Intro to Sensors

WHAT IS A SENSOR?

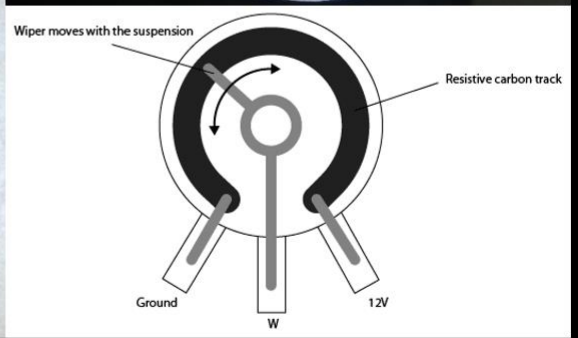
A sensor is an electrical device that provides input to the robot.

Digital: A sensor that communicates through boolean values, true or false.

- Limit Switch
- Encoders

Analog: A sensor that communicates values through variable voltages, generally from 0 to 5 volts in the case of the roboRIO.

- Potentiometer
- Gyroscope



ROBORIO INPUTS AND PWM CABLES

Digital Input/Output (DIO): Measure on or off signals.

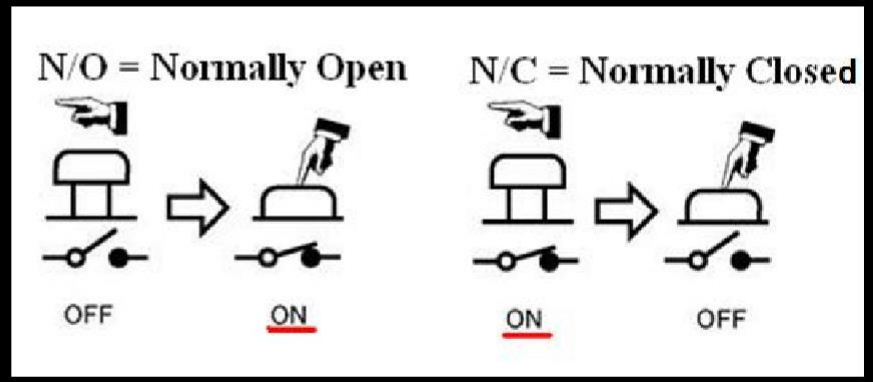
Analog In: Measure between 0 and 5 volts.

White: Signal
Red: +5V
Black: Ground

SWITCHES

A type of sensor that either completes (closes) or breaks (opens) a circuit.

Normally Open: Activating completes the circuit.
Normally Closed: Activating breaks the circuit.

