

Lab 7 - 555 Timer Monostable Delay

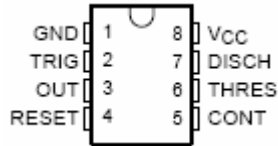
OBJECTIVES

To build and demonstrate a 555 timer circuit for monostable operation.

MATERIALS NEEDED

555 Timer, .01 μ F capacitor, 2.2 μ F capacitor, 10k Ω resistor, 220 Ω resistor, 5M Ω pot, LED.

SUMMARY OF THEORY



The 555 timer is an IC often used in timing circuits. It has two principle operating modes.

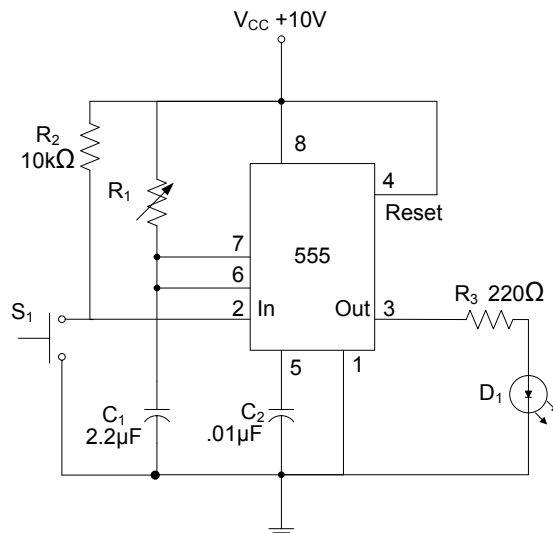
Astable mode causes the 555 to operate as an oscillator. It can be used to send timing pulses for LED flashers, clocks, tone generation, etc.

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 period of time, then go low again. The width of the output pulse is determined by an RC constant. In the schematic below, these are R_1 and C_1 . The formula is $\text{Time} = 1.1R_1C_1$ seconds.

Initially, current flows through R_1 , in on pin 7, through an internal transistor Q_1 , and out pin 1 to ground. When S_1 is **momentarily** closed, it shorts pin 2 to ground, triggering the one-shot. When triggered, Q_1 is turned off, and current flows through R_1 into C_1 , causing it to charge. When the charge in C_1 is $2/3 V_{CC}$, it will be high enough on pin 7 to turn Q_1 back on, causing C_1 to discharge to ground.

The 555 operates on a percentage of the applied voltage. The time of the output pulse is not affected by the level of V_{CC} , (assumed to be between +4 to +15V). This is due to the fact that C_1 must change to $2/3 V_{CC}$, and will take the same time whether the voltage is +5V or +15V.

