Digital System Design

Design of Ripple Counters

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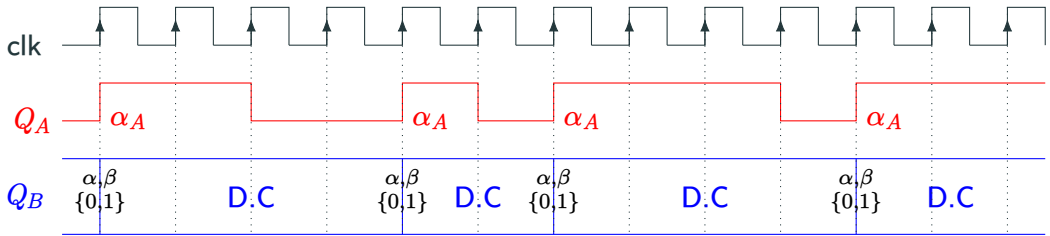
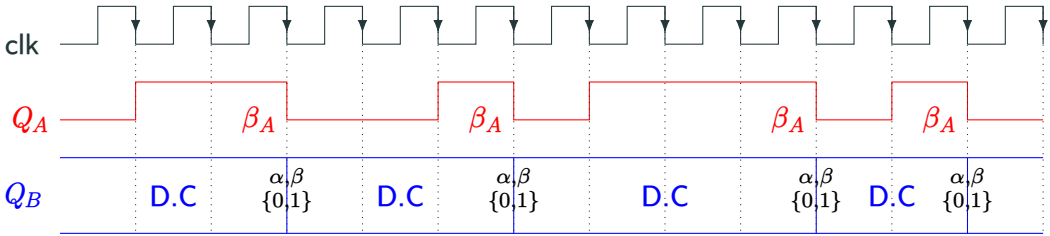
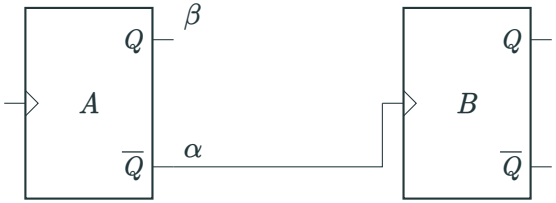
α Transitions



β Transitions



β Transitions in Positive Edge Triggered Flip-Flops

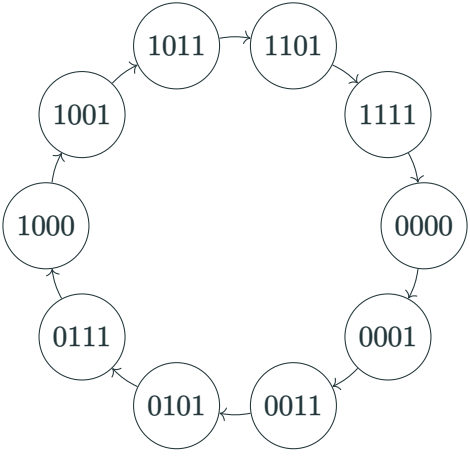


Algorithm

- From the State Diagram, obtain the State Table and Transtion Table.
- Identify the flip-flop '**Z**' that can be clocked by the output of flip-flop '**Y**'. To do that, check if α transitions (or β transitions) in flip-flop **Y** cover all α and β transitions in flip-flop **Z**.
- Modify the transitions of flip-flop **Z** according to the following: for each flip-flop **Z** transition different from α transition (or β transition, respectively) change any '0' and '1' transitions in flip-flop **Z** with dont care transition ('X').
- Construct the Karnaugh maps using the Transition Table.
- Select the flip-flop to be used in the design.
- Using the Karnaugh maps derive the optimum input equations for the selected flip-flops.

