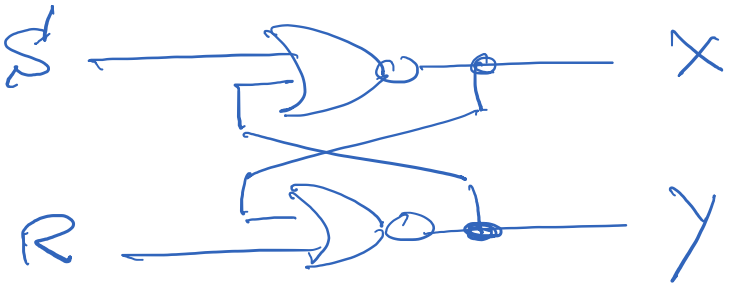
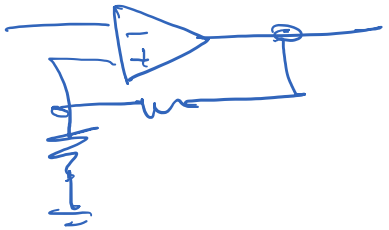
DIGITAL LATCH

A	B	$\overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0
----	----	----





TRUTH TABLE

INPUTS XY

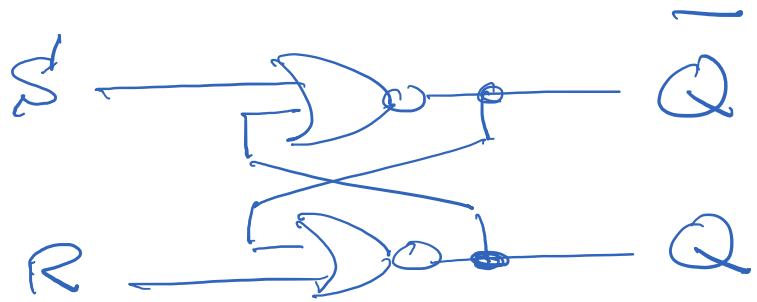
SR	00	01	10	11
→ 00	11	01	10	00
→ 01	10	00	10	00
10	01	01	00	00
→ 11	00	00	00	00

(NOT USED)

→ MEMORY

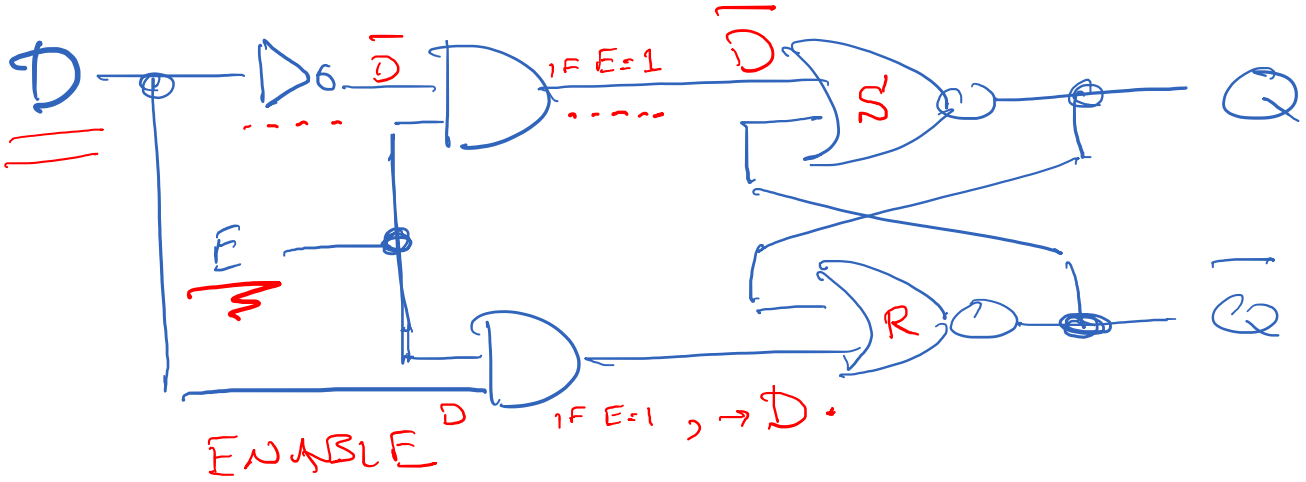
→ OUTPUT BITS XY

Reduced truth table



S	R	Q
0	0	(HOLD)
0	1	0
1	0	1
1	1	(NOT ALLOWED)

