

Smart Meter Data Transmission Using Programming Platform of PLC and HMI

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Abstract: This paper comprises of PLC programming of the smart meters and monitoring network systems (which use smart meter) in real time for data communication. It gives brief of PLC programming for smart-meter. In this one gets to know- how a PLC get the value from a smart meter using wireless communication. Also this paper explains how the field data of sensors (used in industrial purpose) are transferred to PLC, and how it displays on the HMI.

Keywords: HMI, PLC programming, Smart meter, Wireless communication.

I. INTRODUCTION

For PLC programming, use Simatic manager software tool. The Simatic manager is the tool which provides the programming platform for PLC and features to program a Siemens PLC. The hardware part comprises of the CPU, power supply modules, analog and digital cards for receiving data from sensors in the field [1].

- *CPU:* This is the main unit which receives the data from the field and processes the same as per the programming instruction given to the CPU and produces the results. After doing the programming in simatic manager we download the program in CPU.
- *Power Supply Units:* The power supply unit of CPU is the power house for the CPU, since CPU cards needs 24V DC supply so this power supply unit convert 230V AC supply into uninterrupted 24V DC supply [2] [3].
- *Analog and Digital Cards:* Analog and digital cards are the interface between the field sensors and PLC. The sensor data first report to the analog and digital cards (which is installed in the field inside the input and output panels) and then the same is accessed by PLC on specific time cycle basis.
- *Simatic Manager:* Simatic manager is the software tool which provide the features to program a PLC, we define the set of the instructions to PLC through the simatic

manager and on basis of these set of instruction, PLC process the data and create the results.

II. BLOCK DEMONSTRATION FOR A SMART METER DATA TRANSMISSION TO PLC

In Fig. 1 there is a smart meter which is sending the data (V, A, KW, KVA, PF etc.) to another wireless module and that wireless module send the same data to next wireless module which is placed towards the PLC end. PLC receive the data and process the same as per the programing instruction given to PLC, then the same is displayed on HMI (as per the address defined in PLC).

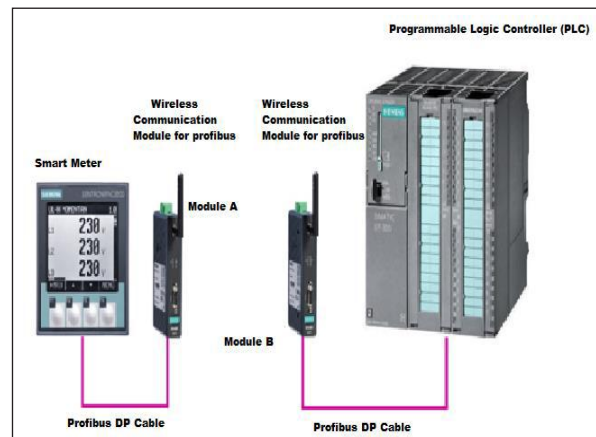


Fig. 1: Architecture of PLC with Smart Meter

III. BLOCK DEMONSTRATION OF FIELD SENSOR DATA TRANSMISSION TO PLC

In Fig. 2, there is one sensor (For eg. temperature RTD) in the field, which is sending data (resistance values) to one transmitter that transmits or converts that data (resistance) into analog value and send it to analog input card which is having interface with PLC and send the same, to PLC on one specific

address which is defined in PLC. PLC process that data and show the same analog values on HMI.

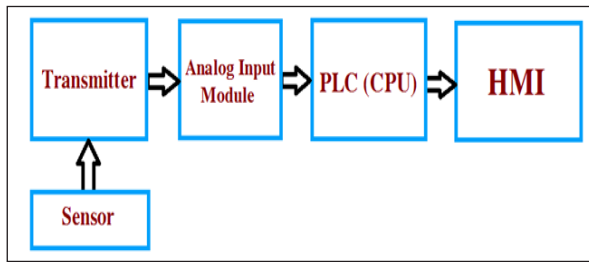


Fig. 2: Block Diagram for Data Transmission

IV. STEPS TO CREATE PROGRAM

For creation of a comprehensive program for a PLC in simatic manager, create a project in simatic manager. Define the hardware configuration of the system so that PLC knows what hardware device is available in the field, and from which device to take data [4].

