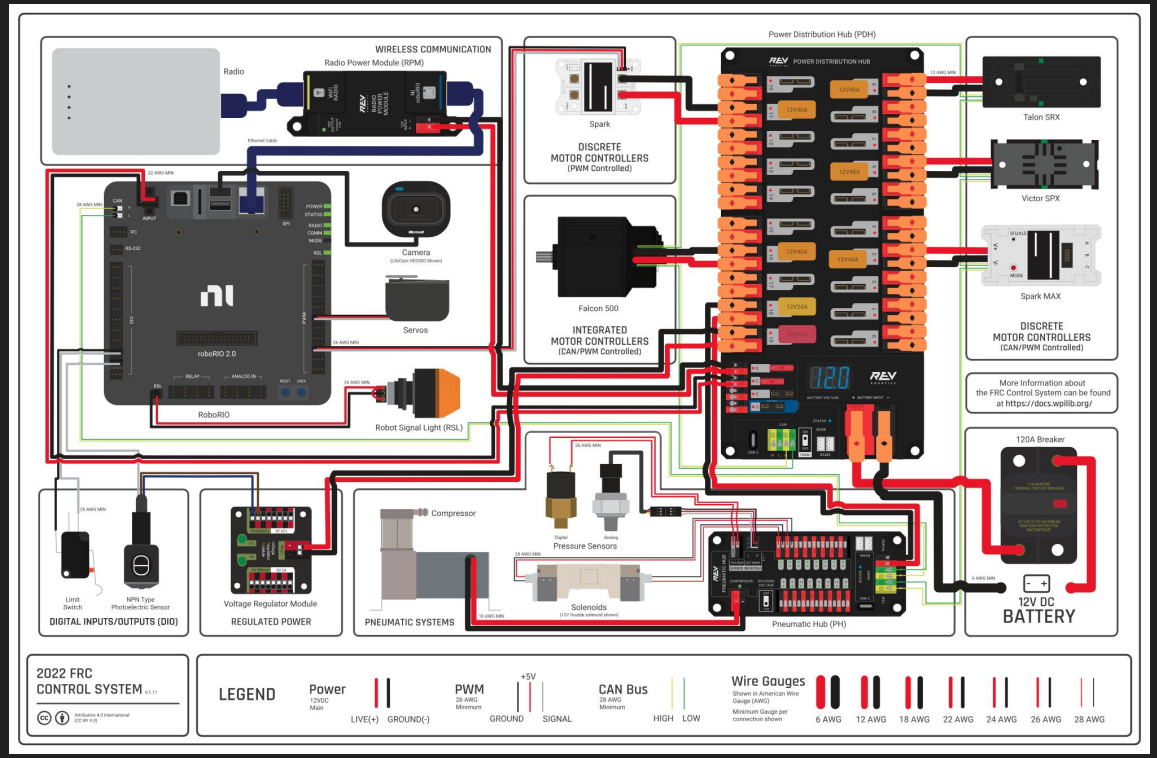
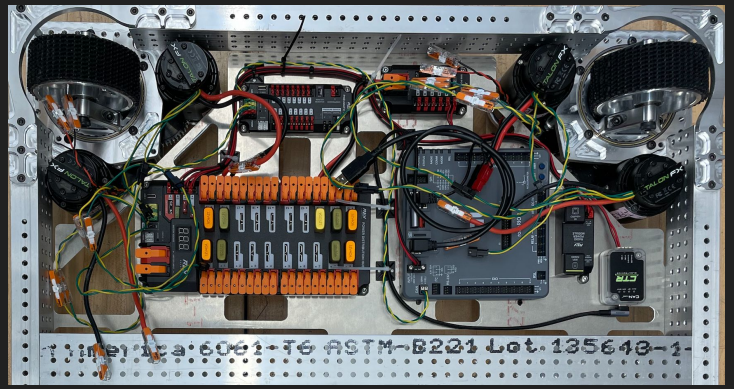
FRC Control System Overview

