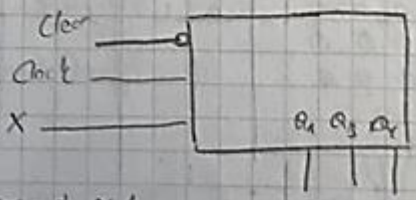
Multi Mode Counter

- Three bits
- Unit Distance code
- Mod 6
- Sync
- Up / Down

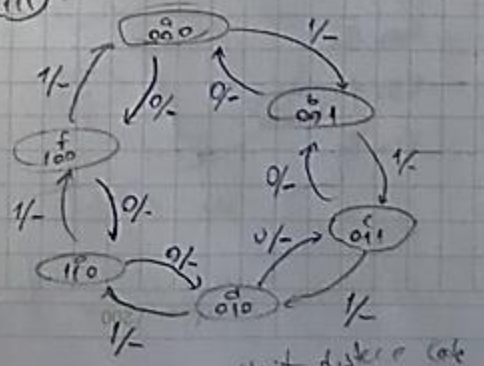


(101 111) φ

Format X/-

X=1 olduğunda ileriye doğru

X=0 geri doğru.



		Q_n				Q_{n+1}								
		A_n	B_n	C_n	X	A_{n+1} (D_A)	B_{n+1} (D_B)	C_{n+1} (D_C)	J_A	K_A	J_B	K_B	J_C	K_C
	0	0	0	0	0	1	0	0	1	φ	0	φ	0	φ
a	1	0	0	0	1	0	0	1	0	φ	0	φ	φ	φ
	2	0	0	1	0	0	0	0	0	φ	0	φ	φ	1
b	3	0	0	1	1	0	1	1	0	φ	1	φ	φ	0
d	4	0	1	0	0	0	1	1	0	φ	φ	0	1	φ
	5	0	1	0	1	1	1	0	1	φ	φ	0	0	φ
c	6	0	1	1	0	0	0	1	0	φ	φ	1	φ	0
	7	0	1	1	1	0	1	0	0	φ	φ	0	φ	1
f	8	1	0	0	0	1	1	0	φ	0	1	φ	0	φ
	9	1	0	0	1	0	0	0	φ	1	0	φ	0	φ
φ	10	1	0	1	0	φ	φ	φ	φ	φ	φ	φ	φ	φ
	11	1	0	1	1	φ	φ	φ	φ	φ	φ	φ	φ	φ
e	12	1	1	0	0	0	1	0	φ	1	φ	0	0	φ
	13	1	1	0	1	1	0	0	φ	0	φ	1	0	φ
	14	1	1	1	0	φ	φ	0	φ	φ	φ	φ	φ	φ
φ	15	1	1	1	1	φ	φ	φ	φ	φ	φ	φ	φ	φ

D ile sadeleştirilecek

K MAP

$D_A = \bar{C}_n (B_n \odot X)$

$D_B = A_n \bar{X} + \bar{A}_n B_n \bar{C}_n + C_n X$

$D_C = \bar{A}_n (B_n \odot X)$

$J_A = \bar{C}_n (B_n \odot X)$

$K_A = B_n \odot X$

$J_B = A_n \bar{X} + C_n X$

$K_B = A_n \bar{X} + C_n X$

$K_B = A_n X + C_n \bar{X}$

$J_C = \bar{A}_n (B_n \odot X)$

$K_C = B_n \odot X$

OSOW

RING COUNTERS
(Johnson or Möbius Counter)

1) Standard-Ring code → Counter

2) Twisted-Ring code → Counter

straight ring counter

Standard Ring Code
(one-hot counter)

A	B	C	D
0	0	0	0
1	0	0	0
0	1	0	0
0	0	1	0
0	0	0	1
0	0	0	0

A	B	C	D
0	0	0	0
0	0	0	1
0	0	1	0
0	1	0	0
1	0	0	0
0	0	0	0

Bunda sadece MSB veya LSB biti evirilip kaydırılıyor.

