Electronic Voting Machine (EVM)

Group Number : **43**

Group Number- **43**

Design Question Number- 6

Group Members:

Sr.No	Name	BITS ID
1	Ambole Sushant Sadashiv	2020A7PS1733G
2	Harshit Samar	2020A7PS0964G
3	Sarthak Nahta	2020A7PS0958G
4	Rahul M. Biju	2020A7PS0953G
5	Saaransh Marwah	2020A7PS1687G
6	Anirudh Mukherjee	2020A7PS0970G

Contents:

Acknowledgement:

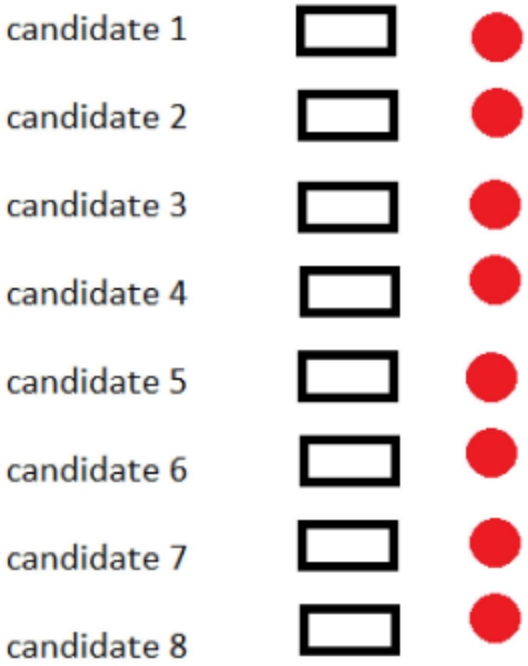
We would like to thank Prof. K. R. Anupama and the entire teaching staff of the course Microprocessors, Programming and Interfacing (CS F241) for giving us this opportunity to broaden our knowledge and get a good understanding of the subject by working on this design assignment.

Problem Statement & User Specifications:

Design Question- 6

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 n 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.

Technical Specifications:

1. The LED next to the candidate's name will glow for 2 seconds after a person votes.
2. The officer's keypad has the following keys: 0-9 numbers, backspace, enter, poll count, lock, unlock, display count.
3. Each password would be a 5-digit code.
4. The number of attempts given for each password is 2, any more failures after that cause the voting to be blocked.
5. The LCD is a 16-character display.
6. The voting is stopped at 5pm, after which the vote count facility becomes available.

Assumptions:

The following assumptions have been made:

1. The vote count is being stored in a word, for each candidate, therefore it is assumed that the total number of votes will not exceed FFFFh (Decimal equivalent 65535).
2. 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).
3. Once a voter has voted, the next voter has to wait for at least 2 seconds, for the LED to switch off.
4. Passwords are decided before initialising the system, and it cannot be changed later.
5. 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.
6. The Voters do not have access to the hex keypad and LCD.

Justifications:

1. The keypad for voting the candidates has been interfaced as a 8x1 keypad instead of a 4x2 matrix keypad. An 8 bit port is being used for the same.
2. 8259 is used because two interrupts are being generated, one is to stop the voting after 10 hours and the other one is to branch to the required ISR when the lock key is pressed.

Components Used & their Description

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.

Sl. No.	Device Name	Number of Devices	Description
1	8086	1	16-bit Intel Microprocessor
2	8284	1	Used to generate clock for the microprocessor and clock for 8253
3	2716	4	2k programmable ROM chip
4	6116	2	2k programmable RAM chip
7	74LS138	1	3x8 Decoder
8	74LS373	3	Octal Latch
9	74LS245	2	Octal Bus Transceiver
10	74LS244	1	Octal 3-state buffer
12	8255	2	General purpose programmable I/O device
13	8253	1	Programmable Interval Timers
14	LM020L	1	16 x 1 LCD Display
15	LEDS	8	LED lights for each candidate
18	8259	1	To give priority to interrupts

Other components used are Resistors, Switches, Push Buttons, Gates.

Address Mapping:

Memory addressing:

RAM – minimum 2k chip- 4k

ROM - minimum 2k chip – 4k + 4k

ROM1: 00000h to 00FFFh

RAM: 01000h to 01FFFh

ROM2: FF000h to FFFFFh

I/O addressing:

8255 (Officer's): 00h to 06h

8255 (Voter's): 10h to 16h

8254: 20h to 26h

8259: 30h to 32h

Detailed Description of I/O Devices Used:

a) 8255 (Officer's)

This 8255 port is used to interface the LCD data lines and the officer's keypad with 8086 microprocessor. The officer's keypad is a 4x4 matrix of one-hotkeys, which are used to input the passwords, lock and unlock the voter's keypad, and to display the poll count of corresponding candidates after the voting period is over.

Port A: 00h [LCD data lines]

Port B: 02h [LCD control lines]

Port C: 04h [Officer's hex keypad]

Control Register: 06h

b) 8255 (Voter's)

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.

Port A: 10h [One-hot voter buttons]

Port B: 12h [One-hot output LEDs]

Port C: 14h

Control Register: 16h

c) 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 IR0 pin of the 8259.

Address and configuration of counters:

Counter Number	Address	Mode of operation	Counter stored	Output
Counter 0	20h	Mode 2	25000d	100Hz
Counter 1	22h	Mode 2	100d	1Hz
Counter 2	24h	Mode 0	36000d	Interrupt after 10 hours
Control Register	26h	-	-	-

d) 8259

8259 is being used to prioritise the interrupts that are generated in the design throughout its working. Interrupt generated by 8253 is connected to the IR0. This interrupt will ensure that the voting is stopped after 10 hours, after which only the poll count facility will be available.

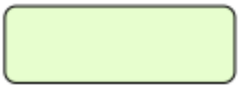
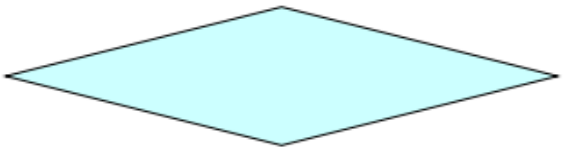
The interrupt generated upon pressing the lock key in the officer's keypad is connected to IR1. This interrupt is implemented in such a way that when the lock key is pressed in the officer's keypad, the corresponding ALP program makes an OR operation between the 8-bit PB port and 00000001b. This ensures that PB0, PB1 and PB2 which are control signals for the LCD remain unaffected, but the PB7 bit becomes 1. This PB7 bit is connected to the IR1 and is used as the interrupt to go to the ISR routine for locking the voting.

Addressing of 8259:

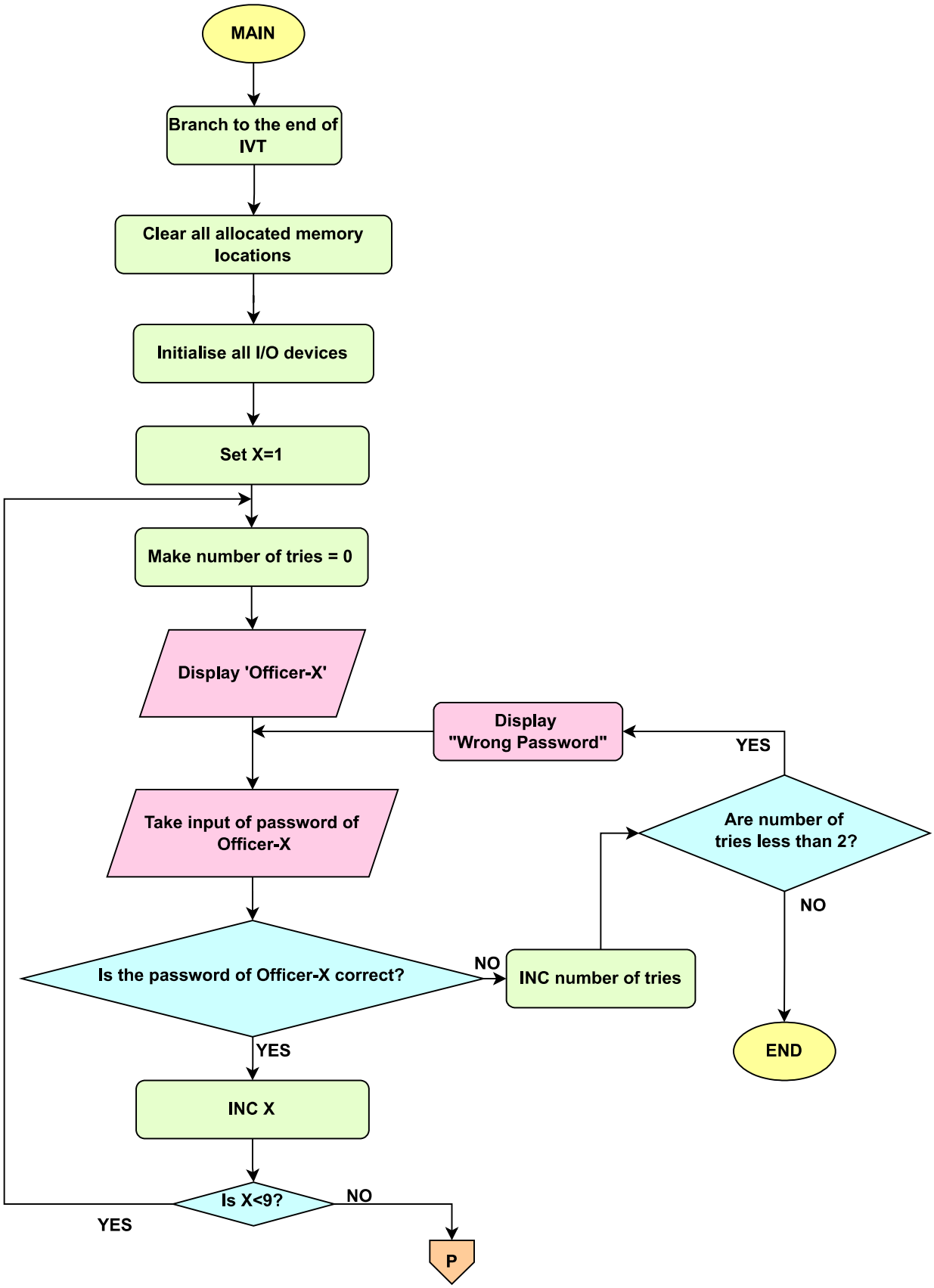
Memory locations 30h and 32h are used as the addresses of 8259.

