Sri Lanka Institute of Information Technology

Digital Electronics Assignment 1

Course Code: IE2010

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Y2. S1. CSNE. 1.3

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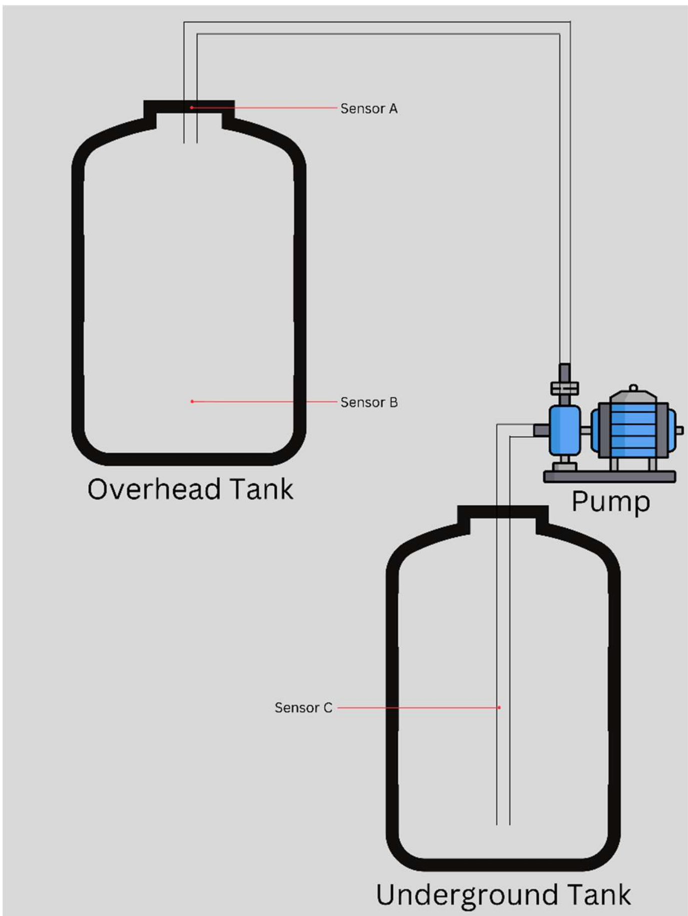
Scenario

A certain house has an Overhead tank of 1000L maximum capacity to store water . An electric water pump is used to fill this overhead tank from the underground storage which has a maximum capacity of 3000 L. The pump operation must be automated under the given operational conditions .

Rough Schematic



According to the given scenario the following operations of the sensors were identified.

The Overhead tank contain 2 sensors :

Sensor A : Detects maximum water level

- When water level is greater than or equal to 1000 L [A=1]

Sensor B : Detects minimum Water level [750 L]

- When water level is less than 750 L [B=1]

The Ground tank contains one sensor:

Sensor C : Detect minimum water level [1000 L]

- When water level is lower than 1000 L [C = 1]

Description of operation

The expected operation of the system can be summarized as an automation of the water refilling process of the overhead tank with the help of an Underground tank. The overhead tank is to be filled when the volume of the water within the tank depletes below 750L which is where sensor B is located at. Whereas the water pump should be turned off either if the underground tank has water less that its minimum threshold(sensor C) [1000L] or when the overhead tank is filled up to the maximum [1000l](sensor A).

Truth Table

A	B	C	F	
0	0	0	1	Issue below[1]
0	0	1	0	
0	1	0	1	
0	1	1	0	
1	0	0	0	
1	0	1	0	
1	1	0	0	
1	1	1	0	

[1]At the instance A=0,B=0,C=0 there is a fatal problem in the system , when the overhead water tank's water is in between A and B the water can be either filling or not filling . Rather than turning on the pump each time the water level decreases below A , it would be more practical to On the pump once the water level reaches below location B.

Using the following method is more convenient due to following reasons

- Greater conservation of energy: The pump operates only when the water level is significantly low, which can save energy in the long run.
- Reduces frequent pump cycling and extends lifetime: Reducing the number of pump activations can extend the life of the pump and reduce wear and tear.

This note will be revisited in the report.

