Citrus Circuits
Fall Workshop Series

Diagnosing Electrical Issues

by Rohan Nepomuceno

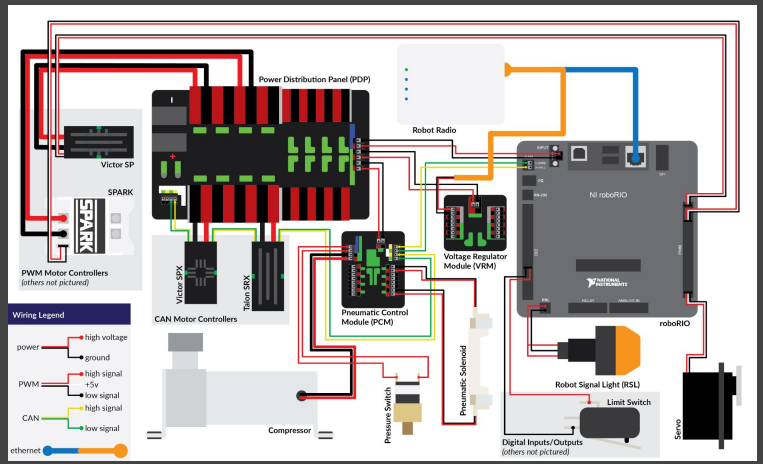
Introduction to Your Presentor

Rohan Nepomuceno

- Senior, Davis Senior High School
- Member of FRC 1678, 4th year member
- Hardware Electrical Lead, Citrus Service

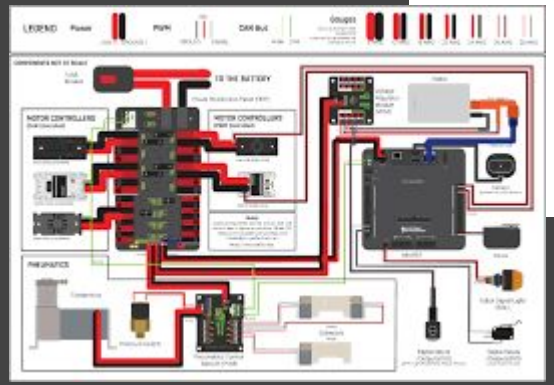
FRC Control System Overview

- The basics of the current control system has been around since 2015 which receives updates yearly
- The main systems that usually have the most issues are the power, signal, and pneumatic systems



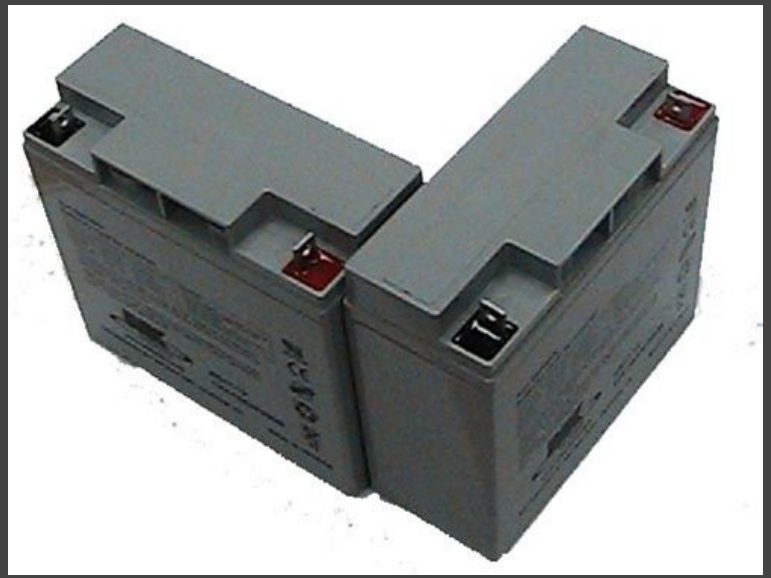
Power System

- Power system supplies all electronic power to the robot components
- All power comes from the battery