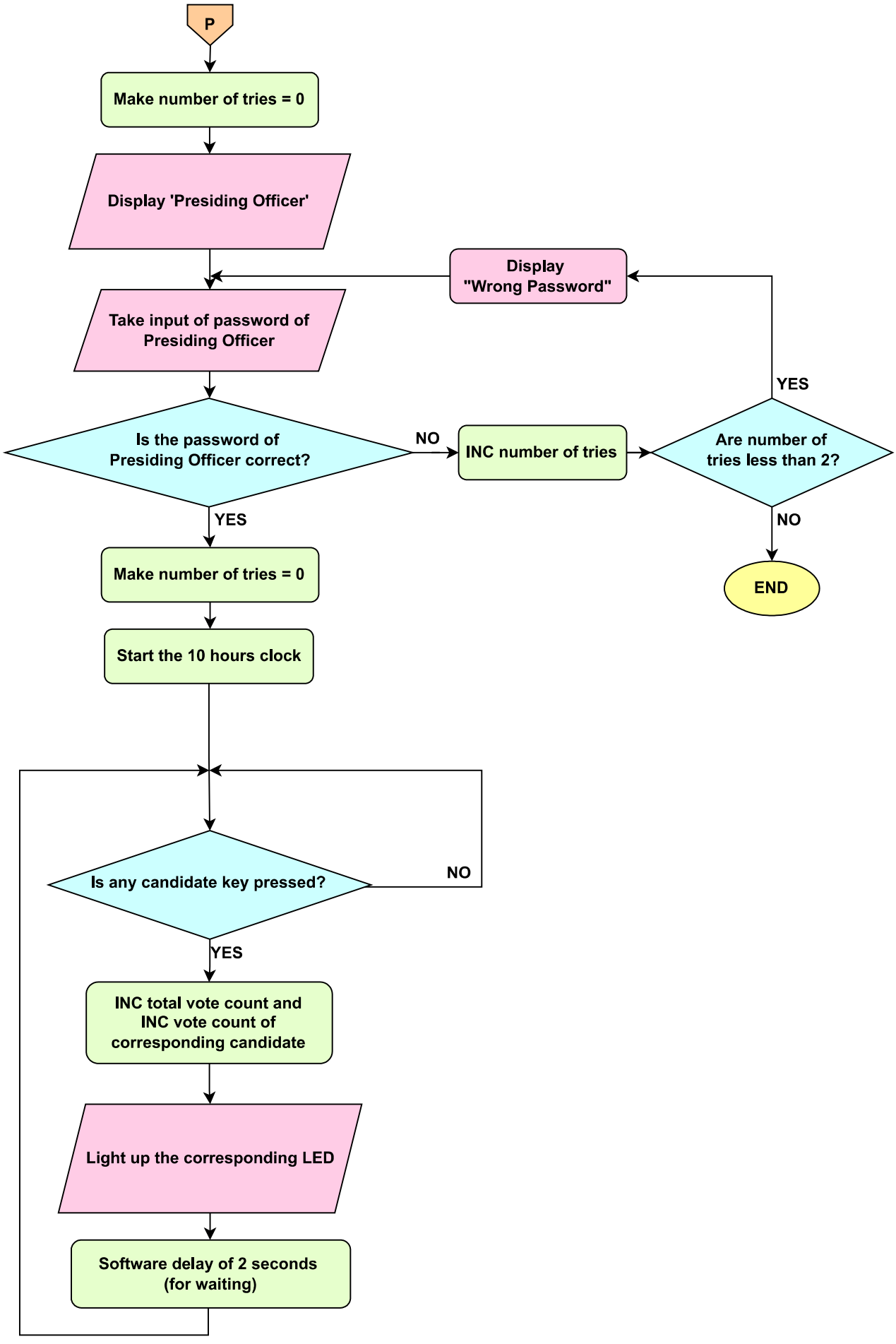
Flowcharts:

Table of symbols used:

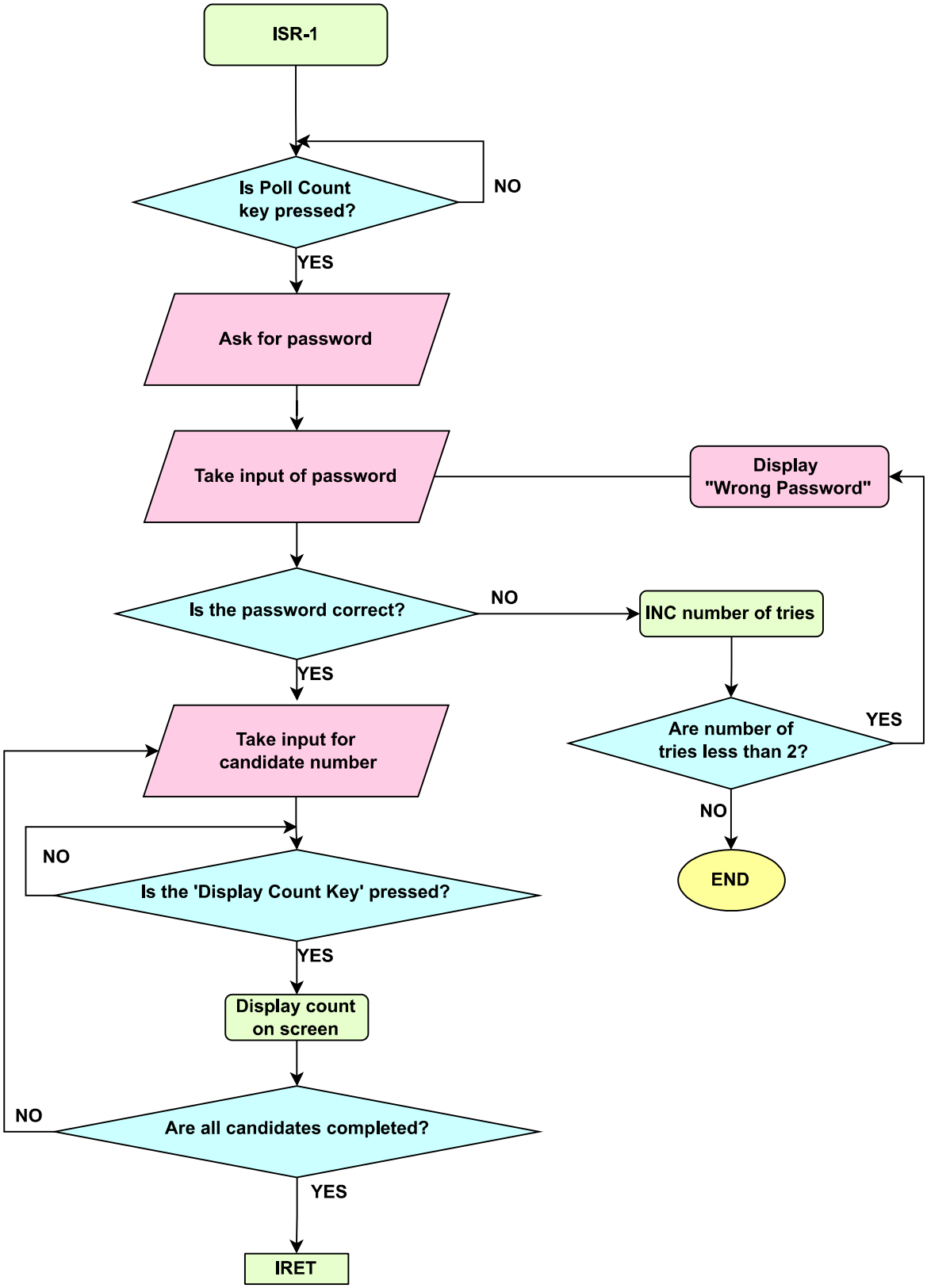
	**Starting or Ending point (Terminator)**
	**Process**
	**Input/Output**
	**Decision**
	**Off-Page Reference (To continue the flow on a new page)**

