BOSCH
Thermotechnology

HVAC Equipment Failure Modes and Potential Solutions

bosch-climate.us

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PROJECT MOTIVATION:

The brand Bosch, **Invented for Life**; is committed to producing the highest quality products, Consumers buy their products and services because they offer quality and reliability. In the HVAC industry, Bosch offers comfort solutions in the form of Air Source Inverter Ducted Split Heat Pumps and Water Source Geothermal Heat Pumps. Beyond the mechanical components these systems require for good heat transfer, the systems have evolved to include more electrical and software based components. A result of increased components is an increase in vulnerability to failure. To maintain the company's reputation of quality and reliability during the manufacturing of these systems, Bosch utilizes low failure-rate components. The focus of this project is to help ensure such an equally satisfying result. Team Bosch is tasked with identifying component failures, and proposing solutions to extend the life of the components. The team devised a means of measuring component operation through both software and circuit design to monitor how various aspects of heating/cooling systems affect unit operation.

ANTICIPATED BEST OUTCOME:

Ideally, our group will build a hardware and software system which will be capable of field failure data for multiple types of HVAC system. This system will extract meaningful input such as temperature, run time, voltage, and current for various mechanisms within the unit. This data will be interpreted using a micro-controller to better understand failures of individual components in HVAC systems. The final deliverable will be a prototype which will incorporate these hardware and software systems.

IMPLICATIONS FOR COMPANY AND INDUSTRY:

The successful completion of this project will provide Bosch with a deeper understanding of how HVAC systems fail in the field. Moreover, this system will allow Bosch to see which components have higher failure rates, when components begin to fail, and how to improve their HVAC systems so that there are less failures and less warranty claims. This will help Bosch to cut both the costs and time taken to resolve claims, helping the industry to address issues faster and more effectively. Ultimately, the resulting information will aid Bosch to further develop higher quality products.

PROJECT OUTCOME:

The Anticipated Best Outcome was achieved.

KEY ACCOMPLISHMENTS:

Power Hardware Specifications: A hardware specification document was written so that once all the components arrived, the infrastructure was immediately known. A Bill of Materials listing all of the requirements to construct a prototype was also written early on. Moreover, circuit schematics were designed for purpose of implementing the electrical components of the HVAC system to the controller. For voltage and current, circuits were created for the 240 VAC motor components down to 5 VDC for purpose of real time continuous metering by the controller. All designs were simulated using software before physical implementation.

Software Specifications: A software specification report was written early on in the capstone process in order to effectively plan out the coding infrastructure before hardware implementation. After the software specification sheet was completed, snippets of code were used for syntax reference, and the overarching code was assembled with a clear vision in mind thanks to the specification guidelines.

Sensor implementation: Sensors were installed within the Inverter Ducted Split (IDS) (Figure 1) air handler and condenser. The needs and requirements were determined before sensor implementation. All required conductors were routed and installed in a clean and professional manner. The sensors were then placed onto the IDS unit, and all the sensor components for the circuits were installed onto breadboards (Figure 2) for purpose of Arduino integration. Once completed, all components were placed in a housing to preserve them from damage and provide a professional finish (Figure 3).

Software implementation: Once the physical devices were installed and functional, the written code was physically linked to its respective sensors in order to be fully debugged in a practical setting. This involved large amounts of wiring and rewiring sensors in order to set up the system most efficiently. Once the Arduino was properly wired to the unit, the code was properly troubleshooted for any remaining issues.

Graphical User Interface: A Graphical User Interface (GUI) has been prototyped (Figure 4) for use on the web. GUI's were researched in depth to determine whether or not one should be written or simply downloaded for the purposes of the project. Ultimately a GUI writing program was found that directly coordinates with Arduino based code. This software was used to make a page of legible meters that ideally will take real time data from the respective sensor and display it both digitally and as an analog reading.

Fig 1: IDS unit – Air Handler (right) & Condenser (left)

