# PROJECT

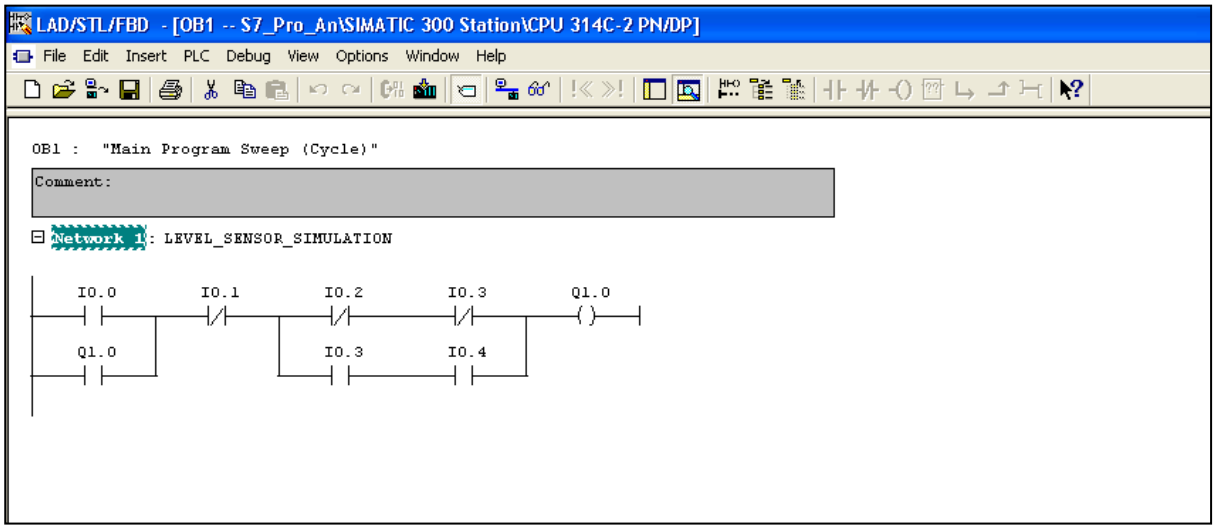
Linear Accelerator system is used to verify and evaluate the solid rocket motors by the radiography process. Since LINAC system is generating the high energy X-rays (15MeV) critical sub systems like Klystron, Linear Accelerator tube, Circulator, Pulse transformer, target and etc are getting heated up and need to be operated in constant temperature. Hence chilled water needs to be circulated to the above-mentioned sub systems in order to maintain constant thermal stability.

This project is the PLC based pump operation & Control System for Linear Accelerator system. Pump operation is controlled through PLC and operated through SCADA from control room. Project consisting of ON/OFF switch and water level sensor used as level interlock.

When the START push button is pressed, the pump is turned on. When the START push button is released, the system will operation in active state. The pump will turn off only if the STOP push button is pressed.

In order to verify the fail-safe condition, level sensor is being simulated and the result of the water circulation is verified. Here simulation is preferred, when the field values are not obtained, then the simulated values are validated for the virtual functioning of the process.

The ladder logic is drawn in the Semantic Manager and shown below.