Main flowchart

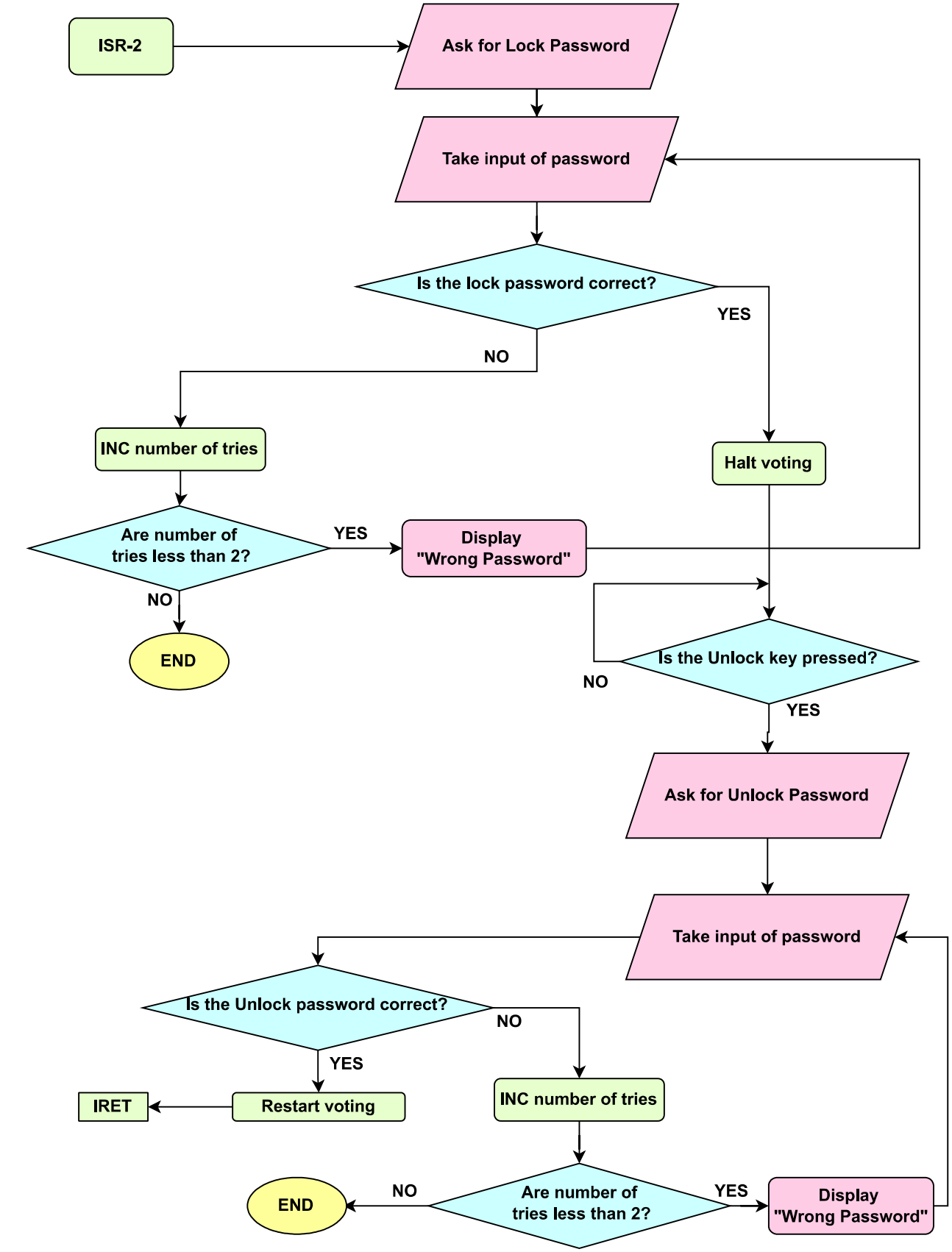



P
Make number of tries = 0
Display 'Presiding Officer'
Display "Wrong Password"
Take input of password of Presiding Officer
YES
Is the password of Presiding Officer correct?
NO
INC number of tries
Are number of tries less than 2?
NO
END
YES
Make number of tries = 0
Start the 10 hours clock
Is any candidate key pressed?
NO
YES
INC total vote count and INC vote count of corresponding candidate
Light up the corresponding LED
Software delay of 2 seconds (for waiting)

ISR-1 flowchart
(10 hour interrupt)



ISR-2 flowchart (lock key pressed)



Datasheets:

- 8086-

  https://www.electro-tech-online.com/datasheets/8086_intel.pdf

- 8255-

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

- 8253-

  https://www.cpcwiki.eu/imgs/e/e3/8253.pdf

- 8284-

  https://www.scs.stanford.edu/10wi-cs140/pintos/specs/8254.pdf

- 8259-

  https://www.renesas.com/us/en/document/dst/82c59a-datasheet

- 2716-

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

- 6116

  http://www.princeton.edu/~mae412/HANDOUTS/Datasheets/6116.pdf

- 74LS373-

  https://www.ti.com/lit/gpn/sn54ls373-sp

- 74LS245-

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- 74LS244-

http://www.sycelectronica.com.ar/semiconductores/74LS244.pdf

- LM020L-

  https://datasheetspdf.com/datasheet/LM020L.html

List of Attachments:

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MICROPROCESSORS, PROGRAMMING AND INTERFACING (CS F241)

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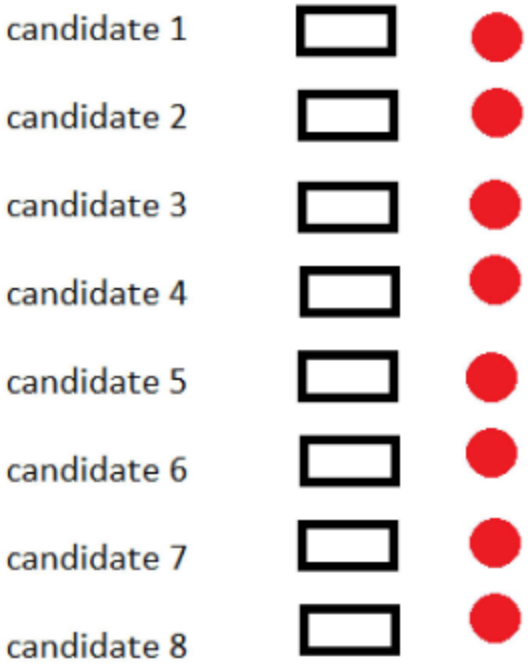

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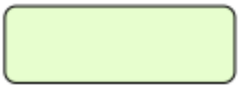	**Process**
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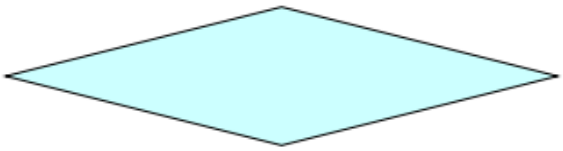	**Decision**
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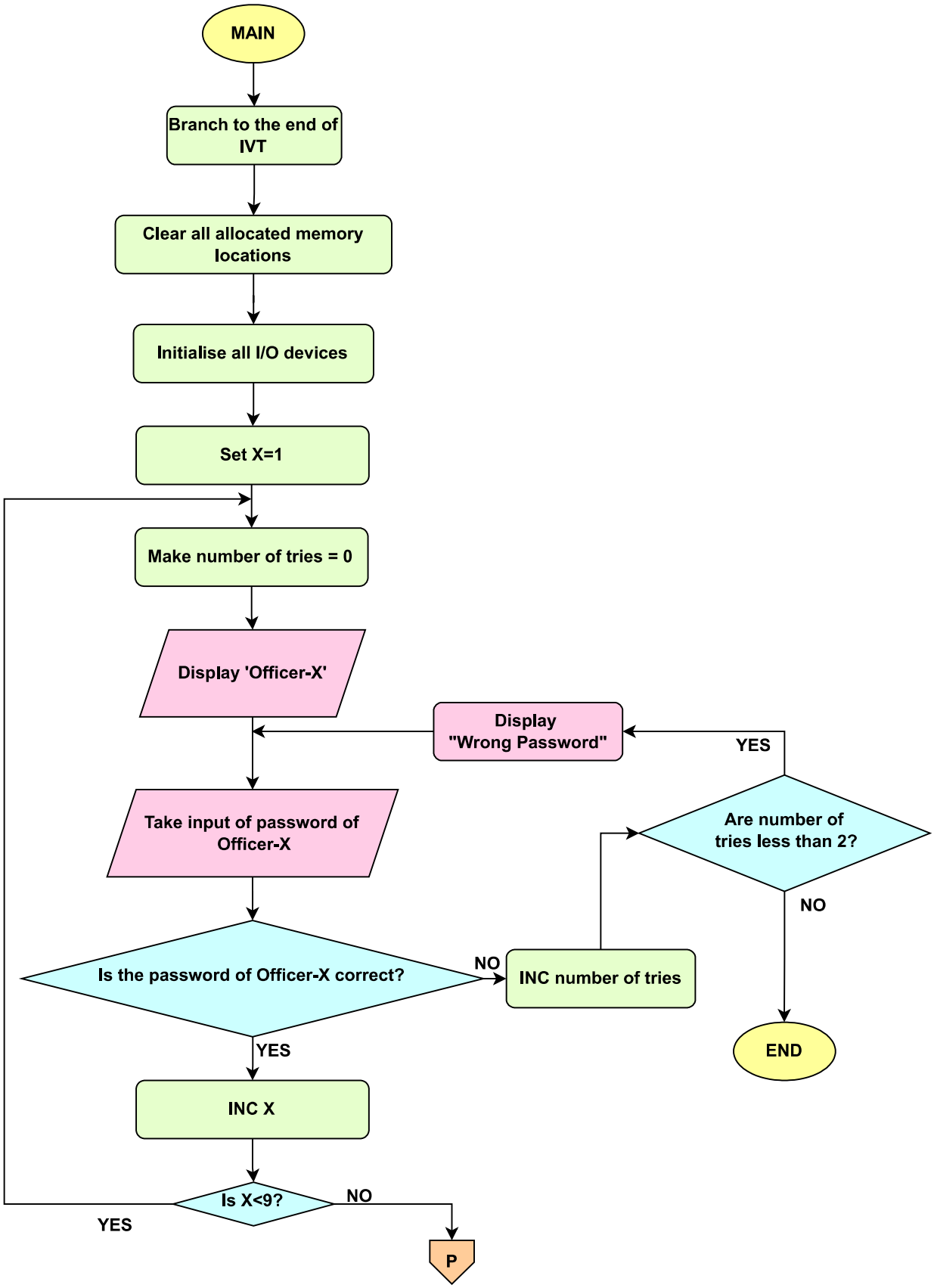

