Up-gradation of Conventional Control Panel with PLC for the Total Utilization of Machine

Miss. Archana R. Hindalekar,
Department of Electronics and Telecommunication
Dr.JJMCOE,Jaysinghpur
Shivaji University,Kolhapur
archana.hindalekar@gmail.com

Dr. Mrs. S. B. Patil,
Department of Electronics
Dr.JJMCOE,Jaysingpur
Shivaji University,Kolhapur
drsbpjjm@gmail.com

Abstract: - In the beginning of industrial revolution, especially in 1960 to 1970, automated machines wear controlled by electromechanical relays. These relays wear hardwired together inside the control panel. Many of the times the control panel was so huge that it would cover entire wall. Every connection in the relay logic must be connected. Wiring is not always perfect; it takes time to troubleshoot the system. This is very time consuming Process. On top of that the relays have limited contacts. If modification is required, the machine has to be stopped, the space may not be available and wiring has to be traced again to accommodate changes. The control panel can only be used for the particular process. It cannot be changed immediately to a new system. It has to be redone. In terms of maintenance, an electrician must be well trained and skilful in troubleshooting the control system. In short, the conventional relay control panel is very inflexible.

Keywords:*PLC,* Relays ,*Contactors, Automation*.

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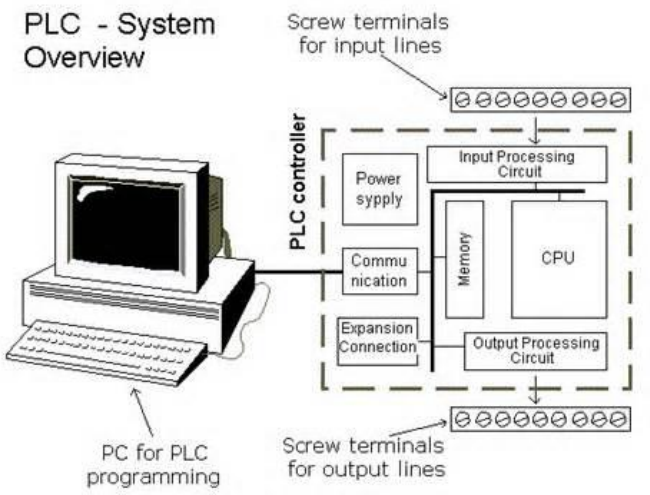
I. INTRODUCTION

In olden days the control panel of machines were generally made with relays ,contactors ,cam timers, drum sequencers, and dedicated closed-loop controllers, for the automation purpose and to increase the productivity of the machine which had reduced the human interference or human dependency for the machine handling process. Relays which were used are in numbers in the hundreds or even thousands, the process for updating such relay based control panel for change-over was very time consuming and expensive, as electricians needed to individually rewire the relays to change their operational characteristics. As days passed there is a lots of changes started involving in technology in all ways including automation. In recent years people started using PLC for the automation purpose instead of Relays and contactors as PLC has many advantages over Relay based control panel[2]. The wiring required for PLC based system is very less almost 80% reduction in wiring of control panel as that of relay based control panel. The system is very flexible in terms of introducing any new changes. PLC system is mainly software based so doing the appropriate changes in program we can modify the existing system into a new system without doing any changes in the hardware of the system when there is no extra inputs and outputs than the available on PLC. We can increase the inputs and output of system by introducing PLC extension module .Generally PLCs were programmed in "ladder logic", which strongly resembles a schematic diagram of relay logic. This program notation was chosen to reduce training demands for the existing technicians. Other early PLCs used a form of instruction list programming, based on a stack-based logic solver.



RELAYS AND CONTACTORS

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate as switch, at the same time other operating principles are also used, like solid-state relays. Relays are used where it is necessary to control a circuit by a low-power signal, or where number of circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers; they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

A simple electromagnetic relay consists of a coil of wire wrapped around a soft iron core, an iron yoke which provides a low reluctance path for magnetic flux, a movable iron armature, and one or more sets of contacts there are two contacts shown in fig 1. The armature is hinged to the yoke and mechanically linked to one or more sets of moving

contacts shown in fig 1. It is held in place by a spring so that when the relay is de-energized there is an air gap in the magnetic circuit. In this condition, one of the two sets of contacts in the relay pictured fig 1 is closed, and the other set is open. Other relays may have more or fewer sets of contacts depending on their function. The relay in Fig 1 also has a wire connecting the armature to the yoke. Which ensures continuity of the circuit between the moving contacts on the armature, and the circuit track on the printed circuit board PCB via the yoke, which is soldered to the PCB.