Output of the Logic Circuit

F $_{[SOP]}$ = A'B'C'+A'BC'

AB/C	00	01	11	10
0	**1**	**1**	**0**	**0**
1	**0**	**0**	**0**	**0**

F $_{[SOP]}$ = A'C'

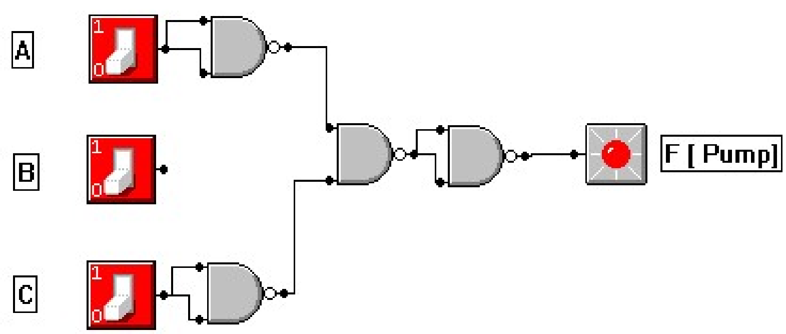
Note : For Second Implementation use the following solutions (will be revisited in the report),

Set = A'BC'

Reset = A'B'C+A'BC+AB'C'+AB'C+ABC'+ABC

Reset$_{[simplified]}$=A + C

<u>Simplified NAND</u>



Simplified : F $_{[SOP]}$ = A'C'

Explanation for the result

The following result was taken due to the fact that if the pump is turned off after the

Lab Report

Abstract

This project focuses on an automated water supply system for residential applications. It maintains precise water levels in an overhead tank, employing sensors, logical control gates, and a reliable electric water pump. The system's control logic, activated by conditions based on the overhead tank's maximum and minimum levels and the underground storage tanks minimum level, ensures water availability while minimizing energy usage and overhead expenditure. Implementation observations suggest the system's energy efficiency, operational consistency, low maintenance requirements, and adaptability to changing conditions. This project was developed with precision and innovative design in mind while offering a promise in efficiency in similar automated systems and guidance for future implementation of similar systems.

Scenario

A certain house has an Overhead tank of 1000L maximum capacity to store water . An electric water pump is used to fill this overhead tank from the underground storage which has a maximum capacity of 3000 L. The pump operation must be automated under the given operational conditions .

The Overhead tank contain 2 sensors :

Sensor A : Detects maximum water level

- When water level is greater than or equal to 1000 L [A=1]

Sensor B : Detects minimum Water level [750 L]

- When water level is less than 750 L [B=1]

The Ground tank contains one sensor:

Sensor C : Detect minimum water level [1000 L]

- When water level is lower than 1000 L [C = 1]

Implementation Solutions

As mentioned earlier this truth table has a major issue , hence 2 possible solutions can be presented . One solution is using the SR flipflop , the other solution is implementing the circuit given by the truth table with a minor change .

Solution 1 : Following the Truth table

Function: Activating the Pump Each Time It Goes Below the Maximum Level (1000L)

Note: B sensor can be safely removed from the tank in this circuit cause it doesn't affect the output of the final circuit.

AB/C	00	01	11	10
0	1	1	0	0
1	0	0	0	0

Considering the functionality

Advantage :

- Immediate supply of water: The pump operates as soon as the water level drops, ensuring a consistent and immediate water supply.
- No risk of running out of water: With the pump turning on at the maximum level, you're less likely to run out of water unexpectedly.
- Lower cost for circuit: The initial cost to create the following circuit will be lower than the second solution.

Disadvantages:

- Potentially higher energy consumption: The pump operates more frequently, which can lead to higher energy usage and electricity costs.
- More frequent wear and tear: Frequent pump cycling may lead to more maintenance and a shorter pump lifespan.
- Higher maintenance: Due to higher consumption and wear and tear of the devices the long-term expenses would be significantly greater.

Solution 2 : Implementation of Flip Flops

Function: Letting the Water Decrease Below 750L Before Activating the Pump

Considering the functionality

Advantage :

- Greater conservation of energy: The pump operates only when the water level is significantly low, which can save energy in the long run.

- Reduces frequent pump cycling: Reducing the number of pump activations can extend the life of the pump and reduce wear and tear.
- Lower maintenance: Due to the lower consumption and higher durability of the pump , long term maintenance expenditures will be significantly lower.

