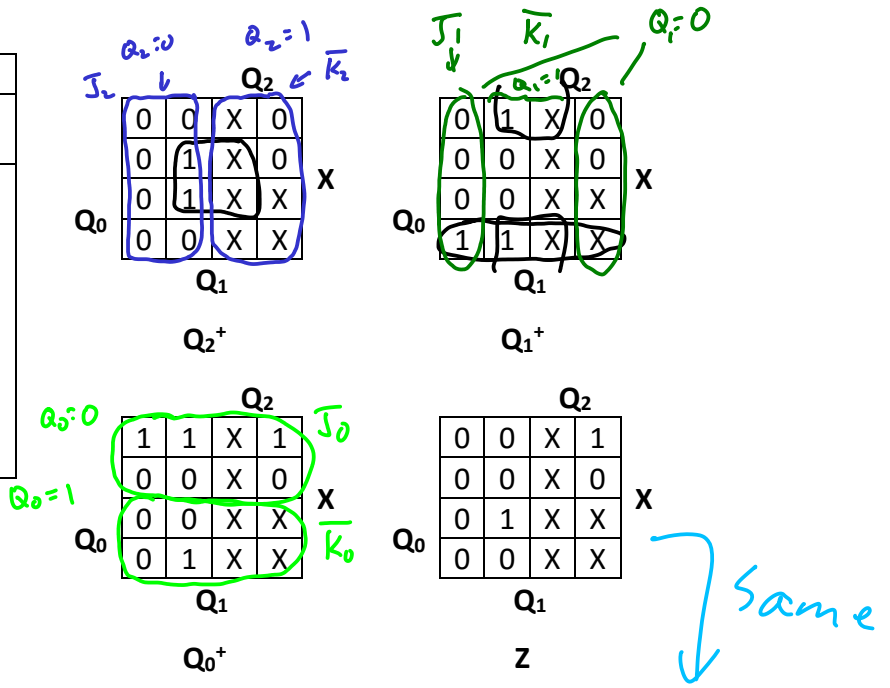


Implementation with D-ff, T-ff and JK-ff

Sequence detector: detect sequences of 0010 or 0001
Overlapping patterns are allowed

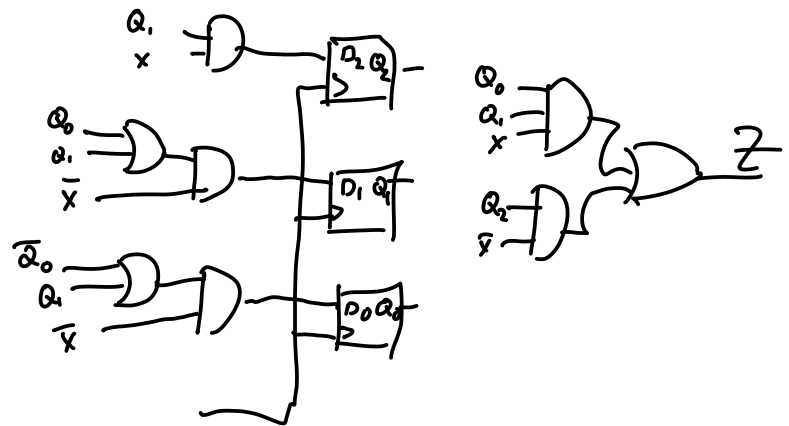
Mealy design: The following assumes the state assignment $S_0 = 000$, $S_1 = 001$, $S_2 = 010$, $S_3 = 011$, $S_4 = 100$. Note: a better state assignment may result in simpler logic.

PS $Q_2Q_1Q_0$	NS		Output	
	X=0 $Q_2^+Q_1^+Q_0^+$	X=1 $Q_2^+Q_1^+Q_0^+$	X=0 z	X=1 z
000	001	000	0	0
001	010	000	0	0
010	011	100	0	0
011	011	100	0	1
100	001	000	1	0
101	XXX	XXX	X	X
110	XXX	XXX	X	X
111	XXX	XXX	X	X



To implement with D-ff, the equations are

$$\begin{aligned}
 D_2 &= Q_2^+ = Q_1X \\
 D_1 &= Q_1^+ = \overline{X} (Q_0 + Q_1) \\
 D_0 &= Q_0^+ = \overline{X} (\overline{Q_0} + Q_1) \\
 Z &= Q_0Q_1X + Q_2 \overline{X}
 \end{aligned}$$



To implement with T-ff:



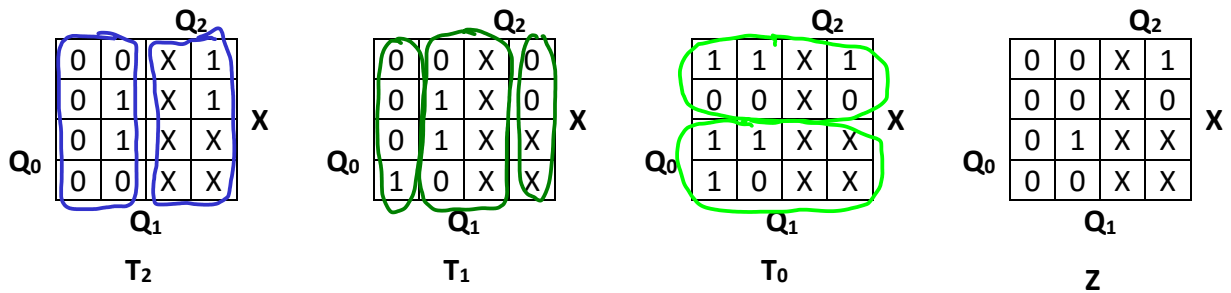
PS $Q_2Q_1Q_0$	NS		T inputs		Output	
	X=0 $Q_2^+Q_1^+Q_0^+$	X=1 $Q_2^+Q_1^+Q_0^+$	X=0 $T_2T_1T_0$	X=1 $T_2T_1T_0$	X=0 z	X=1 z
000	001	000	001	000	0	0
001	010	000	011	001	0	0
010	011	100	001	110	0	0
011	011	100	000	111	0	1
100	001	000	101	100	1	0
101	XXX	XXX	XXX	XXX	X	X
110	XXX	XXX	XXX	XXX	X	X
111	XXX	XXX	XXX	XXX	X	X

Uses the excitation table:

PS

Q	Q ⁺	T
0	0	0
0	1	1
1	0	1
1	1	0

Put these into K-maps. Note that Z is unchanged – it doesn't depend on the type of flip-flop.



So, to implement with T-ff, the equations are

$$T_2 = Q_1X + Q_2$$

$$T_1 = Q_1X + \overline{Q_1} \overline{Q_0} \overline{X}$$

$$T_0 = \overline{Q_0} \overline{X} + X Q_0 + \overline{Q_1} \overline{X}$$

$$Z = Q_0Q_1X + Q_2 \overline{X} \text{ (unchanged)}$$

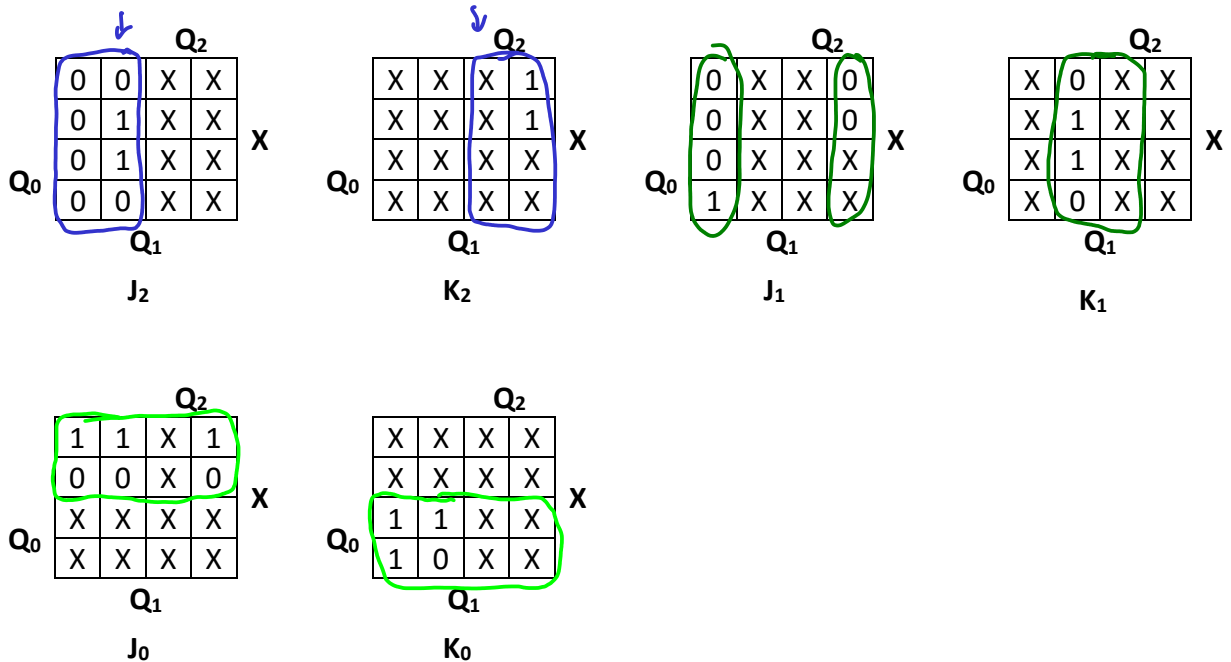
To implement with JK-ff (skipping Z, as it is unchanged):

