Experiment 1: The 555 Timer Applications

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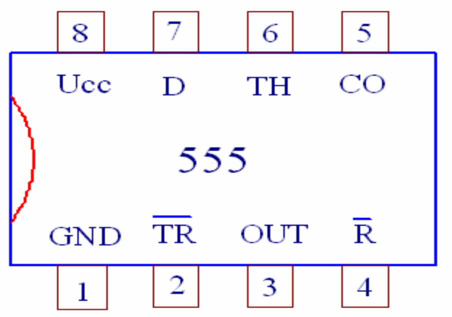
Aim

1. To master the circuit structure and functional principle of 555 timer.
2. To design and test application circuits by 555 timers.

Introduction of components



Inputs			Outputs	
$\overline{R}$	TH	$\overline{TL}$	Q1	Output
0	X	X	On	LOW
1	$>\frac{2}{3}V_{cc}$	$>\frac{1}{3}V_{cc}$	On	LOW
1	$<\frac{2}{3}V_{cc}$	$>\frac{1}{3}V_{cc}$	Holding	Holding
1	$<\frac{2}{3}V_{cc}$	$<\frac{1}{3}V_{cc}$	Off	HIGH
1	$>\frac{2}{3}V_{cc}$	$<\frac{1}{3}V_{cc}$	Off	HIGH

Pin out of LM555 and truth table

The 555 timer is a versatile and widely used IC device because it can be configured in two different modes as either a monostable multivibrator (one–shot), or as an astable multivibrator (pulse oscillator) between two unstable states without any external triggering.

Pin1 is usually connected to ground. Its voltage is lower than any other pins.

Pin2 , trigger voltage is 1/3 Vcc, when its voltage is lower than 1/3 Vcc, the output will be HIGH. The permitted voltage ranges from 0 ~ Vcc.

Pin3, the output is usually Low, and HIGH when triggered.

Pin 4, the external reset input can be used to reset the latch independent of the threshold circuit. The timer can be triggered only if pin4 voltage is more than 1V.

Pin5, the control voltage input can be used to externally adjust the trigger and threshold levels if necessary. When unnecessary, it can be connected to a decoupling capacitor to prevent noise from affecting the trigger and threshold levels. Its voltage range is 0 ~ Vcc.

Pin 6, the threshold, when >2/3 Vcc, the timer is reset, the output is LOW. It is 0 ~ Vcc.

Pin7 is connected to the discharge transistor.

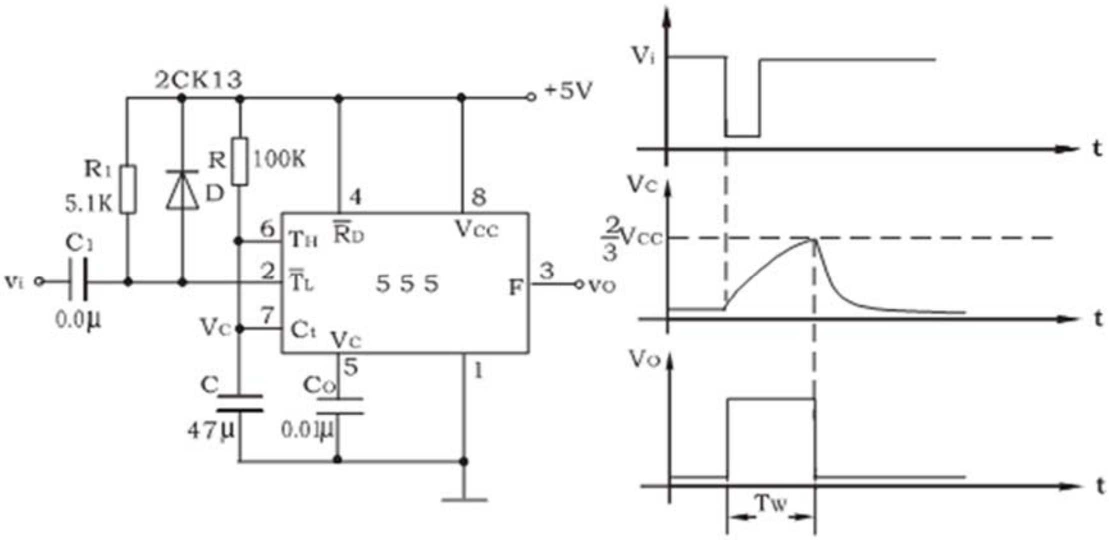
Pin 8 is connected to power from 4.5 ~ 16V.

