AIM

To design counters
a. To design a MOD4 - synchronous up/down counter
b. To study IC 7490 - Asynchronous Decade Counter
c. To study IC 74194 - Ring Counter and Johnson Counter

Apparatus Required

1. Kit
2. IC 7490(Decade counter)
3. IC 74163(Synchronous 4-bit Modulo-16 Up counter)
4. IC 74194(4-bit Bi-directional Shift Register IC)
5. IC 7408(AND Gate)
6. IC 7420(4 Input NAND Gate)
7. IC 7404(NOT Gate)
8. Wires

Software Used

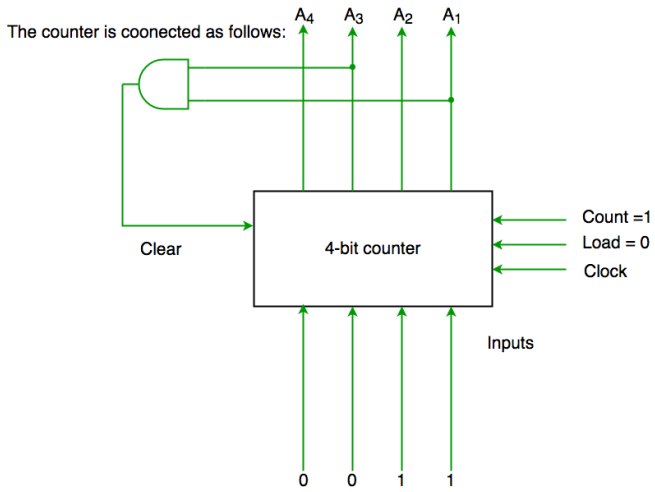
Proteus Software

Theory

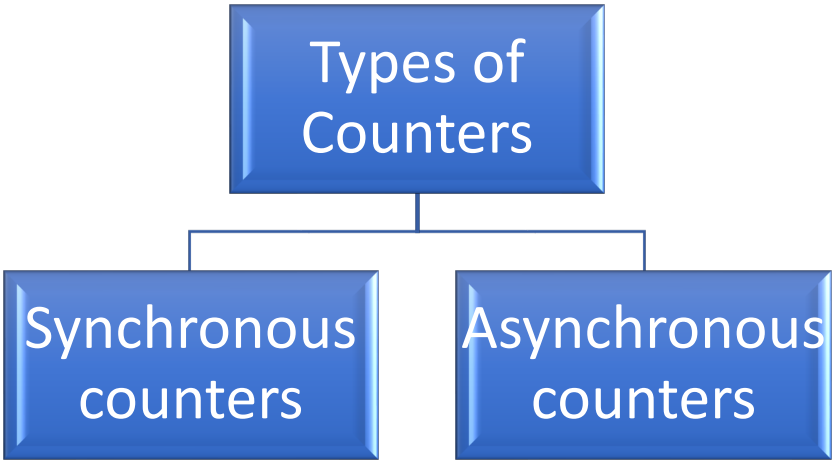
Introduction to Counters

Like shift registers and other combinational circuits, there is another important element in digital electronics which we use most. They are counters. Counters are used not only for counting but also for measuring frequency and time ; increment memory addresses .

Clear	Clock	Load	Count	Function
1	X	X	X	clear to 0
0	X	0	0	No change
0	↑	1	X	Load Input
0	↑	0	1	Count next



Counters are specially designed synchronous sequential circuits, in which , the state of the counter is equal to the count held in the circuit by the flip flops. Counters calculate or note down the number that how many times an event occurred.
Counters are the crucial hard ware components, and are defined as “The digital circuit which is used to count the number of pulses”. Counters are well known to us as “Timers”. Counter circuits are the best example for the flip flop applications. Counters are designed by grouping of flip flops and applying a single clock signal to them. In simple words, the counters are those, which have the group of storage elements like flip flops to hold the count.



Synchronous Counters

The counters which use clock signal to change their transition are called “Synchronous counters”. This means the synchronous counters depends on their clock input to change state values. All flip flops in the synchronous counters are triggered by same clock signal.

Features:

- Their construction is very simple in design. All the flip flops are interconnected and will be driven by same clock signal.
- The state output of the previous flip flop determines the state change of the present flip flop.
- As all the flip flops will work synchronously, the synchronous counters don’t require settling.
- We require number of logic gates to implement the synchronous counters.
- Their operation is fast.

Asynchronous Counters

The counters in which the change in transition doesn’t depend upon the clock signal input is known as “Asynchronous counters”. In these counters, the first flip flop is connected to the external clock signal, and the rest are clocked by the state outputs (Q & Q’) of the previous flip flop.

Features:

- Another name for Asynchronous counters is “Ripple counters”.
- These are very simple in design.
- As its design is simple, they use less number of logic gates to construct an asynchronous counter.
- Operation of asynchronous counters is very slow compared to synchronous counters.

Difference between Asynchronous and Synchronous Counters

SYNCHRONOUS COUNTERS	ASYNCHRONOUS COUNTERS
The propagation delay is very low.	Propagation delay is higher than that of synchronous counters.
Its operational frequency is very high.	The maximum frequency of operation is very low.
These are faster than that of ripple counters.	These are slow in operation.
Large number of logic gates are required to design	Less number of logic gates required.
High cost.	Low cost.
Synchronous circuits are easy to design.	Complex to design.
Standard logic packages available for synchronous.	For asynchronous counters, Standard logic packages are not available.

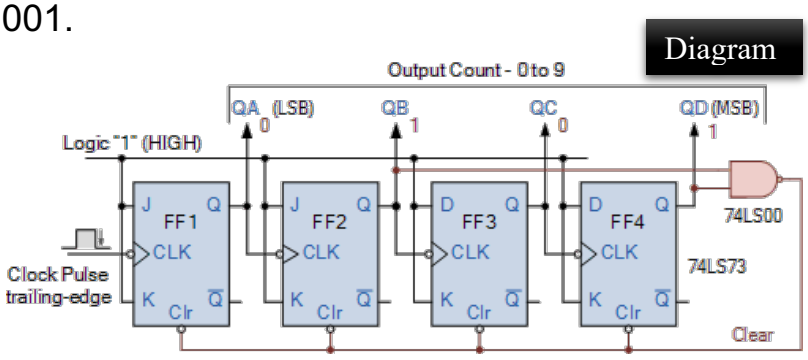
Applications of Counters

Counter found their applications in many digital electronic devices. Some of their applications are listed below.

