

Lab3: Synchronous Generator

Objectives

1. To examine the operating characteristics of a 3-phase synchronous generator.
2. To calculate the voltage regulation of a 3-phase synchronous generator.
3. To synchronize a synchronous generator with a 3-phase power supply, having a frequency of 50 Hz.

Background

The calculations of the voltage regulation of a synchronous generator required determination of the following characteristics:

1. The open-circuit characteristic.
2. The short-circuit characteristic.
3. Zero power factor characteristic.

After determination of the above characteristics, the voltage regulation of a synchronous generator is determined by the following methods:

1. Synchronous reactance.
2. Exact method.

Procedure

Take the complete particulars of the three-phase synchronous generator under test and the driving D.C. shunt generator.

1. Open-circuit test

- a. The alternator is driven by the prime mover at its synchronous speed corresponding to 50 Hz.
- b. The field current of the alternator (I_f) is varied in steps till the terminal voltage reaches 125% of the rated value.
- c. Reduce this voltage in steps.
- d. The O.C. characteristic yielding the relationship $E = f(I_f)$ is plotted with both the voltage rise and voltage fall branches.

2. Short-circuit test

- a. Short-circuit the alternator terminals, while it is driven at the synchronous speed. (be sure that the field current is zero. WHY?)
- b. Vary the field current from zero till the short circuit current reaches the rated value ($I_a = 20$ A)
- c. The S.C. characteristic yielding the relationship $I_{sc} = f(I_f)$ is plotted.

3. Zero power factor test

- a. Drive the alternator at its synchronous speed, connect its terminals across the balanced 3-phase pure inductances. These variable inductances are of the air cored type to ensure linear variation.
- b. Starting from the lowest value of the inductance vary its value in steps keeping the current constant at 20 Amp., using the field current regulating potentiometer.

4. Parallel operation of the alternator and the bus-bar mains

- a. Connect the terminals of the machine to the synchronous board.
- b. Adjust its speed to the synchronous speed value, observe the frequency of the alternator on the board frequency-meter.
- c. By means of two voltmeters, adjust the excitation of the synchronous machine so that its terminal voltage equals the bus-bar voltage.
- d. By means of two phase sequence indicators, check the sequence on both sides.
- e. Close the synchronizing switch at the proper instant which is indicated by the synchroscope or the lamps.

Synchronization using the synchroscope

The synchroscope is connected as shown in figure (2). As the synchroscope is rated for comparatively low voltages, it is usually fed through potential transformers, both from the incoming machine and running machine.

Before closing the switch "S", the following conditions should be satisfied:

- 1) The line voltage of the incoming synchronous generator equals the line voltage of the main bus-bar. This is done by changing the field current of the incoming machine.
- 2) The frequencies of both incoming machine and main bus bar are the same. This is done by changing the field current of the DC driving motor with the help of frequency-meter.
- 3) The phase sequence of the incoming machine and the main bus is the same. This is checked with the help of phase sequence indicator.

At the exact instant of synchronism as indicated by the synchroscope, the incoming machine is switched on using switch "S" to main bus-bar.

Report

- a) Determine the values of the synchronous reactance of the machine under consideration from tests 1 & 2. Plot the synchronous reactance as a function of I_f from tests 1 & 2.
- b) From test 1, 2 and 3, determine the regulation at full load current and voltage for 0.8 pf lagging, unity pf, and 0.8 pf leading by the following methods:
 - 1) Synchronous impedance ($R_a = 0.024$ ohm/phase).
 - 2) Exact method.

Comment

Comment on the results of voltage regulation as determined from the above methods.

