

Brought to you by the Boeing Employee Mentoring Robotics Club

2011 FRC Virtual Training Session 3 Electrical System and Sensors

November 18 2011

Tom Wendel

Game Manual Has the Basics

The Book

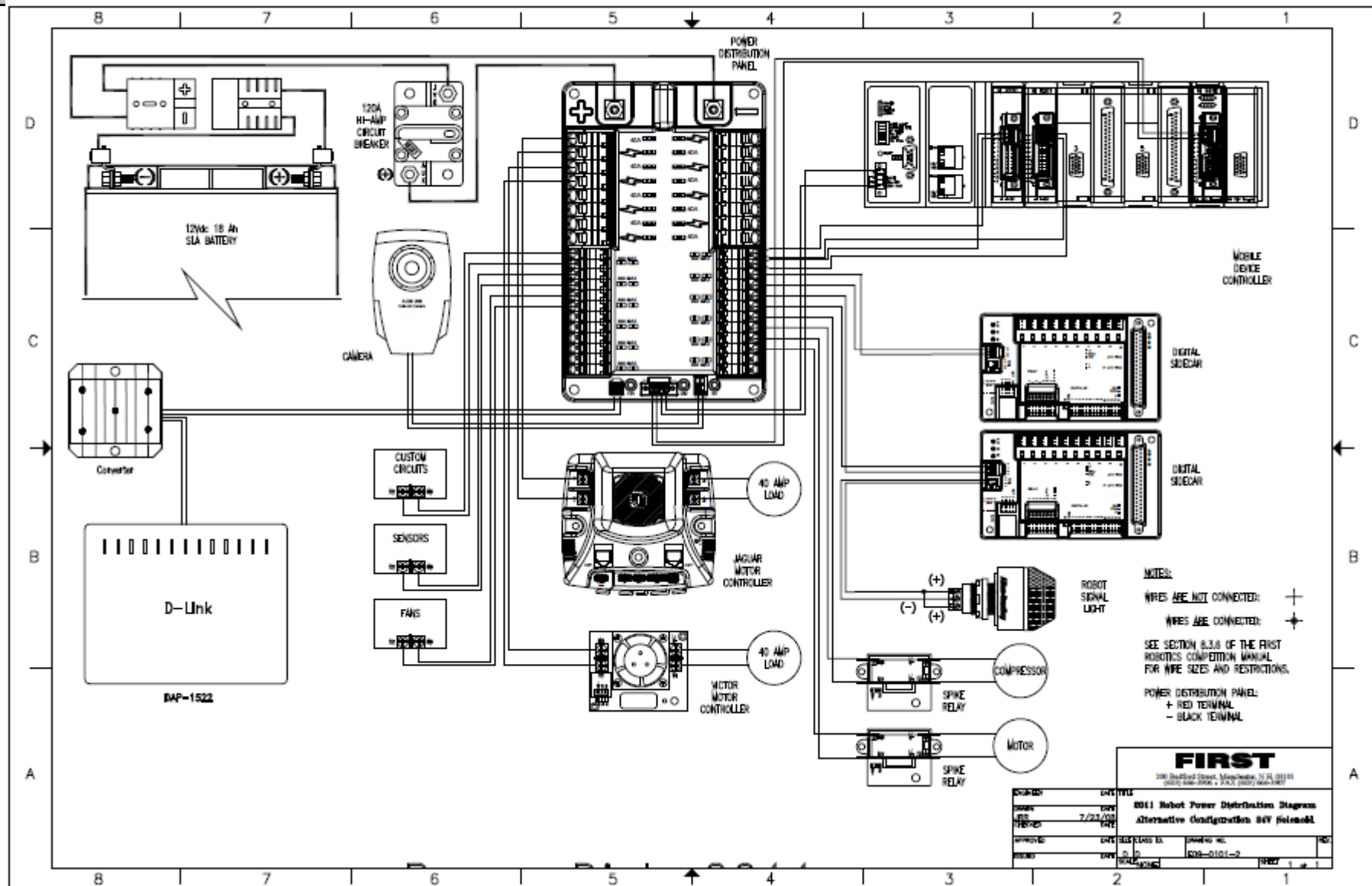
THE ROBOT

TABLE OF CONTENTS

4	OVERVIEW	2
4.1	RELATED DOCUMENTS & RESOURCES	2
4.2	CONVENTIONS	2
4.3	ROBOT RULES.....	2
4.3.1	<i>Safety & Damage Prevention</i>	3
4.3.2	<i>Bumper Rules</i>	5
4.3.3	<i>General Robot Design</i>	8
4.3.4	<i>Budget Constraints</i>	10
4.3.5	<i>Cost Determination of Additional Parts</i>	11
4.3.6	<i>Fabrication Schedule</i>	12
4.3.7	<i>Material Utilization</i>	14
4.3.8	<i>Power Distribution</i>	15
4.3.9	<i>Motors & Actuators</i>	19
4.3.10	<i>Control, Command & Signals System</i>	20
4.3.11	<i>Pneumatic System</i>	25
4.3.12	<i>Operator Console</i>	28
4.3.13	<i>Robot</i>	28

2011 Electrical Layout (typical)

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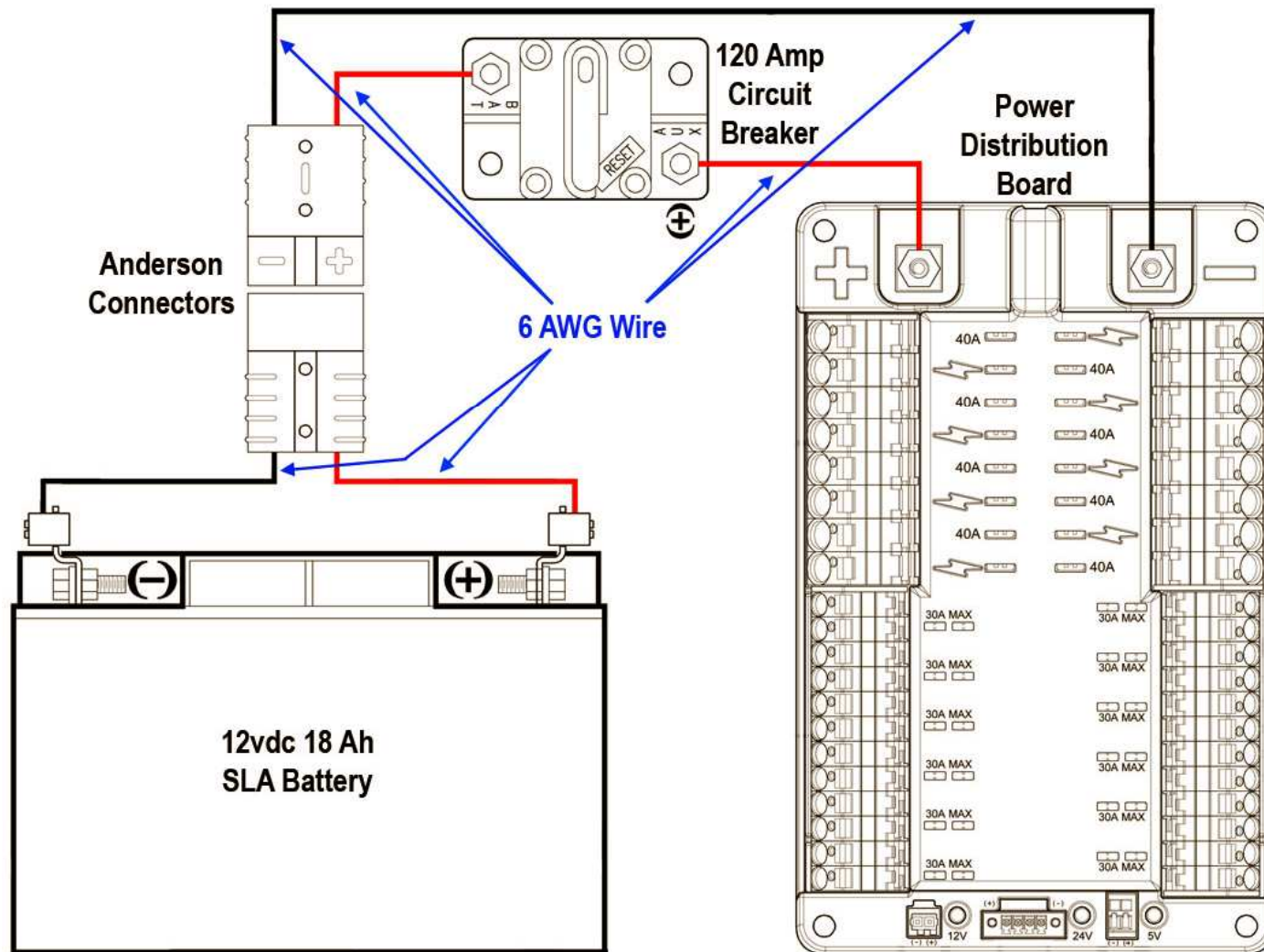
Robot Side

