# Sensors and Control

Team 1732 Electrical Subteam

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# Overview

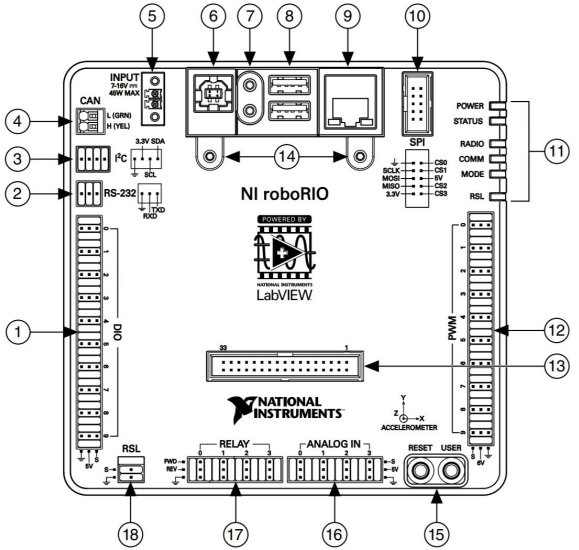
- Roborio
- Motor Controllers
- Radio
- Sensors
  - Encoders
  - Limit Switches
  - Proximity Switches
  - Potentiometers
  - Cameras
  - Ultrasonic Sensors
  - Optical Sensors
  - IMUs

# RoboRIO

- The “brain” of the robot
- Holds the main robot code
- Distributes signal through CAN wires to control the distribution of power.
- It is connected to all of the motor controllers in a CAN wire chain to control the motors.
- Has additional inputs and ouputs for devices like sensors and servo motors

# RoboRIO Ports

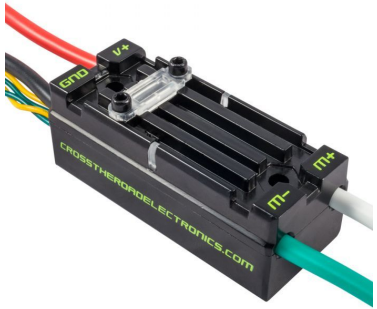
- DIO ports are for digital sensors, like limit switches or encoders
- I2C can be used for some sensors
- CAN (Controller Area Network) communicates to other control system devices
- PWM ports can control servo motors and some motor controllers
- myRIO expansion port adds many more ports and can be used for some sensors, like the NavX IMU
- Analog In ports are for analog sensors like potentiometers
- Relay ports are for relays, which are essentially electronic switches
- RSL port makes the amber light blink




1. Digital input and output (DIO) port
2. RS-232 port
3. I2C port
4. CAN port
5. Power connector
6. USB Device port
7. USB Host retention mount
8. USB Host ports
9. Ethernet port
10. Serial peripheral interface bus (SPI) port
11. LEDs
12. Pulse-width modulation (PWM) port
13. myRIO Expansion Port (MXP)
14. MXP retention mount
15. User and Reset buttons
16. Analog input (AI) port
17. Relay port
18. Robot signal light (RSL) port

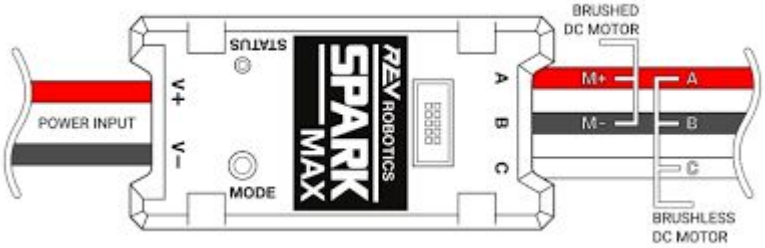
# Motor Controllers

- For brushed motors
  - Talon SRX
    - “Smart” built-in speed control
    - Encoder and limit switch feedback port
  - Victor SPX
    - Cheap + light
    - Can “follow” a Talon SRX
      - In a gearbox with multiple motors, connect the encoder to a Talon and use Victors for the other motors to save money