- Frequency counters
- Digital clocks
- Analog to digital convertors.
- With some changes in their design, counters can be used as frequency divider circuits. The frequency divider circuit is that which divides the input frequency exactly by '2'.
- In time measurement. That means calculating time in timers such as electronic devices like ovens and washing machines.
- We can design digital triangular wave generator by using counters.

MOD 10 Counter

A decade counter is called as mod -10 or divide by 10 counter. It counts from 0 to 9 and again reset to 0. It counts in natural binary sequence. Here 4 T Flip flops are used. It resets after Q3 Q2 Q1 Q0 = 1001.



Diagram

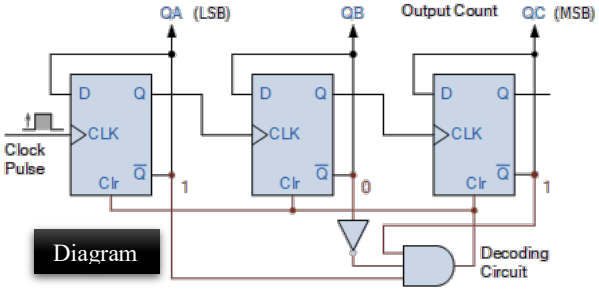
Number	Q_D	Q_C	Q_B	Q_A
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0

X

Truth Table

MOD 5 Counter

We can decode this output state of 101 (5) to give us a signal to clear (clr) the counter back to zero with the help of a 3-input AND gate (TTL 74LS11) and an inverter or NOT gate, (TTL 74LS04). The inputs of the combinational logic circuit consisting of an inverter and a digital logic AND gate are connected to 3-bit counters outputs of: QA, QB, and QC respectively.

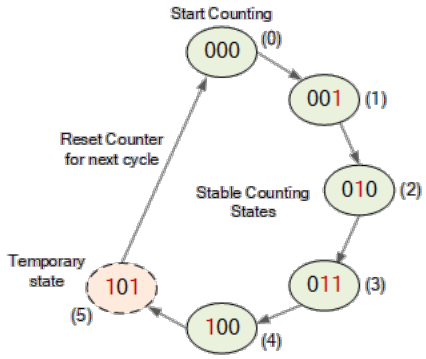


Diagram

Truth Table

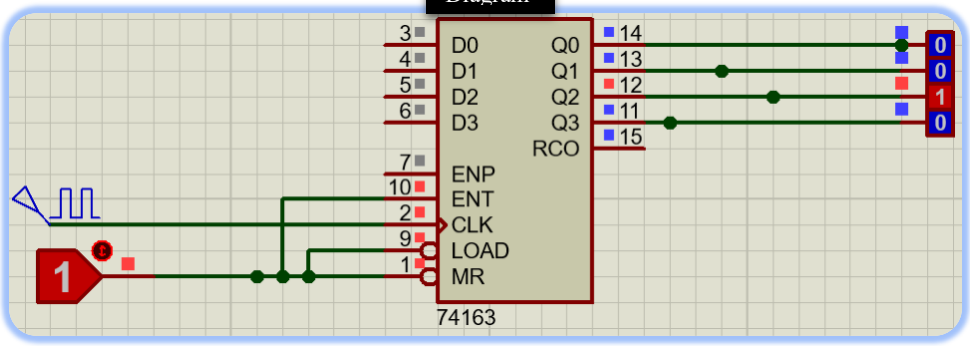
Number	Q_D	Q_C	Q_B	Q_A
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1

X



0-F Counter

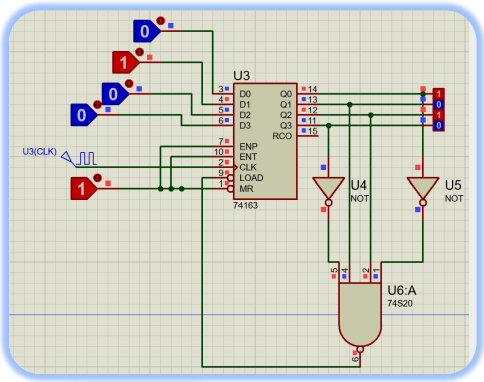
Diagram



Truth Table

Number	Q_D	Q_C	Q_B	Q_A
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1

2-6 Counter



Diagram

Truth Table

Number	Q_D	Q_C	Q_B	Q_A	
0	0	0	0	0	X
1	0	0	0	1	X
2	0	0	1	0	
3	0	0	1	1	
4	0	1	0	0	
5	0	1	0	1	
6	0	1	1	0	
7	0	1	1	1	X

Ring Counter

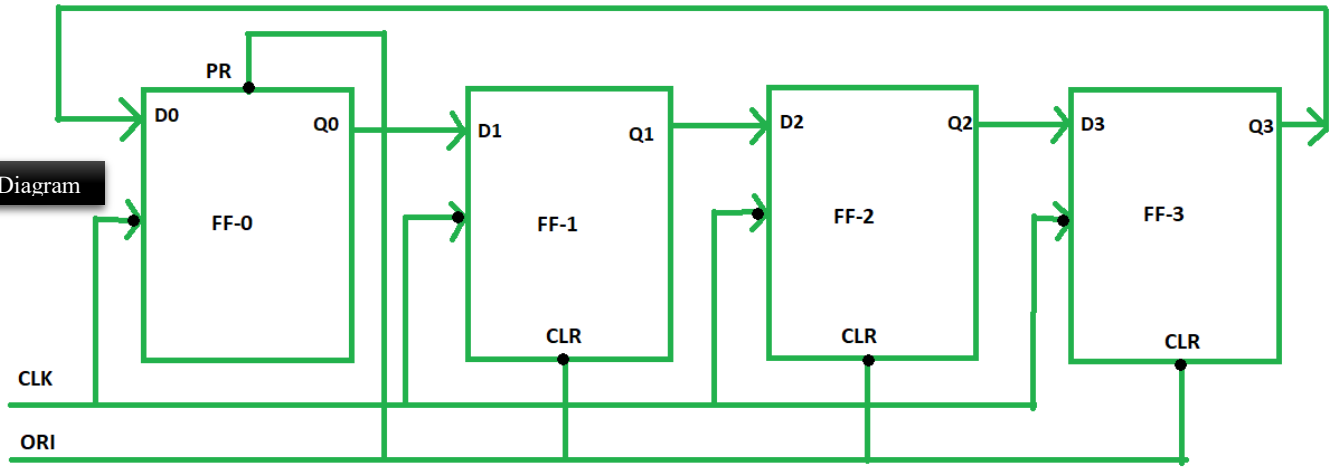
Ring counter is a typical application of Shift resister.

