Project Overview: Digital Clock

What It Is:

A **digital clock** built using **basic digital electronics components**—specifically **logic gates** (AND, NOT, etc.) and **J-K flip-flops**—which counts and displays time in hours, minutes, and seconds.

This type of clock **does not use a microcontroller** or advanced processors. Instead, it relies on **discrete logic** to perform counting and display operations.

How It Works:

Counting Time with J-K Flip-Flops

The time is divided into three main counting sections:

1. **Seconds Counter (00–59)**
   A series of J-K flip-flops is configured to count from 0 to 59. Once the count reaches 60, the circuit resets the seconds counter to 00 and sends a pulse to the next counter.
2. **Minutes Counter (00–59)**
   Another chain of J-K flip-flops counts minutes, incrementing by one each time the seconds counter resets. This counter also resets at 60 and triggers the hours counter.
3. **Hours Counter (00–12)**
   The final stage counts the hours in a 12-hour format. Once it reaches 12, it resets back to 00.

Control with Logic Gates

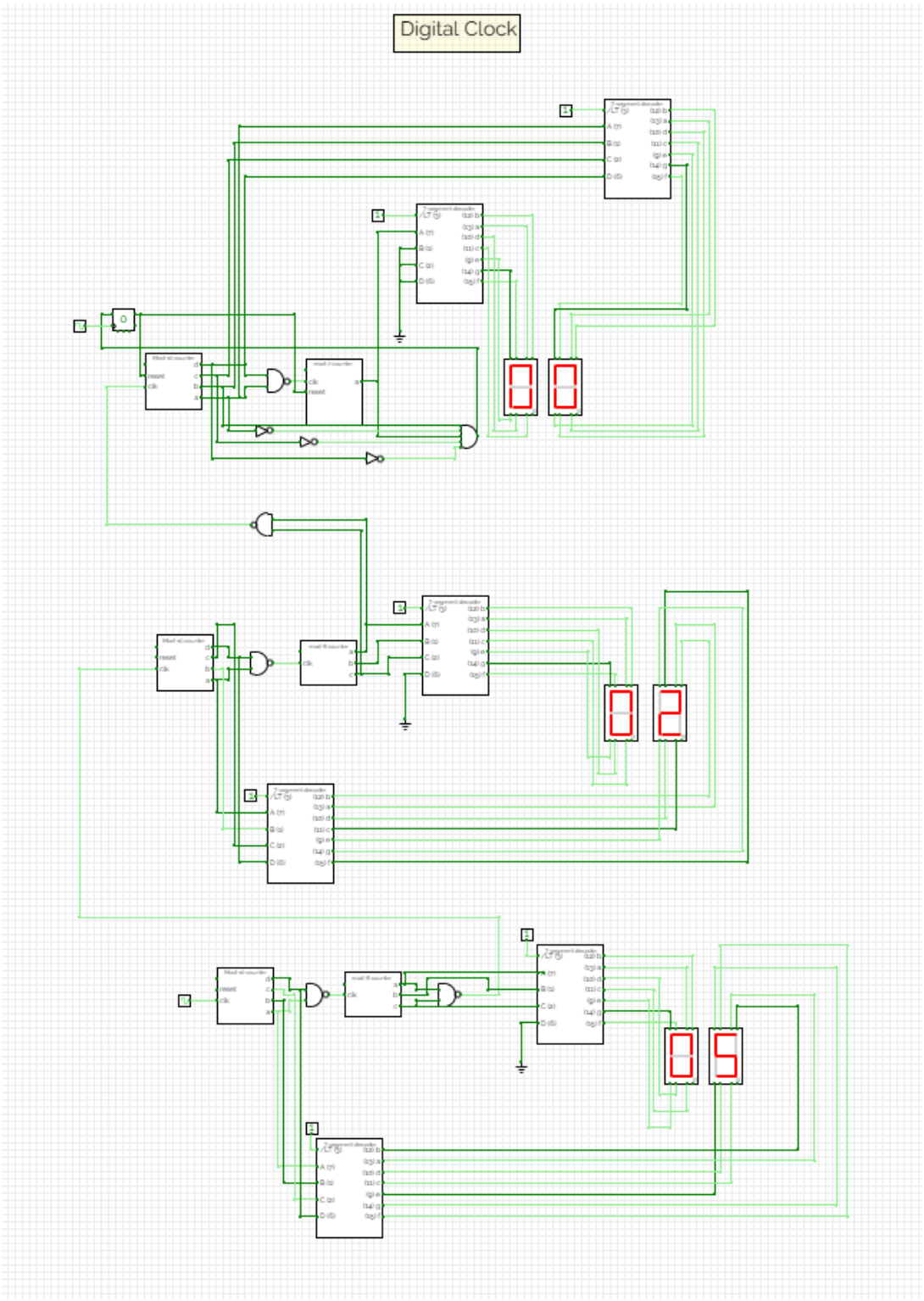
Logic gates (AND, NOT, etc.) are used to:

- Detect when a counter reaches its maximum value (like 59 or 12).
- Reset counters to zero at the correct time.
- Generate carry-out signals to trigger the next stage in the chain.

