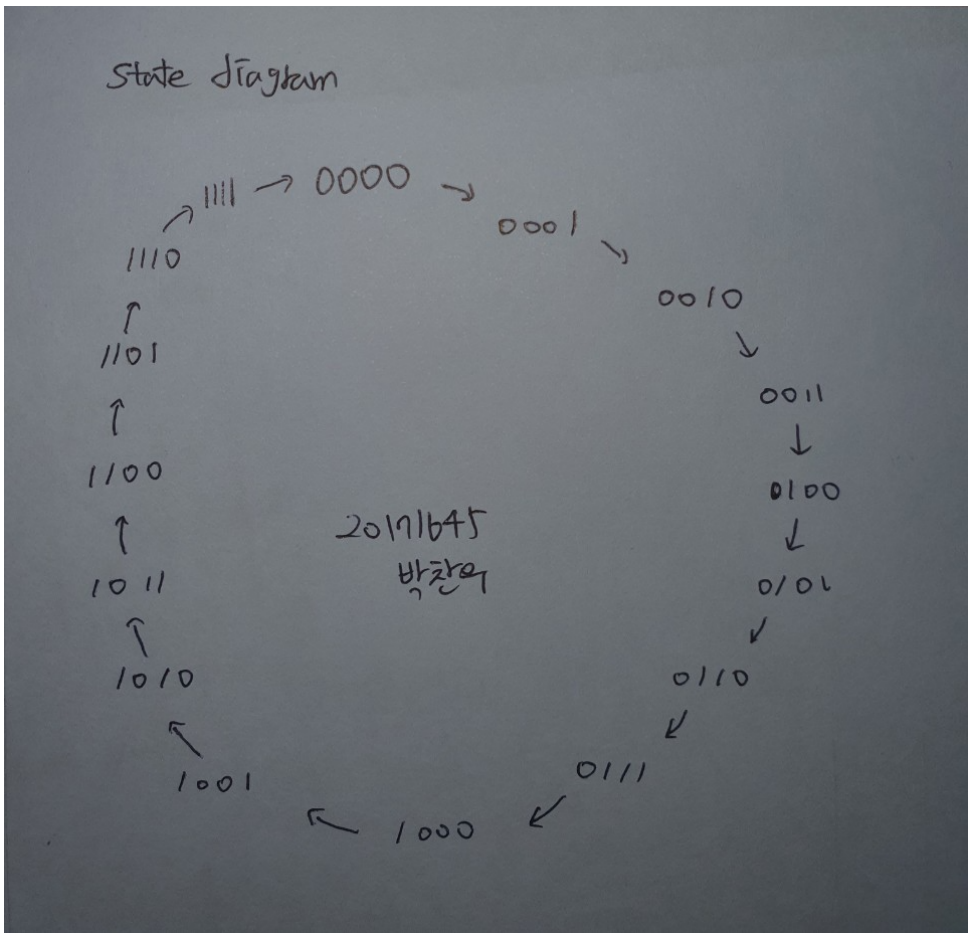
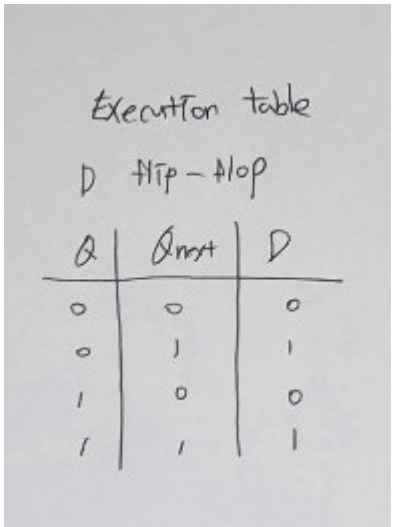
State diagram



