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Introduction to the Industrial Automation Using Schneider Electric M340 PLC work Bench

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ABSTRACT

Industrial automation is the use of control systems, such as computers or robots, and information technologies for handling different processes and machineries in an industry to replace a human being. It is the second step beyond mechanization in the scope of industrialization.This paper describes aboutSchneider Electric M340 PLC which is one of the most famous PLC in the world.Launched as one of the most innovative Programmable Logic Controllers developed to date, Modicon M340 continues to be perceived as a model basis of a modern-day automation platform, garnering recognition for its robust quality and high-end capabilities, including improved performance, compliance with the latest networking standards, and operational cost-efficiency. Designed for a widely range of process and machine management, it finds perfectly his place in numerous segments such as the Food & Beverage etc.

I. INTRODUCTION

PLC Background:

present automation system comes in to existence through its various stages. In the past, automation is done through relays and contactor logics. Since the human intervention is more, the scope of errors was also more. But with the advent of microprocessors & microcontrollers several new tools as PLCs (Programmable Logic controllers) come in to use. These have reduced human intervention. Which in turn has increased accuracy, precision and efficiency.The PLC can be described as a control ladder comprising a sequence program. PLC sequence program consists of normally open and normally closed contacts connected in parallel or in series. It also has relay coils, which turns ON and OFF as the state of these contacts change. In this paper, about all aspects of these powerful and versatile tools and its applications to process automation has been discussed.

PLC: A digitally operating electronic apparatus which uses a programming memory for the internal storage of instructions for implementing specific functions such as logic, sequencing, timing, counting and arithmetic to control through digital or analog modules, various types of machines or process.

With the upcoming technologies and availability of motion control of electric drives, the application of Programmable Logic Controllers with power electronics in electrical machines has been introduced in the development of automation systems.

The use of PLC in automation processes increases reliability, flexibility and reduction in production cost. Use of PLC interfaced with power converters, personal computers and other electric equipment makes industrial electric drive systems more accurate and efficient. PLCs have been gaining popularity on the factory floor and will probably remain preponderant in coming years. Most of this is because of the advantages they offer, like

- ✓ Cost effective for controlling complex systems.
- ✓ Flexible and can be reapplied to control other systems quickly and easily.
- ✓ Computational abilities allow more sophisticated control.
- ✓ Trouble shooting makes programming easier and reduce downtime.
- ✓ Reliable components make these likely to operate for years before failure.

The PLC was contrive in response to the needs of the American automotive manufacturing industry. Automotive industries were the first to adopt programmable logic controllers, where software alteration replaced the rewiring of hard-wired control panels when production models changed. In manufacturing automobiles, earlier, the control, sequencing and the safety interlock logic was accomplished using hundreds or thousands of relays.

Programming:

The programming technique for the first PLCs were based on relay logic wiring schematics. This eliminated the need to teach the technicians, electricians and engineers how to program a computer but this method has stuck and it is the most common technique for programming PLCs today. According to IEC 61131-3 five programming languages is defined for programmable control systems: LD (Ladder diagram), ST (Structured text), SFC (Sequential function chart), FBD (Function block diagram), and IL (Instruction list, similar to assembly language).

Industrial automation systems

Industrial automation is the use of computer and machinery aided systems to operate the various industrial operations in well controlled manner. Based on the operations involved, the industrial automation systems are majorly divided into two types; (a) Manufacturing automation and (b) Process plant automation systems.

a)**Manufacturing Automation System:** The manufacturing industries make the product out of raw materials using robotics/machines. Some of these manufacturing industries include paper making, glass and ceramic, textile and clothing, food and beverages, etc. New trends in manufacturing systems

have been using automation systems at every stage such as material handling, machining, assembling, inspection and packaging. With the computer aided control and industrial robotic systems, the manufacturing automation becomes very flexible and efficient.

b)**Process Plant Automation:** In process industries, the product results from many chemical processes based on some raw materials, some of the industries are cement industry, pharmaceutical, paper industry, petrochemical, etc. Thus the overall process plant is automated to produce the high quality, more productive, high reliable control of the physical process variables.

Salient features of PLC:

The various functionalities of programmable logic controller has evolved over the years to include sequential relay control, distributed control systems, process control, motion control and networking. PLC control system is that it regards PLC as control key component, utilize special I/O module to form hardware of control system with a small amount of measurement and peripheral circuit, to realize control to the whole system through programming.

