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Taine de Buys- DBYTAI001
Michael Altshular -ALTMIC003
David da Costa - DCSDAV001

Q1 microHAT Concept [5]

Our PiHat is a temperature sensor. The circuit is powered from the 5V output pin (pin 2) from the Raspberry pi and is grounded into pin 6. The purpose of the Hat is to allow the user to get a visual representation of the surrounding temperature. The daughter board takes the 5V input and passes it through a power switch regulator, lowering the voltage to 4.3 volts and allowing for the user to turn the Hat on and off while still being plugged in. If the circuit is closed, an LED will turn on to show that there is a voltage being outputted from the switch. This output will then run into an analogue temperature sensor that will be covered in a waterproof casing, so that it may be used as a probe. 3 LEDs display the output. 1 LED will turn on if the temperature is above 0 degrees Celsius. 2 lights will come on for a temperature of above 15 degrees Celsius, and all 3 lights will turn on for if the temperature is above 30 degrees Celsius. The temperature sensor can be used to measure ambient room temperature, or as a probe to measure the temperature of liquids or inside temperature regulated appliances like freezers and fridges.

Q2 Requirements [10]

User role/Scenario1

For a user to be able to see what range the ambient room temperature falls into. This would be for any hobbyist or professional who has their raspberry pi running in different environments. It is important to ensure that the raspberry pi operates at lower temperatures in order to avoid potential damage to components. The lights in the output serve to give the user real time information.

- The Temperature sensor can measure a wide range of temperatures
- Multiple LEDs required to show the different temperatures
- LEDs are easily visible
- That each LED has the same temperature difference between them to make them turn on, this will allow for easier reading.

User role/Scenario2

For a user who would want to know the temperature of liquids or gasses in a controlled environment. This user would likely be in a scientific or engineering environment and would use the temperature sensor as a probe in order to have the piHat and pi at a safe distance from liquids or gasses that could damage the circuit.
Requirements:

- That the sensor is capable of being placed in liquid.
- That the sensor can be placed at an adequate distance from the piHat and raspberry pi itself.
- LEDs must still be visible if temperature probe is in separate room/ chamber

User role/Scenario3

For a user to test heat regulated appliances, ranging from fridges and freezers to hotplates and ovens. This user can be anything from home users who want to test the accuracy of their appliances to testing done by the manufacturer.

- The sensor can deal with higher heats.
- The sensor can deal with low temperature environments.
- The sensor is not affected by the heat coming off of the raspberry pi itself.

Q3 Specifications [20]

Mechanical Specifications

Requirement	**Specification(s)**	**Acceptance Test Criteria**
Temperature can be assessed in liquid.	**Waterproof insulation added around probe**	**While the probe is submerged the temperature will still be measured.**
System can be switched off through the Switch Mode Power Supply (SMPS).	**A physical switch is opened to stop current flow through to the collector of the transistor part of the SMPS.**	**System does not operate while the switch is open and operates while closed.**