SCHEMATIC



PROCEDURE

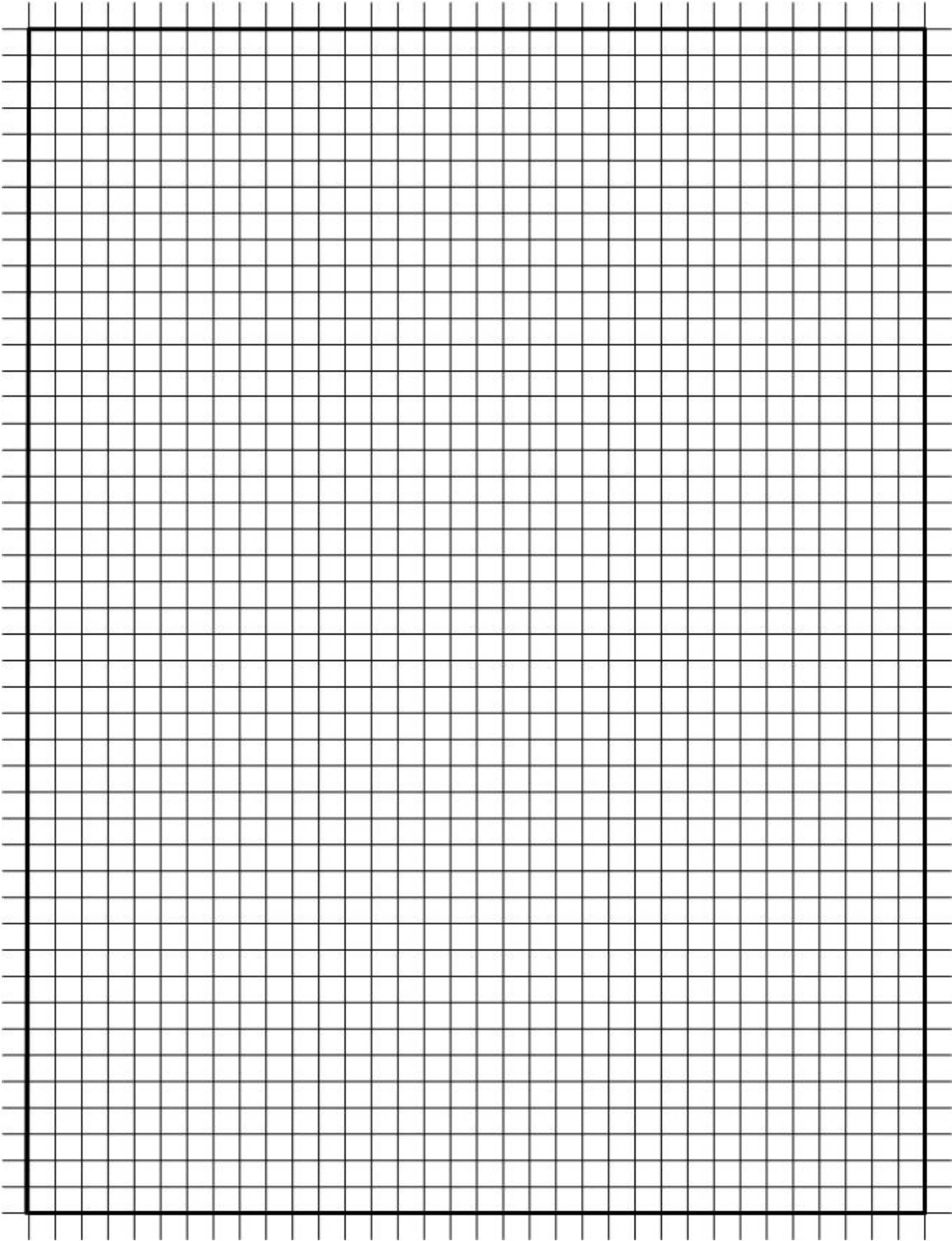
1. Build the circuit as shown.
2. Remove R_1 and adjust to $1M\Omega$, then re-insert R_1 .
3. Test by momentarily closing S_1 . The LED should come on for a few seconds.
4. Repeat step three several times to determine an average time that the LED is on (use a time piece).
5. Demonstrate to your instructor.
6. Repeat starting at step 2, adjusting R_1 to $2M\Omega$, $3M\Omega$, $4M\Omega$, and $5M\Omega$.
7. Plot the line for R_1 ($M\Omega$) (vertical) vs Time (sec) (horizontal).

Table 1

R_1 Nominal	R_1 Measured	Time
$1M\Omega$		
$2M\Omega$		
$3M\Omega$		
$4M\Omega$		
$5M\Omega$		

OBSERVATIONS AND QUESTIONS

1. What does the line you plotted represent?
2. On the same graph, plot the line representing the same range for R_1 ($1M\Omega - 5M\Omega$) if $C_1 = 1\mu F$.



Lab 7b – Using the 555 Timer to Drive a Motor
Bonus 2 marks

OBJECTIVES

To use the previous 555 timer monostable circuit to drive a small DC motor.

MATERIALS NEEDED

555 monostable timer circuit, $10k\Omega$ resistor, TIP 120 NPN Transistor, 1N4004 diode.

SUMMARY OF THEORY

The 555 time circuit provides an output signal which can be used to drive a device for a period of time. Typically, a motor will require more current than the 555 timer can provide for reliable operation. To allow the 555 timer to control a motor, we can add another device such as a relay or power transistor. In this lab, we will add a TIP120 transistor that will act as a switch to allow current to flow to the motor.