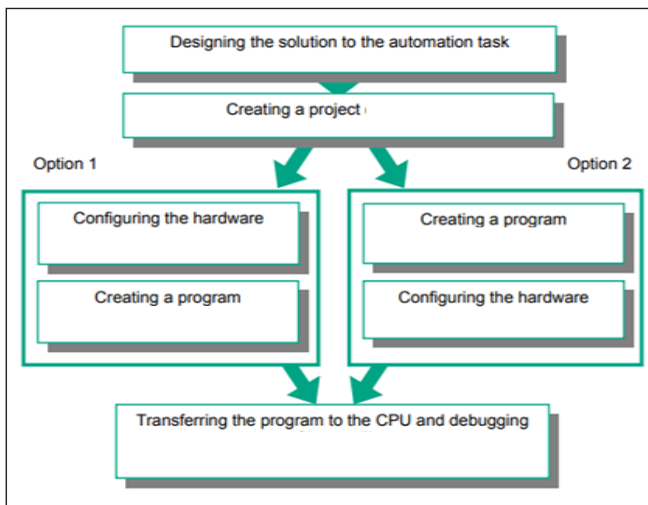


Fig. 3: Steps for Programming

Suppose to use PLC with model no. Siemens S7-400 the hardware configuration needs to define for use of S7-400. Also define power supply modules for use (with model no.), it also have specification of the module like 10A or 20A, along with it define the slot location of the power supply card.

Then define the CPU card along with its sequence in the card board, supposed to use CPU 416-2 DP (T). Define this CPU model along with it there is a need to define the location on the CPU rack. Suppose it is on sequence no. 3. Now if some other cards are available in the CPU rack then define that also. Suppose we have CP443-5 card in CPU rack for field devices and sensors interface to CPU then define that card also in hardware configuration.

Suppose there are some smart meters in the field and we need to take the data from these smart meters and need to show in

HMI then first in the hardware configuration, define that meters like PAC 3200 meter and this is connected through profibus with CPU. Select the model no. of this smart meter from GSD file installed in the system and then select the communication medium between the CPU and the meter.

After defining hardware configuration researcher need to download the program in CPU so PLC will know the devices available in the field and the way it will be communicated to the CPU. Below are the steps for creating a program in PLC:

- First we create project using the wizard.
- Then specify the hardware configuration of the system.
- Select the CPU power supply modules with model no.
- After that select the CPU model no.
- After that select the devices connected (suppose smart meter is connected with model no. PAC3200 then select the same).
- Then select the communication medium between CPU and meter (Fig. 4).
- There are many object blocks choose appropriate blocks (Fig. 5).

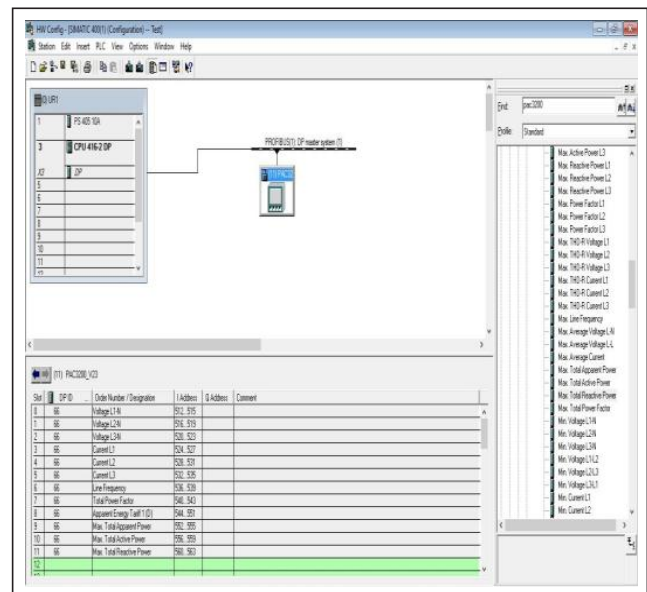


Fig. 4: Select Communication Medium

A. Create Programming Function Blocks

In the PLC, for each and every purpose there are some standard blocks from the software manufacturer which are called functional blocks (FB). Functional blocks define how that particular device or equipment will work. For example if there is one motor in the field and to run that motor from operating station, the standard operation of that motor have one functional block. Inside this block there will be a logic defined, how and when the motor should start and when it should stop along with the conditions. These blocks are the protected blocks by

manufacturer, and they can only open these blocks. Remaining users can only use these blocks..

