

Computer Technology (COS10031) Assignment 2

Lecturer: Mr. Chandana Deshapriya

Student Name: M.A. Nidula Sanketh Mallikarachchi

Course: UniLink Diploma in IT

Swinburne ID: 104756611

NCHS ID: 2023040050

Email: 104756611@student.swin.edu.au

Contact Number: 0741966164

Content

General Overview

Stage 1

- Minutes Units (0-9 Counter)
- Minutes Tens (0-5 Counter)

Stage 2

- Edit Time Pin
- Increment Minutes Button

Stage 3

- Hours Counter
- AM/PM Flip Flop
- Increment Hours Button

Stage 4

- LED toggle at 12:00 PM
- Wrap Back to 01:00 PM after 12:59PM
- LED toggle at 00:00 AM
- Wrap Back to 00:00 AM after 11:59PM

Stage 5

- Set Alarm Time Pin
- Set Alarm Time Button
- LED flash at the Set Alarm Time

Outro

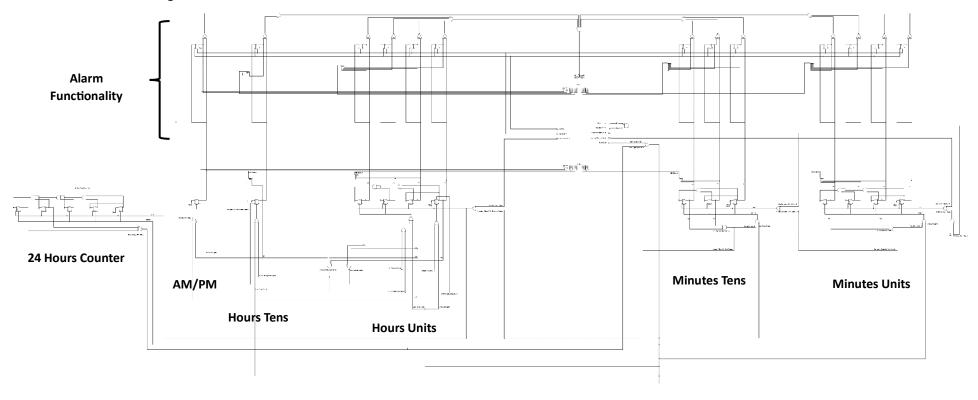
General Overview

Instructions:

Note: This image will not be clearly visible due to its size. I recommend using the image provided in the Zip file to view the image.

Note: The Parts of the circuits have been cropped in this document for maintaining clarity and the ease of understanding. Use the Original Circuit provided in the zip file side by side to compare the areas of the circuit.

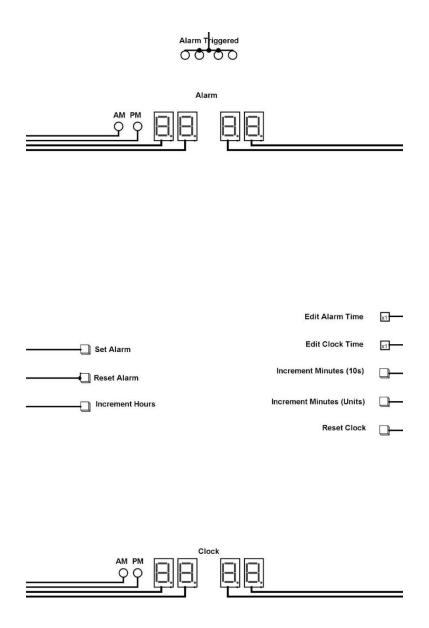
Outline of the Design



Description

The clock I've built has functions like a regular clock with an added alarm feature. It's created using Synchronous Counters which are made from JK Flip Flops. The main clock input is connected directly to the rightmost counter. When this counter reaches 10, it sends a signal to the next counter to increase its value. This way, each counter gets its increment signal from the previous one, allowing the entire circuit to count up. For the alarm, I've used D Flip Flops alongside each JK Flip Flop in the circuit. When the user sets an alarm time, the D Flip Flops store that value in

parallel. As the clock counts, once it matches the set alarm time, the circuit uses XNOR gates and 4 AND gates to verify the alarm time. When the verification succeeds, 4 LEDs light up to indicate that the alarm has been triggered.



