Microprocessors & Interfacing (CS F241)

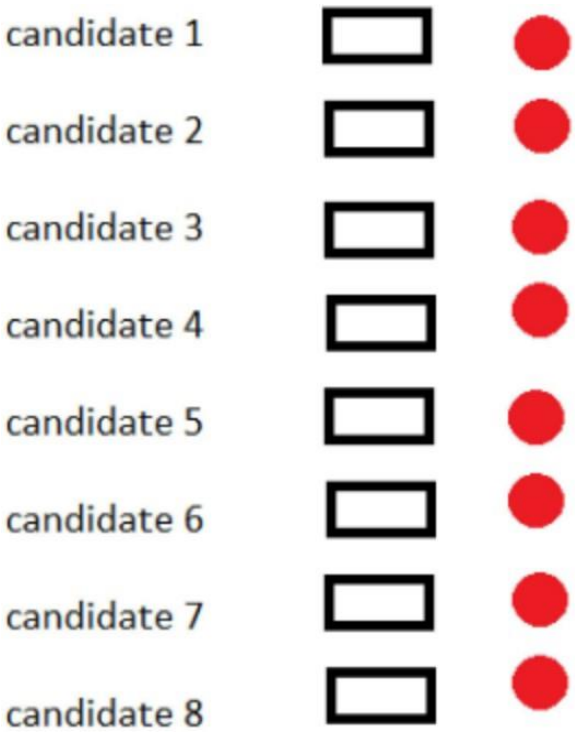
Electronic Voting Machine (EVM)

Contents

PROBLEM STATEMENT

Design a microprocessor Voting Machine which has provision for 8 candidates. It should keep the count of total votes polled and the count of votes polled for each candidate. Before being put in use, it should check if all memory locations allotted to candidates, and the total count are empty. If not, it should clear these as well as the display. There are two keypads, one for the polling officials and one for the voter. The Polling Officers Keypad also comes with a 16 character LCD Display. To put the voter keypad in use, it needs to be enabled by 8 polling agents and the Presiding officer. If anyone is missing it should not be enabled. This enabling is done using the polling officers'+ keypad. The polling officer's keypad has keys 0-9, backspace, enter, Poll count, Lock, Unlock, DisplayCount. Each polling agent and Presiding officer have a unique 5-digit numeric code. The system when turned on displays officer 1 on LCD. The polling officer then enters his numeric code. If correct then the display is updated to officer 2 and so on and finally the Presiding officer enters his code. Each person is allowed 2 retries if there is a failure the voting is blocked.

The voting interface for the user will be as follows:



The name of the candidate followed by a button followed by LED. Voter will press the button against the candidate's name — the LED will glow for 2 seconds. After 10 hours (7 a.m. to 5 p.m.) it should stop taking input from voters. There has to be a provision that the Presiding officer by pressing the Lock key followed by a 5-digit code can lock voting in between & then can restart it by pressing the Unlock key followed by a separate 5-digit code. For retrieving the count of each candidate the Presiding Officer presses the Poll Count key followed by a 5- digit code. The Presiding officer then enters the Candidates Number Followed by Display Count Key — The count for the candidate is displayed. This is done for all candidates.

SPECIFICATIONS

1. 8 candidates will have LEDs next to their names which will glow for 2 seconds (using software delay).
2. The officer's keypad has the following keys: 0-9, backspace, enter, poll count, lock, unlock, display count.
3. The LCD is a single row 16-character display.
4. The number of retries for every polling agent/officer is 2. Therefore each of them has 3 attempts- any more failures after that cause the voting to be blocked.
5. Password for every operation is a 5-digit code.
6. Only when all the 8 polling officers and the presiding officer have entered the correct passwords the voting is started (EVM starts).
7. The presiding officer has the provision to lock the voting in between the voting hours by pressing the lock key followed by a 5 digit code.The voting can be resumed by the presiding officer on pressing the unlock key followed by a separate 5 digit code.
8. Time for voting is from 7am to 5pm (10 hours in total). After that voting is closed and only then the count of votes can be checked.
9. After the voting has ended the presiding officer can check the count of each candidate , he presses the poll count key followed by a 5 digit code and then enters the candidate number, followed by pressing the display count key.
10. RTC (Real Time Clock) is also implemented using interrupts and memory addresses.

ASSUMPTIONS

The following assumptions have been made:

1. The maximum population eligible to vote at the voting centre is assumed to be FFFFFFFFh (decimal equivalent is 4,294,967,295). Hence for the worst case scenario, each candidate's vote can be stored in a double word.
2. After every 5 digit password is entered, the Enter key must be pressed.
3. The Backspace key can be pressed to undo the last character entered by the officer.
4. As soon as the presiding officer enters his password, and presses the enter key, the voting starts (time assumed is 7AM) and an interrupt is generated after 10 hours to stop the voting (at 5PM).
5. Once a particular voter has voted the voter cannot use the voting machine again or press any buttons in the EVM.The next voter has to wait at least for 2 seconds, for the LED to switch off.
6. Passwords of every user are already stored in the ROM before the system has started and it cannot be changed later.
7. There is no auto-enter after 5 digits, which means the enter key in the officer's keypad has to be pressed for the password to be validated.
8. The voters will not be able to use the hex keypad or the 16 character LCD display.
9. A master ON/OFF switch is being used to switch the machine ON or OFF. Interrupts for ON and OFF are connected to the 8259.
10. Number of votes cannot be seen after the Lock key is pressed. This action can be done only after 10 hours have elapsed.
11. Edge-triggered interrupts will be used because for level-triggered interrupts, level needs to be stable for some time for microprocessor or I/O device to detect it.

JUSTIFICATIONS

- Mode 2 is used for frequency reduction and input for the next counter because it is a rate generator. Also its output is connected to a NOT gate to get a 33% duty cycle which is ideal for synchronisation.
- Mode 0 is used to raise an interrupt after 10 hours as the initially low OUT goes high after 10 hours are over. This 0 to 1 transition raises an interrupt to 8259.
- 8259 interrupts are assumed to be edge triggered by configuring the ICW 1 accordingly.
- Since we need a very low frequency for 10 hours, we are using an 8253 instead of an 8254 because the max frequency of 2.6 MHz is sufficient.
- The Reset address (FFFF0h) must be present in ROM.

COMPONENTS

The following table describes the devices used, their number and a brief description of the role they play in the overall design of the EVM.

Sr. no.	Device Name	Quantity	Description
1.	8086	1	16 bit Intel Microprocessor
2.	8253	1	Programmable Interval Timer
3.	8259A	1	Priority Interrupt Controller
4.	8255A	2	Programmable Peripheral Interface
5.	8284	1	Crystal Clock generator for 8086 and for 8253
6.	2716	4	2k programmable ROM chip
7.	6116	2	2k programmable RAM chip
8.	74LS138	3	3:8 Decoder
9.	74LS373	3	Octal Latch
10.	74LS245	2	Octal Bus Transceiver
11.	74LS244	1	Octal 3-state buffer
12.	LM020L	1	16:1 LCD display
13.	Push Button	16	SPST Push Button
14.	IC 7404	1	Hex Inverter
15.	IC 7402	1	Quad 2 input NOR gates
16.	IC 7432	1	Quad 2 input OR gates

Apart from the above components, we will need resistors & push-buttons (one-hot keys).