Instruments

Digital multimeter, digital oscilloscope, DC power supply,

Tasks

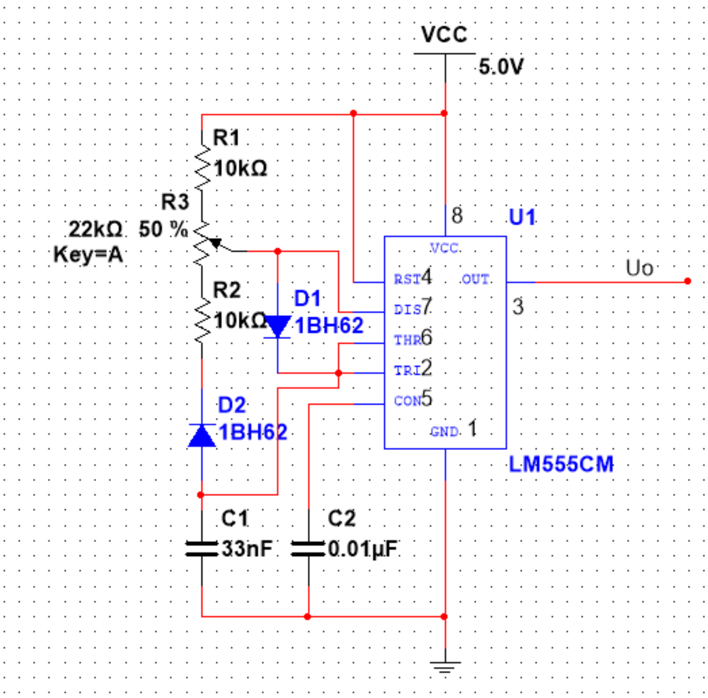
1. Design a timer circuit to get 5s delay time. Test and watch output on CRO and record the wave on square paper.

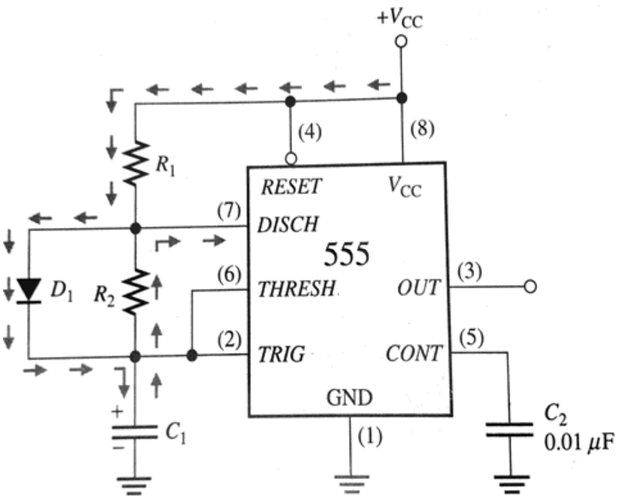


Circuit1 Monostable Multivibrator (One-Shot)

Based on formula $t_w = 1.1R_1C_1$, when C1 we choose 47uF, t_w=5s, after calculating, R1=96.711kΩ≈100 kΩ

2. Build the adjustable duty oscillator circuit to make f=1KHz. Adjust R_D while observing the waveforms change at pin 3 on CRO. Draw the waveforms with the maximum and minimum duty. Measure t_H and t_L, calculate the duty values.



