

FRC TEAM 2898: FLYING HEDGEHOGS

ELECTRICAL BIBLE

Created by FRC 2898 Electrical: bpsrobotics.org/2898

Note: Some materials are NOT our own, this is meant to be a resource for our team to quickly assemble/troubleshoot electrical issues that may occur.

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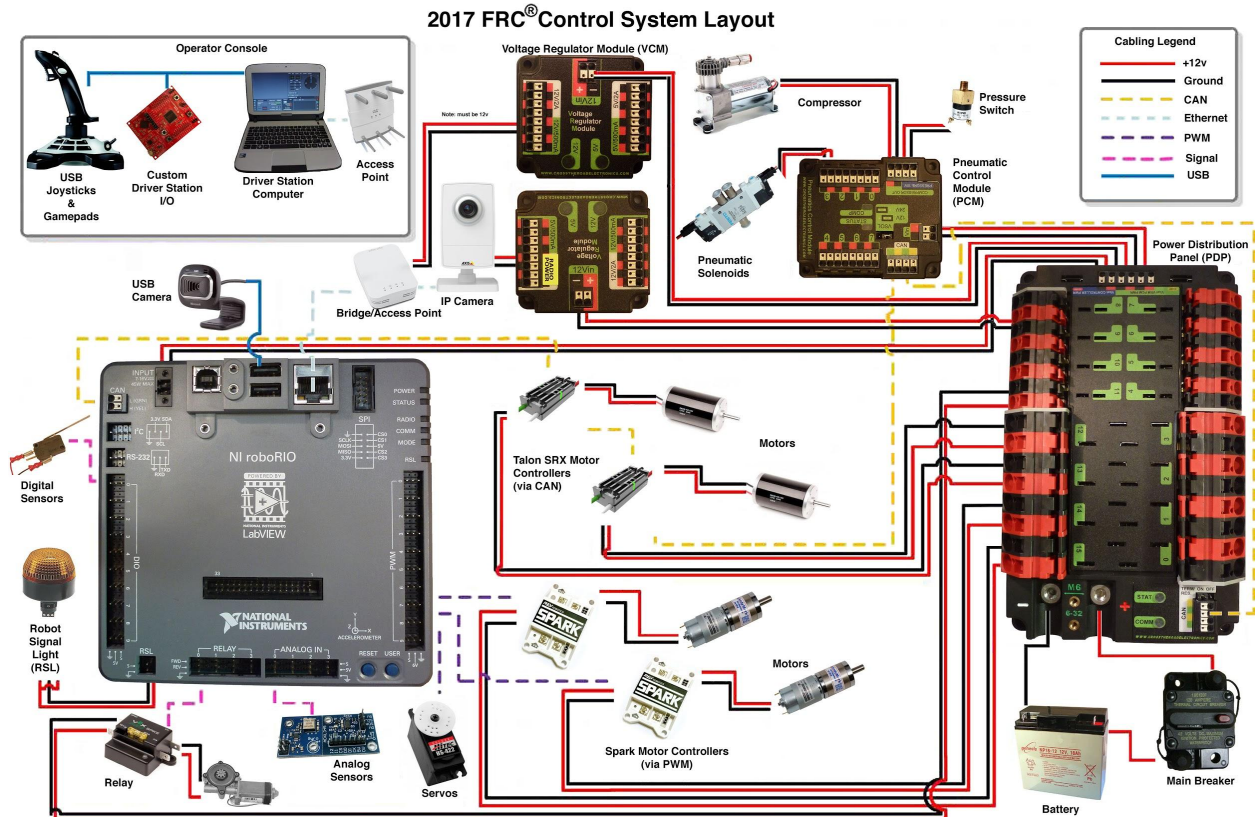
[Section Six](#): Further Resources

NOTE: This is a live document. Any edits will be noted here:

2/6/20 - Added SECTION FIVE: Purchasing More Supplies, moved "Further Resources" to SECTION SIX. Added SECTION 2: Pictures of talon SRX and VRM.

Section One: Overall Electrical Guides

1a. FRC Electrical Schematic



1b. Component Glossary

Battery: Typically 12 volts, connects to breaker and PDP.



Breaker: Used to turn the robot on/off, typically placed in between the battery and the PDP. MUST be easily accessible.

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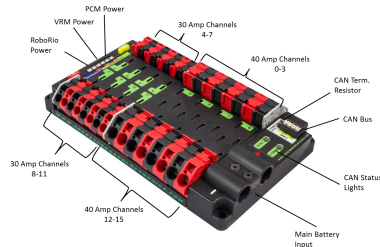
Camera: Mounted in front of any moving parts that the driver may need to see from the driver station in order to accurately use.