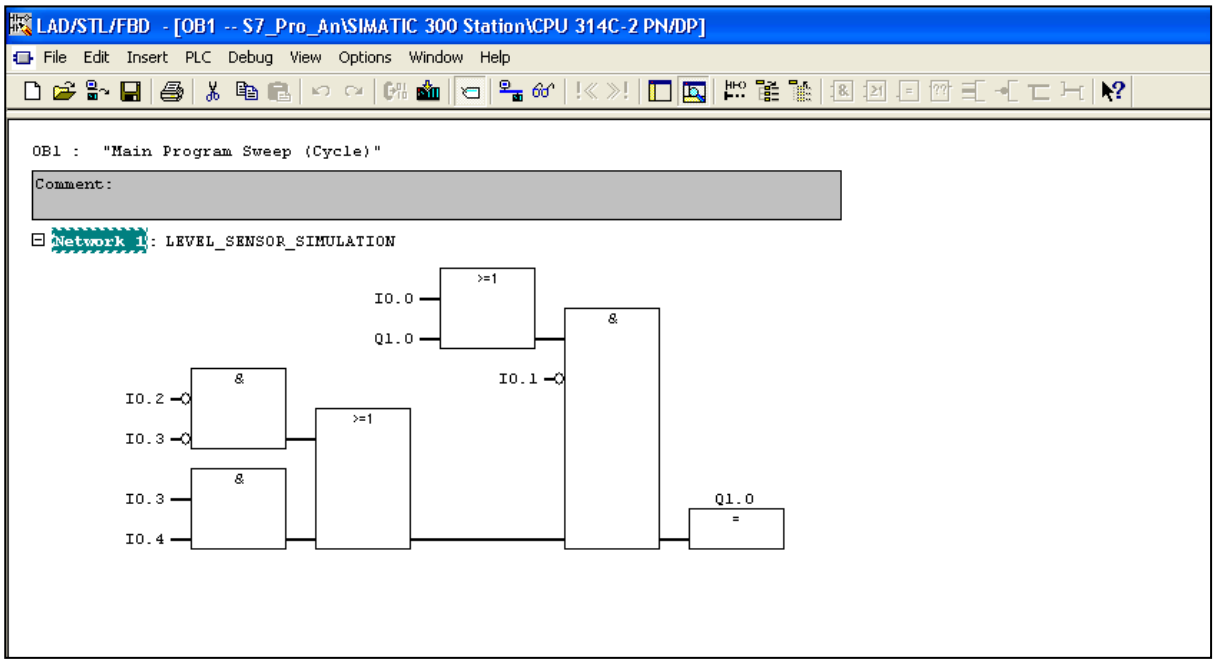

Ladder diagram of Level Interlock Simulation

The START push button is addressed as I0.0. The HOLD is latched with the output address of Q1.0. The STOP push button is created with NC and it is addressed as I0.1.

The LEVEL sensor is NC and the address is given as I0.2. Similarly, the Sensor Simulation Enable is created with NC and addressed as I0.3. The Sensor Simulation Enable is paralleled with the level sensor and fed in series with the Simulation status.

The Simulation Status is normally open and it is addresses as I0.4. The OUTPUT coil is addressed as Q1.0.

The equivalent Functional block diagram (FBD) is shown below.



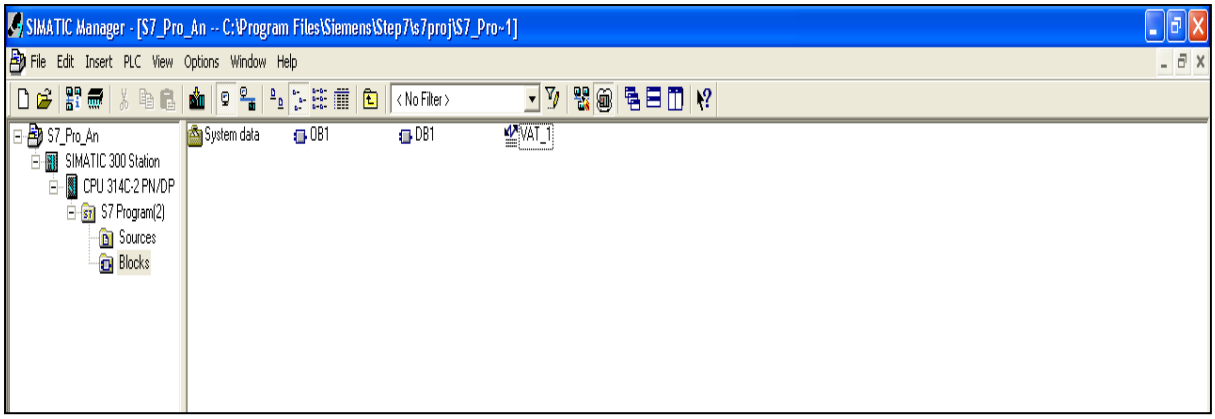

Functional Block Diagram of Level Interlock Simulation

The Standard Text language representation of the logic can be viewed from the VIEW tab in the Ribbon tab. The STL of the formed ladder logic is as follows:

```
A(
O   I   0.0
O   Q   1.0
)
AN  I   0.1
A(
AN  I   0.2
AN  I   0.3
O
A   I   0.3
A   I   0.4
)
=   Q   1.0
```