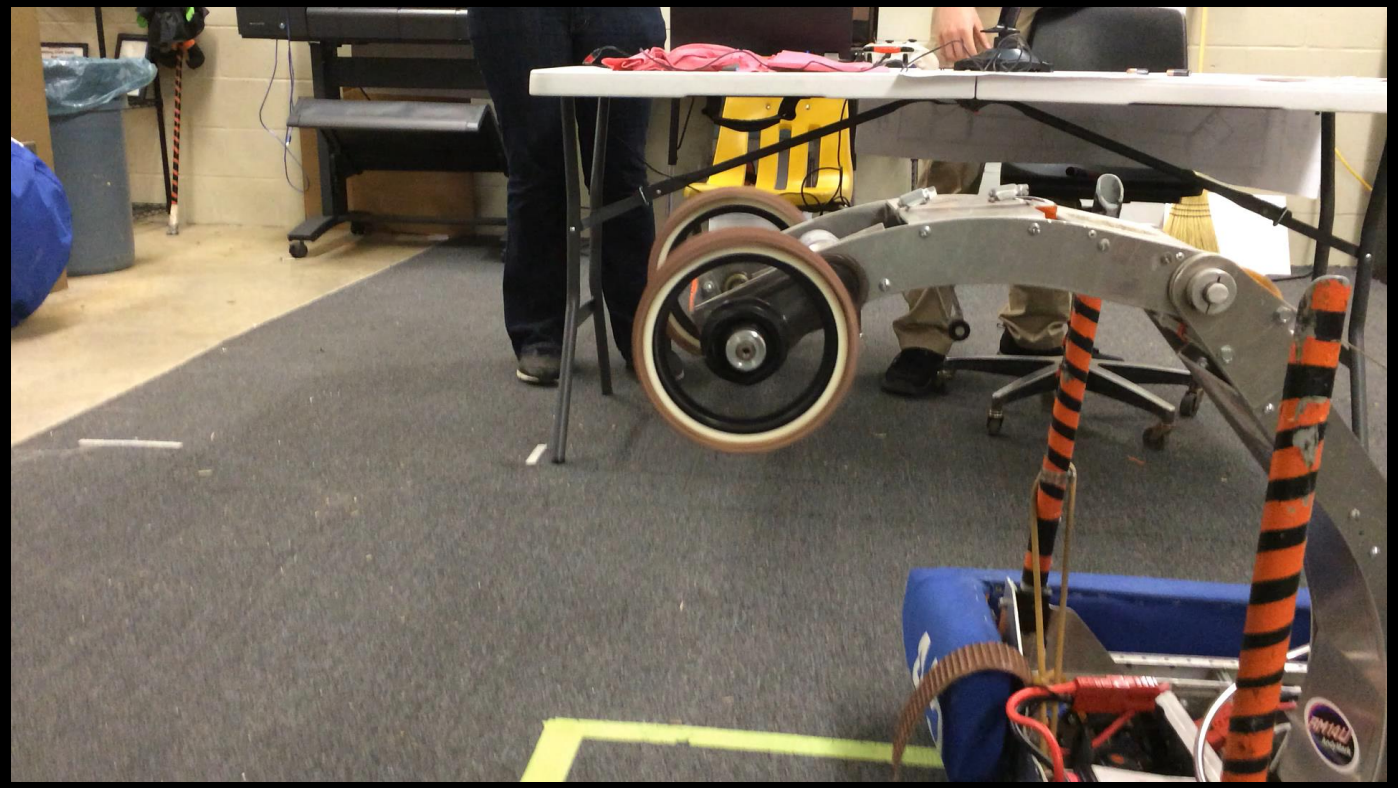


Often used for:

- Limiting movement.
- Toggling or activating functions.

Normally closed switch. Resistance is infinite when pressed.

SWITCH EXAMPLES



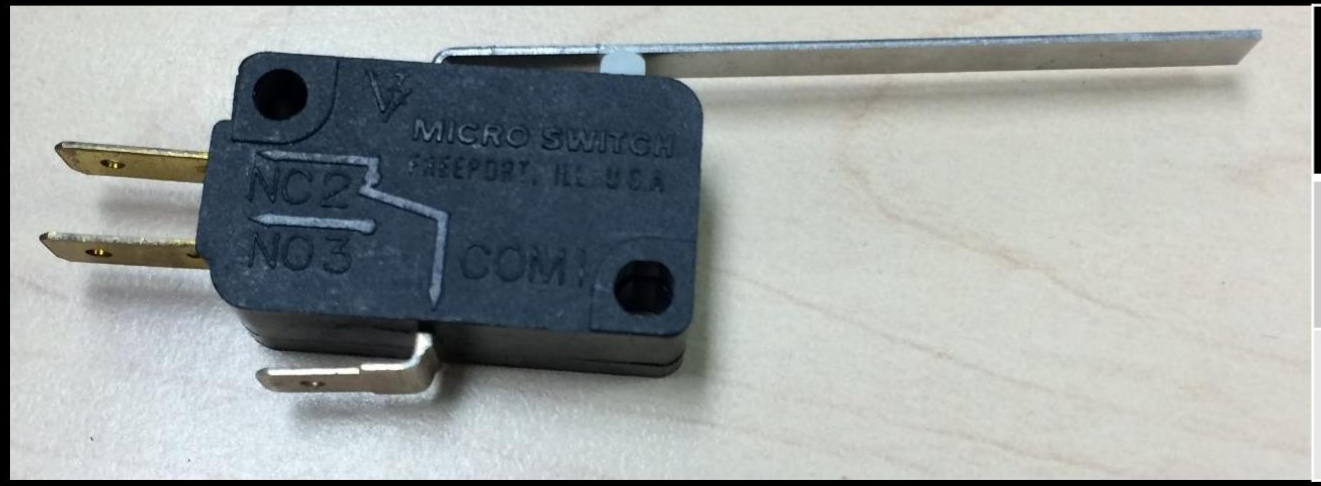
These are some practical examples of where limit switches are useful.

LIMIT SWITCH IMPLEMENTATION

Wiring

- Use only the signal and ground leads on the PWM cable.
- Polarity is unimportant.

```
DigitalInput limitSwitch = new DigitalInput(1); //Input pin ID
boolean state = limitSwitch.get(); //Gets the current state (true or false)
```



