



Project Report- End Sem

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Automation Of Sewage Treatment Plant

USING PLC AND SCADA

Industrial Automation

Industrial automation is the use of control devices such as PC/PLCs/PACs etc. to control industrial processes and machinery by removing as much labour intervention as possible, and replacing dangerous assembly operations with automated ones.

Following are some ways in which automation is achieved: **PLC & PAC; HMI; SCADA; Artificial Neural Network; DCS; Robotics**

Some advantages of this are:

- Increased labour productivity
- Improved product quality
- Reduced labour or production cost
- Reduced routine manual tasks
- Improved safety

Programmable Logic Controller (PLC)

A PLC is a computer specially designed to operate reliably under harsh industrial environments – such as extreme temperatures, wet, dry, and/or dusty conditions. It is used to automate industrial processes such as a manufacturing plant's assembly line, an ore processing plant, or a wastewater treatment plant. A typical block diagram of PLC consists of five parts namely:

- Rack or chassis
- Power Supply Module
- Central Processing Unit (CPU)
- Input & Output Module
- Communication Interface Module



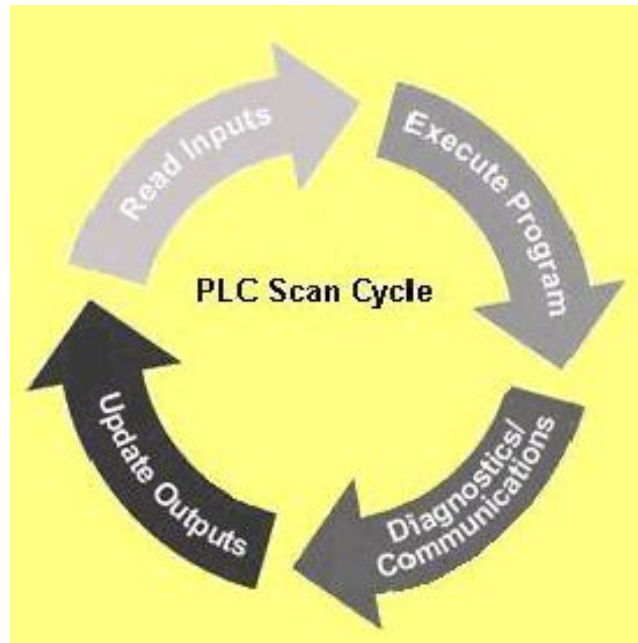
Programmable Logic Controller

- PLC stands for programable logic controller, which acts as an intermediate between sensors(level 0) and SCADA(level 2) and acts as a background for SCADA which runs on the information and values given and processed by PLC. It is a special computer that controls certain processes in an industries.
- There are basically 2 types of PLC; Compact PLC(nano plc, micro plc) and Modular PLC(medium plc and large plc). The basic criteria of types are on Memory, I/O range/Nos., packing and cost per unit.



PLC Scan

PLC Scan : This process has several steps which goes on in a loop such as, Read i/p, execute Program, Diagnostics & communications and Update o/p.



Advantages of PLC

Some advantages of using PLC:

- **Flexible in Nature:** One model of PLC can be used for different operations as per requirement.
- **Easy to install and troubleshooting:** In hard-wired relay-based systems, installation time is more as compared to the PLC-based control panels.
- **Availability of Large contacts:** PLC programming tools contain large no internal number of contacts that can be used for any change induced in different applications.
- **Cost-effective:** Advanced technology and large production of PLC makes it cheaper than the other controller or relay-based systems.
- **Simulation feature:** PLC programming software comes with the simulation features by default.
- **Simple programming methods:** PLC is provided with simple programming methods to program the PLC like Ladder or Boolean type of programming.
- **Ease of maintenance:** As compared with the control systems like relay-based or micro-controller based systems, the maintenance cost of PLC is low.

Supervisory Control and Data Acquisition (SCADA)

SCADA Stands for Supervisory Control and Data Acquisition. More involved in Real-time industrial processes. Helps in monitoring equipments like motors, valves, pumps, relay, sensors etc. SCADA is a combination of telemetry(collection of measurements or data and their automatic transmission to receiving equipments) and data acquisition(process of sampling signals and converting into digital numeric values).

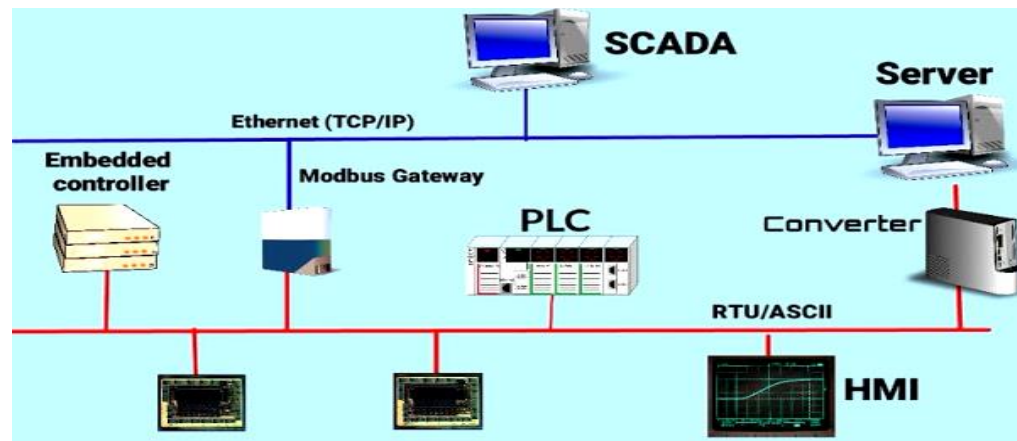
The SCADA concept was developed to be a universal means of remote access to a variety of local control modules, which could be from different manufacturers and allowing access through standard automation protocols.

Functionalities of SCADA

It can log data for further use after performing functions and operators which are to be done according to the program.

It has a very specific feature of IM(instant messaging).

SCADA mobile is a JAVA written program, with detailed alarm and messaging keeping you updated with a refresh time of 2 sec.