Ring counter is almost same as the shift counter. The only change is that the output of the last flip-flop is connected to the input of the first flip-flop in case of ring counter but in case of shift resister it is taken as output. Except this all the other things are same.

Truth Table

Number	Q_D	Q_C	Q_B	Q_A
0	1	0	0	0
1	0	1	0	0
2	0	0	1	0
3	0	0	0	1
4	1	0	0	0
5	0	1	0	0
6	0	0	1	0
7	0	0	0	1

Diagram



Ring Counter

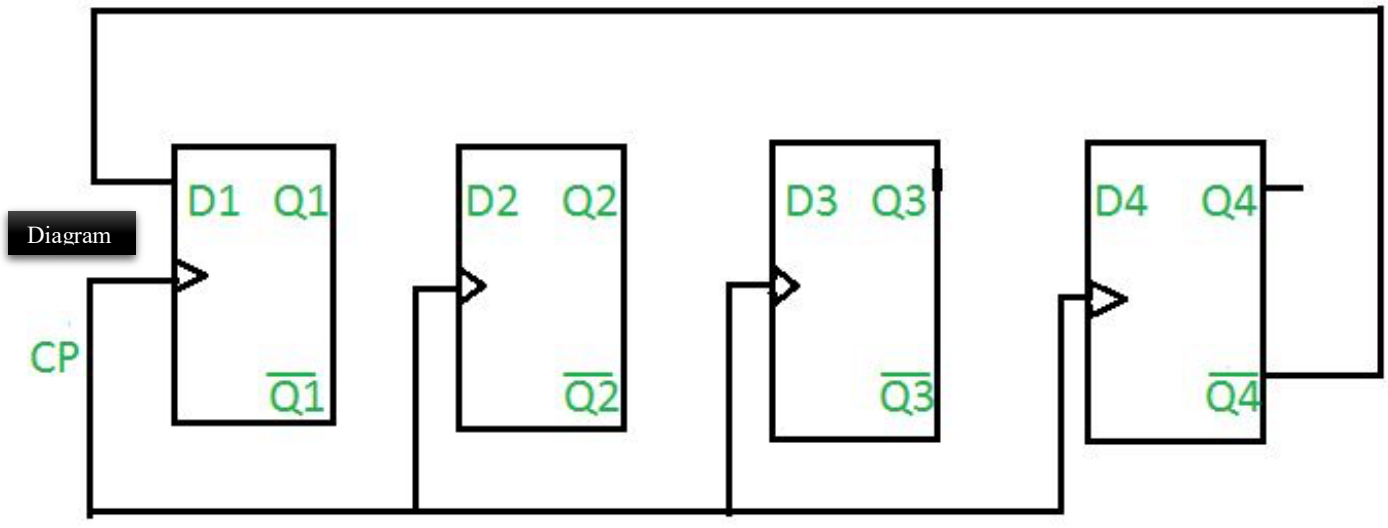
Johnson Counter

Truth Table

Number	Q_D	Q_C	Q_B	Q_A
0	1	0	0	0
1	1	1	0	0
2	1	1	1	0
3	1	1	1	1
4	0	1	1	1
5	0	0	1	1
6	0	0	0	1
7	0	0	0	0

Johnson counter also known as creeping counter, is an example of synchronous counter. In Johnson counter, the complemented output of last flip flop is connected to input of first flip flop and to implement n-bit Johnson counter we require n flip-flop. It is one of the most important type of shift register counter. It is formed by the feedback of the output to its own input. Johnson counter is a ring with an inversion. Another name of Johnson counter are: creeping counter, twisted ring counter, walking counter, mobile counter and switch tail counter.

Diagram



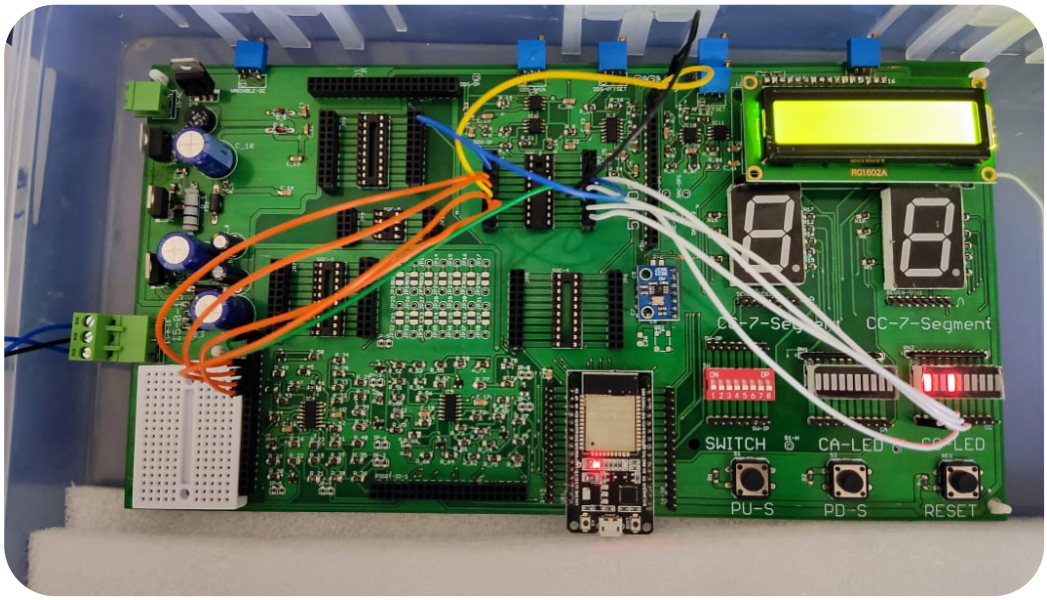
Procedure

1) Open the Kit
2) Place the required IC in slots
3) Connect VCC and Ground to respected pin in IC using wire
4) Make connection to respective pins in IC.
5) If there is a clock ,Connect the clock with clock pin in IC.
6) Connect the output wires to CC-LED.
7) Turn on the kit
8) Check if the output received is equal to desire output.