Electrical Specification

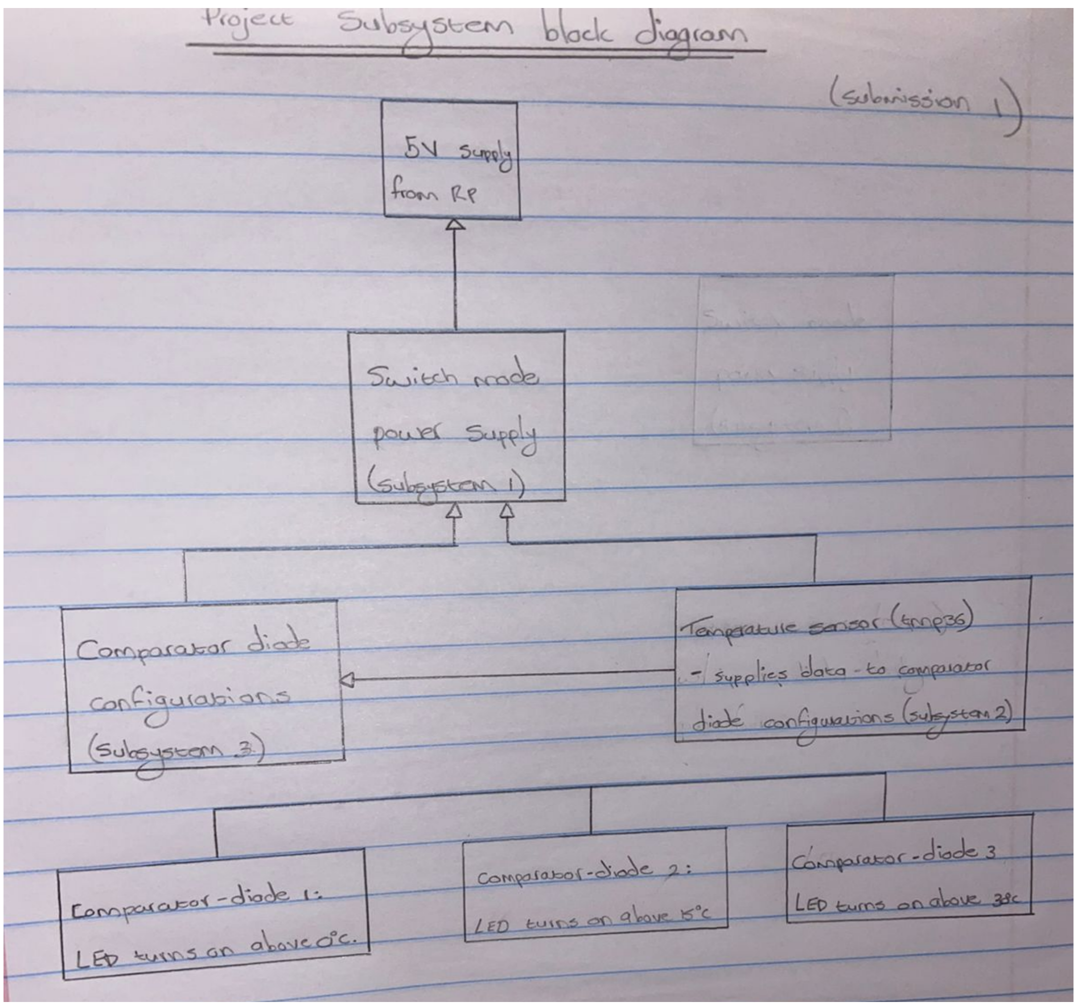
Requirement	Specification(s)	Acceptance Test Criteria
Device is capable reading temperatures between 0-45 degrees	Operating Temperature Range of 0 to 45C	All components selected are rated for operation within given range
LED’s output different temperatures	Comparator circuits will assess the temperature readings and turn on the LEDs accordingly	All LED’s turn on at their correct ranges when tested
System can be switched off through the Switch Mode Power Supply (SMPS).	A physical switch is opened to stop current flow through to the collector of the transistor part of the SMPS.	System does not operate while the switch is open and operates while closed.

Functional Specifications

Requirement	Specification(s)	Acceptance Test Criteria
Device provides LED feedback	LED1 turns on from 0℃ LED2 turns on from 15℃ LED1 turns on from 30 ℃	All LED’s turn on at their correct ranges when tested
System can be switched off through the Switch Mode Power Supply (SMPS).	A physical switch can be opened to stop current flow to the rest of the system.	System does not operate while the switch is open.
Temperature can be assessed in liquid.	Temperature sensor submerged in water or in a damp environment outputs different voltages according to the measured temperature.	While the probe is submerged the temperature will still be measured.