DESCRIPTION OF SELECTED I/O DEVICES

A. 8255A (for the officers)

This 8255 port is used to interface the LCD data lines and the officer's keypad with an 8086 microprocessor. The officer's keypad is a 4:4 matrix of one-hotkeys, which are used to input the passwords for various actions. This hex keypad will also have keys for functions such as lock, unlock, poll count and display count. Lock and Unlock have separate hardware interrupts and hence these keys will be connected to the 8259A by way of NOR gates. The NOR gates connected to specific columns and rows ensure that the interrupt is raised only when the respective key is pressed. This 8255 will be ignored if the 'on_switch' variable is set to 0.

Port A: 50h [LCD data lines]
Port B: 52h [LCD control lines]
Port C: 54h [Hex keypad]
Control Register: 56h

B. 8255A (for the voters)

This 8255 port is used to interface the voter's keypad and the corresponding LEDs with the 8086 microprocessor. When the voter presses the key of their preferred candidate, the corresponding LED lights up for 2 seconds, confirming the vote has been counted. This 8255 will be ignored if the 'lock_en' global variable is set to 1 or 'on_switch' global variable is set to 0 (the latter has more priority).

Port A: 58h [*unused*]
Port B: 5Ah [One-hot output LEDs]
Port C: 5Ch [8**:**1 voter keypad]
Control Register: 5Eh

C. LM020L (16x1 LCD display)

This LCD display will be used majorly for displaying output to mainly build a user friendly interface. Password characters entered will be masked with an asterisk (*) to signify how many characters have been entered. The user will also receive appropriate prompts here such as 'Enter Password', 'Wrong Password', wtc.

Here the **R/W(Read-Write)**
This pin selects if we want to read or write some instruction (Data-Command) to lcd. Signal notifies the lcd controller about potential read write operation.

- If R/W=0 Write operation is selected.
- If R/W=1 Read operation is selected.

En(Enable)
This pin is a push data present on data lines of lcd. Generally it remains low. But when we want to display data on the lcd screen or send the lcd settings command we make this pin high for a few milliseconds and then back again low.

RS
To display data on lcd we have to select the data register of lcd. Send data to the data register. Now To make this data appear on lcd we have to make En(Enable) pin high. If RS=1 Data Register is selected.

Before using lcd we have to set some parameters for lcd. Like the font size of data that we want to display on lcd. Cursor blinking or still settings etc. If RS=0 Command register is selected.

D. 8253

8253 chip is used to generate an interrupt after 10 hours since the beginning of voting. The interrupt is generated as the output of

Counter 2. This interrupt is then connected to the IR2 pin of the 8259A. Counter 0 gets the input clock from the PCLK of the 8284 (crystal generator)- its output goes to Counter 1 as an input clock. Counter 1's output is the input clock for Counter 2. Outputs of Counter 1 & 2 are connected to a NOT gate to get 33% duty cycle. Gates of all counters are connected to =5V supply.
Output of Counter 1 (1 Hz) is used to raise interrupts for the RTC.

Address and configuration of counters:

Counter Number	Address	Mode of Operation	Counter Stored	Output
Counter 0	68h	Mode 2	10000d	250Hz
Counter 1	6Ah	Mode 2	250d	1Hz
Counter 2	6Ch	Mode 0	36000d	Interrupt after 10 hrs
Control Register	6Eh	-	-	-

E. 8259A

8259A is being used to prioritise the interrupts that are generated in the design throughout its working. All interrupts are edge triggered. When the master key is switched ON, an interrupt is raised to IR0 whose ISR handles the switching on of the machine. Similarly, OFF action interrupt is raised to IR1. Whenever input has to be taken, first the value of the 'on_switch' global variable will be checked- if it is 1, only then will the input be registered and appropriate action will be performed.
Interrupt generated by 8253 is connected to the IR2. This interrupt will ensure that the voting is stopped after 10 hours (from 7am to 5pm), only after which the poll count facility will be available.

The interrupt generated upon pressing the Lock key in the officer's keypad is connected to IR3. This interrupt is implemented in such a way that when the Lock key is pressed in the officer's keypad, the NOR gate connected to the corresponding column and row of the key goes high. This raises an interrupt, which sets the 'lock_en' global variable to 1 in the ISR.
Similarly, an interrupt (connected to IR4) is raised on pressing the Unlock key which sets the 'lock_en' global variable to 0.
Interrupt for RTC(Real Time Clock) is connected to IR5 which handles the 10 hours of time required for operating the machine.

Memory locations 7Ch and 7Eh are used as the addresses of 8259A.

ADDRESS MAPPING

1. **Memory Addressing:**

   RAM- min. 2k chip, TOTAL: 4k; ROM- min. 2k chip, TOTAL: 4k + 4k = 8k

   - ROM0: 00000h to 00FFFh
   - RAM0: 01000h to 01FFFh
   - ROM1: FF000h to FFFFFh

2. **I/O Addressing:**

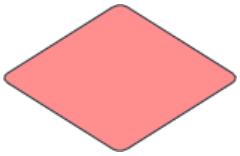
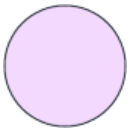
   a. 8255 (for officers): 50h to 56h