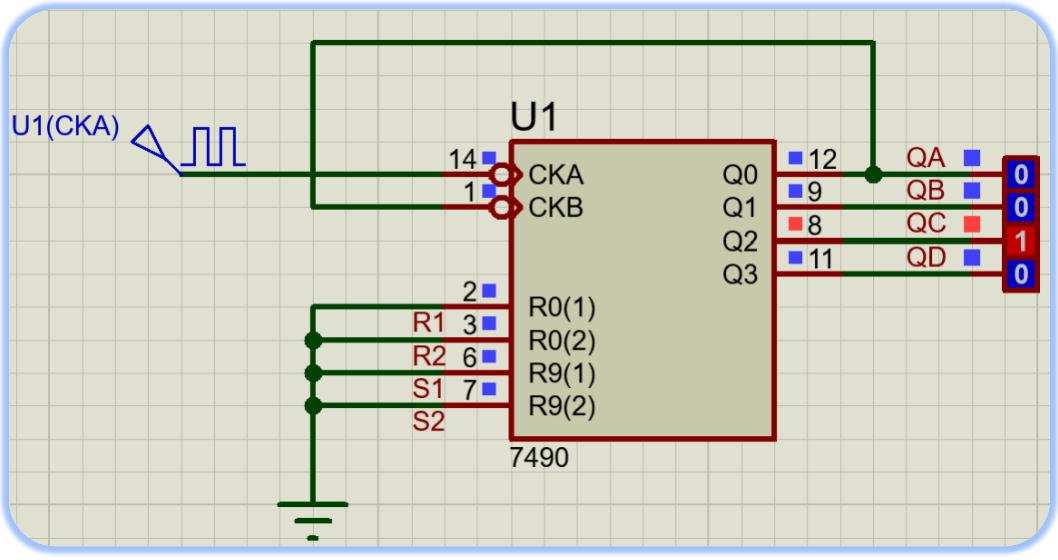
Results and Observations

❖ MOD 10 Counter Using 7490

○ Picture of Circuit

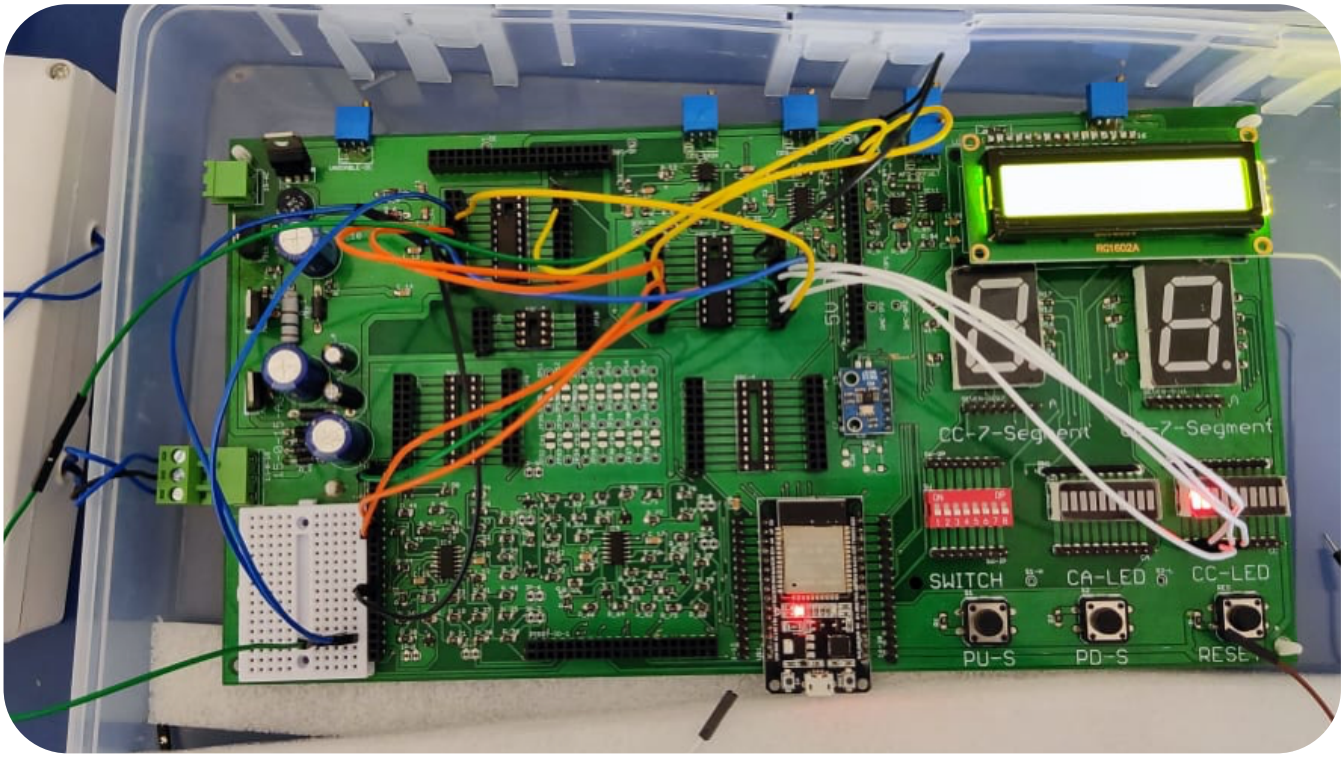


○ In Proteus



