

A PRACTICLE APPLICATION OF SIMPLE PROGRAMING TECHNIQUE FOR COMPLEX PROCESS



Engineering

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ABSTRACT

Industrial application needs different level of automation and this has been achieved through sophisticated and advance electronic hardware. The process is mapped through software having complex logic/algorithm which is difficult to be interpreted by end user. At the same time, it is difficult to understand the logics using hardwire circuit diagrams. The new approach is to preserve logics in form of Boolean algebra which is easy to understand at the time of troubleshooting or creating ladder diagram to convert complex contactor based system in to PLC system.

A. Introduction

The PLC (Programmable Logic Controller) evolves from the rapid developments made in control engineering over the years. A PLC is a modular device which can be programmed using Ladder diagrams or statement list .It is optimized to handle several digital inputs and outputs and is more rugged for use in industrial applications. PLC can be operated through no of different tools and one of which is Ladder logic. The ladder logic is widely used to program industrial sequential control of a process or manufacturing operation in very simple manner. One can develop the logic diagrams using the Boolean algebra to convert any electrical connection into logic form with the help of basic AND, OR and NAND gate. For more complex circuits more logic and gates such as exclusive OR (EOR), NOT AND (NAND) and NOT OR (NOR) are required. The beautiful aspect of Logic diagram is that it provides very simple look to complex function and useful in troubleshooting. The real life application of above was performed at premier power plant as my project work and describe herewith appraising larger engineering fraternity through this case study.

B. Case Study

Thermal Power station requires emergency backup power system either for startup or safe shutdown during grid failure. This is generally provided by Diesel Generator set and hence it is critical equipment and its availability has to be ensuring at all time. The typical electrical arrangement and schematic of typical system is as below:

B. 1. Purpose of AC Emergency Supply system

To facilitate an orderly and safe shutdown of the power generating units under emergency blackout condition, three (3) DG Sets (Two operating for the Power Station and one common standby) are deployed for Power station.

B..2. System Description

Each DG Set consists of one diesel engine and one generator and associated auxiliaries. The Engine, Generator and the radiator is mounted on a common skid. The DG sets are connected to Emergency bus to cater for emergency load requirement during total Plant blackout. DG1 shall be connected to emergency board of Unit-1 through an ACB while DG2 to emergency board of Unit-2. The DG3 will be connected to both the emergency board (Emergency board of Unit-1 and Emergency board of Unit-2) and therefore can be used as standby to DG1 or Dg2.

Each DG sets has its own dedicated AMF (Auto Mains Failure) panel. In auto mode, the start initiation for DG-1 would be BUS under-voltage relay in emergency board of Unit-1 activated, the start initiation for DG-2 would be BUS under-voltage relay in emergency board of Unit-2 activated, the start initiation for DG-3 would be start failure of any of the two DG sets. In manual mode any of the DG sets can be started locally from AMF panel or from control panel at Plant control room. The DG incomer ACB will close to emergency board on dead bus condition. On resumption of normal supply the changeover to normal supply incomer shall be affected manually on dead bus condition. There shall be electrical close interlock to prevent parallel operation of DG source with normal source; therefore no synchronizing provision is envisaged in DG control. The DG Sets are located inside the DG Building.

B. 3 Problems with Existing control system

The conventional DG set with AMF control panel is in operation since the commissioning of the Power station. The historical operational note revealed that at many times during normal day-to day trial and sometimes during AC fail condition, DG did not pick up in AUTO and created havoc.

After detailed study of defect history and interaction with plant maintenance crew, it was objectively evident that the main problem is due to large number of contactors in the AMF panels. There are almost 45 contactors and timers are used in each AMF panel to have sequential operation of DG set in manual or Auto operation. But owing to highest importance of reliable operation of DG during AC fail condition, it was further analyzed and then it was suggested to replace convention contactor based control system by advanced PLC system which have many advantage due to rapid improvement and sophistication progress achieved in Electronics and automation.

B. 4. PLC as system solution

The PLC (Programmable Logic Controller) becomes very handy in each and every process irrespective of the complexity of the process. The PLC offers the following advantages:

SINGLE LINE DIAGRAM-EMERGENCY SUPPLY SYSTEM

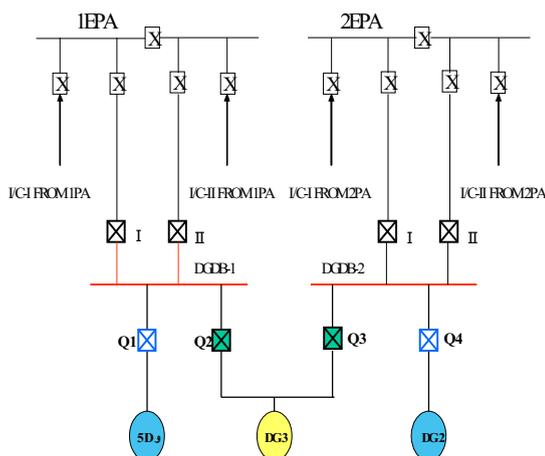


Fig A : Single Line diagram

1. Cost effective for controlling complex system.
2. Flexible and can be reapplied to control other system quickly and easily.
3. Computational abilities allow more sophisticated control.
4. Trouble shooting aids make programming easier and reduce downtime.
5. Reliable component make these likely to operate for years before failure.
6. Best suited for sequential programming.
7. Can be Configure for the most of the communication protocols and platforms.

