BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE - PILANI, GOA CAMPUS

CS/EEE/ENI/ECE F241

GROUP 57

A Report On

Smart Overhead Tank

In partial fulfillment of the course

MICROPROCESSOR PROGRAMMING AND INTERFACING

Prepared for: Dr. K. R. Anupama

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ACKNOWLEDGEMENT

We would like to express our sincere gratitude to Dr. K. R. Anupama, for giving us this opportunity to work on such an amazing project. Application of our knowledge of microprocessors at various stages in this project has helped us gain knowledge of the principles of microprocessor interfacing and hardware programming. We are also indebted to other instructors involved in this course for guiding us during the whole project. Also, we would like to thank Dr. K.R Anupama and her team for their documentation and their constant support without which we could not have completed this project. The project has given us a great insight into the depths of Microprocessor Programming and Interfacing. It helped us in practically applying the major principles of I/O interfacing and interfacing viz. memory interfacing.

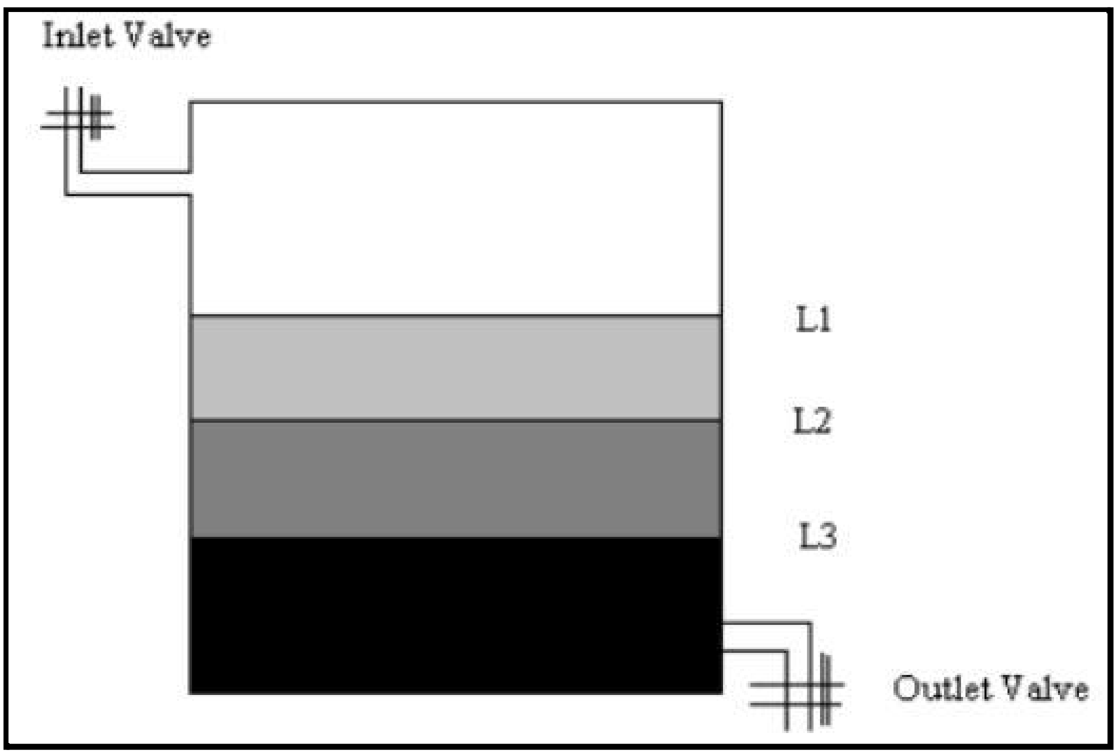
Problem Statement:

Description

This is a tank system in which the water level is maintained according to the time of the day. The water level should be maintained at three different values according to the time of the day.

Peak Hours: Maximum Level of Tank
Peak Hours is between 6:00 AM to 10:00 AM in the Morning and 5:00 - 7:00 PM in the evening
Low Hours: Minimum level of Tank
Low hours is between 12:00 Midnight and 5:00 AM in the morning
The rest of the time it is maintained at a nominal level.