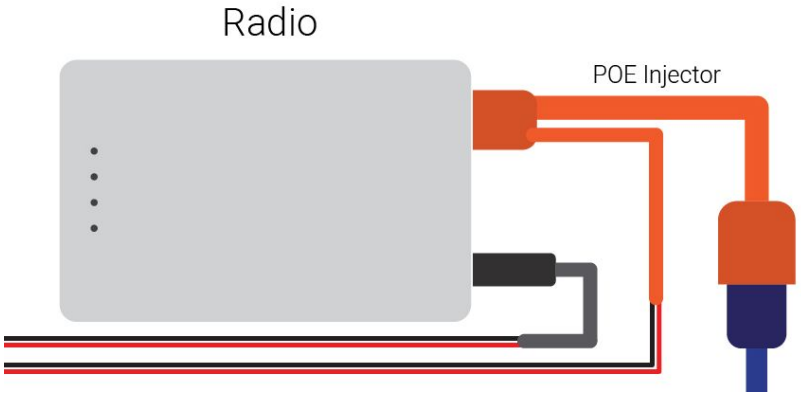

# Motor Controllers - Brushless

- For brushless motors
  - Spark Max
    - For Neo and Neo550 motors
  - Falcon500 + Talon FX built-in controller
    - Includes built-in encoder



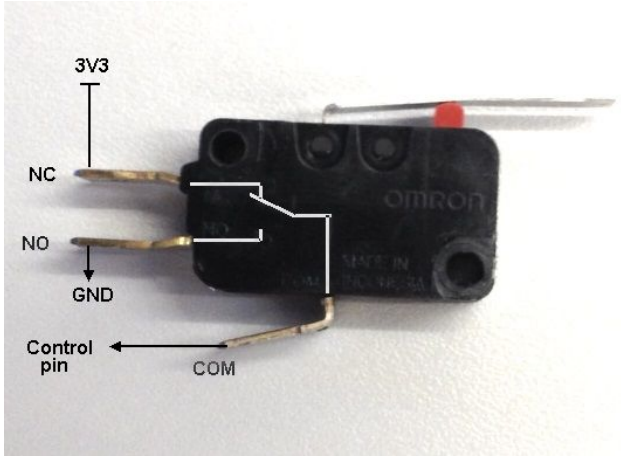

# Radio

- How the robot gets signal from the driver station.
- It connects to WIFI and distributes signal to the Roborio through POE (Power over Ethernet)