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Battery, Switch and Power Distribution

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Battery, Switch and Power Distribution

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Make sure to fully cover the terminals on the battery, switch and power distribution panel with electrical tape or other appropriate material



Power Distribution Rules

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- <R39>** All active PD Board branch circuits shall be protected from overload with an appropriate value auto resetting Snap Action circuit breaker (from the KOP or identical equivalent).
- A. Each speed controller branch circuit must be protected by one and only one 20-amp, 30-amp, or 40-amp circuit breaker on the PD Board. No other electrical load can be connected to the breaker supplying this circuit.
 - B. Each relay module branch circuit must be protected with one and only one 20-amp circuit breaker on the PD Board. No other electrical load can be connected to the breaker supplying this circuit.
 - C. Each Digital Sidecar branch circuit must be protected with one and only one 20-amp circuit breaker on the PD Board. No other electrical load can be connected to the breaker supplying this circuit.
 - D. If the compressor is used, the relay module branch circuit supplying the compressor must be protected with a 20-amp circuit breaker. No other electrical load can be connected to the breaker supplying this circuit.
 - E. A single branch supply circuit may be spliced to supply power to one, two or three of the Analog/Solenoid Breakout Boards. This circuit must be protected with one and only one 20-amp circuit breaker on the PD Board. No other electrical load can be connected to the breaker supplying this circuit.
 - F. Custom circuits and sensors powered via the cRIO-FRC or the Digital Sidecar are protected by the breaker on the circuit(s) supplying those devices. Power feeds to all other custom circuits must be protected with a dedicated 20-amp circuit breaker on the PD Board.



Required Wire Sizes

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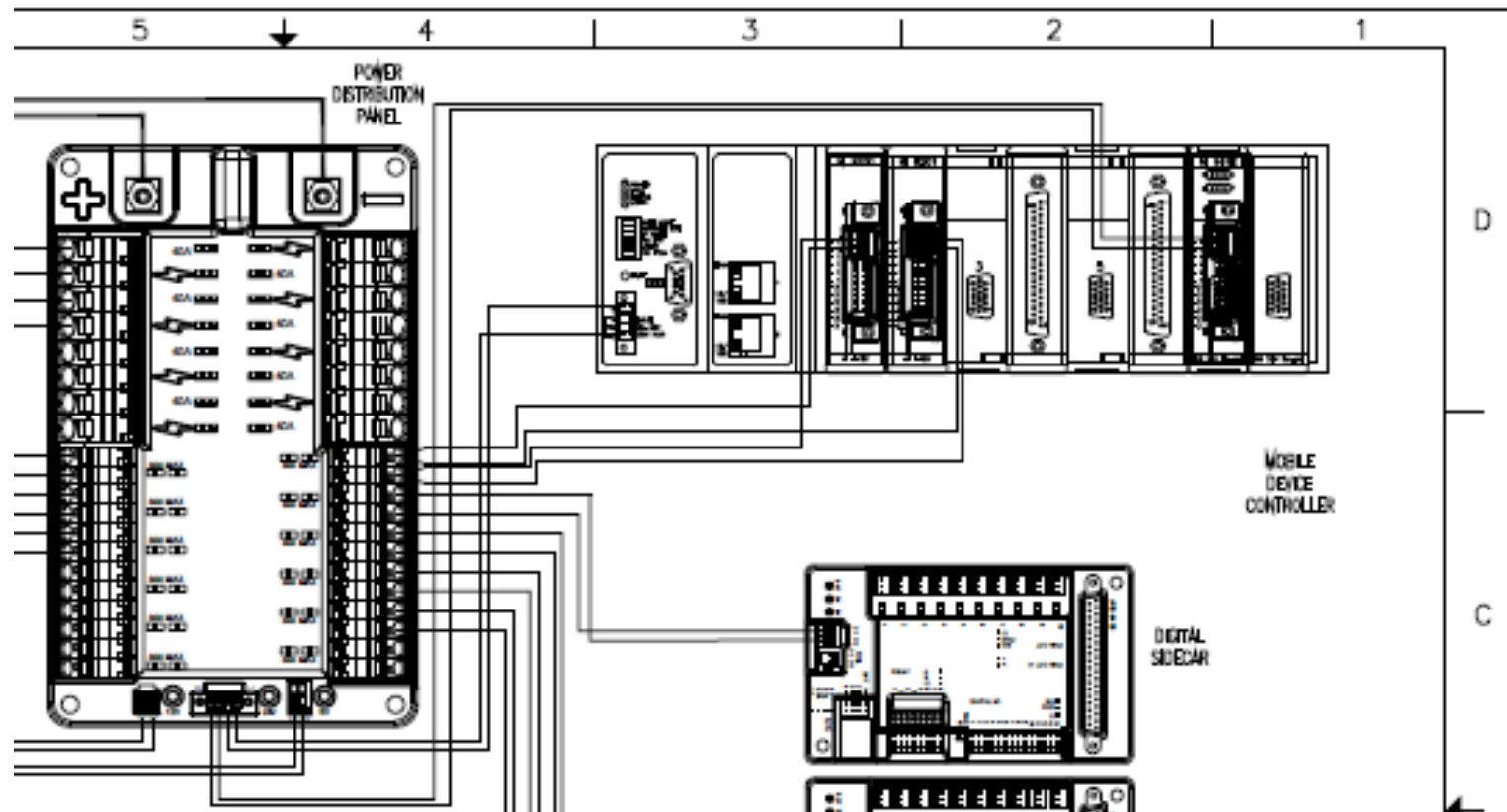
Application	Minimum wire size
40A circuit	12 AWG (2.052mm)
30A circuit	14 AWG (1.628mm)
20A circuit	18 AWG (1.024mm)
between the PD Board and the Analog and/or Solenoid Breakouts if a common power feed is used	18 AWG (1.024mm)
between the PD Board and the Analog and/or Solenoid Breakouts if individual power feeds are used	20 AWG (0.8128mm)
between the PD Board and the cRIO-FRC	20 AWG (0.8128mm)
between the PD Board and the radio	20 AWG (0.8128mm)
pneumatic valves	24 AWG (0.5106mm)

- CIM and Fisher Price Motors Must be Protected by 40A Circuits
- Most Other Motors Can be Protected by 20A Circuits



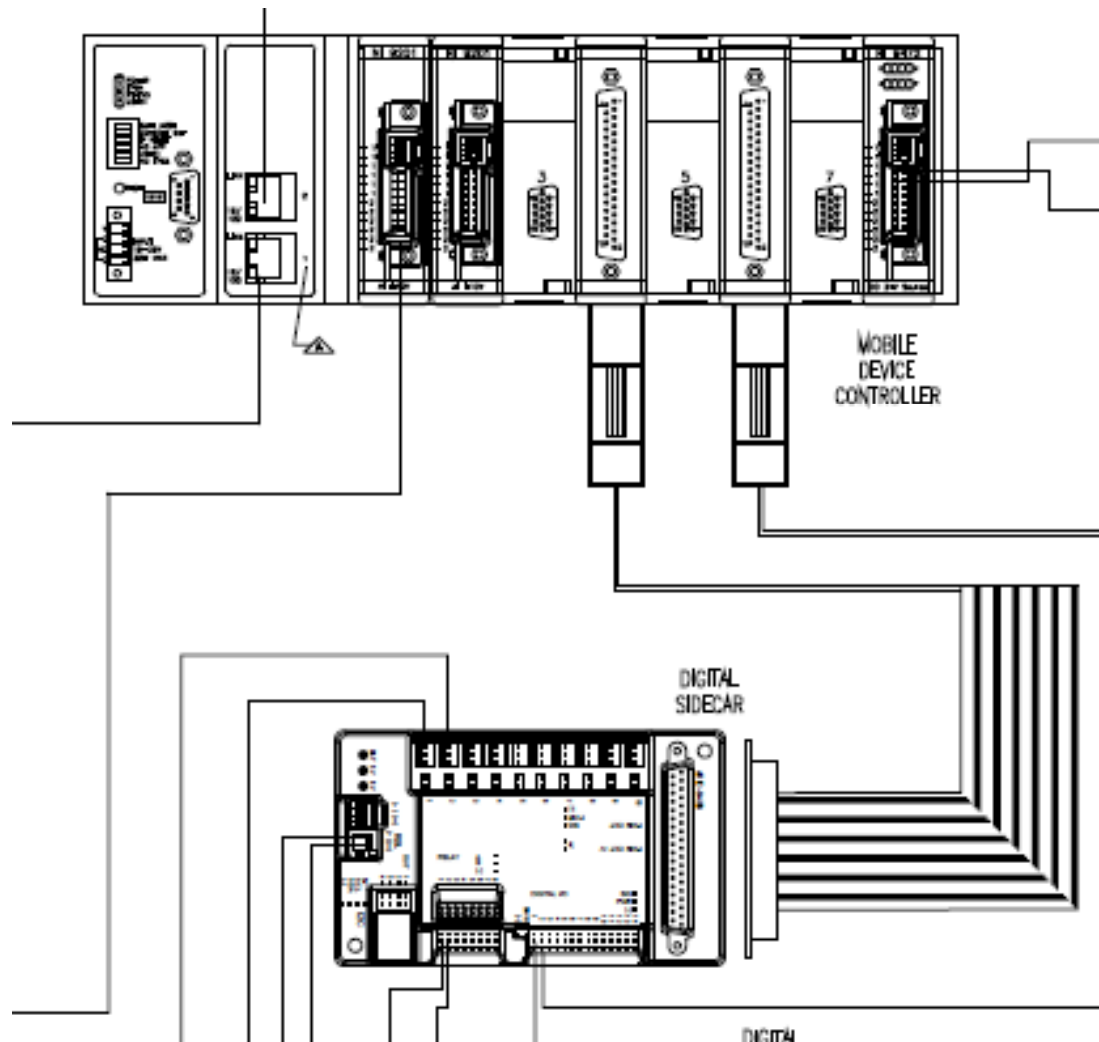
cRIO and Digital Sidecar (power)

