F241: MICROPROCESSOR, PROGRAMMING AND INTERFACING

# DIGITAL ALARM CLOCK

DESIGN ASSIGNMENT

**Submitted by:** Group 17

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# Contents

# User Requirements and Technical Specifications

Design a digital alarm clock that displays time.

## User Interface:

- Time is displayed in Hours and minutes and seconds.
- An LCD is available for display.
- The LCD displays the time as well as date and day.
- Using the Set Switch user can set Minutes, Hours, Seconds, Date, Month, Year, Alarm Hour, Alarm Minute by placing the sliding switch at the appropriate positions.
- When the set switch is in LOCK position the clock functions normally.
- **"ALARM ON/OFF"** switch is used for toggling the Alarm.
- The Hour and the Minute of the Alarm can be set using the "**INC/DEC"** push switch with its corresponding set mode.
- **"INC"** push button is used for incrementing values displayed and **"DEC"** switch is used for decrementing values displayed.
- Time can be displayed in AM/PM or 24 hour format.
- Users can toggle between any of the display formats at any time by pressing the **"12/24"** switch.
- While Time/Alarm is being set the value being set should be seen on the display.

# Assumptions & Justifications

## Assumptions:

- The clock will start from `00:00:00` on 1st of January, 20xx. The clock starts from the year `2000` and for the year , it displays the last two digits.
- Only one button can be pressed at a time.
- The alarm will trigger only on the 0th second of aligned time and only if its toggle state is `ON`, and the clock is operating in `LOCK` state.
- `12/24` is a switch which when pressed changes the mode to 12-hour mode. The default mode is 24-hour.
- One can only view the alarm time (`hour : minute`) when in set alarm hour or minute state. When the alarm is ringing, time is displayed normally.
- Alarm rings for one minute.

## Justifications:

- 2 8255 chips have been used. One 8255 chip is used to interface with the LCD Screen, and the switches for 12/24 format change and alarm on/off. The other 8255 chip is used to interface with the BCD thumb switch, increment and decrement buttons and buzzer.
- 8254 is used to generate an interrupt every second, using a 1kHz external clock.
- 2716 (2k ROM) is used because it is the smallest ROM chip available. This ROM's data bus is 8 bits wide, but the 8086's data bus is 16 bit wide. Therefore 2 ROM chips have been used, one for even bank and one for odd bank.
- 6116 (2k RAM) is used because it is the smallest ROM chip available. This RAM's data bus is 8 bits wide, but the 8086's data bus is 16 bit wide. Therefore 2 RAM chips have been used, one for even bank and one for odd bank.
- We have used a 16×2 LCD screen (LM016L) because we only need two separate lines (one for displaying date, and one for displaying time) and not more than 16 characters.
- The 10th position of the thumb switch is not mapped, because there are only 9 options.
- We are not using an 8254 chip because the design does not need the 8254's read back functionality.
- Data has been stored as a BCD value in memory.

# Components used

## ICs Used:

| Component | IC number | Quantity |
|---|---|---|
| Microprocessor | 8086 | 1 |
| Octal Latch | 74LS373 | 3 |
| Octal Bus Transceiver | 74LS245 | 2 |
| 3 to 8 Line Decoder | 74LS138 | 2 |
| 4 to 10 Line Decoder | 4028 | 1 |
| EPROM | 2732 | 2 |
| RAM | 6116 | 2 |
| Programmable Interval Timer | 8253A | 1 |
| Programmable Peripheral Interface | 8255A | 2 |

## Other Components Used:

| Component | Quantity |
|---|---|
| 2 i/p OR Gate | 4 |
| NOT Gate | 4 |
| 2 i/p AND Gate | 1 |
| 3 i/p AND Gate | 1 |
| 4 i/p NOR Gate | 1 |
| BCD Thumbswitch | 1 |
| SW-SPDT (Alarm ON/OFF) Switch , Reset Switch and 12/24 Switch | 3 |
| SW-SPDT-MOM Switch (INC / DEC) | 2 |
| LM016L (LCD) | 1 |
| 5.0K (Potentiometer) | 1 |
| Digital Sounder | 1 |
| Red LED | 1 |

## Thumb Switch mapping:

| Number on Thumb Switch | Function |
|---|---|
| 0 | LOCK |
| 1 | Set Hour |
| 2 | Set Minute |
| 3 | Set Seconds |
| 4 | Set Date |
| 5 | Set Month |
| 6 | Set Year |
| 7 | Set Alarm Hour |
| 8 | Set Alarm Minute |

# Address Map

## Memory Map:

ROM: 8KB = 4KB (even) + 4KB (odd)

| | |
|---|---|
| ROM start address | 00000H |
| ROM end address | 01FFFH |

RAM: 4KB = 2KB (even) + 2KB (even)

| | |
|---|---|
| RAM start address | 02000H |
| RAM end address | 02FFFH |

## I/O Map:

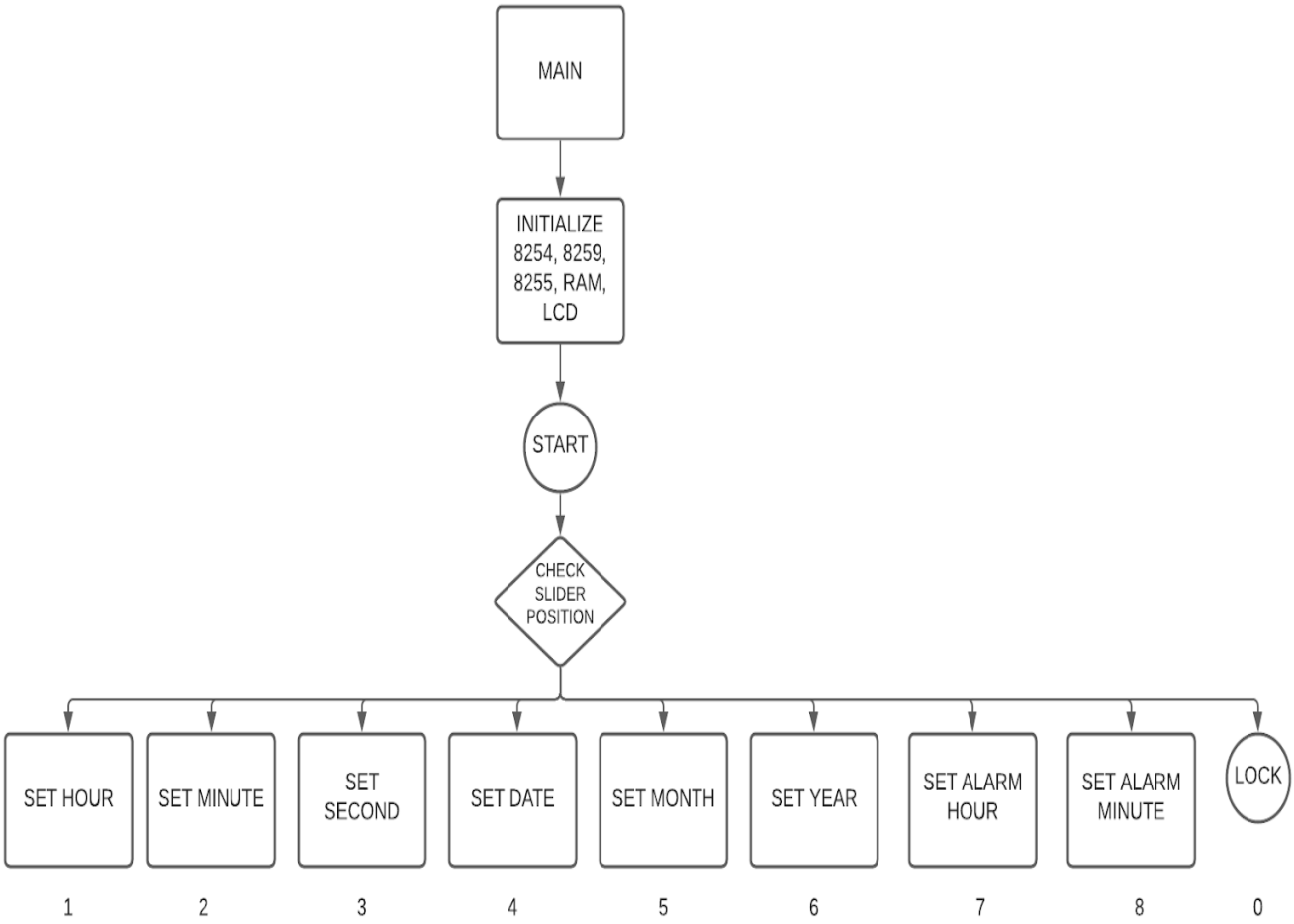
| | |
|---|---|
| 8255 #1 | 00H - 06H |
| 8253 | 08H - 0EH |
| 8255 #2 | 10H - 16H |