Excitation Table of D flip-flop



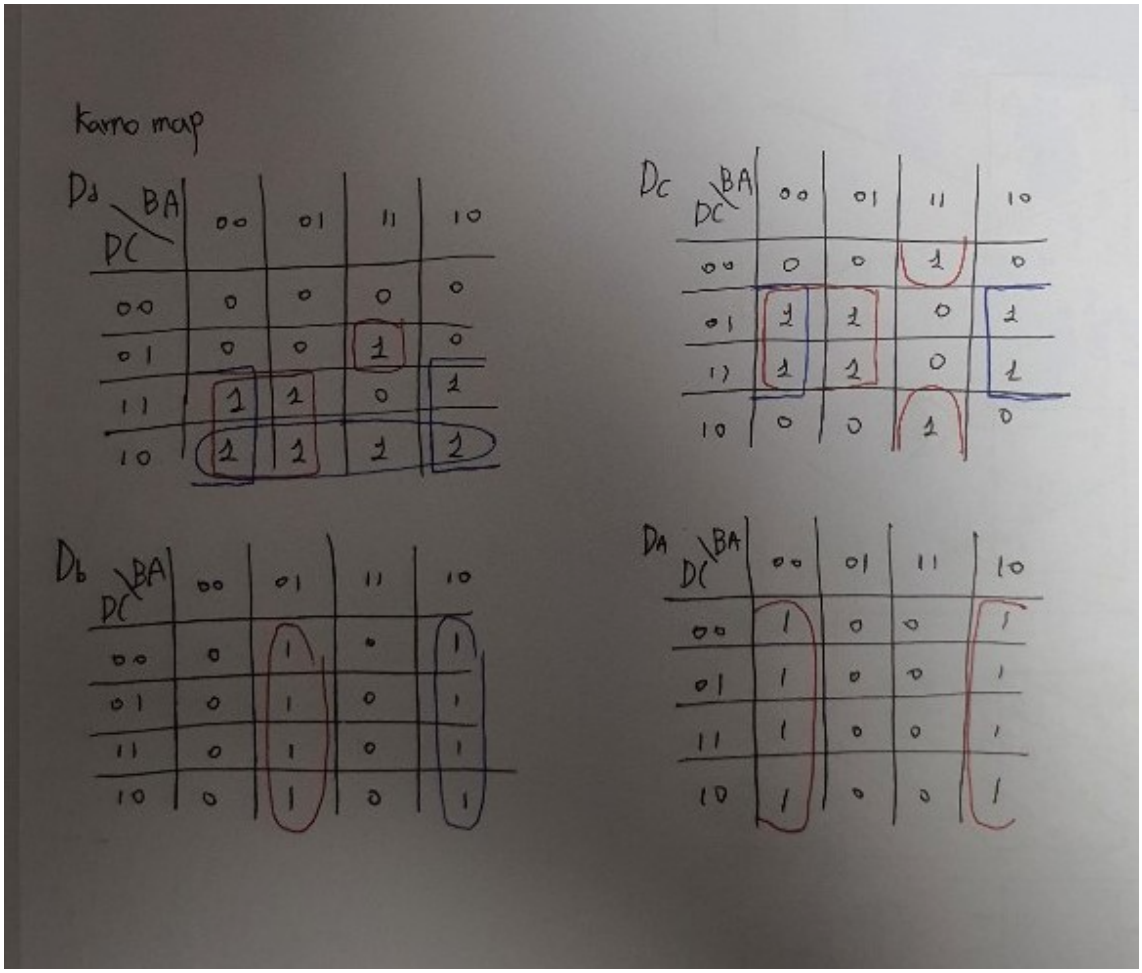
From this excitation table,

State Table of synchronous counter using

D flip-flops is

DCBA	D'C'B'A'	Dd	Dc	Db	Da
0000	0001	0	0	0	1
0001	0010	0	0	1	0
0010	0011	0	0	1	1
0011	0100	0	1	0	0
0100	0101	0	1	0	1
0101	0110	0	1	1	0
0110	0111	0	1	1	1
0111	1000	1	0	0	0
1000	1001	1	0	0	1
1001	1010	1	0	1	0
1010	1011	1	0	1	1
1011	1100	1	1	0	0
1100	1101	1	1	0	1
1101	1110	1	1	1	0
1110	1111	1	1	1	1
1111	0000	0	0	0	0

