ASSIGNMENT - 8

4 bit up and down counters

Submitted by - Sec B
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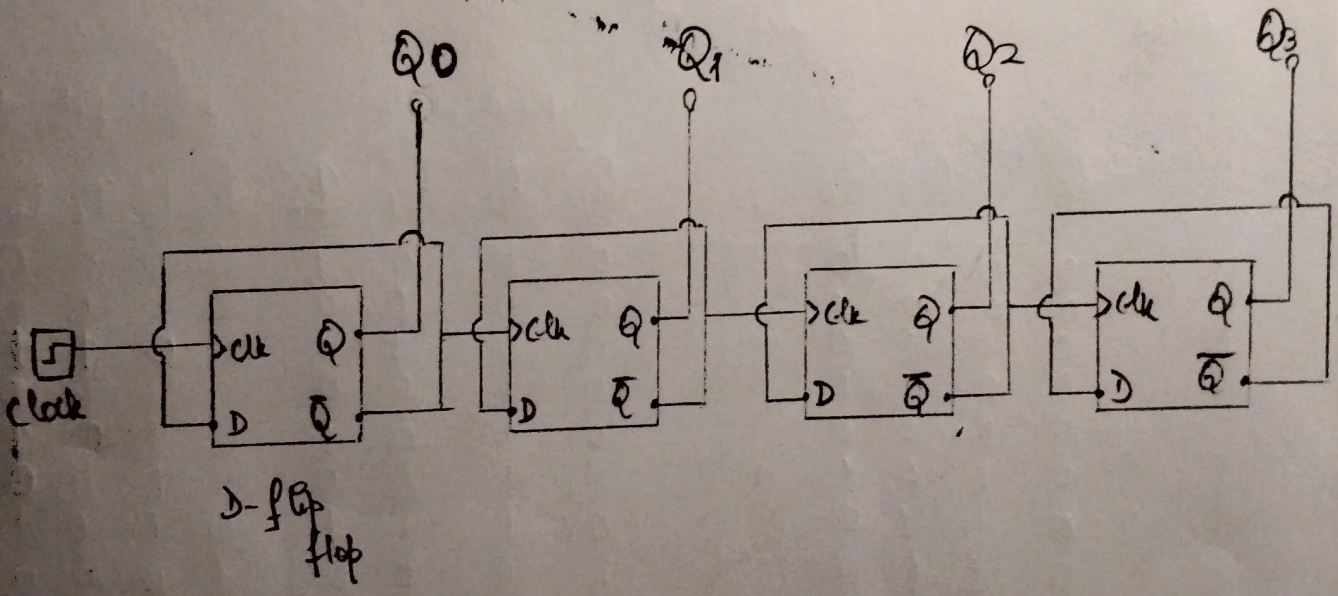
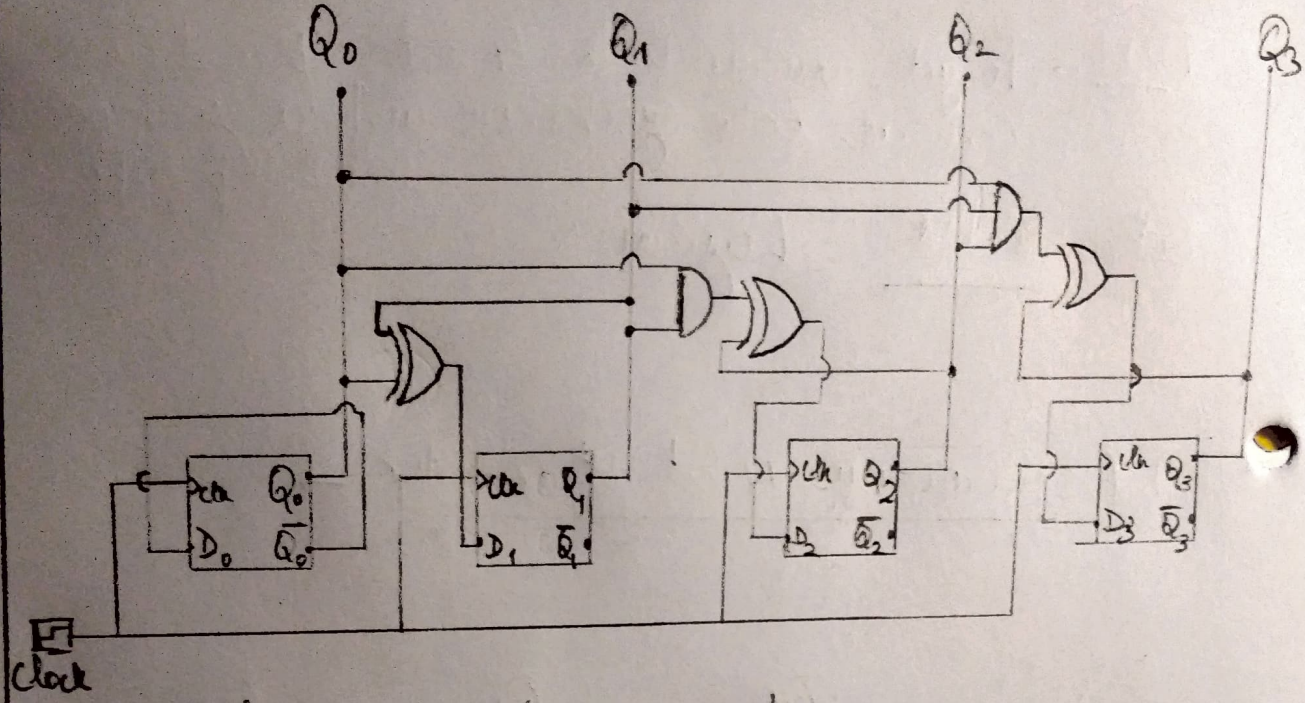
AIM → To get familiar with 4 bit up and down counters, both Synchronous and Asynchronous, made with D-flip flops

