4 - Bit Binary Counter

Experiment No. 09

Aim: To setup a '4-Bit Binary Counter' (IC 7493) and demonstration of its 'Binary Counting Sequence'.

This experiment demonstrates the 'Count Sequence' of 'Binary Numbers' and their 'Binary Coded Decimal' representation. The Binary Counter will be used in subsequent experiments to provide the input 'Binary Signals' for testing various combinational circuits. It also acquaints you how to use oscilloscope in 'Digital Electronics Laboratory'.

General Information

IC 7493 (shown below) consists of four cells called 'Flip-Flop'. These cells can be connected to count in 'Binary' or in 'BCD'.

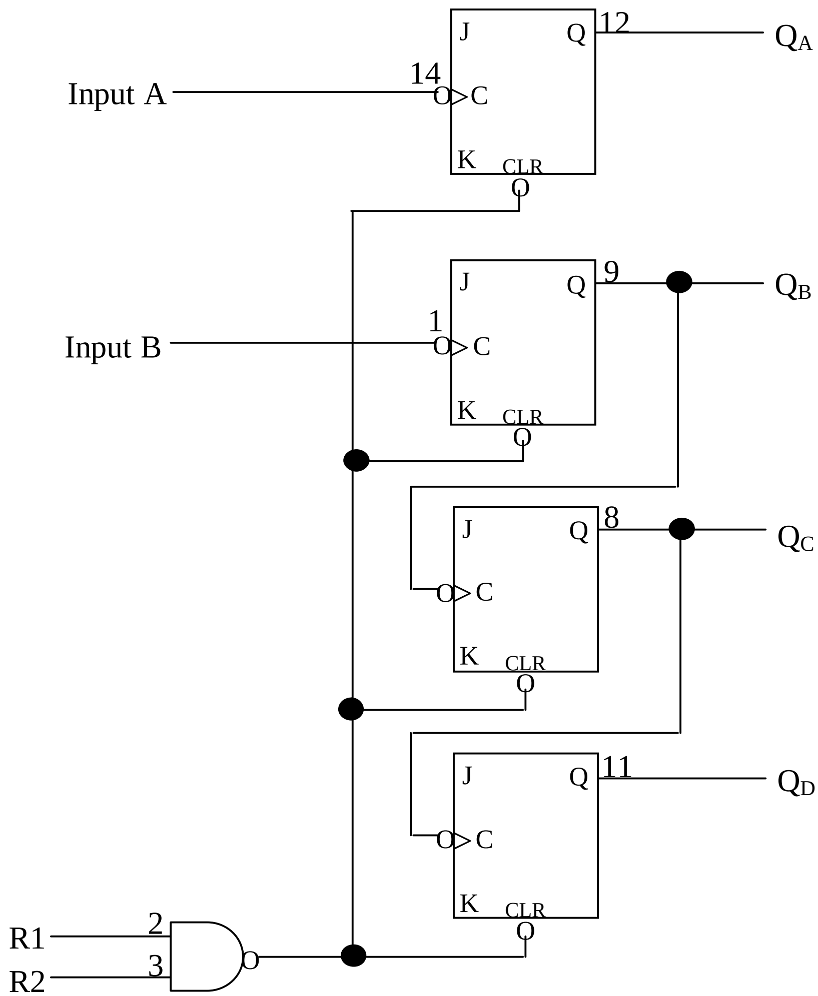
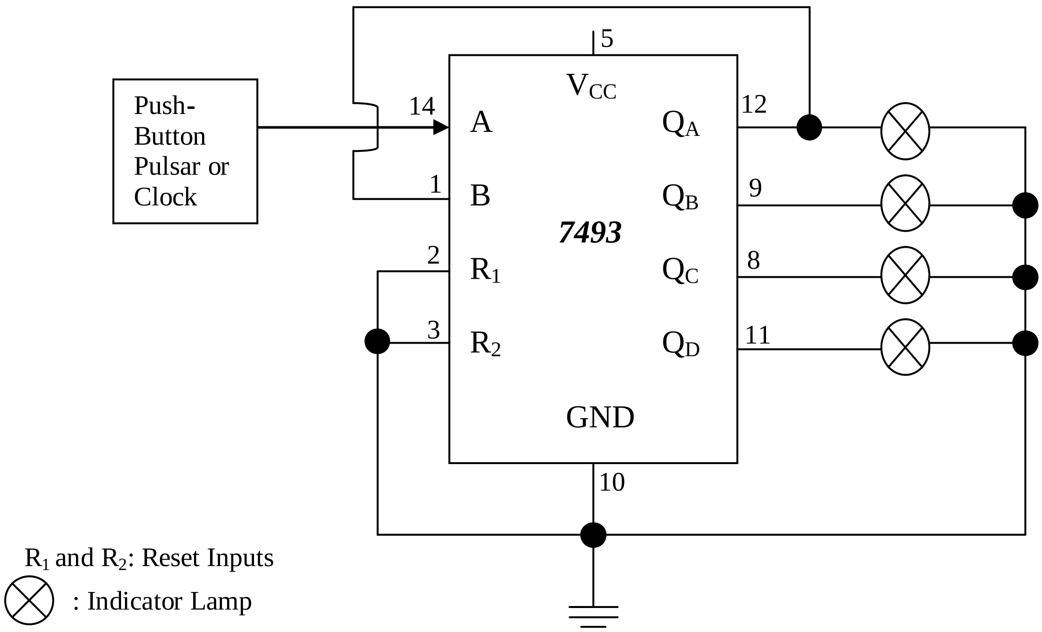


