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A Review on PLC Based Automatic Synchronization of Two Alternators

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ABSTRACT: In this study, an automatic synchronization unit has been developed for the synchronization or parallel connection of synchronous generators. Two synchronous generators are connected in parallel automatically with the developed control unit. Manual synchronization will take more time to take load, which leads to energy loss. Various circuit breaker statuses have to be monitored before synchronization. In order to reduce energy loss during synchronization process, the plant needs an alternative method. My objective is to ensure the synchronization between bus bar and EB, bus bar and DG with smooth process at a leading industry. These conditions are monitored by a PLC. It is the efficient way because of its reliability, effective trouble shooting and can be programmed easily. My objective includes the programming sequence for this PLC unit for the varying parameters and ladder diagrams for various synchronous conditions. Logical continuity is essential for PLC, like electrical continuity for relay logic.

KEYWORDS: synchronization, PLC etc.

I.INTRODUCTION

SYNCHRONIZATION:

Synchronization of alternator means connecting an alternator into grid in parallel with many other alternators, that is in a live system of constant voltage and constant frequency

Fig 1 shows the connection diagram of synchronization of two synchronous generators.

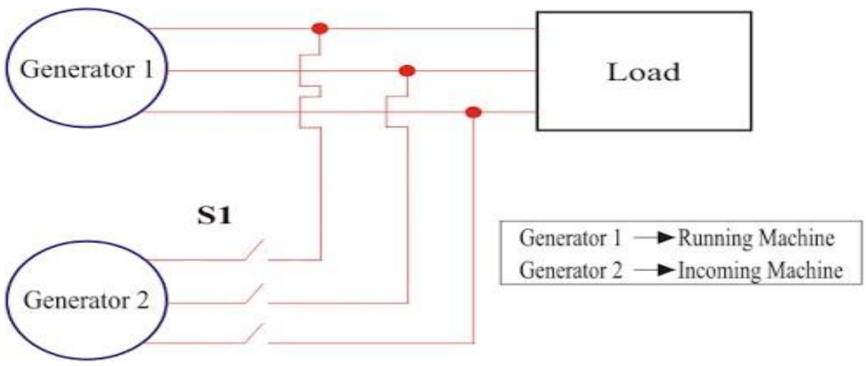

Fig 1- Synchronization of two DG set

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AUTOMATIC SYNCHRONIZATION:

Synchronization by means of manually operated switching served well enough when the individual generators were relatively small, but with the growth of system capacity, it becomes necessary to use automatic devices to ensure the closing of the main switch of the incoming machine at the proper instant. The scheme introduced here is for the complete automation of synchronization i.e. the adjustment of magnitude of voltage and frequency of incoming alternator is done automatically. The two three phase supplies, one is main three phase supply and another one is three phase alternator, both are calibrates their individual SCUs and zero cross detectors, every individual signal conditioning unit is controlled the change of magnitude with respect to the frequency for every individual phase and hence at signals applied to the input of PLC.

II.BASIC CONDITIONS FOR SYNCHRONIZATION

Basic conditions to be satisfied before synchronization of generator to bus bar are:

- Terminal voltage of the alternator should be approximately same as the bus bar voltage. The difference should be less than 5%.
- Incoming frequency and bus bar frequency should be the same. Maximum difference should be less than 1%.
- The incoming supply and bus bar supply should be at the same phase position. The machine can handle 100 phase mismatch between incoming and bus bar voltages.
- The phase sequence of incoming and bus bar supplies should be same.

PLC

A personal digital assistant (PDA), a Programmable Logic Controller (PLC), a wireless device server and its driver are used to realize a servomotor remote control in. PLC and frequency control based water pumping system was designed, constructed and tested. Cables were used for system communication. Conventional cables with PLC were utilized in enormous applications. PLCs are predominantly used in various automatic control system applications. They are programmed using instructions to implement required control functions such as: logic, arithmetic, sequencing, and timing. The digital or analogue input/output modules are used to control various types of processes and machinery. Plant monitoring and control is another important function of PLCs in fields such as energy, telecommunications, oil and gas refining and transportation.

