

Flip-flop: Digital memory unit

You cannot build a memory unit by combining gates:
 How do you design a memory unit?

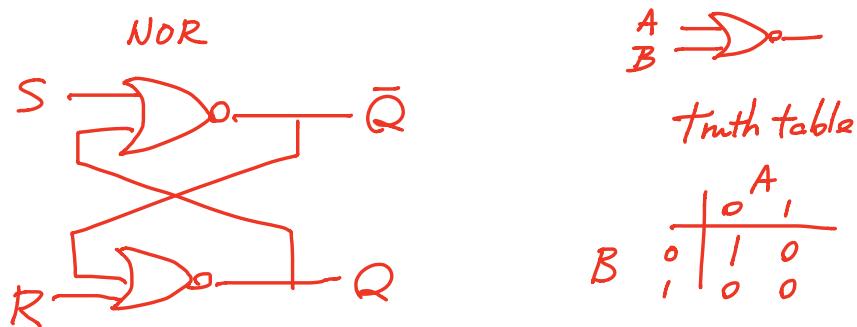
open or close the box
 ↓ gate
 change the info.
 control → 0/1

SR latch (set-reset latch)

$S=1, R=0 \rightarrow Q=1$
$S=0, R=1 \rightarrow Q=0$
$S=0, R=0 \rightarrow Q$ remains (latch mode)
$S=1, R=1$: unused mode

Set register
 Reset → 0/1 → Q

Implementation



So when $S=1, R=0 \Rightarrow Q=1, \bar{Q}=0$
 when $S=0, R=1 \Rightarrow Q=0, \bar{Q}=1$
 when $S=0, R=0 \Rightarrow$ unchange
 when $S=1, R=1 \Rightarrow Q=\bar{Q}=0$ unused mode.

Problem with simple SR flip-flop:

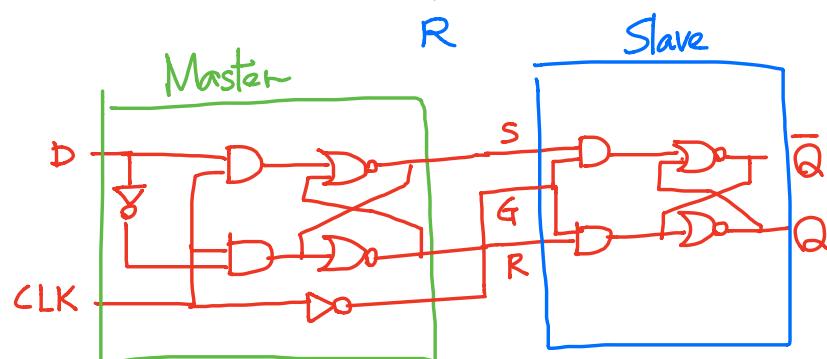
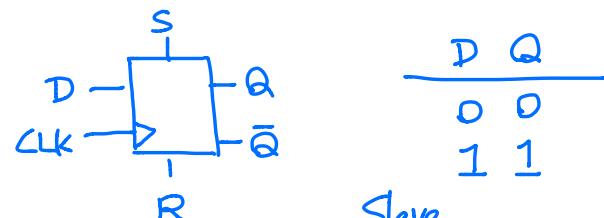


Only when $G = \text{on}$ the above resume the SR-FF

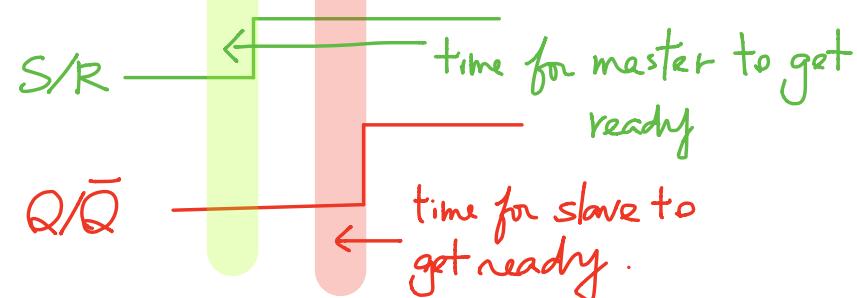
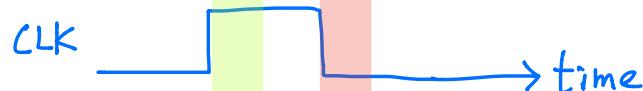
When $G = \text{off}$, SR-FF always in the hold-mode.

\Rightarrow System is updated only when clock is on.

D-type flip-flop



Master works on
raising edge of CLK Slave works on
the lowering edge of CLK.



Does D flip flop have true memory?

JK Flip-Flop:

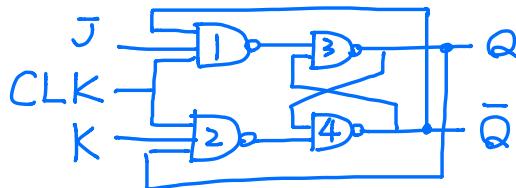
\bar{J} : set. K : reset. $J=K=1$: toggle: output $\rightarrow \overline{\text{output}}$

J	K	action
0	0	unchange
1	0	$Q=1$
0	1	$Q=0$
1	1	toggle $Q \rightarrow \bar{Q}$

Assume $J = \bar{K} = 1$, $Q = 0$

1. $\exists \text{D}_1$ switches from 1 to 0
 $\exists \text{D}_2$ unchanged.

2. $\exists \text{D}_3$ Q switches from 0 to 1



Assume $J = K = 1$.

1. If $Q = 0$, $\exists \text{D}_1$ & $\exists \text{D}_3$ will change $\Rightarrow Q = 1$

2. If $Q = 1$, $\exists \text{D}_2$ & $\exists \text{D}_4$ will change $\Rightarrow Q = 0$

Check for self-consistency yourself.