Motors: Powers moving parts, most commonly wheels. Connected to motor controllers.



Power Distribution Panel (PDP): Provides power for the rest of the components. Comparable to a fuse box in a building.



Radio: Communicates with the Driver Station Laptop via Wifi. Must be placed at least 1 ft away from any Talons to avoid any background noise in communications.



Robot Signal Light (RSL): The primary way of knowing the robot's status from afar. Connected to the RoboRIO and placed in a spot that is visible from afar.



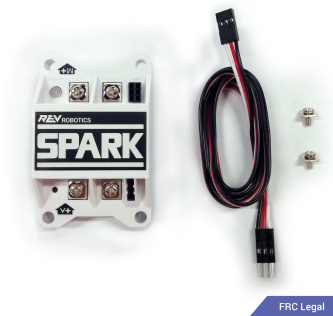
RoboRIO: Raspberry pi



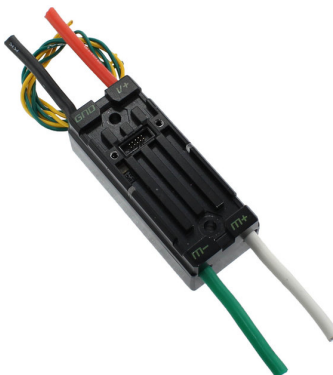
Sensors: There are various kinds including:

Beam breakers

Spark Motor Controllers: Controls motors via PWM



Talon SRX: Motor controllers, uses CAN bus



Voltage Regulator Module (VRM): Regulates voltage and amperage to a more concentrated, lower level.

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1c. Crimp Glossary

Weidmuller Crimps (AKA Ninja Star Crimps, and Ferrule Crimps): used for all connections that go into the PDP, VRM, and PCM, as well as the CAN connection to the RoboRIO.



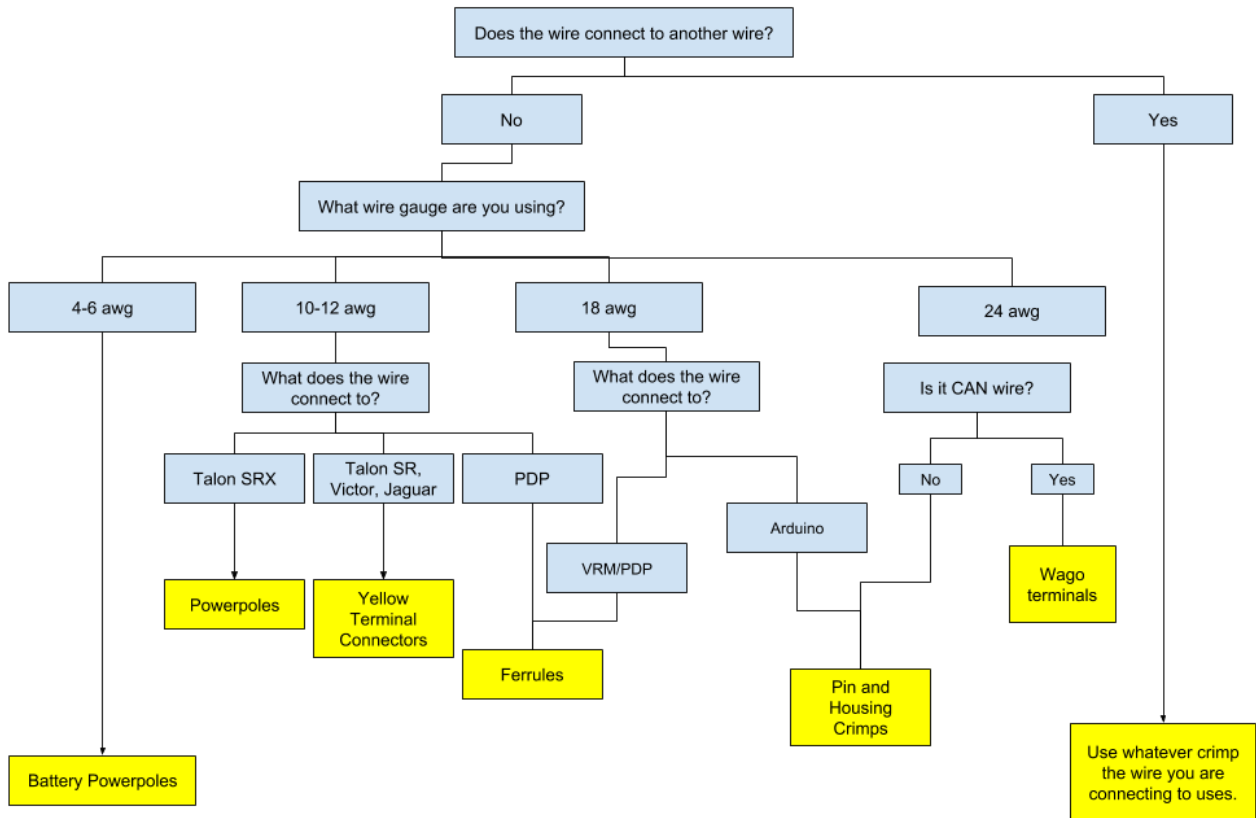
Anderson Powerpole Crimps: Used for any and all connections that have higher amperage voltage going through it.