LEDs must still be visible if temperature probe is in separate room/ chamber	**LEDs placed directly onto PiHAT**	**Is temperature still readable despite sensor in another room.**

Q4 Project Subsystems Block Diagram [5]



Q5 Subsystem Specifications and Interfaces [30]

Subsystem 1: Switching power regulator

The power supply can be mechanically controlled by a switch on the circuit. The regulator is also used in order to pick a desired voltage for the bus that will run the other subsystems in the circuit. It will be set to output a voltage of 4.3V.

Subsystem 2: LED to show circuit is receiving power and is on

When The Circuit is receiving power the LED will turn on.The LED will be a kingbright 2.5V LED.

Subsystem 3:Temperature sensor

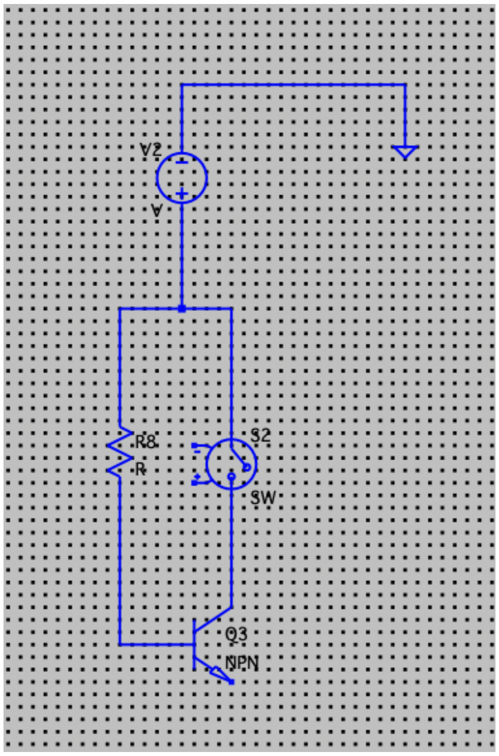
The temperature sensor used is the TMP36. It works with voltages ranging between 2.7V-5.5V. The outputs range between 0 and 1.7V. The input voltage will come from the switching power regulator The output voltage is determined by the formula $Degree = (V_{out}(mV) - 500)/10$

Subsystem 4:Op amp and output LEDs

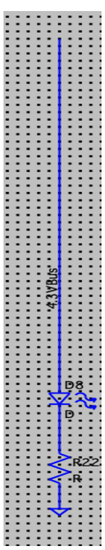
The temperature will be assessed using op amps in comparator configuration. As the temperature increases more LEDs will be turned on.
LED 1 will turn on for temperatures above 0 degrees Celsius
LED 2 will turn on for temperatures above 15 degrees Celsius
LED 3 will turn on for temperatures above 25 degrees Celsius
The comparator resistances will be calculated by using the equation
$V_{out} = V_{in}(R_2 \div (R_1 + R_2))$

Q6 Subsystem Draft Circuits [30]