SOFTWARE USED → Logisim.

(I) Asynchronous 4 bit up counter →

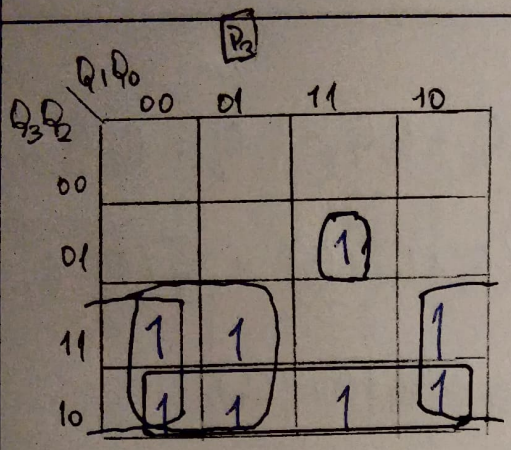


II Synchronous 4 bit up Counter →



				Next state				D flip flop input			
Q_3	Q_2	Q_1	Q_0	Q_3^+	Q_2^+	Q_1^+	Q_0^+	D_3	D_2	D_1	D_0
0	0	0	0	0	0	0	1	0	0	0	1
0	0	0	1	0	0	1	0	0	0	1	0
0	0	1	0	0	0	1	1	0	0	1	1
0	0	1	1	0	1	0	0	0	1	0	0
0	1	0	0	0	1	0	1	0	1	0	1
0	1	0	1	0	1	1	0	0	1	1	0
0	1	1	0	0	1	1	1	0	1	1	1
0	1	1	1	1	0	0	0	1	0	0	0
1	0	0	0	1	0	0	1	1	0	0	1
1	0	0	1	1	0	1	0	1	0	1	0
1	0	1	0	1	0	1	1	1	0	1	1
1	0	1	1	1	1	0	0	1	1	0	0
1	1	0	0	1	1	0	1	1	1	0	1
1	1	0	1	1	1	1	0	1	1	1	0
1	1	1	0	1	1	1	1	1	1	1	1
1	1	1	1	0	0	0	0	0	0	0	0
0	0	0	0								

