ISSN XXXX XXXX © 2017 IJESC

Research Article Volume 7 Issue No.9

8085 Microprocessor Based Auto Synchronizer

Niyas Thayyil,
Assistant Professor
Department Electrical and Engineering
Calicut University Institute of Engineering and Technology, University of Calicut, Tenjipalam, India

Abstract:
The manual method of synchronization demanded a skilled operator and suitable for load operation. Under emergency condition such as lowering frequency or synchronizing of large machine a very fast operation become indispensable which may not be possible for human operation. Thus there is need of auto synchronizer in a power station. This paper describes a microprocessor based setup for synchronizing a three phase alternator to bus bar.

Index Terms: Zero-crossing Detector (ZCD), Potential Transformer (PT), Phase Sequence, 8085 Microprocessor.

I. INTRODUCTION

It is known that electrical load on a power system is never constant but it varies and this variations not only seasonal but is a phenomenon of everyday. To meet the requirement of variable load economically and also for assuring continuity of supply, the number of generating units connected to system busbars are varied suitable. The connection of a new machine to system bus, i.e., synchronization requires fulfillment of the condition like the same phase sequence, equality of the voltage and frequency between the incoming machine and the bus.

The auto synchronizer has been developed to carry out the following tasks, such as:

- To check if the phase sequence of incoming machine is correct or otherwise; in case of wrong phase sequence, to stall further steps in the process and also to indicate corrective action,

- To check if frequency of incoming machine is equal to that of bus and adjust it to a value nearly equal to the bus frequency,

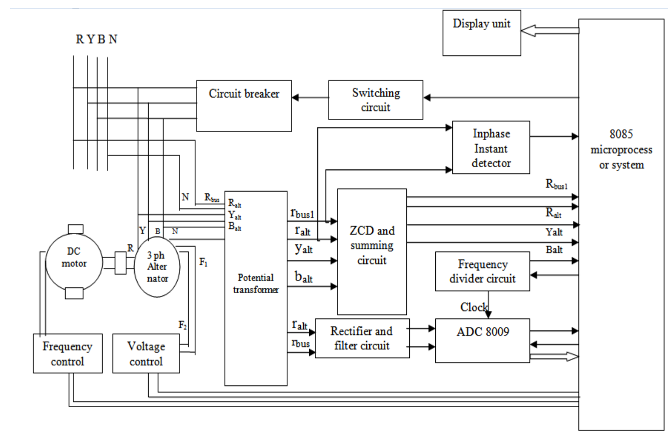
- To check if machine voltage is equal to that of bus and adjust it to a value equal to the bus voltage,

- After ascertaining the fulfillment of the above conditions, to give closing signal to the circuit breaker so that the breaker will close at the exact inphase instan t[2].

II. HARDWARE DETAILS

This hardware has been used to synchronize the alternator unit in the laboratory which the following specifications

Three phase, star connected, 400V, 5A, 5KVA, 50Hz, 1500rpm. Excitation: 200V dc, 2A.
Prime mover DC Shunt Motor: 220V, 15A, 1500rpm. Excitation: 200V, 2A
The set up is shown in fig.1 consists of the following unit:



FREQUENCY CONTROLLING UNIT

The frequency of the alternator can be changed by varying the speed of prime mover, DC shunt motor in this case, a rheostat is provided in the field circuit of the motor. The frequency controlling unit is a lead screw arrangement driven by stepper motor attached to variable point on the rheostat. The stepper motor (SM1) is controlled by a microprocessor system through a driver circuit [1].

VOLTAGE CONTROLLING UNIT

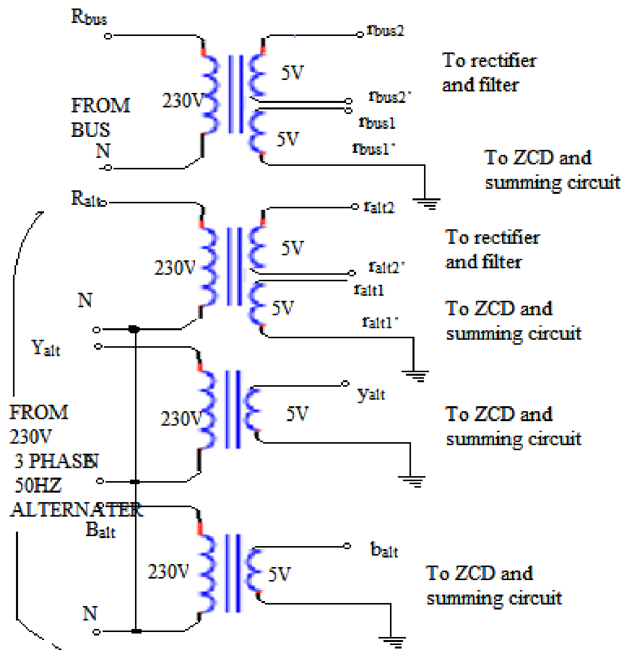
The frequency of alternator is adjusted, its voltage controlled by variation of excitation current of alternator. The excitation current is varied by providing a rheostat in the field circuit. The automatic variation of excitation current is obtained by lead screw and stepper motor (SM2) arrangements similar to the one used for frequency control [1].

