Open Circuit and Short Circuit Test
on a
Synchronous Machine

1 Aim of the Experiment

The aim of this experiment is to determine the regulation of a synchronous machine using Synchronous Impedance method. The open and short circuit tests provide a means to estimate the regulation.

2 Background

The regulation of an alternator describes the extent to which the terminal voltage of the machine working as a generator would change with load, if it is working as a standalone generator. The regulation also reflects the magnitude of the internal impedance of the machine and the extent of armature reaction that can exist in the machine. In the case of a grid connected machine, the terminal voltage is constant if the grid may be assumed to be infinite. However, if the machine has to trip on any condition, then the regulation would indicate the extent to which the terminal voltage could rise upon load throw off.

In this experiment, the regulation is to be determined by three approaches viz., the synchronous impedance method and by direct loading.

3 Procedure

The alternator has to be run by a dc machine. The dc machine therefore acts as a motor and the synchronous machine as a generator. The circuitry required to run the dc machine as a motor is already familiar to you by now.

3.1 Open Circuit Test

This test is to determine the open circuit characteristic of the synchronous machine. This characteristic is a plot between the armature voltage (line) of the synchronous machine and its field current, *for constant (rated) speed*. What are the ratings of the alternator in your setup? The line voltage may be varied upto 125% of the rated value.

Note that the curve is to be obtained from zero field current (of the alternator). As the field current is increased from zero, the speed may drop and hence the dc machine has to be adjusted to maintain rated speed.

3.2 Short Circuit Test

In this case, the alternator is operated under short circuit. The short circuit characteristic describes the variation between field current and armature current *at rated speed* under short circuit conditions. Here, "short circuit" refers to a short of all three terminals.

Here again, the field current has to be varied (with the armature shorted) from zero to value which passes the rated armature current through the short circuit.

4 Calculations

Plot the open circuit and short circuit characteristics of the machine under test.

Estimate the synchronous impedance and hence determine the regulation of the machine for rated kVA output at various power factors (-0.5 to +0.5). Cross check the results obtained with the theoretical results.