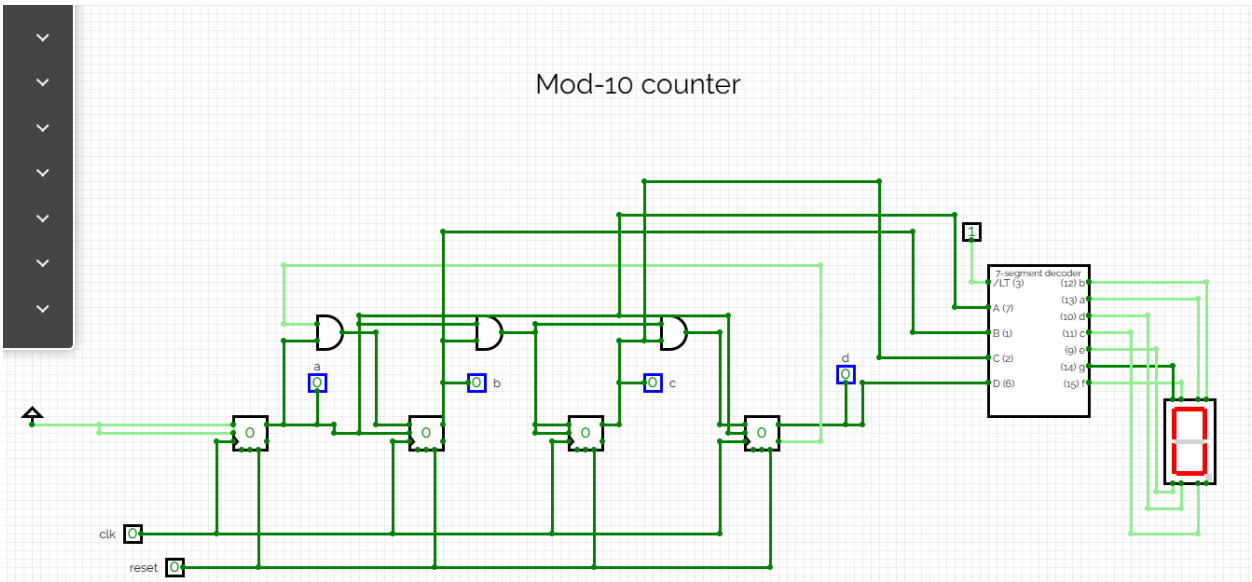
Displaying the Time

The binary output from each counter is connected to a 7-segment decoder, which converts the binary values into signals for a 7-segment display. This allows the current time to be shown in the format HH:MM:SS using 7 segment displays.