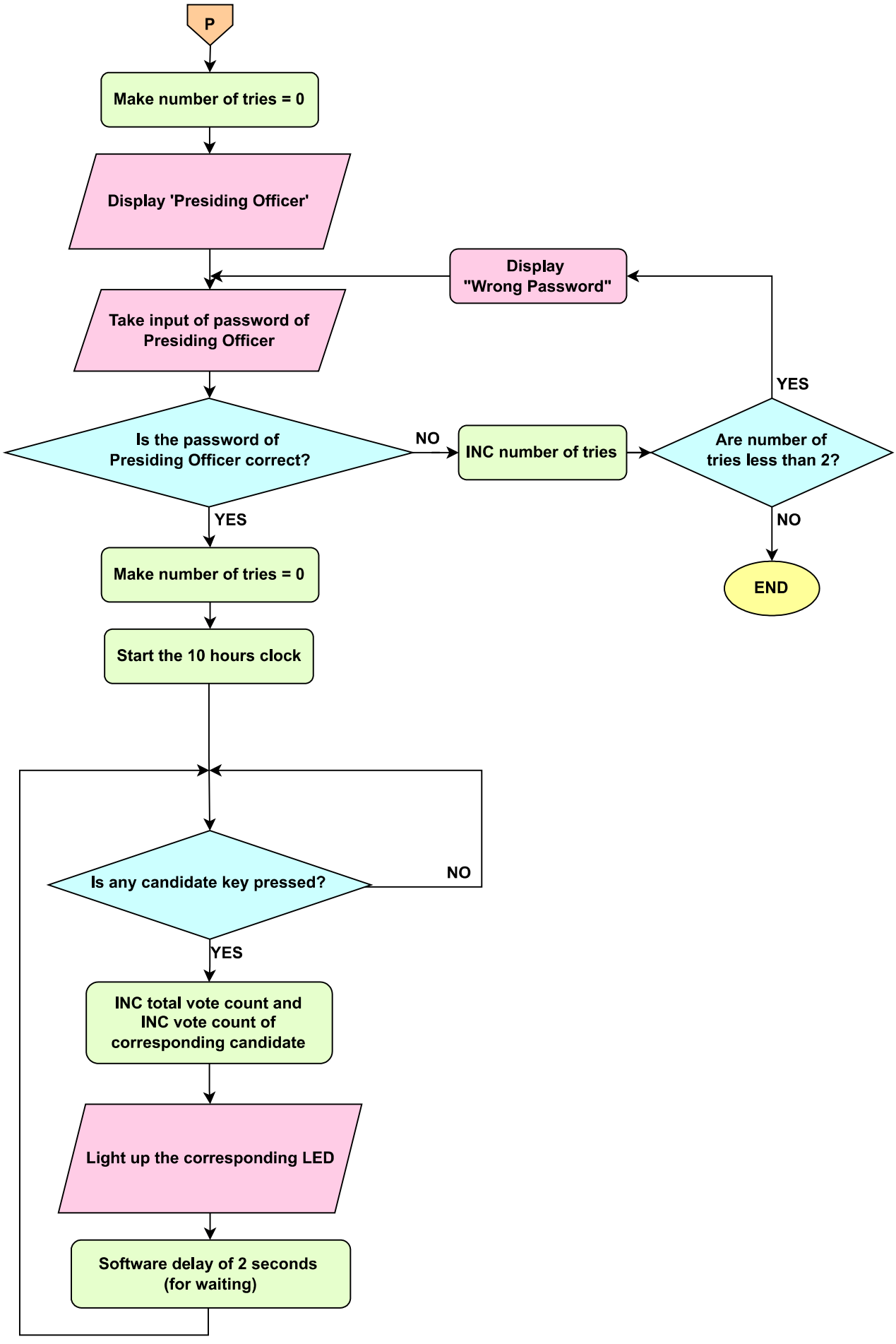
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Take input of password of Presiding Officer
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Is the password of Presiding Officer correct?
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Are number of tries less than 2?
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END
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Make number of tries = 0
Start the 10 hours clock
Is any candidate key pressed?
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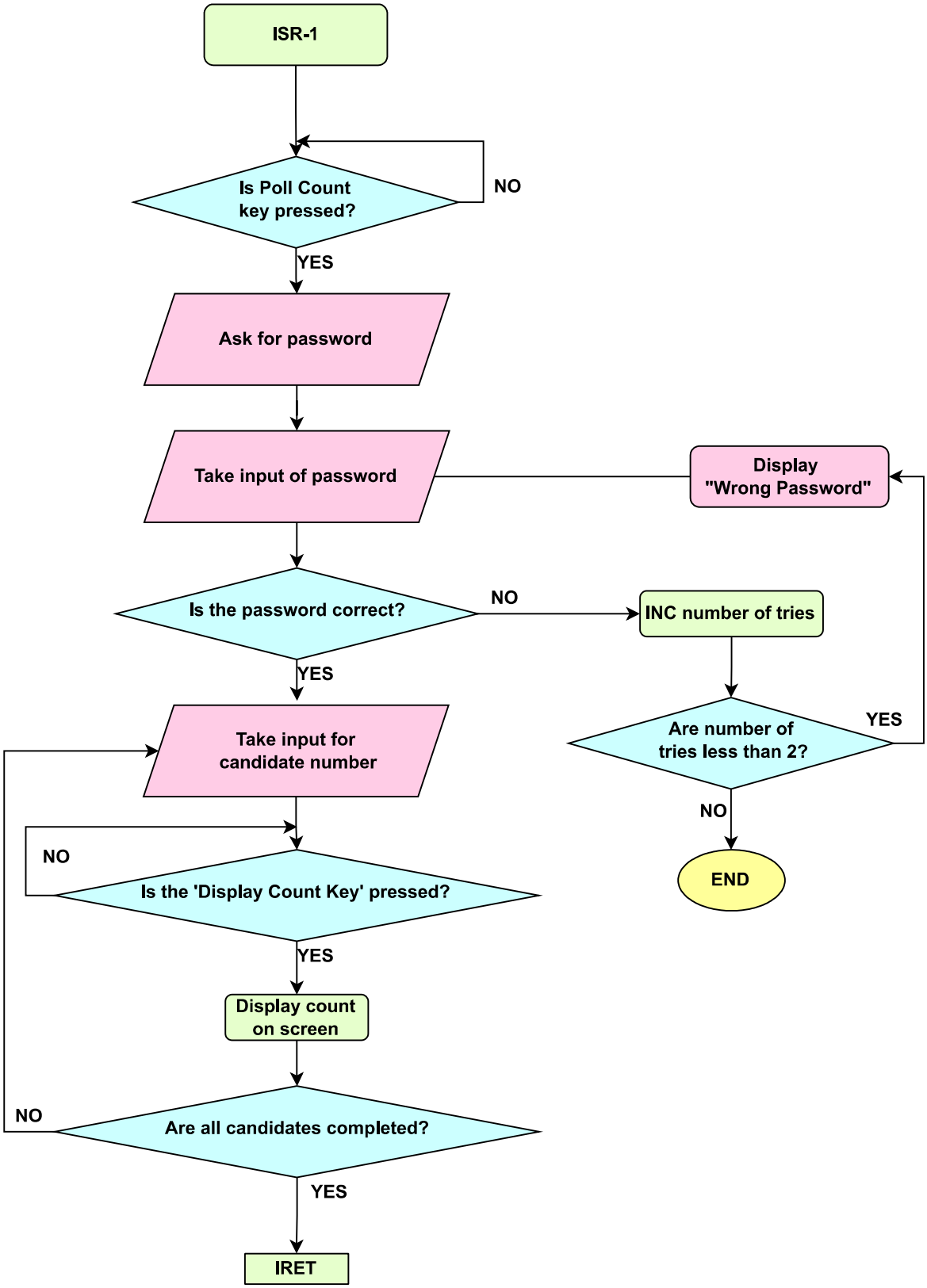
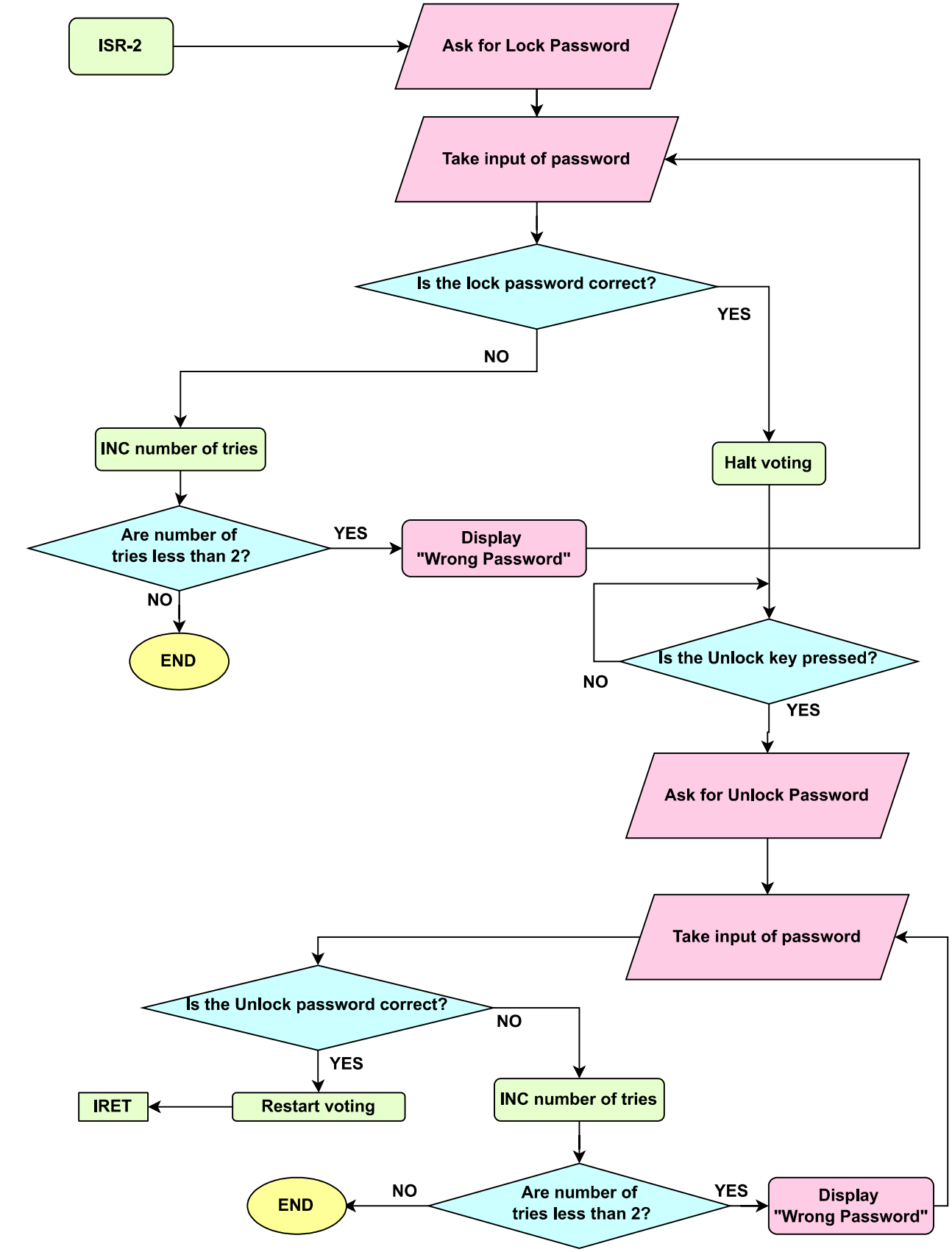
Light up the corresponding LED
Software delay of 2 seconds (for waiting)

ISR-1 flowchart
(10 hour interrupt)



ISR-2 flowchart (lock key pressed)



Datasheets:

- 8086-

  https://www.electro-tech-online.com/datasheets/8086_intel.pdf

- 8255-

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

- 8253-

  https://www.cpcwiki.eu/imgs/e/e3/8253.pdf

- 8284-

  https://www.scs.stanford.edu/10wi-cs140/pintos/specs/8254.pdf

- 8259-

  https://www.renesas.com/us/en/document/dst/82c59a-datasheet

- 2716-

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

- 6116

  http://www.princeton.edu/~mae412/HANDOUTS/Datasheets/6116.pdf

- 74LS373-

  https://www.ti.com/lit/gpn/sn54ls373-sp

- 74LS245-

  https://www.ti.com/lit/gpn/sn54ls245-sp

- 74LS244-

http://www.sycelectronica.com.ar/semiconductores/74LS244.pdf

- LM020L-

  https://datasheetspdf.com/datasheet/LM020L.html

List of Attachments:

1. **Complete on-paper hardware design with proper labelling (attached).**

FIRE ALARM SYSTEM

Submitted by: Group 40

Group Members:

1) Aniket Minesh Tendulkar (2020A7PS0001G)
2) Saket B (2020A7PS0983G)
3) Rushabh Jignesh Shah (2020A7PS1004G)
4) Maanav Ramesh (2020A7PS1007G)
5) Gaurang Nilesh Pendse (2020A7PS0132G)
6) Anshul Rajesh Raje (2020AAPS1024G)

Contents

User Requirements & Technical Specifications

This system checks for abnormal smoke content in a room and under such conditions throws open all exit doors and windows and also opens a valve that releases the gas to put-out the fire. An Alarm is also sounded, this alarm is sounded until the smoke level in the room drops to an acceptable level.
When at least two of the three detectors get turned on, the alarm system is activated. If only one of them is activated a different alarm sound is produced indicating probable malfunction of the alarm. The system can be activated or deactivated using a single master switch.