Same blocks are available for analog signals and digital signals etc.

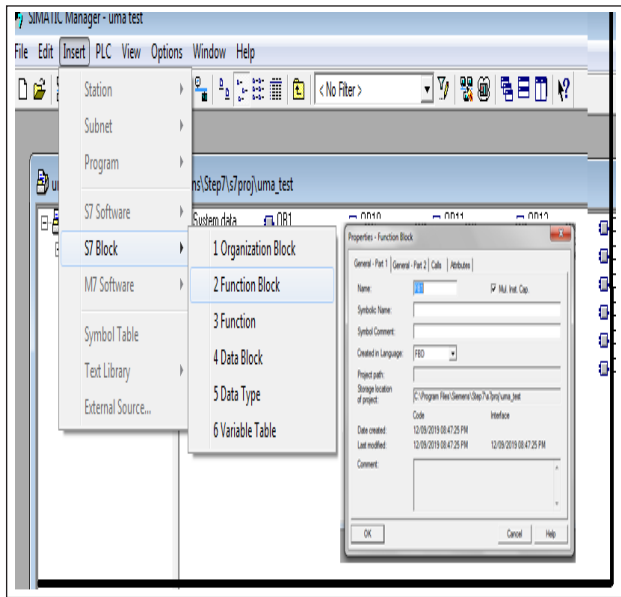


Fig. 5: Select Function Block

FB0	ACESYS_MASTER	STL	1108	Function Block	7.7	Master
FB1	ACESYS_DEPARTMENT	STL	2082	Function Block	7.7	DEPT
FB2	ACESYS_GROUP	STL	6126	Function Block	7.7	Group
FB3	ACESYS_ROUTE	STL	4310	Function Block	7.7	Route
FB4	ACESYS_UNIMOTOR	STL	8026	Function Block	7.7	Unimotor
FB5	ACESYS_BIMOTOR	STL	10100	Function Block	7.7	Bimotor
FB6	ACESYS_MOTORGATE	STL	8928	Function Block	7.7	MotorGate
FB7	ACESYS_POSITIONER	STL	9120	Function Block	7.7	Position
FB8	ACESYS_VALVE	STL	6796	Function Block	7.7	Valve
FB10	ACESYS_SELECT	STL	640	Function Block	7.7	Select
FB11	ACESYS_ALARM	STL	1748	Function Block	7.7	Alarm
FB14	ACESYS_PLC_PLC	STL	20820	Function Block	7.7	PLC-PLC
FB15	ACESYS_ANALOG	STL	4974	Function Block	7.7	Analog
FB18	ACESYS_TOTALIZER	STL	272	Function Block	7.7	Total
FB19	ACESYS_HLC	STL	3140	Function Block	7.7	HLC
FB20	ACESYS_PID	STL	3382	Function Block	7.7	PID
FB23	CRP_OUT	STL	134	Function Block	1.0	CRP_OUT
FB25	DEADBAND	STL	158	Function Block	1.0	DEADBAND
FB26	ACESYS_HW_DIAG	FB	1078	Function Block	0.1	
FB33	LMINGEN_C	STL	1318	Function Block	1.0	LMINGEN_C
FB38	PARA_CTL	STL	270	Function Block	1.0	PARA_CTL
FB39	PID	STL	1254	Function Block	1.1	PID
FB42	RDC_LIM	STL	1038	Function Block	1.1	RDC_LIM
FB63	ACESYS_EXT_MOTOR	STL	19308	Function Block	7.7	Motor

Fig. 6: Function Blocks

B. Create Programming Function Call (FC)

Function call is the block which is created for the individual equipment or sensor available in the field, this block is individually interfaced with the field device input/output PLC address. So suppose one sensor is sending some data to input and output panels in the field then in this block, define that field address and the same value this block show. For each signal or equipment there can be separate block. This is designed by the software supplier and change in the logic and the design of the block is not possible.

C. Create VAT Table for Data

The variable table is named as VAT table, the purpose of this table is to monitor the variable values of multiple inputs and outputs at a particular time. Suppose there are 10 numbers of analog input signals reported to the various addresses of PLC then directly put that analog input address in VAT table and monitor all the real time values together. So to create VAT table go in property option of simatic manager and then create (Fig. 7). After creating VAT table, digital signals can be monitored.

