7-1 Excitation Table of a Flip-Flop

The excitation table is similar to the truth table that we discussed in the previous discussions on flip-flops. The excitation table lists the present state, the desired next state and the flip-flop inputs (J, K, D, etc.) required to achieve that. The same for a J-K flip-flop and a D flip-flop are shown in Tables 11.7 and 11.8 respectively. Referring to Table 11.7, if the output is in the logic '0' state and it is desired that it goes to the logic '1' state on occurrence of the clock pulse, the J input must be in the logic '1' state and the K input can be either in the logic '0' or logic '1' state. This is true as, for a '0' to '1' transition, there are two possible input conditions that can achieve this. These are J = 1, K = 0 (SET mode) and J = K = 1 (toggle mode), which further leads to J = 1, K= X (either 0 or 1). The other entries of the excitation table can be explained on similar lines. In the case of a D flip-flop, the D input is the same as the logic status of the desired next state. This is true as, in the case of a D flip-flop, the D input is transferred to the output on the occurrence of the clock pulse, irrespective of the present logic status of the Q output.

Table 11.7 Excitation table of a *J-K* flip-flop.

Present state (Q_n)	Next state (Q_{n+1})	J	K
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

Table 11.8 Excitation table of a *D* flip-flop.

Present state (Q_n)	Next state (Q_{n+1})	*D*
0	0	0
0	1	1
1	0	0
1	1	1

1.2.4 Monostable and astable multivibrator

As we said above, a monostable multivibrator has only one stable state, the other state being momentary. An astable multivibrator has no stable state; it oscillates back and forth between two states. The integrated circuit NE555 is a multivibrator which cans both function as monostable and as astable.

1.2.4.1 IC NE555:

The 555 integrated circuit is the most popular ship ever manufactured. Independently manufactured by more than 10 manufacturers, still in current production, and almost 40 years old, this little circuit has withstood the test of time. It has been used in many things from toys to spacecraft. The IC 555 integrates a flip flop circuit, and also operational amplifiers. The basic internal constitution of the IC 555 is given as follows.

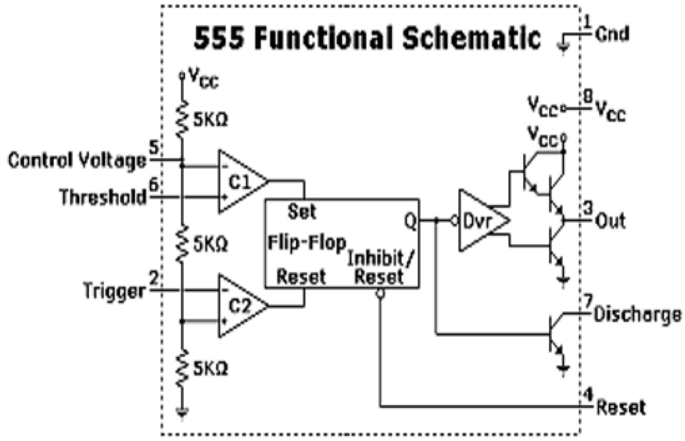


Figure 1.9: Internal diagram of the IC 555.

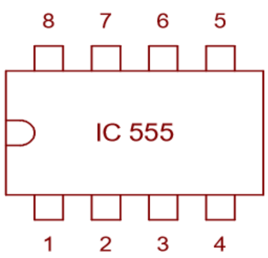


Figure 1.10: External appearance of the IC 555.

1.2.4.2 IC 555 as monostable:

A mechanical analogy of a monostable multivibrator would be a momentary contact push button switch which returns to its normal (stable) position when pressure is removed from its button actuator. In order to work as monostable multivibrator, the IC 555 should be connected as follows. The circuit is designed here using the electronic simulation software ISIS Professional edited by Labcenter. Values of component appearing on the diagram are just suggested.

