Temperature Controller Circuit

Requirements / Specifications

The temperature controller circuit is designed to activate specific components based on temperature variations. It utilizes a combination of NAND gate ICs, operational amplifiers, transistors, multiple potentiometers, and diodes. When the temperate exceeds 30°C, the circuit activates the fan and/or corresponding indicator LED, while when the temperature falls below 25°C, it activates the heater and/or its associated LED indicator. The circuit employs NTC 100K thermistor to detect temperature changes, triggering the appropriate responses through the integrated components.

- Operating Temperature: -40°C to 40°C

Components Selection

The Temperature Controller Circuit is overall comprised of:

- *3x* LM324 Operational Amplifiers
- *2x* 2N3904 Transistors
- *2x* 1N4007 Diode
- *1x* 74LS00D
- *3x* Potentiometers
- *2x* Resistors (quantity may change depending on the requirement)
- *2x* 3V Relays (JQC-3F T73)

Circuit Design and Working

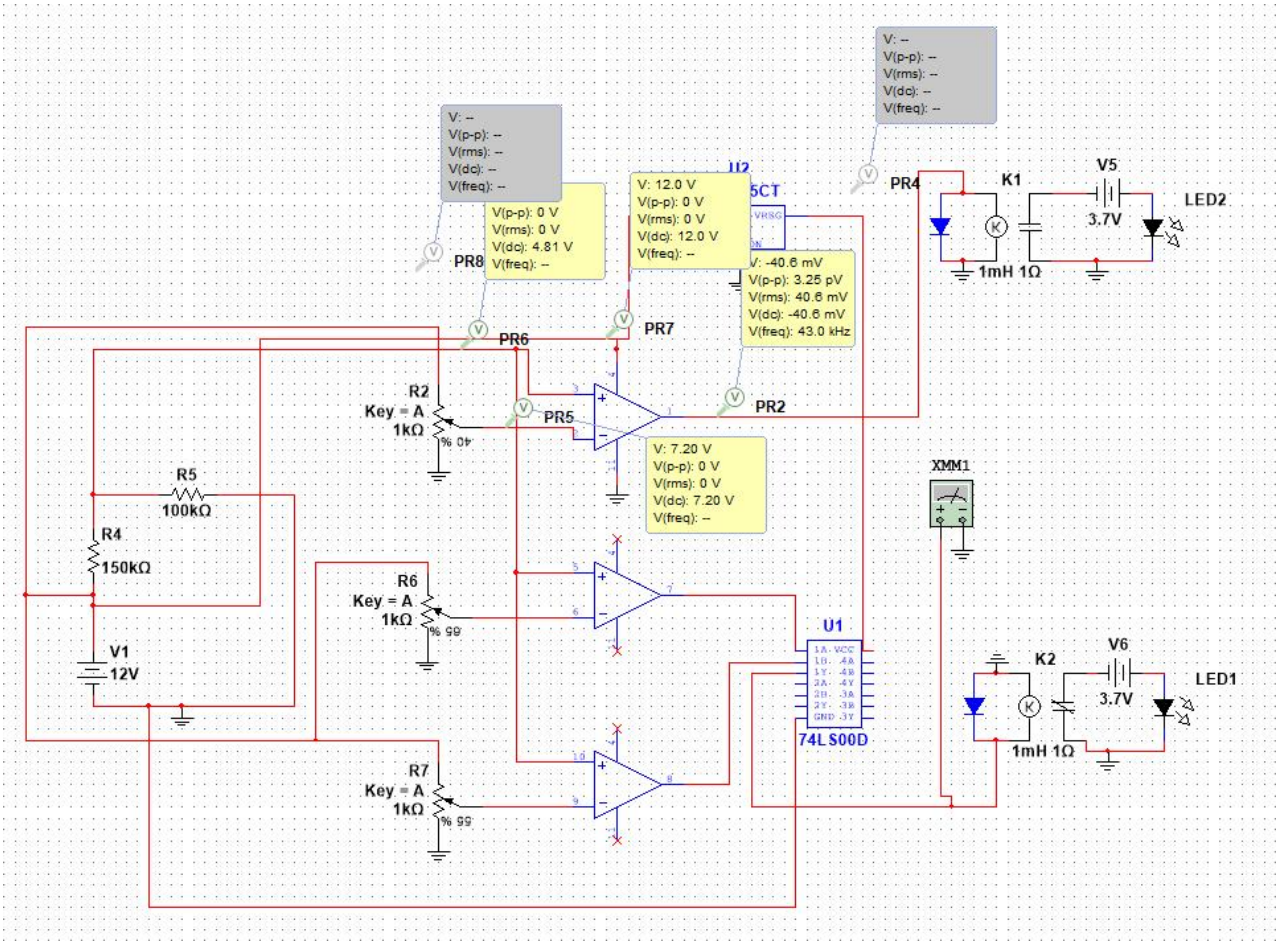

Figure 1