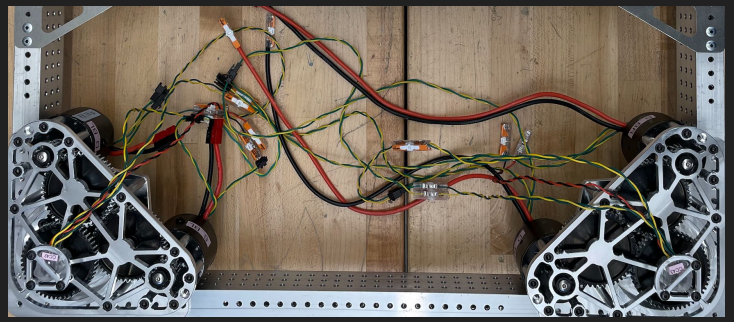
Control System Components



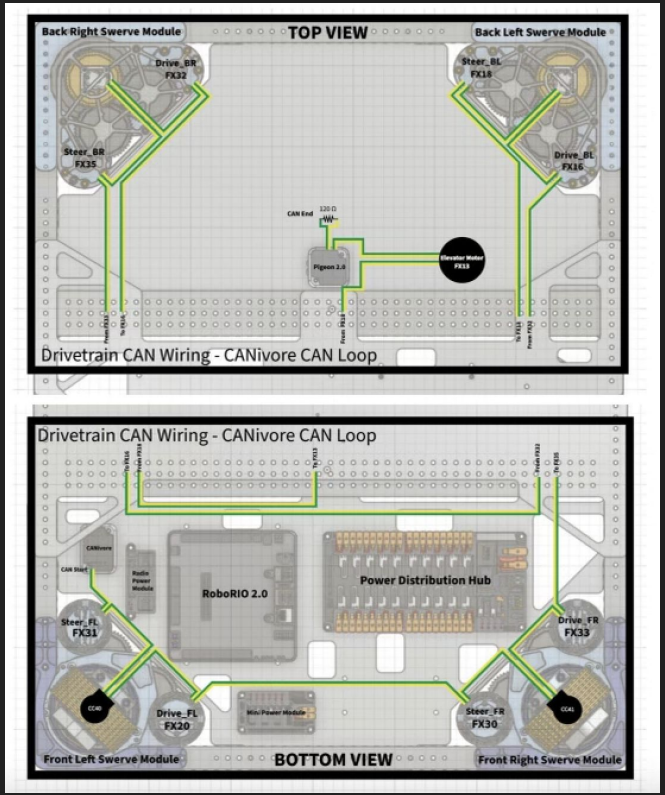
- <u>Mount as low as possible!</u>
  - Low CG = less tipping
- <u>Serviceability is very important</u>
  - Ensure all control system components are easily accessible
  - Helps with troubleshooting.
  - Easier to switch out failed components.
  - Also helps with robot inspections at competitions

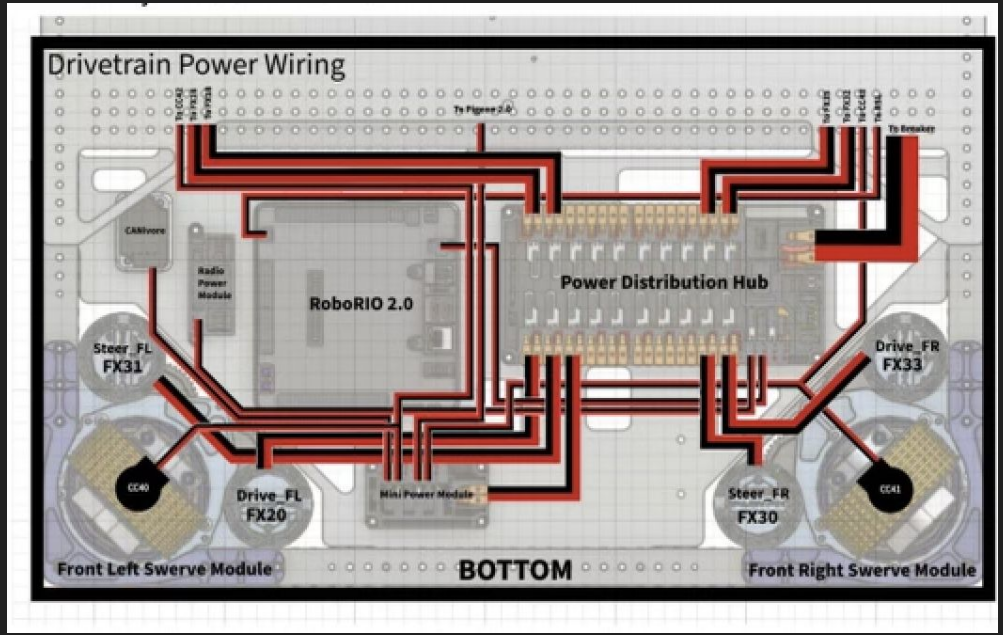
Vertigo (2023 Season Robot)





