H.W:- Design the counter with the sequence 0, 3, 2, 4, 1, 5, 7 and repeat using (D- flip-flop).

H.W:- Design a counter that goes the sequence (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 1, ...) using D-flip-flop.

Example:- Design a synchronous counter that counts the decimal digits according to the 2421 codes using T flip-flop.

Solution:- dicemal digit: 0 ⟶ 9

present state No. of bits = 4 = No. of flip-flops.

2 D_n	4 C_n	2 B_n	1 A_n	next-state D_{n+1}	C_{n+1}	B_{n+1}	A_{n+1}	T_D	T_C	T_B	T_A
0	0	0	0	0	0	0	1	0	0	0	1
0	0	0	1	0	0	1	0	0	0	1	1
0	0	1	0	0	0	1	1	0	0	0	1
0	0	1	1	0	1	0	0	0	1	1	1
0	1	0	0	0	1	0	1	0	0	0	1
0	1	0	1	0	1	1	0	0	0	1	1
0	1	1	0	0	1	1	1	0	0	0	1
0	1	1	1	1	1	1	0	1	0	0	1
1	1	1	0	1	1	1	1	0	0	0	1
1	1	1	1	0	0	0	0	1	1	1	1

BA \ DC	$\bar{D}\bar{C}$	$\bar{D}C$	DC	$D\bar{C}$
$\bar{B}\bar{A}$	0	0	X	X
$\bar{B}A$	0	0	X	X
BA	0	1	1	X
$B\bar{A}$	0	0	0	X

$T_D = CBA$

BA \ DC	$\bar{D}\bar{C}$	$\bar{D}C$	DC	$D\bar{C}$
$\bar{B}\bar{A}$	0	0	X	X
$\bar{B}A$	0	0	X	X
BA	1	0	1	X
$B\bar{A}$	0	0	0	X

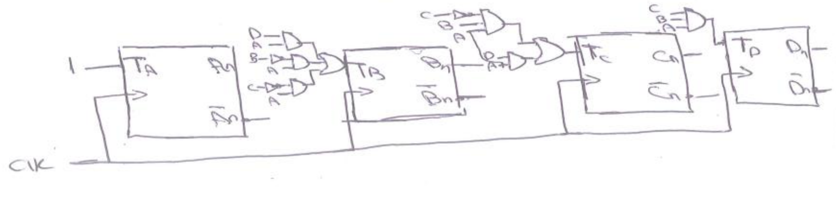
$T_C = DA + \bar{C}BA$

BA \ DC	$\bar{D}\bar{C}$	$\bar{D}C$	DC	$D\bar{C}$
$\bar{B}\bar{A}$	0	0	X	X
$\bar{B}A$	1	1	X	X
BA	1	0	1	X
$B\bar{A}$	0	0	0	X

$T_B = DA + \bar{B}A + \bar{C}A$

BA \ DC	$\bar{D}\bar{C}$	$\bar{D}C$	DC	$D\bar{C}$
$\bar{B}\bar{A}$	1	1	X	X
$\bar{B}A$	1	1	X	X
BA	1	1	1	X
$B\bar{A}$	1	1	1	X

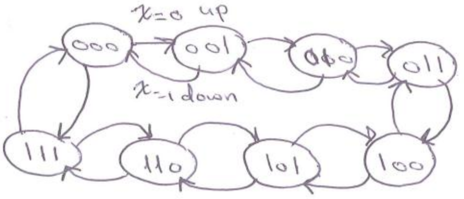
$T_A = 1$



Example:- Design a 3-bit synchronous counter, the counter counts up when the external input $x=0$ and down when $x=\phi$, using T flip-flop:-

note:- up/down counter
$x=0$ up
$x=1$ down

solution:- no. of bits = 3 = no. of flip-flops.