The circuit operates such that when input voltage is given, with set potentiometer resistances, the thermistor changes its resistance based on the temperature and one of two responses is activated; if the temperature falls below 25°C, the LED corresponding to the decrease in temperature gets activated. If the temperature is above 30°C, the LED corresponding to the increase in temperature gets activated. The potentiometers are tweaked to handle appropriate and optimal responses and two relays are used to channel the output into one of the three required outputs; LED on when temperarture is high, LED on when temperature is low or LED off when temperature is normal. Diodes are used to ensure the circuit operates normally with no reverse biasing. The OP-Amp is used as a comparator and the LM7805 Voltage regulator is used to regulate the high voltage level to 5V. The NAND gate requires the voltage to be regulated so it can be used for implementing logic that assists in checking if the temperature is high, low or normal.

Simulation Result

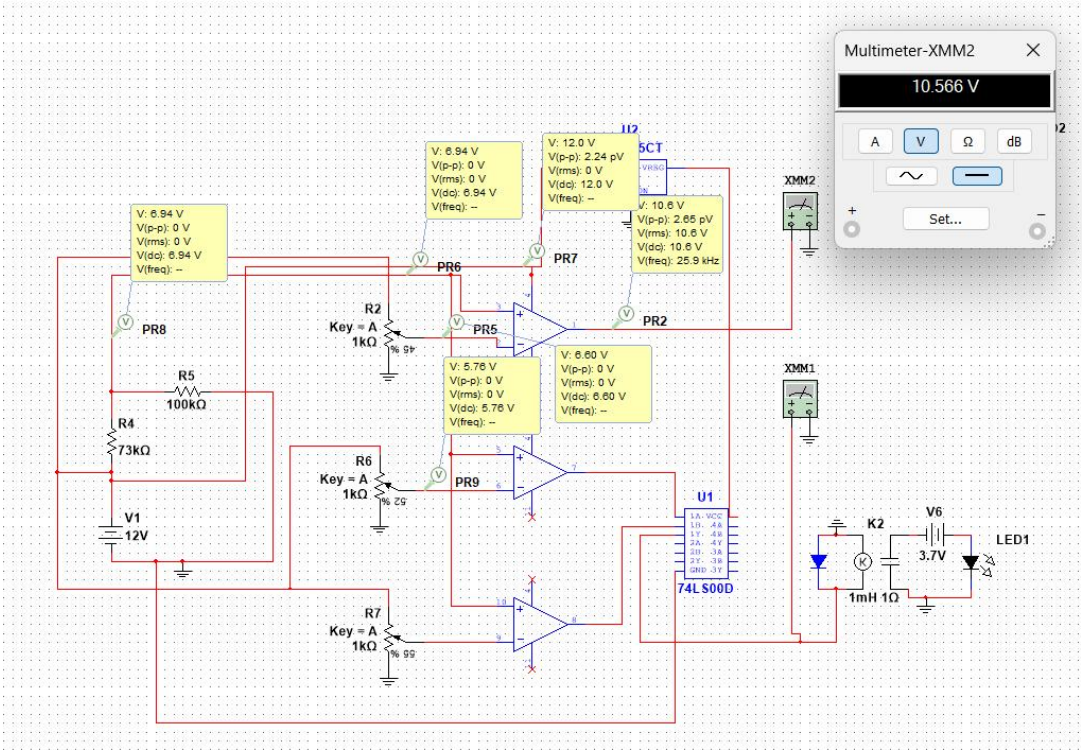

Figure 2: HEAT (31.6 °C)