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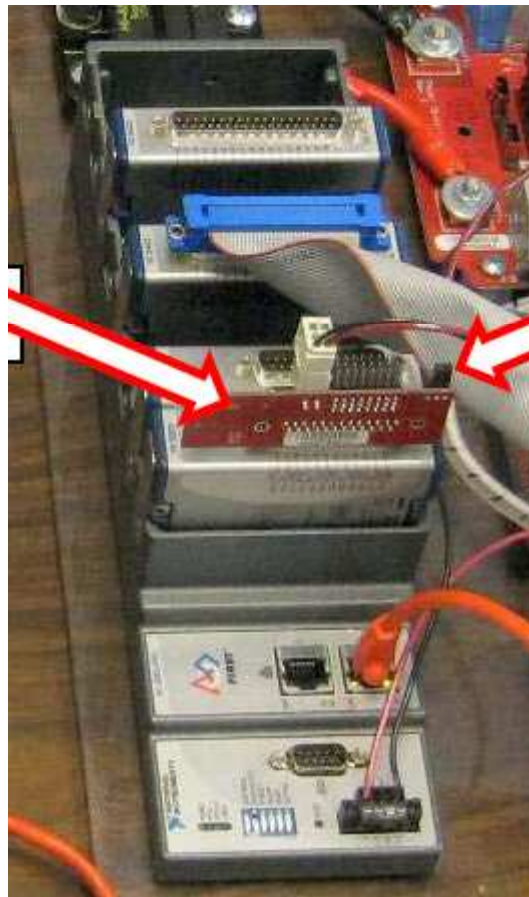
cRIO and Digital Sidecar (data)

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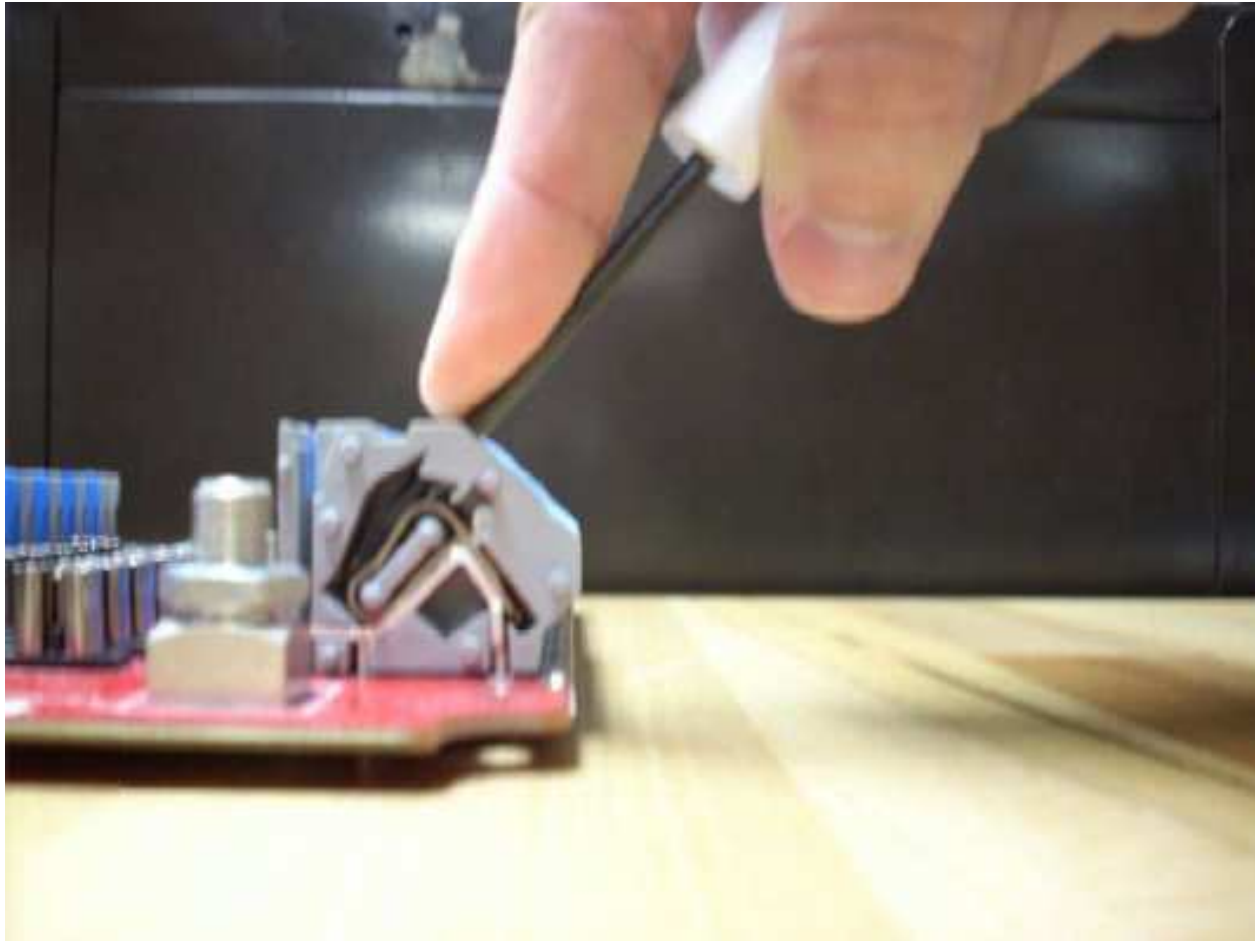
cRIO and Digital Sidecar

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Wago Connector Operation

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Motor Controllers and Spikes

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Motor Controllers

- Variable control of motor
- Typically connected to Digital Sidecar via PWM cable (Jaguars can also use a CAN bus)
- Full forward / Full reverse / Off
- Connected to Digital Sidecar via PWM cable