From this table, get Karnaugh Map



So

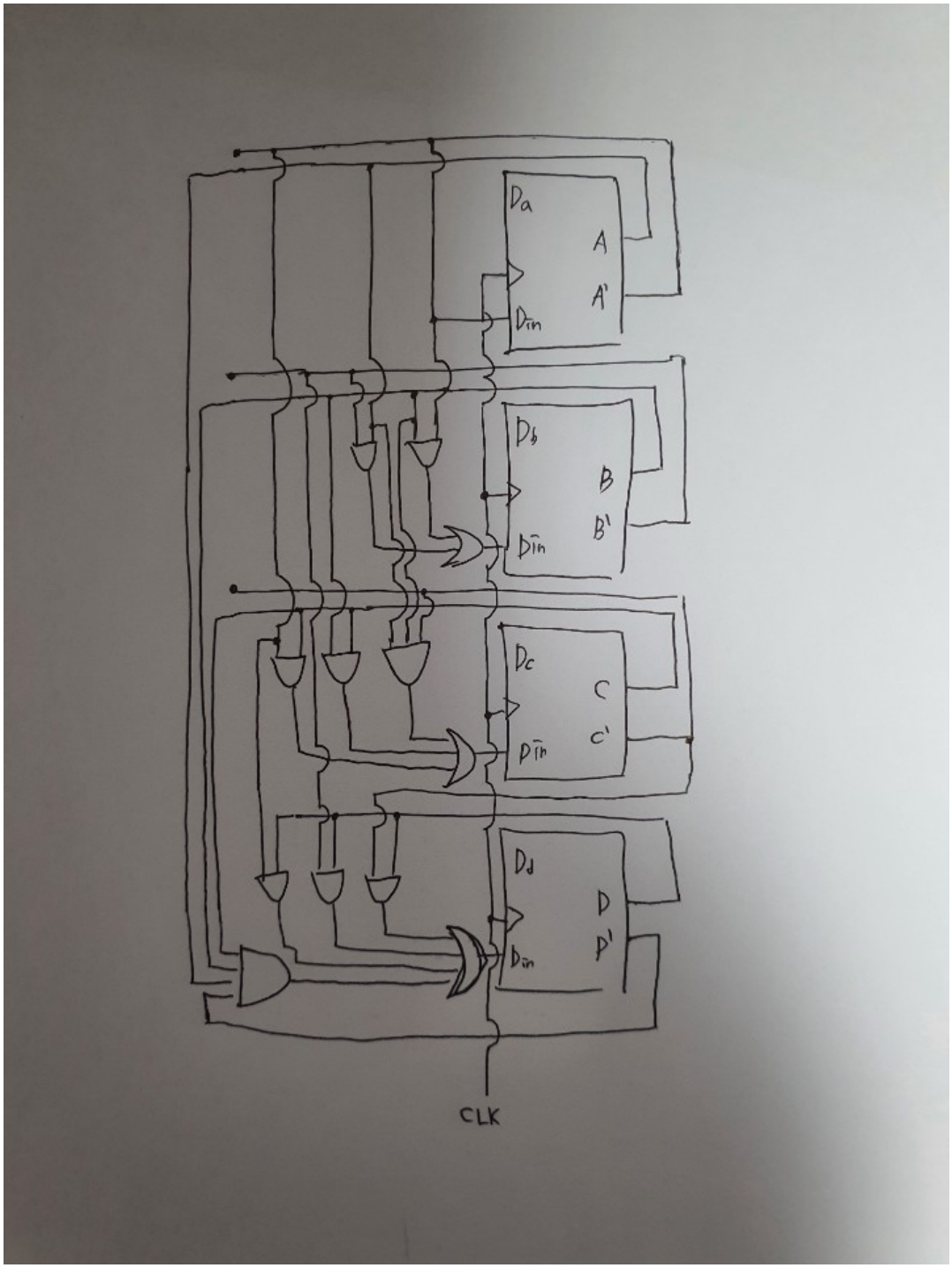
Dd = DC' + DB' + DA' + D'CBA

Dc = CB' + CA' + C'BA

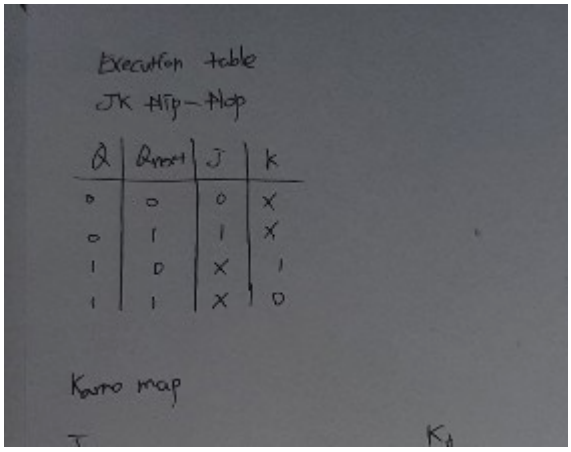
Db = B'A + BA'

