

Ministry of Education and Science of Russian Federation
Federal State Autonomous Educational Institution of Higher Education
Tomsk Polytechnic University
Institute of Power Engineering

Electrotechnical
Complexes and Materials
Department

REPORT

Laboratory session 3 TESTING OF THREE PHASE SYNCHRONOUS GENERATOR

Student - _____, group - _____,

I certify that my answers here are my own work, and that I have appropriately acknowledged all external sources (if any) that were used in this work.

Signature _____, date _____.

Consultant - _____, position - _____,

Signature _____, date _____.

Tomsk – 2014

Purpose of laboratory session

The purpose of the given work is to study construction and working principle of the synchronous generator, to carry out experiments and obtain magnetization curve, external and short circuit characteristics of the synchronous generator.

Operating program

1. To examine the working principle of the synchronous generator and to classify the construction of alternative current machines.
2. To define the laboratory unit.
3. To start the synchronous generator.
4. To make experiment of open circuit of synchronous generator and obtain magnetization curve.
5. To provide load test of synchronous generator and to build external characteristics of synchronous generator.
6. To calculate voltage regulation of synchronous generator.
7. To provide short circuit test of synchronous generator and to build short circuit characteristics of synchronous generator.
8. To analyze the generator characteristics and make conclusions.

Self-instruction

Synchronous generator – (*give the definition*) _____

The synchronous generator consists of following main components (*write title, purpose and material*):

1. _____
2. _____
3. _____
4. _____

The working principle of synchronous generator is based on _____

The constructional differences between salient pole and non-salient pole synchronous generators are following:

The open circuit mode of synchronous generator is _____

To open circuit mode losses could be included following _____

The short circuit test of synchronous generator is _____

To short circuit losses could be included following _____

The load test of synchronous generator is _____

Conditions for parallel operation of synchronous generators:

Starting methods of synchronous motors:

Testing of the three phase synchronous generator

Before turning the module ON: a) double-check your wiring, wiring connection should be examined by consultant also; b) make sure that the field current adjustment knob is in the “zero” position and turned OFF.

Caution! When actual equipment is used, high voltages may be present. NEVER make or modify any connection with the power ON unless otherwise instructed.

In fig. 2 the physical arrangement of synchronous generator testing is presented. And in fig. 3 the physical arrangements of armature winding for short circuit tests are presented, the field circuit in this test remains the same.

The tested machine is the three-phase salient-pole synchronous generator, armature and field circuits are presented in the fig. Synchronous generator is driven by asynchronous motor M which supplied by Q1 switch. Synchronous generator field winding is connected to a DC source by switch S1. Current control of field winding is arranged by auto-transformer. Terminals of three-phase armature winding U1 - U2, V1 - V2, W1 - W2 are presented on the front panel. Field winding F1 - F2 are presented by two terminals on the front panel.

Synchronous generator is loaded up with inductive load, load turns ON by Q2 switch