The inlet valve draws water from the main-tank system and the outlet valve sends the surplus water back to the main tank. The water in the main tank must be maintained at a constant value, if the level drops the motor must be turned on.
The water tank is used for supplying water to bathrooms and kitchen– sensors used must be non-contact.



CONTENTS

User Requirements & Technical Specifications

1. Design a System that controls water level in the smart overhead tank at 3 different levels according to time throughout the day:
    - 00:00am to 05:00am: Level 1 (Minimum Level)
    - 05:00am to 06:00am: Level 2 (Nominal Level)
    - 6:00am to 10:00am: Level 3 (Maximum Level)
    - 10:00am to 5:00pm: Level 2 (Nominal Level)
    - 5:00pm to 7:00pm: Level 3 (Maximum Level)
    - 7:00pm to 00:00am: Level 2 (Nominal Level)
2. The sensors should be non contact.
3. The water in the main tank must be maintained at a constant value, if the level drops the motor must be turned on.

The Technical Specifications are as follows

- The level in the main tank is maintained at a constant level through supply from a reservoir.
- The 3 levels are set by placing 3 “XKC Y25 T12V” sensors at desired heights outside the tank (non contact sensors).
- Thickness of tank wall = 10mm
- Level in the overhead tank is adjusted at required hour, and hour along with water level is displayed on the LED display.
- Dimensions of the overhead tank do not affect the working of design.

Assumptions

1. System starts working at 00:00 hours (24 hour format) at midnight.
2. When the system is switched ON for the first time, the main tank is at its required level and the smart tank is filled till the medium level as required by the user.
3. Positive Edge triggered interrupts in 8259A.

Components used with justification wherever required

- **8086**
- **8284**
- Tank level Sensor (Manual Attached) – 3
    - ❏ **XKC Y25 T12V** – This detects water level at or above the sensor's level
    - ❏ **below level - 0V** output, **at or above level - Vin V** output (we provide Vin of 5V)
    - ❏ Voltage i/p 5-24V – DC Regulated
    - ❏ Four –pin connector – V_{CC}, GND, MODE and OUT

PIN	SIGNAL	Input/ Output	Description
1	Vcc	INPUT	Voltage referenced to the VCC terminal (+5Vdc min to +24Vdc max). We provide Vcc of 5V.
2	GND	INPUT	Ground the GND signal (connects power negative)
3	MODE	INPUT	MODE - HIGH = Active high OUT signal MODE - LOW = Active low OUT signal
4	OUT	OUTPUT	OUT - ACTIVE = water level at or above the sensor OUT - INACTIVE = water level below the sensor

- LD3361BS - Common Anode Seven Segment Display – 4 Nos. As 2 digits are required to display the hour(eg. "13") and 2 for displaying the current level(eg. "L2")
- 7447 – 3 nos. BCD to Common Anode 7 – Segment converter -as values will be only numeric values
- 8255 – Interface the level sensors, motor+pump, valves and 7447
- 8253 – to generate hour clock, for checking and setting desired water level at every hour
- 8259 – Interrupt from sensor output in IR1 and IR2 to raise interrupt and from clock output to IR0 to raise the interrupt.
- Mini Pacific Crompton Greaves 220V AC motor - 4 nos. To pump water in and out of the main tank and the smart tank.
- Solenoid Valve 2WNC - to start/stop flow of water
- RB-LTE-04 4 channel Relay - to connect port B to motors and valves
- 2716 – 4 nos. Smallest ROM chip available is 2K and as we need to have even and odd bank and ROM is required at reset address which is at $FFFF0_H$ and 00000_H we need one more rom bank at end- where there is the IVT
- 6116 – 2 nos. Smallest RAM chip available is 2 K and we need an odd and 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

Address Map

Memory Map

ROM1 - E : 00000 - 00FFE
ROM1 - 0 : 00001 - 00FFF
RAM1 - E : 01000 - 01FFE
RAM1 - 0 : 01001 - 01FFF
ROM2 - E : FF000 - FFFFE
ROM2 - 0 : FF001- FFFFF

