

## Lab Exercise 06 555 Timer Circuit and Soldering<sup>1</sup>

The objectives of this lab exercise are for students:

- 1. to understand the 555 timer,
- 2. to be introduced to digital circuits,
- 3. to learn to solder, and
- 4. to analyze and build relatively complex circuits.

### Lab 06.1 Materials

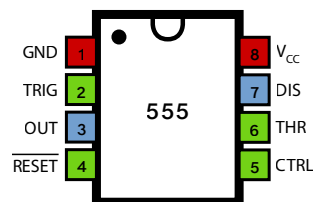
The following materials are required for each lab station:

- 1. a PC with LabVIEW installed,
- 2. a myRIO configured with LabVIEW,
- 3. a multimeter,
- 4. a breadboard,
- 5. a prototyping board,
- 6. wire and jumper wires,
- 7. a 9 V battery,
- 8. a 9 V battery connector,
- 9. a 555 timer integrated circuit,
- 10. two 1 k $\Omega$  resistors,
- 11. a 470 k $\Omega$  resistor,
- 12. an LED, and
- 13. a 1, a 10, and a 100  $\mu$ F capacitor.

### Lab 06.2 555 timers

The *555 timer* is a ubiquitous integrated circuit that can be used to output periodic signals loaded up to around 200 mA. The pinout diagram is shown in [Figure 06.1](#). Note the “dot,” which can be used to orient the circuit.

A functional block diagram is shown in [Figure 06.2](#). The VCC pin 8 has its voltage divided by three 5 k $\Omega$  resistors in green before being grounded by GND pin 1. Pin 2 (TRIG) and pin 6 (THRES) are compared by *comparators* to the one-third and two-thirds of VCC. Comparators

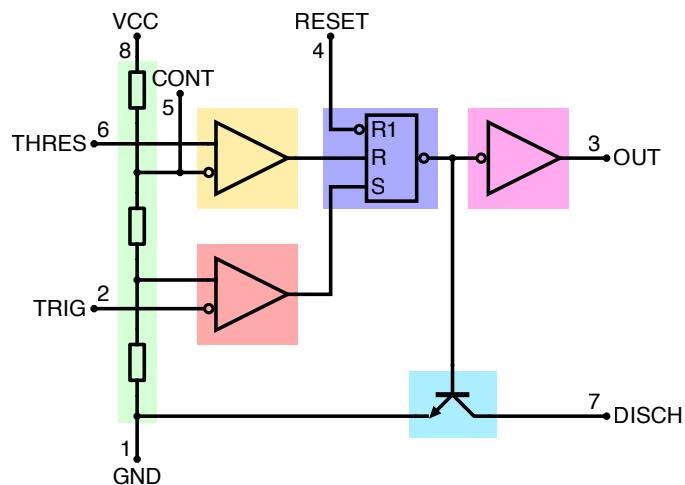


555 timer

**Figure 06.1:** 555 timer pinout (contributors, 2018b).

comparator

<sup>1</sup>Portions of this lab exercise were prepared by Jordan Parker, SMU class of 2019.



**Figure 06.2:** a 555 timer functional block diagram (contributors, 2018a).

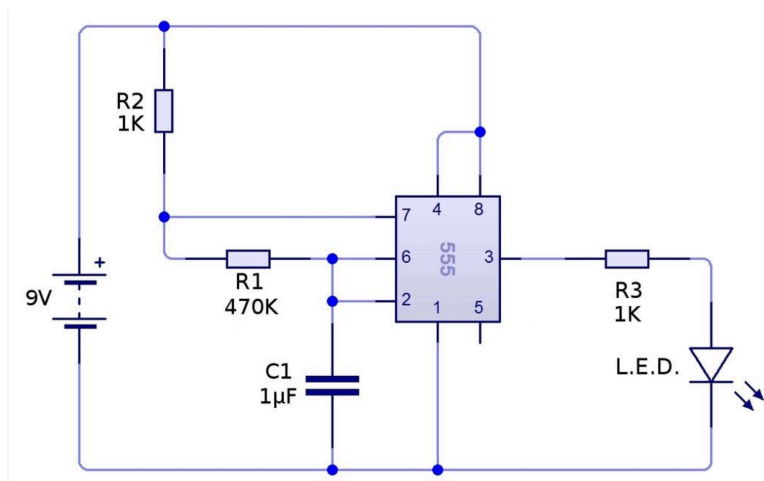
are digital electronic devices that output boolean `TRUE` when the upper terminal has voltage greater than that of the lower terminal—and output `FALSE`, otherwise. Their outputs are connected to an *SR flip-flop* (purple), which gets set to `TRUE` by terminal `S` and reset to `FALSE` by `R`. This flip-flop has a *memory*. Once `S` sets it, even if `S` goes `FALSE`, it will remain `TRUE`. Only if `R` goes `TRUE` will the flip-flop return to `FALSE`. The `RESET` pin 4 can reset the flip-flop state at any time.

