AGC 150

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1. Introduction

1.1 About the Designer's handbook

1.1.1 General purpose

This is the Designer's Handbook for DEIF's Advanced Genset Controller, AGC 150. The general purpose of this document is to provide useful information about the controller's functionality and its applications, and for configuring the controller.

DANGER!
Read this manual before working with the controller. Failure to do this could result in human injury or damage to the equipment.

1.1.2 Intended users of the Designer's handbook

This Designer's handbook is primarily intended for the panel designer in charge. Based on this document, the panel designer can give the electrician the necessary information to install the controller, for example detailed electrical drawings.

The Designer's handbook can also be used during commissioning to check the parameters, and operators may find it useful for understanding the system and for troubleshooting.

1.1.3 List of technical documentation for AGC 150

Document	Contents
Product sheet	• Short description • Controller applications • Main features and functions • Technical data • Protections • Dimensions
Data sheet	• General description • Functions and features • Controller applications • Controller types and variants • Protections • Inputs and outputs • Technical specifications
Designer's handbook	• Principles • General controller sequences, functions and protections • GENSET controller • Mains controller • BTB controller • Hybrid controller • Protections and alarms • AC configuration and nominal settings • Breaker and synchronisation • Regulation • Load sharing • Hardware characteristics • Modbus

Document	Contents
Installation instructions	• Tools and materials • Mounting • Minimum wiring for the controller • Wiring communication
Operator's manual	• Controller equipment (buttons and LEDs) • Operating the system • Alarms • Log
Modbus tables	• Modbus address list ◦ PLC addresses ◦ Corresponding controller functions • Descriptions for function codes, function groups

1.2 Warnings and safety

1.2.1 Safety during installation and operation

Installing and operating the controller may require work with dangerous currents and voltages. The installation must only be carried out by authorised personnel who understand the risks involved in working with electrical equipment.

DANGER!
Hazardous live currents and voltages. Do not touch any terminals, especially the AC measurement inputs and the relay terminals. Touching the terminals could lead to injury or death.

1.2.2 Factory settings

The controller is delivered pre-programmed from the factory with a set of default settings. These settings are based on typical values and may not be correct for your system. You must therefore check all parameters before using the controller.

1.2.3 Electrostatic discharge

Electrostatic discharge can damage the controller terminals. You must protect the terminals from electrostatic discharge during the installation. When the controller is installed and connected, these precautions are no longer necessary.

1.2.4 Data security

To minimise the risk of data security breaches DEIF recommends to:

- As far as possible, avoid exposing controllers and controller networks to public networks and the Internet.
- Use additional security layers like a VPN for remote access, and install firewall mechanisms.
- Restrict access to authorised persons.

1.3 Legal information

1.3.1 Third party equipment

DEIF takes no responsibility for the installation or operation of any third party equipment, including the **genset**. Contact the **genset company** if you have any doubt about how to install or operate the genset.

1.3.2 Warranty

CAUTION
The AGC 150 controller is not to be opened by unauthorised personnel. If opened anyway, the warranty will be lost.

1.3.3 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.

1.3.4 Copyright

2. General product information

2.1 About AGC 150

2.1.1 General description

AGC 150 is a controller containing all necessary functions for protection and control of a genset, a mains breaker, and a bus tie breaker. It can be used as a single controller for one genset, or a number of controllers can be connected in a complete power management system for synchronising projects, island applications or running parallel to mains.

AGC 150 is an economical solution for genset builders, who need a flexible generator protection and controller for small to large genset applications.

AGC 150 contains all necessary 3-phase measuring circuits, and all values and alarms are presented on the sunlight readable LCD display screen.

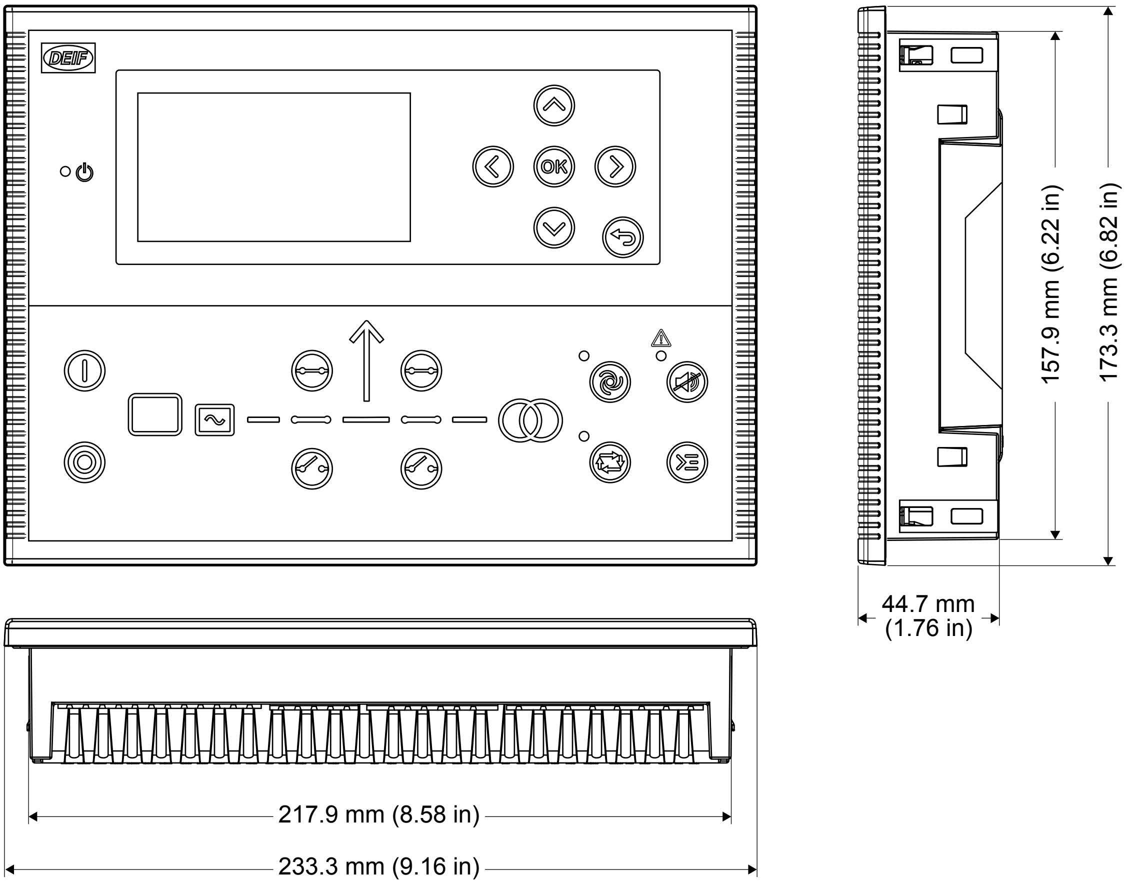
2.1.2 Controller types

The AGC 150 controller comes in four different types.

Select the controller type under **Settings >Basic settings > Controller settings > Type**.

Parameter no.	Controller type	Device type
9101	Genset controller	DG unit
	Mains controller	Mains unit
	BTB controller	BTB unit
	Hybrid controller	DG Hybrid unit

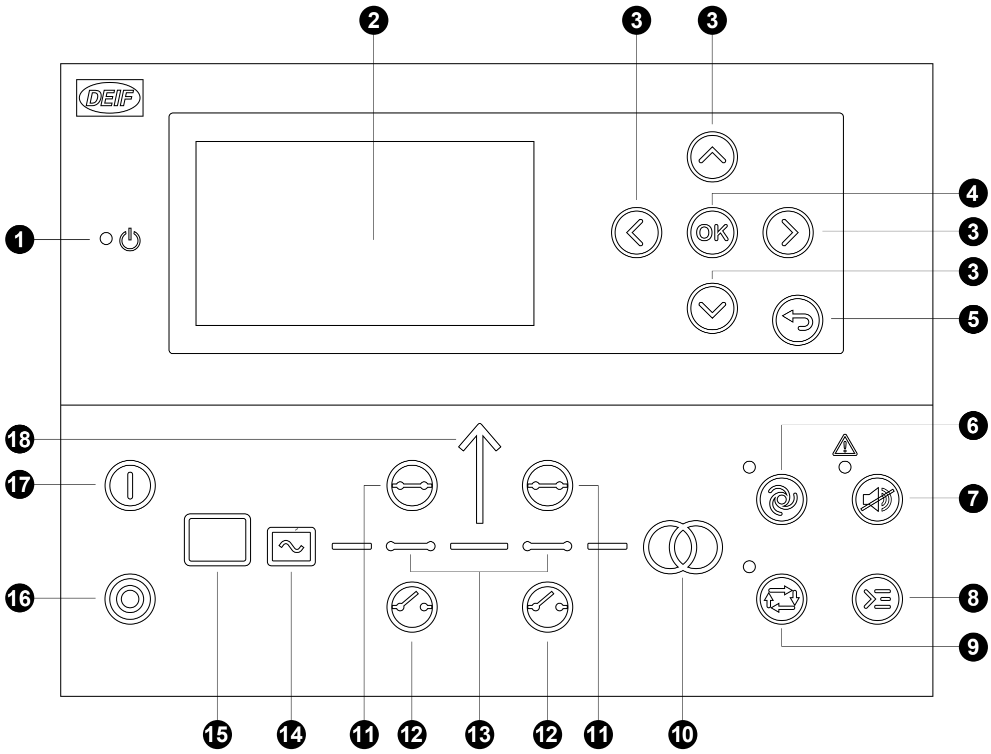
2.1.3 Dimensions and weight



Dimensions and weight	
Dimensions	Length: 233.3 mm (9.16 in) Height: 173.3 mm (6.82 in) Depth: 44.7 mm (1.76 in)
Panel cutout	Length: 218.5 mm (8.60 in) Height: 158.5 mm (6.24 in) Tolerance: ± 0.3 mm (0.01 in)
Max. panel thickness	4.5 mm (0.18 in)
Mounting	UL/cUL Listed: Type complete device, open type 1 UL/cUL Listed: For use on a flat surface of a type 1 enclosure
Weight	0.79 kg

2.2 Controller overview

2.2.1 Front overview



No.	Name	Function
1	Power ON	Green: The controller power is ON. OFF: The controller power is OFF.
2	Display screen	Resolution: 240 x 128 px. Viewing area: 88.50 x 51.40 mm. Six lines, each with 25 characters.
3	Navigation	Move the selector up, down, left and right on the screen.
4	OK	Enter the Menu system. Confirm the selection on the screen.
5	Back	Go to the previous page.
6	AUTO mode	The controller automatically starts and stops gensets according to the system settings. No operator actions are needed.
7	Silence horn	Turns off an alarm horn (if configured) and enters the Alarm menu.
8	Shortcut menu	Gives access to: Jump menu, Mode selection, Test, Lamp test, Hybrid (PV semi start and stop).
9	SEMI-AUTO mode	The controller cannot automatically start, stop, connect or disconnect the genset. The operator can start, stop, connect or disconnect the genset. The controller automatically synchronises before closing a breaker, and automatically de-loads before opening a breaker.
10	Mains symbol	Green: Mains voltage and frequency are OK. The controller can synchronise and close the breaker. Red: Mains failure.
11	Close breaker	Press to close the breaker.
12	Open breaker	Press to open the breaker.
13	Breaker symbols	Green: Breaker is ON. Green flashing: Synchronising or de-loading. Red: Breaker failure.

No.	Name	Function
14	Generator	Green: Generator voltage and frequency are OK. The controller can synchronise and close the breaker. Green flashing: The generator voltage and frequency are OK, but the V&Hz OK timer is still running. The controller cannot close the breaker. Red: The generator voltage is too low to measure.
15	Engine	Green: There is running feedback. Green flashing: The engine is getting ready. Red: The engine is not running, or there is no running feedback.
16	Stop	Stops the genset if SEMI-AUTO or Manual is selected.
17	Start	Starts the genset if SEMI-AUTO or Manual is selected.
18	Load symbol	OFF: Power management application. Green: The supply voltage and frequency are OK. Red: Supply voltage/frequency failure.

2.2.2 Display settings

It is possible to adjust the settings for the display to compensate for ambient lighting. Configure these settings under **Settings > Basic settings > Controller settings > Display > Display control**.

Parameter no.	Text	Range	Default
9151	Backlight dimmer	0 to 15	12
9152	Green LEDs dimmer	1 to 15	15
9153	Red LEDs dimmer	1 to 15	15
9154	Contrast level	-20 to +20	0
9155	Sleep mode timer	1 to 1800 s	60 s
9156	Enable (Sleep mode timer)	OFF ON	ON
9157	Alarm Jump	OFF ON	ON
9158	Engineering units	Bar/Celcius PSI/Fahrenheit	Bar/Celcius

2.2.3 Running mode overview

The AGC 150 has four different running modes and one block mode. The modes are selected with buttons in the lower right corner of the controller front.

Mode	Description
AUTO	In AUTO mode, the controller will operate automatically and the operator cannot initiate any sequences manually.
SEMI-AUTO	In SEMI-AUTO mode, the operator must initiate all sequences. This can be done via the button functions, Modbus commands or digital inputs. When started in SEMI-AUTO 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* buttons. When starting in Manual mode, the genset will start without any subsequent regulation.
OFF	When the OFF mode is selected, the controller is not able to initiate any sequences. OFF mode **must** be selected, when maintenance work is carried out on the genset.

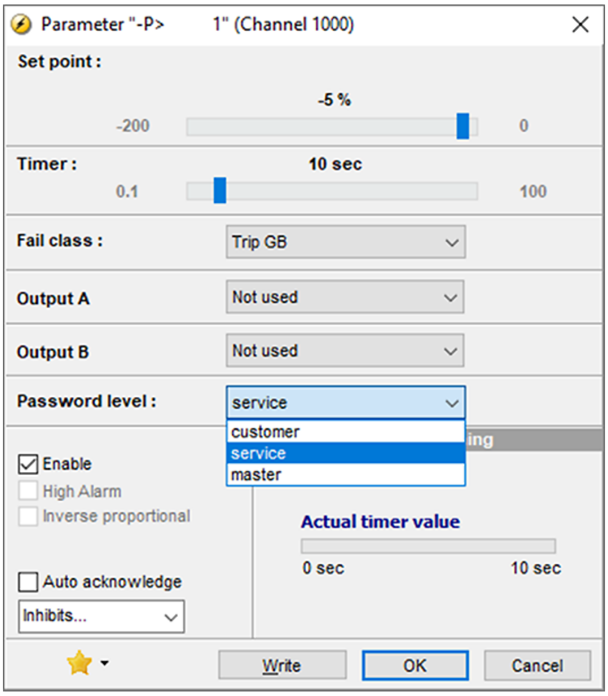
2.2.4 Password

The controller has three password levels that can be configured on the controller or from the Utility Software. Parameter settings cannot be entered with a lower ranking password, but are shown on the display.

Table 2.1 Password levels

Password level	Default password	Customer access	Service access	Master access
Customer	2000	x		
Service	2001	x	x	
Master	2002	x	x	x

With the Utility Software it is possible to protect each parameter with a specific password level. Enter the parameter and select the correct password level.



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

1. Right-click the appropriate field in the Level column.
2. Select *Change access level*.
3. Select the required access level
   - *Customer*
   - *Service*
   - *Master*

2.2.5 Parameter access

To adjust the parameters, the password level must be entered. If the operator is not allowed to change the parameters, the default password must be changed. It is not possible to change the password at a higher level than the password entered.

Configure the password under **Service View > Password**.

Parameter	Text	Range	Default
9111	Customer password	0 to 32000	2000
9112	Service password	0 to 32000	2001
9113	Master password	0 to 32000	2002

2.3 Menu structure

2.3.1 Menu structure

The AGC 150 has two menu systems, which can be used without password entry:

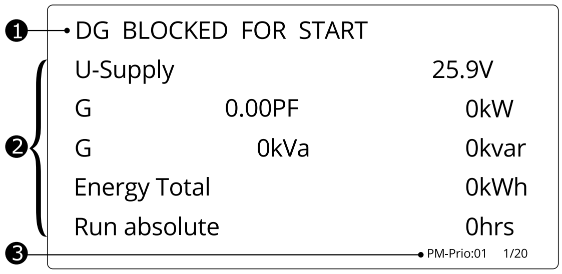
- **The View menu system**: The commonly used menu system, with 20 configurable windows that can be entered with the arrow buttons.
- **The Settings menu system**: The menu system for setting up the controller, and to see detailed information that is not available in the view menu system.

Changes to the parameter settings are password protected.

2.3.2 The View menu

When AGC 150 is powered up, the View menu appears. It is the daily use menu for the operator, which shows various measured values. If an alarm is present, the event and alarm list is shown at power-up.

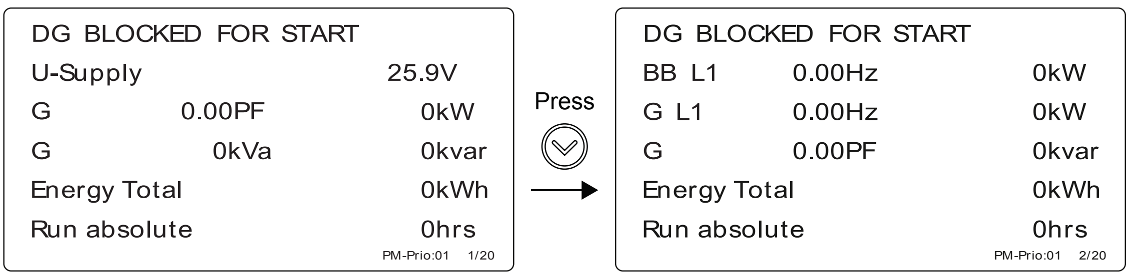
Figure 2.1 The View menu



1. Status line.
2. Operational status or measurements.
3. View Page number, Power Management priority (if available) or Engine DEF level (if available).

The View menu contains up to 20 different pages. Navigate through the pages with the *Up* and *Down* buttons.

Figure 2.2 Example: Navigating the View menu



2.3.3 Status line 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 is 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		
ISLAND AUTO	Genset stopped in AUTO.	
READY ISLAND AUTO		
ISLAND ACTIVE	Genset running in AUTO.	
AMF MAN	Genset stopped or running and no other action taking place.	
AMF SEMI		
AMF AUTO	Genset stopped in AUTO.	
READY AMF AUTO		Genset is stopped, ready to auto start with mains failure.
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		
PEAK SHAVING AUTO		
READY PEAK SHAV AUTO	Genset stopped in AUTO.	
PEAK SHAVING ACTIVE	Genset running in AUTO.	
LOAD TAKE OVER MAN	Genset stopped or running and no other action taking place.	
LOAD TAKE OVER SEMI		
LOAD TAKE OVER AUTO		
READY LTO AUTO	Genset stopped in AUTO.	Genset is stopped, ready to start and load take-over.
LTO ACTIVE	Genset running in AUTO.	Genset is running, ready for load take-over.
MAINS P EXPORT MAN	Genset stopped or running and no other action taking place.	
MAINS P EXPORT SEMI		
MAINS P EXPORT AUTO		
READY MPE AUTO	Genset stopped in AUTO.	

Status text	Condition	Comment
MPE ACTIVE	Genset running in mains power export mode.	
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.	
SHUTDOWN OVERRIDE	The configurable input is active.	
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 Idle run function is active and the timer is counting down.	
COMPENSATION FREQ	Compensation is active.	The frequency is not at the nominal setting.
Aux. test ##.#V ####s	Battery test activated, and the timer is counting down.	
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.	Genset will start when timer expires.
STOP DG(s) IN ###s	The stop genset set point is exceeded.	Genset will stop when timer expires.
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.
MAINS U OK DEL ####s	Mains voltage is OK after a mains failure.	The timer shown is the mains OK delay.
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.	
GENSET STOPPING	This info is shown when cooling down has finished.	
EXT. STOP TIME ###s		
---xx-------- >00< ------------	Generator is synchronising.	The "xx" marks the actual generator phase angle position in the synchronisation. When the "xx" is aligned

Status text	Condition	Comment
		over the 00 centre, the generator is synchronised.
TOO SLOW 00<-------------	Generator running too slow during synchronisation.	
-----------> 00 TOO FAST	Generator running too fast during synchronisation.	
EXT. START ORDER	A planned AMF sequence is activated.	There is no failure on the mains during this sequence.
SELECT GENSET MODE	Power management has been deactivated and no other genset mode has been selected.	
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.	
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.
WARM UP RAMP	Warm up ramp is active.	The available power is limited until the predefined temperature is reached or when the input which activated warm up ramp is set low.
SUNSPEC IDENTIFYING*	Connecting to PV inverter.	Only Sunspec inverters
SUNSPEC INCOMPATIBLE*	PV inverter is not compatible.	Only Sunspec inverters
SUNSPEC INITIALIZED*	PV inverter is successfully initialized.	Only Sunspec inverters

NOTE *Only AGC 150 Hybrid version.

2.3.4 Texts only related to power management

Table 2.2 All controller types

Status text	Condition	Comment
BROADCASTING APPL. #	Broadcast of an application through the CAN line.	Broadcasts one of the four applications from one AGC 150 to the other controllers in the power management system.
RECEIVING APPL. #	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.	
QUICK SETUP ERROR	Quick setup of the application failed.	
MOUNT CAN CONNECTOR	Connect the power management CAN line.	
ADAPT IN PROGRESS	The AGC 150 is receiving the application,to which it has just been connected.	

Status text	Condition	Comment
SETUP IN PROGRESS	The new controller is being added to the existing application.	
SETUP COMPLETED	Successful update of the application in all AGC 150 controllers.	
REMOVE CAN CONNECTOR	Remove the power management CAN lines.	

Table 2.3 DG controller

Status text	Condition	Comment
BLACKOUT ENABLE	This info is shown if a CAN failure is present in a power management application.	
UNIT STANDBY	If redundant mains units are present, this message is shown on the redundant unit.	
DELOADING BTB XX	DG units are load sharing asymmetrically to de-load BTB XX dividing two sections in an island application.	
BTB XX DIVIDING SEC.	BTB XX is dividing two sections in an island application.	
SYNCHRONISING TB XX	TB XX is synchronising.	
SYNCHRONISING MB XX	MB XX is synchronising.	
SYNCHRONISING BTB XX	BTB XX is synchronising.	
De-loading TB XX	Displays that a tie breaker is being de-loaded in SEMI-AUTO mode.	

Table 2.4 Mains controller

Status text	Condition	Comment
UNIT STANDBY	If redundant mains units are present this message is shown on the redundant unit.	
TB TRIP EXTERNALLY	Some external equipment has tripped the breaker.	An external trip is logged in the event log.

Table 2.5 BTB controller

Status text	Condition	Comment
DIVIDING SECTION	A BTB unit is dividing two sections in an island application.	
READY AUTO OPERATION	BTB unit in AUTO and ready for breaker operation (no active BTB trip alarm).	
SEMI OPERATION	BTB unit in SEMI-AUTO.	
AUTO OPERATION	BTB unit in Auto, but not ready for breaker operation (active BTB trip alarm).	
BLOCKED FOR CLOSING	Last open BTB in a ring bus.	
BTB TRIP EXTERNALLY	Some external equipment has tripped the breaker.	An external trip is logged in the event log.

2.3.5 Default display views

Overview of the default display views 1 to 20. The display views are customisable via the Utility Software .

Table 2.6 Display view 1

Line	Generator	Mains	BTB	Hybrid
1	U-Supply 0.0V	U-Supply 0.0V	U-Supply 0.0V	PV OFF 0kvar 0kW
2	G 0.00PF 0kW	M 0.00PF 0kW	BA L1 0.00Hz 0V	G 0.00PF 0kW
3	G 0kVA 0kvar	M 0kVA 0kvar	BA 0kVA 0kvar	G 0kVA 0kvar
4	Energy Total 0kWh	Energy Total 0kWh	BA 0.00PF 0kW	G energy Total 0kWh
5	Run absolute 0 hrs	M 0.00PF 0kW	BA 0 0 0A	Run absolute 0hrs

Table 2.7 Display view 2

Line	Generator	Mains	BTB	Hybrid
1	BB L1 0.00Hz 0V	BB L1 0.00Hz 0V	BB L1 0.00Hz 0V	BB L1 0.00Hz 0V
2	G L1 0.00Hz 0V	M L1 0.00Hz 0V	BA L1 0.00Hz 0V	G L1 0.00Hz 0V
3	G 0.00PF 0kW	M 0.00PF 0kW	BA 0kVA 0kvar	G 0.00PF 0kW
4	G 0kVA 0kvar	M 0kVA 0kvar	BA 0.00PF 0kW	G 0kVA 0kvar
5	G 0 0 0A	M 0 0 0A	BA 0 0 0A	G 0 0 0A

Table 2.8 Display view 3

Line	Generator	Mains	BTB	Hybrid
1	-	-	-	-
2	Synchroniser (graphic)	Synchroniser (graphic)	Synchroniser (graphic)	Synchroniser (graphic)
3	-	-	-	-
4	-	-	-	-
5	-	-	-	-

Table 2.9 Display view 4

Line	Generator	Mains	BTB	Hybrid
1	BB L1 0.00Hz 0V	M 0 0 0V	BA 0 0 0V	BB L1 0.00Hz 0V
2	G 0.00PF 0kW	M L1 0.00Hz 0V	BA f-L1 0.00Hz	G 0.00PF 0kW
3	G 0kVA 0kvar	-	-	G 0kVA 0kvar
4	G 0 0 0A	BB 0 0 0V	BB 0 0 0V	G 0 0 0A
5	G L1 0.00Hz 0V	BB L1 0.00Hz 0V	BB f-L1 0.00Hz	G L1 0.00Hz 0V

Table 2.10 Display view 5

Line	Generator	Mains	BTB	Hybrid
1	G U-L1L2 0V	M P 0kW	BA P 0kW	G U-L1L2 0V
2	G U-L2L3 0V	M Q 0kvar	BA Q 0kvar	G U-L2L3 0V

Line	Generator	Mains	BTB	Hybrid
3	G U-L3L1 0V	M S 0kVA	BA S 0kVA	G U-L3L1 0V
4	G U-Max 0V	M 0 0 0V	BA 0 0 0V	G U-Max 0V
5	G U-Min 0V	M 0 0 0A	BA 0 0 0A	G U-Min 0V

Table 2.11 Display view 6

Line	Generator	Mains	BTB	Hybrid
1	G I-L1 0A	M I-L1 0A	BA I-L1 0A	G I-L1 0A
2	G I-L2 0A	M I-L2 0A	BA I-L2 0A	G I-L2 0A
3	G I-L3 0A	M I-L3 0A	BA I-L3 0A	G I-L3 0A
4	-	M 0.00PF 0kW	BA 0.00PF 0kW	-
5	-	M 0 0 0V	BA 0 0 0V	-

Table 2.12 Display view 7

Line	Generator	Mains	BTB	Hybrid
1	G f-L1 0.00Hz	M f-L1 0.00Hz	BA f-L1 0.00Hz	G f-L1 0.00Hz
2	G f-L2 0.00Hz	M f-L2 0.00Hz	BA f-L2 0.00Hz	G f-L2 0.00Hz
3	G f-L3 0.00Hz	M f-L3 0.00Hz	BA f-L3 0.00Hz	G f-L3 0.00Hz
4	-	M 0.00PF 0kW	BA 0.00PF 0kW	-
5	-	M 0 0 0V	BA 0 0 0A	-

Table 2.13 Display view 8

Line	Generator	Mains	BTB	Hybrid
1	G P 0kW	M U-L1N 0V	BA U-L1L2 0V	G P 0kW
2	G Q 0kvar	M U-L2N 0V	BA U-L2L3 0V	G Q 0kvar
3	G S 0kVA	M U-L3N 0V	BA U-L3L1 0V	G S 0kVA
4	G PF 0.00	M f-L1 0.00Hz	BA f-L1 0.00Hz	G PF 0.00
5	-	M 0 0 0A	BA 0 0 0A	PV Q reference 0kvar

Table 2.14 Display view 9

Line	Generator	Mains	BTB	Hybrid
1	P Available 0kW	P Available 0kW	BB U-L1L2 0V	P Available 0kW
2	P Consumed 0kW	P Consumed 0kW	BB U-L1L2 0V	P Consumed 0kW
3	P 0kW 0%	P 0kW 0%	BB U-L3L1 0V	P 0kW 0%
4	-	Q 0kvar 0%	BB f-L1 0.00Hz	PV P reference 0kW
5	-	S 0kva 0%	BA 0 0 0A	PV actual nom. P 0kW

Table 2.15 Display view 10

Line	Generator	Mains	BTB	Hybrid
1	G U-L1N 0V	M U-L1L2 0V	Multi input 20 0.0V	G U-L1N 0V
2	G U-L2N 0V	M U-L2L3 0V	Multi input 21 0.0V	G U-L2N 0V
3	G U-L3N 0V	M U-L3L1 0V	Multi input 22 0.0V	G U-L3N 0V
4	G energy total 0kWh	M f-L1 0.00Hz	Multi input 23 0.0V	G energy total 0kWh
5	Run absolute 0hrs	M 0 0 0A	-	Run absolute 0hrs

Table 2.16 Display view 11

Line	Generator	Mains	BTB	Hybrid
1	BB U-L1L2 0V	BB U-L1L2 0V	-	BB U-L1L2 0V
2	BB U-L2L3 0V	BB U-L2L3 0V	Date and Time	BB U-L2L3 0V
3	BB U-L3L1 0V	BB U-L3L1 0V	-	BB U-L3L1 0V
4	BB U-Max 0V	BB f-L1 0.00Hz	BTB Operations 0	BB U-Max 0V
5	BB U-Min 0V	M 0 0 0A	-	BB U-Min 0V

Table 2.17 Display view 12

Line	Generator	Mains	BTB	Hybrid
1	G Angle L1L2 -179.9deg	M U-L1N 0V	BB-BA Ang -180.0deg	G Angle L1L2 -179.9deg
2	G Angle L2L3 -179.9deg	M U-L2N 0V	BA AngL1L2 -179.9deg	G Angle L2L3 -179.9deg
3	G Angle L3L1 -179.9deg	M U-L3N 0V	BA AngL2L3 -179.9deg	G Angle L3L1 -179.9deg
4	BB-G Angle -180.0deg	M 0.00PF 0kW	BB AngL1L2 -179.9deg	BB-G Angle -180.0deg
5	-	Energy Total 0kWh	BB AngL3L1 -179.9deg	-

Table 2.18 Display view 13

Line	Generator	Mains	BTB	Hybrid
1	Run absolute 0hrs	Multi input 20 0.0V	-	Run absolute 0hrs
2	GB Operations 0	Multi input 21 0.0V	-	GB Operations 0
3	MB Operations 0	Multi input 22 0.0V	-	MB Operations 0
4	-	Multi input 23 0.0V	-	-
5	-	-	-	-

Table 2.19 Display view 14

Line	Generator	Mains	BTB	Hybrid
1	U-Supply 0.0V	-	-	PV E total 0kWh
2	Date and Time	Date and Time	-	PV E year 0kWh
3	-	-	-	PV E month 0kWh
4	-	MB Operations 0	-	PV E week 0kWh
5	-	TB Operations 0	-	PV E day 0kWh

Table 2.20 Display view 15

Line	Generator	Mains	BTB	Hybrid
1	BB-G Ang -180.0deg	BB-M Angle -180.0deg	-	PV E total 0kvar
2	G Ang L1L2 -179.9deg	M Angle L1L2 -179.9deg	-	PV E year 0kvar
3	BB Ang L1L2 -179.9deg	M Angle L1L2 -179.9deg	-	PV E month 0kvar
4	BB Ang L2L3 -179.9deg	BB Ang L1L2 -179.9deg	-	PV E week 0kvar
5	-	BB Ang L3L1 -179.9deg	-	PV E day 0kvar

Table 2.21 Display view 16

Line	Generator	Mains	BTB	Hybrid
1	T. Coolant N.A.	-	-	PV E curta. total 0kWh
2	T. TurboOil N.A.	-	-	PV E curta. year 0kWh
3	T. Exh. R N.A.	-	-	PV E curta. month 0kWh
4	T. Oil N.A.	-	-	PV E curta. week 0kWh
5	T. Fuel N.A.	-	-	PV E curta. day 0kWh

Table 2.22 Display view 17

Line	Generator	Mains	BTB	Hybrid
1	Start attempts 0	-	-	Start attempts 0
2	GB Operations 0	-	-	GB Operations 0
3	MB Operations 0	-	-	MB Operations 0
4	-	-	-	U-Supply 0V
5	-	-	-	[yyyy-mm-dd time]

Table 2.23 Display view 18

Line	Generator	Mains	BTB	Hybrid
1	Multi input 20 0.0V	-	-	Multi input 20 0.0V
2	Multi input 21 0.0V	-	-	Multi input 21 0.0V
3	Multi input 22 0.0V	-	-	Multi input 22 0.0V
4	Multi input 23 0.0V	-	-	Multi input 23 0.0V
5	MPU 0rpm	-	-	MPU 0rpm

Table 2.24 Display view 19

Line	Generator	Mains	BTB	Hybrid
1	P available 100%	-	-	P available 100%
2	P consumed 0%	-	-	P consumed 0%
3	G 0.00PF 0%P	-	-	G 0.00PF 0%P
4	BB f-L1 0.00Hz	-	-	BB f-L1 0.00Hz
5	BB Ang L1L2 -179.9deg	-	-	BB Ang L1L2 -179.9deg

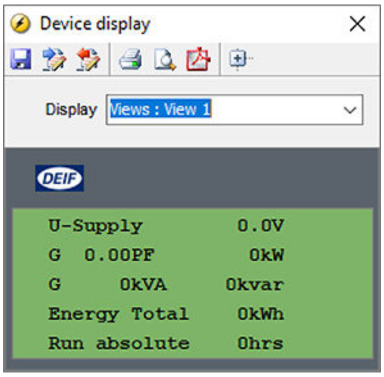
Table 2.25 Display view 20

Line	Generator	Mains	BTB	Hybrid
1	P 0kW 0%	-	-	P 0kW 0%
2	Q 0kvar 0%	-	-	Q 0kvar 0%
3	S 0kVA 0%	-	-	S 0kVA 0%
4	BB Ang L3L1 -179.9deg	-	-	BB Ang L3L1 -179.9deg
5	BB-G Ang -180.0deg	-	-	BB-G Ang -180.0deg

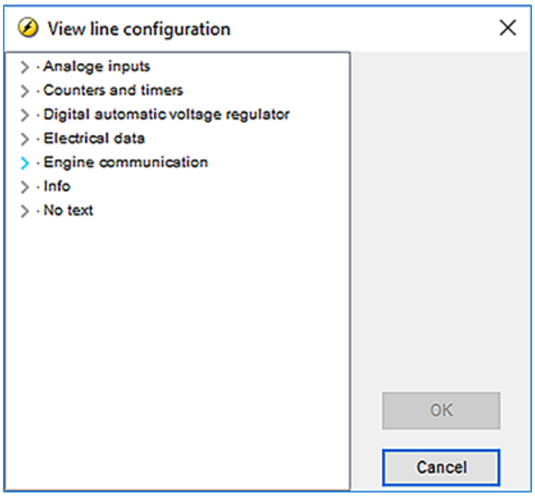
2.3.6 Available display texts

The display views can be configured to apply with the user's wishes. This is made with the Utility Software:

- In the toolbar, select the *Configuration of the user views*  button.
- In the pop-up box, select the display view to be changed.



- Select the display line to be changed.
- In the new pop-up box, navigate to the desired text line, then select OK.



Generator	Mains	BTB	Hybrid
No text	No text	No text	No text
G 0 0 0V	M 0 0 0V	BA 0 0 0V	G 0 0 0V
BB 0 0 0V	M 0 0 0V	BB 0 0 0V	BB 0 0 0V
G 0 0 0A	M 0 0 0A	BA 0 0 0A	G 0 0 0A
G 0.00PF 0kW	M 0.00PF 0kW	BA 0.00PF 0kW	G 0.00PF 0kW

Generator	Mains	BTB	Hybrid
G 0.00cosphi	M 0.00cosphi	BA 0.00cosphi	G 0.00cosphi
G 0kVA 0kvar	M 0kVA 0kvar	BA 0kVA 0kvar	G 0kVA 0kvar
G L1 0.0Hz 0V	M L1 0.0Hz 0V	BA L1 0.0Hz 0V	G L1 0.0Hz 0V
BB L1 0.0Hz 0V	BB L1 0.0Hz 0V	BB L1 0.0Hz 0V	BB L1 0.0Hz 0V
G U-L1N 0V	M U-L1N 0V	BA U-L1N 0V	G U-L1N 0V
G U-L2N 0V	M U-L2N 0V	BA U-L2N 0V	G U-L2N 0V
G U-L3N 0V	M U-L3N 0V	BA U-L3N 0V	G U-L3N 0V
G U-L1L2 0V	M U-L1L2 0V	BA U-L1L2 0V	G U-L1L2 0V
G U-L2L3 0V	M U-L2L3 0V	BA U-L2L3 0V	G U-L2L3 0V
G U-L3L1 0V	M U-L3L1 0V	BA U-L3L1 0V	G U-L3L1 0V
G U-Max 0V	M U-Max 0V	BA U-Max 0V	G U-Max 0V
G U-Min 0V	M U-Min 0V	BA U-Min 0V	G U-Min 0V
G I-L1 0A	M I-L1 0A	BA I-L1 0A	G I-L1 0A
G I-L2 0A	M I-L2 0A	BA I-L2 0A	G I-L2 0A
G I-L3 0A	M I-L3 0A	BA I-L3 0A	G I-L3 0A
G f-L1 0.00Hz	M f-L1 0.00Hz	BA f-L1 0.00Hz	G f-L1 0.00Hz
G f-L2 0.00Hz	M f-L2 0.00Hz	BA f-L2 0.00Hz	G f-L2 0.00Hz
G f-L3 0.00Hz	M f-L3 0.00Hz	BA f-L3 0.00Hz	G f-L3 0.00Hz
G P 0kW	M P 0kW	BA P 0kW	G P 0kW
G P L1 0kW	M P L1 0kW	BA P L1 0kW	G P L1 0kW
G P L2 0kW	M P L2 0kW	BA P L2 0kW	G P L2 0kW
G P L3 0kW	M P L3 0kW	BA P L3 0kW	G P L3 0kW
P 0kW U-Gen L1N 0V			P 0kW U-Gen L1N 0V
G Q 0kvar	M Q 0kvar	BA Q 0kvar	G Q 0kvar
G Q L1 0kvar	M Q L1 0kvar	BA Q L1 0kvar	G Q L1 0kvar
G Q L2 0kvar	M Q L2 0kvar	BA Q L2 0kvar	G Q L2 0kvar
G Q L3 0kvar	M Q L3 0kvar	BA Q L3 0kvar	G Q L3 0kvar
G S 0kVA	M S 0kVA	BA S 0kVA	G S 0kVA
G S L1 0kVA	M S L1 0kVA	BA S L1 0kVA	G S L1 0kVA
G S L2 0kVA	M S L2 0kVA	BA S L2 0kVA	G S L2 0kVA
G S L3 0kVA	M S L3 0kVA	BA S L3 0kVA	G S L3 0kVA
G PF 0.00	M PF 0.00	BA PF 0.00	G PF 0.00
G Angle L1L2 0deg	M Angle L1L2 0deg	BA Angle L1L2 0deg	G Angle L1L2 0deg
G Angle L2L3 0deg	M Angle L2L3 0deg	BA Angle L2L3 0deg	G Angle L2L3 0deg
G Angle L3L1 0deg	M Angle L3L1 0deg	BA Angle L3L1 0deg	G Angle L3L1 0deg
BB U-L1N 0V	BB U-L1N 0V	BB U-L1N 0V	BB U-L1N 0V
BB U-L2N 0V	BB U-L2N 0V	BB U-L2N 0V	BB U-L2N 0V
BB U-L3N 0V	BB U-L3N 0V	BB U-L3N 0V	BB U-L3N 0V
BB U-L1L2 0V	BB U-L1L2 0V	BB U-L1L2 0V	BB U-L1L2 0V

Generator	Mains	BTB	Hybrid
BB U-L2L3 0V	BB U-L2L3 0V	BB U-L2L3 0V	BB U-L2L3 0V
BB U-L3L1 0V	BB U-L3L1 0V	BB U-L3L1 0V	BB U-L3L1 0V
BB U-Max 0V	BB U-Max 0V	BB U-Max 0V	BB U-Max 0V
BB U-Min 0V	BB U-Min 0V	BB U-Min 0V	BB U-Min 0V
BB f-L1 0.00Hz	BB f-L1 0.00Hz	BB f-L1 0.00Hz	BB f-L1 0.00Hz
BB f-L2 0.00Hz	BB f-L2 0.00Hz	BB f-L2 0.00Hz	BB f-L2 0.00Hz
BB f-L3 0.00Hz	BB f-L3 0.00Hz	BB f-L3 0.00Hz	BB f-L3 0.00Hz
BB Angle L1L2 0deg	BB Angle L1L2 0deg	BB Angle L1L2 0deg	BB Angle L1L2 0deg
BB Angle L2L3 0deg	BB Angle L2L3 0deg	BB Angle L2L3 0deg	BB Angle L2L3 0deg
BB-Gen Angle 0deg	BB-M Angle 0deg	Angle BB-BA 0deg	BB-Gen Angle 0deg
I neutral 0A	I neutral 0A	I neutral 0A	I neutral 0A
I earth 0A	I earth 0A	I earth 0A	I earth 0A
4th CT P 0kW	4th CT P 0kW	4th CT P 0kW	4th CT P 0kW
Energy Total 0kWh	Energy Total 0kWh	Energy Total 0kWh	Energy Total 0kWh
Energy Day 0kWh	Energy Day 0kWh	Energy Day 0kWh	Energy Day 0kWh
Energy Week 0kWh	Energy Week 0kWh	Energy Week 0kWh	Energy Week 0kWh
Energy Month 0kWh	Energy Month 0kWh	Energy Month 0kWh	Energy Month 0kWh
Import Total 0kWh	Import Total 0kWh	Import Total 0kWh	Import Total 0kWh
Import day 0kWh	Import day 0kWh	Import day 0kWh	Import day 0kWh
Import week 0kWh	Import week 0kWh	Import week 0kWh	Import week 0kWh
Import month 0kWh	Import month 0kWh	Import month 0kWh	Import month 0kWh
Energy Total 0kvarh	Energy Total 0kvarh	Energy Total 0kvarh	Energy Total 0kvarh
Energy Day 0kvarh	Energy Day 0kvarh	Energy Day 0kvarh	Energy Day 0kvarh
Energy Week 0kvarh	Energy Week 0kvarh	Energy Week 0kvarh	Energy Week 0kvarh
Energy Month 0kvarh	Energy Month 0kvarh	Energy Month 0kvarh	Energy Month 0kvarh
Import Total 0kvarh	Import Total 0kvarh	Import Total 0kvarh	Import Total 0kvarh
Import day 0kvarh	Import day 0kvarh	Import day 0kvarh	Import day 0kvarh
Import week 0kvarh	Import week 0kvarh	Import week 0kvarh	Import week 0kvarh
Import month 0kvarh	Import month 0kvarh	Import month 0kvarh	Import month 0kvarh
I max. demand L1 0A	I max. demand L1 0A	I max. demand L1 0A	I max. demand L1 0A
I max. demand L2 0A	I max. demand L2 0A	I max. demand L2 0A	I max. demand L2 0A
I max. demand L3 0A	I max. demand L3 0A	I max. demand L3 0A	I max. demand L3 0A
I thermal demand L1 0A	I thermal demand L1 0A	I thermal demand L1 0A	I thermal demand L1 0A
I thermal demand L2 0A	I thermal demand L2 0A	I thermal demand L2 0A	I thermal demand L2 0A
I thermal demand L3 0A	I thermal demand L3 0A	I thermal demand L3 0A	I thermal demand L3 0A
Pulse counter 1 0	Pulse counter 1 0	Pulse counter 1 0	Pulse counter 1 0
Pulse counter 2 0	Pulse counter 2 0	Pulse counter 2 0	Pulse counter 2 0
P consumed 0kW	P consumed 0kW		P consumed 0kW
P available 0%	P available 0%		P available 0%

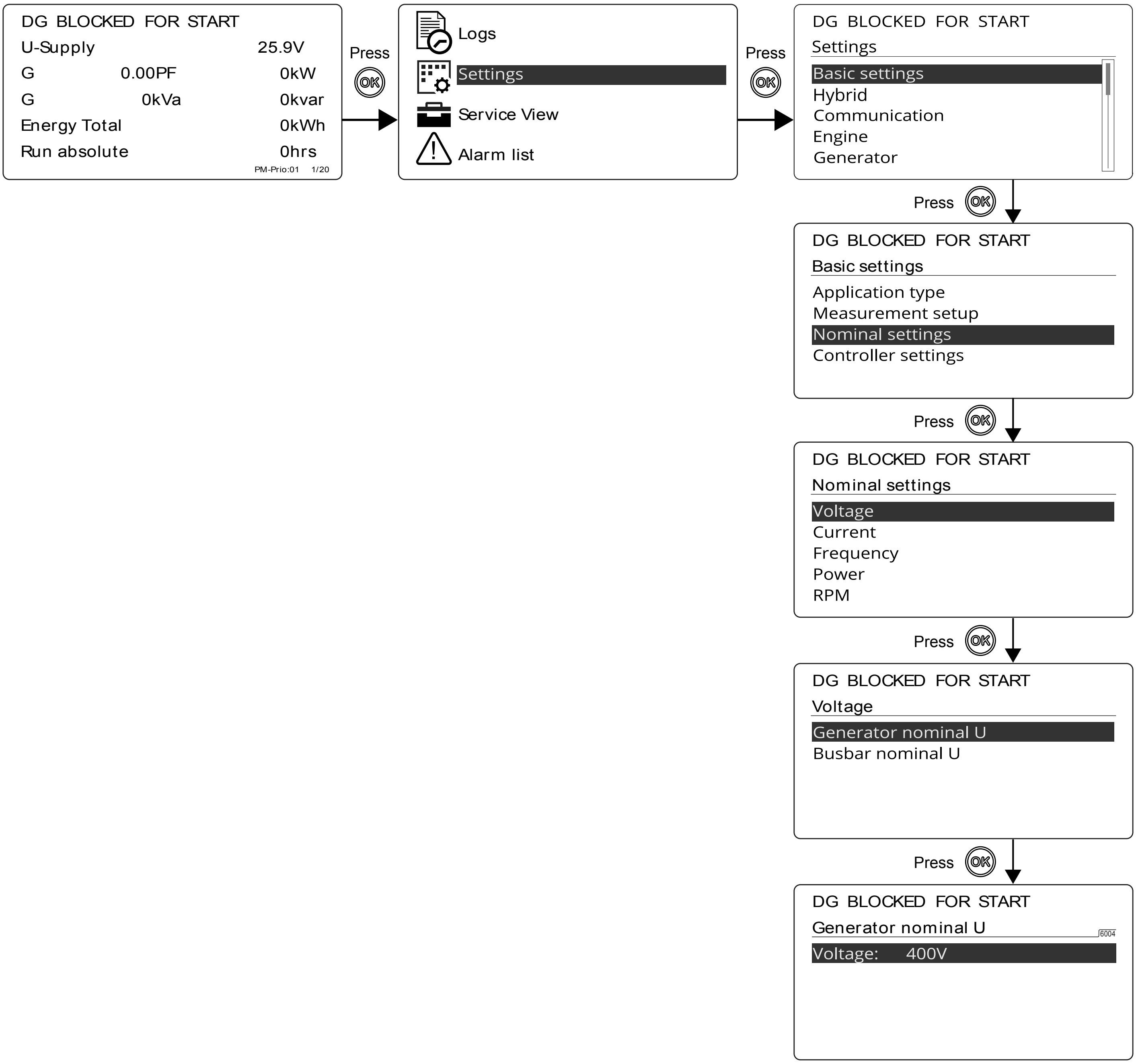
Generator	Mains	BTB	Hybrid
P consumed 0%	P consumed 0%		P consumed 0%
G 0%S 0%Q	M 0%S 0%Q		G 0%S 0%Q
G 0.00PF 0%P	M 0.00PF 0%P		G 0.00PF 0%P
P 0kW 0%	P 0kW 0%		P 0kW 0%
Q 0kvar 0%	Q 0kvar 0%		Q 0kvar 0%
S 0kVA 0%	S 0kVA 0%		S 0kVA 0%
Multi Input 20 0	Multi Input 20 0	Multi Input 20 0	Multi Input 20 0
Multi Input 21 0	Multi Input 21 0	Multi Input 21 0	Multi Input 21 0
Multi Input 22 0	Multi Input 22 0	Multi Input 22 0	Multi Input 22 0
Multi Input 23 0	Multi Input 23 0	Multi Input 23 0	Multi Input 23 0
MPU 0rpm			MPU 0rpm
U-Supply 0.0V	U-Supply 0.0V	U-Supply 0.0V	U-Supply 0.0V
Gov Mode Text	Gov Mode Text	Gov Mode Text	Gov Mode Text
Synchroniser	Synchroniser	Synchroniser	Synchroniser
Date and Time	Date and Time	Date and Time	Date and Time
MB operations 0	MB operations 0		MB operations 0
GB Operations 0	TB Operations 0	BTB Operations 0	GB Operations 0
Start attempts 0			Start attempts 0
Start att Std 0			Start att Std 0
Start att Dbl 0			Start att Dbl 0
Run absolute 0hrs			Run absolute 0hrs
Run relative 0Hour			Run relative 0Hour
Run Time load profile 0Hour			Run Time load profile 0Hour
Run ShtD 0H 0m			Run ShtD 0H 0m
Next prio 0H 0m			Next prio 0H 0m
Serv 1 0d 0h			Serv 1 0d 0h
Serv 2 0d 0h			Serv 2 0d 0h
P mains 0kW	P mains 0kW		P mains 0kW
P available 0kW	P available 0kW		P available 0kW
P mains (PM) 0kW	P mains (PM) 0kW		P mains (PM) 0kW
P DG total 0kW	P DG total 0kW		P DG total 0kW
Negtive volt. 0.0%	Negtive volt. 0.0%	Negtive volt. 0.0%	Negtive volt. 0.0%
Negtive curr. 0.0%	Negtive curr. 0.0%	Negtive curr. 0.0%	Negtive curr. 0.0%
Zero volt. 0.0%	Zero volt. 0.0%	Zero volt. 0.0%	Zero volt. 0.0%
Zero curr. 0.0%	Zero curr. 0.0%	Zero curr. 0.0%	Zero curr. 0.0%
Positive volt 0.0%	Positive volt 0.0%	Positive volt 0.0%	Positive volt 0.0%
P ref. actual 0kW			P ref. actual 0kW
P ref. current 0kW	P ref. current 0kW		P ref. current 0kW
	P tie breaker 0kW	P BTB Ana21 0kW	

Generator	Mains	BTB	Hybrid
Cosphi ref. current 0.00	Cosphi ref. current 0.00		Cosphi ref. current 0.00
Fan A pr: 0 0hrs			Fan A pr: 0 0hrs
Fan B pr: 0 0hrs			Fan B pr: 0 0hrs
Fan C pr: 0 0hrs			Fan C pr: 0 0hrs
Fan D pr: 0 0hrs			Fan D pr: 0 0hrs
Parameter ID	Parameter ID	Parameter ID	Parameter ID
GOV reg. type			GOV reg. type
AVR reg. type			AVR reg. type
External analogue readings			External analogue readings
EIC readings			EIC readings
			PV P energy, total
			PV P energy, year
			PV P energy, month
			PV P energy, week
			PV P energy, day
			PV Q energy, total
			PV Q energy, year
			PV Q energy, month
			PV Q energy, week
			PV Q energy, day
			PV curtailed energy, total
			PV curtailed energy, year
			PV curtailed energy, month
			PV curtailed energy, week
			PV curtailed energy, day
			PV P reference
			PV Q reference
			PV actual Q and P
			PV actual Nom. P

2.3.7 The Settings menu

The Settings menu is used for setting up the controller, and if the operator needs detailed information that is not available in the view menu system. Navigate through the different setup parameters with the *Up*, *Down* and *OK* buttons.

Figure 2.3 Example: Navigating the Settings menu



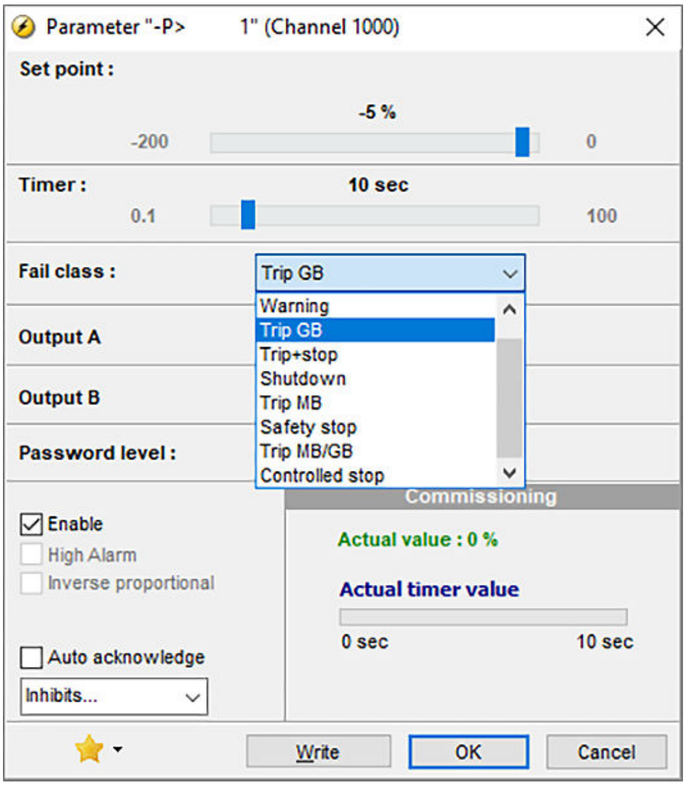
2.4 Fail classes

2.4.1 Fail classes

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 fail class can be selected for each alarm function, either on the controller or with the Utility Software.

To change the fail class with the Utility Software, the alarm function to be configured must be selected. Select the desired fail class in the fail class drop-down list.



Fail classes in genset controller

Fail class/Action	Alarm horn relay	Alarm display	De-load	Trip GB	Trip MB	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. For example, if an alarm is configured with the Shutdown fail class, the following actions occur:

- The alarm horn relay activates
- The alarm is displayed on the alarm info screen
- The generator breaker opens instantly
- The genset is stopped instantly
- The genset cannot be started from the controller (see next table)

NOTE • The Safety stop fail class only de-loads the genset if it is possible. 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, the safety stop does nothing in Load take-over, Island and Automatic Mains Failure (AMF) modes.
- The Trip MB/GB only trips the generator breaker if the genset controller controls 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 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

NOTE *The fail class Trip MB/GB does not block Start and Block GB sequences if the genset controller is in a Stand-alone application with a mains breaker.

Fail classes in mains controller

Fail class/Action	Alarm horn relay	Alarm display	Trip MB	Trip TB
Block	x	x		
Warning	x	x		
Trip TB	x	x		x
Trip MB	x	x	x	
Trip MB/TB*	x	x	x	(x)

NOTE *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)

NOTE *The Trip MB/TB only blocks the TB sequence if there is no mains breaker for the present controller.

Fail classes in BTB controller

Fail class/Action	Alarm horn relay	Alarm display	Trip BTB
Block	x	x	
Warning	x	x	
Trip BTB	x	x	x

Fail class/Action	Alarm horn relay	Alarm display	Trip BTB
Block	x	x	
Warning	x	x	
Trip BTB	x	x	x

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 BTB sequence
Block	
Warning	
Trip BTB	x

Fail classes in hybrid controller

In addition to the fail classes of a genset controller, the hybrid type has the following:

Fail class/Action	Alarm horn relay	Alarm display	Stop power converter
PV shutdown	x	x	x

Fail class/Action	Alarm horn relay	Alarm display	Stop power converter
PV shutdown	x	x	x

The fail class has different impacts on the system. When the engine is stopped, the fail class do as follows:

Fail class/Action	Block power converter start	Block ESB sequence
Block	x	

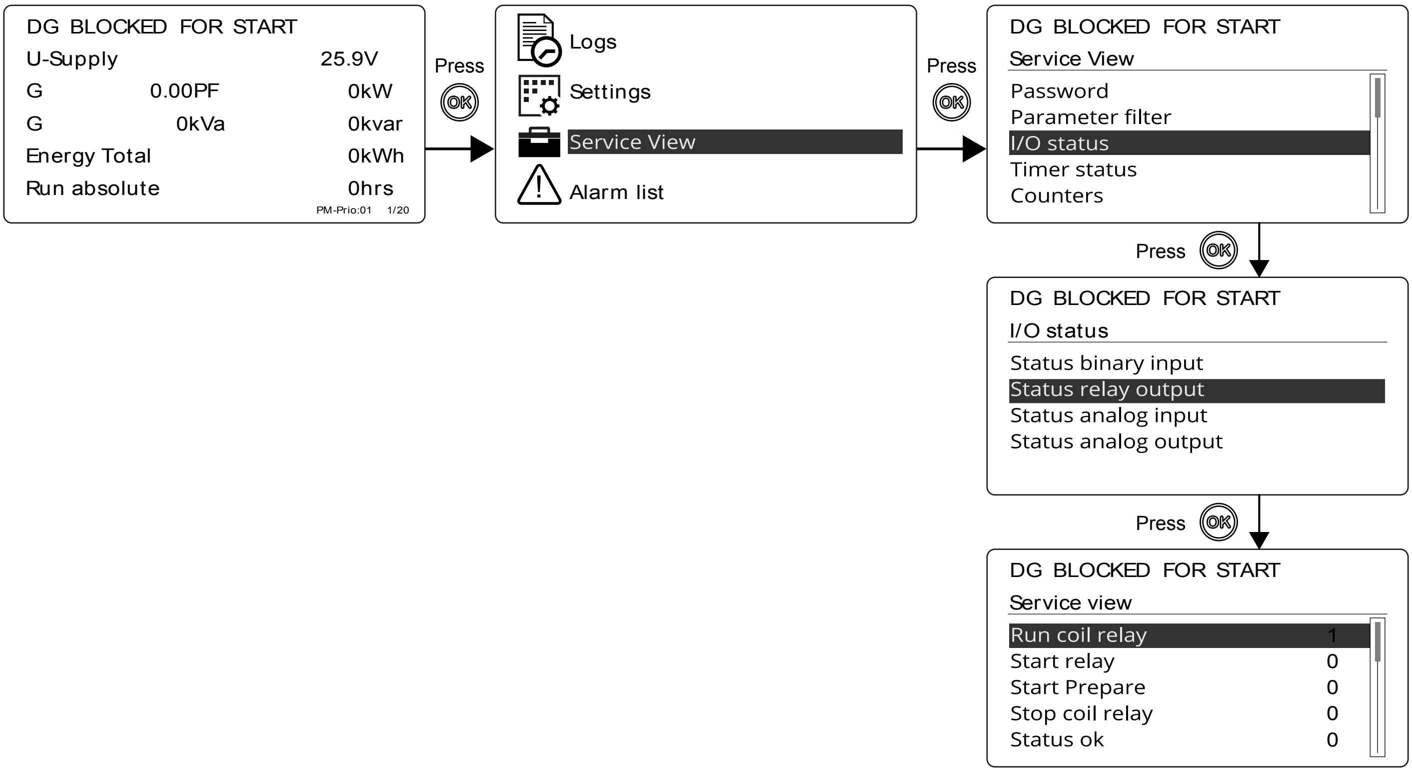
2.5 The Service View

2.5.1 The Service View

The Service View is used to view the status of the controller. The controller settings can not be changed through the Service View, except for changing the Passwords.

Navigate through the different status views with the *Up* , *Down* and *OK* buttons.

Figure 2.4 Example: Navigating the Service View



2.6 Logs

2.6.1 Logs

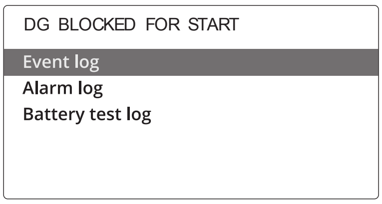
AGC 150 logs three types of data:

- Event log, containing 500 logs.
- Alarm log, containing 500 logs.
- Battery test log, containing 52 logs.

The logs can be viewed in the display or in the Utility Software. When a log reaches its limit, each new event will overwrite the oldest event.

Go to the Log menu:

1. Press the *OK* button.
2. Scroll to the Log menu with the *Up* or *Down* buttons.
3. Press the *OK* button again to open the Log menu.



Select a Log menu:

1. Scroll to the desired Log menu with the *Up* or *Down* buttons.
2. Press the *OK* button again to open the menu.

3. Scroll through the menu with the *Up* or *Down* buttons.

Press the *RETURN* button to return to the Log menu

2.7 M-Logic

2.7.1 M-Logic

The main purpose of M-Logic is to give the operator/designer more flexible possibilities of operating the generator control system.

The M-Logic functionality is included in the AGC 150 and 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.

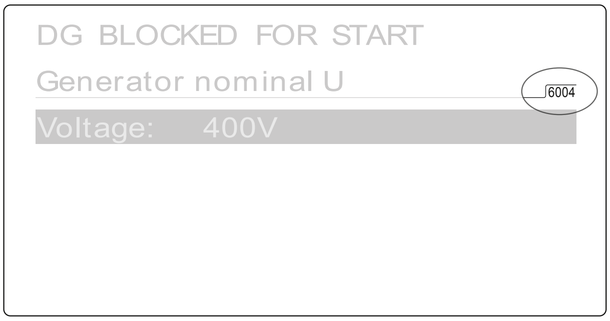
M-Logic is a simple tool based on logic events. One or more input conditions are defined, and at the activation of those inputs, the defined output will occur. A great variety of inputs can be selected, such as digital inputs, alarm conditions and running conditions. A variety of the outputs can also be selected, such as relay outputs, change of genset modes and change of running modes.

The M-Logic is part of the Utility Software, and can only be configured with this, and not via the display.

2.8 Menu numbers and the Jump function

2.8.1 Menu numbers

In AGC 150 each setting or parameter has a unique menu number. On the display screen, the menu number can be seen in the upper right corner:



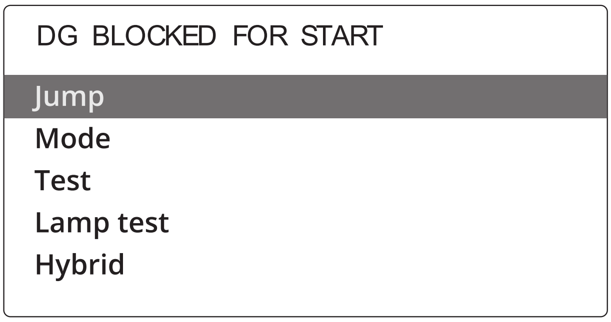
Menu numbers can also be found in the Utility Software:

1. From the toolbar, select the *Parameters* button.
2. In View mode, choose the List view.
3. The menu numbers are shown in the Channel column.

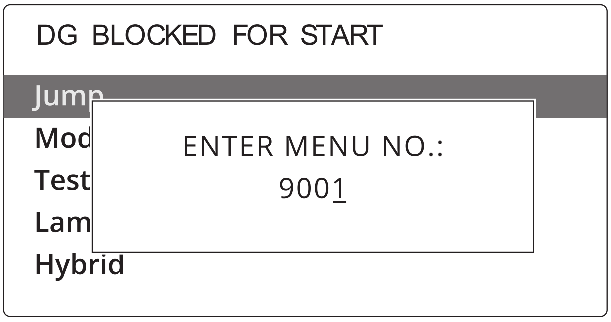
2.8.2 Jump function

If you know the menu number for a setting, you can use the Jump function to select and display settings without navigating through the menus.

To activate the Jump function from the controller, press the *Shortcut* button.



Scroll to the Jump menu with the *Up* and *Down* buttons, and select the menu with the *OK* button.



Enter the menu number and select with the *OK* button.

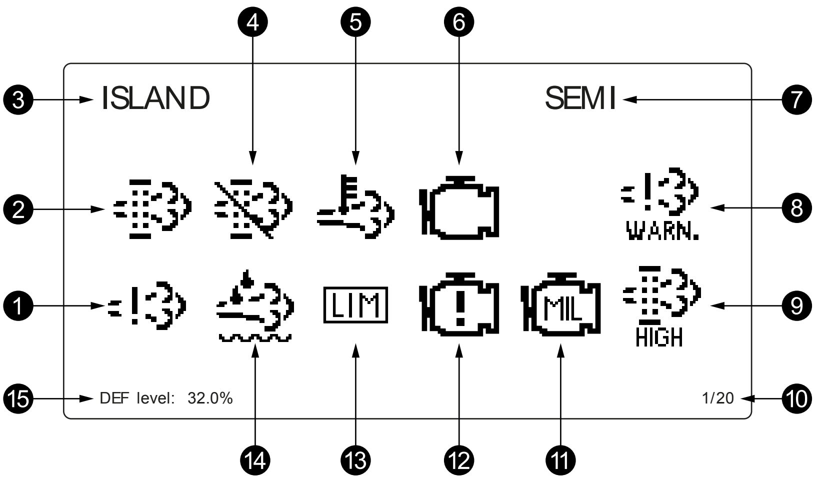
To activate the Jump function in the Utility Software, select the Parameter page and then the Jump menu.

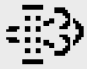
2.9 Exhaust after-treatment (Tier 4 Final/Stage V)

2.9.1 Exhaust after-treatment (Tier 4 Final/Stage V)

AGC 150 supports Tier 4 Final/Stage V requirements, and provides monitoring and control of the exhaust after-treatment system, as requested by the standard.

Figure 2.5 AGC 150 Tier 4 Final screen



No.	Item	Symbol	Notes
1.	Engine emission system failure		Shows an emission failure or malfunction.
2.	Diesel Particle Filter (DPF)		Shows that a regeneration is needed.
3.	Application mode	-	-
4.	Diesel Particle Filter (DPF) Inhibit		Shows that regeneration is inhibited.
5.	High temperature - Regeneration		Shows a high temperature and regeneration is in process.
6.	Engine interface status		Shows an engine warning.
7.	Operation mode	-	-
8.	Engine emission system failure level	  	Shows the severity of an emission failure or malfunction.
9.	Diesel Particle Filter (DPF) level	  	Shows the severity of a needed regeneration.
10.	Page number	-	Shows the number of the View menu screens.
11.	Engine interface status		Indicates a malfunction.
12.	Engine interface status		Shows an engine shutdown.
13.	LIMIT lamp		Only for MTU engines.
14.	Diesel Exhaust Fluid (DEF)		Shows the fluid tank level is low.
15.	Diesel Exhaust Fluid (DEF) % level	-	Shows the level (%) of the Diesel Exhaust Fluid.

NOTE Grey symbols show that communication for the item is available. Not all types of engines support all items shown.

3. Utility Software

3.1 Download, connection and network parameters

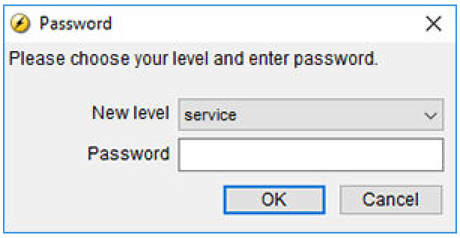
3.1.1 Download of Utility Software v.3.x

The DEIF Utility Software v.3.x is the software interface between a PC and the AGC 150 controller. The software can be downloaded from deif.com, and is free of charge.

3.1.2 USB connection

A USB cable type USB A to B is used to connect the AGC 150 to a PC:

1. Install the Utility Software on a PC.
2. Connect the pc to the AGC 150 service port with the USB cable.
3. Start the Utility Software.
4. Press the *Connection* button in the Utility Software toolbar and select a service port option.
5. When prompted, write the password and select OK.



More information
See **General product information, Controller overview, Password** in this document for information on the default passwords.

3.1.3 Connection TCP/IP and network parameters

The AGC 150 controller can be connected with TCP/IP communication. This requires a crossed Ethernet cable.

When connecting a controller with TCP/IP, you must know the controller's IP address. Find the IP address on the display under **Settings > Communication > Ethernet setup**.

When connecting a controller, it can be required to have a static IP address on the PC. The default network address is:

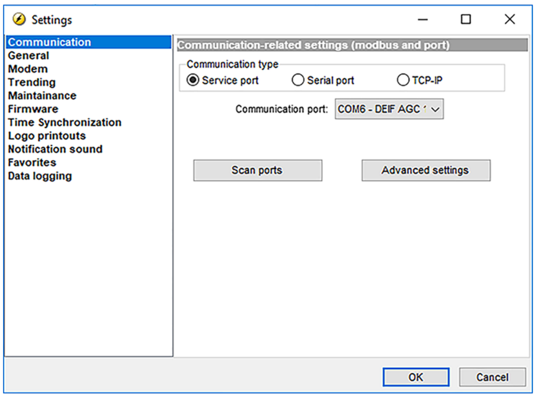
- IP: 192.168.2.2
- Gateway: 192.168.2.1
- Subnet mask: 255.255.255.0

The static IP address on the PC is then 192.168.2.xxx, where xxx is a free IP-address in the network. If the IP address is changed from 192.168.2.xxx, to, for example, 192.168.4.xxx, the connection is lost, and a new static IP for the PC must be made in the area of 192.168.4.xxx.

All controllers can be connected to a switch, but before doing this, it is recommended to create unique IP addresses for all controllers in the network.

The network parameters can be changed with the Utility Software. The first time it is recommended to have a point-to-point connection between the PC and the controller. Open the Utility Software and press the *General settings* button in the top toolbar.

A window appears, where the connecting IP address must be entered:

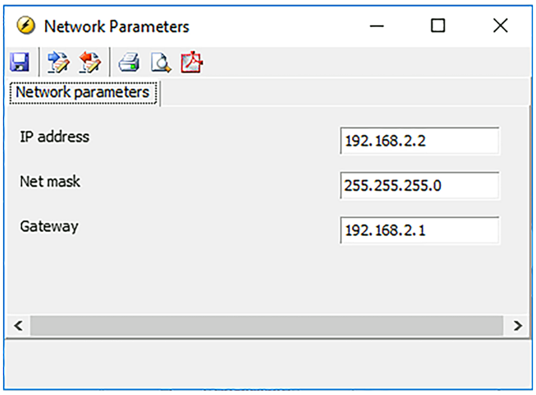


Select the *TCP-IP* button to enter the IP address. Press the *Test* button to check if the connection is successful, then press the *OK* button.

Press the *Communication* button in the top toolbar to connect to the controller via TCP-IP.

Enter the controller password to be able to change the parameters.

To change the network parameters, press the *Option N configuration* button. A window appears, where the network parameters can be entered:



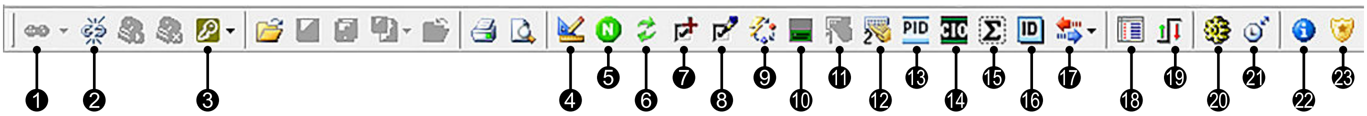
When the network parameters have been changed, press the *Write to device* button in the top of the window. The controller receives the new network parameters and reboots the network hardware. Be aware, when trying to connect to the controller again that the new IP address has to be used, with a fitting static IP address for the PC.

When all the controllers have got separate IP addresses, they 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 shift between controllers in the application supervision window in the Utility Software.

3.1.4 Utility Software buttons

With the Utility Software, you can perform different actions concerning the controller.

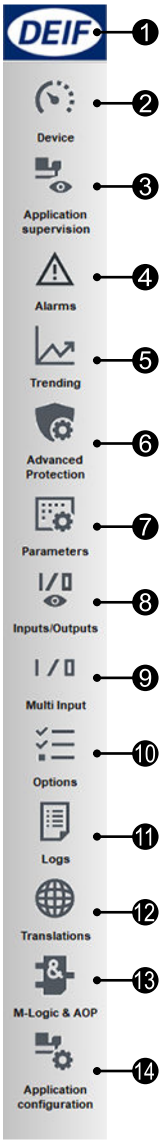
Table 3.1 Top toolbar



1. Connect to a controller.
2. Disconnect from a controller.
3. Permission level.
4. General settings.
5. Configure the network and Option N parameters.
6. Configure Modbus and Profibus.
7. Add options (create an option code and send it to support@deif.com).
8. Enter an upgrade code (received from DEIF support).
9. Update the controller firmware.
10. Configure the display views.
11. Not used for AGC 150.
12. Configure the AOP-2 buttons and LEDs (Additional Operator Panel).
13. Configure the general purpose PIDs.
14. Configure the CIO modules.
15. Read the controller counters.
16. Information on the controller and the software.
17. Read, write, backup and restore the device.
18. Data tracing (shows the max./min. of a value, as long as the data tracer window is open).
19. Configure the controller I/O settings.
20. Send commands to the controller.
21. Synchronise the controller clock with the connected PC.
22. Information about the Utility Software.
23. Configure the permissions.

Other buttons/icons are located in the left menu bar of the Utility Software.

Table 3.2 Left menu bar

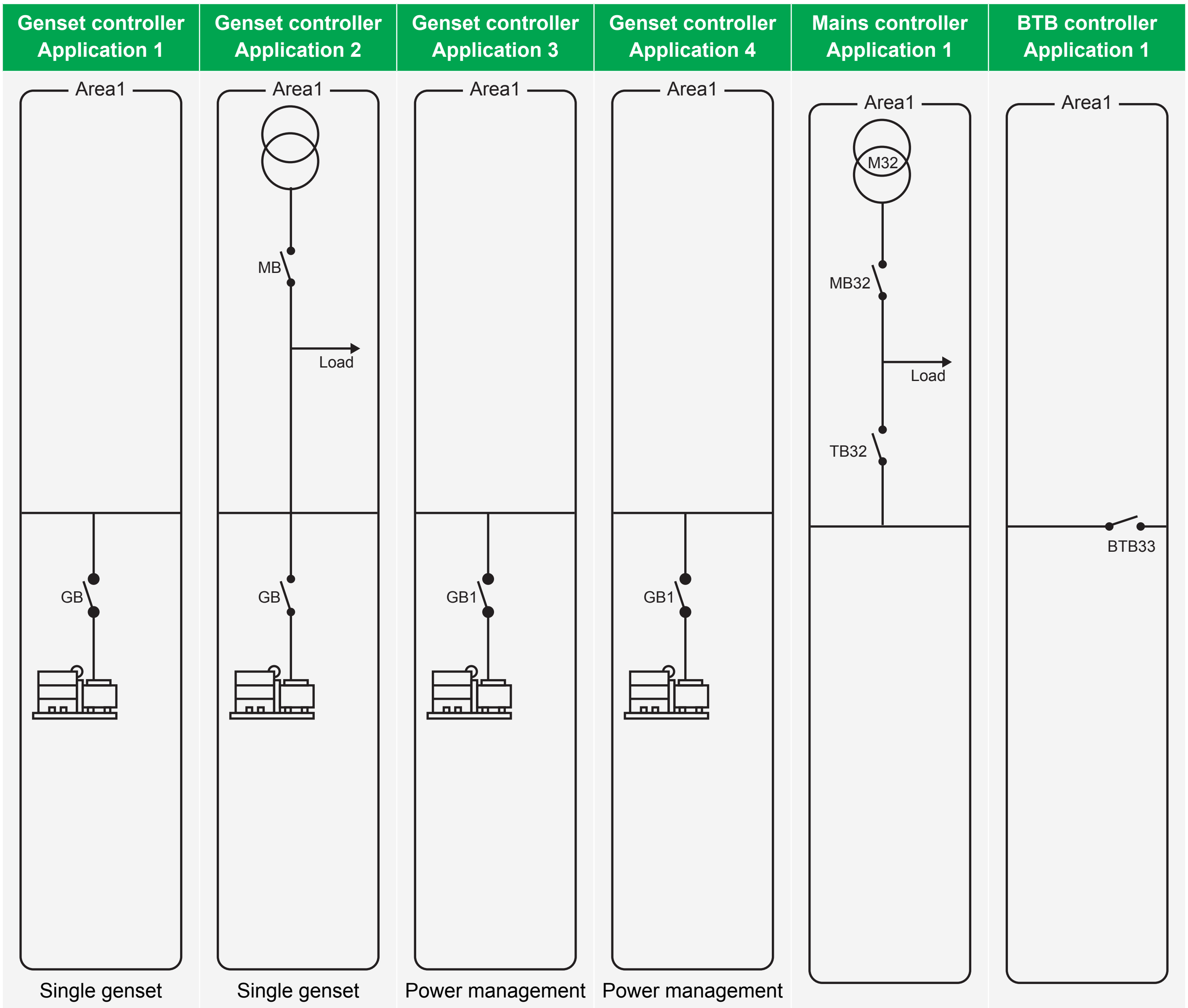


1. A direct link to deif.com.
2. Device page.
   - Gives an overview of the connected controller.
3. Application supervision page.
   - Gives an overview of the plant.
   - Shows how much power each genset produces.
4. Alarms page.
   - Gives an overview of the active alarms.
   - Shows the alarm history (only alarms that have been present during the connection time).
5. Trending page.
   - Trending can be made, when a PC is connected and in the trending window.
   - The controller cannot save trending.
6. Advanced protection page
   - Gives access to advanced protection settings, such as capability curves, droop and more.
7. Parameter page.
   - Gives access to all parameters.
8. Inputs/Outputs page.
   - Gives a status overview of inputs and outputs..
9. Multi inputs page
   - Gives an overview of multi-inputs 20, 21, 22 and 23.
10. Options page.
    - Gives an overview of which options that are available and not available.
11. Logs page.
    - Gives an overview of the alarms and events logs from the controller.
12. Translations page.
    - Gives the possibility to change (translate) almost all text in the controller.
13. M-Logic page.
    - See **General product information, M-Logic** in this document for a description of M-Logic.
14. Application configuration page.
    - Create application single-line drawings.

3.2 Setup of applications

3.2.1 Pre-configured applications

AGC 150 comes with six pre-configured standard applications, four for genset controller, one for mains controller and one for BTB controller.



The pre-configured standard applications can be chosen directly from the controller under **Settings > Basic settings > Application type > Standalone or PM > Application select**.

Parameter	Text	Range	Default
9161	Active application	1 to 4	-
9162	Viewed application	1 to 4	-
9163	Name	Not configurable, dependent on the chosen application.	
9164	Status	Not configurable, dependent on the chosen application.	
9165	Number of gensets	Not configurable, dependent on the chosen application.	
9166	Number of mains	Not configurable, dependent on the chosen application.	
9167	Number of BTBs	Not configurable, dependent on the chosen application.	

The standard applications can be changed with the Utility Software.

3.2.2 Determine the application type

Before the type of application configuration is chosen, it is important to identify:

- The number of controllers
- How the application configuration should be made.

Application type	Configuration characteristics
Stand-alone applications	In a stand-alone application setup, the AGC 150 can not communicate with other controllers. It is possible to make analogue load sharing with other controllers. An AGC 150 in a stand-alone application can operate one genset, one GB and one MB. If one controller has to operate a GB and MB, there must be no other gensets or power sources, due to risk of faulty synchronisation.
2-level power management applications	In a 2-level plant configuration, the controller types are mains and genset. In 2-level applications, the AGC 150 can be in applications with up to 32 genset/mains controllers and 8 BTB controllers (a total of 40 controllers).

3.2.3 Setup of a stand-alone application

In a stand-alone application, the AGC 150 can control one genset, one generator breaker (GB), and one mains breaker (MB).

When connected to a controller with the Utility Software:

1. Press the *Application configuration* button.
2. Press the *New plant configuration* button.
3. The Plant options window appears:

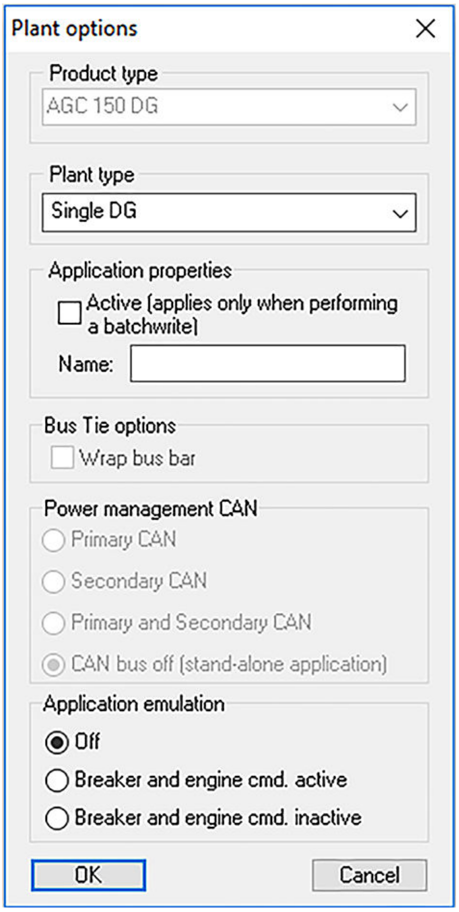
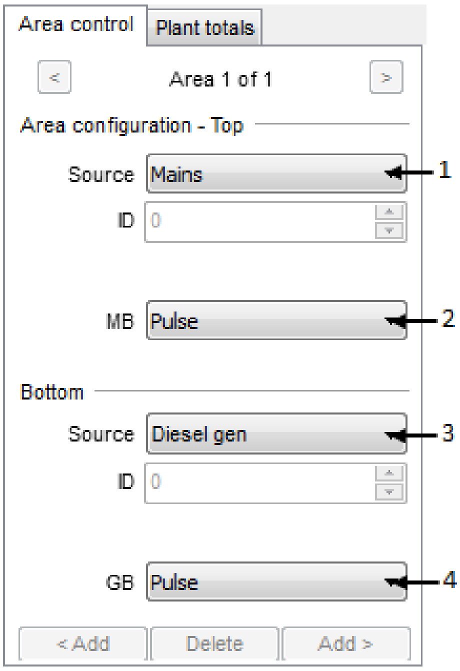


Table 3.3 Select the plant options

	Description	Comments
Product type	Select the controller type.	When connected to a controller, this function is greyed out.
Plant type	Single DG Standard Genset group	If the genset is to be set in a place where this is only one controller, the Single DG should be selected.
Application properties	Activate the application, when it is written to the controller. Name the application.	Naming the application can be helpful, if the controller is in a plant where the controller will switch between application designs. The controllers can switch between four different application designs. Controllers connected to each other via the CAN bus communication can not have different application designs or numbers.

When the plant options have been chosen, the application drawing can be created.

Example



1. Selects the type of power source to be represented in the top area:
   - None
   - Mains
   - Diesel genset
2. Select the breaker type used for Mains breaker:
   - Pulse
   - Continuous NE
   - Compact
   - None
   - Continuous ND
3. Select the power source to be represented in the bottom area:
   - None
   - Mains
   - Diesel genset
4. Select the breaker type used for Diesel genset breaker:
   - Pulse

- Continuous NE
- Compact

After the application drawing is created, press the *Write plant configuration to device* button to send the configuration to the connected controller.

More information
See **Engine/Generator/Mains, Breaker types** in this document for more information about breakers.

3.2.4 Setup of a 2-level application

For the application to operate correctly, the CAN bus communication between the controllers must follow the standards for CAN bus communication.

More information
See **Wirings, Communication** in the Installation instructions for more information on how to wire the CAN bus.

Before configuring the Power Management communication:

- Identify which terminals are used for the communication lines.
  - The lines must run from CAN port B to CAN port B.
  - By default, the controllers will use the Power Management communication protocol Primary CAN on CAN port B.
- Configure the internal IDs.
  - Each controller must have a unique ID number.
  - Configure the parameters for the internal CAN ID under **Settings > Communication > Power management ID**.

Parameter	Text	Range	Default
7531	Int. comm. ID	1 to 32	Controller dependent

When you have found out which CAN ports that is used for Power Management communication, and the internal CAN IDs are set, use the Utility Software to configure the plant layout.

When connected to a controller with the Utility Software:

1. Press the *Application configuration* button.
2. Press the *New plant configuration* button.
3. The Plant options window appears:

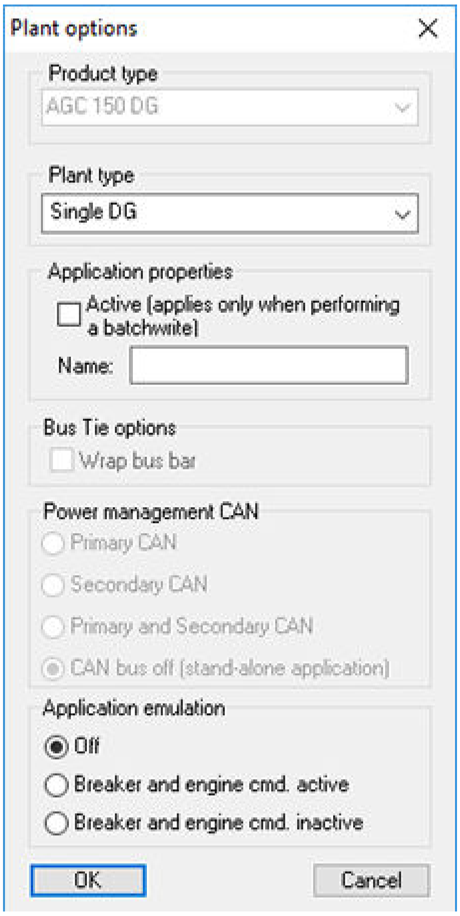
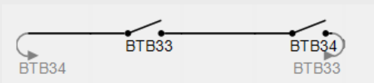


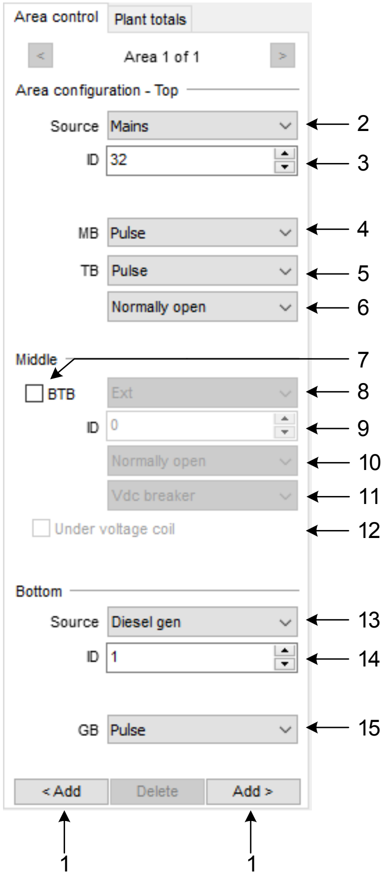
Table 3.4 Select the plant options

	Description	Notes
Product type	Select controller type here.	When connected to a controller, this function is greyed out.
Plant type	• Single DG • Standard	For a 2-level application, the Standard option must always be selected.
Application properties	• Activate the application, when it is written to the controller. • Name the application.	Naming the application can be helpful, if the controller is in a plant where the controller will switch between application designs. The controllers can switch between four different application designs. Controllers connected to each other via the CAN bus communication can not have different application designs or numbers.
Bus tie options	Select the Wrap busbar option.	Activate this option if the busbar is connected as 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 • CAN bus off	Primary CAN must be used, if the Power Management CAN bus is wired to CAN port B on each controller.The CAN bus off option must only be used in configurations where the controller is the only one in the system.

When the plant options have been chosen, the application drawing can be created.

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 with the Utility Software.

Example



1. Add and delete areas.
2. Selects the type of power source to be represented in the top area:
    - None
    - Mains
    - Diesel genset
    - Photovoltaic
    - LG
    - Battery
3. Select the internal command ID:
    - This ID must correspond to the controller ID.
4. Select the breaker type used for Mains breaker:
    - Pulse
    - EX/ATS no control
    - Continuous NE
    - Compact
    - None
    - Continuous ND
5. Select the breaker type for Tie breaker:
    - Pulse
    - Continuous NE
    - Compact
    - None
6. For the Tie breaker, select:
    - Normally open

- Normally closed

7. Tick to add BTB controllers.
8. Select the breaker type for the BTB:
   - Pulse
   - Ext
   - Continuous NE
   - Compact
9. Select the ID for the specific BTB controller.
10. For the specific BTB, select:
    - Normally open
    - Normally closed
11. Select the specific BTB to be:
    - Vdc breaker (the breaker can open and close, when there is no voltage on the busbar).
    - Vda breaker (voltage must be present on the busbar for the breaker to open or close).
12. Tick if the BTB has an under-voltage coil.
13. Select the power source to be represented in the bottom area:
    - None
    - Mains
    - Diesel genset
    - Photovoltaic
    - LG
    - Battery
14. Select the internal command ID:
    - This ID must correspond to the controller ID.
15. Select the breaker type used for Diesel genset breaker:
    - Pulse
    - Continuous NE
    - Compact

After the application drawing is created, press the *Write plant configuration to device* button to send the configuration to the controller connected to the PC. The configuration can then be sent from this controller to all the other controllers by pressing the *Broadcast* button at the Utility Software toolbar.

When the operator has activated the broadcast function, it can also be used to check the CAN lines. The controller 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 connected 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 controllers. You can solve this by pressing the *Broadcast* button again.

4. Basic settings

4.1 Standard functions

4.1.1 Overview of standard functions

The AGC 150 includes many standard functions. Below is an overview of the most important.

Operation modes

- Island operation
- Automatic Mains Failure (AMF)
- Fixed power/base load
- Peak shaving
- Load take-over
- Mains power export
- Power management
- Dry alternator
- Ventilation mode

More information
See **Basic settings, Applications** in this document for more information.

Engine control

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

More information
See **Engine/Generator/Mains, Sequences** in this document for more information.

Generator protections

- 2 x reverse power (ANSI 32R)
- 5 x overload (ANSI 32F)
- 4 x over-current (ANSI 50TD)
- 2 x over-voltage (ANSI 59P)
- 3 x under-voltage (ANSI 27P)
- 3 x over-frequency (ANSI 81O)
- 3 x under-frequency (ANSI 81U)
- Voltage-dependent over-current (ANSI 51V)
- Unbalanced voltage (ANSI 47)
- Unbalanced current (ANSI 48)
- Under-excitation (ANSI 32RV)
- Over-excitation (ANSI 32FV)
- Multi-inputs (digital, 4-20 mA, 0-10 V DC, Pt100, RMI or binary/digital)
- Digital inputs

More information
See **Protections, Generator standard protections** in this document for more information.

Busbar protections

- 3 x over-voltage (ANSI 59P)
- 4 x under-voltage (ANSI 27P)
- 3 x over-frequency (ANSI 81O)
- 3 x under-frequency (ANSI 81U)
- Unbalanced voltage (ANSI 47)

More information
See **Protections, Busbar standard protections** in this document for more information.

Display

- Prepared for remote mounting
- Buttons for start and stop
- Buttons for breaker operations
- Status texts
- Measurement readings
- ECU data
- Alarm indication
- Historical log

More information
See **General product information, Controller overview** in this document for more information.

M-Logic

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

More information
See **General product information, M-Logic** in this document for more information.

4.2 Measurement systems

4.2.1 Measurement systems

The AGC 150 is designed for measurement of voltages in systems with nominal voltages between 100 and 690 V AC. The measurement principle can be changed between three-phase, single-phase and split phase.

More information
See the AC wiring diagrams in **Wirings, AC connections** in the Installation instructions for more information.

CAUTION
Configure the AGC 150 to match the correct measuring system. When in doubt, contact the switchboard manufacturer for information about the required adjustment.

Configure the parameters for the AC connection under **Settings > Basic settings > Measurement setup > Wiring connection > AC configuration**.

Parameter	Text	Range	Default
9131	AC Setup G/M	3 phase 3W4 G/M 2 phase L1/L3 2 phase L1/L2	3 phase 3W4 G/M

Parameter	Text	Range	Default
		1 phase L1 3 phase 3W3 G/M	
9132	AC setup BB	3 phase 3W4 BB 3 phase 3W3 BB	3 phase 3W4 BB

4.2.2 Three-phase system

The three-phase system is the default setting for AGC 150. When this principle is used, all three phases must be connected to the controller.

The following adjustments must be made to make the system ready for the three-phase measuring.

Configure the parameter for Generator/Mains nominal voltage under **Settings > Basic settings > Nominal settings > Voltage > Generator/Mains nominal U**.

Parameter	Text	Range	Adjust to value
6004	Generator/Mains nominal U	100 to 25000 V	U_{NOM}

Configure the parameters for Generator voltage transformer under **Settings > Basic settings > Measurement setup > Voltage transformer > Generator/Mains VT**.

Parameter	Text	Range	Adjust to value
6041	U primary G	100 to 25000 V	Primary VT
6042	U secondary G	100 to 690 V	Secondary VT

Configure the parameter for Busbar nominal voltage under **Settings > Basic settings > Nominal settings > Voltage > Busbar nominal U**.

Parameter	Text	Range	Adjust to value
6053	Busbar voltage	100 to 25000 V	U_{NOM}

Configure the parameters for Busbar voltage transformer under **Settings > Basic settings > Measurement setup > Voltage transformer > Busbar VT**.

Parameter	Text	Range	Adjust to value
6051	U primary BB	100 to 25000 V	Primary VT
6052	U secondary BB	100 to 690 V	Secondary VT

NOTE AGC 150 has two sets of busbar transformer settings, which can be enabled individually in this measurement system.

4.2.3 Split-phase system

The split-phase system is a special application, where two phases and neutral are connected to the AGC 150. The controller shows phases L1 and L2/L3 in the display. The phase angle between L1 and L3 is 180 °. 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).

Configure the parameter for Generator nominal voltage under **Settings > Basic settings > Nominal settings > Voltage > Generator nominal U**.

Parameter	Text	Range	Adjust to value
6004	Generator nominal U	100 to 25000 V	120 V AC

Configure the parameters for Generator voltage transformer under **Settings > Basic settings > Measurement setup > Voltage transformer > Generator VT**.

Parameter	Text	Range	Adjust to value
6041	U primary G	100 to 25000 V	U_{NOM}
6042	U secondary G	100 to 690 V	U_{NOM}

Configure the parameter for Busbar nominal voltage under **Settings > Basic settings > Nominal settings > Voltage > Busbar nominal U**.

Parameter	Text	Range	Adjust to value
6053	Busbar voltage	100 to 25000 V	U_{NOM}

Configure the parameters for Busbar voltage transformer under **Settings > Basic settings > Measurement setup > Voltage transformer > Busbar VT**.

Parameter	Text	Range	Adjust to value
6051	U primary BB	100 to 25000 V	U_{NOM}
6052	U secondary BB	100 to 690 V	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.

NOTE AGC 150 has two sets of busbar transformer settings, which can be enabled individually in this measurement system.

4.2.4 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).

Configure the parameter for Generator nominal voltage under **Settings > Basic settings > Nominal settings > Voltage > Generator nominal U**.

Parameter	Text	Range	Adjust to value
6004	Generator voltage	100 to 25000 V	230 V AC

Configure the parameters for Generator voltage transformer under **Settings > Basic settings > Measurement setup > Voltage transformer > Generator VT**.

Parameter	Text	Range	Adjust to value
6041	U primary G	100 to 25000 V	$U_{NOM} \times \sqrt{3}$
6042	U secondary G	100 to 690 V	$U_{NOM} \times \sqrt{3}$

Configure the parameter for Busbar nominal voltage under **Settings > Basic settings > Nominal settings > Voltage > Busbar nominal U**.

Parameter	Text	Range	Adjust to value
6053	Busbar voltage	100 to 25000 V	$U_{NOM} \times \sqrt{3}$

Configure the parameters for Busbar voltage transformer under **Settings > Basic settings > Measurement setup > Voltage transformer > Busbar VT**.

Parameter	Text	Range	Adjust to value
6051	U primary BB	100 to 25000 V	$U_{NOM} \times \sqrt{3}$
6052	U secondary BB	100 to 690 V	$U_{NOM} \times \sqrt{3}$

NOTE
- The voltage alarms refer to U_{NOM} (230 V AC).
- The AGC 150 has two sets of busbar transformer settings, which can be enabled individually in this measurement system.

4.3 Nominal settings

4.3.1 Nominal settings

The AGC 150 holds four sets of nominal settings for the generator and two sets for the busbar. The four sets of nominal generator settings can be individually configured.

Choose a set of nominal settings under **Settings > Alternative configuration > Generator nominal settings**.

Parameter	Text	Range	Default
6006	Nominal settings selection	1 to 4	1

Switch between the nominal settings

Switching between the four sets of nominal settings can be made in different ways:

1. **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. For 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

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

Event A		Event B		Event C	Output
Button07	or	Not used	or	Not used	Set nom. parameter settings 1
Button 08	or	Not used	or	Not used	Set nom. parameter settings 2

3. **Menu settings**: on the controller or with the Utility Software.

4.3.2 Default nominal settings

The default nominal settings are settings 1. Configure the default nominal settings under **Settings > Basic settings > Nominal settings**.

Parameter	Text	Range	Default
6001	Frequency Nom. f	48.0 to 62.0 Hz	50 Hz
6002	Power Nom. P	10 to 20000 kW	480 kW
6003	Current Nom. I	0 to 9000 A	867 A
6004	Generator nominal U	100 to 25000 V	400 V
6005	Setpoint Nom. rpm	100 to 4000 RPM	1500 RPM
6007	4th current Nom. I	0 to 9000 A	867 A
6053	Busbar nominal U	100 to 25000 V	400 V
6055	4th current Nom. P	10 to 9000 kW	480 kW

4.3.3 Alternative nominal settings

Generator nominal settings 2, 3 and 4

Configure the generator nominal settings 2, 3 and 4 under **Settings > Alternative config. > Generator nominal settings > Nominal settings # > Basic settings**, where # is 2, 3 or 4.

Parameter	Text	Range	Default
6011, 6021 or 6031	Frequency Nom. f	48.0 to 62.0 Hz	50 Hz
6012, 6022 or 6032	Power Nom. P	10 to 20000 kW	480 kW
6013, 6023 or 6033	Current Nom. I	0 to 9000 A	867 A
6014, 6024 or 6034	Generator nominal U	100 to 25000 V	400 V
6015, 6025 or 6035	Setpoint Nom. rpm	100 to 4000 RPM	1500 RPM
6017, 6027 or 6037	4th current Nom. I	0 to 9000 A	867 A

Configure the nominal settings for GOV/AVR offset under **Settings > Alternative config. > Generator nominal settings > Nominal settings # > Offset ctrl. signals**, where # is 2, 3 or 4.

Parameter	Text	Range	Default
2552, 2553 or 2554	GOV output offset	0 to 100 %	50 %
2672, 2673 or 2674	AVR output offset	0 to 100 %	50 %

Busbar nominal settings 2

The AGC 150 holds two sets of nominal settings for the busbar. 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.

Select the type of busbar nominal settings under **Settings > Alternative config. > Busbar nominal settings > Nom. set. selection**.

Parameter	Text	Range	Default
6054	Nominal settings selection	Nominal setting 1 Nominal setting 2 BB Unom = G Unom	Nominal setting 1

If no voltage transformer is installed between generator and busbar, select BB U_{NOM} = G U_{NOM}. 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.

Configure the busbar nominal settings 2 under **Settings > Alternative config. > Busbar nominal settings > Nominal settings 2**.

Parameter	Text	Range	Default
6061	Busbar primary U	100 to 25000 V	400 V
6062	Busbar secondary U	100 to 690 V	400 V
6063	BB nominal U	100 to 25000 V	400 V
6064	4th CT Power	10 to 9000 kW	230 kW

4.3.4 Scaling

Default voltage scaling is set within the range of 100 V to 25000 V. To be able to handle applications above 25000 V and below 100 V, it is necessary to adjust the input range to match the actual value of the primary voltage transformer. This makes it possible for the controller to support a wide range of voltage and power values.

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

Configure the parameters for scaling under **Settings > Basic settings > Measurement setup > Scaling**.

Parameter	Text	Range	Default
9031	Scaling	10 to 2500 V 100 to 25000 V 10 to 160000 V 0.4 to 75000 V	100 to 25000 V

NOTE
- For the best regulation performance, 10 to 2500 V scaling is recommended for generators up to 150 kVA.
- For the best regulation performance, 100 to 25000 V scaling is recommended for generators over 150 kVA.
- All nominal values and the primary VT settings must be corrected after the scaling has been changed.

4.4 Applications

4.4.1 Applications and genset modes

Application modes

An application can consist of a single controller or of more controllers. You can develop various applications by using the Application configuration menu in the Utility Software.

The AGC 150 is designed to handle applications with up to 32 gensets. The application can be handled with controllers in two levels: plant level and genset level.

The AGC 150 can be used for the following standard application modes:

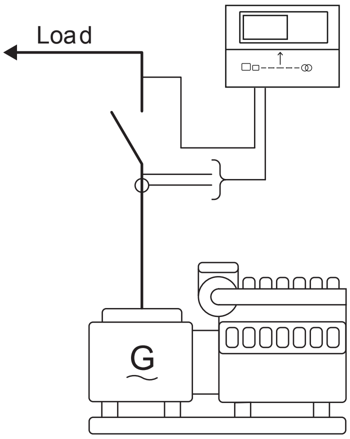
Genset mode	AUTO	SEMI-AUTO	Test	Manual	Block
Island operation	x	x	x	x	x
Automatic Mains Failure	x	x	x	x	x
Load take-over	x	x	x	x	x
Fixed power/base load	x	x	x	x	x
Mains power export	x	x	x	x	x
Peak shaving	x	x	x	x	x

Genset mode	AUTO	SEMI-AUTO	Test	Manual	Block
Multiple gensets, load sharing (analogue load sharing)	x	x	x	x	x
Multiple gensets, power management	x	x	x	x	x

More information
See **Basic settings, Running mode description** in this document for more information.

4.4.2 Island operation

Figure 4.1 Island mode single-line diagram



AUTO mode

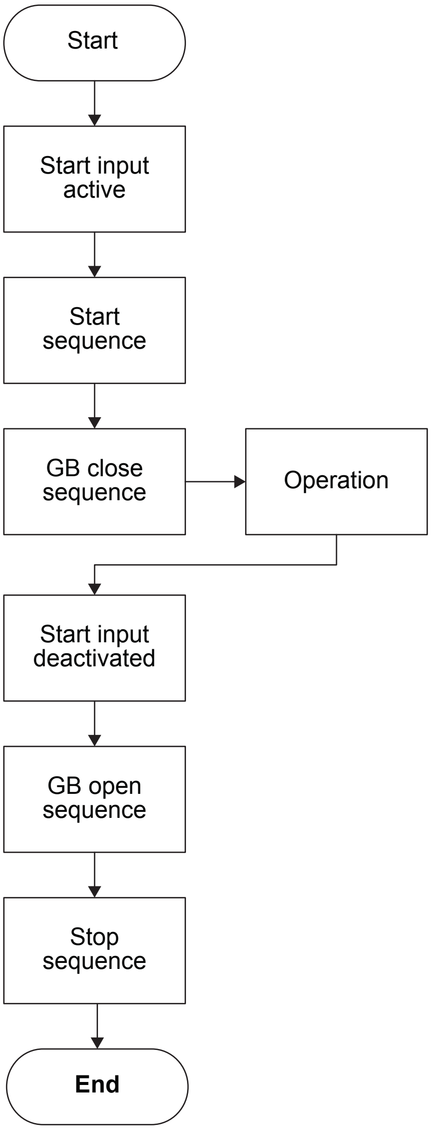
AGC 150 automatically starts the genset and closes the generator breaker at a digital start command. When the stop command is given, the generator breaker is tripped, and the genset will be stopped after a cooling down period. The start and stop commands are used by activating and deactivating a digital 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

When the generator breaker is closed, the controller will use the nominal frequency as set point for the speed governor. If AVR control is selected, the nominal voltage is used as set point.

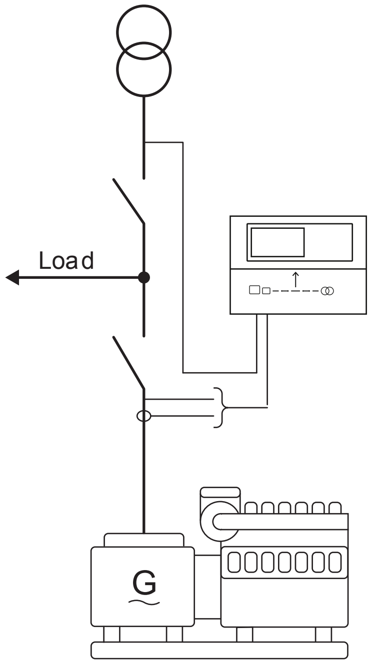
More information
See **Basic settings, Running mode description** in this document for more information.

Island operation flowchart



4.4.3 AMF (Automatic Mains Failure)

Figure 4.2 Automatic Mains Failure single-line diagram



AUTO mode

The AGC 150 automatically starts the genset and switches to generator supply at a mains failure after an adjustable delay time. It is possible to adjust the controller 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 controller will synchronise the mains breaker to the busbar when the Mains OK delay has expired. Then the genset cools down and stops.

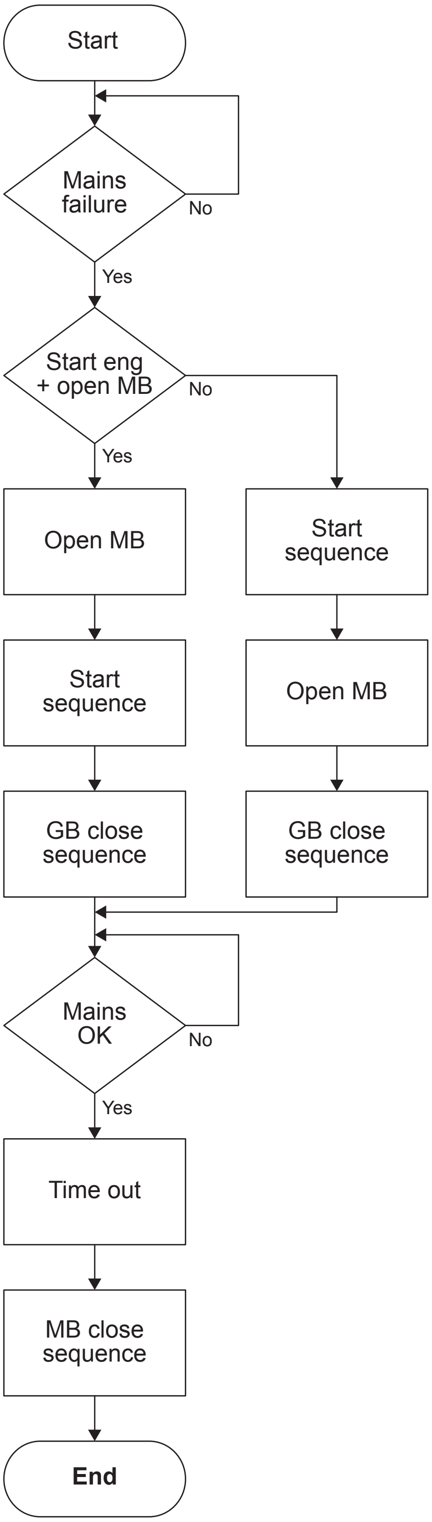
SEMI-AUTO mode

When the generator breaker is closed and the mains breaker is opened, the controller will use the nominal frequency as the set point for the speed governor. If AVR control 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 is selected, the set point will be the adjusted power factor.

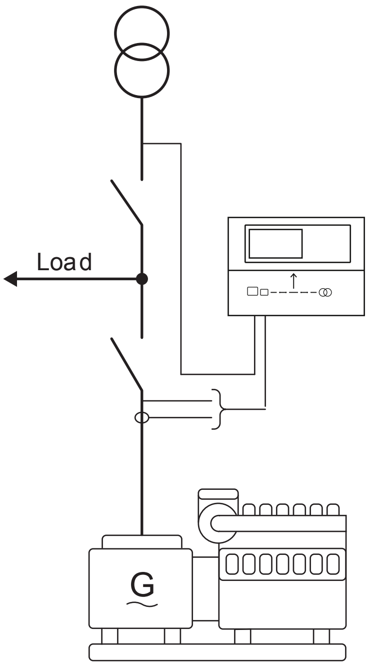
More information
See **Basic settings, Running mode description** in this document for more information.

Automatic Mains Failure flowchart



4.4.4 LTO (Load take-over)

Figure 4.3 Load take-over single-line diagram

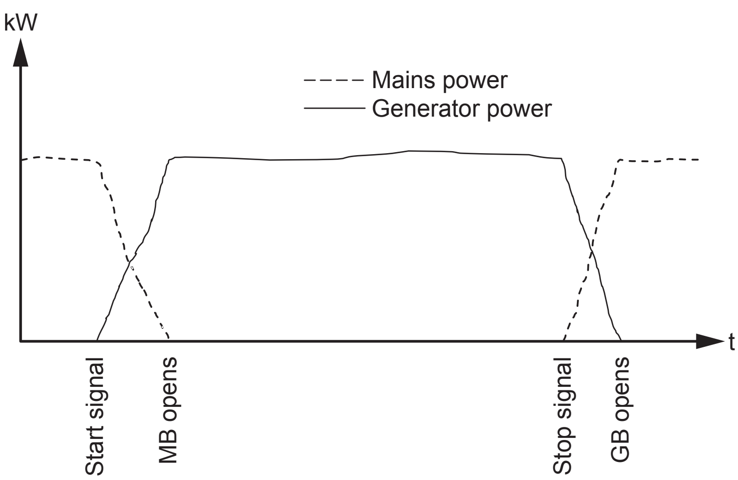


AUTO mode

With back synchronising ON:

- The load take-over mode transfers 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, and the mains breaker opens.
- When the stop command is given, the mains breaker is synchronised to the busbar and after closure the genset is de-loaded, cooled down and stopped.
- A 4-20 mA transducer or 4th CT is used for indication of the power imported from the mains.

Figure 4.4 Load take-over example



With 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.
- The generator supplies the load until the stop command is given.

- The generator breaker opens and the mains breaker closes.
- The genset cools down and stops.

NOTE If the imported load is higher than the nominal genset power, an alarm appears and the load take-over sequence is paused.

SEMI-AUTO mode

When the generator breaker is closed and the mains breaker is opened, the controller will use the nominal frequency as set point for the speed governor. If AVR control is selected, the nominal voltage is used as set point.

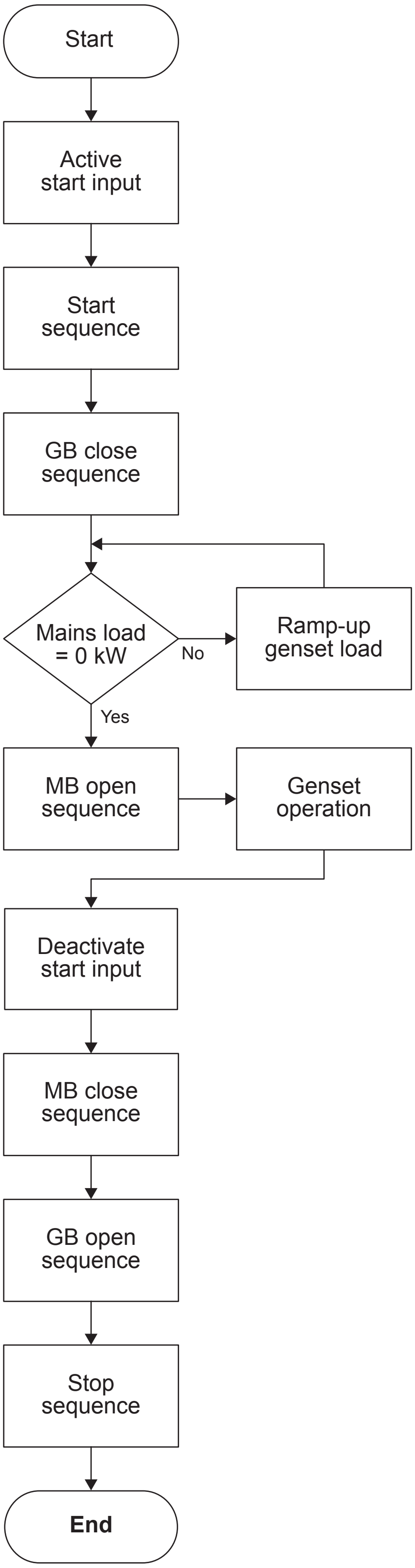
When the generator is paralleled to the mains, it will be controlled so the imported power from the mains will be kept at 0 kW. If AVR control is selected, the set point will be the adjusted power factor.

Configure the Power factor parameter under **Settings > Power set points > Cos phi or Q**.

Parameter	Text	Range	Default
7052	Cos phi Set	0.60 to 1.00	1.00
7053	Type	Inductive Capacitive	Capacitive
7054	Reac power set	-100 to 100 %	0 %
7055	Type	OFF Superior (PMS) Fixed Q	OFF

More information
See **Basic settings, Running mode description** in this document for more information on available running modes.

Load take-over flowchart



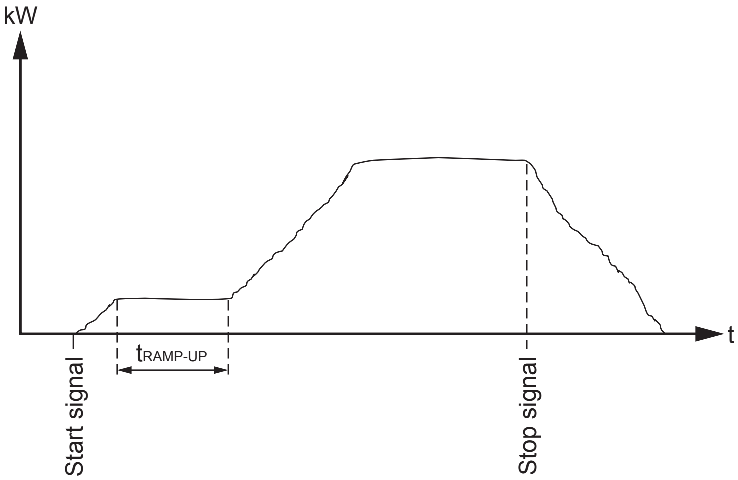
4.4.5 Fixed power/Base load

Fixed power in AUTO mode

The AGC 150 automatically starts the genset and synchronises to the mains, when the digital input Auto start/stop is activated. After the generator breaker closes, the controller ramps up the load to the set point level. When the stop command is given, the genset is de-loaded and stopped after the cooling down period.

The start/stop commands is given by a digital input, or by the time-dependent start/stop commands. AUTO mode must be selected, if the time-dependent start/stop commands are used.

Figure 4.5 Fixed power principle



Fixed power in SEMI-AUTO mode

When the generator breaker is closed and the mains breaker is opened, the controller uses the nominal frequency as set point for the speed governor. If AVR control is selected, the nominal voltage is used as set point.

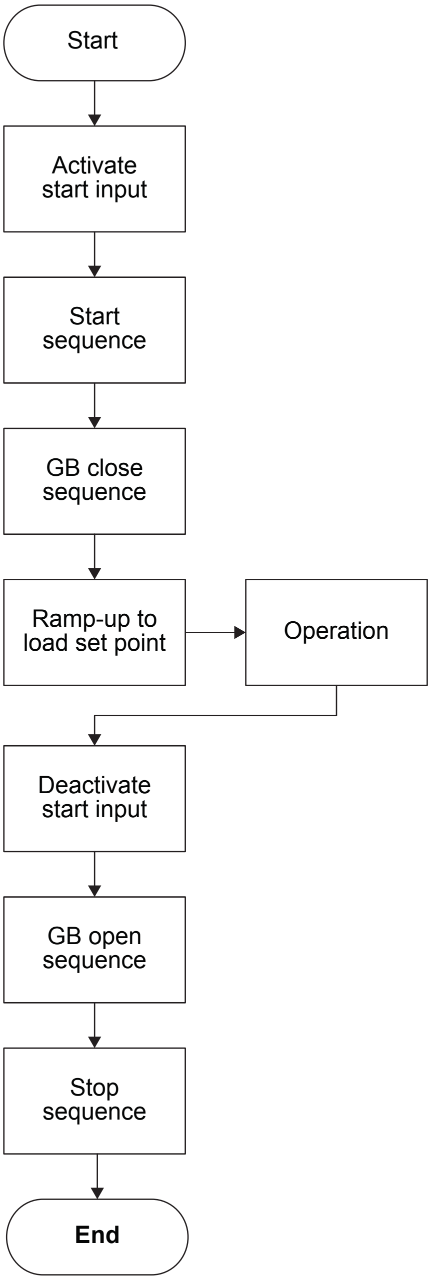
When the generator is paralleled to the mains, the generator power will be increased to the fixed power set point. If AVR control is selected, the set point will be the adjusted power.

Configure the Fixed power factor under **Settings > Power set points > Fixed power**.

Parameter	Text	Range	Default
7051	Fixed power set	0 to 100 %	100 %

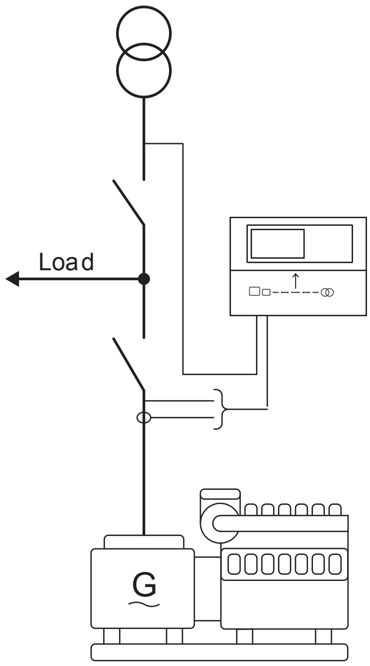
More information
See **Basic settings, Running mode description** in this document for more information about available running modes.

