EE 122 Semester Project
Touch Switch

Preface:
- All work is to be done in groups of two.
- All tech memos are to be turned in as a group.
- There is a creativity portion to the project

Description:
   The project circuit is a touch switch that generates an output pulse, which is indicated by an LED, and toggles a single pull, double throw (SPDT) relay. This circuit is useful for making touch operated products, such as doorbells, toys, buzzers, etc. For the circuit in this project, the 555 timer will be operating in the monostable mode, which generates a fixed output pulse based on the resistor and capacitor values on the discharge and threshold pins of the timer. A transistor is used to drive the relay and control the load, which is user defined and must be designed by each group.
   There are 3 parts to this project: simulation, output design and simulation, and circuit construction with demonstration.

Objectives:
- Learn and apply the fundamentals of a 555 timer.
- Learn and apply the fundamentals of a relay.
- Investigate the application of components in a circuit.
- Learn how to simulate a circuit in Multisim 8.
- Learn how to interact with a circuit simulation in real-time and observe the output.

Equipment:
   This project encourages the use of simulation to develop working knowledge of the given project circuit before constructing and testing it.

For the simulation portion:
- Multisim 8

For the construction portion:
- 555 timer (8 pin IC)
- 10MΩ resistor (R2)
- 2 - 1kΩ resistors (R3,R4)
- 100Ω resistor (R5)
- 1k to 10MΩ resistor (R1)
- 0.1 to 100uF capacitor (C1)
- 2 - 1N4002 diodes (D1, D2)
- 2N3904 BJT (Q1)
- 6-9V Relay
- Red LED (D3)

- Breadboard
- Power supply
- DMM
- Oscilloscope
- Output components of your choice

Touch Switch

The touch switch circuit is given in Figure 1 and is split into 2 stages. Stage one of the circuit produces the output pulse using the 555 timer to turn on the LED (D3). Once the desired output pulse width is defined, then stage two is added to complete the circuit. The input voltage for this circuit can vary widely. Enough voltage should be applied to drive the 555 timer and relay, however, too much voltage could destroy the 555 timer or the relay coil. The output components will also need to be considered when choosing the input voltage. One should consider this circuit as a marketable product for a toy, game, gag gift, holiday decoration, etc. when designing the output portion of the circuit. Important design questions should be answered:

      What type of product am I designing?
      Would I be interested in purchasing it? If not, how can it be improved?
      Will this product be battery powered or use an AC adapter?
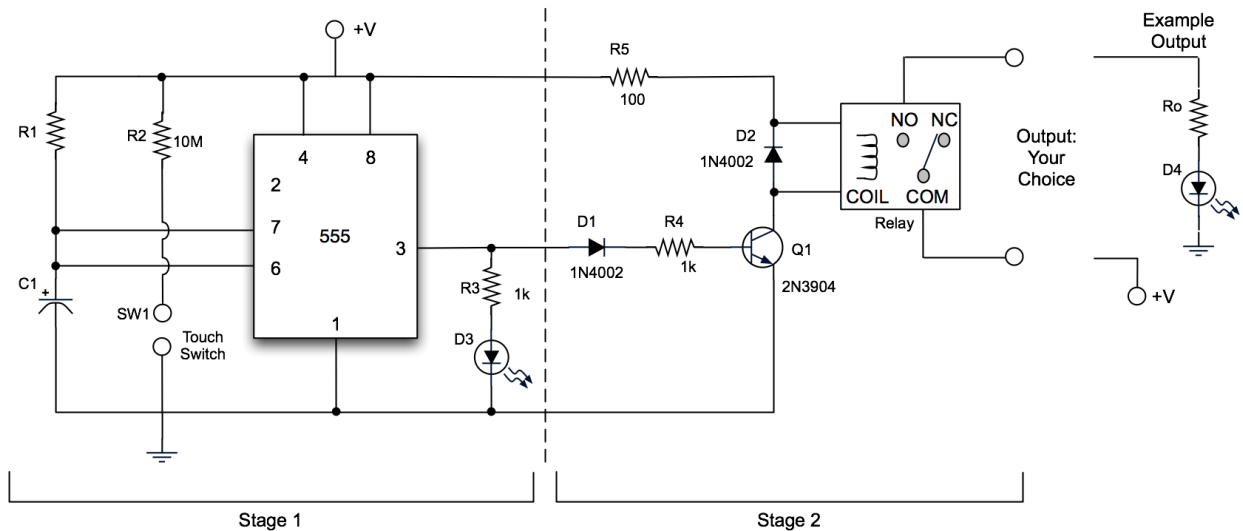   What age group is this product for?

Figure 1: Touch switch circuit

Part 1

This part of the project involves circuit simulation and answering questions about the components within the circuit. Simulation begins with the first stage of the given touch switch circuit followed by an analysis. The second portion of part involves simulation and analysis of the second stage of the circuit. Answer all questions listed below as a discussion in tech memo format. Create all specified appendices in tech memo format.

1. Find and download the datasheet for a National Semiconductor LM555 Timer. Make a table listing the given values for the following: supply voltage, supply current, trigger voltage, and trigger current. Find and download a datasheet for the 6-9 V relay provided in the lab. Make a table listing the given values for the following: contact resistance, nominal voltage, max voltage, min voltage, max current, min current. (Put these tables in Appendix 1)

2. Determine an adequate input voltage for the circuit based on the values provided in the datasheets. Enough voltage should be applied to drive the 555 timer and relay, however, too much voltage could destroy the 555 timer or the relay coil.
    Q1. What is your chosen input voltage?

3. Look in the datasheet for the application information section and read about monostable operation. Study the time delay chart, taking note of the resistance and capacitance values.
    Q2. What are all the combinations of C and R values that provide an output delay of 1 second?