GATED D-LATCH

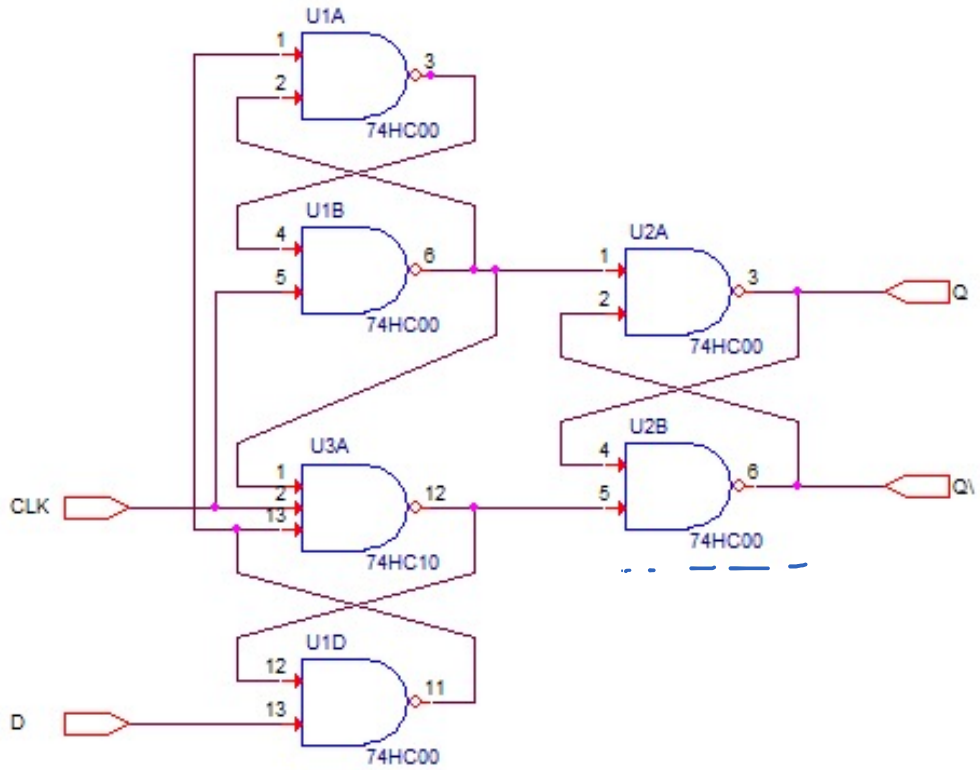


D	E	Q
X	0	(HOLD)
0	1	0
1	1	1

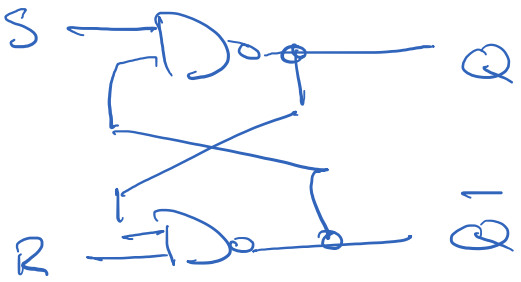
$$A \cdot 0 = 0$$

$$A \cdot 1 = A$$

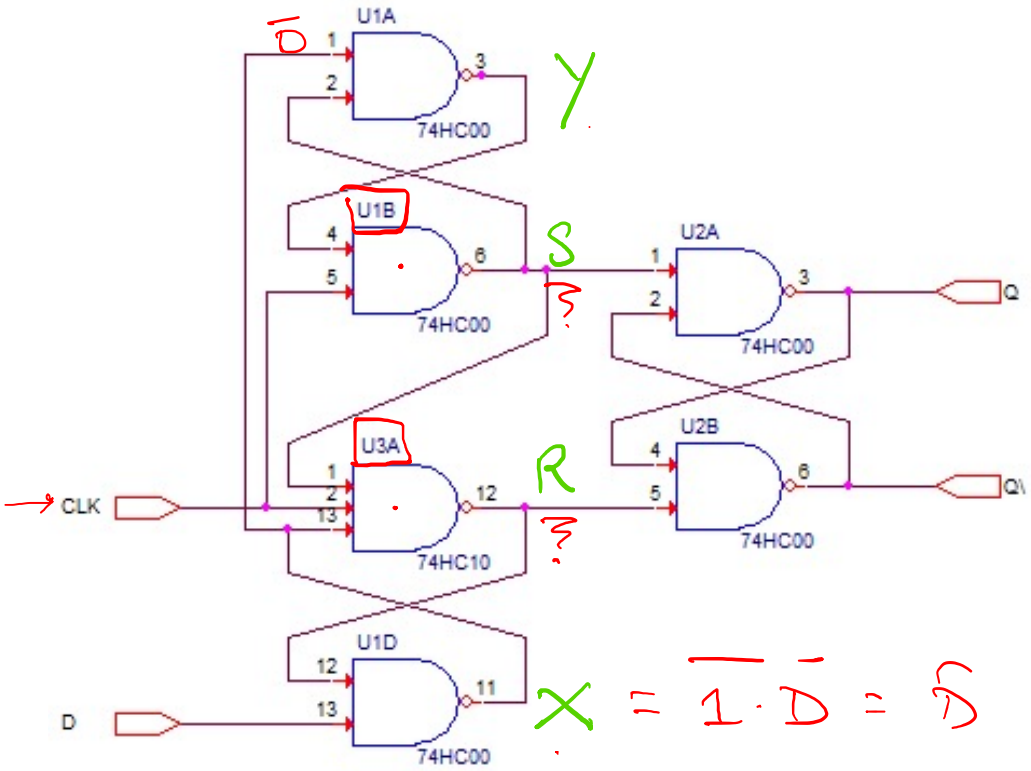
EDGE-TRIGGER D-FLOP FLOP



SR w/ NAND



S	R	Q
0	0	NOT ALLOWED
0	1	1
1	0	0
1	1	HOLD



A	B	$\overline{AB}$