Functionalities of the Clock

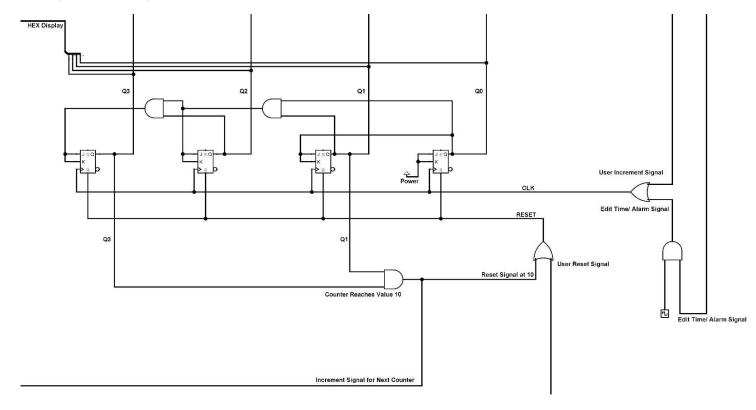
(Interface of the clock)

- Edit Clock Time Lets the user adjust the normal clock time.
- Increment Minutes (Units) Lets user increment the clock minute by minute.
- Increment Minutes (10s) Lets user increment the clock 10 minutes at once.
- Increment Hours Lets user increment the clock hour by hour.
- Reset Clock Resets the Clock
- Edit Alarm Time Lets the user adjust Alarm Time.
- Set Alarm Sets (registers) the user adjusted time as Alarm Time.
- Reset Alarm Resets the Alarm
- Time of the Alarm and the Clock both can be adjusted by the increment options.

Stage 1

Note: The function and the mechanism behind the "Edit Clock" button is explained on page 7.

Minutes Units (0-9 Counter)



Reset Mechanism

Counter Reaches 0b1010 (Decimal = 10).

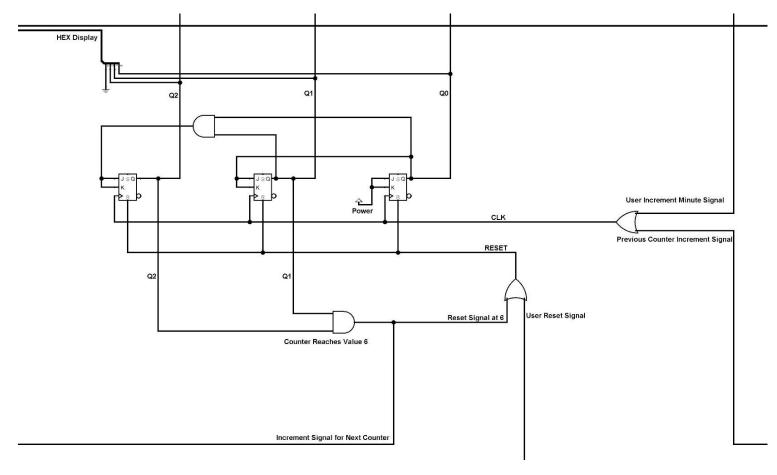
OR

User gives Reset Signal.

Incrementing Mechanism

- When the clock is simulated. AND "EDIT CLOCK TIME" Pin is Off
- OR
- If the Increment minute (units) button is pressed AND "EDIT CLOCK TIME" pin is ON

Minutes Tens (0-5 Counter)



Reset Mechanism

• Counter Reaches 0b110 (Decimal = 6).

