Technical Note
Excitation type: Harmonic excitation system auxiliary winding + PMI (Permanent Magnet Insertion)

Introduction

This technical note introduces a harmonic winding excitation system which is used in the ABB low-voltage synchronous generators. The excitation system consists of the following components: automatic voltage regulator (AVR), brushless direct-current (DC) supplied exciter with permanent magnet inserted (PMI) poles to ensure voltage build-up and an auxiliary winding to supply the excitation power.

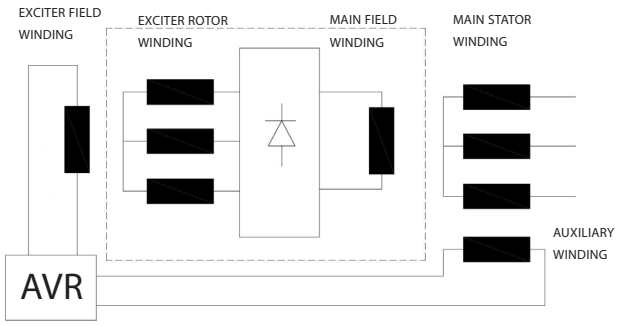

Figure 1: Schematic diagram of harmonic excitation principle

Excitation power supply principles

The excitation power input to the exciter field winding can be supplied by separate ways, the most commonly used excitation types are:

- Direct excitation from the generator main terminals or by voltage transformers.
- By a separate permanent magnet generator (PMG).
- By an auxiliary winding in the stator.

If direct excitation from generator terminals or voltage transformers is used, no excitation power can be obtained during generator short-circuit unless additional current transformers are installed. PMG excitation is more expensive and increases the axial length of the machine. PMG rotor is one additional rotating part for the generator. If the excitation system is preferred as simple as possible, these disadvantages can be avoided if the excitation power is supplied by an auxiliary winding mounted in the main stator slots of the generator. This method can be called harmonic excitation since depending on the auxiliary winding construction, different air-gap flux-density harmonics can be utilized to obtain the excitation power.

Example of harmonic excitation system

Requirements:

- Self excited i.e. voltage build-up of the generator is demanded in every situation.
- Ceiling excitation load: 1,5 x Sn, P.F. 0,8 (for sufficient load transient and over excitation operation).
- Sustained short-circuit current: >3 x In, 10s. (for selective short-circuit protection).

Design:

- Permanent magnet insertion for exciter stator poles is added to ensure voltage build-up.
- The auxiliary winding for fundamental harmonic (H1) is designed according to the maximum excitation requirement during load operation.
- The auxiliary winding for 3rd harmonic (H3) is designed according to the requirement during short-circuit operation.
- Depending on the generator design in some cases only H3 winding is enough for sufficient operation at load and at short-circuit.

Construction:

- High quality permanent magnet pieces are integrated into the exciter stator poles. After vacuum pressure impregnation (VPI) the permanent magnets are rigidly one part of the exciter stator core.
- The optimized auxiliary winding coils are wound into the generator stator slots, after VPI the auxiliary winding is mechanically as strong as the main stator winding of the generator.

Summary

A harmonic excitation system for excitation power supply utilizing an auxiliary winding is presented. By using auxiliary winding for excitation power supply, the overload and short-circuit operation can be optimized based on the requirements. The auxiliary winding reduces the excitation system complexity and makes the system economical and reliable.

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