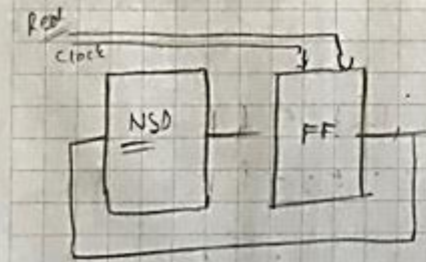
Twisted-Ring Code
(Johnson Counter, Möbius Counter)

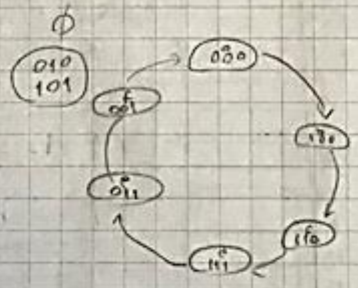
A	B	C
0	0	0
1	0	0
1	1	0
1	1	1
0	1	1
0	0	1
0	0	0

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

Bunda ise LSB veya MSB'den başlayarak her seferinde bir sonraki evriliyor, hepsi bir olduğunda tekrar aynı evirme işlemi yapılıyor.

3 bit twisted ring counter tasarlayalım (MSB evirmeli olsun)



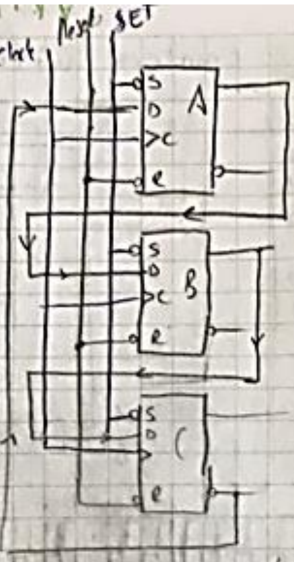


		A_n	B_n	C_n	A_{n+1} (DA)	B_{n+1} (DB)	C_{n+1} (DC)	J_A	K_A	J_B	K_B	J_C	K_C
0	a	0	0	0	1	0	0	1	Φ	0	Φ	0	Φ
1	f	0	0	1	0	0	0	0	Φ	0	Φ	Φ	1
2	Φ	0	1	0	Φ	Φ	Φ	Φ	Φ	Φ	Φ	Φ	Φ
3	e	0	1	1	0	0	1	0	Φ	Φ	1	Φ	0
4	b	1	0	0	1	1	0	Φ	0	Φ	1	0	Φ
5	Φ	1	0	1	Φ	Φ	Φ	Φ	Φ	Φ	Φ	Φ	Φ
6	c	1	1	0	1	1	1	Φ	0	Φ	0	1	Φ
7	d	1	1	1	0	1	1	Φ	1	Φ	0	Φ	0

NSD for D FF

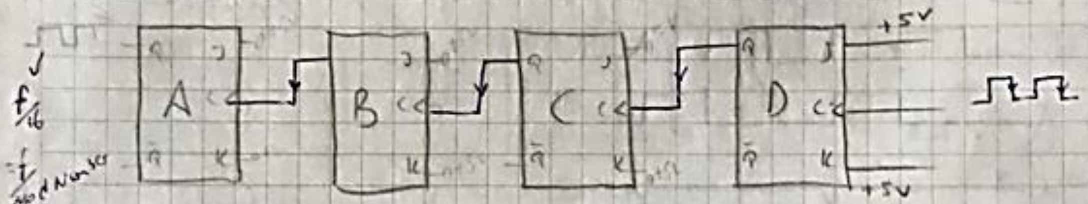
NSD for JK FF

$D_A=\bar{C}$	$J_A=\bar{C}$	$K_A=C$
$D_B=A$	$J_B=A$	$K_B=\bar{A}$
$D_C=B$	$J_C=B$	$K_C=\bar{B}$



RIPPLE (ASYNCHRONOUS) Counters

... Q'lerden seriye ...



