ELECOMP CAPSTONE SUMMIT
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THE UNIVERSITY OF RHODE ISLAND

THINK BIG WE DO℠

HVAC Failure Analysis and Simulation

BOSCH
Invented for life

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Project Motivation

Bosch products have the reputation of being the best products in the industry. The durability of these products have become more predicated on the complexity of their components and the software that is required to operate them. As a result, engineers face more challenges during the early stages of testing. The motivation for this project is to develop a system that will monitor, analyze, and simulate data failures in HVAC systems. The architecture includes a control box that inputs customized data directly into the HVAC unit which can then monitor, store, and relay that data to a cloud based service. This would allow for monitoring possible failures and ensure the quality of their products remotely, with minimal physical interaction.

Key Accomplishments

- **Improved Design:** Created a detailed schematic for all of the existing sensor wiring (thermostat controls, PCB, and breadboard connections) for the conditions of improvement and functionality.
- **HVAC System Components:** Researching the working parts to the Inverter Ducted Split Unit (Figure 1), which is critical for component placement and control wiring between the units. The design will allow for the ease of interconnection between both units with bulk connectors that have the means of connecting or disconnecting all low voltage controls without handling any of the internal connections.
- **Control Wiring:** Upgraded the wiring by removal and replacement of the existing low voltage conductors between both units and encased the new cables within a raceway and increased the wire gauge to meet or exceed the minimum requirements set by UL and NEC electrical standards.
- **PCB Design:** Developed a printed circuit board along with its components, while working toward a specific design for the custom PCB to be used in this prototype design (Figure 2). This PCB design will ensure a more stable connection with all of the components, while also ensuring the portability feature.
- **Sensor Design:** Detailed improvements from the previous design with a focus on electrical reliability of the system by researching various voltage and current sensing designs with less potential design flaws.
- **Internal Prototype Design:** Developed a portion of the design for having multiple relays, with their individual 5VDC and 24VAC coils, that will work in conjunction with multiple I/Os from the PCB's and for the compatibility within the overall area inside the Hammond Board (Figure 3). By incorporating those relays to work with the SPDT switches and the individual thermostat controls on the cover, this will allow for ideally simulating single and/or multiple equipment failures.