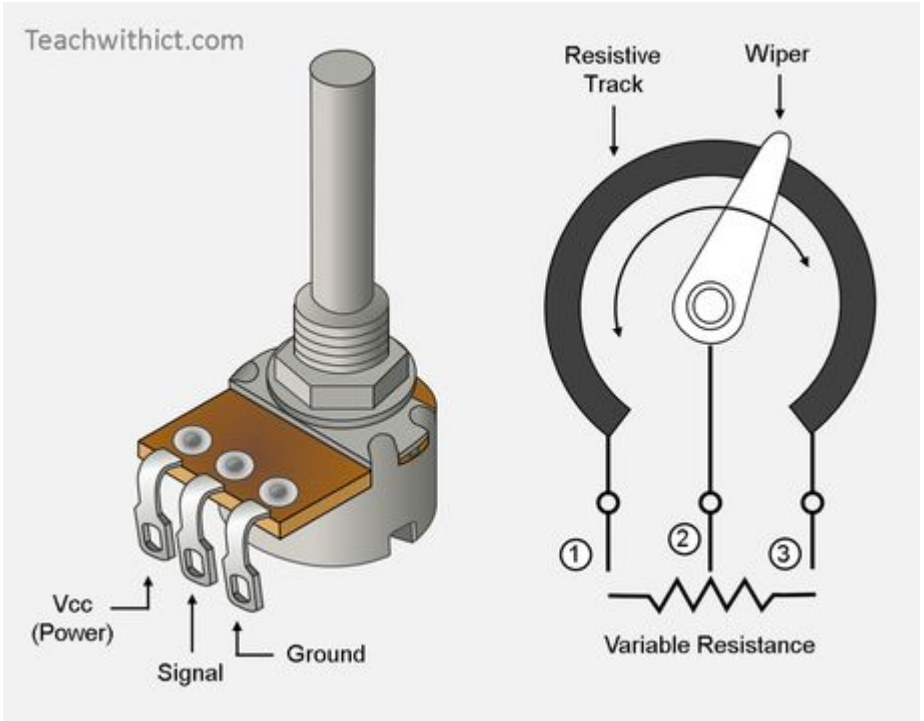

# Limit Switches


- A small button
- Digital output - 0 or 1
- 2 outputs
  - NO = Normally Open
    - Usually 0
    - Pressing the button switches it to 1
  - NC = Normally Closed
    - Usually 1
    - Pressing the button switches it to 0
- Example uses:
  - Homing switch at the bottom of an elevator, used to reset the height count
  - Travel limit sensing - check the CNC or a 3D printer



# Potentiometers


- Rotation or slider sensors
- Analog output - varies from 0V to Vin
- A variable voltage divider
  - If the input is 5V, the output varies from roughly 0-5V depending on the wiper position
- Example uses:
  - A slider on the driver station to set flywheel speed
  - A rotary pot connected to a turret to sense angle



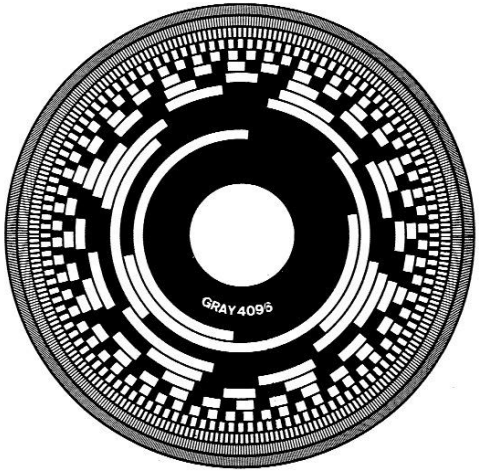
# Encoders

- Rotation sensing
- “Absolute” position
  - A known output for every position
    - I.e. 0 degrees is always -5v, 180 degrees is always 0v
- “Relative” position
  - Counts “ticks” as it rotates
- Magnetic encoder
  - Uses hall effect sensors to check magnetic field
- Example uses:
  - Flywheel speed
  - Arm angle