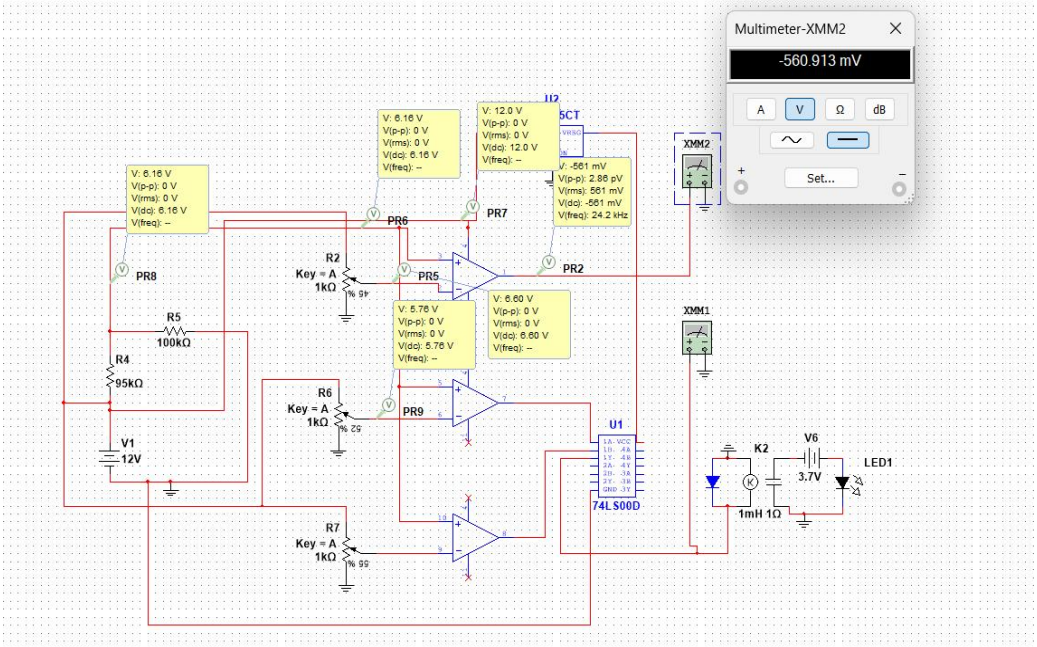

Figure 3: NORMAL (26°C)

