Study on

"Programmable logic controllers"

In

Vizag steel plant

Project Work

Jaideep B
5/7/2014

CERTIFICATE OF ORIGINAL WORK

This is to certify that Mr. B Jaideep studying B.Tech.(ECE) 4th Semester in National Institute of Technology, Tiruchirapalli has planned and written Project report on "Study of Plc in Twin Table Car in SMS/CCD department ", under my complete guidance and supervision.

(Signature of the Project guide)

Mr. Ashok Kumar Naik
Deputy Manager
E.T.L [Electro Technical Laboratory] department
SMS Department
Vizag Steel Plant

Acknowledgement

As the every meaningful and useful thing is a product of integrated and sincere efforts associated with person, this report is also exception to it. Here, I get an opportunity to prepare, a Project report on the Study of Plc in Twin Table Car in SMS/CCD department. Though these areas are very wide, however I managed to do it against the time constraints.

First of all I am in debt to my project guide, Mr. Ashok Kumar Naik, Deputy Manager, E.T.L(Electro technical Laboratory) department, SMS/CCD department .For his valuable suggestion, guidance and untiring help during and after the report preparation.

I express my deep sense of gratitude to my parents and my brothers for their encouragement during the study.

I will also like to thank Mr. Sahu for his cooperative attitude and help during my guidance and supervision.

B Jaideep

Trainee no: 4781

B.Tech (E.C.E)

2nd year

NIT TRICHY

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1. INTRODUCTION:

1.1 ABOUT STEEL PLANT:

Visakhapatnam Steel Plant, popularly known as **Vizag Steel**, is the most advanced steel producer in India with the help of German and soviet technology. Its products have been rated the best in the world market. Almost 80% of its income comes from the exports of steel products to Japan, Germany, United States, Singapore, Dubai, Australia, South American countries and many more. The company has grown from a loss making industry to 3 billion dollar turn over company registering a growth of 203.6% in just 4 years. Vizag Steel Plant has been conferred Navratna status on 17 November 2010. Founded in 1971, the company focuses on producing value-added steel, with 214,000 tonnes produced in August 2010, out of 252,000 tonnes total of salable steel produced. It is the largest single site plant in India and Asia Minor (or south and East Asia combined).

1.2HISTORY

On 17 April 1970, the then Prime Minister of India, the late Indira Gandhi announced the government's decision in the Parliament to establish a steel plant at Visakhapatnam. Planning started by appointing site selection committee in June 1970 and subsequently the committee's report was approved. On 20 January 1971 Mrs. Gandhi laid the foundation stone of the plant. Consultants were appointed in February 1971, and feasibility reports were submitted in 1972. The first block of land was taken over on 7 April 1974. M/s M.N. Dastur & Co was appointed as the consultants for preparing the detailed project report in April 1975 and in October 1977 they submitted a proposal for 3.4 Mtpa of liquid steel. With the offer for assistance from the government of the erstwhile USSR, a revised project evolved. A detailed project report for a plant with a capacity of 3.4 Mtpa was prepared by M/s M.N. Dastur & Co in November 1980.

. In February 1981 a contract was signed with the USSR for the preparation of working drawings of coke ovens, blast furnace and sinter plant. The blast furnace foundation was laid, with first mass concreting, in January 1982. The construction of the local township was also started at the same time.]

In 1970's Kurupam Zamindars donated 6,000 acres of land for Vizag Steel Plant. A new company Rashtriya Ispat Nigam Limited (RINL) was formed on 18 February 1982. Visakhapatnam Steel Plant was separated from SAIL and RINL was made the corporate entity of Visakhapatnam Steel Plant in April 1982.

Vizag Steel Plant is the only Indian shore-based steel plant and is situated on 33,000 acres (13,000 ha), and is poised to expand to produce up to 20 MT in a single campus. Turnover in 2011-2012 was Rs 14,457 Crores. 20 May 2009 Honorable Prime Minister Manmohan Singh launched the expansion project of Visakhapatnam Steel Plant from a capacity of 3.6MT to 6.3MT at a cost of Rs. 8,692 Crores. But the investment was revised to 14,489 crores with the following classification:

- Expenditure for the financial year 2009-10 Rs 1840 Crores.
- Rs 5883 Crores since inception of the Project.
- Total Commitment, including enabling works, steel procurement, Consultancy, Spares, etc. is Rs 11591 Crores as on 25.03.10.

The expansion project is expected to become functional by 2012.It has been rated "the best place to work in India" for consecutive five years.

THE MAIN OBJECTIVES OF THE PLANT ARE:-

- Revamping existing Blast furnaces to make them energy efficient to contemporary levels and in the process increase their capacity by 1 Mt, thus total hot metal capacity to 7.5 Mt
- Be amongst top five lowest cost liquid steel producers in the world Achieve higher levels of customer satisfaction
- Vibrant work culture in the organization
- Be productive in conserving environment, maintaining high levels of safety & addressing social concerns

INFRASTRUCTURE:

- Raw Material Handling Plant (**RMHP**)
- Coke Ovens and Coal Chemical Plant
- Sinter Plant
- Blast Furnace
- Steel Melt Shop and Continuous Casting
- Light and Medium Merchant Mill
- Medium Merchant and Structural Mill
- Wire Rod Mill
- Steel Melt Shop
- THERMAL POWER PLANT

From the Store yard the coking coal is sent to foreign material removing section to remove foreign matter of above 150 mm size. Iron Traps for Ferro magnetic articles and cylindrical screens are provided for this. 16 nos of bins each 800 tonnes capacity are provided along with continuous action feeders of up to 100 tonnes per hour capacity each. After blending the material is crushed to take care of petro graphic non-uniformity, high hardness and mineral content of crushed and blended coal (74-78% of 3mm size is conveyed to two coal towers each of 4000 T capacity. Weigh bridges are provided under coal towers to weigh the coal charge. System of pneumatic blow down of blend is provided in the coal tower to take care of jamming of coal.

BATTERY: The Prepared coal charge in the coal tower is drawn by a charging car on the top of the batteries and charged into the ovens as per sequence. The charged coal is gradually heated by the heating wall of the oven in the absence of air to attain a temperature of 1000°-1050°C at the central axis of the coke mass toward the end of coking period. The coking period is generally specified between 16 hrs and 19 hrs depending on oven condition and production requirement. The volatile matter of coal liberated during carbonization is collected in gas collecting mains in the form of raw coke oven gas passing through stand pipes and direct contact cooling with ammonia liquor spray. The gas cooled from 800°C is draw to coal chemical plant by exhauster. The residual coke is pushed out of the oven by pusher car through a guide into coke bucket. The red hot coke is taken to coke dry cooling plant for cooling. There are 3 batteries, each having 67 ovens each. Each oven can hold 32 tons of dry coal charge. The volumetric capacity of each oven is 41.6 cum the heat for carbonization is supplied by under firing of coke oven gas having CV of 4200 Kcal/Nm3 of mixture of BF gas & CO gas having 900 Kcal/Nm3. The heating system of batteries is of under jet, compound type having twin-heating flues with re-circulation of waste gases.

