AUTOMATION CONTROL LAB

INDUSTRIAL LEVEL CONTROL & BATCH PROCESS REACTOR SYSTEM

STUDENT MANUAL

DesignTech
Technology for designing the future
GTTC
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AUTOMATION CONTROL LAB

In this lab we use different types of Automation and control techniques, we will work on the different applications according to real-time industry scenarios. Understand the role of programmable logic controllers in complex mechatronic systems, modules, and subsystems.

The list of courses offered,

S.No	Name of the Course	Duration
1	Basics of PLC	50 Hours
2	Basic SCADA	50 Hours
3	Industrial Level control and Batch Process Reactor System	30 Hours
4	Process Instrumentation Technology	30 Hours
5	Advance Process Control Techniques	40 Hours
6	Advanced Industrial Electro-Pneumatic System	40 Hours
7	Industrial Electro-Hydraulic System	40 Hours

AUTOMATION CONTROL LAB

INDUTRIAL LEVEL CONTROL AND BATCH PROCESS REACTOR SYSTEMS

PLC based level control and batch process reactor systems offered in Automation Control Lab. In this course you will be learning about kit component like solenoid valve, level sensor, relays, sensors and electrical switches etc., also you will learn about basic programming of logo PLC. You will learn how to read electrical drawings, sensor connection with PLC etc.

S. No	Name of the Course	Duration
1	Industrial Level control and Batch Process ReactorSystem	30 Hours

Hardware equipped

PLC based Water Level control

kit Batch process reactor systems

LOGO PLC

Software: -

LOGOsoft Comfort

Preface

It gives us an immense pleasure to interact with us via this guide. DesignTech believes in Quality at each stage. This guide shares Knowledge on Industrial LevelControl and Batch Process Reactor System. It gives idea to students how to make level control and batch process systems. How to use PLC and its programming software and Give idea about all electrical connection P&I Diagram and All components in the systems.

All your suggestions and comments are most valuable for building this guidefurther.

List of content: -

Course Objectives:

Post successful completion

Industrial Level Control and Batch Process Reactor System Course, the participant should be able to

- Understand Logo PLC basics
- Understand different blocks used in logo PLC
- Understand Industrial Level Control with real time hardware
- Understand Batch Process Reactor System
- Perform Different Example with logo PLC simulation Software.
- Understand electrical and wiring diagram
- Understand P&I diagram

Logic Controller Overview

Communication with LOGO! modules bythe Siemens company

Logical modules LOGO! are suitable for both industrial usage and BMS systems. Examples of usage:

- Simple monitoring and control
- Building automation
- Remote monitoring and controlof smaller machines
- Basic energy monitoring
- Location monitoring forlogistics applications
- And many others

Communication with LOGO! 8 logical modules

The LOGO! 8 module (OBA8) supports Ethernet communication by the S7 protocol.For this communication in the PROMOTIC system can be used: **PmS7 - Driver forcommunication by the S7-TCP/IP protocol**

For easy integration of this driver into the application it is handy to use:

- Reconfiguration "PmS7 - LOGO! 8 - Ethernet - Communication set with data and panel"

Settings S7 protocol parameters for LOGO! 8:

- Communication type = Ethernet ISO on TCP Standard
- Max. PDU length = 960
- Rack = 0
- CPU Slot = 1
- Connection type = 2 = OP-connection

Notes concerning definition of variable address (definition of Item ID):

- The addresses in LOGO! modules start from 1, but in the S7 protocol addresses start from 0.
- Values in data areas (e.g. in I, Q, M areas, etc.) are of the Bit type, but in the S7 protocol these are of the Byte type

(i.e. 8 LOGO! values can "fit into" a single S7 value). Therefore, it is necessary to recount the LOGO! addresses when entering into S7 addresses. Example:

M1 -> M0.0
M8 -> M0.7
M9 -> M1.0

Logo PLC Expansion Module

Connecting an expansion module to LOGO! Basic

LOGO! Basic	Expansion modules					
	DM 8 12/24R	DM 8 24	DM 8 24R	DM 8 230R	AM2/ AM2 PT100	CM
LOGO! 12/24 RC	x	x	x	–	x	x
LOGO! 24	x	x	x	–	x	x
LOGO! 24 RC	x	x	x	–	x	x
LOGO! 230 RC	–	–	–	x	x	x
LOGO! 12/24RCo	x	x	x	–	x	x
LOGO! 24o	x	x	x	–	x	x
LOGO! 24 RCo	x	x	x	–	x	x
LOGO! 230 RCo	–	–	–	x	x	x

Basic Unit

LOGO!8 – basic units				
Siemens Part Code	RS stock number	Description	Display	**Picture**
6ED1052-1MD00-0BA8	825-1644	LOGO! 12/24RCE	yes	
6ED1052-2MD00-0BA8	825-1647	LOGO! 12/24RCEo	no	
6ED1052-1HB00-0BA8	825-1653	LOGO! 24RCE	yes	
6ED1052-2HB00-0BA8	825-1657	LOGO! 24RCEo	no	
6ED1052-1CC01-0BA8	825-1666	LOGO! 24CE	yes	
6ED1052-2CC01-0BA8	825-1669	LOGO! 24CEo	no	
6ED1052-1FB00-0BA8	825-1641	LOGO! 230RCE	yes	
6ED1052-2FB00-0BA8	**825-1650**	**LOGO! 230RCEo**	**no**	

A complete range of logic modules

- 8 basic units for all voltages, with or without display
- All units come with an Ethernet interface and connections are compatible with previous versions
- Integrated web server in all basic units
- Display features a new look and feel

LOGO! 8 – digital modules

Siemens Part Code	RS stock number	Description	I/O	Picture
6ED1055-1MB00-0BA2	825-1681	LOGO! DM8 12/24R	4/4 relays	
6ED1055-1CB00-0BA2	825-1663	LOGO! DM8 24	4/4 transistors	
6ED1055-1CB10-0BA2	825-1672	LOGO! DM16 24	8/8 transistors	
6ED1055-1HB00-0BA2	825-1688	LOGO! DM8 24R	4/4 relays	
6ED1055-1NB10-0BA2	825-1685	LOGO! DM16 24R	8/8 relays	
6ED1055-1FB00-0BA2	825-1675	LOGO! DM8 230R	4/4 relays	
6ED1055-1FB10-0BA2	**825-1679**	**LOGO! DM16 230R**	**8/8 relays**	

Seven digital expansion modules

- Digital outputs increased to 20

Logo PLC Expansion Module

LOGO! 8 – analogue modules

Siemens Part Code	RS stock number	Description	Analogue I/O	Picture
6ED1055-1MA00-0BA2	825-1694	LOGO! AM2	2/0 0-10V - 0/4-20mA	
6ED1055-1MD00-0BA2	825-1697	LOGO! AM2 RTD	2/0 2xPT100 or PT1000 2-wire or 3-wire	
6ED1055-1MM00-0BA2	**825-1691**	**LOGO! AM2 AQ**	**0/2** **0-10V - 0/4-20mA**	

Three analogue expansion modules

- Analogue outputs increased to 8

Logo PLC Display

LOGO! 8 – text display / panels

Siemens Part Code	RS stock number	Description	Supply Voltage	Picture
6ED1055-4MH00-0BA1	825-1701	LOGO! TDE	12/24 V AC/DC	
6AV6647-0AH11-3AX0	746-5502	KP300 Basic mono	24V DC	
6AV2123-2DB03-0AX0	864-3967	KTP400 Basic	24V DC	
6AV2123-2GA03-0AX0	**872-6325**	**KTP700 Basic**	**24V DC**	

Displays to go with LOGO! 8

- From the new 6-line text display TDE with 16 characters per line to the 7” HMI panel with colored, high resolution display the range leaves no gaps

Logo PLC Communication Module

LOGO! 8 – communication modules

Siemens Part Code	RS stock number	Description	Comms ports/ wireless	Picture
6GK7177-1MA20-0AA0	848-6213	LOGO! CSM 12/24	4 x RJ45 jacks / -	
			1x RJ45 jack / SMS, GPRS, GSM	
6GK7142-7BX00-0AX0	**848-6219**	**LOGO! CMR2020**		

Remote communications via cellular phone network

- And completely new – text message communications for alerts and remote control via cell phone using the LOGO! CMRmodule
- Text messaging for active automatic alerts regarding system status
- Position recognition and tracking via GPS, e.g. for cost effectivecontainer tracking and position reporting via text message to acentral office
- CMR2020 can exchange data with LOGO! 8, send text messages independently, and read control commands fromtext messages, introduce them to LOGO! 8,
  and even synchronize to local time worldwide

Logo PLC Power Module

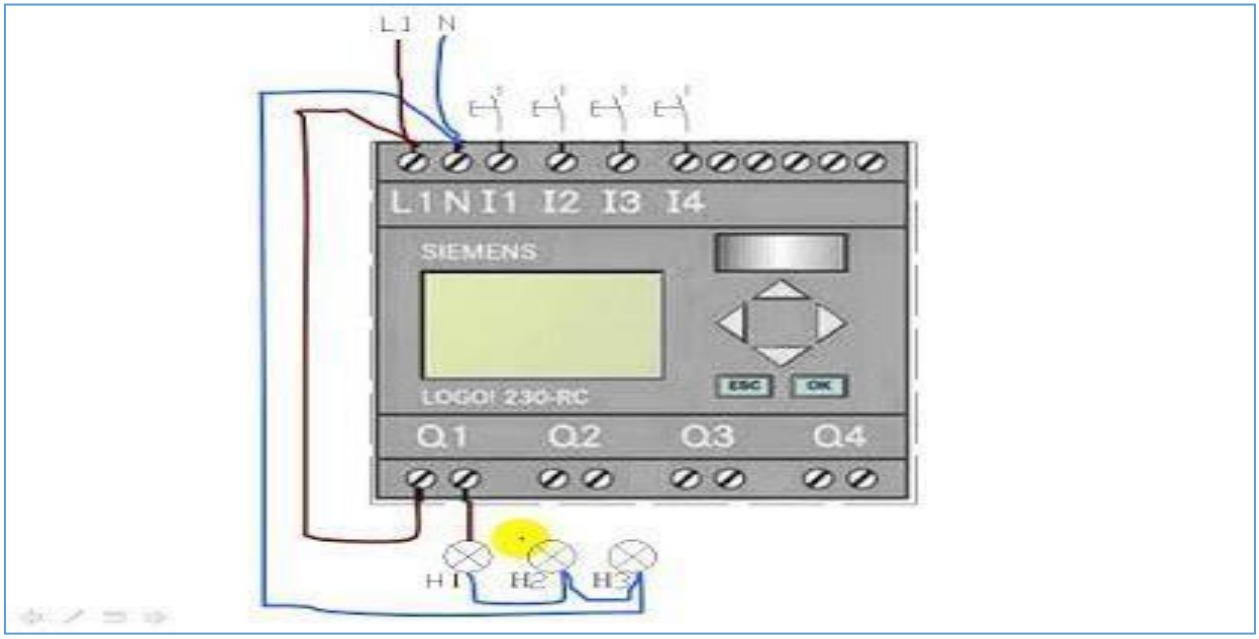
LOGO! Power			
Siemens Part Code	RS stocknumber	Description	**Picture**
6EP1321-1SH03	734-2705	LOGO! Power 12VDC/1,9A	
6EP1322-1SH03	734-2708	LOGO! Power 12VDC/4,5A	
6EP1331-1SH03	734-2714	LOGO! Power 24VDC/1,3A	
6EP1332-1SH43	734-2718	LOGO! Power 24VDC/2,5A	
6EP1332-1SH52	**734-2727**	**LOGO! Power 24VDC/4,0A**	

LOGOsoft comfort Software

LOGO! SOFT COMFORT V8			
Siemens Part Code	RS stocknumber	Description	**Picture**
6ED1058-0CA08-0YE1	825-1708	Upgrade	
6ED1058-0BA08-0YA1	**825-1704**	**License**	

This is the software for Logo PLC.

Wiring Diagram of LOGO PLC

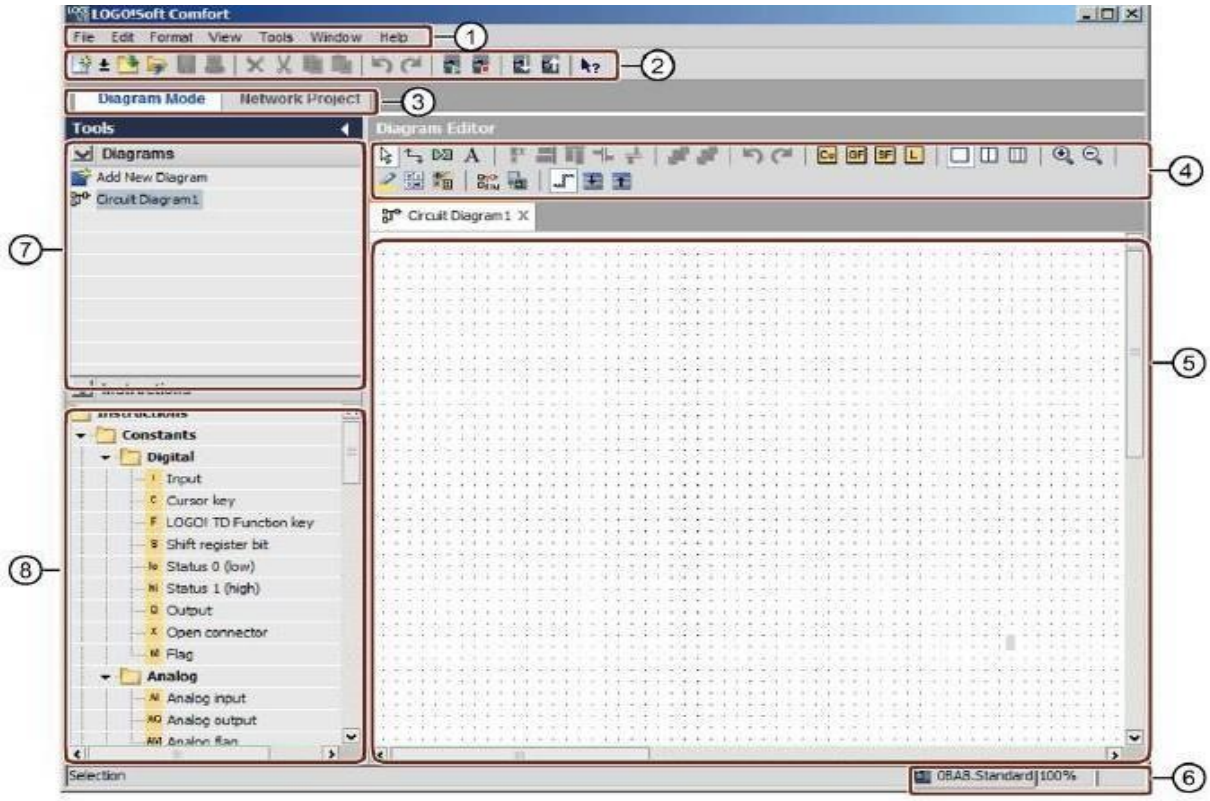


L1, N Power Supply

I1…. I4 Input

Q1…Q4 Output

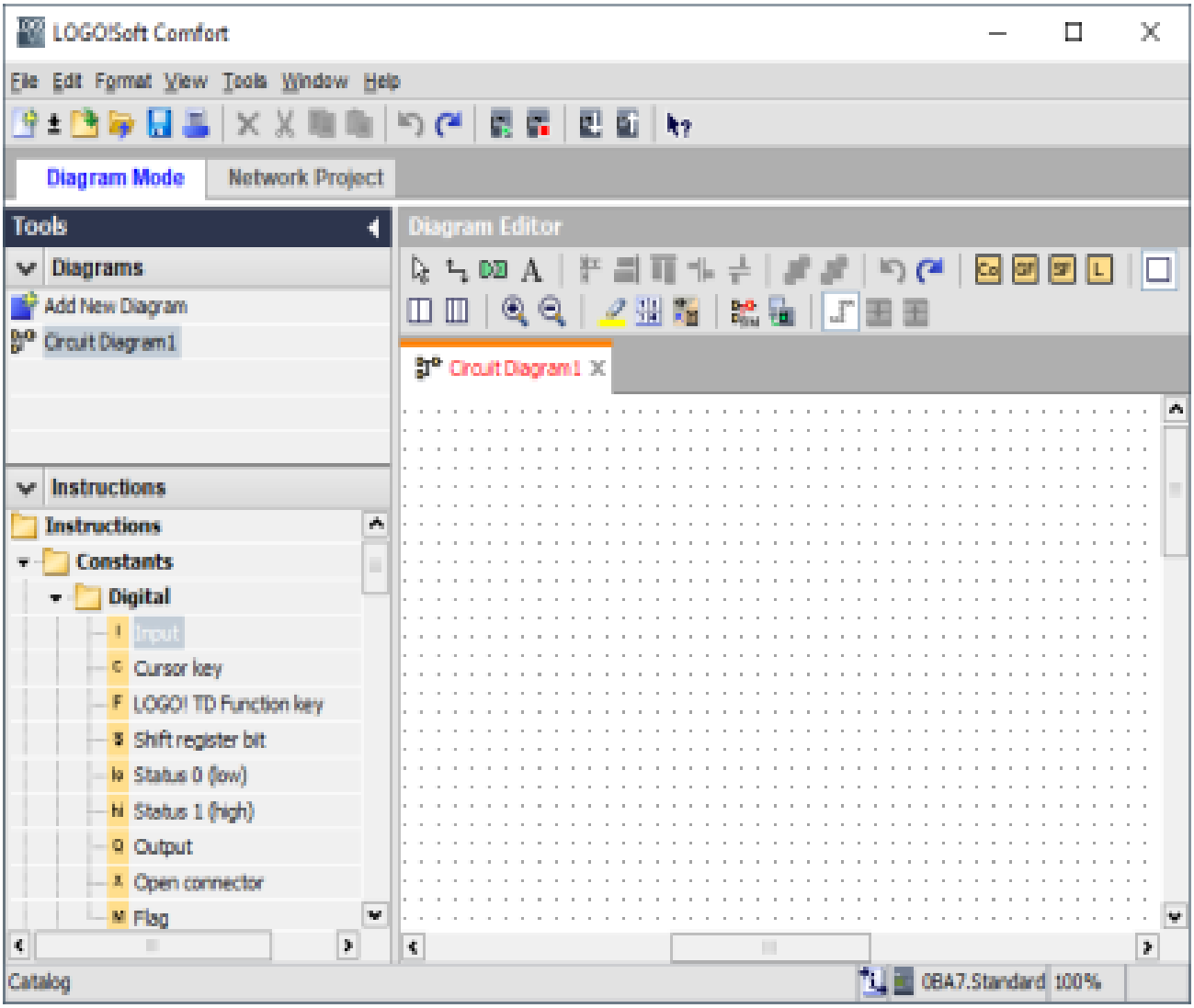
Programming Software LOGOSoft Comfort



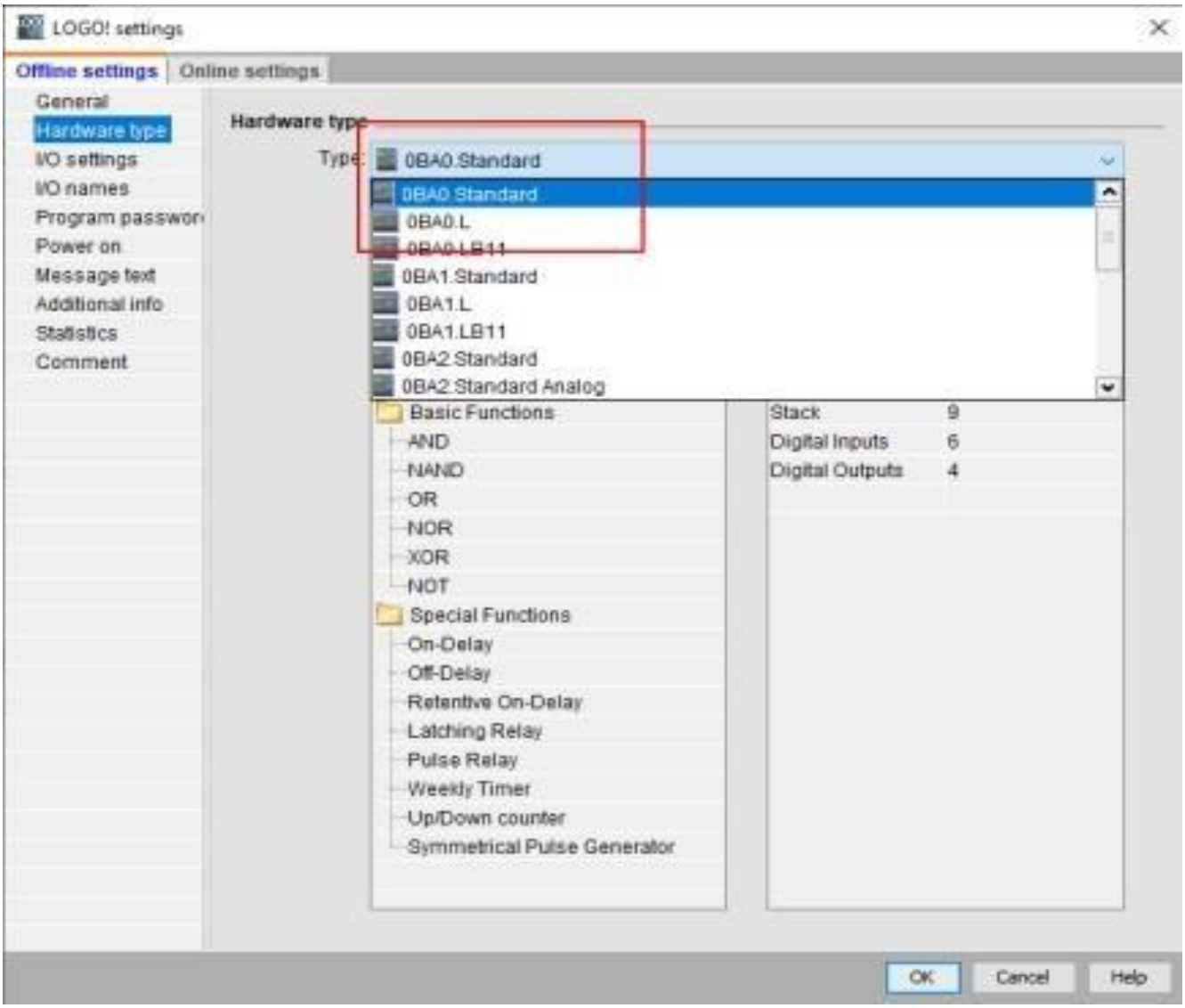
① Menu bar
② Standard toolbar
③ Mode bar
④ Programming toolbar
⑤ Programming interface
⑥ Status bar
⑦ Diagram tree
⑧ Instruction tree

① Menu bar
② Standard toolbar
③ Mode bar
④ Networking toolbar
⑤ Network view
⑥ Programming toolbar
⑦ Programming interface
⑧ Status bar
⑨ Device tree
⑩ Instruction tree

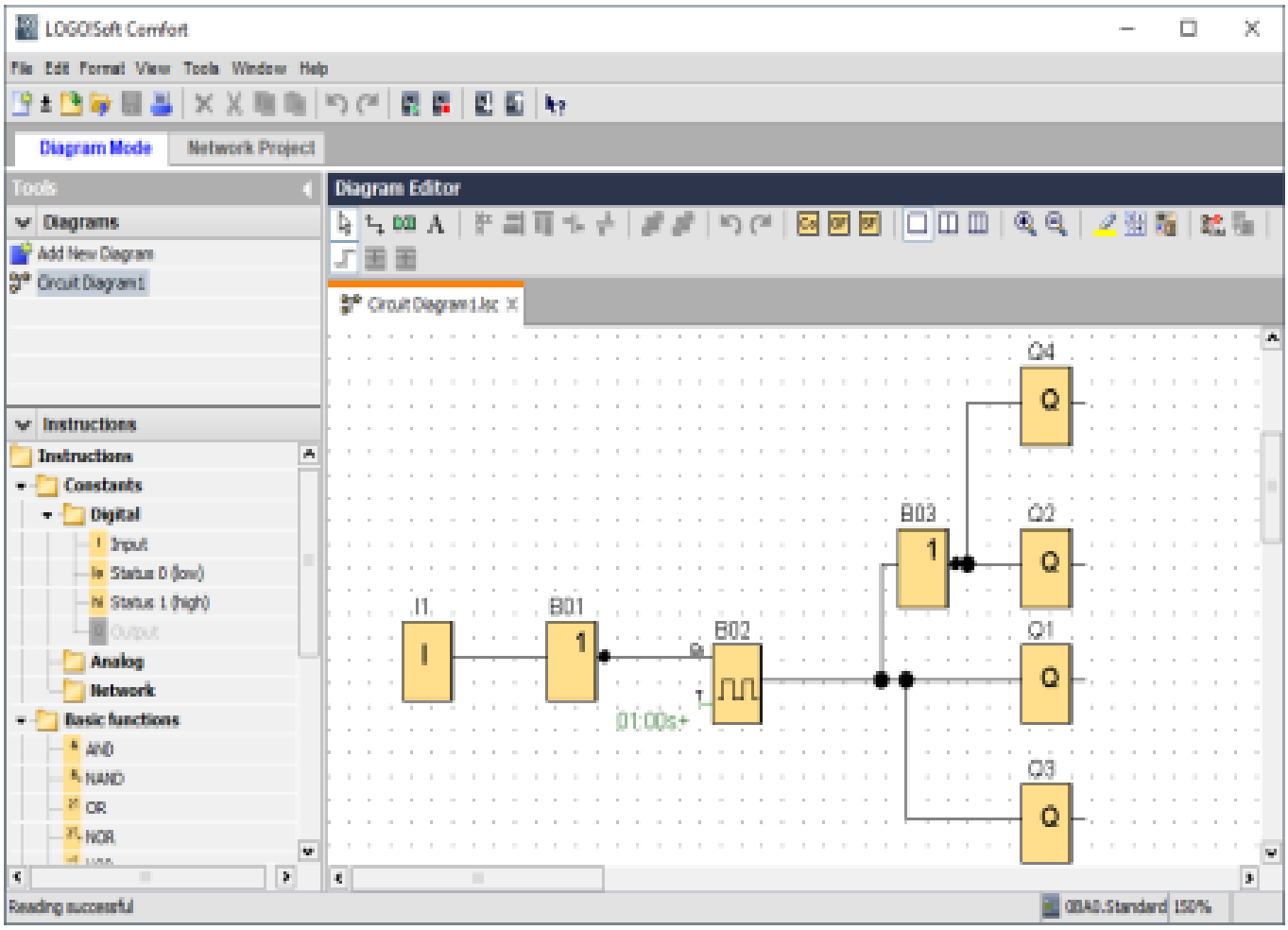
Work Area where we can do programming.