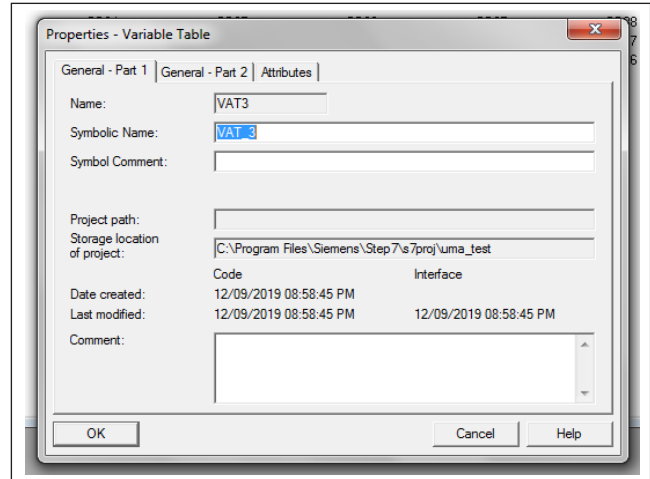


Fig. 7: Create VAT Table

D. Brief Procedure for Communication of PLC with Smart Meter

Since data from smart meter from field is needed, then for that we have to establish the communication with PLC. To communicate with PLC below are the programming steps for establishing the communication:

- Open simatic manager software and create new program. Define hardware configuration in the PLC program, for that define in program whatever the actual hardware is available in the field. After that download the program in the PLC. One thing should be clearly mentioned in the program that is the communication protocol used in the system. Suppose in this case smart meter is communicating with profibus DP with PLC then in the hardware configuration of the program define the medium of communication.
- For installing catalogue we need to install the GSD file in the simatic manager (this GSD will be installed only if the meter is other than Siemens make). Also GSD file will allow us to access the parameter and data which need to monitored and required from meter. For that after installation of GSD there is a need to drag and drop the required parameters from the catalogue to the PLC program. Fig. 8 is the snapshot for the parameter selection from the catalogue window.

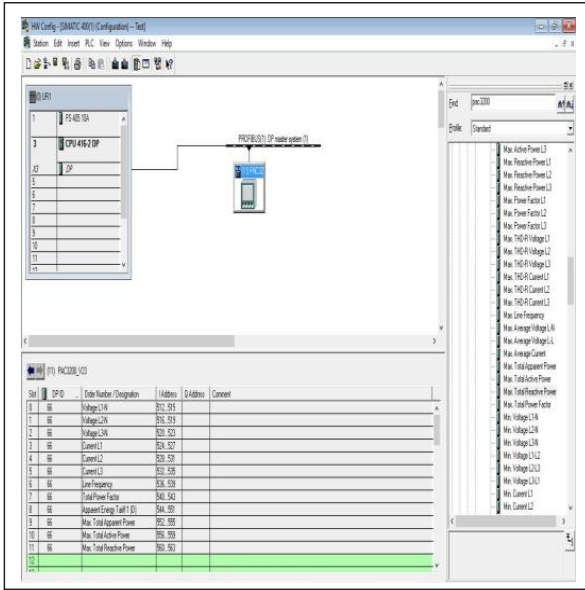


Fig. 8: Select Parameters

Catalogue and parameter are defined after GSD file installation.

E. PLC Programming for Smart Meter

To monitor 3 parameters (3 individual phase voltage) for voltage and 3 parameters (3 individual phase current) for current in simatic manager, at the time of parameter selection there is a need to define the PLC memory address where the input readings will report to PLC (Fig. 9). In Fig. 9, for voltage line L1 the address is 513-515 (4 words), same are for the other phase current and voltages. So when the meter starts to communicate with PLC then the all parameters report on the address mentioned [5].