State diagram

input X	C_n	B_n	A_n	C_{n+1}	B_{n+1}	A_{n+1}	T_C	T_B	T_A	
0	0	0	0	0	0	1	0	0	1	up counting
0	0	0	1	0	1	0	0	1	1	
0	0	1	0	0	1	1	0	0	1	
0	0	1	1	1	0	0	1	1	1	
0	1	0	0	1	0	1	0	0	1	
0	1	0	1	1	1	0	0	1	1	
0	1	1	0	1	1	1	0	0	1	
0	1	1	1	0	0	0	1	1	1	
1	0	0	0	1	1	1	1	1	1	down counting
1	0	0	1	0	0	0	0	0	1	
1	0	1	0	0	0	1	0	1	1	
1	0	1	1	0	1	0	0	0	1	
1	1	0	0	0	1	1	1	1	1	
1	1	0	1	1	0	0	0	0	1	
1	1	1	0	1	0	1	0	1	1	
1	1	1	1	1	1	0	0	0	1	

$B_nA_n \backslash XC_n$	$\bar{X}\bar{C}$	$\bar{X}C$	XC	$X\bar{C}$
$\bar{B}\bar{A}$	0	0	ϕ	1
$\bar{B}A$	0	0	0	0
BA	1	1	0	0
$B\bar{A}$	0	0	0	0

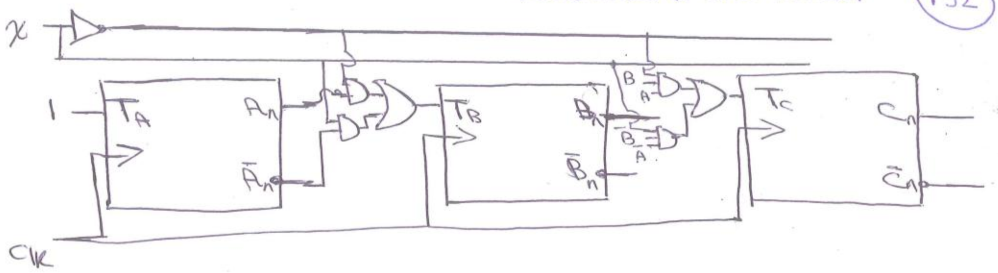
$T_C = \bar{X}BA + X\bar{B}\bar{A}$

$B_nA_n \backslash XC_n$	$\bar{X}\bar{C}$	$\bar{X}C$	XC	$X\bar{C}$
$\bar{B}\bar{A}$	0	0	ϕ	1
$\bar{B}A$	1	1	ϕ	0
BA	1	1	0	0
$B\bar{A}$	0	0	1	1

$T_B = \bar{X}A + X\bar{A}$

$B_nA_n \backslash XC_n$	$\bar{X}\bar{C}$	$\bar{X}C$	XC	$X\bar{C}$
$\bar{B}\bar{A}$	1	1	1	1
$\bar{B}A$	1	1	1	1
BA	1	1	1	1
$B\bar{A}$	1	1	1	1

$T_A = 1$

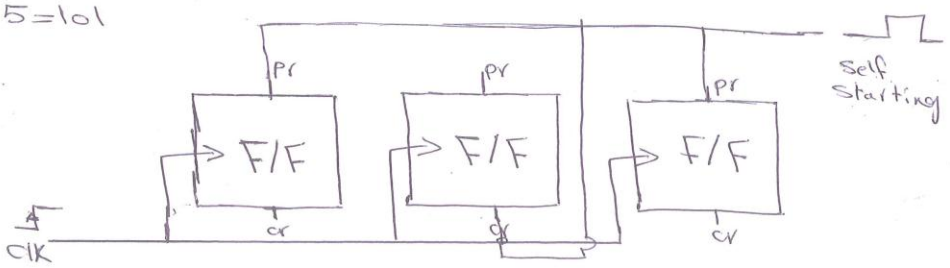


Properties of Synchronous Counter:-

1- Self Starting:- This property used to starting the counter on the desired initial state by counting an external line to (Pr, Cr) lines in the counter.

Example:- the counter has the property of self starting from (5) (Cr, pr) active high.

