FRESHWATER FISH EGG HATCHERY CONTROL SYSTEM

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PROBLEM STATEMENT

Freshwater hatcheries often rely on continuous manual monitoring of critical environmental conditions such as water temperature and pH levels. This process depends heavily on operator attention, is slow to react to sudden fluctuations, and is vulnerable to human error. These limitations can lead to unstable water conditions, reduced hatch success rates, and inconsistent system performance. Therefore, we introduced a system that composes of a monitoring and control system that provides real-time feedback, faster response to environmental changes, and improved reliability while still allowing operators to make key decisions in the hatchery management process.

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SYSTEM OVERVIEW

The system monitors temperature, pH, and water flow, providing real-time data and alerts. It uses assembly language and peripherals like the 8255 Programmable Peripheral Interface and 8259 Programmable Interrupt Controller.

Real-time Data Display

Instantaneous visualization of temperature and pH readings, keeping operators informed.

Configurable Thresholds

Allows users to set custom safe limits for temperature and pH, enabling tailored monitoring based on hatchery requirements.

Real-time Alerts

Immediate audio notifications activate when readings go beyond safe limits, enabling rapid corrective action and preventing system risks.

Manual Pump Control

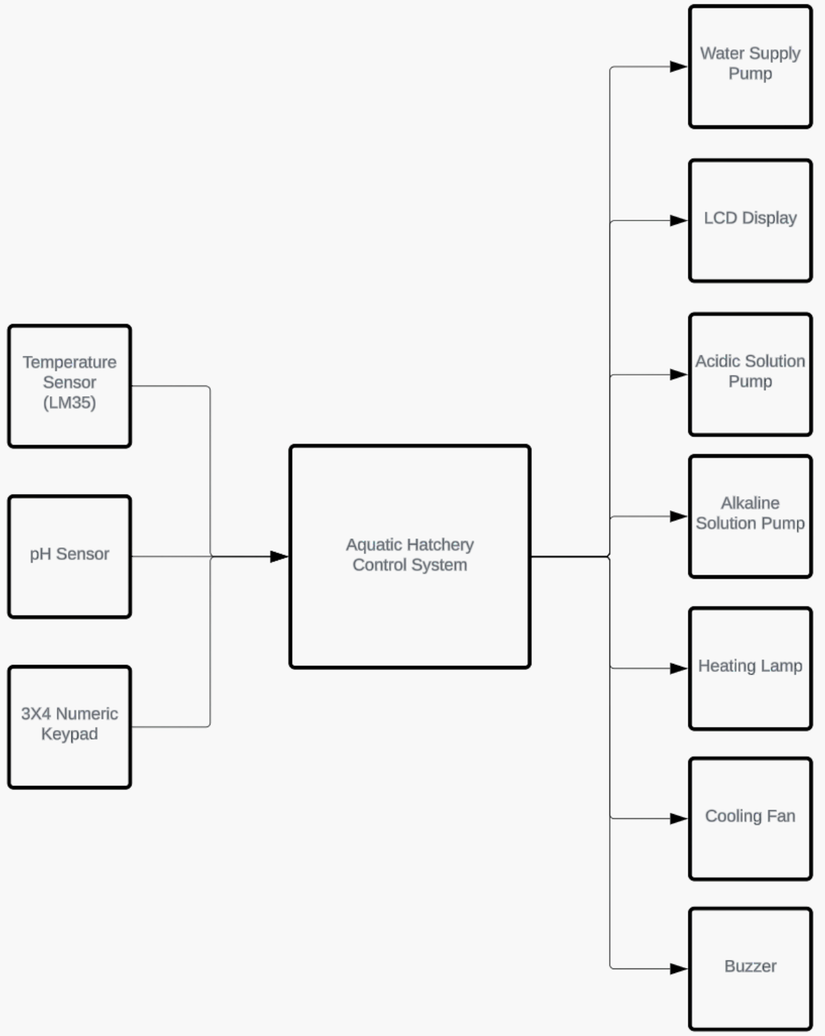
Direct on-demand pump activation through the interface, giving operators full control over water flow adjustments whenever needed.

Menu Driven Interface

A streamlined, user-friendly menu system that simplifies navigation, system configuration, and day-to-day operation.