Jaguar



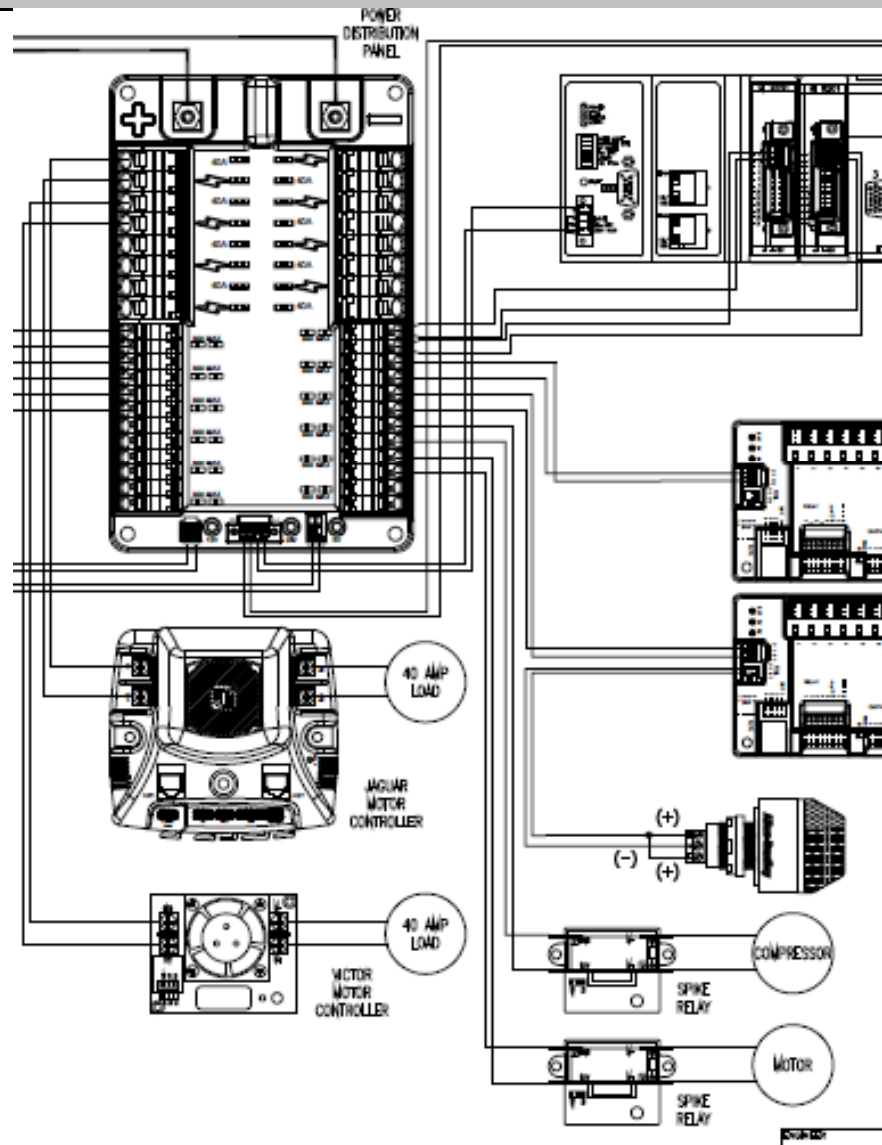
Victor



Make sure that the connection between the PD board and the controllers has + to + and – to –

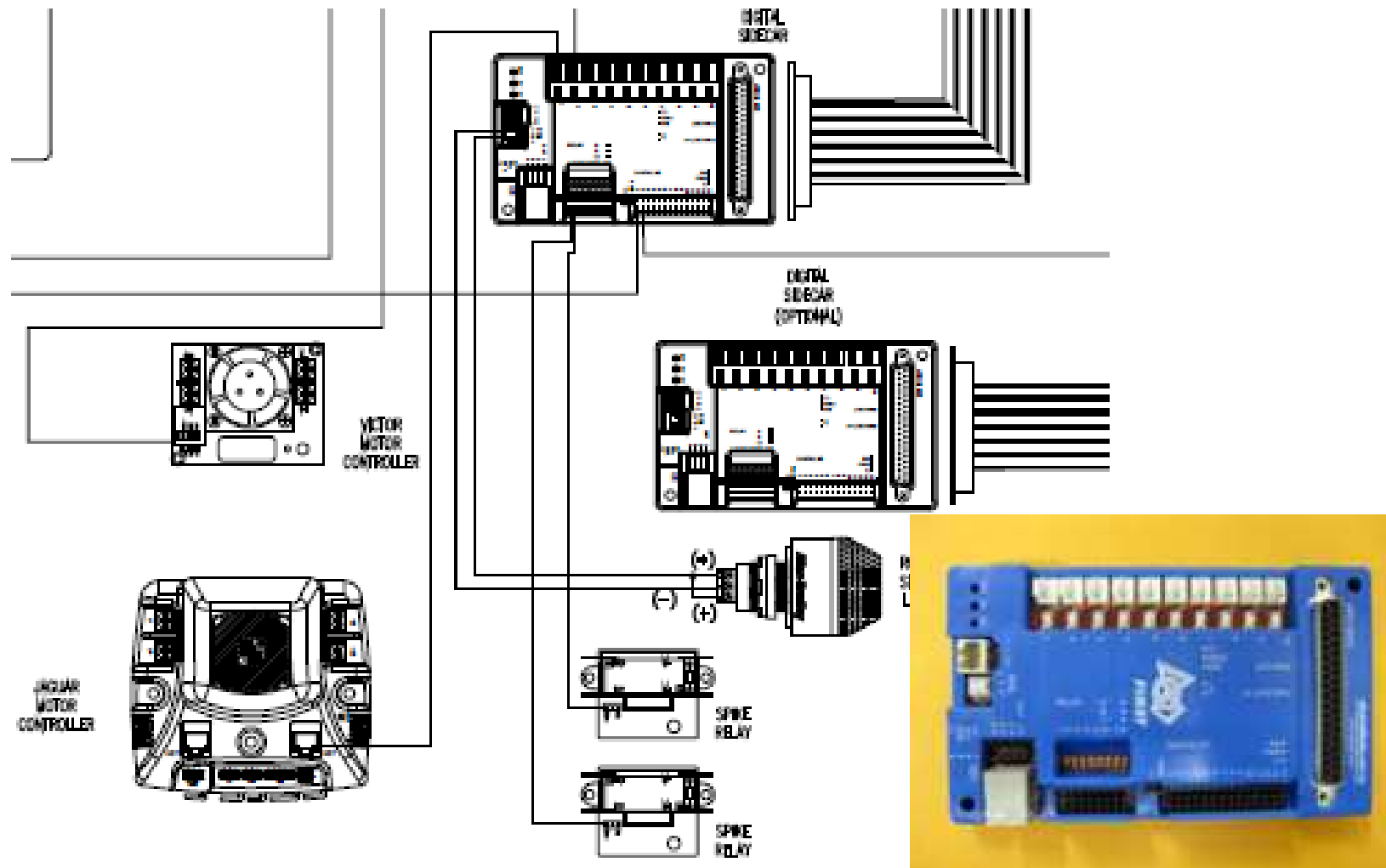
Motor Controllers and Spikes (electrical)

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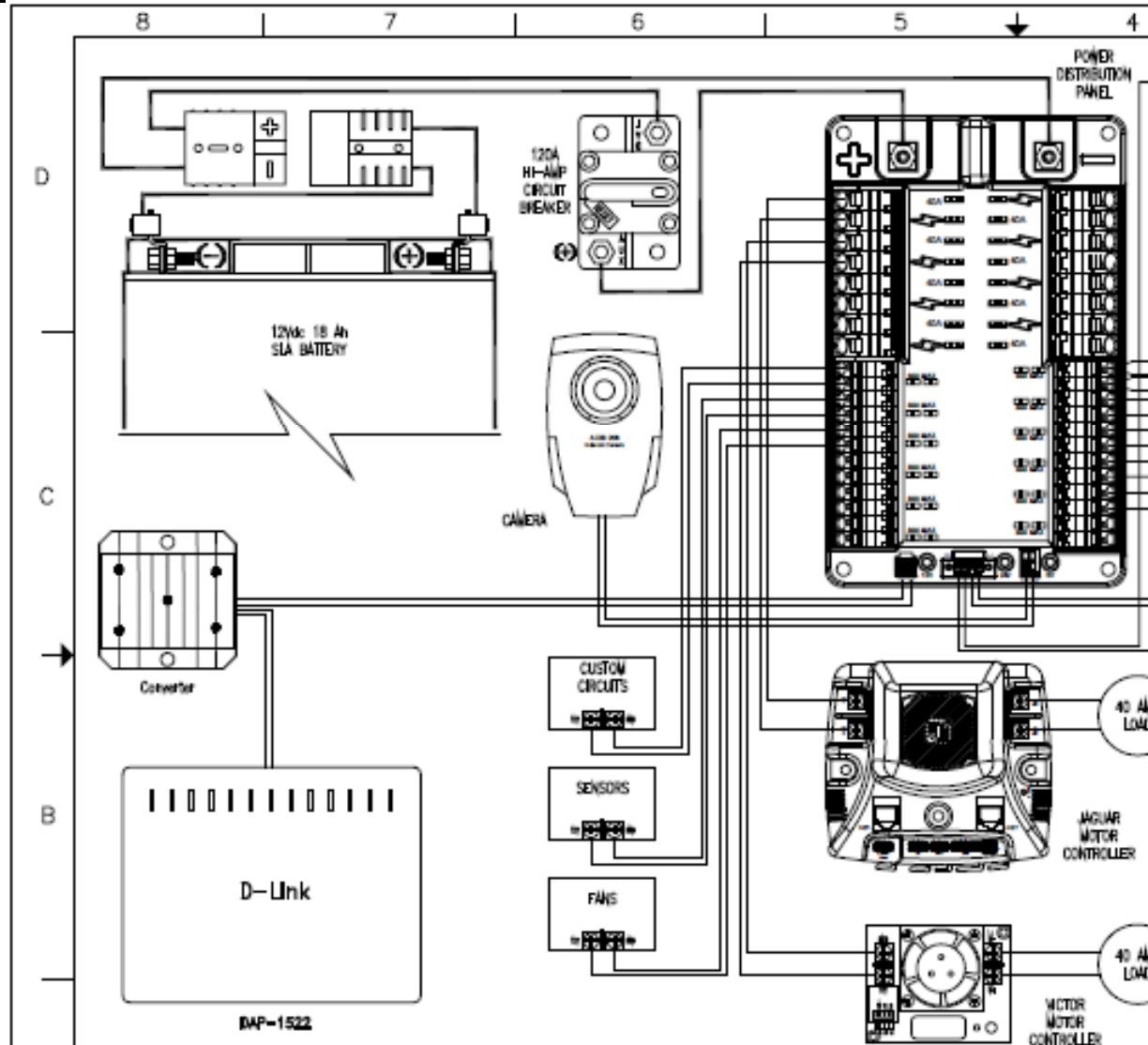
Motor Controllers and Spikes (data)