Disadvantages:

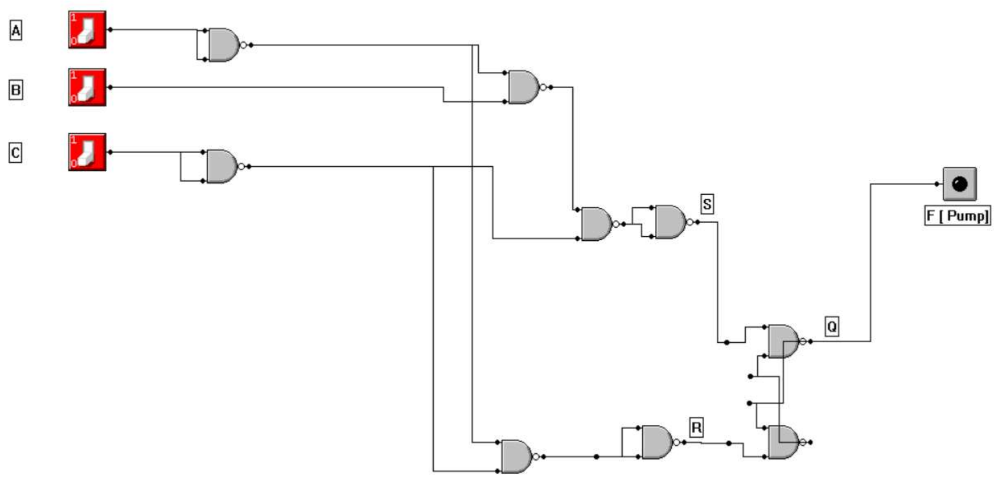
- Possible lack of availability: There might be a delay in refilling the tank, and the water level might drop to a level that some occupants find inconvenient.
- Water scarcity: In areas with limited water supply, you may want to maintain a higher water level to ensure an adequate supply for essential uses.

Implementation Conclusion

After careful consideration of the individual advantages and disadvantages of both the implementation , the most effective and efficient among the presented solutions will be solution number 2.

Implementation

Logic Circuit [Logical Plan for Implementation]



Operations of the circuit

A	B	C	S	R	Q	Q’
0	0	0	0	0	X	X
0	0	1	0	1	0	1
0	1	0	1	0	1	0
0	1	1	0	1	0	1
1	0	0	0	1	0	1
1	0	1	0	1	0	1
1	1	0	0	1	0	1
1	1	1	0	1	0	1

