# MAGNETIC POLARITY DETECTOR

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# Problem Statement

Honeywell has expressed a need for a tool to be used by technicians in their production facility to confirm correct wiring of a magnetic coil early in the fabrication process to prevent errors and potential damage to the equipment that could result from incorrect wiring.

| Functional Requirements | Non-Functional Requirements |
|---|---|
| Less than 10V and 100mA DC | Portable |
| Bench top set up | Easily customizable |
| Easy to use and calibrate | Light and easy to handle |
| Should not be affected by external magnetic fields | Utilize commercially available devices |
| Will not damage product during testing | |

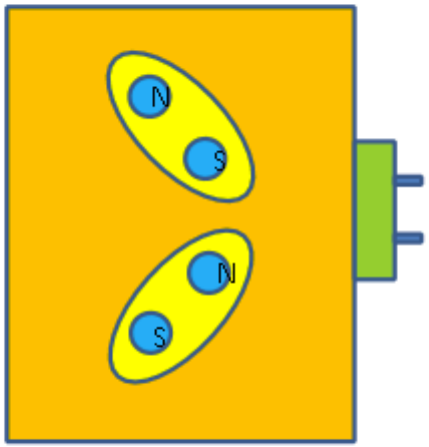
# Problem Statement

## Example of a Possible Magnetic Core Test Unit

Example Unit with two cores wired to external connector

Example
Coil 1 (L1)
- 4 turns of 24 AWG wire
- Polarity as shown

Coil 2 (L2)
- 100 turns of 36 AWG wire
- Polarity as shown




Connector
- L1, Pin 1, V1+
- L1, Pin 2, Grnd
- L2, Pin 3, V2+
- L2, Pin 2, Grnd

Magnetic Core Body
Air Gap
Assembly Body
Wiring
Connector

# A specialized tool

## Gauss meter

- Indicates direction
- Reports magnitude
- Measures field in all directions

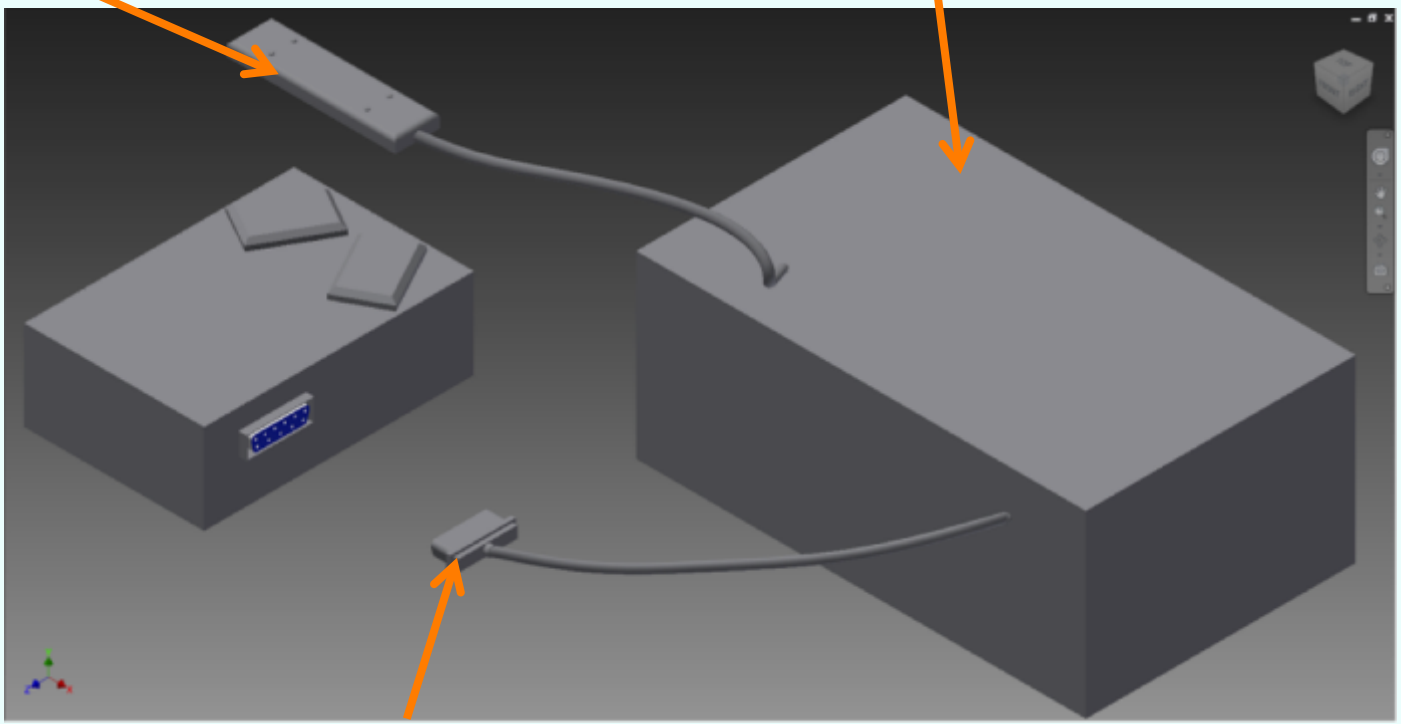
## Our Tool

- Clearly indicates direction
- Reports magnitude
- Indicates correctness with the push of one button
- Fool proof operation