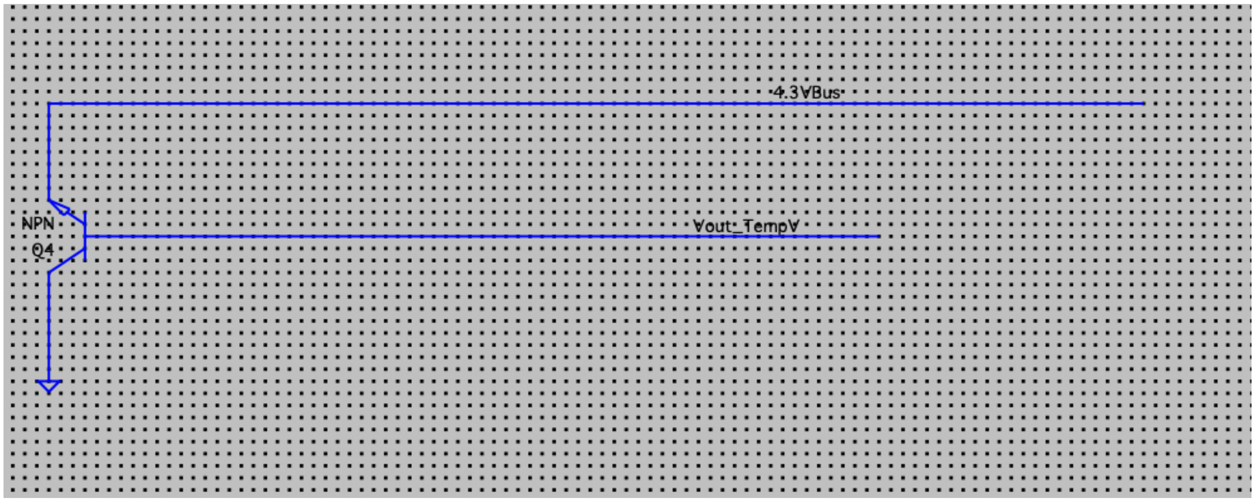
Subsystem 1: Switching power regulator



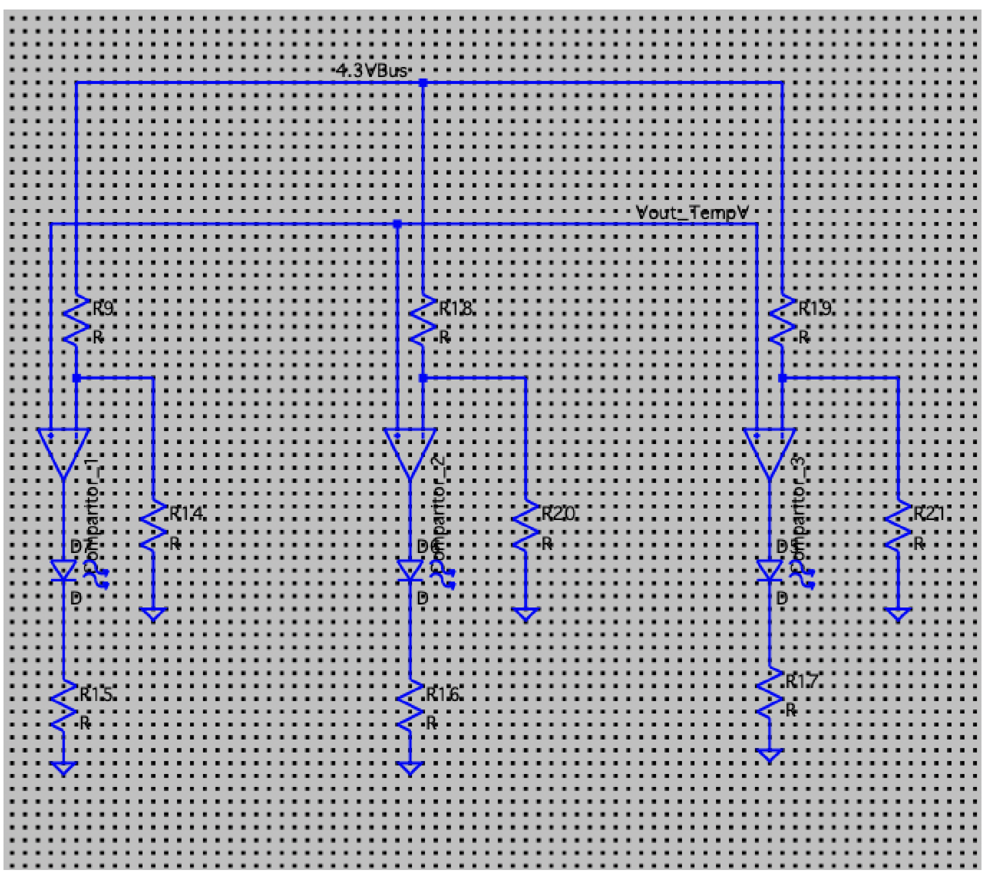
Subsystem 2: LED to show circuit is receiving power and is on



Subsystem 3: Temperature sensor



Subsystem 4:Op amp and output LEDs



Below is a diagram of the entire circuit