Partial Automation

Automatically initiates basic control functions based on sensor data while preserving operator authority for critical decisions.



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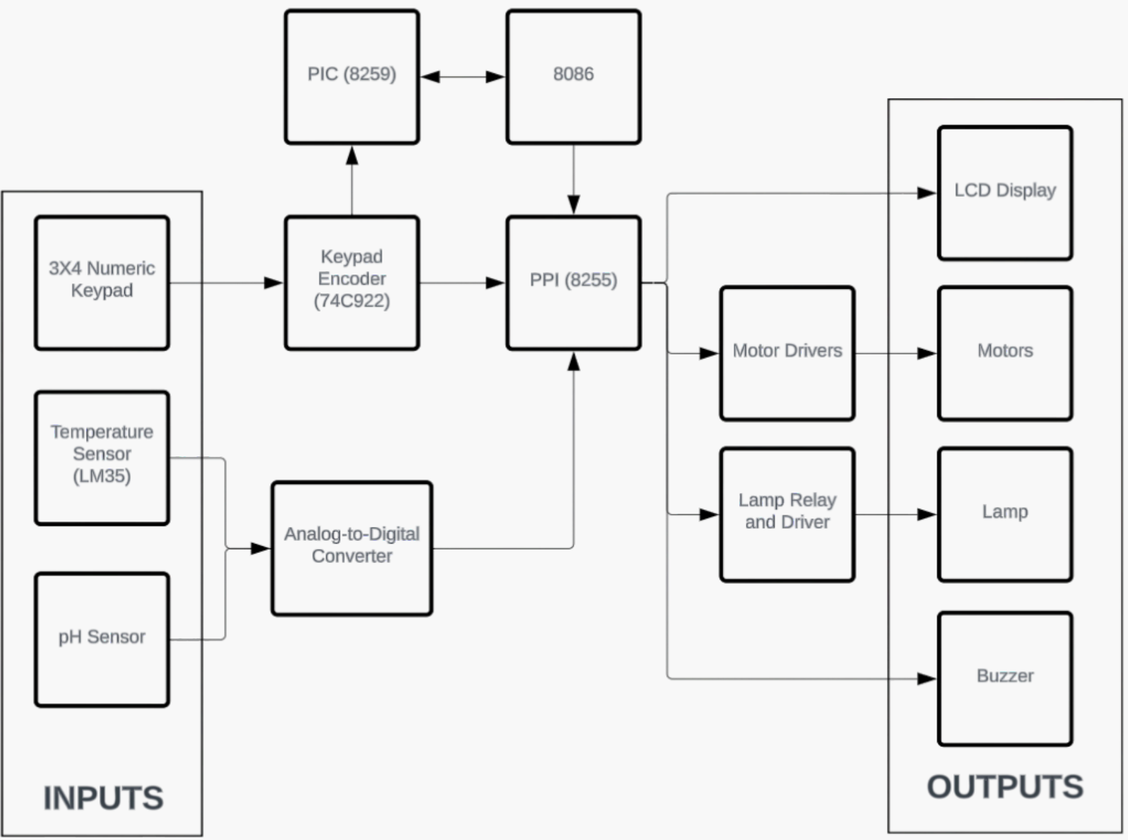
BLOCK DIAGRAM OF AQUATIC HATCHERY CONTROL SYSTEM HARDWARE



The system consists of input modules, a processing unit, and output devices that work together to monitor conditions and perform user-selected actions. Sensor and keypad inputs are digitized and processed by the microprocessor, which then controls the LCD, buzzer, lamp, and motors.

01 Input Modules

The temperature and pH sensors generate analog signals that are digitized by an ADC before being sent to the 8255 PPI. The 3×4 keypad connects to the 74C922 encoder, which outputs digital key codes and triggers the PIC interrupt controller whenever a key is pressed.

02 Processing and Output Control

The 8086 processor reads input data from the PPI and sends commands to the output devices. The LCD, buzzer, lamp, and motors receive their control signals through the PPI, with the lamp and motors driven through relay and driver circuits for proper power handling and safe operation.

