

EET103 Electrical Circuits I

Final Project: 555 Timer Monostable Circuit with Relay Control – Part 2 (Rev 1.1)

Name: _____

Introduction

This document outlines the procedures for building the 555 timer monostable circuit on a perfboard using point-to-point soldering techniques. This phase builds on the breadboard circuit from Part 1 and transitions to a more permanent, soldered assembly. The final build will use a 9V battery as the power source for the control circuit and the controller will be integrated into a 3D printed housing with an acrylic cover. The cup warmer is installed in the housing and connected to the control circuit using the provided terminal blocks.

Additional Parts Required (See instructor)

- SPDT switch
- Momentary pushbutton switch
- 1000 μ F 10V capacitor
- 9 volt relay
- 9V battery connector
- Zip tie
- Housing
- Acrylic cover with buttons
- Screws
- Cup Warmer
- Improved 8 pin IC socket

Perfboard Build Phase

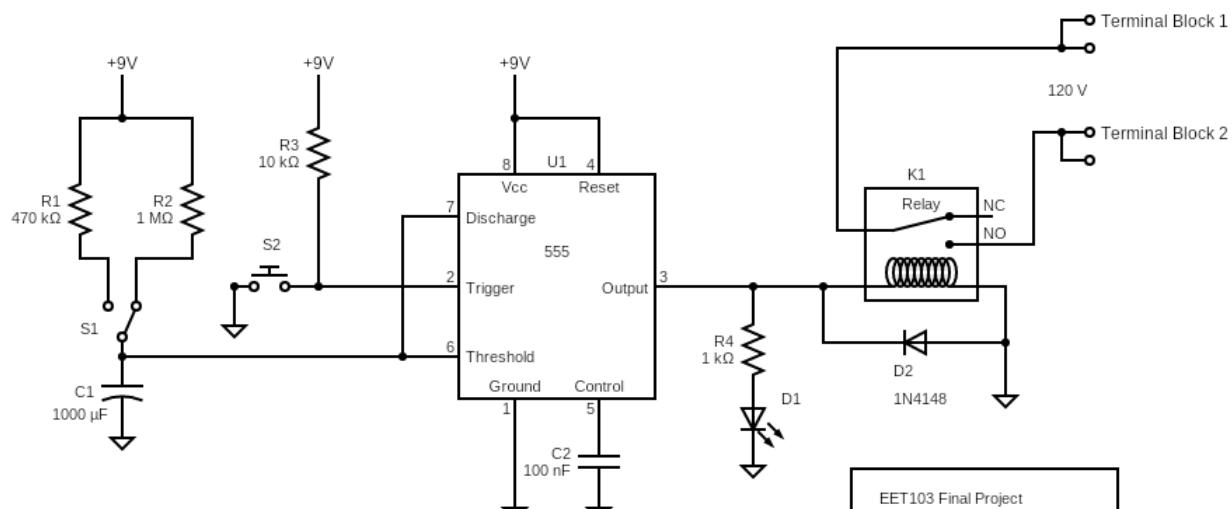
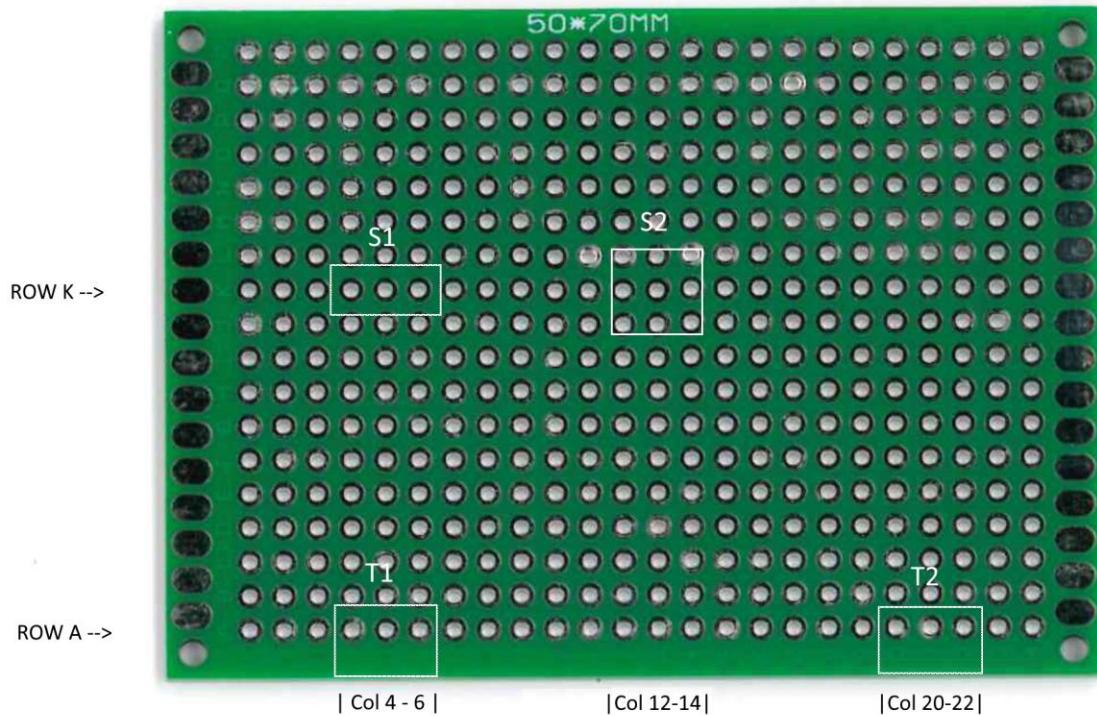
The perfboard build phase involves step-by-step assembly and validation of the circuit. Each stage includes an instructor check to evaluate functionality, soldering quality, and layout organization.

