

Automatic Synchronization of Two Alternators Unit as Per Load Fluctuation

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Abstract— In this paper, a microcontroller based system is developed for the parallel operation of alternators as per the load variation. Two alternators are connected in parallel automatically with the developed circuitry. The voltage, frequency, and phase sequence of incoming alternator is compared with reference alternator with the help of PIC. The system does not require additional measuring tools for monitoring and control process. The developed automatic synchronization unit is fast, reliable, does not require skilled operator. This paper work is made to overcome drawbacks of manually operating and time consuming synchronization methods.

Keywords— Synchronization, Synchronous Generator, Peripheral Interface Controller (PIC), Infinite Bus Bar and Prime mover.

I. INTRODUCTION

The method of connecting two or more alternator in parallel to each other or one alternator to the infinite busbar is known as synchronization. There are many benefits of operating many alternators in parallel to each other like reliability; flexibility etc. single alternator is not capable of supply large loads. Several alternator must be shut down and those remaining operate at or near full load and thus more efficiently. In order to meet the increasing future demand of load more machine can be added automatically. Synchronization by means of manually operated switching is not suitable. Hence there is need of automatic synchronization of alternators unit as per the load demand. In automatic synchronization process, adjustment of magnitude of voltage, frequency and phase sequence of incoming alternator done automatically. When all the parameters of synchronization are satisfied closing of relay circuit of incoming alternator is done by PIC control unit. The paper introduced here is for the complete automation of synchronization. The device displays sufficient electrical parameters of two alternators. When all requirement of synchronization are satisfied, closing of relay switch of operation take place.

II. SYNCHRONIZING TECHNIQUES

A. Single phase alternators

Suppose machine 2 is to be synchronized with or 'put on' the bus bars to which machine 1 is already connected. This is done with the help of two lamps L1 and L2 (known as synchronizing lamps) connected as shown in fig.1. If the speed of incoming machine 2 is not brought up to that of machine 1, its frequency will also be different, hence there will be a phase-difference between their voltages (even when they are equal in magnitude, which is determined by field excitation).

This phase difference will be continuously changing with the changes in their frequencies. The result is that their resultant voltage will undergo changes similar to the frequency changes. Sometimes the resultant voltage is maximum and some other times minimum. Hence, the current is alternating maximum and minimum. Lamps will dark out and glow up alternately. Synchronizing is done at the middle of the dark period. That is why, sometimes, it is known as 'lamps dark' synchronizing. Some engineers prefer 'lamps bright' synchronization because of the fact the lamps are much more sensitive to changes in voltage at their maximum brightness than when they are dark. Hence, a sharper and more accurate synchronization is obtained. In that case, the lamps are connected as shown in fig.2. now, the lamps will glow brightest when the two voltages are in phase with the bus-bar voltage because then voltage across them is twice the voltage of each machine.

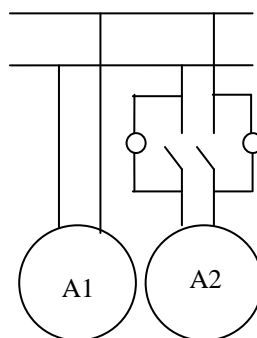


Fig. 1 Dark lamp method

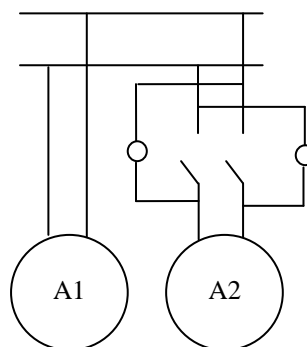


Fig.2 Bright lamp method

B. Three phase alternators

1. Dark lamp method- The three pairs of lamp of equal wattage and voltage ratings are connected as shown in fig.3 across the switch and to the bus bar and alternator terminals.

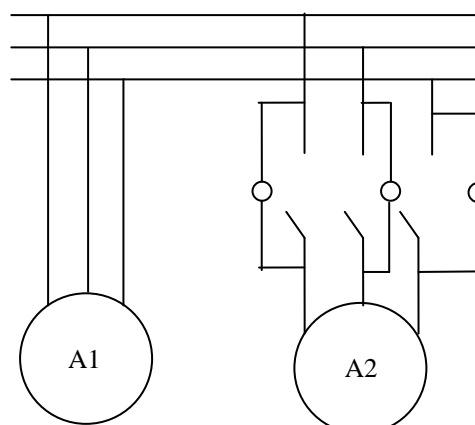


Fig.3 Dark lamp method for three phase alternator

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If the bus bar voltage phasors and the alternator voltage phasors are in phase with each other, then, the polarities of bus bar and alternator are same and at this instant, the voltage across each lamp will be zero and the lamps will be dark. This is the proper instant of synchronizing. The synchronizing switch is made “on” so that the incoming alternator is connected to the system satisfactorily.

2. Bright lamp method- In this method lamp connections are shown in fig.4. The correct moment to close the switch is obtained at the instant when the straight connected lamp is dark, and the cross connected lamps are equally bright. This is happened because cross connected lamps will receive large and equal voltages and will glow equally bright.