0	0	1
0	1	1
1	0	1
1	1	0

S	R	Q	$\overline{Q}$
0	1	1	0
1	0	0	1
1	1	HOLD	

CLK = 0

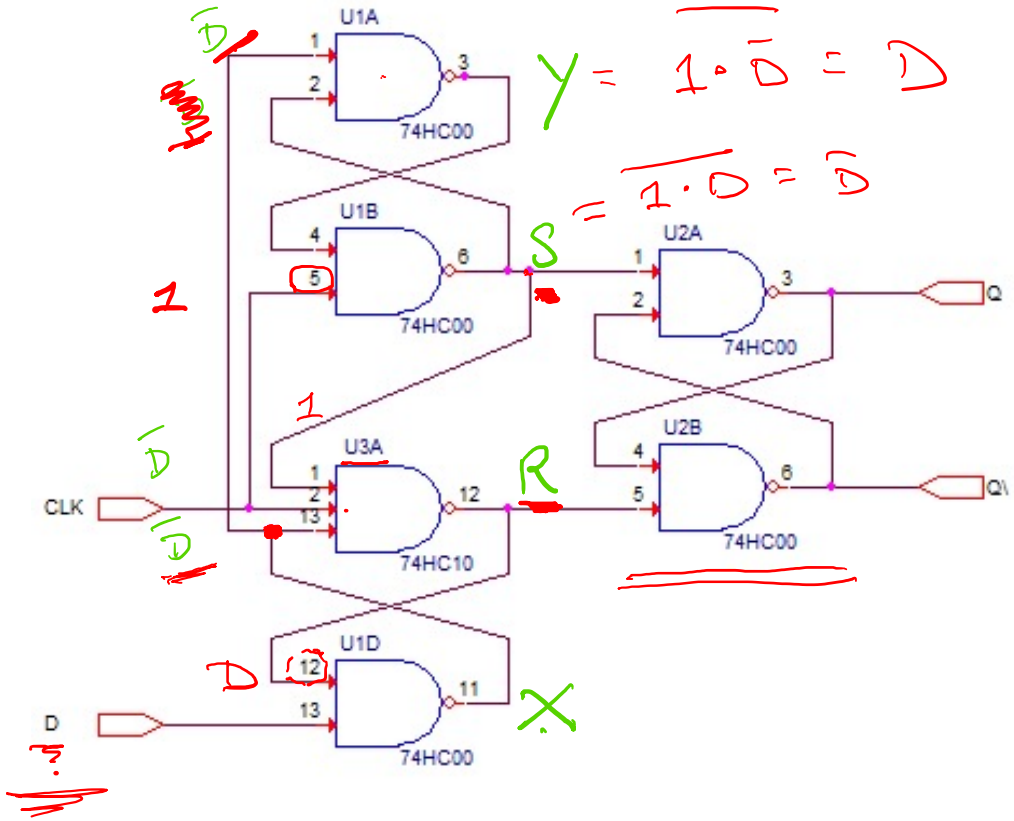
$\Rightarrow$ R = 1

S = 1

OUTPUTS HOLD

$X = \overline{D}$

$Y = D$



A	B	$\overline{AB}$
0	0	1
0	1	1
1	0	1
1	1	0

S	R	Q	$\overline{Q}$
0	1	1	0
1	0	0	1
1	1	HOLD	

→ CLK = 1

⇒

⇒ R = D

