HH:MM:SS clock

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BCSE - II

Hardware Design Lab.

Design a clock in the format HH:MM:SS (Hour : Minute : Seconds)

The two cascaded counters for the minutes and seconds are basically 0-59 up counters that I have designed in the previous assignment.

The cascaded counter for hours is a 0-59 counter capped at 23. The logic is as follows:

The 1's place is output of a Mod 10 counter, and the 10's place is output of a Mod 6 counter. All the JK flipflops are falling edge triggered. In 0-59 normal cascading, the clock of the 10's place counter is high when 1's place is $(1001)_2$. To restrict the counter at 23, the reset pin of the flipflop (asynchronously sets the ff to 0) is high when 1's place is $(0100)_2 = (4)_{10}$ and 10's place is $(0010)_2 = (2)_{10}$, effectively resetting the counter to 00 after 23.

Logic for cascading:

The three counters for hours, minutes and seconds are cascaded to form a 24hr clock. All the flipflops are falling edge triggered. The clock of the hour counter and minute counter becomes high, when respectively, when the 10's places of minute counter and second counter become $(0101)_2 = (5)_{10}$, so that when minute increments from $(59)_{10}$, hour increments, and when second increments from $(59)_{10}$, minutes increment.

Logic for parallel loading:

The flipflops used in the circuit have two special pins. One sets it to 1 and the other resets to 0 asynchronously.

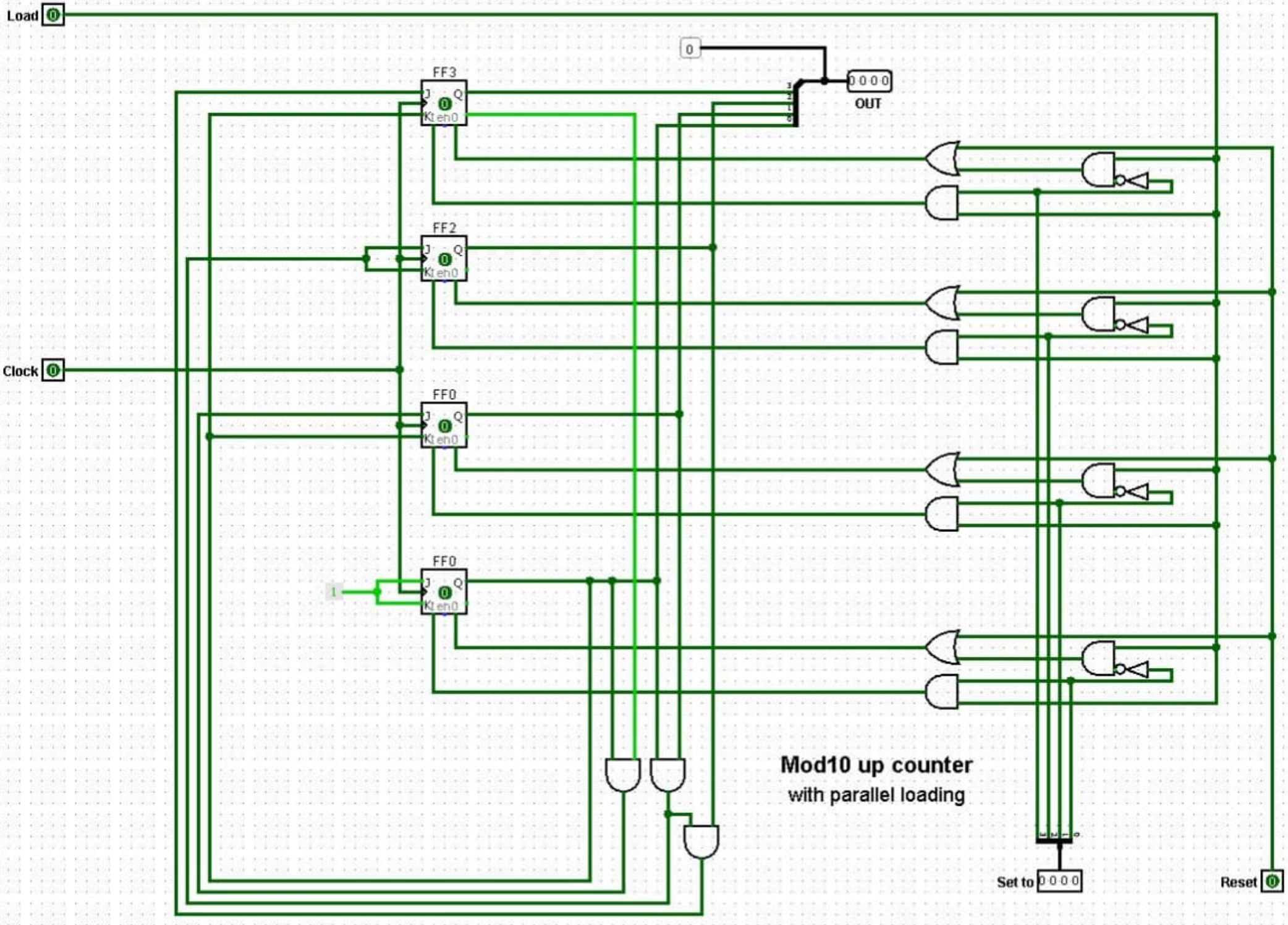
There are two inputs in the counter circuits — load and reset. For each flipflop, there is an one bit input which is used for parallel loading.