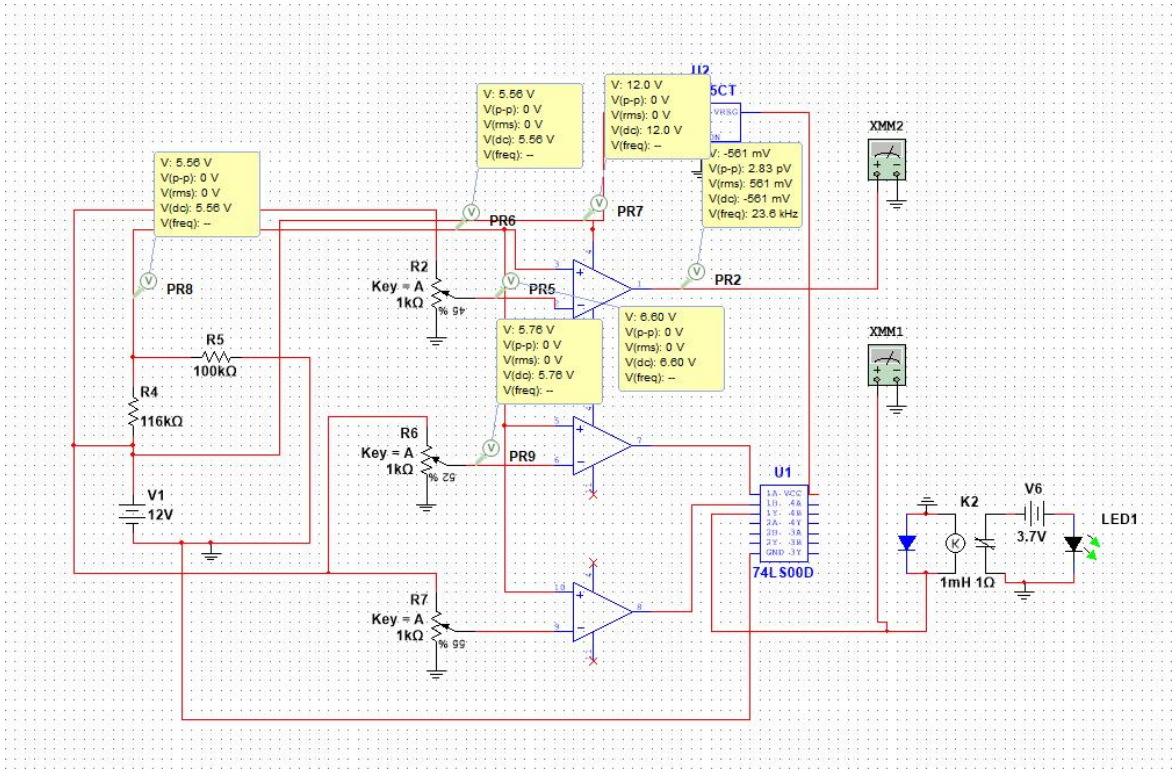

Figure 4: COLD (21°C)

Figures 2, 3 and 4 show how the circuit responds with respect to the difference in thermistor's resistances.

F14

100K Thermistor Output Table

Temperature, Humidity & Pressure Sensors & Transmitters

BAPI

Rev. 01/31/08

100K Thermistor Output Table

°F	°C	Ohms
-39	-39.44	3916295
-37	-38.33	3627711
-35	-37.22	3362274
-33	-36.11	3117987
-31	-35.00	2893035
-29	-33.89	2685770
-27	-32.78	2494694
-25	-31.67	2318444
-23	-30.56	2155781
-21	-29.44	2004274
-19	-28.33	1865595
-17	-27.22	1737397
-15	-26.11	1618827
-13	-25.00	1509102
-11	-23.89	1407512
-9	-22.78	1313405
-7	-21.67	1226184
-5	-20.56	1145306
-3	-19.44	1069620
-1	-18.33	1000019
1	-17.22	935383
3	-16.11	875329
5	-15.00	819505
7	-13.89	767589
9	-12.78	719284
11	-11.67	674319
13	-10.56	632442
15	-9.44	593086
17	-8.33	556739
19	-7.22	522842
21	-6.11	491217
23	-5.00	461699
25	-3.89	434134
27	-2.78	408383
29	-1.67	384316
31	-0.56	361813
33	0.56	340581
35	1.67	320895
37	2.78	302466
39	3.89	285206
41	5.00	269035
43	6.11	253877
45	7.22	239664
47	8.33	226331
49	9.44	213819
51	10.56	201971
53	11.67	190946
55	12.78	180588
57	13.89	170853
59	15.00	161700
61	16.11	153092
63	17.22	144992
65	18.33	137367
67	19.44	130189
69	20.56	123368
71	21.67	117000
73	22.78	110998
75	23.89	105338
77	25.00	100000
79	26.11	94963
81	27.22	90208
83	28.33	85719
85	29.44	81479
87	30.56	77438
89	31.67	73654
91	32.78	70076
93	33.89	66692
95	35.00	63491
97	36.11	60461
99	37.22	57594
101	38.33	54878
103	39.44	52306
105	40.56	49847
107	41.67	47538
109	42.78	45349
111	43.89	43273
113	45.00	41303
115	46.11	39434
117	47.22	37660
119	48.33	35976
121	49.44	34376
123	50.56	32843
125	51.67	31399
127	52.78	30027
129	53.89	28722
131	55.00	27481
133	56.11	26300
135	57.22	25177
137	58.33	24107
139	59.44	23089
141	60.56	22111
143	61.67	21188
145	62.78	20308
147	63.89	19469
149	65.00	18670
151	66.11	17907
153	67.22	17180
155	68.33	16486
157	69.44	15824
159	70.56	15187
161	71.67	14584
163	72.78	14008
165	73.89	13458
167	75.00	12932
169	76.11	12430
171	77.22	11949
173	78.33	11490
175	79.44	11051
177	80.56	10627
179	81.67	10225
181	82.78	9841
183	83.89	9473
185	85.00	9121
187	86.11	8783

Building Automation Products, Inc., 750 North Royal Avenue, Gays Mills, WI 54631 USA
Tel: +1-608-735-4800 • Fax: +1-608-735-4804 • E-mail:sales@bapihvac.com • Web:www.bapihvac.com

The thermistor gives different resistances as per different temperatures, as depicted on the table above; taken from a datasheet.

