

# Magnetic Polarity Detection

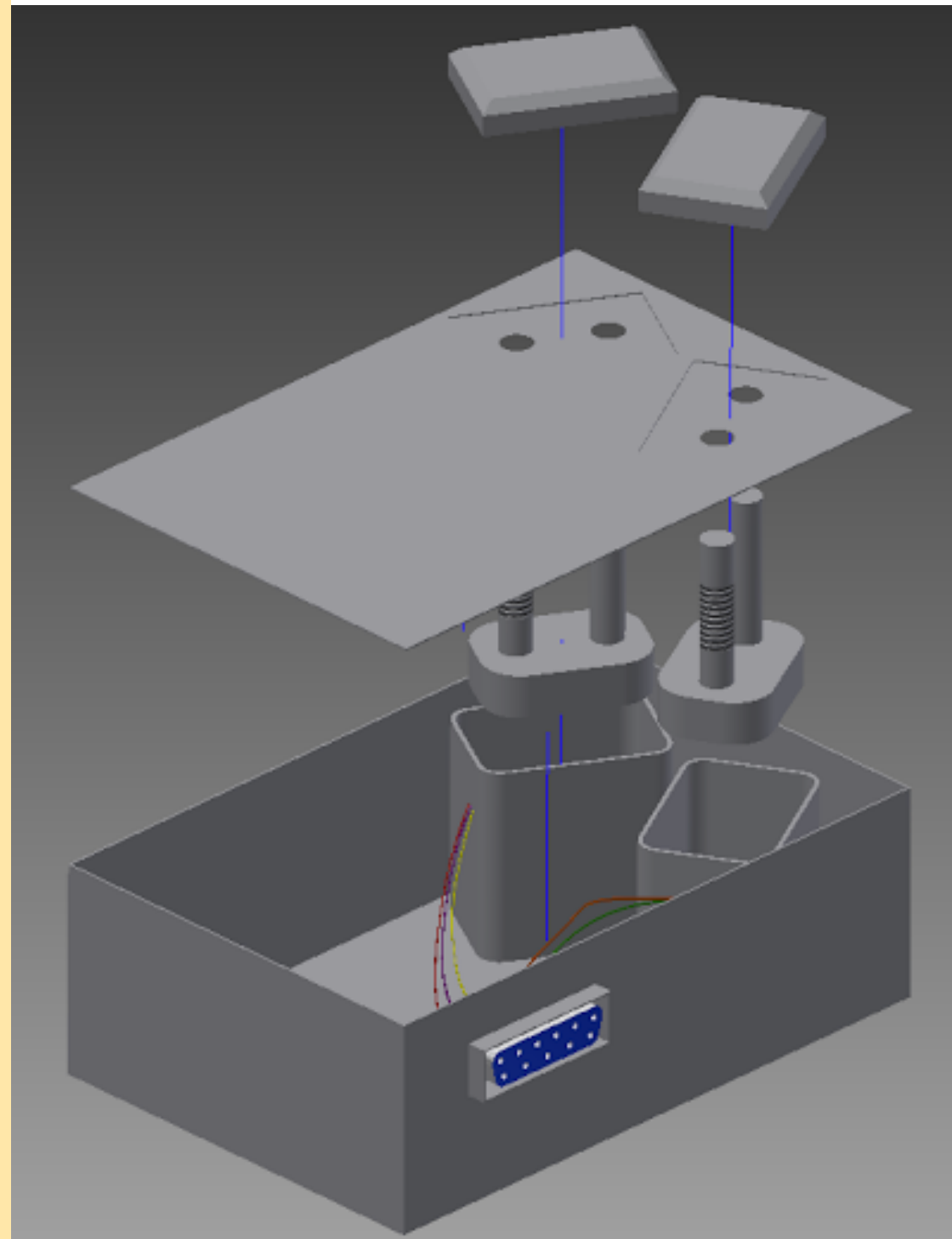
Team Members: Chen Cheng, Jeremiah Janssen, Kailey McGuire, Tori Sorensen, Tym Wood