Contents

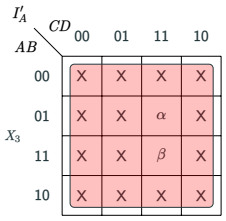
State Diagram



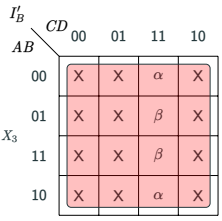
State Table and Transition Table

Present State				Next State				Transitions											
A	B	C	D	A_+	B_+	C_+	D_+	I_A	I_B	I_C	I_D	I'_A	I'_B	I'_C	I'_D	I''_A	I''_B	I''_C	I''_D
0	0	0	0	0	0	0	1	0	0	0	α	X	X	0	α	X	X	0	α
0	0	0	1	0	0	1	1	0	0	α	1	X	X	α	1	X	X	α	1
0	0	1	1	0	1	0	1	0	α	β	1	X	α	β	1	0	α	β	1
0	1	0	1	0	1	1	1	0	1	α	1	X	X	α	1	X	X	α	1
0	1	1	1	1	0	0	0	α	β	β	β	α	β	β	β	α	β	β	β
1	0	0	0	1	0	0	1	1	0	0	α	X	X	0	α	X	X	0	α
1	0	0	1	1	0	1	1	1	0	α	1	X	X	α	1	X	X	α	1
1	0	1	1	1	1	0	1	1	α	β	1	X	α	β	1	1	α	β	1
1	1	0	1	1	1	1	1	1	1	α	1	X	X	α	1	X	X	α	1
1	1	1	1	0	0	0	0	β	β	β	β	β	β	β	β	β	β	β	β

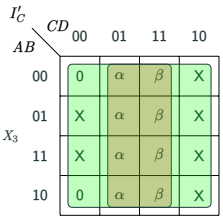
Karnaugh Maps for $\{I'_A, I'_B, I'_C, I'_D\}$



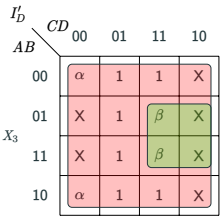
$$J_A = 1$$
$$K_A = 1$$



$$J_B = 1$$
$$K_B = 1$$

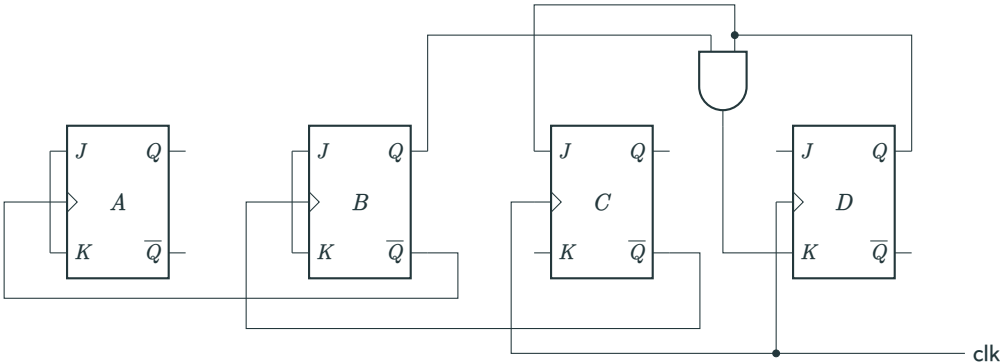


$$J_C = D$$
$$K_C = 1$$

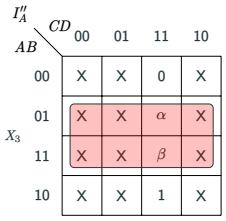


$$J_D = 1$$
$$K_D = BC$$

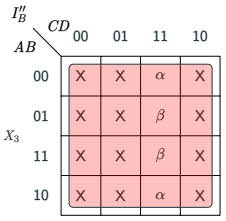
Circuit Diagram



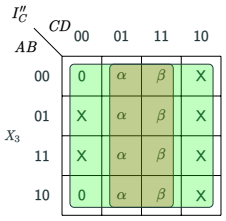
Karnaugh Maps for $\{I''_A, I''_B, I''_C, I''_D\}$



