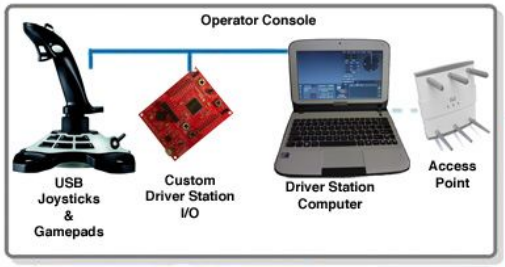
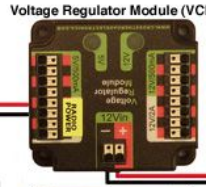
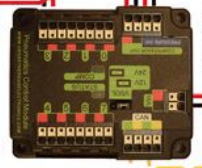
Introduction to FRC Control System

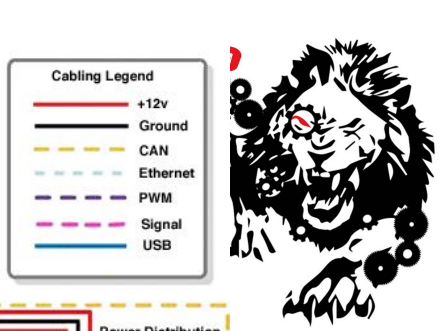
Team 4919 LeoDriods

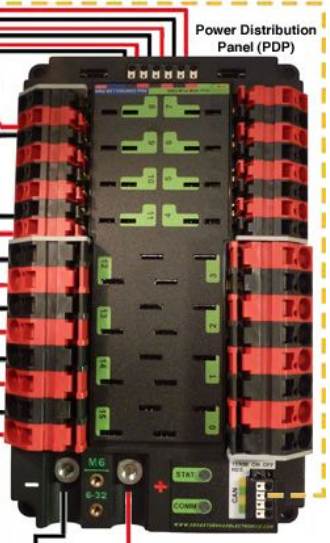
2015 FRC® Control System Layout

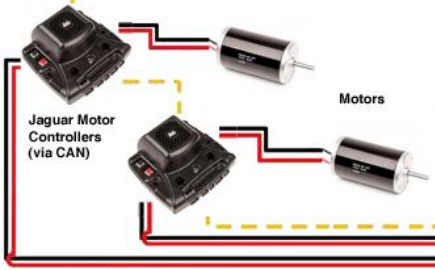












National Instruments roboRIO

- Main robot controller used for FRC.
- Dual-core ARM Cortex-A9 processor
- Integrated I/O controller
  - connections to robot for sensing and control: Ethernet, USB, CAN, SPI, I2C, serial, PWM, servo, digital I/O, and analog I/O channels
- Connect to the dedicated 12V port on the Power Distribution Panel for power
- Wired communication via USB or Ethernet

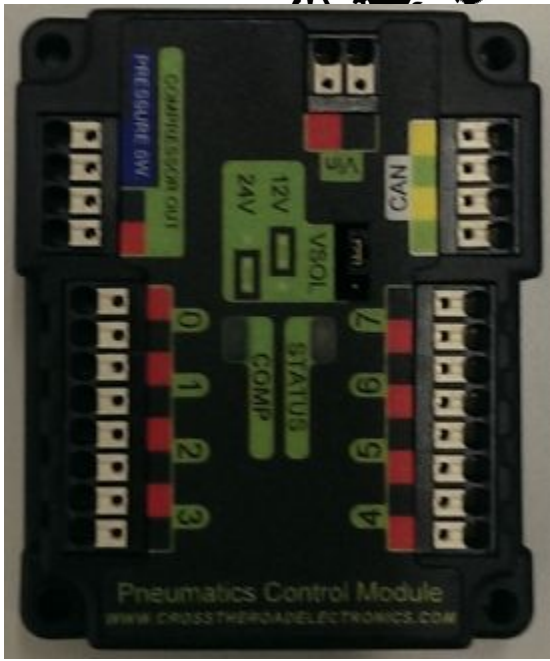
iPhone 4S

Power Distribution Panel (PDP)

- PDP distributes power from 12VDC battery to robot components through auto-resetting circuit breakers & fused connections.
- 8 pairs rated for 40A continuous current
- 8 pairs rated for 30A continuous current.
- 12V connectors for the roboRIO, Voltage Regulator Module and Pneumatics Control Module.

Pneumatics Control Module (PCM)

- PCM contains all inputs and outputs required to operate 12V or 24V pneumatic solenoids and compressor
- Enabled/disabled by the roboRIO with CAN interface
- Input for pressure sensor for automatic compressor control when robot is enabled and a solenoid has been created in the code.
- Collects diagnostic information such as solenoid states, pressure switch state, and compressor state.
- Includes diagnostic LED’s for both CAN and the individual solenoid channels.