❖ MOD 5 Counter Using 7490

○ Picture of Circuit



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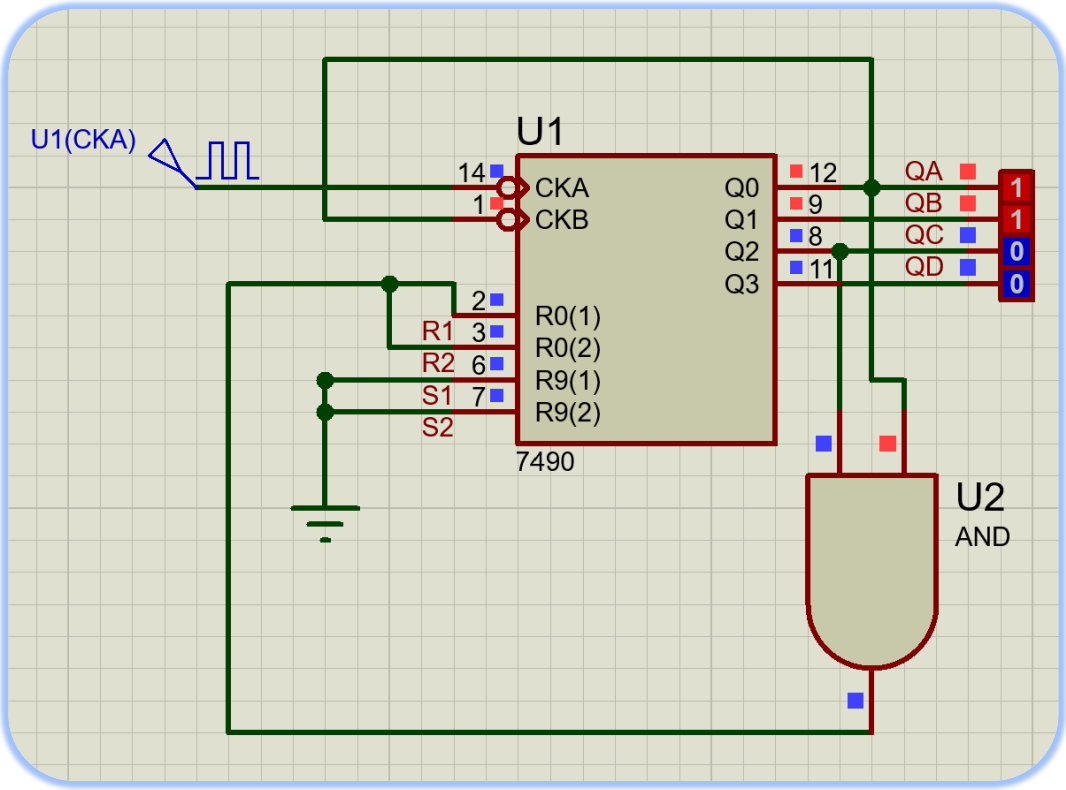
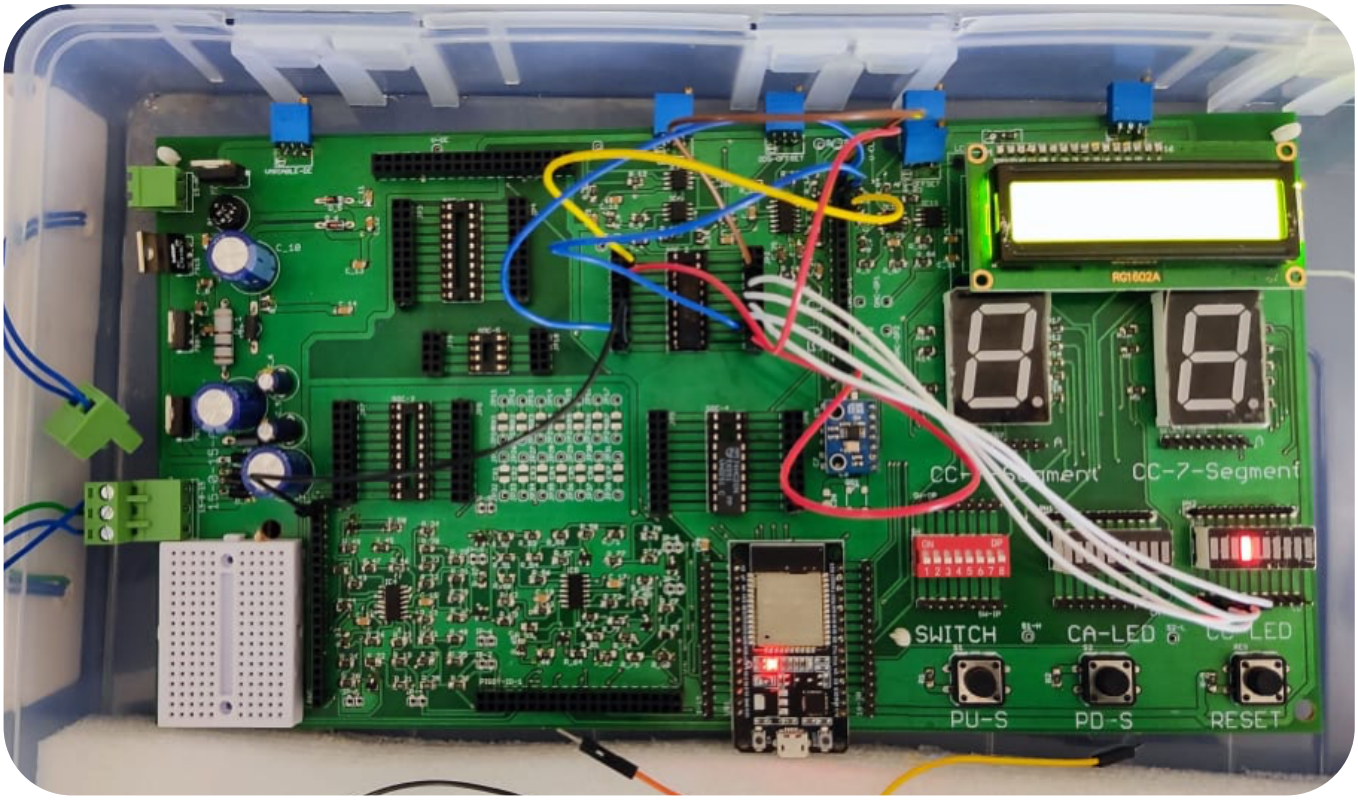