The Technical Specifications are as follows:
• The room has 2 doors.
• The room has 4 windows.
• The room has 1 valve.
• The smoke detection system has 3 smoke sensors on the ceiling of the room.
• There are 2 different alarms.
• There is a master-switch which can activate or reactivate the system

Input of all the smoke detectors is taken every 1 second and the program checks whether the alarm should be sounded or not.

Assumptions & Justifications

Justifications

The MQ2 smoke sensor gives an analog output between 0 to 5V directly proportional to the concentration of smoke detected. The concentration of the smoke detected by MQ2 is between 300 and 10000 ppm, and we have set the dangerous level of smoke to 400 ppm. Since only detection is required, we have used a resolution of 50 ppm(equivalent to 25.773mV), which is compatible with the resolution of an 8 bit ADC, which is 19.6 mV. So the detection would happen at a level of 58.8 mV, which is detected by the ADC.

The DEL1200 electromagnets operate at a voltage of 12V DC. When the current is switched on, the electromagnet is activated and the doors are locked. When at least two of the smoke detectors detect smoke, the current supply is switched off so that the doors and windows are opened. This takes place instantaneously. The interface to 8255 is done using a relay switch and transistor. Also a solenoid valve is connected to 8255 which opens when the alarm is triggered.

ALP1205S, SFM 27-I are the two different types of alarms that are used in our system. Both operate at different frequencies for sounding two different alarms. When at least two smoke detectors are activated (smoke is detected), ALP1205S(2300 Hz) is sounded, and when exactly one smoke detector is active(probable malfunction), SFM 27-I is used (3000HZ). They both operate at 5V DC and are directly connected to 8255.

The master switch is connected to a 5V source. When the switch is ON, it sends a high input to the IR0 of 8259. Being the highest priority interrupt, it gets

executed. We do not set the interrupt flag, so other interrupts are ignored by microprocessor. We check if any alarm is still being sounded; if yes then they are turned off and returned, else we directly return. Once it returns to main program, if switch is still pressed, it means that IR0 is still getting a high input. Again, being the highest priority interrupt, ISR0 will be serviced. This process repeats until switch is turned off making IR0 low and further after returning from ISR0, other interrupts(1s interrupt and ADC interrupt) will be serviced.

Assumptions

1. The three smoke detectors are calibrated in air before the system has been started. This calibration is required for accurate sensing of smoke by the MQ2 smoke detectors.
2. Abnormal Level of Smoke is set to 400 ppm, which triggers the alarm if at least two out of the three smoke detectors sense this value.
3. The opening and closing of the doors and windows through the electromagnets are instantaneous.
4. When the electromagnets are turned off, we assume that the doors are opened to such a position that it will allow the smoke to be released. Similarly, turning on the electromagnets ensure that the valve, doors and windows are in the required position to be closed.
5. During the loop when ISR0 is being serviced(when master switch is on), system will be in a de-actived state as neither any alarm is sounded nor any doors/windows/valves are in motion or the 1s timer interrupt is not being serviced. Once the master switch is turned off, the system continues executing from the immediate 1s timer interrupt and returns to normal state of execution.

Components used with justifications wherever required

- **8086**
- **3 MQ-2 smoke detectors** – Detects between 300-10000 ppm
  Analog Voltage o/p – 0-5V; Resolution – 50ppm
  Analog Output(A0) is connected to ADC input IN0
  Operating voltage of sensor – 5V
  GND pin and Digital Out Pin(D) are present; Digital output not used
  (Datasheet attached)
- **ALP1205S, SFM 27-I alarms**
  They both operate at 5V DC supply voltage and operate at frequencies of 4000 Hz and 3000 Hz respectively, directly connected to 8255.
- **ADC 0804** – 3 analog inputs from MQ-2
- **8254** – Its output provides the clock which is connected to ADC and a 1 second Real Time Interrupt to 8259 in order to read smoke sensor output
- **8255** – Interface ADC and microprocessor
- **8259** – Interrupts from ADC and Timer Interrupt every 1 seconds. Timer given higher priority as the timer is the one that enables the ADC for conversion.
- **2716** – 4 nos. Smallest ROM chip available is 2K and as we need to have an even and odd bank, ROM is required at the reset address, which is at FFFF0H, and also at 00000H, where there is the IVT.
- **6116** – 2 nos. Smallest RAM chip available is 2K and we need an odd and an even bank. We need RAM for stack and temporary storage of data.
- **LS 138** – 2 decoders
- **LS 373, LS 245, LS 244** and required gates.
- **DEL1200** - 6 nos - These are the electromagnet locks for the doors and windows
  Powered at 12V DC supply; current max of 0.5A
  Connected using Relay Switch and NPN transistor to 8255 as an output device.
  Holding force of 1200 lbs - *(Manual attached).* It has two pins connected to VCC and GND.
- **Relay Switch RL1** - 7 nos - Relay switch connected for opening/closing valve as well as the doors and windows
- **Solenoid Valve T8375E** - Valve for releasing the gas to put out the fire, attached to the relay switch.

Operates at 12V DC and current of 22mA - *(Manual attached)*

- **BC547 NPN Transistor** - 1 Nos - For interfacing the solenoid valve to 8255. Operates upto 100 mA, which is sufficient for electromagnets and the solenoid valve.
- **Switches, DC Voltage Supply, Resistors** as per the requirements.
- **2N22A NPN Transistor** - 6 nos - Maximum current rating of 800 mA and voltage rating of 40V which is sufficient for interfacing electromagnets to 8255.

Address Mapping

Memory Mapping:

ROM1 - 00000H-00FFFH
RAM1 - 01000H-01FFFH
ROM2 - FF000H-FFFFFH

	A19	A18	A17	A16	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
RAM1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
RAM1	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
ROM1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ROM1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
ROM1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
ROM1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

A0 is selected for even/odd bank. Since 2K memory is used, 11 address lines A1 - A11 are used for selecting chip in the microprocessor.
A12,A13,A14 are used for decoding the address spaces:

A14A13A12 - 000 ROM1

A14A13A12 - 001 RAM1
A14A13A12 - 111 ROM2

Decoder Outputs are:-
O0 - ROM1, O1 - RAM1, O2 - ROM

Memory Organization:

Total RAM used by system = 4KB (2 Nos)
Total ROM chips used by system = 8KB (4Nos)
RAM chip used = 6116.
ROM chip used =2716.

a) **RAM**

Starting address of RAM = 01000H.
Ending address of RAM = 01FFFH.
Total 4KB
Even Bank of RAM = 01000H,01002H, 01004H, 01006H,.....,01FFEH
Odd Bankof RAM = 01001H,01003H, 01005H, 01007H,.....,01FFFH
RAM used to house the data segment and stack segment.

b) **ROM**

Starting address of ROM1 = 00000H.
Ending address of ROM1 = 00FFFH.
Total 4KB
Even Bank of R0M1= 00000H,00002H, 00004H, 00006H,.....,00FFEH
Odd Bank of R0M1 = 00001H,00003H, 00005H, 00007H,.....,00FFFH
Starting address of ROM2 = FF000H.
Ending address of ROM2 = FFFFFH.
Total 4KB
Even Bankof R0M2 = FF000H,FF002H, FF004H, FF006H,.....,FFFFEH
Odd Bank of R0M2= FF001H,FF003H, FF005H, FF007H,.....,FFFFFH
ROM used to house the code segment. It varies depending on the size of the program.

I/O Mapping:

40H-46H - 8255
48H-4EH - 8253
50H-52H - 8259

- **8255 Programmable Peripheral Interface:**

One 8255 is required to connect with the input/output device and act as an interface to the 8086 microprocessor. It is organized as follows:

Port A: 40H
Port B: 42H
Port C: 44H
Control Register: 46H

	A7	A6	A5	A4	A3	A2	A1	A0
Port A	0	1	0	0	0	0	0	0
Port B	0	1	0	0	0	0	1	0
Port C	0	1	0	0	0	1	0	0
Control Reg	0	1	0	0	0	1	1	0

- **8254 Programmable Interval Timer:**

One 8254 is required to generate the clock signal of 1 MHz for the working of the ADC (Mode 3) and for the generation of the 1s interrupt to read the sensor data (Mode 2). It is organized as follows:

Counter 0: 48H (Count : 5d)
Counter 1: 4AH (Count: 50000d)
Counter 2: 4CH (Count: 100d)
CONTROL REGISTER: 4EH

	A7	A6	A5	A4	A3	A2	A1	A0
Counter 0	0	1	0	0	1	0	0	0
Counter 1	0	1	0	0	1	0	1	0
Counter 2	0	1	0	0	1	1	0	0
Control Reg	0	1	0	0	1	1	1	0

- **<u>8259 Programmable Interrupt Controller</u>:**

To control the interrupts raised - there are two interrupts - one from the clock and one from the ADC. The clock is given higher priority for the interrupt as it is only after this 1s interrupt is raised, that the interrupts from ADC are accepted. It is organized as follows:

A0 : 50H
A1: 52H

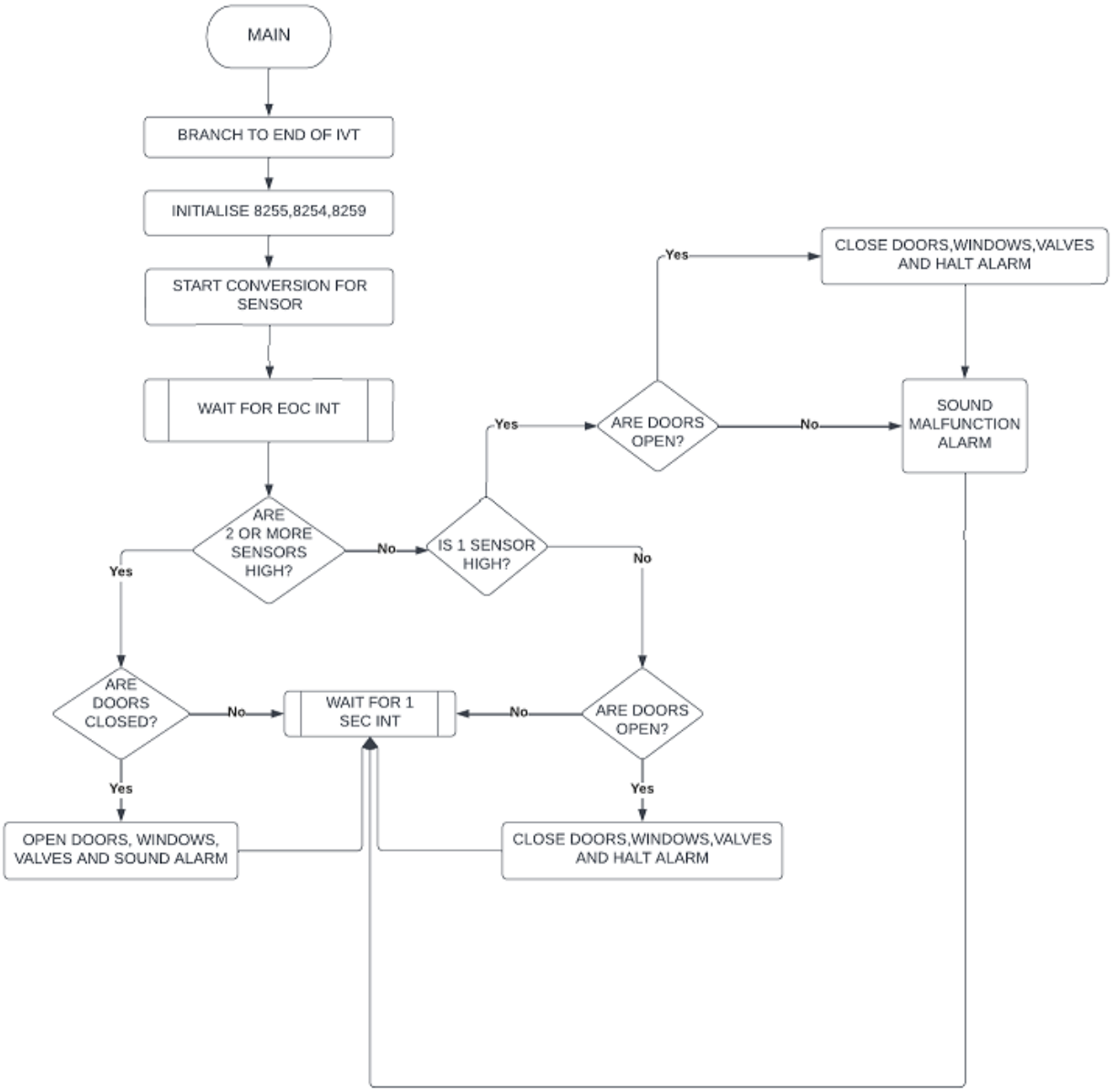
	A7	A6	A5	A4	A3	A2	A1	A0
A2	0	1	0	1	0	0	0	0
A1	0	1	0	1	0	0	1	0

Thus for decoding of i/o devices we can use the bits A3A4A5 as:

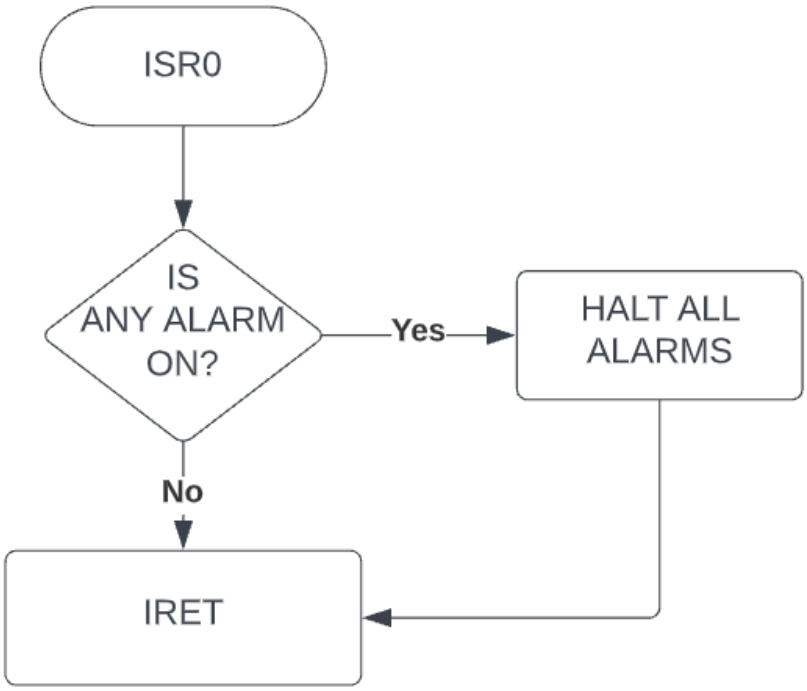
A5A4A3 : 000 - 8255
001 - 8254
010 - 8259

Flow Chart

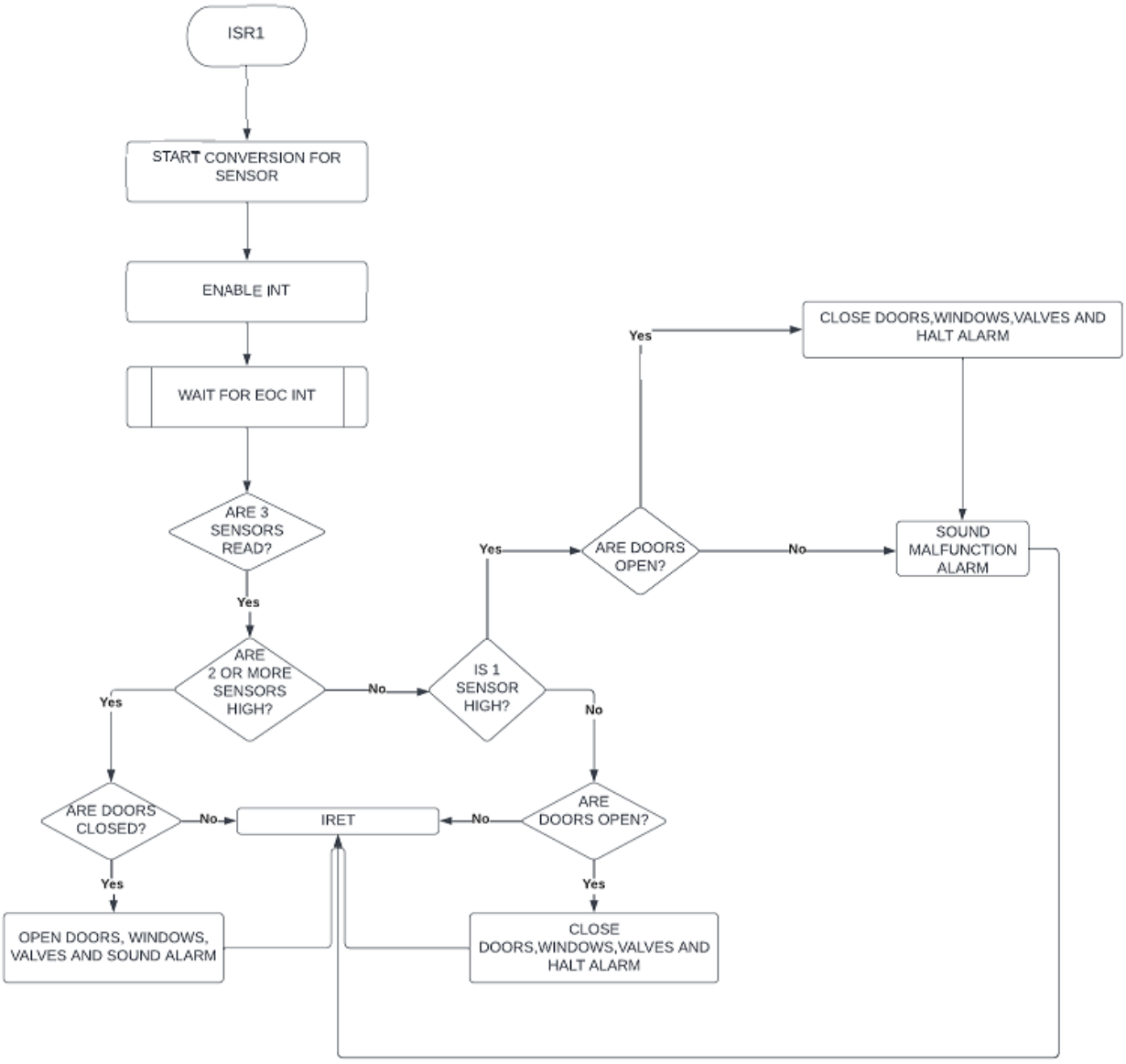
MAIN PROGRAM



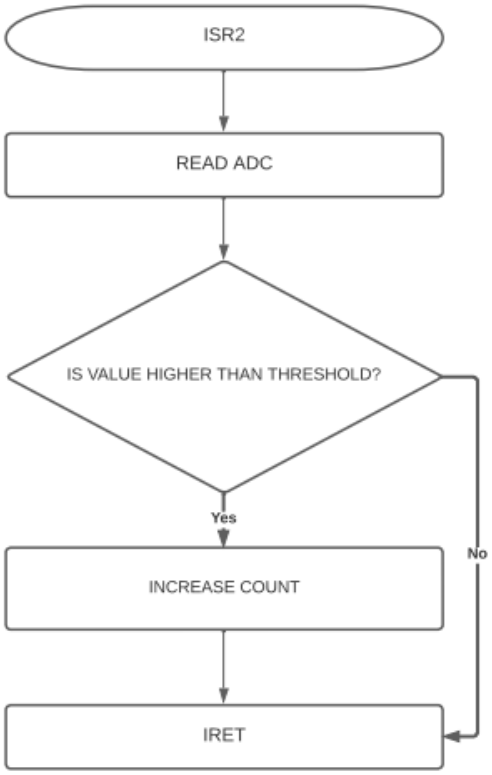
INTERRUPT SERVICE ROUTINE 0



INTERRUPT SERVICE ROUTINE 1



INTERRUPT SERVICE ROUTINE 2



Datasheet Attachments

1) **Manuals**
    a) MQ2 Smoke Sensor
    b) ALP1205S Alarm
    c) SFM-27-I Alarm
    d) DEL1200 Electromagnetic Lock
    e) RL1 Relay Switch
    f) T8375E Solenoid Valve
    g) 2N222A NPN Transistor

FIRE ALARM SYSTEM

Submitted by: Group 40

Group Members:

1) Aniket Minesh Tendulkar (2020A7PS0001G)
2) Saket B (2020A7PS0983G)
3) Rushabh Jignesh Shah (2020A7PS1004G)
4) Maanav Ramesh (2020A7PS1007G)
5) Gaurang Nilesh Pendse (2020A7PS0132G)
6) Anshul Rajesh Raje (2020AAPS1024G)

Contents

User Requirements & Technical Specifications

This system checks for abnormal smoke content in a room and under such conditions throws open all exit doors and windows and also opens a valve that releases the gas to put-out the fire. An Alarm is also sounded, this alarm is sounded until the smoke level in the room drops to an acceptable level.
When at least two of the three detectors get turned on, the alarm system is activated. If only one of them is activated a different alarm sound is produced indicating probable malfunction of the alarm. The system can be activated or deactivated using a single master switch.