Products of Vizag Steel Plant:

Steel products:-

1.) Angels
2.) Billets
3.) Channels
4.) Beams
5.) Squares
6.) Flats
7.) Rounds
8.) Re-bars
9.) Wire rods

By products:-

1.) Nut coke
2.) Coke dust
3.) Coal tar
4.) Anthracene oil
5.) HP Naphthalene
6.) Benzene
7.) Toluene
8.) Zylene

2. ELECTRO TECHNICAL LABORATORY:

In view of the high degree of sophistication and automation used in VSP, a specialized group of supporting electronics in drives and PLC's necessitated. Electro Technical Laboratory (ETL) precisely does the above function. ETL supports electrical groups of different production shops for maintaining 100% availability of electronics pertaining to drives and PLC's.

There are approximately 1200 Thyristor controlled devices in VSP including

- Crane controls
- AC/DC motor controls
- Uninterruptible power supplies
- Computer numerically controlled machines in different shops

FIELD SERVICES:

It is spread all over the plant, caters to supports and performs the following function.

- Carries out predictive and preventive maintenance of thyristor controlled drives and PLC' so that the breakdown time of the systems can be maintained at the minimum.
- Supports shop electrical groups in trouble shooting the in case of break-downs.
- Study and analysis of the day to day activities to maintain the systems trouble free.
- Study and analysis of the performance of the systems by maintaining history records of the equipment and taking corrective function.

Laboratory:

There are located centrally and cater to the electronic PCB repair needs.

The following laboratories are functioning in ETL

- Thyristor controlled drives cards repair lab
- Digital electronic card repair lab
- General electronic lab

The functions carried out by laboratories are:

- Repair of all electronic PCB's pertaining to drive automation.
- Repair of most of the electronic PCB's pertaining to programmable controllers
- Maintenance of history records for all electronic PCB's
- Study of the performance of cards, type wise and card wise, analyzing the defects of the cards and taking actions to reduce the card failure

PLANNING: - This section takes care of procurement and storing of various spare PCB's, instruments like Digital oscilloscopes, function generators, IC tester and components etc., for smooth maintenance of the equipment.

3. PROGRAMMABE LOGIC CONTROLLER (PLC)

INTRODUCTION TO PLC

PLC’s are the control hubs for a wide variety of automated systems and processors.

PLC’s are extensively used in diverse applications ranging from machining to automated assembly. They were designed to replace sequential relay circuits for machine control.

A PLC’s is a device which takes inputs from the field, process the inputs according to the program stored in its memory and sets the output, thus controlling the field equipment on the output.

PLC functions by interpreting the data coming through its inputs a depending upon their states, turns on/off its outputs. They are programmable via standard computer interfaces, proprietary languages and networks options. PLCs function using ladder read, interpreted, and performed in sequential order, ladder logic allows programmable logic controllers to perform any command within the loop at any time without executing previous commands. This allows PLCs to carry on their three basic functions: control, input, and-as needed.

In addition to controlling output functions, PLCs are good for compiling data from many sources and uploading this data into a computer network. PLCs are generally more durable, and less expensive, than computer systems and as a result can be replaced in remote or rugged industrial locations and perform at a high level for many years.

HARDWIRED CONTROL SYSTEM

The program which determines the task of control systems is defined by the interconnections between the individual elements such as sensors contacts; actuators coils etc. a push button, a limit switch and the solenoid are connected in series to form an end function. The push button and the limit switch must be activated in order to energize the activator. Specification to the program involves rewriting of control system. As a consequence, a hardwired control system can only be constructed after its “program”

Programmable control system

In a programmable controller, the construction and wiring are dependent upon the program definition, which means that standard units can be used irrespective of the application.

The program which defines the operation of the controller is written directly into the program memory. This program determines the sequence in which sensor contacts are to be scanned, according to which logic functions (AND, OR) are the operations to be performed or gated. Those results are assigned to the output i.e., whether the actuator are switched ON or OFF. A program modification requires only a change in the contents of the program memory and goes not affect the wiring. A PLC consists of PC with sensors, actuators and indicators. The PC consists of the CPU model with processor program memory, Input/output module and a power supply module.

PLC consists of a basic set of components or parts some of which are hardware items while the others represent the functional characteristics of the PLC software or programs. This is shown in the above figure.

FUNCTIONALITY

Abstraction of a PLC is somewhat like a black box which a set amount of inputs from and outputs to the outside world. It has the capability to make decisions, store data, do timing cycles, perform simple arithmetic operations, and convert codes and so on. The principle difference between the black box abstraction and a hardwired logic system is that specific code messages are stored in areas called program memory. These areas can be PROM or ROM and RAM chip.

As application demands change, the benefits of a PLC when contrasted to a hardwired logic system become quite apparent. The hardwired logic system must be rewired to fit the new needs of the applications. In contrast, the PLC simply needs to be programmed. The saving of the time and expense con is significant. Furthermore, various recipes can be stored in the memory and accessed when required making the program extremely flexible.

PROM and ROM are used to store the coded messages or programs because they are non-volatile. Thus the programs stored in the chips remain intact when program is interrupted or turned off. RAM is used for storage and as a scratch area for temporary data when power is interrupted or turned off. In order to protect the data contained in the RAM PLC's are battery backed.

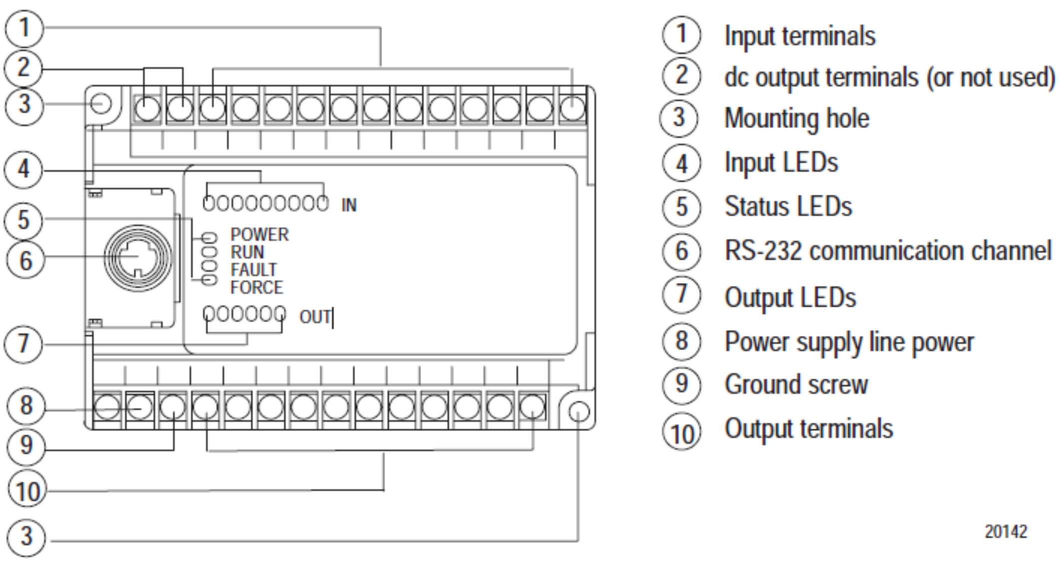
The system operates through interaction with processor and program memory. When the system is initially powered up the processor reads the first code word stored in memory and acts on this instructions. When completed, the next instruction is fetched and executed. This occurs until the task is completed. Hence the name fetch-execute cycle. The processor communicates with the outside world with the input and output modules.