POTENTIAL TRANSFORMER UNIT

This unit consists of a bank of four shell type potential transformer (PTs). Fig. 2.shows the connections diagram. Out of the four transformers there are used for stepping down three phase voltage of the alternator and used for stepping down the voltage of R- phase of the bus bar.

The PTS connected to the R- phase of bus bar and alternator is having two secondary. Hence their rating is: 230V/5V/5V, 10VA.One secondary is used for voltage measurement while the other is used for frequency measurement.

The PTs connected to the Y and B phase of the alternator as 230V/305V, 5VA and have only one secondary each. The primaries PTs connected to the alternator are star connected: similarly the secondary are also connected in star and have ground as the neutral.

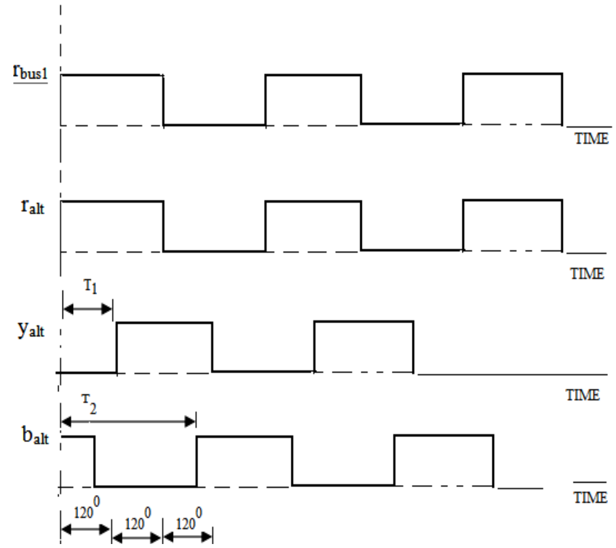


SIGNAL CONDITIONAL UNIT

It is subdivided into (a) signal conditional sub unit, and (b) Analog to Digital (ADC). The signal conditioning unit consists of four ideal circuits each of which comprises a zero crossing detector (ZCD) and a summing circuit (for R_{alt1},Y_{alt2}, B_{alt1} and R_{bus1}), two rectifier and filter circuit (for R_{alt2} and R_{bus2}) and an in phase instant detector circuit, as shown as infig.1. The ZCD converts sinusoidal output of [PT secondary to rectangular signal with +\-5V Peak which is further converted to unidirectional output using summing circuit. These circuits have been designed by using OP-AMP ICs 741.

Fig.3 shows the ZCD output wave forms. These waveforms have been used for measurement of frequency and phase sequence detection using developed software. The rectifier and filter circuits convert the ac signal of R_{alt2} and R_{bus2} from PT to dc signal compatible for ADC. These are used for voltage measurements of alternator and the bus. The bridge of rectifier uses diodes connected to a load resistance, where capacitance is used as filter.

Inphase instant detector circuit is used for detecting in phase instant of signal ralt1 and rbus1 which is the correct instant for synchronization. It consists of two ZCDS followed by a differentiator, the outputs of which are not fed to NOR gate. ADC comprises ADC interface with microprocessor system.



DISPLAY UNIT

Display card has been provided for indication of message during alternator synchronization process. It uses for 7 segments LED displays to represent the three synchronization condition and circuit positions.

CIRCUIT BREAKER WITH SWITCHING CIRCUIT

The circuit breaker used as a synchronizing switch is in the form of a DOL starter. In order to operate the circuit breaker, its operating coil is connected to a 230V dc supply through electromagnetic relay. The relay is activated at proper instant by the microprocessor so that the circuit breaker is closed at the correct inphase instant.