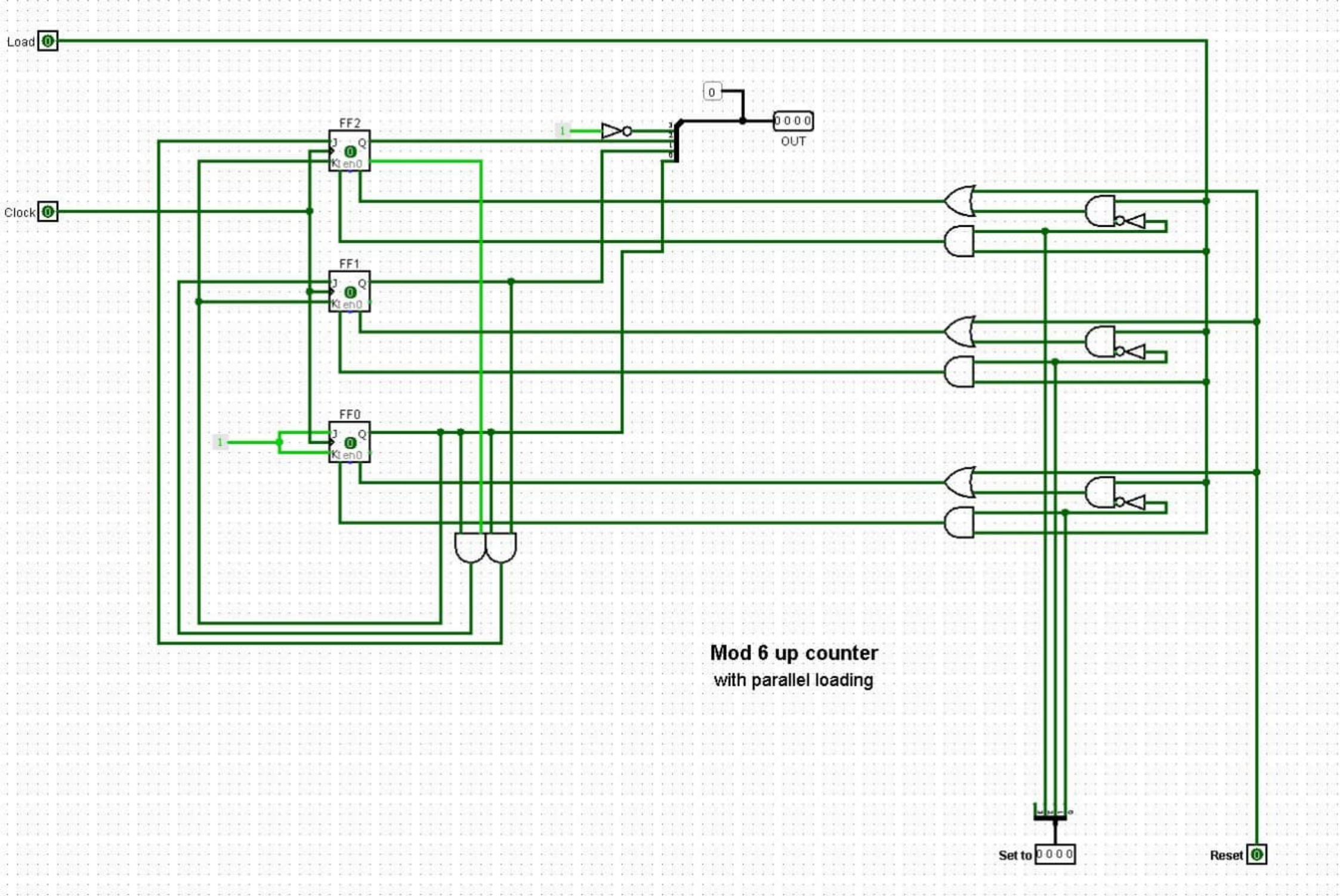
The idea is, when "load" is high, the flipflop will be asynchronously set to whatever the input is.