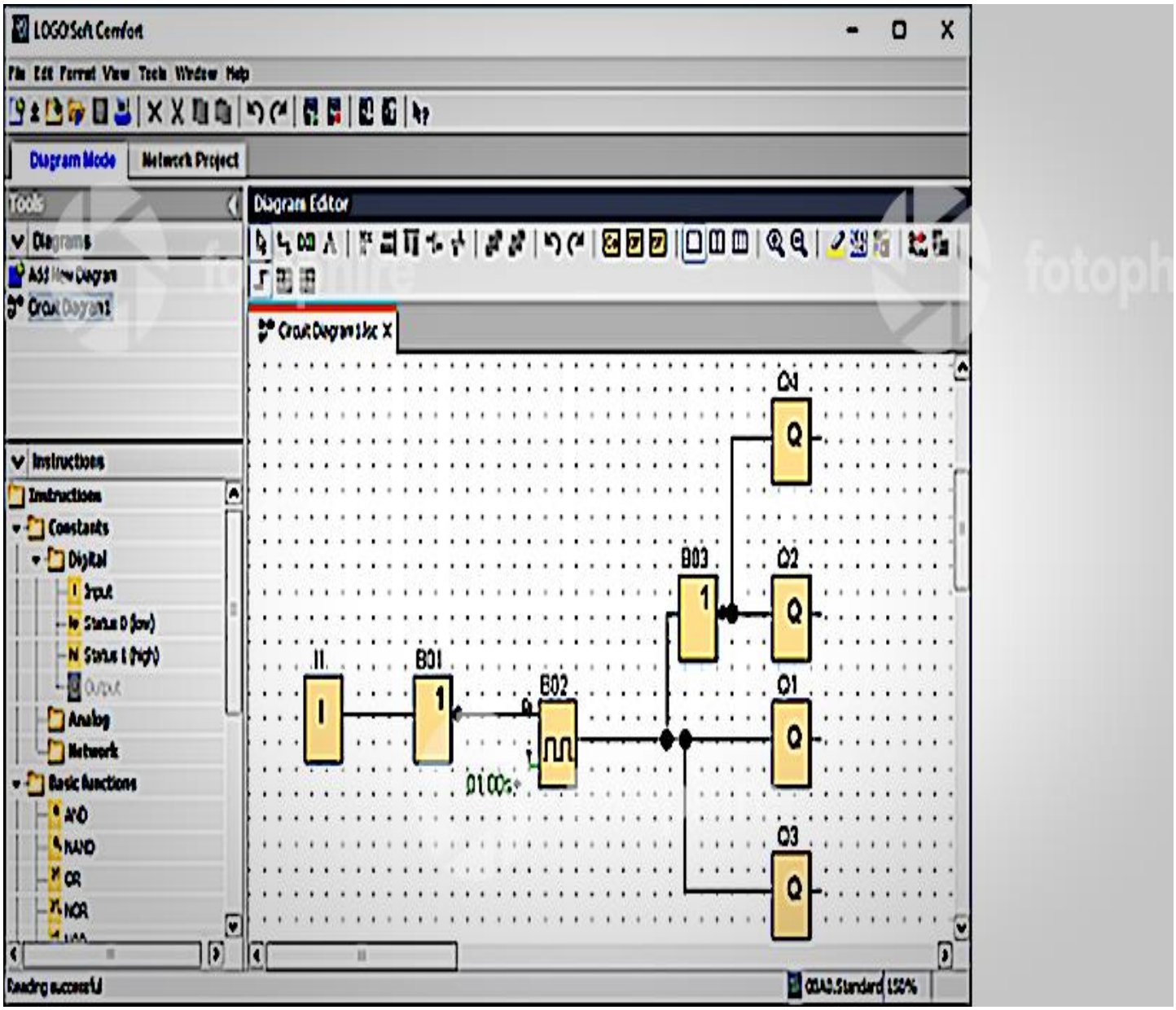
Hardware Selection



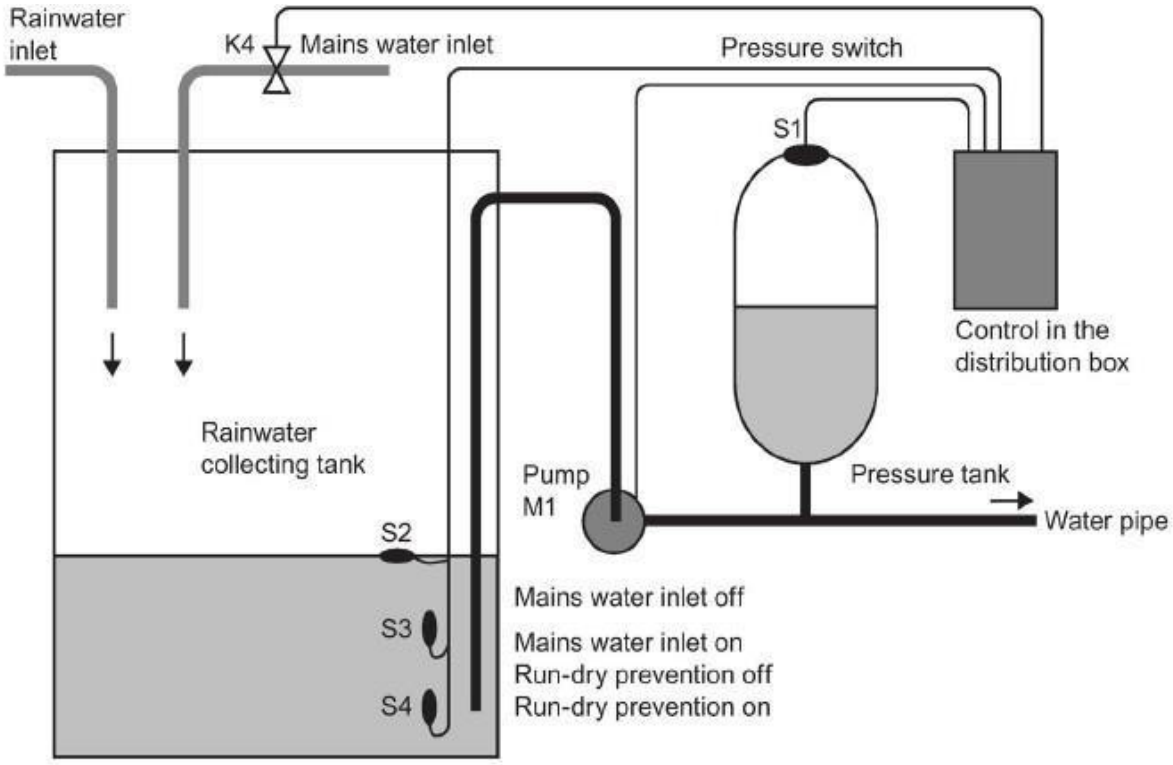
The Programming and connection with input and output of Logosoft comfort



Simulation mode for testing of programming.



Application Example.

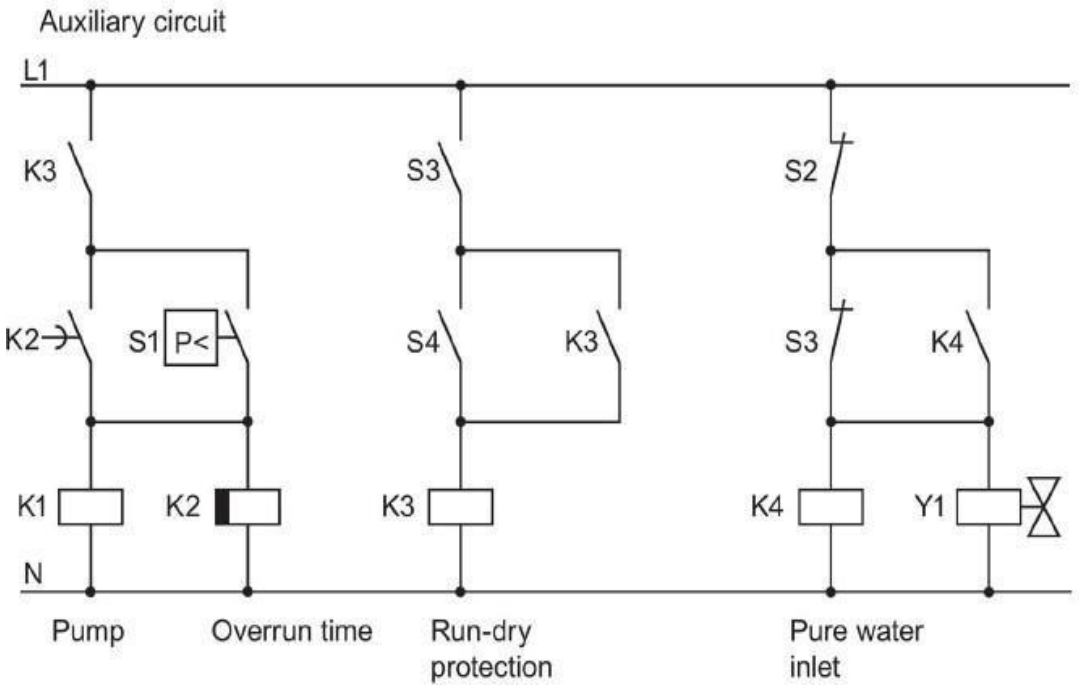


Requirements of the control system

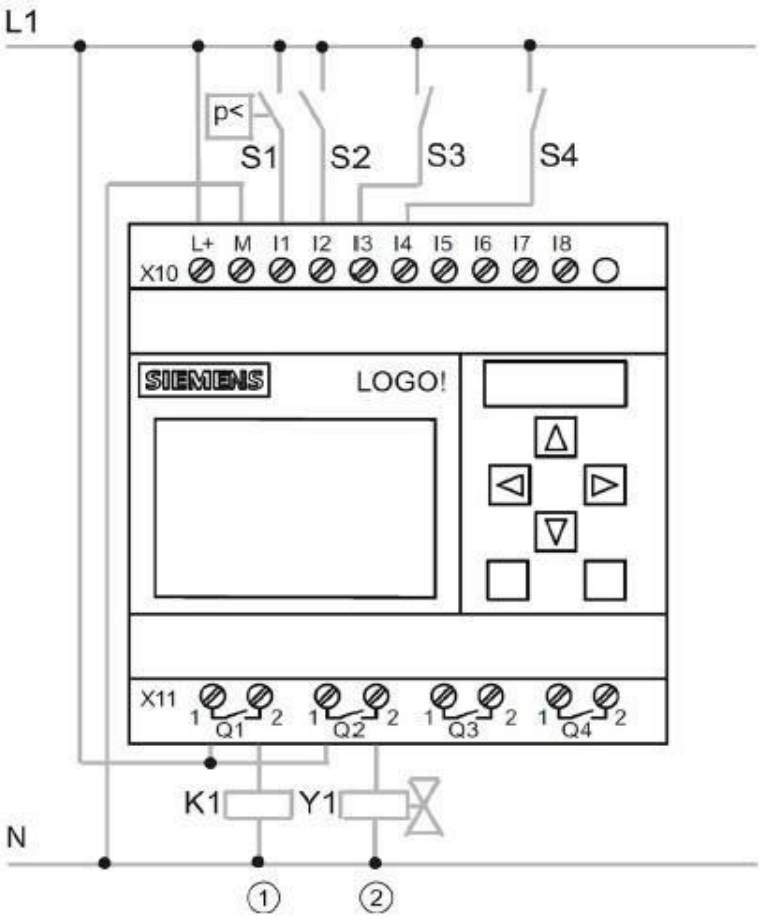
- Service water must be available at all times. An emergency control system must change over to drinking water supply, for example, if service water runs low.
- The ingress of service water into the drinking water network must be prevented when switching over to drinking water supply.
- The pump must be disabled if the service water reservoir runs low of water (dry-run protection).

Layout of the solution

The pump and a solenoid valve are controlled by a pressure switch and three float switches, which are installed in the service water reservoir. The pump must be switched on if the pressure in the reservoir drops below minimum. When the operating pressure is reached, the pump is switched off again after a tracking time of a few seconds. The tracking time prevents pump oscillation if water is tapped over an extended period.

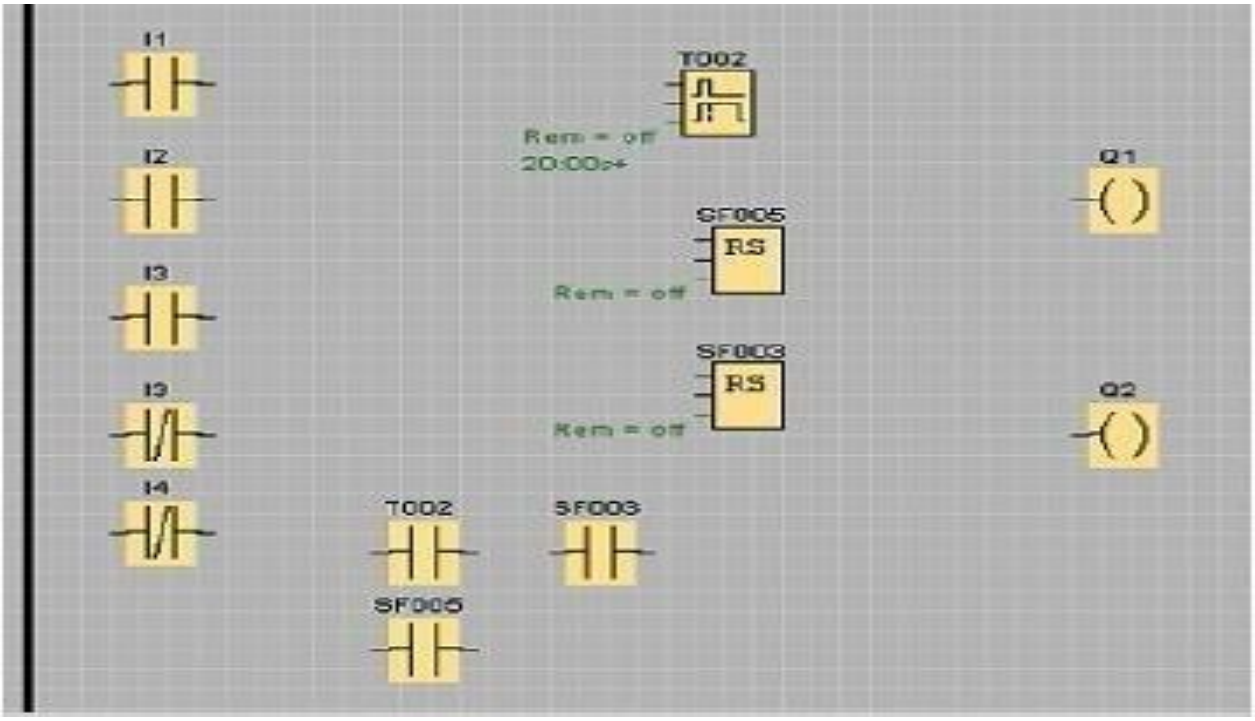


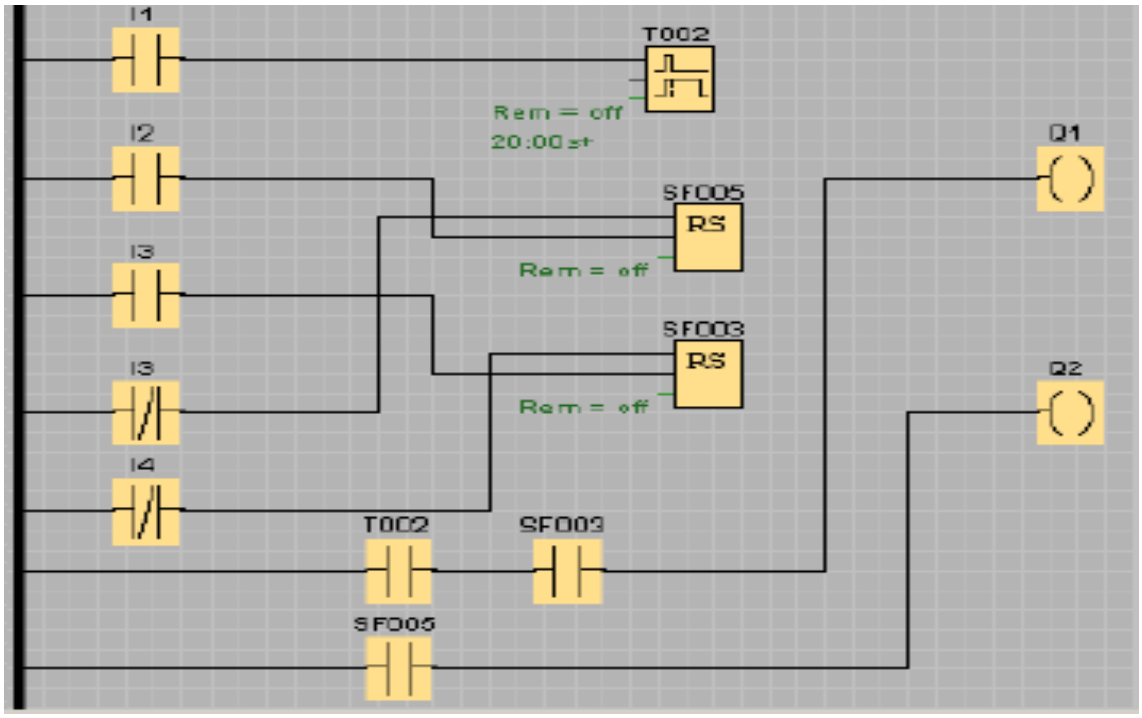
Connection diagram



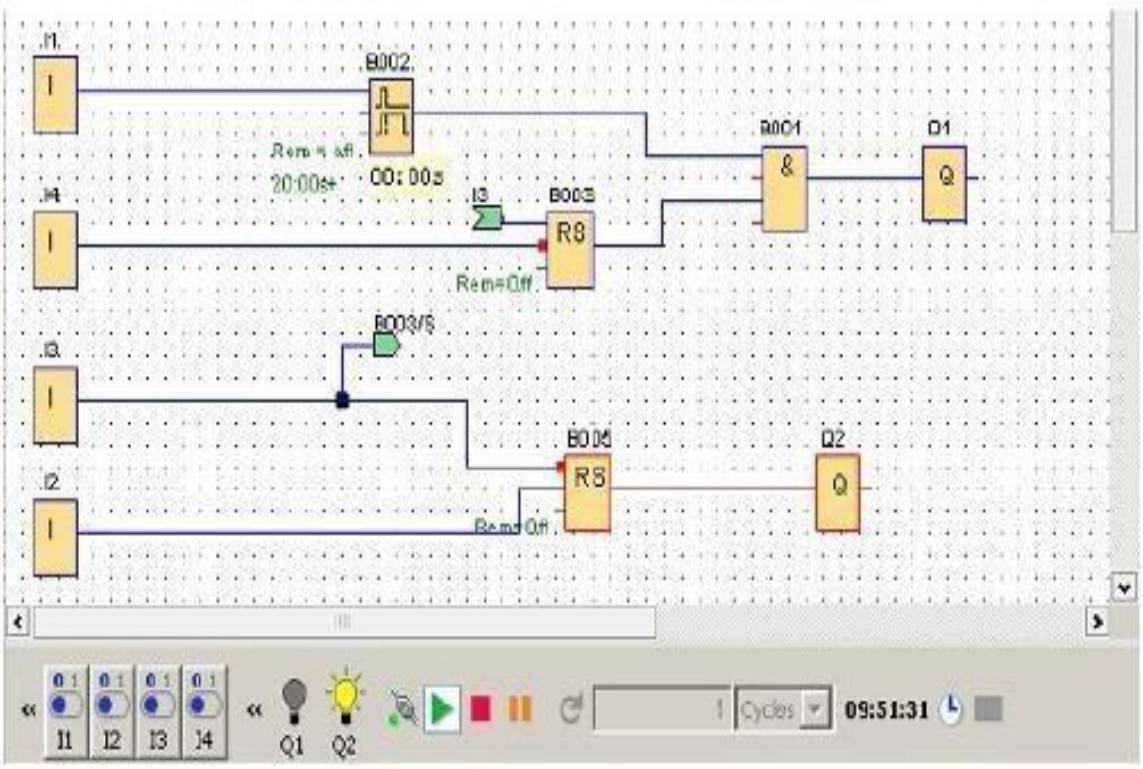
① Pump
② Mains water inlet

Programming




I1
T002
Rem = off
20.00 s
I2
Q1
SF005
RS
Rem = off
I3
SF003
RS
I3
Q2
Rem = off
I4
T002
SF003
SF005

Simulation of Application



Memory Concept in LOGOSoft comfort

Address Type:

- VB: variable byte memory
- DB.DBB: data block byte memory
- MB: flag byte memory
- IB: input byte memory
- QB: output byte memory

Local address + Data length - 1 ≤ 850

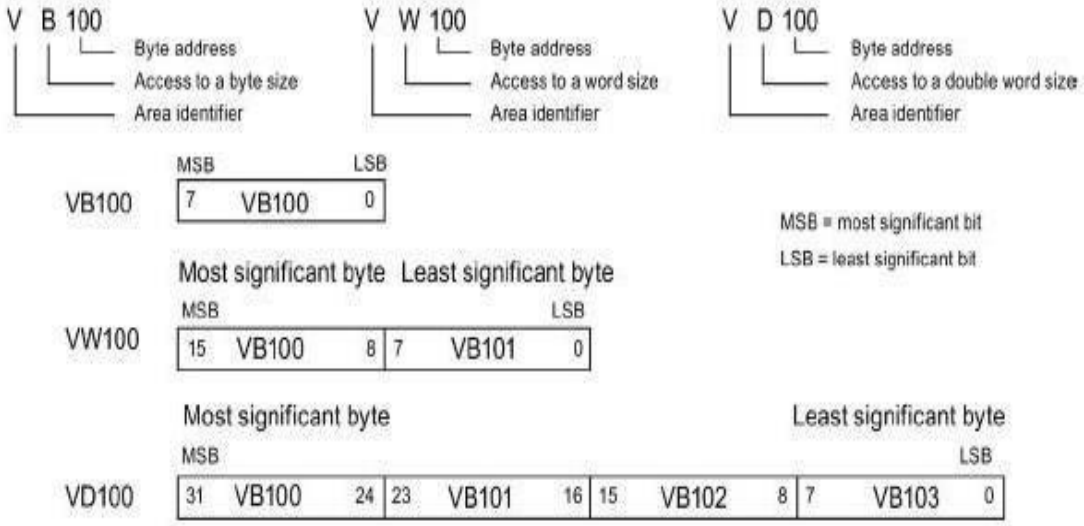
The table below describes the range and local address restrictions of client connection.