$\frac{f}{16}$

$\frac{f}{\text{Mod Number}}$

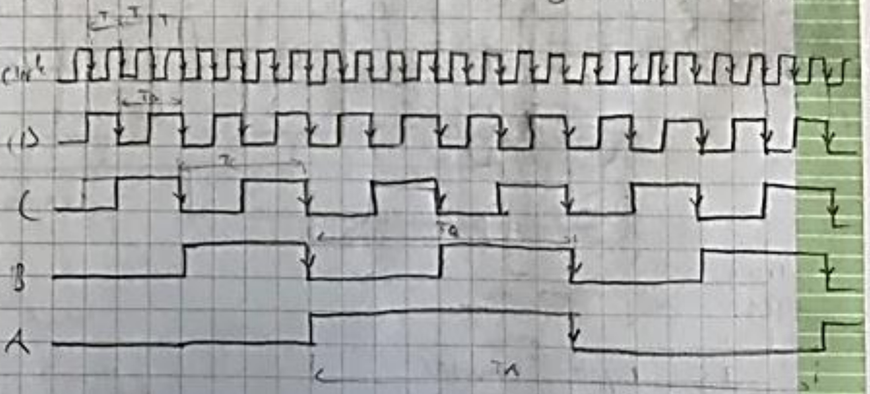
$\frac{f}{2^N}$

MOD NUMBER $= 2^N$

$n=4 \quad 2^N = 16 \Rightarrow$ Mod 16

Ripple Counter'ı ya JK ya da T ff ile gerçekleştirilir.

clock ripple	A	B	C	D
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1



$$f_C = \frac{f_D}{2} = \frac{f}{4}$$

$$f_B = \frac{f_C}{2} = \frac{f}{8}$$

$$f_A = \frac{f_B}{2} = \frac{f}{16} = \frac{f}{\text{Mod Number}} = \frac{f}{2^N}$$