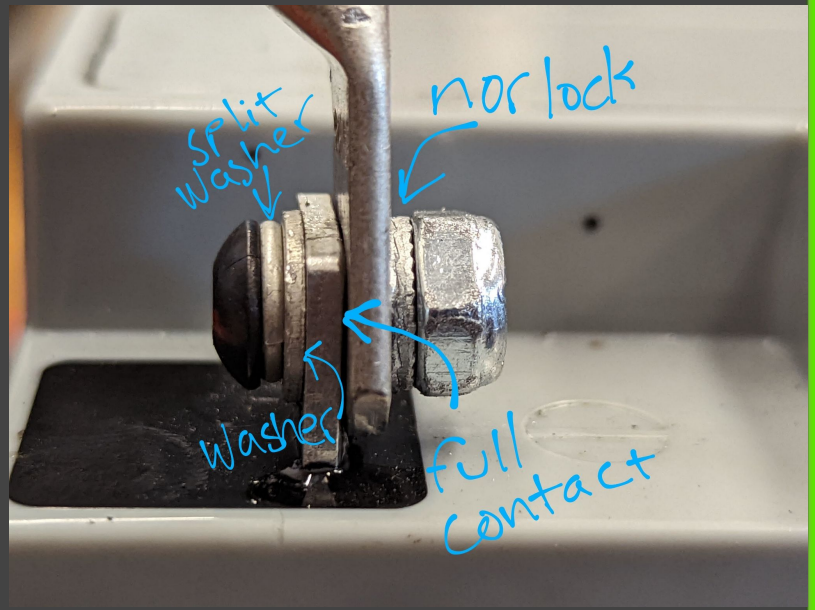
Battery

- Common problems with the battery
  - Strained/ damaged terminal connections
  - Degrading battery cell health
- Signs of problem
  - Voltage drops
  - brownouts



Battery

- Trickle charging- the practice of charging a battery equal to its discharge rate at full capacity
- Nord Lock Terminal Connections
  - Full contact

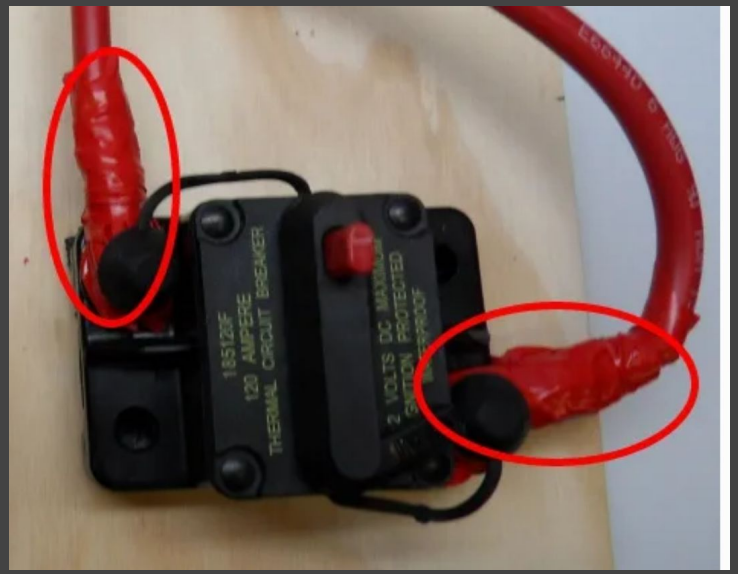


Main Breaker

- Common Problems:
  - Connectivity
- Signs of poor connection to the main breaker
  - Warm to the touch
  - Burn marks
  - Voltage drop
    - Complete loss of power

