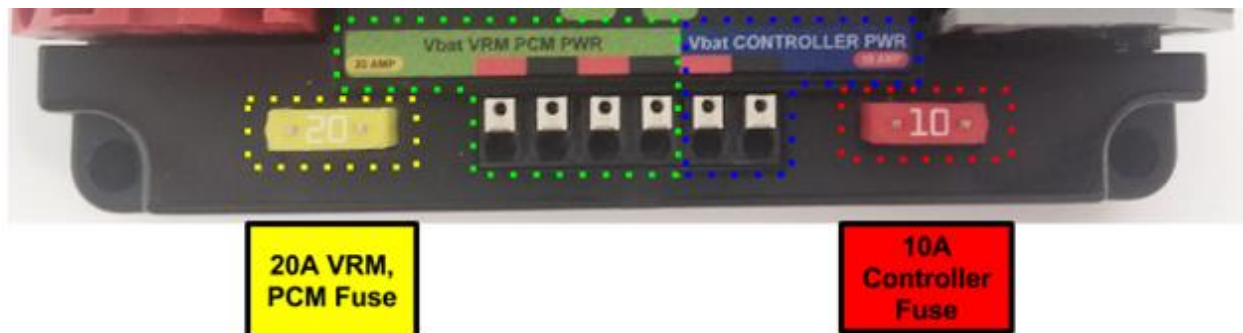
Weidmuller Connectors are also used for CAN Communication. See [Section 2.3. Weidmuller Connectors](#) for wire insertion and removal procedures. Smart Module provides termination and may be placed at the end of CAN bus chain.

#### Termination Resistor Jumper

- Only place the jumper to the ON position when PDP is at the **end** of the CAN bus.
- **ON State** - Positioning the jumper closest to the inside of the PDP (shown above).
- **OFF State** - Positioning the jumper closest to the edge of the PDP or removing the jumper.

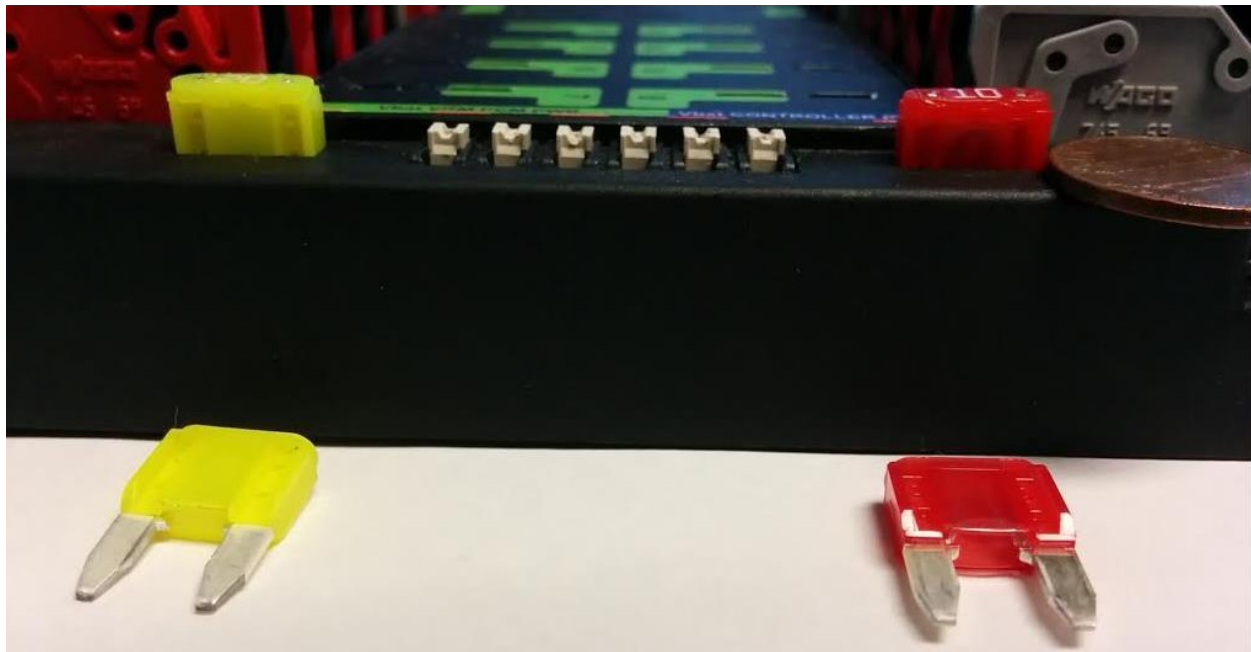


## 2.4. Blade Fuse



Be sure to place the 20A fuse (yellow) on the left and the 10A fuse (red) on the right.