Pin and Housing Crimps: used for connections with lower gauge wire. Female/Male connectors.



1d. Which Crimps Do I Use?



Note: Results may vary, chart may need to updated periodically

1e. Crimping Tools

Pin and Housing Crimper

Powerpole Crimper

Terminal Housing Crimper

Weidmuller Crimper (AKA Ninja Star Crimper)

1f. General Tips and Knowledge

1g. An Idiot's Guide to Batteries

Section Two: Troubleshooting

2a. Talons

For more detailed information go [here](#).

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LED Status	Condition
Both Flashing Green	Forward throttle is applied
Both Flashing Red	Reverse throttle is applied
Flashing Orange	CAN bus detected, robot disabled
Flashing Red (slowly)	CAN bus/PWM not detected
Flashing red (fast)	Fault detected
Flashing red and orange	Damaged hardware
Solid Red	Brake mode

Troubleshooting Quick fixes:

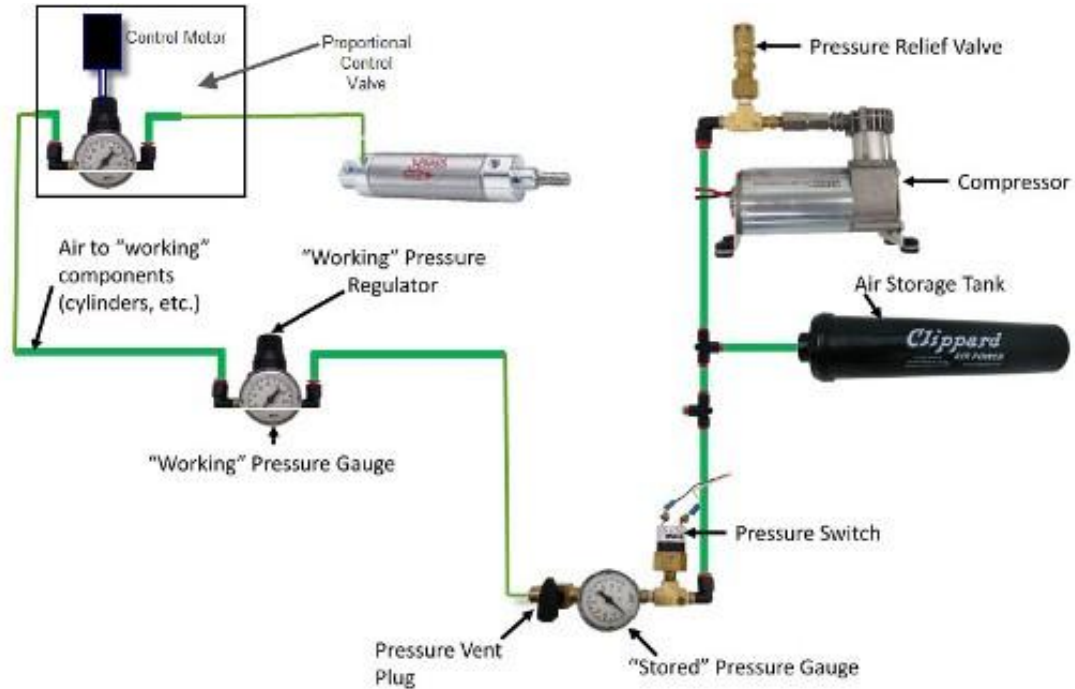
- If the talons are flashing red slowly, indicating a CAN fault, then it must mean one (or more) of the CAN wires aren't securely connected. Check all of the connections.
- If the talons are both red and orange, indicating damaged hardware, replace the talon.