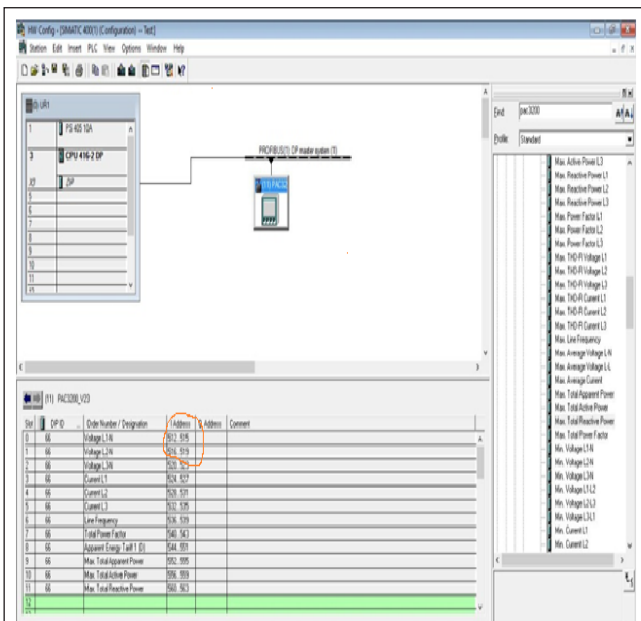


Fig. 9: Input Address for Parameters

Now after defining the PLC address transfer that data to SCADA screen to watch the values of the parameters on HMI, for that programming should be done.

- For Line Voltages

Fig. 10 have 3 blocks for 3 line voltage parameters, and for L1-L2 voltage the PLC address is *DB4345.DBD64*. Using this address PLC is continuously getting input data (L1-L2 voltage) from field so if we want to show the same value on HMI [3] then there is a need to move block and at the input of this move block, there is a need to give the actual PLC address where the input signal (L1-L2 voltage) is reported. At the output give one address to save these values. It means the temporary address (*DB13.DBD904*) where to save these parameter values.

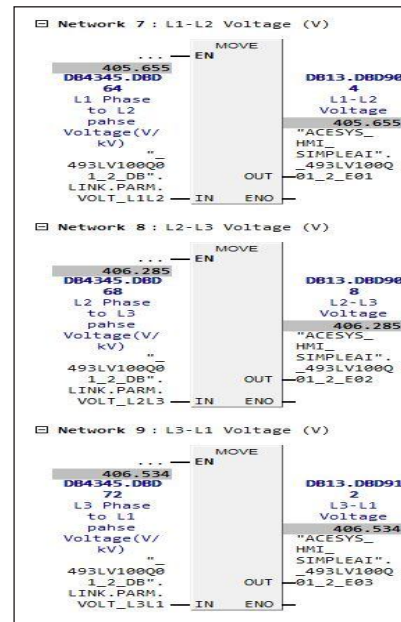


Fig. 10: Line Voltage Readings

Now to monitor the voltage values on the SCADA screen, use the same temporary address *DB13.DBD904*. Hence the same values of the parameter which are reported to PLC will show on HMI. In the same manner for phase voltage L2-L3 voltage, the PLC address is *DB4345.DBD68*. On this address PLC is continuously getting input data (L2-L3 voltage) from field, so now if we want to show the same value on HMI then one move block is needed and at the input of this move block give the actual PLC address where the input signal (L2-L3 voltage) is reporting. At the output give address where we want to save these values, means the temporary address (*DB13.DBD908*). Now suppose we want to monitor the voltage values on the SCADA screen then there is a need to use the same address which has been used as temporary address *DB13.DBD908*. The same values of the parameter which are reporting to PLC are seen on HMI [6].

In the same manner for phase voltage L3-L1 voltage the PLC address is *DB4345.DBD72*. On this address PLC is continuously getting input data (L3-L1 voltage)

from field so now if we want to show the same value on HMI then we need one move block and at the input of this move block we need to give the actual PLC address where the input signal (L3-L1 voltage) is reporting. And at the output we need to give one address where we want to save these values, means the temporary address (DB13.DBD912) where we are going to save these parameter values.

Now suppose we want to monitor the voltage values on the SCADA screen then we have to use the same address which has been used as temporary address DB13.DBD912. Hence the same values of the parameter which are reporting to PLC are shown on HMI.

• For Line Current

Fig. 11 have 3 blocks for 3 line current parameters, now for L1 line current the PLC address is DB4345.DBD80 and on this address PLC is continuously getting input data (L1 current) from field so to show the same value on HMI, we need to move block and at the input of this move block we need to give the actual PLC address where the input signal (L1 line current) is reporting. At the output give one address where we want to save these values, means the temporary address (DB13.DBD892) where we are going to save these parameter values [7].