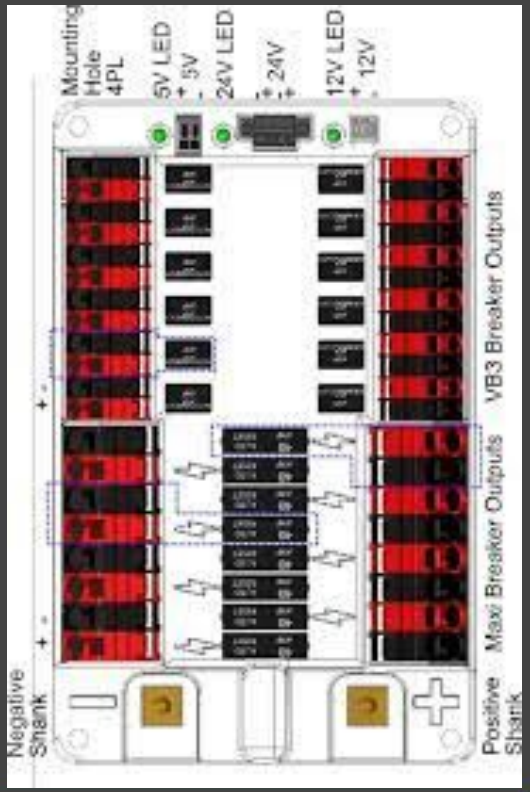
Main Breaker

- Insulation of the power terminals
  - The ones given do not cover enough to be safe
- Switching power problems
  - Damaged hardware
    - Replacement of Main breaker necessary



PDP

- Power distribution panel is a hotspot for electrical issues
- Common Problems
  - Battery/Main breaker connections
  - Port/Gate connection
  - CAN
  - Broken Fuses



PDP

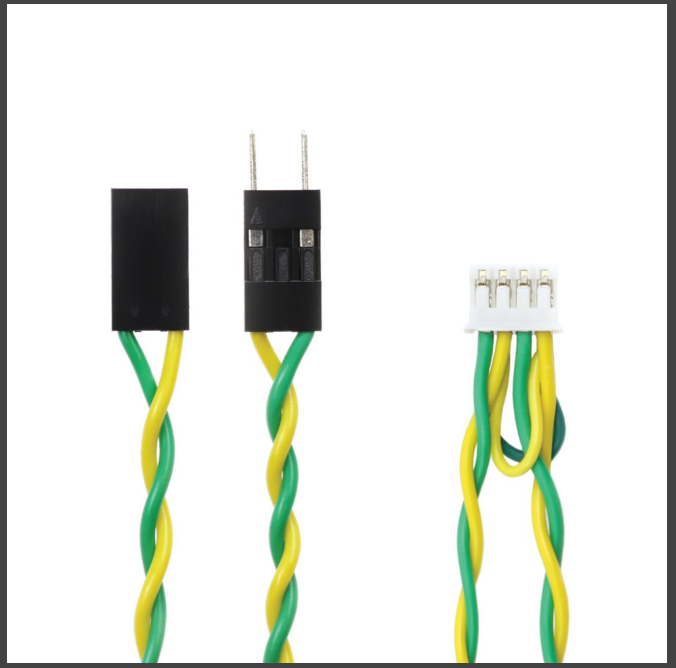
- Connectivity
  - Always insulate any exposed wire
- Understanding Port Layout
  - Once broken replacement is the best option
- Fuses
  - Feature not a bug