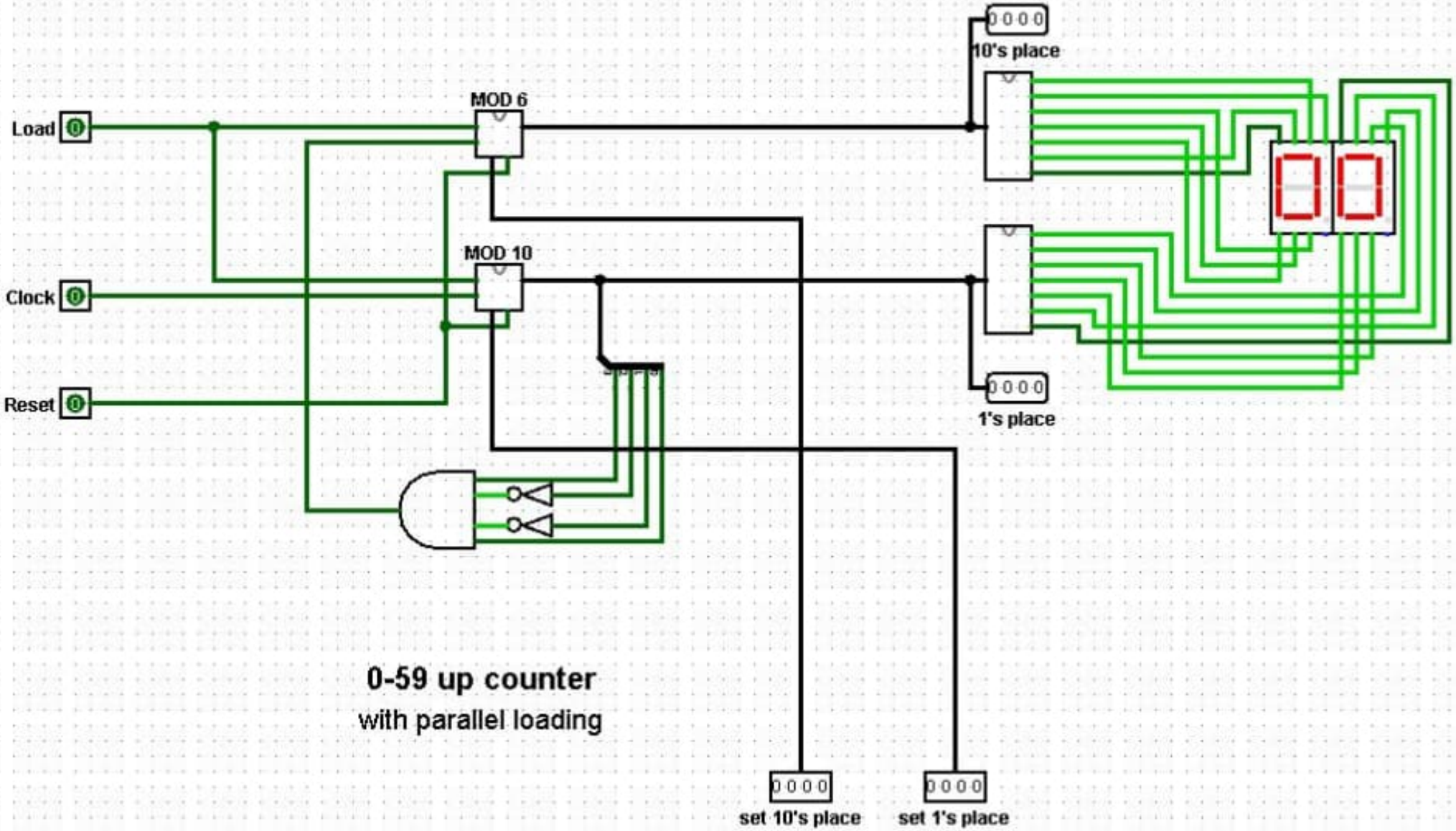
(load . input) → sets the flipflop to 1.

