JK-FF

❖ WHAT IS A JK FLIP-FLOP ?

- A flip-flop is a circuit that has two stable states and can be used to store state information.

- The flip-flop can be made to change state by signals applied to one or more control inputs and will have one or two outputs.

❖ JK STRUCTURE

JK Has 5 inputs named:

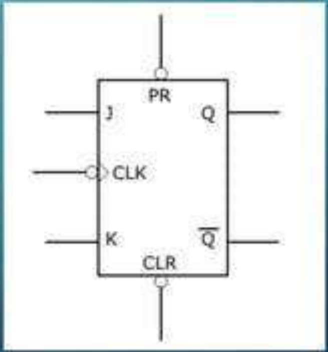
J(set),K(reset), PR, CLR, and CLK

JK Has 2 outputs: Q and Q'

PR = Preset
CLR = Clear
CLK = Clock

Set: when it stores a binary 1

Cleared (reset): when it stores a binary 0

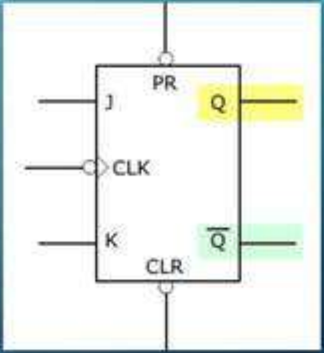


❖ OUTPUTS

The Q output is the primary output. This means that the binary bit stored **in the flip-flop**, 1 or 0, is the **same as Q**.

The Q' output is the **opposite** binary bit value that is stored in Q.

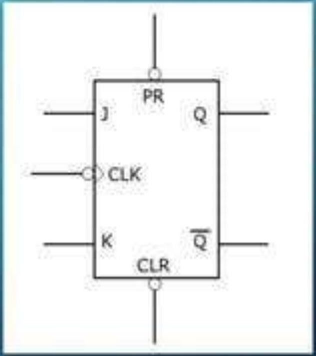
The PR and CLR inputs always **override** the J,K inputs.



❖ INPUTS: PR AND CLR

A low at the PR input sets Q = 1

A low at the CLR input sets Q = 0



❖ INPUTS : J AND K

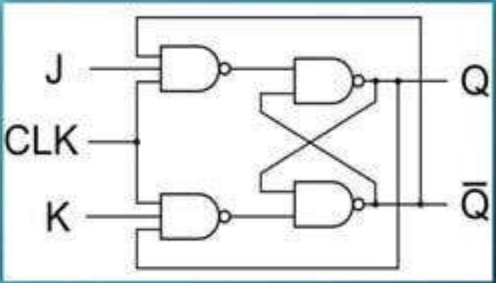
- The logic states applied to the J and K inputs cause the flip-flop to operate 4 different ways.

- The way the logic state is applied to J and K is called **Mode of Operation.**

- The mode of operation refers to the condition of the flip-flop as it prepares for the positive clock pulse.

❖ FOUR MODES OF OPERATION

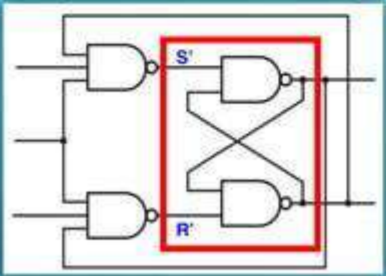
The 4 modes of operation are:
hold, set, reset, toggle



J	K	Q	Q'	Mode
0	0	Q	Q'	Hold
1	0	1	0	Sets
0	1	0	1	Resets
1	1	Q'	Q	Toggle

JK contains an internal
Active Low SR latch.

❖ ACTIVE LOW SR LATCH



Point to remember:

A '0' at the set or the reset will either set or reset the value of Q.

S' – "set"	R' – "reset"	Q	Q'
0	0	Invalid	Invalid
0	1	1	0
1	0	0	1
1	1	Q	Q'

❖ TRUTH TABLE FOR NAND

2 Inputs:

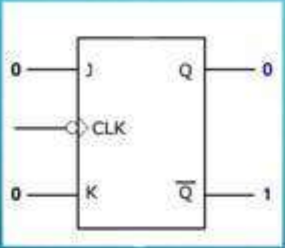
A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

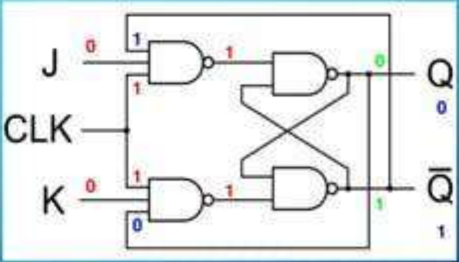
3 Inputs:

A	B	C	X
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

❖ MODE OF OPERATION: HOLD

Hold: no change in Q.

