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Automation Of 400 KV Swichyard using Networked Distributed I/O PLC

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Abstract

A switch-yard is a part of an electrical generation, transmission and distribution system. In a switch yard there are unit feeders and out-going feeders. The paper deals with 400KV switchyard automation. One of the out-going feeders is considered for automation. The elements of the O/G feeders are Bus Isolators, Circuit Breaker, Line Isolator, Earth switches and elaborate Protective Relay circuits. Separate relay panels are available to take care of protection of each and every element in the yard. It is responsible to isolate faulty section immediately in very minimum time, under abnormal situations. Hence at most importance is given for control and protection scheme design. It is a reliable technology working in real-time .By introducing PLC into the switch-yard automation, each and every input/outputs (I/O) will be terminated with remote terminal units

Keywords; *Programmable Logic Controller (PLC),Switchyard, Outgoing feeder,Automation*

I. INTRODUCTION

The paper gives the present scenario of feeder protections & control – as well based on the limitation of the above system, the control part- to implement Programmable Logic Controller for the above task with remarkable benefits is discussed. Since the present logic involves control relays, wirings and highly depends on all the connected interlocks – the trouble shooting under crisiswillbe a tedious one and time consuming too.In each incoming (I/C) or outgoing (O/G) feeders isolators are there. There are two bus isolators and one line isolator. All the isolators are 3-phase motor operated. Looking after the operation of one isolator IT is enough to know the operation of all isolators. Interlocking conditions may vary.All the bus isolators and transfer bus isolators are motor operated. The motor operating mechanism (MOM) is provided in a cabinet and fixed in isolator structure. The operations of isolators are done electrically at ‘Remote’ and at ‘Local’. All the above operations are carried out from the MOM cabinet. The motor is operated in both the direction for opening and closing of isolators through a set of opening contacts ‘OC’ and closing contacts ‘CC’. The motor is protected from being overloaded by the provision of over load relay ‘OLR’ which cuts off the power supply to the motor on over load conditions. The opening and closing operations of isolators are limited by means of operation of limit switches ‘LSO’ and ‘LSC’. This entire process is going to be automated with the help of PLC.We made an attempt to design hardware and software model documentation to up –grade switch-yard element control with Latest PLC technology.For the switch-yard Automation the Networked Distributed I/O PLC should be employed. This one will be the latest trend of technology for the process control operates in Real-Time. If at all PLC is introduced in the automation of Switch-yard, the first advantage will be major reduction in control cables usage- the total bunch between control room and switch-yard bay will be avoided.

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Main function of switch yard

- It makes available the generated power at plant to the people.
- Power generated at power station transmitted via switchyard.
- Switchyard protect the plant due to sudden damage outside the plant
- Switchyard is most essential part of the power system. It is the protective part of the whole power system. Switch yard is also most essential part for transmission, distribution, and collection. There are 15 bays in 400kV switchyard as follows

Types of feeders are

- Incoming feeder or Unit feeder or Generator feeder
- Out-Going feeders.

A feeder mainly consists of 2 bus isolators, one line isolator, one SF6 circuit breaker and three earth switches with associated protective relay circuits

II. GENRAL PROCEDURE FOR ISOLATORS

The interlocks are implemented for safe guarding the equipment and for personal safety. The isolator can be closed / opened electrically, only when certain interlocks (conditions) are satisfied.

For bus isolator 89A i.e. I bus isolator can be opened electrically from remote if the following conditions are satisfied.

a. KIMC (Key interlock main coil) key i.e. isolator manual operation key shall be in the front panel of the MOM box and turned 'ON'.

b. Over load relay should be in healthy (reset) condition.

c. Breaker (52) is open

d. Local / remote switch should be in Remote position.

The bus- I isolator (89A) can be closed electrically from remote if the following conditions are satisfied along with the above mentioned conditions . (If the element is being taken in to service from shutdown).

a.Earth switch (E1) is open

b. CVT-A isolator in closed in condition i.e. 400Kv I bus shall be in charged condition.

For both the opening and closing operations 3phase AC and 220V DC switches shall be in ON condition along with fuses. Fuse rating for 220V DC is 2A and for 3 phase AC is 4A. The open indication of 89A will vanish immediately as soon as command is given provided all the above interlocks are satisfied.