❖ 0-F Counter Using 74163

○ Picture of Circuit



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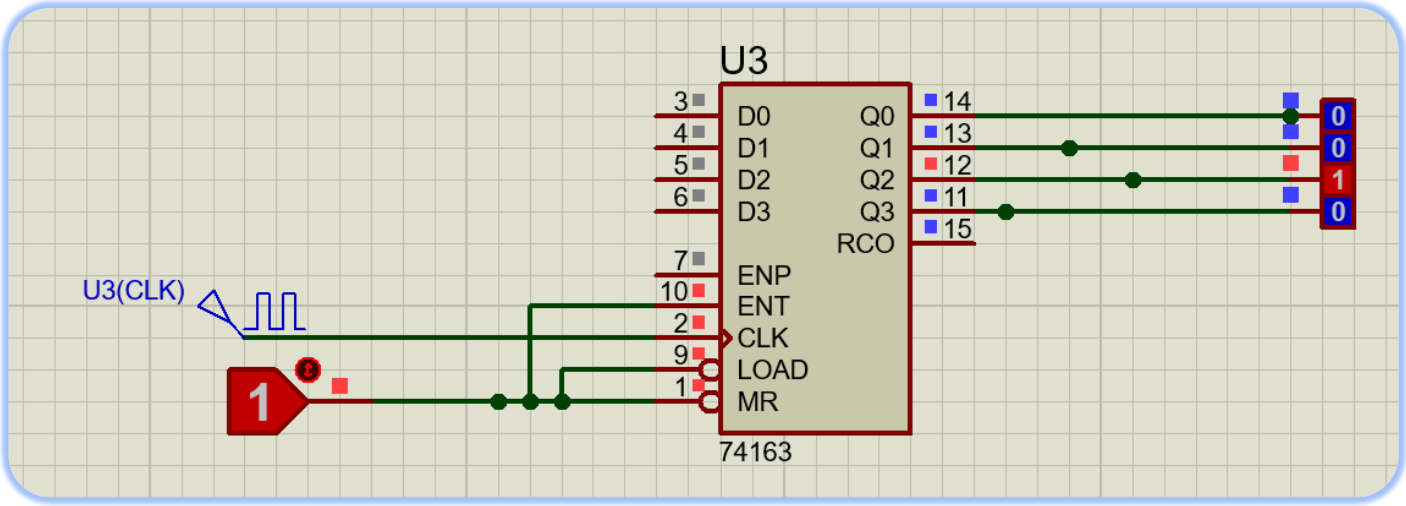
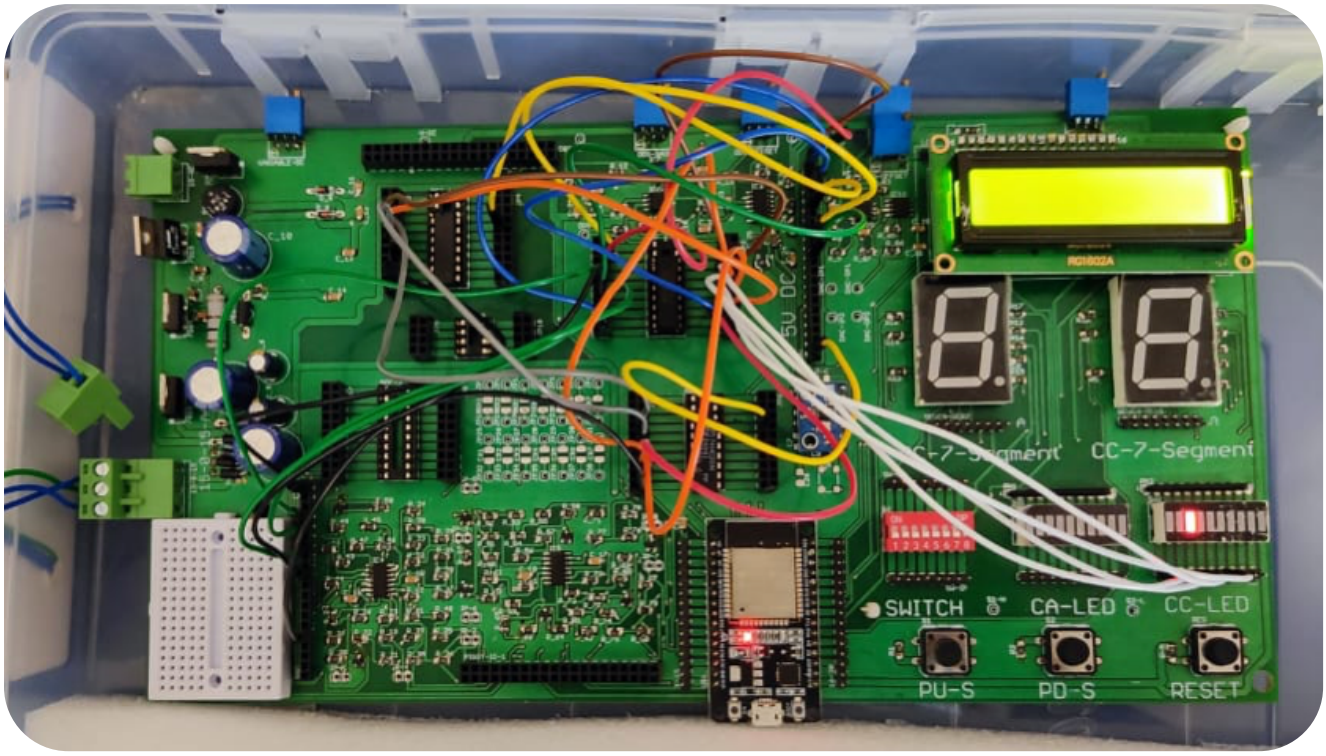
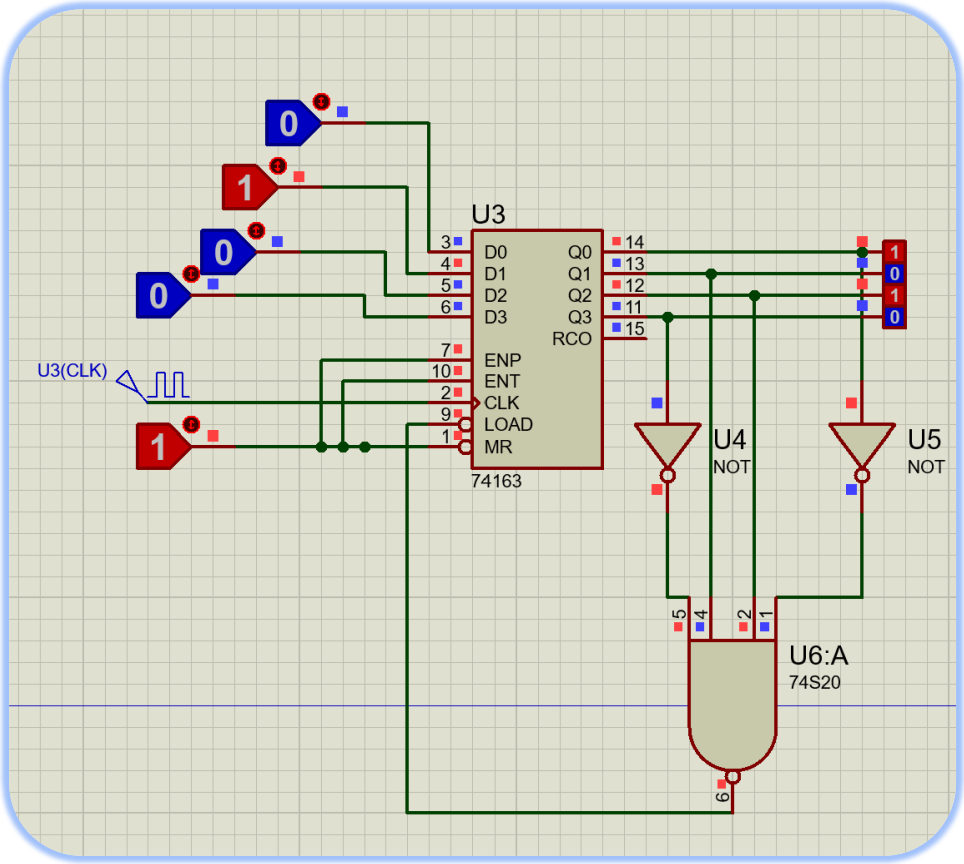