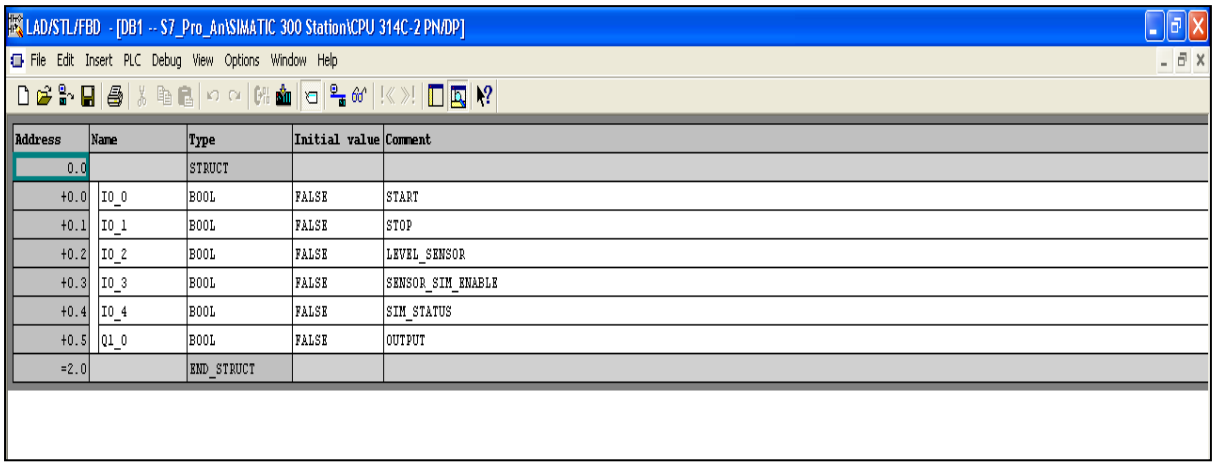
## SIMULATION PROCEDURE

The Ladder logic formed in the Semantic Manager is saved in the OB block and the Datablock (DB) is inserted from the Insert new object. Tags are linked with each object. The Variable block is also created for simulation values.




OB, DB, VAT window

The Datablock (DB) contains the default address of each object and the initial value of the object. Comments are passed for the identification purpose. All the objects are given comments for the identification purpose.



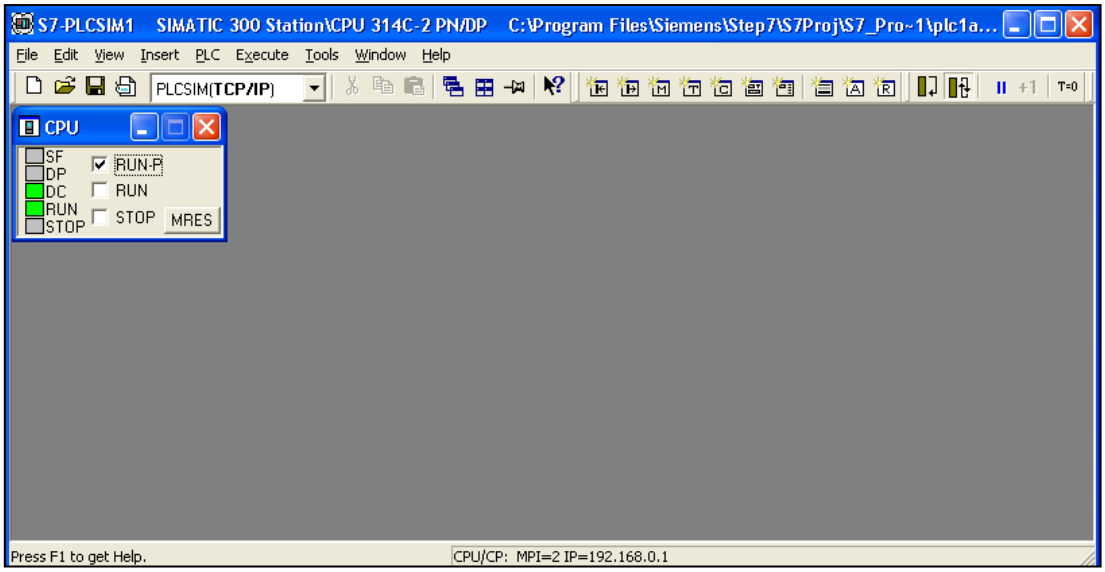

| Address | Name | Type | Initial value | Comment |
|---|---|---|---|---|
| 0.0 | | STRUCT | | |
| +0.0 | I0_0 | BOOL | FALSE | START |
| +0.1 | I0_1 | BOOL | FALSE | STOP |
| +0.2 | I0_2 | BOOL | FALSE | LEVEL_SENSOR |
| +0.3 | I0_3 | BOOL | FALSE | SENSOR_SIM_ENABLE |
| +0.4 | I0_4 | BOOL | FALSE | SIM_STATUS |
| +0.5 | Q1_0 | BOOL | FALSE | OUTPUT |
| =2.0 | | END_STRUCT | | |

DB table window pane

The PLC hardware is configured and the hardware is downloaded. The communication is established with the following steps.