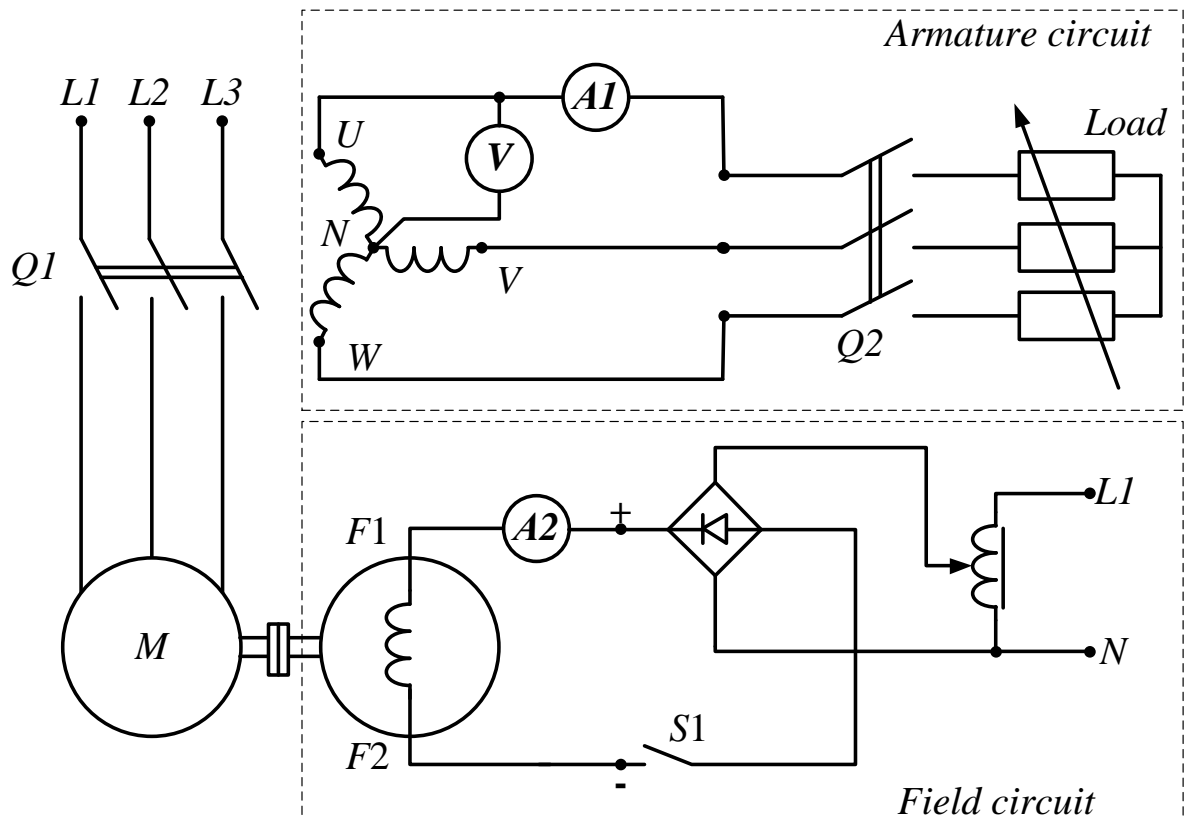


Fig. 2. Physical arrangement

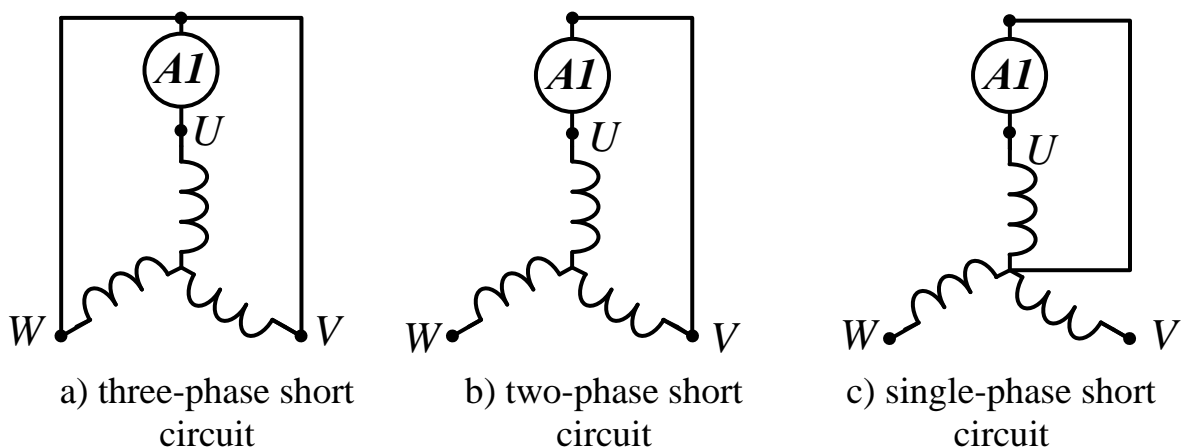


Fig. 3. Physical arrangement of armature circuit for short circuit test

Open circuit test of synchronous generator

The open circuit characteristic or magnetization curve of synchronous generator is the interdependence between $E = f(i_f)$, when armature current $I = 0$ and frequency $f_1 = const$. Magnetization curve of a synchronous generator has a great importance because it represents the saturation of the magnetic circuit. For this reason this curve is also called saturation curve.

To obtain the open-circuit characteristic the machine is driven at its rated speed without load connected to the armature winding. The rotor of a synchronous generator is rotated by motor M, switch Q1 is ON. Turn on S1 and increase the field current until generated EMF reaches the value $(1,1 \dots 1,3)U_{rated}$. At this point the first measurement should be done. Then gradually reduce the field current i_f until it reaches the 0 value and simultaneously measurements should be written into the table 1. The field current should be only decreased during this test at any stage of regulation. The final measurement is performed when $i_f = 0$. In the table 1 also should be written the value of field current ΔI_f when generated EMF is equal 0. E_{ar} is the value of residual magnetization.

Table 1.

№	E	I_f	$I_f + \Delta I_f$	Notes
	V	A	A	
1.				$E_{ar} = \quad V,$ $\Delta I_f = \quad A,$
2.				
3.				
4.				
5.				
6.				

