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Experiment No-8

Aim → To fully understand the functionality of S-R flip-flop, J-K flip-flop, D flip-flop

Theory →

Sequential Circuits: The logic circuits whose outputs at any instant of time depend not only on the present ~~present~~ input but also on the past outputs are called sequential circuits. The simplest kind of sequential circuit which is capable of storing one bit of information is called latch. The operation of basic latch can be modified; by providing an additional control input that determines when the state of the circuit is to be changed. The latch with additional control input is called the flip-flop. The additional control input is either the clock or enable input.

Different types of flip-flop: There are four basic types, namely, S-R, J-K, D and T. Flip fl

S-R Flip Flop →

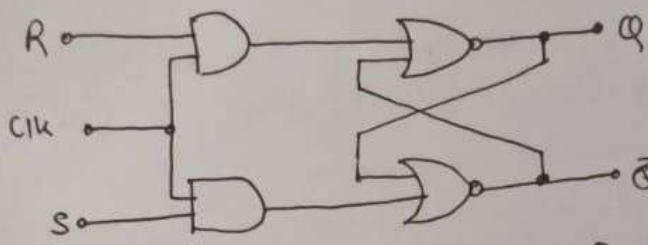


Fig. Clocked NOR-based S-R Flip Flop

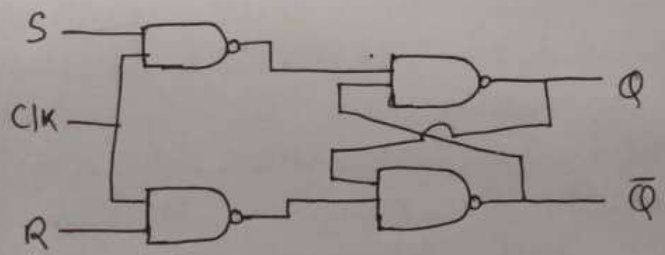
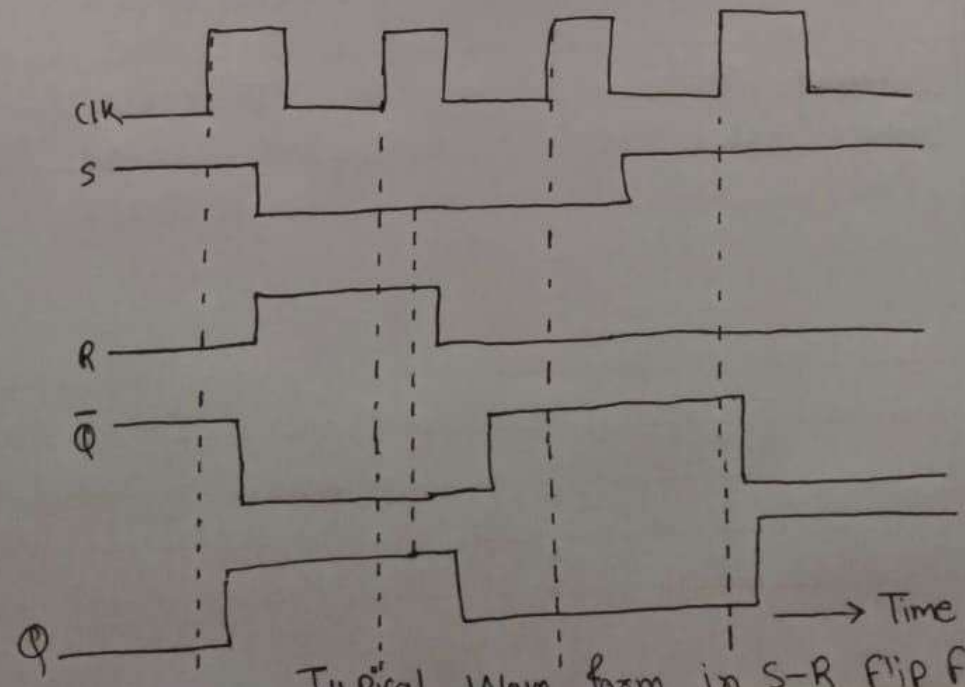


Fig 2. NAND-based S-R Flip Flop



Typical Wave form in S-R Flip Flop

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1. S-R Flip Flop :

→ S-R flip flop characteristic table

S	R	Q(t+1)
0	0	Q(t)
0	1	0
1	0	1
1	1	Not Used

NOTE → CLK, S and R are input signals.
$\overline{Q}$ and Q : Output signals.