   b. 8255 (for voters): 58h to 5Eh

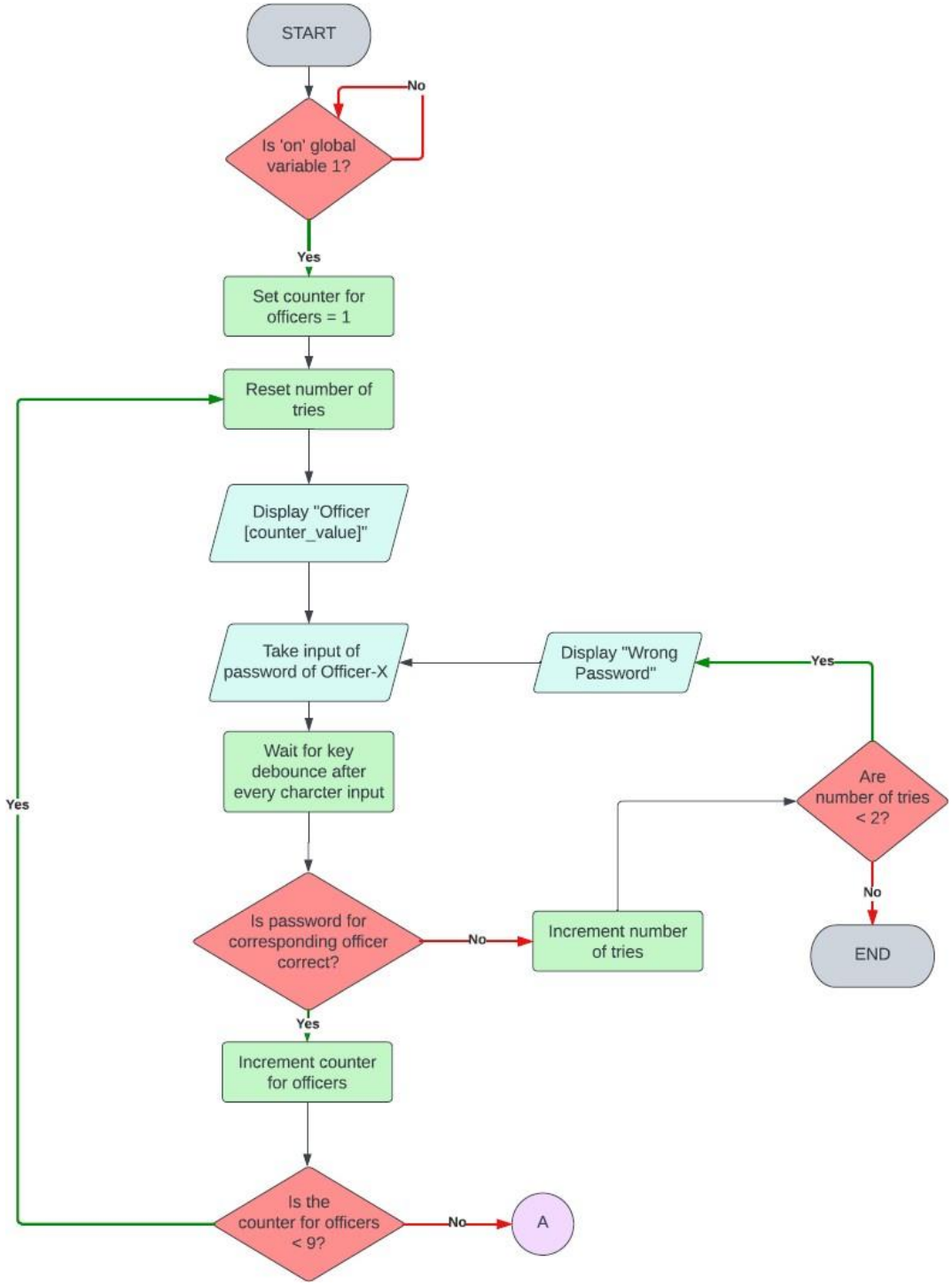
   c. 8253: 68h to 6Eh

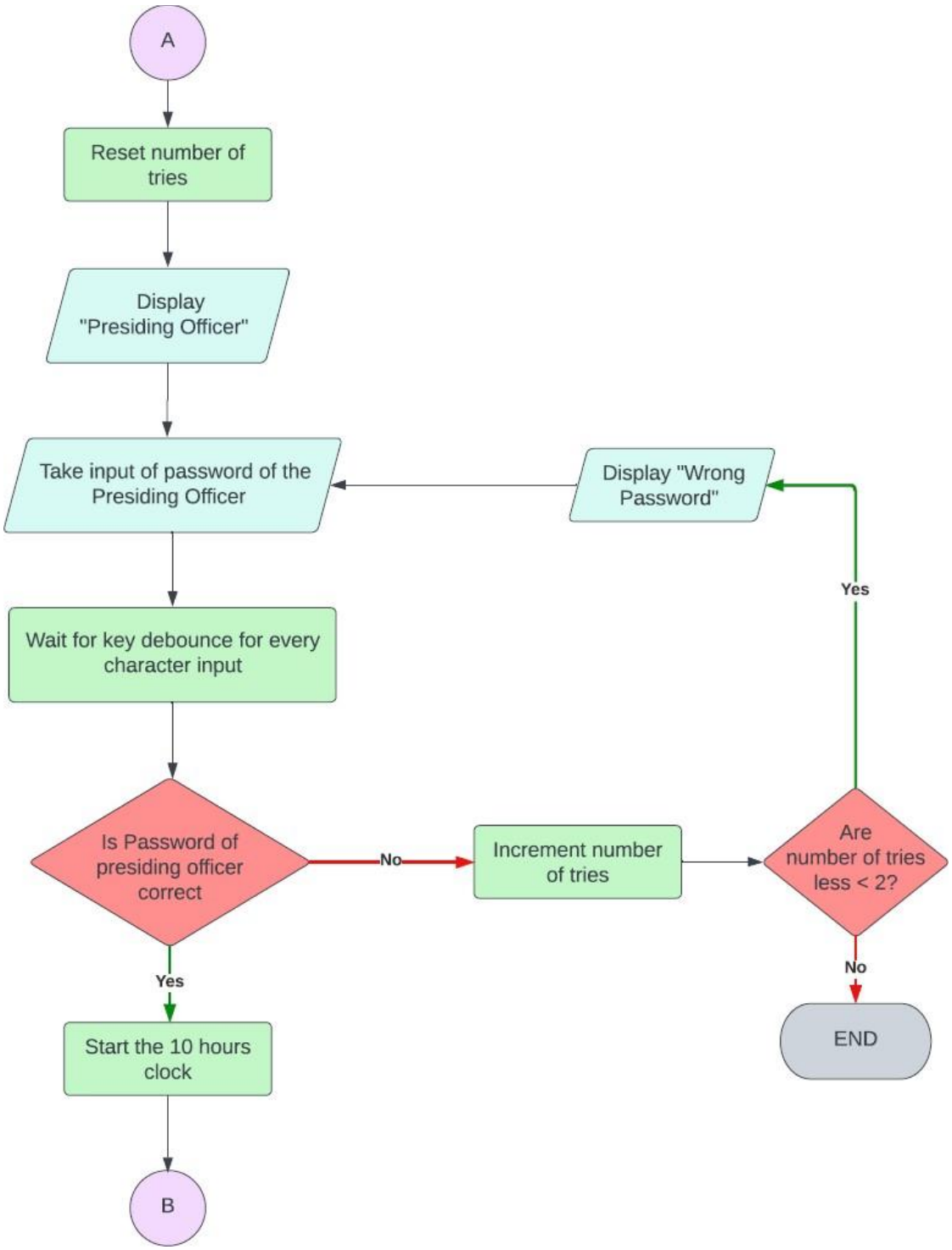
   d. 8259A: 7Ch to 7Eh

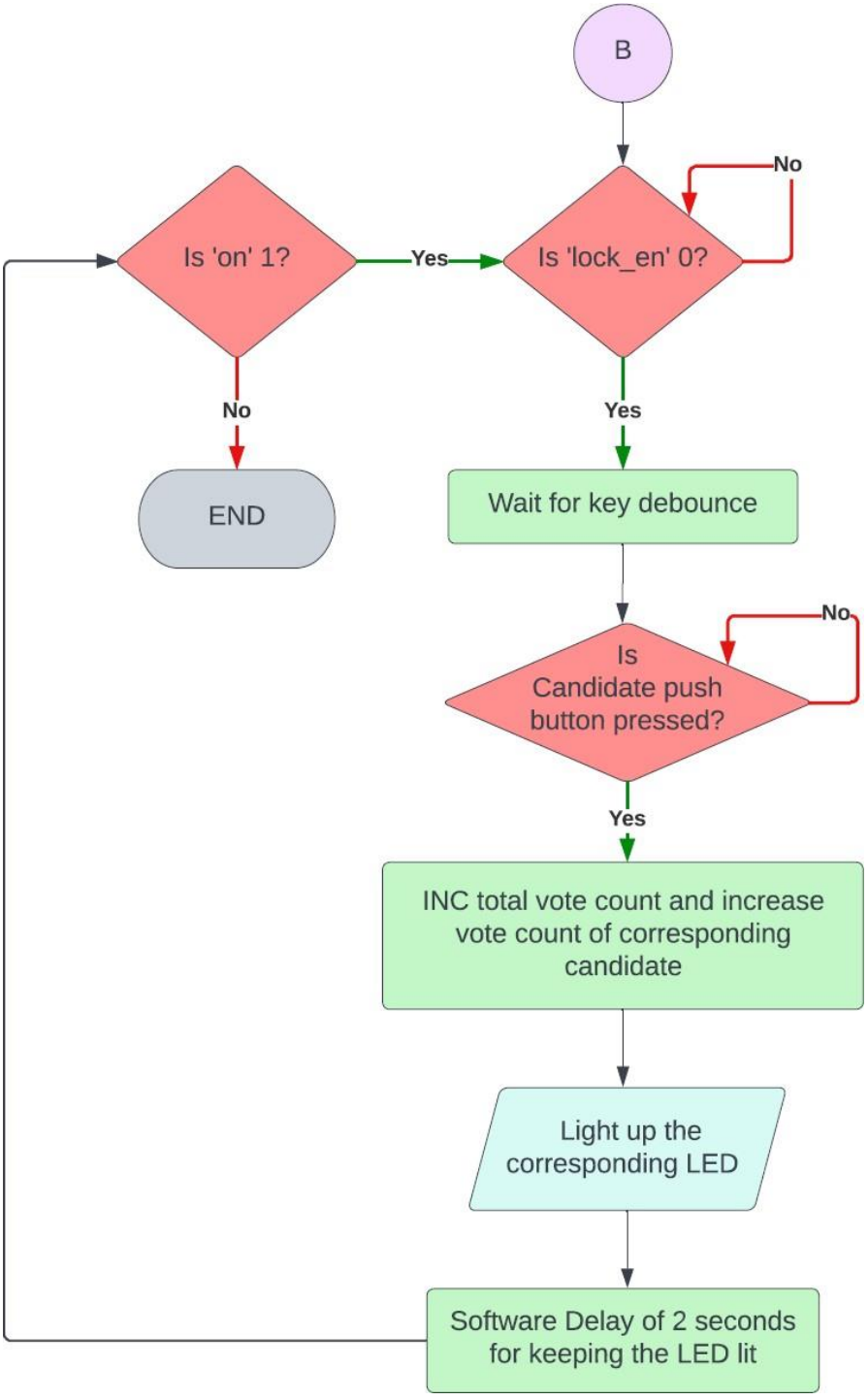
FLOWCHARTS

	Terminator
	Process
	Decision
	Input/Output
	Connector

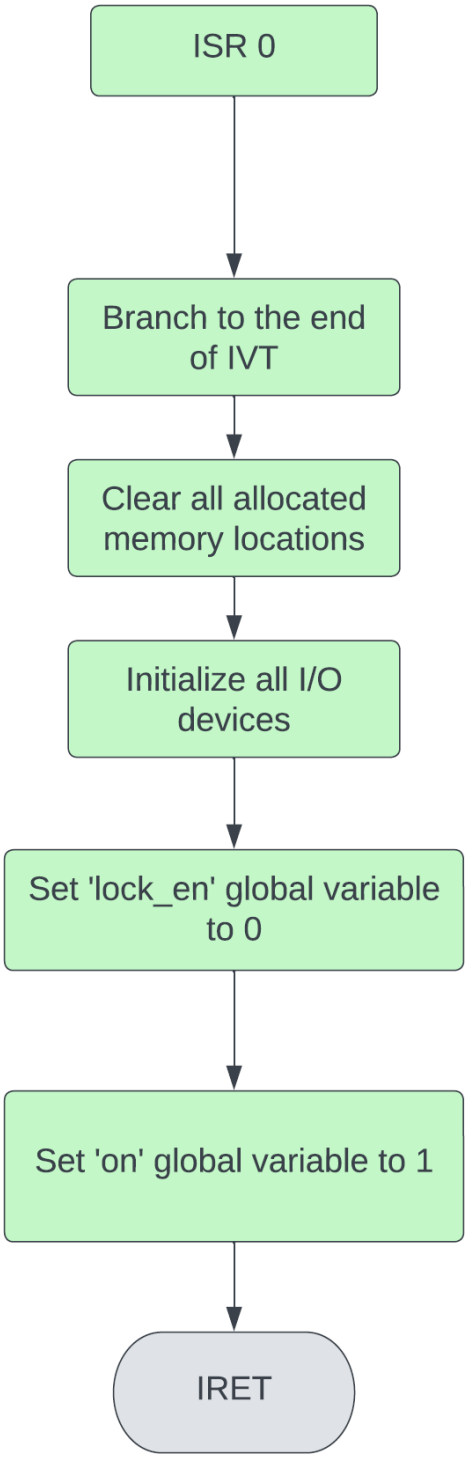
Main program flowchart