Vertigo Wiring (2023 Season Robot)





Robot Battery

Battery Basics

- A 12 V battery
- Do not carry by battery cables
- Replace after each match

Check Battery before placing in robot

- Under .02 resistance (Check With Battery Beak)
- Over 100% Charge
- Check battery terminal insulation and battery cables and connector

Battery Beak

- Connects to battery terminal connector
- Always use before placing battery in robot

How to Use:

- Click the button twice and wait some time for the numbers to appear
- Check for Charge ≥1 00% and “Rist” ≤ .02 Ohms

Robot Circuit Breaker

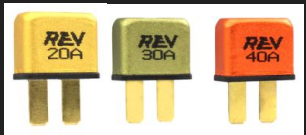
- Needs to be easily accessible on the robot.
- This the main On and off switch for robot
- Rated 25-120 amps
- Click the red thingy to turn off the robot
- Press the lever in to turn on the robot
- Control power from PDH to battery

RSL (Robot Signal Light)

- Enabled - on & flashing
- Disabled - on
- Off - off
- Connected to roborio
- Mount location is important, as it must be visible during matches

Power Distribution HUB (PDH)

PDH Fuses



Mini Power Module

- <u>Powers everything!</u>
- Needs to be easily accessible and during robot inspection
- Receives power from the battery
- Specific ports for specific use cases
- Fuses go into PDH ports
  - 20, 30 & 40 amp
- Connects to roborio with CAN bus - can get current draw in code
- PDH has status lights (unlike PDP)
- Supports up to 40A (unlike PDP)
- BUILT IN Voltage Regulator Module aka the VRM.
- Can add extra power ports via the **Mini Power Module** (MPM)

RoboRIO 2.0 : Brain

- Runs team-generated code that commands all of the other hardware.
- Runs code stored on SD Card
- Connects to sensors, RSL (the light)
- Can connect to drive station computer via USB

Connections:

- To “bridge” through Radio Power Module (RPM) for wifi connection
- To PDH for power
- End of CAN loop
- To drive station computer and the Field Management Systems (FMS) at competitions

Bridge - RADIO

Power	
Blue	On or Powering Up
Blue Blinking	Powering Up
Eth Link	
Blue	Link Up
Blue Blinking	Traffic Present
WiFi	
Off	Bridge Mode, Unlinked or non-FRC firmware
Red	AP, Unlinked
Yellow\Orange	AP, Linked
Green	Bridge Mode, Linked

WiFi light only works after radio has been power cycled.

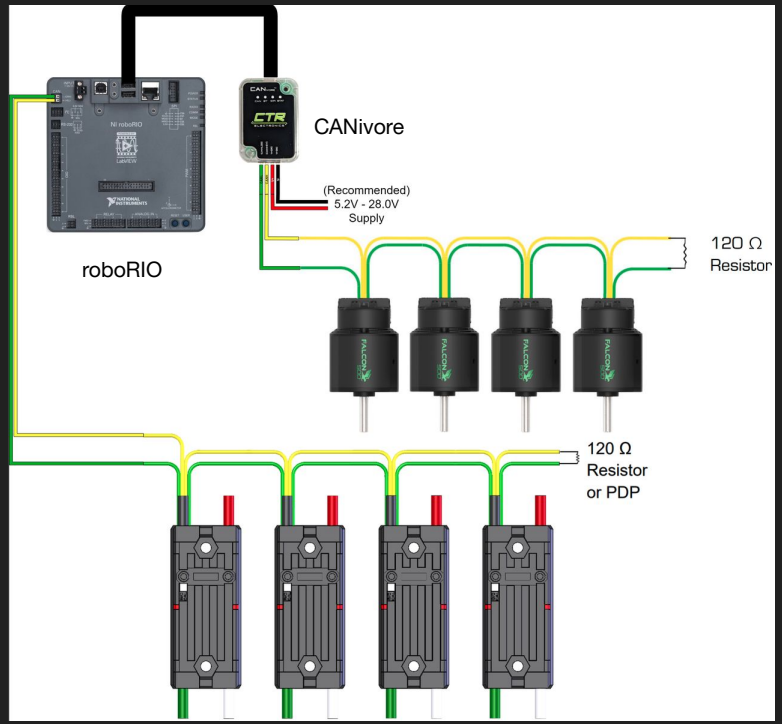
- **Bridge** is also known as the **RADIO**.
- Facilitates communication between driver station, robot, and FMS (Field Management System)
- Wifi - takes a minute to create network
- Mount it high for better connection
- **How to Connect:**
  - First ethernet port to connect to Radio Power Module (RPM)
  - Additional ethernet (PoE) ports to connect to a camera or network switch