3

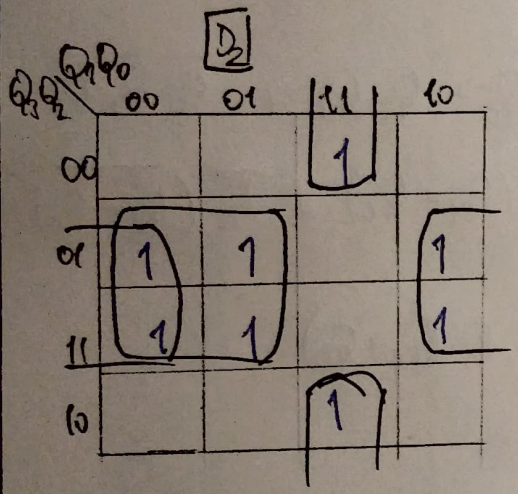


$$D_3 = Q_3\bar{Q}_2 + Q_3\bar{Q}_1 + Q_3\bar{Q}_0 + \bar{Q}_3 Q_2 Q_1 Q_0$$

$$= Q_3[(\bar{Q}_2 + \bar{Q}_1 + \bar{Q}_0)']' + \bar{Q}_3 Q_2 Q_1 Q_0$$

$$= Q_3[Q_2 Q_1 Q_0]' + Q_3' Q_2 Q_1 Q_0$$

$$\underline{D_3 = Q_3 \oplus Q_2 Q_1 Q_0}$$

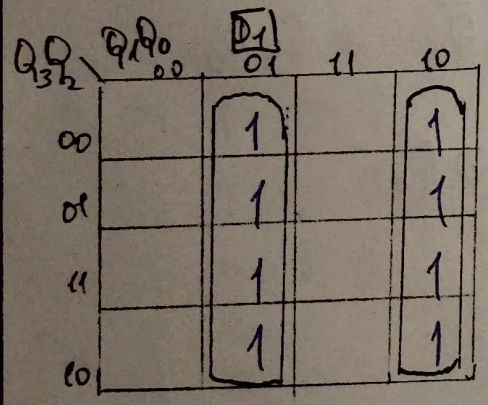


$$D_2 = Q_2\bar{Q}_0 + Q_2\bar{Q}_1 + \bar{Q}_2 Q_1 Q_0$$

$$= Q_2[\bar{Q}_0 + \bar{Q}_1)']' + Q_2' Q_1 Q_0$$

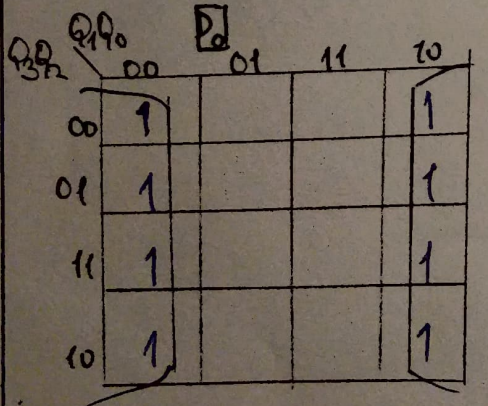