If the flip-flop is set to `TRUE`, two things happen. First, the output is inverted (the symbol  $\circ$  means inversion), and it shuts off the gate for a transistor (blue) to which we will return in a moment. The flip-flop output is inverted again and switches on an output stage (pink), supplying power to the `OUT` pin 3.

Once the `THRES` pin resets the flip-flop, the gate transistor is turned on, allowing current to flow from pin 7 (`DISCH`) to pin 1 (`GND`).

### Lab 06.3 The LED 555 timer circuit

We will be building the circuit diagram of [Figure 06.3](#). This circuit charges, then discharges the capacitor  $C_1$ . The capacitor's voltage is applied to both pins 2 and 6, which control the flip-flop, but which are compared to different voltages. So the capacitor first charges up enough to trigger the output (3, which flows through the LED (through  $R_3$ , which limits current). Once the capacitor charges up to initiate the reset, the LED turns off and the



**Figure 06.3:** 555 Timer circuit diagram (Trilesto, 2018).

discharge transistor turns on. This connects pins 7 and 1, which effectively discharges  $C_1$  to ground through  $R_1$  with time constant  $\tau = R_1 C_1$ . Once it has discharged to the lower threshold voltage, the flip-flop turns back on and recharges the capacitor.

#### Lab 06.4 Building the circuit

Use the following procedure to build the LED 555 timer circuit.

1. Gather the components listed above.
2. Measure and record the parameter value for each resistor, each capacitor, the battery, and the LED in [Table 06.1](#).
3. Lay out the circuit in accordance with the circuit diagram of [Figure 06.3](#) on a prototyping board. Use the  $1\ \mu\text{F}$  capacitor, but connect it with an auxiliary breadboard.
4. Leaving the battery disconnected from its connector, solder each connection, connecting components that aren't directly next to each other with wires.

#### Lab 06.5 Measuring the waveform

Use the myRIO with a LabVIEW VI similar to those you've created previously to record at least a few periods of  $v_{C_1}$  and  $v_{R_3}$ .

**Table 06.1:** nominal and measured parameter values.

	C <sub>1</sub> ( $\mu$ F)	C <sub>2</sub> ( $\mu$ F)	C <sub>3</sub> ( $\mu$ F)	R <sub>1</sub> (k $\Omega$ )	R <sub>2</sub> (k $\Omega$ )	R <sub>3</sub> (k $\Omega$ )	V <sub>S</sub> (V)	v <sub>D</sub> (V)
nominal	1	10	100	470	1	1	9	0.6
measured								

Desolder the capacitor and repeat the previous step with the 10  $\mu$ F capacitor and the 100  $\mu$ F capacitor. Be sure to capture several periods of data for each circuit.

### Lab 06.6 Report requirements

Write a report on your laboratory activities using the template given. Be sure to pay special attention to the following elements:

- 1. In your circuit analysis, predict the entirety of the capacitor voltage waveform for each circuit (different circuits here meaning different capacitors).
- 2. Plot your prediction and the measured waveforms on the same graph (one graph for each circuit, three in total). One period is sufficient, but multiple is also fine. A bit better would be to average multiple periods of measured data. However, some difficulty arises when trying to match the period and this is not required.

It may be helpful to take photos during the laboratory procedure. These can be included in your report.