Hardware Implementation

1) Breadboard Implementation

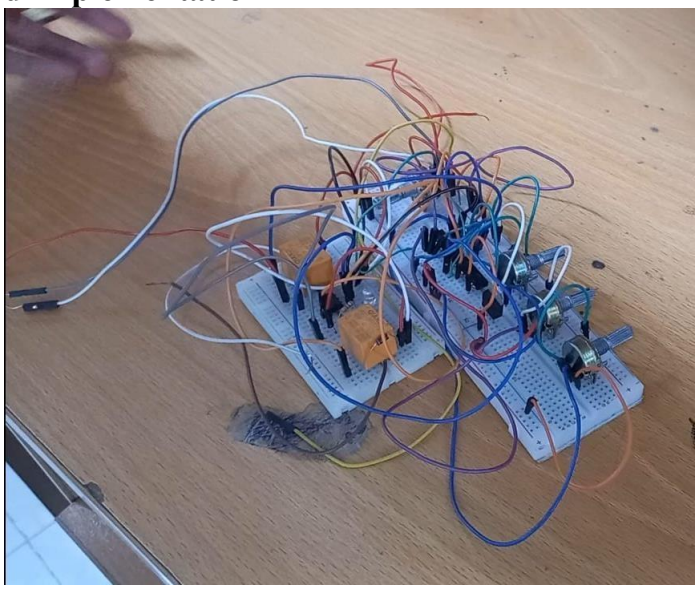

Figure 5

Figure 5 shows the implementation of the circuit from *Figure 1* on a breadboard.

