2 Breakdown

The main goal of the "Granny-Safe" project was to provide precision temperature control with enhanced safety features for a hot plate burner. To best explain the functioning parts of the project, a high level block diagram is shown below in Figure 1. An explanation of the signal flow follows the diagram. Each block is then detailed with its inputs, outputs, and functionality in the system. The full schematic of the Granny-Safe is provided in Appendix B.

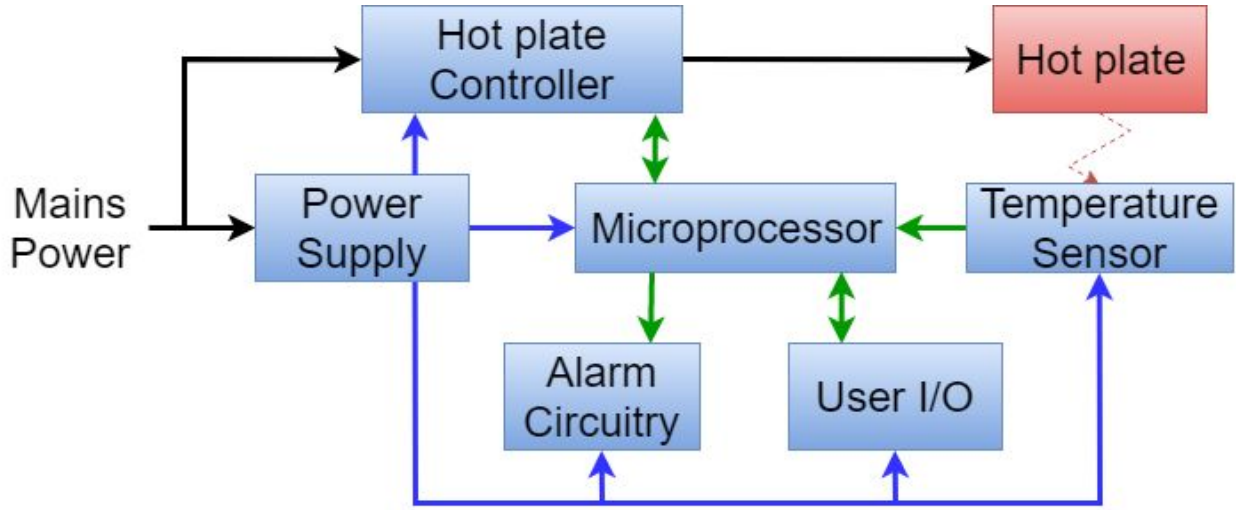

Figure 1: Functional block diagram of the Granny-Safe

As Figure 1 shows, the Granny-Safe is powered by mains power (black arrows). The power supply then steps down the main power to a level usable by the rest of the circuit (blue arrows). The temperature of the hot plate is measured by the temperature sensor and then a data signal (green arrows) is relayed to the microprocessor block. The user I/O block allows the user to view and enter the temperature and desired setpoint. When a setpoint is entered the microprocessor block sends a control signal to the hot plate controller block. The hot plate controller block regulates the power delivered to the hot plate in order to maintain the desired temperature. When certain conditions are met the alarm circuitry block is triggered and emits an audible and visual alarm. If the alarm is not reset by the user through the user I/O block, the hot plate controller will shut off power to the hot plate. The blue blocks in Figure 1 represent Granny-Safe components that were engineered and the red block represents a purchased component.

2.1 Power Supply

The power supply in the Granny-Safe was contractually obligated to provide a 5VDC output capable of supplying at least 500mA with no additional power sources other than 120VAC main.

To satisfy this requirement, a step down transformer and full wave rectifier were used to convert the AC source into a DC value. From there, a buck converter was used to reach the specified voltage and amperage levels.

2.2 Microprocessor

The microprocessor is used to calculate the temperature based on the data received from the temperature sensor. It is also used to process and send data to the user I/O as well as send a control signal to the alarm circuitry to turn it on or off. The microprocessor takes the user entered setpoint along with the temperature data and with the use of a PID function regulates the signal sent to the hot plate controller to then regulate the temperature of the hot plate.

2.3 Temperature Sensor

The temperature sensor uses an RTD to measure the temperature of the second hot plate coil. The temperature sensor is powered by the power supply and uses difference amplifiers to output a voltage that corresponds to a temperature. The output is read by the microprocessor, which then can make changes through the hotplate controls.

2.4 User I/O

The user input enables a user to interact with the control system. Through the user input, the user can dictate what temperature the system will maintain by running the software with an input of the desired temperature. A keypad allows the user to enter a setpoint which is then displayed above the actual temperature on the LCD screen. After ten minutes of being activated, the keypad can be used to reset the automatic shut off time.

2.5 Hot Plate Controller

The hot plate controls use connections from the 5V power supply, 120 VAC main, and microprocessor. A zero sensing circuit is used to find the zero crossings of the AC power, at which, a pulse is sent to the microcontroller. The triac circuit has connections to the main power and microcontroller. At every zero crossing, the microcontroller can send pulses to the triac which allows power to flow to the hot plate. The amount of power going to the hot plate can be manipulated by the microcontroller to adjust the temperature value.

2.6 Alarm Circuitry

The alarm circuitry features an audio alarm and a series of LEDs to serve as safety features for the Granny Safe project. Both the audio and visual alarms take inputs from the microcontroller. The project features three LEDs; a green, yellow, and red. The green LED turns on when a setpoint is entered. The yellow is when the hot plate temperature exceeds 120 degrees. The red LED, as well as the audio alarm, are enabled when the ten minute timer expires.