Additional Information:
[Programming the Radio (wpilib)]

Radio Power Module (RPM)

- Provides powers to the **Bridge**
- Passes signal between the radio and roboRIO
- RPM provides power over the ethernet cable (PoE) to the bridge.
- Connections:
  - Power (red and black) from roborio
  - NI roboRIO Ethernet Port connects to Roborio
  - WIFI RADIO port connects to Bridge

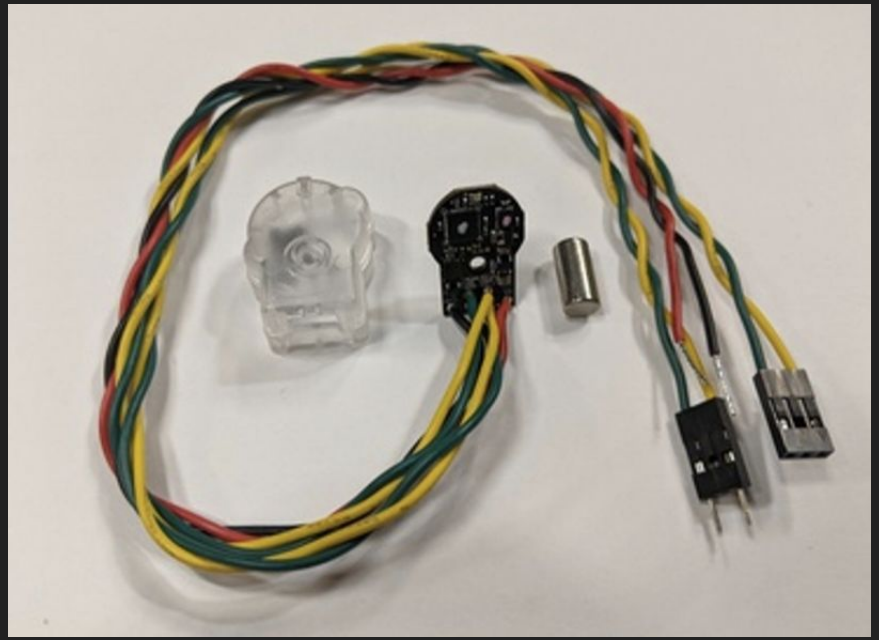
The CAN bus



PDH is not shown being connected into the CAN BUS in the above example.

- **Allows roborio to control stuff**
- CAN wire is green/yellow
- On end of the CAN bus should be connected to a 120 ohm resistor.
- The **CANivore** is a USB-to-CAN device
- CAN Bus daisy chains or control system elements together
    - motor controllers, PDH, Mini Power Module (MPM), and the Pneumatics Hub Control Module (PHCM) if there are pneumatics on the robot
    - If one connection is broken, connection to all devices after the break is lost
- The robot inspector will check the CAN Bus during robot inspection