Advisor: Venkataramana Ajjarapu

Client: Honeywell

Dec 14-10

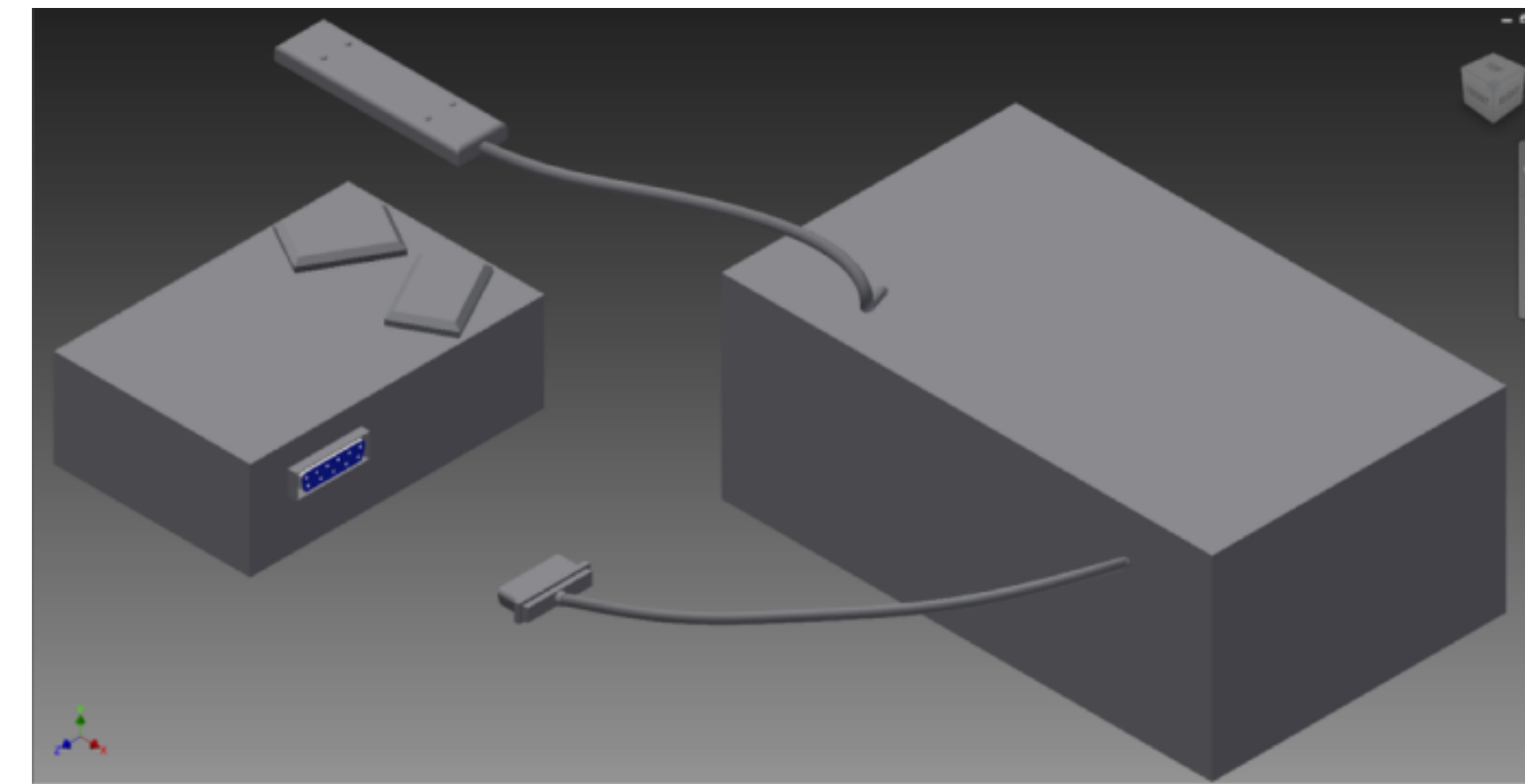
## Problem



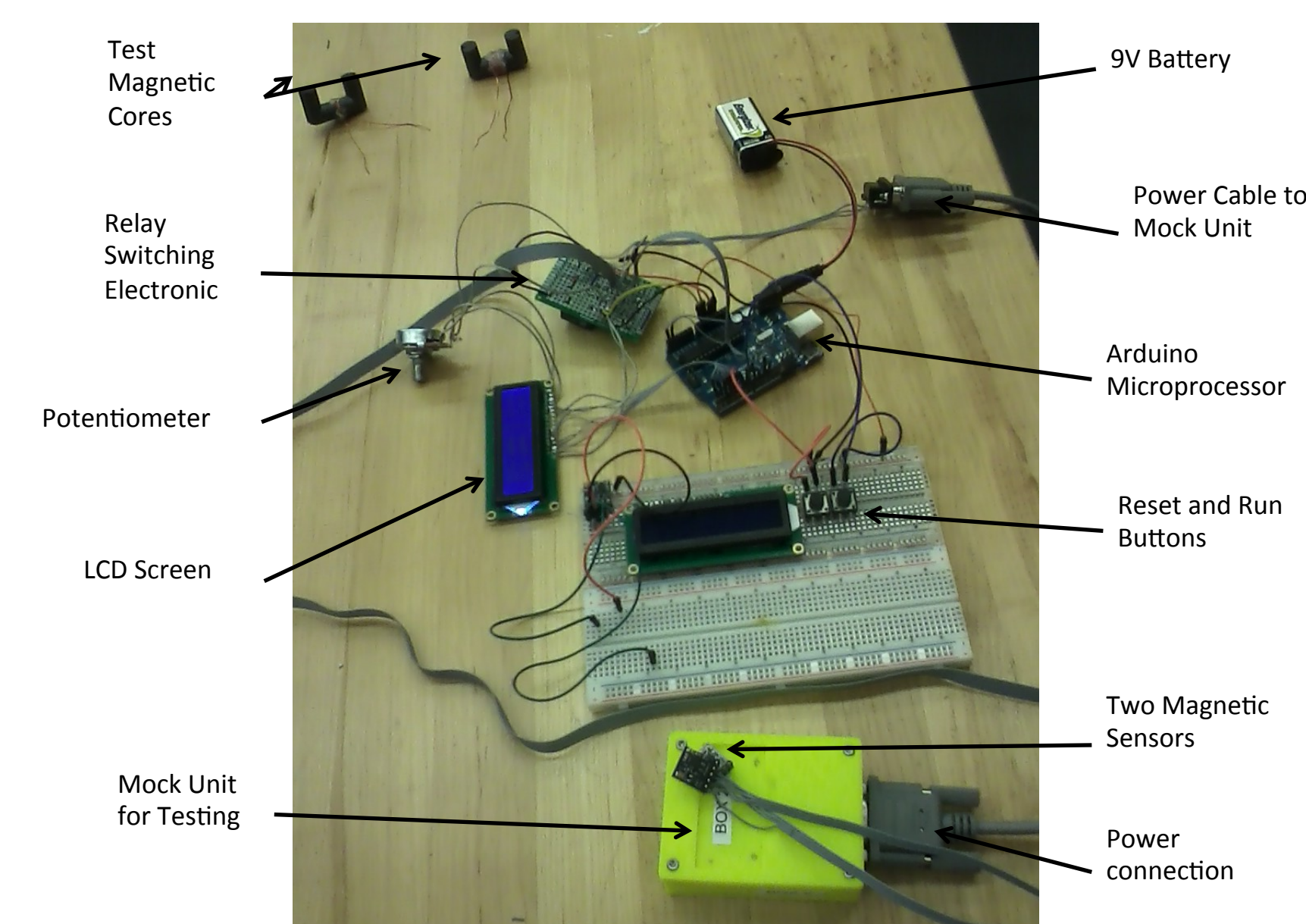
Honeywell has requested a tool to check the polarity of magnetic fields produced by two coils that are components incorporated into a larger unit. The goal is to reduce the cost of finding a discrepancy in later assembly steps. Confirmation that coils are correctly wound and positioned is required at an early stage of production. Currently, testing is not performed until a high level of assembly and the cost to fix a mistake is very expensive. Employing a tool that confirms correct polarity at an early stage in production reduces costs by a factor of ten. The exact configuration of the coils is unknown; therefore, CAD renderings have been created using Inventor software.

Functional Requirements	Non Functional Requirements
Less than 10V and 100mA DC (continuous)	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