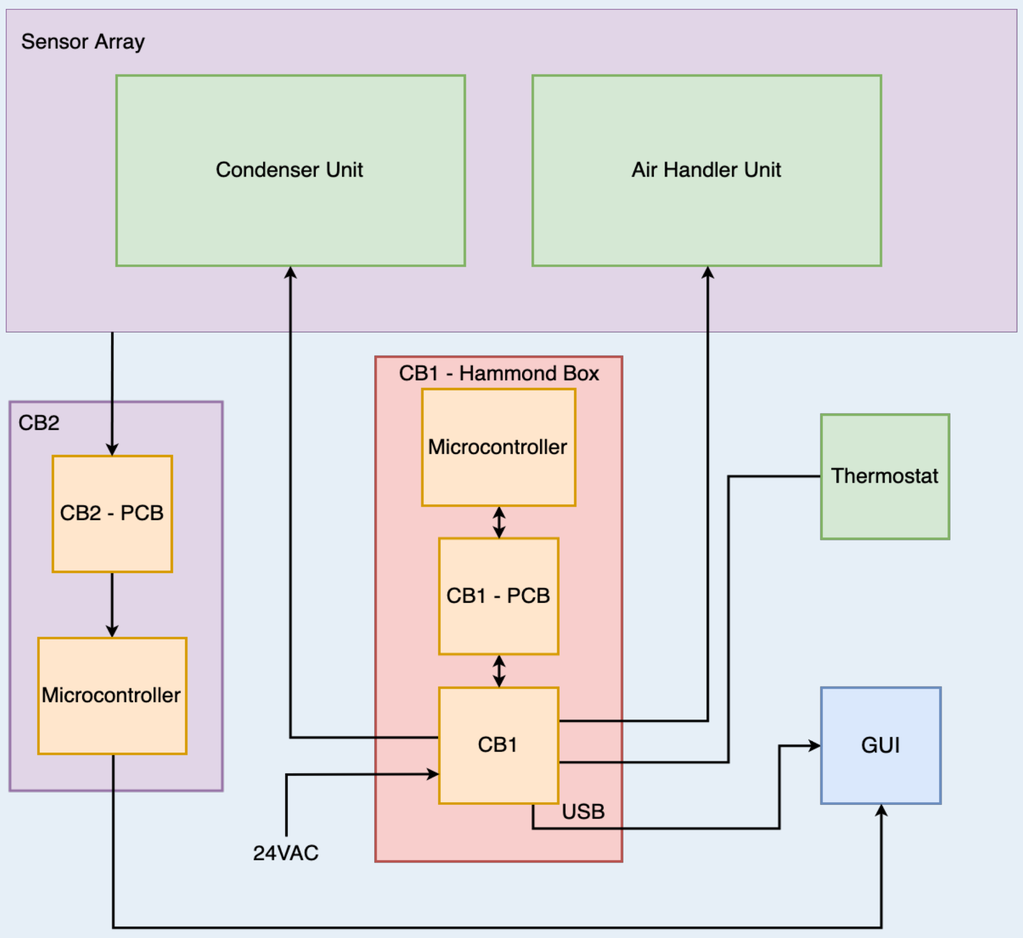

Figure 4 - Final System Architecture

Anticipated Best Outcome

The ideal outcome for this project is to have a functional, semi-modular prototype that has the ability to simulate equipment failures, monitor sensors, and relay data to a program. The analog and digital sensors would allow the system to collect data from the various components, which could be used for future analysis and simulation testing. The layout, design, and construction of a custom printed circuit board would aid in the durability for all of the circuit connections. The physical control box would allow for the flexibility of instant custom user input and also expedite testing and failure simulations.

Project Outcome

The Anticipated Best Outcome was achieved. All milestones were met and the system that was developed is ready for deployment. The final prototype that was created included a testing platform (CB1), a sensor array (CB2), and a graphical user interface to monitor the system. Bosch will be able to use this in an HVAC system to simulate different scenarios easily and accurately.

Figures

Figure 1 - Control Box Prototype

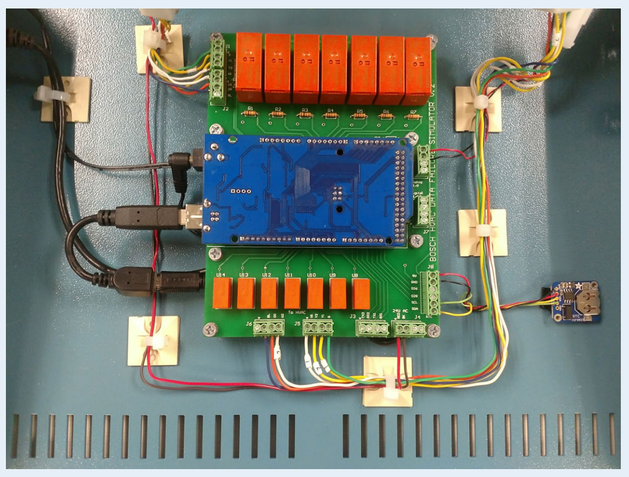

Figure 2 - CB1 Inside the Control Box

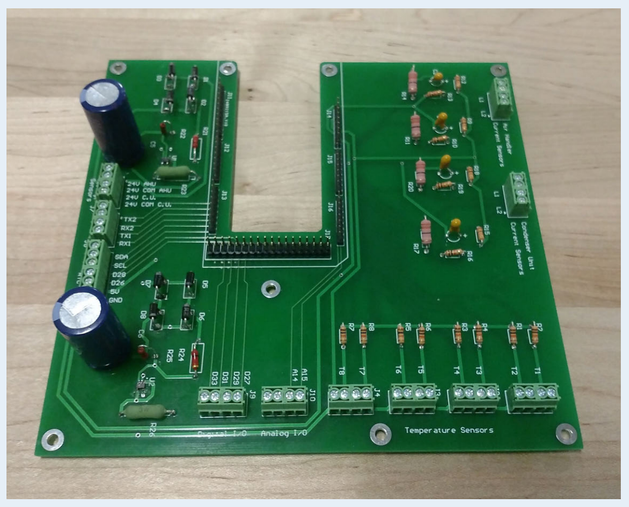

Figure 3 - PCB Housing Circuitry for Sensor Array

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