Some other tools used for automation

➤ Human Machine Interface (HMI):

An HMI is a software application that enables interaction and communication between a human operator and the machine, or production system. It translates complex data into accessible information, allowing better control of the production process and its various applications.

➤ Distributed Control System (DCS):

A DCS is a central monitoring network that interconnects devices to control different elements within an automated system.

Redundancies

- Redundancy is the duplication of critical components or functions of a system with the intention of increasing reliability of the system, usually in the form of a backup or fail-safe.
- In many safety-critical systems some parts of the control system may be Duplicated or triplicated, which is formally termed as Double Modular Redundancy (DMR) or Triple Modular Redundancy (TMR).
- The different redundancy components are as follows –
 - CPU Redundancy
 - Power Supply Redundancy
 - Network Redundancy
 - Server Redundancy
 - Input/Output Redundancy

Types Of Redundancies

➤ The different types of redundancy are:

A. Cold Redundancy: It is for non-critical processes where time is not a high priority, and human intervention is acceptable.

B. Warm Redundancy: If time and response to a failure are more important but not critical, and a temporary outage is acceptable, a warm redundancy strategy may suffice.

C. Hot Redundancy: This is similar to warm redundancy in terms of architecture, but it offers instant process correction when a failure is detected

Programming Concepts in PLC & SCADA

❑ Ladder Logic:

- Ladder logic (also known as ladder diagram or LD) is a programming language used to program a PLC.
- Ladder logic is mainly for bit logic operations, although it is possible to scale a PLC analog input. For example, Parallel switches imply OR function and Series switches imply AND function.
- Ladder logic is a graphical programming language which means that instead of text, the programming is done by combining different graphic elements. These graphic elements are called symbols.

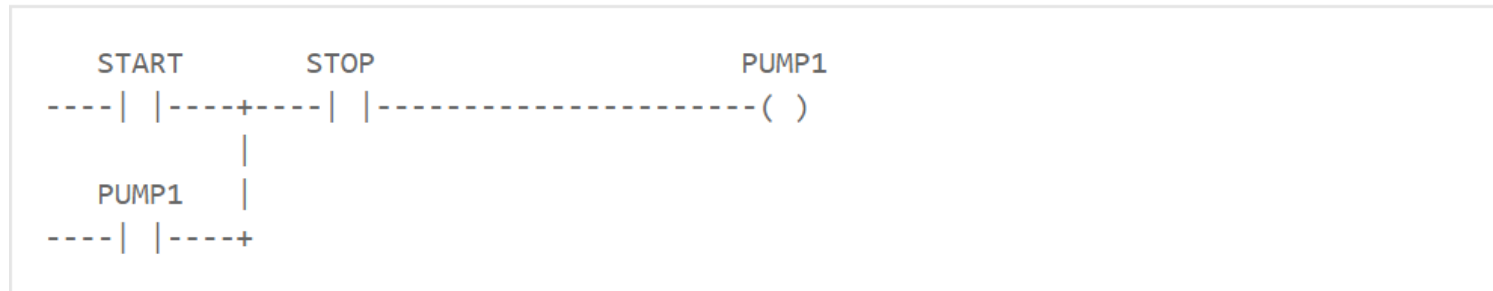
Programming Concepts in PLC & SCADA

❑ Interlocking:

An **interlock** is a feature that makes the state of two mechanisms or functions mutually dependent. It may be used to prevent undesired states in a finite-state machine, and may consist of any electrical, electronic, or mechanical devices or systems.

In case of PLC it can explained as:

Interlocks are conditions that must be TRUE in order for a particular output to be allowed to be energize.



Programming Concepts in PLC & SCADA

❑ Latching:

PLC Latching function is a self-maintaining circuit in that, after being energized, it maintains that state until another input is received.