Can Coder

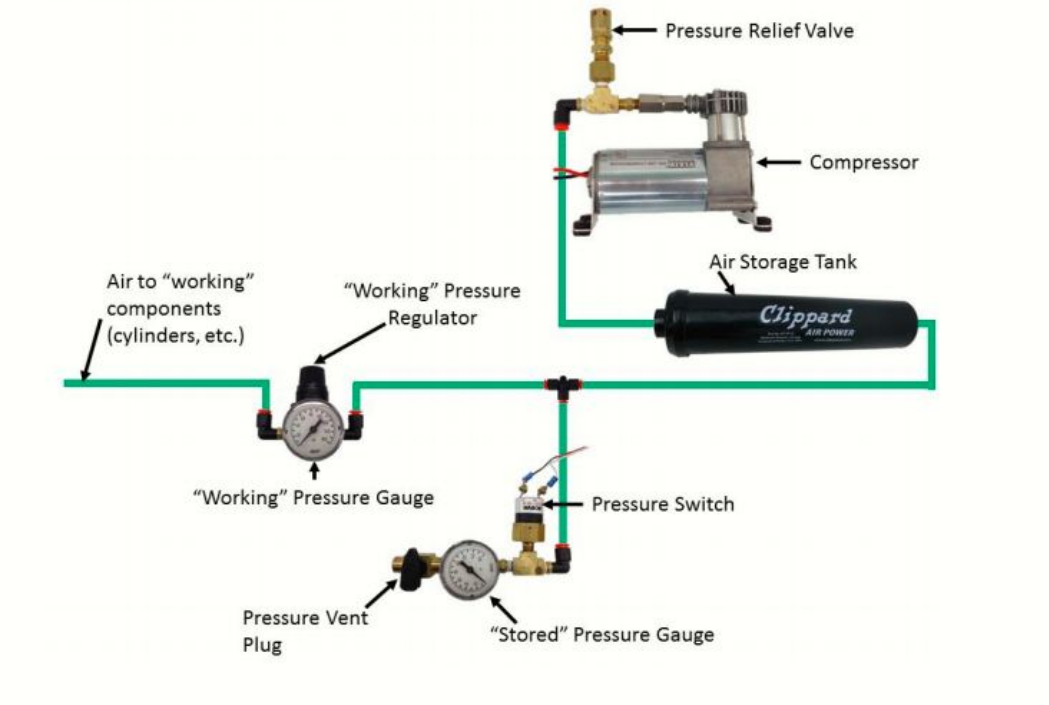


- Rotary magnetic encoder that communicates over the CAN bus.
- Used for swerve modules on robot.

Nav2X & Pigeon 2.0

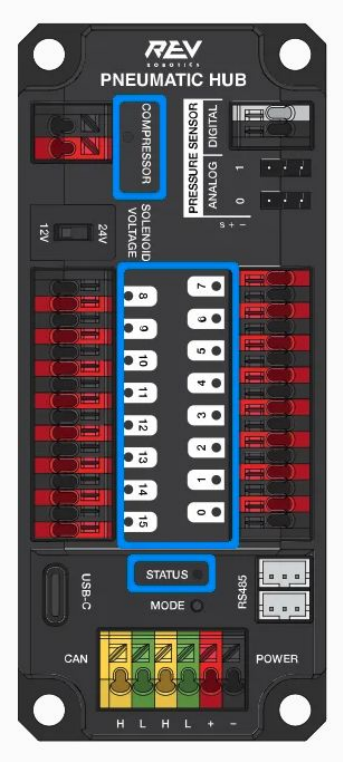
- NavX2 & Pigeon 2.0 are a sensor and motion processor
  - provides accurate measure of motion
- Other end of CAN
- Encoders
  - absolute & quadrature

Pneumatics



- Compressor fills tank
- Pressure release valve to empty tank
- Stored pressure: 120 psi
- Working pressure: 60 psi
- Air ends up in solenoids, solenoids control air to pistons