2. J-K Flip-Flop

J	K	Q(t+1)
0	0	Q(t)
0	1	0
1	0	1
1	1	$\overline{Q}$(t)

J-K Flip-flop characteristic Table.

3. D Flip Flop.

D	Q(t+1)
0	1
1	1

D - flip flop characteristic table.

J-K Flip Flop →

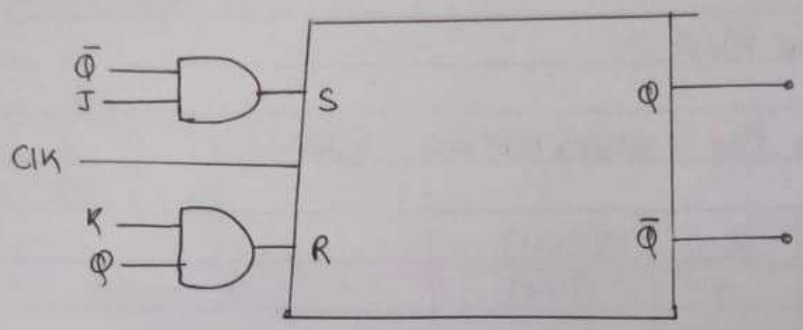


fig. J-K Flip-Flop using S-R Flip flop.

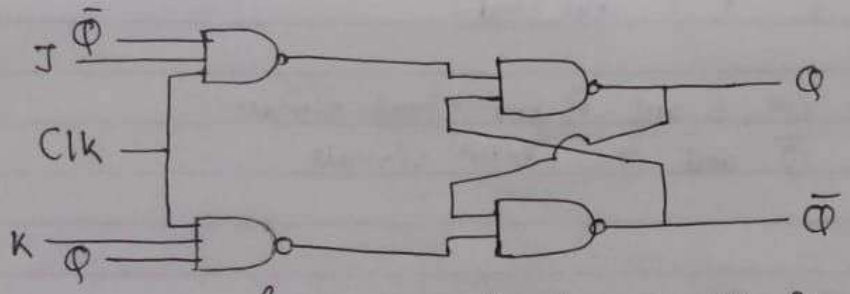
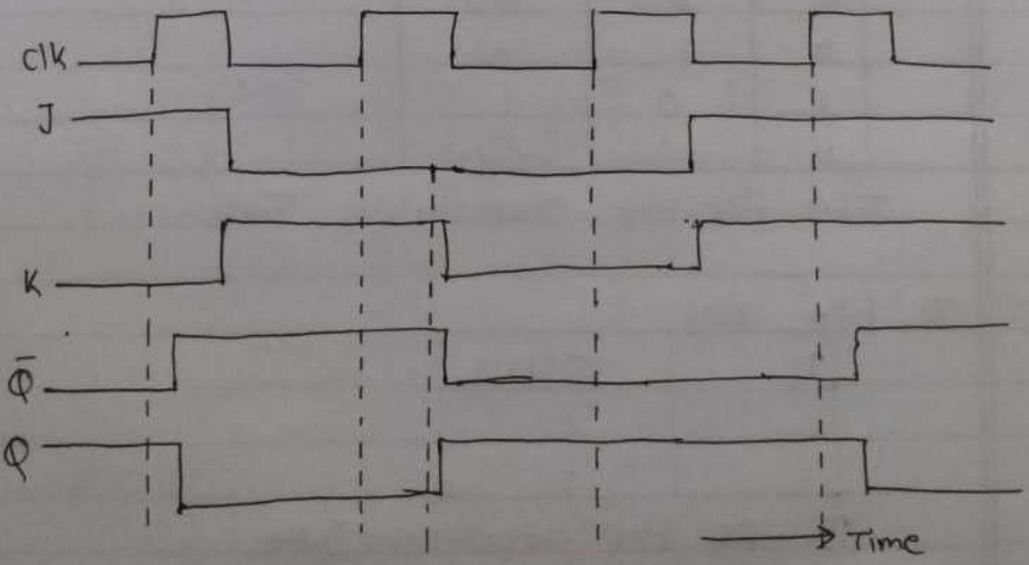


