-power in control

DESIGNER'S HANDBOOK



AGC PM, Automatic Genset Controller, Plant Management

- Functional description
- Display unit and menu structure
- PID controller
- Procedure for parameter setup
- Parameter list

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6. General features

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1. General information

1.1 Warnings, legal information and safety

1.1.1 Warnings and notes

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

Warnings

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

Notes

Notes provide general information, which will be helpful for the reader to bear in mind.

1.1.2 Legal information and disclaimer

DEIF takes no responsibility for installation or operation of the generator set. If there is any doubt about how to install or operate the engine/generator controlled by the Multi-line 2 unit, the company responsible for the installation or the operation of the set must be contacted.

The Multi-line 2 unit is not to be opened by unauthorised personnel. If opened anyway, the warranty will be lost.

Disclaimer
DEIF A/S reserves the right to change any of the contents of this document without prior notice.

The English version of this document always contains the most recent and up-to-date information about the product. DEIF does not take responsibility for the accuracy of translations, and translations might not be updated at the same time as the English document. If there is a discrepancy, the English version prevails.

1.1.3 Safety issues

Installing and operating the Multi-line 2 unit may imply 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.

1.1.4 Electrostatic discharge awareness

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

1.1.5 Factory settings

The Multi-line 2 unit is delivered from factory with certain factory settings. These are based on average values and are not necessarily the correct settings for matching the engine/generator set in question. Precautions must be taken to check the settings before running the engine/generator set.

1.2 About the Designer's handbook

1.2.1 General purpose

This Designer's Reference Handbook mainly includes functional descriptions, presentation of display unit and menu structure, information about the PID controller, the procedure for parameter setup and reference to parameter lists.

The general purpose of this document is to provide useful overall information about the functionality of the unit and its applications. This document also offers the user the information he needs in order to successfully set up the parameters needed in his specific application.

⚠ **Make sure to read this document before starting to work with the Multi-line 2 unit and the genset to be controlled. Failure to do this could result in human injury or damage to the equipment.**

1.2.2 Intended users

This Designer's Reference Handbook is mainly intended for the panel builder designer in charge. On the basis of this document, the panel builder designer will give the electrician the information he needs in order to install the Multi-line 2 unit, for example detailed electrical drawings. In some cases, the electrician may use these installation instructions himself.

1.2.3 Contents and overall structure

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

2. General product information

2.1 Introduction

This chapter will deal with the unit in general and its place in the DEIF product range.

The AGC is part of the DEIF Multi-line 2 product family. Multi-line 2 is a complete range of multi-function generator protection and control products integrating all the functions you need in one compact and attractive solution.

The concept of the AGC is to offer a cost-effective solution to genset builders, who need a flexible generator protection and control unit for medium to large genset applications. Being part of the Multi-line product family, the standard functions can be supplemented with a variety of optional functions.

2.2 Type of product

The AGC PM (Automatic Genset Controller, Plant Management) is a micro-processor based control unit containing all necessary functions for protection and control of a genset.

It contains all necessary 3-phase measuring circuits, and all values and alarms are presented on the LCD display.

2.3 Options

2.3.1 Options

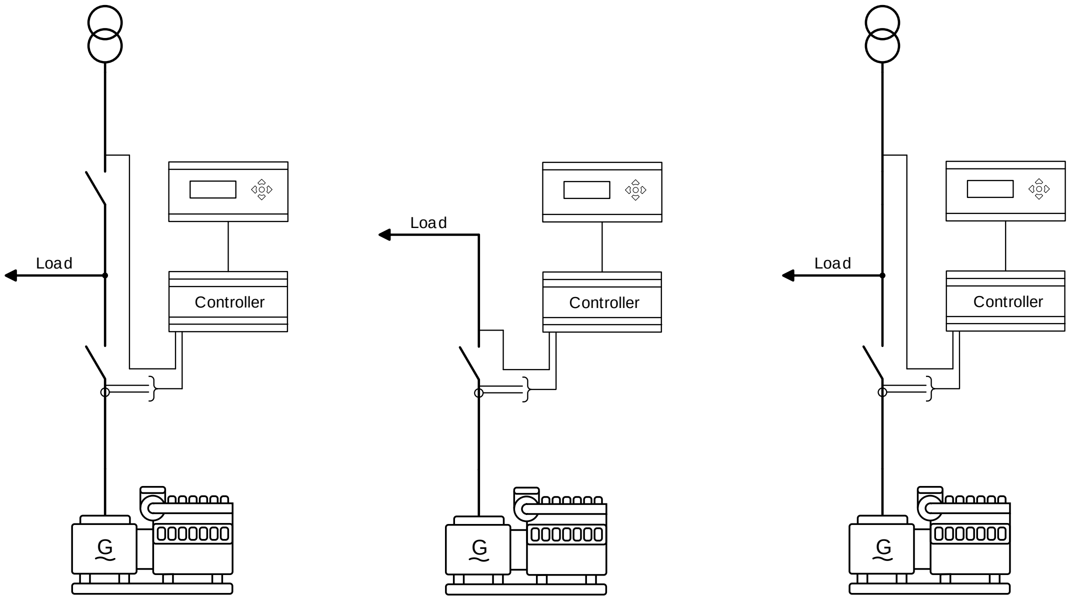
The Multi-line 2 product range consists of different basic versions which can be supplemented with the flexible options needed to provide the optimum solution. The options cover e.g. various protections for generator, busbar and mains, voltage/var/PF control, various outputs, power management, serial communication, additional operator display, etc.

A complete list of available options is included in the data sheet. Please see www.deif.com.

2.4 Single-line diagrams

2.4.1 Stand-alone applications

As stand-alone applications, the AGC PM supports the following:



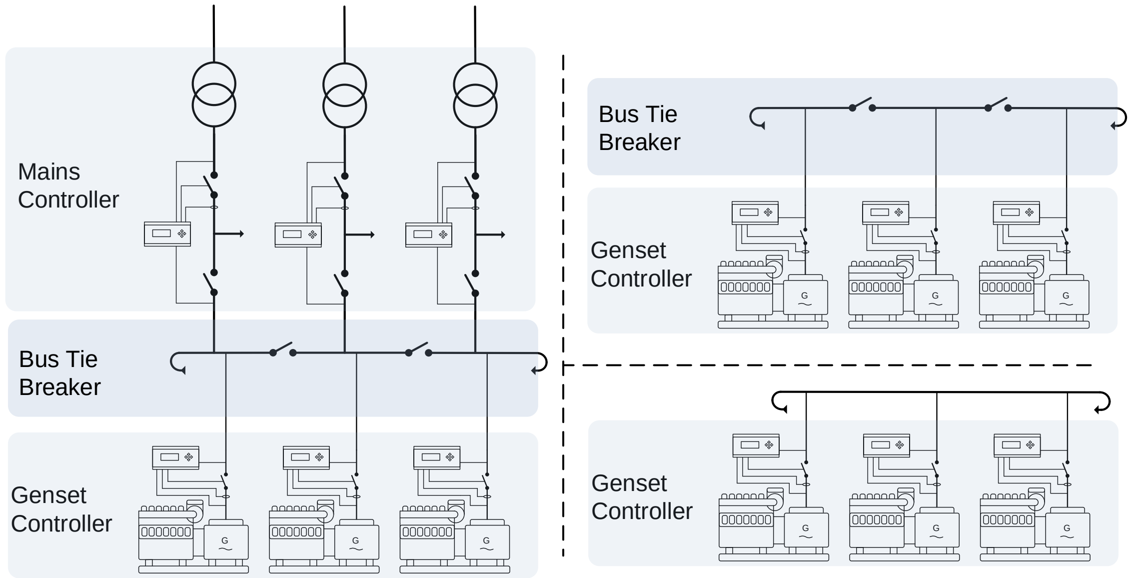
Above is shown three different applications. The first application is where the AGC PM controls the Generator Breaker (GB) and the Mains Breaker (MB). Only in stand-alone applications is the AGC PM capable of controlling a genset, a GB and an MB. The genset will be able to synchronise to the grid, and back synchronise onto the grid. This setup can be used in simple Automatic Mains Failure (AMF) applications. Furthermore, the genset will be able to switch onto Fixed Power mode, Load Take Over (LTO) or Island. Mains Power Export (MPE) and Peak Shaving are not possible, since there is no current measurement to measure the current flowing across the MB.

The next application shows the AGC PM in an island application. The AGC PM will always check if the busbar is live, before closing the breaker. If the busbar is live, the GB will synchronise before it is closed. The AGC PM is able to perform analogue load share with other gensets. The analogue load share will be described later in this document. In the application, the genset will only be able to run in island mode.

The last application shown is an application where there is no MB. If the AGC PM is about to synchronise to the grid, it is important that a grid is included in the application configuration. If not, the AGC PM will think that it is in island, and will try to pull the grid’s frequency up/down to nominal frequency of the genset. In this application configuration, the genset will be able to run in Fixed Power.

2.4.2 2-level power management applications

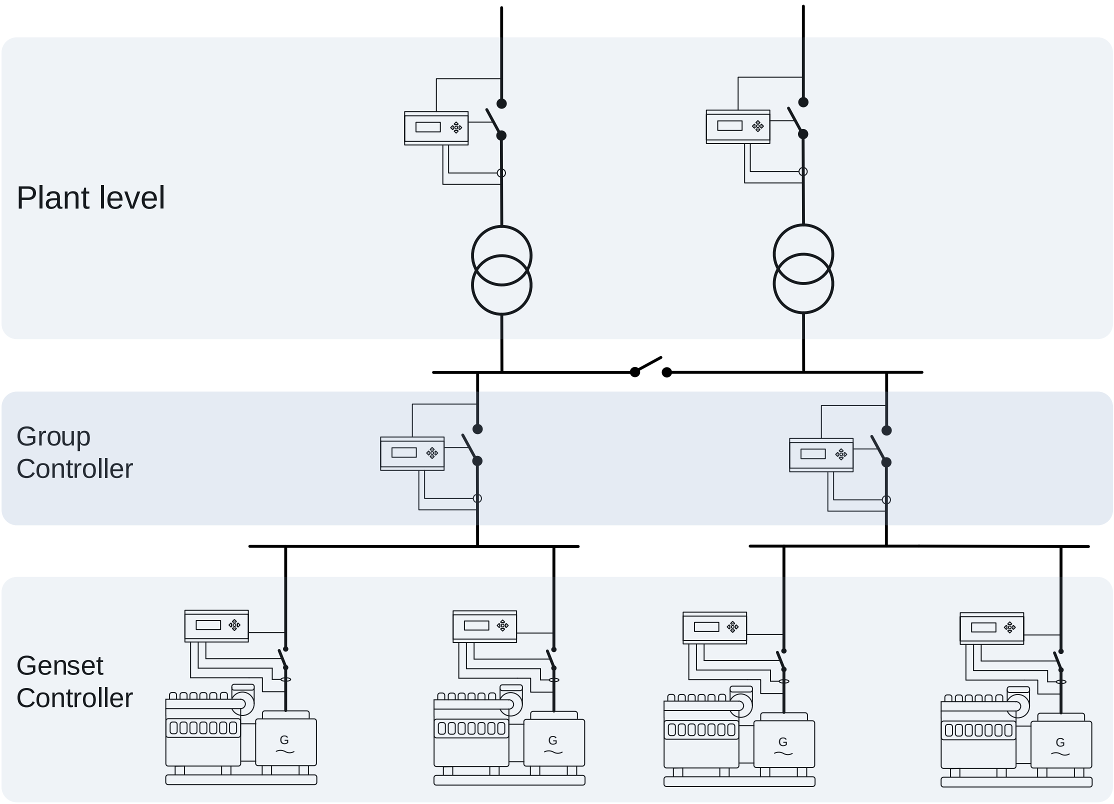
The AGC PM can handle different applications as 2-level applications. Below are some examples:



The drawing above shows three different layouts for the plant. The first is the one to the left, where the plant consists of mains controllers, Bus Tie Breakers (BTB) and gensets. The BTBs cannot be controlled by an AGC PM controller. It has to be externally controlled, and the feedbacks from the externally controlled BTBs will have to be wired to an AGC PM controller. In the drawing above, the busbar is wrapped, but this is not a requirement. In this setup, the gensets are able to run in parallel to the grid and export a fixed load. There are many other possibilities. In the lower right corner, the application is an island application. The AGC PM controllers are able to communicate with each other and by this they can perform some power management, and help each other out, if one of them is having a problem or is out for a service. In this drawing, the application has a busbar that is wrapped. This is not a requirement. In this drawing the gensets will only be able to run in island mode. In the upper right corner, there is an island application. But here it also consists of BTBs. The BTBs cannot be controlled by an AGC PM controller. It has to be externally controlled. Furthermore, the busbar is wrapped. It is not a requirement that the busbar is wrapped. In this application, the gensets will only be able to run in island mode. Common for all the examples above, is that the maximum for all the applications is 32 gensets/plants. The 32 gensets/plants can be combined as desired, but the maximum is 32 controllers. If more than 32 controllers are needed, it will have to be done in a 3-level power management application.

2.4.3 3-level power management applications

These applications are typically used when more than 32 controllers are needed. The 3-level applications consist of plant, group and genset controllers. BTBs can also be a part of these applications, but will always be located in the genset groups. An example of a 3-level application can look like this below.



The application above shows a very simple 3-level application. Only the BTBs located inside the groups can be controlled by an AGC PM. The ones in the top layer will have to be controlled externally, and the feed-backs will have to be wired to one of the controllers in the top layer. In the upper busbar, 8 externally control-led BTBs is the maximum. In this configuration, there are two grid connections. If the plant controllers are re-moved, the gensets will be operated in island mode, and by this the AGC PM can be operated in very big island applications. Inside each genset group, there can be 31 gensets and 8 BTBs, and if there are no grid connections, there will be room for 32 group controllers. This equals 992 gensets as a maximum!

3. Display unit, DU-2

3.1 Presentation

3.1.1 Presentation

This chapter explains the following regarding the Display Unit (DU-2):

- Segments
- Menus
- User access

3.2 Segments

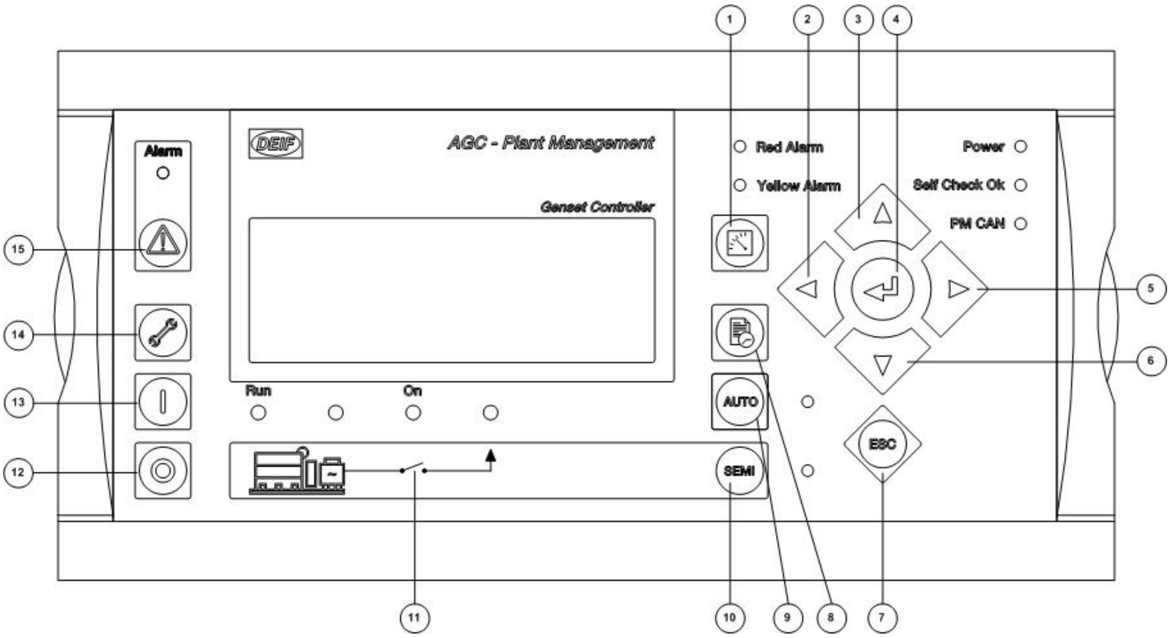
3.2.1 LCD display

The user screen of the Display Unit (DU-2) is a sunshineproof and backlit LCD text display containing four lines with 20 characters in each line.
There is also a back light dimmer function that can be used from the display unit push-buttons. (Jump pressing the  button to menu 9150 and press UP or DOWN).
Basically, all measured and calculated values can be read in the display. These may be selected via the PC utility software (USW).

The Display Unit (DU-2) dimensions are H × W = 115 × 220 mm (4.528” × 9.055”).

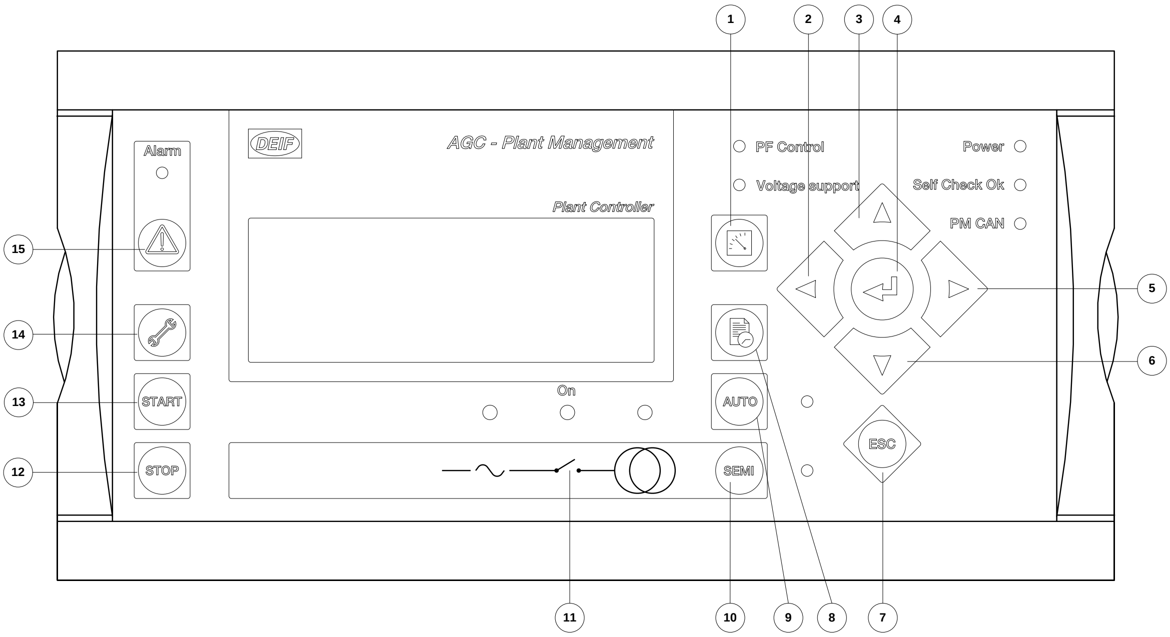
3.2.2 Push-button functions

AGC PM as Genset Controller



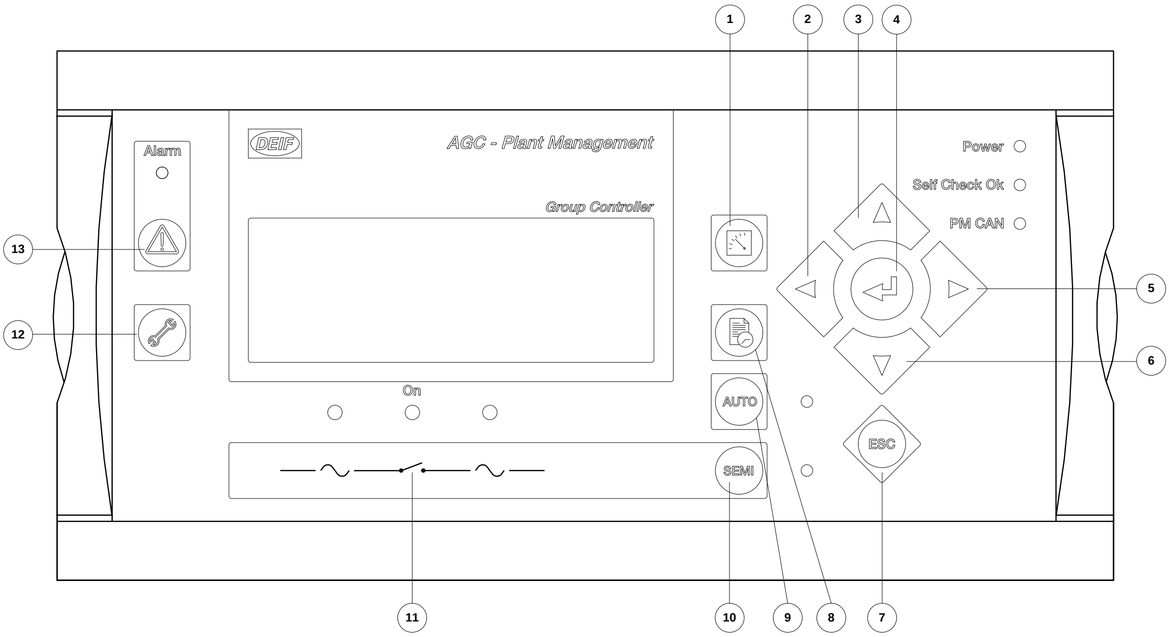
1. Shifts the first line displaying in the setup menus. Push two seconds to switch to master display in case more than one display is connected.
2. Moves the cursor to the left for manoeuvring in the menus.
3. Increases the value of the selected set point (in the setup menu). In the daily use display, this button function is used for scrolling the second line displaying of generator values.
4. Selects the underscored entry in the fourth line of the display.
5. Moves the cursor to the right for manoeuvring in the menus.
6. Decreases the value of the selected set point (in the setup menu). In the daily use display, this button function is used for scrolling the second line displaying of generator values.
7. Jumps one step backwards in the menu (to previous display or to the entry window).
8. Shifts the display three lower lines to show the event and alarm list.
9. Selects AUTO mode for remote or automatic operation.
10. Selects SEMI mode for local control.
11. Manual activation of close breaker and open breaker sequence if "SEMI" is selected.
12. Stop of the genset if "SEMI" is selected.
13. Start of the genset if "SEMI" is selected.
14. Enters a specific menu number selection. All settings have a specific number attached to them. The JUMP button enables the user to select and display any setting without having to navigate through the menus (see later).
15. Shifts the display three lower lines to show the alarm list.

AGC PM as Group Controller



1. Shifts the first line displaying in the setup menus. Push two seconds to switch to master display in case more than one display is connected.
2. Moves the cursor left for manoeuvring in the menus.
3. Increases the value of the selected set point (in the setup menu). In the daily use display, this button function is used for scrolling the second line displaying of generator values.
4. Selects the underscored entry in the fourth line of the display.
5. Moves the cursor right for manoeuvring in the menus.
6. Decreases the value of the selected set point (in the setup menu). In the daily use display, this button function is used for scrolling the second line displaying of generator values.
7. Jumps one step backwards in the menu (to previous display or to the entry window).
8. Shifts the display three lower lines to show the event and alarm list.
9. Selects AUTO mode for remote or automatic operation.
10. Selects SEMI mode for local control.
11. Manual activation of close breaker and open breaker sequence if "SEMI" is selected.
12. Stop of the plant if "AUTO" is selected.
13. Start of the plant if "AUTO" is selected.
14. Enters a specific menu number selection. All settings have a specific number attached to them. The JUMP button enables the user to select and display any setting without having to navigate through the menus (see later).
15. Shifts the display three lower lines to show the alarm list.

AGC PM as Plant Controller

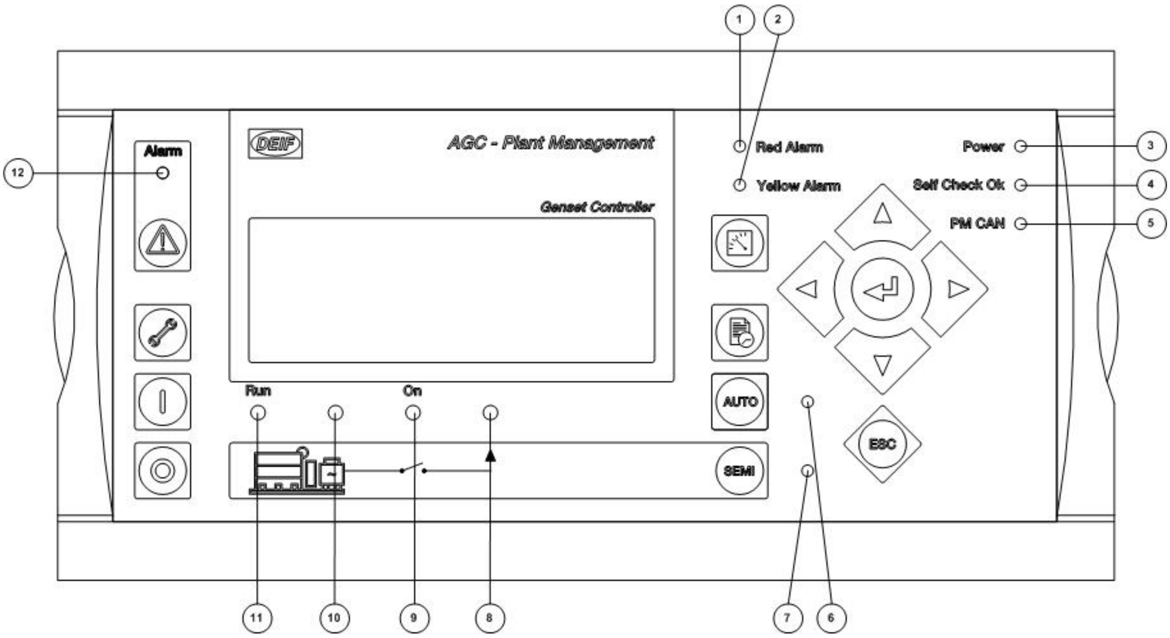


1. Shifts the first line displaying in the setup menus. Push two seconds to switch to master display in case more than one display is connected.
2. Moves the cursor left for manoeuvring in the menus.
3. Increases the value of the selected set point (in the setup menu). In the daily use display, this button function is used for scrolling the second line displaying of generator values.
4. Selects the underscored entry in the fourth line of the display.
5. Moves the cursor right for manoeuvring in the menus.
6. Decreases the value of the selected set point (in the setup menu). In the daily use display, this button function is used for scrolling the second line displaying of generator values.
7. Jumps one step backwards in the menu (to previous display or to the entry window).
8. Shifts the display three lower lines to show the event and alarm list.
9. Selects AUTO mode for automatic operation in its own plant mode.
10. Selects SEMI mode for local control.
11. Manual activation of close breaker and open breaker sequence if "SEMI" is selected.
12. Enters a specific menu number selection. All settings have a specific number attached to them. The JUMP button enables the user to select and display any setting without having to navigate through the menus (see later).
13. Shifts the display three lower lines to show the alarm list.

3.2.3 LED functions

AGC-PM as Genset Controller

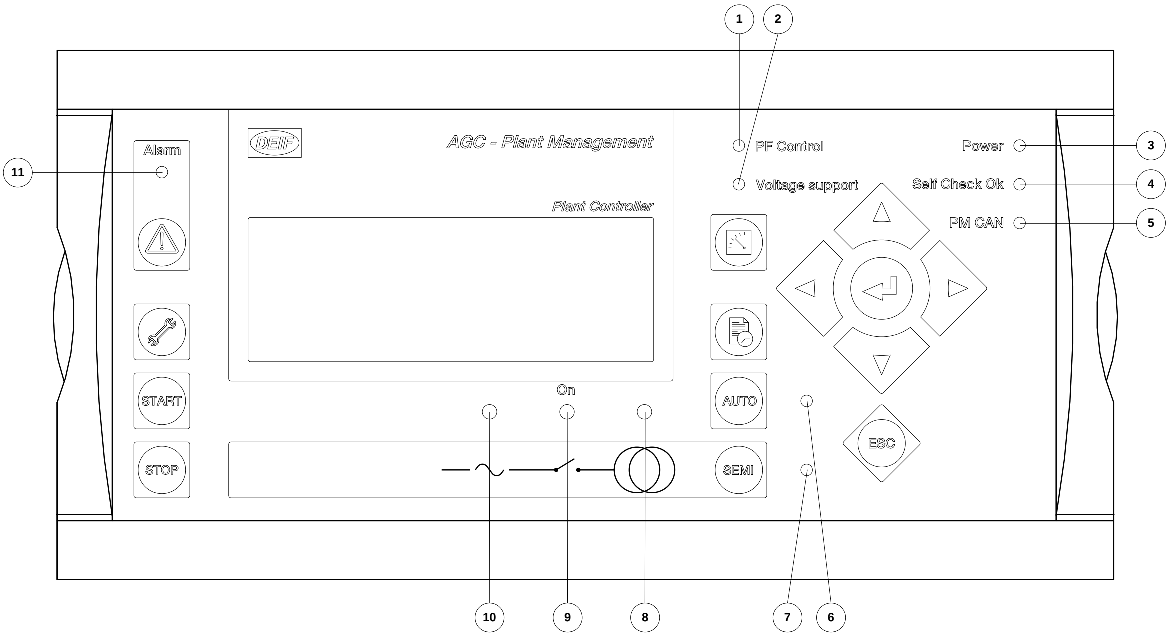
The display unit holds 12 LED functions.
The colour is green or red or a combination in different situations. The display LEDs are indicating as follows:



1. LED indicates a red alarm shutdown in the ECU.
2. LED indicates a yellow alarm in the ECU
3. LED indicates that the auxiliary supply is switched on.
4. LED indicates that the unit is OK.
5. LED indicates that the communication of the plant management is functioning.
6. LED indicates that AUTO mode is selected.
7. LED indicates that SEMI mode is selected
8. LED green light indicates that the voltage/frequency of the busbar is present and OK.
9. LED indicates that the generator breaker is closed.
10. LED green light indicates that the voltage/frequency of the generator is present and OK.
11. LED indicates that the generator is running.
12. LED flashing indicates that unacknowledged alarms are present. LED fixed light indicates that ALL alarms are acknowledged, but some are still present.

AGC PM as Plant Controller

The display unit holds 11 LED functions.
The colour is green or red or a combination in different situations. The display LEDs are indicating as follows:



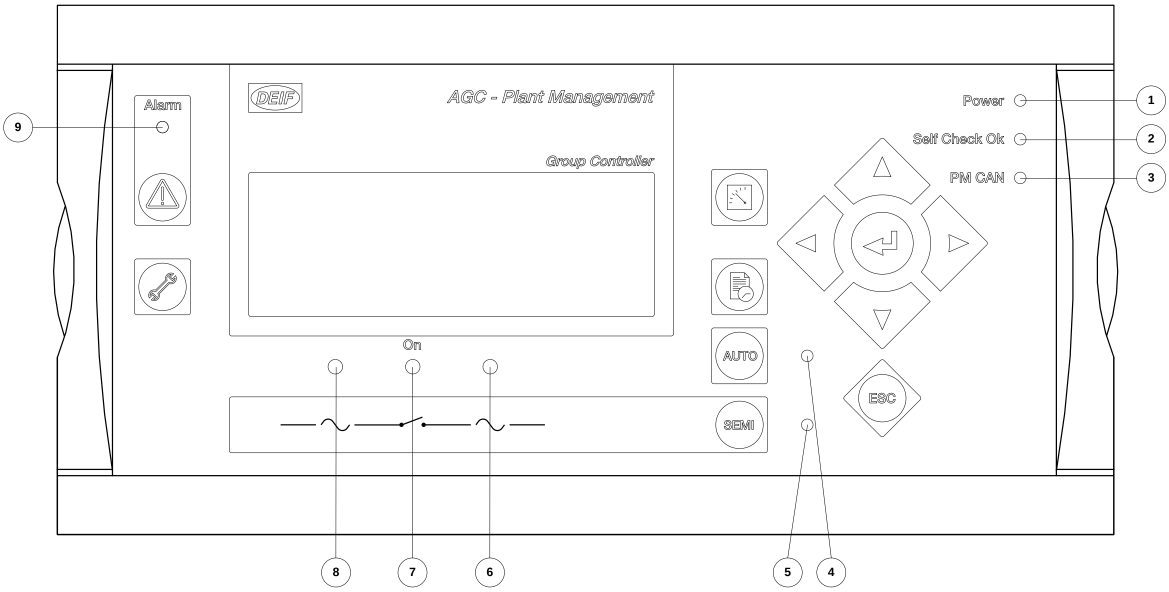
1. LED indicates common PF control (yellow = Fixed for DG) (green = Fixed for import/export).
2. LED indicates that voltage support is activated.
3. LED indicates that the auxiliary supply is switched on.
4. LED indicates that the unit is OK.
5. LED indicates that the communication of the plant management is functioning.
6. LED indicates that AUTO mode is selected.
7. LED indicates that SEMI mode is selected.
8. LED is green if the mains is present and OK. LED is red at a mains failure.
9. LED indicates that the mains breaker is closed.
10. LED green light indicates that the voltage/frequency of the busbar is present and OK.
11. LED flashing indicates that unacknowledged alarms are present. LED fixed light indicates that ALL alarms are acknowledged, but some are still present.

The breaker symbol will be green if the AGC Plant Management does not control any breaker.

AGC PM as Group Controller

The display unit holds 9 LED functions.

The colour is green or red or a combination in different situations. The display LEDs are indicating as follows:



1. LED indicates that the auxiliary supply is switched on.
2. LED indicates that the unit is OK.
3. LED indicates that the communication of the plant management is functioning.
4. LED indicates that AUTO mode is selected.
5. LED indicates that SEMI mode is selected.
6. LED green light indicates that the voltage/frequency of the mains side busbar is present and OK.
7. LED indicates that the group tie breaker is closed.
8. LED green light indicates that the voltage/frequency of the genset side busbar is present and OK.
9. LED flashing indicates that unacknowledged alarms are present. LED fixed light indicates that ALL alarms are acknowledged, but some are still present.

The breaker symbol will be green if the AGC Plant Management does not control any breaker.

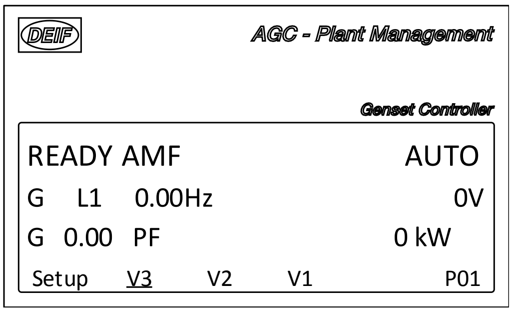
3.3 Menus

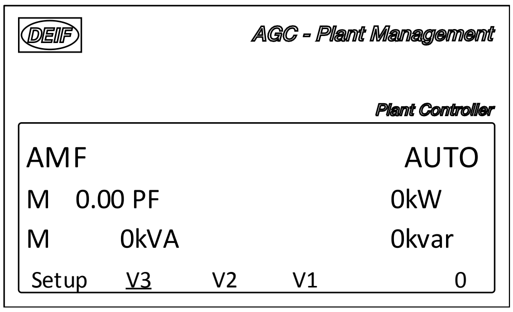
3.3.1 Entry window

When the unit is powered up, an entry window appears. The entry window is the turning point in the menu selection and as such the gateway to the other menus. It can always be reached by pressing the BACK push-button three times.

The event and alarm list will appear at power up if an alarm is present.

Genset controller Plant controller

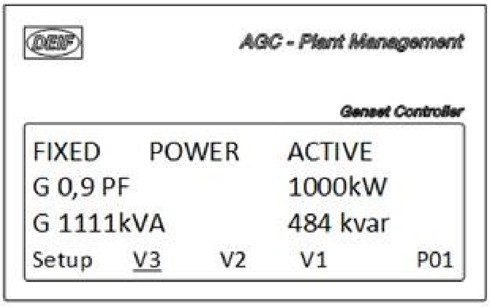




The selectable menus in the entry window are:

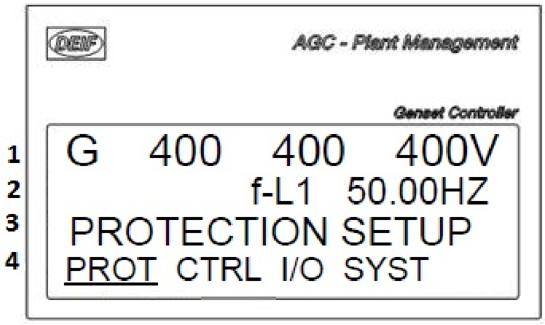
- 1 SETUP
- 2 Views (V3, V2, V1)
- 3 Priority selection (Pxx/0/1)

Below is shown a window from a running generator.



3.3.2 Setup

The setup menu system is used for parameter setup of the unit, and if the user needs detailed information that is not available in the view menu system. So, this menu can be used for both daily use and setup purposes. The menu is entered from the entry window by selecting the entry SETUP in the fourth display line.



1.First display line
(Daily use) The first line is used to display generator and bus values

2.Second display line

(Daily use)	Various values can be displayed
(Menu system)	Information about the selected channel number
(Alarm/event list)	The latest alarm/event is displayed

3.Third display line

(Daily use)	Explanation for the fourth line cursor selection
(Setup menu)	Presents setting of the selected function, and, if changes are made, the possible max. and min. values for the setting

4.Fourth display line

(Daily use)	Entry selection for the setup menu. Press SEL to enter the underscored menu
(Setup menu)	Sub-functions for the individual parameters, e.g. limit

Possible values in second display line, x = value

Displayed text in second line (# = variable values)	DG (X = match)	PLANT & MAINS (X = match)	GROUP (X = match)
G # # # V	X		
B # # # V	X	X	
BA # # # V			X
BA # # # A			X
BA #.## PF # kW			X
BA # .## cosphi			X
BA # kVA # kvar			X
BA-L1 #.# Hz # V			X
M # # # V		X	
M # # # A		X	
M #.## PF # kW		X	
M #.## cosphi		X	
M # kVA # kvar		X	
M-L1 # .# Hz # V		X	
G # # # A	X		
G #.## PF # kW	X		
G #.## cosphi	X		
G # kVA # kvar	X		
G-L1 #.# Hz # V	X		
B-L1 #.# Hz # V	X	X	
U-Gen L1N # V	X		
U-Gen L2N # V	X		
U-Gen L3N # V	X		
U-Gen L1L2 # V	X		
U-Gen L2L3 # V	X		
U-Gen L3L1 # V	X		
U-Gen Ma# # V	X		
U-Gen Min # V	X		
U-BA L1N # V			X
U-BA L2N # V			X
U-BA L3N # V			X
U-BA L1L2 # V			X
U-BA L2L3 # V			X
U-BA L3L1 # V			X

Displayed text in second line (# = variable values)	DG (X = match)	PLANT & MAINS (X = match)	GROUP (X = match)
U-BA Ma# # V			X
U-BA MIN # V			X
U-Mains L1N # V		X	
U-Mains L2N # V		X	
U-Mains L3N # V		X	
U-Mains L1L2 # V		X	
U-Mains L2L3 # V		X	
U-Mains L3L1 # V		X	
U-Mains Ma# # V		X	
U-Mains Min # V		X	
I-L1 # A	X	X	X
I-L2 # A	X	X	X
I-L3 # A	X	X	X
f-L1 #.## Hz	X	X	X
f-L2 #.## Hz	X	X	X
f-L3 #.## Hz	X	X	X
P # kW	X	X	X
P L1 # kW	X	X	X
P L2 # kW	X	X	X
P L3 # kW	X	X	X
P # kW U-BA L1N # V			X
P # kW U-Gen L1N # V	X		
P # kW U-Mains L1N # V		X	
Q # kvar	X	X	X
Q L1 # kvar	X	X	X
Q L2 # kvar	X	X	X
Q L3 # kvar	X	X	X
S # kVA	X	X	X
S L1 # kVA	X	X	X
S L2 # kVA	X	X	X
S L3 # kVA	X	X	X
P-factor #.##	X	X	X
Angle L1L2 # deg	X	X	X
Angle L2L3 # deg	X	X	X
Angle L3L1 # deg	X	X	X

Displayed text in second line (# = variable values)	DG (X = match)	PLANT & MAINS (X = match)	GROUP (X = match)
U-Bus L1 # V	X	X	X
U-Bus L2 # V	X	X	X
U-Bus L3 # V	X	X	X
U-Bus L1L2 # V	X	X	X
U-Bus L2L3 # V	X	X	X
U-Bus L3L1 # V	X	X	X
U-Bus Ma# # V	X	X	X
U-Bus Min # V	X	X	X
f-Bus L1 #.## Hz	X	X	X
f-Bus L2 #.## Hz	X	X	X
f-Bus L3 #.## Hz	X	X	X
Ang BusL1L2 # deg	X	X	X
Ang BusL1L3 # deg	X	X	X
Ang Bus-BA # deg			X
Ang Bus-Gen # deg	X		
Ang Bus-Mains # deg		X	
Etot # kWh	X	X	X
Eday # kWh	X	X	X
Eweek # kWh	X	X	X
Emonth # kWh	X	X	X
Itot # kWh	X	X	X
Iday # kWh	X	X	X
Iweek # kWh	X	X	X
Imonth # kWh	X	X	X
Etot # kvarh	X	X	X
Eday # kvarh	X	X	X
Eweek # kvarh	X	X	X
Emonth # kvarh	X	X	X
Itot # kvarh	X	X	X
Iday # kvarh	X	X	X
Iweek # kvarh	X	X	X
Imonth # kvarh	X	X	X
Ima# demand L1 # A	X	X	X
Ima# demand L2 # A	X	X	X
Ima# demand L3 # A	X	X	X
Ithermal demand L1 # A	X	X	X

Displayed text in second line (# = variable values)	DG (X = match)	PLANT & MAINS (X = match)	GROUP (X = match)
Ithermal demand L2 # A	X	X	X
Ithermal demand L3 # A	X	X	X
Pulse counter 1 #	X	X	X
Pulse counter 2 #	X	X	X
P consumed # kW	X	X	X
P available # %	X	X	X
P consumed # %	X	X	X
G # %S # %Q	X	X	X
G # .# # PF # %P	X	X	X
P # kW # %	X	X	X
Q # kvar # %	X	X	X
S # kVA # %	X	X	X
Analog91 #	X	X	X
Analog93 #	X	X	X
Analog95 #	X	X	X
Analog97 #	X	X	X
Analog127 #	X	X	X
Analog129 #	X	X	X
Analog131 #	X	X	X
Analog133 #	X	X	X
Multi Input 91 #	X	X	X
Multi Input 93 #	X	X	X
Multi Input 95 #	X	X	X
Multi Input 97 #	X	X	X
Multi Input 1# 2 #	X	X	X
Multi Input 1# 5 #	X	X	X
Multi Input 1# 8 #	X	X	X
Multi Input 127 #	X	X	X
Multi Input 129 #	X	X	X
Multi Input 131 #	X	X	X
Multi Input 133 #	X	X	X
Tacho # rpm	X		
U-Supply #.# V	X	X	X
Gov Mode Text	X	X	X
Synchroniser	X	X	X
Date and Time	X	X	X

Displayed text in second line (# = variable values)	DG (X = match)	PLANT & MAINS (X = match)	GROUP (X = match)
MB operations #	X	X	X
GB Operations #	X		
TB Operations #			X
Run Time group # Hour			X
# Start attempts	X		
Run Time total # Hour	X		
Run Time trip # Hour	X		
Run Time load profile # Hour	X		
Next prio # H # m	X		X
Service timer 1 #	X		
Service timer 2 #	X		
P mains Ana1# 2 # kW	X		
P available # kW	X	X	X
P mains # kW	X	X	X
P DG total # kW	X	X	X
Negtive volt. #.# %	X	X	X
Negtive Curr. #.# %	X	X	X
Zero volt. #.# %	X	X	X
Zero Curr. #.# %	X	X	X
Positive volt #.# %	X	X	X
P ref. actual # kW	X		
P mains Ana102 # kW			X
P ref. current # kW	X	X	X
Cosphi ref. current #.##	X	X	X
Fan A running hours	X		
Fan B running hours	X		
Fan C running hours	X		
Fan D running hours	X		
Parameter ID	X	X	X
Fuel volume	X		
GOV reg. type	X		
AVR reg. type	X		
Ext IO Ana In 1	X	X	X
Ext IO Ana In 2	X	X	X
Ext IO Ana In 3	X	X	X

Displayed text in second line (# = variable values)	DG (X = match)	PLANT & MAINS (X = match)	GROUP (X = match)
Ext IO Ana In 4	X	X	X
Ext IO Ana In 5	X	X	X
Ext IO Ana In 6	X	X	X
Ext IO Ana In 7	X	X	X
Ext IO Ana In 8	X	X	X
EIC Speed	X		
EIC T. Coolant	X		
EIC P. Oil	X		
EIC Faults	X		
EIC T. Oil	X		
EIC T. Fuel	X		
EIC P. Boost	X		
EIC T. Air Inl.	X		
EIC L. Coolant	X		
EIC Fuel Rate	X		
EIC P. Charge Air	X		
EIC T. Charge Air	X		
EIC DDETorque	X		
EIC ACTorque	X		
EIC PosAcc	X		
EIC Load speed	X		
EIC P. In. Air	X		
EIC T. Ex. Gas	X		
EIC Operation	X		
EIC P. Fi. Oil	X		
EIC Battery	X		
EIC P. Fuel	X		
EIC L. Oil	X		
EIC P. Crankc.	X		
EIC P. Coolant	X		
EIC Water In Fuel	X		
EIC Blowby Flow	X		
EIC P. Fuel R.	X		
EIC P. Timing	X		
EIC T. Afterc. W.	X		
EIC T.Turbo Oil	X		

Displayed text in second line (# = variable values)	DG (X = match)	PLANT & MAINS (X = match)	GROUP (X = match)
EIC P. Trap Inlet	X		
EIC P. Air f diff 1	X		
EIC P. Air f diff 2	X		
EIC P. Cool f diff	X		
EIC P. Barometric	X		
EIC T. Ambient Air	X		
EIC T. Exh. Right	X		
EIC T. Exh. Left	X		
EIC T. Winding 1	X		
EIC T. Winding 2	X		
EIC T. Winding 3	X		
EIC P. Aux 1	X		
EIC P. Aux 2	X		
EIC T. Turbo	X		
EIC T. Intercooler	X		
EIC Trip fuel liquid	X		
EIC Total fuel liq.	X		
EIC Trip fuel gas.	X		
EIC Total fuel gas.	X		
EIC Fuel rank pos. L	X		
EIC Fuel rank pos. R	X		
EIC P. Intake Man. L	X		
EIC P. Intake man. R	X		
EIC T. Intake man. L	X		
EIC T. Intake man. R	X		
EIC Mean T. fuel	X		
EIC Nominal power	X		
EIC Engine power	X		
EIC P. Intake man. 1	X		
EIC P. Fuel pump	X		
EIC P. Fuel f diff s	X		
EIC P. Fuel f diff	X		
EIC Speed D SW	X		
EIC P. L. Oil Lo	X		
EIC P. L. Oil Lolo	X		
EIC P-Fuel	X		

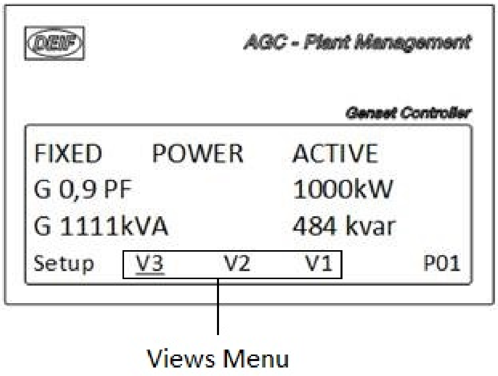
Displayed text in second line (# = variable values)	DG (X = match)	PLANT & MAINS (X = match)	GROUP (X = match)
EIC T-COOL-HI	X		
EIC T-COOL-HIHI	X		
EIC T-INTERC	X		
EIC T-ECU	X		
EIC Act-Droop	X		
EIC INJECT-QUAN	X		
EIC Camshaft	X		
EIC T-LUBE-HI	X		
EIC TLUBE-HIHI	X		
EIC F speed an	X		
EIC Stop Active	X		
DAVR Gen AC " options="108	X		
DAVR Gen Freq " options="108	X		
DAVR Gen Curr " options="108	X		
DAVR Gen E#cC " options="108	X		
DAVR Gen kvar " options="108	X		
DAVR Gen PF " options="108	X		
DAVR Gen PF lag " options="108	X		
DAVR Gen kW " options="108	X		
DAVR Gen kVA " options="108	X		
DAVR Gen PT	X		
DAVR Gen PT	X		
DAVR Gen PT	X		
DAVR Gen Alarm " options="108	X		
Speed D SW	X		
P LOil Lo	X		
P LOil LoLo	X		
P-Fuel	X		

Displayed text in second line (# = variable values)	DG (X = match)	PLANT & MAINS (X = match)	GROUP (X = match)
T-COOL-HI	X		
TCOOL-HIHI	X		
T-INTERC	X		
T-ECU	X		
Act-Droop	X		
INJECT-QUAN	X		
Speed D SW	X		
P LOil Lo	X		
P LOil LoLo	X		
P-Fuel	X		
P TB Ana105 # kW		X	X
T-COOL-HI	X		
TCOOL-HIHI	X		
T-INTERC	X		
T-ECU	X		
Act-Droop	X		
INJECT-QUAN	X		
Camshaft	X		
T-LUBE-HI	X		
TLUBE-HIHI	X		
F speed an	X		
ECU Stop activated #	X		
Exh.P T01	X		
Exh.P T02	X		
Exh.P T03	X		
Exh.P T04	X		
Exh.P T05	X		
Exh.P T06	X		
Exh.P T07	X		
Exh.P T08	X		
Exh.P T09	X		
Exh.P T10	X		
Exh.P T11	X		
Exh.P T12	X		
Exh.P T13	X		
Exh.P T14	X		

Displayed text in second line (# = variable values)	DG (X = match)	PLANT & MAINS (X = match)	GROUP (X = match)
Exh.P T15	X		
Exh.P T16	X		
P. FilFuel	X		
T. Coolant2	X		
T. Coolant3	X		
T. Cool PO	X		
Aux Coolant temp	X		
Internal temperature "hardware="66	X	X	X
Turb.Int1	X		
Turb.Int2	X		
PID1 # %	X		
PID2 # %	X		
PID3 # %	X		
PID4 # %	X		
Mlogic hour count 1 # h" fromversion="5030	X		
Mlogic hour count 2 # h" fromversion="5030	X		
Mlogic hour count 3 # h" fromversion="5030	X		
Mlogic hour count 4 # h" fromversion="5030	X		

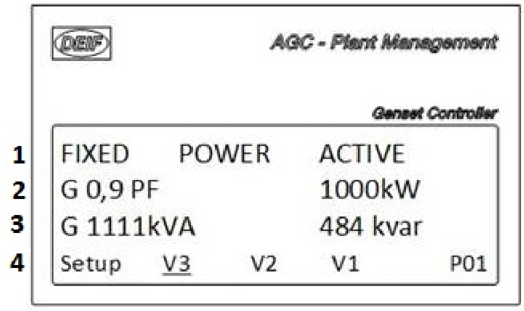
3.3.3 View V3, V2, V1

The view menus (V1, V2 and V3) are the most commonly used menus of the unit.
Various measured values are displayed depending which view V3, V2, V1 is selected.

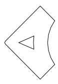
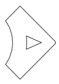


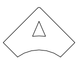
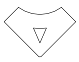
The entry window above displays view V3.

The views V3, V2, V1 are placed in line 4



1. First display line: Operational status or measurements
2. Second display line: Measurements relating to operational status
3. Third display line: Measurements relating to operational status
4. Fourth display line: Selection of setup and view menus

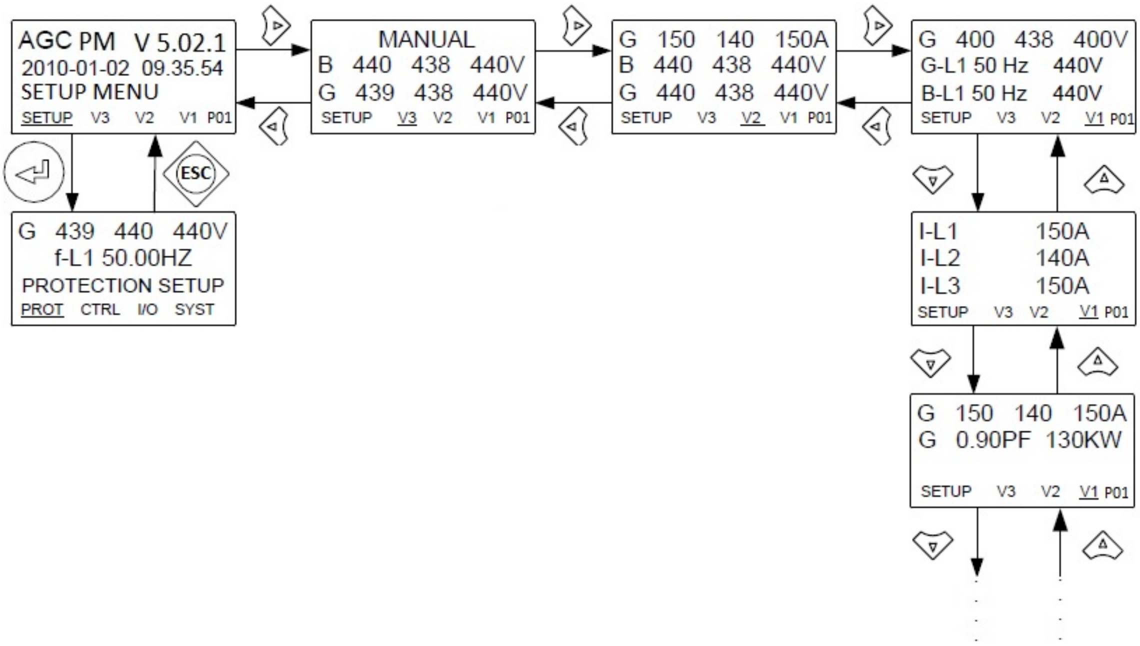
Moving the cursor to the different views V3, V2, V1, is done by using the  and  push-buttons.

After a selected view, using the  or  push-buttons, it is possible to navigate to different windows in the views:

- View V3 – window displays operational status and selectable measurements
- View V2 – window displays selectable measurements. The same as view V1
- View V1 – access to 20 selectable windows displaying selectable measurements

Displaying the measured values according to the selections are made during configuration.

View example:
The following is an example of a configured view menu system.
In this example, three of 20 windows have been configured in view 1.

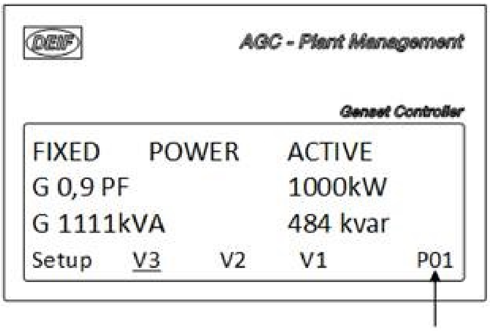


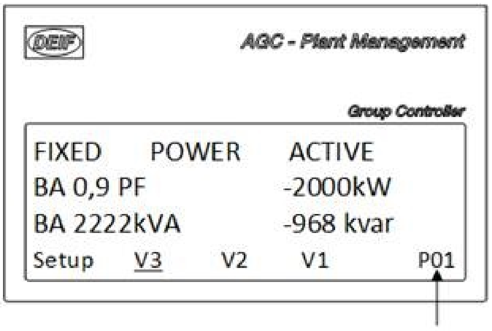
View V3
Display of measured values according to the selections made during configuration.

The V3 display changes with running modes:
First display line indicates running status of the unit. The messages shown in the table at the end of this chapter can be displayed.
Second and third display lines display measured values.
Fourth display line displays the selection line.

3.3.4 Priority

Priority from front screen
From the “entry window” of the genset controller and group controllers, there is information about which priority the genset or group has in the plant. This can be found in the lower right corner of the display, and looks like shown below: Changing the priority can be done using the PC utility software.


DEIF
AGC - Plant Management
Genset Controller
FIXED POWER ACTIVE
G 0,9 PF 1000kW
G 1111kVA 484 kvar
Setup V3 V2 V1 P01


DEIF
AGC - Plant Management
Group Controller
FIXED POWER ACTIVE
BA 0,9 PF -2000kW
BA 2222kVA -968 kvar
Setup V3 V2 V1 P01

3.4 User access

3.4.1 Password adjustment

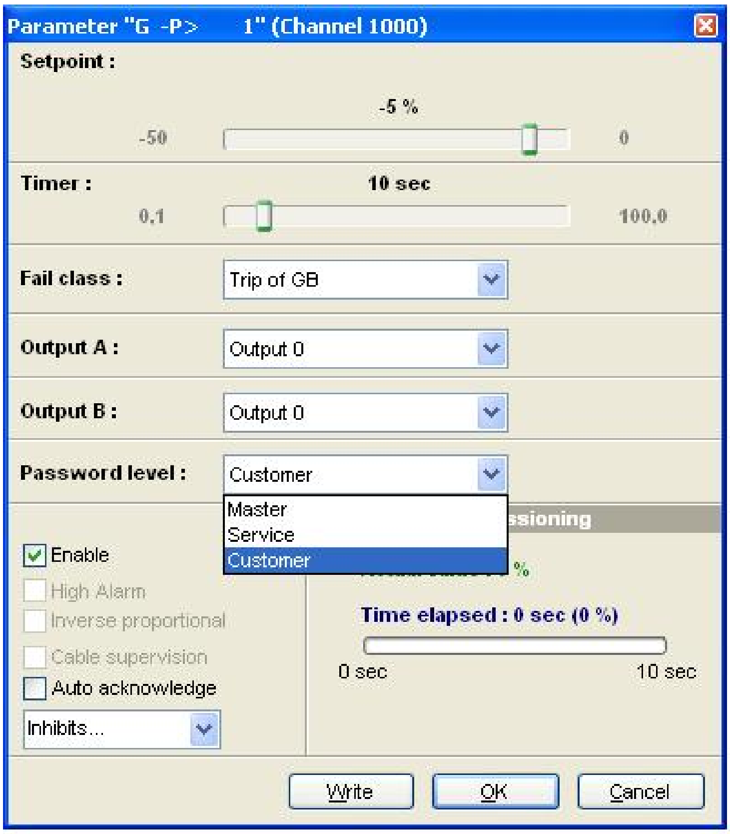
The display unit includes three password levels. All levels can be adjusted using the PC utility software.

Available password levels are:

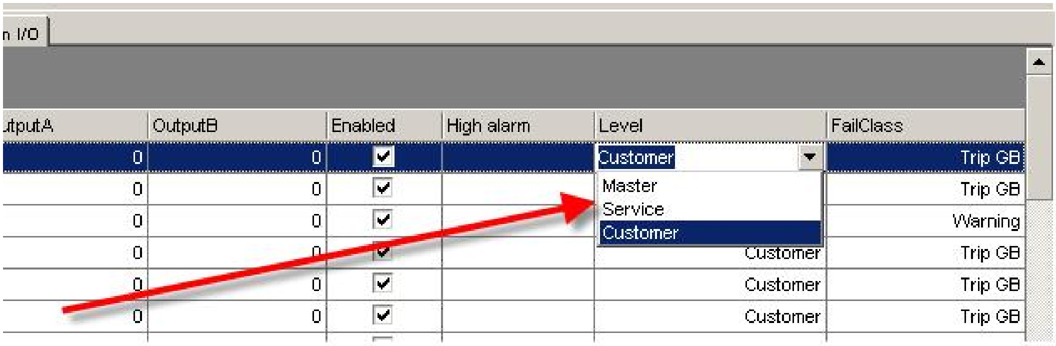
Password level	Factory setting	Access		
		Customer	Service	Master
Customer	2000	X		
Service	2001	X	X	
Master	2002	X	X	X

A parameter cannot be entered with a password that is ranking too low. But the settings can be displayed without password entry.

Each parameter can be protected by a specific password level. To do so, the PC utility software must be used. Enter the parameter to be configured and select the correct password level.



The password level can also be changed from the parameter view in the column "Level".



3.4.2 Change of user level

To gain access to adjust the parameters, the password level must be entered:

If the password level is not entered, it is not possible to enter the parameters.

The customer password can be changed in jump menu 9116. The service password can be changed in jump menu 9117. The master password can be changed in jump menu 9118.

The factory passwords must be changed if the operator of the genset is not allowed to change the parameters.

It is not possible to change the password at a higher level than the password entered.

4. Utility software

4.1 Download, connection and network parameters

4.1.1 Download of utility software v.3.x

The DEIF Utility Software is the software that is used for interfacing between a PC and the AGC PM controller. This Utility Software can be downloaded from DEIF's webpage, and is free of charge. The Utility Software used for the AGC PM Controllers is: Multi-line 2 Utility Software v.3.x.

4.1.2 Connection - USB

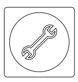
To connect to a unit with USB, a USB cable type USB A to B has to be used. Before connecting to a controller, make sure that the Utility Software is installed. The cable is plugged in the computer aCond to the service port on the controller. When the Utility Software is opened, the communication to the unit has to be activated. This can be done by pressing the connection logo and selecting the service port option:

When connected to a unit and password is typed, it is possible to change all sort of settings in the unit.
The default passwords in the AGC PM are:

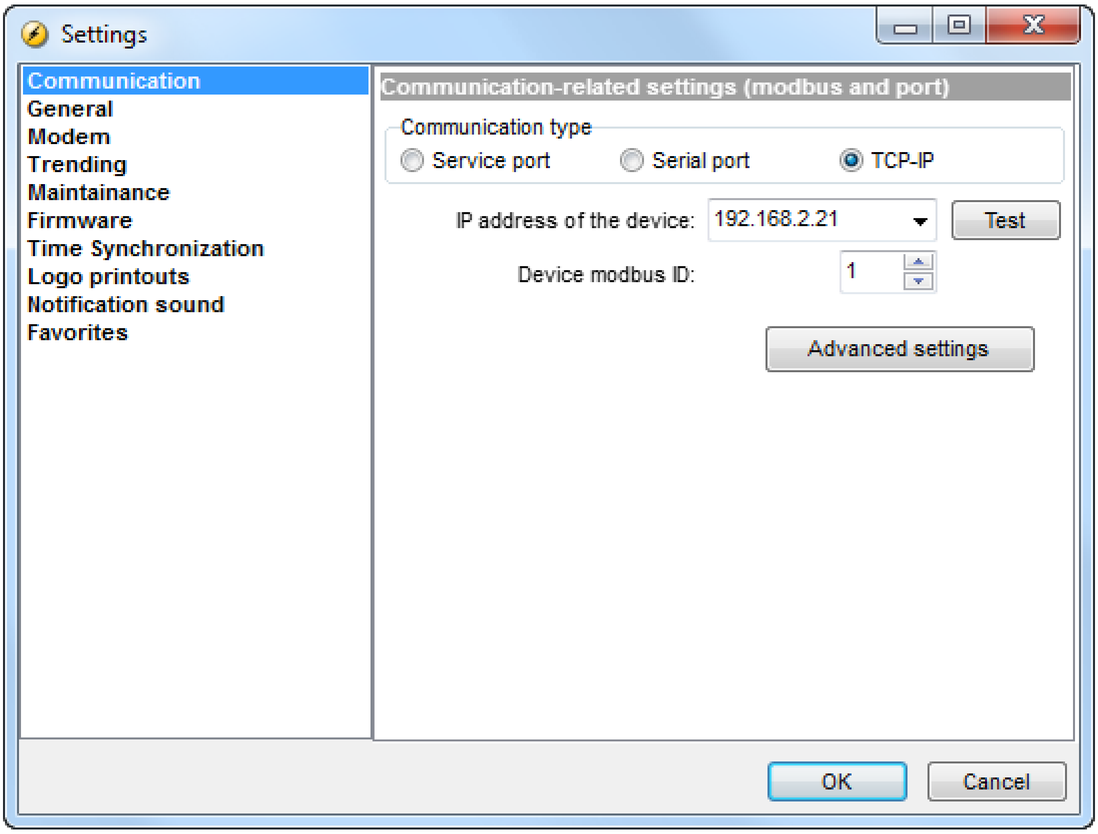
Password level	Factory setting	Access		
		Customer	**Service**	**Master**
Customer	2000	X		
Service	2001	X	X	
Master	2002	X	X	X

4.1.3 Connection TCP/IP and network parameters

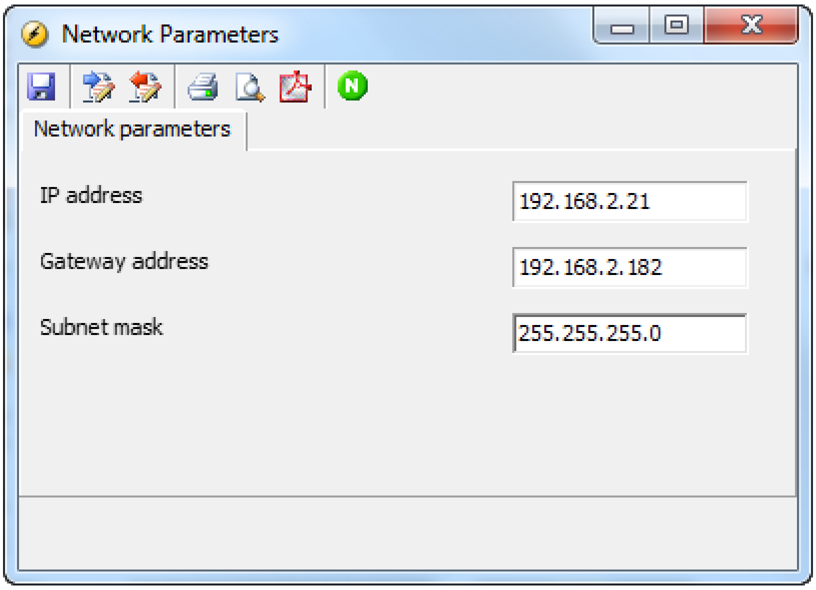
The AGC PM units can also be interfaced with TCP-IP communication. For this, a crossed Ethernet cable is required (Option XX). When trying to connect to a unit with TCP-IP, the IP address of the unit must be known.

The IP address can be found via the display of the unit, by pressing the  button and go to parameter 9003. When trying to connect to a unit, it can be required to have a static IP address on the PC.
The default network address in the units is:
IP: 192.168.2.21
Gateway: 192.168.2.182
Subnet mask: 255.255.255.0
The static IP address on the PC should then be: 192.168.2.___. The last space has to be filled by a free IP-address in the current network. If the IP address is changed from 192.168.2.XXX, to, for example, 192.168.4.XXX, connection will be lost, and a new static IP for the PC has to be made in the area of 192.168.4.___.

All the units can be connected to a switch, but before doing this, it is recommended to change the IP addresses in all the units, so they all have a unique IP address for the network. The IP address can be changed from the display in parameter 7900. Press and write in parameter 7905, and the IP, gateway and subnet will be sent to the unit, even if only one of them has been changed.
The network parameters can also be changed from the Utility Software. If it is the first time, it is recommended to have a point-to-point connection between the PC and the controller. Open the Utility Software and click the Application Setting button in the toolbar in the top of the window: 
A window will pop up, where the IP address trying to connect to has to be entered:



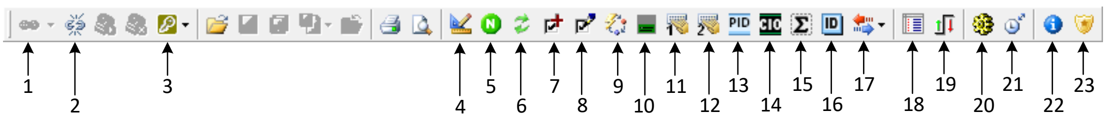
Tick the TCP-IP button at the top to enter the IP address. Then push the test button to check that the connection is successful, and click the OK button.
To make a connection to the unit via TCP-IP it is only required to push the start communication button on the toolbar in the top of the Utility Software: 
Now only the password for the unit has to be entered, and all the parameters can be changed. (Default passwords are shown earlier) To change the network parameters, click the Option-N configuration button: 
A window will now pop up, and the network parameters can be entered:



When the network parameters have been changed, click the Write To Device button in the top of the pop-up window: 
When the Write To Device button has been pressed, the unit will receive the new network parameters and reboot the network hardware in the unit. Be aware when trying to connect to the unit again that the new IP address has to be used, with a fitting static IP address for the PC. When all the units have got separate IP addresses, the units can be connected to a network switch. The PC can then be connected to the switch, and only the IP address that the Utility Software will have to communicate to, has to be changed. The cable can be in the same port of the switch at all times. The TCP-IP connection is faster and gives the possibility to jump between units in the application supervision window in the Utility Software.

4.1.4 Utility software buttons

With the utility software, you can perform different actions concerning the controllers. The most important buttons are described in this chapter. When connected to a controller, the toolbar in the top of the window looks like this:

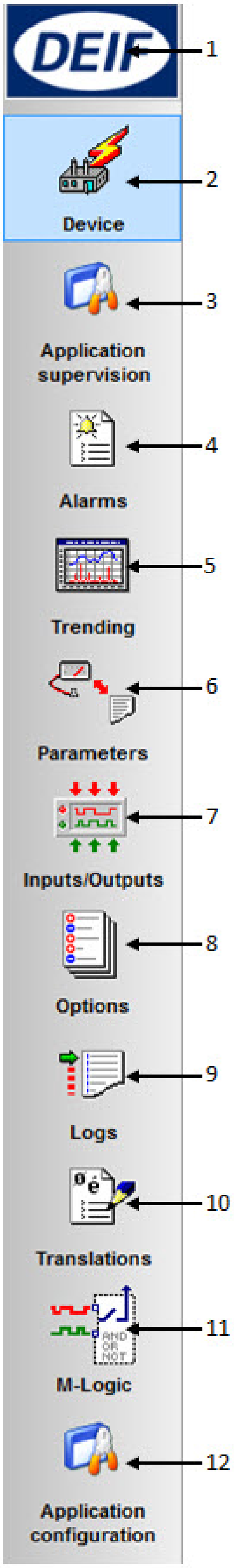


See the list below for explanation of what the buttons/icons and the associated numbers in the picture refer to.

1. Connects to a unit. A drop-down menu provides a list of different connection options.
2. Disconnects from a unit.
3. Grants a higher permission level.
4. Opens a pop-up window, in which you can make some general settings.

5. Enters the network parameters and the Option N configurator. This is to update the image version of the Option N.
6. Enters the Modbus and Profibus configurator. Here you can modify the first 62 addresses of the Profibus protocol and the first 500 addresses of the Modbus protocol. These addresses will have a higher update rate when external equipment is trying to read or write to the unit.
7. Adds options. When you have made a code, send it to support@deif.com.
8. When you receive the upgrade key from DEIF support, enter the code here.
9. Flashes/writes new firmware to the controller.
10. Configures the views in the display of the unit.
11. Configures the AOP-1 buttons and LEDs (Additional Operator Panel).
12. Configures the AOP-2 buttons and LEDs (Additional Operator Panel). You can select all five via an ID selector in the pop-up.
13. Opens the configuration menu for the general purpose PIDs.
14. Opens the configuration menu for the CIO modules.
15. Reads different counters from the controller.
16. Identifier button. Here you can find different information regarding the software in the controller, and the operator can make some identifiers regarding the plant.
17. Batch button. This enables you to make a file that contains all parameter settings and other things. This is typically done before you write new firmware to a controller. When the controller has been updated, you can take the old batch file and write to device. Hereby, all parameters will be as before.
18. Data tracer window. You can use it to check the max./min. of a value, as long as the data tracer window is open. This window can be helpful during the commissioning.
19. Configures the input and output of the controller. For example, you can configure an input for auto start/stop here.
20. Causes a window to pop up, from which you can send some commands to the controller.
21. Synchronises the clock in the controller with the connected PC.
22. Information about the utility software.
23. Permission window.

Some other buttons/icons are located in the left menu bar of the utility software. These are also described by means of numbers:



1: A quick link to www.deif.com
2: Device page. This gives a quick overview of the controller connected to the PC.
3: Application supervision button. Provides an overview of the plant and indicates how much power each genset produces. The emulation stimuli are also made here (from the toolbar in the top, when accessed from this window).
4: Provides an overview of the active alarms and shows the alarm history; however, only the alarms that have been present during the connection time.
5: Trending window. Trending is only done when a PC is connected and in the trending window. The controller cannot save trending.
6: You can access all parameters from here. The parameters are divided into sections/themes.
7: Shows which inputs and outputs that are high and low. It is shown in real time.
8: Shows which options that are available and not available. Green means present and red means not present.
9: You can read all the logs from the controller here and export them to an Excel file. The controller logs alarms and events. An event is, for example, pushing a button or opening breakers.
10: Translation window. From here, you can change almost every bit of text in the controller. The translation window can also be helpful if the meaning of a translation has been forgotten, as it shows what the default text was.
11: M-Logic icon. See description of M-Logic in a separate chapter.
12: Application configuration window. From here, you can make the application drawing so the controllers know which type of application they are based on. You can start and stop the emulation here. See a more detailed description of the application configuration in the next chapter.

4.2 Setup of applications

4.2.1 Determination of application type

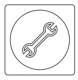
Before choosing which type of application configuration is about to be made, it is important that the number of controllers has been identified, and how the configuration should be made. Below is given a short guide on how to choose which type of application fits, for the present project. Afterwards, it is described how each type is set up in the AGC PM.

Stand-alone applications:
When setting up a stand-alone application, the AGC PM will not be able to communicate with other controllers. It will be possible to analogue load-share with other controllers. The analogue load sharing will be described later. An AGC PM in a stand-alone application can operate one Genset, one Generator Breaker and one Mains Breaker. If one controller has to operate a GB and MB, it is important that there are no other gensets or power sources, since this can give a big risk of faulty synchronisation!

2-level power management applications:
When configuring a 2-level plant, the controllers that are used here is the type of Mains and Genset. In 2-level applications, the AGC PM can be in applications with up to 32 controllers. The 32 controllers can be freely configured to either Genset or Mains.

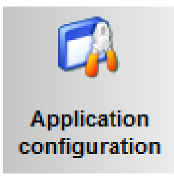
3-level power management applications:
Used when there are more than 32 controllers present in an application. In these 3 level applications, three different types of controllers are used - Genset, Group and Plant. When a 3-level application is about to be made, the gensets will have to be divided into groups of up to 31 gensets. To control each genset group, the group controller is used.

4.2.2 Setup of a stand-alone application

The AGC PM is capable being in an application where it is a stand-alone genset. In stand-alone applications, the AGC PM can handle up to: One genset, one Generator Breaker (GB) and one Mains Breaker (MB). Before an AGC PM can be configured to a stand-alone application, it is required to press the  button, and go to menu number 9100 and check that the controller is set for genset unit.

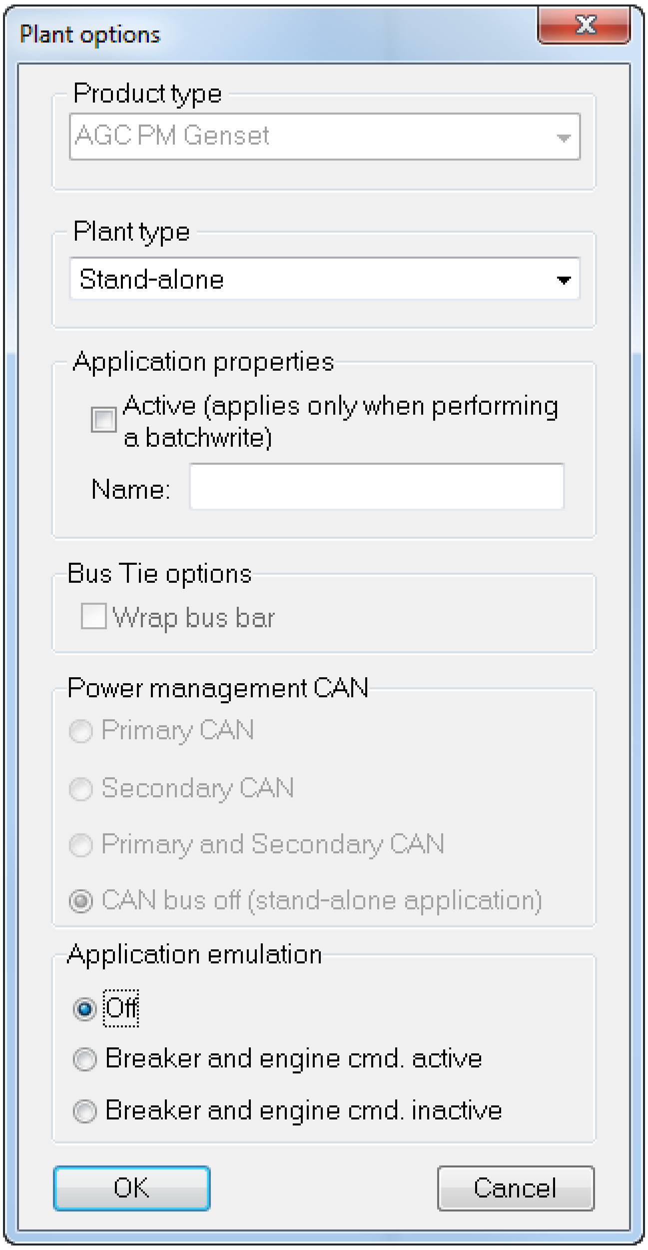
When this setting is changed, the device returns to factory/default settings! Therefore this must be changed prior to other adjustments.

When connected to a controller with the Utility Software, it is required to press the Application configuration tab in the lower left corner. The tab looks like this:



An empty window will appear. To make an application design for the controller, press the New plant configuration button shown below:

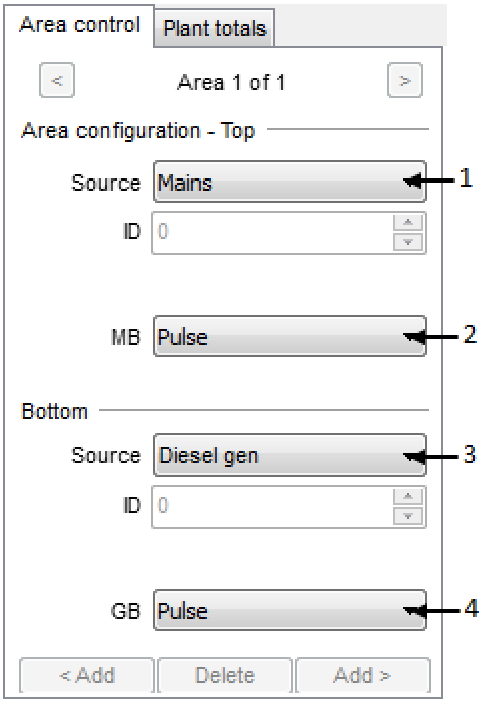
The Plant options window will appear:



The plant options are described below:

	Description	Comments
Product type	Controller type is selected here.	When connected to a controller, this function is greyed out.
Plant type	• Stand-alone • Power Management: Standard • Power Management: Genset group… • Power Management: Genset group…	If the genset is to be set in a place where this is only one controller, the stand-alone should be selected.
Application properties	Here it is possible to activate the application when it is written to the controller. It is also possible to give the application a name.	Giving the application a name can be helpful if the controller is in a plant where the controller will switch between application designs. The controllers are capable of switching between 4 different application designs. Controllers connected to each other via the CAN bus communication cannot have activated different application designs or numbers.
Application emulation	Selections are: • Off • Breaker and engine cmd. active • Breaker and engine cmd. inactive	From here the emulation is started, if the units have option I1. When breaker and engine cmd. active is set, the units will activate the relays (e.g. engine crank), and try to communicate with all other communication equipment. If the units are mounted in a real installation, the breakers will open and close. This will not happen if the breaker and engine cmd. inactive is chosen. In real installations, the emulation can be used during the commissioning. But when the commissioning is done, the emulation will have to be set off.

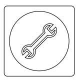
When the choices in the plant options have been made, it is now possible to make the application drawing in the unit.
In the application design, the type of breakers and so on is made. This is done from the left side of the Utility Software.



Number	Description
1	Selects which type of power source should be represented in the top area. Only Mains or Genset can be selected.
2	Because Mains has been selected in the source (no. 1), it is possible to choose which type of breaker is used for Mains Breaker. Choose between Pulse, Continuous ND, Continuous NE, Compact or none.
3	Selects which type of power source should be represented in the bottom area. Only Mains or Diesel genset can be selected.
4	Because Diesel genset has been selected in the power source (no. 3), it is possible to choose which type of breaker is used for Generator Breaker. Choose between Pulse, Continuous NE or Compact.

When the application drawing/design has been made, the configuration will have to be sent to the unit that is connected to the PC. Press the “write plant configuration to device” button, which looks like this: 

4.2.3 Setup of a 2-level application (plant is maximum 32 units)

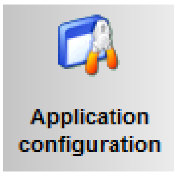
The Power Management system is set up from the display of the units and from the utility software. First, you must go to each unit. Then press the  button and go to menu number 9100. Check that each unit is either a genset or a mains unit, and that it is the correct type of unit in each location.

When you change this setting, the device returns to factory/default settings! Therefore, you must change this before you make other adjustments.

For the application to operate correctly, the serial communication between the controllers must be wired correctly. The communication between the units is CAN bus, and it must follow the standards for CAN bus communication in order to work correctly. See the Installations instructions for description of how to wire the CAN bus between the units.
Before you configure the Power Management communication, it is necessary to identify which of the terminals the communication lines go to. The CAN lines will normally run from CAN port A to CAN port A, or from CAN port B to CAN port B. It is also possible to have the Power Management CAN lines redundant. If the CAN lines are redundant, it is important that the CAN bus lines are wired as two separate buses, and that one bus is always wired to CAN port A and the other bus is wired to CAN port B all the time.
By default, the controllers will use the Power Management communication protocol called Primary CAN on CAN port A, and they will use the Secondary CAN on CAN port B.

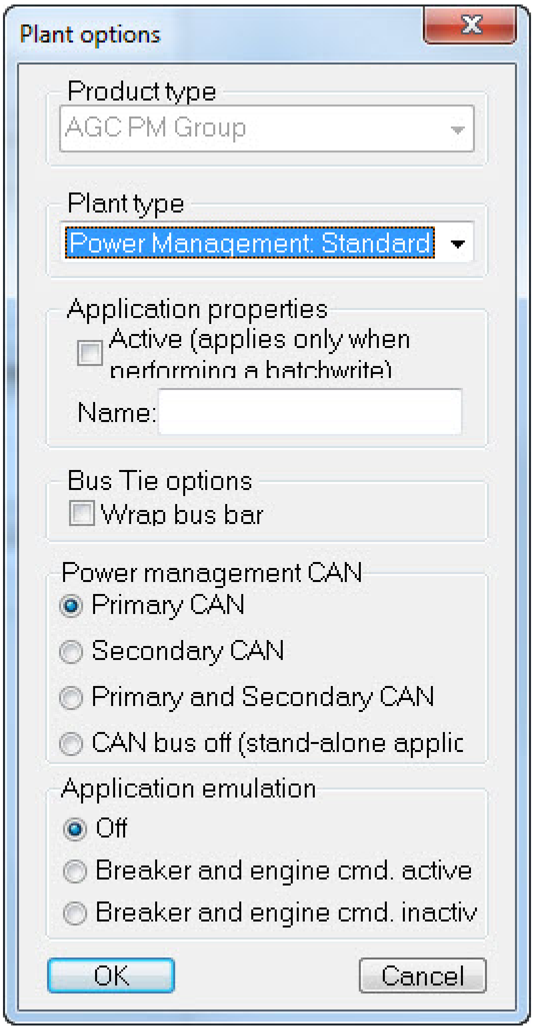
There is no difference in functionality between the Primary CAN and the Secondary CAN protocol.

Before you configure the Power Management communication, the internal IDs must be configured. All the controllers need a unique ID number. This internal CAN ID is set in parameter 7531. Afterwards, it is required to have some knowledge of the plant layout.
When you have found out which CAN ports that is used for Power Management communication, and the internal CAN IDs are set, you must use the utility software to configure the plant layout.
When connected to a controller with the utility software, press the Application configuration tab in the lower left corner:

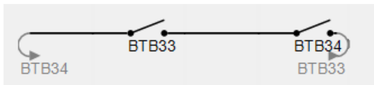


An empty window appears. To make an application design for the controller, press the New plant configuration button shown below:

The Plant options window appears:

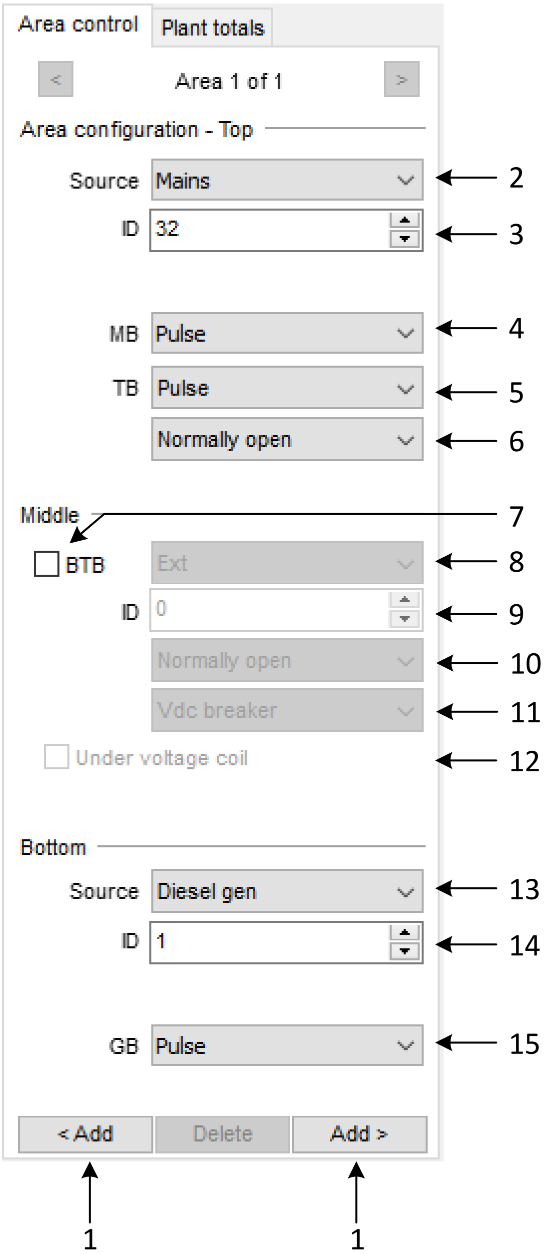


Description of the plant options:

	Description	Comments
Product type	Select controller type here.	When connected to a controller, this function is greyed out.
Plant type	● Stand-alone ● Power Management: Standard ● Power Management: Genset group… ● Power Management: Genset group…	In a 2-level application, the Power Management: Standard must always be selected.
Application properties	Activate the application here, when it is written to the controller. You can also give the application a name.	If the controller is in a plant where the controller will switch between application designs, it can be helpful to give the application a name. The controllers can switch between four different application designs. Controllers connected to each other via the CAN bus communication cannot have different application designs or numbers activated.
Bus tie options	You can select the wrap busbar option here.	Activate this option if the busbar is connected like a ring connection in the plant. When the wrap busbar option is set, it is shown like this in the application: 
Power management CAN	Selections are: ● Primary CAN ● Secondary CAN ● Primary and Secondary CAN ● CAN bus off	When you choose the setting here, be aware that Primary CAN must be used if the Power Management CAN bus is wired to CAN port A on each controller. Secondary CAN is used when the wiring is to CAN port B. Only use the Primary and Secondary CAN if both lines are wired. Otherwise, the controllers will have some CAN faults that cannot be cleared. The CAN bus off option must only be used in configurations where the controller is the only one in the system.

	Description	Comments
Application emulation	Selections are: ● Off ● Breaker and engine cmd. active ● Breaker and engine cmd. inactive	You can start the emulation from here if the units have option I1. When Breaker and engine cmd. active is set, the units will activate the relays and try to communicate with all other communication equipment. If the units are mounted in a real installation, the breakers will open and close. This will not happen if Breaker and engine cmd. inactive is chosen. In real installations, the emulation can be used during the commissioning. But when the commissioning is done, the emulation must be disabled.

When the plant options have been chosen, you can make the application drawing in the units.
Now you can add controllers to the design, choose which type of interfacing that is done to the breakers, and so on. This is done from the left side of the utility software.



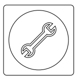
1. Add and delete areas. Adding areas will make the application design/plant bigger.
2. Select which type of power source that is to be represented in the top of the area. You can only select Mains or Diesel genset.
3. Set the internal command ID. This ID must correspond to the ID that is set in the controller.

4. Because Mains has been selected in Source (no. 2), you can choose which type of breaker that is used for Mains Breaker. Choose between Pulse, External controlled/ATS no control, Continuous ND, Continuous NE, Compact or none.
5. Because Mains has been selected in Source (no. 2), you can choose which type of breaker that is used for Tie Breaker. Choose between Pulse, Continuous NE, Compact or none.
6. Choose whether the Tie Breaker must be normally open or normally closed.
7. You can add BTB controllers from this point.
8. The type of breaker that is used for BTB operation. You can only choose External controlled.
9. Set the ID for the specific BTB controller here.
10. Decide whether the BTB must be normally open or normally closed.
11. If the V DC breaker is selected, the breaker can open and close when there is no voltage on the busbar. If the V AC breaker is selected, voltage must be present on the busbar before the breaker can be handled.
12. If the BTB has an under-voltage coil, it must be set here.
13. Choose what type of power source that is to be represented in the bottom of the area. You can only choose Mains or Diesel genset.
14. Set the internal command ID. This ID must correspond to the ID that is set in the controller.
15. Because Diesel genset has been selected in power source (no. 13), you can choose which type of breaker that is used for Generator Breaker. Choose between Pulse, Continuous NE or Compact.

When you have made the application drawing/design, the configuration must be sent to the unit that is connected to the PC. Press the “Write plant configuration to device” button: .
When the operator has pushed the button, only one controller knows the actual application configuration. This configuration can be sent from the particular controller to all the other controllers. Press the “Broadcast” button at the top of the utility software: 
When the operator has activated the broadcast function, it can also be used to check the CAN lines. The unit that is broadcasting will show a message in the display, which indicates that it is broadcasting. All controllers that receive the application design will show a message, which indicates that they are receiving an application. If some of the controllers cannot receive the application, there is most likely a problem with the CAN lines for the controller.
If some controllers have been put on after start of the broadcast function, the controllers will have an alarm indicating: Application Hazard. This means that there is a mismatch between the application configurations between the units. You can solve this by pressing the Broadcast button again.
See the relevant parameter for setup of the plant in the table below:

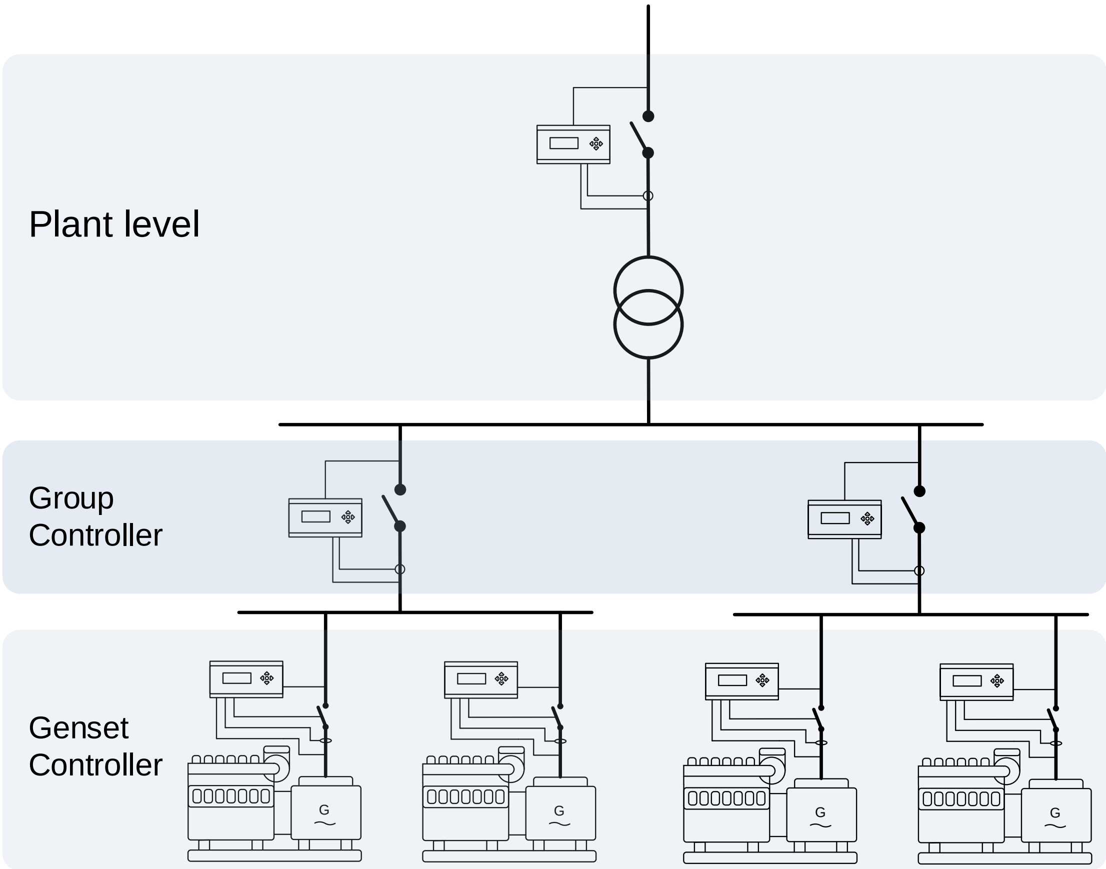
Parameter	Item	Range	Default	Note
7531	Internal communication ID	1 32	Controller-dependent	

4.2.4 Setup of a 3-level application

The Power Management system is set up from the display of the units and from the utility software. First, it is required to go to each unit and press the  button, then go to menu number 9100 and check that each unit is either a genset or a plant unit, and that it is the correct type of unit in each location.

When this setting is changed, the device returns to factory/default settings! Therefore this must be changed prior to other adjustments.

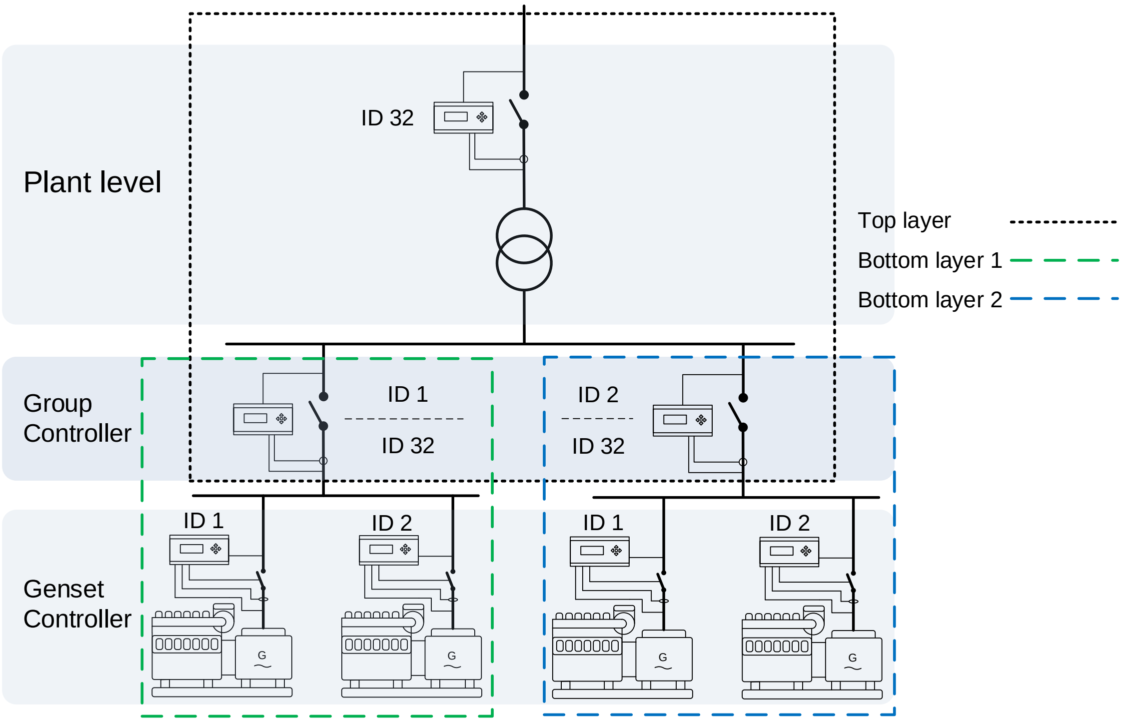
For the application to operate correctly, the serial communication between the units will have to be wired correctly. The communication between the units is CAN bus, and it must follow the standards for CAN bus communication for working correctly.
In this chapter, a setup that looks like below will be configured:



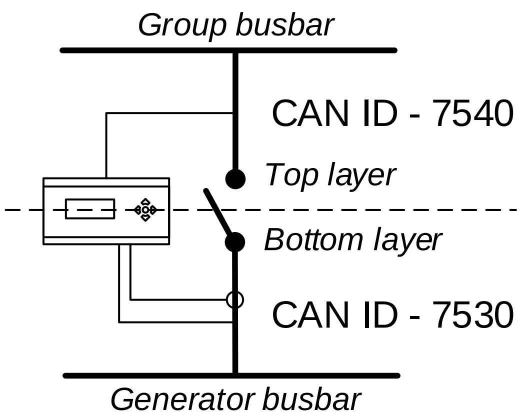
The configuration of this plant will have to be done in 3 steps.

1. Configuration of the top layer, which consists of the plant controller and the group controller.
2. Configuration of genset group 1 and corresponding gensets. (Bottom layer 1)
3. Configuration of genset group 2 and corresponding gensets. (Bottom layer 2)

An overview of the application configurations is shown below:

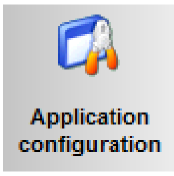


From the drawing above, it can be seen that top layer, in this application, will consist of a plant controller and two group controllers. The ID for the plant is set in parameter 7530, and has to be unique for each plant controller. The group controllers used in 3 level applications can be considered as a “dual personality”. The IDs set in the group controllers are shown in the drawing below:



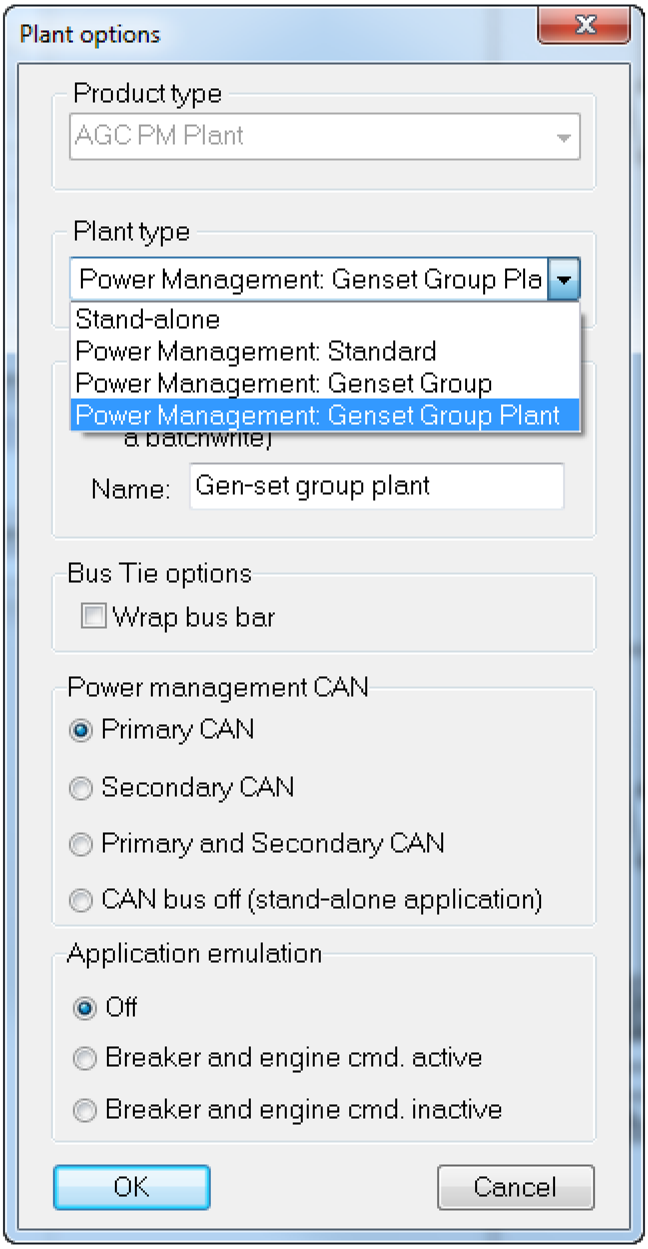
As from the drawing above, it can be seen that the group controller is holding two different CAN IDs. By this, the group controller will then have two application configurations active at one time. Before configuring the plant, the CAN IDs should be set in each controller. The drawing made earlier gave an example on how the IDs could be set.
The 3 steps of the configuration of the plant are described below.

Step1: Configuration of the top layer
Connect to a plant controller with the Utility Software. Press the Application configuration tab in the lower left corner:



An empty window will appear. Start by reading the plant configurations from the plant controllers, which is done from the top bar of the Utility Software. A pop-up window will appear that asks which of the applications the operator wants to be read. Make sure that this is all of them. Afterwards press on application no. 4, in the top. Then press the New plant configuration button which looks like this:

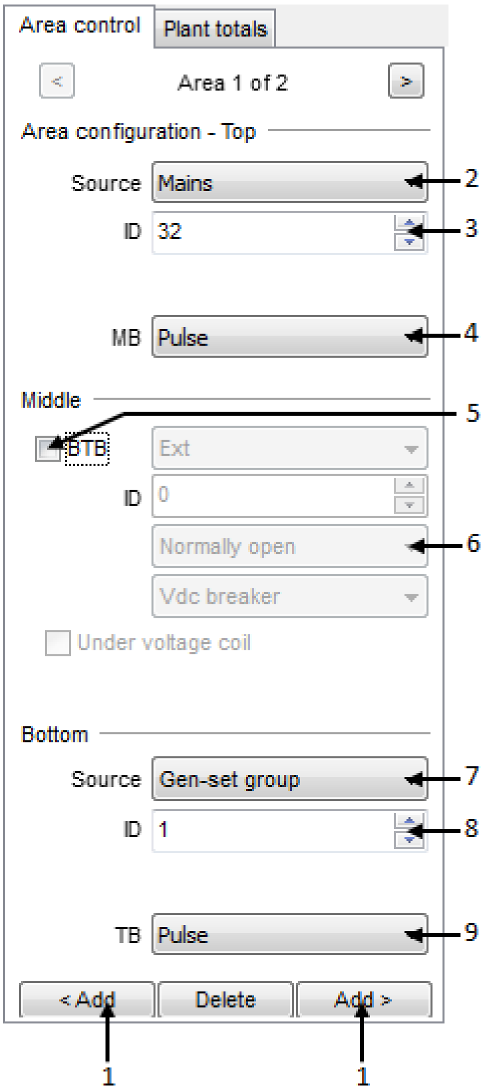
The plant options window shown below will appear:



In plant type, it is important that Power Management: Genset Group Plant is selected. Wrap bus bar is not possible to use in the genset group application. The Primary CAN for Power Management will have to be selected here also. In the bottom, it is selected if the controllers should be using emulation.

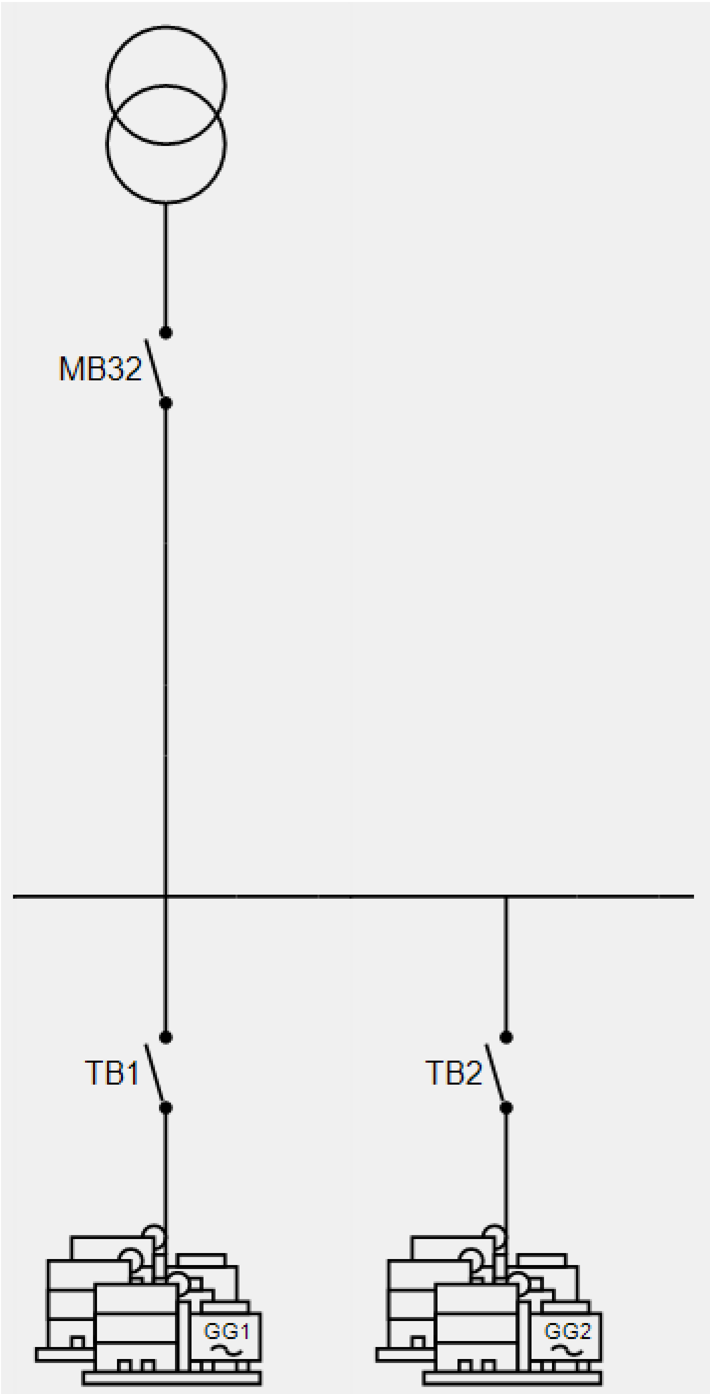
When the selections have been made, the OK button can be pressed.

In the left side, it will look like this:


Area control
Plant totals
<
Area 1 of 2
>
Area configuration - Top
Source
Mains
ID
32
MB
Pulse
Middle
BTB
Ext
ID
0
Normally open
Vdc breaker
Under voltage coil
Bottom
Source
Gen-set group
ID
1
TB
Pulse
< Add
Delete
Add >
1
1
2
3
4
5
6
7
8
9

Number	Description
1	Add and delete areas. Adding areas will make the application design/plant bigger.
2	Select which type of power source should be represented in the top of the area. Only Mains or Genset Group can be selected.
3	Set the internal command ID. This ID should correspond to the ID set in the controller.
4	Because Mains has been selected in the source (no. 2), it is possible to choose which type of breaker is used for Mains Breaker. Choose between Pulse, External controlled/ATS no control, Continuous ND, Continuous NE, Compact or none.
5	Because Mains has been selected in the source (no. 2), it is possible to choose which type of breaker is used for Tie Breaker. Choose between Pulse, Continuous NE, Compact or none.
6	Sets if the BTB is normally closed on normally open.
7	Here it is chosen what type of power source should be represented in the bottom of the area. Only Mains or Genset Group can be chosen.
8	Here the internal command ID is set. This ID should correspond to the ID set in the controller.
9	Because Genset Group has been selected in the power source (no. 7), it is possible to choose which type of breaker is used for Genset Group tie breaker. Choose between Pulse, Continuous NE, Compact or none.

The top layer example in this example will look like this:



Afterwards, the configuration for the plant will need to be sent to the units. This can be done by first pressing the write plant configuration to device button, which looks like this: 

When the button has been pushed, only one controller knows the actual application configuration. This can be sent from the unit that the PC is connected to, into all other controllers. Press the broadcast button in the top of the Utility Software: 

When the broadcast function has been activated, it can also be used to check the CAN lines. The broadcasting unit will show a message in the display telling it is broadcasting. All controllers that are receiving the application design, will show a message that it is receiving an application. If some of the controllers are not receiving the application, there will most likely be a problem with the CAN lines for the controller.

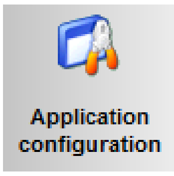
If some controllers have been put on after the broadcast function has started, the controllers will have an alarm saying: Application Hazard. This means that there is a mismatch between the application configurations between the units. This can be solved by pressing the Broadcast button again.

The relevant parameter for setting up the plant is shown in the table below:

Parameter	Item	Range	Default	Note
7531	Internal communication ID	1 32	Controller-dependent	For the mains unit
7541	Internal communication ID for genset group	1 32	1	For the group unit

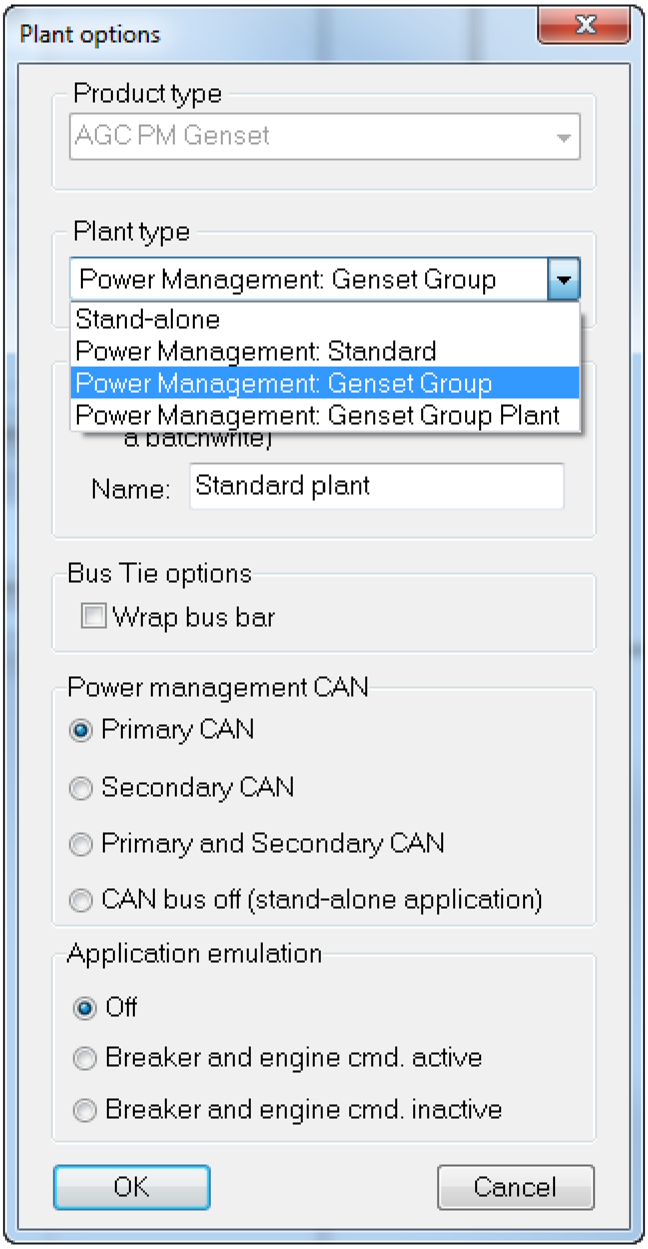
Step 2 and 3: Configuration of a bottom layer

Connect to a genset controller with the Utility Software. Press the Application configuration tab in the lower left corner:

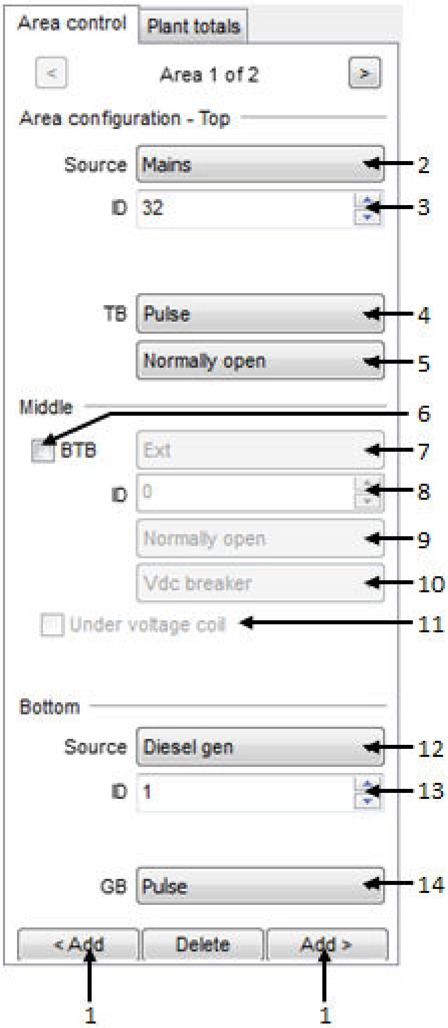


An empty window will appear. Start by reading the plant configurations from the genset controllers, which is done from the top bar of the Utility Software. A pop-up window will appear that ask which of the applications the operator wants to be read. Make sure that it is all of them. Afterwards, press application no.1, 2 or 3 in the top. The bottom layer configuration can only be configured in application 1-3. Then press the New plant configuration button which looks like this:

The plant options window will appear:

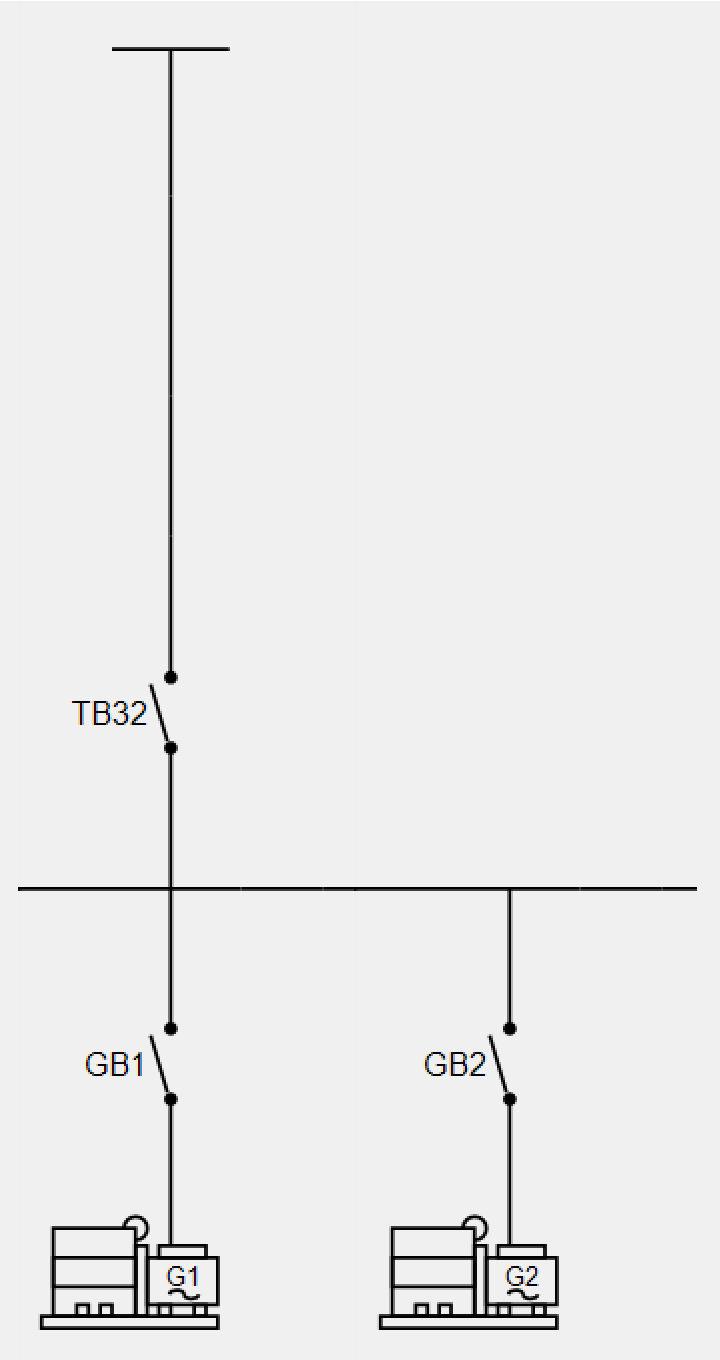


Select Power Management: Genset Group in Plant type. Furthermore, it is required to choose whether there is a wrap bus bar available or not. The Primary CAN for Power Management will have to be selected here also. In the bottom, select if the controllers should be using emulation.
When the selections have been made, press the OK button.
In the left side, it will look like this:


Area control
Plant totals
Area 1 of 2
Area configuration - Top
Source
Mains
2
ID
32
3
TB
Pulse
4
Normally open
5
Middle
6
BTB
Ext
7
ID
0
8
Normally open
9
Vdc breaker
10
Under voltage coil
11
Bottom
Source
Diesel gen
12
ID
1
13
GB
Pulse
14
< Add
Delete
Add >
1
1

Number	Description
1	Add and delete areas. Adding areas will make the application design/plant bigger.
2	Select which type of power source should be represented in the top of the area. Only Mains or Diesel genset can be selected. In this situation, a mains is the same as a group controller.
3	Set the internal command ID. This ID should correspond to the ID set in the controller.
4	Because Mains has been selected in the source (no. 2), it is possible to choose which type of breaker is used for group tie breaker. Choose between Pulse, External controlled/ATS no control, Continuous ND, Continuous NE, Compact or none.
5	Here it is chosen whether the Tie Breaker should be normally open or normally closed.
6	Sets whether there is a Bus Tie Breaker on the application or not.
7	The type of breaker that is used for BTB operation. Choose between Pulse, Continuous NE, Compact or External controlled.
8	The ID for the specific BTB controller is set here.
9	Decides if the BTB should be normally open or normally closed.
10	If V DC breaker is selected, the breaker can open and close when there is no voltage on the busbar. If V AC breaker is selected, voltage must be present on the busbar before the breaker can be handled.
11	If the BTB has an undervoltage coil, it should be set here.
12	Here it is chosen what type of power source should be represented in the bottom of the area. Only Mains or Diesel genset can be chosen. Mains is the same as a Group Controller.
13	Here the internal command ID is set. This ID should correspond to the ID set in the controller.
14	Because Diesel genset has been selected in the power source (Point 12), it is possible to choose which type of breaker is used for Generator Breaker. Choose between Pulse, Continuous NE or Compact.

The bottom layer in this example will look like this:



Afterwards, the configuration for the plant will need to be sent to the units. This can be done by first pressing the write plant configuration to device button, which looks like this:
When the button has been pushed, only one controller knows the actual application configuration. This can be sent from the unit that is connected to the PC, into all other controllers. Press the broadcast button in the top of the Utility Software:

When the broadcast function has been activated, it can also be used to check the CAN lines. The broadcasting unit will show a message in the display telling it is broadcasting. All controllers that are receiving the application design will show a message that it is receiving an application. If some of the controllers are not receiving the application, there will most likely be a problem with the CAN lines for the controller.
If some controllers have been put on after the broadcast function has started, the controllers will have an alarm saying: Application Hazard. This means that there is a mismatch between the application configurations between the units. This can be solved by pressing the Broadcast button again.
The relevant parameter for setting up the plant is shown in the table below:

Parameter	Item	Range	Default	Note
7531	Internal communication ID	1 32	Controller- dependent	In all units

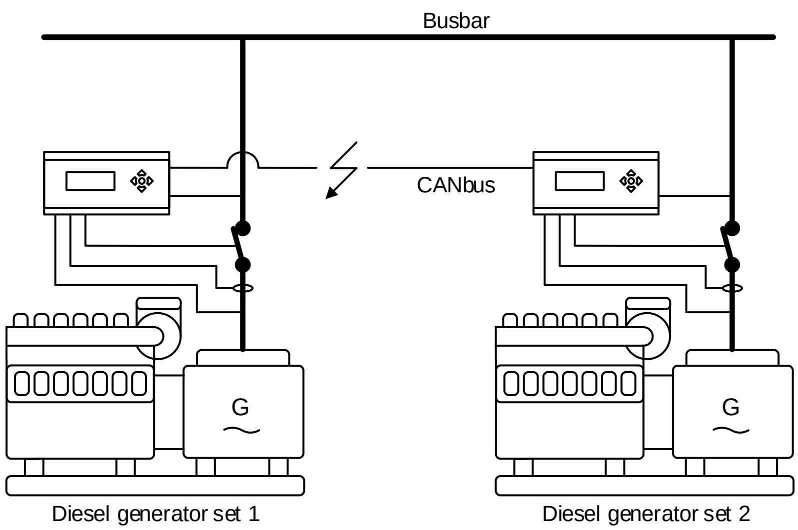
5. Power management

5.1 CAN bus failure handling

5.1.1 CAN failure mode

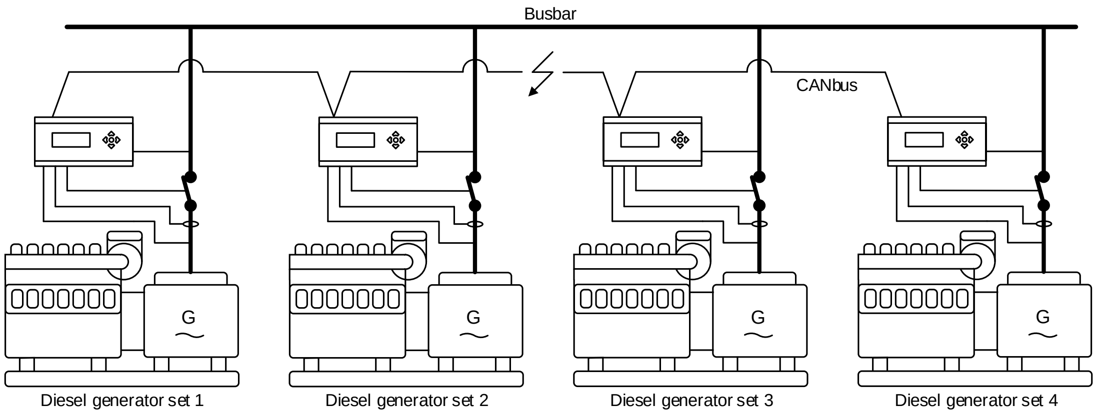
The system behaviour can be set up in different ways to handle a CAN failure on the CAN controlling the power management. In menu 7532, it is decided how the power management system will react in case of a CAN failure. The mode set in parameter 7532 decides what mode the AGC PM should change to, when it is “missing all units”, or missing more than one controller on the CAN bus line (“Fatal CAN error”). The setting in parameter 7532 is shared between genset units internally in a group, or the ones inside a section. There are three selectable modes the controllers can change to in case of a CAN bus failure:

Manual:
If ”Manual” is selected in all the AGC PM unit(s), the controller that has the “missing all units” or ”fatal CAN error” alarm will change mode to manual mode. In this way, the regulators will have no reaction, and it will not be possible to close any breakers (unless the breakers are already within the limits for the sync. window or black busbar). Manual mode is not selectable in Plant, Group or Mains units. When the wire break on the CAN lines occurs, the regulators will stop immediately, and no further action will take place. Protections are still active, so if for example a short circuit or an overload occurs, the AGC PM is still able to make a shut-down or a trip of a breaker. Manual mode can also be described with an example:



If the wire break occurs before the engine is started, the power management system will not start the controller that has changed from AUTO to MANUAL. If more than one genset is present in an application and manual is selected, the faulty one will not be able to load-share with the other(s). Only the protections are active. If more than two gensets are present, the others will be able to load-share with each other. Only the faulty one will not be able to load-share, because it has switched into manual mode.
Be aware that when a CAN bus failure is present, the risk of blackout is also present, since load sharing does not take place in manual mode, and by this overload a generator forcing it into a trip of the breaker. If the AGCs is switched into MANUAL, it is necessary to adjust the droop on the governor.

Semi-auto:
If “SEMI-AUTO” is selected, the AGC PM units will change to semi-auto mode when the “missing all units” or “more than one controller”-is-missing alarms occur.
In semi-auto mode, the regulators in the AGC PM units are still active. This means that the gensets that are visible to each other are able to load-share. This is explained by an example:

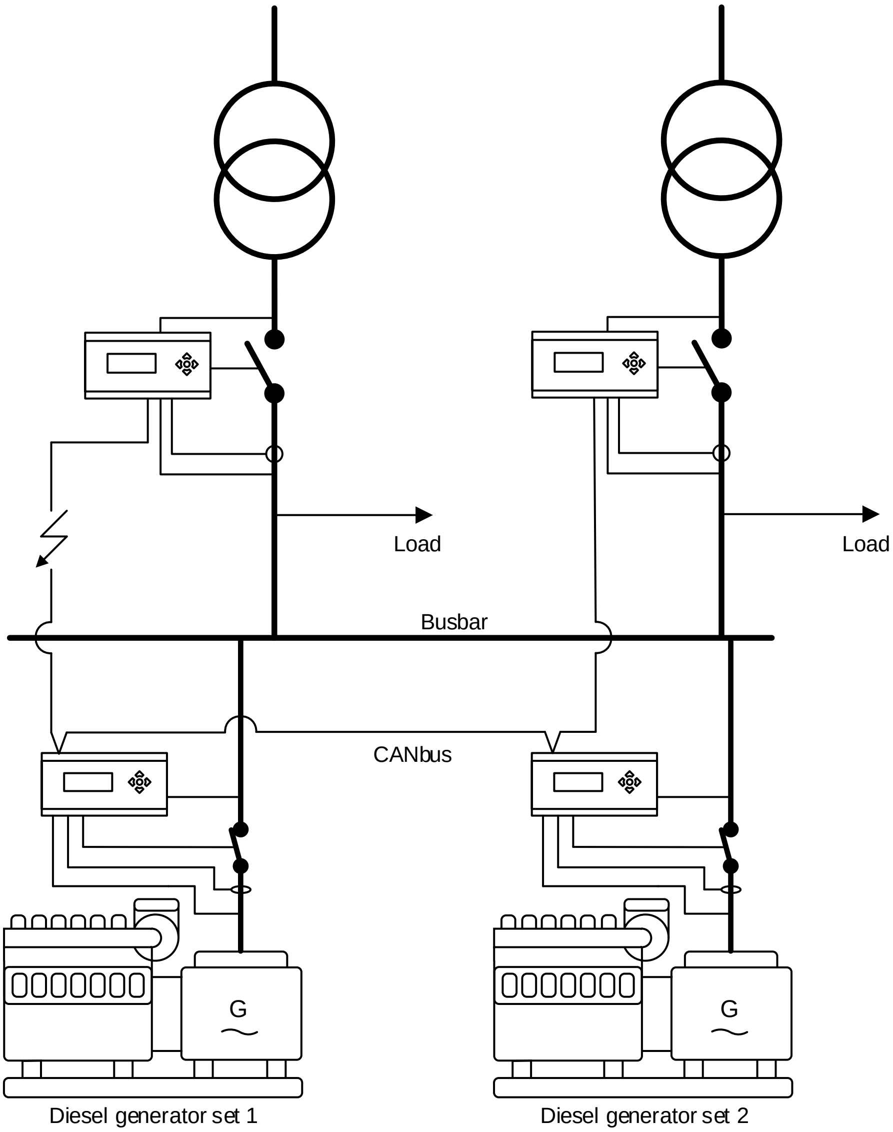


In the diagram above, the CAN bus failure is present between genset 2 and genset 3. This means that gensets 1 and 2 are visible to each other. Gensets 3 and 4 are also visible to each other. Gensets 1 and 2 are able to load-share with each other, and gensets 3 and 4 are able to load-share with each other. But there is still a risk of blackout, since it is still possible to overload two of the gensets, while the other two are not noticeably loaded.
If a CAN bus failure occurs when the gensets are stopped, they will not be blocked, and in this way it will be possible to start them from the display or via commands.

If a CAN bus failure is present in this situation, it is possible to start two gensets and close the breaker onto the busbar at the same time! (Not synchronised)

In the application above, none of the gensets will be in AUTO after the wire break occurs. The power management system will not be able to start any of the gensets. But it will be possible to start the gensets from the display. The load sharing can continue, if the AGC PM is wired up to/programmed for analogue load sharing in case of CAN bus failure. Alternatively, switch over to droop mode (this will have to be programmed).

No mode change:
If “No mode change” is selected, all the AGC PM units will be kept in the mode they were in before the CAN bus failure occurred. In an application with several mains, BTBs and several gensets, if one genset is not visible anymore, the rest of the system can still behave almost like normal and in auto mode. But if the CAN bus failure occurs in a system like the one shown below, it might be a problem.



The application above is made for automatic mains failure operation. In this application, the present CAN bus failure will be a problem, since the gensets will receive a start signal from a mains controller when the mains fails. The mains controller in the left side will not see any gensets, when there is a mains failure, so it will keep its breaker closed. If the mains on the right side also has a mains failure, it will open the mains breaker, and start the gensets. When one of the gensets closes its breaker, the genset can be parallel to a grid failure, since the mains in the left side will not open the breaker. Here, it is instead recommended to use a CAN bus fail class, which is set on parameter 7533 to 7536. If one of the fail classes in the isolated unit has been set for Trip MB, the rest of the system will be able to continue in AUTO.

Note for 3-level applications:

If a CAN bus failure occurs in a 3-level application, the mode change will not be executed across the entire plant. If for example, a CAN bus failure happens in a genset group, only the gensets in the actual group will change the mode. It will also include the group controller. The rest of the plant will not be interfered with a mode change. If the CAN bus failure occurs in the top layer instead, the plant and group controllers will change mode.

5.1.2 CAN bus fail classes

The AGC PM controllers have different CAN bus alarms, which are triggered in different situations.

For 2-level applications, the following fail classes can be executed:

- Missing all units:

Appears only when a controller cannot “see” any other units on the CAN bus line. The fail class selected in parameter 7533 will be executed.

- Fatal CAN error:

Appears when two or more units are not visible, but one or some units are still visible. The fail class selected in parameter 7534 will be executed.

- Any DG missing:

Appears when at least one genset controller is missing. The fail class selected in parameter 7535 will be executed.

- Any mains missing:

Appears when at least one mains controller is missing. The fail class selected in parameter 7536 will be executed.

For 3-level applications, it is easy to look at it as two different layers. The bottom layer will be explained first. In the bottom layer (internally of the genset groups), the fail classes that can possibly be executed are:

- Missing all units:

Appears only when a controller cannot “see” any other units on the CAN bus line. The fail class set in parameter 7533 will be executed.

- Fatal CAN error:

Appears when two or more units are not visible, but one or some units are still visible. The fail class selected in parameter 7534 will be executed.

- Any DG missing:

Appears when at least one genset controller is missing. The fail class selected in parameter 7535 will be executed.

- Any Group Tie missing:

Appears when the group controller is missing in the genset group. The fail class in parameter 7536 will be executed. For the bottom layer, it is only possible to set it in the genset controllers.

The top layer in a 3-level application consists of plant and group controllers. In the plant controllers, the relevant parameters are located in parameter 7533 – 7536, and in group controllers it will be located in 7543 – 7546. The following fail classes can be executed:

- Missing all units:

Appears only when a controller cannot “see” any other units on the CAN bus line. The fail class selected in parameter 7533 (plant) or 7543 (group) will be executed.

- Fatal CAN error:

Appears when two or more units are not visible, but one or some units are still visible. The fail class selected in parameter 7534 (plant) or 7544 (group) will be executed.

- Any group missing:

Appears when at least one group controller is missing. The fail class in parameter 7535 (plant) or 7545 (group) will be executed.

- Any plant missing:

Appears when at least one plant controller is missing. The fail class in parameter 7536 (plant) or 7546 (group) will be executed.

5.1.3 CAN bus alarms

The following alarms can be displayed on an AGC PM unit in case of CAN bus communication failures:

- CAN ID X P missing:

The AGC PM unit has lost CAN bus communication to CAN ID on the PM CAN primary line.

- CAN ID X S missing:

The AGC PM unit has lost CAN bus communication to mains with ID X on the PM CAN secondary line.

- GG CAN ID X missing:

Seen on group controllers. The group has lost communication to CAN ID X in the top layer.

- CAN setup CH: 784x:

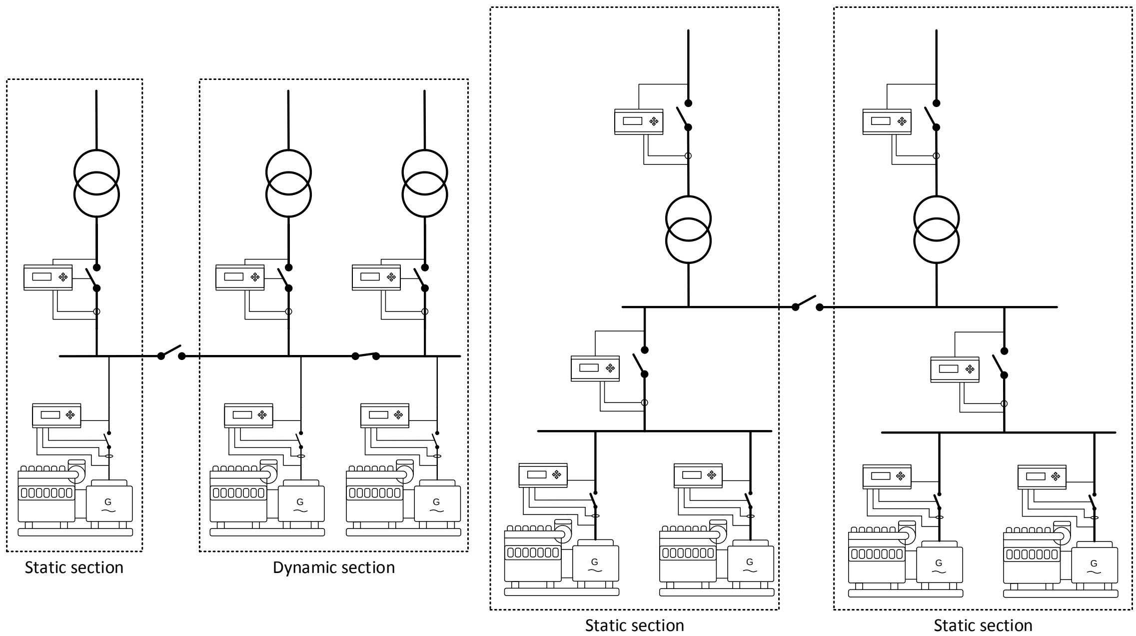
The unit can sense power management communication on a CAN port, but the correct protocol is not set. This alarm is also monitoring the CAN set between engine communication protocol (H5, H13) and the CAN port.

Load sharing backup: It is possible to have a backup of the load sharing if the power management CAN bus should fail. This can be done by analogue load sharing in the gensets.

5.2 Power management principles and rules

5.2.1 Static and dynamic sections

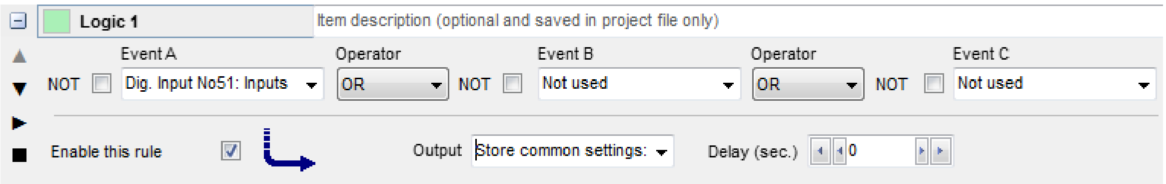
The power management application can be divided into sections. This is done by Bus Tie Breakers (BTBs). If a BTB is open, the two parts that are divided by it can almost be considered as two separate applications. It is very important that if there are any BTBs in the application, then the feedbacks from these must be wired to a controller so the power management system has the overview of the present application. To understand what the difference between a static and dynamic section is, the diagram below can be used for explanation:



Static section:
This is a part of the application that cannot be divided any more by BTBs. If there are no BTBs in the application, the whole application will be a static section. If the operator wants to use BTBs inside genset groups, please contact support@deif.com
Dynamic section:
A dynamic section consists of at least two static sections. A dynamic section will always include a closed BTB, since this is what defines a dynamic section.

5.2.2 Settings in applications with BTBs

When changing settings in the AGC PM, in applications with BTBs it is strongly recommended to have all BTBs opened, before any settings are changed. This is common for applications with AGC PM-controlled BTBs, and also externally controlled BTBs. If settings are made when a BTB is closed, and a BTB is opened, the operator will experience this as if some settings have been lost. The application should be split into static sections, before settings are made. If some settings have to be made, while a BTB is closed and these settings have to be saved, a certain command can be used for this. A spare input for this is required, and the function is programmed through M-Logic. A controller on each side of the BTB will have to have a spare input for this. The configuration has to be made like shown below:



Before a BTB is opened, the “store common settings” command should be used, in a controller on each side of the BTB that is about to be opened.
It is not required to use digital input 51. Another spare input can also be used. When the settings have to be saved, the input has to be activated at least for 1 sec. This input will have to be activated each time before a BTB is opened, to make sure that the settings are saved.

5.2.3 Command unit

The power management system is a multi-master system. In a multi-master system, the available generator units automatically perform the power management control. This means that the system never depends on only one master unit.
If for instance one unit ID is disabled e.g. auxiliary supply switched off, and this was the command unit, then the next available unit will take over the command functions.
The above also applies to the AGC mains units, and AGC plant units.
The command unit cannot be selected by the operator. It is automatically selected when a power management setting is accessed.

5.2.4 Plant running modes

The AGC PM is able to operate in different operating modes, also referred to as genset mode or plant mode. The operating mode for each unit is set in parameter 6070. Common for every application is that, if it is not a stand-alone application, the operating mode in the gensets and groups should always be set to: Power Management. Then the operating mode will be dictated from a Plant, Mains or Group controller. If there is no Plant or Mains controller, the plant mode will change to Island operation. When the gensets are set for power management in parameter 6070, they will be able to load share via CAN bus. Otherwise, they will not be able to load share via CAN. The different plant operating modes will be described below.

Parameter	Item	Range	Default	Note
6070	Plant/genset running mode	Island operation Power management	Automatic Mains Failure	

Automatic Mains Failure (AMF):
Used when the plant is going to start at a mains failure. By default, all gensets will not start at this situation and will have to be programmed. The gensets will be able to make load-dependent start/stop, if the load is small enough for this, or increasing. The AGC PM is able to synchronise back to grid, when the grid returns, and afterwards deload the breakers. The timers and limits for AMF situations can be set.

The limits and timers are set in the controller that is measuring on the grid voltage and frequency. This means that it can be a plant, a mains or a stand-alone AGC PM. This depends on the application types. In stand-alone applications, the same controller will be handling the genset and measuring on the grids voltage and frequency. In a 2-level application, the mains controller will always be measuring on the grid voltage/frequency, and in 3-level applications the plant controller will do it. Common for all the applications is that the limits and timers are set from the same parameter numbers, and described below:

From menu 7061-7066, the limits and timers for the mains voltage is set. Parameter 7061 is a timer that decides how long time the voltage should be outside the limits before it is considered as a mains failure, and the AMF sequence starts up. The lower limit for the voltage is set in parameter 7063, and the upper limit is set in parameter 7064. Both are set in percentage, and this refers to the nominal settings for grid (in stand-alone applications, this is the busbar nominal). In parameter 7062, the mains voltage OK timer is set. This timer defines how long time the voltage has to be inside the limits, before the “return to normal” sequence will be started. Parameter 7066 can be used if the AMF sequence should also start if the grid voltage is unbalanced.

From parameter 7071-7074, the timers and limits for mains frequency are set. These menus hold a fail timer and an OK timer. These work in the same ways as the timers for the mains voltage failure. A high and low limit is also located, which is set in percentage and refers to nominal frequency.

In parameter 7065, there is a selection on what the AGC PM should do with the Mains Breaker in case of an AMF situation. In the parameter, the operator can choose between: Start engine or Start engine + Open MB. If the menu is set to Start engine + Open MB, the Mains Breaker will be opened when a mains fail timer expires, and in the same time the controller will send the start request to the engines. If the menu is set to “Start engine” instead, the Mains Breaker will be kept closed until the genset(s) is ready to supply the load. If there is a Tie Breaker, the gensets can be synchronised before the Mains Breaker is opened.

In the AMF sequence, it is possible to choose whether the gensets are allowed to be synchronised to the grid, when returning to normal procedure.

The parameters that are directly related to the AMF function are shown below:

Parameter	Item	Range	Default	Note
7061	Mains failure voltage timer	0.5 s 990,0 s	5.0 s	
7062	Mains failure voltage OK timer	10 s 9900 s	60 s	
7063	Mains voltage low limit	80 % 100 %	90 %	
7064	Mains voltage high limit	100 % 120 %	110 %	
7065	Mains failure breaker control	Start engine + Open MB Start engine	Start engine + Open MB	
7066	Mains failure unbalance voltage limit	2 % 100 %	100 %	
7071	Mains failure frequency timer	0.5 s 990,0 s	5.0 s	
7072	Mains failure frequency OK timer	10 s 9900 s	60 s	
7073	Mains frequency low limit	80 % 100 %	95 %	
7074	Mains frequency high limit	100 % 120 %	105 %	

Load Take Over (LTO):
Can be used if the operator wants to synchronise to the grid, then deload the Mains Breaker, and afterwards open it. The gensets will keep running with the load, until a stop signal is given. It will be possible to deload all breakers before they are opened. The LTO sequence pays respects to the fact if the gensets are allowed to be synchronised to the grid, and if they are not, the LTO sequence will happen with black transition.
In this running mode, the AGC PM will need an auto start signal before it will start the sequence. The start signal should be given to the controller in the “top layer”, which can be either a mains or a plant. If it is a stand-alone application, the start signal should just be given to the controller.
When the application has been given a start command, the gensets will carry the load until the stop signal is given again.
If a mains failure occurs during an LTO sequence, then the gensets stay connected even though the LTO start signal is removed in order not to disconnect the load unnecessarily. The mode-shift will also have to be activated in this situation (7081).

Island mode:
When the gensets are running in this mode, they should not be able to synchronise to the grid at any point. This is designed for supporting a load, and the AGC PM will try to maintain the nominal frequency and voltage at this plant mode. If there is a Plant or Mains controller, it will still be possible to run in Island mode. If no Plant or Mains controller is present, the gensets and groups will automatically change into Island operation, since this is the only relevant running mode at this point.

If a 2-level application has to have a Tie Breaker that needs to be controlled, it can be handled by a mains controller, even though there is no grid connection. The mains controller will have to be set into Island mode in parameter 6070. The application configuration will have to hold a mains connection even though there isn't any.
In 3-level applications that only have to run in Island mode, the plant controller can be left out, since the group controller will handle the Tie Breakers. The group controllers will need an application configuration where there is no plant controller.

Fixed Power (FP):
In this running mode, the gensets will deliver a constant power, with a fixed power factor. The power factor can be adjusted, and the power set point can also be adjusted. When running in fixed power, the genset(s) have to be parallel with a grid. In fixed power mode, the plant has the possibility to use a frequency-/voltage-dependent power droop, which gives the possibility to support the grid frequency and voltage. The power set point can be controlled in different ways, and it is also possible to make some power offsets that will be adjusted in different situations. When the power set point is adjusted, the AGC PM can automatically start and stop the gensets. The power is controlled from the controller placed in the top layer, which means it can be either from a mains or a plant controller, dependent on the application. The cos phi in fixed power running mode can be controlled in different ways, which makes it possible to have a specific cos phi at a specific location. How this is controlled is described later in this document. When the AGC PM is in fixed power, it is not possible to overload the gensets by purpose. So if the power set point is above what the gensets are able to produce, the gensets will stop at 100 % load.
In applications with more than one mains/plant controller, the AGC PM can be parallel to all of them at one time. This requires that the grid connections are allowed to be parallel, and the AGC PM has been set to Run all Mains. With this setting, it will seek out to be parallel to all the grids, when the start signal is given. If the Run all Mains setting is active, it is possible to exclude some/one of the mains, which prevents that the gensets will be parallel to the grid that is excluded. If more mains/plant controllers are placed in an application, the mains/plant with “ID to run” will control the fixed power set point.
In applications with an open BTB, and a mains/plant on each side, the AGC PM will have two different IDs to run. This means that two different fixed power set points can be active, and these sections can be run independently of each other.
If an AGC PM is placed in a stand-alone application, the fixed power set point is in percentage instead.
The settings for the fixed power mode are shown in the table below:

Parameter	Item	Range	Default	Note
7001	Fixed power set point	0 kW 20000 kW	500 kW	
7002	Fixed power scaling	1 kW: 1 kW 1 KW: 1000 kW	1 kW: 1 kW	

Mains Power Export (MPE):
In this running mode, the plant will try to keep a constant power across the Mains Breaker. If the load in the plant increases, the power from the gensets will rise. But it will not be possible to overload the gensets. If the gensets are 100 % loaded, and the load increases, the gensets will be kept at 100 % load, since it is not allowed to overload them in this running mode.
If the application consists of more than one mains/plant, it is possible to export to all the grid connections. The grid has to be allowed to be parallel, and afterwards the AGC PM has to be set to Run all Mains. In this situation, the mains/plant with “ID to run”, will be the one that controls the power set point.
If Mains Power Export is intended to be used in a stand-alone application, the AGC PM will need a mains power transducer. Otherwise, it will not be able to measure the power across the Mains Breaker (transducers are described later in this document).

Parameter	Item	Range	Default	Note
7011	Mains Power Export set point	-20000 kW 20000 kW	1000 kW	
7013	Mains Power Export/Peak Shaving scaling	1 kW: 1 kW 1 KW: 1000 kW	1 kW: 1 kW	

Peak Shaving:
Here the mains or plant controller is looking at its own power across the mains breaker. The peak shaving is used, when the load on the plant is rising, and the operator does not want to import too much power from the grid. It can be used so the plant is maximum importing a specific amount of power, and then the AGC PM will start and stop gensets according to the load. The peak shaving mode does not need a start signal, since it is the load across the mains/plant breaker that starts and stops the plant.
When the application is set to Peak Shaving mode, load-dependent start/stop for parallel operation is used. So if mains/plant is at a low load, no genset(s) will be running. When the load is increasing, a starting point is set. If the peak shaving power set point is set for e.g. 750 kW, and the load-dependent start setting is 100 kW, the first genset will be started up at 650 kW load. The genset will be running at minimum load, until the load across the mains/plant breaker is increasing above 750 kW. The gensets will not start to increase the power until at this point.
In the peak shaving method, the genset's load-dependent start/stop dictates the settings, since it is only these that have them. If the peak shaving is used in 3-level applications, the genset(s) in different groups may have different load-dependent start/stop settings. The plant controller will then use the load- dependent start/stop settings, from the genset group, where the group controller is the last one modified in the settings.
When the peak shaving method is used in applications with more plants/mains controllers, the "ID to Run" also has an influence on the AGC PM. The power set in the peak shaving power set point is the load for all plant/mains in common (if the system is set to Run all Mains). When a genset is started, it will try to keep the total power import equal to the power value set in the plant/mains with "ID to Run".
If the peak shaving is to be used in a stand-alone application, a mains transducer has to be used. Otherwise the AGC PM will not be able to measure the power across the mains breaker. The settings for peak shaving in stand-alone applications are set in percentage and refers to the nominal power. The settings for peak shaving in stand-alone applications are placed in parameter 7021-7024.
The settings for the peak shaving are shown in the table below:

Parameter	Item	Range	Default	Note
7012	Peak shaving power set point	-20000 kW 20000 kW	750 kW	
7013	Peak shaving scaling	1 kW: 1 kW 1 KW: 1000 kW	1 kW: 1 kW	
7021	Peak shaving start generator limit	5 % 100 %	80 %	Only in stand-alone applications
7022	Peak shaving start delay	0,0 s 990,0 s	10,0 s	Only in stand-alone applications
7023	Peak shaving stop generator limit	0 % 80 %	60 %	Only in stand-alone applications
7024	Peak shaving stop delay	0.0 s 990.0 s	30.0 s	Only in stand-alone applications

Common for all plant running modes:
In all the different plant modes, the load-dependent start and stop function is active. The plant can either be started by an event, or by an operator. Below is an overview that shows which plant modes need a start signal and which are started by events:

Needs start signal	Started by an event
Load Take Over	Automatic Mains Failure (At mains failure)
Fixed Power	
Mains Power Export	Peak shaving (At load increase across the mains breaker)
Island mode	

5.2.5 Controller operation modes

In the AGC PM, the controllers can be operated in different ways. Below is given the different types and what each selection means:

- **AUTO:** When all the controllers in a plant are in AUTO mode, they will all be able to participate in the AUTO sequences. These sequences can involve different things, and this is how the AGC PM is intended to be used. When a genset is in AUTO, it will be ready to participate in the load-dependent start/stop function and be ready to start in e.g. mains failure situations (if the mains/plant controller is also in AUTO). If a genset is not in AUTO, the operator can experience problems with e.g. the power capacity function.
- **SEMI-AUTO (SEMI):** If an AGC PM is in SEMI, the controller will not start by itself, or start up if other gensets are requesting help. When an AGC PM is in SEMI, the regulators are still active and able to load share, but not participating in the power management system. The gensets will have to be started and stopped from the display or inputs. If a genset is running in SEMI, and the GB close button is pushed, the AGC PM will synchronise the breaker and close it. It will then regulate towards a power set point, which can be different according to the situation. In SEMI, none of the AUTO sequences will be initiated.
- **Manual (MAN):** If the genset is set into MAN, the regulators are switched off. So it will not be load sharing, but the protections are still active. When in MAN, the genset will have to be stopped from the display or via inputs. When a genset is in MAN, the power management system cannot start and stop the genset, and it will not be participating in the power management system.
- **Block:** When a genset is forced into block mode, it will not be able to start. An AGC PM in block mode will not be able to start from inputs, the display or from the power management system.

5.2.6 Start and stop of the plant

The start signal for the plant can be given in different ways. It can either be given from a display unit, or from a remote signal. A remote signal could be a digital input or Modbus command. If the start signal is given from a display unit, this will have to be configured in parameter 8051. If this parameter is configured to local, the start signal will have to be given at a display unit. If the parameter is configured to Remote it will have to be a digital input or Modbus command. Because there are different running modes in the AGC PM, some of the running modes require a start signal while others start up automatically due to different events.
If parameter 8051 is configured to local, the start signal can only be given to some specific units dependent on the specific situation.

2-level application start signal:
The start signal in a 2-level application will have to be given to a mains unit. If no mains unit is present in the application, the start signal is given to a genset unit. The signal does not have to go to a specific mains unit or genset unit. Be aware if there are bus tie breakers in the application, since the start signal is not necessarily shared across these!

3-level application start signal:
The start signal in a 3-level application will have to be given to a plant controller. If there is no plant controller in the application, it will have to be given to a group controller. The start signal does not have to go to a specific plant or group controller. Be aware if there are bus tie breakers in the application, since the start signal is not necessary shared across these!

5.2.7 Test mode in 2-level applications

In the AGC PM, there is a mode called Test. The AGC PM holds three different types of tests which give different possibilities. The three different types of tests are set and selected in parameter 7034. It is not possible to have two different types of tests activated within a section. The three different test types are described below:

- **Simple test:** this test mode will start up one/more gensets and let the genset(s) run with open generator breaker. The timer for the test decides how long time the genset(s) should be running before they are stopped again. Afterwards, it is possible to choose which mode the AGC PM should return to, when the genset(s) is stopped. The selections are between SEMI and AUTO. If the active multi-start is set to auto calculation, the AGC PM will use the kW set point to calculate how many gensets should be started in simple test mode. If e.g. 3 x 1000 kW gensets are placed in the application, and the test set point is 2100 kW, the three gensets will start since 2100 kW is bigger than the nominal power of two gensets (in simple test mode, it is the islanded load- dependent start/stop settings that are active).
- **Load test:** the gensets will start and regulate towards a specific power set point set in the parameters for the test mode. In this test mode, the gensets will be parallel to the grid all the time, so it is required that the gensets are allowed to be parallel to the grid. If the test power set point is bigger than the power imported from the grid, the genset(s) will be exporting to the grid. Be aware that the parameter about run all/run one mains has influence on this test. If run all is selected, the AGC PM will synchronise to all the grids, if the grids are allowed to be long time parallel. If run one is selected, the synchronisation will be to the mains with “ID to Run”.
- **Full test:** In this test mode, the gensets will start and synchronise to the grid (if allowed), deload the MB(s) and be powering with all the load. When the full test is started, the AGC PM will be looking at the power on the mains, and start the gensets according to this. If the gensets are not allowed to synchronise to the grid, the gensets are not able to deload the mains breakers, and the sequence will handle this as a black transition. Be aware of the selection between run all/run one mains, since this will affect which mains breakers will be opened. If run one mains is selected, the test will be performed on the mains with “ID to run”.

In load test and full test, the normal load-dependent start/stop function is still active. If load test is used, the cos phi that the gensets will be using follows the principles described in the chapter for “cos phi-controlled export in 2-level applications”.
If e.g. the operator only wants two mains out of three to synchronise in the load test, the exclude function can be used (exclude function is described later). Be aware when using the exclude function, that the power set point used for load test is still active, and not subtracted even though a mains connection has been excluded. The power set point used is the one in the mains with “ID to Run”.
In all test modes, it is possible to choose which mode each AGC PM should return to, when the test has expired. The selections are between SEMI and AUTO.
The parameters for the test functionality are shown below:

Parameter	Item	Range	Default	Note
7031	Test power setpoint	1 kW 20000 kW	500 kW	Controlled from the controller with “ID to Run”
7032	Test timer	0.0 min 999.0 min	5.0 min	Controlled from the controller with “ID to Run”
7033	Test return mode	SEMI mode AUTO mode	AUTO mode	Set individually for each controller
7034	Test type selection	Simple test Full test	Simple test	Controlled from the controller with “ID to Run”

5.2.8 Test mode in 3-level applications

The test mode in 3-level applications is very similar to the function in 2-level applications. Here, the plant controllers control the test function, and they also activate it. The plant controller with “ID to Run” dictates the power set point, test timer and test type. An overview and behaviour of the different test types in 3-level applications are described below:

- **Simple test:** when the simple test is initiated from the plant controller, the gensets according to the power set point will start. The gensets will be running with open breakers in the time defined in the plant controller. If the operator wants more than one group to start, the power set point will have to be increased. The number of gensets that should start is decided by the power set point and the active load-dependent start/stop settings (in simple test, the islanded load-dependent start/stop settings are active).
- **Load test:** when this test is started, the gensets are started, synchronised to each other and afterwards the group tie is synchronised to the grid. The gensets will then be parallel to the grid, where it will regulate towards a power set point. This power set point is defined by the plant controller with “ID to Run”. If the plant controllers are set to run one mains, the controller will only synchronise to one grid connection, so be aware if this plant can carry the load set in the test set point. The plant with “ID to Run” will be synchronised to. If the operator wants to synchronise to more plant connections, the operator has to allow the plants to be in parallel and set them to run all mains. If the operator then wants to synchronise some, but not synchronise others, he must use the exclude parameter or M-Logic to exclude the plant connections that he does not want the controller to synchronise. During the load test, the load-dependent start/stop is active (the load-dependent start/stop setting for parallel operation is active in this situation).
- **Full test:** when the full test is initiated, the gensets will start and seek out to take the load from the grid connections. The AGC PM will deload the breaker, before the plant breaker(s) is opened. The load-dependent start/stop setting for islanded operation will be active in this test mode. When using the full test, the possibilities with run one/run all mains are active, and so is the exclude function, so the operator has the option to exclude some grid connections from being deloaded.

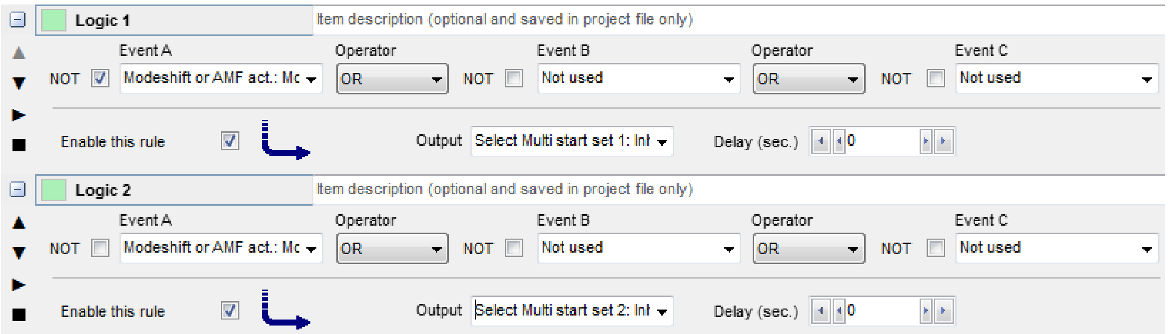
Choose for each AGC PM how they should return after the test is completed. Select this independently on each of them.

If some open BTBs are located in between some plant controllers, the test will only take place in the section where the plant mode test has been started. If the load test is used, the cos phi that each genset uses is defined by different settings. These settings are described in the chapter for “cos phi-controlled export in 3-level applications”. The parameters used for the test in 3-level applications, is the same as the ones used in the 2-level application, which is described earlier.

5.3 Basic functions

5.3.1 Multi-start in 2-level applications

The multi-start function can decide how many gensets should start when a start signal is given to them, and also decide how many gensets should be running as a minimum. In the AGC PM, there are two sets of multi-start, and two sets to dictate many genset(s) should be running as a minimum. These are activated in pairs and can be activated from the display or via M-Logic. The switching can also be used, so at an AMF start, all gensets will start, and at other starts, it will be calculated how many will start. The example below shows how this can be programmed:



The M-Logic above defines that when an AMF situation appears, the multi-start 2 will be used. Multi-start 2 can be set so the AGC PM should start all gensets. With the programming above, the AGC PM will use multi-start 1 when there is no AMF situation.

Each multi-start setting also contains a setting, regarding the minimum numbers running. This setting is respected at all time. To each multi-start, there is a minimum running gensets.

Each multi-start can be set for auto calculation also, instead of a fixed number. This gives the possibility at a e.g. fixed power start, to start up the required set at once. If 4500 kW is requested from the gensets, and they are all 1000 kW gensets, then 5 will be started at the same time. It is not recommended to use the auto calculation at AMF situations, since there will be a time where the controllers will measure 0 kW, and by this it can end up in a situation where only a single genset is started up to take the blackout load.

Parameter	Item	Range	Default	Note
8032	Multi-start 1 – minimum numbers of genset to start	Auto calculation 32 DGs	Auto calculation	Only in genset
8033	Multi-start 1 – minimum gensets running	0 32	1	Only in genset
8034	Selection of which multi-start should be active	Multi-start 1 Multi-start 2	Multi-start 1	Only in genset
8035	Multi-start 2 – minimum numbers of genset to start	Auto calculation 32 DGs	32 DGs	Only in genset
8036	Multi-start 2 – minimum gensets running	0 32	1 DGs	Only in genset

5.3.2 Multi-start in 3-level applications

In 3-level applications, the multi-start is also active. The minimum gensets to start and minimum numbers running is set individually for each group. These settings are set in one of the genset controllers, and afterwards shared automatically to the other genset controllers in the individual group. If e.g. group 1 is requesting group 2 for help, and the minimum number gensets running in group 2 is set to three, then three gensets will be started when the request from group 1 is made. All the gensets running will afterwards load-share.
The auto-calculation is also set individually in each group, and is best explained by an example:
A plant consists of 20 gensets with 1000 kW as nominal power, and 10 gensets are located in each group. At the moment, the plant is at stand still, and now a plant controller requests 10500 kW of fixed power load. In the group with priority 1, the multi-start is set to Auto calculation, and in the group with priority 2, the multi-start is set to start four gensets, and minimum three gensets running. When the start signal from the plant is given, the auto-calculation in group 1 makes all ten gensets start. The first 10000 kW is delivered from group 1, and one genset from group 2 should be enough. The settings in group 2 dictates that minimum four gensets will start at a time, and by this the four gensets will start. When all the gensets are up and running, the load-dependent start/stop function allows some gensets to stop. In group 2, the setting is set for minimum three gensets to run. So the load-dependent start/stop function is only allowed to stop one genset in this situation. The 13 running gensets will share the load equally among them.
If asymmetrical load-share has been activated in the group controllers, group 1 will have been loaded to the set point in the group controllers, and the three gensets in group 2 will have to take the deviations. If asymmetrical load-share is also activated in group 2, the gensets with the highest priority will be loaded more than the others.

5.3.3 Local update/update all in 2-level applications

In the AGC PM, a setting located in parameter 8052 can be set for either Local update or to Update all. If a controller is set to Local update, it will only be possible to switch between SEMI and AUTO from the display of the unit, or via a Modbus address sent to the specific unit. The Update all setting is best explained by an example:

A setup with four gensets, where the last genset has the setting Local update, and all the others are set for Update all. If the operator is switching from SEMI to AUTO on the last genset, the other controllers will not change their mode, since the last genset is set for Local update. If the operator then switches from SEMI to AUTO, on one of them, all the others will change since they are in Update all. The controller in Local update will not change, since it is not paying attention to this.
When a controller in Update all is switching from SEMI to AUTO, or from AUTO to SEMI, all the controllers with Update all will change to the same mode.
If a BTB is placed in the application, the information about AUTO and SEMI is not shared across an open BTB.

Parameter	Item	Range	Default	Note
8052	Selection between local update and update all	Local update Update all	Local update	

5.3.4 Local update/update all in 3-level applications

The local update/update all function is only working in groups. This means that if all controllers in a group are set for Update all, and one is changed, all the controllers internally in this group will be changed to this mode. This includes the group controller, if it is set for Update all.
If all controllers in the plant application is set for Update all, and the mode is changed on a genset controller, then all the controllers internally in the group will change inclusive the group controller. If the mode is changed on a group controller, the mode will change on all the gensets in the specific group. The mode will not change in the other groups, or plant controllers.
If the mode is changed on a plant controller, the groups and other plants will not be affected by this, since this is always done individually on all the controllers in the top layer.

Be aware if the plant controller is changed from AUTO to SEMI, and the plant is started with an AUTO start/stop signal. When the plant is not in AUTO anymore, the AUTO start signal will be inhibited and become a stop signal!

5.4 Load-dependent start and stop in 2-level applications

5.4.1 Principles

The purpose of this function is to ensure that sufficient power is always available on the busbar compared to the load. This means that the gensets will automatically be started and stopped in order to let only the sufficient number of gensets run. This optimises the fuel economy and the maintenance intervals.
The load-dependent start/stop function is active when the plant is in AUTO mode. This starting and stopping of the gensets is automatically carried out according to the adjusted set points and priority selection.
The load-dependent start/stop set points can be selected as:

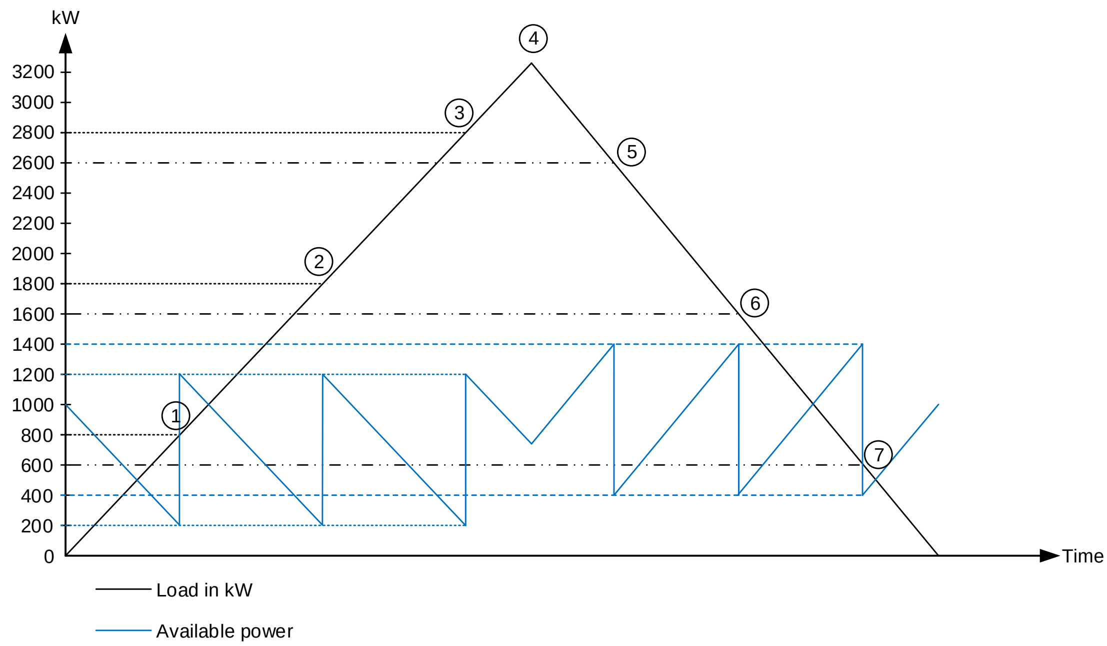
- Power set point/value (P) [kW]
- Percentage set point [%]

This means that the load-dependent start/stop function can be designed for operating dependent on how loaded the gensets is in kW or percentage before the next genset is started or stopped.
The easiest way to configure the load-dependent start/stop function is by using the percentage method. But when there is more than three gensets, it can end up in a situation where a genset is running, even though it could be stopped to save fuel. Both types will be described below.
The choice between types is made in parameter 8021:

Parameter	Item	Range	Default	Note
8021	Load-dependent start/stop method selection	Value percentage	Value	Only in genset

5.4.2 Power set point

To use the power as set points for the load-dependent start/stop function, it is required to go to parameter 8021 and set this to Value. The load-dependent start stop function is most easily explained by an example: Four gensets with a nominal power of 1000 kW can connect to the same busbar. The start limit is set to 200 kW, and the stop limit is set to 400 kW. If one genset is started, running with the load, the power increases, and the available power comes below 200 kW, the next genset will start. When a genset has to stop, the set point is set to 400 kW, which means that there will be an available power of 400 kW after a genset has stopped. The example is illustrated in the diagram below:



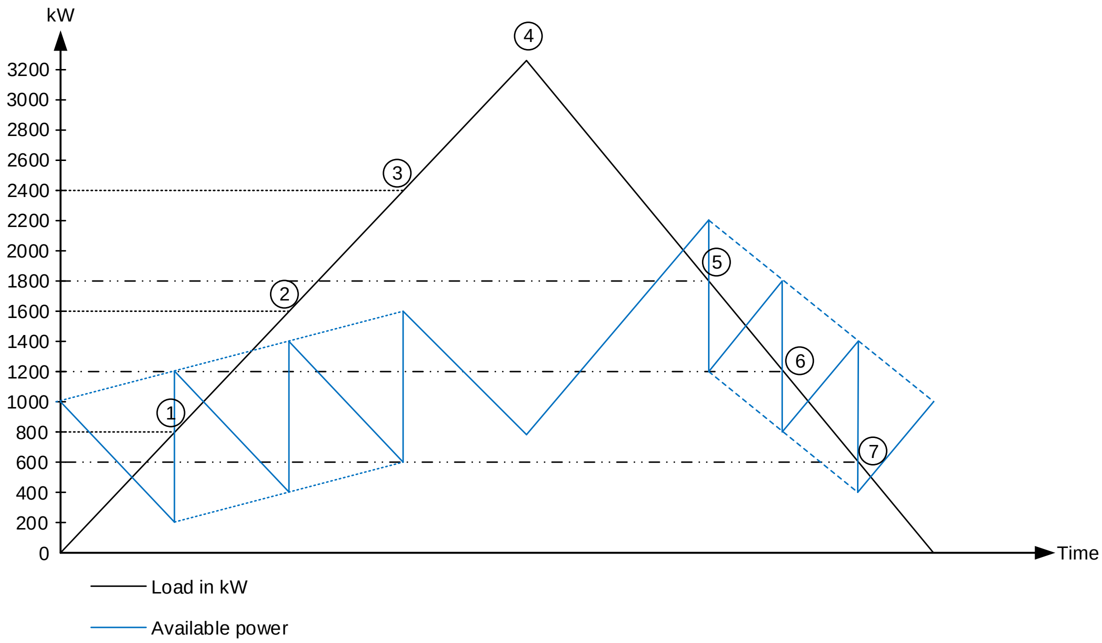
1. The load is increasing, and when it has reached 800 kW, the next genset will start. It starts because the available power has come below 200 kW, which is the set point.
2. The load is still increasing, and now it reaches 1800 kW. This means that the available power has come below 200 kW once again, and the third genset will now start.
3. The load has increased to 2800 kW, so the next genset will start. The available power has once again come below 200 kW.
4. The load has reached at maximum and is starting to decrease again.
5. The load has reached 2600 kW, and 4 gensets are running. This means, if one genset is stopped, the available power will reach 400 kW after one genset has been stopped, which is the set point in this example.
6. The load is still decreasing, and has now reached 1600 kW. When three gensets are running, it means that if one is stopped, the available power will be at least 400 kW again.

7. The load has now decreased to 600 kW. Two gensets are running at this moment, and if one is stopped, the available power will still be above 400 kW. The stop sequence of genset number two will then be executed.

5.4.3 Percentage set point

To use the load percentage as set points for the load-dependent start/stop function, it is required to go to parameter 8021 and set this to Percentage. The load-dependent start stop function is most easily explained by an example:

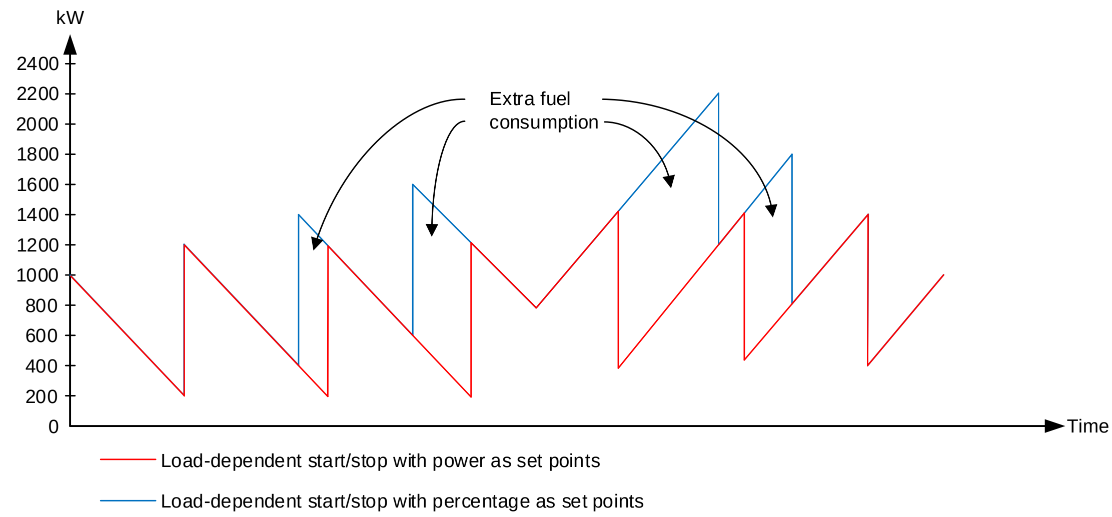
Four gensets with a nominal power of 1000 kW can connect to the same busbar. The start limit is set to 80 %, and the stop limit is set to 60%. If one genset is started, running with the load, the power increases and the load comes higher than 800 kW, the next genset will start (80 %), because the genset is more loaded than 80 %. When a genset has to stop, the set point is set to 60 %, which means that the genset will be 60 % loaded or less, after the genset is stopped. The example is illustrated in the diagram below:



1. The load increases and reaches 800 kW. This means that the genset is 80 % loaded, and by this it will start another genset.
2. The load is still increasing, and now it reaches 1600 kW. This means that both gensets are 80 % loaded. Genset number three will now start.
3. The load has now reached 2400 kW, and the three gensets are by this 80 % loaded. The last genset will now start.
4. The load has reached its maximum and will now decrease.
5. When the load reaches 1800 kW, the first genset will stop. This is because when one genset is stopped and with 1800 kW load on three gensets, they will all be loaded at 60 %.
6. The load has decreased to 1200 kW. This means that one genset can be stopped, since 1200 kW on two gensets equals 60 % load.
7. When the load reaches 600 kW, genset number two can be stopped, since 600 kW on one genset means that it will be 60 % loaded.

5.4.4 Selection between power and percentage method

The difference between the advantages for each type can be hard to figure out. One of the methods can be to compare the two available powers. The more available power equals more spinning reserve which means bigger fuel consumption. This is illustrated in the diagram below:



When tuning in the plant, it is easier to set it up with the percentage method. It will provide a bigger safety, since the spinning reserve is bigger.
When tuning in with the value method, it is important to know how much the load can increase in a short while, before a load-dependent start timer has expired and a genset has started and synchronised.
As it can be seen from the diagram above, the more gensets, the more spinning reserve there will be, when using the percentage method.
If the gensets have different rating, it can be an advantage to use the percentage method.
Generally speaking, a standby power plant should use the percentage method and the prime power plant the value method.

5.4.5 Load-dependent start and stop in island and parallel

The AGC PM has the possibility to switch between two different sets of parameters for the load-dependent start and stop function (LDSS). This switch is made automatically when the gensets are parallel (or not) to the grid, and the plant is in AUTO. The AGC PM can be operated in 6 different modes, where the LDSS can be used also. In three of the modes, the load will be carried by the gensets and will not be parallel to the grid, and in the three other modes, the gensets will be parallel to the grid. An overview of the modes looks like this:

Islanded	Parallel to the grid
Island Mode	Fixed Power
Automatic Mains Failure	Peak Shaving
Load Take Over	Mains Power Export

When the plant is running in one of the islanded modes, the following load-dependent start and stop parameters are used:

Parameter	Item	Range	Default	Note
8001	Load-dependent start Island Power limit	1 kW 20000 kW	100 kW	Only in genset
8002	Load-dependent start Island Percentage limit	1 % 100 %	90 %	Only in genset
8003	Load-dependent start Island Start delay	0.0 s 990,0 s	10,0 s	
8011	Load-dependent stop Island Power limit	1 kW 20000 kW	200 kW	Only in genset
8012	Load-dependent stop Island Percentage limit	1 % 100 %	70 %	Only in genset
8013	Load-dependent stop Island Stop delay	5.0 s 990.0 s	30.0 s	

When the genset is in one of the modes where it is parallel to the grid, these LDSS parameters are to be used instead:

Parameter	Item	Range	Default	Note
8004	Load-dependent start Parallel Power limit	1 kW 20000 kW	100 kW	Only in genset
8005	Load-dependent start Parallel Percentage limit	1 % 100 %	90 %	Only in genset
8006	Load-dependent start Parallel Start delay	0.0 s 990,0 s	10.0 s	
8014	Load-dependent stop Parallel Power limit	1 kW 20000 kW	200 kW	Only in genset
8015	Load-dependent stop Parallel Percentage limit	1 % 100 %	70 %	Only in genset
8016	Load-dependent stop Parallel Stop delay	5.0 s 990.0 s	30.0 s	

5.4.6 Load-dependent start and stop timers

When using load-dependent start and stop, some timers will have to be set. The timers define how long time the load will have to be above/below the set points before a genset starts or stops. The start timers are located in parameters 8003 and 8006. The stop timers are located in parameters 8013 and 8016.

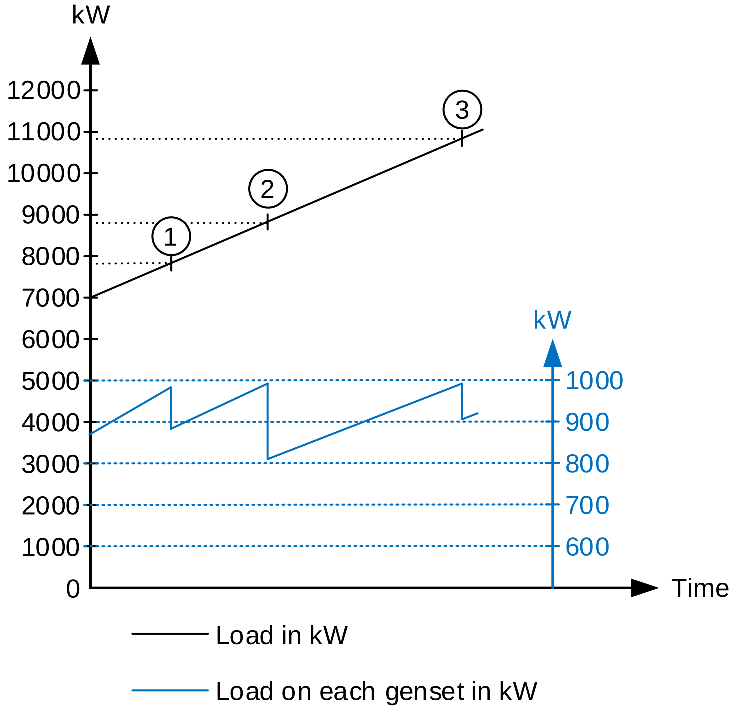
5.5 Load-dependent start and stop in 3-level applications

5.5.1 Principles

Traditional load-dependent starting and stopping, like described above, takes place inside each genset group. But if one group is not able to carry the requested load, the group controller with running gensets is able to request for help from another genset group. The next genset group will have to be in the same static or dynamic section. So, if an opened BTB is between the groups, the help request is not sent. When a group controller is requesting for help, it is not requesting for a specific genset, but instead for a power. By this, the priority inside the groups will be respected.

5.5.2 Start of next groups according to load increase

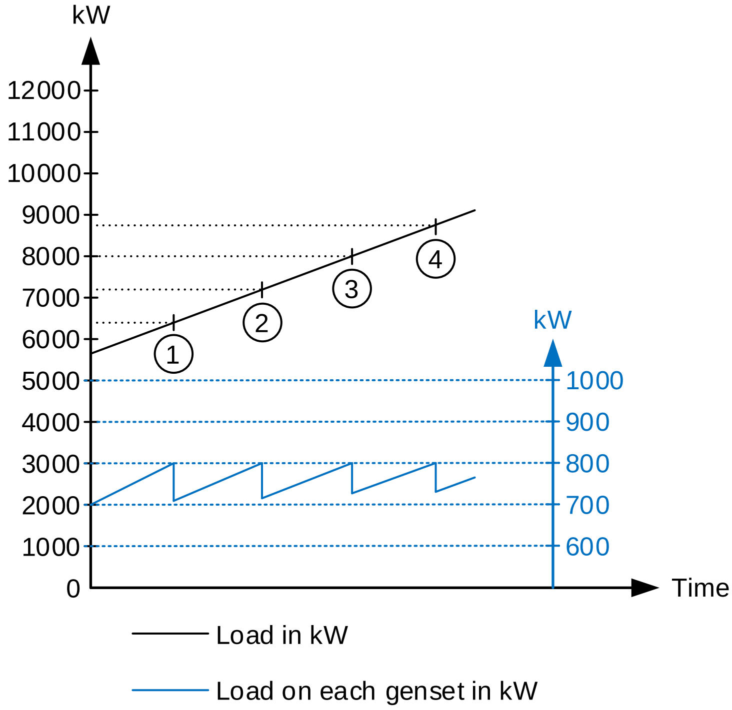
The group with the first priority is the one that will start first (the priority is shown in the lower right corner of the display). When the first group has requested help from another group, the genset with the first priority will start, and the load will balance out between all the running gensets. The set point for when a group is requesting help is placed in parameter 8041 in the group controllers. Before a group controller requests help from another group, all the gensets in the group must be running. So before the request can happen, the two conditions will have to be present. The start point and load sharing across groups is most easily explained by an example:
Two groups with 10 gensets of 1000 kW in each are placed at a plant. The load- dependent start limit (8001) is set to 100 kW in the gensets (when the available power is below 100 kW, the next genset will start). In the group controllers parameter 8041 is set to 80 %. The 80 % is the limit for when the group requests help from another group. But all gensets will have to be running before the request is made.



In the diagram above, it is shown that the load is increasing. The following things will happen in this example:

1. At 7000 kW, the settings dictates that 8 gensets are running. The load now increases to 7900 kW, and by this the available power comes below 100 kW. This means that genset number 9 will start. Furthermore, the load on each genset drops when an extra genset comes into the busbar. When the load exceeds 8000 kW, the load on the group is bigger than 80 %. But the next group will not be requested yet, since not all gensets in the group are running yet.
2. The load has now increased to 8900 kW. This means, that available power will come below 100 kW once more. Genset number 10 will start. When genset number 10 starts, the load will still be bigger than 80 % on the group. By this, the genset with the first priority in group number two will start. So in this case, two gensets will start, and this can also be seen on the load on each genset.
3. Just before this point, 11 gensets are load sharing and balancing the load out equally between them. The load now reaches 10900 kW, and the available power goes below 100 kW once more. Genset number 12 will now start and load-share along with the other gensets.

If the percentage method had been used instead, and it was set to 80 %, the diagram would have looked like this instead:



1. Up to this point, 8 gensets are running. When the load is 6400 kW, the 8 gensets are 80 % loaded, and genset number 9 will start.
2. The load increases to 7200 kW. This means that 9 gensets are 80 % loaded, so genset number 10 will start. When genset number 10 is up and running, all the gensets in the specific group are active. But the group is not loaded at 80 %, so the request for the next group is not made yet.
3. The load will now increase to 8000 kW. This means that the group is loaded at 80 % and all the gensets are running, so the request for help from another will be made. The genset with the first priority in group number two will start, and the gensets will load-share equally across groups.
4. The load has increased to 8800 kW. Genset number 12 will start at this point.

Parameter	**Item**	**Range**	**Default**	**Note**
8041	Asymmetric load share value for groups/set point for help request to another group	1 % 100 %	80 %	Only in group units

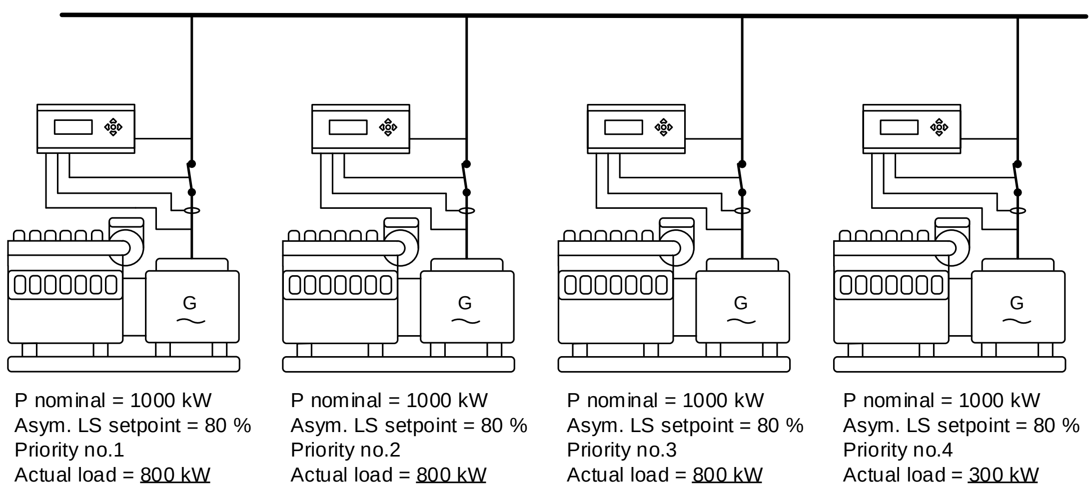
5.6 CAN bus load sharing

5.6.1 Principles

When the power management communication is running, the load sharing is done via the CAN bus between the units. The AGC PM can use analogue load share instead. The analogue load sharing will then have to be programmed with the M-Logic function. In M-Logic there is an output called: Use Ana LS instead of CAN. The analogue load sharing will be described later in this document.

5.6.2 Asymmetrical load sharing in 2-level applications

The AGC PM can make the gensets load share asymmetrically. The point with making them load-share asymmetrically, is that the gensets will be directed towards a specific set point for the load. If four 1000 kW gensets are doing asymmetrical load sharing on 2700 kW load, and the asymmetrical load-share set point is 80 %, the AGC PM will balance the load between them as below:



When the load is increasing or decreasing, the genset with the last priority will take the deviations, so the other(s) can be kept at a more optimum load point. If the load should exceed 3200 kW in the example above, the load will be shared equally between them. If the load afterwards decreases to a level below 3200 kW again, the three first gensets will regulate towards the 80 % again, and the last will take the deviations.
When using the asymmetrical load sharing, the limits for load-dependent start and stop are still respected. So if the start limit is above 80 %, the running gensets will be loaded above 80 %, until the next genset has started.
The set point set in parameter 8041 is shared between the gensets, and the function is enabled in parameter 8042.

Parameter	Item	Range	Default	Note
8041	Asymmetrical load sharing set point - value	1 % 100 %	80 %	Only in genset
8042	Asymmetrical load sharing Enable	OFF ON	OFF	Only in genset

5.6.3 Asymmetrical load sharing in 3-level applications

The AGC PM can be configured to do asymmetrical load sharing in 3-level applications. There are two different types in these applications.

Asymmetrical load sharing internally in groups:
If the plant consists of more than one genset group, it is possible to make asymmetrical load sharing internally in one group, and normal load sharing in another. The internal asymmetrical load sharing in groups is performed like in a 2-level application, which was described earlier.

Asymmetrical load sharing on group controllers:
The AGC PM can make the groups load-share asymmetrically. When this function is enabled in the group controllers, the group with first priority will deliver the power set in parameter 8041 (also in the group controllers). The group with the last priority will take all the deviations in the load so the group(s) with first priority can be kept at the set point. If the load exceeds the asymmetrical load set point, all the genset groups will share the load equally, so not only the group with the last priority will take all the incoming load.
The asymmetrical load sharing on group level is very similar to the function in 2-level applications, which was described earlier.

Parameter	Item	Range	Default	Note
8041	Asymmetric load share value for groups/set point for help request to another group	1 % 100 %	80 %	Only in group
8042	Asymmetrical load sharing Enable	OFF ON	OFF	Only in group

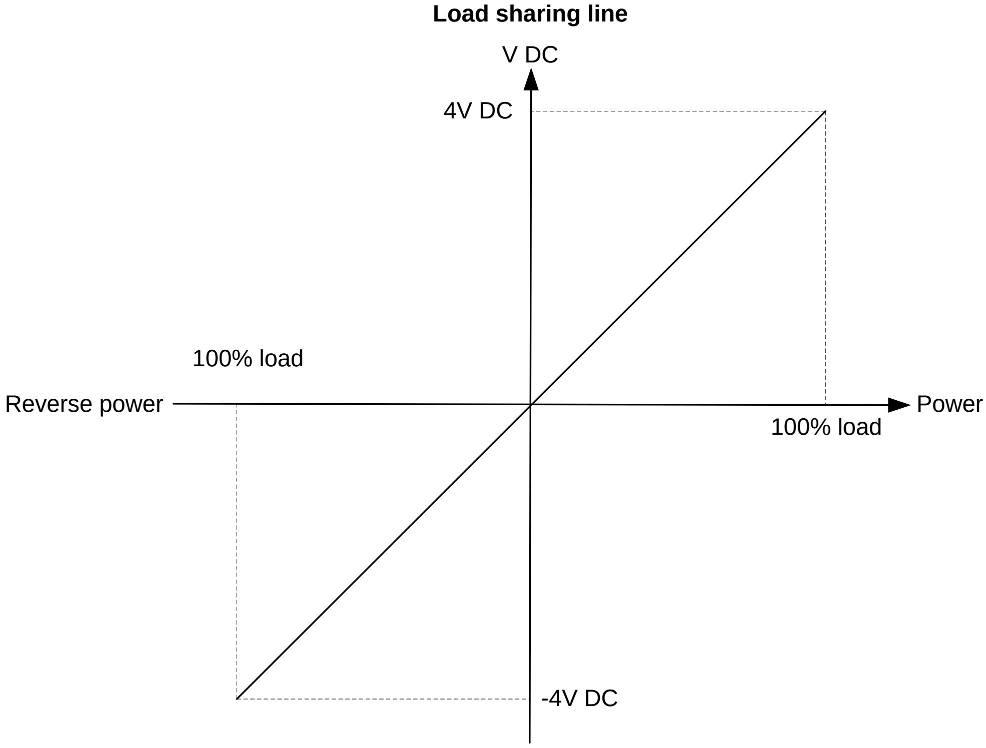
5.7 Analogue load sharing

5.7.1 Principle

The analogue load share makes the AGC able to share the active load and reactive load equally in percentage of the nominal power. The load sharing is active when the genset is running in island mode and the generator breaker is closed.

A voltage signal equal to the load produced by the genset is sent to the load sharing line. When the generator load is 0%, 0V DC is sent to the load share line. When the load is 100%, the voltage will be 4V DC.

This is illustrated in the drawing below.



The active load sharing line is illustrated above, and the characteristics of the reactive load sharing line are equivalent to it.

5.7.2 Working principle

The controller unit will supply a voltage on the load sharing line equal to the actual load. This voltage comes from an internal power transducer. At the same time, the actual voltage on the load sharing line will be measured.

If the measured voltage is higher than the voltage from the internal power transducer, the unit will increase its load in order to match the voltage on the load sharing line.
If the measured voltage is lower than the voltage from the internal power transducer, the unit will decrease its load in order to match the voltage on the load sharing line.

The voltage on the load sharing line will only be different from the voltage from the internal power transducer, if two or more controller units are connected to the load share line.

When the AGC is running in a stand-alone application, the load share line will be active at all times no matter if one generator is running a stand-alone application, or a number of generators are actually sharing the load. In case a generator is running alone, it is recommended to disable the load share line to keep the frequency regulator active.

To disable the load share line, use the M-Logic category output/inhibits in the PC utility software.

To improve the handling of several generators in the same application, the analogue load sharing is working as backup system for the power management system. This means that the load sharing will be done by the CANbus communication as the primary choice, but if a CANbus error occurs, the load sharing will continue on the analogue load sharing line. The generators will stay stable even though the power management is lost.
Example 1:
Two generators are running in parallel. The loads of the generators are:

Generator	Actual load	Voltage on load sharing line
Generator 1	100%	4V DC
Generator 2	0%	0V DC

The voltage level on the load sharing line can be calculated to:

U_{LS}: (4 + 0) / 2 = 2.0V DC

Now generator 1 will decrease the load in order to match the voltage on the load sharing line (in this example 2.0V DC). Generator 2 will increase the load in order to match the 2.0V DC.

The new load share situation will be:

Generator	Actual load	Voltage on load sharing line
Generator 1	50%	2.0V DC
Generator 2	50%	2.0V DC

Example 2:
If the size of the generators differs, the load sharing will still be carried out on the basis of a percentage of the nominal power.

Two generators supply the busbar. The total load is 550 kW.

Generator	Nominal power	Actual load	Voltage on load sharing line
Generator 1	1000 kW	500 kW	2.0V DC
Generator 2	100 kW	50 kW	2.0V DC

Both generators are supplying 50% of their nominal power.

5.7.3 Analogue load sharing type

The AGC can be adjusted to work with different types of load sharing modules and ranges of the load sharing signal. This is controlled by two menus: menu 6380 (signal level) and 6390 (load sharing type). The signal level is used to adjust the maximum output of the LS lines. The default range is 0-4V DC, and therefore 4V DC is the voltage applied to the load sharing line at 100% load. If the AGC is interfacing to another product where the max. range is different, then it can be changed in this menu.

To be able to adjust the max. range, it is necessary to adjust the menu 6391 to "adjustable". The AGC is able to provide between 1.0 and 5.0V DC as 100% load. Load sharing interfacing to DEIF Uni-line LSU (load sharing unit) and Multi-line 2 version 1 and version 2 might require a 0-5V DC range, depending on configuration. If the load sharing is unequal, please check this.