# Design

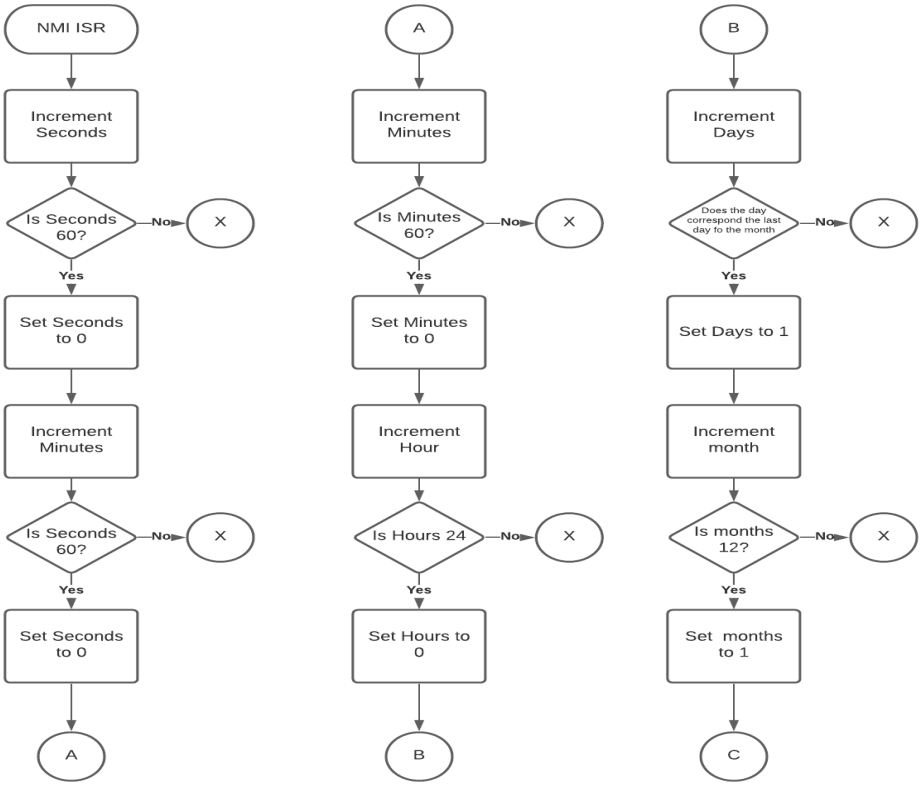
Complete design shown with proper labelling (design attached as "`g17_digital_alarm_clock.dsn`")

