555 Timer – Introduction
Cornerstone Electronics Technology and Robotics II

- **Administration:**
  - Prayer
  - Turn in quiz
- **For 555 Timers – Monostable Operation, see:**
  http://cornerstonerobotics.org/curriculum/lessons_year2/erii5_555_timer_monostable_operation.pdf
- **For 555 Timers – Astable Operation, see:**
  http://cornerstonerobotics.org/curriculum/lessons_year2/erii5_555_timer_astable_operation.pdf
- **The 555 Timer Integrated Circuit:**
  - The 555 Timer IC is an integrated circuit (chip) that can act as a timer or an oscillator. The IC was designed by Hans R. Camenzind in 1970 and brought to market in 1971 by Signetics. The 555 timer is one of the most widely used types of integrated circuits.
  - The 555 Timer IC is called a 555 because of the 3 - 5K internal resistor divider network which are used to set comparator levels. The resistive network sets up a reference voltage of 1/3 the supply voltage, 1/3 V_{CC}, for the TRIGGER Pin 2 and a reference voltage of 2/3 the supply voltage, 2/3 V_{CC}, for the THRESHOLD Pin 6.
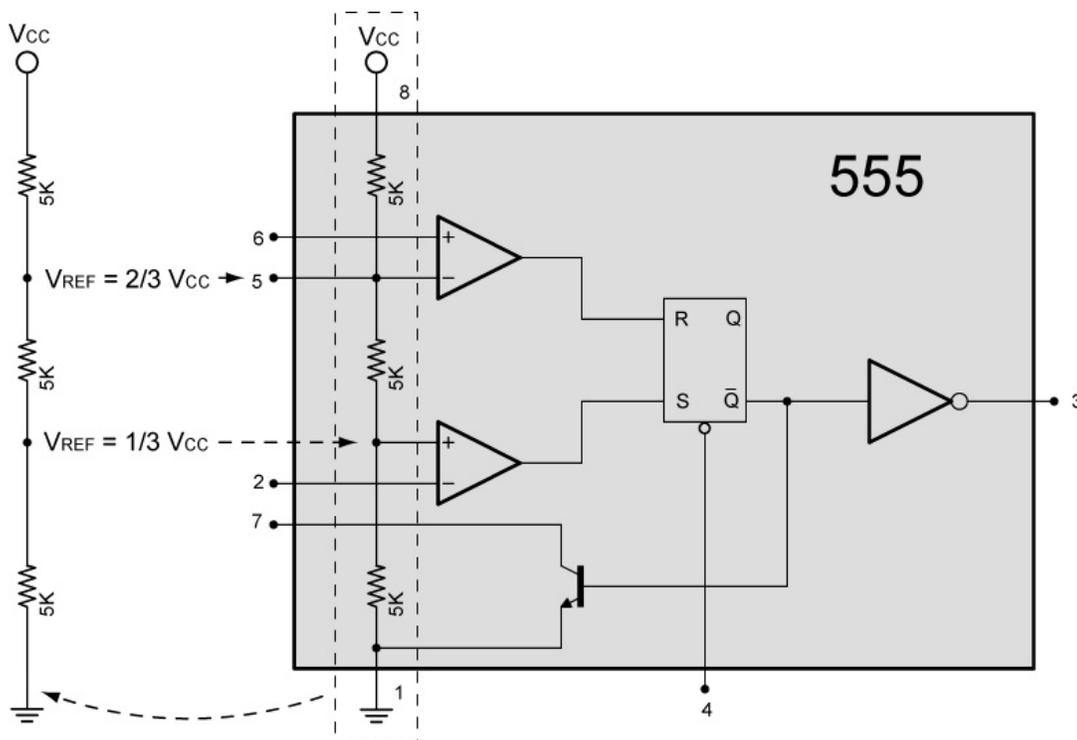
Figure 1, 3 – 5K Internal Resistors as a Voltage Divider
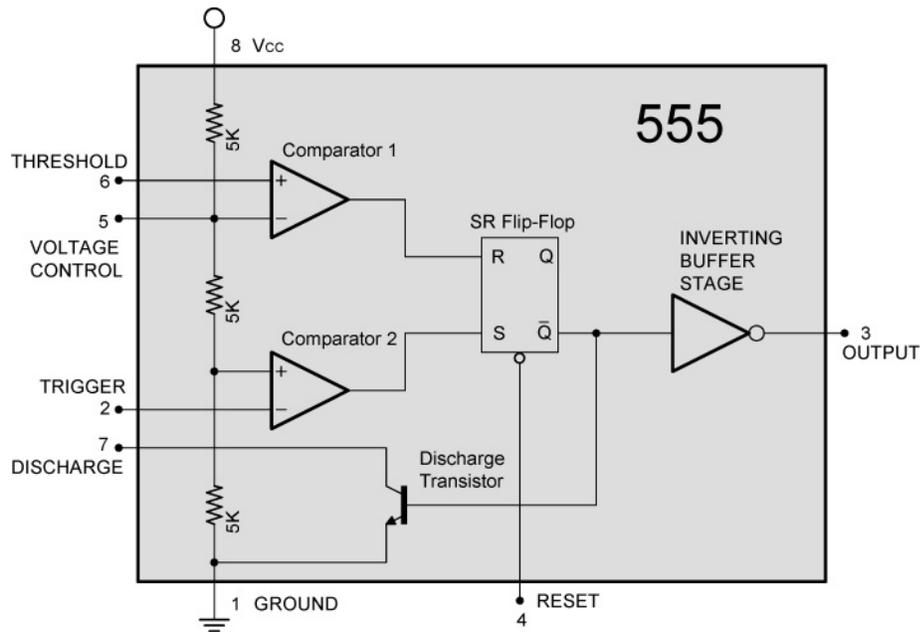
Figure 2 – Internal Block Diagram and Pin Functions