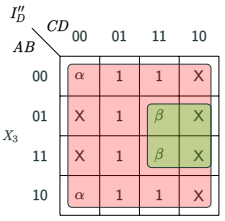
$$J_A = B$$
$$K_A = B$$



$$J_B = 1$$
$$K_B = 1$$

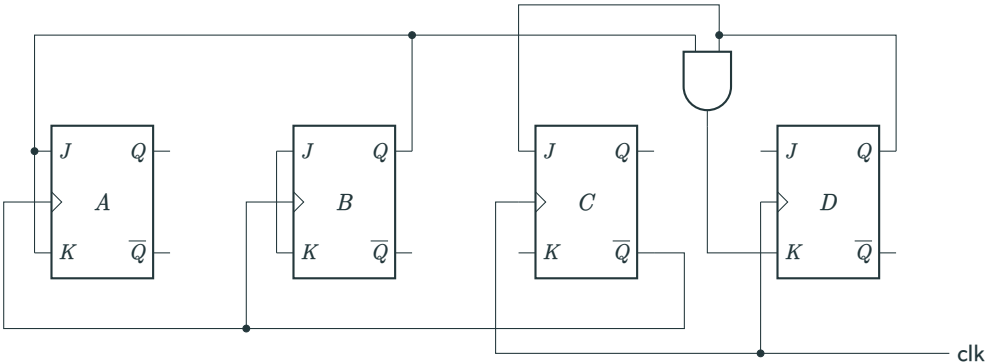


$$J_C = D$$
$$K_C = 1$$



$$J_D = 1$$
$$K_D = BC$$

Circuit Diagram



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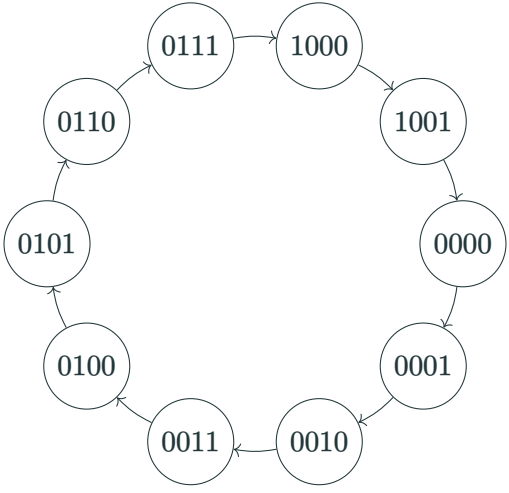
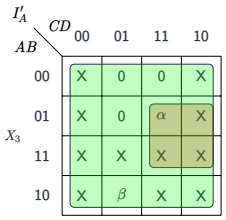
State diagram

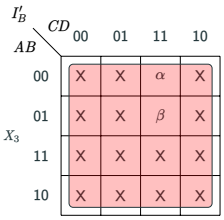


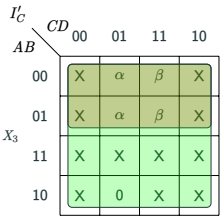
State Table and Transition Table

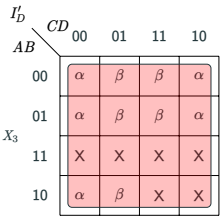
Present State				Next State				Transitions							
A	B	C	D	A_+	B_+	C_+	D_+	I_A	I_B	I_C	I_D	I'_A	I'_B	I'_C	I'_D
0	0	0	0	0	0	0	1	0	0	0	α	X	X	X	α
0	0	0	1	0	0	1	0	0	0	α	β	0	X	α	β
0	0	1	0	0	0	1	1	0	0	1	α	X	X	X	α
0	0	1	1	0	1	0	0	0	α	β	β	0	α	β	β
0	1	0	0	0	1	0	1	0	1	0	α	X	X	X	α
0	1	0	1	0	1	1	0	0	1	α	β	0	X	α	β
0	1	1	0	0	1	1	1	0	1	1	α	X	X	X	α
0	1	1	1	1	0	0	0	α	β	β	β	α	β	β	β
1	0	0	0	1	0	0	1	1	0	0	α	X	X	X	α
1	0	0	1	0	0	0	0	β	0	0	β	β	X	0	β