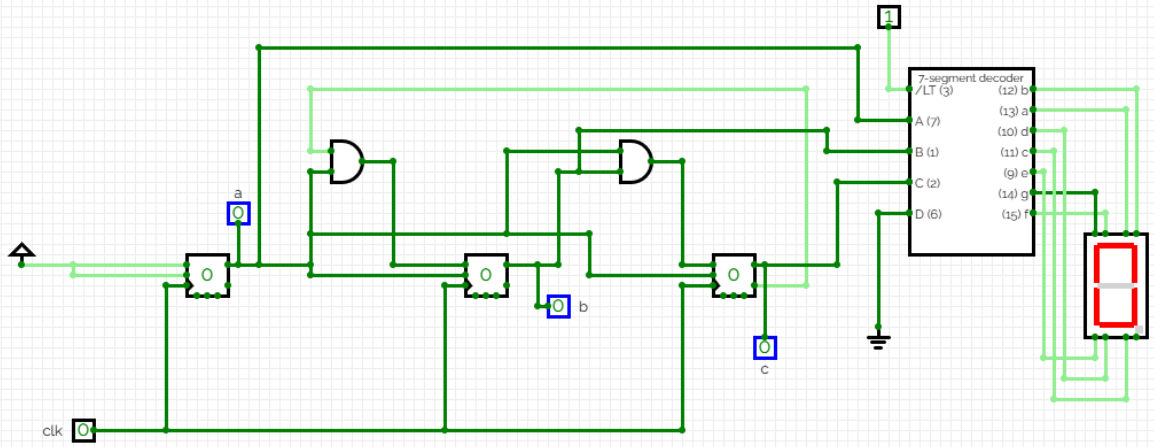
- **Simulation**

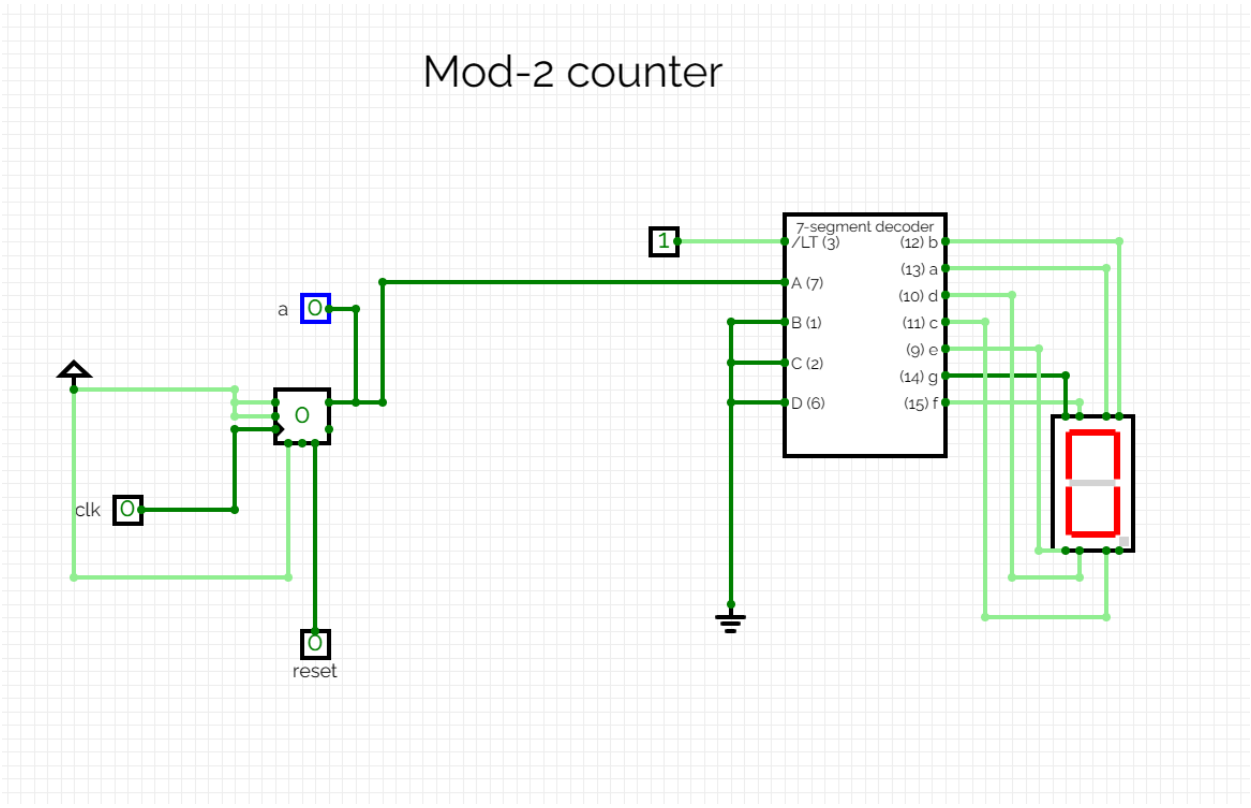


Mod-10 counter

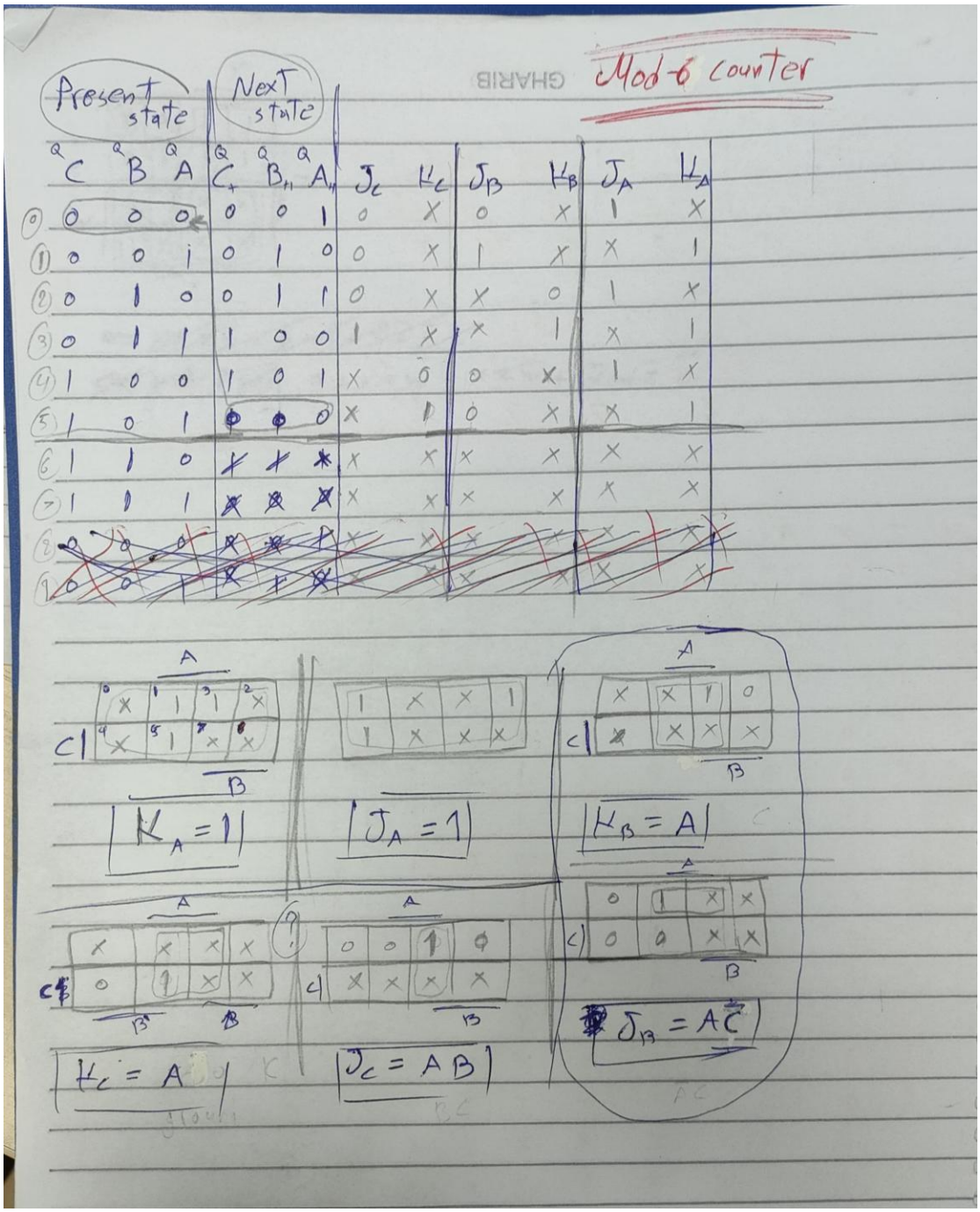


Mod-6 counter




Mod-2 counter
7-segment decoder
/LT (3)
A (7)
B (1)
C (2)
D (6)
(12) b
(13) a
(10) d
(11) c
(9) e
(14) g
(15) f
1
a
0
clk
0
reset
0

- **State Table and logical function**



Mod-10 counter

Present state				Next state											
Q_D	Q_C	Q_B	Q_A	Q_{D+1}	Q_{C+1}	Q_{B+1}	Q_{A+1}	J_D	K_D	J_C	K_C	J_B	K_B	J_A	K_A
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	0	1
1	0	1	0	X	X	X	X	X	X	X	X	X	X	X	X
1	0	1	1	X	X	X	X	X	X	X	X	X	X	X	X
1	1	0	0	X	X	X	X	X	X	X	X	X	X	X	X
1	1	0	1	X	X	X	X	X	X	X	X	X	X	X	X
1	1	1	0	X	X	X	X	X	X	X	X	X	X	X	X
1	1	1	1	X	X	X	X	X	X	X	X	X	X	X	X

Q_n	Q_{n+1}	J	K
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

$K_A = 1$

$J_A = 1$

$K_B = \bar{A}$

$J_B = A\bar{D}$

$K_C = \bar{A}B$

$J_C = AB$

$K_D = A$

$J_D = ABC$