Switch Position	Normally Open	Normally Closed
Pressed	False	True
Free	True	False

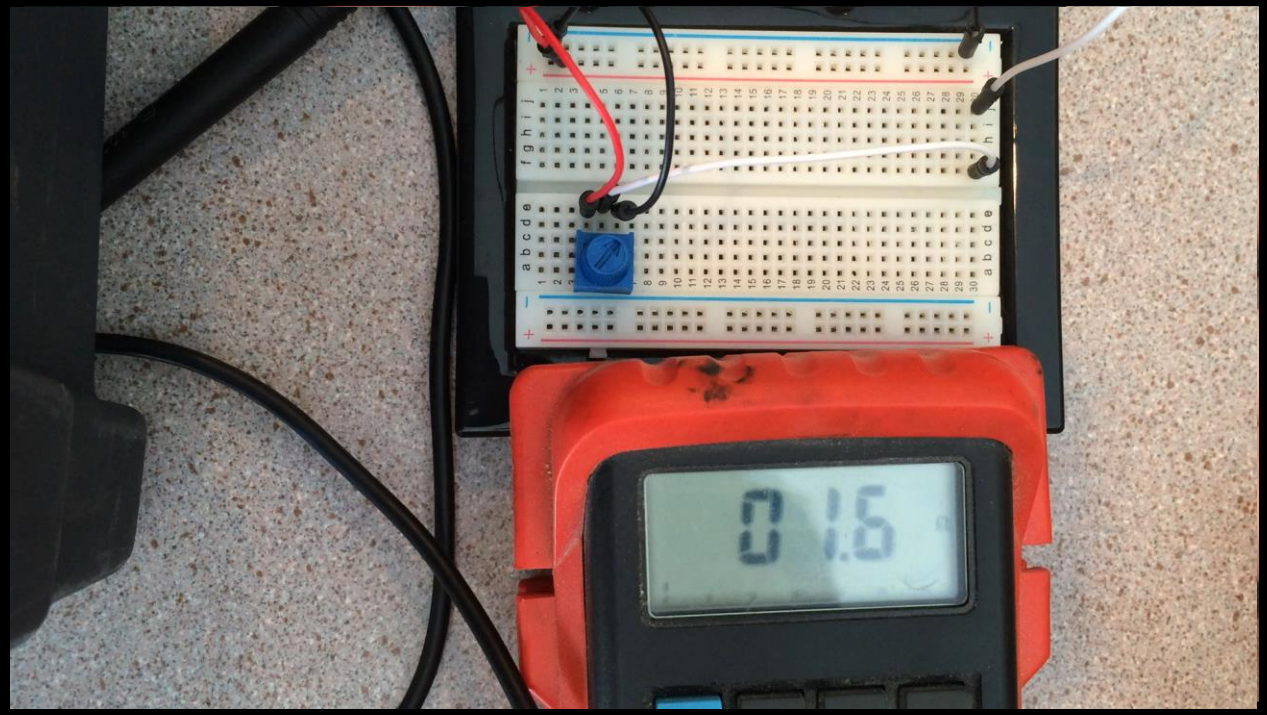
POTENTIOMETERS

Potentiometers are analog sensors that measure resistance. The roboRIO will read the resistance as a variable voltage between 0 and 5 volts.

Often used to measure absolute position or angle.

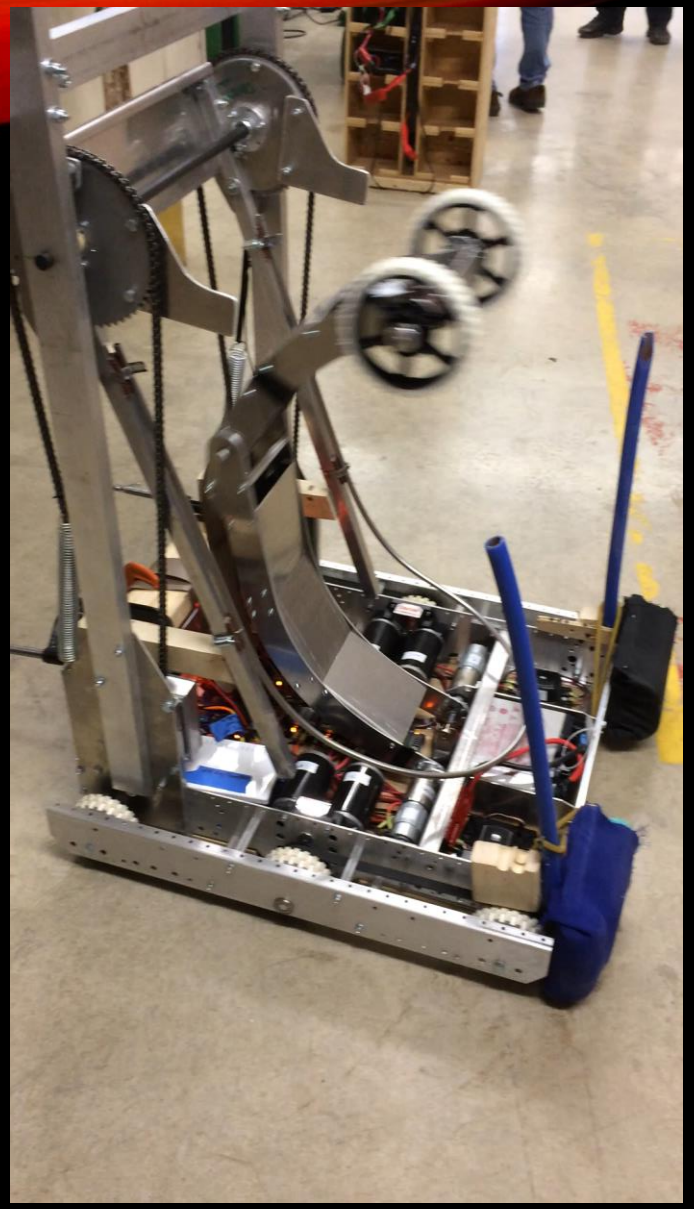
Types:

- Rotary
- Linear
- Multi-turn

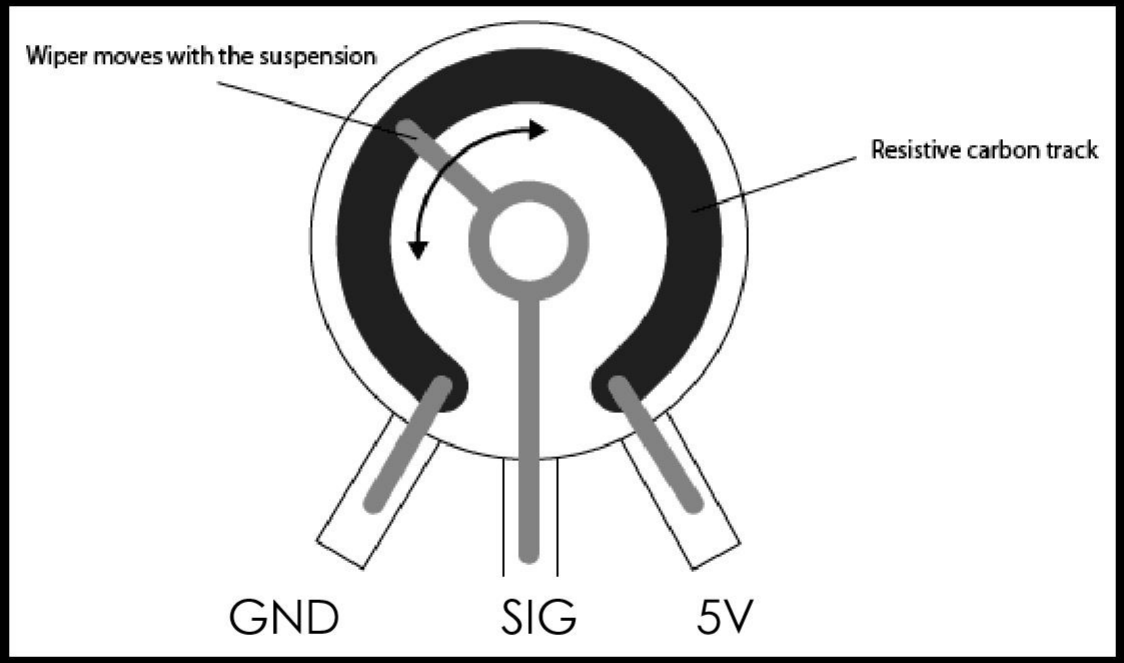


A small hand-tunable 10k Ohm potentiometer.

POTENTIOMETER EXAMPLES



POTENTIOMETER IMPLEMENTATION




```
AnalogInput potentiometer = new AnalogInput(1); //Input pin ID
double value = potentiometer.getVoltage(); //Gets the current value (in Voltage)
```

ROTARY ENCODERS

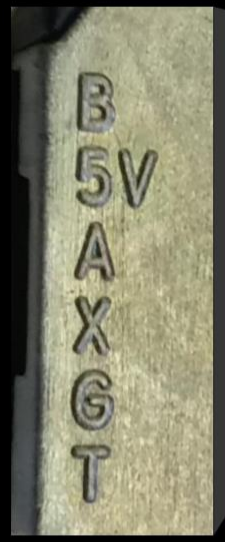
Rotary encoders are sensors that measure rotation in pulses which can be counted and converted to distance and velocity.

The roboRIO will handle counting and conversions.

The precision of encoders can range between ~100 and ~5,000 counts per revolution.

Often used for:

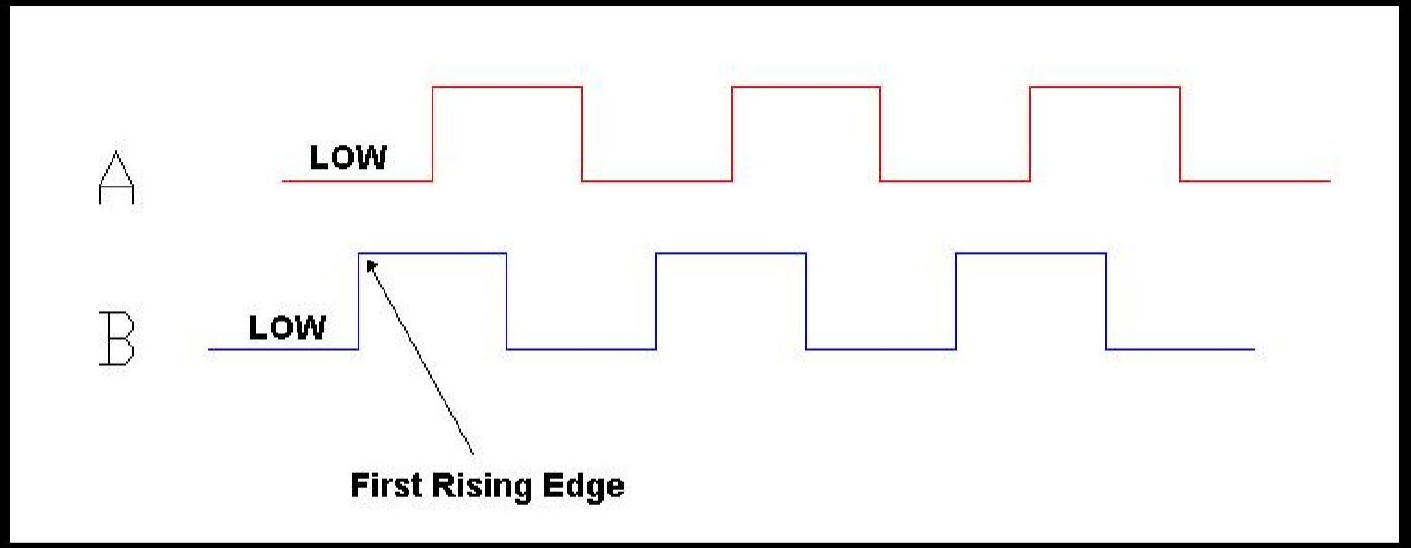
- Measuring distance traveled
- Calculating velocity
- Determining direction (forward or backward)



DUAL-CHANNEL ENCODERS

Dual channel encoders are more commonly used because of their ability to detect direction. They also provide up to 4x resolution.