The PLC was invented as less-expensive replacements for older automated systems that would use hundreds or thousands of relays and cam timers. Often, a single PLC can be programmed to replace thousands of relays. Programmable controllers were initially adopted by the automotive manufacturing industry, where software revision replaces the rewiring of hard wired control panels.

Early PLCs were programmed in Ladder logic which strongly resembles a schematic of relay logic. Modern PLC can be programmed in a variety of ways, from ladder logic to more traditional programming languages such as BASIC and C. The currently used five programming languages for programmable control system are:

FBD (Functional Block Diagram), LD (Ladder diagram), ST (Structured Text, Pascal type language), IL (Instruction list) and SFC (Sequential function chart).

The ladder logic or the ladder programming language is a method of drawing electrical logic schematic. The name has been derived as it resembles the ladders, with two verticals 'rails' and a series of 'rungs' between them. The ladder logic is widely used to program industrial programmable logic controllers, where sequential control of a process or manufacturing operation is required. Ladder logic is useful for simple but critical control systems or for reworking old hardwired relay circuits.

B. 5. Engineering of PLC

As part of effective engineering solution, a systematic approach toward engineering of DG PLC was initiated.

The various stage of engineering are as below:

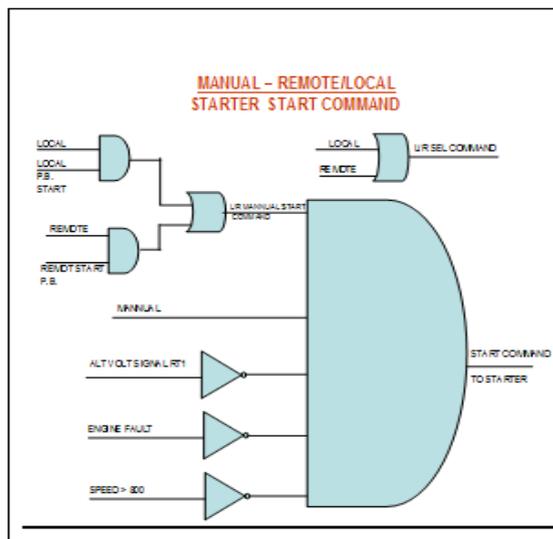
1. Understanding of operation philosophy
2. Determination of Input and Output signals for all three DG sets.
3. Selection of appropriate hardware and software to suit for above system.
4. Finalization of system requirement.
5. Finalization of Overall system layout.
6. Preparation of Control Scheme.
7. Preparation of Logic Diagram.
8. Preparation of Ladder logic.
9. Finalization of Panel layout
10. Installation and Commissioning of Panel.

However, as this paper is aimed to provide application of simple tool for complex process, detail on two specific stage namely Preparation of Logic diagram and Ladder diagram is explained in detail with illustrative examples.