When an electric current is passed through the coil it generates a magnetic field that activates the armature, and the consequent movement of the movable contacts either makes or breaks depending upon construction of a connection with a fixed contact. If the set of contacts was closed when the relay was de-energized, then the movement opens the contacts and breaks the connection, and vice versa if the contacts were open. When the current to the coil is switched off, the armature is returned by a force, approximately half as strong as the magnetic force, to its relaxed position[3].

A contactor is an electrically controlled switch used for switching a power circuit, similar to a relay except with higher current ratings[1]. Contactors come in many forms with varying capacities and features. Unlike a circuit breaker, a contactor is not intended to interrupt a short circuit current. Contactors range from those having a breaking current of several amperes to thousands of amperes and 24 V DC to many kilovolts[1] .The physical size of contactors ranges from a device small enough to pick up with one hand, to large devices approximately a meter on a side.

Contactors are used to control electric motors, lighting, heating, capacitor banks, thermal evaporators, and other electrical loads.

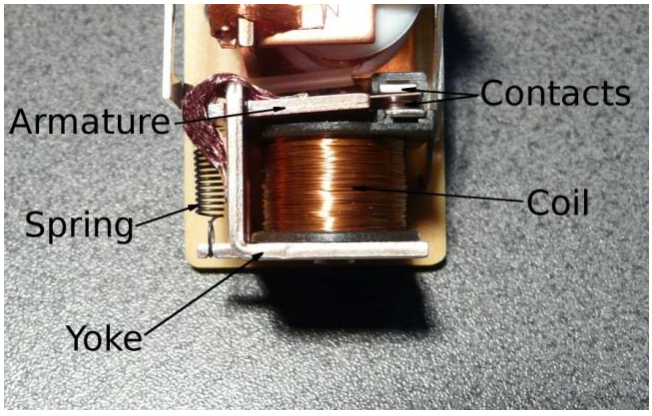


Fig 1

OLD OR RELAY BASED CONTRL PANEL

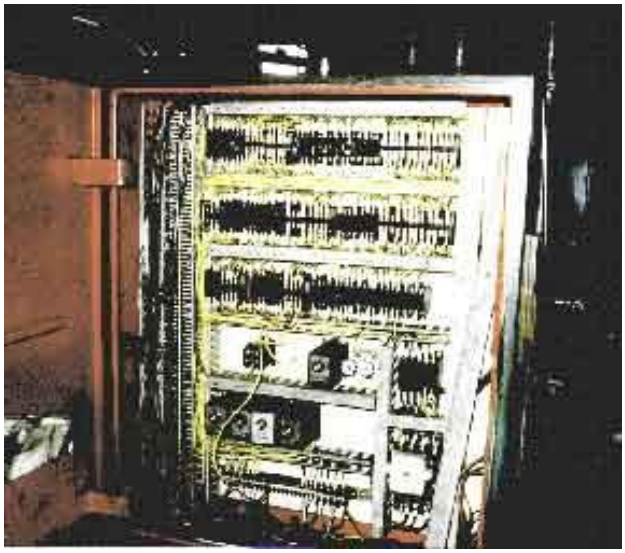


Fig 2

As shown in fig 2 can notice a large number of electrical wires, time relays, timers and other elements of automation typical for that period. Pictured control panel is not one of the more “complicated” ones, so can imagine what complex ones looked like.

Most frequently faced disadvantages of a conventional control panel are:

1) Too much work required in connecting wires.
2) Difficulty with changes or replacements.
3) Difficulty in finding errors; requiring skilful work force.
4) When a problem occurs, hold-up time is indefinite, usually long.

II. PLC BASED CONTROL PANEL

Fig 3

Control panel shown in fig 3 with PLC grey elements in the center. The unit consists of separate elements, from left to right; power supply, controller, relay units for in- and output.

Advantages of control panel that is based on a PLC controller can be presented in few basic points:

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1) Compared to a conventional process control system, number of wires needed for connections is reduced by 80%
2) Consumption is greatly reduced because a PLC consumes less than a bunch of relays
3) Diagnostic functions of a PLC controller allow for fast and easy error detection.
4) Change in operating sequence or application of a PLC controller to a different operating process can easily be accomplished by replacing a program through a console or using a PC software not requiring changes in wiring, unless addition of some input or output device is required.
5) It is much cheaper compared to a conventional system, especially in cases where a large number of I/O instruments are needed and when operational functions are complex.
6) Reliability of a PLC is greater than that of an electro-mechanical relay or a timer

III. PLC COMPONENTS

PLC is actually an industrial microcontroller system where have hardware and software specifically adapted to industrial environment. Block schema with typical components which PLC consists of is found in the following picture. Special attention needs to be given to input and output, because in these blocks can find protection needed in isolating a CPU blocks from damaging influences that industrial environment can bring to a CPU via input lines. Program unit is usually a computer used for writing a program often in ladder diagram[6] . PLC based industrial system is shown in fig 4.

