Programmable logic controller system plc

Technology, Computer

Two decades ago, machines were simple and work in factories was, for the most part, manual in nature. Machines were designed to be manually controlled. Today, if people look for around them will find many things have the control systems, which are necessary to organize the complex devices. The control system is of primary importance for devices and machines in factories, aircraft, cars, and even in some home devices. For this reason, life has become easier and production has dramatically advanced. Now, the control system is acting on behalf of humans, helping them for example to avoid risks in chemical factories, which can be extremely dangerous for humans. Today, it is difficult for people to avoid the use of control systems in the work place. Control systems control complex processes, which regulate the production in huge factories. Without automated control systems, factories face many problems, which would otherwise be very hard to find a solution to.

With the beginning of the modern industries, the engineers needed systems to help them to accelerate production and to get high quality at a low cost. Electronic systems in the form of sensors and switches were invented to monitor and control manufacturing and reduce labor and production errors. Switches and sensors were needed to complement programming and hardware and to speed up the analysis of input data and obtain the results to assist the engineers in processing steps. The first system and software used in this area was the SCADA system. However, this system was complex and could not be linked with other monitoring systems. Hence, they invented the PLC, which in turn facilitated the process of programming. Also, it contained many possibilities including its ability to connect easily with other systems in

production lines to assist in the development of the production process. PLC, which plays an essential part in the process of automation and control, is one of the most important systems in many factory production lines, and it has more features than other systems.

History of PLC

Even after Programmable Logic Controllers (PLCs) were invented, a number of problems with relays remained to be worked out. Many enhancements occurred in the 1960’s. In the 70’s, they improved more. The ability to communicate between PLCs was added. This created a space between the controlling circuit and the machine it was controlling. Other problems had occurred in the 1980’s, but they were controlled. Also during the 1980’s, PLC’s were made much smaller. Many more ways a PLC could be programmed were developed in the 90’s. Overall, industries still use PLC in many ways and it is likely they will continue to be used for a long time to come. (Amunrud, 2002)

Definition

PLC stands for programmable logic controller, which is a device with many useful and helpful applications. PLC’s are used in place of other electromechanical systems. In addition, PLC’s can also control the systems of production, manufacturing, and semiconductor machines. PLC’s can be designed to be used in extreme situations such as, high temperature, high humidity, and in conditions of extreme noise around very large machines . The data of PLC’s can be very different. For example, PLC’s in factories are

all about speed and accuracy, so they depend on the ingredients and measures. However, PLC’s used in traffic systems are all about organization (SIMATIC manual 2004).

How PLC Works:

A programmable logic controller (PLC) receives and collects input data from measurement devices, such as sensors and switches, then analyzes information of these input data at a high rate responding with program instructions as a process computer. After that, the PLC sends back the results as output data to the final devices, like motors, based on outcome estimated (Bern and Olsen, 2002). According to Bryan (1997), PLCs “ are capable of storing instructions, such as sequencing, timing, counting, arithmetic, data manipulation, and communication, to control industrial machines and processes”. Reprogramming a PLC accepts changes on the functional operation of a machine system without main physical changes in the control or output system components or wiring (Cox, 2001). Therefore, a programmable logic controller needs an integrated system consisting of software and hardware.

PLC hardware components

A complete programmable logic controller (PLC), including all input/output (I/O) modules, is called a station. Every station has at least one module rack containing a power supply and a central processing unit module. Input/output modules create the link to the machine or plant. The parts of a station were illustrated below:

Power supply (PS): it provides internal supply voltage, which is either 120V/220V AC, or 24V DC.

A central processing unit (CPU): the CPU, which stores and processes the I/O data, is a memory and processer.

Input and Output modules (I/O): they are receiving and sending data through network from the measurement devices to motors.

Interface Module (IM): it connected the different racks with each other.

A programming device: the two main things in the programming device are communicators and personal computers that help the programmers to create and insert the programs to the PLC.

Human Machine Interface (HMI): it is a display and touch panel where operators can observe and manage the critical equipments.

Those PLC components are working together to reach the objective of controlling the system . The input modules, or points, used by a PLC depends upon the types of input devices used. Some input modules or points react to digital inputs, also called separate inputs, which is either 0/1, on or off statements. Other modules or inputs react to analog signals. These analog signals represent machine or process conditions as a range of current values or voltage. The primary function of a PLC that has input circuitry is to cause these various switches to convert the signals and sensors into logical signals that can be used by the CPU. The CPU evaluates the status of inputs, outputs, and other variables as it executes a stored program. The CPU then

sends signals to update the status of outputs. The output modules convert control signals from the CPU into either digital or analog values that can be used to control various output devices. The programming device is used to enter or change the PLC’s program or to monitor or change stored values. Once entered and programmed, the associated variables are stored in the CPU. In addition to these basic elements, a PLC system may also include an operator interface device to simplify monitoring of the machine or process. Figure 2. 0 below explains how the process of how PLCs connect in industry.

Figure 2. 0 this figure explained the whole system work.

In addition to these basic elements, a PLC system may also include an operator machine interface device to simplify monitoring of the machine or process. Example shown below, pushbuttons (sensors) connected to PLC inputs is use connected to a PLC output through a motor starter (actuator). No programming device or operator interfaces are shown in figure 3. 0.

Figure 3. 0: It show the input, CPU and output

In previous figure 3. 0 it describe the input signal which is came from pushbutton and received by CPU module in PLC rack which analyzing the data and send it to the motor starter then start and stop the motor depends on the type of signal. Sensors are devices that convert a physical condition into an electrical signal, such as a pushbutton that are connected to the input of a PLC. An electrical signal indicating the order (open or closed) of the pushbutton contacts is sent from the pushbutton to the PLC.

Actuators that connected to the PLC output are devices that convert an electrical signal to a physical order from a controller, such as a PLC. A motor starter is one model of an actuator that regularly connected to a PLC output. Depending on the status of the PLC output, the motor starter either supply power to the motor or prevents power from flowing to the motor (figure 4. 0).

Figure 4. 0: more description on PLC from discrete Input to discrete output

In figure, 4. 0 it is described in more details when the PLC rack received the signal which is came to input module then send the signal to CPU which analyze it and send the result to the output module.

PLC Programming:

Numerical systems are useful in most programs, as they are when used in conjunction with Programmable Logic Controllers to make programs. The basic function of programming devices is to show, store, and operate. The numerical system is the most important element of programming a Programmable Logic Controller. The number systems usually encountered while using programmable controllers are base 2, base 8, base 10, and base 16. These systems are called binary, octal, decimal, and hexadecimal, respectively. Using a binary numerical system, which uses 2 as the base, and only allows the use of digits 0 and 1 where there are no 2’s, 3’s , and so on, is used in programming. In devices such as computers and programmable logic controllers, the binary system is useful. It is an easier way to design programs to deal with machines that analyze between only two entries or numbers to start or stop. For example, 0 and 1 represent on and off,

respectively. The octal system acts in place of the binary number system by using fewer digits. The octal system uses the number 8 as a base and only allows eight digits starting with 0 and ending with 7 (0, 1, 2, 3, 4, 5, 6, 7). Also, with other systems, using hexadecimal further reduces the number of digits in the programming language and coding system (Bryan, 1997).

Leader logic is the main method of programming used in PLC’s. This method is used to build the whole program by using the numerical system to save the program in the CPU’s memories. In this section, many programs have their own language and PLC’s have their own special language, which must be expanded and developed. Programming languages helps the programmer and user to build and enter a control program into PLC’s. Types of PLC languages that are used in programming consist of three types: Leader, Boolean, and Grafcet. The Leader and Boolean actually work in the same way, but they have different ways in their insurrections, which are shown and how to enter into PLCs. The Grafcet language implements control instructions in a different manner, based on steps and actions in a graphic oriented program (Bryan, 1997).