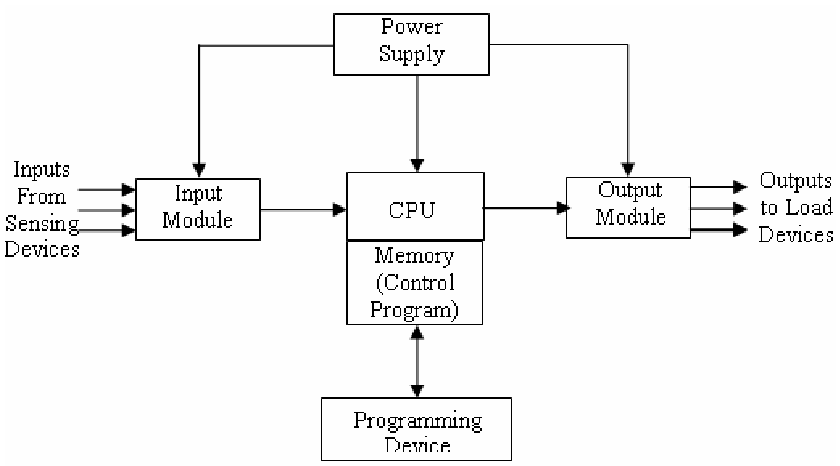

Figure-2 PLC block diagram

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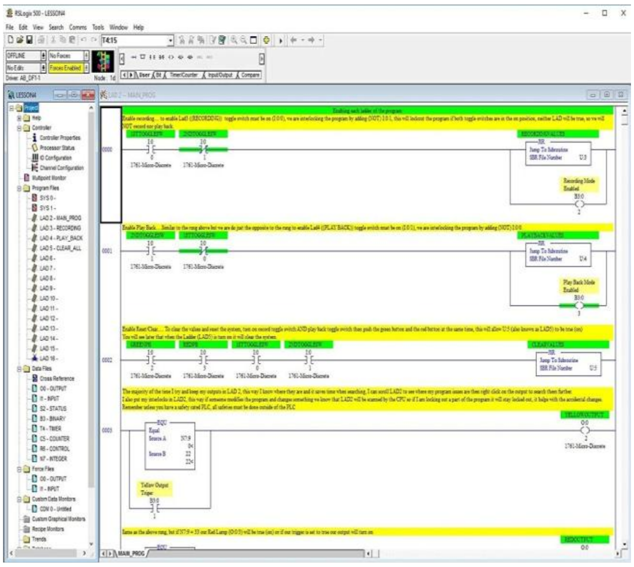
Processor unit, memory, power supply unit, input/output interface section, communications interface, and programming device are the basic building blocks of PLC as shown in Figure

- The processor unit or central processing unit (CPU) contains the microprocessor. The main purpose of this block is to interpret the available input signals and carry out control actions based on program stored in its memory. It then communicates the decisions as action signals to the outputs.
- The power supply unit converts the AC voltage to DC voltage based on compatibility with the processor and the circuits in the input and output interface modules.
- The required program is developed in the programming device and then loaded into the memory of the PLC.
- The memory unit stores the program for the microprocessor. It stores input data for processing and buffers data to output.
- The input and output interfaces assists in communicating with external or peripheral devices. Switches or sensors could act as input devices. Motor starter coils, solenoid valves, or actuators may act as output devices.
- The communications interface is used to receive and transmit data on communication networks. It is responsible for device verification, data acquisition, synchronization between user applications, and connection management.

PLC SOFTWARE INTERFACE(RS LOGIX 500):



FLOWCHART:

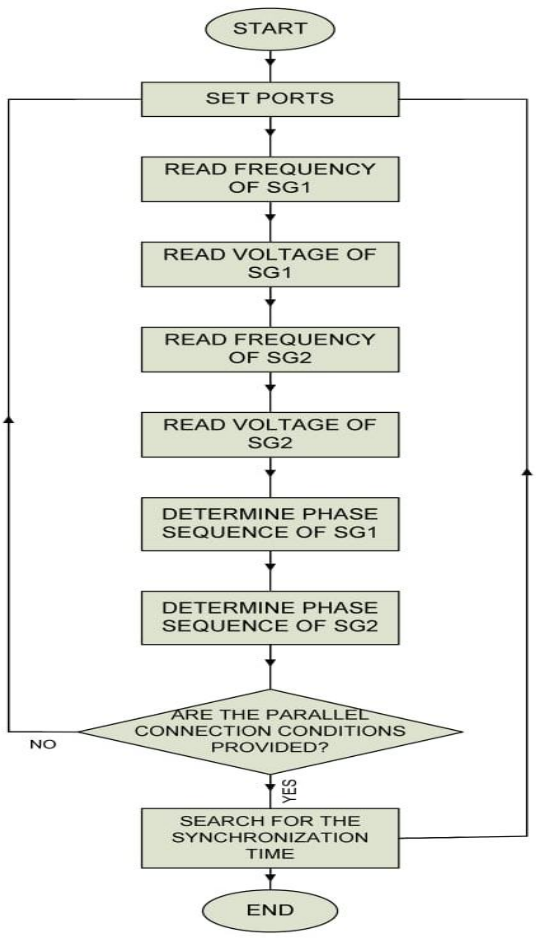


Fig 4. Flowchart

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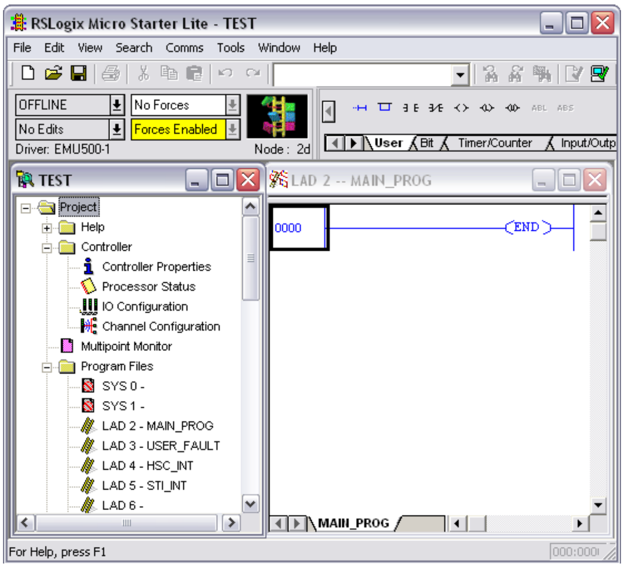