Da = A'

draw Circuit Diagram



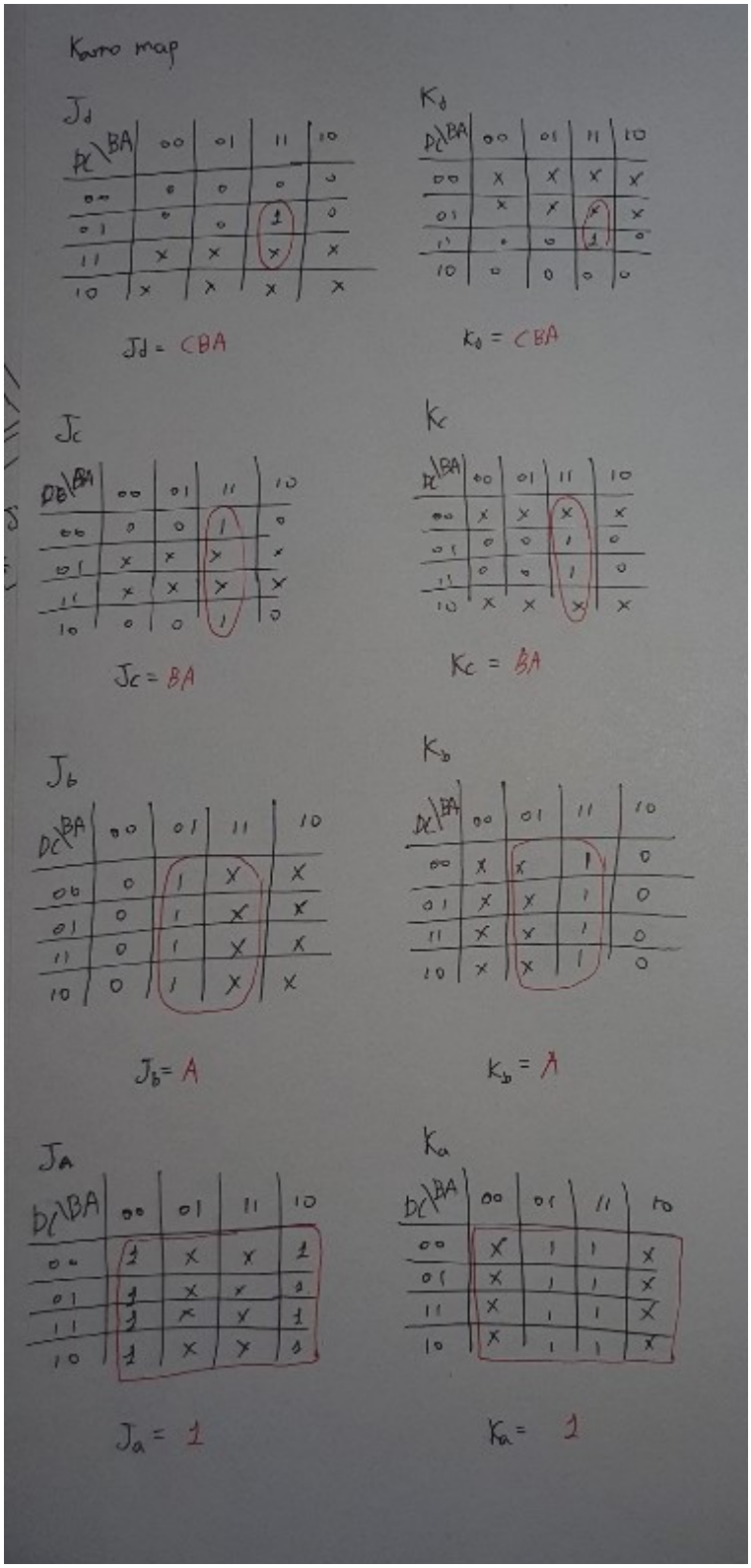
Redesign with JK flip-flops. State Diagram is same as before, and Excitation table of JK flip-flop is