A. High Reliability: In order to make PLC work stably and efficiently in strong interferential conditions, very high reliability and strong anti-interference quality are the most important features of PLC. Software control instead of relay control can decrease faults which are brought about by original electric contact spot outdoor working badly. Industrial grade components made by advance processing technology can sustain interferences, and self-diagnosis measures of watchdog circuit for protecting memory can improve performance of PLC greatly.

B. Good Flexibility: There are various programming languages for PLC including ladder diagram, SFC, STL, ST and soon. If operator can master any one of the programming languages, he can operate PLC well. The person who want to use PLC has a good choice. Based on engineering practice, function and capacity can be expanded by expanding number of module, so PLC has a good flexibility. 5.3 Quality of Strong Easy-Operating It is very easy to change or modify and edit program for PLC by computer offline or online. It is very easy to find out where the fault occurred by showing the information of fault location and function of self-diagnosing and all these makes repair and maintenance for PLC easier. Configuring PLC is very easy due to modularization, standardization and serialization of PLC.

C. Scan Time: A PLC program is generally executed continuously as long as the controlled system is running. The status of physical input signals is copied to an area of memory accessible to the processor, sometimes called the "I/O Image Table". The program is then executed from its first instruction down to the last one as shown in figure 4. It takes some time for the processor of the PLC to evaluate all the instructions and update the I/O image table with the status of outputs. This time of scan may be a few milliseconds for a small program or on a fast processor, but older PLCs executing

very large programs could take much longer i.e. up to 100 ms to execute the program [2]. If the scan time were too long, the response of the PLC to process conditions would be sluggish to be useful.

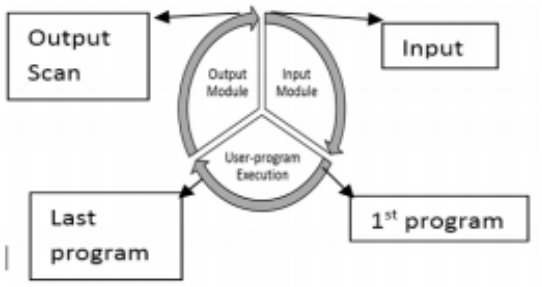

Figure 1. PLC Scan Cycle

D. Input scan: During the input scan, the current status of every signal from input module is stored in the input image (memory) table, making it up-to-date. Thus all the status of the input devices (which in turn is connected to the input module) are updated in the input memory table of PLC.

E. Program scan: Following the input scan, the CPU enters into its user program execution, or program scan. The execution involves starting from the first program
instruction, then moving on to the second instruction and carrying out its execution sequence. This continues up to the last instruction of the program. Throughout the user-program execution, the CPU continually keeps its output image (memory) table up-to-date.

F. Output scan: During program scan, the output modules are not updated continually. Instead, the entire output image table is transferred to the output modules during the output scan which comes after the program execution. Thus the output devices are activated accordingly during the output scan.

Modicon M340 automation platform:

The Modicon M340 automation platform comprises:

1. BMXP34 dedicated processors
2. A Modicon X80 I/O platform, in a single-rack or multi-rack configuration
3. Additional modules for various applications (application-specific,Ethernet communication, etc.)

M340 Processor:

Seven processor models comprising 1 Standard model (BMXP341000) and 6 Performance models (BMXP3420*** or BMXP3420***CL) with different memory capacities, processing speeds, number of I/O and number and type of communication ports.

Depending on the model, they offer a maximum (non-cumulative) of:

a) 512 to 1024 discrete I/O

b)128 to 256 analog I/O

c) 20 to 36 application-specific channels (1) (process counter, motion control and serial link, or RTU)

d) 0 to 3 Ethernet Modbus/TCP or Ethernet/IP networks (with or without integrated port and 2 network modules maximum)

e) 4 "Full Extended master" AS-Interface V3 actuator/sensor buses, profile M4.0

Depending on the model, Modicon M340 processors include:

1.A 10BASE-T/100BASE-TX Ethernet Modbus/TCP port

2. A CANopen machine and installation bus port

3. A Modbus or Character mode serial link port.

Each processor has a USB TER port (for connecting a programming terminal or a Magelis GTO, GTW, STU/STO, etc. HMI terminal).

It is supplied with a memory card (3) that enables:

1. Backing up the application (program, symbols and constants)
2. Activating a standard Web server for the Transparent Ready class B10 integrated Ethernet port (depending on the model) Depending on the model, this memory card can be replaced by another type of memory card (to be ordered separately) that supports:
3. Backing up the application and activation of the standard Web server (same as other card).
4. An 8 MB or 128 MB storage area, depending on the option card, for storing additional data organized in a file system (directories and sub-directories).