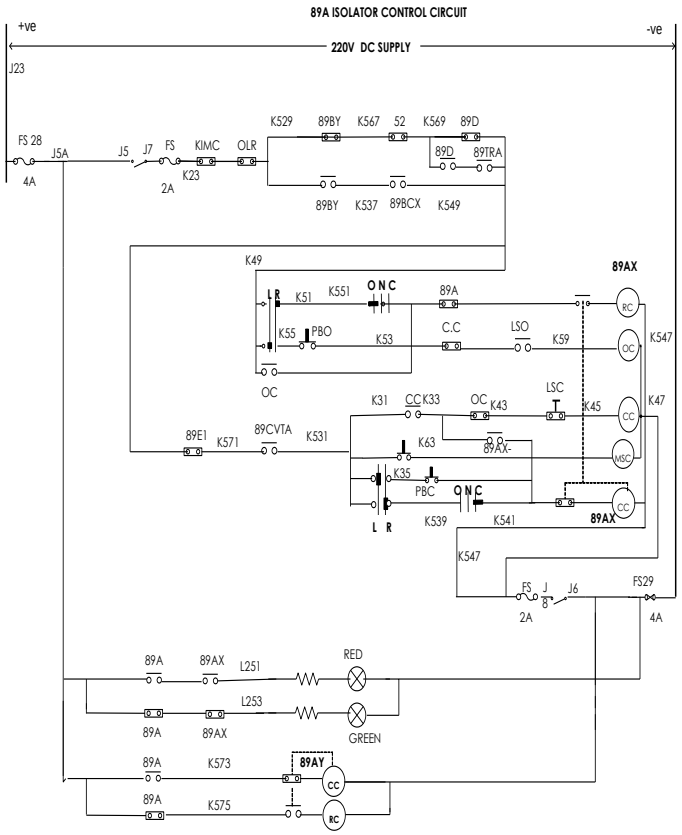

Fig. 1.Circuit of Isolator Control Circuit

III. DRAWBACKS OF PRESENT SYSTEM

- Physical wiring of system is complicated and difficult.
- The panel board arrangement occupies more space. The arrangements also require proper ventilations. The arrangement is not simple and neat.
- Their parts can wear out as the switch contacts become dirty high voltages and currents cause sparks between the contacts.

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- They cannot be switched on and off at high speed because they have a slow response and the switch contacts will rapidly wear out due to the sparking.
- For any automation in power plant, large number of relays is required. The increase in number of relays makes the wiring complex.
- In electromechanical relays, if damping force, spring balances are not accurate, the time setting and current setting may changes.
- Their coil need a fairly high current to energize, which means some micro electronic circuits cannot drive them directly without additional circuitry.
- In the case of hard-wired logic required frequent maintenance and occasional replacement of contact. The maintenance cost will be more.
- In case of control wire logic entire physical arrangement should be changed and reconfiguration cost is more.

In the present control design to enable bi-directional control from control room and bay area large number of cable cores required for each and every element. As the distance of the bay rises the length of control cable laying also going more. Thus for entire switch yard bay operation bunch and bunch of control cables will be here. The chance of cable open/short or earth is possible. This causes operation disturbance and reduced control security.

Trouble shooting for misbehavior is most common happening and it would consume more time to resolve. Hence up-gradation is highly required to modernize PC friendly switch-yard control facility with the help of PLC

IV. PROPOSED SYSTEM

In Switch-yard the control room and process area separated at some distance more than 500M. In addition the process requires the drives to be controlled from both ends. This is referred as bi-directional control, ie., the drives may be controlled through control room commands or through the field commands. The operation is achieved with a selector switch- called Local- Remote. If the selection is in Remote, control room operation only possible and if it is in Local – Local commands only accepted and executed