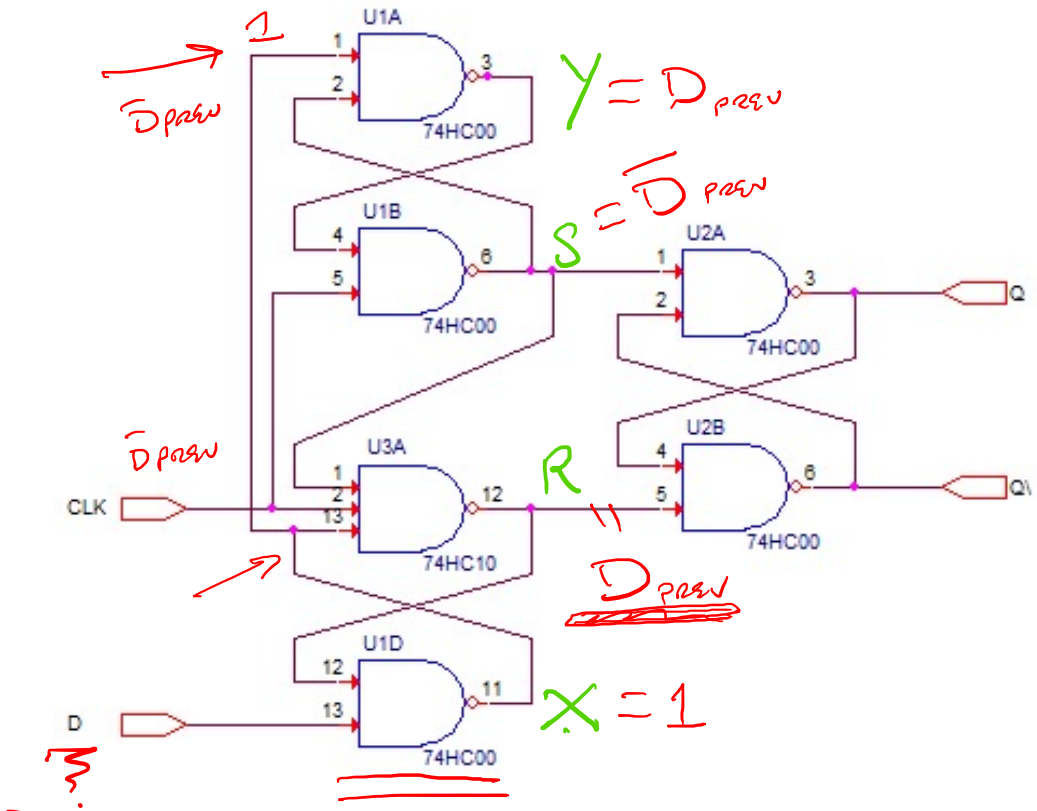
→ X = D

→ Y = D

→ S = D

Q = D

⇒ $\overline{Q} = \overline{D}$



A	B	$\overline{AB}$
0	0	1
0	1	1
1	0	1
1	1	0

S	R	Q	$\bar{Q}$
0	1	1	0
1	0	0	1
1	1	HOLD	

CLK = 1

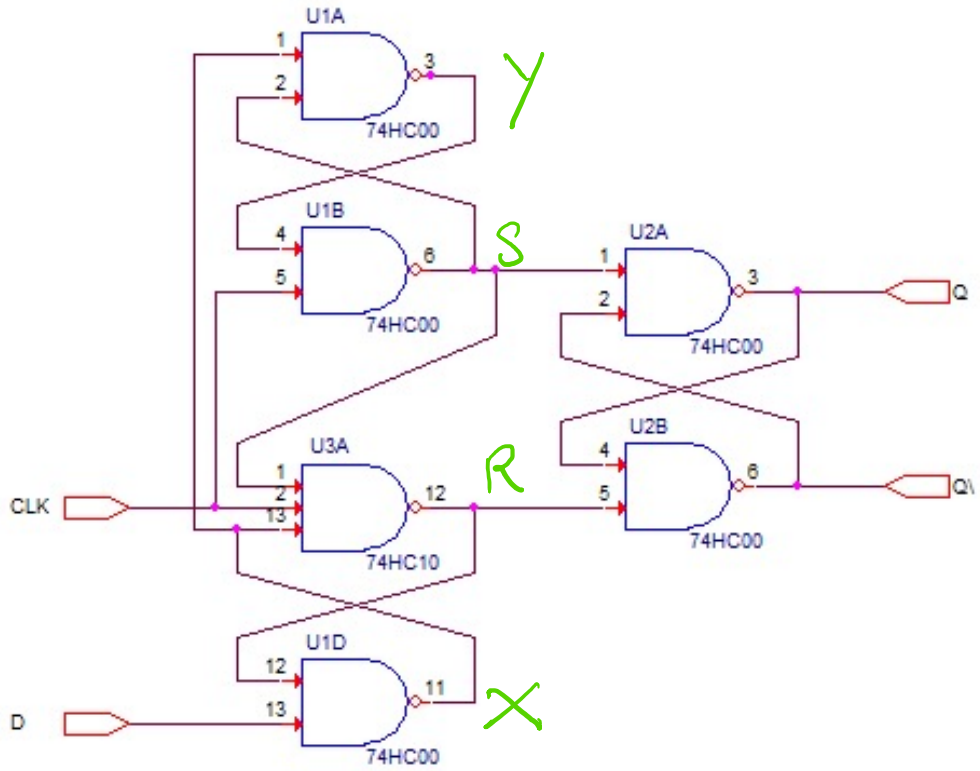
$\Rightarrow$

NOW D CHANGES

$X \rightarrow 1$