PLCs Hardware Concepts

All the PLCs have the basic components such as:

1) Input/output
2) Memory
3) CPU
4) Power Supply
5) Indicator lights

The hardware features of the controller are:



Input/ output modules

The input provides a connection to the machine or process being controlled. The principle function of the module is to receive and convert field signal into a binary signal. The CPU and size of the memory usually limit the number of possible inputs. Discrete input devices are push buttons, select switches, limit switches, relay contacts, circuit breakers, etc.

The output (interface) performs the opposite functions of the input interface. It takes signals from the CPU and translates them into forms that are appropriate to produce control actions by external devices such as solenoids, motors, starters, etc. Most industrial safety and interlock systems operate on inputs from binary elements such as push buttons; limit switches, temperatures, pressure or flow switches and set the final control elements such as contractors to drive motors or solenoids valves. Discrete output devices are control relays, alarm valves, motor starters, solenoids etc.

Memory

It can serve three functions. They are

A) Data tables

The area of memory where data is controlled and utilized is called the data table. It consists of

a) Input image table

b) Output image table

c) Internal storage bits

d) Storage registers

The input table stores information about input devices connected to the PLC. The input image table reflects the status of the input terminals.

The output table also has a size, which corresponds to the number of output devices connected to the machine. The output image table reflects the status of bits controlled by the program.

Each image table is divided into a number of smaller units called bits. A bit is the smallest unit of memory. Bits in the image table are associated with a particular I/O terminal in the input and output section. Internal storage bits are also referred to as software coils. These are used for interfacing purposes in the control program.

B) User program memory

It is the memory set aside for ladder logic programs that are written by the user. This portion of the machine memory is used to store all PLC instructions that have been programmed by the user into the memory. The addresses of all inputs and outputs are stores in the user program. The number of inputs and outputs that the PLC is capable of addressing determines the amount of user programme.

C) Message storage areas

The other major area of memory, program storage, takes up the largest portion of the memory. This is where our instructions in the programmable controller are stored. This set of instructions is called a program.

D) Control processing unit

The core of PLC is the microprocessor. The microprocessor is a clock driven time sequential circuit that corresponds to the central processing unit (CPU) of a digital computer. The microprocessor in combination with RAM for data storage, programmable ROM for storage of programming instructions. Interfacing circuitry for communication to the outside world, and power supply, from a micro-processor based system.

The CPU and memory constitute the crux of PLC. Fundamental operating formation is stored in memory as a pattern of electrical charges (BITs) that is organized into basic working groups called words. Each word stored in memory is piece of data, an instruction, or part of an instruction. Data is fed from the input section and based on stored program the CPU performs logical decisions and drives outputs. The CPU continually refers to the program stored in the memory for instructions concerning its next action and for reference data. It also uses a scratch pad to store output data for future use and for immediate action when some sort of decision operation is involved.

E) Power supply

The power supply provides all the voltage levels needed to operate the PLC. The power supply converts 120v or 240v AC into the DC voltage required by the CPU, memory and I/O modules. A switch mode power supply is generally used for this purpose.

F) Indicator lights

These indicate the status of the PLC including power on, program running, and occurrence of a fault. These are essential when diagnosing a program.

PLC Software Concepts

PLC is programmable via standard computer interfaces and proprietary languages and network options. Programming options for PLC include front panel, handheld, and computer based. PLC software concept deal with the

a) Addressing system

b) Memory organization

c) Programming techniques

d) Programming instructions and

e) Writing an application program

Addressing system specifies the way, in which PLC addresses all form of data handled by it viz. the inputs, outputs, timers, counters, storage bits, storage registers etc.

Memory organization is the way in which the PLC organizes its memory to hold different types of programs and data. Data memory is the capacity for data storage. Program memory is the capacity for control software. Memory organization also specifies the amount of data or program memory basing on which a PLC can be chosen to select one for a specific application.

Programmable Logic Controllers use a variety of Software Programming, techniques for control. These include sequential function chart (SFC), function block diagram (FBD), Ladder Diagram(LD) etc., Ladder Logic programming is a graphical representation of the program design o look like relay logic and is mostly preferred for PLC programming.

Programming Instructions are standard operations (such as math functions) available to PLC software. Advanced ladder logic functions allow controllers to perform calculations, make decisions and do other complex tasks. Timers and counters are examples of ladder functions. They are more complex than basic input contacts and output coils and they rely upon data stored in the memory of the PLC.

Working of PLC:-

The voltage signal comes from the sensor and is connected to the terminal of the input module (inputs of the PC). The processor in the CPU executes the program stored in the memory and scans the individual inputs and outputs of the controller for presence or absence of voltage. Depending on the state of the inputs and on the program stored in the memory the processor directs the output modules to switch voltages to the connectors of the output terminals. The actuators and indicators are switched ON or OFF according to the voltage states at the terminal of the modules of the PC. Total execution is done by the PLC according to a user programming ladder.

Each logic system is written into the memory location in the memory. The individual statement is executed one after the other by the processor of the PC. After executing the last statement in the memory, the processor beings from the first statement in the memory. This is referred as "Cyclic Processing".

A PLC has four modes. They are:-

1. PROG – This programme mode can be used to load the instructions.
2. TEST – This mode can be used for test program operations under simulated operating conditions.
3. RUN - In this mode the processor 'SCANS' and 'EXECUTES' the program.
4. RUN/PROG – In this mode all functions apply as in the RUN and PROG positions.

Operating cycle

We enter a logic program in to the controller using the software. The Logic program is based on the electrical relay print diagrams. It contains instructions that direct control of our application.

With the logic program entered in to the controller, placing the controller in the Run mode initiates an operating cycle. The controller's operating cycle consists of a series of operations performed sequentially and repeatedly, unless altered by the programme logic.

1. Input scan: the time required for the controller to scan and read all input data typically accomplished in micro seconds.
2. Programme scan: The time required for the processor to execute the instructions in the program. The program scan time varies depending on the instructions used and each instruction's status during the scan time.
3. Output scan: the time required for the controller to scan and write all output data typically accomplished with in micro seconds.
4. Service communications: the part of the operating cycle in which communication takes place with other devices such as an HHP (Hand Held Programmer) or a personal computer.
5. Housekeeping and overhead: Time spent on memory management and updating timers and internal registers.

The above steps denote the way in which the processor functions throughout the control process in the run mode.

TIMERS INSTRUCTIONS OVERVIEW

Each timer address is made of a 3-word element. Word 0 is the control word, word 1 stores the present value and word 2 stores the accumulated value.

Entering Parameters

Accumulator Value (ACC)
This is the time elapsed since the timer was last reset. When enabled, the timer updates this continually.

Preset Value (PRE)

Specifies the value which the timer must reach before the controller sets the done bit. When the accumulated value becomes equal to or greater than the preset value, the done bit is set. You can use this bit to control an output device. Preset and accumulated values for timers range from 0 to +32,767. If a timer preset or accumulated value is a negative number, a runtime error occurs.