Set PG/PC interfere → Select PLC version (400 series) → PLC SIM (TCP/IP) → Download PLC → Save & Compile.

The PLC SIM is turned ON and the PLC program is switched to online mode. The Var table is fed with all the address of the objects and the static values are kept in FALSE state. The required simulated value can be fed in the Modify value while online.




PLC SIM interface window

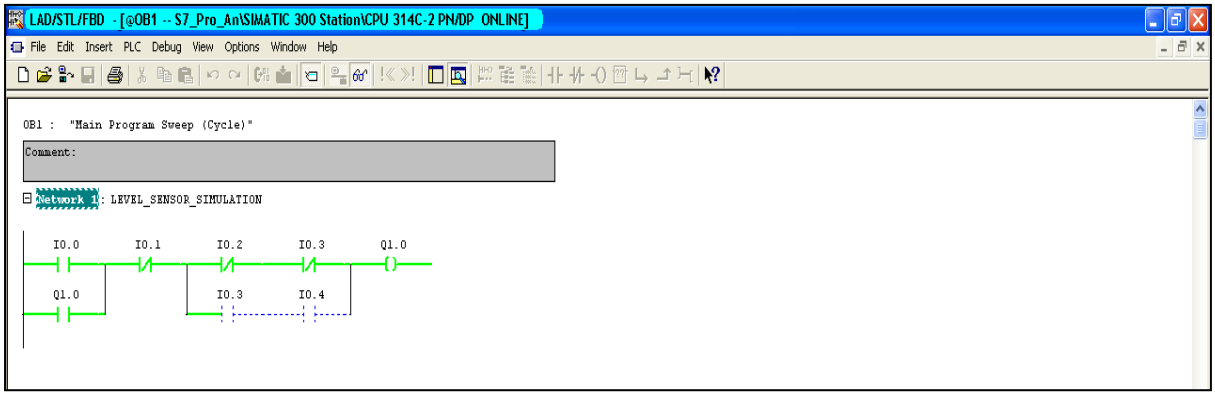
## SIMULATION

The major cases of the masking can include the START, STOP, HOLD and SIMULATE of level sensor. These use cases can be performed by changing the state of its behaviour in the Modify value in the Var table.

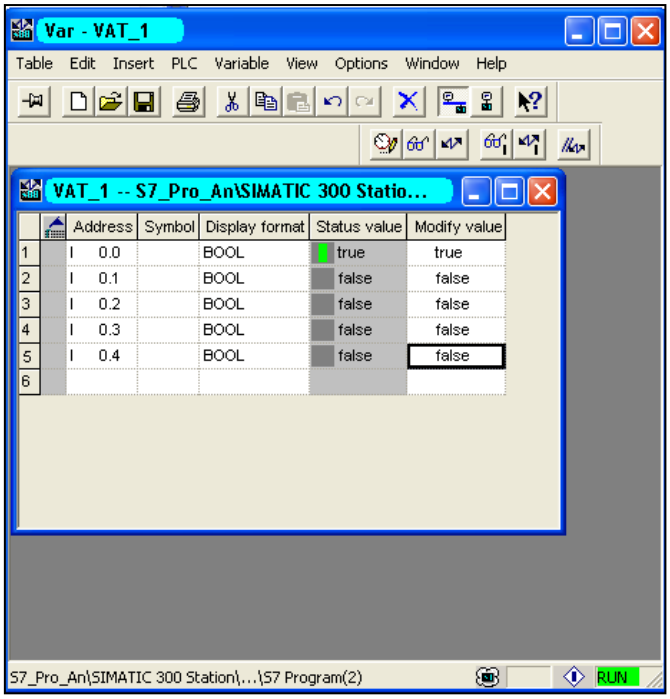
### Case-1: Issue START Command

When the START push button is pressed, then the system generates output if the level interlock is active and turns the Pump ON as the output function. This creates the proper flow of sequence from the start to the end and the output coil becomes active.

The Var table for the START push button is altered by changing the I0.0 to TRUE value. This value is updated to the PLC.