Modicon X80 I/O platform and additional modules:

The "Modicon X80 I/O" platform, which can be used "In Rack" and/or in a remote I/O (RIO) drop depending on the type of automation platform (Modicon M340, Quantum, etc.), comprises the following elements:

a) Racks with 4, 6, 8 or 12 slots (2a)

b) Power supply modules, c or a (2b) b Discrete and analog I/O modules (2c)

c) RTU (Remote Terminal Unit), serial link, AS-Interface, etc. communication modules (2d) Additional dedicated modules for the Modicon M340 automation platform that can be used on "Modicon X80 I/O" are also available:

d) Application-specific b Ethernet (Modbus/TCP, Ethernet/IP) communication module External modules, such as Modbus Plus, Profibus DP/PA communication as well as modules offered as part of CAPP (Collaboration Automation Partner Program), are also available.

Design and setup of Modicon M340 applications:

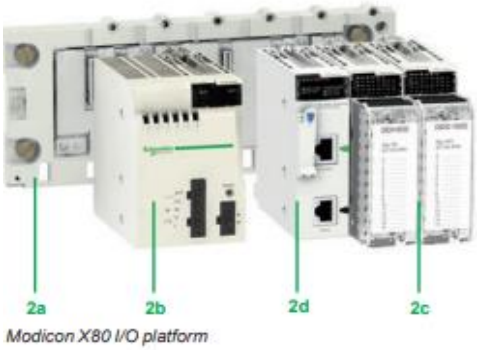

Figure 1. M340 PLC

Setting up of the Modicon M340 automation platform processors requires the use one of the following software packages:

a) Unity Pro Small programming software
b) Unity Pro Medium, Large or Extra Large programming software or identical to that used to set up Modicon Premium and Modicon Quantum automation platforms
c) Optionally, depending on requirements, Unity EFB toolkit software for developing EF and EFB function block libraries in C language

The function block software libraries provide Modicon M340 processors with the processing capability required to meet the specialized requirements within themotion control with multiple independent axis functions domain (MFB "Motion Function Blocks" library). The axes are controlled by Altivar 312/71 variable speed drives or Lexium 32 servo drives connected on the CANopen machine bus.

Unity Pro Programming Software:

Unity Prois the commonprogramming, debugging and operating software for the Premium, M580, M340, and Momentum PLC ranges. Withits five IEC61131-3 languages (ladder, FBD, SFC, IL and ST), all debugtools and diagnostics. **Unity Pro**is made for increasingyourdevelopmentproductivity and ease of maintenance.

An application developmentunder**Unity Pro**requiresseveralsteps:

1. Configure a PLC's hardware for yourproject,

2.Assign and declare all the I/O and variables that are used,

3. Program your application with Ladder Diagram Language,

4. Transfer an application in the PLC memory and test it

Create a project and configure the PLC

The first step of the PLC programmingusingUnity Pro Software consists in the configuration of the PLC's hardware regarding the real PLC configuration used in process.

Programming PLC with LD languageunderUnity Pro :

Create a ladder diagram section

In this, usingUnity Pro, wewilldiscover how to create a section (aworksheet) in whichwe can enter the ladder diagramwhichis the application designed.