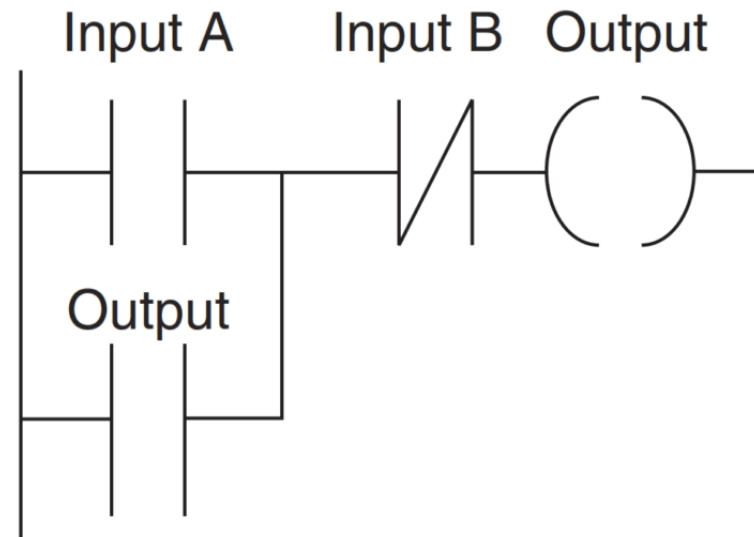


Figure1.18: Latched circuit

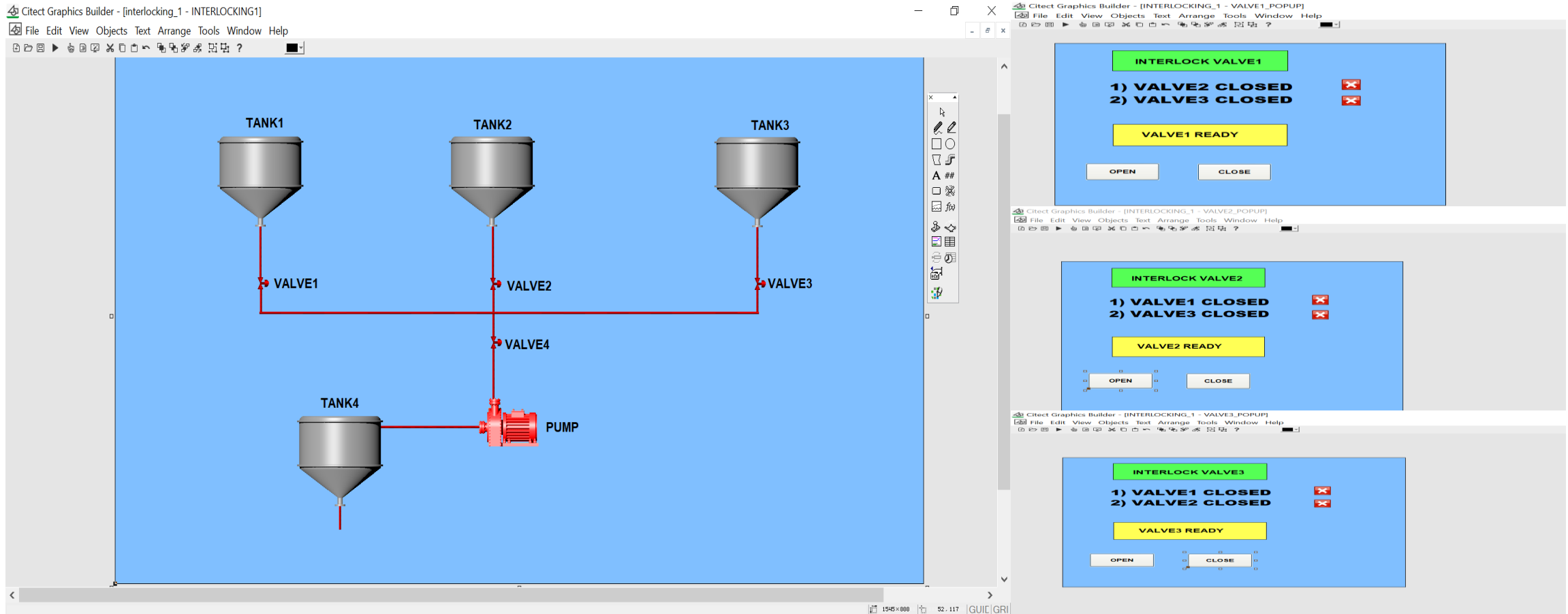
Control Expert and Delta WPLSoft

Control Expert: EcoStruxure Control Expert (formerly known as Unity Pro) is a unique software platform to increase design productivity and performance of your Modicon M340, M580, Momentum, Premium, Quantum and Quantum Safety applications. It is a Schneider Electric based tool used for PLC programming.

Delta WPLSoft: It is a Delta based software used for PLC Programming as an Industrial Automation tool.

One of the common projects that we did was Controlling the level of Tank using overhead tanks with interlocking condition of

Citect Studio and Graphics Builder



PLC Example in Control Expert

The image displays two software interfaces used for PLC programming and monitoring.

EcoStruxure Control Expert (Left Window): This window shows a project titled "INTERLOCKING_FIRST_PROJECT - [MyFirstProgram : [MAST]]". The left sidebar contains a "Project Browser" with a tree view showing the project structure, including "Configuration", "Derived Data Types", "Variables & FB instances", "Communication", "Programs", and "Tasks". The main area displays a ladder logic diagram with 15 rungs. Rungs 1-4 are labeled "valve 1 ready to open condition", "valve 2 ready to open condition", "valve 3 ready to open condition", and "valve 4 ready to open condition" respectively. Rungs 5-8 are labeled "valve 1 ready to open condition", "valve 2 ready to open condition", "valve 3 ready to open condition", and "valve 4 ready to open condition" respectively. Rungs 9-12 are labeled "valve 1 ready to open condition", "valve 2 ready to open condition", "valve 3 ready to open condition", and "valve 4 ready to open condition" respectively. Rung 13 is labeled "pump start condition". Rung 14 is labeled "COMPARE TANK4". Rung 15 is labeled "TANK4_LEVEL_SP_C...".

Citestudio (Right Window): This window shows the "System Model" tab for the project "INTERLOCKING_1 [Active Project]". The "Variables" table lists the following variables:

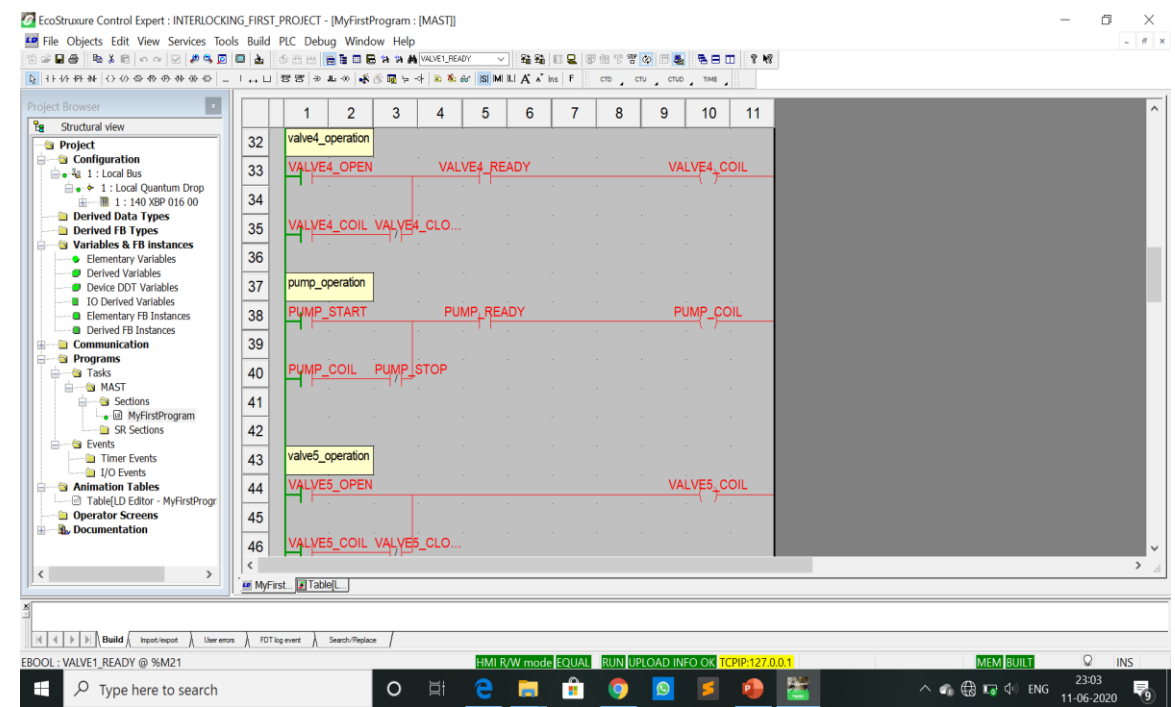
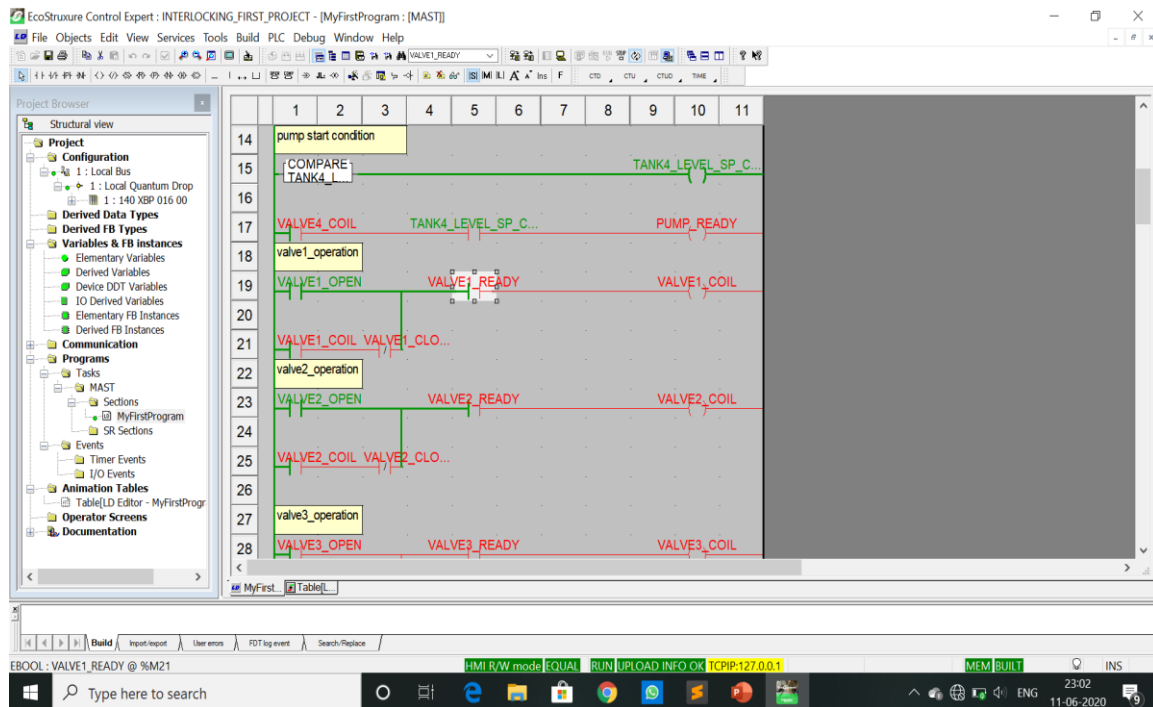
Row	Equipment	Item Name	Tag Name	Cluster Name	I/O Device	Data Type	Address	Comment
1	PUMP_READY		PUMP_READY	Cluster1	IODev	DIGITAL	000012	
2	PUMP_START		PUMP_START	Cluster1	IODev	DIGITAL	000011	
3	PUMP_STOP		PUMP_STOP	Cluster1	IODev	DIGITAL	000026	
4	TANK4_LEVEL		TANK4_LEVEL	Cluster1	IODev	REAL	400001	
5	PUMP_COIL		PUMP_COIL	Cluster1	IODev	DIGITAL	000046	
6	TANK4_LEVEL_SP		TANK4_LEVEL_SF	Cluster1	IODev	REAL	400003	
7	TANK4_LEVEL_SP		TANK4_LEVEL_SF	Cluster1	IODev	DIGITAL	000047	
8	VALVE1_CLOSE		VALVE1_CLOSE	Cluster1	IODev	DIGITAL	000002	
9	VALVE1_COIL		VALVE1_COIL	Cluster1	IODev	DIGITAL	000041	
10	VALVE1_OPEN		VALVE1_OPEN	Cluster1	IODev	DIGITAL	000001	
11	VALVE1_READY		VALVE1_READY	Cluster1	IODev	DIGITAL	000021	

The "Compile Messages" section shows "Not Compiled". The "Equipment" section shows "VALVE1_CLOSE". The "General" section shows "Tag Name: VALVE1_CLOSE", "Cluster Name: Cluster1", "I/O Device: IODev", "Data Type: DIGITAL", "Address: 000002", "Comment", and "Deadband".

The bottom status bar shows "EBOOL : VALVE1_READY @ %M21", "HMI R/W mode EQUAL", "RUN UPLOAD INFO OK", "TCPIP:127.0.0.1", "MEM BUILT", and "INS". The system clock shows "23:02 11-06-2020".

PLC Example in Control Expert

The interlocking condition applied in this automated system is out of the 3 valves one operates only when other two tanks are closed. And if any of the valve for these 3 opens then valve for Tank 4 opens.



Sewage Treatment Plant



Sewage treatment plants in a city are as important as kidneys in a human. They are very much essential to properly deal with waste before releasing into lands & rivers; because eventually, we are the ones who'll be facing all the consequences.

In India itself, the population is increasing at a rapid rate. The growing number of industries across the country has also led to the rise of sewage waste.