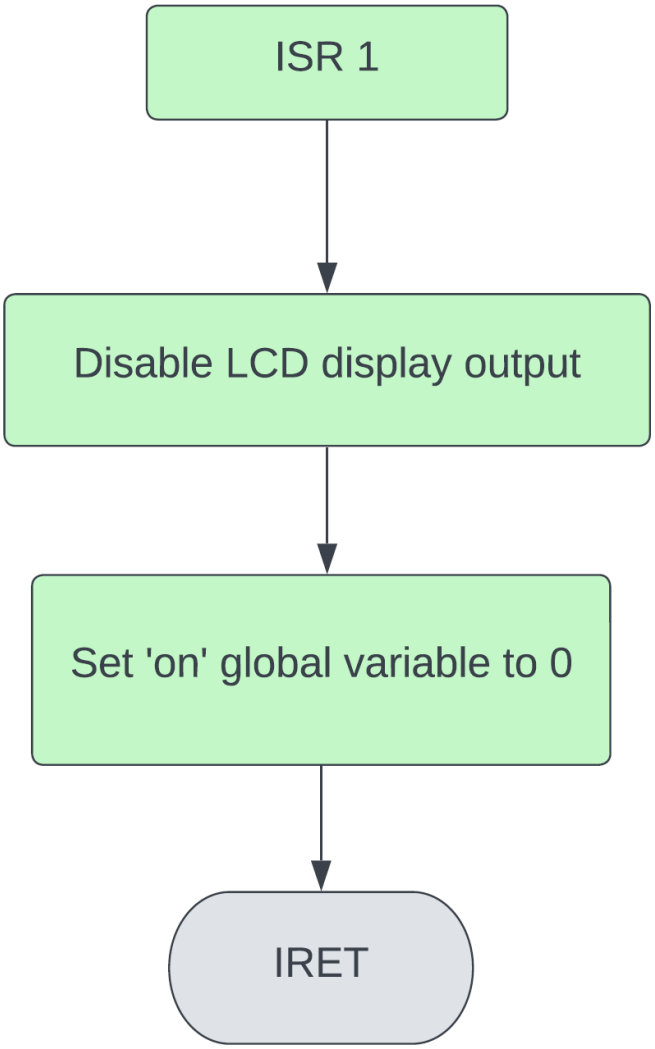

A
Reset number of tries
Display "Presiding Officer"
Take input of password of the Presiding Officer
Display "Wrong Password"
Wait for key debounce for every character input
Is Password of presiding officer correct
No
Increment number of tries
Are number of tries less < 2?
Yes
No
Yes
Start the 10 hours clock
END
B