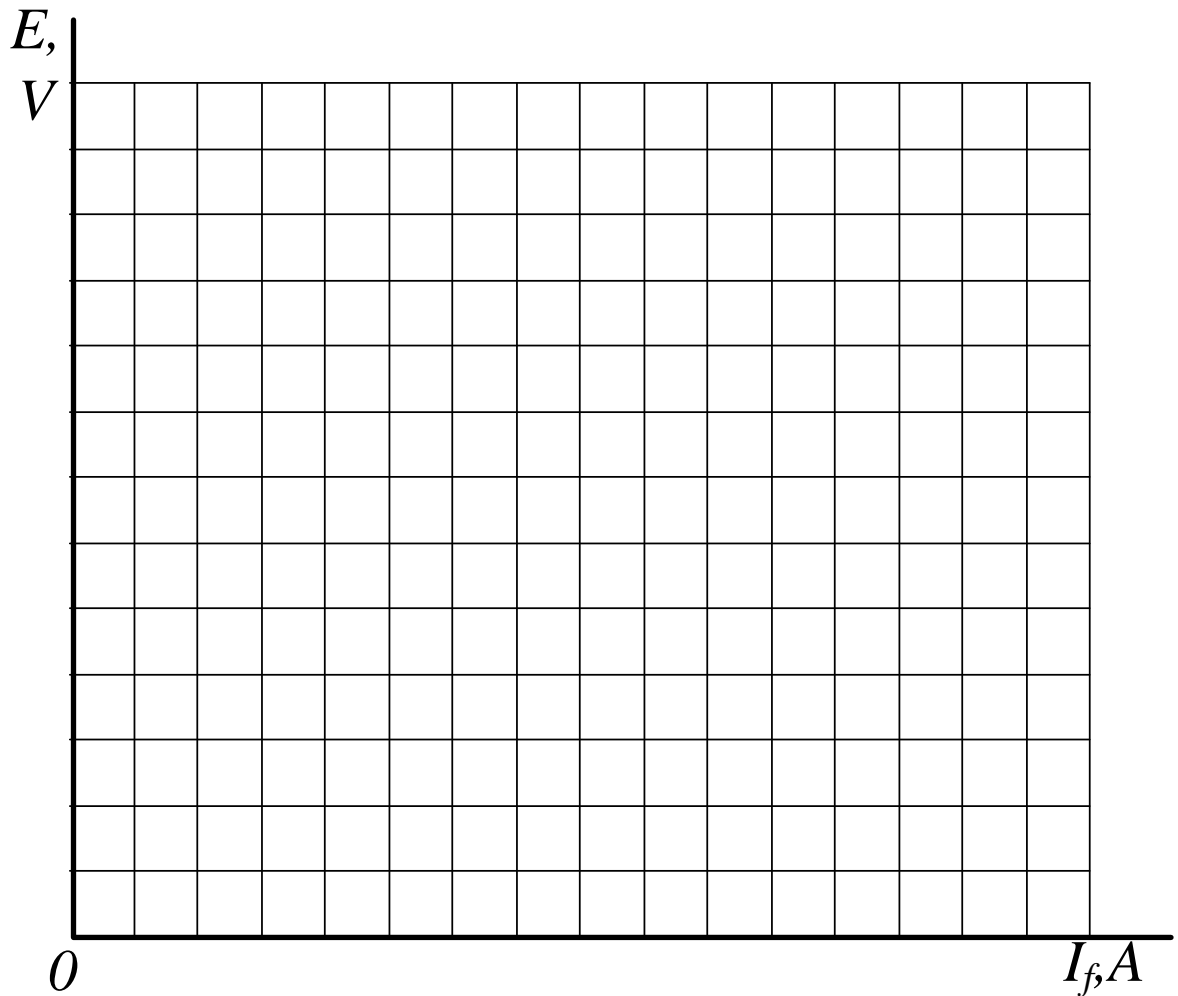


Fig. 4. Open circuit characteristic of synchronous generator

The terminal or external characteristics of synchronous generator

The external characteristic curves show the variation of terminal voltage (U) with the load current (I) - $U = f(I)$, when $i_f = const, \cos \varphi = const$ and $f_1 = const$. External characteristics are obtained for lagging value of the power factor, as the load is inductive.

The rotor of a synchronous generator is rotated by motor M, switch Q1 is ON. Turn on S1 and increase the field current i_f until generated EMF reaches the rated value U_{rated} . That will be the first point of external characteristic when load is increased. Then turn on switch Q2 and adjust the maximum value of the load. Gradually reduce the armature current I until reach the point where the generator will be under the open circuit mode. At the same time the constant value of field current should be provided.