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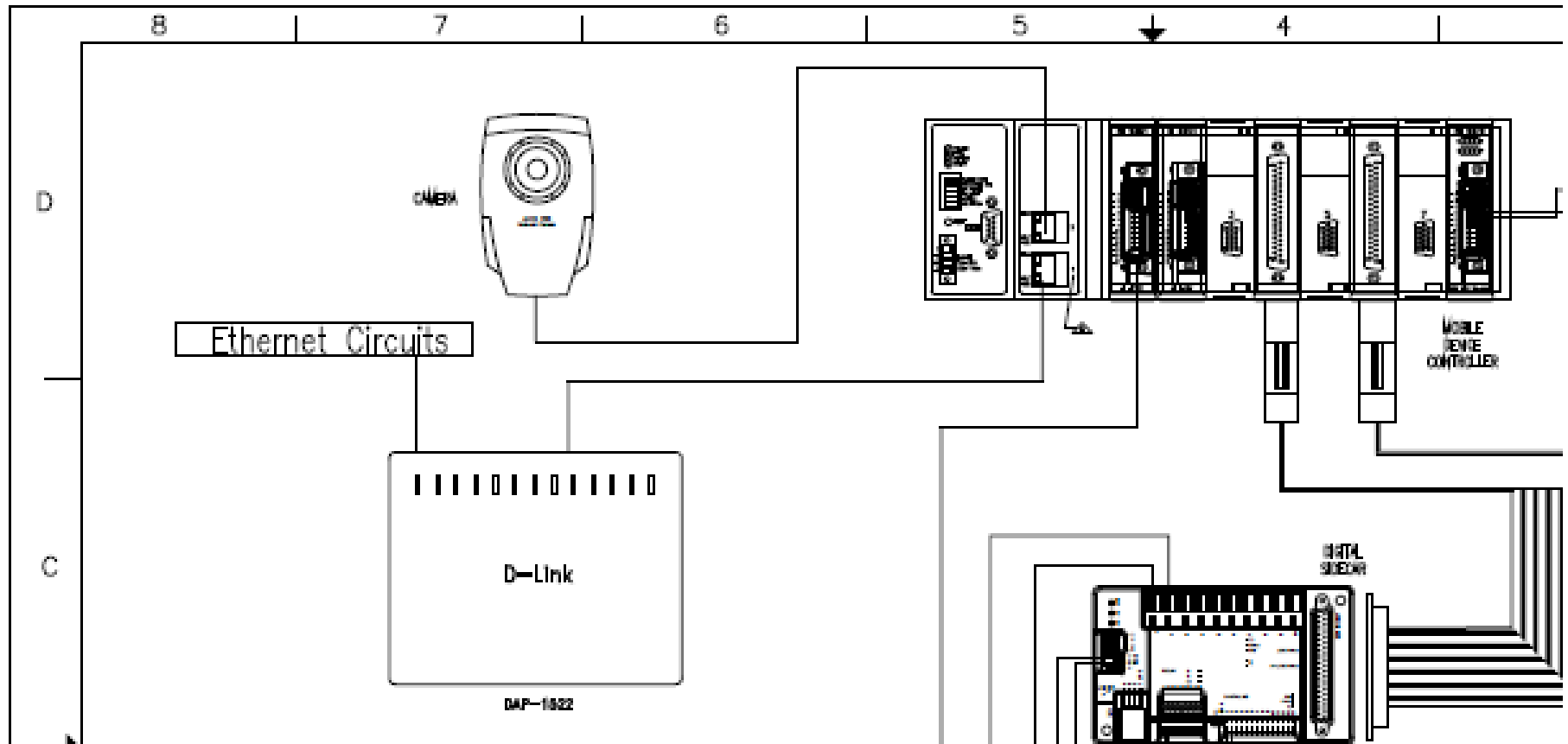
2011 Radio (electrical)

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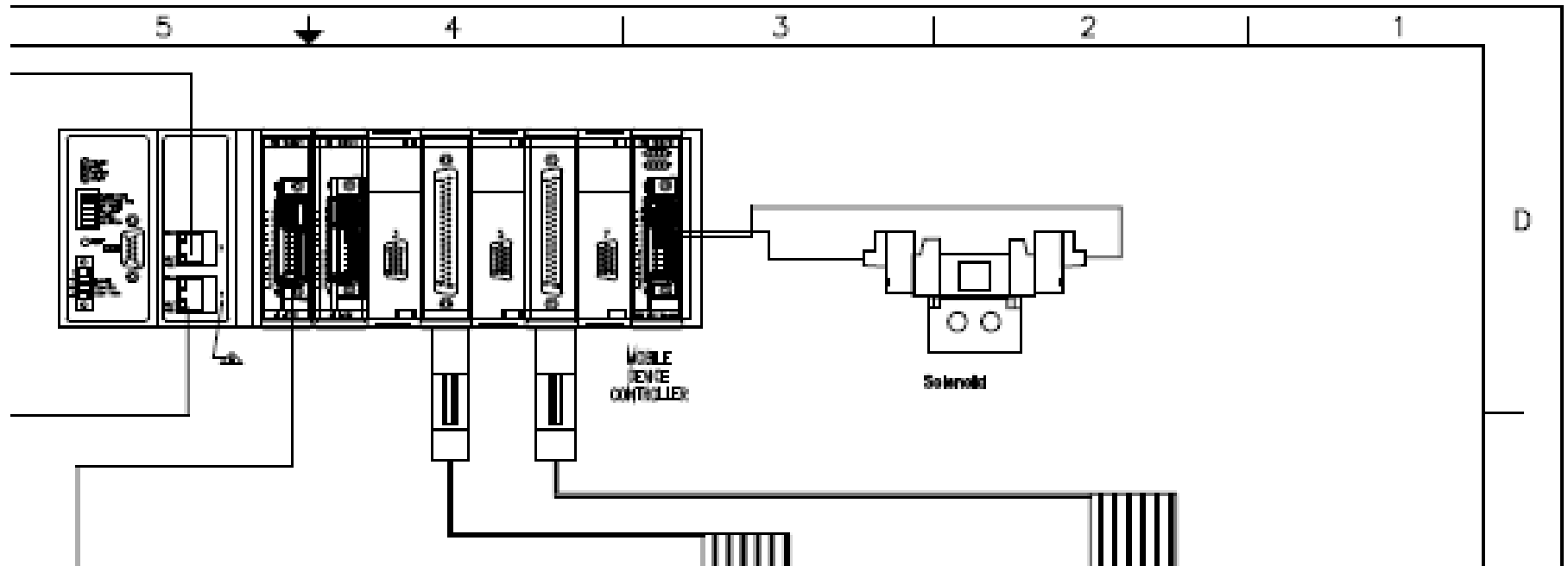
2011 Radio (data)

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2011 Pneumatic Connections

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General Guidelines

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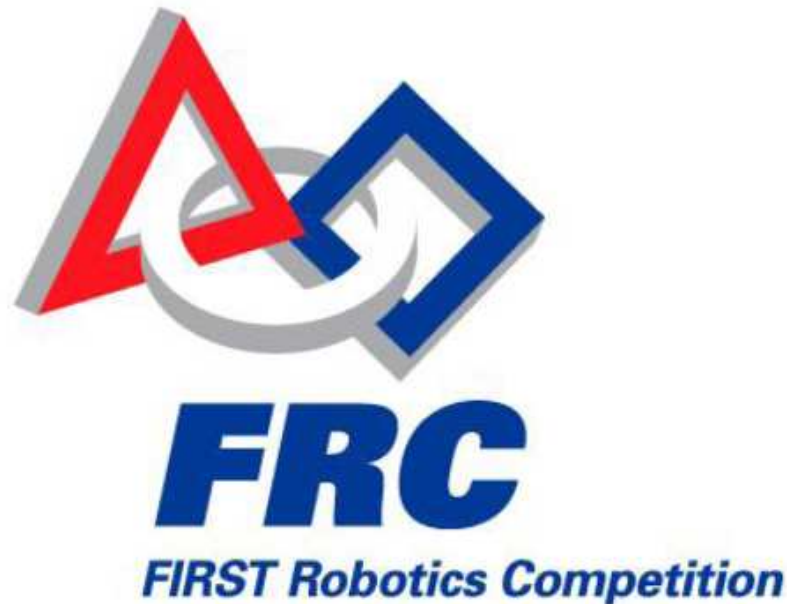
- **cRIO and Camera must be electrically isolated from the rest of the robot**
 - *Do not mount directly to metal robot chassis*
- **Label wires (both ends)**
 - *Electrical*
 - *PWM*
- **Keep things “neat” if possible**
 - *Makes things easier to troubleshoot and*

The background of the slide features a dynamic, abstract design with flowing, wavy lines in various shades of blue and white, creating a sense of motion and depth.

