SYSTEM DESCRIPTION MKC10 EXCITATION AND MKY10 VOLTAGE REGULATOR SYSTEM	Respons. dept GPEL	Date 040216	Reg. E DB 101
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Table of Contents

Approved 2004-02-23 Lars Arvidsson	Latest revision -	Archive	HG 4430
Checked 2004-02-20 Tomas Steinscherer		No. 1CS39675	

Purpose of the system

The purpose of the excitation and voltage regulating system is:

To supply the field winding of the generator with DC-current and control this to:

- Keep the power system voltage constant
- Produce suitable reactive power with generators working in parallel
- Improve the transient stability at disturbances in the power system

At the same time:

- Prevent thermal overload of the generator
- Prevent to large an under excitation where a possible out-of-step condition arise
- To discharge the field winding of the generator and exciter when stopping the unit

General description of the system

Refer to single line block diagram, 1CS28924 for component identification which generally represents the excitation and voltage control system.

For more information regarding the generator see systemdescription for MKA draw.no 2504001.

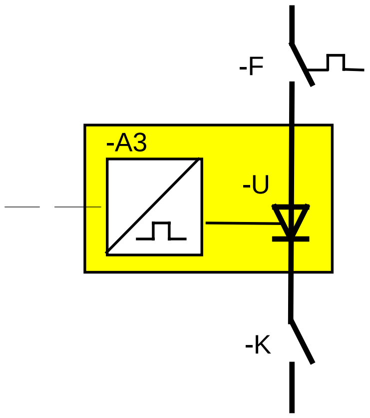
Via a three-phase full-wave rotating rectifier the power from a rotating main AC exciter excites the main generator. The AC exciter is a generator with a stationary field winding and a rotating armature winding driven by the main generator shaft.
The excitation power of the main AC exciter is provided by a pilot exciter, also driven by the main generator shaft, via the controlled rectifier unit (thyristor bridge) of the voltage regulator.
The control of the main generator field current I_f is achieved by varying the excitation of the main exciter, which in turn is excited by the current I_f' controlled by the regulator.

Main components

- PMG (Permanent Magnets Generator)
  MKC10
  The excitation power is derived from the AC pilot exciter with permanent magnets (PMG) installed on the generator shaft, and is supplied via the thyristor rectifier to the DC exciter field winding. The PMG voltage is selected to give the required ceiling voltage from the thyristor rectifier. The rated power shall be enough to supply the maximum continuous exciter field current(If'). The circuit is equipped with an MCB(+MKA10GA007.F01) to protect the PMG against short circuits. The PMG supplies excitation power also during faults in the external power grid.

- The thyristor convertor
  +MKA10GA003.B1
  The thyristor convertor consists mainly of the rectifier bridge(+U) and trigger pulse equipment(+A100). The rectifier is controlled by the regulator(+A01) via the trigger pulse equipment.The trigger pulse equipment converts the analog output signal of the regulator to trigger pulses with correct phase shift in relation to the AC supply voltage. By this a controllable DC

voltage is obtained. The thyristors are protected against short circuit by an MCB(+F01) with a special characteristic adapted to protect semi-conductors.



Block diagram for a thyristor convertor

- F MCB
- U Thyristor convertor
- A3 Trigger pulse equipment
- K(+Q01) Field breaker

- Field breaker

  MKY10GS001_(+MKA10GA003.B1.Q01)

  The equipment for de-excitation consists of a field contactor for breaking of the exciter field circuit, and a discharge resistor(+R01). When the field contactor is opened the thyristor convertor is disconnected from the exciter field, and the current commutated over to the discharge resistor. The resistor absorbs the energy stored in the exciter field winding and reduces the discharge time. To prevent overfluxing in the generator and malfunction of the trigger pulse equipment the field contactor will be tripped below 85% of rated speed (not valid for GTX100).

- Control and supervision

  MKY10

  The functions for control and supervision are mainly performed by voltage regulator DCS (HPC 840) which is connected to the GT control system (AC400) over an AF100-bus. Apart from the regulator the following supervision functions are included.