Menu 6390 holds the following possibilities:

- Adjustable
- Selco T4800
- Cummins PCC

When either "Selco T4800" or "Cummins PCC" is selected, then the adjustable range is ignored. The selection causes the AGC to modify the signal level of the LS lines to adapt to the specific brand of controller/load share unit.

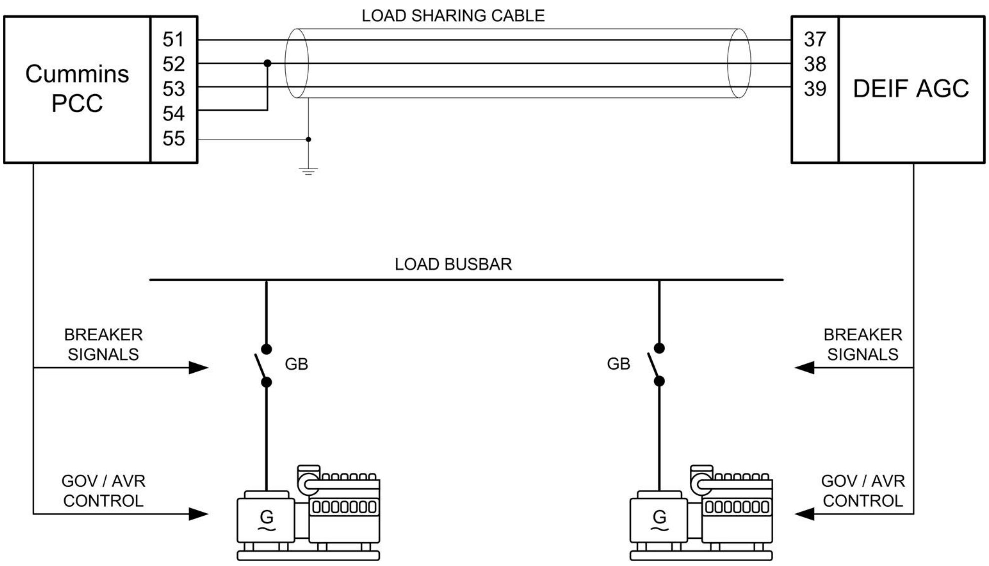
If interfacing is performed to the load sharing modules of unspecified brands, it might be necessary to provide galvanic separation of the load sharing lines. The input impedance of such isolation amplifiers should be high impedance for proper function.

Selco T4800 load sharer:
The signal level is +/-1V DC, so the AGC adapts automatically to this level. The terminals of the T4800 are 12 (com) and 13 (+). When interfacing to the Selco T4800, the frequency difference of the measured compared to generator nominal is taken into account in order to prevent unequal load sharing (not user-configurable). T4800 is for kW sharing only and not kVAr sharing.

Cummins PCC 3100 and 3201:
The signal level is 0.3-2.1V DC, so the AGC adapts automatically to this level. The terminals (TB3) of the PCC3100 and PCC3201 are placed on connector 8, and the terminals are 51 (kW), 53 (kVAr), 52 and 54 (common). Terminal 55 is a dedicated terminal for the shield of the load sharing cable.

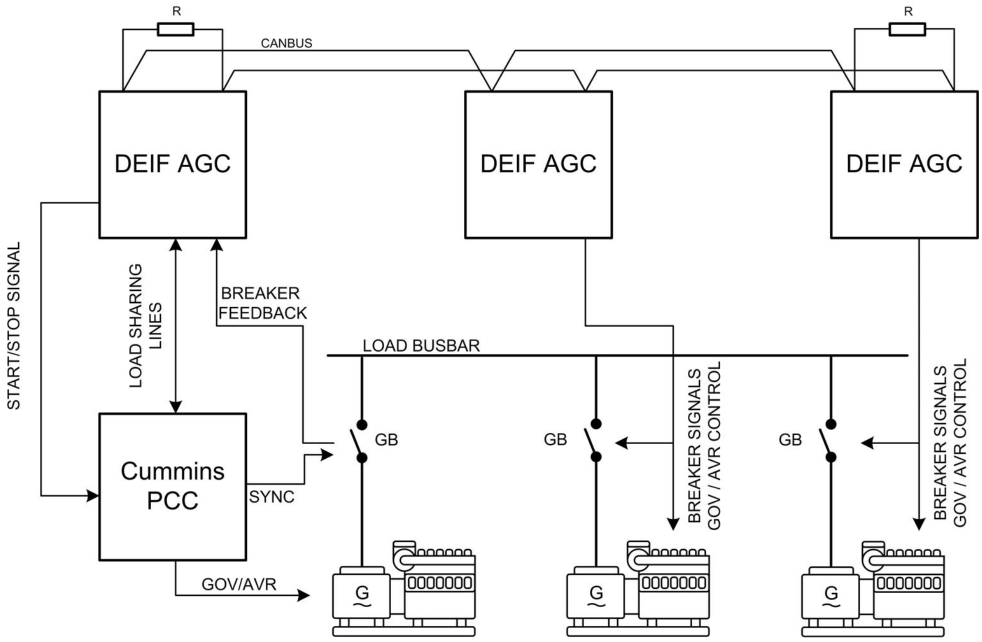
Cummins PCC applications:
When the DEIF AGC is being used, then it is possible to interface directly with the PCC using the terminal numbers as mentioned above.

PCC interface to DEIF AGC



PCC in DEIF power management system

Notice that if the AGC is part of a power management system, then it is possible to enable the analogue load sharing lines. This is done in M-logic by activating the command "Use Ana LS instead of CAN". If the CANbus communication is used for load sharing, the analogue LS line of the AGC is still updated so the Cummins PCC will be able to adjust the load level according to the load level of the AGCs. This is useful if the AGC is placed on all gensets only sending start and stop commands to the PCC. This means that the Cummins ILSI unit is not necessary.



The parameters related to the analogue load sharing are shown in the table below (not regulation parameters):

Parameter	Item	Range	Default	Note
6381	Load share output	1.0 V 5.0 V	4.0 V	Only in genset
6391	Load share type	Adjustable Cummins PCC	Adjustable	Only in genset

5.8 Priority selection

5.8.1 Principle

A big part of the power management system is the priority selection. The point with having prioritisation is that it can be decided in which order the gensets or groups should start. The priority selection can be used to balance the running hours between the gensets, or simply make sure that the gensets always start and stop in a specific order. The prioritisation can be done in different ways. It can be set manually or be set so that the power management system should do the prioritisation automatically. This selection is made from menu 8071, where the operator can choose between Manual priority and Running hour priority. The two types are described below:

5.8.2 Running hours prioritisation - Total/trip

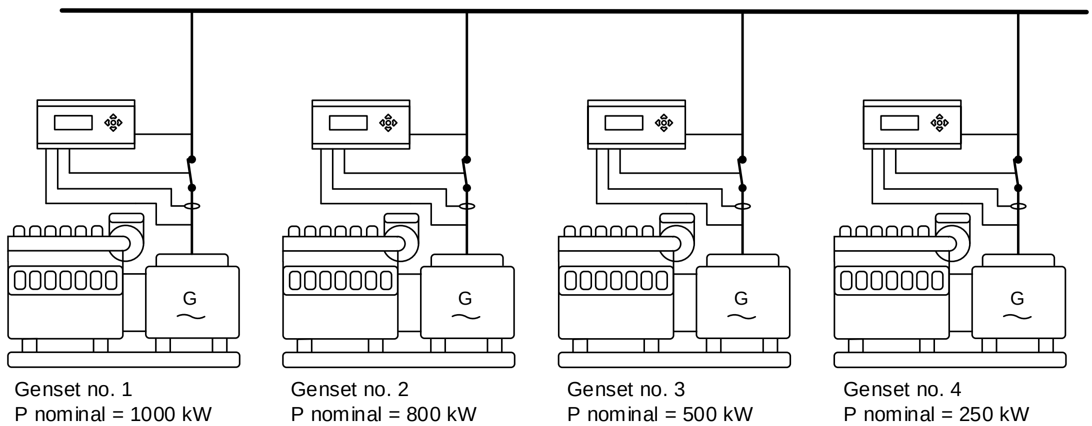
If the AGC PM is set for updating the prioritisation automatically, parameter 8071 will have to be set to Running hours priority. This setting determines that the AGC PM will take care of the priorities, and this is based directly on the running hours of each genset. In parameter 8141, it is set how often the AGC PM is allowed to make new prioritisations. The hours set in here is how many clock hours should pass before it will check if a new prioritisation should be made. If the gensets have had no running hours during the clock hours set in parameter 8141, the prioritisation will be the same as before. In parameter 8142 it is possible to select between Total or Trip (Load profiled is described later). If this parameter is set to total, the running hours that the prioritisation is using, is the total running hours the genset have had. If 8142 had been set for Trip instead, an internal trip counter could be used. This internal trip counter is reset in parameter 8143. So, if the AGC PM is set for Running hours prioritisation, and trip hours, only the running hours after the reset has been done will have any influence on the prioritisation.

5.8.3 Running hours prioritisation - Load profiled

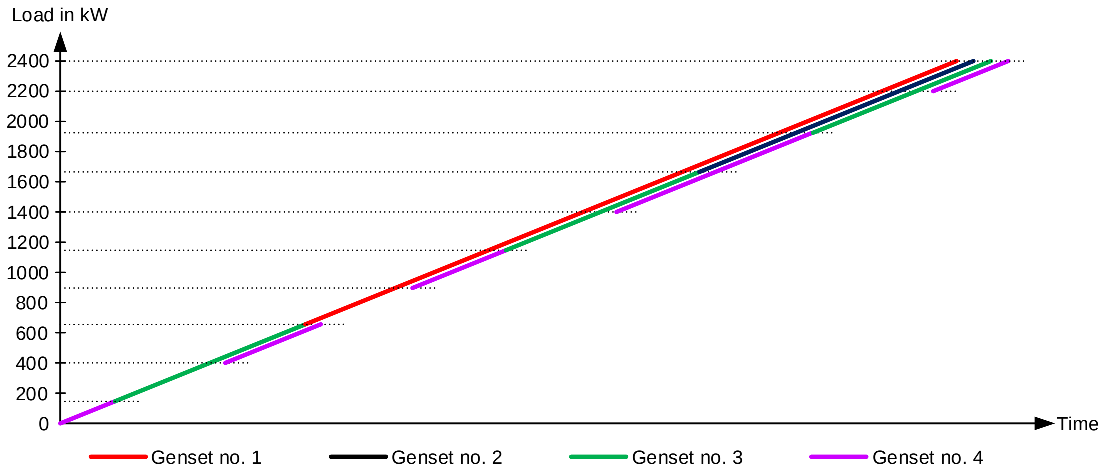
The AGC PM is also capable of doing the prioritisation based in previous load profiles. Before this is possible, it is required to go to parameter 8142 and set this for Load profiled. Parameter 8071 should also be set to Running hours priority. When this has been configured, the prioritisation will instead be based on how loaded each genset has been. The load is measured in kWh from each genset. If these internal counters for prioritisation are desired to be reset, this can be done from parameter 8143. In parameter 8141, it is set how often the AGC PM should do the prioritisation, so the gensets will be balanced and will end up having delivered almost equal energy. The hours set in parameter 8141 are clock hours. So if no gensets have been running within these hours, the prioritisation will be the same as before.

5.8.4 Fuel optimisation

Parameter 8071 can also be set to fuel optimisation. If the fuel optimisation function is enabled, the priorities of the gensets will be disabled, and the gensets will start according to the load. The fuel optimisation function can be useful if the application consists of gensets with different nominal powers. The function is best described with an example:



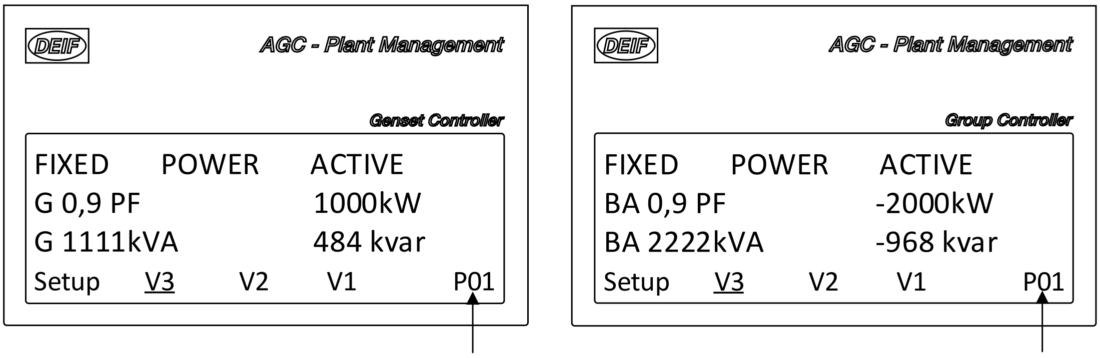
Above is shown an example with four gensets with different nominal powers. Fuel optimisation is activated, so there are no priorities. The AGC PM will make a continuous calculation on how it can be optimised all the time. A sequence where the load is increasing will be shown, and in this example the load-dependent start limit is 100 kW, which means when available power drops below 100 kW, the next genset will start. Below is shown how the gensets will start and participate in the fuel optimisation routine. After the next genset starts, maybe another one stops to optimise the on the fuel consumption.



It can be seen that the smallest genset in this example will start since it is the smallest. Afterwards genset no. 3 will take the load alone, since a bigger genset is not required at the moment. Afterwards, genset no. 4 will start again. At this point, two gensets are running, since the nominal power of genset 3 and 4 is smaller than the nominal power of genset no. 2. As the load increases, some gensets are stopped, and some bigger are started, and at the end all the gensets will run in parallel. With the fuel optimisation activated, it is still possible to use asymmetrical loadshare, or normal loadshare.
Furthermore, the fuel optimisation can be used in 3-level applications. Here it is activated in each group. This also gives the possibility to only have it activated in some groups, and not in others.

5.8.5 Manual selection of priority from front screen

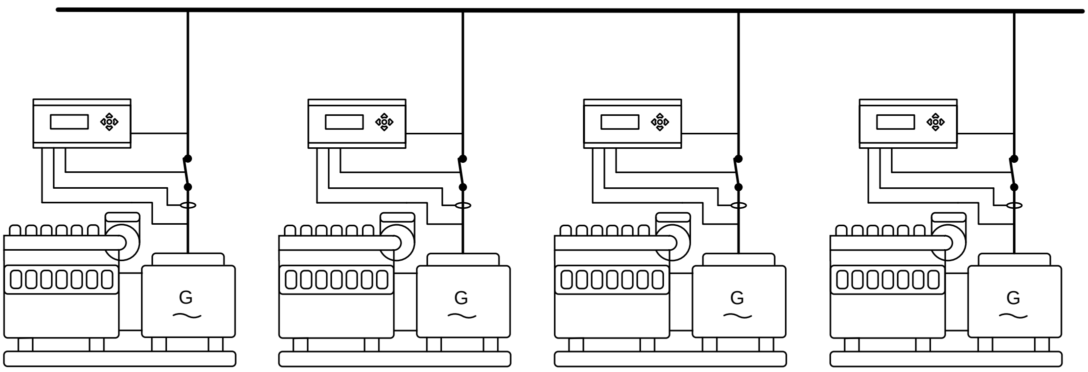
From the “home screen” of a genset controller and group controllers, there is information about which priority the genset or group has in the plant. This can be found in the lower right corner of the display, and looks like this:



It is possible to move the cursor onto the priority, and change it. To change it from here, a password is required.

5.8.6 Manual selection from parameters

From parameter 8081 to 8133, it is possible to make the priorities for all the gensets in a 2-level application, or make the priorities for all the gensets in a group. Furthermore, it is also possible to make all the priorities of the groups from one group controller. Before using this function, all the IDs set in parameter 7531 and 7541 should be known. Also menu 8071 should be set for Manual Priority. The menus for this are working as follows:
From parameter 8081 to 8085, the priority 1-5 is set. How to set these is best explained by an example:



In the picture above, ID 1 has the priority of 1 at the moment. ID 2 has the priority 2 etc. The operator then goes to the display of one of the controllers and moves to parameter 8080. He then makes this configuration:

Parameter	8081 (Prio. 1)	8082 (Prio. 2)	8083 (Prio. 3)	8084 (Prio. 4)	8086
Setting	4 (CAN ID)	1 (CAN ID)	2 (CAN ID)	3 (CAN ID)	ON

The setting made determines that ID 4 will have priority 1, ID 1 will have priority 2 etc. When the operator then sets parameter 8086 to ON, the priority will be transmitted to all controllers. When parameter 8086 has been set to ON, it will automatically set it to OFF, when it has been transmitted.
If the application consists of more than five gensets, the parameters from 8091 to 8131 are used. Remember to select all the priorities, before transmit is set to ON (8086).

5.8.7 Priority selection during running gensets

If the new priority of the gensets is made when some are running, and some are not, and the new priority determines a still standing genset should be running, it will start, and one of the running gensets will stop (if the load-dependent stop conditions are fulfilled).

5.8.8 Priority between groups (3-level applications)

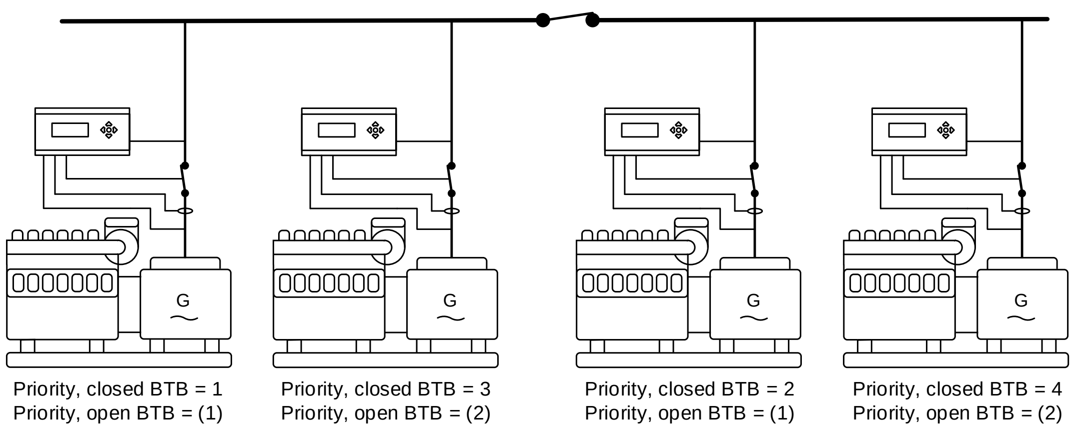
The priority between group controllers is very similar to the methods described above. The only different thing is that the priority is only updated in the group controllers. From the group controller, it is not possible to change any of the priorities in any of the gensets. Otherwise, the priority routines are the same.

5.8.9 Priority selection during running groups (3-level applications)

When the new priority is made in group controllers, it is a possibility that a group starts and another stops. This will happen if the new priority dictates that stopped genset groups should be running. If the load-dependent stop conditions are fulfilled, a group will stop, when the new group is connected to the busbar.

5.8.10 Priorities in applications with BTBs

If the AGC PM is located in an application with BTBs, the priorities will be remembered across the BTBs. This is best explained by an example:



The priorities with closed BTB are shown above. If the BTB is opened, the gensets will need new priorities, since the right side will not have a priority no. 1. Each side of the BTB will after the BTB is opened make a new internal sequential priority based on the priority it had before the BTB was opened. The new priority is not shown in the display. This will still be the priority from when the BTB was closed. The new priority will be based on the priority from before the BTB was opened. The new internal priorities are shown in the picture above.

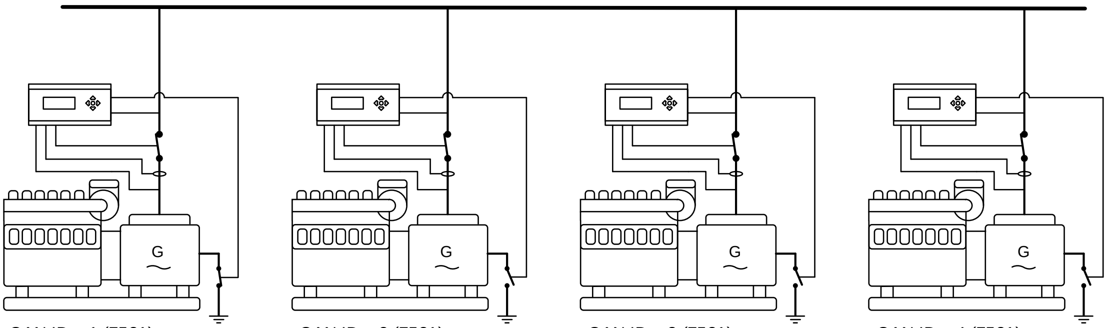
Parameter	**Item**	**Range**	**Default**	**Note**
8071	Priority selection type	Manual priority running hour priori-ty	Manual priority	
8081	Priority 1	PM CAN ID 1 PM CAN ID 32	PM CAN ID 1	
8082	Priority 2	PM CAN ID 1 PM CAN ID 32	PM CAN ID 2	
8083	Priority 3	PM CAN ID 1 PM CAN ID 32	PM CAN ID 3	
8084	Priority 4	PM CAN ID 1 PM CAN ID 32	PM CAN ID 4	
8085	Priority 5	PM CAN ID 1 PM CAN ID 32	PM CAN ID 5	
8086	Transmit the priori-ties	OFF ON	OFF	Will switch back to OFF automatically
8141	Running hours up-date (clock hours)	1 h 20000 h	175 h	
8142	Running hours type	Total Fuel optimisation	Total	
8143	Trip counter	OFF ON	OFF	Will switch back to OFF automatically

The parameters from 8091 - 8133 are similar to parameters 8081 - 8085.

5.9 Ground relay

5.9.1 Principle

The ground relay function can be used, to avoid circulating currents between the generators, which can be a problem in the plant modes where the generators are not parallel to the grid. The principle of the function is to let the biggest genset be the only one which has connected its star point to the earth. If more gensets are connected to the earth at the same time, and the star point of each generator has a slightly different potential, there is a risk of circulating currents. The ground relay function is using both priority and nominal settings for each genset, to select which ground relay should be closed. This is best explained by an example:



In the picture above, the plant consists of four gensets with two different nominal powers. By this, the earth connection must also be different sizes. If all the gensets are running at the same time, and the ground function is enabled, the genset with the biggest nominal power will have closed its ground relay. From the picture above, two gensets have the same nominal power. So the genset with first priority will close the ground relay. If genset with priority 1 is stopped, genset with priority 2 will automatically close its ground relay, since this is the one running with the biggest nominal power. If this priority should be stopped afterwards, the genset with first priority will close its ground relay, since the last two also have the same nominal power. It will be genset 3 since it has the first priority of the remaining gensets.

The ground relay function is not supported in stand-alone configurations.

If a genset with a bigger nominal power starts, and is about to be the biggest on the busbar, this new genset will close its ground relay. The ground relay will be closed shortly after start. When the new genset is connected to the busbar, the previous closed ground relay will open. So there will be a short time were two ground relays are closed at the same time. This is to avoid that there is a situation where no ground relays are closed.
If a BTB was placed in the application above, and placed between genset 2 and 3, and the BTB was open, a ground relay would be activated on each side of the BTB.
It does not matter if the AGC PM is operated in SEMI or AUTO. The ground relay function will work in the same way.
When a genset starts, it will close the ground relay. Otherwise, a genset could be running with open breaker, and not have a connection to earth. When the genset has closed its generator breaker, it will participate in the ground relay routine along with the other gensets. If the new incoming genset is smaller, it will open its ground relay, and if it is the biggest, the former biggest will open its ground relay instead.

5.9.2 Configuration of the ground relay

From parameter 8151 to 8153, the relay output for the earth connection is configured. In parameter 8151, the relay that should be used for closing the breaker is selected. Be aware that only continuous breakers can be used for this, since this function can only give a continuous signal. In parameter 8153, the Ground relay function is activated, and this parameter is shared between the gensets. To make the ground relay function work correctly, all the gensets need to have an earth connection.

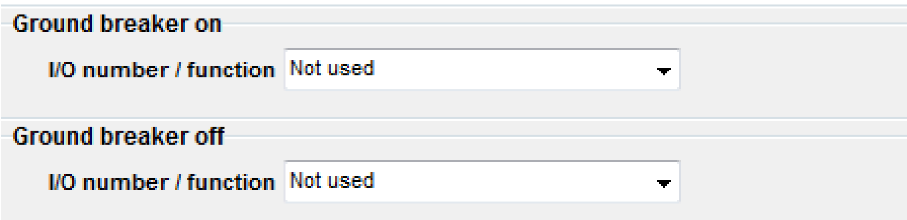
Parameter	Item	Range	Default	Note
8151	Ground relay output A	Not used Option-dependent	Not used	Only in genset
8152	Ground relay output B	Not used Option-dependent	Not used	Only in genset
8153	Ground relay activation	OFF ON	OFF	Only in genset

5.9.3 Ground relay in 3-level applications

If the ground relay function is activated in a 3-level application, the AGC PM will seek to have the biggest running genset in each group connected to the earth. It is also possible to have one genset group running with the ground relay function activated, and another group running with the ground relay function deactivated. The function works independently of what the other group has activated, since information about ground relay is not shared between groups.

5.9.4 Ground relay with breaker position

The AGC PM can monitor the breaker for the earth connection. This will have to be configured, and is found via the Input/Output list in the top of the Utility Software. In the list, the feedbacks are shown like this:



The first input is when the ground breaker is closed, and the other is when it is opened. If the operator wants to use the feedback, both feedbacks will have to be used. It is not possible with just one of them. The feedbacks from the breaker are wired to some spare digital inputs. The supervision of the breaker for earth connection is optional.

From parameter 8161 to 8166, the operator will find some different alarms regarding the supervision of the breaker. The first two parameters are for open failure of the breaker. The timer located in parameter 8161 decides how long time the AGC PM allows, from when it deactivates the ground relay until it sees a feedback telling that the breaker is open. If this timer expires, the AGC PM will do the action selected in parameter 8162. Parameter 8163 and 8164 are very similar. This is related to a close failure instead. This means that the AGC PM has closed the ground relay, but the feedback from the breaker has not changed from open to closed within the timer. Parameter 8165 and 8166 are also similar to the other two alarms. This one is related to the situation where there are no feedbacks, or both feedbacks at the same time to the AGC PM. But before the AGC PM will give the position failure alarm, the timer will have to expire. When the alarm is activated, the action decided in parameter 8186 will take place.

Parameter	Item	Range	Default	Note
8161	Ground relay/earth connection open failure timer	1.0 s 5.0 s	1.0 s	Only in genset
8162	Ground relay/earth connection open failure fail class	Warning Block	Trip GB	Only in genset
8163	Ground relay/earth connection close failure timer	1.0 s 5.0 s	1.0 s	Only in genset
8164	Ground relay/earth connection close failure fail class	Warning Block	Block	Only in genset
8165	Ground relay/earth connection position failure timer	1.0 s 5.0 s	1.0 s	Only in genset
8166	Ground relay/earth connection position failure fail class	Warning Block	Trip GB	Only in genset

5.9.5 Common ground relay failure

If the ground breaker has been configured with feedbacks, there is also an alarm for common ground failure. This alarm is located from parameter 8154 to 8155. This alarm will be activated when no gensets in the present section have the possibility to close the ground relay. This can happen because there is a position failure or a close failure in all of the gensets in the section. From parameter 8156, it is possible to select what should happen in this situation, and in 8155, it is decided for how long time all the controllers should have a ground relay related alarm present, at the same time.

Parameter	Item	Range	Default	Note
8151	Common ground failure alarm timer	1.0 s 5.0 s	1.0 s	Only in genset
8152	Common ground failure alarm fail class	Warning Block	Trip GB	Only in genset

5.10 Set points and power across the plant

5.10.1 Power reference scaling

In the AGC PM, different power references can be scaled. This can make it easier and faster to change a power set point. A power reference is used in different situations, and by this there are some different power reference scalings.

How the power reference is scaled is the same in all situations. It works as follows:

In parameter 7001 and 7002, the power reference and power scaling for fixed power are located. The power is set in parameter 7001, but in parameter 7002 the reference can be changed. By default it is set to 1:1 kW. This means the power set in parameter 7001 is the actual power wanted. If the scaling in parameter 7002 is changed to 1:10 kW, the power set in 7001 will be multiplied with 10. If the operator has put in 700 kW in parameter 7001, the power set point in the AGC PM is 700 kW. If the operator then changes parameter 7002 to 1:10 kW, the power set point in the AGC PM is changed to 7000 kW. The power set point and references for the different locations are located in the following parameters:

Mode	Power reference	Power scaling	Note
Fixed power	7001	7002	
Mains power export	7011	7013	
Peak shaving	7012	7013	
Load test	7031	7002	
LD start/stop	8001/8004/8011/8012	8022	Set in genset units. If this is changed, it must be equal in all gensets.

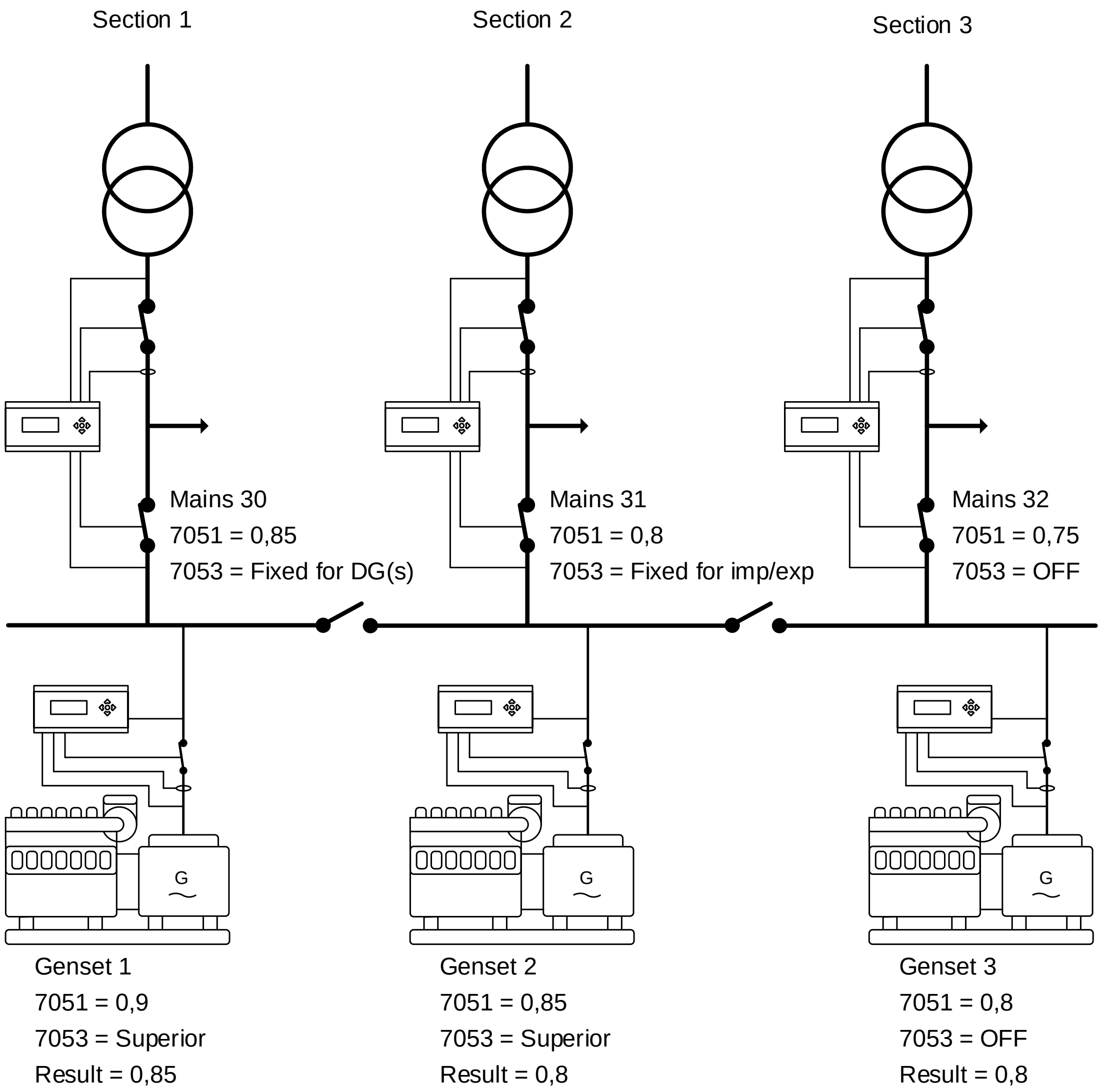
Parameter	Item	Range	Default	Note
7001	Fixed power set point	0 kW 20000 kW	500 kW	
7002	Fixed power reference scaling	1 kW: 1 kW 1 kW: 1000 kW	1 kw: 1 kW	
7011	Mains power export set point	-20000 kW 20000 kW	1000 kW	
7012	Peak shaving power set point	-20000 kW 20000 kW	750 kW	
7013	Fixed power reference scaling	1 kW: 1 kW 1 kW: 1000 kW	1 kw: 1 kW	
7031	Load test set point	1 kW 20000 kW	500 kW	
7002	Load test power reference scaling	1 kW: 1 kW 1 kW: 1000 kW	1 kw: 1 kW	
8022	Load-dependent start and stop, power reference scaling	1 kW: 1 kW 1 kW: 1000 kW	1 kw: 1 kW	Set in genset units

5.10.2 Cos phi control in 2-level applications

When using cos phi-controlled export in mains power export, or cos phi-controlled power in fixed power or cos phi-controlled import/export in peak shaving, some settings/terms need to be stated. These settings can be found in parameter 7053, and defines how the different AGC PMs should react and what the cos phi should be at the different locations:

Setting/term (7053)	**Explanation**
OFF	Ignores the cos phi set points in the level above the controller. The cos phi will then always be the one set in the genset. If the OFF is set in the mains controller, the gensets will use the cos phi in each genset controller.
Fixed for DG(s)	Means that the cos phi is fixed for the DG(s). Each genset will be running at the cos phi in the mains controller. (The cos phi is fixed for each genset at the cos phi in mains controller).
Fixed for imp/exp	The plant will try to maintain the cos phi set in the mains controller, across the mains breaker.
Superior	Allows that it is the controller placed further up in the layer above to control the cos phi set point, and the present controller to use or pass on the set point to a lower layer (gensets).

How the different settings operate in a plant is explained by an example:



IIn the drawing above, the cos phi and the setting for 7053 is different across the application. This gives different possibilities for the plant. The plant above consists of three static sections which will be referred to as section 1, 2 and 3. How the cos phi will be handled in each section will be described below.n the drawing above, the cos phi and the setting for 7053 is different across the application. This gives different possibilities for the plant. The plant above consists of three static sections which will be referred to as section 1, 2 and 3. How the cos phi will be handled in each section will be described below.

- **Section 1:** In the genset, parameter 7053 is set to superior. This means that it allows the controller above to control the cos phi. In the mains controller, parameter 7053 is set to fixed for DG(s). The mains controller says that each genset in this section should be running at the cos phi set in mains controller. In the mains controller, the cos phi (7051) is set to 0.85, so in this section, the genset will have a cos phi of 0.85, even though its own cos phi set point is set to 0.9 in the genset. If another genset was present in this section, and set to OFF instead of superior, the new genset will be running at the cos phi set in it.

- **Section 2:** In the genset, parameter 7053 is set to superior, which means that the genset allows the controller above to decide the cos phi. In the mains controller, parameter 7053 is set to fixed for imp/exp. This means that this section will try to keep at a constant cos phi across the mains breaker. So in this situation, the cos phi will be 0.8 across the mains breaker. If one more genset was present in this section, and its parameter 7053 was set to OFF, the extra genset will keep the cos phi located in the controller. The AGC PM will still try to maintain the cos phi across the mains breaker, which means that the genset(s) set to superior will try to compensate for the other one(s).
- **Section 3:** In this section, the gensets parameter 7053 is set to OFF. This means that the cos phi set point in the genset will always be the ones set in the gensets, and it will be a cos phi across the generator breaker. So it does not matter what has been set in the mains controller, since the genset will ignore this because it is set to OFF. If there was another genset in this section, and parameter 7053 was set to superior, this cos phi set in the genset controller would still be used, since the mains controller's parameter 7053 was set to OFF.

If there were two mains controllers present in one section, and the plant was running in mains power export with a set point of 2000 kW, none of the mains connections would ever reach 2000 kW (if the gensets were exporting to both mains at the same time). This is because 2000 kW forms the totally exported power, and not just a part of the power on the mains with “ID to run”. If the power set in parameter 7011 is different in these two mains controllers, the mains with “ID to run” decides what the set point should be.

5.10.3 Cos phi control in 3-level applications

When using cos phi-controlled export in 3-level applications, the set point can be dictated from different places. To give an overview, it is easiest to explain how the set points react in different situations. The set points for the genset controller can be:

Setting/term (7053)	Explanation (in genset controller)
OFF	Ignores the set point sent from other controllers. The cos phi will always be the one set in the genset controller.
Superior	Allows the genset to receive the cos phi from another controller placed in one of the layers above.

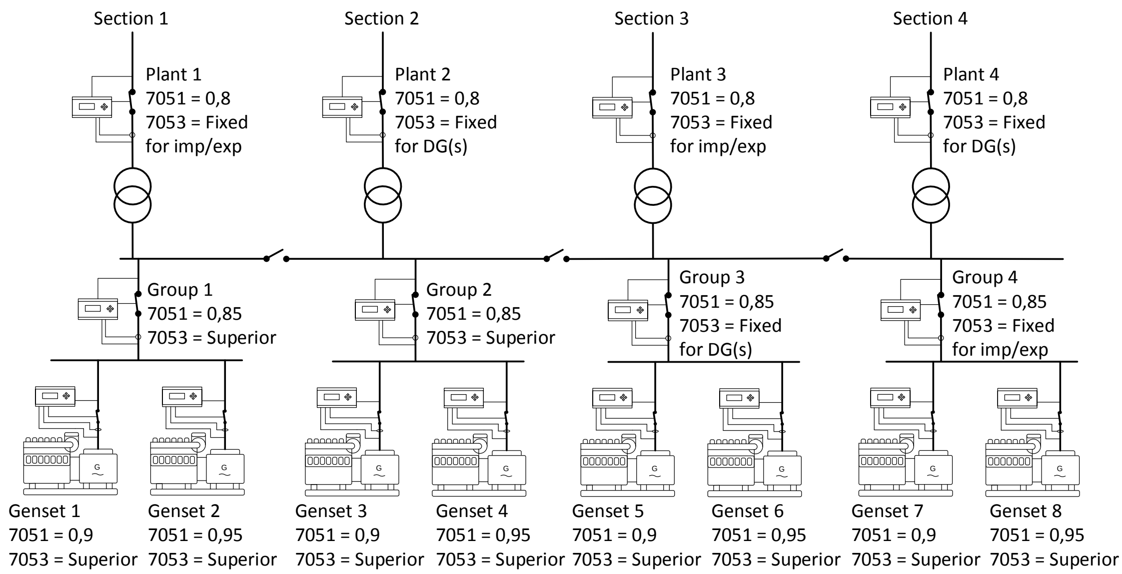
In the group controller, the settings for parameter 7053 can be:

Setting/term (7053)	**Explanation (in group controller)**
OFF	If this is set in the group controllers, the gensets will always use the cos phi set point in the specific genset controller, even though the gensets are set to superior. If this group is set for this, it does not matter what the plant is set for, since this will be ignored.
Superior	The group allows the plant controller to control the cos phi set point. If the plant controller's 7053 is set to OFF, the cos phi will again be the one set in the specific genset controller.
Fixed for DG(s)	If this is set in the group controller, the gensets will all run with the cos phi set point set in the group controller. It will only be the gensets that have been set for superior. The set point in the gensets is not used, but instead the one set in 7051 in the group. If some gensets have been set for OFF, these gensets will use the cos phi set point set in each specific genset controller, and the ones set for superior will run at the cos phi set in group controller. If this group is set for this, it does not matter what the plant is set for, since this will be ignored.
Fixed for imp/exp	When this is set, the group controller adjusts the set points in the gensets, so the cos phi set in 7051 will be maintained across the group tie breaker. If a genset is set to OFF, it will run with the set point set in it, and the other gensets will compensate for it, so the cos phi is kept at the group tie breaker. If this group is set for this, it does not matter what the plant is set for, since this will be ignored.

The set point can be sent from the plant controller, and by this the settings in the plant controller also need to be set. Before a plant controller can decide the cos phi set point, the genset and group will have to be set to superior. In the plant controller, the settings in parameter 7053 will be:

Setting/term (7053)	**Explanation (in plant controllers)**
OFF	If this is set to OFF, and the group and genset is set to superior, the set points in each genset will be active, or controlled from the group controllers.
Fixed for DG(s)	When this is activated, the set point set in parameter 7051 in the plant controller is the one the gensets will use as cos phi set point. Each genset will maintain this set point individually.
Fixed for imp/exp	When the plant controller is set for this, the plant controller is changing the set points accordingly to the load. The plant controller will try to maintain a constant cos phi across the breaker on plant level. This cos phi is set in parameter 7051 in the plant controller.

How all these settings work in a plant can be explained by an example:



The plant above consists of 4 static sections (note that the three BTBs are open). The settings for each controller regarding cos phi control are shown above. How the plant behaves in each section will be described below:

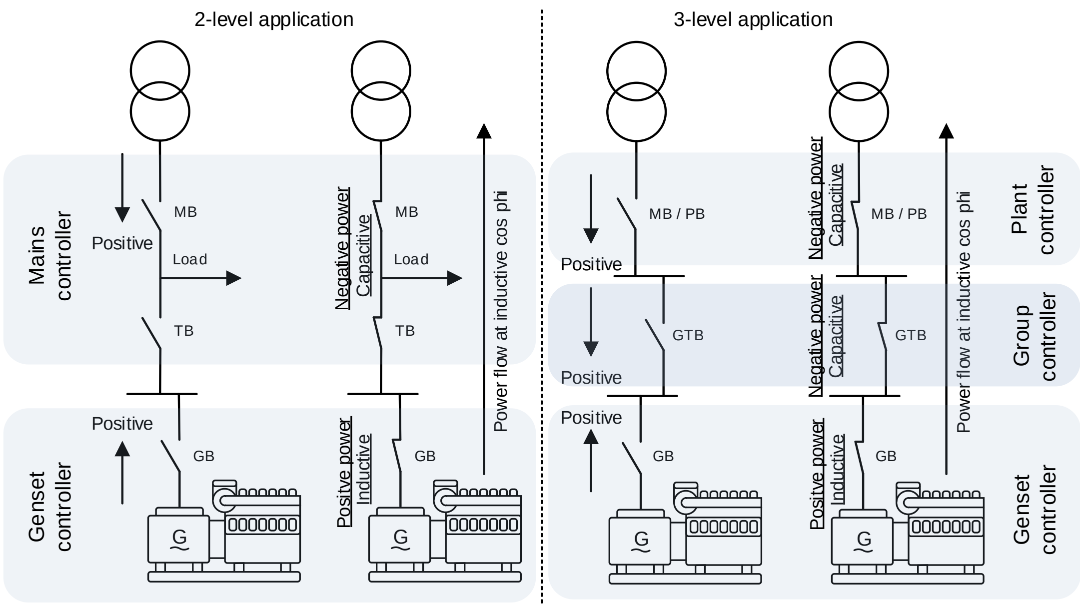
- **Section 1:** The gensets have been set to superior. The group is also set to superior, which means the two bottom layers are ready for receiving the cos phi set point from the plant controller. In the plant controller, 7053 is set for fixed for imp/emp. So, this section will try to maintain a cos phi of 0.8 across the breaker at plant level. The cos phi of 0.8 is the set point in the plant controller. If genset 1 had been set to OFF in parameter 7053, it would run at cos phi 0.9. Then genset 2 would try to compensate for this, so the cos phi could be kept across the plant breaker.
- **Section 2:** The gensets and group is set to superior. This means that it will be the plant controller that can dictate what the cos phi should be. In the plant controller, parameter 7053 is set to fixed for DG(s). This means that the gensets should each run with the cos phi set in the plant controller. So genset 3 and 4 will

be running at cos phi 0.8 at this point. If the parameter 7053 in the plant controller is changed to OFF, the gensets will be running with the cos phi set in each genset controller. This means that genset 3 will be running at cos phi 0.9 and genset 4 will be at 0.95.

- **Section 3:** In this section, the gensets are set to superior. This means that the controller above can control the cos phi. In the group controller, parameter 7053 is set to fixed for DG(s). By this the plant controller will not be able to control the cos phi, since the group controller is not set to superior. The group controller will control the cos phi instead. With the settings in the group controller, each genset will be running at cos phi 0.85, since this is set in the group controller. The fixed for DG(s) setting determines which cos phi each genset should be running at, and in this case the cos phi is decided in the group controller.
- **Section 4:** The gensets are set to superior, so a controller above will control the cos phi. In the group controller, parameter 7053 is set to fixed for imp/exp. The controllers will then maintain the cos phi set in parameter 7051 in the group controller. This cos phi is across the group tie breaker. If parameter 7053 in the group controller is set to OFF, the gensets will be running at the cos phi set in each genset.

5.10.4 Additional information for cos phi control

The AGC PM is capable of measuring the current in both directions. This means it can measure if the power is flowing from the genset (exporting) or going into reverse power (importing power). When the genset is importing power, it is shown in the display as negative power. On the mains controller, positive power is considered when the power flowing from the grid into a load, and by this when exporting to the grid it is shown as negative power. So if the gensets are running at inductive cos phi, the mains controller will calculate it as the opposite, which means it is capacitive for the mains controller. How the different controllers see the power positive and negative is shown below:



Above is shown how the different controllers calculate the power flow as positive. This means if the genset is exporting power to the grid, and there is no load, and the genset is running inductive, the controllers above will see these as negative power, and also the reactive power is considered as capacitive. So if the mains controller should export inductive load to the grid, it will be seen as negative P-power and capacitive Q-power.

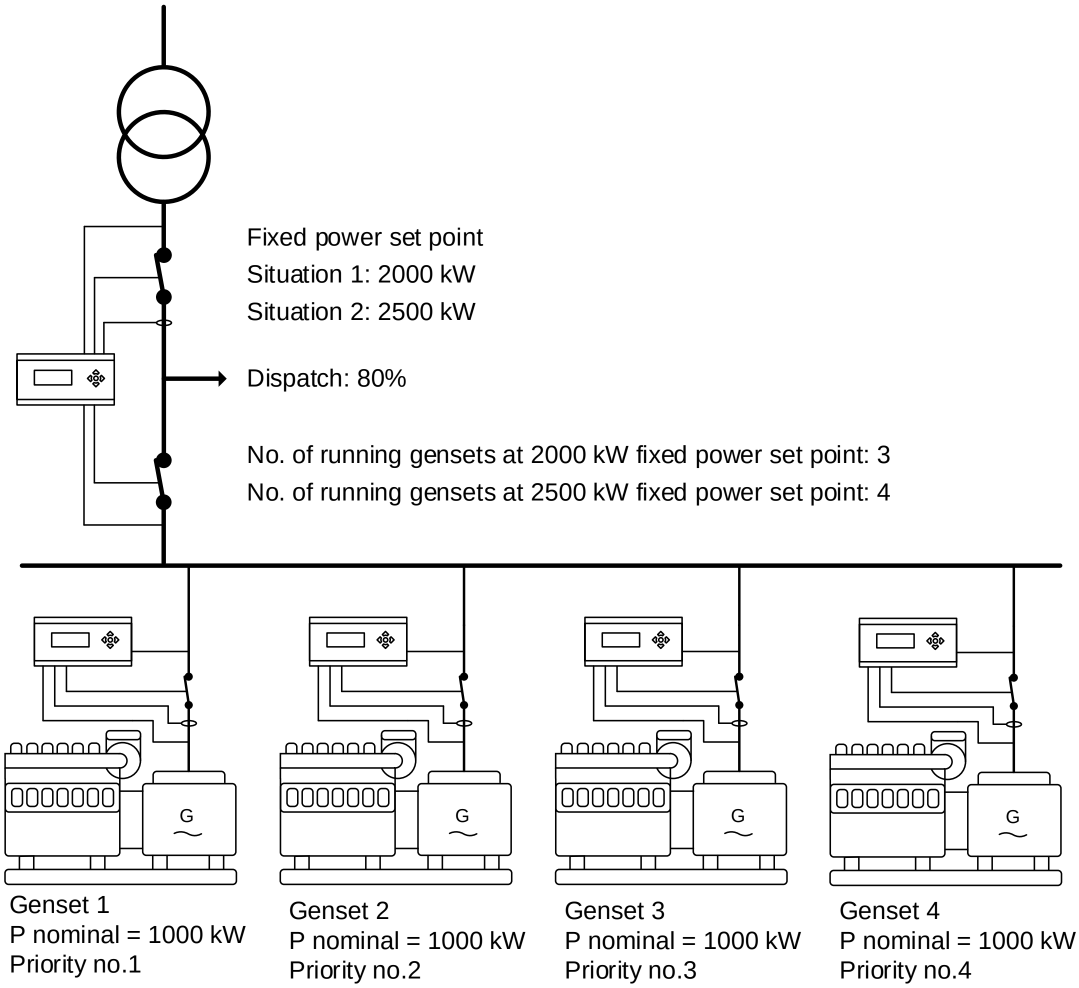
In parameter 7052, it is chosen whether the cos phi is inductive or capacitive. If the operator wants to keep an inductive power towards to the grid, and maintain the cos phi at the MB, it will be required to go to parameter 7052 and change this to capacitive since the power is negative for the mains controller.
This parameter can also be reached from M-Logic, so some custom logic can be made. To change the power reference from the M-Logic, these commands are called: inductive reference and capacitive reference, and they can be found under Commands.
If there is mismatch in reference in some of the controllers, the gensets will regulate towards a cos phi of 1, or be capacitive when inductive is wanted.
Furthermore, the AGC PM holds some limits that can be set when using cos phi-controlled export. In parameter 7054, the operator can choose between three selections, which will be described below:

- **OFF:** When parameter 7054 is set to OFF, there is no outer limits for the cos phi. This can be risky to use since it will be possible to request a cos phi that is above the limits for the alternator’s limits for capacitive or inductive loads.
- **Droop curve:** If parameter 7054 is set to droop curve, the limits for the cos phi is chosen in the droop curve used in voltage support (which will be described later), and set from parameter 7151 to 7183. When droop curve has been chosen at limits, the AGC PM allows regulating to these limits. It does not matter how loaded the genset is, the genset will not cross these limits, even at low loads.
- **Capability curve:** If the controller is set to capability curve, the AGC PM will use the capability curve set from 1741 to 1796. Before the capability curve is set as limits for cos phi, be sure that the capability curve has been configured correctly! (How to configure the capability curve is described later in this document). When the AGC PM uses the capability curve as limits for the cos phi, the phase angle can be very high, since the genset will be allowed to be anywhere inside the capability curve. The AGC PM will now measure directly on the reactive power, instead of a cos phi that must never exceed e.g. 0.8. If the operator wants to narrow the area inside the capability curve, parameter 7055 can be used. This one is set in percentage, and if set to 100 %, it means in cos phi-controlled export, it will be allowed to use the whole area. When turning down on the percentage, the area becomes more narrow which can be used to protect the alternator, since the capability curve describes the limits for the alternator.

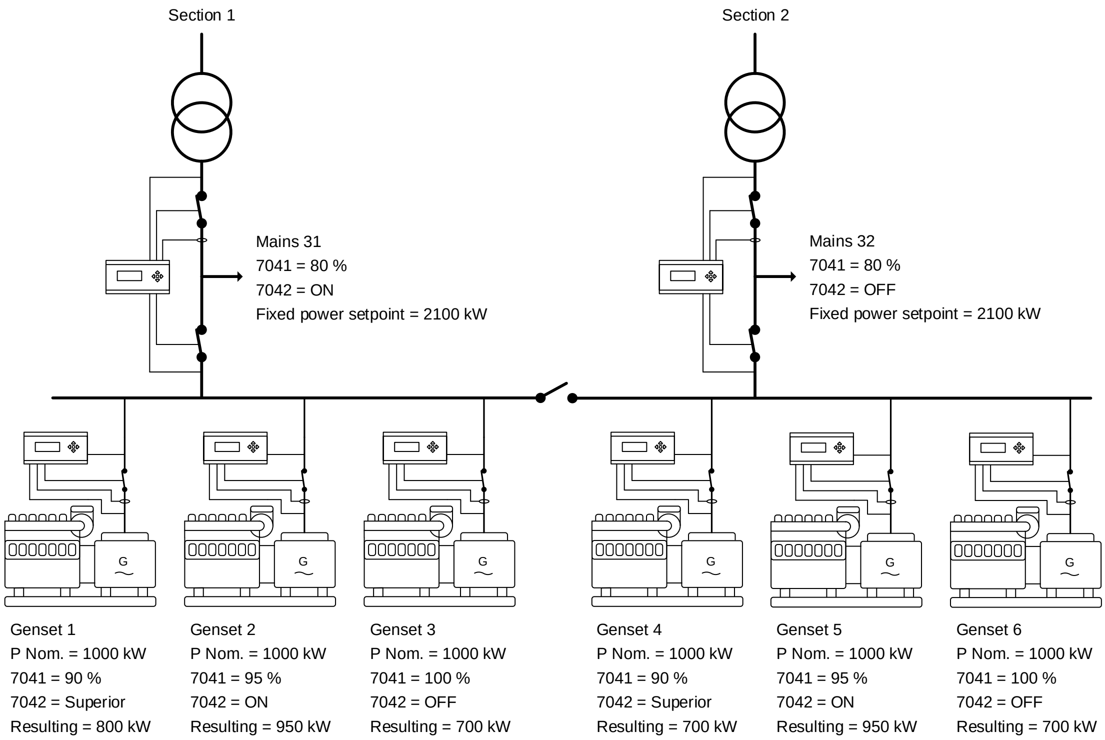
Parameter	**Item**	**Range**	**Default**	**Note**
7051	Cos phi value	0.1 1	0.9	
7052	Selection between inductive or capacitive reference for cos phi	Inductive Capacitive	Inductive	
7053	Power reference location	OFF Superior	Superior (in genset)	
7054	Limits for cos phi in parallel operation	OFF Capability Curve	Droop curve	Capability is only in genset
7055	Capability curve restriction	20 % 100 %	95 %	Only in genset

5.10.5 Dispatch in 2-level applications

The AGC PM holds a function called dispatch. This function allows the operator to overrule the set point for the plant modes with parallel operation. This means that if a plant consisting of AGC PMs is requested to be running at e.g. 15 MW fixed power, and the dispatch function is enabled, the plant will deliver 15 MW as minimum. The dispatch function contains a percentage, which is the load percentage the genset should seek to, instead of matching the load set point exactly. The operator can control this percentage from the controllers. Dependent on the settings, this is set individually in each genset, or from controllers placed in the layer(s) above. How the dispatch function is working is explained by an example:



Above is shown an application with 4 gensets and one mains controller. The dispatch is set to 80 %, and the plant mode is fixed power. At first, the request is 2000 kW, and the load-dependent start/stop dictates that 3 gensets should be running. When the dispatch function is enabled, the three gensets running will be running at the percentage set in the dispatch. The gensets will deliver a bigger power than requested from the fixed power set point, but with the fixed power set point as a minimum power. But still in respect to the fixed power set point. In this situation, the three gensets will be running at 80 % load each, which means that they will be delivering 2400 kW in common., even though only 2000 kW is requested. If the fixed power set point is increased to 2500 kW, the load-dependent start/stop dictates that 4 gensets should be running. When 4 gensets are running with dispatch at 80 %, they will be delivering 3200 kW, at the 2500 kW fixed power set point. The set point for the dispatch function can be controlled from either the mains or each genset. If the dispatch set point is controlled from the mains, all the gensets can be controlled from one mains controller. The different ways to control the dispatch set point in the controllers is shown in the picture below:



In the picture above, the settings regarding dispatch are set differently, and this gives different possibilities to control the power on the gensets. In both sections, the fixed power set point is 2100 kW, and with the load-dependent start/stop settings, three gensets will be running. How the different gensets will react is described below.

- **Section 1:** In this section, genset 1 is set to superior, which means that the controller above is allowed to control the dispatch percentage. Genset 2 is set to ON, which means that it will be the dispatch percentage set in the genset controller. In genset 3, the dispatch function is set to OFF. This means that the dispatch function will not be used, and this genset will follow the fixed power set point in the mains controller. Since genset 1 is set to superior and dispatch is set to 80 % in the mains controller, genset 1 will be running at 80 % dispatch (800 kW). The dispatch function is also enabled on genset 2, but set to ON instead. This means that the genset will use the dispatch percentage set in the genset (95 %), and by this it will be running at 950 kW. Genset 3 is following the set point for the fixed power, and by this it will be running at 700 kW (2100/3).
- **Section 2:** Note that in this section, the dispatch is set to OFF in the mains controller. This changes the situation for the controllers which is set to superior. Genset 4 is set to superior, so it allows that the mains should set the dispatch. When the mains is set to OFF, genset 4 will not use the dispatch, and then just follow the fixed power set point. This means that it will be running at 700 kW (2100/3). Genset 5 is set to ON, instead of superior, so it will be using the dispatch percentage set in the controller, which is 95 %, so it will be running at 950 kW. Genset 6 is set to OFF, so it will be using the fixed power set point as reference, and in this situation it will be running at 700 kW (2100/3).

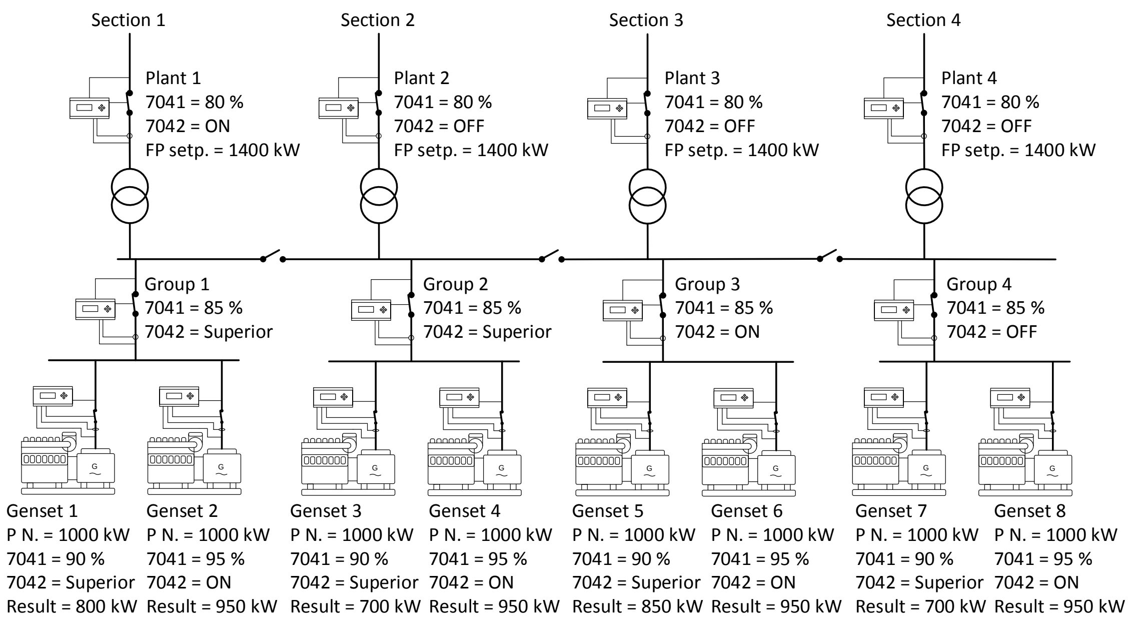
The dispatch function also contains a setting that determines what minimum load on the genset should be when the plant is in a parallel plant running mode. This value set here, is always active even though the dispatch function is disabled.

If more than one mains controller is located in a section, the dispatch percentage and function can be controlled from all the mains controllers, since the percentage and enable/disable is shared between them. It is possible to activate the dispatch in one mains controller, and go to the next and adjust on the dispatch percentage.
If all the gensets are running, and the e.g. fixed power set point is above what all the gensets are delivering in dispatch power, the gensets will instead follow the fixed power set point. The AGC PM will use the dispatch power if this is bigger than the e.g. fixed power set point, and it will use the fixed power set point if it is bigger than the dispatch set point.
The relevant parameters for the dispatch function are shown below:

Parameter	Item	Range	Default	Note
7041	Dispatch percentage	30 % 100 %	100 %	
7042	Dispatch reference	OFF Superior	Superior (in genset)	
7043	Minimum dispatch/ minimum load	0 kW 20000 kW	20 kW	Only in genset

5.10.6 Dispatch in 3-level applications

When using the dispatch function in 3-level applications, the same parameters are used. The dispatch percentage can be controlled from different places in these applications, which gives different possibilities. This is described below:



How the AGC PM reacts in the different scenarios is described for each section:

- **Section 1:** In this section, genset 1 is set to superior, and the group controller is also set to superior. This means that plant controllers are allowed to dictate the dispatch percentage. The plant controllers' dispatch is set to ON, so this percentage will be used in the gensets set to superior. This means that genset

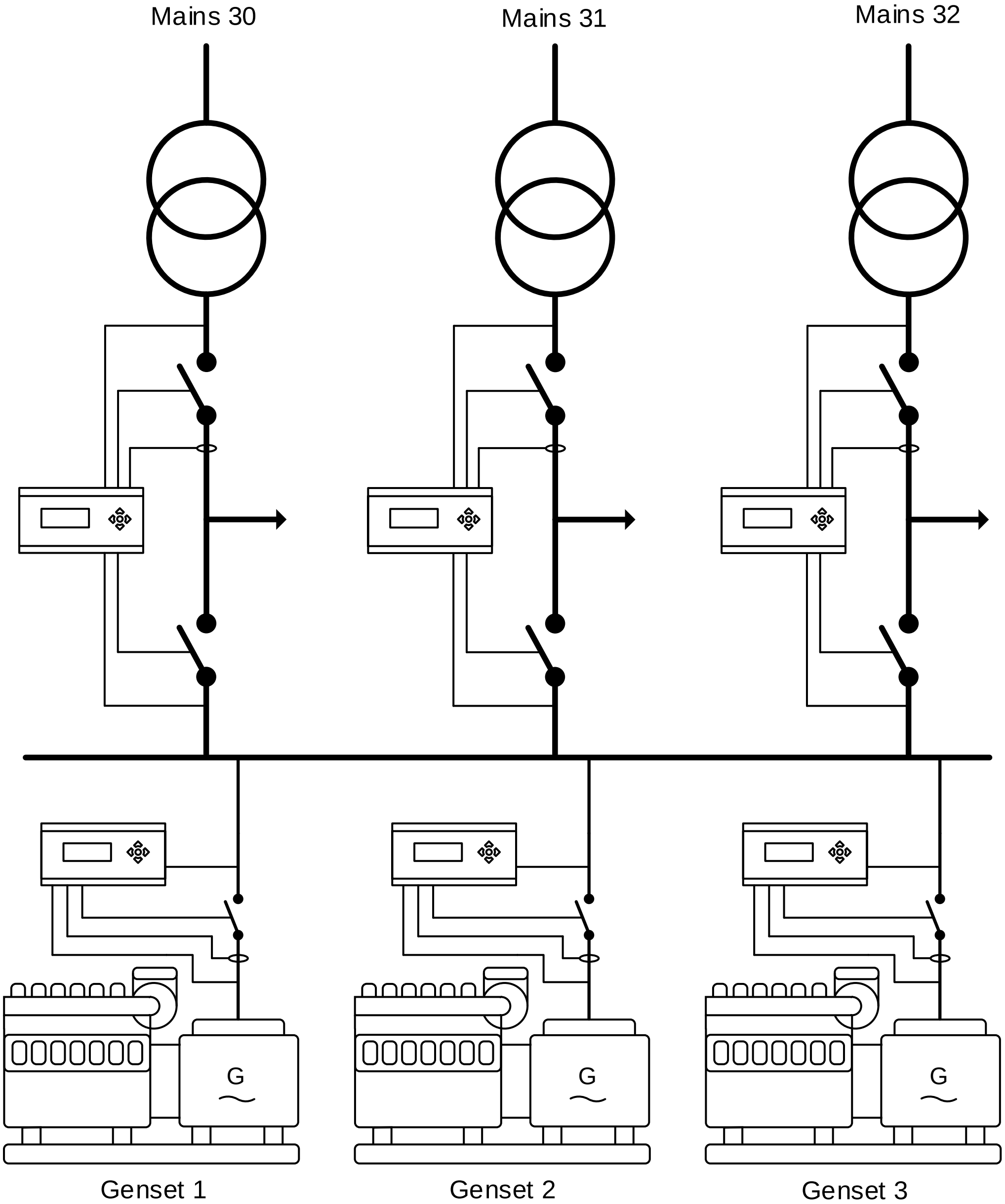
1 will be running at 800 kW (80 % from the plant). Genset 2 is set to ON, which means that it will use the dispatch in it, and by this it will be running at 950 kW (95 %). When it is set to ON, it will always use the dispatch in the genset controller. If one of the gensets were set to OFF, it would be following the fixed power set point and in this case be running at 700 kW (1400/2).

- **Section 2:** Genset 3 and the group controller are set to superior. So genset 3's dispatch is allowed to be dictated from the plant controller. In the plant, the dispatch function is set to OFF, so genset 3 will use the normal fixed power set point as reference, and deliver 700 kW (1400/2) in this situation. Genset 4 is set to ON, so it will be using its local dispatch percentage even though the plant's dispatch is set to OFF. If one of the gensets dispatch were set to OFF it would always follow the fixed power set point.
- **Section 3:** Genset 5 is set to superior, and the group controller is set to ON, which means that the genset will use the dispatch percentage in the group controller. Genset 5 will be running at 850 kW, since the dispatch is set to 85 % in the group controller. Genset 6's dispatch is set to ON, so it will be running at the dispatch percentage it is set for, and by this it will be producing 950 kW (95 %). If one of the gensets were set to OFF, it would be following the fixed power set point, which means in this case that it would be producing 700 kW (1400/2).
- **Section 4:** In this section, genset 7 is set to superior, which allows the controller placed above to control the dispatch. On the group controller, the dispatch is set to OFF, which causes that the dispatch function is switched off in all the genset controllers that has been set to superior. This means that genset 7's dispatch function is switched off, and it will be looking directly at the fixed power set point, and by this it will be running at 700 kW (1400/2). Genset 8 is set to ON, so it will be running at the dispatch percentage set in the specific genset controller, and in this case 950 kW (95 %).

The dispatch function can be used to control the load percentage on all the gensets in the entire plant, or group-wise. This will require that all the gensets are set to superior, so they will be listening to the dispatch from the controllers above. If all the gensets are set to superior, it will be easier for the operator to e.g. go to a group controller and change the dispatch percentage instead of going to all the gensets and activate and change the set point in each of them.
The parameters for the dispatch function are shown in the chapter for dispatch in 2-level applications.

5.10.7 Power offset

In the AGC PM, there is a possibility to active some power offsets via M-Logic. There are three different offsets for the power set point that can be combined, which in total means that a numerous power set points are available. Since the power set point offsets are activated through M-Logic, it is configurable when these should be activated. It can be done by either by events or digital inputs. It is also possible to activate the power offsets via Modbus. If more than one offset is activated at a time, these will be added together. The three set points for the power offset are located from parameter 7221 to 7226. The power set point is explained by an example:



This could be a typical application where the power offsets are used. It can be appropriate that the gensets are running with a higher fixed power set point when more than one mains feeder is synchronised to the busbar. If the power set point is higher than the load-dependent start dictates, an extra genset will be started, since it will not be possible to overload the gensets in fixed power mode. If none of the offsets are activated, the power set point that is used is the normal fixed power set point.

Be aware that the power set point is dictated from the controller with “ID to run” (8066).

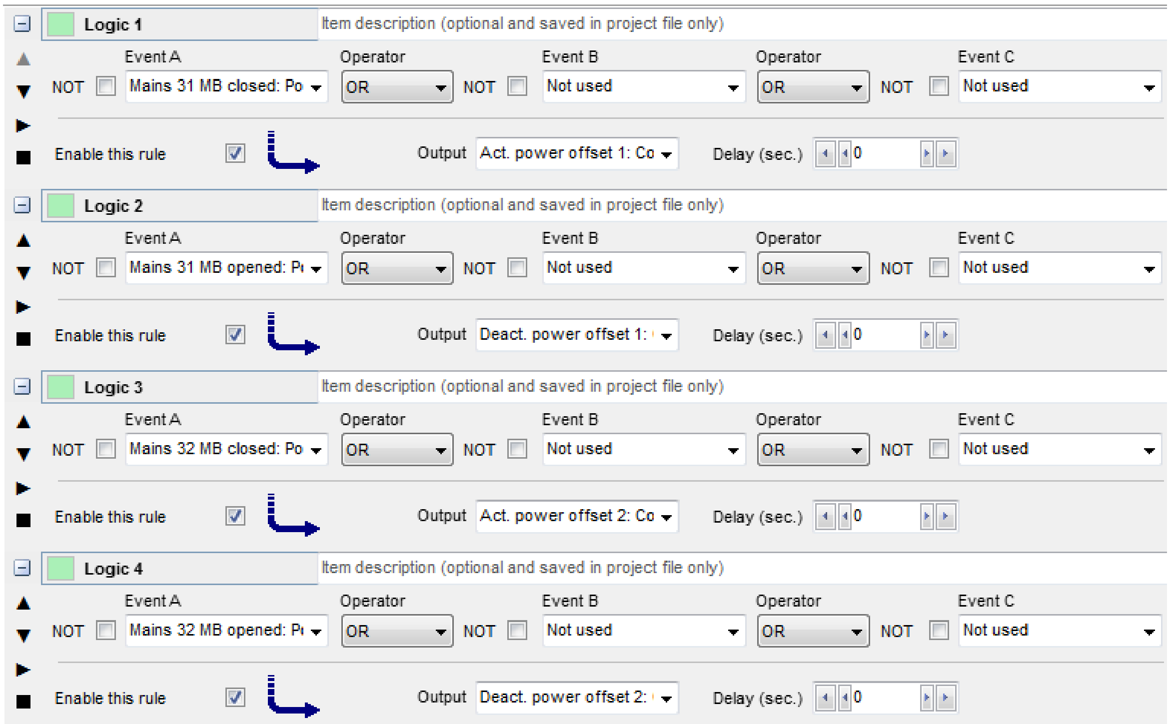
If the offsets are activated, it will have to be done in the controller with “ID to run”, since it is this controller that is dictating the power at the moment.
Now some digital inputs can be programmed to the controller with “ID to run”. The power set points in the different situations are wanted like shown below:

- When only MB40 is closed = 1.5 MW
- When MB30 and MB31 are closed = 3 MW
- When MB31, MB31 and MB32 are closed = 4 MW

The fixed power set point should then be 1.5 MW since it is the smallest. Afterwards, two offsets should then be programmed:

- Power offset 1 (7221): 1500 kW
- Power offset 2 (7223): 1000 kW

The offsets can be handled manually by some digital inputs that can be controlled by an operator or a PLC. Otherwise, this can be controlled by events in M-Logic, where the programming can be like shown below:



In the programming above, the first power offset is activated when MB 31 closes, and deactivated when MB 31 opens. Power offset 2 is activated when MB32 is closed, and deactivated when MB32 is opened. If MB32 is closed before MB31, the power offset 2 will be activated before power offset 1. If the normal fixed power set point is 1.5 MW, and MB32 is closed, the new set point will be 2.5 MW. If MB31 is closed afterwards, the power set point will then be 4 MW (1.5 + 1 + 1.5).
The relevant parameters for the power offset are shown below:

Parameter	Item	Range	Default	Note
7221	Power offset 1 set point	-20000 kW 20000 kW	0 kW	
7222	Power offset 1 activation	OFF ON	OFF	Can be done from M-Logic
7223	Power offset 2 set point	-20000 kW 20000 kW	0 kW	
7224	Power offset 2 activation	OFF ON	OFF	Can be done from M-Logic
7225	Power offset 3 set point	-20000 kW 20000 kW	0 kW	
7226	Power offset 3 activation	OFF ON	OFF	Can be done from M-Logic

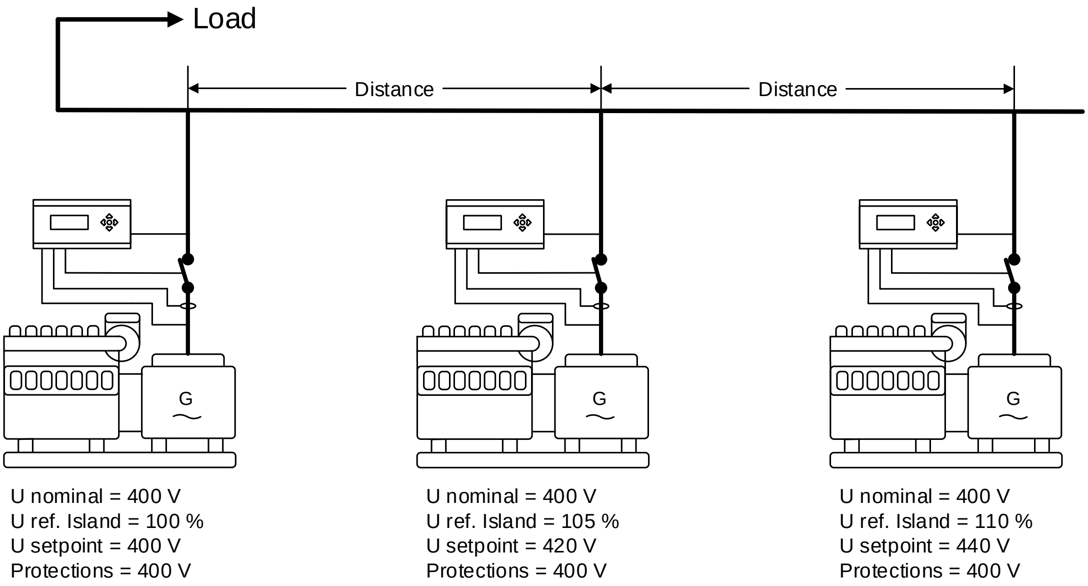
5.10.8 Cos phi offset

The cos phi offset is very similar to the power offset function. This function is active, when it is one of the parallel plant modes. This is also set from parameters and M-Logic. The parameters for the set points for the cos phi offset are located from 7241 to 7246, and they hold three offsets that can be used independently of each other. The set points for these offsets can be set to negative values, which means it is possible to subtract and add to the cos phi used, via the offsets. The calculation is working as follows:
The normal cos phi is set to 0.8. Via a digital input, cos phi offset 1 is activated. When this one is activated, the cos phi should be 0.9. So the setting in parameter 7241 would be 0.1. Now the operator wants to change the cos phi to 0.95 via an extra digital input. This input activates cos phi offset 2, and the setting in parameter 7243 will have to be 0.05.
Note that if a positive value is set in the parameters, this value will be added to the cos phi set point. It is <u>not</u> the new cos phi set point, but a value to be added or subtracted.
The relevant parameters are shown below:

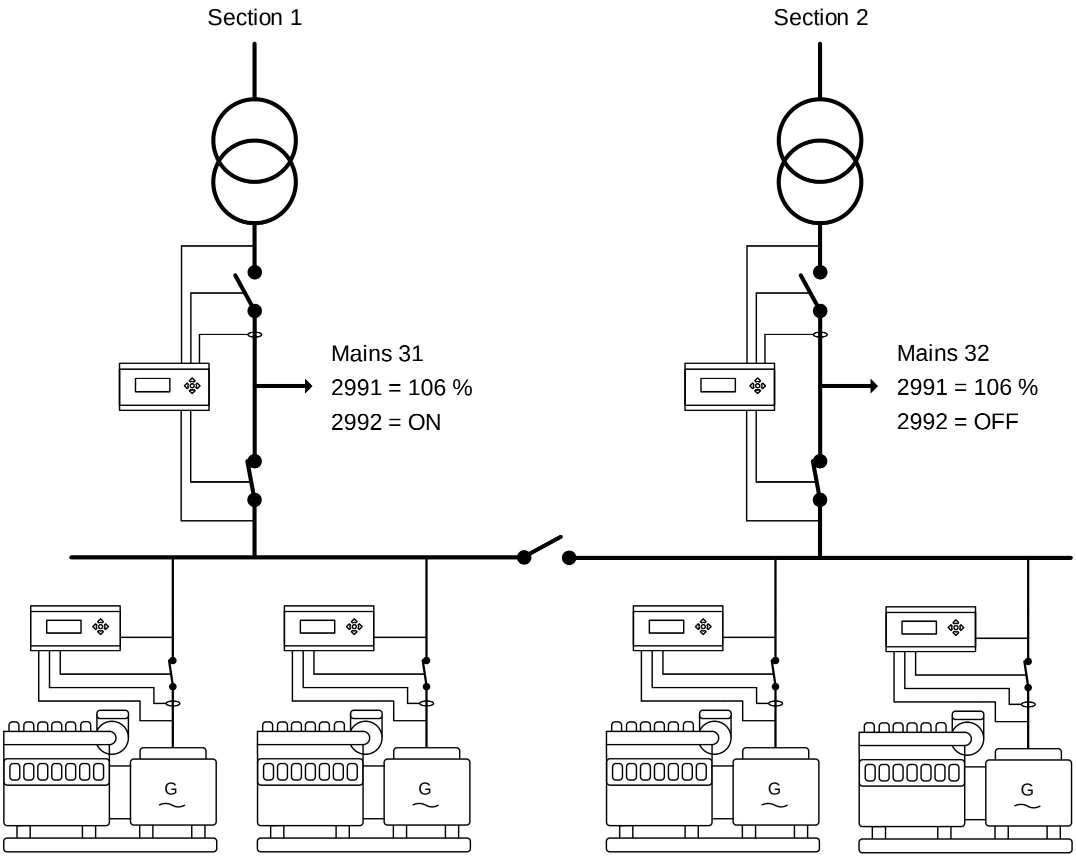
Parameter	Item	Range	Default	Note
7241	Cos phi offset 1 set point	-0.80 0.80	0.00	
7242	Cos phi offset 1 activation	OFF	OFF	Can be done from M-Logic
7243	Cos phi offset 2 set point	-0.80 0.80	0.00	
7244	Cos phi offset 2 activation	OFF	OFF	Can be done from M-Logic
7245	Cos phi offset 3 set point	-0.80 0.80	0.00	
7246	Cos phi offset 3 activation	OFF	OFF	Can be done from M-Logic

5.10.9 Voltage reference in islanded plant running modes in 2-level applications

The AGC PM can be placed in applications where it will be running in one of the islanded plant modes and where there could be a big distance between the gensets. In these applications, it could be a problem to make the gensets load-share the reactive power equally because of the long cables. To compensate for this, the AGC PM holds a function that is described below:



Above is an application with three gensets operating in island mode. Between each genset, there is a big distance, and the load is connected in the end of the busbar for the gensets. This means that one genset will be much closer to the load than the other. This entails that the wires between each genset and the load are very different, and the current running in the cables will give a voltage drop. The longer cables will give a bigger voltage drop, which the AGC PM can compensate for. In each of the gensets, the nominal voltage is set, but also a reference for the voltage in island operation can be set. This island reference is set individually, and should represent the voltage drop that the genset will experience compared to the genset with the lowest voltage drop. This function can only be active in the one of the islanded plant running modes. When the AGC PM is using the voltage reference, it allows rising/lowering the voltage from the nominal voltage. This reference is set in percentage compared to nominal voltage. All the protections in the AGC PM still refer to the nominal voltage, so the protections will not change even though the reference is changed very much.
If the AGC PM is placed in an application with some mains controllers, the voltage reference can be controlled from either the gensets or the mains. This is shown in the diagram below:



In the drawing above, the plant is divided into two static sections by the BTB. Both section's plant mode is Load Take Over (LTO), where the gensets are running. The two sections are described below:

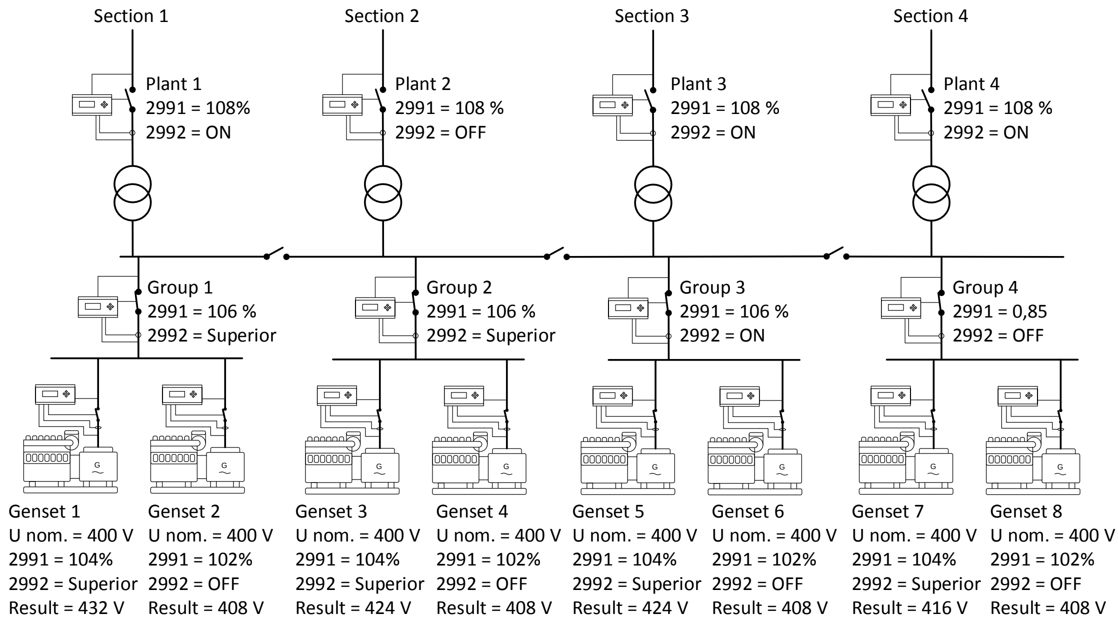
- **Section 1:** in this section, the voltage reference of genset 1 is 102 %, and parameter 2992 is set to superior. This means that the controller above is allowed to control the voltage reference. In the mains controller, parameter 2992 is set to ON, with the reference of 106 %. This means that genset 1 will be running at 106 % voltage, since it is set to let the mains dictate the voltage reference. Genset 2 is set to 104 % reference and parameter 2992 is set to OFF. This entails that the genset's voltage reference will always be used in islanded plant modes. In this case, it will be 104 % (416 V).
- **Section 2:** In this section, genset 3 voltage reference is set to 102 % and parameter 2992 is set to superior. So the mains is allowed to decide the voltage reference for genset 3. In the mains controller, the reference is set to 106 %, but parameter 2992 is set to OFF. This means that the gensets set to superior in parameter 2992 will use the voltage reference setting set in each of them. In the case of genset 3, the genset will be running at 102 %. Genset 4 is set to 104 % voltage reference, and parameter 2992 is set to OFF. This means that genset 4 will be running at 104 %.

The voltage reference for island function is always active. By default, it is set to 100 %, which means the genset will seek to run at its nominal voltage.
If the AGC PM is placed in an application with more mains controllers, the gensets set to superior will allow the mains controllers concerning the voltage to decide. In multi-mains applications, the voltage reference between mains controllers are shared, so when it is changed in one of them, it will be shared between all in the present section.
The relevant parameters for the voltage reference are shown below:

Parameter	Item	Range	Default	Note
2991	Voltage reference Islanded mode	80 % 120 %	100 %	
2992	Voltage reference control	OFF Superior	Superior	

5.10.10 Voltage reference in islanded plant running modes in 3-level applications

The voltage reference function for 3-level applications is very similar to voltage reference in 2-level applications. In 3-level applications, the voltage reference can be controlled by the individually genset, by the group controller or by the plant controller. Below is a description of how the voltage reference is controlled in the different situations:



The different sections will be described below:

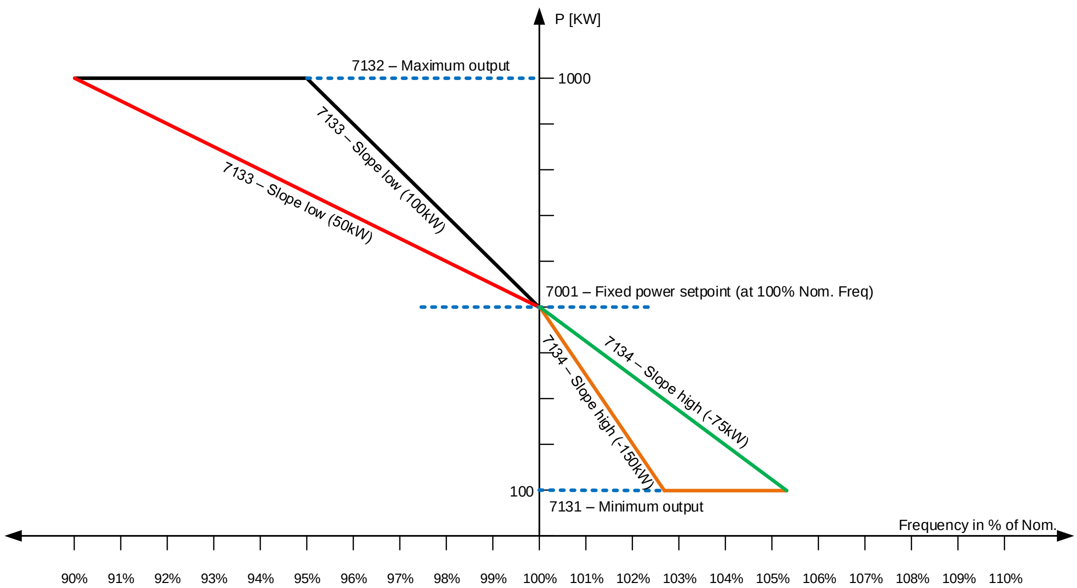
- **Section 1:** in this section, genset 1 and the group controller are set to superior. In this way, the plant controller is allowed to control voltage reference for genset 1. The plant controller's voltage reference is set to ON, so genset 1 will use the voltage reference set in the plant controller (108 %). The voltage reference of genset 3 is set to OFF, so it will be using the voltage reference set in the genset controller (102 %).

- **Section 2:** In this section, genset 3 and the group controller is set to superior. The plant controller is then allowed to control the voltage reference. The plant controller is set to OFF, so genset 3 will instead be using the voltage reference set in the group controller, and by this be running at 106 %. Genset 4 is set to OFF, so it will be using voltage reference set locally in it (102 %).
- **Section 3:** Genset 5 is set to superior and the group controller is set to ON. So the group controller will dictate the voltage for genset 5, and in this situation the genset will be running at 106 %. Genset 6 is set to OFF, so it will be using the voltage reference set in the controller (102 %).
- **Section 4:** Genset 7 is set to superior, but the group controller is set to OFF. The genset will then be running at 104 %, since this is what is set in the controller. Genset 8 is set to OFF, so it will be using the voltage reference set in it locally. In this case, genset 8 will be running at 102 %.

If more than one plant controller is placed in a section, and the voltage reference is changed, the settings regarding this are broadcasted to the other(s), since this is a shared parameter.

5.10.11 Frequency support/frequency-dependent droop

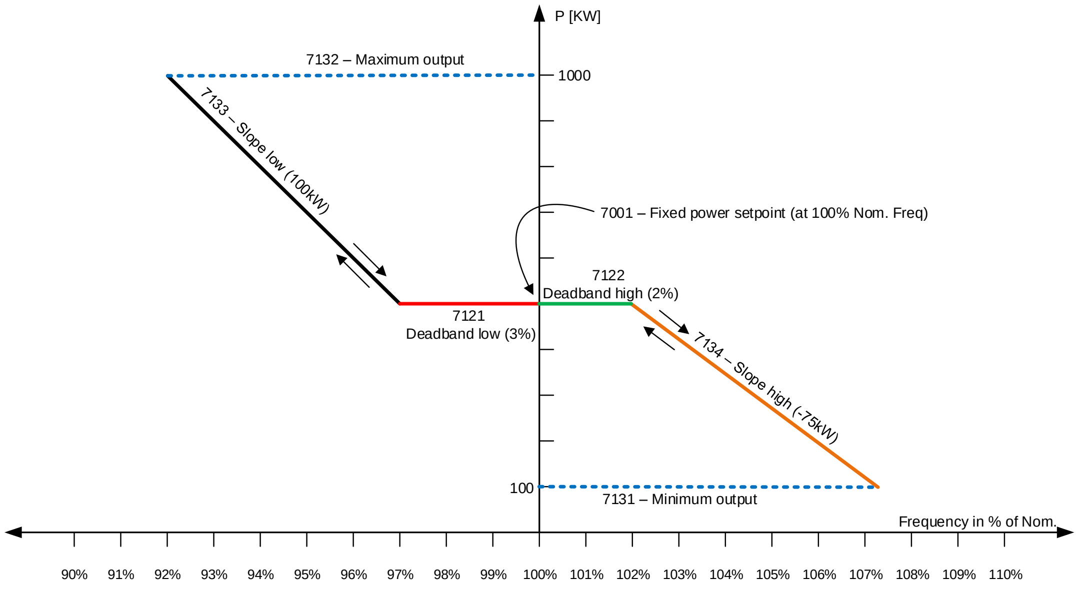
As the AGC PM can export fixed loads towards the grid, it also holds the function so it can make a variation in the set point for the power that should be exported to the grid. This is to support the grid frequency and maintain it so it will be more stable. This function can only be used in the plant modes where the gensets are running in parallel to the grid. The function can be set up, so the power set point will rise when the frequency is dropping, or decrease the power set point if the frequency is getting high. All the power set points for this slope, including optionally hysteresis and deadband are configurable. The function contains a lot of settings, and to facilitate the understanding, the settings will be explained one at a time. The curve below is used to explain the first part of the function.



The diagram above shows some different settings and how they react.

Parameter	Name	Setting	Description
7001	Fixed power set point	50 %/ 500 kW	Defines the power set point, when the frequency is at nominal.
7131	Minimum output	100 kW	Defines the minimum output of the fixed power. If the minimum is reached, it will flatten out (like the orange curve above).
7132	Maximum output	1000 kW	Defines the maximum output of the fixed power. If the maximum is reached, it will flatten out (like the black curve above).
7133	Slope low	50 kW (red) 100 kW (black)	Defines the slope of the power set point when the frequency is below nominal frequency (illustrated with the black and red curves). (Two different slopes are displayed, and only one setting can be used).
7134	Slope high	-75 kW (green) -150 kW (orange)	Defines the slope of the power set point when the frequency is above nominal frequency (illustrated with the orange and green curves). (Two different slopes are displayed, and only one setting can be used).

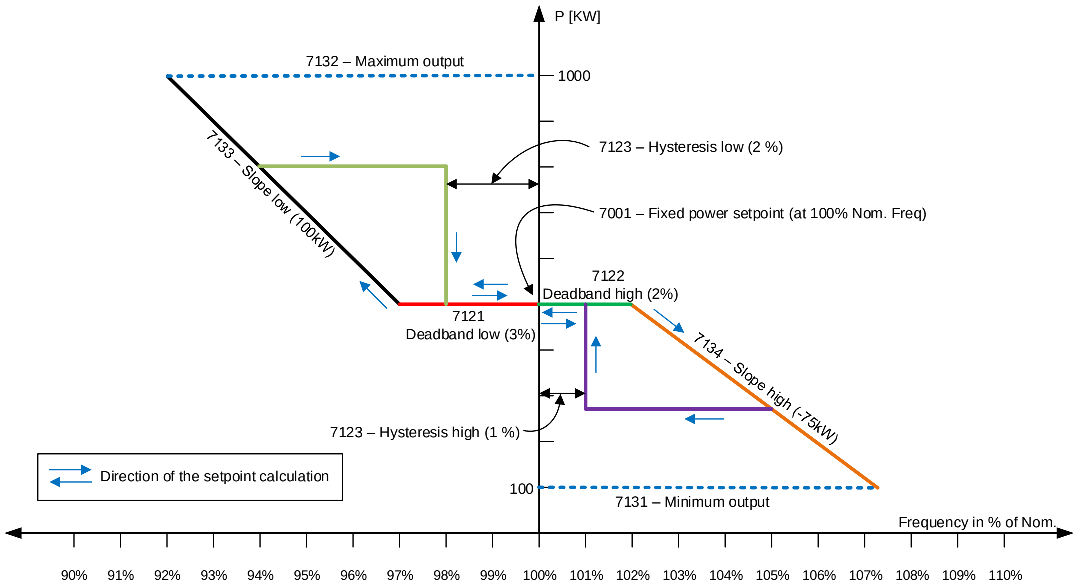
The diagram above shows the first settings to this function and where they are located, regarding the power and frequency. The slope low, and slope high can be set independently of each other. If the slopes have been set so they will reach maximum/minimum load before the mains breaker opens, the curves will flatten out, as above. When the mains breaker should open is decided in parameter 7073 and 7074 (AMF mode).
When the slopes have been set, there is also a deadband that can be used. The deadband is to make sure, that the power set point becomes more steady, when the frequency is close to nominal. The deadband is set in percentage, and it sets how much the frequency should deviate before the slopes are used. Below is a diagram, where the hysteresis is disabled (hysteresis will be described later).



In the diagram above, the hysteresis is also used. The setting for the curve above is shown in the table below:

Parameter	Name	Setting	Description
7001	Fixed power set point	50 %/ 500 kW	Defines the power set point, when the frequency is at nominal.
7121	Deadband low	3 % (red)	Defines how much the frequency should decrease from nominal, before the power droop is used.
7122	Deadband high	2 % (green)	Defines how much the frequency should increase from nominal, before the power droop is used.
7131	Minimum output	100 kW	Defines the minimum output of the fixed power. If the minimum is reached, it will flatten out.
7132	Maximum output	1000 kW	Defines the maximum output of the fixed power. If the maximum is reached, it will flatten out.
7133	Slope low	100 kW (black)	Defines the slope of the power set point when the frequency is below nominal frequency (illustrated with the black curve).
7134	Slope high	-75 kW (orange)	Defines the slope of the power set point when the frequency is above nominal frequency (illustrated with the orange curve).

The AGC PM holds two different deadbands, which can be set independently of each other. With the deadband, the power set point will not be drooped on, when it is close to the nominal frequency. To make a droop curve as above, it is required to disable the hysteresis, which is done by setting the hysteresis higher than the deadband.
Afterwards, the hysteresis can be used. When the hysteresis is enabled, the droop curve will look like shown below:



In the diagram, the hysteresis is activated. The settings in the diagram above are shown in the table below:

Parameter	Name	Setting	Description
7001	Fixed power set point	50 %/ 500 kW	Defines the power set point, when the frequency is at nominal.
7121	Deadband low	3 % (red)	Defines how much the frequency should decrease from nominal, before the power droop is used.
7122	Deadband high	2 % (green)	Defines how much the frequency should increase from nominal, before the power droop is used.
7123	Hysteresis low	2 %	Defines how close the frequency should be to the nominal, before returned using the nominal fixed power set point. The hysteresis low is when the frequency has been low.
7124	Hysteresis high	1 %	Defines how close the frequency should be to the nominal, before returned using the nominal fixed power set point. The hysteresis high is when the frequency has been high.
7131	Minimum output	100 kW	Defines the minimum output of the fixed power. If the minimum is reached, it will flatten out.
7132	Maximum output	1000 kW	Defines the maximum output of the fixed power. If the maximum is reached, it will flatten out.
7133	Slope low	100 kW (black)	Defines the slope of the power set point when the frequency is below nominal frequency (illustrated with the black curve).

Parameter	Name	Setting	Description
7134	Slope high	-75 kW (orange)	Defines the slope of the power set point when the frequency is above nominal frequency (illustrated with the orange curve).

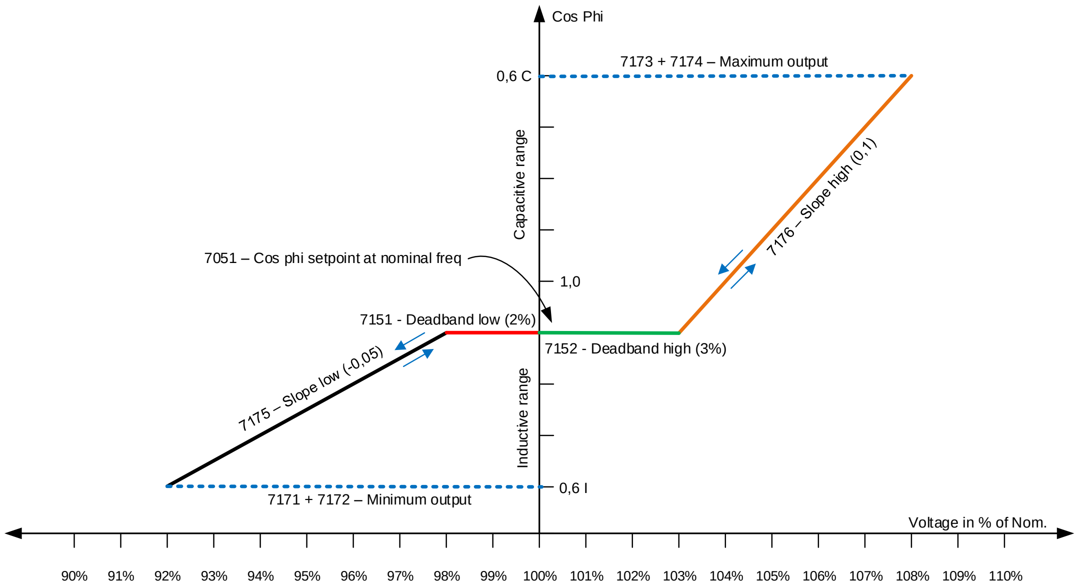
The AGC PM holds two different hysteresis, and these can be set independently of each other. The blue arrows in the diagram show how the AGC PM will calculate a power set points. If the frequency is at nominal (100 %) and decreasing, the power set point will be at the red line. When the frequency has exceeded the deadband, the low slope will be used (black line). As the frequency is decreasing, the power increases until the frequency has reached a minimum (94 %). The frequency is now increasing. Since the hysteresis is activated, the power set point will stay at the lowest it was (the power set point at 94 %). The AGC PM is now using the olive green line. The AGC PM will use this power set point until hysteresis setting is reached. Here, it is set to 2 %, which means that when the frequency has reached 98 %, the power set point go down to the one used at nominal frequency.
The parameters regarding the frequency-dependent droop are shown in the table below:

Parameter	Item	Range	Default	Note
7121	Deadband low	0.00 % 99.99 %	0.4 %	
7122	Deadband high	0.00 % 99.99 %	0.5 %	
7123	Hysteresis low	0.00 % 99.99 %	0.5 %	
7124	Hysteresis high	0.00 % 99.99 %	0.5 %	
7131	Minimum output of droop	0 kW 20000 kW	200 kW	
7132	Maximum output of droop	0 kW 20000 kW	480 kW	
7133	Slope low	-20000 kW 20000 kW	50 kW	
7134	Slope high	-20000 kW 20000 kW	-50 kW	
7143	Activation of the droop function	OFF ON	OFF	

5.10.12 Voltage support/voltage-dependent PF/Q control

As the AGC PM holds the function for drooping on the power compared to the frequency, it also holds a function for drooping on the PF/Q-power based on the present grid voltage. The function is designed so the gensets can help maintain a more stable grid voltage. The voltage-dependent PF/Q control function is very similar to the frequency-dependent droop, but there are some differences. In the AGC PM, it is either set if it should droop on the Q-power or cos phi. The AGC PM can either be controlled on the cos phi or on the Q-power. The AGC PM holds two different curves for the droop, one for Q-power and one for cos phi. By default, the cos phi is used.

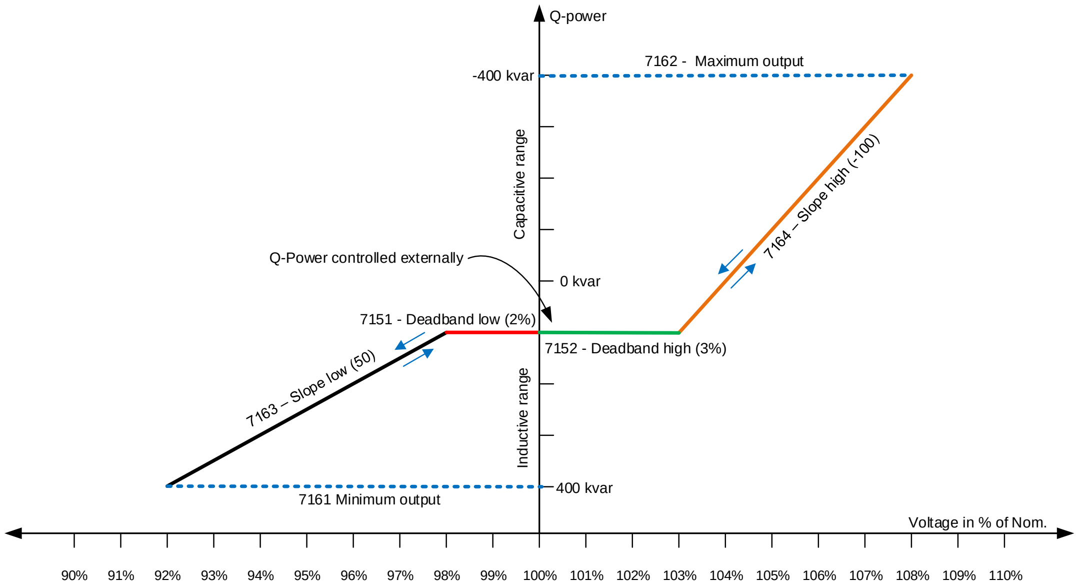
When setting up the voltage-dependent PF/Q control function, it is possible to make the gensets go from inductive to capacitive export. This is shown in the diagram below (cos phi droop):



The settings used above are shown in the table below:

Parameter	Name	Setting	Description
7051	Cos phi set point	0.9	Defines the cos phi set point at nominal voltage.
7151	Deadband low	2 % (red)	Defines how much the voltage should decrease from nominal, before the cos phi droop is used.
7152	Deadband high	3 % (green)	Defines how much the voltage should increase from nominal, before the cos phi droop is used.
7171	Minimum output cos phi value	0.6	Defines the value the cos phi can reach, when the voltage is low.
7172	Minimum output cos phi reference	Inductive	Defines if the minimum value should be in the inductive or capacitive area.
7173	Maximum output cos phi value	0.6	Defines the value the cos phi can reach, when the voltage is high.
7174	Maximum output cos phi reference	Capacitive	Defines if the maximum value should be in the inductive or capacitive area.
7175	Slope low	-0.05 (black)	Defines how much the cos phi should slope, when the voltage is low.
7176	Slope high	0.1 (orange)	Defines how much the cos phi should slope, when the voltage is high.
7181	Curve type	Cos phi	Sets that it is the cos phi, that should be dropped on.

In the diagram above, the hysteresis is disabled (done by setting the hysteresis higher than the deadband).
When setting a cos phi droop, then be aware, that first a value is set and afterwards a reference, to decide if this value is inductive or capacitive.
If the Q-droop is used instead, the droop is set in the following way:



The settings used for making this curve are shown in the table below:

Parameter	Name	Setting	Description
7151	Deadband low	2 % (red)	Defines how much the voltage should decrease from nominal, before the Q-droop is used.
7152	Deadband high	3 % (green)	Defines how much the voltage should increase from nominal, before the Q-droop is used.
7161	Minimum output of Q-power	400 kvar	Defines the value the cos phi can reach, when the voltage is low.
7162	Maximum output of Q-power	-400 kvar	Defines if the minimum value should be in the inductive or capacitive area.
7163	Slope low	50 (black)	Defines how much the Q-power should slope, when the voltage is low.
7164	Slope high	-100 (orange)	Defines how much the Q-power should slope, when the voltage is high.
7181	Curve type	Q-power	Sets that it is the Q-power that should be dropped on.

When using the Q-power, it is required to activate parameter 7505, and control the Q-power externally. This can be done via Modbus, or from dedicated inputs. If parameter 7505 is not activated, the Q-power is to be controlled via a +/- 10 V DC signal on terminal 41 and 42.
The two diagrams about voltage-dependent PF/Q control have had the voltage as a reference for the droop. It is possible to switch the voltage with the P-power on the genset. If this is done, the cos phi/voltage will be directly dependent on the produced fixed power, instead of the voltage. This setting is set in parameter 7182. When set for P instead of U, the horizontal axis in the two diagrams in this chapter will be replaced with power, instead of the voltage.
In the examples in this chapter, the hysteresis is not shown. If the hysteresis is used, it is working in the same way as the hysteresis described in the chapter for frequency-dependent droop. The hysteresis is located in parameter 7153 and 7154.
The relevant parameters for the voltage-dependent PF/Q control function are shown below:

Parameter	Item	Range	Default	Note
7151	Deadband low	0.00 % 99.99 %	2.00 %	
7152	Deadband high	0.00 % 99.99 %	2.00 %	
7153	Hysteresis low	0.00 % 99.99 %	2.10 %	
7154	Hysteresis high	0,00 % 99.99 %	2.10 %	
7161	Minimum output of Q-droop	-20000 kvar 20000 kvar	200 kvar	
7162	Maximum output of Q-droop	-20000 kvar 20000 kvar	480 kvar	
7163	Slope low in Q-droop	-20000 kvar 20000 kvar	50 kvar	
7164	Slope high in Q-droop	-20000 kvar 20000 kvar	-50 kvar	
7171	Minimum output of cos phi droop – value	0.10 1.00	0.8	
7172	Minimum output of cos phi droop – reference	Inductive Capacitive	Inductive	
7173	Maximum output of cos phi droop – value	0.10 1.00	1.0	
7174	Maximum output of cos phi droop – reference	Inductive Capacitive	Inductive	
7175	Slope low in cos phi droop	-1.00 1.00	-0.05	
7176	Slope high in cos phi droop	-1.00 1.00	0.05	
7181	Droop curve type for reactive power	Cos phi (X2) Q (X2)	Cos phi (X2)	
7182	Droop curve reference	U P	U	
7183	Activation of the droop function	OFF ON	ON	

5.10.13 Additional information for O and cos phi/Q-dependent droop

If the AGC PM is used in an application with different types of gensets, the capability curve is not necessarily the same for the gensets. It could also be plausible that the operator does not want a specific genset to a high cos phi. So if a mains or plant controller is requesting a cos phi of e.g. 0.7, and parameter 7171 in a genset is set to 0.8, the specific genset will not be able to bypass cos phi 0.8 in the plant modes parallel to the grid. If this is wanted, it is also required to set parameter 7054 to droop curve, since this one decides that it is droop curves that defines the outer limits for the cos phi in grid parallel operation.

5.11 Additional power management functions

5.11.1 Stop of non-connected gensets

If the plant is operating in a place where load is fluctuating, or the power set point is changing quickly, it is possible that a genset can be started, and when it is about to connect, the set point has decreased afterwards so the genset is not needed. If the operator knows that the load is about to increase in a short while again, there is a function in the AGC PM that can help to solve the situation. Instead of the genset stopping shortly afterwards again, the AGC PM has a timer called Stop of non-connected gensets. The situation with the genset that starts and should be stopped again could be in a peak shaving plant. The load has increased above the start set point and afterwards decreased below the stop set point within a short while. Instead of just stopping the genset immediately, a timer in this function dictates for how long time the genset should be running before it is stopped. This timer is located in parameter 8171. This timer is independent of the timer in the load-dependent stop function. This is because the load-dependent stop timer is active when a generator breaker is closed. This timer is only active if a start has been requested, and afterwards the genset is not needed before the genset has closed its breaker.

Parameter	Item	Range	Default	Note
8171	Stop of non-connected gensets timer	10.0 s 600.0 s	60.0 s	Only in genset

5.11.2 Spinning reserve in 2-level applications

The spinning reserve function determines how much power should be reserved as a spinning reserve. It is possible to request spinning reserve at every controller, and the requested spinning reserve from each controller will be added together to a total spinning reserve. The AGC PM will then seek out to have this spinning reserve until all gensets are loaded so much that it is not possible to maintain the spinning reserve anymore. In applications with BTBs, and a BTB is open, the spinning reserve can be different on each side on the open BTB. If the spinning reserve is enabled in a controller, the spinning reserve will be used in the section where the present controller is located, and not shared across an open BTB.

The spinning reserve function holds two different spinning reserves. One spinning reserve is used for parallel running mode, and one is for islanded running modes. The values for each spinning reserve is set individually, and can also be enabled/disabled individually on each other.

The parameters for spinning reserve are shown below:

Parameter	Item	Range	Default	Note
8181	Spinning reserve value for parallel running modes	0 kW 30000 kW	0 kW	
8182	Enable spinning reserve for parallel running modes	OFF ON	OFF	
8183	Spinning reserve value for islanded running modes	0 kW 30000 kW	0 kW	
8184	Enable spinning reserve for islanded running modes	OFF ON	OFF	

5.11.3 Spinning reserve in 3-level applications

The spinning reserve function is similar to the function in 2-level applications. In 3-level applications, the spinning reserve function also holds two values that can be set independently on each other for either parallel or islanded running mode. It also works in the same way as if a BTB is located in the plant. The spinning reserve set in each controller is only used in the present section.
The difference for spinning reserve in 3-level applications is that if a spinning reserve is set in a genset, the spinning reserve will be kept internally in the group. If the spinning reserve is set in a group or plant controller the spinning reserve will be shared between the plant and group controllers. But only in the top layer. If a BTB is placed in the top layer, the spinning reserve is not shared across an open BTB.

5.11.4 Secured mode in 2-level applications

In the AGC PM, there is a function called secured mode. The secured mode dictates that there should always be a minimum of spinning reserve that is equal to the biggest genset running. So if the biggest genset should have a shutdown, the remaining gensets will still be able to carry the load. If the application has an open BTB in the application, the secured mode will have to be activated in each side of the BTB. This gives the possibility to operate the plant in two different ways if e.g. one side of an open BTB is supporting a critical load, and the other side of the BTB is not as critical.
The relevant parameter for secured mode is shown below:

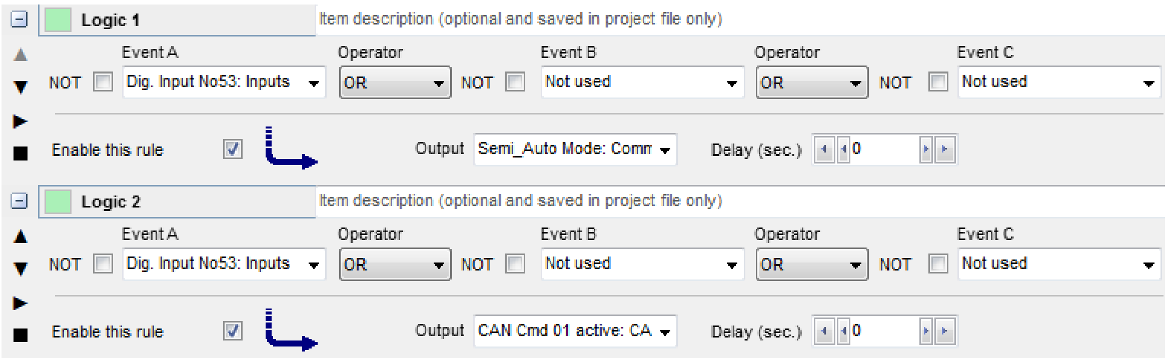
Parameter	Item	Range	Default	Note
8031	Secured mode	Secured mode OFF Secured mode ON	Secured mode OFF	Can only be set in gensets.

5.11.5 Secured mode in 3-level applications

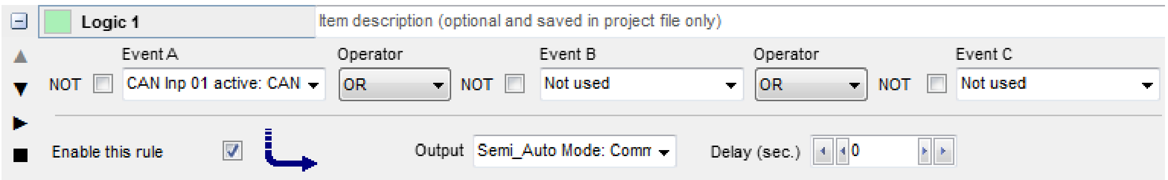
The secured mode in 3-level applications is very similar to the function in 2-level applications. The main difference is here that the secured mode is used internally in the groups. So the secured mode will have to be activated individually in each group. By this, it is possible to have the secured mode activated in some groups and not in others. If secured mode is activated in a group, the group will have to be loaded as much as without secured, before the request for another genset group is made.

5.11.6 CAN commands in 2-level applications

When the AGC PM is placed in an application where there is more than one AGC PM controller, they will be connected to each other with CAN bus communication. The controllers have the possibility to send some CAN commands to each other. This can only be programmed from M-Logic. There are 16 CAN commands that can be used. When a CAN command is activated in one controller, it can be seen by all the other controllers in the plant. An example of what a CAN command can be used to is given below:
All the controllers in a plant have set the mode update (8052) to update local. This means that if one controller is changed from AUTO to SEMI, only the specific controller changes to SEMI. The operator now wants a button, so if this is pushed, all controllers are changed to SEMI. Now a CAN command can be used in M-Logic. If a button is wired to digital input 53 on a controller, the M-Logic in this controller would look like this:



The controller that the input is wired to, now changes to SEMI when the input is ON/high, and also gives a CAN command. The CAN flag is only an internal message going high now. In all other controllers, the line below will have to be programmed:

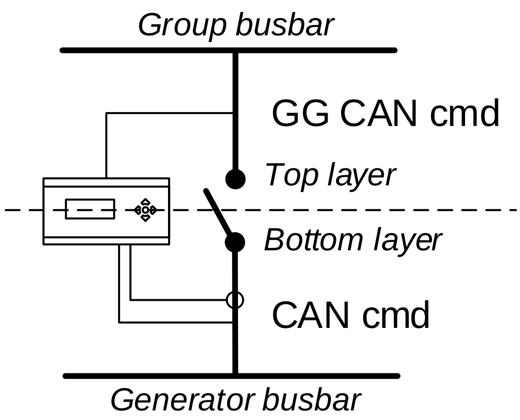


The other controllers can see that a CAN command is high. So when this CAN command is high, the controllers will change into SEMI.

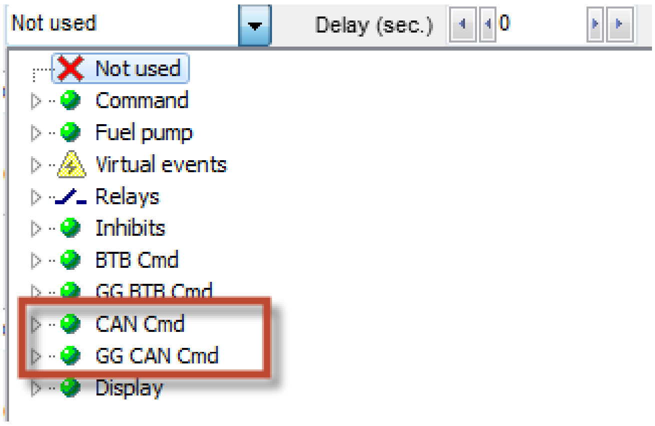
When the input is high, it will NOT be possible to change running mode into AUTO!

5.11.7 CAN commands in 3-level applications

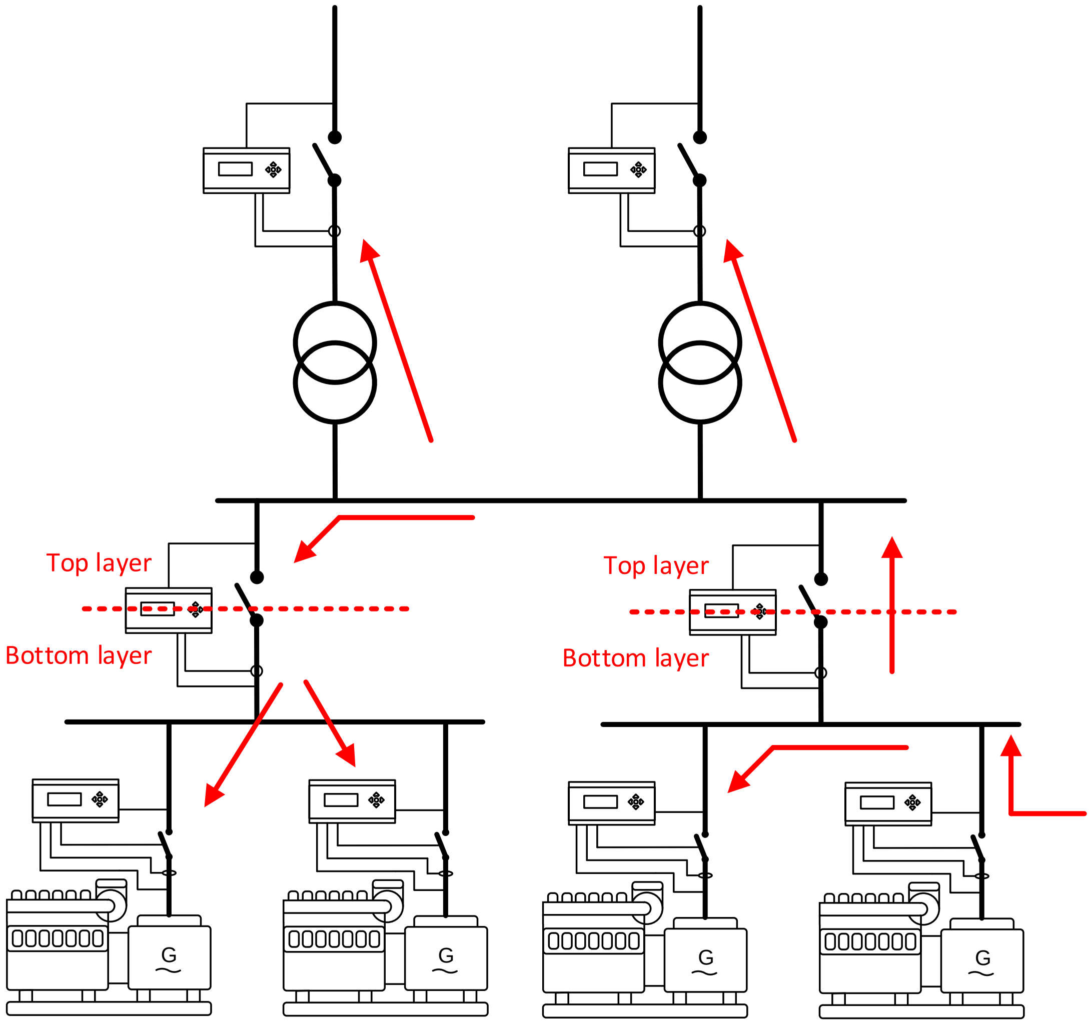
The CAN commands in 3-level applications are very similar to the CAN commands in 2-level applications. But there are some differences. The CAN commands are not sent from a genset to a plant controller. The CAN commands internally in a group stays in the group, so it is not sent to another group. The CAN commands are two different types, and are easiest to see in a group controller. This is because the group controller is able to see the CAN commands in the top layer, and also the ones internally in the genset group. The names of the two types of CAN commands are shown in the picture below:



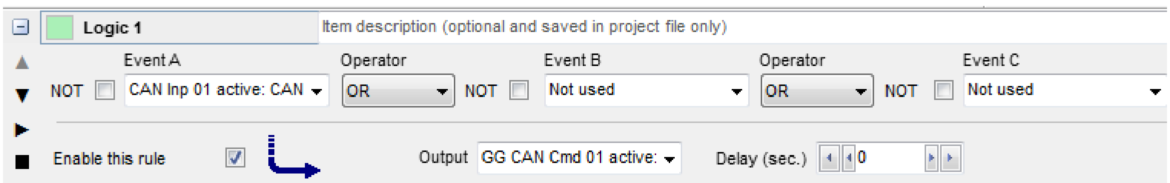
The two names can be found in the M-Logic for a group controller. Here it will look like this:



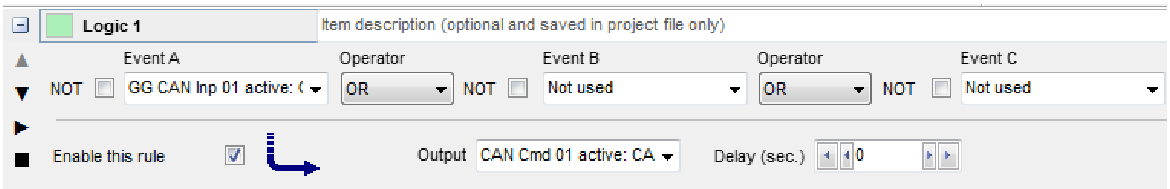
It will still be possible to make a function as the one described in the 2-level application. It is a bit more complicated in 3-level applications, but still possible. If a genset has wired an input to input 53, and the operator wants all controllers in the plant changed into SEMI when this is active, the “flow” of the CAN command would be like shown below:



The input is wired to the genset in the lower right corner. So when the input is activated, the other gensets in the group and the group controller will be able to see the CAN command. The group will need to transfer the CAN command into the layer above, before the controllers in the top layer will be able to see the CAN command. This is programmed like this in the first group controller:



When this line has been made, all the controllers in the top layer can now see the CAN command. This means that right now, the controllers in one genset group and all controllers are able to see the CAN command. The group controller in the left side will need to send a CAN command into the group, when it can see it in the top layer. This shows how to do it:



With these lines, a CAN command from a genset is visible to all controllers in a plant like the one in this example.

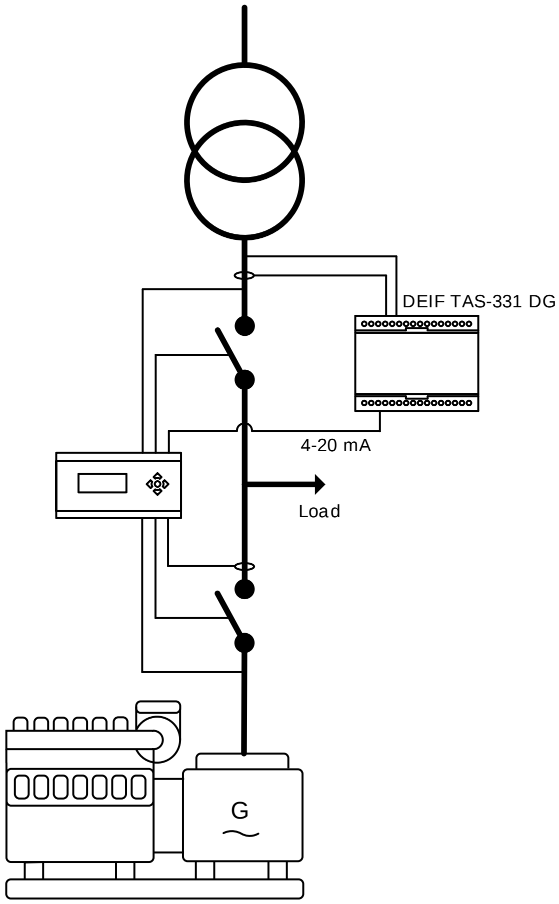
5.12 Power transducers

5.12.1 Principle

The AGC PM supports different types of transducers. The two types supported are transducers for mains/plant power and for tie breaker/group tie breaker power measurement. The idea of having a power transducer instead of using the current inputs in the AGC PM is that the physical current transformers are placed far away from the AGC PM. All transducers will have to be 4-20 mA transducers, and the signal will have to be based on the power. How to wire a transducer to the AGC PM is shown in the installation instructions chapter. Be aware that mains/plant power transducers have to be wired to multi-input 102, and tie breaker/group tie breaker transducers will have to be wired to multi-input 105.

5.12.2 Mains transducer in stand-alone applications

If the AGC PM is set up in a stand-alone application, it is not possible to use the mains power export, peak shaving and load take over modes correctly, if there is no power transducer mounted to measure the power across the mains breaker. The current measurements in the AGC PM in a stand-alone application will have to be used as current measurements for the generator. It is shown below where the power transducer has to be mounted in these applications:



The transducer will have to be wired to multi-input 102 in this case. The AGC PM will need to know what that transducer's output equals, and furthermore the output of the transducer will have to be linear to the power across the mains breaker. When the operator has found out what the 4 mA and 20 mA equals, it is required to set this in the AGC PM. This is done at parameter 7471 and 7472, where 7471 is how many kW it means when the transducer gives 20 mA, and 7472 is how many kW the transducer measures when it has an output of 4 mA.

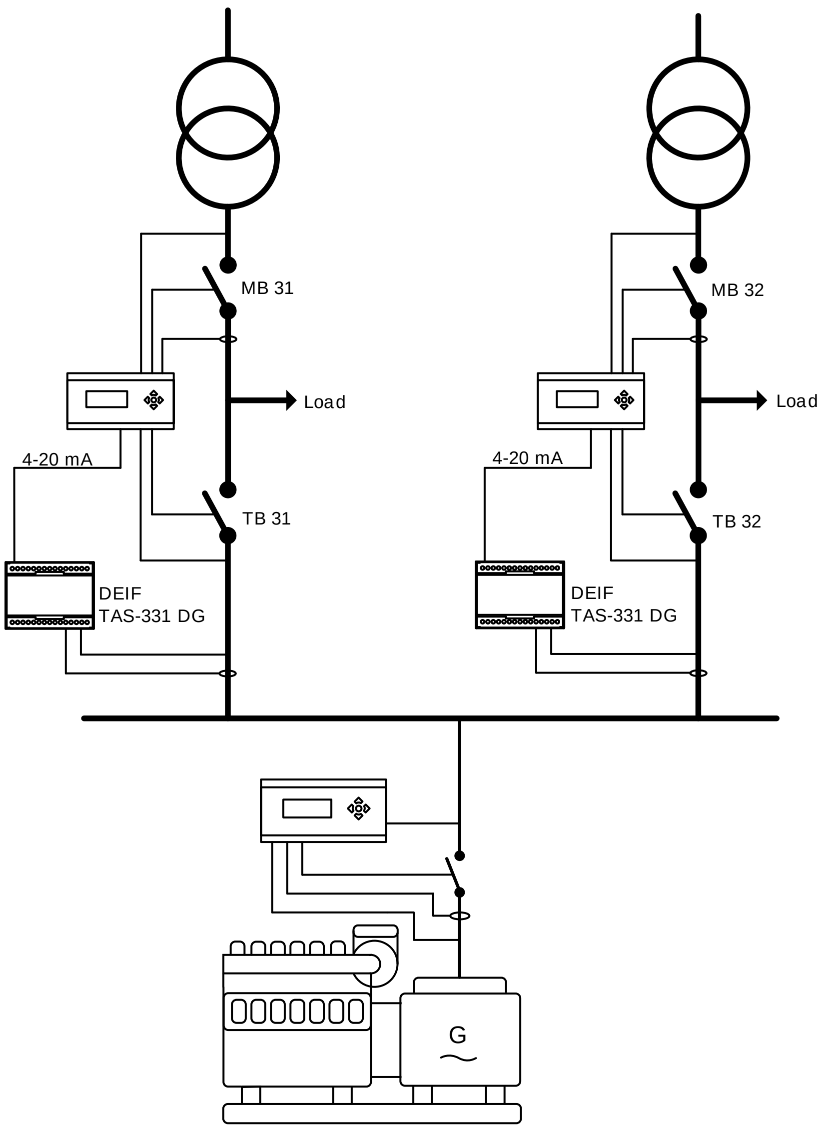
5.12.3 Mains transducer in 2- and 3-level applications

In 2- and 3-level applications, a mains power transducer can also be used. Normally on the mains/plant controllers, the current and voltage inputs are used, and by this a power is calculated. But if the current transformers are placed far away from the AGC PM mains/plant controller, a transducer can be used instead. An AGC PM will always need some voltage measurements, since this is used for synchronising the breakers. If a transducer is used for mains/plant power measurement, it will always have to be wired to multi-input 102. When the transducer has been wired to multi-input 102, it is necessary to know what 4 mA and 20 mA equals of kW from the transducer, and make sure that the output of the transducer is linear to the power. When these data have been retrieved, it is required to go to the mains/plant controller and go to parameter 7471 and 7472. In parameter 7471, it is set how many kW the 20 mA signal equals, and in parameter 7472 it is set how much 4 mA is in kW.

In 2- and 3-level applications, it is possible to have just one mains/plant configured with a transducer, and the other is using the current inputs. The mains/plant power transducer can be configured independently of each other, so this can be configured as wanted.

5.12.4 Tie breaker power transducer in 2-level applications

In 2-level applications with tie breakers, the AGC PM can be configured so there is a power measurement across the tie breaker. With a TB power measurement, the AGC PM is able to deload the TB before it is opened. This can be a good idea in applications like the one below:



The application consists of two mains controllers, with TB power measurements, and a genset. If the genset works as backup power at mains failures, the genset can be in a situation where it is carrying all the load (grid fail). If the mains power comes back again, the AGC PM can back-synchronise the MB, to avoid a blackout again. When one MB is closed, the GB, TB and MB will be closed (the genset will only be parallel to one grid at a time). The load can now be moved back onto the grid. If there is no TB power measurement, the TB will open when the MB is closed, since it does not know which load is flowing across the TB. When a TB transducer has been configured, AGC PM is able to deload the TB before it is opened. Afterwards, it will close the other MB, and then deload the generator breaker. In the application above, all the powers across the breakers are known, so the AGC PM is able to deload all breakers before they are opened.
To set up the TB power transducer correctly, it is required that it is wired to multi-input 105, and is a 4-20 mA signal. The signal will have to be linear to the power across the TB. It is also required to know how many kW 4 mA and 20 mA equals. When these data are known, the AGC PM is programmed from menu 8981 and 8982. In parameter 8981, it is set how much 20 mA equals and in 8982 it is set how much 4 mA is in kW.

5.12.5 Tie breaker power transducer in 3-level applications

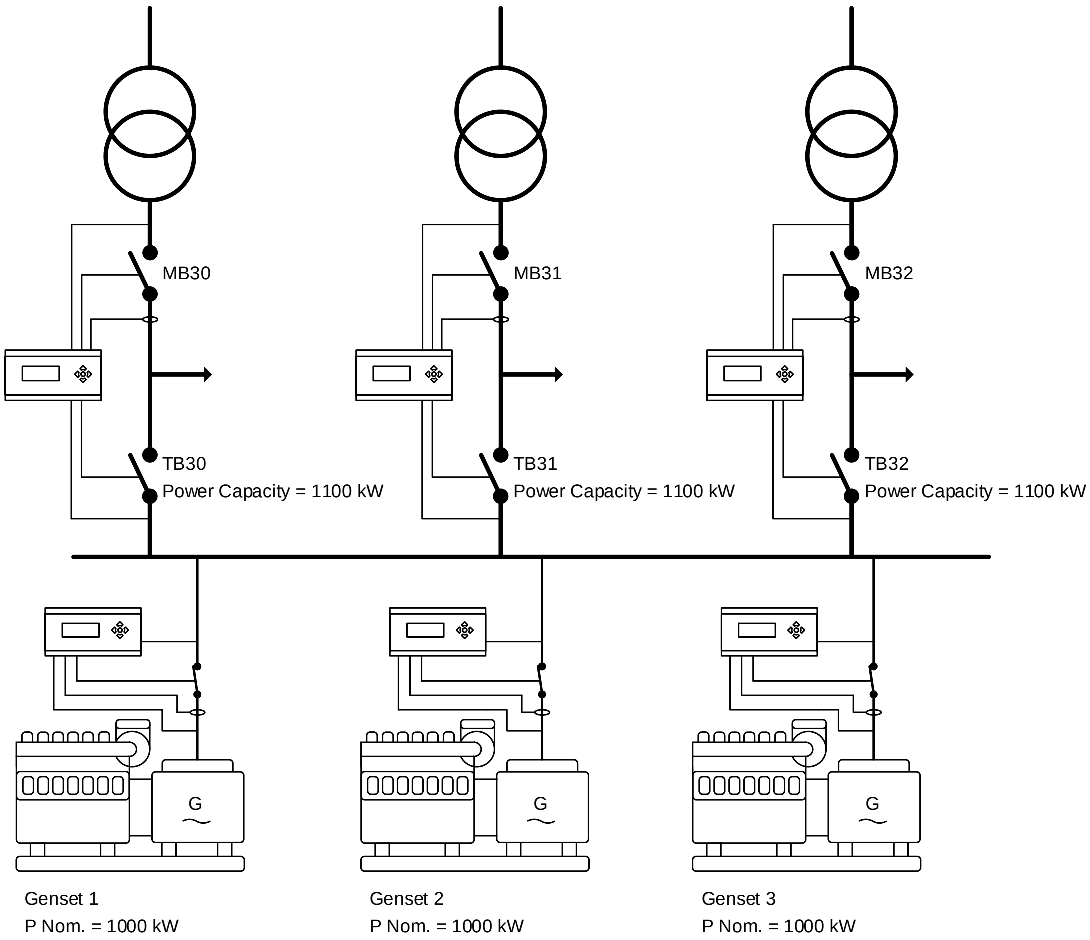
The AGC PM group controller is able to use a power transducer for the power measurement, instead of using its own current inputs. The group controller will still need the voltage measurements, since they are used for synchronisation and also detect if any of the busbars are live. The transducer used for this is wired to multi-input 105 and has to give 4-20 mA signal. The group controller can also work if there are no current inputs or power transducer to it. To configure a group controller with a power transducer, it is required to go to parameter 8981 and 8982. The first parameter should be set to how many kW 20 mA equals in the transducer. In 8982, it is set how many kW 4 mA equals.

Parameter	Item	Range	Default	Note
7471	Mains power transducer max (20 mA)	-20000 kW 0 kW	0 kW	
7472	Mains power transducer min (4 mA)	0 kW 20000 kW	0 kW	
8981	Tie breaker power transducer max (20 mA)	-20000 kW 0 kW	0 kW	
8982	Tie breaker power transducer (4 mA)	0 kW 20000 kW	0 kW	

5.13 Tie breaker functions

5.13.1 Tie breaker power capacity in 2-level applications

This function can be used, to make sure that there is a certain amount of power before the tie breaker (TB) is closed. The setting for power capacity is located in parameter 8992 and is set in kW. The power capacity is always enabled, and if the operator does not want to use this, just set it to a low value. The power capacity can be explained by an example:



The plant shown is set up for running as backup power (AMF). So when there is a total mains failure, all the mains breakers will open. The application above can be configured so all the gensets start in this situation. When the fastest starting genset has closed its breaker, none of the TBs will close since the power capacity is bigger than one genset's nominal power. So when genset number two has synchronised to the busbar, the first TB can close. This will be the TB30, since it is the one with the lowest ID. If there is a load of 900 kW or lower at TB30, the available power will still be above 1100 kW. If the available power is above 1100 kW, it will be allowed to close TB31. When TB31 is closed, it is possible that available power comes below 1100 kW. If this is the situation, the plant will now have to wait until the third genset has synchronised on to the busbar. After the third genset has closed its breaker, the available power will rise, and most likely come above the power capacity set point. When it comes above, TB32 will close.

When setting up the values for power capacity, the numbers should reflect the loads that can be present when the TB is closed. In the example above, the numbers is set, so there is always at least two gensets at the busbar, when a TB is about to close. The numbers have been set for 1100 kW, just to make sure that two gensets are at the busbar. If 1900 kW was used instead, the plant could be slower because if the load at TB30 was above 100 kW, the available power will be below 1900 kW. This means that two gensets was not enough for closing the TB31, and they would have to wait for genset number three.

When using this function, it can hold up the AMF sequence, if the power capacity value is not set correctly! This can happen if the power capacities are set so high, that they cannot be fulfilled, or if a genset is having e.g. start failure.

Be aware that power capacity is active in all plant modes!

The sequence in how the TBs should close can be changed in the AGC PM. The TBs with lowest number in power capacity will be closed first. If some TBs have the same power capacity, the TB with the lowest ID will be closed first. By changing the power capacity, the order on how the TBs should be closed can be set. There is a function to overrule the power capacity, which will also be described, in the chapter for tie breaker power capacity overrule.
Notice that multi-start settings have to be adjusted to have enough gensets start. Default setting is “auto calculate” but it can also be set to a certain number of gensets to start e.g. “start 32 DG”.
The relevant parameter for power capacity is shown below:

Parameter	Item	Range	Default	Note
8992	Power capacity set point	1 kW 20000 kW	50 kW	

5.13.2 Tie breaker power capacity in 3-level applications

The power capacity is very similar to the one in 2-level applications. The difference is that the power capacity function here is for a Group Tie Breaker (GTB). The function is always enabled, and if the operator does not want to use it, simply set it to a very low value and it will then not influence on anything. The power capacity function is set in parameter 8992 in the group controller.

Be aware that power capacity is active in all plant modes!

5.13.3 Tie breaker power capacity overrule in 2-level applications

If the power capacity function is used, an overrule function can be handy in some fail scenarios. If for instance a genset does not start, or the emergency stop is pushed, the sequence can move on. The overrule function is made so the power capacity value may not be present at a certain time, but a TB is closed anyway. When enabling this function, there is also a risk of black out (caused by genset overload), since it is allowed to overrule to power capacity! Therefore, it is recommended to trip lower priority load groups during the delay time for the overrule timer. The power capacity overrule function holds a timer that will start whenever one of the gensets has an alarm. The timer can then be set to a short time, which means the TB will be closed shortly after this failure. If the timer is set for a longer period, the operator has the possibility to acknowledge this alarm, and the system will wait until a new alarm comes again and timer expires before the TB is closed. If an alarm is acknowledged, and a genset comes unto the busbar which means that the power capacity will be fulfilled, the TB can also be closed. The timer starts when a genset has an alarm.
The relevant parameters for the power capacity overrule is shown in the table below:

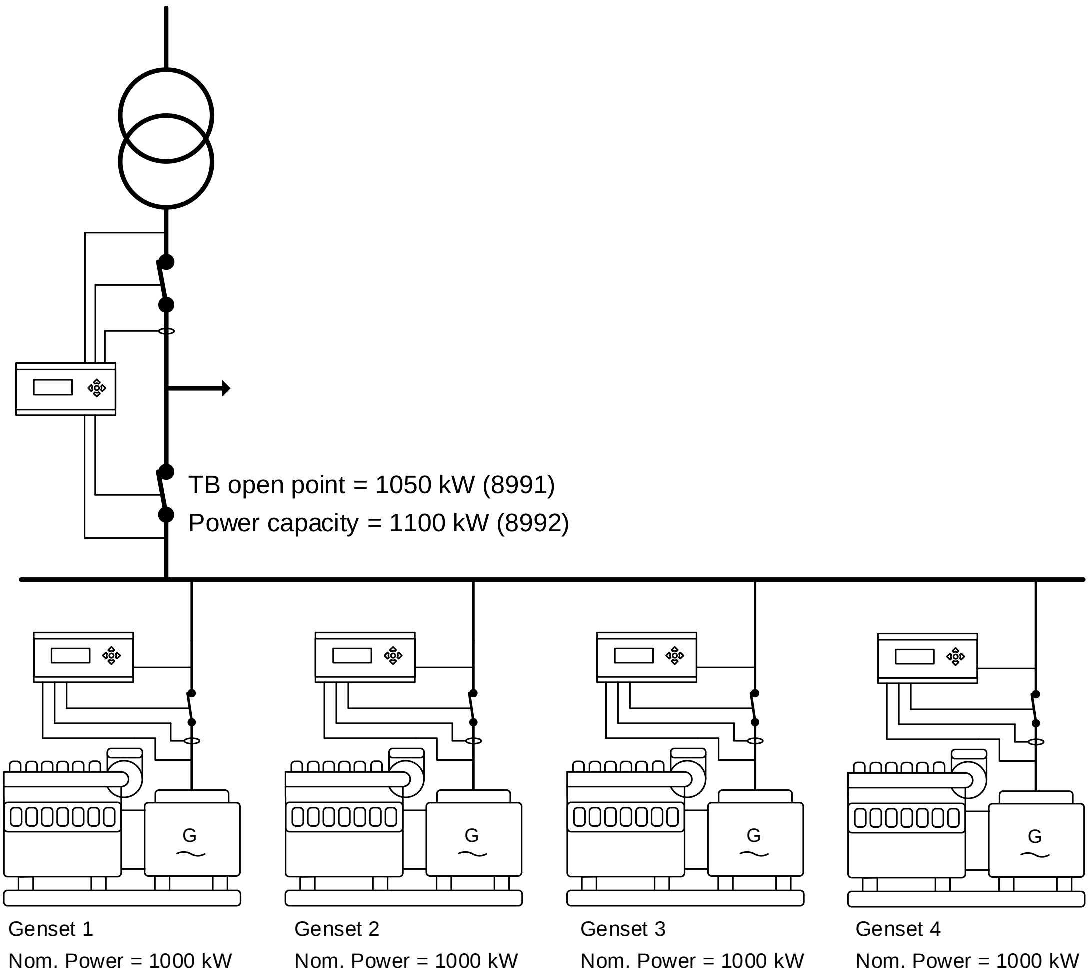
Parameter	Item	Range	Default	Note
8993	Power capacity overrule timer	0.0 s 999.9 s	30.0 s	
8994	Power capacity overrule activation	OFF ON	OFF	

5.13.4 Tie breaker power capacity overrule in 3-level applications

In 3-level applications, there is also a power capacity overrule function. The function works in the same way as in 2-level applications. Note that this is set in the group controller, since this function refers to the group tie breaker.

5.13.5 Tie breaker open point in 2-level applications

If the gensets are running in parallel to the grid, a situation can appear where the mains breaker trips, and to protect a genset from going into overload, the AGC PM can trip the tie breaker and close it again when sufficient power is available on the busbar. The function is explained in this example:



Above is an application with 4 gensets and one mains. The situation could be that genset no. 1 is running in parallel with the grid. Suddenly, the mains breaker will open, which can be caused by e.g. df/dt (ROCOF) or the grid voltage/frequency is outside of the limits. The mains breaker will now open, and in the mains controller, the TB open point has been set to 1050 kW. This means that there should be at least 1050 nominal kW on the busbar to carry the blackout load. Since only one genset is on the busbar, the tie breaker will open.

The function is to prevent that the running genset is not stopped due to overload. Genset no. 1 will keep its breaker closed, and wait until an extra genset is on the busbar. The tie breaker will be kept open until an extra genset is on the busbar, since the power capacity is bigger than 1000 kW.
This function is always active, and if the operator does not want to use it, the setting should be set to a low value.
The relevant parameter for the tie breaker open point is shown below:

Parameter	**Item**	**Range**	**Default**	**Note**
8991	Tie breaker open point	0 kW 20000 kW	50 kW	

5.13.6 Tie breaker open point in 3-level applications

The tie breaker open point function in 3-level applications is very similar to the function in 2-level applications. The difference is that the group tie breaker will open instead of a tie breaker in 2-level applications. The nominal power set point is set in parameter 8991 in the group controllers. This function is always active, so if the function is not desired, the settings should be set to a low value.

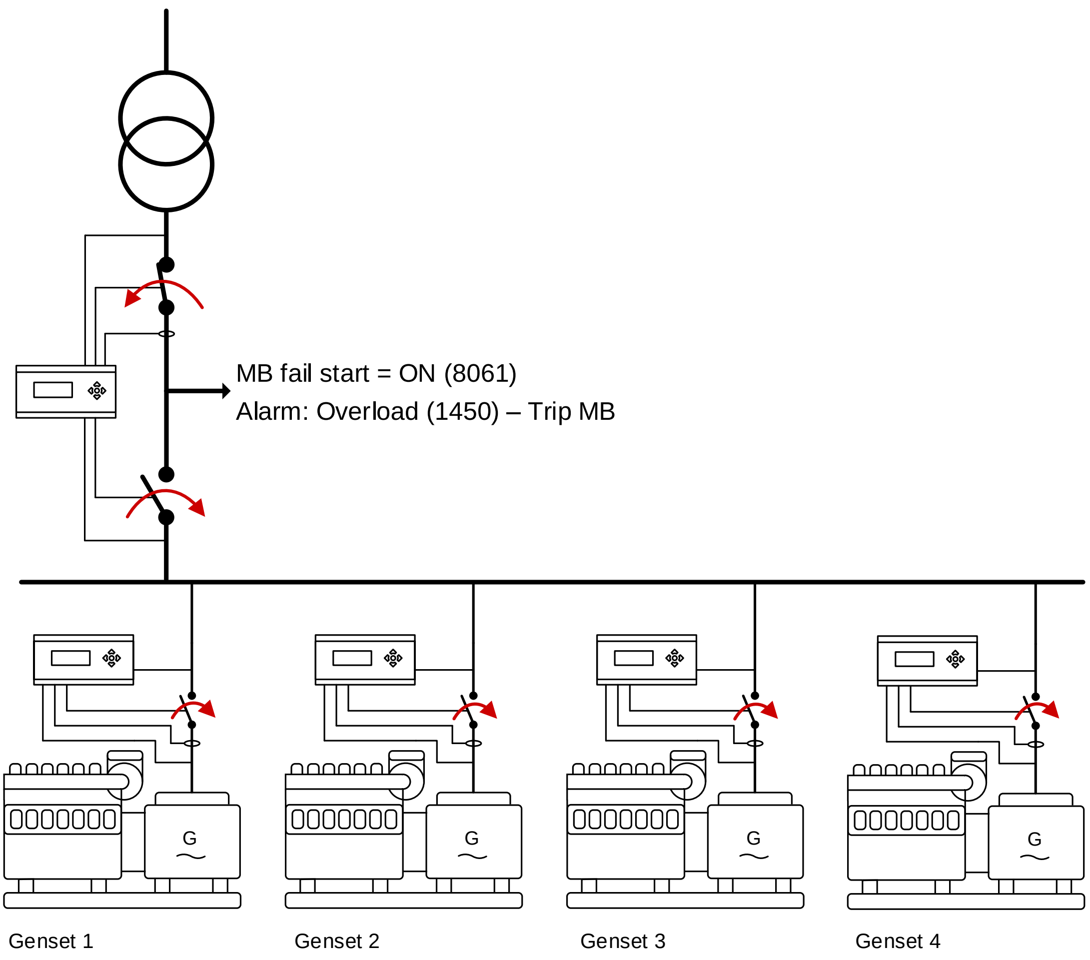
5.14 Multi-mains systems

5.14.1 MB fail start in 2-level applications

The AGC PM holds a function called MB fail start. This function can be used to power a load, if the MB should suddenly trip if a failure occurs. A sudden trip of the MB could be caused by e.g. a trip relay mounted on the breaker. A trip of the breaker can also be caused by the AGC mains PM. This could happen due to overload, or a digital input that has been configured to a trip alarm. Common for all the different things are, that the fail classes have to be configured to: Trip MB, otherwise the AGC mains PM will not give a start signal to the gensets. When the start signal is given, the application will handle it like an AMF situation. An MB close failure alarm will also initiate the MB fail start function.

Please note when enabling the MB fail start, Mode shift is automatically set to ON (7081)

A simple example of the MB fail start is shown below:



In the application above, the mains controllers' overload protections fail class has been set to Trip MB. When the load has increased above the set point level and timer expires, the MB will be tripped assuming a failure occurs. The gensets will now start up (how many is dependent on how the multi-start has been configured), and afterwards the TB will close. The gensets will be running with the load until the alarm is acknowledged at the mains controller.

When the alarm is acknowledged at the mains controller, the genset will synchronise to the grid by synchronising the MB (if configured to), deload the breakers and stop. If the mains controller will have the alarm once again during the deload process of the TB/GBs, the MB will be tripped once again and have the alarm present once more. If the mains breaker is tripped during the deload sequence, the gensets will take the load, and continue to supply the load until the alarm is acknowledged once again.

If another mains feeder + controller were placed in this application, it would be possible to switch over to it before the gensets were started. How to configure this will be described later.

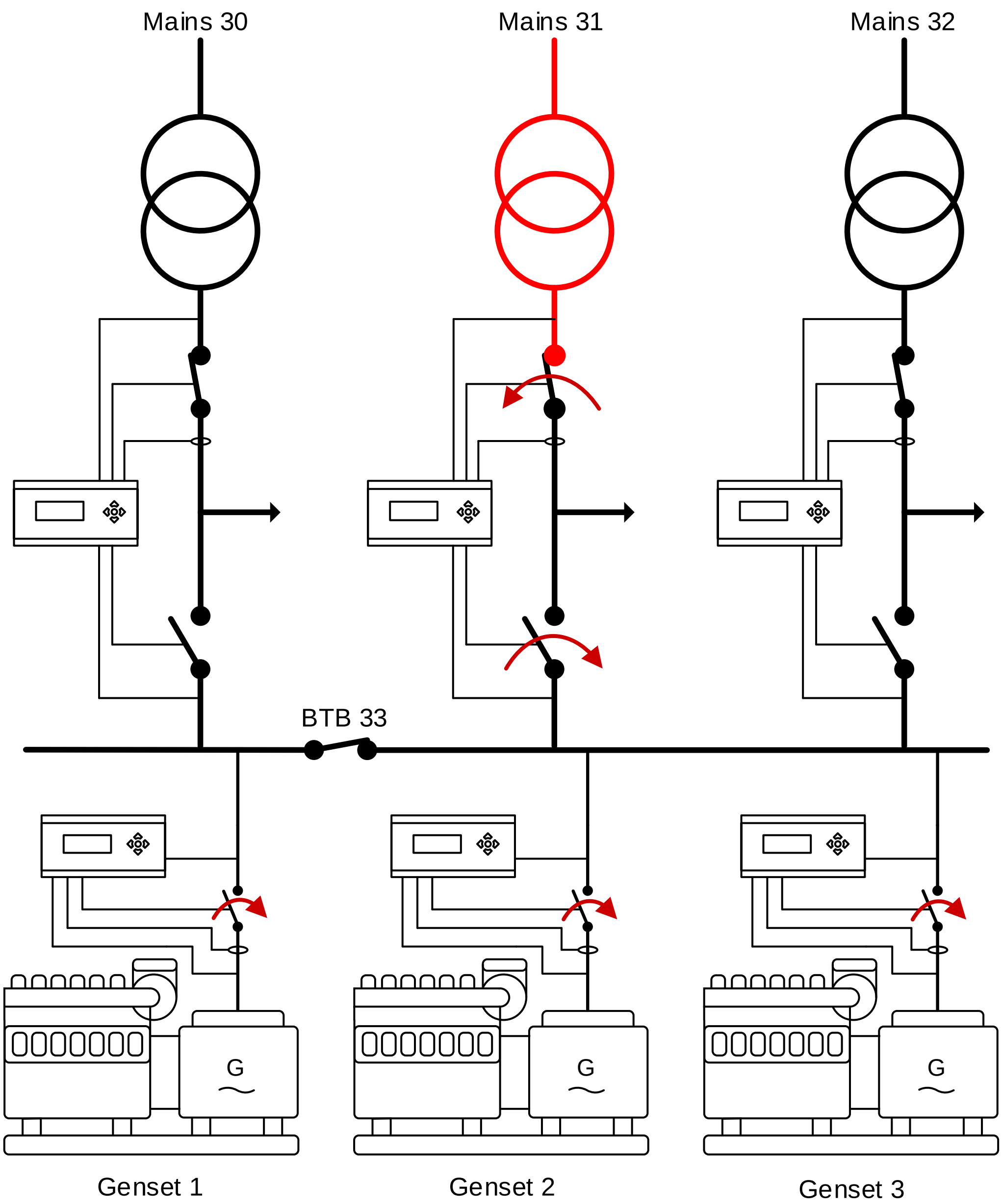
Parameter	Item	Range	Default	Note
8061	MB fail start	ON OFF	OFF	Only in mains/plant controller

5.14.2 Auto switch in 2-level applications

The AGC PM has a function called auto switch. This function has three different settings, which gives different possibilities. The auto switch function is designed to allow other mains feeder support a load, if one mains feeder is having a mains failure, without starting the genset. The auto switch can be set to either OFF, static section or dynamic section. The setting for the auto switch function is located in parameter 8064. The different settings will be described below:

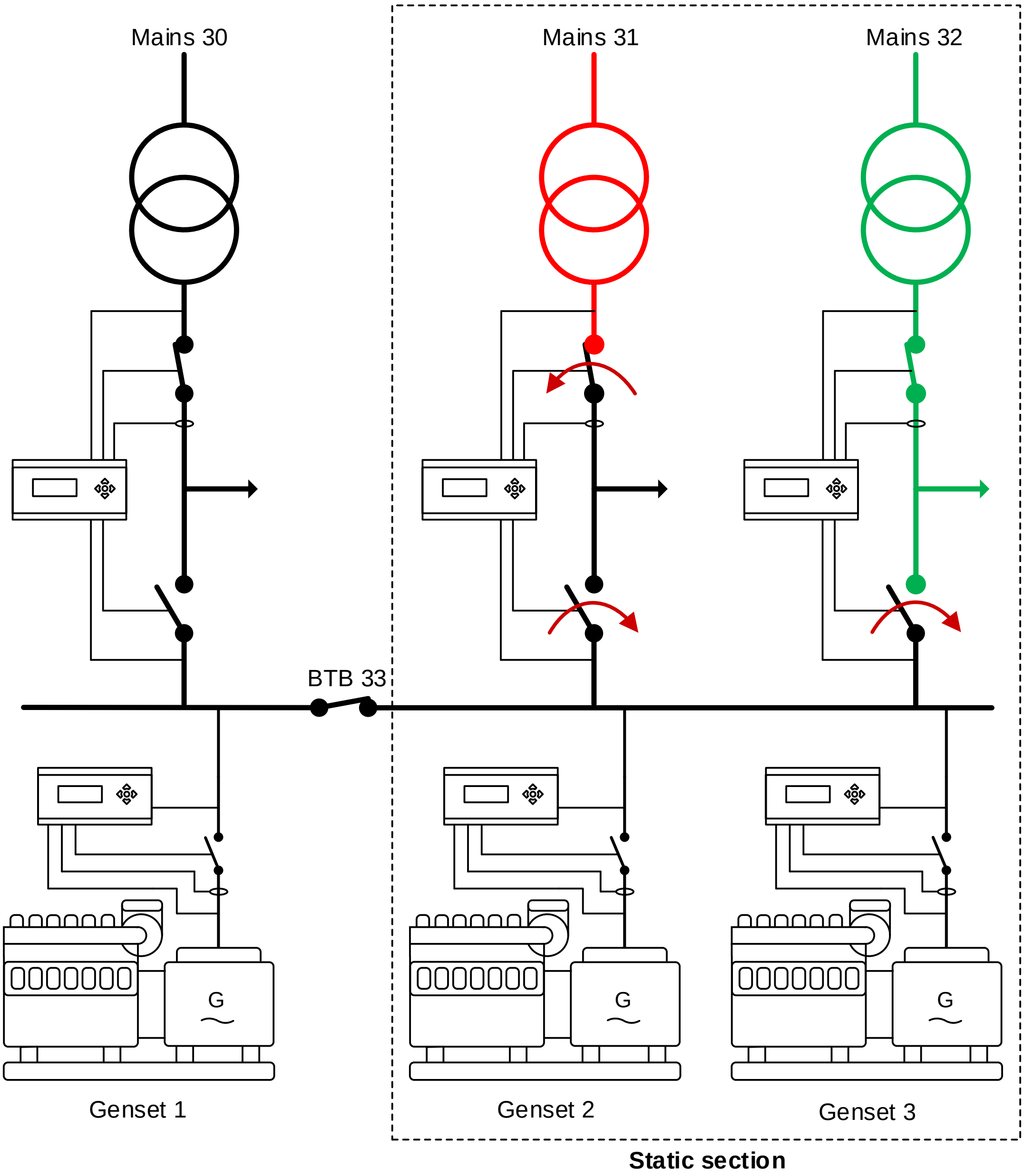
OFF:

Below is shown an application consisting of 3 mains feeders, and three gensets. Each mains controller also controls a TB.



In the application above, the auto switch function is disabled/set to OFF, so the AGC PM is not allowed to use another mains feeder as backup. When one mains fails at this situation, the MB will be opened up, and the genset(s) will start up and carry the load until the mains returns back to normal. The genset will then synchronise (if allowed), and the application will return to normal operation.

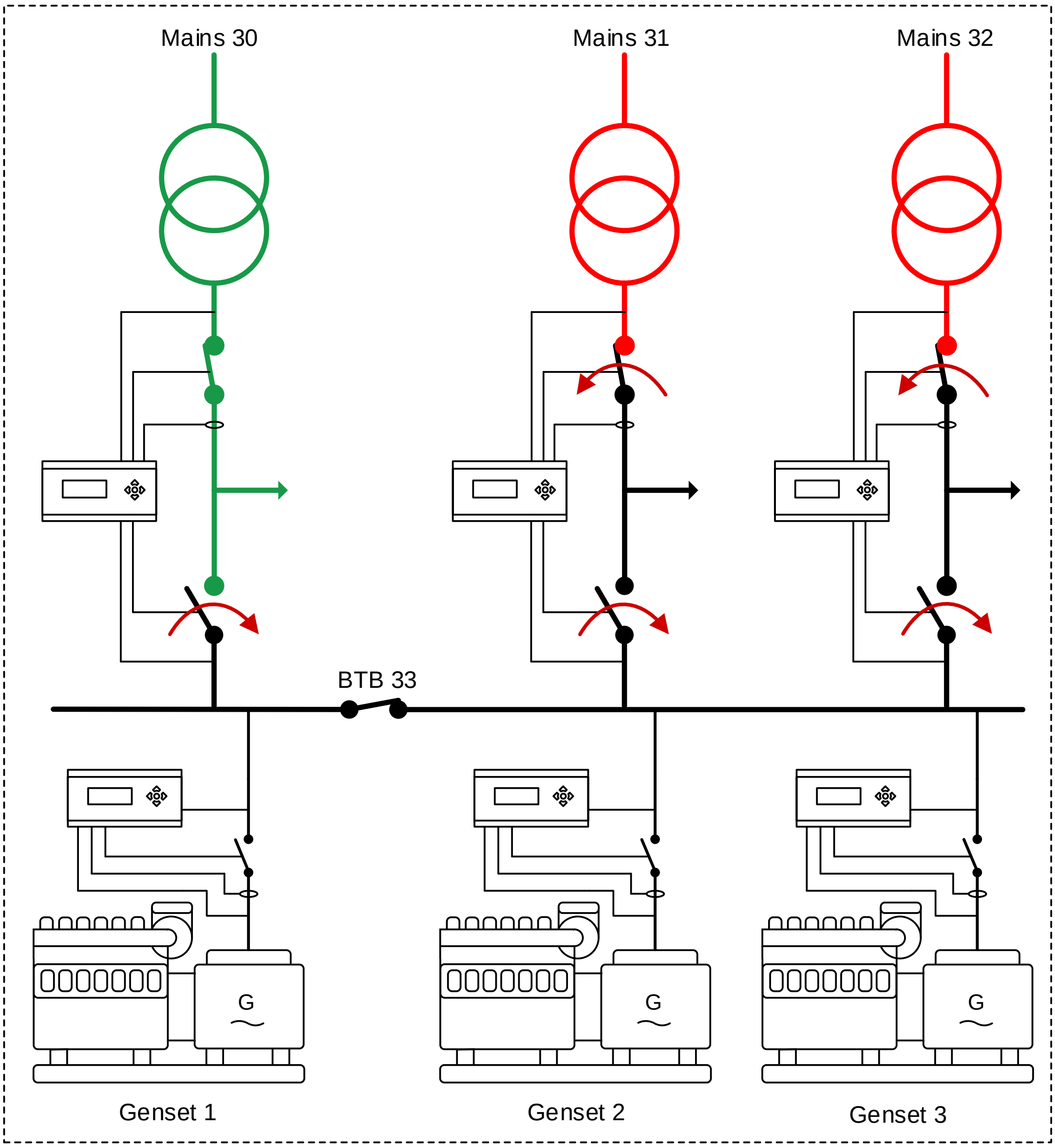
Static section:
If the auto switch is set to: static section, the AGC PM is allowed to use some mains feeder(s) as backup. But only the ones located in the same static section, as the mains fails occur. This is shown in the drawing below:



When the grid at mains 31 is failing, the AGC PM has been allowed to use another mains as backup. In this case, the AGC PM has been set for static section, which means it is allowed to use mains 32 as backup, since it is located in the same static section. TB32 will be closed, and afterwards TB31 will be closed, so it can support the load at mains 31.

If mains 32 fails afterwards, mains 30 will not be used as backup, since it is only the mains feeders located in the same static section that are allowed to be used. If mains 32 also fails, genset 1 is allowed to start since the BTB is closed.

Dynamic section:
The setting for auto switch can also be set to dynamic section. This means that the AGC PM allows a mains feeder from another static section to be used as backup. The BTB between the sections have to be closed. An example of this is shown below:



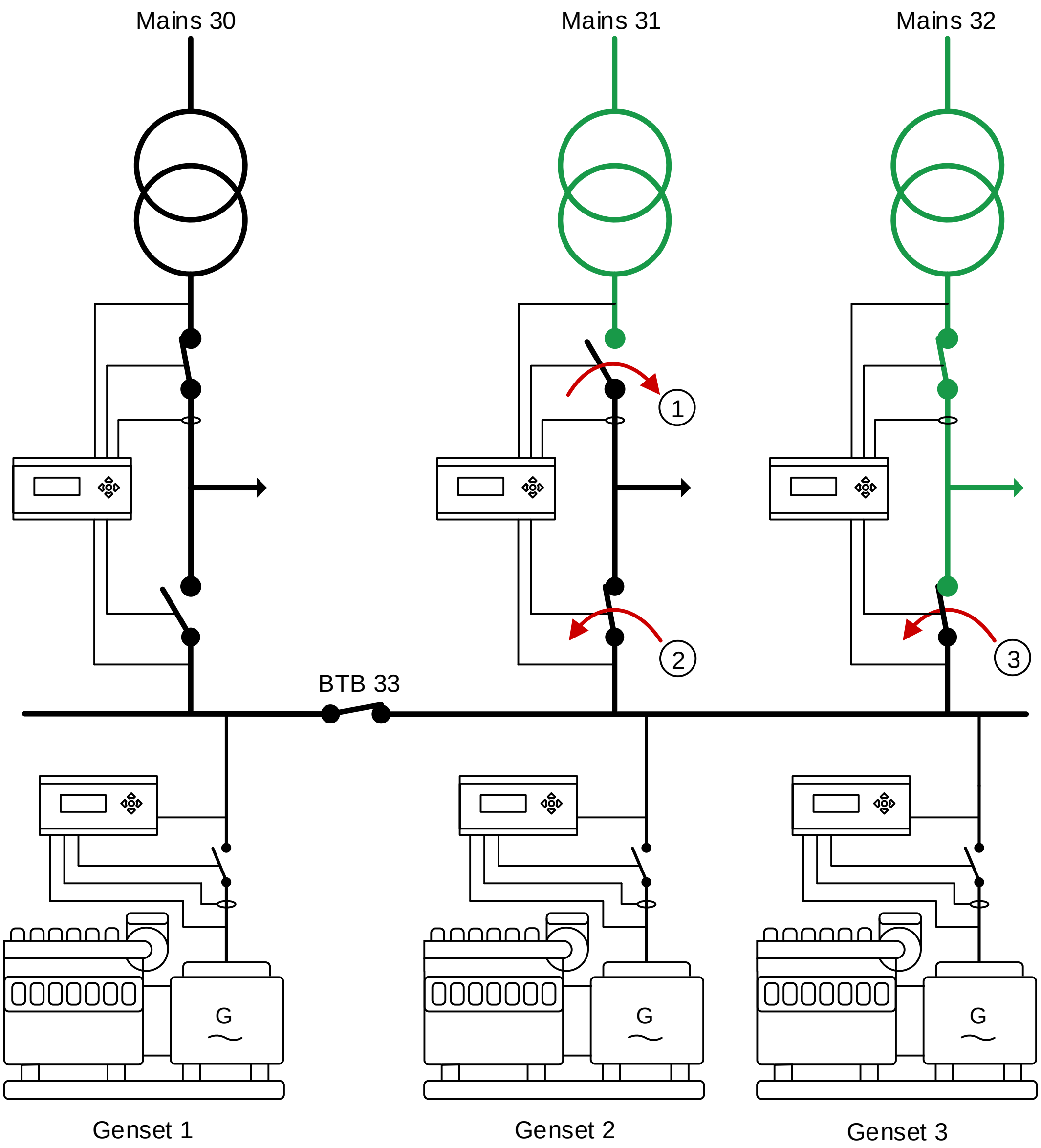
Dynamic section

In the application above, the auto switch is set to dynamic section. If mains 31 fails, the AGC PM will seek out to use mains 32 as backup feeder. If mains 32 fails afterwards, the AGC PM will use mains 30 as the new feeder. With the dynamic section setting, it is allowed to use a mains feeder from another static section when the BTB is closed. If mains 30 fails afterwards, the genset(s) will start up and carry the load.
Note that if the setting is “dynamic section”, mains 30 can then be used because the BTB is closed. If the BTB was open instead of closed, then genset 2 and 3 would be started to supply the load. If the mains failure on M31 and M32 persists and the genset feeds the load, then be careful about closing the BTB. This is because if the BTB is closed, the dynamic section expands to include the section of M30, M31 and M32, and then the conditions of the auto switch is fulfilled so the M30 will feed the loads of M31 and M32, and the gensets will be stopped. Therefore, be sure that M30 can handle the load level if the BTB is closed.

Parameter	Item	Range	Default	Note
8064	Auto switch	OFF Dynamic section	OFF	Only in mains/plant controller

5.14.3 No break transfer in 2-level applications

The No Break Transfer (NBT) function can be described as short time parallel between mains connections. This function is intended to be used along with the auto switch function. How the NBT function works is described below:



To use the NBT function, the auto switch function will have to be set to either static or dynamic section. In the drawing above, mains 31 has had a failure, and mains feeder 32 has been used as backup. Mains 31 is now back to normal, and with the NTB function enabled, the two mains feeders are allowed to be parallel for a short period. MB31 will be closed, and afterwards TB31 will be opened. At last, TB 32 will be opened. If one of the TBs has been configured as normally closed, this one will be kept closed, instead of opened.
The parameter for the no break transfer function is shown below:

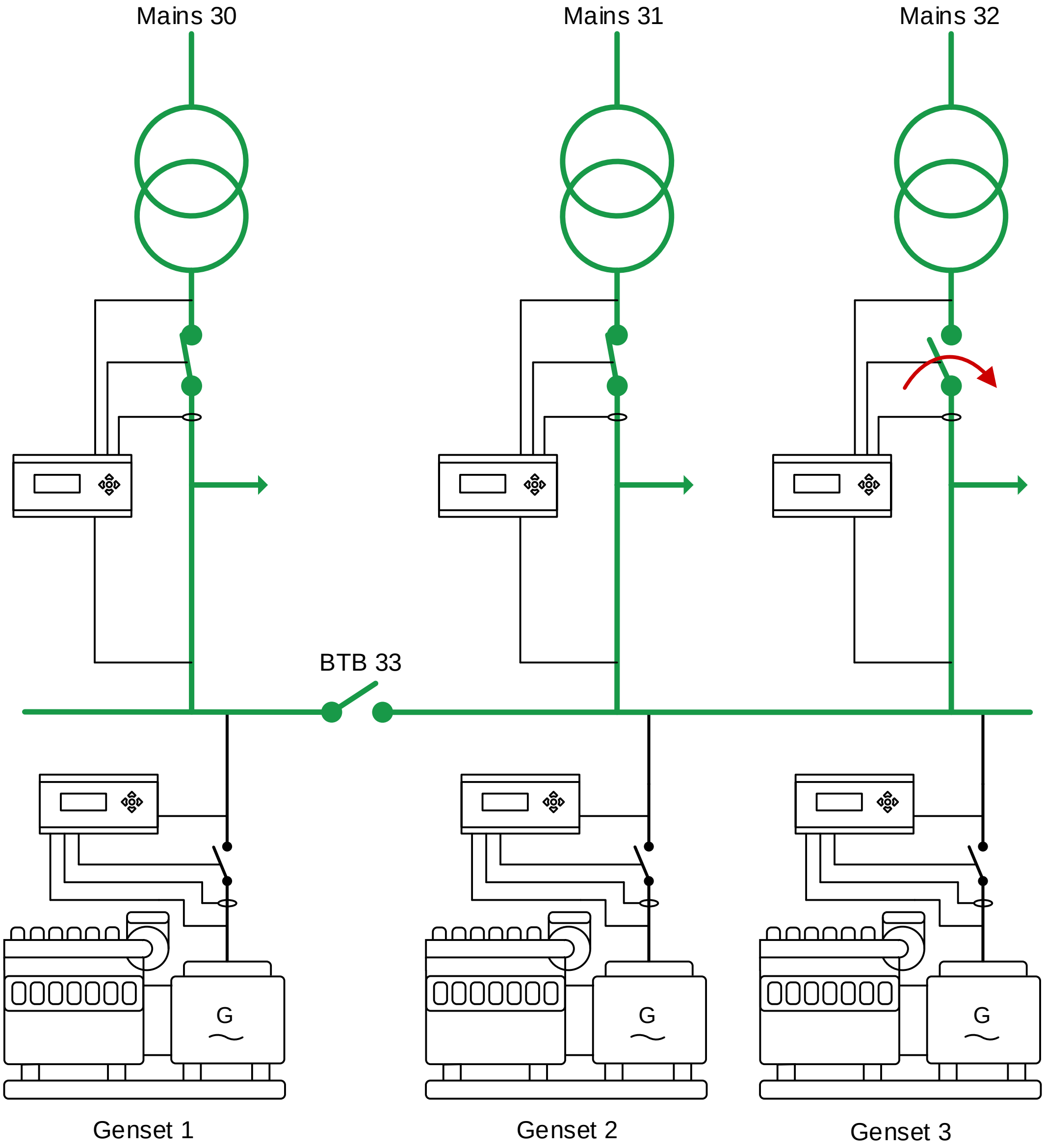
Parameter	Item	Range	Default	Note
8063	No break transfer	ON OFF	OFF	Only in mains/plant controller

5.14.4 Parallel in 2-level applications

The parallel function in the AGC PM allows mains feeders to be long-time parallel. This function is intended to be used when the AGC PM is in applications where the mains feeders can be long-time parallel. It could be e.g. mains power export or be in applications where there are no tie breakers.

Please note when enabling the MB fail start, Mode shift is automatically set to ON (7081)

An application with no tie breakers could look like this:



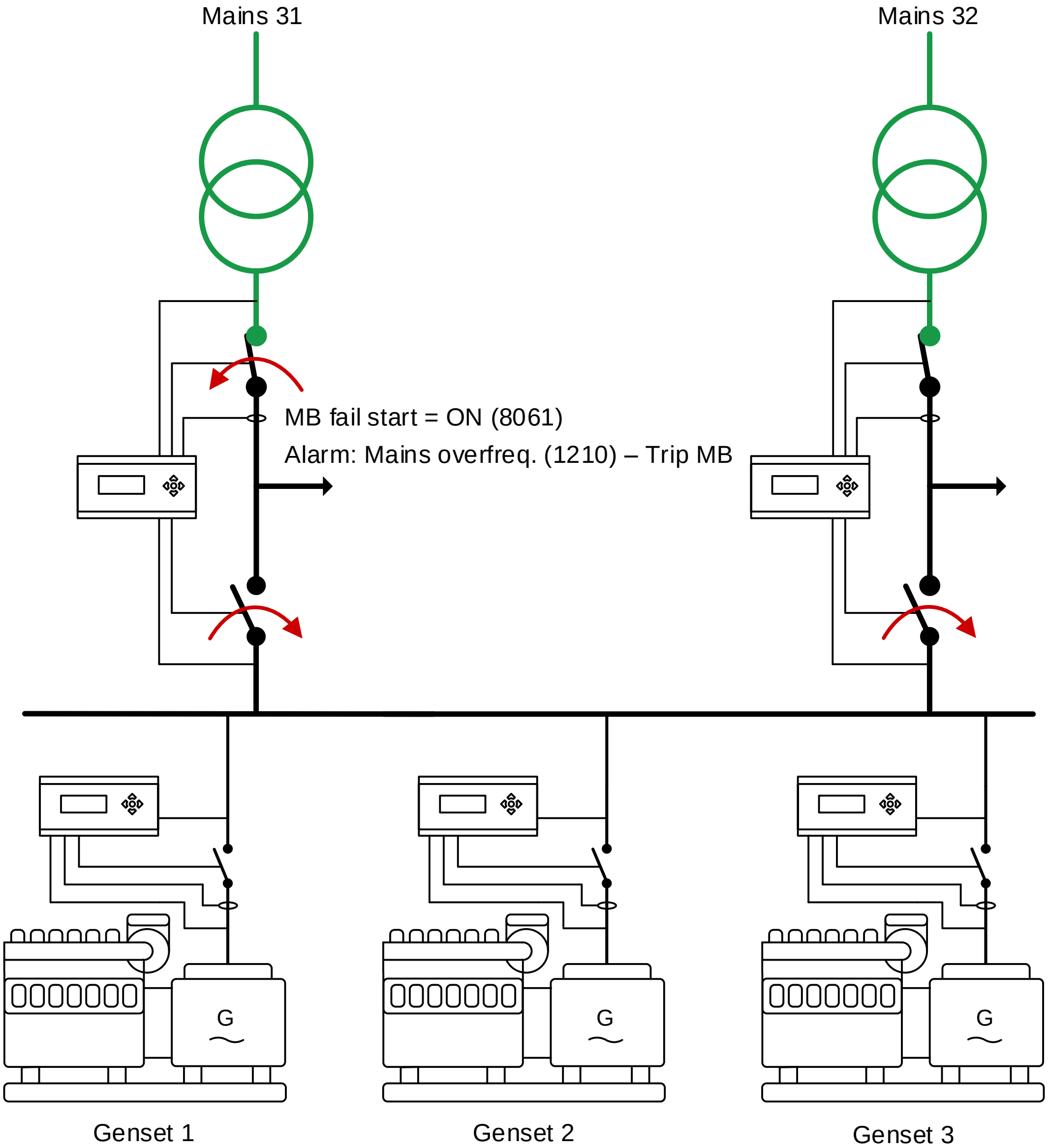
Above is shown an application with 3 mains feeders. The BTB is open, so the application is divided into two static sections. Since the application does not have any tie breakers (TB), the two mains feeders on the right side will have to be parallel if they are both to be used to support the load. Before two mains can be parallel to support a load, the parallel function will have to be enabled in the AGC mains PM. If the parallel function is not enabled, the mains with “ID to Run” will support the load. When the parallel function is enabled, the other MB will be closed. The AGC mains PM will always check for synchronisation before a MB is closed. The two mains feeders will now support the load. How loaded each mains feeder is, depends on the impedance in the transformers and cables.

The parameter for parallel operation is shown in the table below:

Parameter	Item	Range	Default	Note
8062	Parallel	ON OFF	OFF	Only in mains/plant controller

5.14.5 MB fail start + Auto switch + No break transfer in 2-level applications

In the AGC mains PM, the MB fail start (8061) and auto switch (8064) can be combined. When these are about to be combined, the application should consist of more than one mains feeder. Otherwise, the auto switch function does not make sense. An application where the MB fail start and auto switch can be combined could look like this:

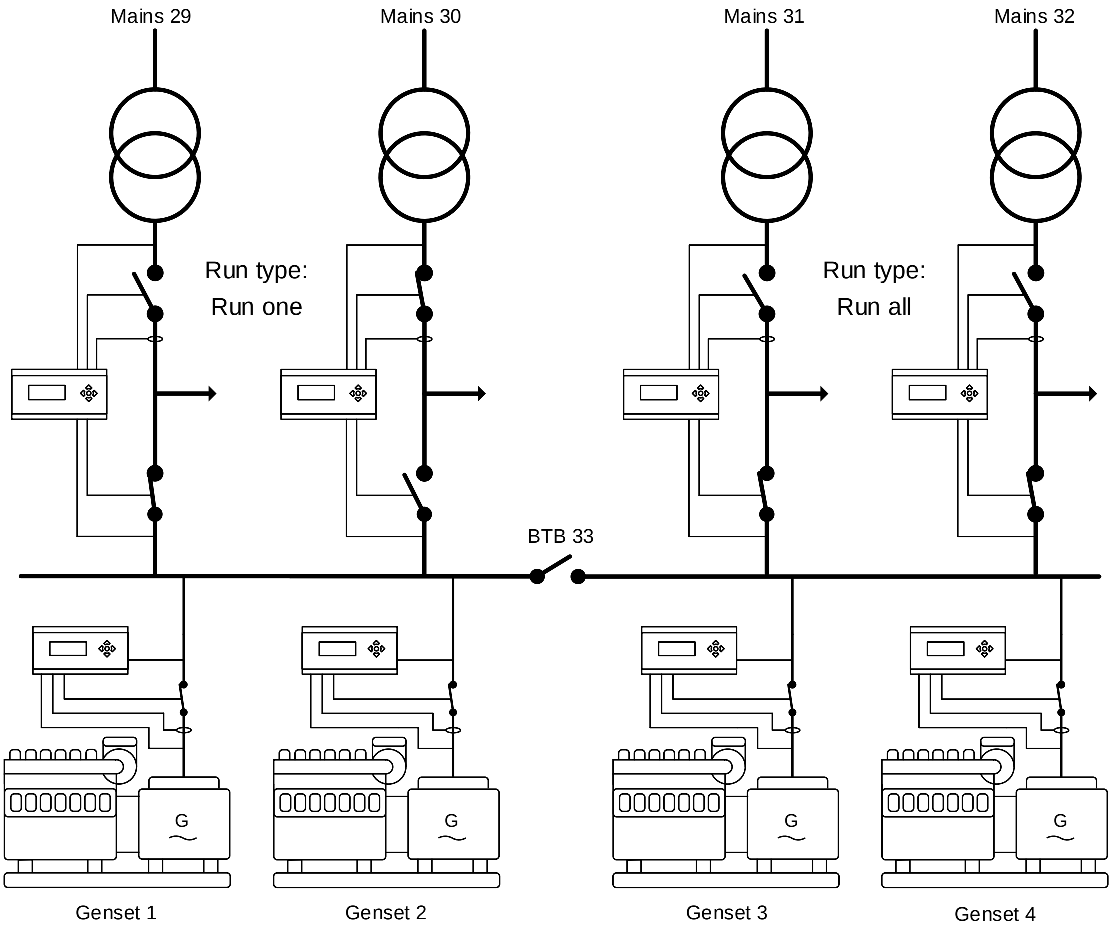


In the application above, the two mains feeders are supporting the load independently of each other. The mains controllers have configured an “over-frequency” alarm with the fail class of “Trip MB”. When the frequency is high on e.g. mains 31, and the fail class has been configured to “Trip MB”, MB 31 will trip. With the “MB Fail start” enabled, mains 31 makes a request for help. Since auto switch is also used, it is allowed to use the other mains feeder for backup. If “MB fail start” is not activated, MB 31 will just trip and nothing happens because there is no mains failure.

If “MB fail start” is not activated, it will only be a mains failure that is allowed to make the other mains to be used as backup feeder. With the “MB fail start” activated, all the alarms with fail class “Trip MB” can make the other mains feeder to be used as backup feeder.
If the “No break transfer” is enabled, the mains connections are allowed to be synchronised when the application is returning back to normal. If the “No break transfer” is disabled, the return sequence will be handled as open transition, so a blackout must be expected, if the application does not have an UPS installation.

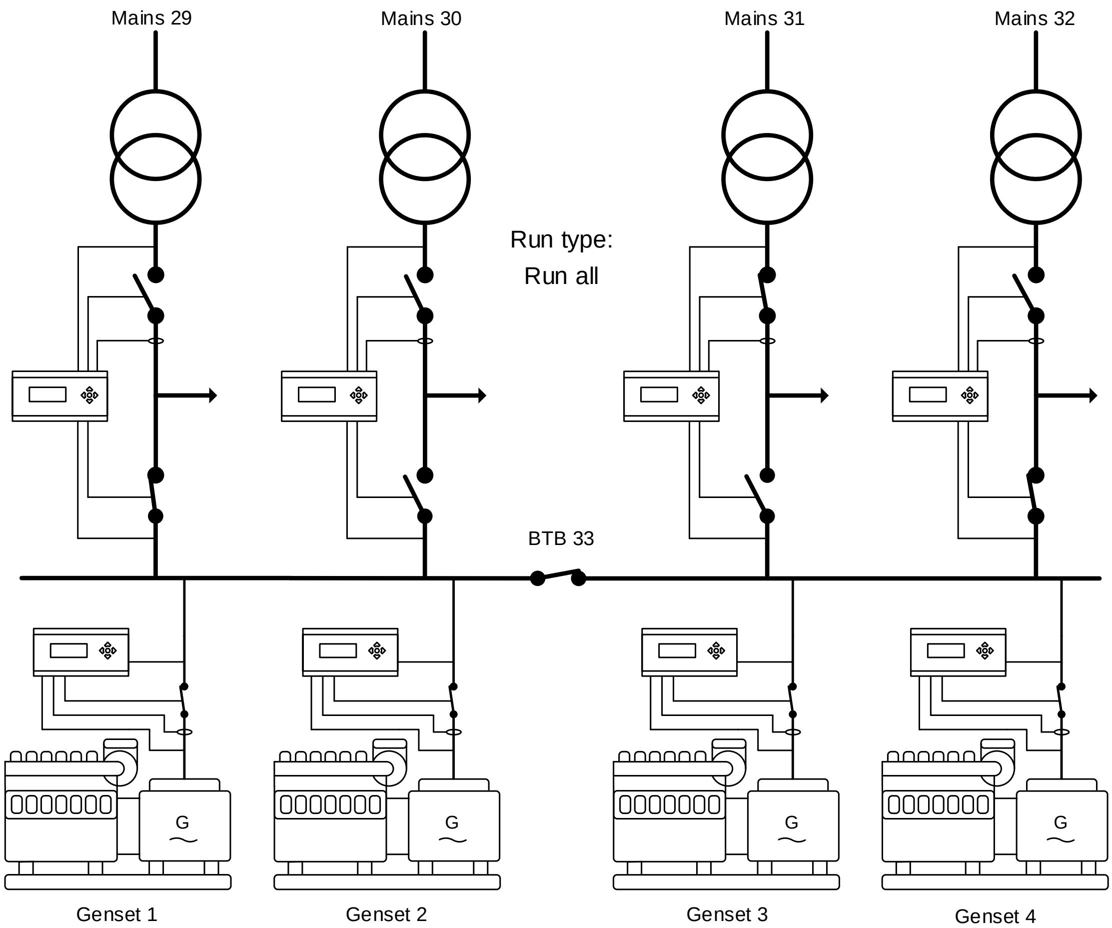
5.14.6 Run type + Include/exclude from run all sequence in 2-level applications

In the AGC PM, there is a menu for selection of run type. The setting in the menu can be set to either: Run one or Run all. The setting for run type determines what should happen in different situations. The different settings will be described based on the application below:



In the application above, the BTB is open, so the application is at the moment two static sections. The AGC PM can have different parameters regarding the run type. In the section to the left, the run type is set to Run one. The plant running mode is Load Take Over. When the run type is set to: Run one, only one MB will be deloaded and afterwards opened. The MB that will be deloaded is decided by the “ID to run” (8066).

In the right side, the run type is set to Run all. So when the start signal is given to the one of the mains controllers, and the controller is in Load Take Over mode, all the MBs will be deloaded. When the run type is set to Run all, the AGC PM use the chosen plant mode on all the mains feeders.
If the AGC PM is placed in a setup with several mains feeders, and not all the mains feeders are intended to be deloaded, the exclude function can be helpful.

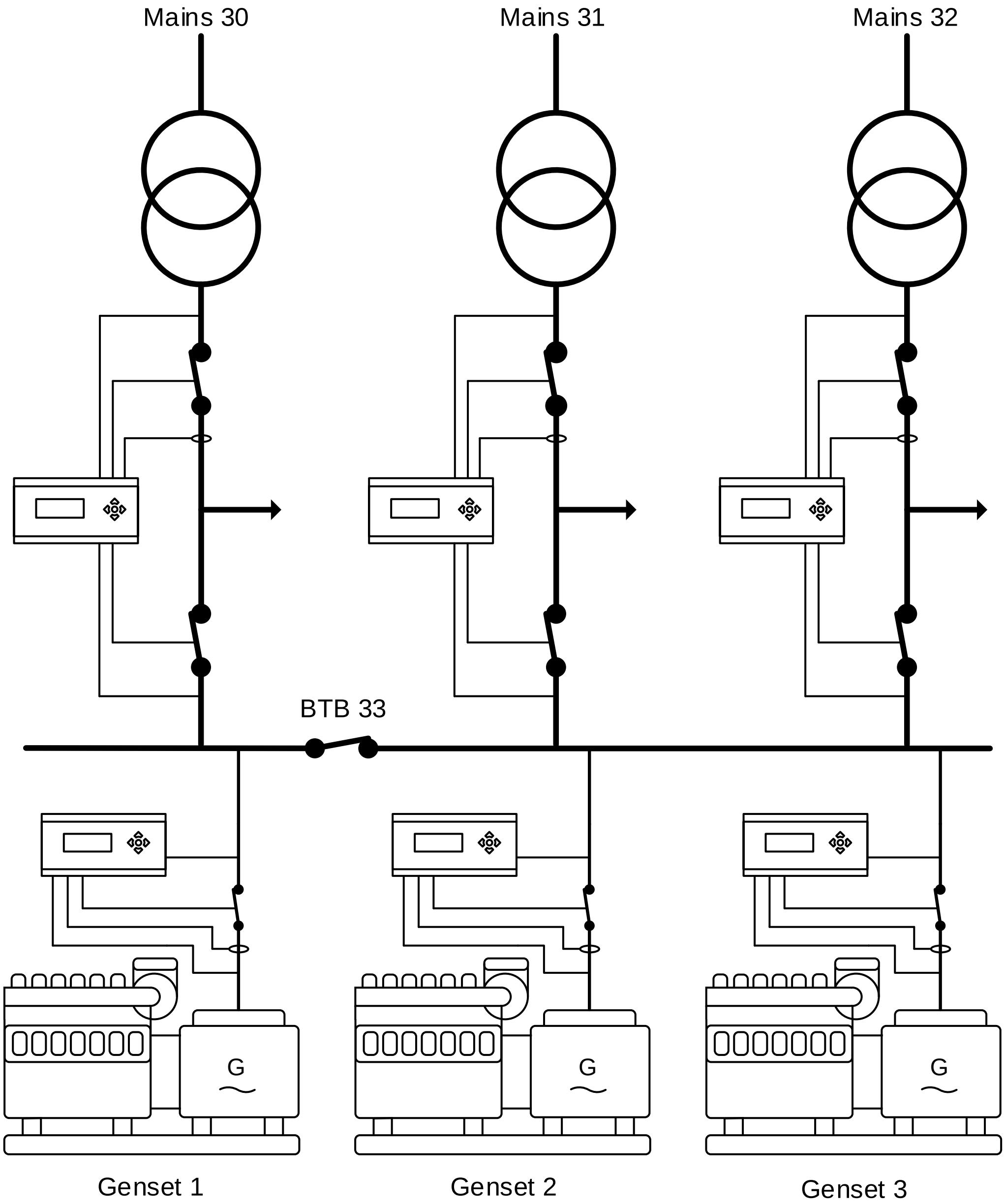


In the application above, the BTB is closed, and the setting for run type is set to Run all. The plant mode is Load Take Over, so when the start signal is given, all the mains feeders are intended to be deloaded. If a mains feeder is not intended to be deloaded, it can be excluded from the run all sequence. There are two different ways to exclude a mains controller from the run all sequence. It can either be done by using parameter 8996 or from M-Logic. When parameter 8996 is set to ON, the mains controller will be excluded from the run all sequence. From the M-Logic, it can also be controlled via two different commands. The two different commands set parameter 8996 to either ON or OFF, dependent on which command is used.
If the AGC PM is set to Mains Power Export mode, and the run type is run all, the AGC PM add all the exported power together, so the total exported power is equivalent to the power set in the AGC PM with “ID to run”.
If the parallel is not enabled, the AGC PM will synchronise to the mains with the lowest CAN ID and export the power set in the set point in the mains controller with “ID to run”.
The relevant parameters for the run type and exclude are shown in the table below:

Parameter	Item	Range	Default	Note
8065	Run type	Run one Run all	Run one	Only in mains/plant controller
8996	Exclude from run all sequence	OFF ON	OFF	Only in mains/plant controller

5.14.7 Run type + Parallel mains feeders in 2-level applications

When the AGC PM has to operate in 2-level applications with several mains feeders and different running modes, the set points across the plant can be used in different ways. The explanations of the systems' behaviours will be based on the application shown below:



Different examples will be explained from the application above. Common for all the applications is that the run type is set to run all, and the parallel is set to ON, so all the mains feeders are allowed to be parallel.

Mains power export: When operating in mains power export, the total power of all the mains feeders is added together and checked if this is matched with the power set point for mains power export. The power set point is decided by the controller with “ID to Run”. If the parallel is disabled, the AGC PM will be synchronised to the mains with the lowest CAN ID.

Peak shaving: If the peak shaving is used, the total imported power of the application is used. The time for a genset to start up is decided by the mains controller with “ID to run”, by the peak shaving power set point. If the parallel is disabled, the gensets will only synchronise to the mains with the lowest CAN ID.

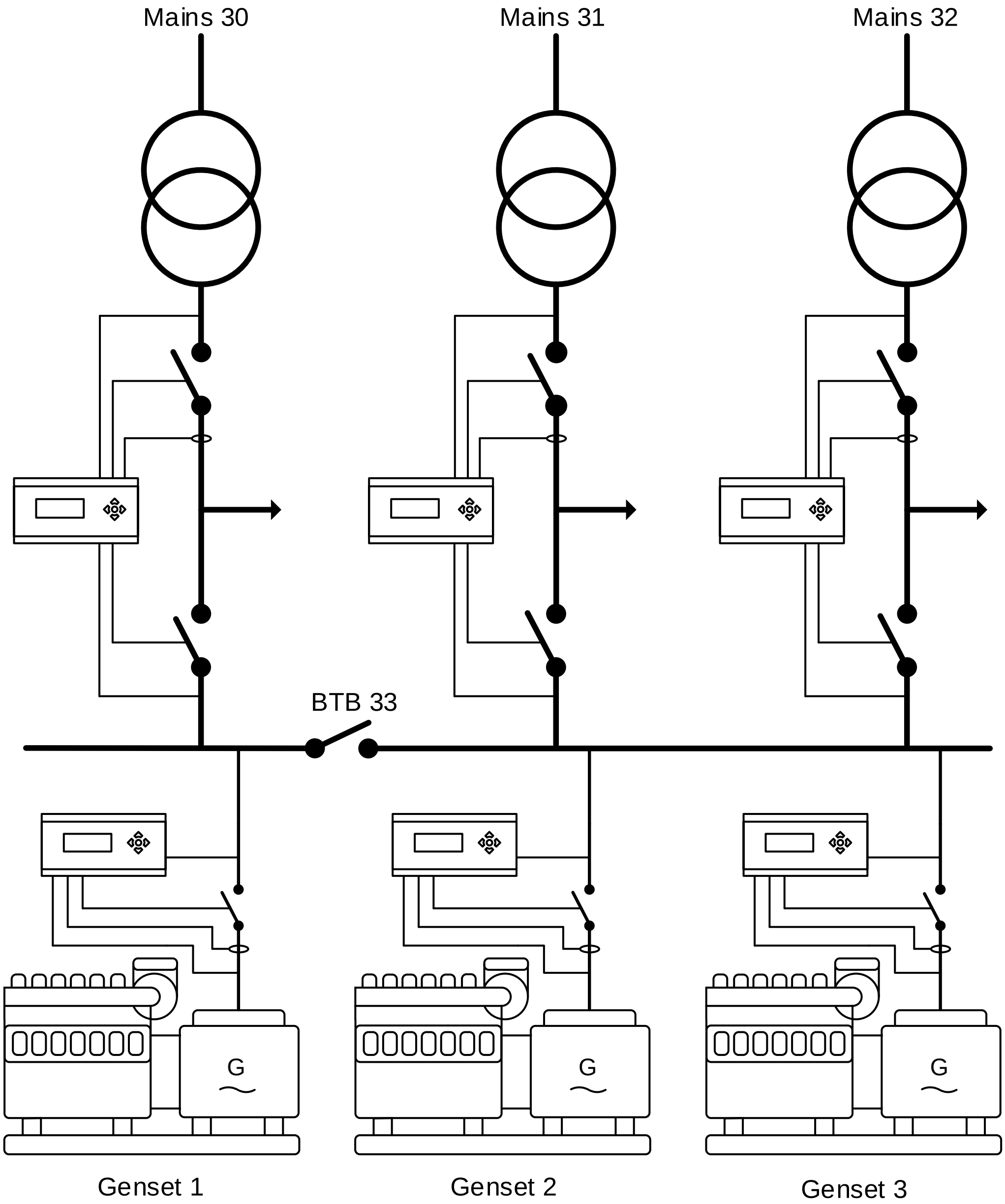
Fixed power set point: If the AGC PM is set to fixed power mode, the gensets will synchronise to all the mains feeders and be running in parallel to them. The power set point is determined by the mains with “ID to run”. Furthermore, the cos phi control is decided from the one with “ID to run”. If the parallel is disabled, the gensets will synchronise to the mains controller with the lowest CAN ID, and ramp up to the power set point set in the mains with “ID to run”.

Load take over: When the start signal is given, the gensets will start up and synchronise all the TBs at once, and deload all the mains feeders at the same time. Each mains controller will open the MB, when it is deloaded. If the parallel is disabled, the AGC PM will be synchronised to one mains feeder at a time.

If it is intended to be parallel to only one mains feeder in mains power export, peak shaving or fixed power set point, it is recommended to switch from run all to run one, and then use the “ID to run” to select which mains feeder to be parallel to.

5.14.8 ID to run in 2-level applications

The AGC mains PM holds a parameter for choosing between which mains parameters should be used, and which feeder e.g. the power should be exported to. This parameter is called “ID to run”. If an application has a BTB in the application, and this BTB is open, the system will have two different “IDs to run”. An application will need the same number of “IDs to run”, as there are sections. So if 3 mains feeders are divided by 2 open BTBs (one in between each mains feeder), the system will need to have 3 different “IDs to run”.
If two mains feeders are located in the same section, the “ID to run” will be broadcasted to the other mains in the section. An AGC mains PM can have an “ID to run”, which is not located in the section. This is described below:



If BTB33 is closed, the three mains would have a common “ID to run”, since the application consists of one dynamic section. When the BTB opens, the application is divided into two sections, so the mains will need to have two different “IDs to run”. In the section to the left, only mains 30 is placed, so the “ID to run” here will have to be ID 30. In the section in the right side, two mains are located, so either mains ID31 or 32 can be used as “ID to run”. When the application is divided by a BTB, the two sections can be considered as almost two separate applications. So if one/some mains controllers have an “ID to run” from another section, it will give an “ID to run conf. fail” alarm.

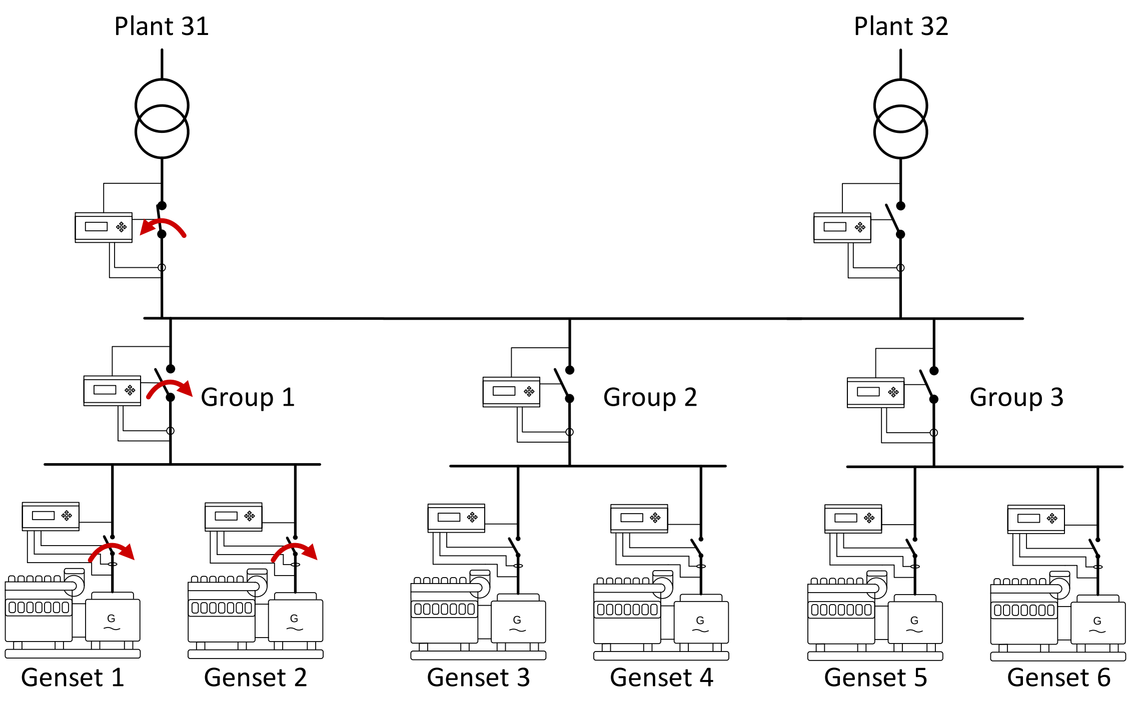
The “ID to run” defines different settings in different situations. Some of them are described below:

When the application is in Fixed Power, Mains Power Export or Peak Shaving, the power set points for each running mode is decided in the mains controller with “ID to run”. This includes the cos phi regulation (if allowed), power set points (if allowed), and also the power offsets (if allowed) and the cos phi offsets (if allowed).
Furthermore, the “ID to run” decides the power set point for the load test, and by this how many gensets should be started, in respect to the load-dependent start-stop settings. It also decides how many gensets should be started in a simple test.
In applications without tie breakers at the mains feeders, where the mains feeders are not allowed to be parallel, the mains with “ID to run” will carry the load in the present section.
In applications where the run type has been set to run one, either the mains with “ID to run” will be deloaded in a load take over sequence, or the one exported to in the mains power export situation. The genset(s) will also be parallel to the mains feeder in a fixed power running mode.
The parameter for “ID to run” is shown below:

Parameter	**Item**	**Range**	**Default**	**Note**
8066	ID to run	1 32	32	Only in mains/plant controller

5.14.9 MB fail start in 3-level applications

As the AGC PM has the MB fail start function for 2-level applications, the function can also be used in 3-level applications. The parameter is located at the same menu number. An application of the 3-level application is shown below:

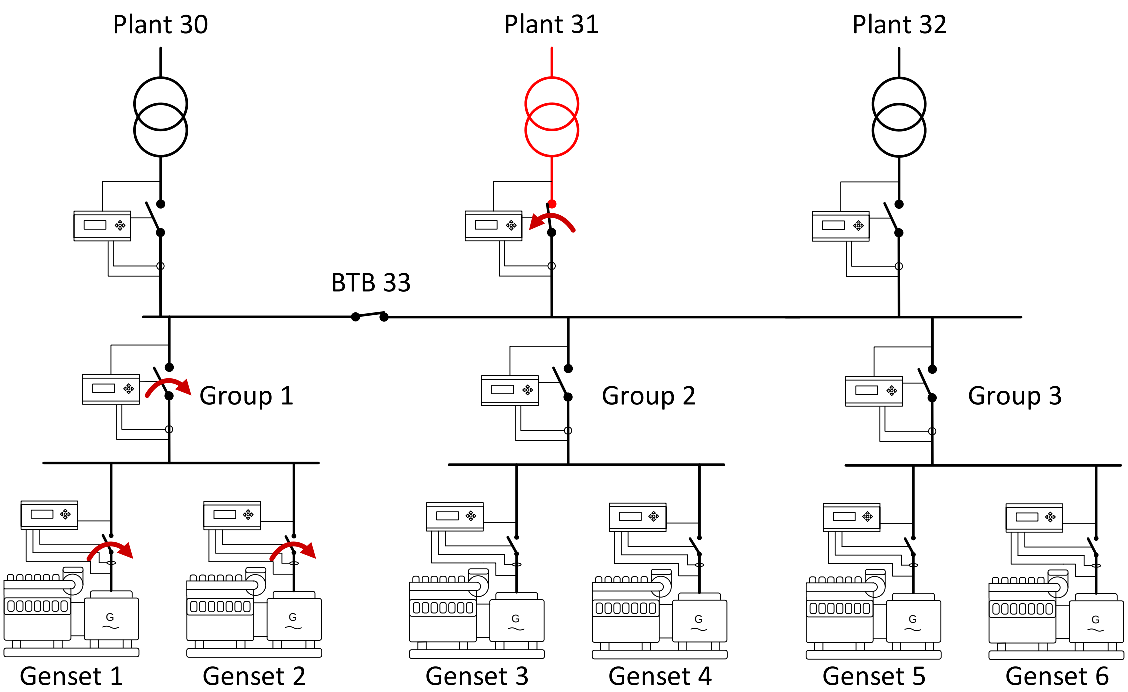


The situation in the application here could be that the mains breaker trips due to an overload or the breaker's own trip relay has been activated. It could also be a digital input that has been configured to the fail class of "Trip MB". The alarms in the plant controller that have the fail class "Trip MB", have the possibility to activate the MB fail start. When an alarm with "Trip MB" appears, the genset(s) in a group with priority will start. The number of gensets that start is determined by the load-dependent start/stop settings.
In the application above, the two mains feeders are not allowed to be parallel, and Plant 31 is "ID to run". This means that MB32 will be kept open. If Plant 32 then has an alarm with the fail class "Trip MB", the AGC PM will not start up the gensets, since the MB is already open.
The genset(s) will be running until the alarm has been acknowledged and the MB is able to close again. If the trip alarm appears during running in e.g. mains power export operation, the gensets will try to support the load, if possible. When the alarm has been acknowledged and the MB is able to close, and auto start signal is still active, the genset(s) will synchronise to the grid and continue the mains power export operation.

5.14.10 Auto switch in 3-level applications

The AGC PM is capable of also performing auto switch in 3-level applications. In these 3-level applications, there are no tie breakers between the mains feeders, so the auto switch functions works a bit differently than in 2-level applications with tie breakers. The auto switch holds three different settings which will be described below:

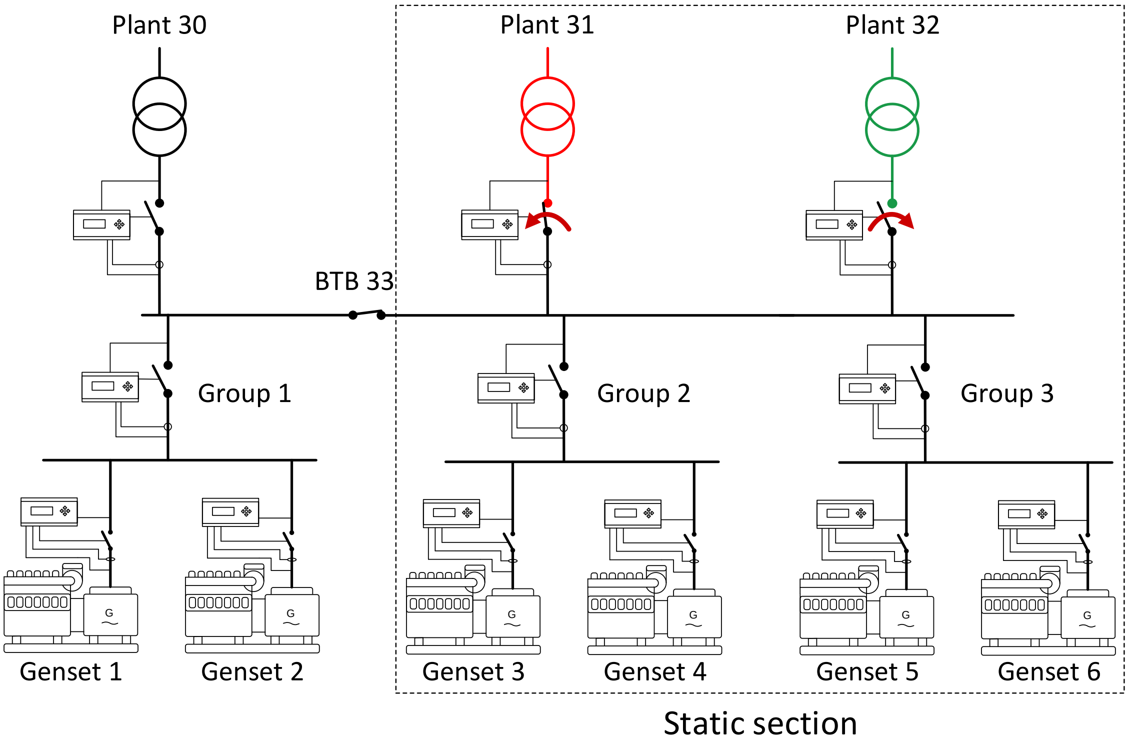
OFF:
An application consisting of 3 mains feeders, 1 BTB and 3 genset groups:



In the application above, the auto switch function is set to OFF. The mains feeders are not allowed to be parallel, and plant 31 is "ID to run". So plant 31 will support the load. When a mains failure appears, the genset group with the lowest ID will get a start signal. The multi-start setting in the genset controllers determines how

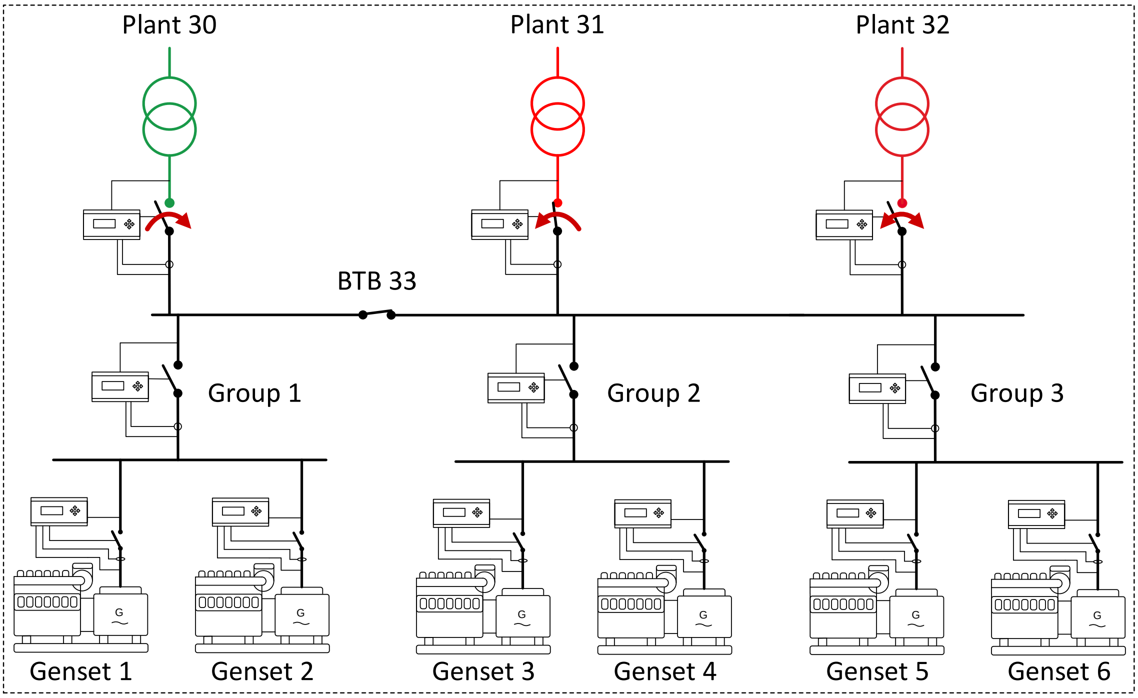
many gensets will start. The genset(s) will then carry the load until the mains is back within normal limits again. This operation will only happen if the plant is set into AMF running mode, or the mode shift (7081) is set to ON.
If a mains failure appears at plant 30 or plant 32, while plant 31 is within limit, the AGC PM will not start the genset(s). Since plant 30 and plant 32 are not connected to the load, plant 31 will just continue to support the load. It will only be a mains failure at a plant that will start up the genset(s).

Static section:
The auto switch can also be set to: static section. When the auto switch has been set to this, the same application will handle the situation like shown below.



With the auto switch set to static section, the plant controller is allowed to use another mains feeder as backup for supporting the load. The plant will be running with the plant controller with “ID to run”, until the mains fails. The AGC PM will then check if another mains feeder within its static section is within the limits for the voltage and frequency, and ready to do backup operation for the mains feeder with failure. When the auto switch is set to static section, it is only allowed to switch to mains feeders within the static section. So if firstly plant 31 has a mains failure, it will switch to plant 32. If this one afterwards has a mains failure, the genset(s) will start. The genset group with the lowest priority will receive the start signal. If mains feeder 32 should come back first within the limit for voltage and frequency, the genset(s) will synchronise to it and deload. If mains 31 then afterwards comes back to normal, the AGC PM will use this one for supporting the load in this example, since it has “ID to run”. If the mains feeders are not allowed to be parallel, or the “no break transfer” is not enabled, the switch between mains feeders will be handled as an open transition.

Dynamic section:
When auto switch has been set to dynamic section, it is allowed to use mains feeders that are placed in another static section. This is described in the example below:

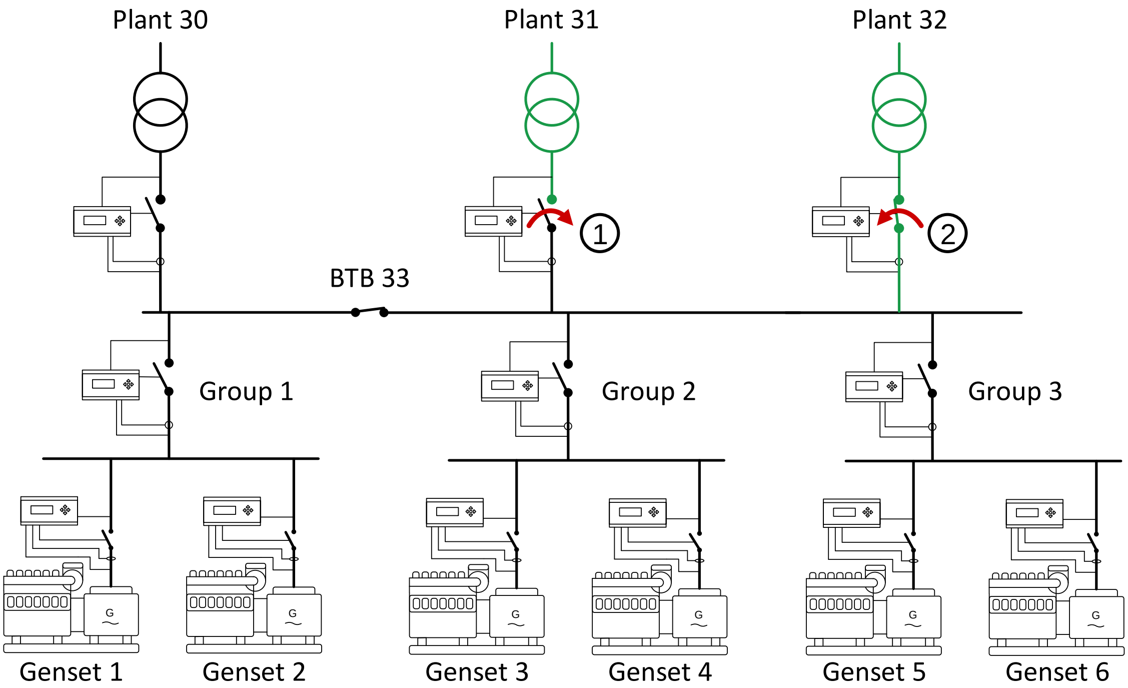


Dynamic section

The BTB33 is closed in the application above. This means that the application above consists of one dynamic section (and two static sections). With the auto switch setting of dynamic section, the mains feeders are allowed to be backup for each other across a closed BTB. In the application, the mains feeders are not allowed to be parallel, and the “ID to run” is plant 31. When plant 31 has a mains failure, the AGC PM will first use the mains feeder found in the same static section. This will be plant 32. If plant 32 then has a mains failure, the mains feeder found in another dynamic section, and in this case plant 30, will be used as backup. If plant 30 afterwards fails, the genset(s) will start.

5.14.11 No break transfer in 3-level applications

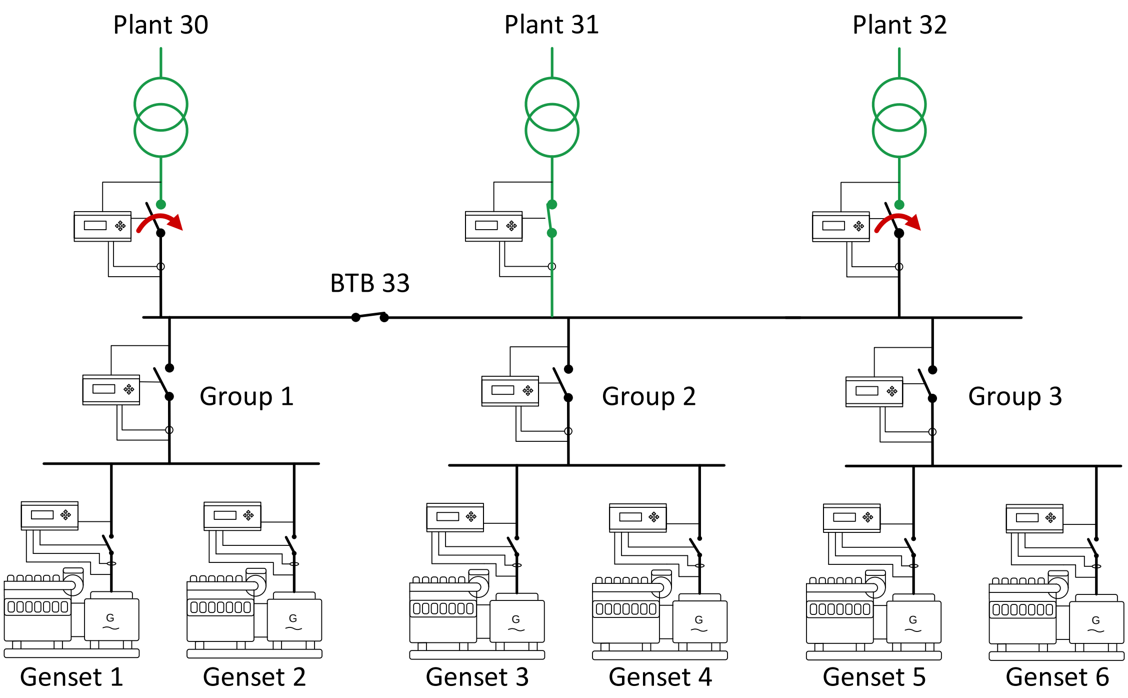
The AGC PM also holds the No Break Transfer (NBT) function for 3-level applications. The NBT allows mains feeders to be parallel when the plant is returning to normal procedure after an auto switch sequence. It can be considered as a short-time parallel between mains feeders. An application where the NBT function can be used is shown below.



In the application above, plant 31 is the “ID to run”, but has had a mains failure. The voltage and frequency is back within normal limits, so the mains feeder can again support the load. The NBT function allows the two mains feeders to be parallel during this operation. So the breaker at mains feeder 31 will be closed, and afterwards the breaker at mains feeder 32 will be opened. If the NBT function was disabled, this would have been handled as an open transition.

5.14.12 Parallel in 3-level applications

The parallel function gives the possibility to long-time parallel for two or more mains feeders. The parallel function can be used in e.g. mains power export, where the genset(s) has to be parallel to more than one mains feeder. Or the operator wants to have more than one mains feeder parallel at genset standstill. An application with parallel is shown below:



In the situation above, the gensets are at standstill, and it is intended that all the mains feeders should be parallel when supporting the load. Furthermore, the run type has been set to run all. The AGC PM will now need to know that the mains feeders are allowed to be parallel, which is done in parameter 8062. When the parallel is enabled, the open mains breakers will synchronise and close.

When enabling the parallel function, the no break transfer function is also enabled.

5.14.13 MB fail start + Auto switch + No break transfer in 3-level applications

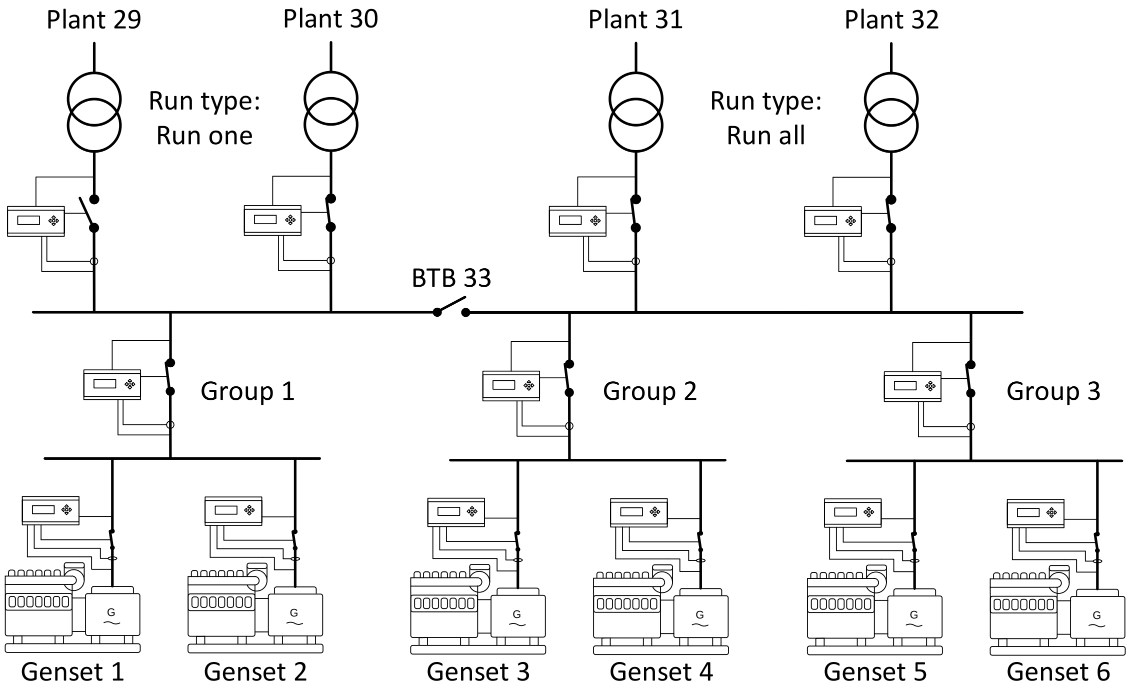
In 3-level applications, the MB fail start (8061) and auto switch can be combined. When these settings are combined, the application should consist of more than one mains feeder, since the auto switch will not make any sense if the application only holds one mains feeder. The systems' behaviour is very similar to the behaviour in 2-level applications.

With the MB fail start and auto switch combined, the AGC PM will use another mains feeder as backup if an alarm with the fail class of “Trip MB” appears on one of the plant controllers. Only alarms with “Trip MB” fail class or a mains failure will activate the auto switch onto another mains feeder. If the auto switch function is used, and the MB fail start is deactivated, the auto switch function will only be used when there is a mains failure.

With the no break transfer function activated, the AGC PM will handle the auto switch function as closed transition.

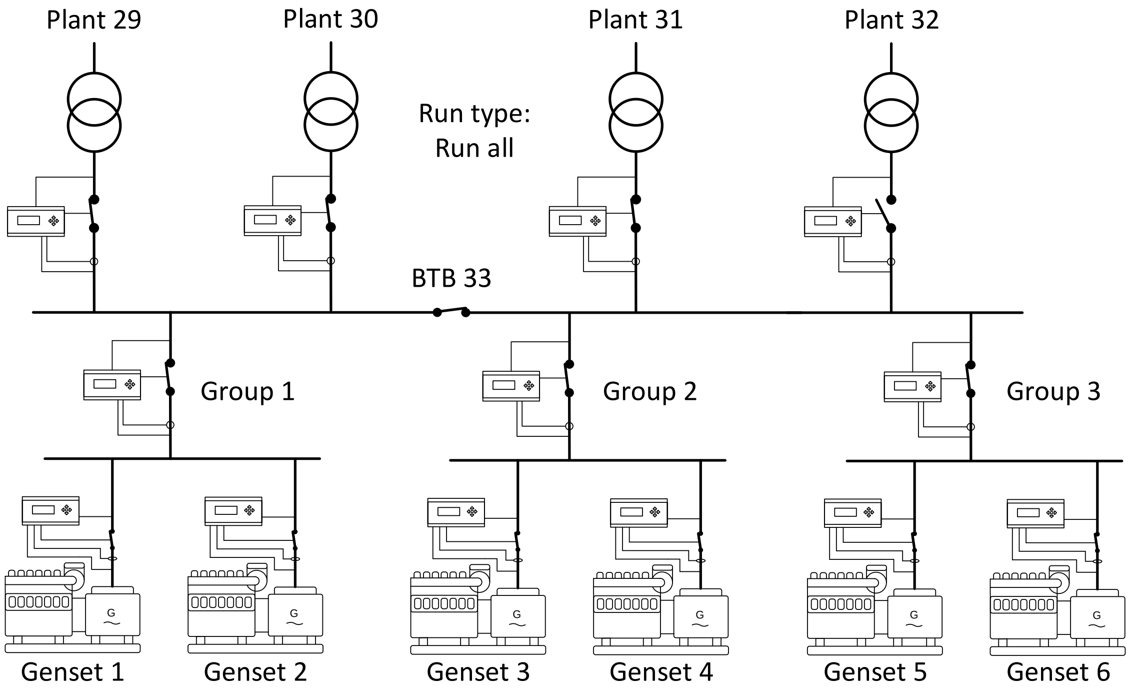
5.14.14 Run type + Include/exclude from run all sequence in 3-level applications

As in 2-level applications, the run type also has influence on the plant running mode in 3-level applications. In these applications, the selection is also between run one or run all. How the plant behaves is shown in the example below:



In the application above, the BTB is open, so the system is divided into 2 static sections. On the left side, the run type has been set to run one, and the plant mode is e.g. mains power export. The gensets will now only be exporting to one mains feeder. The mains feeder that will be exported to is decided by the “ID to run”. It will also be this mains feeder that decides the power set point.

In the right section, the run type is run all. When the plant running mode is mains power export, the AGC PM will export to all the mains feeders. In this situation, the plant with “ID to run” decides the power set point. If the gensets should be running in parallel to all the mains feeders at one time, the mains feeders have to be allowed to be parallel.



In the application above, the BTB has been closed, so the application consists of one whole section. The run type is set to run all, and the plant mode is mains power export. Furthermore, the mains feeders are allowed to be parallel. When the run type has been set to run all, the AGC PM will seek out to be parallel to all mains feeders. If it is not intended to be parallel to all mains feeders, the mains feeders can individually be excluded from the run all sequence. This can be done from either the display, or set via events from M-Logic. The parameter to manually include and exclude from the display is 8996. When the parameter is set to ON, the mains feeder is excluded from the sequence. Be aware that if the “ID to run” is excluded, it is still these power set points that will be used.

5.14.15 ID to run in 3-level applications

In 2-level applications the “ID to run” has a lot of influence on the running modes. This is the same case in 3-level applications, where the “ID to run” function is very similar. In 3-level applications, the AGC PM will also at least need one “ID to run”. If the application is divided into 2 sections by an open BTB, the AGC PM will need an “ID to run”, on each side of the BTB. The ID will have to be located on each side of the open BTB. Otherwise, the AGC PM will give the alarm “ID to run conf fail”. If the BTB is opened, then the dynamic section without an “ID to run” will return to its original (from before the BTB was closed). The “ID to run” in the dynamic section which held the shared “ID to run” will remain the same.
The “ID to run”, decides the power set points for e.g. fixed power, mains power export and peak shaving. It will also control the cos phi and power offsets. Some of them have to be allowed to be controlled from the plant controller.
In 3-level applications, it is also the plant controller that decides the power set points for the different test types.
If the run type is set to run one, this mains feeder will be the only one exported to, and only this one that deloaded in a load take over sequence. But the gensets will also be running in parallel with this one in a load test. In a full test, only this genset will be deloaded.

5.15 Fuel logic

5.15.1 Principle

The AGC PM holds some different functions regarding the fuel for the genset. Before this is programmed, some configuration will have to be done. The different steps for this are described below:

5.15.2 Configuration of the tank and measuring input

Firstly, the day tank capacity is set. This is set from parameter 6911. The tank's volume is set in litres. The range for the day tank is between 1 and 9999 L. The capacity set in this menu is for the supervision and reading of the day tank.

5.15.3 Configuration of fuel level input

This is done in parameter 6591. From this menu, the operator can choose which input to use for fuel measurement. It is not chosen which type the input is. The input will have to be configured as a multi-input and how to scale multi-inputs are described later in this document.

5.15.4 Configuration of output

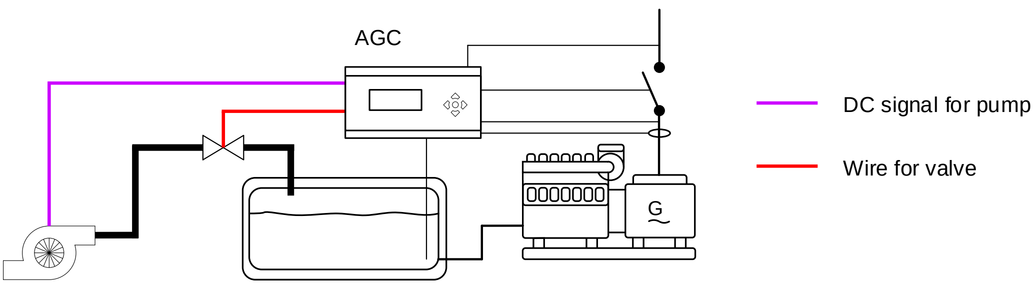
The fuel function needs a relay output it can activate. The fuel logic can be programmed so the AGC PM opens a valve at the day tank, or starts a pump. When the AGC PM is requesting fuel, the relay chosen will be activated all the time, so it is working as a continuous output. The relay output is set in parameter 6933.

5.15.5 Fuel fill check

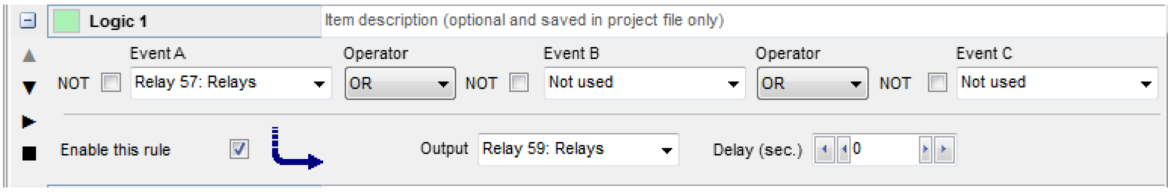
The fuel logic contains an alarm that can be activated when the fuel flow into the day tank has not been enough for a period. The alarm is called fuel fill check, and is located at parameter 6941-6943. Parameter 6941 will enable the function, and when the alarm is present, the AGC PM will use the fail class set in parameter 6942. When the fuel fill check alarm is present, the relay chosen in the fuel logic will also be deactivated. In the fuel fill check alarm, only a timer can be set. This timer should represent how long time it takes to increase the level in the day tank by 2 %. The percentage cannot be changed, so it is only the timer that can be programmed.
The AGC PMs fuel fill function can be used in different setups. Some examples on how it can be done are shown below:

5.15.6 Stand-alone applications

In stand-alone applications, the fuel system could look like below, where an AGC PM is activating a relay for a pump, and for a valve.



By default, it is only possible to configure one relay output in the AGC PM, when using the fuel logic function. If the fuel function requires an extra relay output, this can be programmed with M-Logic. In this setup, the AGC PM can start the pump when the level in the tank is getting low, and stop the pump when the level is getting high. The low/start limit is set in parameter 6931 and the high/stop limit is set in parameter 6932.
If the AGC PM needs to activate more than one relay when the request for fuel is activated, this can be programmed with M-Logic. If for example relay 57 is activated when the fuel is needed, and also relay 59 needs to be activated, the M-Logic can be programmed like shown below:



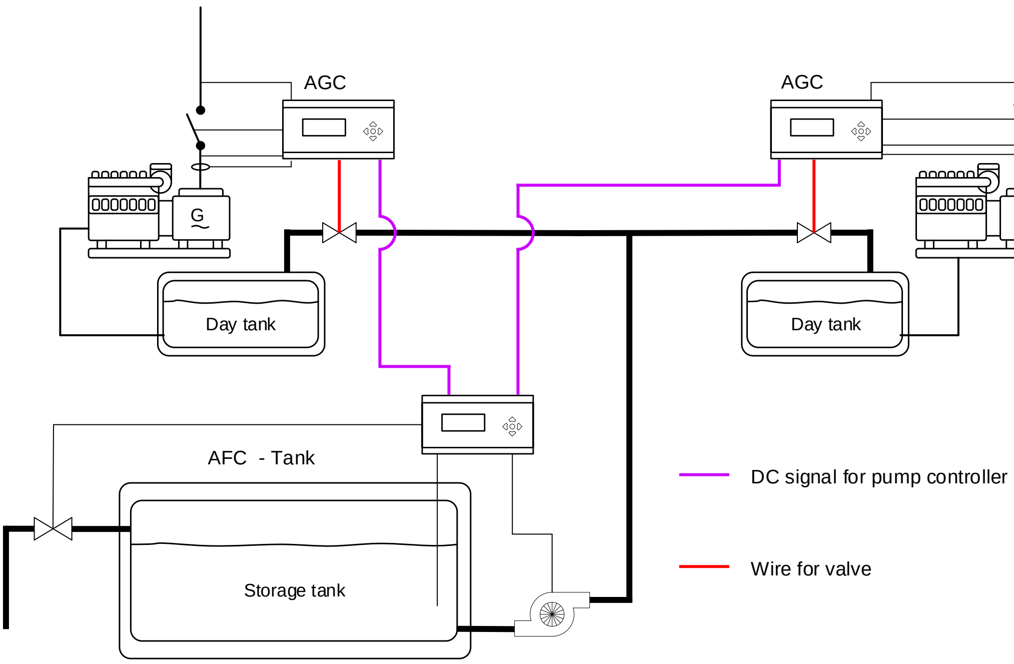
When activating a relay from M-Logic, the relay needs to be set to a limit relay in the parameters for relay 59. From the display, it is also possible to activate the full logic manually. This can be done in parameter 6936, where it can be set to fill manually. The AGC PM will fill the day tank once, and return to the normal fuel logic procedure after the day tank is filled. When it is set to fill manually, the AGC PM will still respect the high/stop limit, so it is not required to stop it manually.

5.15.7 Fill group / Fill all groups

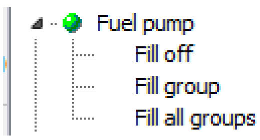
The AGC PM’s fuel function has a function where it is possible that the mains/group/plant controller controls when the gensets should activate the relay(s) for valve and pump. Each genset can be dedicated to a specific fuel group number, and from the mains/group/plant, it can be decided which fuel group number should be filled. The fuel group is independent of the priorities of the genset. If a fuel group number is set to be filled from the mains/group/plant controller, all gensets in the specific fuel group number will be filled. It does not matter if there are any open BTBs or gensets located in another genset group. Furthermore, it can be set how many maximum per fuel group should be filled at a time. This is also set in the mains/group/mains controller.

5.15.8 Fuel logic in 2-level applications

A principle drawing of how the fuel system could be handled in 2-level applications is shown below:



The drawing above shows how the wiring to AFC (Automatic Fuel Controller – Tank unit) can be done. In the system above, an AFC system has been used for monitoring and controlling the fuel system. Between the AGC system and AFC system, the interfacing can be 24 V DC signals. When an AGC PM is requesting fuel, the dedicated relay will close and this will open the fuel valve, and another relay will close so the AFC (tank controller) will get a DC signal telling that a genset is requesting fuel. When more gensets are requesting fuel, each genset will close the relays so the valves can be opened, and the pump controller will know that some are requesting fuel. Each AGC PM should have a DC signal to the pump controller, since it is possible that some tanks are filled before others, and by this their relays will be deactivated before the others. In 2-level applications, the mains controller can dictate that all gensets should fill their day tanks, or a maximum at a time. It can also be chosen which fuel group should be filled if only some are intended to be filled.
The fuel function can be controlled from M-Logic, where the commands also show that it is possible to stop the fuel fill function. The commands for the fuel fill function are shown in the picture below:

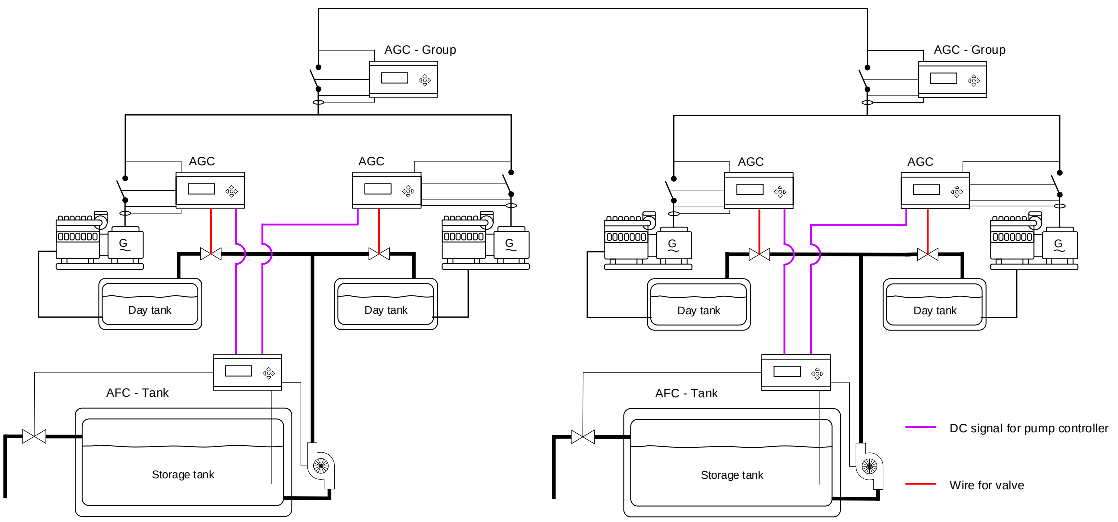


Some limits can be set in each controller. The gensets have a low and high limit. If the low limit is set to e.g. 10 % and the high limit is set to 80 %, the genset controller will activate the relay(s), when the fuel is below 10 %, and deactivate the relay(s), when the fuel has reached 80 %. If the gensets are receiving a fuel fill request from the mains controller, the gensets will be filled to the percentage set in the mains controller. In the gensets, the lower limit can be set for -1 %, which means that the fill request will always have to be given manually to the genset, or from the mains controller.

Parameter	Item	Range	Default	Note
6911	Day tank capacity	1 l 9999 l	1250 l	Only in gensets
6931	Fill threshold low limit	-1 % 100 %	-1 %	Only in gensets
6932	Fill threshold high limit	0 % 100 %	80 %	
6933	Fuel pump output	Not used Option-dependent	Not used	
6934	Assign to fuel group/fill fuel group	1 32	1	
6935	Max gensets per group	1 32	32	
6936	Fill manually	OFF Fill day tank	OFF	
6941	Fuel fill check ena-ble	ON OFF	ON	
6942	Fuel fill check fail class	Warning Block	Warning	
6943	Fuel fill check timer	0.1 s 300.0 s	60.0 s	Only in genset
6951	Fuel level input	Auto detection Option-dependent	Auto detection	Only in genset

5.15.9 Fuel logic in 3-level applications

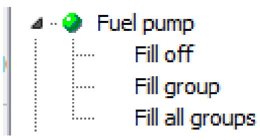
The fuel logic function in the AGC PM can also be used in 3-level applications. A drawing of the principle is shown below:



This drawing above could be from a site where more tanks are located, so the fuel is handled in decentralised tanks. Each tank has an AFC (Automatic Fuel Controller – tank unit). The signals between the AGCs and AFC should be 24 V DC constant signals. In the drawing above, the AGC PMs activate two relays, when they are requesting for fuel. The first one goes to the valve, and the second one is the signal to the AFC system. Each AGC PM should give a signal to the specific AFC that is controlling the nearby tank/pump, so each AGC PM has the possibility to close the valve at the day tanks, while the other genset is receiving fuel. The AFC will have the possibility to keep on pumping as long as at least one AGC PM is giving a 24 V DC signal to the AFC.

In 3-level applications, the group or plant controller can dictate that all gensets should fill their day tanks, or a maximum at a time. It can also be chosen which fuel group should be filled if only some are intended to be filled.

The fuel function can be controlled from M-Logic, where the commands also show that it is possible to stop the fuel fill function. The commands for the fuel fill function are shown in the picture below:



Some limits can be set in each controller. The gensets have a low and high limit. If the low limit is set to e.g. 10 % and the high limit is set to 80 %, the genset controller will activate the relay(s), when the fuel is below 10 %, and deactivate the relay(s), when the fuel has reached 80 %. If the gensets are receiving a fuel fill request from the group or plant controller, the gensets will be filled to the percentage set in the group or plant controller. In the gensets, the lower limit can be set for -1 %, which means that the fill request will always have to be given manually to the genset, or from a group or plant controller.

6. General features

6.1 Standard functions

6.1.1 Standard functions

This chapter includes functional descriptions of standard functions as well as illustrations of the relevant application types. Flowcharts and single-line diagrams will be used in order to simplify the information.

The standard functions are listed in the following paragraphs.

6.1.2 Operation modes

- Island operation
- Fixed power/base load
- Peak shaving
- Load takeover
- Mains power export
- Dry alternator (Option T2 required)
- Ventilation mode (Option T2 required)

6.1.3 Engine control

- Start/stop sequences
- Run and stop coil
- Analogue and ECU governor control

6.1.4 Generator protection (ANSI)

- 2 x reverse power (32)
- 5 x overload (32)
- 6 x over-current (50/51)
- 2 x over-voltage (59)
- 3 x under-voltage (27)
- 3 x over-/under-frequency (81)
- Voltage-dependent over-current (51 V)
- Current/voltage unbalance (60)
- Loss of excitation/over-excitation (40/32RV)
- Multi-inputs (digital, 4-20 mA, 0-40 V DC, Pt100, Pt1000 or RMI)
- Digital inputs

6.1.5 Busbar protection (ANSI)

- 3 x over-voltage (59)
- 4 x under-voltage (27)
- 3 x over-frequency (81)
- 4 x under-frequency (81)
- Voltage unbalance (60)

6.1.6 Display

- Prepared for remote mounting
- Push-buttons for start and stop
- Push-buttons for breaker operations
- Status texts
- Measurement readings

- ECU data
- Alarm indication
- Historical log

6.1.7 M-Logic

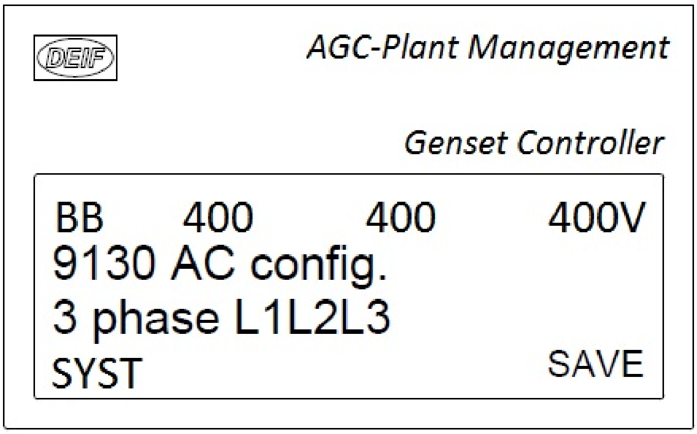
- Simple logic configuration tool
- Selectable input events
- Selectable output commands

6.2 Measurement systems

The AGC PM is designed for measurement of voltages between 100 and 690 V AC. For further reference, see the AC wiring diagrams in the Installation Instructions. In menu 9130, you can change the measurement principle between three-phase, single-phase and split phase.

You can change the settings by using the display. Press the push-button and go to menu 9130, or use the USW.

The menu for adjustment of the measurement principle looks like this:



Use the or push-button to choose between 1-phase, 2-phase or 3-phase. Press the push-button until SAVE is underscored, and then press to save the new setting.

Configure the AGC PM to match the correct measuring system. When in doubt, contact the switchboard manufacturer for information about the required adjustment.

See the parameter for setting of the AC configuration of the application in the table below:

Parameter	Item	Range	Default	Note
9130	AC configuration selection	3-phase L1L2L3 1-phase L1	3-phase L1L2L3	

6.2.1 Three-phase system

When the AGC PM is delivered from the factory, the three-phase system is selected. When this principle is used, all three phases must be connected to the AGC PM.

The following adjustments must be made to make the system ready for the three-phase measuring (example 400/230 V AC):

Setting	Adjustment	Description	Adjust to value
6004	G nom. voltage	Phase-phase voltage of the generator	400 V AC
6041	G transformer	Primary voltage of the G voltage transformer (if installed)	U_{NOM}
6042	G transformer	Secondary voltage of the G voltage transformer (if installed)	U_{NOM}
6051	BB transformer set 1	Primary voltage of the BB voltage transformer (if installed)	U_{NOM}
6052	BB transformer set 1	Secondary voltage of the BB voltage transformer (if installed)	U_{NOM}
6053	BB nom. voltage set 1	Phase-phase voltage of the busbar	U_{NOM}

The AGC PM has two sets of busbar transformer settings, which can be enabled individually in this measurement system.

6.2.2 Split phase system

This is a special application where two phases and neutral are connected to the AGC. The AGC shows phases L1 and L3 in the display. The phase angle between L1 and L3 is 180 degrees. Split phase is possible between L1-L2 or L1-L3.

The following adjustments must be made to make the system ready for the split phase measuring (example 240/120 V AC):

Setting	Adjustment	Description	Adjust to value
6004	G nom. voltage	Phase-phase voltage of the generator	120 V AC
6041	G transformer	Primary voltage of the G voltage transformer (if installed)	U_{NOM}
6042	G transformer	Secondary voltage of the G voltage transformer (if installed)	U_{NOM}
6051	BB transformer set 1	Primary voltage of the busbar voltage transformer (if installed)	U_{NOM}
6052	BB transformer set 1	Secondary voltage of the busbar voltage transformer (if installed)	U_{NOM}
6053	BB nom. voltage set 1	Phase-phase voltage of the busbar	U_{NOM}

The measurement U_{L3L1} shows 240 V AC. The voltage alarm set points refer to the nominal voltage 120 V AC, and U_{L3L1} does not activate any alarm.

The AGC PM has two sets of busbar transformer settings, which can be enabled individually in this measurement system.

6.2.3 Single-phase system

The single-phase system consists of one phase and the neutral.

The following adjustments must be made to make the system ready for the single-phase measuring (example 230 V AC):

Setting	Adjustment	Description	Adjust to value
6004	G nom. voltage	Phase-neutral voltage of the generator	230 V AC
6041	G transformer	Primary voltage of the G voltage transformer (if installed)	$U_{NOM} \times \sqrt{3}$
6042	G transformer	Secondary voltage of the G voltage transformer (if installed)	$U_{NOM} \times \sqrt{3}$
6051	BB transformer set 1	Primary voltage of the busbar voltage transformer (if installed)	$U_{NOM} \times \sqrt{3}$
6052	BB transformer set 1	Secondary voltage of the busbar voltage transformer (if installed)	$U_{NOM} \times \sqrt{3}$
6053	BB nom. voltage set 1	Phase-phase voltage of the busbar	$U_{NOM} \times \sqrt{3}$

The voltage alarms refer to U_{NOM} (230 V AC).

The AGC PM has two sets of busbar transformer settings, which can be enabled individually in this measurement system.

6.3 Nominal settings

6.3.1 Nominal settings

The AGC PM holds four sets of nominal settings, configured in channels 6001 to 6036. It is possible to switch between the nominal settings 1 to 4, to match different voltages and frequencies. Nominal settings 1 (6001 to 6007) are the nominal settings that are used as default. See paragraph "Switch between the nominal settings" for more information about this feature.

The AGC PM holds two sets of nominal settings for the busbar, configured in channels 6051 to 6063. Each set consists of a nominal as well as a primary and secondary voltage value. The "U primary" and "U secondary" are used to define the primary and secondary voltage values, if any measurement transformers are installed. If no voltage transformer is installed between generator and busbar, select "BB Unom = G Unom" in channel 6054. With this function activated, none of the busbar nominal settings will be considered. Instead, the nominal busbar voltage will be considered equal to nominal generator voltage.

6.3.2 Switch between the nominal settings

The four sets of nominal settings can be individually configured. The AGC is able to switch between the different sets of nominal settings, which enables the use of a specific set of nominal settings related to a specific application or situation.

If no busbar voltage transformer is present, the primary and secondary side values can be set to generator nominal value, and channel 6054 is set to "BB Unom = G Unom".

Typically, it is the rental industry that makes use of the possibility to switch nominal parameter settings. The feature is very useful with mobile gensets, where switching in frequency and voltage is required. Stationary gensets can make use of this feature as well. For example, in the event of an AMF situation, it may be desirable to increase the nominal power and current settings to achieve increased tolerance regarding the protections.

Activation

Manual switching between the nominal set points can be done in three ways: digital input, AOP or menu 6045.

When using M-Logic, any event can be used to activate an automatic switching of nominal parameter sets.

Digital input

M-Logic is used when a digital input is needed to switch between the four sets of nominal settings. Select the required input among the input events, and select the nominal settings in the outputs.

Example:

Event A		Event B		Event C	Output
Dig. input no. 23	or	Not used	or	Not used	Set nom. parameter settings 1
Not Dig. input no. 23	or	Not used	or	Not used	Set nom. parameter settings 2

See the "Help" file in the PC utility software for details.

AOP

M-Logic is used when the AOP is used to switch between the four sets of nominal settings. Select the required AOP push-button among the input events, and select the nominal settings in the outputs.

Example:

Event A		Event B		Event C	Output
Button07	or	Not used	or	Not used	Set nom. parameter settings 1
Button08	or	Not used	or	Not used	Set nom. parameter settings 2

See the "Help" file in the PC utility software for details.

Menu settings

In menu 6045, the switching between settings 1 to 4 is made simply by choosing the desired nominal setting.

Four nominal settings of GOV/AVR offsets

In menu 6045, the selection of nominal setting is made. The nominal setting of GOV/AVR offset will follow the setting in 6045, meaning: nominal setting 1 (6001 to 6006) will follow the GOV/AVR offset in 2550.

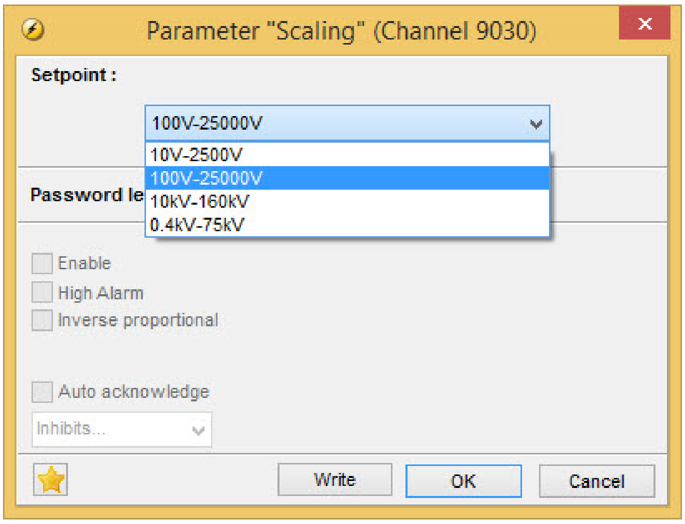
Reg	2550	GOV outp offset	133	50	%
Reg	2551	GOV outp offset	1633	50	%
Reg	2552	GOV outp offset	1634	50	%
Reg	2553	GOV outp offset	1635	50	%

Reg	2670	AVR outp offset	161	50	%
Reg	2671	AVR outp offset	1636	50	%
Reg	2672	AVR outp offset	1637	50	%
Reg	2673	AVR outp offset	1638	50	%

Switching between the two "BB nominal settings" (6050 and 6060) is done in the same way as explained above (channel 6054).

6.3.3 Scaling

Default voltage scaling is set to range 100 V to 25000 V (parameter 9030). To be able to handle applications above 25000 V and below 100 V, it is necessary to adjust the input range so it matches the actual value of the primary voltage transformer. This makes it possible for the unit to support a wide range of voltage and power values. Master password level access is required to change this parameter.



Changing the voltage scaling will also influence the nominal power scaling:

Scaling parameter 9030	**Nom. settings 1 to 4 (power) will change according to parameter 9030**	**Nom. settings 1 to 4 (voltage) will change according to parameter 9030**	**Transformer ratio settings parameters 6041, 6051 and 6053**
10 V to 2500 V	1.0 to 900.0 kW	10.0 V to 2500.0 V	10.0 V to 2500.0 V
100 V to 25000 V	10 to 20000 kW	100 V to 25000 V	100 V to 25000 V
0.4 kV to 75 kV	0.10 to 90.00 MW	0.4 kV to 75.00 kV	0.4 kV to 75.00 kV
10 kV to 160 kV	1.0 to 900.0 MW	10.0 kV to 160.0 kV	10.0 kV to 160.0 kV

All nominal values and the primary VT settings must be corrected after the scaling has been changed in parameter 9030.

6.4 Applications

6.4.1 Applications and genset modes

An application is a setup consisting of several gensets. You can develop various applications by using the"Application configuration " menu in the DEIF utility software (USW).
The AGC PM is designed to handle applications in two different ways. If the application consists of 31 gensets or less, the application can be handled with controllers in two levels: plant level and genset level.
If the application has between 32 and 992 gensets, the application requires controllers in three levels: plant level, group level and genset level.
If the application consists of more than 31 gensets, the present gensets must be divided into groups of up to 31 gensets. The AGC PM controller can be in applications with up to eight Bus Tie Breakers (BTBs), as long as they are externally controlled. This goes for both 2- and 3-level applications.

This section about applications is to be used for reference, using the particular genset mode as starting point. It is not suitable for reading from beginning to end.

The unit can be used for the applications listed in the table below.

Application	**Comment**
Automatic Mains Failure (no back sync.)	Standard
Automatic Mains Failure (with back sync.)	Standard
Island operation	Standard
Fixed power/base load	Standard
Peak shaving	Standard
Load takeover	Standard
Mains power export (fixed power to mains)	Standard
Multiple gensets, load sharing (analogue load sharing)	Standard
Multiple gensets, power management (CAN bus)	Standard

Genset mode	Running mode				
	Auto	Semi	Test	Man	Block
Automatic Mains Failure (no back sync.)	X	X	X	X	X
Automatic Mains Failure (with back sync.)	X	X	X	X	X
Island operation	X	X	X	X	X
Fixed power/base load	X	X	X	X	X
Peak shaving	X	X	X	X	X
Load takeover	X	X	X	X	X
Mains power export	X	X	X	X	X
Multiple gensets, load sharing (analogue load sharing)	X	X	X	X	X
Multiple gensets, power management	X	X	(X)	X	X

For a general description of the available running modes, see the chapter "Running mode description".

6.4.2 AMF (no back synchronisation)

Auto mode description
The unit automatically starts the genset and switches to generator supply at a mains failure after an adjustable delay time. It is possible to adjust the unit to change to genset operation in two different ways.

1. The mains breaker will be opened at genset start-up.
2. The mains breaker will remain closed until the genset is running, and the genset voltage and frequency is OK.

In both cases, the generator breaker will be closed when the generator voltage and frequency is OK, and the mains breaker is open.

When the mains returns, the unit will switch back to mains supply and cool down and stop the genset. The switching back to mains supply is done without back synchronisation when the adjusted "Mains OK delay" has expired.

Semi-auto mode description
When the generator breaker is closed, the unit will use the nominal frequency as the set point for the speed governor. If AVR control (option D1) is selected, then the nominal voltage is used as set point.

For a general description of the available running modes, please refer to the chapter "Running mode description".

6.4.3 AMF (with back synchronisation)

Auto mode description
The unit automatically starts the genset and switches to generator supply at a mains failure after an adjustable delay time. It is possible to adjust the unit to change to genset operation in two different ways:

1. The mains breaker will be opened at genset start-up.
2. The mains breaker will remain closed until the genset is running, and the genset voltage and frequency is OK.

In both cases, the generator breaker will be closed when the generator voltage and frequency is OK, and the mains breaker is open.

When the mains returns, the unit will synchronise the mains breaker to the busbar when the "Mains OK delay" has expired. Then the genset cools down and stops.

Semi-auto mode description
When the generator breaker is closed and the mains breaker is opened, the unit will use the nominal frequency as the set point for the speed governor. If AVR control (option D1) is selected, the nominal voltage is used as the set point.

When the generator is paralleled to the mains, the governor regulation will no longer be active. If AVR control (option D1) is selected, then the set point will be the adjusted power factor **(7050 Fixed power set).**

For a general description of the available running modes, please refer to the chapter "Running mode description".

6.4.4 Island operation

Auto mode description
The unit automatically starts the genset and closes the generator breaker at a digital start command. When the stop command is given, the generator breaker is tripped, and the genset will be stopped after a cooling down period. The start and stop commands are used by activating and deactivating a digital input or with the time-dependent start/stop commands. If the *time-dependent start/stop* commands are to be used, then the auto mode must also be used.

Semi-auto mode description
When the generator breaker is closed, the unit will use the nominal frequency as set point for the speed governor. If AVR control (option D1) is selected, the nominal voltage is used as set point.

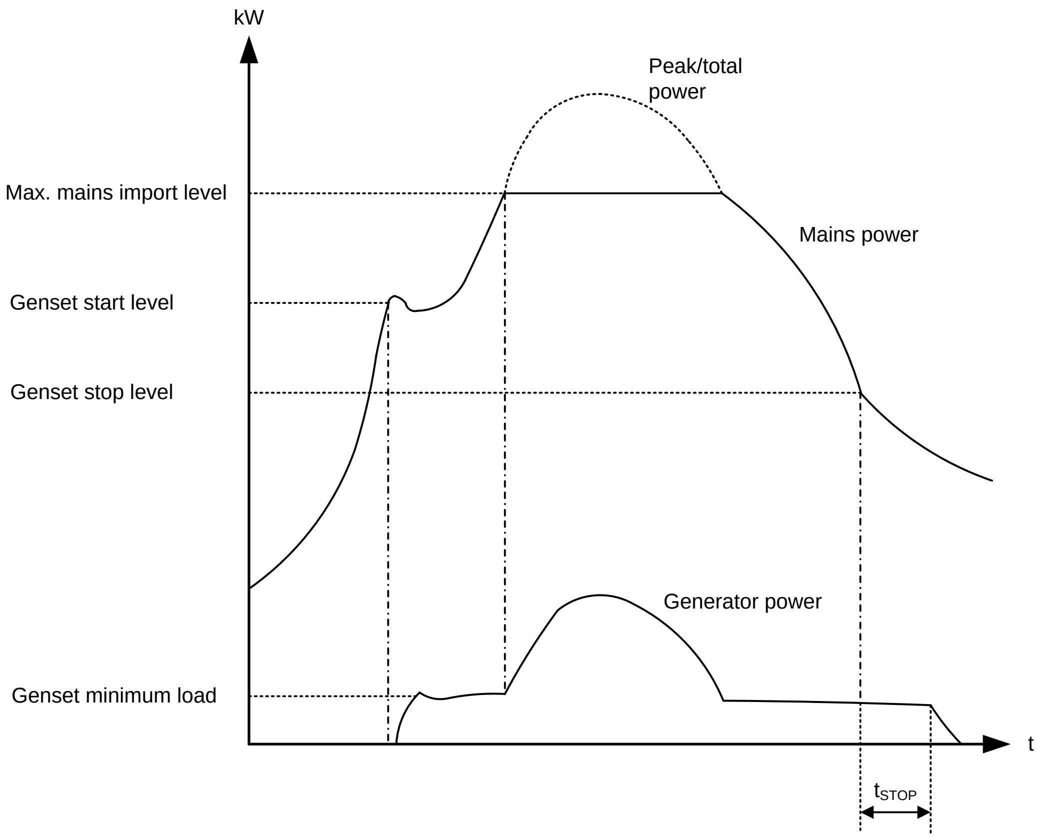
For a general description of the available running modes, please refer to the chapter "Running mode description".

6.4.5 Peak shaving

Auto mode description
The genset will start at a predefined mains import level and run at a fixed minimum load, for example 10 %. When the mains import increases above the maximum mains import set point, the genset will supply the extra load in order to maintain the mains import at the maximum import level.

When the load drops below the maximum mains import set point, the genset will run at min. load again. When the mains import and the generator load decrease below the stop set point, the genset will cool down and stop.

A 4-20 mA transducer is used for indication of the power imported from the mains, please see "Mains transducer" description later in this document.



Diagram, peak shaving – example

Semi-auto mode description
When the generator breaker is closed and the mains breaker is opened, the unit will use the nominal frequency as set point for the speed governor. If AVR control (option D1) is selected, the nominal voltage is used as set point.

When the generator is paralleled to the mains, the generator will be controlled according to the peak shaving set point. So the maximum mains import will not be exceeded in spite of the semi-auto mode. If AVR control (option D1) is selected, the set point is the adjusted power factor **(7050 Fixed power set).**

Set points related to peak shaving

7000 Mains power

Day and night:	The mains power import limits for the peak shaving.
Tmax and Tmin:	The transducer range in kW which corresponds to the 4-20 mA transducer signal connected on multi-input 102.

7010 Daytime period
These settings define the daytime period. The hours outside the daytime period are considered to be the night-time period.

Parameters 7020 and 7030 are used to define the starting and stopping point of an application without power management (option G5). If power management is used, then load-dependent start and stop parameters will be used. For additional information on load-dependent start and stop, please refer to the power management manual, "Description of options G4, G5 and G8".

7020 Start generator

Start set point:	The start set point is in percent of the day and night settings in menu 7000 Mains power.
Delay:	The genset will start when the start set point has been exceeded and this delay has expired.
Load:	The minimum load the genset will produce when parallel to mains.

7030 Stop generator

Stop set point:	The stop set point is in percent of the day and night settings in menu 7000 Mains power.
Delay:	The genset will stop when the stop set point has been exceeded and this delay has expired.

For a general description of the available running modes, please refer to the chapter "Running mode description".

6.4.6 Load takeover

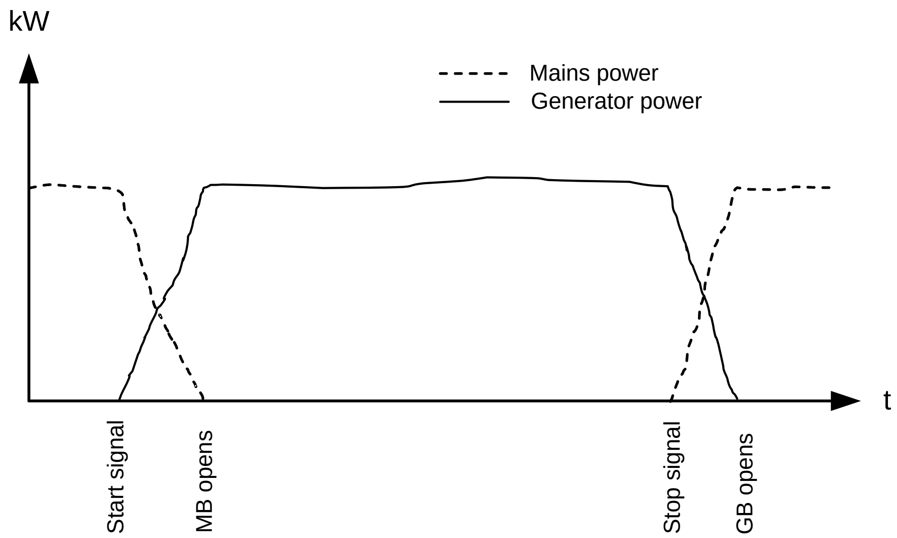
Auto mode description
- Back synchronising ON

The purpose of the load takeover mode is to transfer the load imported from the mains to the genset for operation on generator supply only.

When the start command is given, the genset will start and synchronise the generator breaker to the busbar that is being supplied by the mains. When the generator breaker is closed, the imported load is decreased (the power is being transferred to the genset) until the load is at the open breaker point. Then the mains breaker opens.

When the stop command is given, the mains breaker is synchronised to the busbar and after closure the genset is deloaded, cooled down and stopped.

A 4-20 mA transducer is used for indication of the power imported from the mains, please see "Mains transducer" description later in this document.



Diagram, load takeover - example

If the imported load is higher than the nominal genset power, an alarm appears and the load takeover sequence is paused.

- Back synchronising OFF
When the start command is given, the genset will start. When the frequency and voltage is OK, the mains breaker is opened and the generator breaker is closed. Now, the generator supplies the load until the stop command is given. Then the generator breaker opens and the mains breaker closes. The genset cools down and stops.

If the imported load is higher than the nominal genset, an alarm appears and the load takeover sequence is paused.

Semi-auto mode
When the generator breaker is closed and the mains breaker is opened, the unit will use the nominal frequency as set point for the speed governor. If AVR control (option D1) is selected, the nominal voltage is used as set point.

When the generator is paralleled to the mains, it will be controlled so the imported power from the mains will be kept at 0 kW. If AVR control (option D1) is selected, the set point is the adjusted power factor **(7050 Fixed power set).**

For a general description of the available running modes, please refer to the chapter "Running mode description".

6.4.7 Mains power export (fixed power to mains)

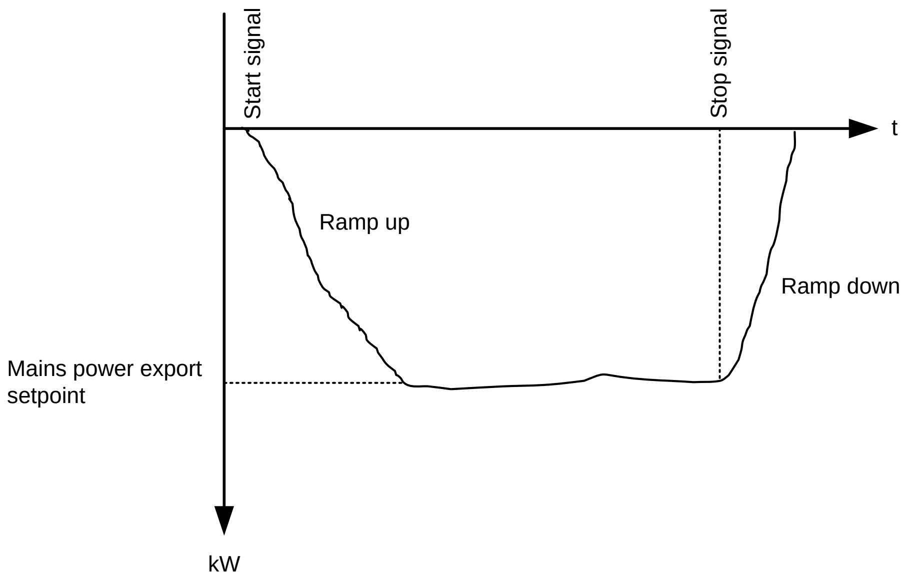
Auto mode description
The mains power export mode can be used to maintain a constant level of power through the mains breaker. The power can be exported to the mains or imported from the mains, but always at a constant level.

If a fixed level of imported power must be used, it is still the mains power export mode that must be selected! This mode covers import as well as export.

The genset starts as a result of a digital start command. It synchronises to the mains and will start to export power to the mains. The amount of power exported will be kept at a fixed level regardless of the load on the busbar (the factory).

The stop command will cause the genset to deload and trip the generator breaker. Afterwards, it will cool down and stop.

A 4-20 mA transducer is used for indication of the power exported from the mains, please see "Mains transducer" description later in this document.



Diagram, mains power export - example

Please notice that the set point of the mains power export can be adjusted to 0 kW. This means that the genset will be parallel to the mains but no power import or export.

Semi-auto mode description
When the generator breaker is closed and the mains breaker is opened, the unit will use the nominal frequency as set point for the speed governor. If AVR control (option D1) is selected, the nominal voltage is used as set point.

When the generator is paralleled to the mains, it will be controlled according to the mains power export set point. If AVR control (option D1) is selected, the set point is the adjusted power factor **(7050 Fixed power set).**

For a general description of the available running modes, please refer to the chapter "Running mode description".

6.5 Running mode description

The unit has four different running modes and one block mode. For detailed information, see chapter "Application".

Auto
In auto mode, the unit will operate automatically, and the operator cannot initiate any sequences manually.

Semi-auto
In semi-auto mode, the operator has to initiate all sequences. This can be done via the push-button functions, Modbus commands or digital inputs. When started in semi-automatic mode, the genset will run at nominal values.

Test
The test sequence will start when the test mode is selected.

Manual
When manual mode is selected, the binary increase/decrease inputs can be used (if they have been configured) as well as the start and stop push-buttons. When starting in manual mode, the genset will start without any subsequent regulation.

Block
When the block mode is selected, the unit is not able to initiate any sequences, for example the start sequence.

Block mode must be selected when maintenance work is carried out on the genset.

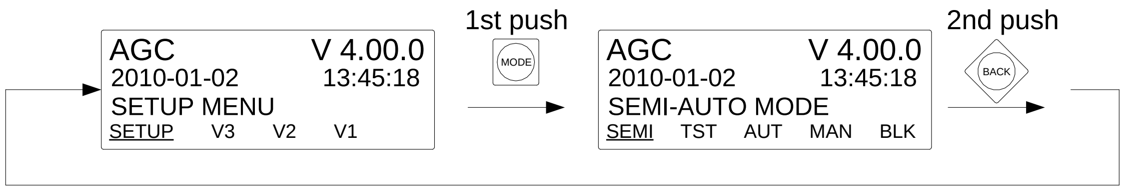
The genset will shut down if block mode is selected while the genset is running.

The following drawings illustrate how the mode selection is carried out.

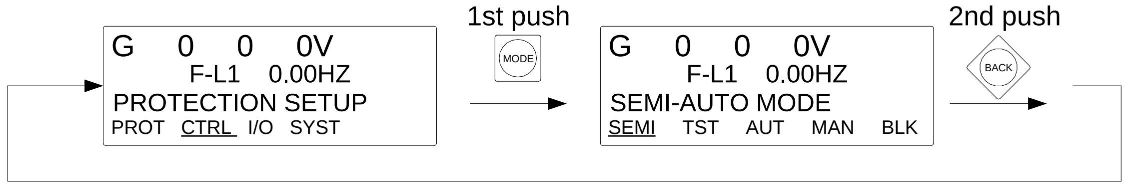
Pushing the MODE push-button will change the displayed text. After pushing "MODE", the fourth display line indicates the selectable modes. In the third display line, the underscored (fourth line) selection will be displayed.

Two possibilities are now available:

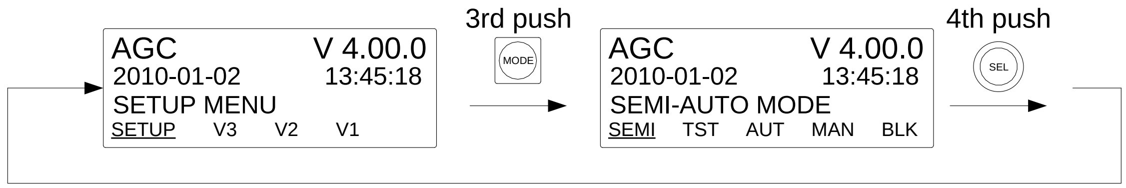
If "BACK" is pushed, the display returns to the original text without changing the mode.



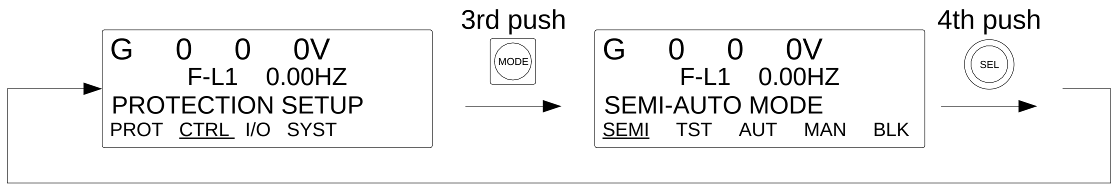
or



If "SEL" is pushed, the underlined mode is selected, and the display returns to the original text. In this example, the SEMI-AUTO mode is selected.



or



6.5.1 Semi-auto mode

The unit can be operated in semi-auto mode. Semi-auto means that the unit will not initiate any sequences automatically, as is the case with the auto mode. It will only initiate sequences, if external signals are given.

An external signal may be given in three ways:

1. Push-buttons on the display are used
2. Digital inputs are used
3. Modbus command

The standard AGC is only equipped with a limited number of digital inputs, please refer to "Digital inputs" in this document and the data sheet for additional information about availability.

When the genset is running in semi-auto mode, the unit will control the speed governor and the AVR, if option D1 is selected.

The following sequences can be activated in semi-auto:

Command	Description	Comment
Start	The start sequence is initiated and continues until the genset starts or the maximum number of start attempts has been reached. The frequency (and voltage) will be regulated to make the GB ready to close.	
Stop	The genset will be stopped. After disappearance of the running signal, the stop sequence will continue to be active in the '"extended stop time" period. The genset is stopped with cooling down time.	The cooling down time is cancelled if the stop button is activated twice.
Close GB	The unit will close the generator breaker if the mains breaker is open, or synchronise and close the generator breaker if the mains breaker is closed.	When AMF mode is selec-ted, the unit will not regulate after breaker closure.
Open GB	The unit will ramp down and open the generator breaker at the breaker open point if the mains breaker is closed. The unit will open the generator breaker instantly if the mains breaker is open or the genset mode is is-land mode.	
Close MB	The unit will close the mains breaker if the generator breaker is open, or synchronise and close the mains breaker if the generator breaker is closed.	
Open MB	The unit opens the mains breaker instantly.	
Manual GOV UP	The regulator is deactivated and the governor output is activated as long as the GOV input is ON.	
Manual GOV DOWN	The regulator is deactivated and the governor output is activated as long as the GOV input is ON.	
Manual AVR UP	The regulator is deactivated and the governor output is activated as long as the AVR input is ON.	Option D1 is re-quired.
Manual AVR DOWN	The regulator is deactivated and the governor output is activated as long as the AVR input is ON.	Option D1 is re-quired.

6.5.2 Test mode

The test mode function is activated by selecting test with the MODE push-button on the display or by activat-ing a digital input.

The settings for the test function are set up in menu

Related parameters:
7040 Test

Parameter	Item	Range	Default	Notes
7041	Set point	1......100 %	80 %	Load set point when paralleling to mains.
7042	Timer	0.0......999.0 min	5.0 min	Engine run time during the test period.
7043	Return	DG: Semi auto, Auto, Manual, No change Mains: Semi auto, Auto, No change.	DG: No change Mains: Auto	When the test is completed, the unit will return to the selected mode.
7044	Type	Simple test, Load test, Full test.	Simple test	Selection of one of the three types of tests: Simple, Load or Full.

If the timer is set to 0.0 min., the test sequence will be infinite.

If the DG unit is in the stop sequence in test mode and the mode is changed to semi-auto, the DG will continue to run.

Test mode in island operation (genset mode selected to island mode) can only run "Simple" and "Full" test.

6.5.3 Simple test

The simple test will only start the genset and run it at nominal frequency with the generator breaker open. The test will run until the timer expires.

6.5.4 Load test

The load test will start the genset and run it at nominal frequency, synchronise the generator breaker and produce the power typed in the set point in menu 7041. The test will run until the timer expires.

To run the load test, "Sync to Mains" must be enabled in menu 7084.

6.5.5 Full test

The full test will start the genset and run it at nominal frequency, synchronise the generator breaker and transfer the load to the generator before opening the mains breaker. When the test timer expires, the mains breaker will be synchronised and the load is transferred back to the mains before the generator breaker is opened and the generator is stopped.

To run the full test, "Sync to Mains" must be enabled in menu 7084.

6.5.6 Manual mode

When manual mode is selected, the genset can be controlled from the display and with digital inputs. The following commands are possible:

Command	Description	Comment
Start	The start sequence is initiated and continues until the genset starts or the maximum number of start attempts has been reached.	No regulation.
Stop	The genset will be stopped. After disappearance of the running signal, the stop sequence will continue to be active in the "extended stop time" period. The genset is stopped with cooling down time.	
Close GB	The unit will close the generator breaker if the mains breaker is open, and synchronise and close the generator breaker if the mains breaker is closed.	No regulation. Sync. failure is deactivated.
Open GB	The unit will open the generator breaker instantly.	
Close MB	The unit will close the mains breaker if the generator breaker is open, and synchronise and close the mains breaker if the generator breaker is closed.	No regulation. Sync. failure is deactivated.
Open MB	The unit will open the mains breaker instantly.	
Manual GOV UP	The unit gives increase signal to the speed governor.	
Manual GOV DOWN	The unit gives decrease signal to the speed governor.	
Manual AVR UP	The unit gives increase signal to the AVR.	Option D1 is required.
Manual AVR DOWN	The unit gives decrease signal to the AVR.	Option D1 is required.

It is possible to open and close both the generator breaker and the mains breaker in manual mode.

6.5.7 Block mode

When the block mode is selected, the unit is locked for certain actions. This means that it cannot start the genset or perform any breaker operations.

To change the running mode from the display, the user will be asked for a password before the change can be made. It is not possible to select "block mode" when running feedback is present.

The purpose of the block mode is to make sure that the genset does not start for instance during maintenance work.

If the digital inputs are used to change the mode, then it is important to know that the input configured to block mode is a constant signal. So, when it is ON, the unit is in a blocked state, and when it is OFF, it returns to the mode it was in before block mode was selected.

If block mode is selected using the display after the digital block input is activated, the AGC will stay in block mode after the block input is deactivated. The block mode must now be changed using the display. The block mode can only be changed locally by display or digital input.

Before the running mode is changed, it is important to check that persons are clear of the genset and that the genset is ready for operation.

Alarms are not influenced by block mode selection.

The genset can be started from the local engine control panel, if such is installed. Therefore, DEIF recommends avoiding local cranking and starting of the genset.

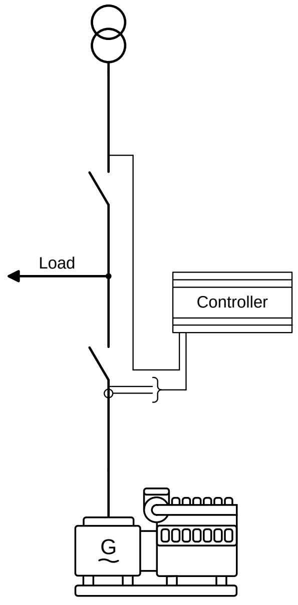
The genset will shut down if block mode is selected while the genset is running.

6.6 Single-line diagrams

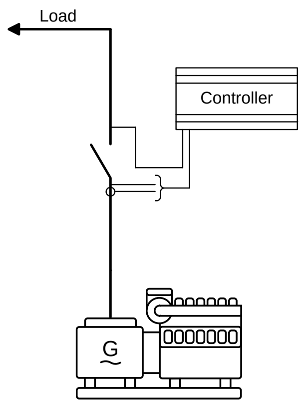
6.6.1 Application illustration

In the following, the various applications are illustrated in single-line diagrams.

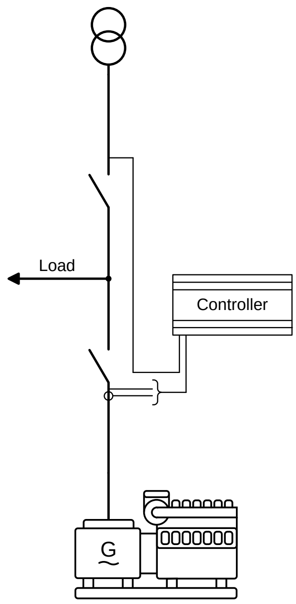
6.6.2 Automatic Mains Failure (AMF)



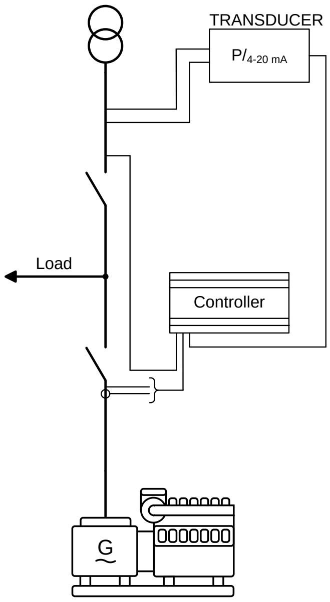
6.6.3 Island operation



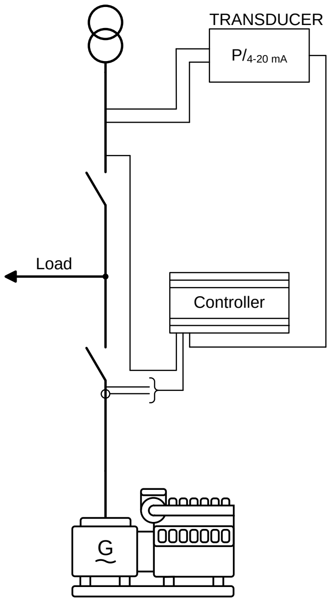
6.6.4 Fixed power/base load



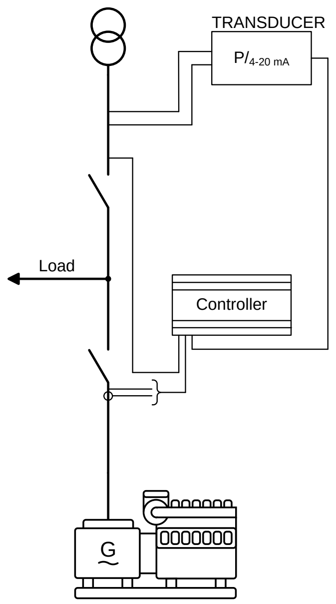
6.6.5 Peak shaving



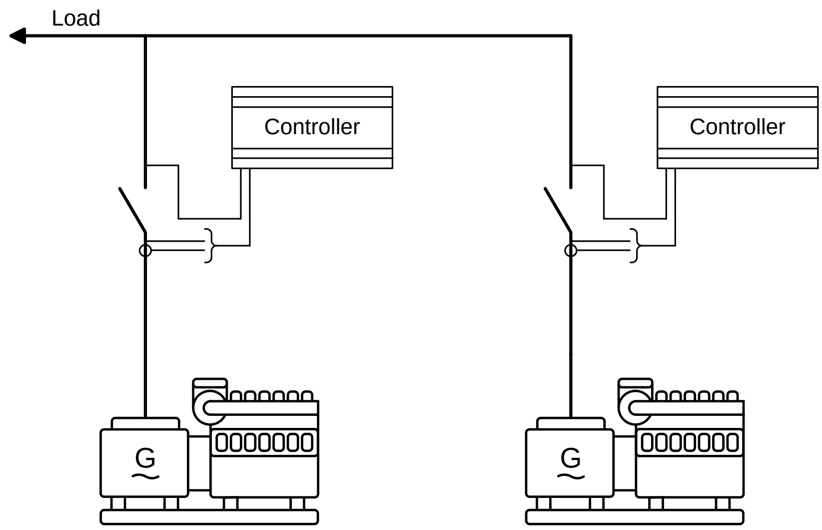
6.6.6 Load takeover



6.6.7 Mains power export

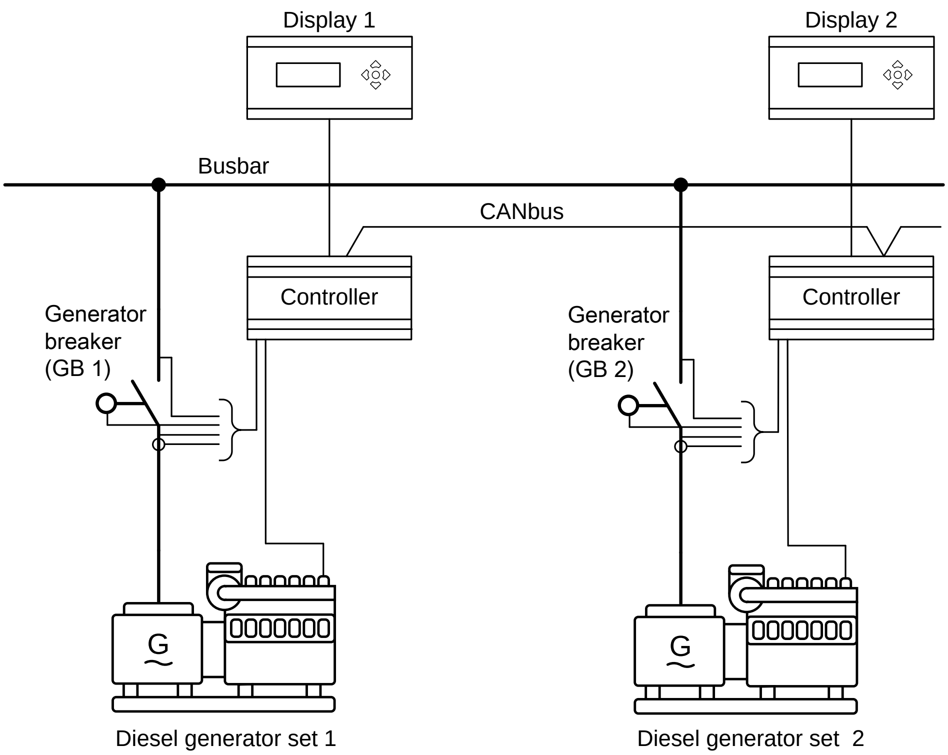


6.6.8 Multiple gensets, load sharing (option G3 required)

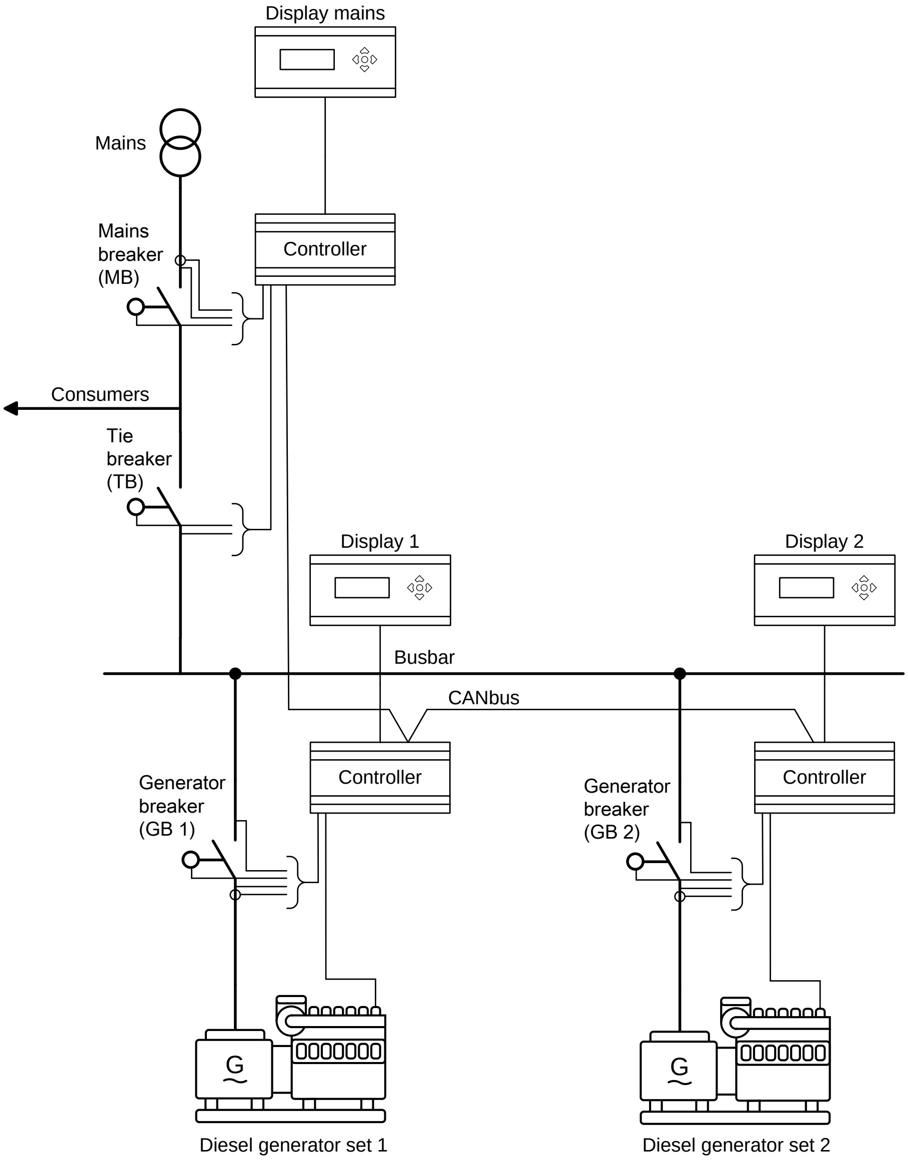


6.6.9 Multiple gensets, power management (option G5 required)

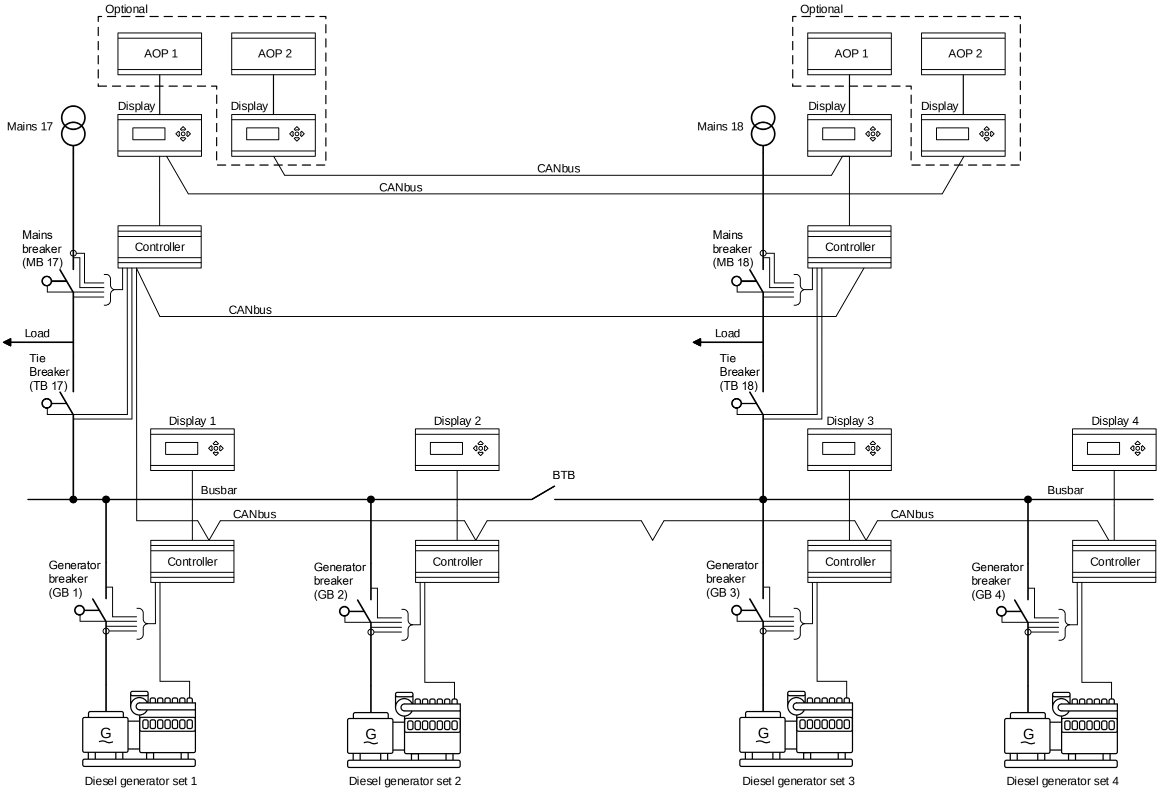
Island mode application



Parallel to mains application

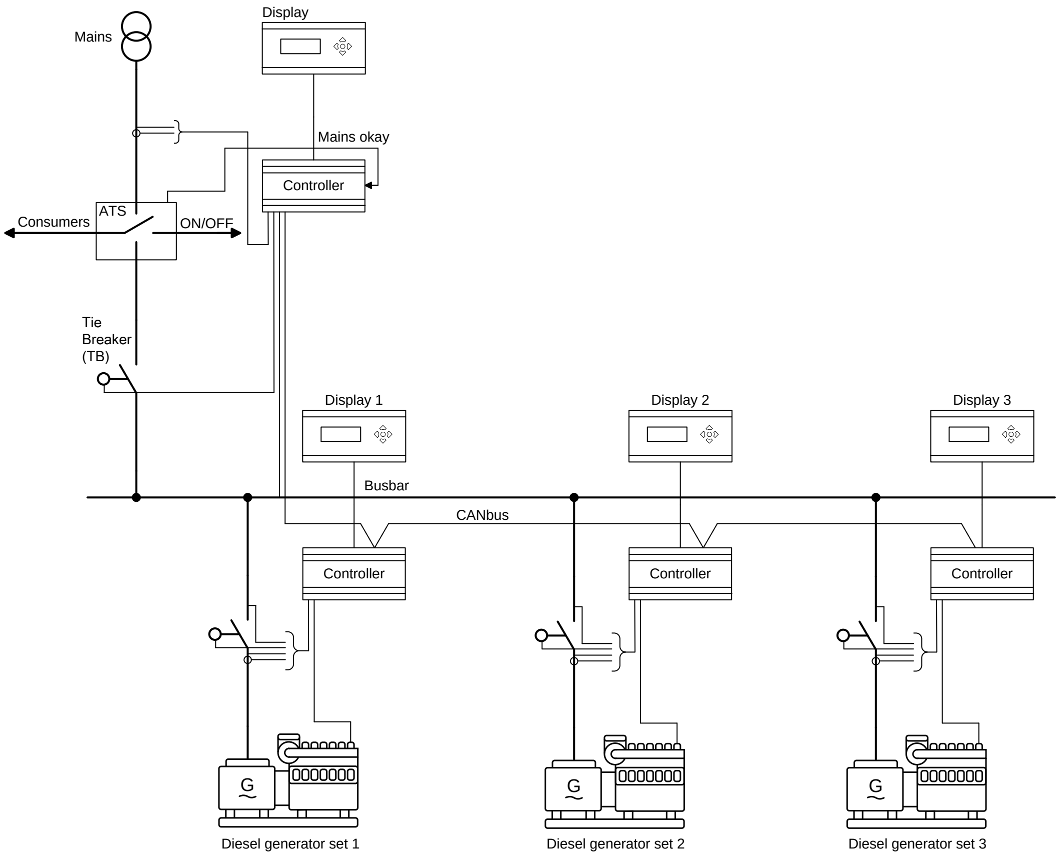


Multi-mains with two mains, two tie breakers, one bus tie breaker and four gensets



The diagram shows four generators, but the system supports up to 16 generators. Please refer to the option G5 manual for further description of multi-mains.

ATS plant, mains unit



6.7 Flowcharts

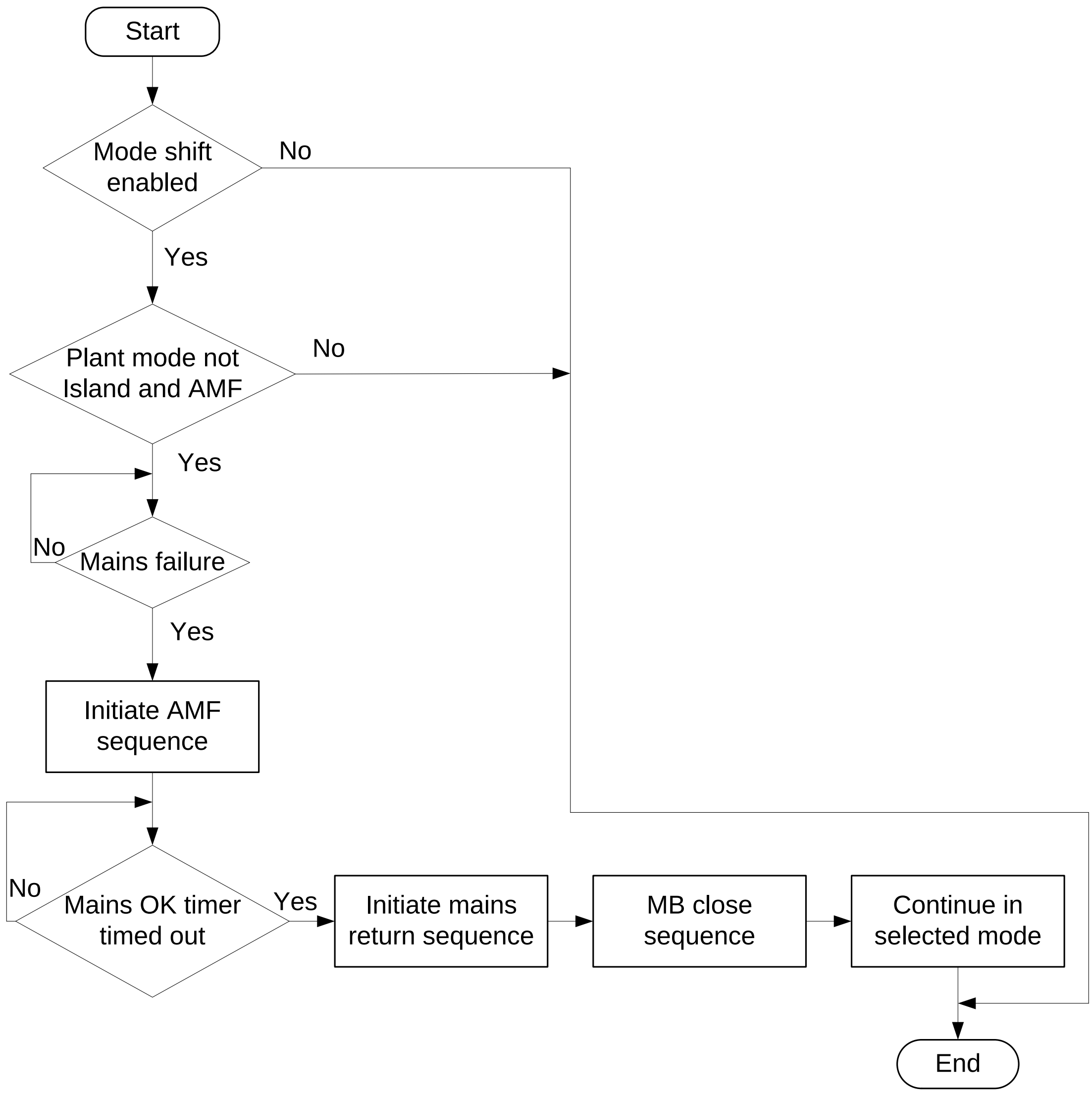
Using flowcharts, the principles of the most important functions will be illustrated in the next sections. The functions included are:

- Mode shift
- MB open sequence
- GB open sequence
- Stop sequence
- Start sequence
- MB close sequence
- GB close sequence
- Fixed power
- Load takeover
- Island operation
- Peak shaving
- Mains power export
- Automatic Mains Failure

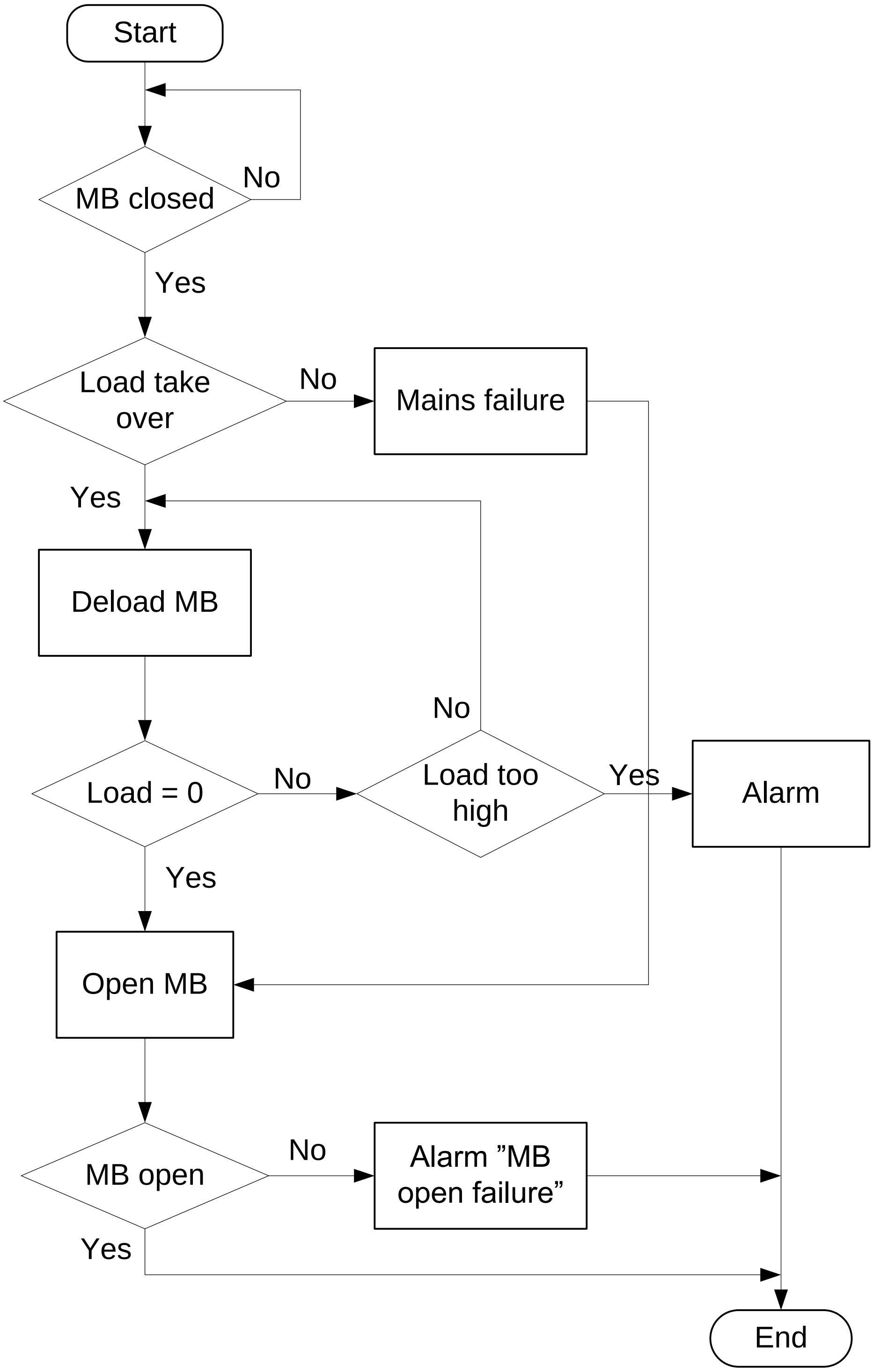
- Test sequence

The flowcharts on the following pages are for guidance only. For illustrative purposes, the flowcharts are simplified to some extent.

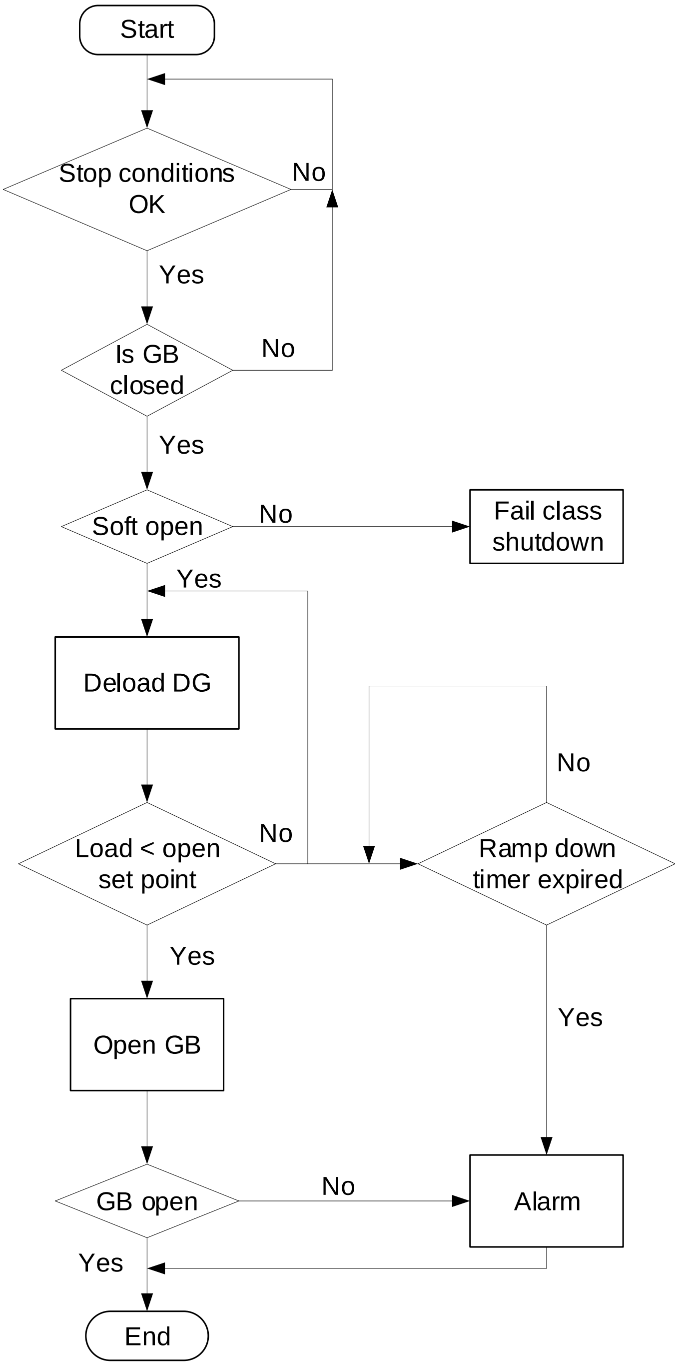
6.7.1 Mode shift



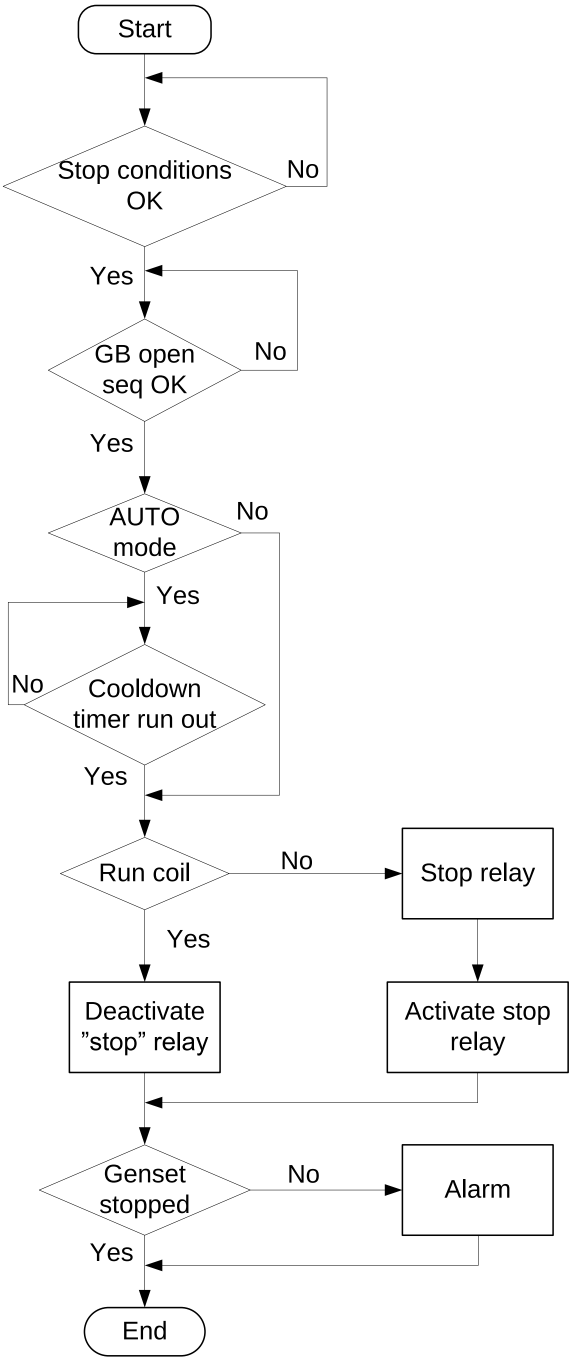
6.7.2 MB open sequence



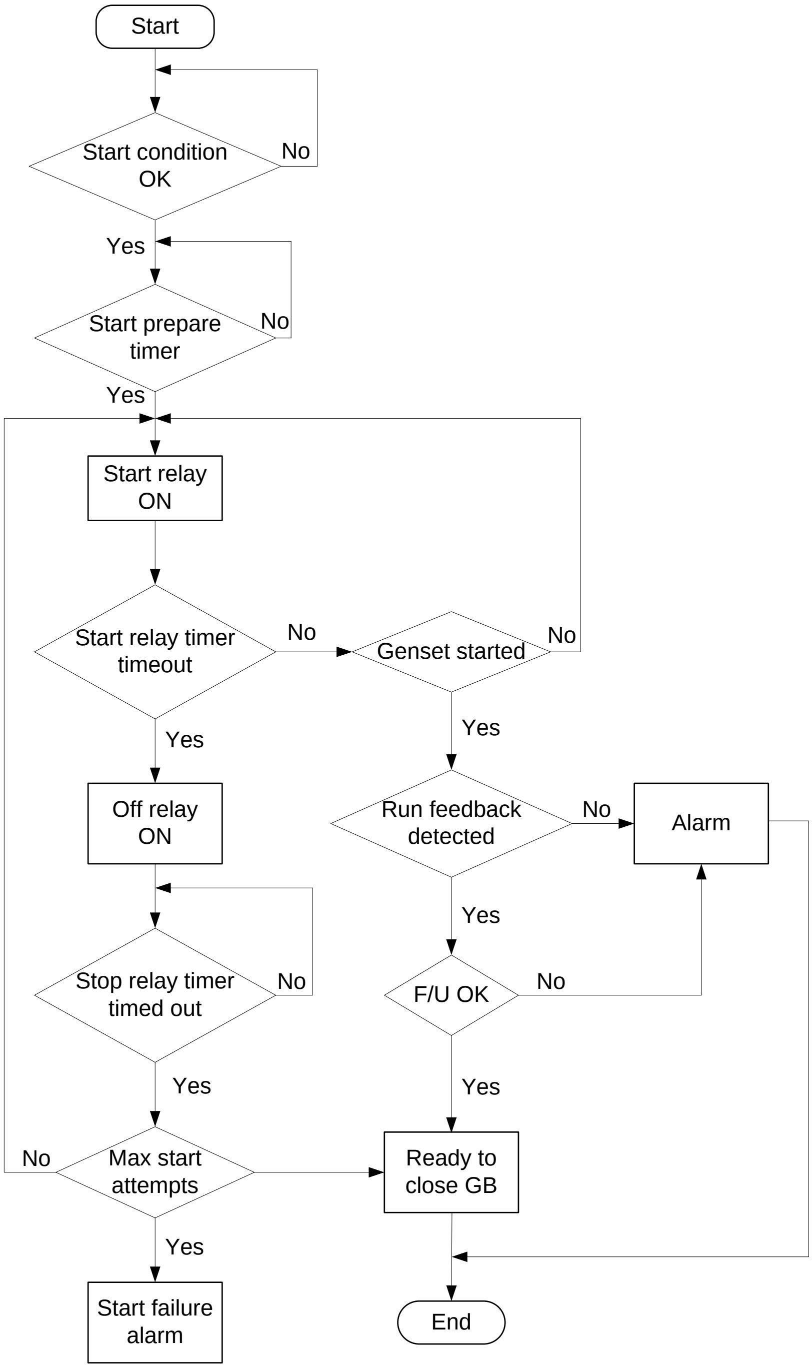
6.7.3 GB open sequence



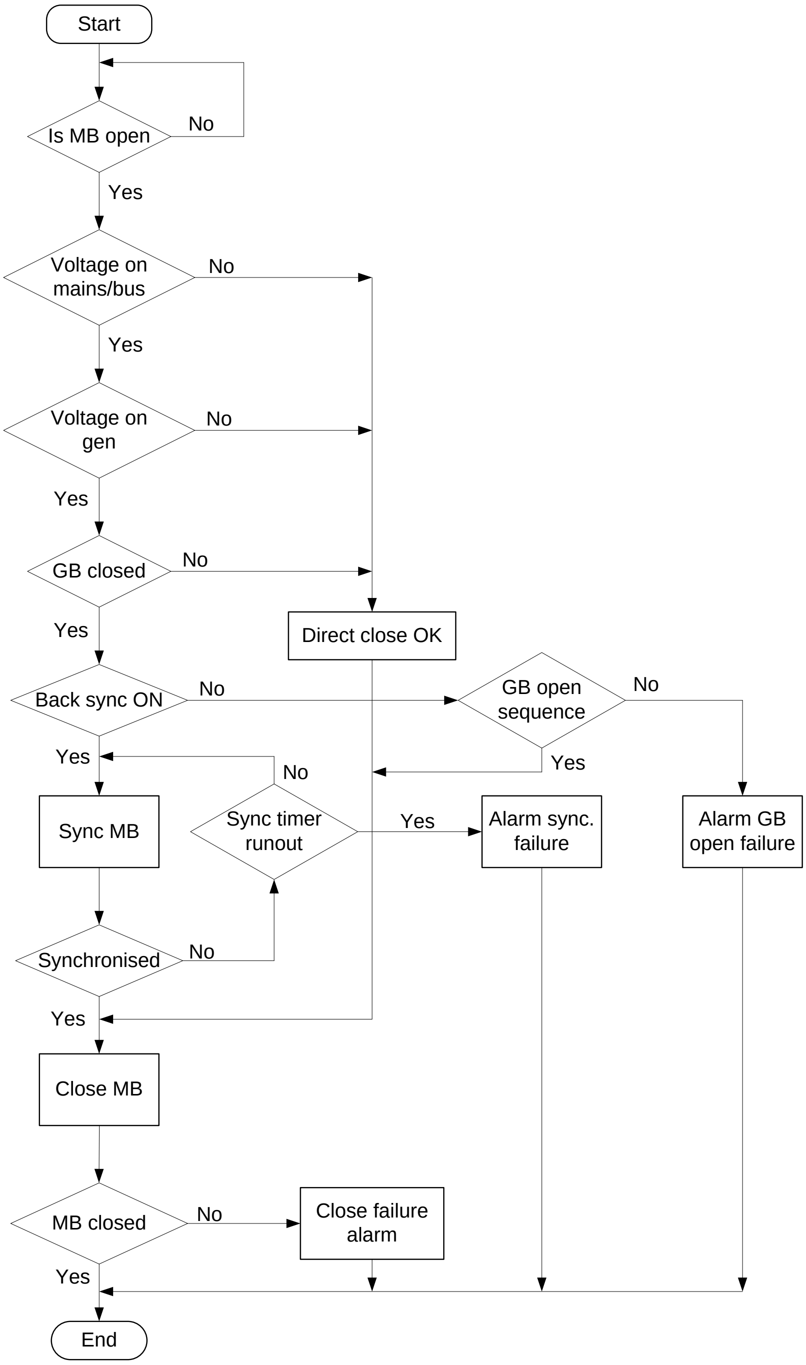
6.7.4 Stop sequence



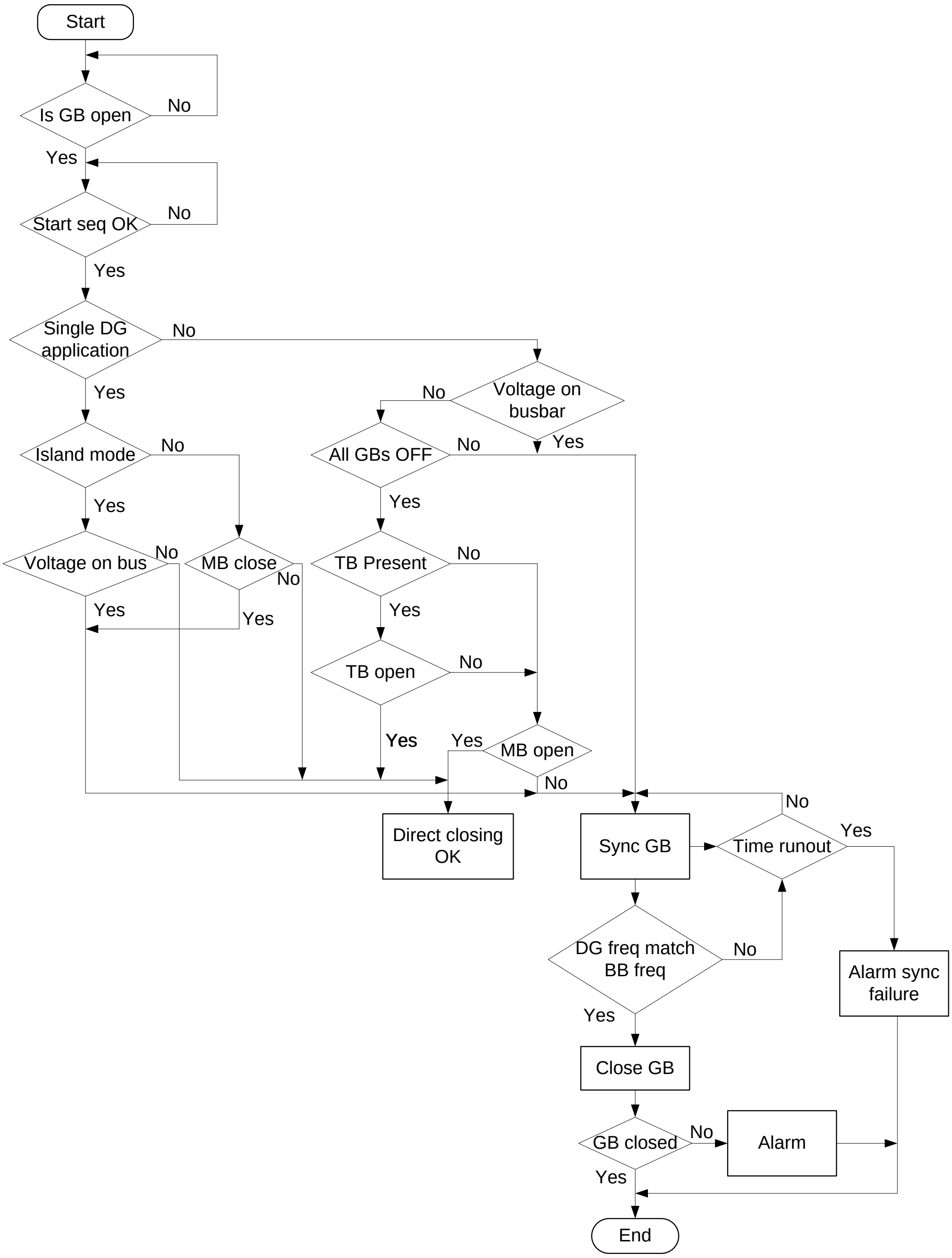
6.7.5 Start sequence



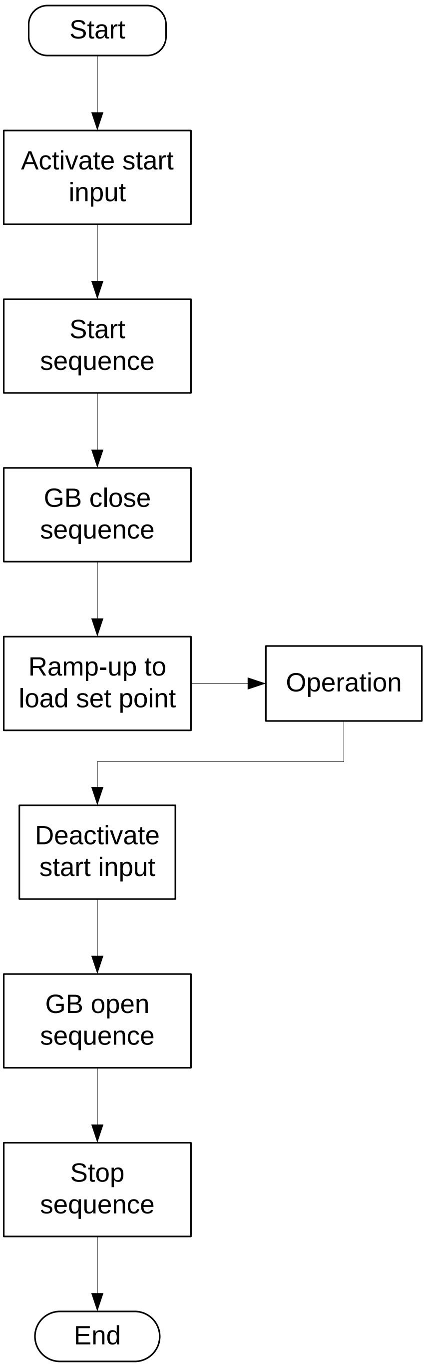
6.7.6 MB close sequence



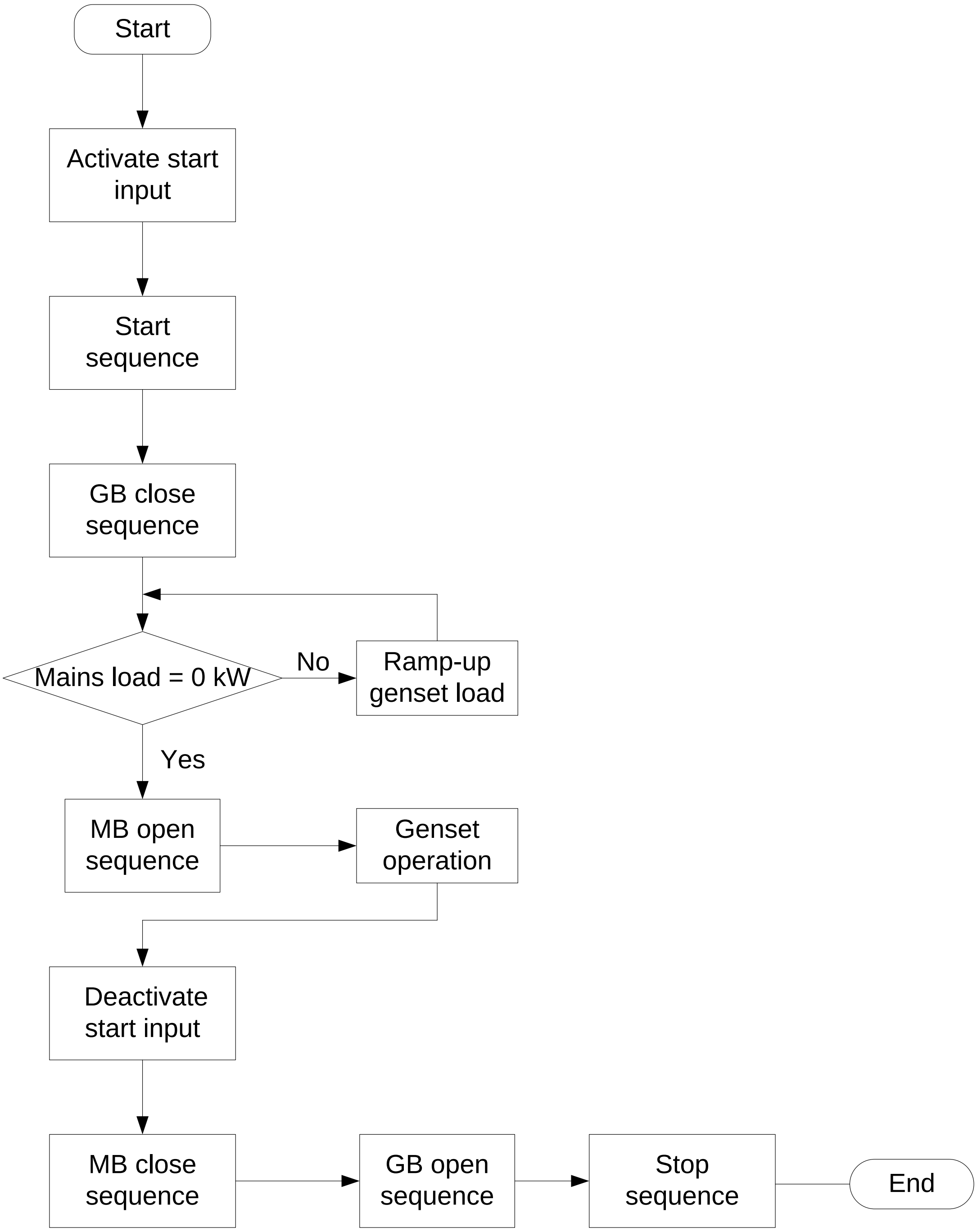
6.7.7 GB close sequence



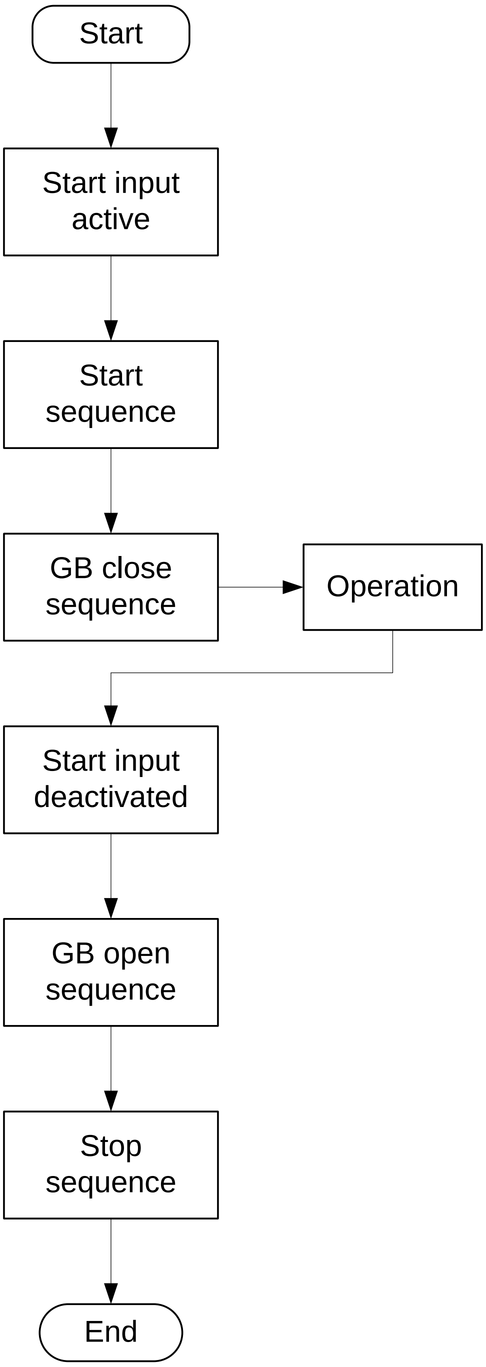
6.7.8 Fixed power



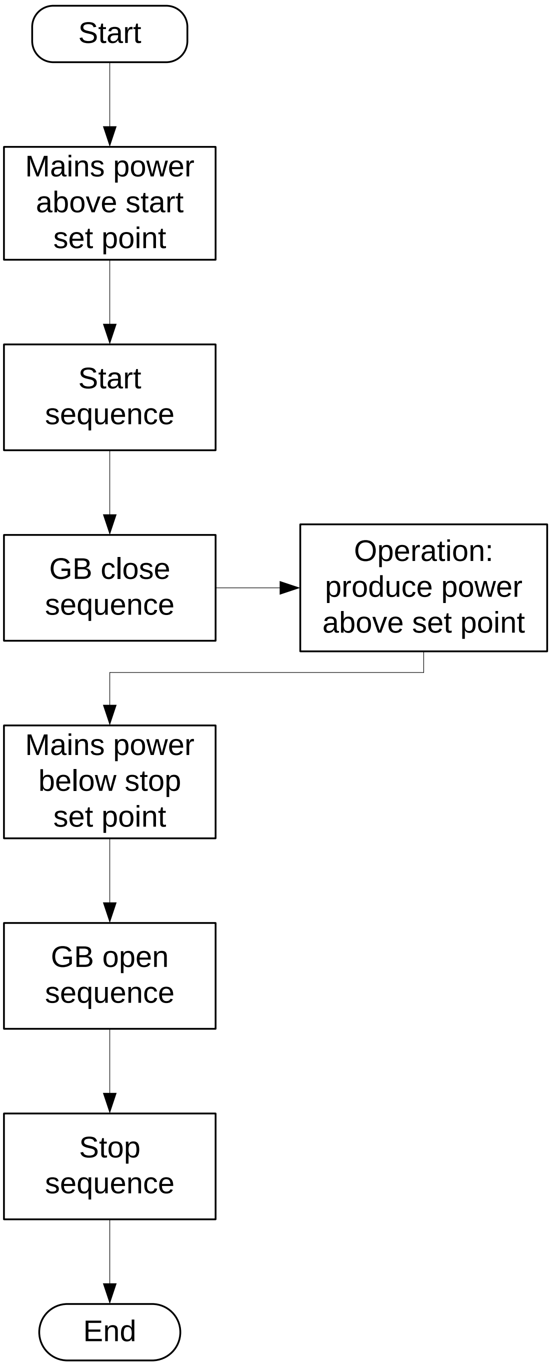
6.7.9 Load takeover



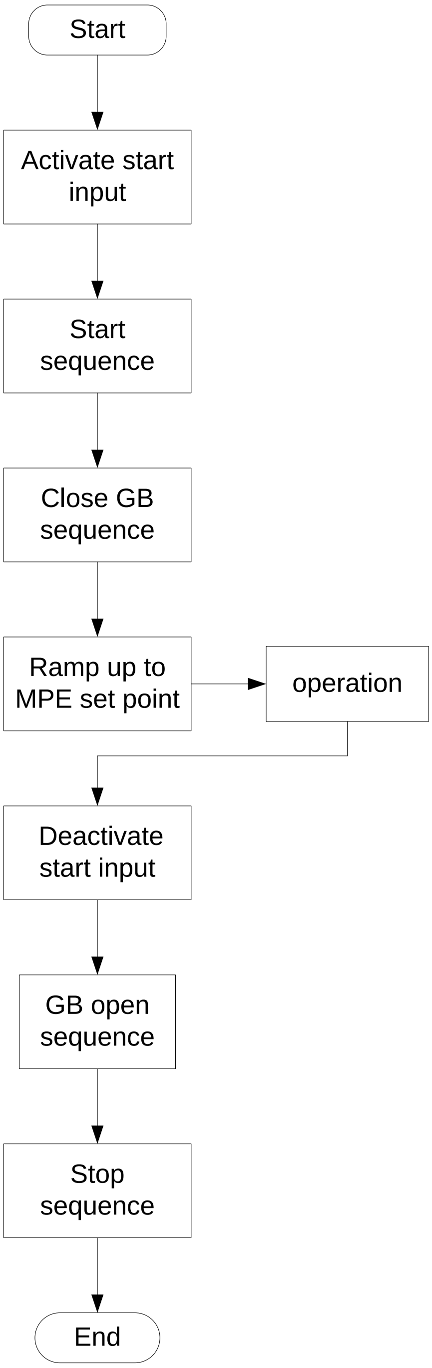
6.7.10 Island operation



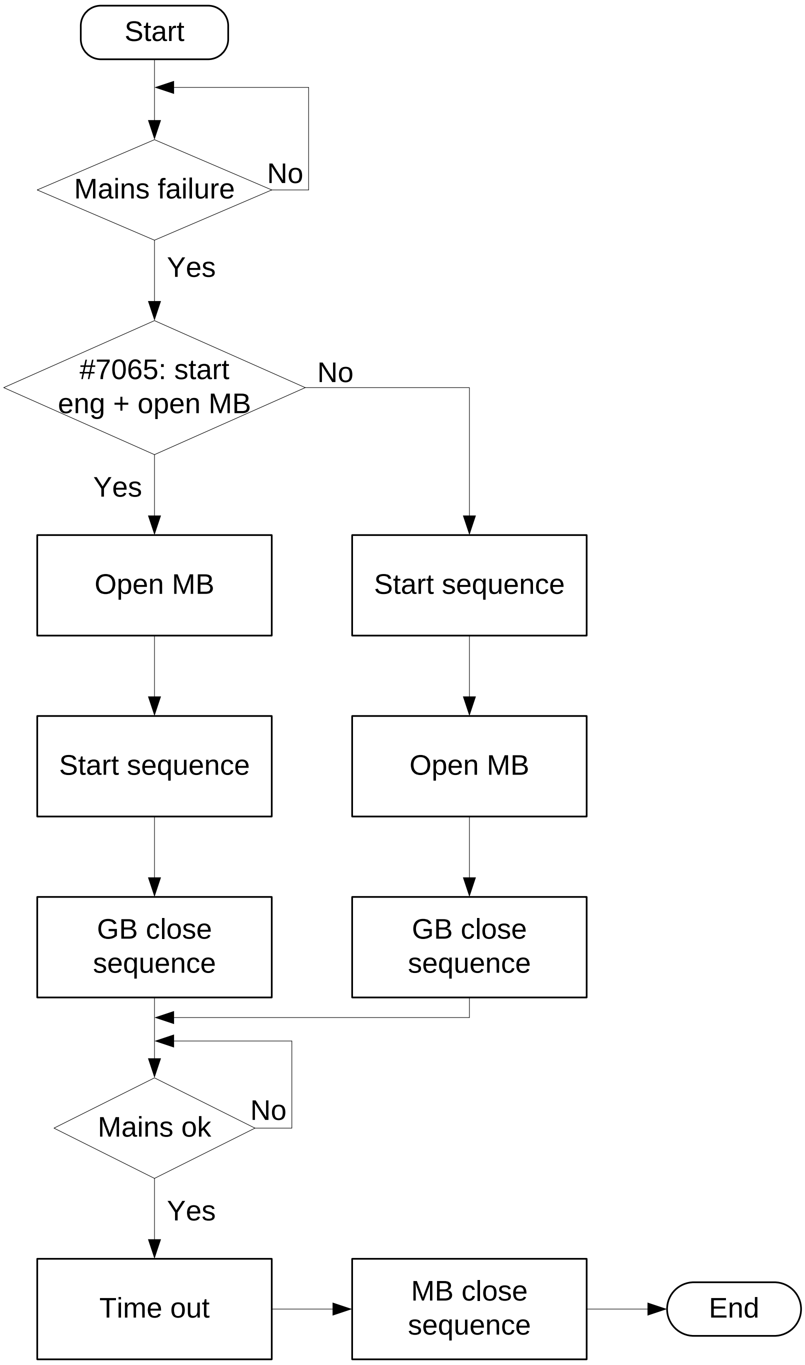
6.7.11 Peak shaving



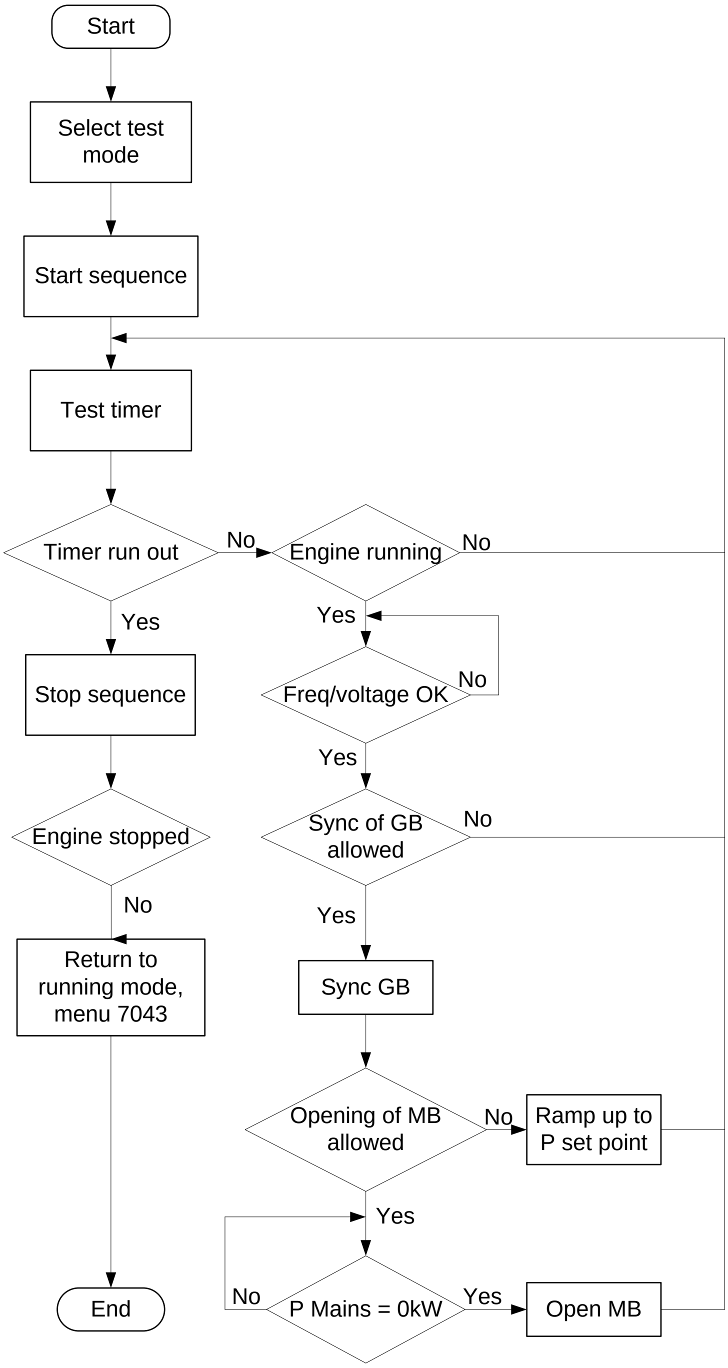
6.7.12 Mains power export



6.7.13 Automatic Mains Failure (AMF)



6.7.14 Test sequence



6.8 Sequences

The following contains information about the sequences of the engine, the generator breaker and, if installed, the mains breaker. These sequences are automatically initiated if the auto mode is selected, or if the commands are selected in the semi-auto mode.

In the semi-auto mode, the selected sequence is the only sequence initiated (e.g. press the START push-button: The engine will start, but no subsequent synchronising is initiated).

The following sequences will be illustrated below:

- START sequence
- STOP sequence
- Breaker sequences

If island operation is selected, the digital input "MB closed" must NOT be activated with a 12/24 volt input signal. A "mains breaker failure" will occur if the wiring of the mains breaker feedback inputs is wrong.

Refer to our application notes or installation instructions for information about the required breaker wiring.

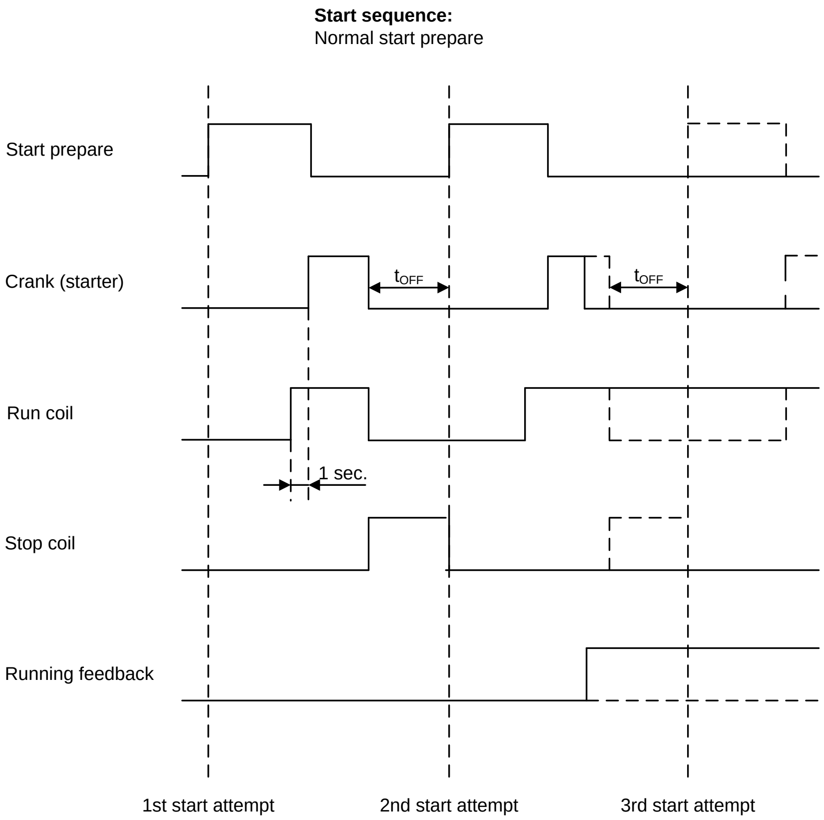
We recommend not using small relays for stop coil output. If small relays are used, a resistor must be mounted across the relay coil to prevent undesirable closing of the relay. This is caused by the wire-break function.

6.8.1 Start sequence

The following drawings illustrate the start sequences of the genset:
- normal start prepare
- extended start prepare

No matter the choice of start prepare function, the running coil is activated 1 s before the start relay (starter).

- Normal start prepare:

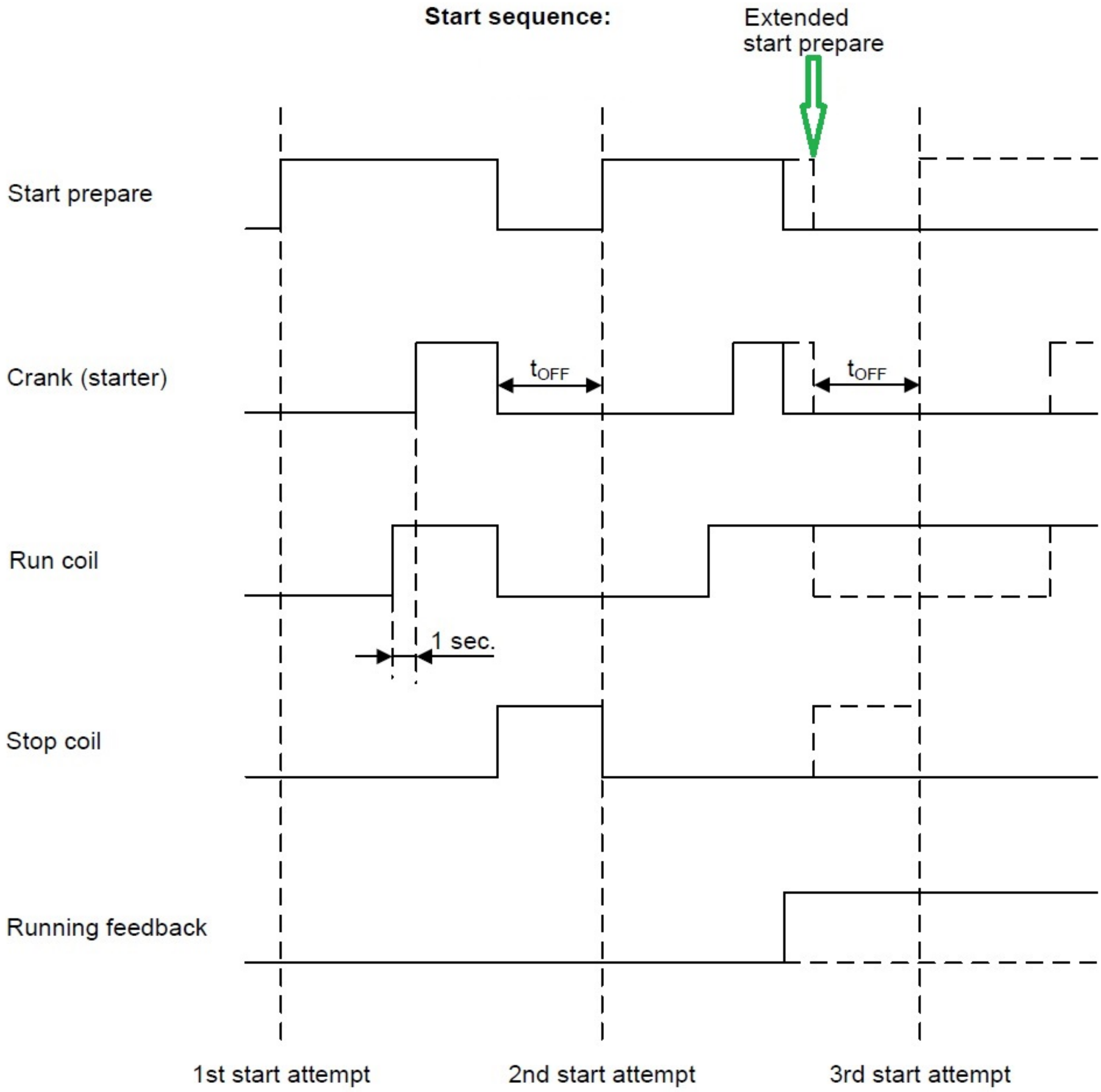


Note that in the example above, the "Run coil" opens between the start attempts. This is because the "Run coil type" is set to pulse (6152). When the engine gets running detection, the run coil will be kept closed until the stop sequence is initiated. If the "Run coil type" has been set to "Continuous", the run coil will be kept closed between the start attempts until start failure, or the stop sequence opens it.

- Related parameters:

Parameter	Item	Range	Default	Notes
6151	Run coil timer	0.0 s 600.0 s	1.0 s	Only in genset. Timer must be set to how long it takes the "Run coil" on the genset to open.
6152	Run coil type selection	Pulse Continuous	Pulse	Only in genset.
6191	Start prepare timer	0.0 s 600.0 s	5.0 s	Only in genset. Decides how long time the "start prepare" relay is closed before the crank relay is closed.
6181	Maximum starter ON time (crank)	1.0 s 180.0 s	5.0 s	Only in genset.
6182	Minimum starter OFF time/time between start attempts	1.0 s 180.0 s	5.0 s	Only in genset.
6183	Maximum number of start attempts before "start failure"	1 10	3	Only in genset.

- Extended start prepare:



Run coil can be activated from 1 to 600 s before crank (starter) is executed. In the example above, the timer is set to 1 s (menu 6151).

The "Extended start prepare" function keeps the "Start prepare" relay closed until "Remove starter" or "Running detection" is reached. This function can be helpful if some booster pumps for start fuel are used, so they are kept on until the engine is running.

- Related parameters:

Parameter	Item	Range	Default	Notes
6192	Extended start pre-pare timer	0.0 s 600.0 s	0.0 s	Only in genset.

6.8.2 Maximum crank counter/crank control

This function holds a timer and a counter. The counter dictates how many start attempts/cranks of the engine that are allowed within the set timer. The counter is set at parameter 6192, and the timer is set at parameter 6193. It is only possible to enable/disable this function with the utility software. Each start attempt is stored for the timer that is set at parameter 6193. So the function will only release "one try" at a time. The parameters for the function are shown below:

Parameter	Item	Range	Default	Notes
6184	Maximum allowed crank attempts	1 30	1	Only in genset. Note that the function is enabled/disabled from the utility software.
6185	Maximum allowed cranks within time	0.0 min 720.0 min	60.0 min	Only in genset.

6.8.3 Start sequence conditions

The start sequence initiation can be controlled by the following conditions in the USW (not possible on AGC PM display):

- Channel 10970 Multi-inp. config. 102 (RMI oil pressure)
- Channel 10980 Multi-inp. config. 105 (RMI water temperature)
- Channel 11000 Multi-inp. config. 108 (RMI oil pressure)
- Binary input

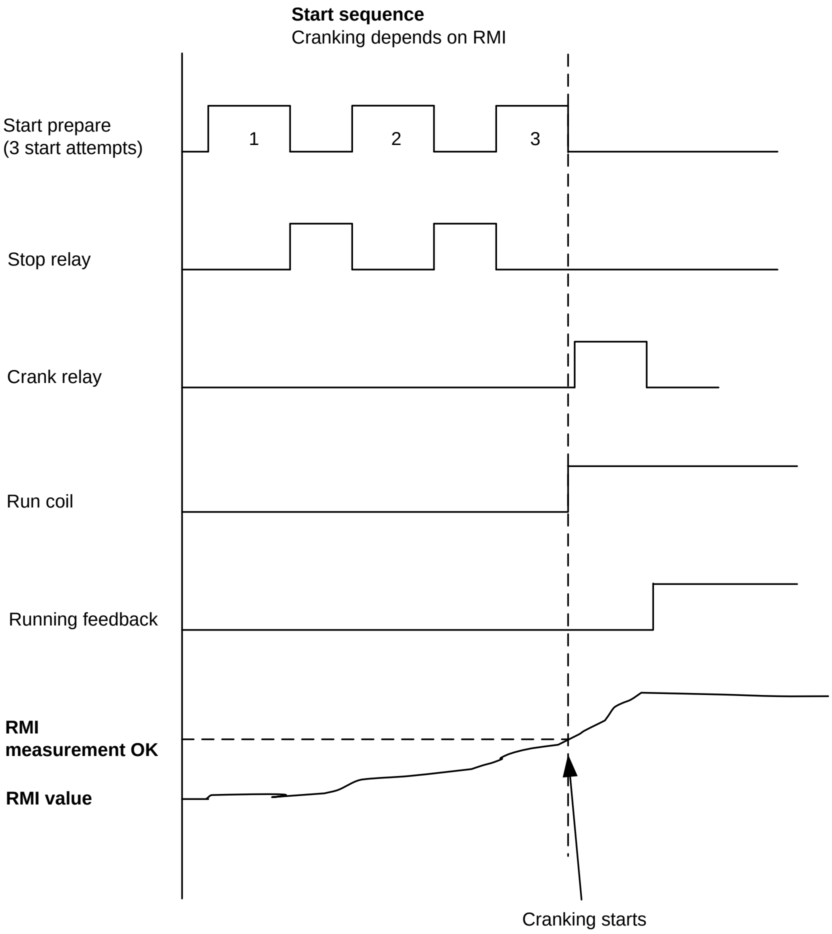
This means that if, for example, the oil pressure is not primed to the sufficient value, the crank relay will not engage the starter motor.

The selection is made in setting 6193. For each of the multi-inp. config. (102-108) settings, the rule is that the value (oil pressure, fuel level or water temperature) must exceed the set point of setting 6194 before starting is initiated.

If the value in 6193 is set to 0.0, the start sequence is initiated as soon as it is requested.

If the "binary start threshold" is to be used, the input is chosen from the "I/O list" in the utility software.

The diagram below shows an example where the multi-inp. config. 102 (RMI oil pressure) signal builds up slowly and starting is initiated at the end of the third start attempt.



In the diagram above, the crank/start is initiated as soon as the "start threshold" limit is reached. By default, the AGC waits until the "start prepare" timer has expired and the "start threshold" conditions are reached before the crank relay/start is initiated. This can be changed from parameter 6195, where the "start prepare type" can be changed to "interrupt start prepare", which means that it is allowed to interrupt the start prepare and initiate as soon as the "start threshold" conditions are reached.

- Related parameters:

Parameter	Item	Range	Default	Notes
6193	Start threshold type - input	Multi-input 102 Binary	Multi-input 102	Only in genset.
6194	Start threshold value/set point	0.0 3000.0	0.0	Only in genset. The range is dependent on the input type.
6195	Start prepare type	Full start prepare Interrupt start prepare	Full start prepare	Only in genset.

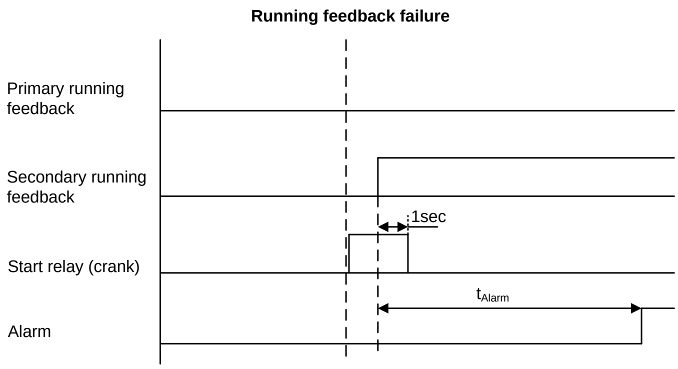
6.8.4 Running feedback

Different types of running feedback can be used to detect if the motor is running. Refer to menu 6170 for selection of the running feedback type.

The running detection is made with a built-in safety routine. The running feedback selected is the primary feedback.
At all times, all types of running feedback are used for running detection.
If, for some reason, the primary choice is not detecting any running feedback, the starter relay will stay activated for 1 additional second. If a running feedback is detected based on one of the secondary choices, the genset will start.
In this way, the genset will still be functional even though a tacho sensor is damaged or dirty.
As soon as the genset is running, no matter if the genset is started based on the primary or secondary feedback, the running detection will be made based on all available types.

The sequence is shown in the diagram below:

- Running feedback



Interruption of start sequence
The start sequence is interrupted in the following situations:

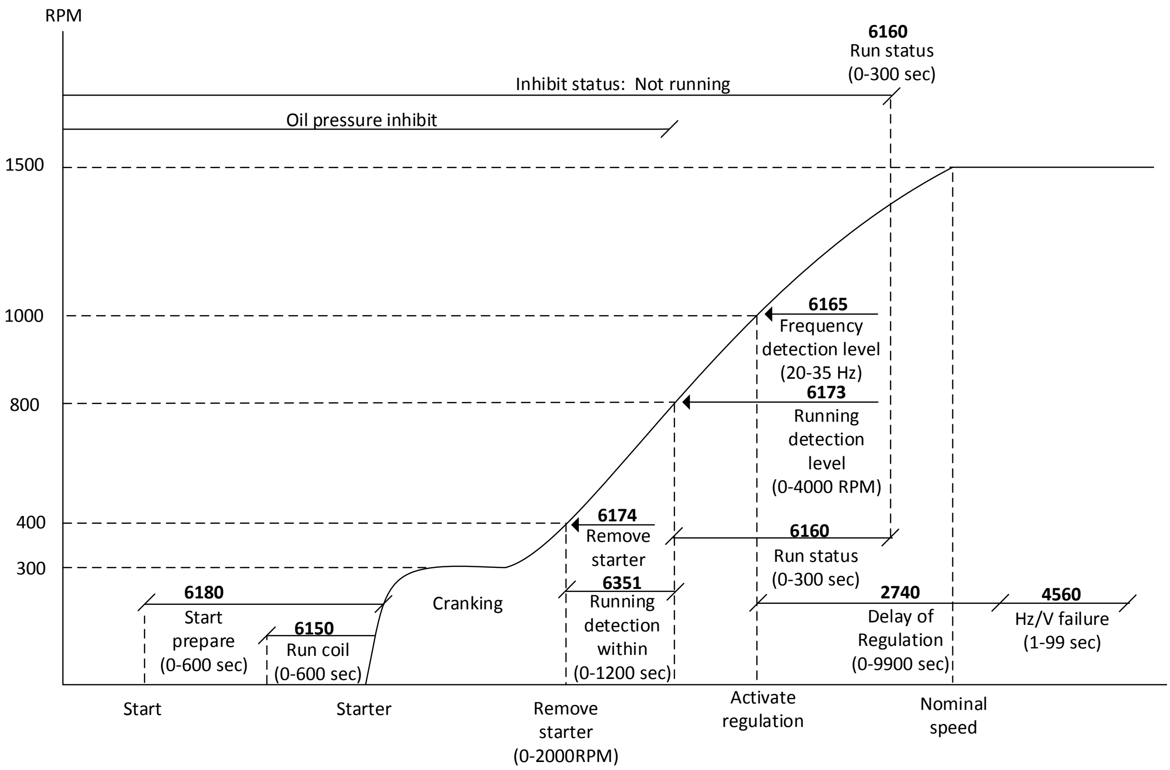
Event	Comment
Stop signal	
Start failure	
Remove starter feedback	Tacho set point.
Running feedback	Digital input.
Running feedback	Tacho set point.
Running feedback	Frequency measurement is between 30.0 and 35.0 Hz (6165). The frequency measurement requires a voltage measurement of 30 % of U_{NOM}. The running detection based on the frequency measurement can replace the running feedback based on tacho or digital input or engine communication.
Running feedback	Oil pressure set point (menu 6175).
Running feedback	EIC (engine communication) (option H5, H12 or H13).
Emergency stop	
Alarm	Alarms with shutdown" or "trip and stop" fail class.
Stop push-button on display	Only in semi-auto or manual mode.
Modbus stop command	Semi-auto or manual mode.
Digital stop input	Semi-auto or manual mode.
Deactivate the "auto start/stop"	Auto mode in the following genset modes: Island operation, fixed power, load takeover or mains power export mode.
Running mode	It is not possible to change the running mode to "block" as long as the genset is running.

If the MPU input is to be used to remove the starter, it must be set up in menu 6174.

- Related parameters:

Parameter	Item	Range	Default	Notes
6171	Number of teeth for MPU running detection.	0 teeth 500 teeth	0 teeth	Only in genset. If 6171 is set to 0, the magnetic pick-up input is not active.
6172	Primary running detection type.	Binary input Multi-input 108	Frequency	Only in genset. If set to anything else than frequency, the frequency will always be used as backup.
6173	Running detection limit.	0 RPM 4000 RPM	1000 RPM	Only in genset. Only used when MPU is selected in 6172
6174	Remove starter limit	1 RPM 2000 RPM	400 RPM	Only in genset. Only working with MPU input.

6.8.5 Start-up overview



Set points related to the start sequence

- Start prepare **(6190 Starter)**

Normal prepare: the start prepare timer can be used for start preparation purposes, e.g. pre-lubrication or pre-glowing. The start prepare relay is activated when the start sequence is initiated and deactivated when the start relay is activated. If the timer is set to 0.0 s, the start prepare function is deactivated.

Extended prepare: the extended prepare will activate the start prepare relay when the start sequence is initiated and keep it activated when the start relay activates until the specified time has expired. If the ext. prepare time exceeds the start ON time, the start prepare relay is deactivated when the start relay deactivates. If the timer is set to 0.0 s, the extended prepare function is deactivated.
Start ON time: The starter will be activated for this period when cranking.
Start OFF time: The pause between two start attempts.

- Run coil timer **(6150 Run coil)**

The timer for the run coil is a set point that sets how long time the run coil will be activated before cranking the engine. This gives the ECU time to start up before cranking.

- Remove starter **(6174 Remove starter)**

The starter is removed, when the RPM set point is reached. This will only work if MPU or EIC RPM is selected in **6172 Run detect type**

- Running detection RPM level **(6173 Running detection level)**

This is the set point where running detection level is defined in RPM. This will only work if MPU or EIC RPM is selected in **6172 Run detect type**.

- Running detection **(6201 Running detection)**

This timer can be set to the needed level. This will make sure that the engine goes from the RPM level set in **(6174 Remove starter)** and **(6173 Running detection level).** If the timer exceeds, and the level is not reached, the start sequence will start over, and have used a start attempt. If all start attempts **(6190 Start attempts)** have been used, the **(4570 start failure)** will appear. This timer will only be active if MPU or EIC RPM is selected in 6172 Run detect type.

If other running detection types than MPU or EIC RPM are used, the starter will be on until 6165 frequency detection level is reached.

- Frequency level **(6165 Frequency detection level)**

This set point is in Hz, and can be set to the needed level. When the level is reached, the regulators will start working, and make sure to reach the nominal values. The regulators can be delayed using **(2740 Delay of regulation)**. See below.

- Run status **(6160 Run status)**

The timer in this set point is started when **6173 Running detection level** is reached, or when **6165 Frequency detection level** is reached. When the timer exceeds, the inhibit status: Not running will be deactivated, and the running alarms and failures will be enabled (see the related failures below).

- Delay of regulation **(2740 Delay of regulation)**

By using this timer, the regulation start can be delayed. The timer will start when **6165 Frequency detection level** is reached.
If the setup is running on nominal settings, and **2740 Delay of regulation** is set to 0, the genset will overshoot the nominal frequency on start-up, as the regulators start increasing as soon as they are turned on.

If this timer is used, the regulation can wait until the genset is already at nominal frequency before starting to regulate.

Failures related to the start sequence

- Crank failure alarm **(4530 Crank failure)**

If MPU is chosen as the primary running feedback, this alarm will be raised if the specified rpm is not reached before the delay has expired.

- Run feedback failure **(4540 Run feedb. fail)**

If primary running feedback is set to e.g. digital input, and is not having a running detection, but one of the active secondary running feedbacks is detecting the engine to be running, e.g. frequency. There is a failure on the primary running feedback, and therefore this alarm will be raised with a delay. The delay to be set is the time from the secondary running detection and until the alarm is raised.

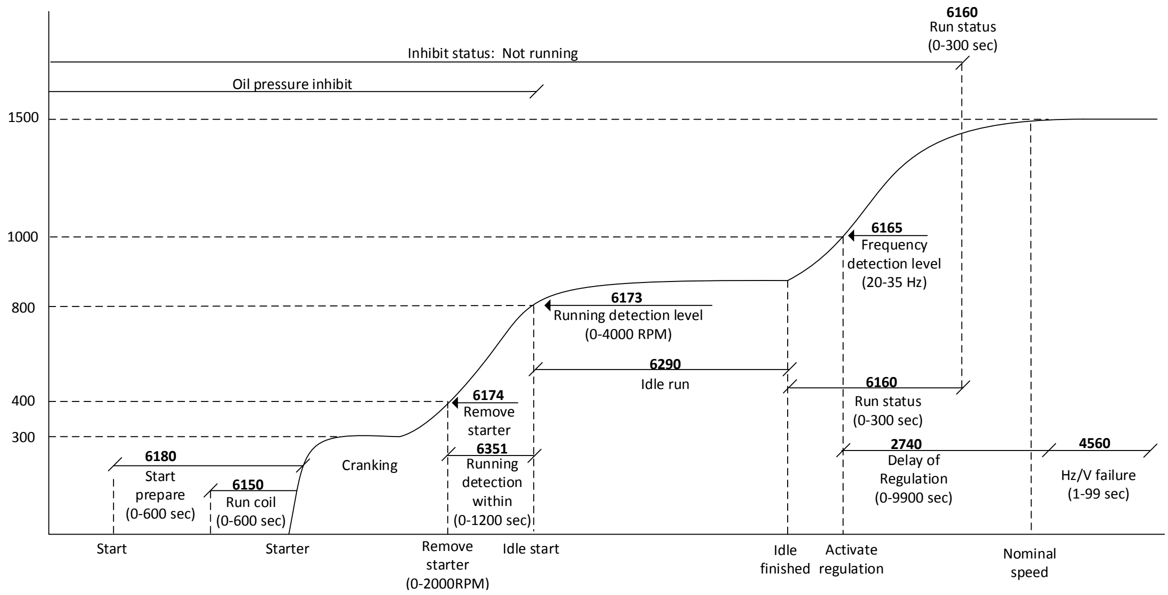
- Hz/V failure **(4560 Hz/V failure)**

If the frequency and voltage are not within the limits set in **2110 Blackout df/dUmax,** after the running feed-back is received, this alarm is raised when the delay has expired.

- Engine externally stopped **(6352 Ext. Eng. Stop)**

If running sequence is active and the engine goes below **6173 Running detection** and **6165 Frequency detection level** without any command from AGC is given, it will activate an alarm, if this parameter is enabled

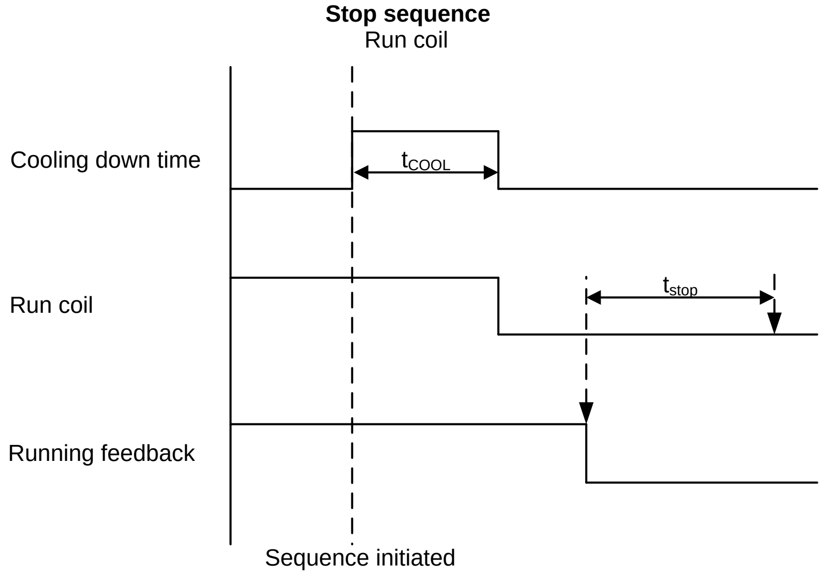
6.8.6 Start-up overview with idle run

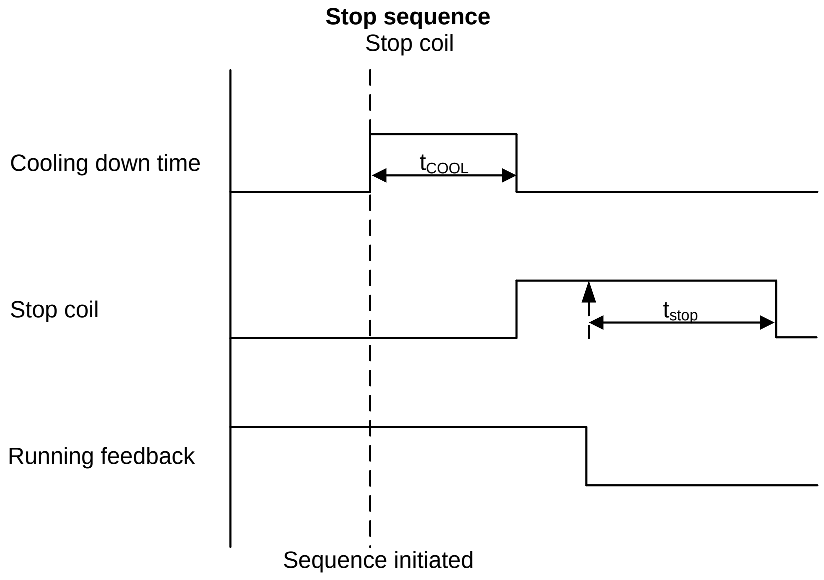


The set points and failures in this overview are the same as described in the chapter "Start-up overview", except for the idle run function. This function is described in the chapter "Idle running".

6.8.7 Stop sequence

The drawings illustrate the stop sequence.





- Related parameters: 6210 STOP

Parameter	Item	Range	Default	Notes
6211	Cooldown timer	0 s 9900 s	240 s	Only in genset. If the timer is set to 0, the cooldown timer will be infinite.

The stop sequence will be activated if a stop command is given. The stop sequence includes the cooling down time if the stop is a normal or controlled stop.

Description	Cooling down	Stop	Comment
Auto mode stop	X	X	
Trip and stop alarm	X	X	
Stop button on display	(X)	X	Semi-auto or manual. Cooling down is interrupted if the stop button is activated twice.
Remove "auto start/stop"	X	X	Auto mode: Island operation, fixed power, load takeover, mains power export.
Emergency stop		X	GB opens and engine shuts down.

The stop sequence can only be interrupted during the cooling down period. If the genset has the status of "genset stopping", a new start sequence cannot be initiated until the genset has been fully stopped. Interruption of the "cooldown period" can occur in these situations:

Event	Comment
Mains failure	AMF mode selected (or mode shift selected ON) and auto mode selected.
Start button is pressed/remote command is given	Semi-auto mode: Engine will run in idle/nominal speed.
Digital start input	Auto mode: Island operation and fixed power, load takeover or mains power export.
Exceeding set point	Auto mode: Peak shaving.
GB close button is pressed/remote command is given	Semi-auto mode only.

When the engine is stopped, the analogue speed governor output is reset to the offset value. Refer to the mentioned option descriptions.

Set points related to the stop sequence

- Stop failure **(4580 Stop failure)** Max. allowed time for stopping the genset
A stop failure alarm will appear if the primary running feedback or the generator voltage and frequency are still present after the delay in this menu has expired. The "stop failure" timer is started when the cooldown timer has expired, or, for example, a shutdown fail class is activated. If the timer expires before the running feedback or generator voltage and frequency have disappeared, the "stop failure" alarm will be activated.

- Related parameters:

Parameter	Item	Range	Default	Notes
4581	Stop failure timer	10.0 s 120.0 s	30.0 s	Only in genset.
4582	Stop failure, Output A	Not used Option-dependent	Not used	Only in genset.
4583	Stop failure, Output B	Not used Option-dependent	Not used	Only in genset.
4584	Activation of the stop failure alarm	ON OFF	ON	Only in genset.
4585	Stop failure alarm fail class	Block Trip MG/GB	Shutdown	Only in genset.

- Stop **(6210 Stop)**
Cooling down:
The length of the cooling down period.

Extended stop:
The delay after the running feedback has disappeared and until a new start sequence is allowed. This is to prevent the starter from being activated on an engine that is still turning below the "running feedback" set point. The extended stop sequence is activated any time the stop button is pressed.

- Related parameter:

Parameter	Item	Range	Default	Notes
6212	Extended stop timer	1.0 s 99.0 s	5.0 s	Only in genset.

Cooldown controlled by engine temperature:
The engine temperature-controlled cooldown is to ensure that the engine is cooled down below the set point in menu 6214 "cool down temperature" before the engine is stopped. This is particularly beneficial if the engine has been running for a short period of time and therefore not reached normal cooling water temperature, as the cooldown period will be very short or none at all. If the engine has been running for a long period of time, it will have reached normal running temperature, and the cooldown period will be the exact time it takes to get the temperature below the temperature set point in menu 6214.

If, for some reason, the engine cannot get the temperature below the temperature set point in 6214 within the time limit in parameter 6211, the engine will be stopped by this timer. The reason for this could be high ambient temperature.

- Related parameters:

Parameter	Item	Range	Default	Notes
6213	Stop threshold type - input	Analogue 102 Option-dependent	Analogue 102	Only in genset.
6214	Stop threshold value/set point	0 °C 482 °C	0 °C	Only in genset.

If the cooling down timer is set to 0.0 s, the cooling down sequence will be infinite.

If the cooling down temperature is set to °C, the cooling down sequence will be entirely controlled by the timer.

If the engine stops unexpectedly, refer to the chapter "Running feedback".

6.8.8 Breaker sequences

The breaker sequences will be activated depending on the selected mode:

Controller operation mode	Plant running mode	Breaker control
Auto	All	Controlled by the unit
Semi-auto	All	Push-button/remote command
Manual (only genset)	All	Push-button/remote command
Block (only genset)	All	None (only possible to open breakers)

Before closing the breakers, it must be checked that the voltage and frequency are OK. The limits are adjusted in menu 2110 Sync. blackout.

Set points related to MB control:

7080 MB control

Mode shift (7081):	When enabled, the AGC will perform the AMF sequence in case of a mains failure regardless of the actual plant running mode.
MB close delay (7082):	The time from GB/TB OFF to MB ON when back synchronisation is OFF (only stand-alone or mains controller with MB and TB).
Back sync. (7083):	Enables synchronisation from mains to generator.
Sync. to mains (7084):	Enables synchronisation from generator to mains.
Load time (7085):	After opening the breaker, the MB ON sequence will not be initiated before this delay has expired. Refer to the description of "Breaker spring load time".

If no MB is represented, then the relays for opening/closing and inputs for feedbacks normally used for MB control/supervision become configurable. The application configuration (USW) is used for configuration of the plant design if the application does not include an MB.

AGC without back synchronisation: The GB can only be closed if the mains breaker is open. The MB can only be closed if the generator breaker is open.

AGC with back synchronisation: If the GB or MB push-button is activated, the AGC will start synchronising if the generator or mains voltage is present. The GB can close directly if the MB is open. The MB can close directly if the GB is open.

The parameters for "MB control" are shown in the table below:

Parameter	Item	Range	Default	Note
7081	Mode shift – allows switch to AMF mode in case of mains failure.	OFF ON	OFF	
7082	MB close delay – how long blackout during open transition.	0.0 s 30.0 s	0.5 s	Can only be used at stand-alone or setup with mains controller with MB and TB.
7083	Enable “Back synchronisation” – allows to put load from DG onto grid.	OFF ON	OFF	
7084	Enable “Synchronisation to mains” – allows to synchronise to mains and export power.	OFF ON	ON	
7085	MB spring load time – how long time it takes before spring in MB has been spun up again.	0.0 s 30.0 s	0.0 s	

AMF MB opening (menu 7065)
It is possible to select the functionality of the mains breaker opening function. This is necessary if the unit operates in Automatic Mains Failure (AMF).

The possibilities in menu 7065 are:

Selection	Description
Start engine + open mains breaker	When a mains failure occurs, the mains breaker opens and the engine starts at the same time.
Start engine	When a mains failure occurs, the engine starts. When the generator is running and the frequency and voltage are OK, the MB opens and the GB closes. If there are TBs in the application, the GB will be closed, and the MB will then open and the TB will close.

This parameter can be helpful in cases when the MB can only be operated if there is voltage either on the mains or the busbar.
The parameter table for the "Mains failure control" is shown below:

Parameter	Item	Range	Default	Note
7065	Start-up sequence when mains failure timer runs out - selection	Start engine + open MB Start engine	Start engine + open MB	Only in genset.

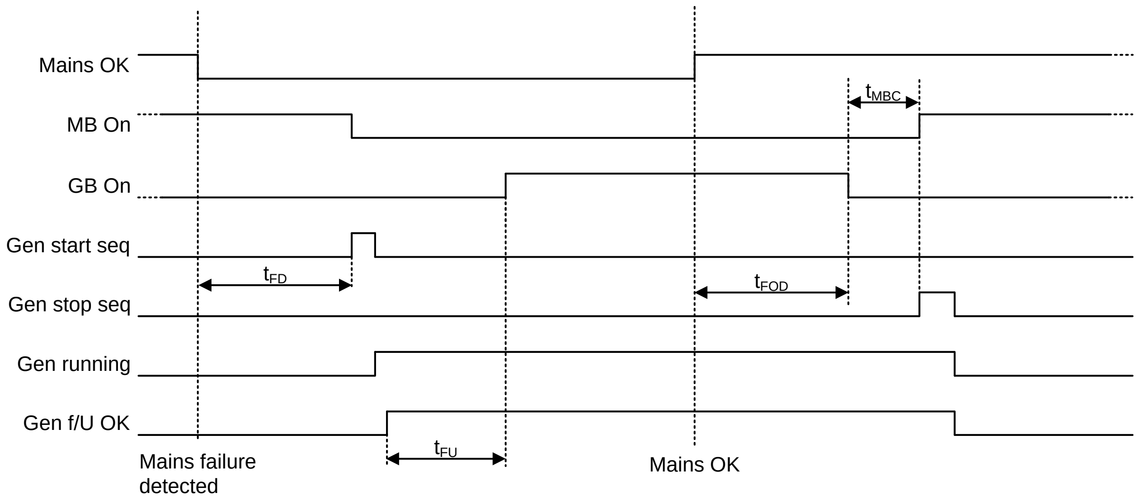
6.8.9 AMF timers

The time charts describe the functionality at a mains failure and at mains return. Back synchronisation is deactivated. The timers used by the AMF function are indicated in the table below:

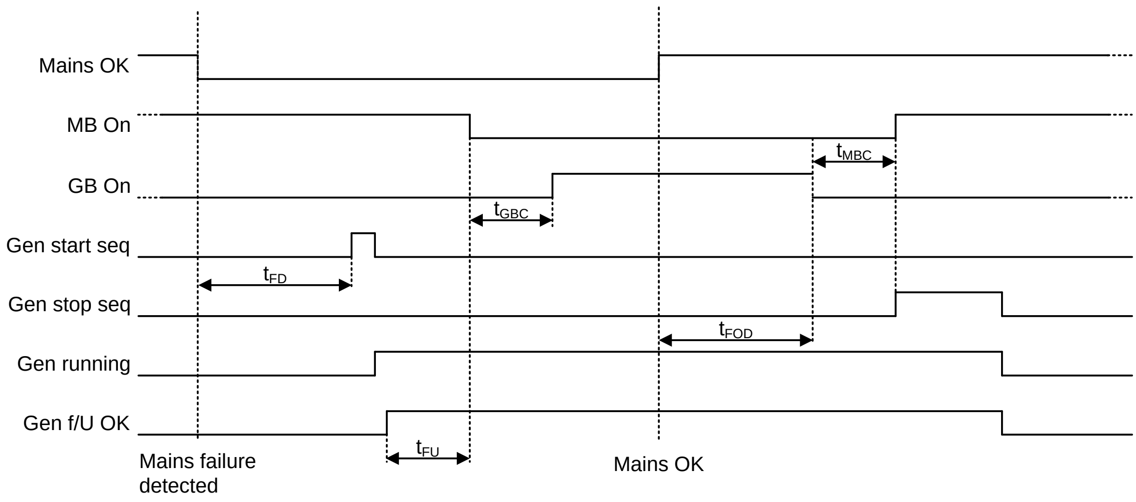
Timer	Description	Menu number
t_{FD}	Mains failure delay	**7071 f mains failure** **7061 U mains failure**
t_{FU}	Frequency/voltage OK	**6220 Hz/V OK**
t_{FOD}	Mains failure OK delay	**7072 f mains failure** **7062 U mains failure**
t_{GBC}	GB ON delay	**6231 GB control**
t_{MBC}	MB ON delay	**7082 MB control**

The timer t_{MBC} is only active if back synchronisation is deactivated.

Example 1:
7065 Mains fail control: Start engine and open MB



Example 2:
7065 Mains fail control: Start engine



Conditions for breaker operations
The breaker sequences react depending on the breaker positions and the frequency/voltage measurements.

The conditions for the ON and OFF sequences are described in the table below:

Conditions for breaker operations	
Sequence	**Condition**
GB ON, direct closing	Running feedback Generator frequency/voltage OK MB open
MB ON, direct closing	Mains frequency/voltage OK GB open
GB ON, synchronising	Running feedback Generator frequency/voltage OK MB closed No generator failure alarms
MB ON, synchronising	Mains frequency/voltage OK GB closed No generator failure alarms
GB OFF, direct opening	MB open
MB OFF, direct opening	Alarms with fail classes: Shut down or Trip MB alarms
GB OFF, deloading	MB closed
MB OFF, deloading	Alarms with fail class: Trip and stop

7. Additional features

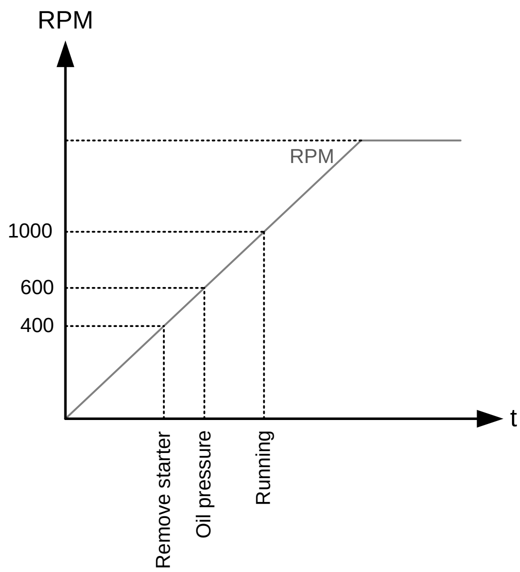
7.1 Start functions

The unit will start the genset when the start command is given. The start sequence is deactivated when the remove starter event occurs or when the running feedback is present.

The reason for having two possibilities to deactivate the start relay is to be able to delay the alarms with run status.

If it is not possible to activate the run status alarms at low revolutions, the remove starter function must be used.

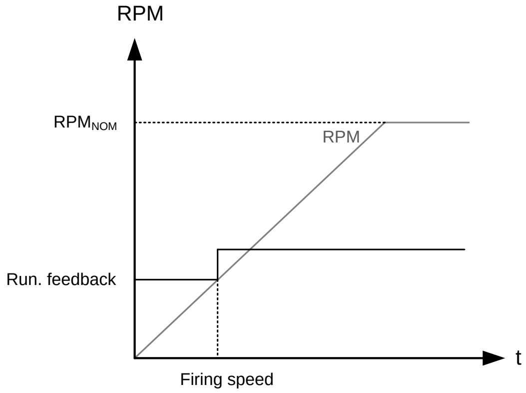
An example of a critical alarm is the oil pressure alarm. Normally, it is configured according to the shutdown fail class. But if the starter motor has to disengage at 400 RPM, and the oil pressure does not reach a level above the shutdown set point before 600 RPM, then, obviously, the genset would shut down if the specific alarm was activated at the preset 400 RPM. In that case, the running feedback must be activated at a higher number of revolutions than 600 RPM.



7.1.1 Digital feedbacks

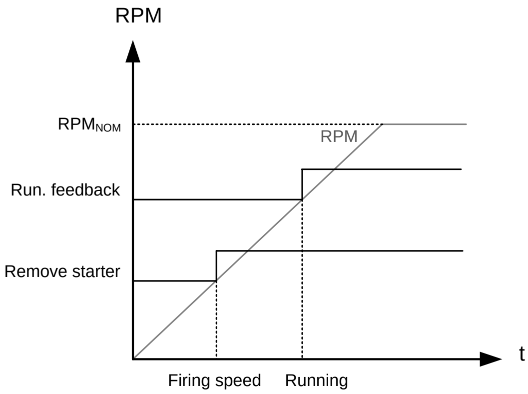
If an external running relay is installed, then the digital control inputs for running detection or remove starter can be used.

Running feedback
When the digital running feedback is active, the start relay is deactivated and the starter motor will be disengaged.



The diagram illustrates how the digital running feedback (terminal 117) is activated when the engine has reached its firing speed.

Remove starter
When the digital remove starter input is present, the start relay is deactivated and the starter motor will be disengaged.



The diagram illustrates how the remove starter input is activated when the engine has reached its firing speed. At the running speed, the digital running feedback is activated.

The remove starter input must be configured from a number of available digital inputs.

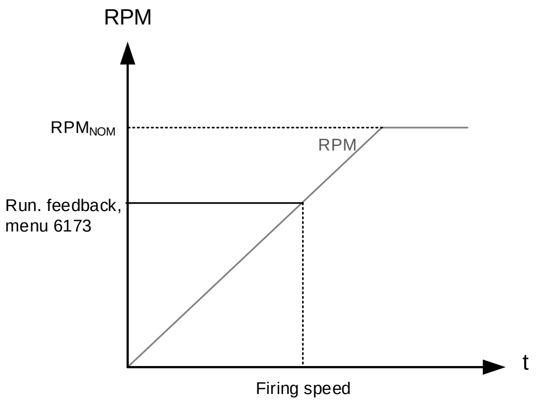
The running feedback is detected by either the digital input (see diagram above), frequency measurement where the set point can be between 20-35 Hz, RPM measured by magnetic pick-up where the set point can be between 0-4000 RPM or EIC (See chapter regarding Engine communication).

7.1.2 Analogue tacho feedback

When a magnetic pickup (MPU) is being used, the specific level of revolutions for deactivation of the start relay can be adjusted.

Running feedback

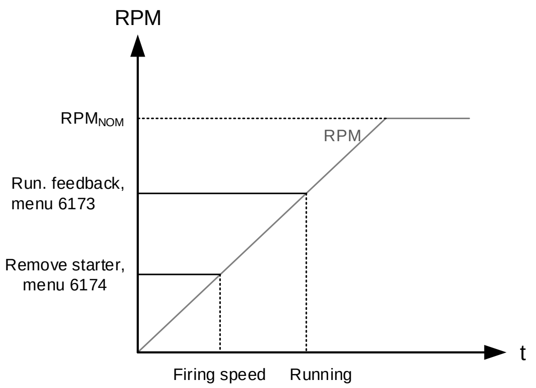
The diagram below shows how the running feedback is detected at the firing speed level. The factory setting is 1000 RPM **(6170 Running detect.).**



Notice that the factory setting of 1000 RPM is higher than the RPM level of starter motors of typical design. Adjust this value to a lower value to avoid damage of the starter motor.

Remove starter input

The drawing below shows how the set point of the remove starter is detected at the firing speed level. The factory setting is 400 RPM **(6170 Running detect.).**



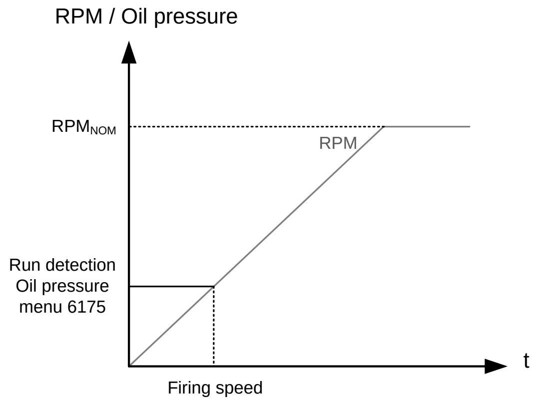
The number of teeth on the flywheel must be adjusted in menu 6170 when the MPU input is used.

7.1.3 Oil pressure

The multi-inputs on terminals 102, 105 and 108 can be used for the detection of running feedback. The terminal in question must be configured as an RMI input for oil pressure measurement.

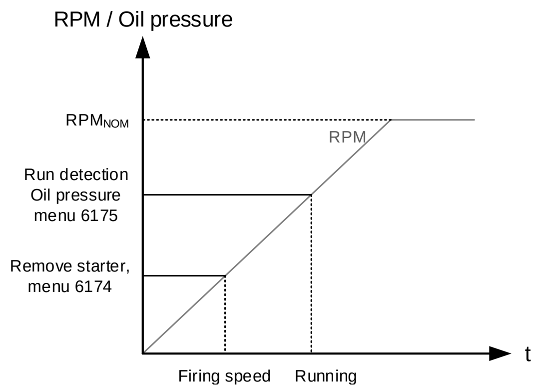
When the oil pressure increases above the adjusted value **(6175 Pressure level)**, the running feedback is detected and the start sequence is ended.

Running feedback



Remove starter input

The diagram below shows how the set point of the "remove starter input" is detected at the firing speed level. The factory setting is 400 RPM **(6170 Running detect.).**



The remove starter function can use the MPU or a digital input.

Related parameters:

6170 Running detec.

Parameter	Item	Range	Default	Notes
6171	Number of teeth on the flywheel	0 teeth 500 teeth	0 teeth	Only in genset.
6172	Primary running detection type	Frequency Multi-input 108	Frequency	Only in genset. If something else than frequency is used, the frequency is always used as backup/secondary.
6173	Running detection set point	0 RPM 4000 RPM	1000 RPM	Only in genset. This set point determines when "running" is obtained and releases the inhibit for "not running".
6174	Remove starter set point	0 RPM 2000 RPM	400 RPM	Only in genset.
6175	Oil pressure level set point	0.0 150.0	0.0	Only in genset. This set point determines when "running detection" is reached, when oil pressure is used for "running detection".

7.2 Breaker types

There are five possible selections for the setting of breaker type for both mains breaker and generator breaker.

Continuous NE and Continuous ND
This type of signal is most often used combined with a contactor. When using this type of signal, the AGC will only use the close breaker relays. The relay will be closed for closing of the contactor and will be opened for opening of the contactor. The open relay can be used for other purposes. Continuous NE is a normally energised signal, and Continuous ND is a normally deenergised signal.

Pulse
This type of signal is most often used combined with circuit breaker. With the setting pulse the AGC will use the close command and the open command relay. The close breaker relay will close for a short time for closing of the circuit breaker. The open breaker relay will close for a short time for opening of the breaker.

External/ATS no control
This type of signal is used to indicate the position of the breaker, but the breaker is not controlled by the AGC.

Compact
This type of signal will most often be used combined with a compact breaker, a direct controlled motor driven breaker. With the setting compact the AGC will use the close command and the open command relay. The close breaker relay will close for a short time for the compact breaker to close. The breaker off relay will close for the compact breaker to open and hold it closed long enough for the motor in the breaker to recharge the breaker. If the compact breaker is tripped externally, it is recharged automatically before next closing.

Common for all:
The breaker type is selected in "Application configuration" in the utility software. Be aware of the "PM CAN IDs" when setting breaker types.
Furthermore, the "reaction time" of each breaker is set. This is primarily used for dynamic synchronisation. These are set at parameters 2024 and 2025. When set correctly, the Multi-line 2 product anticipates how long time before synchronisation the close command should be given.

The open and close pulse lengths are defined in the menus 2160-2170 and 2200-2210. These alarms contain a timer that dictates how long time the command relays are allowed to be closed. If "Continuous" breakers are used, the timer decides for how long time the close/open command is allowed to be active.

