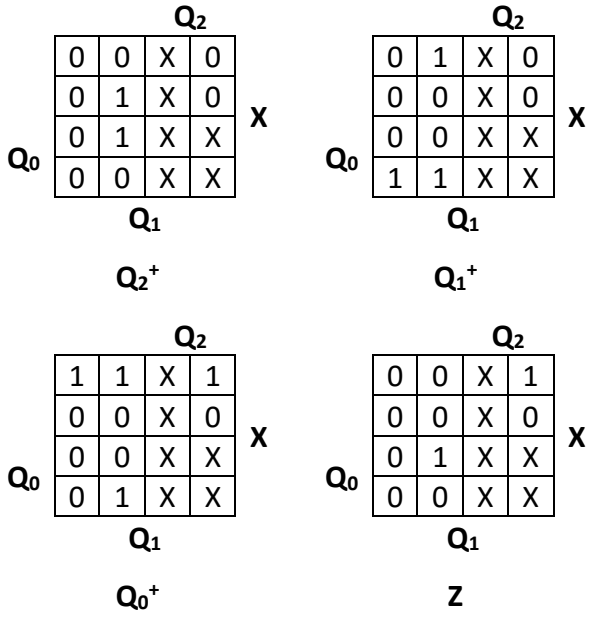
Implementation with D-ff, T-ff and JK-ff

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

Mealy design: The following assumes the state assignment S0 = 000, S1 = 001, S2 = 010, S3 = 011, S4 = 100. Note: a better state assignment may result in simpler logic.

PS	NS		Output	
	X=0	X=1	X=0	X=1
$Q_2Q_1Q_0$	$Q_2^+Q_1^+Q_0^+$	$Q_2^+Q_1^+Q_0^+$	z	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

$D_2 = Q_2^+ = Q_1X$

$D_1 = Q_1^+ = \overline{X}\,(Q_0 + Q_1)$

$D_0 = Q_0^+ = \overline{X}\,(\overline{Q_0} + Q_1)$

$Z = Q_0Q_1X + Q_2\,\overline{X}$

To implement with T-ff:

PS	NS		T inputs		Output	
	X=0	X=1	X=0	X=1	X=0	X=1
$Q_2Q_1Q_0$	$Q_2^+Q_1^+Q_0^+$	$Q_2^+Q_1^+Q_0^+$	$T_2T_1T_0$	$T_2T_1T_0$	z	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:

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.

T_2

Q_0 \ Q_2	0	1	X	X
0	0	1	X	X
1	0	1	X	X

T_1

Q_0 \ Q_2	0	1	X	X
0	0	1	X	X
1	0	1	X	X

T_0

Q_0 \ Q_2	0	1	X	X
0	1	0	X	X
1	1	0	X	X

Z

Q_0 \ Q_2	0	1	X	X
0	0	0	X	X
1	0	0	X	X

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

$T_2 = Q_1X + Q_2$

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

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

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

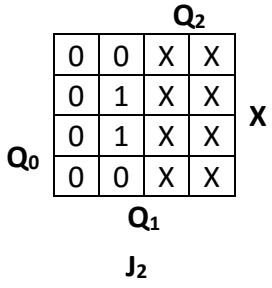
To implement with JK-ff (skipping Z, as it is unchanged):

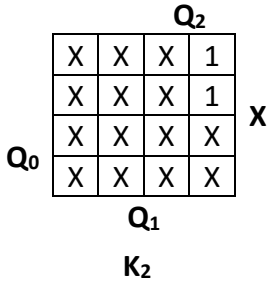
PS	NS		Q_2-ff		Q_1-ff		Q_0-ff	
	X=0	X=1	X=0	X=1	X=0	X=1	X=0	X=1
$Q_2Q_1Q_0$	$Q_2^+Q_1^+Q_0^+$	$Q_2^+Q_1^+Q_0^+$	$J_2\,K_2$	$J_2\,K_2$	$J_1\,K_1$	$J_1\,K_1$	$J_0\,K_0$	$J_0\,K_0$
000	001	000	0 X	0 X	0 X	0 X	1 X	0 X
001	010	000	0 X	0 X	1 X	0 X	X 1	X 1
010	011	100	0 X	1 X	X 0	X 1	1 X	0 X
011	011	100	0 X	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