ROM1

A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	1	1	1	1	1	1	1	1	1	1

RAM1

A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	1	1	1	1	1	1	1	1	1	1	1

ROM2

A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1
1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

I/O Map

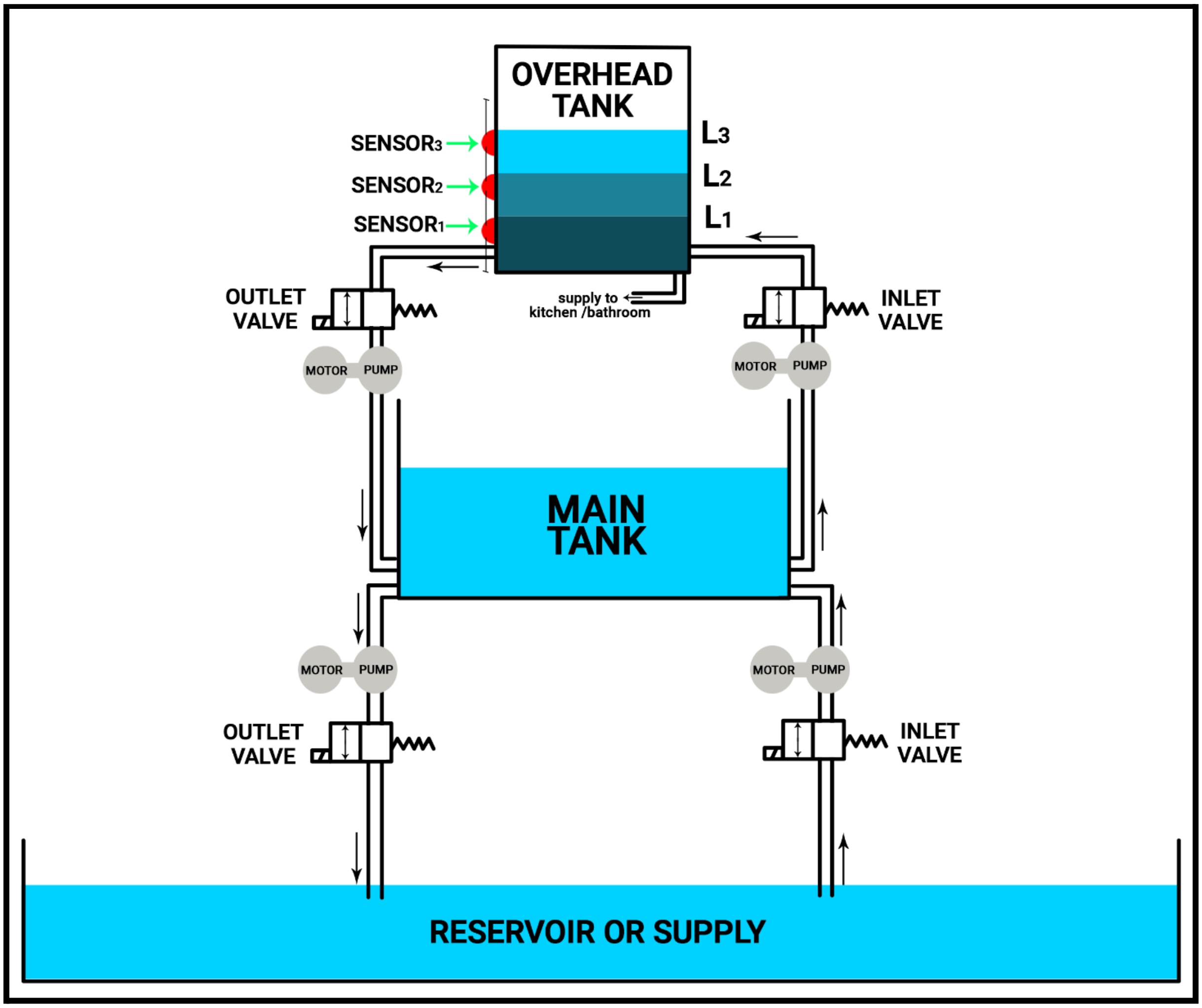
8255 – 00_H – 06_H

8259 – 08_H – $0A_H$

8253 – $0C_H$ – 12_H

Design

Complete design shown with proper labelling (design attached) in Design.pdf file.