$\Rightarrow$ Y, S, R ALL MAINTAIN OUTPUT

$A \cdot \bar{A} = 1$



A	B	$\overline{AB}$
0	0	1
0	1	1
1	0	1
1	1	0

S	R	Q	$\overline{Q}$
0	1	1	0
1	0	0	1
1	1	HOLD	

CLK = 0

$\Rightarrow$ R = 1

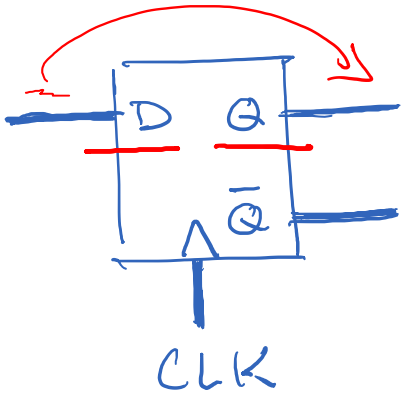
S = 1

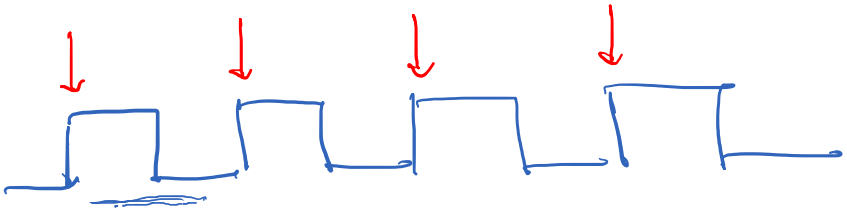
OUTPUTS HOLD

$X = \overline{D}$

$Y = D$

D FLIP FLOP