The parameters for the breaker reaction time/command lengths are shown below:

Parameter	Item	Range	Default	Note
2024	Synchronisation time/reaction time for the GB/TB	40 ms 300 ms	50 ms	
2025	Synchronisation time/reaction time for the MB	40 ms 300 ms	50 ms	
2161	GB/TB open fail – maximum allowed time for open command	1 s 10 s	2 s	
2162	GB/TB open fail – alarm relay output A	Not used Option-dependent	Not used	
2163	GB/TB open fail – alarm relay output B	Not used Option-dependent	Not used	
2164	GB/TB open fail – fail class	Warning Trip MB/GB	Warning	
2171	GB/TB close fail – maximum allowed time for close command	1 s 10 s	2 s	
2172	GB/TB close fail – alarm relay output A	Not used Option-dependent	Not used	
2173	GB/TB close fail – alarm relay output B	Not used Option-dependent	Not used	
2174	GB/TB close fail – fail class	Warning Trip MB/GB	Warning	
2201	MB open fail – maximum allowed time for open command	1 s 10 s	2 s	
2202	MB open fail – alarm relay output A	Not used Option-dependent	Not used	
2203	MB open fail – alarm relay output B	Not used Option-dependent	Not used	
2204	MB open fail – fail class	Warning Trip MB/GB	Warning	

Parameter	Item	Range	Default	Note
2211	MB close fail – maximum allowed time for close command	1 s 10 s	2 s	
2212	MB close fail – alarm relay output A	Not used Option-dependent	Not used	
2213	MB close fail – alarm relay output B	Not used Option-dependent	Not used	
2214	MB close fail – fail class	Warning Trip MB/GB	Warning	

7.3 Breaker position failure

If a Multi-line 2 unit has a "breaker position failure", the system will block/freeze. The "breaker position failure" alarm can appear if a controller has no feedbacks of the breaker position, or if both feedbacks from the breaker has the state of high.

When a controller has a "breaker position failure", it will inform the other controllers in the application about it. The system will then block the section in which it is present. Sections that are not affected by the "breaker position failure" will continue. None of the Multi-line 2 controllers will allow to close a breaker in a section in which there is a "breaker position failure".

It is possible to make the Multi-line 2 controller try to trip the faulty breaker when it discovers a "position failure". This can be handled by the fail class.

The parameters for the "breaker position failure" are shown in the table below:

Parameter	Item	Range	Default	Note
2181	GB/TB position failure – either feedbacks are both high or low	1 s 5 s	1 s	
2182	GB/TB position failure – alarm relay output A	Not used Option-dependent	Not used	
2183	GB/TB position failure – alarm relay output B	Not used Option-dependent	Not used	
2184	GB/TB position failure – fail class	Warning Trip MB/GB	Warning	
2221	MB position failure – either feedbacks are both high or low	1 s 5 s	1 s	
2222	MB position failure – alarm relay output A	Not used Option-dependent	Not used	
2223	MB position failure – alarm relay output B	Not used Option-dependent	Not used	
2224	MB position failure – fail class	Warning Trip MB/GB	Warning	

7.4 Breaker spring load time

To avoid breaker close failures in situations where breaker ON command is given before the breaker spring has been loaded, the spring load time can be adjusted for GB/TB and MB.

The following describes a situation where you risk getting a close failure:

1. The genset is in auto mode, the auto start/stop input is active, the genset is running and the GB is closed.
2. The auto start/stop input is deactivated, the stop sequence is executed and the GB is opened.
3. If the auto start/stop input is activated again before the stop sequence is finished, the GB will give a GB close failure as the GB needs time to load the spring before it is ready to close.

Different breaker types are used, and therefore there are two available solutions:

1. Timer-controlled
A load time set point for the GB,TB and MB control for breakers with no feedback indicating that the spring is loaded. After the breaker has been opened it will not be allowed to close again before the delay has expired. The set points are found in menus 6231 (generator breaker), 7082 (mains breaker) and 8995 (tie breaker).

On the AGC mains/group controller, the spring load feedback from the tie breaker can be connected instead of the GB spring load feedback.

2. Digital input

Two configurable inputs to be used for feedbacks from the breakers: One for GB/TB spring loaded and one for MB spring loaded. After the breaker has been opened it will not be allowed to close again before the configured inputs are active. The inputs are configured in the Utility Software. When the timers are counting, the remaining time is shown in the display.

If the two solutions are used together, both requirements are to be met before closing of the breaker is allowed.

Breaker LED indication
To alert the user that the breaker close sequence has been initiated but is waiting for permission to give the close command, the LED indication for the breaker will be flashing yellow in this case.

If the breaker needs time to reload the spring after it has opened, then the AGC can take this delay into account. This can be controlled through timers in the AGC or through digital feedbacks from the breaker, depending on the breaker type.

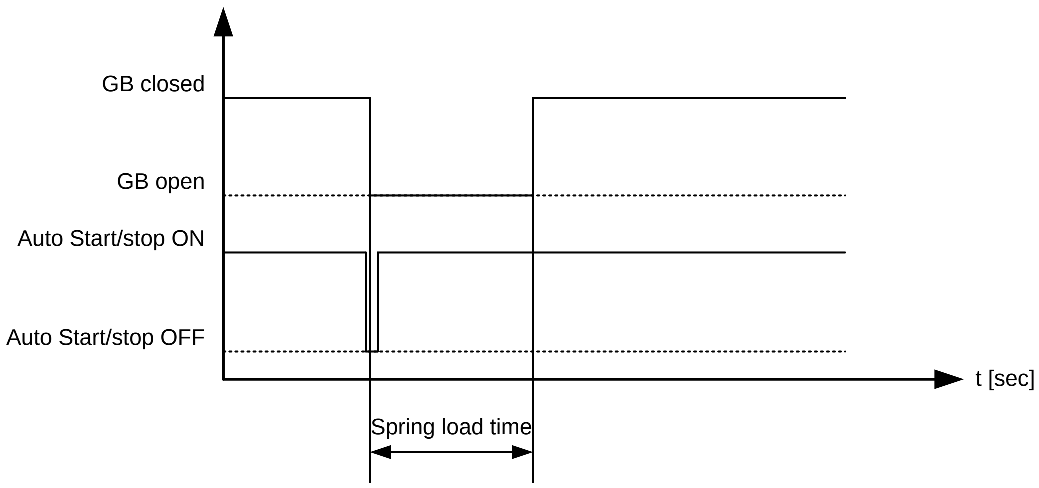
Related parameters:

Parameter	**Item**	**Range**	**Default**	**Note**
6231	Generator breaker, reclose delay	0.0 s 30.0 s	2.0 s	Only in genset.
7082	Mains breaker, reclose delay	0.0 s 30.0 s	0.5 s	Only in plant/ mains.
8995	Tie breaker, reclose delay	0.0 s 30.0 s	0.0 s	Only in mains/ group.

7.4.1 Principle

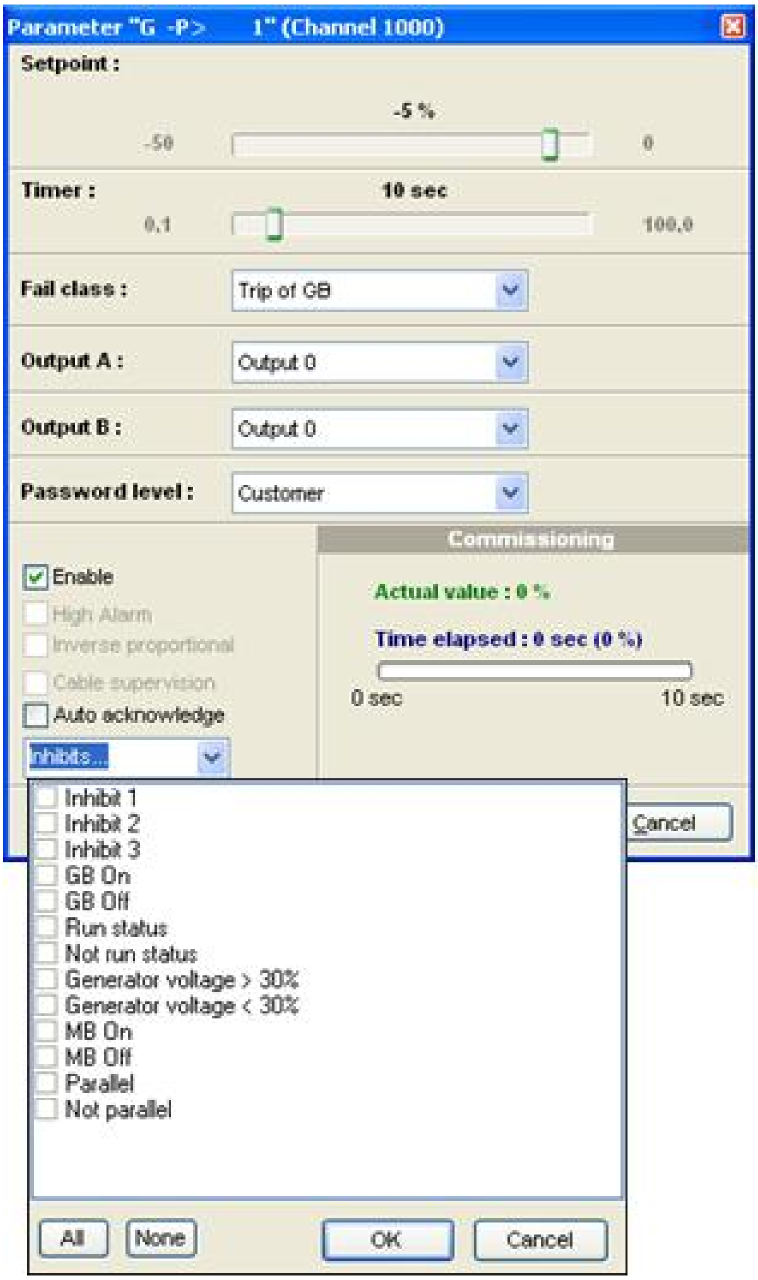
The diagram shows an example where a single AGC in island mode is controlled by the AUTO start/stop input.

This is what happens: When the AUTO start/stop input deactivates, the GB opens. The AUTO start/stop is reactivated immediately after the GB has opened, e.g. by the operator through a switch in the switchboard. However, the AGC waits a while before it issues the close signal again, because the spring load time must expire (or the digital input must be activated - not shown in this example). Then the AGC issues the close signal.


GB closed
GB open
Auto Start/stop ON
Auto Start/stop OFF
t [sec]
Spring load time

7.5 Alarm inhibit

In order to select when the alarms are to be active, a configurable inhibit setting for each alarm has been made. The inhibit functionality is only available via the PC utility software. For each alarm, there is a drop-down window where it is possible to select which signals that have to be present in order to inhibit the alarm.

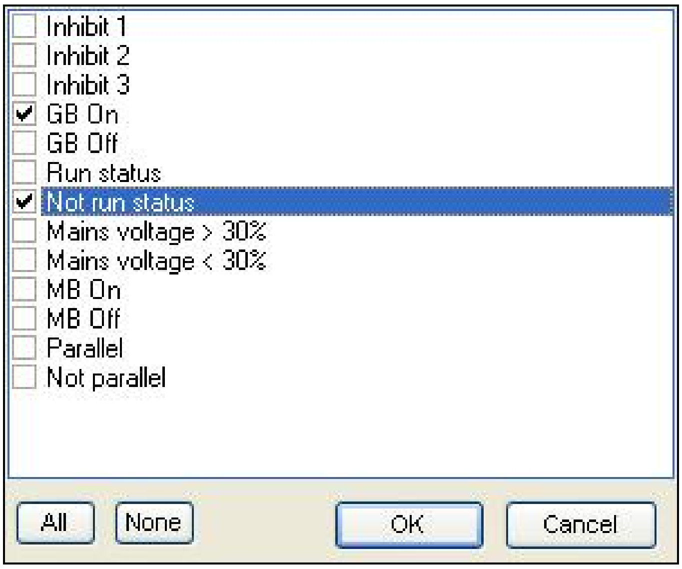


Selections for alarm inhibit:

Function	Description
Inhibit 1	M-Logic outputs: Conditions are programmed in M-Logic
Inhibit 2	
Inhibit 3	
GB/TB/MB ON	Inhibit alarm when the relevant breaker is closed.
GB/TB/MB OFF	Inhibit alarm when the relevant breaker is open.
Run status	Running detected and the timer in menu 6160 expired
Not run status	Running not detected or the timer in menu 6160 not expired
Generator voltage > 30 %	Generator voltage is above 30 % of nominal
Generator voltage < 30 %	Generator voltage is below 30 % of nominal
MB ON	The mains breaker is closed
MB OFF	The mains breaker is open
Parallel	Inhibit alarms when genset(s) is parallel to grid/utility.
Not parallel	Inhibit alarms when genset(s) is not parallel to grid/utility.

The timer in 6160 is not used if binary running feedback is used.

Inhibit of the alarm is active as long as one of the selected inhibit functions is active.



In this example, inhibit is set to **Not run status** and **GB ON**. Here, the alarm will be active when the generator has started. When the generator has been synchronised to the busbar, the alarm will be inhibited again.

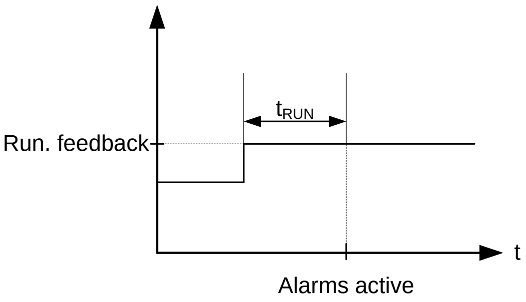
Function inputs such as running feedback, remote start or access lock are never inhibited. Only alarm inputs can be inhibited.

Some controllers do not have running detection, so the only inhibit functions are the digital input and the breaker position.

7.5.1 Run status

Alarms can be adjusted to activate only when the running feedback is active and a specific time delay has expired.

The diagram below illustrates that after activation of the running feedback, a run status delay will expire. When the delay expires, alarms with **Run status** will be activated.



The timer is ignored if digital running feedback is used.

The parameters for using the run status are shown in the table below:

Parameter	Item	Range	Default	Note
6162	Run status delay timer. Timer start when running detection is reached.	0.0 s 300.0 s	5.0 s	Only in genset.
6163	Output A. Relay to activate when run status is reached.	Not used Option dependent	Not used	Only in genset.
6164	Output B. Relay to activate when run status is reached.	Not used Option dependent	Not used	Only in genset.
6165	Run status alarm activation.	OFF ON	OFF	Only in genset.

7.6 Access lock

The purpose of access lock is to deny the operator the possibility to configure the unit parameters and change the running modes.

The input to be used for the access lock function is defined in the ML-2 PC utility software (USW).

Access lock will typically be activated from a key switch installed behind the door of the switchboard cabinet. As soon as access lock is activated, changes from the display cannot be made.

Access lock will only lock the display and will not lock any AOP or digital input. AOP can be locked by using M-Logic.
It will still be possible to read all parameters, timers and the state of inputs in the service menu (9120).

It is possible to read alarms, but not acknowledge any of them when access lock is activated. Nothing can be changed from the display.

This function is ideal for a rental generator, or a generator placed in a critical power segment. The operator does not have the possibility to change anything. If there is an AOP-1 or AOP-2, the operator will still be able to change up to 8 different predefined things.

The stop push-button is not active in semi-auto mode when the access lock is activated. For safety reasons, it is recommended to install an emergency stop switch.

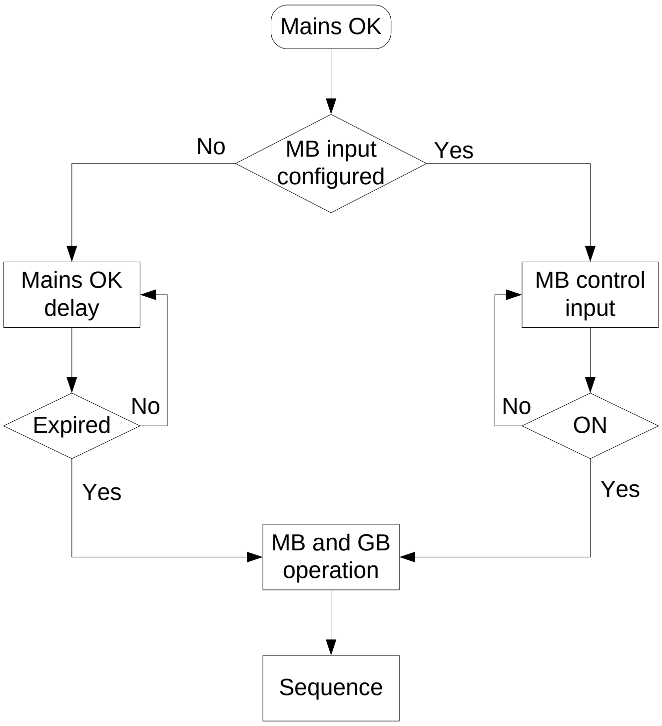
AOP buttons are not locked when access lock is activated.

7.7 Digital mains breaker control

The unit will normally execute the automatic mains failure sequence based on the settings adjusted in the system setup. Besides these settings, it is possible to configure a digital input that can be used to control the mains return sequence. This input is the "mains OK" input. The purpose of this function is to let an external device or an operator control the mains return sequence. The external device can for example be a PLC.

The flowchart below shows that if the input is configured, it needs to be activated (by a pulse) in order to initiate the mains return sequence. The load will continue on generator supply if the input is not activated.

The mains OK delay is not used at all when the "Mains OK" input is configured.



7.8 Command timers

The purpose of the command timers is to be able to e.g. start and stop the genset automatically at specific times each weekday or certain weekdays. If auto mode is activated, this function is available in island operation, load takeover, mains power export and fixed power operation. Up to four command timers can be used for e.g. start and stop. The command timers are available in M-logic and can be used for other purposes than starting and stopping the genset automatically. Each command timer can be set for the following time periods:

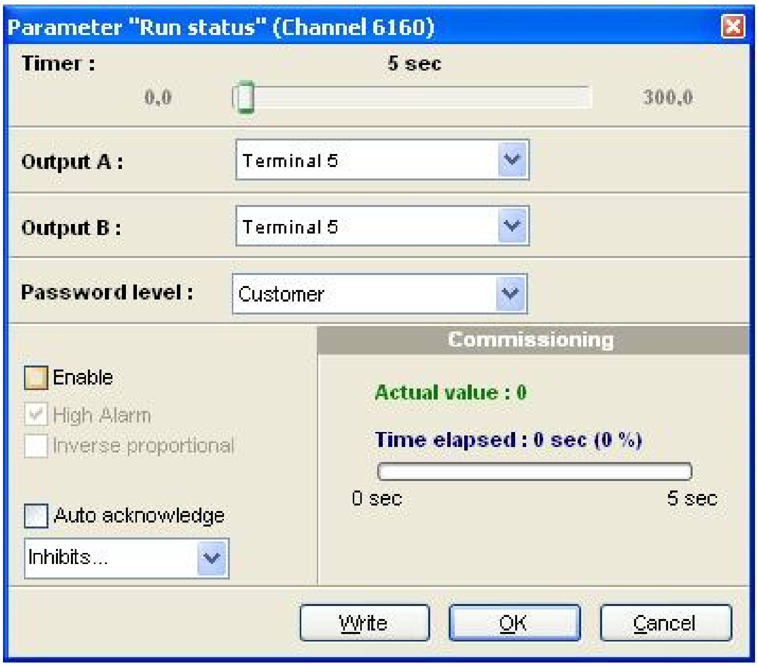
- Individual days (MO, TU, WE, TH, FR, SA, SU)
- MO, TU, WE, TH
- MO, TU, WE, TH, FR
- MO, TU, WE, TH, FR, SA, SU
- SA, SU

To start in AUTO mode, the "Auto start/stop" command can be programmed in M-Logic or in the input settings.

The time-dependent commands are flags that are raised when the command timer is in the active period.

7.9 Running output

Run status can be adjusted to give a digital output when the genset is running.



The timer sets how long time the running detection has to be present, before run status is achieved.
In the lines below it can be set which relays to be activated, when the run status is achieved.

The relay to be activated can be programmed in two different ways (from menu 5000). It can either be programmed to be a alarm relay NE/ND or a limit relay. If the relay has been programmed to be a alarm NE/ND the AGC will give an alarm each time run status has been reached and activate the relevant relay. If it has been programmed to limit relay instead, the programmed relay will just close and there will not be shown any alarm on the display. If it is only intended to activate a relay, the specific relay number will have to be set in both output A and B.

If the relay function is not changed to "limit" function, an alarm will appear at every running situation.

Be aware if this the timer for "run status" is changed, it also affects the "alarm inhibit" for "Not run status". This has been described earlier in this document.

The relevant parameters for the run status is shown below:

Parameter	Item	Range	Default	Note
6162	Run status delay timer. Timer start when running detection is reached.	0.0 s 300.0 s	5.0 s	Only in genset.
6163	Output A. Relay to activate when run status is reached.	Not used Option dependent	Not used	Only in genset.
6164	Output B. Relay to activate when run status is reached.	Not used Option dependent	Not used	Only in genset.
6165	Run status alarm activation.	OFF ON	OFF	Only in genset.

7.10 Derate function

The purpose of the derate function is to be able to reduce the maximum output power or/and reactive power of the genset if specific conditions require this. An example of such a condition is the ambient temperature. If the ambient temperature increases to a level where the cooling water coolers decrease in cooling capacity, it will be necessary to reduce the power of the genset. Another example could be if the temperature in the generator gets to high, it is needed to derate the reactive power. If the genset is not derated, alarms and shutdown events will very likely occur. Up to three power derate curves can be made and two reactive power derate curves can be made to derate the genset independently of each other. The first active curve will derate the genset to the adjusted set point.

The derate function is typically used when cooling problems are expected.

7.10.1 Input selection

The derate function can be configured to one of the following inputs:

<table>
<tr><th>Input</th><th>Comment</th></tr>
<tr><td>Multi-input 102 (slot #7)</td><td rowspan="3">0-40 V DC
4-20 mA
Pt100/1000
RMI
Digital</td></tr>
<tr><td>Multi-input 105 (slot #7)</td></tr>
<tr><td>Multi-input 108 (slot #7)</td></tr>
<tr><td>Analogue input (M15.X)</td><td>4-20 mA</td></tr>
<tr><td>Multi-input (M16.X)</td><td>0-5 V DC
4-20 mA
Pt100</td></tr>
<tr><td>EIC (H5/H13/H12)</td><td>Water temperature
Oil temperature
Ambient temperature
Intercooler temperature
Fuel temperature
Turbo temperature
Turbo pressure</td></tr>
<tr><td>M-Logic</td><td></td></tr>
<tr><td>External analogue input (H8/H12)</td><td></td></tr>
<tr><td>Alternator temperature.</td><td></td></tr>
</table>

Select the needed inputs in 6371, 6381 or 6391 for power derate, and 6401 or 6411 for reactive-power derate.

Refer to the type label for information about engine interface selection.

7.10.2 Power Derate parameters (P-derate)

The parameters that define the derate characteristics are the following:

Start derate point (6372, 6382 and 6392)

This is the setting where the derating must start. The setting is in units. So depending on the input, it can be 4-20 mA or Centigrades ºC (max. 200ºC).

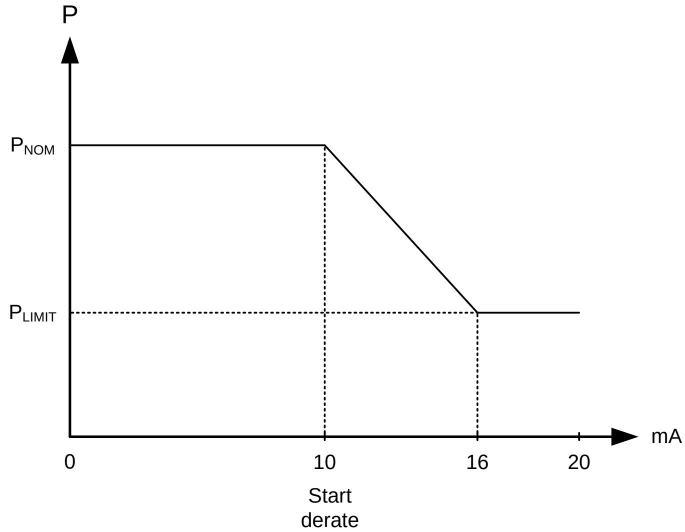
Derate slope (6373, 6383 and 6393)

Adjust the derating speed. The adjustment is in percent per unit. This means that if the 4-20 mA input is used, the derating will be in %/mA, and if the Pt100/Pt1000/RMI input is used, then the derating will be in %/C.

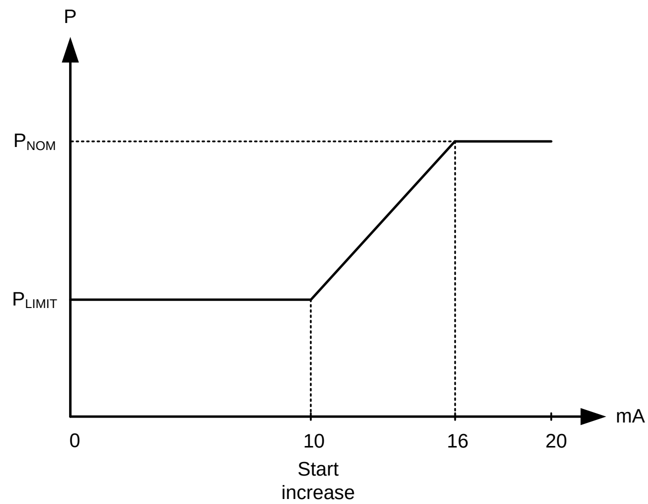
Be aware that the 4-20 mA input can be configured with different minimum and maximum settings. In this case, the settings "start derate point" and "slope" use these new settings.

Derate limit (6376, 6386 and 6396)

This is the lowest derate level. in percent.



It can be selected whether the characteristic of the derating should be proportional or inverse proportional.
The drawing above shows the inverse characteristic.
The proportional characteristic is illustrated below.



The genset is derated when the control value is lower than the set point (in the example above the control value is an mA signal).

The derate characteristic is selected in 6374, 6384 and 6394.

Setting OFF:	Inverse characteristic
Setting ON:	Proportional characteristic

Related parameters:

Parameter	Item	Range	Default	Notes
6371 6381 6391	Power derate input.	Multi-input 102 EIC Turbo 1 in press.	Multi-input 102	Only in DG.
6372 6382 6392	Start derate at this point.	0 20000 Units	16 Units	Only in DG.
6373 6383 6393	Derate slope.	0.1 %/Unit 100.0 %/Unit	5.0 %/Unit	Only in DG.
6374 6384 6394	Proportional controller.	On Off	Off	Only in DG.
6375 6385 6395	Enable power derate.	On Off	Off	Only in DG.
6376 6386 6396	Derate limit. Maximum allowed to derate to this point.	0.0 % 100.0 %	80.0 %	Only in DG.

7.10.3 Reactive power derate parameters (Q-derate)

The reactive power derate works by decreasing the exitation current and therefore decreasing the reactive power and lowering the apparent power. This makes the temperature decrease in the alternator, due to lower magnetic flux. Derating the reactive power is only possible until it reaches zero, or the power factor is 1. If the temperature in the alternator needs to be lowered further, the power derate function has to be used.

The reactive power derate function is using the capability curve, and therefore the option C2 is needed to achieve the Q-derate function.

The Reactive power derate function is using the capability curve, and therefore parameter 7054 must be set to Capability curve to achieve the Q-derate function.

The parameters that define the derate characteristics are the following:

Limiting the cos phi reference (7055)
Here you set how close you will go to the capability curve as part of limiting the cos phi reference scheme. This makes you able to stop before hitting the capability curve.

Start derate point (6402 and 6412)

This is the setting where the derating must start. The setting is in units. So depending on the input, it can be 4-20 mA or Centigrades ºC (max. 200ºC).

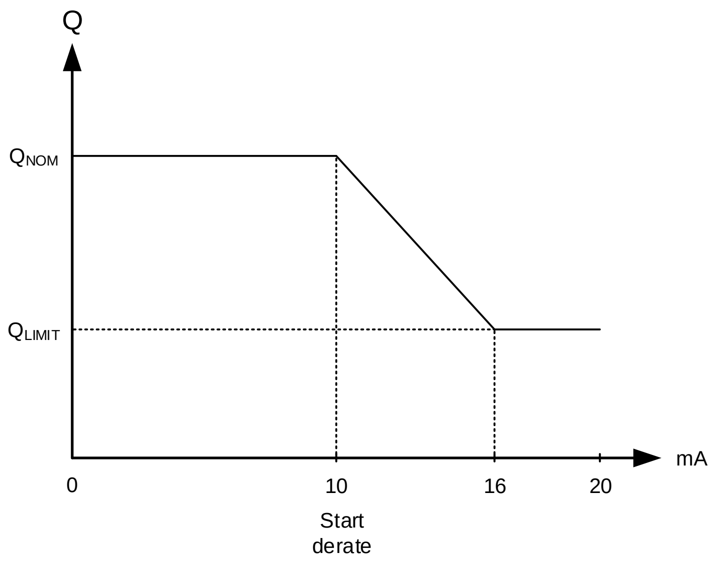
Slope (6403 and 6413)

Adjust the derating slope. The adjustment is in percent per unit, i.e. if the 4-20 mA input is used, then the derating will be in %/mA, and if the Pt100/Pt1000/RMI input is used, then the derating will be in %/C.

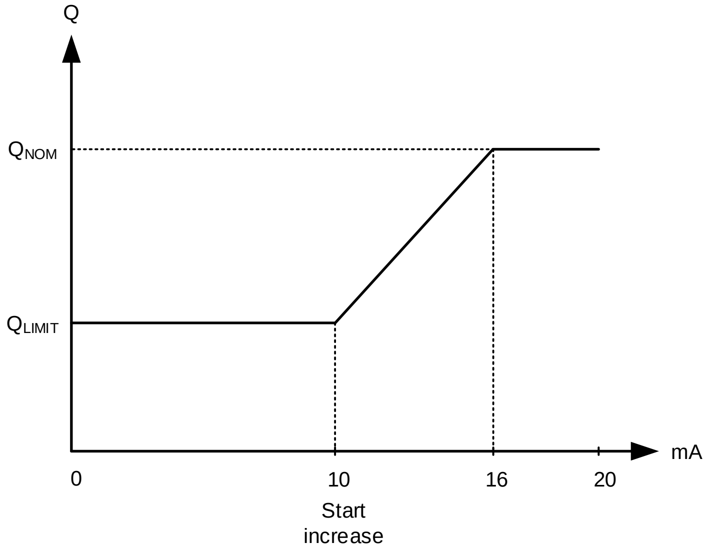
Be aware that the 4-20 mA input can be configured with different minimum and maximum settings. In this case, the settings "start derate point" and "slope" use these new settings.

Derate limit (6406 and 6416)

This is the lowest derate level, in percent.



It can be selected whether the characteristic of the derating should be proportional or inverse proportional.
The drawing above shows the inverse characteristic.
The proportional characteristic is illustrated below.



The genset is derated when the control value is lower than the set point (in the example above, the control value is an mA signal).

Derate Characteristics (6404 and 6414)

Setting OFF: Inverse characteristic
Setting ON: Proportional characteristic

Related parameters:

Parameter	Item	Range	Default	Notes
6401 6411	Reactive power derate input	Multi-input 102 EIC Turbo 1 in press.	Multi-input 102	Only in DG.
6402 6412	Start derate at this point	0 Units 20000 Units	16 Units	Only in DG.
6403 6413	Derate slope	0.1 %/Unit 100.0 %/Unit	5.0 %/Unit	Only in DG.
6404 6414	Proportional controller	On Off	Off	Only in DG.
6405 6415	Enable reactive power derate	On Off	Off	Only in DG.
6406 6416	Derate limit. Maximum allowed to de-rate to this point	0.0 % 100.0 %	80.0%	Only in DG.

7.11 Idle running

The purpose of the idle run function is to change the start and stop sequences to allow the genset to operate under low temperature conditions.

It is possible to use the idle run function with or without timers. Two timers are available. One timer is used in the start sequence, and one timer is used in the stop sequence.

The main purpose of the function is to prevent the genset from stopping. The timers are available to make the function flexible.

The speed governor must be prepared for the idle run function if this function is to be used.

The function is typically used in installations where the genset is exposed to low temperatures which could generate starting problems or damage the genset. It can also be used in some applications where the genset has to run at low RPM until a specific temperature is reached.

7.11.1 Description

The function is enabled and configured in 6290 Idle running. Note that the governor itself must handle the idle speed based on a digital signal from the unit (see the principle diagram below).

When the function is enabled, two digital inputs are used for control purposes:

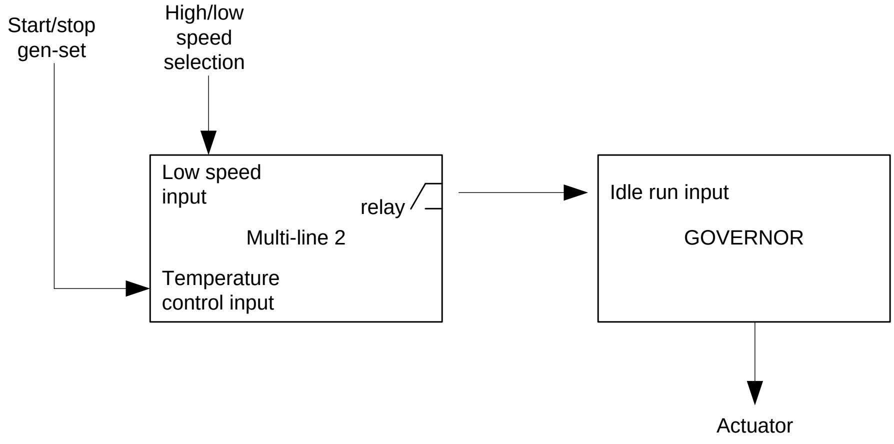
No.	Input	Description
1	Low speed input	This input is used to change between idle speed and nominal speed. This input does not prevent the genset from stopping - it is only a selection between idle and nominal speed.
2	Temperature control input	When this input is activated, the genset will start. It will not be able to stop as long as this input is activated.

If the idle run function is selected by means of timer, the low speed input is overruled.

The input must be configured through the PC software at commissioning.

One extra relay output must be available on the unit. Notice that this is option-dependent.

Turbo chargers not originally prepared for operating in the low speed area can be damaged if the genset is running in "idle run" for too long.



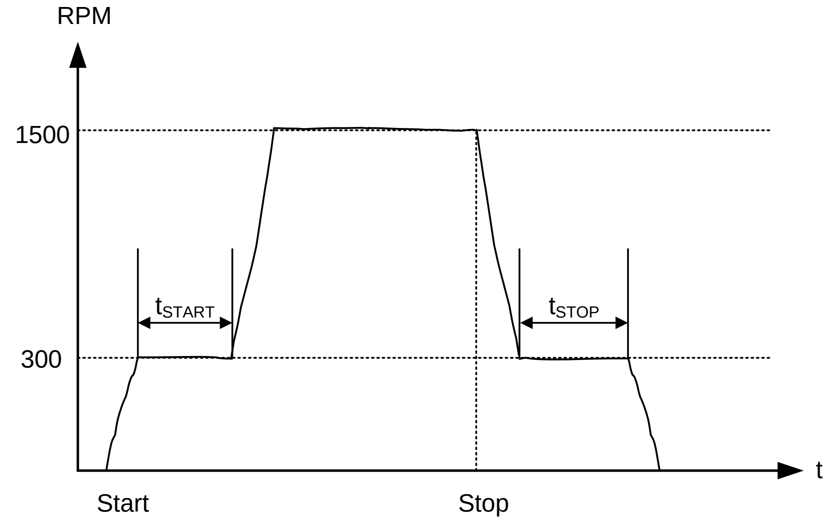
Related parameters:

Parame-ter	Item	Range	Default	Notes
6251	Idle start timer	0.0 min 999.0 min	300.0 min	Only in DG.
6252	Enable idle start timer	On Off	Off	Only in DG. When enabled, the genset will start up with idle timer.
6253	Idle stop timer	0.0 min 999.0 min	300.0 min	Only in DG.
6254	Enable idle stop timer	On Off	Off	Only in DG. When enabled, the genset will stop with idle timer.
6255	Output relay	Not used Option-dependent	Not used	Only in DG. Selects which relay should be used to activate idle on governor.
6256	Enable/allow idle running	On Off	Off	Only in DG. Must be enabled if it is intended to use any idle function.

7.11.2 Examples

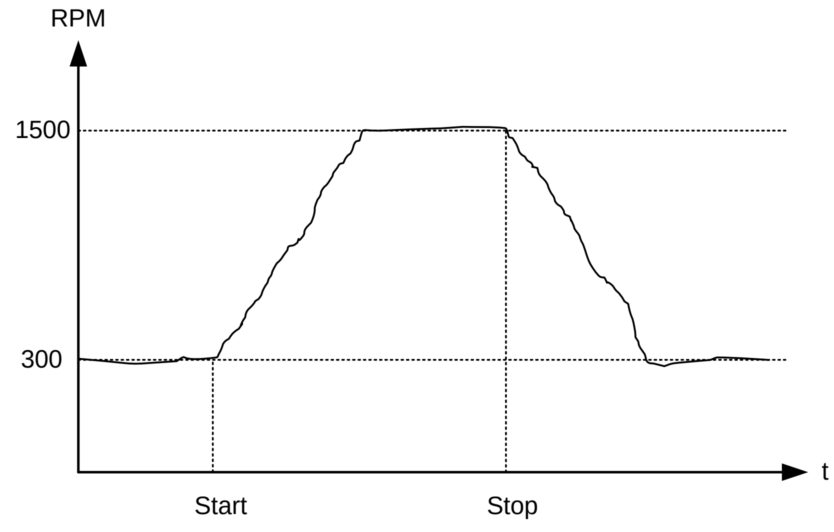
Idle speed during starting and stopping
In this example, both the start and the stop timers are activated.

The start and stop sequences are changed in order to let the genset stay at the idle level before speeding up. It also decreases the speed to the idle level for a specified delay time before stopping.



Idle speed with a digital input configured to low speed
In this example, both timers must be deactivated. The idle speed with low speed activated will run in idle speed until the low speed input is deactivated, and subsequently the genset will regulate to nominal values.

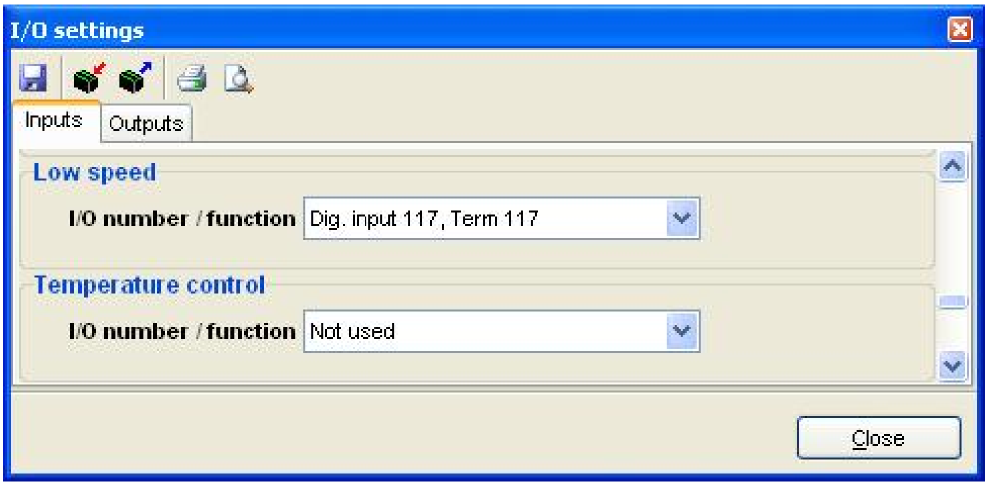
If the genset is to be prevented from stopping, then the digital input "temp control" must be left ON at all times. In that case the characteristic looks like this:



The oil pressure alarm (RMI oil) will be enabled during idle run if set to "ON".

7.11.3 Configuration of digital input

The digital input is configured via the PC software.

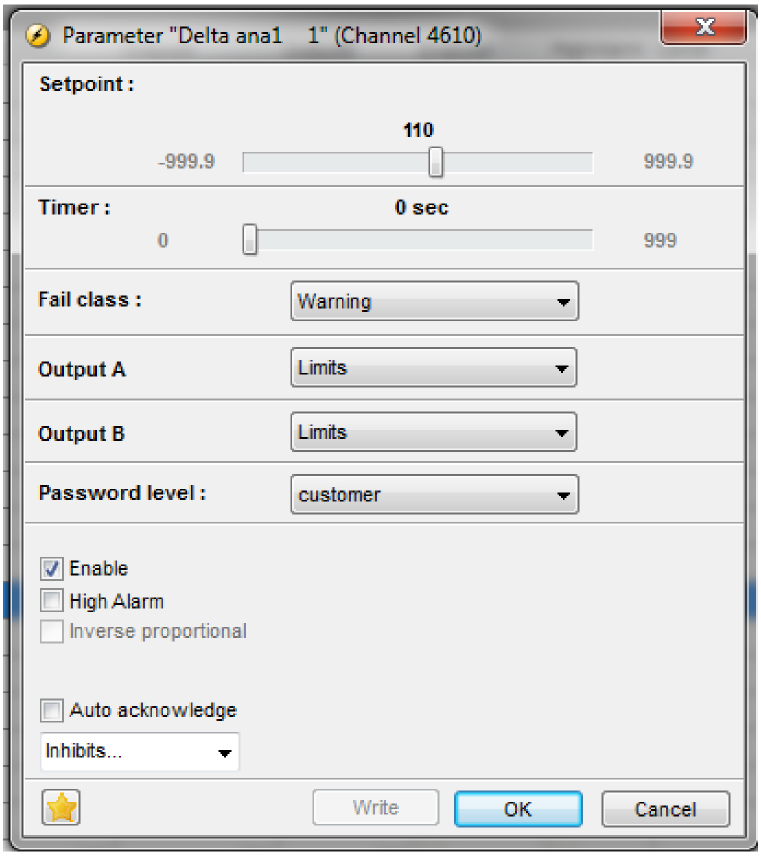


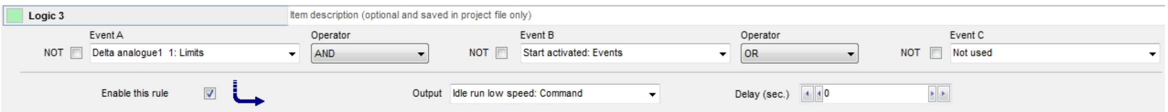
7.11.4 Temperature-dependent idle start-up

This is an example of how to set up a system that will start up in idle speed, if the coolant temperature is below a specified value. When the temperature exceeds the specified value, the genset will ramp up to nominal values.

Example

The function is made with delta analogue 1 (menus 4601, 4602 and 4610) and one M-Logic line. After starting, when the coolant temperature is below 110 degrees, the unit will idle. Once the temperature reaches 110 degrees, the unit will automatically ramp up to full speed. See the settings below.





In order for this function to work, **6295 Idle active** must be enabled, and the relay output must be configured. Otherwise, the low speed function will not work.

7.11.5 Inhibit

The alarms that are deactivated by the inhibit function are inhibited in the usual manner, except for the oil pressure alarms; RMI oil 102, 105 and 108 which are active during "idle run" as well.

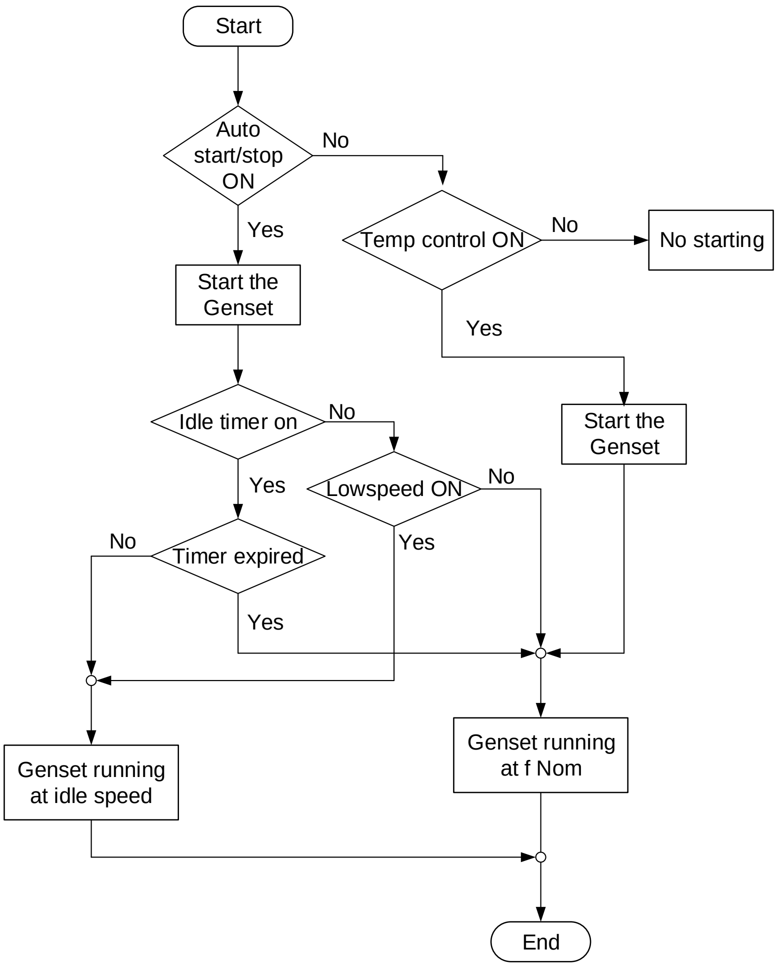
7.11.6 Running signal

The running feedback must be activated when the genset is running in idle mode.

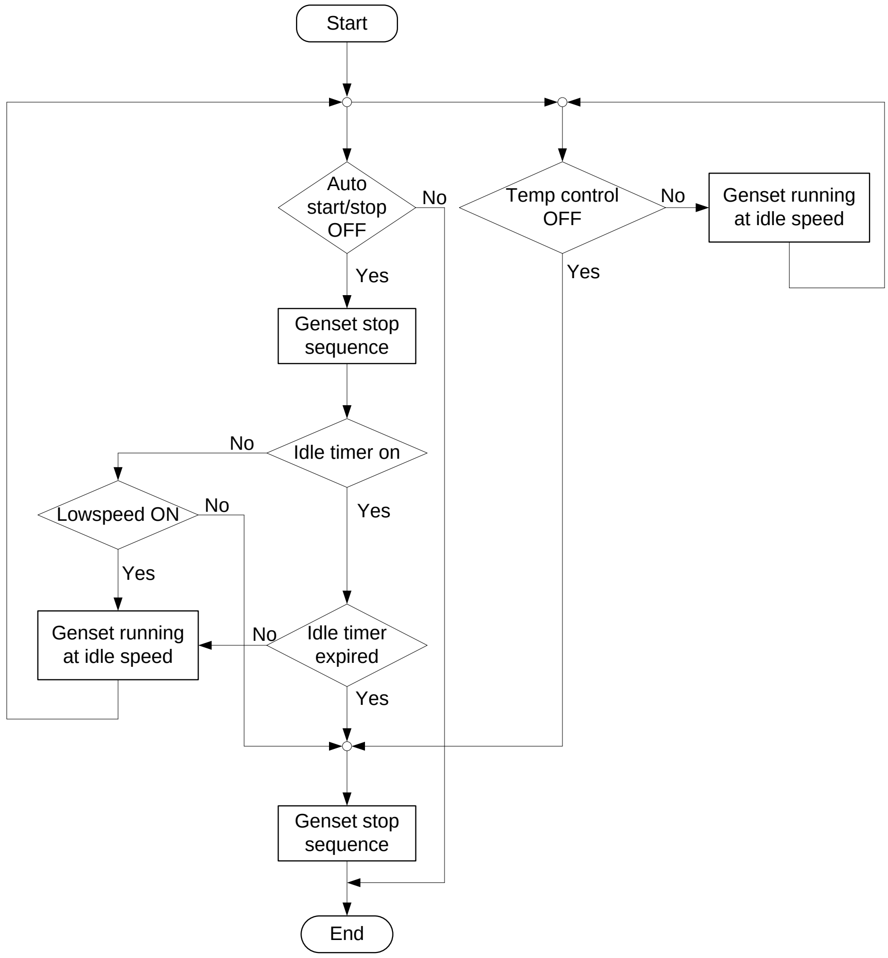
7.11.7 Idle speed flowcharts

The flowcharts illustrate the starting and stopping of the genset by use of the inputs "temp control" and "low speed".

7.11.8 Start


Start
Auto start/stop ON
No
Yes
Start the Genset
Temp control ON
No
No starting
Yes
Start the Genset
Idle timer on
No
Yes
Lowspeed ON
No
Yes
Timer expired
No
Yes
Genset running at idle speed
Genset running at f Nom
End

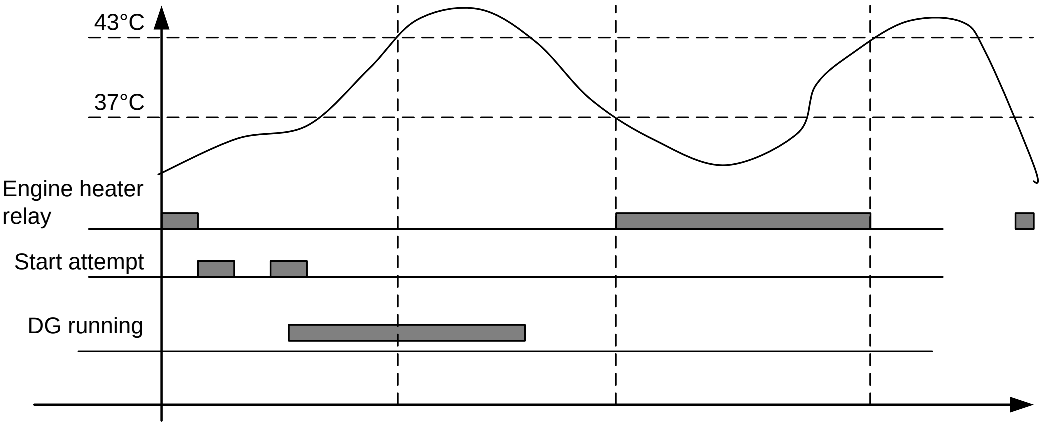
7.11.9 Stop



7.12 Standby heater function

This function is used to control the temperature of the engine, or the alternator. A sensor measuring a temperature is used to activate an external heating system with a relay, to keep the engine/alternator at a minimum temperature. This function is only active, when the genset is not running.

If one of the standby heaters have been configured as engine heater, the sequence will look like below:



The standby heater function is only active when the engine is stopped.

The AGC contains two standby heaters. Each of them is configured individually, which means that e.g. a engine heater and a alternator heater can be configured.

Each heater contains a setpoint, and a hysteresis. In the drawing above, the setpoint is 40 deg. C, and with a hysteresis of 3 deg. C. This means the AGC will open the "standby heater relay" when the engine has reached 43 deg. C, and close when the engine temperature is 37 deg. C.

For each standby heater an relay is chosen. This relay is the one that will close for each standby heater. If a slave relay of the chosen relay is wanted, this can be programmed in M-Logic.

It is possible from M-Logic to activate/deactivate the standby heaters individually. Here the commands called "Standby heater 1/2 manual control" is used. If the standby heater is active, and the "manual control" command has been activated, the standby heater relay will be opened. When the command has been activated again, the heater relay will close if the temperature is below setpoint.

7.12.1 Standby heater function

The setpoints for the standby heater function is placed at:

Parameter	Item	Range	Default	Notes
6261 6281	Standby heater setpoint	0 deg. C 20 deg. C	40 deg. C	Only in DG
6262 6282	Standby heater relay	Not used Option dependent	Not used	Only in DG
6263 6283	Standby heater input/measur-ing	Multi-input 102 Lowest alternator tempera-ture	Multi-input 102	Only in DG
6264 6284	Standby heater hysteresis	1 deg. C 70 deg. C	3 deg. C	Only in DG
6265 6285	Standby heater activation	Off On	Off	Only in DG

7.12.2 Standby heater heater alarm

Each standby heater also has an alarm. Each alarm has a temperature as setpoint, and a timer. If the temperature gets below the setpoint, and the relevant standby heater relay is closed, the timer will be started. If the timer expires and the temperature is below the setpoint, the "standby heater alarm" will be activated.
The alarm cannot be present either, if the genset is running.

Parameter	Item	Range	Default	Notes
6271 6291	Standby heater alarm setpoint	10 deg. C 250 deg. C	30 deg. C	Only in DG
6272 6292	Standby heater alarm timer/ delay	1.0 s 300.0 s	10.0 s	Only in DG
6273 6293	Standby heater alarm - Output A	Not used Option dependent	Not used	Only in DG
6274 6294	Standby heater alarm - Output A	Not used Option dependent	Not used	Only in DG
6275 6295	Standby heater alarm enable	Off On	Off	Only in DG. Alarm can only be active when correspond-ing "standby heater" relay is closed.
6276 6296	Standby heater alarm - Fail-class	Warning Block	Warning	Only in DG

7.13 Not in auto

This function can be used for indication or to raise an alarm in case the system is not in Auto. The function is set up in menu 6540.

Related parameters to the "Not in Auto" alarm is shown in the table below:

Parameter	Item	Range	Default	Notes
6541	Timer for how long time "Not in Auto" before alarm is active	10.0 s 900.0 s	300.0 s	
6542	Not in Auto alarm - Output A	Not used Option dependent	Not used	
6543	Not in Auto alarm - Output B	Not used Option dependent	Not used	
6544	Enable Not in auto - alarm	On Off	Off	
6545	Fail class for Not in auto - alarm	Warning Block	Warning	

7.14 Fail class

7.14.1 Fail class

All activated alarms must be configured with a fail class. The fail classes define the category of the alarms and the subsequent alarm action.

Up to nine different fail classes can be used. The tables below illustrate the action of each fail class when the engine is running or stopped.

7.14.2 Fail classes in genset controller

Fail class	Action	Alarm horn relay	Alarm display	De-load	Trip of generator breaker	Trip of mains breaker	Cooling down genset	Stop genset
Block		X	X					
Warning		X	X					
Trip GB		X	X		X			
Trip + stop		X	X		X		X	X
Shutdown		X	X		X			X
Trip MB		X	X			X		
Safety stop		X	X	(X)			X	X
Trip MB/GB		X	X		(X)	X		
Controlled stop		X	X	X	X		X	X

The table illustrates the action of the fail classes. If, for example, an alarm has been configured with the “shutdown” fail class, the following actions occur:

- The alarm horn relay activates
- The alarm is displayed in the alarm info screen
- The generator breaker opens instantly

- The genset is stopped instantly
- The genset cannot be started from the unit (see next table)

The “safety stop” fail class only de-loads the genset if it is possible. This means that an extra genset can start up and replace the faulty one, or the others have spinning reserve enough to stop the faulty genset. In stand-alone applications only, the safety stop does nothing in “load take over”, “island” and “AMF”.

The “Trip MB/GB” only trips the generator breaker if the genset controller does control a mains breaker. This means that a genset controller can only trip a mains breaker in a “stand-alone” application that contains a mains breaker. Otherwise, the fail class always trips the generator breaker.

The fail classes can have different impacts on the system. When the engine is stopped, the fail classes do as follows:

Fail class	Action	Block engine start	Block MB sequence	Block GB sequence
Block		X		X
Warning				
Trip GB		X		X
Trip + stop		X		X
Shutdown		X		X
Trip MB			X	
Safety stop		X		X
Trip MB/GB		(X)	X	(X)
Controlled stop		X		X

The fail class “trip MB/GB” does not block start and block GB sequence if the genset controller is in a “stand-alone” application, in which there is a mains breaker.

7.14.3 Fail class in mains controller

Fail class	Action	Alarm horn relay	Alarm display	Trip of mains breaker	Trip of tie breaker
Block		X	X		
Warning		X	X		
Trip TB		X	X		X
Trip MB		X	X	X	
Trip MB/TB		X	X	X	(X)

The “trip MB/TB” only trips the tie breaker if the mains controller is in an application, in which there is no mains breaker. So the fail class does NOT trip both the MB and the TB. If there is a mains breaker configured in the application configuration, the mains controller always only trips the MB if the “trip MB/TB” fail class is used.

The fail classes have different impacts on the system. If a breaker is in open position, the alarms have the following impact:

Fail class	Action	Block MB sequence	Block TB sequence
Block			X
Warning			
Trip TB			X
Trip MB		X	
Trip MB/TB		X	(X)

The “trip MB/TB” only blocks the TB sequence if there is no mains breaker for the present controller.

7.14.4 Fail classes in plant controller

Fail class	Action	Alarm horn relay	Alarm display	Trip of mains breaker
Block		X	X	
Warning		X	X	
Trip MB		X	X	X

The fail classes have different impacts on the system. If the breaker is in open position, the alarms have the following impact:

Fail class	Action	Block MB sequence
Block		
Warning		
Trip MB		X

7.14.5 Fail classes in group controller

Fail class	Action	Alarm horn relay	Alarm display	Trip of tie breaker
Block		X	X	
Warning		X	X	
Trip TB		X	X	X

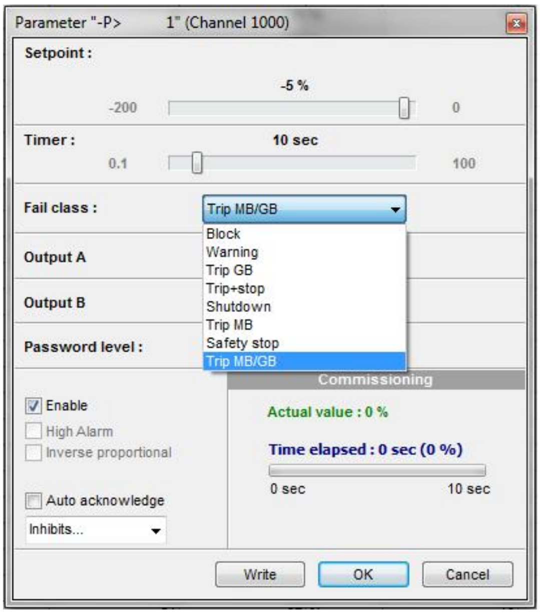
The fail classes have different impacts on the system. If the breaker is in open position, the alarms have the following impact:

Fail class	Action	Block TB sequence
Block		X
Warning		
Trip MB		X

7.14.6 Fail class configuration

The fail class can be selected for each alarm function either via the display or the PC software.

To change the fail class via the PC software, the alarm function to be configured must be selected. Select the desired fail class in the fail class drop-down list.



7.15 Service timers

The unit is able to monitor the maintenance intervals. Two service timers are available to cover different intervals. The service timers are set up in menus 6110 and 6120.

The function is based on running hours. When the adjusted time expires, the unit will display an alarm. The running hours is counting when the running feedback is present.

The AGC will also remember when the last "reset" on each service timer have been made. By this, the AGC will be looking at both the running hours and days since last service. Each service timer works independently on each other.
The AGC will give an alarm with the service timer when either the running hours or days have expired.

The parameters used for service timer 1 and 2 are shown below:

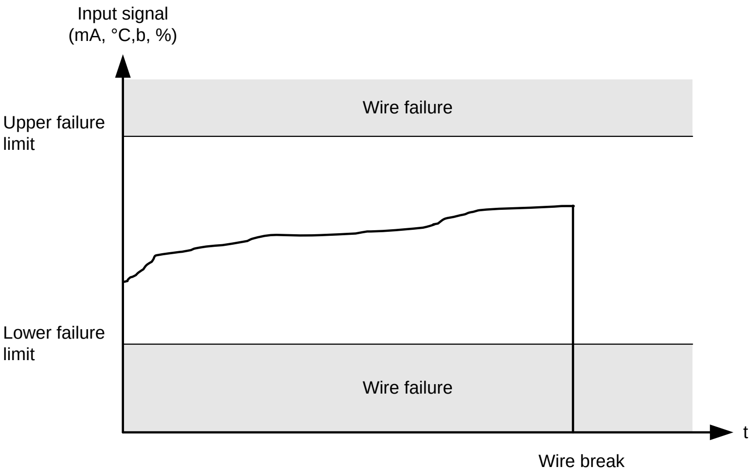
Parameter	Item	Range	Default	Notes
6111 6121	Enable the service timer	On Off	On	Only in DG.
6112 6122	Running hours before alarm	0 hours 9000 hours	500 hours	Only in DG.
6113 6123	Day before alarm	1 day 1000 days	365 days	Only in DG. If it is the "Days" the activates the alarm, it will be activated at 8:00 AM, on the day the "Days" expires.
6114 6124	Fail class when service alarm is active	Warning Block.	Warning	Only in DG.
6115 6125	Output relay	Not used Option dependent	Not used	Only in DG.
6116 6126	Reset the service timer	On Off	Off	Only in DG. Enabling this will reset the service timer to zero. This must be done when the alarm is activated, to make the alarm disappear. When set to ON, the parameter will automatically change to OFF again.

7.16 Wire fail detection

If it is necessary to supervise the sensors/wires connected to the multi-inputs and analogue inputs. Then it is possible to enable the wire break function for each input. If the measured value on the input is outside the normal dynamic area of the input, it will be detected as if the wire has made a short circuit or a break. An alarm with a configurable fail class will be activated.

Input	Wire failure area	Normal range	Wire failure area
4-20 mA	< 3 mA	4-20 mA	> 21 mA
0-40 V DC	≤ 0 V DC	-	N/A
RMI Oil, type 1	< 1.0 ohm	-	> 195.0 ohm
RMI Oil, type 2	< 1.0 ohm	-	> 195.0 ohm
RMI Temp, type 1	< 4.0 ohm	-	> 488.0 ohm
RMI Temp, type 2	< 4.0 ohm	-	> 488.0 ohm
RMI Temp, type 3	< 0.6 ohm	-	> 97.0 ohm
RMI Fuel, type 1	< 0.6 ohm	-	> 97.0 ohm
RMI Fuel, type 2	< 1.0 ohm	-	> 195.0 ohm
RMI configurable	< lowest resistance	-	> highest resistance
Pt100	< 82.3 ohm	-	> 194.1 ohm
Pt1000	< 823 ohm	-	> 1941 ohm
Level switch	Only active if the switch is open		

Principle
The illustration below shows that when the wire of the input breaks, the measured value will drop to zero. Then the alarm will occur.



MPU wire break (menu 4550)
The MPU wire break function is only active when the genset is not running. In this case, an alarm will be raised if the wire connection between the AGC and MPU breaks. The MPU wire alarm comes, when there is more than 400k Ohm.

Stop coil wire break (menu 6240)
The alarm will occur when the stop coil is not activated (generator is running) and the input is deenergised.

The parameters for the MPU and stop coil wire break alarms are shown in the table below:

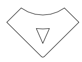
Parameter	Item	Range	Default	Notes
4551 6271	Wire break alarm - output A	Not used Option dependent	Not used	Only in DG
4552 6272	Wire break alarm - output B	Not used Option dependent	Not used	Only in DG
4553 6273	Enable wire fail detection	On Off	Off	Only in DG
4554 6274	Wire fail detection alarm - fail class	Warning Block.	Warning	Only in DG

To each analogue input there "wire break alarm". All of these alarms are located at menu 4xxx. Only one of the wire break alarms parameters will be shown below, since there are several of them:

Parameter	Item	Range	Default	Notes
4241	Wire break alarm for input 102 - output A	Not used Option dependent	Not used	
4242	Wire break alarm for input 102 - output B	Not used Option dependent	Not used	
4243	Enable wire fail detection for input 102	On Off	Off	
4244	Wire fail detection alarm - input 102 - fail class	Warning Block.	Warning	

Above is only shown the parameters for "wire break alarm" for input 102. All the other analogue inputs also have wire break alarms, which is found at menu 4xxx.

7.17 Manual governor and AVR control

The manual governor and AVR control function can be activated by pressing  for more than two seconds, or by activating the digital inputs or AOP buttons for governor or AVR control in semi-auto mode and manuel mode. The intention of this function is to give the commissioning engineer a helpful tool for adjustment of the regulation.

When using the display arrows for increasing or decreasing, the output will change as long as the button is active. For the digital input and AOP buttons, there is a timer so that it is possible to choose how long one pulse should be; the timer can be set to 0.1-10 sec. For the governor, the timer parameter is 2782 and for AVR, it is 2784. If for example the timer is set to 5 sec., then one press on the AOP or one pulse from digital input will give 5 sec. increase or decrease of the output.

The manual steps can also be given from digital inputs, and configured via the "I/O list" from the Utility Software. When these inputs are used, the step will be as long as the inputs is high.

The function of the regulation window depends on the selected mode:

G 0	0	0V
P-Q Setp	100 %	100 %
P-Q Reg.	50 %	60 %
	GOV	AVR

The parameters for the manual step time, when the steps is given via M-Logic are shown in the table below:

Parameter	Item	Range	Default	Notes
2782	Manual steptime for Governor	0.1 s 10.0 s	5.0 s	Only in DG. Only used when manual steps is given via M-Logic.
2784	Manual steptime for AVR	0.1 s 10.0 s	5.0 s	Only in DG. Only used when manual steps is given via M-Logic.

7.17.1 Manual mode

In manual mode, the regulation is deactivated. When activating the up or down arrows, the output value to GOV or AVR is changed, this is the Reg. value in the display. The up and down arrows have the same function as the digital inputs or AOP buttons for governor and AVR control when the window is open. To exit the regulation window press "back".

7.17.2 Semi-auto mode

As in manual mode, the up and down arrows have the same function as the digital inputs or AOP buttons for governor or AVR control when the window is open.

The value Setp can be changed by pressing the arrow up or down. When GOV is underlined, the governor set point will be changed, and vice versa when the AVR is underlined. When changing the Setp value, an offset will be added to or subtracted from the nominal value. The Reg. value is the output value from the regulator. If the genset is running in parallel, the active or reactive nominal power set point value will be changed. If it is a stand-alone genset not parallel to the mains, the nominal frequency or voltage set point will be changed and also displayed. When the "back" button is activated, the regulation set point returns to nominal.

If the digital inputs or AOP buttons are activated in semi-auto, the regulation window is automatically opened.

7.17.3 Auto and test mode

Works as semi-auto, except from the fact that activating the digital inputs or AOP buttons for governor or AVR control will change the regulation set point but not open the regulation window. When the digital inputs or AOP buttons are deactivated, the regulation set point returns to nominal.

Regarding AOP setup, please refer to "Help" in the PC utility software.

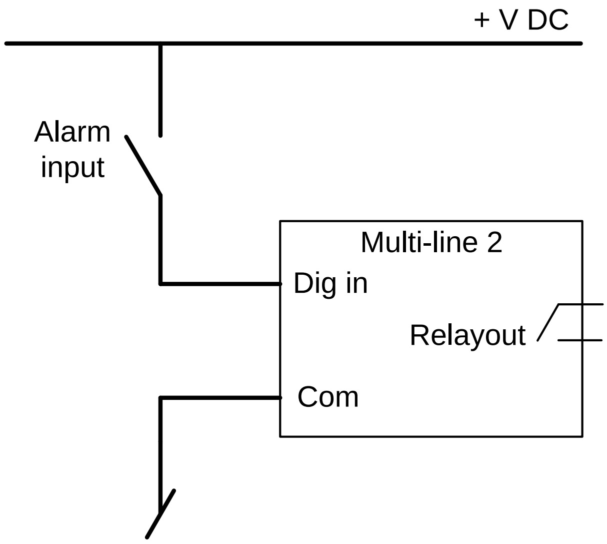
7.18 Input function selection

Digital input alarms can be configured with a possibility to select when the alarms are to be activated. The possible selections of the input function are normally open or normally closed.

The drawing below illustrates a digital input used as an alarm input.

1. Digital input alarm configured to NC, normally closed
   This will initiate an alarm when the signal on the digital input disappears.
2. Digital input alarm configured to NO, normally open
   This will initiate an alarm when the signal on the digital input appears.

The relay output function can be selected to be ND (Normally Deenergised), NE (Normally Energised), Limit or Horn.



7.19 Language selection

The unit has the possibility to display different languages. It is delivered with one master language which is English. This is the default language, and it cannot be changed. In addition to the master language 4 different languages can be configured. This is done via the PC utility software.

The languages are selected in the system setup **menu 6080**. The language can be changed when connected to the PC utility software. It is not possible to make language configuration from the display, but the already configured languages can be selected.

Parameter	Item	Range	Default	Notes
6080	Language selection	English Language 4	English	Languages only editable from the Utility Software

7.20 Texts in status line

The status texts must be self-explanatory. If the operator does something wrong, then the status line must indicate it. The table below indicates the texts in the status line.

7.20.1 Standard texts

Status text	Condition	Comment
BLOCK	Block mode is activated	
SIMPLE TEST	Test mode is activated	
LOAD TEST		
FULL TEST		
SIMPLE TEST ###.#min	Test mode activated and test timer counting down	
LOAD TEST ###.#min		
FULL TEST ###.#min		
ISLAND MAN	Genset stopped or running and no other action taking place	
ISLAND SEMI		
READY ISLAND AUTO	Genset stopped in Auto	
ISLAND ACTIVE	Genset running in Auto	
AMF MAN	Genset stopped or running and no other action taking place	
AMF SEMI		
READY AMF AUTO	Genset stopped in Auto	
AMF ACTIVE	Genset running in Auto	
FIXED POWER MAN	Genset stopped or running and no other action taking place	
FIXED POWER SEMI		
READY FIXED P AUTO	Genset stopped in Auto	
FIXED POWER ACTIVE	Genset running in Auto	
PEAK SHAVING MAN	Genset stopped or running and no other action taking place	
PEAK SHAVING SEMI		
READY PEAK SHAV AUTO	Genset stopped in Auto	
PEAK SHAVING ACTIVE	Genset running in Auto	
LOAD TAKEOVER MAN	Genset stopped or running and no other action taking place	
LOAD TAKEOVER SEMI		
READY LTO AUTO	Genset stopped in Auto	
LTO ACTIVE	Genset running in Auto	
MAINS P EXPORT MAN	Genset stopped or running and no other action taking place	
MAINS P EXPORT SEMI		
READY MPE AUTO	Genset stopped in Auto	
MPE ACTIVE	Genset running in Mains power export mode	
DRY ALTERNATOR MAN	Genset stopped or running and no other action taking place	Requires DVC310
DRY ALTERNATOR SEMI		Requires DVC310
READY DRY ALT AUTO	Genset stopped in Auto	Requires DVC310
DRYING ALTERNATOR	Genset running in Auto	Requires DVC310

Status text	Condition	Comment
VERIFYING SC REMOVED	GB is closed the first time after alternator drying	Requires DVC310
VENTILATION MAN	Genset stopped or running and no other action taking place	Requires DVC310
VENTILATION SEMI		Requires DVC310
READY VENTILATION	Genset stopped in Auto	Requires DVC310
VENTILATION ACTIVE	Genset running in Auto	Requires DVC310
DG BLOCKED FOR START	Generator stopped and active alarm(s) on the generator	
GB ON BLOCKED	Generator running, GB open and an active "Trip GB" alarm	
ACCESS LOCK	The configurable input is activated, and the operator tries to activate one of the blocked keys	
GB TRIP EXTERNALLY	Some external equipment has tripped the breaker	An external trip is logged in the event log
MB TRIP EXTERNALLY	Some external equipment has tripped the breaker	An external trip is logged in the event log
IDLE RUN	The "Idle run" function is active. The genset will not stop until a timer has expired	
IDLE RUN ###.#min	The timer in the "Idle run"' function is active	
COMPENSATION FREQ.	Compensation is active	The frequency is not at the nominal setting
Aux. test ##.#V ####s	Battery test activated	
DELOAD	Decreasing the load of the genset in order to open the breaker	
START DG(s) IN ###s	The start genset set point is exceeded	
STOP DG(s) IN ###s	The stop genset set point is exceeded	
START PREPARE	The start prepare relay is activated	
START RELAY ON	The start relay is activated	
START RELAY OFF	The start relay is deactivated during the start sequence	
MAINS FAILURE	Mains failure and mains failure timer expired	
MAINS FAILURE IN ###s	Frequency or voltage measurement is outside the limits	The timer shown is the mains failure delay.Text in mains units
MAINS U OK DEL ####s	Mains voltage is OK after a mains failure	The timer shown is the mains OK delay

Status text	Condition	Comment
MAINS f OK DEL ####s	Mains frequency is OK after a mains failure	The timer shown is the mains OK delay
Hz/V OK IN ###s	The voltage and frequency on the genset is OK	When the timer runs out, it is allowed to operate the generator breaker
COOLING DOWN ###s	Cooling down period is activated	
COOLING DOWN	Cooling down period is activated and infinite	Cooling down timer is set to 0.0 s
GENSET STOPPING	This info is shown when cooling down has finished	
EXT. STOP TIME ###s		
PROGRAMMING LANGUAGE	This info is shown if the language file is downloaded from the PC utility software	
TOO SLOW 00<-------------	Generator running too slow during synchronising	
-----------> 00 TOO FAST	Generator running too fast during synchronising	
EXT. START ORDER	A planned AMF sequence is activated	There is no failure on the mains during this sequence
MOUNT CAN CONNECTOR	Connect the power management CAN line	
ADAPT IN PROGRESS	The AGC is receiving the application that it has just been connected to	
SETUP IN PROGRESS	The new AGC is being added to the existing application	
SETUP COMPLETED	Successful update of the application in all AGC units	
RAMP TO #####kW	The power ramp is ramping in steps, and the next step that will be reached after the timer has expired will be displayed	
DERATED TO #####kW	Displays the ramp down set point	
PREPARING ETHERNET	Preparing Ethernet connection	
PREPARING ENGINE IF	Preparing engine IF	
PROGRAMMING MLOGIC	Downloading M-Logic to the unit	
UNEXPECTED GB ON BB	Another generator breaker is closed on to the busbar (due to a GB position failure) while no voltage is present on the busbar	This indicates that other breakers cannot close to the busbar because of position failure on one or more GBs.

Status text	Condition	Comment
SELECT GENSET MODE	Genset is in "Power Management", but there is not any communication to a mains unit and the application configuration contains a Mains.	
FILL DAY TANK REQUEST	Genset is requesting fuel but dedicated fuel relay is not closed yet due to maximum allowed no. filling at a time	
FILLING DAY TANK	Genset is filling its own day tank	
FILLING DAY TANKS	Group is getting filled its day tanks	

7.20.2 Texts only related to power management system

Status text	Condition	Comment
DG unit		
BLACKOUT ENABLE	This info is shown if a CAN failure is present in a power management application.	
SYNCHRONISING TB XX	TB XX is synchronising.	
SYNCHRONISING MB XX	MB XX is synchronising.	
Mains unit		
TB TRIP EXTERNALLY	Some external equipment has tripped the breaker.	An external trip is logged in the event log.
All units		
BROADCASTING APPL. #	Broadcast an application through the CAN line.	Broadcasts one of the four applications from one unit to the rest of the AGCs in the power management system.
RECEIVING APPL. #	AGC receiving an application.	
BROADCAST COMPLETED	Successful broadcast of an application.	
RECEIVE COMPLETED	Application received successfully.	
BROADCAST ABORTED	Broadcast terminated.	
RECEIVE ERROR	Application is not received correctly.	

7.21 Internal battery

7.21.1 Memory backup

When changing the internal battery for the memory, all settings will be lost. The memory backup feature gives the possibility to back up the controller settings, and after replacing the battery the settings can be restored.

DEIF recommends that a backup is made at least when the commissioning is tested and done. The following settings will be stored in the backup:

Type	Stored
Identifiers	X
Counters	X
Views configuration	X
Inputs configuration	X
Outputs configuration	X
Translations	
M-Logic configuration	X
AOP-1 configuration	X
AOP-2 configuration	X
Application configuration	X
Parameters	X
Modbus configuration	X
Permissions	X
Logs	

If new firmware is flashed to the controller, the backup will be erased, and replaced with a new with default settings.

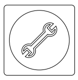
The controller will reboot after a backup has been restored.

The backup is found in parameter **9230 Memory backup** with the jump menu. In this parameter you are able to backup or restore.

Internal battery alarm
If the internal battery is dismounted during operation, a failure will appear on the display.

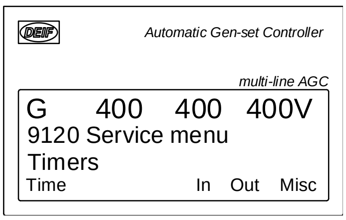
7.22 Service menu

The purpose of the service menu is to give information about the present operating condition of the genset.

The service menu is entered using the  button **(9120 Service menu).**

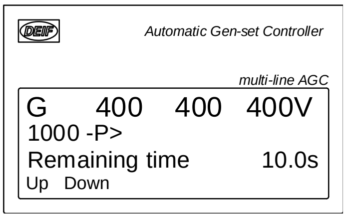
Use the service menu for easy troubleshooting in connection with the event log.

Entry window
The entry shows the possible selections in the service menu.

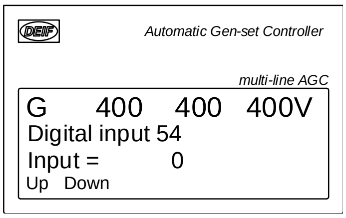


Available selections:

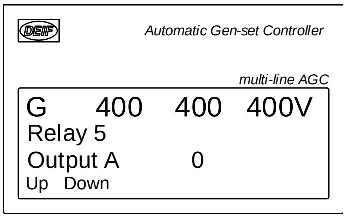
Time
Shows the alarm timer and the remaining time. The indicated remaining time is minimum remaining time. The timer will count downwards when the set point has been exceeded.



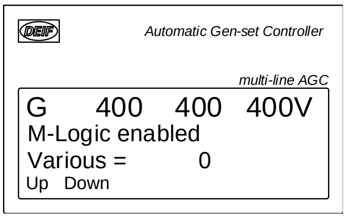
IN (digital input)
Shows the status of the digital inputs.



OUT (digital output)
Shows the status of the digital outputs.



MISC (miscellaneous)
Shows miscellaneous messages.



7.23 Logs

7.23.1 Logs

The logging of data is divided in three different groups:

- Event log containing 500 loggings.
- Alarm log containing 500 loggings.
- Battery test log containing 52 loggings.

There are 500 event and alarm logs in application 4.40.x or later, and in USW 3.36 or later. If older SW is used, it is only 150 event and 30 alarm logs.

The logs can be viewed in the display or in the PC utility software. When the individual logs are full, each new event will overwrite the oldest event following the "first in - first out" principle.

7.23.2 Display

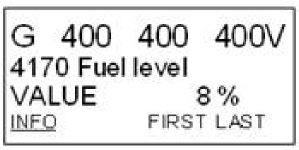
In the display it looks like this when the "LOG" push-button is pressed:

Now it is possible to select one of the three logs.

If the "Event" is selected, the log could look like this:

The specific alarm or event is shown in the second line. In the example above the fuel level alarm has occur-red. The third line shows the time stamp.

If the cursor is moved to "INFO", the actual value can be read when pressing "SEL":



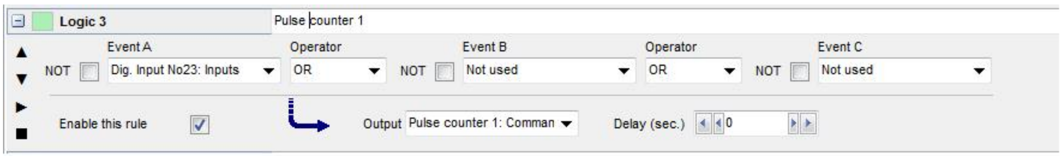
The first event in the list will be displayed if the cursor is placed below "FIRST" and "SEL" is pressed.

The last event in the list will be displayed if the cursor is placed below "LAST" and "SEL" is pressed.

The keyUP and keyDOWN push-buttons are used for navigating in the list.

7.24 Pulse input counters

Two configurable digital inputs can be used for counter input. The two counters can be used for for instance fuel consumption or heat flow. The two digital inputs can ONLY be configured for pulse inputs via M-Logic, as shown in the example below.



Scaling of pulse input can be set in menu 6852/6862. It is possible to determine the scale value to be pulse/unit or unit/pulse.

Counter values can be read out in display, and the number of decimals can be adjusted in menu 6853/6863.

Parameter	Item	Range	Default	Notes
6851/6861	Value	0 to 1000	1	Set point for the value to be coun-ted.
6852/6862	Unit	Unit/pulse or Pulse/unit	Unit/pulse	Select which scaling value.
6853/6863	Decimal	No decimals, One deci-mals, Two decimalls, Three decimals	No deci-mals	Select how many decimals there are on the value.
6854/6864	Enable Counter	On, Off	Off	Select if you want to enable the counter function.

7.25 kWh/kvarh counters

The controller has two transistor outputs, each representing a value for the power production. The outputs are pulse outputs, and the pulse length for each of the activations is 1 second.

Term. number	Output
20	kWh
21	kvarh
22	Common terminal

The number of pulses depends on the actual adjusted setting of the nominal power:

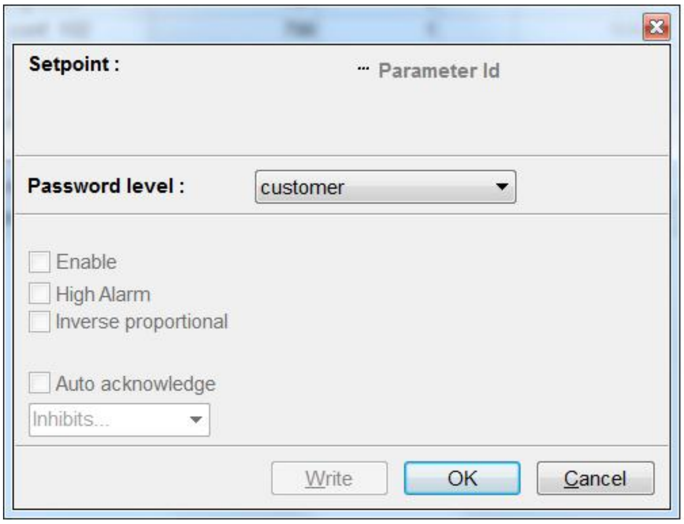
Generator power	Value	Number of pulses (kWh)	Number of pulses (kVArh)
P_{NOM}	<100 kW	1 pulse/kWh	1 pulse/kvarh
P_{NOM}	100-1000 kW	1 pulse/10 kWh	1 pulse/10 kvarh
P_{NOM}	>1000 kW	1 pulse/100 kWh	1 pulse/100 kvarh

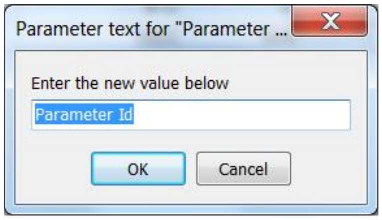
The kWh measurement is shown in the display as well, but the kvarh measurement is only available through the transistor output.

Be careful - the maximum burden for the transistor outputs is 10 mA.

7.26 Parameter ID

This parameter can be used to identify which parameter file is used in the unit. **(11200 Parameter ID)**





7.27 M-Logic

The M-Logic functionality is included in the unit and is not an option-dependent function; however, selecting additional options, such as option M12 which offers additional digital inputs and outputs, can increase the functionality.

M-Logic is used to execute different commands at predefined conditions. M-Logic is not a PLC but substitutes one, if only very simple commands are needed.

M-Logic is a simple tool based on logic events. One or more input conditions are defined, and at the activation of those inputs, the defined output will occur. A great variety of inputs can be selected, such as digital inputs, alarm conditions and running conditions. A variety of the outputs can also be selected, such as relay outputs, change of genset modes and change of running modes.

The M-Logic is part of the PC utility software, and as such, it can only be configured in the PC utility software and not via the display.

The main purpose of M-Logic is to give the operator/designer more flexible possibilities of operating the generator control system.

Please refer to the "Help" function in the PC utility software for a full description of this configuration tool.

7.28 Step-up and step-down transformer

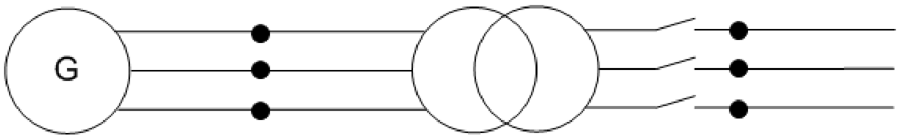
7.28.1 Step-up transformer

In certain cases, the use of a generator with step-up transformer (called a block) is required. This may be to adapt to the closest grid voltage or to step up the voltage to minimise the losses in cables and also to bring down the cable size. The applications that need a step-up transformer are supported by the ML-2. The functions available in this application are:

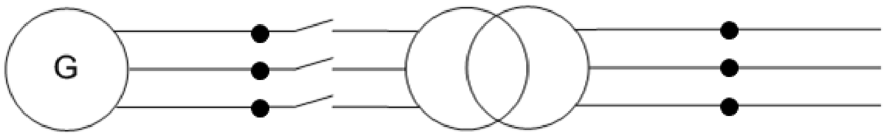
1. Synchronising with or without phase angle compensation
2. Voltage measurement displayed
3. Generator protections
4. Busbar protections

A diagram of a block is shown below.

Generator/transformer block:



Typically, the synchronising breaker is on the high voltage (HV) side, and there is no breaker (or only a manually operated one) on the low voltage (LV) side. In some applications, the breaker could also be placed on the LV side. But this does not influence the setting in the ML-2, as long as the breaker and the step-up transformer are both placed between the measuring points for the ML-2. The measuring points are shown as black dots in the figures above and below.



The phase angle compensation would not be an issue if there was no phase angle shift across the step-up transformer, but in many cases there is. In Europe, the phase angle shift is described using the vector group description. Instead of vector group, this could also be called clock notation or phase shift.

When voltage measurement transformers are used, these must be included in the total phase angle compensation.

When an ML-2 product is used for synchronising, the device uses the ratio of the nominal voltages for the generator and the busbar to calculate a set point for the AVR and the voltage synchronising window (dU_{MAX}).

Example:
A 10000 V/400 V step-up transformer is installed after a generator with the nominal voltage of 400 V. The nominal voltage of the busbar is 10000 V. Now, the voltage of the busbar is 10500 V. The generator is running 400 V before synchronising starts, but when attempting to synchronise, the AVR set point will be changed to:
$U_{BUS\text{-}MEASURED} * U_{GEN\text{-}NOM}/U_{BUS\text{-}NOM}$ = 10500 * 400/10000 = **420 V**

7.28.2 Vector group for step-up transformer

Vector group definition

The vector group is defined by two letters and a number:

The first letter is an upper case D or Y, defining whether the HV side windings are in Delta or Wye configuration.
The second letter is a lower case d, y or z, defining whether the LV side windings are in delta, wye or zigzag configuration.
The number is the vector group number, defining the phase angle shift between HV and LV side of the step-up transformer. The number is an expression of the LV side lag compared to the HV side voltage. The number is an expression of the lag angle divided by 30 degrees.

Example:
Dy11 = HV side: Delta, LV side: Wye, vector group 11: Phase shift = 11x (-30) = -330 degrees.

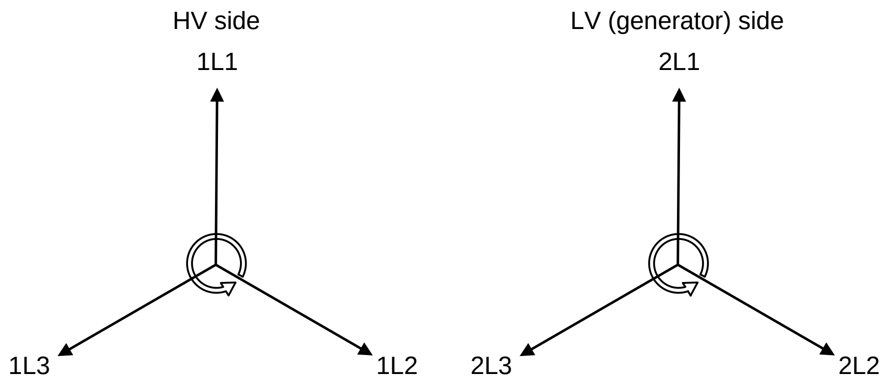
Typical vector groups

Vector group	Clock notation	Phase shift	LV lag degrees compared to HV
0	0	0 °	0 °
1	1	-30 °	30 °
2	2	-60 °	60 °
4	4	-120 °	120 °
5	5	-150 °	150 °
6	6	-180 °/180 °	180 °
7	7	150 °	210 °
8	8	120 °	240 °
10	10	60 °	300 °
11	11	30 °	330 °

Vector group 0

The phase angle shift is 0 degrees.

Yy0 example:

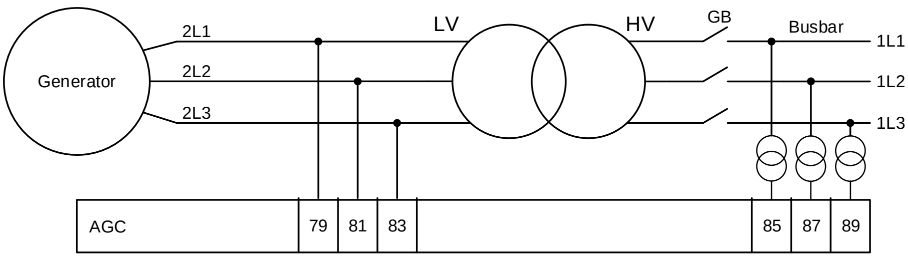


1L1 to 2L1 phase angle is 0 degrees

Phase compensation setting:

Parameter	Function	Setting
9141	BB (mains)/generator angle compensation	0 degrees

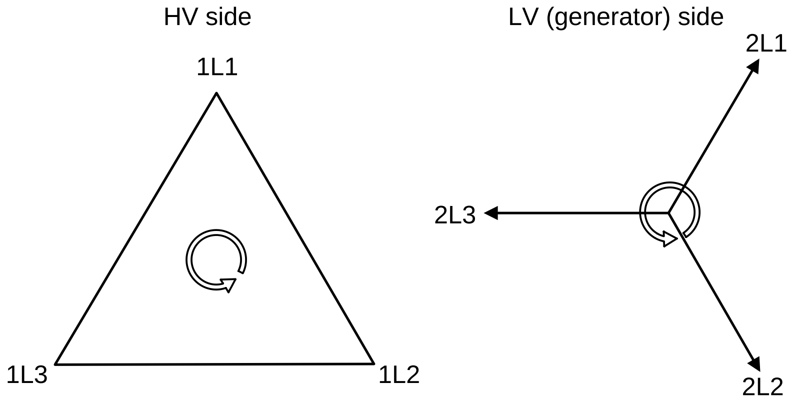
Connections:



The connection that is shown in the diagram should always be used when an ML-2 is used for a genset.

Vector group 1
The phase angle shift is -30 degrees.

Dy1 example:

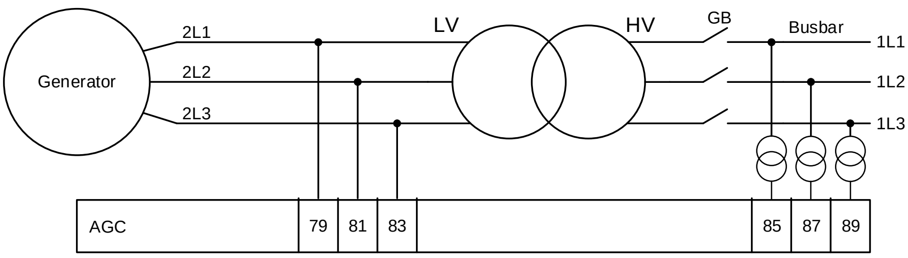


1L1 to 2L1 phase angle is -30 degrees.

Phase compensation setting:

Parameter	Function	Setting
9141	BB (mains)/generator angle compensation	30 degrees

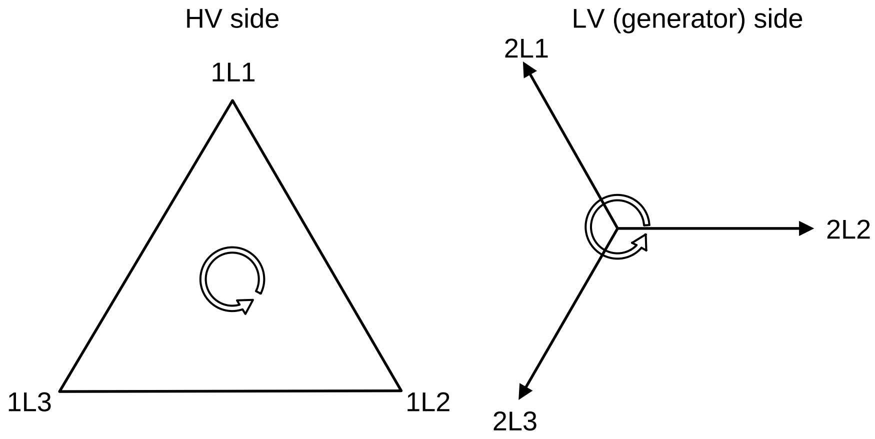
Connections:



The connection that is shown in the diagram should always be used when an ML-2 product is used for a genset.

Vector group 11
The phase angle shift is 11 x (-30) = -330/+30 degrees.

Dy11 example:

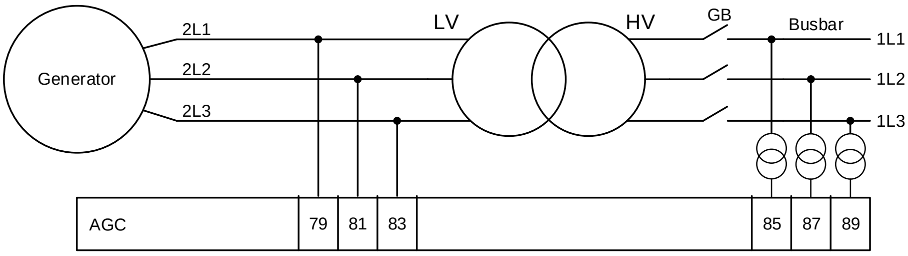


1L1 to 2L1 phase angle is -330/+30 degrees.

Phase compensation setting:

Parameter	Function	Setting
9141	BB (mains)/generator angle compensation	-30 degrees

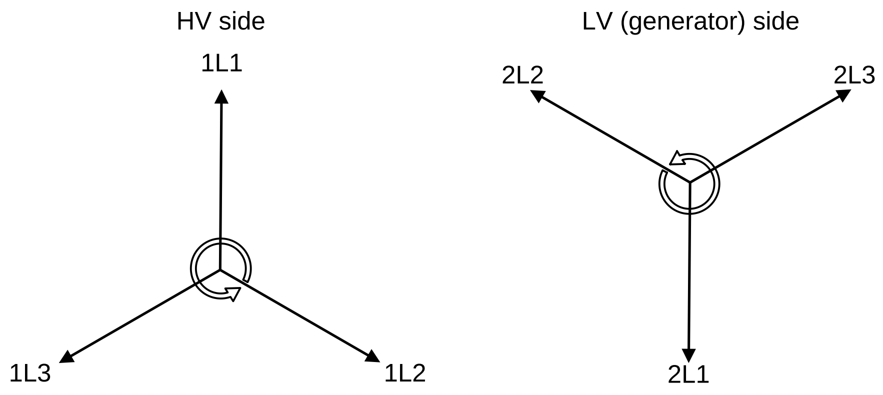
Connections:



The connection that is shown in the diagram should always be used when an ML-2 product is used for a gen-set.

Vector group 6
The phase angle shift is 6 x 30 = 180 degrees.

Yy6 example:

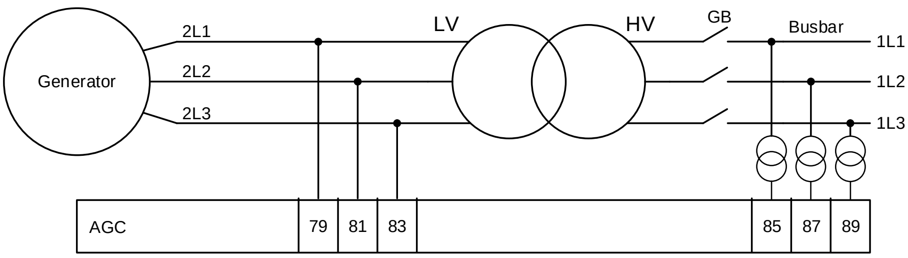


1L1 to 2L1 phase angle is -180/+180 degrees.

Phase compensation setting:

Parameter	Function	Setting
9141	BB (mains)/generator angle compensation	180 degrees

Connections:



The connection that is shown in the diagram should always be used when an ML-2 product is used for a genset.

Select 179 degrees in parameter 9141 when vector group 6 is used.

Comparison table between different terminologies

Vector group	Clock notation	Phase shift	LV lag degrees compared to HV	LV side lagging	LV side leading
0	0	0 °	0 °	0 °	
1	1	-30 °	30 °	30 °	
2	2	-60 °	60 °	60 °	
4	4	-120 °	120 °	120 °	
5	5	-150 °	150 °	150 °	
6	6	-180 °/180 °	180 °	180 °	180 °
7	7	150 °	210 °		150 °
8	8	120 °	240 °		120 °
10	10	60 °	300 °		60 °
11	11	30 °	330 °		30 °

In the following, the name vector group will be used.

Table to read parameter 9141 compared to a step-up transformer

Vector group	Step-up transformer types	Parameter 9141
0	Yy0, Dd0, Dz0	0 °
1	Yd1, Dy1, Yz1	30 °
2	Dd2, Dz2	60 °
4	Dd4, Dz4	120 °
5	Yd5, Dy5, Yz5	150 °
6	Yy6, Dd6, Dz6	180 °
7	Yd7, Dy7, Yz7	-150 °
8	Dd8, Dz8	-120 °
10	Dd10, Dz10	-60 °
11	Yd11, Dy11, Yz11	-30 °

Note that DEIF does not take responsibility that the compensation is correct. Before closing the breaker, DEIF recommends that customers always measure the synchronisation themselves.

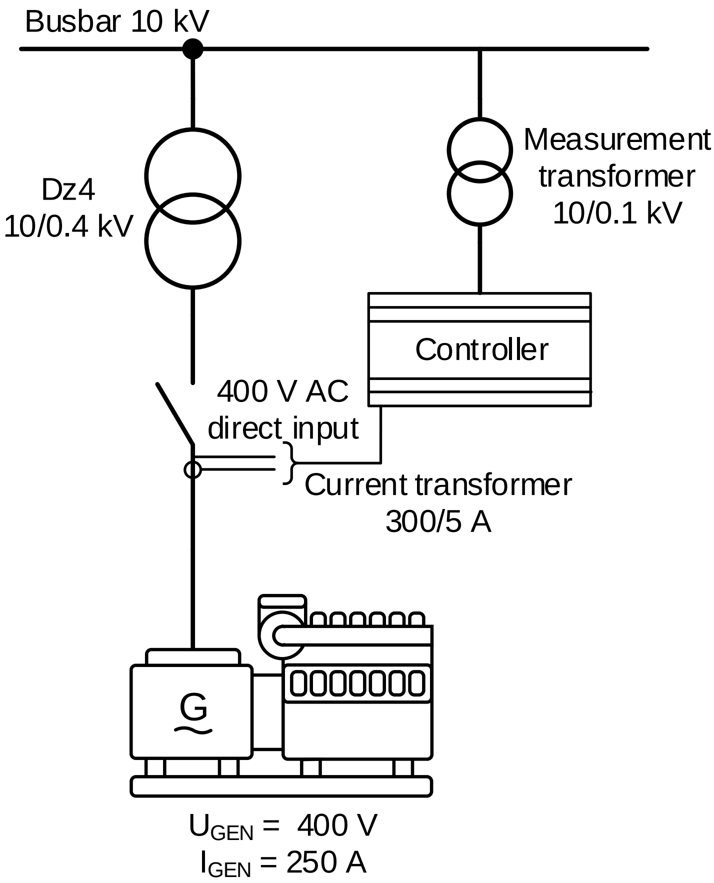
Note that if voltage measurement is connected incorrectly, the setting in parameter 9141 will be wrong!

Note that the setting shown in the table above does not include any phase angle twist made by measurement transformers!

The settings shown in the table above are not correct if a step-down transformer is used. These settings are shown later.

7.28.3 Setup of step-up transformer and measurement transformer

If the HV side of the transformer transforms the voltage up to a voltage level higher than 690 V AC, it will be necessary to use measurement transformers. The setup of all these parameters can be done from the utility software. The setup of all these parameters is explained by an example:



The transformer is a Dz4 step-up transformer with nominal settings of 10/0.4 kV.

The generator has a nominal voltage of 0.4 kV, a nominal current of 250 A and a nominal power of 140 kW.

The measurement transformer has a nominal voltage of 10/0.1 kV and no phase angle twist!

The nominal voltage of the busbar (BB) is 10 kV.

Because the generator’s nominal voltage is 400 V, there is no need for a measurement transformer on the LV side in this example. The ML-2 can handle up to 690 V. But it is still required to set up current transformers on the LV side. In this example, the current transformers have a nominal current of 300/5 A.

Due to the fact that the step-up transformer is a Dz4, there is a phase angle twist of -120 °.

These settings can be programmed by the display or by the utility software. These settings must be put into the parameters shown in the table below:

Parameter	Comment	Setting
6002	Generator nominal power	140
6003	Generator nominal current	250
6004	Generator nominal voltage	400
6041	LV measurement transformer primary side (there is none here)	400
6042	LV measurement transformer secondary side (there is none here)	400
6043	Current transformer primary side	300
6044	Current transformer secondary side	5
6051	HV (BB) measurement transformer primary side	10000
6052	HV (BB) measurement transformer secondary side	100
6053	Nominal HV setting of step-up transformer	10000
9141	Phase angle compensation	120 °

Note that the ML-2 controller can directly handle voltage levels between 100 and 690 V. If the voltage level in the application is higher or lower, it is required to use measurement transformers that transform the voltage into a number between 100 and 690 V.

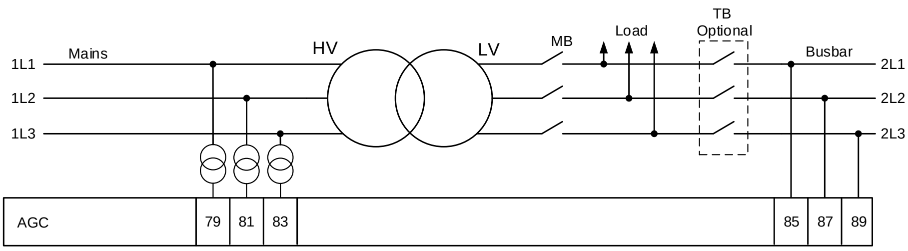
7.28.4 Vector group for step-down transformer

In some applications, a step-down transformer can also be used. This could be to transform a grid voltage down, so the load can handle the voltage level. The ML-2 controller is able to synchronise the busbar with the mains, even if there is a step-down transformer with a phase angle twist. The transformer must be between the measuring points for ML-2. If a step-down transformer is used, these settings must be set in parameter 9141 to compensate the phase angle twist.

Vector group	Step-up transformer types	Parameter 9141
0	Yy0, Dd0, Dz0	0 °
1	Yd1, Dy1, Yz1	-30 °
2	Dd2, Dz2	-60 °
4	Dd4, Dz4	-120 °
5	Yd5, Dy5, Yz5	-150 °
6	Yy6, Dd6, Dz6	180 °
7	Yd7, Dy7, Yz7	150 °
8	Dd8, Dz8	120 °
10	Dd10, Dz10	60 °
11	Yd11, Dy11, Yz11	30 °

If a step-down transformer is mounted with an ML-2 genset unit, the settings shown in the table above should also be used.

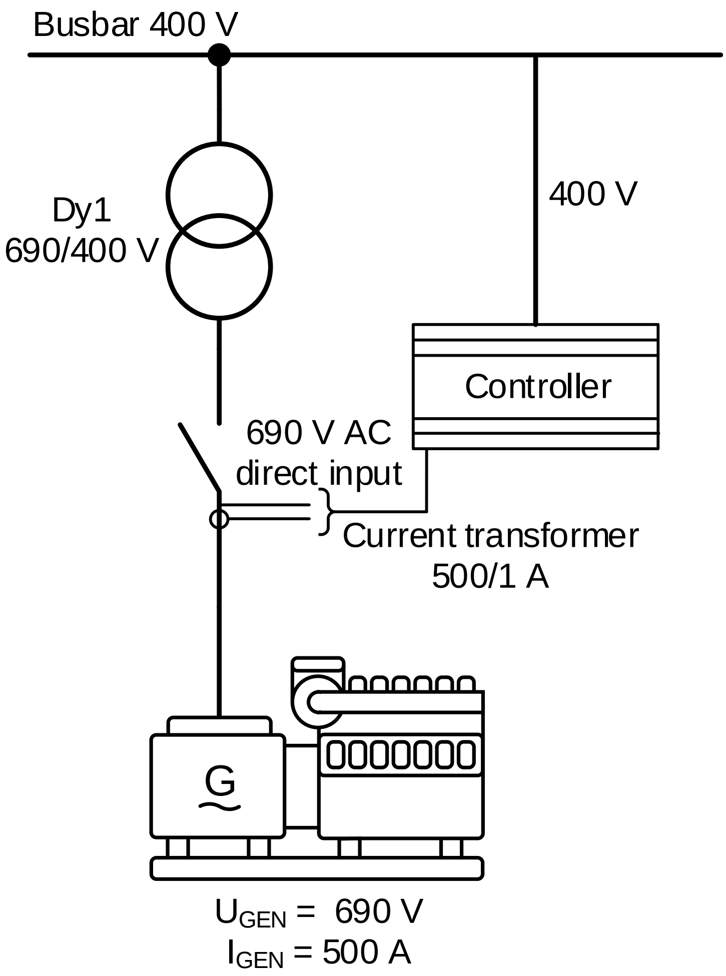
If a step-down transformer and an ML-2 product for the mains breaker are mounted, note how the measurements are mounted on the ML-2. The correct connection is shown below.



The connection that is shown in the diagram should always be used when an ML-2 product is used for a mains breaker.

7.28.5 Setup of step-down transformer and measurement transformer

If the HV side of the transformer has a voltage level higher than 690 V AC, it is necessary to use measurement transformers. In this example, the HV side is 690 V, and therefore there is no need for a measurement transformer. The step-down transformer can have a phase angle twist, that needs to be compensated for. The setup of all the parameters can be done from the utility software. The setup of all these parameters is explained by an example:



The transformer is a Dy1step-down transformer, with nominal settings of 690/400 V.

The generator has a nominal voltage of 690 V, a nominal current of 500 A and a nominal power of 480 kW.

There is no measurement transformer in this application, because the ML-2 is able to handle the voltage levels directly.

The nominal voltage of the busbar (BB) is 400 V.

It is still required to set up current transformers. In this example, the current transformers have a nominal current of 500/1 A.

Due to the fact that the step-down transformer is a Dy1, there will be a phase angle twist of +30 °.

These settings can be programmed by the display or by the utility software. These settings must be put into the parameters shown in the table below:

Parameter	Comment	Setting
6002	Generator nominal power	480
6003	Generator nominal current	500
6004	Generator nominal voltage	690
6041	HV measurement transformer primary side (there is none here)	690
6042	HV measurement transformer secondary side (there is none here)	690
6043	Current transformer primary side	500
6044	Current transformer secondary side	1
6051	LV (BB) measurement transformer primary side (there is none here)	400
6052	LV (BB) measurement transformer secondary side (there is none here)	400
6053	Nominal LV setting of step-up transformer	400
9141	Phase angle compensation	-30 °

7.29 Demand of peak currents

It is possible to have two different readouts shown in the display. The first readout is called I thermal demand. This readout shows the average **maximum** peak current over an adjustable time interval. The second readout is called I maximum demand, and shortened in the unit, I max. demand.
The readouts are not per default set to be shown in the display, this has to be set up via the utillity software in views.

7.29.1 I thermal demand

This measurement is used to simulate a bimetallic system, known from the Maximum Demand ammeter, which is specifically suited for indication of thermal loads in conjunction with cables, transformers, etc.

Be aware that the calculated average is NOT the same as the average current over time. The I thermal demand value is an average of the MAXIMUM PEAK current in the adjustable time interval.

The measured peak currents are sampled once every second, and every 6 seconds an average peak value is calculated. If the peak value is higher than the previous maximum peak value, it is used to calculate a new average. The thermal demand period will provide an exponential thermal characteristic.

The time interval in which the average maximum peak current is calculated can be adjusted in parameter 6840. The value can also be reset. If the value is reset, it will be logged in the event log and the readout in the display is reset to 0.

7.29.2 I max. demand

This readout displays the newest maximum peak current value. When a new maximum peak current is detected, the value is saved in the display. The value can be reset in parameter 6843. If the value is reset, it will be logged in the event log.

The two reset functions will also be available as commands through M-Logic.

Display readout is updated with an interval of 6 seconds.

7.30 Fan logic

The AGC is able to control four different fans. This could for example be air supply fans for supplying air to a genset in a closed enclosure, or radiator fans for switching on and off cooling fans for air coolers.

There are two features in the fan control of the AGC.

1. Priority rearranging depending on running hours of the fans
2. Temperature-dependent start and stop

A priority routine ensures that the running hours of the available fans are evened out and the priority shifts between them.

The functionality behind the temperature-dependent start/stop is that the AGC measures a temperature, for example cooling water temperature, and based on this temperature it switches on and off relays that must be used for engaging the fan(s) itself.

The fan control function is active as long as running feedback is detected.

7.30.1 Fan parameters

Each fan has a group of parameters that defines their scheme of operation. It is recommended to use the PC utility SW for the setup, because then it is possible to see all parameters. The setup of the fan control is done in the menus 6561 to 6620 and by using M-Logic in the PC utility SW.

Related parameters:

6560-6620

Parameter	Item	Range	Default	Notes
6561	Fan input	Multi-input 102 - CIO 308	Multi-input 102	Selection of the temperature input for fan control
6562	Fan prio update	0 - 200 hours	0 hours	Priority update interval
6563	1st prio fan	0 - 250 deg	70 deg	Set point for first priority fan
6564	1st pr. fan hys	0 - 50 deg	10 deg	Hysteresis for first fan priority set point
6565	2nd prio fan	0 - 250 deg	80 deg	Set point for second priority fan
6566	2nd pr. fan hys	0 - 50 deg	10 deg	Hysteresis for second fan priority set point
6571	3rd prio fan	0 - 250 deg	90 deg	Set point for third priority fan
6572	3rd pr. fan hys	0 - 50 deg	10 deg	Hysteresis for third fan priority set point
6573	4th prio fan	0 - 250 deg	100 deg	Set point for fourth priority fan
6574	4th pr. fan hys	0 - 50 deg	10 deg	Hysteresis for fourth fan priority set point
6581	Fan A output	Not used - limits	Not used	Relay output for fan A
6582	Fan B output	Not used - limits	Not used	Relay output for fan B
6583	Fan C output	Not used - limits	Not used	Relay output for fan C
6584	Fan D output	Not used - limits	Not used	Relay output for fan D
6585	Fan Run.H reset	OFF - fan D hours reset	OFF	Resetting the running hours of each individual fan
6586	Fan start delay	0 - 30 s	OFF	Resetting the running hours of each individual fan
6590	Fan A failure	0.1 - 300 s	10 s	Timer for fan A running feedback failure
	Relay output A	Not used - limits	Not used	Relay output A for fan A feedback failure
	Relay output B	Not used - limits	Not used	Relay output B for fan A feedback failure
	Enable	Disabled - enabled	Disabled	Enabling of running failure detection of fan A
6600	Fan B failure	0.1 - 300 s	10 s	Timer for fan B running feedback failure
	Relay output A	Not used - limits	Not used	Relay output A for fan B feedback failure
	Relay output B	Not used - limits	Not used	Relay output B for fan B feedback failure
	Enable	Disabled - enabled	Disabled	Enabling of running failure detection of fan B

Parameter	Item	Range	Default	Notes
6610	Fan C failure	0.1 - 300 s	10 s	Timer for fan C running feedback failure
	Relay output A	Not used - limits	Not used	Relay output A for fan C feedback failure
	Relay output B	Not used - limits	Not used	Relay output B for fan C feedback failure
	Enable	Disabled - enabled	Disabled	Enabling of running failure detection of fan C
6620	Fan D failure	0.1 - 300 s	10 s	Timer for fan D running feedback failure
	Relay output A	Not used - limits	Not used	Relay output A for fan D feedback failure
	Relay output B	Not used - limits	Not used	Relay output B for fan D feedback failure
	Enable	Disabled - enabled	Disabled	Enabling of running failure detection of fan D

7.30.2 Input for fan control

The fan control requires a temperature input in order to start and stop the fans based on a temperature measurement.

Fan temperature input is set up in parameter 6561, and this input can be selected between these inputs:

- Three multi-inputs in slot #7 are available
- EIC measurement (engine interface communication)
- External analogue input 1-8 (H8.X)
- Analogue inputs (M15.X)
- Multi-inputs (M16.X)
- CIO 308

The multi-inputs can be configured to, for example, a Pt100 sensor that measures an engine- or ambient temperature. If EIC is selected, this is defined as the highest measured temperature of either cooling water or oil temperatures.

Based on the measurement of the selected input, the fan(s) is (are) started and stopped.

7.30.3 Fan start/stop

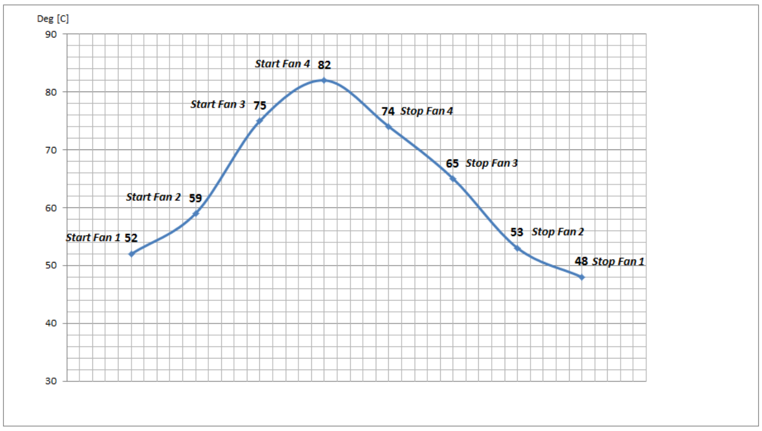
The start and stop settings of the fan(s) are set up in parameters 6563 to 6574. With the settings in the table below, the illustrative curve can be observed.

A hysteresis (abbreviation: hyst.) ensures that there is a range between the start and stop.

6563	1st level fan setp.	50	deg
6564	1st level fan hyst.	2	deg
6565	2nd level fan setp.	56	deg
6566	2nd level fan hyst.	3	deg
6571	3rd level fan setp.	70	deg
6572	3rd level fan hyst.	5	deg
6573	4th level fan setp.	78	deg
6574	4th level fan hyst.	4	deg

Fan	Setp.	hys.	Start	Stop
1	50	2	52	
2	56	3	59	
3	70	5	75	
4	78	4	82	
4	78	4		74
3	70	5		65
2	56	3		53
1	50	2		48

The following start/stop curve will be generated if a bow setting is used:



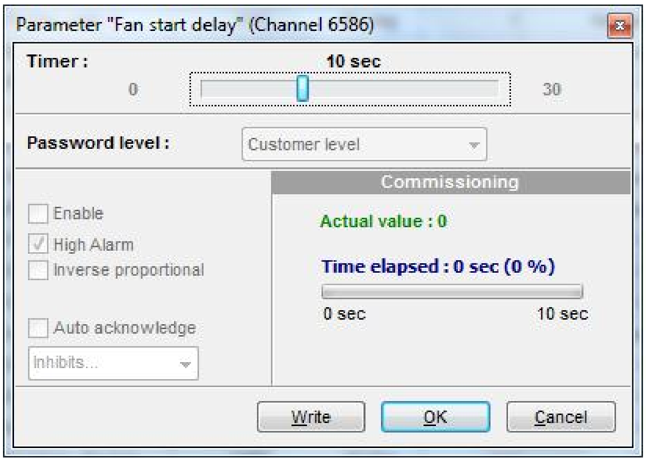
7.30.4 Fan output

At parameter 6581 to 6584, the output relays for fans A to D are selected. The purpose of these relays is to issue a signal to the fan starter cabinet. The relay must be energised for the fan to run.

Gen	6581	Fan A output	1472	N/A		N/A	Terminal 57
Gen	6582	Fan B output	1473	N/A		N/A	Terminal 59
Gen	6583	Fan C output	1540	N/A		N/A	Terminal 61
Gen	6584	Fan D output	1541	N/A		N/A	Terminal 63

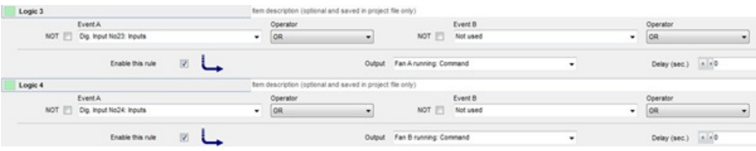
7.30.5 Fan start delay

If two or more fans are requested to be started at the same time, it is possible to add a start delay between each fan start. The reason for this is to limit the peak start current, so all fans will not contribute with a start current at the same time. This delay is adjusted in the menu 6586.



7.30.6 Fan running feedback

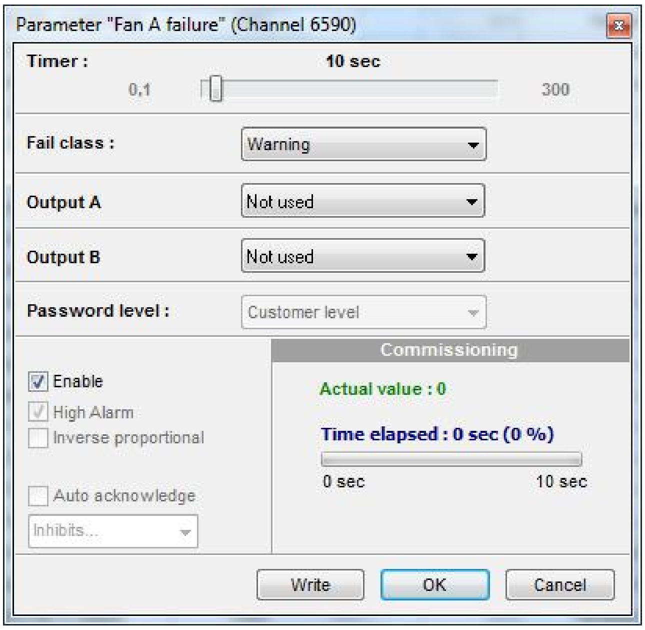
To make sure that the fan is running, it is possible to assign a digital input as a running feedback. The running feedback has to be programmed through M-Logic, below is an example of how to programme it.



The "Fan A/B/C/D running command" output tells the AGC that the fan is running. The output is found under Output and Command as shown in the screenshot above.

7.30.7 Fan failure

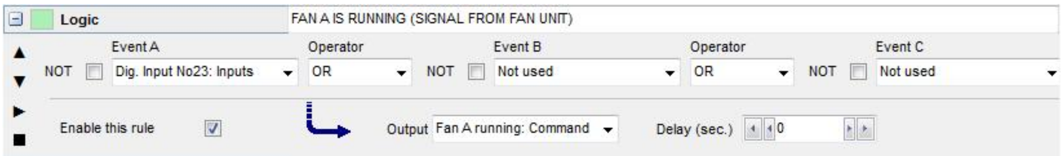
It is possible to activate an alarm if the fan does not start. The fan failure alarm appears if the running feed-back from the fan does not appear. In parameters 6590 to 6620, the fan failure alarms are set up for fans A to D.



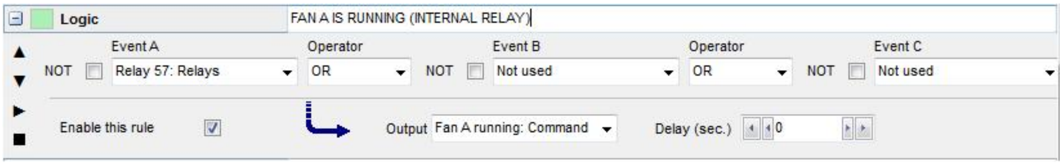
7.30.8 Fan priority (running hours)

The priority of the fans A to D rotates automatically from 1st to 4th priority. This is done automatically, because the running hours of the fans are detected and are used for the rearranging.

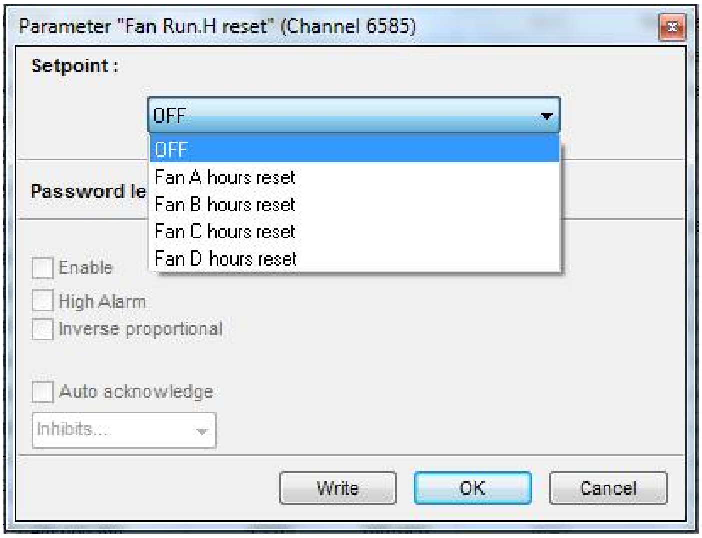
M-Logic setup:
If the fan unit is raising a signal that is led to a digital input on the AGC when it is running, then the following M-Logic must be programmed:



When it is not possible to get a running feedback from the fan unit, the internal relay of the AGC must be used to indicate that the fan is running. If for example R57 is the relay for FAN A, the following M-Logic must be programmed:



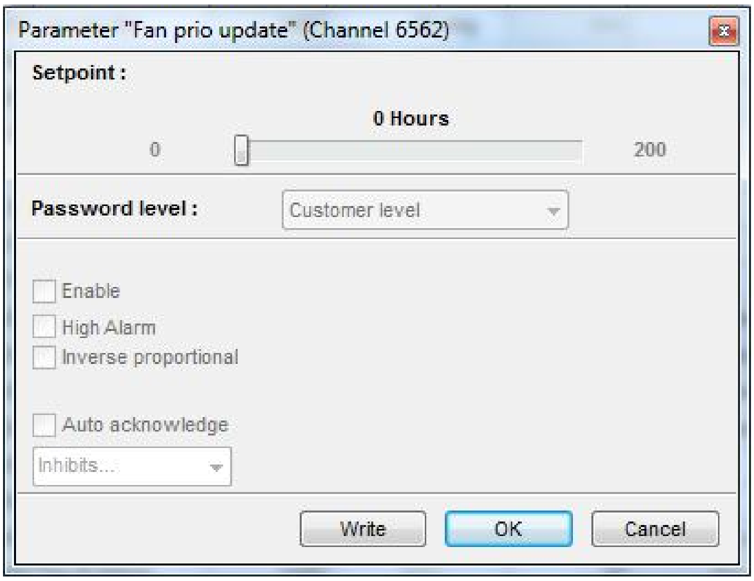
The running hour can be reset by entering parameter 6585 and then selecting the desired fan hours to be reset.



Only reset is possible. It is not possible to add an offset to the run hour counter.

7.30.9 Fan priority update

In parameter 6562, the priority update rate (hours between priority rearrange) is selected:



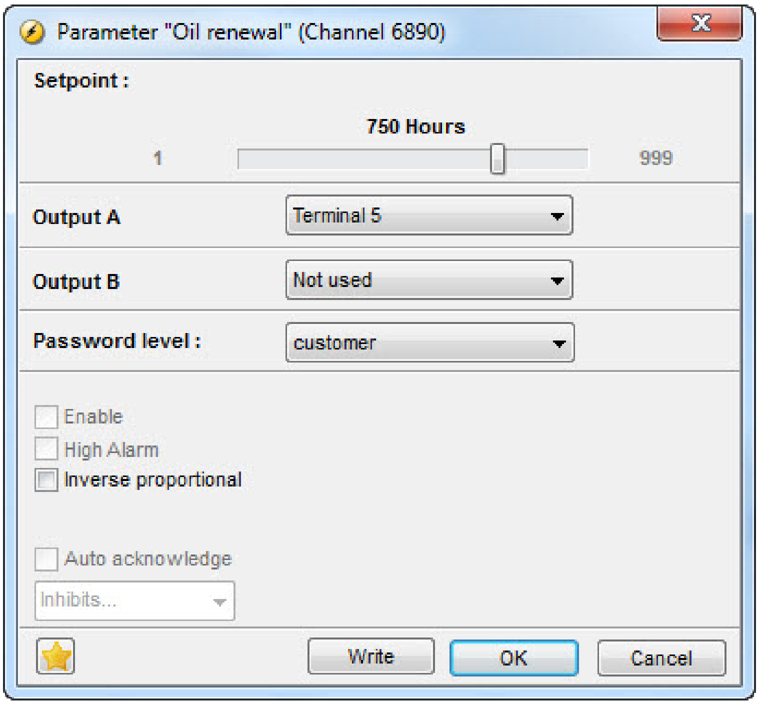
If the fan priority update is set to 0 hours, the order of priority will be fixed at: Fan A, fan B, fan C and fan D.

7.31 Oil renewal function

The purpose of the oil renewal function is to give the possibility to exchange a small portion of the lubricating oil of the engine with fresh or new oil. This means that the quality of the oil is kept at a satisfactory level without significant degrading of the oil (for example contamination and TBN value) in the entire period between the oil changes.

The time interval between the oil changes is assumed to be 1000 hours of operation. The renewal function reads the engine hours from the engine interface communication (EIC). The running hours counter in the AGC is only used if the EIC counter is not available.

The function in the AGC is to activate a relay under defined conditions. Then the relay must be used for the oil renewal system (not part of the DEIF scope of supply) where lubricating oil is removed and added to the engine. Any freely configurable relay is available for this feature. In parameter 6890, a set point is available, which can be set between 1 and 999 hours to define when the relay should close, and it is possible to choose which relay should be used. Furthermore, this parameter can be inversed, meaning that the relay will remain closed until the set point is reached.



When the running hours counter has reached 1000 hours, the AGC will reset the hours just for the oil renewal function. If, for example, the set point has been set to 750 hours and inverse is not enabled, the relay will close at 750 hours and remain closed until 1000 hours is reached, and then the hours counter starts from 0 hours again.

Related parameters:
6890 Oil renewal

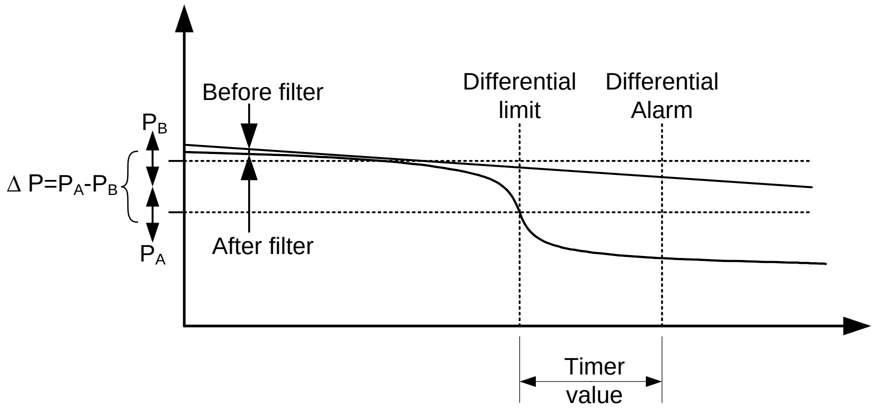
Parame-ter	Item	Range	Default	Notes
6891	Set point	1 to 999 hours	750 hours	Set point for the relay to close and then it will be closed until 1000 hours to change some of the oil.
6892	Output re-lay A	Relay: 05, 08, 11, 14, 17, 20, 21, 57, 59, 61, 63, CIO, limits	Not used	Select which output relay is used.

7.32 Differential measurement

7.32.1 Differential measurement

With the differential measurement function, it is possible to compare two analogue inputs and trigger on the difference between the two values.

If the differential function is for example air filter check, the timer will be activated if the set point between PA (analogue A) and PB (analogue B) is exceeded. If the differential value drops below the set point value before the timer runs out, then the timer will be stopped and reset.



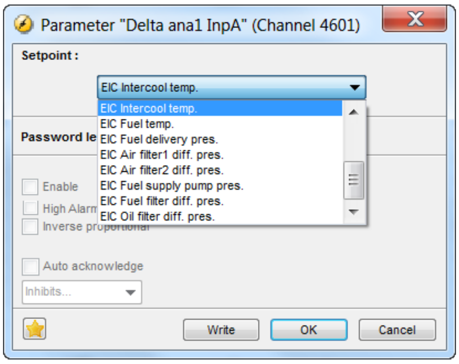
Six different differential measurements between two analogue input values can be configured.

Differential measurements between two sensors can be configured in menus 4600-4606 and 4670-4676. As an example, the figure below shows the two parameters for input selection for differential measurement 1.

Ain	4601	Delta ana1 InpA	1482	4	
Ain	4602	Delta ana1 InpB	1483	4	

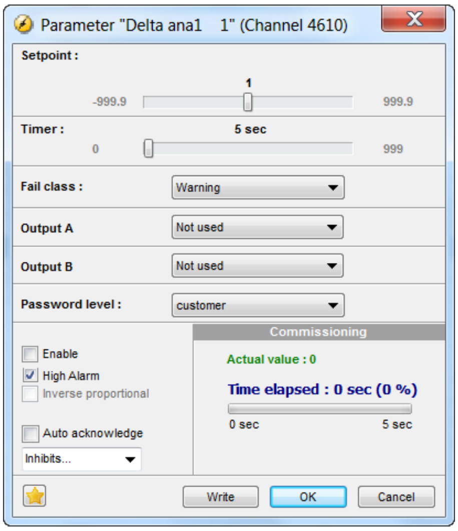
Inputs are selected from the input list as shown below, avaible inputs are:

- Multi-inputs
- EIC measurements
- External inputs (option H8)
- Analogue input (M15.X)
- Multi-input (M16.X)



The relevant alarm set point is chosen in parameters 4610-4660 and 4680-4730. Each alarm can be configured in two alarm levels for each differential measurement between analogue input A and input B. The figure below shows the two parameters to configure alarm level 1 and 2, for differential measurement 1.

Ain	4610	Delta ana1	1		1488	1
Ain	4620	Delta ana1	2		1489	1



7.33 Battery asymmetry

7.33.1 Introduction

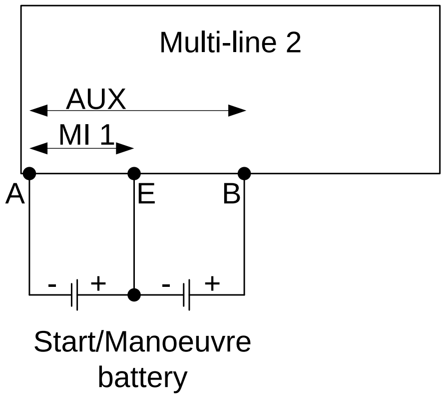
The reason for making the battery asymmetry test is to determine if one of the batteries is getting weak. The battery asymmetry is a combination of measurements and calculations and is set up in parameter 6430.

Set points available:

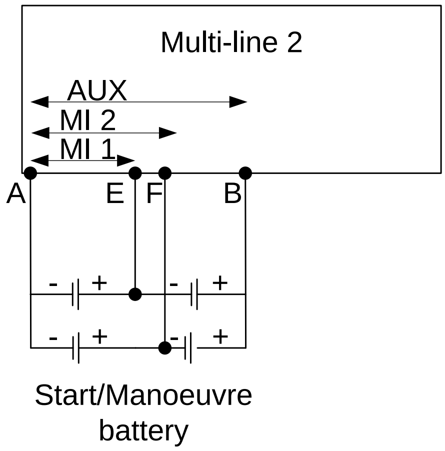
T1: The input type to be used for calculation of battery asymmetry 1.
RF1: Reference of asymmetry measurement no. 1.
T2: The input type to be used for calculation of battery asymmetry 2.
RF2: Reference of asymmetry measurement no. 2.

The following seven battery applications are supported. The shown applications are merely examples – the choice of multi-input (MI) or power supply input is configurable in menu 6410.

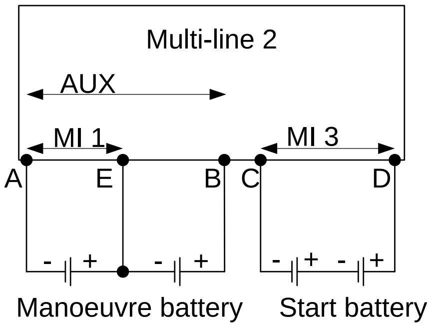
Application 1:



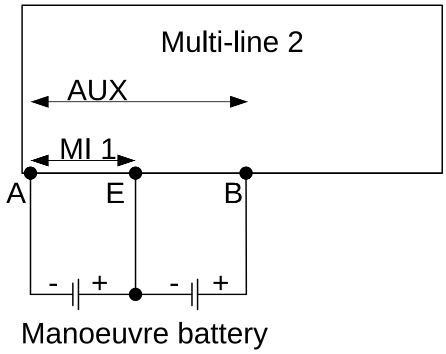
Application 2:



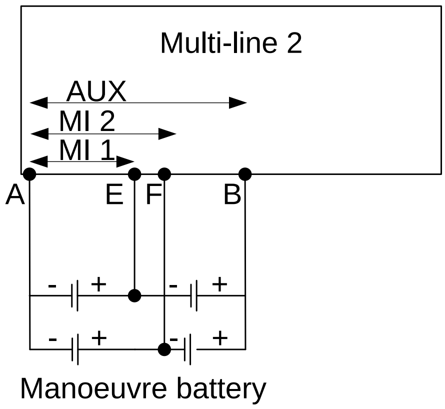
Application 3:



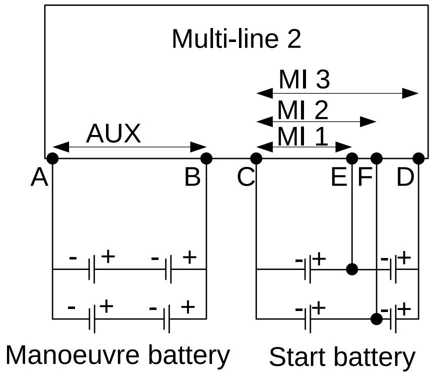
Application 4:



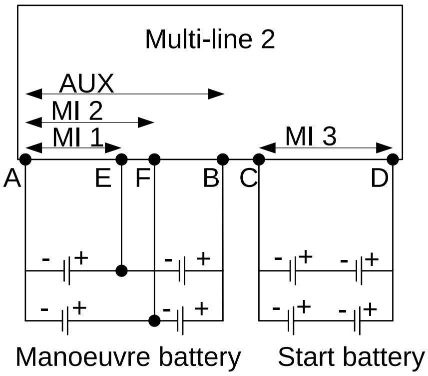
Application 5:



Application 6:

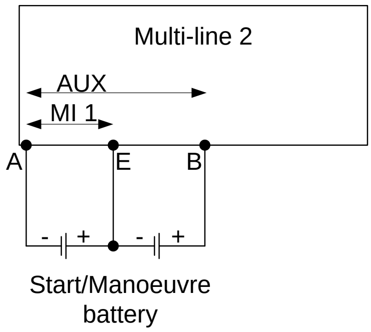


Application 7:



Looking at battery application 1 as an example:

Application 1:



The power supply measurement is used as the reference RF1 (point A and B) in menu 6432, and multi-input 1 is used as the type T1 (point A and E) in menu 6431. By making these measurements, it is possible to calculate the voltage between E and B. This gives a full picture of battery voltages, for example:

Measured value A/B (RF1) = 21 V DC
Measured value A/E (T1) = 12 V DC
Calculated value E/B (RF1 – T1) = 9 V DC

Battery asymmetry = E/B – (RF1*1/2) = 9 – (21*1/2) = -1.5 V DC

It is expected that the multi-inputs used for the battery asymmetry are configured to "0-40 V DC".

The selection power supply is referring to the supply on terminals 1 and 2.

Battery asymmetry alarm
Alarms for battery asymmetry 1 and 2 are set up in menus 6440 and 6450.

The set point in menus 6440 and 6450 is only set in positive values, however, it will also trigger if the battery asymmetry calculation results in a negative value.

7.33.2 Battery asymmetry parameters

Related parameters:
6430/6440/6450 Battery asymmetry

Parameter	Item	Range	Default	Notes
6431	Test settings input alarm 1	Multi-input 102, Multi-input 105, Multi-input 108, power supply, power supply 98/99	Multi-input 105	The input type to be used for calculation of battery asymmetry 1
6432	Test settings reference alarm 1	Multi-input 102, Multi-input 105, Multi-input 108, power supply, power supply 98/99	Multi-input 105	Reference of asymmetry measurement no. 1
6433	Test settings input alarm 2	Multi-input 102, Multi-input 105, Multi-input 108, power supply, power supply 98/99	Multi-input 105	The input type to be used for calculation of battery asymmetry 2
6434	Test settings reference alarm 2	Multi-input 102, Multi-input 105, Multi-input 108, power supply, power supply 98/99	Multi-input 105	Reference of asymmetry measurement no. 2
6441/6451	Set point	0.1 to 15 V	1 V	Selection of the set point
6442/6452	Time delay	0 to 10 s	1 s	Selection of the time delay for the alarm
6443/6453	Output A	Relay: 05, 08, 11, 14, 17, 20, 21, 57, 59, 61, 63, CIO, limits	Not used	This is the output selection
6444/6454	Output A	Relay: 05, 08, 11, 14, 17, 20, 21, 57, 59, 61, 63, CIO, limits	Not used	This is the output selection
6445/6455	Enable battery asymmetry	On, Off	Off	This will enable the battery asymmetry function

7.34 Analogue fan control

7.34.1 Introduction

The analogue fan control does not actually control a fan, this is taken off by a frequency drive (VFD). The AGC PM does only send a 4-20 mA reference signal to the VFD. So the regulation is done by the VFD.
The reference signal depends on different factors, and perhaps looks at multiple inputs to calculate the correct reference signal.

The analogue fan control function is active as long as running feedback is detected.

7.34.2 Reference signal

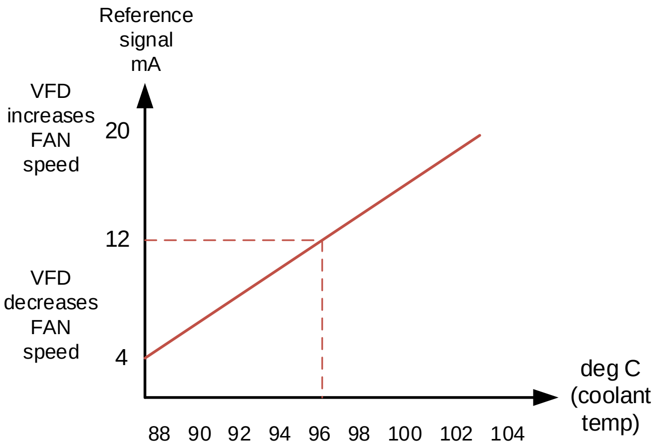
The AGC PM will send a signal to the VFD according to the reference set in parameters 6632/ 6635/ 6642/ 6645. The AGC PM is looking on all 4 of them, But they are 4 different inputs:

For example:

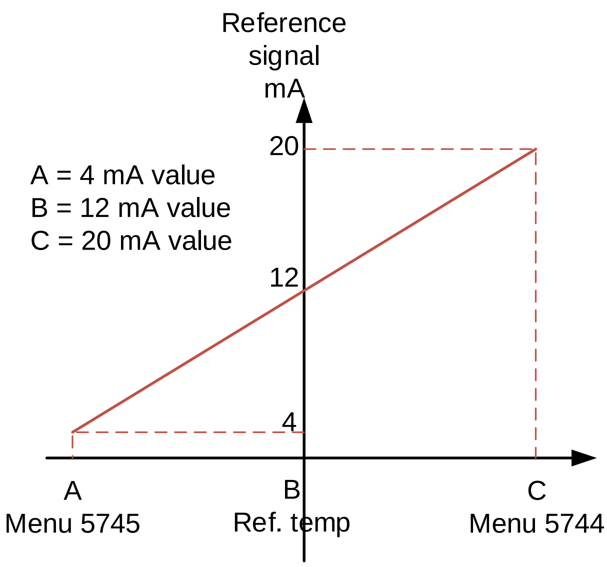
- Ref. 6632 Coolant water temp.
- Ref. 6635 Inter cooler temp.
- Ref. 6642 Oil Temp.

- Ref. 6645 Ambient temp.

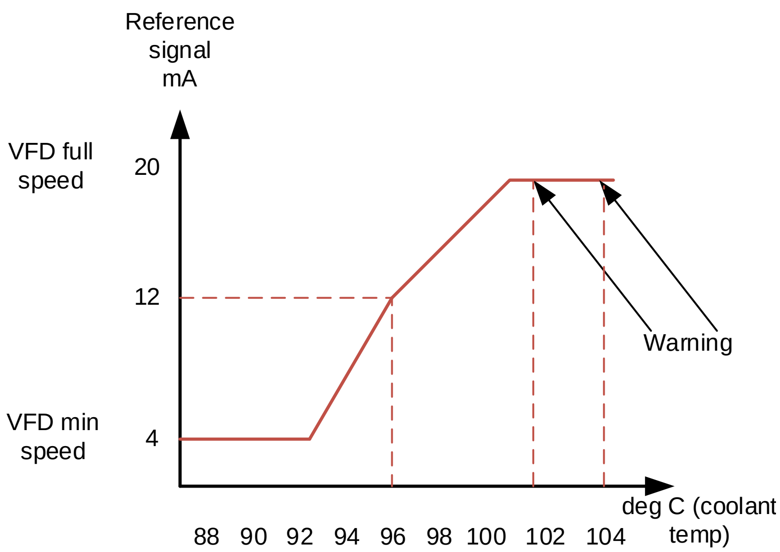
If the coolant water reference is set to 96 degC, and the temp is 96 degC, the AGC PM will send a 12 mA signal to the VFD. See below picture.



The temperature is of course changing, so if the temperature falls, the reference signal will also fall, and the opposite happens if temperature rises.
Therefore we need to clarify the minimum and maximum temperature drop and rise, compared to the 4-20 mA reference signal. The minimum setting is set in parameter 5745 and the maximum is set in 5744. Default this is set to minimum = -50°C and maximum = +50°C. So if the reference is set to 96°C and the temperature drops to 46°C, the signal sent to the VFD will be 4 mA, and of course if the temperature rises to 146°C the signal will be 20 mA. See picture below.



If the temperature rises further than the 146 degC to for example 160°C, and the fan cannot cool it down, the AGC PM will go into alarm with a warning first and then shut down. See below picture.



The minimum and maximum setting is the same for all four inputs, but because we maybe think it is okay to switch 50°C in coolant water temp. before the alarm will go off, it might not be the same for the oil temperature. With the oil temperature, we would like the minimum to be -10°C and maximum to be +10°C, then we have to scale it. There is a parameter to scaling for each input.
If we want the input to be scaled like the values in minimum and maximum (-50 and +50°C) the scale value must be 1. But with the oil temperature input, it should only be -10°C and +10°C, then the scale value must be 5. With these scale parameters, the different inputs can be placed on different values according to the main values set in parameter 5744 and 5745.

In the parameters, there are two different sets of reference settings for the four different inputs. In the start of this chapter, the first set of reference were described, the other set of reference settings are in parameter 6651/6652/6653/6654. These are normally set to the same values as the first set of reference parameters. The second set of settings is still referring to the same input and scale value as the first settings. The difference between these two sets is that you can change the frequency level between 50 Hz and 60 Hz, this is done in parameter 6655.

7.34.3 Input for analogue fan control

The analogue fan control requires a temperature input in order to calculate the reference signal sent to the VFD.

The four different analogue fan temperature inputs are set up in parameter 6631/6634/6641/6644, and these input can be selected from this list:
- Three multi-inputs in slot #7 are available
- EIC measurement (engine interface communication)
- External analogue input 1-8 (H8.X)
- Analogue inputs (M15.X)
- Multi-inputs (M16.X)

The multi-inputs can be configured to for example a Pt100 sensor that measures an engine- or ambient temperature. If EIC is selected, this is defined as the highest measured temperature of either cooling water or oil temperatures.

7.34.4 Output for analogue fan control

In parameter 5743, you can choose which signal type you wish to send to the VFD, and in parameter 5741 the transducer output is chosen.

7.34.5 Related parameters

Related parameters

5740/ 6630/6640/ 6650 Analogue fan control

Parameter	Item	Range	Default	Notes
5741	Transducer output	Disabled, Transducer 68, 70 PWM, 72	Disa-bled	Here you select the transducer output for the ref. signal.
5743	Fan output type	Disabled, 0-20 mA, 4-20 mA, 0-10 V, -10 - 10 V	Disa-bled	Here you chose the fan output type.
5744	Fan output max.	-999.9........+999.9°C	50°C	Here you choose the maximum value for the output
5745	Fan output min.	-999.9........+999.9°C	-50°C	Here you choose the minimum value for the output
6631/6634/6641/6644	Ana. fan inp. 1,2,3,4	Multi-input 102, multi-input 105, multi-input 108, M-Logic, EIC Water temp., EIC Oil temp., EIC Ambient temp., EIC Inter cool. temp., EIC Fuel temp., Alterna-tor temp.,EIC Turbo 1 in temp., EIC Turbo 1 in press.	Multi-in-put 102	Here you choose the input type for the four different inputs.
6632/6635/6642/6645	Ana. fan ref. 1,2,3,4 set nr. one	0 to 250°C	80°C	Here you set the refer-ence temperature, for set no. one (50 Hz)
6633/6636/6643/6646	Ana. fan. sca. 1,2,3,4	0 to 100	0	This is were the mini-mum and maximum values is scaled.
6651/6652/6653/6654	Ana. fan ref. 1,2,3,4 set nr. two	0 to 250°C	80°C	Here you set the refer-ence temperature, for set no. two (60 Hz)
6655	Fan ref. set	Fan ref. set 1, Fan ref. set 2	Fan ref. set 1	This function change between the two refer-ence settings (50 or 60 Hz)

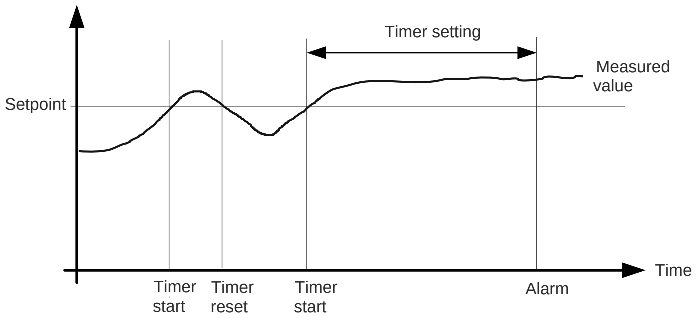
8. Protections

8.1 Common

8.1.1 Common

All settings are stated in percent of the nominal generator value.
The protections are all of the definite time type; this means a set point and time is selected.

If for example, the function is over-voltage, the timer will be activated if the set point is exceeded. If the voltage value falls below the set point value before the timer runs out, then the timer will be stopped and reset.



When the timer runs out, the output is activated. The total delay will be the delay setting + the reaction time.

When parameterising the DEIF controller, the measuring class of the controller and an adequate "safety" margin has to be taken into consideration.

An example:
A power generation system must not reconnect to a network when the voltage is 85 % of Un +/-0 % ≤ U ≤ 110 % +/-0 %. In order to ensure reconnection within this interval, a control unit's tolerance/accuracy (Class 1 of the measuring range) has to be taken into consideration. It is recommended to set a control unit's setting range 1-2 % higher/lower than the actual set point if the tolerance of the interval is +/-0 % to ensure that the power system does not reconnect outside the interval.

- **Phase-neutral voltage trip**

If the voltage alarms are to work based on phase-neutral measurements, please adjust "Channel 1201 G voltage trip" (Generator measurement type selection : phase to phase/phase to neutral) and "channel 1202 BB voltage trip" (busbar measurement type: phase to phase/phase to neutral) accordingly. Depending on the selections, either phase-phase voltages or phase-neutral voltages will be used for the alarm monitoring.

As indicated in the vector diagram, there is a difference in voltage values at an error situation for the phase-neutral voltage and the phase-phase voltage.

The table shows the actual measurements at a 10 % under-voltage situation in a 400/230 volt system.

	Phase-neutral	Phase-phase
Nominal voltage	400/230	400/230
Voltage, 10 % error	380/207	360/185

The alarm will occur at two different voltage levels, even though the alarm set point is 10 % in both cases.

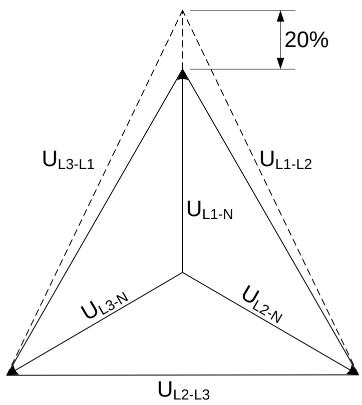
The below 400 V AC system shows that the phase-neutral voltage must change 20 %, when the phase-phase voltage changes 40 volts (10 %).

Example:
U_{NOM} = 400/230 V AC

Error situation:
U_{L1L2} = 360 V AC
U_{L3L1} = 360 V AC

U_{L1-N} = 185 V AC

ΔU_{PH-N} = 20 %

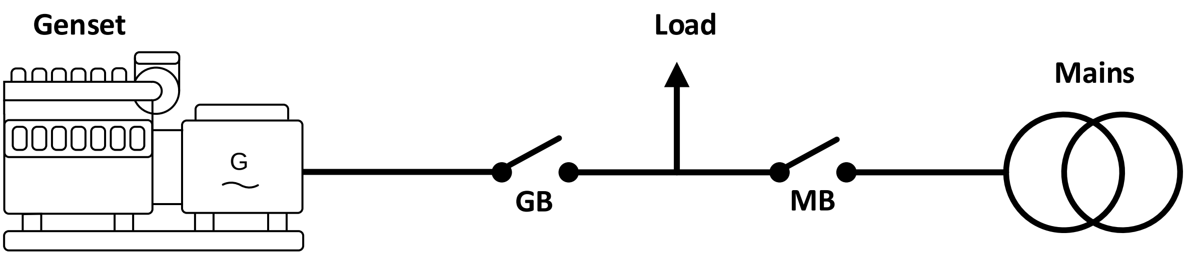


8.1.2 Phase sequence error and phase rotation

The AGC PM is able to monitor the rotation of the voltage, and to give an alarm if the voltage is rotating in the wrong direction. The AGC PM can monitor the rotation in both direction. From the alarm it is possible to set different failclasses, which give different possibilities. The documentation about phase sequence error can divided into two sections, where the first chapter will be about Stand alone applications, and the other chapter will be about Power management controller applications.

Stand alone applications

A Stand alone application is able to handle up to one genset, one generator breaker and one mains breaker. An application like this is shown below:



When the AGC PM is mounted correctly, the gensets voltage measurements are mounted between the Generator Breaker (GB) and the genset. The other voltage measurements are mounted between the Mains Breaker (MB) and the incoming grid connection. On the AGC PM controller the voltage terminals is shown below:

Controller type	Genset voltage terminals	Mains voltage terminals
AGC PM	79-84	85-89

The table above is only for Stand alone application!

In the AGC there are two different alarms concerning the phase sequence error, and hereby two different failclasses. The alarm for phase sequence error and phase rotation is set in parameter 2150. The menu numbers is described in the table below:

Menu/ parameter no.	Menu text	Description
2151	Output A	Relay output if the AGC detecs a phase sequence error on the genset voltage terminals.
2152	Output B	Relay output if the AGC detects a phase sequence error on the genset voltage terminals.
2153	Failclass	Determines how the AGC reacts if the AGC sees a phase sequence error on the genset voltage terminals.
2154	Rotation	Determines the rotation of the voltages the AGC is measuring on. This is both for the Genset voltages and Mains voltages.
2155	Output A	Relay output if the AGC detects a phase sequence error on the mains voltage terminals. Since there is no output B on this alarm, it has been configured that output B is the same as output A.
2156	Failclass	Determines how the AGC reacts if the AGC sees a phase sequence error on the mains voltage terminals.

Example:
In a Stand alone application with GB and MB (like the application shown above), the parameters are set like in the table below:

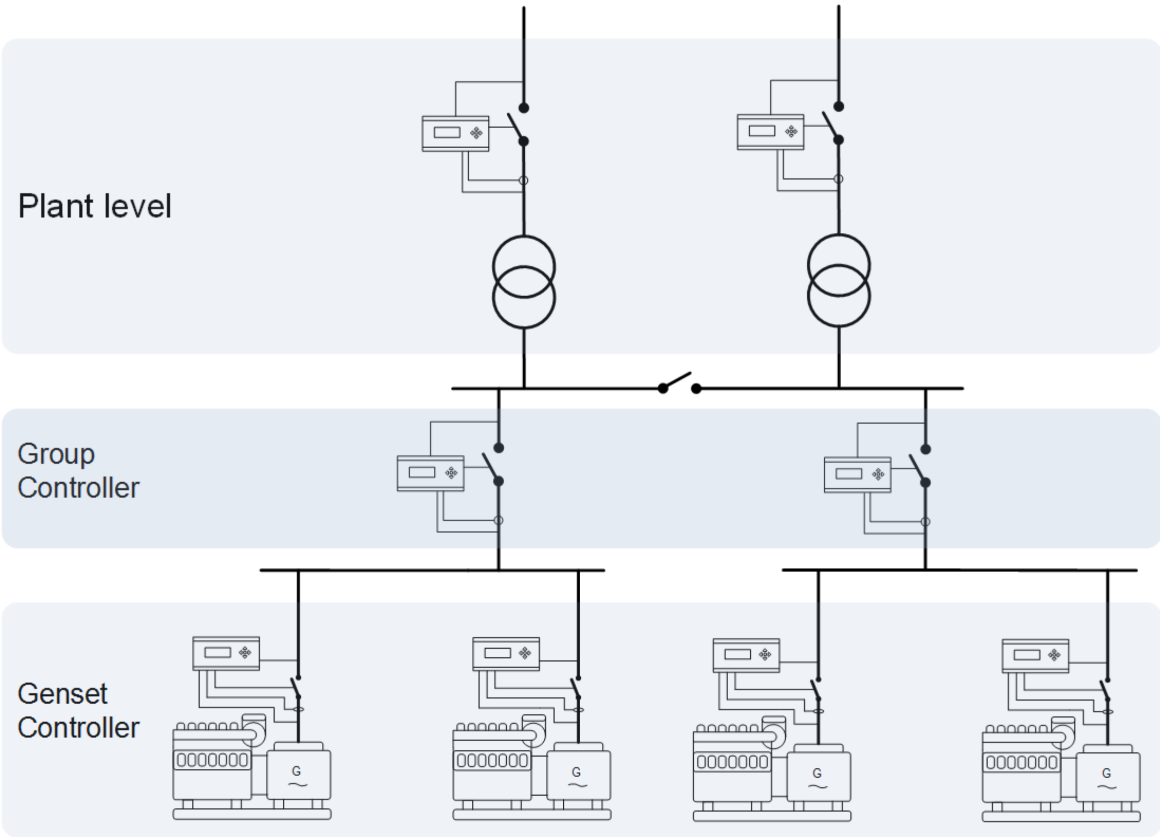
Menu/parameter no.	Menu text	Description
2151	Output A	Not used
2152	Output B	Not used
2153	Failclass	Trip+Stop
2154	Rotation	L1L2L3
2155	Output A	Not used
2156	Failclass	Trip MB

If the controller is set to Load Take Over (LTO) and the start signal is given the genset will start up. If there have been performed a service of the alternator, and two of the phases have been switched when the alternator has been assembled again, the AGC will now discover a phase sequence fail. Since this is on the genset

voltage terminals, the failclass set in parameter 2153 will be used. The failclass is set to Trip+Stop, which will trip the breaker (If the breaker is not closed, the controller will not send a trip signal), and then afterwards go into the stop sequence. If the alarm is acknowledged, the genset will start up again, if the start signal is still present.
In this plant there could be a situation where there is some changing in the grid. If the grid company is coupling in the grid, and the phase sequence in changed on the grid connection, and the Mains fail timers does not react on the small blackout, the failclass in parameter 2156 will be used. At the moment there is a phase sequence error on the mains voltage terminals, and the failclass is Trip MB. When the MB is tripped, the genset is started, since there is a trip alarm MB, and load does not have any power at the moment. In the same plant it can be possible to that a service of the transformer is going to happen. To test the Automatic Mains Failure (AMF) sequence, the technician removes the fuses, and the AGC will then discover the voltage is not present and afterwards start up the genset and take the load. When the technician is assembling the transformer again he accidently switches two phases. When the fuses is set into place again, the AGC will discover a phase sequence error on the mains voltages, and by this it will still keep running, until the phase sequence has been fixed.

Power management controller applications

In these applications there are different types of controllers. The three different types are: Genset, Group and Plant / Mains. The phase sequence alarms are located at parameter 2150. From here it is possible to configure both the alarms for phase sequence errors and also the phase rotation.
The alarms refer to different voltage terminals. The different types and models of controllers have different terminals. To know which voltage terminals the different alarms refers to, the drawing and tables below can be helpful.



For all the different controllers the table below is applicable:

Controller type	Mains voltage terminals	Busbar voltage terminals
AGC PM	79-84	85-89

Parameter 2150 is consisting of two alarms, and the phase rotation direction setting. The phase rotation setting is the same for the both terminal sets. The two alarms refer to the voltage terminals. To know which alarm refers to voltage measurement, the table below has been made to make an overview:

Menu/Parameter no.	Plant/Mains controller	Group controller	Genset controller
2153	Mains voltage	Bus A voltage	Genset voltage
2156	Busbar voltage	Bus B voltage	Busbar voltage

The diagram made earlier, can be helpful in locating where the different location of each voltage measurement is made.

When setting up the phase sequence alarms, it can be helpful to activate MB fail start (8181) in some of the mains controllers. This gives the possibility if e.g. the phase sequence error for mains voltage (2153) appears, and the failclass is Trip MB, then the gensets will start. If then autoswitch is enabled also (8184) the other grid connection can supply as backup load, before the gensets will start. If the other mains do not have a phase sequence error, the other mains will keep on supplying the load, and the gensets will not start.

8.2 Standard protections for generator

Standard protections for generator (ANSI)

- 2 x reverse power (32)
- 5 x overload (32)
- 6 x over-current (50/51)
- 2 x over-voltage (59)
- 3 x under-voltage (27)
- 3 x over-/under-frequency (81)
- Voltage-dependent over-current (51V)
- Current/voltage unbalance (60)
- Loss of excitation/over-excitation (40/32RV)
- Non-essential load/load shedding, 3 levels (I, Hz, P>, P>>)
- Multi-inputs (digital, 4-20 mA, 0-40 V DC, Pt100, Pt1000 or RMI)
- Digital inputs

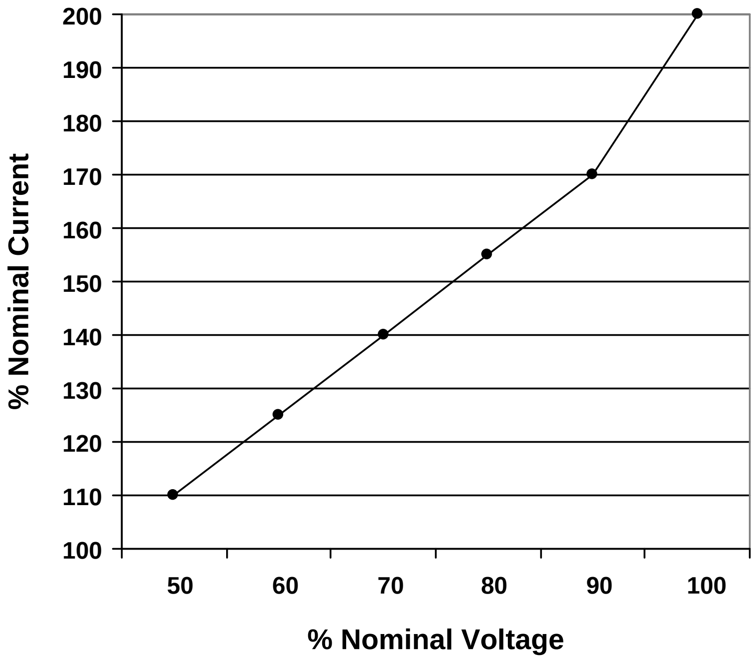
8.2.1 Voltage-dependent (restraint) over-current

Purpose
Over-current protection is a crucial component of the generator protection system, and its purpose is to protect the generator against overloading.
It is also used to isolate the generator in the event of a short-circuit fault.

Functional description
However, there is one issue to be considered when designing a protection for a generator. In case of a short circuit, the fault current is very high for a few milliseconds after a fault. This heavy current causes the generator voltage to drop. This drop in voltage causes the current to decay. Therefore, a high over-current setting may not operate in the event of a short-circuit.

To solve this problem, voltage-dependent over-current relays bias the over-current setting with the measured voltage. That is, at normal voltage, the over-current relay operates if the current exceeds the set-point. However, if there is a voltage drop the over-current setting also progressively decreases according to the biasing. Thus, at lower voltages, the current required to operate the relay is very low.
The protection will be activated based on the over-current set point as a function of the measured voltage on the generator voltage terminals.

The result can be expressed as a curve function where the voltage set points are fixed values and the current set points can be adjusted (parameter 1100). This means, that if the voltage drops, the over-current set point will also drop.



- *How a typical voltage-restrained relay works*

The voltage-restrained relay is using a voltage restraint U-Magnet and a coil to produce a restraint torque to oppose the operating coil to avoid false trips. The restraining torque is proportional to the voltage and shifts the relay pickup current. The voltage-restrained relay becomes more sensitive with increasing voltage drop, but is insensitive at normal voltage. At nominal voltage, the voltage-restrained relay is set to ride through permissible power swings.

The voltage values for the six points on the curve are fixed; the current values can be adjusted in the range 50-200 %.

Voltage and current % values refer to the nominal settings.

Timer value can be adjusted in the range 0.1- 60.0 sec.

Related parameters:

1100 G Iv > (50 %) Voltage-dependent over-current curve setting

Parameter	Item	Range	Default	Notes
1101	I1, G Iv > (50 %)	50.0%..... 200.0 %	110 %	Set point @50 % nom. voltage for generator current I1.
1102	I2, G Iv > (60 %)	50.0%..... 200.0 %	125 %	Set point @60 % nom. voltage for generator current I2.
1103	I3, G Iv > (70 %)	50.0%..... 200.0 %	140 %	Set point @70 % nom. voltage for generator current I3.
1104	I4, G Iv > (80 %)	50.0%..... 200.0 %	155 %	Set point @80 % nom. voltage for generator current I4.
1105	I5, G Iv > (90 %)	50.0%..... 200.0 %	170 %	Set point @90 % nom. voltage for generator current I5.
1106	I6, G Iv > (100 %)	50.0%..... 200.0 %	200 %	Set point @100 % nom. voltage for generator current I6.

The condition has to be true; this means that I1<I2<I3<I4<I5<I6. If this is not fulfilled, the worst-case set point I1 will be used.
Set points 3 to 6 include relay output A and B.

1110 G Iv > Voltage-dependent over-current alarm

Parameter	Item	Range	Default	Notes
1111	G Iv >, DEL	0.1 s.....10.0 s	1.0 s	DELAY Timer for voltage-dependent over-current alarm in seconds. The alarm is activated when the voltage-dependent over-current has been continuously above the programmed value during the programmed delay.
1112	G Iv >, OA	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63 Limits	Not used	Relay output A Option-dependent
1113	G Iv >, OB	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63 Limits	Not used	Relay output B Option-dependent
1114	G Iv >, ENA	OFF/ON	ON	Enables/disables alarm for voltage-dependent over-current. (Tick "Enable" in parameter 1110 i USW)
1115	G Iv >, FC	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/GB	Trip GB	Fail class. Selection of how the system should react when the voltage-dependent over-current has been continuously above the programmed value during the programmed time (delay).

Unbalanced current

The generator can be in a situation where it is not delivering its rated load, but the current is very high in one of the phases. This can be caused by an unbalanced load. When a generator load is unbalanced, the stress on the generator will be higher than normal. The heat in one of the windings can also be very high. Unbalanced load can also develop if a cable has been damaged or dropped off, or if a fuse to a single phase has blown. To protect the generator from unnecessary stress, the protection against unbalanced load can be used. It is located in parameters 1501 to 1506. Parameter 1203 is also related to these parameters, and it defines how the calculations should be done, and it can be set to nominal or average.

If parameter 1203 is set to nominal, the AGC uses the maximum and the minimum current and subtracts the values. Then it will compare this to the nominal current typed in parameter 6003, 6013, 6023 or 6033, depending on which of the nominal settings is activated. The comparison to the nominal current will give a percentage that is related to parameter 1501.

Example:
A genset is rated at 400 A and is supplying a load. The currents of the three phases are: 115 A, 110 A and 100 A. The AGC PM will use the maximum and the minimum current, in this case 115 A and 100 A. The calculation will now be: ((115 - 100)*100)/400 = 3.75 %. If parameter 1501 is set to 4 %, the genset will keep running. If parameter 1501 is set to 4 %, and the genset's rated current is 400 A, it can be calculated how unbalanced the genset is allowed to be: (4*400)/100 = 16 A. When the phases are loaded more than 16 A, the generator breaker will be tripped. This is independent of the size of the load.

Parameter 1203 can also be set to average. The AGC PM will then calculate an average of the phases and compare how unbalanced the load is between them.

Example: A genset is rated at 400 A and is supplying a load. The currents of the three phases are: 115 A, 110 A and 100 A. The AGC will now calculate an average of these currents, take the one that differs most from the average and calculate a percentage of deviation: (115 + 110 + 100)/3 = 108.3 A. Then the AGC will analyse which of the currents that differs most. In this example, it will be the 100 A. The maximum difference will be compared to the average current: ((108.3 - 100)*100)/108.3 = 7.7 %. If the load had been bigger, this calculated percentage would have been smaller. If the phase currents were 315 A, 310 A and 300 A, the average would be: (315 + 310 + 300)/3 = 308.3 A. This would give a deviation of:

((308.3 - 300)*100)/308.3 = 2.7 %.

- Related parameters

1500 Unbalance I 1 (unbalance current 1)

Parameter	Item	Range	Default	Notes
1501	Unbalance I 1, SP	0.0 %.....100.0 %	30.0 %	Set point for unbalance I 1 in % of I nominal
1502	Unbalance I 1, DEL	0.1 s.....100.0 s	10.0 s	DELAY Timer for unbalance I (current) 1 alarm in seconds. The alarm is activated when the unbalance I (current) 1 has been continuously above the programmed value during the programmed delay.
1503	Unbalance I 1, OA	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	A relay can be activated by output A. Option-dependent
1504	Unbalance I 1, OB	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	A relay can be activated by output A. Option-dependent
1505	Unbalance I 1, ENA	OFF/ON	OFF	Enables/disables alarm for unbalance I (current) 1. (Tick "Enable" in parameter 1500 i USW)
1506	Unbalance I 1, FC	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/G	Trip GB	Fail class. Selection of how the system should react when the unbalance I (current) 1 has been continuously above the programmed value during the programmed time (delay).

Unbalanced voltage

As well as having an unbalanced current protection, the AGC PM also has an unbalanced voltage protection. The AGC PM will measure on each of the phase voltages and compare them to each other. If the genset is mounted in an application with capacitors to compensate, and a failure occurs in one of the capacitors, a difference in voltage may appear. The windings for this phase will be overheated and thus exposed to heavy stress. To prevent this, the unbalanced voltage protection can be set.

The percentage set in parameter 1511 is a percentage of deviation compared to the average voltage in the three phases. The average comparison is described with an example below.

Example:
Phase L1 to L2 is 431 V, phase L2 to L3 is 400 V and phase L3 to L1 is 410 V. The three voltages must be added up to find an average voltage:
(431 + 400 + 410)/3 = 414 V. Now the voltage with the biggest voltage difference must be subtracted, in this case L1 to L2: 431 - 414 = 17 V.
Now the biggest voltage deviation in percent can be calculated: 17/414 = 4.1 %.

This means, that if parameter 1511 is set to 4.1 %, it is allowed to have a voltage difference of 31 V in this application, before the unbalanced voltage protection can be activated.

In the example, phase-phase measurements have been used. Phase-phase is selected as default, but it can also be phase-neutral measurements, and this can be changed in parameter 1201.

Be aware that when parameter 1201 is changed, it will influence other protections.

In parameter 1512, the timer can be set, and in parameter 1515 this protection is enabled. In parameter 1516 the fail class is decided. It is also possible to enable two relay outputs when the alarm occurs. The two relay outputs can be set in parameters 1513 and 1514.

- Related parameters

1510 G Unbalance U (unbalanced voltage)

Parameter	Item	Range	Default	Notes
1511	G Unbalance U, SP	0.0 %.....50.0 %	10.0 %	Set point for G Unbalance U in % of U nominal
1512	G Unbalance U, DEL	0.1 s.....100.0 s	10.0 s	DELAY Timer for G Unbalance U alarm in seconds. The alarm is activated when the G Unbalance U has been continuously above the programmed value during the programmed delay.
1513	G Unbalance U, OA	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	A relay can be activated by output A. Option-dependent
1514	G Unbalance U, OB	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	A relay can be activated by output A. Option-dependent
1515	G Unbalance U, ENA	OFF/ON	OFF	Enables/disables alarm for G Unbalance U. (Tick "Enable" in parameter 1510 i USW)
1516	G Unbalance U, FC	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/G	Trip GB	Fail class. Selection of how the system should react when the Unbalance I (current) 1 has been continuously above the programmed value during the programmed time (delay).

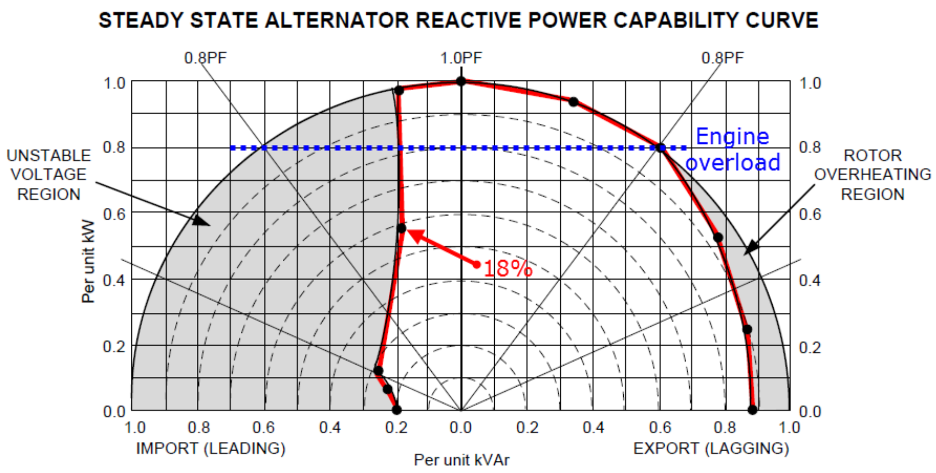
8.2.2 Loss of excitation/over-excitation

Loss of excitation (Reactive power import)
To prevent damage to the generator because of a pole slip, the AGC PM has a protection that can trip a breaker for example if loss of excitation occurs. The protection is located in parameters 1521 to 1526.

The percentage set in parameter 1521 is the maximum percentage of imported kvar compared to the nominal kW of the genset.

Example: The genset has a nominal of 1000 kW. The percentage in parameter 1521 is set to 15 %. This means that if the genset is 150 kvar capacitive or more, the timer set in parameter 1522 will start. When the timer has expired, an action will occur. This action/fail class is decided in parameter 1526.

To set the percentage correctly, a calculation must be made. For this purpose, the operating chart for the generator is needed. An operating chart for a generator is shown below.



The alternator 100 % load is the outer circle, and the engine 100 % load is the blue dotted line. With the operating chart, it is possible to see where the alternator-safe line is closest to the 1.0 PF line. This is marked with a red arrow. In this operating chart, each vertical line represents 10 %, and by this, the dot closets to 1.0 PF has been read to 18 %. With the nominal alternator values and the nominal engine values, the calculations can be made.

Example: The reading of 18 % is used. The alternator has a nominal power of 2500 kVA, and the engine has a nominal power of 2000 kW. The distance between the dot and the 1.0 PF line represents a power, and this is calculated to: 2500 kVA*18 % = 450 kvar.

The setting of parameter 1521 can now be calculated: 450 kvar/2000 kW = 22.5 %

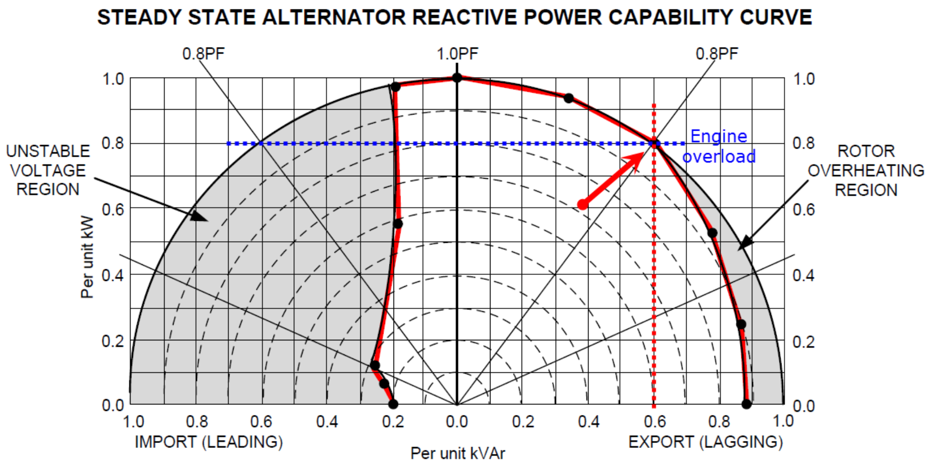
- Related parameters

1520 -Q > (Reactive power import (loss of excitation) protection)

Parameter	Item	Range	Default	Notes
1521	-Q >, SP	0.0 %.....150.0 %	50.0 %	Set point for -Q > (loss of excitation) in % of nominal power Pnom
1522	-Q >, DEL	0.1 s.....100.0 s	10.0 s	DELAY Timer for -Q > (loss of excitation) alarm in seconds. The alarm is activated when the -Q > (loss of excitation) has been continuously above the programmed value during the programmed delay.
1523	-Q >, OA	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	A relay can be activated by output A. Option-dependent
1524	-Q >, OB	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	A relay can be activated by output A. Option-dependent
1525	-Q >, ENA	OFF/ON	OFF	Enables/disables alarm for -Q > (loss of excitation). (Tick "Enable" in parameter 1520 i USW)
1526	-Q >, FC	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/G	Trip GB	Fail class. Selection of how the system should react when the -Q > (loss of excitation) has been continuously above the programmed value during the programmed time (delay).

Over-excitation (Reactive power export)
When heavy inductive loads are connected, an over-excitation of the generator can occur. Over-excitation can overheat windings in the generator and create a failure over time. Over-excitation can also occur if the load of a generator quickly changes from inductive to capacitive, or in an application with more than one generator in case one of the generators' exciter fails. To set the over-excitation protection correctly, the operating chart of the genset is requisite.

A random operating chart of a genset is shown below:



An example will be used to describe how the setting is made.

Example:
The engine is of 2000 kW, and the alternator is of 2500 kVA. The engine represents the blue dotted line in the diagram above, and the alternator is the "outer circle". When this protection is set, a specific point should be pointed out. It is the point where the engine curve and the alternator curve intersect, and it is marked with a red arrow in the operating chart. It is requisite to calculate how many kvar the genset can export:

$Q = \sqrt{S^2 - P^2} = \sqrt{2500^2 - 2000^2} = 1500\ kvar$. The kvar is used to calculate a percentage for parameter 1531. The percentage is calculated like this: kvar/kw = 1500/2000 = 75 %. When parameter 1531 is set to 75 %, the genset is allowed to export 1500 kvar all the time. The 75 % setting represents the red dotted line in the operating chart. It will be possible to set an alarm when the load has crossed the red dotted line for a certain period of time. The timer is set in parameter 1532.

- Related parameters

1530 Q > Reactive power export (over-excitation) protection

Parameter	Item	Range	Default	Notes
1531	Q >, SP	0.0 %.....100.0 %	60.0 %	Set point for Q > (over-excitation) in % of nominal pow-er Pnom
1532	Q >, DEL	0.1 s.....100.0 s	10.0 s	DELAY Timer for Q > (over-excitation) alarm in seconds. The alarm is acti-vated when the Q > (over-excitation) has been continu-ously above the programmed value during the pro-grammed delay.
1533	Q >, OA	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	A relay can be acti-vated by output A. Option-dependent
1534	Q >, OB	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	A relay can be acti-vated by output A. Option-dependent
1535	Q >, ENA	OFF/ON	OFF	Enables/disables alarm for Q > (over-excitation). (Tick "Enable" in parameter 1530 i USW)
1536	Q >, FC	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/G	Warning	Fail class. Selection of how the system should react when the Q > (over-excitation) has been continu-ously above the programmed value during the pro-grammed time (de-lay).

8.3 Standard protections for busbar

- 3 x over-voltage (59)
- 4 x under-voltage (27)
- 3 x over-frequency (81)
- 4 x under-frequency (81)
- Voltage unbalance (60)

8.4 Optional protections

8.4.1 Option A1

The option A1 (loss of mains protection package) is a software option and therefore not related to any hardware apart from the standard-installed hardware.
The option A1 is a mix of the following protections:
- Vector jump & df/dt (ROCOF)
- Time-dependent under-voltage
- Under-voltage & reactive power low
- Average busbar over-voltage

8.4.2 Vector jump and df/dt (ROCOF)

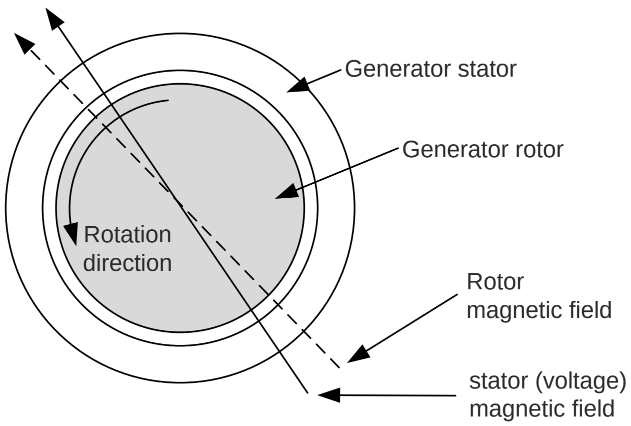
Purpose
The vector jump and df/dt protections are intended for detection of a mains failure and subsequent opening of the mains breaker.

Functional description
The vector jump (rapid phase jump) and df/dt (change of frequency over time), protections are used when the generator is paralleling with the mains. They are based on three individual single-phase measurements (individual monitoring of phases L1, L2 and L3). Therefore, the relay will trip if a vector jump and/or df/dt occurs in one of the three phases.

<u>The reasons are</u>:
In case of mains failure the generator will run "stand-alone" on the grid, attempting to supply power to all consumers. Naturally, this is not possible because of the mains failure, and an overload/over-current situation is likely to be the end result, as the mains consumption normally exceeds the generator capacity.
Mains transformer protection systems are constructed with a so-called "fast re-closing" feature. This means that if a failure occurs (e.g. a short circuit), then the transformer protection system will open the transformer breaker. But after a while (the actual time period depends on the specific country (e.g. 330 ms in Denmark)), the breaker will be re-closed to check whether it was a short-time failure, e.g. two overhead wires meeting shortly, a lightning strike, a branch falling down from a tree, etc. If the failure is still present, then the breaker will be reopened and remain there. This reclosing combined with the high overload on the generator means that the generator and the mains will be paralleled again without synchronisation, an operation which will most likely damage the entire genset. Ordinary protections will not identify a mains failure before it is too late (300 ms). Therefore, the vector jump and/or df/dt protections are used. These will detect the mains failure and open the breaker before re-closing occurs.

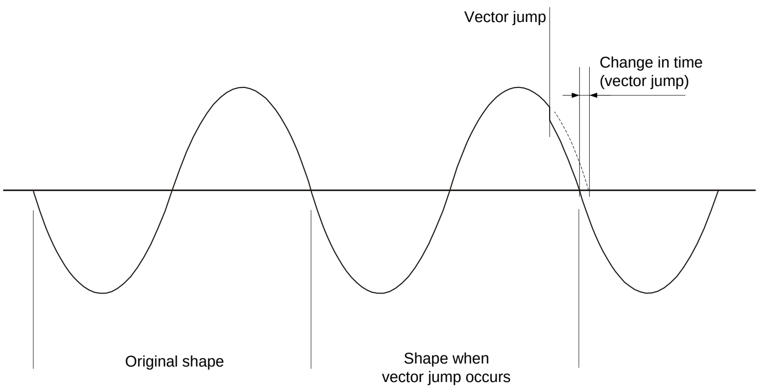
- **Vector jump**

Vector jump is based on the fact that the stator magnetic field – and as a result, the 3-phase voltage from a generator – lag a little behind the rotor magnetic field (in time and position).



If a mains failure occurs, the time lag of the stator magnetic field (and the output voltage) will change (jump). This is called a vector jump.

A vector jump illustrated in a sine wave:



Again, comparing the sine curve time duration with the previous ones, a sudden change in time can be detected. This is the vector jump.
The vector jump setting is made in electrical degrees. The Vector jump has no delay setting, since it reacts instantaneously. The delay will be the reaction time.

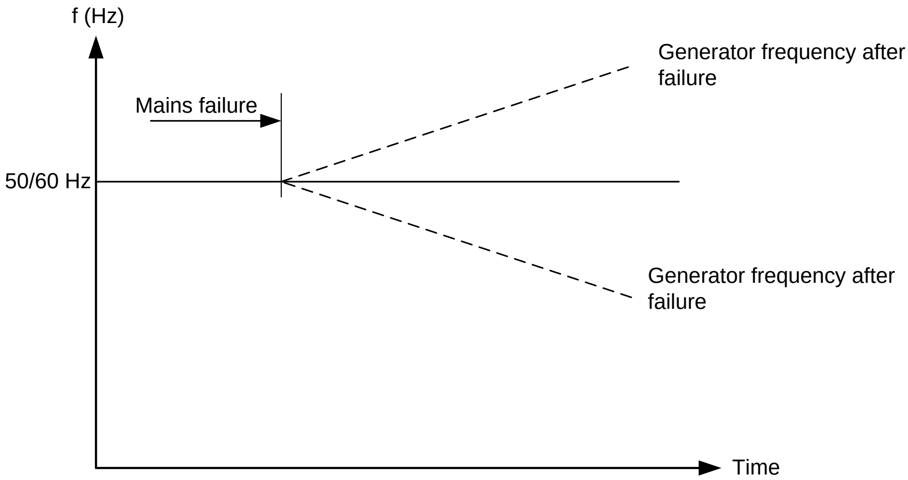
- Related parameters

1430 Vector jump

Parameter	Item	Range	Default	Notes
1431	Vector jump, SP	1.0 deg......90.0 deg.	10.0 deg.	Set point in degrees of vector jump protection
1432	Vector jump, OA	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output A Option-dependent
1433	Vector jump, OB	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output B Option-dependent
1434	Vector jump, ENA	OFF/ON	OFF	Enables/disables alarm for vector jump. (Tick "Enable" in parameter 1430 i USW)
1435	Vector jump, FC	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/GB	Trip MB	Fail class. Selection of how the system should react when a vector jump is detected.
1436	Vector jump, TYPE	Individual phases / All phases	Individual phases	Vector jump trip selection

- **df/dt (ROCOF)**

The df/dt function is based on the fact that the generator, if overloaded, will loose speed dramatically. Alternatively, it will speed up dramatically if a lot of load is dropped instantly.



So, a dramatic drop/increase of frequency over time is a mains failure. The df/dt setting is made in Hz/sec. The delay is set in periods, i.e. if the setting is set to "6per" (factory setting), the time delay will be 120 ms (50 Hz) or 100 ms (60 Hz). The total delay will be the delay setting + reaction time.

- **Adjustment of vector jump and df-dt (ROCOF)**
  - Distant mains breaker decoupling
    If a mains failure occurs in a system where a generator is running as a peak lopping/automatic mains failure generator, and if the loss of mains protections are used to decouple a mains breaker, care must be taken to prevent the generator breaker short circuit from tripping the generator breaker before the mains breaker is tripped. This may happen if the mains failure is a distant one, because it will leave so many remaining consumers connected to the genset that they will appear to be a short circuit when compared to the generator's nominal current. Compare the reaction + delay time of the vector jump/df/dt protection to the delay time of the generator breaker short circuit protection to determine whether this is a problem.
  - Load jumps
    Vector jump and df/dt protections are generally very reliable when used for generator protection to avoid asynchronous reconnection of the generator to the mains after a mains failure. Nevertheless, the protections may fail to react if no or a very small load change takes place upon mains failure. This can happen when the generator is used in a peak lopping or Combined Heat and Power (CHP) system, where the power flow to the mains is very low. In general, the system load change that is necessary to activate the vector jump or the df/dt protections is between 15-20 % of the plant’s rated power. Attempting to increase the sensitivity of the protection by lowering the set point value may result in false trips, because even the mains grid is not completely stable.

- **Related parameters**

1420 df/dt (ROCOF)

Parameter	Item	Range	Default	Notes
1421	df/dt (ROCOF), SP	1.5 Hz/s.....10.0 Hz/s	5.0 Hz/s	Set point for RO-COF protection (Rate Of Change Of Frequency)
1422	df/dt (ROCOF), DEL	3 periods.....20 pe-riods	6 periods	DELAY Timer for ROCOF protection delay in cycles
1423	df/dt (ROCOF), OA	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output A Option-dependent
1424	df/dt (ROCOF), OB	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output B Option-dependent
1425	df/dt (ROCOF), ENA	OFF/ON	OFF	Enables/disables alarm for df/dt. (Tick "Enable" in parameter 1430 i USW)
1426	df/dt (ROCOF), FC	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/GB	Trip MB (F6)	Fail class. Selection of how the system should react when the df/dt rate has been continuously above the programmed value during the programmed num-ber of periods (de-lay).

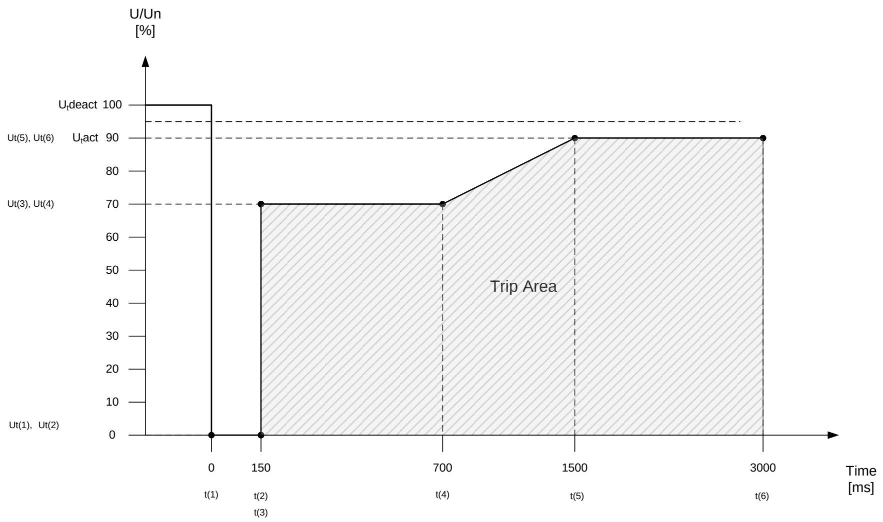
8.4.3 Time-dependent under-voltage

Purpose
The purpose of time-dependent under-voltage protection is to protect against any phase-phase voltage falls under the set voltage value .

Functional description
The time-dependent under-voltage protection is defined by six curve points. Each point consists of a voltage limit value and a time delay.

The protection will activate if any phase-phase voltage at any given time drops below the set voltage value (below the curve).
Between any two neighbouring points, the resulting curve is a straight line.

Example:



The above example is configured with the following parameter settings:

Menu	Settings	Name	Description
1631	30 %	Ut(1) Setting 1	Curve setting for time-dependent under-voltage. Settings relate to nominal generator voltage. The condition has to be true, which means that Ut(1)≤Ut(2)≤Ut(3)≤Ut(4)≤Ut(5)≤Ut(6). If this is not fulfilled, the worst-case set point Ut(6) will be used.
1632	0.00 sec.	t(1) Delay 1	
1633	30 %	Ut(2) Setting 1	
1634	0.15 sec.	t(2) Delay 1	
1635	70 %	Ut(3) Setting 1	
1636	0.15 sec.	t(3) Delay 1	
1641	70 %	Ut(4) Setting 1	
1642	0.70 sec.	t(4) Delay 1	
1643	90 %	Ut(5) Setting 1	
1644	1.50 sec.	t(5) Delay 1	
1645	90 %	Ut(6) Setting 1	
1646	3.00 sec.	t(6) Delay 1	
1651	90 %	$U_t$act (Activate)	Activate is the voltage value where the function timer starts.
1652	95 %	$U_t$deact (Reset)	Reset is the value where the function timer is reset to 0 ms.
1653	1.00 sec.	Delay	Delay is the delay timer for the reset.
1654		Relay output A	The relay outputs will activate immediately when the function timer starts.
1655		Relay output B	
1656	ON	Enable	
1661		Relay output A	The alarm and fail class is activated instantaneously when the voltage value is below the programmed value curve.
1662		Relay output B	
1663	ON	Enable	
1664	Trip MB	Fail class	

Please add 100 ms to the set point to allow for necessary relay reaction. So, if a set point of 150 ms is required, the t2 and t3 must be adjusted to [150+100=250 ms].

$U_t$deact: The voltage level in % of nominal voltage where the function is reset (function timer stops and resets)

$U_t$act: The voltage level in % of nominal voltage where the function is activated (function timer starts running)

U_t(1)-U_t(6): The voltage set points in % of nominal voltage

t(1)-t(6): The time in ms corresponding to the voltage set-point

U_t can be set with a minimum setting of 30 % of Unom. If the setting U_t(1) has a value of 30 % of Unom (minimum value), then this alarm is inhibited, allowing the voltage to drop to 0 % without tripping.

The under-frequency alarms are also inhibited until the time reaches the value t(2). The settings U_t(2) to U_t(6) will not affect the under-frequency alarm.

Related parameters

1630 Ut < SP 1-3 1 Time-dependent under-voltage 1-3 Setting 1
Curve setting for time-dependent under-voltage. Settings relate to nominal generator voltage. The condition has to be true, which means that Ut(1)≤Ut(2)≤Ut(3)≤Ut(4)≤Ut(5)≤Ut(6). If this is not fulfilled, the worst-case set point Ut(6) will be used.

Parameter	Item	Range	Default	Notes
1631	U1, U SP1, Ut < SP1 1	30.0%....120.0 %	30.0 %	Set-point, Setting 1 for time-dependent under-voltage.
1632	T1, Delay value SP1	0.00 s.....20.00 s	0.15 s	Timer (in seconds), delay 1
1633	U2, USP2 Ut < SP2 1	30.0%.....120.0 %	70.0 %	Setting 2 for time-dependent under-voltage.
1634	T2, Delay value SP2	0.00 s.....20.00 s	0.15 s	Timer (in seconds), delay 2
1635	U3, USP3 Ut < SP3 1	30.0%.....120.0 %	70.0 %	Setting 3 for time-dependent under-voltage.
1636	T3, Delay value SP3	0.00 s.....20.00 s	0.70 s	Timer (in seconds), delay 3

1640 Ut < SP 4-6 1 Time-dependent under-voltage 4-6 Setting 1
Curve setting for time-dependent under-voltage. Settings relate to nominal generator voltage. The condition has to be true, which means that Ut(1)≤Ut(2)≤Ut(3)≤Ut(4)≤Ut(5)≤Ut(6). If this is not fulfilled, the worst-case set point Ut(6) will be used.

Parameter	Item	Range	Default	Notes
1641	U4, U SP4, Ut < SP4 1	30.0 %....120.0 %	90.0 %	Setting 4 for time-dependent under-voltage.
1642	T4, Delay value SP4	0.00 s.....20.00 s	1.50 s	Timer (in seconds), delay 4
1643	U5, U SP5, Ut < SP5 1	30.0 %.....120.0 %	90.0 %	Setting 5 for time-dependent under-voltage.
1644	T5, Delay value SP5	0.00 s.....20.00 s	2.00 s	Timer (in seconds), delay 5
1645	U6, U SP6, Ut < SP6 1	30.0 %.....120.0 %	90.0 %	Setting 6 for time-dependent under-voltage.
1646	T6, Delay value SP6	0.00 s.....20.00 s	3.00 s	Timer (in seconds), delay 6

1670 Ut < SP 1-3 2 Time-dependent under-voltage 1-3 Setting 2
Curve setting for time-dependent under-voltage. Settings relate to nominal generator voltage. The condition has to be true, which means that Ut(1)≤Ut(2)≤Ut(3)≤Ut(4)≤Ut(5)≤Ut(6). If this is not fulfilled, the worst-case set point Ut(6) will be used.

Parameter	Item	Range	Default	Notes
1671	U1, U SP1, Ut < SP1 2	30.0 %.....120.0 %	30.0 %	Set point, Setting 1 for time-dependent under-voltage.
1672	T1, Delay value SP1	0.00 s.....20.00 s	0.15 s	Timer (in seconds), delay 1
1673	U2, USP2, Ut < SP2 2	30.0 %.....120.0 %	70.0 %	Setting 2 for time-dependent under-voltage.
1674	T2, Delay value SP2	0.00 s.....20.00 s	0.15 s	Timer (in seconds), delay 2
1675	U3, USP3 Ut < SP3 2	30.0 %.....120.0 %	70.0 %	Setting 3 for time-dependent under-voltage.
1676	T3, Delay value SP3	0.00 s.....20.00 s	0.70 s	Timer (in seconds), delay 3

1680 Ut < SP 4-6 2 Time-dependent under-voltage 4-6 Setting 2
Curve setting for time-dependent under-voltage. Settings relate to nominal generator voltage. The condition has to be true, which means that Ut(1)≤Ut(2)≤Ut(3)≤Ut(4)≤Ut(5)≤Ut(6). If this is not fulfilled, the worst-case set point Ut(6) will be used.

Parameter	Item	Range	Default	Notes
1681	U4, U SP4, Ut < SP4 2	30.0 % .....120.0 %	90.0 %	Set point, Setting 4 for time-dependent under-voltage.
1682	T1, Delay value SP4	0.00 s .....20.00 s	1.50 s	Timer (in seconds), delay 4
1683	U4, USP5, Ut < SP5 2	30.0 % .....120.0 %	90.0 %	Setting 5 for time-dependent under-voltage.
1684	T5, Delay value SP5	0.00 s .....20.00 s	2.00 s	Timer (in seconds), delay 5
1685	U6, USP6, Ut < SP6 2	30.0 % .....120.0 %	90.0 %	Setting 6 for time-dependent under-voltage.
1686	T6, Delay value SP6	0.00 s .....20.00 s	3.00 s	Timer (in seconds), delay 6

1650 Ut < Activate 1 Time-dependent under-voltage Setting 1 activation

Parameter	Item	Range	Default	Notes
1651	Ut < Activate 1	30.0 %.....120.0 %	90 %	Set point for "Activate". "Activate" is the voltage value where the function timer starts. Time-dependent under-voltage.
1652	SP, Ut < Recovery 1	30.0 %.....120.0 %	95 %	"Recovery" is the value where the function timer is reset to 0 ms. Time-dependent under-voltage.
1653	DEL, Ut < Recovery 1	0.0 s.....320.0 s	1.00 s	DELAY is the delay timer for the reset.
1654	OA, Ut < Activate 1	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output A activates immediately when the function timer starts. Option dependent Time dependent under -voltage.
1655	OB, Ut < Activate 1	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output B activates immediately when the function timer starts. Option-dependent Time-dependent under-voltage.
1656	ENA, Ut < Activate 1	OFF/ON	OFF	ENABLE, enables/ disables alarm for Activate 1. (Tick "Enable" in parameter 1654 i USW)

1690 Ut < Activate 2 Time-dependent under-voltage Setting 2 activation

Parameter	Item	Range	Default	Notes
1691	Ut < Activate 2	30.0 % .....120.0 %	90 %	Set point for "Activate". "Activate" is the voltage value where the function timer starts. Time-dependent under-voltage.
1692	SP, Ut < Recovery 2	30.0 % .....120.0 %	95 %	"Recovery" is the value where the function timer is reset to 0 ms. Time-dependent under-voltage.
1693	DEL, Ut < Recovery 2	0.0 s .....320.0 s	1.00 s	DELAY (in seconds) is the delay timer for the reset.
1694	OA, Ut < Activate 2	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output A activates immediately when the function timer starts. Option-dependent Time-dependent under-voltage.
1695	OB, Ut < Activate 2	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output B activates immediately when the function timer starts. Option-dependent Time-dependent under-voltage.
1696	ENA, Ut < Activate 2	OFF/ON	OFF	ENABLE, enables/disables alarm for Ut < Activate 2. (Tick "Enable" in parameter 1654 i USW)

1660 Ut < 1 Time-dependent under-voltage Setting 1

Parameter	Item	Range	Default	Notes
1661	OA, Ut < 1	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output A Option-dependent
1662	OB, Ut < 1	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output B Option-dependent
1663	ENA, Ut < 1	OFF/ON	OFF	ENABLE, enables/ disables alarm for Ut < 1 . (Tick "Enable" in parameter 1660 i USW). The alarm is activated instantaneously when the voltage value is under the programmed value curve.
1664	FC, Ut < 1	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/GB	Trip MB	Fail class. Selection of how the system should react when the voltage value is under the programmed value curve.

1700 Ut < 2 Time-dependent under-voltage Setting 2

Parameter	Item	Range	Default	Notes
1701	OA, Ut < 2	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output A Option-dependent
1702	OB, Ut < 2	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output B Option-dependent
1703	ENA, Ut < 2	OFF/ON	OFF	ENABLE, enables/ disables alarm for Ut < 2 . (Tick "Enable" in parameter 1700 i USW). The alarm is activated instantaneously when the voltage value is under the programmed value curve
1704	FC, Ut < 2	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/GB	Trip MB	Fail class. Selection of how the system should react when the voltage value is under the programmed value curve.

8.4.4 Under-voltage (U) and reactive power (Q) low, option A1

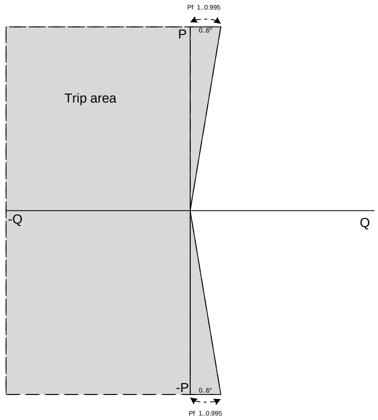
Purpose

The purpose of the both protection types (under-voltage U and reactive power Q low) is to avoid this at the same time:
- all three phase-phase generator voltages fall under the set voltage value and
- the reactive power Q = 0 or Q < 0

Functional description

The function U&Q< is active as soon as all three phase-phase generator voltages go below the voltage limit value (U-trip value) and the reactive power is equal to or below 0 (Q-trip value) at the same time. Tripping takes place if the function is active for more than the adjusted delay t(U&Q<).
The practical meaning of this is that the generator has no estabilishing effect for the disturbed grid and therefore must be disconnected.
The alarm in menu 1960 will be inhibited until the measured values are inside the limits in menus 1991 and 1992.

Menu 1993-1994 "U and Q Inh 2" is handled in the same way as "U and Q Inh".



Alarms in menus 1960 and 1970 will work without inhibits if default settings are used in menus 1991 and 1992.

Positive reactive Q > 0 means overexcited operation.

- **Related parameters**

1990 U and Q < 1, U and Q < 2 U and Q low Setting 1, U and Q low Setting 2
The setting relates to the generator nominal voltage. The condition for trip is that the actual voltage drops below the setting value and the reactive power is ≤ 0 kvar.

The following parameters are only displayed on the AGC PM controller and not visible on the USW (utility software). Only parameter 1960 is visible on the USW.

Parameter	Item	Range	Default	Notes
1991	I1, I Min. , U and Q< 1	0 %.....20 %	0 %	I Min. 1 is required as set-point for min. current level for each phase to activate the alarm. (setting 1) Settings relate to U and Q< parameters 1960 and 1970. Condition for "U and Q<" trip is that the current exceeds the I Min. set point.
1992	PHI1, U and Q< 1 Min. phi angle	0°..... 6°	0°	Angle 1 is required as set point for limitation of the power factor (PF) to activate the alarm 0° pf = 1.0 6° pf = 0.995 Set set points to 0 for backward compatibility
1993	I2, I Min. , U and Q< 2	0 %.....20 %	0 %	I Min. 2 is required as set point for min. current level for each phase to activate the alarm. (setting 2) Settings relate to U and Q< parameters 1960 and 1970. Condition for "U and Q<" trip is that the current exceeds the I Min. set point.

Parameter	Item	Range	Default	Notes
1994	PHI2, U and Q< 2 Min. phi angle	0°..... 6°	0°	Angle 2 is required as set point for limitation of the power factor (PF) to activate the alarm 0° pf = 1.0 6° pf = 0.995 Set set points to 0 for backward compatibility

1960 U and Q < 1 Under-voltage and reactive power low Setting 1
The setting relates to the generator nominal voltage. The condition for trip is that the actual voltage drops below the setting value and the reactive power is ≤ 0 kVAr.
The following parameters are only displayed on the AGC PM controller and not visible on the USW (utility software). Only the parameter 1960 is visible on the USW.

Parameter	Item	Range	Default	Notes
1961	SP, U and Q< 1	40.0 %.....100.0 %	85.0 %	Set-point for undervoltage (U and Q< 1)
1962	DEL, U and Q< 1	0.1 s.....3200.0 s	0.5 s	DELAY, Timer
1963	OA, U and Q< 1	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63 Limits	Not used	Relay output A Option-dependent
1964	OB, U and Q< 1	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63 Limits	Not used	Relay output B Option-dependent
1965	ENA, U and Q< 1	ON/OFF	OFF	ENABLE, enables/ disables alarm for U and Q <1 . (Tick "Enable" in parameter 1960 i USW)
1966	FC, U and Q< 1	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/GB	Warning	Fail class. Selection of how the AGC PM should react when the defined set point and timer values for the under-voltage and reactive power are exceeded.

1970 U and Q < 2 Undervoltage and reactive power low Setting 2
The setting relates to the generator nominal voltage. The condition for trip is that the actual voltage drops below the setting value and the reactive power is ≤ 0 kVAr.
The following parameters are only displayed on the AGC PM controller and not visible on the USW (utility software). Only the parameter 1970 is visible on the USW.

Parameter	Item	Range	Default	Notes
1971	SP, U and Q< 2	40.0 %.....100.0 %	85.0 %	Set point under-voltage and reactive power, setting 2
1972	DEL, U and Q< 2	0.1 s.....3200.0 s	0.5 s	DELAY, Timer
1973	OA, U and Q< 2	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63 Limits	Not used	Relay output A Option-dependent
1974	OB, U and Q< 2	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63 Limits	Not used	Relay output B Option-dependent
1975	ENA, U and Q< 2	ON/OFF	OFF	ENABLE, enables/disables alarm for U and Q <1 . (Tick "Enable" in parameter 1970 i USW)
1976	FC, U and Q< 2	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/GB	Warning	Fail class. Selection of how the AGC PM should react when the defined set point and timer values for the under-voltage and reactive power are exceeded.

8.4.5 Average busbar over-voltage

Purpose
The purpose of the average busbar over-voltage protection is to protect the busbar against an over-voltage.

Functional description
This type of protection is a busbar over-voltage alarm and is based on measuring, sampling and performing calculations to deliver a busbar voltage value. This is different from a usual definite time type alarm where a measured value trips an alarm according to a set point after expiring a predefined time.

Here the value, which trips the alarm according to a set point after expiring a predefined time must be calculated by the AGC PM (**average calculation**) and is not a measured value.
The AGC PM supports the busbar over-voltage protection with two levels of alarms:
(Avg U BB> 1 and Avg U BB> 2) which can be configured independently of each other. (See "Related parameters")

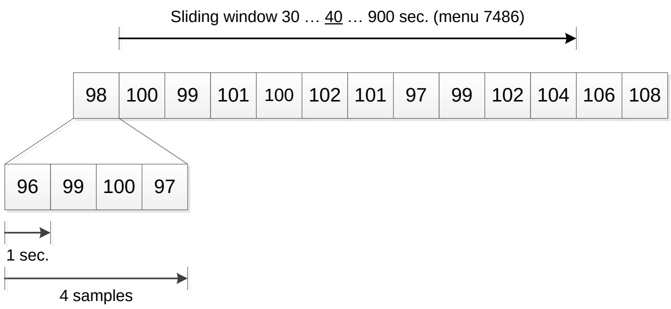
- **Average calculation**

The busbar voltage measurement is sampled once every second.
Then an intermediate average of the four samples is calculated and transferred to an ongoing stack (sliding window), where they are stored temporarily.
Then for the duration time (adjustable with parameter 7486) of the sliding window, the average busbar voltage value (avg. value) is calculated by a formula : **Avg. value = ∑values / n** .

The sliding window works after the FIFO (First In First Out) principle. This means here that every four seconds, the first intermediate calculation results in the sliding window being overwritten.
This also means that the average busbar voltage value (Avg. value) is calculated (updated) every time the sliding window time (adjustable with parameter 7486) expires.

The following example illustrates the "Average calculation" from above.

- **Example:**



The numbers in the above figure represent the busbar voltage as a percentage of the nominal busbar voltage.

As the figure shows, the value of the first intermediate calculation is 98 % ([96+99+100+97]/4), and this is transferred to the ongoing stack. The duration of the sliding window has been set to 40 seconds (with parameter 7486).
This means that the average value of the alarm is based on 10 four-sample intermediate average calculations.

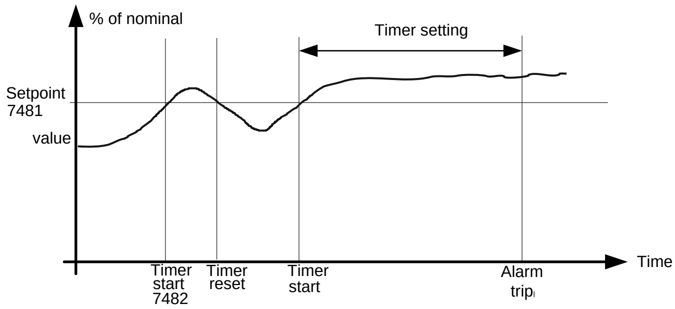
In this example, the average value will be:

$$Avg.value = \frac{\sum values}{n} = \frac{100+99+101+100+102+101+97+99+102+104}{10} = 100.5\ \%$$

- **Average alarm**

The value of the average calculation can be considered as an actual value.

In this context, the alarm works like a conventional definite alarm.
Once the value reaches the set point (adjustable with parameter 7481) for the busbar over-voltage alarm, the timer (adjustable with parameter 7482) related to this alarm is initiated and will trip the alarm if the value is higher than the set point for this period.
If the avg. value goes below the set point, the timer (parameter 7482) is reset.



Change of set point in menu 7486 will reset the Avg U BB > 1 value.

- **Related parameters**

7480 Avg U BB 1 7480 Average U BB Level 1

Parameter	Item	Range	Default	Notes
7481	SP, Avg U BB > 1	100.0 %..... 120.0 %	110.0 %	Set point for average voltage on bus-bar, level 1 (first critical value (level 1), e.g. when value exceeds 105.0 %, then the AGC PM gives a "Warning" as an alarm. Afterwards, when the value still increases to second critical value (level 2) the AGC PM for example trips the generator breaker (Trip GB).
7482	DEL, Avg U BB > 1	0.1 s.....3200.0 s	10.0 s	DELAY, timer (in seconds) for selection of how long the AGC PM waits before activating the selected alarm type ("Fail class" in USW) for level 1

Parameter	Item	Range	Default	Notes
7483	OA, Avg U BB > 1	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63 Limits	Not used	Output A for relay selection for level 1. Option-dependent. Selection of which relay/limits through output A is activated in case of an alarm. Possibly both on USW parameter 7480: output A, and on the AGC PM display: parameter 7483. Selection of an already used relay in output A gives a relay error (red alarm LED is flashing on the AGC PM display, and an error is displaed on the USW). Acknowledgement of the alarm sets the selection of relay to default: Not used).

Parameter	Item	Range	Default	Notes
Not available on AGC PM display	OB, Avg U BB > 1	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63 Limits	Not used	Output B for second relay selection for Level 1. Only visible in USW parameter 7480. Not visible on the AGC PM display. Option-dependent. Selection of which relay/limits through output A is activated in case of an alarm. Selection of an already used relay in output B gives a relay error (red alarm LED is flashing on the AGC PM display, and an error is displayed on the USW). Acknowledgement of alarm sets the selection of relay to default: Not used).
7484	ENA, Avg U BB > 1	ON/OFF	OFF	ENABLE, enables/ disables alarm related to parameter: Avg U BB > 1. (Tick "Enable" in parameter 7480 i USW)
7485	FC, Avg U BB > 1	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/GB	Warning	Fail class. Selection of how the AGC PM should react when the defined set point and timer value for the parameter 7480 Average U BB Level 1, is exceeded.

Parameter	Item	Range	Default	Notes
7486	AVG, Avg U BB > 1	30 s.....900 s	600 s	Average timer (in seconds) setting 1 for duration of sliding window to calculate the "Average value" as busbar voltage.

7490 Avg U BB 2, 7490 Average U BB Level 2

Parameter	Item	Range	Default	Notes
7491	SP, Avg U BB > 2	100.0 %..... 120.0 %	110.0 %	Set point busbar over-voltage average protection level 2
7492	DEL, Avg U BB > 2	0.1 s.....3200.0 s	0.5 s	DELAY, timer (in seconds)
7493	OA, Avg U BB > 2	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63 Limits	Not used	Relay output A Option-dependent
Not available on AGC-PM display	OB, Avg U BB > 2	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63 Limits	Not used	Output B for second relay selection for level 1. Only visible in USW parameter 7480. Not visible on the AGC PM display. Option-dependent. Selection of which relay/limits through output A is activated in case of an alarm. Selection of an already used relay in output B gives a relay error (red alarm LED is flashing on the AGC PM display, and an error is displayed on the USW). Acknowledgement of alarm is setting the selection of relay to default: Not used).

Parameter	Item	Range	Default	Notes
7494	ENA, Avg U BB > 2	ON/OFF	OFF	ENABLE, enables/ disables alarm related to parameter: Avg U BB > 2 . (Tick "Enable" in parameter 7490 i USW)
7495	FC, Avg U BB > 2	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/GB	Warning	Fail class. Selection of how the AGC PM should react when the defined set point and timer values for the under-voltage and reactive power are exceeded.
7496	AVG, Avg U BB > 2	30 s.....900 s	600 s	Average timer (in seconds) Setting 2 for duration of sliding window to calculate the "Average value" as busbar voltage.

8.4.6 Option A4 (positive sequence)

Purpose

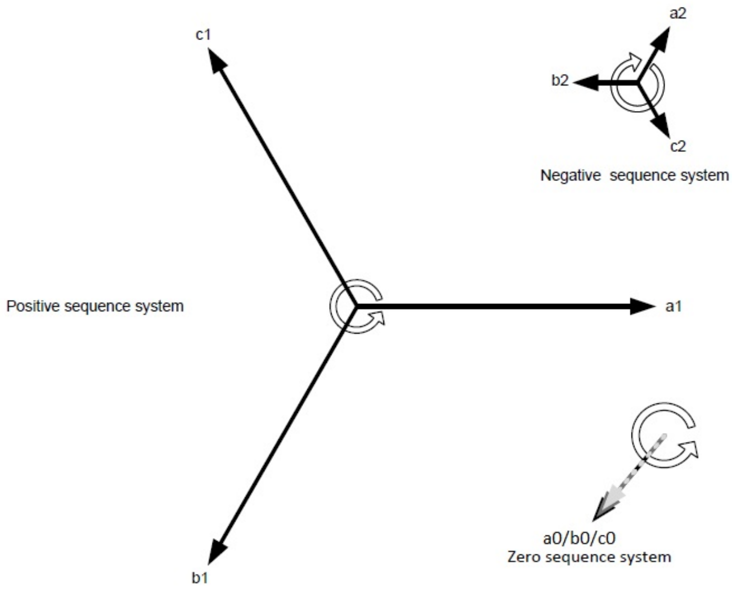
The purpose of the Option A4 protection (positive sequence) is to prevent motor malfunctioning due to insufficient or unbalanced supply voltage and is used when the generator is running in parallel with the mains.
It is a software option and therefore not related to any hardware apart from the standard-installed hardware.
In the following, the function of the Option A4 protection is described.

Functional description

- **Voltage vector system**

The measurements of the bus-bar/mains voltages are split up in three theoretical systems:
- The positive sequence system with a positive direction of rotation (Option A4).
- The negative sequence system with a negative direction of rotation (see Option C2).
- The zero sequence system with a positive direction of rotation (see Option C2).

As a result of the generator’s power production to the consumers, the positive sequence system represents the fault-free part of the voltages and currents.
The negative sequence system, which rotates in the opposite direction of the generator, is used by the protection’s negative sequence current and negative sequence voltage to prevent the generator from overheating.
The zero sequence system is used for detection of earth faults.



- **Positive sequence voltage**

The positive sequence voltage detects voltage state on the positive sequence voltage part of the 3-phase voltage vector diagram of the busbar/mains.
The positive sequence voltage low calculation takes place in the zero crossing of all three phases to make the protection as fast as possible.

- Related parameters

1440 BB Pos seq volt (Busbar positive sequence voltage)

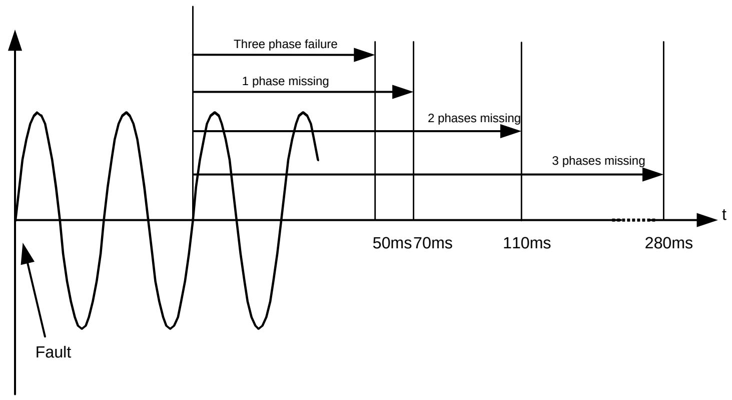
Parameter	Item	Range	Default	Notes
1441	BB Pos seq volt, SP	10.0 %.....110.0 %	70 %	Set point in % of U nominal for positive sequence (mains) voltage low
1442	BB Pos seq volt, DEL	1 per.....9 per	2 periods	DELAY time for the positive sequence alarm. Timer for positive sequence voltage, which detects the voltage state on the positive sequence voltage part of the three-phase voltage vector diagram of the busbar/mains. Default of 2 periods means that the error has to be active in 2 whole periods before the alarm will be tripped. **Read response time
1443	BB Pos seq volt, OA	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output A Selection of relay output to trip at the same time as the busbar positive sequence voltage alarm. Option-dependent
1444	BB Pos seq volt, OB	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output B Selection of relay output to trip at the same time as the busbar positive sequence voltage alarm. Option-dependent

Parameter	Item	Range	Default	Notes
1445	BB Pos seq volt, ENA	OFF/ON	OFF	Enables/disables alarm for bus-bar positive sequence voltage. (Tick "Enable" in parameter 1440 in the USW)
1446	BB Pos seq volt, FC	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/GB	Trip MB	Fail class. Selection of how the system should react when a busbar positive sequence voltage is detected. Here, the selected fail class is activated when the symmetrical (positive sequence) voltage has been continuously below the programmed value during the programmed delay.

- ****Response time**

The time delay for the positive sequence alarm can be adjusted. It is adjusted in periods, not seconds. The response times specified below are measured with a 2-period delay.

Delay:	Response time	Recommended protection for fast trip	Remarks
Fault:			
3-phase fault	<50 ms	BB pos seq volt	Option A4
1 phase missing	<70 ms	BB U<	Option A1
2 phases missing	<110 ms	BB U<	Option A1
3 phases missing	<285 ms	df/dt or vector jump	Option A1



The diagram shows that when the fault has been present for two periods, the relay will trip within the specified time.

Response time is with 2 periods delay setting. The response time counts from the end of the delay.

8.4.7 Option A5 (directional over-current protection)

Purpose

The purpose of the Option 5 (Directional over-current protection) is to protect against over-currents for a particular current-direction flow.
This type of protection is often used when dictated by a national or regional utility company.
It can also be used as a supplement to reverse power. In case of a distortion of currents in a reverse power situation, the total reverse power remains the same, and reverse power protection will not activate. In such a situation, the "Directional over-current protection" is applicable to ensure tripping.
Option A5 is a software option and therefore not related to any hardware apart from the standard-installed hardware.

Functional description

- *Loss of mains protection*

Typically, a loss of mains situation will result in activation of one or more of the loss of mains protections. The directional over-current protection is also ranged in the group of loss of mains protections but does not substitute the traditional loss of mains protections.
When operating parallel to the mains, for example in a base load application where the base-loaded generator is only meant to supply the factory load, a disconnected breaker in the HV transmission line means that the generator plant will be islanded, and it will supply power to the consumers that are connected on the mains side.
Then, the directional over-current protection activates and trips the MB.

- **Parallel mains application**

The protection is typically used when it is not allowed to export power to the mains.
In such a system, the AGC PM plant is working parallel to the mains. The generators supply part of the load, and the mains supply the remaining part of the load.

If the load decreases and the generators produce the same power, eventually the generators would supply power to the mains, and in some places this is not allowed by the utility company.
The set point can be adjusted to activate at a slight current export, for example -0.1 %.

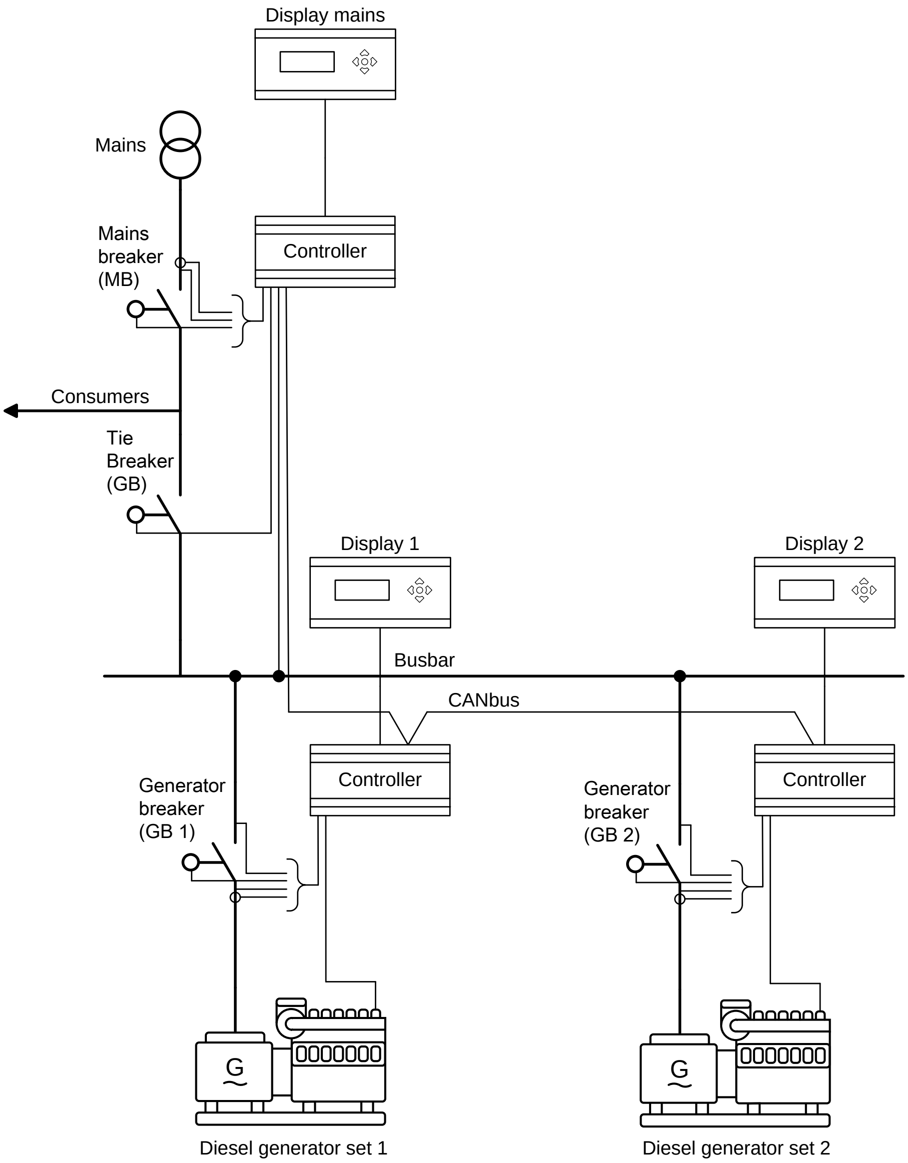
- **Measurement explanations**

The power measurement will be shown on the display with either positive or negative sign. When the measurement is positive, the current is flowing towards the application. When the measurement is negative, the current is flowing towards the generator if it is a generator controller, and towards the mains if it is a mains controller. The measurement of the AC-directional over-current protection is based on actual current measurements on the unit. If any of the three current measurements flows to an unwanted direction, the relay will trip (depending on the set point).
The setting range of the protection is: - 200 %.....0..... 200 %.
In the negative range, the current flows towards the generator if it is a generator controller, and towards the mains if it is a mains controller.
In the positive range, the current flows towards the application.

- **Examples**

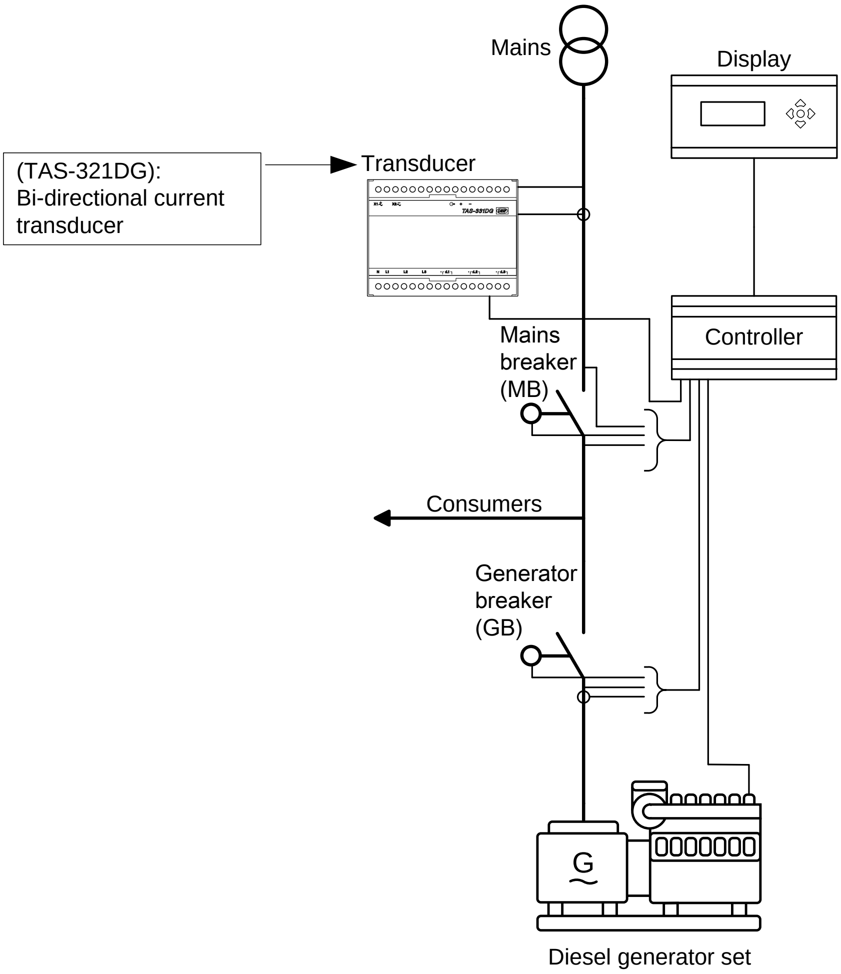
Example 1: Directional over-current protection with mains unit

The directional over-current protection is typically used for tripping the mains breaker (MB) controlled by the AGC PM.



Example 2: Directional over-current protection without a mains unit

If the loss of mains protection is needed for the AGC PM without power management (no mains unit is installed), it is necessary to install a measurement transducer TAS-321DG (please refer to www.deif.com for details). The transducer will measure the direction of the current and will send a 4 to 20 mA signal to an analogue input on the AGC PM.



Channel 7003	Channel 7004
Transducer maximum	Transducer minimum
20 mA	4 mA
Setting: For example 200 kW	Setting: For example -200 kW

The current measurement is positive when current is supplied from the generator or mains to the application. The current measurement is negative when current is flowing to the mains or the generator.

Related parameters

1600 I > direct. 1 (Directional over-current 1)

Parameter	Item	Range	Default	Notes
1601	I> direct 1, SP	- 200.0 %... 200.0 %	120.0%	Set point 1 in % of nominal current (I) for directional over-current alarm. **(-) Negative range:** The measured current flows towards the generator if it is a generator controller, and towards the mains if it is a mains controller. **Positive range:** The current flows towards the application
1602	I> direct 1, DEL	0.0 s.....100.0 s	0.1 s	DELAY, timer (in seconds) for selection of how long the AGC PM waits before activating the selected alarm type ("Fail class" in USW) for directional over-current alarm set point 1 (I> direct 1)
1603	I> direct 1, OA	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output A Selection of relay output to trip in same time with directional over-current alarm. Option-dependent
1604	I> direct 1, OB	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output B Selection of relay output to trip in same time with directional over-current alarm. Option-dependent

Parameter	Item	Range	Default	Notes
1605	I> direct 1, ENA	ON/OFF	OFF	Enables/disables alarm for directional over-current. (Tick "Enable" in parameter 1600 in USW)
1606	I> direct 1, FC	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/GB	Trip MB	Fail class. Selection of how the system should react when a directional over-current is detected. Here the selected fail class is activated when the directional over-current has been continuously over the programmed value during the programmed delay.

1610 I > direct. 2 (Directional over-current 2)

Parameter	Item	Range	Default	Notes
1611	I> direct 2, SP	- 200.0 %... 200.0 %	130.0%	Set point 2 in % of nominal current (I) for directional over-current alarm. **(-) Negative range:** The measured current flows towards the generator if it is a generator controller, and towards the mains if it is a mains controller. **Positive range:** The current flows towards the application
1612	I> direct 2, DEL	0.0 s.....100.0 s	0.1 s	DELAY, timer (in seconds) for selection of how long the AGC PM waits before activating the selected alarm type ("Fail class" in USW) for directional over-current alarm set point 2 (I> direct 2)
1613	I> direct 2, OA	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output A Selection of relay output to trip at the same time as the directional over-current alarm. Option-dependent
1614	I> direct 2, OB	Not used, Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output B Selection of relay output to trip at the same time as the directional over-current alarm. Option-dependent

Parameter	Item	Range	Default	Notes
1615	I> direct 2, ENA	ON/OFF	OFF	Enables/disables alarm for directional over-current. (Tick "Enable" in parameter 1610 in USW)
1616	I> direct 2, FC	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/GB	Trip MB	Fail class. Selection of how the system should react when a directional over-current is detected. Here the selected fail class is activated when the directional over-current has been continuously over the programmed value during the programmed delay.

8.4.8 Option C2 (negative, zero sequence, power-dependent reactive power, inverse time over-current)

Purpose:

The Option C2 (also named as "Generator add-on protection package") consists of the following protections:

- Negative sequence (voltage/current), used to prevent the generator from overheating.

- Zero sequence (voltage/current), used to recognise earth faults.

- Power-dependent reactive power, used to indicate reactive loads at any power load for the generator.

- Inverse time over-current, used to protect against current faults due to a time characteristic.

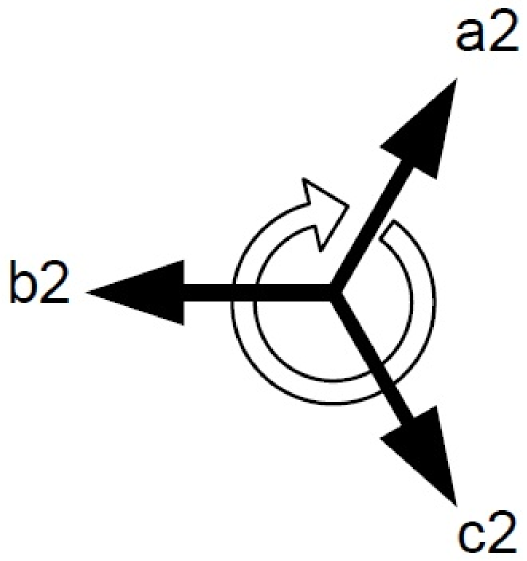
The Option C2 is used when the generator is running parallel with the mains and protects against motor malfunctioning due to insufficient or unbalanced supply voltage.
It is a software option and therefore not related to any hardware apart from the standard-installed hardware.
In the following, the function of the Option C2 protection is described.

Functional description:

- **Negative sequence**

The negative sequence system, which rotates in the opposite direction of the generator, is used by the protections negative sequence current and negative sequence voltage.
A negative sequence current increases the risk of dangerous overheating in the generator, which could lead to general damage.

The negative sequence currents and voltages can occur e.g. in the event of single phase loads, unbalanced line short circuits and open conductors, unbalanced phase-phase or phase-neutral loads.
Especially the negative sequence currents can produce harmful overheating inside the generator. The reason is that these currents produce a magnetic field counter-rotating to the rotor.



- Related parameters

1540 Neg. seq. I (Negative sequence current, I), all settings relate to nominal current

Parameter	Item	Range	Default	Notes
1541	Neg. seq. I, SP	1.0.....100.0 %	20 %	Set point for (Neg. seq. I) negative sequence current alarm
1542	Neg. seq. I, DEL	0.2.....100.0 s	0.5 s	DELAY, timer (in seconds) for selection of how long the AGC PM waits before activating the selected alarm type ("Fail class" in USW) for (Neg. seq. I) Negative sequence current alarm.
1543	Neg. seq. I, OA	Not used Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output A Selection of relay output to trip at the same time as (Neg. seq. I) negative sequence current alarm.
1544	Neg. seq. I, OB	Not used Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output B Selection of relay output to trip at the same time as (Neg. seq. I) negative sequence current alarm.
1545	Neg. seq. I, ENA	ON OFF	OFF	Enables/disables alarm for (Neg. seq. I) negative sequence current. (Tick "Enable" in parameter 1540 in USW)

Parameter	Item	Range	Default	Notes
1546	Neg. seq. I, FC	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/GB	Trip MB	Fail class. Selection of how the system should react when a (Neg. seq. I) negative sequence current is detected. Here the selected fail class is activated when the (Neg. seq. I) negative sequence current has been continuously over the programmed value during the programmed delay.

1550 G neg. seq. U (Negative sequence voltage, U), all settings relate to nominal voltage

Parameter	Item	Range	Default	Notes
1551	G neg. seq. U, SP	1.0.....100.0 %	5.0 %	Set point for (Neg. seq. U) negative sequence voltage alarm
1552	G neg. seq. U, DEL	0.2.....100.0 s	0.5 s	DELAY, timer (in seconds) for selection of how long the AGC PM waits before activating the selected alarm type ("Fail class" in USW) for (Neg. seq. U) negative sequence voltage alarm.
1553	G neg. seq. U, OA	Not used Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output A Selection of relay output to trip at the same time as (Neg. seq. U) negative sequence voltage alarm.
1554	G neg. seq. U, OB	Not used Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output B Selection of relay output to trip at the same time as (Neg. seq. U) negative sequence voltage alarm.
1555	G neg. seq. U, ENA	ON/OFF	OFF	Enables/disables alarm for (Neg. seq. U) negative sequence voltage. (Tick "Enable" in parameter 1550 in USW)

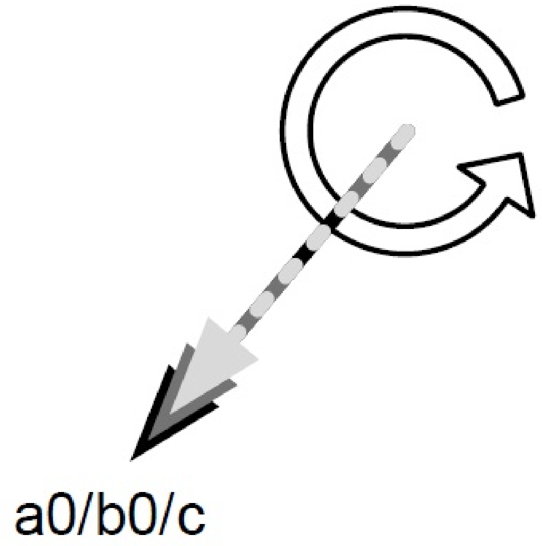
Parameter	Item	Range	Default	Notes
1556	G neg. seq. U, FC	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/GB	Trip MB	Fail class. Selection of how the system should react when a (Neg. seq. U) negative sequence voltage is detected. Here the selected fail class is activated when the (Neg. seq. U) negative sequence voltage has been continuously over the programmed value during the programmed delay.

1560 Neg. seq select (negative sequence selection)

Parameter	Item	Range	Default	Notes
1561	Neg. seq select, TYPE	G measurement BB measurement	G measurement	Selection between generator or bus bar measurement of negative sequence voltage.

- **Zero Sequence**

Zero sequence is used to detect an earth fault (earth current or neutral voltage).
It is performed by measuring the vectorial displacement of the zero value (star point) for both current and voltage.
The zero sequence measurement can therefore replace the more well-known methods, namely those using zero voltage measurement or summation transformers (zero sequence transformers).


a0/b0/c

- Related parameters

1570 Zero seq. I (zero sequence current, I), settings relate to nominal current

Parameter	Item	Range	Default	Notes
1571	Zero seq. I, SP	0.0.....100.0 %	20.0 %	Set point for (Zero seq. I) zero sequence current alarm
1572	Zero seq. I, DEL	0.2.....100.0 s	0.5 s	DELAY, timer (in seconds) for selection of how long the AGC PM waits before activating the selected alarm type ("Fail class" in USW) for (Zero seq. I) zero sequence current alarm.
1573	Zero seq. I, OA	Not used Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output A Selection of relay output to trip at the same time as (Zero seq. I) zero sequence current alarm.
1574	Zero seq. I, OB	Not used Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output B Selection of relay output to trip at the same time as (Zero seq. I) zero sequence current alarm.
1575	Zero seq. I, ENA	ON OFF	OFF	Enables/disables alarm for (Zero seq. I) zero sequence current . (Tick "Enable" in parameter 1570 in USW)

Parameter	Item	Range	Default	Notes
1576	Zero seq. I, FC	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/GB	Trip MB	Fail class. Selection of how the system should react when a (Zero seq. I) zero sequence current is detected. Here the selected fail class is activated when the (Zero seq. I) zero sequence current has been continuously over the programmed value during the programmed delay.

1580 G zero seq.U (zero sequence voltage, U)

Parameter	Item	Range	Default	Notes
1581	G zero seq. U, SP	0.0.....100.0%	5.0 %	Set point for (Zero seq. U) zero sequence voltage alarm
1582	G zero seq. U, DEL	0.2.....100.0 s	0.5 s	DELAY, timer (in seconds) for selection of how long the AGC PM waits before activating the selected alarm type ("Fail class" in USW) for (Zero seq. U) zero sequence voltage alarm.
1583	G zero seq. U, OA	Not used Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output A Selection of relay output to trip at the same time as (Zero seq. U) zero sequence voltage alarm.
1584	G zero seq. U, OB	Not used Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63	Not used	Relay output B Selection of relay output to trip at the same time as (Zero seq. U) zero sequence voltage alarm.
1585	G zero seq. U, ENA	ON OFF	OFF	Enables/disables alarm for (Zero seq. U) zero sequence voltage. (Tick "Enable" in parameter 1580 in USW)

Parameter	Item	Range	Default	Notes
1586	G zero seq. U, FC	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/GB	Trip MB	Fail class. Selection of how the system should react when a (Zero seq. U) Zero sequence voltage is detected. Here the selected fail class is activated when the (Zero seq. U) zero sequence voltage has been continuously over the programmed value during the programmed delay.

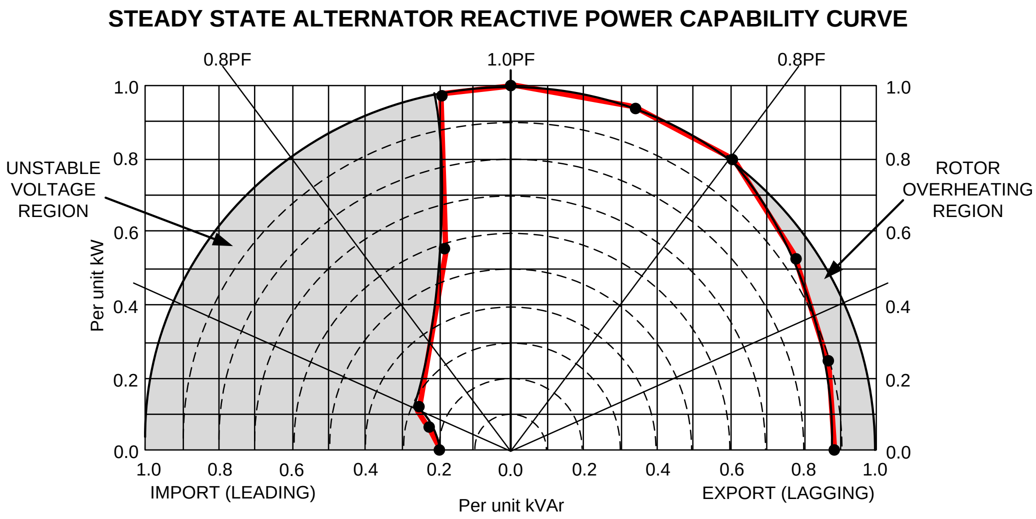
1590 Zero seq select (zero sequence selection)

Parameter	Item	Range	Default	Notes
1591	Zero seq select	G measurement BB measurement	G measurement	Selection between generator or busbar measurement of zero sequence voltage.

- **Power dependent reactive power**

Steady state alternator reactive power capability curve:
This curve indicates the possible reactive load at any given power load for the generator in question, for exporting and importing reactive power.
As the reactive power varies in a non-linear way with actual (power) load, the setting of trip values is made with a 12-point curve, six for lagging and six for leading reactive power. The unit carries out a linear regression between any two given points in order to find the trip point between the curve point settings.
Each of the 12 points has a setting for real power (P) and a setting for the related reactive power (Q). There are two separate reference settings (parameters) for apparent power, one for reactive power import and one for reactive power export. The intention of these two settings is that they should match the rated nominal apparent power of the genset. These two parameters only apply to this specific protection.

Setting curves:



The settings of points 1-6, leading and lagging, should represent the generator manufacturer's recommended settings for var import (-Q)/export (+Q).
Please notice that the above curve is just an example, the actual values must be obtained from the generator manufacturer.

It is imperative that the generator does not enter any of the grey areas. If it does, rotor overheating (export) or loss of synchronism (import) may occur.

In the above diagram, the positive power/reactive power flow direction is defined as the direction from the generator to the consumer, i.e. increasing export (lagging) is equal to increasing excitation.

- Related parameters

1740 P dep Q < 1-3 (power-dependent reactive power import 1-3)

Parameter	Item	Range	Default	Notes
1741	P dep Q < Q1	0.0.....100.0 %	20 %	Set point for reactive power Q1 of power-dependent reactive power import
1742	P dep Q < P1	0.0.....100.0 %	0.0 %	Set point for power P1 of power-dependent reactive power import
1743	P dep Q < Q2	0.0.....100.0 %	22.0 %	Set point for reactive power Q2 of power-dependent reactive power import
1744	P dep Q < P2	0.0.....100.0 %	7.0 %	Set point for power P2 of power-dependent reactive power import
1745	P dep Q < Q3	0.0.....100.0 %	27.0 %	Set point for reactive power Q3 of power-dependent reactive power import
1746	P dep Q < P3, SP	0.0.....100.0 %	12.0 %	Set point for power P3 of power-dependent reactive power import

1750 P dep Q < 4-6 (power-dependent reactive power import 4-6)

Parameter	Item	Range	Default	Notes
1751	P dep Q < Q4	0.0.....100.0 %	18.0 %	Set point for reactive power Q4 of power-dependent reactive power import
1752	P dep Q < P4	0.0.....100.0 %	55.0 %	Set point for power P4 of power-dependent reactive power import
1753	P dep Q < Q5	0.0.....100.0 %	21.0 %	Set point for reactive power Q5 of power-dependent reactive power import
1754	P dep Q < P5	0.0.....100.0 %	97.0 %	Set point for power P5 of power-dependent reactive power import
1755	P dep Q < Q6	0.0.....100.0 %	1.0 %	Set point for reactive power Q6 of power-dependent reactive power import
1756	P dep Q < P6	0.0.....100.0 %	100.0 %	Set point for power P6 of power-dependent reactive power import

1760 P dep Q < (power-dependent reactive power import)

Parameter	Item	Range	Default	Notes
1761	P dep Q <, DEL	0.1.....300.0 s	1.0 s	DELAY, timer (in seconds) for selection of how long the AGC PM waits before activating the selected alarm type ("Fail class" in USW) for P dep Q < Power-dependent reactive power import alarm.
1762	P dep Q <, OA	Not used Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63 Limits	Not used	Relay output A Selection of relay output to trip in same time with P dep Q < Power-dependent reactive power import alarm. Option-dependent
1763	P dep Q <, OB	Not used Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63 Limits	Not used	Relay Output B Selection of relay output to trip in same time with P dep Q < Power-dependent reactive power import alarm. Option-dependent
1764	P dep Q <, ENA	ON OFF	OFF	Enables/disables alarm for P dep Q < Power-dependent reactive power import. (Tick "Enable" in parameter 1761 in USW)

Parameter	Item	Range	Default	Notes
1765	P dep Q <, FC	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/GB	Trip GB	Fail class. Selection of how the system should react when a directional over-current is detected. Here the selected fail class is activated when the P dep Q < Power-dependent reactive power import has been continuously over the programmed value during the programmed delay.

1770 P dep Q > 1-3 (power-dependent reactive power export 1-3)

Parameter	Item	Range	Default	Notes
1771	P dep Q > Q1	0.0.....100.0 %	88.0 %	Set point for reactive power Q1 of power-dependent reactive power export
1772	P dep Q > P1	0.0.....100.0 %	0.0 %	Set point for power P1 of power-dependent reactive power export
1773	P dep Q > Q2	0.0.....100.0 %	86.0 %	Set point for reactive power Q2 of power-dependent reactive power export
1774	P dep Q > P2	0.0.....100.0 %	24.0 %	Set point for power P2 of power- dependent reactive power export
1775	P dep Q > Q3	0.0.....100.0 %	77.0 %	Set point for reactive power Q3 of power-dependent reactive power export
1776	P dep Q > P3	0.0.....100.0 %	53.0 %	Set point for power P3 of power-dependent reactive power export

1780 P dep Q > 4-6 (power-dependent reactive power export 4-6)

Parameter	Item	Range	Default	Notes
1781	P dep Q > Q4	0.0.....100.0 %	60.0 %	Set point for reactive power Q4 of power-dependent reactive power export
1782	P dep Q > P4	0.0.....100.0 %	80.0 %	Set point for power P4 of power-dependent reactive power export
1783	P dep Q > Q5	0.0.....100.0 %	33.0 %	Set point for reactive power Q5 of power-dependent reactive power export
1784	P dep Q > P5	0.0.....100.0 %	95.0 %	Set point for power P5 of power-dependent reactive power export
1785	P dep Q > Q6	0.0.....100.0 %	1.0 %	Set point for reactive power Q6 of power-dependent reactive power export
1786	P dep Q > P6	0.0.....100.0 %	100.0 %	Set point for power P6 of power-dependent reactive power export

1790 P dep Q > (power-dependent reactive power export)

Parameter	Item	Range	Default	Notes
1791	P dep Q >, DEL	0.1.....300.0 s	1.0 s	DELAY, timer (in seconds) for selection of how long the AGC PM waits before activating the selected alarm type ("Fail class" in USW) for P dep Q < Power-dependent reactive power export alarm.
1792	P dep Q >, OA	Not used Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63 Limits	Not used	Relay output A Selection of relay output to trip at the same time as P dep Q < Power-dependent reactive power export alarm. Option-dependent
1793	P dep Q >, OB	Not used Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63 Limits	Not used	Relay output B Selection of relay output to trip at the same time as P dep Q < Power-dependent reactive power export alarm. Option-dependent
1794	P dep Q >, ENA	ON OFF	OFF	Enables/disables alarm for P dep Q < power-dependent reactive power export . (Tick "Enable" in parameter 1791 in USW)

Parameter	Item	Range	Default	Notes
1795	P dep Q >, FC	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/GB	Trip GB	Fail class. selection of how the system should react when a directional over-current is detected. Here the selected fail class is activated when the P dep Q < Power-dependent reactive power export has been continuously over the programmed value during the programmed delay.

- **Inverse time over-current**

The inverse time over-current is based on IEC 60255 part 151.
This protection trips when the current exceeds a predetermined (pickup) value due to an inverse time characteristic, see formula below t(G).
"Inverse time" means that the protection operates faster as the current increases.
The operating time decreases as the current increases, see "standard curves".

The time characteristic is described by this formula:

$$t(G) = TMS \left(\frac{k}{\left(\frac{G}{G_S}\right)^{\alpha} - 1} + C \right)$$

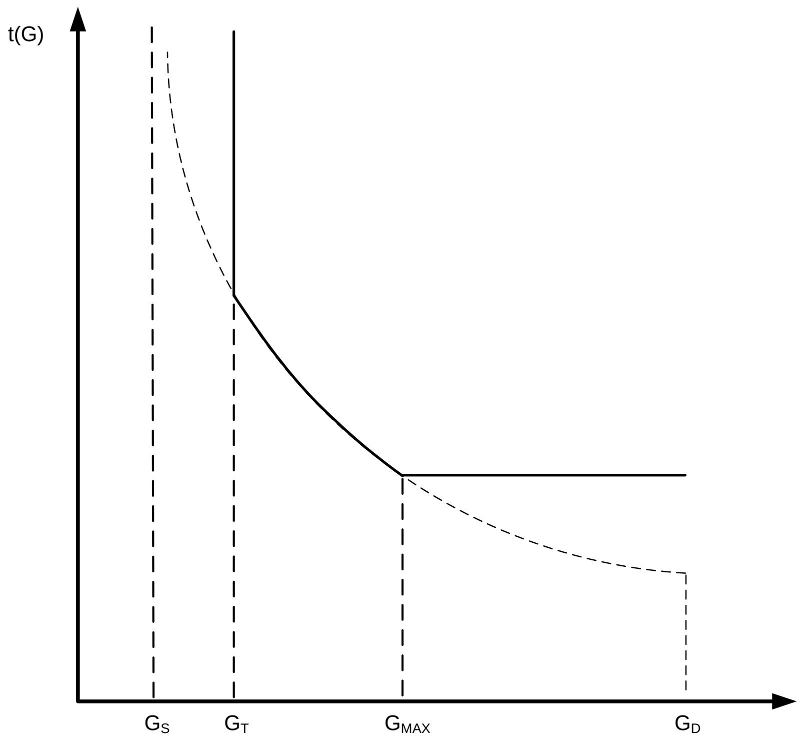
Explanations of the variables in the formula:

t(G)	Theoretical operating time constant value of G in seconds
k, c, α (unit of k, c is seconds and α is unit-less)	Constants characterising the selected curve Unit of k, c is seconds and α is unit-less
G	Measured value of the characteristic quantity
G_S	Setting value
TMS	Time Multiplier Setting, unit-less

There is no intentional delay on reset. The function will reset when $G < G_S$.

Curve shapes:

Time characteristic:



$G_S = I_{nom}$ x LIM
$G_T = 1.1$ x G_S
G_{MAX} = Over-current factor x CT_P

G_T: Minimum trip current
G_{MAX}: Maximum trip current
I_{nom}: Nominal current setting
CT_P: Connected current transformer primary side value
G_D: The point where the alarm shifts from an inverse curve to a definite time characteristic. This point is defined as $G_D = 20 * G_S$.
t_{MIN}: Minimum trip time that can used for protection purpose. Only a calculation can show if this value will interfere with the intended trip curve.

Product	**Over-current factor**	**t_{MIN}**
AGC PM	2.2	250 ms

There is a choice between seven different curve shapes, of which six are predefined and one is user-definable.

See related parameters: parameter 1081

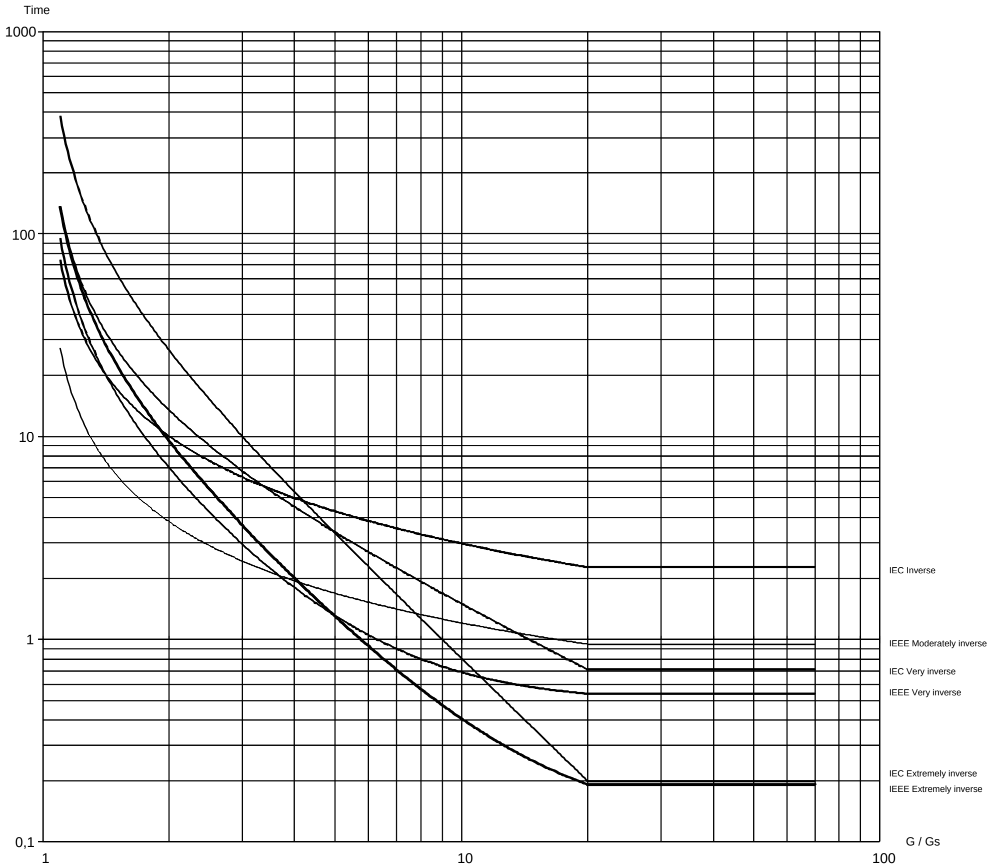
Common settings for all types:

Setting	Parameter no.	Factory setting value	Equals
LIM	1082	110%	LIM = G_S/ I_{nom}
TMS	1083	1.0	Time multiplier setting

The following constants apply to the predefined curves:

Curve type	k	c	α
IEC Inverse	0.14	0	0.02
IEC Very Inverse	13.5	0	1
IEC Extremely Inverse	80	0	2
IEEE Moderately Inverse	0.515	0.1140	0.02
IEEE Very Inverse	19.61	0.491	2
IEEE Extremely Inverse	28.2	0.1217	2

**Standard curves:



The curves are shown for TMS = 1.

Related parameters:

1080 I > inv. set(I inverse setting)

Parameter	Item	Range	Default	Notes
1081	I > inv. set Type	IEC Inverse IEC Very Inverse IEC Extremely Inv. IEEE Moderately Inv. IEEE Very Inverse IEEE Extremely Inv. Custom	IEC Inverse	Inverse time over-current trip method selection. Selection for curve type Curve shapes, pre-defined. Custom: user-definable. **See standard curves.
1082	I > inv. Limit	50 %.....200 %	110 %	Set point. Inverse time over-current limit setting (2x Gs)
1083	I > inv. TMS	0.010.....100.0 s	1.00 s	Set point. Inverse time over-current Time Multiplier Setting (TMS)
1084	I > inv. k	0.001.....32.000 s	0.140 s	Set point. Inverse time over-current constant (k) for user defined curve.
1085	I > inv. c	0.000.....32.000 s	0.000 s	Set point. Inverse time over-current constant (c) for user defined curve.
1086	I > inv. a	0.001.....32.000 s	0.020 s	Set point. Inverse time over-current constant (a) for user defined curve.

1090 I > inv.

Parameter	Item	Range	Default	Notes
1091	I > inv., OA	Not used Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63 Limits	Not used	Relay output A Selection of relay output to trip at the same time as time inverse over-current alarm.
1092	I > inv., OB	Not used Terminal 5, 8, 11, 14, 17, 20, 21, 57, 59, 61, 63 Limits	Not used	Relay output B Selection of relay output to trip at the same time as time inverse over-current alarm.
1093	I > inv., ENA	ON OFF	ON	Enables/disables alarm for inverse over-current. (Tick "Enable" in parameter 1090 in USW)
1094	I > inv., FC	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/GB	Trip GB	Fail class. Selection of how the system should react when a inverse over-current is detected. Here the selected fail class is activated immediately when an inverse over-current is detected.

ANSI for optional protections:

In the design of electrical power systems, the ANSI (American National Standards Institute) standard device numbers (ANSI /IEEE Standard C37.2 Standard for Electrical Power System Device Function Numbers, Acronyms, and Contact Designations) identifies the features of a protective device such as a relay or circuit breaker.
These types of devices protect electrical systems and components from damage when an unwanted event occurs, such as an electrical fault. Device numbers are used to identify the functions of devices shown on a schematic diagram. Function descriptions are given in the standard.

- **ANSI for Option A1**

Protection	ANSI number
Vector jump	78
df/dt (ROCOF)	81
Time-dependent under-voltage, U_t <	27t
Under-voltage and reactive power low, U_Q <	27Q
Average BB over-voltage U	59AVG

- **ANSI for Option A4**

Protection	ANSI no.
Positive sequence voltage	47 U1, 27 pos

- **ANSI for Option A5**

Protection	ANSI no.
AC-directional over-current protection	67

- **ANSI for Option A5**

Protection	ANSI no.
Negative sequence current	46
Negative sequence voltage	47
Zero sequence current	$51I_0$
Zero sequence voltage	$59U_0$
Power-dependent reactive power	40
Inverse time over-current	51

9. PID controller

9.1 Description of PID controller

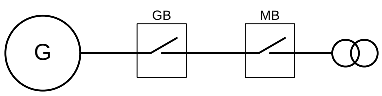
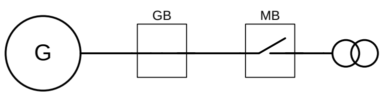
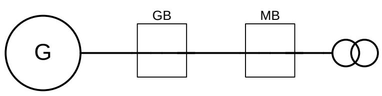
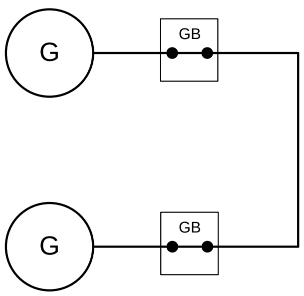
The unit controller is a PID controller. It consists of a proportional regulator, an integral regulator and a differential regulator. The PID controller is able to eliminate the regulation deviation and can easily be tuned in.

9.2 Controllers

There are three controllers for the governor control and also three controllers for the AVR control.

Controller	GOV	AVR	Comment
Frequency	X		Controls the frequency
Power	X		Controls the power
P load sharing	X		Controls the active power load sharing
Voltage		X	Controls the voltage
VAr		X	Controls the power factor
Q load sharing	X	X	Controls the reactive power load sharing

The table below indicates when each of the controllers is active. This means that the controllers can be tuned in when the shown running situations are present.

Governor			AVR			Schematic
Frequency	**Power**	**P LS**	**Voltage**	**VAr**	**Q LS**	
X			X			
		X			X	
	X			X		
		X			X	

9.3 Automatic selection

The AGC PM will switch between the PID controllers automatically (P-controllers for relay regulation). The controllers have different set point and also inputs for the control loops. To give an overview towards what the different regulators are regulating, the table below can be helpful:

GOV:

	Generator breaker open	Generator breaker closed but not parallel to grid	Generator parallel to grid
Fixed frequency (f-controller)	X		
kW sharing with fixed frequency (P LS-controller)		X	
Fixed kW (P-controller)			X

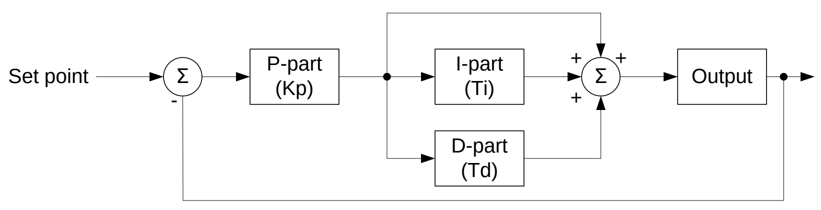
AVR:

	Generator breaker open	Generator breaker closed but not parallel to grid	Generator parallel to grid
Fixed voltage (U-controller)	X		
kvar sharing with fixed voltage (Q LS-controller)		X	
Fixed cos phi (Q-controller)			X

The AGC automatically shift between the different controllers according to the situation and position of the breakers in the application.

9.4 Principle drawing

The drawing below shows the basic principle of the PID controller.



$$\mathrm{PID}(s) = Kp \cdot \left(1 + \frac{1}{Ti \cdot s} + Td \cdot s\right)$$

As illustrated in the above drawing and equation, each regulator (P, I and D) gives an output which is summarised to the total controller output.

The adjustable settings for the PID controllers in the AGC unit are:

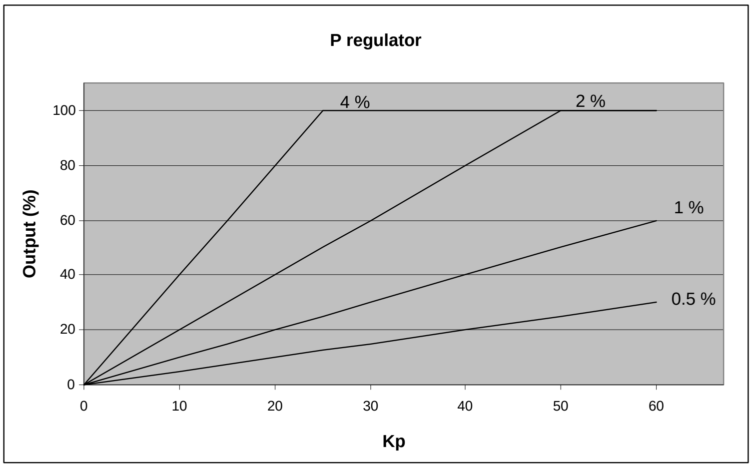
Kp: The gain for the proportional part.
Ti: The integral action time for the integral part.
Td: The differential action time for the differential part.

The function of each part is described in the following.

9.5 Proportional regulator

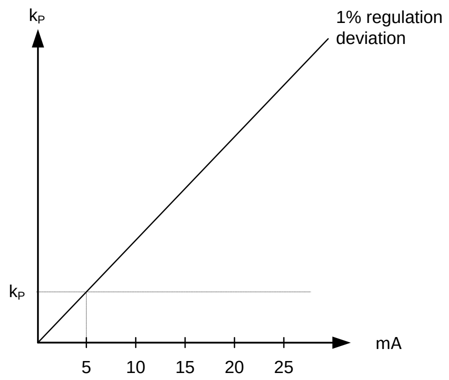
When the regulation deviation occurs, the proportional part will cause an immediate change of the output. The size of the change depends on the gain Kp.

The diagram shows how the output of the P regulator depends on the Kp setting. The change of the output at a given Kp setting will be doubled if the regulation deviation doubles.



9.5.1 Speed range

Because of the characteristics above, it is recommended to use the full range of the output to avoid an unstable regulation. If the output range used is too small, a small regulation deviation will cause a rather big output change. This is shown in the drawing below.



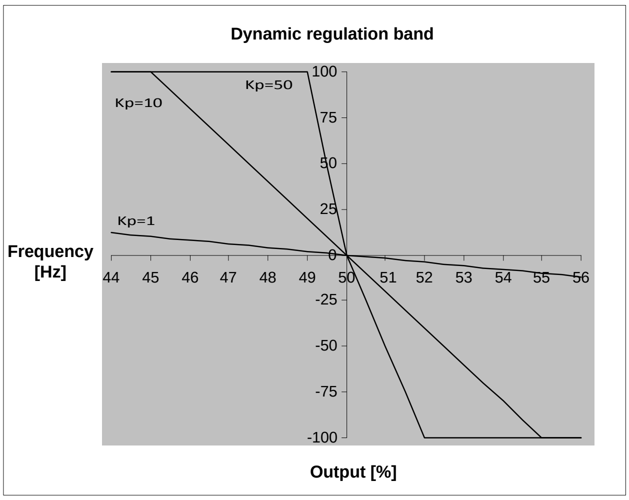
A 1 % regulation deviation occurs. With the Kp setting adjusted, the deviation causes the output to change 5 mA. The table shows that the output of the AGC changes relatively much if the maximum speed range is low.

Max. speed range	Output change		Output change in % of max. speed range
10 mA	5 mA	5/10*100 %	50
20 mA	5 mA	5/20*100 %	25

DEIF recommends the bias range for the speed signal to be +/- 4 Hz, and the voltage can be regulated +/- 10 % of the nominal voltage.

9.5.2 Dynamic regulation area

The drawing below shows the dynamic regulation area at given values of Kp. The dynamic area gets smaller if the Kp is adjusted to a higher value.

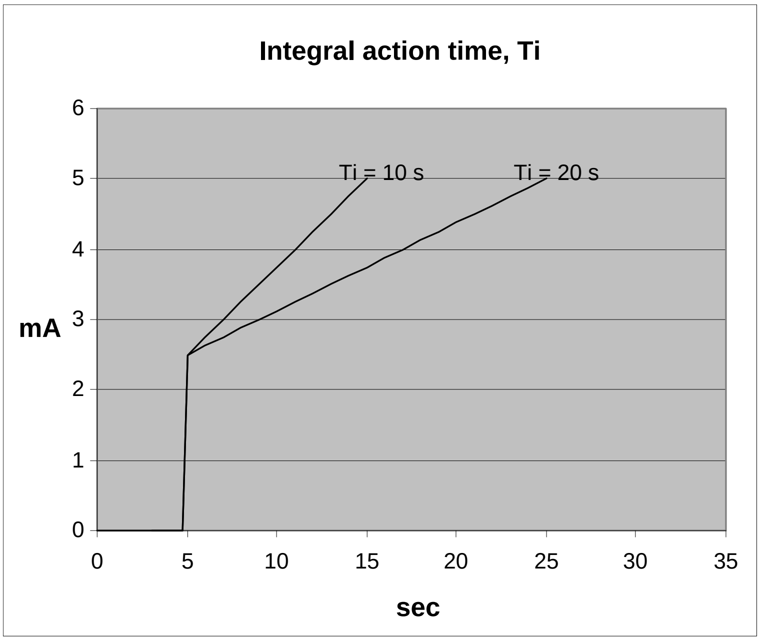


9.6 Integral regulator

9.6.1 Integral regulator

The main function of the integral regulator is to eliminate offset. The integral action time Ti is defined as the time the integral regulator uses to replicate the momentary change of the output caused by the proportional regulator.

In the drawing below, the proportional regulator causes an immediate change of 2.5 mA. The integral action time is then measured when the output reaches 2 x 2.5 mA = 5 mA.



As shown in the drawing, the output reaches 5 mA twice as fast at a Ti setting of 10 s than with a setting of 20 s.

The integrating function of the I-regulator is increased if the integral action time is decreased. This means that a lower setting of the integral action time Ti results in a faster regulation.

If the Ti is adjusted to 0 s, the I-regulator is switched OFF.

The integral action time, Ti, must not be too low. This will make the regulation hunt similar to a too high proportional action factor, Kp.

9.7 Differential regulator

9.7.1 Differential regulator

The main purpose of the differential regulator (D-regulator) is to stabilise the regulation, thus making it possible to set a higher gain and a lower integral action time Ti. This will make the overall regulation eliminate deviations much faster.

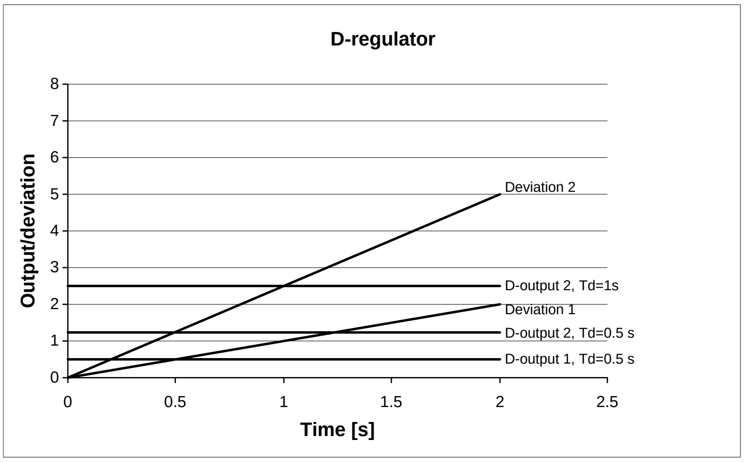
In most cases, the differential regulator is not needed; however, in case of very precise regulation situations, e.g. static synchronisation, it can be very useful.

The output from the D-regulator can be explained with the equation: $D = Td \cdot Kp \cdot \frac{de}{dt}$

D = Regulator output
Kp = Gain
de/dt = Slope of the deviation (how fast does the deviation occur)

This means that the D-regulator output depends on the slope of the deviation, the Kp and the Td setting.

Example:
In the following example, it is assumed that Kp = 1.



Deviation 1:	A deviation with a slope of 1.
Deviation 2:	A deviation with a slope of 2.5 (2.5 times bigger than deviation 1).
D-output 1, Td=0.5 s:	Output from the D-regulator when Td = 0.5 s and the deviation is according to Deviation 1.
D-output 2, Td=0.5 s:	Output from the D-regulator when Td = 0.5 s and the deviation is according to Deviation 2.
D-output 2, Td=1 s:	Output from the D-regulator when Td = 1 s and the deviation is according to Deviation 2.

The example shows that the bigger deviation and the higher Td setting, the bigger output from the D-regulator. Since the D-regulator is responding to the slope of the deviation, it also means that when there is no change, the D-output will be zero.

When commissioning, please keep in mind that the Kp setting has influence on the D-regulator output.

If the Td is adjusted to 0 s, the D-regulator is switched OFF.

The differential action time, Td, must not be too high. This will make the regulation hunt similar to a too high proportional action factor, Kp.

9.8 Open GB controllers

When the genset is started and the generator breaker is open, the AGC PM will use the f-controller for the governor, and the U-control for the AVR. The AGC PM will regulate the frequency towards the nominal frequency and voltage used in the nominal settings, and try to maintain them at the nominals.

If the controller is using analogue or digital regulation, the parameters used at this point is for the governor placed in parameter 2511 – 2513 and for the AVR it is in 2641-2643.

If relay regulation is used for governor control the parameter is located in 2571-2572, and for the AVR the relay parameters for open GB control are located in 2691-2692.

During the start sequence, it is possible to delay the regulation. This makes it possible to have the AGC PM's regulators kept at the offset until a timer has expired. This delay is started when the “running detection” has been fulfilled. The timer in the delay of regulation function is always active and is by default set to 0 sec. If the enable in the “delay of regulation” is ticked/set to ON, the AGC PM will give an alarm when the “delay of regulation” is active. If the enable is not ticked/set to OFF, it is possible to set the timer and not have any alarm of this.

All the parameters for regulation with open GB are shown in the table below:

Parameter	Item	Range	Default	Note
2511	Frequency controller Kp	0.00 60.00	0.50	Only in genset
2512	Frequency controller Ti	0.00 60.00	5.00 s	Only in genset
2513	Frequency controller Td	0.00 2.00	0.00 s	Only in genset
2571	Frequency controller - Relay regulation - deadband	0.2 % 10.0 %	1 %	Only in genset
2572	Frequency controller - Relay regulation - Kp	0 100	10	Only in genset
2641	Voltage controller Kp	0.00 60.00	0.50	Only in genset
2642	Voltage controller Ti	0.00 60.00	5.00	Only in genset
2643	Voltage controller Td	0.00 2.00	0.00 s	Only in genset
2691	Voltage controller - Relay regulation - deadband	0.2 % 10.0 %	2 %	Only in genset
2692	Voltage controller - Relay regulation - Kp	0 100	10	Only in genset
2741	Delay of regulation - Alarm	0 s 9900 s	0 s	Only in genset. Timer is always active, even though alarm is not activated.
2742	Delay of regulation - Alarm - Output A	Not used Option-dependent	Not used	Only in genset
2743	Delay of regulation - Alarm - Output B	Not used Option-dependent	Not used	Only in genset
2744	Delay of regulation - Alarm - Enable	OFF ON	OFF	Only in genset

9.9 Load sharing controllers

The AGC PM will use the load share controllers, when the generator breaker is closed, and not parallel to the grid. When the AGC PM is using the load sharing controller for the governor, it is looking at two things at the regulation. Firstly, the AGC PM will look at the frequency and try to maintain it at the nominal. Furthermore, it will communicate with other controllers and make sure that the gensets share the load equally.

For the AVR, the AGC PM is also looking at two things for the regulation when the genset should be load sharing. Firstly, the AGC is looking at the voltage where it will try to maintain the voltage at the nominal. Secondly, the AGC will be look at the reactive power among all the gensets, and then make sure to balance it out so they will be load-sharing the reactive power.

Both the P LS-controller and the Q LS-controller have a weight factor that can be adjusted. By default the load share regulators will primarily be regulating towards the nominal settings for the frequency and voltage. The weight factor then decides how much the active and reactive power should have as impact on the load share controllers. If the weight factor is turned up, the load sharing between the controllers will be faster, but the regulation towards the nominals will be slower. So, if a smooth load sharing is required, the weight factor can be turned up, but the regulation towards the nominals will be slower. If the weight factor is turned up to 100 %, the regulation will look equally on the frequency/voltage and the load sharing.

When the AGC PM has synchronised a generator breaker and closed it, the power of the genset will by default be ramped up, following a power ramp setting. This makes it possible to have an aggressive regulation which can handle load impacts quite fast, but be quite controlled when ramping up in power to minimise the risk of instability in the other gensets.

Be aware if relay regulation is used, that there is a deadband both for the frequency and load sharing for the governor in load share control. For the AVR, there is a deadband for both the voltage and load sharing in load share control. The relay regulation also holds the weight factor for load share control.

The parameters for the load share controllers are shown below:

Parameter	Item	Range	Default	Note
2541	Load share controller – Governor Kp	0.00 60.00	0.50	Only in genset
2542	Load share controller – Governor Ti	0.00 s 60.00 s	5.00 s	Only in genset
2543	Load share controller – Governor Td	0.00 s 2.00 s	0.00 s	Only in genset
2544	Load share controller – Governor - Weight factor	0.0 % 100.0 %	10.0 %	Only in genset
2591	Load share controller – Governor – Relay regulation frequency deadband	0.2 % 10.0 %	1.0 %	Only in genset
2592	Load share controller – Governor – Relay regulation Kp	0 100	10	Only in genset
2593	Load share controller – Governor – Relay regulation – Power deadband	0.2 % 10.0 %	2.0 %	Only in genset
2594	Load share controller – Governor – Relay regulation – Weight factor	0.0 % 100.0 %	10.0 %	Only in genset
2661	Load share controller – AVR Kp	0.00 60.00	0.50	Only in genset
2662	Load share controller – AVR Ti	0.00 s 60.00 s	5.00 s	Only in genset
2663	Load share controller – AVR Td	0.00 s 2.00 s	0.00 s	Only in genset
2664	Load share controller – AVR - Weight factor	0.0 % 100.0 %	10.0 %	Only in genset
2711	Load share controller – AVR – Relay regulation voltage deadband	0.2 % 10.0 %	1.0 %	Only in genset
2712	Load share controller – AVR – Relay regulation Kp	0 100	10	Only in genset

2713	Load share controller – AVR – Relay regulation – Power deadband	0.2 % 10.0 %	2.0 %	Only in genset
2714	Load share controller – AVR – Relay regulation – Weight factor	0.0 % 100.0 %	10.0 %	Only in genset

9.10 Parallel to grid controllers

When the AGC PM is parallel to the grid, it will switch into using the parallel controllers. When the genset is parallel to the grid, the AGC PM will not be load sharing like normal, but instead receive the power and cos phi set point from the mains controller, or instead use the set points located in the genset controller.

When the mains breaker has just been closed, the AGC PM will by default use power ramps when tuning up the power. So the regulators will use this ramp when increasing in power towards the power. When the AGC PM has ramped up the power of the genset to the set point, the regulator will be used for keeping it at the set point. So it is possible to have aggressive regulators for parallel controllers, but it will ramp up the power slowly. If the regulators have been tuned aggressively, the AGC PM will be able to hold the power ramp when ramping up or down, even though the grid frequency or voltage is fluctuating.
The parameters for the parallel controllers are shown below:

Parameter	Item	Range	Default	Note
2531	Parallel controller – Governor Kp	0.00 60.00	0.50	Only in genset
2532	Parallel controller – Governor Ti	0.00 s 60.00 s	5.00 s	Only in genset
2533	Parallel controller – Governor Td	0.00 s 2.00 s	0.00 s	Only in genset
2581	Parallel controller – Governor – Relay regulation dead-band	0.2 % 10.0 %	2 %	Only in genset
2582	Parallel controller – Governor – Relay regulation Kp	0 100	10	Only in genset
2651	Parallel controller - AVR Kp	0.00 60.00	0.50	Only in genset
2652	Parallel controller - AVR Ti	0.00 s 60.00 s	5.00 s	Only in genset
2653	Parallel controller - AVR Td	0.00 s 60.00 s	0.00 s	Only in genset
2701	Parallel controller – AVR – Relay regulation deadband	0.2 % 10.0 %	2 %	Only in genset
2702	Parallel controller – AVR – Relay regulation Kp	0 100	10	Only in genset

9.11 Synchronising controller

The synchronising controller is used in the AGC whenever synchronising is activated. After a successful synchronisation, the frequency controller is deactivated and the relevant controller is activated. This could e.g. be the load sharing controller. The adjustments are made in the menu 2050.

Dynamic synchronising
When dynamic synchronising is used, the controller "2040 f_{SYNC} controller" is used during the entire synchronising sequence. One of the advantages of dynamic synchronising is that it is relatively fast. In order to improve the speed of the synchronising further, the generator will be sped up between the points of synchronisation (12 o'clock to 12 o'clock) of the two systems. Normally, a slip frequency of 0.1 Hz gives synchronism each 10 seconds, but with this system on a steady engine, the time between synchronism is reduced. If relay regulation is used, the AGC PM uses the Kp set in parameter 2050.
The relevant parameters are shown in the table below:

Parameter	Item	Range	Default	Note
2041	Frequency synchronisation controller Kp	0.00 60.00	0.50	Only in genset
2042	Frequency synchronisation controller Ti	0.00 s 60.00 s	5.00 s	Only in genset
2043	Frequency synchronisation controller Td	0.00 s 2.00 s	0.00 s	Only in genset
2050	Frequency synchronisation controller – Relay regulation - Kp	0 100	10	Only in genset

Static synchronising

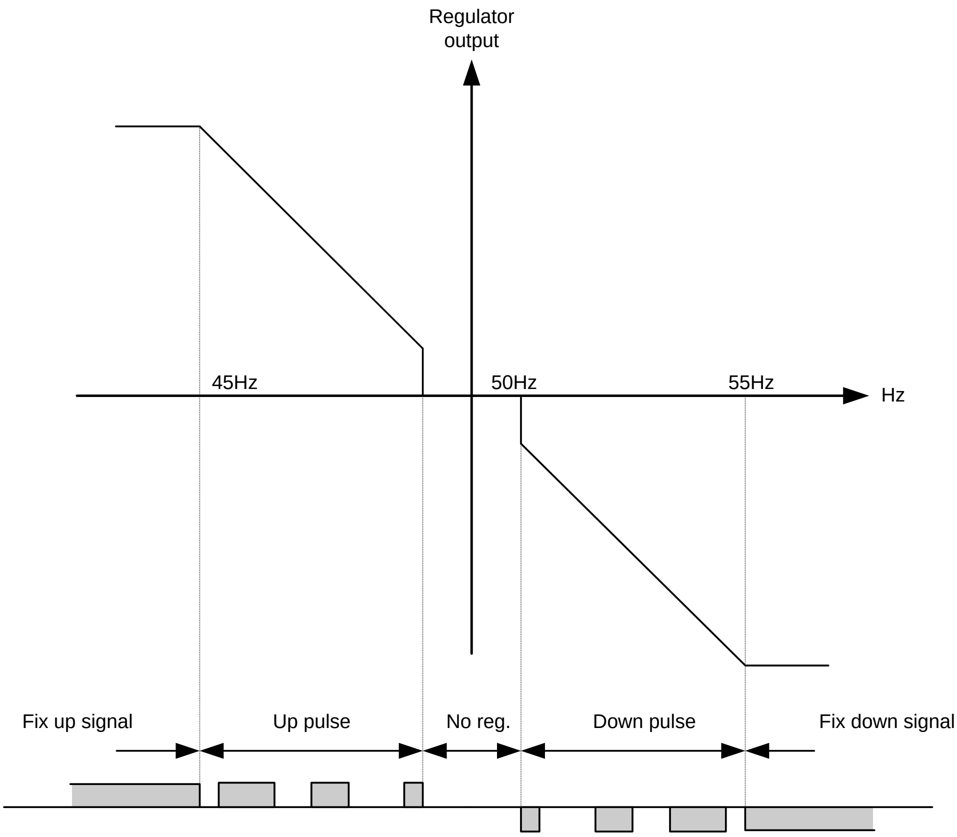
When synchronising is started, the synchronising controller "2040 f_{SYNC} controller" is activated and the generator frequency is controlled towards the busbar/mains frequency. The phase controller takes over when the frequency deviation is so small that the phase angle can be controlled. The phase controller is adjusted in the menu 2060 ("2060 phase controller"). If relay regulation is used the phase controller is located at parameter 2070.

The parameters for the phase controller are shown in the table below:

Parameter	Item	Range	Default	Note
2061	Phase/angle controller – Static synchronisation - Kp	0,00 60,00	0,50	Only in genset
2062	Phase/angle controller – Static synchronisation – Ti	0,00 s 60,00 s	5,00 s	Only in genset
2063	Phase/angle controller – Static synchronisation – Td	0,00 s 2,00 s	0,00 s	Only in genset
2070	Phase/angle controller – Static synchronisation – Relay regulation - Kp	0 100	10	Only in genset

9.12 Relay control

When the relay outputs are used for control purposes, the regulation works like this:



The regulation with relays can be split up into five steps.

#	Range	Description	Comment
1	Static range	Fix up signal	The regulation is active, but the increase relay will be constantly activated because of the size of the regulation deviation.
2	Dynamic range	Up pulse	The regulation is active, and the increase relay will be pulsing in order to eliminate the regulation deviation.
3	Deadband area	No reg.	In this particular range, no regulation takes place. The regulation accepts a predefined deadband area in order to increase the lifetime of the relays.
4	Dynamic range	Down pulse	The regulation is active, and the decrease relay will be pulsing in order to eliminate the regulation deviation.
5	Static range	Fix down signal	The regulation is active, but the decrease relay will be constantly activated because of the size of the regulation deviation.

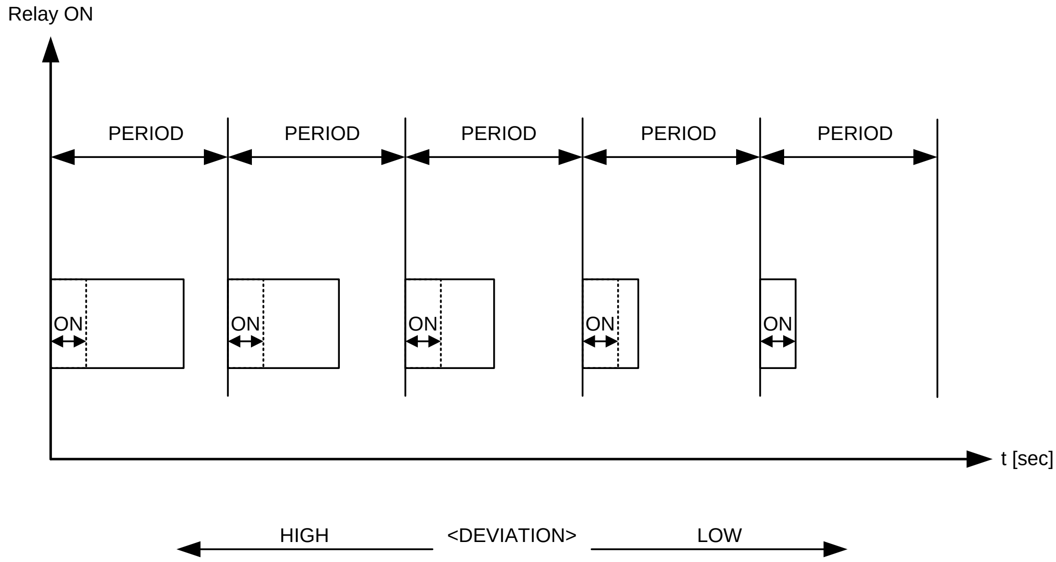
As the drawing indicates, the relays will be fixed ON if the regulation deviation is big, and they will be pulsing if it is closer to the set point. In the dynamic range, the pulses get shorter and shorter when the regulation deviation gets smaller. Just before the deadband area, the pulse is as short as it can get. This is the adjusted time "GOV ON time"/("AVR ON time"). The longest pulse will appear at the end of the dynamic range (45 Hz in the example above).

9.12.1 Relay adjustments

The time settings for the regulation relays can be adjusted in the control setup. It is possible to adjust the "period" time and the "ON time". They are shown in the drawing below.

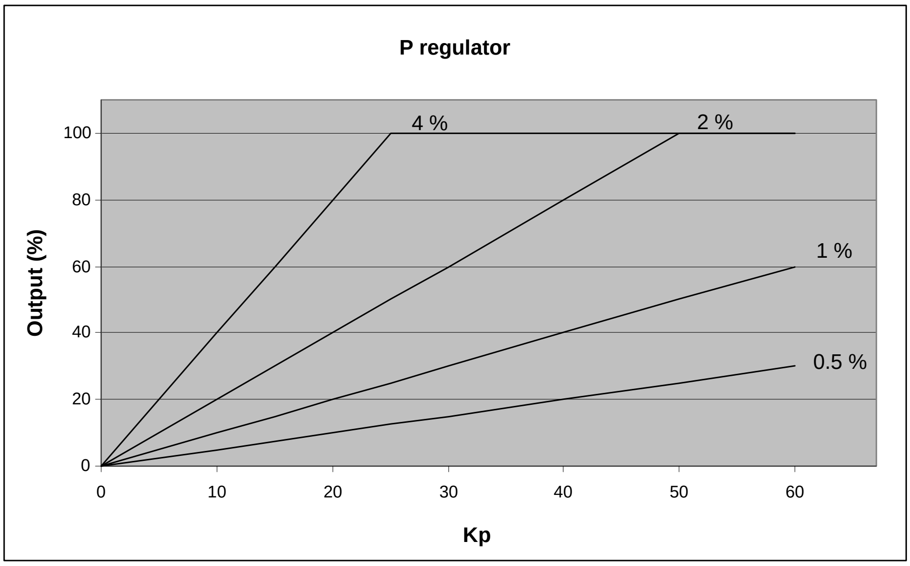
Adjustment	Description	Comment
Period time	Maximum relay time	The time between the beginnings of two subsequent relay pulses.
ON time	Minimum relay time	The minimum length of the relay pulse. The relays will never be activated for a shorter time than the ON time.

As it is indicated in the drawing below, the length of the relay pulse will depend on the actual regulation deviation. If the deviation is big, then the pulses will be long (or a continued signal). If the deviation is small, then the pulses will be short.



9.12.2 Signal length

The signal length is calculated compared to the adjusted period time. In the drawing below, the effect of the proportional regulator is indicated.



In this example, we have a 2 percent regulation deviation and an adjusted value of the Kp = 20. The calculated regulator value of the unit is 40 %. Now the pulse length can be calculated with a period time = 2500 ms:

eDEVIATION/100*tPERIOD
40/100*2500 = 1000 ms

The length of the period time will never be shorter than the adjusted ON time.

9.13 Droop mode

9.13.1 Principle and setup

Droop mode can be used when a new genset is installed together with existing gensets which operate in droop mode in order to make equal load sharing with the existing gensets. This regulation mode can be used where it is required/allowed that the generator frequency drops with increasing load.

The droop mode parameters can be adjusted between 0-10 % droop. If the value is different from 0 %, the droop percentage will be applied on top of the regulation output of the governor (f) or AVR (U).

Frequency droop: it is determined in percentage of nominal frequency. The analogue controller is set in menu 2514. The set point is 4 % by default. So if the active power is 0 %, the reference frequency is equal to the nominal frequency. And if the active load is 100 %, the reference frequency is 96 % of the nominal frequency.

Voltage droop: it is determined in percentage of nominal voltage. The analogue controller is set in menu 2644. The set point is 4 % by default. So if the reactive power is 0 %, the reference voltage is equal to the nominal voltage. And if the reactive inductive load is 100 %, the reference voltage is 96 % of the nominal voltage. And if the reactive capacative load is 100 %, the reference voltage is 104 % of the nominal voltage.

Droop regulation parameters

Parameter	Item	Range	Default	Notes
2514	f droop	0.0......10.0 %	4.0 %	Droop setting for frequency regulator with analogue output
2573	f droop relay	0.0......10.0 %	4.0 %	Droop setting for frequency regulator with relay regulation
2644	U droop	0.0......10.0 %	4.0 %	Droop setting for voltage regulator with analogue output
2693	U droop relay	0.0......10.0 %	4.0 %	Droop setting for voltage regulator with relay regulation

When using droop mode, the frequency PID (f) and voltage PID (U) is active

Activating droop regulation
The following M-Logic commands are used to activate droop regulation. This gives more options to activate the droop regulation with for example a digital input, AOP button or an event.

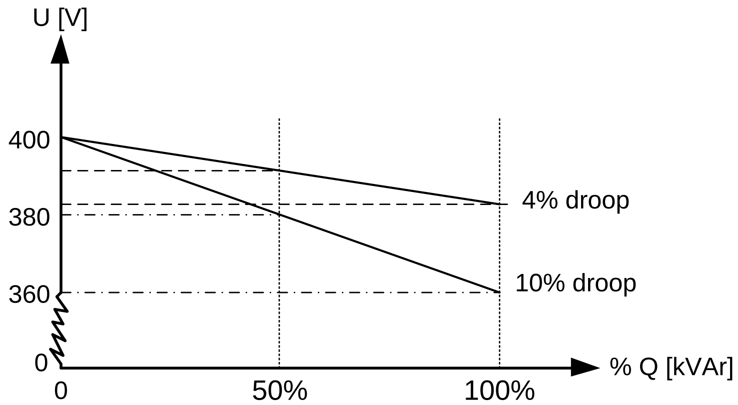
M-Logic output	M-Logic command	Description
GOV/AVR control	Act. frequency droop regulation	Activates the use of frequency droop parameters mentioned above
GOV/AVR control	Act. voltage droop regulation	Activates the use of voltage droop parameters mentioned above

Because the power management option G3 is standard in AGC PM, the command "Inhibit analogue loadshare" needs to be activated in M-Logic. This is needed to force the controller from loadshare PID into frequency PID (f) and voltage PID (U). Otherwise, the droop function will not work.

Application configuration
When operating in droop mode, the AGC has to be configured with a **Single DG** application drawing. This is done through the utility software.
Please see the utility software help function (F1) for details about application configuration.

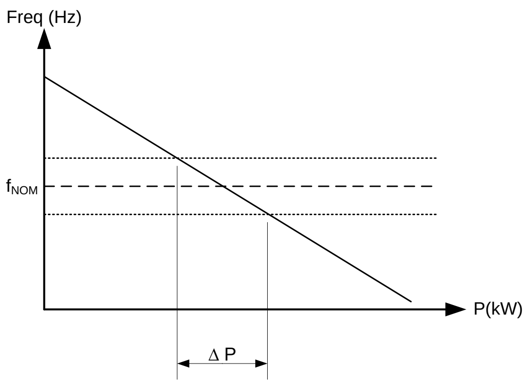
9.13.2 Voltage droop example

The diagram below shows an example for one generator where the voltage droop setting is 4 % and 10 % in proportion to the reactive power, Q (kVAr). As it is shown in the example, the voltage drops as the load increases. The principle is the same with generators in parallel where the generators will use the droop to share the load and allow the voltage/frequency to drop accordingly.



9.13.3 High droop setting

To illustrate the influence of a high droop setting, the diagram below shows how a frequency variation gives a change in the load. The principle is the same with voltage regulation. The load change is marked as ΔP.

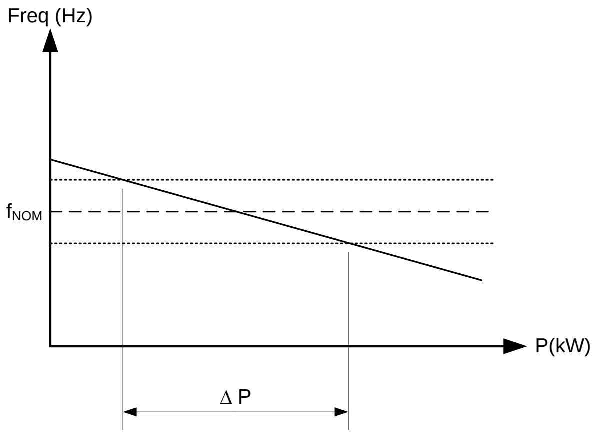


This can be used if the generator must operate base-loaded.

9.13.4 Low droop setting

To illustrate the influence of a low droop setting, the diagram below shows how a frequency variation gives a change in the load. The principle is the same with voltage droop regulation. The load change is marked as ΔP.

In this diagram, the load change (ΔP) is larger than before. This means that the generator will vary more in loading than with the higher droop setting.



This can be used if the generator must operate as a peak load machine.

9.13.5 Compensation for isochronous governors

When the genset is equipped with a governor only providing isochronous operation, the droop setting can be used to compensate for the missing droop setting possibility on the governor.

9.14 External set points

The AGC PM holds a function where the power/frequency/voltage etc. set points can be controlled from an analogue signal. The analogue signal could be given from e.g. a PLC or another variable +/- 10 V DC power supply. To activate the external set point, this can be done from the “Input/Output” list in the utility software, or in parameter 7500-7505. The terminal numbers for controlling the set point is 40, 41 and 42. Terminal 40 is the (+) signal for governor control, and terminal 42 is the (+) signal for the AVR control. The common terminal for these inputs is no. 41.
The governor can be externally controlled in the following ways:

Mode	Input voltage	Description	Comment/note	Input
Fixed frequency	+/- 10 V DC	Adjust the nominal frequency +/- 10 %. Can only be used when AGC is not parallel to the grid.	If regulation range is smaller than 10 %, it will not be possible to regulate outside the 10 %. 1 V DC on the input equals 1 % frequency deviation.	Ext. frequency control. Can also be found in parameter 7501.
Fixed kW	+ 10 V DC	Adjust the kW set point when parallel to the grid.	10 V DC equals 100 % power, which means that 1 V DC equals 10 % nominal power.	Ext. power control. Can also be found at parameter 7502.

As the governor can be controlled externally, so can the AVR. The table below gives an overview of what the different external controls can do:

Mode	Input voltage	Description	Comment/note	Input
Fixed voltage	+/- 10 V DC	Adjust the nominal voltage +/- 10 %. Can only be used when AGC is not parallel to the grid.	If regulation range is smaller than 10 %, it will not be possible to regulate outside the 10 %. 1 V DC on the input equals 1 % voltage deviation.	Ext. voltage control. Can also be found in parameter 7502.
Fixed Q	+/- 10 V DC	Adjust the kvar set point when parallel to the grid.	10 V DC equals 100 % “power”, which means that 1 V DC equals 10 % nominal “power”. If a 1000 kW is used, it equals 1000 kvar of reactive power as the range.	Ext. var control. Can also be found in parameter 7503.
Fixed cos phi	+/- 10 V DC	Adjust the cos phi set point when parallel to the grid.	The range is 0.6 inductive to 0.6 capacitive. The range can be limited by the capability curve, or the limits in parameter 7170.	Ext. cos phi control. Can also be found in parameter 7504.

The external set point can also be controlled via Modbus instead. The Modbus addresses can be found in the Modbus table appendix.

The relevant parameters for the external set point are shown in the table below:

Parameter	Item	Range	Default	Note
7501	External power set point control	OFF ON	OFF	
7502	External frequency set point control	OFF ON	OFF	Only in genset
7503	External voltage set point control	OFF ON	OFF	Only in genset
7504	External cos phi set point control	OFF ON	OFF	Only in genset
7505	External reactive power set point control	OFF ON	OFF	Only in genset

9.15 Regulation failure

The AGC PM holds an alarm for regulation failure. This can be set both for governor and AVR. The alarm holds a percentage that dictates a deviation. This deviation is best explained in this example:

A genset has the nominal of 440 V AC. In a situation where there is an inductive load, it is not possible for the genset to regulate up to its nominal voltage. If the genset is capable of regulating up to 400 V AC, there is a deviation of 9.1 %. If the regulation failure alarm has then been configured to 9 %, it will give a regulation failure alarm, if the voltage is not back within the range before the timer expires. If the limit has been configured to 9.2 % instead, no alarm will be present.

The regulation failure alarm can be used to detect that the AGC PM has been regulating towards the set point, and maybe is in its maximum and it has not been possible to reach the set point. The regulation failure alarm can also appear if the regulation is too slow.
The relevant parameters for the regulation failure are shown below:

Parameter	Item	Range	Default	Note
2561	Governor regulation failure - Deadband	1.0 % 100.0 %	30.0 %	Only in genset
2562	Governor regulation failure – Timer	10.0 s 300.0 s	60.0 s	Only in genset
2563	Governor regulation failure – Output A	Not used Option-dependent	Not used	Only in genset
2564	Governor regulation failure – Output B	Not used Option-dependent	Not used	Only in genset
2565	Governor regulation failure – Failclass	Block Trip MB/GB	Warning	Only in genset
2681	AVR regulation failure – Deadband	1.0 % 100.0 %	30.0 %	Only in genset
2682	AVR regulation failure – Timer	10.0 s 300.0 s	60.0 s	Only in genset
2683	AVR regulation failure – Output A	Not used Option-dependent	Not used	Only in genset
2684	AVR regulation failure – Output B	Not used Option-dependent	Not used	Only in genset
2685	AVR regulation failure – Failclass	Block Trip MB/GB	Warning	Only in genset

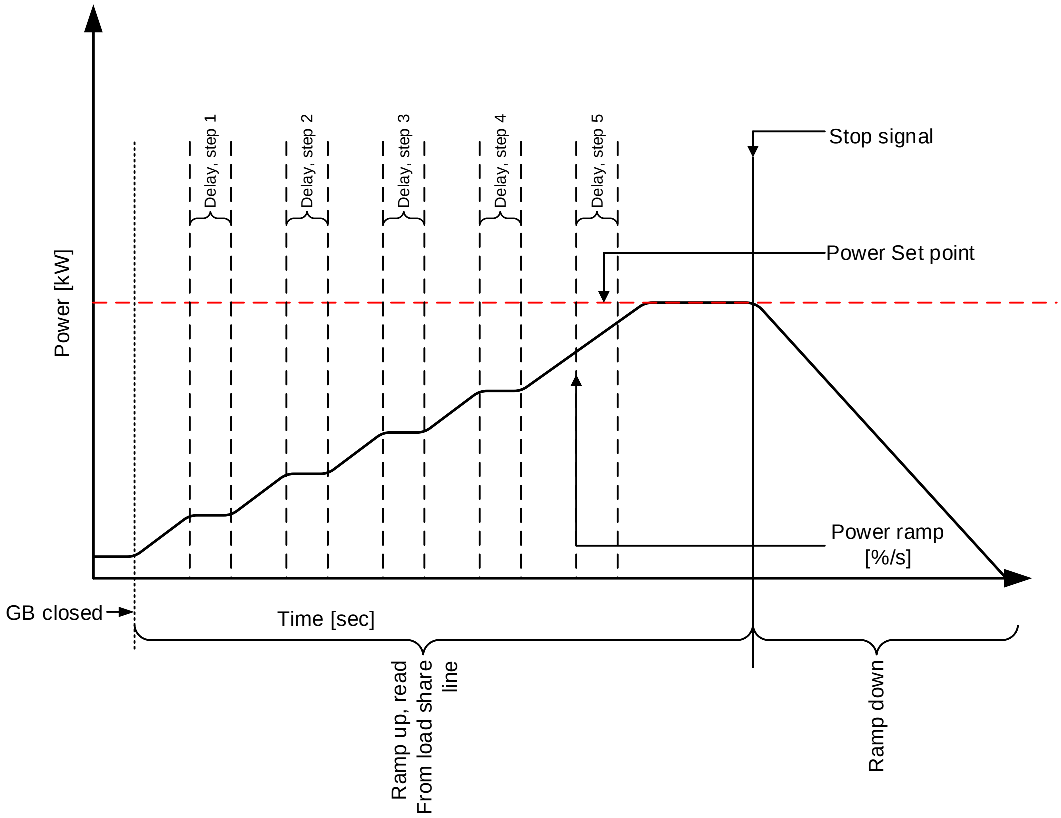
9.16 Power ramp

By default, the AGC PM has some power ramps that are used when ramping up or down towards set points. For example in the situation where a breaker has just been closed, and a genset is parallel to the grid. The power ramp will then be used when ramping up towards the power set point. The ramp is set in %/s, which means how fast it should be ramping up towards the set point. The regulators can then be tuned quite aggressively, so genset will be kept at the power ramps when going up or down towards the set point, and when the set point has been reached, the regulators can be aggressive so the power set point will be kept even though deviations in the frequency should appear.

In an islanded running mode, the power ramp is also used. This can be handy in the situation where a genset is started in e.g. an AMF situation to help other running genset(s). When the generator breaker is closed, the incoming genset will take load with the power ramp as slope, instead of taking load very aggressively, which can give instability.

The power ramp up can have load steps. It can be chosen how many steps the power ramp should have from 0-100 % power, and how many percent there should be between each step. When each step has been reached, it is also possible to set a delay for the AGC PM to wait, before regulating further up on the power ramp.

The power ramp up slope and power ramp down slope is configured individually on each other. The slopes will be used in all running modes. To give an overview on how the slopes and power ramp function can be programmed, the drawing below can make it easier to understand.



The power ramp can be freezed with M-Logic commands. When the power ramp is freezed, the AGC PM will maintain the set point as long as the freeze function is active. If the function is freezed when ramping from one point to another, the ramp will be fixed until the function is deactived again. The freeze can also be activated while the delay timer is timing out. The timer will then be stopped and will not continue until the function is deactived again.

The relevant parameters for the power ramp function are shown in the table below:

Parameter	Item	Range	Default	Note
2611	Power ramp up – slope	0.1 %/s 20.0 %/s	2.0 %/s	Only in genset
2612	Power ramp up – delay points	1 % 100 %	10 %	Only in genset
2613	Power ramp up – delay at each step	0 s 9900 s	10 s	Only in genset
2614	Power ramp up – Load steps enable	OFF ON	OFF	Only in genset
2615	Power ramp up – Number of load steps	0 100	1	Only in genset
2621	Power ramp down – slope	0.1 %/s 20.0 %/s	10.0 %/s	Only in genset
2622	Breaker open point	1 % 20 %	5 %	

10. Synchronisation

10.1 Synchronisation principles

The unit can be used for synchronisation of generator and mains breaker (if installed). Two different synchronisation principles are available, namely static and dynamic synchronisation (dynamic is selected by default). This chapter describes the principles of the synchronisation functions and the adjustment of them.

In the following, the term "synchronisation" means "synchronising and closing of the synchronised breaker".

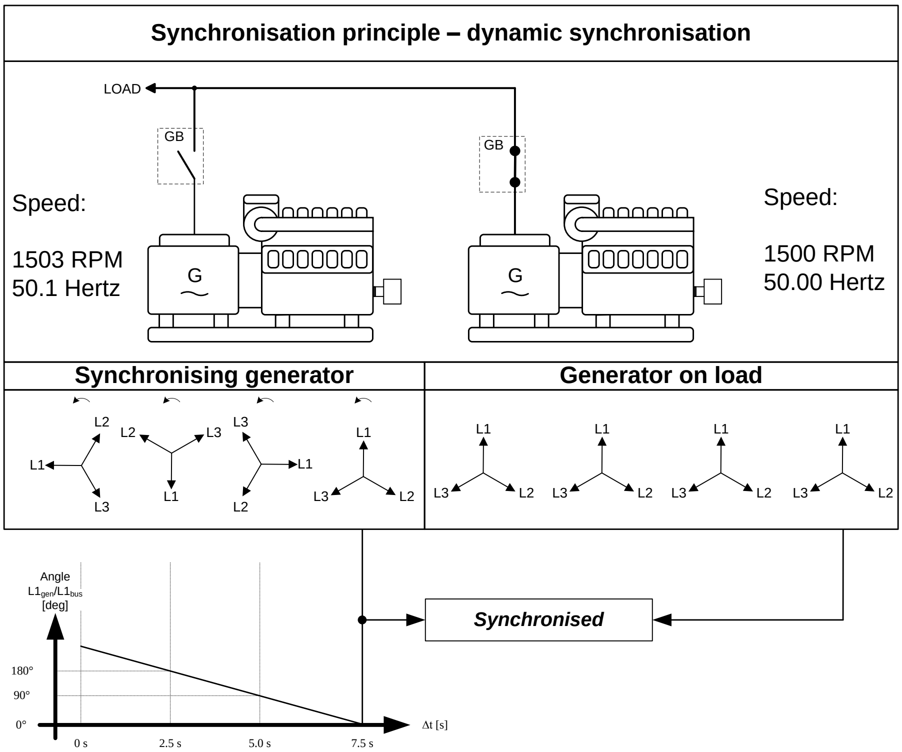
The parameter for switching between dynamic and static synchronisation is shown below:

Parameter	Item	Range	Default	Note
2001	Synchronisation type	Dynamic synchronisation Static synchronisation	Dynamic synchronisation	Only in genset

10.2 Dynamic synchronisation

In dynamic synchronisation, the synchronising genset is running at a different speed than the generator on the busbar. This speed difference is called "slip frequency". Typically, the synchronising genset is running with a positive slip frequency. This means that it is running with a higher speed than the generator on the busbar. The objective is to avoid a reverse power trip after the synchronisation.

The dynamic principle is illustrated below.



In the example above, the synchronising genset is running at 1503 RPM ~ 50.1 Hz. The generator on load is running at 1500 RPM ~ 50.0 Hz. This gives the synchronising genset a positive slip frequency of 0.1 Hz.

The intention of the synchronising is to decrease the phase angle difference between the two rotating systems. These two systems are the three-phase system of the generator and the three-phase system of the busbar. In the illustration above, phase L1 of the busbar is always pointing at 12 o'clock, whereas phase L1 of the synchronising genset is pointing in different directions due to the slip frequency.

Of course both three-phase systems are rotating, but for illustrative purposes the vectors for the generator on load are not shown to be rotating. This is because we are only interested in the slip frequency for calculating when to release the synchronisation pulse.

When the generator is running with a positive slip frequency of 0.1 Hz compared to the busbar, then the two systems will be synchronised every 10 seconds.

$$tSYNC = \frac{1}{50.1 - 50.0} = 10\,\text{sec}$$

Please observe the chapter regarding PID controllers and the synchronising controllers.

In the illustration above, the difference in the phase angle between the synchronising set and the busbar gets smaller and will eventually be zero. Then the genset is synchronised to the busbar, and the breaker will be closed.

10.2.1 Close signal

The unit always calculates when to close the breaker to get the most accurate synchronisation. This means that the close breaker signal is actually issued before being synchronised (read L1 phases exactly at 12 o’clock).

The breaker close signal will be issued depending on the breaker closing time and the slip frequency (response time of the circuit breaker is 250 ms, and the slip frequency is 0.1 Hz):

deg close = 360*tCB*fSLIP
deg close = 360*0.250*0.1
deg close = 9 deg

The synchronisation pulse is always issued, so the closing of the breaker will occur at the 12 o’clock position.

The length of the synchronisation pulse is the response time + 20 ms **(2020 Synchronisation).**

10.2.2 Load picture after synchronising

When the incoming genset has closed its breaker, it will take a portion off the load depending on the actual position of the fuel rack. Illustration 1 below indicates that at a given **positive** slip frequency, the incoming genset will **export** power to the load. Illustration 2 below shows that at a given **negative** slip frequency, the incoming genset will **receive** power from the original genset. This phenomenon is called **reverse power**.

To avoid nuisance trips caused by reverse power, the synchronising settings can be set up with a positive slip frequency.

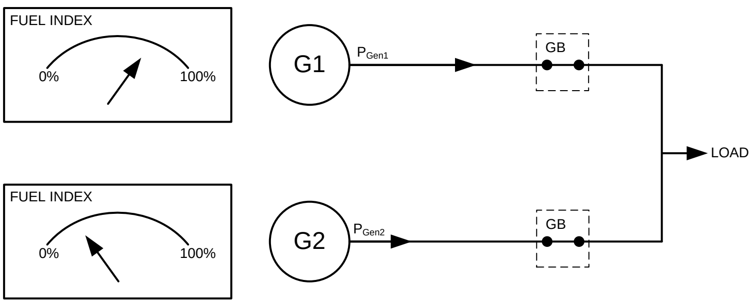


Illustration 1, POSITIVE slip frequency

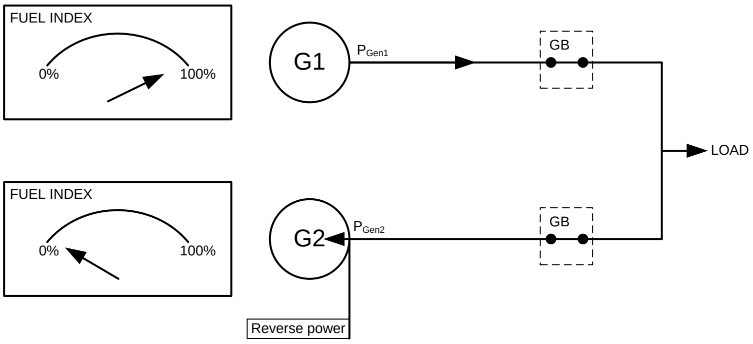


Illustration 2, NEGATIVE slip frequency

10.2.3 Adjustments

The dynamic synchroniser is selected in **2000 Sync. type** in the control setup and is adjusted in **2020 Synchronisation**.

Setting	Description	Comment
2021 f_{MAX}	Maximum slip frequency	Adjust the maximum positive slip frequency where synchronising is allowed.
2022 f_{MIN}	Minimum slip frequency	Adjust the maximum negative slip frequency where synchronising is allowed.
2023 U_{MAX}	Maximum voltage differrence (+/- value)	The maximum allowed voltage difference between the busbar/mains and the generator.
2024 t_{GB}	Generator breaker closing time	Adjust the response time of the generator breaker.
2025 t_{MB}	Mains breaker closing time	Adjust the response time of the mains breaker.

It is obvious that this type of synchronisation is able to synchronise relatively fast because of the adjusted minimum and maximum slip frequencies. This actually means that when the unit is aiming to control the frequency towards its set point, then synchronising can still occur as long as the frequency is within the limits of the slip frequency adjustments.

Dynamic synchronisation is recommended where fast synchronisation is required, and where the incoming gensets are able to take load just after the breaker has been closed.

Static and dynamic synchronisation can be switched by using M-Logic.

The PID controller used at the synchronisation process, is described in the chapter for PID controllers.
The parameters used for the adjustment of the synchronisation process are shown below:

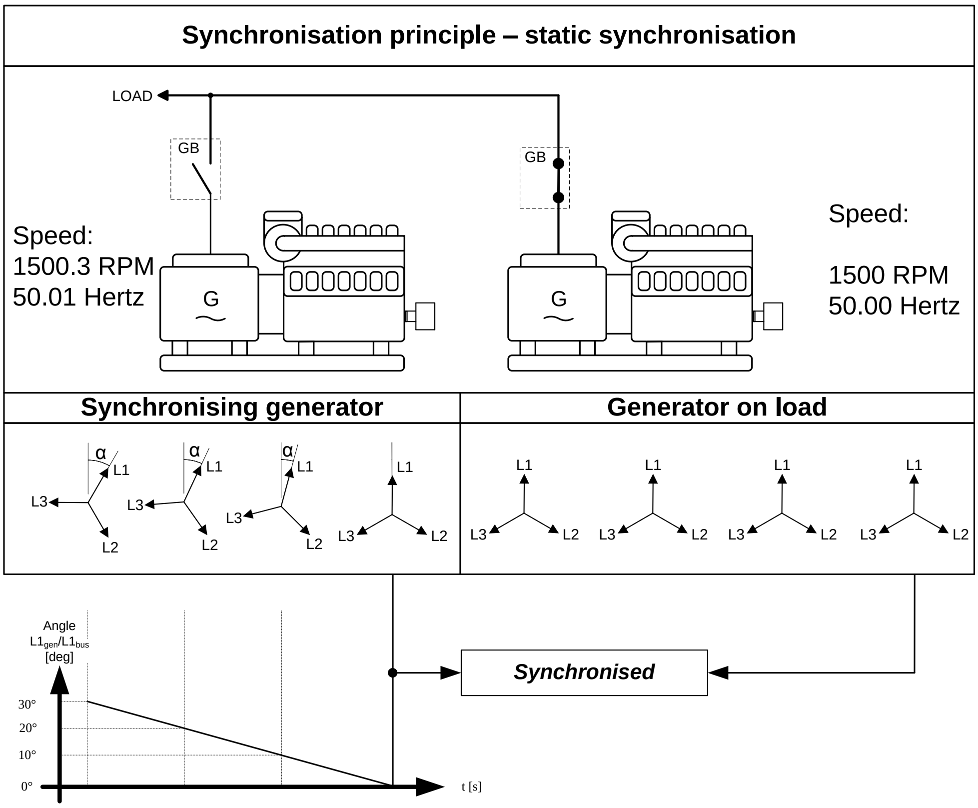
Parameter	Item	Range	Default	Note
2021	Maximum slip frequency	0.0 Hz 0.5 Hz	0.3 Hz	
2022	Minimum slip frequency	-0.5 Hz 0.3 Hz	0.0 Hz	
2023	Maximum difference in voltage	2 % 10 %	5 %	
2024	GB/TB breaker own time/reaction time	40 ms 300 ms	50 ms	
2025	MB breaker own time/reaction time	40 ms 300 ms	50 ms	

10.3 Static synchronisation

In static synchronisation, the synchronising genset is running very close to the same speed as the generator on the busbar. The aim is to let them run at exactly the same speed and with the phase angles between the three-phase system of the generator and the three-phase system of the busbar matching exactly.

It is not recommended to use the static synchronisation principle when relay regulation outputs are used. This is due to the slower nature of the regulation with relay outputs.

The static principle is illustrated below.



10.3.1 Phase controller

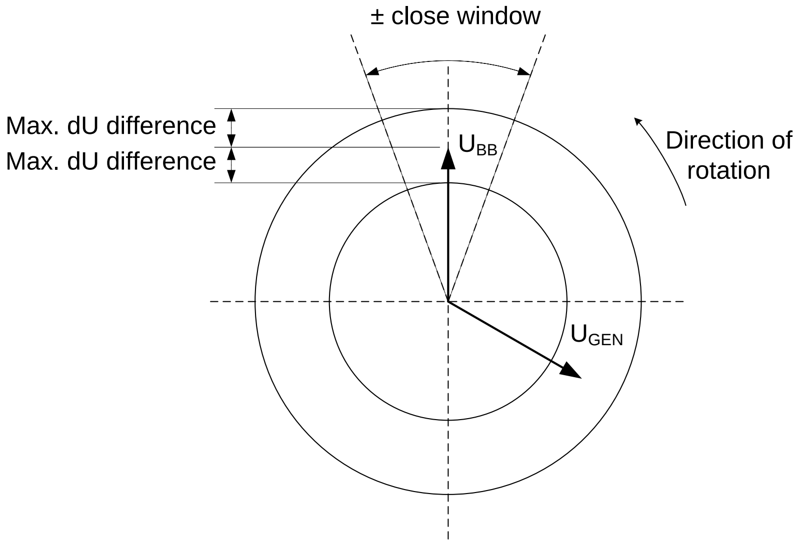
When the static synchronisation is used and the synchronising is activated, the frequency controller will bring the genset frequency towards the busbar frequency. When the genset frequency is within 50 mHz of the busbar frequency, then the phase controller takes over. This controller uses the angle difference between the generator system and the busbar system as the controlling parameter.

This is illustrated in the example above where the phase controller brings the phase angle from 30 deg. to 0 deg.

10.3.2 Close signal

The close signal will be issued when phase L1 of the synchronising generator is close to the 12 o'clock position compared to the busbar which is also in 12 o'clock position. It is not relevant to use the response time of the circuit breaker when using static synchronisation, because the slip frequency is either very small or non-existing.

To be able to get a faster synchronisation, a "close window" can be adjusted. The close signal can be issued when the phase angle U_{GENL1}-U_{BBL1} is within the adjusted set point. The range is +/-0.1-20.0 deg. This is illustrated in the drawing below.



The synchronisation pulse is sent dependent on the settings in menu 2030. It depends on whether it is the GB or the MB that is to be synchronised.

10.3.3 Load picture after synchronisation

The synchronised genset will not be exposed to an immediate load after the breaker closure if the maximum df setting is adjusted to a low value. Since the fuel rack position almost exactly equals what is required to run at the busbar frequency, no load jump will occur.

If the maximum df setting is adjusted to a high value, then the observations in the section about "dynamic synchronisation" must be observed.

After the synchronising, the unit will change the controller set point according to the requirements of the selected genset mode.

Static synchronisation is recommended where a slip frequency is not accepted, for instance if several gensets synchronise to a busbar with no load groups connected.

Static and dynamic synchronisation can be switched by using M-Logic.

10.3.4 Adjustments

The following settings must be adjusted if the static synchroniser is selected in menu 2000:

Setting	Description	Comment
2031 Maximum df	The maximum allowed frequency difference between the busbar/mains and the generator.	+/- value.
2032 Maximum dU	The maximum allowed voltage difference between the busbar/mains and the generator.	+/- value related to the nominal generator voltage.
2033 Closing window	The size of the window where the synchronisation pulse can be released.	+/- value.
2034 Static sync	Minimum time inside the phase window before sending a close command.	
2035 Static type GB	"Breaker" or "Infinite sync" can be chosen.	"Infinite sync" will close the MB to the busbar and run the generator in sync with the mains. The GB is not allowed to close.
2036 Static type MB	"Breaker" or "Infinite sync" can be chosen.	"Infinite sync" will close the GB to the busbar and run the generator in sync with the mains. The MB is not allowed to close.

The PID controller used at the synchronisation process is described in the chapter for PID controllers. The other parameters can be adjusted as in the table below:

Parameter	Item	Range	Default	Note
2031	Max allowed slip frequency for static synchronisation	0 Hz 0.5 Hz	0.1 Hz	
2032	Max voltage difference for static synchronisation	2 % 10 %	5 %	
2033	Max difference in degrees for static synchronisation	0.1 deg 20.0 deg	10.0 deg	
2034	Minimum time inside window for static synchronisation	0.1 s 99.0 s	1.0 s	
2035	Static synchronisation type for GB	Breaker Infinite sync.	Breaker	
2036	Static synchronisation type for MB	Breaker Infinite sync.	Breaker	Only in stand-alone applications

10.4 GB closing before excitation

It is possible to adjust the AGC to start the genset with the excitation switched off. When the gensets are started, the breakers will be closed and the excitation started. It is also possible to close the breaker before the engine is started. This function is called "close before excitation".

The purpose of the "close before excitation" is that the gensets are able to be ready for the load very quickly. All of the gensets will be connected to the busbar as soon as they are started, and as soon as the excitation is switched on, the gensets are ready for operation. This is faster than the normal synchronising, because in that case the breakers will not be closed until the generator voltage is in the synchronised position, and it takes some time to achieve that position.

The "close before start" function can also be used if the load requires a "soft" start. This can be the case when the gensets connect to a transformer.

As soon as the excitation is activated, the generators will equalise the voltage and frequency and will eventually run in a synchronised system. When the excitation is activated, then the regulators of the AGC will be switched on after an adjustable delay.

The excitation must be increased slowly when this function is used.

This function can only be used with a magnetic pick-up or J1939 speed signal.

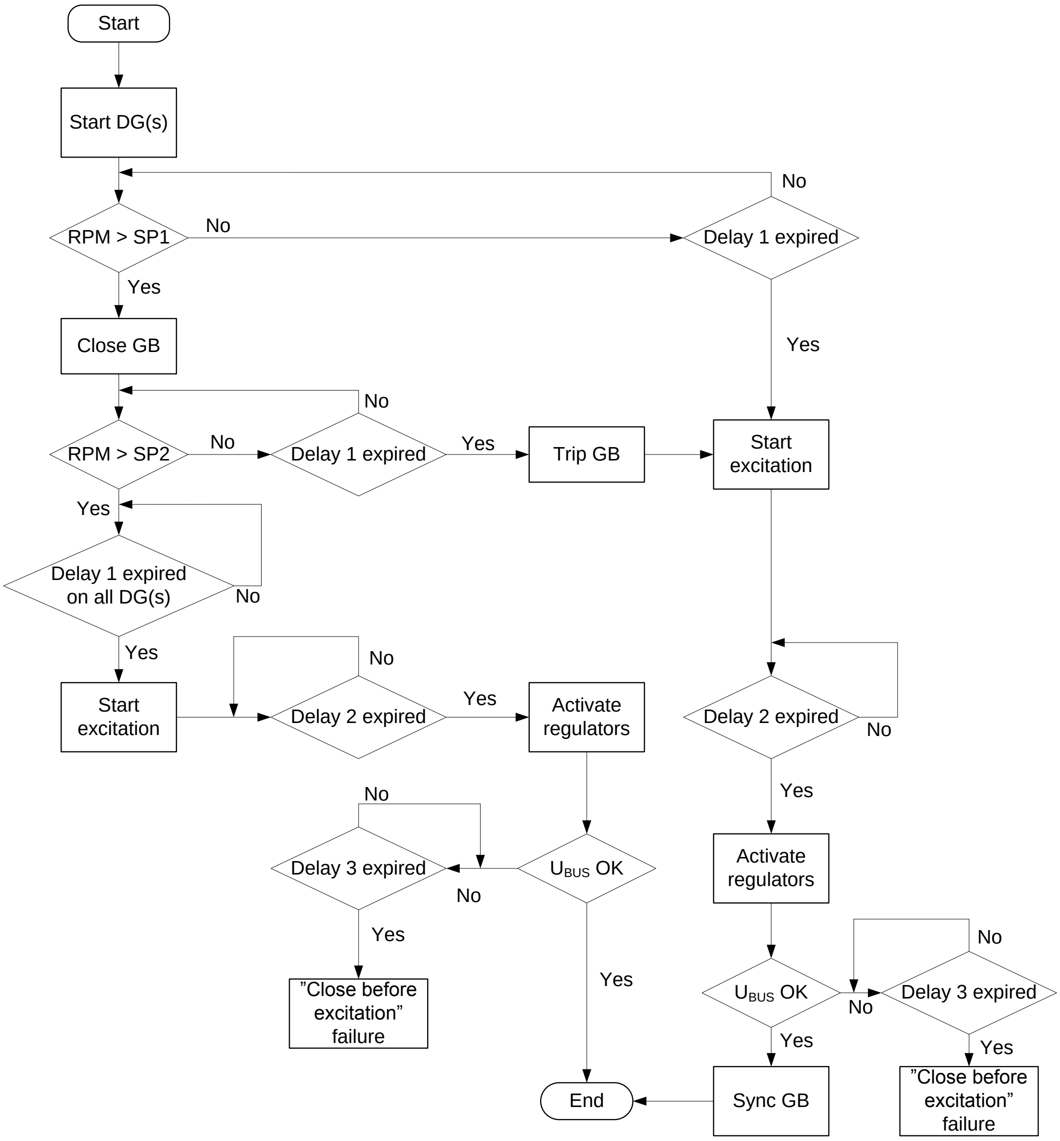
The principle is described in the flowcharts below.

Flowchart abbreviations

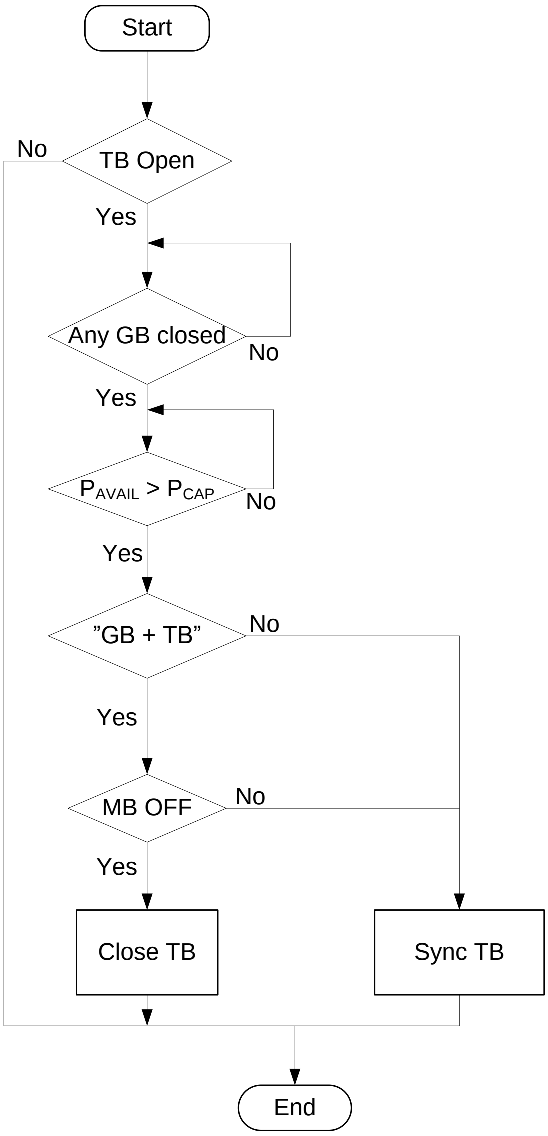
Delay 1	=	Menu 2252
Delay 2	=	Menu 2262
Delay 3	=	Menu 2271

SP1	=	Menu 2251
SP2	=	Menu 2263

10.4.1 Flowchart 1, GB handling



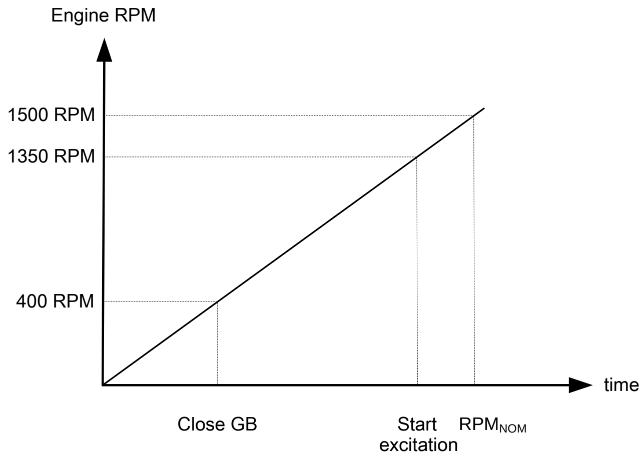
10.4.2 Flowchart 2, TB handling



10.4.3 Genset start actions

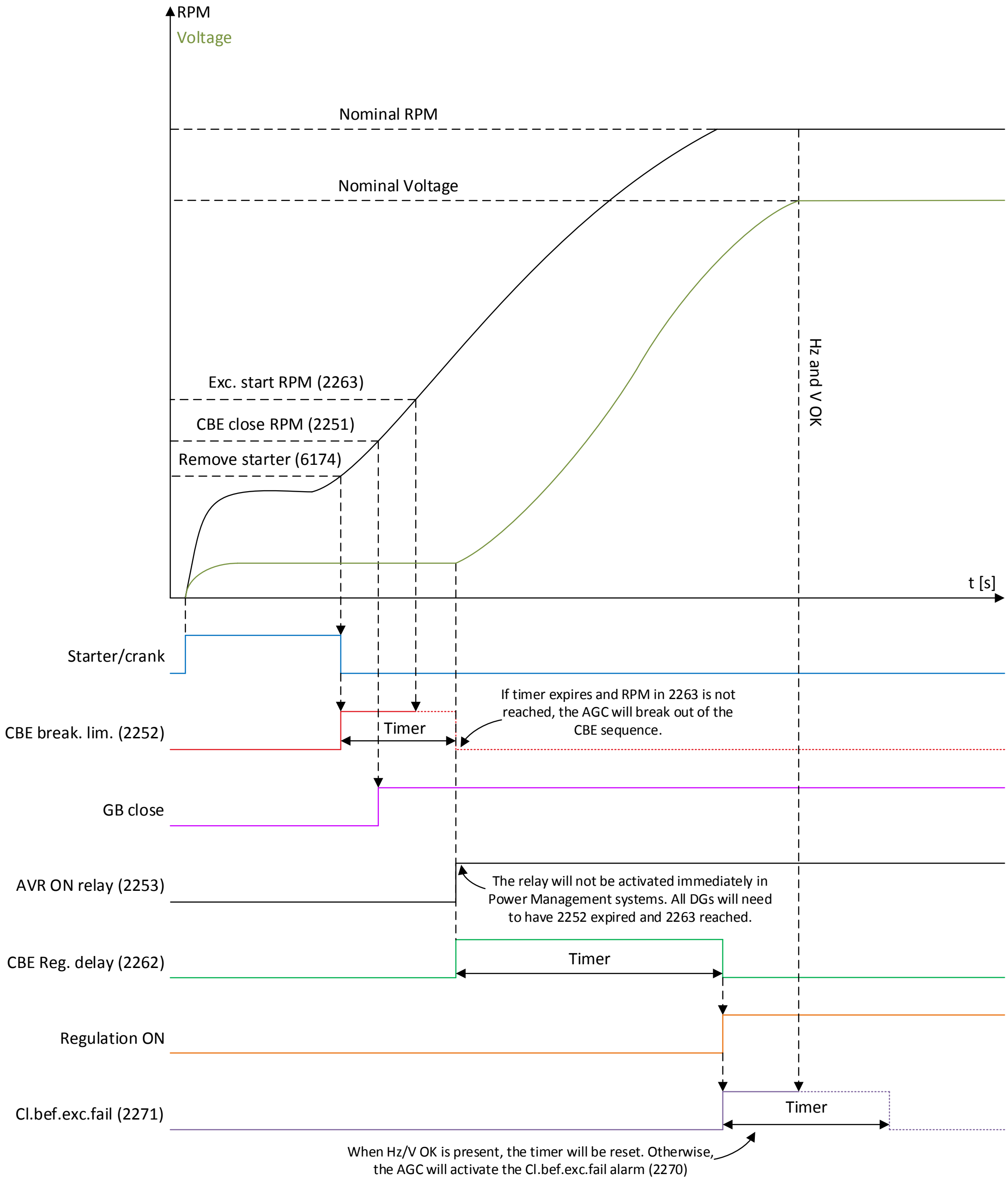
The start sequence of the AGC is changed in order to achieve the function "close before excitation". The following parameters must be adjusted:

Menu	Description	Comment
2251	RPM set point for breaker closing	The generator breaker will close at the adjusted level. The range is from 0-4000 RPM. If it is adjusted to 0, then the breaker will be closed when the start command is given. In the example below, the setting is adjusted to 400.
2252	RPM timer	The genset must reach the set point (menu 2263) within the adjusted delay. When the delay expires and the RPM is above the set point, then the excitation will be started. If the RPM is below the set point, then the GB will be tripped.
2253	Output A	Select the relay output that must be used to start the excitation. Configure the relay to be a limit relay in the I/O setup.
2255	Enable	Enable the function "close before excitation".



The diagram above shows that the GB will be closed at 400 RPM. When the engine RPM has reached the set point (menu 2263) (1350 RPM), the excitation is switched on.

The different parameters and timers will be activated and deactivated at different levels and times. This gives the possibility to make the "Close before excitation" sequence so it matches the application. An overview of the "Close before excitation" sequence is shown below:



Furthermore, the parameters and limits for them are shown below:

Parameter	Item	Range	Default	Note
2251	Close breaker RPM	0 rpm 4000 rpm	400 rpm	Only in genset
2252	Breakout limit – Timer	0.1 s 999.0 s	5.0 s	Only in genset
2253	AVR ON/Excitation ON relay	Not used Option-dependent	Not used	Only in genset
2254	Close before excitation Enable	OFF ON	OFF	Only in genset
2261	Breaker sequence for Close before excitation	Close GB Close GB+TB	Close GB	Only in genset
2262	Close before excitation regulation delay	0.0 s 999.0 s	5.0 s	Only in genset
2263	Close before excitation – excitation start relay	0 rpm 4000 rpm	1450 rpm	Only in genset

10.4.4 Breaker sequence

The "GB close before start" function can be used in different applications:

1. Stand-alone applications
2. 2-level application - no tie breaker present
3. 2-level application - tie breaker present
4. 3-level application - group tie breaker present (Not possible to start all groups at once)

In one of the applications, a tie breaker is present, and it must be adjusted in the menu 2261 whether only the generator breaker must be closed or both the generator breaker and the tie breaker should also be closed .

The breaker sequence adjustments are the following:

Menu	Description	Comment
2261	Breaker selection	Select breakers to close: GB or GB + TB.
2262	Timer	The timer defines the period from the excitation is started and until the regulation is activated. The alarms with inhibit set to "Not run status" will be activated after this timer has expired.
2263	Excitation start level	The setting defines at what level of RPM the excitation is started.
2264	Voltage discharge	This timer delays the closing of the GB after removing excitation. The intention of this delay is to let the voltage of the generator discharge, so that only remanence voltage is present when the GB is closed.

10.4.5 "Close before excitation" failure

If the starting of the genset does not succeed, then the alarm menu 2270 "Cl.bef.exc.fail" will occur, and the selected fail class will be executed.
The parameters for the "Close before excitation failure", are shown in the table below:

Parameter	**Item**	**Range**	**Default**	**Note**
2271	Close before excitation fail - Timer	0.0 s 999.0 s	5.0 s	Only in genset
2272	Close before excitation fail – Output A	Not used Option dependent	Not used	Only in genset
2273	Close before excitation fail – Output B	Not used Option dependent	Not used	Only in genset
2274	Close before excitation fail – Enable	OFF ON	OFF	Only in genset
2275	Close before excitation fail – Fail-class	Block Trip MB/GB	Warning	Only in genset

10.5 Separate synchronising relay

When the AGC gives the synchronising command, then the relays on terminal 17/18/19 (generator breaker) and terminal 11/12/13 (mains breaker) will activate, and the breaker must close when this relay output is activated.

This default function can be modified using a digital input and extra relay outputs depending on the required function. The relay selection is made in the menu 2240, and the input is selected in the input settings in the utility software.

The table below describes the possibilities.

Input	Relay	Relay selected Two relays used	Relay not selected One relay used
Not used		**Synchronising:** The breaker ON relay and the sync. relay activate at the same time when synchronising is OK. **Blackout closing:** The breaker ON relay and the sync. relay activate at the same time when the voltage and frequency are OK.	**Synchronising:** The breaker ON relay activates when synchronising is OK. **Blackout closing:** The breaker ON relay activates when the voltage and frequency are OK. **DEFAULT selection**
Low		**Synchronising:** Not possible. **Blackout closing:** The breaker ON relay and the sync. relay activate at the same time when the voltage and frequency are OK.	**Synchronising:** Not possible. **Blackout closing:** The breaker ON relay activates when the voltage and frequency are OK.
High		**Synchronising:** The relays will activate in two steps when the synchronising is selected: 1. Breaker ON relay activates. 2. When synchronised the sync. relay activates. **See note below!** **Blackout closing:** The breaker ON relay and the sync. relay activate at the same time when the voltage and frequency are OK.	**Synchronising:** Not possible. **Blackout closing:** The breaker ON relay activates when the voltage and frequency are OK.

When two relays are used together with the separate sync. input, then please notice that the breaker ON relay will be activated as soon as the GB ON/synchronising sequence is activated.

Care must be taken that the GB ON relay cannot close the breaker, before the sync. signal is issued by the sync. relay.

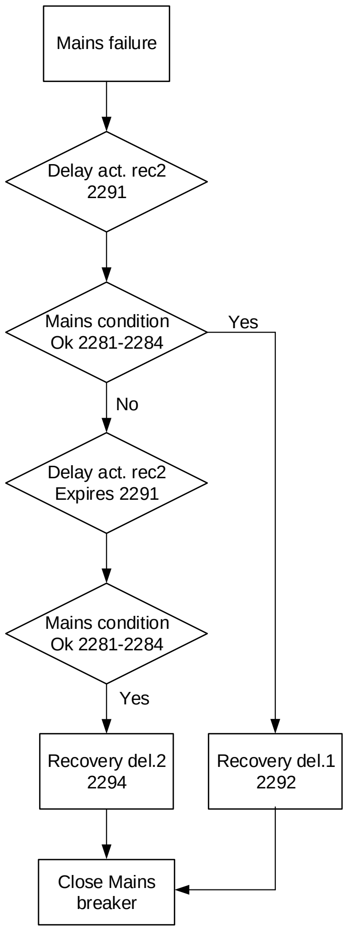
The selected relay for this function must have the "limit" function. This is adjusted in the I/O setup.

The parameters for the seperate synchronising relay function are shown below:

Parameter	Item	Range	Default	Note
2241	Separate synchro-nising relay for GB/TB	Not used Option-dependent	Not used	
2242	Separate synchro-nising relay for MB	Not used Option-dependent	Not used	

10.6 Inhibit conditions before synchronising mains breaker

This function is used to inhibit the synchronising of the mains breaker after blackout. After blackout, the timer in menu 2291 ("Delay activate recovery 2") will start to run, and if the mains voltage and frequency are inside the limits (2281/2282/2283/2284) before the timer runs out, the short interruption timer (menu 2292 "Recovery del. 1") will be started. When the timer has run out, the synchronising of the MB will start.



If the "Delay activate recovery 2" timer runs out, the long interruption timer (menu 2294 "Recovery del. 2") will start to run.

Examples:

Recovery timer 1 (short interruption timer)

Menu 2291 = 3 s
Menu 2292 = 5 s

That means: if the short interruption timer is set to ≤ 3 s, and the grid is back and voltage and frequency are inside the acceptable range stated above, then after 5 s the MB can be closed.

Recovery timer 2 (long interruption timer)

Menu 2291 = 3 s
Menu 2294 = 60 s

The long interruption timer will allow the MB to reconnect as soon as the mains voltage and frequency have been uninterrupted within the timer setting in menu 2294 ("Recovery del. 2"). Then the MB can be closed.

The inhibit parameters for synchronising the MB are disabled by default.

The table for the parameters are shown below:

Parameter	Item	Range	Default	Note
2281	Mains sync inhibit – Voltage low limit	80 % 100 %	85 %	
2282	Mains sync inhibit – Voltage high limit	100 % 120 %	110 %	
2283	Mains sync inhibit – Frequency low limit	90.0 % 100.0 %	95.0 %	
2284	Mains sync inhibit – Frequency high limit	100.0 % 110.0 %	101.0 %	
2285	Mains sync inhibit – Enable function	OFF ON	OFF	
2286	Mains sync inhibit – fail class	Block Trip MB/GB	Trip GB	
2291	Mains sync inhibit – Delay 1	0.0 s 20.0 s	3.0 s	
2292	Mains sync inhibit – Delay 2	0.0 s 60.0 s	5.0 s	
2293	Mains sync inhibit – Delay 2 – Output A	Not used Option-dependent	Not used	
2294	Mains sync inhibit – Delay 3	0.0 s 900.0 s	60.0 s	
2295	Mains sync inhibit – Delay 3 – Output A	Not used Option-dependent	Not used	

11. General purpose PID

11.1 Introduction

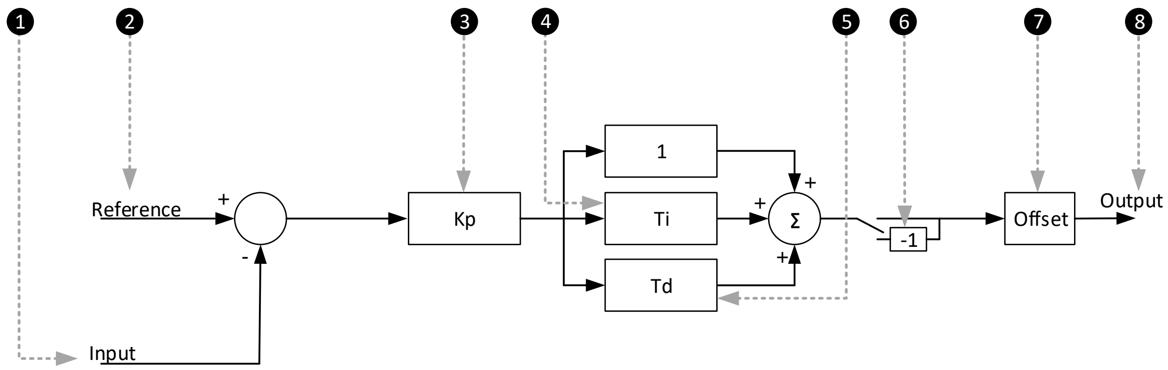
11.1.1 Introduction

The general purpose PID controllers are principally similar to the PID controllers for AVR and governor output. They consist of a proportional, integral and differential part, and the integral and differential parts are dependent on the proportional gain. A functional description of the principle can be found in the chapter about controllers for AVR and governor. The GP PIDs are slightly less responsive, though. They are meant for purposes such as temperature regulation, controlling fans, valves, and so on. The principle of relay control is also described in the chapter about AVR/governor control. Configuration of the GP PIDs is documented by describing the possibilities of the GP PID interface, and with examples of configuration for different purposes.

Acronyms:
GP: General Purpose
SP: Set Point
PV: Process Variable

11.1.2 General purpose PID analogue loop

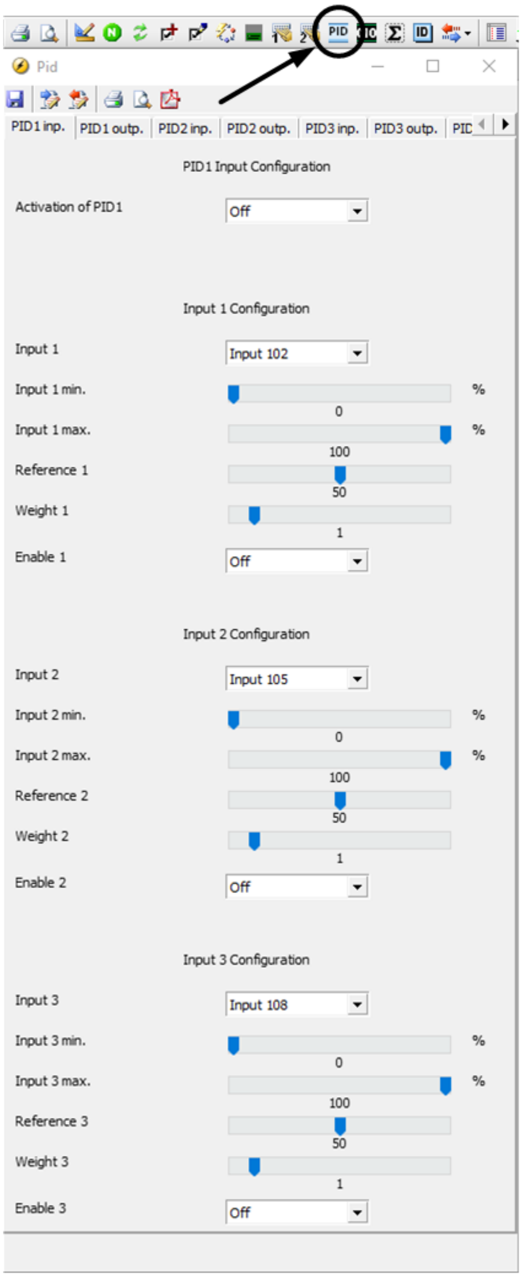
The analogue regulation in the general purpose PIDs is handled by a PID loop. The diagram below shows which elements the PID loop consists of.



1. **Input:** This is the analogue input that measures the process the controller is trying to regulate. See under *Input* later in this document for more details.
2. **Reference:** This is the set point that the controller is trying to bring the input to match. See under *Input* later in this document for more details.
3. **Kp:** The proportional gain of the PID loop. See under *Output* later in this document for more details.
4. **Ti:** The integral gain of the PID loop.
5. **Td:** The derivative gain of the PID loop.
6. **Inverse:** Enabling inverse will give the output a negative sign. See under *Output* later in this document for more details.
7. **Offset:** The offset is added on the function and displaces the regulation range. See under *Output* later in this document for more details.
8. **Output:** This is the final output from the PID, controlling the transducer.

11.1.3 GP PID interface in USW

Configuration of the GP PID's input and output settings is done with the “PID” interface in the DEIF USW, it cannot be done from the display of the controller.

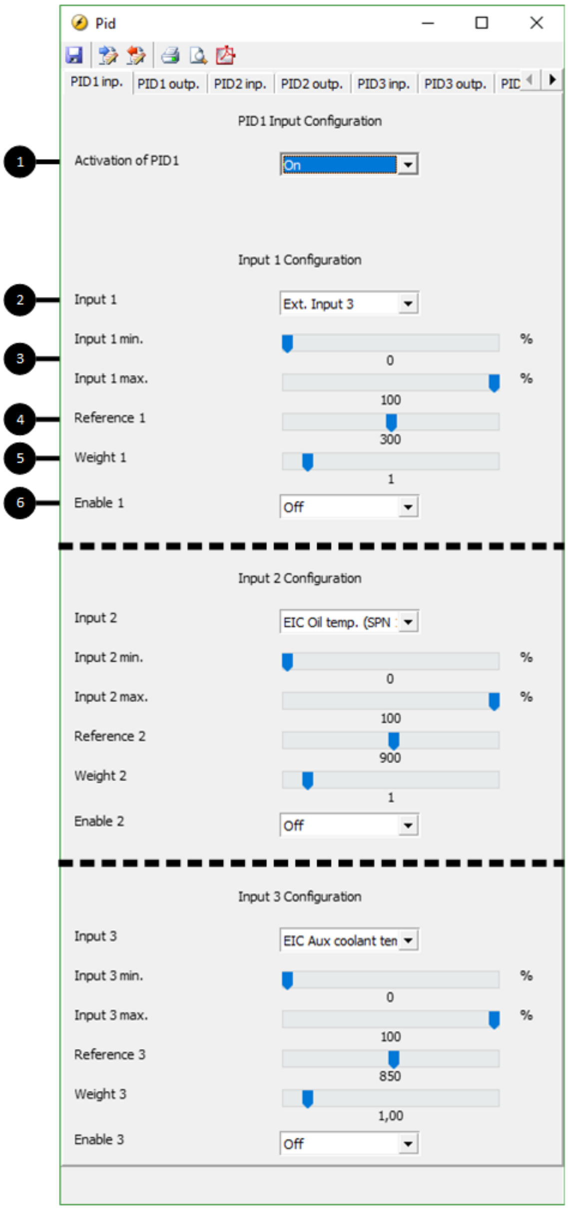


11.2 Inputs

11.2.1 Inputs

Each output holds the possibility of up to three inputs. Only one input at a time is used for calculation of output signal. It is described in “Dynamic input selection” how the selection is handled.

Explanation of GP PID settings



1: Activation drop-down

Enables the PID or allows it to be enabled from M-Logic.

2: Top drop-down

The source of this input is chosen here.

3: “Input 1 min.” and “Input 1 max.”
Defines the scale of the input value evaluated.

4: “Reference 1”
The set point for this particular input (30 °C).

5: “Weight 1”
The weight factor is multiplied by the input value. A weight factor of 1 means that the real input value is used in calculations. A weight factor of 3 means that the input value is considered three times as big in calculations.

6: Bottom drop-down
On: This input will be evaluated. Off: This input will not be evaluated.

11.2.2 Dynamic input selection

Each GP PID holds the possibility of up to three active inputs. All activated inputs are evaluated constantly, and the input causing the greatest or smallest output is selected. Priority of great or small output is selected in the output settings.

Example explaining dynamic input selection
Ventilation of a container fitted with a genset inside is a realistic example for use of the dynamic input selection. The following three variables depend on the ventilation, hence it makes sense to let them share the output.

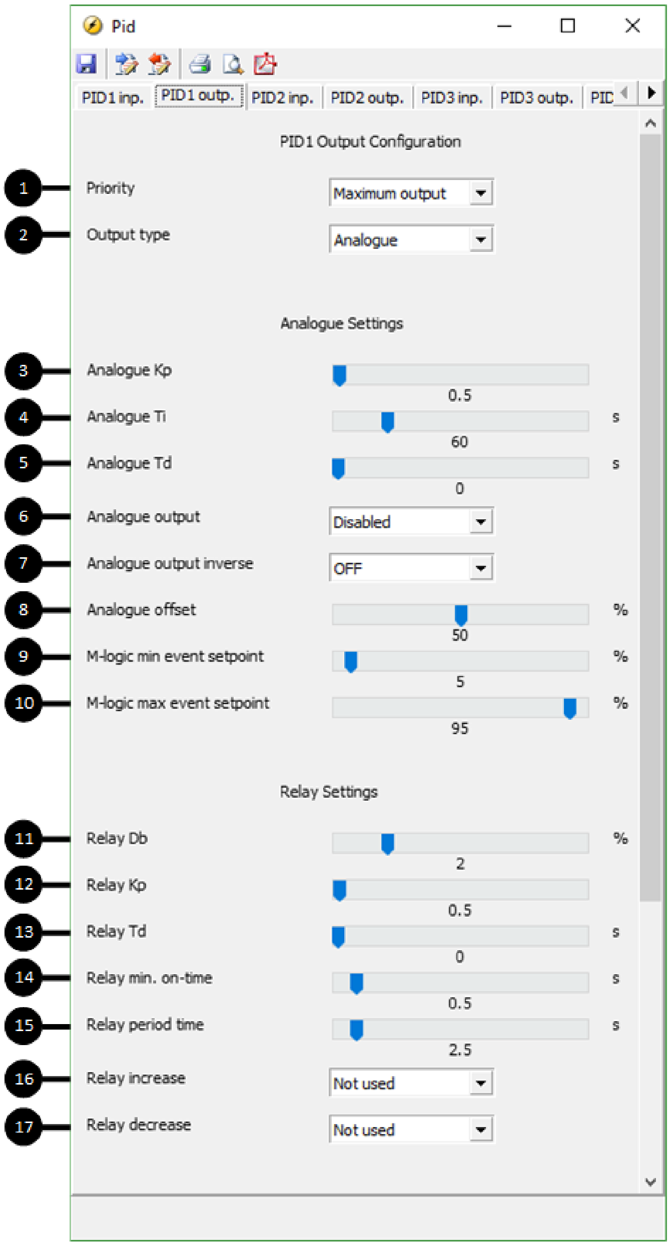
- The container is fitted with a temperature sensor for internal container temperature. Due to lifetime of electronics inside the container, maximum maintained temperature is desired to be 30 °C. (Input 1).
- The engine air intake is located inside the container, hence turbo compressor inlet temperature depends on the air temperature in the container. Maximum maintained intake air temperature is 32 °C. (Input 2).
- The alternator is cooled by air in the container, hence the alternator winding temperature depends on the air temperature in the container. Maximum maintained winding temperature is 130 °C. (Input 3).

This is the data that is used to configure the inputs in the screenshot in the previous paragraph (Inputs). All inputs are configured with both full range of measurement (0 to 100 %) and a weight factor of 1. The common output to the ventilator speed drive is configured to prioritise maximum output as explained in the next chapter, “Output”. This configuration is meant to ensure that none of the input set points are continuously exceeded, unless maximum ventilation is reached.
A scenario of operation could be that the controller has been using input 1, and a temperature of 30 °C is maintained in the container. At a point, the air filter housing is heated by radiation from the engine, causing input 2 to rise more above 32 °C than input 1 is above 30 °C. This means that input 2 now has the greatest positive deviation. All inputs are configured with a weight factor of 1 and maximum output is prioritised, hence the greatest positive deviation results in maximum output, or, to put it in another way, input 2 is now the one selected.
The genset is running at full load with a maximum of reactive load, and the alternator windings heat up beyond the 130 °C set point due to high currents. At some point, input 3 will result in maximum output and hence be selected as the input used in output calculation. Ventilation is increased and the winding temperature may reach a steady state of 130 °C with a container room temperature of 27 °C and a compressor inlet temperature of 30 °C. As long as this is the situation, input 3 will remain the selected input, as this is the input causing the greatest output.

In case of high ambient temperatures, the ventilation might not be able to influence the temperature enough, and the temperatures start to rise above set point. The output will stay at 100 % as long as any of the inputs are continuously above their set points.
Weight factor applies to dynamic input selection as well. In the event that different weight factors have been configured for any of the three inputs, maximum deviation cannot be equated to maximum output. If two inputs with similar deviation to their respective set points are configured with weight factors of 1 and 2 respectively, the latter will result in twice the output as the first.

11.3 Output

11.3.1 Explanation of output settings



1: Priority
This setting determines whether it is min. or max. output that is prioritised. This setting is used for the dynamic input selection feature. “Maximum output” results in selection of the input that gives the greatest output. “Minimum output” results in selection of the input that gives the smallest output.

2: Output type
Choose between relay or analogue output. The following parameters marked “analogue” only apply to the use of analogue regulation, in the same way as parameters marked “relay” only apply to relay regulation.

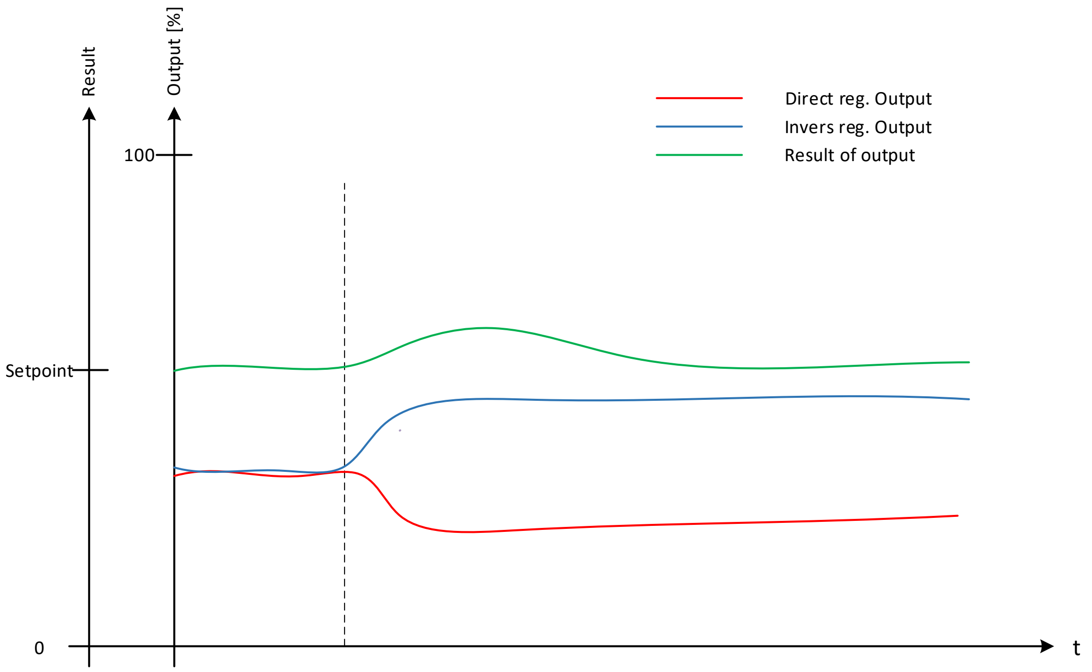
3: Analogue Kp
This is the proportional gain value. Increasing this value gives a more aggressive reaction. Adjusting this value also affects the integral and derivative output. If Kp needs adjustment without affecting the Ti or Td part, adjust these accordingly.

4: Analogue Ti
Increasing the Ti results in less aggressive integral action.

5: Analogue Td
Increasing the Td gives more aggressive derivative action.

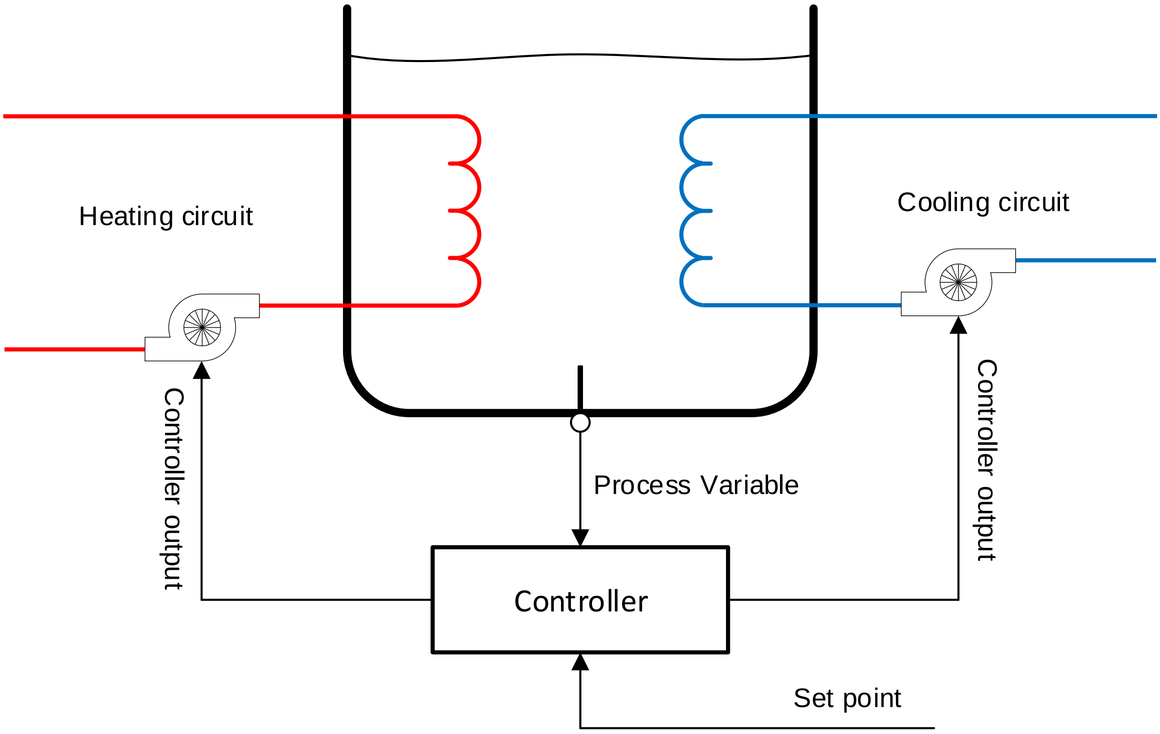
6: Analogue output
Choose the physical internal or external output.

7: Analogue output inverse
Enabling this inverses the output function.



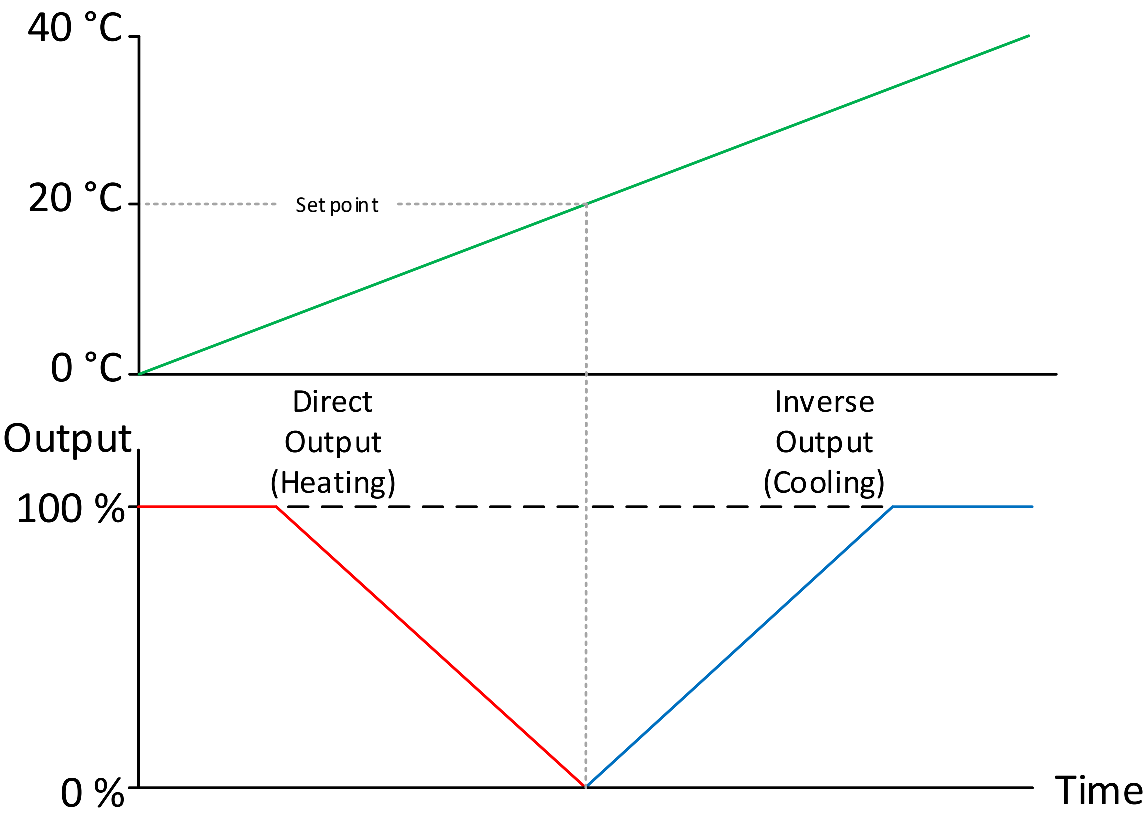
Direct error = SP - PV
Inverse error = PV - SP
Direct output is used in applications where a rise in analogue output increases the process variable.
Inverse output is used in applications where a rise in analogue output decreases the process variable.

Example explaining direct and indirect regulation:
Typically, heating applications use direct output and cooling applications use inverse output. Imagine a container of water, which must be kept at a set point of 20 °C at all times. The container can be exposed to temperatures between 0 and 40 °C, hence it is fitted with both a heating coil and a cooling coil. See the illustrations of this below here.



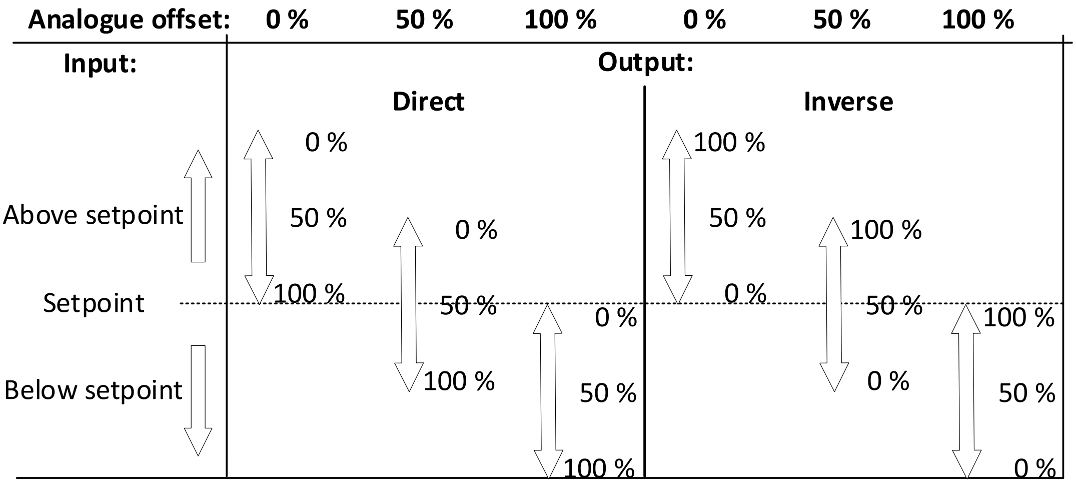
For this application, two controllers must be configured: one with direct output for the heating pump and one with inverse output for the cooling pump. To achieve the illustrated inverse output, an offset of 100 % is needed. See the sections about “Analogue offset” and “Example of inverse output with 100 % offset” for more information regarding offset.

Temperatures below 20 °C then result in a positive output for the heating pump, in the same way as temperatures above 20 °C result in a positive output for the cooling pump, and the temperature is maintained around the set point.



8: Analogue offset

Determines the output starting point. The full range of output can be seen as values in the range between 0 and 100 %. The offset displaces this range. 50 % offset centres the range of output at the set point. 0 and 100 % offset result in having the full range of output above or below the set point. See the table below for illustration of how the output behaves according to the input and with different offsets.



100 % offset is commonly used with inverse output, like in the previous cooling example. For an example of other use, see “Example of inverse output with 0 % offset”.

9: M-Logic min event set point
Determines the output of M-Logic function "PID1 force min. Outp."

10: M-Logic max event set point
Determines the output of M-Logic function "PID1 force max. Outp."

11: Relay Db
Deadband setting for relay control.

12: Relay Kp
Proportional gain value for relay control.

13: Relay Td
Derivative output for relay control.

14: Relay min on-time
Minimum output time for relay control. Set this to the minimum time that is able to activate the controlled actuator.

15: Relay period time
Total time for a relay activation period. When the regulation output is above this period time, the relay output is constantly activated.

17: Relay increase

Choose the terminal for the relay used for positive activation.

18: Relay decrease
Choose the terminal for the relay used for negative activation.

11.4 Kp gain compensation

11.4.1 Introduction

This document describes the functionality regarding the “Kp gain compensation”, so it is possible to utilise the function parameters and help with setting up the function. This function is intended to be used when the AGC is controlling the cooling water system for the genset.
As it is today, there are two situations in which the engine is in danger of ending in an oscillation that could shut down the engine:

1. Load impacts
2. Cold start of engine

In both situations, it is desired to have a higher gain when the change is needed, but a lower gain when the system has to stabilise. Without "Kp gain compensation", the PID settings need to be balanced between reaction and stability. The “Kp gain compensation” function allows slower PID settings for when there are no changes or stabilising, and when there are significant changes in the system it will increase the reaction of the PID.

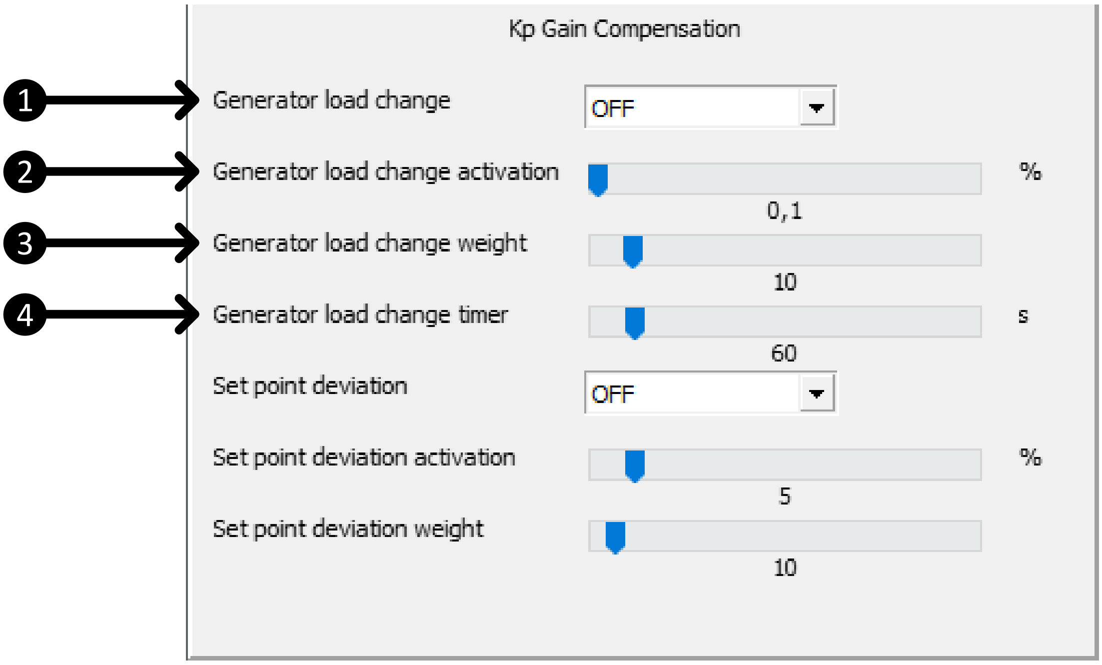
The "Kp gain compensation" consists of two separate functions:
1. The load change gain compensation.
2. Set point deviation compensation.

These two functions, the load-dependent compensation and the set point deviation compensation, can be used separately or together. If they are used together, it is always the one with the highest returned gain that is used.

11.4.2 Load change gain compensation

In case of large load impacts or rejections, it can create large deviation in the need of cooling, and thereby create some instability in the cooling system. To alleviate some of this instability, the load change gain compensation will instantaneously increase the gain in relation to the load gain. Larger load changes give a bigger increase in gain. This increase in gain will decrease over a set time till it reaches the nominal gain.

Explanation of settings



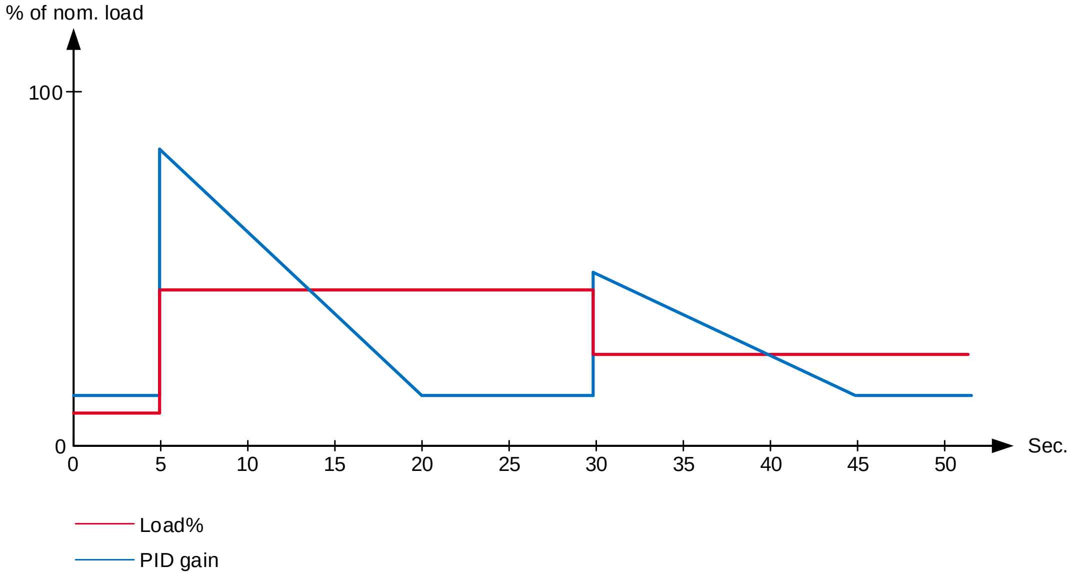
1: Generator load change
Enables/disables load change compensation.

2: Generator load change activation
Load change limit. The controller needs to detect a load change larger than this limit before activating the gain compensation. For example, if the limit is set for 10 %, there must be a load impact or rejection of at least 10 % of the genset nominal power before this function activates.

3: Generator load change weight
The gain increase is based on the load change compared to nominal, and this ratio is multiplied by the load weight.

4: Generator load change timer
The gain increase will be instantaneous, but it will decrease linearly over the set time until it reaches nominal gain.

Example of load change gain compensation

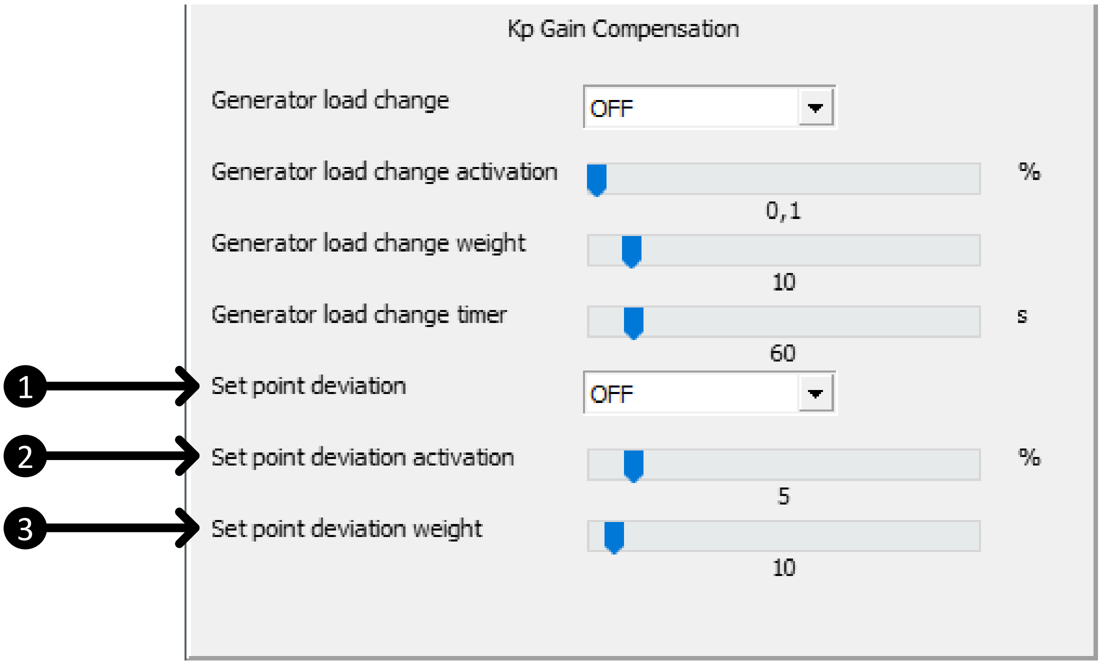


The diagram above shows the reaction of the gain, based on two load changes.
In the first situation, there is a large load impact that triggers the load change gain compensation and increases the gain instantaneously. This increase will decrease, in this case over 15 seconds, and bring the gain back to nominal.
After some seconds, the system drops some load again, but only half of the former impact. Gain is again instantaneously increased, but this time only half as much because the load change is only half as big. The increase will still decrease over 15 seconds.

11.4.3 Set point deviation compensation

This function is intended to help minimise overshoots. Especially in a cooling water system where the set point is often very close to the shutdown limit, it is difficult for a slow system to react in time to avoid a shutdown. This function will drastically increase the gain when the actual value overshoots the set point more than the set deadband, but the further the actual value is from the set point, it will decrease. If the value drops below the set point, the function works reversed. Close to set point, the gain increase is small, but the further the actual value is from the set point, it will increase. This is to avoid that the system starts hunting.

Explanation of settings

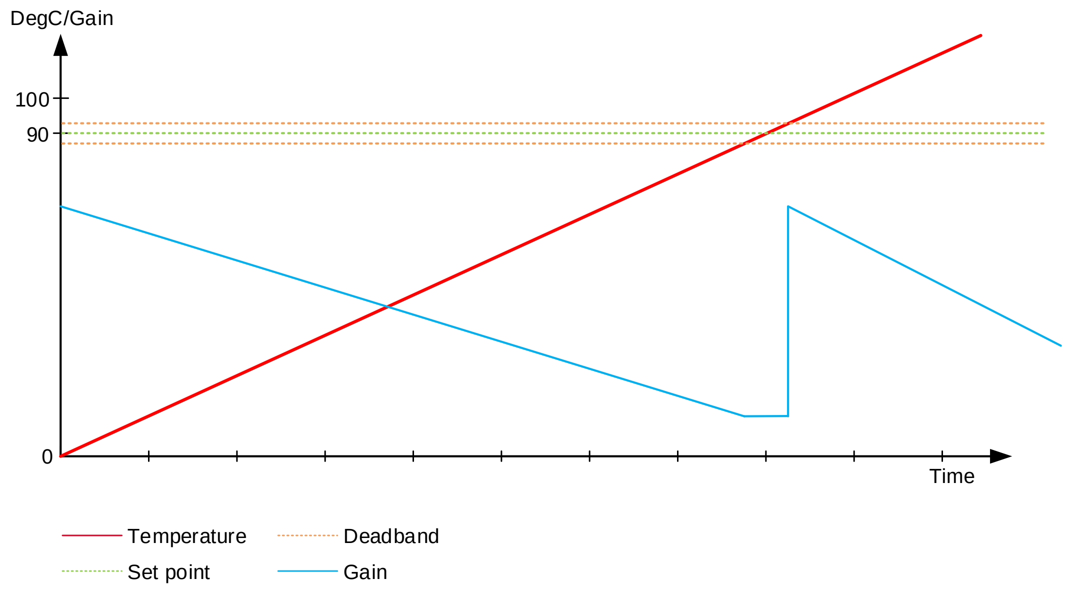


1: Set point deviation
Enables/disables set point deviation compensation.

2: Set point deviation activation
Deviation deadband. As long as the actual value does not deviate more than the deadband in this parameter, the function is not activated.

3: Set point deviation weight
The gain increase is based on the set point deviation compared to nominal, and this ratio is multiplied by the weight factor.

Example of set point deviation compensation



The diagram above shows how the reaction to a set point deviation could look.
This situation could be rising cooling water temperature in a genset. Below the set point, the gain is very high, but as the temperature is getting closer to the set point, it decreases the gain compensation. Within the activation limit, the gain is at nominal value.
As the temperature keeps rising, it exceeds the activation limit again, and when it is above set point the gain is increased instantaneously. As the temperature keeps rising, the gain compensation decreases again.

11.5 M-Logic

11.5.1 Introduction

All functions of the GP PIDs can be activated and deactivated by means of M-Logic. In the following, events and commands regarding the GP PIDs are described.

11.5.2 Events

PID active
This event is active when the related PID is activated.

PID at min output
This event is active when the output is below the output parameter “M-Logic min event set point”.

PID at max output
This event is active when the output is above the output parameter “M-Logic max event set point”.

PID using input 1
This event is active when dynamic input selection has selected input 1 for output calculation.

PID using input 2
This event is active when dynamic input selection has selected input 2 for output calculation.

PID using input 3
This event is active when dynamic input selection has selected input 3 for output calculation.

PID Modbus control
This event is active when remote Modbus control of this PID is requested.

11.5.3 Commands

PID activate
This command activates the PID controller.

PID force min. outp.
This command forces the output to the value set in the output parameter “Analogue min outp.”

PID force max. outp.
This command forces the output to the value set in the output parameter “Analogue max outp.” (for example, for post-cooling purposes).

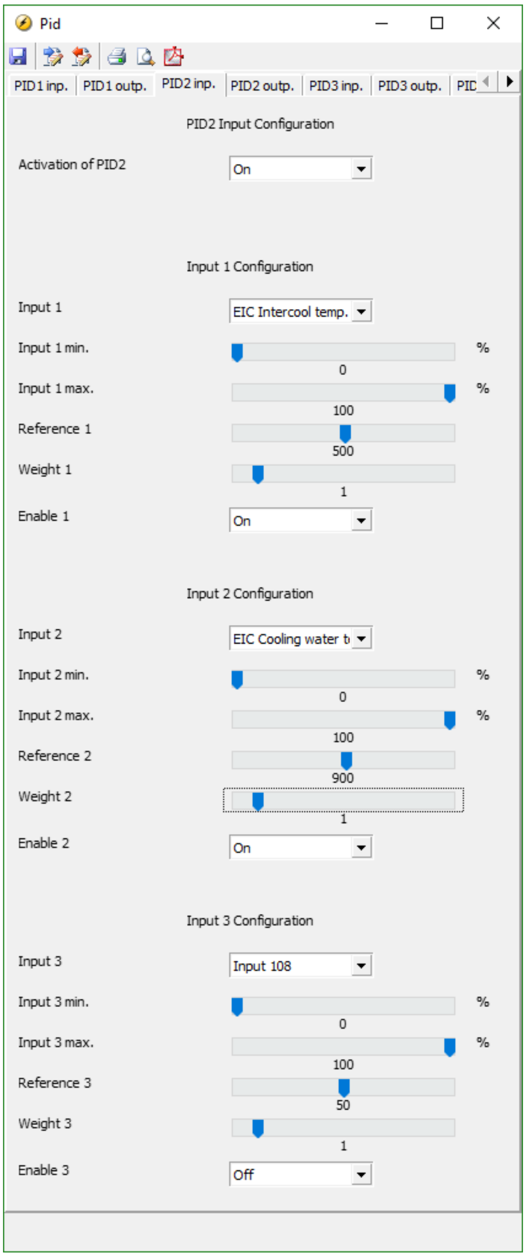
PID reset
This command forces the output to the value set in the output parameter “Analogue offset”.

PID Freeze
This command freezes the output at the current value.

11.6 Example

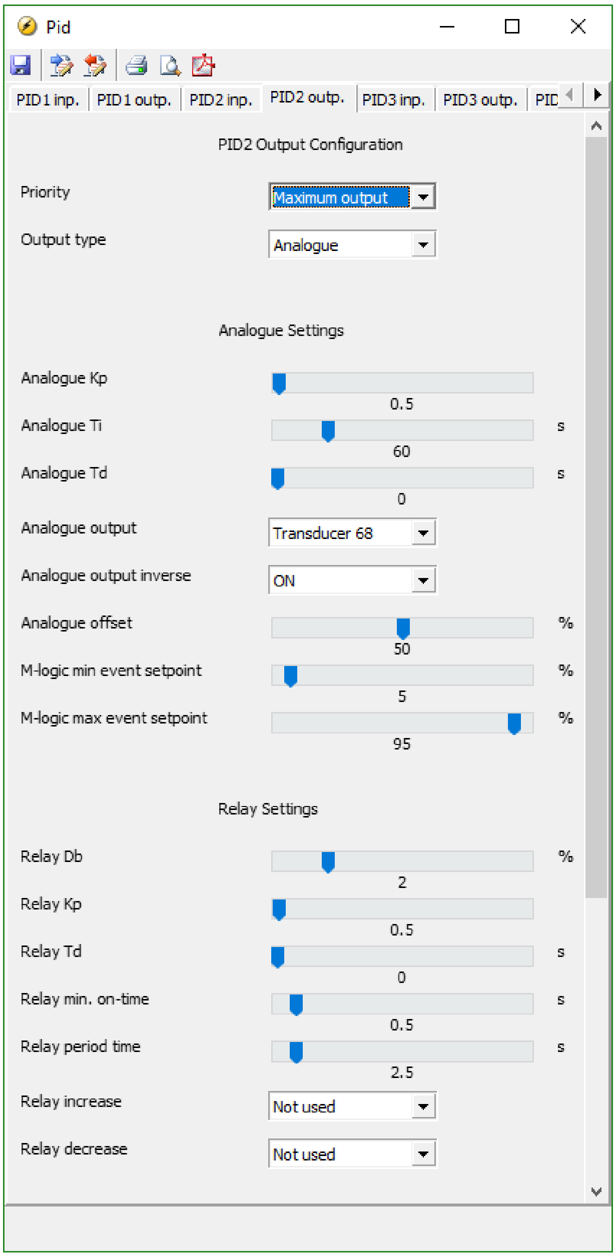
11.6.1 Example

An example for use of a GP PID could be analogue fan control. The fan in this example is mounted on a radiator “sandwich” construction. The fan drags air through two radiators, one for cooling of the intercooler coolant and one for cooling of the jacket water. As these two systems have different temperature set points, the dynamic set point selection is used. PID2 is used in this example, and the picture shows an example of input settings.



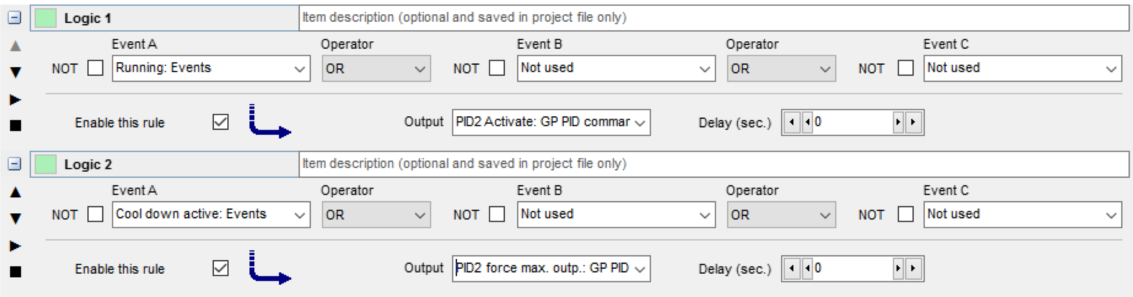
In this example, the ECM (Engine Control Module) measures both the intercooler coolant temperature as well as the jacket cooling water temperature. The generator controller receives these values by an EIC option (Engine Interface Communication).

EIC Intercool temp. is selected as input 1, and EIC Cooling water temp. as input 2. Min. and max. values are configured for full range. Input 1 reference set point is set at 500 to achieve a temperature set point of 50.0 °C for intercooler coolant. Input 2 has a reference set point set at 900 to achieve a set point of 90.0 °C jacket water coolant. To achieve equal weighting of the inputs when calculating the output, both weight factors are set to a value of 1. Both desired inputs are activated, leaving input 3 to be deactivated.



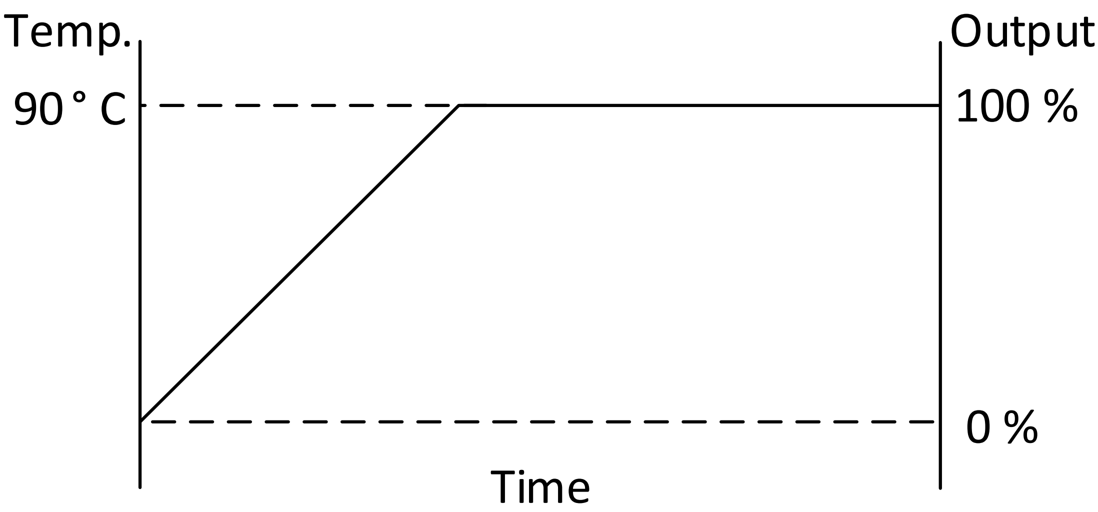
In this application, it is desired to ensure that none of the temperatures permanently exceed their set points. This is achieved by selecting maximum output as priority for the dynamic input selection.
In this example, “Analogue” is selected as output type, and the physical output is selected to be “transducer 68”. Inverse output is activated to obtain a rise in analogue output to the fan when the temperature rises.
An offset of 100 % is chosen to achieve 100 % output at the set point.
Full range of output is selected. As this is output for a fan, it may be preferred to use a minimum output.
Standard settings are used for M-Logic min./max. events.
No relay settings are configured, as this is an analogue function.

Below is an example of M-Logic lines for this application. Logic 1 makes sure that the regulation is active and the output is calculated as long as the engine is running. Logic 2 forces the fan to maximum speed during cool-down to ensure efficient cool-down.



The fan then functions as in the description below.
When the engine is started and running, the regulation is activated and an output is calculated. When either the intercooler or jacket water coolant exceeds their set point, the output starts to increase from 0 %. The input that results in calculation of greatest output is prioritised at all times, making sure that both systems are supplied with adequate cooling. During stop sequence, the fan is forced to max. output, ensuring most possible cooling. The output remains at 0 % until the engine is started again.

This is an example that uses inverse output combined with 0 % offset. The application is an engine with electric thermostat control. During engine start-up, it is preferred to start the output before the set point is reached, to help avoid overshooting the set point too much. This is obtained by using inverse output with no offset. The diagram below illustrates this function if the controller is configured as straight proportional without integral or derivative action. With these settings, the output is 100 % when the set point is reached, and the beginning of the output is determined by the proportional gain.



12. Digital inputs, DI

12.1 Digital inputs and explanation

12.1.1 DI list and explanation

The unit has a number of binary inputs. The table from below shows a list of them with running mode, configurable and input type.

No.	Digital input function	Explanation digital Input	Run. mode: Auto	Run. mode: Semi	Run. mode: Test	Run. mode: Man	Run. mode: Block	Configurable	Input type
1	Access lock	Activating the access lock input deactivates the control display push-buttons. It will only be possible to view measurements, alarms and the log.	X	X	X	X	X	Yes	Constant
2	Running detect.	The input is used as a running indication of the engine. When the input is activated, the start relay is deactivated.	X	X	X	X	X	Yes	Constant
3	Remote start	This input initiates the start sequence of the genset when semi-auto or manual mode is selected.		X		X		Yes	Pulse
4	Remote stop	This input initiates the stop sequence of the genset when semi-auto or manual mode is selected. The genset will stop without cooling down		X		X		Yes	Pulse
5	Semi-auto mode	Changes the present running mode to semi-auto.	X		X	X	X	Yes	Pulse
6	Test mode	Changes the present running mode to test.	X	X		X	X	Yes	Pulse
7	Auto mode	Changes the present running mode to auto.		X	X	X	X	Yes	Pulse
8	Manual mode	Changes the present running mode to manual.		X	X		X	Yes	Pulse

No.	Digital input function	Explanation digital Input	Run. mode: Auto	Run. mode: Semi	Run. mode: Test	Run. mode: Man	Run. mode: Block	Confi-gurable	Input type
9	Block mode	Changes the present running mode to block.	X	X	X	X		Yes	Const.
10	Remote GB ON	The generator breaker ON sequence will be initiated and the breaker will synchronise if the mains breaker is closed, or close without synchronising if the mains breaker is open.		X				Yes	Pulse
11	Remote GB OFF	The generator breaker OFF sequence will be initiated. If the mains breaker is open, then the generator breaker will open instantly. If the mains breaker is closed, the generator load will be deloaded to the breaker open limit followed by a breaker opening.		X				Yes	Pulse
12	Remote MB ON	The mains breaker ON sequence will be initiated and the breaker will synchronise if the generator breaker is closed, or close without synchronising if the generator breaker is open.		X				Yes	Pulse
13	Remote MB OFF	The mains breaker OFF sequence will be initiated, and the breaker will open instantly.		X				Yes	Pulse
14	Remote alarm ack.	Acknowledges all present alarms, and the alarm LED on the display stops flashing.	X	X	X	X	X	Yes	Constant

No.	Digital input function	Explanation digital Input	Run. mode: Auto	Run. mode: Semi	Run. mode: Test	Run. mode: Man	Run. mode: Block	Confi-gurable	Input type
15	Auto start/stop	The genset will start when this input is activated. The genset will be stopped if the input is deactivated. The input can be used when the unit is in island operation, fixed power, load takeover or mains power export and the auto running mode is selected.	X					Yes	Constant
16	Remove starter	The start sequence is deactivated. This means the start relay deactivates, and the starter motor will disengage.	X	X	X	X		Yes	Constant
17	Man. GOV up	If manual mode is selected, then the governor output will be increased. **Can only be used in manual mode**	X	X	X	X		Yes	Constant
18	Man. GOV down	If manual mode is selected, then the governor output will be decreased. **Can only be used in manual mode**	X	X	X	X		Yes	Constant
19	Man. AVR up	If manual mode is selected, then the AVR output will be increased. **Can only be used in manual mode**	X	X	X	X		Yes	Constant
20	Man. AVR down	If manual mode is selected, then the AVR output will be decreased. **Can only be used in manual mode**	X	X	X	X		Yes	Constant

No.	Digital input function	Explanation digital Input	Run. mode: Auto	Run. mode: Semi	Run. mode: Test	Run. mode: Man	Run. mode: Block	Confi-gurable	Input type
21	GB position ON	The input function is used as an indication of the generator breaker position. The unit requires this feedback when the breaker is closed or a position failure alarm occurs.	X	X	X	X	X	No	Constant
22	GB position OFF	The input function is used as an indication of the generator breaker position. The unit requires this feedback when the breaker is opened or a position failure alarm occurs.	X	X	X	X	X	No	Constant
23	MB position ON	The input function is used as an indication of the mains breaker position. The unit requires this feedback when the breaker is closed or a position failure alarm occurs.	X	X	X	X	X	No	Constant
24	MB position OFF	The input function is used as an indication of the mains breaker position. The unit requires this feedback when the breaker is opened or a position failure alarm occurs.	X	X	X	X	X	No	Constant
25	Emergency stop	The input shuts down the engine immediately. At the same time it opens the generator breaker. **The "Shutdown" fail class must be selected**	X	X	X	X	X	No	Constant

No.	Digital input function	Explanation digital Input	Run. mode: Auto	Run. mode: Semi	Run. mode: Test	Run. mode: Man	Run. mode: Block	Confi-gurable	Input type
26	Low speed	Disables the regulators and keeps the genset running at a low RPM. The governor must be prepared for this function.	X	X	X			Yes	Constant
27	Temperature control	This input is part of the idle mode function. When the input is high, the genset starts. It starts at high or low speed, depending on the activation of the low speed input. When the input is deactivated, the genset goes to idle mode (low speed = ON), or it stops (low speed = OFF).	X	X	X			Yes	Constant
28	Ext. F control	The nominal frequency set point will be controlled from the analogue inputs terminal 40/41. The internal set point will not be used. Note that a -10 V to 10 V signal is used to control and that the nominal frequency value will be located at 0 V.	X	X	X			Yes	Constant
29	Ext. P control	The power set point in fixed power will be controlled from the analogue inputs terminal 40/41. The internal set point will not be used. Note that a 0 V - 10 V is used for control.	X	X	X			Yes	Constant

No.	Digital input function	Explanation digital Input	Run. mode: Auto	Run. mode: Semi	Run. mode: Test	Run. mode: Man	Run. mode: Block	Configurable	Input type
30	Ext. cosphi control	The cos phi set point will be controlled from the analogue inputs terminal 41/42. The internal set point will not be used. Note that a 0 V to 10 V signal is used for control.	X	X	X			Yes	Constant
31	Ext. U control	The nominal voltage set point will be controlled from the analogue inputs terminal 41/42. The internal set point will not be used. Note that a -10 V to 10 V signal is used for control.	X	X	X			Yes	Constant
32	Ext. Q control	The reactive power set point will be controlled from the analogue inputs terminal 41/42. The internal set point will not be used. Note that a -10 V to 10 V signal is used for control.	X	X	X			Yes	Constant
33	GB close inhibit	When this input is activated, the generator breaker cannot close.	X	X	X	X	X	Yes	Constant
34	MB close inhibit	When this input is activated, the mains breaker cannot close.	X	X	X	X	X	Yes	Constant
35	Enable mode shift	The input activates the mode shift function, and the AGC will perform the AMF sequence in case of a mains failure. When the input is configured, the setting in menu 7081 (mode shift ON/OFF) is disregarded.	X	X	X	X	X	Yes	Constant

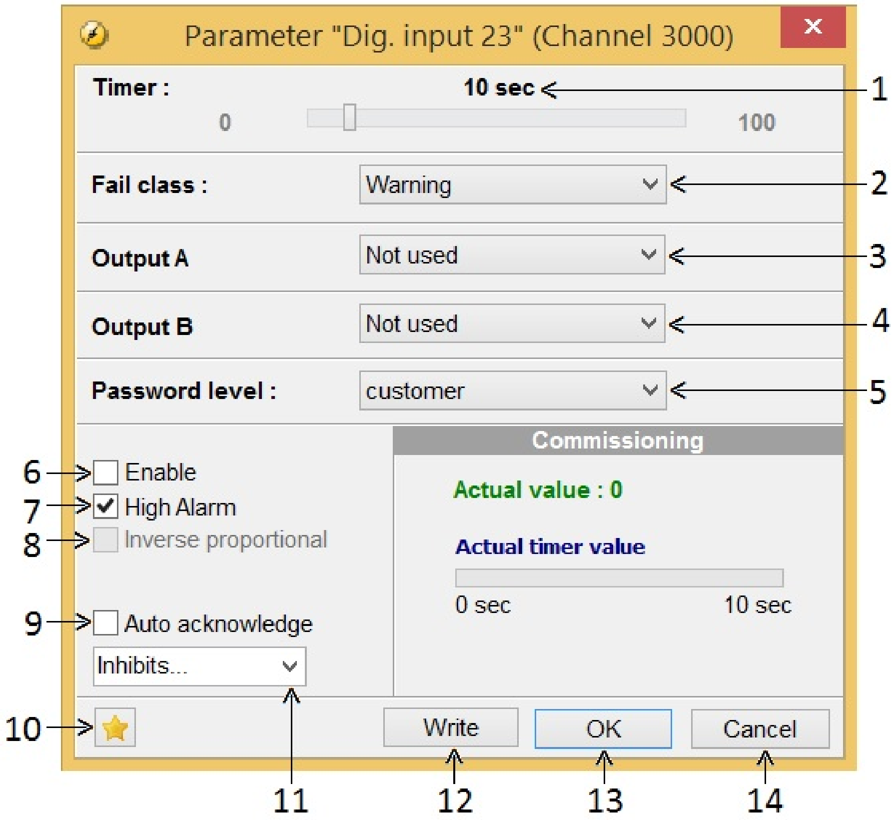
No.	Digital input function	Explanation digital Input	Run. mode: Auto	Run. mode: Semi	Run. mode: Test	Run. mode: Man	Run. mode: Block	Configurable	Input type
36	Enable GB black close	When the input is activated, the AGC is allowed to close the generator on a black busbar, providing that the frequency and voltage are inside the limits set up in menu 2110.	X	X	X	X	X	Yes	Constant
37	Enable sep. sync.	Activating this input will split the breaker close and breaker synchronisation functions into two different relays. The breaker close function will remain on the relays dedicated for breaker control. The synchronisation function will be moved to a configurable relay dependent on the options configuration. **This function is option-dependent. Option M14.x is required.**	X	X	X	X	X	Yes	Constant
38	Start enable	The input must be activated to be able to start the engine. **When the genset is started, the input can be removed**.	X	X	X	X		Yes	Constant
39	GB spring loaded	The AGC will not send a close signal before this feedback is present.	X	X	X	X	X	Yes	Constant
40	MB spring loaded	The AGC will not send a close signal before this feedback is present.	X	X	X	X	X	Yes	Constant
41	Deload	A running genset will start to ramp down the power.	X					Yes	Constant

No.	Digital input function	Explanation digital Input	Run. mode: Auto	Run. mode: Semi	Run. mode: Test	Run. mode: Man	Run. mode: Block	Configurable	Input type
42	GB OFF and BLOCK	The generator breaker will open, the genset will activate the stop sequence and when the genset is stopped, it will be blocked for start.		X				Yes	Pulse
43	Secured ON	Starts secured running mode. Secured mode adds an extra generator to the system, this means that one generator too many will be running when comparing with the actual power requirement.	X	X	X	X	X	Yes	Pulse
44	Secured OFF	Ends secured running mode. Secured mode adds an extra generator to the system, this means that one generator too many will be running when comparing with the actual power requirement.	X	X	X	X	X	Yes	Pulse
45	Ground breaker ON	Feedback from ground breaker when this is active. **The input functions are set up with the PC utility software. Please refer to "Help**.	X	X	X	X	X	Yes	Constant
46	Ground breaker OFF	Feedback from ground breaker when this is inactive. **The input functions are set up with the PC utility software. Please refer to "Help".**	X	X	X	X	X	Yes	Constant

12.1.2 Alarms related to DIs

In the following, alarms related to the digital inputs Dig. input 23-27, Dig. input 43-55 and Dig. input112-117 are described.

Dig. input 23



1. Timer:
The timer setting is the time that must expire from the alarm level is reached until the alarm occurs.

2. Fail class:
When the alarm occurs, the unit will react depending on the selected fail class. Select the required fail class from the drop-down list. The list may contain items like Block, Warning, Trip GB, Shutdown, Safety stop.

3/4. Output A/output B:
Select which terminal to activate in the case of an alarm. A terminal number can be chosen, but there is also a "limit" among the items in the drop down list. Limit is used to make the alarm useable as an input event in M-Logic.

5. Password level: Select which password level that is needed to modify this parameter. Can not be edited if the user has lower privileges. See chapter user access.

6. Enable:
Activates/deactivates the alarm function related to parameter "Dig. input 23"

7. High Alarm:
The alarm is triggered when the signal is high. Used to indicate whether the alarm is activated when the signal exceeds for a given time.

8. Inverse proportional:
Defines whether the "Dig. input 23" signal is proportional or inverse. Not adjustable for "Dig. input 23".

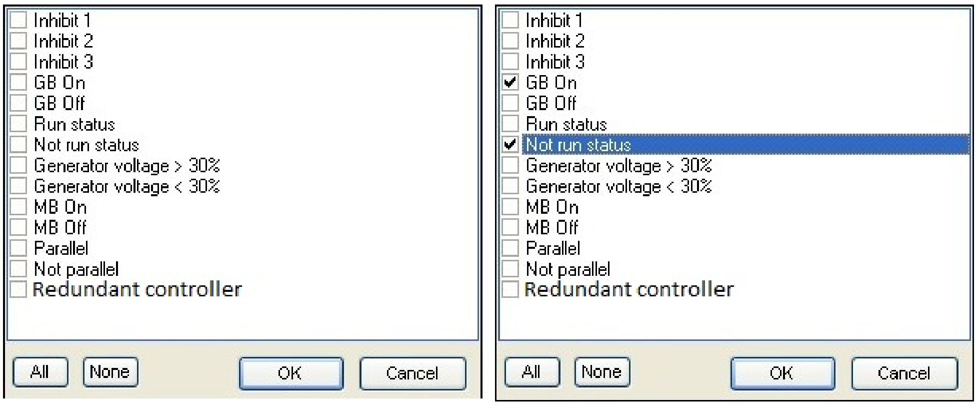
9. Auto acknowledge:
If this option is set, the alarm is automatically acknowledged if the signal related to the alarm disappears.

10. Favourite:
Marks the selected configuration for the parameter as favourite, which can be recalled later from the top menu on USW. It will show only favourite parameters list.

11. Inhibits:
Used to express exceptions to when an alarm must be triggered. In order to select when the alarms are to be active, a configurable inhibit setting for every alarm has been made. The inhibit functionality is only available via the PC utility software. For every alarm, there is a drop-down window where it is possible to select which signals have to be present in order to inhibit the alarm.

Function	Description
Inhibit 1	M-Logic outputs: conditions are programmed in M-Logic
Inhibit 2	
Inhibit 3	
GB ON (TB ON)	The generator breaker (GB) is closed (TB= tie breaker)
GB OFF (TB ON)	The generator breaker is opened
Run status	Running detected and the timer in menu 6160 expired
Not run status	Running not detected and the timer in menu 6160 not expired
Generator voltage > 30 %	Generator voltage is above 30 % of nominal
Generator voltage < 30 %	Generator voltage is below 30 % of nominal
MB ON	The mains breaker is closed
MB OFF	The mains breaker is opened
Parallel	Both GB (TB) and MB are closed
Not parallel	Either GB (TB) and MB are closed, but not both
Redundant controller	Allows a redundant controller to operate in hot standby with the master controller and to assume control even in engine running conditions if a problem occurs on the master (hot standby). Only the "Breaker externally tripped" alarms are inhibited as default in case a unit has redundant status. Read more in Option T1.

Example:



Inhibit of the alarm is active as long as one of the selected inhibit functions are active.
In the example above, inhibit is set to **GB On** and **Not run status**. Here, the alarm will be active when the generator has started. When the generator has been synchronised to the busbar, the alarm will be disabled again.

- Function inputs such as running feedback, remote start or access lock are never inhibited. Only alarm inputs can be inhibited.
- If an alarm is configured to activate a limit relay, the relay will activate despite that the inhibit input is ON.
- The bus tie breaker unit has no running detection that can be configured, so the only inhibit functions are the digital input and the position of the bus tie breaker and the voltage on bus A (< 30 %/>30 %).

12. Write: Press to write the actually selected changes to the AGC PM.

13. OK Press to confirm after each writing to the AGC PM.

14. Cancel: Quits the selected changes without writing to the AGC PM.

Commissioning
When connected to the device, the actual value inside commissioning shows the current value relative to the set point. The time elapsed shows the time the value is above the set point. These values are used during commissioning to study the behaviour of a genset and to put the set point values appropriate for the genset. The commissioning section is mainly relevant for protections.

Parameter	Item	Description	Range	Default
3001	Dig. input 23, DEL	DELAY. Timer in seconds which is of the definite time type, this means that a set time is selected. The delay will be activated if the input goes ON (or OFF if selected to be N/C). If the input is reset before the delay runs out, the delay will be reset.	0.0 s.....100.0 s	10.0 s
3002	Dig. input 23, OA	Relay Output A Selection of relay output to trip at the same time as the signal at Dig. input 23 is high/low after expiring delay time.	Not used Limits	Not used
3003	Dig. input 23, OB	Relay Output B Selection of relay output to trip at the same time as the signal at Dig. input 23 is High/Low after expiring delay time.	Not used Limits	Not used
3004	Dig. input 23, ENA	Enable/disable the alarm related to Dig. input 23 when the signal at Dig. input 23 is high/low after expiring delay time. Tick Enable in USW parameter 3000.	ON OFF	OFF
3005	Dig. input 23, FC	Fail class. Selection of how the system should react when an alarm related to Dig. input 23 is detected . Here the selected fail class is activated when the signal at Dig. input 23 is high/low after expiring delay time.	Block Warning Trip GB Trip+stop Shutdown Trip MB Safety stop Trip MG/GB	Warning
3006	Dig. input 23, N/X	Selection of when the alarm related to Dig. input 23 is triggered. High Alarm (N/O): The alarm is triggered when the signal is high. Low Alarm (N/C): The alarm is triggered when the signal is low.	N/C N/O	N/O

Note :
The same settings apply to:
- inputs 24-27, parameters 3010 to 3040
(Inputs 24-27 are by default used for breaker feedback. These inputs are only available if no MB or TB is present in the application.
- inputs 43-55, parameters 3130 to 3250
- inputs 112-117, parameters 3430 to 3480

12.1.3 Standard DIs in the AGC PM

In the following, all digital inputs which the AGC PM has as standard are described.

As standard, the AGC PM has 13 x digital inputs (Dig. input 43-55, Option M12) and
12 x digital inputs for engine control/protection (Dig. input 23-27, Dig. input 112-118, Option M4).

Dig. input 23-27:
When the AGC PM is used as genset unit:
Dig. input 23, Dig. input 24, Dig. input 25 are configurable
Dig. input 26 reserved for GB open
Dig. input 27 reserved for GB Closed

When the AGC PM is used as plant unit:
Dig. input 23, Dig. input 26, Dig. input 27 are configurable
Dig. input 24 reserved for MB open
Dig. input 25 reserved for MB Closed

When the AGC PM is used as group unit:
Dig. input 23, Dig. input 24, Dig. input 25 are configurable
Dig. input 26 reserved for TB open
Dig. input 27 reserved for TB Closed

Dig. input 43-55
When the AGC PM is used as genset/plant/group unit:
Dig. input 43 - 55 are configurable

Dig. input 112-118 (Dig. input 118 is named as Emergency STOP in USW)
When the AGC PM is used as genset unit:
Dig. input 112 - 117 are configurable
Dig. input 118 reserved for Emergency stop

When the AGC PM is used as plant/group unit:
Dig. input 112 - 117 are configurable
Dig. input 118 is not used

12.1.4 Optional DIs (option M13.x)

The AGC PM can be extended with an option M13, which is a hardware option.
It is a separate PCB and must be installed in addition to the standard-installed hardware.
In the following, all optional digital inputs related to the various Option M13s option are described.

Dig. input 66-72
These optional digital inputs relate to Option M13.4.
7 x digital inputs, all free configurable.

Dig. input 91-97
These optional digital inputs relate to Option M13.6.
7 x digital inputs, all free configurable.

Dig. input 127-133
These optional digital inputs relate to Option M13.8.
7 x digital inputs, all free configurable.

13. Multi-inputs

13.1 Common information

13.1.1 Introduction

The AGC PM has three multi inputs as standard and more can be added by using option M15 and M16.

Multi input 102, 105 and 108

The three standard inputs can be configured to be used as the following inputs:

- 4-20 mA
- 0-40 V DC
- Pt100
- Pt1000
- RMI oil pressure
- RMI water temperature
- RMI fuel level
- Binary/digital input

The function of the multi inputs can only be configured in the utility software.

The multi-inputs are placed in slot #7 on the AGC PM and use terminals 102-110.

Option M15 and M16

M15 consists of four 4-20 mA inputs and M16 has four inputs, which can be set up to 4-20 mA/0-5 V DC/Pt100.
M15 and M16 can be placed at slot #6 and #8 and are named M15.6 and M15.8 respectively for M15 and M16.6 and M16.8 for M16.

13.1.2 Application description

The multi-inputs can be used in many different applications. Here is a list of a few of the most common usages:

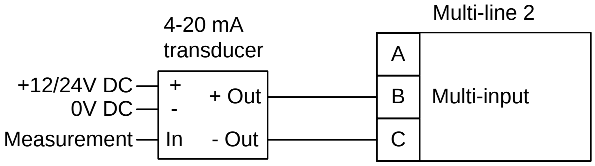
- Power transducer. If you want to measure the current to a load, across a TB or something else, a power transducer sending a 4-20 mA signal could be connected to multi-input 102.
- Battery assymmetry test. The multi-inputs can be set to measure 0-40 V DC to detect failing batteries.
- Temperature sensor. Pt100 or pt1000 resistors are often used to measure temperature. In the utility software, you can choose whether the temperature should be shown as Celsius or Fahrenheit.
- RMI inputs. The AGC has three RMI types; oil, water and fuel. It is possible to choose different types within each RMI type. There is also a configurable type.
- An extra push-button. If the input is configured as digital, it works like an extra digital input.
- Max. difference between ambient and generator temperature. Differential measurement can be used to give an alarm, if two values are too far apart.

13.1.3 Wiring

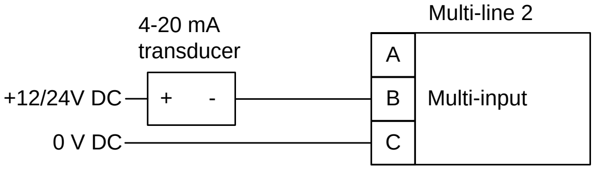
The three standard multi-inputs each have three terminals; A, B and C. How to wire the inputs depends on what you want to measure; current, voltage or resistance. The setups are described below. The inputs on M15 and M16 only have two terminals per input, where it's only necessary to be aware that + and - are connected correctly.

4-20 mA

Active transducer

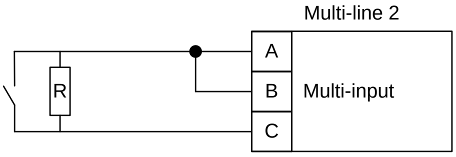


Passive transducer



If the passive sensor has its own battery supply, the voltage must not exceed 30 V DC.

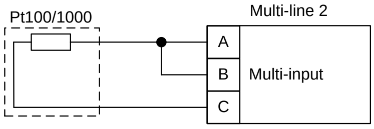
Digital inputs



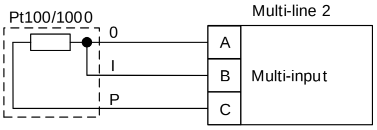
The resistor is only mounted if wire fail supervision is required. The value of the resistor should be 270 Ω +/-10 %.

Pt100/Pt1000

2-wire



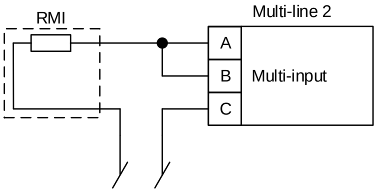
3-wire

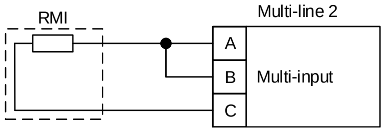


RMI

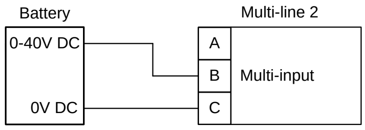
1-wire

2-wire





0-40 V DC



13.1.4 Wire break

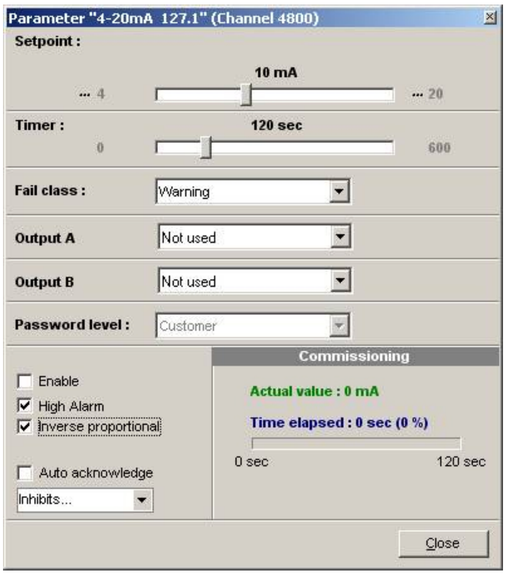
If it is necessary to supervise the sensors/wires connected to the multi-inputs and analogue inputs, then it is possible to enable the wire break function for each input. If the measured value on the input is outside the normal dynamic area of the input, it will be detected as if the wire has made a short circuit or a break. An alarm with a configurable fail class will be activated.
The ranges for each input are:

Input	Wire failure area	Normal range	Wire failure area
4-20 mA	<3 mA	4-20 mA	> 21 mA
0-40 V DC	≤0 V DC	-	N/A
RMI Fuel pressure, sensor type 1	<1.0 Ω	-	>195.0 Ω
RMI Fuel pressure, sensor type 2	<1.0 Ω	-	>195.0 Ω
RMI fuel temperature, sensor type 1	<4.0 Ω	-	>488.0 Ω
RMI fuel temperature, sensor type 2	<4.0 Ω	-	>488.0 Ω
RMI fuel temperature, sensor type 3	<0.6 Ω	-	>97 Ω
RMI fuel level, sensor type 1	<0.6 Ω	-	>97 Ω
RMI fuel level, sensor type 2	<1.0 Ω	-	>195.0 Ω
RMI configurable	<Lowest resistance	-	>Highest resistance
Pt 00	<82.3 Ω	-	>194.1 Ω
Pt1000	<823 Ω	-	>1941 Ω

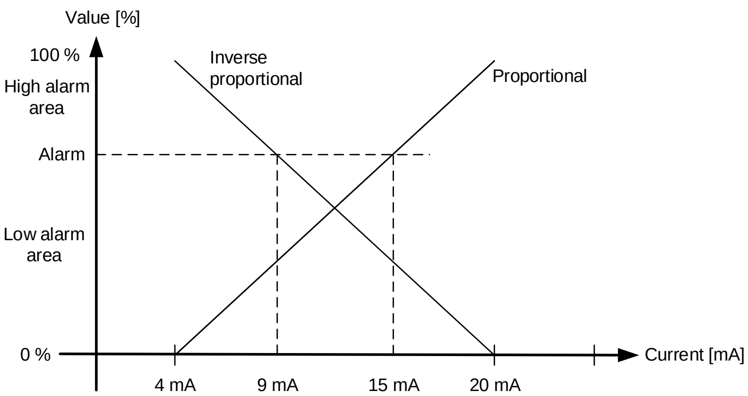
It is also possible to detect wire break on digital inputs, but it can only detect a wire break and not a short circuit. Wire break detection requires a resistor - see the chapter about wiring for this.

The parameters for wire fail is menu 4240 for multi-input 102, 4370 for multi-input 105 and 4500 for multi-input 108. Wire fail also applies to option M15 and M16.

In situations where the signal of the input is reversed, the "Inverse proportional" selection can be activated. The selection ensures that the display reading is correct when an "inversed" signal is made.



The diagram shows the characteristics of the "normal" proportional sensor and of the inversed proportional sensor.



This function can only be activated by using the PC utility software.

13.1.5 Differential measurement

Differential measurement can be used to compare two measurements, and give an alarm or trip if the difference between two measurements become too large - or too small. Remove check mark from "High Alarm" in the alarm configuration, to have the alarm activate if the difference between the two inputs are lower than the alarm's set point..
It is possible to have up to six comparisons, and two alarms can be configured to each comparison.
Inputs for differential measurements can be chosen as the list below shows:

- Multi-input 102
- Multi-input 105
- Multi-input 108
- Ext. I/O analogue In 1-8
- EIC oil pressure
- EIC cooling water temp.
- EIC oil temp.
- EIC ambient temp.
- EIC intercool temp.
- EIC fuel temp.
- EIC fuel delivery press
- EIC air filter f1 diff. press.
- EIC air filter f2 diff. press.
- EIC fuel supply pump press.
- EIC fuel filter diff. press.
- EIC oil filter diff. press.
- EIC T. exhaust left
- EIC T. exhaust right
- EIC P. fuel f diff.

Parameters for differential measurement

Parameter	Item	Range	Default	Note
4600 Delta analogue input 1, 2, 3				
4601	Input A for comparison 1	Multi-input 102-EIC	Multi-input 102	
4602	Input B for comparison 1	Multi-input 102-EIC	Multi-input 102	
4603	Input A for comparison 2	Multi-input 102-EIC	Multi-input 102	
4604	Input B for comparison 2	Multi-input 102-EIC	Multi-input 102	
4605	Input A for comparison 3	Multi-input 102-EIC	Multi-input 102	
4606	Input B for comparison 3	Multi-input 102-EIC	Multi-input 102	
4610 Delta analogue 1.1				
4611	Set point, max (or min.) difference to alarm 1 for comparison 1	-9999 9999	10	
4612	Timer to alarm 1 for comparison 1	0.0 s 999.0 s	5.0 s	
4613	Relay A to alarm 1 for comparison 1	Not used Option-dep.	Not used	
4614	Relay B to alarm 1 for comparison 1	Not used Option-dep.	Not used	
4615	Enable alarm 1 for comparison 1	OFF ON	OFF	
4616	Fail class to alarm 1 for comparison 1	F1…F8	Warning (F2)	
4620 Delta analogue 1.2				
4621	Set point, max (or min.) difference to alarm 2 for comparison 1	-9999 9999	10	
4622	Timer to alarm 2 for comparison 1	0.0 s 999.0 s	5.0 s	
4623	Relay A to alarm 2 for comparison 1	Not used Option-dep.	Not used	
4624	Relay B to alarm 2 for comparison 1	Not used Option-dep.	Not used	
4625	Enable alarm 2 for comparison 1	OFF ON	OFF	

Parameter	Item	Range	Default	Note
4626	Fail class to alarm 2 for comparison 1	F1…F8	Warning (F2)	
4630 Delta analogue 2.1				
4631	Set point, max (or min.) difference to alarm 1 for comparison 2	-9999 9999	10	
4632	Timer to alarm 1 for comparison 2	0.0 s 999.0 s	5.0 s	
4633	Relay A to alarm 1 for comparison 2	Not used Option-dep.	Not used	
4634	Relay B to alarm 1 for comparison 2	Not used Option-dep.	Not used	
4635	Enable alarm 1 for comparison 2	OFF ON	OFF	
4636	Fail class to alarm 1 for comparison 2	F1…F8	Warning (F2)	
4640 Delta analogue 2.2				
4641	Set point, max (or min.) difference to alarm 2 for comparison 2	-9999 9999	10	
4642	Timer to alarm 2 for comparison 2	0.0 s 999.0 s	5.0 s	
4643	Relay A to alarm 2 for comparison 2	Not used Option-dep.	Not used	
4644	Relay B to alarm 2 for comparison 2	Not used Option-dep.	Not used	
4645	Enable alarm 2 for comparison 2	OFF ON	OFF	
4646	Fail class to alarm 2 for comparison 2	F1…F8	Warning (F2)	
4650 Delta analogue 3.1				
4651	Set point, max (or min.) difference to alarm 1 for comparison 3	-9999 9999	10	
4652	Timer to alarm 1 for comparison 3	0.0 s 999.0 s	5.0 s	
4653	Relay A to alarm 1 for comparison 3	Not used Option-dep.	Not used	
4654	Relay B to alarm 1 for comparison 3	Not used Option-dep.	Not used	

Parameter	Item	Range	Default	Note
4655	Enable alarm 1 for comparison 3	OFF ON	OFF	
4656	Fail class to alarm 1 for comparison 3	F1…F8	Warning (F2)	
4660 Delta analogue 3.2				
4661	Set point, max (or min.) difference to alarm 2 for comparison 3	-9999 9999	10	
4662	Timer to alarm 2 for comparison 3	0.0 s 999.0 s	5.0 s	
4663	Relay A to alarm 2 for comparison 3	Not used Option-dep.	Not used	
4664	Relay B to alarm 2 for comparison 3	Not used Option-dep.	Not used	
4665	Enable alarm 2 for comparison 3	OFF ON	OFF	
4666	Fail class to alarm 2 for comparison 3	F1…F8	Warning (F2)	
4670 Delta analogue input 4, 5, 6				
4671	Input A for comparison 4	Multi-input 102-EIC	Multi-input 102	
4672	Input B for comparison 4	Multi-input 102-EIC	Multi-input 102	
4673	Input A for comparison 5	Multi-input 102-EIC	Multi-input 102	
4674	Input B for comparison 5	Multi-input 102-EIC	Multi-input 102	
4675	Input A for comparison 6	Multi-input 102-EIC	Multi-input 102	
4676	Input B for comparison 6	Multi-input 102-EIC	Multi-input 102	
4680 Delta analogue 4.1				
4681	Set point, max (or min.) difference to alarm 1 for comparison 4	-9999 9999	10	
4682	Timer to alarm 1 for comparison 4	0.0 s 999.0 s	5.0 s	
4683	Relay A to alarm 1 for comparison 4	Not used Option-dep.	Not used	

Parameter	Item	Range	Default	Note
4684	Relay B to alarm 1 for comparison 4	Not used Option-dep.	Not used	
4685	Enable alarm 1 for comparison 4	OFF ON	OFF	
4686	Fail class to alarm 1 for comparison 4	F1…F8	Warning (F2)	
4690 Delta analogue 4.2				
4691	Set point, max (or min.) difference to alarm 2 for comparison 4	-9999 9999	10	
4692	Timer to alarm 2 for comparison 4	0.0 s 999.0 s	5.0 s	
4693	Relay A to alarm 2 for comparison 4	Not used Option-dep.	Not used	
4694	Relay B to alarm 2 for comparison 4	Not used Option-dep.	Not used	
4695	Enable alarm 2 for comparison 4	OFF ON	OFF	
4696	Fail class to alarm 2 for comparison 4	F1…F8	Warning (F2)	
4700 Delta analogue 5.1				
4701	Set point, max (or min.) difference to alarm 1 for comparison 5	-9999 9999	10	
4702	Timer to alarm 1 for comparison 5	0.0 s 999.0 s	5.0 s	
4703	Relay A to alarm 1 for comparison 5	Not used Option-dep.	Not used	
4704	Relay B to alarm 1 for comparison 5	Not used Option-dep.	Not used	
4705	Enable alarm 1 for comparison 5	OFF ON	OFF	
4706	Fail class to alarm 1 for comparison 5	F1…F8	Warning (F2)	
4710 Delta analogue 5.2				
4711	Set point, max (or min.) difference to alarm 2 for comparison 5	-9999 9999	10	
4712	Timer to alarm 2 for comparison 5	0.0 s 999.0 s	5.0 s	

Parameter	Item	Range	Default	Note
4713	Relay A to alarm 2 for comparison 5	Not used Option-dep.	Not used	
4714	Relay B to alarm 2 for comparison 5	Not used Option-dep.	Not used	
4715	Enable alarm 2 for comparison 5	OFF ON	OFF	
4716	Fail class to alarm 2 for comparison 5	F1…F8	Warning (F2)	
4720 Delta analogue 6.1				
4721	Set point, max (or min.) difference to alarm 1 for comparison 6	-9999 9999	10	
4722	Timer to alarm 1 for comparison 6	0.0 s 999.0 s	5.0 s	
4723	Relay A to alarm 1 for comparison 6	Not used Option-dep.	Not used	
4724	Relay B to alarm 1 for comparison 6	Not used Option-dep.	Not used	
4725	Enable alarm 1 for comparison 6	OFF ON	OFF	
4726	Fail class to alarm 1 for comparison 6	F1…F8	Warning (F2)	
4730 Delta analogue 6.2				
4731	Set point, max (or min.) difference to alarm 2 for comparison 6	-9999 9999	10	
4732	Timer to alarm 2 for comparison 6	0.0 s 999.0 s	5.0 s	
4733	Relay A to alarm 2 for comparison 6	Not used Option-dep.	Not used	
4734	Relay B to alarm 2 for comparison 6	Not used Option-dep.	Not used	
4735	Enable alarm 2 for comparison 6	OFF ON	OFF	
4736	Fail class to alarm 2 for comparison 6	F1…F8	Warning (F2)	

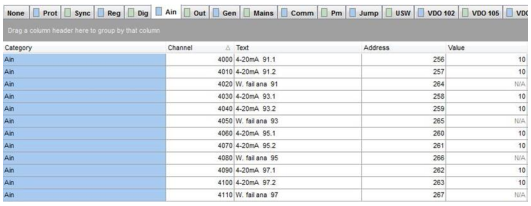
13.1.6 Scaling of 4-20 mA inputs

The scaling of the analogue inputs are made to ensure that the readout of the inputs is made with a resolution that fits the connected sensor. It is recommended to follow the list below when changing the scaling of the analogue inputs.

Only 4-20 mA signals can be scaled.

1. Set up the multi-input for 4-20 mA. This is done in menu 10980-11000 for multi-input 102-108 and in menu 11120-11190 for option M15 or M16.
2. Now the scaling parameters are available in menu 11010-11110. Now you can choose to use auto scale (item 3) or manual scaling (item 4).
3. AUTO SCALE is activated by activating the enable check box in the scale parameter (11010-11110). This means that the reading remains the same - but decimals are added.
4. Deactivating the enable check box will make the reading smaller by a factor of 10 for each decimal added.
5. Then the alarm parameters for the multi-inputs can be configured.
6. A parameter file (usw file) should always be saved without the AUTO SCALE enabled.

The setup of the multi-inputs and alarm parameters must be done in the above order. If not, the alarm levels will be wrong.



Category	Channel	Text	Address	Value
Ain	4000	4-20mA 91.1	256	10
Ain	4010	4-20mA 91.2	257	10
Ain	4020	W. fail ana 91	264	N/A
Ain	4030	4-20mA 93.1	258	10
Ain	4040	4-20mA 93.2	259	10
Ain	4050	W. fail ana 93	265	N/A
Ain	4060	4-20mA 95.1	260	10
Ain	4070	4-20mA 95.2	261	10
Ain	4080	W. fail ana 95	266	N/A
Ain	4090	4-20mA 97.1	262	10
Ain	4100	4-20mA 97.2	263	10
Ain	4110	W. fail ana 97	267	N/A

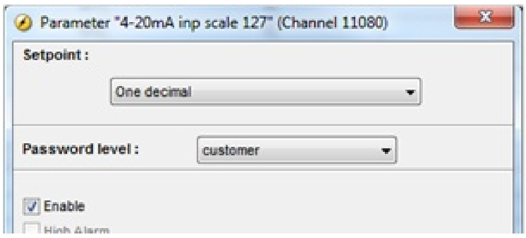
Setting up decimals:
No decimals:
0-5 bar oil pressure transducer (4-20 mA)
Decimals = 0

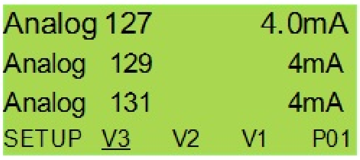
Without use of decimals, the set point can only be adjusted in steps of one bar, which gives a very rough range of setting.

The display will show 0-5 bar in the measuring range 4-20 mA.

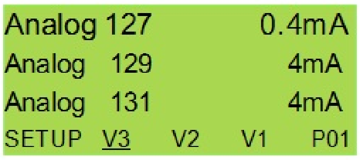
One decimal:
0-5 bar oil pressure transducer (4-20 mA)
Decimals = 1

Auto scale = enable





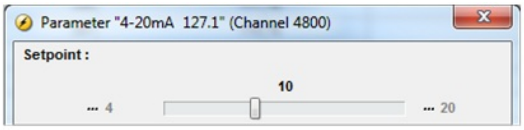
Decimals = 1, AUTO SCALE = enabled



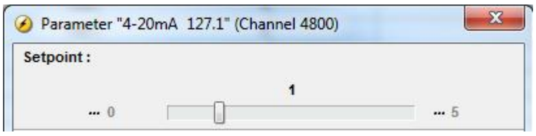
Decimals = 1, AUTO SCALE = disabled

Regarding AUTO SCALE: if the number of decimals is changed without enabling the set point, the 4-20 mA will be presented as 0.4-2.0 mA (0.0-0.5 bar). In other words, the "auto scaling" bit decides where the decimal point is placed. If auto scale is disabled, the set point range should be multiplied by 10 if 1 decimal is used, and multiplied with 100 if 2 decimals are used.

Setting up the measuring range of the sensor:
The measuring range of the multi-input is set up inside the actual alarm:

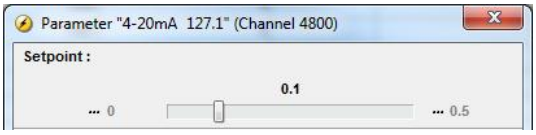


The three dots to the left of the figures is a button. Scale the input as required, e.g. 0-5 bar:

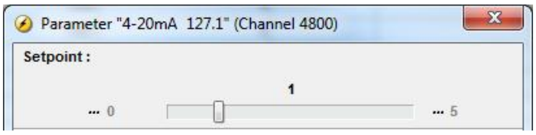


The display will then show 0 at 4 mA.

In order to get the alarm input to work again after changing the "decimal setting", it is necessary to make a readjustment of the alarm:

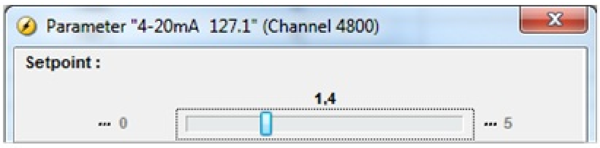


Change it to match the new selection of decimals.



Therefore, when selecting decimals, the selection of AUTO SCALE depends on whether the alarm inputs are already set up. If they are set up, it is a good idea to select AUTO SCALE. If they are not set up, it is voluntary if AUTO SCALE is selected.

Reload parameters:
It is necessary to upload the parameters from the device to the computer after changing the scale (no decimal/one decimal/two decimal) settings. This is in order to refresh the parameter list so the alarm settings present the correct value:



In the example shown above, the value can be adjusted with one decimal. If the parameters were not refreshed, it would still only be possible to adjust the set point without decimals.

Save the parameter file:
A parameter file (usw file) should always be saved without the AUTO SCALE enabled.

After having set up the 4-20 mA inputs (HW as well as alarms), the parameter file should be uploaded from the device to the PC and then saved. In this way, the AUTO SCALE is then deactivated (automatically cleared by the device), and the settings will not be modified again if the parameters are reloaded to the device.

If the file is saved with the AUTO SCALE enabled, then the minimum and maximum values of the alarm will be affected (multiplied by 10 or 100) at the next use of the parameter file (under certain conditions).

13.1.7 Display

When recieving a 4-20 mA signal (or any other analogue signal) the display will as default show the measured value, but it's also possible to change the text and convert the value, so it's easier for the operator to read the value of interest. This can be done for all the different types of inputs.

If RMI fuel, water or oil is used, the display will automatically show the level/temperature/pressure.

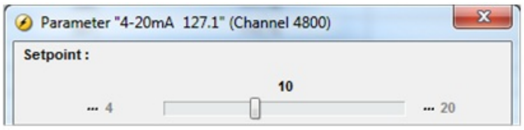
It can be chosen to use bar/celsius or psi/fahrenheit as units in parameter 10970.

Converting the displayed value

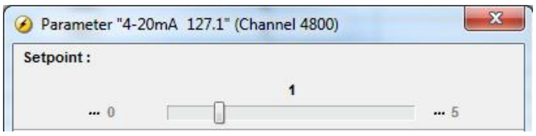
Using the utility software, open the parameter for the first alarm for the input. For example for input 102 set to 0-40 V DC open parameter 4140.

Input type	Multi-input 102	Multi-input 105	Multi-input 108
4-20 mA	4120/4130	4250/4260	4380/4390
0-40 V DC	4140/4150	4270/4280	4400/4410
Pt100/Pt1000	4160/4170	4290/4300	4420/4430
RMI fuel pressure	4180/4190	4310/4320	4440/4450
RMI fuel temperature	4200/4210	4330/4340	4460/4470
RMI fuel level	4220/4230	4350/4360	4480/4490
Digital/Binary	3400	3410	3420

The measuring range of the multi-input is set up inside the actual alarm:



The three dots to the left of the figures is a button. Scale the input as required, for example 0-5 bar:



The display will then show 0 at 4 mA.

Changing the displayed text

From the utility software, it is possible to change the text on the display. Go to Translations, read the languages from the device  and then find and change the string of text.
The number sign (#) is used to indicate the figures related to the signal.

13.2 Multi-inputs 102, 105 and 108

13.2.1 Introduction

The AGC PM has three multi inputs which can be configured to be used as the following inputs:

- 4-20 mA
- 0-40V DC
- Pt100
- Pt1000
- RMI oil pressure
- RMI water temperature
- RMI fuel level
- RMI configurable
- Binary/digital input

The function of the multi inputs can only be configured in the utility software.

The multi-inputs are placed in slot #7 on the AGC and use terminals 102-110.

13.2.2 Terminals

Each multi-input has three terminals, A, B and C. The purpose of each terminal depends on the type of input (0-40 V DC, Pt100 etc.). See the chapter about wiring for more information regarding connection of the multi-inputs.

Term.	Function	Technical data	Description
102	A	0(4)-20 mA Digital Pt100 Pt1000 RMI 0-40 V DC	Multi-input 1
103	B		
104	C		
105	A		Multi-input 2
106	B		
107	C		
108	A		Multi-input 3
109	B		
110	C		

13.2.3 Alarms

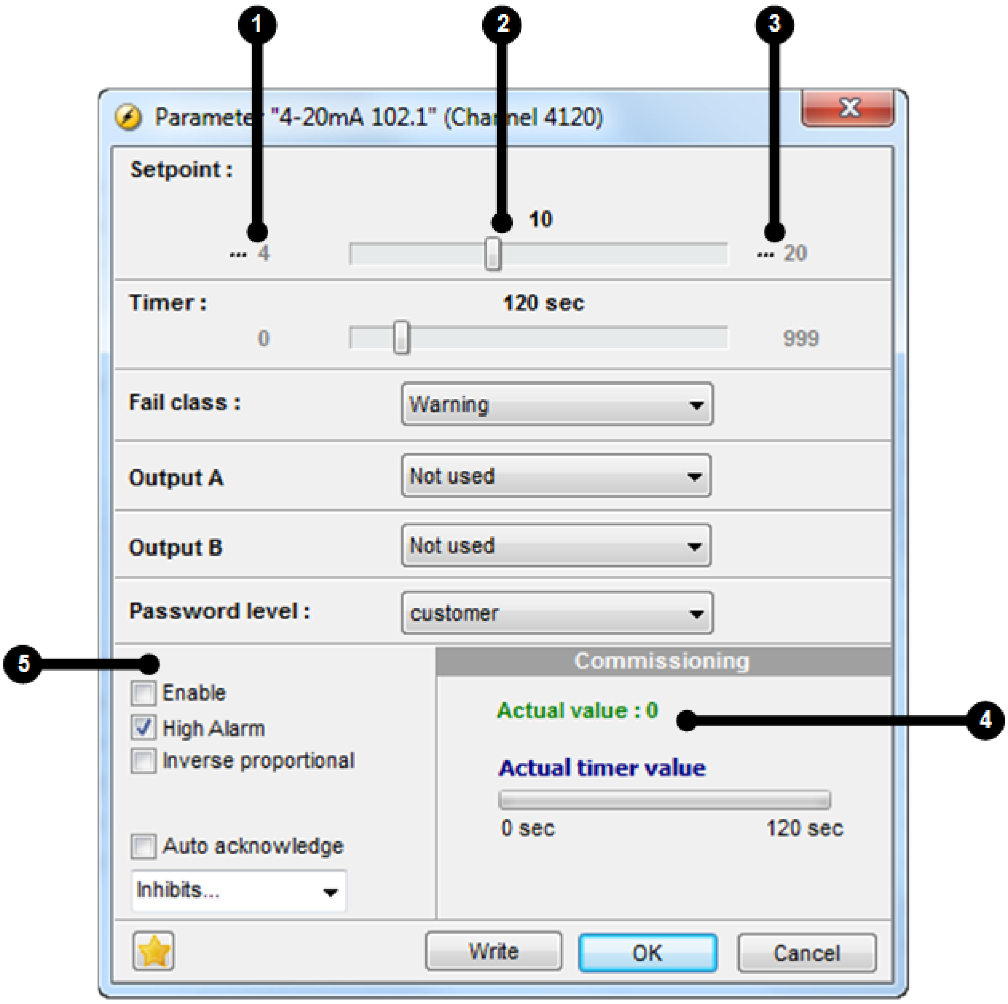
For each input, two alarm levels are available. The menu numbers of the alarm settings for each multi-input is controlled by the configured input type as seen in the following table:

Input type	Multi-input 102	Multi-input 105	Multi-input 108
4-20 mA	4120/4130	4250/4260	4380/4390
0-40 V DC	4140/4150	4270/4280	4400/4410
Pt100/Pt1000	4160/4170	4290/4300	4420/4430
RMI fuel pressure	4180/4190	4310/4320	4440/4450
RMI fuel temperature	4200/4210	4330/4340	4460/4470
RMI fuel level	4220/4230	4350/4360	4480/4490
Digital/Binary	3400	3410	3420

Only one alarm level is available for the digital/binary input type.

The philosophy behind having two alarms is that the first alarm can be slow reacting and the other can be faster reacting. If the sensor measures generator current as protection against overload, a small overload is okay for a minute, but in case of a large overload, the alarm should activate quickly.
The configuration of the multi input alarms can be done from the utility software. Below is a description for menu 4120 which is a 4-20 mA signal, but other input types look the same.

How to set up a 4-20 mA input is easiest explained with an example:
A multi-input is used for pressure detection and measures 0-6 bars and the transducer gives 4-20 mA output to the controller. First, it is required to go to parameter 10980 and set the relevant input to 4-20 mA input. The scaling in parameter 11010 is set to 2 decimals - see "Display and scaling" for more information about this.



1. Here it can be set how many bars of pressure 4 mA input equals. In this example, this setting should be 0. This is changed by pressing on the three dots.
2. Set point for the alarm. This can be changed by moving the slider, or by pressing the number above (10 in the picture).
3. Here it can be set how many bars of pressure 20 mA input equals. In this example this setting should be 600. This is changed by pressing the three dots. Writing 600 is because the scaling is set to two decimals, so a 20 mA signal indicates 6.00 bars.
4. Commisiong window. Here the present pressure value is shown.
5. Remember to enable the alarm.
   As other alarms, it is possible to configure timer, fail class, outputs and so on.

The range for the set point is also used by the display, to show the measured value.

When using both alarms for a multi-input, the range for the set points should be the same.

If a sensor only gives 12 mA as maximum output some calculations have to be done to calculate what a 20 mA signal would indicate.
Example: A pressure sensor gives 4 mA at 0 bars and 12 mA at 5 bars. So, a rise of 8 mA adds 5 bars. Each mA indicate a rise of 0.625 bar (= 5 bars/8 mA). The sensor gave 4 mA at 0 bar, so a rise of 16 mA gives 10 bars (=16 mA * 0.625 bar/mA). If the scaling is set to two decimals, the max set point range should be set to 1000, which equals 10.00 bars.

13.2.4 RMI sensor types

The three standard multi-inputs can be set up to RMI inputs. The inputs have different functions, as the hardware design allows for several RMI types.
These various types of RMI inputs are available for all multi-inputs:

RMI oil:	Oil pressure
RMI water:	Cooling water temperature
RMI fuel:	Fuel level sensor

For each type of RMI input, it is possible to select between different characteristics including a configurable. Setting up a configurable RMI sensor is described at the bottom of this chapter.

RMI Oil
This RMI input is used for measuring the lubricating oil pressure.

		RMI sensor type		
Pressure		**Type 1**	**Type 2**	**Type 3**
Bar	**psi**	**Ω**	**Ω**	**Ω**
0	0	10.0	10.0	Not used Shows 0.0 bar at all times
0.5	7	27.2		
1.0	15	44.9	31.3	
1.5	22	62.9		
2.0	29	81.0	51.5	
2.5	36	99.2		
3.0	44	117.1	71.0	
3.5	51	134.7		
4.0	58	151.9	89.6	
4.5	65	168.3		
5.0	73	184.0	107.3	
6.0	87		124.3	
7.0	102		140.4	
8.0	116		155.7	
9.0	131		170.2	
10.0	145		184.0	

The configurable type is configurable with eight points in the range 0-480 Ω. The resistance as well as the pressure can be adjusted.

If the RMI input is used as a level switch, then be aware that no voltage must be connected to the input. If any voltage is applied to the RMI inputs, it will be damaged. Please refer to the Application Notes for further wiring information.

RMI water

This RMI input is used for measuring the cooling water temperature.

		RMI sensor type		
Temperature		Type 1	Type 2	Type 3
°C	°F	Ω	Ω	Ω
40	104	291.5	480.7	69.3
50	122	197.3	323.6	
60	140	134.0	222.5	36.0
70	158	97.1	157.1	
80	176	70.1	113.2	19.8
90	194	51.2	83.2	
100	212	38.5	62.4	11.7
110	230	29.1	47.6	
120	248	22.4	36.8	7.4
130	266		28.9	
140	284		22.8	
150	302		18.2	

The configurable type is configurable with eight points in the range 0-480 Ω. The temperature as well as the resistance can be adjusted.

RMI fuel

This RMI input is used for the fuel level sensor.

	RMI sensor type
	Type 1
Value	Resistance
0 %	78.8 Ω
100 %	1.6 Ω

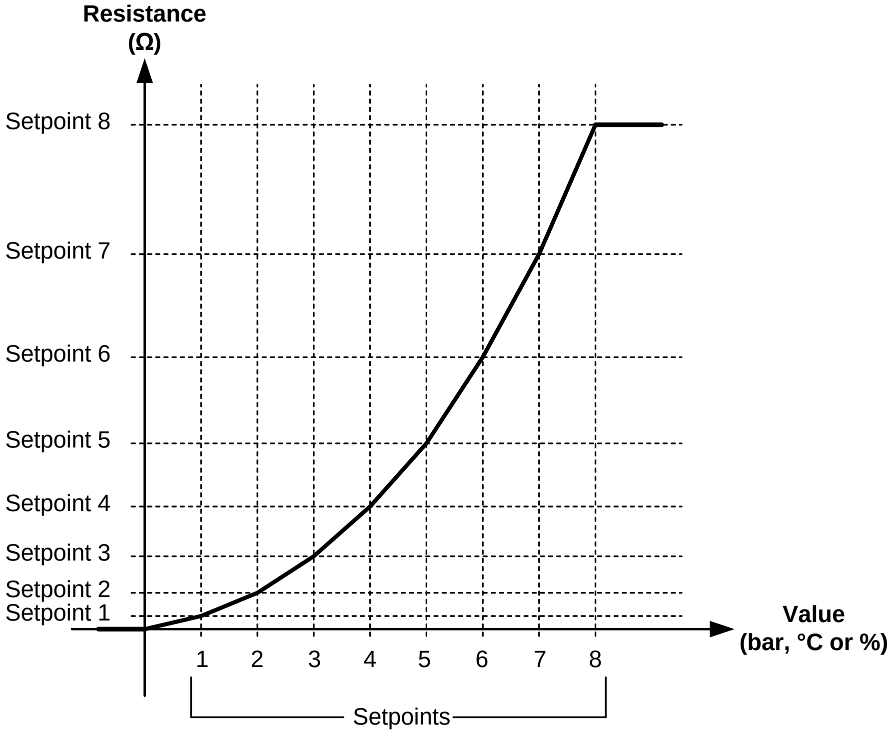
	RMI sensor type
	Type 2
Value	Resistance
0 %	3 Ω
100 %	180 Ω

If the RMI input is used as a level switch, then be aware that no voltage must be connected to the input. If any voltage is applied to the RMI inputs, it will be damaged. Please refer to the Wiring chapter for further wiring information.

Configurable RMIs

If a multi-input is set to RMI oil, water or fuel, it is possible to choose between the premade settings and configuring the setup.

The correlation between resistance and value (pressure and temperature on RMI oil, water or fuel) is adjusted with 8 set points. Every set point has a resistance and a value. The curve will be linear between the points.



The configurable type is configurable with eight points in the range 0-1800 Ω. The value as well as the resistance can be adjusted.

Parameters for RMI

The table below shows parameters for RMI 102. The same parameters are found in menus 10630-10790 for RMI 105 and menus 10800-10960 for RMI 108.

In parameter 10460, RMI type is selected to use either the predefined sensor types or use the configurable settings. If "Configurable RMI" is used, parameters 10470-10620 indicate the correlation between resistance and value of interest (temperature, oil pressure or fuel level). The input set point parameter is the resistance value measured in ohm and the output set point is the converted value, for example 0 if the set point is for 0 % fuel level.

RMI settings are only accessible in the utility software.

Temperature set points can be in deg. C or F, dependent on the unit selection (menu 10970).

Parameter	Item	Range	Default	Notes
10460	RMI 1 type	Sensor type 1 Configurable RMI	Sensor type 1	
10470	RMI 1 input set point 1	0 Ohm 1800 Ohm	10 Ohm	This is the resistance that indicates "output setpoint 1".
10480	RMI 1 output set point 1	-49 482	40	
10490	RMI 1 input set point 2	0 Ohm 1800 Ohm	44.9 Ohm	
10500	RMI 1 output set point 2	-49 482	50	
10510	RMI 1 input set point 3	0 Ohm 1800 Ohm	81 Ohm	
10520	RMI 1 output set point 3	-49 482	60	
10530	RMI 1 input set point 4	0 Ohm 1800 Ohm	134.7 Ohm	
10540	RMI 1 output set point 4	-49 482	80	
10550	RMI 1 input set point 5	0 Ohm 1800 Ohm	184 Ohm	
10560	RMI 1 output set point 5	-49 482	100	
10570	RMI 1 input set point 6	0 Ohm 1800 Ohm	200 Ohm	
10580	RMI 1 output set point 6	-49 482	110	
10590	RMI 1 input set point 7	0 Ohm 1800 Ohm	210 Ohm	
10600	RMI 1 output set point 7	-49 482	115	
10610	RMI 1 input set point 8	0 Ohm 1800 Ohm	220 Ohm	
10620	RMI 1 output set point 8	-49 482	120	

13.2.5 Parameters for multi input 102

The available menus depend on the input type (menu 10980).

Parameter	Item	Range	Default	Notes
4120 4-20 mA 102.1				
4121	Set point for alarm #1 to multi-input 102, 4-20 mA	4 mA 20 mA	10 mA	Visible when multi-input 102 has been configured as 4-20 mA.
4122	Timer for alarm #1 to multi-input 102, 4-20 mA	0.0 s 999.0 s	120.0 s	
4123	Relay output A for alarm #1 to multi-input 102, 4-20 mA	Not used Option-dep.	Not used	
4124	Relay output B for alarm #1 to multi-input 102, 4-20 mA	Not used Option-dep.	Not used	
4125	Enables alarm #1 to multi-input 102, 4-20 mA	OFF ON	OFF	
4126	Fail class for alarm #1 to multi-input 102, 4-20 mA	F1…F8	Warning (F2)	
4130 4-20 mA 102.2				
4131	Set point for alarm #2 to multi-input 102, 4-20 mA	4 mA 20 mA	10 mA	Visible when multi-input 102 has been configured as 4-20 mA.
4132	Timer for alarm #2 to multi-input 102, 4-20 mA	0.0 s 999.0 s	120.0 s	
4133	Relay output A for alarm #2 to multi-input 102, 4-20 mA	Not used Option-dep.	Not used	
4134	Relay output B for alarm #2 to multi-input 102, 4-20 mA	Not used Option-dep.	Not used	
4135	Enables alarm #2 to multi-input 102, 4-20 mA	OFF ON	OFF	
4136	Fail class for alarm #2 to multi-input 102, 4-20 mA	F1…F8	Warning (F2)	
4140 V DC 102.1				

Parameter	Item	Range	Default	Notes
4141	Set point for alarm #1 to multi-input 102, 0-40 V DC	0.0 V DC 40.0 V DC	20.0 V DC	Visible when multi-input 102 has been configured as V DC.
4142	Timer for alarm #1 to multi-input 102, 0-40 V DC	0.2 s 999.0 s	10.0 s	
4143	Relay output A for alarm #1 to multi-input 102, 0-40 V DC	Not used Option-dep.	Not used	
4144	Relay output B for alarm #1 to multi-input 102, 0-40 V DC	Not used Option-dep.	Not used	
4145	Enables alarm #1 to multi-input 102, 0-40 V DC	OFF ON	OFF	
4146	Fail class for alarm #1 to multi-input 102, 0-40 V DC	F1…F8	Warning (F2)	
4150 V DC 102.2				
4151	Set point for alarm #2 to multi-input 102, 0-40 V DC	0.0 V DC 40.0 V DC	20.0 V DC	Visible when multi-input 102 has been configured as V DC.
4152	Timer for alarm #2 to multi-input 102, 0-40 V DC	0.2 s 999.0 s	10.0 s	
4153	Relay output A for alarm #2 to multi-input 102, 0-40 V DC	Not used Option-dep.	Not used	
4154	Relay output B for alarm #2 to multi-input 102, 0-40 V DC	Not used Option-dep.	Not used	
4155	Enables alarm #2 to multi-input 102, 0-40 V DC	OFF ON	OFF	
4156	Fail class for alarm #2 to multi-input 102, 0-40 V DC	F1…F8	Warning (F2)	
4160 Pt100 102.1				

Parameter	Item	Range	Default	Notes
4161	Set point for alarm #1 to multi-input 102, Pt100	-49 482	80	Visible when multi-input 102 has been configured as Pt100. Pt100 set point can be in deg. C or Fahrenheit, de-pendent on the unit selection (menu 10970).
4162	Timer for alarm #1 to multi-input 102, Pt100	0.0 s 999.0 s	5.0 s	
4163	Relay output A for alarm #1 to multi-input 102, Pt100	Not used Option-dep.	Not used	
4164	Relay output B for alarm #1 to multi-input 102, Pt100	Not used Option-dep.	Not used	
4165	Enables alarm #1 to multi-input 102, Pt100	OFF ON	OFF	
4166	Fail class for alarm #1 to multi-input 102, Pt100	F1…F8	Warning (F2)	
4170 Pt100 102.2				
4171	Set point for alarm #2 to multi-input 102, Pt100	-49 482	80	Visible when multi-input 102 has been configured as Pt100. Pt100 set point can be in deg. C or Fahrenheit, de-pendent on the unit selection (menu 10970).
4172	Timer for alarm #2 to multi-input 102, Pt100	0.0 s 999.0 s	10.0 s	
4173	Relay output A for alarm #2 to multi-input 102, Pt100	Not used Option-dep.	Not used	
4174	Relay output B for alarm #2 to multi-input 102, Pt100	Not used Option-dep.	Not used	
4175	Enables alarm #2 to multi-input 102, Pt100	OFF ON	OFF	
4176	Fail class for alarm #2 to multi-input 102, Pt100	F1…F8	Warning (F2)	
4180 RMI oil 102.1				
4181	Set point for alarm #1 to multi-input 102, RMI oil	0.0 145.0	4.0	Visible when multi-input 102 has been configured as RMI oil pressure.
4182	Timer for alarm #1 to multi-input 102, RMI oil	0.0 s 999.0 s	5.0 s	

Parameter	Item	Range	Default	Notes
4183	Relay output A for alarm #1 to multi-input 102, RMI oil	Not used Option-dep.	Not used	Oil pressure set point can be in Bar or PSI, dependent on the unit selection (menu 10970).
4184	Relay output B for alarm #1 to multi-input 102, RMI oil	Not used Option-dep.	Not used	
4185	Enables alarm #1 to multi-input 102, RMI oil	OFF ON	OFF	
4186	Fail class for alarm #1 to multi-input 102, RMI oil	F1…F8	Warning (F2)	
4190 RMI oil 102.2				
4191	Set point for alarm #2 to multi-input 102, RMI oil	0.0 145.0	5.0	Visible when multi-input 102 has been configured as RMI oil pres- sure. Oil pressure set point can be in Bar or PSI, dependent on the unit selection (menu 10970).
4192	Timer for alarm #2 to multi-input 102, RMI oil	0.0 s 999.0 s	5.0 s	
4193	Relay output A for alarm #2 to multi-input 102, RMI oil	Not used Option-dep.	Not used	
4194	Relay output B for alarm #2 to multi-input 102, RMI oil	Not used Option-dep.	Not used	
4195	Enables for alarm #2 to multi-input 102, RMI oil	OFF ON	OFF	
4196	Fail class for alarm #2 to multi-input 102, RMI oil	F1…F8	Warning (F2)	
4200 RMI water 102.1				
4201	Set point for alarm #1 to multi-input 102, RMI water	-49 482	100	Visible when multi-input 102 has been configured as RMI water tem- pera- ture. Water temperature set point can be in deg. C or F, de- pend- ent on the unit selection (menu 10970).
4202	Timer for alarm #1 to multi-input 102, RMI water	0.0 s 999.0 s	5.0 s	
4203	Relay output A for alarm #1 to multi-input 102, RMI water	Not used Option-dep.	Not used	

Parameter	Item	Range	Default	Notes
4204	Relay output B for alarm #1 to multi-input 102, RMI water	Not used Option-dep.	Not used	
4205	Enables alarm #1 to multi-input 102, RMI water	OFF ON	OFF	
4206	Fail class for alarm #1 to multi-input 102, RMI water	F1…F8	Warning (F2)	
4210 RMI water 102.2				
4211	Set point for alarm #2 to multi-input 102, RMI water	-49 482	110	Visible when multi-input 102 has been configured as RMI water tem- pera- ture. Water temperature set point can be in deg. C or F, de- pend- ent on the unit selection (menu 10970).
4212	Timer for alarm #2 to multi-input 102, RMI water	0.0 s 999.0 s	5.0 s	
4213	Relay output A for alarm #2 to multi-input 102, RMI water	Not used Option-dep.	Not used	
4214	Relay output B for alarm #2 to multi-input 102, RMI water	Not used Option-dep.	Not used	
4215	Enables alarm #2 to multi-input 102, RMI water	OFF ON	OFF	
4216	Fail class for alarm #2 to multi-input 102, RMI water	F1…F8	Warning (F2)	
4220 RMI fuel level 102.1				
4221	Set point for alarm #1 to multi-input 102, RMI fuel	0 % 100 %	10 %	Visible when multi-input 102 has been configured as RMI fuel level.
4222	Timer for alarm #1 to multi-input 102, RMI fuel	0.0 s 999.0 s	10.0 s	
4223	Relay output A for alarm #1 to multi-input 102, RMI fuel	Not used Option-dep.	Not used	
4224	Relay output B for alarm #1 to multi-input 102, RMI fuel	Not used Option-dep.	Not used	

Parameter	Item	Range	Default	Notes
4225	Enables alarm #1 to multi-input 102, RMI fuel	OFF ON	OFF	
4226	Fail class for alarm #1 to multi-input 102, RMI fuel	F1…F8	Warning (F2)	
4230 RMI fuel level 102.2				
4231	Set point for alarm #2 to multi-input 102, RMI fuel	0 % 100 %	5 %	Visible when multi-input 102 has been configured as RMI fuel level.
4232	Timer for alarm #2 to multi-input 102, RMI fuel	0.0 s 999.0 s	10.0 s	
4233	Relay output A for alarm #2 to multi-input 102, RMI fuel	Not used Option-dep.	Not used	
4234	Relay output B for alarm #2 to multi-input 102, RMI fuel	Not used Option-dep.	Not used	
4235	Enables alarm #2 to multi-input 102, RMI fuel	OFF ON	OFF	
4236	Fail class for alarm #2 to multi-input 102, RMI fuel	F1…F8	Warning (F2)	
4240 Wire fail 102				
4241	Wire fail detection, relay output A	Not used Option-dep.	Not used	
4242	Wire fail detection, relay output B	Not used Option-dep.	Not used	
4243	Enables wire fail detection	OFF ON	OFF	
4244	Fail class	F1…F8	Warning (F2)	

13.2.6 Parameters for multi input 105

The available menus depend on the input type (menu 10990).

Parameter	Item	Range	Default	Notes
4250 4-20 mA 105.1				
4251	Set point for alarm #1 to multi-input 105, 4-20 mA	4 mA 20 mA	10 mA	Visible when multi-input 105 has been configured as 4-20 mA.
4252	Timer for alarm #1 to multi-input 105, 4-20 mA	0.0 s 999.0 s	120.0 s	
4253	Relay output A for alarm #1 to multi-input 105, 4-20 mA	Not used Option-dep.	Not used	
4254	Relay output B for alarm #1 to multi-input 105, 4-20 mA	Not used Option-dep.	Not used	
4255	Enables alarm #1 to multi-input 105, 4-20 mA	OFF ON	OFF	
4256	Fail class for alarm #1 to multi-input 105, 4-20 mA	F1…F8	Warning (F2)	
4260 4-20 mA 105.2				
4261	Set point for alarm #2 to multi-input 105, 4-20 mA	4 mA 20 mA	10 mA	Visible when multi-input 105 has been configured as 4-20 mA.
4262	Timer for alarm #2 to multi-input 105, 4-20 mA	0.0 s 999.0 s	120.0 s	
4263	Relay output A for alarm #2 to multi-input 105, 4-20 mA	Not used Option-dep.	Not used	
4264	Relay output B for alarm #2 to multi-input 105, 4-20 mA	Not used Option-dep.	Not used	
4265	Enables alarm #2 to multi-input 105, 4-20 mA	OFF ON	OFF	
4266	Fail class for alarm #2 to multi-input 105, 4-20 mA	F1…F8	Warning (F2)	
4270 V DC 105.1				

Parameter	Item	Range	Default	Notes
4271	Set point for alarm #1 to multi-input 105, 0-40 V DC	0.0V DC 40.0V DC	20.0 V DC	Visible when multi-input 105 has been configured as V DC.
4272	Timer for alarm #1 to multi-input 105, 0-40 V DC	0.2 s 999.0 s	10.0 s	
4273	Relay output A for alarm #1 to multi-input 105, 0-40 V DC	Not used Option-dep.	Not used	
4274	Relay output B for alarm #1 to multi-input 105, 0-40 V DC	Not used Option-dep.	Not used	
4275	Enables alarm #1 to multi-input 105, 0-40 V DC	OFF ON	OFF	
4276	Fail class for alarm #1 to multi-input 105, 0-40 V DC	F1…F8	Warning (F2)	
4280 V DC 105.2				
4281	Set point for alarm #2 to multi-input 105, 0-40 V DC	0.0V DC 40.0V DC	20.0 V DC	Visible when multi-input 105 has been configured as V DC.
4282	Timer for alarm #2 to multi-input 105, 0-40 V DC	0.2 s 999.0 s	10.0 s	
4283	Relay output A for alarm #2 to multi-input 105, 0-40 V DC	Not used Option-dep.	Not used	
4284	Relay output B for alarm #2 to multi-input 105, 0-40 V DC	Not used Option-dep.	Not used	
4285	Enables alarm #2 to multi-input 105, 0-40 V DC	OFF ON	OFF	
4286	Fail class for alarm #2 to multi-input 105, 0-40 V DC	F1…F8	Warning (F2)	
4290 Pt100 105.1				

Parameter	Item	Range	Default	Notes
4291	Set point for alarm #1 to multi-input 105, Pt100	-49 482	80	Visible when multi-input 105 has been configured as Pt100. Pt100 Set point can be in deg. C or F, dependent on the unit selection (menu 10970).
4292	Timer for alarm #1 to multi-input 105, Pt100	0.0 s 999.0 s	5.0 s	
4293	Relay output A for alarm #1 to multi-input 105, Pt100	Not used Option-dep.	Not used	
4294	Relay output B for alarm #1 to multi-input 105, Pt100	Not used Option-dep.	Not used	
4295	Enables alarm #1 to multi-input 105, Pt100	OFF ON	OFF	
4296	Fail class for alarm #1 to multi-input 105, Pt100	F1…F8	Warning (F2)	
4300 Pt100 105.2				
4302	Timer for alarm #2 to multi-input 105, Pt100	0.0 s 999.0 s	10.0 s	Visible when multi-input 105 has been configured as Pt100. Pt100 Set point can be in deg. C or F, dependent on the unit selection (menu 10970).
4303	Relay output A for alarm #2 to multi-input 105, Pt100	Not used Option-dep.	Not used	
4304	Relay output B for alarm #2 to multi-input 105, Pt100	Not used Option-dep.	Not used	
4305	Enables alarm #2 to multi-input 105, Pt100	OFF ON	OFF	
4306	Fail class for alarm #2 to multi-input 105, Pt100	F1…F8	Warning (F2)	
4310 RMI oil 105.1				
4311	Set point for alarm #1 to multi-input 105, RMI oil	0.0 145.0	4.0	Visible when multi-input 105 has been configured as RMI oil pres- sure. Oil pressure Set point can be in Bar or PSI, dependent on the unit selec- tion (menu 10970).
4312	Timer for alarm #1 to multi-input 105, RMI oil	0.0 s 999.0 s	5.0 s	
4313	Relay output A for alarm #1 to multi-input 105, RMI oil	Not used Option-dep.	Not used	

Parameter	Item	Range	Default	Notes
4314	Relay output B for alarm #1 to multi-input 105, RMI oil	Not used Option-dep.	Not used	
4315	Enables alarm #1 to multi-input 105, RMI oil	OFF ON	OFF	
4316	Fail class for alarm #1 to multi-input 105, RMI oil	F1…F8	Warning (F2)	
4320 RMI oil 105.2				
4321	Set point for alarm #2 to multi-input 105, RMI oil	0.0 145.0	5.0	Visible when multi-input 105 has been configured as RMI oil pres- sure. Oil pressure Set point can be in Bar or PSI, dependent on the unit selec- tion (menu 10970).
4322	Timer for alarm #2 to multi-input 105, RMI oil	0.0 s 999.0 s	5.0 s	
4323	Relay output A for alarm #2 to multi-input 105, RMI oil	Not used Option-dep.	Not used	
4324	Relay output B for alarm #2 to multi-input 105, RMI oil	Not used Option-dep.	Not used	
4325	Enables alarm #2 to multi-input 105, RMI oil	OFF ON	OFF	
4326	Fail class for alarm #2 to multi-input 105, RMI oil	F1…F8	Warning (F2)	
4330 RMI water 105.1				
4331	Set point for alarm #1 to multi-input 105, RMI water	-49 482	100	Visible when multi-input 105 has been configured as RMI water tem- pera- ture. Water temperature Set point can be in deg. C or F, de- pendent on the unit selection (menu 10970).
4332	Timer for alarm #1 to multi-input 105, RMI water	0.0 s 999.0 s	5.0 s	
4333	Relay output A for alarm #1 to multi-input 105, RMI wa- ter	Not used Option-dep.	Not used	
4334	Relay output B for alarm #1 to multi-input 105, RMI wa- ter	Not used Option-dep.	Not used	

Parameter	Item	Range	Default	Notes
4335	Enables alarm #1 to multi-input 105, RMI water	OFF ON	OFF	
4336	Fail class for alarm #1 to multi-input 105, RMI water	F1…F8	Warning (F2)	
4340 RMI water 105.2				
4341	Set point for alarm #2 to multi-input 105, RMI water	-49 482	110	Visible when multi-input 105 has been configured as RMI water tem- pera- ture. Water temperature Set point can be in deg. C or F, de- pendent on the unit selection (menu 10970).
4342	Timer for alarm #2 to multi-input 105, RMI water	0.0 s 999.0 s	5.0 s	
4343	Relay output A for alarm #2 to multi-input 105, RMI wa- ter	Not used Option-dep.	Not used	
4344	Relay output B for alarm #2 to multi-input 105, RMI wa- ter	Not used Option-dep.	Not used	
4345	Enables alarm #2 to multi-input 105, RMI water	OFF ON	OFF	
4346	Fail class for alarm #2 to multi-input 105, RMI water	F1…F8	Warning (F2)	
4350 RMI fuel level 105.1				
4351	Set point for alarm #1 to multi-input 105, RMI fuel	0% 100%	10 %	Visible when multi-input 105 has been configured as RMI fuel level.
4352	Timer for alarm #1 to multi-input 105, RMI fuel	0.0 s 999.0 s	10.0 s	
4353	Relay output A for alarm #1 to multi-input 105, RMI fuel	Not used Option-dep.	Not used	
4354	Relay output B for alarm #1 to multi-input 105, RMI fuel	Not used Option-dep.	Not used	
4535	Enables alarm #1 to multi-input 105, RMI fuel	OFF ON	OFF	

Parameter	Item	Range	Default	Notes
4356	Fail class for alarm #1 to multi-input 105, RMI fuel	F1…F8	Warning (F2)	
4360 RMI fuel level 105.2				
4361	Set point for alarm #2 to multi-input 105, RMI fuel	0% 100%	5 %	Visible when multi-input 105 has been configured as RMI fuel level.
4362	Timer for alarm #2 to multi-input 105, RMI fuel	0.0 s 999.0 s	10.0 s	
4363	Relay output A for alarm #2 to multi-input 105, RMI fuel	Not used Option-dep.	Not used	
4364	Relay output B for alarm #2 to multi-input 105, RMI fuel	Not used Option-dep.	Not used	
4365	Enables alarm #2 to multi-input 105, RMI fuel	OFF ON	OFF	
4366	Fail class for alarm #2 to multi-input 105, RMI fuel	F1…F8	Warning (F2)	
4370 Wire fail 105				
4371	Wire fail detection, relay output A	Not used Option-dep.	Not used	
4372	Wire fail detection, relay output B	Not used Option-dep.	Not used	
4373	Enables wire fail detection	OFF ON	OFF	
4374	Fail class	F1…F8	Warning (F2)	

13.2.7 Parameters for multi-input 108

The available menus depend on the input type (menu 11000).

Parameter	Item	Range	Default	Notes
4380 4-20 mA 108.1				
4381	Set point for alarm #1 to multi-input 108, 4-20 mA	4 mA 20 mA	10 mA	Visible when multi-input 108 has been configured as 4-20 mA.
4382	Timer for alarm #1 to multi-input 108, 4-20 mA	0.0 s 999.0 s	120.0 s	
4383	Relay output A for alarm #1 to multi-input 108, 4-20 mA	Not used Option-dep.	Not used	
4384	Relay output B for alarm #1 to multi-input 108, 4-20 mA	Not used Option-dep.	Not used	
4385	Enables alarm #1 to multi-input 108, 4-20 mA	OFF ON	OFF	
4386	Fail class for alarm #1 to multi-input 108, 4-20 mA	F1…F8	Warning (F2)	
4390 4-20 mA 108.2				
4391	Set point for alarm #2 to multi-input 108, 4-20 mA	4 mA 20 mA	10 mA	Visible when multi-input 108 has been configured as 4-20 mA.
4392	Timer for alarm #2 to multi-input 108, 4-20 mA	0.0 s 999.0 s	120.0 s	
4393	Relay output A for alarm #2 to multi-input 108, 4-20 mA	Not used Option-dep.	Not used	
4394	Relay output B for alarm #2 to multi-input 108, 4-20 mA	Not used Option-dep.	Not used	
4395	Enables alarm #2 to multi-input 108, 4-20 mA	OFF ON	OFF	
4396	Fail class for alarm #2 to multi-input 108, 4-20 mA	F1…F8	Warning (F2)	
4400 V DC 108.1				
4401	Set point for alarm #1 to multi-input 108, 0-40 V DC	0.0 V DC 40.0 V DC	20.0 V DC	Visible when multi-input 108 has been configured as V DC.

Parameter	Item	Range	Default	Notes
4402	Timer for alarm #1 to multi-input 108, 0-40 V DC	0.2 s 999.0 s	10.0 s	
4403	Relay output A for alarm #1 to multi-input 108, 0-40 V DC	Not used Option-dep.	Not used	
4404	Relay output B for alarm #1 to multi-input 108, 0-40 V DC	Not used Option-dep.	Not used	
4405	Enables alarm #1 to multi-input 108, 0-40 V DC	OFF ON	OFF	
4406	Fail class for alarm #1 to multi-input 108, 0-40 V DC	F1…F8	Warning (F2)	
4410 V DC 108.2				
4411	Set point for alarm #2 to multi-input 108, 0-40 V DC	0.0 V DC 40.0 V DC	20.0 V DC	Visible when multi-input 108 has been configured as V DC.
4412	Timer for alarm #2 to multi-input 108, 0-40 V DC	0.2 s 999.0 s	10.0 s	
4413	Relay output A for alarm #2 to multi-input 108, 0-40 V DC	Not used Option-dep.	Not used	
4414	Relay output B for alarm #2 to multi-input 108, 0-40 V DC	Not used Option-dep.	Not used	
4415	Enable for alarm #2 to multi-input 108, 0-40 V DC	OFF ON	OFF	
4416	Fail class for alarm #2 to multi-input 108, 0-40 V DC	F1…F8	Warning (F2)	
4420 Pt100 108.1				
4421	Set point for alarm #1 to multi-input 108, Pt100	-49 482	80	Visible when multi-input 108 has been configured as Pt100.

Parameter	Item	Range	Default	Notes
4422	Timer for alarm #1 to multi-input 108, Pt100	0.0 s 999.0 s	5.0 s	Pt100 Set point can be in deg. C or F, dependent on the unit selection (menu 10970).
4423	Relay output A for alarm #1 to multi-input 108, Pt100	Not used Option-dep.	Not used	
4424	Relay output B for alarm #1 to multi-input 108, Pt100	Not used Option-dep.	Not used	
4425	Enables alarm #1 to multi-input 108, Pt100	OFF ON	OFF	
4426	Fail class for alarm #1 to multi-input 108, Pt100	F1…F8	Warning (F2)	
4430 Pt100 108.2				
4431	Set point for alarm #2 to multi-input 108, Pt100	-49 482	80	Visible when multi-input 108 has been configured as Pt100. Pt100 Set point can be in deg. C or F, dependent on the unit selection (menu 10970).
4432	Timer for alarm #2 to multi-input 108, Pt100	0.0 s 999.0 s	10.0 s	
4433	Relay output A for alarm #2 to multi-input 108, Pt100	Not used Option-dep.	Not used	
4434	Relay output B for alarm #2 to multi-input 108, Pt100	Not used Option-dep.	Not used	
4435	Enables alarm #2 to multi-input 108, Pt100	OFF ON	OFF	
4436	Fail class for alarm #2 to multi-input 108, Pt100	F1…F8	Warning (F2)	
4440 RMI oil 108.1				
4441	Set point for alarm #1 to multi-input 108, RMI oil	0.0 145.0	4.0	Visible when multi-input 108 has been configured as RMI oil pres- sure. Oil pressure Set point can be in Bar or PSI, dependent on the unit selec- tion (menu 10970).
4442	Timer for alarm #1 to multi-input 108, RMI oil	0.0 s 999.0 s	5.0 s	
4443	Relay output A for alarm #1 to multi-input 108, RMI oil	Not used Option-dep.	Not used	

Parameter	Item	Range	Default	Notes
4444	Relay output B for alarm #1 to multi-input 108, RMI oil	Not used Option-dep.	Not used	
4445	Enables alarm #1 to multi-input 108, RMI oil	OFF ON	OFF	
4446	Fail class for alarm #1 to multi-input 108, RMI oil	F1…F8	Warning (F2)	
4450 RMI oil 108.2				
4451	Set point for alarm #2 to multi-input 108, RMI oil	0.0 145.0	5.0	Visible when multi-input 108 has been configured as RMI oil pres- sure. Oil pressure Set point can be in Bar or PSI, dependent on the unit selec- tion (menu 10970).
4452	Timer for alarm #2 to multi-input 108, RMI oil	0.0 s 999.0 s	5.0 s	
4453	Relay output A for alarm #2 to multi-input 108, RMI oil	Not used Option-dep.	Not used	
4454	Relay output B for alarm #2 to multi-input 108, RMI oil	Not used Option-dep.	Not used	
4455	Enables alarm #2 to multi-input 108, RMI oil	OFF ON	OFF	
4456	Fail class for alarm #2 to multi-input 108, RMI oil	F1…F8	Warning (F2)	
4460 RMI water 108.1				
4461	Set point for alarm #1 to multi-input 108, RMI water	-49 482	100	Visible when multi-input 108 has been configured as RMI water tem- pera- ture. Water temperature Set point can be in deg. C or F, de- pend- ent on the unit selection (menu 10970).
4462	Timer for alarm #1 to multi-input 108, RMI water	0.0 s 999.0 s	5.0 s	
4463	Relay output A for alarm #1 to multi-input 108, RMI wa- ter	Not used Option-dep.	Not used	
4464	Relay output B for alarm #1 to multi-input 108, RMI wa- ter	Not used Option-dep.	Not used	

Parameter	Item	Range	Default	Notes
4465	Enables alarm #1 to multi-input 108, RMI water	OFF ON	OFF	
4466	Fail class for alarm #1 to multi-input 108, RMI water	F1…F8	Warning (F2)	
4470 RMI water 108.2				
4471	Set point for alarm #2 to multi-input 108, RMI water	-49 482	110	Visible when multi-input 108 has been configured as RMI water tem- pera- ture. Water temperature Set point can be in deg. C or F, de- pend- ent on the unit selection (menu 10970).
4472	Timer for alarm #2 to multi-input 108, RMI water	0.0 s 999.0 s	5.0 s	
4473	Relay output A for alarm #2 to multi-input 108, RMI wa- ter	Not used Option-dep.	Not used	
4474	Relay output B for alarm #2 to multi-input 108, RMI wa- ter	Not used Option-dep.	Not used	
4475	Enables alarm #2 to multi-input 108, RMI water	OFF ON	OFF	
4476	Fail class for alarm #2 to multi-input 108, RMI water	F1…F8	Warning (F2)	
4480 RMI fuel level 108.1				
4481	Set point for alarm #1 to multi-input 108, RMI fuel	0 % 100 %	10 %	Visible when multi-input 108 has been configured as RMI fuel level.
4482	Timer for alarm #1 to multi-input 108, RMI fuel	0.0 s 999.0 s	10.0 s	
4483	Relay output A for alarm #1 to multi-input 108, RMI fuel	Not used Option-dep.	Not used	
4484	Relay output B for alarm #1 to multi-input 108, RMI fuel	Not used Option-dep.	Not used	
4485	Enables alarm #1 to multi-input 108, RMI fuel	OFF ON	OFF	

Parameter	Item	Range	Default	Notes
4486	Fail class for alarm #1 to multi-input 108, RMI fuel	F1…F8	Warning (F2)	
4490 RMI fuel level 108.2				
4491	Set point for alarm #2 to multi-input 108, RMI fuel	0 % 100 %	5 %	Visible when multi-input 108 has been configured as RMI fuel level.
4492	Timer for alarm #2 to multi-input 108, RMI fuel	0.0 s 999.0 s	10.0 s	
4493	Relay output A for alarm #2 to multi-input 108, RMI fuel	Not used Option-dep.	Not used	
4494	Relay output B for alarm #2 to multi-input 108, RMI fuel	Not used Option-dep.	Not used	
4495	Enables alarm #2 to multi-input 108, RMI fuel	OFF ON	OFF	
4496	Fail class for alarm #2 to multi-input 108, RMI fuel	F1…F8	Warning (F2)	
4500 Wire fail 108				
4501	Wire fail detection, relay output A	Not used Option-dep.	Not used	
4502	Wire fail detection, relay output B	Not used Option-dep.	Not used	
4503	Enables wire fail detection	OFF ON	OFF	
4504	Fail class	F1…F8	Warning (F2)	

13.3 Option M15

Option M15 has four 4-20 mA inputs, and the PCB can be installed at slot #6 (called M15.6) and slot #8 (called M15.8).
See "Common information" for multi-inputs for information about wiring, scaling, display etc.

For each input, two alarm levels are available. The menu numbers of the alarm settings for each multi-input are controlled by the configured input type as seen in the following tables.
Just as the other multi-inputs, the value on the display relates to the range for the set point in the first alarm (for example parameter 4000 for multi-input 91).

The table below shows related parameter numbers when M15 is placed in slot 6:

Input type	Multi-input 91	Multi-input 93	Multi-input 95	Multi- input 97
4-20 mA	4000/4010	4030/4040	4060/4070	4090/4100
Wire break	4020	4050	4080	4110

The table below shows related parameter numbers when M15 is placed in slot 8:

Input type	Multi-input 127	Multi-input 129	Multi-input 131	Multi-input 133
4-20 mA	4800/4810	4830/4840	4860/4870	4890/4900
Wirebreak	4820	4850	4880	4910

13.3.1 Terminal description, M15.6

Term.	Function	Technical data	Description
90	Analogue input 91	Common	4-20 mA input, configurable
91	Analogue input 91	4-20 mA in	
92	Analogue input 93	Common	4-20 mA input, configurable
93	Analogue input 93	4-20 mA in	
94	Analogue input 95	Common	4-20 mA input, configurable
95	Analogue input 95	4-20 mA in	
96	Analogue input 97	Common	4-20 mA input, configurable
97	Analogue input 97	4-20 mA in	

13.3.2 Terminal description, M15.8

Term.	Function	Technical data	Description
126	Analogue input 127	Common	4-20 mA input, configurable
127	Analogue input 127	4-20 mA in	
128	Analogue input 129	Common	4-20 mA input, configurable
129	Analogue input 129	4-20 mA in	
130	Analogue input 131	Common	4-20 mA input, configurable
131	Analogue input 131	4-20 mA in	
132	Analogue input 133	Common	4-20 mA input, configurable
133	Analogue input 133	4-20 mA in	

13.3.3 Parameters, analogue input setup (option M15.6)

These parameters will only be visible if the AGC PM has option M15.6.

Parameter	Item	Range	Default	Notes
4000 4-20 mA 91.1				
4001	Set point for alarm #1 to input 91, 4-20 mA	4 mA 20 mA	10 mA	
4002	Timer for alarm #1 to input 91, 4-20 mA	0.0 s 600.0 s	120.0 s	
4003	Relay output A for alarm #1 to input 91, 4-20 mA	Not used Option-dep.	Not used	
4004	Relay output B for alarm #1 to input 91, 4-20 mA	Not used Option-dep.	Not used	
4005	Enables alarm #1 to input 91, 4-20 mA	OFF ON	OFF	
4006	Fail class for alarm #1 to input 91, 4-20 mA	F1…F8	Warning (F2)	
4010 4-20 mA 91.2				
4011	Set point for alarm #2 to input 91, 4-20 mA	4 mA 20 mA	10 mA	
4012	Timer for alarm #2 to input 91, 4-20 mA	0.0 s 600.0 s	120.0 s	
4013	Relay output A for alarm #2 to input 91, 4-20 mA	Not used Option-dep.	Not used	
4014	Relay output B for alarm #2 to input 91, 4-20 mA	Not used Option-dep.	Not used	
4015	Enables alarm #2 to input 91, 4-20 mA	OFF ON	OFF	
4016	Fail class for alarm #2 to input 91, 4-20 mA	F1…F8	Warning (F2)	
4020 Wire fail 4-20 mA 91				
4021	Wire fail detection, relay output A	Not used Option-dep.	Not used	The wire fault will detect if the current drops below 3 mA or exceeds 21 mA. In both cases the alarm will be activated.
4022	Wire fail detection, relay output B	Not used Option-dep.	Not used	
4023	Enables wire fail detection	OFF ON	OFF	
4024	Fail class for wire fail detection	F1…F8	Warning (F2)	
4030 4-20 mA 93.1				
4031	Set point for alarm #1 to input 93, 4-20 mA	4 mA 20 mA	10 mA	
4032	Timer for alarm #1 to input 93, 4-20 mA	0.0 s 600.0 s	120.0 s	

Parameter	Item	Range	Default	Notes
4033	Relay output A for alarm #1 to input 93, 4-20 mA	Not used Option-dep.	Not used	
4034	Relay output B for alarm #1 to input 93, 4-20 mA	Not used Option-dep.	Not used	
4035	Enables alarm #1 to input 93, 4-20 mA	OFF ON	OFF	
4036	Fail class for alarm #1 to input 93, 4-20 mA	F1…F8	Warning (F2)	
4040 4-20 mA 93.2				
4041	Set point for alarm #2 to input 93, 4-20 mA	4 mA 20 mA	10 mA	
4042	Timer for alarm #2 to input 93, 4-20 mA	0.0 s 600.0 s	120.0 s	
4043	Relay output A for alarm #2 to input 93, 4-20 mA	Not used Option-dep.	Not used	
4044	Relay output B for alarm #2 to input 93, 4-20 mA	Not used Option-dep.	Not used	
4045	Enables alarm #2 to input 93, 4-20 mA	OFF ON	OFF	
4046	Fail class for alarm #2 to input 93, 4-20 mA	F1…F8	Warning (F2)	
4050 Wire fail 4-20 mA 93				
4051	Wire fail detection on input 93, Relay output A	Not used Option-dep.	Not used	The wire fault will detect if the current drops below 3 mA or exceeds 21 mA. In both cases the alarm will be activated.
4052	Wire fail detection on input 93, Relay output B	Not used Option-dep.	Not used	
4053	Enable wire fail detection on input 93	OFF ON	OFF	
4054	Fail class for wire fail detection on input 93	F1…F8	Warning (F2)	
4060 4-20 mA 95.1				
4061	Set point for alarm #1 to input 95, 4-20 mA	4 mA 20 mA	10 mA	
4062	Timer for alarm #1 to input 95, 4-20 mA	0.0 s 600.0 s	120.0 s	
4063	Relay output A for alarm #1 to input 95, 4-20 mA	Not used Option-dep.	Not used	
4064	Relay output B for alarm #1 to input 95, 4-20 mA	Not used Option-dep.	Not used	
4065	Enable alarm #1 to input 95, 4-20 mA	OFF ON	OFF	

Parameter	Item	Range	Default	Notes
4066	Fail class for alarm #1 to input 95, 4-20 mA	F1…F8	Warning (F2)	
4070 4-20 mA 95.2				
4071	Set point for alarm #2 to input 95, 4-20 mA	4 mA 20 mA	10 mA	
4072	Timer for alarm #2 to input 95, 4-20 mA	0.0 s 600.0 s	120.0 s	
4073	Relay output A for alarm #2 to input 95, 4-20 mA	Not used Option-dep.	Not used	
4074	Relay output B for alarm #2 to input 95, 4-20 mA	Not used Option-dep.	Not used	
4075	Enable alarm #2 to input 95, 4-20 mA	OFF ON	OFF	
4076	Fail class for alarm #2 to input 95, 4-20 mA	F1…F8	Warning (F2)	
4080 Wire fail 4-20 mA 95				
4081	Wire fail detection on input 95,Relay output A	Not used Option-dep.	Not used	The wire fault will detect if the current drops below 3 mA or exceeds 21 mA. In both cases the alarm will be activated.
4082	Wire fail detection on input 95,Relay output B	Not used Option-dep.	Not used	
4083	Enable wire fail detection on input 95	OFF ON	OFF	
4084	Fail class for wire fail detection on input 95	F1…F8	Warning	
4090 4-20 mA 97.1				
4091	Set point for alarm #1 to input 97, 4-20 mA	4 mA 20 mA	10 mA	
4092	Timer for alarm #1 to input 97, 4-20 mA	0.0 s 600.0 s	120.0 s	
4093	Relay output A for alarm #1 to input 97, 4-20 mA	Not used Option-dep.	Not used	
4094	Relay output B for alarm #1 to input 97, 4-20 mA	Not used Option-dep.	Not used	
4095	Enable alarm #1 to input 97, 4-20 mA	OFF ON	OFF	
4096	Fail class for alarm #1 to input 97, 4-20 mA	F1…F8	Warning (F2)	
4100 4-20 mA 97.2				
4101	Set point for alarm #2 to input 97, 4-20 mA	4 mA 20 mA	10 mA	

Parame-ter	Item	Range	Default	Notes
4102	Timer for alarm #2 to input 97, 4-20 mA	0.0 s 600.0 s	120.0 s	
4103	Relay output A for alarm #2 to input 97, 4-20 mA	Not used Option-dep.	Not used	
4104	Relay output B for alarm #2 to input 97, 4-20 mA	Not used Option-dep.	Not used	
4105	Enable alarm #2 to input 97, 4-20 mA	OFF ON	OFF	
4106	Fail class for alarm #2 to input 97, 4-20 mA	F1…F8	Warning (F2)	
4110 Wire fail 4-20 mA 97				
4111	Wire fail detection on input 97,Relay output A	Not used Option-dep.	Not used	The wire fault will detect if the current drops below 3 mA or exceeds 21 mA. In both cases the alarm will be activated.
4112	Wire fail detection on input 97,Relay output B	Not used Option-dep.	Not used	
4113	Enable wire fail detection on input 97	OFF ON	OFF	
4114	Fail class for wire fail detection on input 97	F1…F8	Warning (F2)	

13.3.4 Parameters, analogue input setup (option M15.8)

No.	Setting	Min. Max.	Default	Notes
4800 4-20 mA 127.1				
4801	Set point for alarm #1 to input 127, 4-20 mA	4 mA 20 mA	10 mA	
4802	Timer for alarm #1 to input 127, 4-20 mA	0.0 s 600.0 s	120.0 s	
4803	Relay output A for alarm #1 to input 127, 4-20 mA	Not used Option-dep.	Not used	
4804	Relay output B for alarm #1 to input 127, 4-20 mA	Not used Option-dep.	Not used	
4805	Enable alarm #1 to input 127, 4-20 mA	OFF ON	OFF	
4806	Fail class for alarm #1 to input 127, 4-20 mA	F1…F8	Warning (F2)	
4810 4-20 mA 127.2				
4811	Set point for alarm #2 to input 127, 4-20 mA	4 mA 20 mA	10 mA	
4812	Timer for alarm #2 to input 127, 4-20 mA	0.0 s 600.0 s	120.0 s	
4813	Relay output A for alarm #2 to input 127, 4-20 mA	Not used Option-dep.	Not used	
4814	Relay output B for alarm #2 to input 127, 4-20 mA	Not used Option-dep.	Not used	
4815	Enable alarm #2 to input 127, 4-20 mA	OFF ON	OFF	
4816	Fail class for alarm #2 to input 127, 4-20 mA	F1…F8	Warning (F2)	
4820 wire fail 4-20 mA 127				
4821	Wire fail detection, relay output A	Not used Option-dep.	Not used	The wire fault will detect if the current drops below 3 mA or exceeds 21 mA. In both cases the alarm will be activated.
4822	Wire fail detection, relay output B	Not used Option-dep.	Not used	
4823	Enables wire fail detection	OFF ON	OFF	
4824	Fail class for wire fail detection	F1…F8	Warning (F2)	
4830 4-20 mA 129.1				
4831	Set point for alarm #1 to input 129, 4-20 mA	4 mA 20 mA	10 mA	

No.	Setting	Min. Max.	Default	Notes
4832	Timer for alarm #1 to input 129, 4-20 mA	0.0 s 600.0 s	120.0 s	
4833	Relay output A for alarm #1 to input 129, 4-20 mA	Not used Option-dep.	Not used	
4834	Relay output B for alarm #1 to input 129, 4-20 mA	Not used Option-dep.	Not used	
4835	Enable alarm #1 to input 129, 4-20 mA	OFF ON	OFF	
4836	Fail class for alarm #1 to input 129, 4-20 mA	F1…F8	Warning (F2)	
4840 4-20 mA 129.2				
4841	Set point for alarm #1 to input 129, 4-20 mA	4 mA 20 mA	10 mA	
4842	Timer for alarm #1 to input 129, 4-20 mA	0.0 s 600.0 s	120.0 s	
4843	Relay output A for alarm #1 to input 129, 4-20 mA	Not used Option-dep.	Not used	
4844	Relay output B for alarm #1 to input 129, 4-20 mA	Not used Option-dep.	Not used	
4845	Enable alarm #1 to input 129, 4-20 mA	OFF ON	OFF	
4846	Fail class for alarm #1 to input 129, 4-20 mA	F1…F8	Warning (F2)	
4850 Wire fail 4-20 mA 129				
4851	Wire fail detection on input 129, relay output A	Not used Option-dep.	Not used	The wire fault will detect if the current drops below 3 mA or exceeds 21 mA. In both cases the alarm will be activated.
4852	Wire fail detection on input 129, relay output B	Not used Option-dep.	Not used	
4853	Enable wire fail detection on input 129	OFF ON	OFF	
4854	Fail class for wire fail detection on input 129	F1…F8	Warning (F2)	
4860 4-20 mA 131.1				
4861	Set point for alarm #1 to input 131, 4-20 mA	4 mA 20 mA	10 mA	
4862	Timer for alarm #1 to input 131, 4-20 mA	0.0 s 600.0 s	120.0 s	
4863	Relay output A for alarm #1 to input 131, 4-20 mA	Not used Option-dep.	Not used	
4864	Relay output B for alarm #1 to input 131, 4-20 mA	Not used Option-dep.	Not used	

No.	Setting	Min. Max.	Default	Notes
4865	Enables alarm #1 to input 131, 4-20 mA	OFF ON	OFF	
4866	Fail class for alarm #1 to input 131, 4-20 mA	F1…F8	Warning (F2)	
4870 4-20 mA 131.2				
4871	Set point for alarm #2 to input 131, 4-20 mA	4 mA 20 mA	10 mA	
4872	Timer for alarm #2 to input 131, 4-20 mA	0.0 s 600.0 s	120.0 s	
4873	Relay output A for alarm #2 to input 131, 4-20 mA	Not used Option-dep.	Not used	
4874	Relay output B for alarm #2 to input 131, 4-20 mA	Not used Option-dep.	Not used	
4875	Enables alarm #2 to input 131, 4-20 mA	OFF ON	OFF	
4876	Fail class for alarm #2 to input 131, 4-20 mA	F1…F8	Warning (F2)	
4880 Wire fail 4-20 mA 131				
4881	Wire fail detection, relay output A	Not used Option-dep.	Not used	The wire fault will detect if the current drops below 3 mA or exceeds 21 mA. In both cases the alarm will be activated.
4882	Wire fail detection, relay output B	Not used Option-dep.	Not used	
4883	Enables wire fail detection	OFF ON	OFF	
4884	Fail class for wire fail detection	F1…F8	Warning (F2)	
4890 4-20 mA 133.1				
4891	Set point for alarm #1 to input 133, 4-20 mA	4 mA 20 mA	10 mA	
4892	Timer for alarm #1 to input 133, 4-20 mA	0.0 s 600.0 s	120.0 s	
4893	Relay output A for alarm #1 to input 133, 4-20 mA	Not used Option-dep.	Not used	
4894	Relay output B for alarm #1 to input 133, 4-20 mA	Not used Option-dep.	Not used	
4895	Enables alarm #1 to input 133, 4-20 mA	OFF ON	OFF	
4896	Fail class for alarm #1 to input 133, 4-20 mA	F1…F8	Warning (F2)	
4900 4-20 mA 133.2				

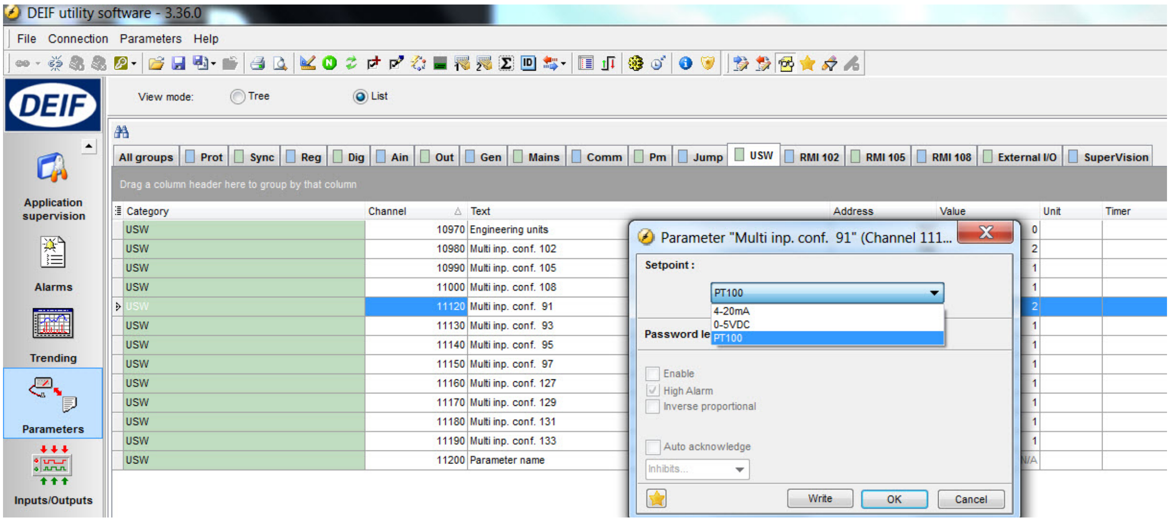
No.	Setting	Min. Max.	Default	Notes
4901	Set point for alarm #2 to input 91, 4-20 mA	4 mA 20 mA	10 mA	
4902	Timer for alarm #2 to input 91, 4-20 mA	0.0 s 600.0 s	120.0 s	
4903	Relay output A for alarm #2 to input 91, 4-20 mA	Not used Option-dep.	Not used	
4904	Relay output B for alarm #2 to input 91, 4-20 mA	Not used Option-dep.	Not used	
4905	Enables alarm #2 to input 91, 4-20 mA	OFF ON	OFF	
4906	Fail class for alarm #2 to input 91, 4-20 mA	F1…F8	Warning (F2)	
4910 Wire fail 4-20 mA 133				
4911	Wire fail detection, relay output A	Not used Option-dep.	Not used	The wire fault will detect if the current drops below 3 mA or exceeds 21 mA. In both cases the alarm will be activated.
4912	Wire fail detection, relay output B	Not used Option-dep.	Not used	
4913	Enables wire fail detection	OFF ON	OFF	
4914	Fail class for wire fail detection	F1…F8	Warning (F2)	

13.4 Option M16

Option M16 has four multi-inputs, and the PCB can be installed at slot #6 (called M16.6) and slot #8 (called M16.8).
The inputs can be configured to be used as the following three input types:

1. 4-20 mA
2. 0-5 V DC
3. Pt100

The configuration of each multi-input can be done by using PC utility software, by pressing the tab USW in the programme. See the picture below.



The function of the multi-inputs can only be configured in the PC utility software.

For each input, two alarm levels are available. The display settings can be configured in the same way as the regular multi-inputs, see the "Display" section in the "Common information" chapter for more information.

The table below shows related parameter numbers when M16 is placed in slot 6:

Input type	Multi-input 91	Multi-input 93	Multi-input 95	Multi-input 97
4-20 mA/0-5 V/Pt100	4000/4010	4030/4040	4060/4070	4090/4100
Wire break	4020	4050	4080	4110

The table below shows related parameter numbers when M16 is placed in slot 8:

Input type	Multi-input 127	Multi-input 129	Multi-input 131	Multi-input 133
4-20 mA/0-5 V/Pt100	4800/4810	4830/4840	4860/4870	4890/4900
Wire break	4820	4850	4880	4910

13.4.1 Terminal description, M16.6

Term.	Function	Technical data	Description
90	Multi-input 91	Common	Multi-input configurable: 4-20 mA/0-5 V/Pt100
91	Multi-input 91	Analogue in	
92	Multi-input 93	Common	Multi-input configurable: 4-20 mA/0-5 V/Pt100
93	Multi-input 93	Analogue in	
94	Multi-input 95	Common	Multi-input configurable: 4-20 mA/0-5 V/Pt100
95	Multi-input 95	Analogue in	
96	Multi-input 97	Common	Multi-input configurable: 4-20 mA/0-5 V/Pt100
97	Multi-input 97	Analogue in	

13.4.2 Terminal description, M16.8

Term.	Function	Technical data	Description
126	Multi-input 127	Common	Configurable: 4-20 mA/0-5 V/Pt100
127	Multi-input 127	Analog in	
128	Multi-input 129	Common	Configurable: 4-20 mA/0-5 V/Pt100
129	Multi-input 129	Analog in	
130	Multi-input 131	Common	Configurable: 4-20 mA/0-5 V/Pt100
131	Multi-input 131	Analog in	
132	Multi-input 133	Common	Configurable: 4-20 mA/0-5 V/Pt100
133	Multi-input 133	Analog in	

Please refer to the Installation Instructions for wiring of the different types of sensors.

13.4.3 Multi-input selections option M16.6

Parameter	Item	Range	Default	Notes
11120 Multi-input configuration 91				
11120	Multi-input confguration 91	4-20 mA Pt100	0-5V DC	Possible selections: 4-20 mA 0-5V DC Pt100
11130 Multi-input configuration 93				
11130	Multi-input confguration 93	4-20 mA Pt100	0-5V DC	Possible selections: 4-20 mA 0-5V DC Pt100
11140 Multi-input configuration 95				
11140	Multi-input confguration 95	4-20 mA Pt100	0-5V DC	Possible selections: 4-20 mA 0-5V DC Pt100
11150 Multi-input configurable 97				
11150	Multi-input confguration 97	4-20 mA Pt100	0-5V DC	Possible selections: 4-20 mA 0-5V DC Pt100

13.4.4 Parameters, analogue input setup (option M16.6)

Parameter	Item	Range	Default	Notes
4000 4-20 mA 91.1				
4001	Set point for alarm #1 to multi-input 91, 4-20 mA	4 mA 20 mA	10 mA	The value shown in this parameter group is available when 4-20 mA is selected in parameter 11120.
4002	Timer for alarm #1 to multi-input 91, 4-20 mA	0.0 s 600.0 s	120.0 s	
4003	Relay output A for alarm #1 to multi-input 91, 4-20 mA	Not used Option-dep.	Not used	
4004	Relay output B for alarm #1 to multi-input 91, 4-20 mA	Not used Option-dep.	Not used	
4005	Enables alarm #1 to multi-input 91, 4-20 mA	OFF ON	OFF	
4006	Fail class for alarm #1 to multi-input 91, 4-20 mA	F1…F8	Warning (F2)	
4000 V DC 91.1				
4001	Set point for alarm #1 to multi-input 91, 0-5 V DC	0 V 5 V	2 V	The value shown in this parameter group are available when 0-5 V is selected in parameter 11120.
4002	Timer for alarm #1 to multi-input 91, 0-5 V DC	0.0 s 600.0 s	120.0 s	
4003	Relay output A for alarm #1 to multi-input 91, 0-5 V DC	Not used Option-dep.	Not used	
4004	Relay output B for alarm #1 to multi-input 91, 0-5 V DC	Not used Option-dep.	Not used	
4005	Enables alarm #1 to multi-input 91, 0-5 V DC	OFF ON	OFF	
4006	Fail class for alarm #1 to multi-input 91, 0-5 V DC	F1…F8	Warning (F2)	
4000 Pt100 91.1				
4001	Set point for alarm #1 to multi-input 91, Pt100	-49°C 482°C	80°C	The value shown in this parameter group is available when Pt100 is selected in parameter 11120.
4002	Timer for alarm #1 to multi-input 91, Pt100	0.0 s 600.0 s	120.0 s	
4003	Relay output A for alarm #1 to multi-input 91, Pt100	Not used Option-dep.	Not used	

Parameter	Item	Range	Default	Notes
4004	Relay output B for alarm #1 to multi-input 91, Pt100	Not used Option-dep.	Not used	
4005	Enables alarm #1 to multi-input 91, Pt100	OFF ON	OFF	
4006	Fail class for alarm #1 to multi-input 91, Pt100	F1…F8	Warning (F2)	
4010 4-20 mA 91.2				
4011	Set point for alarm #2 to multi-input 91, 4-20 mA	4 mA 20 mA	10 mA	The value shown in this parameter group is available when 4-20 mA is selected in parameter 11120.
4012	Timer for alarm #2 to multi-input 91, 4-20 mA	0.0 s 600.0 s	120.0 s	
4013	Relay output A for alarm #2 to multi-input 91, 4-20 mA	Not used Option-dep.	Not used	
4014	Relay output B for alarm #2 to multi-input 91, 4-20 mA	Not used Option-dep.	Not used	
4015	Enables alarm #2 to multi-input 91, 4-20 mA	OFF ON	OFF	
4016	Fail class for alarm #2 to multi-input 91, 4-20 mA	F1…F8	Warning (F2)	
4010 V DC 91.2				
4011	Set point for alarm #2 to multi-input 91, 0-5 V DC	0 V 5 V	2 V	The value shown in this parameter group is available when 0-5 V is selected in parameter 11120.
4012	Timer for alarm #2 to multi-input 91, 0-5 V DC	0.0 s 600.0 s	120.0 s	
4013	Relay output A for alarm #2 to multi-input 91, 0-5 V DC	Not used Option-dep.	Not used	
4014	Relay output B for alarm #2 to multi-input 91, 0-5 V DC	Not used Option-dep.	Not used	
4015	Enables alarm #2 to multi-input 91, 0-5 V DC	OFF ON	OFF	
4016	Fail class for alarm #2 to multi-input 91, 0-5 V DC	F1…F8	Warning (F2)	
4010 Pt100 91.2				
4011	Set point for alarm #2 to multi-input 91, Pt100	-49°C 482°C	80°C	The value shown in this parameter group is available when Pt100 is selected in parameter 11120.

Parameter	Item	Range	Default	Notes
4012	Timer for alarm #2 to multi-input 91, Pt100	0.0 s 600.0 s	120.0 s	
4013	Relay output A for alarm #2 to multi-input 91, Pt100	Not used Option-dep.	Not used	
4014	Relay output B for alarm #2 to multi-input 91, Pt100	Not used Option-dep.	Not used	
4015	Enables alarm #2 to multi-input 91, Pt100	OFF ON	OFF	
4016	Fail class for alarm #2 to multi-input 91, Pt100	F1…F8	Warning (F2)	
4020 Wire fail 91				
4021	Wire fail detection, relay A	Not used Option-dep.	Not used	For function descriptiono of wire fail, see the Option M16 manual.
4022	Wire fail detection, relay B	Not used Option-dep.	Not used	
4023	Enables wire fail detection	OFF ON	OFF	
4024	Fail class for wire fail detection	F1…F8	Warning (F2)	
4030 4-20 mA 93.1				
4031	Set point for alarm #1 to multi-input 93, 4-20 mA	4 mA 20 mA	10 mA	The value shown in this parameter group is available when 4-20 mA is selected in parameter 11130.
4032	Timer for alarm #1 to multi-input 93, 4-20 mA	0.0 s 600.0 s	120.0 s	
4033	Relay output A for alarm #1 to multi-input 93, 4-20 mA	Not used Option-dep.	Not used	
4034	Relay output B for alarm #1 to multi-input 93, 4-20 mA	Not used Option-dep.	Not used	
4035	Enables alarm #1 to multi-input 93, 4-20 mA	OFF ON	OFF	
4036	Fail class for alarm #1 to multi-input 93, 4-20 mA	F1…F8	Warning (F2)	
4030 V DC 93.1				
4031	Set point for alarm #1 to multi-input 93, 0-5 V DC	0 V 5 V	2 V	The value shown in this parameter group is available when 0-5 V is selected in parameter 11130.
4032	Timer for alarm #1 to multi-input 93, 0-5 V DC	0.0 s 600.0 s	120.0 s	

Parameter	Item	Range	Default	Notes
4033	Relay output A for alarm #1 to multi-input 93, 0-5 V DC	Not used Option-dep.	Not used	
4034	Relay output B for alarm #1 to multi-input 93, 0-5 V DC	Not used Option-dep.	Not used	
4035	Enables alarm #1 to multi-input 93, 0-5 V DC	OFF ON	OFF	
4036	Fail class for alarm #1 to multi-input 93, 0-5 V DC	F1…F8	Warning (F2)	
4030 Pt100 93.1				
4031	Set point for alarm #1 to multi-input 93, Pt100	-49°C 482°C	80°C	The value shown in this parameter group is available when Pt100 is selected in parameter 11130.
4032	Timer for alarm #1 to multi-input 93, Pt100	0.0 s 600.0 s	120.0 s	
4033	Relay output A for alarm #1 to multi-input 93, Pt100	Not used Option-dep.	Not used	
4034	Relay output B for alarm #1 to multi-input 93, Pt100	Not used Option-dep.	Not used	
4035	Enables alarm #1 to multi-input 93, Pt100	OFF ON	OFF	
4036	Fail class for alarm #1 to multi-input 93, Pt100	F1…F8	Warning (F2)	
4040 4-20 mA 93.2				
4041	Set point for alarm #2 to multi-input 93, 4-20 mA	4 mA 20 mA	10 mA	The value shown in this parameter group is available when 4-20 mA is selected in parameter 11130.
4042	Timer for alarm #2 to multi-input 93, 4-20 mA	0.0 s 600.0 s	120.0 s	
4043	Relay output A for alarm #2 to multi-input 93, 4-20 mA	Not used Option-dep.	Not used	
4044	Relay output B for alarm #2 to multi-input 93, 4-20 mA	Not used Option-dep.	Not used	
4045	Enables alarm #2 to multi-input 93, 4-20 mA	OFF ON	OFF	
4046	Fail class for alarm #2 to multi-input 93, 4-20 mA	F1…F8	Warning (F2)	
4040 V DC 93.2				

Parameter	Item	Range	Default	Notes
4041	Set point for alarm #2 to multi-input 93, 0-5 V DC	0 V 5 V	2 V	The value shown in this parameter group is available when 0-5 V is selected in parameter 11130.
4042	Timer for alarm #2 to multi-input 93, 0-5 V DC	0.0 s 600.0 s	120.0 s	
4043	Relay output A for alarm #2 to multi-input 93, 0-5 V DC	Not used Option-dep.	Not used	
4044	Relay output B for alarm #2 to multi-input 93, 0-5 V DC	Not used Option-dep.	Not used	
4045	Enables alarm #2 to multi-input 93, 0-5 V DC	OFF ON	OFF	
4046	Fail class for alarm #2 to multi-input 93, 0-5 V DC	F1…F8	Warning (F2)	
4040 Pt100 93.2				
4041	Set point for alarm #2 to multi-input 93, Pt100	-49°C 482°C	80°C	The value shown in this parameter group is available when Pt100 is selected in parameter 11130.
4042	Timer for alarm #2 to multi-input 93, Pt100	0.0 s 600.0 s	120.0 s	
4043	Relay output A for alarm #2 to multi-input 93, Pt100	Not used Option-dep.	Not used	
4044	Relay output B for alarm #2 to multi-input 93, Pt100	Not used Option-dep.	Not used	
4045	Enables alarm #2 to multi-input 93, Pt100	OFF ON	OFF	
4046	Fail class for alarm #2 to multi-input 93, Pt100	F1…F8	Warning (F2)	
4050 Wire fail 93				
4051	Wire fail detection, relay A	Not used Option-dep.	Not used	For function description of wire fail, see the Option M16 manual.
4052	Wire fail detection, relay B	Not used Option-dep.	Not used	
4053	Enables wire fail detection	OFF ON	OFF	
4054	Fail class for wire fail detection	F1…F8	Warning (F2)	
4060 4-20 mA 95.1				

Pa-rame-ter	Item	Range	Default	Notes
4061	Set point for alarm #1 to multi-input 95, 4-20 mA	4 mA 20 mA	10 mA	The value shown in this parameter group is available when 4-20 mA is selected in parameter 11140.
4062	Timer for alarm #1 to multi-input 95, 4-20 mA	0.0 s 600.0 s	120.0 s	
4063	Relay output A for alarm #1 to multi-input 95, 4-20 mA	Not used Option-dep.	Not used	
4064	Relay output B for alarm #1 to multi-input 95, 4-20 mA	Not used Option-dep.	Not used	
4065	Enables alarm #1 to multi-input 95, 4-20 mA	OFF ON	OFF	
4066	Fail class for alarm #1 to multi-input 95, 4-20 mA	F1…F8	Warning (F2)	
4060 V DC 95.1				
4061	Set point for alarm #1 to multi-input 95, 0-5 V DC	0 V 5 V	2 V	The value shown in this parameter group are available when 0-5 V is selected in parameter 11140.
4062	Timer for alarm #1 to multi-input 95, 0-5 V DC	0.0 s 600.0 s	120.0 s	
4063	Relay output A for alarm #1 to multi-input 95, 0-5 V DC	Not used Option-dep.	Not used	
4064	Relay output B for alarm #1 to multi-input 95, 0-5 V DC	Not used Option-dep.	Not used	
4065	Enables alarm #1 to multi-input 95, 0-5 V DC	OFF ON	OFF	
4066	Fail class for alarm #1 to multi-input 95, 0-5 V DC	F1…F8	Warning (F2)	
4060 Pt100 95.1				
4061	Set point for alarm #1 to multi-input 95, Pt100	-49°C 482°C	80°C	The value shown in this parameter group is available when Pt100 is selected in parameter 11140.
4062	Timer for alarm #1 to multi-input 95, Pt100	0.0 s 600.0 s	120.0 s	
4063	Relay output A for alarm #1 to multi-input 95, Pt100	Not used Option-dep.	Not used	
4064	Relay output B for alarm #1 to multi-input 95, Pt100	Not used Option-dep.	Not used	

Parameter	Item	Range	Default	Notes
4065	Enables alarm #1 to multi-input 95, Pt100	OFF ON	OFF	
4066	Fail class for alarm #1 to multi-input 95, Pt100	F1…F8	Warning (F2)	
4070 4-20 mA 95.2				
4071	Set point for alarm #2 to multi-input 95, 4-20 mA	4 mA 20 mA	10 mA	The value shown in this parameter group is available when 4-20 mA is selected in parameter 11140.
4072	Timer for alarm #2 to multi-input 95, 4-20 mA	0.0 s 600.0 s	120.0 s	
4073	Relay output A for alarm #2 to multi-input 95, 4-20 mA	Not used Option-dep.	Not used	
4074	Relay output B for alarm #2 to multi-input 95, 4-20 mA	Not used Option-dep.	Not used	
4075	Enables alarm #2 to multi-input 95, 4-20 mA	OFF ON	OFF	
4076	Fail class for alarm #2 to multi-input 95, 4-20 mA	F1…F8	Warning (F2)	
4070 V DC 95.2				
4071	Set point for alarm #2 to multi-input 95, 0-5 V DC	0 V 5 V	2 V	The value shown in this parameter group is available when 0-5 V is selected in parameter 11140.
4072	Timer for alarm #2 to multi-input 95, 0-5 V DC	0.0 s 600.0 s	120.0 s	
4073	Relay output A for alarm #2 to multi-input 95, 0-5 V DC	Not used Option-dep.	Not used	
4074	Relay output B for alarm #2 to multi-input 95, 0-5 V DC	Not used Option-dep.	Not used	
4075	Enables alarm #2 to multi-input 95, 0-5 V DC	OFF ON	OFF	
4076	Fail class for alarm #2 to multi-input 95, 0-5 V DC	F1…F8	Warning (F2)	
4070 Pt100 95.2				
4071	Set point for alarm #2 to multi-input 95, Pt100	-49°C 482°C	80°C	The value shown in this parameter group is available when Pt100 is selected in parameter 11140.
4072	Timer for alarm #2 to multi-input 95, Pt100	0.0 s 600.0 s	120.0 s	

Parameter	Item	Range	Default	Notes
4073	Relay output A for alarm #2 to multi-input 95, Pt100	Not used Option-dep.	Not used	
4074	Relay output B for alarm #2 to multi-input 95, Pt100	Not used Option-dep.	Not used	
4075	Enables alarm #2 to multi-input 95, Pt100	OFF ON	OFF	
4076	Fail class for alarm #2 to multi-input 95, Pt100	F1…F8	Warning (F2)	
4080 Wire fail 95				
4081	Wire fail detection, relay A	Not used Option-dep.	Not used	For function descriptiono of wire fail, see the Option M16 manual.
4082	Wire fail detection, relay B	Not used Option-dep.	Not used	
4083	Enables wire fail detection	OFF ON	OFF	
4084	Fail class for wire fail detection	F1…F8	Warning (F2)	
4090 4-20 mA 97.1				
4091	Set point for alarm #1 to multi-input 97, 4-20 mA	4 mA 20 mA	10 mA	The value shown in this parameter group is available when 4-20 mA is selected in parameter 11140.
4092	Timer for alarm #1 to multi-input 97, 4-20 mA	0.0 s 600.0 s	120.0 s	
4093	Relay output A for alarm #1 to multi-input 97, 4-20 mA	Not used Option-dep.	Not used	
4094	Relay output B for alarm #1 to multi-input 97, 4-20 mA	Not used Option-dep.	Not used	
4095	Enables alarm #1 to multi-input 97, 4-20 mA	OFF ON	OFF	
4096	Fail class for alarm #1 to multi-input 97, 4-20 mA	F1…F8	Warning (F2)	
4090 V DC 97.1				
4091	Set point for alarm #1 to multi-input 97, 0-5 V DC	0 V 5 V	2 V	The value shown in this parameter group are available when 0-5 V is selected in parameter 11150.
4092	Timer for alarm #1 to multi-input 97, 0-5 V DC	0.0 s 600.0 s	120.0 s	

Parameter	Item	Range	Default	Notes
4093	Relay output A for alarm #1 to multi-input 97, 0-5 V DC	Not used Option-dep.	Not used	
4094	Relay output B for alarm #1 to multi-input 97, 0-5 V DC	Not used Option-dep.	Not used	
4095	Enables alarm #1 to multi-input 97, 0-5 V DC	OFF ON	OFF	
4096	Fail class for alarm #1 to multi-input 97, 0-5 V DC	F1…F8	Warning (F2)	
4090 Pt100 97.1				
4091	Set point for alarm #1 to multi-input 97, Pt100	-49°C 482°C	80°C	The value shown in this parameter group is available when Pt100 is selected in parameter 11150.
4092	Timer for alarm #1 to multi-input 97, Pt100	0.0 s 600.0 s	120.0 s	
4093	Relay output A for alarm #1 to multi-input 97, Pt100	Not used Option-dep.	Not used	
4094	Relay output B for alarm #1 to multi-input 97, Pt100	Not used Option-dep.	Not used	
4095	Enables alarm #1 to multi-input 97, Pt100	OFF ON	OFF	
4096	Fail class for alarm #1 to multi-input 97, Pt100	F1…F8	Warning (F2)	
4100 4-20 mA 97.2				
4101	Set point for alarm #2 to multi-input 97, 4-20 mA	4 mA 20 mA	10 mA	The value shown in this parameter group is available when 4-20 mA is selected in parameter 11150.
4102	Timer for alarm #2 to multi-input 97, 4-20 mA	0.0 s 600.0 s	120.0 s	
4103	Relay output A for alarm #2 to multi-input 97, 4-20 mA	Not used Option-dep.	Not used	
4104	Relay output B for alarm #2 to multi-input 97, 4-20 mA	Not used Option-dep.	Not used	
4105	Enables alarm #2 to multi-input 97, 4-20 mA	OFF ON	OFF	
4106	Fail class for alarm #2 to multi-input 97, 4-20 mA	F1…F8	Warning (F2)	
4100 V DC 97.2				

Parameter	Item	Range	Default	Notes
4101	Set point for alarm #2 to multi-input 97, 0-5 V DC	0 V 5 V	2 V	The value shown in this parameter group is available when 0-5 V is selected in parameter 11150.
4102	Timer for alarm #2 to multi-input 97, 0-5 V DC	0.0 s 600.0 s	120.0 s	
4103	Relay output A for alarm #2 to multi-input 97, 0-5 V DC	Not used Option-dep.	Not used	
4104	Relay output B for alarm #2 to multi-input 97, 0-5 V DC	Not used Option-dep.	Not used	
4105	Enables alarm #2 to multi-input 97, 0-5 V DC	OFF ON	OFF	
4106	Fail class for alarm #2 to multi-input 97, 0-5 V DC	F1…F8	Warning (F2)	
4100 Pt100 97.2				
4101	Set point for alarm #2 to multi-input 97, Pt100	-49°C 482°C	80°C	The value shown in this parameter group is available when Pt100 is selected in parameter 11150.
4102	Timer for alarm #2 to multi-input 97, Pt100	0.0 s 600.0 s	120.0 s	
4103	Relay output A for alarm #2 to multi-input 97, Pt100	Not used Option-dep.	Not used	
4104	Relay output B for alarm #2 to multi-input 97, Pt100	Not used Option-dep.	Not used	
4105	Enables alarm #2 to multi-input 97, Pt100	OFF ON	OFF	
4106	Fail class for alarm #2 to multi-input 97, Pt100	F1…F8	Warning (F2)	
4110 Wire fail 97				
4111	Wire fail detection, relay A	Not used Option-dep.	Not used	For function descriptiono of wire fail, see the Option M16 manual.
4112	Wire fail detection, relay B	Not used Option-dep.	Not used	
4113	Enables wire fail detection	OFF ON	OFF	
4114	Fail class for wire fail detection	F1…F8	Warning (F2)	

13.4.5 Multi-input selections M16.8

Parameter	Item	Range	Default	Notes
11160 Multi-input configuration 127				
11160	Multi-input confguration 127	4-20 mA Pt100	0-5V DC	Possible selections: 4-20 mA 0-5V DC Pt100
11170 Multi-input configuration 129				
11170	Multi-input confguration 129	4-20 mA Pt100	0-5V DC	Possible selections: 4-20 mA 0-5V DC Pt100
11180 Multi-input configuration 131				
11180	Multi-input confguration 131	4-20 mA Pt100	0-5V DC	Possible selections: 4-20 mA 0-5V DC Pt100
11190 Multi-input configurable 133				
11190	Multi-input confguration 133	4-20 mA Pt100	0-5V DC	Possible selections: 4-20 mA 0-5V DC Pt100

13.4.6 Parameters, analogue input setup (option M16.8)

No.	Setting	Min. Max.	Factory setting	Description
4800 4-20 mA 127.1				
4801	Set point for alarm #1 to multi-input 127, 4-20 mA	4 mA 20 mA	10 mA	The value shown in this parameter group is available when 4-20 mA is selected in parameter 11160.
4802	Timer for alarm #1 to multi-input 127, 4-20 mA	0.0 s 600.0 s	120.0 s	
4803	Relay output A for alarm #1 to multi-input 127, 4-20 mA	Not used Option-dep.	Not used	
4804	Relay output B for alarm #1 to multi-input 127, 4-20 mA	Not used Option-dep.	Not used	
4805	Enables alarm #1 to multi-input 127, 4-20 mA	OFF ON	OFF	
4806	Fail class for alarm #1 to multi-input 127, 4-20 mA	F1…F8	Warning (F2)	
4800 V DC 127.1				
4801	Set point for alarm #1 to multi-input 127, 0-5 V DC	0 V 5 V	2 V	The value shown in this parameter group are available when 0-5 V is selected in parameter 11160.
4802	Timer for alarm #1 to multi-input 127, 0-5 V DC	0.0 s 600.0 s	120.0 s	
4803	Relay output A for alarm #1 to multi-input 127, 0-5 V DC	Not used Option-dep.	Not used	
4804	Relay output B for alarm #1 to multi-input 127, 0-5 V DC	Not used Option-dep.	Not used	
4805	Enables alarm #1 to multi-input 127, 0-5 V DC	OFF ON	OFF	
4806	Fail class for alarm #1 to multi-input 127, 0-5 V DC	F1…F8	Warning (F2)	
4800 Pt100 127.1				
4801	Set point for alarm #1 to multi-input 127, Pt100	-49°C 482°C	80°C	The value shown in this parameter group is available when Pt100 is selected in parameter 11160.
4802	Timer for alarm #1 to multi-input 127, Pt100	0.0 s 600.0 s	120.0 s	
4803	Relay output A for alarm #1 to multi-input 127, Pt100	Not used Option-dep.	Not used	

No.	Setting	Min. Max.	Factory setting	Description
4804	Relay output B for alarm #1 to multi-input 127, Pt100	Not used Option-dep.	Not used	
4805	Enables alarm #1 to multi-input 127, Pt100	OFF ON	OFF	
4806	Fail class for alarm #1 to multi-input 127, Pt100	F1…F8	Warning (F2)	
4810 4-20 mA 127.2				
4811	Set point for alarm #2 to multi-input 127, 4-20 mA	4 mA 20 mA	10 mA	The value shown in this parameter group is available when 4-20 mA is selected in parameter 11160.
4812	Timer for alarm #2 to multi-input 127, 4-20 mA	0.0 s 600.0 s	120.0 s	
4813	Relay output A for alarm #2 to multi-input 127, 4-20 mA	Not used Option-dep.	Not used	
4814	Relay output B for alarm #2 to multi-input 127, 4-20 mA	Not used Option-dep.	Not used	
4815	Enables alarm #2 to multi-input 127, 4-20 mA	OFF ON	OFF	
4816	Fail class for alarm #2 to multi-input 127, 4-20 mA	F1…F8	Warning (F2)	
4810 V DC 127.2				
4811	Set point for alarm #2 to multi-input 127, 0-5 V DC	0 V 5 V	2 V	The value shown in this parameter group is available when 0-5 V is selected in parameter 11160.
4812	Timer for alarm #2 to multi-input 127, 0-5 V DC	0.0 s 600.0 s	120.0 s	
4813	Relay output A for alarm #2 to multi-input 127, 0-5 V DC	Not used Option-dep.	Not used	
4814	Relay output B for alarm #2 to multi-input 127, 0-5 V DC	Not used Option-dep.	Not used	
4815	Enables alarm #2 to multi-input 127, 0-5 V DC	OFF ON	OFF	
4816	Fail class for alarm #2 to multi-input 127, 0-5 V DC	F1…F8	Warning (F2)	
4810 Pt100 127.2				
4811	Set point for alarm #2 to multi-input 127, Pt100	-49°C 482°C	80°C	The value shown in this parameter group is available when Pt100 is selected in parameter 11160.
4812	Timer for alarm #2 to multi-input 127, Pt100	0.0 s 600.0 s	120.0 s	

No.	Setting	Min. Max.	Factory setting	Description
4813	Relay output A for alarm #2 to multi-input 127, Pt100	Not used Option-dep.	Not used	
4814	Relay output B for alarm #2 to multi-input 127, Pt100	Not used Option-dep.	Not used	
4815	Enables alarm #2 to multi-input 127, Pt100	OFF ON	OFF	
4816	Fail class for alarm #2 to multi-input 127, Pt100	F1…F8	Warning (F2)	
4820 Wire fail 127				
4821	Wire fail detection, relay A	Not used Option-dep.	Not used	For function descriptiono of wire fail, see the Option M16 manual.
4822	Wire fail detection, relay B	Not used Option-dep.	Not used	
4823	Enables wire fail detection	OFF ON	OFF	
4824	Fail class for wire fail detection	F1…F8	Warning (F2)	
4830 4-20 mA 129.1				
4831	Set point for alarm #1 to multi-input 129, 4-20 mA	4 mA 20 mA	10 mA	The value shown in this parameter group is available when 4-20 mA is selected in parameter 11170.
4832	Timer for alarm #1 to multi-input 129, 4-20 mA	0.0 s 600.0 s	120.0 s	
4833	Relay output A for alarm #1 to multi-input 129, 4-20 mA	Not used Option-dep.	Not used	
4834	Relay output B for alarm #1 to multi-input 129, 4-20 mA	Not used Option-dep.	Not used	
4835	Enables alarm #1 to multi-input 129, 4-20 mA	OFF ON	OFF	
4836	Fail class for alarm #1 to multi-input 129, 4-20 mA	F1…F8	Warning (F2)	
4830 V DC 129.1				
4831	Set point for alarm #1 to multi-input 129, 0-5 V DC	0 V 5 V	2 V	The value shown in this parameter group are available when 0-5 V is selected in parameter 11170.
4832	Timer for alarm #1 to multi-input 129, 0-5 V DC	0.0 s 600.0 s	120.0 s	
4833	Relay output A for alarm #1 to multi-input 129, 0-5 V DC	Not used Option-dep.	Not used	

No.	Setting	Min. Max.	Factory setting	Description
4834	Relay output B for alarm #1 to multi-input 129, 0-5 V DC	Not used Option-dep.	Not used	
4835	Enables alarm #1 to multi-input 129, 0-5 V DC	OFF ON	OFF	
4836	Fail class for alarm #1 to multi-input 129, 0-5 V DC	F1…F8	Warning (F2)	
4830 Pt100 129.1				
4831	Set point for alarm #1 to multi-input 129, Pt100	-49°C 482°C	80°C	The value shown in this parameter group is available when Pt100 is selected in parameter 11170.
4832	Timer for alarm #1 to multi-input 129, Pt100	0.0 s 600.0 s	120.0 s	
4833	Relay output A for alarm #1 to multi-input 129, Pt100	Not used Option-dep.	Not used	
4834	Relay output B for alarm #1 to multi-input 129, Pt100	Not used Option-dep.	Not used	
4835	Enables alarm #1 to multi-input 129, Pt100	OFF ON	OFF	
4836	Fail class for alarm #1 to multi-input 129, Pt100	F1…F8	Warning (F2)	
4840 4-20 mA 129.2				
4841	Set point for alarm #2 to multi-input 129, 4-20 mA	4 mA 20 mA	10 mA	The value shown in this parameter group is available when 4-20 mA is selected in parameter 11170.
4842	Timer for alarm #2 to multi-input 129, 4-20 mA	0.0 s 600.0 s	120.0 s	
4843	Relay output A for alarm #2 to multi-input 129, 4-20 mA	Not used Option-dep.	Not used	
4844	Relay output B for alarm #2 to multi-input 129, 4-20 mA	Not used Option-dep.	Not used	
4845	Enables alarm #2 to multi-input 129, 4-20 mA	OFF ON	OFF	
4846	Fail class for alarm #2 to multi-input 129, 4-20 mA	F1…F8	Warning (F2)	
4840 V DC 129.2				
4841	Set point for alarm #2 to multi-input 129, 0-5 V DC	0 V 5 V	2 V	The value shown in this parameter group is available when 0-5 V is selected in parameter 11170.
4842	Timer for alarm #2 to multi-input 129, 0-5 V DC	0.0 s 600.0 s	120.0 s	

No.	Setting	Min. Max.	Factory setting	Description
4843	Relay output A for alarm #2 to multi-input 129, 0-5 V DC	Not used Option-dep.	Not used	
4844	Relay output B for alarm #2 to multi-input 129, 0-5 V DC	Not used Option-dep.	Not used	
4845	Enables alarm #2 to multi-input 129, 0-5 V DC	OFF ON	OFF	
4846	Fail class for alarm #2 to multi-input 129, 0-5 V DC	F1…F8	Warning (F2)	
4840 Pt100 129.2				
4841	Set point for alarm #2 to multi-input 129, Pt100	-49°C 482°C	80°C	The value shown in this parameter group is available when Pt100 is selected in parameter 11170.
4842	Timer for alarm #2 to multi-input 129, Pt100	0.0 s 600.0 s	120.0 s	
4843	Relay output A for alarm #2 to multi-input 129, Pt100	Not used Option-dep.	Not used	
4844	Relay output B for alarm #2 to multi-input 129, Pt100	Not used Option-dep.	Not used	
4845	Enables alarm #2 to multi-input 129, Pt100	OFF ON	OFF	
4846	Fail class for alarm #2 to multi-input 129, Pt100	F1…F8	Warning (F2)	
4850 Wire fail 129				
4851	Wire fail detection, relay A	Not used Option-dep.	Not used	For function descriptiono of wire fail, see the Option M16 manual.
4852	Wire fail detection, relay B	Not used Option-dep.	Not used	
4853	Enables wire fail detection	OFF ON	OFF	
4854	Fail class for wire fail detection	F1…F8	Warning (F2)	
4860 4-20 mA 131.1				
4861	Set point for alarm #1 to multi-input 131, 4-20 mA	4 mA 20 mA	10 mA	The value shown in this parameter group is available when 4-20 mA is selected in parameter 11180.
4862	Timer for alarm #1 to multi-input 131, 4-20 mA	0.0 s 600.0 s	120.0 s	
4863	Relay output A for alarm #1 to multi-input 131, 4-20 mA	Not used Option-dep.	Not used	

No.	Setting	Min. Max.	Factory setting	Description
4864	Relay output B for alarm #1 to multi-input 131, 4-20 mA	Not used Option-dep.	Not used	
4865	Enables alarm #1 to multi-input 131, 4-20 mA	OFF ON	OFF	
4866	Fail class for alarm #1 to multi-input 131, 4-20 mA	F1…F8	Warning (F2)	
4860 V DC 131.1				
4861	Set point for alarm #1 to multi-input 131, 0-5 V DC	0 V 5 V	2 V	The value shown in this parameter group are available when 0-5 V is selected in parameter 11180.
4862	Timer for alarm #1 to multi-input 131, 0-5 V DC	0.0 s 600.0 s	120.0 s	
4863	Relay output A for alarm #1 to multi-input 131, 0-5 V DC	Not used Option-dep.	Not used	
4864	Relay output B for alarm #1 to multi-input 131, 0-5 V DC	Not used Option-dep.	Not used	
4865	Enables alarm #1 to multi-input 131, 0-5 V DC	OFF ON	OFF	
4866	Fail class for alarm #1 to multi-input 131, 0-5 V DC	F1…F8	Warning (F2)	
4860 Pt100 131.1				
4861	Set point for alarm #1 to multi-input 131, Pt100	-49°C 482°C	80°C	The value shown in this parameter group is available when Pt100 is selected in parameter 11180.
4862	Timer for alarm #1 to multi-input 131, Pt100	0.0 s 600.0 s	120.0 s	
4863	Relay output A for alarm #1 to multi-input 131, Pt100	Not used Option-dep.	Not used	
4864	Relay output B for alarm #1 to multi-input 131, Pt100	Not used Option-dep.	Not used	
4865	Enables alarm #1 to multi-input 131, Pt100	OFF ON	OFF	
4866	Fail class for alarm #1 to multi-input 131, Pt100	F1…F8	Warning (F2)	
4870 4-20 mA 131.2				
4871	Set point for alarm #2 to multi-input 131, 4-20 mA	4 mA 20 mA	10 mA	The value shown in this parameter group is available when 4-20 mA is selected in parameter 11180.
4872	Timer for alarm #2 to multi-input 131, 4-20 mA	0.0 s 600.0 s	120.0 s	

No.	Setting	Min. Max.	Factory setting	Description
4873	Relay output A for alarm #2 to multi-input 131, 4-20 mA	Not used Option-dep.	Not used	
4874	Relay output B for alarm #2 to multi-input 131, 4-20 mA	Not used Option-dep.	Not used	
4875	Enables alarm #2 to multi-input 131, 4-20 mA	OFF ON	OFF	
4876	Fail class for alarm #2 to multi-input 131, 4-20 mA	F1…F8	Warning (F2)	
4870 V DC 131.2				
4871	Set point for alarm #2 to multi-input 131, 0-5 V DC	0 V 5 V	2 V	The value shown in this parameter group is available when 0-5 V is selected in parameter 11180.
4872	Timer for alarm #2 to multi-input 131, 0-5 V DC	0.0 s 600.0 s	120.0 s	
4873	Relay output A for alarm #2 to multi-input 131, 0-5 V DC	Not used Option-dep.	Not used	
4874	Relay output B for alarm #2 to multi-input 131, 0-5 V DC	Not used Option-dep.	Not used	
4875	Enables alarm #2 to multi-input 131, 0-5 V DC	OFF ON	OFF	
4876	Fail class for alarm #2 to multi-input 131, 0-5 V DC	F1…F8	Warning (F2)	
4870 Pt100 131.2				
4871	Set point for alarm #2 to multi-input 131, Pt100	-49°C 482°C	80°C	The value shown in this parameter group is available when Pt100 is selected in parameter 11180.
4872	Timer for alarm #2 to multi-input 131, Pt100	0.0 s 600.0 s	120.0 s	
4873	Relay output A for alarm #2 to multi-input 131, Pt100	Not used Option-dep.	Not used	
4874	Relay output B for alarm #2 to multi-input 131, Pt100	Not used Option-dep.	Not used	
4875	Enables alarm #2 to multi-input 131, Pt100	OFF ON	OFF	
4876	Fail class for alarm #2 to multi-input 131, Pt100	F1…F8	Warning (F2)	
4880 Wire fail 131				

No.	Setting	Min. Max.	Factory setting	Description
4881	Wire fail detection, relay A	Not used Option-dep.	Not used	For function descriptiono of wire fail, see the Option M16 manual.
4882	Wire fail detection, relay B	Not used Option-dep.	Not used	
4883	Enables wire fail detection	OFF ON	OFF	
4884	Fail class for wire fail detection	F1…F8	Warning (F2)	
4860 4-20 mA 131.1				
4861	4-20 mA 131.1	4 mA 20 mA	10 mA	The value shown in this parameter group is available when 4-20 mA is selected in parameter 11180.
4862	4-20 mA 131.1	0.0 s 600.0 s	120.0 s	
4863	4-20 mA 131.1	Not used Option-dep.	Not used	
4864	4-20 mA 131.1	Not used Option-dep.	Not used	
4865	4-20 mA 131.1	OFF ON	OFF	
4866	4-20 mA 131.1	F1…F8	Warning (F2)	
4860 V DC 131.1				
4861	V DC 131.1	0 V 5 V	2 V	The value shown in this parameter group is available when 0-5 V is selected in parameter 11180.
4862	V DC 131.1	0.0 s 600.0 s	120.0 s	
4863	V DC 131.1	Not used Option-dep.	Not used	
4864	V DC 131.1	Not used Option-dep.	Not used	
4865	V DC 131.1	OFF ON	OFF	
4866	V DC 131.1	F1…F8	Warning (F2)	
4860 Pt100 131.1				
4861	Pt100 131.1	-49°C 482°C	80°C	The value shown in this parameter group is available when Pt100 is selected in parameter 11180.
4862	Pt100 131.1	0.0 s 600.0 s	120.0 s	
4863	Pt100 131.1	Not used Option-dep.	Not used	

No.	Setting	Min. Max.	Factory setting	Description
4864	Pt100 131.1	Not used Option-dep.	Not used	
4865	Pt100 131.1	OFF ON	OFF	
4866	Pt100 131.1	F1…F8	Warning (F2)	
4870 4-20 mA 131.2				
4871	4-20 mA 131.2	4 mA 20 mA	10 mA	The value shown in this parameter group is available when 4-20 mA is selected in parameter 11180.
4872	4-20 mA 131.2	0.0 s 600.0 s	120.0 s	
4873	4-20 mA 131.2	Not used Option-dep.	Not used	
4874	4-20 mA 131.2	Not used Option-dep.	Not used	
4875	4-20 mA 131.2	OFF ON	OFF	
4876	4-20 mA 131.2	F1…F8	Warning (F2)	
4870 V DC 131.2				
4871	V DC 131.2	0 V 5 V	2 V	The value shown in this parameter group is available when 0-5 V is selected in parameter 11180.
4872	V DC 131.2	0.0 s 600.0 s	120.0 s	
4873	V DC 131.2	Not used Option-dep.	Not used	
4874	V DC 131.2	Not used Option-dep.	Not used	
4875	V DC 131.2	OFF ON	OFF	
4876	V DC 131.2	F1…F8	Warning (F2)	
4870 Pt100 131.2				
4871	Pt100 131.2	-49°C 482°C	80°C	The value shown in this parameter group is available when Pt100 is selected in parameter 11180.
4872	Pt100 131.2	0.0 s 600.0 s	120.0 s	
4873	Pt100 131.2	Not used Option-dep.	Not used	
4874	Pt100 131.2	Not used Option-dep.	Not used	

No.	Setting	Min. Max.	Factory setting	Description
4875	Pt100 131.2	OFF ON	OFF	
4876	Pt100 131.2	F1…F8	Warning (F2)	
4890 4-20 mA 133.1				
4891	Set point for alarm #1 to multi-input 133, 4-20 mA	4 mA 20 mA	10 mA	The value shown in this parameter group is available when 4-20 mA is selected in parameter 11120.
4892	Timer for alarm #1 to multi-input 133, 4-20 mA	0.0 s 600.0 s	120.0 s	
4893	Relay output A for alarm #1 to multi-input 133, 4-20 mA	Not used Option-dep.	Not used	
4894	Relay output B for alarm #1 to multi-input 133, 4-20 mA	Not used Option-dep.	Not used	
4895	Enables alarm #1 to multi-input 133, 4-20 mA	OFF ON	OFF	
4896	Fail class for alarm #1 to multi-input 133, 4-20 mA	F1…F8	Warning (F2)	
4890 V DC 133.1				
4891	Set point for alarm #1 to multi-input 133, 0-5 V DC	0 V 5 V	2 V	The value shown in this parameter group are available when 0-5 V is selected in parameter 11120.
4892	Timer for alarm #1 to multi-input 133, 0-5 V DC	0.0 s 600.0 s	120.0 s	
4893	Relay output A for alarm #1 to multi-input 133, 0-5 V DC	Not used Option-dep.	Not used	
4894	Relay output B for alarm #1 to multi-input 133, 0-5 V DC	Not used Option-dep.	Not used	
4895	Enables alarm #1 to multi-input 133, 0-5 V DC	OFF ON	OFF	
4896	Fail class for alarm #1 to multi-input 133, 0-5 V DC	F1…F8	Warning (F2)	
4890 Pt100 133.1				
4891	Set point for alarm #1 to multi-input 133, Pt100	-49°C 482°C	80°C	The value shown in this parameter group is available when Pt100 is selected in parameter 11120.
4892	Timer for alarm #1 to multi-input 133, Pt100	0.0 s 600.0 s	120.0 s	
4893	Relay output A for alarm #1 to multi-input 133, Pt100	Not used Option-dep.	Not used	

No.	Setting	Min. Max.	Factory setting	Description
4894	Relay output B for alarm #1 to multi-input 133, Pt100	Not used Option-dep.	Not used	
4895	Enables alarm #1 to multi-input 133, Pt100	OFF ON	OFF	
4896	Fail class for alarm #1 to multi-input 133, Pt100	F1…F8	Warning (F2)	
4900 4-20 mA 133.2				
4901	Set point for alarm #2 to multi-input 133, 4-20 mA	4 mA 20 mA	10 mA	The value shown in this parameter group is available when 4-20 mA is selected in parameter 11120.
4902	Timer for alarm #2 to multi-input 133, 4-20 mA	0.0 s 600.0 s	120.0 s	
4903	Relay output A for alarm #2 to multi-input 133, 4-20 mA	Not used Option-dep.	Not used	
4904	Relay output B for alarm #2 to multi-input 133, 4-20 mA	Not used Option-dep.	Not used	
4905	Enables alarm #2 to multi-input 133, 4-20 mA	OFF ON	OFF	
4906	Fail class for alarm #2 to multi-input 133, 4-20 mA	F1…F8	Warning (F2)	
4900 V DC 133.2				
4901	Set point for alarm #2 to multi-input 133, 0-5 V DC	0 V 5 V	2 V	The value shown in this parameter group is available when 0-5 V is selected in parameter 11120.
4902	Timer for alarm #2 to multi-input 133, 0-5 V DC	0.0 s 600.0 s	120.0 s	
4903	Relay output A for alarm #2 to multi-input 133, 0-5 V DC	Not used Option-dep.	Not used	
4904	Relay output B for alarm #2 to multi-input 133, 0-5 V DC	Not used Option-dep.	Not used	
4905	Enables alarm #2 to multi-input 133, 0-5 V DC	OFF ON	OFF	
4906	Fail class for alarm #2 to multi-input 133, 0-5 V DC	F1…F8	Warning (F2)	
4900 Pt100 133.2				
4901	Set point for alarm #2 to multi-input 133, Pt100	-49°C 482°C	80°C	The value shown in this parameter group is available when Pt100 is selected in parameter 11120.
4902	Timer for alarm #2 to multi-input 133, Pt100	0.0 s 600.0 s	120.0 s	

No.	Setting	Min. Max.	Factory setting	Description
4903	Relay output A for alarm #2 to multi-input 133, Pt100	Not used Option-dep.	Not used	
4904	Relay output B for alarm #2 to multi-input 133, Pt100	Not used Option-dep.	Not used	
4905	Enables alarm #2 to multi-input 133, Pt100	OFF ON	OFF	
4906	Fail class for alarm #2 to multi-input 133, Pt100	F1…F8	Warning (F2)	
4910 Wire fail 133				
4911	Wire fail detection, relay A	Not used Option-dep.	Not used	For function descriptiono of wire fail, see the Option M16 manual.
4912	Wire fail detection, relay B	Not used Option-dep.	Not used	
4913	Enables wire fail detection	OFF ON	OFF	
4914	Fail class for wire fail detection	F1…F8	Warning (F2)	

14. Relay outputs

14.1 Relay outputs and explanations

14.1.1 Standard relay outputs in the AGC PM

In the following, all standard relay outputs of the AGC PM are described.

The AGC PM has 16 x relay outputs as standard.

Status output relay:
When AGC PM is used as genset/group/plant/mains unit:
Reserved for supervision of power supply/processor status
24 V DC/1 A
Normally closed relay.

Relay 05:
Reserved for central alarm "Horn relay" as standard
250 V AC/5 A
Configurable as: Alarm relay ND*/Limit relay/Horn relay/Siren relay/Alarm relay NE*.
When the relay is closed, the unit status is OK.

Relay 08:
When AGC PM is used as genset/group unit:
250 V AC/5 A
Configurable as: Alarm relay ND*/Limit relay/Horn relay/Siren relay/Alarm relay NE*.

When AGC PM is used as plant/mains unit:
250 V AC/5 A
Reserved for "Open mains breaker".

Relay 11:
When AGC PM is used as genset/group unit:
250 V AC/5 A
Configurable as: Alarm relay ND*/Limit relay/Horn relay/Siren relay/Alarm relay NE*.

When AGC PM is used as plant/mains unit:
250 V AC/5 A
Reserved for "Close mains breaker (sync.)".

Relay 14:
When AGC PM is used as genset unit:
250 V AC/5 A
Reserved for "Open generator breaker".

When AGC PM is used as group/mains unit:
250 V AC/5 A
Reserved for "Open tie breaker"/configurable.

When AGC PM is used as plant unit:
250 V AC/5 A
Configurable as: Alarm relay ND*/Limit relay/Horn relay/Siren relay/Alarm relay NE*.

Relay 17:
When AGC PM is used as genset unit:
250 V AC/5 A
Reserved for "Close generator breaker (sync.)".

When AGC PM is used as group/mains unit:
250 V AC/5 A
Reserved for "Close tie breaker (sync.)"/configurable.

When AGC PM is used as plant unit:
250 V AC/5 A
Configurable as: Alarm relay ND*/Limit relay/Horn relay/Siren relay/Alarm relay NE*.

Relay 20:
When AGC PM is used as genset/group/plant/mains unit:
Reserved for transistor output.
Pulse output 1
kWh counter/configurable
This relay is only available if "Relay" is selected in menu 5271.
Max 36 V DC/10 mA.

Relay 21:
When AGC PM is used as genset/group/plant/mains unit:
Reserved for transistor output.
Pulse output 2.
kvarh counter/configurable.
This relay is only available if "Relay" is selected in menu 5272.
Max 36 V DC/10 mA.

Relay 57, relay 59, relay 61 and relay 63:
When AGC PM is used as genset/group/plant/mains unit:
250V AC/5 A.
Configurable as: Alarm relay ND*/Limit relay/Horn relay/Siren relay/Alarm relay NE*.

Relay 119:
When AGC PM is used as genset unit:
24 V DC/5 A.
Reserved for "Run coil".

When AGC PM is used as plant/group/mains unit:
Not used.

Relay 120:
When AGC PM is used as genset unit:
24 V DC/5 A.
Reserved for "Start prepare".

When AGC PM is used as plant/group/mains unit:
Not used.

Relay 122:
When AGC PM is used as genset unit:
24 V DC/5 A.

Reserved for starter "Crank".

When AGC PM is used as plant/group/mains unit:
Not used.

Relay 124:
When AGC PM is used as genset unit:
24 V DC/5 A.
Reserved for starter "Stop coil w/wire failure detection".

When AGC PM is used as plant/group/mains unit:
Not used.

*ND (Normally De-energised),*NE (Normally Energised)

14.1.2 Optional relay outputs (option M14.x)

The AGC PM can be extended with an option M14, which is a hardware option.
It is a separate PCB and must be installed in addition to the standard installed hardware.
In the following, all relay outputs related to the various M14 options are described.

M14.2:
The following optional relay outputs relate to option M14.2
4 x relay outputs, all 250 V AC/5 A, all configurable.
The option M14.2 holds: relay 29, relay 31, relay 33 and relay 35.

M14.4:
The following optional relay outputs relate to option M14.4.
4 x relay outputs, all 250 V AC/5 A, all configurable.
The option M14.4 holds: relay 65, relay 67, relay 69 and relay 71.

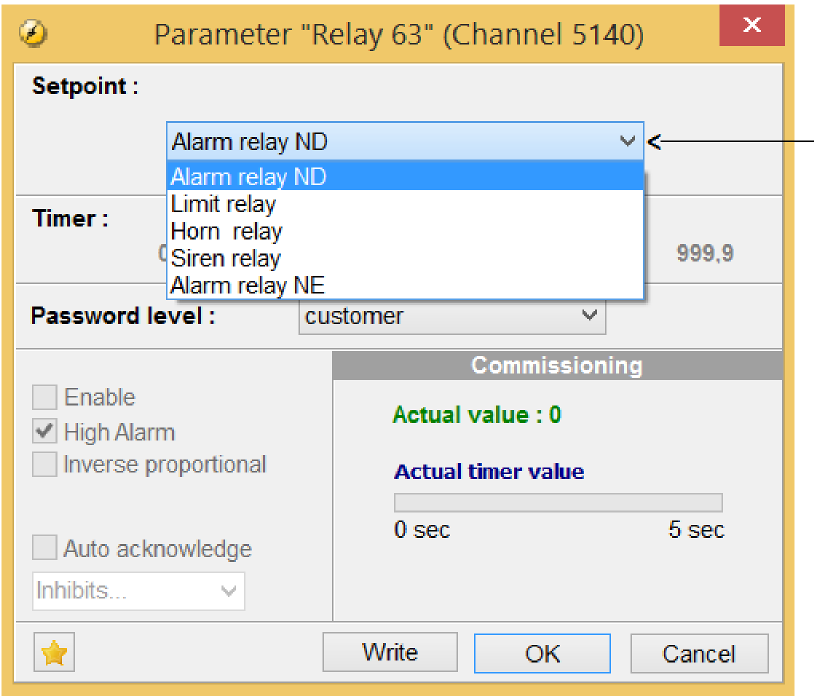
M14.6:
The following optional relay outputs relate to option M14.6.
4 x relay outputs, all 250 V AC/5 A, all configurable.
The option M14.6 holds: relay 90, relay 92, relay 94 and relay 96.

M14.8:
The following optional relay outputs relate to option M14.8.
4 x relay outputs, all 250 V AC/5 A, all configurable.
The option M14.8 holds: relay 126, relay 128, relay 130 and relay 132.

14.1.3 Configuration of relay outputs

Description for relay output selection:

Example: Relay 63



The AGC PM has relays inside the controller at different outputs (relay outputs) which can be used for controlling electrical components, for example mains breakers, generator breakers or other activators.
Some of these relay outputs are reserved. For example "Relay 14", which is reserved for control of the breaker "Open generator breaker".
Some of the relays are free configurable. For example "Relay 63".
The screenshot above shows the different selections for "Relay 63" as an example.
In the utility software with parameter 5140 under "Setpoint", it is possible to select different relay types for "Relay 63".

In the following, the configuration for "Relay 63" is described. The configuration for all other configurable relay outputs is the same.

Alarm relay ND
The related relay (for example "Relay 63") is used as an alarm relay of "ND" (Normally De-energised) type.
The relay is activated until the alarm that caused the activation is acknowledged and gone.
The alarm LED is flashing or constant, depending on the acknowledged state.

Limit relay
The related relay (for example "Relay 63") will activate at the limit set point. No alarm will appear when both outputs (OA/OB) of the alarm are adjusted to the limit relay. After the condition activating this relay has returned to normal, the relay will deactivate when the "OFF delay" has expired. The OFF delay is adjustable.
An output relay should be configured as a limit relay. Otherwise, an alarm will be raised whenever the output is activated

Horn relay
All configurable relays can be selected to be a horn output (horn relay).

This means that for example the "Relay 63" can be connected to an alarm annunciator, for example a horn. By selection of "Horn relay" for "Relay 63", every time a new alarm occurs, an external horn gets activated. If the "Timer" is adjusted to 0 seconds, the horn remains activated until the alarm is acknowledged. In case the adjusted "Timer" delay differs from 0 seconds, the "Horn relay" output resets itself after the adjusted "Timer" delay has expired even though the alarm is still present.

Siren relay

By this selection, an external siren gets activated on all alarms like selection "Horn relay". When the siren relay is activated, and another alarm is active, a short-time reset will be activated. In case the "Timer" is adjusted to 0 seconds, the siren relay remains activated until all alarms are acknowledged.

Alarm relay NE

The related relay (for example "Relay 63") is used as an alarm relay of "NE" (Normally energised) type. The relay is deactivated until the alarm that caused the deactivation is acknowledged and gone. The alarm LED is flashing or constant, depending on the acknowledged state.

15. Analogue outputs for regulation (option E variants)

15.1 Introduction

15.1.1 Introduction

Option E variants are hardware options. Each option is a separate PCB that is installed in slot #4.

The analogue outputs are active and galvanically separated. No external supply can be connected.

The following table shows the available options regarding transducer outputs.

Option	Description	Comment
E1	2 x +/- 25 mA out	
E2	2 x 0(4)...20 mA out	
EF2	1 x +/- 25 mA out; 1 x 0(4)...20 mA out	
EF4	1 x +/- 25 mA out; 2x relay outputs	
EF6	2 x +/- 25 mA out; 1 x PWM out	

The current outputs can be converted to any voltage in the range inside +/-10 V DC by mounting a resistor across the terminals.

Example: A 200 Ω resistor across the terminals of the +/-25 mA output will supply a range of +/-5 V DC.

The choice of resistor depends on the specific governor. Please refer to the DEIF document "Interfacing DEIF Equipment with Governors and AVRs"

Place the resistor at the governor/AVR end to prevent the signal from being disturbed by noise.

15.2 ANSI numbers

Function	ANSI no.
Selectable +/-25 mA or relay output for speed control (governor)	77
Selectable +/-25 mA or relay output for voltage control (AVR)	77
PWM speed control output for CAT® engines	77
1 x 0(4)-20 mA outputs	77
2 x 0(4)-20 mA outputs	77

15.3 Option E1

Option E1 consists of two analogue outputs. They can be used to control the governor output and AVR output or indicate voltage, frequency, power and so on.

15.3.1 Terminal description

Term.	Function	Description
65	Not used	
66	+/-25 mA	Speed governor, AVR or transducer output 66.
67	0	
68	Not used	
69	Not used	
70	+/-25 mA	Speed governor, AVR or transducer output 71.
71	0	
72	Not used	

15.3.2 Related parameters

Parameters 5820-5970 deal with setting the analogue outputs indicating a value; for example generated power, frequency and so on. This is described in "Transducer outputs".
Below is shown a table for the parameters limiting the transducer output range. An explanation of this can be found in "Limits" later in this chapter.

Parameter	Item	Range	Default	Notes
5781	AOUT 66 Limits	-25 mA...10 mA	-20 mA	Here you choose the minimum level.
5782	AOUT 66 Limits	10 mA...25 mA	20 mA	Here you choose the maximum level.
5791	AOUT 71 Limits	25 mA...10 mA	-20 mA	Here you choose the minimum level.
5792	AOUT 71 Limits	10 mA...25 mA	20 mA	Here you choose the maximum level.
5981	Governor output	Disabled, Transducer 66, Transducer 71	Disabled	Here you choose the output.
5991	AVR output	Disabled, Transducer 66, Transducer 71	Disabled	Here you choose the output.

In parameter 5980 and 5990, you can choose to use analogue output for governor and AVR control.

15.4 Option E2

Option E2 is a hardware option, and a separate PCB is installed in slot #4.

15.4.1 Terminal description

Term.	Function	Description
65	Not used	
66	0(4)-20 mA	Speed governor, AVR or transducer output 66.
67	0	
68	Not used	
69	Not used	
70	0(4)-20 mA	Speed governor, AVR or transducer output 71.
71	0	
72	Not used	

Transducer outputs are 0(4)-20 mA outputs.

15.4.2 Related parameters

Parameters 5820-5970 deal with setting the analogue outputs indicating a value; e.g. generated power, frequency and so on. This is described in "Transducer outputs" located in the "Mutual parameters" chapter. Below is shown a table for the parameters limiting the transducer output range. An explanation of this can be found in "Limits" later in this chapter.

Parameter	Item	Range	Default	Notes
5781	AOUT 66 Limits	0 mA...10 mA	0 mA	Here you choose the minimum level.
5782	AOUT 66 Limits	10 mA 20 mA	20 mA	Here you choose the maximum level.
5791	AOUT 71 Limits	0 mA...10 mA	0 mA	Here you choose the minimum level.
5792	AOUT 71 Limits	10 mA...20 mA	20 mA	Here you choose the maximum level.
5981	Governor output	Disabled, Transducer 66, Transducer 71.	Disabled	Here you choose the output.
5991	AVR output	Disabled, Transducer 66, Transducer 71.	Disabled	Here you choose the output.

In parameter 5980 and 5990, you can choose to use analogue output for governor and AVR control.

15.5 Option EF2

Option EF2 is a hardware option, and a separate PCB is installed in the slot #4.

15.5.1 Terminal description

Term.	Function	Description
65	Not used	
66	+/-25 mA	Speed governor, AVR or transducer output 66.
67	0	
68	Not used	
69	Not used	
70	0(4)-20 mA	Speed governor, AVR or transducer output 71.
71	0	
72	Not used	

15.5.2 Related parameters

Parameters 5820-5970 deal with setting the analogue outputs indicating a value; for example generated power, frequency and so on. This is described in "Transducer outputs" located in the "Mutual parameters" chapter.
Below is shown a table for the parameters limiting the transducer output range. An explanation of this can be found in "Limits" later in this chapter.

Parameter	Item	Range	Default	Notes
5781	AOUT 66 Limits	-25 mA...10 mA	-20 mA	Here you choose the minimum level.
5782	AOUT 66 Limits	0 mA...20 mA	20 mA	Here you choose the maximum level.
5791	AOUT 71 Limits	0 mA...10 mA	0 mA	Here you choose the minimum level.
5792	AOUT 71 Limits	10 mA...20 mA	20 mA	Here you choose the maximum level.
5981	Governor output	Disabled, Transducer 66, Transducer 71.	Disabled	Here you choose the output.
5991	AVR output	Disabled, Transducer 66, Transducer 71.	Disabled	Here you choose the output.

In parameter 5980 and 5990, you can choose to use analogue output for governor and AVR control.

15.6 Option EF4

15.6.1 Option EF4

Option EF4 is a hardware option, and a separate PCB is installed in the slot #4.

15.6.2 Terminal description

Term.	Function	Description
65	+/-25 mA	Speed governor, AVR or transducer output 66.
66	0	
67	Not used	
68	Not used	
69	Relay 69	Speed governor, AVR or configurable.
70		
71	Relay 71	Speed governor, AVR or configurable.
72		

Transducer outputs are 0(4)-20 mA outputs.

AVR control requires option D1.

15.6.3 Related parameters

Parameters 5820-5970 deal with setting the analogue outputs indicating a value; for example generated power, frequency and so on. This is described in "Transducer outputs" located in the "Mutual parameters" chapter.

Below is shown a table for the parameters limiting the transducer output range. An explanation of this can be found in "Limits" later in this chapter.

Parame-ter	Item	Range	Default	Notes
5781	AOUT 66 Limits	-25 mA...10 mA	-20 mA	Here you choose the minimum level.
5782	AOUT 66 Limits	10 mA...25 mA	20 mA	Here you choose the maximum level.
5981	Govenor output	Disabled, Transducer 66	Disabled	Here you choose the output.
5991	AVR output	Disabled, Transducer 66	Disabled	Here you choose the output.
2781	Reg. output GOV	Relay, Analogue, EIC	Analogue	
2783	Reg. output AVR	Relay, Analogue, EIC	Analogue	
2603	Output A	Not used, Terminal, 5, 8, 11, 14, 17, 20, 21, 69, 71	Not used	
2604	Output B	Not used, Terminal, 5, 8, 11, 14, 17, 20, 21, 69, 71	Not used	
2723	Output A	Not used, Terminal, 5, 8, 11, 14, 17, 20, 21, 69, 71	Not used	
2724	Output B	Not used, Terminal, 5, 8, 11, 14, 17, 20, 21, 69, 71	Not used	

In parameter 5980 and 5990, you can choose to use analogue output for governor and AVR control.

15.7 Option EF6

Option EF6 is a hardware option, and a separate PCB is installed in slot #4. The PWM (Pulse Width Modulated) speed output is intended for Caterpillar® electronic engine control systems ADEM and PEEC.

15.7.1 Terminal description

Term.	Function	Description
65	Not used	
66	Not used	
67	0	Speed governor, AVR or transducer output 68.
68	+/-25 mA	
69	PWM -	PWM speed governor signal.
70	PWM +	
71	0	Speed governor, AVR or transducer output 72.
72	+/-25 mA	

Connect PWM (-) to the engine battery negative and PWM (+) to the engine control system S-SPD (speed) input (called RATED SPEED on the ADEM controller and PRIMARY THROTTLE on the PEEC controller).

15.7.2 Related parameters

Parameters 5820-5970 deal with setting the analogue outputs indicating a value; for example generated power, frequency and so on. This is described in the "Transducer outputs" section in the "Mutual parameters" chapter.
The princple of PWM is described in the section called "Duty cycle", which starts on the next page.
Below is shown a table for the parameters limiting the transducer output range. An explanation of this can be found in "Limits" later in this chapter.

Parameter	Item	Range	Default	Notes
5781	AOUT 68 Limits	-25 mA...10 mA	-20 mA	Here you choose the minimum level.
5782	AOUT 68 Limits	10 mA...25 mA	20 mA	Here you choose the maximum level.
5791	AOUT 72 Limits	25 mA...10 mA	-20 mA	Here you choose the minimum level.
5792	AOUT 72 Limits	10 mA...25 mA	20 mA	Here you choose the maximum level.
5721	PWM 70 limits	0 %...50 %	10 %	Here you choose the minimum level.
5722	PWM 70 limits	50 %...100 %	90 %	Here you choose the maximum level.
5981	Govenor output	Disabled, Transducer 66, Transducer 71.	Disabled	Here you choose the output.
5991	AVR output	Disabled, Transducer 66, Transducer 71.	Disabled	Here you choose the output.

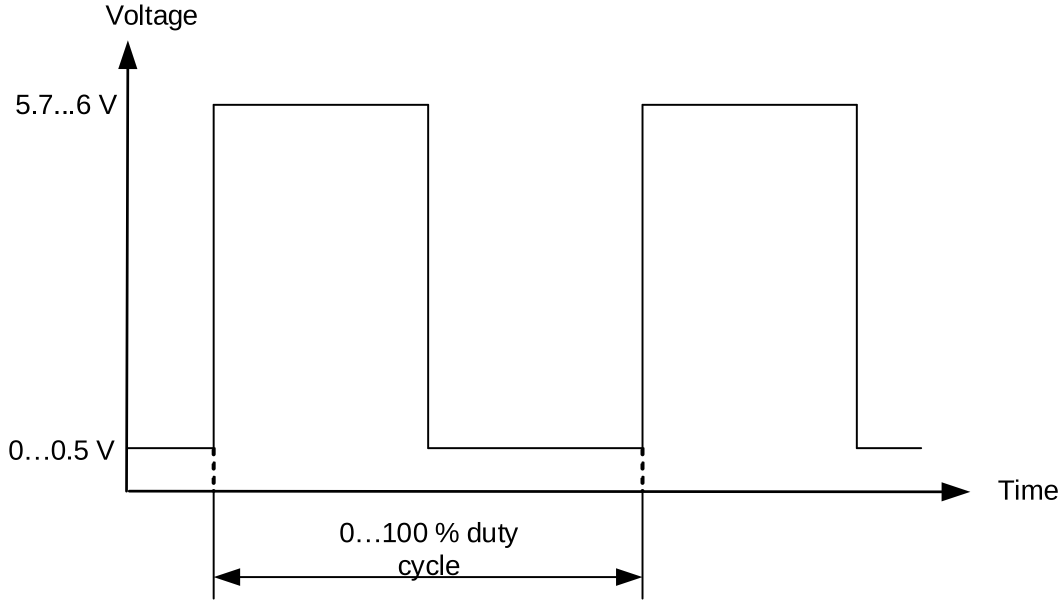
In parameter 5980 and 5990, you can choose to use analogue output for governor and AVR control.

15.8 Duty cycle

15.8.1 Duty cycle

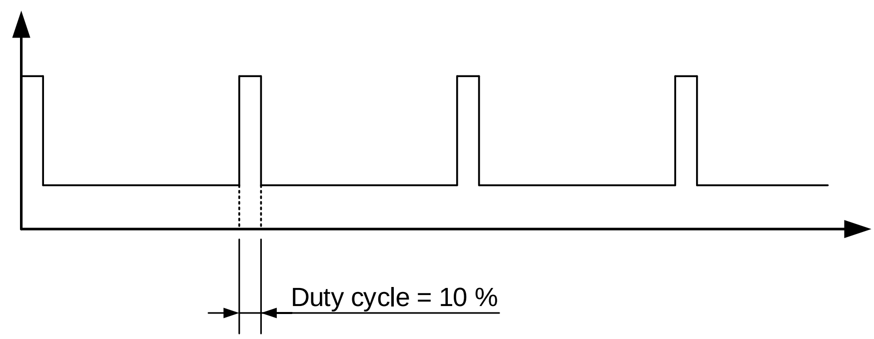
The PWM signal has a frequency of 500 Hz +/- 50 Hz. The resolution of the duty cycle is 12 bits, which gives output 4095 different levels. The output is an open collector output with a 1 kΩ pull-up resistor.

The low level of the signal is between 0 and 0.05 V, whereas the high level is between 5.7 and 6 V.

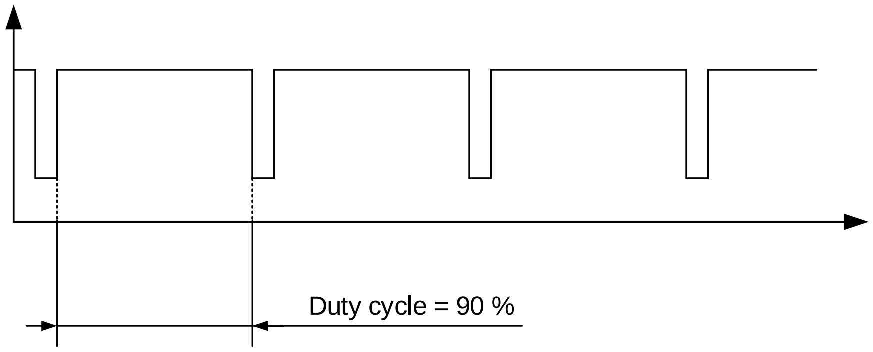


15.8.2 Principle of duty cycles

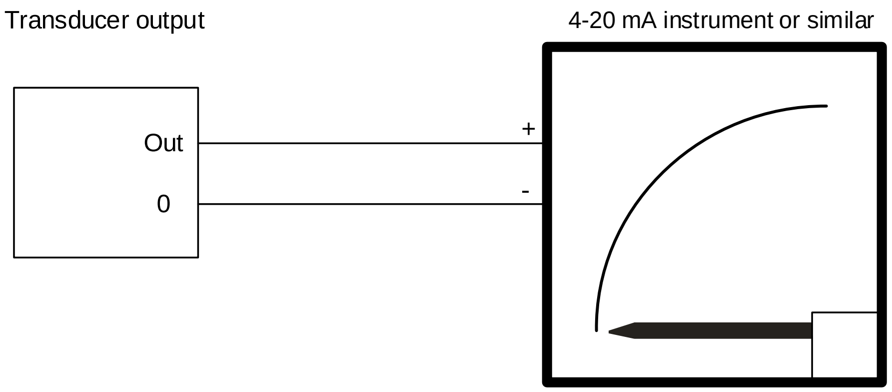
The drawing below shows an example of a 10 % duty cycle:



The drawing below shows an example of a 90 % duty cycle:



When used as transducer outputs, the signal can be connected directly to 4-20 mA instruments as shown below.



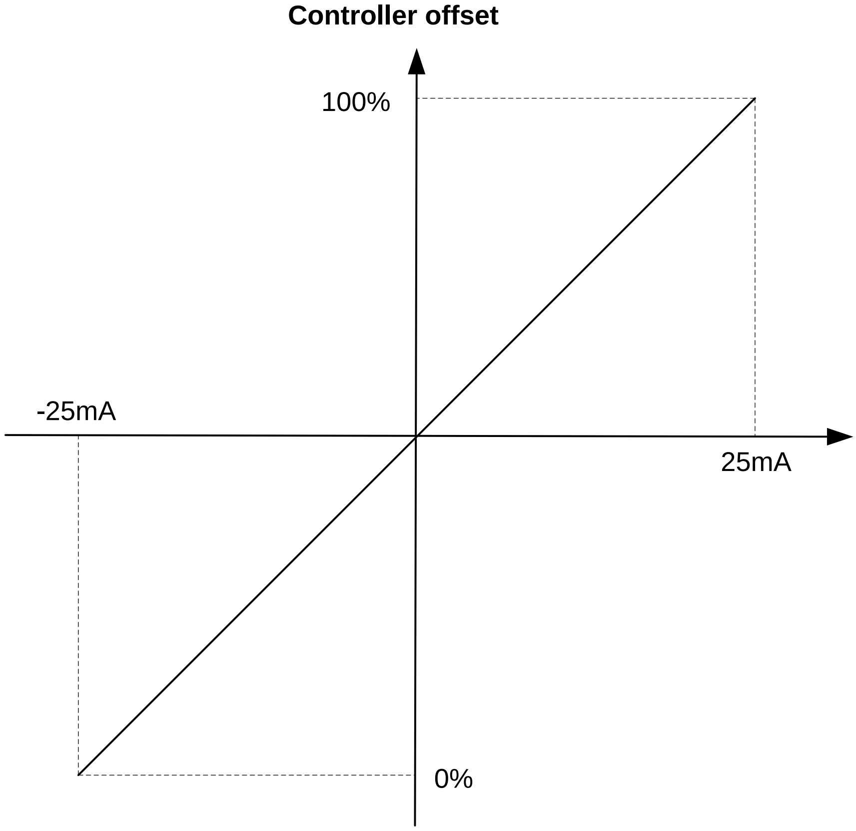
It is recommended to use instruments from the DQ series of DEIF instruments. Please refer to www.deif.com for more information.

15.9 Mutual parameters

15.9.1 Analogue controller offset

In addition to the controller parameters, this additional setting can be used. The purpose of this setting is to give the analogue output an offset value when powering up the unit. Furthermore, a digital input can be used to reset the output to the offset value. The offset value must be adjusted so that the genset will start at the correct speed and voltage.

The following drawing is for the option E1 with the output limits set to +/-25 mA.



The offset always refers to the analogue output limits.

When the engine is stopped, the controller outputs are reset to the analogue offset value.

Typically, the initial speed/voltage adjustment is made on the speed governor/AVR itself.

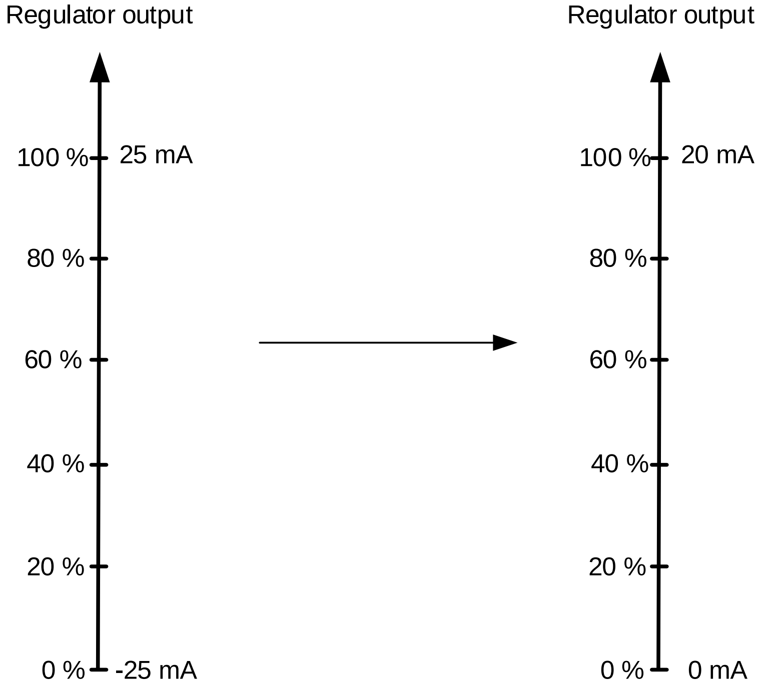
Output for GOV/AVR can be inversed in parameters: 2181 + 2182.

15.9.2 Output limits

If the full range of the analogue output is not needed, it is possible to limit the maximum and minimum output values.

This can especially be useful when using the analogue output for governor control, since some governors only accept a specific voltage range.

In the following example, analogue output 66 with a standard output of +/- 25 mA (option E1) is limited to an output of 0-20 mA to be used for governor control.



The menus used for setting up the output limits are 5780 to 5810. The menus available are option-dependent.

15.9.3 Transducer outputs

No.	Setting		Min. Max.	Factory setting	Notes	Ref.	Description
5820 P output 1							
5821	P output 1	Transducer A	Disabled Option-dep.	Disabled			Set point selections for all transducer outputs: - Disabled - 0-20 mA - 4-20 mA - 0-10 V - -10-0-10 V
5822	P output 1	Transducer B	Disabled Option-dep.	Disabled			
5823	P output 1	Set point	Disabled -10-0-10 V	Disabled			
5824	P output 1	Max. value	0 kW 20000 kW	500 kW			
5825	P output 1	Min. value	-9999 kW 20000 kW	0 kW			
5830 P output 2							
5831	P output 2	Transducer A	Disabled Option-dep.	Disabled			
5832	P output 2	Transducer B	Disabled Option-dep.	Disabled			
5833	P output 2	Set point	Disabled -10-0-10 V	Disabled			
5834	P output 2	Max. value	0 kW 20000 kW	500 kW			
5835	P output 2	Min. value	-9999 kW 20000 kW	0 kW			
5840 P output 3							
5841	P output 3	Transducer A	Disabled Option-dep.	Disabled			
5842	P output 3	Transducer B	Disabled Option-dep.	Disabled			
5843	P output 3	Set point	Disabled -10-0-10 V	Disabled			
5844	P output 3	Max. value	0 kW 20000 kW	500 kW			
5845	P output 3	Min. value	-9999 kW 20000 kW	0 kW			
5850 S output							
5851	S output	Transducer A	Disabled Option-dep.	Disabled			
5852	S output	Transducer B	Disabled Option-dep.	Disabled			

No.	Setting		Min. Max.	Factory setting	Notes	Ref.	Description
5853	S output	Set point	Disabled -10-0-10 V	Disabled			
5854	S output	Max. value	0 kVA 20000 kVA	600 kVA			
5855	S output	Min. value	-9999 kVA 20000 kVA	0 kVA			
5860 Q output							
5861	Q output	Transducer A	Disabled Option-dep.	Disabled			
5862	Q output	Transducer B	Disabled Option-dep.	Disabled			
5863	Q output	Set point	Disabled -10-0-10 V	Disabled			
5864	Q output	Max. value	0 kVAr 16000 kVAr	400 kvar			
5865	Q output	Min. value	8000 kVA 16000 kVA	0 kvar			
5870 Cos phi output							
5871	Cos phi output	Transducer A	Disabled Option-dep.	Disabled			Positive value means inductive. Negative value means capacitive.
5872	Cos phi output	Transducer B	Disabled Option-dep.	Disabled			
5873	Cos phi output	Set point	Disabled -10-0-10 V	Disabled			
5874	Cos phi output	Max. value	0.50 0.99	0.80			
5875	Cos phi output	Min. value	-0.99 -0.50	-0.80			
5880 f output							
5881	F output	Transducer A	Disabled Option-dep.	Disabled			
5882	F output	Transducer B	Disabled Option-dep.	Disabled			
5883	F output	Set point	Disabled -10-0-10 V	Disabled			
5884	F output	Max. value	0.0 Hz 70.0 Hz	55.0 Hz			
5885	F output	Min. value	0.0 Hz 70.0 Hz	45.0 Hz			
5890 U output							

No.	Setting		Min. Max.	Factory setting	Notes	Ref.	Description
5891	U output	Transducer A	Disabled Option-dep.	Disabled			The voltage output represents L1-L2 voltage.
5892	U output	Transducer B	Disabled Option-dep.	Disabled			
5893	U output	Set point	Disabled -10-0-10 V	Disabled			
5894	U output	Max. value	0 V 28000 V	500 V			
5895	U output	Min. value	0 V 28000 V	0 V			
5900 I output							
5901	I output	Transducer A	Disabled Option-dep.	Disabled			The current output represents L1 cur-rent.
5902	I output	Transducer B	Disabled Option-dep.	Disabled			
5903	I output	Set point	Disabled -10-0-10 V	Disabled			
5904	I output	Max. value	0 A 9000 A	1000 A			
5905	I output	Min. value	0 A 9000 A	0 A			
5910 U BB output							
5911	U BB output	Transducer A	Disabled Option-dep.	Disabled			The voltage output represents L1-L2 voltage.
5912	U BB output	Transducer B	Disabled Option-dep.	Disabled			
5913	U BB output	Set point	Disabled -10-0-10 V	Disabled			
5914	U BB output	Max. value	0 V 28000 V	500 V			
5915	U BB output	Min. value	0 V 28000 V	0 V			
5920 f BB output							
5921	F BB output	Transducer A	Disabled Option-dep.	Disabled			
5922	F BB output	Transducer B	Disabled Option-dep.	Disabled			
5923	F BB output	Set point	Disabled -10-0-10 V	Disabled			
5924	F BB output	Max. value	0.0 Hz 70.0 Hz	55.0 Hz			

No.	Setting		Min. Max.	Factory setting	Notes	Ref.	Description
5925	F BB output	Min. value	0.0 Hz 70.0 Hz	45.0 Hz			
5930 Multi-input 102							
5931	Multi-input 102	Transducer A	Disabled Option-dep.	Disabled			
5932	Multi-input 102	Transducer B	Disabled Option-dep.	Disabled			
5933	Multi-input 102	Set point	Disabled -10-0-10 V	Disabled			
5934	Multi-input 102	Max. value	0 28000	500			
5935	Multi-input 102	Min. value	0 28000	0			
5940 Multi-input 105							
5941	Multi-input 105	Transducer A	Disabled Option-dep.	Disabled			
5942	Multi-input 105	Transducer B	Disabled Option-dep.	Disabled			
5943	Multi-input 105	Set point	Disabled -10-0-10 V	Disabled			
5944	Multi-input 105	Max. value	0 28000	500			
5945	Multi-input 105	Min. value	0 28000	0			
5950 Multi-input 108							
5951	Multi-input 108	Transducer A	Disabled Option-dep.	Disabled			
5952	Multi-input 108	Transducer B	Disabled Option-dep.	Disabled			
5953	Multi-input 108	Set point	Disabled -10-0-10 V	Disabled			
5954	Multi-input 108	Max. value	0 28000	500			
5955	Multi-input 108	Min. value	0 28000	0			
5960 P total consumed							
5961	P total con- sumed	Transducer A	Disabled Option-dep.	Disabled			
5962	P total con- sumed	Transducer B	Disabled Option-dep.	Disabled			

No.	Setting		Min. Max.	Factory setting	Notes	Ref.	Description
5963	P total consumed	Set point	Disabled -10-0-10 V	Disabled			
5964	P total consumed	Max. value	0 kW 20000 kW	500 kW			
5965	P total consumed	Min. value	-9999 kW 20000 kW	0 kW			

16. Transducer output (option F1)

16.1 Option F1

Option F1 is a hardware option, and a separate PCB is installed in slot #6 in addition to the standard-installed hardware.
It has two analogue outputs, and each output can indicate one of the following values: power (P or S), current, voltage, frequency, multi-input 102, multi-input 105 and multi-input 108.

The analogue outputs are active and galvanically separated. No external supply can be connected.

Option F1 can not be used for analogue regulation to AVR and governors - an option E variant is required for that.

The current outputs can be converted to any voltage in the range inside 0-10 V DC by mounting a resistor across the terminals.

Example: A 500 Ω resistor across the terminals of the 0-20 mA output will supply a range of 0-10 V DC.

16.1.1 Terminal description

The default analogue output range is 0-20 mA, but it is possible to change the range to for example 4-20 mA. This can be done for output 91 by changing parameter 5801 to 4 mA or parameter 5811 for output 95. For more information about transducer limitations, see "Limits" in the chapter for option E variants.

Term.	Function	Description
90	Not used	
91	0	Transducer output 91
92	0(4)-20 mA	
93	Not used	
94	Not used	
95	0	Transducer output 95
96	0(4)-20 mA	
97	Not used	

Transducer outputs are 0(4)-20 mA outputs.

16.1.2 Related parameters

Parameters 5820-5975 are used to choose what the analogue outputs indicate and the input range. These parameters are also used for option E variants.

The table below shows the parameters for limiting analogue output range.

Parameter	Item	Range	Default	Notes
5801	AOUT 91 Limits	0 mA...10 mA	0 mA	Here you choose the minimum level.
5802	AOUT 91 Limits	10 mA...20 mA	20 mA	Here you choose the maximum level.
5811	AOUT 95 Limits	0 mA...10 mA	0 mA	Here you choose the minimum level.
5812	AOUT 95 Limits	10 mA...20 mA	20 mA	Here you choose the maximum level.

No.	Setting		Min. Max.	Factory setting	Notes	Ref.	Description
5800 Aout 91 limits							
5801	AOUT 91 Limits	Min.	0 mA 10 mA	0 mA			
5802	AOUT 91 Limits	Max.	10 mA 20 mA	20 mA			
5810 Aout 95 limits							
5811	AOUT 95 Limits	Min.	0 mA 10 mA	0 mA			
5812	AOUT 95 Limits	Max.	10 mA 20 mA	20 mA			

17. Engine communication

17.1 Introduction to engine communication

17.1.1 Engine communication

The engine communication module gives the possibility to communicate between an AGC PM and several engine types over the CAN bus. The engine communication module is by default placed at slot #2 or slot #8. With the engine communication, it is possible to read different information from the ECM of the engine, and on some ECMs also to regulate and send different commands.