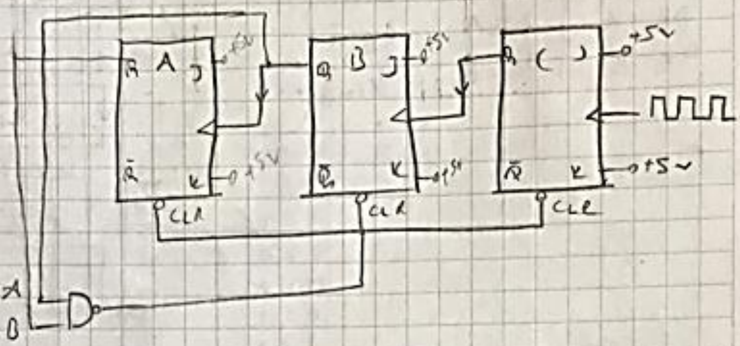
$T_D = 2T$

$$\frac{1}{f_D} = 2 \cdot \frac{1}{f}$$

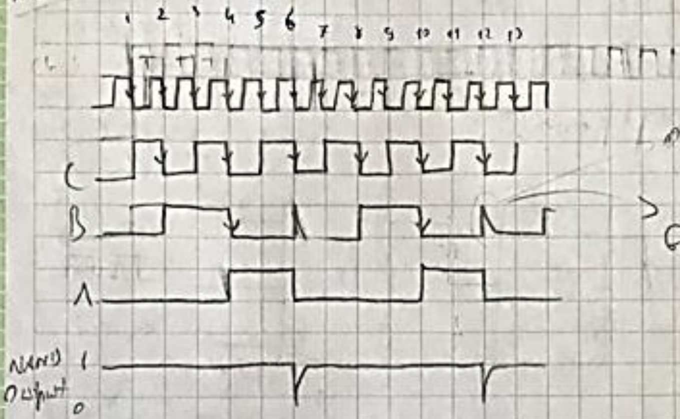
$$\boxed{f_D = \frac{f}{2}}$$

Counters with Mod Number $< 2^N$

	A	B	C
0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
	1	1	0

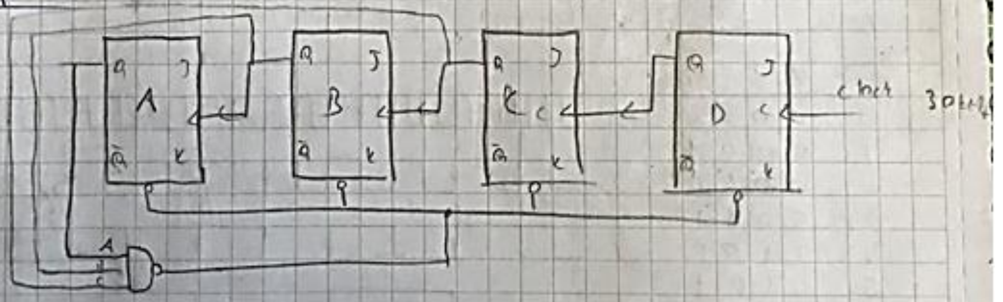


MOD 6



Mod 14 ripple counter design

MOD 14



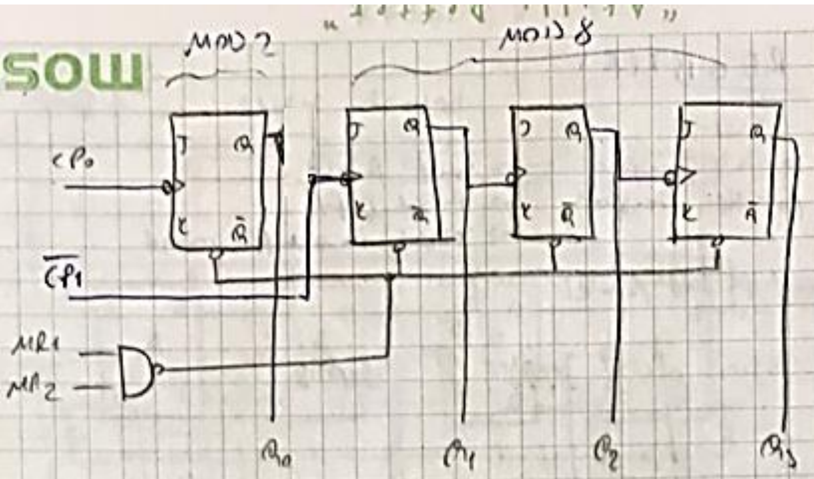
1101 → 13
1110 → 14

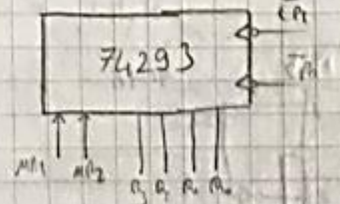
IC Ripple counter

TTL : 7493, 74293

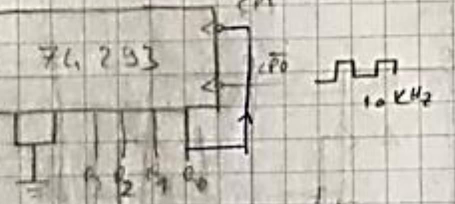
CMOS : 74 HC 4024 (7bit), 74 HC 4040 (12bit)

28



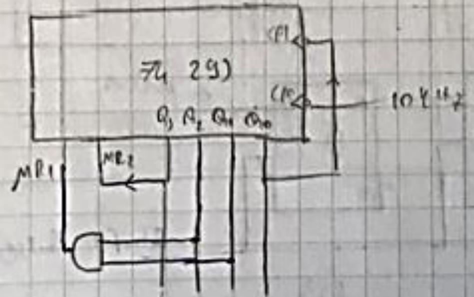


MOD 16



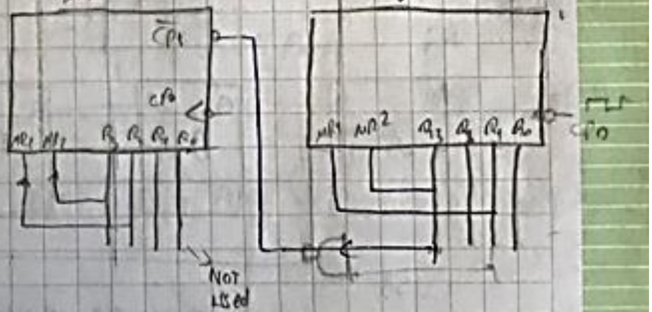
$$f_3 = \frac{f}{16} = \frac{10 KHz}{16} = 625 Hz$$