Design with JK Flip-Flops









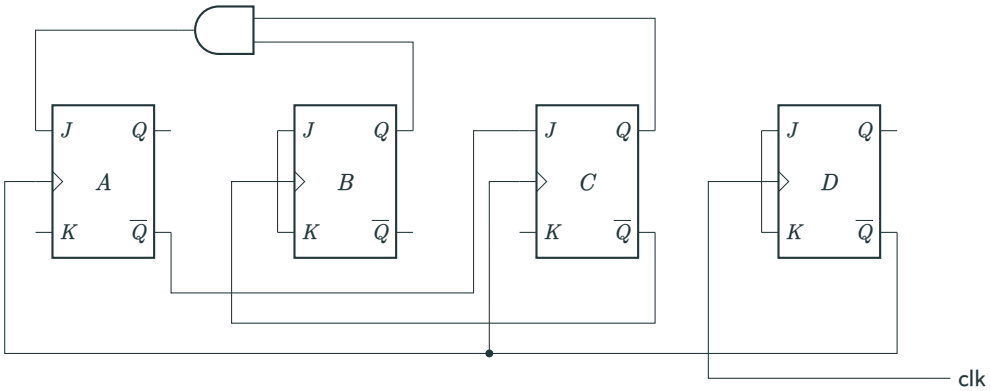
$$J_A = BC \qquad K_A = 1$$

$$J_B = 1 \qquad K_B = 1$$

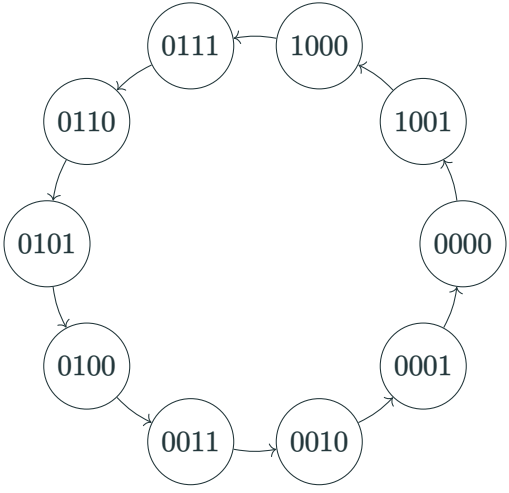
$$J_C = \overline{A} \qquad K_C = 1$$

$$J_D = 1 \qquad K_D = 1$$

Circuit Diagram



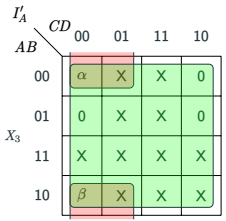
State diagram (Down Counter)