B
Is 'on' 1?
Yes
Is 'lock_en' 0?
No
No
Yes
END
Wait for key debounce
Is Candidate push button pressed?
No
Yes
INC total vote count and increase vote count of corresponding candidate
Light up the corresponding LED
Software Delay of 2 seconds for keeping the LED lit

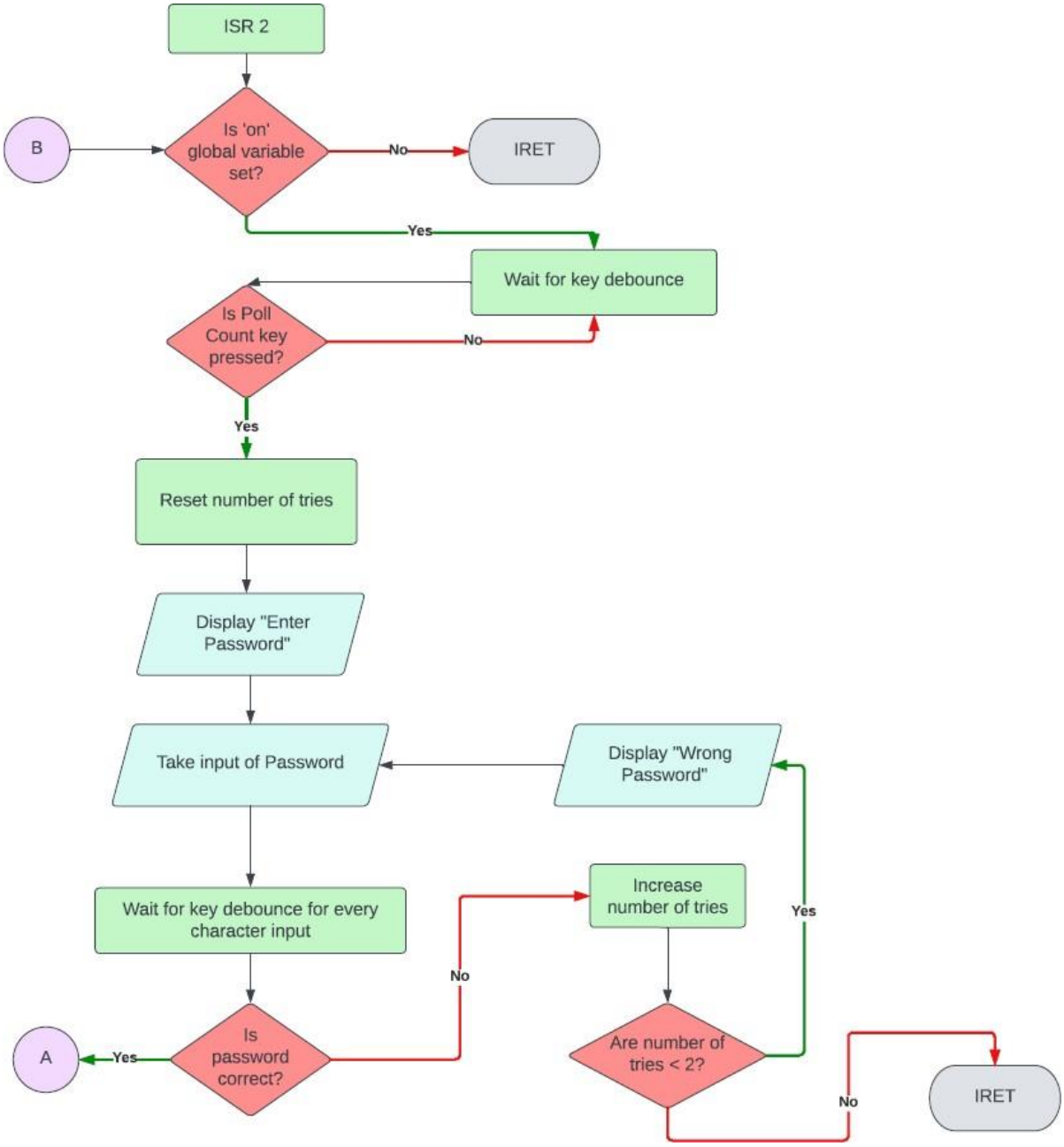
ISR 0

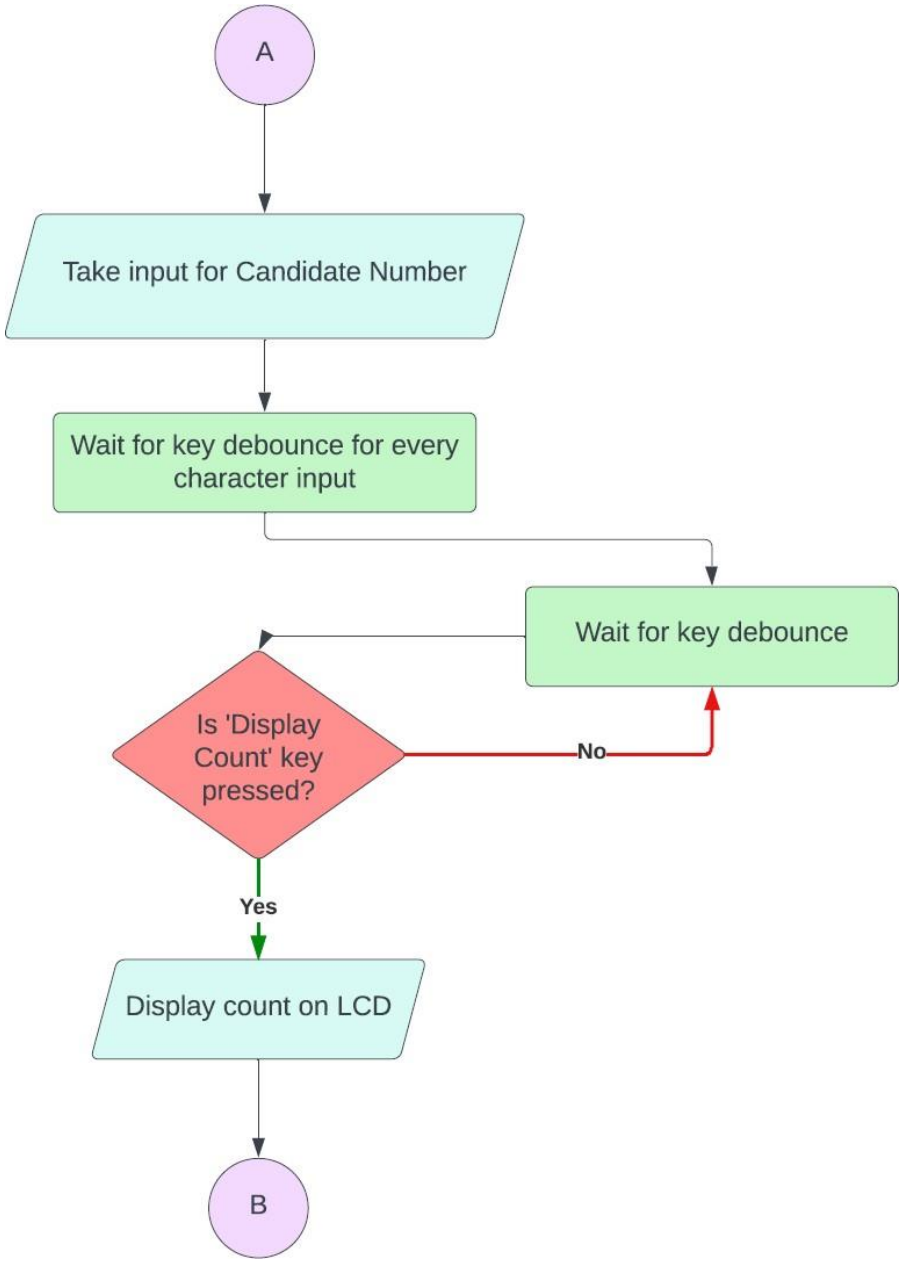

ISR 0
Branch to the end of IVT
Clear all allocated memory locations
Initialize all I/O devices
Set 'lock_en' global variable to 0
Set 'on' global variable to 1
IRET