Mod 14



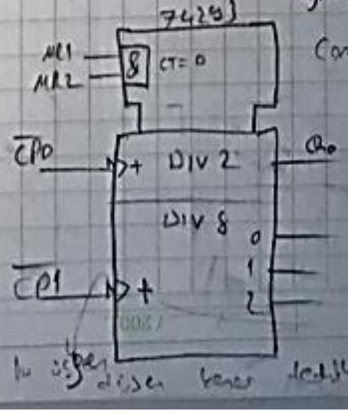
$$f_3 = \frac{10 KHz}{14} = 714 HZ$$

MOD 6 MOD 10



MOD 60 = MOD 6 . MOD 10

IEEE/ANSI Symbol



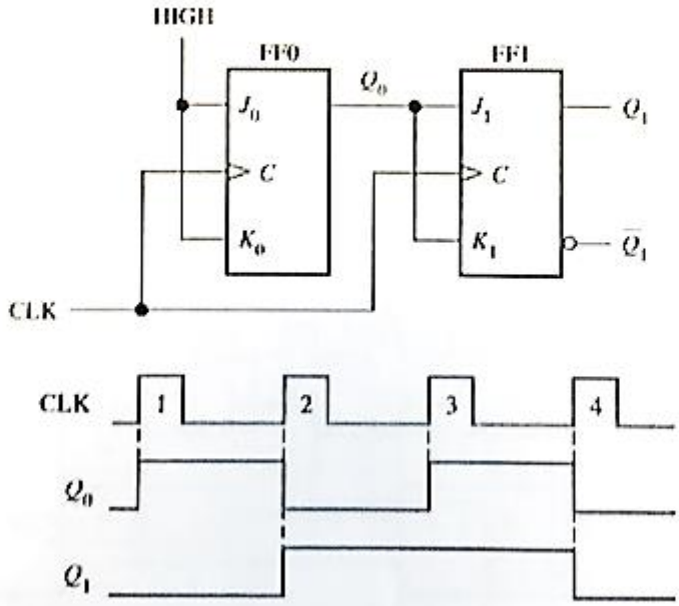
Bu artı işaret ileri saydırmayı sağlıyor

Bu işaret düşen kenar tetiklemeli olduğunu gösteriyor

29

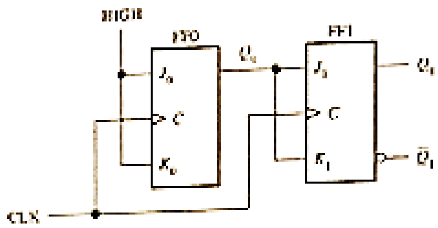
Syncronous counters

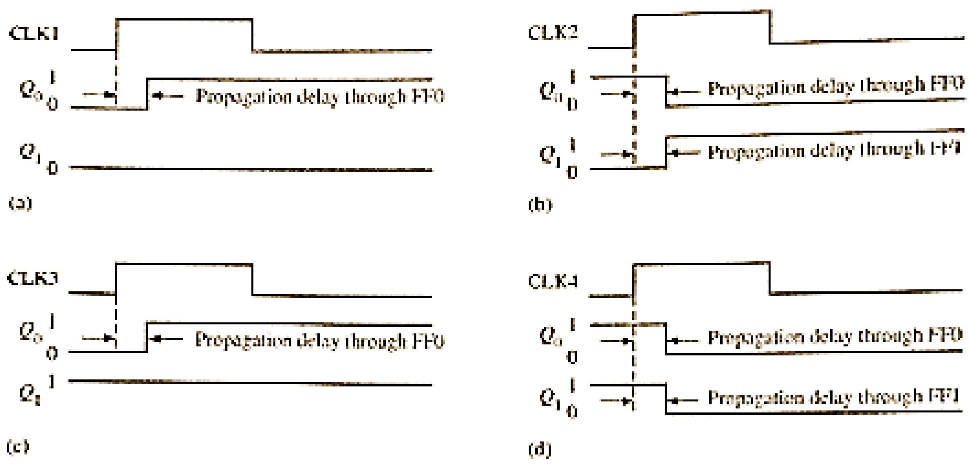
A 2-bit synchronous binary counter.



Syncronous counters

Timing details for the 2-bit synchronous counter operation (the propagation delays of both flip-flops are assumed to be equal).





Syncronous counters

A 3-bit synchronous binary counter