OR

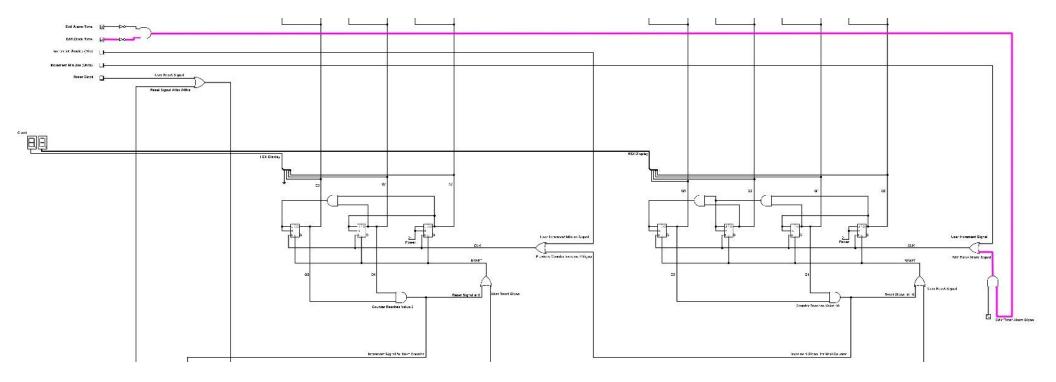
User gives Reset Signal.

Incrementing Mechanism

- If the value of the previous counter reaches 0b1010 value (Decimal: 10)
- 0R
- If the Increment minute (Tens) button is pressed AND "EDIT CLOCK TIME" Pin is ON

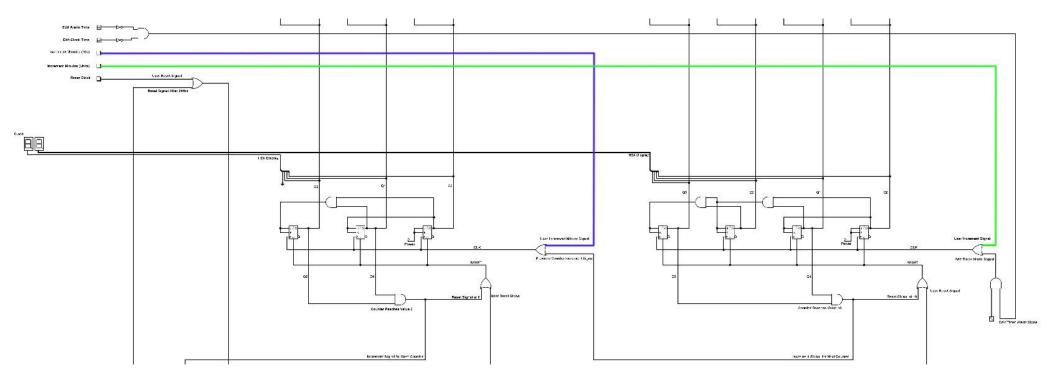
Stage 2

♣ Edit Time Pin



The clock can be set to the desired time by the user. But before the user set the time of the clock, the clock signal given to the units' place of the minute hand should be stopped (Paused). To pause the time of the clock, the pin EDIT CLOCK TIME is set to 1 by the user (Purple Line). When the EDIT CLOCK TIME input is set to 1, due to the NOT GATE in the connecting line the output becomes Logic 0. This connecting line is given as 1 input for the AND GATE as shown in the figure and the other input is allocated for the clock signal. Meaning that whenever user wants to set the time of the clock the logical value of AND GATE will become 0. Hence there will be no clock transition in the circuit. Hence the value of the clock will stay paused until the EDIT TIME is set to Logic 0.

♣ Increment Minutes Button



For incrementing the units place of the minute hand, a button is connected. This button will generate a logic 1 pulse every time it is pressed. Hence it is connected to the CLK input of the Flip Flops. Each time it receives a pulse the circuit will increment the value by 1.

The same logic is used to increment the value of the tens place of the minute hand and the hours hand of the clock.

Note that to increment the minutes the Clock Input should be paused using the Edit Time pin provided on the interface.

