AGC-4 Automatic Controller for steam turbine
DESIGNER'S REFERENCE HANDBOOK ADDENDUM

- Functional description, added functions
- PID-controller for backpressure
- Parameters for added functions

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1. About this document

This chapter includes general user information about this handbook concerning the general purpose, the intended users and the overall contents and structure.

General purpose

This document is an addendum to the Designer's Reference Handbook (document no. 4189340686) for DEIF's Automatic Genset Controller, the AGC-4. The addendum describes the functions added to the AGC-4 to enable it to control a steam turbine.

Please make sure to read this addendum and the Designers Reference Handbook before working with the Multi-line 2 controller and the genset to be controlled. Failure to do this could result in human injury or damage to the equipment.

Intended users

The addendum is mainly intended for the person responsible for the unit parameter setup. In most cases, this would be a panel builder designer. Naturally, other users might also find useful information in the addendum.

Contents/overall structure

The addendum is divided into chapters and in order to make the structure of the document simple and easy to use, each chapter will begin from the top of a new page. The following will outline the contents of each of the chapters.

2. Warnings and legal information

This chapter includes important information about general legal issues relevant in the handling of DEIF products. Furthermore, some overall safety precautions will be introduced and recommended. Finally, the highlighted notes and warnings, which will be used throughout this handbook, are presented.

Legal information and responsibility

DEIF takes no responsibility for installation or operation of the generator set. If there is any doubt about how to install or operate the generator set controlled by the unit, the company responsible for the installation or the operation of the set must be contacted.

The units are not to be opened by unauthorised personnel. If opened anyway, the warranty will be lost.

Electrostatic discharge awareness

Sufficient care must be taken to protect the terminals against static discharges during the installation. Once the unit is installed and connected, these precautions are no longer necessary.

Safety issues

Installing the unit implies work with dangerous currents and voltages. Therefore, the installation should only be carried out by authorised personnel who understand the risks involved in working with live electrical equipment.

Be aware of the hazardous live currents and voltages. Do not touch any AC measurement inputs as this could lead to injury or death.

Definitions

Throughout this document a number of notes and warnings will be presented. To ensure that these are noticed, they will be highlighted in order to separate them from the general text.

Notes

The notes provide general information which will be helpful for the reader to bear in mind.

Warnings

The warnings indicate a potentially dangerous situation which could result in death, personal injury or damaged equipment, if certain guidelines are not followed.

3. Functional descriptions, turbine controller

This chapter includes functional descriptions of steam turbine related function added to the AGC-4.

Digital input power setpoint

It is possible to change the internal sepoint for fixed power via digital inputs. The inputs used can be set in input settings or via M-Logic (event: Digital input), and the control also selected in M-Logic (command: raise power setpoint/lower power setpoint)

M-Logic

Func.	Name	Remarks
Event		
Events	Digital input	Select the input used
Output		
Command	Raise power setpoint	Increase power setpoint for fixed power, relates to: - Fixed power raise speed, parameter 2624 - Fixed power setting, parameter 7051
Command	Lower power setpoint	Decrease power setpoint for fixed power, relates to: - Fixed power lower 2 speed, parameter 2625 - Fixed power setting, parameter 7051

Raising or lowering setpoint affects both night and day settings (parameters 7001/7002)

Digital input power factor setpoint

It is possible to change the internal sepoint for fixed power mode power factor via digital inputs. The inputs used can be set in input settings or selected via M-Logic (event: Digital input), and the control also selected in M-Logic (command: raise power factor setpoint/lower power factor setpoint)

M-Logic

Func.	Name	Remarks
Event		
Events	Digital input	Select the input used
Output		
Command	Raise PF setpoint	Increase power factor setpoint for fixed power (1%/s, relates to setting 7052)
Command	Lower PF setpoint	Decrease power factor setpoint for fixed power (1%/s, relates to setting 7052)

Analogue input frequency/power and voltage/power factor setpoints

The analogue inputs for frequency/power (terminals 40(+)-41(-)) and voltage/power factor (terminals 42(+)-41(-)) can be scaled to match the external source. Normal voltage range is 0-10 VDC, by adding a 500 Ω resistor across the terminals and scale to 2-10 V DC, a 4-20 mA source can be used.

Parameters:

Param.	Name	Setting range	Factory setting	Remarks
2840	Max f/P input	-10…10V	10V	
2841	Min f/P input	-10…10V	0V	
2842	Max U/Q/cos φ input	-10…10V	10V	
2843	Min U/Q/cos φ input	-10…10V	-10V	

Power setpoint alarm (wirebreak)

An alarm is available for triggering if the analogue input for power setpoint value goes below 1.5 VDC (3 mA).