# Conceptual Sketch

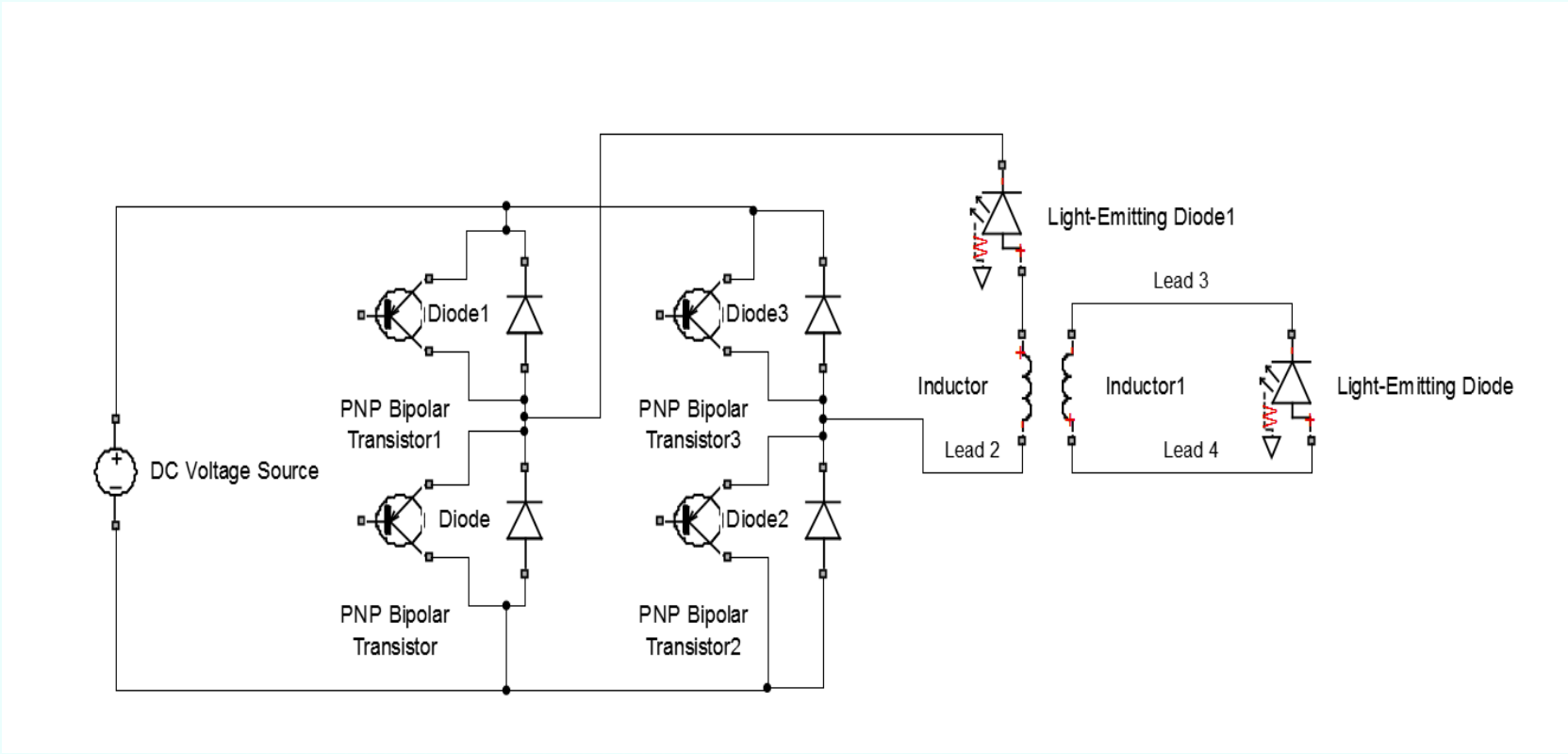
Wand

Unit (battery and circuitry)



DB9 Connection

# Original design



# Sensitive Information

- Limits on information that can be released
- Testing units not available to the team
- Solution:

  **Increased communication with Honeywell and created our own coils for testing**

# Selection of Senor

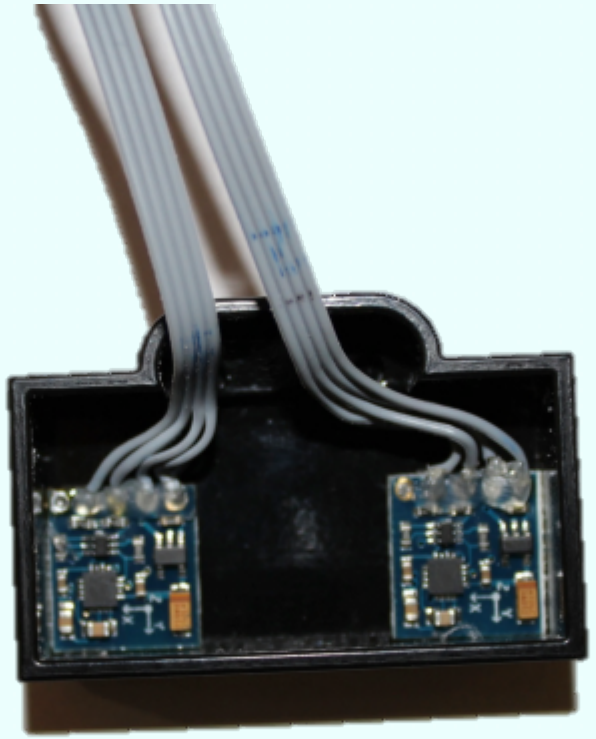
- Honeywell had been working with a very sensitive 3-axis chips
- The budget did not allow for the purchase of two of those chips
- Solution:

  **After testing, we were able to confirm that a less sensitive, more cost effective sensor could be used.**

# Data retrieval from sensors

- Both sensors have the same address
- Need to take readings from both sensors in the same run
- Solution:

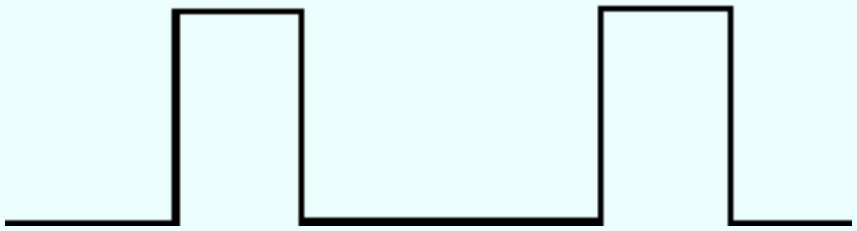
  **Use two transistors to control the data lines to ensure we are getting readings from the desired coil.**