Voltage regulation is defined by:

$$\Delta U = \frac{E_0 - U_{rated}}{U_{rated}} \cdot 100\% = \text{_____} \cdot 100\% = \text{_____}\%$$

Table 2.

№	U	I	Notes
	V	A	
1.			$\cos\varphi \cong 0,7;$ $I_{rated} =$ A. $\Delta U =$ %
2.			
3.			
4.			
5.			
6.			

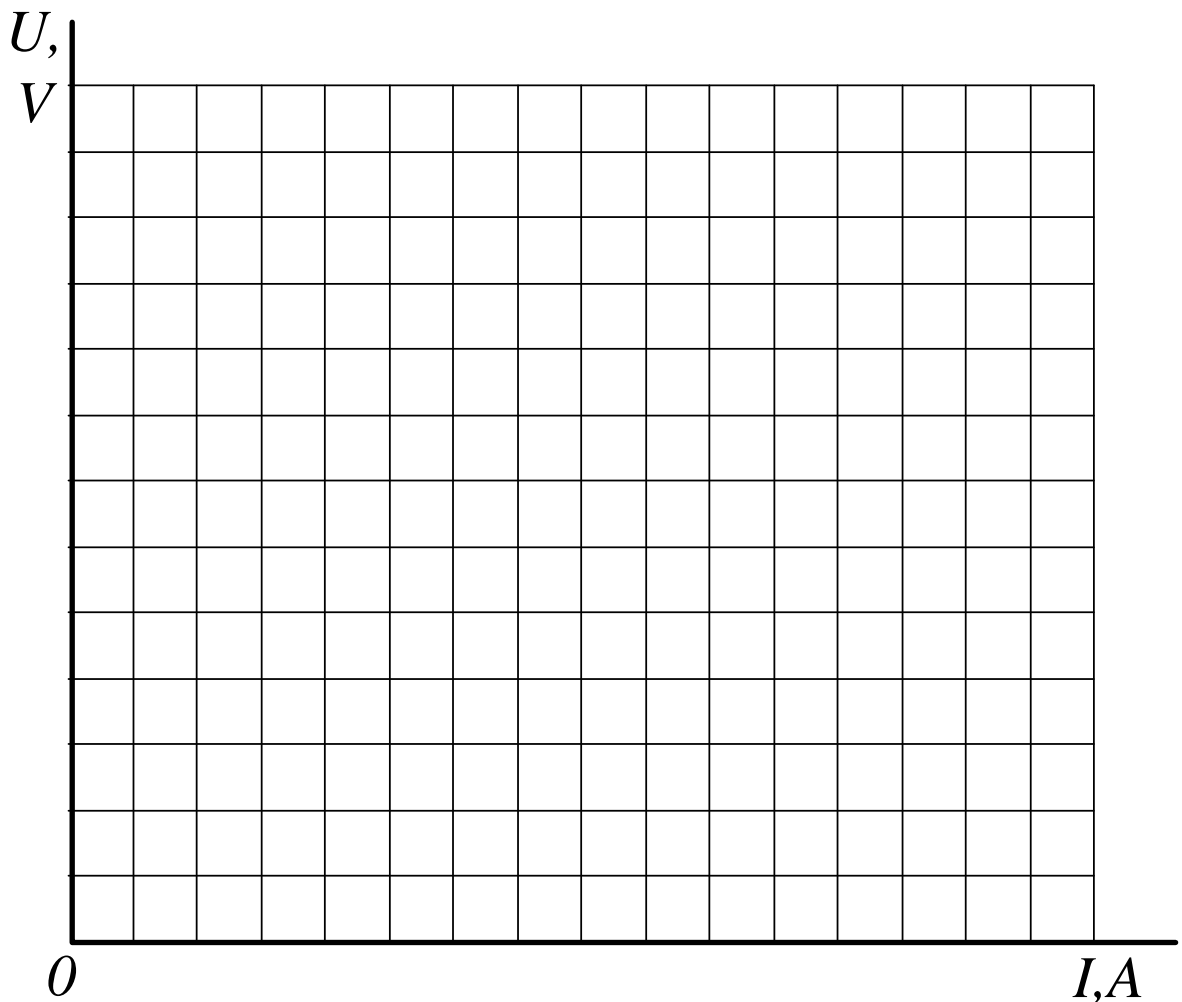


Fig. 5. Terminal characteristic of synchronous generator

Short circuit test of synchronous generator

Short circuit characteristic of synchronous generator is drawn between the armature current and the field current - $I_a = f(i_f)$ when $U = 0$ and $f_1 = const.$ In this part three tests should be done - three-phase, two-phase and single phase

short circuits. The physical arrangement of armature windings is presented in fig. 3, note that field circuit remains the same as in previous tests.

