Flip Flop Conversion

1. Consider the characteristic table of desired flip-flop.
2. Fill the excitation values inputs of given flip-flop for each combination of present
3. Get the simplified expressions for each excitation input. If necessary, use K maps for simplifying.
4. Draw the circuit diagram of desired flip-flop according to the simplified expressions using given flip-flop and necessary logic gates.

SR → D flip → Desired flip flop

↓

Available

Step 1

① Desired flip flop truth table

D	Q P.S	Q(t+1) N.S
0	0	0
0	1	0
1	0	1
1	1	1

Step 2 :- Excitation table for available flip flop

SR flip flop excitation table

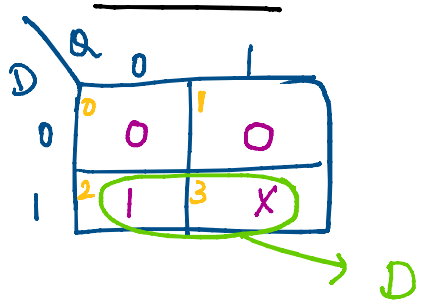
Q	Q(t+1)	S	R
0	0	0	X
0	1	1	0
1	0	0	1
1	1	X	0

Step 3 Combine step 1 & step 2 derived flip flop truth table & SR excitation i/ps

Decimal	D flip flop truth: D	Q	Q(t+1)	excitation i/ps: S ✓	R ✓
0	0	0	0	0	X
1	0	1	0	0	1
2	1	0	1	1	0
3	1	1	1	X	0

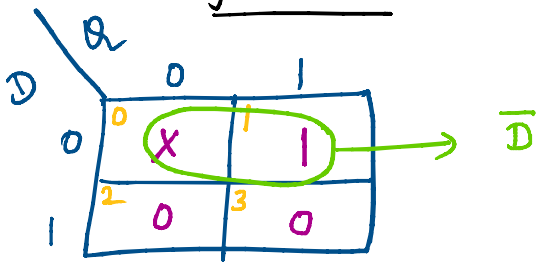
Step 4 :- Get simplified expression for excitation i/ps (S & R) either by using K map (or) Boolean laws

for S

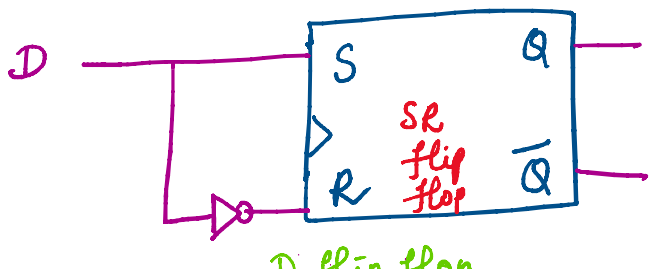


$S = D$

for R



$R = \overline{D}$



D flip flop

SR Flip-Flop to other Flip-Flop Conversions

Following are the three possible conversions of SR flip-flop to other flip-flops.

- SR flip-flop to D flip-flop
- SR flip-flop to JK flip-flop
- SR flip-flop to T flip-flop

SR flip-flop to D flip-flop conversion

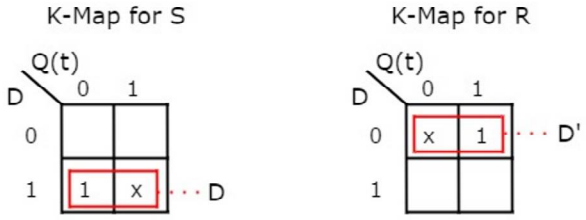
Here, the given flip-flop is SR flip-flop and the desired flip-flop is D flip-flop. Therefore, consider the following characteristic table of D flip-flop.

