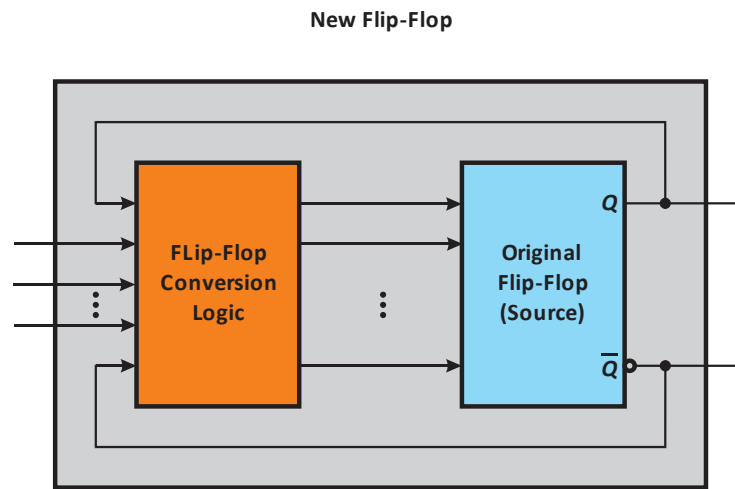
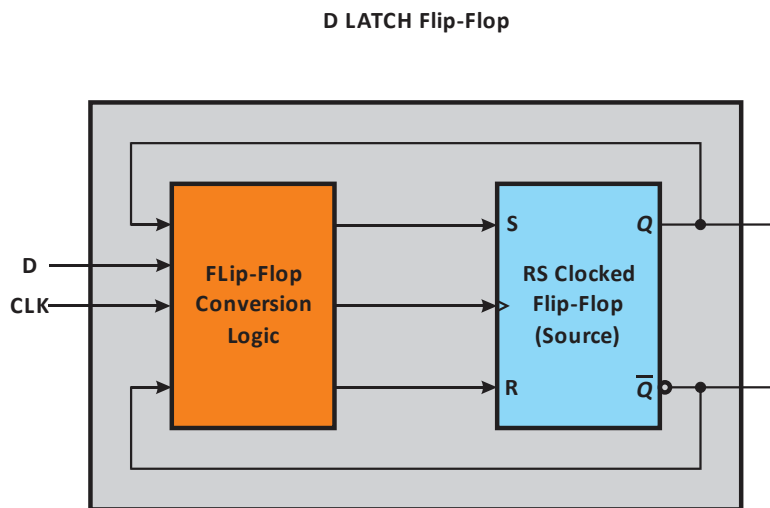


Write equations for the new flip-flop in terms of the controls for the original flip-flop.



Flip-Flop Conversion Block Diagram

1. Draw the block diagram.



RS Flip-Flop Conversion to D LATCH Flip-Flop

2. Write the New Flip-Flop Characteristic Table.

Example: the new flip-flop is a D LATCH flip-flop

	CLK	D	$Q(t)$	$Q(t + 1)$	
0	0	0	0	0	No Clock Flip-Flop Retains State
1	0	0	1	1	
2	0	1	0	0	
3	0	1	1	1	
4	1	0	0	0	Reset
5	1	0	1	0	
6	1	1	0	1	Set
7	1	1	1	1	

D Latch Clocked Flip-Flop Characteristic Table

3. Augment the Characteristic Table with the SR Flip-Flop controls. Enter values in SR Flip-Flop control fields that implement the actions defined by the Characteristic Table.

	CLK	D	$Q(t)$	$Q(t + 1)$	S	R	
0	0	0	0	0	0	x	No Clock Flip-Flop Retains State
1	0	0	1	1	x	0	
2	0	1	0	0	0	x	
3	0	1	1	1	x	0	
4	1	0	0	0	0	x	Reset
5	1	0	1	0	0	1	
6	1	1	0	1	1	0	Set
7	1	1	1	1	x	0	