Power Distribution Hub

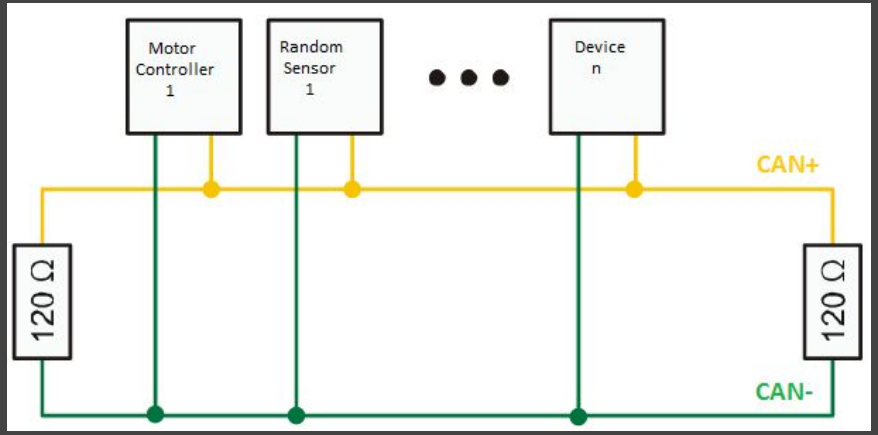
- Power Distribution Hub is an alternative to the PDP
- Common Problems
  - Frayed Port Connections
  - CAN
  - Broken Fuses

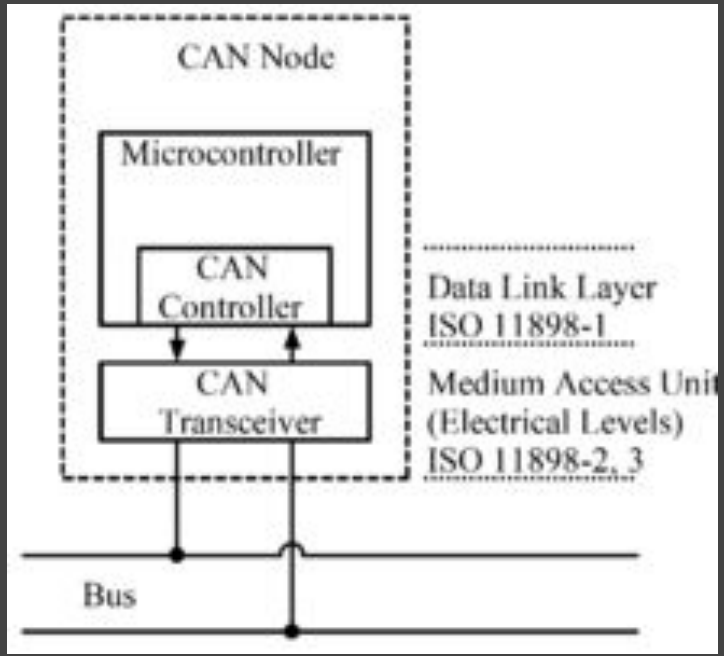
CAN

- Control Area Network
  - Nodes
    - Receiver and Transmitter
- Common Problems
  - Poor Connection
  - ID’s
  - Shorting



CAN cont.


Motor Controller 1
Random Sensor 1
Device n
CAN+
CAN-
120 Ω
120 Ω


CAN Node
Microcontroller
CAN Controller
CAN Transceiver
Data Link Layer
ISO 11898-1
Medium Access Unit
(Electrical Levels)
ISO 11898-2, 3
Bus

CAN

- No CAN Signal being received
  - Check connectivity between components
  - Check resistance between components
  - Check connectivity to the robot frame

CAN

- No CAN Signal cont.
  - Checking that there are ID’s on the component being tested
  - Terminating resistor on PDP
  - Hardware Problem

CAN

- Fuzzy/ Inconsistent CAN
  - Temporary discontinuity
    - Moving Part/Jostling around
- EMF disruption
  - Electromagnetic Field run though coiled wired
    - Avoiding large coils
      - Increased Resistance

RoboRio

- The central processor of the robot
- Common Problems
  - Power
  - CAN
  - Port Connections
  - Processing