The Smart Overhead Tank system design consists of 3 tanks - the Smart Overhead Tank, the Main Tank and a Reservoir.

The Smart Overhead Tank is situated at the top and is used to supply the bathrooms and kitchens. The main tank is used to supply and receive water from the Smart tank when level changes are required. The reservoir is used to maintain the level in the main tank.

The system contains 4 Valves (S6-20-220-0 Pneumadyne, 220V AC, Normally Closed) and 4 Motors (MINI PACIFIC 1 Crompton Greaves, 220V AC). The sensor used to check water level is a non contact water level (XKC Y25 T12V). 3 of these sensors are placed outside on the tank wall at the desired maximum(level 3), minimum(level 1), and nominal(level 2) levels. They can be placed at the levels according to convenience.

As clear from the diagram, there are 2 inlet and 2 outlet valves (S6-20-220-0 Pneumadyne, 220V AC) in the pipes connecting the Smart Overhead tank to the main tank, and those connecting the main tank to the reservoir, the flow being controlled by the motors(MINI PACIFIC 1 Crompton Greaves, 220V AC).

The dimensions of the main tank don't affect the system as water is maintained at a constant level using pumps (amount of inlet water always equal to amount of outlet water). The dimensions of the Smart Tank only provide restriction on the thickness of walls, which should be less than or equal to 12mm (working range of XKC Y25 T12V sensor).

Working Of The Motor

MINI PACIFIC 1 Crompton Greaves, 220V AC – operates at 220V AC. The motor gets switched on when we get a 5V high signal from the 8255 chip to the relay module (RB-Ite-04 4-Channel 5V Relay Module DC 5V Relay Module) which converts it to 220V AC.

Working Of The Valves

S6-20-220-0 Pneumadyne, 220V AC, Normally Closed – Operates at 220V AC. The valve gets switched on when we get a 5V high signal from the 8255 chip to the relay module (RB-Ite-04 4-Channel 5V Relay Module DC 5V Relay Module) which converts it to 220V AC.

Generation of Clock

2.5MHz clock is given from 8284A to the first counter of 8253 with a counter value of 25000 in mode 3 giving a output clock of 100Hz, which is given as input clock to the second counter of the same 8253 with a counter value of 100 in mode 3 giving an output clock of 1 Hz. This is given as input clock to the third counter of the same chip with count value of 3600 in mode 3 to get a rising edge every hour respectively, which is used to raise an interrupt through the IR0 of 8259 PIC.

HANDLING OF THE SENSOR OUTPUTS

OUT 1 = 5V (ON), when the sensor detects water

at or above its level.

OUT 1 = 0V (OFF), when the sensor does not detects water

at its level.

This implies level codes to be:

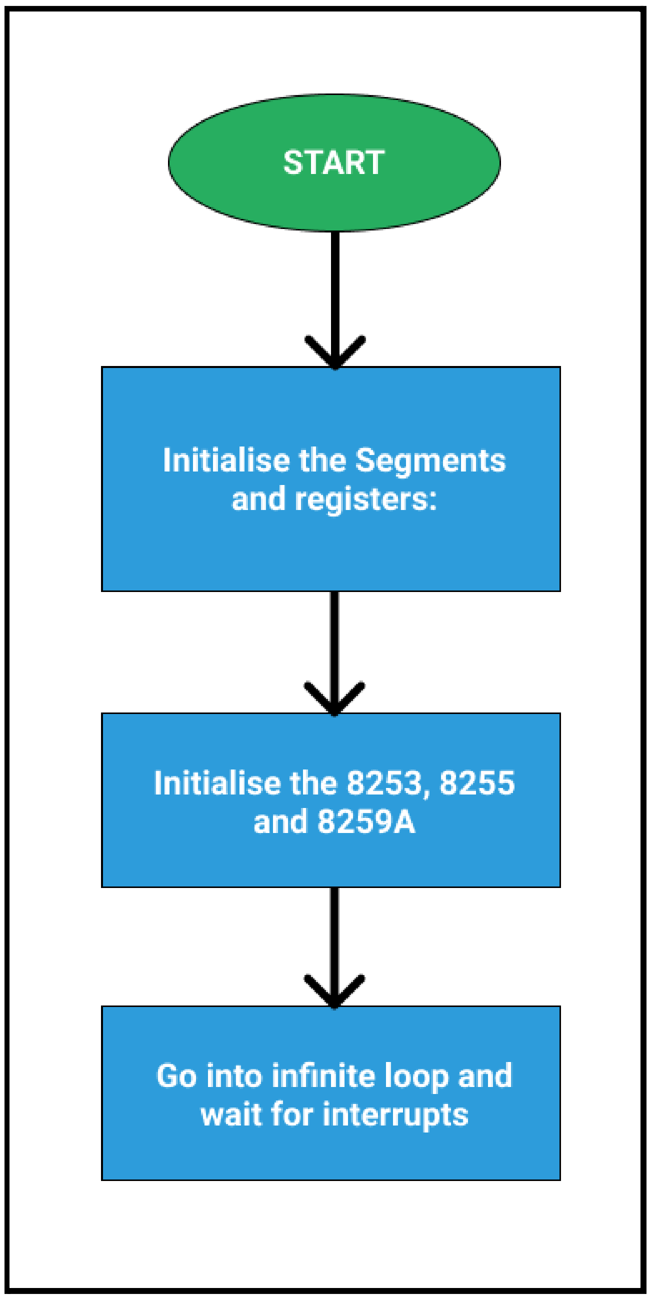
Level	Level Code(sensor3 sensor2 sensor1)
0 <= Level < Minimum	000
Minimum <= Level < Nominal	001
Nominal <= Level < Maximum	011
Maximum <= Level	111

These outputs are then taken as input in 3 Pins of port B of 8255, and their XOR is sent to IR1 of 8259 and XOR’ is sent to IR2 of 8259.