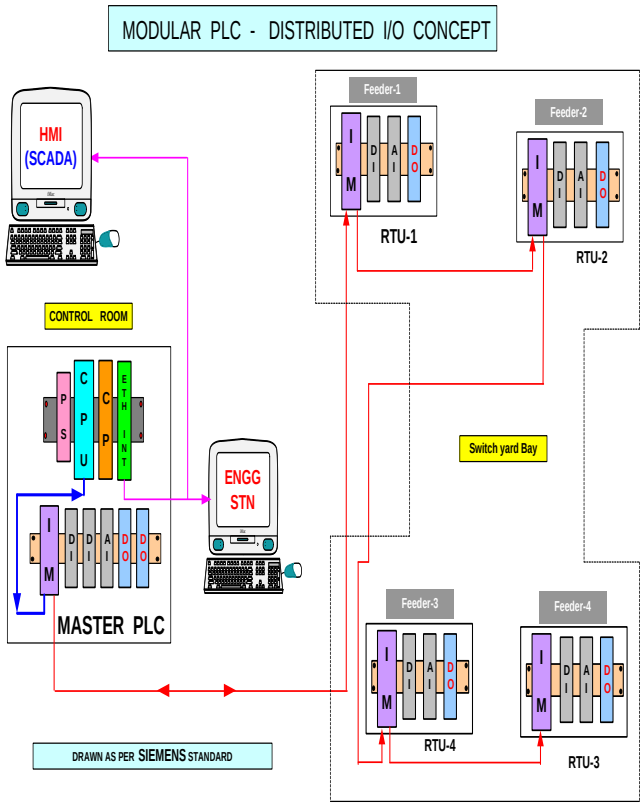

Fig.2. PC Integration Block Diagram

Concept is very simple – control room commands and protections plus all other inputs available near to control room are terminated with the PLC (Master) available in control room. Like wise the field inputs are combined and terminated at the PLC (Slave) available near to process area. Both the Master and Slave PLCs are connected through a two core cable which carries out the communication activities between two in Real-Time.

PLC is a reliable Real-Time operating technology-today's PLC gives scan time of the process even in minimum of milliseconds. Modular PLC will be the best choice for the Automation and hence dominates well in the field of Automation successfully

The Latest developments in the VLSI field make today's PLCs very close to the DCS technology. We

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didn't find much difference between today's PLC and DCS. Latest PLC's are very intelligent in handling Digital, Analog and even Pulse signals. Industrial AUTOMATION mostly uses MODULAR type PLCs. In the industrial set-up generally the process area and control end are separated at distance. This type of control will be closely ensured with the MODULAR PLCs.

The types of PLCs are broadly classified into three types like Micro PLC and Networked Modular PLC. Though there are two types of PLCs, the operation and programming being very similar to all types. The first type may be programmed using LAD (Ladder logic) software and the second one having options for program using STL (Structured List or Statement List), LAD (Ladder Logic), FBD (Functional Block Diagram) or through IL (Instruction List). For limited process applications first two types may be employed. The Modular PLC concept will be the best choice for distributed I/O applications which involves control action at both ends. The total process being monitored through desk top- using SCADA software. The PLC monitors the process happenings in Real-Time and hence it dominates well in the field of Industrial Automation.

The Nano, Micro PLCs are single module pack, within which it has a CPU, Input Module, Program Memory and Output Module. Let us have a look on application part of this technology implementing the available types.

In Switch-yard the control room and process area separated at some distance more than 500M. In addition the process requires the drives to be controlled from both ends. This is referred as bi-directional control, ie., the drives may be controlled through control room commands or through the field commands. The operation is achieved with a selector switch- called Local- Remote. If the selection is in Remote, control room operation only possible and if it is in Local – Local commands only accepted and executed.

For this distance and bi-directional application, the PLC technology gives better solution now a days using Master-Slave concept. This one is the latest generation PLCs called Modular PLC concept. SIEMENS and GE-FANUC are some of the leading legends in this technology.

Concept is very simple – control room commands and protections plus all other inputs available near to control room are terminated with the PLC (Master) available in control room. Like wise the field inputs are combined and terminated at the PLC (Slave) available near to process area. Both the Master and Slave PLCs are connected through a two core cable which carries out the communication activities between two in Real-Time.The sketch below shows the concept clear. With the help of this technology we propose switch-yard automation. Here the Master PLC is available in Control room and Slave RTU (Remote Terminal Units) available in Field.PLC is a reliable Real-Time operating technology- today's PLC gives scan time of the process even in minimum of milliseconds. Modular PLC will be the best choice for the Automation and hence dominates well in the field of Automation successfully.