$$= Q_2[Q_1 Q_0]' + Q_2' Q_1 Q_0$$

$$\underline{D_2 = Q_2 \oplus Q_1 Q_0}$$

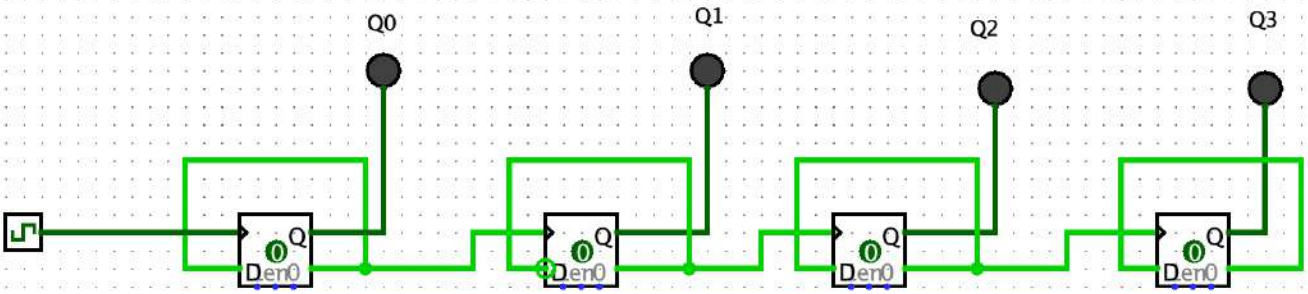


$$D_1 = \bar{Q}_1 Q_0 + Q_1 \bar{Q}_0$$

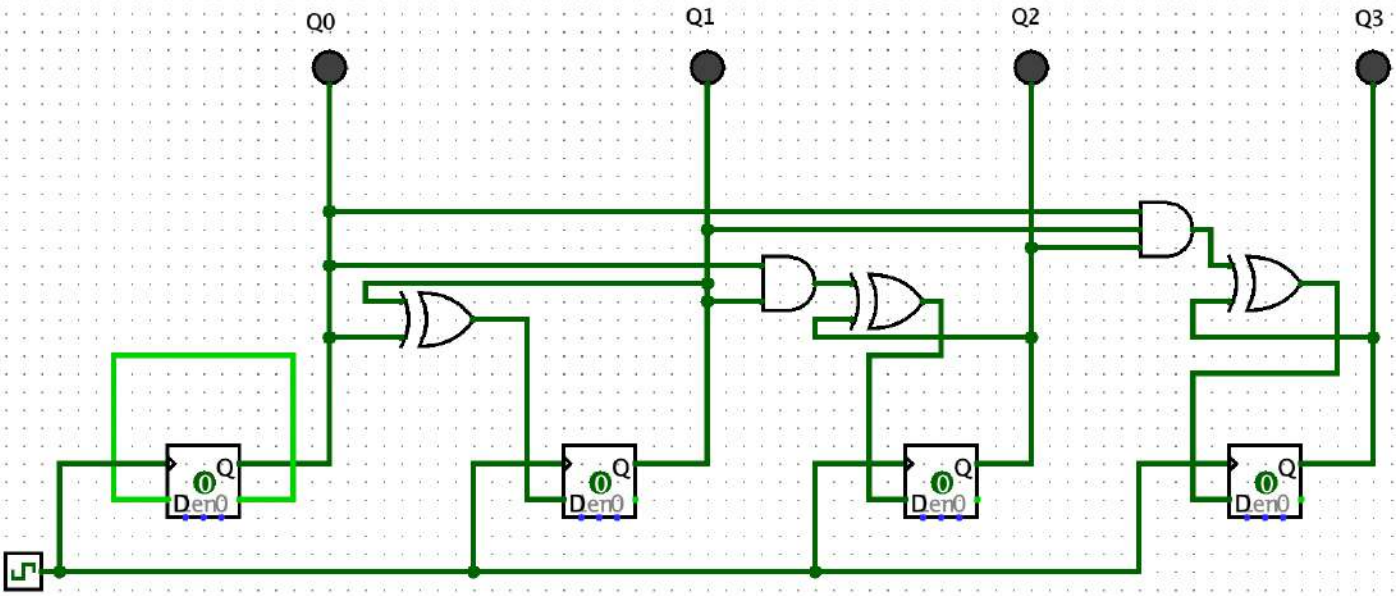
$$\underline{D_1 = Q_1 \oplus Q_0}$$



$$\underline{D_0 = \bar{Q}_0}$$

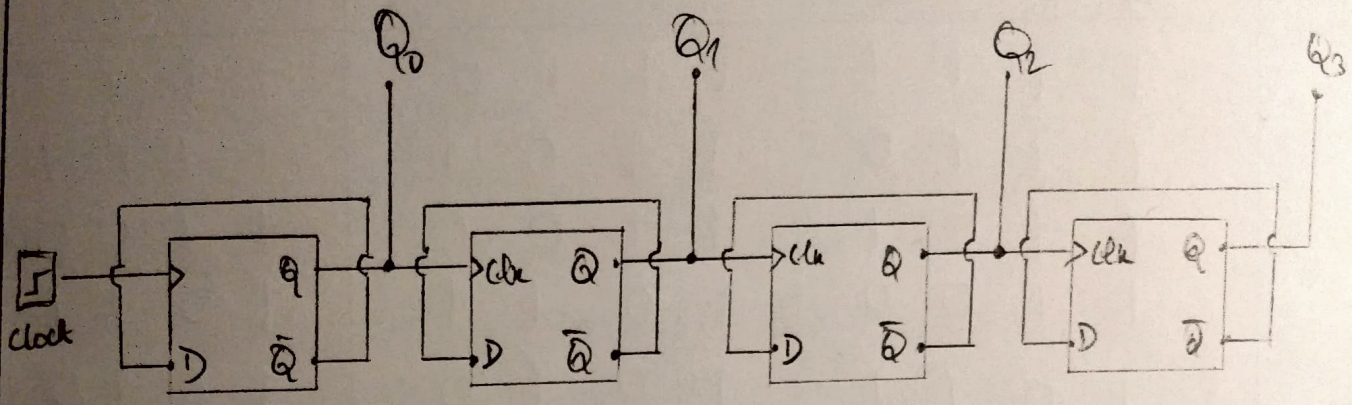


Asynchronous 4 bit up counter

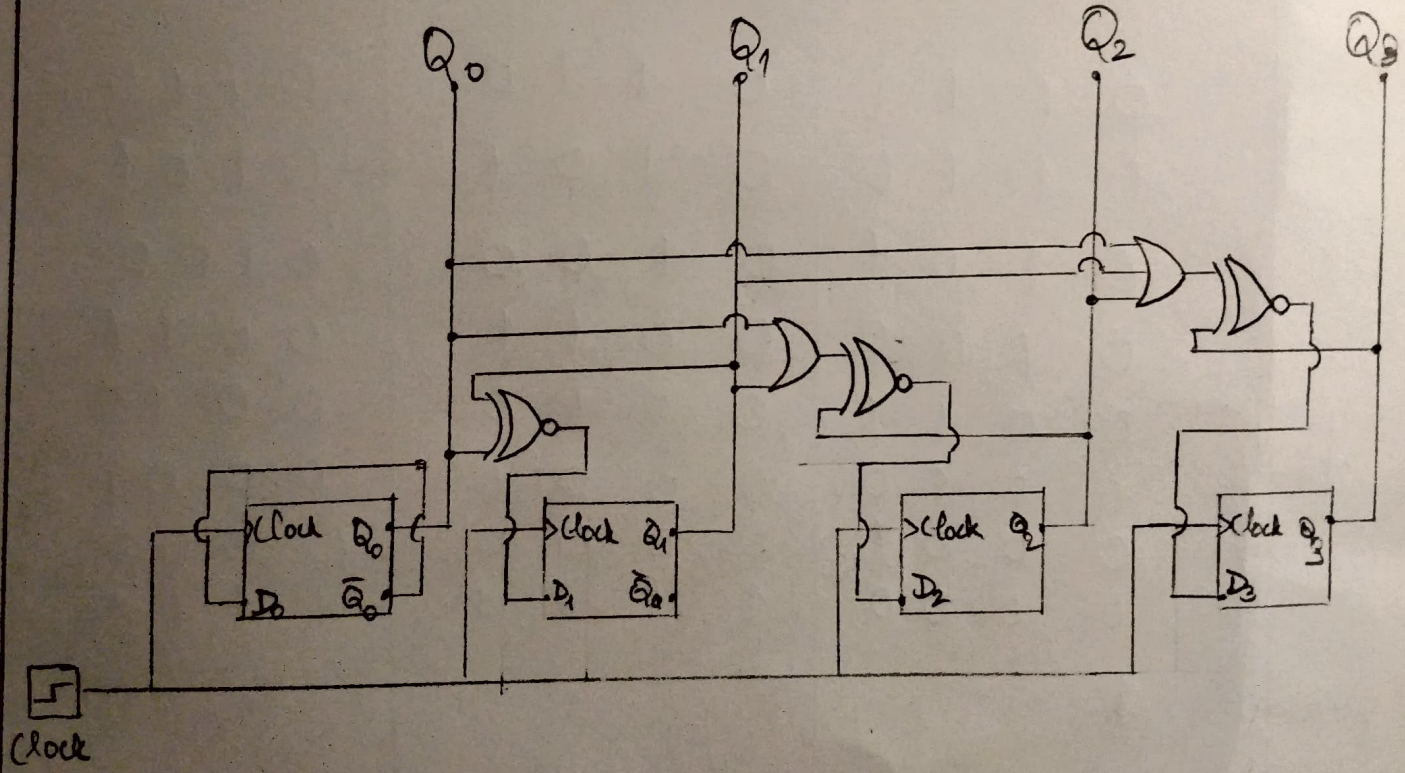


synchronous 4 bit up counter

(III) Asynchronous 4 bit down counter →