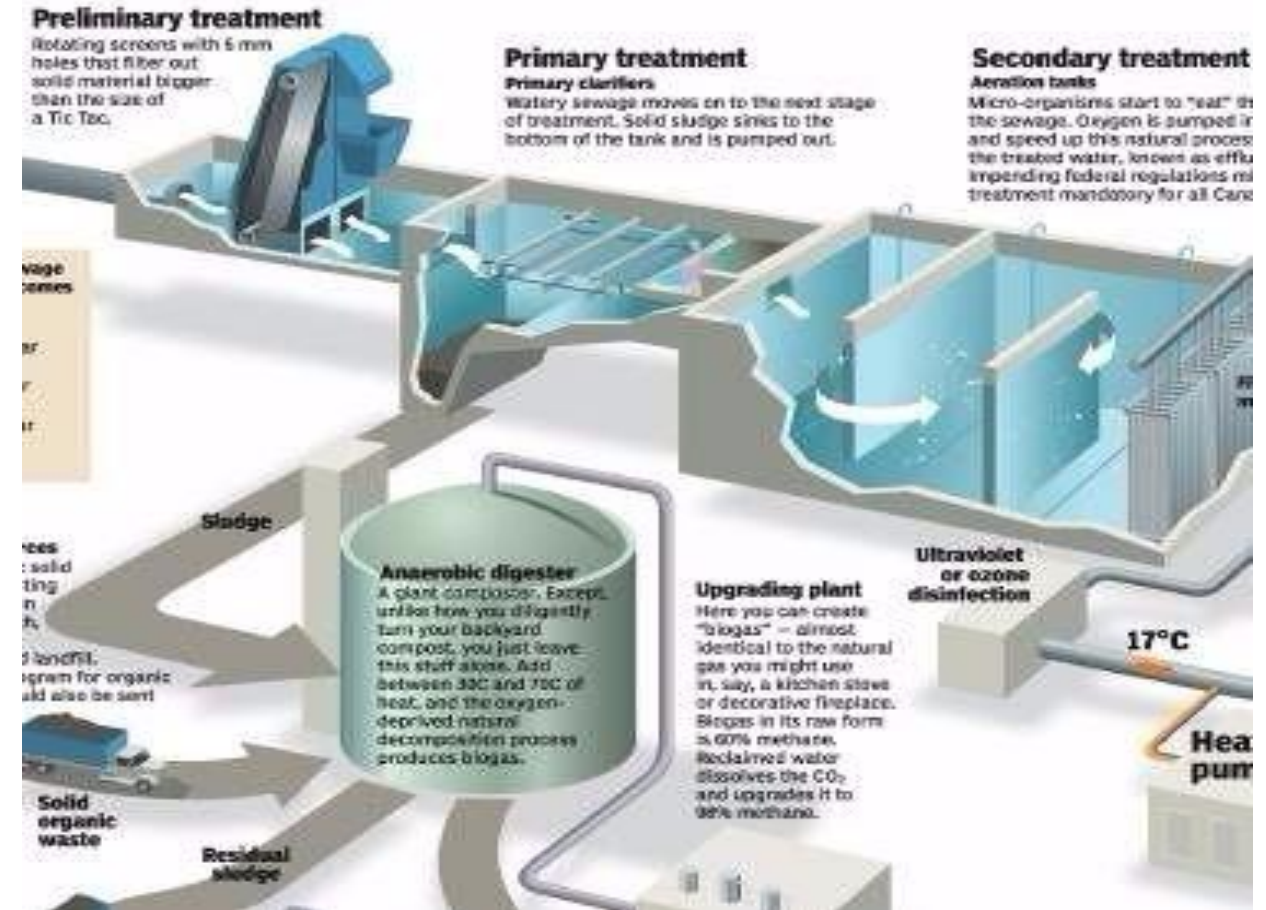
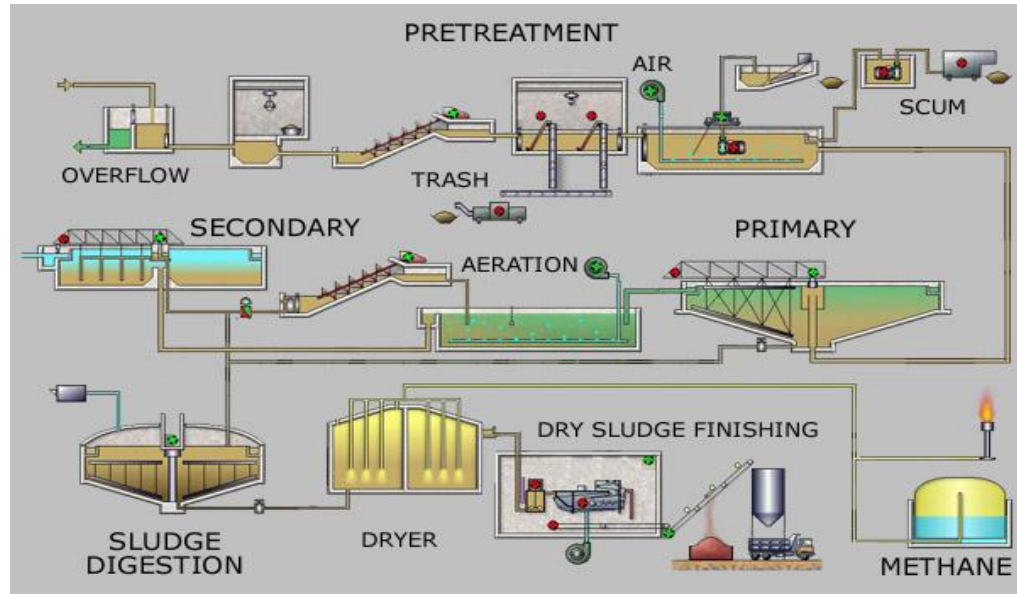
Through multiple processes, the harmful substances in the wastewater are removed and made good enough to be released to the environment. This includes physical, biological and chemical treatment of sewage. These processes occur in a dedicated facility called as the sewage treatment plant.