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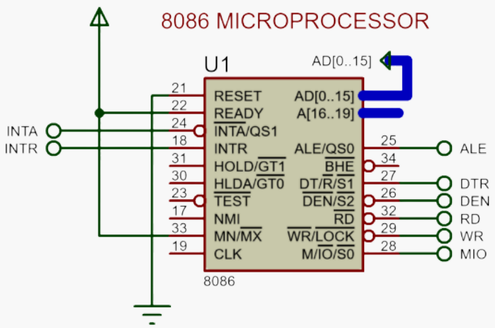
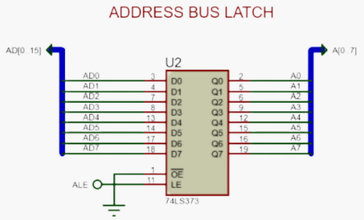
HARDWARE COMPONENTS

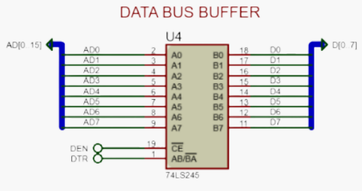
Peripheral	Functionality
ADC0808 Programmable Peripheral Interface	PPI for ADC0808 related I/O. Sends out the setup and control bits for the ADC0808. Reads the digital output converted by the ADC0808 from the analog voltage output of the sensors used. Uses the addresses C0H-C8H.
I/O Devices Programmable Peripheral Interface	Receives keypad input from the keypad encoder. Sends out bits to the different output devices to enable or disable them. Uses the addresses C8H-CEH.
LCD Control Programmable Peripheral Interface	Sends out instructions and data to initialize and display on the LCD. Uses the addresses D0H-D6H.
8259 Programmable Interrupt Controller	Manages hardware interrupts from the keypad. This allows the system to perform other tasks without having to wait for a user input, and instead respond immediately to interrupt requests sent by the 8259 to the 8086. Uses the addresses D8H-DEH.

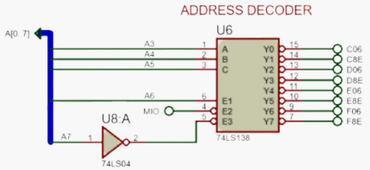
Peripheral	Functionality
Analog-to-Digital Controller (ADC0808)	Converts the analog voltage signals from the temperature and pH sensors into digital data. Sends this digital output to the PPI so the microprocessor can process and use the sensor readings.
Motor Drivers (L298)	Amplifies current and voltage to power the motor. Uses pulse width modulation to maintain consistent motor speed.
Lamp Relay and Driver (ULN2003A)	Safely connects the PPI and lamp output which requires higher current and voltage supply. This allows the 8255 to control the lamp without making contact with the high voltage circuitry.
Keypad Encoder (74C922)	Encodes the input from the 3x4 keypad array of SPST switches into a 4-bit binary code.

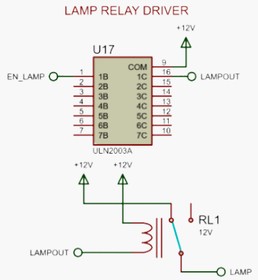
Input	Functionality	Analog/Digital
3x4 Numerical Keypad	To accept user input in selecting various system operations	Digital
Temperature Sensor (LM35)	Measures water temperature	Analog
pH Sensor (variable DC voltage source)	Measures pH level	Analog
Outputs	**Functionality**	**Analog/Digital**
Lamp	Raises aquarium temperature	Digital
Motors	Control for the main hatchery water circulation pump, cooling fan system, and pH alkaline/acidic solution pumps	Digital
LCD Display	Display for UI	Digital
Buzzer	Alarm for parameters entering dangerous levels	Digital