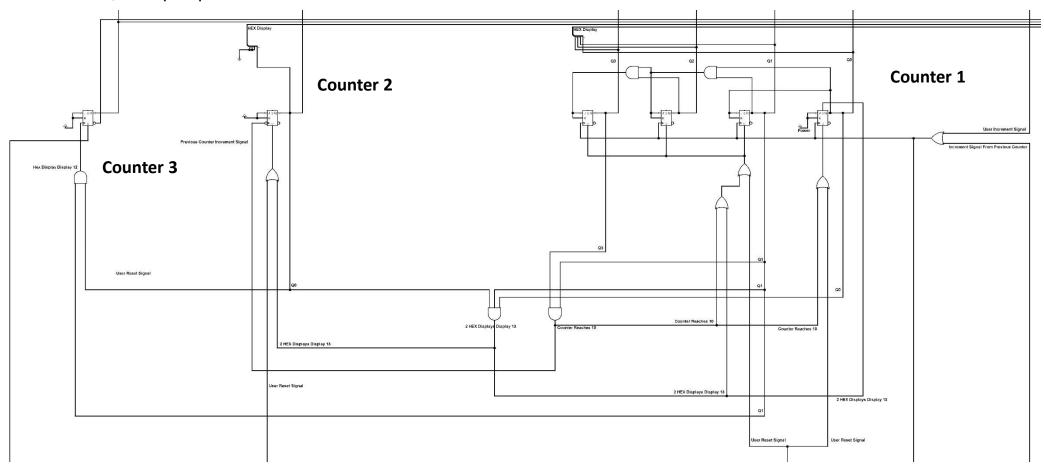
Each Increment line is represented by the colored lines:

Blue Line = Increment Minutes Tens

Green Line = Increment Minutes Units

Stage 3 (Part I)

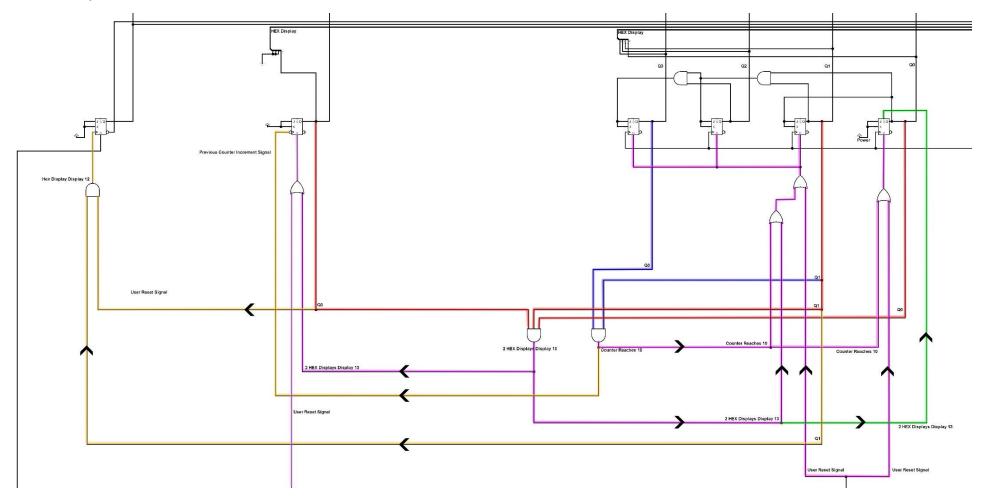
- **Hours Counter**
- ♣ AM/PM Flip Flop



The Hours Counter has 6 JK Flip Flops. Out Of these 6 JK Flip Flops 1 FF represents the AM/PM State (Counter 3), 1FF represents the Tens hand of the hour (Counter 2) and 4 of them represent the units' hand of the hour (Counter 1). For the Ease of understanding I have named these 3 counters as "Counter 1", "Counter 2" and "Counter 3". Carefully observe that there is a PRESET signal that is being given to the 1st Flip Flop of the Counter 1. This will be explained further below.

