0-59 up-counter

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BCSE-II

Hardware Design Lab.

Design a counter which counts from 0-59 (up-counter)

For a 0-59 up-counter, we can cascade a decade counter and a Mod 6 counter.

For the decade counter:

Excitation table:

Q_3	Q_2	Q_1	Q_0	Q_3^+	Q_2^+	Q_1^+	Q_0^+	J_3	K_3	J_2	K_2	J_1	K_1	J_0	K_0
0	0	0	0	0	0	0	1	0	x	0	x	0	x	1	x
0	0	0	1	0	0	1	0	0	x	0	x	1	x	x	1
0	0	1	0	0	0	1	1	0	x	0	x	x	0	1	x
0	0	1	1	0	1	0	0	0	x	1	x	x	1	x	1
0	1	0	0	0	1	0	1	0	x	x	0	0	x	1	x
0	1	0	1	0	1	1	0	0	x	x	0	1	x	x	1
0	1	1	0	0	1	1	1	0	x	x	0	x	0	1	x
0	1	1	1	1	0	0	0	1	x	x	1	x	1	x	1
1	0	0	0	1	0	0	1	x	0	0	x	0	x	1	x
1	0	0	1	0	0	0	0	x	1	0	x	0	x	x	1

Minimization:

J_0 :

Q_3Q_2 \ Q_1Q_0	00	01	11	10
00	1	x	x	x
01	1	x	x	1
11	x	x	x	x
10	1	x	x	x

$J_0 = 1$

K_0 :

Q_3Q_2 \ Q_1Q_0	00	01	11	10
00	x	x	1	x
01	x	1	1	x
11	x	x	x	x
10	x	1	x	x

$K_0 = 1$

J_1 :

Q_3Q_2 \ Q_1Q_0	00	01	11	10
00	0	1	x	x
01	0	1	x	x
11	x	x	x	x
10	0	0	x	x

$J_1 = Q_0 \overline{Q_3}$

K_1 :

Q_3Q_2 \ Q_1Q_0	00	01	11	10
00	x	x	1	0
01	x	x	1	0
11	x	x	x	x
10	x	x	x	x

$K_1 = Q_0$

J_2 :

Q_3Q_2 \ Q_1Q_0	00	01	11	10
00	0	0	1	0
01	x	x	x	x
11	x	x	x	x
10	0	0	x	x

$J_2 = Q_1 Q_0$

K_2 :

Q_3Q_2 \ Q_1Q_0	00	01	11	10
00	x	x	x	x
01	0	0	1	0
11	x	x	x	x
10	x	x	x	x

$K_2 = Q_1 Q_0$

J_3 :

Q_3Q_2 \ Q_1Q_0	00	01	11	10
00	0	0	0	0
01	0	0	1	0
11	x	x	x	x
10	x	x	x	x

$J_3 = Q_0 Q_1 Q_2$

K_3 :

Q_3Q_2 \ Q_1Q_0	00	01	11	10
00	x	x	x	x
01	x	x	x	x
11	x	x	x	x
10	0	1	x	x

$K_3 = Q_0$

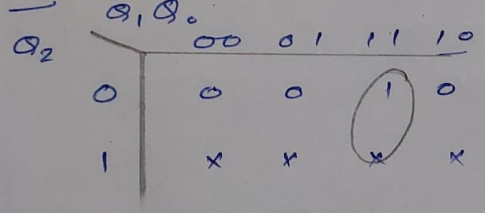
For the Mod6 counter:

Exitation table:

Q_2	Q_1	Q_0	Q_2^+	Q_1^+	Q_0^+	J_2	K_2	J_1	K_1	J_0	K_0
0	0	0	0	0	1	0	x	0	x	1	x
0	0	1	0	1	0	0	x	1	x	x	1
0	1	0	0	1	1	0	x	x	0	1	x
0	1	1	1	0	0	1	x	x	1	x	1
1	0	0	1	0	1	x	0	0	x	1	x
1	0	1	0	0	0	x	1	0	x	x	1

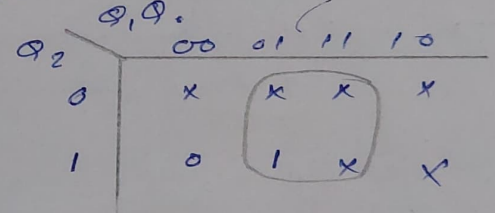
Minimization:

J_2:



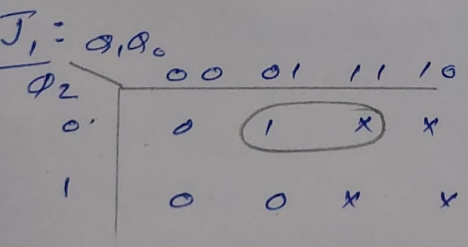
$J_2 = Q_0 Q_1$

K_2:



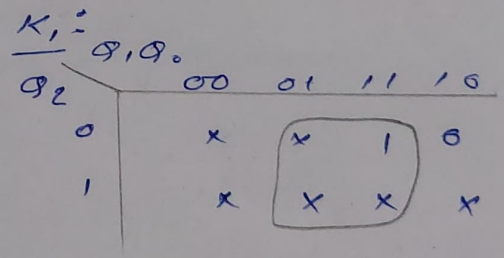
$K_2 = Q_0$

J_1:



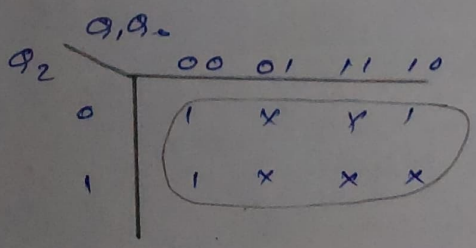
$J_1 = Q_0 \overline{Q_2}$

K_1:



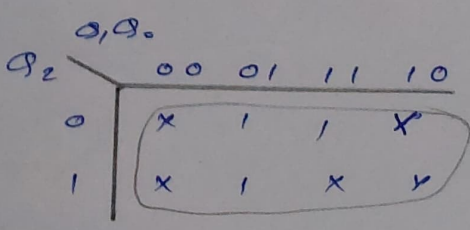
$K_1 = Q_0$

J_0:



$J_0 = 1$

K_0:

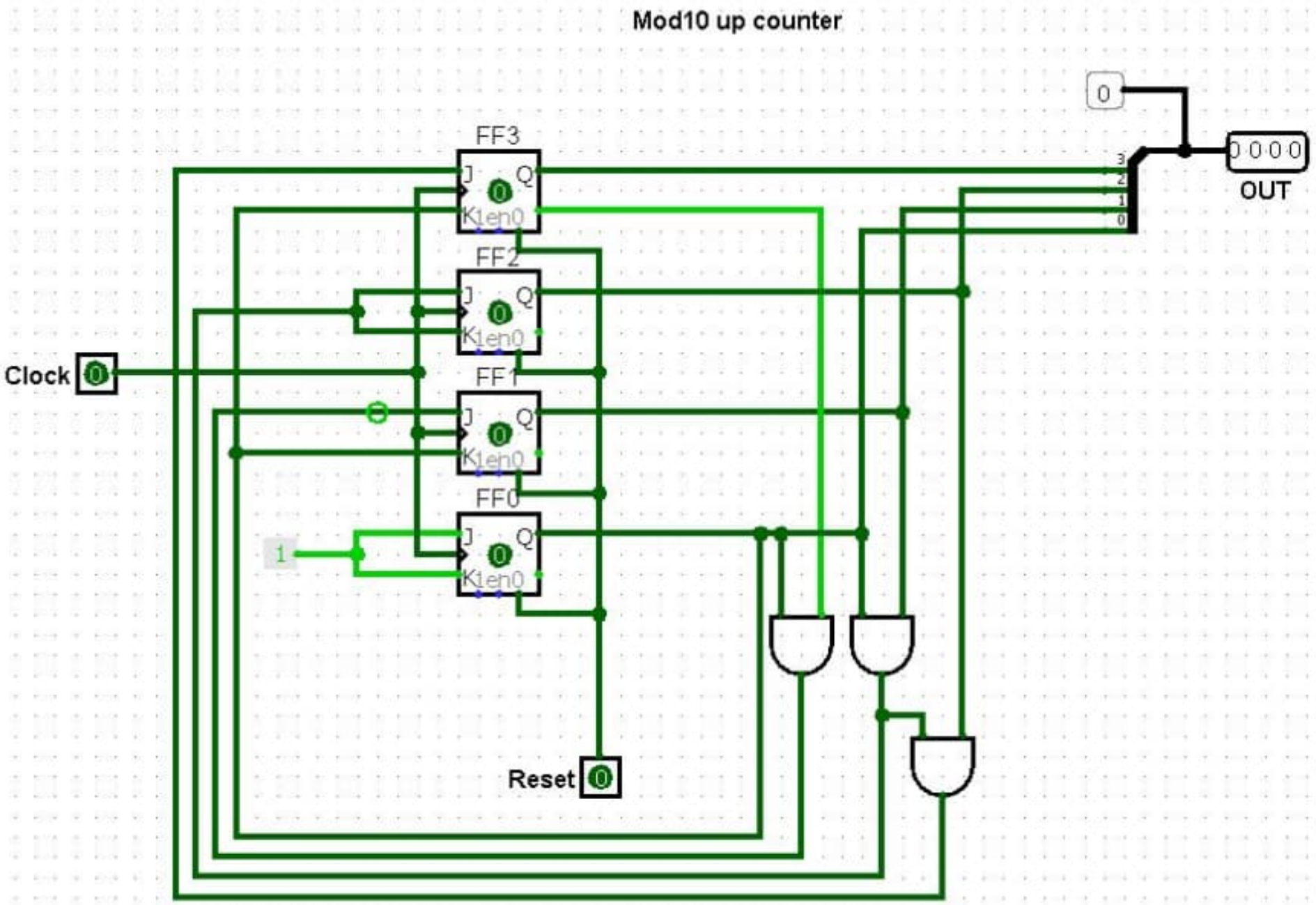


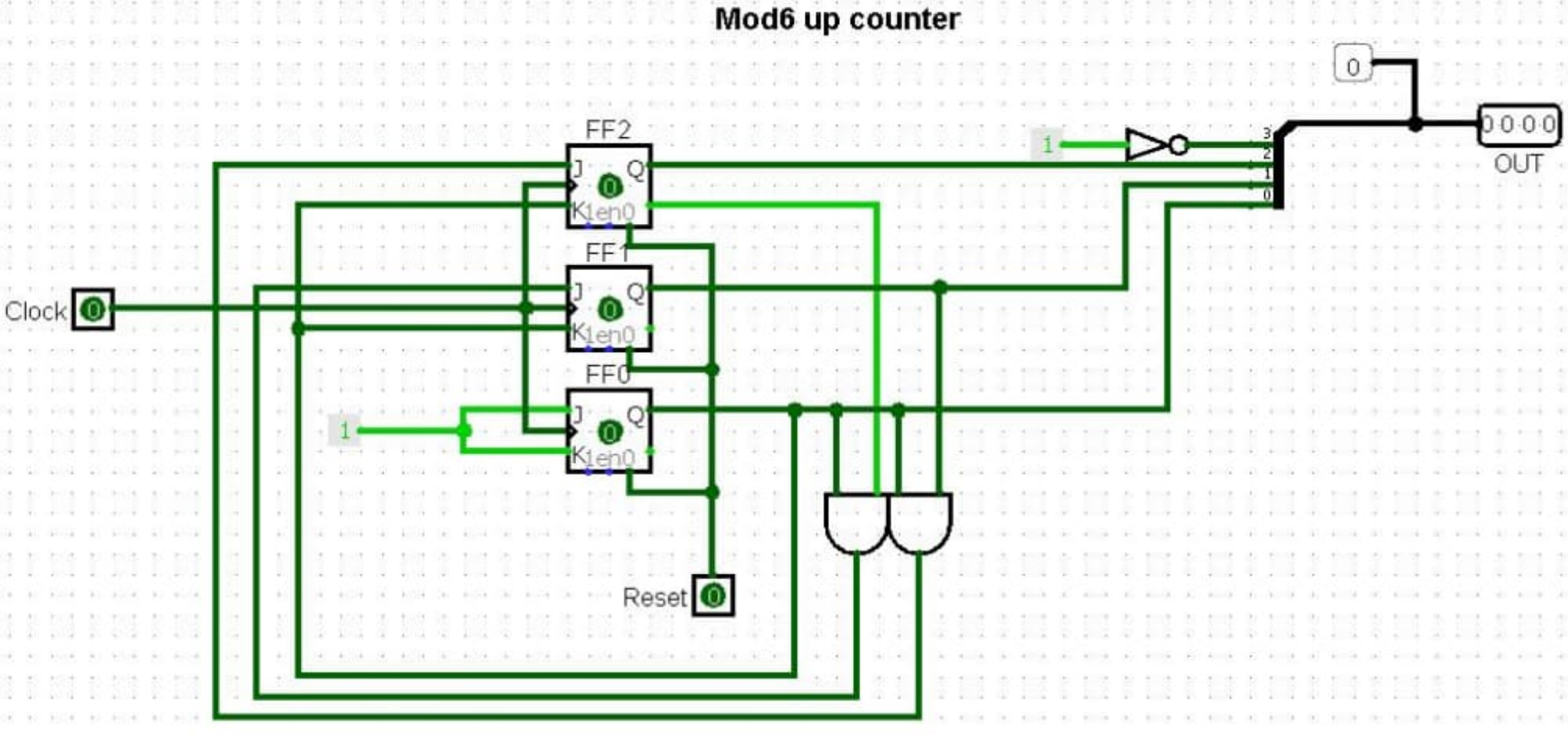
$K_0 = 1$

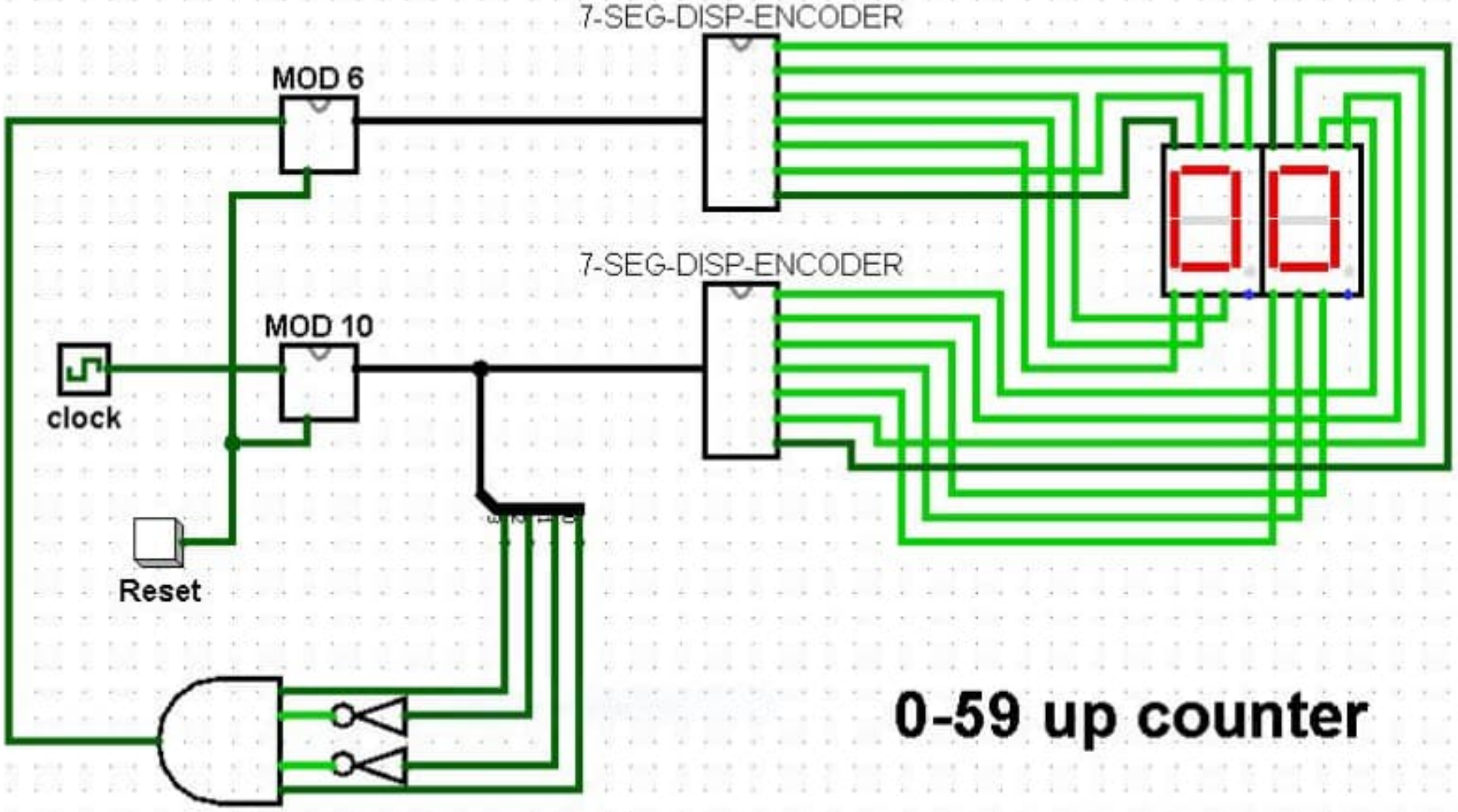
Cascading Logic:

All flipflops are falling edge triggered. Now, the counter only upcounts, so the 10's place changes when the counter on 1's place changes state, from $(1001)_2$ to $(0000)_2$.

∴ the clock input in the Mod 6 counter in 10's place is high only when the decade counter at 1's place is at state $(1001)_2$.


Mod10 up counter
FF3
FF2
FF1
FF0
J
Q
K
en
Clock
Reset
1
0
0000
OUT
3
2
1
0


Mod6 up counter
FF2
FF1
FF0
J
Q
K
en
Clock
Reset
1
0
OUT



0-59 up counter