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Automatic Parallel Operation of Alternator using Arduino

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Abstract:
We have made an arduino based system which verifies the conditions required for the synchronization of two alternators that are,

1. *The terminal voltage of two alternators should be equal.*
2. *The frequency of two alternators must be same.*
3. *The phase sequences of two alternators should be same.*

The arduino checks for the fulfillment of these conditions. It firstly measures the parameters of main alternator, and then it compares the upcoming and main alternator parameters. If all the conditions are satisfied then the arduino connects the two alternators in parallel otherwise it takes remedial steps that satisfy the conditions. The voltage, frequency and phase sequence of main alternators are taken as reference values. The upcoming alternator's values are sensed by arduino. Then it compares both the values. If any mismatch found in those values, at that time it takes immediate actions to match those values. We have used Arduino mega as controller. Also we have used PWM technique and relays for matching the values.

Key Words:- **Arduino mega, parallel operation, main alternator, upcoming alternator.**

1. INTRODUCTION

The process of connecting two or more alternator in parallel with each other or one alternator to the infinite busbar is commonly known as synchronisation. Our power system is comprises of interconnection of huge numbers of alternators connected in parallel. The voltage and frequency of the infinite busbar is constant. There are many advantages of several alternators in parallel to each other such as continuity of power supply, reliability, high efficiency, flexibility and expandability. A single alternator is not capable of supplying large load. Several alternators can connected in parallel to share large loads. During periods of low or minimum load, one or more alternator can be shut down and those remaining operate at or near full load and thus more efficiently.

When one machine is taken out of service for its scheduled maintenance and inspection, the remaining machine maintains the continuity of supply. If there is breakdown of alternator, there is no interruption of power supply. In order to meet the increasing future demand more machines can be added without disturbing the original installation. Synchronization by means of manually operated switching is not suitable for the system having large capacity. Hence there is a need of automatic synchronization in a power station or in an industrial establishment where generators are employed.

In automatic synchronization process, the adjustment of magnitude of voltage, frequency and phase sequence of incoming alternator is done automatically by use of arduino. When all the conditions of synchronization are satisfied, closing of the circuit breaker of the incoming machine is done by the automatic synchronizer. The manual method of synchronization demands a skilled operator and is suitable for no load operation or normal frequency condition. Under contingency condition such given as lowering of the frequency or synchronizing of large machines the very fast action is needed, this may not be possible for a human operator. The paper introduced here is for the complete automation of synchronization i.e. the correction of magnitude of voltage

and frequency of incoming alternator is made automatically. When all the necessary conditions of synchronization are satisfied, closing of the main switch of the incoming machine is done by the automatic synchronizer.

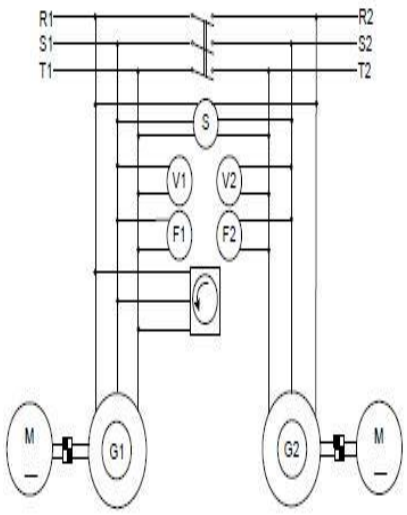

FIG 1. Parallel connection of alternators

Parallel operation by Arduino

In the plants, the parallel connection is usually controlled by using analogue measurement instruments and classical methods by the operator. In this project, the Arduino Microcontroller system was used to make the parallel connection process independent of the operator, more reliable, more practical and faster. Digital equipments used in our project to collect measurements in the Arduino is shown in Figure 1. Arduino reads the data from its digital and analogue ports, interprets and sends signal to relay when the parallel connection conditions are provided. After this, the load sharing takes place by alternators connected in parallel.

The equilibrium of voltages, which is the first condition of the connection, is measured with a PWM technique. By the help of the measured value, excitation currents equality is obtained by setting the alternator. The equilibrium of frequency, which is the second condition of the connection, is measured with a ZCD. By setting the number of revolutions per minute of the systems that rotate the alternators, equality is provided in the frequencies they produce. The identity of phase sequences, which is the third condition of the connection, is measured with a relays and corrected by programme in arduino.

Arduino controls each of these conditions respectively. Figure 3 shows the flow diagram of the program embedded in Arduino. Arduino calculates the frequency and voltage values of the alternator according to the signals. Then, it makes a comparison. The difference between the frequencies of two alternators should be equal to 0.5% or less. When this controls the relay at the system output, provides parallel connections by sending digital signals. In addition, since the frequency and voltage amplitudes in the alternator can not be the same every time, these values are measured several times at different times during parallel connection. It has been seen that magnetic fields arising from asynchronous motors and alternators do not affect arduino and measurement system. For that we have placed opto-isolator in order not to damage arduino and digital measuring instruments.

Flowchart:-

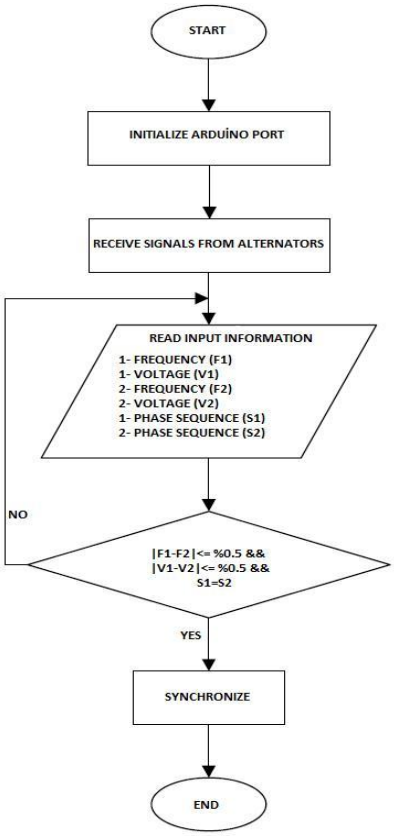

FIG 3. Flowchart

5. CONCLUSION

The automatic parallel operation of two alternators is achieved by satisfying the synchronizing parameters by doing voltage, frequency and phase sequence of the incoming alternator equal to the frequency, voltage and phase sequence of the main alternator. The synchronizing system is specially designed to control the phase sequence, voltage and frequency of the incoming alternator. The frequency can be varied automatically as well by increasing or decreasing the speed of the prime mover i.e. DC shunts motor. The voltage can be increased or decreased by PWM technique. The phase sequence is adjusted by the help of relays.

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