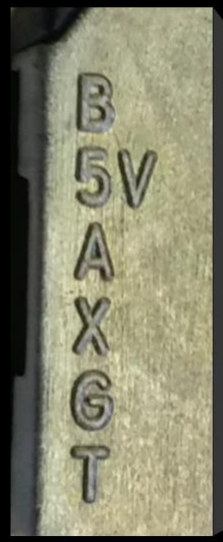
Depending on the direction of turn, channel A or B will always return high before the other channel. In this case, B channel activates first, indicating a direction.



ENCODER EXAMPLES

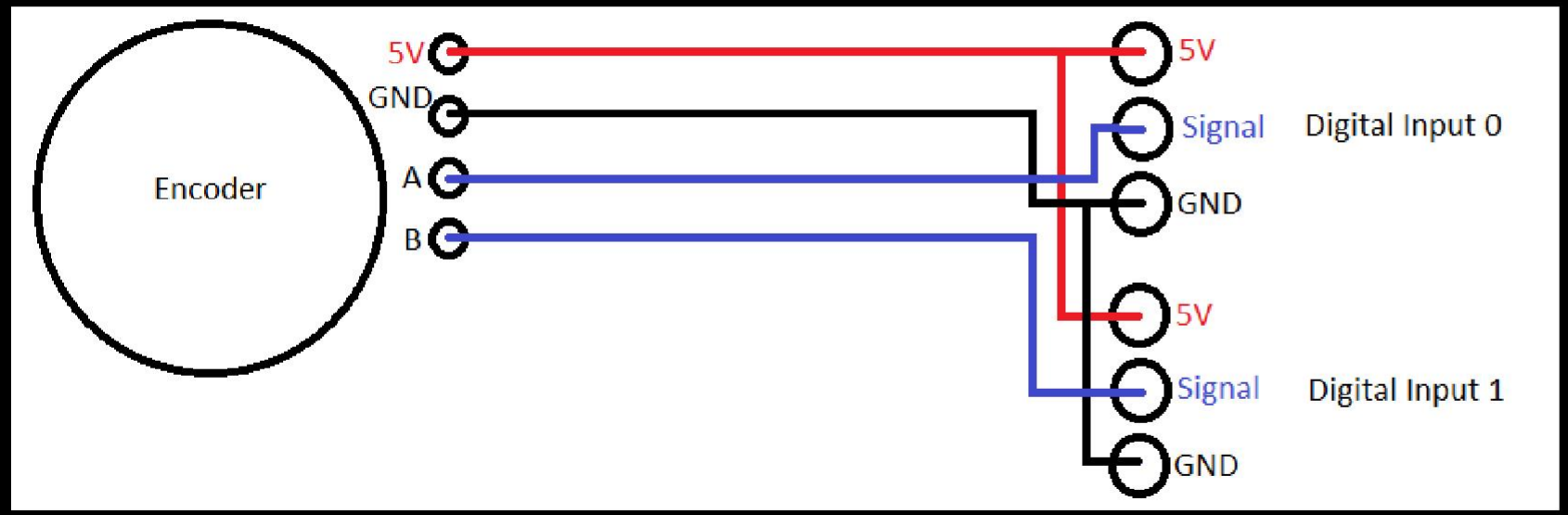
- Uses velocity calculations from the encoder
- Maintains constant velocity regardless of weight lifted

ENCODER IMPLEMENTATION



Wiring

- Requires two digital IO ports, channel A and B



ENCODER IMPLEMENTATION

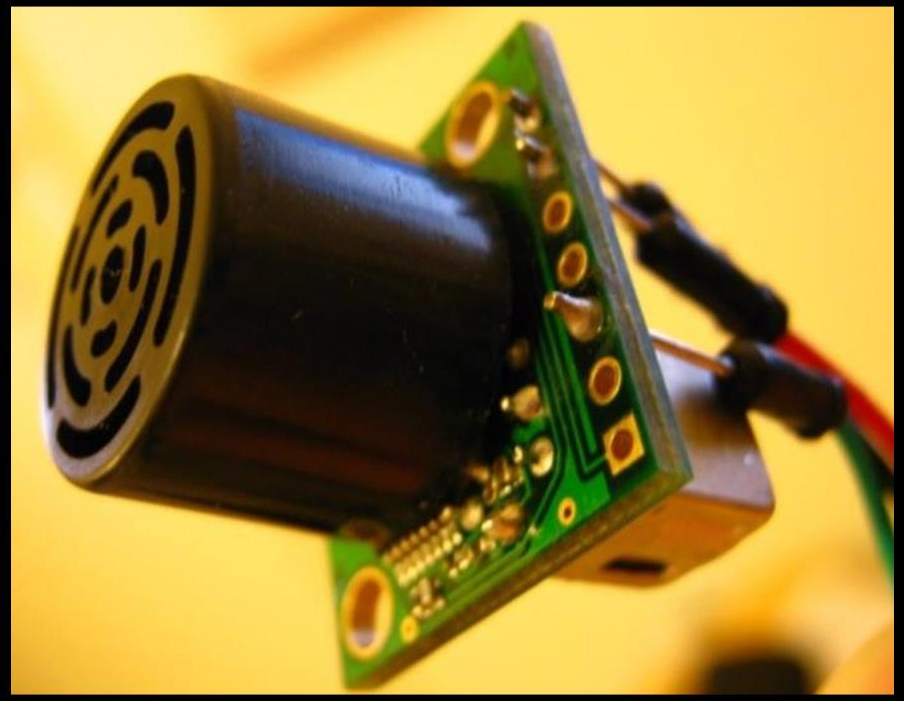
Calibration, start with math – end with real world testing.