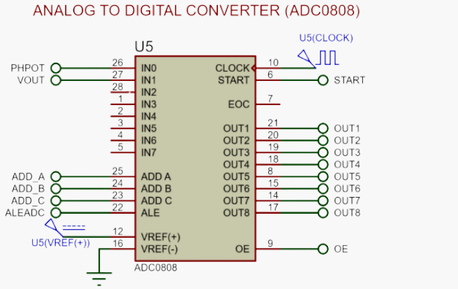


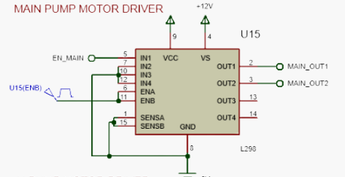


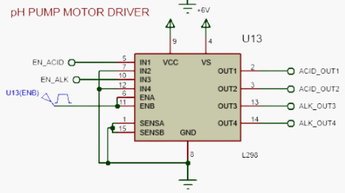


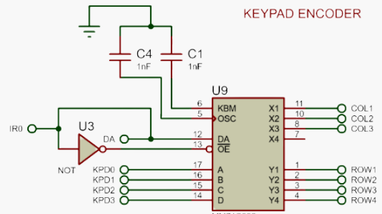


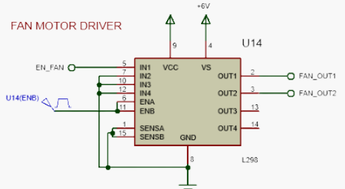


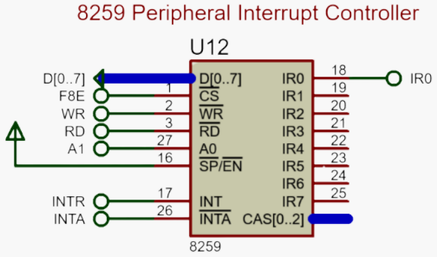


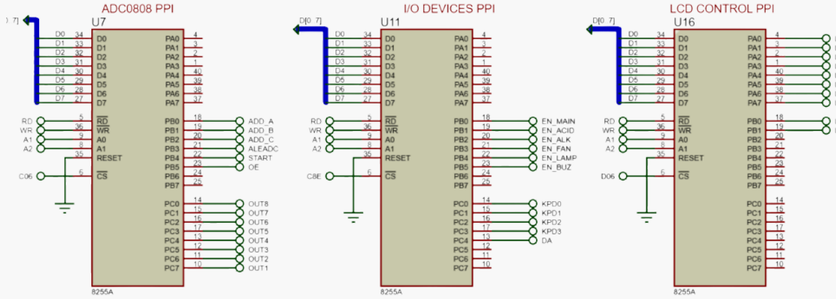












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SOFTWARE ARICHTECTURE

A hybrid software architecture using both programmed I/O and interrupts was implemented. Programmed I/O handled periodic system tasks like sensor readings and peripheral outputs, while interrupts managed asynchronous events such as keypad inputs for selecting operation modes in the main menu.

01 Sensor Reading

The system reads the pH and LM35 temperature sensors through the ADC0808, which converts their analog outputs into 8-bit digital values. Using programmed I/O, the software starts the ADC conversion and retrieves the result. For pH, the digital reading is scaled back to its analog equivalent using:

Analog = (Digital × 3 × 10) ÷ 256

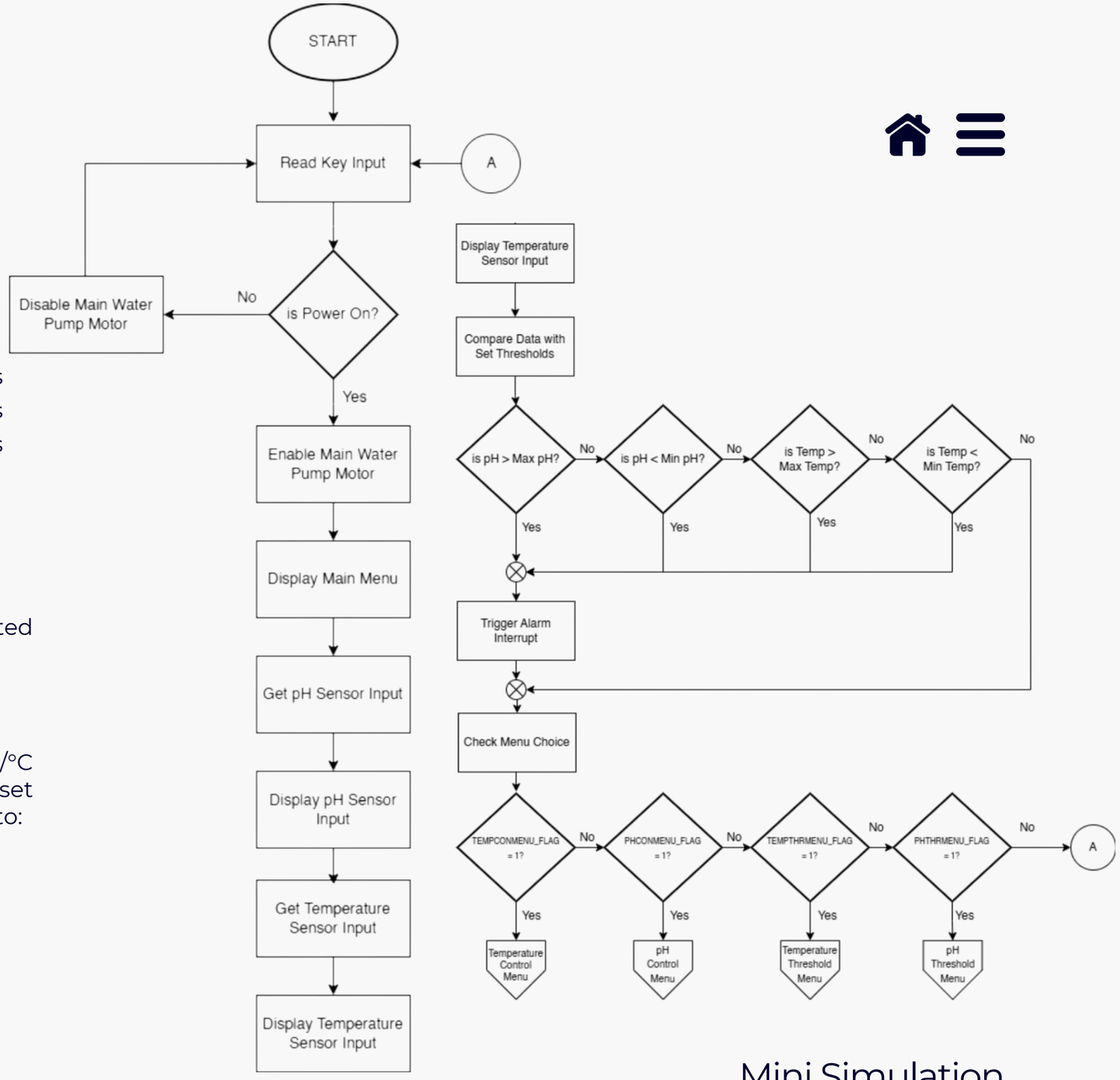
02 ADC Conversion Formulas

After scaling, the pH value is calculated through the system's formula:

pH = (140 − (Analog × 14 ÷ 3)) ÷ 10

Temperature uses the LM35's 10 mV/°C characteristic. With the ADC reference set to 2.56 V, each digital step corresponds to:

N = (V_{in} ÷ Vref(+)) × 256
1°C = (0.01 V ÷ Vref(+)) × 256
Vref(+) = 2.56 V



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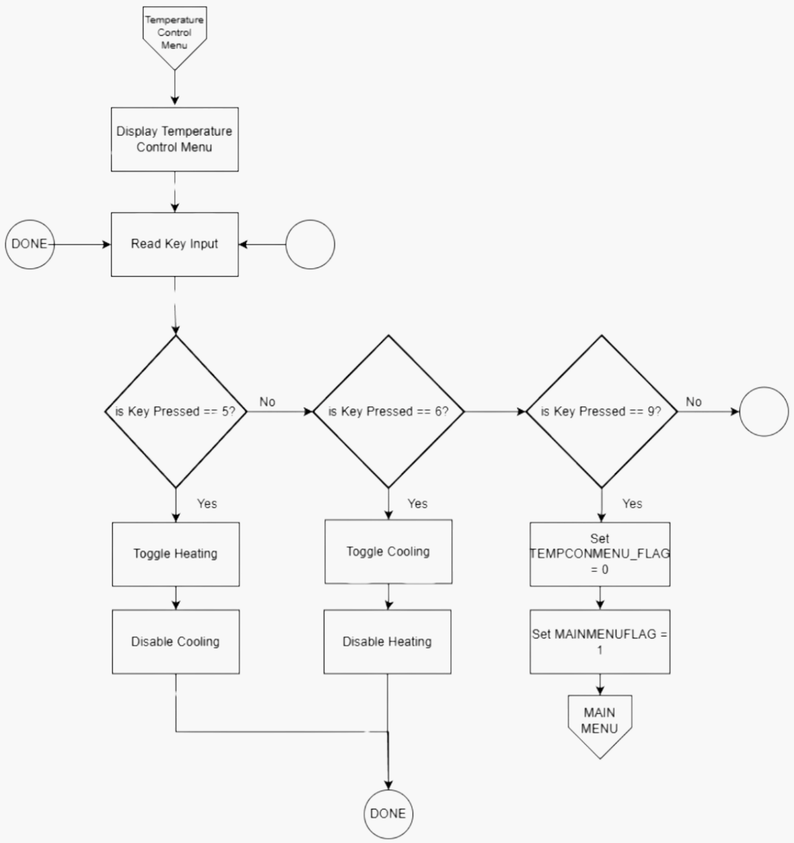