## Design Approach



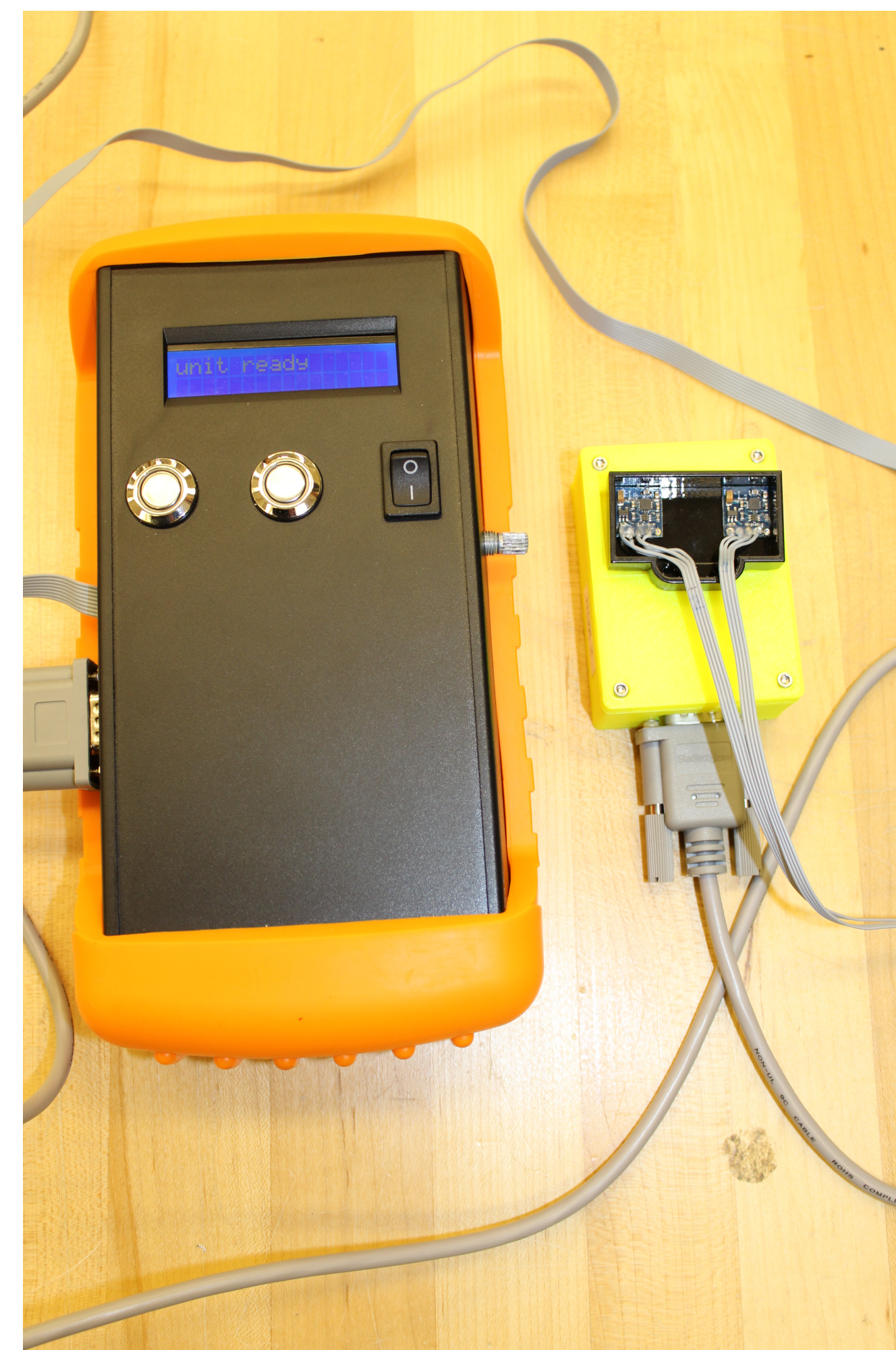
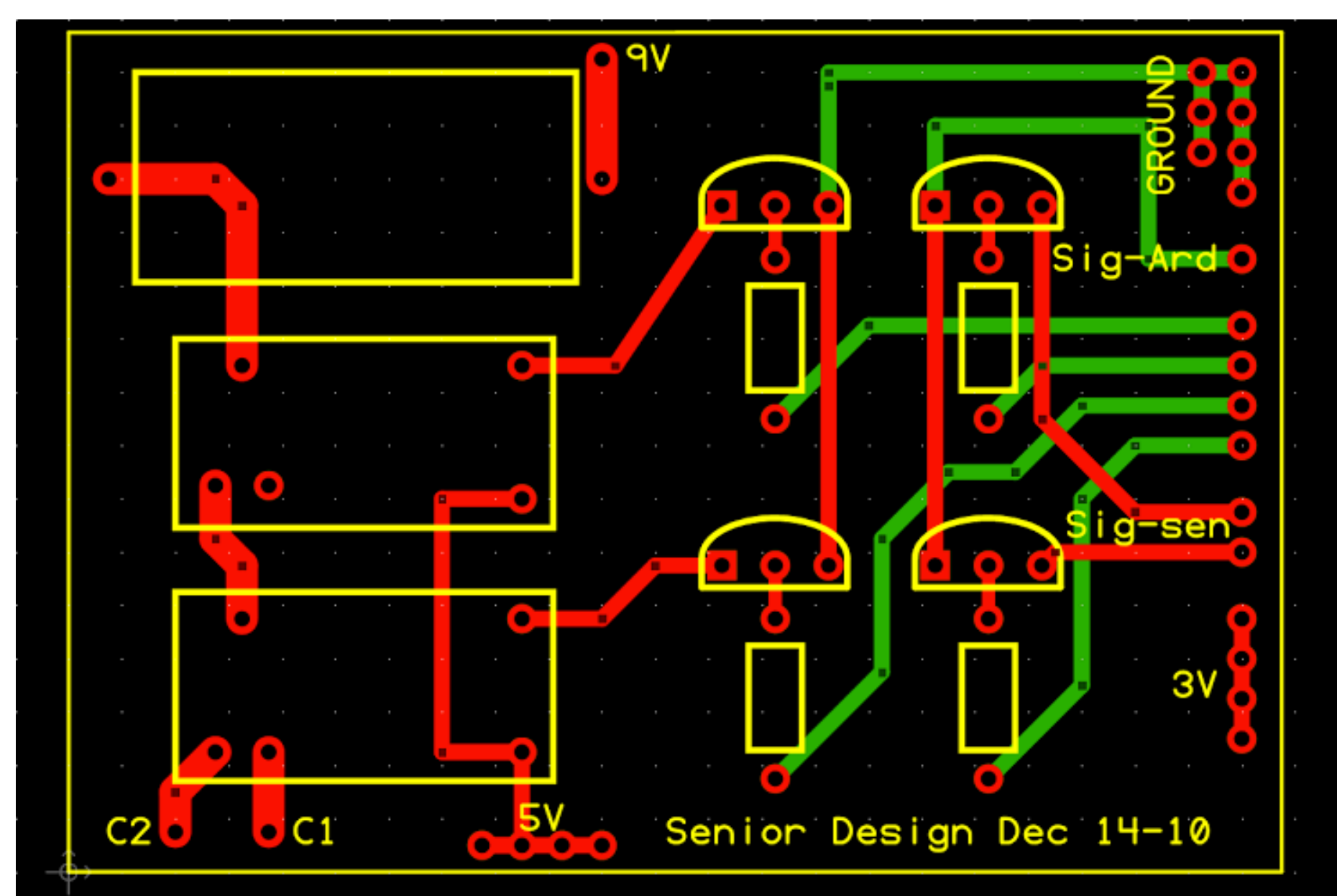
Two sensors are placed directly over the two coils to read the magnetic field produced by each coil. In the figure to the left, the CAD rendering of the Honeywell unit is shown on the left, with the testing unit on the right. The sensors are attached to the testing unit on a wand, and the testing unit has a DB9 connection to the Honeywell unit to provide power.