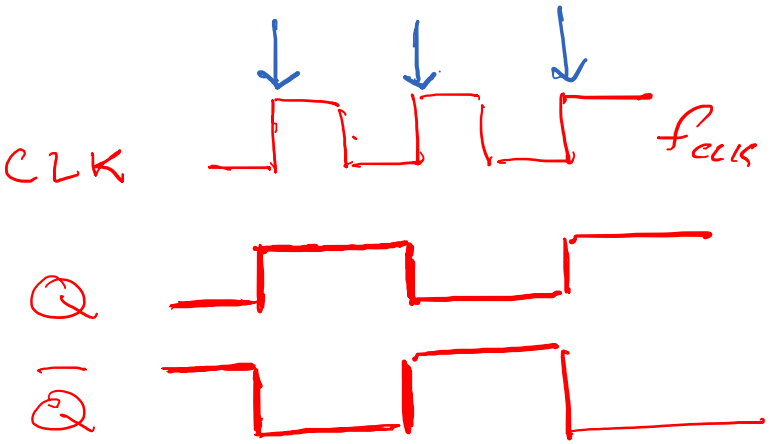


CLK	D	Q
RISING EDGE	0	0
RISING EDGE	1	1
NON RISING	X	Q

$Q_{next} = D$

$Q_{n+1} = D_n$

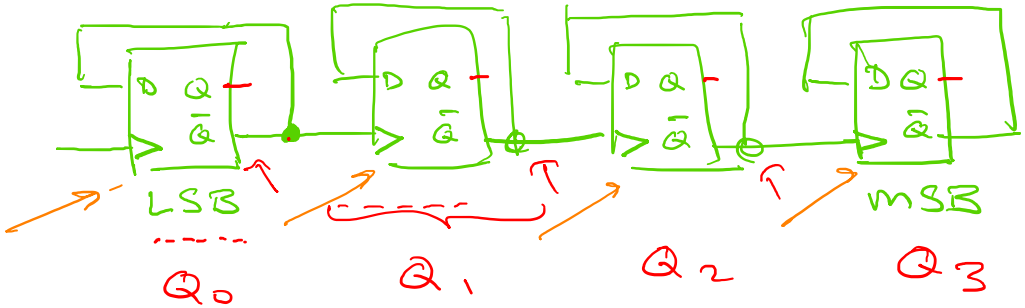
DIVIDE-BY-TWO

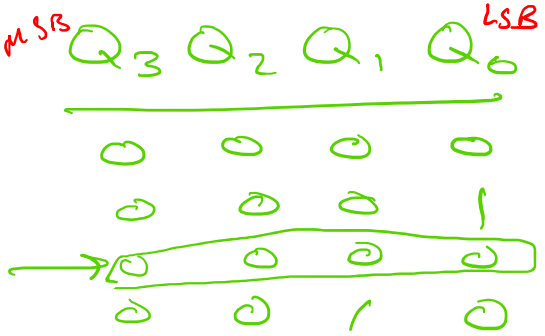


$f_{out} = \frac{1}{2} f_{CLK}$

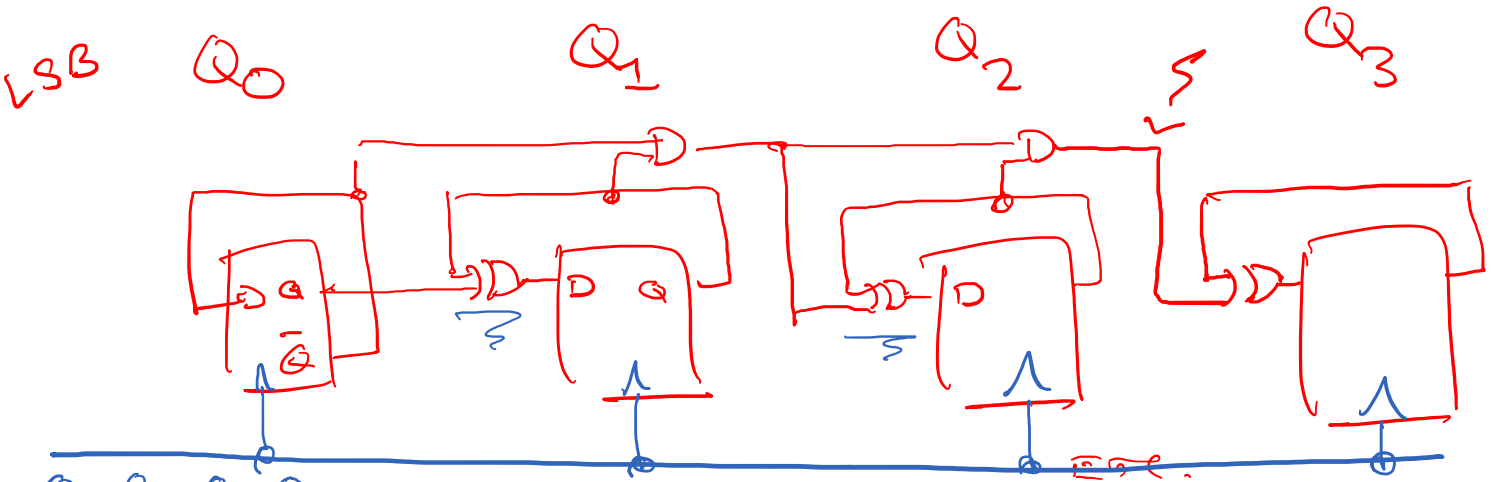