ISR 1

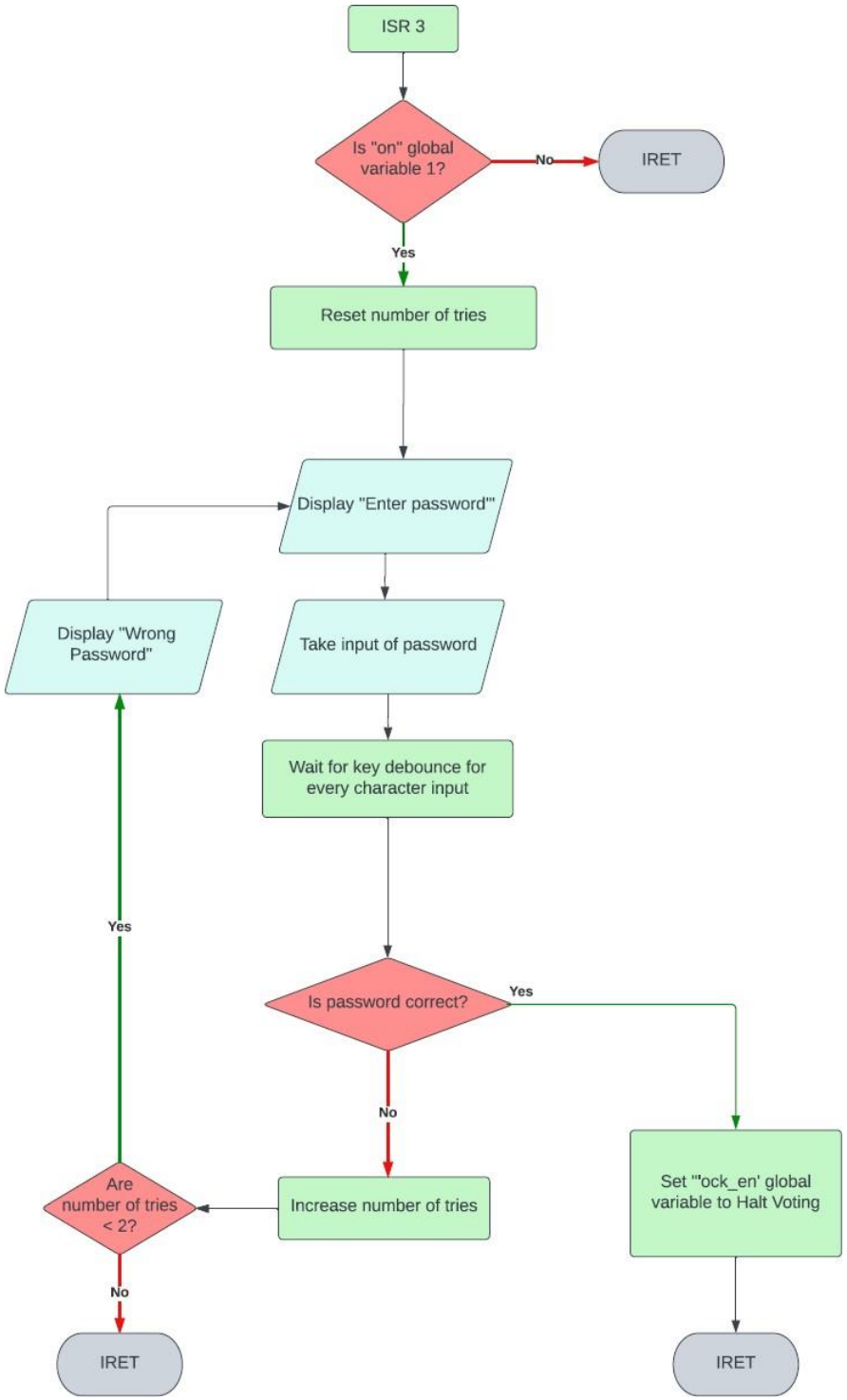

ISR 1
Disable LCD display output
Set 'on' global variable to 0
IRET

ISR 2

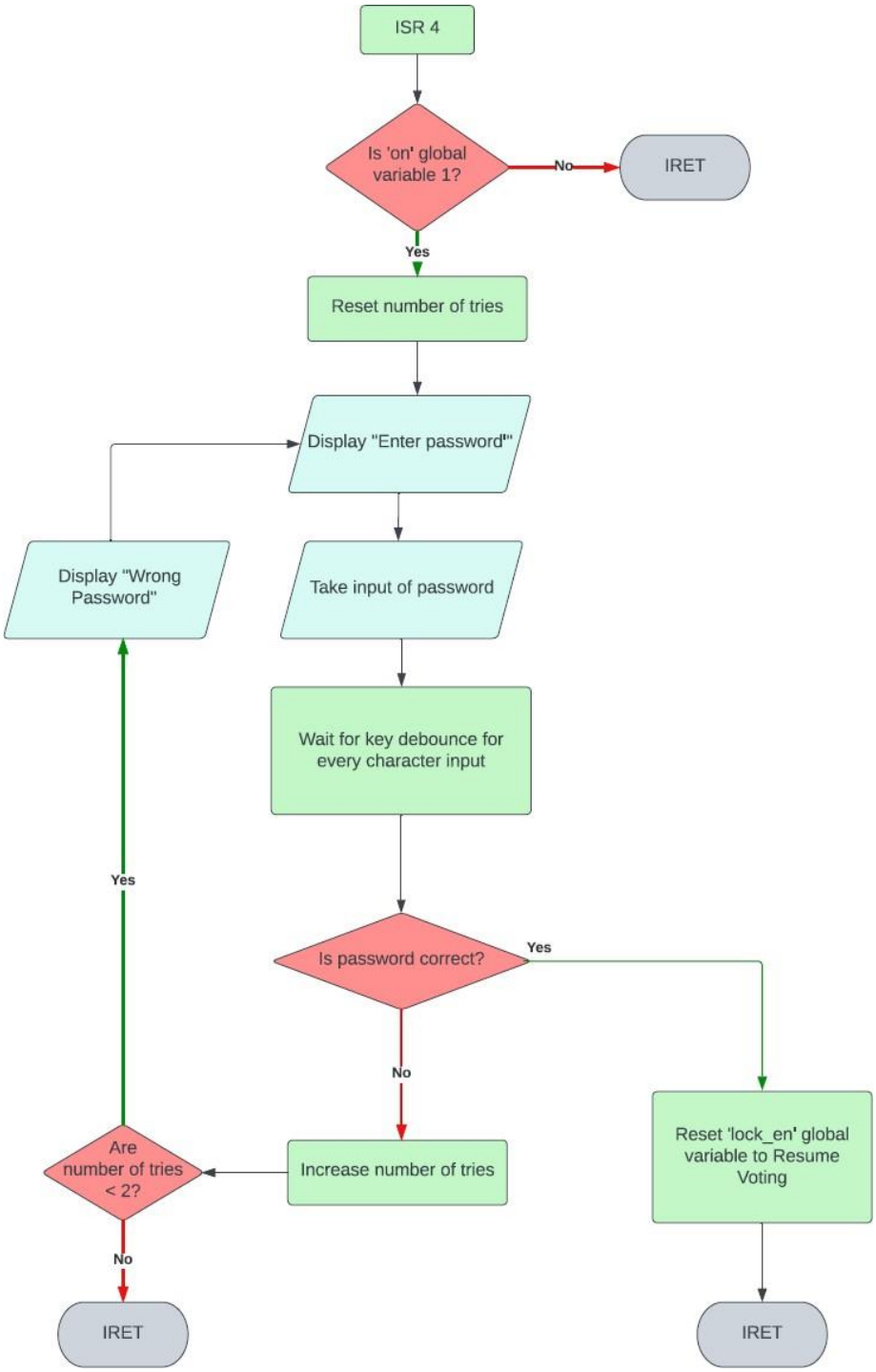

ISR 2
B
Is 'on' global variable set?
No
IRET
Yes
Wait for key debounce
Is Poll Count key pressed?
No
Yes
Reset number of tries
Display "Enter Password"
Take input of Password
Display "Wrong Password"
Wait for key debounce for every character input
Increase number of tries
Yes
No
A
Yes
Is password correct?
Are number of tries < 2?
No
IRET


A
Take input for Candidate Number
Wait for key debounce for every character input
Wait for key debounce
Is 'Display Count' key pressed?
No
Yes
Display count on LCD
B