Write requests:

Local address (LOGO!)		**Remote address (S7 compatible device)**	
Address Type	Range	Address Type	Range
VB	0 to 850	VB	0 to 65535
MB	0 to 3	DB.DBB	DB[0,16000].DBB[0,65535]
IB	0 to 2	MB	0 to 65535
QB	0 to 1	IB	0 to 65535
		QB	0 to 65535

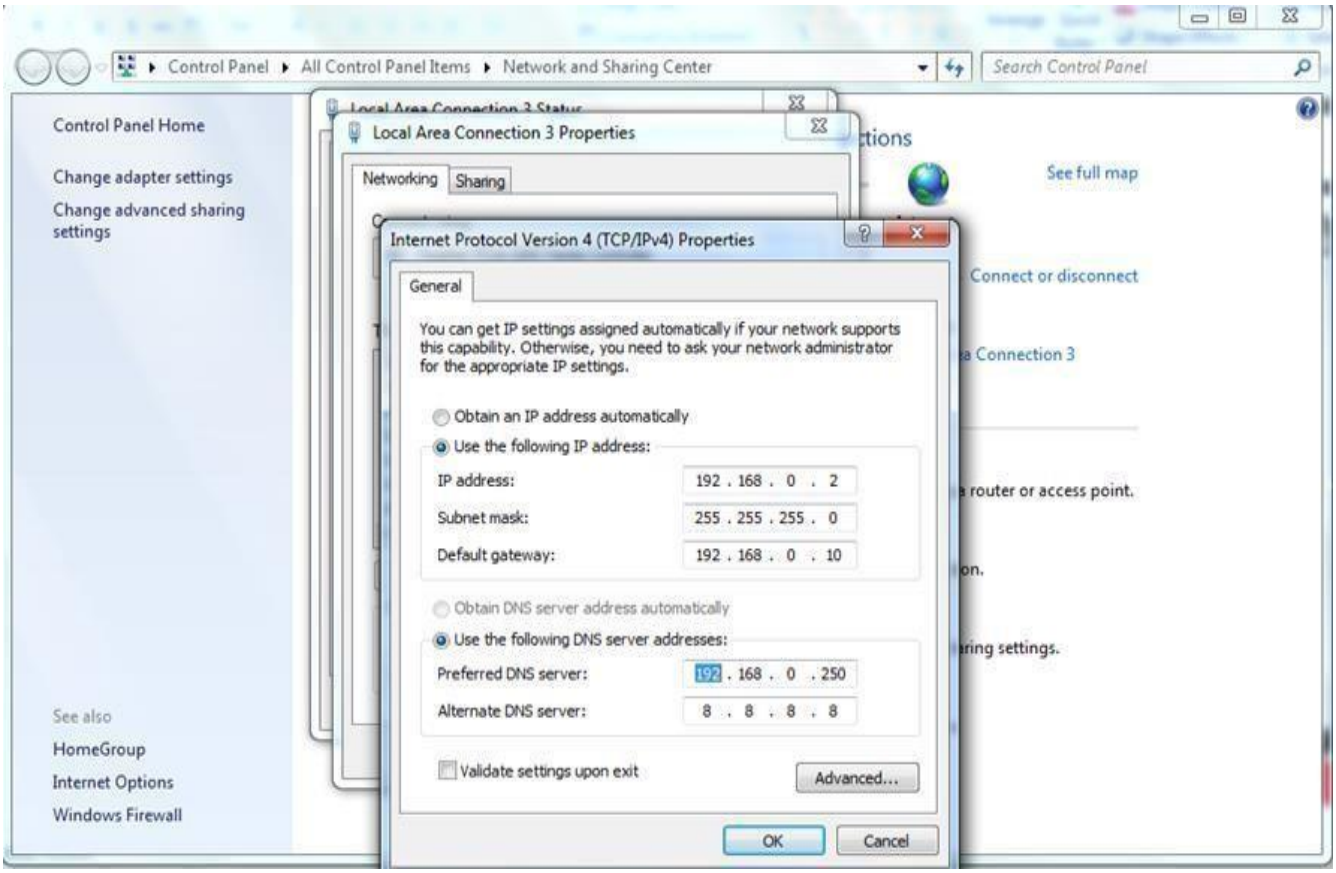
Data type and VM address

The following illustrates VM addressing and data type usage:

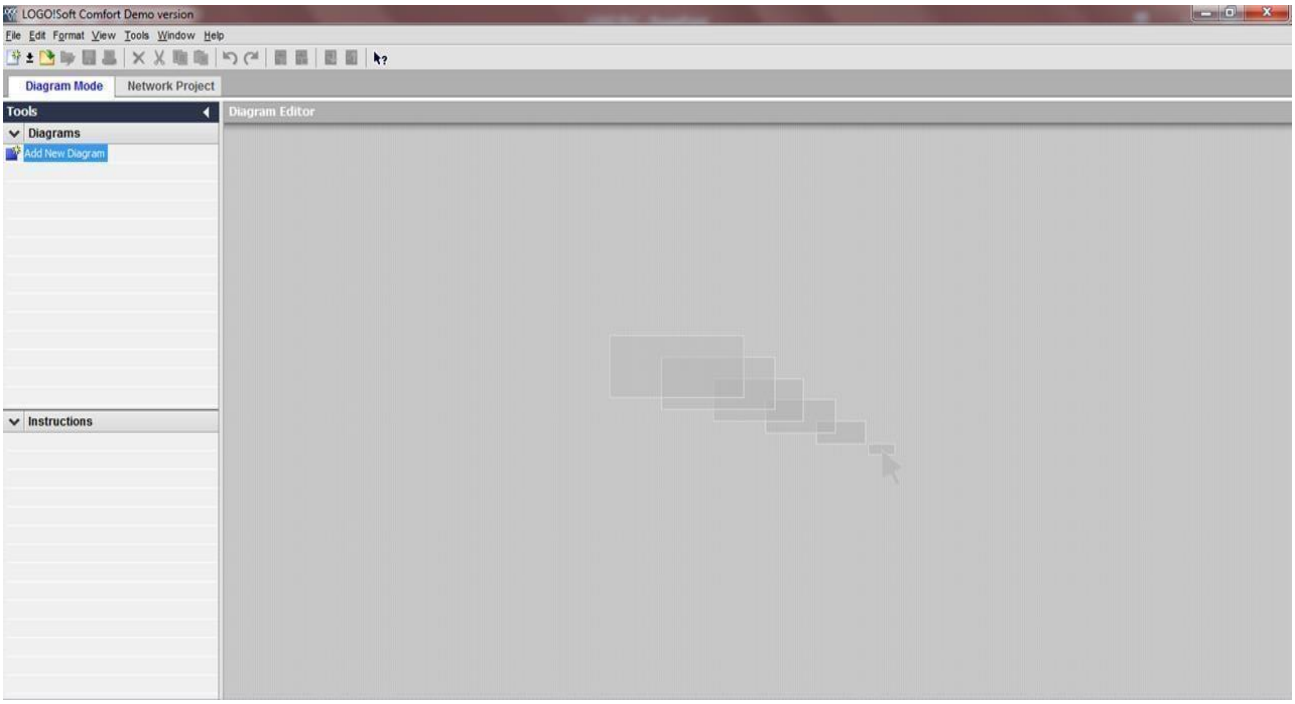


Create and Download the PLC Program

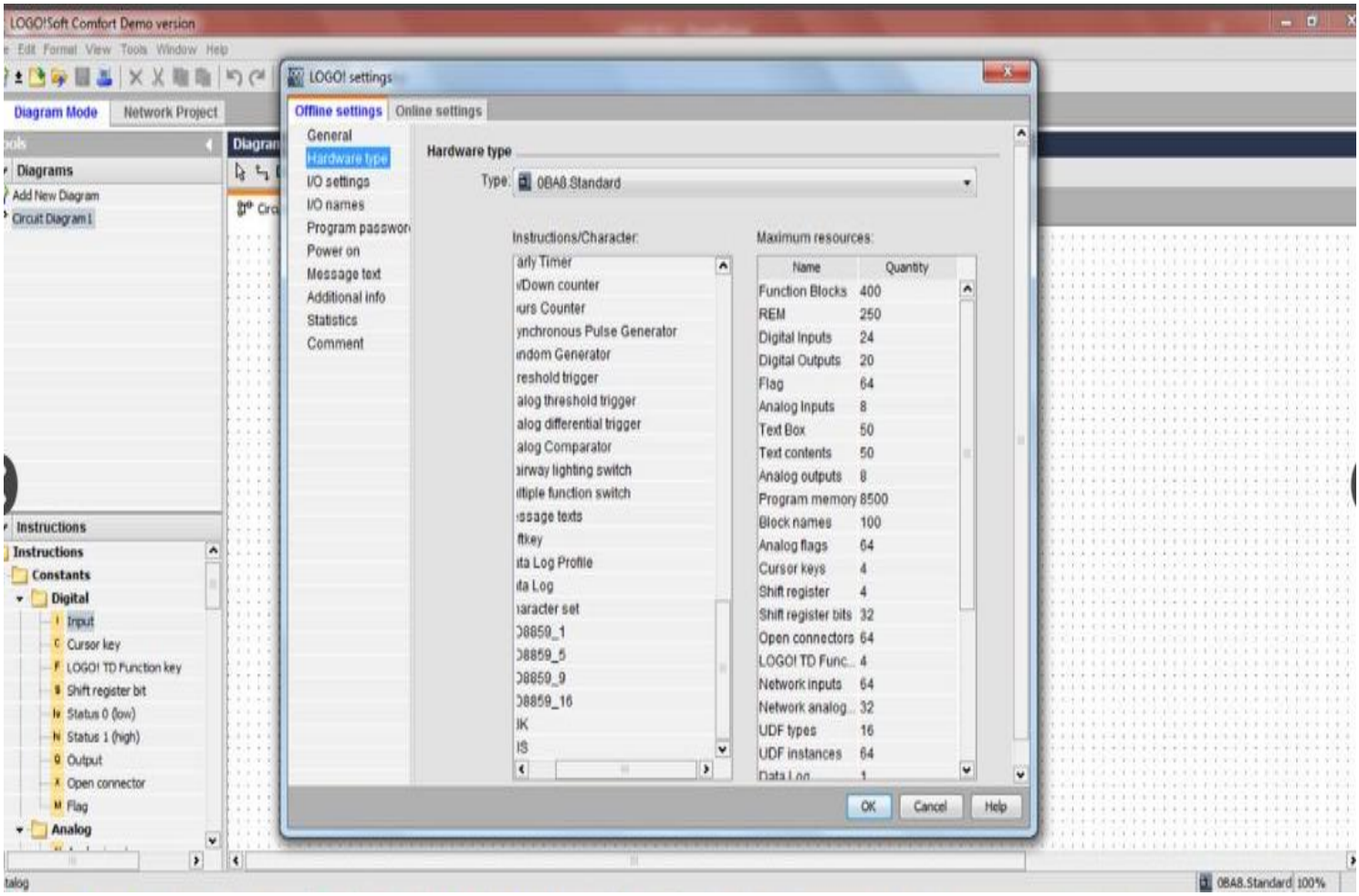
Step 1: - Set the IP address in the system



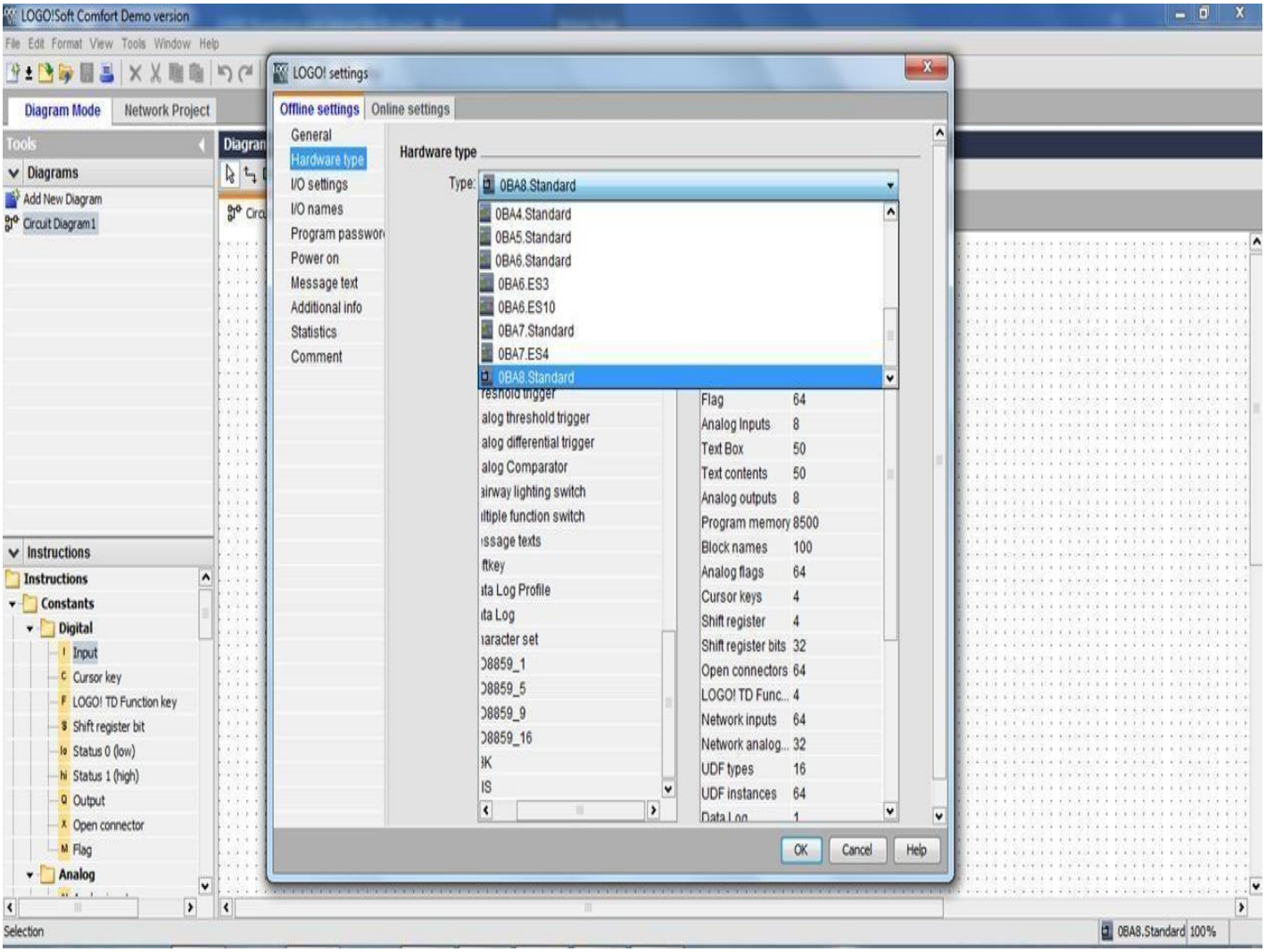
Step 2: - Add new program



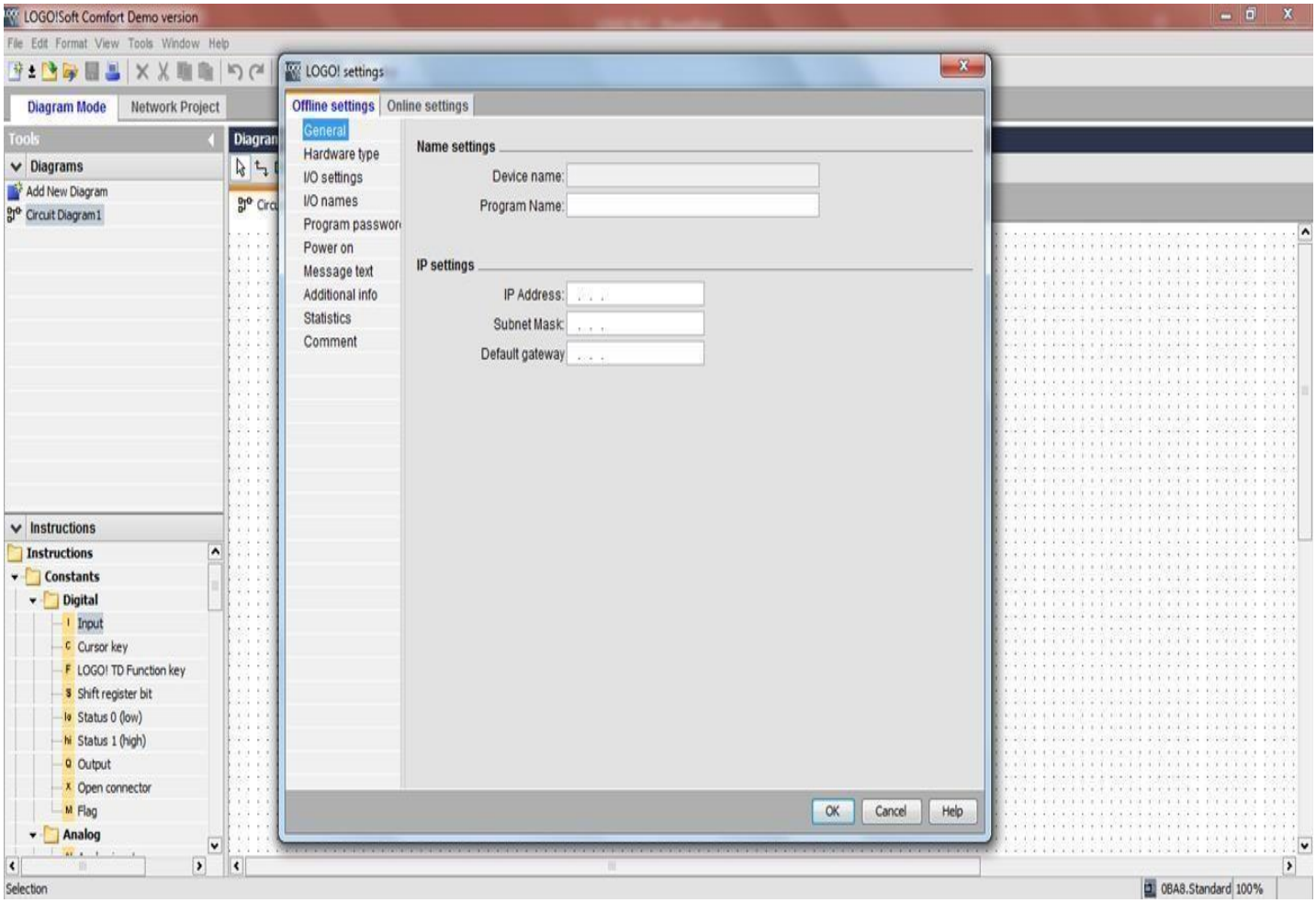
Step 3: - For Offline setting go to Offline menu