❖ 2-6 Counter Using 74163

○ Picture of Circuit

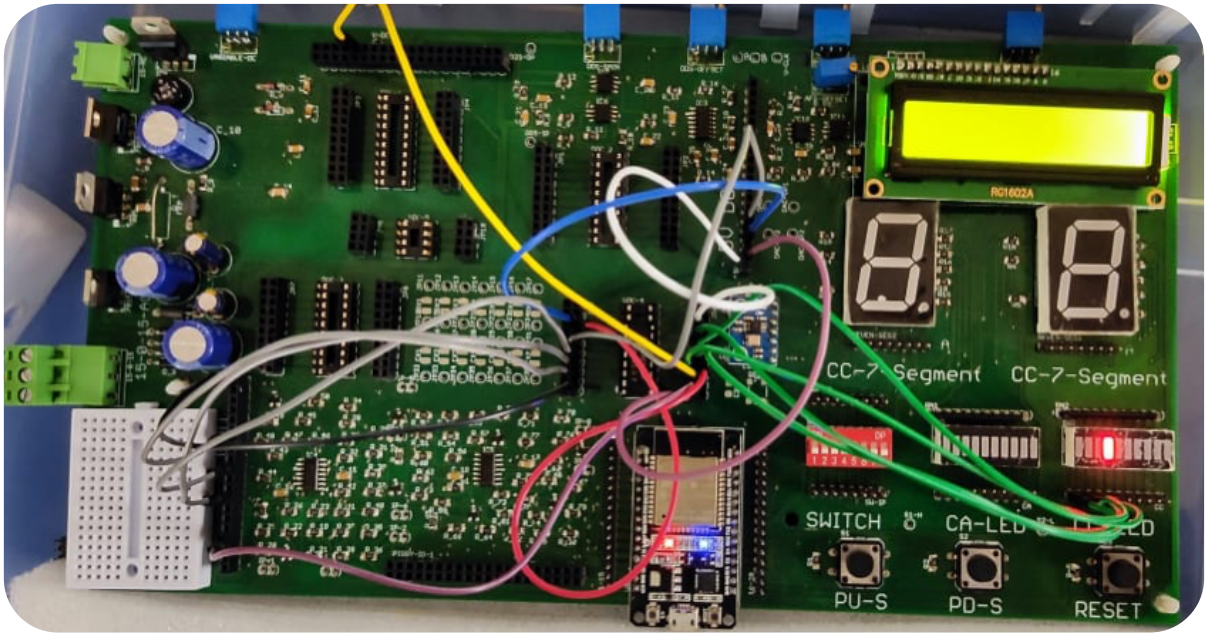


○ In Proteus

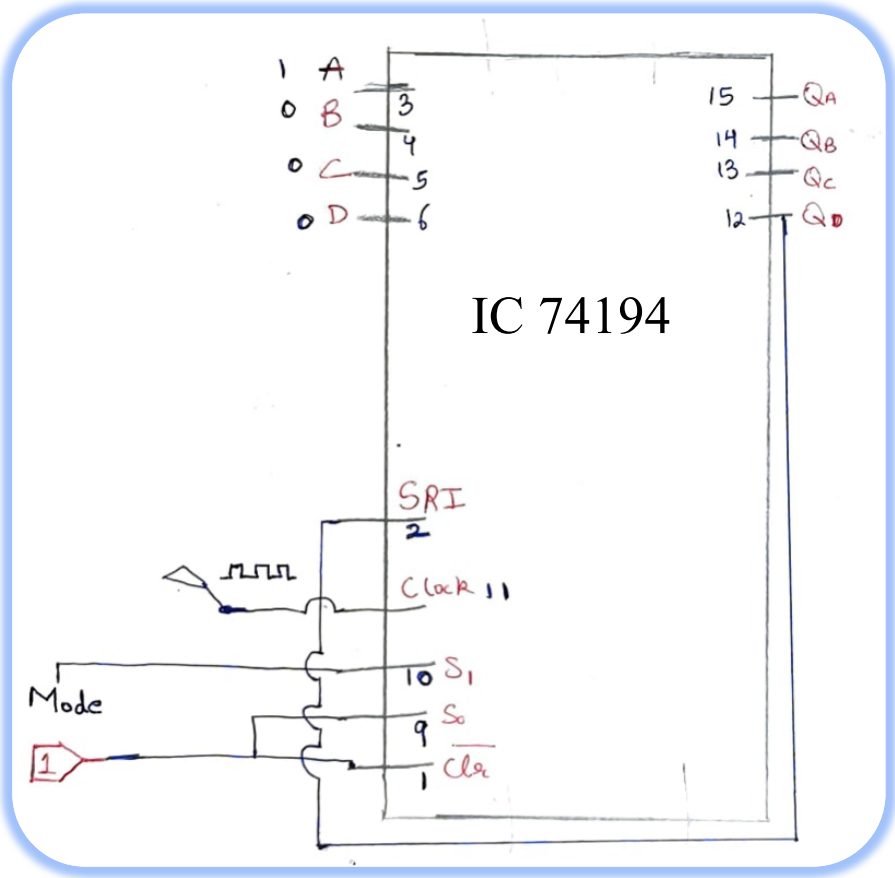


❖ Ring Counter Using 74194

○ Picture of Circuit

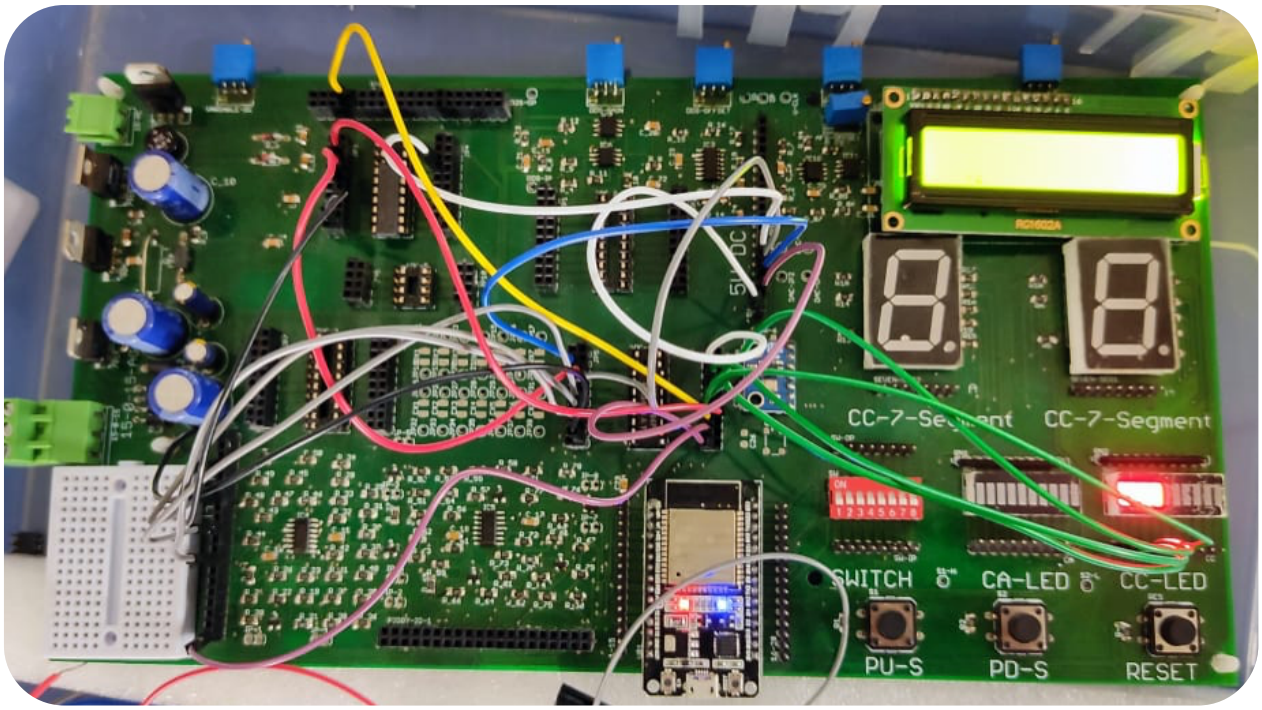


○ Pin Diagram

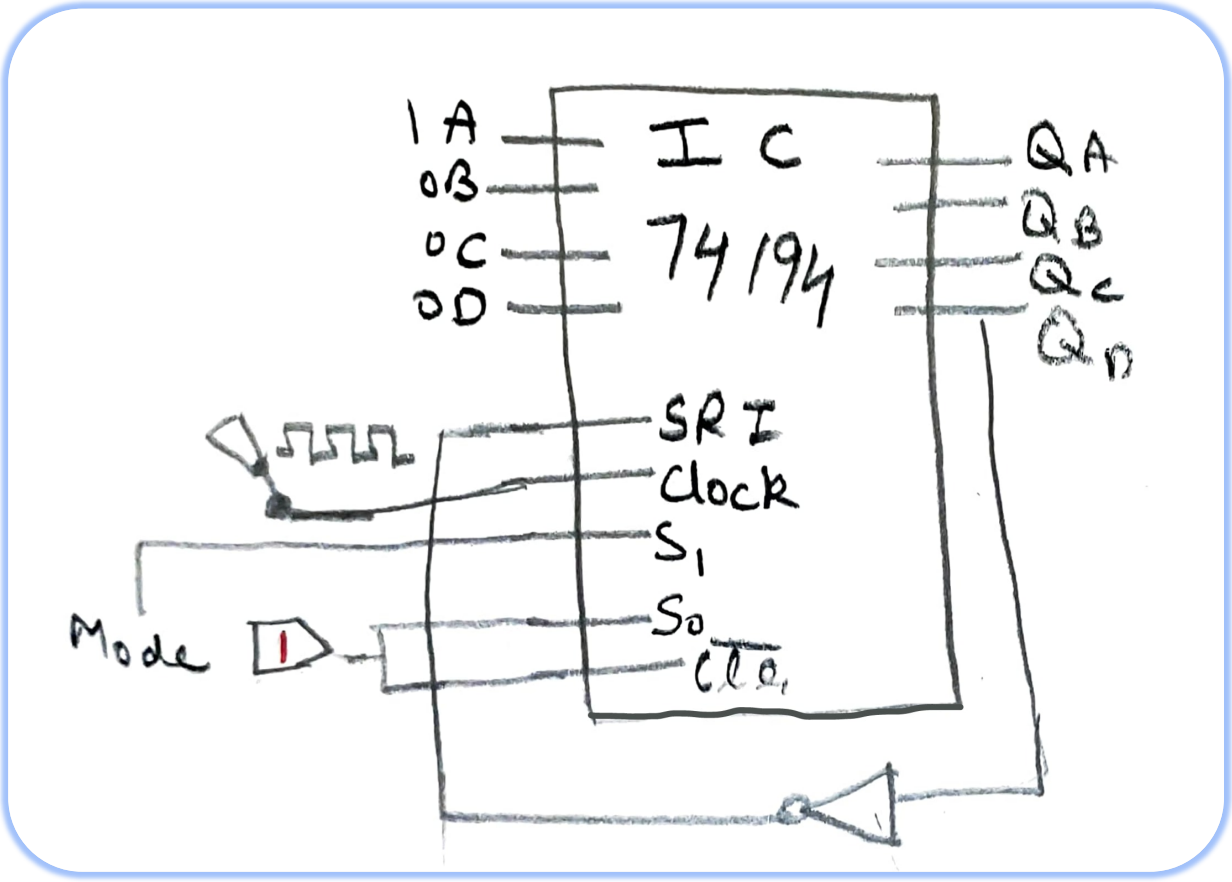


❖ Johnson Counter Using 74194

○ Picture of Circuit



○ Pin Diagram



Conclusion

We learned to implement the different type of MOD Counter using KIT. We also learned to implement Synchronous & asynchronous counter. We also learned to implement different type counter like Ring Counter & Johnson's Counter using KIT.