(load . $\overline{\text{input}}$) + reset → sets the flipflop to 0

In the final circuit, one load button is input to all the counters for parallel loading in all counters simultaneously

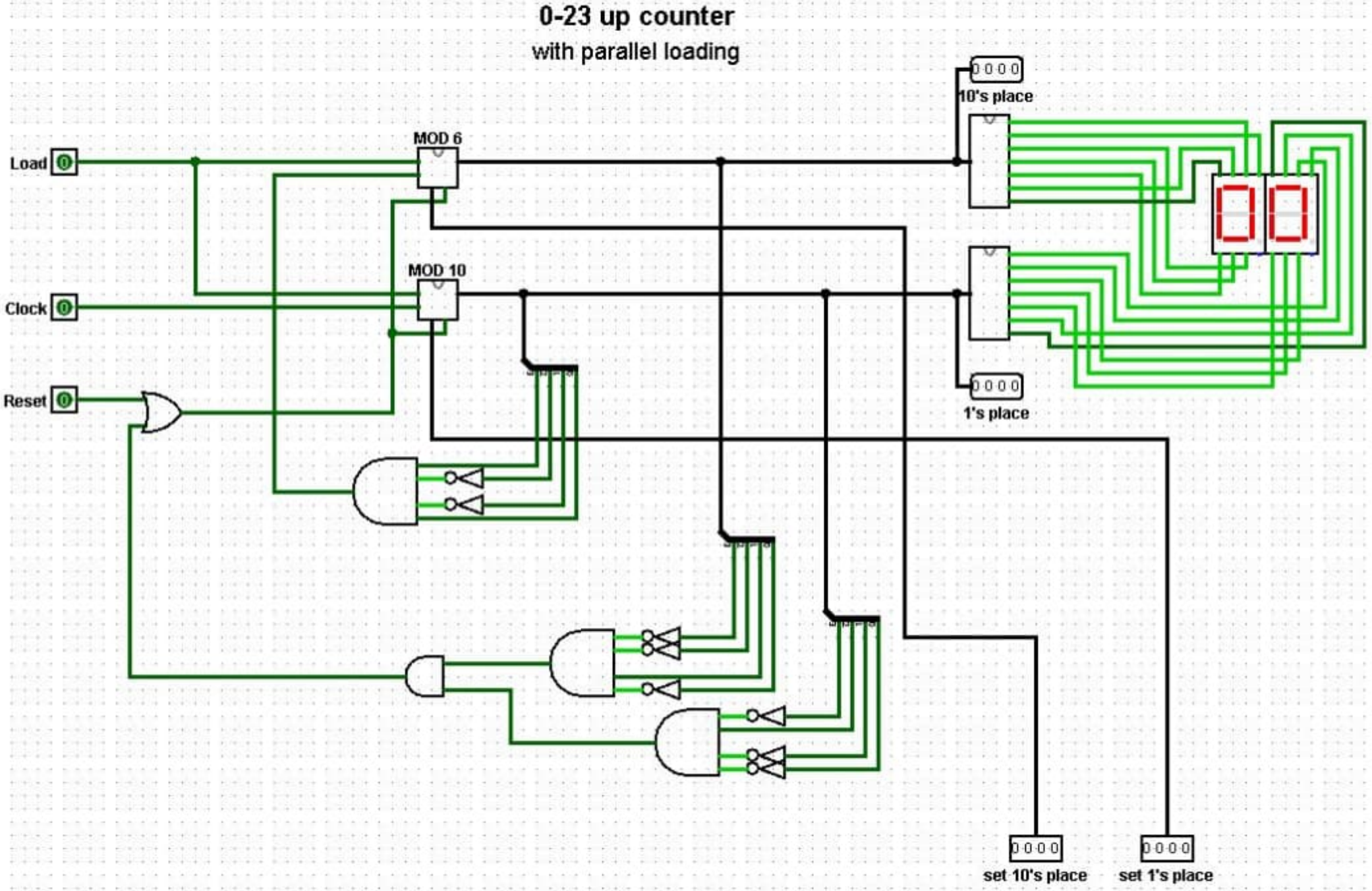

Load
0
FF3
FF2
FF0
FF0
Clock
1
0
0000
OUT
Mod10 up counter
with parallel loading
Set to 0000
Reset