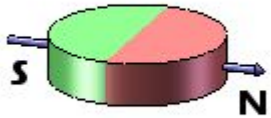

Rev Through Bore

SRX Mag Encoder

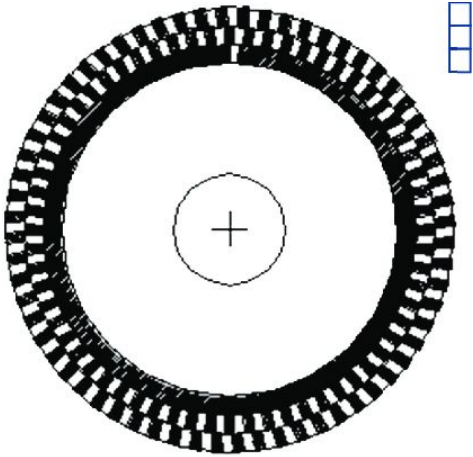
Grayhill 63R




Absolute disc



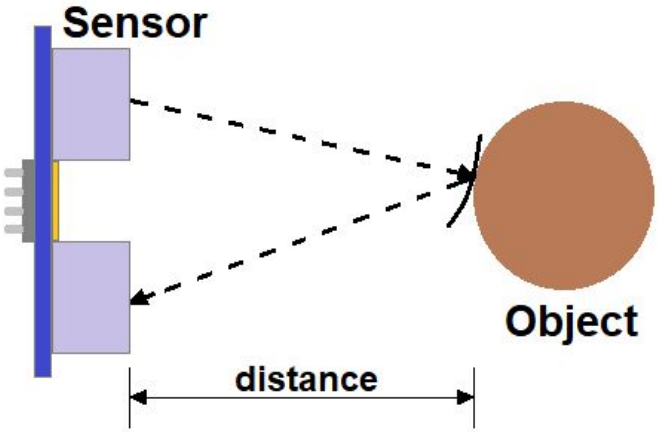

Diametrically Polarized Magnet



Relative disc

# Proximity Sensors

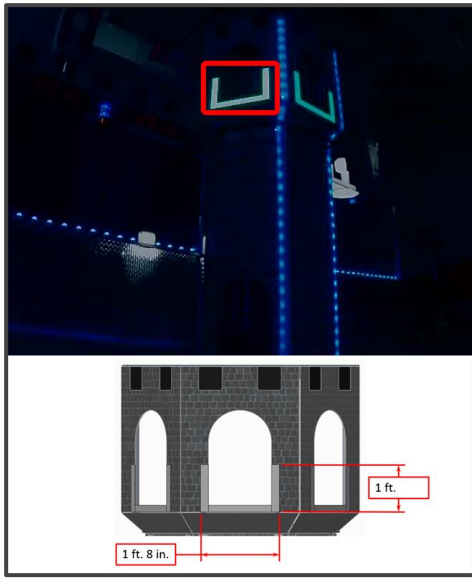
- A category of sensing to detect a nearby object or measure distance
- Many different types
  - **Inductive** prox switch detects metal that interacts with a magnetic field
  - **Photoelectric** switches emit light and measure how much bounces back
  - **Ultrasonic** sensors emit and measure ultrasounds
  - **Hall-effect** sensors measure the magnitude of a magnetic field
  - **Lidar** sensors measure the time of flight of laser beams
  - And more! But that's most of what we use.


$$Distance = \frac{Time\ x\ Speed\ of\ Sound\ in\ Air\ (343m/s)}{2}$$

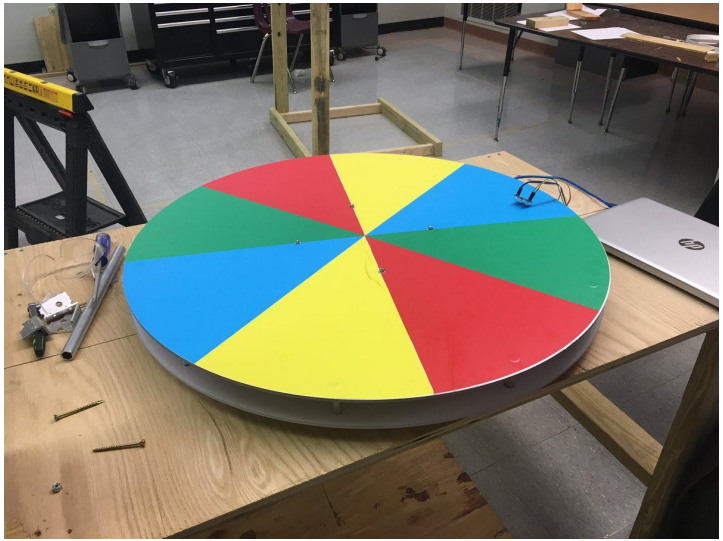
# Sensors Cont.