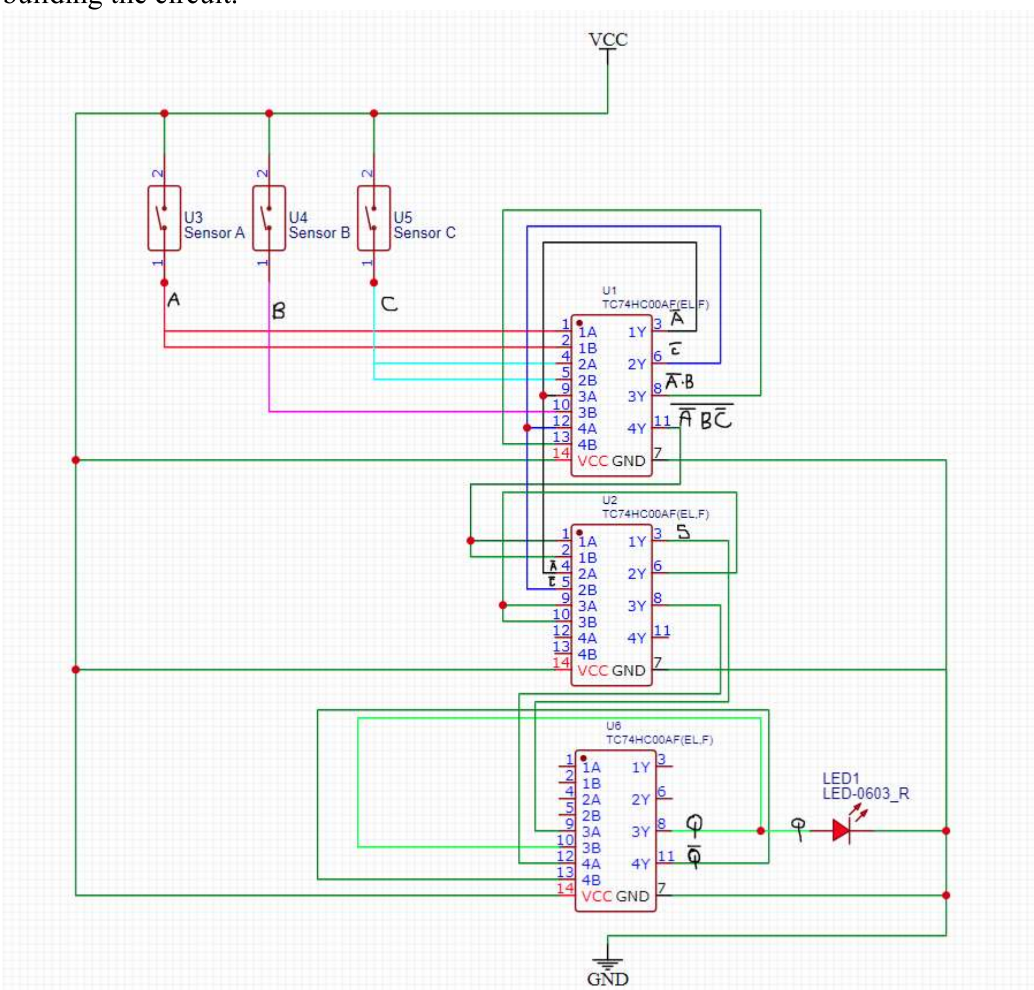
Implementation Plan

Components

1. Power Supply
2. Bread Board
3. Jumper cables
4. NAND Gate ICs x 3 [7400 Series]
5. LED
6. Switch

Schematic Diagram and Lab Implementation

Use the following schematic diagram to build the circuit. When supplying voltage, it is recommended to use of resistors to avoid damages to the circuit and it's components. Any 7400 series NAND ICs can be used for this experiment.
Note : The Switchers used aren't three way, replace with three-way switches when building the circuit.



Observation

When the water level of the Overhead tank reaches below 750L the pump is activated and it will be filled until it reaches 1000L or until the Underground tank reaches a volume below 1000L of water. This process will be repeated as long as the water in the underground tank is sufficient.

Discussion : Reason for not stating a sensor for detection of maximum water level of underground water storage tank.

In the design and automation of the given system, the absence of a sensor to detect the maximum water level in the underground storage tank can be attributed to several factors and considerations. However, the main and the simplest reason for doing so is that there is no necessity to implement the automation of the underground tank where the storage is around 3000L whereas the tank will stop filling after reaching 1000L .This plan also resembles a systematic automation of an underground well but it can also be attributed to an underground tank as presented by the scenario of this assignment.

Other than the above-mentioned reasons the following reasons can also be attributed for this decision,

- **Focus on Overhead Tank:** The primary focus of the system is to ensure the efficient management and utilization of water in the overhead tank as mentioned above. As such, the automation system is tailored to meet the requirements of the overhead tank, rather than the underground storage.
- **Complexity and Cost:** Adding a sensor to detect the maximum water level in the underground storage would introduce additional complexity to the system. This complexity would involve extra components, wiring, and potential maintenance requirements. Moreover, the inclusion of an additional sensor could increase the overall cost of the system.
- **Unnecessary Information:** In the context of the described scenario, knowing the maximum water level in the underground storage might not be critical to the system's operation. The primary objective is to maintain the water levels in the overhead tank within specified limits. Therefore, the system is designed to focus on the relevant conditions for this purpose.
- **Operational Objectives:** The specified conditions for the system operation revolve around ensuring the overhead tank's water levels do not fall below a critical threshold and that the underground tank maintains a minimum level. The system's primary goal is to avoid potential disruptions in water supply to the overhead tank, which can be achieved without knowledge of the maximum level in the underground storage.

Conclusion

In bringing our automated water supply system from concept to implementation and through post-implementation observations, this project has illuminated the path toward efficient and sustainable resource management. The culmination of our efforts underscores the significance of precision, practicality, and adaptability in the field of water management and automation.

Our system's capability to consistently maintain water levels within the overhead tank has proven to be a paramount achievement, ensuring that users are never inconvenienced by water shortages. The automated control of the water pump, triggered by specified conditions, has struck a harmonious balance between resource conservation and uninterrupted supply.

Post-implementation observations have validated the system's real-world effectiveness. Notably, it has displayed remarkable energy efficiency, underlining the importance of automation in minimizing resource wastage. Furthermore, the system's low maintenance requirements enhance its appeal for long-term deployment.

This project serves as a microcosm of resource management's broader landscape, where trade-offs between conservation and consumption are constant considerations. It is our belief that this system exemplifies a promising solution for achieving a sustainable equilibrium.

As we chart our journey beyond this project, we continue to explore the ever-evolving dynamics of automation and resource management. The relentless quest for increased efficiency, user convenience, and sustainable practices remains at the forefront of our mission.

In conclusion, our automated water supply system symbolizes an impactful contribution to the endeavor of resource management, emphasizing the essential role of automation in the efficient use of valuable resources. We look forward to the opportunities and challenges that lie ahead as we persist in our commitment to innovation and progress