Here in modular concept, the internal parts of PLCs are separated as modules. First rack is known as Mother Slot. It carries Power supply, CPU, Communication Processor and Ethernet Interface. The address of Power supply will be always zero and CPU will be one and so on.

Second and all available racks are I/O racks. In general one Interface Module simply called IM is used to manage the I/O activities. The IM is connected with mother slot through a two core communication cable. During Multiplexer operation it collects all input information from the input modules connected and supplies it to CPU to enable Input Scanning cycle. The total operation is being monitored by the CPU.

Siemens step-7 PLC is capable of handling 1024

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inputs and outputs. The inbuilt timer and counter function ready to give 256 options. It just needs the set point- to be fixed by the operator or programmer. All the available process signals are being (Analog, Digital, Pulse) handled by the PLC. It is used in Instrument process also since it is capable of handling Analog inputs as well. This concept renders us superior communication capabilities through PC, LAN and even INTERNET also.

It gives flexibility to program in all available types like IL, LAD, FBD and STL. Computer based HMI (Human Machine Interface) and SCADA (Supervisory Control And Data Acquiring system) are the optional features of Modular PLC. Alarming, trending and event registers are there to know the status and past history. It provides excellent documentation of our control software.

In last type of Modular PLC is Distributed I/O concept. Here there will be a centralized control room and the process area were distributed over some distance and bi-directional control of each and every drive should also to be ensured when required.

The hardware configuration of above discussed type distributed I/O process is given in below sketch. Each and every process area will be monitored through an IM module- I/O devices are racked into the backplane bus. The operation of Distributed I/O or Micro PLC remains same with programming concepts. We will do programming for Isolators, Breakers with Ladder language using Omron Make 20C-D1-D-V2 Zen model.

V. ADVANTAGES OVER EXISTING SYSTEM

1. The process inputs are connected directly to the PLC input module. Hence it doesn't require any additional interfacing agent like the other available technologies.

2. The executed results of our process activities are also taken directly from PLC, through its output module.

3. More than 80% of physical wiring will be avoided using this intelligent hardware, whose operation purely depends on software.

4. No limitation for the auxiliary contacts as in the case of hard-wired logic. We can use thousands of NO-NC for a programmed coil or register (solid memory)

5. It does not require physical Timers, Counters. All these will be availed as software. It just need the delay time.

6. Power consumption is very minimum.

7 It will support for Real- Time monitoring of electrical and Instrument Process.

8. Power consumption is very minimum.

9. Accommodates very less space.

10. Supports well for further expansion.

11. User-friendly software – easy to understand.

12. Modification is very easy. Entire program can be erased if we wish and re-programmed effectively. This is not possible with micro-controller also. Part of the program may be erasable and re-programmed in embedded logic.

13. Trial running is possible. This is very useful because we first check our logic for results that we need for our process requirements. If the results are correct or our program is correct then we will command PLC to run our program.

14. Superior PC capability. Hence modifications and monitoring through system

is possible. This makes it very convenient for the engineers.

15. Support data sharing and pumping through LAN.

16. We can avail SCADA facility PLC plays major role in the SCADA – as RTU's (Remote Terminal Units).

17. Analog and digital signals can be processed

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effectively and hence it proves the talents in the instrumentation process also.

VI. DISADVANTAGES

1. Initial installation will be more

2. Needs skilled person to communicate.

VII. CONCLUSION

We finished our project with the knowledge to control and automate the main feeder elements located in switch yard. By using PLC with interconnected PC- we may control breakers and isolators of any feeder. All our programs and software developed here were simulated and tested. Program developing trouble-shooting prepare us in relevant software developing skills. We conclude that our project is very much helpful to improve and to maintain good discipline in switch yard operation & control. This system reduces the control cable usage, timers and relays. The further extension of PLC based SCADA design system will improve the switchyard consistency more. PC friendly desktop will render end-user, to have good visual idea and alertness over system for running and faults.

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Fayaz Ahamed received her Bachelor of Engineering (2009) Alagappa Chettiar Government College Of Engineering And Technology(Autonomous) affiliated to Madurai Kamaraj University and Master of Engineering (2010) in Power Electronics and Drives from College of Engineering Guindy. He has thirteen years of teaching experience in Engineering colleges. At present, he is working with RMK Engineering. College in the Department of Electrical and Electronics Engineering.

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