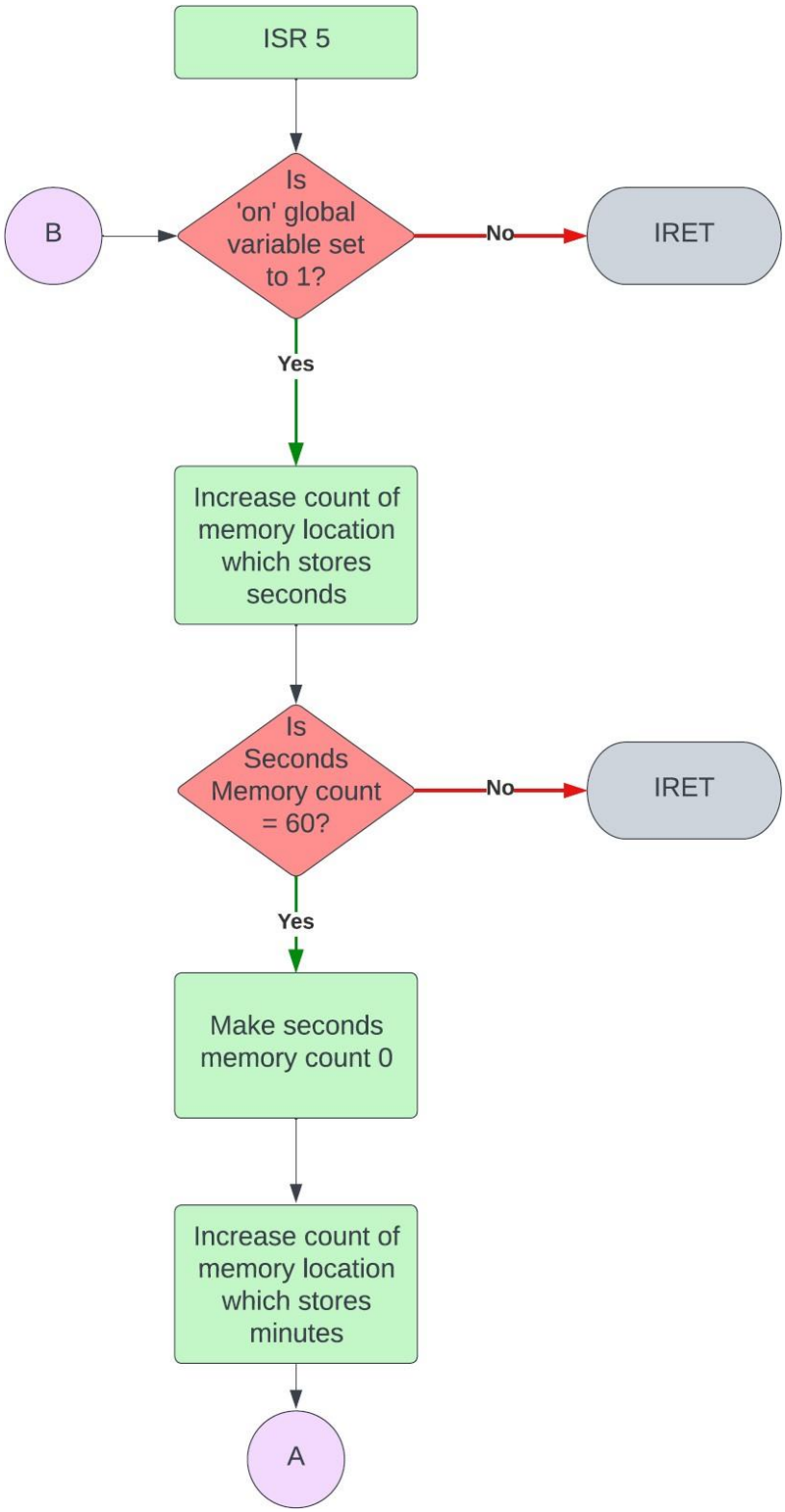
ISR 3

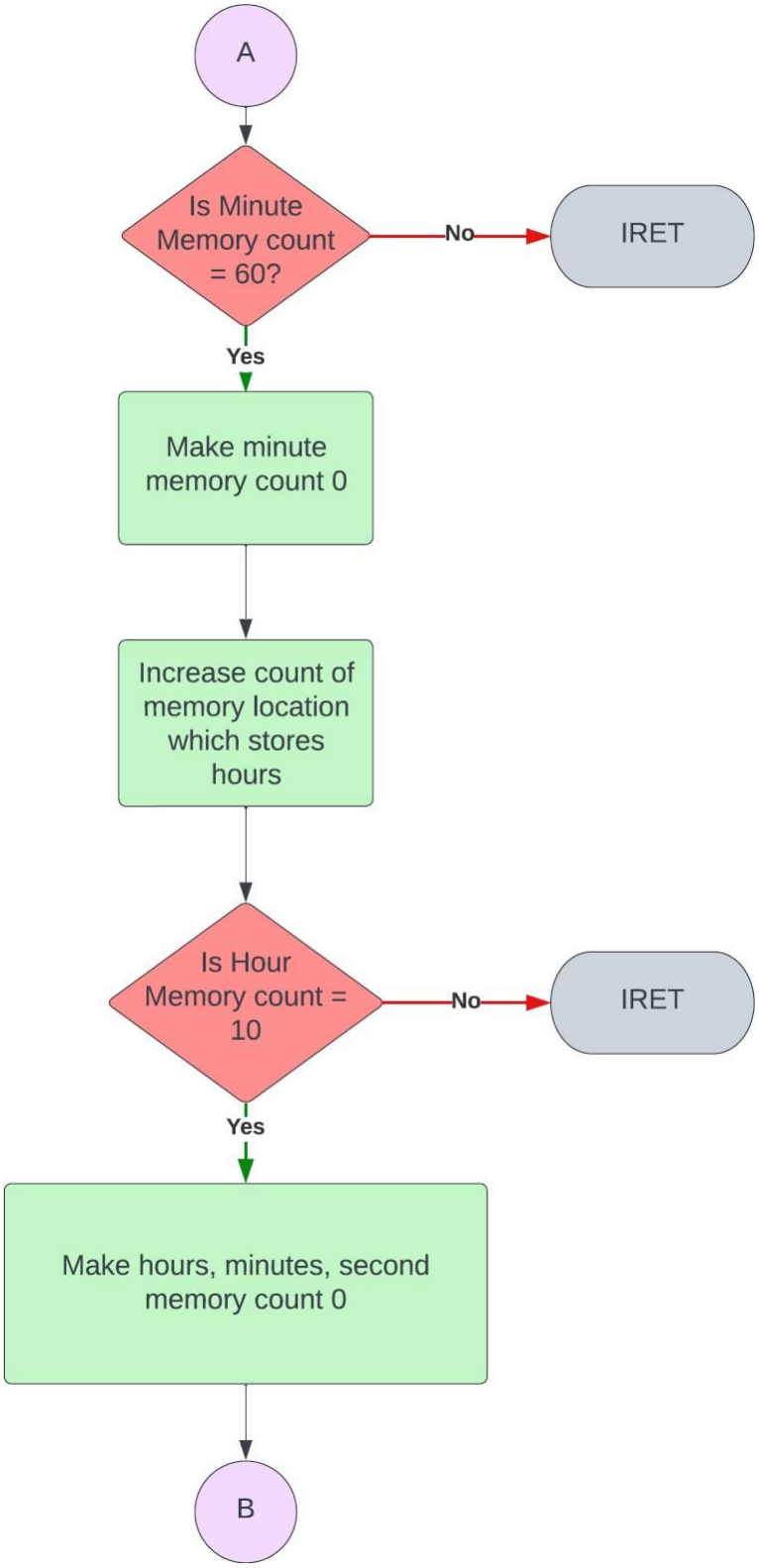

ISR 3
Is "on" global variable 1?
No
IRET
Yes
Reset number of tries
Display "Enter password""
Display "Wrong Password"
Take input of password
Wait for key debounce for every character input
Yes
Is password correct?
Yes
No
Are number of tries < 2?
Increase number of tries
Set '"ock_en' global variable to Halt Voting
No
IRET
IRET

ISR 4


ISR 4
Is 'on' global variable 1?
No
IRET
Yes
Reset number of tries
Display "Enter password"'
Display "Wrong Password"
Take input of password
Wait for key debounce for every character input
Yes
Is password correct?
Yes
No
Are number of tries < 2?
Increase number of tries
Reset 'lock_en' global variable to Resume Voting
No
IRET
IRET

ISR 5


ISR 5
B
Is 'on' global variable set to 1?
No
IRET
Yes
Increase count of memory location which stores seconds
Is Seconds Memory count = 60?
No
IRET
Yes
Make seconds memory count 0
Increase count of memory location which stores minutes
A


A
Is Minute Memory count = 60?
No
IRET
Yes
Make minute memory count 0
Increase count of memory location which stores hours
Is Hour Memory count = 10