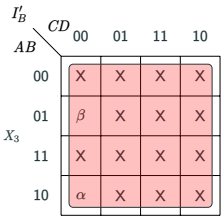


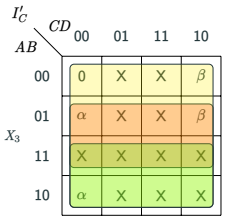
State Table and Transition Table

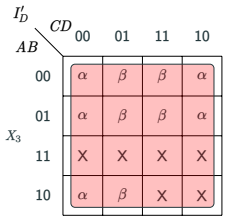
Present State				Next State				Transitions							
A	B	C	D	A_+	B_+	C_+	D_+	I_A	I_B	I_C	I_D	I'_A	I'_B	I'_C	I'_D
0	0	0	0	1	0	0	1	α	0	0	α	α	X	0	α
0	0	0	1	0	0	0	0	0	0	0	β	X	X	X	β
0	0	1	0	0	0	0	1	0	0	β	α	0	X	β	α
0	0	1	1	0	0	1	0	0	0	1	β	X	X	X	β
0	1	0	0	0	0	1	1	0	β	α	α	0	β	α	α
0	1	0	1	0	1	0	0	0	1	0	β	X	X	X	β
0	1	1	0	0	1	0	1	0	1	β	α	0	X	β	α
0	1	1	1	0	1	1	0	0	1	1	β	X	X	X	β
1	0	0	0	0	1	1	1	β	α	α	α	β	α	α	α
1	0	0	1	1	0	0	0	1	0	0	β	X	X	X	β

Design with JK Flip-Flops









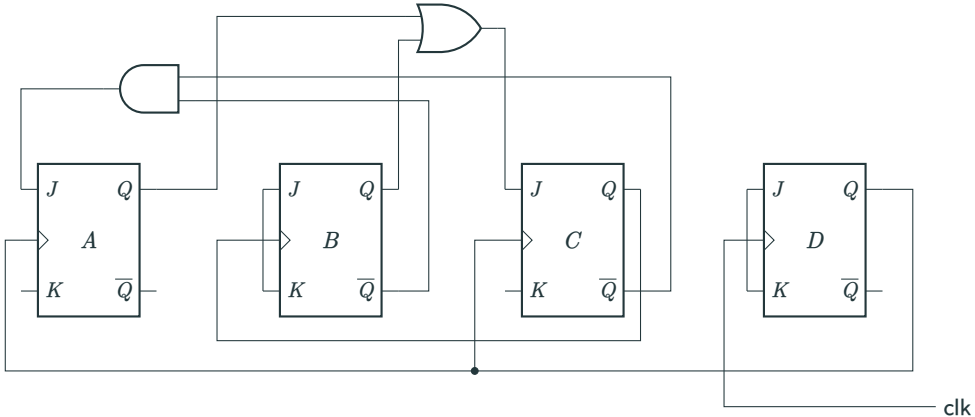
$$J_A = \overline{B}\,\overline{C}$$
$$K_A = 1$$

$$J_B = 1$$
$$K_B = 1$$

$$J_C = A + B$$
$$K_C = 1$$

$$J_D = 1$$
$$K_D = 1$$

Circuit Diagram



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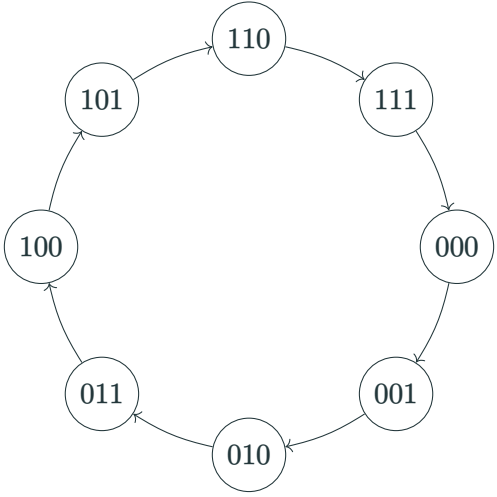
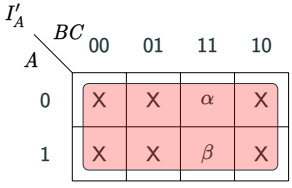
State diagram



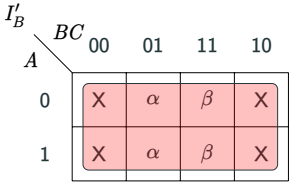
State Table and Transition Table

Present State			Next State			Transitions					
A	B	C	A_+	B_+	C_+	I_A	I_B	I_C	I'_A	I'_B	I'_C
0	0	0	0	0	1	0	0	α	X	X	α
0	0	1	0	1	0	0	α	β	X	α	β
0	1	0	0	1	1	0	1	α	X	X	α
0	1	1	1	0	0	α	β	β	α	β	β
1	0	0	1	0	1	1	0	α	X	X	α
1	0	1	1	1	0	1	α	β	X	α	β
1	1	0	1	1	1	1	1	α	X	X	α
1	1	1	0	0	0	β	β	β	β	β	β