Augmented D Latch Clocked Flip-Flop Characteristic Table

$Q(t)$	$\rightarrow$	$Q(t + 1)$	S	R
0		0	0	x
0		1	1	0
1		0	0	1
1		1	x	0

SR Excitation Table

4. Plot the S/R control values so that equations for the Characteristic Table can be found.

S
 $DQ(t)$
 CLK

	00	01	11	10
0	0	x	x	0
1	0	0	x	1

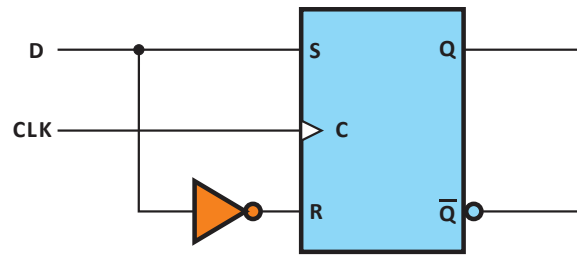
$$S = CLK \cdot D$$

R
 $DQ(t)$
 CLK

	00	01	11	10
0	x	0	0	x
1	x	1	0	0

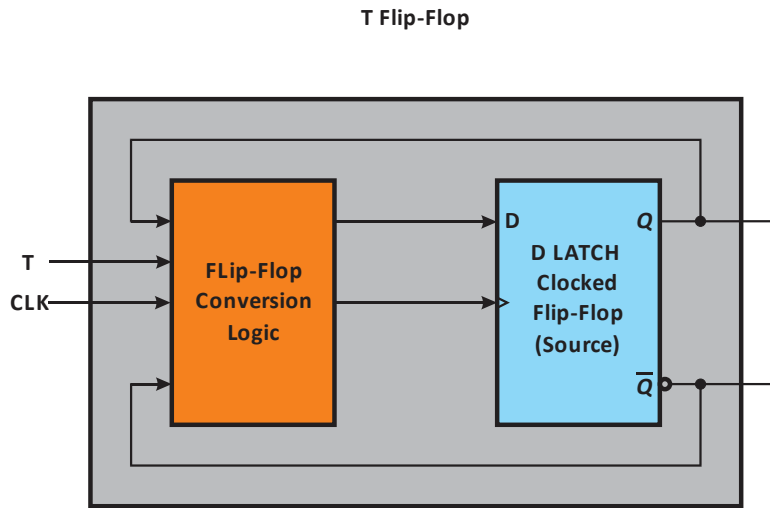
$$R = CLK \cdot \overline{D}$$

5. Draw the Logic Diagram of the Flip-Flop.



D LATCH Clocked Flip-Flop

1. Draw the block diagram to convert a D LATCH Flip-Flop to a T Flip-Flop



D-LATCH Flip-Flop Conversion to T Flip-Flop

2. Write the New Flip-Flop Characteristic Table.

Example: the new flip-flop is a T flip-flop

	<i>T</i>	<i>Q(t)</i>	<i>Q(t + 1)</i>	
0	0	0	0	Retain State
1	0	1	1	
2	1	0	1	Toggle
3	1	1	0	

T Flip-Flop Characteristic Table

3. Augment the Characteristic Table with the D Flip-Flop controls. Enter values in SR Flip-Flop control fields that implement the actions defined by the Characteristic Table.

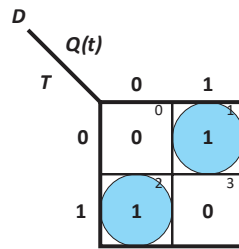
	<i>T</i>	<i>Q(t)</i>	<i>Q(t + 1)</i>	<i>D</i>	
0	0	0	0	0	Retain State
1	0	1	1	1	
2	1	0	1	1	Toggle
3	1	1	0	0	

Augmented T Flip-Flop Characteristic Table

<i>Q(t)</i>	$\rightarrow$ <i>Q(t + 1)</i>	<i>D</i>
0	0	0
0	1	1
1	0	0
1	1	1

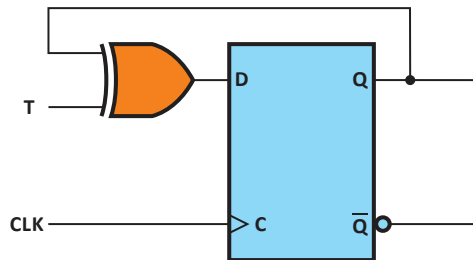
Clocked D Flip-Flop Excitation Table

4. Plot the D control values so that equations for the Characteristic Table can be found.



$$D = T\bar{Q} + \bar{T}Q = T \oplus Q$$

5. Draw the Logic Diagram of the Flip-Flop.



T Clocked Flip-Flop