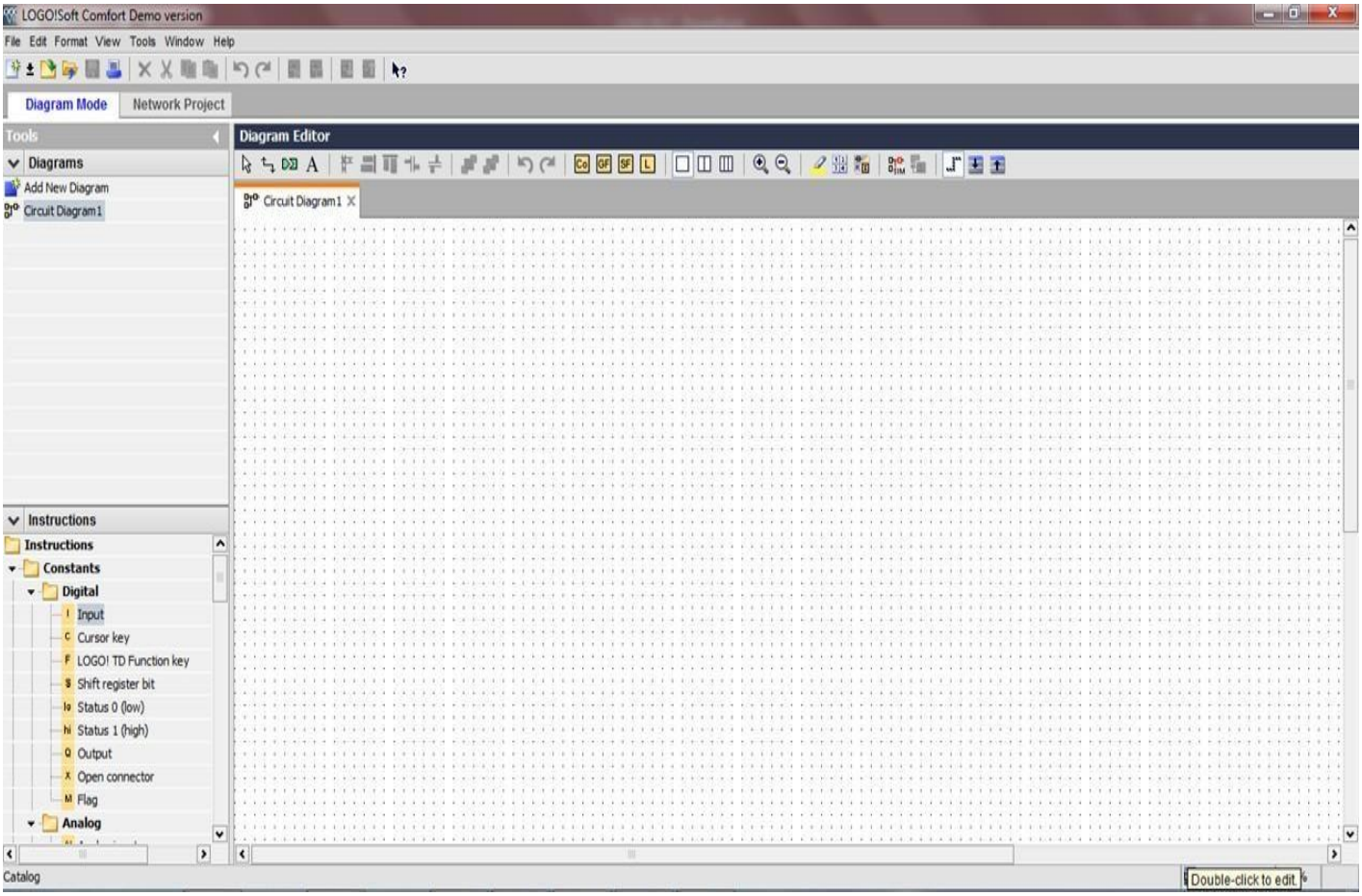
Step 4: - Select hardware



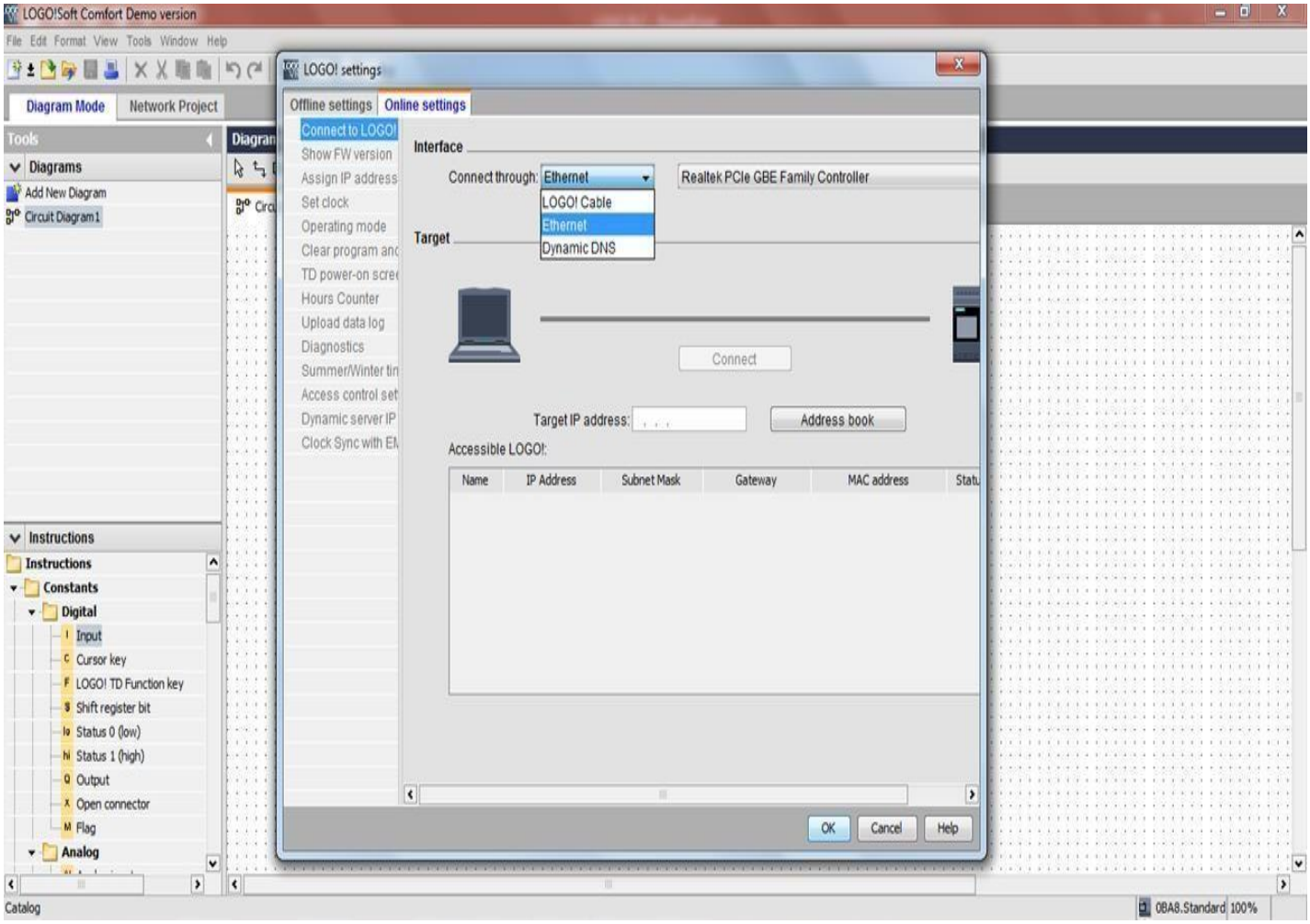
Step 5: - Set IP Address



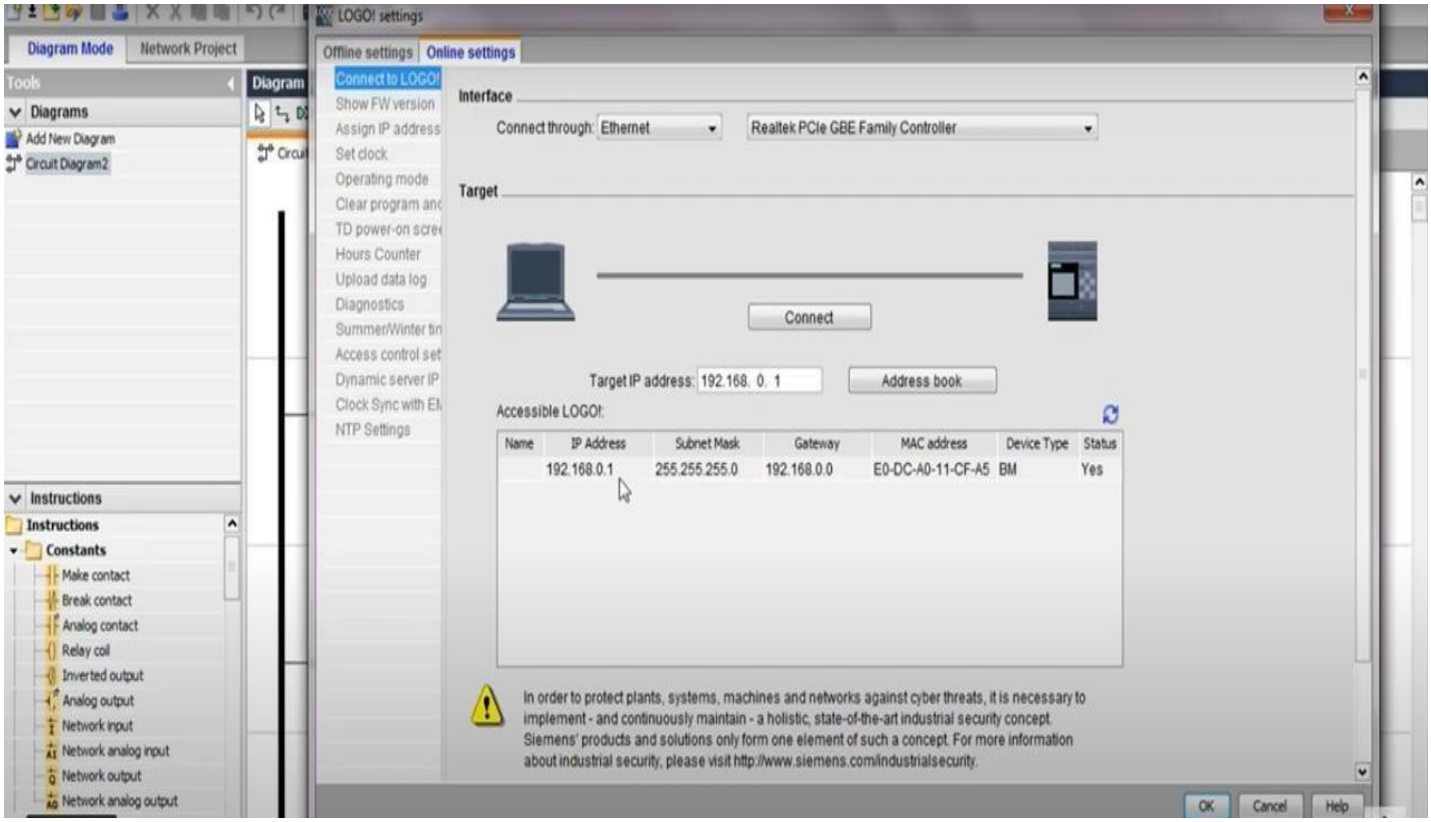
Step 6: - Press Double Click to edit



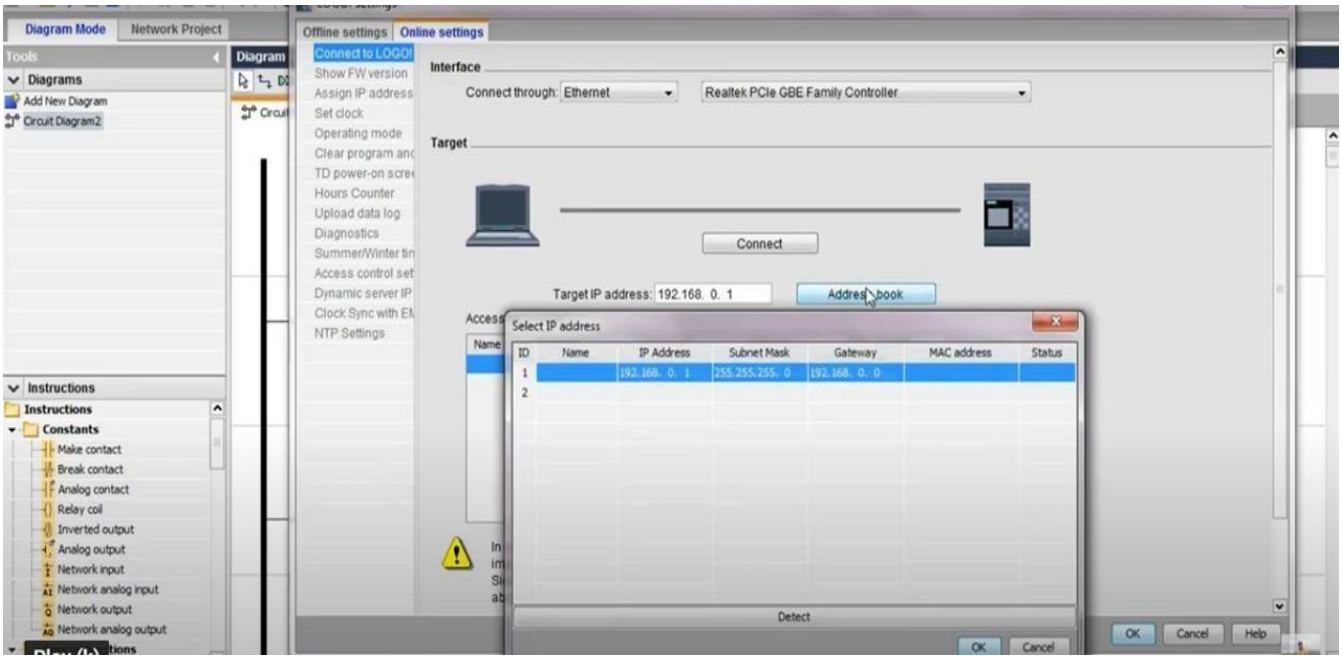
Step7: - Online Setting Select the Ethernet



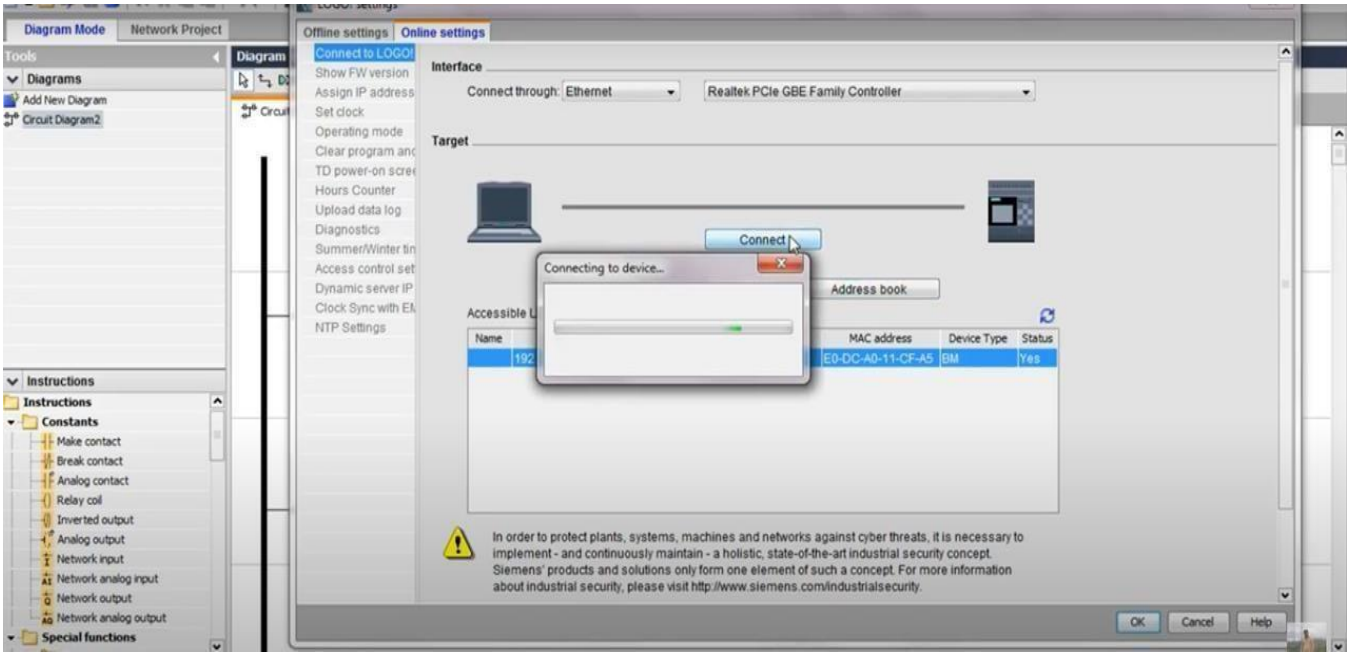
Step 8: - Press Refresh Button it is showing device type



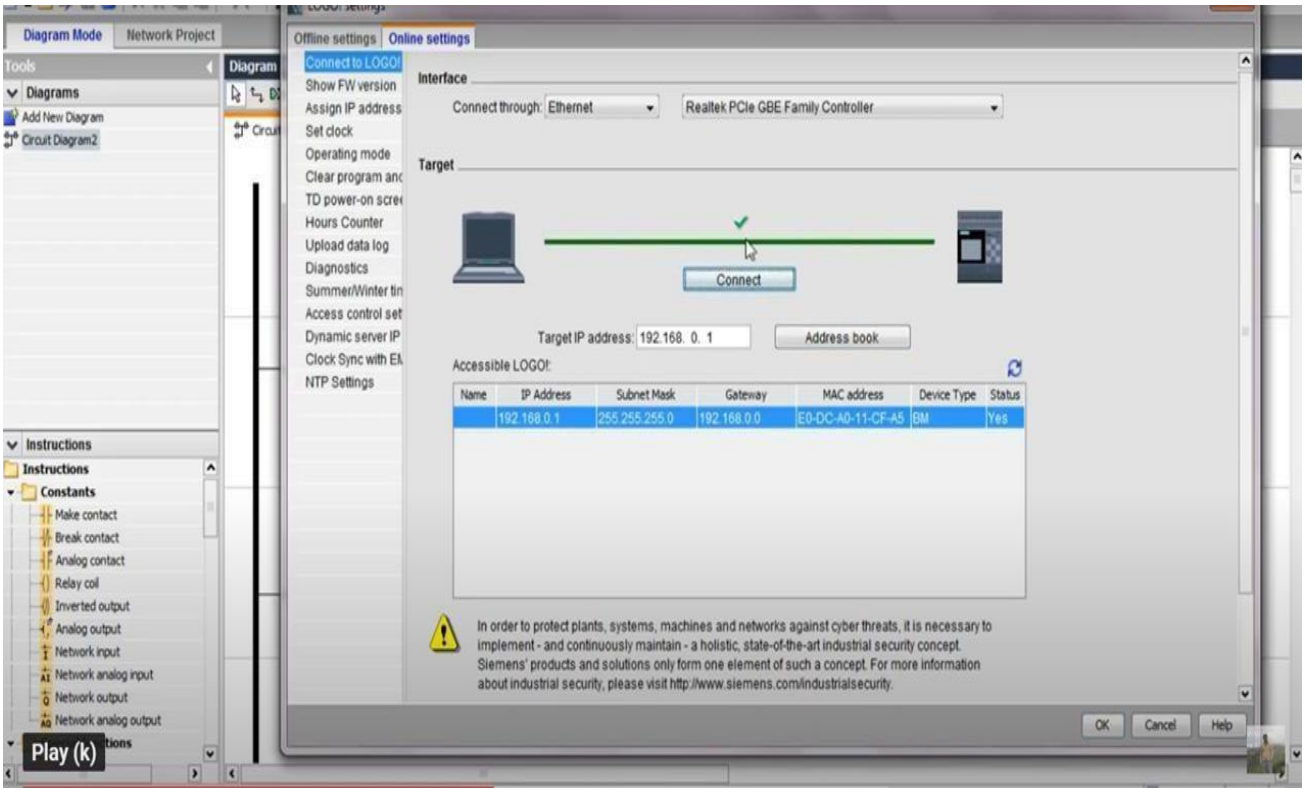
Step 9: - Set IP Manually or Detect



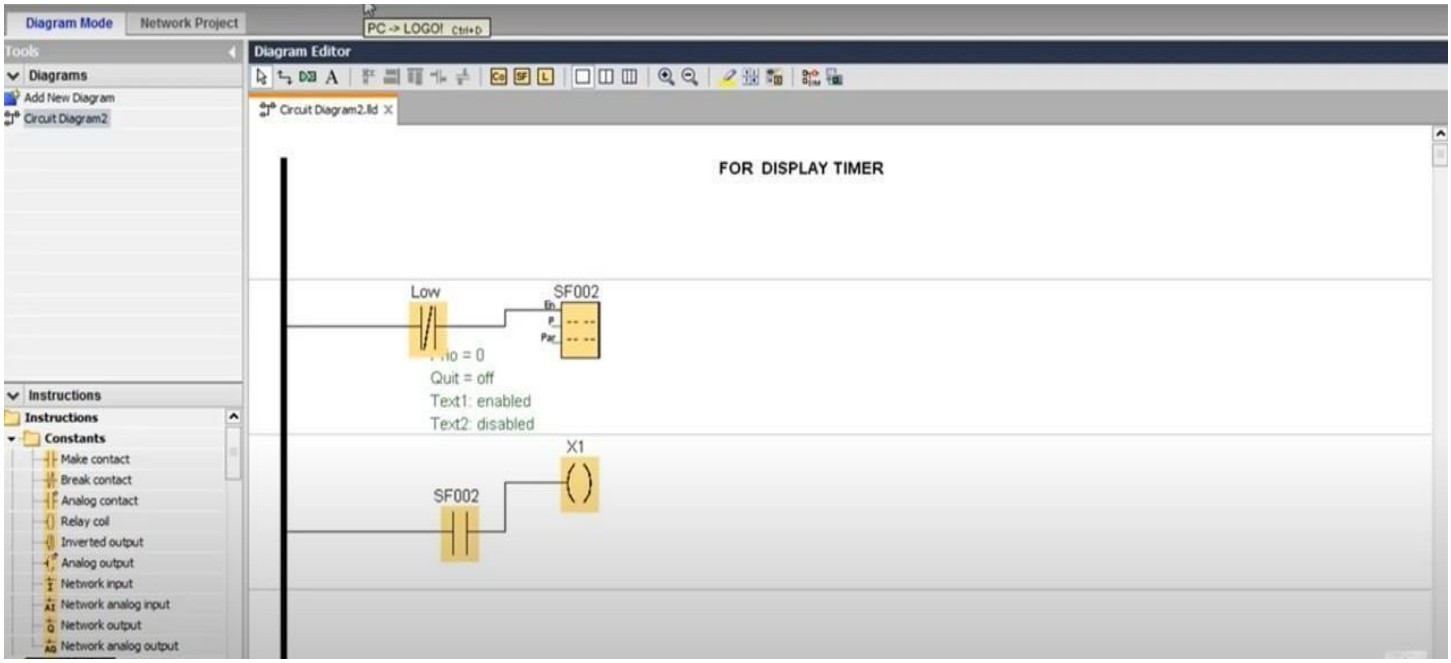
Step 10: - Press Connect



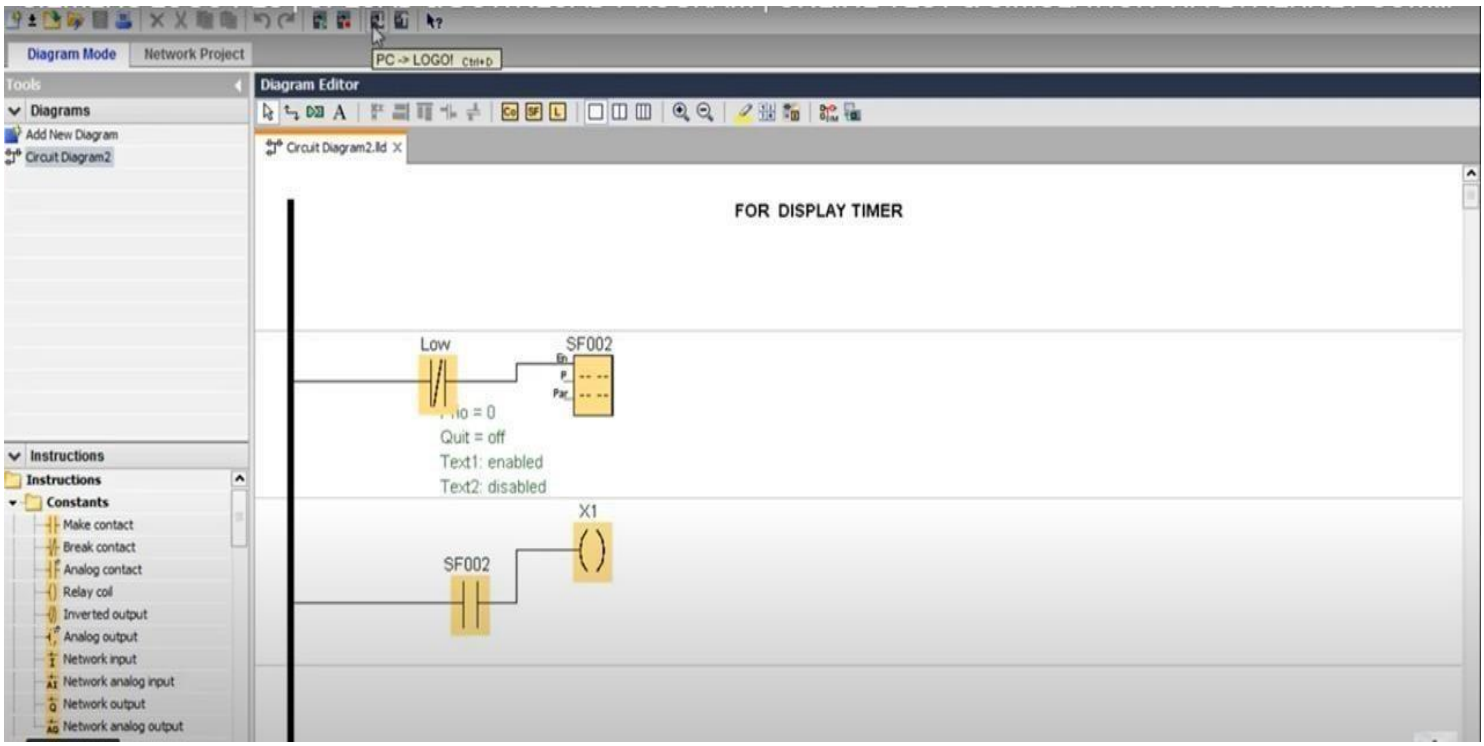
Step 11: - Showing Green indication and Right mark