Stage 4 (Part I)

- ♣ LED toggle at 12:00 PM
- ♣ Wrap Back to 01:00 PM after 12:59PM



Reset Lines = Purple Lines

Increment Signal Lines = Yellow Lines

Preset Line = Green Line

Resetting Mechanism Behind Hours Clock

At the time 12:59PM the clock should wrap back to 01:00PM. For this the following conditions have been given to the circuit to preset itself to 1 after 12:59

Counter 1 Reset

FF1 of Counter 1 Reset

• If the "Reset Clock" Button is pressed.

OR

• The Counter 1 Reaches value 10 (0b 1010)

FF 2,3,4 of Counter 1 Reset

- If the "Reset Clock" Button is pressed.
 OR
- Counter 1 has value 10 (0b 1010)

0R

Counter 2 = 1 (0b0001) AND Counter 1 = 3 (0b 0011)
 (At the moment where HEX Display is displaying 13)

Counter 2 Reset

User Reset Signal is Given

OR

• Counter 1 is 3 (0b0011) and Counter 2 is 1 (0b0001)

Counter 2 Toggle

Will set itself to 1 When the previous counter reaches the value 10 (0b1010)

Presetting Mechanism for Counter 1 FF 1

The FF1 of counter 1 will only be PRESET when.

When the Counter 2 has value 1

AND

• Counter 1 has the value 3 (0b 0011)
(At the moment where HEX Display is displaying 13)

Counter 3 Toggle

The Am/Pm Light will toggle when:

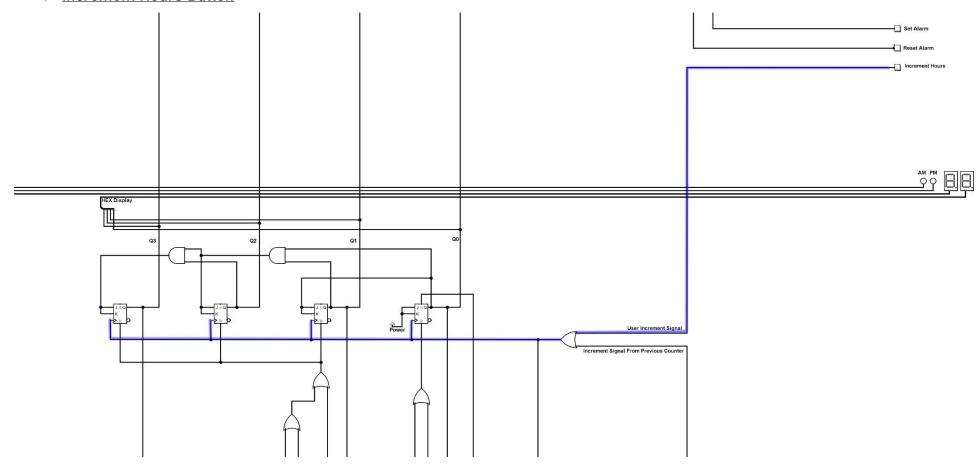
• Counter 2 has value 1.

AND

Counter 1 has the value 2 (0b 0010)
 (At the moment where HEX Display is displaying 12)

Stage 3 (Part II)

↓ Increment Hours Button



The Hours counter will increment under 2 conditions.