ASYNCHRONOUS COUNTER

"RIPPLE" COUNTER





SYNCHRONOUS COUNTER

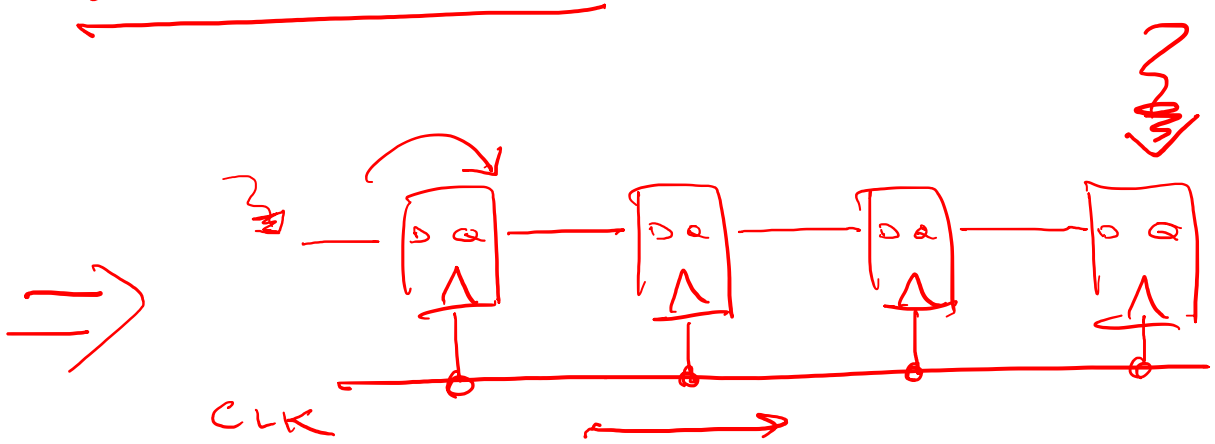


Q_3	Q_2	Q_1	Q_0
0	0	0	0
0	0	0	1
0	0	1	0
0	0	1	1
0	1	0	0
0	1	0	1

$$Q_{1,next} = Q_{0,prev} \oplus Q_{1,prev}$$

$$Q_{2,next} = (Q_{0,p} \cdot Q_{1,prev}) \oplus Q_{2,prev}$$

SHIFT REGISTER



Q_3	Q_2	Q_1	Q_0	D