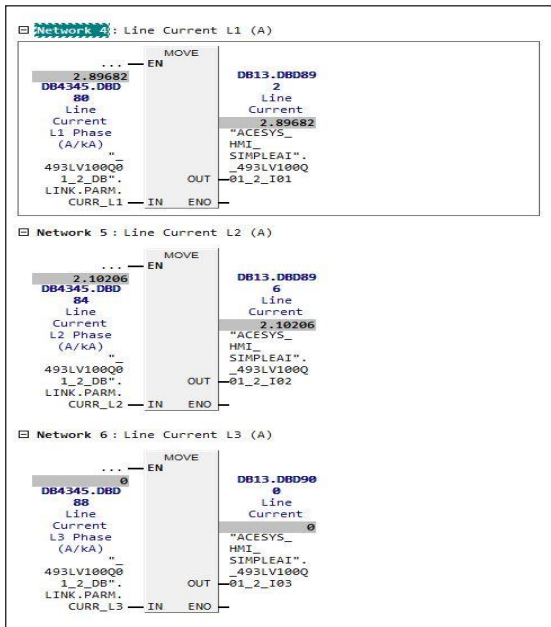


Fig. 11: Line Current Readings

To monitor the voltage values on the SCADA screen use the same address which we have used as temporary address DB13.DBD892. So the same values of the parameter which are reporting to PLC are shown on HMI [8].

Now in the same manner for line current L2 we have 3 blocks for 3 line current parameters, now for L2 line current the PLC address is DB4345.DBD84. On this address PLC is continuously getting input data (L2

current) from field so now if we want to show the same value on HMI then we need one move block and at the input of this move block we need to give the actual PLC address where the input signal (L2 line current) is reporting. And at the output we need to give one address where we want to save these values, means the temporary address (DB13.DBD896) where we are going to save these parameter values.

Now suppose we want to monitor the voltage values on the SCADA screen then we have to use the same address which we have used as temporary address DB13.DBD896. So the same values of the parameter which are reporting to PLC will shown on HMI [9].

Now in the same manner for line current L3 we have 3 blocks for 3 line current parameters, now for L3 line current the PLC address is DB4345.DBD88 on this address PLC is continuously getting input data (L3 current) from field so now if we want to show the same value on HMI then we need one move block and at the input of this move block we need to give the actual PLC address where the input signal (L3 line current) is reporting. And at the output we need to give one address where we want to save these values, means the temporary address (DB13.DBD900) where we are going to save these parameter values [10].

Now suppose we want to monitor the voltage values on the SCADA screen then we have to use the same address which we have used as temporary address DB13.DBD900. So the same values of the parameter which are reported to PLC will appear on HMI.

• Programming for Frequency, PF, Apparent Power

In the same manner we do for the frequency, power factor and apparent power, as shown in Fig. 12.

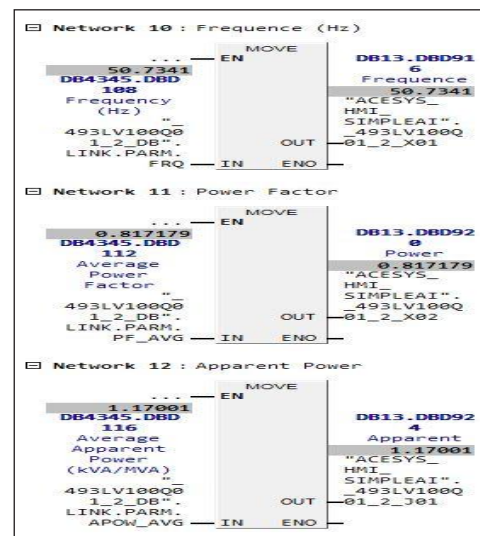


Fig. 12: Apparent Power Readings

So above are the program for the smart meter data communication to PLC and the same values are shown on SCADA.

V. FUTURE SCOPE

Future scope of PLC is good with automation techniques. It is very important for different control devices which controls various operations of a field without any type of intervention of human and provides better performance. PLC technology helps to monitor and control distributed server application. It provide clear and accurate image of operation to fulfill the demands of multiple users and maintain operation for input and output information to make it reliable and robust.

VI. CONCLUSION

Most of the industries including automation are using PLCs and install control systems to reduce the manual labor and to improve the precision and efficiency. PLCs are very popular because of their precision. PLC use progressive and enhancing functionalities and provide better security. The development of internet technologies for flexibility, reliability, and safety is the main concern of the new generation industries which are using PLC.

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