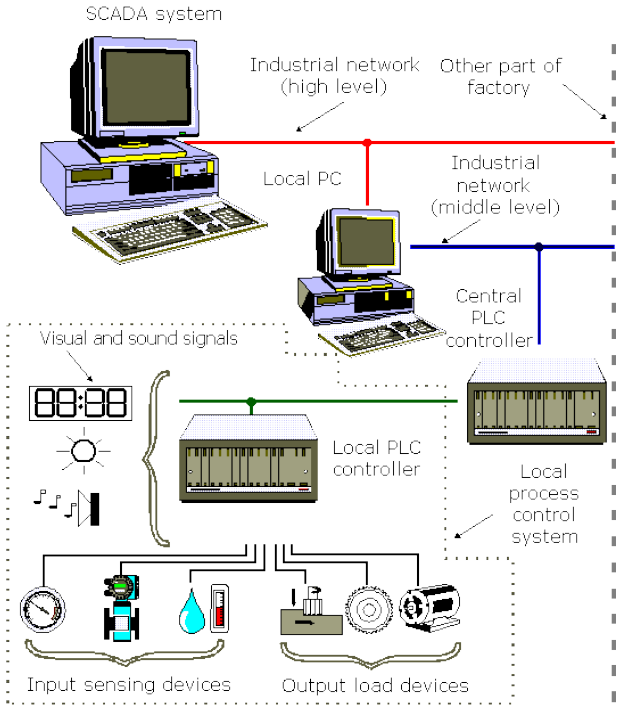

Fig 4

1. CPU- CENTRAL PROCESSING UNIT

Central Processing Unit is the brain of a PLC controller. CPU itself is one of the microcontrollers which takes the charge of events occurring to perform the specific operation . CPU takes care of communication, Timing interconnectedness among other parts of PLC controller, program execution, memory operation, overseeing input and setting up of an output[4]. PLC controllers have complex routines for memory checkup in order to ensure that PLC memory was not damaged memory checkup is done for safety reasons[5].

2. MEMORY

PLC System memory is generally implemented in FLASH technology for process control system. As we know any machine can understand the language of ones and zeros i.e. binary form known as machine language so translation of user program into binary form is done and stored into the memory. Changes in the translated FLASH memory contains will be done only if there is any change is made in user program. Earlier PLC controllers were having EPROM memory instead FLASH memory and had to be erased with UV lamp [6]. With the use of FLASH technology this process was greatly shortened. Reprogramming of a program memory is done through a serial cable for modified and required changes in application development. User memory is divided into parts having particular functions. Some parts of a memory are used for the storage of input and output status. The true status of an input is stored either as "1" or as "0" in a specific memory bit. Each input and output has one corresponding status bit in memory. Other parts of memory are used to accumulate or store variable contents of variables which are used in user program. For example, the value of timer or counter would be stored in this part of the memory.

3. PROGRAMMING A PLC CONTROLLER

PLC programming is a flexible programming can be changed or reprogrammed as per the new required changes in the system output. Reprogramming can be done through computer and also can be done through manual programmers. Any PLC can be programmed through computer by using the respective supporting software to programmed PLC according to the system inputs and outputs[7]. Most of the software's and its free trials are freely available on internet which can be accessed from anywhere this is more advantageous in terms of system flexibility. Once the system is corrected, according to new requirements it is necessary to read the corrected program into a PLC again. It is good to have a periodic examination whether program in a PLC has not changed. This periodic checking will avoid hazardous and dangerous situations in factory rooms and automated industries. Programmer can add description or remarks, about names of input and output

devices, and the important comments which can be useful when finding errors, and at time of system maintenance. Included comments and remarks will help to the technician to understand a ladder diagram.

Comments and remarks will help to speed up the process of modification of program in case of new changes in system. In olden days the person who was developing the system had security on to the developed program so no one else will easily understand how the system is technically working. At the time of system modification the correctly documented ladder diagram has to maintained so that any technician will thoroughly understand how exactly system is functioning.