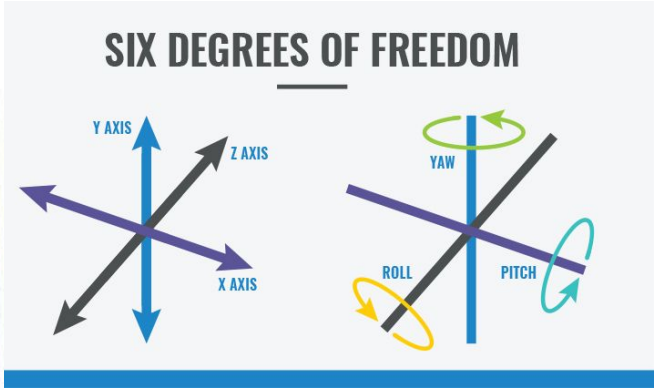
- Driver feedback cameras stream to the driver’s station where the video is displayed
- Vision tracking systems like Limelight and Gloworm use software to recognize known shapes on the field

# Other Sensors

- **Color sensor**
  - Used to read and compare colors
  - Example: Rev Color sensor and 2020 Color Wheel
- **IMU:** Inertial Measurement Unit
  - Used to measure rotation, acceleration
  - Useful for autonomous route tracking
  - Example: NavX board



# Power Distribution Parts

Team 1732 Electrical Subteam

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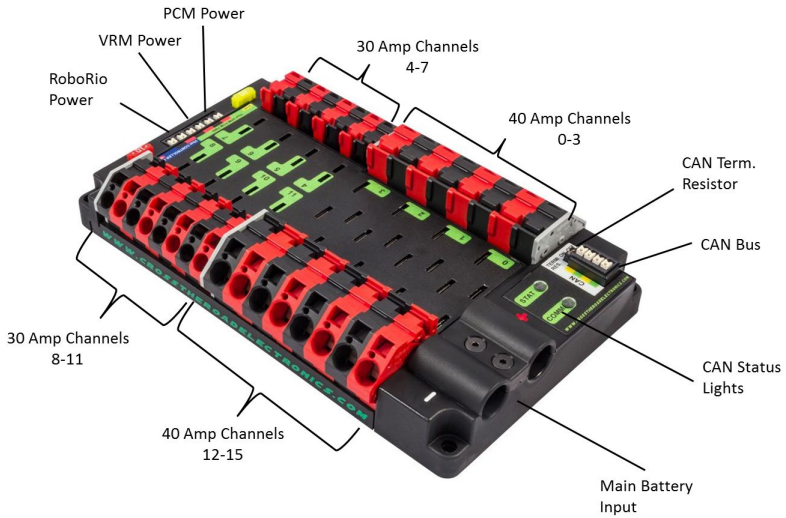
Updated 12/2020

# Overview

- PDP
- VRM
- PCM
- Breakers
  - Main Breaker
  - Fuses
- Power Flow

# PDP

- **PDP - Power Distribution Panel** - This is where the power of the battery goes to immediately. This panel distributes the power to all of the parts of the robot like motor controllers and pneumatic solenoids.
  - There are two main channels on the board: 30 amp and 40 amp.
  - The 40 amp channels normally power Talons or Neos
  - The 30 amp channels normally power victors or other small things.
  - Connected by CAN wire to the Roborio, motor controllers and other Power Controllers



# VRM

- **VRM - Voltage Regulator Module** - This controller gets power from the PDP and distributes it the pieces on the robot that require much lower voltages than the PDP outputs
  - Radio
  - limelight

# PCM

- **PCM - Pneumatics Control Module** - This gives power to the pneumatics and controls it through differential voltages.
  - Solenoids
  - Compressor
  - Pressure switch

# Breakers and Fuses

- **Breakers** - these are placed in the PDP to regulate the amount of amperage that flows into an output at one time. They will “break” and open the circuit if the amperage exceeds that point as to not damage anything.
  - On PDP
    - 30 and 40 Amp breakers for motor controllers

- **Main Breaker** - this is a manually operated breaker which connects the battery to the PDP. This breaker is opened if the robot is turned off or if there is an emergency stop required. It is the main switch of electrical flow.


- **Fuses** - these are like breakers, but they do not reset after broken and must be replaced.
  - On PDP, used for lower amp distribution (VRM, PCM, RoboRIO)

# TEAM 3161

# FRC ROBOT CONTROL SYSTEM

COMPONENTS NOT TO SCALE