Fig 3. Ladder logic diagram

III.MEHODOLOGY

PARALLEL OPERATION OF THE ALTERNATORS:

SGs are connected in parallel to feed bigger loads and improve reliability of the electrical power systems. When required conditions are occur a SG can be connected in parallel with another SG or with transmission line. The parallel conditions required for the parallel connection of SGs are given as follows:

1. Frequencies should be equal (f1=f2)
2. Voltages should be equal (V1=V2)
3. Phase sequence of the SGs should be same (Direction of the rotating field should be same)
4. Parallel connection should be realized at the synchronism time.

In the classical systems frequencies are measured with frequency meters, voltages are measured with voltmeters, phase sequence is measured with phase sequence meter, and synchronism time is measured with synchroscope. In the presented study, all of the measurement tools are eliminated from the system. The developed control unit measures required signals of the SGs and determines parallel connection time when all conditions are provided .The hardware implementation of the parallel operation system with classical measurement tools.

AUTOMATIC SYNCHRONIZATION UNIT

To eliminate measurement tools and to obtain simplified, precise and quick parallel connection for SGs PLC based automatic synchronization monitoring and control unit has been designed. The main block diagram of the PLC based parallel connection system.
Transformers are used to convert phase voltages to the lower voltages that can be processed with PLC. PLC converts these signals and then calculates the frequencies, voltages, phase sequence of the SGs. If these three conditions are provided, PLC captures synchronism time between phase voltages of the SGs. When synchronization occurs the PLC

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sends the control signal to the relay and parallel connection switch is turned on for parallel operation. The designed automatic synchronization control unit has been shown.
The flowchart of the main software program coded into the PLC for the parallel operation of the SGs .As shown from the flowchart; frequency, voltage, and phase sequence of the each SG is determined, respectively and when all the conditions occur, the synchronism time is searched to achieve parallel operation of the system.
Each parallel connection condition has been determined by sub-routine of the software program. Detailed information about sub-routines are given as follows, individually.

FREQUENCY CALCULATION:

The signals received from the R phases of the generators are checked for the calculation of frequencies. Comparator module of the PLC is used in this stage. Input signal is compared with internal produced reference voltage Vref=0 and then converted to the square wave signal.
This square wave signal takes logic 1 and 0 data. PLC run the Timer-1 when the value of signal is 1 and stop the Timer-1 when the signal rising from the 0 to the 1 once more. This is a period of the signal. PLC read value of the counter and calculates the frequency from the loop time.

VOLTAGE CALCULATION:

The signals received from the R phases of the generators are used for the calculation of voltages. The received signals are converted to the square wave signals as described in the calculation of the frequency. PLC captures point of the square wave falling from the 1 to the 0. The reference signal is bigger than the reference signal in the period of square wave has a 0 value. In the other words, the input signal is in the positive period. PLC receives approximately 300 samples from the signal until the square wave rising to the 1 once again. Each received sample compared with the previous sample and the bigger value is saved as a new value. As a result, the peak value of the half period of the input signal is obtained. Then the rms value of the voltage is calculated.

DETERMINATION OF THE PHASE SEQUENCE:

The signals received from the R and S phases of the generators are used for the determination of the phase-sequence. The received signals are converted to the square wave signals. PLC captures point of the square wave falling from the 1 to the 0 and wait 90^o to 120^0 beginning from that point. Controller captures the peak value of the phase-R with the 90^o waiting period and then checks the peak value of the phase-S has peak value or not at the 120^o forward. According to the calculation, the controller determining the phase sequence direction as 0 or 1. If the phase sequence is determined as 0, the phase sequence is in CW direction, else the phase sequence is determined as 1 and the phase sequence is in CCW direction.

IV.CONCLUSION

The most important aspect of any power generation system is the generation control. Several techniques can be implemented to control the generator in power plant. The method that has to be used relies on varied objectives like superior quality, increased efficiency, high profit and other such points depending upon the purpose. With the prime objective of catering to these necessities and the needs of the industrial sector, significance has been given here to automation. This paper presented here has kept in mind, the ceaseless changes that are relentlessly taking place in the contemporary scenario of the industrial segment. Emphasis has been given to the automation process that is now rapidly taking its place in all the power plants across the globe. The Paper has furnished itself to study the integral parts of the entire process involved, their implementation and the problems that may show up have also been given their due importance.

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