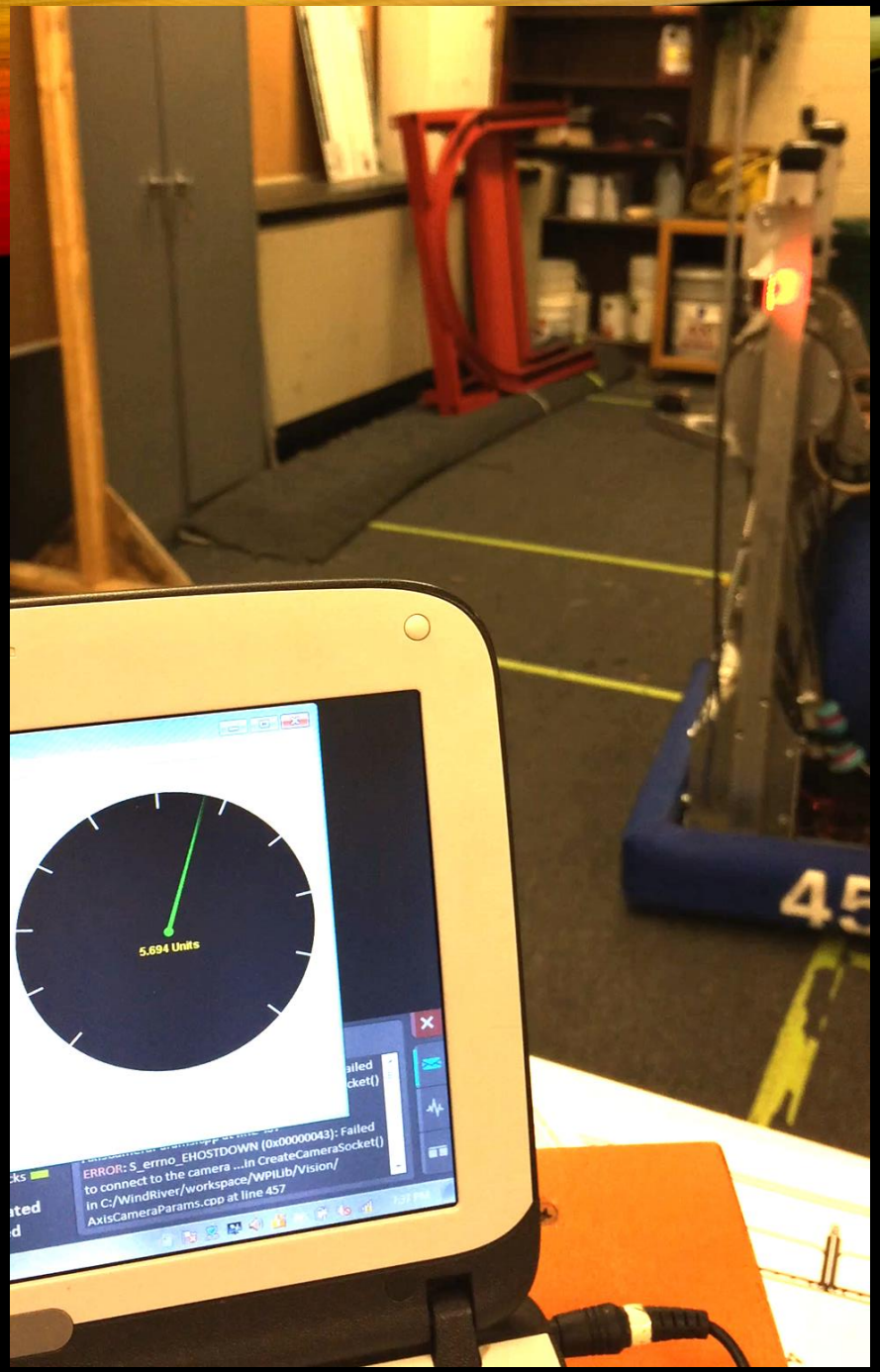
```
/*
 * Parameters:
 *   int - The digital input pin for channel A.
 *   int - The digital input pin for channel B.
 *   boolean - Whether or not to reverse the counting direction.
 *   EncodingType - The accuracy at which to count the encoding channels.
 */
Encoder encoder = new Encoder(1, 2, true, EncodingType.k4X);
encoder.setDistancePerPulse(1.0/COUNTS_PER_INCH); //Used as a scaler when calculating rate and distance.
encoder.reset(); //Reset the encoder's counts to 0.
int count = encoder.get(); //Get the current count of the encoder.
double distance = encoder.getDistance(); //Get the current scaled distance (relative to distancePerPulse).
double rate = encoder.getRate(); //Get the current scaled velocity (distance per second relative to distancePerPulse).
boolean direction = encoder.getDirection(); //Get the current rotation direction.  True for up, false for down.
```

ULTRASONIC SENSORS

Ultrasonic sensors measure distance by emitting a sound and timing the echo.

MaxBotix sensors are popular and can be read using analog or digital inputs.