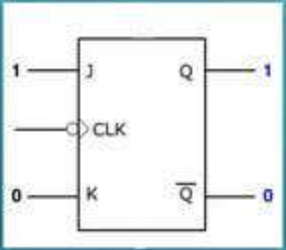


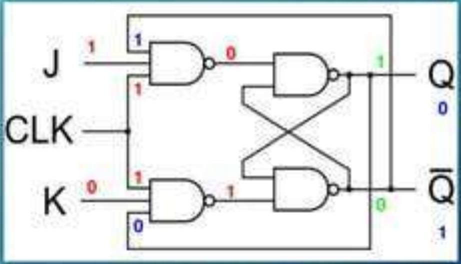


J	K	Q	Q'	Orig. Q	Orig. Q'
0	0	0	1	0	1

❖ MODE OF OPERATION: SET

Set: Q = 1.

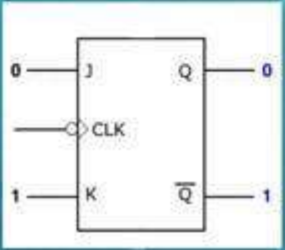


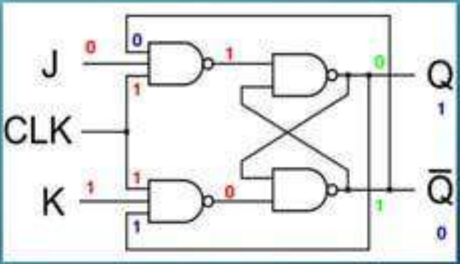


J	K	Q	Q'	Orig. Q	Orig. Q'
1	0	1	0	0	1

❖ MODE OF OPERATION: RESET

Reset: Q = 0.

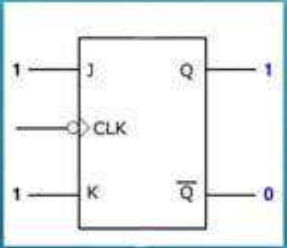


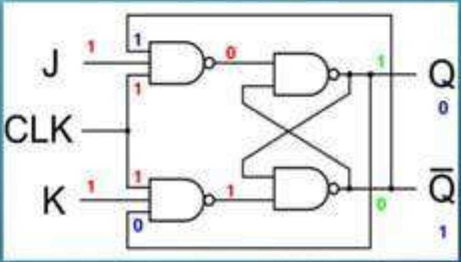


J	K	Q	Q'	Orig. Q	Orig. Q'
0	1	0	1	1	0

❖ MODE OF OPERATION: TOGGLE

Toggle: Q = Q'.

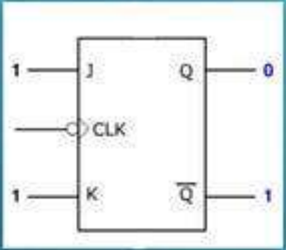


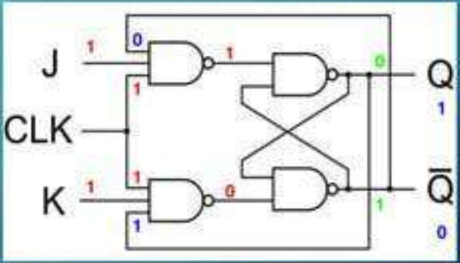


J	K	Q	Q'	Orig. Q	Orig. Q'
1	1	1	0	0	1

❖ MODE OF OPERATION: TOGGLE AGAIN

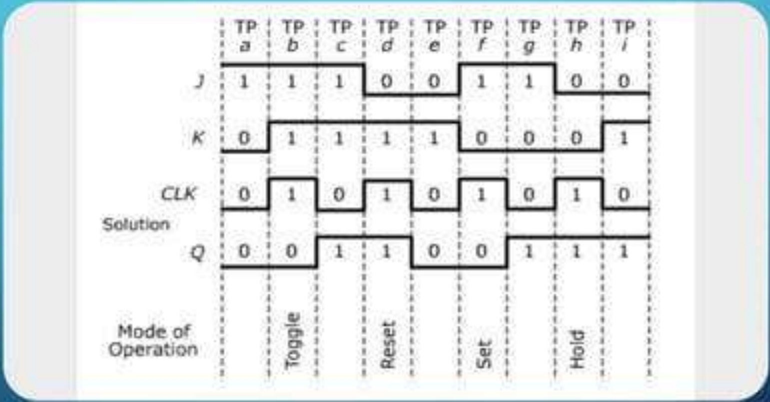
Toggle: Q = Q'.