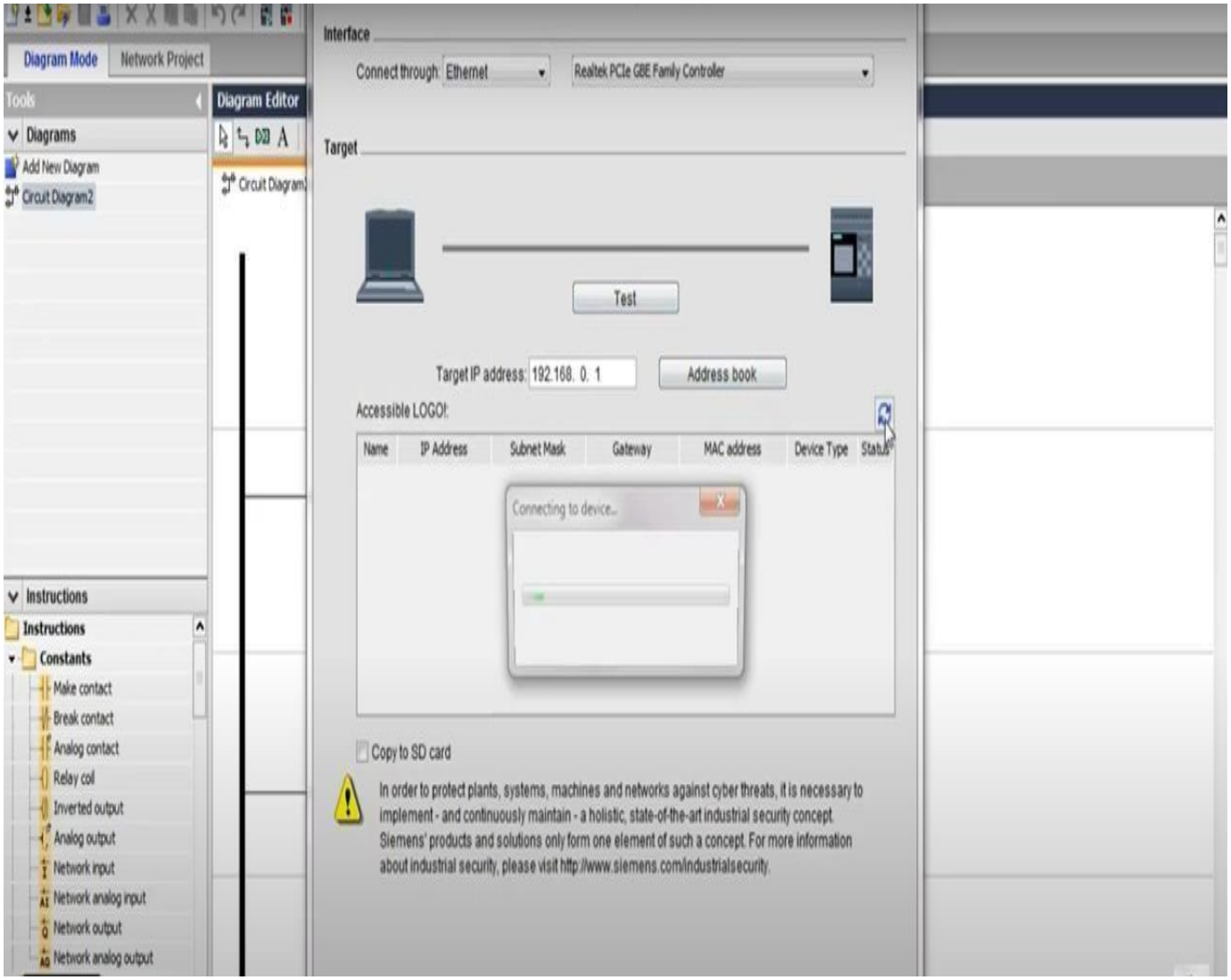
Step 12: - Go to in diagram mode, add new Ckt. DiagramDo Programming



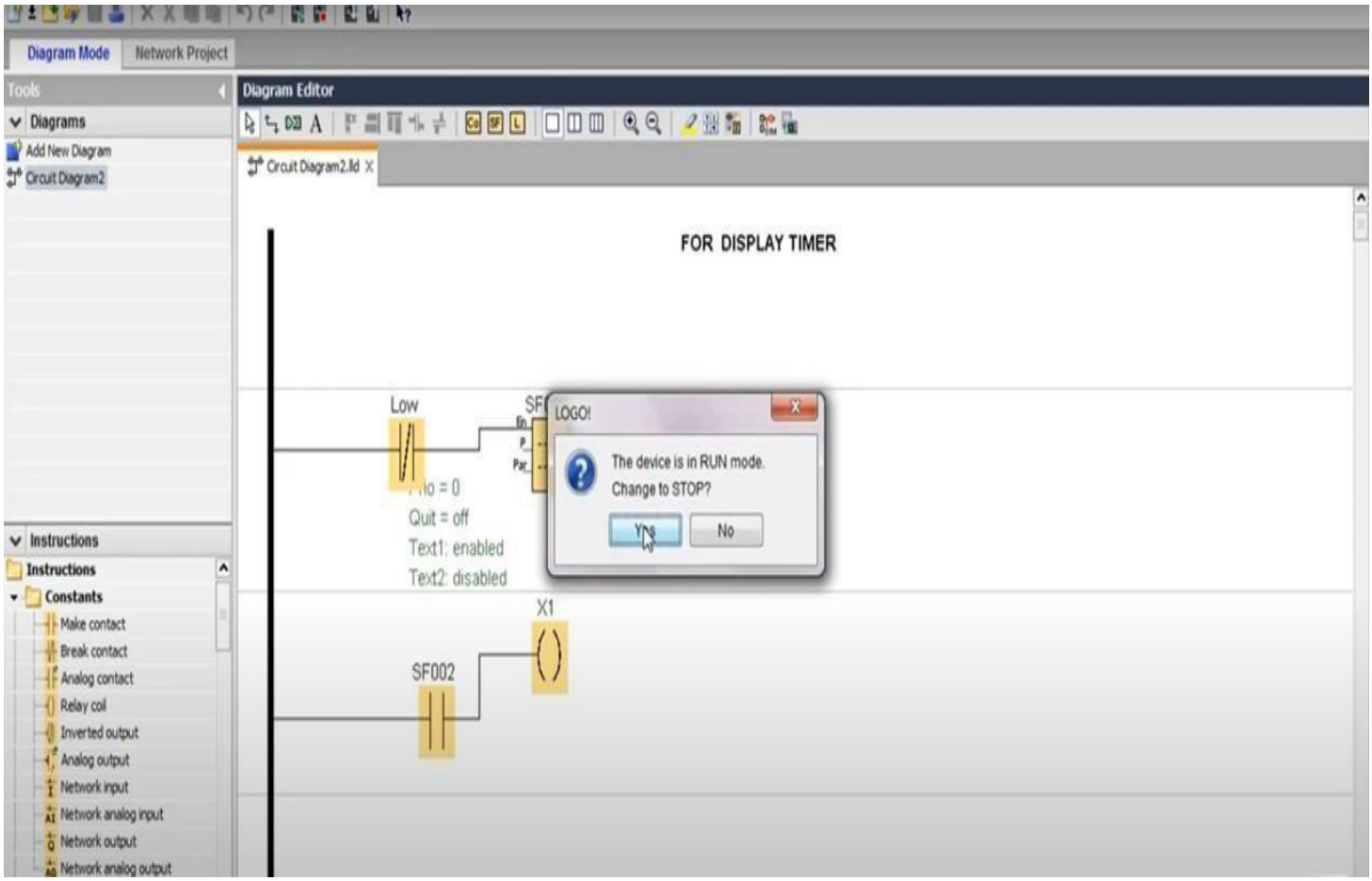
Step 13: - Click on download option



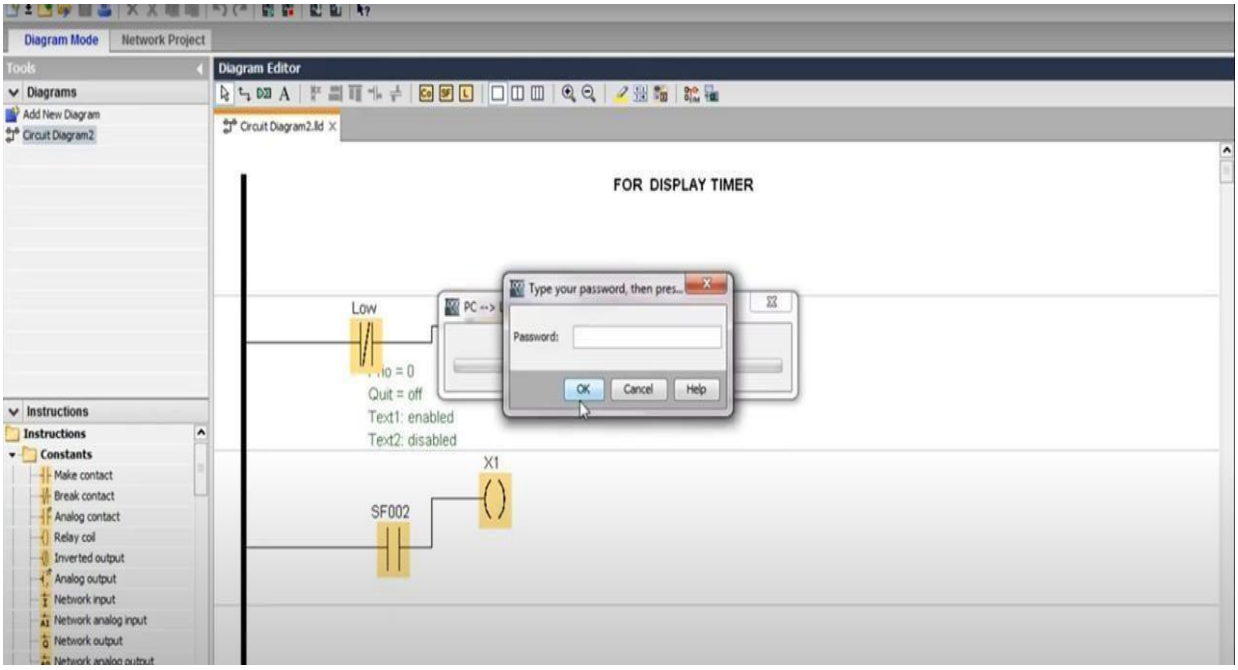
Step 14: - Press Refresh button



Step 15: - Change CPU from Run to Stop while downloading

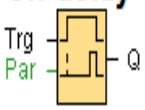


Step 16: - Enter Password if it is password protected.



Timer and Counter Introduction

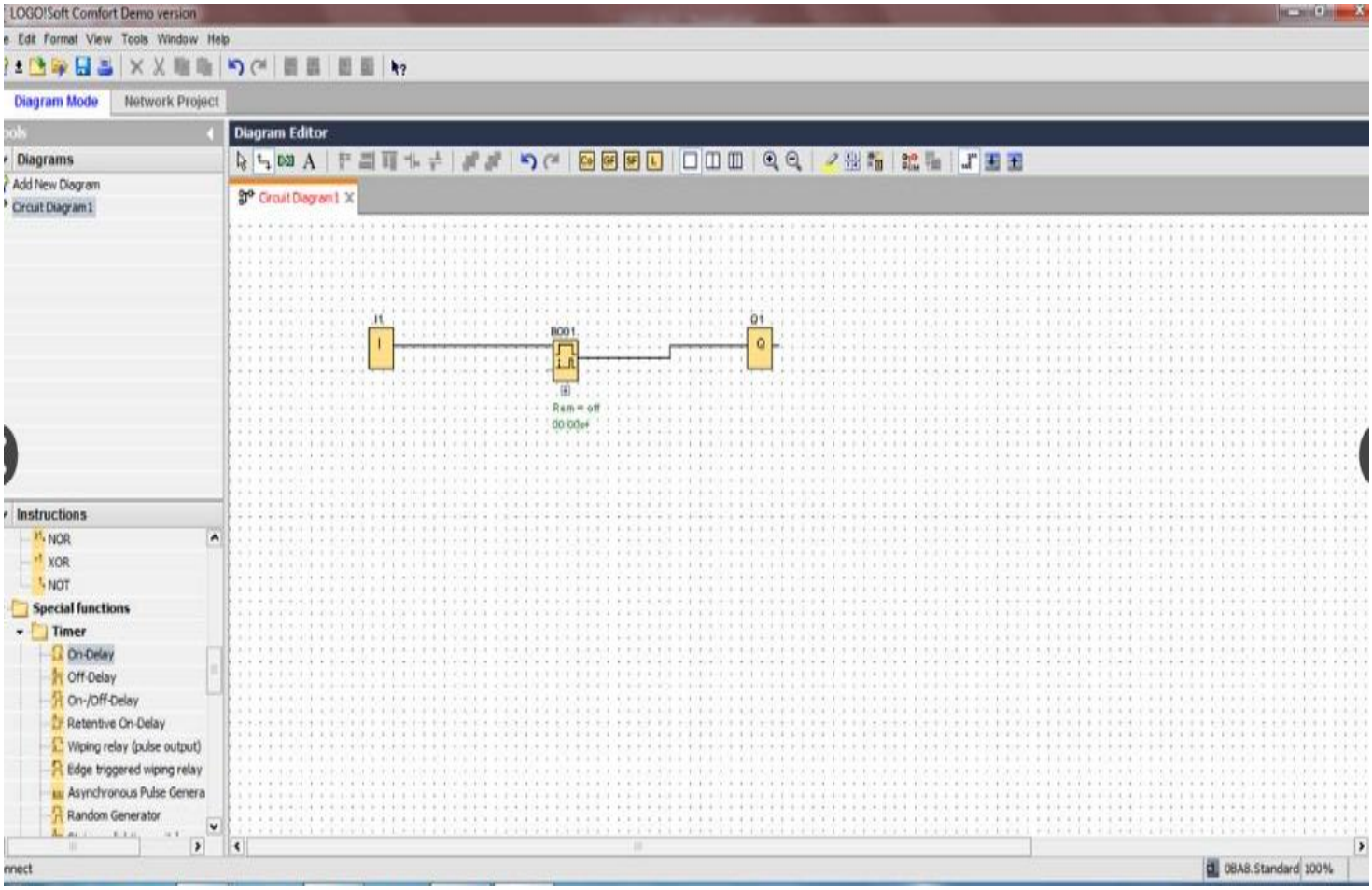
On-delay

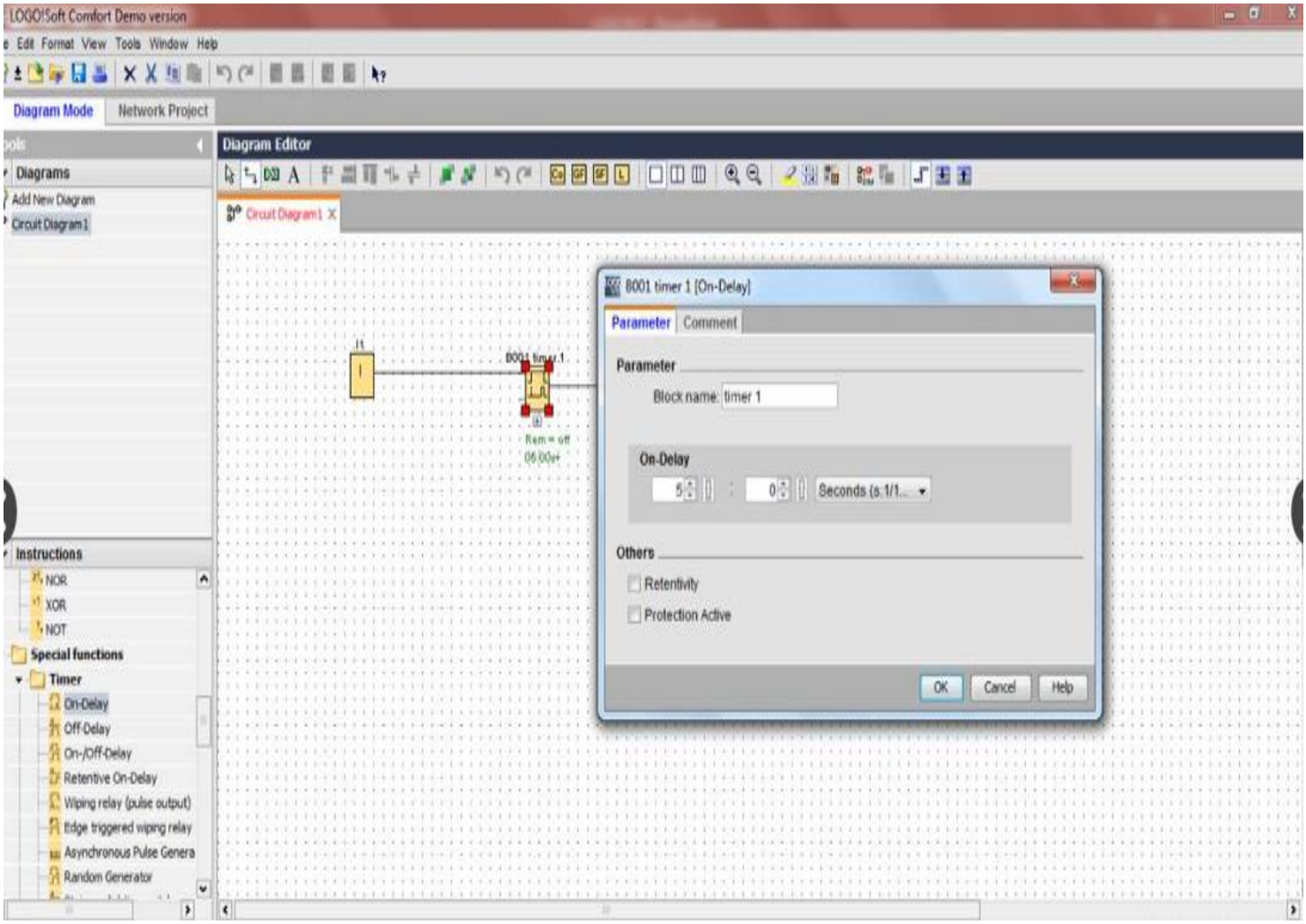


Short description

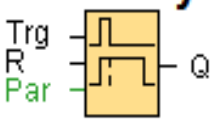
The output does not switch on until a configured delay time has expired.

Connection	Description
Trg input	The Trg (Trigger) input triggers the on-delay time.
Parameter	**T:** represents the on-delay time after which the output is switched on (output signal transition 0 to 1). **Retentivity** on = the status is retentive in memory.
Output **Q**	**Q** switches on after a specified time T has expired, provided Trg is still set.





Off-delay

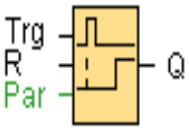


Short description

The output with off-delay resets after a defined time has expired.

Connection	Description
Input **Trg**	Start the off-delay time with a negative edge (1 to 0 transition) at input **Trg** (Trigger).
Input **R**	Reset the off-delay time and set the output to 0 via the **R** (Reset) input. Reset has priority over **Trg**.
Parameter	**T:** The output is switched off on expiration of the delay time **T** (output signal transition 1 to 0). **Retentivity** on = the status is retentive in memory.
Output **Q**	**Q** switches on for the duration of the time **T** after a trigger at input **Trg**.

Retentive on-delay

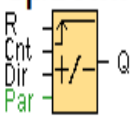


Short description

A one-shot at the input triggers a configurable time. LOGO! sets the output upon expiration of this time.

Connection	Description
Input **Trg**	Trigger the on-delay time via the **Trg** (Trigger) input.
Input **R**	Reset the on-delay time and reset the output to 0 via input **R** (Reset). Reset takes priority over **Trg**.
Parameter	**T** is the on-delay time for the output (output signal transition 0 to 1).
Output **Q**	**Q** switches on upon expiration of the time **T**.