**Warning:** Also take care to ensure **fuses are fully seated** into the fuse holders. The fuses should descend **at least** as far as the figure below (different brand fuses have different lead lengths). It should be **nearly impossible to remove the fuse** with bare hands (without the use of pliers). If this is not properly done, the robot/radio may exhibit **intermittent connectivity issues**.



### 2.4.1. Blade Fuse Replacements

Both automotive fuses are type **ATM** automotive blade mini fuses. Spares can be purchased at most hardware stores (Do **not** purchase ATC as they will not fit).



Example replacement purchase for 10A Controller fuse

### 2.5. WAGO OperatingTool

A small flathead screwdriver may be used to operate the WAGO connectors. More information (and video) can be found online at <http://wpilib.screenstepslive.com>.

However there is an available tool designed specifically for WAGO connectors that teams may choose to purchase.

#### WAGO 210-658 OPERATING TOOL, 3.5 X 0.5 MM, SHORT ANGLED



Write a Review

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*Image is for illustrative purposes only.  
Please refer to product description.*



Manufacturer: [WAGO](#)

Newark Part No.: 79K2417

Manufacturer Part No 210-658



[Technical Data Sheet \(1.41KB\) EN](#)

### 3. LED States

The STAT and COMM LEDs are multi-color LEDs that can blink green, orange, or red.



The two LEDs are always the same color/blink pattern. The only exception to this is when the device is in boot-loader.

LED Blink/Color	Description
Fast Green Blink	Robot is enabled.
Slow Green Blink	Robot is disabled.
Slow Orange Blink	Robot is disabled. Sticky Fault present.
Slow Red Blink	No CAN Comm.
(COMM LED only) Green/Orange Blink	Device is in boot-loader. Field-upgrade necessary.
Both LEDs off	Device is NOT powered.



## 4. Functional Limitations (software)

Functional Limitations describe behavior that deviates from what is documented. Feature additions and improvements are always possible thanks to the field-upgrade features of the PDP.

### **4.1. Firmware <1.40: If Robot Is Enabled/Disabled/Enabled Quickly, FRC robot may momentarily disable.**

When PDP is wired to roboRIO's CAN bus and robot enters disabled state, roboRIO typically begins extracting logged records from PDP. However if robot is immediately enabled after initially entering disable, the roboRIO may very briefly disable as it finishes extracting PDP logs despite being enabled in the Driver Station.

This occasionally causes motor-drive to briefly disable once after enabling robot. Additionally the fault count will increment in the Driver Station (lightening tab).

Issue is fixed in PDP Firmware 1.40. When PDP detects roboRIO is enabled it will abort extraction, therefore preventing the problem condition from occurring.

### **4.2. Firmware <1.40: Power and Energy**

Power and energy signals were not computed correctly in firmware versions earlier than 1.40. Updating to 1.40 will ensure Power and Energy signals are updated correctly.

### **4.3. LabVIEW: Energy signal is not scaled to Joules.**

The Energy signal in LabVIEW is computed in engineering units where each unit is 0.020 Joules. Multiply the signal value by 0.020 to scale to Joules.

### **4.4. C++/Java: Energy signal is in Millijoules.**

The Energy signal in C++/Java is computed in units where each unit is 0.001 Joules. Multiply the signal value by 0.001 to scale to Joules. If using this signal for robot-processing, be sure to check for the fix whenever updating C++/Java libraries.

### **4.5. Firmware <1.37: Current may read ~2A when there is no current.**

The current sense circuitry has biasing (similar to a gyro). Firmware 1.37 and on will zero the output so that 0A is read when there is no load.

#### 4.6. FRC2016 roboRIO: CAN Device does not appear in web page diagnostics.

Under specific conditions, a CAN device may no longer appear in the left tree view in the roboRIO web-based configuration page. For this to occur the following criteria must be met.

- FRC\_roboRIO\_2016\_v19.zip is imaged in the roboRIO.
- The missing device ID must be greater than 20.
- All other device IDs must be either: greater than the missing ID, or less than missing ID minus 50.

