

VOLTAGE REGULATION OF A SYNCHRONOUS GENERATOR

Objective:

To determine the voltage regulation of an alternator by the synchronous impedance method

Theory:

Voltage regulation of an alternator is defined as the rise in terminal voltage of the machine expressed as a fraction of percentage of the initial voltage when specified load at a particular power factor is reduced to zero, the speed and excitation remaining unchanged.

The experiment involves the determination of the following characteristics and parameters:

1. The open -circuit characteristic(the O.C.C)
2. The short-circuit characteristic(the S.C.C)
3. The effective resistance of the armature winding.

The O.C.C is a plot of the armature terminal voltage as a function of field current with a symmetrical three phase short-circuit applied across the armature terminals with the machine running at rated speed.

At any value of field current, if E is the open circuit voltage and I_{sc} is the short circuit current then for this value of excitation

$$Z_s = E/I_{sc}$$

At higher values of field current, saturation increases and the synchronous impedance decreases. The value of Z_s calculated for the unsaturated region of the O.C.C is called the unsaturated value of the synchronous impedance.

If R_a is the effective resistance of the armature per phase, the synchronous reactance X_s is given by

$$X_s = \sqrt{Z_a^2 - R_a^2}$$

If V is the magnitude of the rated voltage of the machine and the regulation is to be calculated for a load current I at a power factor angle ϕ , then the corresponding magnitude of the open circuit voltage E is

$$\mathbf{E = V + IZ_s}$$

Here bold letters indicate complex numbers.

$$\text{Regulation} = (E-V)/V$$

Procedure:

1. Open circuit characteristic

Connect the alternator as shown in FIG.1. The prime mover in this experiment is a D.C. shunt motor, connected with resistances in its armature and field circuits so as

to enable the speed of the set to be controlled. Run the set at the rated speed of the alternator, and for each setting of the field current, record the alternator terminal voltage and the field current. Note that there is no load on the alternator. Record readings till then open circuit voltage reaches 120% of the rated voltage of the machine.

2. Short circuit characteristic

(FIG.2) Connect as in FIG.1, but short-circuit the armature terminals through an ammeter. The current range of the instrument should be about 25-50 % more than the full load current of the alternator. Starting with zero field current, increase the field current gradually and cautiously till rated current flows in the armature. The speed of the set in this test also is to be maintained at the rated speed of the alternator.

3. Measure the D.C. resistance of the armature circuit of the alternator. The effective a.c resistance may be taken to be 1.2 times the D.C. resistance.

Report:

1. Plot on the same graph sheet, the O.C.C (open circuit terminal voltage per phase versus the field current), and the short-circuit characteristic (short-circuit armature current versus the field current).
2. Calculate the unsaturated value of the synchronous impedance, and the value corresponding to rated current at short circuit. Also calculate the corresponding values of the synchronous reactance.
3. Calculate regulation of the alternator under the following conditions:
 - Full load current at unity power factor
 - Full load current at 0.8 power factor lagging.
 - Full -load current at 0.8 power factor leading.

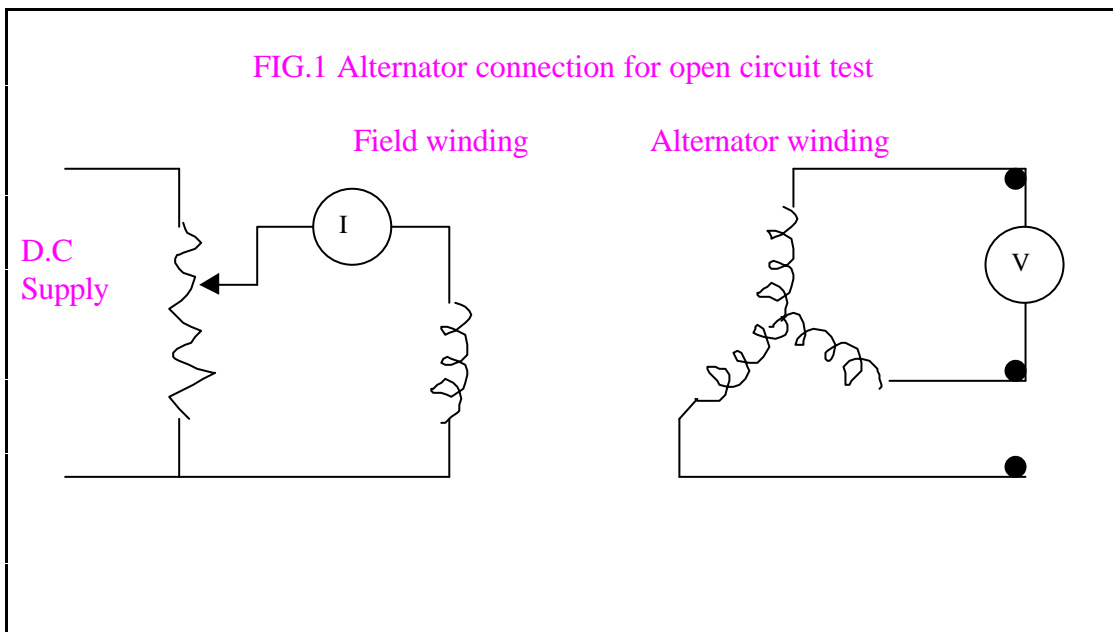


FIG.2 Alternator connection for short circuit test