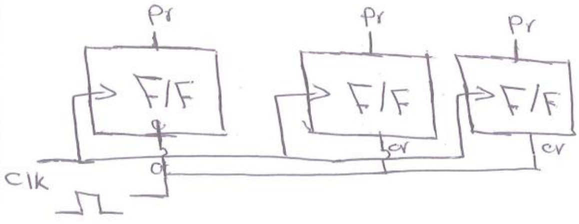
5=101

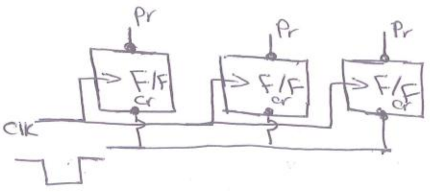


Example:- Draw the block diagram for a counter (3-bit) with self clearing (Zero self starting):-

① active high (cr, pr). ② active low (cr, pr).

Solution:- 1- active high (Cr, pr) 2- active low (cr, pr).

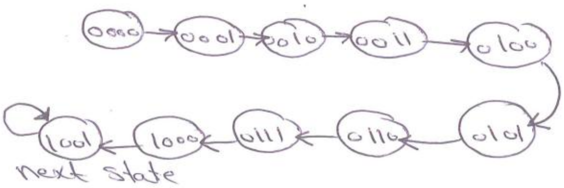




2- Self stopping (Dead end):- This property used to stop the counter on the desired state. This self stopping property can be obtained by the state table and putting the next state as the same as present state (desired stopping state).

Example:- Design BCD up synchronous counter with the property of self stopping using D Flip-flop.

Solution:- no. of bits = 4 = no. of Flip-flop



State diagram

present state				next state							
D_n	C_n	B_n	A_n	D_{n+1}	C_{n+1}	B_{n+1}	A_{n+1}	D_D	D_C	D_B	D_A
0	0	0	0	0	0	0	1	0	0	0	1
0	0	0	1	0	0	1	0	0	0	1	0
0	0	1	0	0	0	1	1	0	0	1	1
0	0	1	1	0	1	0	0	0	1	0	0
0	1	0	0	0	1	0	1	0	1	0	1
0	1	0	1	0	1	1	0	0	1	1	0
0	1	1	0	0	1	1	1	0	1	1	1
0	1	1	1	1	0	0	0	1	0	0	0
1	0	0	0	1	0	0	1	1	0	0	1
1	0	0	1	1	0	0	1	1	0	0	1
1	0	1	0	X	X	X	X	X	X	X	X
1	0	1	1	X	X	X	X	X	X	X	X
1	1	0	0	X	X	X	X	X	X	X	X
1	1	0	1	X	X	X	X	X	X	X	X
1	1	1	0	X	X	X	X	X	X	X	X
1	1	1	1	X	X	X	X	X	X	X	X

$\frac{DC}{BA}$	$\bar D\bar C$	$\bar D C$	DC	$D\bar C$
$\bar B\bar A$	0	0	X	1
$\bar B A$	0	0	X	1
BA	0	1	X	X
$B\bar A$	0	0	X	X

$D_D = D + CBA$

$\frac{DC}{BA}$	$\bar D\bar C$	$\bar D C$	DC	$D\bar C$
$\bar B\bar A$	0	1	X	0
$\bar B A$	0	1	X	0
BA	1	0	X	X
$B\bar A$	0	1	X	X

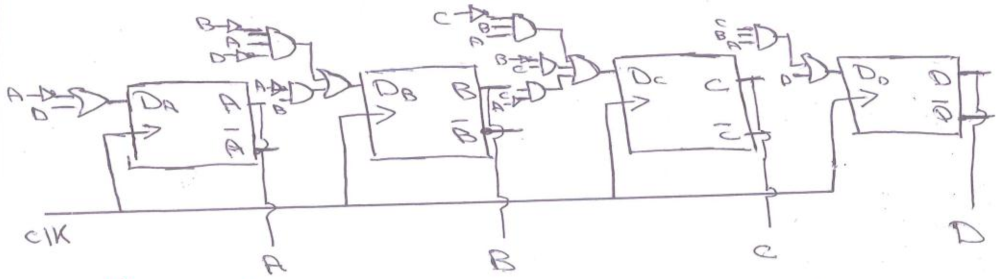
$D_C = \bar C \cancel{B}A + C\bar A + \bar B C$

