

Control Systems Components

Team 177
October 2018

Control Components

- Main Components
- Additional Components
- Power and Motor Components
- Pneumatic Components
- Human Interface Components
- Robot Programming Development Components

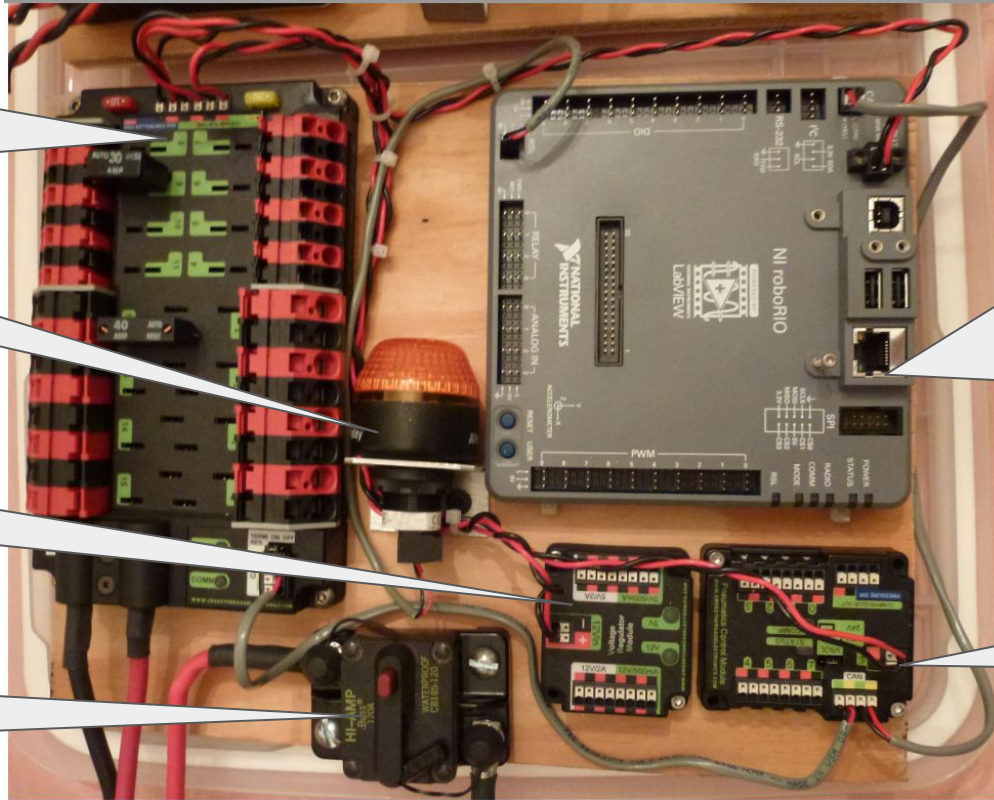
Main Control Components

Power
Distribution
Panel (PDP)

Robot Status
Light (RSL)

Voltage
Regulator
Module (VRM)