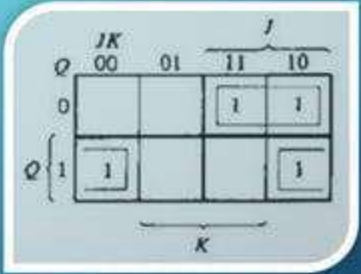
J	K	Q	Q'	Orig. Q	Orig. Q'
1	1	0	1	1	0

❖ MODE OVERVIEW: DURING A TIME PERIOD



❖ CHARACTERISTIC EQUATION

Q	J	K	Q(t + 1)
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	0



Characteristic Equation:

$Q(t+1) = J.Q' + K'.Q$

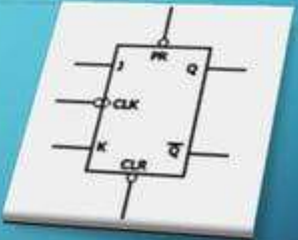
" SUMMARY "

Characteristic Equation:

$Q(t+1) = J.Q' + K'.Q$

Q is the primary output.

J	K	Q	Q'	Mode
0	0	Q	Q'	Hold
1	0	1	0	Sets
0	1	0	1	Resets
1	1	Q'	Q	Toggle



SR Latch:

A '0' at the set or the reset will either set or reset the value of Q.

❖ FLIP FLOPS APPLICATIONS : DATA STORAGE

- A flip flop store one bit at a time in digital circuit. In order to store more than one bit flip flop can be connected in series and parallel called registers. A register is simply a data storage device for a number of bits in which each flip flop store one bit of information (0 or 1). Thus a 4 bit register consists of 4 individual flip flops, each able to store one bit of information at a time.
- Figure 1 shows a 4 bit register. Any number from $(0000)_2$ to $(1111)_2$ may be stored in it simply by setting or resetting the appropriate flip flops. Let us suppose that flip flop one is SET(1) , Flip flop 2 is RESET(0), flip flop 3 is RESET(0) and flip flop 4 is SET(1), the binary number stored in this register is $(1001)_2$.

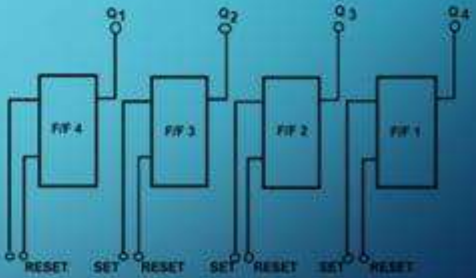


Figure 1: Bit Binary Register

❖ FLIP FLOPS APPLICATIONS : **COUNTER**

- Another major application of flip flops is a digital counter. It is used to count pulses or events and it can be made by connecting a series of flip flops. Counter can count up to 2^n. Where **n** is the number of flip flops. Figure 3 shows a simplest binary ripple counter made by flip flops. It consists of connections of flip flop without any logic gate. Each flip flop is triggered by the output of its proceeding flip flop.
- They are used in digital equipment's, clocks, frequency counters and computers etc.

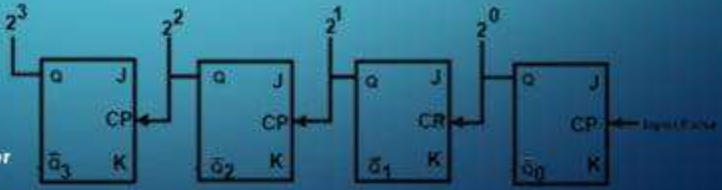


Figure 3: Four stage Counter

❖ FLIP FLOPS APPLICATIONS : FREQUENCY DIVIDER

- Flip flops can divide the frequency of periodic waveform. When a pulse wave is used to toggle an flip flop, the output frequency becomes one half the input frequency, as shown in Figure 4
- The output of each flip flop is half the frequency of an input. If the input frequency is 160 KHz then output of each flip flop would be so after first flip flop, 40 after second flip flop and 20 after third flip flop.
- Suppose that the input frequency 160 KHz :

  Frequency of first flip flop 80 KHz

  Frequency of 2^{nd} flips flop 40 KHz

  Frequency of 3^{rd} flips flop 20 KHz

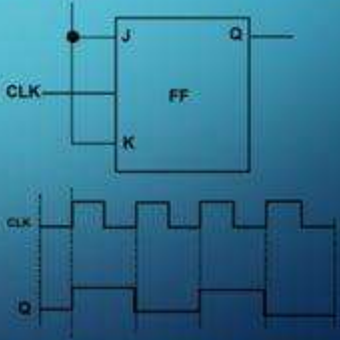


Figure 4: JK Flip Flop Used as A Frequency Division