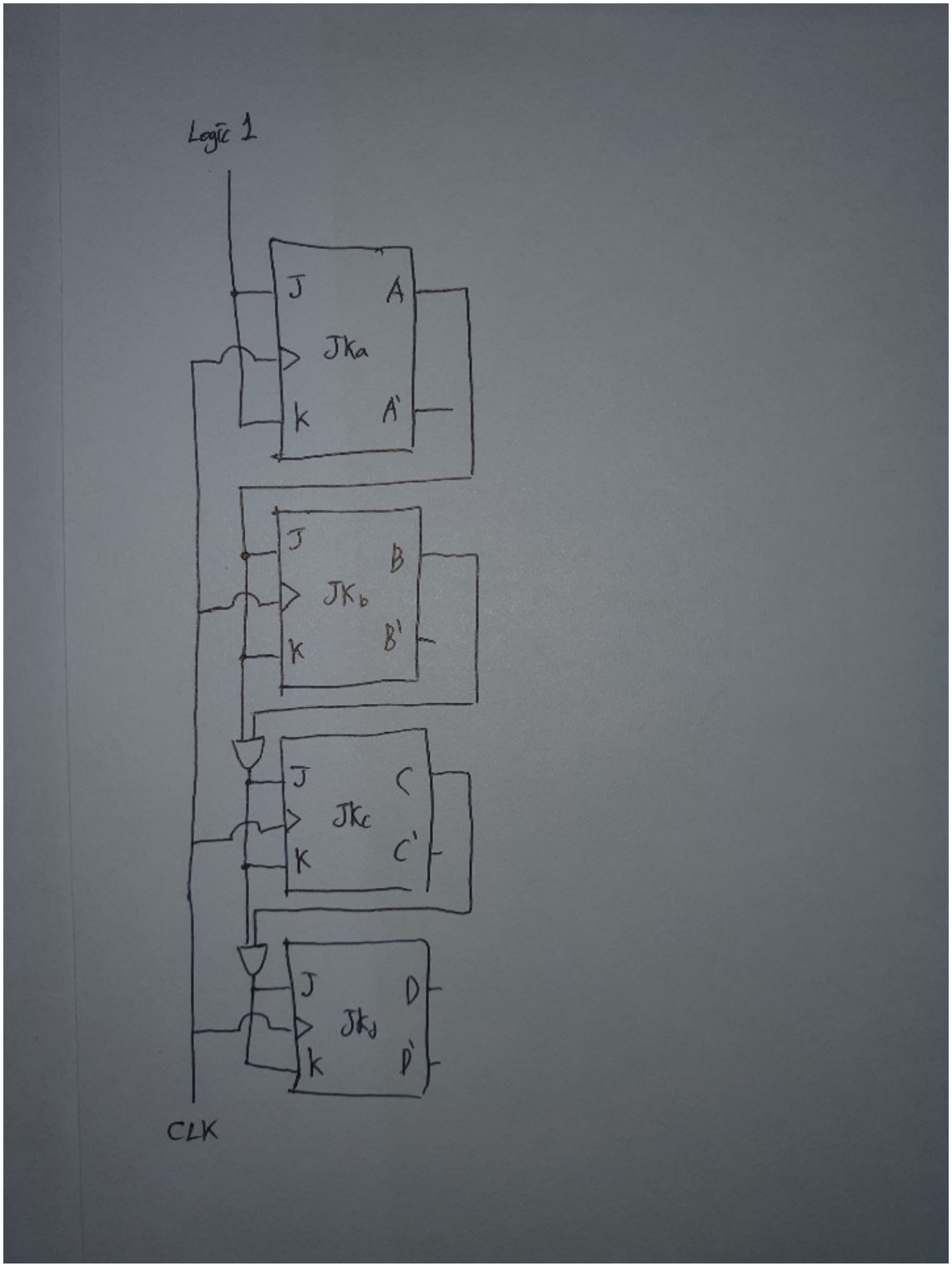
so State Table of synchronous counter using JK flip-flops is