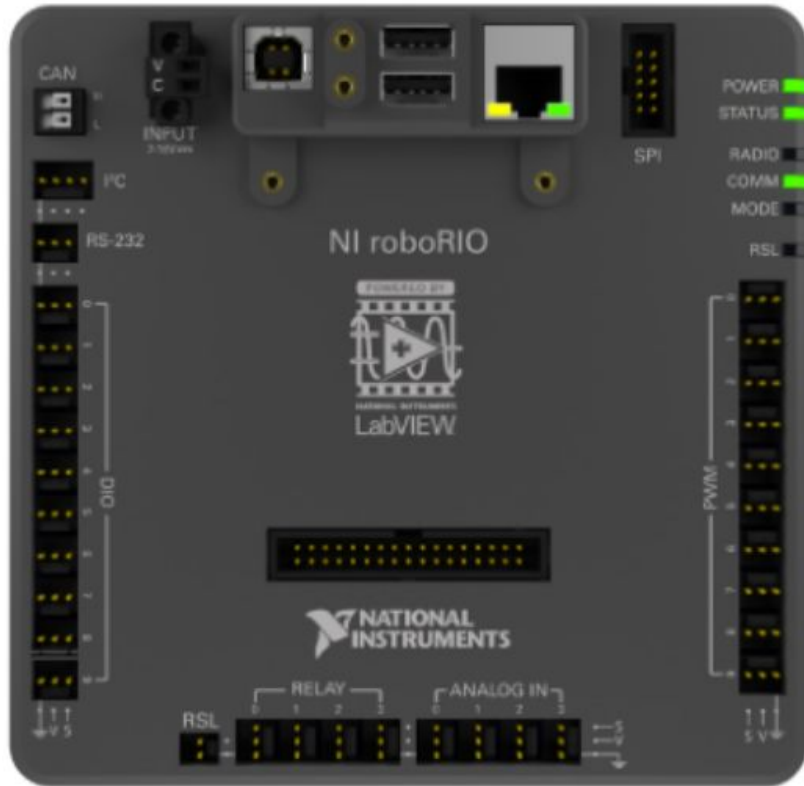
Main Breaker



RoboRIO -
Main
Computer,
runs robot
code
controls all
other
components

Pneumatics
Control Module
(PCM)

National Instruments roboRIO



The RIO is the main robot controller. used for FRC. Can communicate with driver station over Ethernet (wired on-board, or wireless radio), and USB connection.

Communicates with control components using CAN, PWM, digital I/O, and analog I/O channels for sensing and control. Connects to the dedicated 12V port on the PDP for power.

Robot Status Light



In Emergency:

**Spacebar Disables
Robot**

Light indicates robot state:

OFF - robot off: nothing is on, *however pressure can still be up*

ON SOLID - robot disabled: robot will not move, compressor won't run

ON FLASHING - robot enabled: robot can move, mechanisms can actuate unexpectedly if robot in autonomous mode. CAUTION

Power Distribution Panel (PDP)

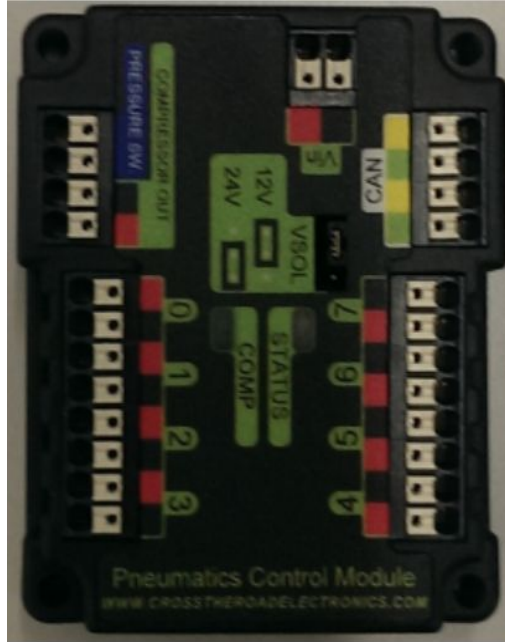


The PDP is designed to distribute power from a 12VDC battery to various robot components through auto-resetting circuit breakers and a small number of special function fused connections. The PDP provides 8 output pairs rated for 40A continuous current and 8 pairs rated for 30A continuous current. The PDP provides dedicated 12V connectors for the roboRIO, as well as connectors for the Voltage Regulator Module and Pneumatics Control Module. It also includes a CAN interface for logging current, temperature, and battery voltage



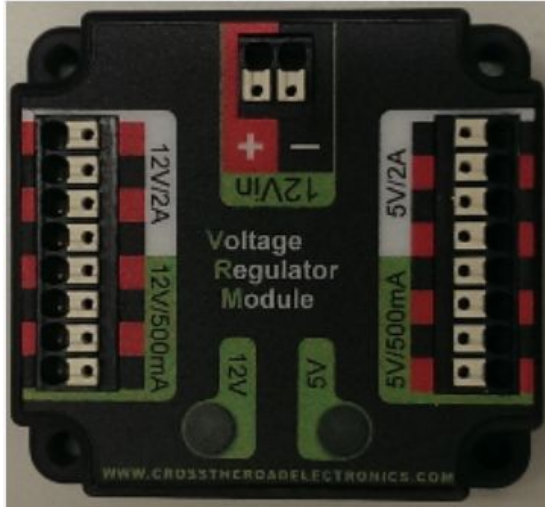
Circuit breakers used in the PDP to limit current to individual circuits/motors. Larger channels use 40 Amp breakers, and smaller channels use 30 Amp breakers. Breakers can reset automatically.