If the alarm triggers, it will, at the same time, freeze the power setpoint at the present value. This will prevent unwanted power drops.

The alarm has fixed settings:

Limit: 1.5 V DC (~3 mA with a 500Ω resistor across terminals)
Time delay: 1 sec
Failclass: Warning
Active: When breaker is closed and running mode is fixed power

Parameters:

Param.	Name	Setting range	Factory setting	Remarks
2844	Fixed P setp wirebreak	ON/OFF	OFF	

Reset of Mains power export setpoint

If needed, an M-Logic command can be used to reset the MPE power setpoint to a pre-determined value.

Parameters:

Param.	Name	Setting range	Factory setting	Remarks
7006	Reset MPE setting	-20000 to +20000 kW	1000 kW	

M-Logic command:

Reset Mains Power Export Setpoint.

Reset of fixed power setpoint

If needed, an M-Logic command can be used to reset the fixed power setpoint to a pre-determined value.

Parameters:

Param.	Name	Setting range	Factory setting	Remarks
7055	Reset Fixed P setting	-20000 to +20000 kW	1000 kW	

Valve motion

In order to prevent steam control valve seizure (seizure of the stem in the stuffing box) a time-dependent valve motion function is available.

When no speed output change is happening, the analogue speed output is increased/decreased in a cyclic manner inside a selectable +/- value.
Effectuated with MIN->MAX once per hour +/- output, selectable, provided no movement of the speed control output has taken place in the meantime (+/- 2%)

Valve motion is selected via M-Logic

Parameters:

Param.	Name	Setting range	Factory setting	Remarks
2783	Reg. governor motion	0.0…100.0 %	0.0%	+/- motion value

M-Logic

Func.	Name	Remarks
Event		
Events	Valve motion allowed	No movement has taken place
Events	Valve motion active	Valve motion in progress
Output		
Command	Force valve motion	Force the valve motion to activate

Expanded ramp functions

2nd ramp setting (Power ramp up 2) is introduced for:

- Ramp speed of digital input increase/decrease function
  - Direct ramp speed when in manual
  - Ramp speed used in semi when moving fixed power set point with digital inputs
  - Ramp speed used in semi when using external fixed power set point

RAMP speed 2 does, unlike ramp speed 1, not contain any ramp pause for pre-heating.

RAMP speed 2 can also be selected via M-Logic

Ramping function (after GB closing):

1) RAMP UP 1 start
2) RAMP UP 1 follows the settings
3) IF fixed power setpoint is reached (+/- 3% of Pnom)
   OR if "Goto RAMP 2, Pset = Pact" M-Logic command is set
   The command forces P setpoint value to P actual value
   THEN RAMP UP 1 deactivates
   RAMP UP 1 remains deactivated until after next time synchronization has taken place
4) RAMP speed 2 hereafter activates if
   Actual power deviates more than +/- 3% from fixed power setpoint (3% of nominal power value)

Power setpoint is controlled via digital inputs UP/DOWN or active change of value (e.g. via display or modbus) or via analogue input.

RAMP down activates when ramp down command is set

RAMP down can be de-activated by issuing the GB ON command. In this case, the system returns condition 4).

Parameters:

Param.	Name	Setting range	Factory setting	Remarks
2611	Power ramp up	0.1…20.0 %/s	2.0 %/s	Ramp #1
2616	Power ramp up 2	0,01…20.00 %/s	2.00 %/s	Ramp #2

M-Logic

Func.	Name	Remarks
Event		
Events	Ramp up speed 1 active	Ramp 1 is in progress
Output		
Command	Goto Ramp up 2, Pset = Pact	Jump to ramp speed 2. At the same time let the actual generator power value become the power setpoint value.

Voltage dependent PF control ON/OFF

If the mains/BB voltage goes above or below a certain limit, freeze the AVR control (goto MAN)

Parameters:

7190 Freeze PF control max

Param.	Name	Setting range	Factory setting	Remarks
7191	Setpoint	0.0…20.0%	5.0%	Setting is related to mains nominal voltage (setting 6053). If mains voltage raises above setting the function triggers.
7192	Delay	0.1…10.0 sec	1.0 sec	
7193	Freeze ON/OFF	ON…OFF	OFF	

7120 Freeze PF control min

Param.	Name	Setting range	Factory setting	Remarks
7121	Setpoint	0.0…-20.0%	-5.0%	Setting is related to mains nominal voltage (setting 6053). If mains voltage drops below setting the function triggers.
7122	Delay	0.1…10.0 sec	1.0 sec	
7123	Freeze ON/OFF	ON…OFF	OFF	

Breaker close error

When trying to close the breaker, it has the amount of tries that is set in the related parameter. At a failed breaker close, alarm will come, but this will be cleared after 4 seconds, and it will try again.