Table 2. NI roboRIO Input Voltage Brownout Behavior

Stage	Input Voltage Range	Behavior
1	6.3 V to 6.8 V	The +6 V voltage rail starts to drop.
2	4.5 V to 6.3 V	The NI roboRIO enters a brownout fault condition and the following precautions are taken: • User voltage rails become disabled. • All PWM generation stops at the conclusion of the current cycle. • GPIOs configured as outputs go to High-Z. • Relay control outputs are driven low. • CAN-based motor controllers become disabled. The following systems continue to function normally with valid data and communication: • FPGA, processor, RAM, disk, and user code • USB power and communication • Radio, if powered by USB • Ethernet • CAN • AI and AO • I^2C • SPI • RS-232 serial • LED and RSL status lights Stage 2 continues until the input voltage rises to greater than 7.5 V or drops to less than 4.5 V.
3	Less than 4.5 V	All controller functions cease and the controller state is lost. This condition continues until the input voltage rises to greater than 4.65 V, at which point the controller starts the normal booting sequence. At startup, the controller remains in Stage 2 until the input voltage rises to greater than 7.5 V.

RoboRIO Power

- Input 7V-16V
- When the voltage drops to 4.5V - 6.8V RoboRIO enters brownout mode
- Polarity

RoboRio

- Signs of poor port connections
  - No power to sensors
  - No receiving of sinal
- Check Voltage with a multimeter from the Voltage out to Ground
- Hot Glueing Connections in place

RoboRio

- Signal Lights of the RoboRIO
- Lag or dropping Code processes
  - Processing Problems
    - Revived by external components

Table 13. Power LED Indications

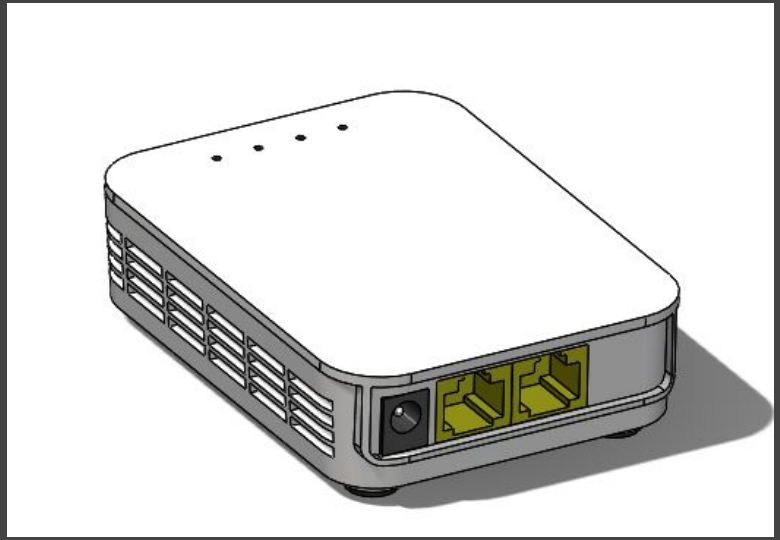
Color	State	Indication
Off	Off	Power is outside valid input range.
Green	Solid	Power is valid with no fault condition.
Red	Solid	Fault condition detected. One or more user voltage rails are in short-circuit or overcurrent condition.
Red	Flashing	The input voltage is too high (greater than 16 V) and all outputs, including the RSL output, are disabled.
Yellow	Solid	Brownout condition detected. The 6 V user rail and outputs are disabled.

RoboRio Processors

- Canifier
  - Microprocessor that uses CAN FD
    - USB port
- Pi Pico
  - Microprocessor connected to MXP port

Radio

- The Communicator between the driver station and the Robot
- Common Problems
  - Power
  - Switch Ports



Radio

- Power
  - Radio Power
    - 12V/2A -VRM
  - Barrel Jack power
  - RPM- more consistent
- Switch Ports
  - Ethernet switch power
  - Hot Glue Ethernet into place