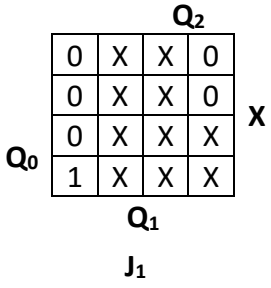
Uses the excitation table:

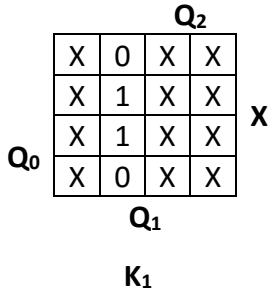
$Q\,Q^+$	J	K
0 0	0	X
0 1	1	X
1 0	X	1
1 1	X	0

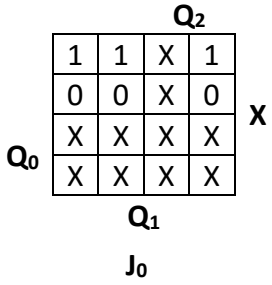
Put these into K-maps.

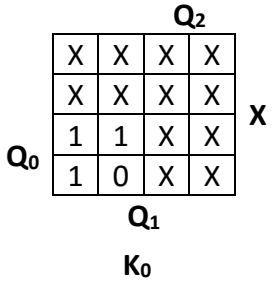












So, to implement with JK-ff, the equations are

$J_2 = Q_1X$

$K_2 = 1$

$J_1 = Q_0\,\overline{X}$

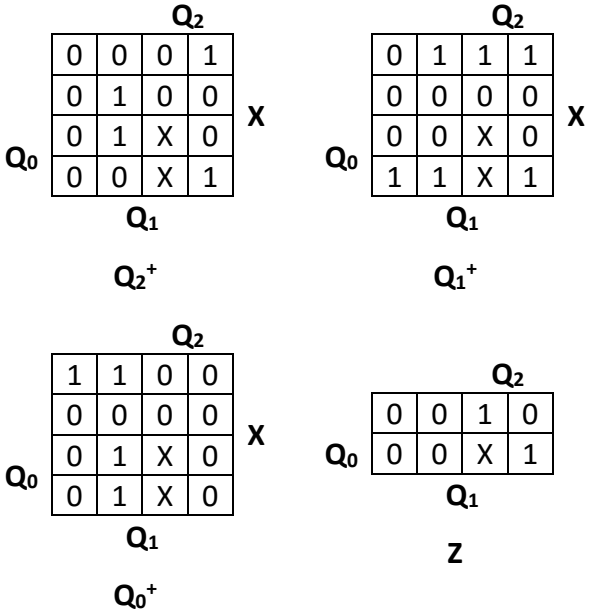
$K_1 = X$

$J_0 = \overline{X}$

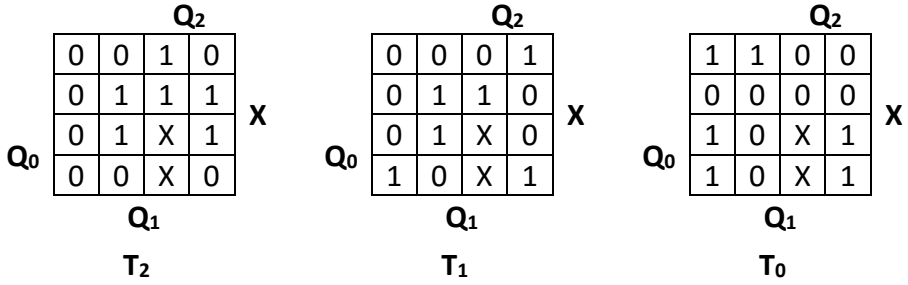
$K_0 = X + \overline{Q_1}$

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