The wiring is made when the field current adjustment knob is in the “zero” position and turned OFF. Then the rotor of generator should be driven by the motor M. turn ON S1 and increase the field current until I_{sc} the armature current reaches the rate value, simultaneously three points should be written into the table. Short circuit characteristics are built in the same axes.

Table 3.

№	three-phase short circuit		two-phase short circuit		single-phase short circuit		Notes
	I_{sc3}	I_f	I_{sc2}	I_f	I_{sc1}	I_f	
	A	A	A	A	A	A	
1.							$I_{rated} = \quad A.$
2.							
3.							

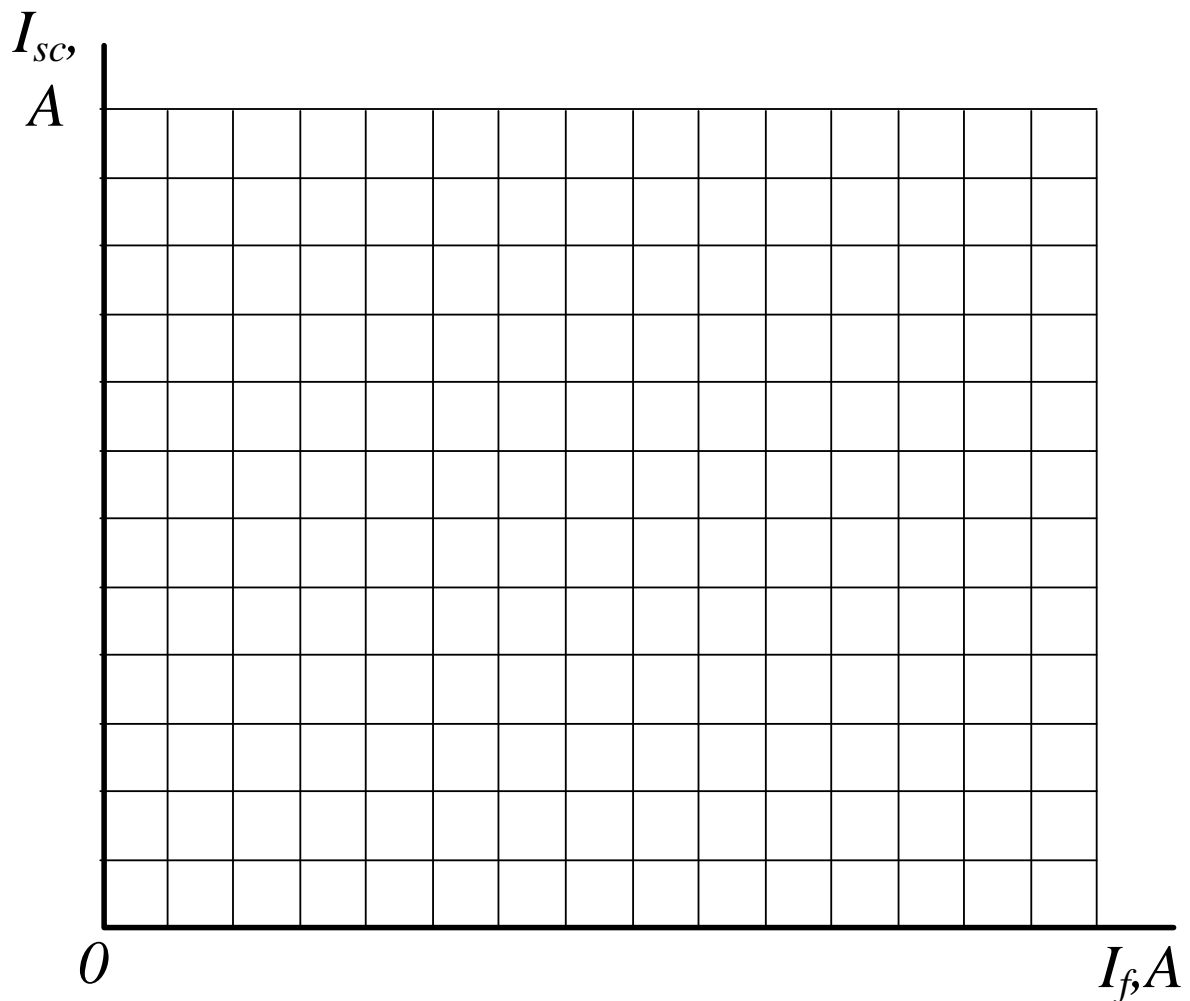


Fig. 6. Short circuit characteristics of synchronous generator

References

1.

2.

3.