PS Q ₂ Q ₁ Q ₀	NS		Q ₂ -ff		Q ₁ -ff		Q ₀ -ff	
	X=0 Q ₂ ⁺ Q ₁ ⁺ Q ₀ ⁺	X=1 Q ₂ ⁺ Q ₁ ⁺ Q ₀ ⁺	X=0 J ₂ K ₂	X=1 J ₂ K ₂	X=0 J ₁ K ₁	X=1 J ₁ K ₁	X=0 J ₀ K ₀	X=1 J ₀ K ₀
000	001	000	0 X	0 X	0 X	0 X	1 X	0 X
001	010	000	0 X	0 X	1 X	0 X	X 1	X 1
010	011	100	0 X	1 X	X 0	X 1	1 X	0 X
011	011	100	0 X	1 X	X 0	X 1	X 0	X 1
100	001	000	X 1	X 1	0 X	0 X	1 X	0 X
101	XXX	XXX	X X	X X	X X	X X	X X	X X
110	XXX	XXX	X X	X X	X X	X X	X X	X X
111	XXX	XXX	X X	X X	X X	X X	X X	X X

Uses the excitation table:

Q Q ⁺	J	K
0 0	0	X
0 1	1	X
1 0	X	1
1 1	X	0

Put these into K-maps.



So, to implement with JK-ff, the equations are

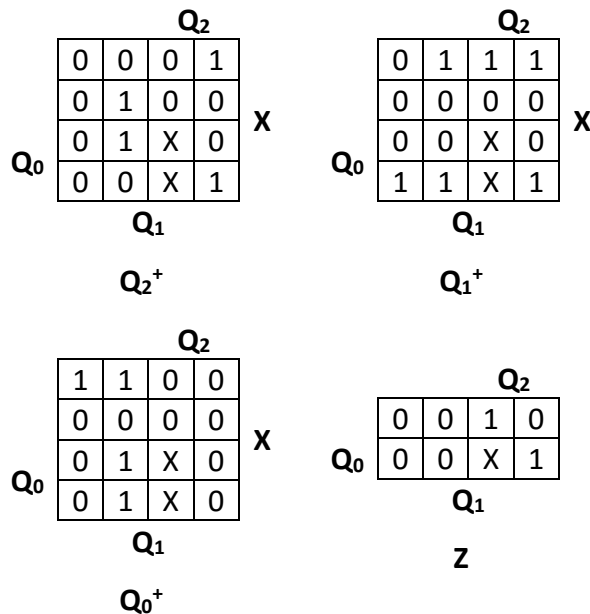
$$\begin{aligned}
 J_2 &= Q_1 X \\
 K_2 &= 1 \\
 J_1 &= Q_0 \overline{X} \\
 K_1 &= X \\
 J_0 &= \overline{X} \\
 K_0 &= X + \overline{Q_1}
 \end{aligned}$$

There are more input equations than with D-ff but the logic tends to be simpler

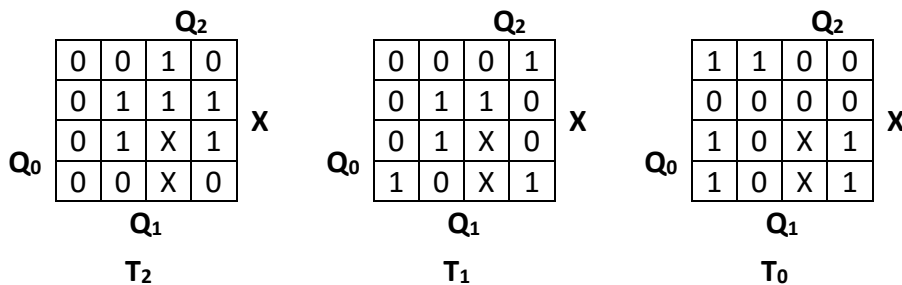
↓ Moore version

Moore design: The following assumes the state assignment $S0 = 000$, $S1 = 001$, $S2 = 010$, $S3 = 011$, $S4 = 100$, $S5 = 101$, $S6 = 110$. A better state assignment may result in simpler logic.

PS	NS		Output
	X=0	X=1	
$Q_2Q_1Q_0$	$Q_2^+Q_1^+Q_0^+$	$Q_2^+Q_1^+Q_0^+$	z
000	001	000	0
001	010	000	0
010	011	100	0
011	011	101	0
100	110	000	0
101	110	000	1
110	010	000	1
111	XXX	XXX	X



Maps for implementing with T-ff:



Maps for implementing with JK-ff