After last attempt, if failing, will end the breaker close sequence, and stop.

Parameters:

Param.	Name	Setting range	Factory setting	Remarks
2190	GB Close fail	1…10	3	

PID controller for backpressure

This function is only available if the generator is running fixed power mode

Regulator output selection

Besides ordinary relay/analogue outputs, the PID regulator output can, via M-Logic, be used to control the fixed power setpoint, and thereby backpressure control is made possible.

Param.	Name	Setting range	Factory setting	Remarks
2783	Reg output PID1	Relay…Analogue	Relay	Leave in relay selection if used for fixed power setpoint

Setting range 28xx is only accessible via PC Utility Software

Regulator input selection

The analogue input selected must represent the turbine backpressure.

Param.	Name	Setting range	Factory setting	Remarks
2801	PID input	All analogue inputs available	None	

Regulator setup

Param.	Name	Setting range	Factory setting	Remarks
2802	PID minimum	0.0…49.9 %	0.0 %	Limit
2803	PID maximum	50.0…100.0 %	100.0 %	Limit
2804	PID reference	0.0…100.0 %	50.0 %	Setpoint
2805	PID offset	0.0…100.0 %	50.0 %	Start point

Param.	Name	Setting range	Factory setting	Remarks
2811	Analogue Kp PID1	0.00…60.00	0.50	0 ~ deactivated
2812	Analogue Ti PID1	0.00…60.00 sec	0.50 sec	0 ~ deactivated
2813	Analogue Td PID1	0.00…2.00 sec	0.00 sec	0 ~ deactivated

Param.	Name	Setting range	Factory setting	Remarks
2821	Relay DB PID1	0.2…10.0 %	2 %	The deadband represents the area around the setpoint where relay outputs are not activated
2822	Relay Kp PID1	0.00…10.00	1.00	0 ~ deactivated

2823	Relay Td PID1	0.00…2.00 sec	2.00 sec	0 ~ deactivated

Regulator relay output selection

Param.	Name	Setting range	Factory setting	Remarks
2831	On Time PID1	0…6500 ms	500 ms	Only available if "relay" is chosen in menu 2783
2832	Period time PID1	0…32500 ms	2500 ms	
(2832)	Output A	All relay outputs	Not used	Increase relay
(2832)	Output B	All relay outputs	Not used	Decrease relay

Regulator analogue output selection

Param.	Name	Setting range	Factory setting	Remarks
5691	PID output	All analogue outputs available		Only available if "analogue" is chosen in menu 2783

M-Logic

Func.	Name	Remarks
Event		
Events	PID 1 activate	
Events	PID 1 min	
Events	PID 1 max	
Events	PID 1 reset to offset	
Output		
Command	Raise PID reference	
Command	Lower PID reference	
PID1control	PID1 Activate	
PID1control	PID1 Min	
PID1control	PID1 Max	
PID1control	PID1 reset to offset	

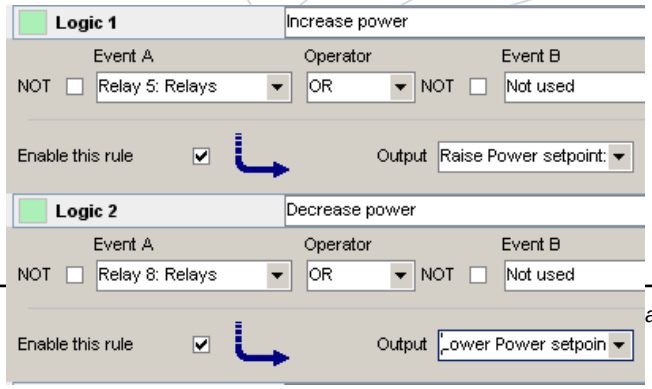
Backpressure control

In order to carry out backpressure control via M-Logic, the following selections are to be made.

Output (setting 2783): Select relay
Relays (setting 2832): Physical relays must be selected

M-Logic example:

Relay 5 is increase
Relay 8 is decrease



Busbar single phase voltage measurement

JUMP menu 9130:
Select:
3-ph GEN L1L2 BUS

Selection of 3 phase generator voltage measurement and 2 phase L1-L2 busbar measurement.