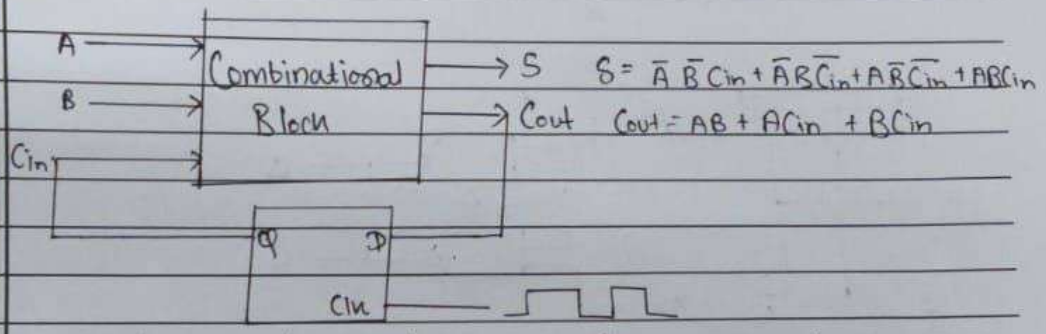
fig 2. NAND based J-K Flip flop.



Typical Wave form in J-K Flip-Flop

→ Synthesis using Flip-Flop

As a simple exercise students can verify the operation of a serial (sequential) adder (1 bit full adder) Carry output of a one bit full adder can be fed back to the input of a D flip flop. The output of this flip flop can be fed back to the carry input of that adder.



Verification of the functionality of a combinational circuit using sequential element (Flip-flop).

A	B	Cin	S	Cout
0	0	0	0	0
0	1	0	1	0
1	0	0	1	0
1	1	0	0	1
0	0	1	1	0
0	1	1	0	1
1	0	1	0	1
1	1	1	1	1

Truth table of 1 bit Full adder.

Conclusion → We have fully understood the concept and functionality of S-R, J-K and D flip flop.

→ D Flip-Flop

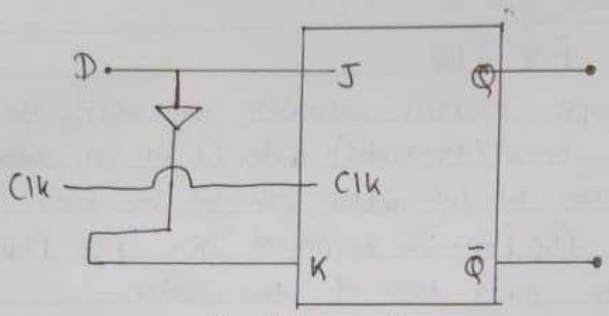


fig1. D Flip-Flop

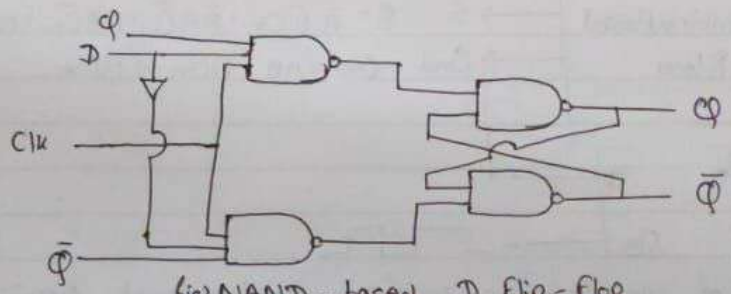
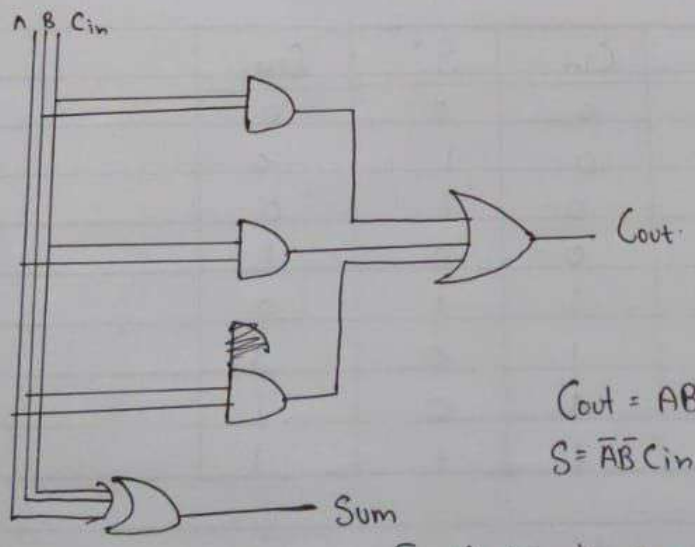


fig2 NAND - based D Flip-Flop



$C_{out} = AB + ACin + B Cin$

$S = \bar{A}\bar{B}Cin + \bar{A}B\bar{Cin} + A\bar{B}\bar{Cin} + ABCin$

Fig→Gate diagram of combinational circuit (1 bit full adder)