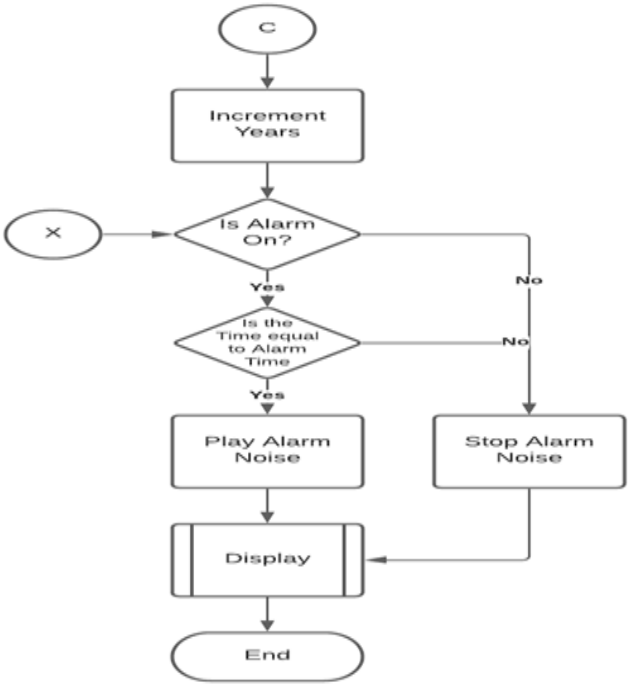
# Flow Charts

## Flow Chart of the Main Program:

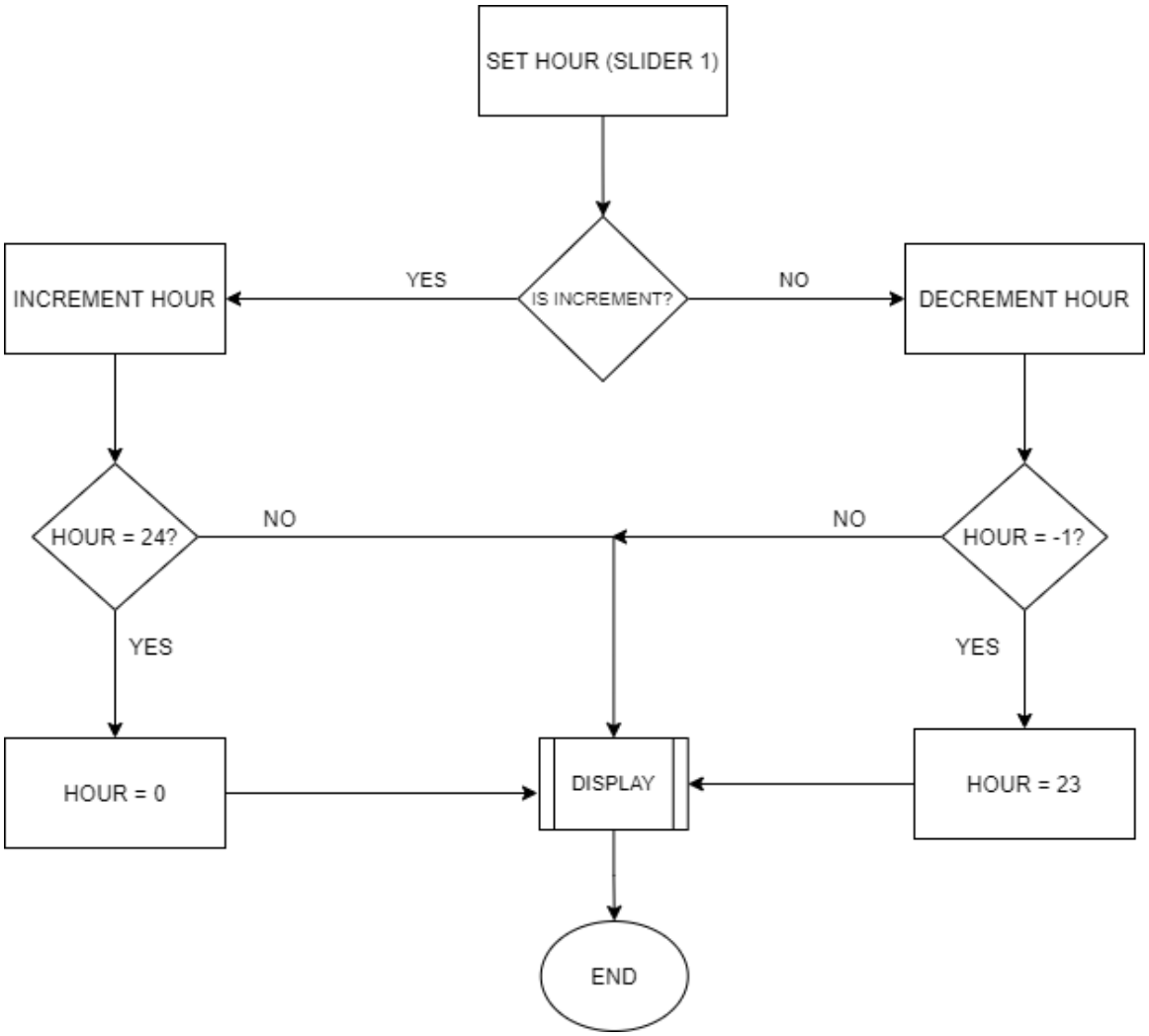


## Flow Chart of Normal Clock Running (NMI Interrupt):