Crimps and Connectors

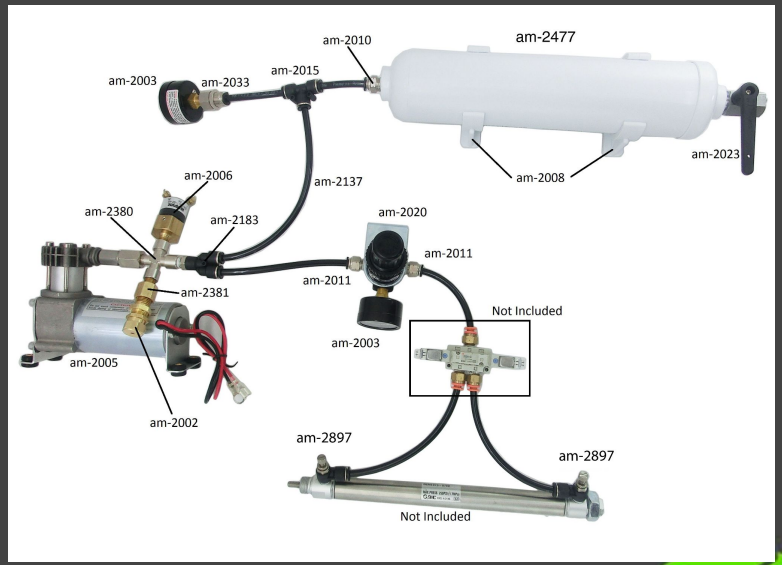
- Anderson Crimps
  - Power connections
- Ferrule crimps
  - Component Gates
- Molex connectors
  - PWM/ Signal Wires
- Lever Locks
  - Prototyping/ Repair

Soldering

- Great way to connect wires if done right
- Common Problems
  - Poor connectivity
  - Melted/Burned insolation
  - Sheer force snapping
- Resistance Checks
  - Heat shrink protection

Pneumatics

- Controls the flow of air on the robot
- Common problems
  - Leaks
    - Do not show up digitally
  - Power
    - Pressure switch
    - Solenoid power



Pneumatic Control Module

- The PCM controls all power for the pneumatic system
- Common Problems include the Output voltage to the solenoids
  - Single and Double
  - CAN

Pressure Switch

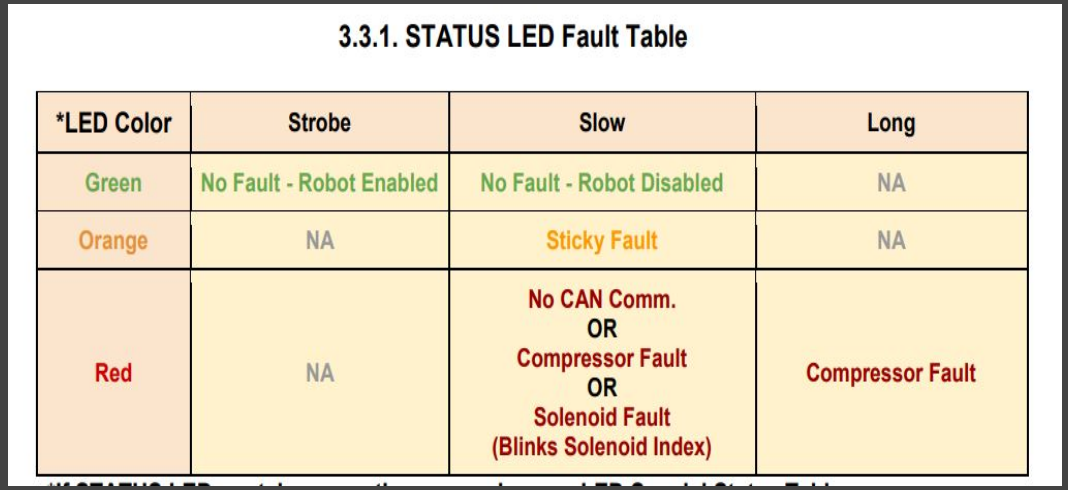
- The Pressure Switch detects the pressure
- Dipolar
- Specialized port
- Common problems
  - Factory pressure
    - Replacement/ Adjustment