The TIP120 comes in a TO-220 package (Figure 1). Note that the lead configuration differs from the TO-92 package. The transistor is a Darlington pair. Inside the package are two transistors that are cascaded to increase the gain. The TIP120 has a current gain of about 1000. Figure 2 is the equivalent circuit. Note, in the table below, that the maximum ratings are V_{CE} of 60V, I_C of 5 Amps and I_B of 120mA.

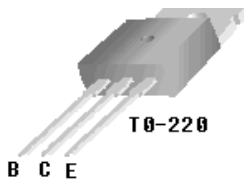


Figure 1

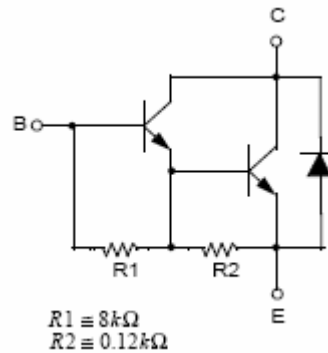


Figure 2

Absolute Maximum Ratings $T_C=25^\circ\text{C}$ unless otherwise noted

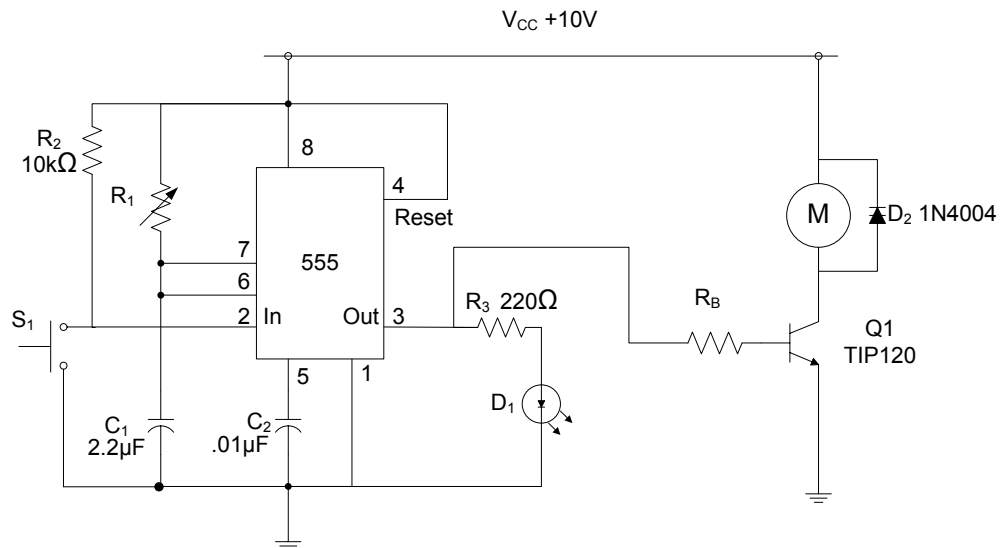
Symbol	Parameter	Value	Units
V_{CBO}	Collector-Base Voltage : TIP120	60	V
	: TIP121	80	V
	: TIP122	100	V
V_{CEO}	Collector-Emitter Voltage : TIP120	60	V
	: TIP121	80	V
	: TIP122	100	V
V_{EBO}	Emitter-Base Voltage	5	V
I_C	Collector Current (DC)	5	A
I_{CP}	Collector Current (Pulse)	8	A
I_B	Base Current (DC)	120	mA
P_C	Collector Dissipation ($T_a=25^\circ\text{C}$)	2	W
P_C	Collector Dissipation ($T_C=25^\circ\text{C}$)	65	W
T_J	Junction Temperature	150	$^\circ\text{C}$
T_{STG}	Storage Temperature	- 65 ~ 150	$^\circ\text{C}$

PROCEDURE

1. Add the TIP120 to your existing circuit as shown in the schematic below. You will have to use Ohm's Law calculate a value for R_B . From the table above, the maximum value of I_B is 120mA. The voltage from the 555 timer output is in the range of 8 – 10V.

Note: The 1N4004 diode (D_2) that is parallel to the motor will block the current generated by the counter electromotive force generated by the motor from entering your circuit.

2. Remove R_1 and adjust to $1M\Omega$, then re-insert R_1 .
3. Test by momentarily closing S_1 . The motor and the LED should come on for a few seconds.
4. Demonstrate to your instructor.

SCHEMATIC

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