Pneumatics Control Module (PCM)



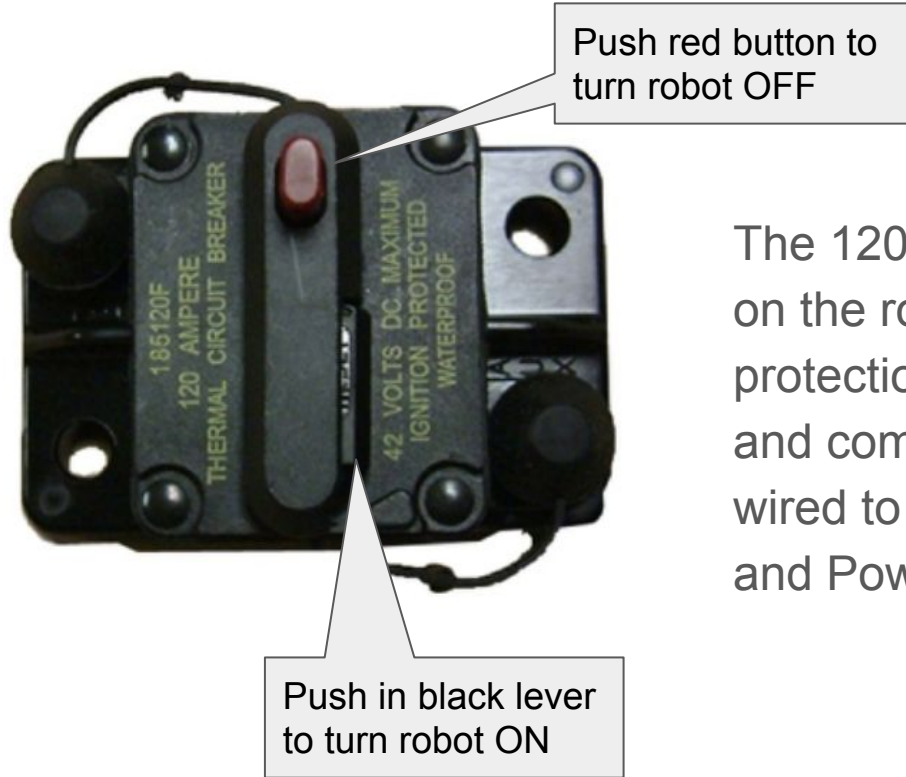
The PCM has all of the inputs and outputs required to operate 12V or 24V pneumatic solenoids and the on board compressor. The PCM is enabled/disabled by the roboRIO over the CAN interface. The PCM contains an input for the pressure sensor and will control the compressor automatically when the robot is enabled and a solenoid has been created in the code. The device also collects diagnostic information such as solenoid states, pressure switch state, and compressor state. The module includes diagnostic LED's for both CAN and the individual solenoid channels.

Voltage Regulator Module (VRM)