The AGC PM can be ordered with an option H5 or an option H12. Option H5 can be considered as a single CAN port PCB for engine communication. Option H12 is a dual CAN port PCB, which includes the same functionality as option H5. For both options H5 and H12, option H13 can be added. Option H13 is a software option, which gives the possibility to communicate with MTU module 501 ADEC ECM without a SAM module. In the following pages, an option called H7 is also mentioned, but this cannot be ordered for an AGC PM.

17.1.2 Modbus communication

It is possible to read some of the engine data over the Modbus.

Refer to the document "Modbus table".

The Modbus data for the EIC-relevant values is shown later in this chapter. Other Modbus data is found in the "Modbus table".

17.1.3 Terminal description

The engine communication in the AGC PM can be done from different PCBs. These PCBs can be located at different locations, so the terminal numbers differ. An overview of the terminal numbers is shown below:

When the CAN bus PCB is placed in slot #2, and the PCB called H5 is used, the terminal numbers are as shown below:

Term.	Function	Description
29	CAN-H	CAN bus card option H5 or H13, Engine Interface communication. Note that terminals 29 and 32 are internally connected. Terminals 31 and 34 are also internally connected.
30	CAN-GND	
31	CAN-L	
32	CAN-H	
33	CAN-GND	
34	CAN-L	
35	Not used	
36	Not used	

If the CAN bus card called H5 is placed at slot #8, the terminal numbers used for communication are:

Term.	Function	Description
133	CAN-H	CAN bus card option H5 or H13, Engine Interface communication. Note that terminals 133 and 130 are internally connected. Terminals 131 and 128 are also internally connected.
132	CAN-GND	
131	CAN-L	
130	CAN-H	
129	CAN-GND	
128	CAN-L	
127	Not used	
126	Not used	

If option H12.2 is used for CAN bus communication to the engine, the terminal numbers are as shown below:

Term.	Function	Description
29	CAN-H	Dual CAN bus card option H12.2 Engine Interface communication. Note that this option consists of two separate CAN bus lines. CAN port C: Terminal 29-31 CAN port D: Terminal 32-34
30	CAN-GND	
31	CAN-L	
32	CAN-H	
33	CAN-GND	
34	CAN-L	
35	Not used	
36	Not used	

Option H12 is a dual CAN card that has two separate CAN ports. Option H12 can be ordered to fit in slot #2 OR slot #8. Setup of the terminals is done in the following parameters: Option H12.2 - parameters 7843 and 7844; option H12.8 - parameters 7845 and 7846.

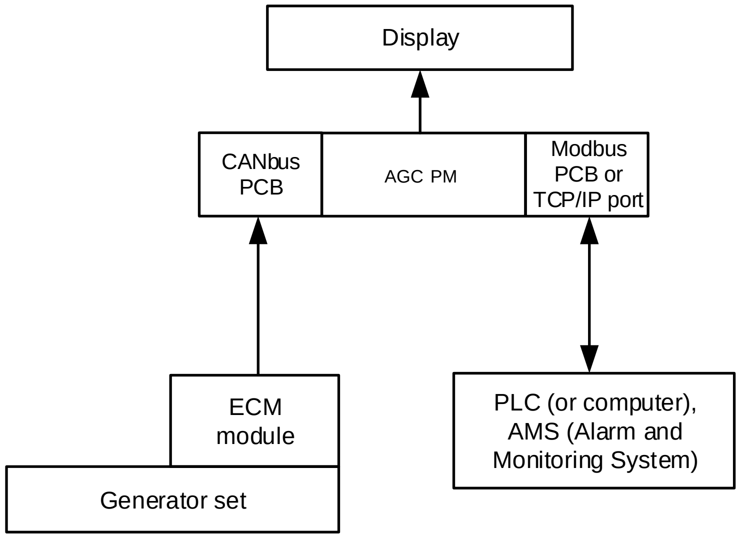
If the AGC PM is provided with option H12.8 for dual CAN operation, the terminal numbers are shown below:

Term.	Function	Description
133	CAN-H	Dual CAN bus card option H12.8 Engine Interface communication. Note that this option consists of two separate CAN bus lines. CAN port E: Terminal 128-130 CAN port F: Terminal 131-133
132	CAN-GND	
131	CAN-L	
130	CAN-H	
129	CAN-GND	
128	CAN-L	
127	Not used	
126	Not used	

Option H12 is a dual CAN card that has two separate CAN ports. Option H12 can be ordered to fit in slot #2 OR slot #8. Setup of the terminals is done in the following parameters: Option H12.2 - parameters 7843 and 7844; option H12.8 - parameters 7845 and 7846.

17.1.4 From CAN bus to Modbus

The AGC PM has a function for displaying of some of the readings and alarms from the ECM module onto the Modbus.
This can only be done if the engine has a CAN bus interface and the AGC PM is connected to the ECM module.
The data in the Modbus can be found in the Modbus table appendix. The principle of how the connections to the AGC PM are done is shown below.



17.2 Functional description

17.2.1 Electronic control module (ECM)

This communication extracts information from the Electronic Control Module (ECM) of an engine equipped with an ECM module with CAN bus interface. The values can be used as display values, alarms/shutdown alarms and values to be transmitted through Modbus.

17.2.2 Engine types

Data can be transmitted between the ML-2 units and the following engine controllers/types:

Engine manufacturer	Engine controller/type	Comment	H5	H7	H12	H13
Caterpillar	ADEM III and A4/C4.4, C6.6, C9, C15, C18, C32	Rx/Tx	X	X	X	X
Cummins	CM 500/558/570/850/2150/2250, QSL, QSB5, QXL15 and 7, QSM11, QSK 19/23/50/60	Rx/Tx	X	X	X	X
Detroit Diesel	DDEC III and IV/Series 50, 60 and 2000	Rx/Tx	X	X	X	X
Deutz	EMR3[1], EMR 2 (EMR)/912, 913, 914 and L2011	Rx/Tx	X	X	X	X
-	Generic J1939	Rx/Tx	X	X	X	X
Iveco	EDC7 (Bosch MS6.2)/Series NEF, CURSOR and VECTOR 8	Rx/Tx	X	X	X	X
John Deere	JDEC/PowerTech M, E and Plus	Rx/Tx	X	X	X	X
MTU	MDEC, module M.302 or M.303/Series 2000 and 4000	Rx	X	-	X	X
MTU	MDEC, module M.201 or M.304/Series 2000 and 4000	Rx Select M. 303	X	-	X	X
MTU	ADEC/Series 2000 and 4000 MTU Px-Engines [2] (ECU7), with SAM module	Rx/Tx	X	X	X	X
MTU[1]	J1939 Smart Connect/Series 1600 (ECU8)	Rx/Tx	X	X	X	X
MTU[1]	ADEC/Series 2000 and 4000 (ECU7), without SAM module (software module 501)	Rx/Tx	-	-	-	X
Perkins	Series 850, 1100, 1200, 1300, 2300, 2500 and 2800.	Rx/Tx	X	X	X	X
Scania	EMS	Rx	X	X	X	X
Scania	EMS S6 (KWP2000)/Dx9x, Dx12x, Dx16x	Rx/Tx	X	X	X	X
Volvo Penta	EDC4	Rx Select EMR 2	X	X	X	X
Volvo Penta	EMS	Rx	X	X	X	X
Volvo Penta	EMS 2 and EDCIII/D6, D7, D9, D12 and D16 (GE and AUX variants only)	Rx/Tx	X	X	X	X

Rx/Tx: See the section "Specific engine type descriptions" for details of data read and write.

Contact DEIF A/S for support of controller/engine types not listed.

Protocols marked [1] do not apply to PPM-3.

The engine type PX engines marked[2] requires that the MTU SAM module is with updated J1939 protocol supporting DM1/DM2.

The parameter for setting the engine interface is shown in the table below:

Parameter	Item	Range	Default	Note
7561	Engine interface selection	OFF MTU Smart connect	OFF	Only in genset

17.2.3 AVR types

Data can be transmitted between the ML-2 units and the following AVRs

Engine manufacturer	AVR types	Comment
Caterpillar	CDVR	Tx

AVR control requires option D1 in combination with option H5, H7 or H13.

AVR control only applies to AGC-3, AGC-4, GPC-3, PPU-3 and GPU-3.

The parameter for setting the AVR interface is shown in the table below:

Parameter	Item	Range	Default	Note
7565	AVR interface selection	OFF Caterpillar CDVR	OFF	Only in genset

17.2.4 Communication system

All these protocols are based on a CAN bus communication system. Except for the MDEC and ADEC communication, all of them are based on the J1939. The MDEC and ADEC protocols are MTU-designed protocols.
The Baud rate is fixed by the engine manufacturer at:

MDEC, ADEC	Caterpillar, Cummins, Detroit Diesel, Deutz, Iveco, John Deere, Perkins, MTU J1939 Smart Connect[1], Scania and Volvo Penta
125 kb/s	250 kb/s

Protocols marked [1] do not apply to PPM-3

17.2.5 EIC unit

The selection of the EIC unit (menu 10970) determines whether bar/Celsius or PSI/Fahrenheit is used. The selection affects display readings, values used for alarm evaluation (menu 76xx) and data readable by Modbus communication (option H2/N).

The parameter for setting the EIC units is shown in the table below:

Parameter	Item	Range	Default	Note
10970	EIC unit selection	Bar/Celsius PSI/Fahrenheit	Bar/Celsius	Only in genset. Can only be changed from the utility software.

17.2.6 Common for alarm functions

A number of alarms can be configured.

The following items can be configured to an alarm:

Menu number	Alarm	Comment
7570	EI comm. error	Communication error
7580	EIC warning	Any alarm listed as warning for the selected engine type in the section "Specific engine type descriptions".
7590	EIC shutdown	Any alarm listed as shutdown for the selected engine type in the section "Specific engine type descriptions".
7600	EIC overspeed	Actual RPM
7610/7620	EIC coolant t. (2 levels)	Actual temperature
7630/7640	EIC oil press. (2 levels)	Actual pressure
7650/7660	EIC oil temp. (2 levels)	Actual temperature
7670/7680	EIC coolant level (2 levels)[1]	Actual cooling water level

Alarms marked [1] do not apply to PPM-3.

17.2.7 J1939 measurement table

This is the common J1939 measurement overview showing which measurements are available. Note that not all measurements are supported by the individual engines; refer to the specific engine description.

The table below shows which values can be displayed in the view menu. That is in V1, V2 and V3.

For information about the menu structure, see the "Designer's reference handbook".

The display values corresponding to the engine communication have a description beginning with "EIC".

Error messages:
The following error messages can occur:

Message	Description
Engine I. value N.A.	The view is not selectable for the present engine type.
Value selected error	The value cannot be read due to sensor error, sub-system or module error.
"N.A."	The value is not supported by the engine, or due to communication error.

Object selection, J1939:
The view lines can be configured with these available values.

See the chapter "Modbus communication" for Modbus scaling.

The engine is by default settings expected to use source address 0 which is also the most commonly used setting on ECUs. If a different source address is required, it can be changed in parameter 7562.

Object	PGN (Dec/Hex)	S	L	P	SPN	Unit	J1939-71 scaling
EngineAuxShutdownSW, MLogic[9]	61441/F001	4.5	2 bits	6	970	0..3	4 states/2 bit, 0 offset
EIC acc. pedal pos.	61443/F003	2	1	3/6	91	%	0.4%/bit, offset 0
EIC % load, c. speed	61443/F003	3	1	3/6	92	%	1%/bit, offset 0
EIC d.d.% torque	61444/F004	2	1	3/6	512	%	1%/bit, offset -125%
EIC actual % torque	61444/F004	3	1	3/6	513	%	1%/bit, offset -125%
EIC speed	61444/F004	4	2	3/6	190	rpm	0.125 rpm/bit, offset 0
AT1IntTNOx [9]	61454/F00E	1	2	6	3216	ppm	0.05 ppm/bit, -200 ppm offset
AT1OutLNOx [9]	61455/F00F	1	2	6	3226	ppm	0.05 ppm/bit, -200 ppm offset
AT2IntTNOx [9]	61456/F010	1	2	6	3255	ppm	0.05 ppm/bit, -200 ppm offset
AT2OutLNOx [9]	61457/F011	1	2	6	3265	ppm	0.05 ppm/bit, -200 ppm offset
AT1ExhFA.DQ [9]	61475/F023	1	2	3	4331	g/h	0.3 g/h per bit, 0 offset
AT1ExhFluDAB [9]	61475/F023	6	1	3	4334	kPa	8 kPa/bit, 0 offset
AT1ExhFluDRQ [9]	61476/F024	1	2	6	4348	g/h	0.3 g/h per bit, 0 offset
AT2ExhFA.DQ [9]	61478/F026	1	2	3	4384	g/h	0.3 g/h per bit, 0 offset
AT2ExhFluDAB [9]	61478/F026	6	1	3	4387	kPa	8 kPa/bit, 0 offset
AT2ExhFluDRQ [9]	61479/F027	1	2	3	4401	g/h	0.3 g/h per bit, 0 offset
Next Regen [9]	64697/FCB9	1	4	6	5978	s	1 s/bit
AT2SCRCInG [9]	64824/FD38	1	2	6	4413	°C	0.03125 deg C/bit, -273 deg C offset
AT2SCRCOuG [9]	64824/FD38	4	2	6	4415	°C	0.03125 deg C/bit, -273 deg C offset
AT2ExhFlu DT [9]	64827/FD3B	3	1	6	4390	°C	1 deg C/bit, -40 deg C offset
AT1SCRCInG [9]	64830/FD3E	1	2	5	4360	°C	0.03125 deg C/bit, -273 deg C offset
AT1SCRCOuG [9]	64830/FD3E	4	2	5	4363	°C	0.03125 deg C/bit, -273 deg C offset

Object	PGN (Dec/Hex)	S	L	P	SPN	Unit	J1939-71 scaling
AT1ExhFlu DT [9]	64833/FD41	3	1	6	4337	°C	1 deg C/bit, -40 deg C offset
EngOperatingState [9]	64914/FD92	1.1	4 bits	3	3543	0..15	16 states/4 bit, 0 offset
EngineAT1Regenera-tionStatus, MLogic[9]	64929/FDA1	7.5	2 bits	6	3483	0..3	4 states/2 bit, 0 offset
DPF OUTL T [9]	64947/FDB3	3	2	6	3246	°C	0.03125 deg C/bit, -273 deg C offset
EIC Air filter diff. pres-sure	64976/FDD0	1	1	6	2809	bar	0.05 kPa, offset 0
EIC Intake manifold #1 absolute pressure[1]	64976/FDD0	5	1	6	3563	bar	2 kPa/bit
Sp.Humidity [9]	64992/FDE0	3	2	6	4490	g/kg	0.01 g/kg per bit, 0 offset
EIC Exhaust gas temp. R manifold[2]	65031/FE07	1	2	6	2433	°C	0.03125ºC/bit, offset -273°C
EIC Exhaust gas temp. L manifold[2]	65031/FE07	3	2	6	2434	°C	0.03125ºC/bit, offset -273°C
DEF LEVEL [9]	65110/FE56	1	1	6	1761	%	0.4 %/bit, 0 offset
AT1ExhFluTank deg[9]	65110/FE56	2	1	6	3031	°C	1 deg C/bit, -40 deg C offset
bScrOprInducementActi-veLamp, MLogic[9]	65110/FE56	5.6	3 bits	6	5245	0 to 7	8 states/3 bit, 0 offset
SCR IND. SEV. [9]	65110/FE56	6.6	3 bits	6	5246	0 to 7	8 states/3 bit, 0 offset
No view, for Coolant wa-ter regulation[9]	65129/FE69	3	2	6	1637	°C	0.03125 deg C/bit, -273 deg C offset
EIC Fuel supply pump inlet pressure	65130/FE6A	2	1	6	1381	bar	2 kPa/bit offset 0
EIC Fuel filter (ss) diff. pressure	65130/FE6A	3	1	6	1382	bar	2 kPa/bit offset 0
EngineFuelLeak1, MLo-gic[9]	65169/FE91	1	2	7	1239	bit	00 no leakage de-tect. 01 leakage detect.
AuxCool Pr. [9]	65172/FE94	1	1	6	1203	kPa	4 kPa/bit gain, 0 kPa offset
T. Cool Aux [9]	65172/FE94	2	1	6	1212	°C	1 °C/bit gain, −40 °C offset
Tcharger 2 [9]	65179/FE9B	2	2	7	1169	rpm	4 rpm/bit gain, 0 rpm offset

Object	PGN (Dec/Hex)	S	L	P	SPN	Unit	J1939-71 scaling
Tcharger 3 [9]	65179/FE9B	4	2	7	1170	rpm	4 rpm/bit gain, 0 rpm offset
T-ECU [9]	65188/FEA4	3	2	6	1136	°C	0.03125 °C/bit gain, −273 °C offset
Intake Man T2 [9]	65189/FEA5	1	1	7	1131	°C	1 °C/bit gain, −40 °C offset
EIC trip fuel gaseous	65199/FEAF	1	4	7	1039	kg	0.5 kg/bit, offset 0
EIC total fuel used gaseous	65199/FEAF	5	4	7	1040	kg	0.5 kg/bit, offset 0
EIC Mean trip fuel consumption[1]	65203/FEB3	5	2	7	1029	l/h	0,05 [l/h]/bit
Est. Fan RPM [9]	65213/FEBD	1	1	6	975	%	0.4%/bit gain, 0% offset
EIC Nominal Power[1]	65214/FEBE	1	2	7	166	kW	0,5 kW/bit
Diagnostic message 1/2	65226/FECA	-	-	3/6/7	-	-	-
EIC faults[8]	65230/FECE	1	1	6	1218	-	1/bit, offset 0
Tcharger 1 [9]	65245/FEDD	2	2	6	103	rpm	4 rpm/bit gain, 0 rpm offset
Nom. Friction [9]	65247/FEDF	1	1	6	514	%	1%/bit gain, −125% offset
Desired [9]	65247/FEDF	2	2	6	515	rpm	0.125 rpm/bit gain, 0 rpm offset
EngineWaitToStart, MLogic[9]	65252/FEE4	4.1	2 bits	6	1081	bit	00 off 01 on
EngineProtectSysShutdown, MLogic[9]	65252/FEE4	5.1	2 bits	6	1110	bit	00 yes 01 no
EngineProtectSysAproShutdown, MLogic[9]	65252/FEE4	5.3	2	6	1109	bit	00 not approaching 01 approaching
EngineAlarmAcknowledge, MLogic[9]	65252/FEE4	7.1	2 bits	6	2815	0..3	4 states/2 bit, 0 offset
EngineAirShutoffCommandStatus, MLogic[9]	65252/FEE4	7.5	2 bits	6	2813	0..3	4 states/2 bit, 0 offset
EngineOverspeedTest, MLogic[9]	65252/FEE4	7.7	2 bits	6	2812	0..3	4 states/2 bit, 0 offset
EngineShutoffStatus, MLogic[9]	65252/FEE4	8.3	2 bits	6	5404	0..3	4 states/2 bit, 0 offset
EIC engine hours	65253/FEE5	1	4	6	247	h	0.05 hrs/bit, offset 0, max: 32767 hrs

Object	PGN (Dec/Hex)	S	L	P	SPN	Unit	J1939-71 scaling
EIC engine trip fuel	65257/FEE9	1	4	6	182	L	0.5 L/bit, offset 0
EIC engine total fuel used	65257/FEE9	5	4	6	250	L	0.5 L/bit, offset 0
EIC coolant temp.[5]	65262/FEEE	1	1	3/6	110	°C	1 deg C/bit, offset -40°C
EIC fuel temp.	65262/FEEE	2	1	3/6	174	°C	1°C/bit, offset -40°C
EIC oil temp.[7]	65262/FEEE	3	2	3/6	175	°C	0.03125°C/bit, offset -273°C
EIC turbo oil temp.	65262/FEEE	5	2	3/6	176	°C	0.03125°C/bit, offset -273°C
EIC Intercooler temperature[2]	65262/FEEE	7	1	3/6	52	°C	1°C/bit, offset -40°C
EIC fuel del. press.	65263/FEEF	1	1	6	94	bar	4 kPa/bit, offset 0
EIC oil level	65263/FEEF	3	1	6	98	%	0.4%/bit, offset 0
EIC oil pressure[6]	65263/FEEF	4	1	6	100	bar	4 kPa/bit, offset 0
EIC crankcase press.	65263/FEEF	5	2	6	101	bar	1/128 kPa/bit, offset -250 kPa
EIC coolant pressure	65263/FEEF	7	1	6	109	bar	2 kPa/bit, offset 0
EIC coolant level	65263/FEEF	8	1	6	111	%	0.4%/bit, offset 0
EIC fuel rate	65266/FEF2	1	2	6	183	l/h	0.05 l/h per bit, offset 0
EIC atmospheric press.	65269/FEF5	1	1	6	108	bar	0.5 kPa/bit, offset 0
EIC ambient air temp.	65269/FEF5	4	2	6	171	°C	0.03125°C/bit, offset -273°C
EIC air inlet temp.	65269/FEF5	6	1	6	172	°C	1°C/bit, offset -40°C
EIC particulate trap inlet	65270/FEF6	1	1	6	81	bar	0.5 kPa/bit, offset 0
EIC intake manifold #1 P.[3]	65270/FEF6	2	1	6	102	bar	2 kPa/bit, offset 0
EIC intake manifold 1 temp.[4]	65270/FEF6	3	1	6	105	°C	1°C/bit, offset -40°C

Object	PGN (Dec/Hex)	S	L	P	SPN	Unit	J1939-71 scaling
EIC air inlet pressure	65270/FEF6	4	1	6	106	bar	2 kPa/bit, offset 0
EIC air filter diff.	65270/FEF6	5	1	6	107	bar	0.05 kPa/bit, offset 0
EIC exhaust gas temp.	65270/FEF6	6	2	6	173	°C	0.03125°C/bit, offset -273°C
EIC coolant filter diff.	65270/FEF6	8	1	6	112	bar	0.5 kPa/bit, offset 0
EIC key switch battery potential	65271/FEF7	7	2	6	158	V DC	0.05V DC/bit, offset 0
EIC Fuel filter diff. pressure[2]	65276/FEFC	3	1	3/6	95	bar	2 kPa/bit. 0 offset
EIC oil filter diff. press.	65276/FEFC	4	1	3[1]/6	99	bar	0.5 kPa/bit, offset 0
EIC water in. fuel	65279/FEFF	1	2	6	97	-	00: No, 01: Yes, 10: Error, 11: Not available

PGN: Parameter group number
SPN: Suspect parameter number
P: J1939 priority
S: Object's start byte in CAN telegram
L: Object's length is normally written as byte, exceptions of length are written as "bit"
Unit: Unit in display (Bar/°C can be changed to PSI/°F)

Objects marked [1] do not apply to PPM-3.

Objects marked [2] only apply to AGC-4, AGC 200 and AGC PM.

Objects marked [3] also called EIC boost P.

Objects marked [4] also called EIC charge air temp.

Objects marked [5] EIC coolant temp.: PGN = 65282, priority = 6, start at byte 5, length = 1 byte, SPN = 110, same scale (only Iveco Vector 8 type)

Objects marked [6] EIC oil pressure. PGN = 65282, priority = 6, start at byte 7, length = 1 byte, 8 kPa/bit gain, 0 kPa offset, data range: 0 to +2000 kPa (only Iveco Vector 8 type)

Objects marked [7] EIC oil temp.: PGN=65282, priority = 6, start at byte 6, length = 1byte, SPN = 175, same scale (only Iveco Vector 8 type)

Objects marked [8] EIC Faults: PGN=65284, priority = 6, start at byte 1, length = 2 byte (only MTU smart connect)

Objects marked [9] are not supported by option H7

17.2.8 Engine values in display unit/auto-view

It is possible to parameterise the ML-2, so all values from the engine CAN bus are shown in the display unit. This is an example, in which speed, coolant- and air inlet temperature are shown. The number of available views is 20. The number can be increased with the auto-view function.

Speed	1500 rpm
T.Coolant	85 deg
T.Oil	50 deg
Setup V3 V2 V1	P01

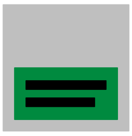
The ML-2 can be set up in two ways:

1. Using the "configuration of the user views" function of the PC utility software. In this way, the 20 three-line views can be configured to show the desired. A total of 20 views is displayed (unless fewer is set up).
2. Using the auto-view function in the communication setup (menu number 7564). In this way, the 20 three-line views are kept with their present setup, and all engine values are added to the list of the 20 three-line views. A total of 20 + 14 three-line views is available. The 20 lines are user-configurable (as mentioned above), but the additional 14 three-line views are dedicated to EIC and cannot be modified by the user.

The first option is useful when a few EIC values need to be shown, and if all of the 20 user-configurable views are not already used to display requested values.

The second option is useful if it is requested to read **all available** EIC data from the ECU. It must be noted that all available data is shown when using this method, until the additional 14 three-line views are used. The number of extra display views depends on the available data from the specific engine controller connected to the ML-2.

Configuration of user views:
This configuration is done in the PC utility software by pressing the user view icon in the horizontal toolbar



Activation of auto-view:
The extra view lines are displayed if the menu 7564 is switched to "ON" and the engine CAN bus is active. Note that it might be necessary to start the engine before switching 7564 to "ON". The setting automatically returns to "OFF".

Follow the steps below to deactivate the auto-view function:

1. Adjust engine I/F type to "OFF" (menu 7561)
2. Adjust EIC AUTOVIEW to "ON" (menu 7564)
3. Adjust EIC AUTOVIEW to "OFF" (menu 7564)

(The menu is not reset automatically when no engine is selected)

The parameter for the auto-view is shown below:

Parameter	Item	Range	Default	Note
7564	Autoview enable	OFF ON	OFF	Only in genset. Note that it automatically switches to OFF again.

17.2.9 Verification of J1939 objects

To verify the communication, various CAN PC tools can be used. Common for these are that they must be connected to the CAN bus between the Multi-line 2 unit and the engine controller. When the tool is connected, it is possible to monitor the communication between the two units. For use of the CAN tool, refer to the manual of the product used.

As an example, see the following telegram:

0xcf00400 ff 7d 7d e0 15 ff f0 ff
DATA BYTE: 1 2 3 4 5 6 7 8

- 0xc is the priority
- f004 is the PGN number (61444 in decimal value)
- The 8 bytes following the CAN ID (**0xcf00400**) are data, starting with byte 1

The priority needs to be converted to decimal. Note that the three priority bits in this case are displayed in the CAN ID (you see 0x**c**f00400 instead of 0x**0c**f00400). In other cases you may read, for example, 0x18fef200 (PGN 65266).

The formula to find the priority number (P) is to divide by 4:

0xc = 12 (Dec) => Priority 3

Priority	Decimal ID	Hexadecimal ID
1	4d	0x4
2	8d	0x8
3	12d	0xc
4	16d	0x10
5	20d	0x14
6	24d	0x18

Normally in SAE J1939, only priorities 3 and 6 are used.

Hereafter, the data can be read (PGN 61444):

0xcf00400 xD ff 7d 7d e0 15 ff f0 ff

Engine torque	(Data byte 1)	ff	Not available
Driver demand torque	(Data byte 2)	7d	
Actual engine torque	(Data byte 3)	7d	
Engine speed	(Data byte 4)	e0	
Engine speed	(Data byte 5)	15	
Source address	(Data byte 6)	ff	Not available
Engine starter mode	(Data byte 7)	f0	
Engine Demand	(Data byte 8)	ff	Not available

Calculation example:

RPM resolution is 0.125 RPM/bit, offset 0.
The result is then 15e0 (Hex) or 5600 (dec)*0.125 = 700 RPM.

17.2.10 Displaying of J1939 DM1/DM2, Scania KWP2000 and Caterpillar/ Perkins alarms (Multi-line 2)

Besides some engine-specific alarms that are shown in the standard alarm list, the J1939 diagnostic messages DM1 (active alarms) and DM2 (historic alarm log list) as well as the Scania KWP 2000 alarms can all be shown on the display.

<u>J1939</u>
Press the LOG button for 2 seconds. That will bring the alarm log on the display.

Example:

```
SPN 100 FMI15  oc34
Oil pressure
Slightly above range
CLRALL            DM1   DM2
```

The alarm log always shows the DM1 (active alarms) as default. By selecting DM2 (move the cursor under DM2 and press ENTER), the historical alarm list can be shown.

Use the and buttons to scroll through the list.

Oc: This indicates how many times a specific alarms has occurred.

CLRALL: Pressing ENTER clears the entire alarm log list. For safety reasons, this requires the master password (see the "Designer's reference handbook" for details of passwords).

If the controller has no translation text of an SPN diagnostic number, "Text N/A." is shown. For information about particular SPN numbers, consult the engine manufacturer's documentation or SAE J1939-71 for a general description.

<u>Scania KWP 2000</u>
Press the LOG button for 2 seconds. That will bring the alarm log on the display. The top line shows readings of AC values and is not used by the alarm list.

Example:

```
BB      0      0      0V
1105 Speed sensor 1
Active alarms: 6
CLRALL          First  Last
```

The Scania KWP 2000 log shows active and passive alarms in a mix.

Use the and buttons to scroll through the list.

CLRALL: Pressing ENTER clears the entire alarm log list. For safety reasons, this requires the master password (see the "Designer's reference handbook" for details of passwords).

<u>Caterpillar/Perkins</u>
Press the LOG button for 2 seconds. That will bring the alarm log on the display. Caterpillar and Perkins have a primary and a secondary DM1 log as well as one DM2 log.

Example:

```
SPN 100 FMI15  oc34
Oil pressure
Slightly above range
CLRALL  DM1  DM1se  DM2
```

The primary DM1 log shows alarms from the ADEM III/IV engine controllers. The secondary DM1 log shows alarms from the EMCP 3.x genset controller. Similar to the J1939 protocol, the DM2 log shows the historical alarms. Use the and buttons to scroll through the list.

Oc: This indicates how many times a specific alarm has occurred.

CLRALL: Pressing ENTER clears the entire alarm log list. For safety reasons, this requires the master password (see the "Designer's reference handbook" for details of passwords).

The display of Caterpillar/Perkins secondary DM 1 log only applies to AGC-3, AGC-4, AGC PM, GPC-3, PPU-3 and GPU-3.

17.2.11 Control commands sent to the engine

The table below shows the engine types with the possibility to send commands to the ECM via the CAN bus communication line.
Necessary options for these commands are option H5, H7, H12.

Engine type / **Command**	**Detroit Diesel DDEC**	**John Deere JDEC**	**Cater-pillar**	**Per-kins**	**Cum-mins**	**Generic J1939**	**Deutz EMR**	**Iveco**	**Iveco Vector 8**
Preheat	-	-	-	-	-	-	-	-	-
Start/Stop	-	-	X[1, 5]	X[1, 5]	-	-	-	-	-
Run/Stop (fuel)	-	-	-	-	X[4]	-	-	-	-
Speed Bias	X	X	X	X	X[1, 2]	X[1]	X	X	X
Nominal fre-quency	-	-	-	-	X	-	-	-	-
Governor gain	-	-	-	-	X	-	-	-	-
Idle speed	X[1]	X[1]	X[1]	X[1]	X	X[1]	X[1]	X[1]	-
MTU Alternate Droop Setting (M-Logic)	-	-	X[1]	X[1]	X	-	-	-	-
Shutdown override	-	-	-	-	X	-	-	-	-
Engine over-speed test	-	-	-	-	-	-	-	-	-
Enable cylinder cut out	-	-	-	-	-	-	-	-	-
Intermittent oil priming	-	-	-	-	-	-	-	-	-
Engine operat-ing mode	-	-	-	-	-	-	-	-	-
Demand switch	-	-	-	-	-	-	-	-	-
Trip counter re-set	-	-	-	-	-	-	-	-	-
Engine speed GOV parame-ter command	-	-	-	-	-	-	-	-	-

Engine type Command	MTU MDEC	MTU ADEC	MTU ADEC M501	MTU J1939 Smart Connect	Scania EMS	Scania EMS S6	Volvo Penta	Volvo Penta EMS 2
Preheat	-	-	-	-	-	-	-	X
Start/Stop	-	X	X	X[1, 5]	-	X	-	X
Run/Stop (fuel)	-	-	-	-	-	-	-	-
Speed Bias	-	X	X	X[1,5]	-	X	-	X
Nominal frequen-cy	-	X	X	X[1]	-	X	-	X
Governor gain	-	-	-	-	-	-	-	-
Idle speed	-	X[1]	X[1]	X[1]	-	X	-	X
MTU Alternate Droop Setting (M-Logic)	-	X[1]	X[1]	X[1,5]	-	X	-	X
Shutdown over-ride	-	X[1]	X[1]	X[1]	-	X	-	X[1]
Engine over-speed test	-	-	-	X[1]	-	-	-	-
Enable cylinder cut out	-	X[1]	X[1]	X[1]	-	-	-	-
Intermittent oil priming	-	-	-	X[1]	-	-	-	-
Engine operating mode	-	-	-	X[1]	-	-	-	-
Demand switch	-	X[1]	X[1]	X[1]	-	-	-	-
Trip counter reset	-	X[1]	X[1]	X[1]	-	-	-	-
Engine speed GOV parameter command	-	-	-	X[1]	-	-	-	-
Reset trip fuel value	X[3]	-	-	-	-	-	-	-

For engine types not mentioned, CAN bus control is not supported. In these cases, start/stop, and so on, must be sent to the controller using hardwired connections.

The menu number 7563 must be used to enable or disable the transmission of all the Multi-line 2 unit EIC control frames listed in the table above.

Commands marked X[1] do not apply to PPM-3.

Commands marked X[2] do not apply to AGC 100, CGC 400, GC-1F and GC-1F/2.

Commands marked X[3] only apply to AGC-4, AGC 200 and AGC PM together with MDEC 303.

Commands marked X^4 only apply to Cummins CM570 ECU.

Commands marked X^5 are not possible with option H7.

Option H7 does not support ECU9

The table below shows the parameter to set ON if the engine is to be controlled from the Multi-line 2 unit:

Parameter	Item	Range	Default	Note
7563	EIC control	OFF ON	OFF	Only in genset.

EIC 50 Hz - 60 Hz switch:
If the set point $f_{nominal}$ is changed in the ML-2 between 50 and 60 Hz, then the change is made with a frequency ramp of 2 Hz per second. This frequency ramp is used when switching between nominal settings 1 to 4 or if the parameter of the nominal frequency is changed between 50 and 60 Hz.

EIC droop:
There are two ways of obtaining a speed droop:

For engines from which the droop command or set point can be sent to the engine controller, the droop setting in parameter 2771 is the actual droop that is being used, and this set point is sent to the ECU. This method is referred to as "EIC droop".

For engines from which the droop command or set point cannot be sent to the engine controller, the droop setting in parameter 2771 is used for droop emulation in the ML-2. This method is referred to as "EIC droop emulation". EIC droop emulation is a generic function, developed by DEIF, which it is possible to use on every engine type.

In both cases, the droop function is activated in the M-Logic (EIC droop/EIC droop emulation) command output.

In the table below, it is shown which engine types support EIC droop with a command or set point.

Engine type/protocols	Command	Set point
Scania	X	X
Cummins	X	X
Iveco	X	-
Perkins	X	-
Caterpillar	X	-
Volvo	X	-
MTU	-	-
DDEC (Detroit Diesel)	-	-
JDEC (John Deere)	-	-
EMR (Deutz)	-	-
Generic J1939	-	-

The parameters for the EIC droop command and set points are shown in the table below:

Parameter	Item	Range	Default	Note
2771	EIC Droop	0.0 % 25.0 %	0.0 %	Only in genset.
2772	Scania RPM	User Low idle	User	Only in genset.
2773	Cummins gain- Kp	0.00 10.0	5.00	Only in genset.

EIC inhibit:
The EIC alarms can be inhibited through M-Logic. This could typically be necessary during stopping of the engine. The following alarms can be inhibited:

- EIC red alarm
- EIC yellow alarm
- EIC malfunction
- EIC protection

EIC Idle:
The "Idle" function of the ML-2 is activated in menu 6290. If this is used with engines with speed control from CAN bus communication, the speed is defined to be 700 RPM.

TSC1 SA "Torque Speed Control":
TSC1 which is "Torque Speed Control 1" is the speed bias control signal transmitted from the DEIF controller towards the engine ECU. The DEIF controller chooses the expected source address for known protocols when parameter 7566 is set to -1 (default value). It is possible to change parameter 7566 to a specific source address. If in doubt, consult your engine manufacturer for verification of TSC1 source address. TSC1 is only relevant for J1939 protocols.

17.3 Specific engine type descriptions

17.3.1 About type descriptions

The J1939 warnings/shutdowns with corresponding SPN and FMI numbers in this chapter refer to those that will automatically appear in the alarm list. The alarms can be acknowledged from the display.

The available alarms vary from engine type to engine type. Besides these, the entire log list can be read in the engine controller by holding the "LOG"/ button for 3 seconds.

17.3.2 Caterpillar/Perkins (J1939)

Object selection:

The view lines can be configured with these available values.

See the chapter "Modbus communication" for Modbus scaling.

EIC Exhaust Gas P1...P16 are fixed to the source address 241. The remaining entries in the table below are fixed to source address 0.

Object	PGN	P	S	L	SPN	Unit	J1939-71 scaling
EIC Exhaust Gas P1 Temp	65187	7	1	2	1137	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P2 Temp	65187	7	3	2	1138	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P3 Temp	65187	7	5	2	1139	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P4 Temp	65187	7	7	2	1140	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P5 Temp	65186	7	1	2	1141	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P6 Temp	65186	7	3	2	1142	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P7 Temp	65186	7	5	2	1143	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P8 Temp	65186	7	7	2	1144	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P9 Temp	65185	7	1	2	1145	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P10 Temp	65185	7	3	2	1146	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P11 Temp	65185	7	5	2	1147	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P12 Temp	65185	7	7	2	1148	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P13 Temp	65184	7	1	2	1149	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P14 Temp	65184	7	3	2	1150	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P15 Temp	65184	7	5	2	1151	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P16 Temp	65184	7	7	2	1152	°C	0.03125 °C/bit, -273°C offset
EIC Coolant Temp 2	64870	6	1	1	4076	°C	1 °C/bit, -40 °C offset
EIC Coolant Temp 3	64870	6	8	1	6209	°C	1 °C/bit, -40 °C offset
EIC Coolant Pump Outlet Temp	64870	6	2	1	4193	°C	1 °C/bit, -40 °C offset
EIC Filtered Fuel Delivery Pressure	64735	6	2	1	5579	kPa	4 kPa/bit, 0 offset
EIC Auxiliary Coolant Temp	65172	6	2	1	1212	kPa	4 kPa/bit, 0 offset
EIC Turbo 1 Intake Temp	65176	6	1	2	1180	°C	0.03125 °C/bit, -273°C offset
EIC Turbo 2 Intake Temp	65176	6	3	2	1181	°C	0.03125 °C/bit, -273°C offset

PGN: Parameter group number
P: J1939 priority
S: Object's start byte in CAN telegram
L: Object's length (byte)
Unit: Unit in display (Bar/°C can be changed to PSI/°F)

The table above only applies to AGC-4, AGC 200 and AGC PM.

Readings from display:

SAE name	Displayed text
Engine Exhaust Gas Port 1 Temperature	Exh.P T01
Engine Exhaust Gas Port 2 Temperature	Exh.P T02
Engine Exhaust Gas Port 3 Temperature	Exh.P T03
Engine Exhaust Gas Port 4 Temperature	Exh.P T04
Engine Exhaust Gas Port 5 Temperature	Exh.P T05
Engine Exhaust Gas Port 6 Temperature	Exh.P T06
Engine Exhaust Gas Port 7 Temperature	Exh.P T07
Engine Exhaust Gas Port 8 Temperature	Exh.P T08
Engine Exhaust Gas Port 9 Temperature	Exh.P T09
Engine Exhaust Gas Port 10 Temperature	Exh.P T10
Engine Exhaust Gas Port 11 Temperature	Exh.P T11
Engine Exhaust Gas Port 12 Temperature	Exh.P T12
Engine Exhaust Gas Port 13 Temperature	Exh.P T13
Engine Exhaust Gas Port 14 Temperature	Exh.P T14
Engine Exhaust Gas Port 15 Temperature	Exh.P T15
Engine Exhaust Gas Port 16 Temperature	Exh.P T16
Engine Coolant Temperature 2	T. Coolant2
Engine Coolant Temperature 3	T. Coolant3
Engine Coolant Pump Outlet Temperature	T. Cool PO
Engine Filtered Fuel Delivery Pressure	P. FilFuel
Engine Auxiliary Coolant Temperature	T. Cool Aux
Engine Turbocharger 1 Turbine Intake Temperature	Turb.int1
Engine Turbocharger 2 Turbine Intake Temperature	Turb.int2

Warnings and shutdowns:

Warning/shutdown list	J1939 codes		
	SPN	FMI warning	FMI shutdown
Low oil pressure	100	17	1
Intake manifold #1 P	102	15	-
Coolant temperature	110	15	1
High inlet air temp.	172	15	-
Fuel temperature	174	15	-
Overspeed	190	15	0
EIC yellow lamp	-	X	-
EIC red lamp	-	-	X
EIC malfunction[1]	-	X	-
EIC protection[1]	-	X	-

FMI indication " – " means that the alarm in question is not supported.

Warnings and shutdowns marked [1] do not apply to PPM-3.

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (for example: speed, start/stop, and so on) are enabled in setting 7563 (EIC Controls).
- Engine speed
  CAN bus ID for speed control: 0x0c000000. J1939 TSC1.
- M-Logic commands are available to enable/disable start/stop and speed controls
  - EIC start/stop enable[1]
  - EIC speed control inhibit[1]

The speed regulation is enabled in settings 2781 (Reg. output) and 7563 (EIC Controls).

Commands marked [1] do not apply to PPM-3.

Write commands to AVR:

- AVR control
  All write commands to the AVR (voltage control) are enabled in menu 7563 (EIC controls). If engine controls are needed but not the AVR control, the latter can be disabled through menu 7565.

Write commands to AVR only apply to AGC-3, AGC-4, AGC 200 and AGC PM, GPC-3, PPU-3 and GPU-3.

17.3.3 Cummins CM850-CM570 (J1939)

Warnings and shutdowns:

Warning/shutdown list	J1939 codes		
	SPN	FMI warning	FMI shutdown
Low oil pressure	100	18	1
Coolant temperature	110	16	0
Oil temperature	175	16	0
Intake manifold temp	105	16	0
Fuel temperature	174	16	0
Coolant level low	111	18	1
Overspeed	190	-	16
Crankcase pressure high	101	-	0
Coolant pressure low	109	-	1
EIC yellow lamp	-	X	-
EIC red lamp	-	-	X
EIC malfunction[1]	-	X	-
EIC protection[1]	-	X	-

FMI indication " – " means that the alarm in question is not supported.

Warnings and shutdowns marked [1] do not apply to PPM-3.

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (for example: speed, start/stop, and so on) are enabled in setting 7563 (EIC Controls).

  M-Logic commands are available to enable/disable speed controls:
  - EIC speed control inhibit[1].
- Engine speed
  CAN bus ID for speed control: 0x00FF69DC. For Cummins proprietary "Engine governing" EG telegram, the source address of the ML-2 controller is 0xDC/220 (dec).
- Engine speed (engine with PCC controller)[1, 2]
  CAN bus ID for speed control: 0x00FF5FDC. For Cummins propietary "Engine governing" EG telegram, the source address of the ML-2 controller is 0xDC/220 (dec.). This speed telegram is used by enabling the M-Logic function "EIC select Cummins PCC1301".

The speed regulation is enabled in settings 2781 (Reg. output) and 7563 (EIC Controls).

- Frequency selection
  Nominal frequency is written automatically, based on the frequency nominal setting. 50 Hz is written if fNOM < 55 Hz, 60 Hz is written if fNOM is > 55 Hz.
- Gain setting
  Gain is set in menu 2773.
- Shutdown override*

This command can be used in order to prevent shutdown actions from the ECU. The function follows the standard AGC function "shutdown override" (digital input on the AGC)

Commands marked 1 do not apply to PPM-3.

Commands marked 2 do not apply to AGC 100, CGC 400, GC-1F and GC-1F/2.

Cummins aftertreatment:
If Cummnins aftertreatment equipment is installed in the exhaust line and the system is connected to the ECU, then indicators from the treatment system can be read over the J1939 link and some regeneration can be controlled.

The table shows lamps and status indicators from the aftertreatment. The states can be reached through M-Logic and can be shown on a DEIF AOP-1 or AOP-2 display unit.

Status indicator	Diesel particulate filter regeneration status	Diesel particulate filter status	Particulate filter lamp	High exhaust system temp.	Regeneration disabled
State					
OFF	-	-	X	X	-
ON solid	-	-	X	X	-
ON fast blink	-	-	X	-	-
Inhibited	-	-	-	-	X
Not inhibited	-	-	-	-	X
Not active	X	-	-	-	-
Active	X	-	-	-	-
Regeneration needed	X	-	-	-	-
Regeneration not needed	-	X	-	-	-
Regeneration lowest level	-	X	-	-	-
Regeneration moderate level	-	X	-	-	-
---Regeneration highest level	-	X	-	-	-

Besides the lamp and status indicators, two aftertreatment switches for control of the regeneration are available. These can be reached through M-Logic in the command group.

1. Cummins particulate filter manual (non-mission) regeneration initiate.
2. Cummins particulate filter regeneration.

Cummins aftertreatment does not apply to PPM-3.

17.3.4 Detroit Diesel DDEC (J1939)

Warnings and shutdowns:

Warning/shutdown list	J1939 codes		
	SPN	FMI warning	FMI shutdown
EIC yellow lamp	-	X	-
EIC red lamp	-	-	X
EIC malfunction[1]	-	X	-
EIC protection[1]	-	X	-

FMI indication " – " means that the alarm in question is not supported.

Warnings and shutdowns marked [1] do not apply to PPM-3.

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (for example: speed, start/stop, and so on) are enabled in setting 7563 (EIC Controls).
- Engine speed
  CAN bus ID for speed control: 0x0c000003. J1939 TSC1.
  M-Logic commands are available to enable/disable start/stop and speed controls
  - EIC speed control inhibit[1]

The speed regulation is enabled in settings 2781 (Reg. output) and 7563 (EIC Controls).

Commands marked [1] do not apply to PPM-3.

17.3.5 Deutz EMR 2 - EMR 3 (J1939)

Warnings and shutdowns:

Warning/shutdown list	J1939 codes		
	SPN	FMI warning	FMI shutdown
Low oil pressure	100	-	1
Coolant temperature	110	-	0
Overspeed	190	-	0
EIC yellow lamp	-	X	-
EIC red lamp	-	-	X
EIC malfunction[1]	-	X	-
EIC protection[1]	-	X	-

FMI indication " – " means that the alarm in question is not supported.

Warnings and shutdowns marked [1] do not apply to PPM-3.

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (for example: speed, start/stop, and so on) are enabled in setting 7563 (EIC Controls).
- Engine speed
  CAN bus ID for speed control: 0xc000003. For J1939 TSC1, the source address of the ML-2 controller is 3.

  M-Logic commands are available to enable/disable speed controls:
  - EIC speed control inhibit[1]

The speed regulation is enabled in settings 2781 (Reg. output) and 7563 (EIC Controls).

Commands marked [1] do not apply to PPM-3.

17.3.6 Generic J1939 (J1939)

Warnings and shutdowns:

Warning/shutdown list	J1939 codes		
	SPN	FMI warning	FMI shutdown
EIC yellow lamp	-	X	-
EIC red lamp	-	-	X
EIC malfunction[1]	-	X	-
EIC protection[1]	-	X	-

FMI indication " – " means that the alarm in question is not supported.

Warnings and shutdowns marked [1] do not apply to PPM-3.

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (for example: speed, start/stop, and so on) are enabled in setting 7563 (EIC Controls).
- Engine speed
  CAN bus ID for speed control: 0x0c000003. J1939 TSC1.
  M-Logic commands are available to enable/disable start/stop and speed controls
  - EIC speed control inhibit[1]

The speed regulation is enabled in settings 2781 (Reg. output) and 7563 (EIC Controls).

Commands marked [1] do not apply to PPM-3.

17.3.7 Iveco (J1939)

Warnings and shutdowns:

Warning/shutdown list	J1939 codes		
	SPN	FMI warning	FMI shutdown
Low oil pressure	100	17	1
Intake manifold #1 P	102	15	-
Coolant temperature	110	15	0
High inlet air temp.	172	15	-
Fuel temperature	174	15	-
Overspeed	190	15	0
EIC yellow lamp	-	X	-
EIC red lamp	-	-	X
EIC malfunction[1]	-	X	-
EIC protection[1]	-	X	-

FMI indication " – " means that the alarm in question is not supported.

Warnings and shutdowns marked [1] do not apply to PPM-3.

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (for example: speed, start/stop, and so on) are enabled in setting 7563 (EIC Controls).
- Engine speed
  CAN bus ID for speed control: 0xc000003.
  For J1939 TSC1, the source address of the ML-2 controller is 3.
  For the Iveco Vector 8 type only: CAN bus ID for speed control: 0xcFF0027.
  M-Logic commands are available to enable/disable start/stop and speed controls:
  - EIC speed control inhibit[1]

The speed regulation is enabled in settings 2781 (Reg. output) and 7563 (EIC Controls).

Commands marked [1] do not apply to PPM-3.

17.3.8 John Deere JDEC (J1939)

Warnings and shutdowns:

Warning/shutdown list	J1939 codes		
	SPN	FMI warning	FMI shutdown
Low oil pressure	100	18	1
Intake manifold	105	16	-
Coolant temperature	110	16	0
Fuel injection pump	1076	10	6
Fuel temperature	174	-	16
ECU failure	2000	-	6
EIC yellow lamp	-	X	-
EIC red lamp	-	-	X
EIC malfunction[1]	-	X	-
EIC protection[1]	-	X	-

FMI indication " – " means that the alarm in question is not supported.

Warnings and shutdowns marked [1] do not apply to PPM-3.

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (for example: speed, start/stop, and so on) are enabled in setting 7563 (EIC Controls).
- Engine speed
  CAN bus ID for speed control: 0x0c000003. J1939 TSC1.
  M-Logic commands are available to enable/disable start/stop and speed controls
  - EIC speed control inhibit[1]

The speed regulation is enabled in settings 2781 (Reg. output) and 7563 (EIC Controls).

Commands marked [1] do not apply to PPM-3.

17.3.9 MTU ADEC (CANopen)

The MTU ADEC is not a part of the J1939, therefore the reading of values, alarms and shutdowns is different.

Readings from the display:

Display readings
Battery
EIC faults
Engine power[1]
Fuel rate
Mean T. fuel
Nom. power[1]
Operation
P. Aux 1
P. Aux 2
P. Boost
P. Fuel
P. Oil
Speed
T. Charg A
T. Coolant
T. Exh. L
T. Exh. R
T. Fuel
T. Int. Co.
T. Oil
T. Winding 1
T. Winding 2
T. Winding 3
Trip fuel

The Modbus addresses are read-only (function code 04h) and are only available if option H2/N Modbus RTU is implemented.

Objects marked [1] only apply to AGC 100, AGC-4, AGC 200, AGC PM and CGC 400.

Warning:
Below is a list of warnings that can be shown on the display. The warnings will be shown as an alarm in the alarm window. The alarms can be acknowledged from the display, but they will be visible until the alarm disappears in the ECM module.

Warning list	Display list
Coolant temp. high	HI T-Coolant
Charge air temp. high	HI T-Charge Air
Intercooler coolant temp. high	HI T-Coolant Interc
Lube oil temp. high	HI T-Lube Oil
ECU temp. high	HI T-ECU
Engine speed too low	SS Engine Speed Low
Prelube fail.	AL Prelub. Fail
Start speed not reached	AL Start Spe. N. Re.
Common alarm (yellow)	AL Com. Alarm Yellow
Lube oil pressure low	LO P-Lube Oil
Coolant level low	LO Coolant Level
Intercooler coolant level low	LO Interc. Cool. L.
ECU defect	AL ECU Defect
Speed demand failure	AL Speed Demand Def.
Power supply low voltage	LO Power Supply
Power supply high voltage	HI Power supply
Overspeed	SS Overspeed
Lube oil pressure low low	LOLO P-Lube Oil
Coolant temp. high high	HIHI T-Coolant
Lube oil temp. high high	HIHI T-Lube Oil
Charge air temp. high high	HIHI T-Charge Air
ECU power supply high high	HIHI ECU PS Voltage
ECU power supply low low	LOLO ECU PS Voltage
Generator temp. high	T-Generator Warning
Holding tank high level	HI Level Day-Tank
Holding tank low level	LO Level Day-Tank
Generator winding 1 high temp.	HI T-Winding 1
Generator winding 2 high temp.	HI T-Winding 2
Generator winding 3 high temp.	HI T-Winding 3
Ambient temp. high	HI T-Ambient
Water in fuel 1	AL Water I F. Pref. 1
Water in fuel 2	AL Water I F. Pref. 2
Fuel temp. high	HI T-Fuel
Exhaust bank A high temp.	HI T-Exhaust A
Exhaust bank B high temp.	HI T-Exhaust B
Fuel high pressure 1	HI Pressure 1
Fuel high pressure 2	HI Pressure 2

Warning list	Display list
Day tank high level	HI L. Holding-Tank
Day tank low level	LO L. Holding-Tank
Run-up speed not reached	AL Runup. Speed N. Re
Idle speed not reached	AL Idle Speed N. Re

Shutdown:
Below is a shutdown value that can be shown on the display. It is possible to configure "EIC shutdown" in the system setup to put the unit in a shutdown state and/or to activate relay outputs if necessary. The shutdown state is present until it disappears in the ECM module.

Shutdown list	Display text
AL Com. Alarm Red	AL Com. Alarm Red

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (for example: speed, start/stop, and so on) are enabled in setting 7563 (EIC Controls).
- Engine speed
  CAN bus ID for speed control: 0x300+ADEC ID – speed demand telegram (ADEC ID is selected in menu 7562, default ID is 6: 0x306).

  M-Logic commands are available to enable/disable start/stop and speed controls:
  - EIC start/stop enable[1]

The speed regulation is enabled in settings 2781 (Reg. output) and 7563 (EIC Controls). Commands marked [1] do not apply to PPM-3.

- Start/stop command
- Frequency selection
  Nominal frequency is written automatically based on the frequency nominal setting. 50 Hz is written if fNOM < 55 Hz, 60 Hz is written if fNOM is > 55 Hz.

The CANopen node ID no. is selected in setting 7562. The default value (6) usually matches the ADEC setting.

- Demand switch*
  Set method of speed control between digital ("Up/down ECU" with relay controls), analogue ("Analog ECU Relative" for analogue V DC control) or from J1939 commands ("Analog CAN"). This is selected in menu 2790. Refer to the MTU documentation of the ECU8 for further information about switching between normal and emergency operation in local or remote.
- Trip counter*
  This command resets the trip fuel consumption counter. The command is activated through M-Logic.
- Enable Cylinder Cutout
  The command can be used to engage all cylinders if the engine is running with one bank only. The command is activated through M-Logic.
- Shutdown override

This command can be used in order to prevent shutdown actions from the ECU. The function follows the standard AGC function "shutdown override" (digital input on the AGC).

17.3.10 MTU ADEC module 501, without SAM module (CANopen)(Option H13)

The MTU ADEC module 501 is not a part of the J1939, therefore the reading of values, alarms and shutdowns is different.

Readings from the display:

Display readings
Act-Droop
Battery
Camshaft
ECU Stop activated 1
F speed an
INJECT-QUAN
MDEC Faults
Mean T. fuel
Nom power[1]
Operation[1]
P L Oil Lo
P L Oil Lolo
P. Ch. Air
P. Fuel
P. Oil
Speed
Speed D SW[1]
T. Ch. Air[1]
T. Coolant[1]
T. Fuel[1]
T. Oil[1]
TCOOL-HIHI[1]
T-ECU[1]
T-INTERC[1]
T-LUBE-HI[1]
T-LUBE-HIHI[1]
Total fuel[1]
Trip fuel[1]

The Modbus addresses are read-only (function code 04h) and are only available if the option H2/N Modbus RTU is implemented.

Objects marked [1] only apply to AGC-4, AGC 200 and AGC PM.

Alarms:
Below is a list of alarms that can be shown on the display. The alarms will be shown in the alarm window. The alarms can be acknowledged from the display, but they will be visible until the alarm disappears in the ECM module.

Alarm list	Display text	Warning	Shutdown
ADEC yellow alarm	EIC yellow lamp WA	X	-
ADEC red alarm	EIC red lamp SD.	-	X
High high engine speed	Overspeed shutdown	X	-
Low low lube oil pressure	L Oil Pres. Shutdown	X	-
High high coolant temperature	H Coolant T Shutdown	X	-
High intercooler temperature	H Interc. T Warning	X	-
Sensor Defect Coolant Level	SD Coolant Level	X	-
Low low coolant level	L Cool. Lev. Shutdown	X	-
ADEC ECU failure	MDEC ECU Failure	X	-
Low Lube oil pressure[1]	L Oil Pres. Warning	X	-
Low Common rail fuel pressure[1]	LO P-Fuel Com-Rail	X	-
High Common rail fuel pressure[1]	HI P-Fuel Com-Rail	X	-
Low preheat temperature[1]	AL Preheat Temp. Low	X	-
Low low Charge air coolant level[1]	SS Cool Level Ch-Air	X	-
Power amplifier 1 failure[1]	AL Power Amplifier 1	X	-
Power amplifier 2 failure[1]	AL Power Amplifier 2	X	-
Transistor output status[1]	AL Status Trans-Outp	X	-
Low ECU power supply voltage[1]	LO ECU Power Supply	X	-
High ECU power supply voltage[1]	HI ECU Power	X	-
High charge air temperature[1]	HI T-Charge Air	X	-
High Lube oil temperature[1]	HI T-Lube Oil	X	-
High ECU temperature[1]	HI T-ECU	X	-
Low engine speed[1]	SS Eng. Speed Low	X	-
Check error code[1]	AL Check Error Code	X	-
Common rail leakage[1]	AL Com. Rail Leakage	X	-
Automatic engine stop[1]	AL Aut. Engine Stop	X	-
MG Start speed not reached[1]	MG Start Speed Fail	X	-
MG runup speed not reached[1]	MG Runup Speed Fail	X	-
MG idle speed reached[1]	MG Idle Speed Fail	X	-
Low low ECU power supply voltage[1]	LOLO ECU Pow. Supply	X	-
High high ECU power supply voltage[1]	HIHI ECU Pow. Supply	X	-
Sensor Defect coolant level charge air[1]	SD Cool Level Ch-Air	X	-
High fuel temperature[1]	HI T-Fuel	X	-
Override feedback from ECU[1]	SS Override	X	-

Alarm list	Display text	Warning	Shutdown
High high lube oil temperature[1]	H Oil Temp. Shutdown	X	-
Speed demand defected[1]	AL Speed demand Def.	X	-
High coolant temperature[1]	H Coolant T Warning	X	-
High high temperature charge air[1]	H Ch. Air T Shutdown	X	-
Low fuel oil pressure[1]	LO P-Fuel Oil	X	-
Low low fuel oil pressure[1]	SS P-Fuel Oil	X	-

MDEC indication " – " means that the alarm in question is not supported.

Alarms marked [1] only apply to AGC-4, AGC 200 and AGC PM.

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (for example: speed, start/stop, and so on) are enabled in setting 7563 (EIC Controls).
- Engine speed
  M-Logic commands are available to enable/disable start/stop and speed controls:
  - EIC start/stop enable[1]
  - EIC speed control inhibit[1]
- Manual speed control (up/down)

The speed regulation is enabled in settings 2781 (Reg. output) and 7563 (EIC Controls).

- Start/stop command
- Frequency selection
  Nominal frequency is written automatically based on the frequency nominal setting. 50 Hz is written if fNOM < 55 Hz, 60 Hz is written if fNOM is > 55 Hz.
- Shutdown override
  This command can be used with a digital input in order to override shutdown actions from the ECU.
- Trip counter reset*
  This command resets the trip fuel consumption counter. The command is activated through M-Logic.
- Enable Cylinder Cutout*
  The command can be used to engage all cylinders if the engine is running with one bank only. The command is activated through M-Logic.
- Engine overspeed test
  The command is activated through M-Logic. Testing of the overspeed function at any given RPM.
- EIC alarms acknowledgement
- Intermittent oil priming
  Engages the pre-lubrication oil pump, if installed. The command is activated through M-Logic.
- Priming on engine start

Commands marked [1] do not apply to PPM-3.

17.3.11 MTU J1939 Smart Connect (J1939)

This protocol is available with MTU series 1600 with ECU8/ECU9/Smart Connect.

This protocol does not apply to PPM-3.

Alarm texts for ECU9 can be found in the Appendix under "MTU Smart Connect ECU9".

Warnings and shutdowns:

Warning/shutdown list	J1939 codes		
	SPN	FMI warning	FMI shutdown
EIC yellow lamp	-	X	-
EIC red lamp	-	-	X
EIC malfunction	-	X	-
EIC protection	-	X	-

FMI indication " – " means that the alarm in question is not supported.

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (for example, speed, start/stop, and so on) are enabled in setting 7563 (EIC controls).
- Engine speed
  CAN bus ID for speed control: 0x0c0000ea.J1939TSC1.
  M-Logic commands are available to enable/disable start/stop and speed controls:
  - EIC start/stop enable
  - EIC speed control inhibit

The speed regulation is enabled in settings 2781 (Reg. output) and 7563 (EIC controls).

- Frequency selection
  Normal frequency is written automatically based on the frequency nominal setting. 50 Hz is written if $f_{nominal}$ <55 Hz, 60 Hz is written if $f_{nominal}$ is >55 Hz.
- Shutdown override
  This command can be used with a digital input in order to override shutdown actions from the ECU.
- Engine overspeed test
  The command is activated through M-Logic. Testing of the overspeed function at any given RPM.
- Enable cylinder cutout
  The command can be used to engage all cylinders if the engine is running with one bank only. The command is activated through M-Logic.
- Intermittent oil priming
  Engages the pre-lubrication oil pump, if installed. The command is activated through M-Logic.
- Engine operating mode
  Switches the operating mode of the engine. The command is activated through M-Logic (EIC Engine opr mode command).
- Demand switch

Set method of speed control between digital ("Up/down ECU" with relay controls), analogue ("Analog ECU Relative" for analogue V DC control) or from J1939 commands ("Analog CAN"). This is selected in menu 2790. Refer to the MTU documentation of the ECU8 for further information about switching between normal and emergency operation in local or remote.
If the MTU ECU is unable to detect a valid speed demand signal, it will issue the "Al Speed deman def.". This alarm indicates that the MTU ECU may see a CAN speed bias signal and is set up to 3 - ADEC Analog Relative, or that 4 - ADEC Analog relative is used and the signal is out of range (not connected, and so on).
When this happens, check the settings on the MTU ECU,
PR500 (MTU SAM/Diasys reference)
0 - Default dataset ADEC
1 - ADEC Increase/Decrease Input
2 - CAN Increase/Decrease Input
3 - ADEC Analog Absolute
4 - ADEC Analog Relative
5 - ADEC Frequency Input
6 - CAN Analog
7 - CAN Speed Demand Switch

- Speed gov. param command
  Parameter switch for selection between: Default and Variant 1 M-Logic is used to select variant 1 parameters.
- Trip counter reset
  This command resets the trip fuel consumption counter. The command is activated through M-Logic.
- Idle Run
  This command activates idle speed.
- Speed Increase
  This command increases the speed of the engine by a small amount. The command is activated through M-Logic.
- Speed Decrease
  This command decreases the speed of the engine by a small amount. The command is activated through M-Logic.
- Alternate Droop Setting
  This command activates alternate droop setting. The command is activated through M-Logic.
- Start
  This command starts the genset.
- Stop
  This command stops the genset.

Demand switch:
For the ECU8/9/Smart connect, the AGC holds some parameters, in which it is possible to make a switch between different inputs on the ECM for the speed signal/bias. The setting in the parameters can be chosen between:

Setting	Description
Analog CAN	Commands the ECM to receive the speed signal/bias via the CAN bus. The signal will be a digital signal that is similar to an analogue regulation signal. This can be considered as “analogue regulation via CAN bus”.
Up/Down ECU	Commands the ECM to receive the speed signal/bias via digital inputs. To control the ECM from the AGC, this must be done with relay regulation. This can be considered as “normal relay regulation”.
Up/Down CAN	Commands the ECM to receive the speed signal/bias via the CAN bus. The signal will be a digital signal. The AGC will send commands to increase or decrease to the ECM. This can be considered as “relay regulation via CAN bus”.
Analog ECU	Commands the ECM to receive the speed signal/bias via analogue input. To control the ECM from the AGC, it must be done via analogue regulation. With this setting, the ECM will regulate the whole engine range on the analogue signal. This could be, for example, 0 to 5 V DC equals 700 RPM – 2000 RPM. This can be considered as “analogue regulation with a big regulation range”.
Analog ECU Relative	Commands the ECM to receive the speed signal/bias via analogue input. To control the ECM from the AGC, it must be done via analogue regulation. With this setting, the ECM will be regulated in a smaller range. This could be, for example, 0 to 5 V DC equals 1350 RPM – 1650 RPM. This gives a higher resolution in the regulation area. This can be considered as “analogue regulation with a narrow range”.
Frequency	Commands the ECM to receive the speed signal/bias via a frequency/PWM input.

The ECU8/9 can be in four different states. These are:

- Local, Normal operation (2791)
- Local, Emergency operation (2792)
- Remote, Normal operation (2793)
- Remote, Emergency operation (2794)

The AGC has the possibility to set which type of speed signal should be used for each state. The parameters for each state are shown in the table below:

Parameter	Item	Range	Default	Note
2791	Local, Normal operation – Speed signal	Analog CAN Frequency	Analog CAN	Only in genset
2792	Local, Emergency operation – Speed signal	Analog CAN Frequency	Analog CAN	Only in genset
2793	Remote, Normal operation – Speed signal	Analog CAN Frequency	Analog CAN	Only in genset
2794	Remote, Emergency operation – Speed signal	Analog CAN Frequency	Analog CAN	Only in genset

When changing one of the parameters above, parameter 7563 (EIC control) must be ON. Otherwise the command will not be sent.
If the AGC is showing an alarm with "AL speed dem. def.", it means that there is a mismatch between the speed signal/bias. The ECM has been set to run with a speed signal from one source, but detects something on another source. This may be because the ECM module has been configured to have the speed signal from one source, and the AGC sends the AGC speed signal from another.

17.3.12 MTU MDEC module 302/303 (CANopen)

The MTU MDEC is not a part of the J1939, therefore the reading of values, alarms and shutdowns is different.

Readings from display:

Display readings
Act-Droop
Battery
Camshaft
ECU Stop activated 1
F speed an
Fuel Rate
INJECT-QUAN
MDEC Faults
Mean T. fuel
Nom power
Operation
P L Oil Lo
P LOil Lolo
P. Ch. Air
P. Fuel
P. Oil
Speed
Speed D SW[1]
T. Ch. Air[1]
T. Coolant[1]
T. Fuel[1]
T. Oil[1]
T-COOL-HI[1]
TCOOL-HIHI[1]
T-ECU[1]
T-INTERC[1]
T-LUBE-HI[1]
T-LUBE-HIHI[1]
Total fuel[1]
Trip fuel[1]

The Modbus addresses are read-only (function code 04h) and are only available if the option H2/N Modbus RTU is implemented.

Objects marked [1] only apply to AGC-4, AGC 200, AGC PM and CGC 400.

Alarms:

Below is a list of alarms that can be shown on the display. The alarms will be shown in the alarm window. The alarms can be acknowledged from the display, but they will be visible until the alarm disappears in the ECM module.

Alarm list	Display text	Warning	Shutdown
MDEC yellow alarm	EIC yellow lamp	X	-
MDEC red alarm	EIC red lamp SD.	-	X
High high engine speed	Overspeed shutdown	-	X
Low low lube oil pressure	L Oil Pres. Shutdown	X	X
High high coolant temperature	H Coolant T Shutdown	X	X
High high lube oil temperature	H Oil Temp. Shutdown	-	X
High intercooler temperature	H Interc. T Warning	X	-
Sensor Defect Coolant Level	SD Coolant Level	X	-
Low low coolant level	L Cool. Lev. Shutdown	-	X
MDEC ECU failure	MDEC ECU Failure	-	X
Low fuel oil pressure[1]	LO P-Fuel Oil	X	-
Low Lube oil pressure[1]	L Oil Pres. Warning	X	-
Low Common rail fuel pressure[1]	LO P-Fuel Com-Rail	X	-
High Common rail fuel pressure[1]	HI P-Fuel Com-Rail	X	-
Override feedback from ECU[1]	SS Override	X	-
Low preheat temperature[1]	AL Preheat Temp. Low	X	-
Low low Charge air coolant level[1]	SS Cool Level Ch-Air	X	-
Power amplifier 1 failure[1]	AL Power Amplifier 1	X	-
Power amplifier 2 failure[1]	AL Power Amplifier 2	X	-
Transistor output status[1]	AL Status Trans-Outp	X	-
Low ECU power supply voltage[1]	LO ECU Power Supply	X	-
High ECU power supply voltage[1]	HI ECU Power	X	-
High charge air temperature[1]	HI T-Charge Air	X	-
High Lube oil temperature[1]	HI T-Lube Oil	X	-
High ECU temperature[1]	HI T-ECU	X	-
Low engine speed[1]	SS Eng. Speed Low	X	-
Check error code[1]	AL Check Error Code	X	-
Common rail leakage[1]	AL Com. Rail Leakage	X	-
Automatic engine stop[1]	AL Aut. Engine Stop	X	-
MG Start speed not reached[1]	MG Start Speed Fail	X	-
MG runup speed not reached[1]	MG Runup Speed Fail	X	-
MG idle speed reached[1]	MG Idle Speed Fail	X	-
Low low ECU power supply voltage[1]	LOLO ECU Pow. Supply	X	-
High high ECU power supply voltage[1]	HIHI ECU Pow. Supply	X	-

Alarm list	Display text	Warning	Shutdown
Sensor Defect coolant level charge air[1]	SD Cool Level Ch-Air	X	-
High fuel temperature[1]	Hi T-Fuel	X	-

MDEC indication " – " means that the alarm in question is not supported.

Alarms marked [1] only apply to AGC-4, AGC 200 and AGC PM.

Write commands to engine controller:

None.

17.3.13 Scania EMS (J1939)

Warnings and shutdowns:
None.

Write commands to engine controller:
None.

17.3.14 Scania EMS 2 S6 (J1939)

Scania EMS 2 S6 does not use the J1939 SPN/FMI (Suspect Parameter Number/Failure Mode Indicator) system for alarm handling. Instead, the DNL2 system is used. For this reason, the alarm handling is also different.

Warnings and shutdowns (DNL2 alarms):
Below is a list of warnings and shutdowns that can be shown on the display. They will be shown as an alarm in the alarm window. The alarms can be acknowledged from the display, but they will be visible until the alarm disappears in the ECM module.

Warning/shutdown list	DNL2 warning	DNL2 shutdown
EMS warning	X	-
Low oil pressure	X	-
High coolant temp	X	-
Stop limit exceeded	-	X
Charge 61	X	-
EIC yellow lamp	X	-
EIC red lamp	-	X
EIC malfunction[1]	X	-
EIC protection[1]	X	-

DNL2 indication " – " means that the alarm in question is not supported.

Handling of alarms is only active when the engine is running.

Warnings and shutdowns marked [1] do not apply to PPM-3.

Error log:
It is possible to retrieve and acknowledge alarms in the error log of the Scania EMS S6 (KWP 2000).

The alarms available are the same alarms that can be read by the flash combination of the diagnostics lamp on the EMS S6 (refer to the engine documentation).

For option H5 or H13, the EMS S6 software version and engine number is automatically retrieved when CAN bus communication is established.

Flash code	ML-2 displayed text	Description
11	Overreving	One or both engine speed sensors have indicated above 3000 rpm
12	Speed sensor 1	Engine sensor 1
13	Speed sensor 2	Engine sensor 2
14	Water T sen.	Engine coolant temperature sensor
15	Char. air T sen	Charge air temperature sensor
16	Char. air P sen	Charge air pressure sensor
17	Oil temp. sen.	Oil temperature sensor
18	Oil pres. sen.	Oil pressure sensor
23	Fault in cor.	Fault in coordinator
25	Throttle pedal	CAN message for fine tune nominal speed out of range
27	Emerg. stop o.r	Engine stop overridden
31	Oil pres. prot	Oil pressure protection activated
32	Wrong parameter	Wrong parameter setting for defect CAN communication
33	Battery voltage	Battery voltage out of range
37	Emerg. stop cor	Emergency stop switch activated
43	CAN cir. defect	CAN circuit defect
48	CAN mess. DLN1	CAN message from the coordinator missing or not correct
49	Wrong CAN ver.	Non-matching CAN version in EMS and coordinator
51	Un. inj. cyl. 1	Unit injector cylinder 1
52	Un. inj. cyl. 2	Unit injector cylinder 2
53	Un. inj. cyl. 3	Unit injector cylinder 3
54	Un. inj. cyl. 4	Unit injector cylinder 4
55	Un. inj. cyl. 5	Unit injector cylinder 5
56	Un. inj. cyl. 6	Unit injector cylinder 6
57	Un. inj. cyl. 7	Unit injector cylinder 7
58	Un. inj. cyl. 8	Unit injector cylinder 8
59	Extra ana. inp.	Voltage out of range on extra analogue input pin
61	System shutdown	System shut down incorrectly
66	Coola. l. prot.	Low engine coolant level
86	HW watchdog	Hardware watchdog
87	Fault in RAM	The EMS has detected that the fault code memory is not functioning correctly
89	Seal	The programme in the EMS has been altered in a prohibited manner
94	Coola. shut off	Engine coolant temperature/oil pressure shutdown
96	Overheat prot.	Overheat protection activated
99	Fault in TPU	Error in TPU Timer Processor Unit

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (for example, speed, start/stop, and so on) are enabled in setting 7563 (EIC Controls).
- Droop
- Engine speed

CAN bus ID:	Offset: 0xcfff727
Speed	0x0cff8027

  M-Logic commands are available to enable/disable start/stop and speed controls:
  - EIC start/stop enable[1]
  - EIC speed control inhibit[1]

- Frequency selection
  Nominal speed/frequency is selected in 2772. If "User" is selected, nominal speed/frequency is written automatically, based on the frequency nominal setting.
- Start/stop command

The speed regulation is enabled in settings 2781 (Reg. output) and 7563 (EIC Controls).

It is only possible to write commands to the engine when the Scania Coordinator is NOT mounted.

Commands marked [1] do not apply to PPM-3.

Control:
In parameter 2770 it is possible to configure the droop setting and the initial speed setting.

17.3.15 Volvo Penta EMS (J1939)

Warnings and shutdowns:

Warning/shutdown list	J1939 codes		
	SPN	FMI warning	FMI shutdown
Low oil pressure	100	5	-
Intake manifold #1 P	102	-	-
Coolant temperature	110	5	-
High inlet air temp.	172	5	-
Fuel temperature	174	-	-
Fuel pressure	94	5	-
Oil level	98	5	-
Overspeed	190	-	0
Coolant level low	111	-	1
EIC yellow lamp	-	X	-
EIC red lamp	-	-	X
EIC malfunction[1]	-	X	-
EIC protection[1]	-	X	-

Warnings and shutdowns marked [1] do not apply to PPM-3.

Write commands to engine controller:

None.

17.3.16 Volvo Penta EMS 2 (J1939)

EMS 2 and EDCIII/D6, D7, D9, D12 and D16 (GE and AUX variants only).

Warnings and shutdowns:

Warning/shutdown list	J1939 codes		
	SPN	FMI warning	FMI shutdown
Low oil pressure	100	5	-
Intake manifold #1 P	102	-	-
Coolant temperature	110	5	-
High inlet air temp.	172	5	-
Fuel temperature	174	-	-
Fuel pressure	94	5	-
Oil level	98	5	-
Overspeed	190	-	0
Coolant level low	111	-	1
EIC yellow lamp	-	X	-
EIC red lamp	-	-	X
EIC malfunction[1]	-	X	-
EIC protection[1]	-	X	-

FMI indication " – " means that the alarm in question is not supported.

Warnings and shutdowns marked [1] do not apply to PPM-3.

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (for example, speed, start/stop, and so on) are enabled in setting 7563 (EIC Controls).
- Engine speed
  CAN bus ID for speed control: 0x0cff4611 – Volvo Penta proprietary telegram
  M-Logic commands are available to enable/disable start/stop and speed controls:
  - EIC start/stop enable[1]
  - EIC speed control inhibit[1]
- Pre-heat
- Start/stop

Commands marked [1] do not apply to PPM-3.

Readable states:
- Pre-heat and running

The speed regulation is enabled in settings 2781 (Reg. output) and 7563 (EIC Controls).

Selection of primary or secondary speed is selected in setting 2774.

17.4 Modbus communication

17.4.1 Additional information for H2/N

This chapter is to be considered as additional information for option H2/N (Modbus RS-485 RTU). Refer to the ECM (Engine Communication Module) user manuals for more information about the ECM protocol technical description and the details of each communication value. If option H2/N is installed, the data can be transmitted to a PLC, a computer, the alarm- and monitoring system or a Scada system.

Refer to the option H2/N technical documentation for more information about our standard external Modbus communication.

A certain amount of engine data can be transmitted from the engine communication module to the controller unit. They can be transmitted through Modbus option H2/N.

The available values depend on the selected type of engine communication.

The data readable by the Modbus communication is converted into the chosen unit in menu 10970.

17.4.2 Readings via Modbus - analogue values

The reading of values is independent of engine type, so all readings below are available in the Modbus protocol.

The availability of data from the individual engine types is dependent on the specific engine. Refer to the engine manual in question.

This data refers to the common J1939 display reading list, as well as the overview of readings in the MTU ADEC (CANopen) and MTU MDEC (MTU protocol).

Measurement table (read only) function code 04h.						
Addr.	Content	Unit	Scaling			Description
			J1939	ADEC	MDEC	
593	EIC speed	[RPM]	1/1	1/1	1/1	Speed
594	EIC coolant temp.	[deg] [F]	1/10	1/10	1/10	Coolant temperature
595	EIC oil pressure	[bar] [psi]	1/100	1/100	1/100	Engine oil pressure
596	EIC no of faults	[Faults]	1/1	1/1	1/1	Number of faults
597	EIC oil temp.	[deg] [F]	1/10	1/10	1/10	Engine oil temperature
598	EIC fuel temp.	[deg] [F]	1/1	1/10	1/10	Fuel temperature
599	EIC intake manifold #1 P	[bar] [psi]	1/100	1/100	-	Intake manifold #1 P
600	EIC air inlet temp.	[deg] [F]	1/1	-	-	Air inlet temperature
601	EIC coolant level	[%]	1/10	-	-	Coolant level
602	EIC fuel rate	[L/h]	1/10	1/1	-	Fuel rate
603	EIC charge air press	[bar] [psi]	-	-	1/100	Charge air press
604	EIC intake manifold 1 T (or EIC charge air T)	[deg] [F]	1/1	-	1/10	Intake manifold 1 tempera-ture
605	EIC d.d. % torque	[%]	1/1	-	-	Driver’s demand engine - percent torque
606	EIC actual % torque	[%]	1/1	-	-	Actual engine - percent torque
607	EIC acc. pedal pos.	[%]	1/1	-	-	Accelerator pedal position
608	EIC % load, c. speed	[%]	1/1	-	-	Percent load at current speed
609	EIC air inlet pressure	[bar] [psi]	1/100	-	-	Air inlet pressure
610	EIC exhaust gas temp.	[deg] [F]	1/10	-	-	Exhaust gas temperature
611	EIC engine hours	[H]	1/1	1/1	1/1	ENGINE HOURS
612	EIC oil filter diff. press.	[bar] [psi]	1/100	-	-	Oil filter diff press
613	EIC battery voltage	[V]	1/10	1/10	-	Keyswitch battery potential
614	EIC fuel del. press.	[bar] [psi]	1/100	1/100	-	Fuel delivery pressure
615	EIC oil level	[%]	1/10	-	-	Engine oil level
616	EIC crankcase press.	[bar] [psi]	1/100	-	-	Crankcase pressure
617	EIC coolant pressure	[bar] [psi]	1/100	-	-	Coolant pressure
618	EIC water in fuel	[2 bits]	1/1	-	-	Water in fuel (1 = Yes, 0 = NO)
619	Reserved	-	-	-	-	-
620	Reserved	-	-	-	-	-
621	Reserved	-	-	-	-	-
622	Reserved	-	-	-	-	-
623	EIC turbo oil temp.	[deg] [F]	1/10	-	-	Turbo oil temp.

Measurement table (read only) function code 04h.						
Addr.	Content	Unit	Scaling			Description
			J1939	ADEC	MDEC	
624	EIC trap inlet	[bar] [psi]	1/100	-	-	Trap inlet
625	EIC Air filter diff press	[bar] [psi]	1/1000	-	-	Air filter diff press
626	EIC Cool filter diff press	[bar] [psi]	1/100	-	-	Cool filter diff press
627	EIC Atm press	[bar] [psi]	1/100	-	-	Atmospheric pressure
628	EIC Ambient air temp	[deg] [F]	1/10	-	-	Ambient air temp [F/10]
629	EIC exch. temp A	[deg] [F]	1/10	1/10	-	Exch. temp bank A
630	EIC exch. temp B	[deg] [F]	1/10	1/10	-	Exch. temp bank B
631	EIC Winding 1 temp	[deg] [F]	-	1/1	-	Gen winding 1 temp
632	EIC Winding 2 temp	[deg] [F]	-	1/1	-	Gen winding 2 temp
633	EIC Winding 3 temp	[deg] [F]	-	1/1	-	Gen winding 3 temp
634	Reserved	-	-	-	-	-
635	Reserved	-	-	-	-	-
636	EIC T. Charge A	[deg] [F]	-	1/10	-	Turbo Charger Air temp
637	EIC Intercooler temp	[deg][F]	-	1/10	-	Intercooler temp
638	EIC engine trip fuel	[L]	1/1	1/1	-	Engine trip fuel
639	EIC engine total fuel used	[kL]	1/10	-	-	Engine total fuel used
640	EIC trip fuel_gaseous	[kg]	1/1	-	-	Trip fuel, gaseous
641	EIC total fuel used_gaseous	[ton]	1/10	-	-	Total fuel used, gaseous
850[3]	AT2ExhFluDRQ	[g/h]	1/10	-	-	Aftertreatment 2 Diesel Exhaust Fluid Dosing Requested Quantity
851[3]	AT2SCRCInG	[deg] [F]	1/10	-	-	Aftertreatment 2 SCR Catalyst Intake Gas Temperature
852[3]	AT2SCRCOuG	[deg] [F]	1/10	-	-	Aftertreatment 2 SCR Catalyst Outlet Gas Temperature
853	EIC Engine Oil-Filter Outlet Pressure	[bar] [psi]	1/100	-	-	Engine Oil-Filter Outlet Pressure
854[3]	EngOperatingState	-	1/1	-	-	Engine Operating State
855	EIC SA of Controlling Device	-	1/1	-	-	Source Address of Controlling Device
856	EIC Engine Rated Speed	[RPM]	1/1	-	-	Engine Rated Speed
857	EIC Engine Speed At Idle, Point 1	[RPM]	1/1	-	-	BAM message: Engine Speed At Idle, Point 1 (Engine Configuration)
858	EIC Engine Controller 5	-	1/1	-	-	MTU only: Engine Controller 5

Measurement table (read only) function code 04h.						
Addr.	**Content**	**Unit**	**Scaling**			**Description**
			J1939	**ADEC**	**MDEC**	
859	EIC Fuel Consumption	[g/kWh]	1/1	-	-	MTU only: Fuel Consumption
860	EIC UREA Level	[%]	1/10	-	-	Scania only: UREA Level
861[3]	SCR IND. SEV		1/1	-	-	Severity status of the operator inducement system
862[3]	Next Regen	[deg] [F]	1/10	-	-	Time to activate next regeneration for diesel particulate filter
900	EIC trip average fuel rate	[L/h]	-	1/10	-	Average fuel rate (trip)
901[1]	EIC nominal power	[Kwm]	1/1	1/1	-	Nominal power of the engine
902	EIC trip fuel liquid	[L]	1/2	1/10	-	High word
903	EIC trip fuel liquid	[L]	1/2	1/10	-	Low word
904	EIC total fuel liquid	[L]	1/2	1/10	-	High word
905	EIC total fuel liquid	[L]	1/2	1/10	-	Low word
906	EIC mean trip fuel consumption	[L/h]	-	1/1000	-	High word
907	EIC mean trip fuel consumption	[L/h]	-	1/1000	-	Low word
908[1]	EIC engine power	[Kwm]	-	1/1	-	Nominal power of the engine (ADEC)
911[1]	EIC intake manifold #1 absolute pressure	Bar or psi	1/100	-	-	*Only MTU J1939 Smart Connect
912	EIC Air filter diff. pressure	Bar or psi	1/100	-	-	Change in engine air system pressure
913	EIC Fuel supply pump inlet pressure	Bar or psi	1/100	-	-	Absolute pressure of fuel at the fuel supply pump intake
914	EIC Fuel filter (suction side) diff. pressure	Bar or psi	1/100	-	-	Differential pressure measured across the fuel filter between the fuel tank and the supply pump
915[2]	EIC Fuel filter diff. pressure	Bar or psi	1/100	-	-	Diff pressure
932[2]	EIC Speed Demand source	Digit	-	-	-	Identifies speed demand source
933[2]	EIC lube oil pressure LO limit	mbar	-	-	1/100	Lubrication oil pressure limit 1
934[2]	EIC lube oil pressure LOLO limit	mbar	-	-	1/100	Lubrication oil pressure limit 2

Measurement table (read only) function code 04h.						
Addr.	Content	Unit	Scaling			Description
			J1939	ADEC	MDEC	
935[2]	EIC fuel pressure	bar	-	-	1/100	Fuel pressure
936[2]	EIC coolant limit HI	[deg] [F]	-	-	1/10	Coolant high limit temp. 1
937[2]	EIC coolant limit HIHI	[deg] [F]	-	-	1/10	Coolant high limit temp. 2
938[2]	EIC intercooler coolant	[deg] [F]	-	-	1/10	Intercooler coolant temperature
939[2,3]	T-ECU	[deg] [F]	-	-	1/10	ECU temperature
940[2]	EIC actual droop	%	-	-	1/10	Actual droop percentage
941[2]	EIC act. inject. Quantity	%	-	-	1/10	Injection quantity Act. DBR %
942[2]	EIC camshaft	[RPM]	-	1/1	-	Camshaft speed
943[2]	EIC Temp lube HI	[deg] [F]	-	1/10	-	Lube oil temperature HI
944[2]	EIC Temp lube HIHI	[deg] [F]	-	1/10	-	Lube oil temperature HIHI
945[2]	EIC speed demand analog	Digit	-	1/1	-	Speed demand analog
946[2]	EIC act. inject Quantity	[bit]	-	-	-	1: Stop activated, 0: Stop not activated
971[3]	T. Cool Aux	[deg] [F]	1/1	-	-	Coolant temperature of intercooler which is located after the turbocharger
974	EIC Engine Auxiliary Coolant Pressure	[bar] [psi]	1/100	-	-	Engine Auxiliary Coolant Pressure
975[3]	Sp.Humidity	[g/kg]	1/10	-	-	Ambient Conditions 2 Specific Humidity
976[3]	Tcharger 2	[RPM]	1/1	-	-	Engine Turbocharger 2 Speed
977[3]	Tcharger 3	[RPM]	1/1	-	-	Engine Turbocharger 3 Speed
978	EIC Trip Engine Running Time	[h]	1/1	-	-	Trip Engine Running Time
979	EIC Trip Idle Time	[h]	1/1	-	-	Trip Idle Time
980	EIC Estimated Percent Fan Speed	[%]	1/10	-	-	Estimated Percent Fan Speed
981[3]	Tcharger 1	[RPM]	1/1	-	-	Engine Turbocharger 1 Speed
982	EIC Nominal Friction - Percent Torque	[%]	1/1	-	-	Nominal Friction - Percent Torque
983	EIC Engine's Desired Operating Speed	[RPM]	1/1	-	-	Engine's Desired Operating Speed

Measurement table (read only) function code 04h.						
Addr.	Content	Unit	Scaling			Description
			J1939	ADEC	MDEC	
984	EIC Engine Intake Manifold 2 Temperature	[deg] [F]	1/1	-	-	Engine Intake Manifold 2 Temperature
985[3]	EIC DEF LEVEL	[%]	1/10	-	-	Aftertreatment 1 Diesel Exhaust Fluid Tank Level
986[3]	EIC DEF temperature	[deg] [F]	1/1	-	-	Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature
987[3]	AT1IntTNOx	[ppm]	1/10	-	-	Aftertreatment 1 Intake NOx
988[3]	AT1OutLNOx	[ppm]	1/10	-	-	Aftertreatment 1 Outlet NOx
989[3]	AT1ExhFA.DQ	[g/h]	1/10	-	-	Aftertreatment 1 Diesel Exhaust Fluid Actual Dosing Quantity
990[3]	AT1ExhFluDAB	[bar] [psi]	1/100	-	-	Aftertreatment 1 Diesel Exhaust Fluid Dosing Absolute Pressure
991[3]	AT1ExhFlu DT	[deg] [F]	1/1	-	-	Aftertreatment 1 SCR Dosing Air Assist Valve
992[3]	AT1ExhFlu DT	[g/h]	1/1	-	-	Aftertreatment 1 Diesel Exhaust Fluid Dosing Requested Quantity
993[3]	AT1SCRCInG	[deg] [F]	1/10	-	-	Aftertreatment 1 SCR Catalyst Intake Gas Temperature
994[3]	AT1SCRCOuG	[deg] [F]	1/10	-	-	Aftertreatment 1 SCR Catalyst Outlet Gas Temperature
995[3]	AT2IntTNOx	[ppm]	1/10	-	-	Aftertreatment 2 Intake NOx
996[3]	AT2OutLNOx	[ppm]	1/10	-	-	Aftertreatment 2 Outlet NOx
997[3]	AT2ExhFA.DQ	[g/h]	1/10	-	-	Aftertreatment 2 Diesel Exhaust Fluid Actual Dosing Quantity
998[3]	AT2ExhFluDAB	[bar] [psi]	1/100	-	-	Aftertreatment 2 Diesel Exhaust Fluid Dosing Absolute Pressure
999[3]	AT2ExhFlu DT	[deg] [F]	1/1	-	-	Aftertreatment 2 SCR Dosing Air Assist Valve

Measurement table (read only) function code 04h.						
Addr.	**Content**	**Unit**	**Scaling**			**Description**
			J1939	**ADEC**	**MDEC**	
1819[3]	Intake Man T2	[deg] [F]	1/1	-	-	Temperature of pre-combustion air found in intake manifold of engine air supply system

Addresses marked [1] only apply to AGC 100, AGC-3, AGC-4, AGC 200, AGC PM and CGC 400.

Addresses marked [2] only apply to AGC-4, AGC 200, AGC PM and CGC 400.

Addresses marked [3] are not supported for option H7.

17.4.3 Readings via Modbus - analogue values specific for CAT and Perkins protocol

Measurement table (read only) function code 04h.						
Addr.	Content	Unit	Scaling			Description
			J1939	ADEC	MDEC	
947	EIC Exhaust Gas P1 Temp	[deg] [F]	1/10	-	-	
948	EIC Exhaust Gas P2 Temp	[deg] [F]	1/10	-	-	
949	EIC Exhaust Gas P3 Temp	[deg] [F]	1/10	-	-	
950	EIC Exhaust Gas P4 Temp	[deg] [F]	1/10	-	-	
951	EIC Exhaust Gas P5 Temp	[deg] [F]	1/10	-	-	
952	EIC Exhaust Gas P6 Temp	[deg] [F]	1/10	-	-	
953	EIC Exhaust Gas P7 Temp	[deg] [F]	1/10	-	-	
954	EIC Exhaust Gas P8 Temp	[deg] [F]	1/10	-	-	
955	EIC Exhaust Gas P9 Temp	[deg] [F]	1/10	-	-	
956	EIC Exhaust Gas P10 Temp	[deg] [F]	1/10	-	-	
957	EIC Exhaust Gas P11 Temp	[deg] [F]	1/10	-	-	
958	EIC Exhaust Gas P12 Temp	[deg] [F]	1/10	-	-	
959	EIC Exhaust Gas P13 Temp	[deg] [F]	1/10	-	-	
960	EIC Exhaust Gas P14 Temp	[deg] [F]	1/10	-	-	
961	EIC Exhaust Gas P15 Temp	[deg] [F]	1/10	-	-	
962	EIC Exhaust Gas P16 Temp	[deg] [F]	1/10	-	-	
967	EIC Filtered Fuel DeliveryPress	[bar] [psi]	1/100	-	-	
968	EIC Coolant Temp 2	[deg] [F]	1/1	-	-	
969	EIC Coolant Temp 3	[deg] [F]	1/1	-	-	
970	EIC Coolant Pump Outlet Temp	[deg] [F]	1/1	-	-	
971	EIC Auxiliary Coolant Temp	[deg] [F]	1/1	-	-	
972	EIC Turbo 1 Intake Temp	[deg] [F]	1/10	-	-	
973	EIC Turbo 2 Intake Temp	[deg] [F]	1/10	-	-	

17.4.4 Readings via Modbus - diagnostic codes

To interpret an SPN and/or FMI number, refer to the documentation of the engine manufacturer.

SPN means "Suspect Parameter Number". For example, if the coolant water temperature becomes too high, the SPN code "110" will be shown.

FMI means "Failure Mode Identifier". For example, if the temperature in the above example is at shutdown level, the FMI code "0" will be shown.

Oc means "occurrence counter", and it indicates how many times a specific alarm has occurred. For example, if the specific alarm in the above example (SPN 100, FMI 0) has occurred twice, the oc code "2" will be shown.

In the table below, a specific SPN number is linked to the same FMI and oc number.

Active Diagnostic Code (DM1/SPN)		
Addr.	**Content**	**Description**
1370	SPN diagnostic no. 1	Lo word
1371	SPN diagnostic no. 2	Lo word
1372	SPN diagnostic no. 3	Lo word
1373	SPN diagnostic no. 4	Lo word
1374	SPN diagnostic no. 5	Lo word
1375	SPN diagnostic no. 6	Lo word
1376	SPN diagnostic no. 7	Lo word
1377	SPN diagnostic no. 8	Lo word
1378	SPN diagnostic no. 9	Lo word
1379	SPN diagnostic no. 10	Lo word
1380	SPN diagnostic no. 1	Hi word
1381	SPN diagnostic no. 2	Hi word
1382	SPN diagnostic no. 3	Hi word
1383	SPN diagnostic no. 4	Hi word
1384	SPN diagnostic no. 5	Hi word
1385	SPN diagnostic no. 6	Hi word
1386	SPN diagnostic no. 7	Hi word
1387	SPN diagnostic no. 8	Hi word
1388	SPN diagnostic no. 9	Hi word
1389	SPN diagnostic no. 10	Hi word
1390-1401	Not used	Reserved

Active Failure Mode Identifier (DM1/FMI)		
Addr.	**Content**	**Description**
1402	FMI diagnostic no. 1	-
1403	FMI diagnostic no. 2	-
1404	FMI diagnostic no. 3	-
1405	FMI diagnostic no. 4	-
1406	FMI diagnostic no. 5	-
1407	FMI diagnostic no. 6	-
1408	FMI diagnostic no. 7	-
1409	FMI diagnostic no. 8	-
1410	FMI diagnostic no. 9	-
1411	FMI diagnostic no. 10	-
1412-1417	Not used	Reserved

Active Occurrence Counter (DM1/OC)		
Addr.	**Content**	**Description**
1418	Occurrence counter diagnostic no. 1	-
1419	Occurrence counter diagnostic no. 2	-
1420	Occurrence counter diagnostic no. 3	-
1421	Occurrence counter diagnostic no. 4	-
1422	Occurrence counter diagnostic no. 5	-
1423	Occurrence counter diagnostic no. 6	-
1424	Occurrence counter diagnostic no. 7	-
1425	Occurrence counter diagnostic no. 8	-
1426	Occurrence counter diagnostic no. 9	-
1427	Occurrence counter diagnostic no. 10	-
1428-1433	Not used	Reserved

Active Diagnostic Codes (DM2/SPN)		
Addr.	**Content**	**Description**
1434	SPN diagnostic no. 1	Lo word
1435	SPN diagnostic no. 2	Lo word
1436	SPN diagnostic no. 3	Lo word
1437	SPN diagnostic no. 4	Lo word
1438	SPN diagnostic no. 5	Lo word
1439	SPN diagnostic no. 6	Lo word
1440	SPN diagnostic no. 7	Lo word
1441	SPN diagnostic no. 8	Lo word
1442	SPN diagnostic no. 9	Lo word
1443	SPN diagnostic no. 10	Lo word
1444	SPN diagnostic no. 1	Hi word
1445	SPN diagnostic no. 2	Hi word
1446	SPN diagnostic no. 3	Hi word
1447	SPN diagnostic no. 4	Hi word
1448	SPN diagnostic no. 5	Hi word
1449	SPN diagnostic no. 6	Hi word
1450	SPN diagnostic no. 7	Hi word
1451	SPN diagnostic no. 8	Hi word
1452	SPN diagnostic no. 9	Hi word
1453	SPN diagnostic no. 10	Hi word
1454-1465	Not used	Reserved

Active Failure Mode Identifier (DM2/FMI)		
Addr.	**Content**	**Description**
1466	FMI diagnostic no. 1	-
1467	FMI diagnostic no. 2	-
1468	FMI diagnostic no. 3	-
1469	FMI diagnostic no. 4	-
1470	FMI diagnostic no. 5	-
1471	FMI diagnostic no. 6	-
1472	FMI diagnostic no. 7	-
1473	FMI diagnostic no. 8	-
1474	FMI diagnostic no. 9	-
1475	FMI diagnostic no. 10	-
1476-1481	Not used	Reserved

Active Occurrence Counter (DM2/OC)		
Addr.	**Content**	**Description**
1482	Occurrence counter diagnostic no. 1	-
1483	Occurrence counter diagnostic no. 2	-
1484	Occurrence counter diagnostic no. 3	-
1485	Occurrence counter diagnostic no. 4	-
1486	Occurrence counter diagnostic no. 5	-
1487	Occurrence counter diagnostic no. 6	-
1488	Occurrence counter diagnostic no. 7	-
1489	Occurrence counter diagnostic no. 8	-
1490	Occurrence counter diagnostic no. 9	-
1491	Occurrence counter diagnostic no. 10	-
1492-1499	Not used	Reserved

17.4.5 Alarms via Modbus - Caterpillar/Perkins

Alarm, status and measurement table (read only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 7570 EIC communication error
		Bit 1 7580 EIC warning
		Bit 2 7590 EIC shutdown
		Bit 3 7600 EIC overspeed
		Bit 4 7610 EIC coolant water temperature 1
		Bit 5 7620 EIC coolant water temperature 2
		Bit 6 7630 EIC oil pressure 1
		Bit 7 7640 EIC oil pressure 2
		Bit 8 7650 EIC oil temp. 1
		Bit 9 7660 EIC oil temp. 2
		Bit 10 7670 EIC coolant level 1[1]
		Bit 11 7680 EIC coolant level2[1]
1024	EIC alarms, engine controller (DM1)	Bit 1 EIC low oil pressure, warning
		Bit 2 EIC low oil pressure, shutdown
		Bit 3 EIC boost pressure, warning
		Bit 4 EIC high coolant temperature, warning
		Bit 5 EIC low coolant level, shutdown
		Bit 6 EIC high inlet air temperature, warning
		Bit 7 EIC fuel temperature, warning
		Bit 8 EIC ECM yellow lamp, warning
		Bit 9 EIC ECM red lamp, shutdown
		Bit 10 EIC overspeed, warning
		Bit 11 EIC overspeed, shutdown
		Bit 12 EIC protection[1]
		Bit 13 EIC malfunction[1]

Bits marked [1] do not apply to PPM-3.

17.4.6 Alarms via Modbus - Cummins

Alarm, status and measurement table (read only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 7570 EIC communication error
		Bit 1 7580 EIC warning
		Bit 2 7590 EIC shutdown
		Bit 3 7600 EIC overspeed
		Bit 4 7610 EIC coolant water temperature 1
		Bit 5 7620 EIC coolant water temperature 2
		Bit 6 7630 EIC oil pressure 1
		Bit 7 7640 EIC oil pressure 2
		Bit 8 7650 EIC oil temp. 1
		Bit 9 7660 EIC oil temp. 2
		Bit 10 7670 EIC coolant level 1[1]
		Bit 11 7680 EIC coolant level 2[1]
1023	EIC alarms, engine controller (DM1)	Bit 0 EIC yellow[1]
		Bit 1 Red*
		Bit 2 EIC protection[1]
		Bit 3 EIC malfunction[1]
1024	EIC alarms, engine controller (DM1)	Bit 0 EIC DEC communication error
		Bit 1 EIC low oil pressure, warning
		Bit 2 EIC low oil pressure, shutdown
		Bit 3 EIC high coolant temp, warning
		Bit 4 EIC high coolant temperature, shutdown
		Bit 5 EIC low coolant level, warning
		Bit 6 EIC low coolant level, shutdown
		Bit 7 EIC intake manifold temp, warning
		Bit 8 EIC intake manifold, shutdown
		Bit 9 EIC fuel temp., warning
		Bit 10 EIC fuel temp, shutdown
		Bit 11 EIC coolant pressure, shutdown
		Bit 12 EIC oil temp., warning
		Bit 13 EIC oil temp., warning
		Bit 14 EIC overspeed shutdown
		Bit 15 EIC crankcase press., shutdown

Bits marked [1] do not apply to PPM-3.

17.4.7 Alarms via Modbus - DDEC - Detroit engines

Alarm, status and measurement table (read only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 7570 EIC communication error
		Bit 1 7580 EIC warning
		Bit 2 7590 EIC shutdown
		Bit 3 7600 EIC overspeed
		Bit 4 7610 EIC coolant water temperature 1
		Bit 5 7620 EIC coolant water temperature 2
		Bit 6 7630 EIC oil pressure 1
		Bit 7 7640 EIC oil pressure 2
		Bit 8 7650 EIC oil temp. 1
		BIt 9 7660 EIC oil temp. 2
		Bit 10 7670 EIC coolant level 1[1]
		Bit 11 7680 EIC coolant level 2[1]
1024	EIC alarms, engine controller (DM1)	Bit 0 EIC communication error, warning
		Bit 1 EIC warning
		Bit 2 EIC shutdown
		Bit 3 EIC protection[1]
		Bit 4 EIC malfunction[1]

Bits marked [1] do not apply to PPM-3.

17.4.8 Alarms via Modbus - EMR 2 - EMR 3 - Deutz engines

Alarm, status and measurement table (read only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 7570 EIC communication error
		Bit 1 7580 EIC warning
		Bit 2 7590 EIC shutdown
		Bit 3 7600 EIC overspeed
		Bit 4 7610 EIC coolant water temperature 1
		Bit 5 7620 EIC coolant water temperature 2
		Bit 6 7630 EIC oil pressure 1
		Bit 7 7640 EIC oil pressure 2
		Bit 8 7650 EIC oil temp. 1
		Bit 9 7660 EIC oil temp. 2
		Bit 10 7670 EIC coolant level 1[1]
		Bit 11 7680 EIC coolant level 2[1]
1024	EIC alarms, engine controller (DM1)	Bit 0 EIC high coolant temperature, shutdown
		Bit 1 EIC low oil pressure, shutdown
		Bit 2 EIC overspeed, shutdown
		Bit 3 EIC EMR shutdown (LS: lamp status)
		Bit 4 EIC EMR warning (LS: lamp status)
		Bit 5 EIC communication error
		Bit 6 EIC protection[1]
		Bit 7 EIC malfunction[1]

Bits marked [1] do not apply to PPM-3.

17.4.9 Alarms via Modbus - Generic J1939

Alarm, status and measurement table (read only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 7570 EIC communication error
		Bit 1 7580 EIC warning
		Bit 2 7590 EIC shutdown
		Bit 3 7600 EIC overspeed
		Bit 4 7610 EIC coolant water temperature 1
		Bit 5 7620 EIC coolant water temperature 2
		Bit 6 7630 EIC oil pressure 1
		Bit 7 7640 EIC oil pressure 2
		Bit 8 7650 EIC oil temp. 1
		Bit 9 7660 EIC oil temp. 2
		Bit 10 7670 EIC coolant level 1[1]
		Bit 11 7680 EIC coolant level 2[1]
1024	EIC alarms, engine controller (DM1)	Bit 0 EIC communication error[1]
		Bit 1 EIC yellow[1]
		Bit 2 EIC red[1]
		Bit 3 EIC protection[1]
		Bit 4 EIC malfunction[1]

Bits marked [1] do not apply to PPM-3.

17.4.10 Alarms via Modbus - Iveco

Alarm, status and measurement table (read only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 7570 EIC communication error
		Bit 1 7580 EIC warning
		Bit 2 7590 EIC shutdown
		Bit 3 7600 EIC overspeed
		Bit 4 7610 EIC coolant water temperature 1
		Bit 5 7620 EIC coolant water temperature 2
		Bit 6 7630 EIC oil pressure 1
		Bit 7 7640 EIC oil pressure 2
		Bit 8 7650 EIC oil temp. 1
		Bit 9 7660 EIC oil temp. 2
		Bit 10 7670 EIC coolant level 1[1]
		Bit 11 7680 EIC coolant level 2[1]
1024	EIC alarms, engine controller (DM1)	Bit 0 EIC communication error
		Bit 1 EIC low oil pressure, warning
		Bit 2 EIC low oil pressure, shutdown
		Bit 3 EIC boost pressure, warning
		Bit 4 EIC high coolant temperature, warning
		Bit 5 EIC low coolant level, shutdown
		Bit 6 EIC high inlet air temperature, warning
		Bit 7 EIC fuel temperature, warning
		Bit 8 EIC ECM yellow lamp, warning
		Bit 9 EIC ECM red lamp, shutdown
		Bit 10 EIC overspeed, warning
		Bit 11 EIC overspeed, shutdown
		Bit 12 EIC protection[1]
		Bit 13 EIC malfunction[1]

Bits marked [1] do not apply to PPM-3.

17.4.11 Alarms via Modbus - JDEC - John Deere engines

Alarm, status and measurement table (read-only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 7570 EIC communication error
		Bit 1 7580 EIC warning
		Bit 2 7590 EIC shutdown
		Bit 3 7600 EIC overspeed
		Bit 4 7610 EIC coolant water temperature 1
		Bit 5 7620 EIC coolant water temperature 2
		Bit 6 7630 EIC oil pressure 1
		Bit 7 7640 EIC oil pressure 2
		Bit 8 7650 EIC oil temp. 1
		Bit 9 7660 EIC oil temp. 2
		Bit 10 7670 EIC coolant level 1[1]
		Bit 11 7680 EIC coolant level 2[1]
1024	EIC alarms, engine controller (DM1)	Bit 0 EIC high coolant temperature, shutdown
		Bit 1 EIC low oil pressure, shutdown
		Bit 2 EIC fuel temperature, shutdown
		Bit 3 EIC fuel control valve, shutdown
		Bit 4 EIC ECU failure, shutdown
		Bit 5 EIC oil pressure, warning
		Bit 6 EIC intake manifold, warning
		Bit 7 EIC coolant temperature, warning
		Bit 8 EIC fuel injection pump, warning
		Bit 9 EIC JDEC shutdown (LS: lamp status)
		Bit 10 EIC JDEC warning (LS: lamp status)
		Bit 11 EIC communication error[1]
		Bit 12 EIC protection[1]
		Bit 13 EIC malfunction[1]

Bits marked [1] do not apply to PPM-3.

17.4.12 Alarms via Modbus - MTU ADEC

Alarm, status and measurement table (read only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 EIC 7570 communication error
		Bit 2 EIC 7590 shutdown
		Bit 3 EIC 7600 overspeed
		Bit 4 EIC 7610 coolant water temperature 1
		Bit 5 EIC 7620 coolant water temperature 2
		Bit 6 EIC 7630 oil pressure 1
		Bit 7 EIC 7640 oil pressure 2
		Bit 8 EIC 7650 oil temp. 1
		Bit 9 EIC 7660 oil temp. 2
		Bit 10 EIC 7670 coolant level 1[1]
		Bit 11 EIC 7680 coolant level 2[1]
1022	EIC alarms, engine controller	Bit 0 EIC ECU power supp voltage LoLo
		Bit 1 EIC Fuel high temp
		Bit 2 EIC Exhaust A high temp
		Bit 3 EIC Exhaust B high temp
		Bit 4 EIC Pressure 1 high (Aux 1)
		Bit 5 EIC Pressure 2 high (Aux 2)
		Bit 6 EIC Day tank high level
		Bit 7 EIC Day tank low level
		Bit 8 EIC Run-up speed not reached
		Bit 9 EIC Idle speed not reached
1023	EIC alarms, engine controller	Bit 0 EIC Common alarm red
		Bit 1 EIC Overspeed
		Bit 2 EIC Lube oil press LowLow
		Bit 3 EIC Coolant temperature HiHi
		Bit 4 EIC Lube oil temp HiHi
		Bit 5 EIC Charge air temp HiHi
		Bit 6 EIC ECU power supp voltage HiHi
		Bit 7 EIC Generator temp high warning
		Bit 8 EIC Holding tank high level
		Bit 9 EIC Holding tank low level
		Bit 10 EIC Winding 1 temp high
		Bit 11 EIC Winding 2 temp high
		Bit 12 EIC Winding 3 temp high

Addr.	Content	Type
		Bit 13 EIC Ambient temp high
		Bit 14 EIC Water in fuel 1
		Bit 15 EIC Water in fuel 2
1024	EIC alarms, engine controller	Bit 0 EIC Coolant high temp
		Bit 1 EIC Charge air high temp
		Bit 2 EIC Intercooler coolant high temp
		Bit 3 EIC Lube oil high temp
		Bit 4 EIC ECU high temp
		Bit 5 EIC Engine speed low
		Bit 6 EIC Prelube fail
		Bit 7 EIC Start speed not reached Common alarm
		Bit 8 EIC yellow
		Bit 9 EIC Lube oil pressure low
		Bit 10 EIC Coolant level low
		Bit 11 EIC Intercooler coolant level low
		Bit 12 EIC ECU defect
		Bit 13 EIC Speed demand defect
		Bit 14 EIC Power supply low voltage
		Bit 15 EIC Power supply high voltage

Bits marked [1] do not apply to PPM-3.

17.4.13 Alarms via Modbus - MTU ADEC module 501, without SAM module

Alarm, status and measurement table (read only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 EIC communication error
		Bit 2 EIC shutdown
		Bit 3 EIC overspeed
		Bit 4 EIC coolant water temperature 1
		Bit 5 EIC coolant water temperature 2
		Bit 6 EIC oil pressure 1
1022	EIC alarms, engine controller	Bit 0 EIC Automatic engine stop[1]
		Bit 1 EIC MG start speedfail[1]
		Bit 2 EIC Runup speedfail1
		Bit 3 EIC Idle speedfail[1]
		Bit 4 EIC ECU power supply voltage low limit2[1]
		Bit 5 EIC ECU power supply voltge high limit2[1]
		Bit 6 EIC Aftercooler coolant level sensor defect[1]
		Bit 7 EIC Fuel temperature high limit 2[1]
1023	EIC alarms, engine controller	Bit 0 EIC Common rail fuel pressure limit 1[1]
		Bit 1 EIC Common rail fuel pressure limit 2[1]
		Bit 2 EIC Override[1]
		Bit 3 EIC Preheat temperature low[1]
		Bit 4 EIC Charge air coolant level 2[1]
		Bit 5 EIC Power amplifier 1[1]
		Bit 6 EIC Power amplifier 2[1]
		Bit 7 EIC Transistor output status, TAA1 to TAA6[1]
		Bit 8 EIC ECU Power supply voltage low limit1[1]
		Bit 9 EIC ECU Power supply voltage high limit1[1]
		Bit 10 EIC Charge air temperature limit1[1]
		Bit 11 EIC Lube oil temperature limit1[1]
		Bit 12 EIC ECU temperature limit1[1]
		Bit 13 EIC Engine speed low limit1[1]
		Bit 14 EIC Check error code[1]
		Bit 15 EIC Common rail leakage[1]
1024	EIC alarms, engine controller	Bit 0 EIC overspeed, shutdown
		Bit 1 EIC low oil pressure, warning

Addr.	Content	Type
		Bit 2 EIC low oil pressure, shutdown
		Bit 3 EIC low coolant level, shutdown
		Bit 4 EIC ADEC ECU failure, shutdown
		Bit 5 EIC high coolant temperature, warning
		Bit 6 EIC high coolant temperature, shutdown
		Bit 7 EIC high intercooler coolant temp, warning
		Bit 8 EIC high oil temperature, shutdown
		Bit 9 EIC high charge air temperature, shutdown
		Bit 10 EIC defect coolant level switch, warning
		Bit 11 EIC ADEC yellow alarm, warning
		Bit 12 EIC ADEC red alarm, shutdown
		Bit 13 EIC communication error[1]
		Bit 14 EIC fuel delivery pressure limit1[1]
		Bit 15 EIC fuel delivery pressure limit2[1]

Bits marked [1] only apply to AGC-4, AGC 200 and AGC PM.

17.4.14 Alarms via Modbus - MTU Smart Connect

Alarm, status and measurement table (read only) function code 04h.

This protocol does not apply to PPM-3.

Addr.	Content	Type
1020	EIc alarms, DEIF controller	Bit 0 7570 EIC communication error
		Bit 1 7580 EIC warning
		Bit 2 7590 EIC shutdown
		Bit 3 7600 EIC overspeed
		Bit 4 7610 EIC coolant water temp. 1
		Bit 5 7620 EIC coolant water temp. 2
		Bit 6 7630 EIC oil pressure level 1
		Bit 7 7640 EIC oil pressure level 2
		Bit 8 7650 EIC oil temp. 1
		Bit 9 7660 EIC oil temp. 2
		Bit 10 7670 EIC coolant level 1
		Bit 11 7680 EIC coolant level 2
1024	EIC alarms, engine controller (DM1)	Bit 0 EIC communication error
		Bit 1 EIC yellow
		Bit 2 EIC red
		Bit 3 EIC protection
		Bit 4 EIC malfunction

17.4.15 Alarms via Modbus - MTU MDEC series - 2000/4000 - module 302 & 303

Alarm, status and measurement table (read-only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 EIC communication error
		Bit 2 EIC shutdown
		Bit 3 EIC overspeed
		Bit 4 EIC coolant water temperature 1
		Bit 5 EIC coolant water temperature 2
		Bit 6 EIC oil pressure 1
		Bit 7 EIC oil pressure 2
1022	EIC alarms, engine controller	Bit 0 EIC Automatic engine stop[1]
		Bit 1 EIC MG start speed fail[1]
		Bit 2 EIC Runup speed fail[1]
		Bit 3 EIC Idle speed fail[1]
		Bit 4 EIC ECU power supply voltage low limit 2[1]
		Bit 5 EIC ECU power supply voltage high limit 2[1]
		Bit 6 EIC Aftercooler coolant level sensor defect[1]
		Bit 7 EIC Fuel temperature high limit 2[1]
1023	EIC alarms, engine controller	Bit 0 EIC Common rail fuel pressure limit 1[1]
		Bit 1 EIC Common rail fuel pressure limit 2[1]
		Bit 2 EIC Override[1]
		Bit 3 EIC Preheat temperature low[1]
		Bit 4 EIC Charge air coolant level 2[1]
		Bit 5 EIC Power amplifier 1[1]
		Bit 6 EIC Power amplifier 2[1]
		Bit 7 EIC Transistor output status, TAA1 to TAA6[1]
		Bit 8 EIC ECU Power supply voltage low limit 1[1]
		Bit 9 EIC ECU Power supply voltage high limit 1[1]
		Bit 10 EIC Charge air temperature limit 1[1]
		Bit 11 EIC Lube oil temperature limit 1[1]
		Bit 12 EIC ECU temperature limit 1[1]
		Bit 13 EIC Engine speed low limit 1[1]
		Bit 14 EIC Check error code[1]
		Bit 15 EIC Common rail leakage[1]

Addr.	Content	Type
1024	EIC alarms, engine controller	Bit 0 EIC overspeed, shutdown
		Bit 1 EIC low oil pressure, warning
		Bit 2 EIC low oil pressure, shutdown
		Bit 3 EIC low coolant level, shutdown
		Bit 4 EIC MDEC ECU failure, shutdown
		Bit 5 EIC high coolant temperature, warning
		Bit 6 EIC high coolant temperature, shutdown
		Bit 7 EIC high intercooler coolant temp, warning
		Bit 8 EIC high oil temperature, shutdown
		Bit 9 EIC high charge air temperature, shutdown
		Bit 10 EIC defect coolant level switch, warning
		Bit 11 EIC MDEC yellow alarm, warning
		Bit 12 EIC MDEC red alarm, shutdown
		Bit 13 EI communication error[1]
		Bit 14 EIC fuel delivery pressure limit 1[1]
		Bit 15 EIC fuel delivery pressure limit 2[1]

Bits marked [1] only apply to AGC-4, AGC 200, AGC PM and CGC 400.

17.4.16 Alarms via Modbus - Scania

Alarm, status and measurement table (read-only) function code 04h.

Addr.	Content	Type
1026	EIC alarms (KWP 2000)	Bit 0 EIC overreving
		Bit 1 EIC speed sensor 1
		Bit 2 EIC speed sensor 2
		Bit 3 EIC water temp. sensor
		Bit 4 EIC charge air temp. sensor
		Bit 5 EIC charge air pressure sensor
		Bit 6 EIC oil temp. sensor
		Bit 7 EIC oil pressure sensor
		Bit 8 EIC fault in cor.
		Bit 9 EIC throttle pedal
		Bit 10 EIC emergency stop override
		Bit 11 EIC oil pressure prot.
		Bit 12 EIC wrong parameter
		Bit 13 EIC battery voltage
		Bit 14 EIC oil pressure prot.
		Bit 15 EIC emergency stop cor.
1027	EIC alarms (KWP 2000)	Bit 0 EIC CAN cir. defect
		Bit 1 EIC CAN mess. DLN1
		Bit 2 EIC Wrong CAN version
		Bit 3 EIC un. inj. cyl. 1
		Bit 4 EIC un. inj. cyl. 2
		Bit 5 EIC un. inj. cyl. 3
		Bit 6 EIC un. inj. cyl. 4
		Bit 7 EIC un. inj. cyl. 5
		Bit 8 EIC un. inj. cyl. 6
		Bit 9 EIC un. inj. cyl. 7
		Bit 10 EIC un. inj. cyl. 8
		Bit 11 EIC extra ana. inp.
		Bit 12 EIC system shutdown
		Bit 13 EIC coola. L. prot.
		Bit 14 EIC HW watchdog
		Bit 15 EIC fault in RAM
1028	EIC alarms (KWP 2000)	Bit 0 EIC seal
		Bit 1 EIC coola. shut OFF

Addr.	Content	Type
		Bit 2 EIC overheat prot.
		Bit 3 Fault in TPU
		Bit 4 Not used
		Bit 5 Not used
		Bit 6 Not used
		Bit 7 Not used
		Bit 8 Not used
		Bit 9 Not used
		Bit 10 Not used
		Bit 11 Not used
		Bit 12 Not used
		Bit 13 Not used
		Bit 14 Not used
		Bit 15 Not used

17.4.17 Alarms via Modbus - Volvo Penta

Alarm, status and measurement table (read-only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 7570 EIC communication error
		Bit 1 7580 EIC warning
		Bit 2 7590 EIC shutdown
		Bit 3 7600 EIC overspeed
		Bit 4 7610 EIC coolant water temperature 1
		Bit 5 7620 EIC coolant water temperature 2
		Bit 6 7630 EIC oil pressure 1
		Bit 7 7640 EIC oil pressure 2
		Bit 8 7650 EIC oil temp. 1
		Bit 9 7660 EIC oil temp. 2
		Bit 10 7670 EIC coolant level 1*
		Bit 11 7680 EIC coolant level 2*
1024	EIC alarms (DM 1)	Bit 0 EIC overspeed, warning
		Bit 1 EIC oil pressure, warning
		Bit 2 EIC oil temperature, warning
		Bit 3 EIC high coolant temperature, warning
		Bit 4 EIC low coolant level, warning
		Bit 5 EIC fuel pressure, warning
		Bit 6 EIC ECM yellow lamp, warning
		Bit 7 EIC ECM red lamp, shutdown
		Bit 8 EIC high inlet air temperature, warning
		Bit 10 EIC battery voltage, warning
		Bit 11 EIC low oil level, warning
		Bit 12 EIC protection*
		Bit 13 EIC malfunction*

Bits marked * do not apply to PPM-3.

17.5 Appendix

17.5.1 MTU Smart Connect ECU9 - alarm texts

DEIF display	MTU	SPN	FMI
SD Feedback Thrott A	SD Feedback Throttle A	51	11
Al Req Angle Throt A	Al Req Angle Throttle A	51	15
AL mixture throt A f	AL mixture throttle A fault	51	31
SS T-Coolant Interco	SS T-Coolant Intercooler	52	0
SD T-Coolant InterC	SD T-Coolant Intercooler	52	11
HI T-Coolant Interco	HI T-Coolant Intercooler	52	15
SS P-Fuel	SS P-Fuel	94	1
SD P-Fuel before Fil	SD P-Fuel before Filter	94	11
LO P-Fuel	LO P-Fuel	94	17
SS P-Diff-Fuel	SS P-Diff-Fuel	95	0
SD P-Diff Fuel	SD P-Diff Fuel	95	11
HI P-Diff-Fuel	HI P-Diff-Fuel	95	15
SD Level W.Fuel PreF	SD Level Water Fuel Prefilter	97	11
HI Level W.Fuel PreF	HI Level Water Fuel Prefilter	97	15
AL L2 Level Lube oil	AL L2 Level Lube Oil J1939	98	1
SD Level Lube oil	SD Level Lube Oil J1939	98	11
SD Level Lube oil	SD Level Lube Oil	98	11
AL L1 Level Lube Oil	AL L1 Level Lube Oil J1939	98	17
SS P-Diff-Lube Oil	SS P-Diff-Lube Oil	99	0
SD P-Diff Lube Oil	SD P-Diff Lube Oil	99	11
HI P-Diff-Lube Oil	HI P-Diff-Lube Oil	99	15
SS P-Lube Oil	SS P-Lube Oil	100	1
SD P-Lube Oil	SD P-Lube Oil	100	11
LO P-Lube Oil	LO P-Lube oil	100	17
SS P-Crank Case	SS P-Crank Case	101	0
LOLO P-Crank Case	LOLO P-Crank Case	101	1
SD P-CrankCase	SD P-CrankCase	101	11
HI P-Crank Case	HI P-Crank Case	101	15
LO P-Crank Case	LO P-Crank Case	101	17
HIHI P-Charge Mix A	HIHI P-Charge Mix A	102	0
SD P-Charge Mix A	SD P-Charge Mix A	102	11
SS ETC1 Overspeed	SS ETC1 Overspeed	103	0
SD Charger 1 Speed	SD Charger 1 Speed	103	11
HI ETC1 Overspeed	HI ETC1 Overspeed	103	15

DEIF display	MTU	SPN	FMI
AL L2 P-Lubeoil ETCA	AL L2 P-Lubeoil ETC A	104	1
SD-P-Lubeoil ETC A	SD-P-Lubeoil ETC A	104	11
AL L1 P-Lubeoil ETCA	AL L1 P-Lubeoil ETC A	104	17
HIHI T-Charge Mix	HIHI T-Charge Mix	105	0
HIHI T-Intake Air	HIHI T-Intake Air	105	0
SS T-Charge Air	SS T-Charge Air	105	0
SD T-Charge Air	SD T-Charge Air	105	11
SD T-Charge Mix	SD T-Charge Mix	105	11
HI T-Charge Mix	HI T-Charge Mix	105	15
HI T-Charge Air	HI T-Charge-air	105	15
HI T-Intake Air	HI T-Intake Air	105	15
LO T-Charge Mix	LO T-Charge Mix	105	17
SD P-Intake Air Filt	SD P-Intake Air Filter Diff.	107	11
SD P-AmbientAirT2800	SD P-Ambient Air (HDT2800)	108	11
SS P-Coolant	SS P-Coolant	109	1
SD P-Coolant	SD P-Coolant	109	11
HI P-Coolant	HI P-Coolant	109	15
LO P-Coolant	LO P-Coolant	109	17
SS T-Coolant L4	SS T-Coolant L4	110	0
SD T-Coolant	SD T-Coolant	110	11
HI T-Coolant	HI T-Coolant	110	15
SS T-Coolant	SS T-Coolant	110	16
ALL2 Lev Cool. Water	AL L2 Level Coolant Water	111	1
SD Level Coolant W.	SD Level Coolant Water	111	11
ALL1 Lev Coola Water	AL L1 Level Coolant Water	111	17
LO Coolant Level	LO Coolant Level	111	17
SD P-Coolant Diff	SD P-Coolant Diff	112	11
LO P-Coolant Diff	LO P-Coolant Diff	112	17
SD P-HD	SD P-HD	157	11
HI P-Fuel (ComRail)	HI P-Fuel (Common Rail)	157	15
LO P-Fuel (ComRail)	LO P-Fuel (Common Rail)	157	17
HIHI ECU PS Voltage	HIHI ECU Power Supply Voltage	158	0
LOLO ECU PS Voltage	LOLO ECU Power Supply Voltage	158	1
SD ECU PS Voltage	SD ECU Power Supply Voltage	158	11
HI ECU PS Voltage	HI ECU Power Supply Voltage	158	15
LO ECU PS Voltage	LO ECU Power Supply Voltage	158	17
SD T0-AmbientAir	SD T0-Ambient Air (HDT2800)	171	11

DEIF display	MTU	SPN	FMI
LOLO T-Intake Air	LOLO T-Intake Air	172	1
SD T-Intake Air	SD T-Intake Air	172	11
LO T-Intake Air	LO T-Intake Air	172	17
SD-T-Exh. after Eng.	SD-T-Exh. after Engine	173	11
AL L1 T-Exh. aft.Eng	AL L1 T	173	17
AL L2 T-Fuel b.Eng.	AL L2 T-Fu	174	0
SS T-Fuel	SS T-Fuel	174	0
AL T-Gas L2	AL T-Gas L2	174	1
SD T-Fuel	SD T-Fuel	174	11
SD T-Fuel b.Engine	SD T-Fu	174	11
SD T-Gas	SD T-Gas	174	11
AL L1 T-Fuel b.Eng.	AL L1 T-Fu	174	15
HI T-Fuel	HI T-Fuel	174	15
AL T-Gas L1	AL T-Gas L1	174	17
SS T-Lube Oil	SS T-Lube Oil	175	0
SD T-Lube Oil	SD T-Lube Oil	175	11
HI T-Lube Oil	HI T-Lube Oil	175	15
AL L2 T-Lubeoil ETC	AL L2 T-Lubeoil ETC	176	0
SD-T-Lubeoil ETC	SD-T-Lubeoil ETC	176	11
AL L1 T-Lubeoil ETC	AL L1 T-Lubeoil ETC	176	15
SS Idle Sp.N Reac	SS Idle Speed Not Reached	188	1
SS Engine Overspeed	SS Engine Overspeed	190	0
SS Engine Speed tooL	SS Engine Speed too Low	190	1
AL Eng Hours Cnt def	AL Eng Hours Counter Defect	247	31
AL Fuel Cons.Cnt def	AL Fuel Cons. Counter Defect	250	31
AL L1 T-Aux 1	AL L1 T-Aux 1	441	15
AL L2 T-Aux2	AL L2 T-Aux2	442	0
AL L1 T-Aux 2	AL L1 T-Aux 2	442	15
AL Comb. Alarm Red	AL Comb. Alarm Red (Plant)	623	31
AL Comb. Alarm Yel	AL Comb. Alarm Yel (Plant)	624	31
SD Speed Demand	SD Speed Demand	898	11
AL Develop PR Set	AL Develop PR Set	966	31
AL L2 Aux1	AL L2 Aux1	1083	0
SD AUX 1	SD AUX 1	1083	11
AL L1 Aux 1	AL L1 Aux 1	1083	15
AL L2 Aux2	AL L2 Aux2	1084	0
SD AUX 2	SD AUX 2	1084	11

DEIF display	MTU	SPN	FMI
AL L1 Aux 2	AL L1 Aux 2	1084	15
AL HIHI T-ChargeAirB	AL HIHI T-Charge Air B	1131	0
SD T-Charge Air B	SD T-Charge Air B	1131	11
AL HI T-Charge Air B	AL HI T-Charge Air B	1131	15
SD T-ECU	SD T-ECU	1136	11
HI T-ECU	HI T-ECU	1136	15
AL L2 P-Lubeoil ETCB	AL L2 P-Lubeoil ETC B	1168	1
AL L1 P-Lubeoil ETCB	AL L1 P-Lubeoil ETC B	1168	17
SD P-Lube Oil (R2)	SD P-Lube Oil (R2)	1168	31
SD-P-Lubeoil ETC B	SD-P-Lubeoil ETC B	1168	31
SS ETC2 Overspeed	SS ETC2 Overspeed	1169	0
SD Charger 2 Speed	SD Charger 2 Speed	1169	11
HI ETC2 Overspeed	HI ETC2 Overspeed	1169	15
SS ETC3 Overspeed	SS ETC3 Overspeed	1170	0
SD Charger 3 Speed	SD Charger 3 Speed	1170	11
HI ETC3 Overspeed	HI ETC3 Overspeed	1170	15
SS ETC4 Overspeed	SS ETC4 Overspeed	1171	0
SD Charger 4 Speed	SD Charger 4 Speed	1171	11
HI ETC4 Overspeed	HI ETC4 Overspeed	1171	15
ALL2TExh.bef.TurbA1	AL L2 T-Exh. bef. HP Turbine A1	1172	1
ALL1TExh.bef.TurbA1	AL L1 T-Exh. bef. HP Turbine A1	1172	17
AL L2 P-IntakeA a.FA	AL L2 P-Intake Air after Filter A	1176	1
AL L1 P-IntakeA a.FA	AL L1 P-Intake Air after Filter A	1176	17
AL L2 P-IntakeA a.FB	AL L2 P-Intake Air after Filter B	1177	1
AL L1 P-IntakeA a.FB	AL L1 P-Intake Air after Filter B	1177	17
SS P-Coolant InterC	SS P-Coolant InterCooler	1203	1
SD P-Coolant InterC	SD P-Coolant Intercooler	1203	11
LO P-Coolant InterC	LO P-Coolant InterCooler	1203	17
SD P-Lube Oil bef. F	SD P-Lube Oil before Filter	1208	11
AL Override applied	AL Override applied	1237	31
SD Level Leak. Fuel	SD Level Leakage Fuel	1239	11
HI Level LeakageFuel	HI Level Leakage Fuel	1239	15
SD P-HD2	SD P-HD2	1349	11
SD-P-Fuel before Eng	SD-P-Fuel before Engine	1349	11
HI P-Fuel 2(ComRail)	HI P-Fuel 2 (Common Rail)	1349	15
AL L1 P-Fuel bef.Eng	AL L1 P-Fuel before Engine	1349	17
LO P-Fuel 2(ComRail)	LO P-Fuel 2 (Common Rail)	1349	17

DEIF display	MTU	SPN	FMI
SD-Level Oil Refill	SD-Level Oil Refill Tank	1380	11
LO Oil Level Refill	LO Oil Level Refill	1380	17
AL L2 T-Aux1	AL L2 T-Aux1	1385	0
SD T-AUX 1	SD T-AUX 1	1385	11
SD T-AUX 2	SD T-AUX 2	1386	11
AL L2 P-Aux1	AL L2 P-Aux1	1387	1
SD P-AUX 1	SD P-AUX 1	1387	11
AL L1 P-Aux 1	AL L1 P-Aux 1	1387	17
AL L2 P-Aux2	AL L2 P-Aux2	1388	1
SD P-AUX 2	SD P-AUX 2	1388	11
AL L1 P-Aux 2	AL L1 P-Aux 2	1388	17
Niveau RM Tank	Niveau RM Tank	1761	11
SS T-Exhaust B	SS T-Exhaust B	2433	0
SD T-Exhaust B	SD T-Exhaust B	2433	11
HI T-Exhaust B	HI T-Exhaust B	2433	15
SS T-Exhaust A	SS T-Exhaust A	2434	0
SD T-Exhaust A	SD T-Exhaust A	2434	11
HI T-Exhaust A	HI T-Exhaust A	2434	15
SD P-Ch MixbefThrott	SD P-Charge Mix before Throttle	2631	11
SD T-RM Tank	SD T-RM Tank	3031	11
HIHI Nox Value	HIHI Nox Value	3226	0
LOLO Nox Value	LOLO Nox Value	3226	1
SD Smart NOx Oxi.Fac	SD Smart NOx Oxidation Factor O2	3226	11
HI Nox Value	HI Nox Value	3226	15
LO Nox Value	LO Nox Value	3226	17
AL NOx ATO1Comm.lost	AL NOx ATO1 Communication Lost	3226	31
AL L2 T-Exhaust Bef.	AL L2 T-Exhaust Before DPF	3242	0
SD T-Exhaust bef.DPF	SD T-Exhaust before DPF A	3242	11
AL L1 T-Exhaust Bef.	AL L1 T-Exhaust Before DPF	3242	15
AL L2 T-ExhaustAfter	AL L2 T-Exhaust After DPF	3246	0
SD T-Exhaust a. DPF	SD T-Exhaust after DPF A	3246	11
AL L1 T-ExhaustAfter	AL L1 T-Exhaust After DPF	3246	15
AL L2 P-DPF Diff.	AL L2 P-DPF Difference	3251	0
SD P-DeltaExhaustDPF	SD P-DeltaExhaust DPF A	3251	11
AL L1 P-DPF Diff.	AL L1 P-DPF Difference	3251	15
SS T-Fuel B	SS T-Fuel B	3468	0
SD-T-Fuel B	SD-T-Fuel B	3468	11

DEIF display	MTU	SPN	FMI
HI T-Fuel B	HI T-Fuel B	3468	15
AL Urea Qua Release	AL Urea Quality Release	3516	31
AL turning activated	AL turning activated	3543	31
HIHI P-Charge Mix B	HIHI P-Charge Mix B	3562	0
SD P-Charge Mix B	SD P-Charge Mix B	3562	11
SS P-Charge Air	SS P-Charge Air	3563	0
SD P-Charge Air	SD P-Charge Air	3563	11
HI P-Charge Air	HI P-Charge Air	3563	15
SD Level Cool.InterC	SD Level Coolant Intercooler	3668	11
LO Coolant LevelIntC	LO Coolant Level Intercooler	3668	17
SD Feedback Thrott B	SD Feedback Throttle B	3673	11
Al Req Angle Throt B	Al Req Angle Throttle B	3673	15
AL mix throt B fault	AL mixture throttle B fault	3673	31
AL DPF Rigorous TM S	AL DPF Rigorous TM Suppression	3703	11
SD T-Coolant (R2)	SD T-Coolant (R2)	4076	31
SS T-Coolant bef Eng	SS T-Coolant before Engine	4193	0
SD T-Coolant b.Engin	SD T-Coolant b.Engine	4193	11
HI T-Coolant bef Eng	HI T-Coolant before Engine	4193	15
SD EngRPM 3rd Sensor	SD Engine Speed 3rd Sensor	4202	31
AL SCR F1 SU AdBlueQ	AL SCR F1 SU AdBlue Quantity	4348	15
AL L2 T-Exh.Bef.SCR1	AL L2 T-Exhaust Before SCR F1	4360	0
SD T-Exh bef. SCR F1	SD T-Exh before SCR F1	4360	11
SD T-Exh bef. SCR F3	SD T-Exh before SCR F3	4360	11
AL L1 T-Exh.Bef.SCR1	AL L1 T-Exhaust Before SCR F1	4360	15
AL F1 T-Exh bef.SCRL	AL F1 T-Exh before SCR too LOW	4360	17
AL L2 T-Exh.Aft.SCR1	AL L2 T-Exhaust After SCR F1	4363	0
SD T-Exh a. SCR F1	SD T-Exh after SCR F1	4363	11
SD T-Exh aft. SCR F3	SD T-Exh after SCR F3	4363	11
AL L1 T-Exh.Aft.SCR1	AL L1 T-Exhaust After SCR F1	4363	15
AL F1 T-Exh aft.SCRL	AL F1 T-Exh after SCR too LOW	4363	17
AL SCR F1 SU Rev. Ra	AL SCR F1 SU Revolution Range	4375	31
AL SCR F2 SU AdBlueQ	AL SCR F2 SU AdBlue Quantity	4401	15
AL L2 T-Exh.Bef.SCR2	AL L2 T-Exhaust Before SCR F2	4413	0
SD T-Exh bef. SCR F1	SD T-Exh before SCR F2	4413	11
AL L1 T-Exh.Bef.SCR2	AL L1 T-Exhaust Before SCR F2	4413	15
AL F2 T-Exh bef.SCRL	AL F2 T-Exh before SCR too LOW	4413	17
AL L2 T-Exh.Aft.SCR2	AL L2 T-Exhaust After SCR F2	4415	0

DEIF display	MTU	SPN	FMI
SD T-Exh a. SCR F2	SD T-Exh after SCR F2	4415	11
AL L1 T-Exh.Aft.SCR2	AL L1 T-Exhaust After SCR F2	4415	15
AL F2 T-Exh aft.SCRL	AL F2 T-Exh after SCR too LOW	4415	17
AL SCR F2 SU Rev. Ra	AL SCR F2 SU Revolution Range	4441	31
SD Air Humidity	SD Air Humidity	4490	11
SD Air Humidity	SD Air Humidity (HDT2800)	4490	11
AL Rel. Humidity L1	AL Rel. Humidity L1	4490	15
AL L2 T-Exhaust Bef.	AL L2 T-Exhaust Before DOC	4765	0
SD T-Exhaust bef.DOC	SD T-Exhaust before DOC A	4765	11
AL L1 T-Exhaust Bef.	AL L1 T-Exhaust Before DOC	4765	17
AL Battery Not Charg	AL Battery Not Charging	4990	31
AL L2 P-Charge Air B	AL L2 P-Charge Air B	5422	1
AL L1 P-Charge Air B	AL L1 P-Charge Air B	5422	17
SD-P-Fuel Returnpath	SD-P-Fuel Return path	5571	11
AL L1 P-FuelRet.Path	AL L1 P-Fuel Return Path	5571	17
SD P-L Oil aft L. Pu	SD-P-Lube Oil aft Level Pump	520406	11
AL L1 P-OilNivPump	AL L1 P-OilNivPump	520406	17
AL Wiring TO 1	AL Wiring TO 1	520872	31
AL Selected Mode NV	AL Selected Mode not Valid	520873	31
AL No Valid ModeSw.S	AL No Valid Mode Switch Signal	520874	11
AL Speed Demand Fail	AL Speed Demand Failure	520875	31
AL SD Stop Button	AL SD Stop Button	520876	11
AL SD Start Button	AL SD Start Button	520877	11
AL SD Up Button	AL SD Up Button	520878	11
AL SD Down Button	AL SD Down Button	520879	11
AL SD Ext. Speed D_S	AL SD Ext. Speed Demand Switch	520880	11
AL SD Speed D Inc	AL SD Speed Demand Increase	520881	11
AL SD Bin Speed Lim	AL SD Binary Speed Limitation	520882	11
AL SD Droop 2 Switch	AL SD Droop 2 Switch	520883	11
AL SD Frequency SW	AL SD Frequency Switch	520884	11
AL SD Test Overspeed	AL SD Test Overspeed	520885	11
AL SD Override Butto	AL SD Override Button	520886	11
AL SD Alarm Reset	AL SD Alarm Reset	520887	11
AL SD Cylin CutOut	AL SD Cylinder Cut Out	520888	11
AL SD Request BinOut	AL SD Request BinOut Test	520889	11
AL SD Ext.Engine Pro	AL SD Ext. Engine Protection	520890	11
AL SD Prelubri. Sig.	AL SD Prelubrication Signal	520891	11

DEIF display	MTU	SPN	FMI
AL SD Ext.IncIdleBin	AL SD Ext. Increased Idle Bin	520892	11
AL SD Request P. DBR	AL SD Request Plant DBR	520893	11
AL Wiring Cylind.A1	AL Wiring Cylinder A1	520900	31
AL Wiring Cylind.A2	AL Wiring Cylinder A2	520901	31
AL Wiring Cylind.A3	AL Wiring Cylinder A3	520902	31
AL Wiring Cylind.A4	AL Wiring Cylinder A4	520903	31
AL Wiring Cylind.A5	AL Wiring Cylinder A5	520904	31
AL Wiring Cylind.A6	AL Wiring Cylinder A6	520905	31
AL Wiring Cylind.A7	AL Wiring Cylinder A7	520906	31
AL Wiring Cylind.A8	AL Wiring Cylinder A8	520907	31
AL Wiring Cylind.A9	AL Wiring Cylinder A9	520908	31
AL Wiring Cylind.A10	AL Wiring Cylinder A10	520909	31
AL Wiring Cylind.B1	AL Wiring Cylinder B1	520910	31
AL Wiring Cylind.B2	AL Wiring Cylinder B2	520911	31
AL Wiring Cylind.B3	AL Wiring Cylinder B3	520912	31
AL Wiring Cylind.B4	AL Wiring Cylinder B4	520913	31
AL Wiring Cylind.B5	AL Wiring Cylinder B5	520914	31
AL Wiring Cylind.B6	AL Wiring Cylinder B6	520915	31
AL Wiring Cylind.B7	AL Wiring Cylinder B7	520916	31
AL Wiring Cylind.B8	AL Wiring Cylinder B8	520917	31
AL Wiring Cylind.B9	AL Wiring Cylinder B9	520918	31
AL Wiring Cylind.B10	AL Wiring Cylinder B10	520919	31
SS T-Coolant L3	SS T-Coolant L3	520923	0
AL Power too high	AL Power too high	520924	15
AL Open L.Cylind.A1	AL Open Load Cylinder A1	520930	31
AL Open L.Cylind.A2	AL Open Load Cylinder A2	520931	31
AL Open L.Cylind.A3	AL Open Load Cylinder A3	520932	31
AL Open L.Cylind.A4	AL Open Load Cylinder A4	520933	31
AL Open L.Cylind.A5	AL Open Load Cylinder A5	520934	31
AL Open L.Cylind.A6	AL Open Load Cylinder A6	520935	31
AL Open L.Cylind.A7	AL Open Load Cylinder A7	520936	31
AL Open L.Cylind.A8	AL Open Load Cylinder A8	520937	31
AL Open L.Cylind.A9	AL Open Load Cylinder A9	520938	31
AL Open L.Cylind.A10	AL Open Load Cylinder A10	520939	31
AL Open L.Cylind.B1	AL Open Load Cylinder B1	520940	31
AL Open L.Cylind.B2	AL Open Load Cylinder B2	520941	31
AL Open L.Cylind.B3	AL Open Load Cylinder B3	520942	31

DEIF display	MTU	SPN	FMI
AL Open L.Cylind.B4	AL Open Load Cylinder B4	520943	31
AL Open L.Cylind.B5	AL Open Load Cylinder B5	520944	31
AL Open L.Cylind.B6	AL Open Load Cylinder B6	520945	31
AL Open L.Cylind.B7	AL Open Load Cylinder B7	520946	31
AL Open L.Cylind.B8	AL Open Load Cylinder B8	520947	31
AL Open L.Cylind.B9	AL Open Load Cylinder B9	520948	31
AL Open L.Cylind.B10	AL Open Load Cylinder B10	520949	31
AL Wiring TOP 1	AL Wiring TOP 1	520952	31
AL Wiring TOP 2	AL Wiring TOP 2	520953	31
AL Wiring TOP 3	AL Wiring TOP 3	520954	31
AL Wiring TOP 4	AL Wiring TOP 4	520955	31
AL Open Load DI 1	AL Open Load Digital Input 1	520958	31
AL Open Load DI 2	AL Open Load Digital Input 2	520959	31
AL Open Load DI 3	AL Open Load Digital Input 3	520960	31
AL Open Load DI 4	AL Open Load Digital Input 4	520961	31
AL Open Load DI 5	AL Open Load Digital Input 5	520962	31
AL Open Load DI 6	AL Open Load Digital Input 6	520963	31
AL Open Load DI 7	AL Open Load Digital Input 7	520964	31
AL Open Load DI 8	AL Open Load Digital Input 8	520965	31
AL Wiring PWM_CM1	AL Wiring PWM_CM1	520970	31
AL Wiring PWM_CM2	AL Wiring PWM_CM2	520971	31
AL Wiring PWM_CM3	AL Wiring PWM_CM3	520972	31
AL Wiring PWM_CM4	AL Wiring PWM_CM4	520973	31
AL Wiring PWM_CM5	AL Wiring PWM_CM5	520974	31
AL Wiring PWM_CM6	AL Wiring PWM_CM6	520975	31
AL Wiring PWM_CM7	AL Wiring PWM_CM7	520976	31
AL Wiring PWM_CM8	AL Wiring PWM_CM8	520977	31
AL Wiring PWM_CM9	AL Wiring PWM_CM9	520978	31
AL Wiring PWM_CM10	AL Wiring PWM_CM10	520979	31
HIHI U-PDU	HIHI U-PDU	520982	0
LOLO U-PDU	LOLO U-PDU	520982	1
SD U-PDU	SD U-PDU	520982	11
HI U-PDU	HI U-PDU	520982	15
LO U-PDU	LO U-PDU	520982	17
AL Wiring Suct. Res1	AL Wiring Suction Restrictor 1	520983	31
AL Wiring Suct. Res2	AL Wiring Suction Restrictor 2	520984	31
AL Wiring Pres.CV 1	AL Wiring Pressure Control Valve 1	520985	31

DEIF display	MTU	SPN	FMI
AL Wiring Pres.CV 2	AL Wiring Pressure Control Valve 2	520986	31
AL Crash Rec. Init.	AL Crash Rec. Init. Error	520990	31
AL ECUPower OFF/ON R	AL ECU Power OFF/ON Required	520991	31
AL OL ASO FlapFeedbB	AL OL ASO Flap Feedback B	520994	11
AL ASOFlapB cl. Aerr	AL ASO Flap B closed, A failed	520995	11
AL OL ASO FlapFeedbA	AL OL ASO Flap Feedback A	520996	31
AL ASOFlapA cl. Aerr	AL ASO Flap A closed, B failed	520997	31
AL ASO Flaps Closed	AL ASO Flaps Closed	520998	31
AL ASOFlaps open/err	AL ASO Flaps open / failed to close	520999	31
AL ASO Flap A Not Cl	AL ASO Flap A Not Closed by ECU	521000	31
AL Rail Leakage	AL Rail Leakage	521001	31
SS Release Sp.N Reac	SS Release Speed Not Reached	521002	1
SS Starter Sp.N Reac	SS Starter Speed Not Reached	521003	1
SS T-Preheat	SS T-Preheat	521004	1
LO T-Preheat	LO T-Preheat	521004	17
AL ASO Flap B Not Cl	AL ASO Flap B Not Closed by ECU	521005	31
AL CAN1 Node Lost	AL CAN1 Node Lost	521006	31
AL CAN2 Node Lost	AL CAN2 Node Lost	521007	31
AL CAN Wrong Param.	AL CAN Wrong Parameters	521008	31
AL CAN No PU-Data	AL CAN No PU-Data	521009	31
AL CAN PU-Data Flash	AL CAN PU-Data Flash Error	521010	31
AL CAN1 Bus Off	AL CAN1 Bus Off	521011	31
AL CAN1 Error Pass.	AL CAN1 Error Passive	521012	31
AL CAN2 Bus Off	AL CAN2 Bus Off	521013	31
AL CAN2 Error Pass.	AL CAN2 Error Passive	521014	31
AL Stop Camsh. S def	AL Stop Camshaft Sensor Defect	521016	31
SD Crankshaft Speed	SD Crankshaft Speed	521017	11
SD Camshaft Speed	SD Camshaft Speed	521018	11
SD Frequency Input	SD Frequency Input	521019	11
AL Power Stage Low	AL Power Stage Low	521020	31
AL Power Stage High	AL Power Stage High	521021	31
AL Stop Power Stage	AL Stop Power Stage	521022	31
AL L2 Aux1 Plant	AL L2 Aux1 Plant	521023	0
AL L1 Aux1 Plant	AL L1 Aux1 Plant	521023	15
AL Stop MVWiring GND	AL Stop MV-Wiring Ground	521023	31
AL Open Load Emerg.	AL Open Load Emerg. Stop Input ESI	521024	31
SD Idle/End-TorqueIN	SD Idle/End-Torque Input [%]	521025	11

DEIF display	MTU	SPN	FMI
SS Power Reduct. Act	SS Power Reduction Active	521026	31
AL Stop SD	AL Stop SD	521027	31
AL Wiring FO	AL Wiring FO	521028	31
AL Wiring PWM_CM2	AL Wiring PWM_CM2	521028	31
AL Ext. Engine Prot.	AL Ext. Engine Protection	521029	31
AL Starter Not Engag	AL Starter Not Engaged	521030	31
AL Power Cut-Off det	AL Power Cut-Off detected	521031	31
AL ESCM Override	AL ESCM Override	521032	31
AL MD CANReq Idle S.	AL MD CAN Request Idle Speed	521033	31
AL MD CAN Speed Limi	AL MD CAN Speed Limitation	521034	31
AL L2 PRV Defect	AL L2 PRV Defect	521035	0
AL L1 PRV Defect	AL L1 PRV Defect	521035	15
AL L1 PRV Defect	AL L1 PRV Defect	521036	31
AL L2 PRV Defect	AL L2 PRV Defect	521037	31
SD ETC1+ETC2	SD ETC1+ETC2	521038	11
AL Doub.Nod. Lost1+2	AL Double Nodes Lost CAN 1 + 2	521039	31
AL EIL Protection	AL EIL Protection	521040	31
AL EIL Error	AL EIL Error	521041	31
AL EGR Throttle ADef	AL EGR Throttle A Defect	521042	31
AL Bypass Throt. Def	AL Bypass Throttle Defect	521043	31
AL Dispen. Throt.Def	AL Dispenser Throttle Defect	521044	31
SD P-Exhaust Lambda	SD P-Exhaust Lambda	521045	11
SD P-Charge Air B	SD P-Charge Air B	521046	11
SD Smart NOx HeaterE	SD Smart NOx Heater Element	521047	11
SD Smart NOx Concent	SD Smart NOx Concentration	521048	11
AL Emission Fault	AL Emission Fault	521050	31
SD P-Fuel	SD P-Fuel	521052	11
AL L2L Voltage ASO	AL L2L Voltage ASO	521053	1
AL SD Voltage ASO	AL SD Voltage ASO	521053	11
AL L1L Voltage ASO	AL L1L Voltage ASO	521053	17
SD P-Ambient Air	SD P-Ambient Air	521060	11
AL Emerg. Stop fail	AL Emergency Stop Failed	521061	31
AL CAN Engine St.Loc	AL CAN Engine Start Lock	521062	31
SD P-Fuel bef. Add.s	SD P-Fuel bef. Add.sec.fuelfilter	521063	11
AL L1 P-Fuel Add.sec	AL L1 P-Fuel Add.sec.fuelfilt. Diff	521063	15
AL L2 P-Fuel b.o.F.	AL L2 P-Fuel b.o.F.	521064	0
SD P-Fuel b.o.F.	SD P-Fuel b.o.F.	521064	11

DEIF display	MTU	SPN	FMI
AL L1 P-Fuel b.o.F.	AL L1 P-Fuel b.o.F.	521064	15
AL Emission Warning	AL Emission Warning	521067	31
AL Gas Path Warning	AL Gas Path Warning	521068	31
AL Gas Path Fault	AL Gas Path Fault	521069	31
AL GPE Lambda v.inva	AL GPE Lambda value invalid	521070	31
AL NOx value invalid	AL NOx value invalid	521071	31
AL Thermal Manag.Act	AL Thermal Management active	521072	31
AL p5 ctrlvar LO Act	AL p5 ctrlvar lower limit active	521073	31
AL p5 ctrlvar max BO	AL p5 ctrlvar max BOI min active	521074	31
AL Lambda ctrlvar li	AL Lambda ctrlvar limit min active	521075	31
AL Lambda ctrlvar ma	AL Lambda ctrlvar max BOI min act	521076	31
AL Nox p5 min BOI ma	AL Nox p5 min BOI max active	521077	31
AL NOx p5 max BOI mi	AL NOx p5 max BOI min active	521078	31
AL GPS p5 ctrlvar ma	AL GPS p5 ctrlvar max active	521080	31
AL GPS p5 ctrlvar mi	AL GPS p5 ctrlvar min active	521081	31
AL GPS p5 ctrlvar mi	AL GPS p5 ctrlvar min active	521082	31
AL Bypass Throttle 2	AL Bypass Throttle 2 Defect	521083	31
AL Bypass Valve Def.	AL Bypass Valve Defect	521084	31
AL Intake AirThrottl	AL Intake AirThrottle Defect	521085	31
SD Bosch LSU LambdaS	SD Bosch LSU Lambda Sensor	521086	11
AL EGR Throttle BDef	AL EGR Throttle B Defect	521087	31
AL L2 Delta T-NT Int	AL L2 Delta T-NT Intercooler	521088	0
AL L1 Delta T-NT Int	AL L1 Delta T-NT Intercooler	521088	17
AL Lim T-Coolant LT	AL Lim T-Coolant LT Fan	521089	31
AL ETC2 CutIn Failur	AL ETC2 CutIn Failure	521091	31
AL Prelubrication	AL Prelubrication Fault	521092	31
AL MCR exceeded 1h	AL MCR exceeded 1 hour	521093	31
AL EMU Parameter Not	AL EMU Parameter Not Supported	521094	31
SD Spinning Value	SD Spinning Value	521095	11
AL MCR exceeded	AL MCR exceeded	521096	31
AL Rail 2 Leakage	AL Rail 2 Leakage FMI-	521097	31
HI T-Exhaust EMU	HI T-Exhaust EMU	521098	15
LO T-Exhaust EMU	LO T-Exhaust EMU	521098	17
HI T-Coolant EMU	HI T-Coolant EMU	521099	15
SD Coil Current	SD Coil Current	521100	11
AL ETC4 CutIn Failur	AL ETC4 CutIn Failure	521103	31
AL ETC3 CutIn Failur	AL ETC3 CutIn Failure	521104	31

DEIF display	MTU	SPN	FMI
AL Wiring POM Starte	AL Wiring POM Starter 1	521105	11
AL Wiring POM Starte	AL Wiring POM Starter 2	521106	11
AL Open Load POM Alt	AL Open Load POM Alternator	521107	11
AL L1 T-Raw W a. Pum	AL L1 T-Raw water after Pump	521108	17
AL CAN POM Node Lost	AL CAN POM Node Lost	521109	11
AL Low Starter Volta	AL Low Starter Voltage	521110	1
AL POM Error	AL POM Error	521111	31
AL Wrong POM-ID	AL Wrong POM-ID	521112	31
Write Error Flash	Write Error Flash	521113	31
Oillevel Calibration	Oillevel Calibration Error	521114	31
SD P-Intake Air a.FA	SD P-Intake Air after Filter A	521115	11
SD P-Intake Air a.FB	SD P-Intake Air after Filter B	521116	11
SS Engine Oversp. CS	SS Engine Overspeed Camshaft	521117	0
SD T-Lube Oil Pan	SD T-Lube Oil Pan	521118	11
AL T-Lube Oil Pan LO	AL T-Lube Oil Pan Low	521118	17
SD P-Oil Refill Pump	SD P-Oil Refill Pump	521119	11
LO P-Oil Refill Pump	LO P-Oil Refill Pump	521119	17
SD T-Exhaust A+B	SD T-Exhaust A+B	521120	11
SD T-Lube Oil Pan	SD T-Lube Oil Pan J1939	521121	11
AL MB Valve error	AL MB Valve error	521122	31
AL L2 P-DPF Norm Dif	AL L2 P-DPF Norm Difference	521123	0
AL L4 P-DPF Norm Dif	AL L4 P-DPF Norm Difference	521123	1
AL L1 P-DPF Norm Dif	AL L1 P-DPF Norm Difference	521123	15
AL L3 P-DPF Norm Dif	AL L3 P-DPF Norm Difference	521123	17
AL DPF Rigorous TM A	AL DPF Rigorous TM Aborted	521124	11
AL DPF Periodic Rigo	AL DPF Periodic Rigorous TM	521125	11
AL DPF Flash ReadErr	AL DPF Flash Read Error	521126	11
AL DEF Nozzle Damage	AL DEF Nozzle Damage	521127	11
AL SmartConnect Lost	AL Smart Connect Lost	521128	11
SD-T-Sea water a.Pum	SD-T-Sea water after Pump	521129	11
SD-P-LOil, HP Pump A	SD-P-Lube Oil at HP Pump A	521131	11
SD-P-LOil, HP Pump B	SD-P-Lube Oil at HP Pump B	521132	11
SD Charger 5 Speed	SD Charger 5 Speed	521133	11
AL F1 NOx bef. SCR	AL F1 NOx before SCR SensorDefect	521134	11
AL F1 NOx bef. SCR	AL F1 NOx before SCR Comm Lost	521134	31
AL F1 NOx a. SCR	AL F1 NOx after SCR SensorDefect	521135	11
AL F1 NOx a. SCR C	AL F1 NOx afterSCR Comm Lost	521135	31

DEIF display	MTU	SPN	FMI
AL F2 NOx bef. SCR	AL F2 NOx before SCR SensorDefect	521136	11
AL F2 NOx bef. SCR	AL F2 NOx before SCR Comm Lost	521136	31
AL F2 NOx a. SCR	AL F2 NOx after SCR SensorDefect	521137	11
AL F2 NOx a. SCR	AL F2 NOx after SCR Comm Lost	521137	31
AL F3 NOx bef. SCR	AL F3 NOx before SCR SensorDefect	521138	11
AL F3 NOx bef. SCR	AL F3 NOx before SCR Comm Lost	521138	31
AL F3 NOx a. SCR	AL F3 NOx after SCR SensorDefect	521139	11
AL F3 NOx a. SCR	AL F3 NOx after SCR Comm Lost	521139	31
HI ETC1 Idle Speed H	HI ETC1 Idle Speed too High	521140	31
HI ETC2 Idle Speed H	HI ETC2 Idle Speed too High	521141	31
HI ETC3 Idle Speed H	HI ETC3 Idle Speed too High	521142	31
HI ETC4 Idle Speed H	HI ETC4 Idle Speed too High	521143	31
HI ETC5 Idle Speed H	HI ETC5 Idle Speed too High	521144	31
AL ETC1 Speed Dev.	AL ETC1 Speed Deviation	521145	31
AL ETC2 Speed Dev.	AL ETC2 Speed Deviation	521146	31
AL ETC3 Speed Dev.	AL ETC3 Speed Deviation	521147	31
AL ETC4 Speed Dev.	AL ETC4 Speed Deviation	521148	31
AL ETC5 Speed Dev.	AL ETC5 Speed Deviation	521149	31
AL ETC Job Rotation	AL ETC Job Rotation	521150	31
AL EIL Different Eng	AL EIL Different Engine Number	521151	31
AL ash volume	AL ash volume	521152	31
AL HIHI T-ChargeAEGR	AL HIHI T-Charge Air before EGR	521153	0
AL HI T-ChargeAirEGR	AL HI T-Charge Air before EGR	521153	15
SD T-Charge Air bef.	SD T-Charge Air before EGR	521153	31
AL HIHI T-Char.ADAB	AL HIHI T-Charge Air Diff AB	521154	0
AL HI T-ChargeAirDAB	AL HI T-Charge Air Diff AB	521154	15
AL Ext.Start, HD HI	AL External Start and HD too high	521155	31
AL Max. BlankShot TE	AL Max. Blank Shot time expired	521156	31
AL HSB1 Comm. lost	AL HSB1 Communication Lost	521157	31
AL HSB1 Actuat. def.	AL HSB1 Actuator defect	521158	31
AL NOx ATO1 Sen. Def	AL NOx ATO1 Sensor Defect	521159	31
AL HSB2 Comm. lost	AL HSB2 Communication Lost	521160	31
AL HSB2 Actuator def	AL HSB2 Actuator defect	521161	31
Defect DEFPsns/act S	Defect in DEF pipe sns/act system	521162	31
DEF Tank ht. sns/act	DEF Tank ht. sns/act defect	521163	31
AL HSB3 Comm. lost	AL HSB3 Communication Lost	521164	31
AL HSB3 Actuator def	AL HSB3 Actuator defect	521165	31

DEIF display	MTU	SPN	FMI
AL HSB4 Comm. lost	AL HSB4 Communication Lost	521166	31
AL HSB4 Actuator def	AL HSB4 Actuator defect	521167	31
AL MB Valve defect 2	AL MB Valve defect 2	521168	31
AL EGR A Ref.learn	AL EGR A Reference learn failed	521169	31
AL Urea Tank L.Empty	AL Urea Tank Level Empty	521170	31
AL EGR B Ref. learn	AL EGR B Reference learn failed	521171	31
AL Bypass A Ref.	AL Bypass A Reference learn failed	521172	31
AL Bypass B Fast lea	AL Bypass B Fast learn failed	521173	31
AL Dispenser Ref.lea	AL Dispenser Reference learn failed	521174	31
AL Intake Thr. Ref L	AL Intake Throttle Ref learn failed	521175	31
AL SCR AdBlue press.	AL SCR AdBlue pressure	521176	31
AL Flow1 SU 1 Comm L	AL Flow 1 Supply Unit 1 Comm Lost	521177	31
AL Flow1 SU 2 Comm L	AL Flow 1 Supply Unit 2 Comm Lost	521178	31
AL Flow2 SU 1 Comm L	AL Flow 2 Supply Unit 1 Comm Lost	521179	31
AL Flow2 SU 2 Comm L	AL Flow 2 Supply Unit 2 Comm Lost	521180	31
AL Flow3 SU 1 Comm L	AL Flow 3 Supply Unit 1 Comm Lost	521181	31
AL Flow3 SU 2 Comm L	AL Flow 3 Supply Unit 2 Comm Lost	521182	31
AL Trican Comm. Lost	AL Trican Communication Lost	521183	31
AL OLT Comm. Lost	AL OLT Communication Lost	521184	31
AL SD T Coolant Cy.H	AL SD T Coolant at cylinder head	521187	11
HI T-Coolant Cy.Head	HI T-Coolant Cylinder Head	521187	15
SS T-Coolant Cyl. H	SS T-Coolant Cylinder Head	521187	16
AL F1 DEF consump.	AL F1 DEF consumption error	521188	31
AL F1 DEF balance	AL F1 DEF balance error	521189	31
AL F1 Raw gas emissi	AL F1 Raw gas emission error	521190	31
AL F1 NOx Annaeherun	AL F1 NOx Annaeherung error	521191	31
AL Texh bef SCR F1F2	AL T-Exh bef SCR between F1 and F2	521192	31
AL F1 Erw Tabg v SCR	AL F1 Erw T-Abg vor SCR Error	521193	31
AL F1Exp TExh af SCR	AL F1 Exp T-Exh aft SCR error	521194	31
AL F1 gr TExh bf SCR	AL F1 grad T-Exh bef SCR error	521195	31
AL F2 gr TExh bf SCR	AL F2 grad T-Exh bef SCR error	521196	31
AL F1 gr TExh af SCR	AL F1 grad T-Exh aft SCR error	521198	31
AL F2 gr TExh af SCR	AL F2 grad T-Exh aft SCR error	521199	31
AL SCR F3 T-Exh aft.	AL SCR F3 T-Exh after gradient	521200	31
AL L2 T-Exh.Bef.SCR3	AL L2 T-Exhaust Before SCR F3	521201	0
AL L1 T-Exh.Bef.SCR3	AL L1 T-Exhaust Before SCR F3	521201	15
AL L2 T-Exh.Aft.SCR3	AL L2 T-Exhaust After SCR F3	521202	0

DEIF display	MTU	SPN	FMI
AL L1 T-Exh.Aft.SCR3	AL L1 T-Exhaust After SCR F3	521202	15
AL SCR oper. T TooLO	AL SCR operating temperature too-LOW	521203	17
AL Cataly conv. F1	AL Cataly conversion too lowF1	521204	17
AL Cataly conv. F2	AL Cataly conversion too lowF2	521205	17
AL Cataly conv. F3	AL Cataly conversion too lowF3	521206	17
AL Invalid LSI Ch.Co	AL Invalid LSI Channel Config	521207	31
AL SCR SU fault(s)	AL SCR SU fault(s) exist	521208	31
AL ETC0 CutIn Fail	AL ETC0 CutIn Failure	521209	31
AL ETC1 CutIn Fail	AL ETC1 CutIn Failure	521210	31
AL SCR SU fault(s)F2	AL SCR SU fault(s) exist F2	521211	31
AL SCR SU Prim. RF1	AL SCR SU Priming Request F1	521213	31
AL SCR SU Prim. RF2	AL SCR SU Priming Request F2	521214	31
AL L1 P-Oil bef. PuA	AL L1 P-Oil before HD Pump A	521216	17
AL L1 P-Oil bef. PuB	AL L1 P-Oil before HD Pump B	521217	17
SD Loadp.Analog filt	SD Loadp.Analog filt	521218	11
SD T-Intake Air B	SD T-Intake Air B	521219	11
SS P-Coolant befEng	SS P-Coolant before Engine	521220	1
SD P-Coolant b.Engin	SD P-Coolant b.Engine	521220	11
LO P-Coolant befEngi	LO P-Coolant before Engine	521220	17
SD P-Charge Mix Diff	SD P-Charge Mix Diff	521221	11
HI P-Charge Mix Diff	HI P-Charge Mix Diff	521221	31
HIHI P-ChargeMixDiff	HIHI P-Charge Mix Diff	521221	31
SD ele. Eng powerAI2	SD electr. engine power AI2	521222	31
AL CR Trig. Eng.Stop	AL CR Trigger Engine Stop	521223	31
HIHI Power Diff	HIHI Power Difference	521224	0
LOLO Power Diff	LOLO Power Difference	521224	1
AL GasControlCheck	AL GasControlCheck Fault	521225	31
AL Ignition Fault	AL Ignition Fault	521226	31
AL GasValve Fault	AL GasValve Fault	521227	31
AL EngineSpeedCollap	AL EngineSpeedCollapse Fault	521228	31
AL SAM Missing Data	AL SAM Missing Data Fault	521229	31
L3 AI CANMaxRetar. T	L3 AI CAN Max. Retarded Timing	521235	0
L1 AI CANMaxRetar. T	L1 AI CAN Max. Retarded Timing	521235	15
L2 AI CANMaxRetar. T	L2 AI CAN Max. Retarded Timing	521235	16
AL Cir. Break closed	AL Circuit Breaker Closed	521236	31
AL Hut Changespeed M	AL Hut Changespeed	521237	31
HIHI Actual Value Hu	HIHI Actual Value Hu	521238	0

DEIF display	MTU	SPN	FMI
LOLO Actual Value Hu	LOLO Actual Value Hu	521238	1
HI Actual Value Hu	HI Actual Value Hu	521238	15
LO Actual Value Hu	LO Actual Value Hu	521238	17
Al Knock Intensity	Al Knock Intensity	521239	31
AL Preheating Error	AL Preheating Error	521240	31
AL GET Comm Lost	AL GET Comm Lost	521241	31
AL IC92x Comm Lost	AL IC92x Comm Lost	521242	31
AL FSeries Comm Lost	AL FSeries Comm Lost	521243	31
AL TecJet Comm Lost	AL TecJet Comm Lost	521244	31
AL ProActA Comm Lost	AL ProActA Comm Lost	521245	31
AL ProActB Comm Lost	AL ProActB Comm Lost	521246	31
AL NOxA Comm Lost	AL NOxA Comm Lost	521247	31
AL NOxB Comm Lost	AL NOxB Comm Lost	521248	31
AL Oil Refill Error	AL Oil Refill Error	521249	31
AL GET Yellow	AL GET Yellow	521250	31
AL IC92x Yellow	AL IC92x Yellow	521251	31
AL FSeries Yellow	AL FSeries Yellow	521252	31
AL TecJet Yellow	AL TecJet Yellow	521253	31
AL ProActA Yellow	AL ProActA Yellow	521254	31
AL ProActB Yellow	AL ProActB Yellow	521255	31
AL NOxA Yellow	AL NOxA Yellow	521256	31
AL NOxB Yellow	AL NOxB Yellow	521257	31
AL GET Red	AL GET Red	521258	31
AL IC92x Red	AL IC92x Red	521259	31
AL FSeries Red	AL FSeries Red	521260	31
AL TecJet Red	AL TecJet Red	521261	31
AL ProActA Red	AL ProActA Red	521262	31
AL ProActB Red	AL ProActB Red	521263	31
AL NOxA Red	AL NOxA Red	521264	31
AL NOxB Red	AL NOxB Red	521265	31
AL Lube Oil Min	AL Lube Oil Min	521266	31
AL Lube Oil Max	AL Lube Oil Max	521267	31
LO Oil Refill	LO Oil Refill	521268	31
HI Oil Refill	HI Oil Refill	521269	31
HI Lube Oil L. Ref	HI Lube Oil Level refill	521270	31
AL ActFuelValvePosL1	AL ActFuelValvePos L1	521271	31
AL MIC5 Yellow	AL MIC5 Yellow	521272	31

DEIF display	MTU	SPN	FMI
AL MIC5 Red	AL MIC5 Red	521273	31
AL MIC5 Comm Lost	AL MIC5 Comm Lost	521274	31
AL ESI activated	AL ESI activated	521275	31
AL MIC5 Sign. diff	AL MIC5 Signature difference	521276	31
AL CAN3 Bus Off	AL CAN3 Bus Off	521277	31
AL CAN3 Error Pas	AL CAN3 Error Passive	521278	31
AL CAN4 Bus Off	AL CAN4 Bus Off	521279	31
AL CAN4 Error Pas	AL CAN4 Error Passive	521280	31
HIHI Delta NOx (A-B)	HIHI Delta NOx (A-B)	521297	0
HI Delta NOx (A-B)	HI Delta NOx (A-B)	521297	15
HI Delta p5 for NOx	HI Delta p5 for NOx	521298	15
AL MIC5 para. DL act	AL MIC5 parameter download active	521299	31
AL F2 DEF consumptio	AL F2 DEF consumption error	521332	31
AL F2 DEF balance	AL F2 DEF balance error	521333	31
AL F2 Raw gas emissi	AL F2 Raw gas emission error	521334	31
AL F2 Nox Annaeherun	AL F2 NOx Annaeherung error	521335	31
AL TExh af. SCR F1F2	AL T-Exh aft SCR between F1 and F2	521336	31
AL F2Exp TExh bf SCR	AL F2 Exp T-Exh bef SCR error	521337	31
AL F2Exp TExh af SCR	AL F2 Exp T-Exh aft SCR error	521338	31
AL SCRSU AdBlue Pres	AL SCR SU AdBlue Pressure	521350	31
AL Check Sum IIG	AL Check Sum IIG	521351	31
SS ETC5 Overspeed	SS ETC5 Overspeed	521352	0
HI ETC5 Overspeed	HI ETC5 Overspeed	521352	15
AL NOxATO2 Sens Def.	AL NOx ATO2 Sensor Defect	521353	11
AL Nox ATO2 Comm.err	AL NOx ATO2 Communication Lost	521353	19
AL DEF Tank Lev. low	AL DEF Tank Level low	521354	17
AL T.Breakd.NOx sen.	AL Total breakdown NOx sensors	521355	31
AL Redun.lossNOx sen	AL Redundancy loss NOx sensors	521356	31
AL Engine Cold Activ	AL Engine Cold Active	521357	31
AL Engine Cool. T.SD	AL Engine Coolant Temperature SD	521358	11
AL Intake Air T. SD	AL Intake Air Temperature SD	521359	11
AL DEF Tank T. SD	AL DEF Tank Temperature SD	521360	11
AL Engine Cool.V.DEF	AL Engine Coolant Valve Defect(DEF)	521361	31
AL Fl.EgrA Comm.lost	AL Flap Egr A Communication Lost	521362	31
AL Fl.EgrA T.t. high	AL Flap Egr A Temperature too high	521363	0
AL Fl.EgrA Targ.pos	AL Flap Egr A Targetposition	521364	31
AL Fl.EgrB Comm.lost	AL Flap Egr B Communication Lost	521365	31

DEIF display	MTU	SPN	FMI
AL Fl.EgrB T.t. high	AL Flap Egr B Temperature too high	521366	0
AL Fl.EgrB Targ.pos	AL Flap Egr B Targetposition	521367	31
AL Fl.By.A Comm.lost	AL Flap BypassA Communication Lost	521368	31
AL Fl.By.A T.to.high	AL Flap BypassA Temperature too high	521369	0
AL Fl. By. A Tar.pos	AL Flap Bypass A Targetposition	521370	31
AL Fl.By B comm.lost	AL Flap BypassB Communication Lost	521371	31
AL Fl.Byp.B. T. high	AL Flap BypasB Temperature too high	521372	0
AL Fl.Byp B Tar.pos.	AL Flap Bypass B Targetposition	521373	31
AL Fl.Disp.Comm.lost	AL Flap Dispens Communication Lost	521374	31
AL Fl.Disp.T.toohigh	AL Flap DispensTemperature too high	521375	0
AL Fl. Disp. Tar.pos	AL Flap Dispenser Targetposition	521376	31
AL Fl. Int.Comm.lost	AL Flap Intake Communication Lost	521377	31
AL Fl.Int.T.too high	AL Flap Intake Temperature too high	521378	0
AL Fl.int.A Tar.pos.	AL Flap Intake Air Targetposition	521379	31
AL Fl.EgrA Calibr.Dr	AL Flap Egr A Calibration Drive Err	521380	31
AL Fl.EgrB Calibr.Dr	AL Flap Egr B Calibration Drive Err	521381	31
AL Fl.ByA Calibr. Dr	AL Flap BypassA Calibr. Drive Err	521382	31
AL Fl.Byp Calibr. Dr	AL Flap BypassB Calibr. Drive Err	521383	31
AL Fl.Disp.Calibr Dr	AL Flap Dispenser Calibr Drive Err	521384	31
AL Fl.Int.A.Cali. Dr	AL Flap Intake Air Calibr Drive Err	521385	31
AL L2 PCV Defect	AL L2 PCV Defect	521386	0
AL L1 PCV Defect	AL L1 PCV Defect	521386	15
AL L2 PCV2 Defect	AL L2 PCV2 Defect	521387	0
AL L1 PCV2 Defect	AL L1 PCV2 Defect	521387	15
AL Short Cir.Ana.O 1	AL Short Circuit Analog Out 1	521388	6
AL Short Cir.Ana.O 2	AL Short Circuit Analog Out 2	521389	6

18. Digital AVR (option T2)

18.1 Setup of DVC 310

18.1.1 Setting up the DVC 310 for the first time

By default, the DVC 310 expects the interfacing to be done via CAN bus. In the following chapters, it is described how to set up the DVC 310 with the Multi-line 2 unit and the present alternator.

Some settings in the DVC 310 can be sent from the Multi-line 2 product, whereas other settings must be made from the DEIF EasyReg software. You can download the EasyReg software at DEIF's website, www.deif.com. The installation of the EasyReg software must be done by an administrator. On some PCs, the EasyReg software must also be run by an administrator, even though it has been installed by an administrator. The first time you set up a DVC 310, the EasyReg software must be used, and the CAN bus communication between the Multi-line 2 unit and the DVC 310 should not be connected.

Always run the EasyReg software before connecting the DVC 310 to the computer through USB, otherwise the message "No firmware loaded" may appear (Win8/10).

You can see the wiring for the DVC 310 in the EasyReg software. The picture/animation will change as the settings are changed.

Always use twisted pairs, shielded cables (120 ohm impedance) of good quality for the CAN bus communication, such as Belden 3105A or Unitronic Bus CAN.

The genset should not be started before this manual states that it is allowed to start. This is to ensure that the proper protections and settings have been made.

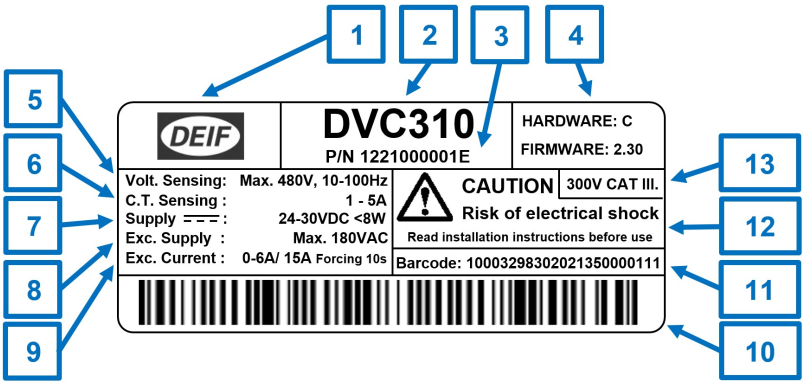
Leroy Somer D510C is compliant with the DVC 310, meaning that whenever a DVC 310 is mentioned in this document, it is also possible to use a Leroy Somer D510C.
To enable this, the Leroy Somer D510C must have the same software version as the DVC 310.This is indicated in the next paragraph.

18.1.2 Software version

This document is based on the following software and P/N revisions:

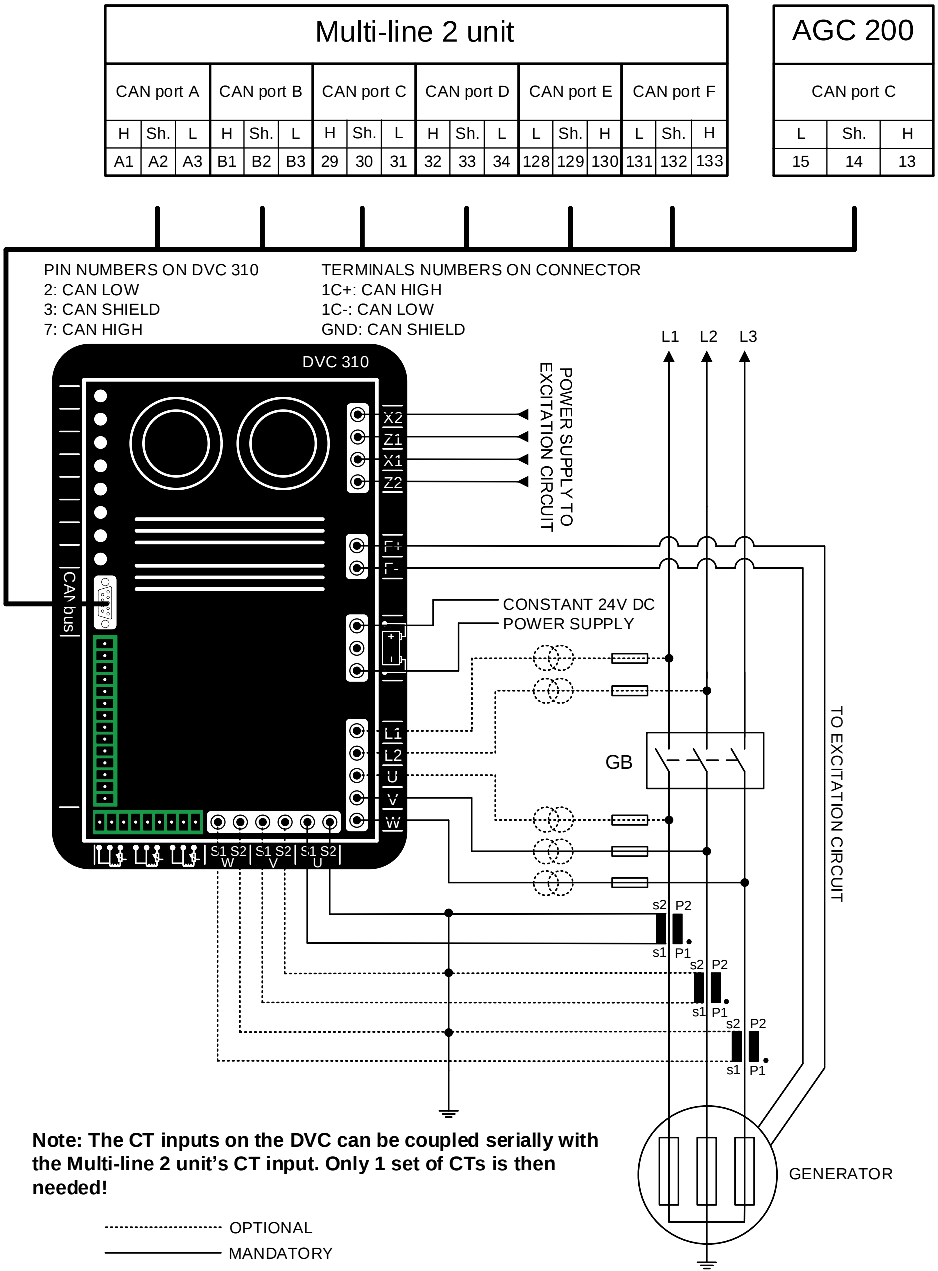
Software type	Software version
DVC 310 firmware	2.30
EasyReg for DEIF	2.60

Hardware identification	Revision
DVC 310 hardware	Rev. C
DVC 310 Part Number (P/N)	Rev. E

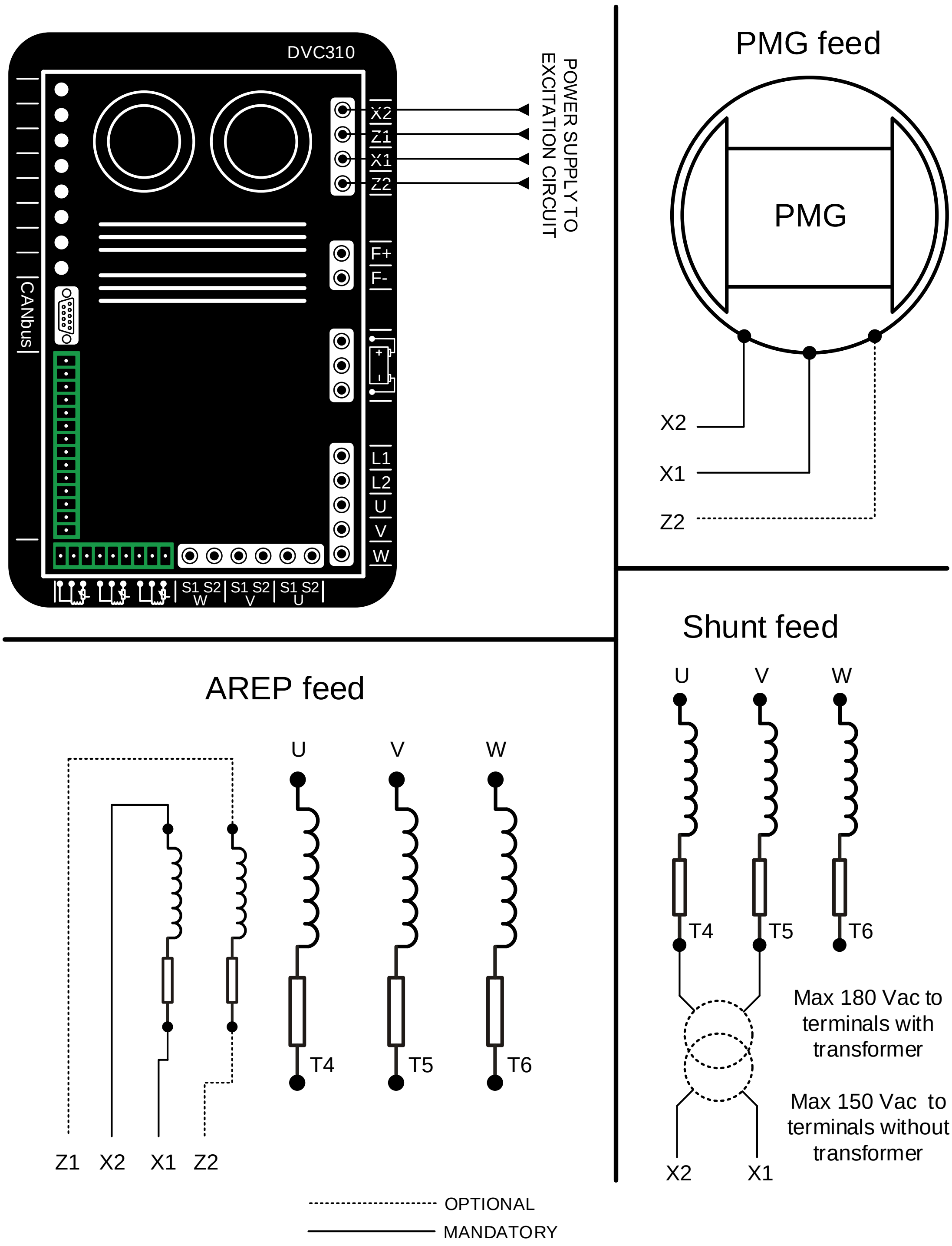

1
2
3
4
5
6
7
8
9
10
11
12
13
DEIF
DVC310
P/N 1221000001E
HARDWARE: C
FIRMWARE: 2.30
Volt. Sensing: Max. 480V, 10-100Hz
C.T. Sensing : 1 - 5A
Supply : 24-30VDC <8W
Exc. Supply : Max. 180VAC
Exc. Current : 0-6A/ 15A Forcing 10s
CAUTION
300V CAT III.
Risk of electrical shock
Read installation instructions before use
Barcode: 10003298302021350000111

	Text/ area	Description	Contains
1	DEIF	DEIF logo	DEIF logo printed in black
2	Type name	Product type name	Text: “DVC310”
3	P/N	DEIF part number and revision letter	Text example: “P/N 1221000001E”
4	Hardware, Firmware	Hardware and firmware versions	Text example: “Hardware: C”, “Firmware: 2.30”
5	Volt. sensing	Electrical specifications	Text: “Volt. Sensing: Max. 480V, 10-100Hz”
6	C.T. Sensing	Electrical specifications	Text: “C.T. Sensing: 1 - 5A”
7	DC Supply	Electrical specifications	Text: “Supply 24-30VDC <8W”
8	Exc. Supply	Electrical specifications	Text: “Exc. Supply: Max. 180VAC”
9	Exc. Current	Electrical specifications	Text: “Exc. Current: 6A/ 15A Forcing 10s.”
10	Barcode	Barcode standard: Code 128	Barcode consisting of (9+3+11 = 23 digits): [Purchase order number] [Order line number] [LS Serial number] Example: PO = 100032983; OL = 020; LS-SN; 21350000111
11	Barcode numbers	Numbers of the barcode	● Text example: “ Barcode: 10003298302021350000111”
12	User information	Warning symbol and text	Risk symbol and text: “CAUTION Risk of electrical shock” “Read installation instructions before use ”
13	Category	Electrical specification	Text: “300V CAT III.”

18.1.3 Wiring to the DVC 310



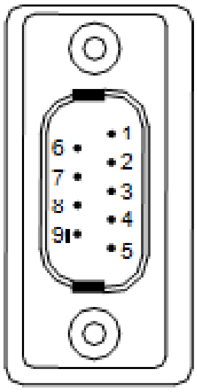
The CT inputs on the DVC 310 can be coupled serially with the Multi-line 2 unit's CT input. In that case, only one set of CTs is needed.


DVC310
CANbus
X2
Z1
X1
Z2
F+
F-
L1
L2
U
V
W
S1 S2 W
S1 S2 V
S1 S2 U
POWER SUPPLY TO EXCITATION CIRCUIT
PMG feed
PMG
X2
X1
Z2
Shunt feed
U
V
W
T4
T5
T6
Max 180 Vac to terminals with transformer
Max 150 Vac to terminals without transformer
X2
X1
AREP feed
U
V
W
T4
T5
T6
Z1
X2
X1
Z2
OPTIONAL
MANDATORY

18.1.4 Communication/wiring between Multi-line 2 unit and DVC 310

Communication between the DVC 310 and a Multi-line 2 unit is established with the engine communication port via J1939 CAN bus. To facilitate the wiring, the terminal numbers are shown below.

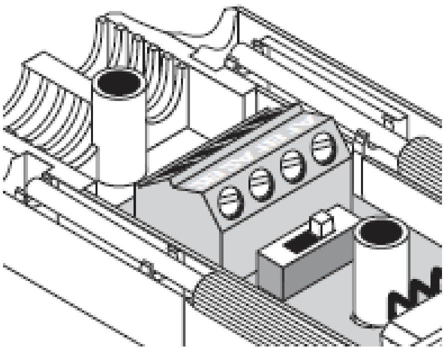
Communication port on DVC 310:



Terminal 2: CAN Low
Terminal 3: CAN Shield
Terminal 7: CAN High

In the included CAN connector, the wiring to the terminals must be as shown in the table below.

Term.	Function
1C+	CAN-H
1C-	CAN-L
GND	CAN-Shield



Check the setting of the terminal resistor when the wiring is done. It can be set to ON or OFF on the switch next to the terminals in the included CAN connector.

The terminal numbers of the Multi-line 2 unit are shown in the diagram in paragraph *Wiring to the DVC 310*.

18.1.5 PID start settings

The table below shows a list of PID settings collected from different sizes of generators. These settings can be used as starting point for the DVC 310 voltage regulation.

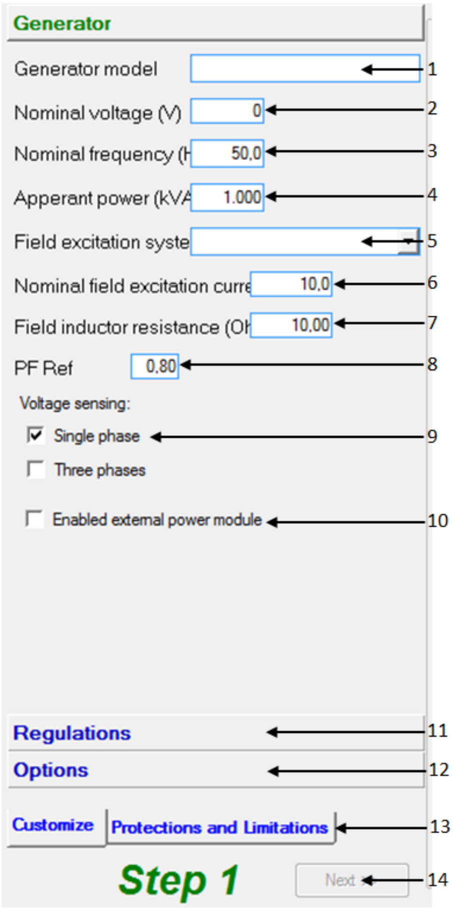
The settings for PID in the DVC 310 must be used shortly after the nominal settings have been made.

Generator size [kVA]	P	I	D	GAIN	Scale	Voltage [V]
15	20	2	150	20	1/1	400
30	25	2	200	20	1/1	400
50	30	2	200	20	1/1	400
70	30	2	200	20	1/1	400
110	40	2	300	20	1/1	400
150	50	2	300	20	1/1	400
240	60	2	400	20	1/1	400
400	60	2	400	20	1/1	400
580	70	2	400	20	1/1	400
820	70	2	500	20	1/1	400
1060	85	2	600	20	1/1	400
1360	85	2	800	20	1/1	400
1860	85	2	1000	20	1/1	400
2250	100	2	1200	20	1/1	400
2500	100	2	1200	20	1/1	400
1300	60	2	1200	20	1/1	6600
1700	60	2	1200	20	1/1	6600
2100	60	2	1200	20	1/1	6600
2800	60	2	1200	20	1/1	6600

The values shown above are not the final settings. They should only be considered as start settings that must be tuned in for the present alternator.