Sensors

Good Source of Information

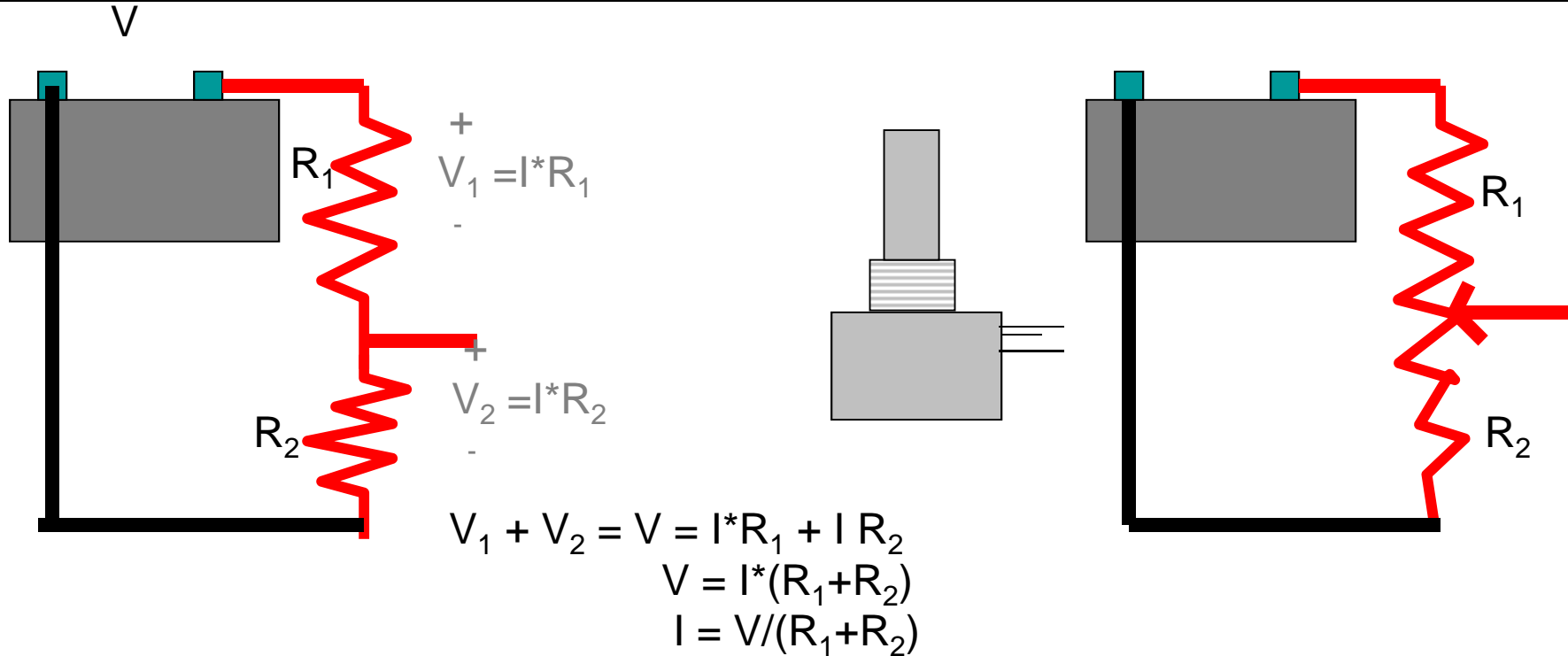
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2011 *FIRST* Robotics Competition
Sensor Manual

Voltage Dividers/ Potentiometers

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$$V_2 = I \cdot R_2 = V / (R_1 + R_2) \cdot R_2 = V \cdot R_2 / (R_1 + R_2)$$

When $R_1 = 0$,

When $R_1 = R_2$,

When $R_2 = 0$,

$$V_2 = V \cdot R_2 / (0 + R_2) = V (R_2 / R_2) = V$$

$$V_2 = V \cdot R_2 / (R_1 + R_2) = V (R_2 / 2R_2) = V / 2$$

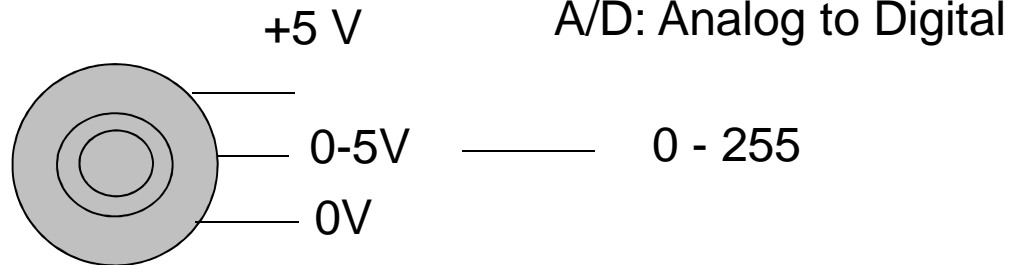
$$V_2 = V \cdot 0 / (R_1 + 0) = 0 / R_1 = 0$$

Potentiometer as a Sensor

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0 – 180 degrees

0 – 270 degrees

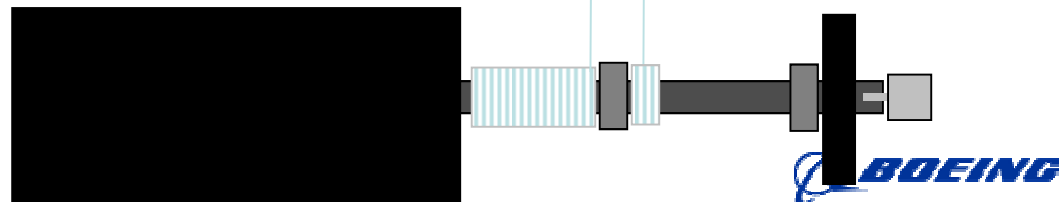
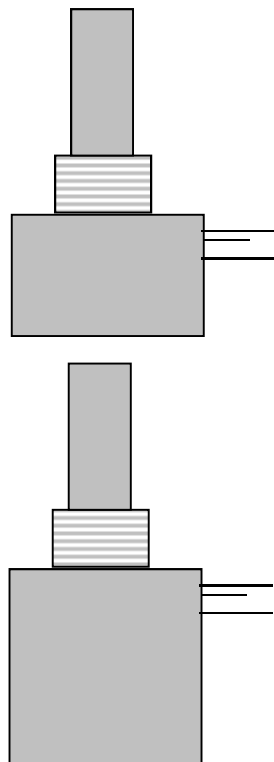


FIRST Recommends 100K Olms
Said to work with 10K Olms

0 - 5 turns

0-10 turns

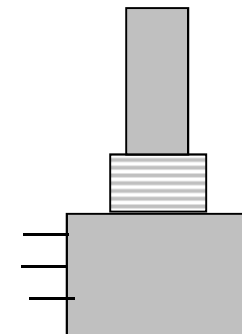
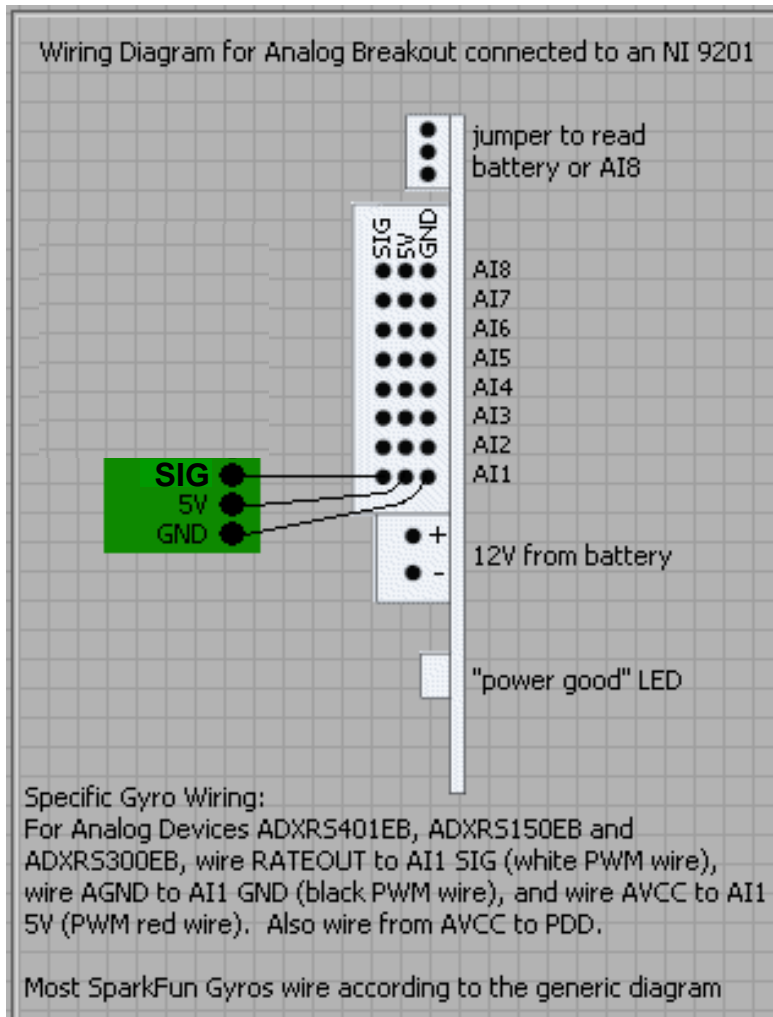
0-20 turns