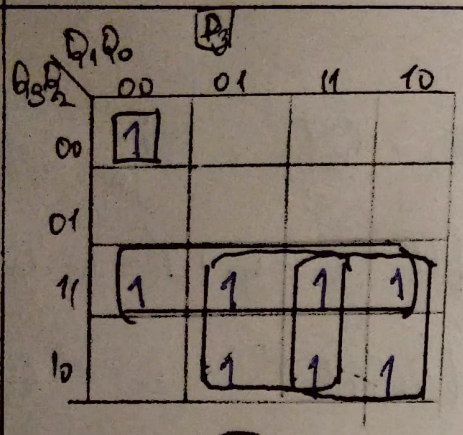


(IV) Synchronous 4 bit down counter →



				Next state				D-flip flop input			
Q_3	Q_2	Q_1	Q_0	Q_3^+	Q_2^+	Q_1^+	Q_0^+	D_3	D_2	D_1	D_0
1	1	1	1	1	1	1	0	1	1	1	0
1	1	1	0	1	1	0	1	1	1	0	1
1	1	0	1	1	1	0	0	1	1	0	0
1	1	0	0	1	0	1	1	1	0	1	1
1	0	1	1	1	0	1	0	1	0	1	0
1	0	1	0	1	0	0	1	1	0	0	1
1	0	0	1	1	0	0	0	1	0	0	0
1	0	0	0	0	1	1	1	0	1	1	1
0	1	1	1	0	1	1	0	0	1	1	0
0	1	1	0	0	1	0	1	0	1	0	1
0	1	0	1	0	1	0	0	0	1	0	0
0	1	0	0	0	0	1	1	0	0	1	1
0	0	1	1	0	0	1	0	0	0	1	0