Step 1: Component Placement Planning

Before soldering, students must carefully plan the placement of components on the perfboard to align with the physical enclosure. Specific placement requirements are as follows. See the image below.

- **T1 Terminal Block:** Positioned from A4 to A6. Wire port facing out.
- **T2 Terminal Block:** Positioned from A20 to A22. Wire port facing out.
- **S1 Selector Switch:** SPDT switch positioned from K4 to K6.
- **S2 Trigger Switch:** Momentary pushbutton switch positioned from K12 to K14.
- Additionally, the capacitor must be installed on its side to enable clearance for the enclosure cover.

Ensure these placements allow for proper alignment with the enclosure's ports and switches. Double-check the positions before proceeding with soldering to avoid misalignment.



Note: R1 and R2 are swapped with 47K and 100K values during breadboarding to enable testing.

EET103 Final Project
Cup Warmer with 555 Timer
Keith E Kelly
11/17/2024

Step 2: Power Supply

1. Insert an 8-pin IC socket into the perfboard. Ensure the socket is positioned on the board to allow space for the RC circuit and switch on the left and the output components on the right. Use the image above to plan your layout and wire routes. Create a +V rail across the top of the perfboard and a ground rail across the bottom. This creates a similar layout to what you have used with the breadboard construction.
2. Attach the 9V battery connector to the upper left of the board. Cut the lead lengths so that they are long enough to remove and insert the battery into the enclosure.
 2. Solder connections for pin 8 (Vcc) and pin 4 (Reset) to the positive supply rail. Solder pin 1 (Ground) to the ground rail.
 3. Solder a 0.1 μ F capacitor between pin 5 (Control) and ground.
 4. Temporarily attach the 9V battery and use a multimeter to verify power is applied to the required IC pins.