o **Pin Functions:**
  - Pin 1: **Ground**, The 0V connection to the power supply. All voltages are measured with respect to this terminal.
  - Pin 2: **Trigger**, The negative input into inverting comparator 2. A negative pulse on this pin "sets" the internal flip-flop. When the trigger voltage drops from above to below 1/3 V_{CC}, the inverting comparator 2 output switches from a LOW to a HIGH state, setting the flip-flop output Q to LOW.
  - Pin 3: **Output**, The digital output of the 555. Output HIGH is capable of sourcing up to 200mA while output LOW is capable of sinking up to 200mA. When the 555 output is HIGH, the output voltage is approximately $V_{CC} - 1.5$ V; when LOW, the output voltage is approximately 0.1 V.
  - Pin 4: **Reset**, This active-low input forces the 555 output pin 3 into a LOW state. The reset is an overriding function. It is generally connected to V_{CC} when not used to prevent any unwanted resetting of the output.
  - Pin 5: **Control Voltage**, This pin overrides the 2/3 V_{CC} level of the voltage divider network. An external voltage applied to this terminal changes the threshold as well as trigger voltage. When not used, it is connected to ground via a 0.01 µF capacitor to eliminate V_{CC} supply noise.
  - Pin 6: **Threshold**, The positive input into non-inverting comparator 1. When the threshold voltage rises from below to above 2/3 V_{CC}, the non-inverting comparator 1 output switches from a LOW to a HIGH state, resetting the flip-flop output Q to HIGH.
  - Pin 7: **Discharge**, The discharge pin is connected directly to the collector of an internal NPN transistor. When the flip-flop output Q is HIGH, the discharge transistor is saturated and shorts (discharges) the external timing capacitor to ground.
  - Pin 8: **Supply +Vcc**, This is the power supply pin and for general purpose TTL 555 timers is between 4.5V and 15V.