For more information: <https://wpilib.screenstepslive.com/s/currentCS/m/troubleshooting>

2b. RoboRIO and Radio

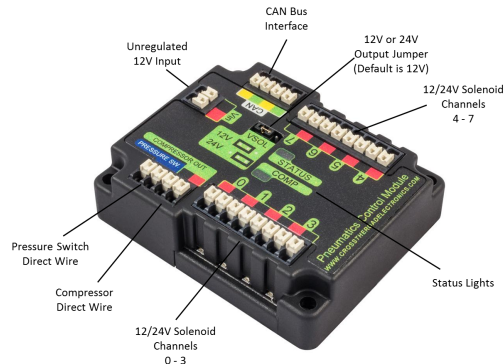
Section Three: Pneumatics

3a. Pneumatics Schematic



3b. Pneumatics Components

PCM - Pneumatics Control Module: Takes the CAN signal from the roborio to control the solenoids (Think of it as a motor controller for air flow)



Compressor: The compressor is an air pump that fills the system with air pressure (up to 120 psi)

Note: USE VIBRATION MOUNTS and use caution, this gets extremely hot when active



Pressure Relief Valve: This component releases pressure from the compressor. It is mounted to the compressor and required for safety reasons.



Pressure Switch: This is used to regulate the pressure in the system. The valve turns the compressor off when the air pressure gets too high.



Air Tank: These hold up to 125 psi of air.

Note: These must be mounted in a safe place where they can never be ruptured

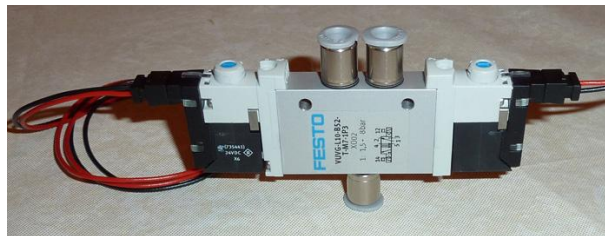


Regulator: This component limits the downstream pressure of the system, and must be placed BEFORE any working components



Solenoid Valves: These are actuated valves that control air flow using electric currents controlled by the PCM. Using these, flow can be turned on and off.

Note: Has push-to-connect type tubing inserts



Pressure Gauge: Gauges are used to measure “stored” and “working” pressure in the system. Two are usually required, one on the regulator (stored) and one after (working).



Parker Fittings: These are plug valves that release air in the system and connect tubes and hard components.

Note: Use Teflon tape to seal properly



Tubing: This is used to channel air between components

Note: Cut properly! Angled cuts create leaks.



Cylinders/pistons: These apply pressure using the power of compressed air, providing lateral motion and force. There are double acting and single acting cylinders.

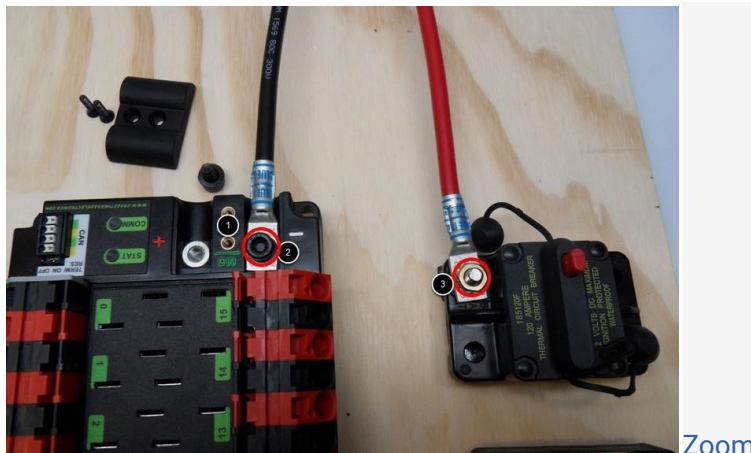
BORE: Diameter

STROKE: Extended Length



Section Four: Wiring the Control System

Attaching the Battery Connector to the PDP



Requires: Battery Connector, 6AWG terminal lugs, 1/16" Allen, 5mm Allen, 7/16" Box end

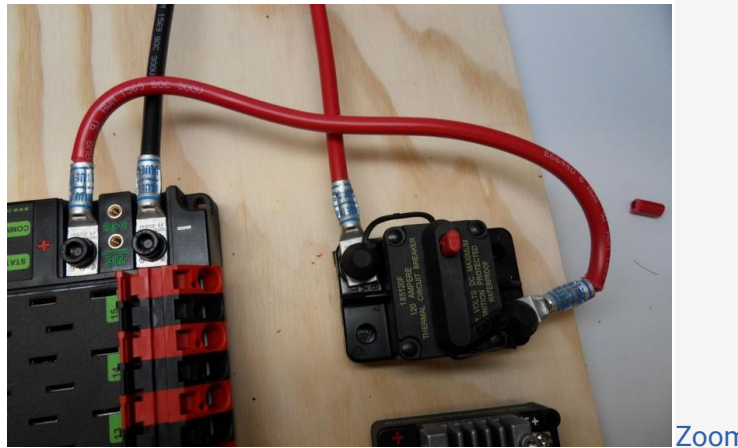
1. Attach terminal lugs to battery connector.