_____ Instructor Check: Validate power connections and soldering quality.

Step 3: RC Timing Circuit

1. Solder a 1M resistor (R1) and a 470K resistor (R2) to the SPDT switch (S1). Note the position of S1 specified in Part 1 of this document. Attach these resistors to the S1 switch so that the lower R value is selected when the switch is in the left position and the higher R value is selected when the switch is in the right position. **Install the C1,1000 μ F capacitor on its side.** See earlier note on final assembly. Connect C1 to the center pin on the switch enabling an RC selector circuit. Place these components to the left of the IC socket on the perfboard.
2. Solder a connection from the RC charging circuit to pin 6 (Threshold) and pin 7 (Discharge) of the IC socket.
3. Temporarily attach the 9V battery and use a multimeter to measure the capacitor voltage as it charges and verify the timing behavior with the switch in both positions:
 - Position 1 (left - 470K): $\tau = R * C = 470$ seconds.
 - Position 2 (right - 1M): $\tau = R * C = 1000$ seconds.

_____ Instructor Check: Validate RC timing functionality and soldering quality.

Step 4: Digital Switch

1. Solder a 10K pull-up resistor (R3) and a push button switch (S2) to create the logic switch as shown in the schematic diagram. Note the position of S2 specified in Part 1 of this document. Apply the switch signal to the Trigger input on pin 2 of the IC socket.
2. Temporarily attach the 9V battery and verify the pull-up resistor's function and the active low trigger signal that is applied to pin 2 when the switch is pressed.

_____ Instructor Check: Validate trigger functionality and soldering quality.

Step 5: Output Circuit

1. Solder the output pin 3 of the IC socket to the relay coil (pin 1). Connect the other coil terminal (pin 8) to ground.
2. Solder an LED (D1) in parallel with the relay coil, including a 1K current limiting resistor.
3. Temporarily attach the 9V battery and use a jumper to apply 9V to the output pin 3. The LED should light and you will hear the relay “pull in”. Use a multimeter to verify the N.O. connections are now closed.

_____ Instructor Check: Validate relay operation, LED indicator functionality, and soldering quality.

Step 6: Final Integration and Testing

1. Insert the 555 timer IC into the socket.
2. Connect the 9V battery and verify the circuit functionality by measuring continuity across the N.O. relay output.
3. Demonstrate the timing behavior with the S1 switch in both positions.
4. Confirm the layout follows a left-to-right flow: RC charging circuit on the left, trigger input in the center-left, IC socket in the center-right, and output circuit on the far right.

_____ Instructor Check: Validate functionality, layout organization, and soldering quality.

Step 7: Final Assembly

1. Use a small zip tie as a strain relief for the 9V battery connector leads. Refer to the provided image for proper installation.
2. Insert the control board into the provided enclosure and attach the cover with button assemblies.
3. Test the button and circuit functionality to ensure proper operation.
4. Remove the cover in preparation for final assembly.
5. Use a zip tie to secure the AC plug as a safety precaution, preventing the cup warmer from being powered until all testing is completed.
6. Remove the existing switch from the cup warmer. Refer to the image provided on the following page for guidance.



7. Insert the power cord of the cup warmer into the enclosure and secure the exposed leads from the prior switch to Terminal Blocks 1 and 2.
8. Reattach the enclosure cover to shield the exposed 120V cup warmer connections.
9. A final instructor check is required. Once completed, remove the zip tie from the AC plug and validate the cup warming function.

_____ Instructor Check: Validate final assembly, safety measures, and cup warming functionality.

⚠ Caution: Handling 120V AC Connections

Working with 120V AC power can be dangerous if not handled properly. To ensure safety during the assembly and testing of the cup warmer:

1. **Disconnect Power:** Ensure the AC plug is zip-tied and cannot be inserted into a power outlet during assembly.
2. **Verify Connections:** Double-check that all exposed wires are securely connected to the terminal blocks (T1 and T2).
3. **Use Insulated Tools:** Always use insulated tools when handling connections involving 120V AC.
4. **Inspect Enclosure:** Confirm the enclosure cover is securely attached to prevent accidental contact with exposed 120V AC terminals.
5. **Instructor Validation:** Do not power the circuit until it has been inspected and approved by your instructor.