4. POWER SUPPLY

It is used to supply electrical energy to electrical processing unit. It is mainly used to convert one form of electrical energy into another so also called as "electrical power converter". Most of the PLC controllers work either at 24 VDC or 220 VAC. Some PLC controllers can see with electrical supply as a separate module[8] , usually bigger PLC controllers having the separate supply module, while small and medium series already contains the supply module. User has to find out how much current is required from I/O module to ensure that electrical supply provides appropriate amount of current. Different types of modules use different amounts of electrical current. This provided electrical supply is not generally used to start external inputs or outputs. Instead User has to provide separate supplies in starting PLC controller inputs and outputs because then we can ensure provided supply is a "pure" supply for the PLC controller. The use of a Pure supply we mean supply where industrial environment can not affect it damagingly. Some of the smaller PLC controllers provides their inputs with voltage from a small supply source which is already incorporated into a PLC.

5. PLC CONTROLLER INPUTS

Efficiency or Intelligence of an automated system judged largely on the ability of a PLC controller to read signals from different types of sensors and input devices such as Push buttons ,Limit switches, keyboards ,functional switches etc. are a basis for man versus machine relationship. In order to detect a working piece, view a mechanism in motion, check temperature, pressure or fluid level which is needed to be sensed by automatic devices such as proximity sensors, level sensors, marginal or limit switches, photoelectric sensors, etc. Input signals can be logical i.e. either on or off or analog. Mostly smaller PLC controllers usually have only digital input lines while larger can accept both digital as well as analog inputs through special units attached to PLC controller. Sensors are generally used as inputs for PLCs. They can sense presence of some parts, measure liquid level, temperature, pressure, or some other physical dimension, etc.

Other devices like potentiometric sensors, Thermo couples, LVDTs, and RTDs also can serve as inputs to PLC controller. Intelligent devices like video systems, robots, etc. are capable of sending signals to input modules of a PLC controller. Robot, can send a signal to PLC controller input as system information when it has done with moving an object from one location to the other.

6. PLC CONTROLLER OUTPUT

The output from the CPU of PLC controller is provided to output devices. Output devices will vary the output according to the stored program. Most frequently used output devices are motors, solenoids, relays, indicators, sound signalization etc. By starting a relay or motor, PLC can control a system like system for sorting products and the complex systems such as service system for positioning head of CNC machine. Output can be of digital or analog type. Digital output signal works as a switch; which connects and disconnects line. Analog output is used to generate the analog signal ex. motor whose speed can be controlled by a voltage which corresponds to a desired speed.

7. INPUT AND OUTPUT ADJUSTMENT INTERFACE

Input interface is placed between input lines and CPU unit where as output is placed between CPU unit and output lines. Purpose of adjustment interface is to protect a CPU from disproportionate signals. Input interface turns level of real logic to the logic which will suits to the CPU unit..[9]

8. EXTENSION LINES

Every PLC controller has a limited number of input/output lines. In case when there is need to expand current system with some more inputs and outputs then it can be done by using expansion supporting module of respective PLCs which are available in market. Instead of using new PLC to modify the system use of expansion module with existing PLC will reduce the cost and just by changing the previous program according to the current requirement will give the modified system with required increased number of inputs and outputs. .

IV. DISCUSSION

Up-gradation of conventional control panels which are generally made up with relays and contactors based system can be replaced with PLC which will increases productivity of the respective machine by reducing the processing time. Power consumption is also less for PLC based operation. So the PLC based control panel overall increases effectively of the respective control panel in terms of the utility of the machine.

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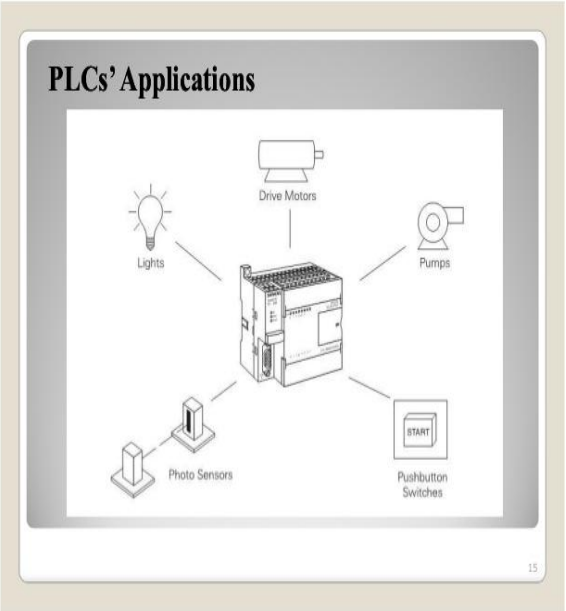

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