PUSH_ON State

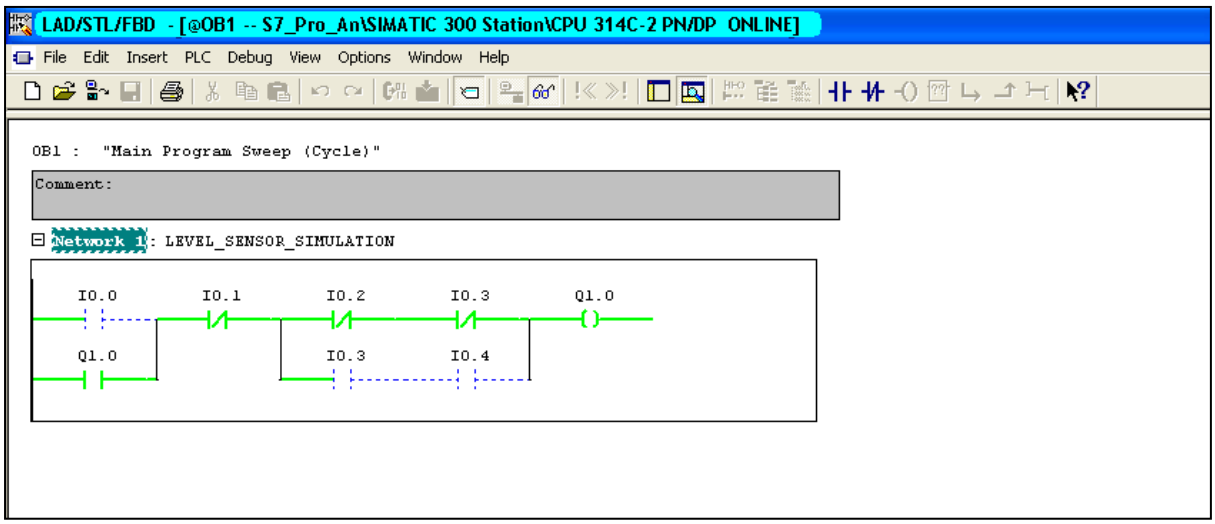



Var Table of PUSH_ON

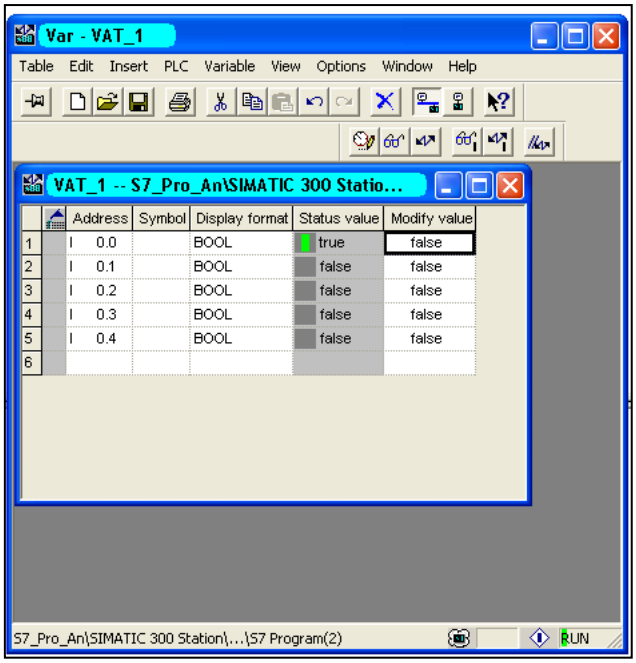
## Case-2: Latching of START Command:

When the START push button is released, the entire system should function until the STOP push button is pressed. This mode of function is having the function to be in hold function. For this the modify value in the Var table is changed from TRUE to FALSE for I0.0. The sequence of flow is proper through the NO switch placed parallelly with the START push button.

The Var table is updated and the PLC is switched to ONLINE mode and the flow is observed.




