

FLIP FLOPS

SEQUENTIAL LOGIC CIRCUITS

Made By: Rohnak Agarwal, CSE, 2ND Year, 3RD SEM, 2019.

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Sources: 1. Rashmi mam's notes
2. Google

Notations: Q_{n+1} : Present State

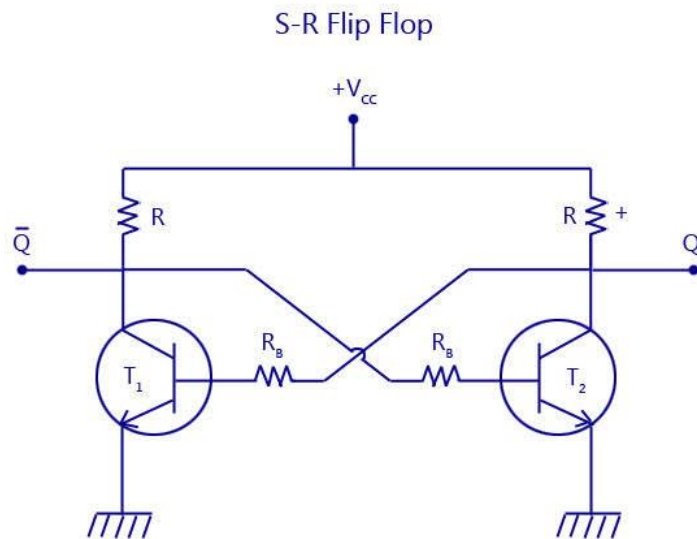
Q_n : Past/ Previous state

Note: Characteristic table is same as state table, but without the CLK column.

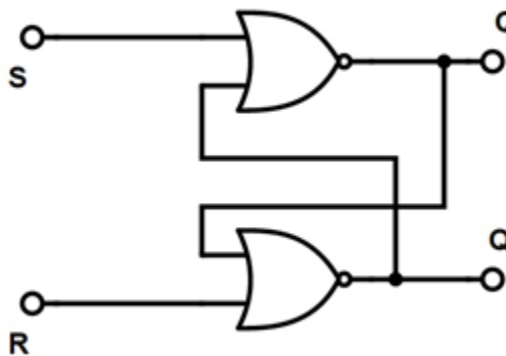
1. SR Latch

(No Clock Pulse)

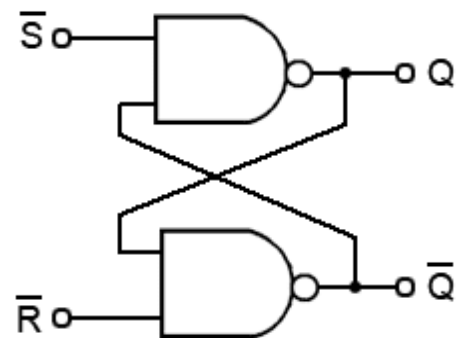
Transistor Diagram:



Gate (circuit) diagram: (Active High)



Gate (circuit) diagram: (Active Low)



Truth Table (Active High):

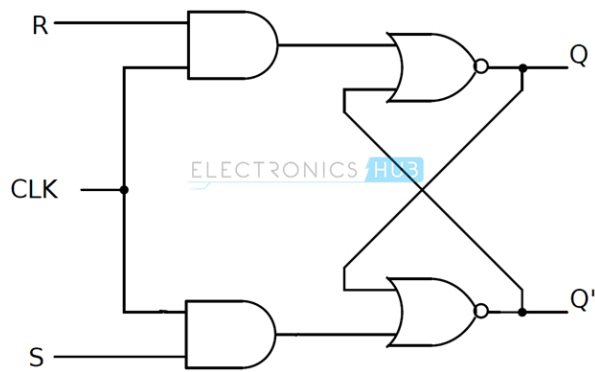
S	R	Q_{n+1}	$\overline{Q_{n+1}}$	Remarks
0	0	Q_n	$\overline{Q_n}$	No change
0	1	0	1	Reset
1	0	1	0	Set
1	1	?	?	Forbidden

Truth Table (Active Low):

\overline{S}	\overline{R}	Q_{n+1}	$\overline{Q_{n+1}}$	Remarks
0	0	?	?	Forbidden
0	1	1	0	Set
1	0	0	1	Reset
1	1	Q_n	$\overline{Q_n}$	No change

2. SR Flip Flop (Set Reset Flip Flop)(With Clock pulse)

Gate (circuit) diagram: (Active High)



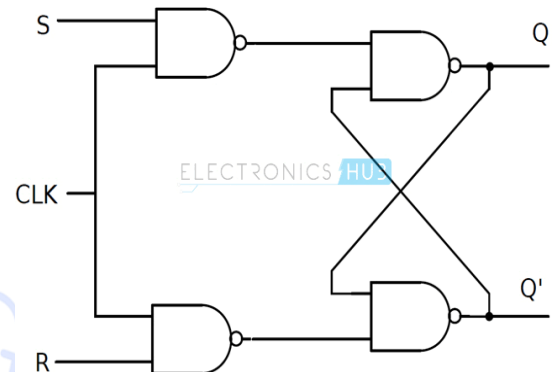
Truth Table (Active High):

CLK	S	R	Q_{n+1}	\overline{Q}_{n+1}	Remarks
↓	d	d	Q_n	\overline{Q}_n	No change
↑	0	0	Q_n	\overline{Q}_n	No change
↑	0	1	0	1	Reset
↑	1	0	1	0	Set
↑	1	1	?	?	Forbidden

State Table:

Inputs			Output
Q_n	S	R	Q_{n+1}
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	?
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	?