Fig. IC Type 7493 Ripple Counter 'Internal Circuit Diagram'

Activity-1(a). Binary Count

Step.1. Connect the IC 7493 to operate as a '4-Bit Binary Counter' by wiring the external terminals, with Q_A as LSB and Q_D as MSB.



Step.2. Turn ON power and observe the four 'Indicator Lamps' (LEDs) by applying a 'Single Pulse' with the help of the 'Mono Pulse Generator' at pin 14.

Observations

No. of Pulses	*Count Sequence*			
	Q_D	Q_C	Q_B	Q_A
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				

Write: The count first goes up to ………… and then back to ……….**.**

Activity-1(b)*. *Binary Count Verification

Connect the 'Clock Generator' that produces a 'Train' of 'Clock Pulse' at a 'Low Frequency' of about 'One Pulse Per Second' i.e., 1Hz by disconnecting the 'Pulsed Input' to the 'Counter'. *This will provide an 'Automatic Binary Count'.* Observe and verify, your previous results you tabulated in previous page.

Observations:

Write Comment: ……………………………………………………………………………………..

Activity 2*. *Oscilloscope Display

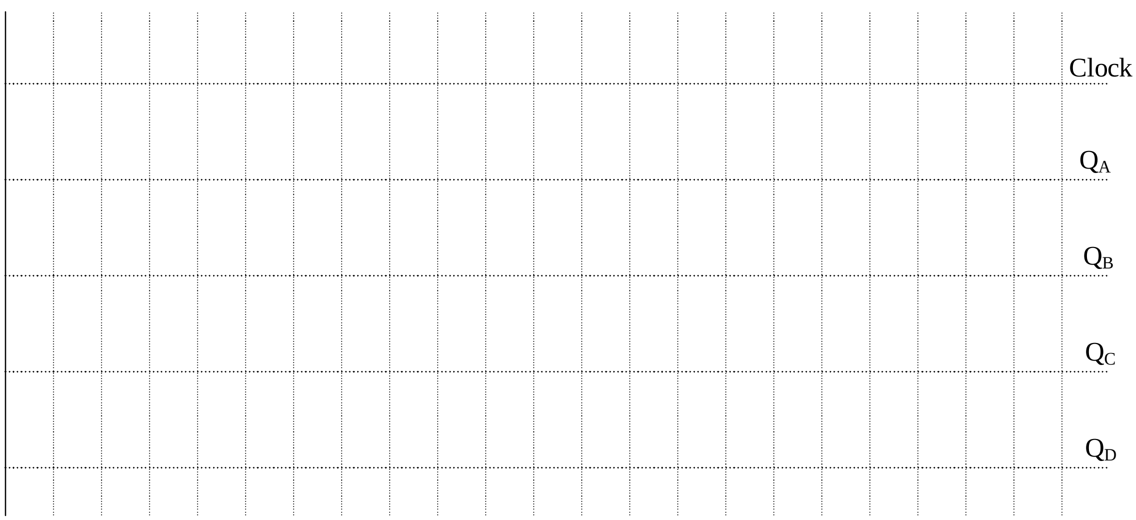
Step.1. Increase the 'Clock Frequency' to 10kHz. Observe this 'Clock' output in an 'Oscilloscope'. Sketch its waveform. *(Make sure that you included at least 16 clock pulses).*

*Step.2.*In a 'Dual-Trace Oscilloscope' connect the output Q_A to one channel and the output of the clock to second channel. Sketch, the output Q_A with reference to clock applied.

Step.3. Repeat by observing and recording the waveforms of Q_A together with Q_B, followed by the waveforms of Q_B with Q_C and then Q_C with Q_D.

Observations

Note: Your final result should be a diagram showing the 'Time Relationship' of the clock and the four outputs in one composite diagram having at least 16 clock pulses.



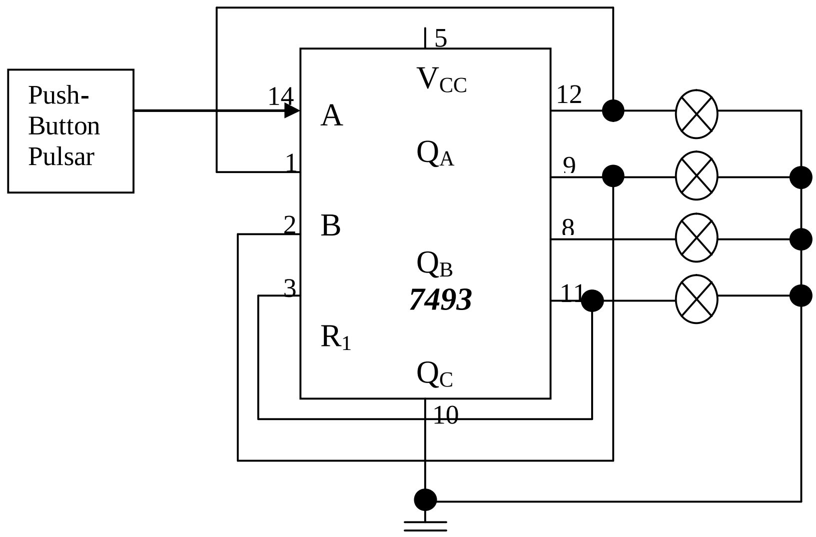
By observing the above waveforms, write:

1. The output of Q_A is complemented every time the clock pulse goes through a … .. transition, i.e., from ……………. to …………….. .
2. What is the relationship between clock and output Q_A, f_{clock}= ………& f_{QA}………
3. What is the relationship between outputs Q_B and Q_A, f_{QB} = ………& f_{QA}……….
4. What is the relationship between outputs Q_C and Q_B, f_{QC} = ………& f_{QB}………

5. What is the relationship between outputs Q_D and $Q_{C,}$ f_{QD} = …..…..& f_{QC}………
Discuss above points: ………………………...……………………………… ……… …… …..………… ………………………………………………………………… …… … ……………… …………………………………………………………………………… …

Activity-3(a). *BCD Counts*

The counter starts from 0 (0000) and every input pulse increments it by 1 until it reaches the count of 9 (1001). The next pulses changes the output again to 0 (0000). The BCD representation uses the binary numbers from 0000 to 1001 for representing the 'Decimal Digits' form 0 to 9. IC type 7493 can be operated as a 'BCD Counter' by making the external connections, as shown below.



Procedure
Step.1. Construct the circuit as shown above.
Step.2. Connect the input to a pulsar and the four outputs to indicator lamps (LEDs).

Observations

Input Pulses	*Outputs*			
	Q_A	Q_B	Q_C	Q_D
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				

Activity-3(b). *BCD Counts(output display through seven-segment)*

Procedure

Step.1. Disconnect the input from the pulsar and connect a 1Hz clock generator, and verify the truth table you made above.

*Step.2.*Disconnect the 1Hz input clock and four outputs from the four indicator lamps/LEDs. Step.3. Reconnect input to a pulsar and connect outputs to a '7-Segment LED Display' by connecting Q_D as MSB and Q_A as LSB.

Step.4. See and record the outputs displayed on the '7-Segment LED Display'.