Up/Down counter

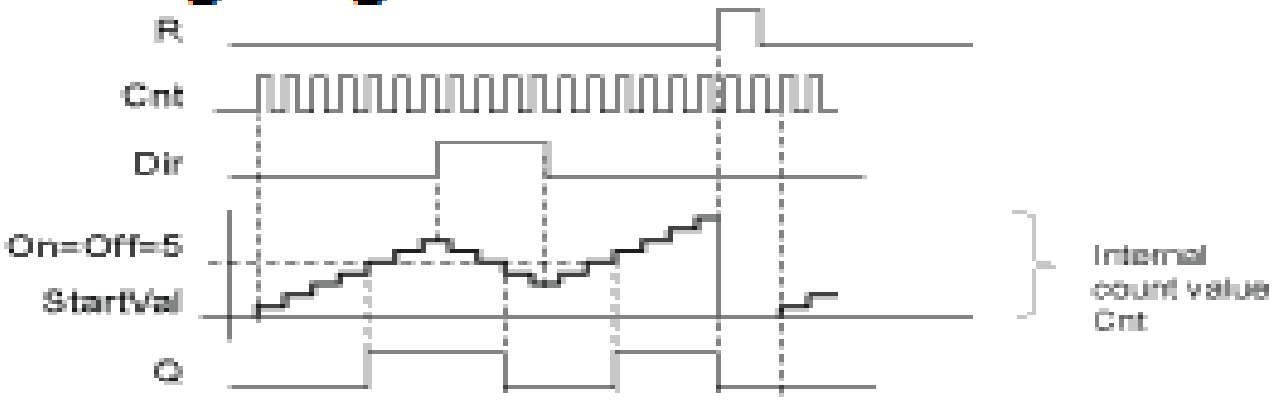


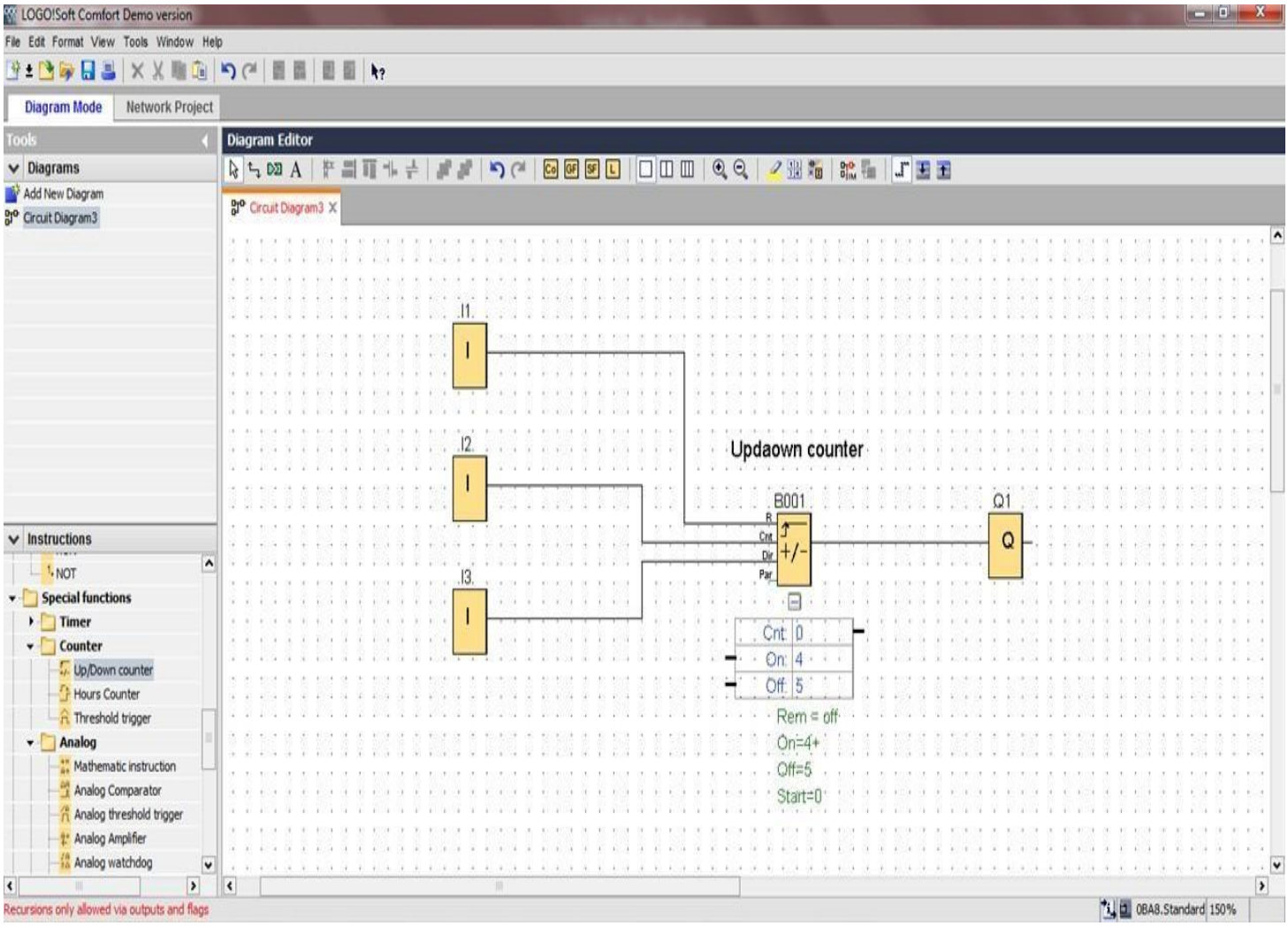
Short description

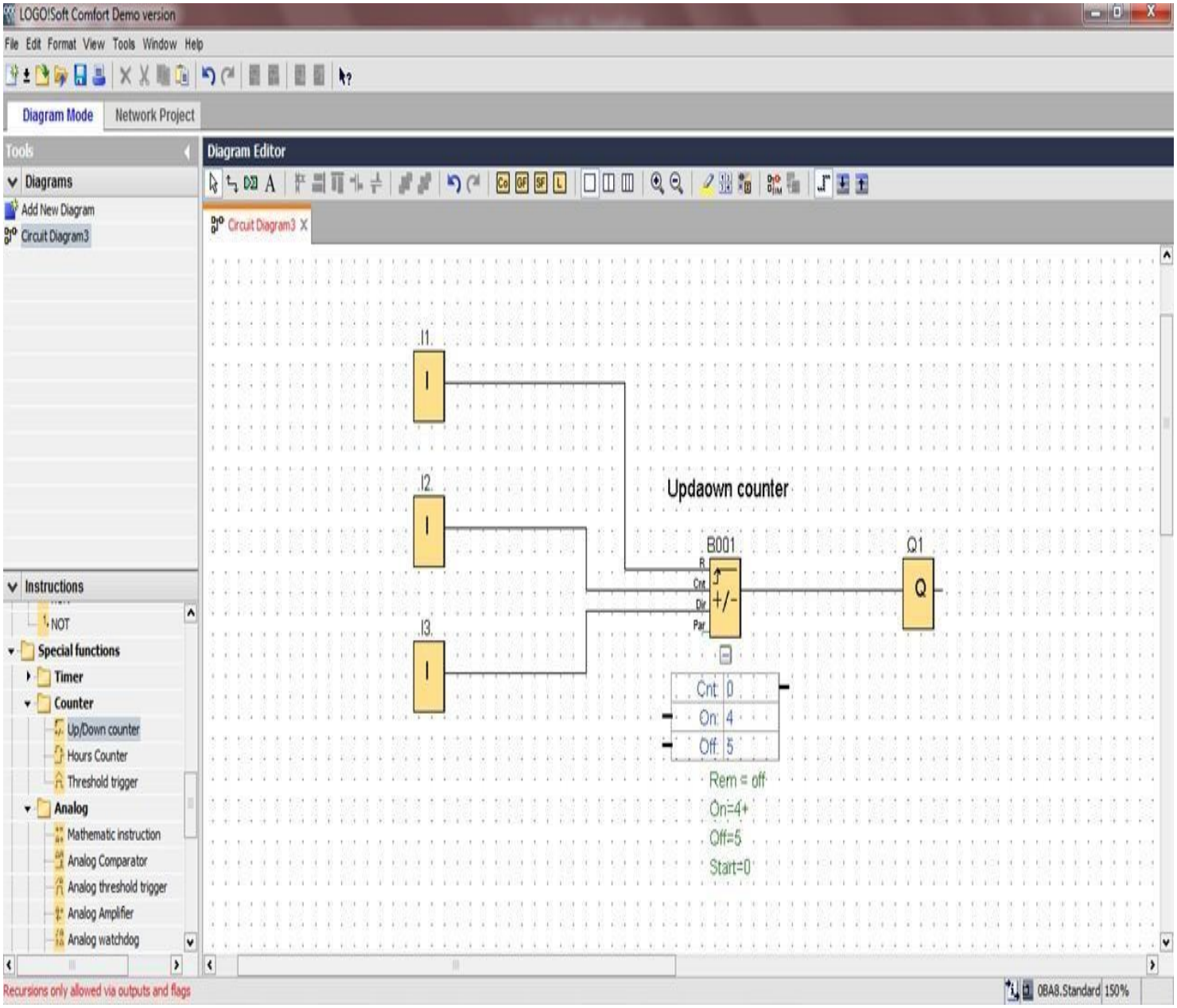
An input pulse increments or decrements an internal value, depending on the parameter setting. The output is set or reset when a configured threshold is reached. The direction of count can be changed with a signal at input Dir.

Connection	Description
Input **R**	You reset the output and the internal counter value to the start value (StartVal) with a signal at input **R** (Reset)
Input **Cnt**	This function counts the 0 to 1 transitions at input **Cnt**. It does not count 1 to 0 transitions. ● Use the inputs I3, I4, I5, and I6 for high-frequency counts (LOGO! 12/24RC/RCo, LOGO! 12/24RCE, LOGO! 24/24o and LOGO! 24C/24Co): max. 5 kHz, if the fast input is directly connected to the Up/Down counter function block ● Use any other input or circuit element for low-frequency counts (typically 4 Hz).
Input **Dir**	Input **Dir** (Direction) determines the direction of count: Dir = 0: Up Dir = 1: Down
Parameter	**On**: On threshold / Value range: 0 to 999999 **Off**: Off threshold / Value range 0 to 999999 **Start Value**: Initial value from which to begin counting either down or up. **Retentivity** on = the status is retentive in memory.
Output **Q**	**Q** is set and reset according to the actual value at Cnt and the set thresholds.

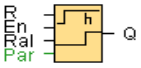
Timing diagram






LOGO!Soft Comfort Demo version
File Edit Format View Tools Window Help
Diagram Mode
Network Project
Tools
Diagrams
Add New Diagram
Circuit Diagram3
Diagram Editor
Circuit Diagram3
I1.
I2.
I3.
Updaown counter
B001
R
Cnt
Dir
Par
+/-
Q1
Q
Cnt: 0
On: 4
Off: 5
Rem = off
On=4+
Off=5
Start=0
Instructions
NOT
Special functions
Timer
Counter
Up/Down counter
Hours Counter
Threshold trigger
Analog
Mathematic instruction
Analog Comparator
Analog threshold trigger
Analog Amplifier
Analog watchdog
Recursions only allowed via outputs and flags
0BA8.Standard
150%

Hours counter

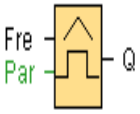


Short description

A configured time is triggered with a signal at the monitoring input. The output is set when this time has expired.

Connection	Description
Inout **R**	A positive edge (0 to 1 transition) at input **R** resets output **Q** and sets a configured value MI at the counter for the duration of the time-to-go (MN).
Input **En**	**En** is the monitoring input. LOGO! scans the On Time of this input.
Input **Ral**	A positive edge at input Ral (Reset all) resets the hours counter (OT) and the output, and sets the time-to-go value (MN) to the configured maintenance interval (MI): ● Output Q = 0 ● The measured operating hours OT = 0 ● The time-to-go of the maintenance interval MN = MI.
Parameter	**MI**: Maintenance interval to be specified in units of hours and minutes Range of values: 0000 h to 9999 h, 0 m to 59 m **OT:** Accumulated total operating time. An offset start time can be specified in hours and minutes. Range of values: 00000 h to 99999 h, 0 m to 59 m **Q → 0**: ● **When "R" is selected:** Q = 1, if MN = 0; Q = 0, if R = 1 or Ral = 1 ● **When "R+En" is selected**: Q = 1, if MN = 0; Q = 0, if R = 1 or Ral = 1 or En = 0.
Output **Q**	The output is set when the time-to-go MN = 0. The output is reset: ● **When "Q → 0:R+En",** if R = 1 or Ral = 1 or En = 0 ● **When "Q → 0:R"**, if R = 1 or Ral = 1.

Threshold trigger

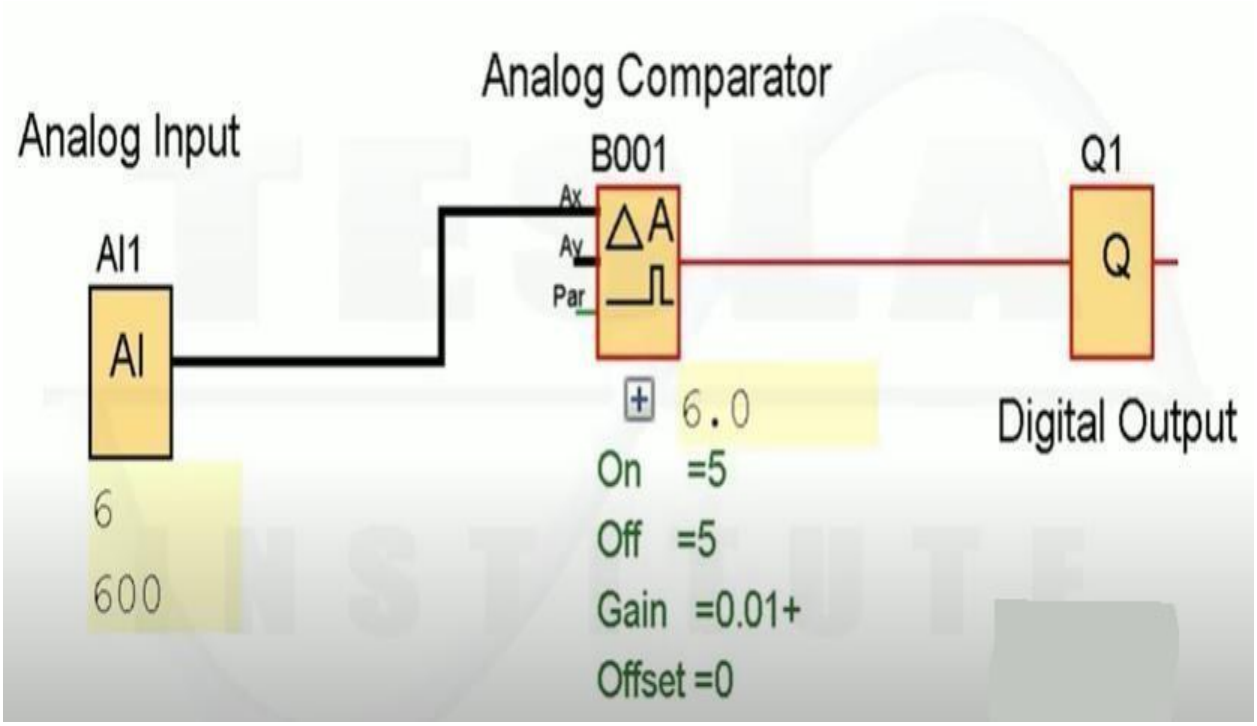


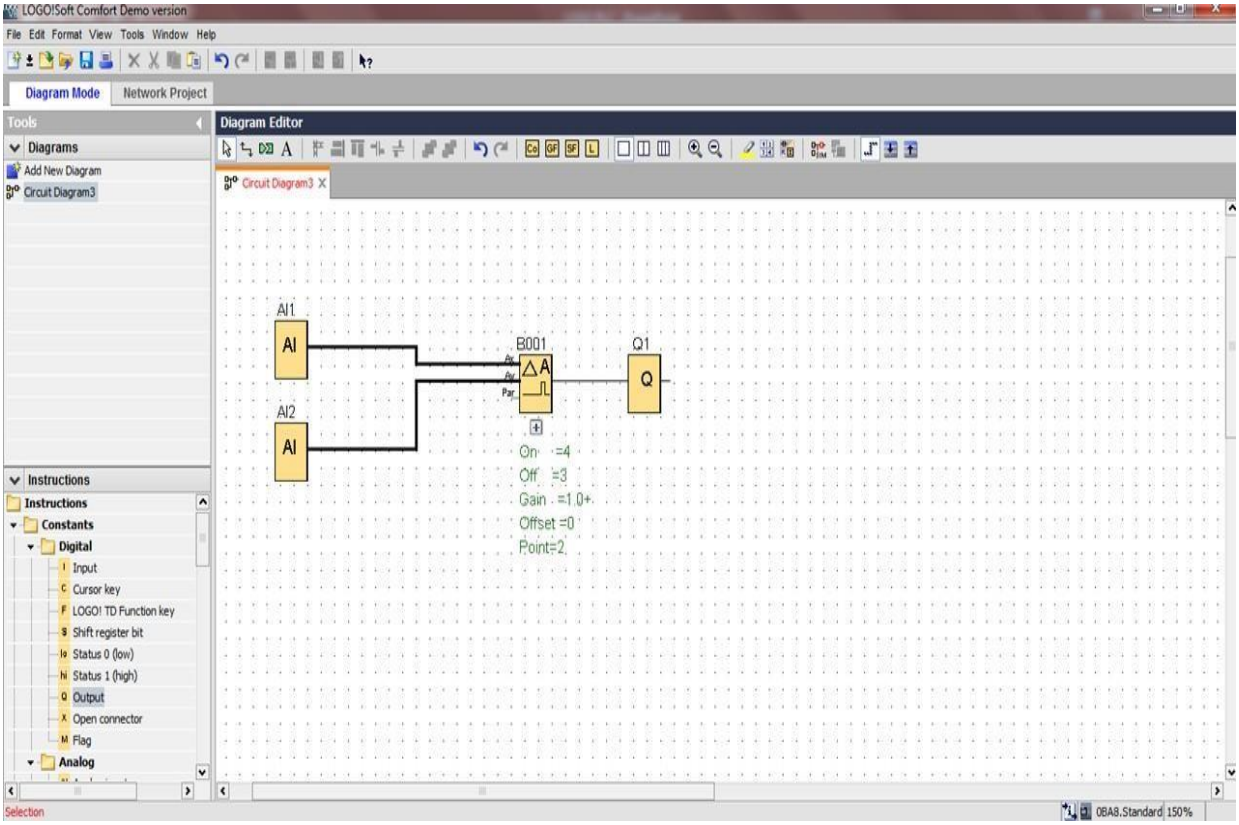
Short description

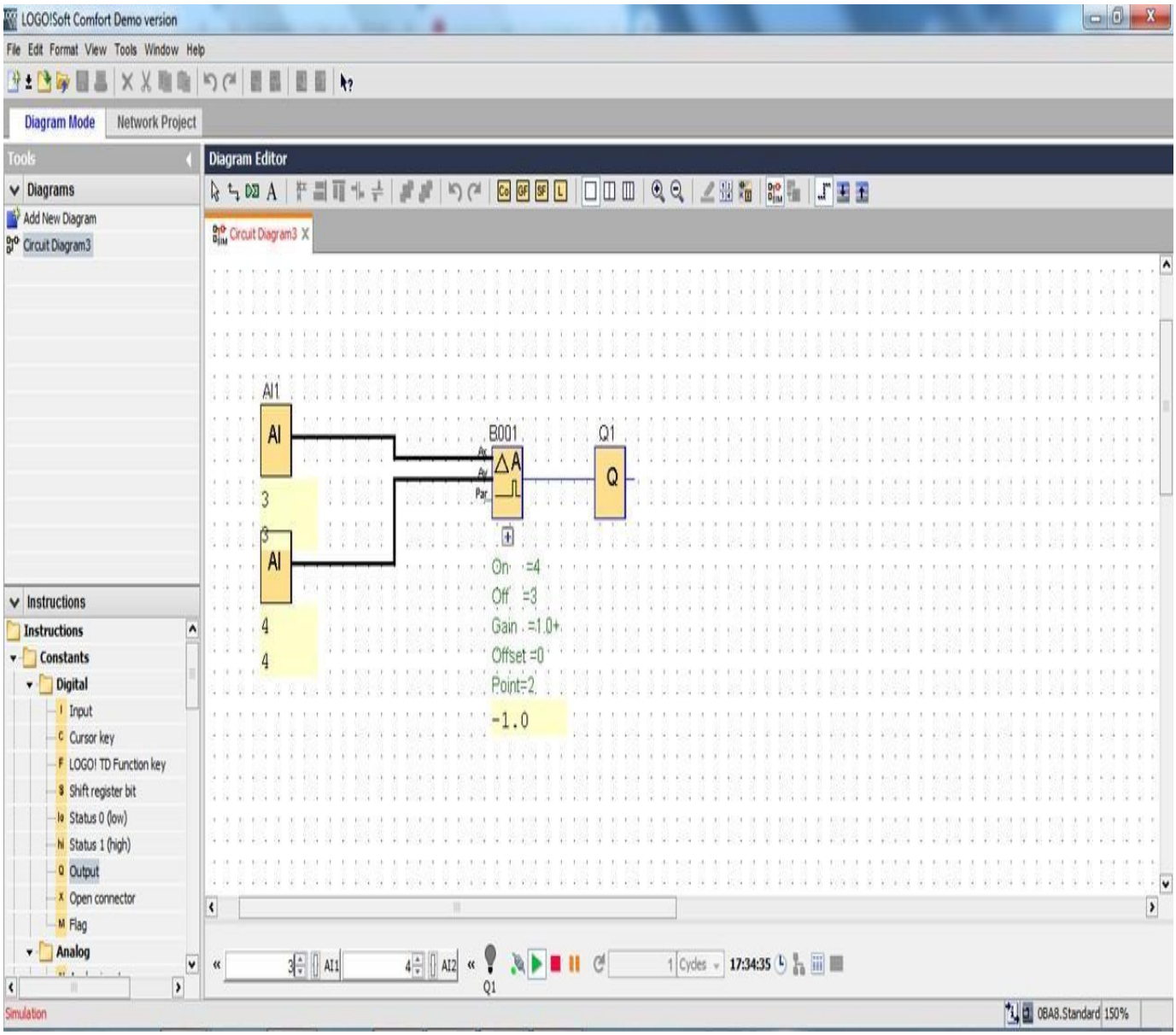
The output is switched on and off depending on two configurable frequencies.

Connection	Description
Input **Fre**	The function counts 0 to 1 transitions at input **Fre**. Transitions from 1 to 0 are not counted. ● Use the inputs I3, I4, I5, and I6 for high-frequency counts (LOGO! 12/24RC/RCo, LOGO! 12/24RCE, LOGO! 24/24o and LOGO! 24C/24Co): max 5kHz, if the fast input is directly connected to the threshold trigger function block ● Use any other input or circuit element for low frequencies (typical 4 Hz).
Parameter	**On:** On threshold Range of values: 0000 to 9999 **Off:** Off threshold Range of values: 0000 to 9999 **G_T:** Time interval or gate time during which the input pulses are measured. Range of values: 00:00 s to 99:99 s
Output **Q**	Q is set or reset according to the threshold values.

Comparator Introduction







The output is set and reset, depending on the difference Ax –Ay and on two configurable thresholds