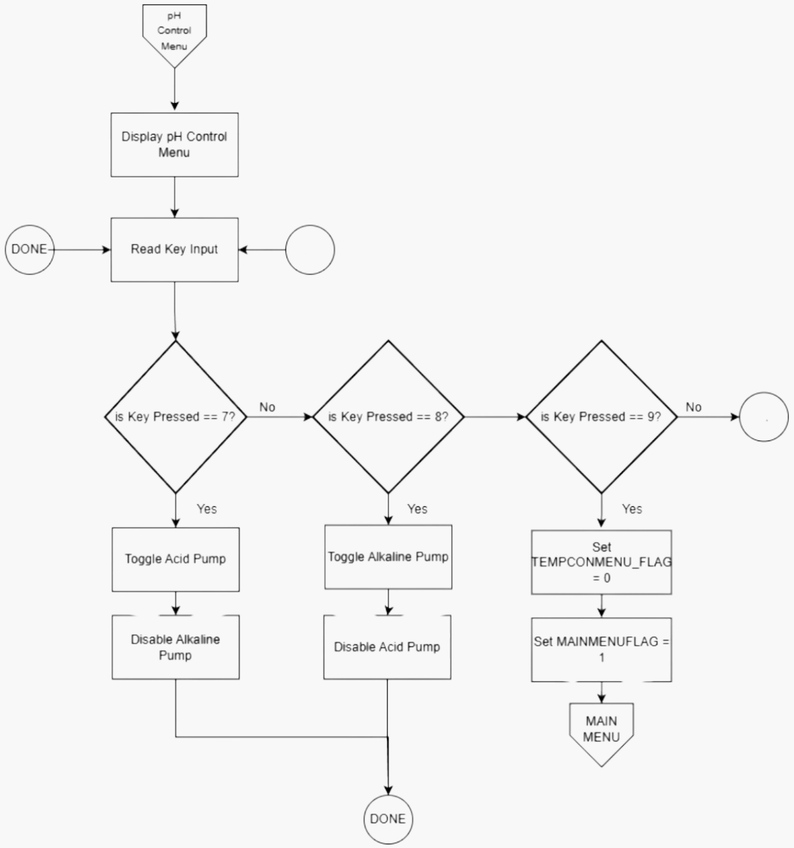
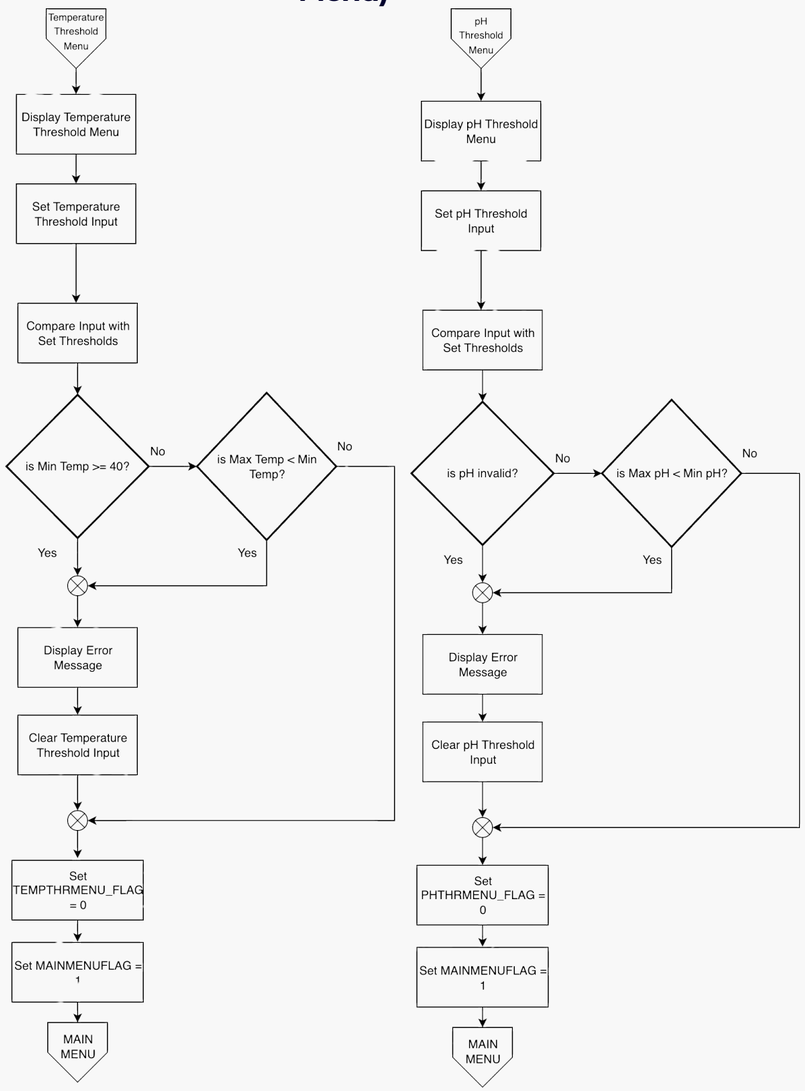
Submenus Flow (Temperature and pH Control Menu)