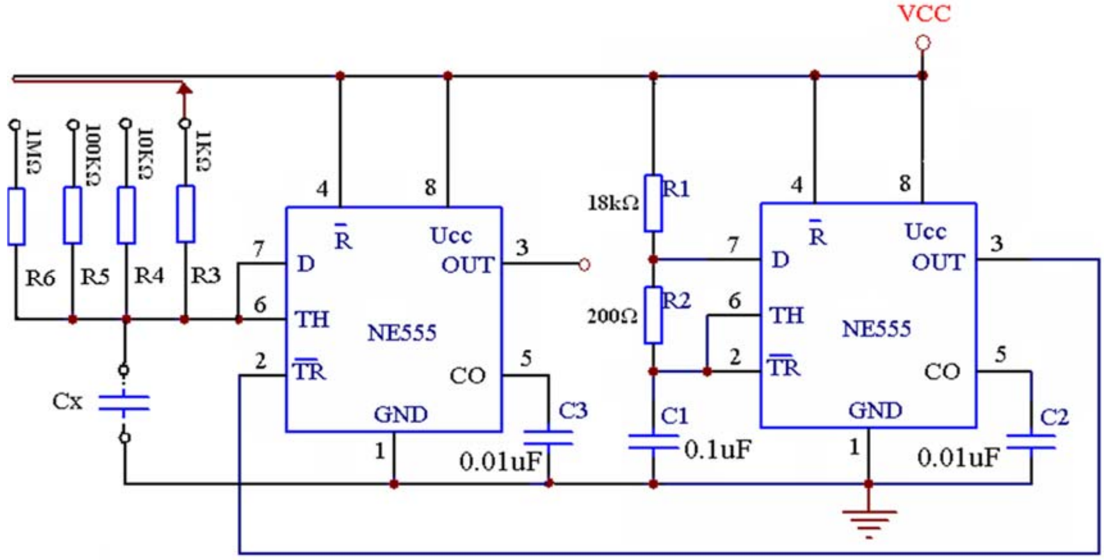


$$D = \left(\frac{R_1}{R_1+R_2}\right)100\%$$

Circuit2 Astable Multivibrator (Oscillator)

3. Build the capacitor testing circuit. Test the following capacitors: 0.1uF, two 0.1uF in parallel; 0.01uF, two 0.01uF in parallel; 0.001uF, two 0.001uF in parallel by selecting corresponding testing resistors.

Resistor	1M	100K	10K	1K
Range	100-1000pF	1000pF-0.01uF	0.01uF-0.1uF	0.1uF-1uF

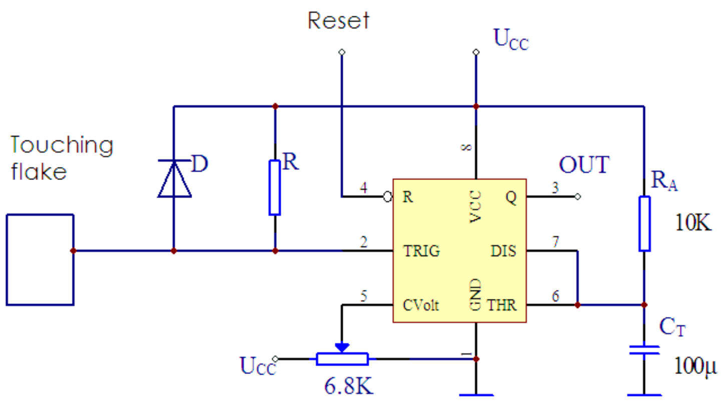


Circuit3 Simple capacitor testing circuit

$Cx=t/1.1R$

t is pulse width of output waveform. R is resistor you choose.

4. Design and construct a hand-touching switch circuit. Pay attention to the effects on output waves while adjusting the potentiometer.



Circuit4 Touching switch circuit

Data collation and analysis

Task1

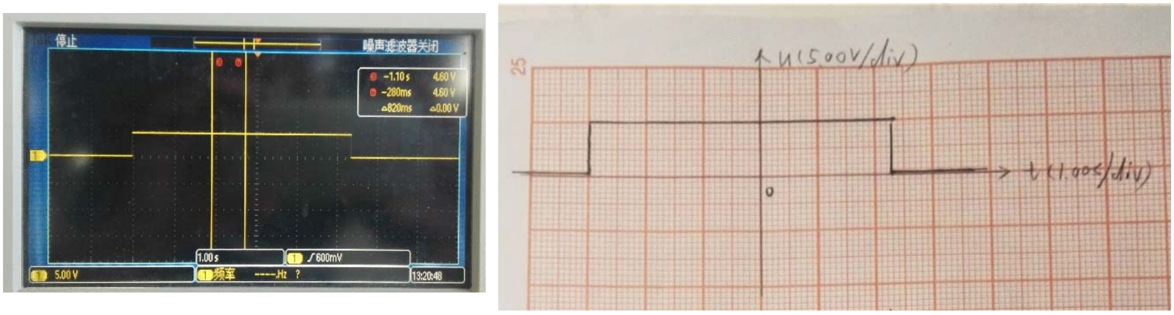


Figure1 the waveform of Monostable Multivibrator (One-Shot)

After testing the waveform, delay time is around 5.3s. The error comes from the fact that the value of the resistance and capacitance is slightly different from the theoretical value.