0	0	0	0	1
0	0	0	1	0
0	0	1	0	1
0	1	0	1	1
1	0	1	1	

J K. FLIP FLOP

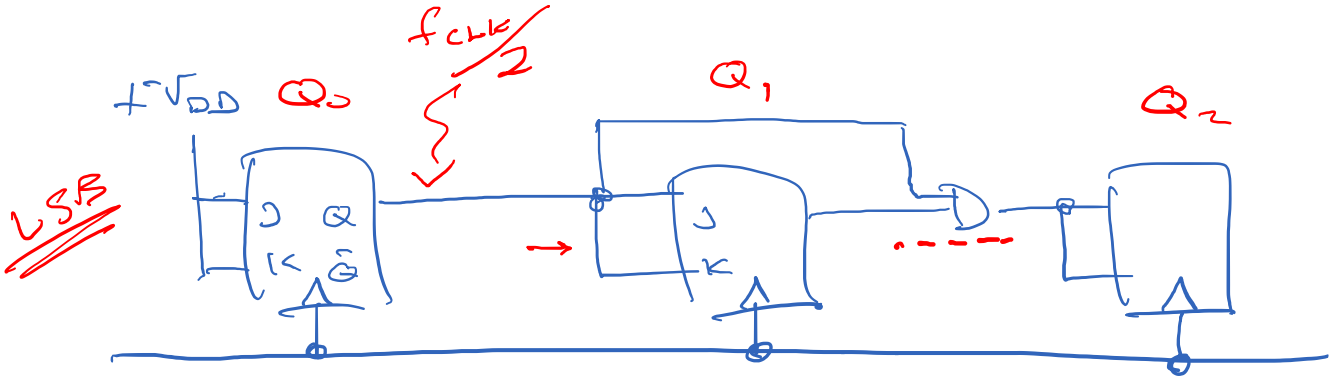
EDGE-TRIGGERED

J	K	Q_{next}
0	0	Q
0	1	0
1	0	1
1	1	$\bar{Q}$

TOGGLE

@ RISING EDGE

SYNCHRONOUS COUNTER



SHIFT REGISTER

J	K	Q_{n+1}	
0	0	Q_n	← COUNTING
0	1	0	SHIFT REGISTERS
1	0	1	
1	1	$\overline{Q}_n$	←