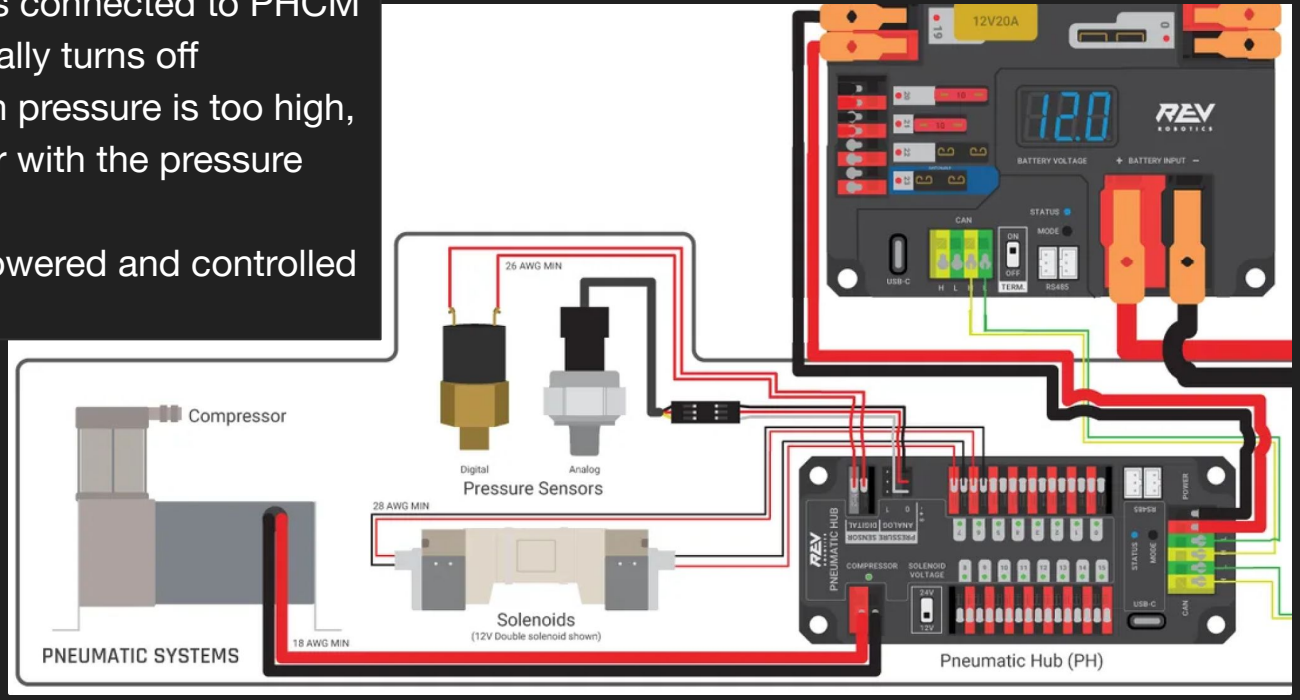
Pneumatics Hub Control Module (PHCM)



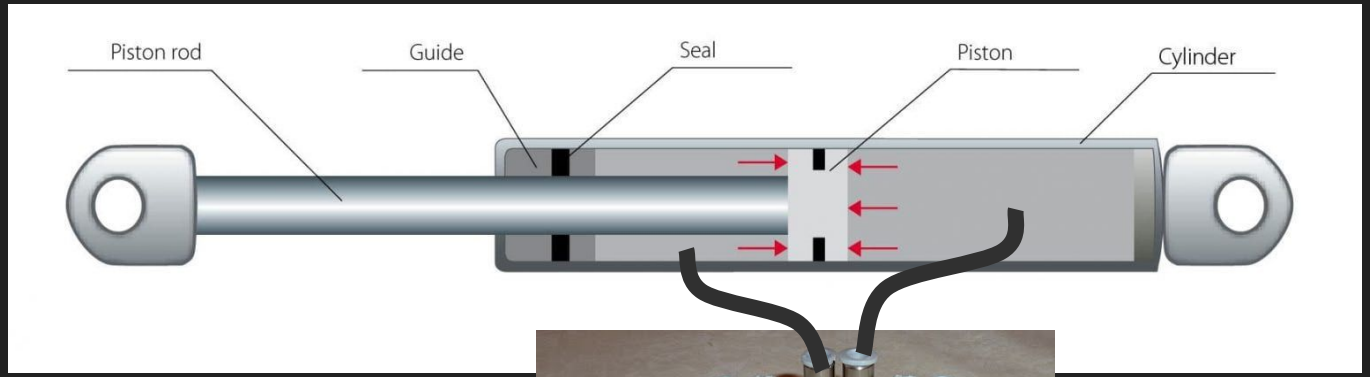
- Controls solenoids
  - Solenoids control pistons
- Controls compressor
- Controls pressure switch
- Each port is labelled and controls one solenoid
- Double solenoids use two ports since they have two solenoids in them
- Part of CAN bus
- Can be powered from PDH