D flip-flop input	Present State	Next State
D	**Q**(t)	**Q**(t+1)
0	0	0
0	1	0
1	0	1
1	1	1

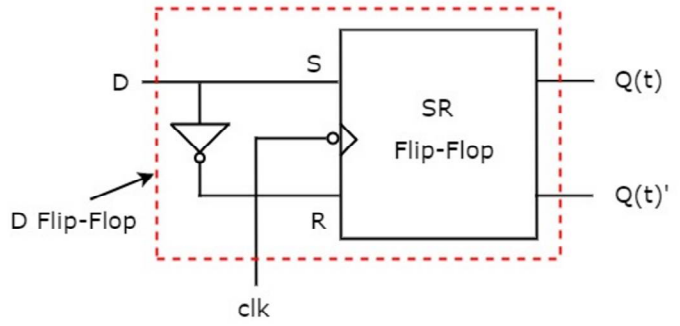
1. We know that SR flip-flop has two inputs S & R.
2. So, write down the excitation values of SR flip-flop for each combination of present state and next state values.
3. The following table shows the characteristic table of D flip-flop along with the excitation inputs of SR flip-flop.

D flip-flop input	Present State	Next State	SR flip-flop inputs	
D	**Q**(t)	**Q**(t+1)	**S**	**R**
0	0	0	0	x
0	1	0	0	1
1	0	1	1	0
1	1	1	x	0

We can use 2 variable K-Maps for getting simplified expressions for these inputs. The k-Maps for S & R are shown below.



So, we got S = D & R = D' after simplifying. The circuit diagram of D flip-flop is shown in the following figure.



This circuit consists of SR flip-flop and an inverter. This inverter produces an output, which is complement of input, D. So, the overall circuit has single input, D and two outputs Q(t) & Q(t'). Hence, it is a D flip-flop. Similarly, you can do other two conversions.

SR flip flop to JK flip flop

Decimal	JK flip flop J	K	Q	Q(t+1)	excitation i/p S	R
0	0	0	0	0	0	X
1	0	0	1	1	X	0
2	0	1	0	0	0	X
3	0	1	1	0	0	1
4	1	0	0	1	1	0
5	1	0	1	1	X	0
6	1	1	0	1	1	0
7	1	1	1	0	0	1

for S

J \ KQ	00	01	11	10
0	0 (6)	X (1)	0 (3)	0 (2)
1	1 (4)	X (5)	0 (7)	1 (6)

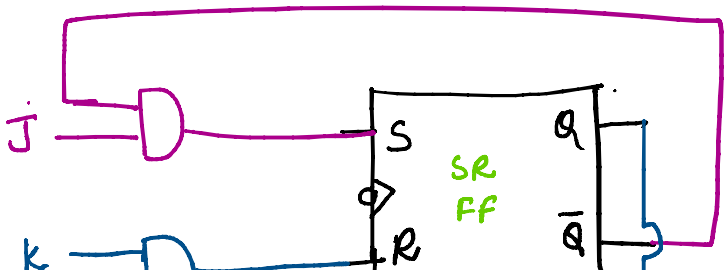
$S = J\bar{Q}$

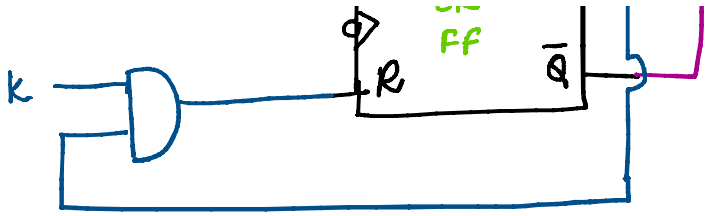
for R

J \ KQ	00	01	11	10
0	X (0)	0 (1)	1 (3)	X (2)
1	0 (4)	0 (5)	1 (7)	0 (6)

$R = KQ$

SR flip to JK flip flop





SR flip flop to T flip flop

T flip flop			excitation i/p	
T	Q	Q(t+1)	S	R
0	0	0	0	X
0	1	1	X	0
1	0	1	1	0
1	1	0	0	1