ULTRASONIC EXAMPLES

The sensors will measure from a few inches to ~25 feet, with accuracy to a fraction of an inch.

Can measure from 10-20 times a second.

SONIC IMPLEMENTATION

MB1210-MB1310

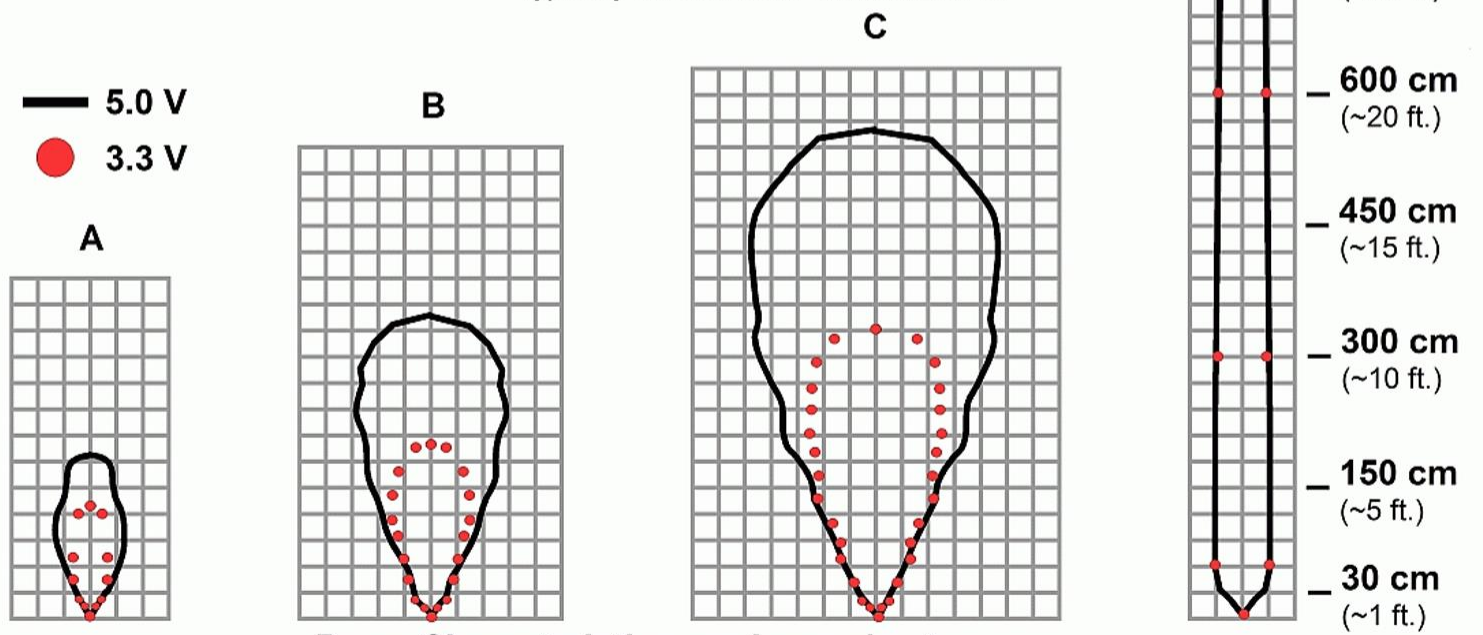
XL-MaxSonar®-EZ/AE1™ Beam Pattern

Sample results for measured beam pattern are shown on a 30-cm grid. The detection pattern is shown for dowels of varying diameters that are placed in front of the sensor

A 6.1-mm (0.25-inch) diameter dowel
B 2.54-cm (1-inch) diameter dowel
C 8.89-cm (3.5-inch) diameter dowel

D 11-inch wide board moved left to right with the board parallel to the front sensor face. This shows the sensor's range capability.

Note: For people detection the pattern typically falls between charts A and B.