PUSH_ON Released state

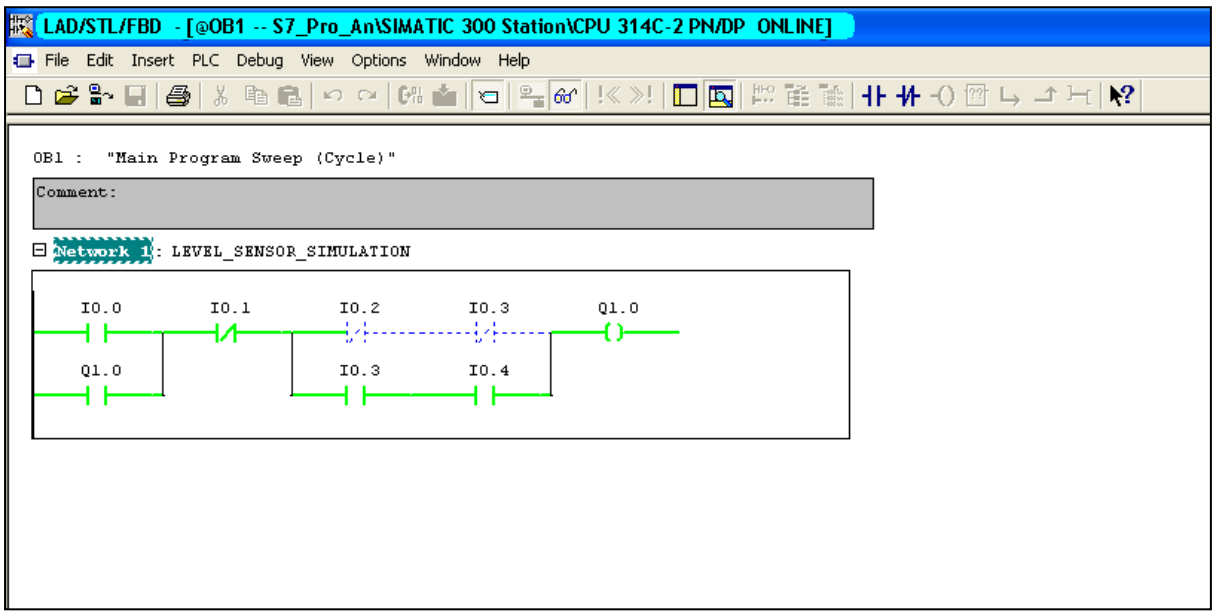



Var Table of PUSH_ON Released

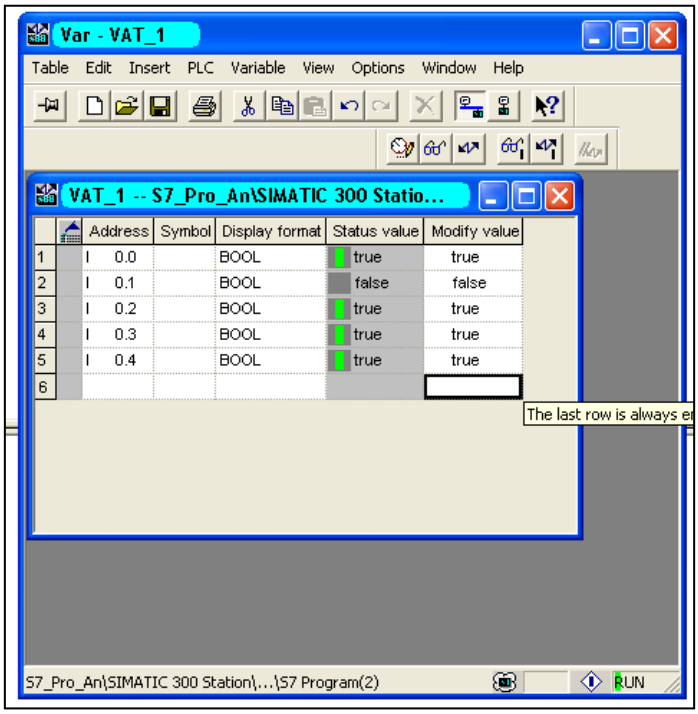
## Case-3: Level sensor Simulation:

When the Level Sensor is not in Healthy status, then the Sensor Simulation Enable is ON. The Level Sensor is addressed to I0.2 and it is in NC. The Sensor Simulation Enable is addressed to I0.3 and it is also in NC. This would activate the other I0.3 which is in NO in parallel configuration with the level sensor. The state of NO I0.3 is high and it in turn activates the Simulation status. The Simulation status is addressed to I0.4 and it is in NO.

The Var table is updated with changing the field values. The values of the status values of I0.2, I0.3, I0.4 are changed from FALSE to TRUE. These values are updated and the PLC SIM is made to run. The flow of sequence is passed via the Sensor Simulation enable and the Simulation status. The output coil turns active.