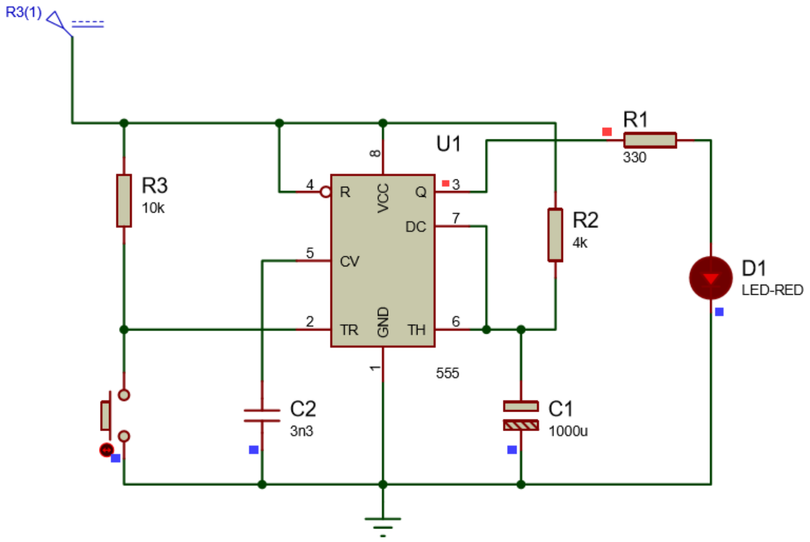
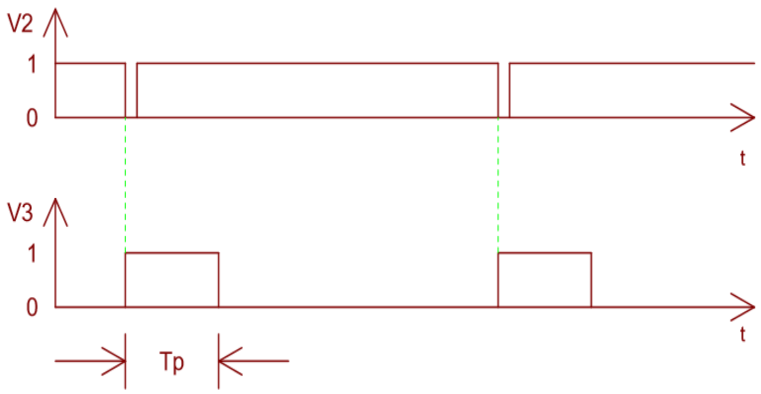


Figure 1.11: Simulation diagram for the IC 555 connected as monostable.

Probes 2 and 3 being respectively trigger and output, waveforms expected from them are as follows.



Anytime the circuit is triggered, that is by sending a brief low level logic signal at the lead number 2, the output 3 pass from its stable state which is low (0) to a momentary high logic level that delays for a duration Tp. The duration Tp depends on the values of R2 and C1and is given by the following formula.

$$\boxed{T_P = R_2 C_1 \ln 3 = 1.1 R_2 C_1}$$

For our example the duration of the temporization **Tp** will be calculated as follows:

$$R_2 = 4k\Omega$$

$$C_1 = 1000\mu F$$

$$T = 4000x3000x10^{-6}x1.1 = 4.4s$$

So, the duration of the temporisation is 4.4 seconds.

1.2.4.3 IC 555 as astable:

Astable multivibrator has no stable state and oscillates back and forth between an output of 0 and 1. In order to function as an astable, the IC 555 should be connected as follows:

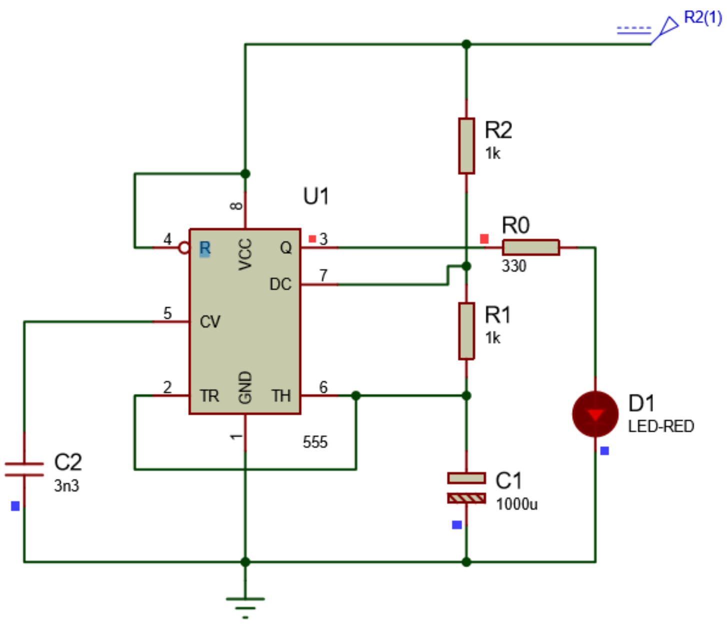
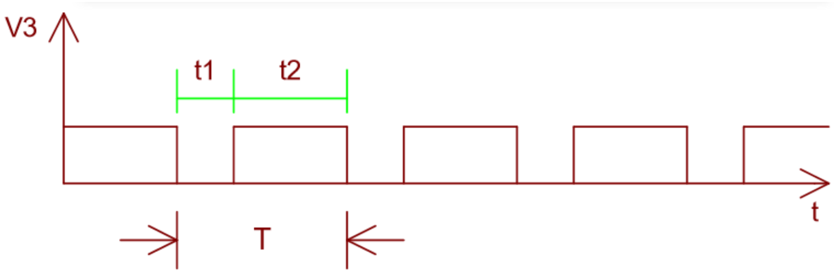


Figure 1.12: Simulation diagram for the IC 555 connected as an astable.