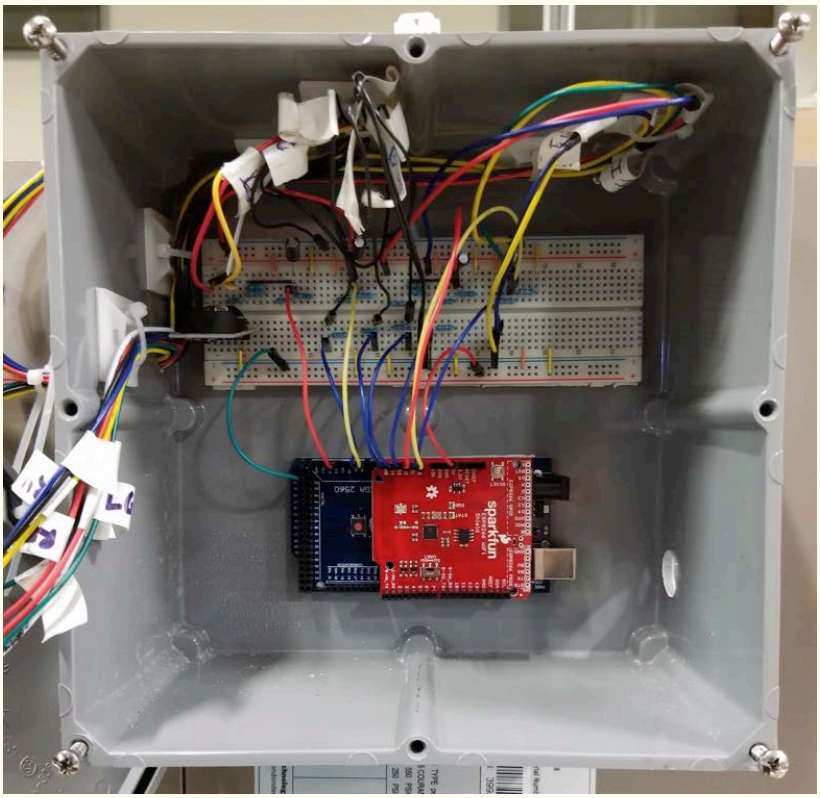

Fig 2: Sensor circuits with components integrated to Arduino

Fig 3: Housing with touchscreen IDS control

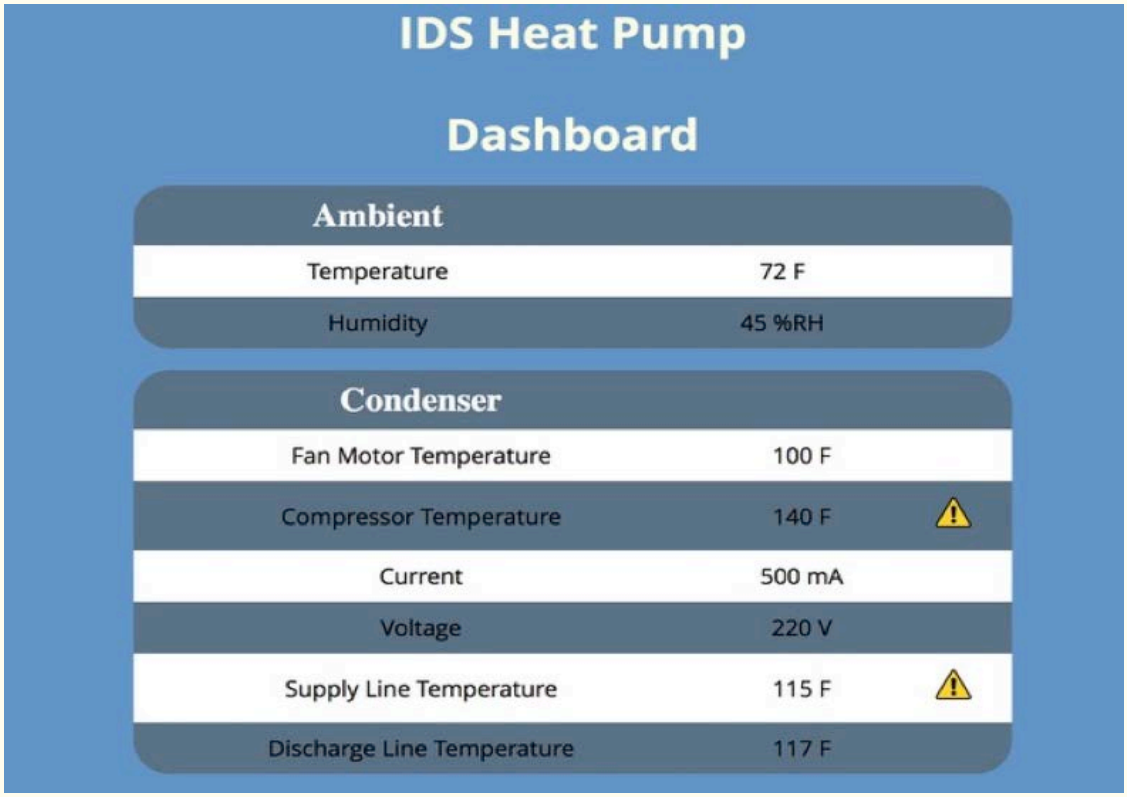

Fig 4: Graphical User Interface displaying real time values with alarms present