  The signal exchange between the voltage regulator DCS and the GT control system are:

  Digital Signals: Voltage Regulator => GT

  Signals described under "System faults" which are send over the AF100-bus. There are also some additional signals that not are used in this application which are:

  -UNLOADING_Mvar_ENDED
  -ROTOR_EARTH_FAULT
  -CONVERTOR_1_FAULT
  -CONVERTOR_2_FAULT
  -NOT_VOLTAGE_BALANCE
  -TRIPPED_MCB_SUP_2

Analog Signals: Voltage Regulator => GT
The signals which are connected to the voltage regulator DCS (see below) are send over the AF100-bus to the AC400. Additional signals are:
-REF_2_AVR
-REF_2_FCR
-COSPHI_A
There are also some additional signals that only are used in the GT35 application which are:
-REG-BAL
-Ref_Q_Inc_Dec
-Ref_PF_Inc_Dec

Digital Signals: GT => Voltage regulator
-MKY_VAR_INDON
-MKY_U_INDON
-MKY_FCR_INDON
-MKY_PHI_INDON
-CBP10EA901ZU11, SYNCHRONIZING
-UNLOAD_MVAR
-AVR_RESET
-BAC10GS001XP11, GCB_POS_ON

Analog Signals: GT => Voltage regulator
-CFA10CE003, Grid voltage
-CJP10_FREQ, Frequency
-MKY10DE901:SETP, Voltage setpoint
-MKY10DE902:SETP, Reactive load setpoint
-MKY10DE903:SETP, Cosphi setpoint
-MKY10DE904:SETP, Fied current setpoint
-MKA10CT025, Generator cooling air NDE temperature

- Rotating diode protection
  MKY10EG002(+MKA10GA003.B1.F05)
  At a short circuit or open circuit in a diode in the rotating rectifier voltage and current pulsations will be induced in the exciter field circuit. The pulsations are detected by the diode failure protection and a trip signal is initiated.

The following measurements are connected to the "control and supervision" voltage regulator DCS.(and then send over the AF100 to the GT control system)

- Field current
  MKY10CE005
- Field voltage
  MKY10CE010
- Generator current L1

MKY10CE015
- Generator current L2
  MKY10CE020
- Generator current L3
  MKY10CE025
- Active load
  MKY10FE005
- Reactive load
  MKY10FE010
- Voltage reference
  MKY10FE015

Function

The system is in operation during synchronisation , GT operation and stop.

Start up

During start up the system starts to work when the field breaker is switched on. The excitation starts and rises the voltage up to net voltage. Then synchronisation is made and the voltage regulator starts to regulate.

Continuous operation

The voltage regulator regulates in one of the desired control modes:
- Power factor.
- Voltage
- Reactive power
- Field current

The voltage regulator is also limited by the following factors:
- High field current (thermal limitation)
- Under excitation
- High stator current (thermal limitation)
- Low frequency reduces stator voltage

Turbine stop

The system regulates until the generator breaker is opened and short after the field breaker will open.

Stand still

System is not active.

Disturbances

Gas turbine trip

The field breaker opens after a slight delay and system goes out of operation.

Generator breaker trip

The field breaker opens and system goes out of operation.

Loss of power supply

The power supply to voltage regulator control system is taken from the UPS system. The excitation system (field breaker included) is supplied from a voltage transformer connected to the generator terminals. The protection relay "40 Loss of Excitation Protection" in the generation protection system (CHA10) trips the generator breaker and consequently cuts the power supply to the excitation system.

System faults

The faults, which are supervised by alarms and/or shutdown procedures are listed in the alarm and trip list. Supervision is made in the GT control system. All signals that have there origin in the voltage regulator DCS are send to the GT control system (AC400) over an AF100-bus.

Other faults

If the control system (MKY10) goes out of operation the field current control loop gets into back-up mode. The field current can now be adjusted from the back-up panel where also the grid voltage, frequency, active and reactive load are monitored.

Technical specification

Design criteria and standards

The voltage regulating equipment is designed for installation in self-ventilated cubicles. The equipment should be placed in an environment free from dust and moisture.

The voltage regulating equipment is specified in ALSTOM-binder HPC 840, FMVC 815 documents HDE 6-007E rev 2, RS 9-001E rev 1, HDE 8-008 rev -, HDE 8-011 rev -, HDE 8-013 rev -, HDE 8-015 rev -.