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2. Using a 1/16" Allen wrench, remove the two screws securing the PDP terminal cover.
3. Using a 5mm Allen wrench (3/16" will work if metric is not available), remove the negative (-) bolt and washer from the PDP and fasten the negative terminal of the battery connector.
4. Using a 7/16" box end wrench, remove the nut on the "Batt" side of the main breaker and secure the positive terminal of the battery connector.

Wiring the Breaker to the PDP



Requires: 6AWG red wire, 2x 6AWG terminal lugs, 5mm Allen, 7/16" box end

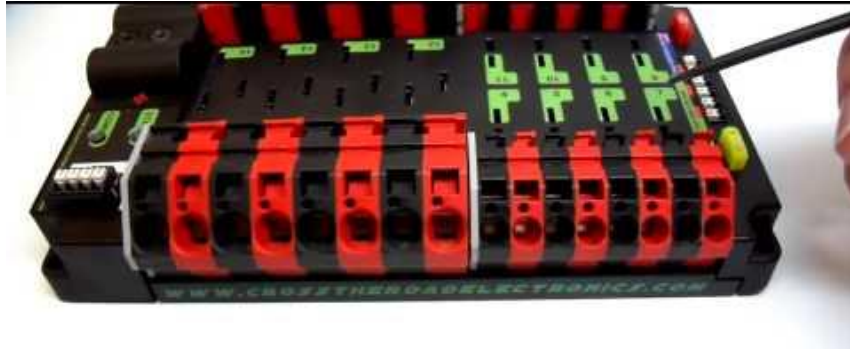
Secure one terminal lug to the end of the 6AWG red wire. Using the 7/16" box end, remove the nut from the "AUX" side of the 120A main breaker and place the terminal over the stud. Loosely secure the nut (you may wish to remove it shortly to cut, strip, and crimp the other end of the wire). Measure out the length of wire required to reach the positive terminal of the PDP.

1. Cut, strip, and crimp the terminal to the 2nd end of the red 6AWG wire.
2. Using the 7/16" box end, secure the wire to the "AUX" side of the 120A main breaker.
3. Using the 5mm, secure the other end to the PDP positive terminal

Wago connectors to the PDP

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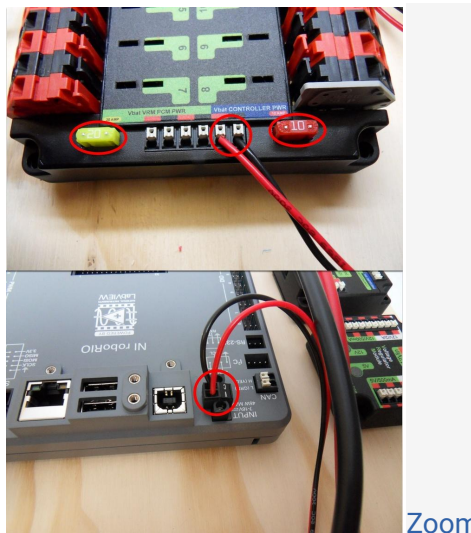


To use the Wago connectors, insert a small flat blade screwdriver into the rectangular hole at a shallow angle then angle the screwdriver upwards as you continue to press in to actuate the lever, opening the terminal. Two sizes of Wago connector are found on the PDP:

- Small Wago connector: Accepts 10AWG-24AWG, strip 11-12mm (~7/16")
- Large Wago connector: Accepts 6AWG-12AWG, strip 12-13mm(~1/2")

To maximize pullout force and minimize connection resistance wires should not be tinned (and ideally not twisted) before inserting into the Wago connector.

Roborio Power



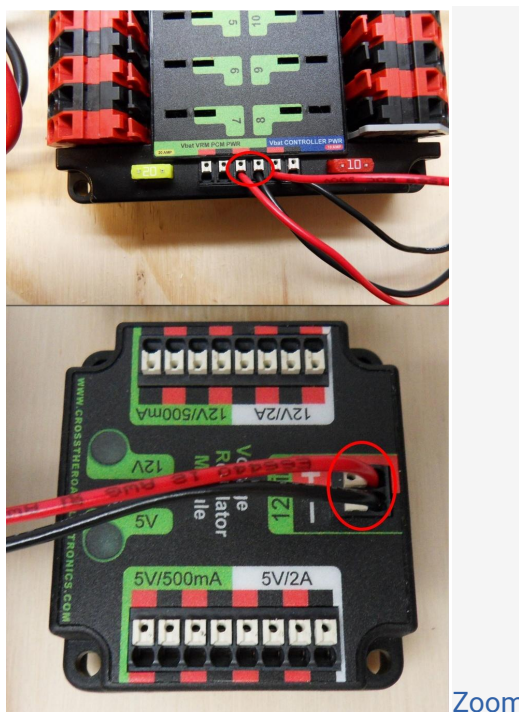
Created by FRC 2898 Electrical: [bpsrobotics.org/2898](https://www.bpsrobotics.org/2898)