for S

T \ Q	0	1
0	0	X
1	1	0

$T\bar{Q}$

$S = T\bar{Q}$

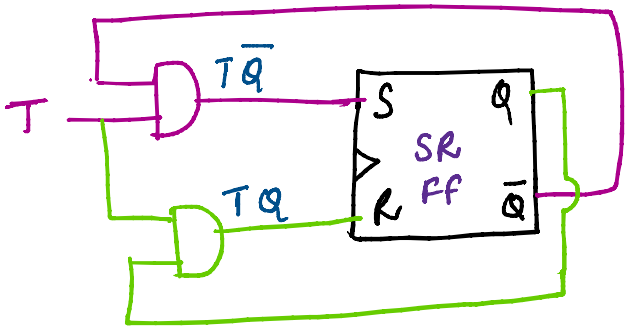
for R

T \ Q	0	1
0	X	0
1	0	1

TQ

$R = TQ$

SR to T flip flop



D Flip-Flop to other Flip-Flop Conversions

Following are the three possible conversions of D flip-flop to other flip-flops.

- D flip-flop to T flip-flop
- D flip-flop to SR flip-flop
- D flip-flop to JK flip-flop

D flip-flop to T flip-flop conversion

Here, the given flip-flop is D flip-flop and the desired flip-flop is T flip-flop. Therefore, consider the following characteristic table of T flip-flop.

T flip-flop input	Present State	Next State
T	**Q(t)**	**Q(t+1)**
0	0	0
0	1	1
1	0	1
1	1	0

1. We know that D flip-flop has single input D.
2. So, write down the excitation values of D flip-flop for each combination of present state and next state values.

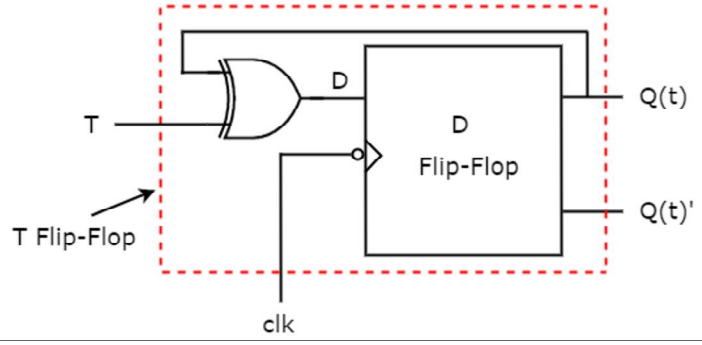
The following table shows the characteristic table of T flip-flop along with the excitation input of D flip-flop.

T flip-flop input	Present State	Next State	D flip-flop input
T	**Q(t)**	**Q(t+1)**	**D**
0	0	0	0
0	1	1	1
1	0	1	1
1	1	0	0

From the above table, we can directly write the Boolean function of D as below.

$D=T \oplus Q(t)$

So, we require a two input Exclusive-OR gate along with D flip-flop. The circuit diagram of T flip-flop is shown in the following figure.



This circuit consists of D flip-flop and an Exclusive-OR gate. This Exclusive-OR gate produces an

output, which is Ex-OR of T and Q(t). So, the overall circuit has single input, T and two outputs Q(t) & Q(t)'. Hence, it is a T flip-flop.

JK Flip-Flop to other Flip-Flop Conversions

Following are the three possible conversions of JK flip-flop to other flip-flops.

- JK flip-flop to T flip-flop
- JK flip-flop to D flip-flop
- JK flip-flop to SR flip-flop

JK flip-flop to T flip-flop conversion

Here, the given flip-flop is JK flip-flop and the desired flip-flop is T flip-flop. Therefore, consider the following characteristic table of T flip-flop.

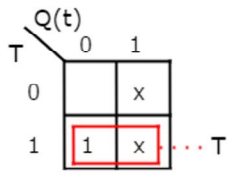
T flip-flop input	Present State	Next State
T	**Q(**t)	**Q(**t+1)
0	0	0
0	1	1
1	0	1
1	1	0

We know that JK flip-flop has two inputs J & K. So, write down the excitation values of JK flip-flop for each combination of present state and next state values. The following table shows the characteristic table of T flip-flop along with the excitation inputs of JK flipflop.