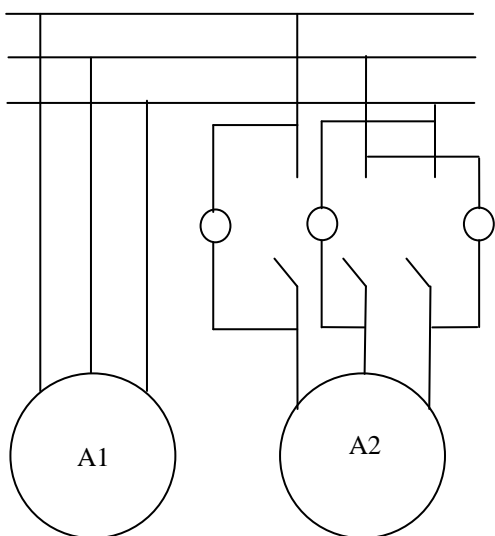


Fig.4. Bright lamp method of three phase alternator

3. Synchronoscope – In the above two methods, it is difficult to know whether the incoming machine is slow or fast. To overcome this difficulty, a “synchronoscope” is connected to the bus bar and the incoming machine. The stator of the incoming machine is connected to the terminals of the incoming machine. Whereas its rotor is connected to the terminals of incoming machine.

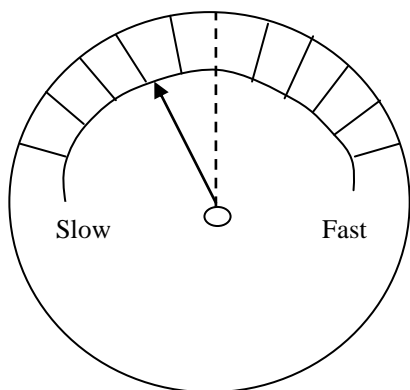


Fig.5 Synchronoscope

If the incoming machine is slow, the pointer of the synchronoscope turns in anticlockwise direction and

indicates “slow” and vice versa. When speed of alternator is proper so that its frequency is equal to the bus bar frequency, the pointer of synchronoscope is at the central position. This is the correct instant of synchronizing.

III. SYNCHRONIZING PARAMETERS

For proper synchronization of two alternators and an alternator and ac power grid, basically three parameters have to be considered.

- (1) Phase sequence – Alternators has three 120 degree apart phases which can be delta or star connected. This phase sequence of two alternators or an alternator and grid should be equal.
- (2) Voltage magnitude – Every alternator is designed to give specific output voltage magnitude. The voltage of two alternators connected in parallel or an alternator and grid should be equal.
- (3) Frequency – the frequency of two alternators should be equal to each others frequency or an alternator and grid frequency.

BLOCK DIAGRAM

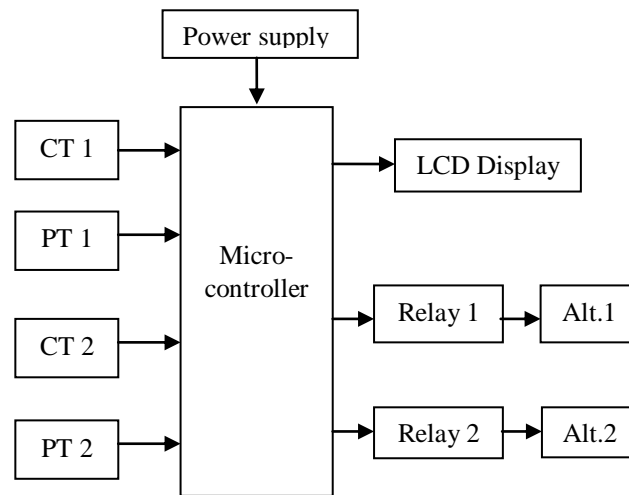


Fig. 6. Block diagram of automatic synchronization unit

Figure 6 shows the block diagram of synchronization of alternators. This diagram consists of two alternator blocks, incoming and reference alternator block. The phase voltage of reference alternator block is given to current transformer and potential transformer, through them it is given to PIC. Power supply block is provided to supply 5V DC to the PIC. LCD (16x2) will display the output result of the PIC. Relay is used for switching purpose in order to fulfill the varying load demand.

The voltage of three phases of both the units are monitored using PIC, the difference in the voltage is then displayed on the LCD. As the difference between reference alternator quantities and incoming alternator quantities becomes zero then relay get activated and synchronization as per the load requirement takes place.

IV. AUTOMATIC SYNCHRONIZATION UNIT

As the name indicates this system is method of automatic synchronizing process. This automatic synchronizer is capable of monitoring and controlling of voltage, frequency and phase sequence. It also provides improvements for voltage and frequency matching with grid and if condition are satisfied it will give command to breaker to close contact at correct instant.

This paper introduces a system for synchronization of single phase alternators. Two current transformers and two potential transformers are used to measure current and voltage of two alternators. If the load demand is not fulfilled by single alternator controller will give command to second relay to turn on the second alternator.

V. CONCLUSION

In this paper, the automatic synchronization of two alternators is achieved by satisfying synchronizing parameters by making voltage, frequency and phase sequence of the incoming alternator. This synchronizing system is designed to control the voltage and frequency of the incoming alternator. The frequency can be varied manually as well by increasing or decreasing the speed of the prime mover.

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