Threshold Menu (Set Temperature Threshold Menu and Set pH Threshold Menu)



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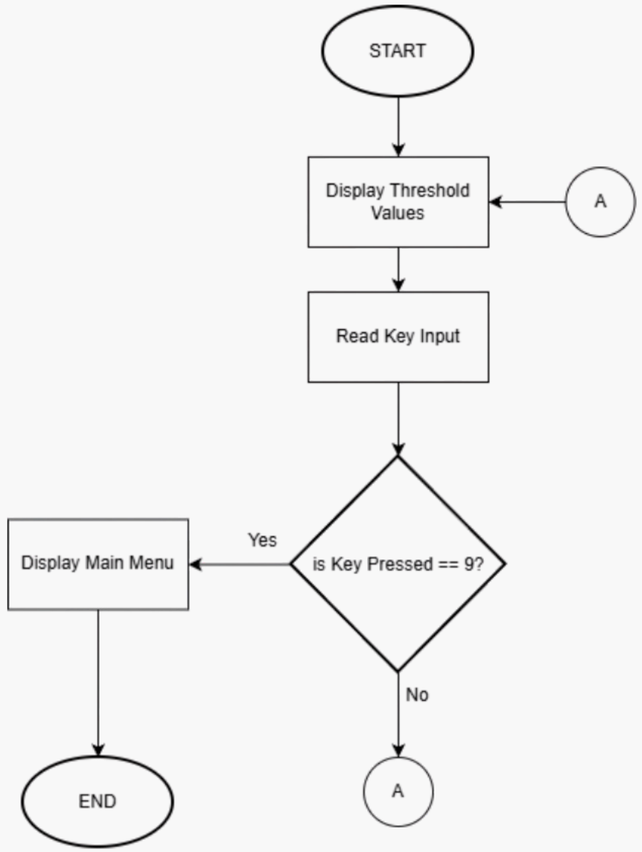
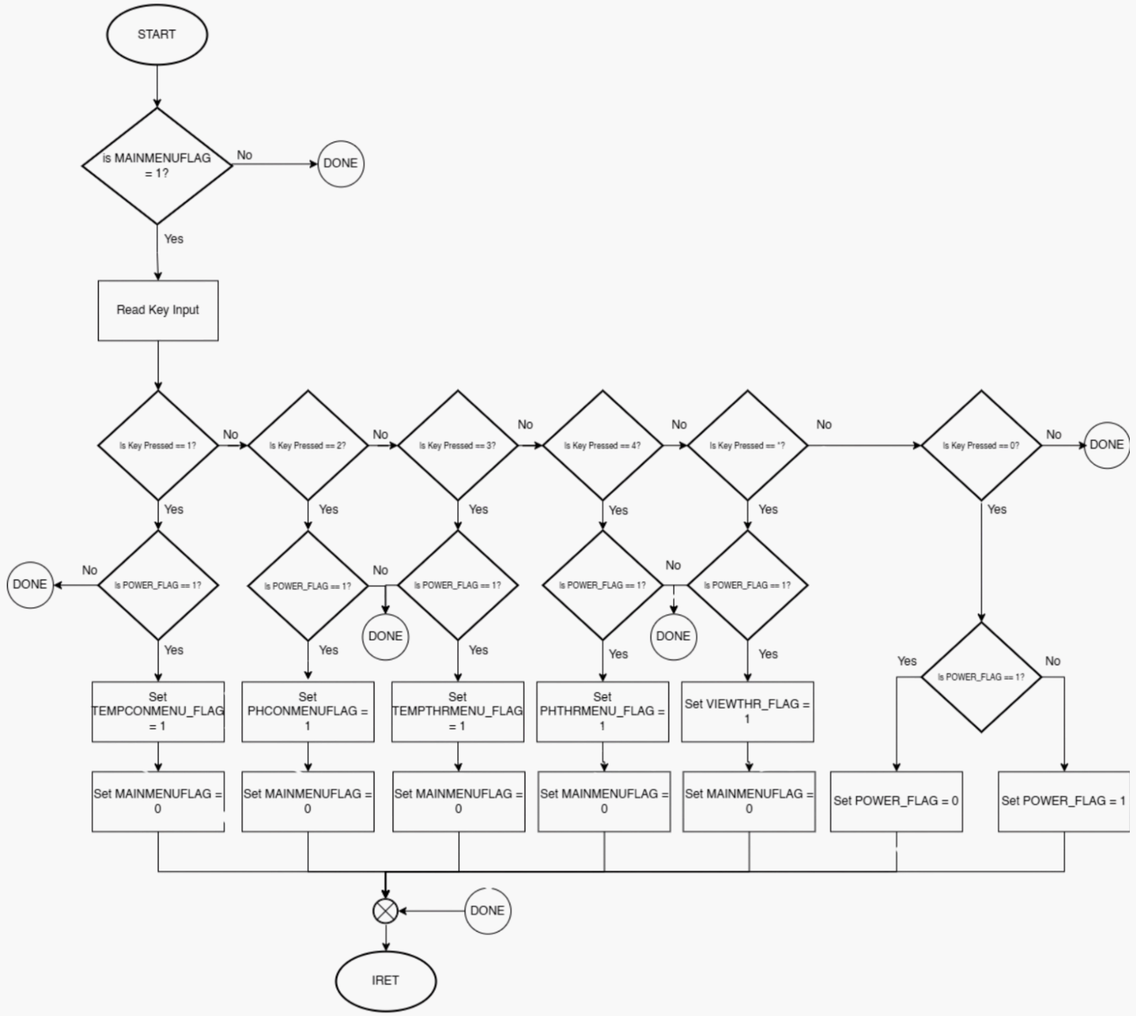
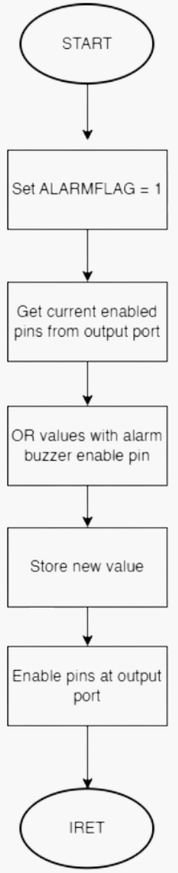
Threshold Values (View Threshold Values)



System Flow (Main Menu and Power Detect Key Input)



System Flow (Alarm Buzzer Interrupt)



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