Timer Accuracy

Timing accuracy is -0.01 to +0 seconds, with a program scan of up to 2.5 seconds. The 1-second timer maintains accuracy with a program scan of up to 1.5 seconds. If your programs can exceed 1.5 or 2.5seconds, repeat the timer instruction rung so that the rung is scanned within these limits.

NOTE:

Timing could be inaccurate if Jump (JMP), Label (LBL), Jump to Subroutine (JSR), or Subroutine (SBR) instructions skips over the rung containing a timer instruction while the timer is timing. If the skip duration is within 2.5 seconds, no time will be lost; if the skip duration exceeds 2.5 seconds, an undetectable timing error occurs. When using subroutines, a timer must be executed at least every 2.5 seconds to prevent a timing error.

Addressing Structure:

Address bits and words using the format **Tf:e.s/b**

Format	Explanation		
	T	Timer file	
	F	File number. The only valid file number is 4.	
		Element delimiter	
Tf:e	e	Element number	Ranges from 0 - 39. These are 3-word elements. See figure on page 6-8.
		Word element	
	S	Subelement	
	/	Delimiter	
	b		

Addressing Examples

- T4:0/15 or T4:0/EN Enable bit
- **T4:0/14** or **T4:0/TT** Timer timing bit
- T4:0/13 or T4:0/DN Done bit
- **T4:0.1** or **T4:0.PRE** Preset value of the timer
- **T4:0.2** or **T4:0.ACC** Accumulator value of the timer
- **T4:0.1/0 or T4:0.PRE/0** Bit 0 of the present value
- **T4:0.2/0 or T4:0.ACC/0** Bit 0 of the accumulated value

Timer present on delay (TON):

Using Status Bits

This Bit	Is Set When	And Remains Set Until One of the Following
Timer Done Bit DN (bit 13)	accumulated value is equal to or greater than the preset value	rung conditions go false
Timer Enable Bit EN (bit 14)	rung conditions are true	rung conditions go false
Timer Timing Bit TT (bit 15)	rung conditions are true and the accumulated value is less than the preset value	rung conditions go false or when the done bit is set

When the controller changes from the REM Run or REM Test mode to the REM Program mode or user power is lost while the instruction is timing but has not reached its preset value, the following occurs:

- Timer Enable (EN) bit remains set.
- Timer Timing (TT) bit remains set.
- Accumulated value (ACC) remains the same.

On returning to the REM Run or REM Test mode, the following can happen

Condition	Result
If the rung is true:	EN bit remains set. TT bit remains set. ACC value is reset.
If the rung is false:	EN bit is reset. TT bit is reset. ACC value is reset.

Timer Off-Delay (TOF):

Use the TOF instruction to delay turning on or off an output. The TOF instruction begins to count time base intervals when the rung makes a true-to-false transition. As long as rung conditions remain false, the timer increments its accumulated value (ACC) each scans until it reaches the present value (PRE). The controller resets the accumulated value when rung conditions go true regardless of whether the timer has timer out.

Using Status Bits

This Bit	Is Set When	And Remains Set Until One of the Following
Timer Done Bit DN (bit 13)	rung conditions are true	rung conditions go false and the accumulated value is greater than or equal to the preset value
Timer Timing Bit TT (bit 14)	rung conditions are false and the accumulated value is less than the preset value	rung conditions go true or when the done bit is reset
Timer Enable Bit EN (bit 15)	rung conditions are true	rung conditions go false

When the controller changes from the REM Run or REM Test mode to the REM Program mode, or user power is lost while a timer off-delay instruction is timing but has not reached its preset value, the following occurs:

- Timer Enable (EN) bit remains set.
- Timer Timing (TT) bit remains set.
- Timer Done (DN) bit remains set.

Accumulated value (ACC) remains the same.

On returning to the REM Run or REM Test mode, the following can happen:

Condition	Result
If the rung is true:	TT bit is reset. DN bit remains set. EN bit is set. ACC value is reset.
If the rung is false:	TT bit is reset. DN bit is reset. EN bit is reset. ACC value is set equal to the preset value.

The Reset (RES) instruction cannot be used with the TOF instruction because RES always clears the status bits as well as the accumulated value. (See page 6-20.)

NOTE: The TOF times inside an inactive MCR Pair.

<u>Selection criteria of a PLC</u>

There are a number of PLC's available in market viz. ALLEN BRADELY, Siemens, GE Fanuc, L&T, ABB, Schneider etc., we choose the required PLC out of the various types available, basing on the following criteria(which keeps on varying from one application to another)-

a) Number of inputs and outputs needed
b) Length of the program
c) Critically of the program
d) Distance of inputs/ outputs from the programming unit.
e) Speed of processing
f) Number of controls

Inputs to, and outputs from a PLC are necessary to monitor and control a process. Available inputs for PLC's include DC, AC analog input, and thermocouple, frequency or pulse, transistor and interrupt inputs. Outputs for PLC's include dc, ac relay, analog outputs, frequency or pulse, transistor and TRAIC.

Inputs of PLC's have come from sensors that translate physical phenomena into electrical signals. Outputs to actuators allow a PLC to cause something to happen on process. Outputs from PLC's are often relays, but they can also be solid-state electronic devices such as transistors for with digital to analog convertors, DC outputs or TRIAC for AC outputs. Continuous outputs require special output cards.

Replacing relays with PLC's:

The first thing that we should do is to create a ladder diagram. We have to create one of these because a PLC doesn't understand a schematic diagram. It only recognizes code. Fortunately most PLC's have software which converts ladder diagrams into code.

First step – We have to translate all of the items we are using into symbols that PLC understands, The PLC doesn't understand terms like switch, relay, bell, etc. It prefers input, output, coil, contact, etc. It only cares if it's an input or an output.

We draw bus bars which simply look like two vertical bars one on each side of the diagram. Next we give the inputs a symbol.

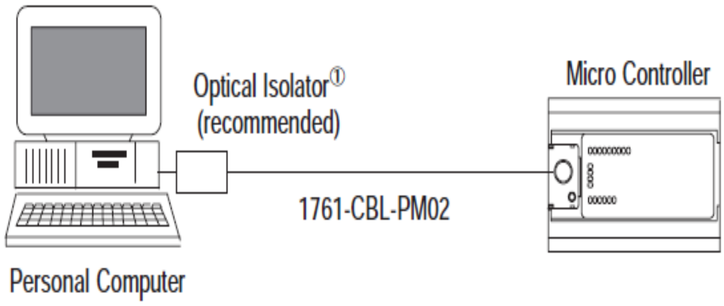
Next we give the inputs a symbol.

Second step – We must tell the PLC where everything is located. In other words we have to give all the devices an address. Where is the switch going to be physically connected to the PLC? How about the bell? The PLC has a lot of inputs and outputs but we have to figure out which device is connected where.

Final step – We have to convert the schematic into a logical sequence of events. The program we are going to write, tells the PLC what to do when certain events take place with

Making an Isolated Point-to-Point Connection

You can connect the MicroLogix 1000 programmable controller to your personal computer using a serial cable from your personal computer's serial port to the micro controller.