Fixed power flow chart



4.4.6 MPE (Mains power export)

Figure 4.6 Mains power export single-line diagram



AUTO mode

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.

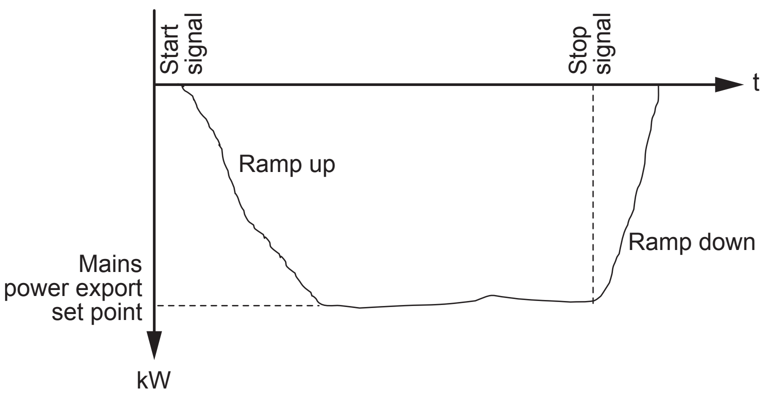
If a fixed level of imported power must be used, it is still the mains power export mode that must be selected! This mode covers import as well as export.

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 de-load and trip the generator breaker. Afterwards, it will cool down and stop.

A 4-20 mA transducer or 4th CT is used for indication of the power exported from the mains.

Figure 4.7 Mains power export example



NOTE 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

When the generator breaker is closed and the mains breaker is opened, the controller will use the nominal frequency as set point for the speed governor. If AVR control is selected, the nominal voltage is used as set point.

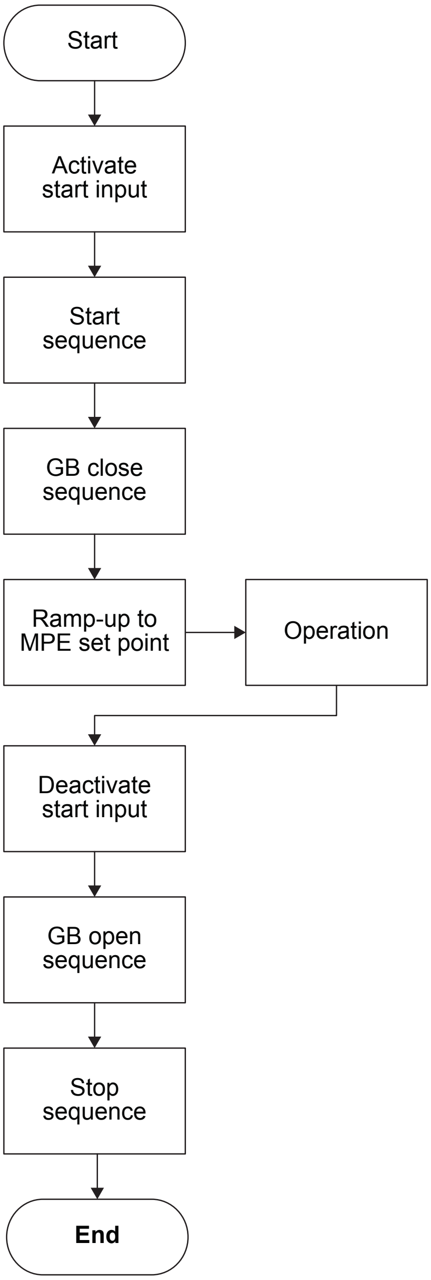
When the generator is paralleled to the mains, it will be controlled according to the mains power export set point. If AVR control is selected, the set point will be the adjusted power factor.

Configure the power factor parameter under **Settings > Power set points > Cos phi or Q**.

Parameter	Text	Range	Default
7052	Cos phi Set	0.60 to 1.00	1.00
7053	Type	Inductive Capacitive	Capacitive
7054	Reac power set	-100 to 100 %	0 %
7055	Type	OFF Superior (PMS) Fixed Q	OFF

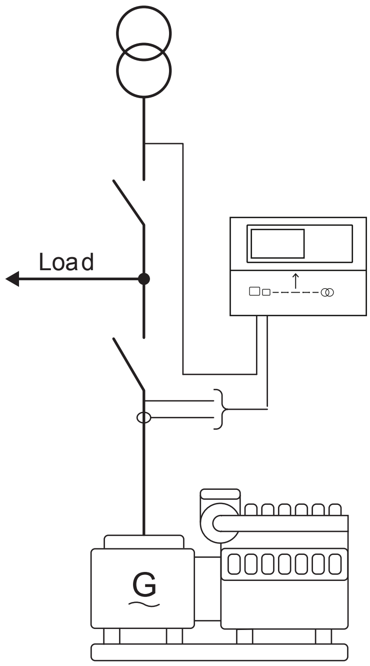
More information
See **Basic settings, Running mode description** in this document for more information on available running modes.

Mains power export flowchart



4.4.7 Peak shaving

Figure 4.8 Peak shaving single-line diagram



AUTO mode

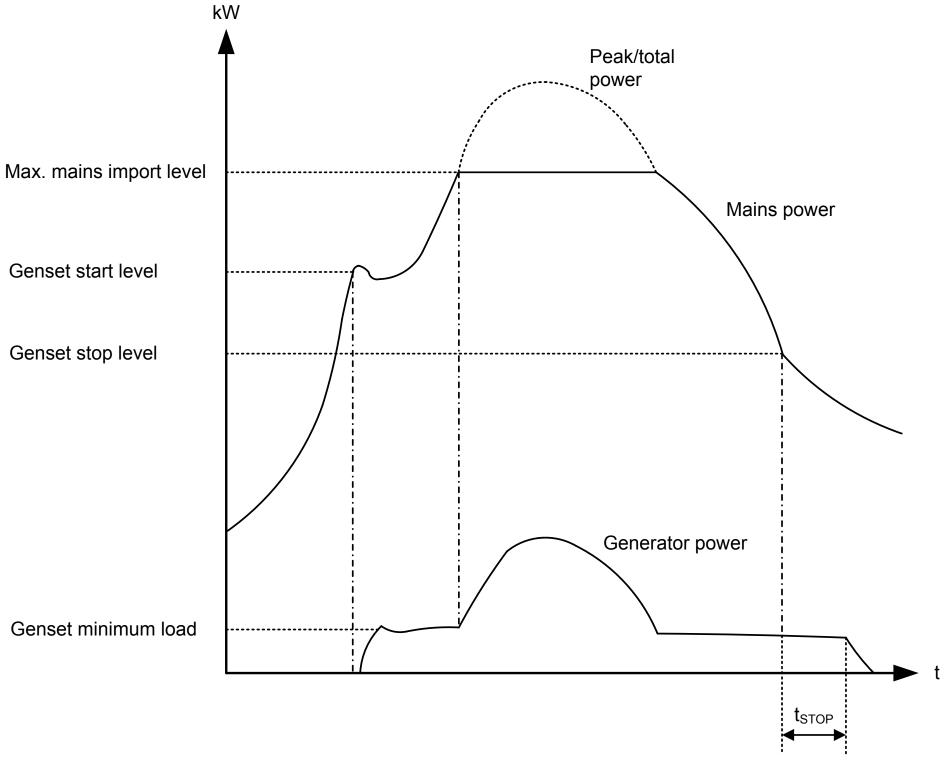
The genset will start at a predefined mains import level and run at a fixed minimum load, for example 10 %. When the mains import increases above the maximum mains import set point, the genset will supply the extra load in order to maintain the mains import at the maximum import level.

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 or the 4th CT is used for indication of the power imported from the mains.

More information
See **Power management, Power transducers** in this document for more information on mains transducer.

Figure 4.9 Peak shaving example



SEMI-AUTO mode

When the generator breaker is closed and the mains breaker is opened, the controller will use the nominal frequency as set point for the speed governor. If AVR control is selected, the nominal voltage is used as set point.

When the generator is parallel to the mains, the generator will be controlled according to the peak shaving set point. The maximum mains import will not be exceeded in spite of the SEMI-AUTO mode. If AVR control is selected, the set point will be the adjusted power factor.

Configure the power factor parameter under **Settings > Power set points > Cos phi or Q**.

Parameter	Text	Range	Default
7052	Cos phi Set	0.60 to 1.00	1.00
7053	Type	Inductive Capacitive	Capacitive
7054	Reac power set	-100 to 100 %	0 %
7055	Type	OFF Superior (PMS) Fixed Q	OFF

Configure the day/night power settings under **Settings > Power set points > MPE/Peak shaving > Day/Night power set.**.

Parameter	Text	Range	Default
7001	Mains power, Day	-20000 to 20000kW	750 kW
7002	Mains power, Night	-20000 to 20000kW	1000 kW
7021	Start generator set point	5 to 100 %	80 %
7023	Start generator min. load	0 to 100 %	5 %
7031	Stop generator set point	0 to 80 %	60 %

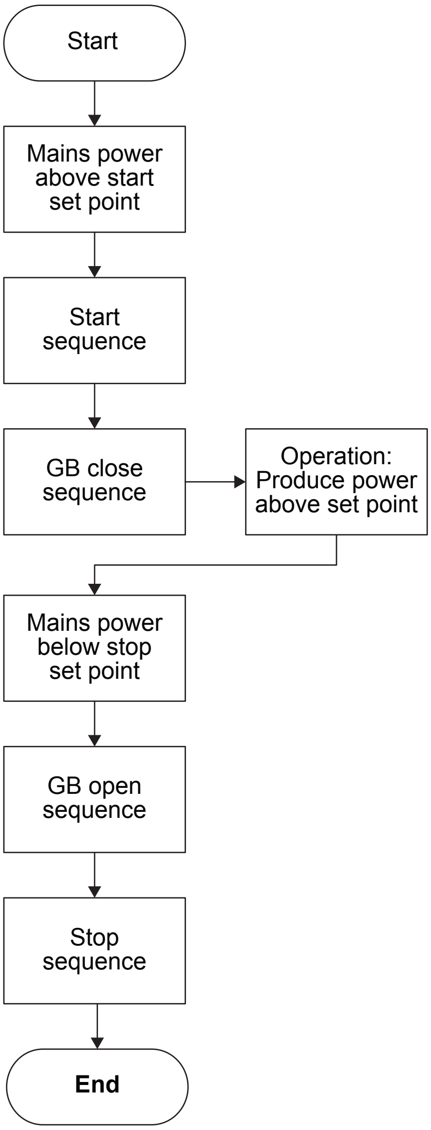
Configure the day/night settings under **Settings > Power set points > MPE/Peak shaving > Day/Night settings**.

Parameter	Text	Range	Default
7011	Daytime period, start hour	0 to 23	8
7012	Daytime period, start min.	0 to 59	0
7013	Daytime period, stop hour	0 to 23	16
7014	Daytime period, stop min.	0 to 59	0

*Note: With power management the load-dependent start and stop parameters are used.

More information
See **Basic settings, Running mode description** in this document for more information on available running modes.

Peak shaving flowchart



4.4.8 Multiple gensets, load sharing

Figure 4.10 Analogue load sharing (with optional IOM 230 external box)

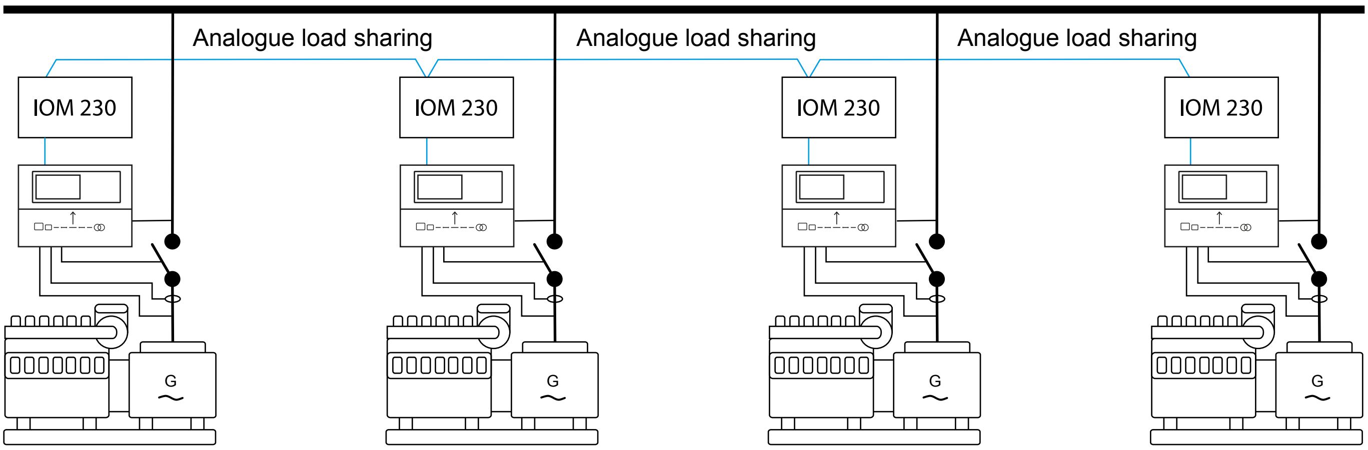


Figure 4.11 Analogue load sharing with 3rd party controllers

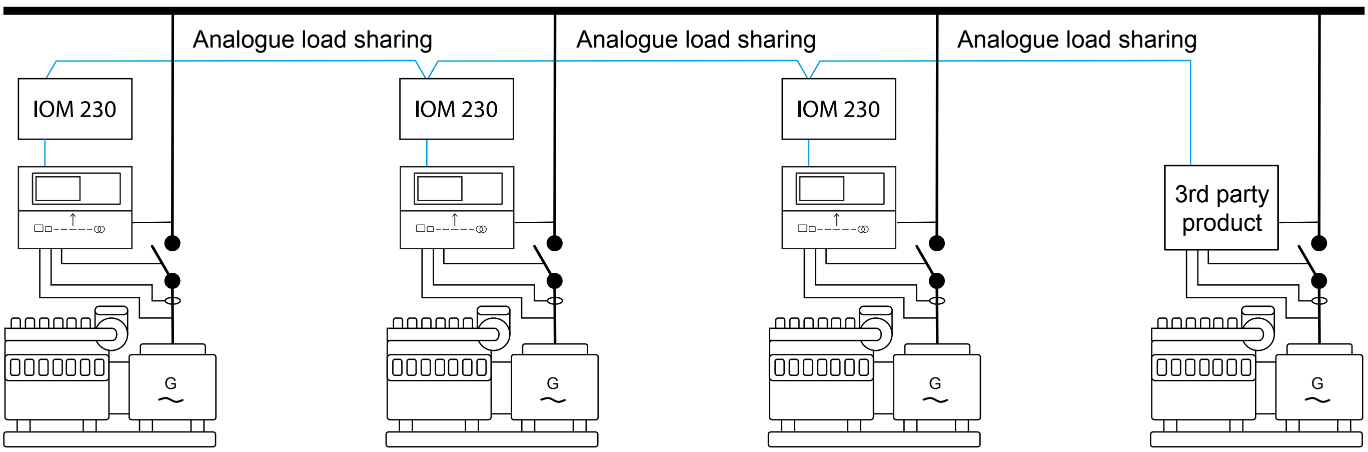
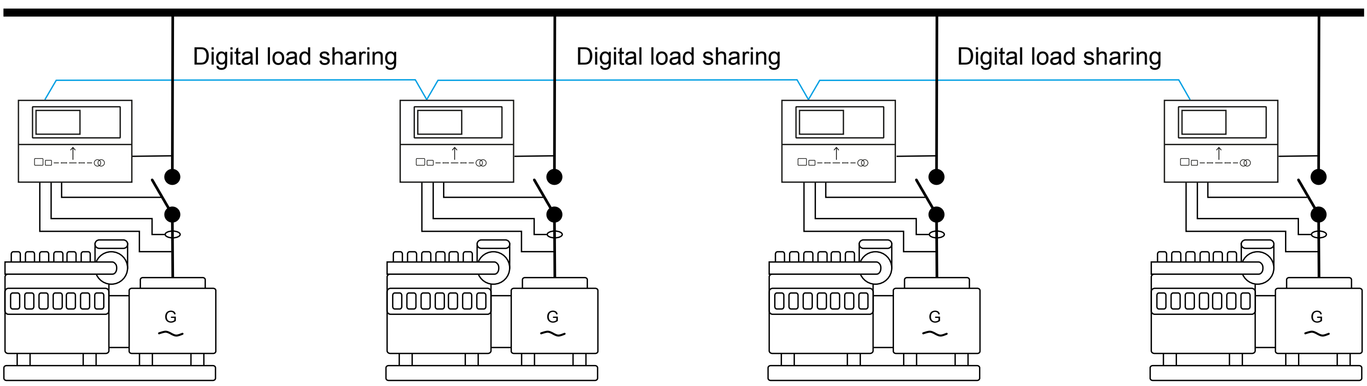


Figure 4.12 Digital load sharing (CANshare)



4.4.9 Multiple gensets, power management

Figure 4.13 Island mode application

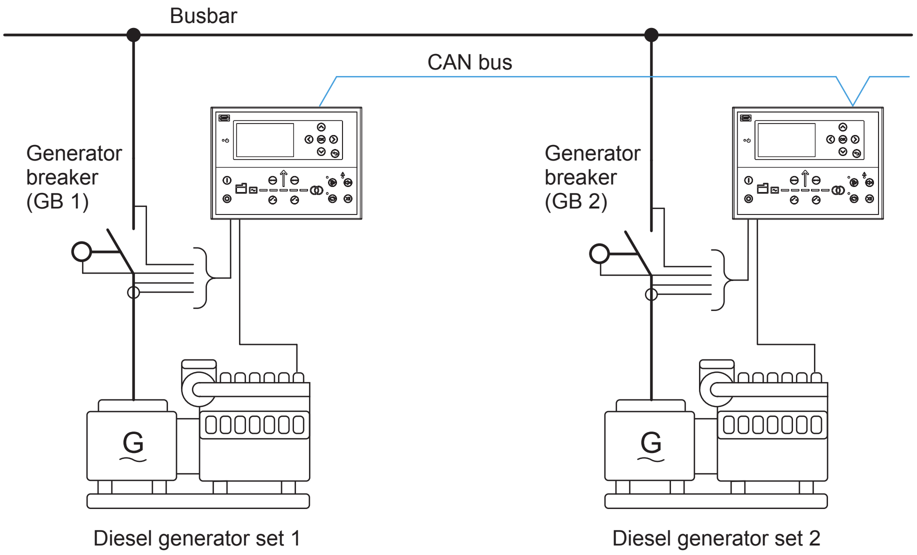


Figure 4.14 Parallel to mains application

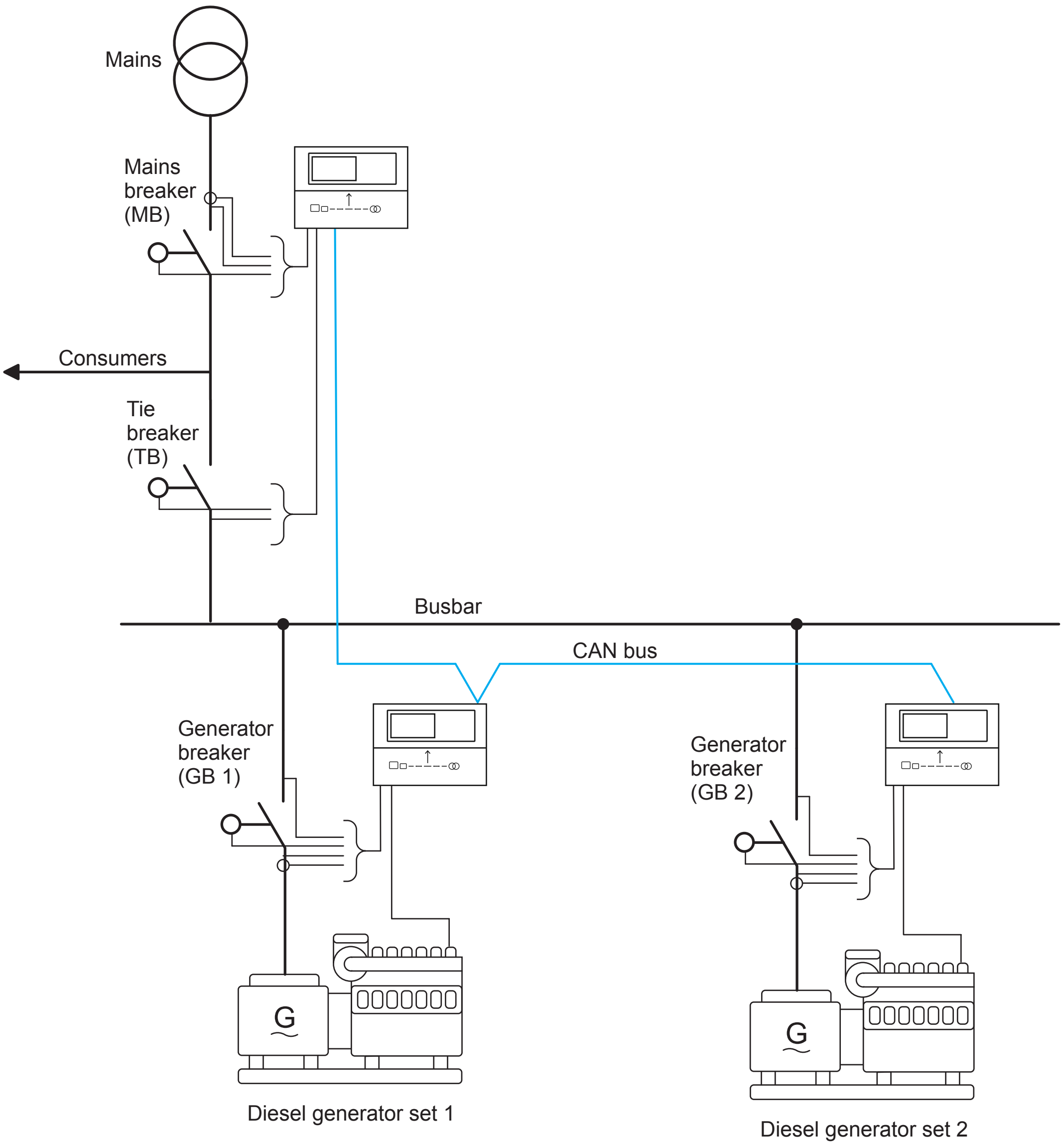
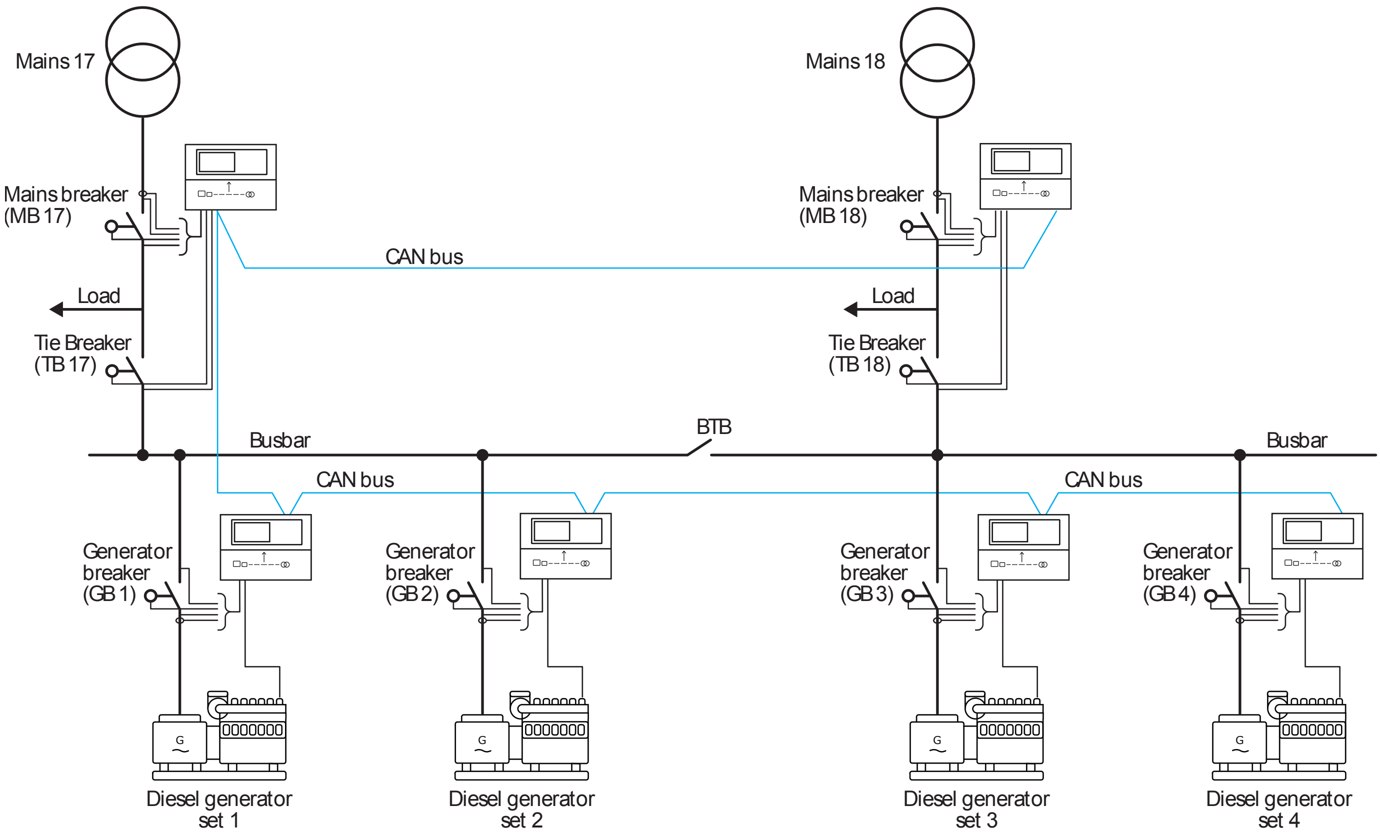
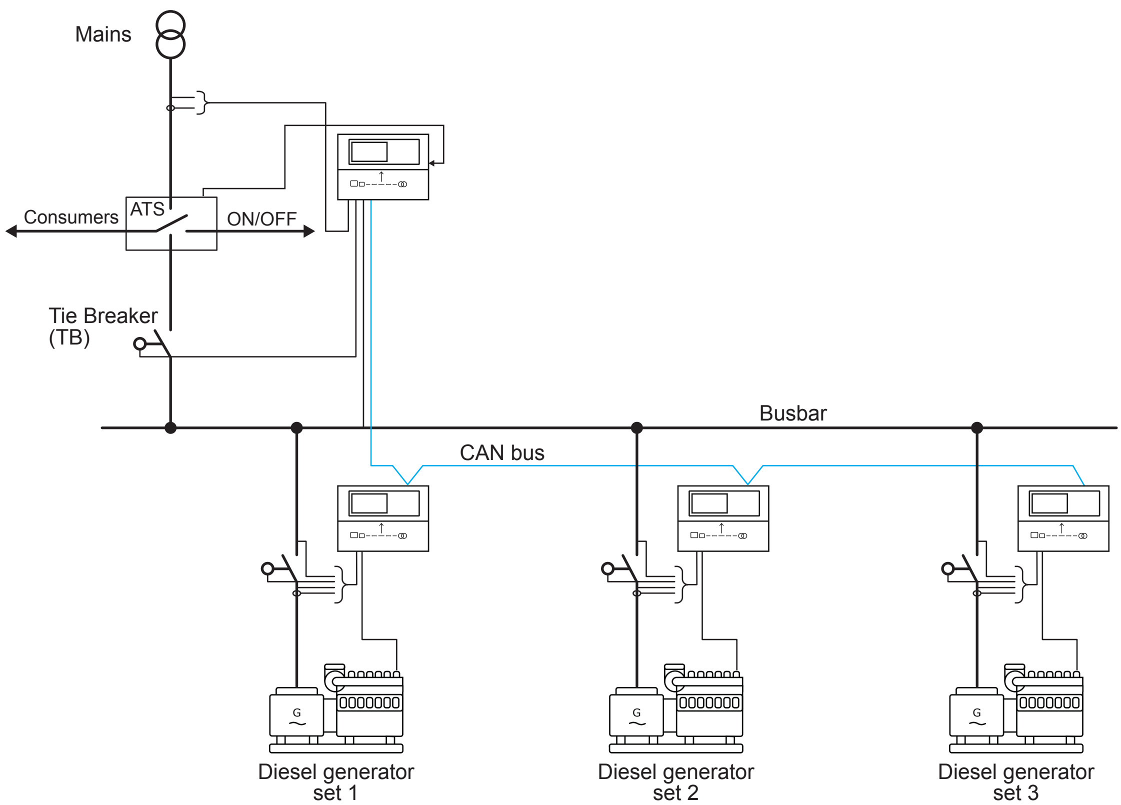


Figure 4.15 Multi-mains with two mains, two tie breakers, one bus tie breaker and four gensets



INFO
The diagram shows four generators, but the system supports up to 32 connected genset or mains controllers.

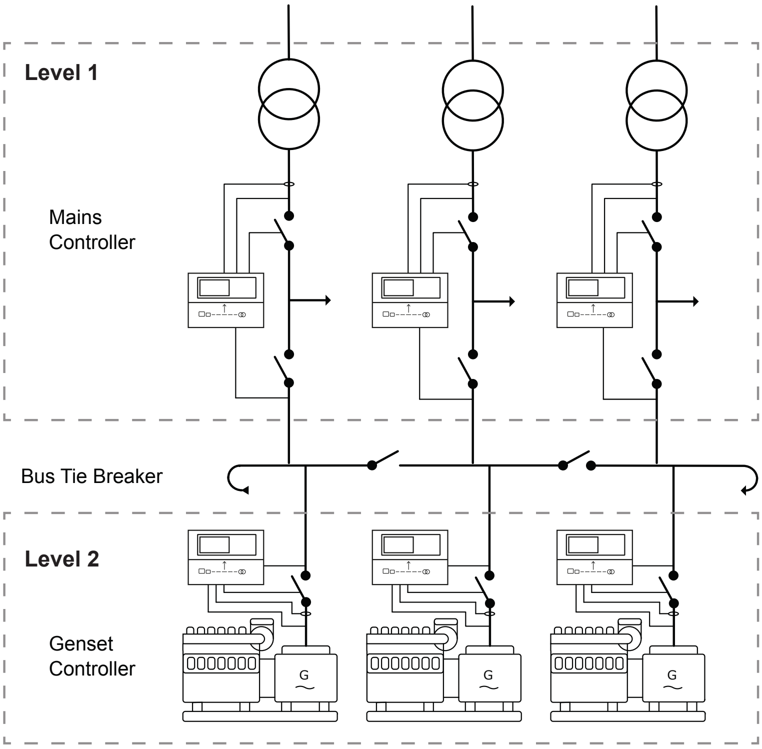
Figure 4.16 ATS plant, mains unit



4.4.10 2-level power management applications

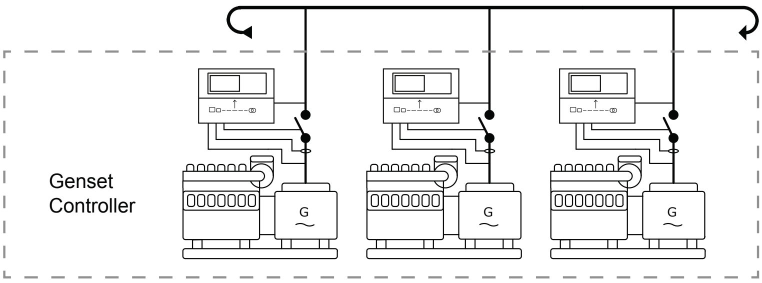
The AGC 150 can handle different applications as 2-level applications.

Example 1



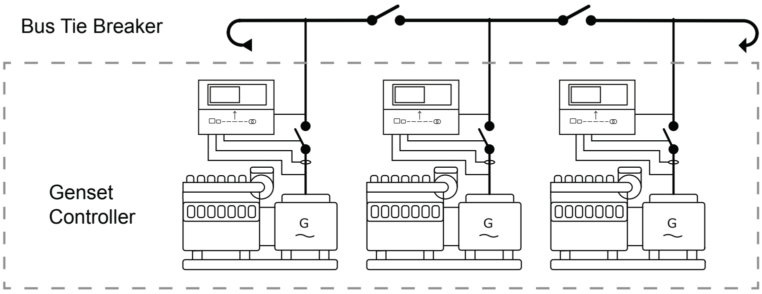
- The plant includes mains controllers, bus tie breakers (BTB) and gensets.
- The feedbacks from the externally controlled BTBs must be wired to the AGC 150 controller.
- The busbar is wrapped, but this is not a requirement.
- In this example, the gensets are able to run in parallel to the grid and export a fixed load.

Example 2



- Island application.
- The AGC 150 controllers communicates with each other to perform some power management.
- If one controller is having a problem or is taken out for a service, the other controllers will take over.
- The busbar is wrapped, but this is not a requirement.
- In this example, the gensets will only be able to run in island mode.

Example 3



- Island application with bus tie breakers.
- The busbar is wrapped, but this is not a requirement.
- In this example, the gensets will only be able to run in island mode.

For all examples, 32 gensets/plants are maximum.

4.5 Running mode description

4.5.1 Mode overview

AGC 150 has four different running modes and one block mode:

- **AUTO**: In AUTO mode, the controller 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 buttons, Modbus commands or digital inputs. When started in SEMI-AUTO 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 digital increase/decrease inputs can be used (if they have been configured) as well as the *Start* and *Stop* buttons. When starting in Manual mode, the genset will start without any subsequent regulation.
- **Block**: When the block mode is selected, the controller 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.

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

4.5.2 SEMI-AUTO mode

AGC 150 can be operated in SEMI-AUTO mode. This means that the controller 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. Buttons on the display are used
2. Digital inputs are used
3. Modbus command

NOTE The AGC 150 is only equipped with a limited number of digital inputs. Please refer to **Digital inputs, DI** in this document for additional information about availability.

When the genset is running in SEMI-AUTO mode, AGC 150 will control the speed governor and the AVR.

Table 4.1 SEMI-AUTO mode commands

Command	Description	Notes
Start	The start sequence is initiated and continues until the genset starts or the maximum number of start attempts is reached. The	

Command	Description	Notes
	frequency (and voltage) will be regulated to make the GB ready to close.	
Stop	The genset is stopped. Without the running signal, the stop sequence continues 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 controller closes 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 selected, the controller will not regulate after breaker closure.
Open GB	The controller ramps down and opens the generator breaker at the Breaker open point if the mains breaker is closed. The controller opens the generator breaker instantly if the mains breaker is open or the genset mode is island mode.	
Close MB	The controller closes the mains breaker if the generator breaker is open, or synchronises and closes the mains breaker if the generator breaker is closed.	
Open MB	The controller 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.	
Manual AVR DOWN	The regulator is deactivated and the governor output is activated as long as the AVR input is ON.	

4.5.3 Test mode

The test mode function is activated by selecting test with the *Shortcut* button on the display or by activating a digital input.

Configure the Test mode parameters under **Settings > Power set points > Test**.

Parameter	Text	Range	Default
7041	Set point	1 to 100	1
7042	Timer	0.0 to 999.0 min	0.0 min
7043	Return mode	DG: • SEMI-AUTO • AUTO • Manual • No mode change Mains: • SEMI-AUTO • AUTO • No mode change	DG: No change Mains: AUTO
7044	Type	Simple test Load test Full test	Simple test

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

- If the DG controller 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.

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.

Load test

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

Full test

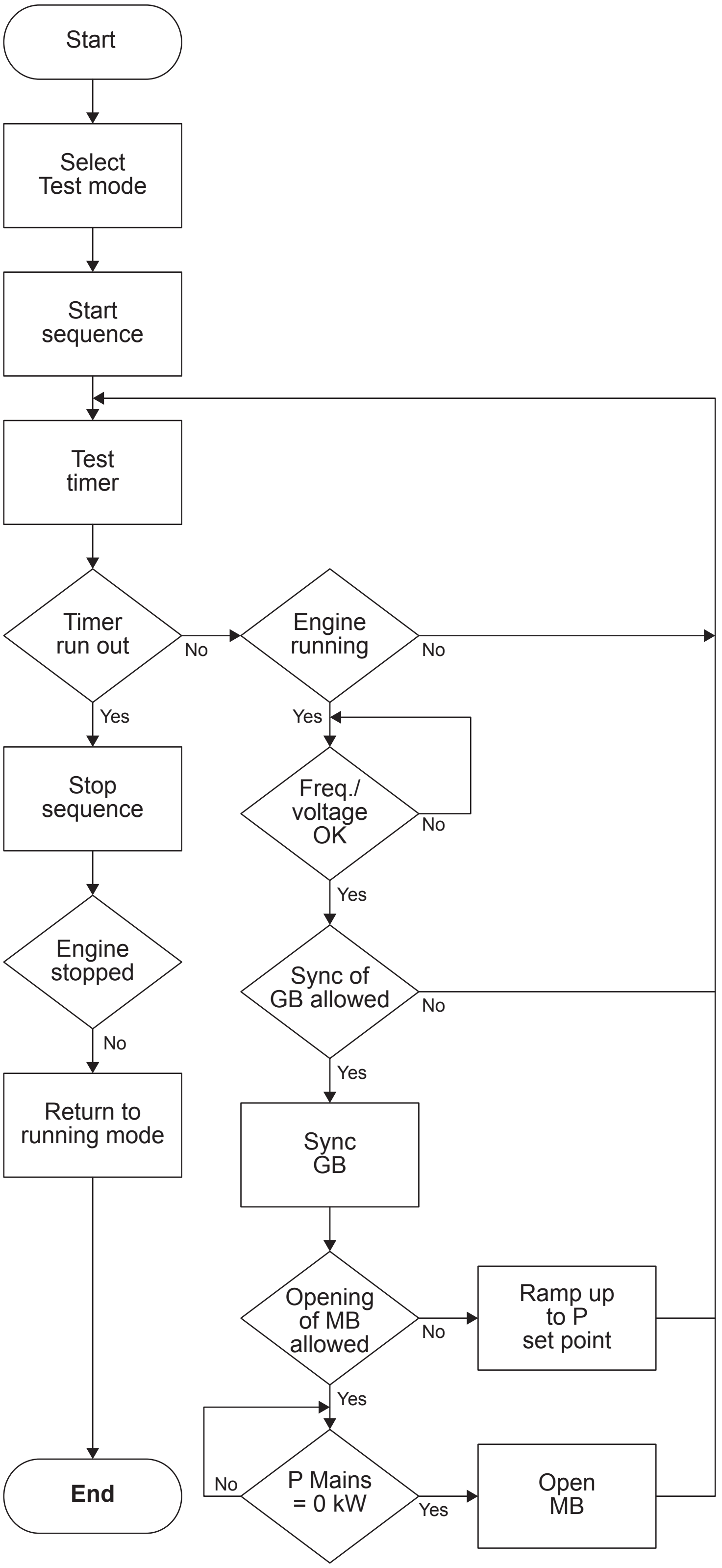
The full test will start the genset and run it at nominal frequency, synchronise the generator breaker and transfer the load to the generator before opening the mains breaker. When the test timer expires, the mains breaker will be synchronised and the load is transferred back to the mains before the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

Sync. to mains

To run a Load test or a Full test, the parameter Sync. to mains must be enabled under **Settings > Synchronisation > Mains parallel settings > Sync. to mains**.

Parameter	Text	Range	Default
7084	Sync. to mains	OFF ON	OFF

Test sequence flowchart



4.5.4 Manual mode

When Manual mode is selected, the genset can be controlled from the display and with digital inputs.

Table 4.2 Manual mode commands

Command	Description	Notes
Start	The start sequence is initiated and continues until the genset starts or the maximum number of start attempts are reached.	No regulation
Stop	The genset is stopped. Without the running signal, the stop sequence continues to be active in the Extended stop time period. The genset is stopped with cooling down time.	
Close GB	The controller closes the generator breaker if the mains breaker is open, and synchronises and closes the generator breaker if the mains breaker is closed.	No regulation Sync. failure is deactivated
Open GB	The controller opens the generator breaker instantly.	
Close MB	The controller closes the mains breaker if the generator breaker is open, and synchronises and closes the mains breaker if the generator breaker is closed.	No regulation Sync. failure is deactivated
Open MB	The controller opens the mains breaker instantly.	
Manual GOV UP	The controller gives increase signal to the speed governor.	
Manual GOV DOWN	The controller gives decrease signal to the speed governor.	
Manual AVR UP	The controller gives increase signal to the AVR.	
Manual AVR DOWN	The controller gives decrease signal to the AVR.	

NOTE Both the generator breaker and the mains breaker can be opened and closed in Manual mode.

4.5.5 Block mode

When the block mode is selected, AGC 150 is locked for certain actions. This means that the controller 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.

If the digital inputs are used to change the mode, it is important that the input configured to Block mode is a constant signal:

- When the signal is ON, the controller is blocked.
- When the signal is OFF, the controller returns to the mode selected before block mode.

If block mode is selected using the display after the digital block input is activated, the AGC 150 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. Alarms are not influenced by block mode selection.

CAUTION

- 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.
- 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.

4.6 Language selection

4.6.1 Language selection

The AGC 150 can show several languages. The default master language is English, which cannot be changed. 11 different languages can be configured with the Utility Software.

The configured languages can be selected from the display under **Settings > Basic settings > Controller settings > Language**.

Parameter	Text	Range	Default
6081	Language selection	English Language 1 to 11	English

5. Engine/Generator/Mains

5.1 Sequences

5.1.1 Sequences

The sequences of the engine, the generator breaker and, if installed, the mains breaker are automatically initiated if the AUTO mode is selected, or if the commands are selected in the SEMI-AUTO mode. The sequences for AGC 150 are:

- START sequence
- STOP sequence
- Breaker sequences

In the SEMI-AUTO mode, the selected sequence is the only sequence initiated. For example, when the *START* button is pressed: The engine will start, but no subsequent synchronising is initiated.

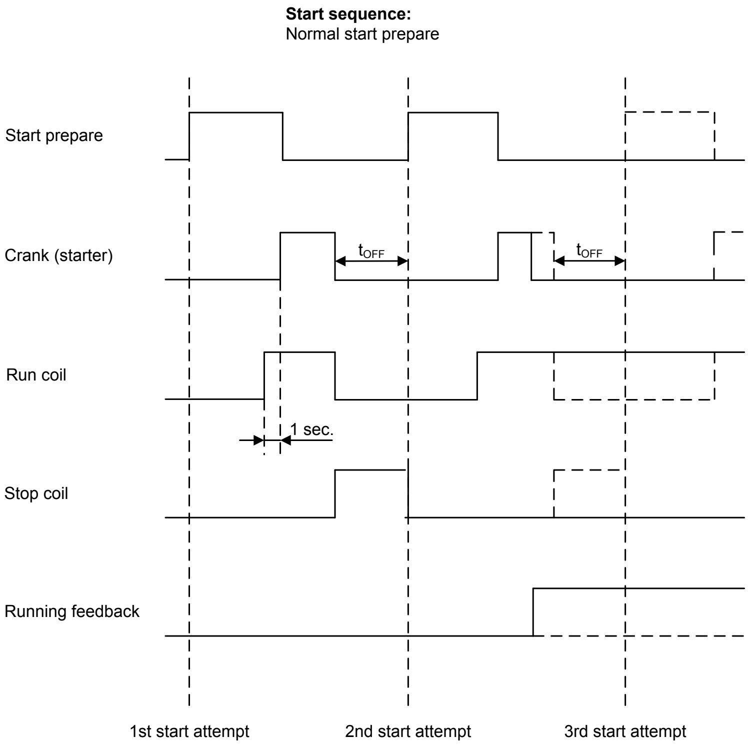
If island operation is selected, the digital input *MB closed* must not be activated with a 12/24 volt input signal. A Mains breaker failure will occur if the wiring of the mains breaker feedback inputs is wrong.

NOTE It is not recommended to use small relays for the 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.

5.1.2 Start sequence

The start sequences of the genset can be either Normal start prepare or Extended start prepare. In both cases, the running coil is activated 1 s before the start relay (starter).

Normal start prepare sequence



In this example, the Run coil opens between the start attempts. This is because the Run coil type is set to pulse. 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.

Configure the Run coil parameters under **Settings > Engine > Start sequence > Before crank > Run coil**.

Parameter	Text	Range	Default
6151	Run coil timer	0.0 to 600.0 s	1.0 s
6152	Run coil type	Pulse Continuous	Pulse

Configure the Start prepare parameters under **Settings > Engine > Start sequence > Before crank > Start prepare**.

Parameter	Text	Range	Default
6181	Start prepare	0.0 to 600.0 s	5.0 s
6182	Ext. prepare	0.0 to 600.0 s	0.0 s

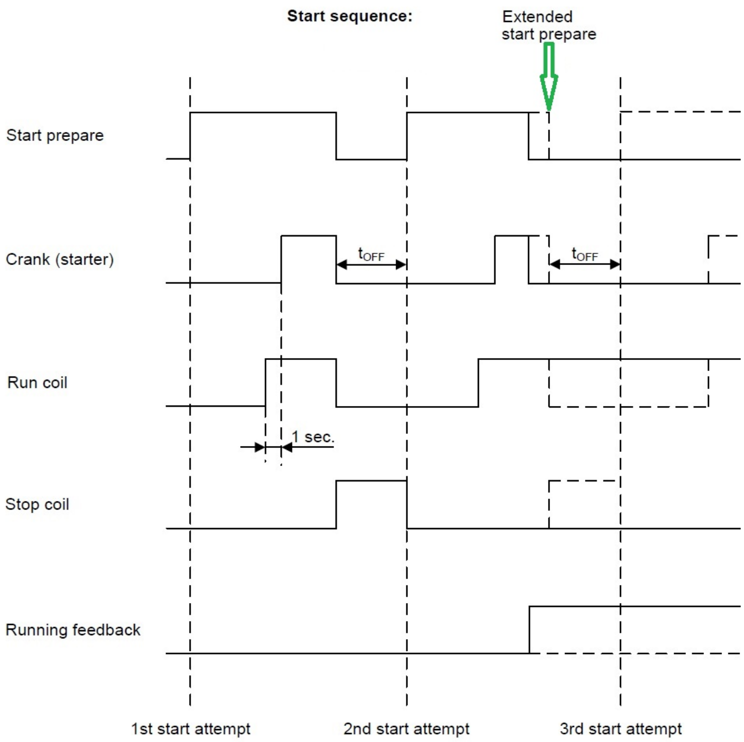
Configure the Start attempts parameters under **Settings > Engine > Start sequence > Crank > Start attempts**.

Parameter	Text	Range	Default
6191	Single starter attempts	1 to 100	3
6192	Double starter attempts	0 to 10	0

Configure the Crank timer parameters under **Settings > Engine > Start sequence > Crank > Crank timers**.

Parameter	Text	Range	Default
6183	Start ON time	1.0 to 600.0 s	5.0 s
6184	Start OFF time	1.0 to 99.0 s	5.0 s

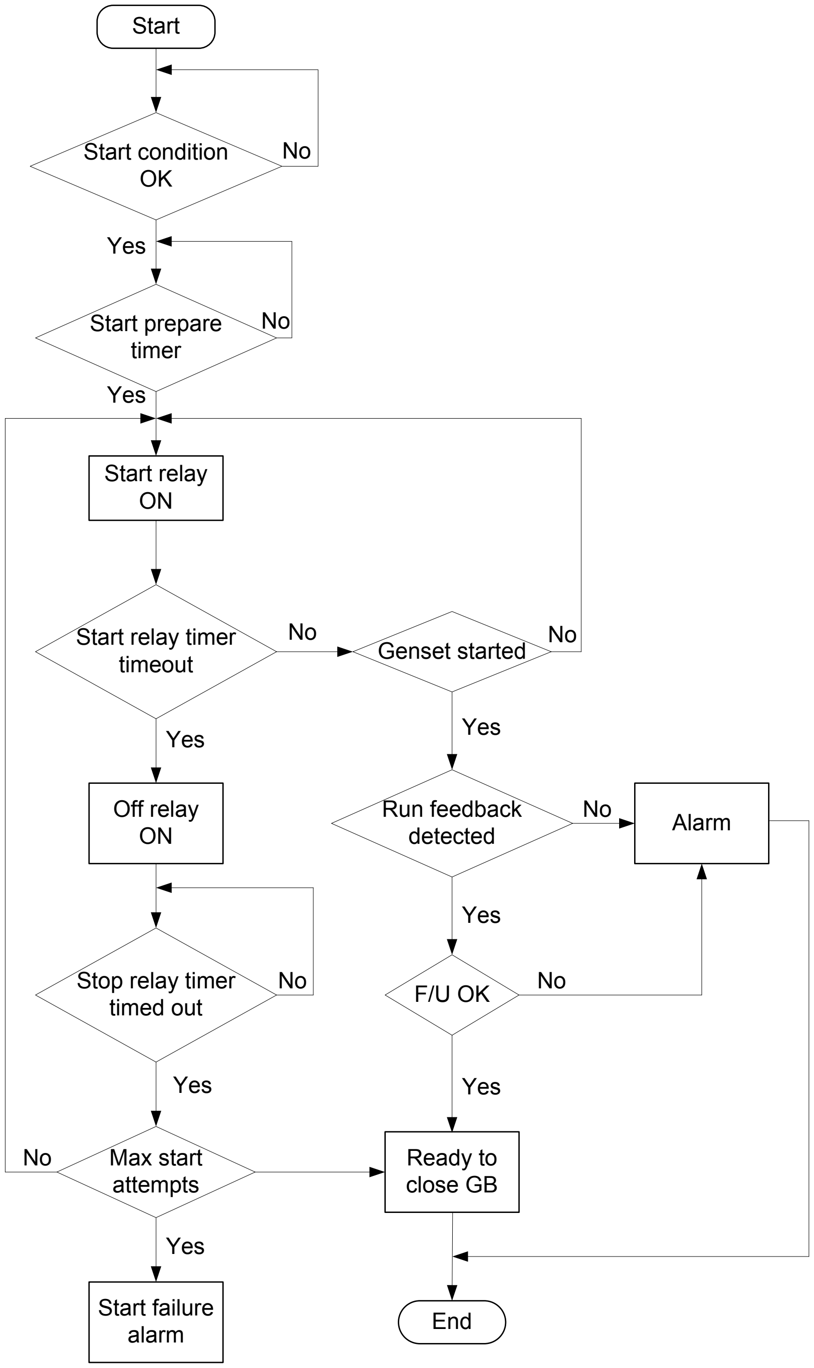
Extended start prepare sequence



Run coil can be activated from 0 to 600 s before crank (starter) is executed. In this example, the timer is set to 1.0 s.

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.

Start sequence flowchart



5.1.3 Start sequence conditions

The start sequence initiation can be controlled by the following multi-input conditions:

- RMI oil pressure
- RMI water temperature
- RMI oil pressure
- Binary input

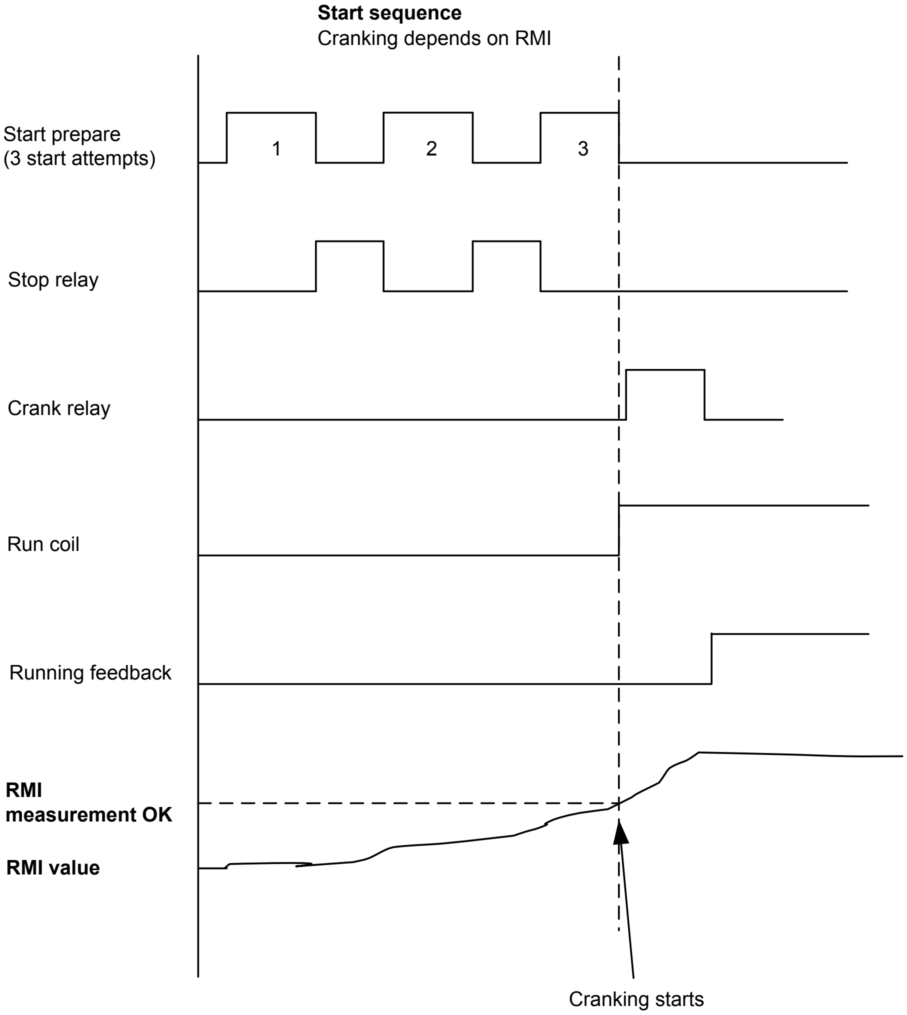
This means that if, for example, the oil pressure is not primed to the sufficient value, the crank relay will not engage the starter motor.

These multi-input conditions can only be set with the USW.

More information
See the chapter **Multi-inputs** in this document for more information about configuring multi-inputs.

If the Binary start threshold is used, the input is chosen from the I/O list in the Utility Software.

The diagram below shows an example where the RMI oil pressure signal in multi-input 20 builds up slowly and start is initiated at the end of the third start attempt.



The crank/start is initiated as soon as the Start threshold limit is reached. By default, the AGC 150 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 6185, 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.

Configure the Start sequence parameters under **Settings > Engine > Start sequence > Before crank > Start threshold**.

Parameter	Text	Range	Default
6185	Start threshold input type	Multi-input 20 Multi-input 21 Multi-input 22	Multi-input 20
6186	Start threshold set point	0.0 to 300.0	0.0

5.1.4 Running feedback

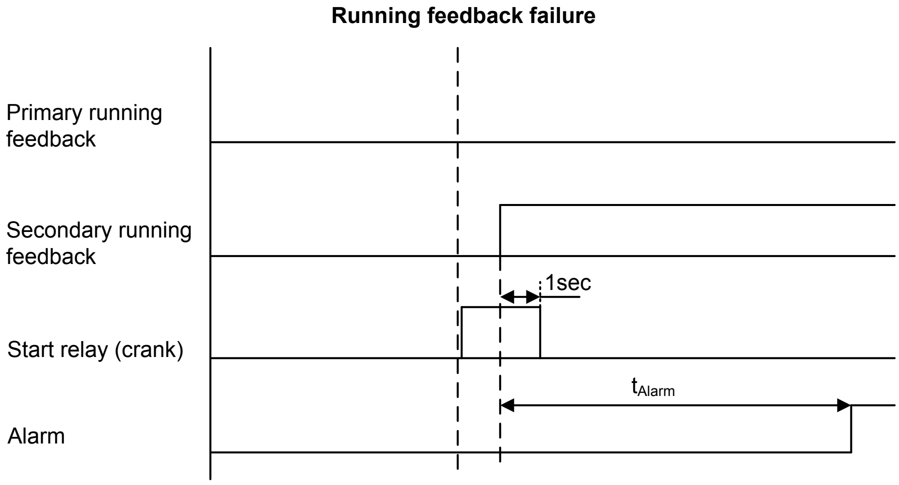
Different types of running feedback can be used to detect if the motor is running. The running detection is made with a built-in safety routine. The running feedback selected is the primary feedback.

At all times, all types of running feedback are used for running detection. If 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.

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.

Figure 5.1 Running feedback



Interruption of the start sequence

The start sequence is interrupted in the following situations:

Event	Notes
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. 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.
Running feedback	EIC (engine communication).
Emergency stop	
Alarm	Alarms with Shutdown or Trip and stop fail class.
Stop button on the 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 genset modes Island operation, Fixed power, Load take-over 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.

Configure the parameters for Start sequence interruption under **Settings > Engine > Running detection**.

Parameter	Text	Range	Default
6171	Number of teeth for MPU running detection	0 to 500 teeth	0 teeth
6172	Primary running detection type	Digital input MPU input Frequency EIC Multi-input 20 to 23	Frequency
6173	Running detection	0 to 4000 RPM	1000 RPM
6175	Oil pressure	0.0 to 150.0 bar	0.0 bar

MPU wire break

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 400 kΩ.

Configure the parameters for MPU wire break alarms under **Settings > Engine > Running detection > MPU wirebreak**.

Parameter	Text	Range	Default
4551	Tacho sensor	Tacho sensor Hall sensor*	Tacho sensor
4552	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
4553	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
4554	Enable	OFF ON	OFF
4555	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning

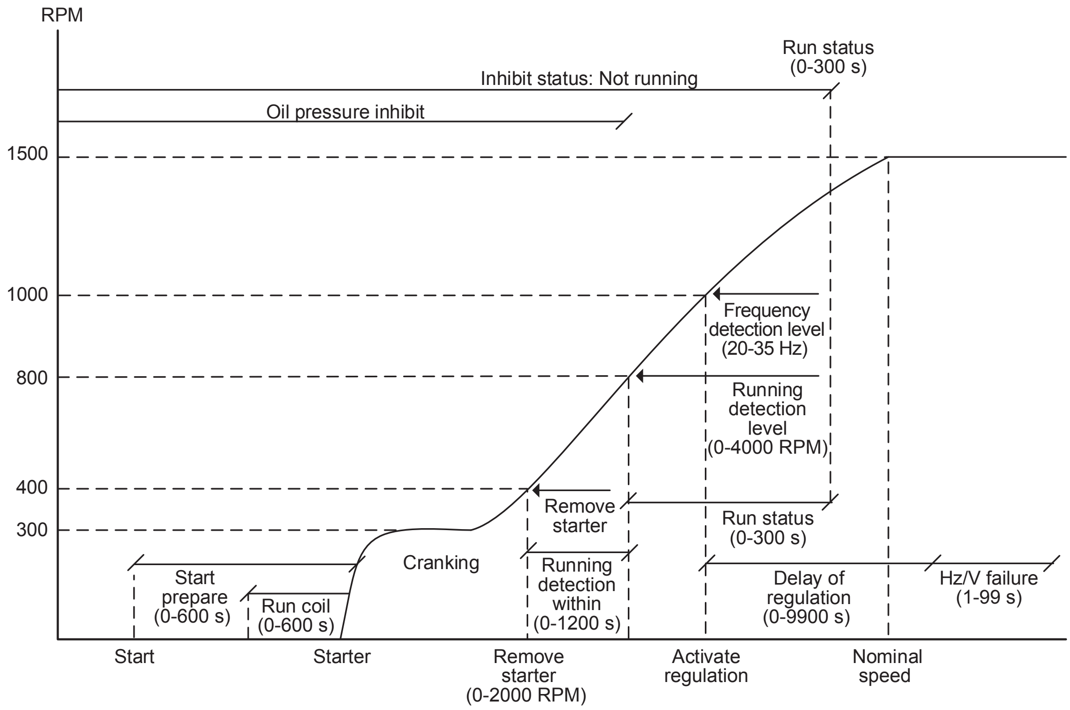
*Note: No wire break on Hall sensor.

Configure the parameter for Remove starter under **Settings > Engine > Start sequence > After crank > Remove starter**.

Parameter	Text	Range	Default
6174	Remove start	1 to 2000 RPM	400 RPM

5.1.5 Start-up overview

Figure 5.2 Start up overview



Set points related to the start sequence

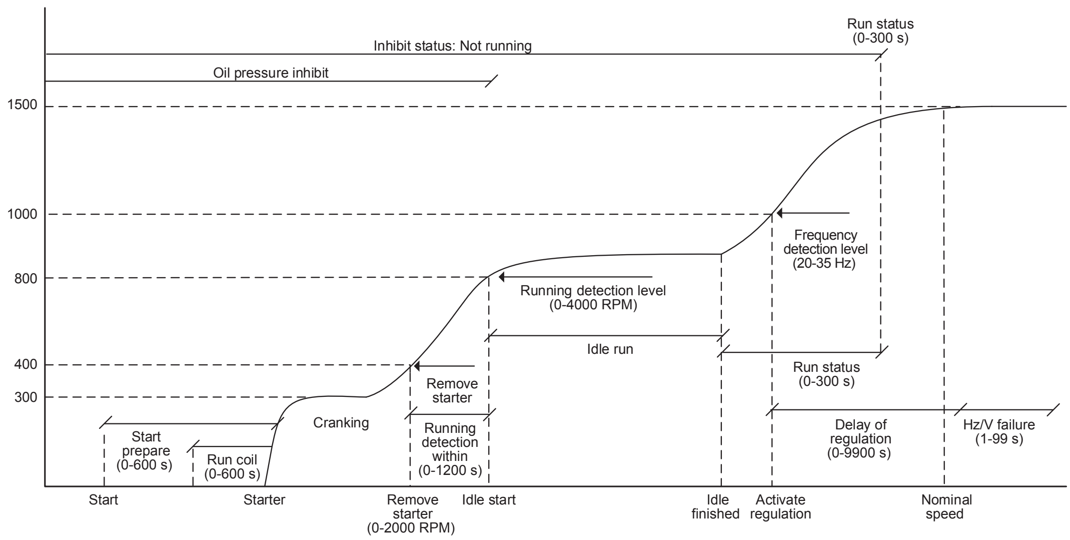
Parameter	Text	Description
6181	Start prepare	Start prepare is used for start preparation, for example pre-lubrication or pre-glowing. The Start prepare relay is activated when the start sequence is initiated, and deactivated when the start relay is activated. If the timer is set to 0.0 s, the Start prepare function is deactivated.
6182	Extended prepare	Extended prepare will activate the Start prepare relay when the start sequence is initiated. The relay is activated until the specified time has expired. If the Extended 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.
6183	Start ON time	The starter will be activated for this period when cranking.
6184	Start OFF time	The pause between two start attempts.
6151	Run coil timer	The timer for the run coil is a set point for how long the run coil will be activated before cranking the engine. This gives the ECU time to start up before cranking.
6174	Remove starter	The starter is removed, when the RPM set point is reached. (only when the Running detection type is configured as either MPU or EIC RPM).
6173	Running detection RPM level	The set point defines the Running detection level in RPM (only when the Running detection type is configured as either MPU or EIC RPM).
6351	Run detection	This timer is set to make sure that the engine goes from the RPM level, Remove starter and Running detection level (only when the Running detection type is configured as either MPU or EIC RPM). If other Running detection types than MPU or EIC RPM are used, the starter is ON until the Frequency detection level is reached. If the timer exceeds, and the level is not reached, the start sequence will repeat, using a start attempt. If all Start attempts is used, the Start failure will appear.

Parameter	Text	Description
6165	Frequency detection level	When the configured level is reached, the regulators will start working to reach the nominal values. The regulators can be delayed with Delay regulation.
2740	Delay regulation	The regulation start can be delayed with this timer. If the setup is running on nominal settings, and Delay 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 is delayed until the timer has expired. The timer is usually set so the generator can reach the nominal frequency and voltage within the time frame.
6161	Run status timer	The timer starts when the Running detection level or the 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.

Alarms related to the start sequence

Parameter	Text	Description
4530	Crank failure alarm	This alarm is activated, if MPU is configured as the primary running feedback and the specified RPM is not reached before the delay has expired.
4540	Run feedback failure alarm	This alarm is activated, if there is a failure on the Primary running feedback. For example, if the Primary running feedback is configured to digital input without running detection, and an active secondary running feedback detects the engine to be running. The delay to be set is the time from the secondary running detection until the alarm is raised.
4560	Hz/V failure alarm	This alarm is activated, if the frequency and voltage are not within the limits configured in Blackout df/dUmax, after the running feedback is received.
6352	Engine externally stopped	This alarm is activated, if the running sequence is active and the engine is below Running detection and Frequency detection level without any command from AGC 150.

Start up overview with idle run

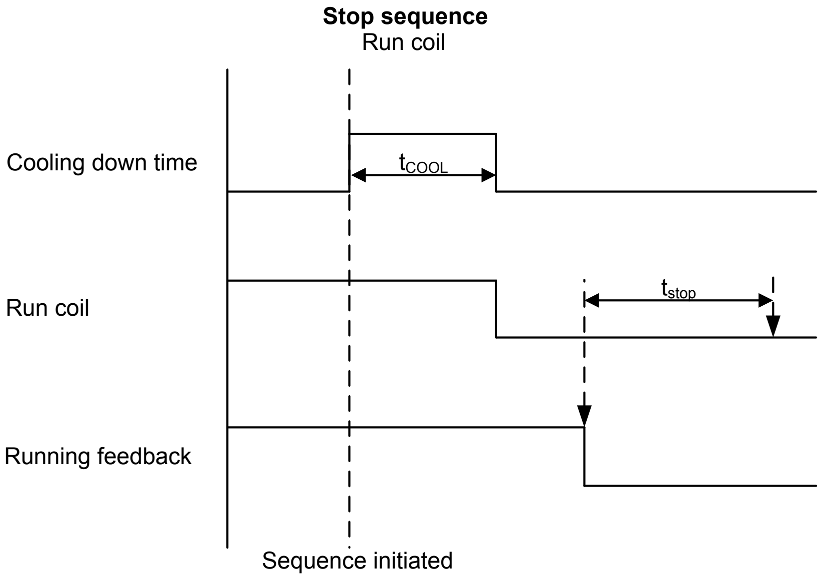


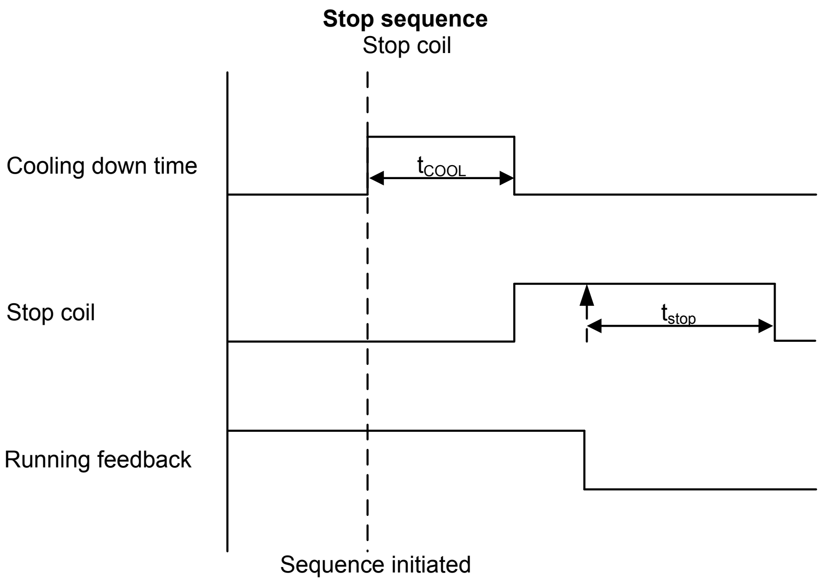
The set points and alarms are the same as above, except for the idle run function.

More information
See **Engine/Generator/Mains, Idle running** in this document for more information on the idle running function.

5.1.6 Stop sequence

Stop sequence





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.

Configure the Stop sequence cooling down time under **Settings > Engine > Stop sequence > Cooldown**.

Parameter	Text	Range	Default
6211	Cooling down	0 to 9900 s	240 s

Table 5.1 Stop sequence commands

Description	Cooling down	Stop	Notes
AUTO mode stop	x	x	
Trip and stop alarm	x	x	

Description	Cooling down	Stop	Notes
Stop button on the 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 take-over • 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	Notes
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 take-over or mains power export.
Exceeding set point	AUTO mode: Peak shaving.
GB close button is pressed/remote command is given	SEMI-AUTO mode only.

NOTE When the engine is stopped, the analogue speed governor output is reset to the offset value.

Set points related to Stop sequence

Configure the parameters for Stop failure under **Settings > Engine > Stop sequence > Stop failure**.

Parameter	Text	Range	Default
4581	Stop failure timer	10.0 to 120.0 s	30.0 s
4582	Stop failure, Output A	Not used	Not used
4583	Stop failure, Output B	Not used	Not used
4584	Activation of the stop failure alarm	OFF ON	ON
4585	Stop failure alarm fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Shutdown

Configure the parameter for Extended stop under **Settings > Engine > Stop sequence > Extended stop**.

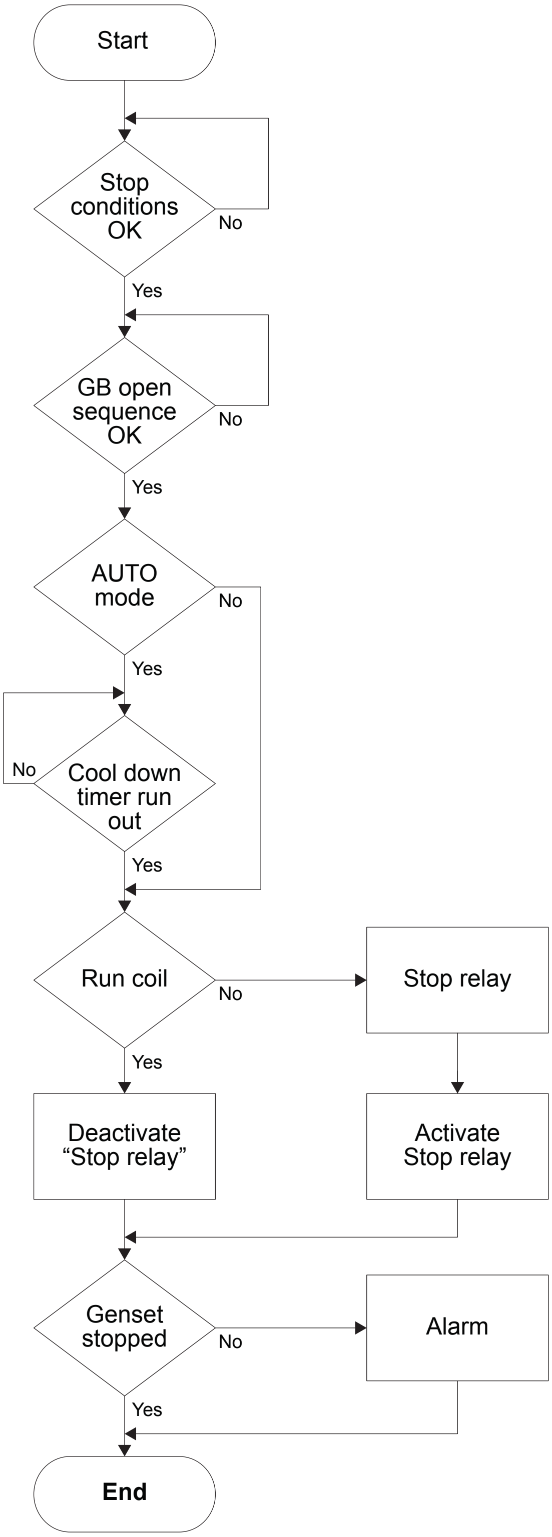
Parameter	Text	Range	Default
6212	Extended stop timer	1.0 to 99.0 s	5.0 s

Configure the parameters for Stop threshold under **Settings > Engine > Stop sequence > Stop threshold**.

Parameter	Text	Range	Default
6213	Input type	Multi input 20 to 23 M-Logic EIC temp. inputs	Multi input 20
6214	Threshold value/set point	0 to 482 °	0 °

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

Stop sequence flowchart



5.1.7 Breaker sequences

The breaker sequences is activated according to the selected mode.

Table 5.2 Controller operation modes

Controller operation mode	Plant running mode	Breaker control
AUTO	All	Controlled by AGC 150
SEMI-AUTO	All	Button/remote command

Controller operation mode	Plant running mode	Breaker control
Manual (only genset)	All	Button/remote command
Block (only genset)	All	None (only possible to open breakers)

Before closing the breakers, the voltage and frequency must be stabilised within a defined time frame.

Configure the time frame under **Settings > Generator > AC configuration > Voltage and freq. OK > Hz/V OK**.

Parameter	Text	Range	Default
6221	Hz/V OK timer	0.0 to 99.0 s	5.0 s

Configure the parameters for the allowed deviation from nominal voltage and frequency settings under **Settings > Generator > AC configuration > Voltage and freq. OK > Blackout / Hz/V OK***.

Parameter	Text	Range	Default
2111	Blackout dfMin	0.0 to 5.0 Hz	3.0 Hz
2112	Blackout dfMax	0.0 to 5.0 Hz	3.0 Hz
2113	Blackout dUMin	2 to 20 %	5 %
2114	Blackout dUMax	2 to 20 %	5 %

*Note: The settings are used for both Hz/V OK and Blackout.

Configure the voltage and frequency failure alarm under **Settings > Generator > AC configuration > Voltage and freq. OK > Hz/V failure**.

Parameter	Text	Range	Default
4561	Timer	1.0 to 99.0 s	30.0 s
4562	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
4563	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
4564	Enable	OFF ON	OFF
4565	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Shutdown

Set points for MB control

Parameter	Text	Description
7081	Mode shift	When enabled, the AGC will perform the AMF sequence in case of a mains failure, regardless of the actual plant running mode.
7082	MB close delay	The time from GB/TB OFF to MB ON, when back synchronisation is OFF (only stand-alone or mains controller with MB and TB).
7083	Back Sync.	Enables synchronisation from mains to generator. With back synchronisation: When the *GB* or *MB* button is activated, the AGC 150 starts synchronising if the generator or mains voltage is present. The GB can close directly if the MB is open, and the MB can close directly if the GB is open 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
7084	Sync. to mains	Enables synchronisation from generator to mains.
7085	Load time	After opening the breaker, the MB ON sequence will not be initiated before this delay has expired.

If no MB is represented, then the relays for opening/closing and inputs for feedbacks normally used for MB control/supervision become configurable. With the Utility Software, select the *Application configuration*  tab to configure the plant design, if the application does not include an MB.

Configure the Mode shift under **Settings > Mains > AMF functions > AMF timers**.

Parameter	Text	Range	Default
7081	Mode shift	Mode shift OFF Mode shift ON	Mode shift OFF

Configure the MB close delay and Spring load time under **Settings > Breakers > Mains breaker > Breaker configuration**.

Parameter	Text	Range	Default
7082	MB close delay	0.0 to 30.0 s	0.5 s
7085	Spring load time	0.0 to 30.0 s	0.0 s

Configure the Synchronisation under **Settings > Synchronisation > Mains parallel settings**.

Parameter	Text	Range	Default
7083	Back synchronisation	OFF ON	OFF
7084	Synchronisation to mains	OFF ON	ON

AMF MB opening

If AGC 150 operates in Automatic Mains Failure (AMF), it is necessary to select the functionality of the mains breaker opening function. This can be helpful, when the MB can only be operated with voltage on the mains or on the busbar.

Configure the parameter for Mains failure control under **Settings > Mains > AMF functions > Start seq. in AMF mode**.

Parameter	Text	Range	Default
7065	Start-up fail control	Start engine + open MB Start engine	Start engine + open MB

Parameter	Text	Range	Default
		Open MB when eng ready	

Table 5.3 Parameter 7065 sequences

Setting	Sequence with no failure	Sequence with start failure
Start engine + open MB	1. Mains failure delay timer is running. 2. Mains breaker opens. 3. Engine starts. 4. Volt/Hz OK timer is running. 5. Generator breaker closes.	1. Mains failure delay timer is running. 2. Mains breaker opens. 3. Engine tries to start. 4. Generator start failure.
Start engine	1. Mains failure delay timer is running. 2. Engine starts. 3. Volt/Hz OK timer is running. 4. Mains breaker opens. 5. Generator breaker closes.	1. Mains failure delay timer is running. 2. Engine tries to start. 3. Generator start failure. 4. Mains breaker opens.
Open MB when eng ready	1. Mains failure delay timer is running. 2. Engine starts. 3. Volt/Hz OK timer is running. 4. Mains breaker opens. 5. Generator breaker closes.	1. Mains failure delay timer is running. 2. Engine tries to start. 3. Generator start failure. 4. Mains breaker stays closed.

AMF timers

Configure the AMF timers under **Settings > Mains > AMF functions > AMF timers**.

Parameter	Text	Range	Default
7061	U mains failure delay	0.5 to 990.0 s	5.0 s
7062	U mains OK delay	2 to 9900 s	2 s
7071	f mains failure delay	0.5 to 990.0 s	5.0 s
7072	f mains OK delay	2 to 9900 s	2 s
7081	Mode shift	OFF ON	OFF

Configure the Voltage unbalance under **Settings > Mains > Voltage and freq. limits > Voltage settings**.

Parameter	Text	Range	Default
7066	U unbalance	2 to 100 %	100 %

Configure the timer for Voltage and frequency OK under **Settings > Generator > AC configuration > Voltage and freq. OK > Hz/V OK**.

Parameter	Text	Range	Default
6221	Hz/V OK timer	0.0 to 99.0 s	5.0 s

Configure the timers for GB control under **Settings > Breakers > Generator breaker > Breaker configuration**.

Parameter	Text	Range	Default
6231	GB close delay	0.0 to 30.0 s	2.0 s
6232	Load time	0.0 to 30.0 s	0.0 s

Configure the timers for MB control under **Settings > Breakers > Mains breaker > Breaker configuration**.

Parameter	Text	Range	Default
7082	MB close delay	0.0 to 30.0 s	0.5 s
7085	Load time*	0.0 to 30.0 s	0.0 s

*Note: The MB Load time timer is only active if back synchronisation is deactivated.

Figure 5.3 Example 1: Mains fail control (Start engine and open MB)

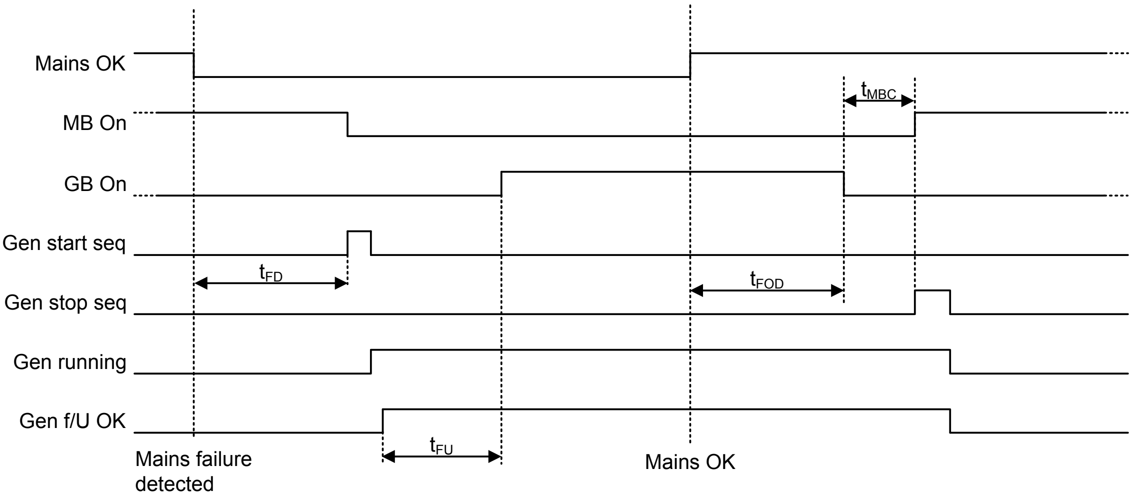
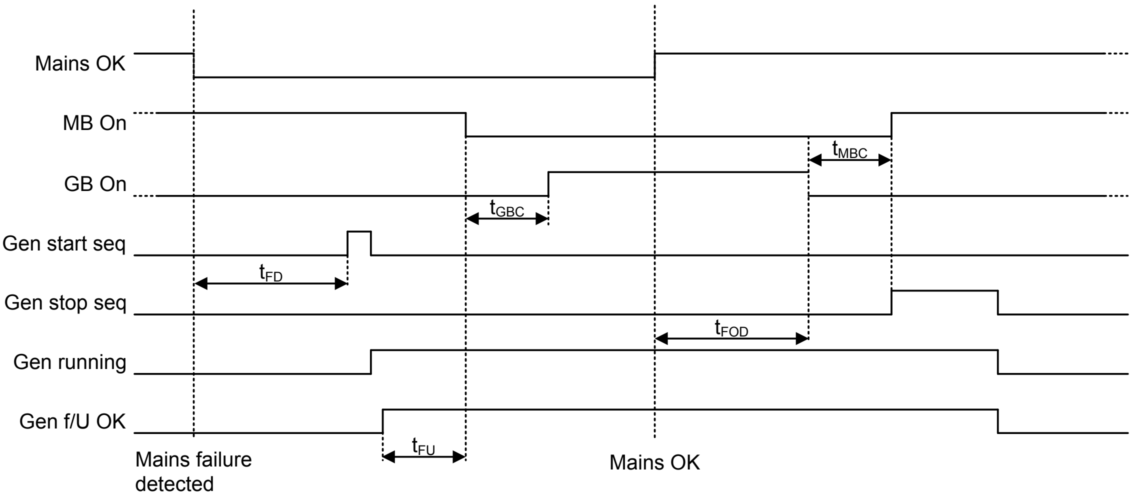


Figure 5.4 Example 2: Mains fail control (Start engine)



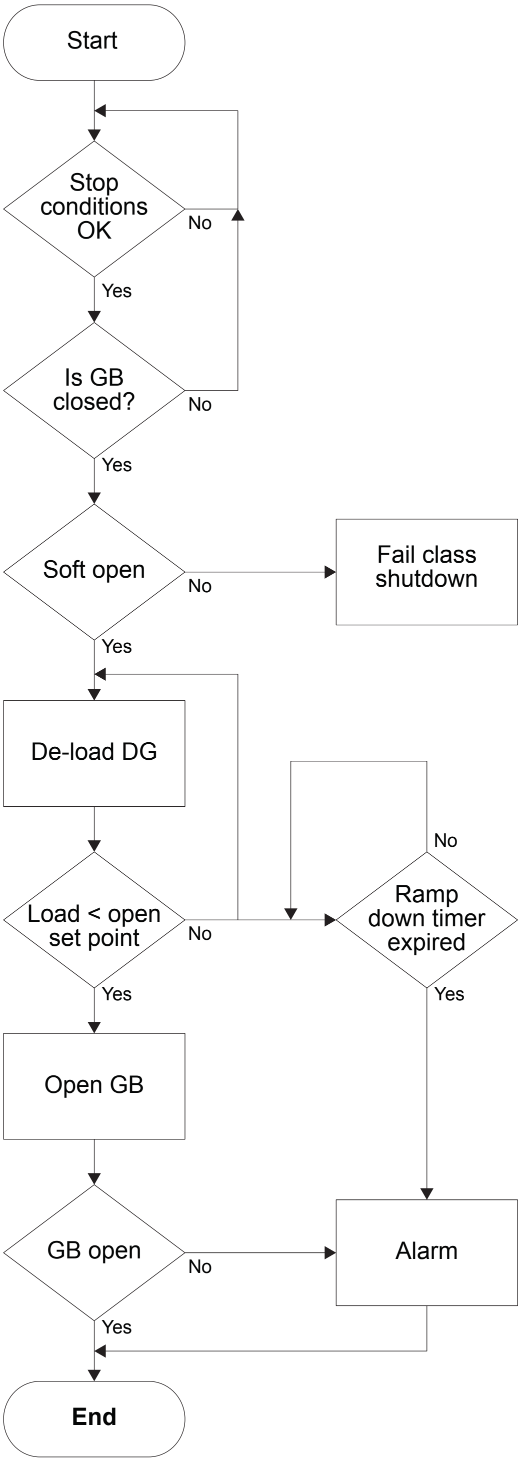
Conditions for breaker operations

The breaker sequences depend on the breaker positions and the frequency/voltage measurements.

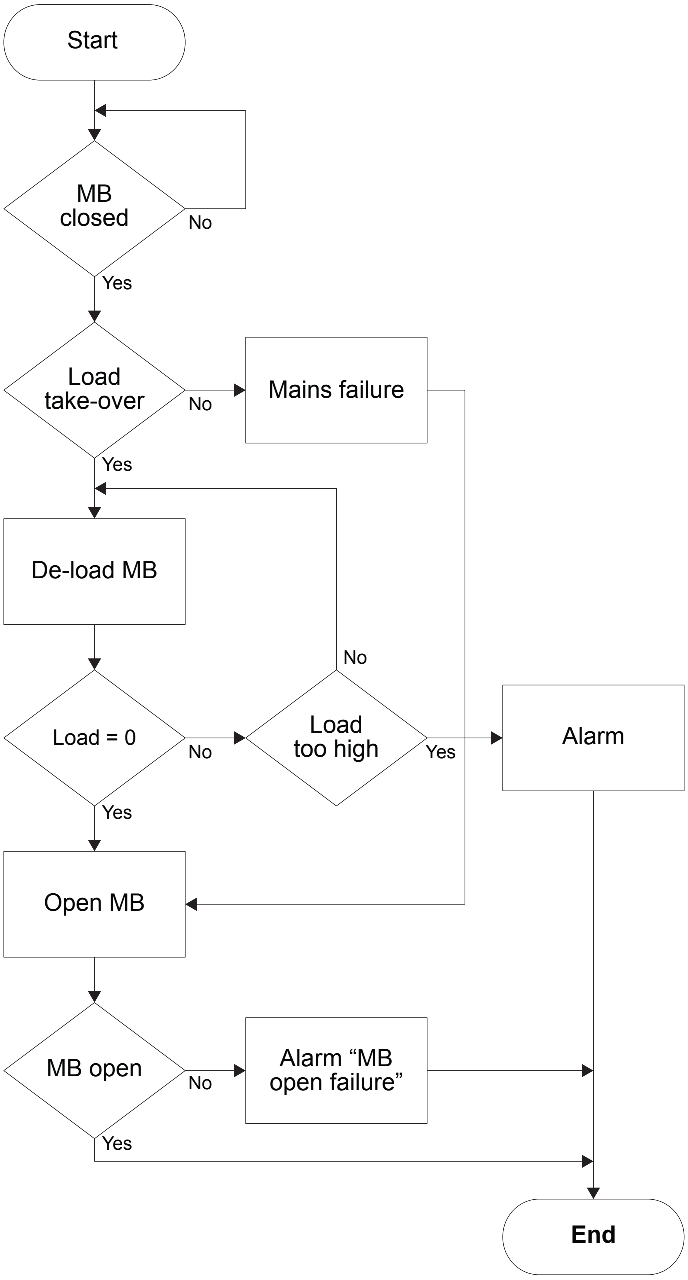
Sequence	Condition
GB ON, direct closing	Running feedback Generator frequency/voltage OK

Sequence	Condition
	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, de-loading	MB closed
MB OFF, de-loading	Alarms with fail class: Trip and stop

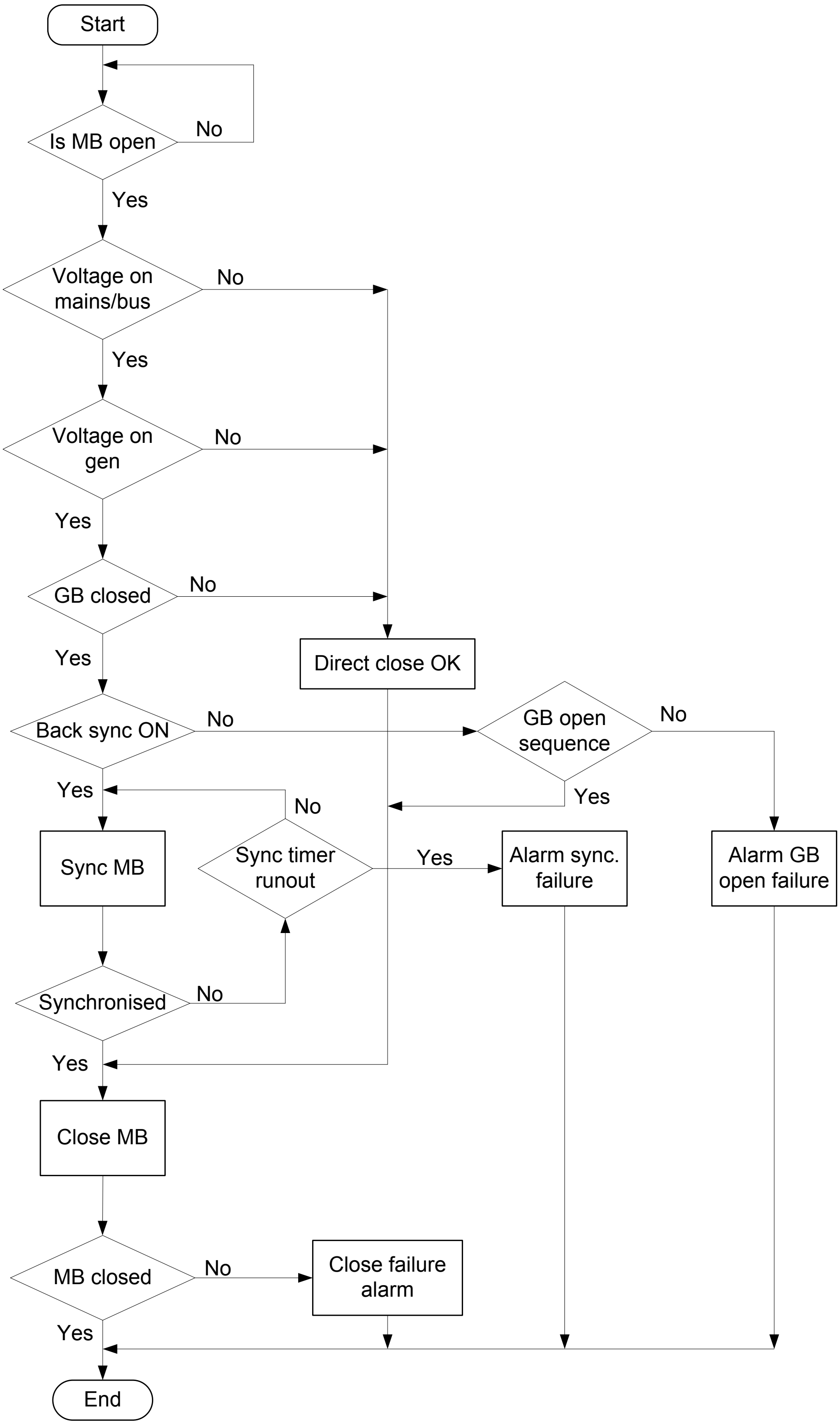
GB open sequence flowchart



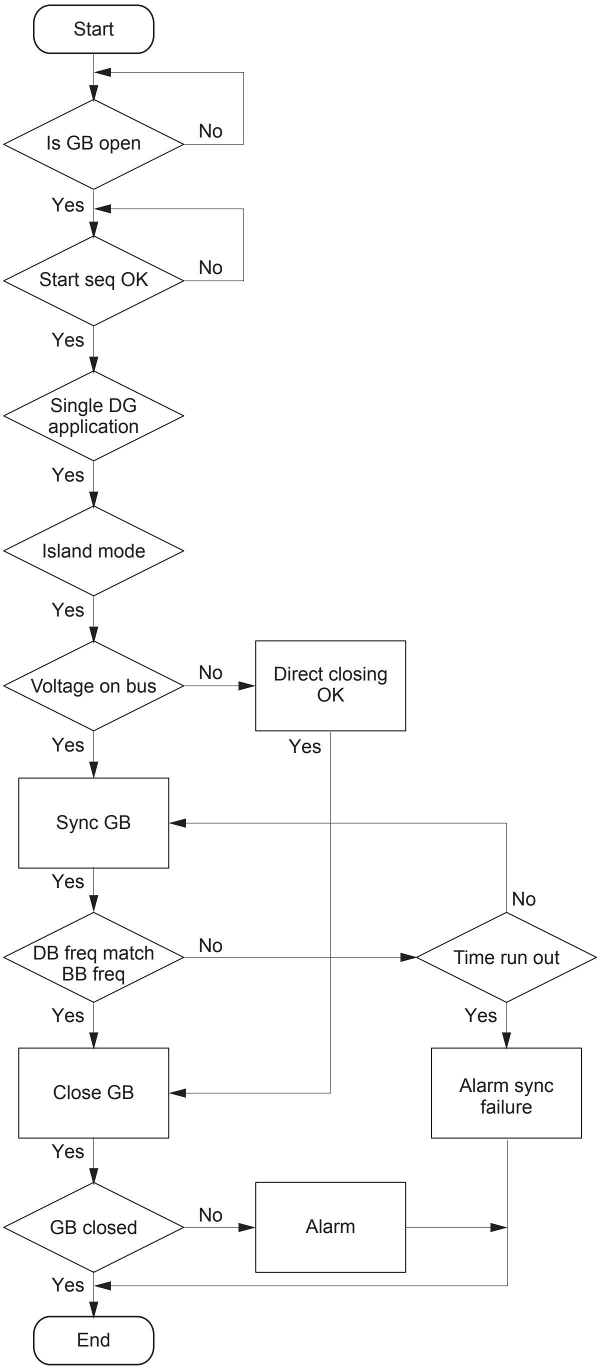
MB open sequence flowchart



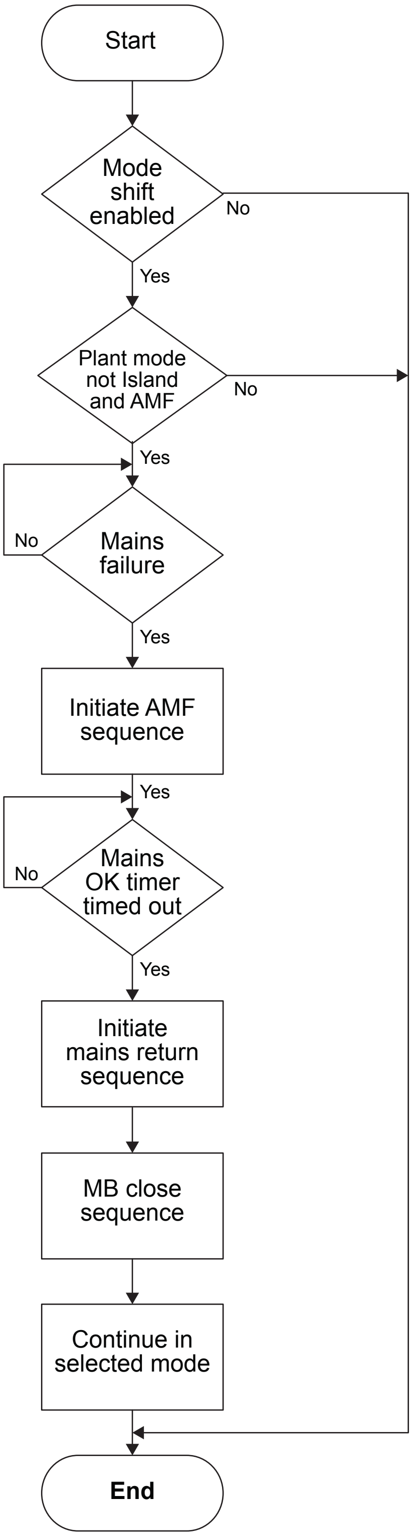
MB close sequence flowchart



GB close sequence flowchart



Mode shift flowchart



5.2 Breaker types

5.2.1 Breaker types

There are five breaker type settings for generator breaker and mains breaker. Set the breaker type with the Utility Software under *Application configuration*.

More information
See **Utility Software, Setup of applications** in this document for more information about how to set up applications.

Continuous NE and Continuous ND

Continuous NE is a normally energised signal, and Continuous ND is a normally de-energised signal. These settings are usually used in combination with a contactor.

AGC 150 will only use the Close breaker output:

- Closed output is closing the contactor.
- Opened output is opening the contactor.

The Open breaker output can be used for other purposes.

Pulse

This setting is usually used in combination with a circuit breaker. AGC 150 will use the Close breaker and the Open breaker outputs

- The Close breaker output will close shortly to close the the circuit breaker.
- The Open breaker output will close shortly to open the circuit breaker.

External/ATS no control

This setting is used to indicate the position of the breaker, but the breaker is not controlled by AGC 150.

Compact

This setting is usually used in combination with a direct controlled motor driven breaker. AGC 150 will use the Close breaker and the Open breaker outputs:

- The Close breaker output will close shortly to close the compact breaker.
- The Open breaker output will close to open the compact breaker and keep closed long enough to recharge the breaker.

If the compact breaker is tripped externally, it is recharged automatically before next closing.

Settings (all breaker types)

Configure the synchronisation time for each breaker under **Settings > Synchronisation > Dynamic sync.**

Parameter	Text	Range	Default
2025	Synchronisation time GB/TB	40 to 300 ms	50 ms
2026	Synchronisation time MB	40 to 300 ms	50 ms

Settings for Generator breaker

Configure the parameters for GB Open fail time under **Settings > Breakers > Generator breaker > Breaker monitoring > GB Open fail**.

Parameter	Text	Range	Default
2161	Timer	1.0 to 10.0 s	2.0 s
2162	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
2163	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
2164	Enable	OFF ON	ON
2165	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop	Warning

Parameter	Text	Range	Default
		Trip MB/GB Controlled stop	

Configure the parameters for GB Close fail time under **Settings > Breakers > Generator breaker > Breaker monitoring > GB Close fail**

Parameter	Text	Range	Default
2171	Timer	1.0 to 10.0 s	2.0 s
2172	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
2173	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
2174	Enable	OFF ON	
2175	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning

Settings for Mains breaker

Configure the parameters for MB Open fail time under **Settings > Breakers > Mains breaker > Breaker monitoring > MB Open fail**.

Parameter	Text	Range	Default
2201	Timer	1.0 to 10.0 s	2.0 s
2202	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
2203	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
2204	Enable	OFF ON	ON
2205	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning

Configure the parameters for MB Close fail time under **Settings > Breakers > Mains breaker > Breaker monitoring > MB Close fail**.

Parameter	Text	Range	Default
2211	Timer	1.0 to 10.0 s	2.0 s
2212	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
2213	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
2214	Enable	OFF ON	ON
2215	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning

NOTE For continuous breakers the timer decides how long the close/open command is active.

5.3 Breaker position failure

5.3.1 Breaker position failure

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.

It is possible to make the AGC 150 controller try to trip the faulty breaker when it discovers a Breaker position failure. This can be handled by the fail class.

Configure the parameters for the Generator breaker position failure under **Settings > Breakers > Generator breaker > Breaker monitoring > GB Pos fail**.

Parameter	Text	Range	Default
2181	Timer	1.0 to 5.0 s	1.0 s
2182	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
2183	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
2184	Enable	OFF ON	ON
2185	Fail class	Block Warning Trip GB Trip + Stop Shutdown	Warning

Parameter	Text	Range	Default
		Trip MB Safety stop Trip MB/GB Controlled stop	

Configure the parameters for the Mains breaker position failure under **Settings > Breakers > Mains breaker > Breaker monitoring > MB Pos fail**.

Parameter	Text	Range	Default
2221	Timer	1.0 to 5.0 s	1.0 s
2222	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
2223	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
2224	Enable	OFF ON	ON
2225	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning

5.4 Breaker spring load time

5.4.1 Breaker spring load time

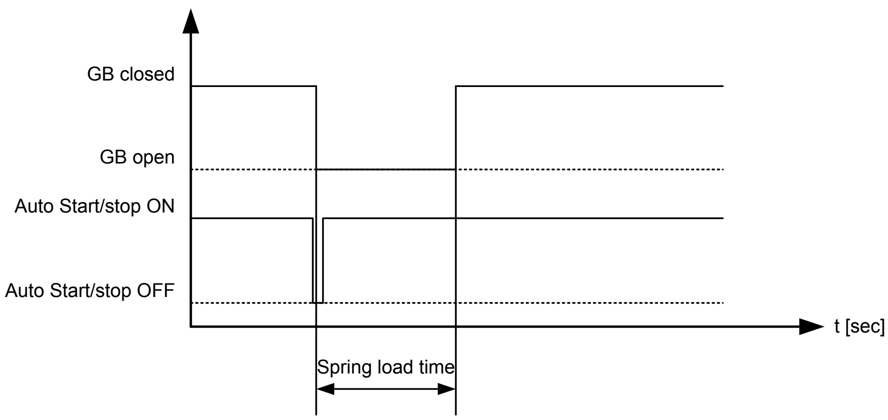
To avoid breaker close failures in situations where breaker ON command is given before the breaker spring has been loaded, the spring load time can be adjusted for GB/TB and MB.

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.

Principle

The diagram shows an example where a single AGC 150 in island mode is controlled by the Auto start/stop input.



- When the Auto start/stop input deactivates, the GB opens.
- The Auto start/stop is re-activated immediately after the GB has opened, for example by the operator using a switch in the switchboard.
- The AGC 150 waits a while before sending the close signal again, because the spring load time must expire.

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.
2. **Digital input.** Two configurable inputs is 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 (inputs are configured with 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.

Configure the parameters for Generator breaker spring load time under **Settings > Breakers > Generator breaker > Breaker configuration**.

Parameter	Text	Range	Default
6231	GB close delay	0.0 to 30.0 s	2.0 s
6232	Load time	0.0 to 30.0 s	0.0 s

Configure the parameters for Mains breaker spring load time under **Settings > Breakers > Mains breaker > Breaker configuration**.

Parameter	Text	Range	Default
7082	MB close delay	0.0 to 30.0 s	0.5 s
7085	Load time	0.0 to 30.0 s	0.0 s

Configure the parameter for TB spring load time under **Settings > Breakers > Tie breaker > Breaker configuration**.

Parameter	Text	Range	Default
8191	TB open point	0 kW to 20000 kW	50 kW
8195	Load time	0.0 to 30.0 s	0.0 s

If the breaker needs time to reload the spring after it has opened, AGC 150 can take this delay into account. This can be controlled through timers in the controller or through digital feedbacks from the breaker, depending on the breaker type.

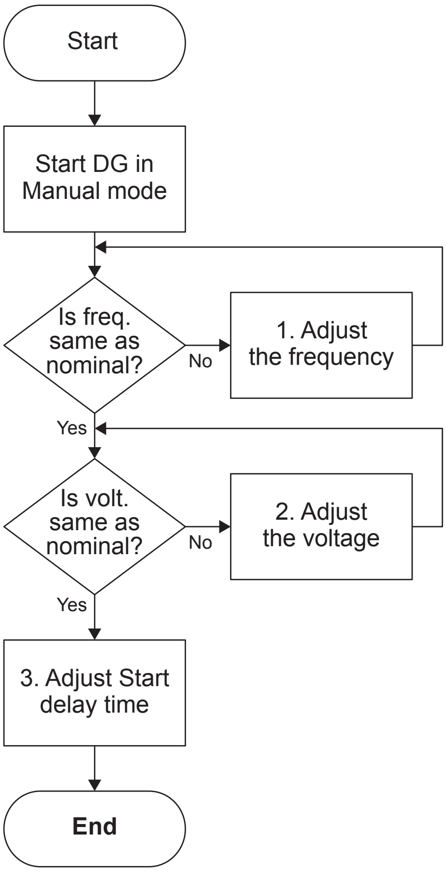
5.5 Governor and AVR configuration

5.5.1 Configuration of controller with EIC governor and anlogue AVR

Initial settings

No.	Setting	Parameter path	Parameter
1	Set the GOV type to EIC	Settings > Engine > GOV > General configuration	2781
2	Select the engine type	Settings > Engine > GOV > EIC configuration > Engine type	7561
3	Set the EIC controls to ON	Settings > Engine > GOV > EIC configuration > EIC controls	7563
4	Set the AVR type to Analogue	Settings > Generator > AVR > General configuration	2782
5	Set the AVR output to Ana Out 55	Settings > Generator > AVR > Analogue configuration > Analogue output	5991

Adjustments in Manual mode

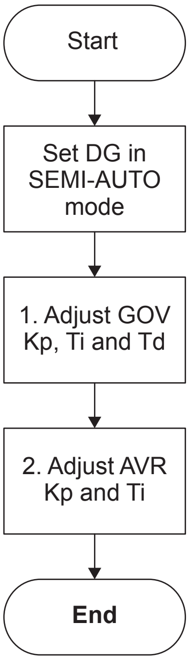


1. Adjust the frequency under:
Settings > Engine > GOV > Offset for control signal (2551).

2. Adjust the voltage under:
Settings > Generator > AVR > Offset for control signal (2671).

3. If needed, adjust the Start regulation delay time under:
Settings > Engine > Start sequence > After crank > Reg. delay at start > Delay reg. (2741).

Adjustments in SEMI-AUTO mode



1. Adjust GOV Kp, Ti and Td:

- Island settings under **Settings > Engine > GOV > Speed PID > Island** (2511, 2512 and 2513).
- Mains parallel settings under **Settings > Engine > GOV > Speed PID > Mains parallel** (2531, 2532 and 2533).
- Load share settings under **Settings > Engine > GOV > Speed PID > Load share** (2541, 2542 and 2543).
- Sync. regulator settings under **Settings > Synchronisation > Sync. regulator** (2041, 2042 and 2043).

2. Adjust AVR Kp and Ti:

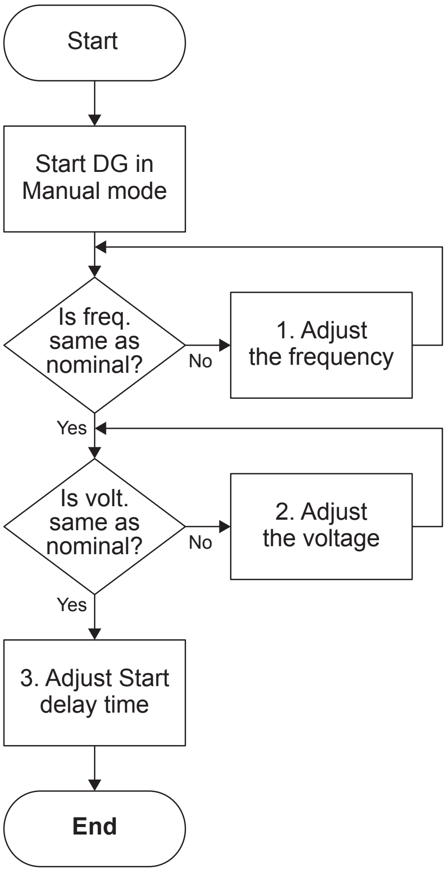
- Island settings under **Settings > Generator > AVR > Voltage PID > Island** (2641 and 2642).
- Mains parallel settings under **Settings > Generator > AVR > Voltage PID > Mains parallel** (2651 and 2652).
- Load share settings under **Settings > Generator > AVR > Voltage PID > Load share** (2661 and 2662).

5.5.2 Configuration of controller with analogue governor and analogue AVR

Initial settings

No.	Setting	Parameter path	Parameter
1	Set the GOV type to Analogue	Settings > Engine > GOV > General configuration	2781
2	Set the AVR type to Analogue	Settings > Generator > AVR > General configuration	2782
3	Set the GOV output to Ana Out 52	Settings > Engine > GOV > Analogue configuration > Analogue output	5981
4	Set the AVR output to Ana Out 55	Settings > Generator > AVR > Analogue configuration > Analogue output	5991

Adjustments in Manual mode

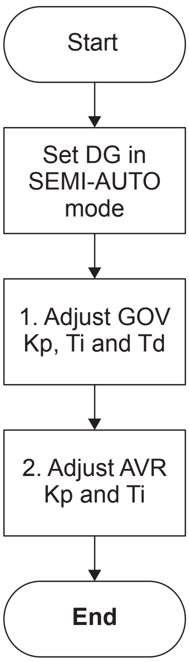


1. Adjust the frequency under:
Settings > Engine > GOV > Offset for control signal (2551).

2. Adjust the voltage under:
Settings > Generator > AVR > Offset for control signal (2671).

3. Adjust the Start delay time under:
Settings > Engine > Start sequence > After crank > Reg. delay at start > Delay reg. (2741).

Adjustments in SEMI-AUTO mode



1. Adjust GOV Kp, Ti and Td:

- Island settings under **Settings > Engine > GOV > Speed PID > Island** (2511, 2512 and 2513).
- Mains parallel settings under **Settings > Engine > GOV > Speed PID > Mains parallel** (2531, 2532 and 2533).
- Load share settings under **Settings > Engine > GOV > Speed PID > Load share** (2541, 2542 and 2543).
- Sync. regulator settings under **Settings > Synchronisation > Sync. regulator** (2041, 2042 and 2043).

2. Adjust AVR Kp and Ti:

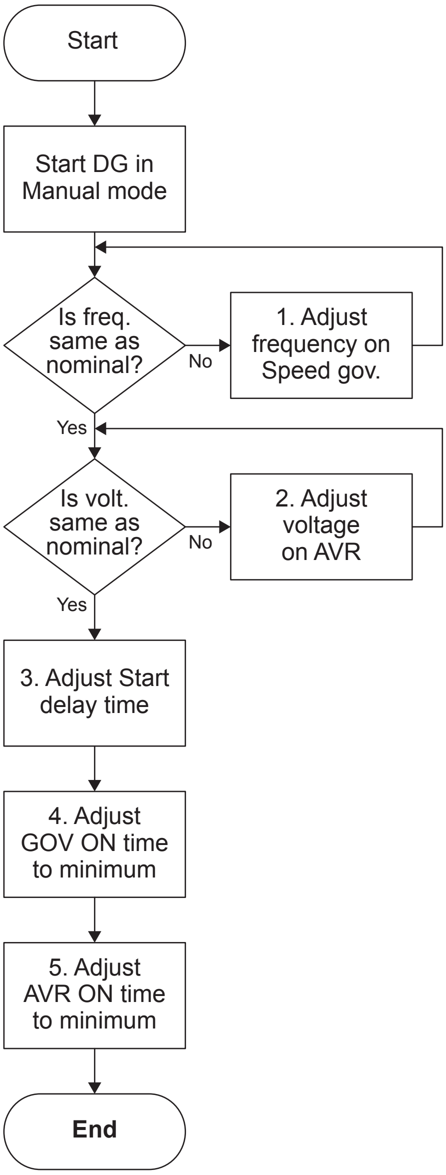
- Island settings under **Settings > Generator > AVR > Voltage PID > Island** (2641 and 2642).
- Mains parallel settings under **Settings > Generator > AVR > Voltage PID > Mains parallel** (2651 and 2652).
- Load share settings under **Settings > Generator > AVR > Voltage PID > Load share** (2661 and 2662).

5.5.3 Configuration of controller with relay governor

Initial settings

No.	Setting	Parameter path	Parameter
1	Set the GOV type to Relay	Settings > Engine > GOV > General configuration	2781
2	Set the AVR type to Relay	Settings > Generator > AVR > General configuration	2782
3	Select the Increase relay for AVR	Settings > Generator > AVR > Relay configuration > Output and period	2723
4	Select the Decrease relay for AVR	Settings > Generator > AVR > Relay configuration > Output and period	2724
5	Select the Increase relay for GOV	Settings > Engine > GOV > Relay configuration > Output and period	2603
6	Select the Decrease relay for GOV	Settings > Engine > GOV > Relay configuration > Output and period	2604

Adjustments in Manual mode



1. Adjust the frequency on the external Speed governor.

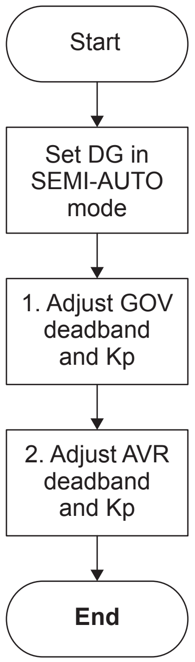
2. Adjust the voltage on the external AVR.

3. Adjust the Start delay time under:
Settings > Engine > Start sequence > After crank > Reg. delay at start > Delay reg. (2741).

4. Adjust the GOV ON time to minimum under:
Settings > Engine > GOV > Relay configuration > Output and period (2601).

5. Adjust the AVR ON time to minimum under:
Settings > Generator > AVR > Relay configuration > Output and period (2721).

Adjustments in SEMI-AUTO mode



1. Adjust GOV deadband and Kp:

- Island settings under **Settings > Engine > GOV > Speed PID > Island** (2571 and 2572).
- Mains parallel settings under **Settings > Engine > GOV > Speed PID > Mains parallel** (2581 and 2582).
- Load share settings under **Settings > Engine > GOV > Speed PID > Load share** (2591, 2592, 2593 and 2594).
- Sync. regulator settings under **Settings > Synchronisation > Sync. regulator** (2051).

2. Adjust AVR deadband and Kp:

- Island settings under **Settings > Generator > AVR > Voltage PID > Island** (2691 and 2692).
- Mains parallel settings under **Settings > Generator > AVR > Voltage PID > Mains parallel** (2701 and 2702).
- Load share settings under **Settings > Generator > AVR > Voltage PID > Load share** (2711, 2712, 2713 and 2714).

5.6 Start functions

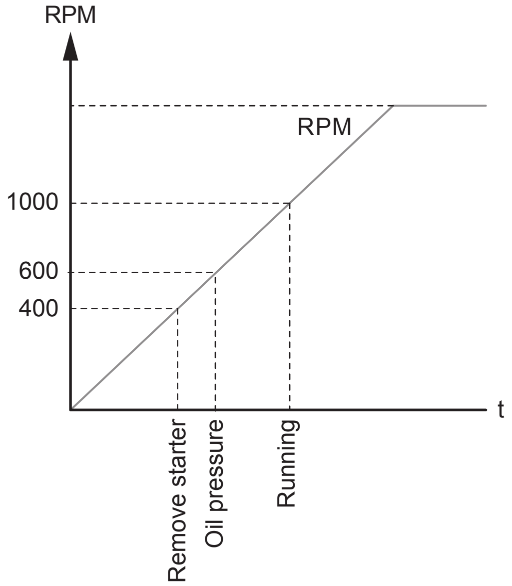
5.6.1 Start functions

The AGC 150 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.

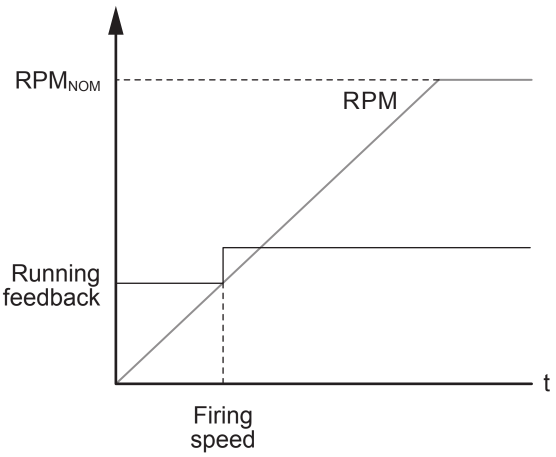


5.6.2 Digital feedbacks

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

Running feedback

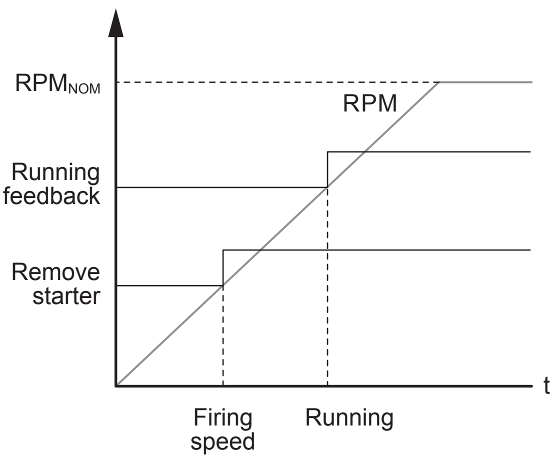
When the digital running feedback is active, the start relay is deactivated and the starter motor will be disengaged.



The diagram illustrates how the digital running feedback 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 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.

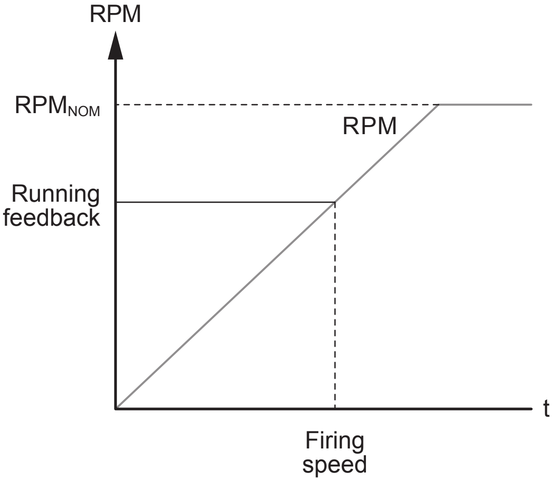
NOTE
The remove starter input must be configured from a number of available digital inputs.

5.6.3 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

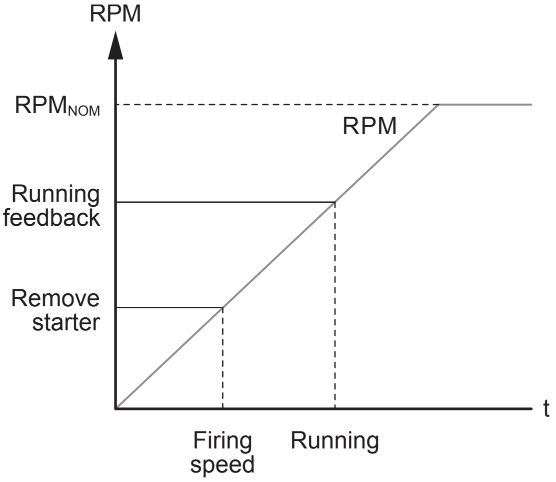
The diagram shows how the running feedback is detected at the firing speed level. The factory setting is 1000 RPM.



CAUTION
The factory setting of 1000 RPM is higher than the RPM level of typical starter motors. Adjust the setting to a lower value to avoid damage of the starter motor.

Remove starter input

The diagram shows how the set point of the remove starter is detected at the firing speed level. The factory setting is 400 RPM.



The number of teeth on the flywheel must be adjusted when the MPU input is used.

Configure the Remove starter input under **Settings > Engine > Start sequence > After crank > Remove starter**.

Parameter	Text	Range	Default
6174	Remove start	1 to 2000 RPM	400 RPM

NOTE The Remove starter function can use the MPU or a digital input.

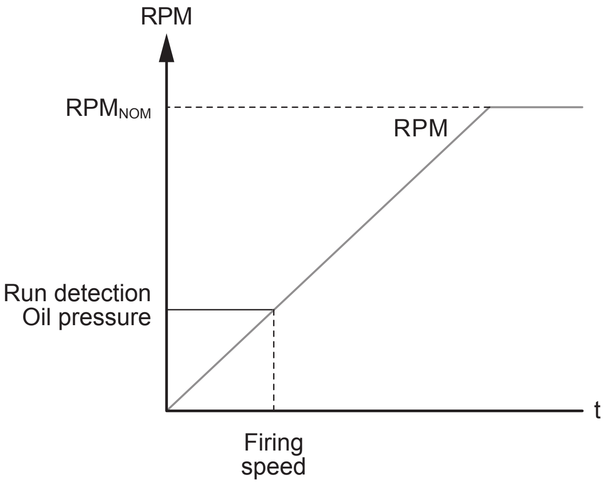
5.6.4 Oil pressure

The multi-inputs on terminals 20, 21, 22 and 23 can be used for the detection of running feedback. The terminal in question must be configured as an RMI input for oil pressure measurement. This is done with the Utility Software:

1. Press the *Multi Input*  button.
2. Select the desired Multi-input tab.
3. In the Input type menu, select RMI oil pressure.

When the oil pressure increases above the adjusted value, the running feedback is detected and the start sequence is ended.

Running feedback



Configure the parameters for Running feedback under **Settings > Engine > Running detection**.

Parameter	Text	Range	Default
6171	Teeth	0 to 500	0
6172	Type	Digital input MPU input Frequency EIC Multi-input 20 to 23	Frequency
6173	Running detect	0 to 4000 RPM	1000 RPM
6175	Oil pressure	0.0 to 150.0	0.0

5.7 Idle running

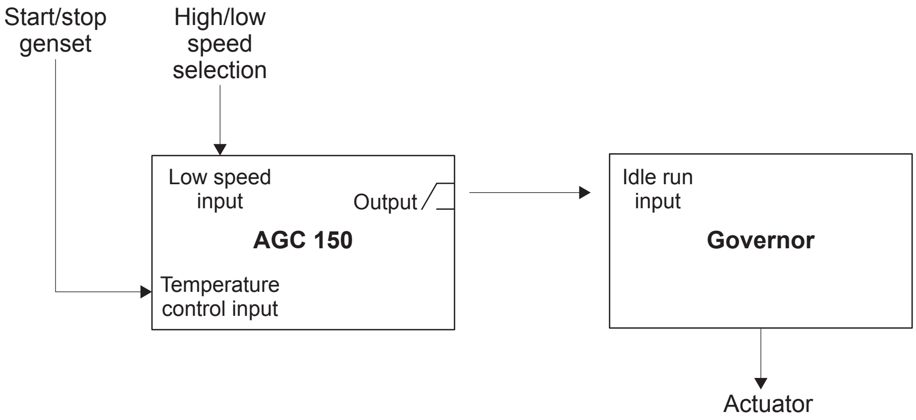
5.7.1 Idle running

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.

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.

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 timers are available to make the function flexible.

The speed governor must be prepared for the idle run function based on a digital signal from the controller.



When the function is enabled, two digital inputs are used for control purposes:

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 a timer, the low speed input is overruled. The input must be configured through the PC software at commissioning. One extra digital output must be available on the controller.

NOTE 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.

Configure the start sequence parameters under **Settings > Engine > Start sequence > Idle run**.

Parameter	Text	Range	Default
6291	Start timer	0.0 to 999.0 min	300.0 min
6292	Enable start	OFF ON	OFF
6295	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
6296	Enable idle run	OFF ON	OFF

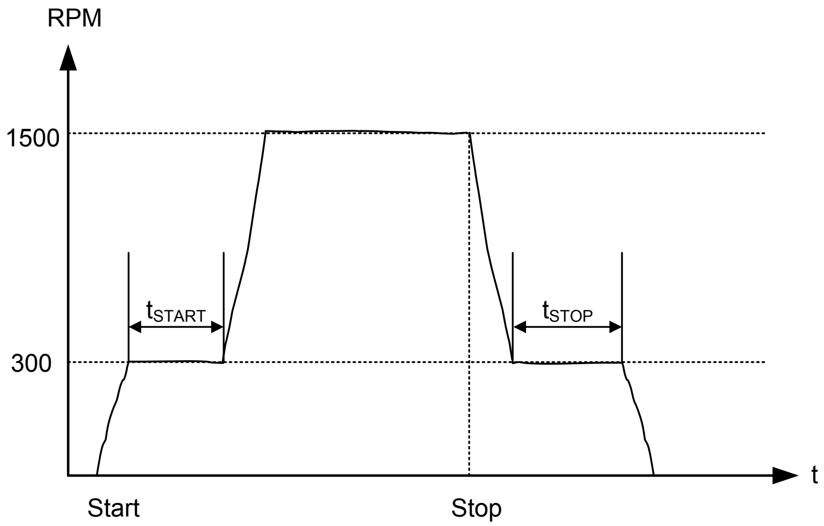
Configure the stop sequence parameters under **Settings > Engine > Stop sequence > Idle stop**.

Parameter	Text	Range	Default
6293	Stop timer	0.0 to 999.0 min	300.0 min
6294	Enable stop	OFF ON	OFF

Examples:

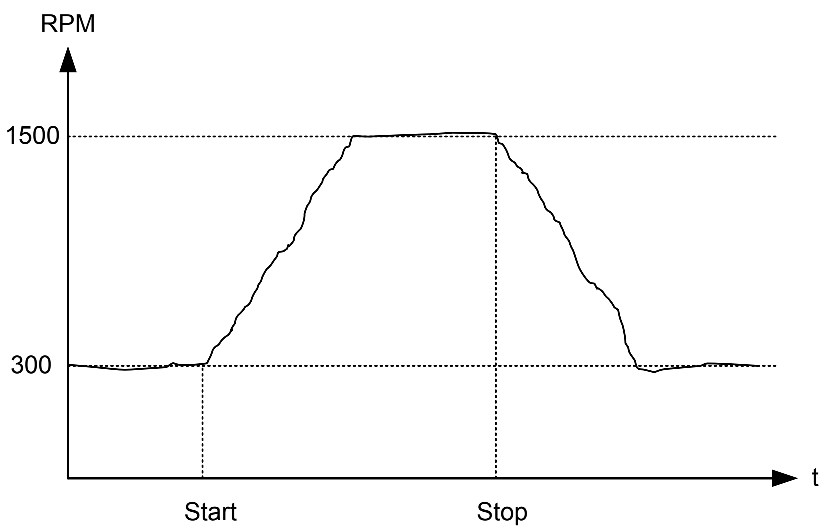
Idle speed during starting and stopping

- 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

- 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:



NOTE The oil pressure alarm (RMI oil) will be enabled during idle run if set to ON.

5.7.2 Temperature-dependent idle start-up

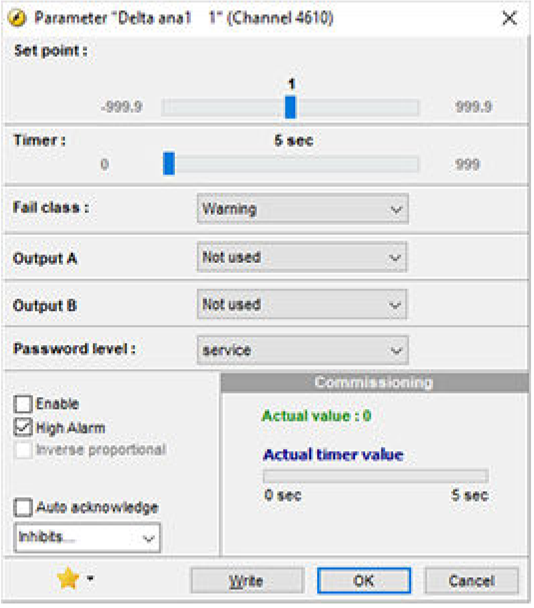
This is an example of a system that will start up in idle run, if the coolant temperature is below a specified value. When the temperature exceeds the specified value, the genset will ramp up to nominal values.

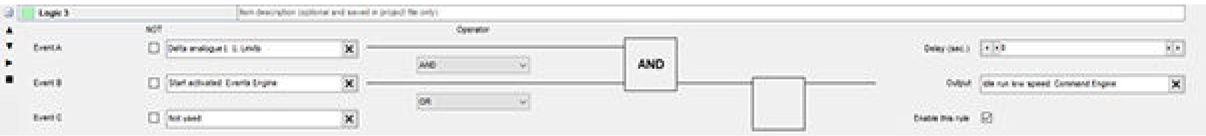
In order for this function to work, Idle running must be ON and the digital output must be configured. Configure Idle running under **Settings > Engine > Start sequence > Idle run**.

Parameter	Text	Range	Set value to
6296	Idle running	OFF ON	ON

Example:

The function is made with delta analogue 1 (parameters 4601, 4602 and 4610) and one M-Logic line. After starting, when the coolant temperature is below 110 °C, the controller will idle. Once the temperature reaches 110 °C, the controller will automatically ramp up to full speed.





5.7.3 Inhibit

The alarms that are deactivated by the inhibit function are inhibited in the usual manner, except for the oil pressure alarms; RMI oil 20, 21, 22 and 23 which are active during Idle run as well.

5.7.4 Running signal

The running feedback must be activated when the genset is running in idle mode.

5.7.5 Idle speed flowcharts

The flowcharts illustrate start and stop of the genset by use of the inputs *Temp control* and *Low speed*.

Figure 5.5 Start flowchart

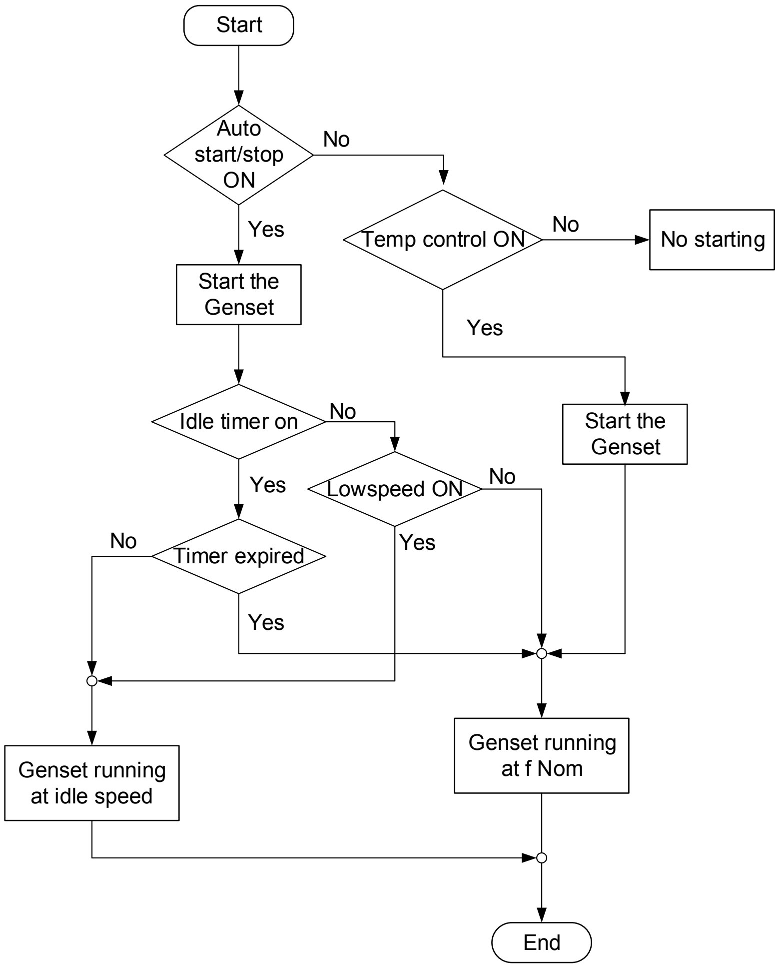
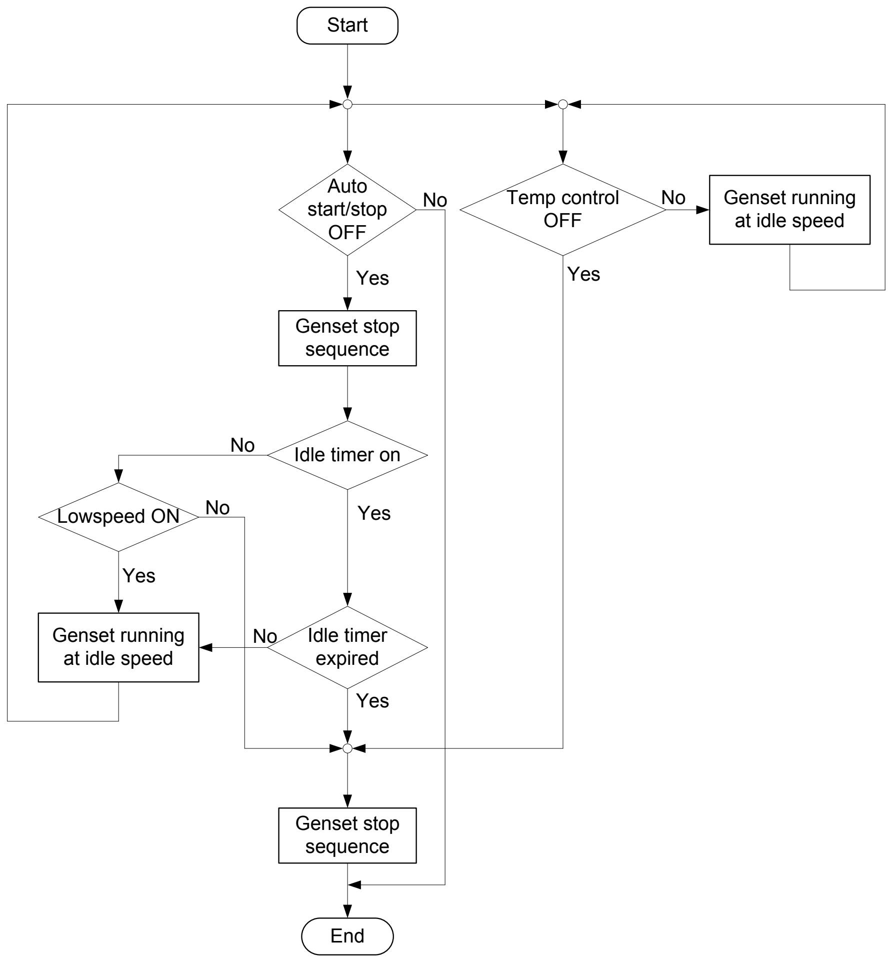


Figure 5.6 Stop flowchart



5.8 Derate function

5.8.1 Derate function

The derate function is used to reduce the maximum output power and/or reactive power of the genset. The derate function is typically used when cooling problems are expected. For example:

1. If the ambient temperature increases to a level that exceeds the cooling capacity, it will be necessary to reduce the power of the genset.
2. If the temperature in the generator gets to high, the reactive power must be derated to avoid alarms and shutdown.

Up to three power derate curves and two reactive power curves can be made to derate the genset. The first active curve will derate the genset to the adjusted set point.

Table 5.4 Derate function inputs

Input	Notes
Multi-input 20	0-10 V DC 4-20 mA Pt100 RMI Digital
Multi-input 21	
Multi-input 22	
Multi-input 23	
M-Logic	
EIC	Water temperature Oil temperature

Input	Notes
	Ambient temperature Intercooler temperature Fuel temperature

5.8.2 Power Derate parameters (P-derate)

The parameters that define the power derate characteristics are:

Parameter name	Description
Start derate point	Starting point for the derate. Depending on the input, the unit can be 4-20 mA or ºC (max. 200 ºC).
Derate slope	Adjust the derate speed 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/RMI input is used, then the derating will be in %/ºC. 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	The lowest derate level in percent. It can be selected whether the characteristic of the derate should be proportional or inverse proportional. 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).

Figure 5.7 Proportional

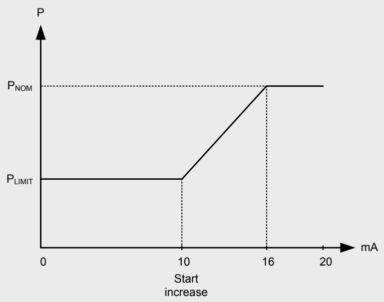
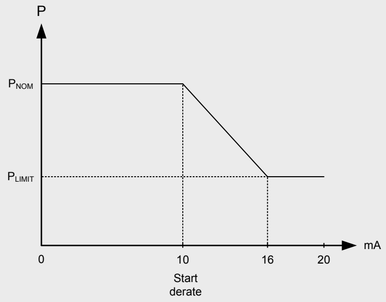


Figure 5.8 Inverse proportional



Configure the Power derate parameters under **Settings > Engine > Protections > Power derate > Power derate #**, where # is 1,2 or 3.

Parameter	Text	Range	Default
6241, 6251 or 6261	Power derate input type	Multi-input 20 to 23 M-Logic EIC temperature inputs Ext. I/O Analogue 1 to 8	Multi-input 20
6242, 6252 or 6262	Start derate at . . .	0 to 20000 units	16 units
6243, 6253 or 6263	Derate slope	0.1 to 100.0 %/unit	5.0 %/unit
6246, 6256 or 6266	Derate limit	0.0 to 100.0 %	80 %

5.9 Service timers

5.9.1 Service timers

AGC 150 has two separate service timers to monitor maintenance intervals.

The timer function is based on running hours. When the adjusted time expires, the controller will display an alarm. The running hours is counting when the running feedback is present. An alarm occurs when either the running hours or days have expired.

AGC 150 will remember the last reset on each service timer. By this, the AGC 150 will be looking at both the running hours and days since last service.

Configure the parameters under **Settings > Engine > Maintenance > Service timer #**, where # is 1 or 2.

Parameter	Text	Range	Default
6111 or 6121	Enable	OFF ON	OFF
6112 or 6122	Running hours	0 to 9000 hours	500 hours
6113 or 6123	Days	1 to 1000 days	365 days
6114 or 6124	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning
6115 or 6125	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
6116 or 6126	Reset	OFF ON	OFF

5.10 Alarm inhibit

5.10.1 Alarm inhibit

With the Utility Software it is possible to configure inhibits for each alarm. When configuring the parameters for an alarm, inhibits can be selected in a drop-down window.

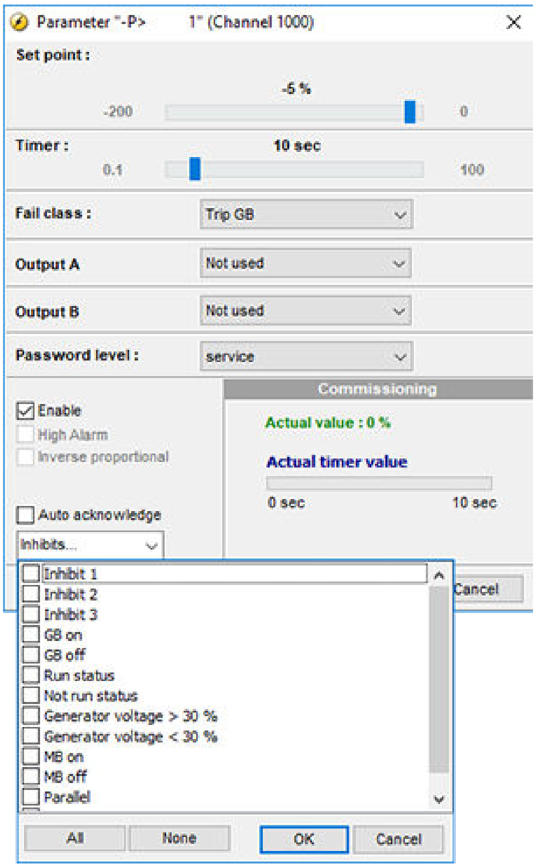
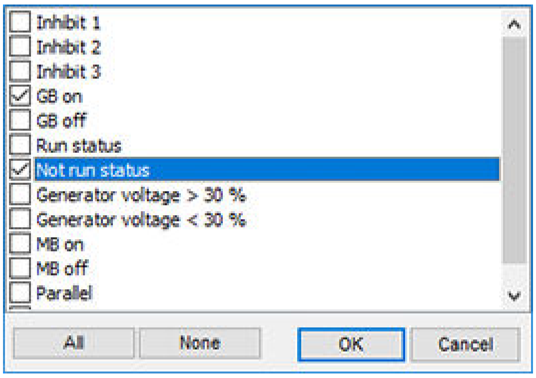


Table 5.5 Alarm inhibits

Function	Notes
Inhibit 1	
Inhibit 2	M-Logic outputs: Conditions are programmed in M-Logic.
Inhibit 3	
GB/TB/BTB ON	Inhibit alarm when the relevant breaker is closed.
GB/TB/BTB OFF	Inhibit alarm when the relevant breaker is open.
Run status	Running detected and the timer has expired*.
Not run status	Running not detected or the timer has 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.

*Note: The Run status timer is configured under **Settings > Functions > Run status > Timer**. With binary running feedback the timer is not used.

Alarm inhibit is active as long as one of the selected inhibits are active.



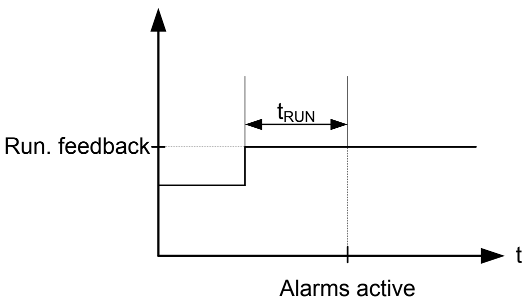
In this example, inhibit is set to Not run status and GB ON. The alarm will be active when the generator is started. When the generator has been synchronised to the busbar, the alarm will be inhibited again.

Only alarm inputs can be inhibited. Function inputs such as running feedback, remote start or access lock are never inhibited.

5.10.2 Run status

Alarms can be configured 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.



Configure the parameters under **Settings > Functions > Run status**.

Parameter	Text	Range	Default
6161	Run status delay timer	0.0 to 300.0 s	5.0 s
6162	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
6163	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
6164	Enable	OFF ON	OFF

5.11 Access lock

5.11.1 Access lock

With the access lock on, the operator can not change controller parameters or running modes. The input to be used for the access lock function is defined in the Utility Software.

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.

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-2, the operator will still be able to change up to 8 different predefined things.

NOTE
- The *Stop* 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.

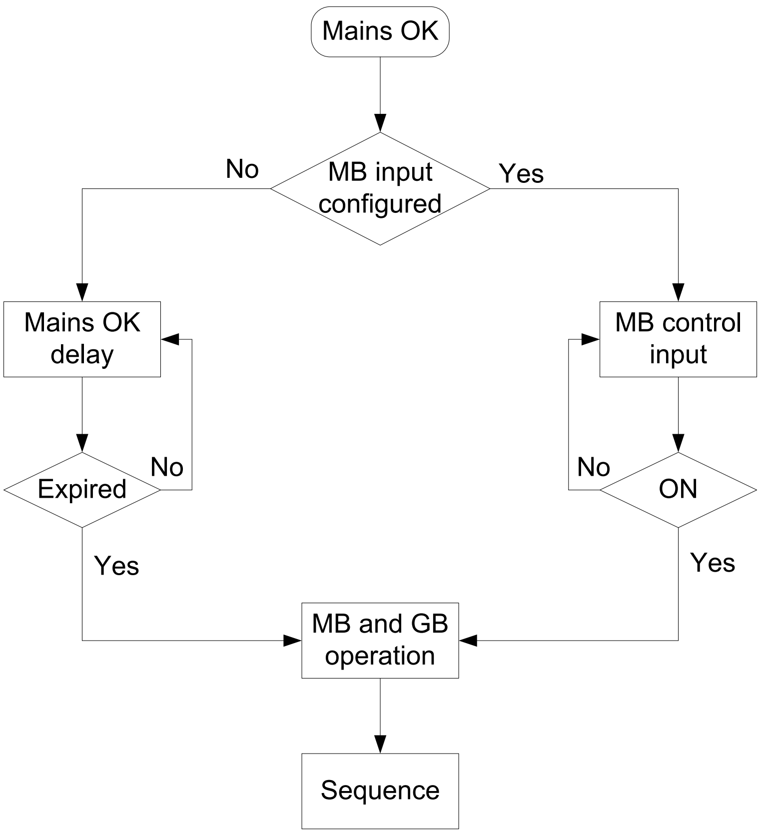
5.12 Digital mains breaker control

5.12.1 Digital mains breaker control

The AGC 150 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 the Mains OK digital to be used to control the mains return sequence. The purpose of this function is to let an external device (for example, a PLC) or an operator control the mains return sequence.

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.



5.13 PID controller

5.13.1 Description of PID controller

AGC 150 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.

5.13.2 Controllers

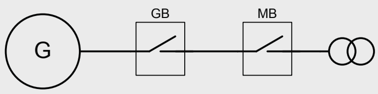
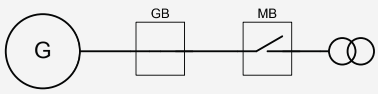
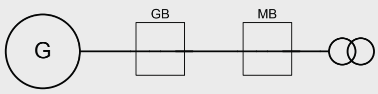
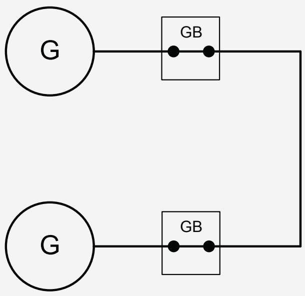
There are three controllers for the governor control and also three controllers for the AVR control.

Table 5.6 Controllers for GOV and AVR

Controller	GOV	AVR	Note
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	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 runningsituation shown is present.

Table 5.7 Active controller

Governor			AVR			Schematic
Frequency	Power	PLS	Voltage	var	QLS	
x			x			
		x			x	
	x			x		
		x			x	

5.13.3 Automatic selection

The AGC 150 will switch between the PID controllers automatically (P-controllers for relay regulation). The controllers have differentset point and also inputs for the control loops. To give an overview towards what the different regulators are regulating, the tablebelow can be helpful:

Table 5.8 Governor

	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

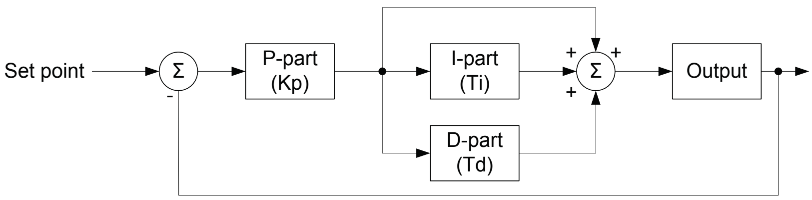
Table 5.9 AVR

	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.

5.13.4 Principle drawing

The drawing below shows the basic principle of the PID controller.



$$\mathrm{PID}(s) = Kp \cdot \left(1 + \frac{1}{Ti \cdot s} + Td \cdot s\right)$$

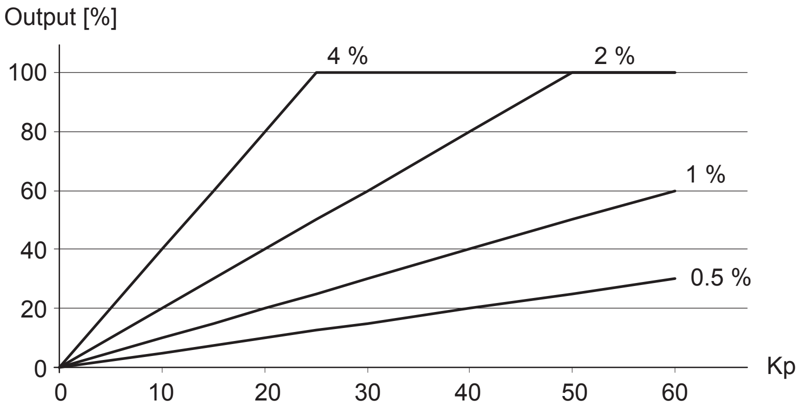
Each regulator (P, I and D) gives an output which is summarised to the total controller output. The adjustable settings for the PID controllers in AGC 150 are:

- 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.

5.13.5 Proportional part of the regulator

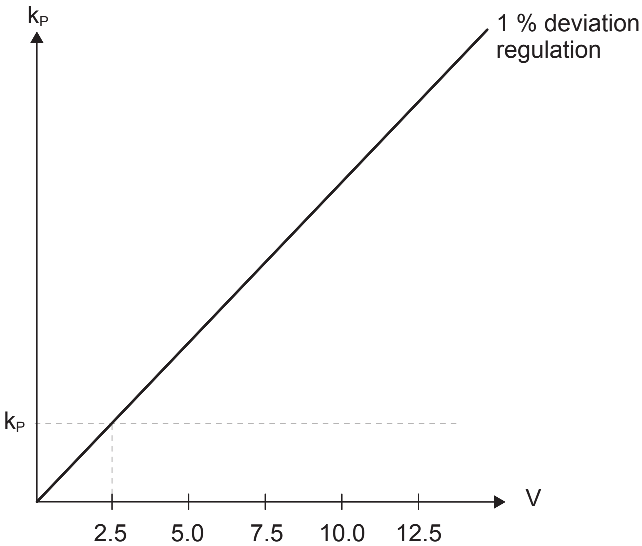
When the regulation deviation occurs, the proportional part will cause an immediate change of the output. The size of the changedepends on the gain Kp.

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 willbe doubled if the regulation deviation doubles.



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.



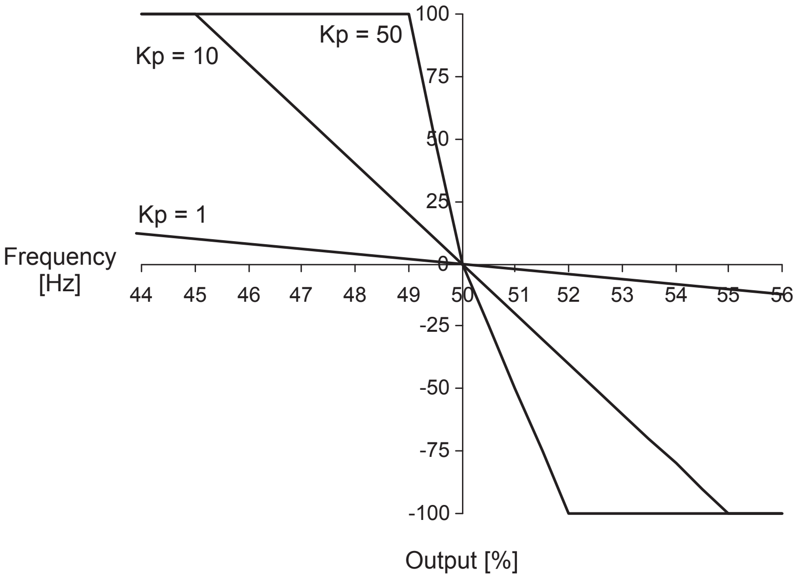
A 1 % regulation deviation occurs. With the Kp setting adjusted, the deviation causes the output to change 2.5 V. The table shows that the output of the AGC changes relatively much if the maximum speed range is low.

Max. speed range	Output change		Output change in % of max. speed range
5 V	2.5 V	2.5/5 · 100 %	50 %
10 V	2.5 V	2.5/10 · 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.

Dynamic regulation area

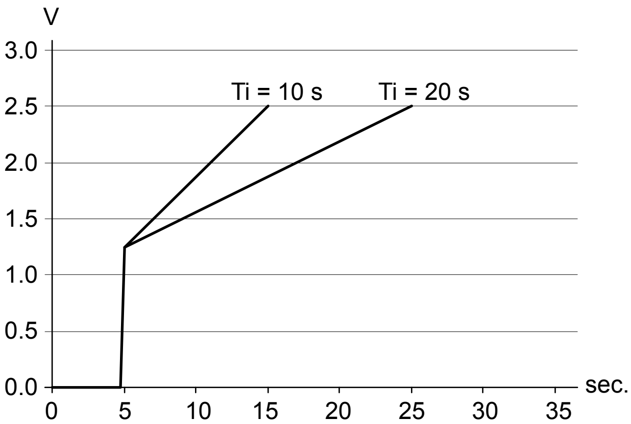
The drawing below shows the dynamic regulation area at given values of Kp. The dynamic area gets smaller if the Kp is adjusted toa higher value.



5.13.6 Integral part of the regulator

The main function of the integral regulator part is to eliminate offset. The integral action time Ti is defined as the time the integral regulator part uses to replicate the momentary change of the output caused by the proportional regulator part.

In the drawing below, the proportional regulator part causes an immediate change of 1.25 V. The integral action time (Ti) is then measured when the output reaches 2 x 1.25 V = 2.5 V.



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.

NOTE
- 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.

5.13.7 Differential part of the regulator

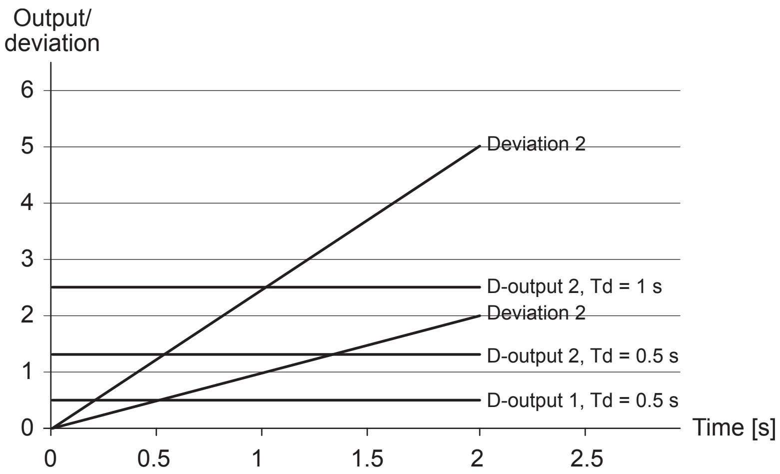
The main purpose of the differential regulator part is to stabilise the regulation, thus making it possible to set a higher gain and a lower integral action time Ti. This will make the overall regulation eliminate deviations much faster.

In most cases, the differential regulator part is not needed; however, in case of very precise regulation situations, for example static synchronisation, it can be very useful.

The output from the differential regulator part can be explained with the equation: $D = Td \cdot Kp \cdot \frac{de}{dt}$, where

- D = Regulator output
- Kp = Gain
- de/dt = Slope of the deviation (how fast does the deviation occur).

This means that the differential regulator part output depends on the slope of the deviation, the Kp and the Td setting. In the following example Kp= 1.



Deviation:

- 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 differential regulator part when Td = 0.5 s and the deviation is according to Deviation 1.
- D-output 2, Td=0.5 s: Output from the differential regulator part when Td = 0.5 s and the deviation is according to Deviation 2.
- D-output 2, Td=1 s: Output from the differential regulator part 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 differential regulator part. Since this is responding to the slope of the deviation, it also means that when there is no change, the D-output will be zero.

NOTE

- When commissioning, please keep in mind that the Kp setting has influence on the differential regulator part output.
- If the Td is adjusted to 0 s, the differential regulator part 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.

5.13.8 Open GB controllers

When the genset is started and the generator breaker is open, AGC 150 uses the f-control for the governor, and the U-control for the AVR. AGC 150 regulates the frequency towards the nominal frequency and nominal voltage, and try to maintain them at the nominal values.

During the start sequence, it is possible to delay the regulation. This makes it possible to have the AGC 150's regulators kept at theoffset 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 ON, the AGC 150 will give an alarm when the Delay of regulation is active. If the enable is OFF, it is possible to set the timer and not have any alarm of this.

Configure the Analogue or Digital governor regulation under **Settings > Engine > GOV > Speed PID > Island**.

Parameter	Text	Range	Default
2511	Frequency controller Kp	0.00 to 60.00	2.50
2512	Frequency controller Ti	0.00 to 60.00 s	1.50 s
2513	Frequency controller Td	0.00 to 2.00 s	0.00 s
2514	Droop	0.0 to 10.0 %	4 %

Configure the Analogue or Digital AVR regulation under **Settings > Generator > AVR > Voltage PID > Island**.

Parameter	Text	Range	Default
2641	Voltage controller Kp	0.00 to 60.00	2.50
2642	Voltage controller Ti	0.00 to 60.00 s	1.50 s
2643	Voltage controller Td	0.00 to 2.00 s	0.00 s
2644	Droop	0.0 to 10.0 %	4 %

Configure the Relay governor regulation under **Settings > Engine > GOV > Speed PID > Island**.

Parameter	Text	Range	Default
2571	Frequency controller - Relay regulation - deadband	0.2 to 10.0 %	1.0 %
2572	Frequency controller - Relay regulation - Kp	0 to 100	10
2573	Droop	0.0 to 10.0 %	4.0 %

Configure the Relay governor regulation under **Settings > Engine > GOV > Speed PID > Island**.

Parameter	Text	Range	Default
2691	Voltage controller - Relay regulation - deadband	0.0 to 10.0 %	2.0 %
2692	Voltage controller - Relay regulation - Kp	0 to 100	10
2693	Droop	0.0 to 10.0 %	4.0 %

Configure the Delay regulation under **Settings > Engine > Start sequence > After crank > Reg. delay at start > Delay reg.**.

Parameter	Text	Range	Default
2741	Delay timer	0 to 9900 s	3 s
2742	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
2743	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
2744	Enable	OFF ON	OFF

5.13.9 Load sharing controllers

The AGC 150 will use the load sharing controllers, when the generator breaker is closed, and not parallel to the grid. When the AGC150 is using the load sharing controller for the governor, it is looking at two things at the regulation. Firstly, the AGC 150 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 150 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 sharing 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 sharing 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 150 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 sharing control.

Configure the Load sharing GOV controllers under **Settings > Engine > GOV > Speed PID > Load share**.

Parameter	Text	Range	Default
2541	Governor f Kp	0.00 to 60.00	2.50
2542	Governor f Ti	0.00 to 60.00 s	1.50 s
2543	Governor f Td	0.00 to 2.00 s	0.00 s
2544	Governor P weight factor	0.0 to 100.0 %	10.0 %
2591	Governor Relay f deadband	0.2 to 10.0 %	1.0 %
2592	Governor Relay f Kp	0 to 100	10
2593	Governor Relay P deadband	0.2 to 10.0 %	2.0 %
2594	Governor Relay P weight factor	0.0 to 100.0 %	10.0 %

Configure the Load sharing AVR controllers under **Settings > Generator > AVR> Voltage PID > Load share**.