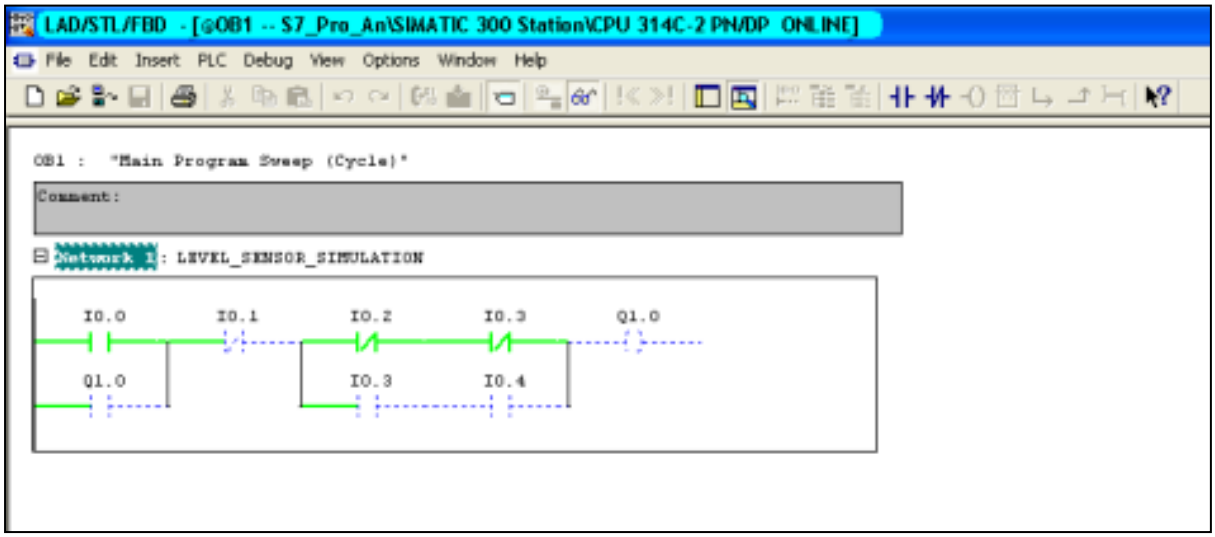
Level Interlock Simulation



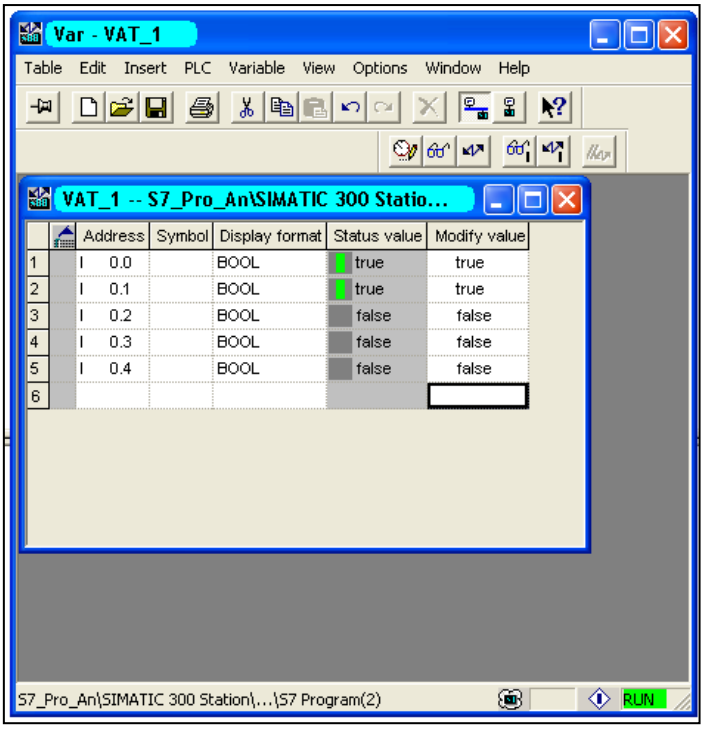

Var Table of Level Interlock

**Case-4: Issuing of STOP Command:**

When the STOP push button is pressed, the entire system stops functioning. The flow of sequence breaks at the STOP button. This button is addressed as I0.1 and it is given as NC. The value of I0.1 is changed to TRUE in the modify value and the table is updated.




PUSH_OFF State




Var table of PUSH_OFF