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Requires: 10A/20A mini fuses, Wire stripper, very small flat screwdriver, 18AWG Red and Black

1. Insert the 10A and 20A mini fuses in the PDP in the locations shown on the silk screen (and in the image above)
2. Strip ~5/16" on both the red and black 18AWG wire and connect to the "Vbat Controller PWR" terminals on the PDB
3. Measure the required length to reach the power input on the roboRIO. Take care to leave enough length to route the wires around any other components such as the battery and to allow for any strain relief or cable management.
4. Cut and strip the wire.
5. Using a very small flat screwdriver connect the wires to the power input connector of the roboRIO (red to V, black to C). Also make sure that the power connector is screwed down securely to the roboRIO.

Voltage Regulator Module Power



Requires: Wire stripper, small flat screwdriver (optional), 18AWG red and black wire

1. Strip ~5/16" on the end of the red and black 18AWG wire.
2. Connect the wire to one of the two terminal pairs labeled "Vbat VRM PCM PWR" on the PDP.

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3. Measure the length required to reach the "12Vin" terminals on the VRM. Take care to leave enough length to route the wires around any other components such as the battery and to allow for any strain relief or cable management.
4. Cut and strip ~5/16" from the end of the wire.
5. Connect the wire to the VRM 12Vin terminals.

Pneumatics Control Module Power



Requires: Wire stripper, small flat screwdriver (optional), 18AWG red and black wire

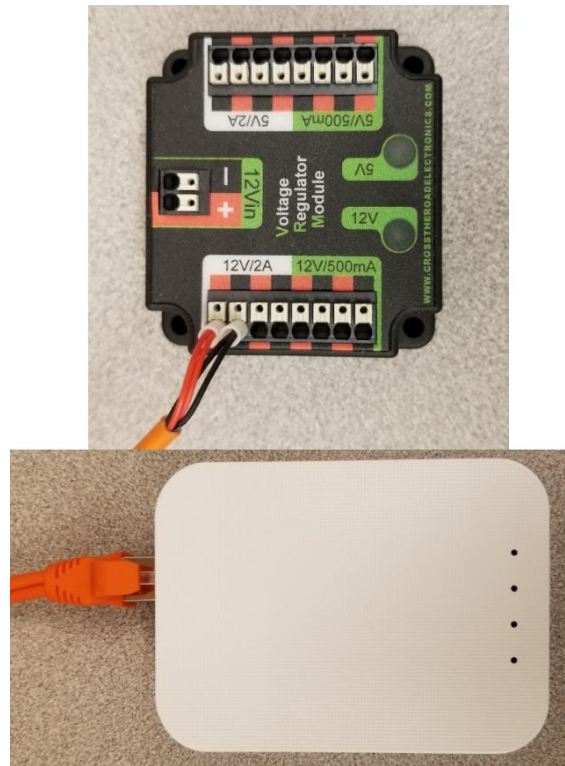
Note: The PCM is an optional component used for controlling pneumatics on the robot.

1. Strip ~5/16" on the end of the red and black 18AWG wire.
2. Connect the wire to one of the two terminal pairs labeled "Vbat VRM PCM PWR" on the PDP.
3. Measure the length required to reach the "Vin" terminals on the VRM. Take care to leave enough length to route the wires around any other components such as the battery and to allow for any strain relief or cable management.
4. Cut and strip ~5/16" from the end of the wire.
5. Connect the wire to the VRM 12Vin terminals.

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Radio Power and Ethernet



Requires: Small flat screwdriver (optional), Rev radio PoE cable

1. Insert the ferrules of the passive PoE injector cable into the corresponding colored terminals on the 12V/2A section of the VRM.
2. Connect the male RJ45 (Ethernet) end of the cable into the Ethernet port on the radio closest to the barrel connector (labeled 18-24v POE)

RoboRIO to Radio Ethernet

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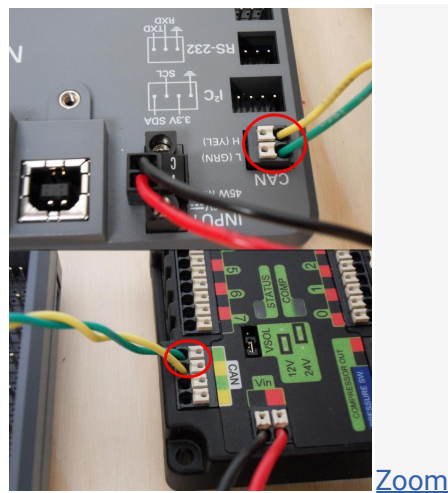
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Requires: Ethernet cable

Connect an Ethernet cable from the female RJ45 (Ethernet) port of the Rev Passive POE cable to the RJ45 (Ethernet) port on the roboRIO.