• If the Increment hours button is pressed (Blue Line)

OR

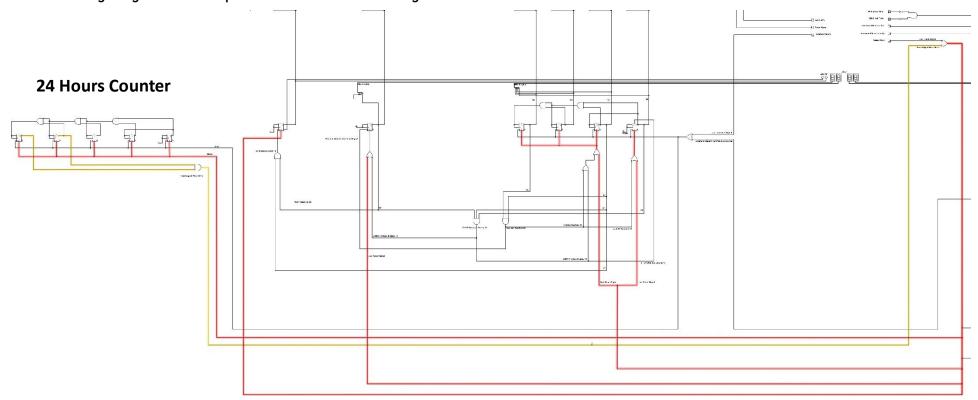
• If the counter 2 reaches value 0b110 (Decimal: 6)

Stage 4 (Part II)

- LED toggle at 00:00 AM
- Wrap Back to 00:00 AM after 11:59PM

The method I have used to reset the counter to 00:00 AM after 11.59PM is by using a 24-Hour Counter. It is named as "24 Hours Counter" in the diagram. The Clock Signal for this counter is given by the Increment line of the Minute tens Counter. When the Minute 10s Counter Reach the Value 6 this counter will have an increment signal. Thus, it will count up to 24 hours. After counting up to 24 hours the "24 hours Counter" will Reset itself and give a reset signal to the whole circuit to make the values 00:00 AM

The following diagram will help better understand the logic.

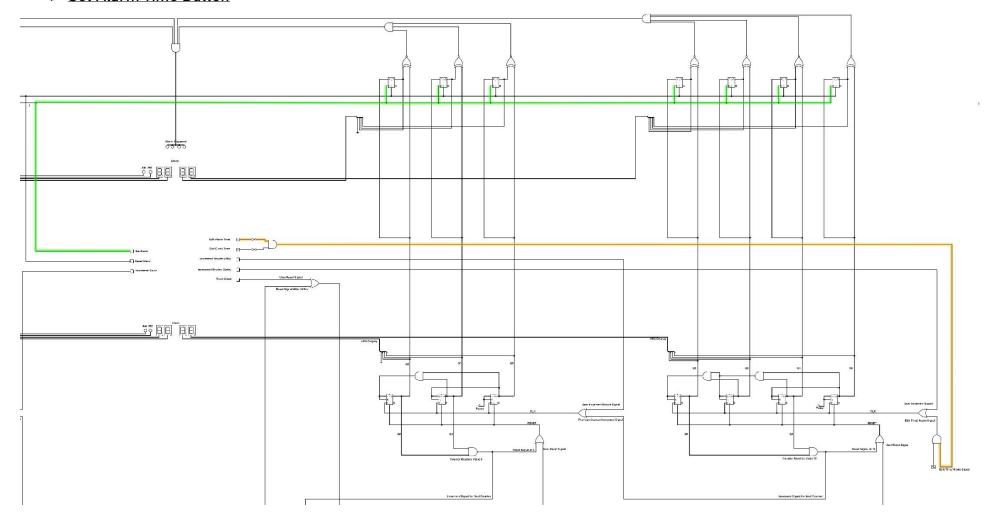


Yellow Lines – At the time of 24 hours the reset signal is forwarded to the whole circuit.

Red lines - The Reset signal is received to each circuit.