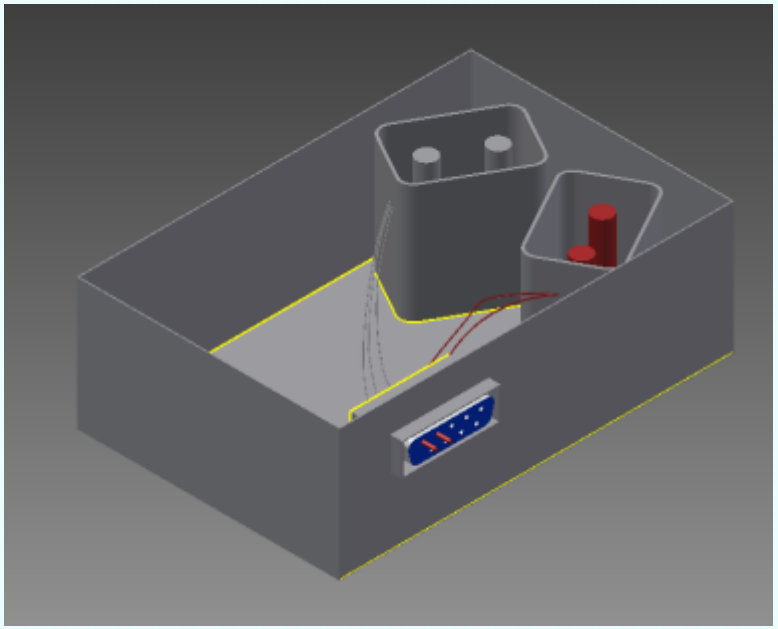
# Powering the magnetic field

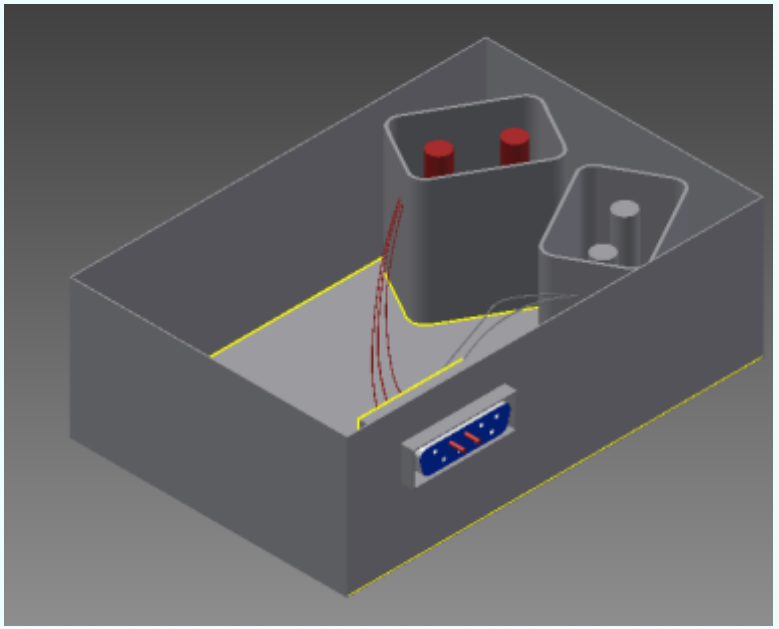
- Magnetic field strength: 10-1100 mG
- Current limitation: 100 mA continuous
- Solution:

  **Pulse the power supply to the coil in order to supply a larger current without damaging the coils.**

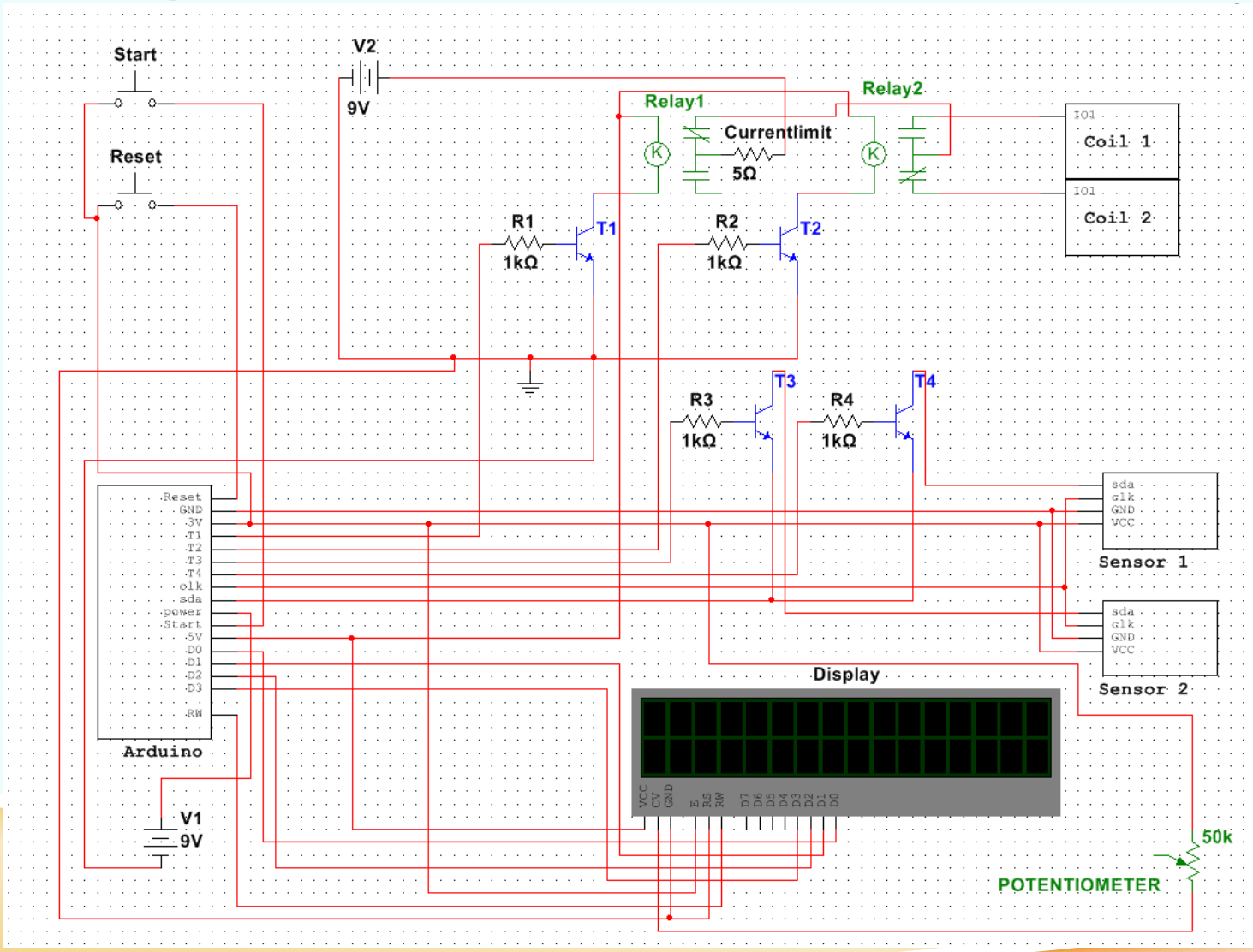



# Mock Unit Power Setup



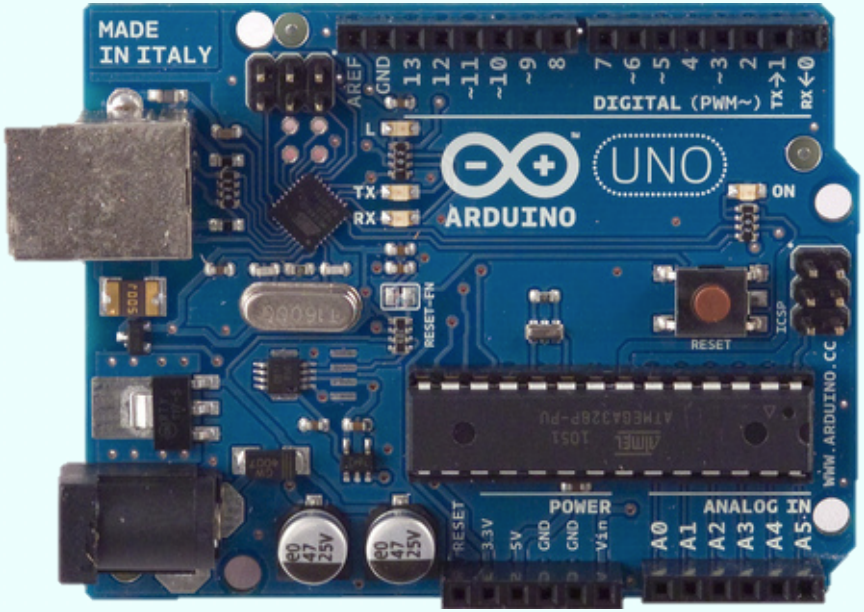


# Concept Circuit

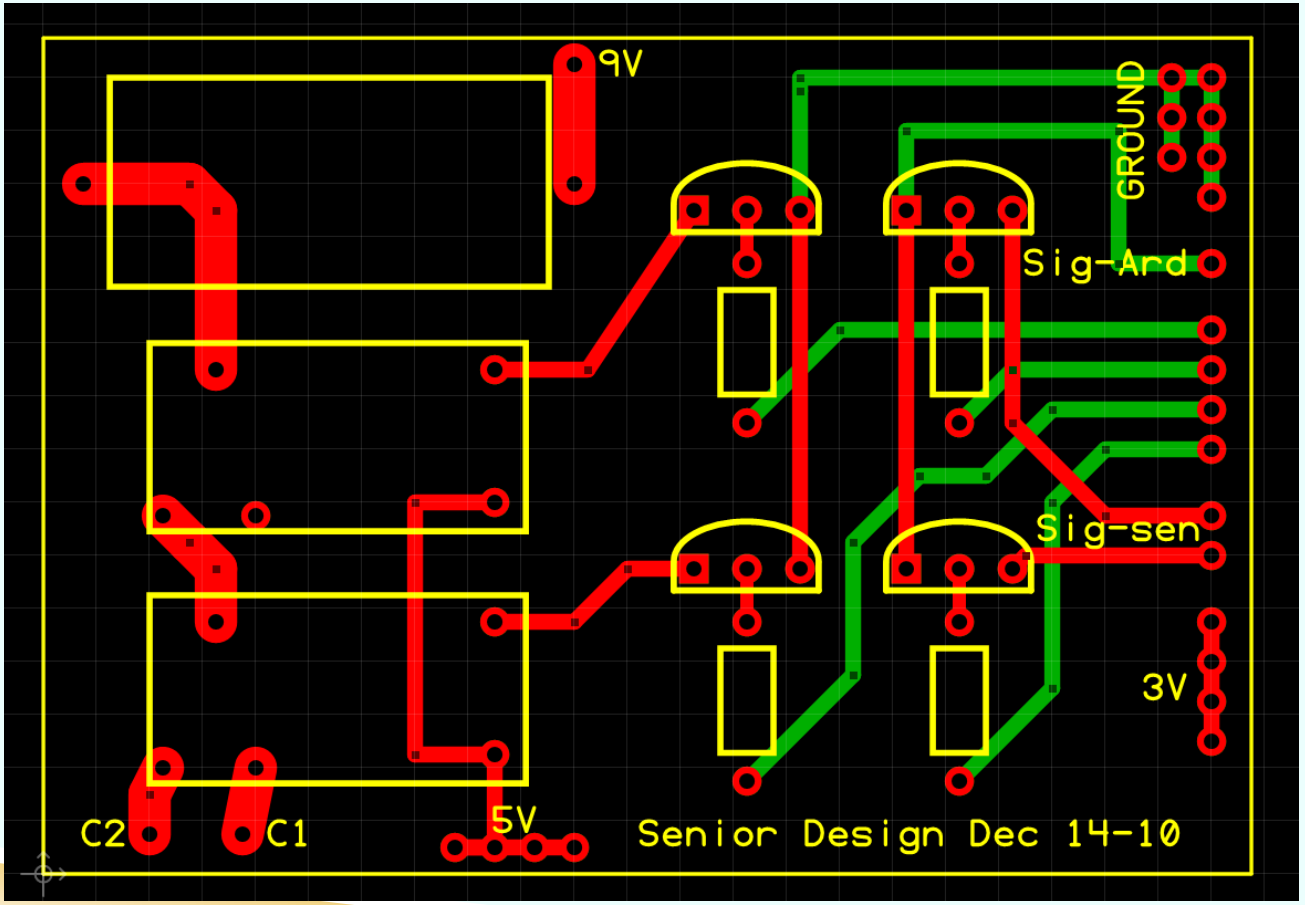


# Arduino

- Easy to modify
- I2C interface
- Room for expansion

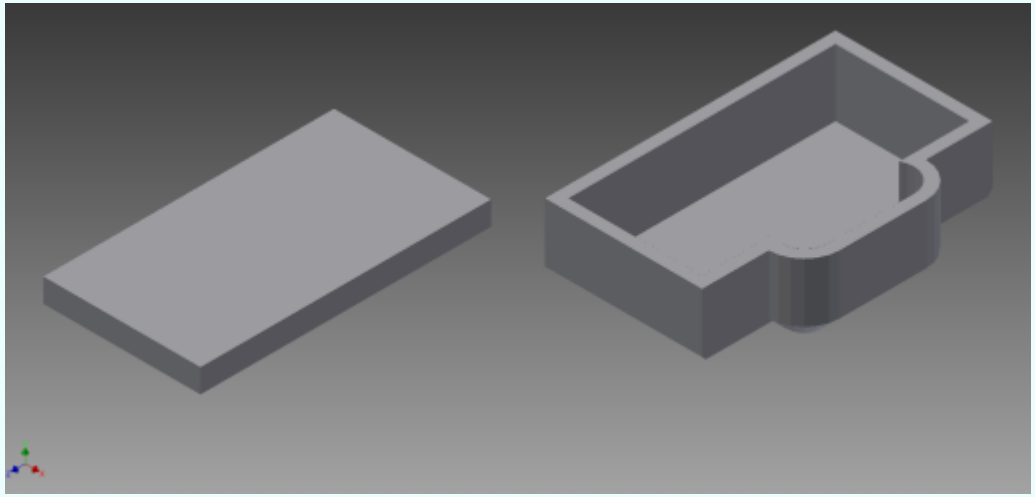


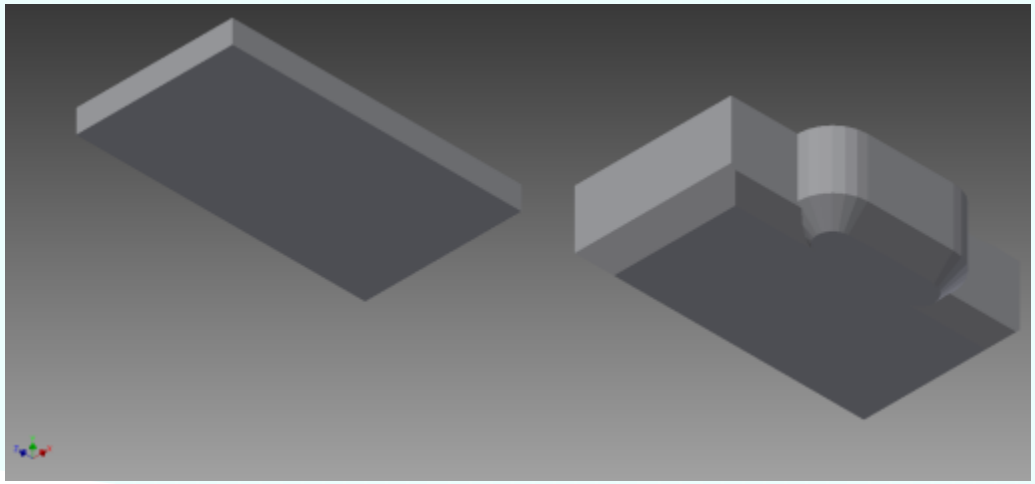
# PCB Design



# Wand Design

- Indentation matches box
- Sensors are optimally placed within the box to achieve precise readings