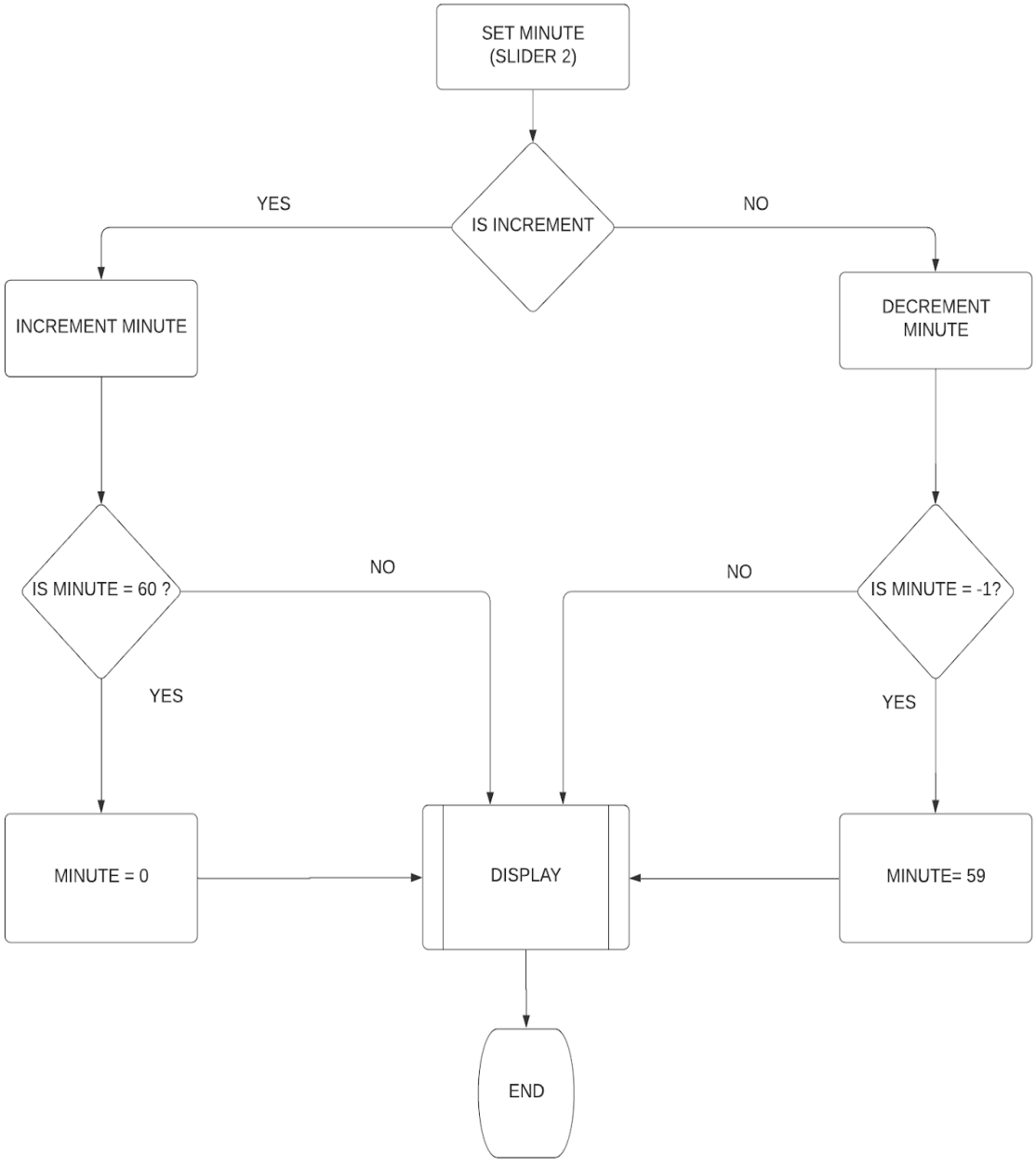


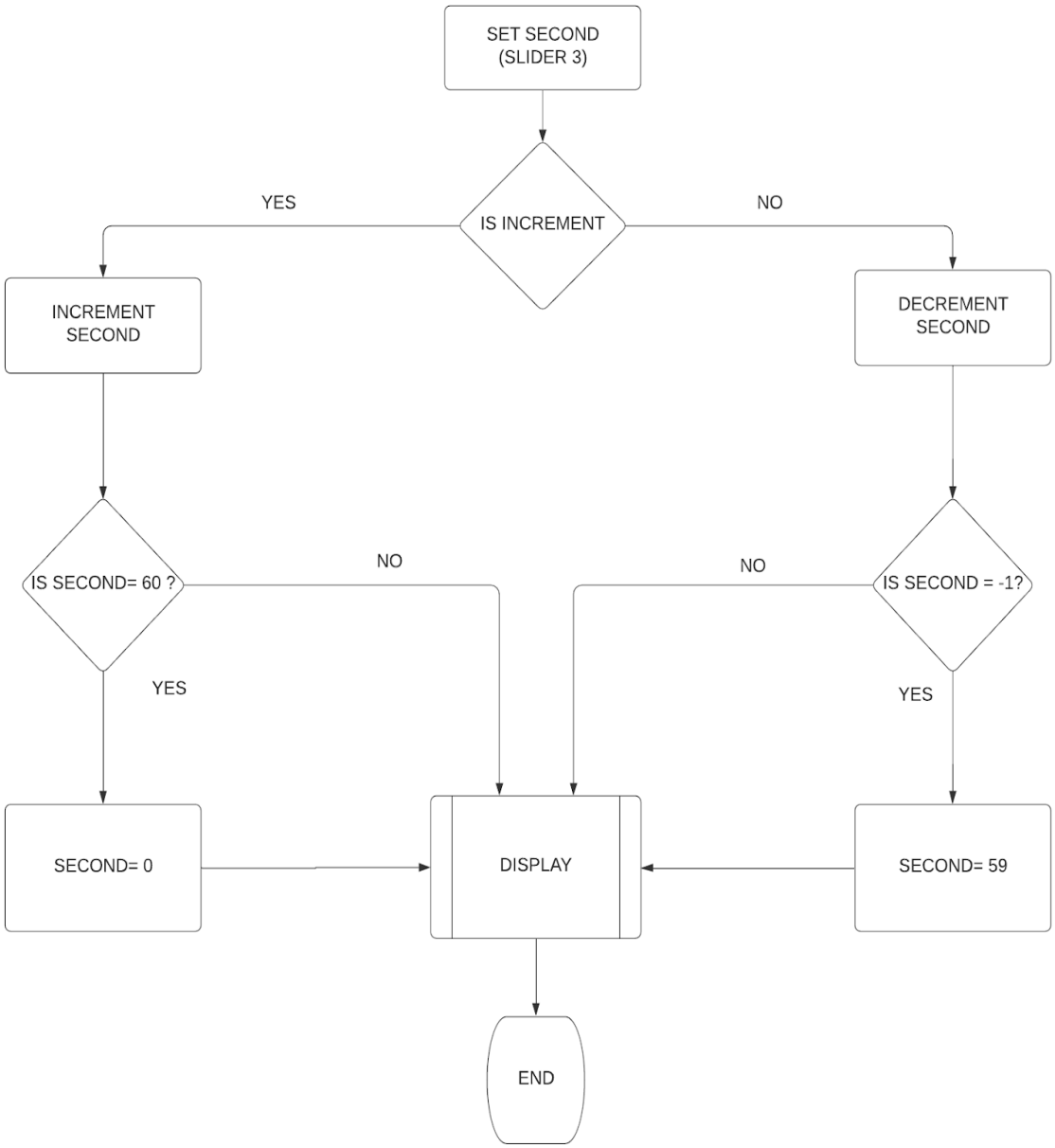
## Flow Chart of Set Hour:



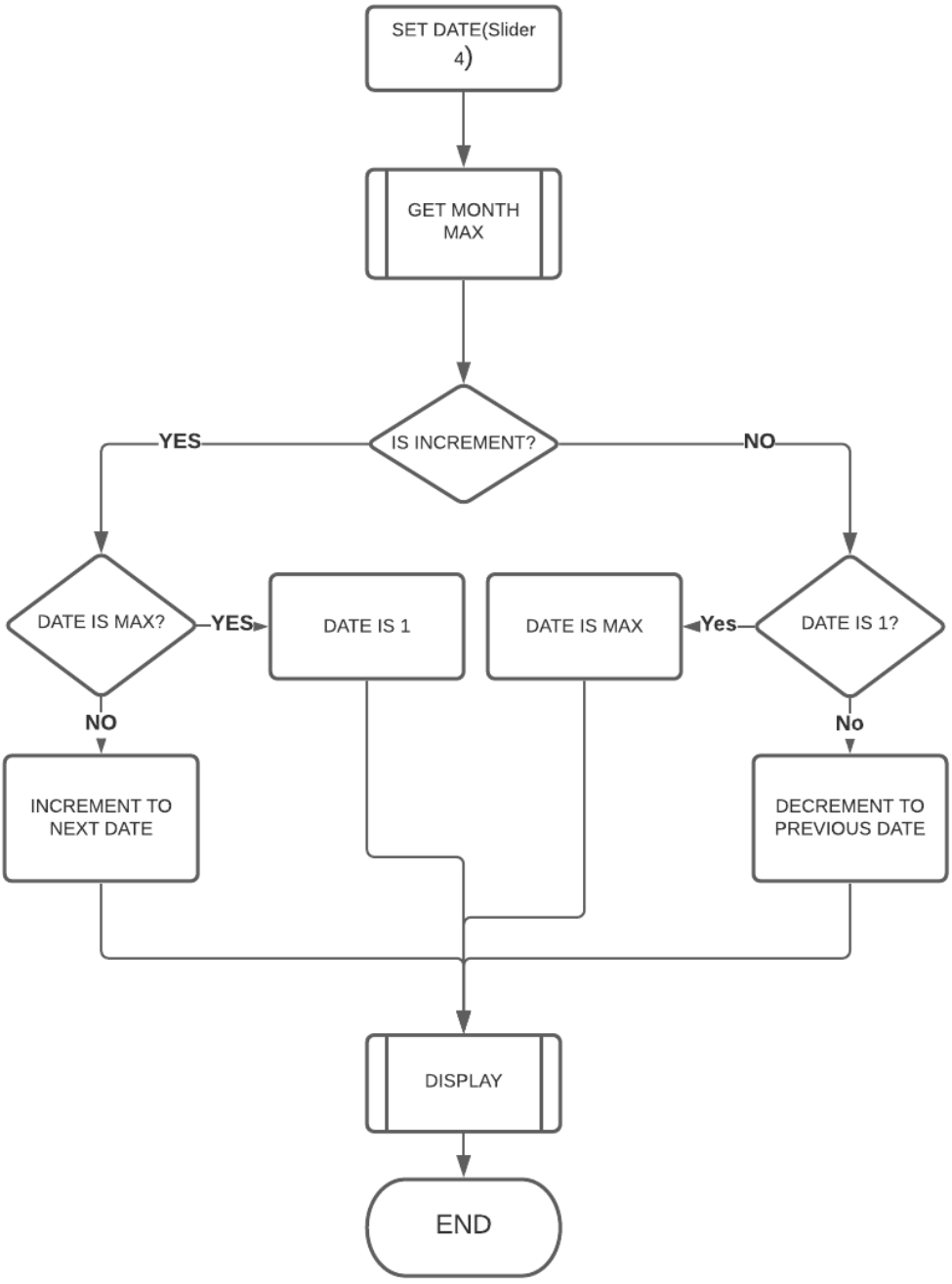
## Flow Chart of Set Minute:



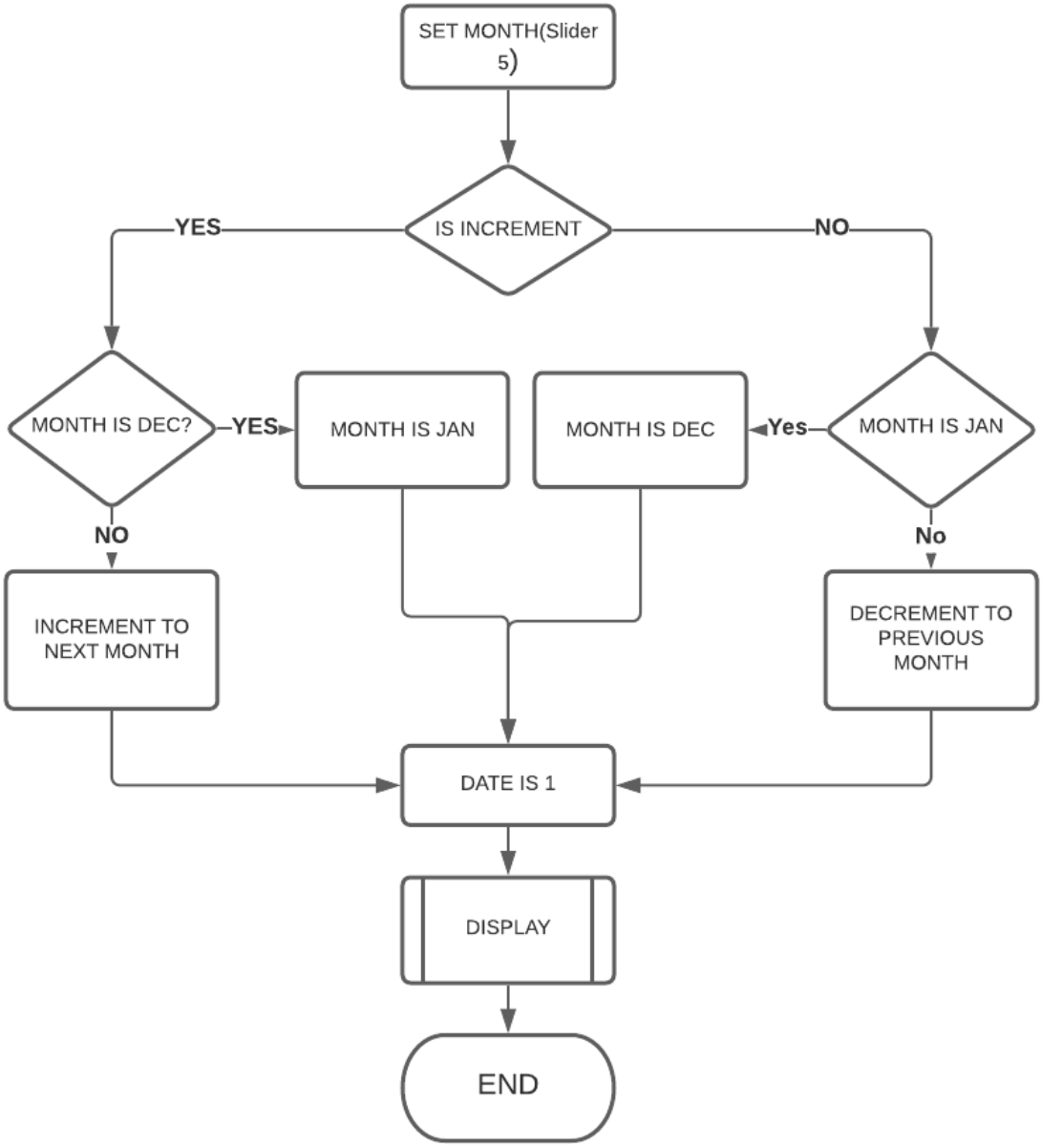
## Flow Chart of Set Second:



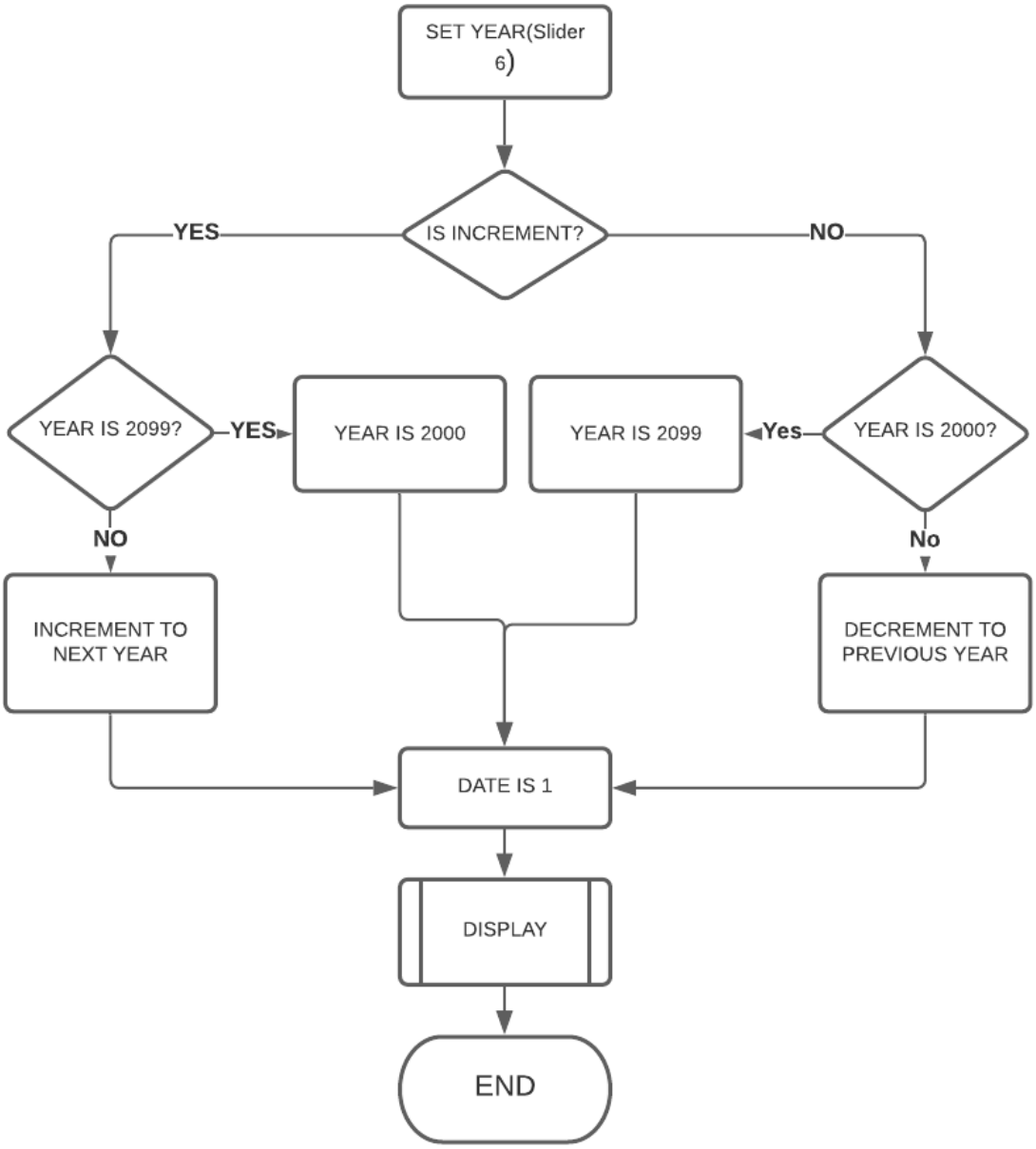
## Flow Chart of Set Date:



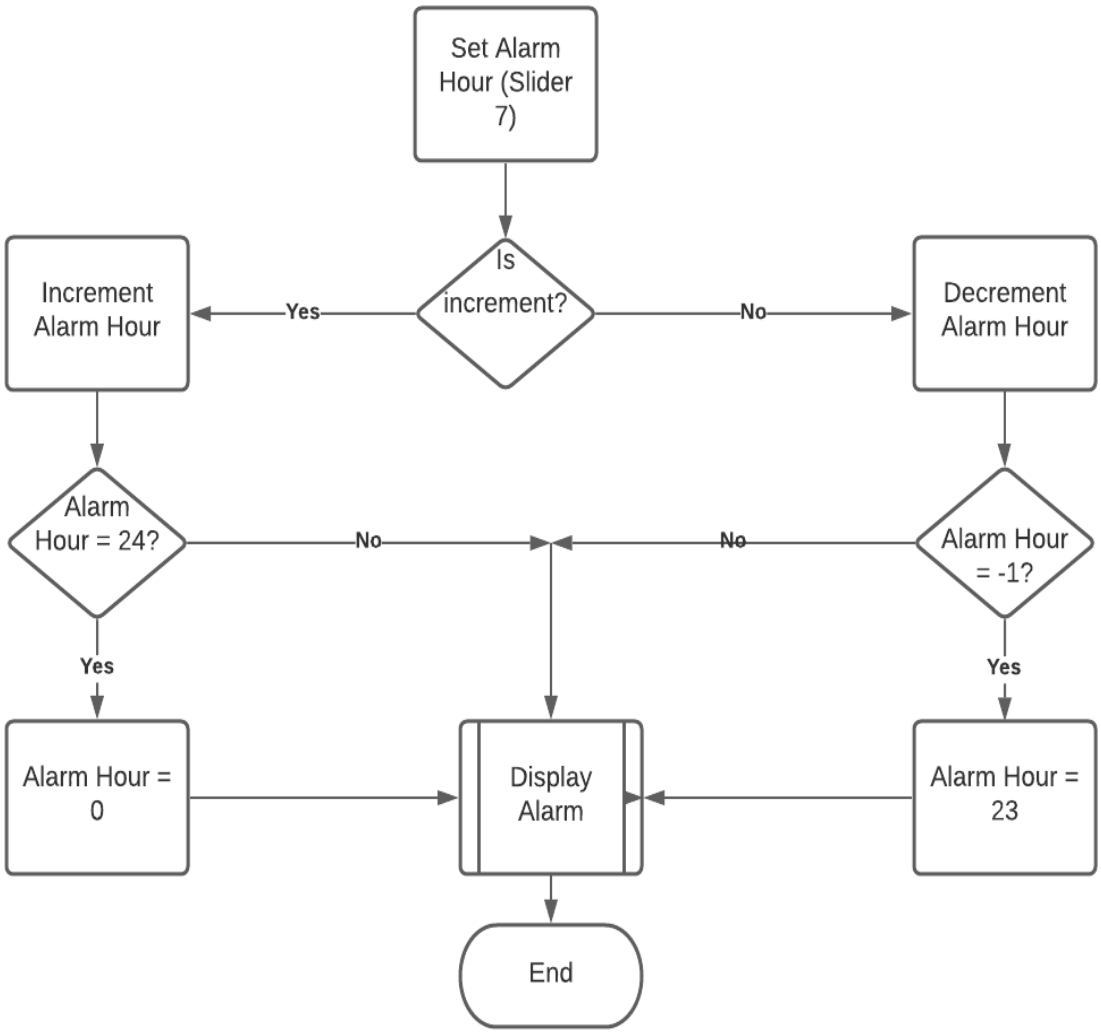
## Flow Chart of Set Month:



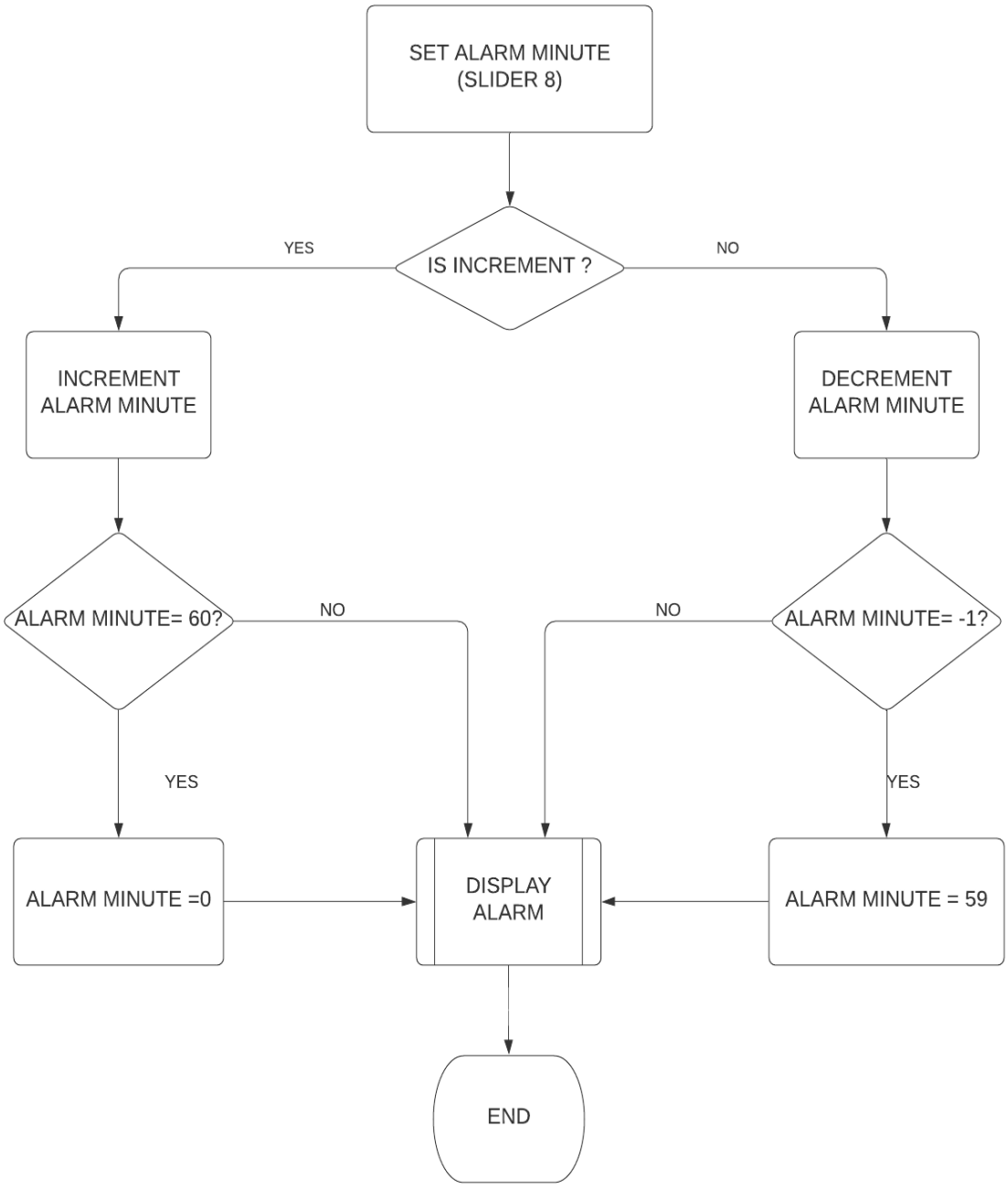
## Flow Chart of Set Year:



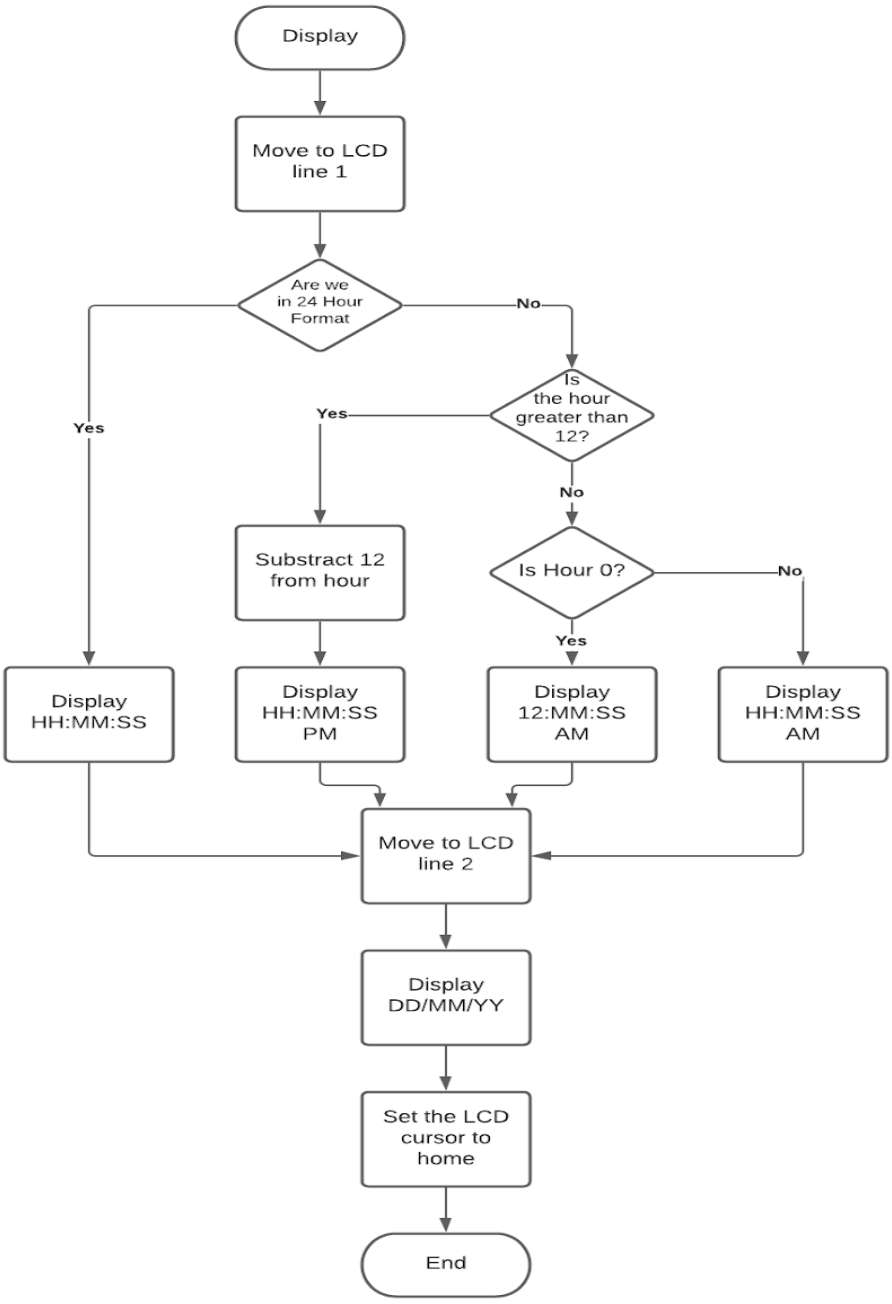
## Flow Chart of Set Alarm Hour:



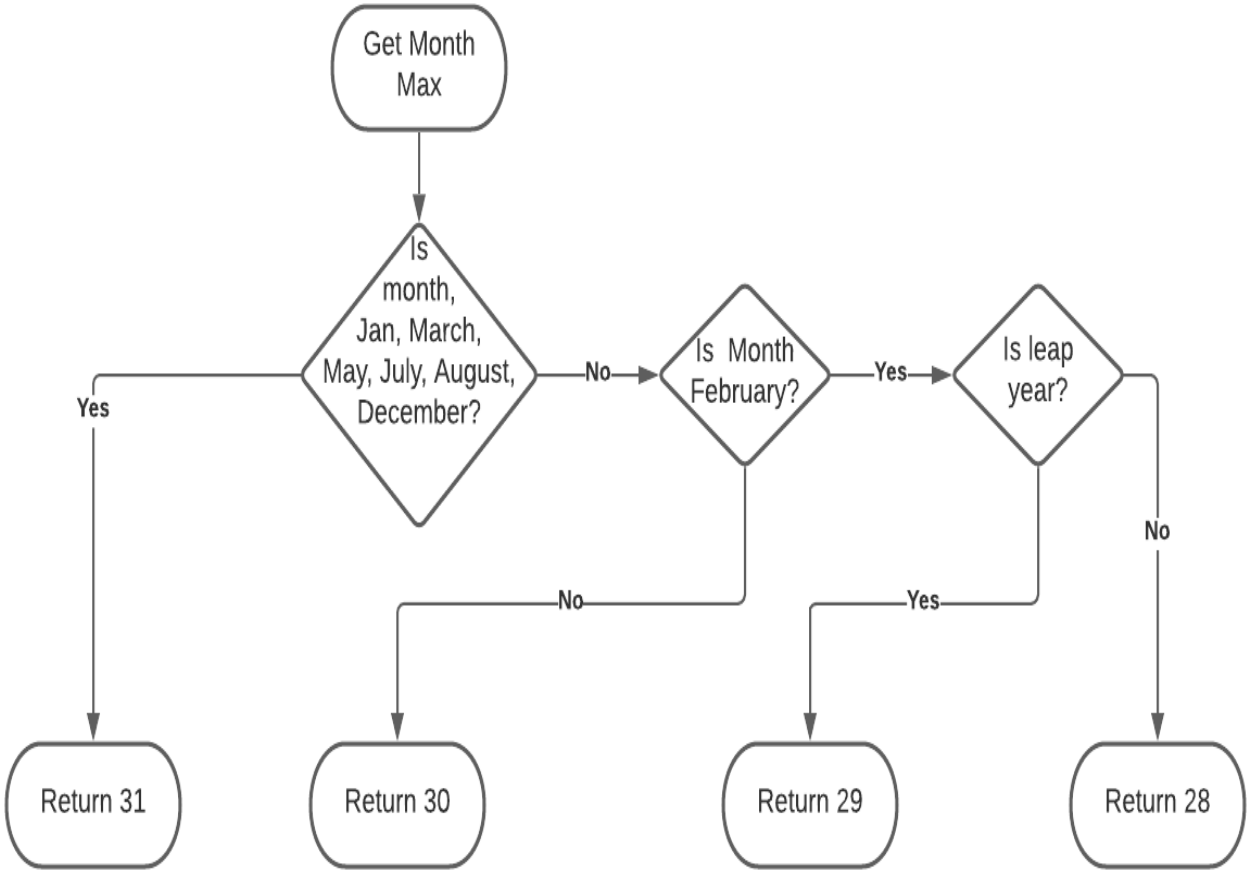
## Flow Chart of Set Alarm Minute:



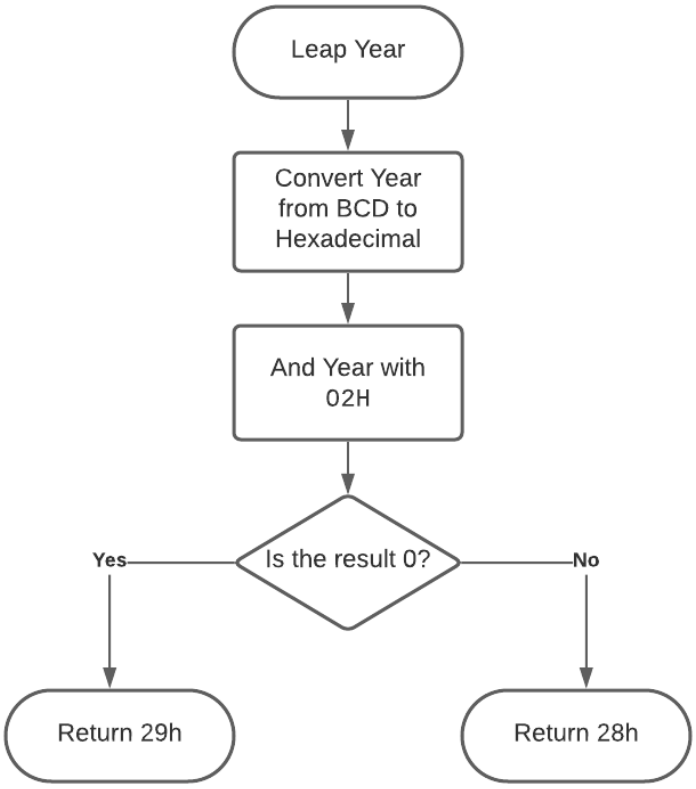
## Flow Chart of the Display:



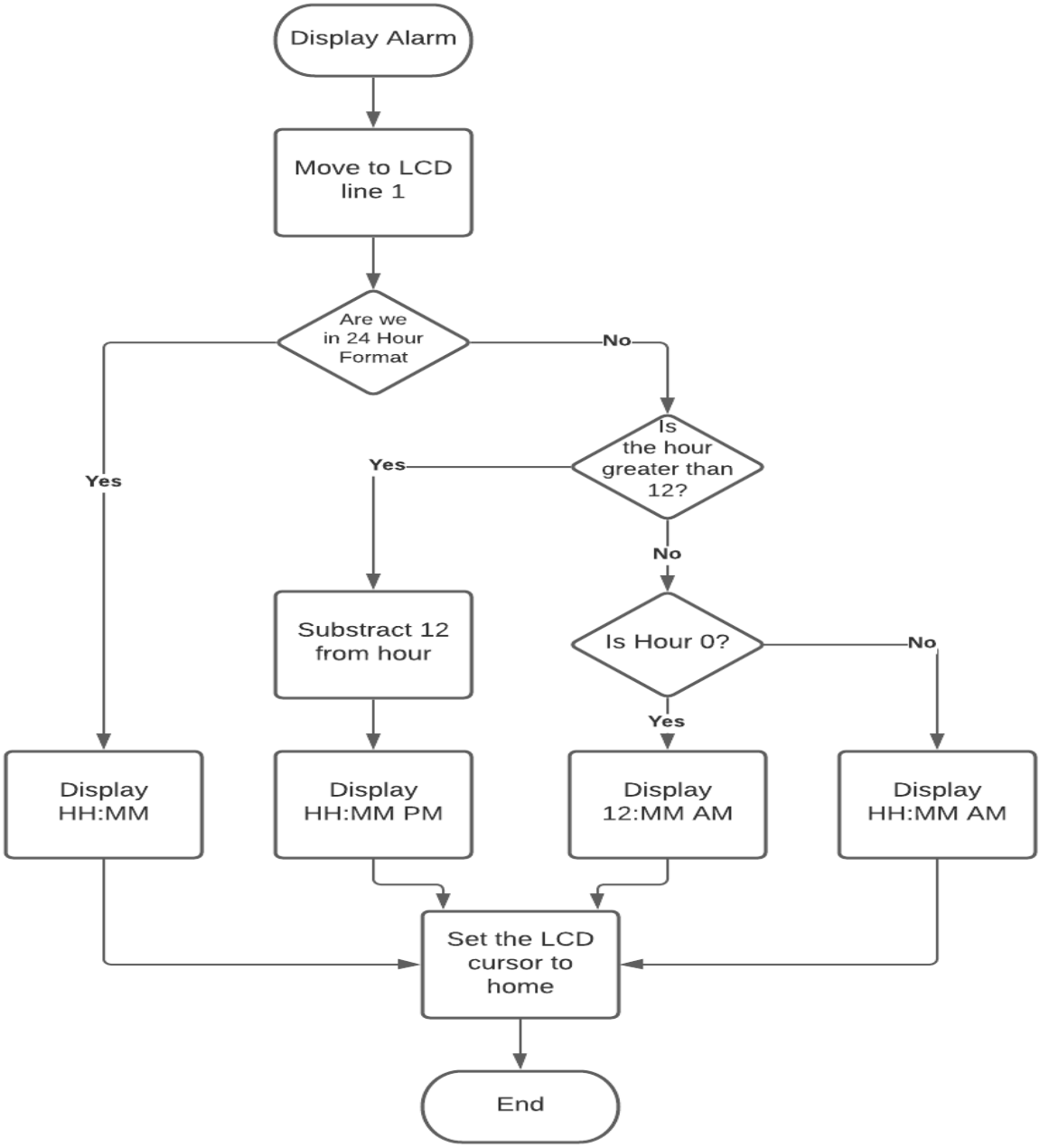
## Flow Chart of Get Month Max:



## Flow Chart of Leap Year:



## Flow Chart of Display Alarm:



# Variations in Proteus Implementation with Justification

- 8284 has been omitted from the Proteus implementation because Proteus does not support 8284. Instead a 2 MHz clock has been directly edited into the 8086 chip in Proteus.
- 2732 (4KB) chips have been used instead of 2716 because 2716 chips are not available in Proteus.

# Firmware

“`g17_digital_alarm_clock.asm`” file implemented using emu8086 attached

# List of Attachments

## Complete Hardware Real World Design

- “G17 Pinout Diagrams.pdf”

## Manuals Attached

- 8086 Microprocessor
- 74LS373 Octal Latch
- 74LS245 Octal Bus Transceiver
- 74LS138 3 to 8 Line Decoder
- 4028 4 to 10 Line Decoder
- 2732 EPROM
- 6116 RAM
- 8253A Programmable Interval Timer
- 8255A Programmable Peripheral Interface
- LM016L LCD

## Proteus File

- “g17_digital_alarm_clock.dsn”

## EMU8086 ASM File

- “g17_digital_alarm_clock.asm”

## Binary File after assembly

- “g17_digital_alarm_clock.bin”