DCBA	D'C'B'A'	Jd	Kd	Jc	Kc	Jb	Kb	Ja	Ka
0000	0001	0	x	0	x	0	x	1	x
0001	0010	0	x	0	x	1	x	x	1
0010	0011	0	x	0	x	x	0	1	x
0011	0100	0	x	1	x	x	1	x	1
0100	0101	0	x	x	0	0	x	1	x
0101	0110	0	x	x	0	1	x	x	1
0110	0111	0	x	x	0	x	0	1	x
0111	1000	1	x	x	1	x	1	x	1
1000	1001	x	0	0	x	0	x	1	x
1001	1010	x	0	0	x	1	x	x	1
1010	1011	x	0	0	x	x	0	1	x
1011	1100	x	0	1	x	x	1	x	1
1100	1101	x	0	x	0	0	x	1	x
1101	1110	x	0	x	0	1	x	x	1
1110	1111	x	0	x	0	x	0	1	x
1111	0000	x	1	x	1	x	1	x	1

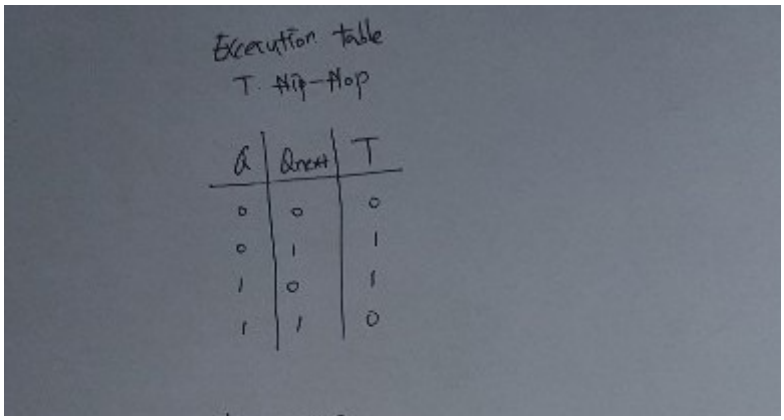
by this table, get Karnaugh map



draw Circuit Diagram


Logic 1
J
A
JKa
K
A'
J
B
JKb
K
B'
J
C
JKc
K
C'
J
D
JKd
K
D'
CLK

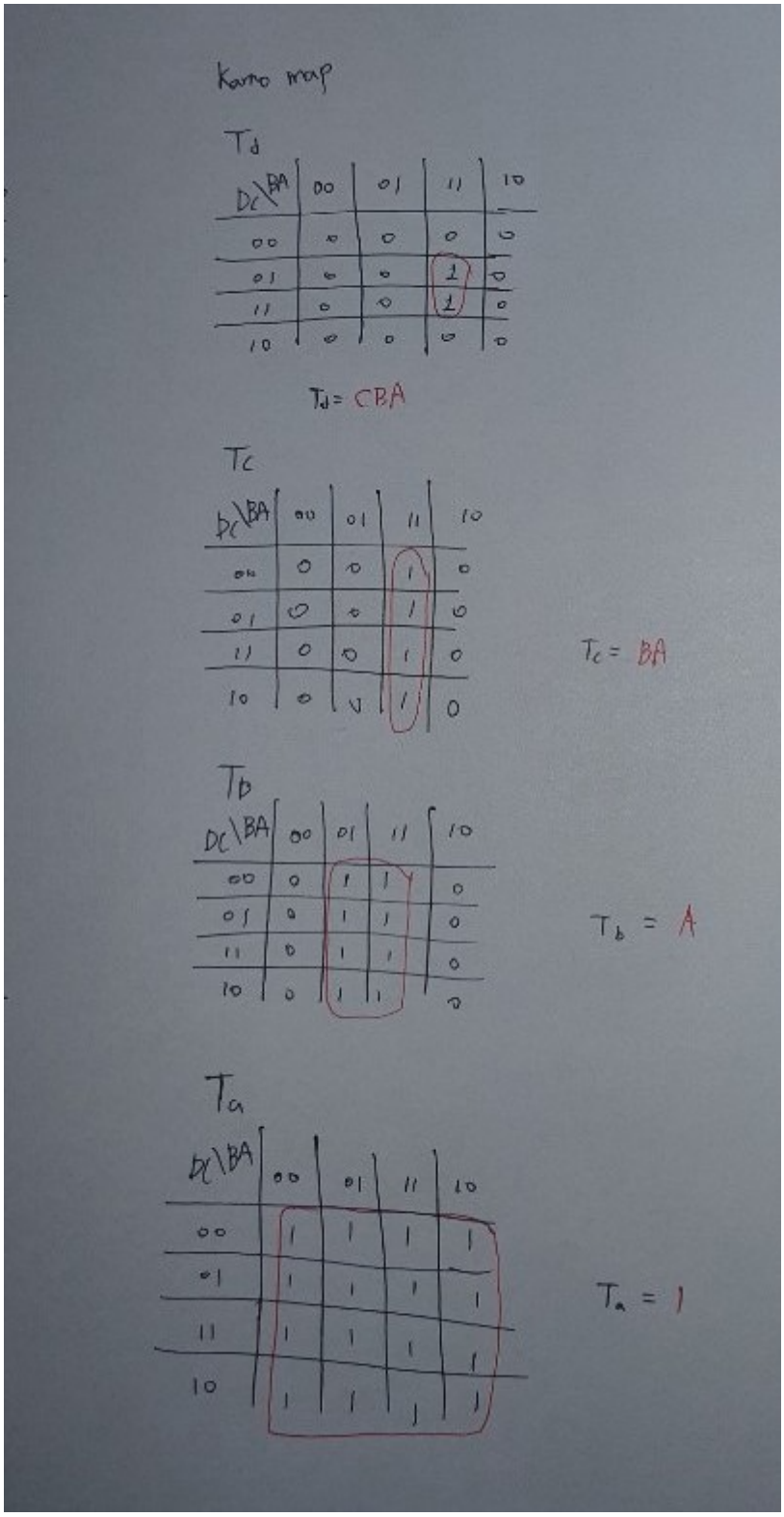
Redesign with T flip-flops. State Diagram is same as before, and Excitation table of T flip-flop is