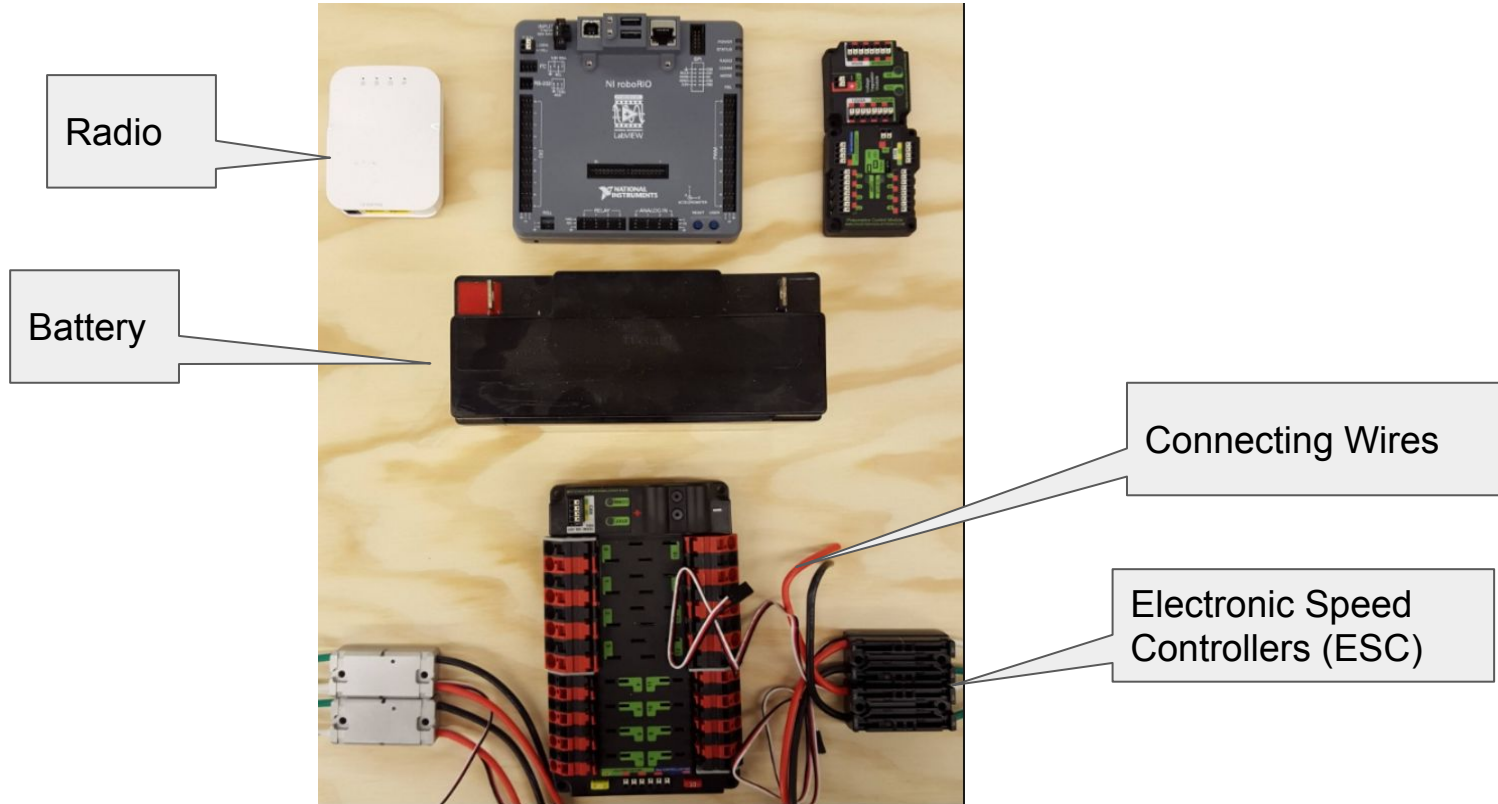
The VRM is an independent module that is powered by 12 volts. The device is wired to a dedicated connector on the PDP. The module has multiple regulated 12V and 5V outputs. The purpose of the VRM is to provide regulated power for the **robot radio**, custom circuits, and IP vision cameras.