2) Veroboard Implementation

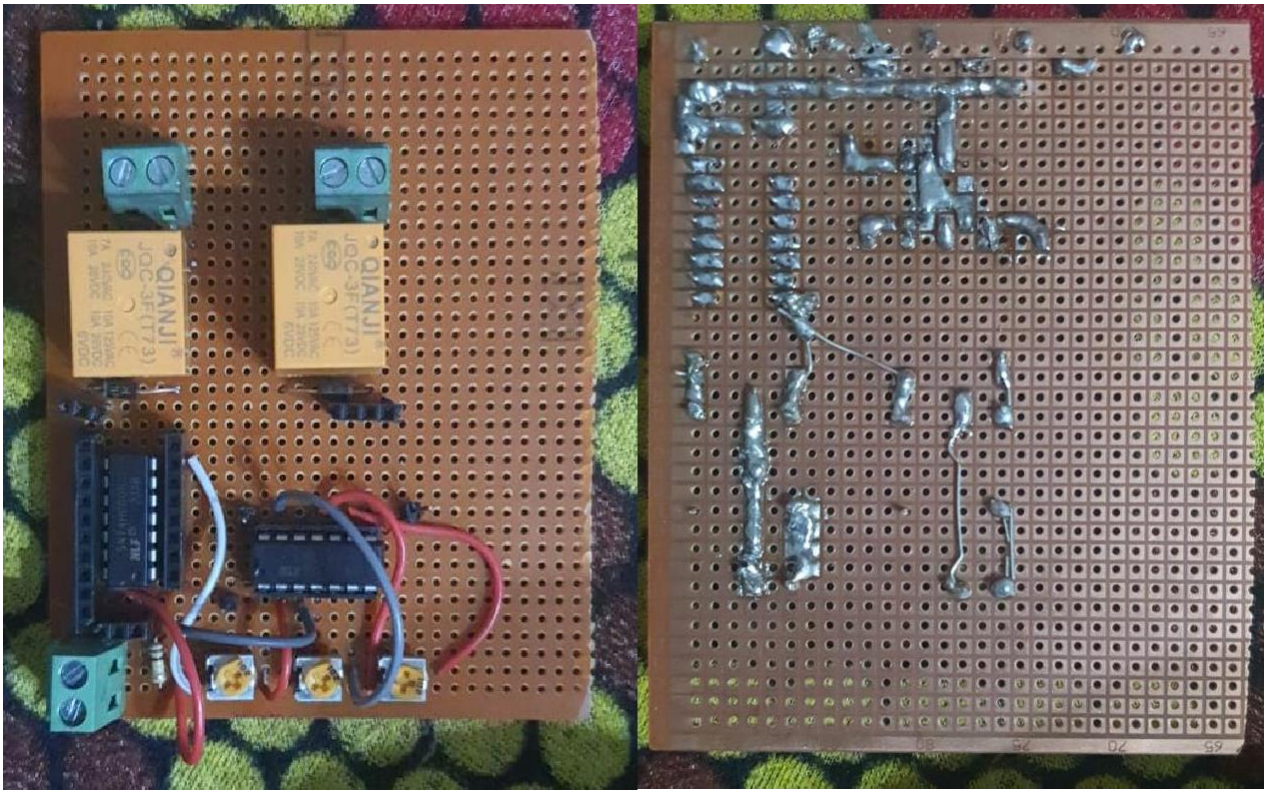

Figure 6

Figure 6 show the implementation of the circuit from *Figure 1* on a Veroboard. The left picture shows the placement of different components on the veroboard and the right picture shows how these components have been connected and soldered for smooth operation.

Result

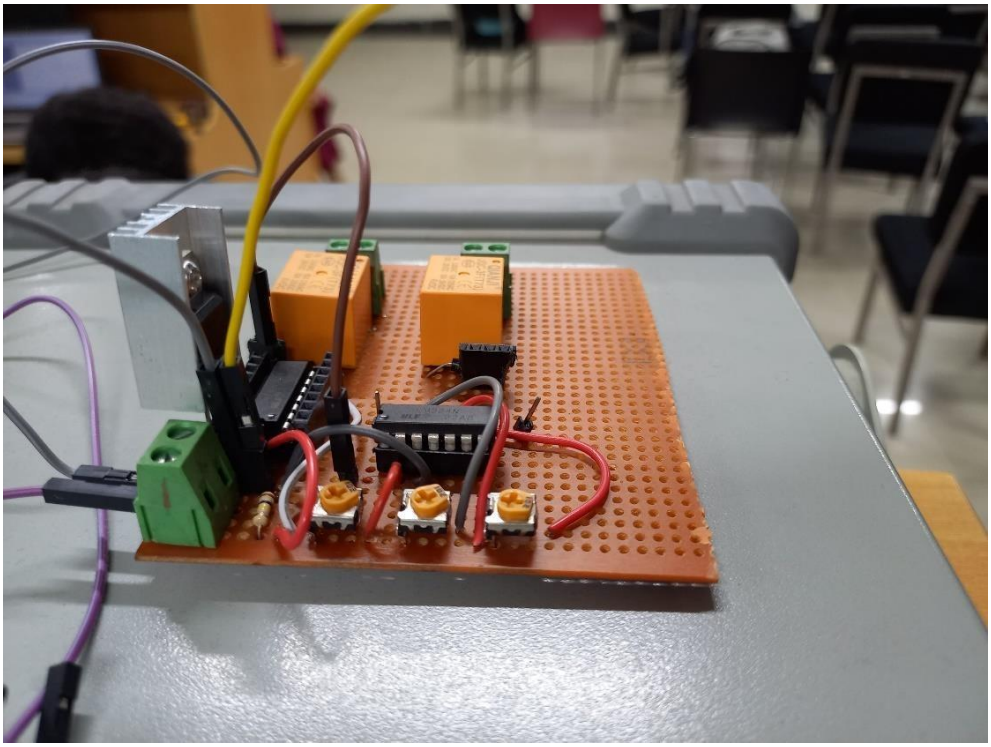

Figure 7

After the implementation of the circuit on the Veroboard and thorough testing, the Temperature Controller Circuit is ready. In cold temperatures, the blue LED at the bottom side turns on. In hot temperatures, the blue LED at the top turns on. If the thermistor is in a room temperature, none of the LEDs turn on.