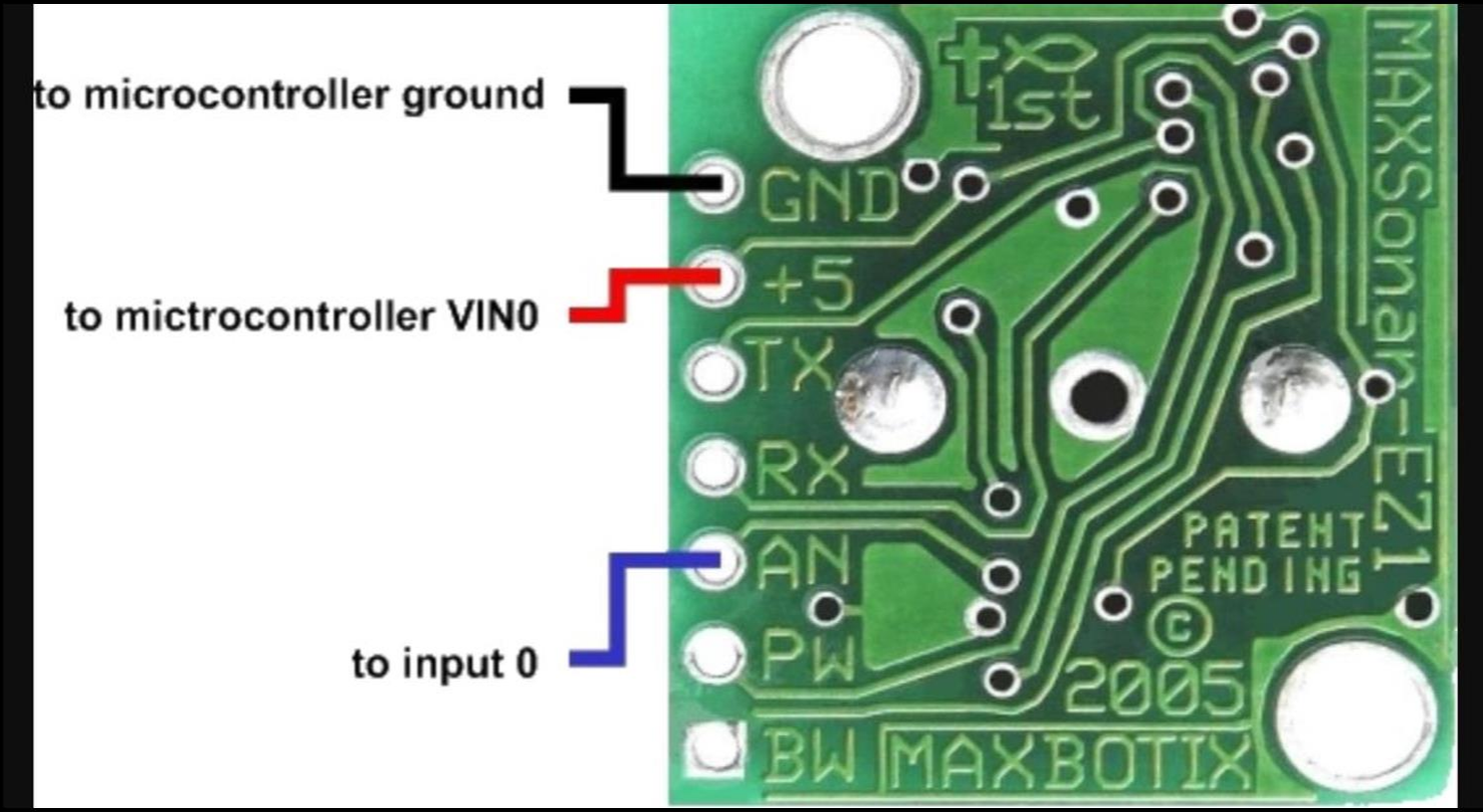


Beam Characteristics are Approximate

Beam Patterns drawn to a 1:95 scale for easy comparison to our other products.

MaxBotix® Inc. For more information or latest product datasheets visit: www.maxbotix.com

SONIC IMPLEMENTATION



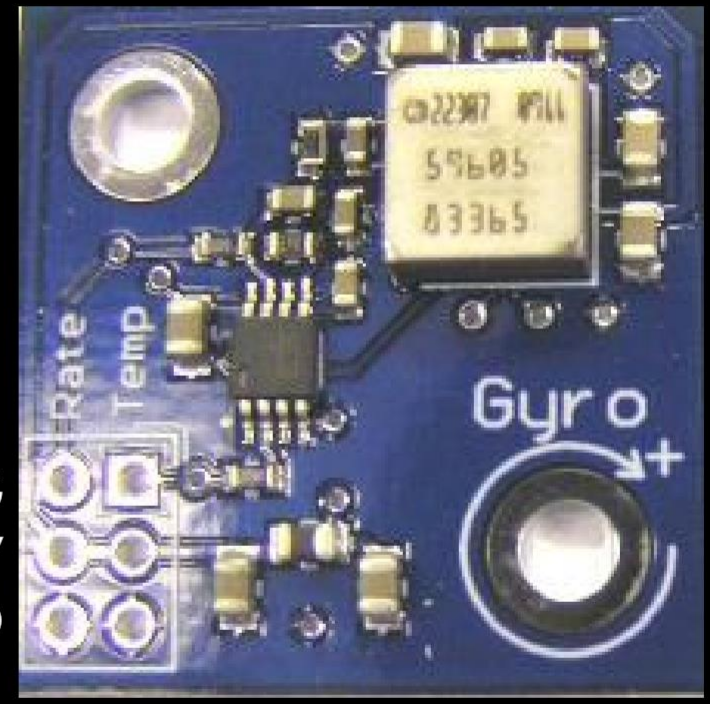

```
double VOLTS_PER_INCH = 5.0 / 1024 * 2.54; //The scaling factor for volts/inch
AnalogInput ultrasonic = new AnalogInput(1); //Input pin ID
double range = ultrasonic.getVoltage() / VOLTS_PER_INCH; //The object range in volts/inch
```

GYROS

Gyroscopes measure angular velocity.

By summing the velocity over time, you can derive a heading in degrees. WPILib does this for you.

The gyro in the picture returns an analog value.



GYRO EXAMPLES

Gyros are commonly used in controlling the heading of the robot.

GYRO IMPLEMENTATION

The calibration will require some trial and error.

Gyro heading will drift over time.

```
double GYRO_CALIBRATION = 0.00669; //Volts/second/degree
Gyro gyro = new Gyro(1); //Gyro on Analog Channel 1
gyro.setSensitivity(GYRO_CALIBRATION); //Calibrate the gyro
gyro.reset(); //Zero the current heading when the robot is enabled.
gyro.getAngle(); //Gets the current cumulative heading in degrees.
```