Different processes of Sewage Treatment Plant

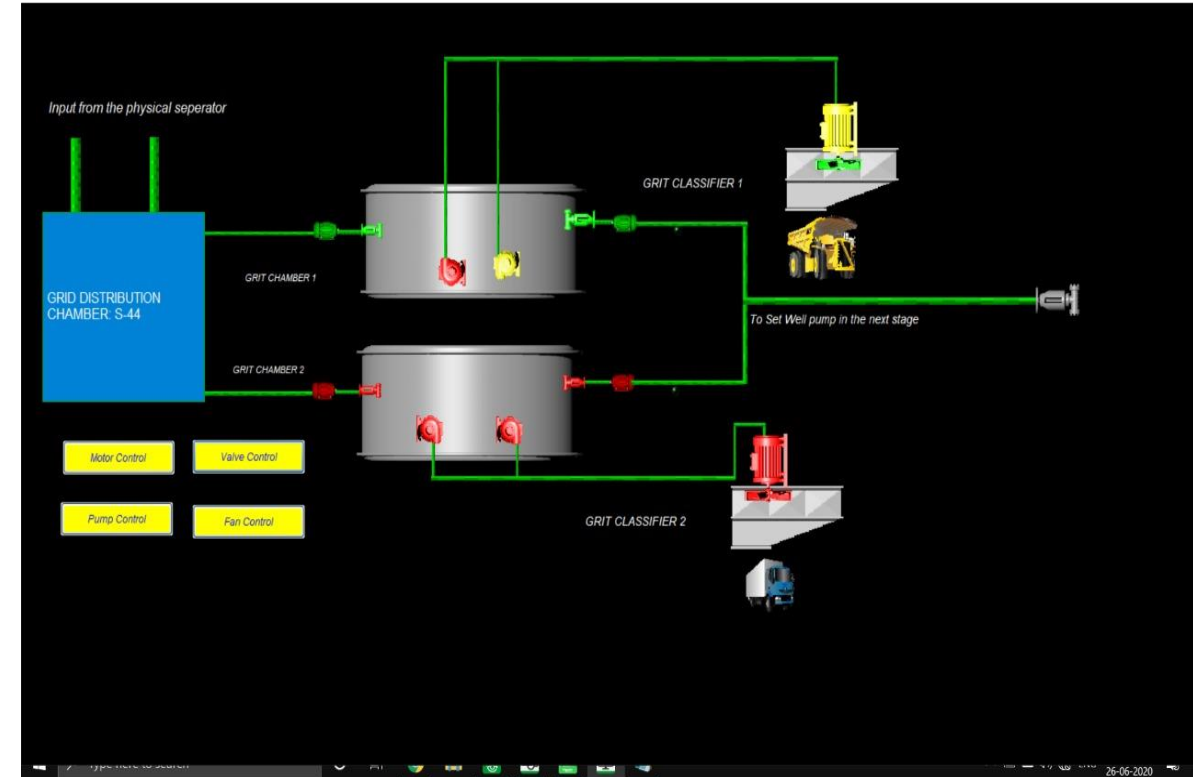
There are basically three different stages of treatment in the sewage treatment plant.

- **Primary Treatment** The primary treatment basically involves physical treatment like screening and oil & grease removal.
- **Secondary Treatment** The secondary treatment is a biological process where the major COD & BOD reduction takes place. The biological treatment provided in this plant is a Fluidized Aerobic Bioreactor which is an attached growth process. After the biological treatment there is a chlorination system also provided which helps in disinfection. Normally as per the pollution control norms the secondary treated sewage can be disposed into the drainage line without any problem.
- **Tertiary Treatment** In the tertiary treatment there are filters (DMF & ACF) provided to polish the treated sewage to the extent of reuse. Here the BOD & COD levels are further brought down so that the treated water can be now reused. This tertiary treated water can be reused in various applications like Car wash, Gardening, Cooling tower, etc. This water can also be recycled if required to further treat and use in other process applications.

Schematic Diagram of Treatment stages



Here is what our project looks like on implementation of the actual one.



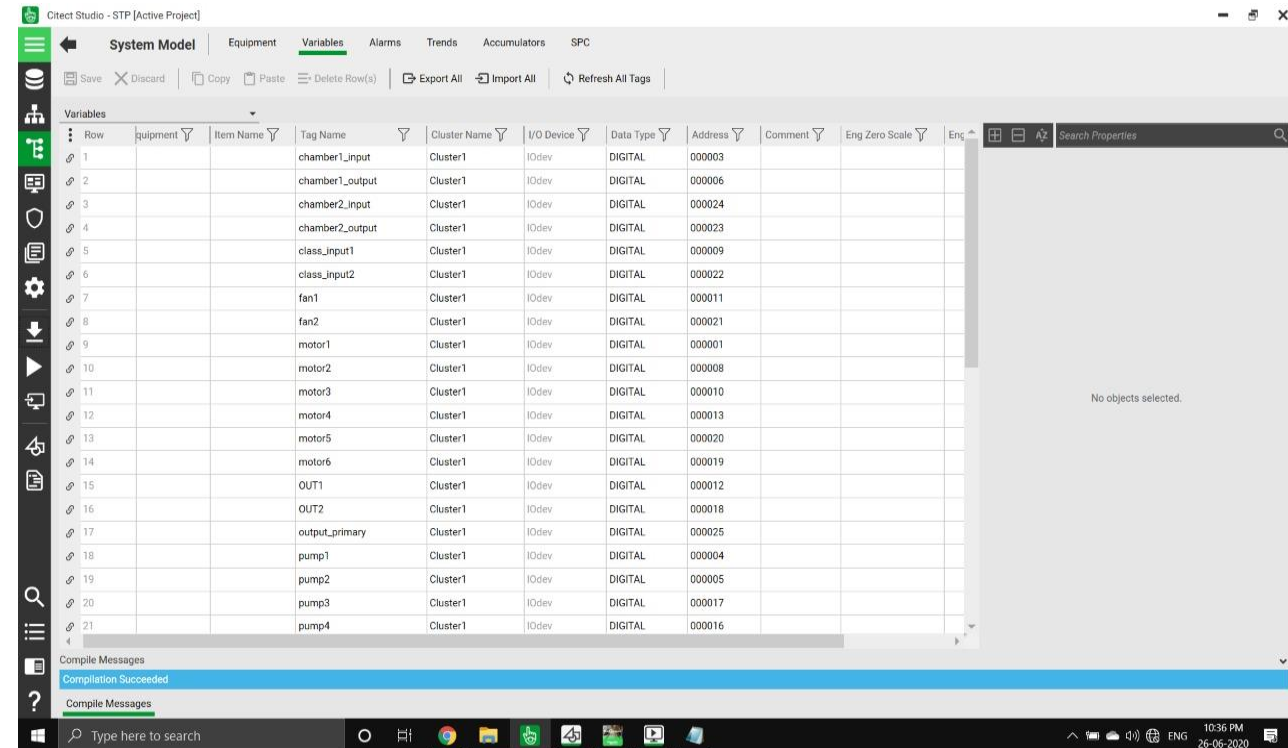
Project Implementation

Here is the Citect Software Implementation of popups.