$\frac{DC}{BA}$	$\bar D\bar C$	$\bar D C$	DC	$D\bar C$
$\bar B\bar A$	0	0	X	0
$\bar B A$	1	1	X	0
BA	0	0	X	X
$B\bar A$	1	1	X	X

$D_B = B\bar A + \bar B A \bar D$

$\frac{DC}{BA}$	$\bar D\bar C$	$\bar D C$	DC	$D\bar C$
$\bar B\bar A$	1	1	X	1
$\bar B A$	0	0	X	1
BA	0	0	X	X
$B\bar A$	1	1	X	X

$D_A = \bar A + D$



3- Self correction:- This property used to avoid an error states (unwanted states). It can be obtained by putting initial state in the unwanted state instead of don't care conditions in the state table.

Example:- Design BCD up synchronous counter that has the property of self correction using D- flip flop.

Solution:- no. of bits = 4 = no. of flip-flop.

BCD 0 → 1 → 2 → 3 → 4 → 5 → 6 → 7
(0) repeate ← 9 ← 8 ←

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D_n	C_n	B_n	A_n	D_{n+1}	C_{n+1}	B_{n+1}	A_{n+1}	D_D	D_C	D_B	D_A
0	0	0	0	0	0	0	1	0	0	0	1
0	0	0	1	0	0	1	0	0	0	1	0
0	0	1	0	0	0	1	1	0	0	1	1
0	0	1	1	0	1	0	0	0	1	0	0
0	1	0	0	0	1	0	1	0	1	0	1
0	1	0	1	0	1	1	0	0	1	1	0
0	1	1	0	0	1	1	1	0	1	1	1
0	1	1	1	1	0	0	0	1	0	0	0
1	0	0	0	1	0	0	1	1	0	0	1
1	0	0	1	0	0	0	0	0	0	0	0
1	0	1	0	0	0	0	0	0	0	0	0
1	0	1	1	0	0	0	0	0	0	0	0
1	1	0	0	0	0	0	0	0	0	0	0
1	1	0	1	0	0	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0	0	0

$^{DC}_{BA}$	$\bar{D}\bar{C}$	$\bar{D}C$	DC	$D\bar{C}$
$\bar{B}\bar{A}$	0	0	0	1
$\bar{B}A$	0	0	0	0
BA	0	1	0	0
$B\bar{A}$	0	0	0	0

$D_D = \bar{D}CBA + D\bar{C}\bar{B}\bar{A}$

$^{DC}_{BA}$	$\bar{D}\bar{C}$	$\bar{D}C$	DC	$D\bar{C}$
$\bar{B}\bar{A}$	0	1	0	0
$\bar{B}A$	0	1	0	0
BA	1	0	0	0
$B\bar{A}$	0	1	0	0

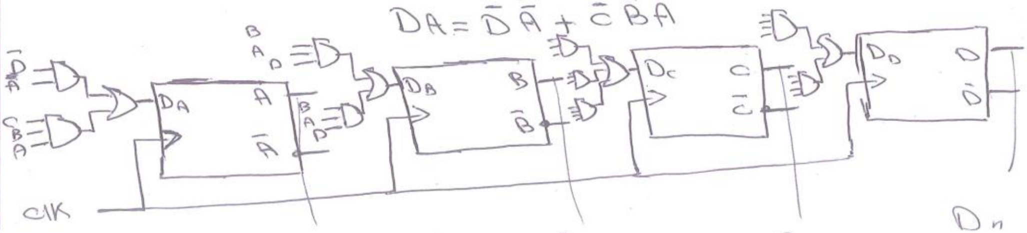
$D_C = \bar{D}C\bar{B} + \bar{D}C\bar{A} + \bar{D}\bar{C}BA$