Once the circuit is supplied by a 5 V DC source, the output begins to oscillate between 0 and 1 logic levels. The led goes on and off alternatively. The waveform expected from the output is given as follows:



The period of the signal generated by the output is given as follows:

$$t_1 = R_1 C_1 \ln 2$$
$$t_2 = (R_1 + R_2) C_1 \ln 2$$
$$T = t_1 + t_2 = (R_2 + 2R_1) C_1 \ln 2$$
$$T = 0.693 (R_2 + 2R_1) C_1$$

For our example the duration of the period of the signal can therefore be calculated:

$$R_1 = R_2 = 1k\Omega$$

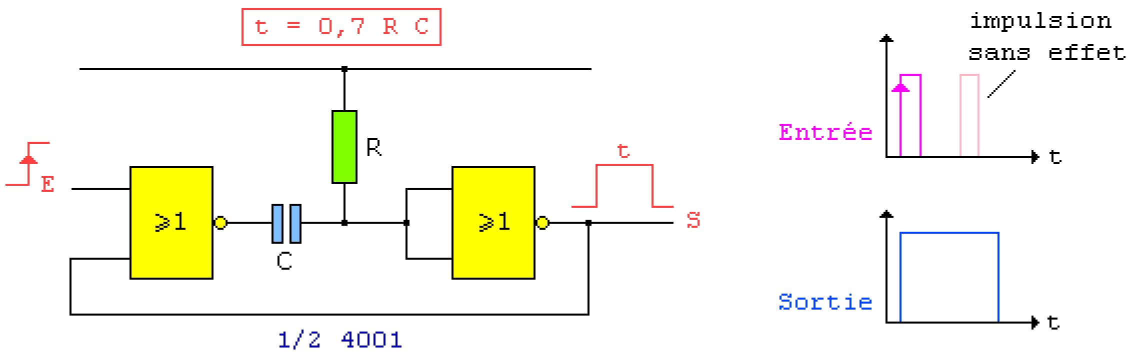
$$C = 1000\mu F$$

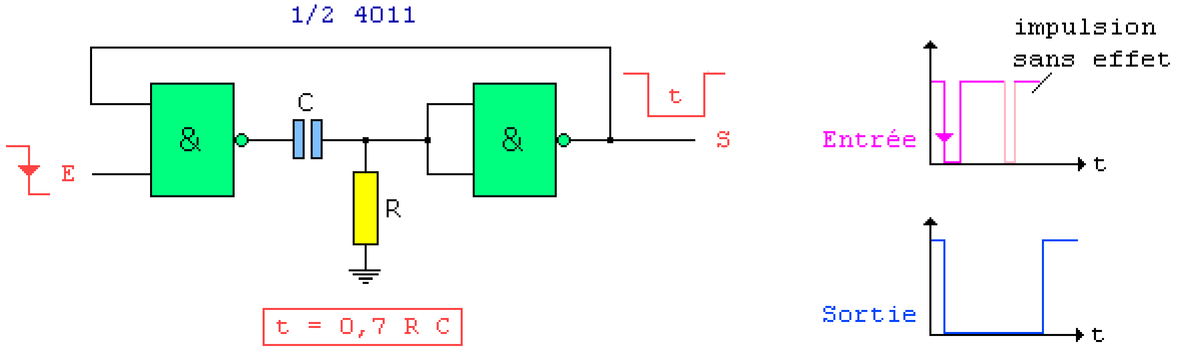
$$T = 0.693x3000x10^{-6} = 2.079s$$

So, the period of the signal generated by the output is 2.079 seconds.

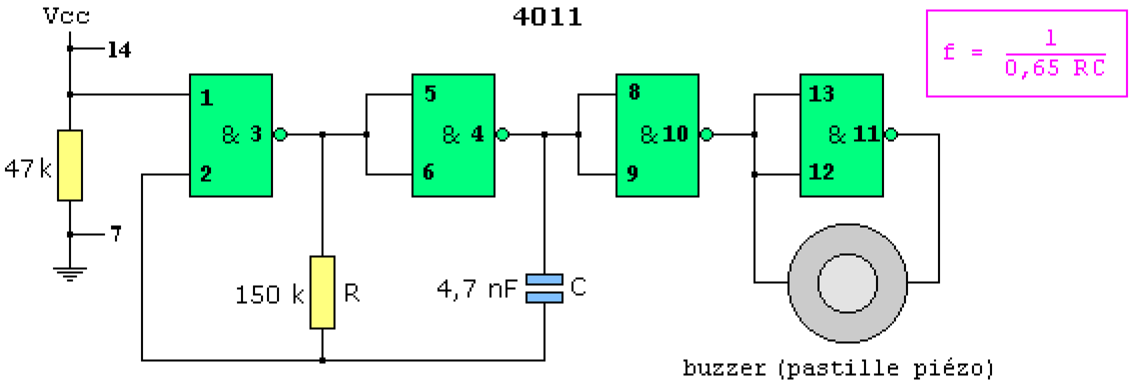
ASTABLE AND MONOSTABLE WITH LOGIC GATES

Monostable





Astable



1.3 Conclusion:

This chapter has permitted us to study latches and flip-flops which are elementary tools used in the designing of many sequential circuits. The notion of multivibrator has been introduced and discussed. The IC 555 has been presented and its functioning as monostable and stable multivibrator studied. The focus of the following chapter is the study of counters, which are of great importance in many digital circuits.