Task2

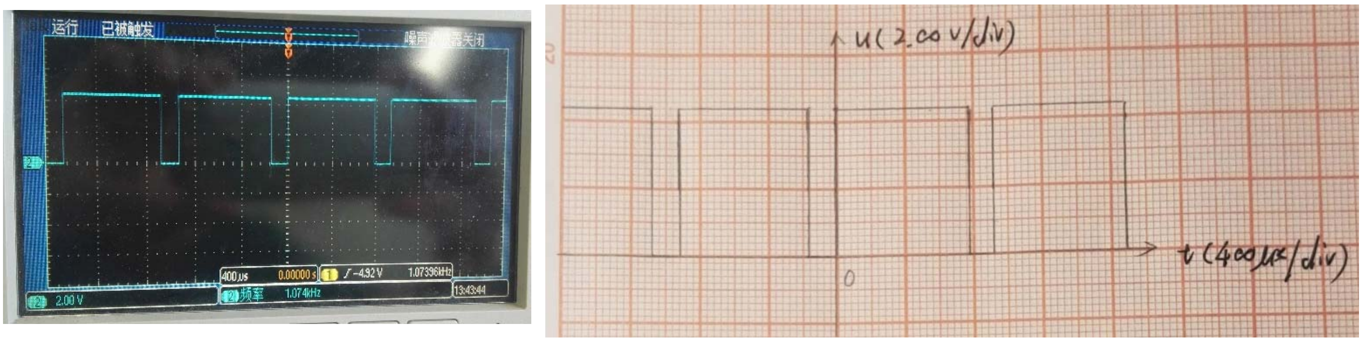


Figure2 the waveform of astable multivibrator when duty ratio greater than fifty percent

f=1.07396kHz

duty ratio=85.34%

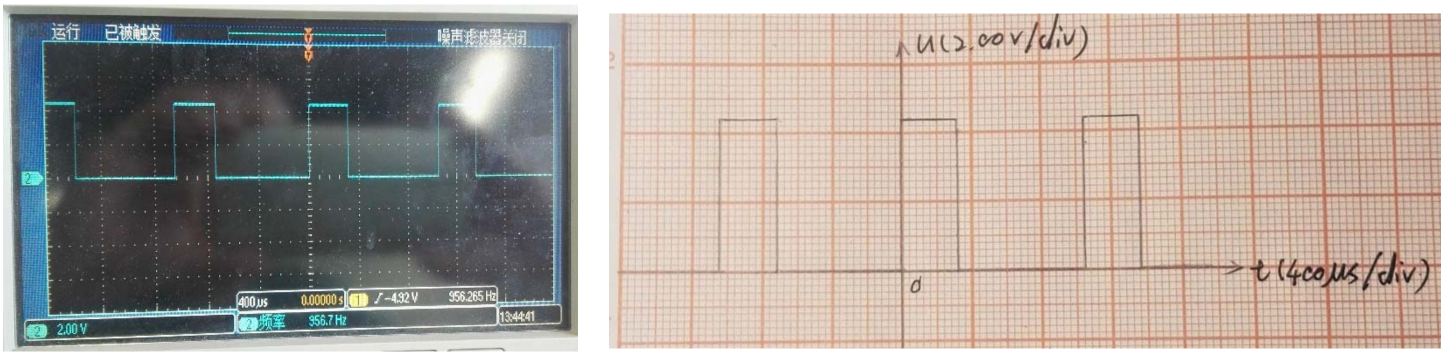


Figure3 the waveform of astable multivibrator when duty ratio less than fifty percent

f=956.265Hz

duty ratio=30.77%

This astable multivibretor can work correctly, and when $R_A=R_B$, the duty ratio is 50%.