Main Breaker

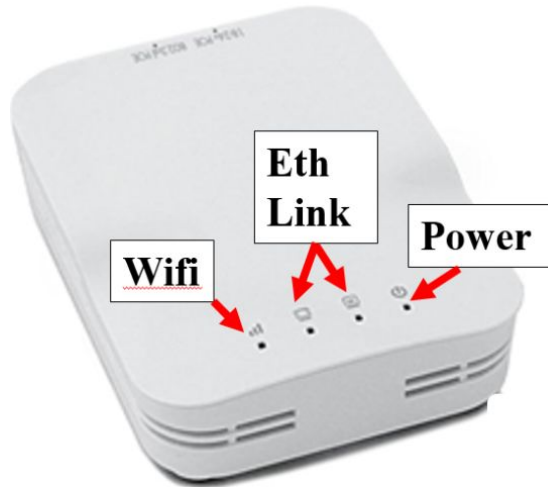


The 120A Main Circuit Breaker serves two roles on the robot: the main robot power switch and a protection device for downstream robot wiring and components. The 120A circuit breaker is wired to the positive terminals of the robot battery and Power Distribution boards.

Additional Control Components



Wifi Radio



The OpenMesh OM5P wireless radio is used to provide wireless communication functionality to the robot. The robot radio should be powered by one of the 12V outputs on the VRM or a Power-Over-Ethernet (POE) connection, and connected to the roboRIO Ethernet port.

The Battery



- “Half Size Car Battery”
- 12v DC
- Connected to robot using
Anderson SB50 connector

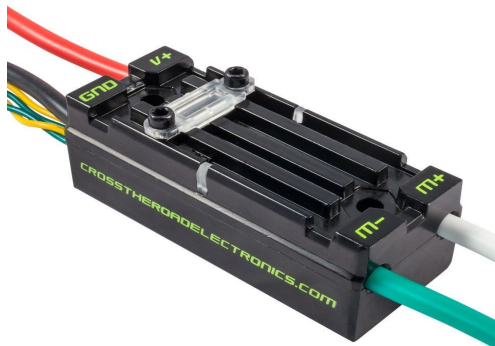
- **Never Pick Up by Cable**

Electronic Speed Controllers (ESC)

Connect power from PDP to motor under control of roboRIO -- marriage of power and information. We typically use CANbus to connect ESCs

Some have ability to read sensors and provide advanced control modes.

Talon SRX speed controller



Victor SPX speed controller



Motor



Connecting Control Components

PWM - carries information as an analog signal. (Used to connect analog & digital sensors)



CAN Bus - carries information to all components of controls System Used to connect motor controllers to roboRIO



Power and generic connections:

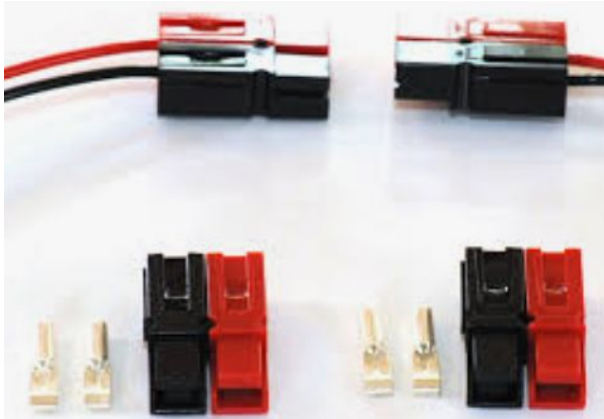
- 18 gauge generic connections
- 8-12 gauge for motors
- 6 gauge (battery)



Making connections

Starting in 2018 Team 177 started using Anderson Powerpole connectors for *most* electrical connections:

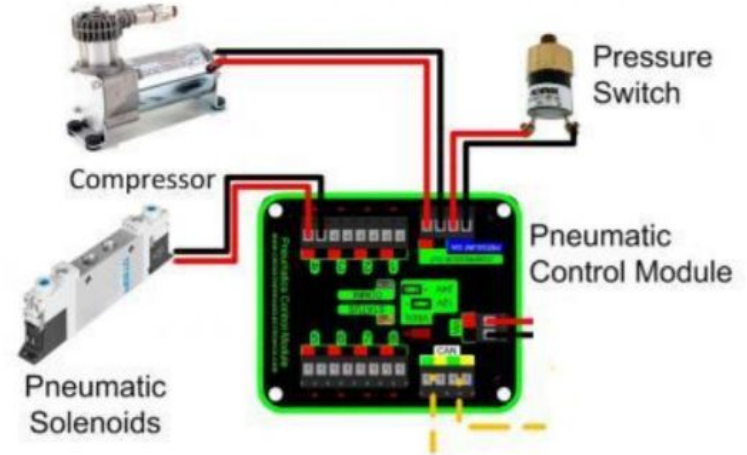
After crimping connector on wire easy to connect/disconnect to swap components if needed.