If there is a CAN device which has an ID that meets this criteria, and therefore is no longer appearing in the web-page, the user can apply the following procedure. This procedure will force the device to appear, and will allow the user to change the device ID so as to work around this limitation. The user can either...

- Power cycle just the missing-ID-device and manually refresh the browser until device appears...
- ...or alternatively disconnect CAN bus between the robot controller and the missing-ID-device. Then power-cycle or reboot the roboRIO. Navigate to the roboRIO's webpage and wait until page fully renders. Now reconnect CAN bus and manually-refresh the browser until device appears.

After forcing the missing device to appear, modify its device ID so that this limitation doesn't occur again. To work around this limitation, either...

- use device IDs less than 20 or ...
- ...avoid gaps in IDs that exceed 50 and ensure there is (at least) one device ID less than 20.

This limitation will not prevent the robot API from controlling/monitoring CTRE CAN Devices.

Note that if this functional limitation is in effect, the PDP LEDs will still transition from slow-green blink to fast-green blink when robot controller is enabled.

## 5. Troubleshooting Tips and Common Questions

### 5.1. What is the threshold for Vbat fault?

PDP will assert the battery fault when battery voltage drops below 6.5V. This only causes the status LED to slowly blink orange when robot-disabled. No robot functionality is affected. Battery voltage is ignored the first 500ms since power-up to ensure erroneous trips are not detected (battery connect, closing 200A breaker).

### 5.2. Are sticky faults cleared during/after a firmware field-update?

No. Sticky faults will persist during and after a field-update. They do not affect robot functionality and only exist for diagnostic purposes. See FRC WPILib Screensteps (<http://wpilib.screenstepslive.com>) for steps to detect and clear faults ("Updating and Configuring Pneumatics Control Module and Power Distribution Panel").

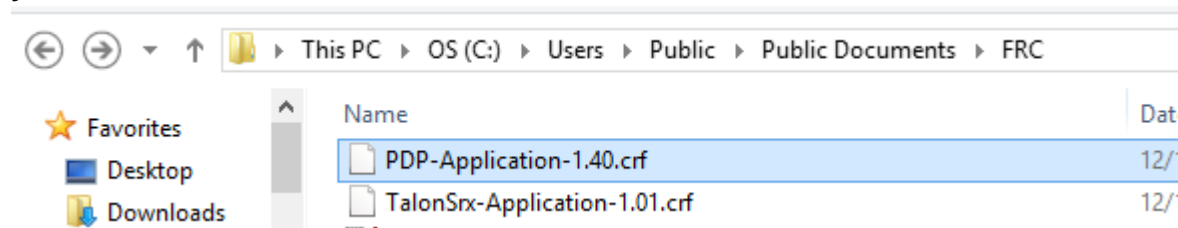
At the time of writing this link can be used:

<http://wpilib.screenstepslive.com/s/4485/m/24166/l/216217-updating-and-configuring-pneumatics-control-module-and-power-distribution-panel>

### 5.3. Do I need to firmware-update? Where are the files?

The ship firmware of the PDP is not FRC legal. The latest CRF can be found at [http://www.crosstheroadelectronics.com/control\\_system.html](http://www.crosstheroadelectronics.com/control_system.html). Consult FRC game rules for what is required. Consult [Section 4](#) for software details.

Additionally the firmware file can be found after updating/installing the driver station software **on your hard drive**.



Instructions on how to field-upgrade the PDP are available at FRC WPILib Screensteps (<http://wpilib.screenstepslive.com>).

At the time of writing this link can be used:

<http://wpilib.screenstepslive.com/s/4485/m/24166/l/216217-updating-and-configuring-pneumatics-control-module-and-power-distribution-panel>

## 6. Revision History

Revision	Date	Description
1.5	24-Jan-16	New CTRE Logo. Section 4.6 added.
1.4	3-Mar-15	Section 2.1.1 added for lock washer. Section 2.4 has additional content for fuse seating. Section 5 moved to Section 6. Section 5 added.
1.3	19-Feb-15	Section 2.5 Added
1.2	22-Jan-15	Moved Section 4 to Section 5. Added Section 4 Functional Limitations.
1.1	19-Jan-15	Added Section 2.4 for fuse replacements Added screw length details in Section 2.1 Warnings Added in Section 2.2 for inductive loads.
1.0	30-Dec-14	Initial Creation