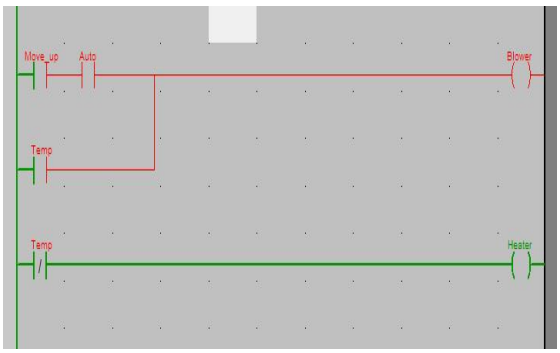

Figure 2. Ladder Editor Menu

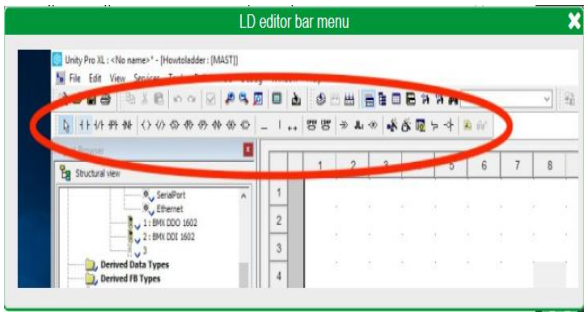

Figure 3. Input Program Example

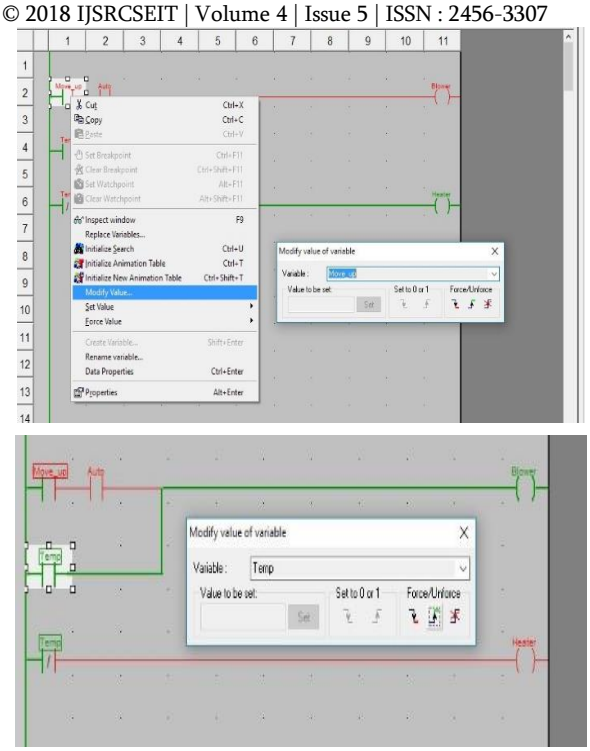

Figure 4. Output Program Example

Areas of application of PLC :

Every system or machine has a controller. Depending on the type of technologyused, controllers can bedividedintopneumatic, hydraulic, electrical and electroniccontrollers. Frequently, a combination of different technologies isused. Furthermore, differentiationis made betweenhardwired programmable (e.g. wiring of electromechanical or electronic components) and programmable logiccontrollers. The first isusedprimarily in cases, whereanyreprogramming by the user is out of the question and the job size warrants the development of a specialcontroller. Typical applications for suchcontrollers can befound in automaticwashing machines, video cameras, and cars. However, if the job size does not warrant the development of a specialcontroller or if the user is to have the facility of making simple or independent program changes, or of setting timers and counters, then the use of a universalcontroller, where the program iswritten to an electronic memory, is the preferred option. The PLC representssuch a universalcontroller. It can beused for different applications and, via the program installed in its memory, provides the user with a simple means of changing, extending and optimizing controlprocesses. The original task of a PLC involved the interconnection of input signalsaccording to a specified program and, if "true", to switch the corresponding output. Boolean algebraforms the mathematical basis for thisoperation, whichrecognizespreciselytwodefinedstatuses of one variable: "0" and "1" [2]. Proper application of a PLC beginswith an economical justification analysis. The batch process in chemical, cement, food and paper industries are sequential in nature, requiring time or eventbaseddecisions. PLCs are beingused more and more as total solutions to a

batch problem in these industries ratherthanjust a tool. In batch process savings are developedprincipally fromreduced cycle time and scheduling. Cycle automation providesrigid control enforcement to eliminatehumanerrors and to minimizemanual interventions. Increasedefficiency in schedulingis to beexpected with maximum utilization of equipment and reduction of fluctuatingdemands on criticalequipment. In large process plants PLCs are beingincreasinglyused for automatic start up and shutdown of criticalequipment. A PLC ensuresthat an equipmentcannotbestartedunless all the permissive conditions for safe start have been established. It also monitors the conditions necessary for safe running of the equipment and trip the equipmentwheneveranyabnormality in the system isdetected.

Advantages of programmable controller

- Less operating time.
- High flexibility
- Absence of moving parts increasesreliability
- Low power consumption
- Easy maintenance due to modular fabrication.
- Easyfaultfinding and diagnostic.
- Capable of handling of complicatedlogicoperations.
- Good documentation and data collectingfacilities
- Easy to interface with the process computers.
- Analog signal handling and close loop control programming.
- Timer, counter and comparator can beprogrammed.

II. CONCLUSION

The automation of the design of industrial control processes has a history of strong innovations. In this paper the concept of Programmable logic controllers and its applications are discussed. PLC applications are typically highly customized systems so the cost of a packaged PLC is less compared to the cost of a specific custom-built controller design. Development of small modular structure incomparison with earlier structures have increased the flexibility of PLC configurations, PLC computing, scan time, data processing, network communication, graphics display, and other functions. The PLC programming tools are constantly developing, so it can be used more widely in the applications of numerical control technology, control of machining center which will be more flexible and reliable.

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