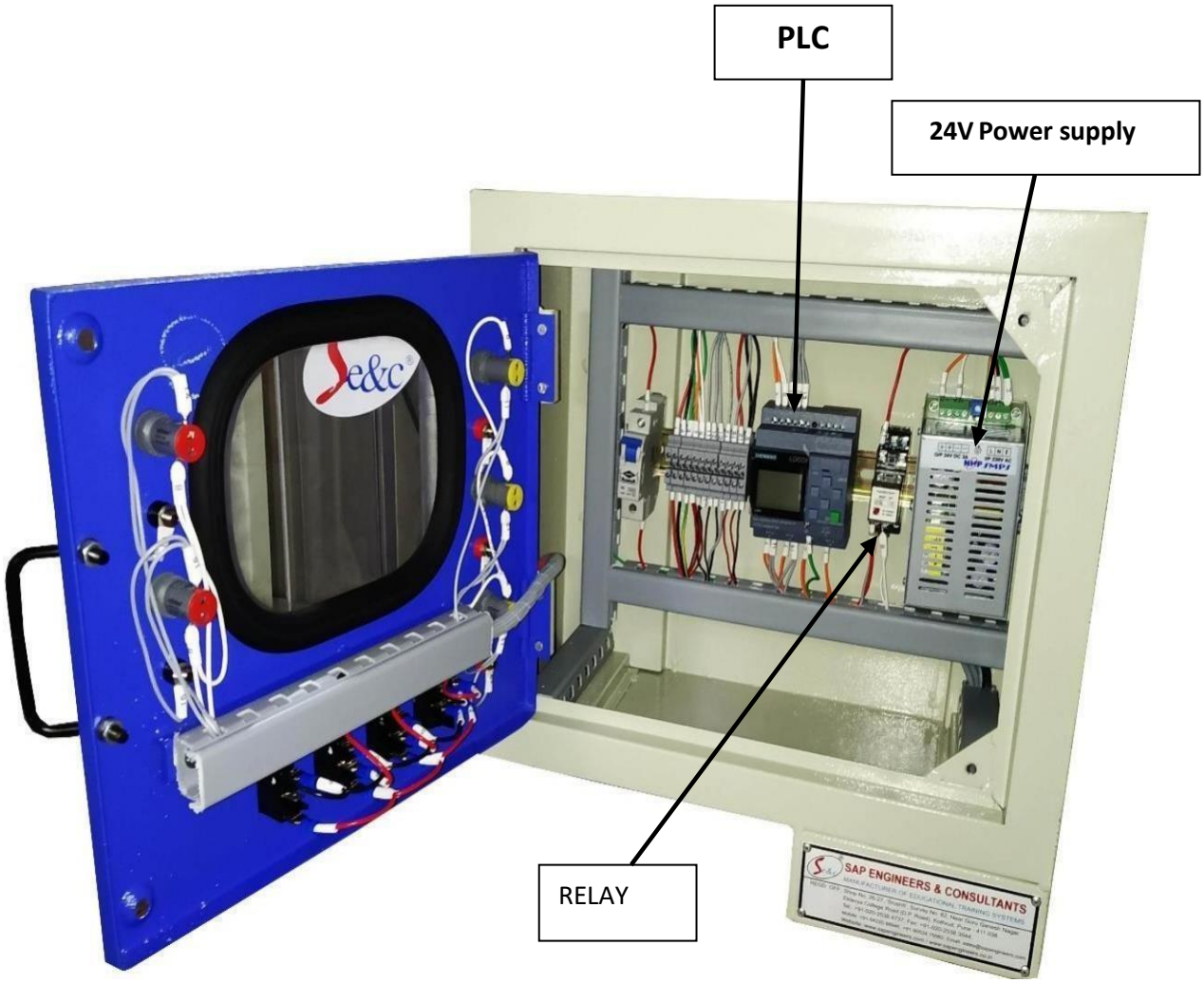
PLC BASED WATER LEVEL CONTROL SYSTEM

Index

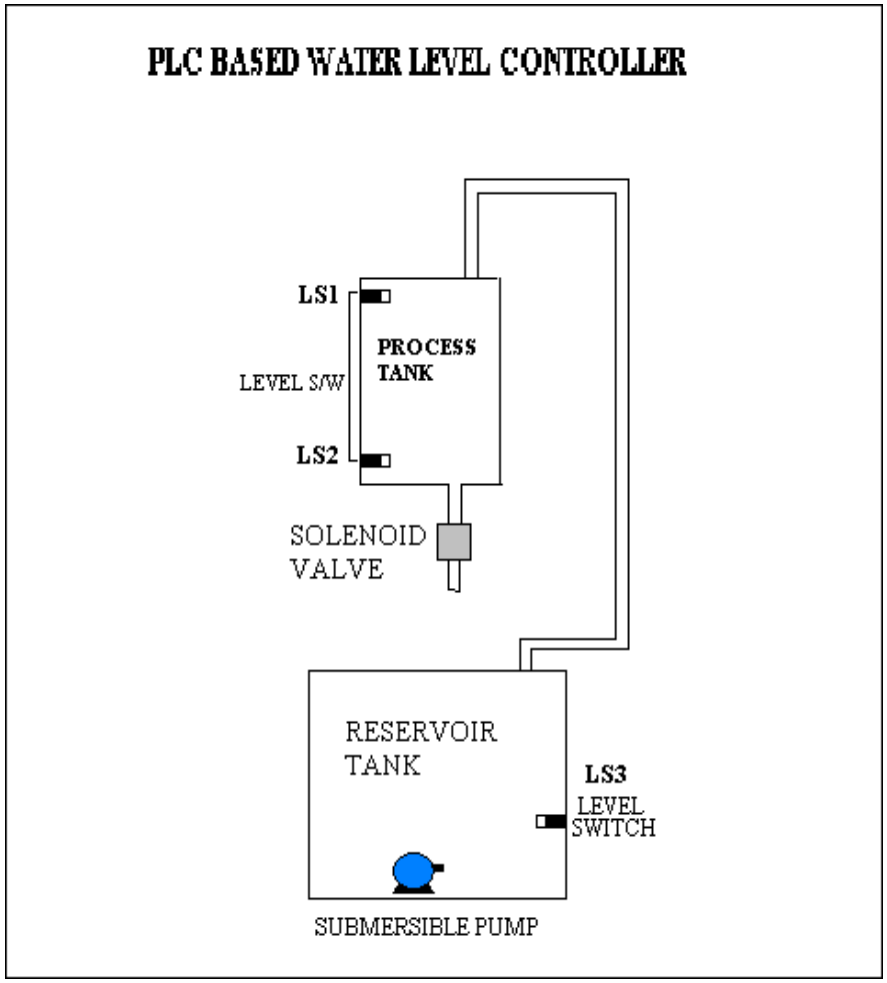
1. PHOTO OF TRAINER KIT: -

PLC BASED WATER LEVEL CONTROL SYSTEM

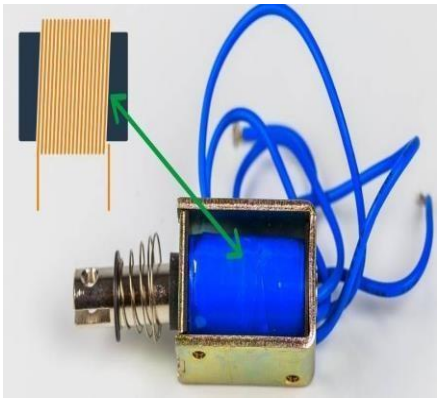
2. PHOTO OF WIRING: -



3. P&I DIAGRAM


PLC BASED WATER LEVEL CONTROLLER
LS1
PROCESS TANK
LEVEL S/W
LS2
SOLENOID VALVE
RESERVOIR TANK
LS3
LEVEL SWITCH
SUBMERSIBLE PUMP

4. SOLENOID VALVE: -



A solenoid valve is an electromechanical valve for use with liquid or gas. The valve is controlled by an electric current through a solenoid coil. Solenoid valves may have two or more ports: in the case of a two-port valve the flow is switched on or off; in the case of a three-port valve, the outflow is switched between the two outlet ports. Multiple solenoid valves can be placed together on a manifold.

A solenoid valve has two main parts: the solenoid and the valve. The solenoid converts electrical energy into mechanical energy which, in turn, opens or closes the valve mechanically.

5. LEVEL SWITCH

FLOAT SWITCH:

A float switch is an electro-mechanical switch which allows for an electrical switch to be opened or closed depending on the fluid level in a container. The float switch allows for automatic operation of devices depending on the level of fluid, such as the operation of pumps, or the opening or closing of valves. Float switches of numerous configurations have been used for various marine and industrial applications. Most float switches contain an electrical switch imbedded within the body of the float switch device. The electrical switch is actuated upon physical movement of the portion of the float switch device containing the electrical switch or upon physical movement of another portion of the float switch device.

6. PLC LOGIC:

Incoming control signals, or inputs, interact with instructions specified in the user ladder program, which tells the PLC how to react with the incoming signals. The user program also directs the PLC on how to control field devices like motor starters, pilot lights, & solenoids. A signal going out of the PLC to control a field device is called an Output.

The objective of the experiment is to control the water level in the tank by using PLC.

For the execution of this operation, the lower tank must be filled with water above the LS3 (level switch 3), to 75% of the reservoir. Interlocking is provided so that pump will be ON, only when LS3 is ON, avoiding dry run of the pump.

Initially turn ON all the switches, Mains ON Switch, PLC On Switch.

As LS3 (Level Switch) gets activated and LS2 (Level switch 2) is deactivated, Pump is started & remains on till level reaches LS1 (Level Switch 1) in the Level Tank.

When the level of the water in the Level Tank reaches up to LS1 (Level Switch 1), the Pump is turned off. After that 5 sec of delay occurs & the solenoid valve situated below the tank is operated and remains in operation till the level goes below to LS2 (Level Switch2).

As LS2 (Level Switch 2) level is reached, Solenoid Valve is turned OFF & the Pump is restarted to maintain water level up to LS1.

The Inputs & Outputs used in PLC are,

I/P 1: - LS-1	Level Switch 1	O/P1 Q1: - PUMP ON
I/P 2:- LS-2	Level Switch 2	O/P2 Q2:- SOLENOID VALVE ON
I/P 3:- LS-3	Level Switch 3	

7. OPERATING PROCEDURE FOR PLC BASED WATER LEVEL CONTROL MODULE

1. Pour / Fill 75 % of Sump Tank with Pure Water or Distilled Water
2. Provide 230V, 50hz AC Supply to Panel
3. Switch ON Level Control Module using mains button
4. Switch On 24V DC Switch.
5. Switch ON 'PLC ON'.
6. Wait for few seconds

OPERATION:

1. As the desired level of water reaches in the sump tank i.e above the level switch the pump gets ON.
2. As soon as the higher level of the level tank is reached the submersible pump gets OFF
3. As the water level of the level tank reaches the level sensor LS1, the pump gets OFF and the SOLENOID Valve gets ON
4. As the level of the level tanks falls down below the level switch LS2, the PUMP gets ON automatically and the SOLENOID Valve turned OFF.

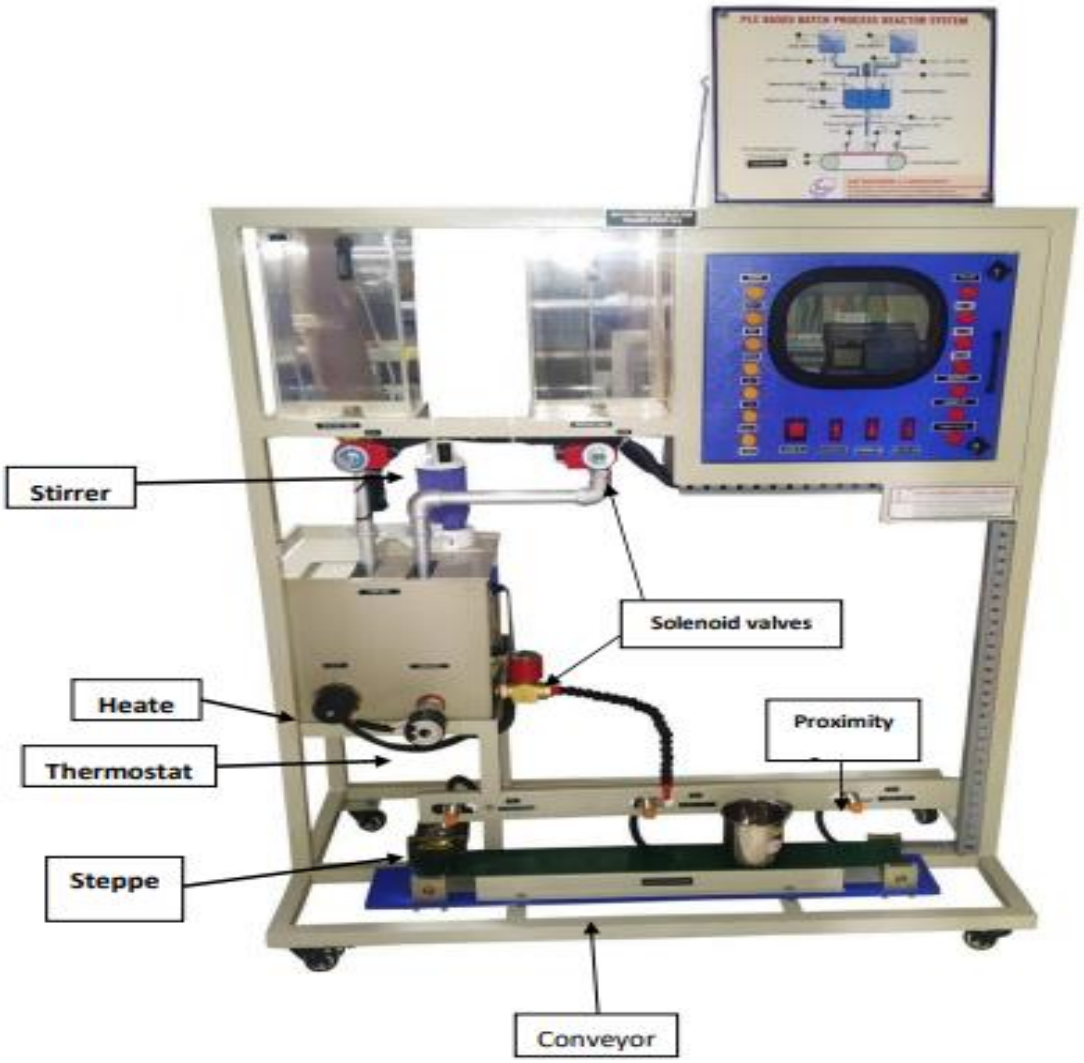
Note: Close the Ball Valve below the Level Tank and Drain Valve should be closed

8. DO'S & DON'TS FOR PLC BASED WATER LEVEL CONTROL MODULE

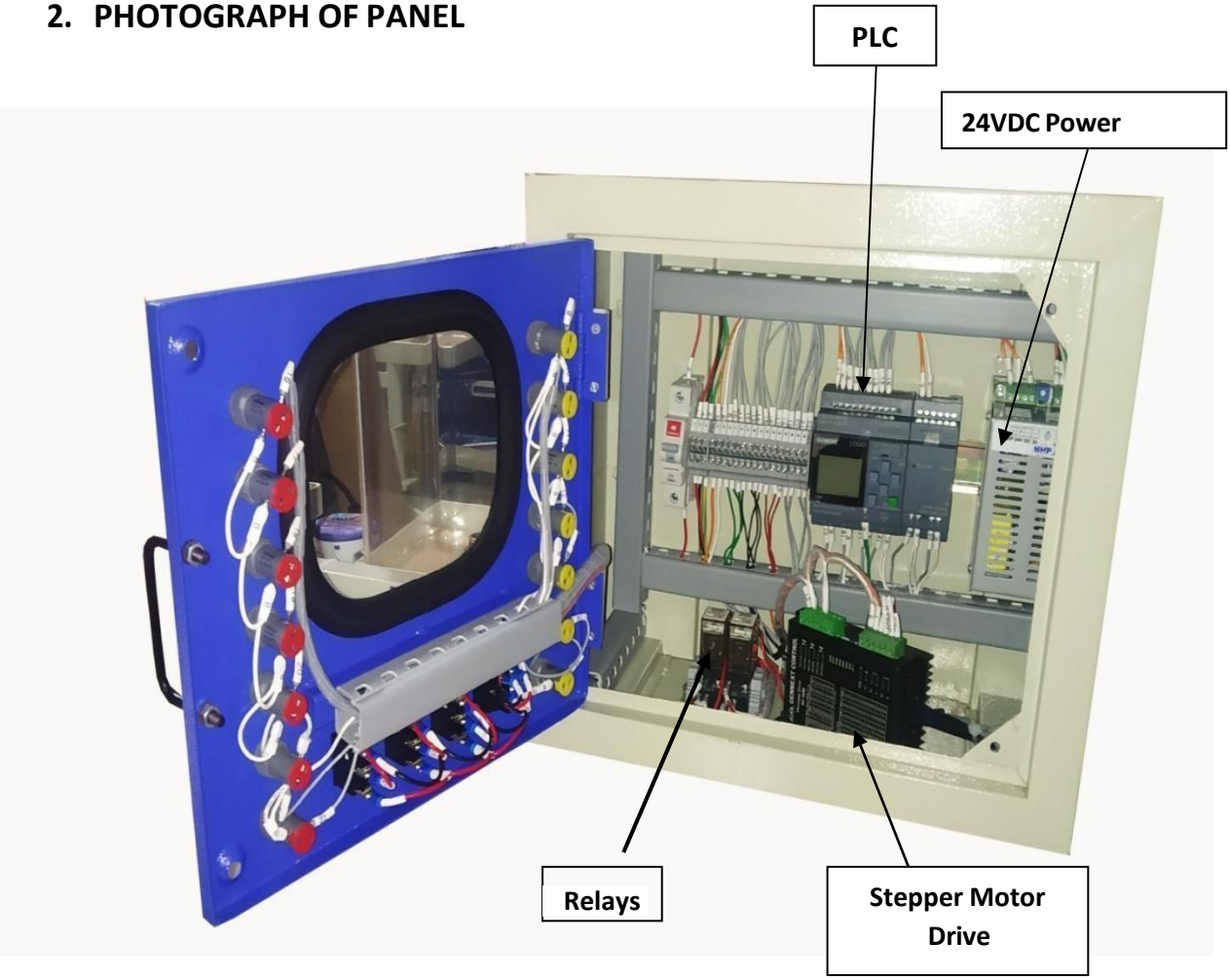
- Before starting operation of level controller ensure the water Level in the Sump Tank i.e. LS3 (Level Switch) is ON and water is filled 75% of tank level.
- Follow operating procedure given above to perform the experiment
- During the experiment always maintain the level of Liquid in the tank.
- If the system is not in use for longer period, replace the water from the tank with fresh water prior performing an experiment.
- Use clean water only.
- Do not keep water in the tank for longer period that may damage the tank wall surface.
- Test points on the Control Panel are for reading purpose, 24VDC input and Output.
- If you want to Hookup this level control trainer with another PLC trainer, then turn OFF internal Siemens Logo PLC.

PLC based Batch Process Reactor System

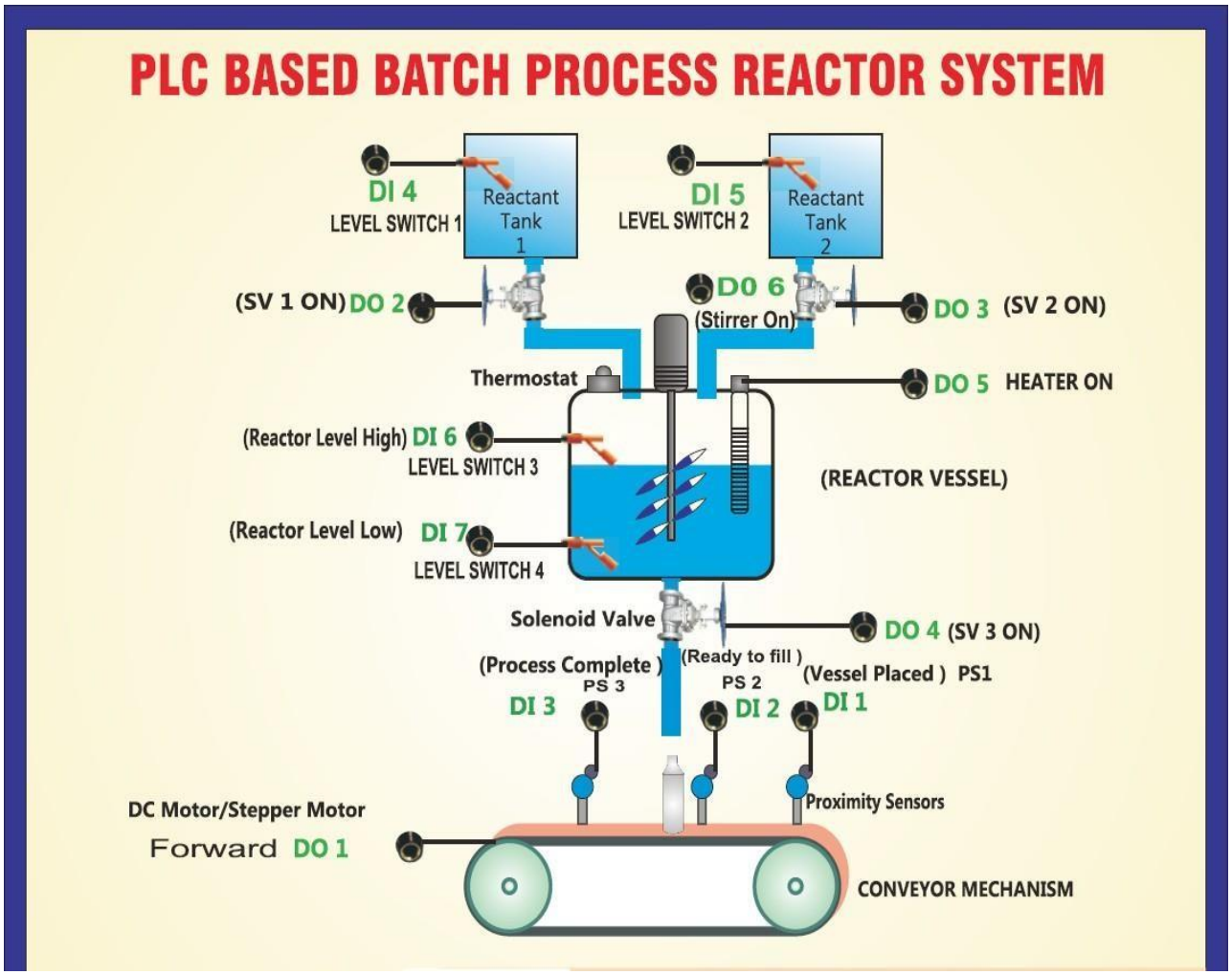
1. PLC BASED BATCH PROCESS REACTOR SYSTEM



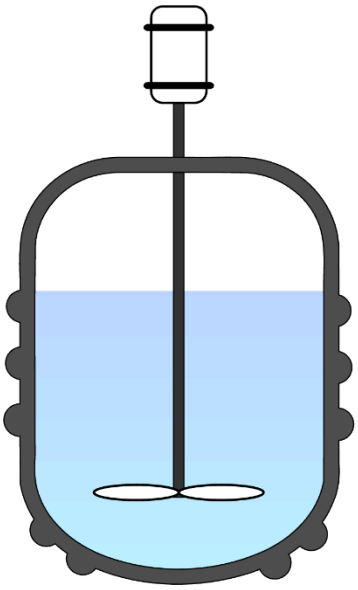
2. PHOTOGRAPH OF PANEL



3. MIMIC DIAGRAM



4. BATCH REACTOR



A batch reactor is the simplest type of reactor vessel used for chemical or industrial processes. A typical batch reactor consists of a tank where chemical reactions occur. These tanks also have an agitator and an internal heating or cooling system. Batch Reactor vessels are used for a variety of process operations which include solids dissolution, product mixing, chemical reactions, batch distillation, crystallization, liquid/liquid extraction, and polymerization. In some cases, reactors but have a name that reflects the role they perform (such as crystallizer, or bioreactor).

A typical batch reactor consists of a tank with an agitator and an integral heating/cooling system. These vessels may vary in size from less than 1 liter to more than 15,000 liters.

They are usually fabricated in steel, stainless steel, glass-lined steel, glass, or exotic alloy. Liquids and solids are usually charged via connections in the top cover of the reactor. Vapors and gases also discharge through connections in the top. Liquids are usually discharged out of the bottom.

One of the biggest advantages of the batch reactor is that a single vessel can carry out a sequence of different operations without the need to break containment which is useful when processing, toxic or highly potent compounds.

5. SYSTEM COMPONENTS

a. PROCESS TANK: A process tank is a vessel or other container used for the mixing or batching of chemicals, feeds, wastewater, or other components, or for the preparation of one or more components, leading to the production of the desired product. The term includes all attached piping and other fixtures necessary for the intended operation of the vessel or container.

b. STIRRER/AGITATOR: An Agitator/Stirrer is used for mixing different process media – liquids, gases, and solids in chemical addition or Pharmaceutical Ingredients. The agitator imparts energy through mechanical means by rotating a shaft on which there is an impeller designed specifically for the duty. This could be axial pumping, gas induction, flocculating, high viscosity products, high & low shear mixing, etc. An agitator is also used in the Water Industry for adding various chemicals to bring the source water up to drinking water standards. The usual agitator arrangement is a centrally mounted driveshaft with an overhead drive unit. Impeller blades are mounted on the shaft. A wide variety of blade designs are used and typically the

blades cover about two-thirds of the diameter of the reactor. Where viscous products are handled, anchor-shaped paddles are often used which have a close clearance between the blade and the vessel walls. Most batch reactors also use baffles. These are stationary blades that break up flow caused by the rotating agitator. These may be fixed to the vessel cover or mounted on the interior of the side walls. Despite significant improvements in agitator blade and baffle design, mixing in large batch reactors is ultimately constrained by the amount of energy that can be applied. An Agitator is generally made up of three main components

– a shaft with impellers, a mechanical seal, and a motor with the option of gearbox for lower RPM duties. The agitator is mounted onto the vessel or via a supporting bridge in the water industry. The mechanical seal has several options depending on the duty – single/double mechanical seal, dry or wet mechanical seal, gas lift-off mechanical seal that is related to the duty involved. An agitator shaft is connected to the drive unit (motor & gearbox) and where the impellers used for the mixing are welded or bolted onto.

c. HEATING SYSTEM: Products within batch reactors usually liberate or absorb heat during processing. Even the action of stirring stored liquids generates heat. To hold the reactor contents at the desired temperature, heat has to be added or removed by a cooling jacket or cooling pipe. Heating/cooling coils or external jackets are used for heating and cooling batch reactors. Heat transfer fluid passes through the jacket or coils to add or remove heat.

d. REACTOR/LEVEL TANKS: The liquid before entering the process tank is stored in the level tanks. Their capacity depends upon the capacity of the Process Tank. Level switches are mounted on these level tanks so that the desired amount of liquid is transferred to the Process Tank.