M-Logic, misc. related commands

Func.	Name	Remarks
Output		
Command	Freeze analogue GOV	Governor in MAN mode
Command	Freeze analogue AVR	AVR in MAN mode
Command	Freeze relay GOV	Governor in MAN mode
Command	Freeze relay AVR	AVR in MAN mode
Command	Inhibit GB/MB close signal	Prevents closing of breaker at synchronizing point

4. Functional descriptions, Mains controller

Digital input power setpoint

It is possible to change the internal sepoint for fixed power via digital inputs. The inputs used can be selected in input settings or selected via M-Logic (event: Digital input), and the control also selected in M-Logic (command: raise power setpoint/lower power setpoint)

M-Logic

Func.	Name	Remarks
Event		
Events	Digital input	Select the input used
Output		
Command	Raise power setpoint	Increase power setpoint for fixed power (starts with 0.1%/s if input is maintained high, it goes to 1%/s, relates to setting 7051)
Command	Lower power setpoint	Decrease power setpoint for fixed power (starts with 0.1%/s if input is maintained high, it goes to 1%/s, relates to setting 7051)

Raising or lowering setpoint affects both night and day settings (parameters 7001/7002)

Digital input power factor setpoint

It is possible to change the internal sepoint for fixed power mode power factor via digital inputs. The inputs used can be selected inn input settings or via in M-Logic (event: Digital input), and the control also selected in M-Logic (command: raise power factor setpoint/lower power factor setpoint)

M-Logic

Func.	Name	Remarks
Event		
Events	Digital input	Select the input used
Output		
Command	Raise PF setpoint	Increase power factor setpoint for fixed power (1%/s, relates to setting 7052)
Command	Lower PF setpoint	Decrease power factor setpoint for fixed power (1%/s, relates to setting 7052)

Analogue input frequency/power and voltage/power factor setpoints

The analogue inputs for frequency/power (terminals 40(+)-41(-)) and voltage/power factor (terminals 42(+)-41(-)) can be scaled to match the external source. Normal voltage range is 0-10 VDC, by adding a 500 Ω resistor across the terminals and scale to 2-10 V DC, a 4-20 mA source can be used.

Parameters:

Param.	Name	Setting range	Factory setting	Remarks
2840	Max f/P input	-10…10V	10V	
2841	Min f/P input	-10…10V	0V	
2842	Max U/Q input	-10…10V	10V	
2843	Min U/Q input	-10…10V	-10V	

Reset of Mains power setpoint

If needed, an M-Logic command can be used to reset the fixed power setpoint to a pre-determined value.

Parameters:

Param.	Name	Setting range	Factory setting	Remarks
7006	Reset MPE setting	-20000 to +20000 kW	1000 kW	

M-Logic command:

Reset Mains Power Export Setpoint.

Voltage dependent PF control ON/OFF

If the mains voltage goes above or below a certain limit, freeze the AVR control (goto MAN)

Parameters:

7190 Freeze PF control max

Param.	Name	Setting range	Factory setting	Remarks
7191	Setpoint	0.0…20.0%	5.0%	Setting is related to mains nominal voltage (setting 6053). If mains voltage raises above setting the function triggers.
7192	Delay	0.1…10.0 sec	1.0 sec	
7193	Freeze ON/OFF	ON…OFF	OFF	

7120 Freeze PF control min

Param.	Name	Setting range	Factory setting	Remarks
7121	Setpoint	0.0…-20.0%	-5.0%	Setting is related to mains nominal voltage (setting 6053). If mains voltage drops below setting the function triggers.
7122	Delay	0.1…10.0 sec	1.0 sec	
7123	Freeze ON/OFF	ON…OFF	OFF	

Breaker close error

When trying to close the breaker, it has the amount of tries that is set in the related parameter. At a failed breaker close, alarm will come, but this will be cleared after 4 seconds, and it will try again.

After Last attempt, if failing, will end the breaker close sequence, and stop.

Parameters:

Param.	Name	Setting range	Factory setting	Remarks
2195	MB close fail	1…10	3	

Busbar single phase voltage measurement

JUMP menu 9130:
Select:
3-ph GEN L1L2 BUS

Selection of 3 phase Mains voltage measurement and 2 phase L1-L2 busbar measurement.

GEN = Mains

5. Functional descriptions, Bus Tie Breaker controller

SEMI AUTO deload

In SEMI AUTO plant mode it is possible to open a bus tie breaker (BTB) with deload prior to opening the breaker.

The operator initiates the sequence buy BTB OPEN command.

Since the system is in SEMI AUTO, the operator needs to consider the power balance of the system:

- If there is insufficient available power on one of the busbars after opening the breaker, a generator overload will appear on this side.
- If there are no generators on line on one of the busbars, the BTB opens instantly and causes a blackout on this busbar.
- If there are sufficient available power on both busbars, a deload and BTB open sequence will take place