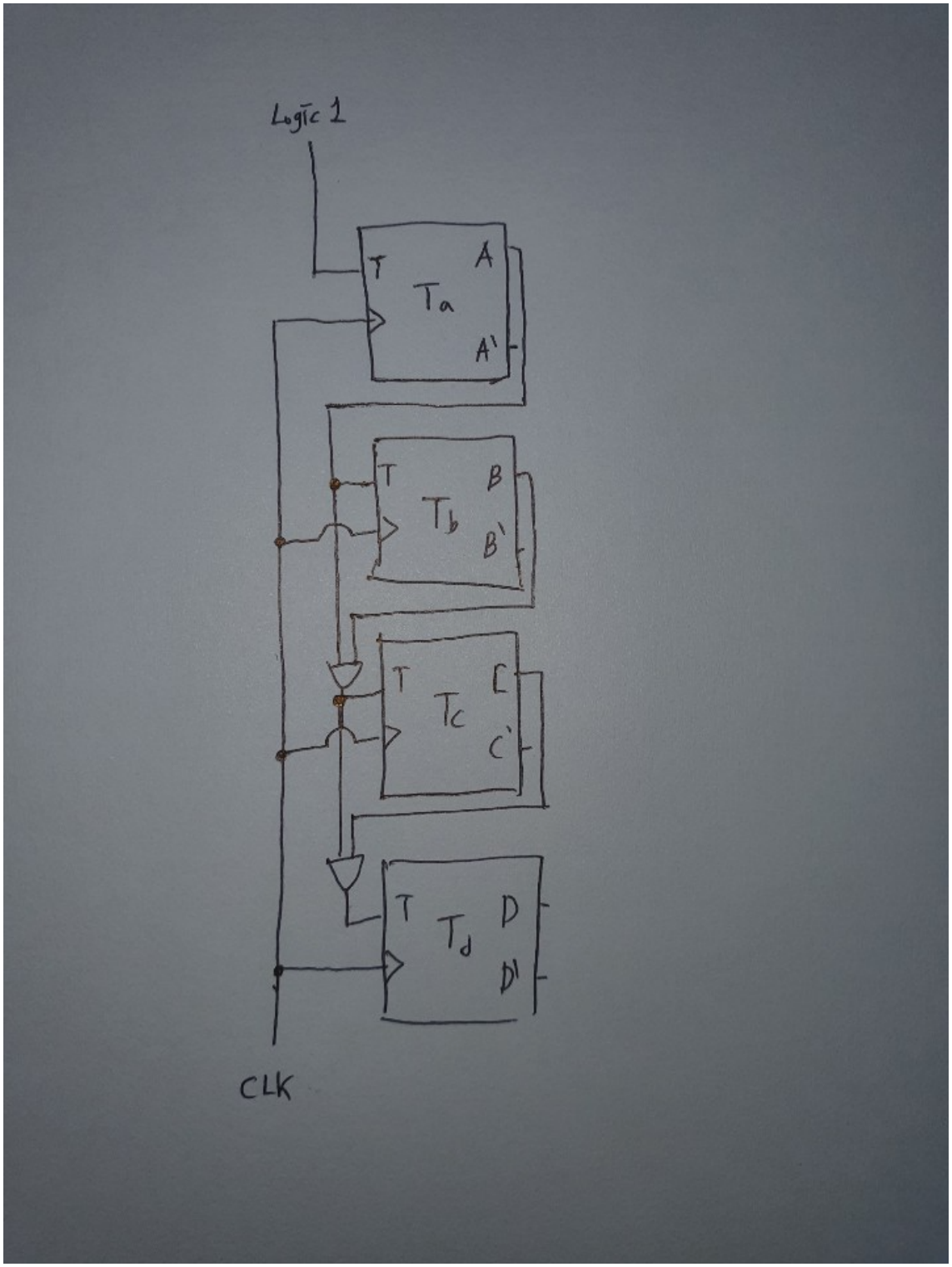
so State Table of synchronous counter using T flip-flops is

DCBA	D'C'B'A'	Td	Tc	Tb	Ta
0000	0001	0	0	0	1
0001	0010	0	0	1	1
0010	0011	0	0	0	1
0011	0100	0	1	1	1
0100	0101	0	0	0	1
0101	0110	0	0	1	1
0110	0111	0	0	0	1
0111	1000	1	1	1	1
1000	1001	0	0	0	1
1001	1010	0	0	1	1
1010	1011	0	0	0	1
1011	1100	0	1	1	1
1100	1101	0	0	0	1
1101	1110	0	0	1	1
1110	1111	0	0	0	1
1111	0000	1	1	1	1

by this table, get Karnaugh map



draw Circuit Diagram


Logic 1
T
A
T_a
A'
T
B
T_b
B'
T
C
T_c
C'
T
D
T_d
D'
CLK

모든 사진자료는 자필로 직접 작성했습니다.