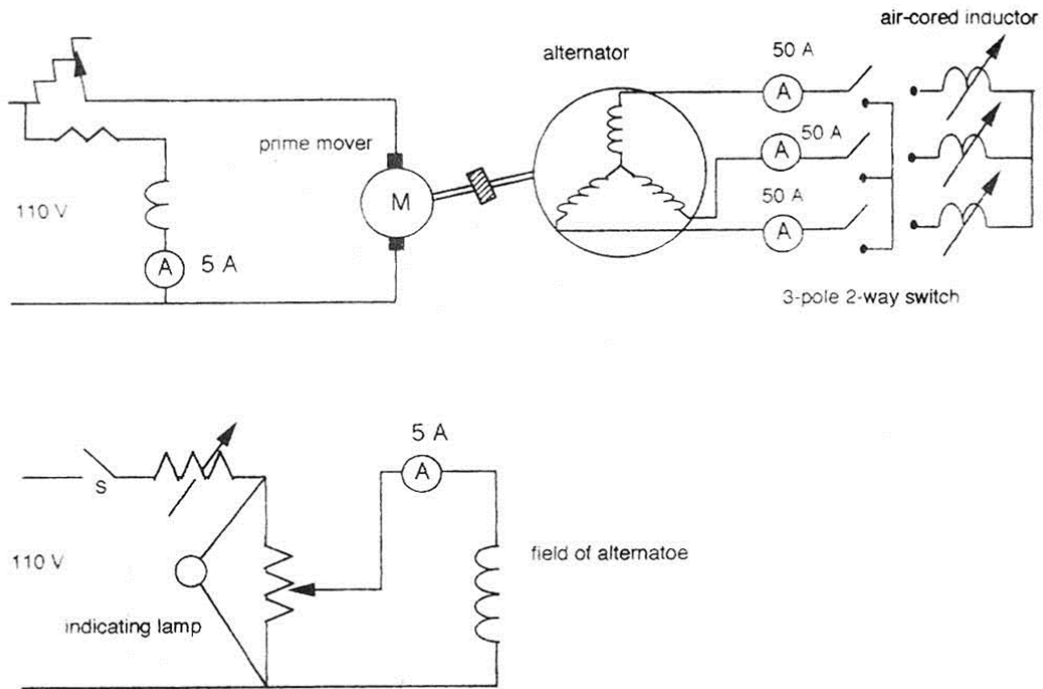


Figure (1) Connection Diagram

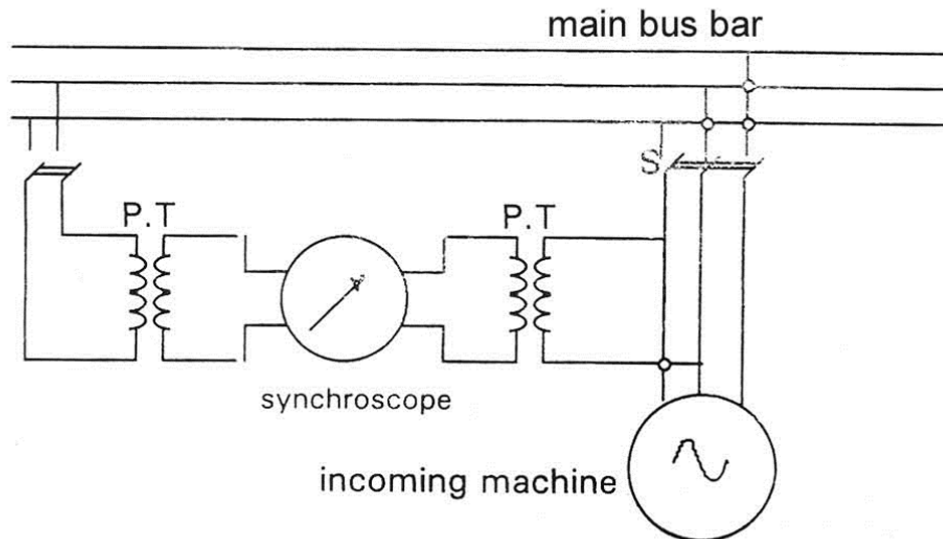


Figure (2) Connection of Synchroscope



Lab3 Synchronous Generator

Report

Name:

Number:



Lab3: Synchronous Generator
Lab results

1. Open Circuit Test

| | | | | | | |
|----------|--|--|--|--|--|--|
| E_{oc} | | | | | | |
| I_f | | | | | | |

2. Short Circuit Test

| | | |
|----------|---|--|
| I_{sc} | 0 | |
| I_f | 0 | |

3. Zero Power Factor Test

At $I_a =$

| | | | | | | |
|-------|--|--|--|--|--|--|
| V | | | | | | |
| I_f | | | | | | |

Machine Ratings

| | |
|-------|----------------------|
| $S =$ | <i>no of poles =</i> |
| $V =$ | |
| $f =$ | |