$^{DC}_{BA}$	$\bar{D}\bar{C}$	$\bar{D}C$	DC	$D\bar{C}$
$\bar{B}\bar{A}$	0	0	0	0
$\bar{B}A$	1	1	0	0
BA	0	0	0	0
$B\bar{A}$	1	1	0	0

$D_B = \bar{B}A\bar{D} + B\bar{A}\bar{D}$

$^{DC}_{BA}$	$\bar{D}\bar{C}$	$\bar{D}C$	DC	$D\bar{C}$
$\bar{B}\bar{A}$	1	1	0	1
$\bar{B}A$	0	0	0	0
BA	0	0	0	0
$B\bar{A}$	1	1	0	0

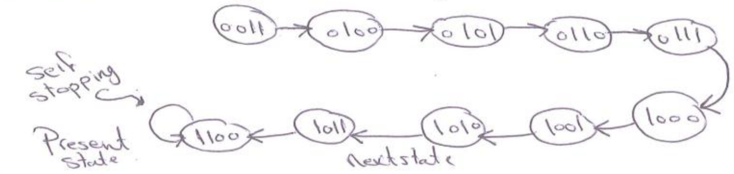
$DA = \bar{D}\bar{A} + \bar{C}\bar{B}\bar{A}$



Example:- Design an Ex-3 synchronous up counter has the property of self stopping and self correcting to initial state using D.F.F.

Solution:- no. of bits = 4 = no. of Flip-Flop

0, 1, 2, 13, 14, 15 ⤵ self correcting.



D_n	C_n	B_n	A_n	D_{n+1}	C_{n+1}	B_{n+1}	A_{n+1}	D_D	D_C	D_B	D_A
0	0	0	0	0	0	1	1	0	0	1	1
0	0	0	1	0	0	1	1	0	0	1	1
0	0	1	0	0	0	1	1	0	0	1	1
0	0	1	1	0	1	0	0	0	1	0	0
0	1	0	0	0	1	0	1	0	1	0	1
0	1	0	1	0	1	1	0	0	1	1	0
0	1	1	0	0	1	1	1	0	1	1	1
0	1	1	1	1	0	0	0	1	0	0	0
1	0	0	0	1	0	0	1	1	0	0	1
1	0	0	1	1	0	1	0	1	0	1	0
1	0	1	0	1	0	1	1	1	0	1	1
1	0	1	1	1	1	0	0	1	1	0	0
1	1	0	0	1	1	0	0	1	1	0	0
1	1	0	1	0	0	1	1	0	0	1	1
1	1	1	0	0	0	1	1	0	0	1	1
1	1	1	1	0	0	1	1	0	0	1	1

H.w:- Find the equ. for D_D - D_C - D_B & D_A using K-map and then connect the cct.

Example :- Check if the following system has the property of self correcting. with the BCD up synchronouse Counter that has the following state equation :-

$D_A = A\bar{B}\bar{C}\bar{D} + \bar{A}BCD$ (MSB)

$D_B = \bar{A}B\bar{D} + \bar{A}B\bar{C} + \bar{A}\bar{B}CD$

$D_C = \bar{A}\bar{C}D + \bar{A}C\bar{D}$

$D_D = \bar{A}\bar{D} + \bar{\bar{B}}\bar{C}\bar{D}$ (LSB).

Solution :- $(10, 11, 12, 13, 14, 15) \xrightarrow[\text{state}]{\text{Next}} 0000$

ABCD	ABCD	ABCD	ABCD	ABCD	ABCD
1010,	1011,	1100,	1101,	1110,	1111
↓	↓	↓	↓	↓	↓
$D_A D_B D_C D_D$	$D_A D_B D_C D_A$	$D_A D_B D_C D_A$	$D_A D_B D_C D_A$	$D_A D_B D_C D_D$	$D_A D_B D_C D_D$
0000	0000	0000	0000	0000	0000

نعوضها في معادلات

∴ this system has the popelty of self correct.

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2017/3/25