Using this methodology, a prototype was created using the desired components assembled onto bread board and prototype board. Once the prototype was functional, the process of migrating towards a portable bench top setup began.

## Technical Details

By printing a circuit board (shown below), all components fit efficiently inside the housing. The power to the coils is supplied through the relays on the left half of the board. The transistors on the right half of the board display the layout of the sensing circuit. Using a printed circuit board allows for significant size reduction.



The Arduino platform is designed to read the data from the sensors and report this data in a simple format to the user. This adds ease of use and flexibility to the design of the polarity checker.

One 9 V battery is used to power the coils using a pulse instead of a continuous current. This allows for a sufficient current over a short enough time to ensure the coil is not damaged while still providing a significant magnetic field that may be read by the sensors. The current supplied is easily adjusted by changing the current limiting resistor in the circuit.

Two 3-axis magnetic sensors are used to determine the polarity of the coils. The sensors transmit data via the I2C serial bus which allows for fewer connections and simpler data readings.

## Testing

Testing of the Honeywell units is only permitted with supervision. In addition to this supervised testing, two prototype cores were wound to replicate the magnetic field. Testing of the prototype cores confirmed that the device correctly identifies polarity. Taking it one step further, formal testing with the Honeywell units was performed to determine the preciseness of the magnitude readings.

Trial	Mock Unit 1	Mock Unit 2
1	1058	28
2	1060	25
3	1055	27
4	1056	33
5	1054	27
6	1057	35
7	1054	29
8	1056	33
9	1053	35
10	1054	28

By examining the test data, the first coil exhibits a standard deviation of 2.05 mG and the second coil exhibits a standard deviation of 5.57 mG. Testing was also performed using a metal plate to determine at what point in manufacturing the polarity testing should take place. At this point in development, it has been determined that accurate readings are not able to be taken through the metal housing.

## Future Work

The polarity checking tool will serve as a base model for a similar testing unit. Adaptations will be made based on the specific use. For this reason, the tool was designed to be easily adaptable.

The Arduino platform is extremely easy to access, and the code was written with consideration given to the user who would like to make adjustments.

The current provided to the coils is also very easily raised if a stronger field is required, or lowered if it is found that the current will damage the coils.

Other adaptations could address issues including:

- Reading a magnetic field through metal
- Examining effects from equipment on a magnetic field
- Redesigning for differing coil configurations
- Editing the format of data reporting
- Reducing the size of the testing unit
- Powering the testing unit from a wall outlet