4. Simulate Stage 1
Build stage 1 of the Project circuit (Figure 1) and simulate it for 10 seconds. Use the input voltage stated in Q2. To simulate the touch input to pin 2, use a monetary switch or push-button. Observe how long the LED is on for chosen values of R1 and C1. Compare the output pulse to the values given in the 555 timer datasheet. **Stage 2 components that should not appear in stage one simulations are: D1, D2, R4, R5, Q1, Relay, Output components. Save the schematic. Use the oscilloscope function to generate waveforms for the input or pin 2 and output of pin 3. Save the waveforms. Make sure that each waveform is distinguishable when printed in black and white. Make separate graphs if you have to or use the excel export function to make dashed/dotted lines. (Put these images in Appendix 2)
    Q3. What is happening internal to the timer when the touch switch is activated?
    Q4. Why is there a 10MΩ resistor on pin 2 of the timer?
    Q5. What values of R1 and C1 were chosen? What is the output pulse in seconds?
    Q6. Was the output pulse time as expected or as specified from the datasheet?

4. Simulate Stage 2

Add stage 2 to the previous circuit simulation and simulate it for 10 seconds. Use the input voltage stated in Q2. Use the example output after the relay from the project circuit given in Figure 1. To simulate the touch input to pin 2, use a monetary switch or push-button. Use a EDR201A05 Relay in your circuit, which can be found in the relay category of component group basic. This is a SPST relay with a NO contact, and not a SPDT relay like we have in the lab, but when the circuit is built only the NO will be required. **When simulating the full circuit, only tap the space bar once or an error will occur. Observe how long the LED is on for chosen values of R1 and C1. Compare the output pulse to the values given in the 555 timer datasheet. Save the schematic. Use the oscilloscope function to generate waveforms for the input pin 2, output of pin 3, and the collector side of the BJT. Save the waveforms. Make sure that each waveform is distinguishable when printed in black and white. Make separate graphs if you have to or use the excel export function to make dashed/dotted lines. (Put these images in Appendix 3)

     Q7. What color LED was used for the example output of the relay? What is the voltage drop across the LED?

     Q8. What are the purpose of diodes D1 and D2?

     Q9. Why is a transistor used to control the relay coil?

     Q10. With the added components and relay, was the output pulse time as expected or as specified from the datasheet?

Part 2

This part of the project involves designing the creative portion of the circuit and performing a simulation. As a group, develop an output to the circuit (i.e. what is the circuit going to do?). As mentioned before, this circuit is useful for making touch operated products, such as doorbells, toys, buzzers, etc. The output components will need to be considered when choosing the input voltage. Consider this circuit as a marketable product for a toy, game, gag gift, holiday decoration, doorbell. Answer all questions listed below as a discussion in tech memo format. Create all specified appendices in tech memo format.

1. Create a schematic of the touch switch circuit output design. Save the schematic. (Put these images in Appendix 1)

     Q1. Explain the design chosen for the output portion of the touch switch circuit.

     Q2. Why was the design chosen? What could it be used for?

     Q3. Does the output design change the input voltage? Explain. What is the new input voltage?

2. Add the output design to the simulation from step 4 of Part 1. Save the schematic. Use the oscilloscope function to generate waveforms for the timer, input pin 2 and output pin 3, the normally closed (N.C.) connection and any other important components on the N.C. connection of the relay. Save the waveforms. Make sure that each waveform is distinguishable when printed in black and white. Make

separate graphs if you have to or use the excel export function to make
dashed/dotted lines. (Put these images in Appendix 2)

Part 3

This part of the project involves constructing the circuit and demonstrating that it works
as demonstrated by the simulation. Build each stage of the circuit in Figure 1 and then
add the designed output portion. Answer all questions listed below as a discussion in
tech memo format. Create all specified appendices in tech memo format.

1. Construct stage 1 of Figure 1. Take oscilloscope measurements on this circuit just as
   you did in the simulation. Save a waveform that captures the input trigger and one
   that captures the output pulse. (Put these images in Appendix 1)
        Q1. What is the input voltage for the circuit?
        Q2. What are the values of R1 and C1?
        Q3. How does the experimental circuit output compare to the simulated circuit
output?
        Q4. What is the percent difference between the output pulse length (in seconds)
of the simulation and experiment.

2. Add stage 2 of Figure 1 to the circuit of step 1, including the example output. **Be
   sure to use the same LED as specified in Q7 of Part 1. Take oscilloscope
   measurements on this circuit just as you did in the simulation. Save a waveform that
   captures the input trigger, one that captures the output pulse and one that captures
   the collector side of the BJT. (Put these images in Appendix 2)
        Q5. How does the experimental circuit output compare to the simulated circuit
output?
        Q6. What is the percent difference between the output pulse length (in seconds)
of the simulation and experiment.
        Q7. Does the circuit operate as expected? Explain.

3. Add the designed output to the circuit of step 2. Take oscilloscope measurements on
   this circuit just as you did in the simulation. Save a waveform that captures the input
   trigger, one that captures the output pulse and one that captures the N.C. connection
   of the relay and any other points that were measured in the simulation. (Put these
   images in Appendix 3)
        Q8. How does the experimental circuit output compare to the simulated circuit
output?
        Q9. What is the percent difference between the output pulse length (in seconds)
of the simulation and experiment.
        Q10. Does the circuit operate as expected? Explain.
4. Evaluate the lab project.
        Q11. Did you learn the objectives of this project?
        Q12. Was the project helpful for your education of electronic devices?

Q13. What would you change about the project?
Q14. Provide any general comments or suggestions.