PLC programming languages are used in the SIMATIC programming languages to write a user program to control the machines or devices. Programmers have many choices of programming languages and programming methods in SIMATIC. The most useful programming language in PLC’s is LAD (Ladder Logic Diagrams). Also programmers can resemble programs by using electronic circuit diagrams (Function Block Diagrams

FBD). Those familiar with textual languages or coding languages can use and handle Statement List STL with many complex variables (SIMATIC, 2003).

Programmable logic controllers have different languages that offer different advantages and benefits for the process engineers. Different languages in PLC applications help engineers in the complex projects that give the process engineers flexibility in determining which is the most appropriate language to use. The differences between languages in programmable logic controller are in the structure but not in the instruction. For example, LAD uses block symbols language, but STL uses coding language. Figure 5. 0 below is helpful in describing the differences between the two languages (SIMATIC, 2003).

Figure 5. 0: it describe the differences between LAD, STL and FBD

Figure 5. 0 describes three different languages. The first row explains the LAD language. Element symbols, which are described “ NO contact”, stand for normally open contact with the signal 1 (yes) if it is active and 0 (NO) if it is not active. The next symbol “ NC contact’, stands for normally closed contact. In the second row, the FBD language blocks describe other kinds of language in same manner but in different shape. Normally open contact in FBD language appears as a box and it is possible to write the value inside the box. On other hand, normally closed contact is in the same shape of normally open contact but with a small circle by the side of input to express a closed state. STL language has a different formula but the same instruction coding system. In the development of programming, engineers can convert the program display from one language to the other to check and correct

instructions. All subprograms and instructions in different languages for devices and machines could work together as one program to achieve the process needs (Berger, 2008).

Advantages of programmable logic controller (PLC)

PLC has many advantages that make it a unique process controller. The advantages are always increasing. Programmers, operators, and engineers prefer the PLC’s over other control systems, because of their simplicity, security, and reliability.

PLC Is Simple and Flexible

No control systems are easy or simple, but PLC’s have emerged as comparatively simple and easy to other leading process control systems. In PLC is easy to add or remove any ending device without affected the whole process. Also, PLC has the flexibility to monitor and correct the system anytime even though the plant On-line situation or Off-line situation (SIMATIC, 2003).

PLC Is Distributed

Allocated controlling system implicates many computers and stations on network occupied to gather. PLC is created to make allocated controlling system smooth with the networking faculty and equipments that are inseparably joined to it. PLC is considered the sender and receiver on writing network system files. Also, PLC is able to work with the hardware parts and

the software side of the computer, including those operating systems Windows 95 and NT, the Macintosh, XP and Vista (SIMATIC, 2003).

PLC Is Secure

The security in PLC is excellent. It is one of the first control program that has the most powerful protection from risks, losing data and the damage to the users. Those features have made PLC a sophisticated and useful control program system. Comparing PLC with SCADA from the security side PLC has the greatest result (SIMATIC, 2003).

PLC Is Reliable

Both reliability and security are important to each control system. PLC is one example of those control systems, which have them. PLC affords multiple points of reliability measures, starting with PLC itself and ending with many of its features. For example, “ pointers and automatic type conversion are included in PLC “. Before PLC is finished doing and start a program it has to check if there is any mistake that it can fix by itself or ask the user about it (SIMATIC, 2003).

Conclusion

Programmable logic controller (PLC) language has helped develop the control system, and it has become the most useful language. Programmable Logic Controllers have become the language that most companies and factories use. They supply and support engineers with what they need and they keep operators protected from hazardous machines. The potential of

programmable logic controllers in controlling systems is almost limitless. Programmable logic controls have fed and supported control systems in many ways. Most process computers utilized in factories with humans have more advantages than disadvantages as a secure system when dealing with complex process. Programmable logic controllers have proven to be an effective and helpful tool in many industries in the past. With their many advantages, they will continue to be useful in the future as well.