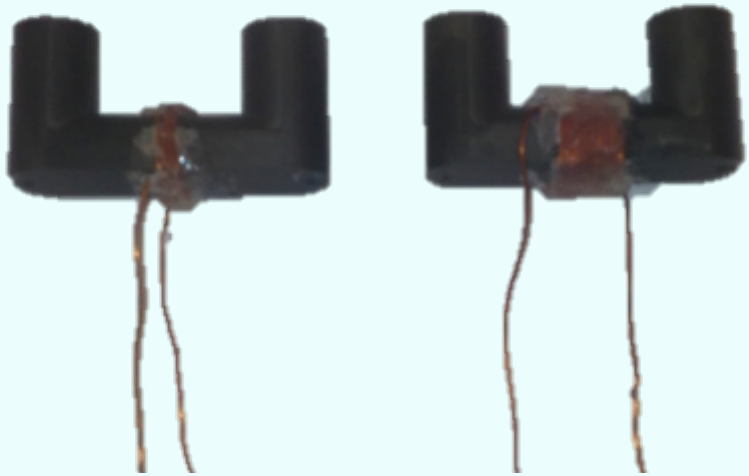
# Final Design

- 2 magnetic sensors
- Arduino UNO microcontroller
- Printed circuit board
- LCD Screen

# Demo

# Testing

Initial testing performed with prototype cores



Final testing performed with Honeywell units

# Testing

| Trial | Mock Unit 1 | | Mock Unit 2 | |
|---|---|---|---|---|
| 1 | 1058 | 28 | -952 | -34 |
| 2 | 1060 | 25 | -947 | -29 |
| 3 | 1055 | 27 | -942 | -31 |
| 4 | 1056 | 33 | -938 | -26 |
| 5 | 1054 | 27 | -942 | -31 |
| 6 | 1057 | 35 | -934 | -34 |