Gate (circuit) diagram: (Active High)



Truth Table (Active High):

CLK	S	R	Q_{n+1}	\overline{Q}_{n+1}	Remarks
↓	d	d	Q_n	\overline{Q}_n	No change
↑	0	0	Q_n	\overline{Q}_n	No change
↑	0	1	0	1	Reset
↑	1	0	1	0	Set
↑	1	1	?	?	Forbidden

K-map for State Table:

S R		00	01	11	10
$Q(n)$	0				1
	1	1			1

State Equation:

$$Q_{n+1} = Q_n \overline{R} + S \overline{R}$$

Excitation table:

Inputs		Output s	
Q_n	Q_{n+1}	S	R
0	0	0	d
0	1	1	0
1	0	0	1
1	1	d	0

Equation for S:

$Q(n)$	$Q(n+1)$	
	0	1
0	0	1
1	0	X

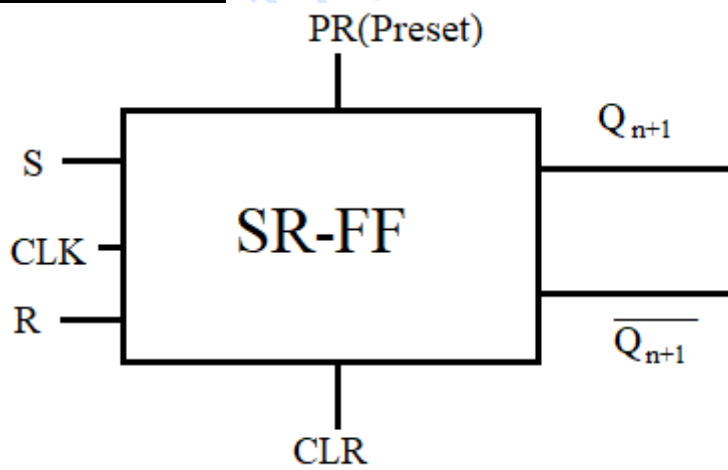
$$S = Q_{n+1}$$

Equation for R:

$Q(n)$	$Q(n+1)$	
	0	1
0	X	0
1	1	0

$$R = \overline{Q_{n+1}}$$

Block diagram:



3. D Flip Flop

(Delay Flip Flop)

Truth table:

CLK	D	Q_{n+1}
↓	d	Q_n
↑	0	0
↑	1	1

State table:

Inputs		Output
Q_n	D	Q_{n+1}
0	0	0
0	1	1
1	0	0
1	1	1

State equation:

$Q(n)$	D	
	0	1
0		1
1		1

$$Q_{n+1} = D$$

Excitation Table:

Inputs		Output
Q_n	Q_{n+1}	D
0	0	0
0	1	1
1	0	0
1	1	1

Equation for D:

$Q(n)$	$Q(n+1)$	
	0	1
0		1
1		1

$$D = Q_{n+1}$$

Block diagram:



4. JK Flip Flop

(Jolly Koggler Flip Flop)

Truth table:

CLK	J	K	Q_{n+1}	$\overline{Q_{n+1}}$	Remarks
↓	d	d	Q_n	$\overline{Q_n}$	No change
↑	0	0	Q_n	$\overline{Q_n}$	No change
↑	0	1	0	1	Reset
↑	1	0	1	0	Set
↑	1	1	$\overline{Q_n}$	Q_n	Inversion

State table:

Inputs			Output
Q_n	J	K	Q_{n+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

State equation:

$Q(n)$	J K			
	00	01	11	10
0			1	1
1	1			1

$$Q_{n+1} = JQ_n + Q_n\overline{K}$$

Excitation table:

Inputs		Outputs	
Q_n	Q_{n+1}	J	K
0	0	0	d
0	1	1	d
1	0	d	1
1	1	d	0

Equation of J:

$Q(n)$	$Q(n+1)$	
	0	1
0	0	1
1	X	X

$$J = Q_{n+1}$$

Equation of K:

$Q(n)$	$Q(n+1)$	
	0	1
0	X	X
1	1	0

$$K = \overline{Q_{n+1}}$$

Block diagram:



5. T Flip Flop (Toggle Flip Flop)

Truth table:

CLK	T	Q_{n+1}
↓	d	Q_n
↑	0	Q_n
↑	1	$\overline{Q_n}$

State table:

Inputs		Output
Q_n	T	Q_{n+1}
0	0	0
0	1	1
1	0	1
1	1	0

State equation:

T	$Q(n)$	
	0	1
0	0	1
1	1	0

$$Q_{n+1} = T\overline{Q_n} + \overline{T}Q_n = T \oplus Q_n$$

Excitation Table:

Inputs		Output
Q_n	Q_{n+1}	T
0	0	0
0	1	1
1	0	1
1	1	0

Equation of T:

$Q(n)$	$Q(n+1)$	
	0	1
0	0	1
1	1	0

$$T = Q_n\overline{Q_{n+1}} + \overline{Q_n}Q_{n+1} = Q_n \oplus Q_{n+1}$$

Block diagram:

