

System Architecture:

- Uses sensors (Temperature, pH, Turbidity, DO) to measure water quality.
- Employs an **ADC0808** to convert analog sensor signals to digital.
- Uses an **8051 microcontroller (AT89C51)** to process and display data.
- Drives **7-segment displays** using **MAX7219**.
- Triggers **alerts** using **comparators (LM339)**, LEDs, and buzzers if readings are out of safe range.

Detailed Flow

1. Sensors & Signal Conditioning

Each sensor is connected through a voltage divider (variable resistor for calibration):

- **RV1 + LM35** → Temperature sensor
- **RV2 + pH Sensor** → pH level
- **RV3 + Turbidity Sensor**
- **RV4 + DO Sensor**

These output analog voltages proportional to the measured parameters.

2. Analog Multiplexer (U2 - ADC0808)

- Accepts 8 analog input channels (A0–A7).
 - Converts selected analog signal to digital using 8-bit resolution.
 - Controlled via select lines (A, B, C) from the microcontroller.
 - **OE**, **START**, **EOC**, and **ALE** are control signals for synchronization.
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3. 8086 Microcontroller (U1)

- Central processor that:
 - Selects ADC channel.
 - Starts conversion.
 - Waits for **EOC** (End of Conversion).
 - Reads converted 8-bit value.
 - Sends data to display.
 - Checks thresholds and activates alarms.
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4. Display Driver (U3, U40 - MAX7219)

- **MAX7219** takes SPI input from 8051 and drives 7-segment displays.
 - 4-digit 7-segment display used for each parameter.
 - Each parameter has its own MAX7219 driving it (DIG0–DIG3).
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5. Alarms (Comparators + LEDs + Buzzers)

- **LM339 quad comparator** is used for each parameter.
 - Receives:
 - One input from sensor signal (via voltage divider).
 - One input from reference voltage (threshold).
 - If the sensor value exceeds the reference:
 - Comparator output goes HIGH.
 - Drives RED LED + BUZZER for that parameter.
 - Activates corresponding alert signal to microcontroller.
 - Alerts:
 - ALERT_TEMPERATURE
 - ALERT_PH
 - ALERT_TURBIDITY
 - ALERT_DO
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6. Multiplexing & Control Logic

- 74LS373, 74LS573, 74LS138 (U4, U5, U8, U9, U11) handle:
 - Data/address multiplexing.
 - Output enable control.
 - Chip selection.
 - Used to expand addressable memory/data lines for the 8051.
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7. Control Logic for Timing (U6, U7)

- NOR gates combine control signals:
 - Ensure correct timing between ADC **START**, **WR**, **ALE** signals.
 - Avoid data corruption during ADC reading.

Displays

7-Segment LEDs

- 4 separate sections showing:
 - **Temperature** – LM35 (display in °C)
 - **pH** – pH Sensor (0–14 scale)
 - **Turbidity** – in NTU (Nephelometric Turbidity Units)
 - **Dissolved Oxygen** – in mg/L
- Each has:
 - 4-digit display
 - Green/Red LED based on safety range
 - Buzzer for alert
 - Safe range labeled for reference

Threshold Values and Alert Conditions

Parameter	Safe Range	Alert Condition	Signal
Temperature	15–35°C	<15 or >35 triggers alert	ALERT_TEMPERATURE
pH	6.5–8.5	Outside this range	ALERT_PH
Turbidity	0–50 NTU	>50 triggers alert	ALERT_TURBIDITY
Dissolved Oxygen	>5 mg/L	<5 triggers alert	ALERT_DO