| 7 | 1054 | 29 | -941 | -31 |
| 8 | 1056 | 33 | -938 | -23 |
| 9 | 1053 | 35 | -936 | -23 |
| 10 | 1053 | 28 | -933 | -30 |

Standard deviation of Coil 1: 2.05 mG
Standard deviation of Coil 2: 5.57 mG

# Cost Estimate

| | |
|---|---|
| Arduino UNO | $23.25 |
| Potentiometer | $1.12 |
| Backlit LCD screen | $9.99 |
| DB9 cable | $4.00 |
| USB cable | $4.67 |
| Push buttons (2) | $9.90 |
| Enclosure | $39.10 |
| Wand | $16.09 |
| Printed circuit board | $18.05 |
| Relay (2) | $3.90 |
| Power switch | $0.95 |
| Battery (2) | $4.00 |
| 3 axis magnetic sensor (2) | $13.98 |
| Transistors (4) | $1.68 |

Our total cost:

**$150.68**

Our total budget:

**$700**

Our project was

**$549.32**

under budget

The cost of a similar tool is

**$40,000**

# Key Points for Honeywell

- Benefits of pulsing current
  - Allows for higher current use for a short period of time
  - Better testing data
- Capacitor
  - Could eliminate one 9V battery
  - More sophisticated design
- Different sensor
  - Better sensitivity
  - Possible ability to lower pulse power consumption

# Questions?