Potentiometer Connections

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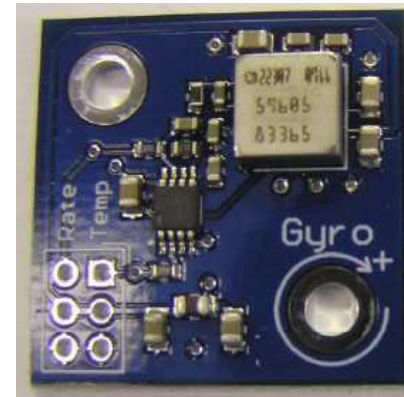
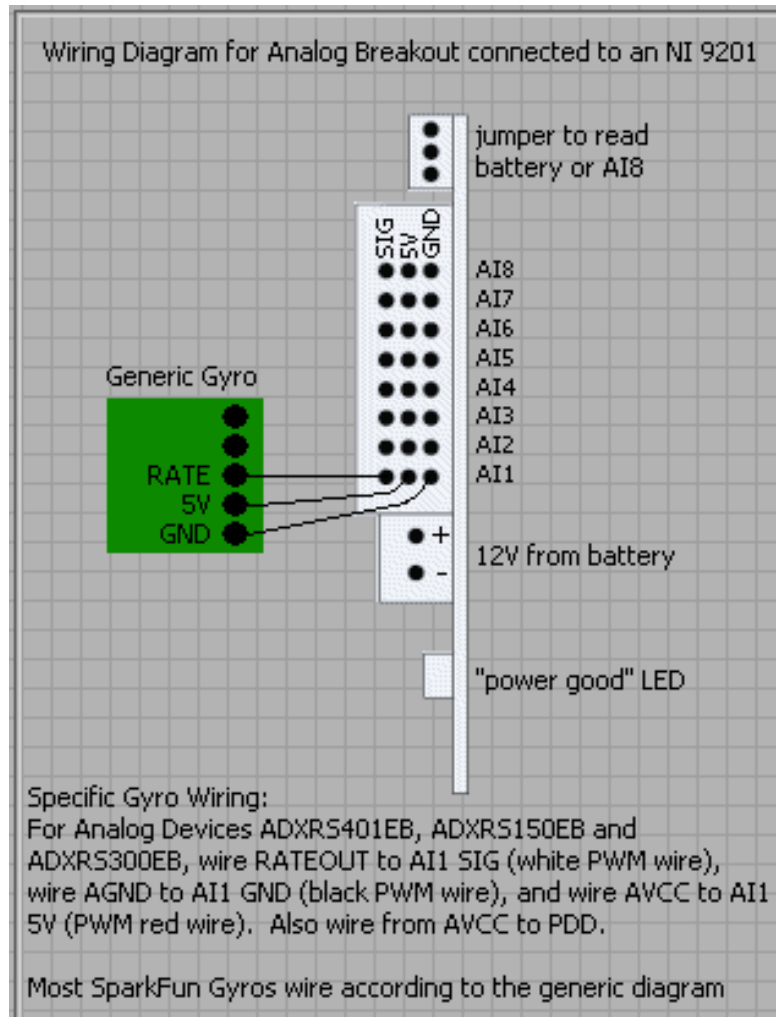
Analog Sensor



Gyro Connections

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Analog Sensor

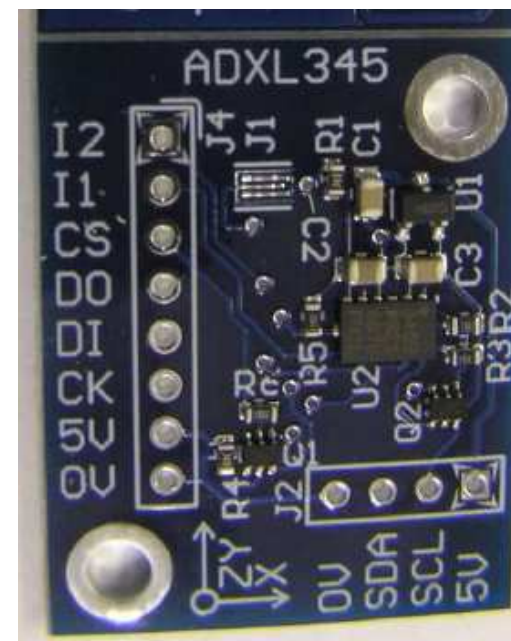
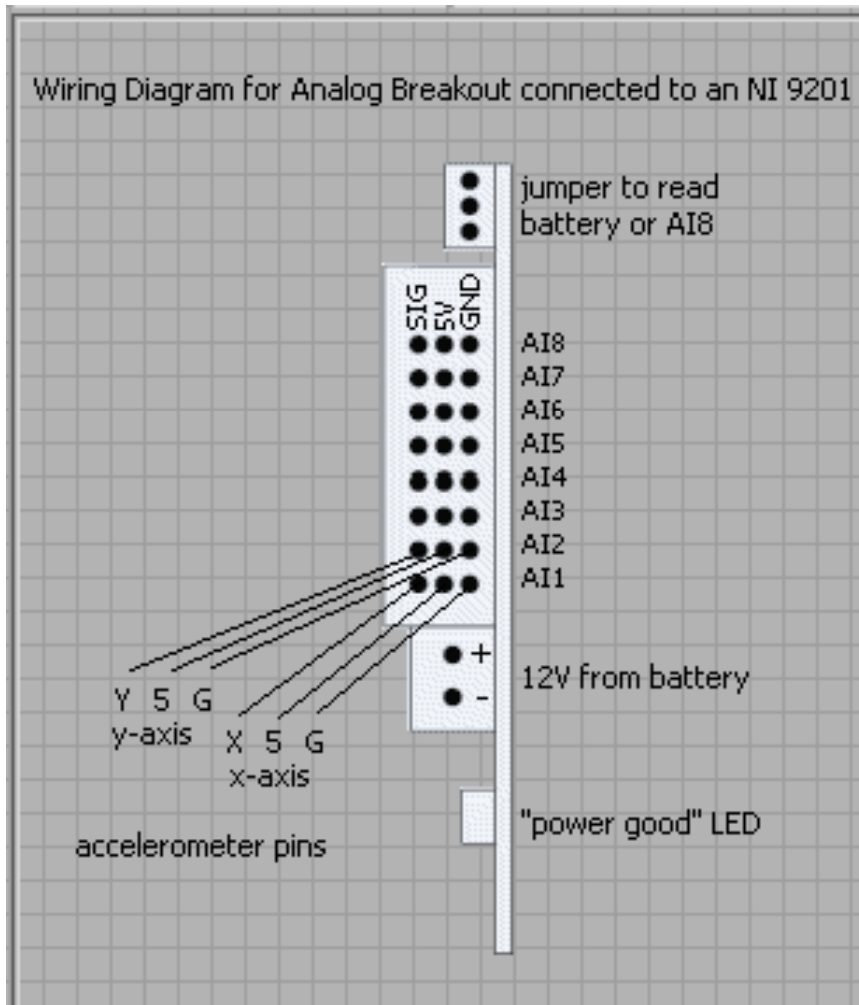


- Measures rotation rate
- Can be integrated to provide an angle (function provided by software provided to teams)

