Digi-Course II

Chapter 7

In this chapter of Digi Course, we introduce another important concept of the logic circuits — the time dependant operation. In case of such circuits which will be described in this chapter, the logic state of the circuits depends not only on the input levels, but also on the moment of time of viewing.

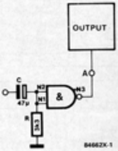
For experimenting with time dependant cirucit we shall need some passive components:

3 Resistors 3.3 K Ω / ⅛ Watt.
3 Electrolytic Capacitors 47 μF/16V.
1 Electrolytic Capacitor 4.7 μF/16V.

A connecting link will have to be soldered to each lead of these components so that they can be used directly on our Digilex PCB.

The circuit shown in figure 1 is a simple 'Monoflop'

1

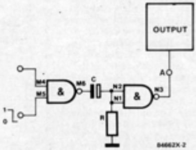


The solid black bar in the capacitor symbol is the negative terminal of the capacitor. Connect this terminal to zero level (ground line) so that the capacitor is fully discharged. The capacitor voltage is 0 V and the output indicator LED lights up because of the NAND gate inverter. Now if the "1" or +5V level is given at the negative terminal of the capacitor the LED is turned off for some time and then it lights again on its own.

With a high input to the capacitor, the voltage at the input of the NAND inverter also jumps to "1", thus turning off the LED. As the capacitor slowly charges, the current flow through 3.3K resistor decays and along with that the voltage at the input of the NAND inverter also decays to "0". Once this stage is reached, the output of the NAND inverter again becomes "1" and the LED glows. The time taken by the capacitor to charge is decided by the values of R and C, which also decide the time for which the LED remains turned off.

The circuit in figure 1 can be further modified as shown in figure 2.

2

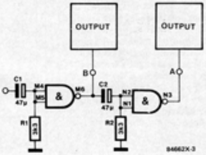


With this modification the circuit becomes a controlled Monoflop. With M4 at "0" level the circuit can be disabled and with M4 at "1" the circuit is enabled and becomes operative. Terminal M5 is the trigger input. Many standard ICs have an input similar to the terminal M4 which is called the Enable Input.

The Monoflop just described is also known as a Monostable Multivibrator. The Flipflop described in previous chapters is known as a bistable multivibrator.

Now let us see the effect of connecting two Monoflops in series as shown in figure 3.

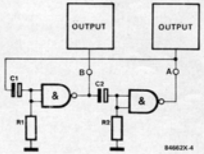
3



When capacitor is switched from "0" to "1" first the LED B is turned off, then after a period decided by the values of R1 and C1, it glows again. At this exact moment of time the second Monoflop gets a transition from "0" to "1" at the input of capacitor C_2 which turns off LED A for an equal amount of time, then it glows again.

Similar to the "0" to "1" transition available at M6 when B started glowing again, we also have a "0" to "1" transition available at N3 when A starts glowing again. This transition canbe further used to trigger the first Manoflop again. Connect the circuit as shown in figure 4 and observe what happens!

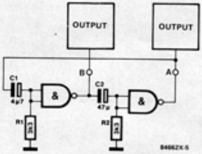
4



This circuit will switch both the Monoflops alternately and the LEDs will glow and extinguish alternately. This is an oscillator — called Astable Multivibrator. The period of osciallations will be decided by the individual values of R1, C1 and R2, C2

To study the effect of R and C values, change the capacitor C1 from 47 μF to 4.7μF. Now the periods of LEDs A and B glowing and extinguishing become unequal. The exact effect is illustrated in the pulse diagram of figure 6. The diagrams on the left correspond to circuit values in figure 3 and the diagrams on right correspond to circuit values in figure 5

5



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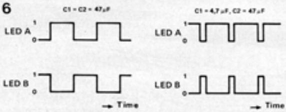


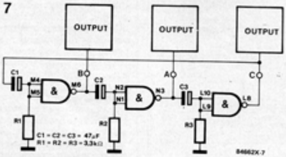
In engineering language this is called a symmetric and asymmetric duty cycle. A simple explanation of the three terms we have encountered so far in multivibrators is as follows. A Monostable Multivibrator is one which has only one stable state, if we force it to change the state, it returns to its stable state after a fixed period of time. Other names for this circuit are Monoflop or Monoshot.

A Bistable Multivibrator has two stable states, if we force it to change its present state it goes to the other stable state and remains in that state till forced again to change state. Another name for this circuit is FlipFlop.

An Astable Multivibrator has two states, but it can never remain in one state permanently. It keeps on changing the states periodically. There is no other name for this circuit.

We can as well add one more Monoflop to our Astable Multivibrator to obtain the circuit shown in figure 7.

7

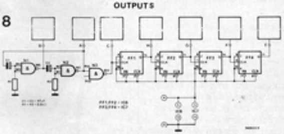


This circuit gives a running light effect, as the three LEDs turn ON and OFF serially. If this circuit does not start up on its own, it must be externally triggered. Any number of extra Monoflops can be added to this circuit provided that the total number is odd.

In Digital Technology, there are many more oscillator circuits. To enumerate those will be outside the scope of this series. An important point worth mentioning here is about the high frequency oscillators. Such circuits are used for generating the clock frequencies for computers and other applications, and to obtain a stable frequency quartz crystals are used.

The simple oscillator circuit of figure 4 can be combined with one of the counter or shift - register cirucits described earlier. One such arrangement is shown in figure 8

8



Like the Flipflops studied in previous chapters, Monoflops are also available commercially as integrated circuits. One such IC is the 74123 which contains two Monoflops. The Monoflops are retriggerable, that is, they can be triggered again during the ON period. The time period is calculated as follows :

$$t = 0.32 \times C \times (R + 700)$$

for R = 5 to 25 KΩ and C= 10 pF

In case of electrolytic capacitors, a diode 1N4148 must be used as shown in figure 9. and the period is shortened to

$$t = 0.28 \times C \times (R + 700)$$

The Monoflops trigger on rising edge at B if A is on "0" and on falling edge at A if B is on "1"

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