- Sinking and Sourcing the 555 Timer Output:
    - The terminology source and sink is from the water analogy, where water flows out of the source and then drains into the sink.
    - 555 Output as a Sink: In Figure 3, when pin 3 output is LOW it provides a current path to ground through the 555 (the 555 sinks the current) and the LED is switched on.
    - 555 Output as a Source: In Figure 4, when the pin 3 output is HIGH it provides a current source from the 555 and the LED is switched on.
    - The 555 timer can sink or source up to 200 mA.
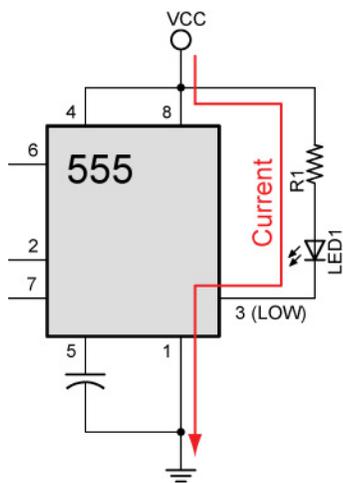
Figure 3 – 555 as a Sink   **Figure 4 – 555 as a Source**
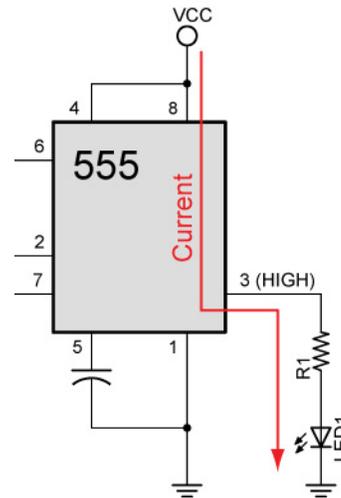
    - Perform 555 Timer Basics Lab 1 – Sinking and Sourcing
- Sinking and Sourcing Higher Powered Devices:
    - If the 555 timer must drive a load with a current in excess of 200mA, a transistor driver may be added to amplify the 555 timer current output to provide the higher current to the load.
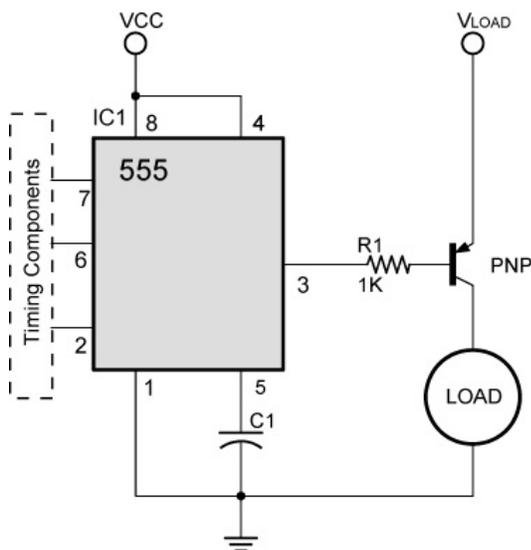
Figure 5 - Sinking Base Current from PNP   **Figure 6 - Sourcing Base Current to NPN**
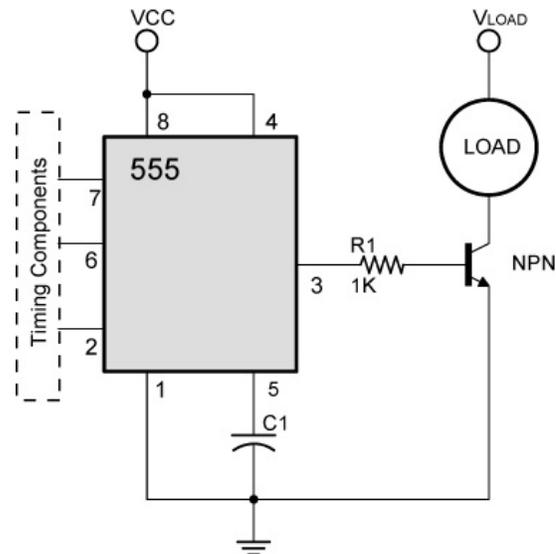
    - Notice V_{LOAD} does not have to equal V_{CC}.