The Technical Specifications are as follows:
• The room has 2 doors.
• The room has 4 windows.
• The room has 1 valve.
• The smoke detection system has 3 smoke sensors on the ceiling of the room.
• There are 2 different alarms.
• There is a master-switch which can activate or reactivate the system

Input of all the smoke detectors is taken every 1 second and the program checks whether the alarm should be sounded or not.

Assumptions & Justifications

Justifications

The MQ2 smoke sensor gives an analog output between 0 to 5V directly proportional to the concentration of smoke detected. The concentration of the smoke detected by MQ2 is between 300 and 10000 ppm, and we have set the dangerous level of smoke to 400 ppm. Since only detection is required, we have used a resolution of 50 ppm(equivalent to 25.773mV), which is compatible with the resolution of an 8 bit ADC, which is 19.6 mV. So the detection would happen at a level of 58.8 mV, which is detected by the ADC.

The DEL1200 electromagnets operate at a voltage of 12V DC. When the current is switched on, the electromagnet is activated and the doors are locked. When at least two of the smoke detectors detect smoke, the current supply is switched off so that the doors and windows are opened. This takes place instantaneously. The interface to 8255 is done using a relay switch and transistor. Also a solenoid valve is connected to 8255 which opens when the alarm is triggered.

ALP1205S, SFM 27-I are the two different types of alarms that are used in our system. Both operate at different frequencies for sounding two different alarms. When at least two smoke detectors are activated (smoke is detected), ALP1205S(2300 Hz) is sounded, and when exactly one smoke detector is active(probable malfunction), SFM 27-I is used (3000HZ). They both operate at 5V DC and are directly connected to 8255.

The master switch is connected to a 5V source. When the switch is ON, it sends a high input to the IR0 of 8259. Being the highest priority interrupt, it gets

executed. We do not set the interrupt flag, so other interrupts are ignored by microprocessor. We check if any alarm is still being sounded; if yes then they are turned off and returned, else we directly return. Once it returns to main program, if switch is still pressed, it means that IR0 is still getting a high input. Again, being the highest priority interrupt, ISR0 will be serviced. This process repeats until switch is turned off making IR0 low and further after returning from ISR0, other interrupts(1s interrupt and ADC interrupt) will be serviced.

Assumptions

1. The three smoke detectors are calibrated in air before the system has been started. This calibration is required for accurate sensing of smoke by the MQ2 smoke detectors.
2. Abnormal Level of Smoke is set to 400 ppm, which triggers the alarm if at least two out of the three smoke detectors sense this value.
3. The opening and closing of the doors and windows through the electromagnets are instantaneous.
4. When the electromagnets are turned off, we assume that the doors are opened to such a position that it will allow the smoke to be released. Similarly, turning on the electromagnets ensure that the valve, doors and windows are in the required position to be closed.
5. During the loop when ISR0 is being serviced(when master switch is on), system will be in a de-actived state as neither any alarm is sounded nor any doors/windows/valves are in motion or the 1s timer interrupt is not being serviced. Once the master switch is turned off, the system continues executing from the immediate 1s timer interrupt and returns to normal state of execution.

Components used with justifications wherever required

- **8086**
- **3 MQ-2 smoke detectors** – Detects between 300-10000 ppm
  Analog Voltage o/p – 0-5V; Resolution – 50ppm
  Analog Output(A0) is connected to ADC input IN0
  Operating voltage of sensor – 5V
  GND pin and Digital Out Pin(D) are present; Digital output not used
  (Datasheet attached)
- **ALP1205S, SFM 27-I alarms**
  They both operate at 5V DC supply voltage and operate at frequencies of 4000 Hz and 3000 Hz respectively, directly connected to 8255.
- **ADC 0804** – 3 analog inputs from MQ-2
- **8254** – Its output provides the clock which is connected to ADC and a 1 second Real Time Interrupt to 8259 in order to read smoke sensor output
- **8255** – Interface ADC and microprocessor
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- **LS 138** – 2 decoders
- **LS 373, LS 245, LS 244** and required gates.
- **DEL1200** - 6 nos - These are the electromagnet locks for the doors and windows
  Powered at 12V DC supply; current max of 0.5A
  Connected using Relay Switch and NPN transistor to 8255 as an output device.
  Holding force of 1200 lbs - *(Manual attached).* It has two pins connected to VCC and GND.
- **Relay Switch RL1** - 7 nos - Relay switch connected for opening/closing valve as well as the doors and windows
- **Solenoid Valve T8375E** - Valve for releasing the gas to put out the fire, attached to the relay switch.

Operates at 12V DC and current of 22mA - *(Manual attached)*

- **BC547 NPN Transistor** - 1 Nos - For interfacing the solenoid valve to 8255. Operates upto 100 mA, which is sufficient for electromagnets and the solenoid valve.
- **Switches, DC Voltage Supply, Resistors** as per the requirements.
- **2N22A NPN Transistor** - 6 nos - Maximum current rating of 800 mA and voltage rating of 40V which is sufficient for interfacing electromagnets to 8255.

Address Mapping

Memory Mapping:

ROM1 - 00000H-00FFFH
RAM1 - 01000H-01FFFH
ROM2 - FF000H-FFFFFH

	A19	A18	A17	A16	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
RAM1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
RAM1	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
ROM1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ROM1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
ROM1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
ROM1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

A0 is selected for even/odd bank. Since 2K memory is used, 11 address lines A1 - A11 are used for selecting chip in the microprocessor.
A12,A13,A14 are used for decoding the address spaces:

A14A13A12 - 000 ROM1

A14A13A12 - 001 RAM1
A14A13A12 - 111 ROM2

Decoder Outputs are:-
O0 - ROM1, O1 - RAM1, O2 - ROM

Memory Organization:

Total RAM used by system = 4KB (2 Nos)
Total ROM chips used by system = 8KB (4Nos)
RAM chip used = 6116.
ROM chip used =2716.

a) **RAM**

Starting address of RAM = 01000H.
Ending address of RAM = 01FFFH.
Total 4KB
Even Bank of RAM = 01000H,01002H, 01004H, 01006H,.....,01FFEH
Odd Bankof RAM = 01001H,01003H, 01005H, 01007H,.....,01FFFH
RAM used to house the data segment and stack segment.

b) **ROM**

Starting address of ROM1 = 00000H.
Ending address of ROM1 = 00FFFH.
Total 4KB
Even Bank of R0M1= 00000H,00002H, 00004H, 00006H,.....,00FFEH
Odd Bank of R0M1 = 00001H,00003H, 00005H, 00007H,.....,00FFFH
Starting address of ROM2 = FF000H.
Ending address of ROM2 = FFFFFH.
Total 4KB
Even Bankof R0M2 = FF000H,FF002H, FF004H, FF006H,.....,FFFFEH
Odd Bank of R0M2= FF001H,FF003H, FF005H, FF007H,.....,FFFFFH
ROM used to house the code segment. It varies depending on the size of the program.

I/O Mapping:

40H-46H - 8255
48H-4EH - 8253
50H-52H - 8259

- **8255 Programmable Peripheral Interface:**

One 8255 is required to connect with the input/output device and act as an interface to the 8086 microprocessor. It is organized as follows:

Port A: 40H
Port B: 42H
Port C: 44H
Control Register: 46H

	A7	A6	A5	A4	A3	A2	A1	A0
Port A	0	1	0	0	0	0	0	0
Port B	0	1	0	0	0	0	1	0
Port C	0	1	0	0	0	1	0	0
Control Reg	0	1	0	0	0	1	1	0

- **8254 Programmable Interval Timer:**

One 8254 is required to generate the clock signal of 1 MHz for the working of the ADC (Mode 3) and for the generation of the 1s interrupt to read the sensor data (Mode 2). It is organized as follows:

Counter 0: 48H (Count : 5d)
Counter 1: 4AH (Count: 50000d)
Counter 2: 4CH (Count: 100d)
CONTROL REGISTER: 4EH

	A7	A6	A5	A4	A3	A2	A1	A0
Counter 0	0	1	0	0	1	0	0	0
Counter 1	0	1	0	0	1	0	1	0
Counter 2	0	1	0	0	1	1	0	0
Control Reg	0	1	0	0	1	1	1	0

- **<u>8259 Programmable Interrupt Controller</u>:**

To control the interrupts raised - there are two interrupts - one from the clock and one from the ADC. The clock is given higher priority for the interrupt as it is only after this 1s interrupt is raised, that the interrupts from ADC are accepted. It is organized as follows:

A0 : 50H
A1: 52H

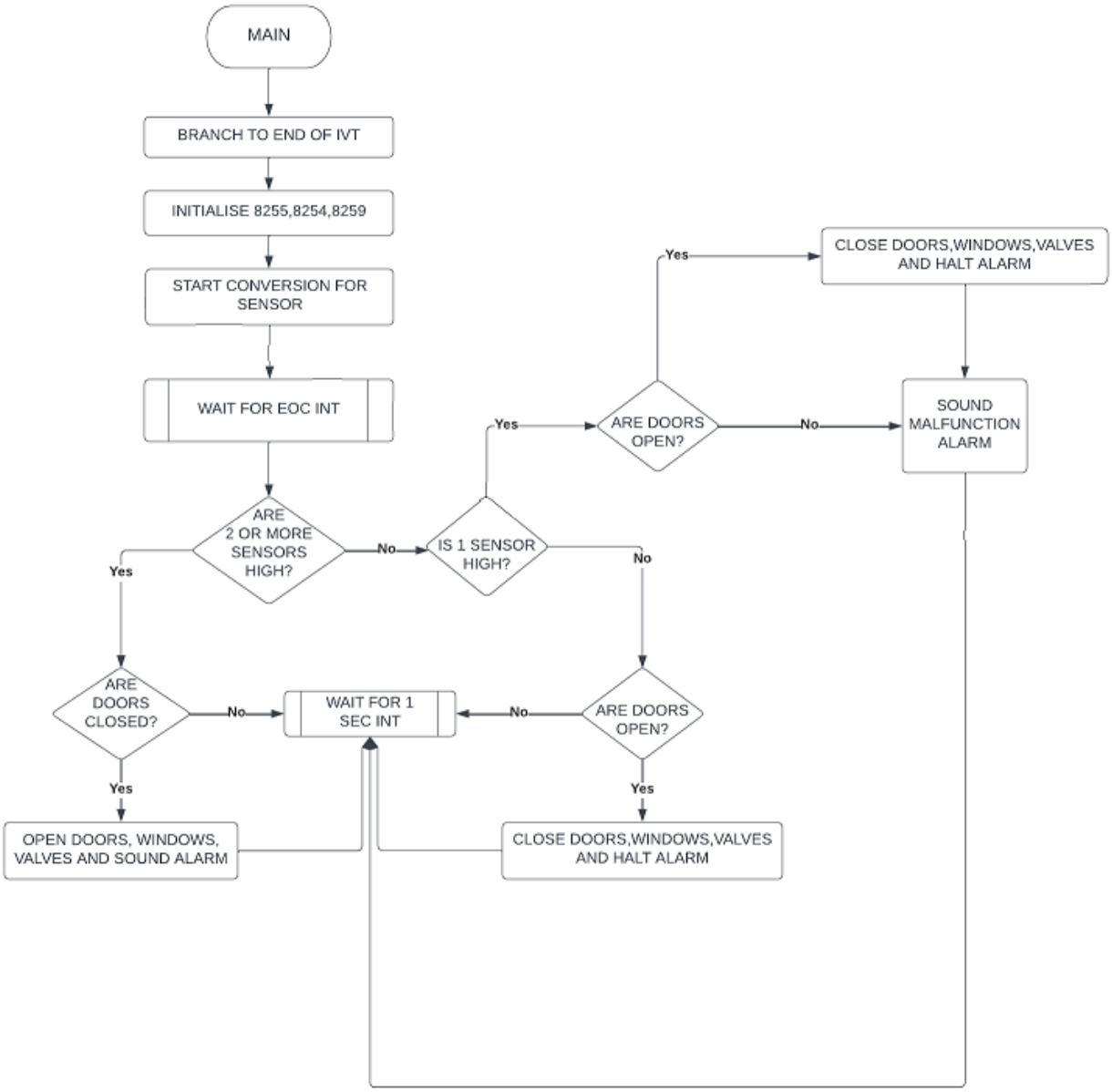
	A7	A6	A5	A4	A3	A2	A1	A0
A2	0	1	0	1	0	0	0	0
A1	0	1	0	1	0	0	1	0

Thus for decoding of i/o devices we can use the bits A3A4A5 as:

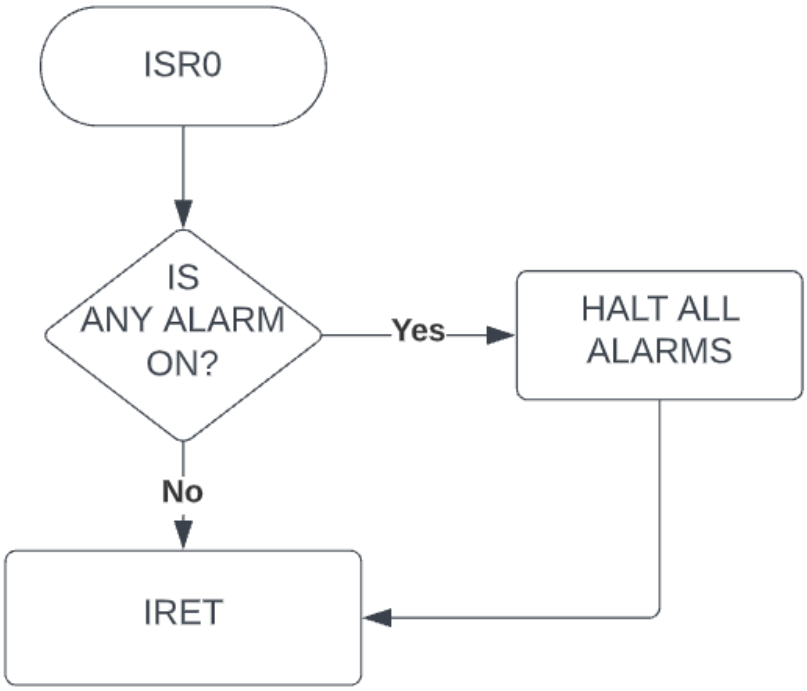
A5A4A3 : 000 - 8255
001 - 8254
010 - 8259

Flow Chart

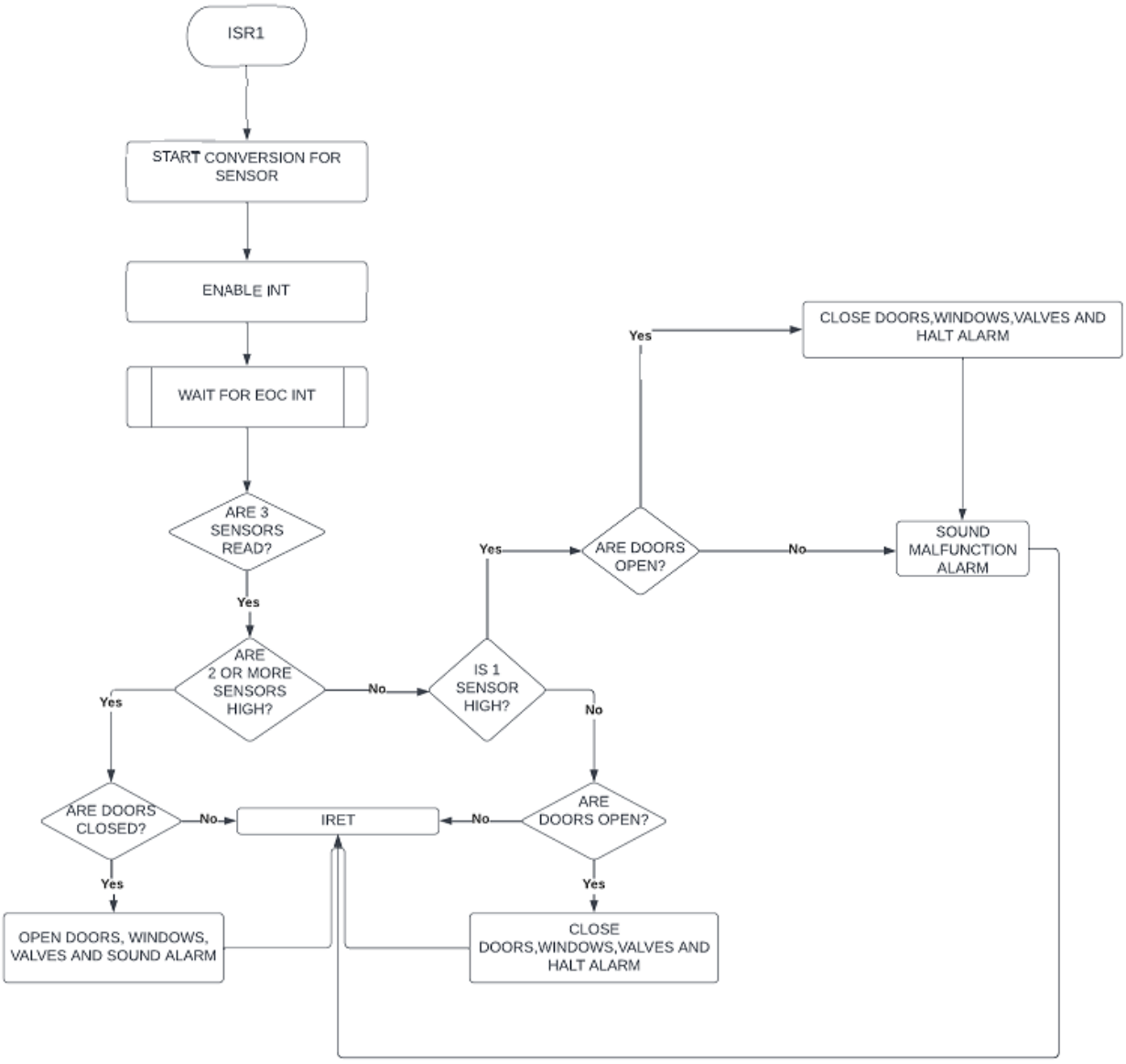
MAIN PROGRAM



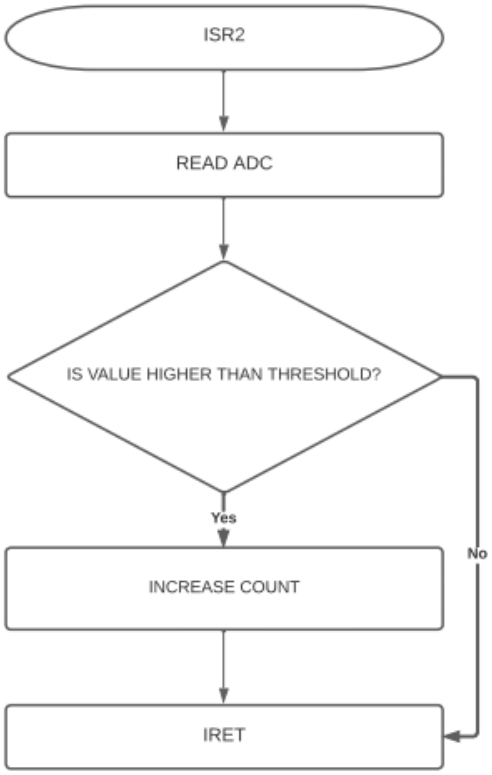
INTERRUPT SERVICE ROUTINE 0



INTERRUPT SERVICE ROUTINE 1



INTERRUPT SERVICE ROUTINE 2



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