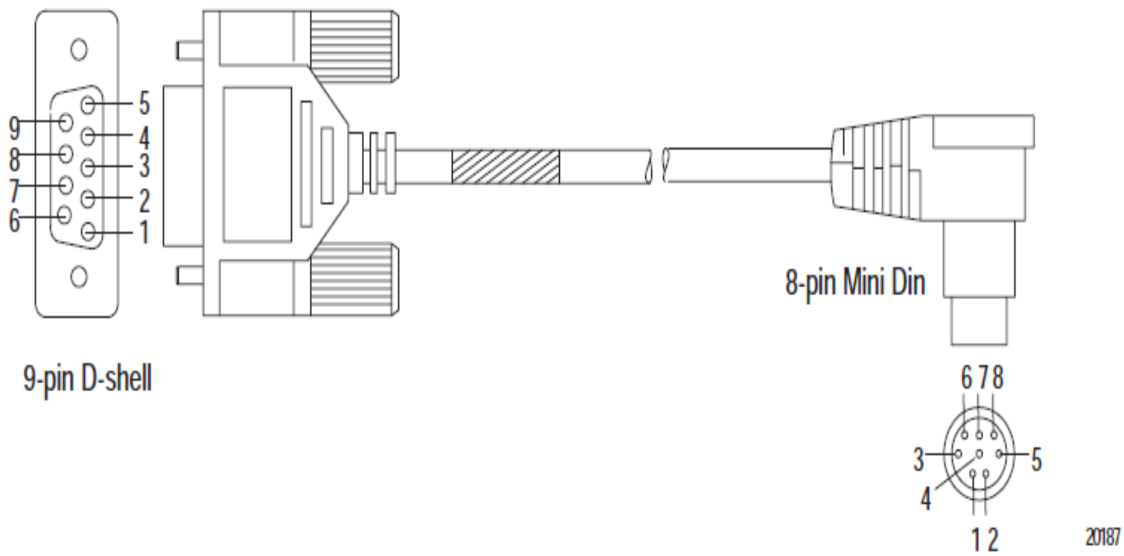


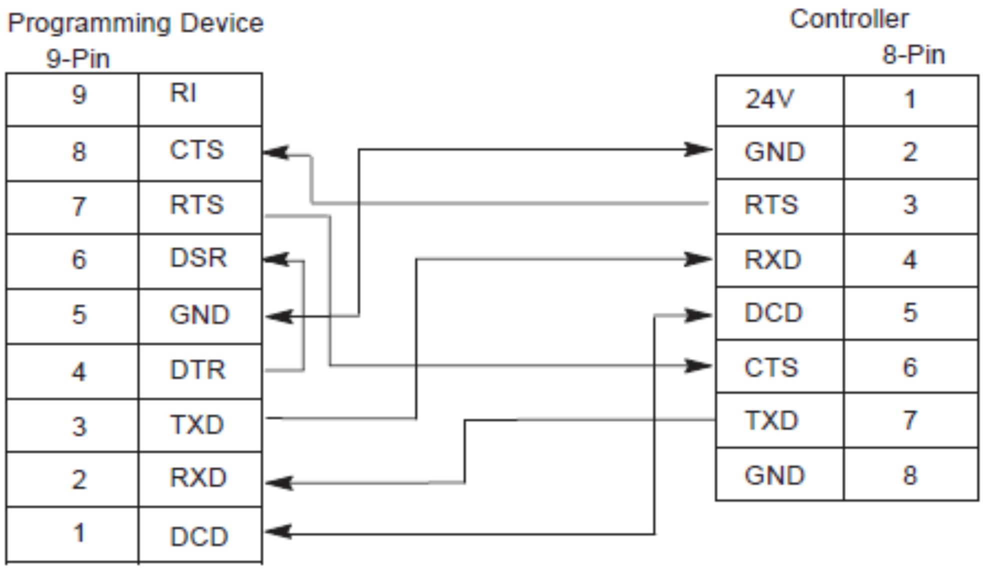
① We recommend using an AIC+, catalog number 1761-NET-AIC, as your optical isolator. See page 3–11 for specific AIC+ cabling information.

With the help of serial connector we can connect computer and PLC.

And the way the PLC and computer are connected via serial are shown in the table given below i.e., which pins are connected together are shown below.

1761-CBL-PM02 Series B Cable





INTRODUCTION TO LADDER LOGIC PROGRAMMING

Ladder logic programming is one of the most commonly used programming techniques. The decision to use the relay logic diagrams was a strategic one. By selecting ladder logic as the main programming method, the amount of retraining needed for engineers and trade people was greatly reduced. Modern control systems still include relays, but these are rarely used for logic. Now they are merely used for interfacing purpose.

The logic that we enter into micro controller makes up a ladder program(LP). A LP consists of a set of instructions used to control a machine or a process. Ladder logic is a graphical programming language based on electrical relay diagrams. A ladder diagram identifies each of the elements in an electro-mechanical circuit and represents them graphically. This allows the user to see how the control circuit operates before actually starts the physical operation of the system.

In a ladder diagram each of the input devices are represented is series or parallel combinations across the Rung of the ladder. The last element of the Rung is the output that receives the action as a result of the conditioner state of the inputs on the rung.

Each output instruction is executed by the controller when the rung is scanned and the condition on the rung is true. When the rung is not scanned or the logic condition on the rung do not create a true logic path, the output is not output is not executed. The software allows the user to enter a ladder logic program into micro-controller.

STRUCTURE OF LADDER LOGIC PROGRAMMING:--

Ladder logic programming resembles a similar structure to that of a ladder. It is more like a flow chart than a program. There are two vertical lines coming down the programming environment, one in the left and one on the right. Then, you have rungs in conditionals on the left that lead to outputs on the right.

Advantages of the PLC's:

a) PLC's can accept a large number of inputs and has a large capacity of outputs
b) They are easy to program and install
c) They are provided with quick release type screw connection for fast wiring of input and output devices
d) Online changes can be done very easily
e) A PLC is provided with self-diagnostics and hence any malfunctioning of PLC can be very easily isolated thus protecting the safety of the plant
f) Since it is an electronic system it needs no maintenance
g) Problem solving with PLC's is a major advantage over any other type of control system
h) They are provided with diagnostic indicators whenever monitor power supply failure. CPU faults, low battery, power for memory back up, input and output conditions, forced output conditions, etc, occur.
i) It can be operated in local mode and remote mode
j) Linking capabilities to communicate with main computer systems
k) They can designed with communication capabilities that allow them to converse with local and remote computer systems or to provide human interfaces
l) They can function in a harsh environmental condition and can meet any set installation requirements
m) Indenting of relays are not required, relay spares cost will reduced
n) The speed with which internal timers operate is much more than conventional time delay systems

Hence a PLC is preferred to relay.

FEATURES

1. Memory in use is up to 1KB.
2. EPROM nonvolatile program and data.
3. Memory module is through hand held programmer.

4. 32 Embedded digital I/O’s
5. Embedded analog I/O are two current and two voltage inputs with one current or voltage output on 20 point controllers.
6. No local expansion I/O, max.
7. No thermocouple/ HTD.
8. No networked expansion I/O.
9. 6.6 KHz high speed counters.
10. Software is RSLogix500/Micro.
11. Handheld programmer.
12. 8-pin mini DIN RS-232 ports.
13. Device Net Peer-to-peer messaging, slave I/O can e done with 1761-NET-DNI.
14. Ether Net with 1761-NET-ENI.
15. Web server capabilities with 1761-NET-ENIW.