Learn how to use
crimping tool before
making connections

Pneumatic Control Components

- Compressor
- Pressure Switch and Relief Valve
- Regulators and Pressure Gauges
- Air Tanks
- Solenoids/Valves
- Pneumatic cylinders
- Tubing, Fittings, etc.



Compressor



The compressor is a Viar 090C Air Compressor. It will put out approximately 120psi before the relief valve opens. Because the compressor can produce a significant amount of vibration, it is recommend to use vibration isolation mounts that come preinstalled on the compressor. The compressor can also get **very hot** and should not be in direct contact with anything else.

Pressure Switch and Relief Valve

Pressure Switch



This switch is normally closed. The switch will open at approximately 115 psi and will not close again until the pressure drops to approximately 95 psi. It must be wired directly to the PRESSURE SW connector on the PCM. The PCM will handle turning the compressor on and off based on the state of the pressure switch and the Enable state of the robot if any Solenoid Valve object in your code.

Pressure Relief Valve



120 PSI pressure relief valve in connected to compressor via hard fittings. Intended to stop the the pneumatics system from reaching pressures above 120PSI.

Regulators and Pressure Gauges

Regulators



Allow the team to set the working pressure of the robots pneumatic actuators

Gauges



Allow the team to monitor pressure of storage tanks and working pressure downstream of regulator.



Also available as smaller in-line components.

Air Tanks

Air Tank



The tanks are designed to withstand up to 125 psi and temperatures from 35F to 100F. Multiple tanks can be connected to provide more high pressure air storage. Tanks should also be installed to reduce impact and reduce the risk of rupturing. When securing the tank ensure that fasteners do not get over tightened or apply pressure to the tank.

Solenoids/Valves



Available as double or single solenoid units. Typically 12V solenoids (older solenoids may be 24V devices -- do not use for current robot construction) note position of jumper on PCM. Some units may already have fittings for tubing attached others will need to have fittings added.

Note, solenoids may return to default position when de-powered, so **when the robot is turned off pneumatic actuators may move.**

Pneumatic Cylinders



Have ports on each end. When pressure is supplied to one side the rod in the cylinder will extend or retract depending on which port is pressurized. Different cylinder diameters and lengths available for different applications.

Tubing, Fittings, etc.

Tubing



The tubing has an outside diameter of 0.25" and an inside diameter of 0.160". Be careful when cutting tubing as angled cuts can result in leaks.



Many fittings available -- tee, elbow, straight, flow restrictor, etc. All are "push-in" type, to connect push in the tube and pull back slightly to disconnect push in on collar and remove tube.



Exhaust valve, used to release pressure before working on robot or at end of match.

Human Interface Components

Driver Station

Laptop Computer

NI DriverStation Software

SmartDashBoard & ShuffleBoard Monitoring

Joysticks and Gamepad input Devices

Robot Programming Development Components

- Development Environment:
 - Eclipse (2018)
 - Visual Studio Code (2019)
- WPI Library
- OI Class to interface driver & operator
- TimedRobot base class -- Main entry point for robot code
 - RobotInit
 - Auto Init & Periodic
 - Teleop Init & Periodic
- Other items for robot code architecture and decomposition

Thanks and more info:

Much of the info and pictures in these slides came from:

WPI LIB Screen Steps “FRC Control System Hardware Overview” at:
https://wpilib.screenstepslive.com/s/currentCS/m/getting_started/I/599672-frc-control-system-hardware-overview this is a very good sight to review for more control component information.

“The Control System.pdf” by Elliot Bushman 2017

Andymark website: <https://www.andymark.com>