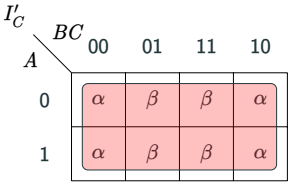
Design with T Flip-Flops



$T_A = 1$

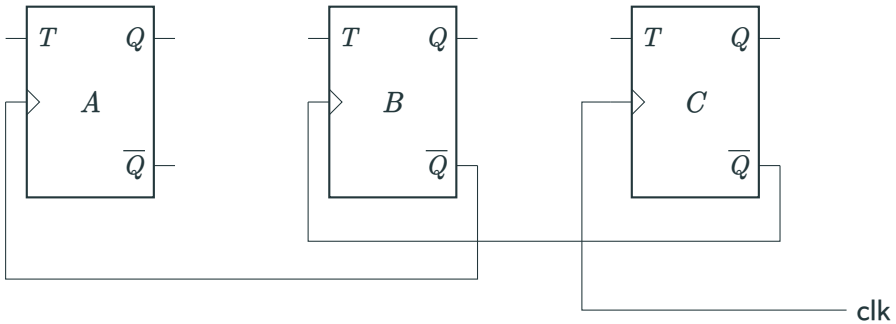


$T_B = 1$

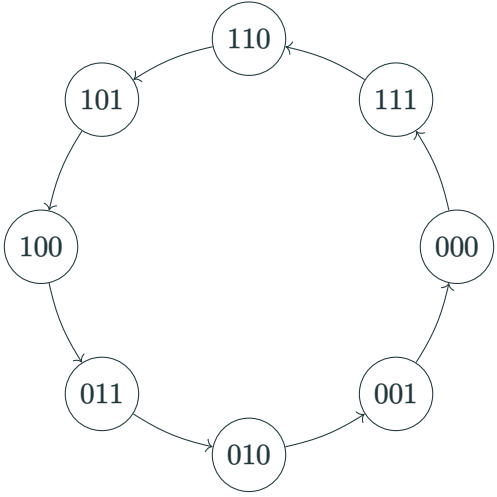


$T_C = 1$

Circuit Diagram



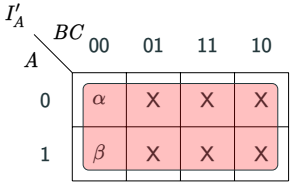
State diagram (Down Counter)



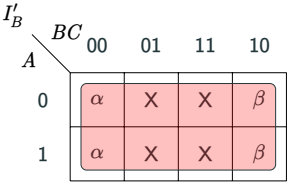
State Table and Transition Table

Present State			Next State			Transitions					
A	B	C	A_+	B_+	C_+	I_A	I_B	I_C	I'_A	I'_B	I'_C
0	0	0	1	1	1	α	α	α	α	α	α
0	0	1	0	0	0	0	0	β	X	X	β
0	1	0	0	0	1	0	β	α	X	β	α
0	1	1	0	1	0	0	1	β	X	X	β
1	0	0	0	1	1	β	α	α	β	α	α
1	0	1	1	0	0	1	0	β	X	X	β
1	1	0	1	0	1	1	β	α	X	β	α
1	1	1	1	1	0	1	1	β	X	X	β

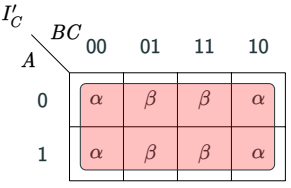
Design with T Flip-Flops



$T_A = 1$



$T_B = 1$



$T_C = 1$

Circuit Diagram