INPUTS AND OUTPUTS OF PLC-1:-

Plc-1 is used for long travel motors

<u>List of inputs of PLC-1:-</u>

1. LT forward 3EP-1
2. LT reverse 3EP-1
3. LT slow speed 3EP-1
4. LT forward 3EP-2
5. LT reverse 3EP-2
6. LT slow speed 3 EP-2
7. LT forward 3EP-3
8. LT reverse 3 EP-3
9. LT slow speed 3 EP-3
10. Enable of car-2(option)
11. LT brake ACK (KM7)
12. LT overload(option)
13. Control supply healthy(KM7)
14. NO E-stop
15. ACC close ACK(1B25K5)
16. Converter section (AT 101CP)
17. LT DCC ON ACK (1B2546)

18. LT DBC ON ACK(1B25K9)
19. Drive OK from ADD32(1B25K9)
20. Motor speed zero(1B25K4)

LIST OF OUTPUTS FOR PLC-1:-

1. DCCB trip signal 3F40K1 time 115v
2. ACC trip 3F25K1
3. Circuit deadliness LT to ADD-32
4. Field failure to ADD-32
5. LT DCC close command 1B32K1
6. LT brake on command
7. LT DBC on command
8. ACC close AUX healthy(1B39K1)
9. LT forward to ADD-32
10. LT reverse to ADD-32
11. LT slow speed to ADD-32
12. LT DCC close to ADD-32

INPUTS AND OUTPUTS OF PLC-2:-

PLC-2 is used for roll table motors

List of inputs of PLC-2:-

1. RT-1 forward from 3EP-1
2. RT-1 reverse from 3EP-1
3. RT-2 forward from 3EP-1
4. RT-2 reverse from 3EP-1
5. RT-1 forward from 3EP-2
6. RT-1 reverse from 3EP-2
7. RT-2 forward from 3EP-2
8. RT-2 reverse from 3EP-2
9. RT-1 forward from 3EP-3
10. RT-1 reverse from 3EP-3
11. RT-2 forward from 3EP-3
12. RT-2 reverse from 3EP-3
13. RT-1 motor overload relay(option)NC
14. RT-2 motor overload relay(option)NC
15. RT-1 DCC ON ACK(1B25K7)

16. RT-2 DCC ON ACK(1B25K8)
17. DCCB on ACK(1B25K10)
18. ACC on ACK+ AUX healthy(1BB9K1)
19. NO E stop(1B32K7)
20. Motor speed zero(1B25K4)

List of inputs of PLC-2:-

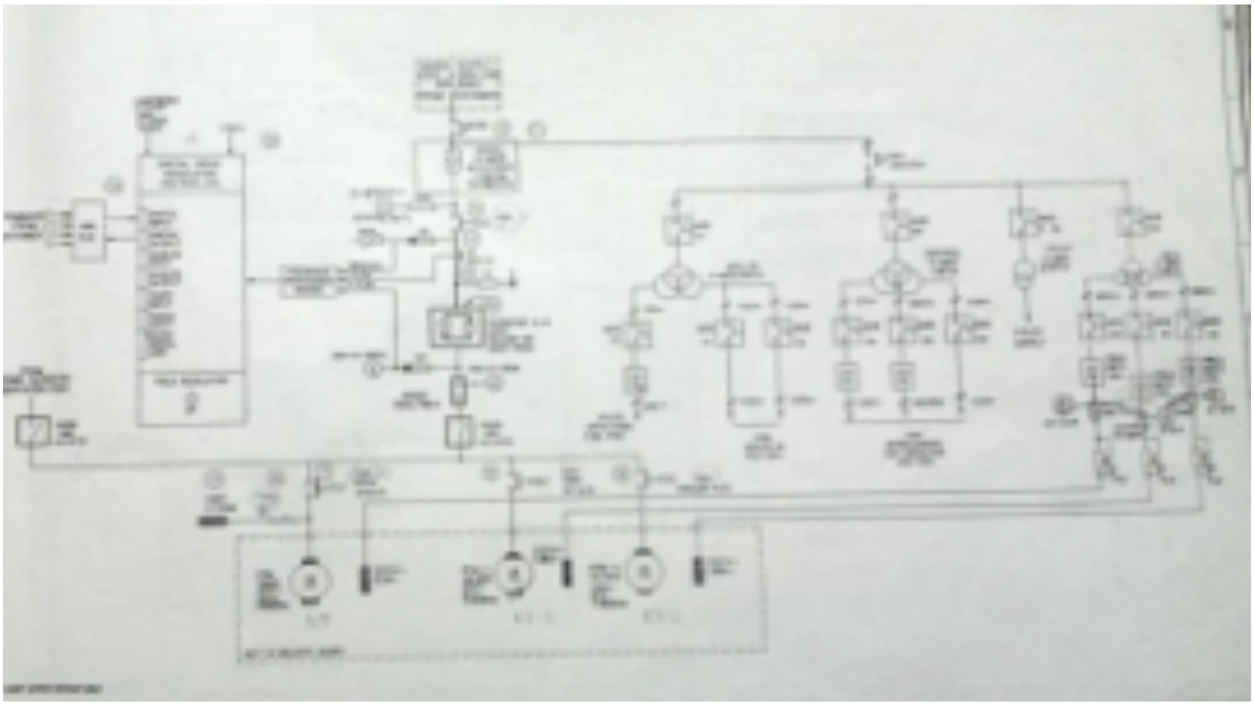
1. RT-1 DCC on command(1B32K4)
2. Spare
3. Spare
4. RT-2 DCC on command(1B32K5)-spare
5. RT-1 & RT-2 CLR (circuit ready)
6. spare
7. spare
8. spare
9. spare
10. RT-1/RT-2 forward command to ADD-32
11. RT-1/RT-2 reverse command to ADD-32
12. RT DCC close command to ADD-32