DETECTION OF PHASE SEQUENCE

The program checks the ZCD outputs corresponding to R_{alt1} and Y_{alt} phases for their low to high transitions and count corresponding to time T1(as shown in fig.3) is obtained using subroutine PSEQ. Similarly, the ZCD outputs corresponding to R_{alt1} and B_{alt} are checked for their zero to one transition and count corresponding to time T2 is obtained.

To check the phase sequence, T1 and T2are compared. When T1 is greater than T2, the sequence is not okay. This condition is indicated by displaying 'N'and the display of message 'Halt' and program execution is stopped. On the other hand if T1is less than T2, the [phase sequence is 'OK', i.e. R-Y-B and is indicated by displaying 'O'. thereafter the program control is transferred to frequency control and measurement part.

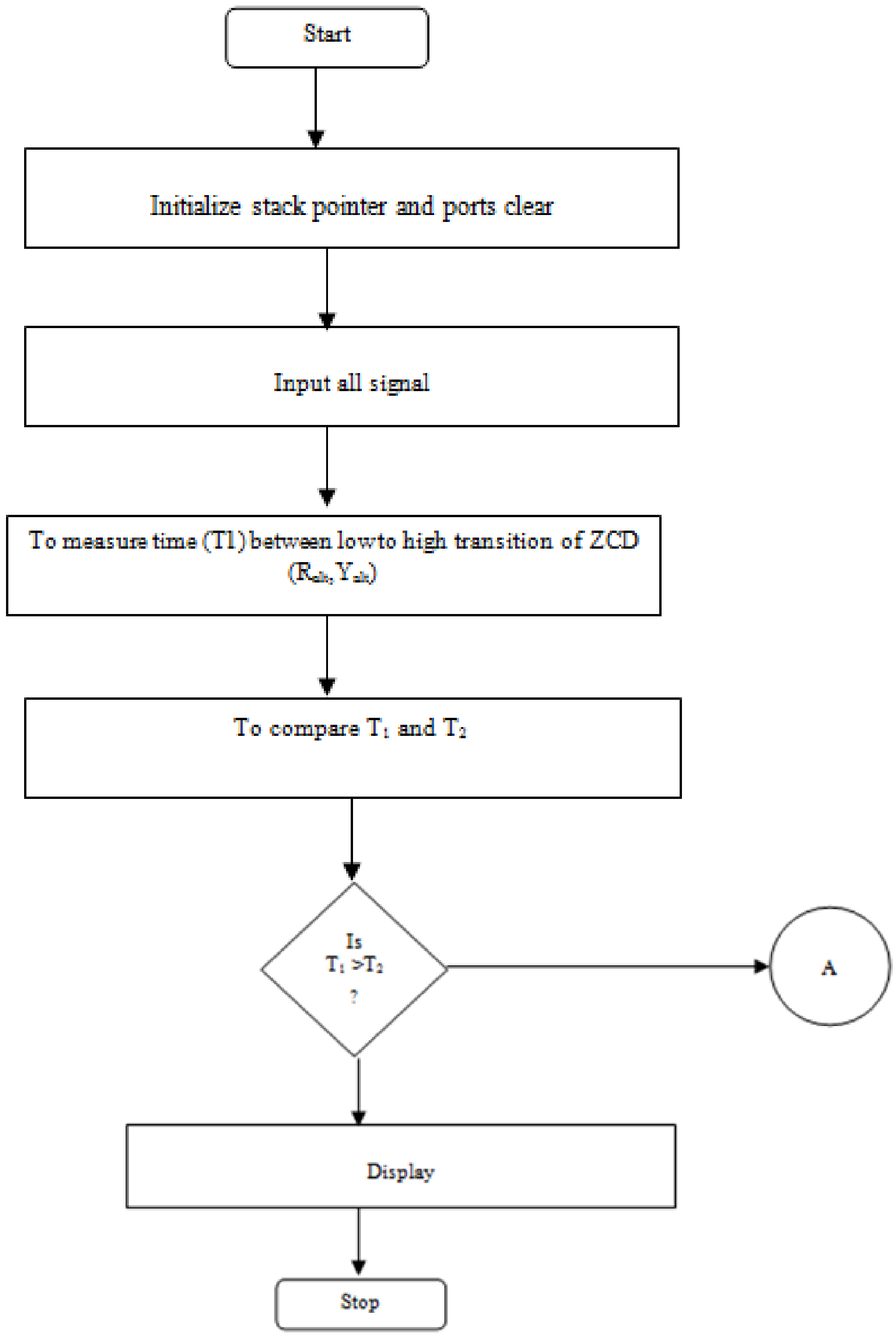
FREQUENCY MEASUREMENT AND CONTROL

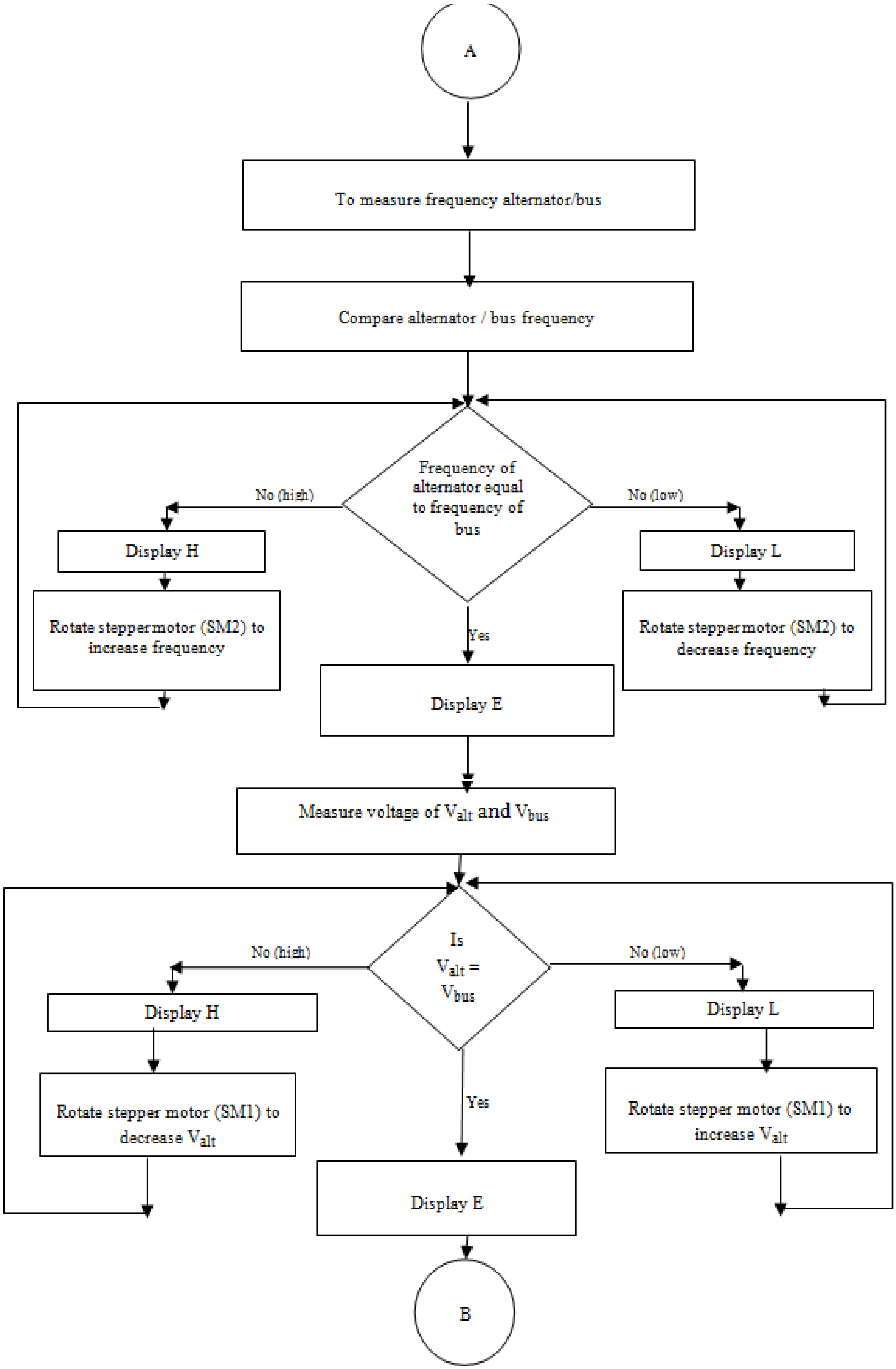
The subroutine FRQ written for frequency measurement of bus\alternator checks their respective ZCD outputs for low to high transitions. In software, the register pairs HL/DE initialized with zero contents are incremented till the ZCD outputs attain a high to low transition.