0	0	1	0	0	0	0	1	0	0	0	1
0	0	0	1	0	0	0	0	0	0	0	0
0	0	0	0	1	1	1	1	1	1	1	1

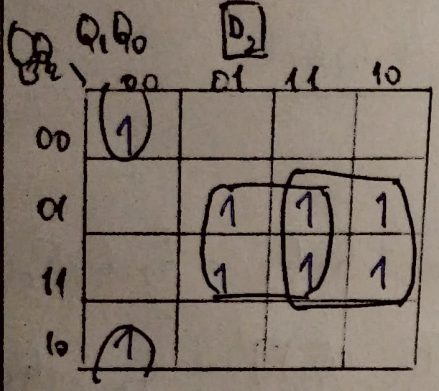
b



$$D_3 = Q_3Q_2 + Q_3Q_1 + Q_3Q_0 + \bar{Q}_3\bar{Q}_2\bar{Q}_1\bar{Q}_0$$

$$= Q_3(Q_2+Q_1+Q_0) + \bar{Q}_3\overline{(Q_2+Q_1+Q_0)}$$

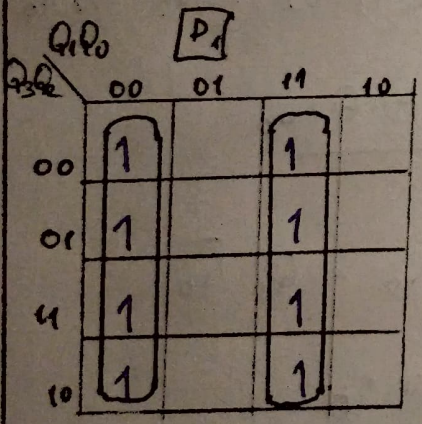
$$D_3 = Q_3 \odot (Q_2+Q_1+Q_0)$$



$$D_2 = Q_2Q_0 + Q_2Q_1 + \bar{Q}_2\bar{Q}_1\bar{Q}_0$$

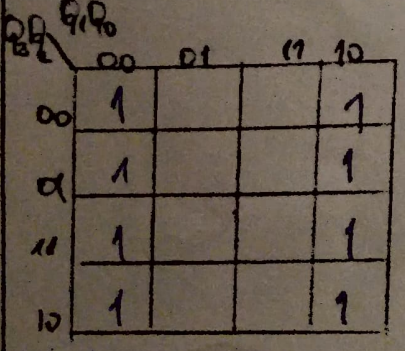
$$= Q_2(Q_1+Q_0) + \bar{Q}_2\overline{(Q_1+Q_0)}$$