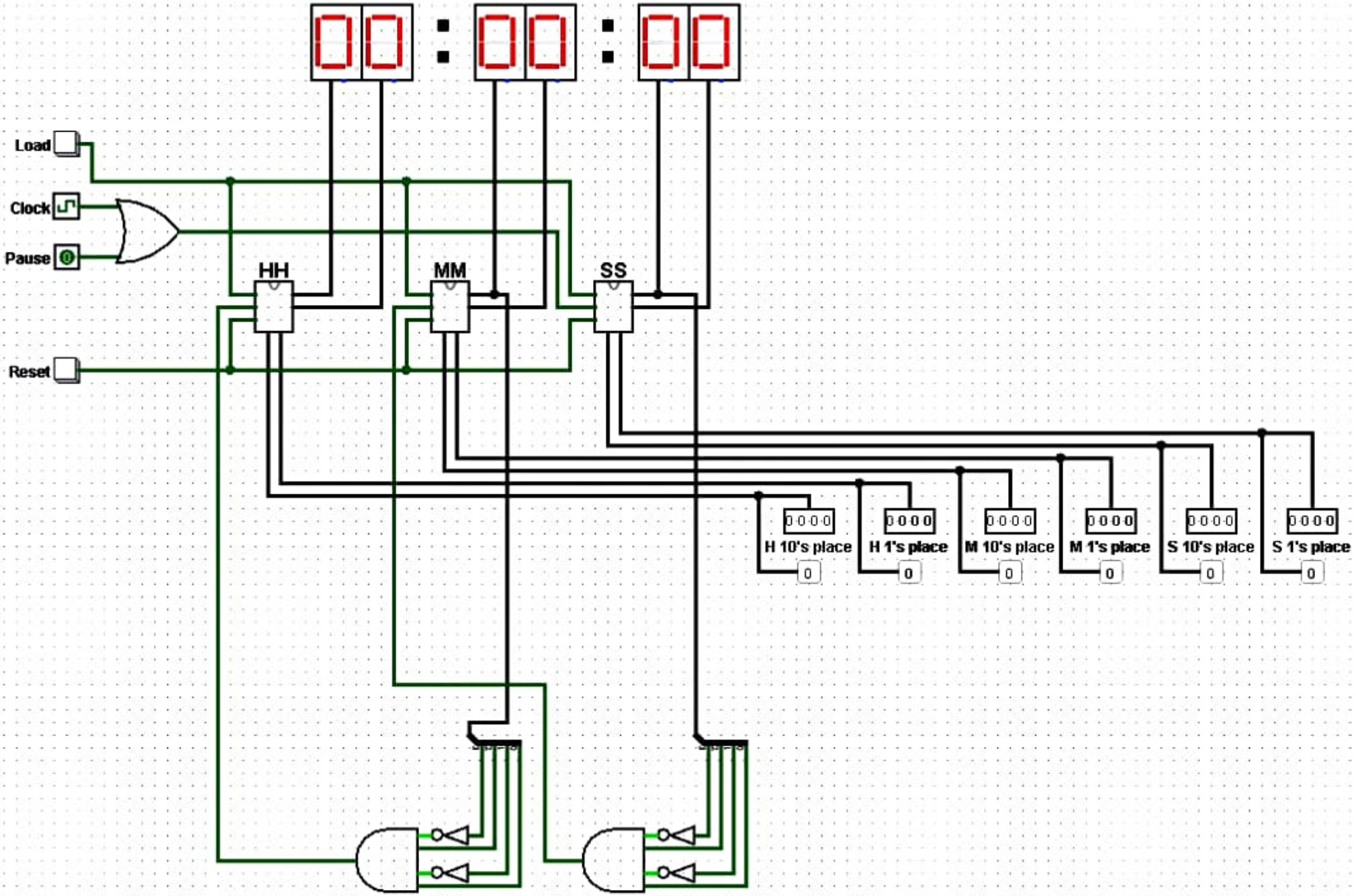

Load
Clock
FF2
FF1
FF0
J
Q
K
en
0
1
0
0 0 0 0
OUT
Mod 6 up counter
with parallel loading
Set to 0 0 0 0
Reset



0-59 up counter

with parallel loading


0-23 up counter
with parallel loading
0000
10's place
MOD 6
Load
0
MOD 10
Clock
0
Reset
0
0000
1's place
0000
set 10's place
0000
set 1's place


00 : 00 : 00
Load
Clock
Pause
Reset
HH
MM
SS
H 10's place
H 1's place
M 10's place
M 1's place
S 10's place
S 1's place
0000
0