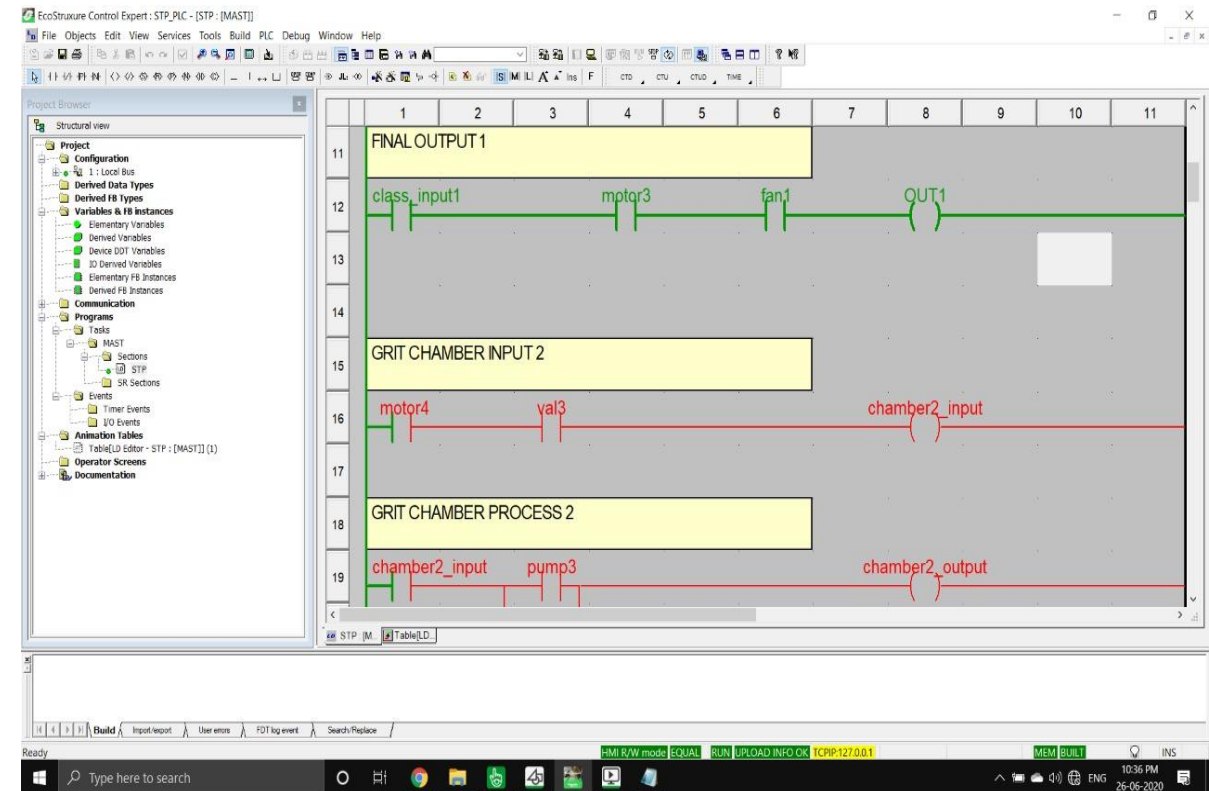
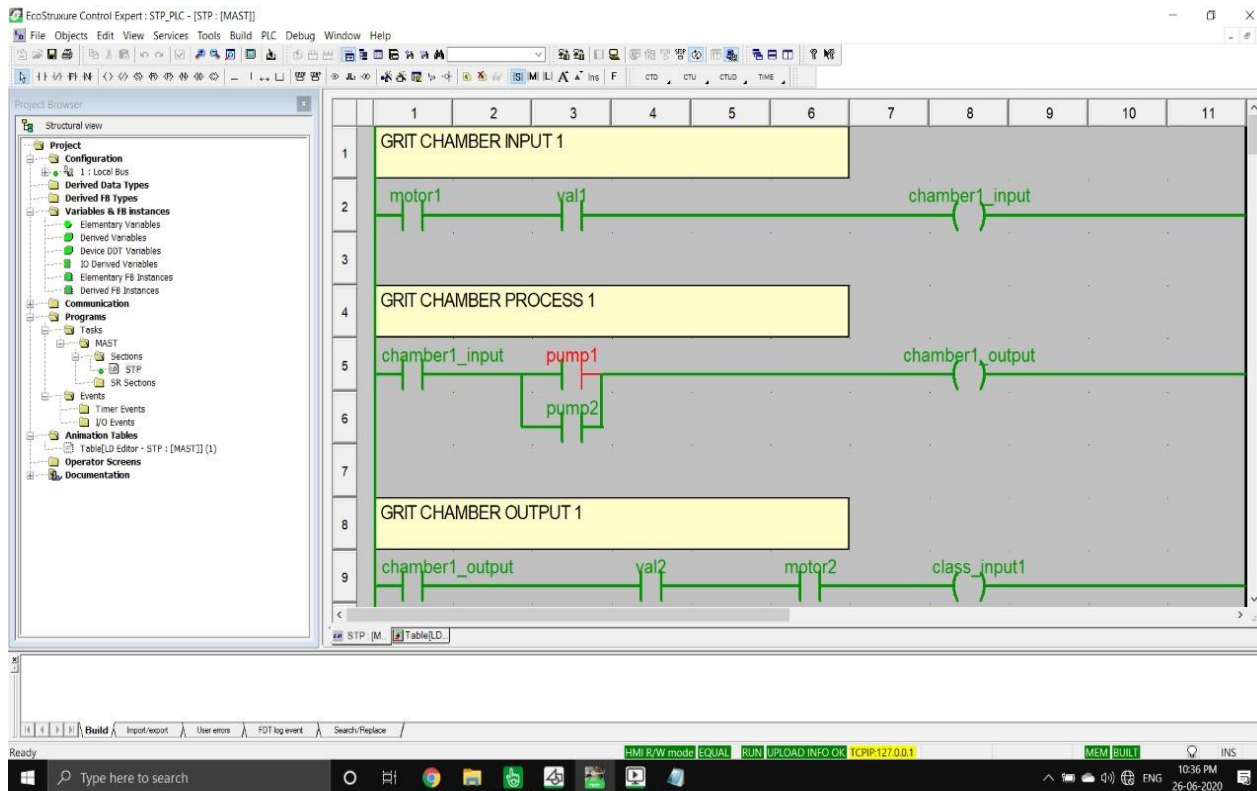
Project Implementation