Air Leaks

- Air leaks are undetectable digitally- Listening
  - Pressure Gauges Shifts
    - Show Pressure drops
  - Resulting from poor connection
    - Metal Components
  - Puncture in tube
    - Split and divide

Pneumatic Control Module

- Checking the output voltage setting on the PCM and input voltage to your solenoids
- Signal Lights
  - None- not receiving power

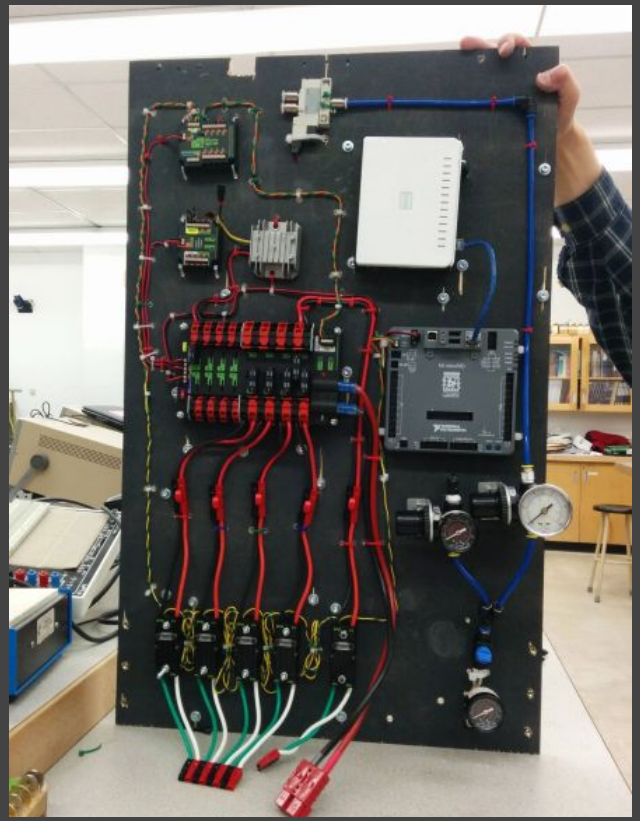


3.3.1. STATUS LED Fault Table

*LED Color	Strobe	Slow	Long
Green	No Fault - Robot Enabled	No Fault - Robot Disabled	NA
Orange	NA	Sticky Fault	NA
Red	NA	No CAN Comm. OR Compressor Fault OR Solenoid Fault (Blinks Solenoid Index)	Compressor Fault

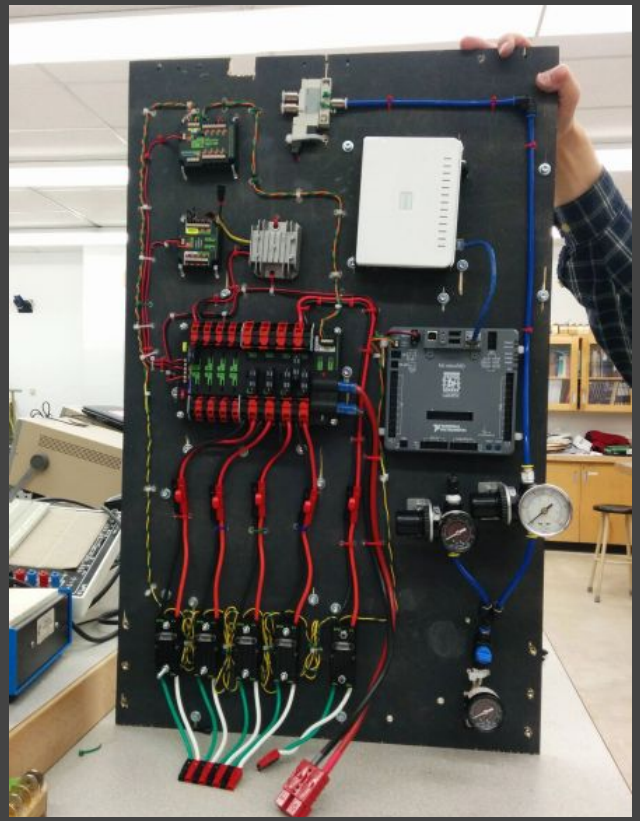
Organization

- Organization
  - Labeling/ Diagrams
  - Routine Checks
  - Wire Protection
  - Design/ Software Collaboration
    - IDs/Bellypan Layout