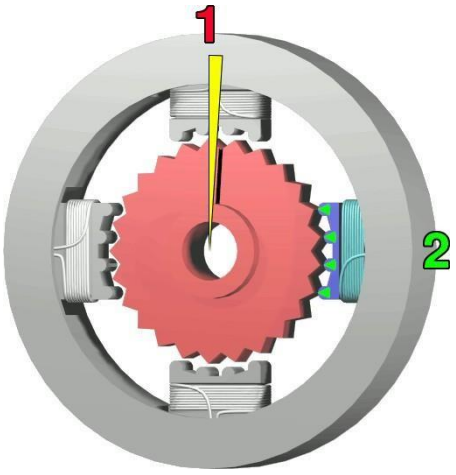
e. LEVEL/FLOAT SWITCHES: A float switch is an electromechanical switch that allows for an electrical switch to be opened or closed depending on the fluid level in a container. The float switch allows for automatic operation of devices depending on the level of fluid, such as the operation of pumps, or the opening or closing of valves. Float switches of numerous configurations

have been used for various marine and industrial applications. Most float switches contain an electrical switch embedded within the body of the float switch device. The electrical switch is actuated upon physical movement of the portion of the float switch device containing the electrical switch or upon physical movement of another portion of the float switch device.

f. SOLENOID VALVES **(**24V DC operated ½" size): A solenoid valve is an electrically controlled valve. The valve features a solenoid, which is an electric coil with a movable ferromagnetic core (plunger) in its center. In the rest position, the plunger closes off a small orifice. An electric current through the coil creates a magnetic field. The magnetic field exerts an upwards force on the plunger opening the orifice. This is the basic principle that is used to open and close solenoid valves.

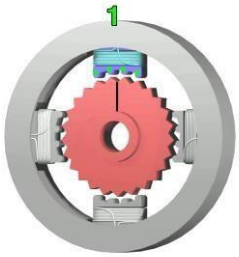
A solenoid valve has two main parts: the solenoid and the valve. The solenoid converts electrical energy into mechanical energy which, in turn, opens or closes the valve mechanically.

g. STEPPER MOTOR: A stepper motor is an electric motor whose main feature is that its shaft rotates by performing steps, that is, by moving by a fixed number of degrees. This feature is obtained thanks to the internal structure of the motor and allows to know the exact angular position of the shaft by simply counting how many steps have been performed, with no need for a sensor. This feature also makes it fit for a wide range of applications. Stepper motors, on the other hand, effectively have multiple "toothed" electromagnets arranged around a central metal gear, as shown at right. To make the motor shaft turn, first one electromagnet is given power, which makes the gear's teeth magnetically attracted to the electromagnet's teeth. When the gear's teeth are thus aligned to the first electromagnet, they are slightly offset from the next electromagnet. So, when the next electromagnet is turned on and the first is turned off, the gear rotates slightly to align with the next one, and from there the process is repeated. Each of those slight rotations is called a "step." In that way, the motor can be

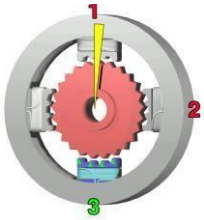


turned at a precise angle. There are two basic arrangements for the electromagnetic coils: bipolar and unipolar.

The top electromagnet (1) is charged, attracting the topmost four teeth of a sprocket.

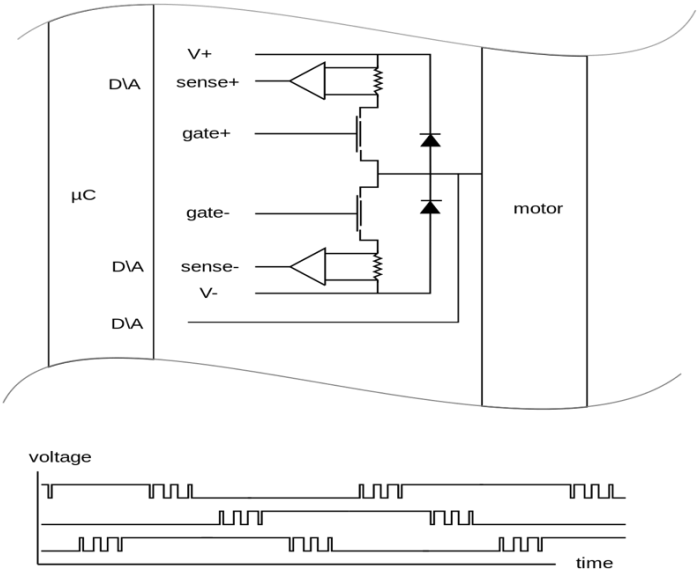


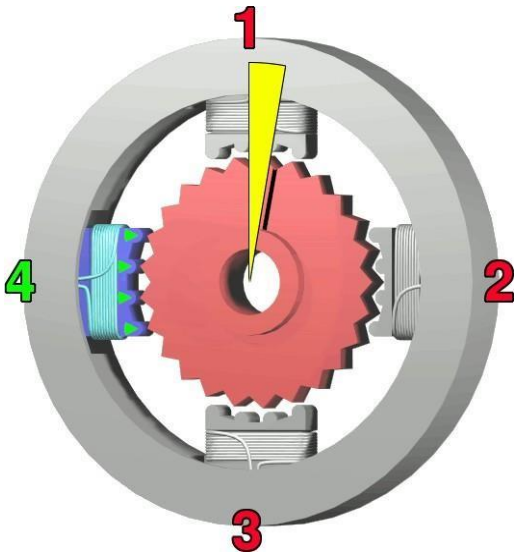
The top electromagnet (1) is turned off, and the right electromagnet (2) is charged, pulling the nearest four teeth to the right. This results in a rotation of 3.6°.



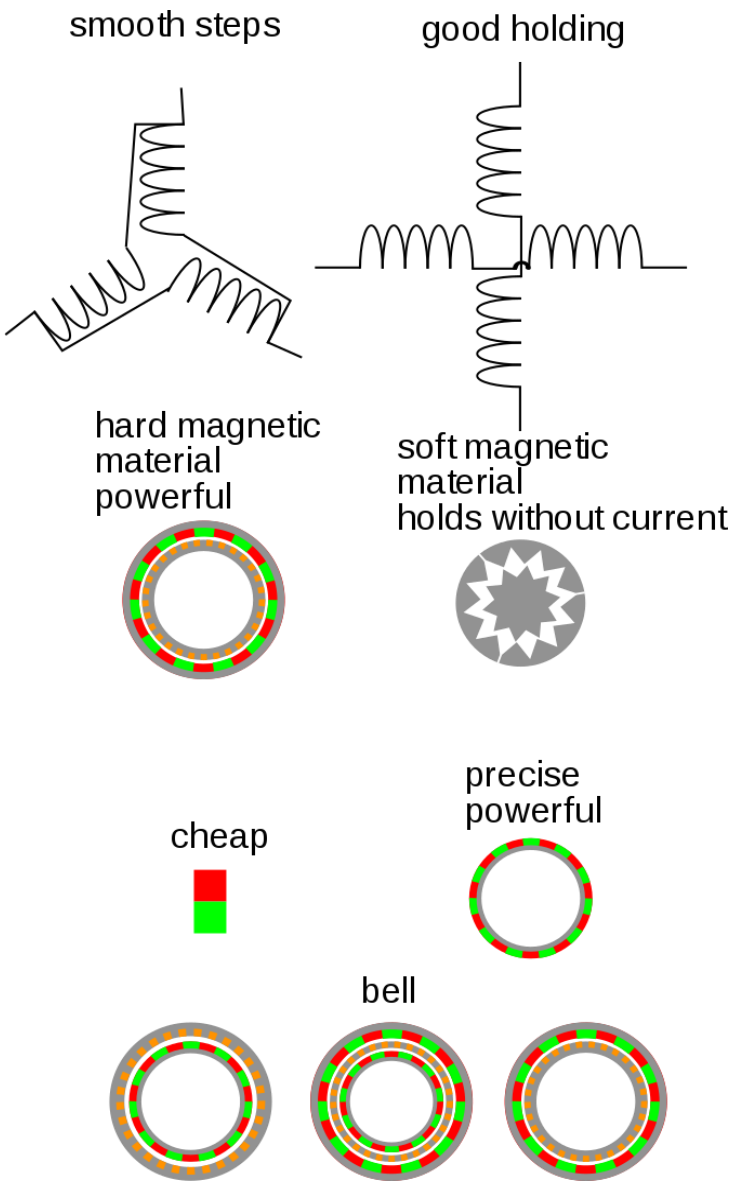
The bottom electromagnet (3) is charged; another 3.6° rotation occurs.

The left electromagnet (4) is enabled, rotating again by 3.6°. When the top electromagnet (1) is again charged, the teeth in the sprocket will have rotated by one tooth position; since there are 25 teeth, it will take 100 steps to make a full rotation.





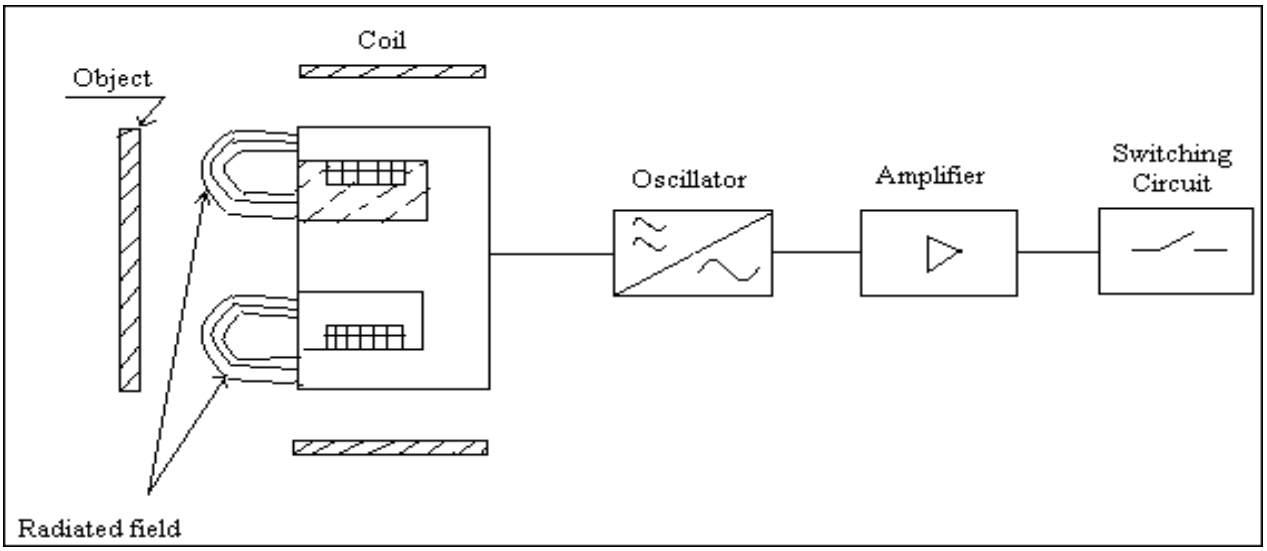
Because of induction of the windings, power requirements, and temperature management some glue circuitry is necessary between digital controller and motor.



Different details of configuration have to be decided when choosing a motor. Almost everything is combinable.

h. PROXIMITY SWITCH: A **proximity switch** is one detecting the proximity (closeness) of some object. By definition, these switches are non-contact sensors, using magnetic, electric, or optical means to sense the proximity of objects. A proximity switch will be in its "normal" status when it is distant from any detectable object. Being non-contact in nature, proximity switches are often used instead of direct-contact limit switches for the same purpose of detecting the position of a machine part, with the advantage of never wearing out over time due to repeated physical contact. Most proximity switches are active in design. That is, they incorporate a powered electronic circuit to sense the proximity of an object. Inductive proximity switches sense the presence of metallic objects through the use of a high-frequency magnetic field. Capacitive proximity switches sense the presence of non-metallic objects through the use of a high-frequency electric field. Optical proximity switches detect the interruption of a light beam by an object. Ultrasonic proximity switches sense the presence of dense matter by the reflection of sound waves.

Operating Principle: These types of switches work on the "Damped Oscillator" principle. During operation, a frontally radiated electromagnetic oscillating field is projected from the sensing face. Any Electrically conductive material entering this field causes damping of the oscillations. This change is detected by the in-built sensitive & reliable electronic circuit and is converted into an effective output signal.



SENSING OBJECT MATERIAL:

The standard inductive proximity switches can sense any metallic (electrically conductive) object. However, there are special types of switches to sense either only ferrous objects orsense only non-ferrous (Cu, Al, etc.) objects.

SENSING ZONE:

These Switches have a dome-shaped electromagnetic field present in front of the sensing area. The switch will sense the object entering into this domain.

SENSING DISTANCE (Sn): This is the distance between the target and the sensing face at which the switch operates. This is usually specified considering M.S.

PLC LOGIC:

Incoming control signals, or inputs, interact with instructions specified in the user ladder program, which tells the PLC how to react with the incoming signals. The user program also directs the PLC on how to control field devices like motor starters, pilot lights, & solenoids. A signal going out of the PLC to control a field device is called an Output.

The objective of the experiment is to mix up two liquids from two different tanks, then the process of heating and mixing takes place in the third tank and then fill up cups on the conveyor assembly automatically by using PLC.

For the execution of this operation, the lower tank must be filled with water upto the LS4 (level switch 4), to 25% of the reservoir. Then fill both the reactant tanks with water upto LS1 & LS2. Place the Metal Cup/Mug at the position in front of Proximity sensor PS1 on the conveyor.

Distance between sensor & Cup wall should be a minimum 3mm so that the PS1 indication lamp glows. Keep Thermostat on 100°C.

When you turn ON all supply switches,

As LS1 & LS2 (Level Switch) gets activated and LS3 (Level switch 3) is deactivated, Solenoid valve SV1 and SV2 turns ON, water started to flow in Mixing Tank & Solenoid valves remains ON till level reaches LS3 (Level Switch 3) in the Mixing Tank.

When the level of the water in the Mixing Tank reaches up to LS3 (Level Switch 3), the Stirrer Motor and Heater is turned ON. After that 5 sec of delay occurs & the solenoid valve situated below the tank is operated and remains in operation till the level goes below LS2 (Level Switch2).

As LS2 (Level Switch 2) level is reached, Solenoid Valve is turned OFF & the Pump is restarted to maintain water level up to LS1.

The Inputs & Outputs used in PLC are,

I/P 1: -LS-1	Level Switch 1	O/P1 Q1: - PUMP ON
I/P 2: -LS-2	Level Switch 2	O/P2 Q2: - SOLENOID VALVE ON
I/P 3: - LS-3	Level Switch 3	

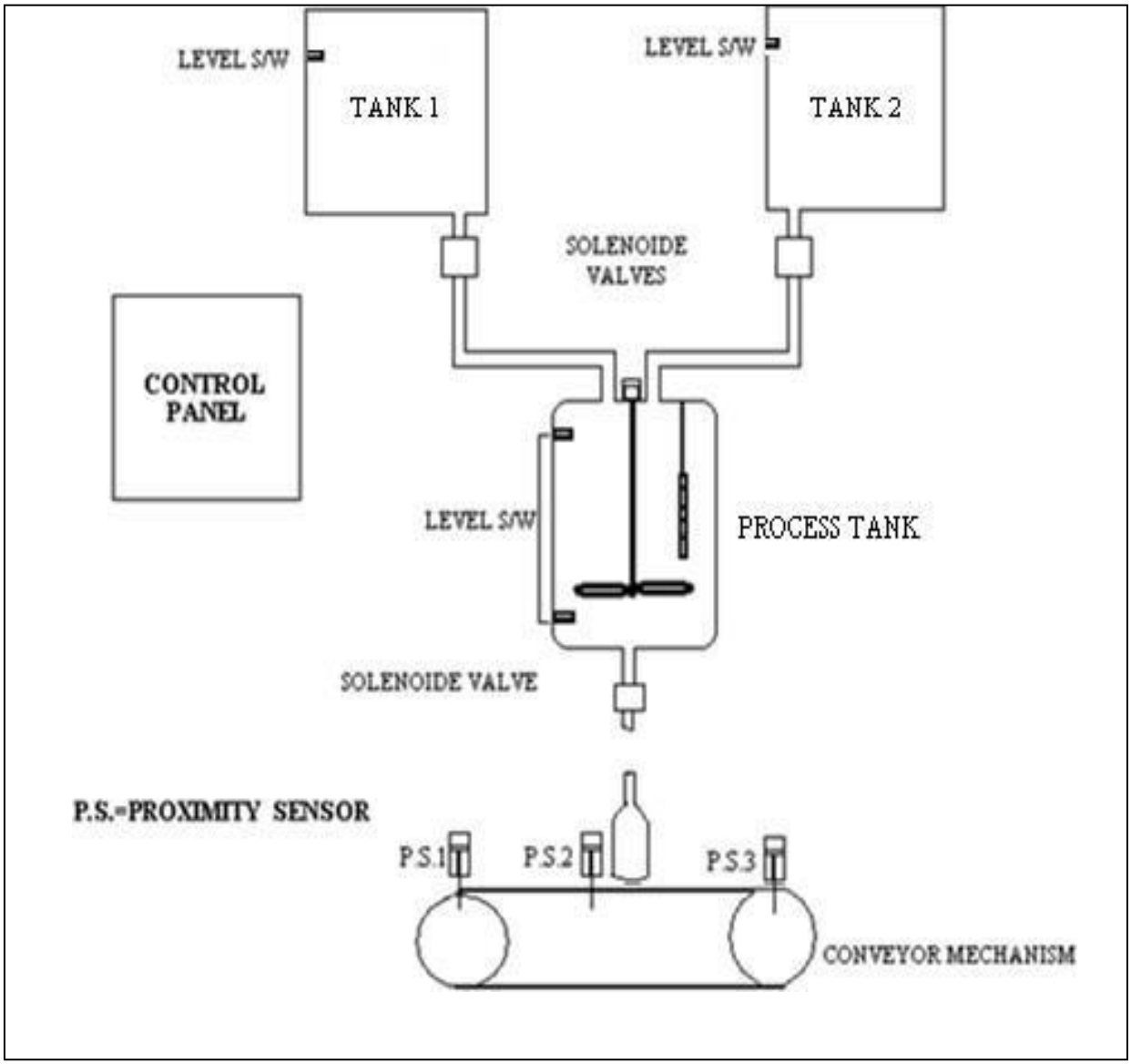
6. OPERATING PROCEDURE

a. Before starting the trainer pour clean water in the respective level tanks to its fullest level marked on the tank.
b. Switch 'ON' the MAINS ON, 24V DC, HEATER ON & STIRRER ON switches.
c. Keep the small Metal Jar / Mug on a conveyer belt at P.S.-1.
d. Download Program to PLC using Logo PC-PLC cable & Run the Program.

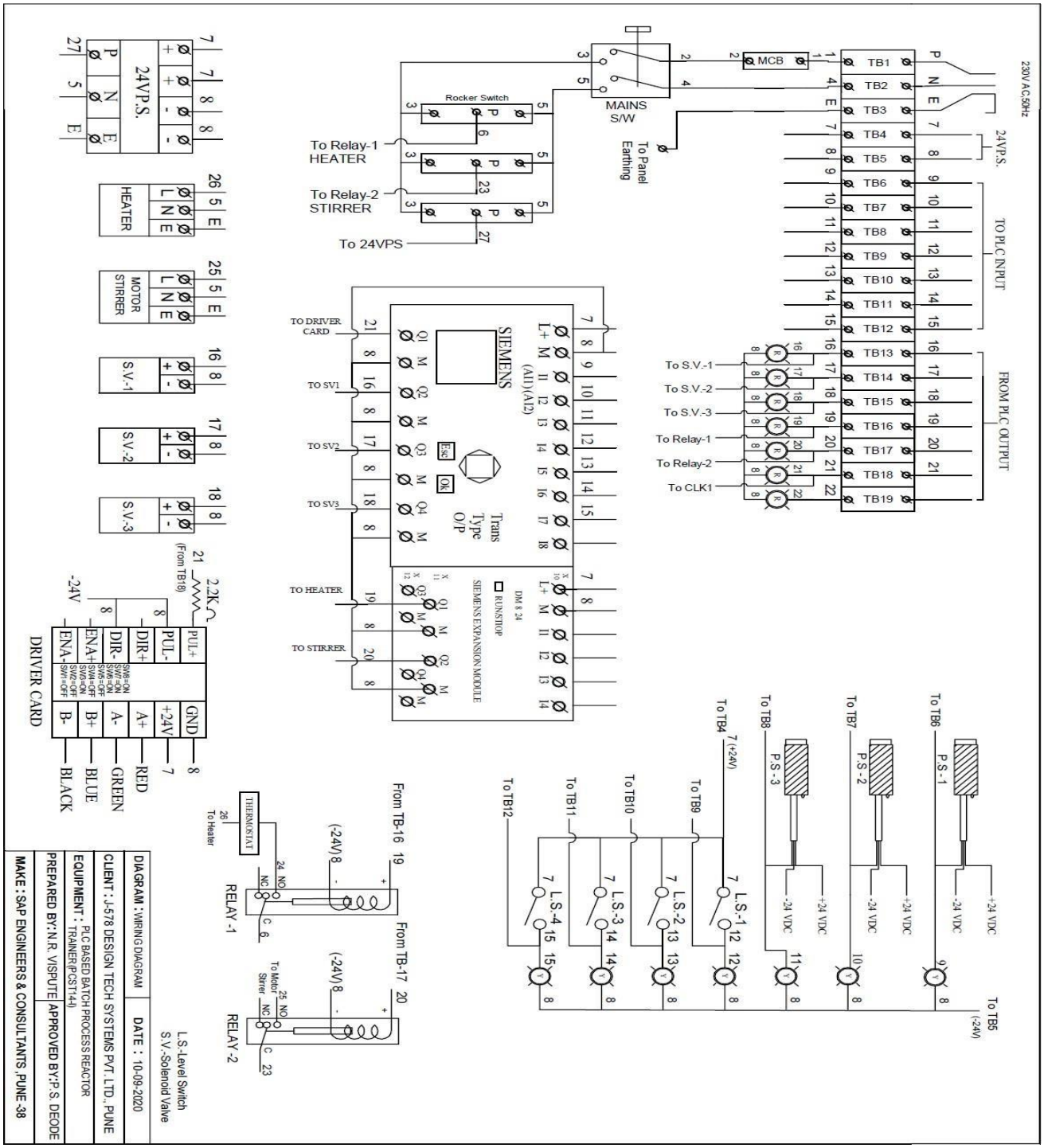
7. OBSERVATIONS

a. According to the program, the fluid will flow from the reactant tank to the process tank through solenoid valves 1 & 2.
b. When the upper-level switch will reach in the process tank, the solenoid valves will get off.
c. Then heater and stirrer will start simultaneously, so that the heat will uniformly get distributed in the fluid inside the process tank.
d. When fluid will get heated at desired temperature level, the heater & stirrer will be turned off.
e. When proximity sensor 1 will detect the metal glass or vessel, the conveyor will start running in the forward direction through the stepper motor.
f. When proximity sensor 2 will detect the metal (vessel), the conveyor will stop and the glass or vessel will fill by solenoid valve 3.
g. After filling the glass or vessel the solenoid valve 3 will be turned off & the conveyor will start again.
h. When proximity sensor 3 will detect the metal, the conveyor will stop finally.

8. P & I DIAGRAM


LEVEL S/W
TANK 1
LEVEL S/W
TANK 2
SOLENOIDE VALVES
CONTROL PANEL
LEVEL S/W
PROCESS TANK
SOLENOIDE VALVE
P.S.=PROXIMITY SENSOR
PS.1
PS.2
PS.3
CONVEYOR MECHANISM

9. WIRING DIAGRAM



10. DO'S AND DONT'S

a. Keep the system clean and away from the wet surface.
b. Take care of PLC, Insert PC-PLC cable carefully.
c. After performing the experiment, keep the cable in a clean place away from dust.
d. Make connections as per the wiring diagram.
e. For troubleshooting refer wiring diagram.
f. In case of any difficulty contact manufacturer.
g. Switch off mains supply after practical is completed, without fail.
h. Do not touch any internal wiring from the backside of the panel unless the mains power is 'off'.
i. In any case, don't modify the program of The PLC without an expert's advice. Changing the program may lead to the malfunction of the system.