Here are Citect Studio Implementations of the project.



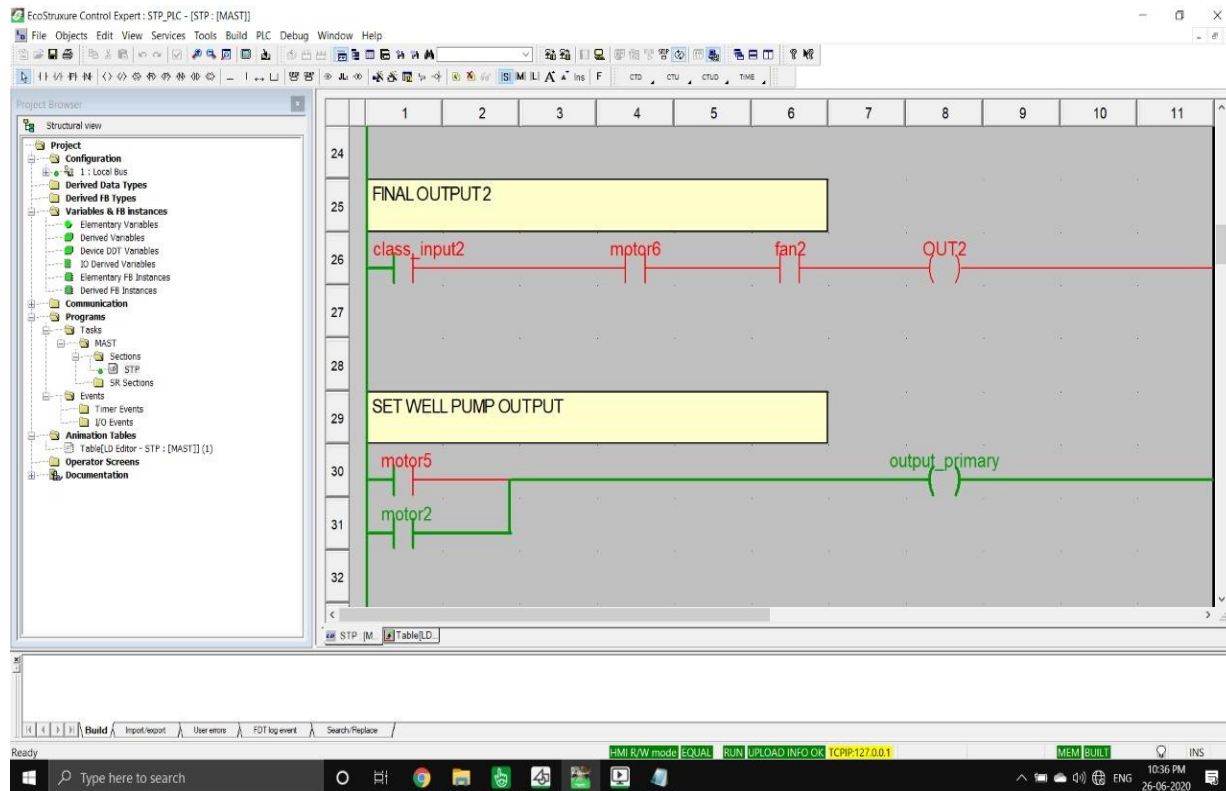
Project Implementation

Here is the PLC Programming of Project on Control Expert



Project Implementation

Here is the PLC Programming of Project on Control Expert



The screenshot displays the EcoStruxure Control Expert software interface, specifically the variable declaration table. The table lists various variables and their types, including 'val4', 'val3', 'val2', 'val1', 'pump4', 'pump3', 'pump2', 'pump1', 'output_primary', 'OUT2', 'OUT1', 'motor6', 'motor5', 'motor4', 'motor3', 'motor2', 'motor1', 'fan2', 'fan1', 'class_input2', 'class_input1', 'chamber2_output', 'chamber2_input', 'chamber1_output', and 'chamber1_input'. The table also includes columns for 'Value', 'Type', and 'Comment'.

Name	Value	Type	Comment
val4	0	EBOOL	
val3	0	EBOOL	
val2	1	EBOOL	
val1	1	EBOOL	
pump4	0	EBOOL	
pump3	0	EBOOL	
pump2	1	EBOOL	
pump1	0	EBOOL	
output_primary	1	EBOOL	
OUT2	0	EBOOL	
OUT1	1	EBOOL	
motor6	0	EBOOL	
motor5	0	EBOOL	
motor4	0	EBOOL	
motor3	1	EBOOL	
motor2	1	EBOOL	
motor1	1	EBOOL	
fan2	0	EBOOL	
fan1	1	EBOOL	
class_input2	0	EBOOL	
class_input1	1	EBOOL	
chamber2_output	0	EBOOL	
chamber2_input	0	EBOOL	
chamber1_output	1	EBOOL	
chamber1_input	1	EBOOL	

Thank You

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