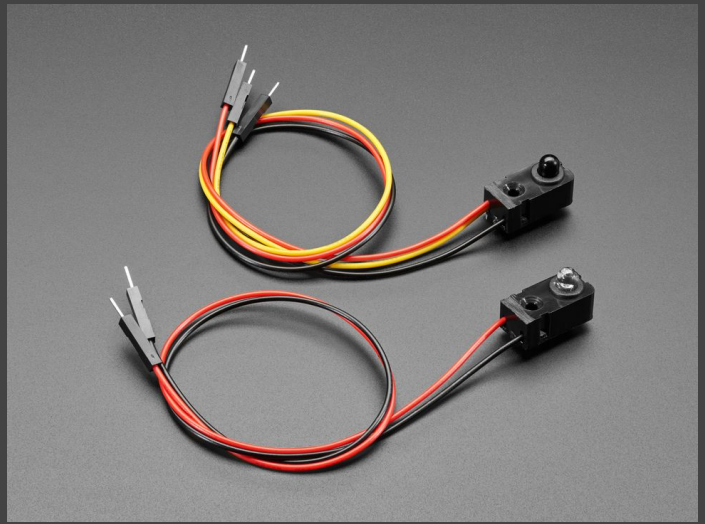
Organization

- Organization
  - Wire Layering
    - Power
    - CAN
    - Pneumatics
  - 90 Degree bends
  - Wire Tensioning
  - Kinetic Wiring



Sensors

- Sensors on the robot are fragile than other components
  - Beam breaks color sensors
- Often times the best solution to a nonfunctional sensor is to replace it

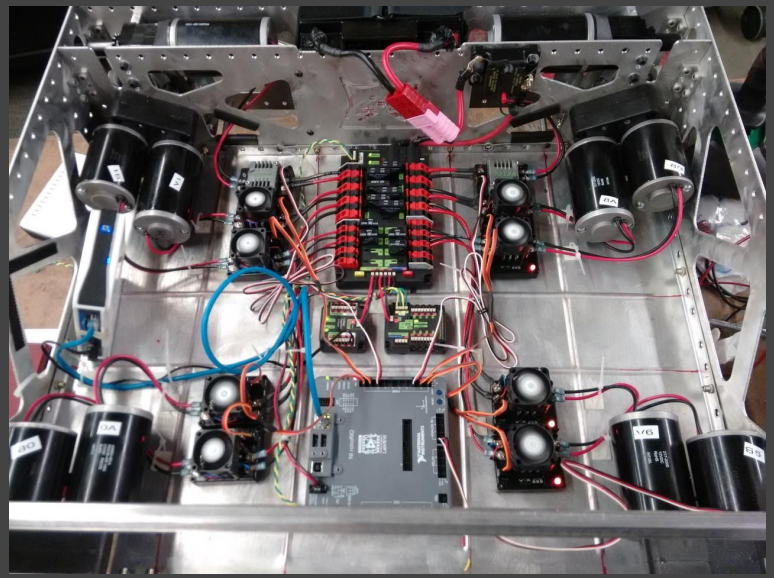


Expansion Boards

- MXP Port of the RoboRio
- Common replacement for the I2C port on the robot as it relieves the processing units of the RoboRio

Misc.

- Grounded frame
- Routine Electrical Checks
  - Pull tests
  - Compressed Air
  - Resistance Checks
- Working with members of software
- Return Merchandise Authorization



Citrus Circuits
Fall Workshop Series

rohannepo@gmail.com

Questions?