Pneumatics Components

- Pressure switch is connected to PHCM
- PHCM automatically turns off compressor when pressure is too high, also will let out air with the pressure switch
- Compressor is powered and controlled by PHCM



Pistons



- Manifold, space efficient stackable solenoid

- Double solenoid will send air to one of the two cavities
- This will make the piston expand or contract

Motors - 3 main classes

NEOs

- Use sparkmax
- Brushless
- Integrated encoder
- Completely different system than other motors

Classic Motors

- Use any motor controller
- No integrated encoder
- Examples: CIM, 775, BAG

Falcon 500

- Integrated motor controller and encoder
- Newest FRC motor, most powerful motor
- brushless

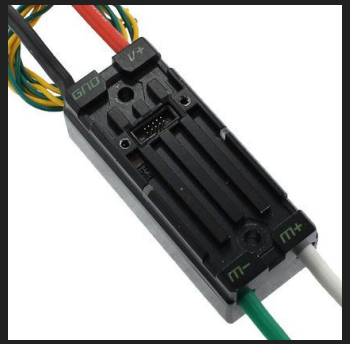
Motor Controllers

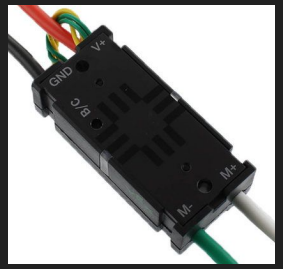
- Get power from PDH, gives power to motors
- Controlled with CAN bus via Canivore & roboRIO
- Sometimes can read encoders
- Brushless motors NEED brushless motor controllers

Motor controllers

Brushed motor controllers

- Talon SRX
  - Has encoder port for encoder
- Victor SPX
  - Does not have encoder port for encoder



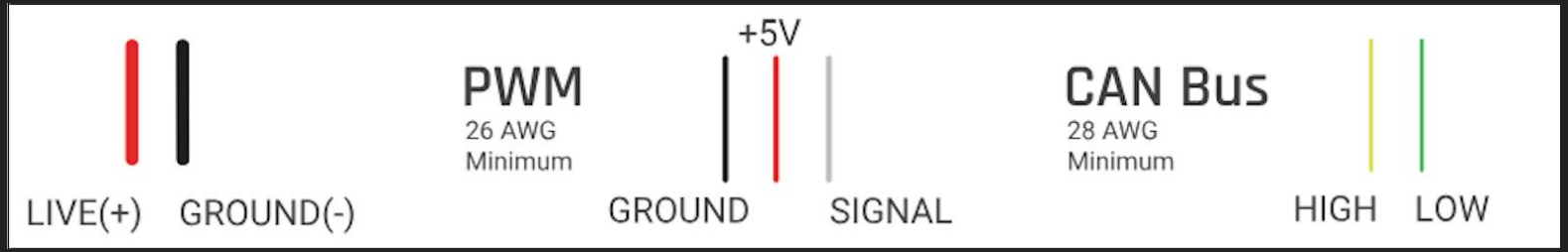


Brushless motor controllers

- SparkMax
  - Controls all NEO motors
- **Requires encoder to be plugged in**
  - Talon FX
  - Integrated into Falcon 500 motor

Typical Wiring used on our Robots

- Stranded wires
- 24 AWG - Sensors
- 22 AWG - CAN, Limit Switch
- 12 AWG - PDH to Motors
- 6 AWG - Battery



Recap on Control System choices

- Control system component placement should be considered during all aspects of robot design.
  - Lowest possible center of gravity (CG) should be considered at all times.
- Serviceability, all parts must be easy to see, reach and replace.
  - You will need to troubleshoot and replace failed control system components.
  - This will also help you out during robot inspection.
- Components should never be used as hard stops
- Wiring, and cable management
  - Consider how to effectively use cable trays and plan cable runs with serviceability in mind.
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Self Study - You can learn more at:

https://docs.wpilib.org/en/stable/index.html