Flow Chart

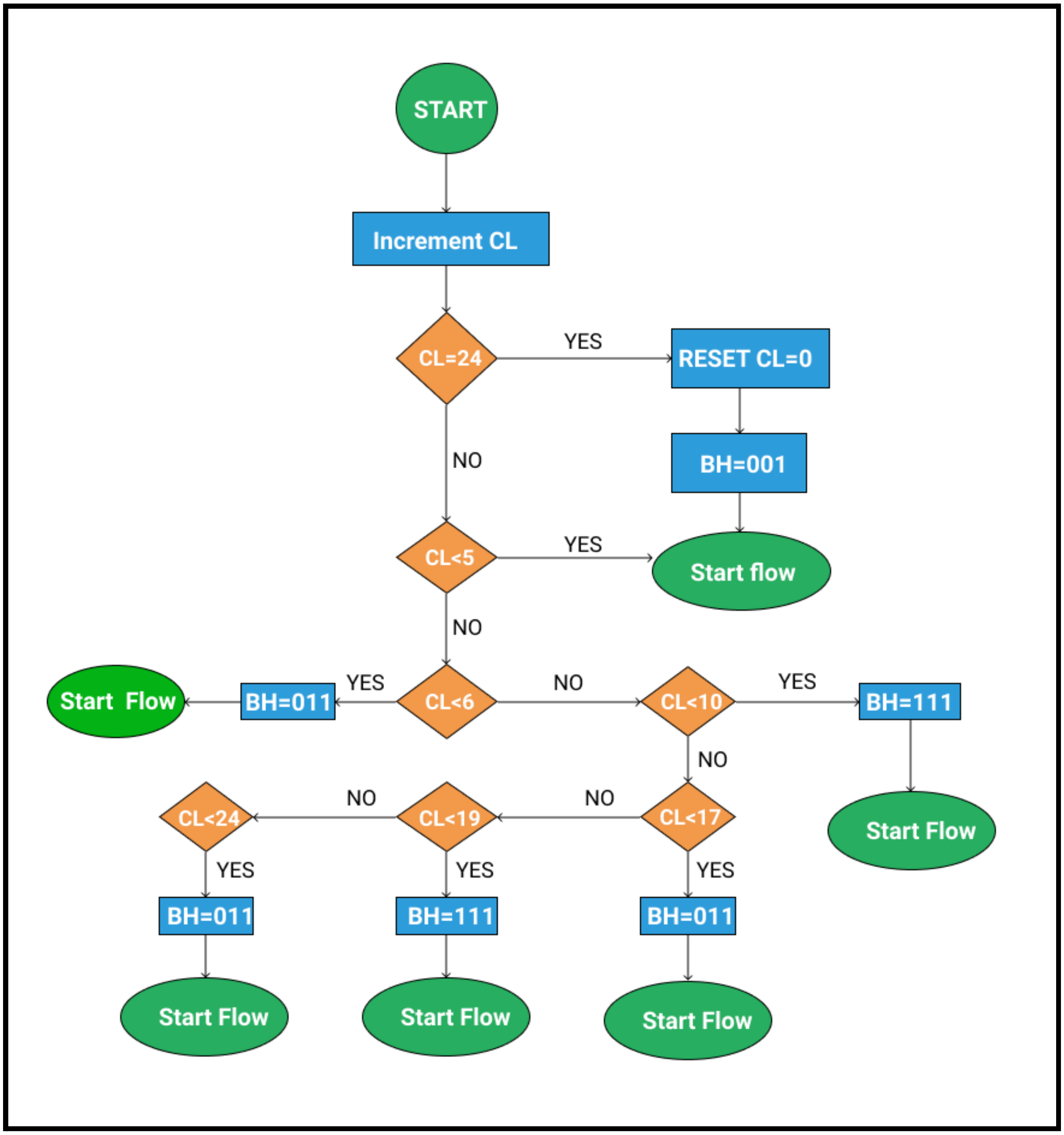
Main Program

1. **Dedicated registers :**
    a. **BL - Current water leve**l, as per sensor output combination is stored here.
        i. level 1(Minimum) BL= 001
        ii. evel 2(Nominal) BL = 011
        iii. level 3(Maximum) BL = 111.
    b. **BH - Required water level** to be checked for according to time of the day.(same level codes as BL)
    c. **CL - Stores the current hour count** using the 8253 counter, resets after 24 hours.