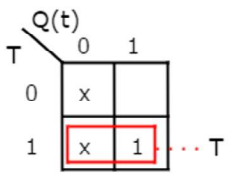
T flip-flop input	Present State	Next State	JK flip-flop inputs	
T	**Q**tt	**Q**t+1t+1	**J**	**K**
0	0	0	0	x
0	1	1	x	0
1	0	1	1	x
1	1	0	x	1

From the above table, we can write the Boolean functions for each input as below.
We can use 2 variable K-Maps for getting simplified expressions for these two inputs. The k-Maps for J & K are shown below.

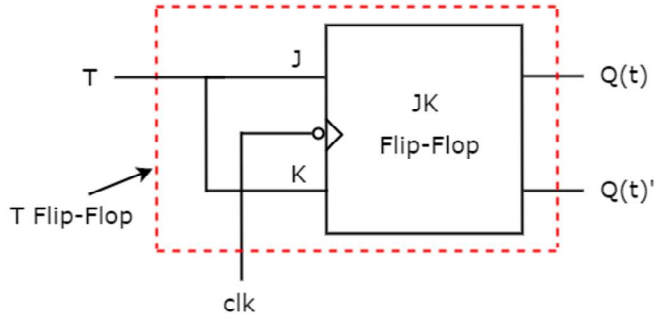
K-Map for J



K-Map for K



So, we got, J = T & K = T after simplifying. The circuit diagram of T flip-flop is shown in the following figure.



This circuit consists of JK flip-flop only. It doesn't require any other gates. Just connect the same input T to both J & K. So, the overall circuit has single input, T and two outputs Q(t) & Q(t'). Hence, it is a T flip-flop. Similarly, you can do other two conversions.

T Flip-Flop to other Flip-Flop Conversions

Following are the three possible conversions of T flip-flop to other flip-flops.

- T flip-flop to D flip-flop
- T flip-flop to SR flip-flop
- T flip-flop to JK flip-flop

T flip-flop to D flip-flop conversion

1. The given flip-flop is T flip-flop and the desired flip-flop is D flip-flop.
2. Consider the characteristic table of D flip-flop and write down the excitation values of T flip-flop for each combination of present state and next state values.

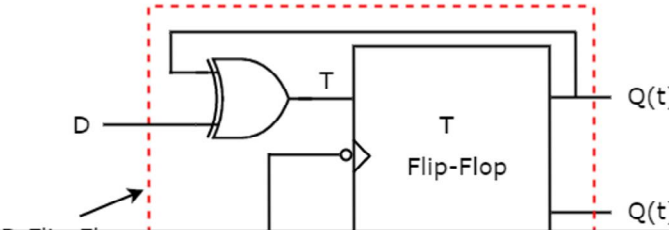
The following table shows the characteristic table of D flip-flop along with the excitation input of T flip-flop.

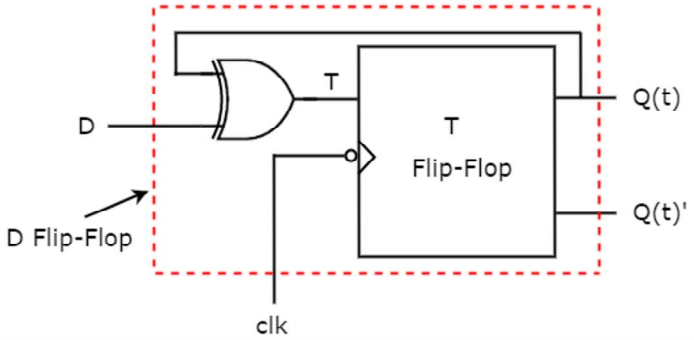
D flip-flop input	Present State	Next State	T flip-flop input
D	**Q(**t)	**Q(**t+1)	**T**
0	0	0	0
0	1	0	1
1	0	1	1
1	1	1	0

From the above table, we can directly write the Boolean function of T as below.

$T=D \oplus Q(t)$

So, we require a two input Exclusive-OR gate along with T flip-flop. The circuit diagram of D flip-flop is shown in the following figure.





This circuit consists of T flip-flop and an Exclusive-OR gate. This Exclusive-OR gate produces an output, which is Ex-OR of D and Q(t). So, the overall circuit has single input, D and two outputs Q(t) & Q(t'). Hence, it is a D flip-flop. Similarly, you can do other two conversions.