Dimensioning data

Supply voltage to the thyristor convertor,	U_{AC} 1-phase 110- 350 V AC, in steps 3-phase 50 - 500 V AC, in steps
Maximum deviation, continuous	0,5-1,1 * U_{AC}
Maximum deviation, for 1 sec	1,7 * U_{AC}
Transient	1-phase: 1400 V 3-phase: 1800 V
Frequency range	25-600 Hz, in steps
Maximum DC output voltage, at rated current	1-phase: 0,8 * U_{AC} 3-phase: 1,2 * U_{AC}
Maximum continuous DC current without field forcing	1-phase: 30 A DC 3-phase: 50 A DC
Maximum continuous DC current with field forcing	1-phase: 20 A DC 3-phase: 30 A DC
Maximum allowed field forcing	1-phase: 40 A DC for 10 sec 3-phase: 75 A DC for 10 sec
Test voltage towards earth:	Main circuit 2,5 kV AC, 1 min Control circuits 1,5 kV AC, 1 min Electronics 0,5 kV AC 1 sec
Ambient temperature	
- operation	0 - +50°C
- storing	-20 - +70°C

This information has its origin from the ALSTOM system description RS 9-001E rev 1.

Engineering data

"Options" according to product specification:

- 305, Dual bridge, 1-phase PMG

Emergency power supply

Power supply to voltage regulator control system is taken from the UPS system. The excitation system (field breaker included) is supplied from a voltage transformer connected to the generator terminals.

Installation

The AVR controller is located in the CHA10 cubicle placed in the GT control room. The power supply and measuring devices are located in the cubicle MKA10GA003 placed in the generator room. The rotating rectifier, AC exciter and pilot exciter are located on the generator shaft NDE. The rotating diode failure protection relay is located in a terminal box on the generator.

Testing and service

General

The excitation equipment should be checked at regular intervals. The frequency of routine checks depends on the environment and the operating hours. When the environment is of normal control room class the suitable interval of routine checks is 2-3 years.

The maintenance personnel should be experienced and have enough technical knowledge for the equipment. The system has only a few moving parts, and therefore the maintenance of the equipment is cut down to prevention maintenance.

Routine check

The machine should be stopped and the excitation equipment deenergized.

- Check that all wires and apparatus are firmly screwed in place and that there are no loose screws or nuts.
- Check that no cables or wires in the equipment chafe against sharp edges.
- Vacuum clean the cubicle if required.
- Maintenance of the voltage regulator HPC 840 should be performed according to the Technical Description for Advant Controller 110 doc. no. 3BSE009131R0001.
- Check relays and contactors with regard to burn damages and wear, especially the field breaker contactor.
- If the converter is fitted with an incoming air filter, remove and wash the filter lightly in water (max 40°C). Cleaning of the filter can also be done by light beating or vacuum cleaning. Do not wring or squeeze the filter during washing, also avoid strong water and air jets.

Functional check

Certain functions are easiest checked with the machine and equipment in operation, for example the different regulator modes. Measuring values and procedures to be followed during inspection should be noted and kept for comparison during the next check.

With the machine at stand still

Auxiliary supply :

- Check the voltage level of the auxiliary 24V DC with all electronic units connected.

Electronic units :

- Check the voltage levels for the circuit boards according to data sheet.

Alarms and trips :

- Perform secondary injection tests on all relay protections and guards and check that alarms and trips operate according to the circuit diagram.

Discharge circuit :

- Check that the discharge resistor is connected when the field contactor is opened.

With the machine rotating not synchronized

Auxiliary supply units, supplied from generator voltage or PMG :

- Check the voltage level of the auxiliary 24V DC with all electronic units connected.

Control circuits :

- Change over between AVR and FCR. Check that bump-less change-over is achieved, and that the correct mode of regulation is indicated.
- Give different reference values (increase/decrease or a figure value) and check that the regulator adjusts the generator voltage/field current in a correct way.

Back-up control :

- Simulate fault in the HPC 840 regulator, for example by a temporary jumper on the digital output for change over to back-up control. The field current shall adjust to the value which is pre-set on the back-up regulator.
- A bump-less change-over back to computer control will occur when activating the reset push button.

Converter and trigger pulse equipment :

- Check with an oscilloscope that the output voltage from the converter is symmetric. Note! Proceed with greatest caution when measuring in the main circuit.

With the machine synchronized

Transducers :

- Check that the analog input signals to the regulator has correct value in the program by using the Test-function on the computer programming aid**.**

Reactive power or power factor control :

- Change over between the different mode of regulations. The change-over shall be bumpless, and the correct mode of regulation indicated.
- Give different reference values (increase/decrease or a figure value) and check that the regulator adjusts to the proper value without any disturbance.

Index of Components