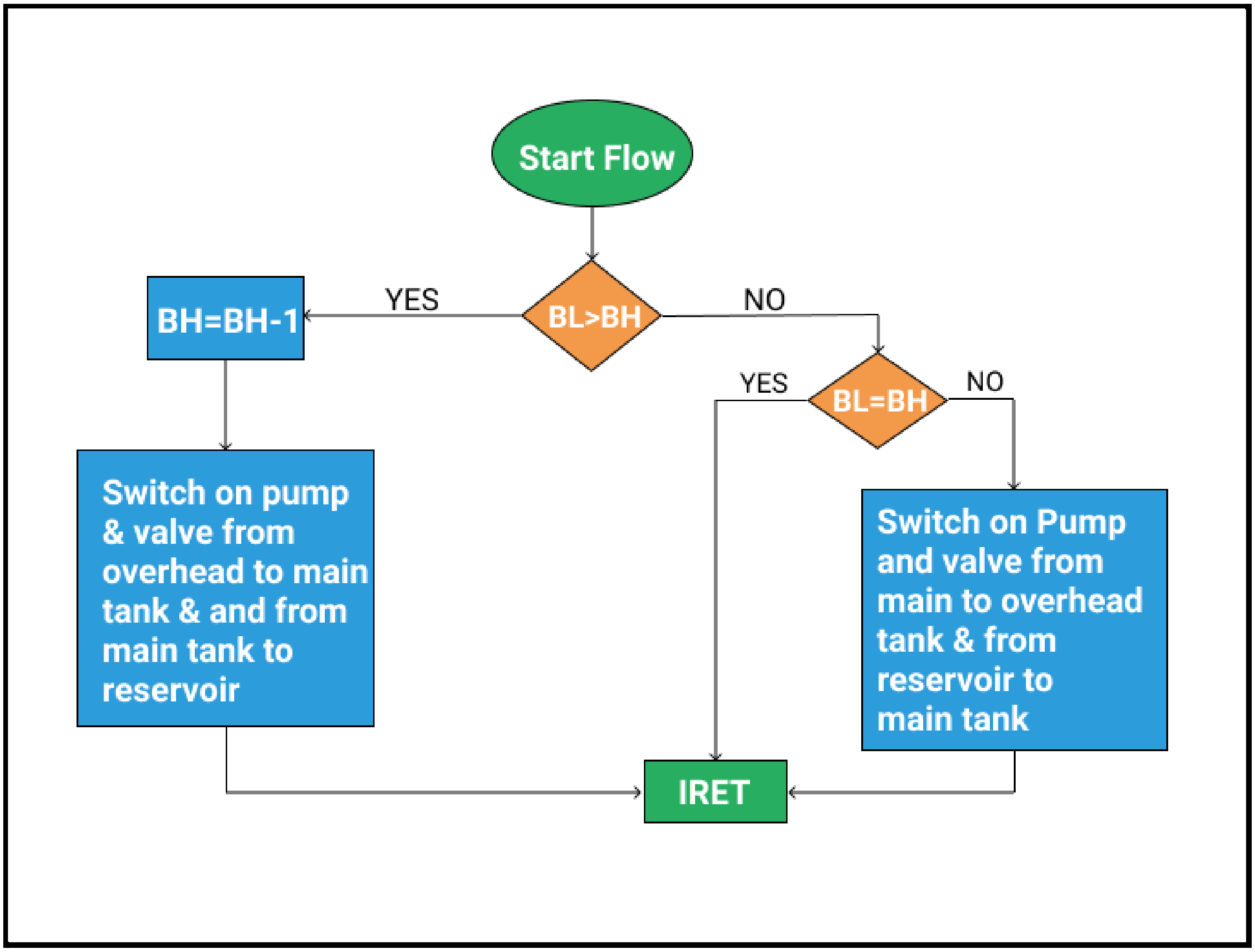


Flow Chart of ISR

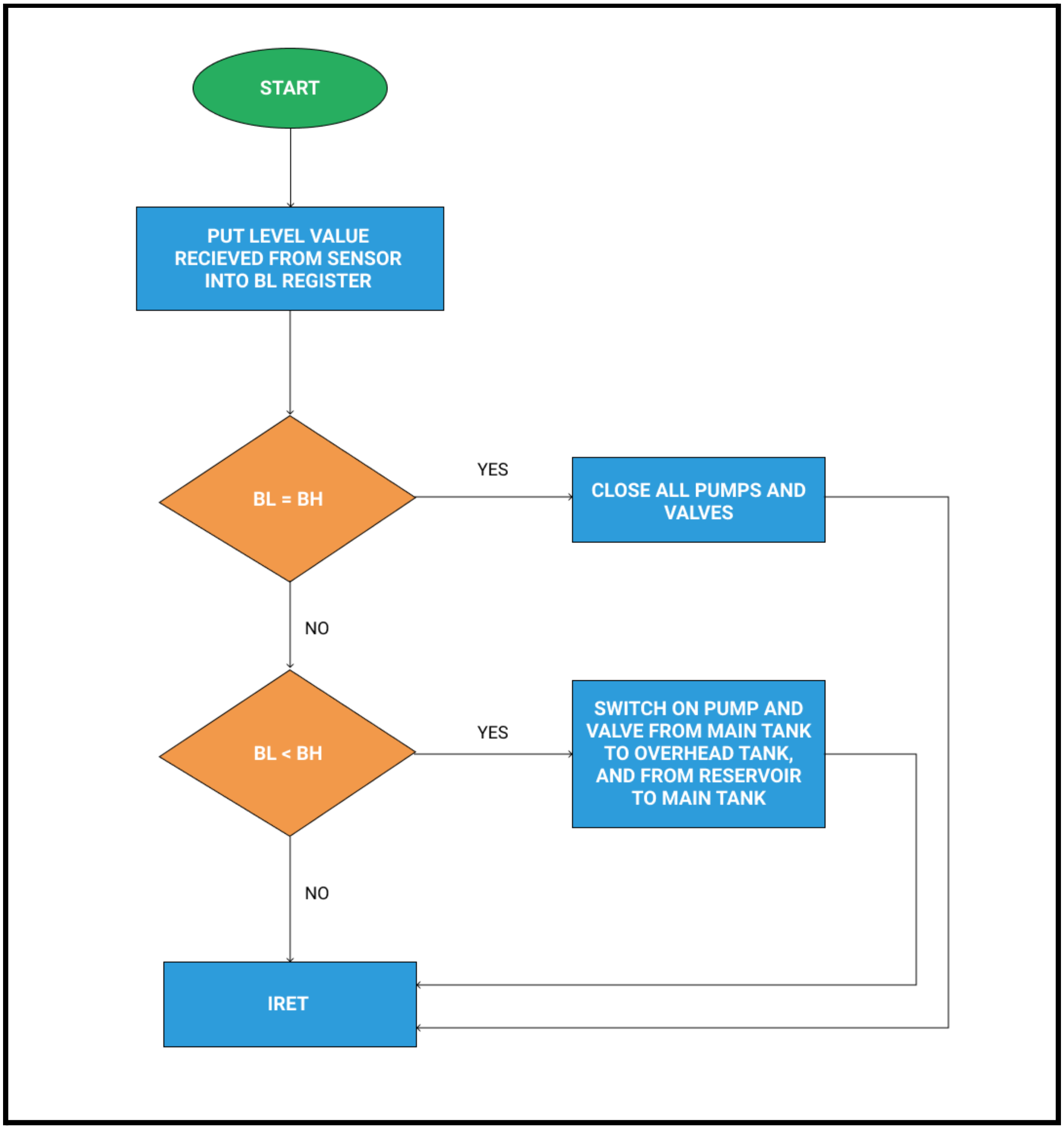
IR0 interrupts ISR when an interrupt is raised by the clock generator at every hour.



Start Flow function - Called after desired water level is decided according to the clock interrupt. Desired level is passed in BH, the current level as per sensor output is stored in BL register.



Sensor Output XOR and XOR' Interrupt at IR1 and IR2 of 8259 - One of the Interrupts raised whenever there is any change in the signals. The current level is then stored in the BL, compared with the desired level in BH(according to time) and pumps and valves are started/ stopped so as to reach the desired level.



Variations in Proteus Implementation with Justification

1. 8259 does not work in proteus, so we implemented the sensor output interrupt by using polling, checking the Port value of 8255 for change in sensor outputs.
2. 2732 is used as 2716 is not available in Proteus.
3. Using a gate-based circuit for memory – does the same as LS 138 here
4. Level sensor - not available in Proteus so a DC voltage of 5V with switches is used to represent various sensor outputs.
5. Pump+motor and Solenoid valve not available so LEDs are used to show their state(ON/OFF)
6. 8259 not there – justification is as per point 1.

Firmware

Implemented using emu8086 attached.

List of Attachments

1) Complete Hardware Real World Design with labelling. –Design.pdf
2) Manuals
    a) 2716- 2KB ROM
    b) 6116
    c) 8086
    d) 8253
    e) 8255A
    f) 8259
    g) 8284
    h) RB-LTE-04 4 channel Relay
    i) KY-019 1 channel Relay
    j) LS244
    k) LS245
    l) LS7447
    m) DM74LS04
    n) Solenoid Valve 2WNC
    o) 74HC08
    p) SN5432
    q) MINI PACIFIC Crompton Greaves
    r) XKC Y25 T12V
    s) 74HCT86
    t) LD3361BS
3) Proteus File –Overhead_Tank.dsn
4) EMU8086 ASM File –Overhead_Tank_code.asm
5) Binary File after assembly – Overhead_Tank_codeb.bin