Observations

Pulses	0	1	2	3	4	5	6	7	8	9	10
Output											

Activity-3(c). ***BCD Counts(Output observe through CRO)***

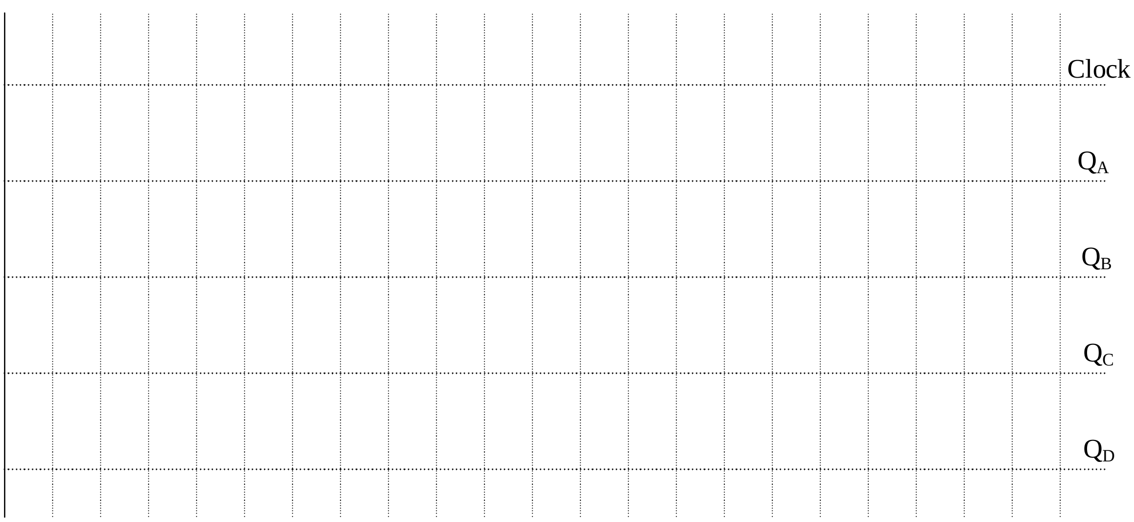
Step.1. Disconnect the pulsar from the input and connect the input to a 1Hz clock generator. Observe and verify the table you made in step4, above.

Step.2. Disconnect the input from the 1Hz clock and connect it to a clock generator with a frequency of 10kHz.

Step.3. Observe and record the clock waveform and the four outputs on the oscilloscope to obtain an accurate timing diagram showing the time relationship between the clock and the four outputs.

Observations

Note: Make sure that you have included at least ten clock pulses in the oscilloscope display and in the composite timing diagram.

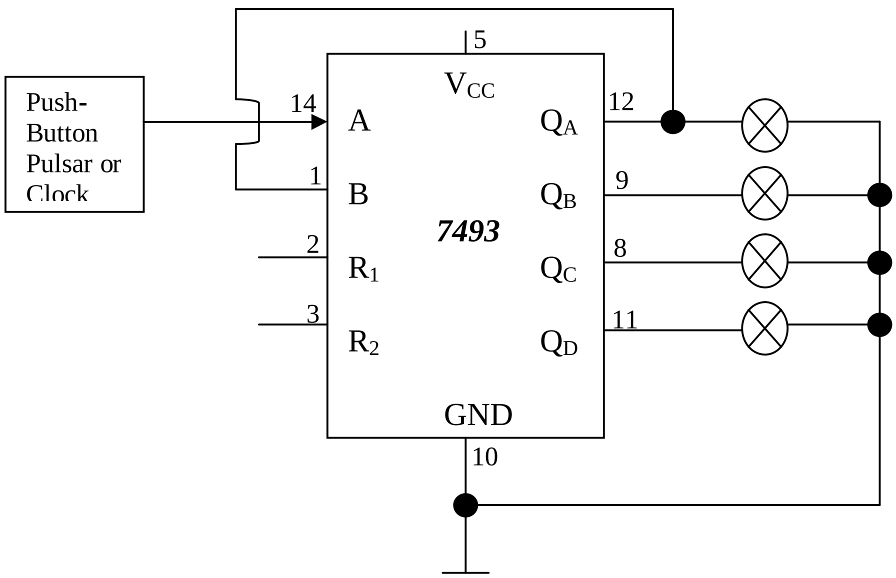


Activity-4. Implementation of MOD-5 Counter.

IC type 7493 can be connected to count from 0 to 15 to verify a variety of final counts. This is done by connecting (as design requires) one or two outputs to the reset inputs, R_1 and R_2; e.g., if R_1 is connected to Q_A instead of Q_B (previous case), the resulting count will starts from 0000 and goes up to 1000 and then back to 0000 (verify it).

Exercise: Utilizing your knowledge of how R_1 and R_2 affect the final count, connect the IC 7493 to count from 0000 to the following final counts. Connect each circuit and verify its count sequence by applying pulses from the pulsar and observe the output count in the indicator lamps. *Note:* If the initial count starts with a value greater than the final count, keep applying input pulses until the output clears to 0.

From 0000 to 0101



Activity 4. MOD-7 Counter.