Voltage Regulator Module

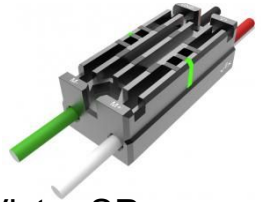
- VRM an independent module powered by 12 VDC wired to a dedicated connector on the PDP.
- Multiple regulated 12V and 5V outputs
  - regulated power for the robot radio, custom circuits, and IP vision cameras.
- Connector pairs have combined rating of label indication (5V/500mA total for both pairs not each pair).
- The 12V/2A limit is a peak rating, should not be loaded with more than 1.5A continuous current draw.

Motor Controllers

- PWM variable speed motor controllers:
  - SPARK Motor Controller from REV Robotics
  - Talon Motor Controller from Cross the Road Electronics
  - Victor 888 from VEX Robotics
  - Victor SP, from Cross The Road Electronics/VEX Robotics
- Jaguar is CAN-enabled "smart motor controller" or PWM controlled from VEX Robotics

Talon

Spark


Victor SP


Victor 888


Jaguar

Spike H-Bridge Relay

- Controls power to motors or other custom robot electronics.
- On/Off control in both the forward and reverse directions.
- Independently controlled outputs: can provide power to up to 2 custom electronic circuits
- Connect to a relay output of the roboRIO and power from PDP

Microsoft Lifecam HD3000

- The Microsoft Lifecam HD3000 is a USB webcam that can be plugged directly into the roboRIO
- Capable of capturing up to 1280x720 video at 30 FPS

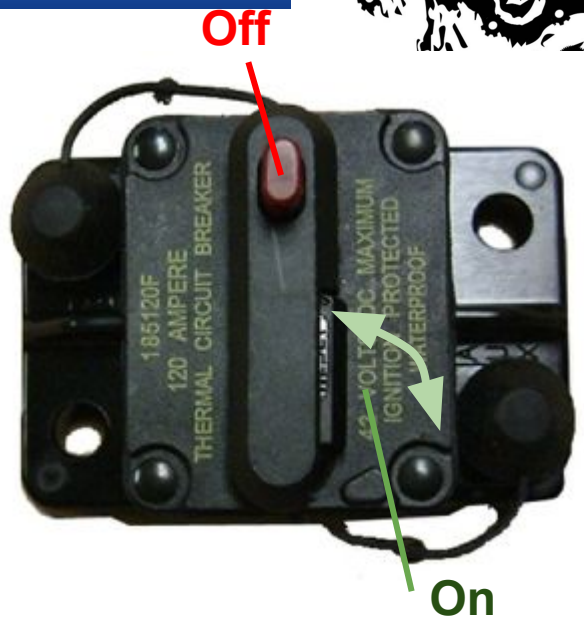
OpenMesh Radio

- OpenMesh OM5P-AN or OM5P-AC radio on the robot radio provides wireless communication functionality
- Can be configured as:
  - Access Point for connection of a laptop for home
  - Bridge for use on the field
- Powered by 12V outputs on the VRM
- Connected to roboRIO over Ethernet
  - Can use POE injector for secure power connection

120A Circuit Breaker

- Turn OFF Power to Robot Before Work
- Announce When Turning on Robot

- Serves as main robot power switch
- Also as protection for downstream robot wiring and components.
- Wired between the positive terminals of the robot battery and Power Distribution boards.

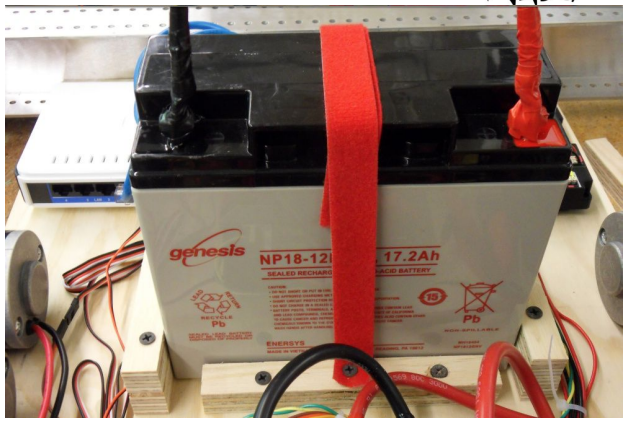


Snap Action Circuit Breakers

- The Snap Action circuit breakers used with PDP to limit current to branch circuits
- MX5-A40 40A MAXI circuit breaker used with larger channels on PDP to power loads which draw current up to 40A continuous
- VB3 series used with smaller channels on PDP to power loads which draw current of 30A or less continuous

Robot Battery

- The power supply for an FRC robot is a single 12V 18Ah battery
- Sealed lead acid batteries capable of meeting the high current demands
- Never lift the battery by the cables
- Neutralize Leaking Battery by pouring the sodium bicarbonate on all wetted surfaces. Notify mentor.



Never cause a direct short circuit.
This may cause high heat to develop in the battery terminal/part/tool area and the battery could explode

Motors

CIM, Mini-CIM, Bag
CIM motors are used in drivetrains rules only allow 6 per bot. Mini CIM can be used in pace of CIM bu less powerful

775, 9015, 550
Useful for shooters and such, where they can run at high rpm

Throttle
Not that fast or powerful. The location of the electrical inputs makes them hard to locate or use.