$$D_2 = Q_2 \odot (Q_1+Q_0)$$

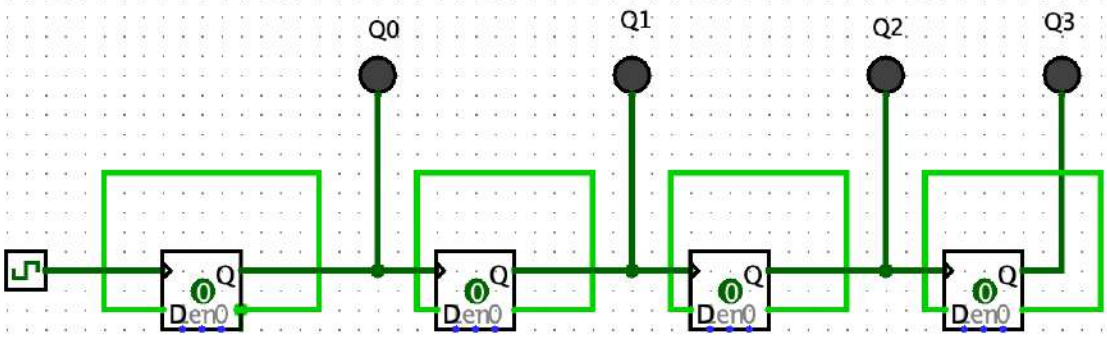


$$D_1 = \bar{Q}_1\bar{Q}_0 + Q_1Q_0$$

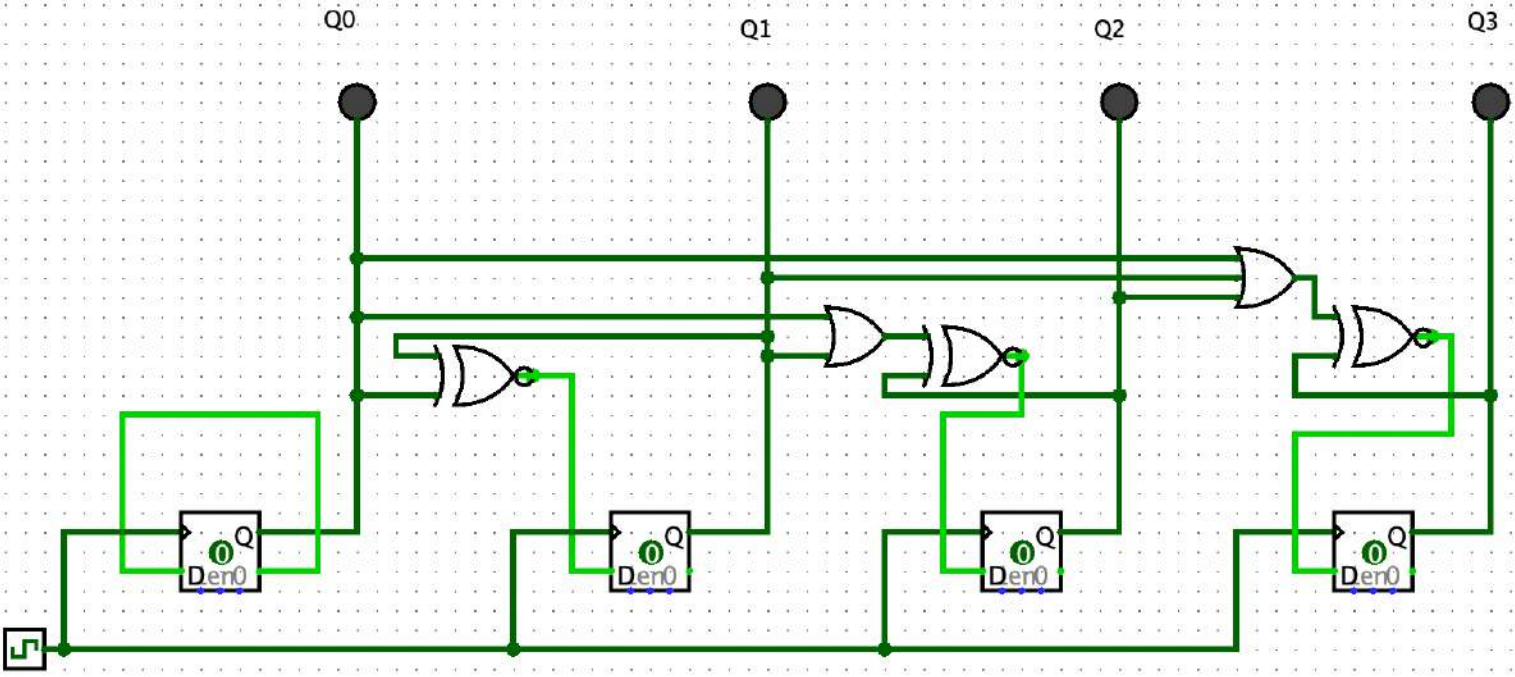
$$= Q_1 \odot Q_0$$



$$D_0 = \bar{Q}_0$$



asynchronous 4 bit down counter



Synchronous 4 bit down counter