PROJECT WORK

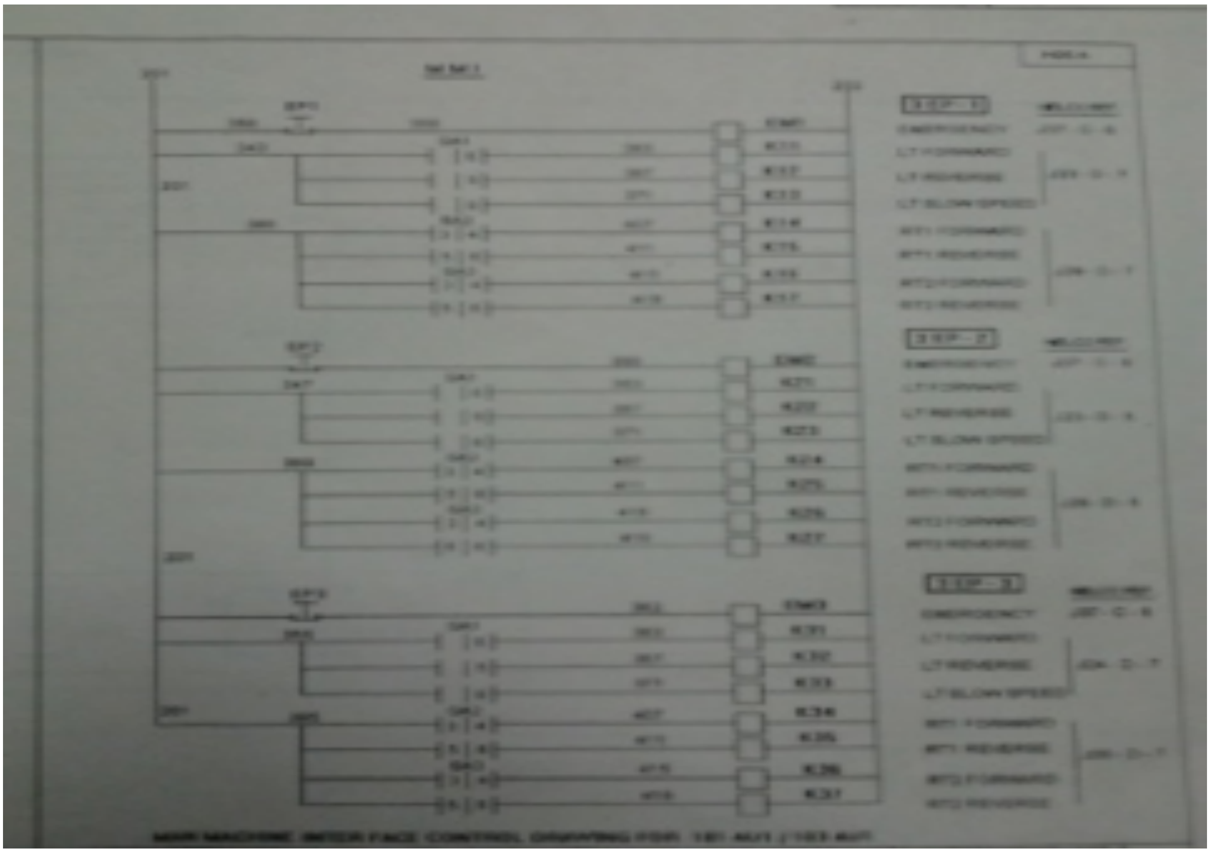
PROGRAM (logic)

- There are two plc's PLC-1 & PLC-2 for controlling long travel motors and roller table motors of a twin table car respectively.
- Both the PLC's will be in ETL (Electro technical laboratory) and its operation is checked here.
- There is a circuit which gives a connection between the control of motors and DCC and ACC switches which is shown in picture-1 and in picture-2 we can see how the commands have been directed to control.

PICTURE- 1



PICTURE- 2



PICTURE – 3

And we have done field study of PLC-1 & 2 and how inputs and outputs are related and it is illustrated in picture 3.

PLC-1 & PLC-1 has 20 inputs and 12 outputs and they are interlinked with each other using logic.

<u>LOGIC FOR PLC-1</u>

Output 0, 11(i.e., LT DCC close command) is generated when

- Aux healthy & ACC closed
- No motor overload
- FWD/REV activated or no speed zero ack. From add-32- digout-1
- DBC on or motor at zero speed

Output 1(i.e., LT brake contactor on command) is generated when

- FWD/REV activated
- Motor at zero speed

- If brake continues on command is given brake is not released within a specified (i.e., ack. Not received) then apply brake continuously on command again and again through brake applied too long on delay timer

Output 2 (i.e., LT DBC on command) is generated when

- Aux healthy command is acknowledged
- DCC is closed

Output 3(i.e., aux healthy+ ACC closed command) is acknowledged) when

- Aux healthy and ACC closed command is acknowledged
- (this command is used for KT-plc in order to reduce number of inputs)

Output 4

- When any one converter is selected then DCCB of other converter will trip

Output 5(i.e., acc to trip command) is generated when

- The corresponding DCCB in that converter is selected
- AUX. healthy command is acknowledged

Output 6(i.e., gives circuit readiness command as a user fault in add-32) is generated when

- Converter is selected
- FWD/REV is activated or circuit readiness command to add-32 is activated
- No E-stop
- No motor overload
- Control supply healthy

Output 7(i.e., field failure indication to led indicator) is generated when

- Control supply is not healthy

Output 8(i.e., LT forward command) is generated when

- FWD is selected from any desk
- Car-2 not enabled
- No e-stop

- DCC & DBC closed
- No speed zero acknowledgement from Digout-1 or LT forward command to ADD-32 is active

Output 9(i.e., LT rev command for ADD-32) is generated when

- REV is selected from any desk
- Car-2 not enabled
- No E-stop
- DCC & DBC closed
- No speed zero acknowledgement from ADD-32, Digout-1 or LT rev. command to ADD-32

Output 10(i.e., LT slow command for ADD-32) is generated when

- Slow is selected from any desk
- Car-2 not enabled
- No e-stop
- DCC & DBC closed

<u>LOGIC FOR PLC-2</u>

Output 2(i.e., RT-1 DCC on command) is generated when

- ACC on acknowledgement + AUX healthy are activated
- No motor overload
- RT-1 FWD/REV activated
- Motor not zero speed

Output 3(i.e., RT-2 DCC on command) is generated when

- ACC on acknowledgement + AUX healthy are activated
- No RT-2 motor overload relay
- 3EP-1 allow flag is activated
- Motor at zero speed
- RT-1 DCC on command not activated

Output 4(i.e., RT-1 and RT-2 OLR (ok circuit readiness to add-32)) is generated when

- RT-1 motor overload relay
- RT-2 motor overload relay

Output 9(i.e., RT-1/RT-2 forward command to ADD-32) is generated when

- RT-1 or RT-2 forward are closed
- No e-stop
- Speed zero acknowledgement from ADD-32 and RT-1/RT-2 REV from ADD-32
- RT-1 DCC on acknowledgment
- RT-2 forward from 3EP-3

Output 10(i.e., RT-1/RT-2 rev command to add-32) is generated when

- RT-1 or RT-2 rev and corresponding DCC closed
- No e-stop
- Speed zero acknowledgement from add-32 and RT-1/RT-2 rev from ADD-32
- RT-1 or RT-2 DCC on acknowledgement

Output 11(i.e., RT DCC closed command) outputs to ADD-32 when

- RT-1 DCC is on
- RT-2 DCC is on

INTEGRATION with Image Sensor system(In-Sight):

The Image Sensor system is communicated to the PLC system to control the rollers based on the logic. This sensor is a self-contained vision system, complete camera, programmable image processor and interface to connect to laptop.

Received video sequences are processed using (TOFD image based processing techniques) Time of flight diffraction, image analysis for crack detection .

Most commonly used technique for crack detection is IR-based image technique. Infrared (IR) thermography method based on IR image rectification with the extraction of Isotherms which allows the detection of cracks as well as the geometric characterization and orientation of the crack to assist the prediction of the direction of propagation of the crack through the material.

Based on the input from the machine vision system the PLC is controlled using the 8 input pins.