Task3

R(kΩ)	10	1	10	10	100	100
t(ms)	1.04	0.2	0.104	0.206	0.122	0.238
Cx(measurement)/μF	0.0945	0.1818	0.0095	0.0187	0.0011	0.0022
Cx(in fact)/ μF	0.1	0.2	0.01	0.02	0.001	0.002
Relative error	5.45%	9.09%	5.45%	6.36%	10.91%	8.18%

There is some error between measurement and fact. One possible reason is the waveform distortion like figure 4.

Figure4 waveform distortion of output

Change astable multivibretor to one shot trigger may reduce measurement error.

Task5

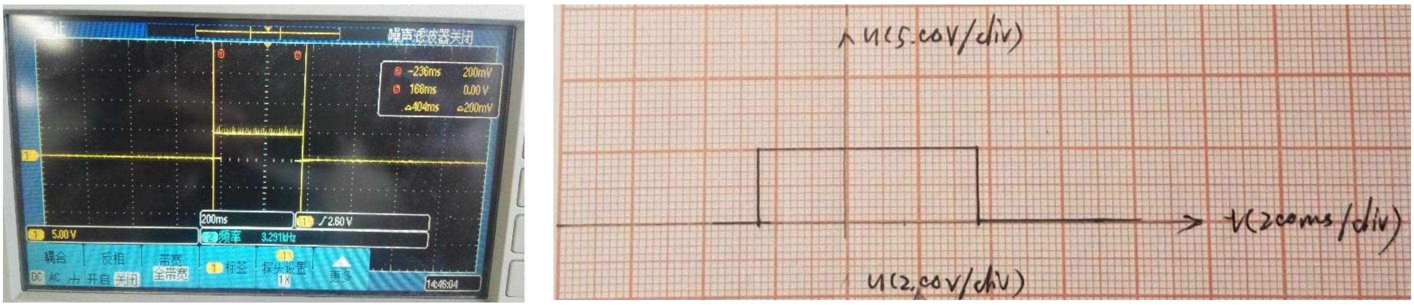


Figure5 waveform of touching switch circuit-1

U5=1.499V, Δt=404ms

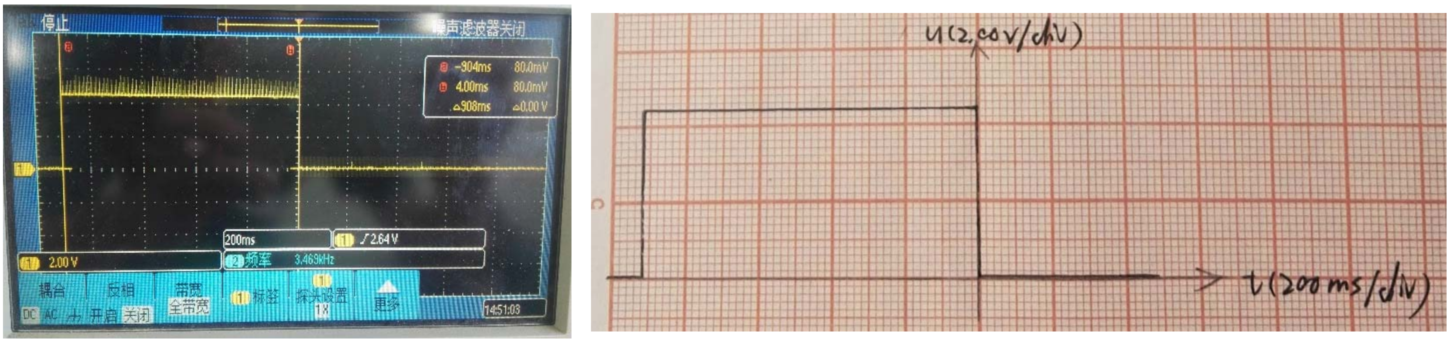


Figure6 waveform of touching switch circuit-2

U5=3.332V, Δt=908ms

From this experiment, I find that the bigger U5 is, the longer high-level duration is. When the capacity charges to U5, high level will turn to low level.

Summary

In experiments today, I learned some typical application of 555 timer. If we use these IC more flexible, we can design many circuits to implement a wide range of functions.