Accelerometer Connections

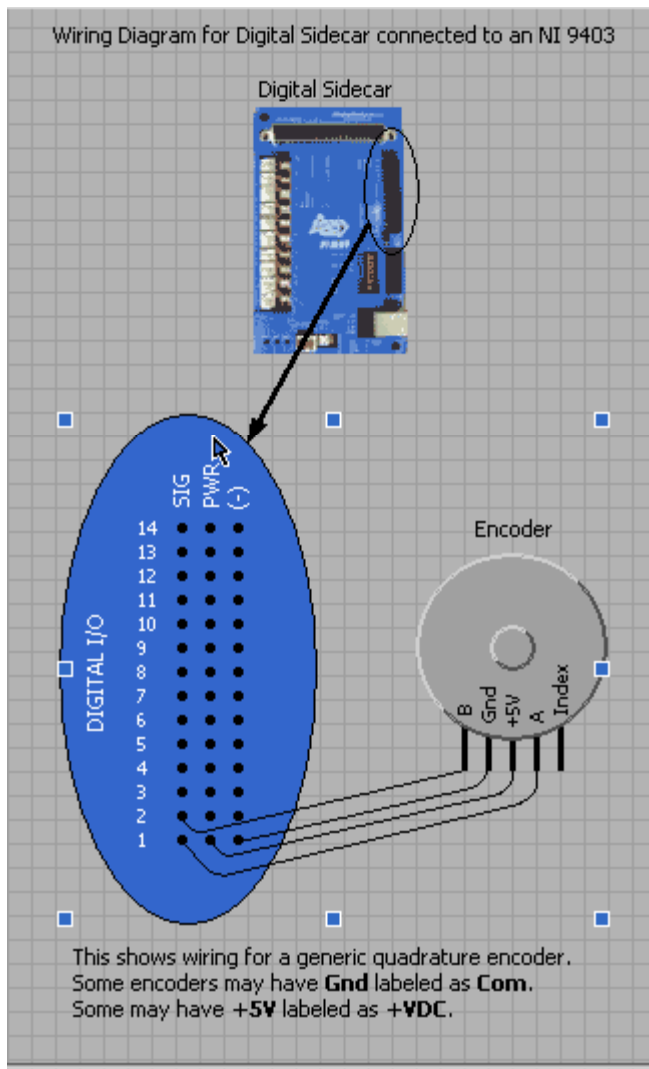
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Analog Sensor

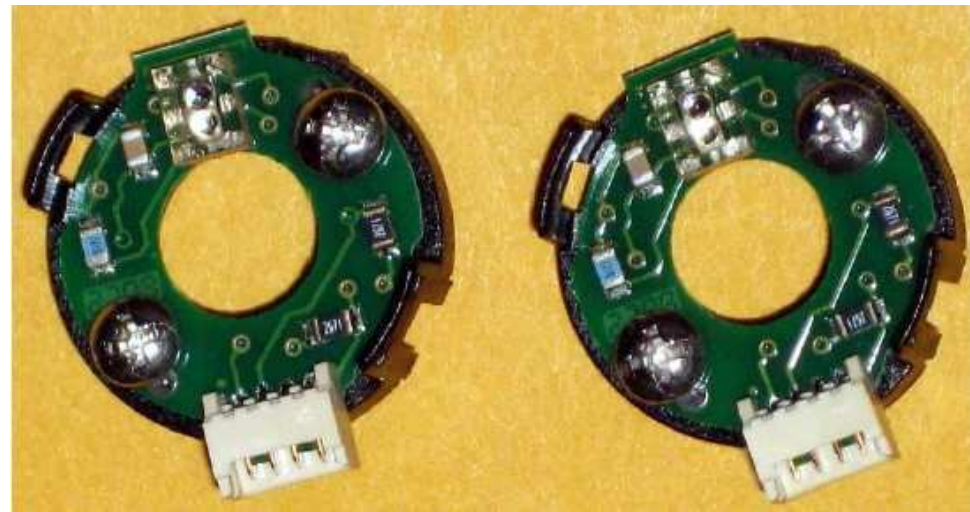


Encoder Connections

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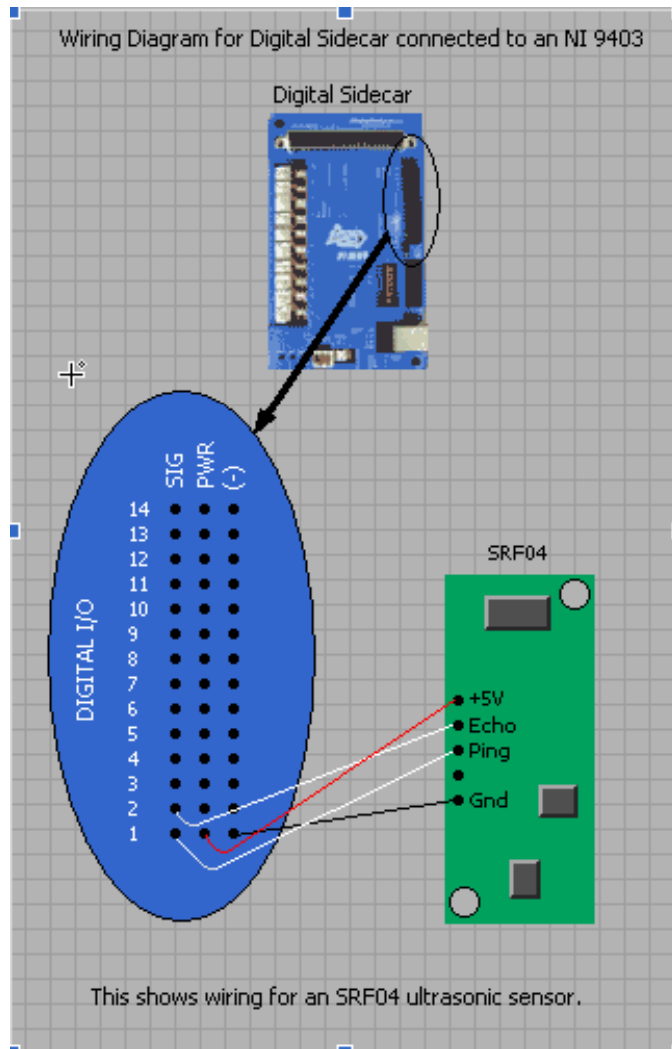
Digital Sensor



- Measures number of rotations since power on or last reset
- Good for attaching to drive system to measure distances during autonomous mode

Ultrasonic Sensor Connections

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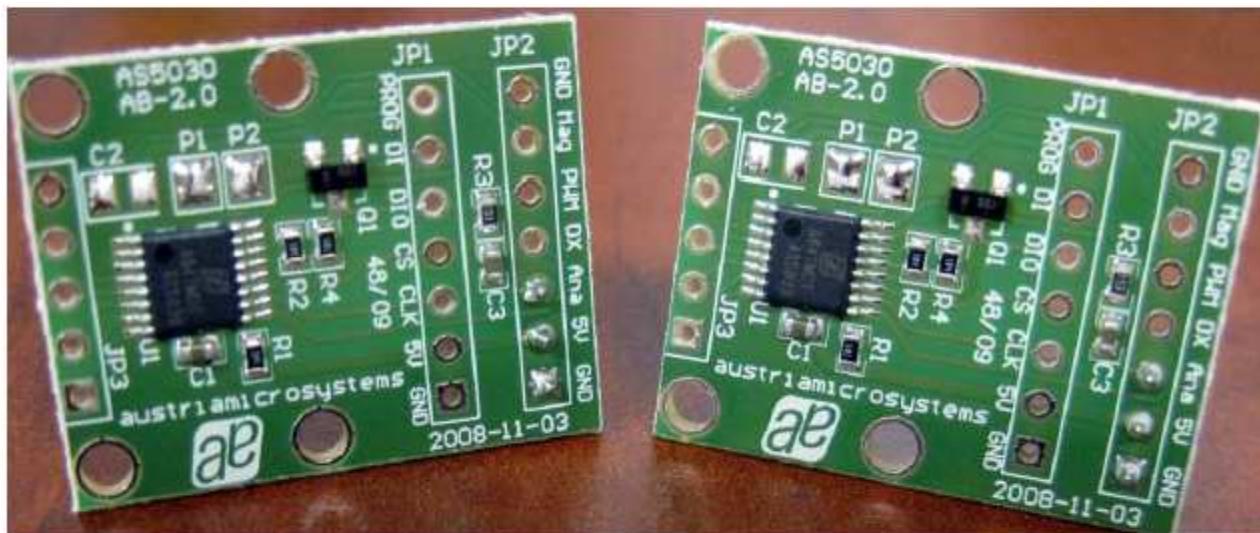


- Measures distance from a surface

2011 Magnetic Encoder

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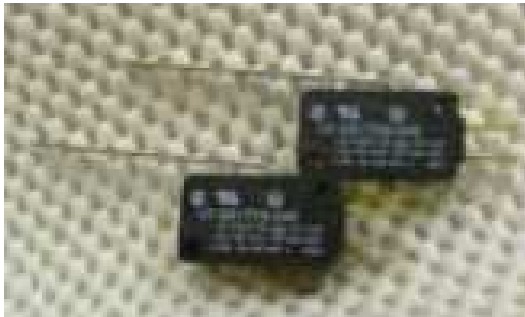
**austriamicrosystems Magnetic Encoder
(austriamicrosystems PN AS5030)**



Typical Limit Switches

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Digital Sensor



Pressure Switch That Must Be
Used With Compressor

Additional Sensor Information Sources

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- **Kit of Parts Web Site**
 - <http://www.usfirst.org/roboticsprograms/frc/2011-frc-kit-of-parts>
- **Labview Examples**
- **Manufacturer Fact Sheets**