# **Mini-Lecture Series**

Team 3176 Off-Season Engineering Orientation

# **Electricity & Electronics**



#### **Previous Lectures...** REDESIGN THE NEED COMMUNICATE RESEARCH THE DESIGN PROBLEM ENGINEERING **DESIGN LOOP** DEVELOP POSSIBLE **TEST AND** EVALUATE SOLUTIONS PROTOTYPE SELECT THE MOST CONSTRUCT PROMISING SOLUTION Motor Curve for CIM Motor 700 140 600 120 Speed (x10 rpm); Power (W) 500 100 🔗 400 80 Current Speed Power 60 300 Efficiency 200 100

AM802-001A PM25R-45F-1003 12VDC PM25R RoHS

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# **Electricity & Electronics**

- The primary source of power for the robot is the electrical battery. It is key to understand the efficient use of this power and how to control it safely.
- In this mini-lecture, we'll cover
  - Some basic electrical concepts
  - Review robot components
  - Design considerations



# **Electricity Basics**

- All matter is made up of atoms
  - Protons, Neutrons, & Electrons



• Movement through a magnetic field, heat, friction, or a chemical reaction









# **Characteristics of Electricity**

- Voltage (E or V) difference in charge in circuit
  - Measured in Volts (V)
- **Current (I)** flow rate in the circuit
  - Measured in Amperes (A)
- Resistance (R) tendency to resist the flow
  - Measured in Ohms ( $\Omega$ )
  - Conductors vs. Insulators





Resistance

# **Ohm's Law**

- These three characteristics (V, I, R) are related in a simple equation:
  - V = I x R
  - or I = V / R
  - or R = V / I



- Electrical designers use Ohm's Law to determine how much voltage is required for a certain load, like a motor, a computer, or even a house full of appliances.
- Remember, Power is related to Voltage and Current

# $- P = I \times V = I^2 \times R$



#### Battery



- The power supply for an FRC robot is a single 12V 18Ah battery.
- The batteries used for FRC are sealed lead acid batteries capable of meeting high current demands of an FRC robot.







- The 120A Main Circuit Breaker serves two roles:
  - Main robot power switch
  - Protection device for downstream robot wiring and components
- The 120A circuit breaker is wired between of the battery and Power Distribution Panel.
- The circuit breakers are also used on the Power Distribution Panel to limit current to branch circuits.



### **Power Distribution Panel**

#### **Voltage Regulator Module**





- The Power Distribution Panel (PDP) distributes power from a 12VDC battery to various robot components through autoresetting circuit breakers and a small number of special function fused connections.
- VRM provides regulated power for the robot radio, custom circuits, and IP vision cameras.



# roboRIO



- The NI-roboRIO is the main robot controller (the "brains").
- Integrated controller I/O includes a variety of communication protocols (Ethernet, USB, CAN, SPI, I2C, and serial) as well as PWM, servo, digital I/O, and analog I/O channels used to connect to robot peripherals for sensing and control.



#### **Wireless Bridge**

#### **Motor Controller**



- The wireless radio is used as the robot radio to provide wireless communication functionality to the robot. The device can be configured as an Access Point for direct "tethered" connection to a laptop.
- The Talon SRX motor controller varies power to the motors as controlled by the roboRIO signals.





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# **Design Considerations**

- Wire Gauge
  - Current capacity and resistance
    - Higher Gauge = Smaller Wire (e.g., 14 AWG)
  - Wire routings excessive lengths leads to losses
- Number of Motors / Controllers / Sensors
- Battery access
  - We need a fresh battery for every round
  - Ease of access vs. stable placement (low center)
- Safety
  - Keep wires insulated and free from moving components
  - Loose wires and metal components don't mix!



# **Questions?**

Sources:

http://www.electronicstheory.com/ http://www.eaton.com/flash/electrical/101series/Fundamentalsof Electricity/story.html https://learn.sparkfun.com/tutorials/voltage-current-resistance-and-ohms-law http://wpilib.screenstepslive.com/s/4485/m/13503/l/599672-2016-frc-control-systemhardware-overview