No
IRET
Yes
Make hours, minutes, second memory count 0
B

DATASHEETS

A. 8086
8086 16-BIT HMOS MICROPROCESSOR 8086 8086-2 8086-1

B. 8255
http://aturing.umcs.maine.edu/~meadow/courses/cos335/Intel8255A.pdf

C. 8253
https://pdf1.alldatasheet.com/datasheet-pdf/view/122714/INTEL/82530.html

D. 8284
https://www.ndr-nkc.de/download/datenbl/i8284a.pdf

E. 8259
8259A PROGRAMMABLE INTERRUPT CONTROLLER (8259A 8259A-2)

F. 2716
https://amigan.yatho.com/2716EPROM.pdf

G. 6116
CMOS STATIC RAM 16K (2K x 8 BIT)

H. 74LS373

Octal D-Type Transparent Latches And Edge-Triggered Flip-Flops datasheet (Rev. B)

I. 74LS245
SNx4LS245 Octal Bus Transceivers With 3-State Outputs datasheet (Rev. B)

J. 74LS244
https://www.ti.com/lit/ds/symlink/sn74ls244.pdf

K. LM020L
https://datasheetspdf.com/pdf-file/605218/ETC/LM020L/1

L. IC 7404
https://www.ti.com/lit/ds/symlink/sn74ls04.pdf

M. IC 7402
https://www.ti.com/lit/ds/symlink/sn7402.pdf?ts=1681510030164&ref_url=https%253A%252F%252Fwww.ti.com%252Fproduct%252FSN7402

N. IC 7432
https://www.ti.com/lit/ds/symlink/sn7432.pdf?ts=1681510059827&ref_url=https%253A%252F%252Fwww.ti.com%252Fproduct%252FSN7432