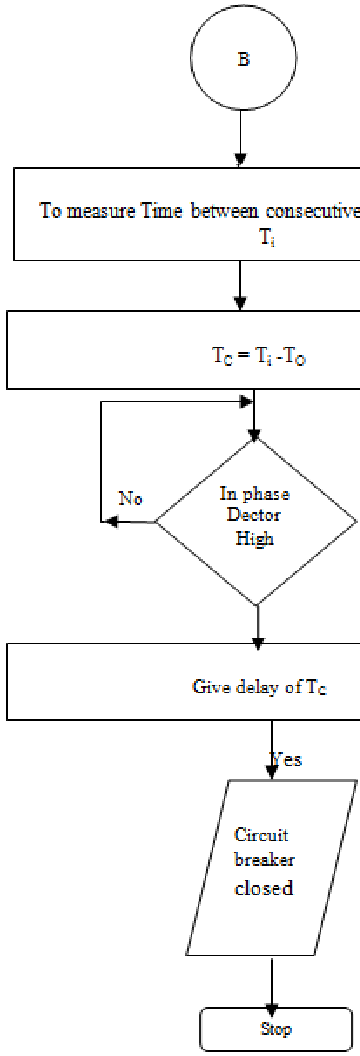
This count in HL/DE is equivalent to the time period corresponding to half cycle of bus\ alternator signal. The count obtained in hl and de register pairs are compared, if the count in HL is less than DE, it indicates that alternator frequency is less than the bus frequency. The difference in frequency is checked and the difference is greater than allowed difference (0.1Hz) than stepped motor (SM2) is rotated to bring the difference within limit and 'E' is displayed when this condition is achieved. On the other hand if (HL) is greater than (DE), alternator frequency is high and indicated by 'H'. The stepper motor (SM2) is rotated in reverse direction to bring the difference in frequency within limit till 'E' is displayed.

III. VOLTAGE MEASUREMENT AND CONTROL

The digital outputs corresponding to the alternator and the bus voltage are obtained using separate channels for alternator and bus voltage. The digital outputs are compared and difference of these is obtained. When difference is less than allowed difference (equivalent to 4v or about 1%) than 'E' is displayed and program execution continued. When the difference is greater than allowed difference either 'H' or 'L' is displayed to indicate high of low voltage of alternator, respectively. The stepper motor (SM1) is rotated in appropriate direction to bring this difference within limit till 'E' is displayed [3].




A
To measure frequency alternator/bus
Compare alternator / bus frequency
Frequency of alternator equal to frequency of bus
No (high)
No (low)
Display H
Display L
Rotate steppermotor (SM2) to increase frequency
Rotate steppermotor (SM2) to decrease frequency
Yes
Display E
Measure voltage of V alt and V bus
Is V alt = V bus
No (high)
No (low)
Display H
Display L
Rotate stepper motor (SM1) to decrease V alt
Rotate stepper motor (SM1) to increase V alt
Yes
Display E
B



IV. SYNCHRONIZING

After satisfying all conditions, the time (T_i) between the consecutive inphase instant of R_{alt1} and R_{bus1} (obtained from inphase instant detector). The time interval (T_i-T_o) where T_o is operating time of switching circuit, is obtained. The closure of the circuit breaker is achieved by sensing next inphase instant with delay of (T_i-T_o) which will enable to switch ON the circuit the circuit breaker exactly at the next inphase instant.

V. RESULT

In this paper, the 'auto synchronizer' has been tested for synchronism the 400V, 50Hz star connected alternator with the bus. The following tests as mentioned earlier have been performed:

(1) Checking of phase sequence,

(2) Measuring the alternator frequency and to adjust it to have equality with the bus,

(3) Measuring the alternator voltage and to adjust it to have equality with the bus,

(4) Checking the proper inphase instant.

VI. ACKNOWLEDGEMENT

The authors would like to thanks my teachers from NSS College of engineering, Palakkad, my colleges and lab staff in Calicut University of institute and technology, Thenhipalam, for their assistance in constructing the experimental converters and collecting data.

VII. REFERENCES

[1]. B. L. Theraja, "A Textbook of Electrical Technology" vol. 1, chapter 35, pp. 1492-1497, Oct. 2005

[2]. L. Huber, Microprocessor based Alternator Synchronizer," *IEEE Trans*. Electrical Machines., vol.25, no.1,pp. 85-64, Jan. 2010.

[3]. H. Endo, T. Yamashita, "Synchronizing Generators," in *Proc. IEEE computer application*, Jun.1999, pp. 171-176

[4]. Ramesh S Gaonkar, "Microprocessor architecture, Programming and application", vol. 4, no.8, pp. 321-329, Oct. 1999.