CONCLUSION:-

Initially the PLC was used to replace relay logic, but its ever-increasing range of functions means that it is found in many and more complex applications. Because the structure of a PLC is based on the same principles as those employed in computer architecture, it is capable not only of performing relay switching tasks, but also of performing other applications such as counting, calculating, comparing, and the processing of analog signals.

Programmable controllers offer several advantages over a conventional relay type of control. Relays have to be hardwired to perform a specific function. When the system requirements change, the relay wiring has to be changed or modified. In extreme cases, such as in the auto industry, complete control panels had to be replaced since it was not economically feasible to rewire the old panels with each model changeover. The programmable controller has eliminated much of the hand wiring associated with conventional relay control circuits. It is small and inexpensive compared to equivalent relay-based process control systems. Programmable controllers also offer solid-state reliability, lower power consumption, and case of expendability.

If an application has more than a half-dozen relays, it probably will be less expensive to install a PLC. Simulating a hundred relays, timers, and counters is not a problem even on small PLC's. Programmable Logic Controllers are easy to program and install. Access to PLC's can be restricted by hardware features such as key locks, and by software features such as passwords. Problem solving with PLC's is a major advantage over relay-type control systems. PLC's can be designed with communications capabilities that allow them to converse with other computer systems or to provide human interfaces. Communications can be over data highway or Ethernet networks.
One the method currently studied, is to replace Micrologix 1000 using with Micrologic5000 to integrate the vision system using In-sight. A small study was recommended and performed to consider the feasibility with the existing setup.

ADVANTAGES OF THE PLC:

The following are some of the major advantages of using a programmable controller:
Flexibility

In the past, each different electronically controlled production machine required its own controller; 15 machines might require 15 different controllers. Now it is possible to use just one model of a PLC to run any one of the 15 machines. Furthermore, you would probably need fewer than 15 controllers, because one PLC can easily run many machines. Each of the 15 machines under PLC control would have its own distinct program.

Implementing Changes and Correcting Errors.

With a wired relay-type panel, any program alterations require time for rewiring of panels and devices. When a PLC program circuit or sequence design change is made, the PLC program can be changed from a keyboard sequence in a matter of minutes. No rewiring is required for a PLC controlled system. Also, if a programming error has to be corrected in a PLC control ladder diagram, a change can be typed in quickly.

Large Quantities of Contacts

The PLC has a large number of contacts for each coil available in its programming. Suppose that a panel-wired relay has four contacts and all are in use when a design change requiring three more contacts is made. It would mean that time must be taken to procure and install a new relay or relay contact block. Using a PLC, however, would only require that three more contacts be typed in. The three contacts would be automatically available in the PLC.

Lower Cost

Increased technology makes it possible to compact more functions into smaller and less expensive packages. In the 1990s you can purchase a PLC with numerous relays, timers, counters, a sequencer, and other functions for a few hundred dollars.

Pilot Running

A PLC programmed circuit can be pre-run and evaluated in the office or lab. The program can be typed in, tested, observed, and modified if needed, saving valuable factory time. In contrast, conventional relay systems have been best tested on the factory floor, which can be very time consuming.

Visual Observation

A PLC circuit's operation can be seen during operation directly on a CRT screen. The operation or non-operation of a circuit can be observed as it happens. Logic paths light up on the screen as they are energized. Troubleshooting can be done quicker during visual observation.

In advanced PLC systems, an operator message can be programmed for each possible malfunction; descriptions of the function of each circuit component are added.

Speed of Operation

Relays can take an unacceptable amount of time to actuate. The operational speed for the PLC program is very fast. The speed for the PLC logic operation is determined by scan time, which is a matter of milliseconds.

Programming Methods

The PLC programming can be accomplished in the ladder, Instruction List, Function Block, SFC and Structured Text. In accordance with the Worldwide Standards.

Reliability

Solid-state devices are more reliable, in general, than mechanical or electrical relays and timers. The PLC is made up of solid-state electronic components with very high reliability rates.

Simplicity of Ordering Control System Components

A PLC is one device with one delivery date. When the PLC arrives, all the counters, relays, and other components also arrive. In designing a relay panel, on the other hand, you may have different relays and timers from different suppliers. Obtaining the parts on time involves various delivery dates and availabilities. With a PLC you have one product and one lead-time for delivery. In a relay system, forgetting to buy one component would mean delaying the start-up of the control system until that component arrives. With the PLC, one more relay is always available-providing you ordered a PLC with enough extra computing power.

Documentation

An immediate printout of the true PLC circuit is available in minutes, if required. There is no need to look for the blueprint of the circuit in remote files. The PLC prints out the actual circuit in operation at a given moment. Often, the file prints for relay panels are not properly kept up to date. A PLC printout is the circuit at the present time; no wire tracing is needed for verification.

Security

A PLC program change cannot be made unless the PLC is properly unlocked and programmed. Relay panels tend to undergo undocumented changes. People on late shifts do not always record panel alterations made when the office area is locked up for the night.

Ease of Changes by Reprogramming

Since the PLC can be reprogrammed quickly, mixed production processing can be accomplished in a very short time.

Programmable Automation Controller (PAC)

Programmable Automation Controller or PAC a relatively new name coined for small, local control systems. The name is derived largely from the popular PLC or Programmable Logic Controller. One major difference between a PLC and a PAC is the programming interface. Most PLCs are programmed in a graphical representation of coils and contacts called Ladder Logic. Most PACs are programmed in a modern programming language such as C or C++.

Since they are no longer handcuffed by the largely digital nature of Ladder Logic, PACs have become extremely popular is systems with a high percentage of analog I/O, in systems with extensive network interface requirements or in systems with direct user interaction requirements.

The primary difference between a PAC and a simple PC-based control system is that in a PAC, the "box" containing the I/O, also includes the processor and software. In fact the CPU running the system is actually built into the I/O system itself. While a typical, slaved data acquisition system is hosted by some type of general purpose PC complete with mouse, monitor and other human interface devices (HID), a Programmable Automation Controller's processor is usually dedicated to controlling the I/O system and often does not provide any direct human interface.

Physical differences between a PAC and a standard PC-based DAQ system are easily observed. However, the differences in software are equally noticeable. While most PCs operating systems for your desktop and laptop computer are large (in terms of RAM and hard drive space needed), operating systems developed for embedded systems are likely to be smaller and have been developed without all of the built-in GUIs as well as much of office equipment peripheral support.

Linux and Windows CE and Linux are likely to be the operating system under the hood of an embedded controller. Also, it is much more likely that one of these systems is running a real-time operations system such as QNX, RTX or RTAI Linux as a substantial percentage of these applications have either timing critical or high throughput requirements.

It is not uncommon for a PAC to run independent of any supervisory or otherwise outside controller. However, there is usually some link to the outside world. This may be limited to providing a simple status such as "I have no error conditions to report at this time", or it may such a tight connection that it allows an external computer take complete control while the interface between the two computers is alive. Typically, if will be in the middle where an external computer tracks system status, provides some control of key factors (e.g. temperature set point or target RPM), and/or offers the interface between the system and a human controller in charge of overall system operation

.PACs are often the heart of industrial control systems or process control applications. Programmable Automation Controllers may also be at the center of a portable data acquisition system or remote controller that allows an application to keep running even if its umbilical link to the outside world is cut.