RoboRIO to PCM CAN



Requires: Wire stripper, small flat screwdriver (optional), yellow/green twisted CAN cable

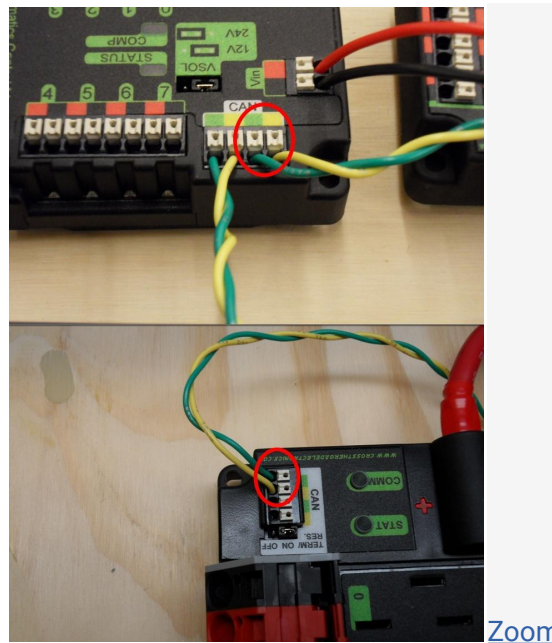
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Note: The PCM is an optional component used for controlling pneumatics on the robot. If you are not using the PCM, wire the CAN connection directly from the roboRIO (shown in this step) to the PDP (show in the next step).

1. Strip ~5/16" off of each of the CAN wires.
2. Insert the wires into the appropriate CAN terminals on the roboRIO (Yellow->YEL, Green->GRN).
3. Measure the length required to reach the CAN terminals of the PCM (either of the two available pairs). Cut and strip ~5/16" off this end of the wires.
4. Insert the wires into the appropriate color coded CAN terminals on the PCM. You may use either of the Yellow/Green terminal pairs on the PCM, there is no defined in or out.

PCM to PDP CAN



Requires: Wire stripper, small flat screwdriver (optional), yellow/green twisted CAN cable

Note: The PCM is an optional component used for controlling pneumatics on the robot. If you are not using the PCM, wire the CAN connection directly from the roboRIO (shown in the above step) to the PDP (show in this step).

1. Strip ~5/16" off of each of the CAN wires.
2. Insert the wires into the appropriate CAN terminals on the PCM.

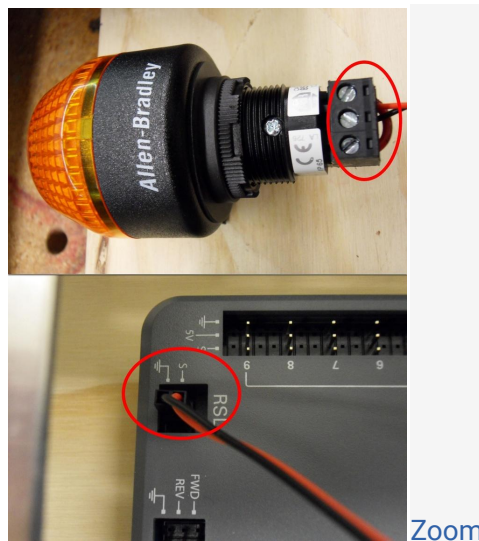
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3. Measure the length required to reach the CAN terminals of the PDP (either of the two available pairs). Cut and strip ~5/16" off this end of the wires.
4. Insert the wires into the appropriate color coded CAN terminals on the PDP. You may use either of the Yellow/Green terminal pairs on the PDP, there is no defined in or out.

Note: The PDP ships with the CAN bus terminating resistor jumper in the "ON" position. It is recommended to leave the jumper in this position and place any additional CAN nodes between the roboRIO and the PDP (leaving the PDP as the end of the bus). If you wish to place the PDP in the middle of the bus (utilizing both pairs of PDP CAN terminals) move the jumper to the "OFF" position and place your own 120 ohm terminating resistor at the end of your CAN bus chain.

Robot Signal Light



Requires: Wire stripper, 2 pin cable, Robot Signal Light, 18AWG red wire, very small flat screwdriver

1. Cut one end off of the 2 pin cable and strip both wires
2. Insert the black wire into the center, "N" terminal and tighten the terminal.
3. Strip the 18AWG red wire and insert into the "La" terminal and tighten the terminal.
4. Cut and strip the other end of the 18AWG wire to insert into the "Lb" terminal

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5. Insert the red wire from the two pin cable into the "Lb" terminal with the 18AWG red wire and tighten the terminal.
6. Connect the two-pin connector to the RSL port on the roboRIO. The black wire should be closest to the outside of the roboRIO.