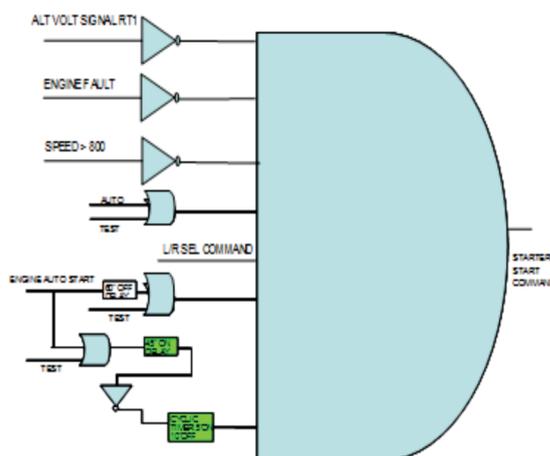
B. 6. Preparation of Logic Diagram

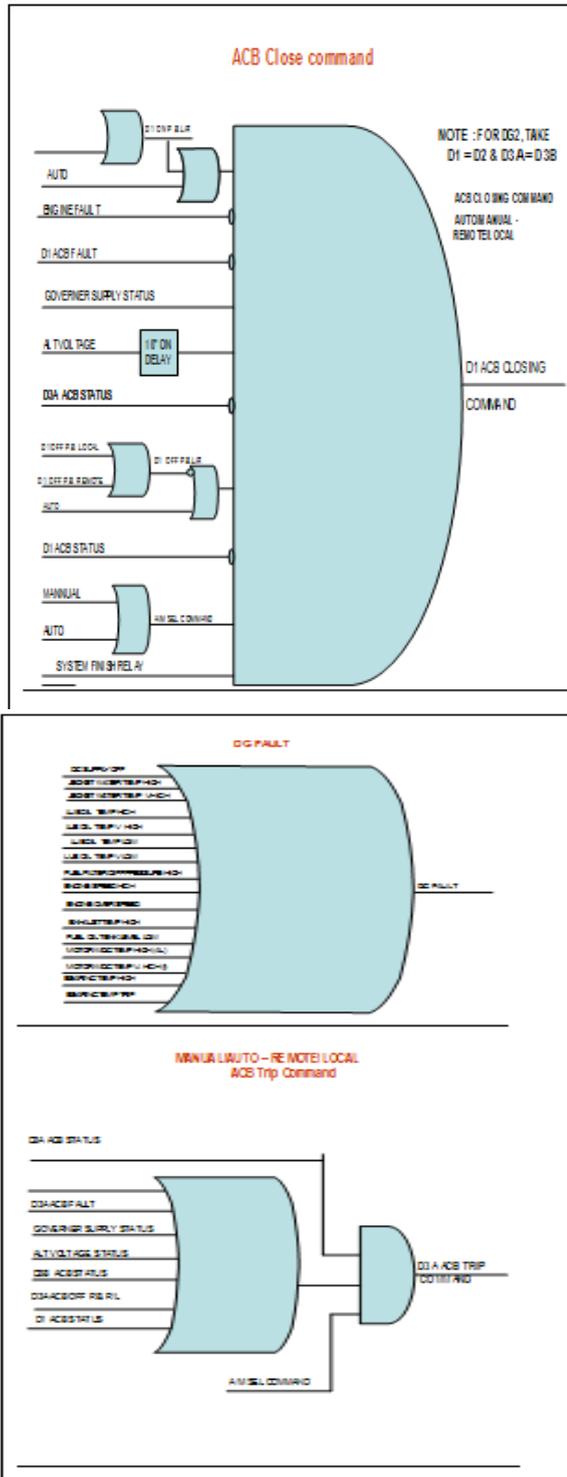
As described in introduction part, with lot of advantage offered by logic diagram, same was used to for all operation, monitoring and protection function control for DG PLC system. Some of this is illustrated below for quick reference:

- Logic diagram for Manual – Remote/Local Starter Start Command
- Logic diagram for Auto /Test Remote/Local Starter Start Command
- Logic Diagram for ACB Closing Command (Auto/Manual - Remote/Local)
- Logic Diagram for ACB Trip Command (Auto/Manual – Remote/Local)
- Logic Diagram for DG Fault
- Logic Diagram for DG TRIP



AUTO /TEST REMOTE/LOCAL STARTER START COMMAND



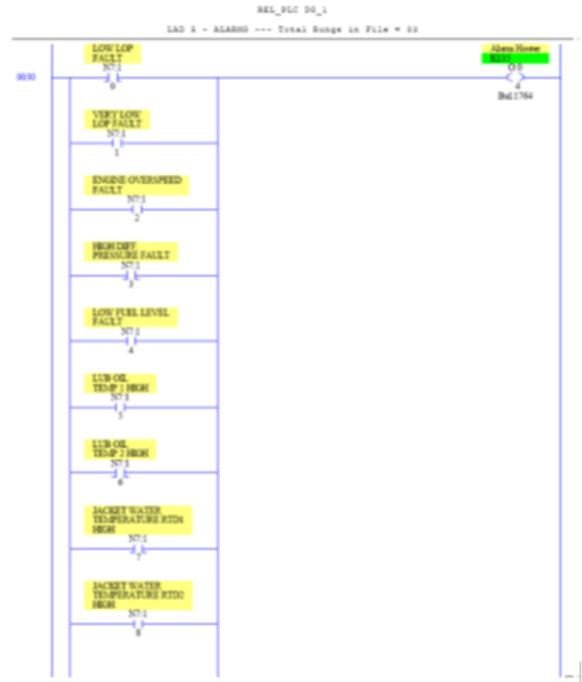


B. 7. Preparation of Ladder Diagram

Ladder logic is the main programming method used for PLCs. As mentioned before, ladder logic has been developed to mimic relay logic. By selecting ladder logic as the main programming method, the amount of retaining needed for engineers is greatly reduced.

The ladder logic in the PLC is actually a computer program that the user can either enter or change.

In ladder logic diagrams the input, Output and relays are easily programmed. I have developed the Ladder logic programming for DG set. One such example is reproduced over here as illustration:



C. Conclusion

This paper describes the technological solution to the industry problem. The project right from the concept to commission passed through various stages of understanding the system, exploring the alternate solution, design and engineering of system and its implementation. The chronic problem of non-availability of DG set during starting and running resolved through the induction of the PLC system. During design stage, lots of options were explored in order to make system simple but reliable and in this context, application of logic diagram and ladder diagram not only speed up conversion from hard wire to PLC programming, it also benefits to maintenance staff to understand system logic in most simplified manner. Moreover, recent feedback also suggested that this has been particularly helpful during trouble shooting and even new engineer also can understand system and troubleshoot with help of this approach. So, it proved that even for complex process system, simple solution are more beneficial and help is achieving real objective.

REFERENCE

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