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- o **Two Operating Modes:**
  - Astable Mode: Astable mode causes the 555 timer to operate as an oscillator. It can be used to send timed pulses for LEDs, tone generation, clocks, etc. See lesson on astable operation at: http://cornerstonerobotics.org/curriculum/lessons_year2/erii5_555_timer_astable_operation.pdf
  - Monostable Mode: Monostable mode causes the 555 to operate as a "one shot". When a trigger is received on the input pin, the output will go high for a set period of time, and then go low again. The width of the high output pulse is determined by the RC constant for R1 and C1; it is independent of the supply voltage. The monostable circuit has only one stable state (output low) hence the name monostable.
- o **Other Information about the 555 Timer:**
  - 555 Timer is nonprogrammable
  - The 556 contains two in dependent 555 timers in one IC.
  - The circuit can produce brief dips in the voltage of the supply. This can be corrected by placing a large value capacitor across the supply rails. This eliminates the voltage change.
- o **Internet References:**
  - http://www.uoguelph.ca/~antoon/gadgets/555/555.html
  - http://www.kpsec.freeuk.com/555timer.htm#astable
  - http://www.doctronics.co.uk/555.htm
  - http://www.dprg.org/tutorials/2005-11a/index.html
  - http://www.leang.com/robotics/info/articles/minison/minison.html
  - http://www.kingcharlesschool.co.uk/admin/files/Public/Departments/5/Downloads/555TIMER.pdf

o **Purpose:** The purpose is to introduce the student to the principles of sinking and sourcing a 555 timer output.

o **Apparatus and Materials:**

- 1 - Breadboard w/ +5V Power Supply
- 1 – 555 Timer IC
- 1 – NO Momentary Switch
- 2 – 220 Ohm Resistors
- 1 – 10K Resistor
- 1 – 1M Resistor
- 1 – 1.0 µF Capacitor
- 1 – 0.01 µF Capacitor
- 2 – LEDs, One Red, One Green

o **Procedure:**
- Build the circuit below.
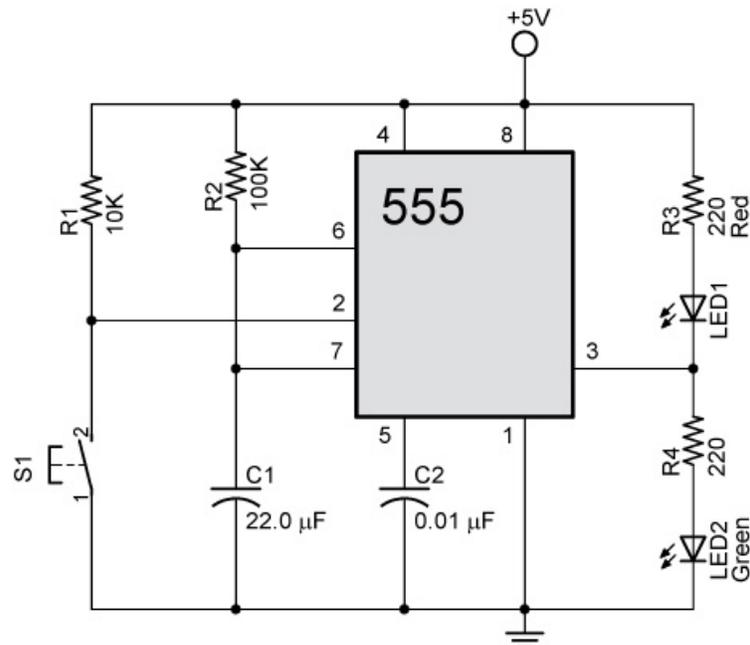
555 Timer Sinking and Sourcing

- Press S1 and record your observations.

o **Results:**
- What happens when S1 is not pressed?

- What happens when S1 is pressed?

o **Conclusions:**
- Which LED is illuminated when the 555 timer is acting as a sink?