You may wish to temporarily secure the RSL to the control board using zipties or Dual Lock (it is recommended to move the RSL to a more visible location as the robot is being constructed)

Section Five: Purchasing More Supplies

SUPPLIERS:

Supplier:	Link:	What You Can Buy: BEST YOU CAN BUY
Amazon <i>Bulk products, low prices, okay quality, but be wary! Make sure you are buying NAME BRAND power poles or you will cry</i>	www.amazon.com/	<ul style="list-style-type: none"> ● Crimps <ul style="list-style-type: none"> ○ Ferrules <ul style="list-style-type: none"> ■ 12 awg ■ 18 awg ■ 22 awg ○ Powerpoles ● Tools <ul style="list-style-type: none"> ○ Wago tools ○ Flush cutters ○ Wire strippers ● Accessories <ul style="list-style-type: none"> ○ Zip Ties
Andymark	www.andymark.com/	<ul style="list-style-type: none"> ● Motors ● Bundles <ul style="list-style-type: none"> ○ PDP Bundle ● Wires <ul style="list-style-type: none"> ○ Can bus Wire ● Crimps <ul style="list-style-type: none"> ○ Ferrules <ul style="list-style-type: none"> ■ 12 awg ■ 18 awg ■ 22 awg ○ Powerpoles <ul style="list-style-type: none"> ■ Red housing ■ Black housing ● Sensors

		<ul style="list-style-type: none"> ○ Encoders ● Accessories
<p>Digikey</p> <p><i>For cheap, yet good quality crimps</i></p>		<ul style="list-style-type: none"> ●
<p>Powerwerx</p> <p><i>Best supplier for wire and power poles</i></p> <p><i>Note: THEY SELL NAME BRAND POWER POLES</i></p>	<p>powerwerx.com/</p>	<ul style="list-style-type: none"> ● Anderson Powerpoles <ul style="list-style-type: none"> ○ Loose Contacts 15 awg ○ Loose Contacts 30 awg ○ Loose Contacts 45 awg ○ Housings ● Zip-bonded wire <ul style="list-style-type: none"> ○ 12 awg ○ 18 awg ○ 22 awg ○ 24 awg ● Battery Crimps <ul style="list-style-type: none"> ○ SB50s ○ SB50 Housings
<p>VEX Robotics</p>	<p>www.vexrobotics.com/vexpro/motors-electronics</p>	<ul style="list-style-type: none"> ● Components <ul style="list-style-type: none"> ○ Talon SRX ○ Victor SPX ○ VRM ○ PCM ○ PDP ● Encoders <ul style="list-style-type: none"> ○ Versaplanetary Integrated Encoder (SRX Mag Encoders) ● Accessories <ul style="list-style-type: none"> ○ Circuit Breakers (20a, 30a, and 40a) ○ Extension Cable Retaining Clips ○ Breakout boards ● Wire <ul style="list-style-type: none"> ○ Silicone Wire ○ CAN bus Wire
<p>West Coast Products</p>		<ul style="list-style-type: none"> ●

PURCHASING TIPS:

- CHECK PAST ORDER LISTS IF YOU NEED LINKS FOR STUFF!!!
- West Coast Products has good shipping time (because they're from California, not the East)
- Pneumatics and more expensive components can be found on FIRST Choice
 - ◆ FIRST Choice tips: Try to avoid adding things to your FIRST Choice list that you don't need or that other teams aren't likely to request. If you add an item that isn't in high demand by other teams, you'll probably end up getting it instead of the items you really wanted.
- Different suppliers (Andymark, WCP, McMaster) might have different prices for the SAME ITEM, be sure to double check before you order. Or else Hendel will. Don't do that to him.
- Finding stuff on Digikey is a pain. Don't take it personally.
- Don't wait too long to buy more commonly used crimps. Running out sucks. You should be very scared of running out.

Section Six: Further Resources

For more information on FRC Electrical here are some quick links to check out:

Control System Hardware:

https://wpilib.screenstepslive.com/s/currentCS/m/cs_hardware

Wiring the Control System:

https://wpilib.screenstepslive.com/s/currentCS/m/cs_hardware/l/144971-wiring-the-frc-control-system

Mililani Robotics Electrical Bible:

<https://mililanirobotics.gitbooks.io/frc-electrical-bible/content/>

Team 1678's Wiring Seminar:

<https://www.youtube.com/watch?v=LWMRDBBXymI>

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