Stage 5

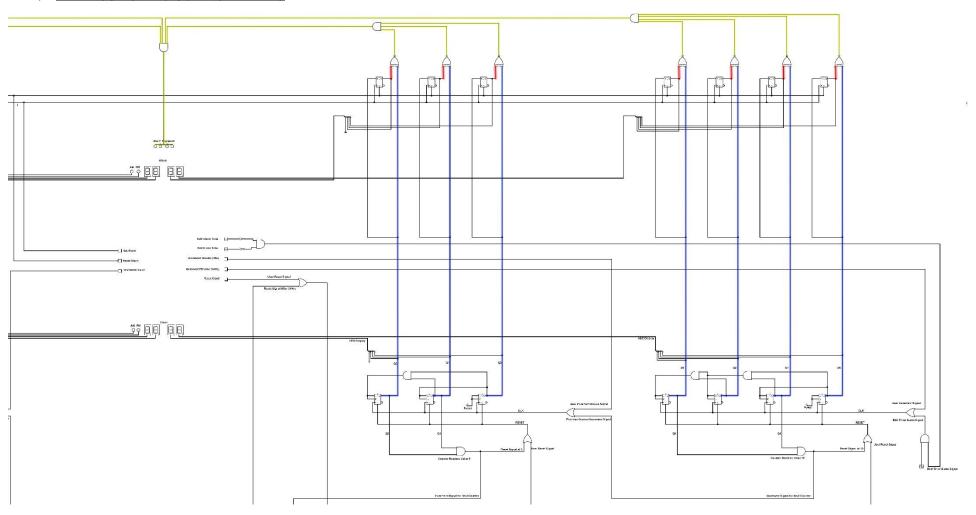
- Set Alarm Time Pin
- **♣** Set Alarm Time Button



Observe: Every JK Flip Flop (FFs Below) are connected to the D input of the D Flip Flops (FFs Above). This is done so that when the user enters a time to set to the clock, that time can be parallelly loaded to the D flip flops.

Note: These D flip Flops are also connected to the Hours hand but are not included in this image due to low clarity of the image.

- Yellow Lines (Edit Alarm Pin) Note that for the user to enter a desired alarm time the clock should be paused first. To pause the clock the clock signal should be blocked first. For that this pin is connected to a not gate through a and gate and given to the 1st counter. (Same mechanism that was used to "Edit Clock Time" [Explained better on Page 7]).
- Green Line (Set Alarm Button) After the user sets his/hers desired time and this button is pressed The D flip flops will receive a signal to their clock input. Hence the data in the JK Flip Flops below will be parallel loaded to the D Flip Flops. After that this D Flip Flop will act as the set alarm time.
- ♣ LED flash at the Set Alarm Time



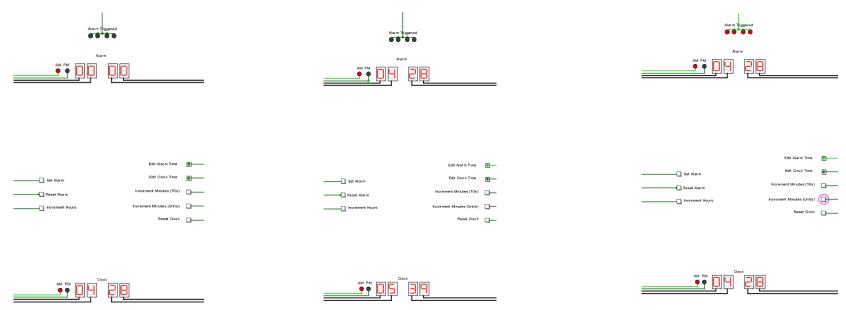
Observe: Q output of both D (Red Line) and the JK Flip Flops (Blue Line) have been connected to a XNOR Gate. XNOR Gate will represent its state as 1 when both input values are same.

All these XNOR Gates are connected to AND Gates (Yellow Line) and finally connected to the LEDs on the top of the circuit. When the Clock reaches the set alarm time those LEDS will light up.

Note:

- Additionally, a Reset Button is provided for the D flip Flops to Reset their values if needed by the user.
- 4 extra HEX displays are added to display the value that is stored in the D Flip Flops For the ease of the user (Since it is hard to remember the time you set for the alarm always)

Screenshots of the working Circuit



Outro

In summary, this circuit represents a remarkable achievement, free from any contradictions or invalid values. It's a fully operational and engaging system.

Thank You!