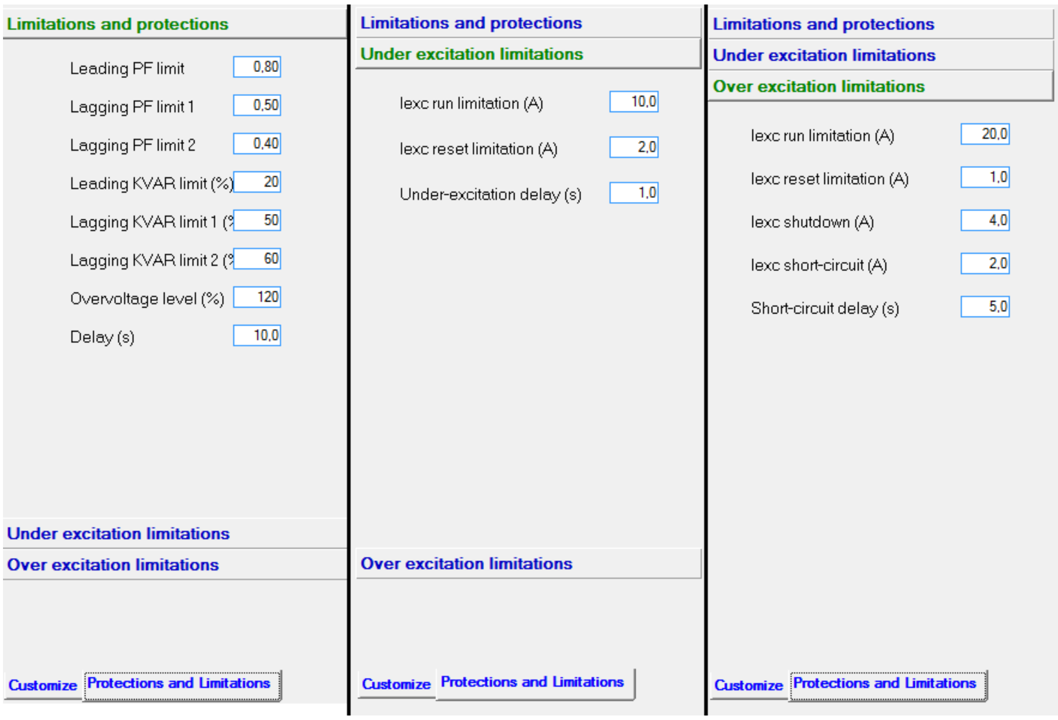
18.1.6 Setup of DVC 310 to match alternator

First, open the EasyReg software and then connect a USB cable between the PC and the DVC 310. Press File at the top of the window and then New Customised Configuration, and the window shown below will appear.



1. A name for the generator can be entered here.
2. The nominal voltage of the generator is set here.
3. The nominal frequency is set here.
4. The apparent power of the alternator is set here.
5. The type of field excitation system is set here.
6. The nominal field excitation is set here.
7. The resistance of the excitation circuit is entered here. This can be measured with a multimeter: Take the F+ and F- wires of the terminals and measure the resistance through the excitation circuit on the alternator.
8. This value indicates at which power factor the alternator can give the apparent power that has been set earlier (no. 4).
9. The voltage sensing for the DVC 310 on the alternator is selected here. (True RMS regulation is only available with single phase measurement).
10. The DVC 310 is not ready for this function yet. If the function is enabled, the excitation supply circuit will be switched off.
11. Some PID settings must be set here. Refer to the paragraph "PID start settings" in this document for a table listing the PID settings collected from different sizes of generators. When the DVC 310 is to be controlled by a Multi-line 2 unit, the DVC 310 will be in voltage regulation. So the PID settings should be made for voltage regulation. Copy the settings into the PF and Iexc. regulators.
12. Temperature sensing and current transformers are set in this menu. It is also set whether a step-up transformer is present in the application. If voltage transformers are present in the application, these can also be set here. If the DVC 310 is to be used at a single phase alternator, it must be set from this window. Refer to the paragraph "Single phase operation".

13. This menu consists of three different windows, as shown below:



The three windows contain different settings. Some of them are used when the DVC 310 is interfaced with a Multi-line 2 unit. In the first window, only over-voltage and delay are used. None of the settings in the second window are used. In the third window, all settings are used. In the settings that are not used, a proper value must be entered. Refer to the chapter "Protections" for a description of all protections.

14. When all the settings above have been made correctly, press the Next button.

Subsequently, the next window in EasyReg appears, as shown below:

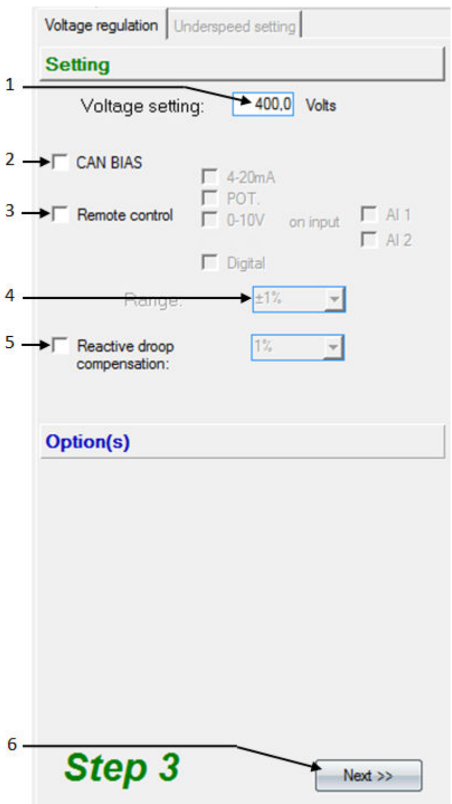
The user can now make four different selections (marked with arrows).

1. If Voltage is selected, settings for voltage regulation are shown. When the DVC 310 is to be controlled by a Multi-line 2 product, the DVC 310 will be in voltage regulation. In this case, the voltage regulation function should be activated, so the user is trimming the DVC 310 in voltage regulation afterwards. In the voltage regulation function, different options regarding the start-up and engine aid are also set.
2. If the DVC 310 is to be used in power factor regulation mode, PF should be selected. The power factor regulation mode is very similar to the voltage regulation mode. In PF mode, another tab with settings will appear. This setting determines which power factor reference the DVC 310 should have during parallel

operation. The DVC 310 will need an input to know when it is in parallel to grid. When the DVC 310 is controlled by a Multi-line 2 product, PF will not be used because the cos phi is controlled at the Multi-line 2 controller instead.

3. If the DVC 310 is to be used in fixed kvar regulation mode, "kVAR" must be selected. The fixed kvar regulation mode is very similar to the voltage regulation mode. In kvar mode, another tab with settings will appear. This setting determines which kvar power reference the DVC 310 should have during parallel operation. The DVC 310 will need an input to know when it is in parallel to grid. When the DVC 310 is controlled by a Multi-line 2 product, kvar will not be used because the cos phi is controlled at the Multi-line 2 controller instead.
4. If the DVC 310 is to be used in excitation regulation mode, I exc. must be selected. The excitation regulation mode is very similar to the voltage regulation mode. In I exc. mode, another tab with settings will appear. This setting determines which excitation current should be applied by the DVC 310. This functionality can be employed if the user wants to manually apply a fixed excitation, or to control the excitation externally. When the DVC 310 is controlled by a Multi-line 2 product, I exc. will not be used because the bias is controlled at the Multi-line 2 controller instead.

When Voltage has been selected, the window below appears.



1. The set point for the voltage regulation is entered in this box.

2. This setting determines the origin of the bias signal to the DVC 310, it must come via J1939 CAN bus. When a Multi-line 2 unit is to control the DVC 310, it is recommended to have the DVC 310 set to CAN BIAS.

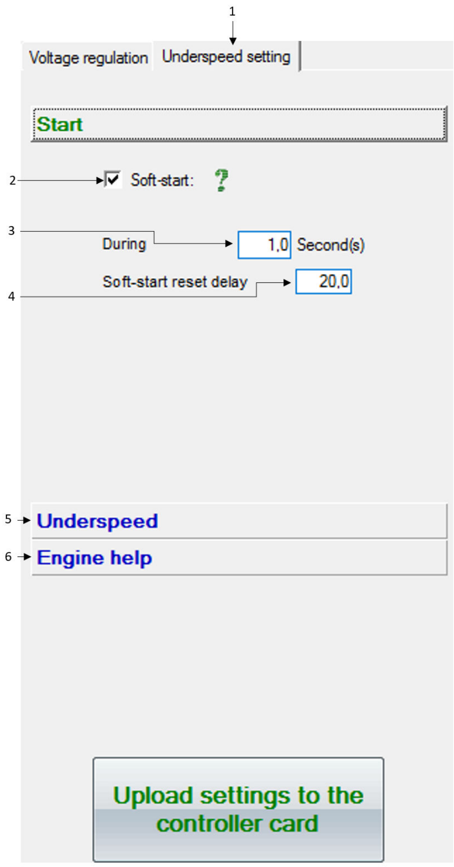
3. This setting determines the origin of the bias signal to the DVC 310, it must come via an analogue input. If analogue bias is to be used, the specific input terminal on the DVC 310 must also be chosen.

4. This setting determines the bias range when analogue regulation is used. This range relates to point 1 in this picture. If the set point of the DVC 310 is 400 V and the bias range is (as an example) +/- 10 %, the external equipment can move the set point of the DVC 310 between 360 V and 440 V.

5. This setting activates the droop in the DVC 310. It is required to have current transformers wired to the DVC 310. Otherwise it is not possible to enable the setting. Furthermore, the droop percentage is set. The droop curve is shown in EasyReg.

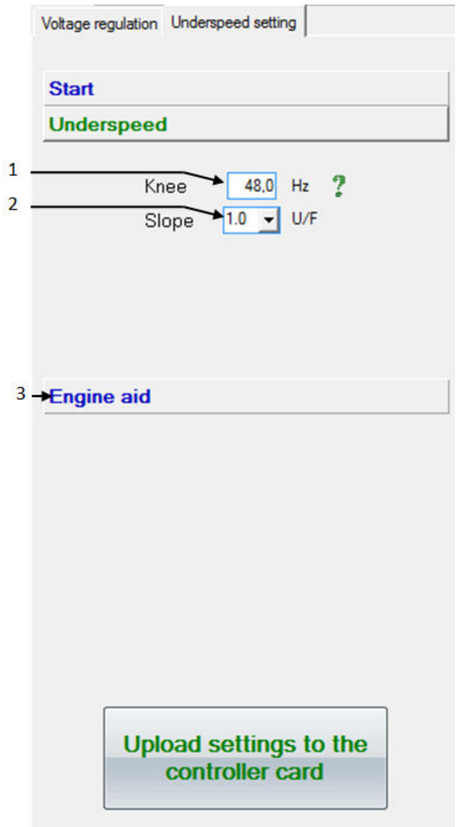
6. When the settings above have been made, press the Next button.

Subsequently, the window below appears:



1. The user should now be at the "Underspeed setting" tab.
2. From here the soft-start ramp during start is enabled. If the soft-start is disabled, the DVC 310 will set the soft-start ramp to 0.1 s. This means that during start-up, the ramp will be controlled by the U/f law instead. This can cause overshoot on faster starting engines.
3. This is the timer for the soft-start ramp. Note that the setting is in seconds. This means how long time the DVC 310 should take to ramp up the voltage from 0 to voltage set point. A more detailed description of the soft-start can be found in the section "Soft-start".
4. This delay secures that soft-start is only activated in the event of a real start. Soft-start will only be activated if this delay has expired before the genset is restarted. Configurable between 5 and 20 s.
5. When the "Underspeed" tab is pushed, another new window will appear, which will be described below.
6. When the "Engine aid" tab is pushed, another new window will appear, which will also be described below.

When the "Underspeed" tab has been pushed, the window below appears:

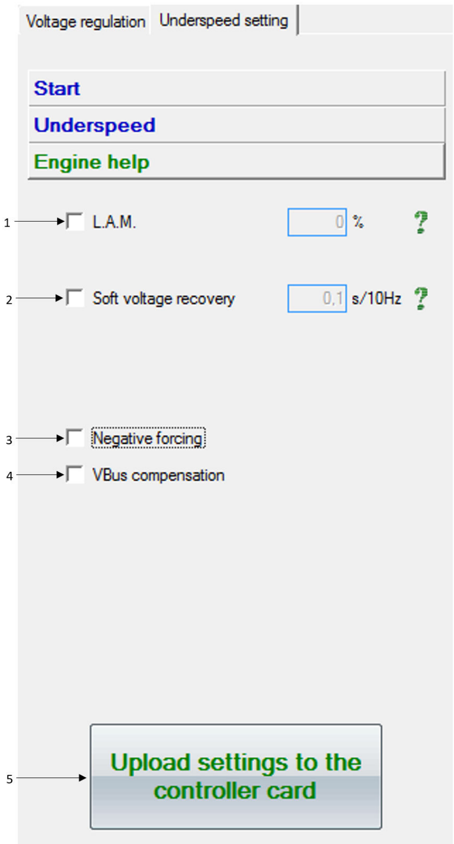


1. This setting determines the upper limit for the U/f slope. If there is a load impact on the genset, and the frequency reaches this set point, the DVC 310 starts slope on the voltage. The knee function is described in the section "U/f (knee function)".

2. From here the slope for the U/f law is set. To see how the calculation for U/f slope is made, see the description in the section "U/f (knee function)". If the soft-start ramp is disabled, the DVC 310 will try to follow this slope during ramp up.

3. When the "Engine aid" tab is pushed, a new window will appear. This window is described below.

After the settings for the "Underspeed" have been made, the settings for the "Engine aid" can be set:



1. Firstly, the L.A.M. (Load Acceptance Module) function is set. When the L.A.M. function is enabled, a percentage must be set. The percentage determines how much the voltage should drop immediately when the knee set point is reached. The setting is related to the voltage set point. So if the set point is 400 V, and the L.A.M. set point is 10 %, and the knee point is reached, the voltage will immediately be dropped 40 V. To read more about the L.A.M. function, refer to the section "Load acceptance module (LAM)".

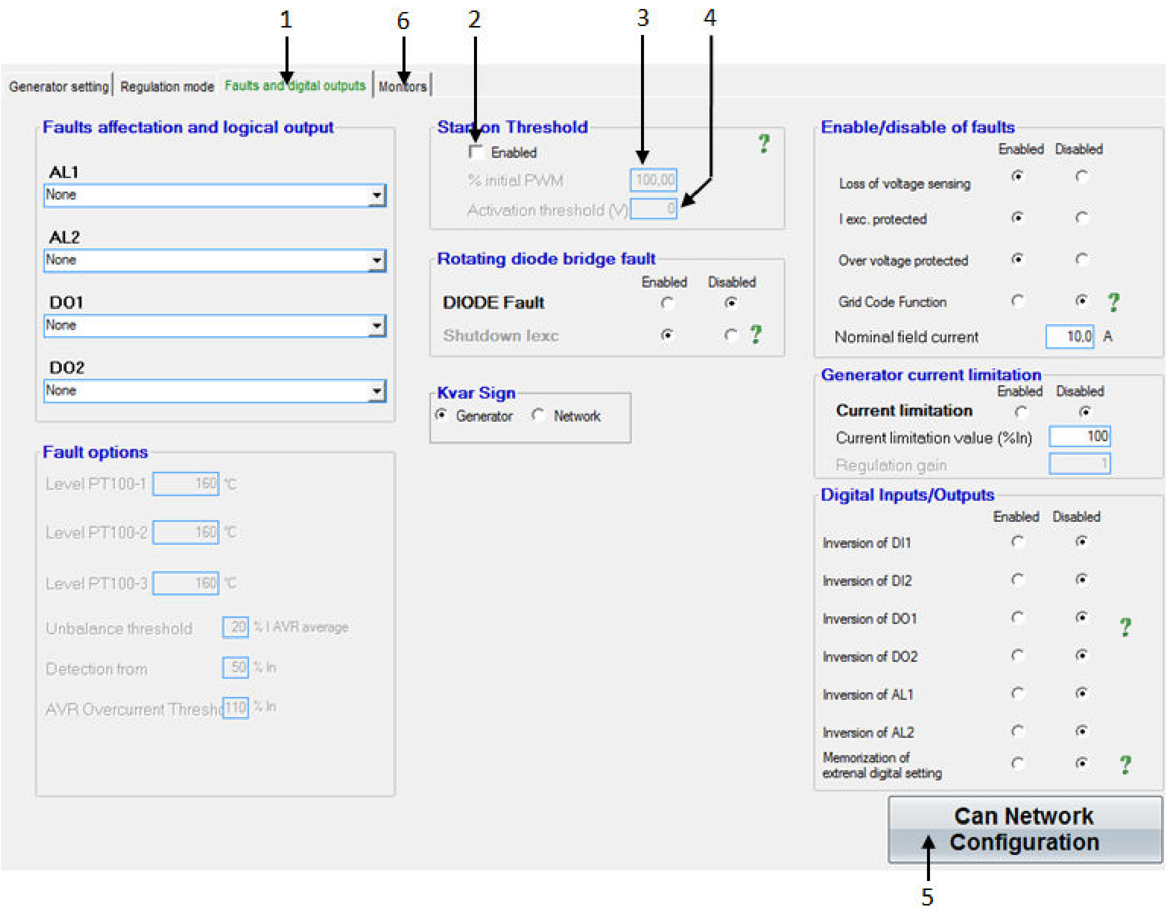
2. From here the SVR (Soft Voltage Recovery) function is enabled. The SVR function determines how fast the DVC 310 is allowed to ramp up the voltage after the L.A.M. function has been active. For more info about the SVR function, refer to the section "Soft voltage recovery (SVR)".

3. Activation of "Negative forcing" allows to reverse the excitation voltage to minimise voltage overshoot during load rejection.

4. A tick mark in "VBus compensation" allows to compensate regulation from knowledge of the actual excitation supply voltage potential (VBus measurement).

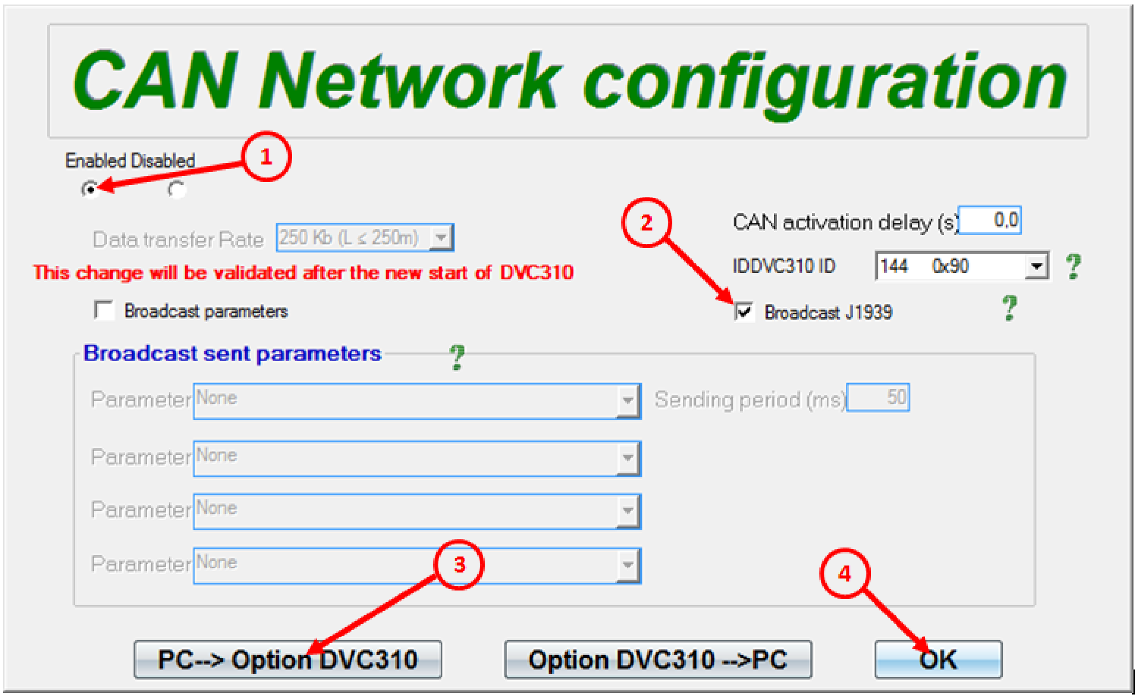
5. When all the desired settings and parameters have been made, all the settings can be uploaded to the DVC 310 by pressing "Upload settings to the controller card".

When the settings have been uploaded to the DVC 310, the "Fault and digital outputs" tab in the top of the EasyReg software can be pushed to also make some settings.



1. Here the "Fault and digital inputs" tab can be pushed, and then the window should look like above.
2. When this box is ticked, a constant PWM output on the excitation current will be applied on the excitation circuit. The start-on threshold function is activated when the box is ticked, and extra information about this function can be found in the section called "Start-on threshold".
3. The PWM output for the start-on threshold is set in here. Note that this setting should be 0 the first time the genset is about to be started, or a very small percentage.
4. This setting determines when the start-on threshold function should be deactivated, and the DVC 310 should shift over to the soft-start function instead. How the different ramps work during start is described in the section "Excitation ramp". Values between 5 and 35 % of nominal voltage is a reasonable starting point, which can be tweaked on later. The value must be entered in volt, where the Multi-line 2 unit is set in percentage of nominal voltage.
5. When this button is pushed, a pop-up window will appear, in which it is possible to set the CAN bus configuration for the DVC 310. This pop-up window is described shortly hereafter.
6. When the settings have been made, the monitor window will open. The monitor window will be described after the "Can Network Configuration" has been described.

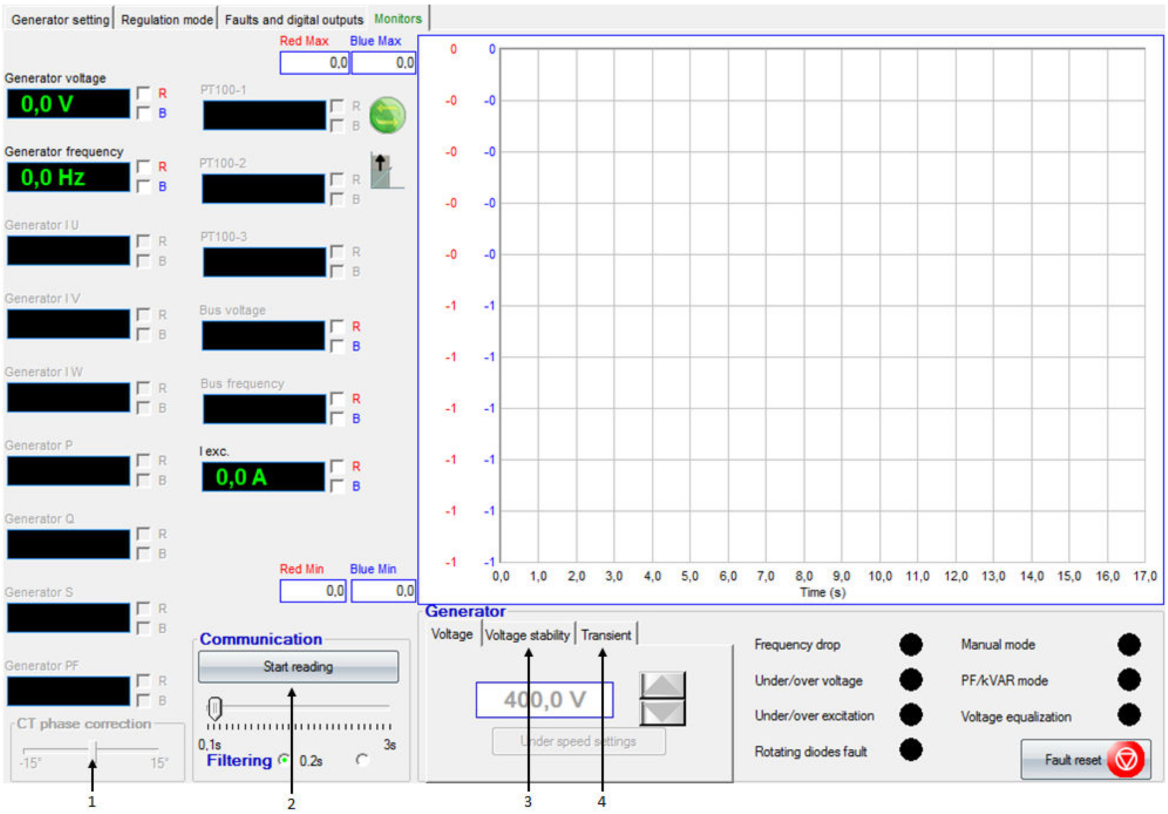
When the "Can Network Configuration" button has been pushed, the pop-up window below will appear.



The buttons and check boxes marked with arrows must be checked.

If J1939 is used as communication IF between the DVC and the controller, the drop-down menu IDDVC310 ID is configured to 144 0x90 as shown above.

The monitor window can now be entered.



In this window, it is possible to trend for example the voltage and the frequency at the same time. The monitor is limited to trending max. two different values at a time. To specify which value to be displayed in the trending window, the checkbox to the right of the displayed values must be marked. The trending window can be helpful when tuning in the regulators.

1. This "CT phase correction" slider can be used to fine-tune on the power readings of the DVC 310.
2. When the "Start reading" button has been pushed, the EasyReg software will start to read live data from the DVC 310. To start trending, the button must also be pushed.
3. From here the PID settings are shown for the active regulator. When settings from this window are changed, they are changed on the fly (these are the only settings with this behaviour). Because they are changed on the fly, some cautiousness must be considered if settings are changed with a running alternator.
4. From here the steps for the transient test is configured, and also where the transient test is started.

18.1.7 Start up and tuning in DVC 310

To protect against over-voltage and over-current, make a shutdown alarm in the Multi-line 2 unit before tuning in the regulators.

The CAN bus communication between the Multi-line 2 unit and the DVC 310 should not be connected yet. It will be stated later in this document when this should be connected.

Before the first start of the genset with the DVC 310, make sure that the PWM for start-on threshold is set to 0 % and the "Activation threshold" set point is high, for example 90 % of nominal voltage. It is also a good idea to remove the excitation circuit supply (X1-X2-Z1-Z2) terminal connector. Furthermore, the "Soft-start" ramp should be set slow, for example 10 s, to ensure that a slow PID regulation is able to follow the ramp.

When the alarms and start-on threshold + soft-start settings have been made, the genset is ready for the first start.

When the genset is started for the first time, it is presumed that all other equipment is tested, verified and tuned as desired. This manual is only relevant for when the DVC 310 is ready for the first start!

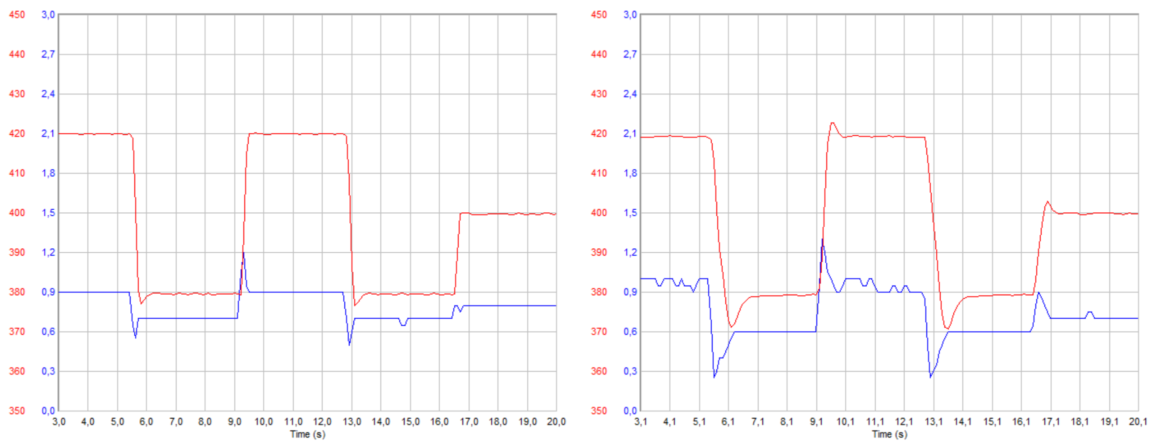
At the first start, only remanence voltage will be present, since the PWM is set to 0 %. This remanence voltage can be used to verify that the DVC 310 is able to measure alternator voltage correctly. This measurement should be compared to the genset controller's measured voltage and/or a multimeter reading.

The genset can then be stopped, and the PWM settings can be raised to, for example, 2 % (small steps), and the "Activation threshold" can be set to, for example, 15 % of nominal voltage. The user must verify that voltage is not shooting upwards, and the PWM can be raised until the alternator reaches "Activation threshold" voltage.
When the DVC 310 reaches this "Activation threshold", the "Soft-start" ramp will now be used, up till the voltage set point.

When the voltage has reached the set point for the alternator, a transient test can be performed from the "Monitor" window.
For the first transient test, the voltage steps should only deviate about 2 % from the voltage set point.
With the result of the transient test, the regulation of the DVC 310 can now be verified, to see the regulation response.

It is now possible with the transient test to tune the DVC 310 regulation. When the sufficient response is acquired, the deviations for the transient test can be raised to +/- 5 % of the voltage set point.

Shown below are transient tests from two different alternators, which are both considered reasonably tuned. (Red line trends voltage, and the blue line trends excitation current).



When the regulation has been tuned sufficiently, the "soft-start" ramp can be tuned down until the user finds the start-up ramp fast enough.

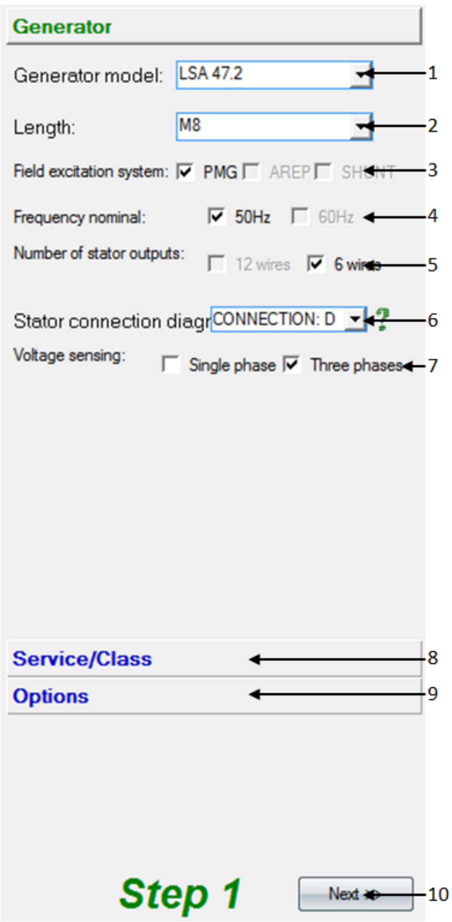
Furthermore, the PWM percentage can be raised, until the first part of the ramp is fast enough for the user. Be aware that the DVC 310's regulation is not active during start-on threshold. The PWM is a constant percentage of voltage that is led directly through the excitation circuit.
When the regulators and functions have been tuned in, the CAN bus cable between the Multi-line 2 unit and the DVC 310 can be connected. Subsequently, it is recommended to go to parameter 7805 and set this to ON. Then the Multi-line 2 unit will be in control of the DVC 310, which makes it possible, for example, to switch regulation modes.

Before the CAN bus line on the DVC 310 is set, make sure that the gain factor in the EasyReg and the gain factor parameter 7801 are the same.

When the CAN bus cable is connected between the Multi-line 2 unit and the DVC 310, it is necessary that the user reads the table "Overview of shared parameters related to option T2" and sets the desired settings for "soft-start" ramp, "start-on threshold", "PWM" and other settings made during commissioning of the DVC 310.

18.1.8 Setup with a Leroy Somer alternator

Connect a USB cable between the PC and the DVC 310. Open the EasyReg software. Press File at the top of the window and then New Configuration, and the window shown below appears.



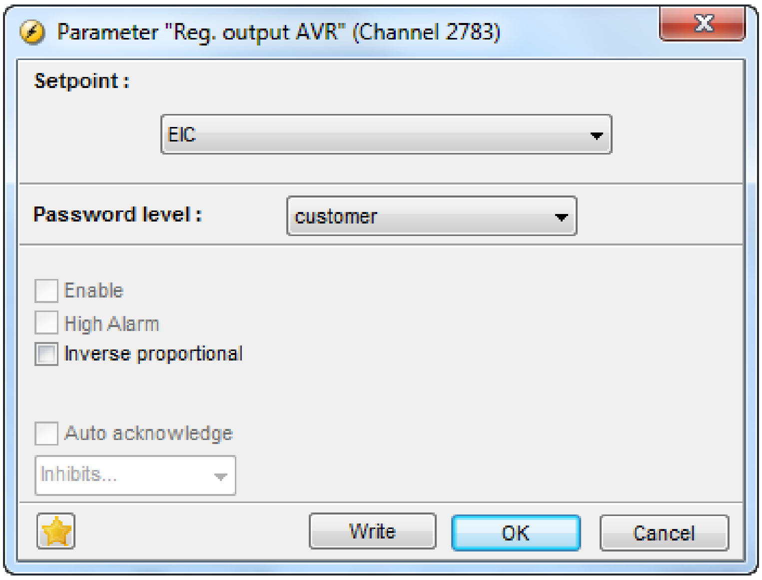
1. The Leroy Somer alternator type is set here.
2. The length of the alternator is set in this parameter.
3. The type of field excitation system of the alternator is selected here.
4. The nominal frequency of the alternator is set here.
5. The number of stator outputs is selected here.
6. The stator connection type is selected here. Press the question mark to see a picture of the type selected. This can be helpful if in doubt.
7. The type of voltage measurement on the DVC 310 is selected here.
8. The maximum temperature of the windings is selected in this menu, and also the nominal power.
9. The following is selected in this menu: Temperature sensing - the options are Pt100 sensors or thermo couplers; CTs - make sure to set the CT ratio correctly; voltage transformers, if these are used - both for alternator and the busbar; step-up transformer, if this is present in the application.
10. When the settings 1 to 9 above have been made, push the Next button.

To set up the DVC 310 for CAN bias regulation and for tuning in the regulator, refer to the section "Setup of DVC 310 to match alternator".

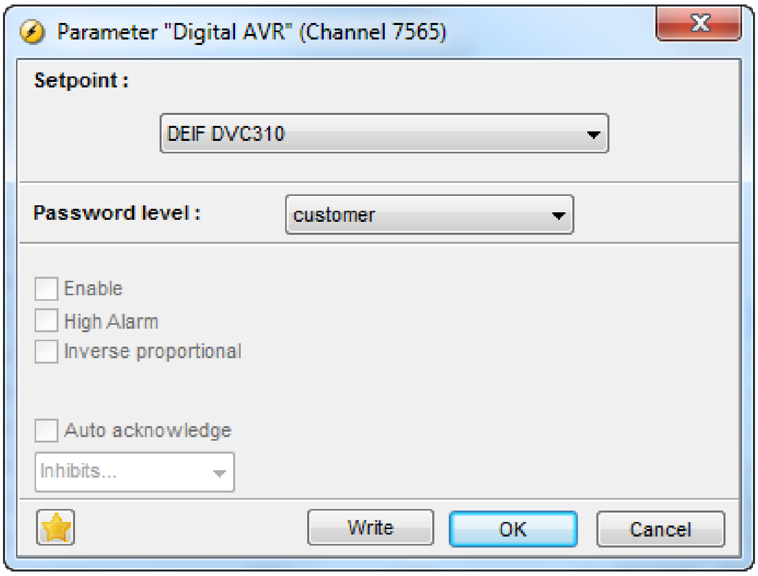
18.1.9 Setting up communication

To be able to communicate with a DVC 310, three settings must be made.

First, select the regulation output AVR to be EIC at parameter 2783.



Then select the AVR type at parameter 7565.



At last, the engine interface must be set; this is done at parameter 7561. It must be set even though relay or analogue regulation is used for governor control, and it must be set to anything else than OFF.

When performing initial setup of the DVC 310 with the EasyReg software, it is recommended not to have the CAN bus connected to the DVC 310.

AGC 200: The "Engine I/F" must be set to anything else than "IOM 220/230" and "OFF"

18.1.10 Voltage transformer settings

The DVC 310 has the possibility to use voltage transformers (VT or PT) for alternator as well as busbar measurements. The nominal voltage input on the DVC 310 may never be below 90 V, see the example below:

$$\frac{VT_{\text{secondary}}}{VT_{\text{primary}}} \cdot U_{\text{nominal}} \geq 90\ \text{V}$$

These system values will not be suitable: Voltage transformer values: Primary = 11000 V, secondary = 100 V, nominal voltage = 9000 V.

$$\frac{100\ \text{V}}{11000\ \text{V}} \cdot 9000\ \text{V} = 81.8\ \text{V}$$

If the secondary side of the VT was 115V instead, the values would be suitable for the DVC 310.

$$\frac{115\ \text{V}}{11000\ \text{V}} \cdot 9000\ \text{V} = 94.1\ \text{V}$$

The VT ratio is configured in the general settings in the Multi-line 2 unit (parameters 6041-6042 and 6051-6052). The DVC 310 provides the opportunity to have different VTs than those used in the Multi-line 2 (meaning that the range of the DVC 310 VTs is different from the range of the Multi-line 2 unit VTs). If this is the case, parameter 7745 must be enabled, and then the parameters 7741 to 7744 are used and must be configured for DVC 310 VT ratio.

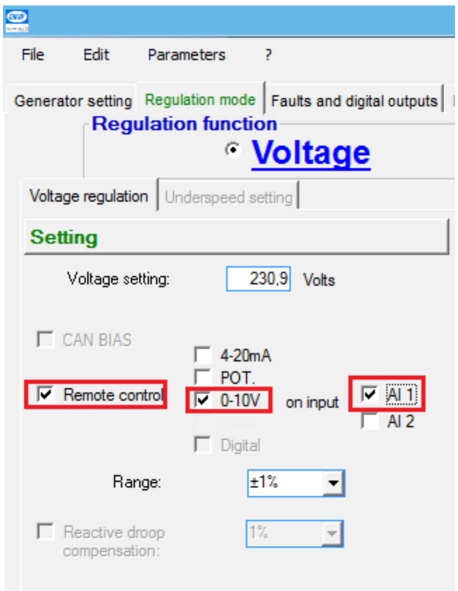
Be aware that when the communication between the Multi-line 2 unit and the DVC 310 is running, multiple settings are sent to the DVC 310. This is, for example, knee set point, soft-start timers, VT settings. The list of settings is found in the section "Overview of shared parameters related to option T2".

Parameter	Item	Range	Default	Note
7741	DVC 310 VT's primary setting (side that is in contact with generator voltage).	400 V 32000 V	400 V	Only in genset.
7742	DVC 310 VT's secondary setting (side that is in contact with the DVC 310 voltage input).	50 V 600 V	400 V	Only in genset.
7743	DVC 310 busbar VT's primary setting (side that is in contact with busbar voltage).	400 V 32000 V	400 V	Only in genset.
7744	DVC 310 busbar VT's secondary setting (side that is in contact with the DVC 310 voltage input).	50 V 600 V	400 V	Only in genset.
7745	Activation of VT settings in the DVC 310 (when set to ON, the settings above will be sent).	OFF ON	OFF	Only in genset.

18.1.11 Alternative connection possibility, analogue output from ML-2

It is possible to connect the DVC 310 to the Multi-line 2 unit or any other controller, and to have the voltage regulation made using analogue lines. Using the control way to the DVC 310, digital features will not be available. Only voltage regulation will be effective when using the analogue lines.

In order to use analogue lines, the DVC 310 must be configured to listen to the analogue signals on the analogue input 1 (AI1). This can be made by using EasyReg and configuring the input as below:



It is also possible to configure analogue regulation from the Multi-line 2 unit by switching parameter 2783 to analogue instead of EIC. Remember to set the transducer output also at parameter 5991. At parameter 7806, the input type on the DVC 310 is set, and it will expect it to have the analogue input on AI1. To enable sending of all these commands, parameter 7805 must be enabled. By this, it is possible to send all commands via CAN bus and to control the DVC 310 via analogue bias.

18.2 Functional description - DVC 310

18.2.1 Start modes

The DVC 310 is able to handle two start modes:

- Normal start
- Close before excitation (CBE)

Normal start:
Excitation is activated at start-up. Normal start is obtained when close before excitation is disabled at parameter 2254. During a normal start, the start-on threshold function will be used, and the soft-start function will also be used.

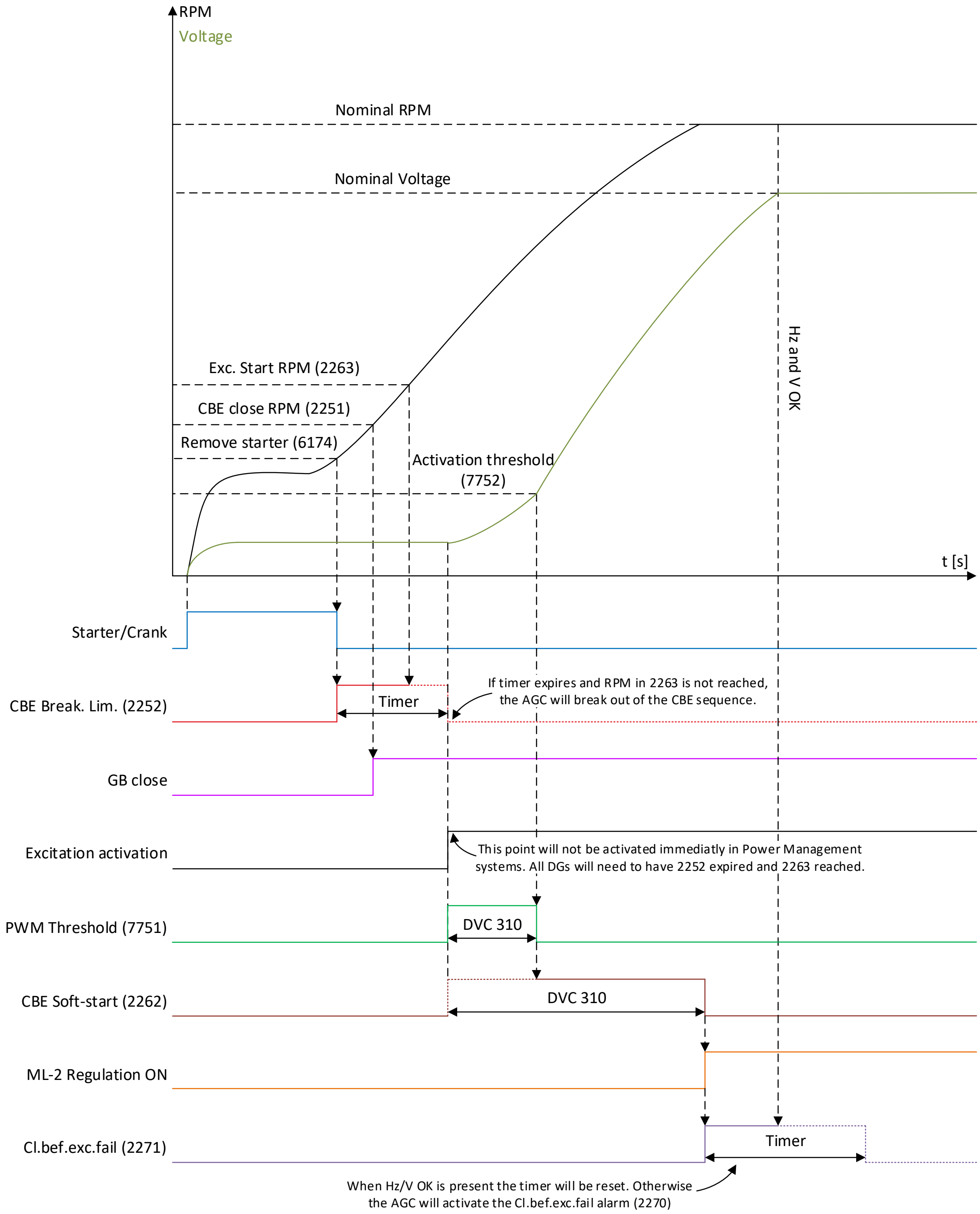
The normal start can be done in two ways. One way is to control the excitation ramp with the start-on threshold and soft-start ramp. In this way, the excitation ramp is controlled during start-up. It can also be done by setting the start-on threshold to 100 % (7751), the upper limit for the start-on threshold to 0 % (7752), and setting the soft-start ramp to 0.1 s (7753). In this way, the start-up ramp is controlled by the U/f slope, and the DVC 310 will regulate towards this on start-up, as the RPMs are ramping up during a start sequence. Not using the soft-start functionality is only recommended on engines that slowly ramp up the RPM, since the U/f law ramp-up can give an overshoot.

Close before excitation (CBE):
Excitation is applied after the genset is started and the breaker is closed. Close before excitation is enabled at parameter 2254.

Normally with an analogue AVR, switching on/off the excitation is controlled by a relay output from the AGC to the AVR. When excitation is switched on, the rate of voltage build-up is controlled solely by the AVR. Using the DVC 310 provides the possibility of switching the excitation on/off without the use of a relay output. Furthermore, the rate of voltage build-up is automatically configured via parameter 2262 as part of the existing setup of close before excitation.

The settings for close before excitation are described in the Designer's reference handbook (AGC-4/AGC 200), or earlier in this document (AGC PM) . When doing close before excitation with the DVC 310, it is possible to apply a little excitation current before voltage build-up. The excitation will be applied after the breaker is closed.

The drawing below can help to give an overview of how the different settings are working, when performing close before excitation with the DVC 310.



Note that the soft-start ramp time is started when the excitation is started. The soft-start timer should be considered as an angle of slope instead of a specific time.

The purpose of applying the excitation current is to couple the generators tighter together before initiating the voltage build-up. Note that if the excitation current reference is set too high, and voltage generated at that state in the close before excitation sequence exceeds 30 % of nominal voltage, the close before excitation sequence will be aborted. During a CBE sequence, the start-on threshold function will be used and the soft-start function will also be used. The soft-start timer is not the same for the CBE sequence and a normal start. These are two separate timers/angles which can be adjusted individually.

It is described later in this manual how to tune the start-on threshold and soft-start ramp.

Parameter	Item	Range	Default	Note
7792	Excitation reference at close before excitation	0.0 A 0.5 A	0.0 A	Only in genset

It is recommended to have zero or a low value in this parameter when doing CBE.

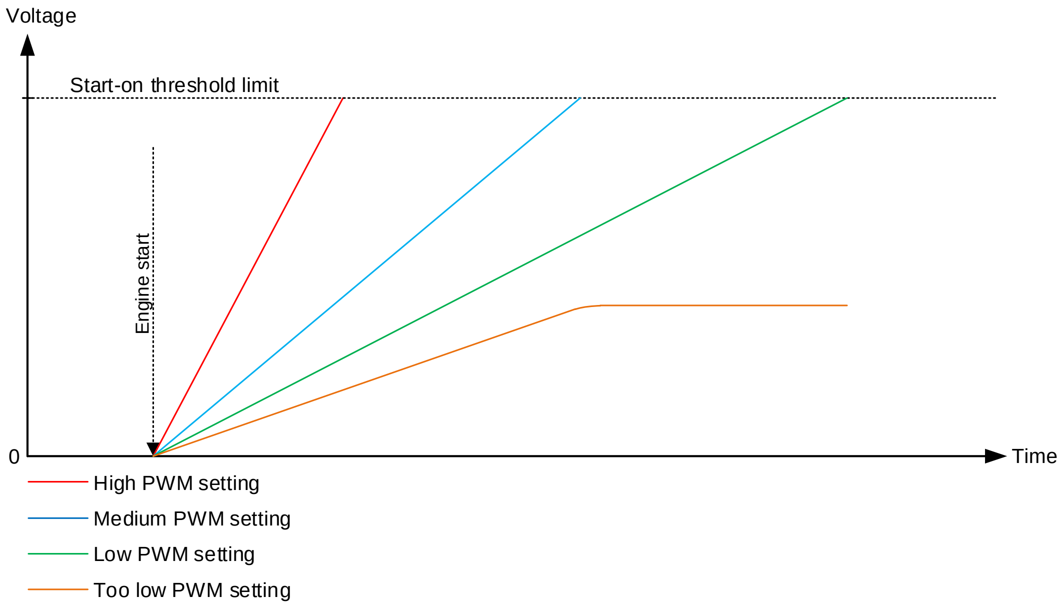
CBE is not possible with GPC-3.

18.2.2 Excitation ramp

During start-up of a generator, the curve can have different characteristics. During each start, the start-on threshold function and the soft-start function will make a part of the characteristic for the excitation. If the generator is used with CBE, the characteristics will be different from a normal start. But in the normal start as well as the CBE start, the start-on threshold and soft-start are used. Be aware that there are different soft-start timers for normal start and for CBE start.

Note that the voltage can never exceed the U/f law, which is described later in this document. This also applies during start-up ramps and soft-starts.

Start-on threshold:
The first part of the excitation ramp is called the start-on threshold. The relevant parameters for start-on threshold are located at parameters 7751 and 7752. Here it is possible to set the upper limit and a PWM output. The upper limit determines when the soft-start function takes over. As a default, this value is set to 35 %, which means 140 V AC for a 400 V alternator. This means that the start-on threshold is the excitation ramp from 0 V AC to default 140 V AC. The PWM output decides how steep the slope for the excitation is. When setting the PWM higher, the excitation slope will be steeper/more aggressive. In the graph below, only the PWM is changed:



When the upper limit for the start-on threshold is changed, the start point for the soft-start is also changed. The upper limit for start-on threshold is always the start point for soft-start.

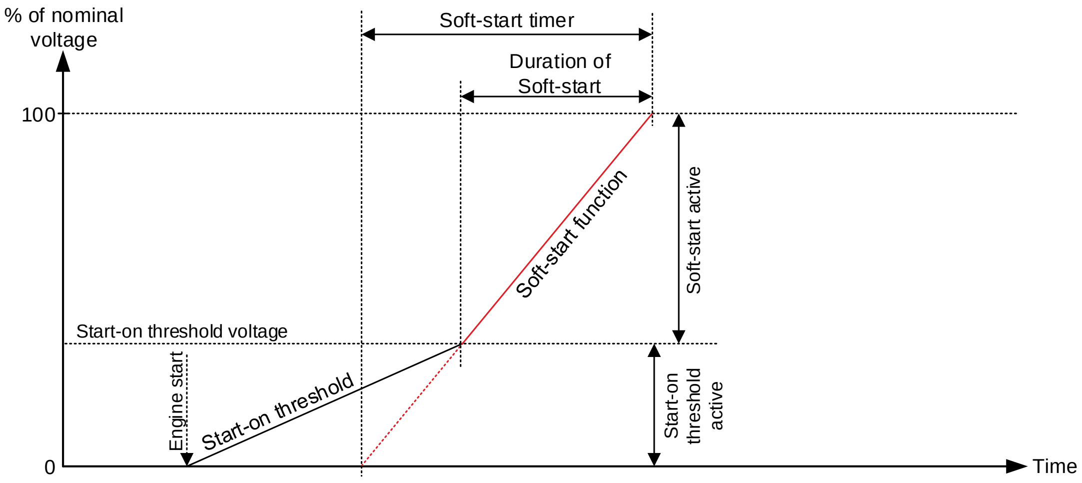
The relevant parameters for start-on threshold are shown in the table below:

Parameter	Item	Range	Default	Note
7751	PWM signal for start-on threshold ramp	0.00 % 100.00 %	10.00 %	Only in genset
7752	Start-on threshold set point	0.0 % 100.0 %	35.0 %	Only in genset

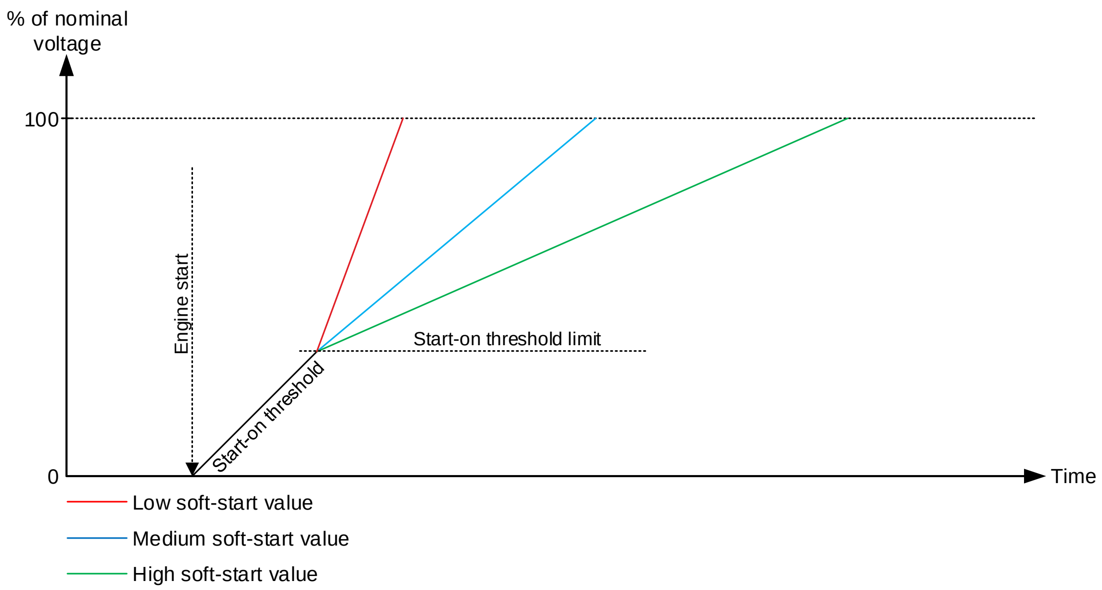
Soft-start:
When the upper limit of the start-on threshold function has been reached, the soft-start function will be initiated. The soft-start is used from the point of the upper limit of start-on threshold until the nominal voltage has been reached. In the soft-start function, only a timer is available; this is found in parameter 7753. The timer defines how long time it should take for the soft-start to increase the voltage from 0 to nominal voltage. So, if the timer is set to 5 seconds, for example, and the start-on threshold is set to 120 V AC and the nominal voltage is 400 V AC, the soft-start will be active for 3.5 seconds. The calculation will be like this:

$$\text{Duration of Soft-start} = \frac{(\text{Nominal voltage}) - (\text{Start-on threshold voltage})}{\text{Nominal voltage}} \cdot \text{timer for Soft-start}$$

The graph below shows how the different things are placed:



The graph below shows three different settings in the soft-start. The first one has a low timer, the second a medium and the last a high timer. If the DVC 310 has been configured with start-on threshold, the soft-start should not be considered as a timer, but instead as an angle.



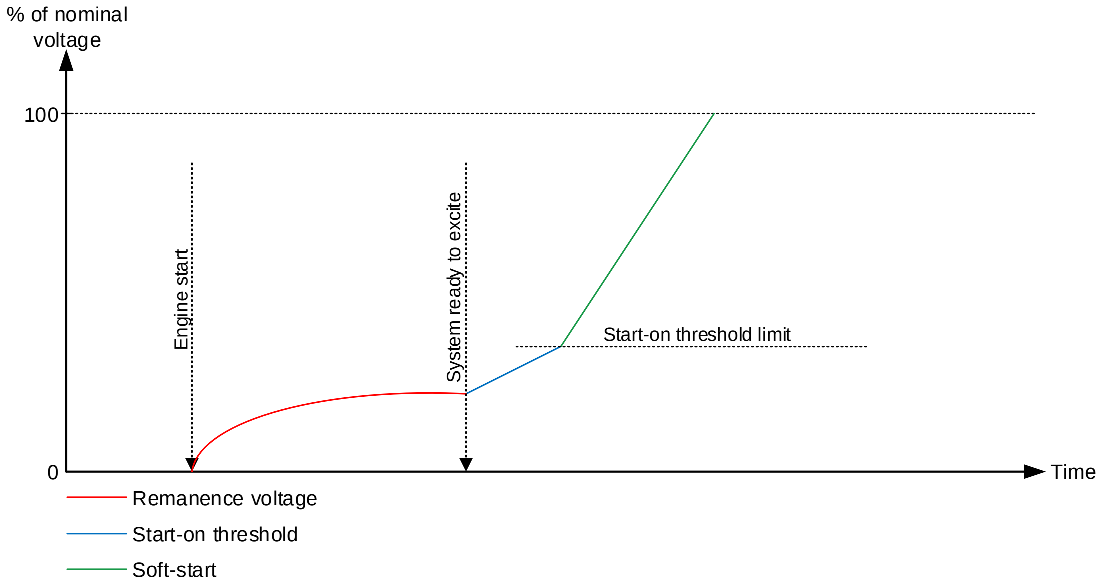
Since the soft-start timer represents how much time it should take to ramp up the voltage from 0 V to nominal, the full timer will not be used if the start-on threshold function is also used. If the wanted duration of the soft-start is known, the timer to set in the parameter can be calculated instead:

$$\text{Timer for Soft-start} = \frac{\text{Nominal voltage}}{(\text{Nominal voltage}) - (\text{Start-on threshold voltage})} \cdot \text{Duration of Soft-start}$$

If the soft-start ramp is set to 0.1 s, the soft-start function is disabled. The DVC 310 will then use the U/f slope when ramping up the excitation.

Parameter	Item	Range	Default	Note
7753	Soft-start ramp timer/angle	0.1 s 120.0 s	2.0 s	Only in genset

Excitation during CBE:
During a CBE sequence, the excitation ramp will look different from the curves in the normal start. The start-on threshold will be inhibited until the timer in parameter 2252 has run out. The timer in 2252 decides how long it should take before the excitation from the DVC 310 begins. The generator is able to build up some voltage because of the remanence in the rotor of the alternator. The CBE excitation curve will have a characteristic as shown below:



The soft-start timer in CBE is not the same as the soft-start timer in normal start, but the start-on threshold parameters are the same as in the normal start. Having different settings for the soft-start gives the possibility to have, for example, a more aggressive excitation ramp for CBE sequences. The timer for the soft-start in CBE is located in parameter 2262. Note that this timer is different from the one in normal start.

Parameter	Item	Range	Default	Note
2252	Timer for initiation of the start-on threshold	0.1 s 999.0 s	5.0 s	Only in genset
2262	Soft-start timer during CBE sequence	0.0 s 999.0 s	5.0 s	Only in genset

18.2.3 Stator current limitation

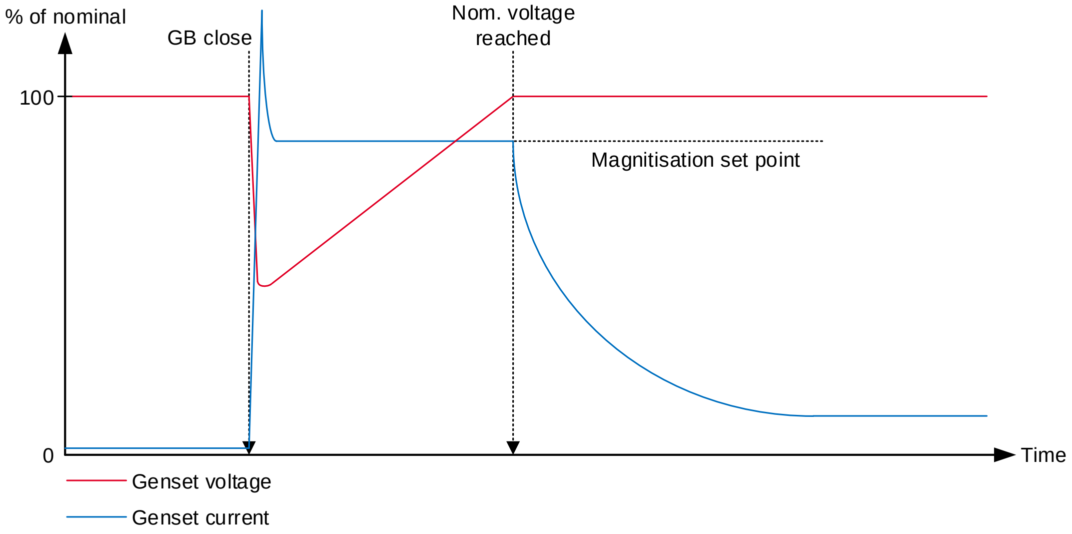
DVC 310 provides the possibility of limiting the stator current. This can be used when applying inductive loads drawing large in-rush currents such as transformers and inductive motors. The function can be controlled through the Multi-line 2 unit. At normal operation, the DVC 310 will have the voltage as set point. When stator current limitation is active, the DVC 310 will instead keep the current as reference and let the voltage drop until the voltage reaches nominal level again.

Activating current limitation in the Multi-line 2 unit is done at parameter 7795 where you have the following three possibilities:

- Off
- Magnetisation
- Inductive motor

The selection of stator current limitation type is also available through M-Logic. The M-Logic commands related to option T2 can be found later in this manual.

Magnetisation:
The magnetisation function is intended to be used when a load must be magnetised up to nominal voltage. The Multi-line 2 unit will first raise the voltage to nominal and then close the generator breaker. Before the breaker is closed, the Multi-line 2 unit will activate the stator current limitation function in the DVC 310, and when the current has decreased, the stator current limitation function will be disabled again. When the current is decreasing after the breaker is closed, the genset will be able to support a short-circuit, since the stator current limitation is OFF.
If magnetisation is activated, the stator current limitation will be activated every time the generator breaker is opened. When the breaker closes, the current will quickly rise. When the function is enabled, the current will only rise to a point defined in parameter 7793. The DVC 310 will regulate with the current as set point. This parameter indicates a percentage of the nominal current for the genset. The DVC 310 will then let the voltage drop and keep the current at a constant level. The voltage will then start to rise, and when it reaches its nominal voltage, the DVC 310 will instead regulate with the voltage as set point again. The current will then decrease again. When the current has decreased to a level of 5 % below the current limitation, the transformer magnetisation function is not active any more. The transformer magnetisation will not be activated again until the generator breaker has been opened. If the genset is closing the breaker towards a busbar with live voltage, the transformer magnetisation function will be deactivated as soon as the breaker is closed, because then the transformer will already be magnetised. A typical passage with the transformer magnetisation function can look like this:



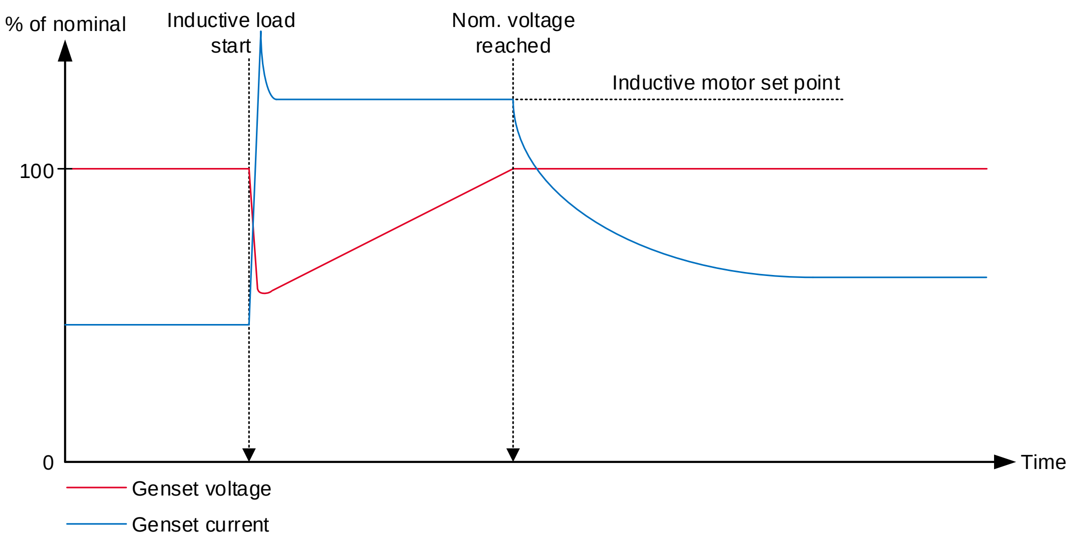
The first dotted line shows when the generator breaker closes. The second dotted line shows when the transformer magnetisation function will be deactivated (5 % below the current limitation set point set at parameter 7793).

Parameter	Item	Range	Default	Note
7793	Current limitation for magnetisation	0.0 % 300.0 %	100.0 %	Only in genset
7795	Enabling of current limitation function	OFF Inductive motor	OFF	Only in genset

Settings at parameters 7793 and 7795 are treated as common set points among the AGC DG units in power management applications.

Inductive motor:
The inductive motor function is very similar to the magnetisation function. The main difference is that the magnetisation function is only active when the generator breaker has just been closed, whereas the inductive motor starting function is active all the time the genset is running and the generator breaker is closed, and the function is enabled. If a heavy inductive load is turned on, the current from the generator will rise, which gives a risk of tripping an over-current protection. To avoid tripping the over-current protection, the DVC 310 is capable of limiting the current by dropping the voltage instead. By lowering the voltage, the power produced from the genset is also reduced, which means a lower risk of tripping from an over-power protection.
Be aware that if the "Inductive motor" is active all the time, the genset will drop the reactive power, and by this the short circuit level will not be maintained during a short circuit. The "inductive motor" function can be enabled/disabled via M-Logic, so that it can be controlled by either a digital input or via some custom-made logic.

A typical passage with the inductive motor function is shown below:



When the inductive load is turned on, the current will rise. The inductive motor function will limit the current to the pre-defined level set in parameter 7794. The DVC 310 will change to have the current as set point and let the voltage drop. When the voltage reaches the nominal value again, the DVC 310 will change to regulate with the voltage as set point again.

Parameter	Item	Range	Default	Note
7794	Current limitation for inductive motor	0.0 % 300.0 %	100.0 %	Only in genset
7795	Enabling of current limitation function	OFF ON	OFF	Only in genset

Settings at parameters 7794 and 7795 are treated as common set points among the AGC DG units in power management applications.

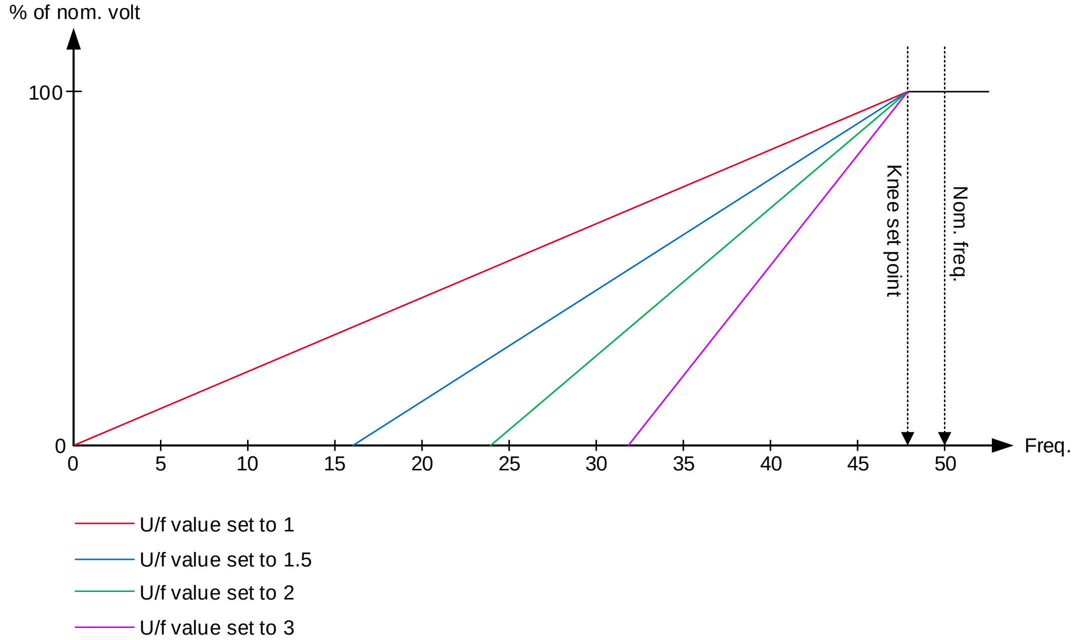
The inductive motor function is not active when the generator is parallel to the mains.

18.2.4 Operation modes

U/f variable slope (knee function):

The U/f variable slope (U/f law) determines the voltage reference/set point used by the DVC 310, depending on the frequency. The U/f law is used to ensure that the genset does not reach its cutout limit. Some gensets are restricted to cut out when reaching 40 Hz, for example. This limit can be reached at heavy loads. If the dive in frequency is below the genset's cutout limit, the genset will be forced to stop. The U/f law allows the voltage to droop and by this reduce the torque on the engine, so the frequency can be kept above the cutout limit. This function will not work with load that determines constant power, such as frequency converters and UPS installations. But it will work with, for example, electrical motors and electrical heaters where the voltage can be reduced. The U/f law determines how much the DVC 310 should droop the voltage compared to the frequency drop at big loads. It is possible to configure at which frequency the knee set point should be, and this is set in parameter 7771. Below the knee set point, the DVC 310 will let the voltage droop. The slope of how much the voltage should droop compared to the frequency can be set in parameter 7772.

The changes on the U/f law are shown in the graph below. The knee point is held constant in all of them. The graph shows how much the DVC 310 will regulate down in nominal voltage:



The knee set point determines when the U/f law becomes active. When the frequency goes below the knee set point, the U/f law defines a temporary voltage set point for the DVC 310.

The U/f setting can also be calculated instead. This is best explained by an example:

A genset has the nominal voltage of 400 V AC, the knee set point is set to 48 Hz. The genset will cut out at 40 Hz, and the breaker will open at 350 V AC. The calculation for the U/f slope will be like this:

$$U/f = \frac{100 - \left(\frac{\text{Minimum voltage}}{\text{Nominal voltage}} \cdot 100\right)}{\text{Knee set point} - \text{Cutout limit}}$$

For this example, the calculation will be like this:

$$U/f = \frac{100 - \left(\frac{350}{400} \cdot 100\right)}{48 - 40} = 1.56$$

So the U/f slope can now be set to either 1.5 or 1.6.

The U/f law (knee function) is set up in the parameters shown below:

Parameter	Item	Range	Default	Note
7771	Knee set point	70.0 % 100.0 %	96.0 %	Only in genset
7772	U/f variable slope	1.0 3.0	1.0	Only in genset

The voltage regulator of the Multi-line 2 unit is inhibited in case the frequency drops below knee set point.

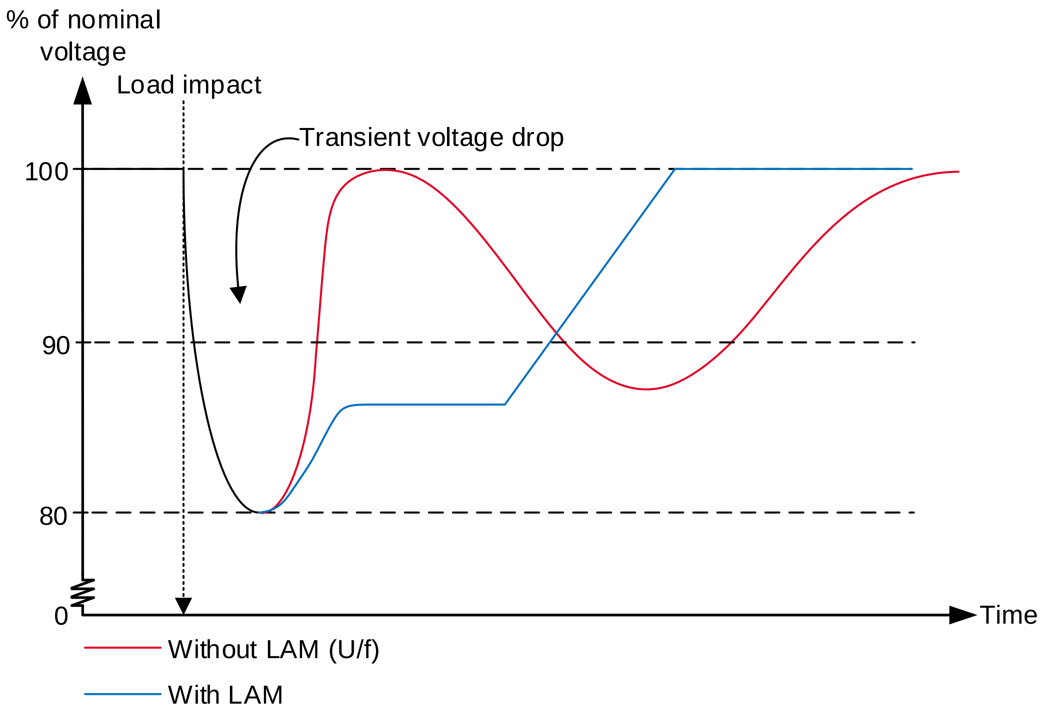
Voltage reference is limited by U/f law at any time.

Settings at parameters 7771 and 7772 are treated as common set points among the AGC DG units in power management applications.

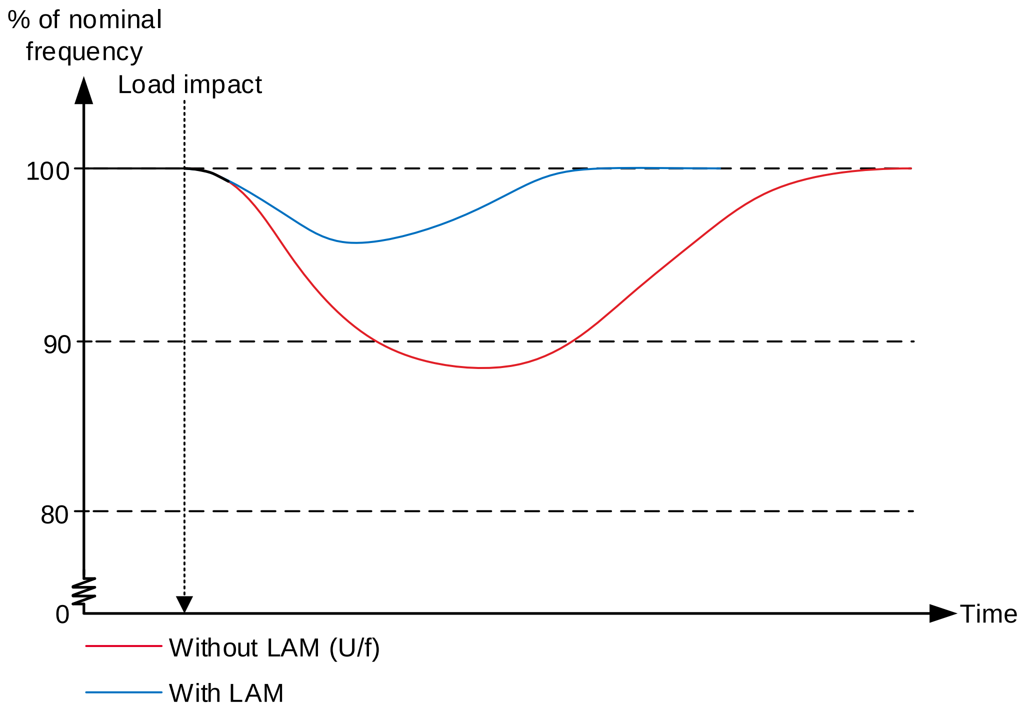
The functionality is automatically disabled by the Multi-line 2 unit when operating parallel to mains.

Load acceptance module (LAM):
The DVC 310 supports LAM, which is a functionality to optimise transient performance of frequency when high load steps are applied. This is achieved by dropping the voltage reference momentarily when the frequency drops below the knee point. In this way, the torque demand on the engine is reduced momentarily. Afterwards, the voltage is raised slowly (according to the soft voltage recovery setting) towards the voltage reference defined by the U/f law. The LAM function can be used to gain more stability in the regulation when a big load impact has been experienced. The percentage set in the LAM function defines how many percent the voltage is allowed to drop, as soon as the knee point is reached.

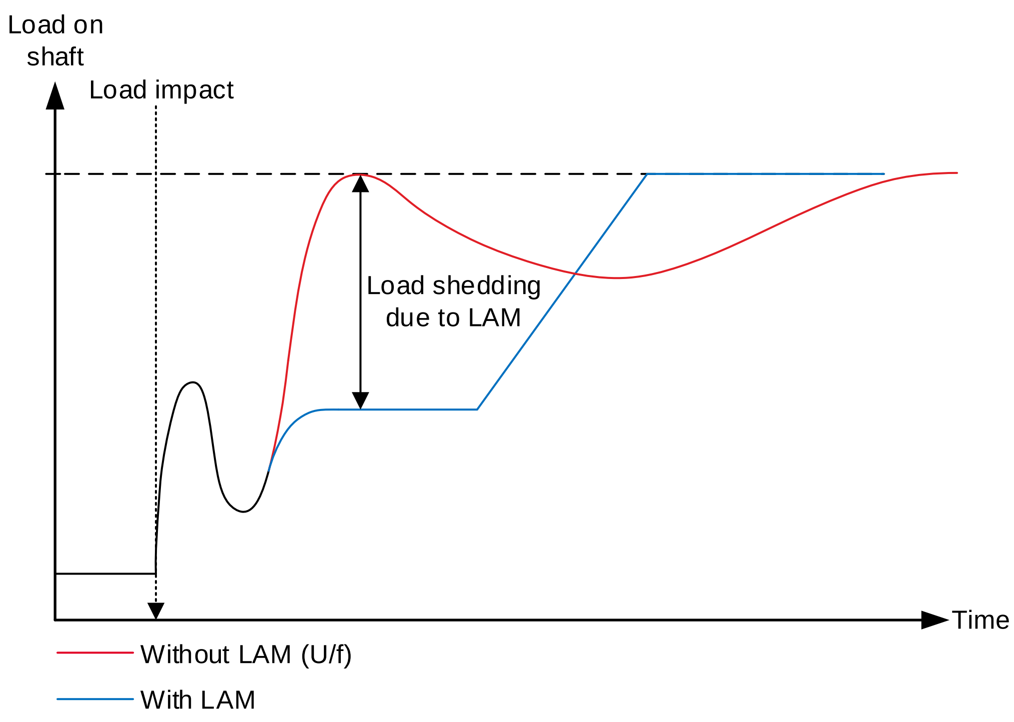
A comparison of U/f and LAM system performance is shown below:



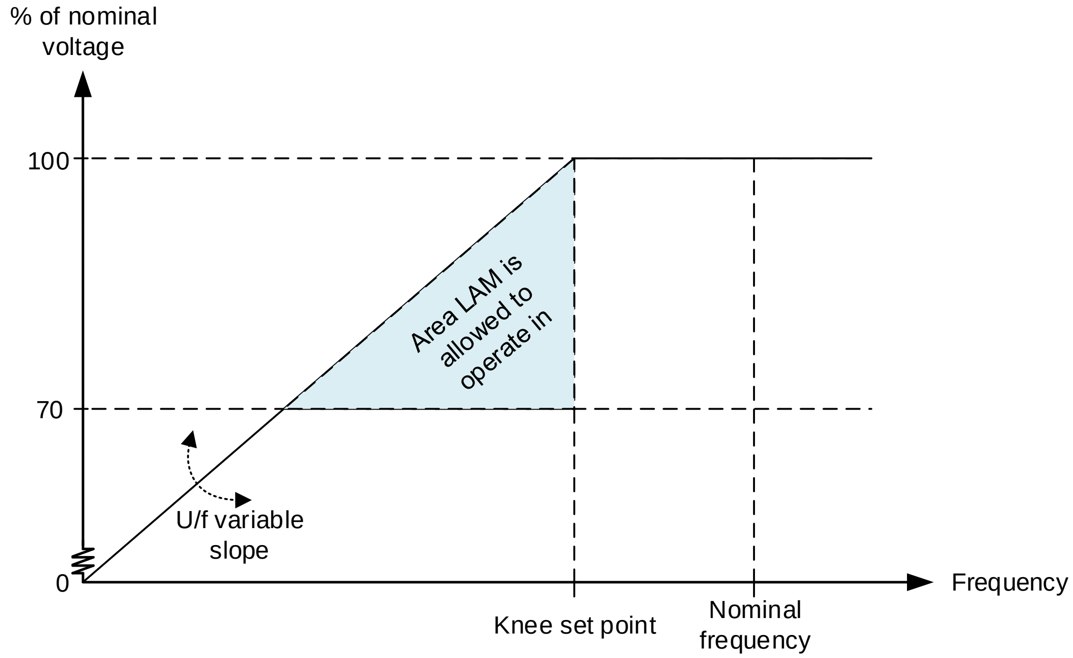
In the graph above, a comparison is made with and without the LAM function. Without the LAM function, the voltage may get unstable at load impacts. Here it is only the U/f law from the knee set point function that determines the voltage set point. With the LAM function, it is allowed to drop the voltage for a short time. The LAM function will start to ramp up the voltage when the frequency is starting to ramp up again. The slope of the ramp-up of the voltage is controlled by the soft voltage recovery function, which will be described later.



The graph above shows that with the LAM function, the frequency will rise and stabilise faster after a big load impact. This is because the LAM function will drop the voltage and by this lower the torque on the engine.



The graph above shows a comparison of the load on the shaft of the engine, with the LAM function enabled and disabled. When the LAM function drops the voltage, the torque on the shaft is lightened, which makes it possible for the engine to rise faster in RPM after a load impact. This also gives the possibility to steadily reach nominal values faster after the load impact, since the LAM function will increase system stability.



The graph above is very similar to the U/f law graph. The difference is that a triangle is marked here. When the LAM function is enabled, the genset is allowed to be inside the marked area. When having the U/f law, the DVC 310 will never cross the U/f law line in the graph, but will always seek to be near it. When the genset is above the knee set point, the DVC 310 will regulate up to the nominal voltage instead. But as long as it is in the marked area (triangle), the DVC 310 will have the U/f law to determine the voltage set point.

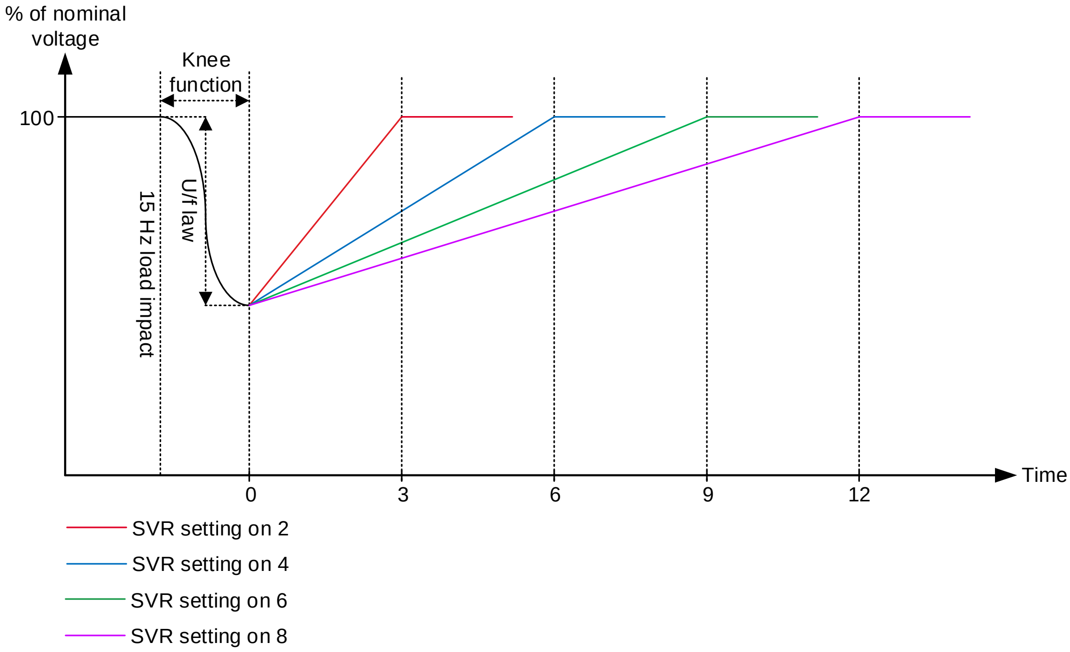
The LAM set point in the DVC 310 is set in percentage of how much it should drop the voltage compared to nominal. So if a set point of 10 % is made, the voltage will drop to 90 % of nominal when the LAM function is active. In the Multi-line 2 unit, the LAM function is set on how much it should drop to when LAM is active. So, if the LAM function in the Multi-line 2 unit is set to 90 %, the DVC 310 will drop the voltage to 90 % of the nominal voltage when LAM is active.

Parameter	Item	Range	Default	Note
7775	LAM set point	70 % 100 %	90 %	Only in genset. Defines the voltage level to which the voltage is dropped when the knee set point is reached.
7776	Activation of LAM function	OFF ON	OFF	Only in genset

Settings at parameters 7775 and 7776 are treated as common set points among the AGC DG units in power management applications.

The functionality is automatically disabled by the Multi-line 2 unit when operating parallel to mains.

Soft voltage recovery (SVR):
Soft voltage recovery (SVR) is an add-on to LAM that helps the genset return to its rated speed after experiencing a load impact. This is done by gradually increasing the voltage towards the voltage defined by the U/f law. The SVR is activated when the frequency drops below the knee point and an increase in frequency is detected. The setting for the SVR function defines the slope for the voltage recovery after a load impact. The SVR setting in parameter 7773 defines how many seconds the voltage should take to recover to nominal voltage from a 10 Hz load impact.



In the graph above, different SVR settings are shown at 15 Hz load impact. The dotted line at time point 0 represents where the frequency is starting to recover again. When the frequency starts to recover, the SVR function will be activated. When the genset is exposed to a 15 Hz load impact and the SVR setting is 4 s/10 Hz, the voltage will be recovered in 6 seconds. But the U/f law can still not be passed, which can make the SVR longer than for example 6 seconds. This can happen if the engine is not fast to recover in RPM from a load impact.

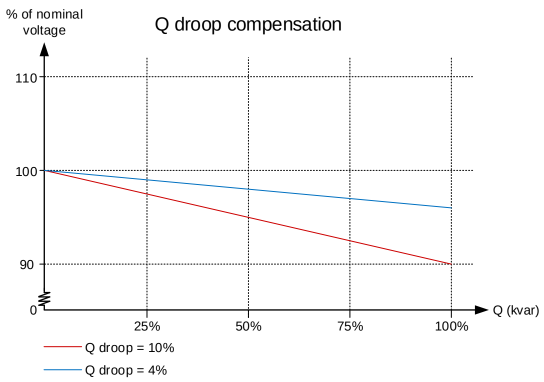
Parameter	Item	Range	Default	Note
7773	Soft voltage recovery timer	0.1 s/10 Hz 30.0 s/10 Hz	2.0 s/10 Hz	Only in genset
7774	Activation of soft voltage recovery function	OFF ON	OFF	Only in genset

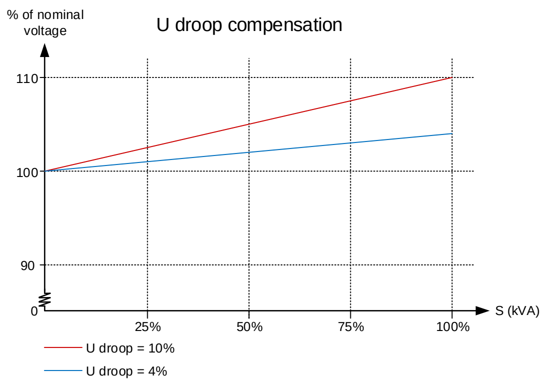
The voltage regulator of the Multi-line 2 unit is inhibited in case the SVR functionality is active. Regulation is activated again when the SVR timer runs out.

Settings at parameters 7773 and 7774 are treated as common set points among the AGC DG units in power management applications.

The functionality is automatically disabled by the Multi-line 2 unit when operating parallel to mains.

Droop compensation:
Two types of droop compensation are supported by the DVC 310: Reactive droop and voltage line droop. They can be controlled via the Multi-line 2 unit.





The droop compensation decides how much the voltage is allowed to droop if the regulation is turned off in the Multi-line 2 unit. The regulation can be turned off by setting the Multi-line 2 unit to MANUAL. The regulation can also be off if the CAN bus cables should break. With the droop, it is possible to give the DVC 310 a set point for the voltage if an error in the CAN bus lines should occur. This makes it possible for the genset to share the reactive load when no interfacing is available.

It is recommended that the U droop compensation is not turned on when interfacing the DVC 310 with a Multi-line 2 unit. These functions will try to work in opposite directions, which may cause instability.

All settings for droop are found in menu 7780 - Droop compensation.

Parameter	Item	Range	Default	Note
7781	Q droop compensation set point	0.0 % 10.0 %	2.0 %	Only in genset
7782	U droop compensation set point	0.0 % 10.0 %	2.0 %	Only in genset
7783	Activate droop compensation type	Q droop compensation OFF	Q droop compensation	Only in genset

All settings at menu 7780 are treated as common set points among the AGC DG units in power management applications.

The functionality is automatically disabled by the Multi-line 2 unit when operating parallel to mains.

Only one of the droop functions can be active.

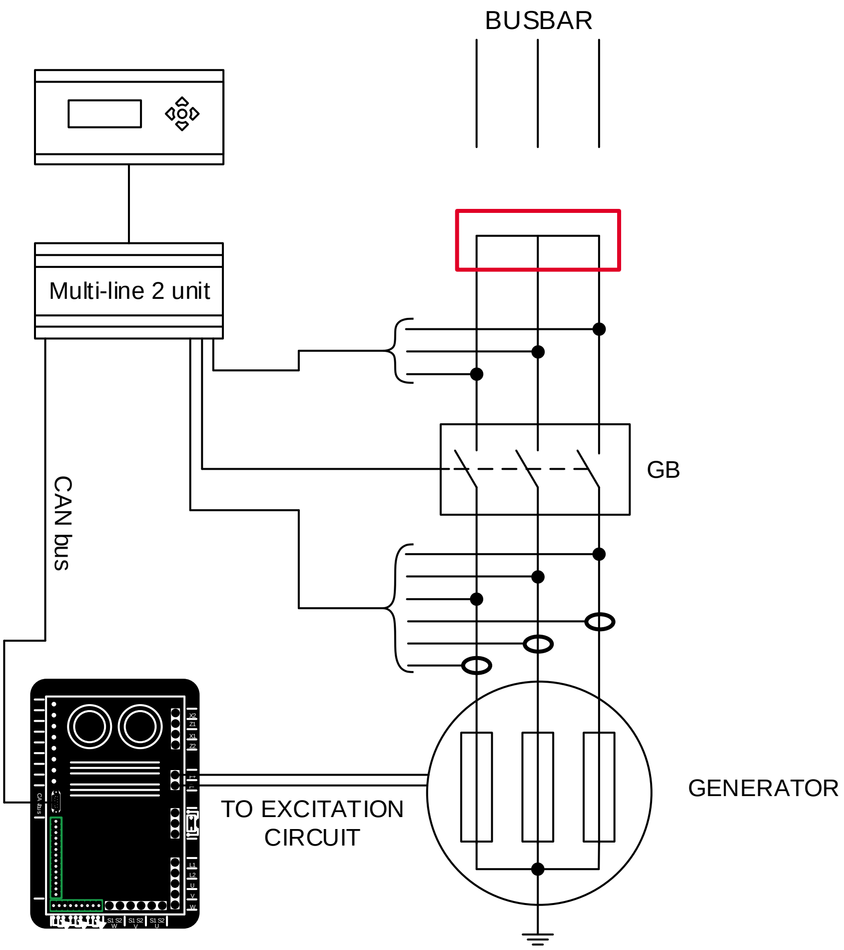
18.2.5 Genset modes

The option T2 and the DVC 310 combined give two new genset modes which are available at parameter 6070 - Genset mode:

- Dry alternator
- Ventilation

Dry alternator:
The purpose of the dry alternator is to dry the windings in the generator before use. The reason for drying the windings is to prevent the winding insulation from being degraded due to moisture in the generator and to prevent arc-over in the windings. External heat sources can be used to vaporise the moisture, but the DVC 310 provides the possibility of using the alternator to dry the windings instead. It is done in this way:

1. Make a short circuit of the busbar, meaning that when the GB closes, the generator will supply a short circuit. At parameter 7791, it is possible to type in a set point for excitation current, meaning that if the set point is set to 0.1 A, the DVC 310 will supply 0.1 A excitation current. This will result in much higher current in the stator, and the heating from the stator current will dry the windings.



2. Choose dry alternator mode at parameter 6071. Start the genset in semi-auto mode and close the GB. When the windings are dried out, open the GB and stop the genset.

3. Now set the Multi-line 2 unit into the desired genset mode at parameter 6071. Start the generator again and close the GB. Now the DVC 310 will slowly raise the excitation current. If the voltage is not raised, the Multi-line 2 unit will make a shutdown, because it means that the short circuit is not removed.

Parameter	Item	Range	Default	Note
7791	Excitation reference for dry alternator	0.0 A 20.0 A	1.5 A	Only in genset

If the excitation supply for the DVC 310 comes from AREP or shunt, an external supply is needed when running dry alternator mode. Only a PMG does not require external supply.

Dry alternator mode is not possible with GPC-3.

Ventilation mode:
The purpose of ventilation is to remove humidity before use. It is done in this way:

1. Select ventilation mode at parameter 6071.
2. Start the genset in semi-auto mode with open GB, and the generator will be ventilated by fan air. The excitation current will be 0 A.
3. Now set the Multi-line 2 unit into the desired genset mode at parameter 6071.

Ventilation mode is not possible with GPC-3.

18.3 Protections

18.3.1 Voltage loss detection

The DVC 310 is able to shut down the excitation if a loss of voltage sensing is detected in 1 second. The reason for shutdown of the excitation is that the DVC 310 does not have a voltage reading as regulation feedback. This is to protect the alternator from overheating the windings, and also to protect the equipment from over-voltage when operating in island mode.

The loss of voltage detection alarm will be triggered when the measured voltage is below 40 % of the set point. Note that the set point may vary, following the U/f rule.

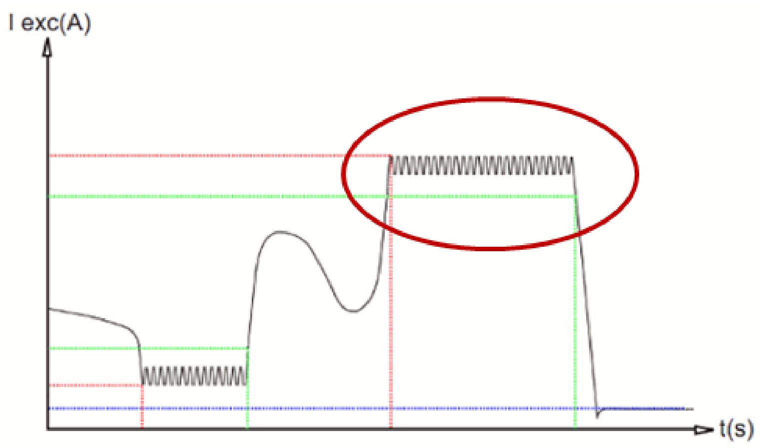
This detection is made in configuration 1ph as well as 3ph. If configured in 3ph, the voltage considered for the alarm is the average global voltage.

The voltage loss detection can be enabled in parameter 7821:

Parameter	Item	Range	Default	Note
7821	Activation of voltage loss detection	OFF ON	OFF	Only in genset

18.3.2 Excitation current run limitation/shutdown excitation

This protection is to ensure that the excitation of the alternator does not exceed the upper limit. The upper limit is shown in the graph below.



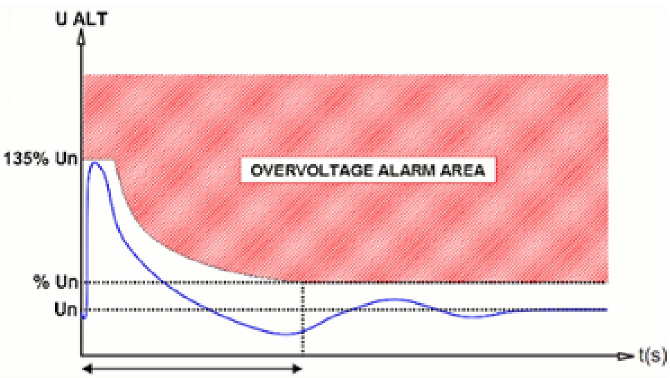
If the genset is supporting a very inductive load, the magnetic flux density in the rotor can be very high, which can cause end-turn burning. This protection contains three parameters that can all be found in the EasyReg software.

The first parameter (Iexc run limitations) determines how much excitation is allowed before a timer starts. The second parameter (Iexc reset limitation) determines how much the excitation must drop to stop the timer. By default, the timer is 10 seconds and cannot be changed. If the timer expires, the excitation will be turned down to the current set in the third parameter (Iexc shutdown). This protection is used for thermal protection of the windings in the alternator. These settings can all be found in the EasyReg software, which will be described later.
This protection is enabled at parameter 7822:

Parameter	Item	Range	Default	Note
7822	Activation of excitation current protection	OFF ON	OFF	Only in genset

18.3.3 Over-voltage protection

This protection is to prevent the alternator from running with high voltage over a long period of time. The timer and the limit are set in the EasyReg software. The voltage value, to which the over-voltage protection percentage is applied, is the at any time used voltage regulation set point during voltage regulation. During a soft-start sequence, this means that if the alternator voltage is 210 V AC, but the regulation's set point is 200 V AC, a 5 % deviation is now present. The curve for over-voltage characteristic can only be changed when customised configuration is chosen. The mentioned curve for the over-voltage protection is shown below.



The over-voltage protection in the DVC 310 is enabled in parameter 7823:

Parameter	Item	Range	Default	Note
7823	Activation of over-voltage protection	OFF ON	OFF	Only in genset

18.3.4 Diode fault

The DVC 310 is able to:

- measure on the excitation circuit in the alternator and thus ensure that all diodes are working normally

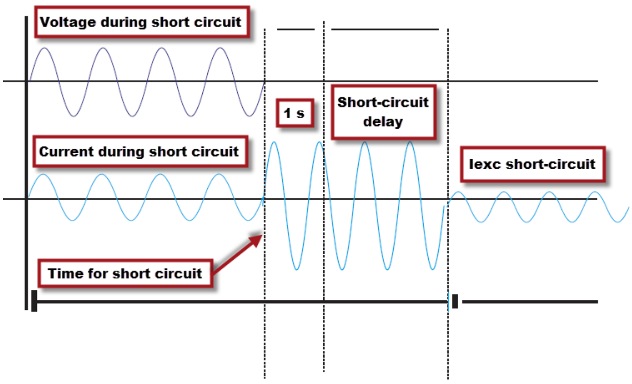
- measure the ripples for the excitation and thus detect faulty diodes
- switch off the excitation if it detects a diode fault
- send alarms through the CAN bus communication when it detects a diode fault.

The diode fault detection is enabled in parameter 7824:

Parameter	Item	Range	Default	Note
7824	Activation of diode fault supervision	OFF ON	OFF	Only in genset

18.3.5 Short circuit

If the DVC 310 detects that the voltage disappears and the phase current exceeds two times nominal, the DVC 310 will see this as a short circuit. From the point when the voltage disappears, a one second timer is started. The DVC 310 has a short circuit protection, which uses two parameters. The first parameter (short circuit delay) determines how long a new timer should be active, before the excitation is shut down to a pre-defined level (I-excitation short circuit). The short circuit protection will only be able to activate if one or three CTs are installed. The short circuit protection is shown in the graph below.



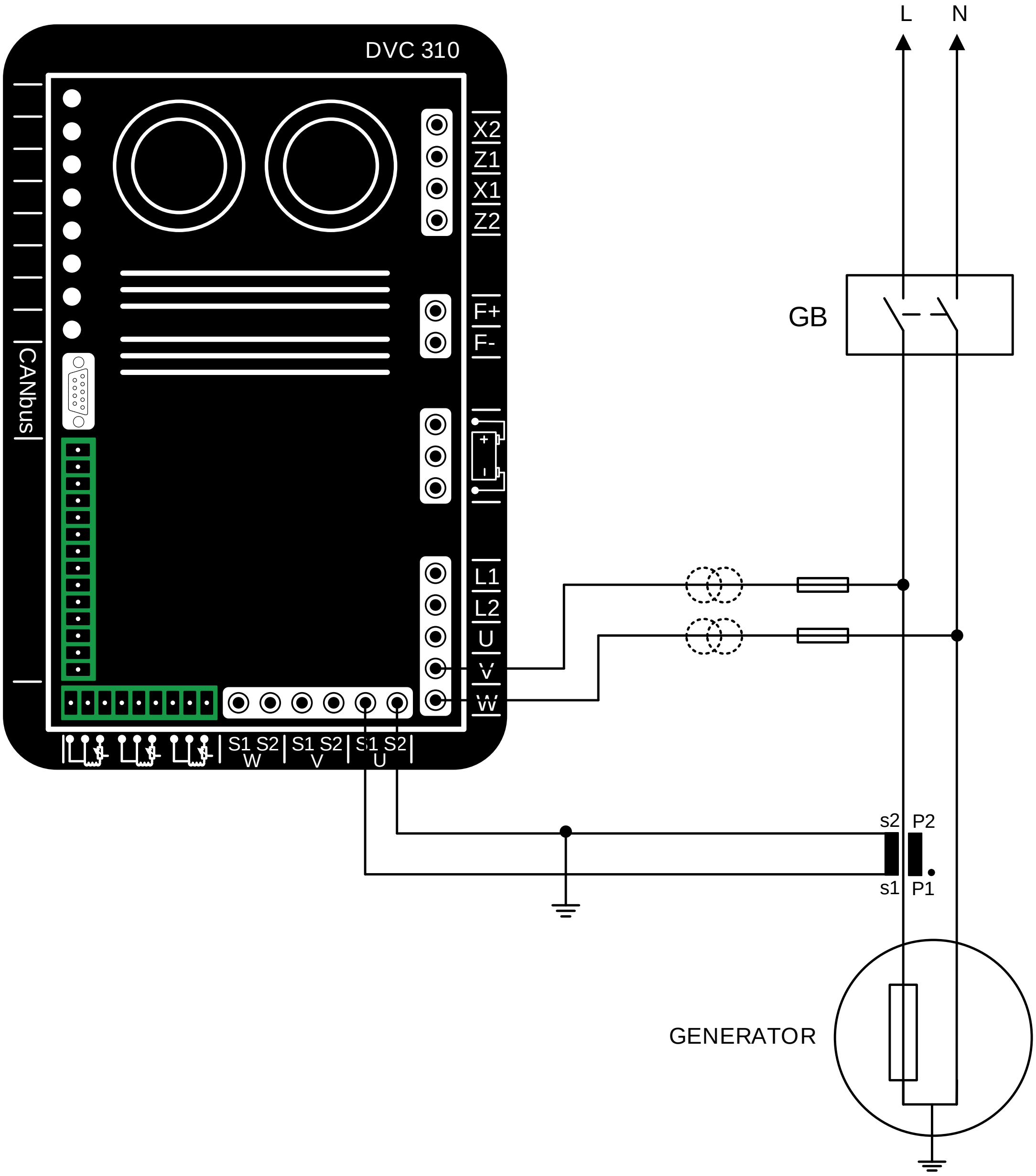
The short circuit protection is activated at parameter 7825:

Parameter	Item	Range	Default	Note
7825	Activation of shut-down diodes pro-tection	OFF ON	OFF	Only in genset

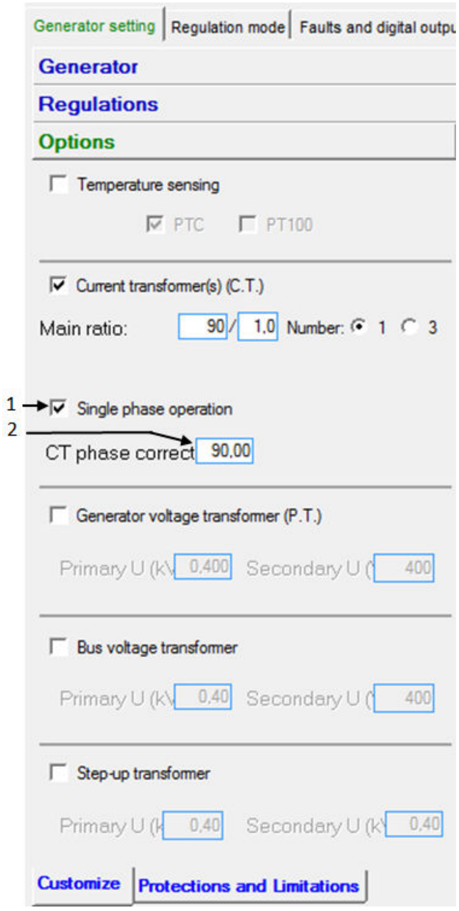
18.4 DVC 310 options

18.4.1 Single-phase operation

The DVC 310 is able to perform single-phase operation, which means that it is able to measure the voltage on a phase and a neutral. The DVC 310 needs some information to do this. The voltage sensing must be done with the phase voltage on the V terminal and the neutral on the W terminal. The current transformer must then be mounted to the U-S1 and U-S2 terminals on the DVC 310, with P1 facing the alternator on the phase line. The specifics for the installation of a single-phase generator are shown below. The other connections are connected in the same way as on a three-phase generator, which was shown earlier.



For the DVC 310 to measure correctly, the current transformer needs a phase correction, which is set in the EasyReg software. In the EasyReg software, this is configured in the "Generator setting - Options" window.



1. Firstly, the "Single phase operation" setting is enabled. The DVC 310 then expects that the alternator is single-phase.
2. From here, the "CT phase correction" is set. This must be set to 90 degrees when a setup as shown above is used.

The above-mentioned specifics are all that you need to be aware of when using a single-phase generator. The rest of this option description fits three-phase as well as single-phase generators.

18.4.2 IN, IN/2 or IN/4 sensing

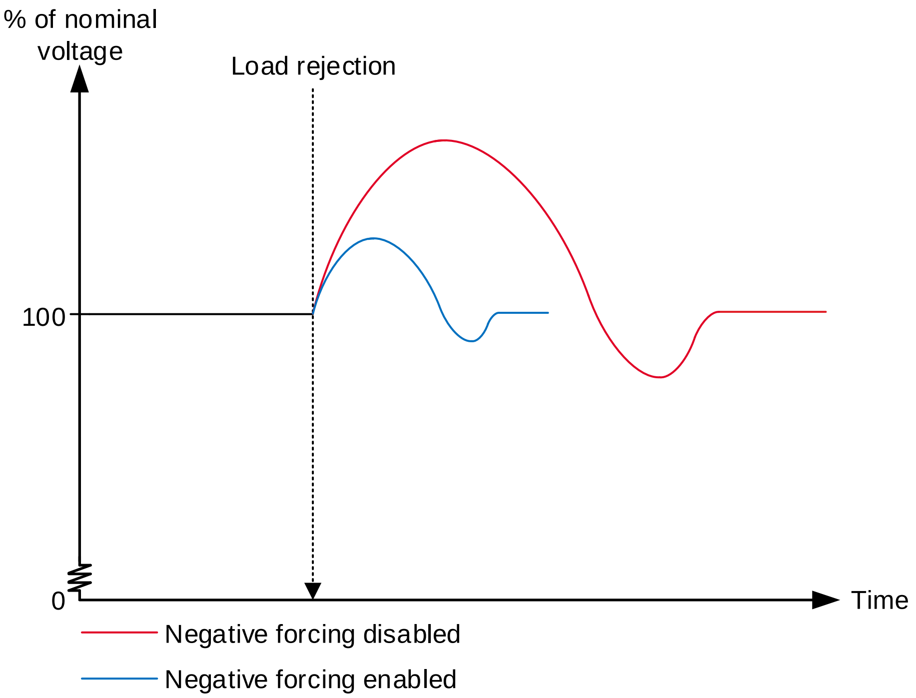
On some alternators, the current transformers can be mounted inside the alternators. The DVC 310 needs to be programmed for this configuration. The DVC 310 can be set to IN, IN/2 or IN/4 sensing from the options menu, in a new configuration. When IN is selected, it means that the CT measures the full current; when IN/2 is selected, it means that the CT measures half of the full current; and when IN/4 is selected, the CT measures one fourth of the full current.

18.4.3 External power module

This function allows the DVC 310 to regulate on an inverter or a bigger AVR. If the external power module is activated, the excitation power supply circuit will be shut off. This function is not completed yet.

18.4.4 Negative forcing

The negative forcing function enables the DVC 310 to reverse the excitation voltage because of the principle with two transistors instead of one. It allows to have reversed voltage at the output (field excitation), because the two transistors are in parallel and upside down. This function can be useful if the DVC 310 is placed in an application where big loads are turning off. When shutting off a big load, the voltage may increase. By reversing the excitation for a moment, the nominal voltage will be recovered faster. In the graph below, it is shown with the negative forcing function enabled and disabled.



18.4.5 VBus compensation

This function is used to compensate for the deviations in voltage, to which the excitation circuit can be exposed. If the excitation circuit's supply voltage is lower for a moment, the excitation current will also be lower at this time. The PID controller must then be slightly more aggressive to raise the excitation current again. On the other hand, if the excitation circuit's supply voltage is higher than normal, the PID controller must be less aggressive to make sure that the excitation will match the nominal voltage.

18.5 Regulation related to DVC 310

18.5.1 Average and true RMS regulation

In the DVC 310 it is possible to make a selection between average and true RMS regulation. This makes it possible to choose how the DVC 310 should manage the voltage readings. If the DVC 310 is mounted in applications with much harmonic distortion, the regulation should be switched to true RMS regulation. Otherwise, the setting should be average regulation.

True RMS can only be used with 1-phase measurement.

18.5.2 PID settings

Access to PID settings is added in the Multi-line 2 unit menu 7800.

Parameter	Description	Comment
7801	PID Gain	This is a gain for the PID regulator in the DVC 310
7803	Wr All settings	This parameter sends all settings to the DVC 310 (this is a pulse command, by default the parameter returns to OFF state after use)

The PID regulators can only be changed with the EasyReg software. When the Multi-line 2 unit has the control (7805 to ON, described in the section "DAVR control"), only the voltage regulators are used. The gain for voltage regulator is set from the Multi-line 2 unit at parameter 7801.

Regarding the "Write all settings" parameter (7803), the Multi-line 2 unit writes the settings on the fly, as the settings are made. The user can apply this parameter to ensure that all the settings regarding the DVC 310 in the Multi-line 2 unit are written once more.

The ranges and defaults for the parameters are shown below:

Parameter	Item	Range	Default	Note
7801	PID gain in DVC 310	1 100	20	Only in genset
7803	Write all settings to DVC 310	OFF ON	OFF	Only in genset. When set to ON, it will automatically reset to OFF.

18.5.3 Bias and control

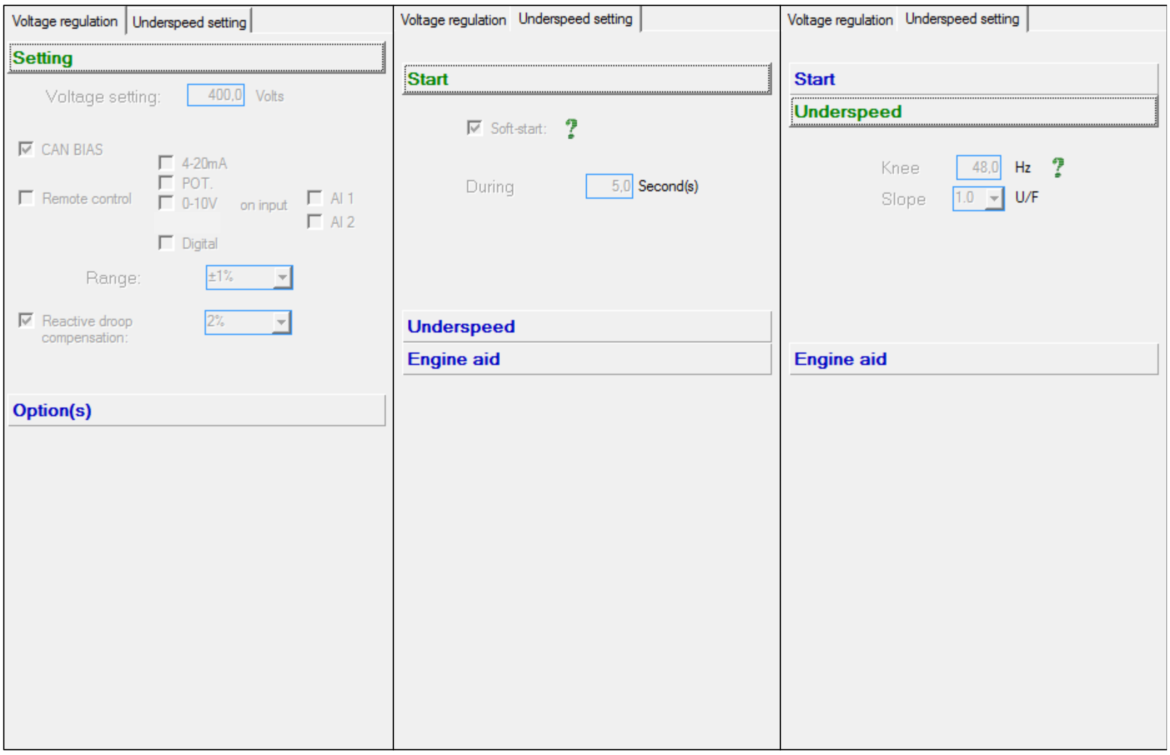
Bias range:
At parameter 7804, the Multi-line 2 unit can control how wide the bias range should allow the Multi-line 2 unit to control the voltage in the DVC 310. By default, it is set to +/- 10 %, which means that the Multi-line 2 unit is allowed to regulate the voltage on a 400 V genset from 360 V to 440 V. The bias range should be wide enough to ensure that the gensets can load-share the reactive power in both capacitive and inductive situations. By making the bias range wider, the resolution for load sharing between the Multi-line 2 units will be harder, since a small step gives a bigger response. By experience, the +/- 10 % bias range covers most applications.
The bias range is only for CAN bus-based bias signal.

Bias for analogue regulation:
At parameter 7806 it can be set which type of input the DVC 310 should expect to receive if parameter 2783 is set to analogue.
To ensure that the DVC 310 is regulated from the Multi-line 2 unit, parameter 5990 must be set to the correct transducer output that must give the bias to the DVC 310.

DAVR control:
This parameter is located at 7805. It controls whether the Multi-line 2 unit should send commands and information in the CAN bus. This could, for example, be controlling the DVC 310 in switching regulation mode, and sets the knee set point and other settings/commands to the DVC 310.

It does not matter if the "DAVR control" is set to ON or OFF as regards the bias signal. The Multi-line 2 unit is still able to regulate on the CAN bus-based bias to the DVC 310. Parameter 2783 must then still be set to "EIC", and the engine interface (7561) must be set to a J1939-based protocol.

If the Multi-line 2 unit has the control and the communication is up and running, it can be seen in the EasyReg software. A lot of settings are greyed out, so these settings can only be changed from the Multi-line 2 unit. The settings that are greyed out are the ones that correspond to those mentioned in the table for "Common settings related to DVC 310". The picture below shows what it looks like when the settings in EasyReg are greyed out.



The table below shows the parameters that are described above:

Parameter	Item	Range	Default	Note
7804	DVC 310 bias range for CAN bus-based regulation	0.1 % 30.0 %	10.0 %	Only in genset.
7805	Allow the Multi-line 2 unit to control DVC 310	OFF ON	ON	Only in genset.
7806	DVC 310 analogue bias input type	4 to 20 mA 0 to 10 V DC	0 to 10 V DC	Only in genset.

18.6 Multi-line 2 and DVC 310 in cooperation

18.6.1 Nominal settings

When the CAN bus communication is established and the parameter for “DAVR control” (7805) is enabled, the Multi-line 2 unit is able to control the nominal settings in the DVC 310. For rental customers, this can be helpful in cases where the gensets are exposed to different scenarios where different nominal settings can be required. By shifting the nominal settings in the DVC 310, it makes sure that the bias range is still the same even though the nominal voltage is either higher or lower.

The nominal settings that are sent automatically from the Multi-line 2 unit are active nominal voltage and frequency. So if the nominal setting is shifted between the four possible nominal settings, the active nominal settings will be sent automatically to the DVC 310.

18.6.2 Auto-view

If the CAN bus communication between the Multi-line 2 unit and the DVC 310 is established, the Multi-line 2 unit is able to display some values that it receives via the CAN bus. These values will be added to the 20 views that are already present in the Multi-line 2 unit, so the total number of views will be expanded. It will still only be possible to configure the first 20 views.

The extra lines will be displayed if parameter 7564 is switched to “ON” and the CAN bus is active. Parameter 7564 will automatically switch to “OFF” again.

Note that if the DVC 310 is mounted on a genset that also has an ECU, and the ECU also gives information via the CAN bus, then the ECU data might not be required to start the genset before toggling the auto-view to “ON”, because some ECUs only give information when the engine is running.

The parameter for auto-view is shown below:

Parameter	Item	Range	Default	Note
7564	Auto-view - enable	OFF ON	OFF	Only in genset. Note that it automatically switches to OFF again.

18.6.3 Pt100 sensors at the DVC 310

At menu 7810 in the Multi-line 2 unit, it is possible to set the alarm limit for the three Pt100 inputs on the DVC 310. It is not required that a Pt100 sensor is wired to all inputs. The Multi-line 2 unit can then send the limit setting, indicating when the DVC 310 should give an alarm regarding high temperature. The three input limits can be set independently of each other.

The relevant parameters are shown in the table below:

Parameter	Item	Range	Default	Note
7811	Pt100 input no.1 on the DVC 310 - threshold	50 deg. 200 deg.	160 deg.	Only in genset.
7812	Pt100 input no.2 on the DVC 310 - threshold	50 deg. 200 deg.	160 deg.	Only in genset.
7813	Pt100 input no.3 on the DVC 310 - threshold	50 deg. 200 deg.	160 deg.	Only in genset.

18.6.4 Communication error

When the settings regarding communication to the DVC 310 have been set, the Multi-line 2 unit has an alarm for surveillance of the communication lines. If the communication between the Multi-line 2 unit and the DVC 310 suddenly stops, the Multi-line 2 unit will give an alarm called "DAVR Comm. Err".

The alarm can be configured in menu 7830, in which it is also possible to set a fail class to activate if the "DAVR Comm. Err" alarm appears.

The parameters used for the communication alarm error are shown below:

Parameter	Item	Range	Default	Note
7831	Digital AVR communication error - delay	0.0 s 100.0 s	0.0 s	Only in genset.
7832	Digital AVR communication error - output A	Not used Option-dependent	Not used	Only in genset.
7833	Digital AVR communication error - output B	Not used Option-dependent	Not used	Only in genset.
7834	Digital AVR communication error - enable	OFF ON	OFF	Only in genset.
7835	Digital AVR communication error - fail class	Block Trip MB/GB	Warning	Only in genset.

18.6.5 DVC 310 alarms on Multi-line 2 unit

The Multi-line 2 unit has the possibility to act on alarms given from the DVC 310 via CAN bus.

The DVC 310 can give two different levels of alarms, of which the first level is "DAVR Warning" and the next level "DAVR Trip". This is enabled in menu 7760, in which it is also possible to set a fail class for a "DAVR Warning" and for a "DAVR Trip".

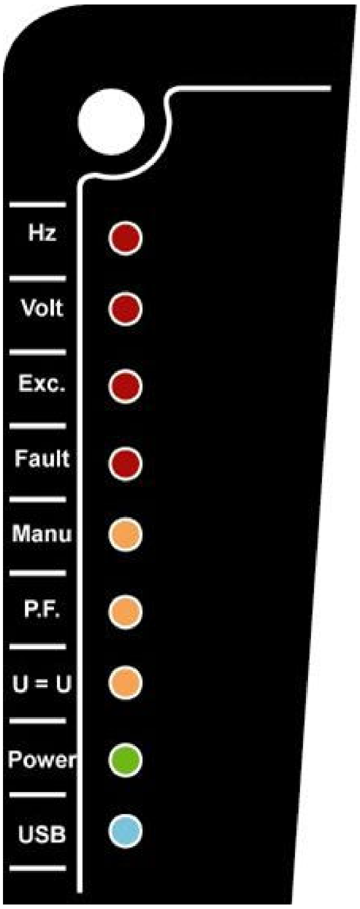
The relevant parameters are shown in the table below:

Parameter	Item	Range	Default	Note
7761	DVC 310 Warning - enable	OFF ON	OFF	Only in genset.
7762	DVC 310 Warning - fail class	Block Trip MB/GB	Warning	Only in genset.
7763	DVC 310 Trip - en-able	OFF ON	OFF	Only in genset.
7764	DVC 310 Trip - fail class	Block Trip MB/GB	Warning	Only in genset.

18.7 DVC 310 LEDs

18.7.1 DVC 310 LEDs

The DVC 310 has numerous LEDs that can be used for indication and information. The LEDs are placed in the upper left corner, as shown below.



Hz: Glows red if the speed has dropped below the knee set point and the U/f law is active.

Volt: Glows red if the voltage is high or low compared to the nominal volt-age.

Exc.: Glows red if the alternator is exposed to either over- or under-exci-tation.

Fault: Glows red if the DVC 310 has detected a diode fault.

Manu: Glows yellow when a Multi-line 2 unit is ready for a CBE start. Can be used to indicate that all conditions are present for a CBE start.

P.F.: Glows yellow when PF or kvar regulation mode is active. (PF and kvar regulation cannot be activated when interfacing with a Multi-line 2 unit).

U = U: Glows yellow when voltage matching is active. (Not available when interfacing with a Multi-line 2 unit).

Power: Glows green when a 24 V DC supply is present on the DC supply terminals of the DVC 310.

USB: Glows blue when the DVC 310 is connected to a PC.

18.8 M-Logic related to DVC 310

18.8.1 M-Logic events, outputs and commands

In M-Logic, there are additional possibilities with the option T2.

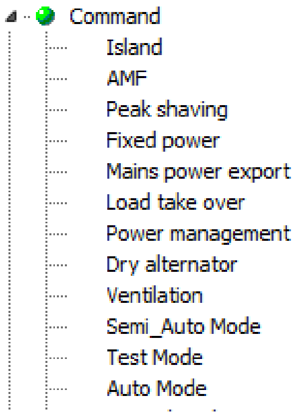
A list of the events is shown below:

- DAVR event
  - LED: Power On
  - LED: U=U
  - LED: PFkVAR
  - LED: Manual
  - LED: Fault
  - LED: Exc.
  - LED: Exc. blink
  - LED: Volt
  - LED: Hz
  - General trip
  - Short circuit
  - Loss of voltage sensing
  - Under excitation
  - Over excitation (level)
  - Over excitation (curve)
  - Over voltage
  - High temperature PT100_1
  - High temperature PT100_2
  - High temperature PT100_3
  - High temperature PTC
  - Stator over current
  - Stator over current U
  - Stator over current V
  - Stator over current W
  - Imbalance Stator current
  - Diode fault
  - Shutdown diodes
  - Stator current limitation off
  - Stator current limitation TM
  - Stator current limitation IM
  - Stator current limitation Active

For outputs, these four are possible:

- DAVR commands
  - Set stator current limitation off
  - Set stator current limitation TM
  - Set stator current limitation IM
  - Reset trip alarms

Furthermore, two lines have been added in the command window in M-Logic: Dry alternator and Ventilation.



18.9 Common settings related to DVC 310

18.9.1 Overview of shared parameters related to option T2

This chapter is made to give the user an overview of parameters that are shared between the AGC DG units and between a Multi-line 2 unit and a DVC 310.

Parameter	Parameter no.	AGC DG to AGC DG	ML-2 unit to DVC 310
CBE set point	2251	X	
CBE delay	2252	X	
CBE enable	2254	X	
CBE breaker sequence	2261	X	
CBE soft-start timer	2262	X	X
CBE RPM excite	2263	X	
Generator nominal voltage - nominal set 1	6004		X
Generator nominal voltage - nominal set 2	6014		X
Generator nominal voltage - nominal set 3	6024		X
Generator nominal voltage - nominal set 4	6034		X
Generator voltage transformer primary side	6041		X
Generator voltage transformer secondary side	6042		X
Busbar voltage transformer primary side - busbar nominal set 1	6051		X
Busbar voltage transformer secondary side - busbar nominal set 1	6052		X
Busbar voltage transformer primary side - busbar nominal set 2	6061		X
Busbar voltage transformer secondary side - busbar nominal set 2	6062		X
DVC 310 generator primary voltage	7741		X
DVC 310 generator secondary voltage	7742		X
DVC 310 busbar primary voltage	7743		X
DVC 310 busbar secondary voltage	7744		X
DVC 310 voltage transformer enable	7745		X
Start-on threshold PWM	7751		X
Start-on threshold voltage limit	7752		X
Soft-start timer (Normal start)	7753		X
Knee set point	7771	X	X
U/f law slope	7772	X	X
Soft voltage recovery timer	7773	X	X
Soft voltage recovery enable	7774	X	X
LAM set point	7775	X	X

Parameter	Parameter no.	AGC DG to AGC DG	ML-2 unit to DVC 310
LAM enable	7776	X	X
Q droop compensation set point	7781	X	X
U droop compensation set point	7782	X	X
Droop compensation type	7783	X	X
Excitation current for dry alternator mode	7791		X
Excitation current for CBE during remanence phase	7792		X
Transformer excitation set point for current	7793		X
Inductive motor starting set point for current	7794		X
Stator current limitations enable	7795		X
PID Gain	7801		X
Write all settings to DVC 310	7803		X
DVC 310 bias range	7804		X
DVC 310 controls	7805		X
DVC 310 bias analogue type	7806		X
Pt100_1 threshold set point	7811		X
Pt100_2 threshold set point	7812		X
Pt100_3 threshold set point	7813		X
Voltage loss detection enable	7821		X
Excitation current protection enable	7822		X
Over-voltage protection enable	7823		X
Diode fault protection enable	7824		X
Shutdown diode protection enable	7825		X

19. External I/O

19.1 Introduction to external I/O

19.1.1 External I/O

The external I/O function gives the possibility to communicate with an external input/output module via CAN bus. The communication can be done from different CANports. The external input/output function can be used when the AGC does not hold enough inputs/outputs. The inputs/outputs of the module can only be configured from the utility software, since the parameter numbers are not reachable from the display.

19.1.2 Terminal description

The communication to the external I/O module can be done from different CANports. This means that it can be done from different PCBs, whereas these PCBs can be located in different slots in the AGC. By default, the AGC can use CANport B for communication to the external I/O module. The overview of the terminals are shown below:

Term.	Function	Description
B1	CAN-H	CANport B, placed at slot #7. If CANport B is used for communication to an external I/O module, it is not possible to have redundant CAN bus for the power management.
B2	CAN-GND	
B3	CAN-L	

If the AGC has been ordered with the Dual CAN PCB (option H12), this can be placed at two different slots. If the dual CAN PCB is placed at slot #2, the terminals that can be used for communication to the external I/O module are:

Term.	Function	Description
29	CAN-H	Dual CAN bus card option H12.2 External I/O module communication. Note that this option consists of two seperate CAN bus lines. CAN port C: Terminal 29-31 CAN port D: Terminal 32-34
30	CAN-GND	
31	CAN-L	
32	CAN-H	
33	CAN-GND	
34	CAN-L	
35	Not used	
36	Not used	

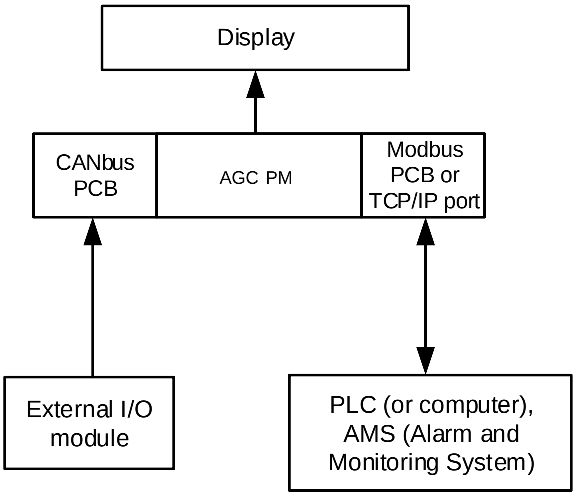
If instead, the unit has been ordered with a dual CAN PCB in slot #8, the terminals used for communication are shown below:

Term.	Function	Description
133	CAN-H	Dual CAN bus card option H12.8 External I/O module communication. Note that this option consists of two seperate CAN bus lines. CAN port E: Terminal 128-130 CAN port F: Terminal 131-133
132	CAN-GND	
131	CAN-L	
130	CAN-H	
129	CAN-GND	
128	CAN-L	
127	Not used	
126	Not used	

Option H12 is a dual CAN card that has two seperate CANports. Option H12 can be ordered to fit in slot #2 OR slot #8. Setup of the terminals is done in the following parameters: Option H12.2 - parameters 7843 and 7844; option H12.8 - parameters 7845 and 7846.

19.1.3 From CAN bus to Modbus

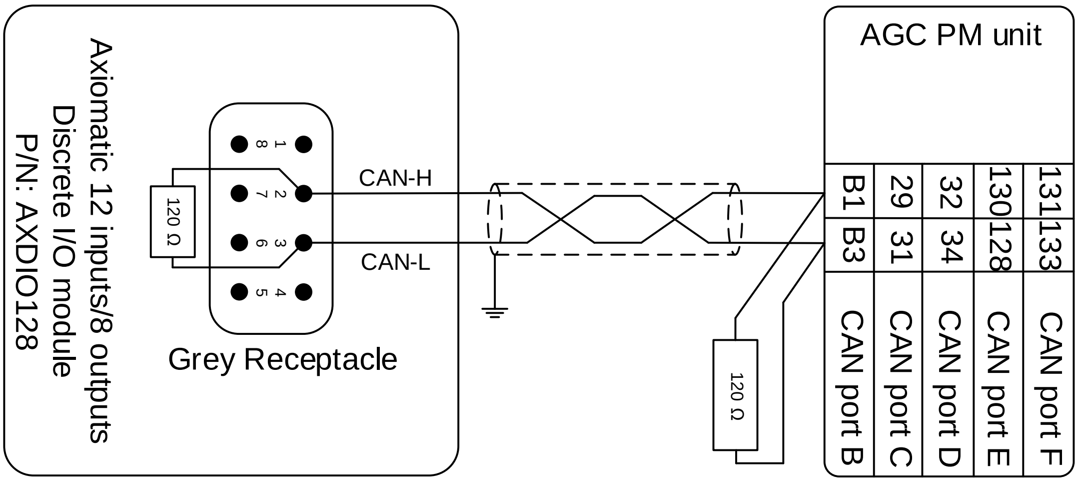
In the AGC, it is possible to read the states of the different inputs via Modbus.
The data in the Modbus can be found in the Modbus table, which can be found in the documentaton for the AGC PM on www.deif.com. Below is the principle that shows how the connections to the AGC are done.



19.2 Functional description

19.2.1 Supported modules and wiring

The AGC supports the Axiomatic ACDIO128 module and can communicate to this via the CAN bus. This can be done from the CANports shown below. Furthermore, the wiring to an Axiomatic AXDIO128 module is shown.



Please note that CANport A cannot be used for communication to the Axiomatic module. If the AGC has to communicate with the Axiomatic module on CANport C or D, the AGC has to be equipped with option H12.2. If the CANport E or F has to be used, the AGC has to be equipped with option H12.8.

The supported Axiomatic module has 12 digital inputs and 8 relay outputs. These inputs and outputs can only be configured from the utility software.
The inputs can be configured in parameter 12540-12650, and the outputs can be configured in parameter 12790-12860.
Inputs in the external I/O module can be configured in the same way as normal digital inputs with for example auto acknowledgde, fail class, timer, limit, high/low alarm and inhibits.
The outputs in the external module can be cofigured as an alarm relay ND, alarm relay NE or a limit relay. Furthermore, it also has a timer that can be configured.

19.2.2 Additional information about Modbus communication

The inputs and outputs for the external input/output module can have different states.
It is possible to connect external equipment to the AGC and read different values via the Modbus. When an AGC is connected to an external I/O module, it is also possible to read the states of the external I/O module via the Modbus. On the Modbus, it is also possible to read the alarms concerning the inputs, if alarms have been configured to the inputs.
These data can be read either from the TCP/IP connection or from an RS485 port (option H2).
All these data can be found in the "Modbus table", which can be found in the documentaton for AGC PM on www.deif.com.

19.2.3 Setting up the AGC

When the AGC is to connect to an external module, this will have to be configured.
In the AGC, it is required to select which CANport is used for communication to the external I/O module.

CANport A cannot be used for communication to the external I/O module. CANport C, D, E or F can only be used for communication to the external I/O module if the AGC is equipped with an option H12.

If any doubt, the communication lines between the external I/O module can be followed, to check which CAN-port on the AGC should be used for communication to the external I/O module.
When it has been setteled which CANport should be used, then find and select the specific CANport in menu 7840. The CANport can now communicate with an external I/O module by selecting the "External I/O" at the specific CANport.
When the CANport has been selected, go to parameter 7890 and set which type of external I/O module the AGC has to communicate with. This could for example be Axiomatic. When this is done, the AGC can is ready to communicate with the external I/O module.
The parameters used for setting up the communication in the AGC are shown in the table below:

Parameter	Item	Range	Default	Note
7842	CANport B selection	OFF Axiomatic	OFF	
7843	CANport C selection	OFF Axiomatic	OFF	Requires option H12.2
7844	CANport D selection	OFF Axiomatic	OFF	Requires option H12.2
7845	CANport E selection	OFF Axiomatic	OFF	Requires option H12.8
7846	CANport F selection	OFF Axiomatic	OFF	Requires option H12.8
7891	External I/O module communication protocol	OFF Axiomatic	OFF	

19.2.4 Communication error

When the settings regarding communication to the external I/O module have been set, the AGC has an alarm for surveillance of the communication lines. If the communication between the AGC and the external I/O module suddenly stops, the AGC will give an alarm called "Ext IO comm error".
This alarm can be configured in parameter 7930 where it is also possible to set a fail class to active if the "Ext IO comm error" alarm appears.
The parameters used for the communication alarm error are shown below:

Parameter	Item	Range	Default	Note
7931	External I/O module communication error – delay	2.0 s 600.0 s	10.0 s	
7932	External I/O module communication error – output A	Not used Option-dependent	Not used	
7933	External I/O module communication error – output A	Not used Option-dependent	Not used	
7934	External I/O module communication error – enable	ON OFF	ON	
7935	External I/O module communication error – failclass	Block Trip MB/GB	Warning	

20. Dual CAN (option H12)

20.1 Dual CAN (option H12)

20.1.1 Dual CAN (option H12)

The option H12 is a dual CAN bus communication hardware and software option, used as serial interface for external I/O, power management system between controllers and ngine communication. It gives the possibility of two extra CAN bus lines in one piece of hardware
It gives the possibility to communicate between AGC PM units (plant, group and genset), and several engine types over the CAN bus.
You can also add more inputs and outputs to AGC PM controllers via the CAN bus.

Option H12 types:
The option H12 has two types. Option H12.2 and option H12.8.
Both options are the same option hardware. Only the usage of a jumper makes the difference.
If there is no jumper mounted on the option H12 hardware, then it is an option H12.2.
In case a jumper is mounted on the option H12 hardware, then it is an option H12.8.

Availability:
The option H12 is available for:
- AGC PM group controller (Plant Management communication only)
- AGC PM genset controller (engine communication, DVC 310 if option T2 is enabled)

Limitations:
- It will only be possible to have one H12 hardware per controller. Option H12.2 or H12.8.
- Engine and DVC 310 communication is only available from the same CAN bus ports on the H12 hardware. (For example it is not possible to have EIC on CAN-E and DVC 310 on CAN-F)

In general, it is not possible to use the DVC 310 communication if the EIC communication is set to CAN open.

Location:

Option H12.2 dual CAN is placed on slot #2 (only to be used on AGC PM group controllers).

Slot #2, Terminal 29-36	Function	Description
29	CAN-H	CAN C
30	CAN-GND	CAN C
31	CAN-L	CAN C
32	CAN-H	CAN D
33	CAN-GND	CAN D
34	CAN-L	CAN D
35	-	Not used
36	-	Not used

Option H12.8 dual CAN is placed on slot #8 (only to be used for Plant Management communication)

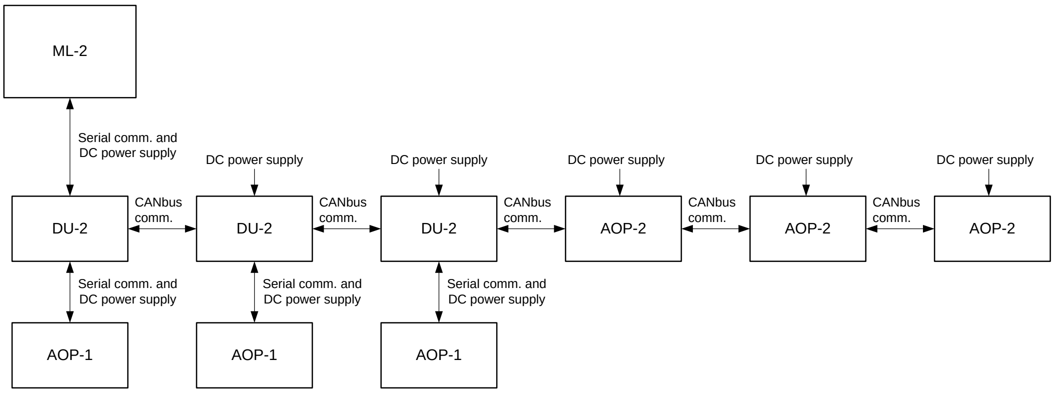
Slot #8, Terminal 126-133	**Function**	**Description**
126	-	Not used
127	-	Not used
128	CAN E	CAN-L
129	CAN E	CAN-GND
130	CAN E	CAN-H
131	CAN F	CAN-L
132	CAN F	CAN-GND
133	CAN F	CAN-H

Related parameters:
Option H12.2: Setup of the terminals for the option H12.2 is done with the parameters 7843 and 7844.
Option H12.8: Setup of the terminals for the option H12.8 is done with the parameters 7845 and 7846.

21. Additional operator panel and display foils

21.1 Additional displays and operator panels

Below is a principle diagram of the connection of the additional displays and operator panels.



Only three AOP-2 units are shown in the diagram, but up to five units are supported.

Only one DU-2 has to be connected to the ML-2 unit. The rest of the displays and AOP units are connected to each other with communication lines (serial or CAN bus) and get their information through the DU-2 unit connected to the ML-2 unit.

21.2 Option X2 - additional display

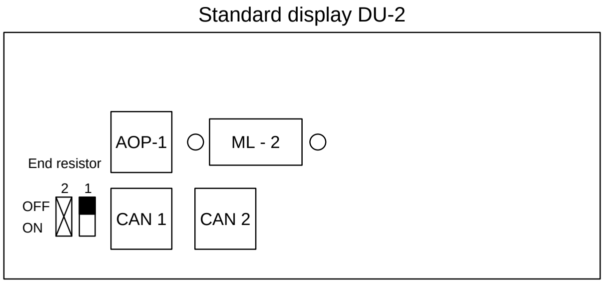
The option includes an additional standard display (DU-2) for the ML-2 unit to be connected to the original display unit via a CAN bus connection.

With additional DU-2 units, it is possible to operate the system from various positions, e.g. start/stop, alarm acknowledge, readings, access set points, etc.

A maximum of three standard displays can be connected to each ML-2 unit.

The maximum length of the CAN bus line is 300 m.

21.2.1 Rear side view

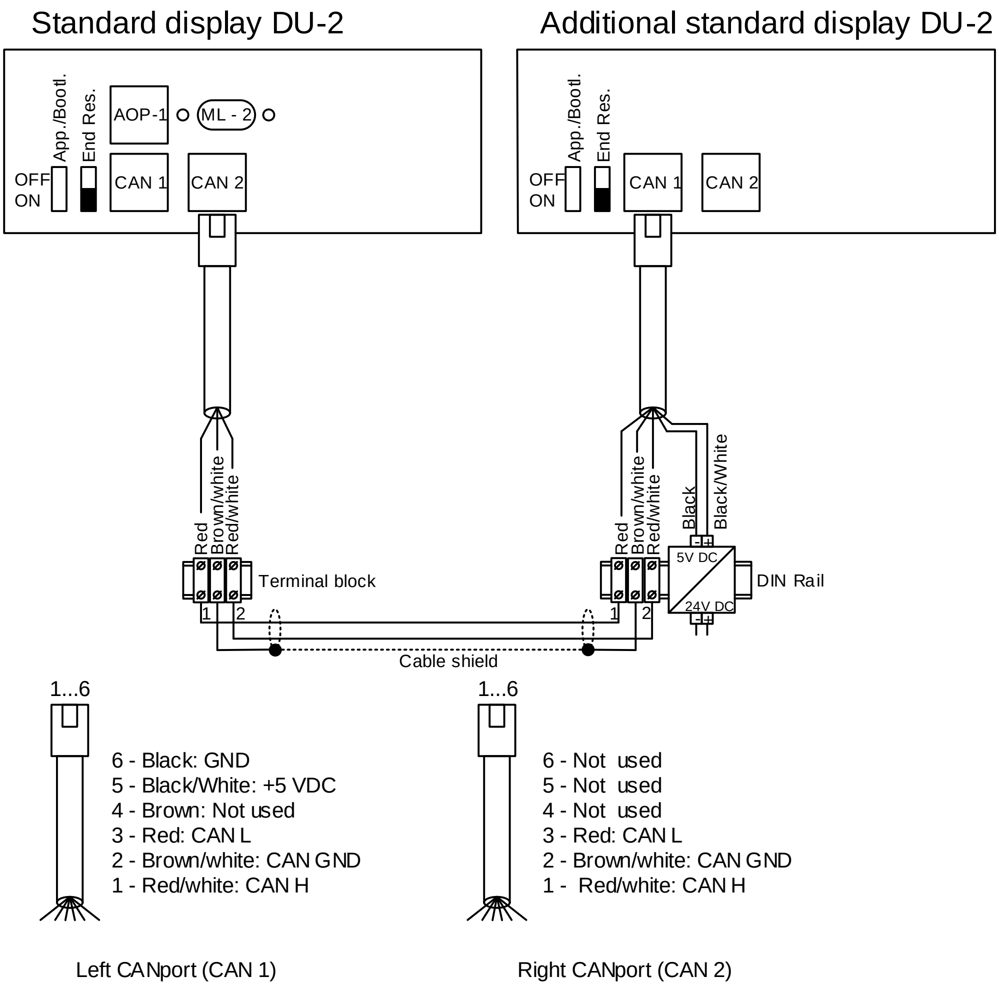


21.2.2 Connectors

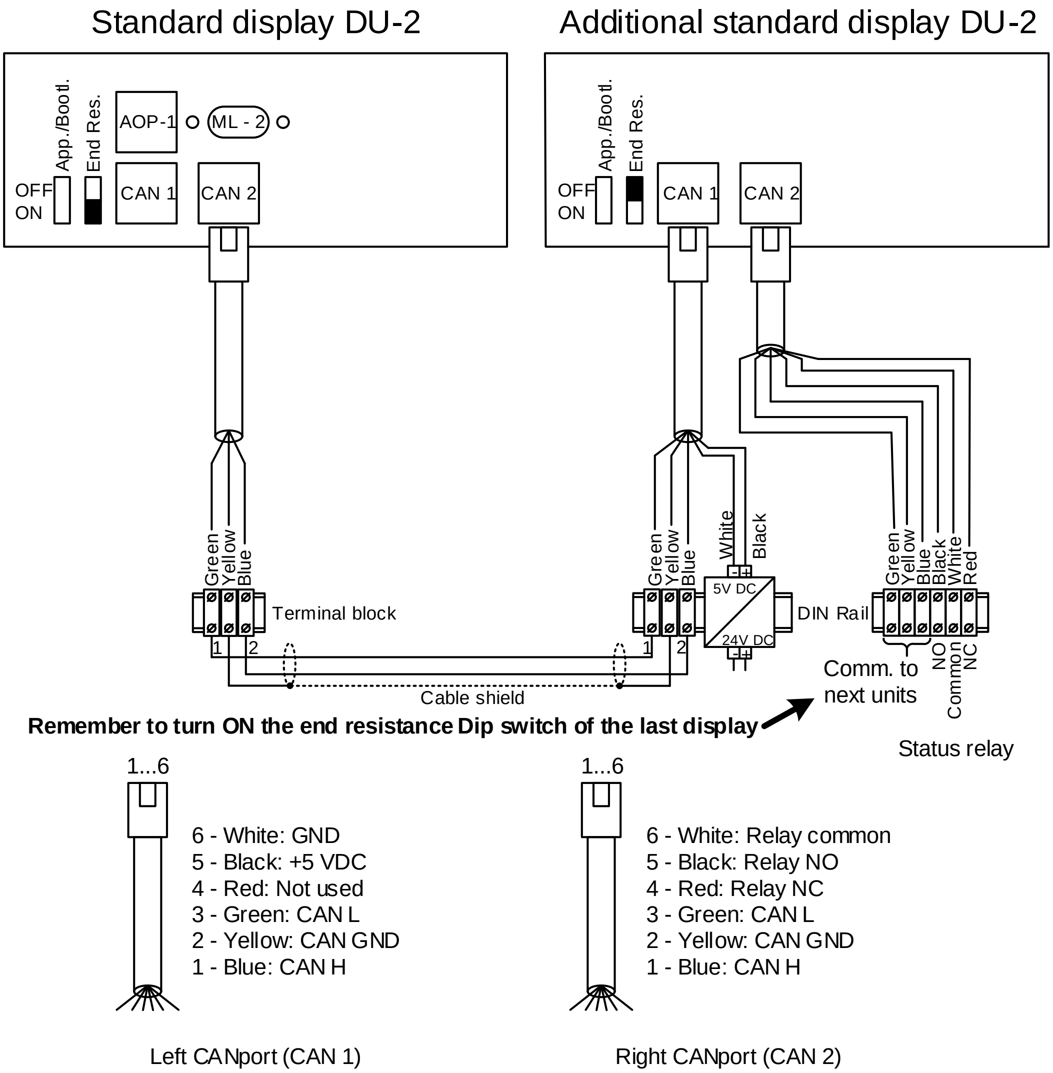
ML-2:	The serial connection to/from the display port of the ML-2 unit.
AOP-1:	The connector for the cable to an AOP-1.
CAN 1:	DC supply and CAN bus communication to/from other DU-2 or AOP-2 units.
CAN 2:	CAN bus communication to/from other DU-2 or AOP-2 units.
End resistor:	Dip switch for 120 Ω end resistor for the CAN bus communication. Dip switch no. 2 is not to be used.

21.2.3 Wiring - cable type 1

Be aware that two cables can be chosen, and that there is a difference in the colour codes of the wires. The diagrams below show how to wire both cable types.



21.2.4 Wiring - cable type 2



It is recommended to keep a fair distance to power cables.

The maximum length of the CAN bus line is 300 m.

A DC/DC converter for the DC supply voltage and 2 x 1 m cable with an RJ45 plug in one end and stripped wires in the other end are included in the DU-2 delivery.

21.2.5 End resistor

2 units connected:	Dip switch no. 1 has to be set to ON on both units.
3 units connected:	Dip switch no. 1 has to be set to ON on unit 1 and unit 3.
More than 3 units connected:	Dip switch no. 1 has to be set to ON on the first and the last unit on the CAN bus line.

21.2.6 CAN ID configuration

The CAN ID on the DU-2 can be set from 0 to 3. If it is set to zero, the CAN bus communication is deactivated.

The CAN ID selection is done in the following way:

1. On the DU-2, press the left , up and right buttons at the same time to activate a CAN ID selection menu.
2. Select the desired CAN ID with the up and down buttons and press ENTER.

The CAN ID of the DU-2 has now been selected.

The DU-2 which is connected to the ML-2 unit has to have CAN ID no. 1.

If the CAN bus communication to other DU-2 or AOP-2 units are not used, the CAN ID should be set to zero.

21.2.7 Protocol selection

The DU-2 contains three protocols for the data transmission between the ML-2 unit and the display. Normally, the protocol is set automatically, however if the display is used with older ML-2 units, it is necessary to choose the protocol which supports these according to the following table.

Protocol	Supports	Comment
1	Std. ML-2 with software version 1.xx.x and 2.xx.x	
2	AGC units with software version 1.xx.x and 2.xx.x PPM units with software version 2.xx.x	
3	AGC units with software version 3.xx.x and 4.xx.x GPC/GPU/PPU units with software version 3.xx.x PPM units with software version 3.xx.x	

Change of protocol is done like this:

1. On the DU-2, press the left , ENTER and right buttons at the same time to activate a protocol selection menu.

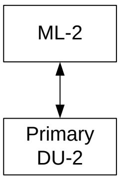
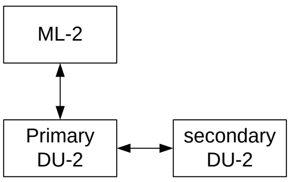
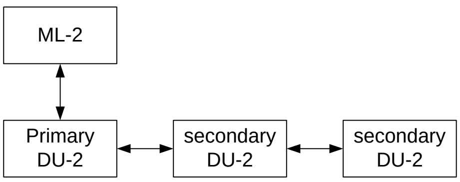
2. Select the desired protocol with the up and down buttons and press ENTER .

21.2.8 Access from primary and secondary DU-2

The below table describes what can be done from the displays. "Read" means that it is only possible to supervise e.g. parameter settings. "Write" means that it is possible to make changes in for example parameter settings.

The drawings in the table show examples of different set-ups. The selection of primary and secondary display is independent of wiring and CANbus IDs. In this way, any given DU-2 in a set-up can be primary or secondary display.

The table also describes the settings of the CAN bus IDs for the displays.

Set-up variants	**Functionality of the primary DU-2**	**Functionality of the secondary DU-2**	**CANbus ID of DU-2 connected to ML-2**	**CANbus ID of secondary DU-2**
	Read/write	-	0	-
	Read/write	Read	1	2
	Read/write	Read	1	2, 3

Pressing the "View" button for three seconds and entering the customer password on any secondary display will turn this DU-2 into the primary display and enable reading/writing from this display. There can only be one primary display in a set-up, so when turning a secondary display into primary, the former primary will automatically be switched to a secondary display.

21.2.9 Duplicate CAN ID

DU-2:
If two units on the CAN bus have the same CAN ID, the following will be displayed:

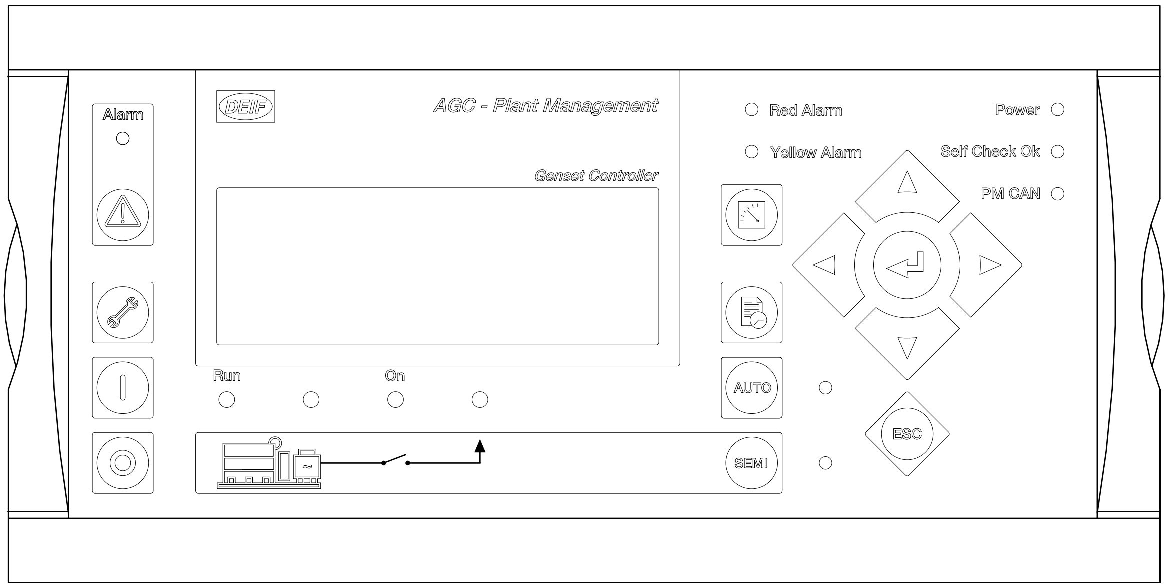
Warning: Two displays have same CAN ID, Press Enter.

When ENTER is pressed, the CAN ID change menu will be displayed and another CAN ID can be selected for the unit.

21.3 Option Y - display layouts

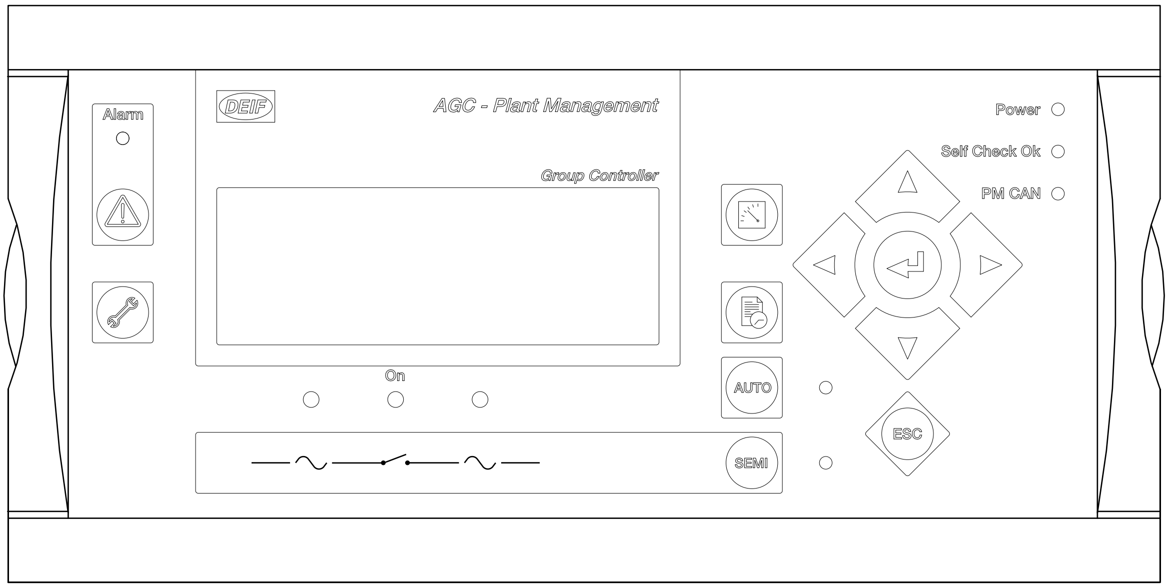
21.3.1 Option Y1 - genset controller

Option Y1 is the foil for a genset controller.



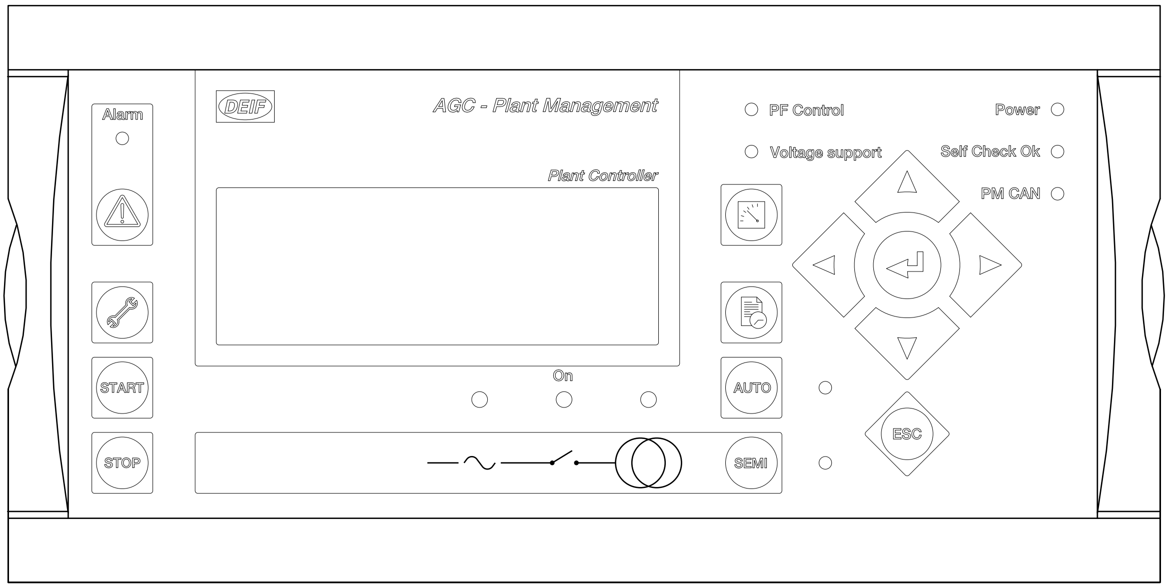
21.3.2 Option Y8

Option Y8 is the foil for a group controller.



21.3.3 Option Y9

Option Y9 is the foil for a plant controller.



21.4 Option X3 - additional operator panel (AOP-1)

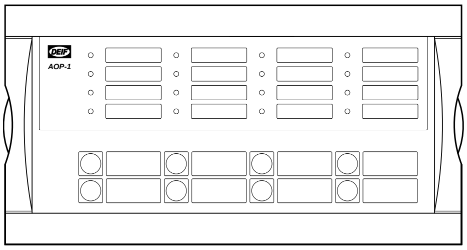
The option includes an additional operator's panel (AOP-1) which is to be connected directly to a standard display (DU-2) via a serial communication line, and only one AOP-1 can be connected to each DU-2. The AOP-1 has 16 configurable LEDs and eight configurable buttons, which are programmed with the PC utility software. It can be used as an interface to the ML-2 units for indication of status and alarms together with buttons for e.g. alarm acknowledge and mode selection.

Since a DU-2 is required for each AOP-1, the possible number of AOP-1 units is determined by the number of DU-2 units.

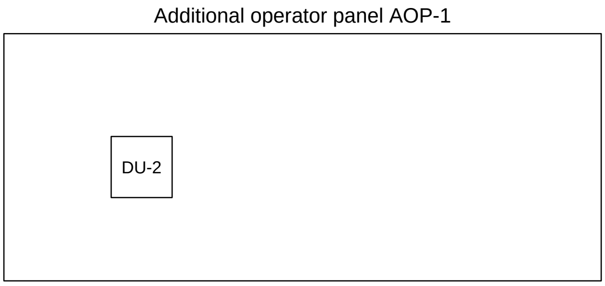
The maximum distance between the DU-2 and the AOP-1 is 0.5 m.

21.4.1 Option X3

Additional operator panel - AOP-1. Used for plant and/or genset control and status/alarm indication.



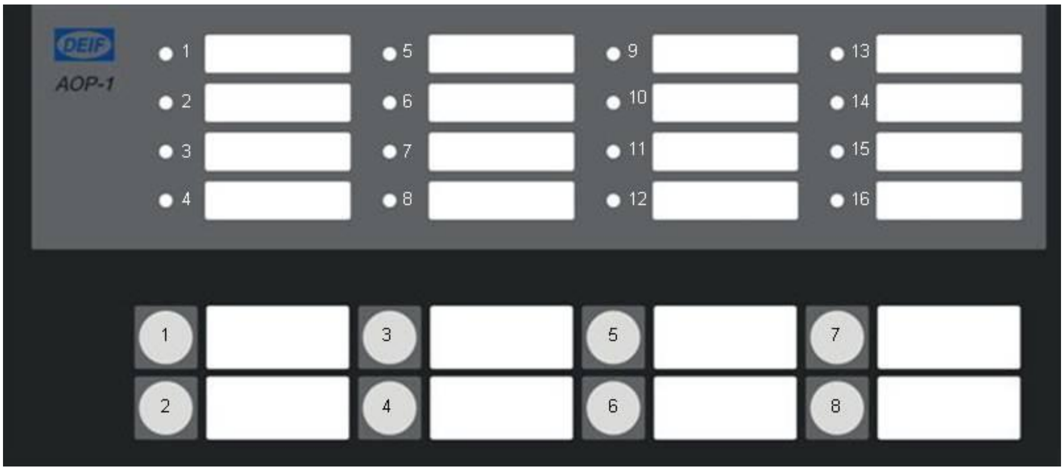
21.4.2 Rear side view



21.4.3 Connectors

DU-2: DC power supply and serial communication to/from the DU-2.

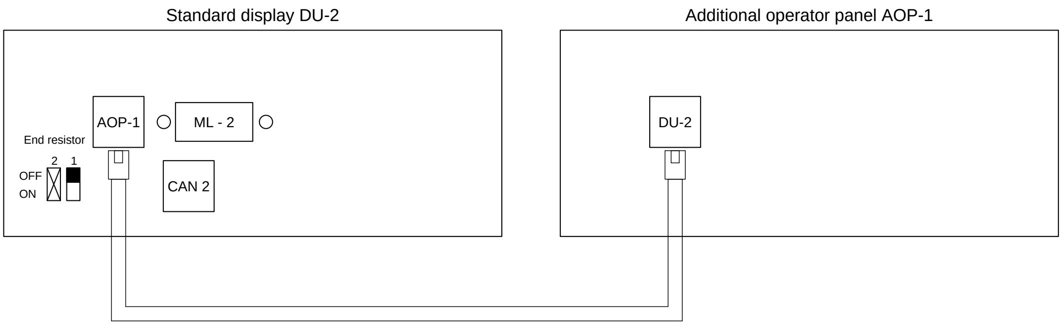
21.4.4 Front side view



As shown on the drawing, the configurable LEDs are named 1 to 16, and the buttons are named 1 to 8.

21.4.5 Wiring

The AOP-1 is connected to the connection on the DU-2 named AOP-1 by means of the enclosed cable. This connection handles the communication and power supply.



The maximum distance between the DU-2 and the AOP-1 is 0.5 m.

The cable for connection between the AOP-1 and DU-2 is included in the AOP-1 delivery.

21.4.6 CAN ID configuration

The ID of the AOP-1 is decided by the DU-2 unit to which it is connected.

21.4.7 Programming

The programming of the AOP-1 is made with the PC utility software, which can be downloaded from www.deif.com. Please refer to the help function in the PC utility software for programming instructions.

21.5 Option X4 - additional operator panel (AOP-2)

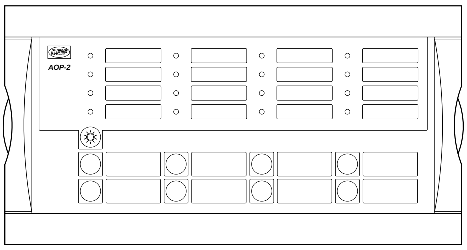
This option includes an additional operator panel (AOP-2) which can be connected to the standard display via a CAN bus communication line. The AOP-2 has 16 configurable LEDs and eight configurable buttons, which are programmed with the PC utility software. It can be used as an interface to the ML-2 units for indication of status and alarms together with buttons for for example alarm acknowledge and mode selection.

A maximum of five AOP-2 units can be connected to each ML-2 unit.

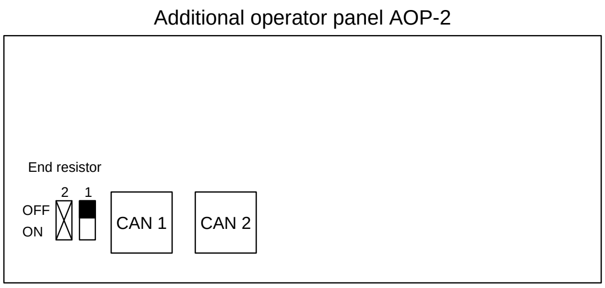
The maximum length of the CAN bus line is 300 m.

21.5.1 Option X4

Additional operator panel - AOP-2. Used for plant and/or genset control and status/alarm indication (maximum 5 per AGC).



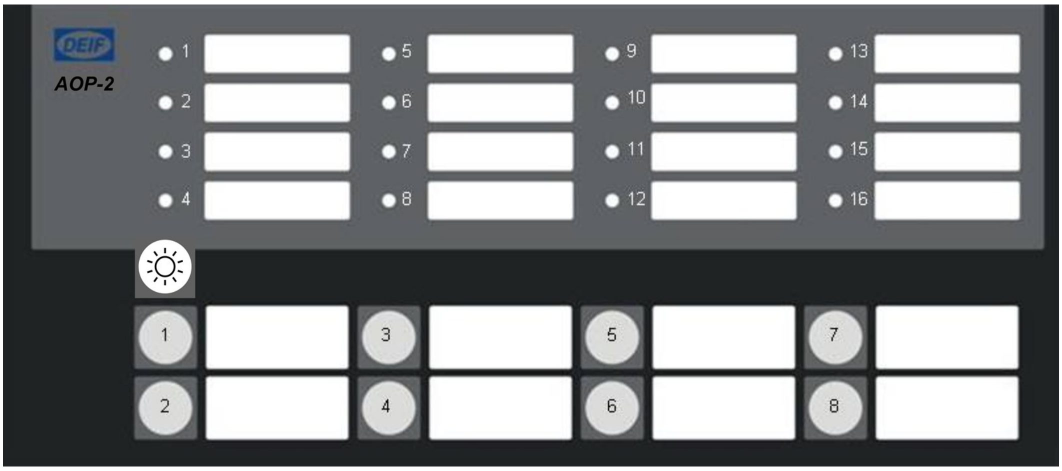
21.5.2 Rear side view



21.5.3 Connectors

CAN 1:	DC supply and CAN bus communication to/from other DU-2 or AOP-2 units.
CAN 2:	CAN bus communication to/from other DU-2 or AOP-2 units and status relay output.
End resistor:	Dip switch for 120 Ω end resistor for the CAN bus communication. Dip switch no. 2 is not to be used.

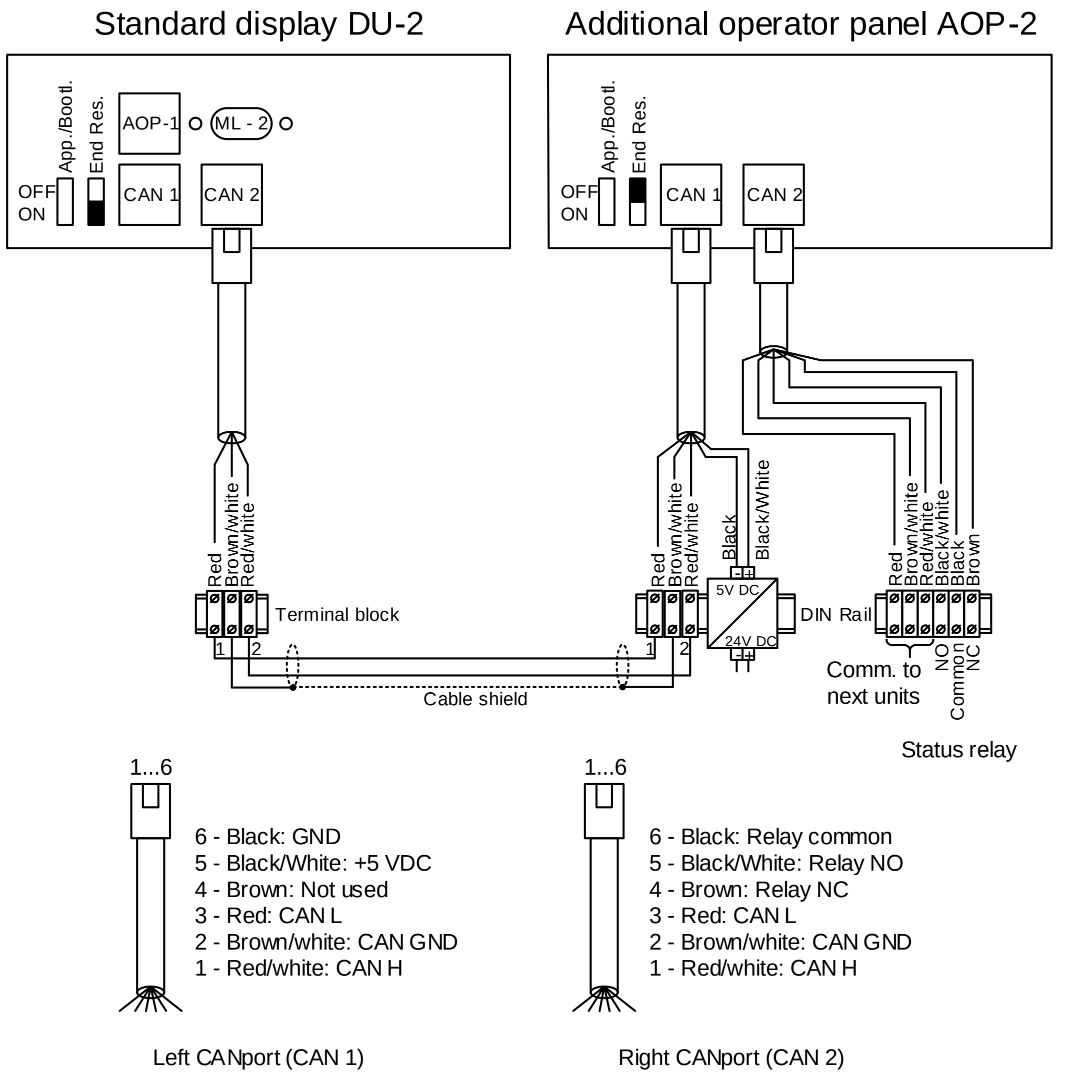
21.5.4 Front side view



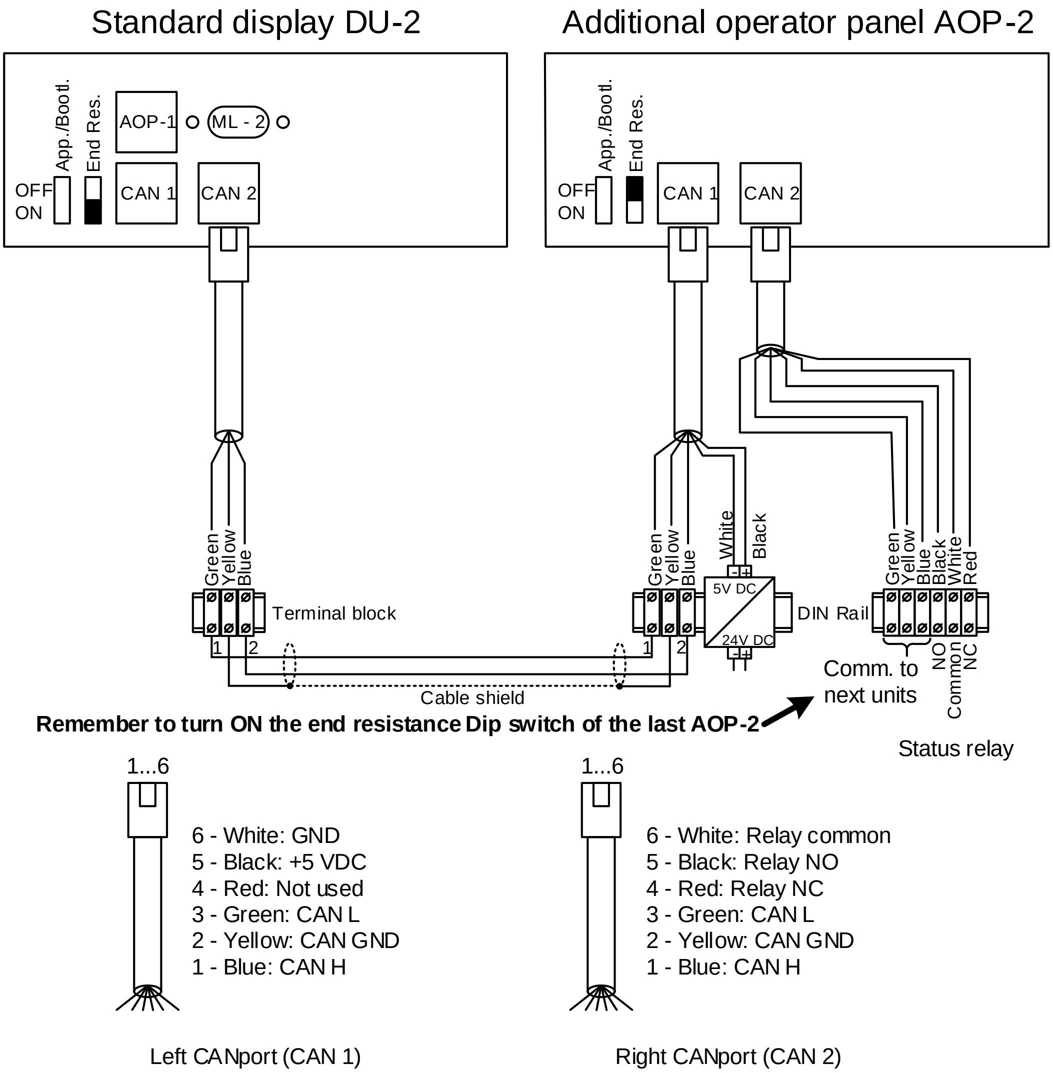
As shown on the drawing, the configurable LEDs are named 1 to 16, and the buttons are named 1 to 8.

21.5.5 Wiring - cable type 1

Be aware that two cables can be chosen, and that there is a difference in the colour codes of the wires. The diagrams below show how to wire both cable types.



21.5.6 Wiring - cable type 2



A DC/DC converter for the DC supply voltage and 2 x 1 m cable with an RJ12 plug in one end and stripped wires in the other end is included in the AOP-2 delivery.

The cable between the terminal blocks should be shielded twisted pair.

The maximum length of the CAN bus line is 200 m.

21.5.7 End resistor

2 units connected:	Dip switch no. 1 on both units should be set to ON.
3 units connected:	Dip switch no. 1 on unit 1 and unit 3 should be set to ON.
More than 3 units connected:	Dip switch no. 1 on the first and the last unit on the CAN bus line should be set to ON.

21.5.8 CAN ID configuration

The CAN ID for the AOP-2 can be changed by the following procedure:

1. Push-button no. 7 and no. 8 at the same time to activate the CAN ID change menu. This will activate the LED for the present CAN ID number, and LED no. 16 will be flashing.
2. Use button no. 7 (increase) and button no. 8 (decrease) to change the CAN ID according to the table below.
3. Press button no. 6 to save the CAN ID and return to normal operation.

Selection of CAN ID:

CAN ID	Indication of CAN ID selection
0	CAN bus OFF: LED 16 flashes
1	LED 1 light steady + LED 16 flashes (default value)
2	LED 2 light steady + LED 16 flashes
3	LED 3 light steady + LED 16 flashes
4	LED 4 light steady + LED 16 flashes
5	LED 5 light steady + LED 16 flashes

21.5.9 Status relay

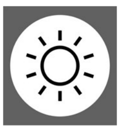
The status relay will activate approximately five seconds after power up.

21.5.10 Programming

The programming of the AOP-2 is made with the PC utility software, which can be downloaded from www.deif.com. Please refer to the help function in the PC utility software for instructions regarding the programming.

21.5.11 Lamp test/dimmer

The AOP-2 has a separate push-button for the combined lamp test and dimmer functionality.



A short activation of the push-button will activate the lamp test function. If no further action is done within three seconds, the AOP-2 will turn back to normal indication.

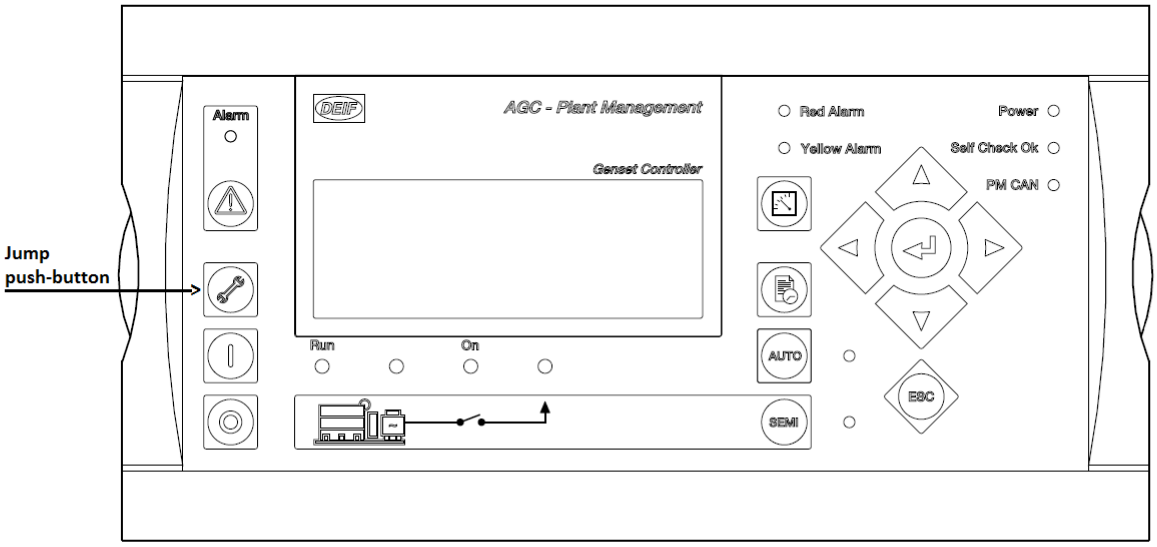
To activate the dimmer function, the push-button has to be pressed more times or continuously to reach the desired light intensity.

22. Jump/menu 9000

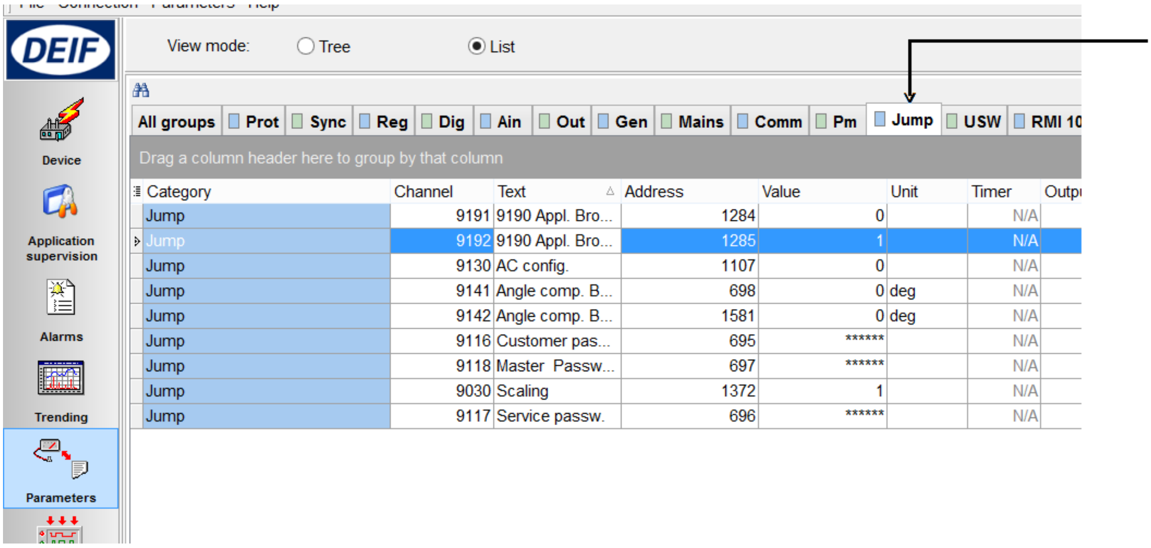
22.1 Jump menu

22.1.1 Jump menu 9000-9230

The AGC PM supports the user with a "Jump" push-button on the display  , which enables the user to select and display any setting without having to navigate through the menus.
The picture below shows where to find this "Jump" push-button on the AGC PM display.



You can enter some of the menus by pressing the "Jump" push-button  on the AGC PM display. This can also be found under the menu "Jump" in the DEIF utility software.

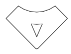


By pressing the jump push-button  on the AGC PM display, you can enter the following menus:

Parameter	Item	Visible on AGC PM display	Visible in DEIF utility software	Possible selections	Default	Description
9000	Software version APPL	X	-	-	-	This menu shows the software version of the AGC PM unit. For example "AGC PM V 9.91.0". It also shows the date and clock in the AGC PM unit. For example "Nov 19 2015 13:29:23".
9001	Software version REV	X	-	-	-	This sub menu shows the revision of the software in the AGC PM unit. For example "Revision 25048".
9002	Software version W1	X	-	-	-	This sub menu shows the IP address and the subnet mask in the AGC PM unit. Requires "Option N". For example "IP:192.168.10.159, SM:255.255.255.0".
9003	Software version W1	X	-	-	-	This sub menu shows the gateway and the image version of the Option N in the AGC PM unit. Requires "Option N". For example "GW:192.168.10.182, Image Ver. 2.40.1".

Parameter	Item	Visible on AGC PM display	Visible in DEIF utility software	Possible selections	Default	Description
9010	Display character test	X	-	-	-	Shows a test print of the character set in the display. For example "Disp. character test, Euro é ò û ù Ü á".
9020	Service port	X	-	1 0	0	In this menu, the Modbus protocol type can be changed from RTU to ASCII. When set to 1, the ASCII protocol type is used, and the unit will allow for the slower modem communication. Selection "0" must be used for cable connection between the AGC PM and the PC. Selection "1" must be used for modem connection between the AGC PM and the PC.
9030	Scaling	X	X	10 V-2500 V 100 V-25000 V 1 kV-75 kV 10 kV-160 kV	100 V-25000 V	Using this menu you can select the voltage range of operation for the AGC PM.
9070	M4,SW	X	-	-	-	This menu informs about the M4 software version. For example "M4 SW version 2.03.0".
9071	M4,PROT	X	-	-	-	Shows the M4 protocol version. For example "M4 prot.ver.1.01.0".
9072	M4,REV	X	-	-	-	Shows the M4 software revision. For example "M4 SW revision 11292".
9073	M4,PROT	X	-	-	-	For example "M4 SW revision 2.03.0".
9100	Device type APPL	X	-	Genset unit Plant unit Genset Grp. Tie unit Mains unit	Genset unit	Using this menu, you can change the device type of the AGC PM unit.
9116	Customer passw.	X	X	0...32000	2000	Using this menu you can change the customer password.

Parameter	Item	Visible on AGC PM display	Visible in DEIF utility software	Possible selections	Default	Description
9117	Service passw.	X	X	0...32000	2001	Using this menu you can change the service password.
9118	Master Password	X	X	0...32000	2002	Using this menu you can change the master password.
The default passwords must be changed if the operator of the genset is not allowed to change the parameters. **It is not possible to change the password at a higher level than the password entered.**						
9120	Service menu	X	-	-	-	The Service menu is used to show information (explained below 9121, 9123-9125) about the present operating condition of the genset. It can be used for easy trouble-shooting in connection with the event log.
9121	Service menu TIME	X	-	-	-	Timers. Show the values of differential timers.
9123	Service menu IN	X	-	-	-	Digital inputs. Show the status of the digital inputs of the unit.
9124	Service menu OUT	X	-	-	-	Digital outputs. Show the status of the digital outputs of the unit.
9125	Service menu MISC	X	-	-	-	Miscellaneous. Shows the status of the different lines in M-Logic.
9130	AC config.	X	X	3 phase L1L2L3 2 phase L1L3 2 phase L1L2 1 phase L1	3 phase L1L2L3	The AC configuration menu is used to select the AC configuration.
9140	Angle comp.B B/G	X	-	-	-	9141 and 9142 are used to compensate the transformer phase angle when the generator and busbar measurements are made on each side of a transformer.

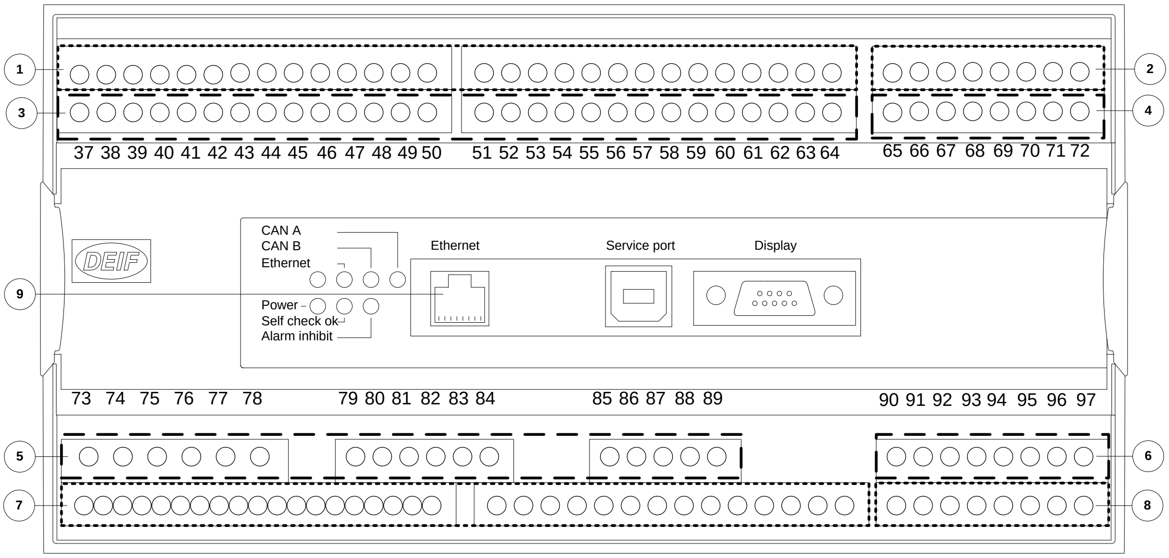
Parameter	Item	Visible on AGC PM display	Visible in DEIF utility software	Possible selections	Default	Description
9141	Selection of Set point for BB/G1	X	X	-179.0 deg.. +179.0 deg	0.0 deg	Selection of set point for BB/G1.
9142	Angle comp.BB/G2		X	-179.0 deg.. +179.0 deg	0.0 deg	Selection of set point for BB/G2.
9150	Backlight dim, DIM	X	-	-	-	Backlight dimmer. Using  and , you can change the light intensity for the display.
9160	Application drawing	X	-	A1 A2 A3 A4	A1	This menu is used to switch between different applications (A1-A4). In the bottom right corner, it is shown which application is active. When placed on active application, it will say ACT in the bottom right corner of the display, otherwise IN-ACT if not placed on active application.
9190	Application broadcast	X	X 9191, 9192	For Enable: OFF, Broadcast, Broadcast + activate For Application: Application 1 Application 2 Application 3 Application 4	For Enable: OFF For Application: Application 1	This menu makes it possible to broadcast an application between all AGC units connected on the CAN A or CAN B line.
9230	Memory backup	X	-	-	-	This menu makes it possible to back-up the memory before changing the internal battery.
9231	BACK-UP	X	-	-	-	This function stores the memory. For example: Backup memory as: 2010-01-12 03:50:11.
9232	RE-STORE	X	-	-	-	This function restores the memory. For example: Restore memory from: Auto stored image.

23. Option overview

23.1 Hardware options

23.1.1 Hardware options

The following picture shows the slot positions.



In the table below, you can see all possible hardware options and the explanations.

Notice that it can only be one hardware option in each slot.
For example, it is not possible to select option H2 and option M13.2 at the same time, because both options require a PCB in slot #2.

Slot #	Option	Description
1		**Terminal 1-28**
	Standard	Power supply, +12/24 VDC 1 × status output relay 5 × Relay outputs (2 x fixed for breaker handling) 2 × configurable relay outputs for pulse outputs (kWh and kvarh) 5 × Digital inputs (2 x fixed for breaker feedback)
2		**Terminal 29-36***(No standard hardware)*
	H2	Serial Modbus RTU (RS-485) communication
	H5.2	CAN bus J1939 engine communication and MTU (ADEC/MDEC) on CAN port C *(Not compatible with H5.8 option)*
	H12.2	Dual CAN bus communication (includes option H5 and H8): CAN bus based engine interface communication (AGC PM genset) Power management communication in 3 level applications (AGC PM group)
	M13.2	7 × configurable digital inputs
	M14.2	4 × configurable relay outputs
3		**Terminal 42-64**
	M12 (standard)	13 × configurable digital inputs 4 × configurable relay outputs 1 × output, reserved for active (P) power load sharing, not used for plant and group unit 1 × output, reserved for reactive (Q) power load sharing, not used for plant and group unit Option G3 is included, see software options
4		**Terminal 65-72***(No standard hardware)*
	E1	2 × +/-25 mA analogue outputs for GOV, AVR or transducer
	E2	2 × 0(4) to 20 mA analogue outputs for GOV, AVR or transducer
	EF2	Analogue outputs for GOV, AVR or transducer: 1 × +/-25 mA 1 × 0(4) to 20 mA
	EF4	1 × +/-25 mA analogue output for GOV, AVR or transducer 2 × relay outputs for GOV/AVR or configurable
	EF6	2 × +/-25 mA analogue outputs for GOV, AVR or transducer 1 × PWM (Pulse Width Modulated) output for GOV
	M13.4	7 × configurable digital inputs
	M14.4	4 × configurable relay outputs
5		**Terminal 73-89**
	AC measurement (standard)	AGC PM genset: 3 × generator current, 3 × generator voltage, 3 × generator busbar voltage AGC PM plant: 3 × plant current, 3 × mains voltage, 3 × group busbar voltage AGC PM group: 3 × group current, 3 × group busbar voltage, 3 × generator busbar voltage

Slot #	Option	Description
6		**Terminal 90-97***(No standard hardware)*
	F1	2 × 0(4) to 20 mA analogue outputs for transducers. This option can not be used for GOV/AVR outputs.
	M13.6	7 × configurable digital inputs
	M14.6	4 × configurable relay outputs
	M15.6	4 × configurable 4 to 20 mA analogue inputs
	M16.6	4 × configurable analogue multi inputs for: 4 to 20 mA 0 to 5 V Pt100
7		**Terminal 98-125**
	M4, Engine interface (standard)	1 × power supply with 8 to 36 VDC 1 × magnetic pick-up with wire break with 0.5-70 V AC/10-10,000 Hz 3 × configurable analogue multi inputs for: 0(4)-20 mA 0-40 VDC Pt100/Pt1000 VDO 0-40 VDC 6 × configurable digital inputs 1 × reserved digital input for emergency stop 4 × configurable relay outputs (not used in AGC PM plant and group): Reserved in AGC PM genset for Run coil, Start prepare, Crank and Stop coil w/ wire failure detection 2 × CAN bus interfaces with CAN port A and CAN port B for power management communication Requires option G7 when the AGC PM is used as genset or plant unit Requires option G7 and (H5_x or H12_x) when the AGC PM is used as group unit Follows with option H8.7
	H8.7 (standard)	Extern I/O CANbus communication Following with option M4, see above
8		**Terminal 126-133***(No standard hardware)*
	M13.8	7 × configurable digital inputs
	M14.8	4 × configurable relay outputs
	M15.8	4 × 4 to 20 mA inputs
	M16.8	4 × configurable analogue multi inputs for: 4 to 20 mA 0 to 5 V Pt100
	H5.8	CAN bus engine interface communication Not compatible with option H5.2
	H12.8	Dual CAN bus communication (includes option H5 and H8): CAN bus based engine interface communication (AGC PM genset) Power management communication in 3 level applications (AGC PM group)

Slot #	Option	Description
9		**LED I/F**
	H10 (standard)	1 × display port (9-pole SUB-D) 1 × service port (USB B type) 1 × USB port (USB A type, currently not used) All ports must be configured with the DEIF Multi-line 2 Utility Software.
	N (standard)	1 × Ethernet TCP/IP

23.2 Software options

23.2.1 Software options

In the table below, you can see all possible software options and the explanations.

Option	Description
A	
A1	**Mains protection package** Time-dependent under-voltage Under-voltage and reactive power low Average BB over-voltage Vector jump df/dt (ROCOF)
A4	**Loss of mains protection package** Positive sequence voltage
A5	**Directional overcurrent protection**
C2	**Generator add-on protection package** Negative sequence voltage high Negative sequence current high Zero sequence voltage high Zero sequence current high Power dependent reactive power Inverse time over-current
D1 (standard)	**Voltage/VAr/cos phi control** Voltage synchronisation matching Constant voltage control for stand-alone generator Constant reactive power control for paralleling generator Constant cos phi control for paralleling generator Reactive power load sharing for paralleling with other generators
G	**Load sharing, power management**
G3 (standard)	Load sharing with analogue lines, follows with option M12 1 × -5/+5V DC analogue I/O for active load sharing 1 × -5/+5V DC analogue I/O for reactive load sharing 1 × -10/+10 VDC analogue I/O for f/P Set point 1 × -10/+10 VDC analogue I/O for U/Q Set point
G5 (standard)	Power management, 2 level applications (support of application type: standard) Requires option G7
G7 (standard)	Plant management, 3 level applications (support of application type: genset group and genset group plant) Requires option G5
H13	**Serial communication** Engine interface communication, J1939 Requires H5.x or H12.x Not compatible with T2
I1 (standard)	**Application emulation** Emulation, PC-controlled emulation of your application
T2	**Digital AVR communication** Requires (H5.x or H12.x) and option D1 Not compatible with H13