Window, Seat, Snowblower
Has torque at lower speed

Servo
For moving camera

For more Motor info see VEX Robotics DC Motor Information: http://motors.vex.com/introduction

Robot Sensors

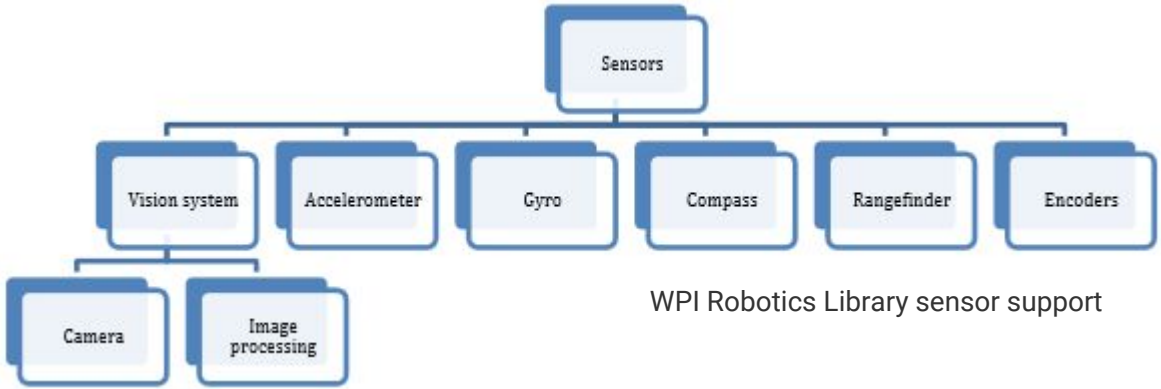
How do I do _____?

Selecting the right sensor for the job

Robot Sensors Overview

Sensors categories:

- Wheel/motor position measurement -
  - Gear-tooth counters, encoders, analog encoders, and potentiometers
- Robot orientation -
  - Compass, gyro, accelerometer, ultrasonic rangefinder
- Generic -
  - Pulse output Counters, analog, I2C, SPI, Serial, Digital input



WPI Robotics Library sensor support

Detecting 1 or 2 positions of a mechanism

Limit Switches

- Common solution for this scenario.
- To defining limits of mechanism, set switches in position where they can't be missed and wont get damaged
- Simple to implement, fairly cheap, and can be used in a large variety of situations.
- Have "normally opened" or "normally closed" outputs.
- Wire the switch between a digital input signal connection and ground.

Detecting position at many different points

Examples:

- how high up is your elevator,
- how high up an arm is from its starting position,
- what angle your shooter head is pointed at,
- how far is the robot from the field element

Sensors to use:

➔ **Ultrasonic** Sensors - Measuring robot distance to a surface
➔ **Infrared** Distance Sensors - Measuring robot distance to a surface
➔ **Counters** and **Encoders** - Measuring rotation, counting pulses and more
➔ **Potentiometers** - Measuring joint angle or linear motion
➔ **Accelerometers** - Measuring acceleration and tilt

Driving Straight

For robot to drive itself straight in autonomous, you have a couple sensors that will work to get the job done.

(Gyroscope) **Gyros** - sensor pointing in a direction, telling when you deviate from that direction, and how far.

- Correct for one motor being slightly slower than the other,
- or an accurate measurement of how far we have turned in autonomous
- measures off an initial point, if robot is put in wrong place, it will not know that

Encoders - sensor for measuring the rotation of a spinning shaft

- on drive motors, measures how far the wheels have turned
- if one of measures further than the other, you can correct for it
- not as effective when turning because wheels can slip

How far have I gone?

In autonomous program, you will most likely need to drive, but it wont know how far it's gone or how far it needs to go without sensors.

Encoders - measures number of rotations a motor has gone since last reset

- calculate rotations to distance for the different gear and pulley ratios
- gets a little less accurate the further away from your wheels

Distance Sensors (**Ultrasonic**, **Infrared**)

- not very common due hard to set up the robot on the field
- can tell how far you have gone if you have a point to measure from.
- usually not possible to tell how far you have gone after a turn, or how far you have gone if its too far away from a static object.

Cameras and Vision

Why use vision? Vision is a very powerful tool:

- it can give you an idea of how far you are from something,
- how many items you have in front of you,
- where you are pointing, and
- how fast you are moving, all from one sensor.

All this from knowing the viewing angle of the camera, resolution, and size of a known object

To use vision, you need to have a few things:

1. A good quality camera,
2. a way to process the visual information into meaningful data,
3. and someone willing to learn advanced visual identification & libraries.

More advanced vision may a separate processor and a better camera than KOP

How fast is that wheel spinning?

Why? With shooters, you may want to know how fast a wheel is spinning to know when to shoot.

Counters and **Encoders** - measure the number of rotations

When measured over a given period of time you get the speed of the wheel

Other Sensors and Problems

Sometimes available sensors are not good enough:

- encoders not able to read at the speeds you need
- ultrasonic sensors too inaccurate after a certain distance

These are all challenges to solve, and is the reason you are really here. This is when some of the best and most creative solutions to problems are created.