Parameter	Text	Range	Default
2661	AVR U Kp	0.00 to 60.00	2.50
2662	AVR U Ti	0.00 to 60.00 s	1.50 s
2663	AVR U Td	0.00 to 2.00 s	0.00 s
2664	AVR Q weight factor	0.0 to 100.0 %	10.0 %
2711	AVR Relay U deadband	0.2 to 10.0 %	1.0 %
2712	AVR Relay U Kp	0 to 100	10
2713	AVR Relay P deadband	0.2 to 10.0 %	2.0 %
2714	AVR Relay Q weight factor	0.0 to 100.0 %	10.0 %

5.13.10 Parallel to grid controllers

When the AGC 150 is parallel to the grid, it will switch into using the parallel controllers. When the genset is parallel to the grid, the AGC 150 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 150 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 150 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 150 will be able to hold the power ramp when ramping up or down, even though the grid frequency or voltage is fluctuating.

Configure the Parallel to grid GOV controllers under **Settings > Engine > GOV > Speed PID > Mains parallel**.

Parameter	Text	Range	FDefau
2531	Governor P Kp	0.00 to 60.00	2.50
2532	Governor P Ti	0.00 to 60.00 s	1.50 s
2533	Governor P Td	0.00 to 2.00 s	0.00 s
2581	Governor Relay P deadband	0.2 to 10.0 %	2.0 %
2582	Governor Relay P Kp	0 to 100	10

Configure the Parallel to grid AVR controllers under **Settings > Generator > AVR > Voltage PID > Mains parallel**.

Parameter	Text	Range	FDefau
2651	AVR Q Kp	0.00 to 60.00	2.50
2652	AVR Q Ti	0.00 to 60.00 s	1.50 s
2653	AVR Q Td	0.00 to 2.00 s	0.00 s
2701	AVR Relay Q deadband	0.2 to 10.0 %	2.0 %
2702	AVR Relay Q Kp	0 to 100	10

5.13.11 Synchronising controllers

The synchronising controller is used in the AGC 150 whenever synchronising is activated. After a successful synchronisation, the frequency controller is deactivated and the relevant controller is activated. This could for example be the load sharing controller.

Select between dynamic and static synchronisation under **Settings > Synchronisation > Sync. type**.

Parameter	Text	Range	Default
2001	Type	Dynamic sync. Static sync.	Dynamic sync.

Dynamic synchronising

When dynamic synchronising is used, the 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.

Configure the parameters for dynamic synchronisation under **Settings > Synchronisation > Sync. regulator**.

Parameter	Text	Range	Default
2041	Frequency sync. controller Kp	0.00 to 60.00	2.50
2042	Frequency sync. controller Ti	0.00 to 60.00 s	1.50 s
2043	Frequency sync. controller Td	0.00 to 2.00 s	0.00 s
2050	Frequency sync. controller –Relay f Kp	0 to 100	10

Static synchronisation

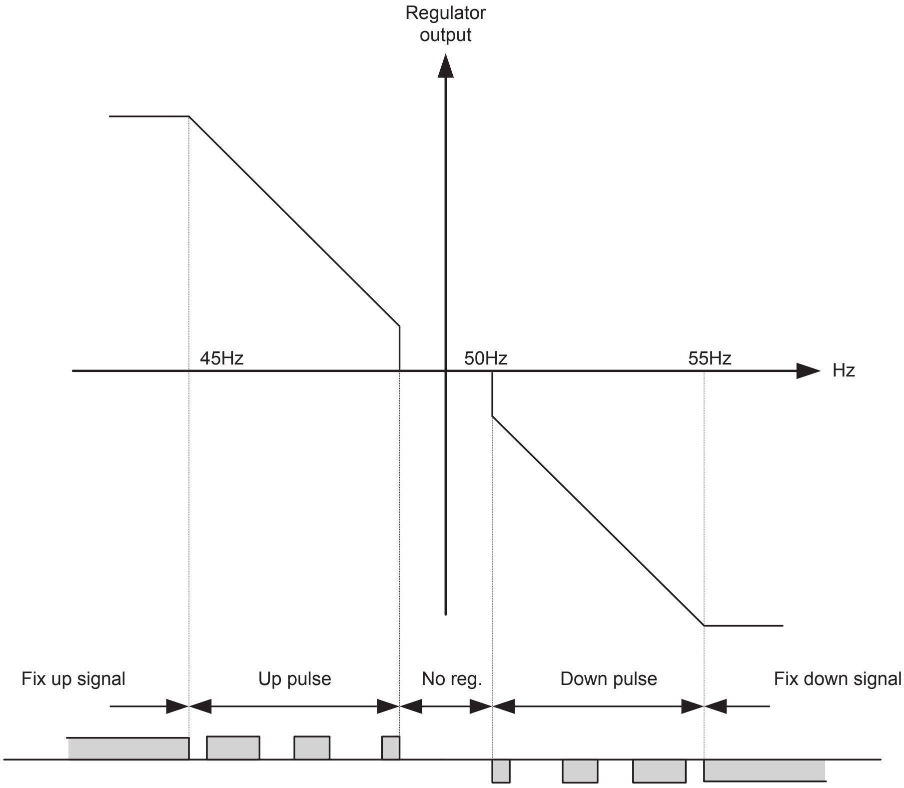
When synchronising is started, the synchronising controller f_{SYNC} controller is activated and the generator frequency is controlled towards the busbar/mains frequency. The phase controller takes over when the frequency deviation is so small that the phase angle can be controlled.

Configure the parameters for staticsynchronisation under **Settings > Synchronisation > Static sync > Sync. regulator**.

Parameter	Text	Range	Default
2061	Static phase Kp	0.00 to 60.00	0.50
2062	Static phase Ti	0.00 to 60.00 s	3.00 s
2063	Static phase Td	0.00 to 2.00 s	0.00 s
2070	Static phase –Relay phase Kp	0 to 100	10

5.13.12 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.

No.	Range	Description	Note
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.

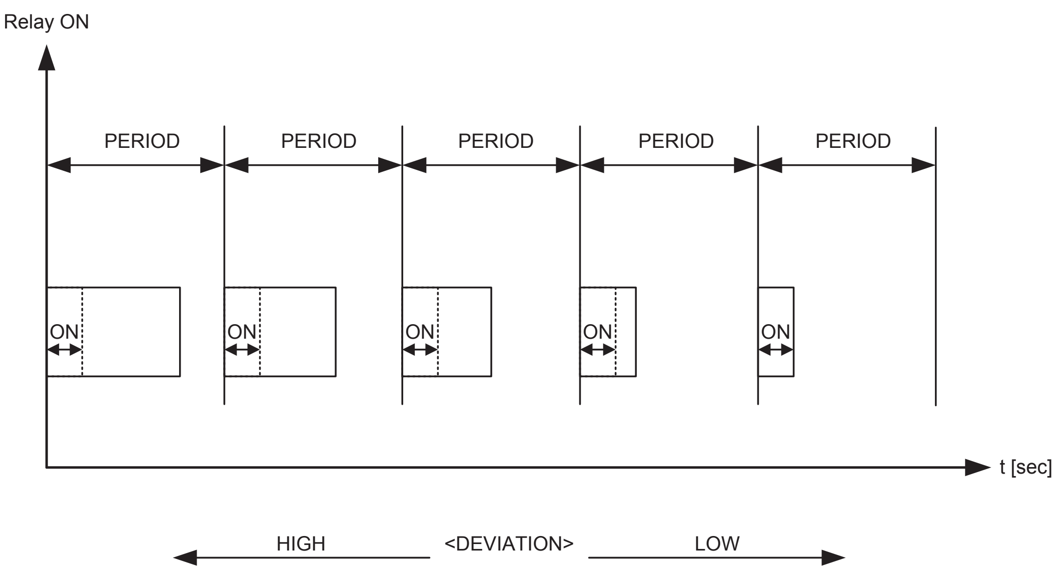
As the drawing indicates, the relays will be fixed ON if the regulation deviation is big, and they will be pulsing if it is closer to the set point. In the dynamic range, the pulses get shorter and shorter when the regulation deviation gets smaller. Just before the deadband area, the pulse is as short 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).

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.

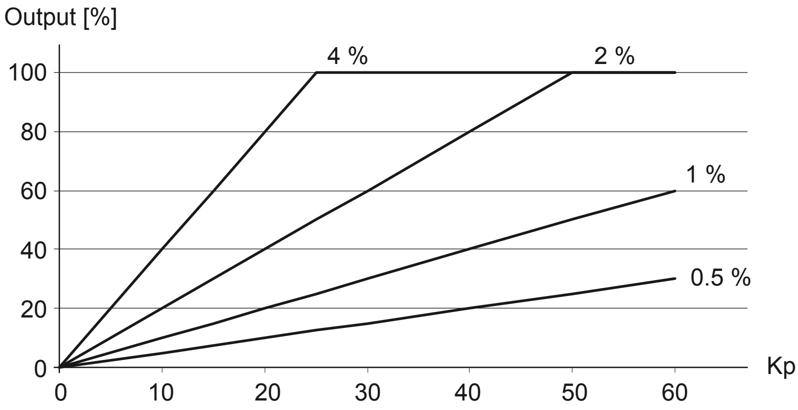
Adjustment	Description	Note
Period time	Maximum relay time	The time between the beginnings of two subsequent relay pulses.
ON time	Minimum relay time	The minimum length of the relay pulse. The relays will never be activated for a shorter time than the ON time.

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 acontinued signal). If the deviation is small, then the pulses will be short.



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 % regulation deviation and an adjusted value of the Kp = 20. The calculated regulator value of the controller 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.

5.14 Droop mode

5.14.1 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 is determined as a percentage of the nominal frequency:

- If the active power is 0 %, the reference frequency is equal to the nominal frequency.
- If the active load is 100 %, the reference frequency is 96 % of the nominal frequency.

Voltage droop is determined as a percentage of the nominal voltage:

- If the reactive power is 0 %, the reference voltage is equal to the nominal voltage.
- If the reactive inductive load is 100 %, the reference voltage is 96 % of the nominal voltage.
- If the reactive capacative load is 100 %, the reference voltage is 104 % of the nominal voltage.

Configure the parameters for f droop under **Settings > Engine > GOV > Speed PID > Island**.

Parameter	Text	Range	Default
2514	f droop	0.0 to 10.0 %	4.0 %
2573	f droop relay	0.0 to 10.0 %	4.0 %

Configure the parameters for U droop under **Settings > Generator > AVR > Voltage PID > Island**.

Parameter	Text	Range	Default
2644	U droop	0.0 to 10.0 %	4.0 %
2693	U droop relay	0.0 to 10.0 %	4.0 %

NOTE 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.

Table 5.10 M-Logic commands

M-Logic output	M-Logic command	Note
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.

NOTE The command Inhibit analogue loadshare must be activated in M-Logic to force the controller from load sharing PID to frequency PID (f) and voltage PID (U). Otherwise, the droop function will not work.

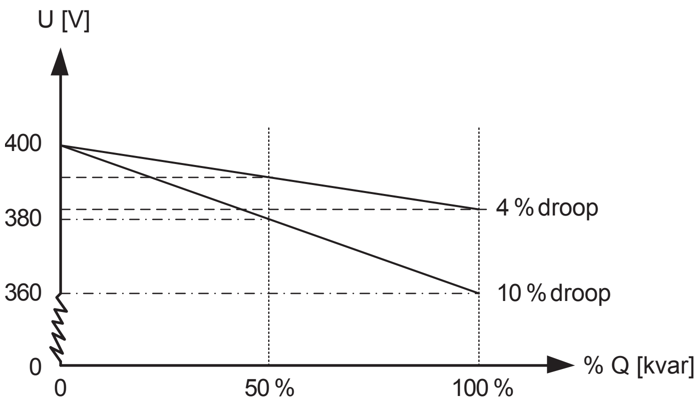
Application configuration

When operating in droop mode, AGC 150 must be configured with a single genset application drawing. This is done with the Utility Software. Use one of the pre-configured applications, or configure a single genset application.

More information
See **Utility Software, Setup of applications** in this document for more information about application configuration.

5.14.2 Voltage droop example

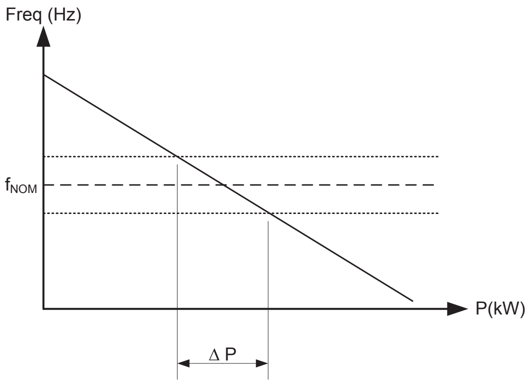
The diagram below shows an example for one generator where the voltage droop setting is 4 % and 10 % in proportion to the reactive power, Q (kvar). As it is shown in the example, the voltage drops as the load increases. The principle is the same with generators in parallel where the generators will use the droop to share the load and allow the voltage/frequency to drop accordingly.



5.14.3 Droop settings

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.

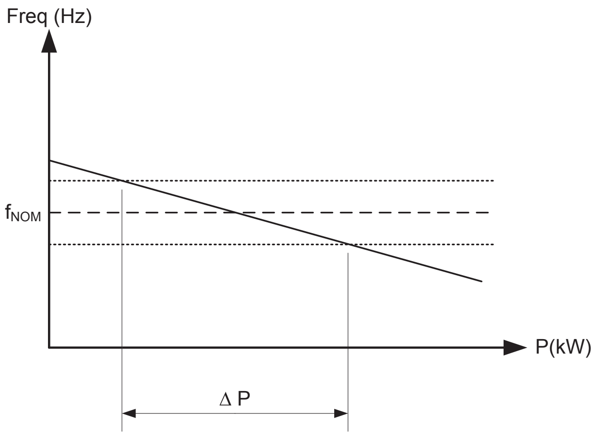


This can be used if the generator must operate base-loaded.

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.

5.14.4 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.

5.15 External set points

5.15.1 External set points

It is possible to control the governor and the AVR externally. A multi-input can be configured to receive a signal with the desired set point. The external control is enabled through M-Logic. The internal set point is discarded when the external control is enabled.

The governor can be controlled using the modes "External frequency control" and "External power control". The AVR can be controlled using the modes "External voltage control", "External reactive power control" and "External cos phi control".

The signal used to control the modes can be set up within the limitations of the multi-inputs. The inputs are configured with the Utility Software. See the Utility Software help function (F1) for more details.

Example: Configuring M-Logic

In M-Logic, external power control from input 20 is enabled as an output by using the command "Ext Power (Gov): Input 20: Gov/AVR control". Commands relevant for external governor/AVR control are found under "Gov/AVR control". Any relevant events can be used to activate the command.

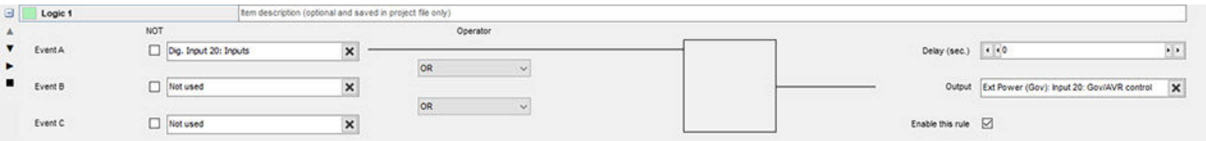


Table 5.11 M-Logic outputs that activate external Gov/AVR control

GOV/AVR control	M-Logic output	Multi-input selection
GOV Ext. frequency	Input: When mA is selected, a 4 to 20 mA signal is used for control and the nominal frequency is 12 mA	Multi-input 20 Multi-input 21 Multi-input 22 Multi-input 23
GOV Ext. power	Input: When mA is selected, a 12 to 20 mA signal is used for control (0 to 100 %)	
AVR Ext. voltage	Input: When mA is selected, a 4 to 20 mA signal is used for control	
AVR Ext. cos phi	Input: When mA is selected, a 12 to 20 mA signal is used for control	
AVR Ext. var	Input: When mA is selected, a 4 to 20 mA signal is used for control	

NOTE When external control is enabled, the internal set point is discarded.

The external set point can also be controlled via Modbus. Configure the External set points under **Settings > Power set points > Ext. power set point**.

Parameter	Text	Range	Default
7501	External power set point	OFF ON	OFF
7502	External frequency set point	OFF ON	OFF
7503	External voltage set point	OFF ON	OFF
7504	External cos phi set point	OFF ON	OFF
7505	External reactive power set point	OFF ON	OFF

More information
See the document **Modbus tables** on deif.com.

5.16 Regulation failure

5.16.1 Regulation failure

The AGC 150 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 upto 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 150 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.

Configure the Governor Regulation failure under **Settings > Engine > GOV > Regulation failure > GOV reg. fail**.

Parameter	Text	Range	Default
2561	Deadband	1.0 to 100.0 %	30.0 %
2562	Timer	10.0 to 300.0 s	60.0 s
2563	Output A	Not used	Not used
2564	Output B	Not used	Not used
2565	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning

Configure the AVR Regulation failure under **Settings > Generator > AVR > Regulation failure > AVR reg. fail**.

Parameter	Text	Range	Default
2681	Deadband	1.0 to 100.0 %	30.0 %
2682	Timer	10.0 to 300.0 s	60.0 s
2683	Output A	Not used	Not used
2684	Output B	Not used	Not used
2685	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning

5.17 Power ramp

5.17.1 Power ramp

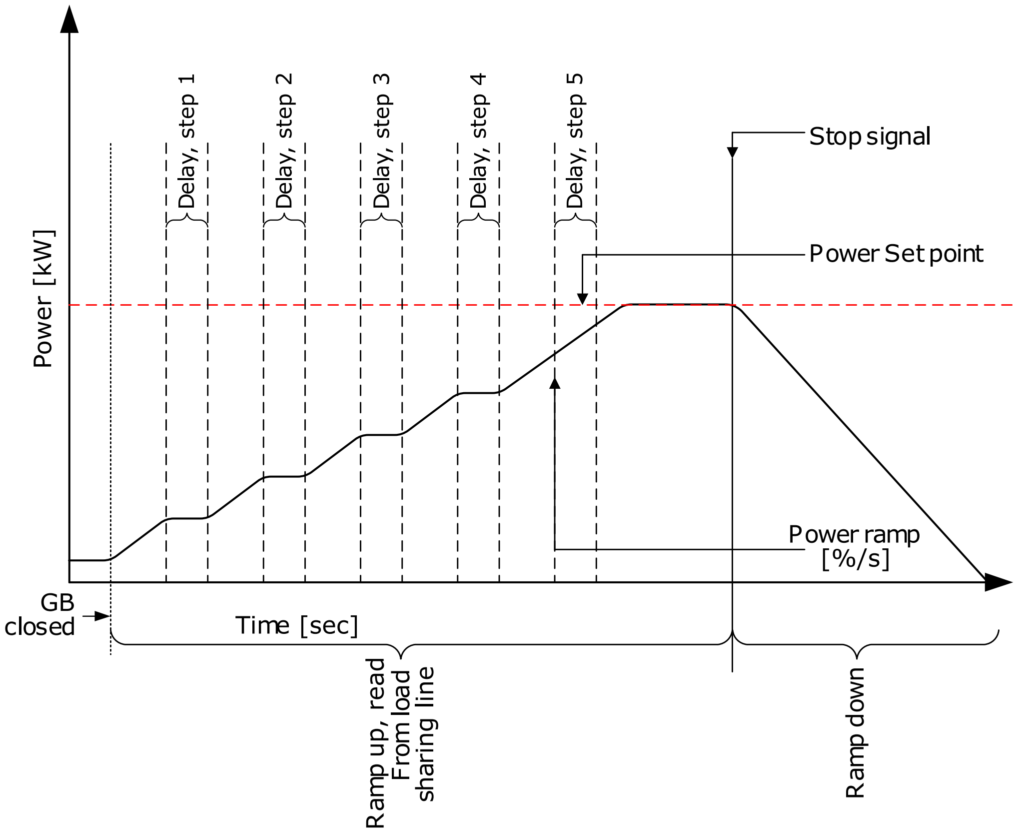
AGC 150 has a Power ramp function that are used for ramping up or down towards the set points. For example, when a breaker has just been closed, and a genset is parallel to the grid. The power ramp will then be used to ramp up towards the power set point.

Power ramp is set in %/s, which means how fast it should ramp up towards the set point. The regulators can then be fine tuned, so the genset is kept at the power ramps when going up or down towards the set point. When the set point is reached, the regulators keep the power set point even though deviations in the frequency appear.

In island running mode, the power ramp is also used. For example, when a genset is started in 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.

The power ramp up can have load steps. It can be chosen how many steps the power ramp should have from 0 to 100 % power, and how many percent between each step. When each step is reached, it is possible to set a delay time, before regulating further up on the power ramp. The power ramp up speed and power ramp down speed are configured individually, and are used in all running modes.

To give an overview on how the speed and power ramp function can be programmed, the drawing below can make it easier to understand.



Configure the Power ramp up function under **Settings > Power set points > Loading/Deloading ramps > kW ramp up speed**.

Parameter	Text	Range	Default
2611	Power ramp up speed 1	0.1 to 20.0 %/s	2.0 %/s
2612	Power ramp up delay point	1 to 100 %	10 %
2613	Power ramp up delay at each step	0 to 9900 s	10 s
2614	Power ramp up island ramp	OFF ON	OFF
2615	Power ramp up steps	0 to 100	1
2616	Power ramp up speed 2	0.1 to 20.0 %/s	0.1 %/s

Power ramp 1 is the primarily used power ramp. Power ramp 1 is only ignored during Frequency-dependent power droop or if power ramp 2 is activated with M-Logic.

Power ramp 2 is a secondary power ramp. It is normally used for Frequency-dependent power droop, but it can also be activated with any M-Logic event. Set the Auto Ramp Select function to OFF, if Power ramp 2 should bee activated br M-Logic.

Select the Auto Ramp Select function under **Settings > Power set points > Loading/Deloading ramps > Auto Ramp Select**.

Parameter	Text	Range	Default
2624	Auto Ramp Select	OFF ON	OFF

Ramp up with load steps

When the GB is closed, the power set point continues to rise in steps, determined by the setting in parameter 2615. If the delay point is set to 20 %, the delay time to 10 seconds, and the number of load steps is set to 3:

- The genset will ramp to 20 %
- Wait 10 seconds
- Ramp to 40 %
- Wait 10 seconds
- Ramp to 60 %
- Wait 10 seconds
- Ramp to the present power set point

Configure the Power ramp down function under **Settings > Power set points > Loading/Deloading ramps > kW ramp down speed**.

Parameter	Text	Range	Default
2621	Power ramp down speed 1	0.1 to 20.0 %/s	3.3 %/s
2623	Power ramp down speed 2	0.1 to 20.0 %/s	0.1 %/s

Freeze power ramp

A way to define the ramp up steps is to use the Freeze power ramp command in M-Logic.

Freeze power ramp active: The power ramp stops at any point of the power ramp, and this set point is maintained as long as the function is active. If the function is activated while ramping from one delay point to another, the ramp is fixed until the function is deactivated again.

6. Functions

6.1 Command timers

6.1.1 Command timers

Command timers are used to execute a command on a specific time. For example, to start and stop the genset automatically at specific times on certain weekdays. In AUTO mode, this function is available in island operation, load take-over, mains power export and fixed power operation.

Up to four command timers can be configured with M-Logic. 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.

6.2 Running output

6.2.1 Running output

Run status can be configured 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.

Configure the Run status under **Settings > Functions > Run status**.

Parameter	Text	Range	Default
6161	Timer	0.0 to 300.0 s	5.0 s
6162	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
6163	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
6164	Enable	OFF ON	OFF

NOTE If the timer for Run status is changed, it also affects the Alarm inhibit for Not run status.

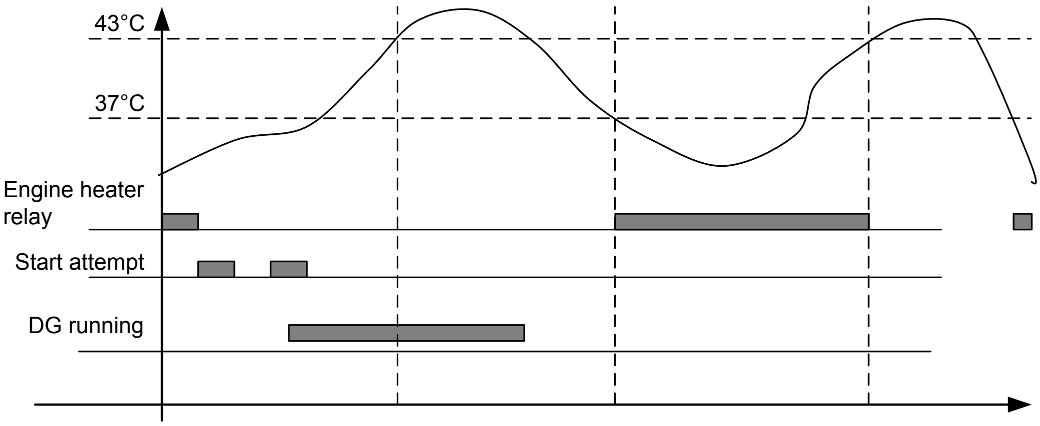
More information
See **Engine/Generator/Mains, Alarm inhibit, Run status** in this document for more information on parameter settings for Run status.

6.3 Engine heater

6.3.1 Engine heater function

This function is used to control the temperature of the engine or the alternator. A temperature sensor is used to activate an external heating system to keep the engine/alternator at a minimum temperature. This function is only active, when the genset is stopped.

Figure 6.1 Example: Engine heater sequence



The engine heater contains a set point and a hysteresis. In the example, the set point is 40 °C with a hysteresis of 3 °C. The AGC 150 will open the engine heater relay when the engine has reached 43 °C, and close when the engine temperature is 37 °C.

A relay must be chosen for the engine heater. If a slave relay of the chosen relay is wanted, this can be programmed in M-Logic.

If the engine heater is active, and the Manual control command has been activated, the engine heater relay will be opened. When the command is activated again, the heater relay will close if the temperature is below the set point.

Configure the parameters under **Settings > Functions > Engine heater**.

Parameter	Text	Range	Default
6321	Set point	20 to 250 °C	40 °C
6322	Output A	Not used Relas 5, 6 and 9 to 18 Limits	Not used
6323	Input type	Multi-input 20 to 23 EIC temp. inputs	Multi-input 20
6324	Hysteresis	1 to 70 °C	3 °C

6.3.2 Engine heater alarm

The engine heater alarm has a temperature set point and a timer. If the temperature gets below the set point, and the engine heater relay is closed, the timer will start. If the timer expires, and the temperature is below the set point, the Standby heater alarm is activated.

Configure the parameters for the engine heater alarm under **Settings > Functions > Engine heater > Engine heater 1**.

Parameter	Text	Range	Default
6331	Set point	10 to 250 °C	30 °C
6332	Timer	1.0 to 300.0 s	10.0 s
6333	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
6334	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used

Parameter	Text	Range	Default
6335	Enable	OFF ON	OFF
6336	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning

6.4 Not in auto

6.4.1 Not in Auto

This function is used to indicate and/or to raise an alarm if the system is not in Auto.

Configure the parameters under **Settings > Functions > Not in Auto**.

Parameter	Text	Range	Default
6541	Timer	10.0 to 900.0 s	300.0 s
6542	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
6543	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
6544	Enable	OFF ON	OFF
6545	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning

6.5 4th current transformer input

6.5.1 4th current transformer input

The 4th current transformer input (terminals 60-61) can be used for three different functions:

- Mains power measurement by placing a CT in the mains L1 connection.
  - Select input under **Settings > Power set points > MPE/Peak shaving > Mains power measure > 4th CT power meas (internal)**.
- Neutral line over-current protection.
  - See **Protections, Generator standard protections, Neutral inverse time over-current (ANSI 51N)** in this document for more information.

- Generator earth current (ground fault) measured in the generator star point ground connection. The function includes a 3rd harmonics filtering of the signal.
    - See **Protections, Generator standard protections, Earth fault inverse time over-current (ANSI 51G)** in this document for more information.

Configure the 4th CT nominal power under **Settings > Basic settings > Nominal settings > Power > 4th CT nominal**.

Parameter	Text	Range	Default
6055	4th CT Power	10 to 9000 kW	480 kW

Configure the 4th CT primary and secondary side under **Settings > Basic settings > Measurement setup > Current transformer > 4th CT**.

Parameter	Text	Range	Default
6045	I primary E/N/M	5 to 9000 A	1000 A
6046	I secondary E/N/M	1 A 5 A	1 A

If the input is not used for mains power, but the measurement is needed anyway, select Multi-input 20 instead. In this case, a separate transducer is needed to measure the mains power.

More information
See the chapter **Multi-inputs** in this document for more information about multi-inputs.

NOTE Only one of the three functions can be used, combinations are not possible.

6.6 Manual governor and AVR control

6.6.1 Manual governor and AVR control

This function can be activated in MANUAL/SEMI-AUTO mode by the digital inputs or the *AOP* buttons for governor or AVR control. The function must be configured through M-Logic, and it gives the commissioning engineer a helpful tool for adjustment of the regulation.

When using digital inputs or an *AOP* button to increase/decrease the GOV/AVR signal, the length of the pulse can be adjusted.

The manually controlled regulator is not active as long as a manual step signal is active. When the manual step signal has expired, the normal regulator will be active again.

Example: A genset is running with the GB open. An AOP is configured with manual up and down and a signal length of 5 s. When the AOP button is pressed for manual GOV up, the RPM for the genset will increase for five seconds. The GOV regulator is deactivated for five seconds. When the five seconds have expired, the normal regulator will regulate the genset down again to the nominal set point.

Governor settings

Configure the GOV type under **Settings > Engine > GOV > General configuration**.

Parameter	Text	Range	Default
2781	GOV type	Relay Analogue EIC	EIC

Configure the GOV manual steptime under **Settings > Engine > GOV > Manual step**.

Parameter	Text	Range	Default
2783	Manual GOV ON	0.1 to 10.0 s	5.0 s

Configure the GOV output offset under **Settings > Engine > GOV > Offset for control signal**.

Parameter	Text	Range	Default
2551	GOV output offset	0 to 100 %	50

AVR settings

Configure the AVR type under **Settings > Generator > AVR > General configuration**.

Parameter	Text	Range	Default
2782	AVR type	Relay Analogue EIC	Analogue

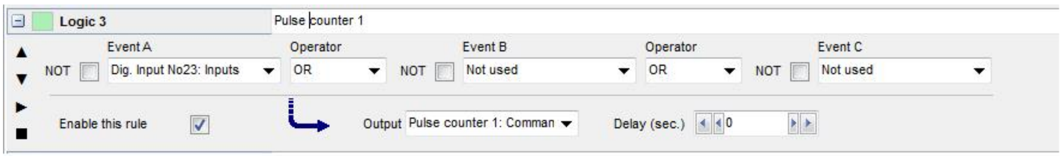
Configure the AVR manual steptime under **Settings > Generator > AVR > Manuel step**.

Parameter	Text	Range	Default
2784	Manual AVR ON	0.1 to 10.0 s	5.0 s

6.7 Pulse input counters

6.7.1 Pulse input counters

Two configurable digital inputs can be used for counter inputs. The two counters can for example be used for 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.



Configure the parameters under **Settings > Functions > Pulse counters**.

Parameter	Text	Range	Default
6851 or 6861	Value	0 to 1000	1
6852 or 6862	Unit type	Unit/pulse Pulse/unit	Unit/pulse
6853 or 6863	Decimal type	No decimals One decimal Two decimals Three decimals	No decimals

6.8 Load shedding and adding

6.8.1 Load shedding and adding

Load shedding can be configured for up to five levels to take place, when the genset is about to take load. This makes it possible to remove none-essential loads before closing the load switch, and keep the initial load of the genset to a minimum.

Load adding begins when the genset load falls below the Load adding return set point.

- The Load adding return timer is activated if the load remains below the Load adding return set point.
- After the timer has expired, the Load group start output is activated.
- This process continues until all outputs are activated.

Load shedding begins when the genset load exceeds the trip level and the trip timer expires.

- The highest Load group is de-activated.
- If the high load is still above the trip level after the timer expires, the next Load group start output is de-activated.
- This process continues until all outputs are de-activated.

If a stop sequence is initiated for the genset, all the Load group start outputs are activated, when the Load switch gets a signal to open.

Configure the parameters for Load shedding and adding under **Settings > Functions > Load shedding/adding**.

Parameter	Text	Range	Default
6381	Load group start	0 to 5	3
6382	Load shedding trip	30 to 100 %	80 %
6383	Load shedding trip timer	1 to 100 s	5 s
6384	Load adding return	30 to 100 %	70 %
6385	Load adding return timer	1 to 100 s	5 s
6386	Enable load shedding/adding	OFF ON	OFF

6.9 Fuel pump

6.9.1 Fuel pump logic

The fuel pump logic is used to start and stop the fuel supply pump to maintain the fuel level in the service tank at pre-defined levels. The start and stop limits are detected from one of the multi-inputs.

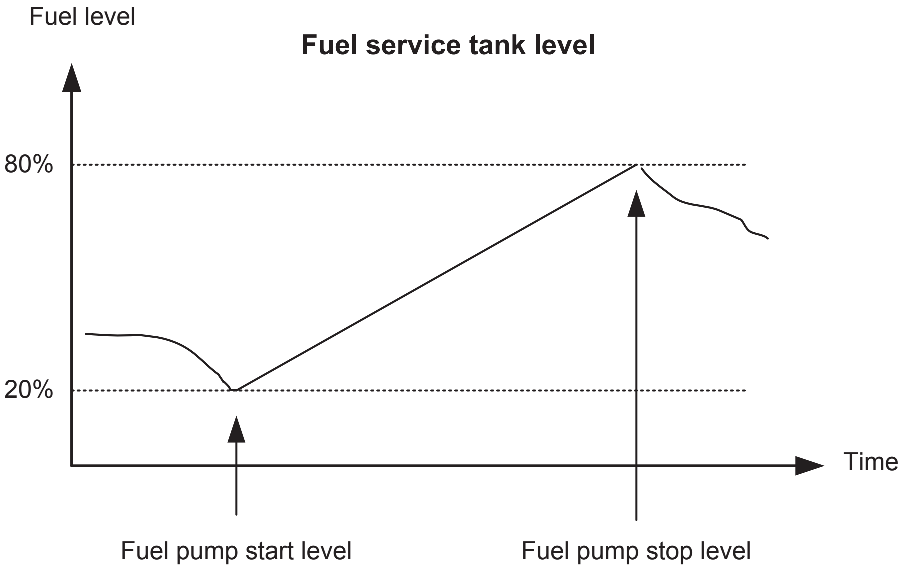
Configure the parameters for Fuel pump logic under **Settings > Functions > Fuel**.

Parameter	Text	Range	Default
6551	Fuel pump start set point	0 to 100 %	20 %
6552	Fuel pump stop set point	0 to 100 %	80 %
6553	Fuel fill check	0.1 to 999.9 s	60.0 s
6554	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
6555	Type	Multi-input 20 to 23 Auto detection	Auto detection

Parameter	Text	Range	Default
6556	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip Mb Safety stop Trip MB/GB Controlled stop	Warning
6557	Fuel fill slope	1 to 10 %	2 %

NOTE
- The fuel pump output can be activated via M-Logic.
- The output relay must be configured as a limit relay.

Example

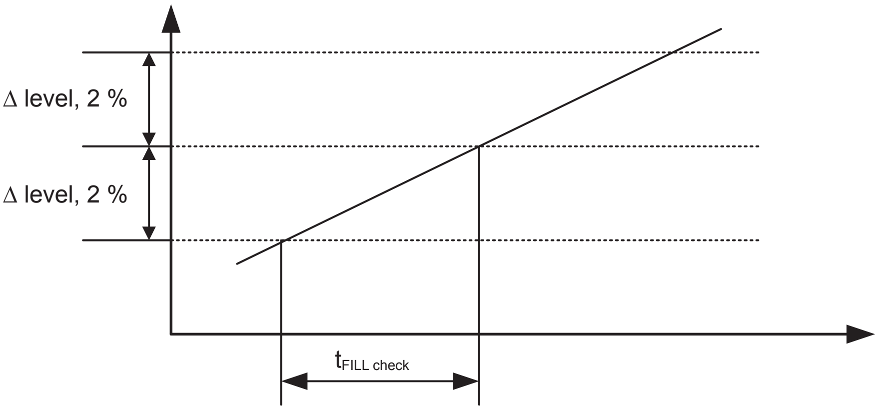


The fuel pump starts when the level reaches 20 % and stops again when the level has reached 80 %.

6.9.2 Fuel fill check

The fuel pump logic includes a fuel fill check function. When the fuel pump is running, the fuel level must increase by at least the percentage value in menu 6557 fuel fill slope within the fuel fill check timer set in menu 6553. If the fuel level does not increase as the slope defines within the adjusted delay time, then the fuel pump output deactivates and a fuel fill alarm occurs. The fuel fill alarm can be enabled/disabled in menu 6553.

Figure 6.2 Example



6.10 Demand of peak currents

6.10.1 Demand of peak currents

It is possible to have two different readings shown in the display:

1. **I thermal demand** shows the average maximum peak current over a time interval.
2. **I max. demand** shows the latest maximum peak current value.

I thermal demand

This measurement is used to simulate a bimetallic system, which is specifically suited for indication of thermal loads in conjunction with for example cables and transformers.

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 six 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 or reset. If the value is reset, it will be logged in the event log and the reading on the display is reset to 0*.

Configure the parameters for I thermal demand under **Settings > Generator > Current protections > Peak and Mean values**.

Parameter	Text	Range	Default
6841	Timer	0.0 to 20.0 min.	8.0 min.
6842	Reset	OFF ON	OFF

I max demand

When a new maximum peak current is detected, the value is shown on the display, and updated every six seconds. If the value is reset, it will be logged in the event log.

Reset the value for I max demand under **Settings > Generator > Current protections > Peak and Mean values**.

Parameter	Text	Range	Default
6843	Reset	OFF ON	OFF

NOTE Both reset functions are also available as commands through M-Logic.

6.11 Fan logic

6.11.1 Fan logic

AGC 150 can control four different fans, for example air supply fans for a genset in a closed enclosure, or radiator fans for air cooling.

There are two features in the fan control of the AGC:

1. Priority rearranging according to running hours of the fans.
   - A priority routine ensures that the running hours of the available fans are evened out.
2. Temperature-dependent start and stop.
   - AGC 150 measures a temperature, for example the cooling water temperature, and uses the measured values to switch on and off relays, which are engaging the fan(s) itself.

The fan control function is active as long as running feedback is detected.

6.11.2 Input for fan control

The fan control requires a temperature input in order to start and stop the fans based on a temperature measurement.

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.

Configure the Fan control input under **Settings > Functions > Fan > Multiple fan start/stop > Fan configuration**.

Parameter	Text	Range	Default
6561	Fan input	Multi-input 20 to 23 EIC temp. inputs	Multi-input 20

6.11.3 Fan start/stop

Configure the parameters for Fan start/stop temperature under **Settings > Functions > Fan > Multiple fan start/stop > Start temperature**.

Parameter	Text	Range	Default
6563	1st level set point	20 to 250 °C	70 °C
6564	1st level hyst.	0 to 50 °C	10 °C
6565	2nd level set point	0 to 250 °C	90 °C
6566	2nd level hyst.	0 to 50 °C	10 °C
6571	3rd level set point	0 to 250 °C	110 °C
6572	3rd level hyst.	0 to 50 °C	10 °C
6573	4th level set point	0 to 250 °C	130 °C
6574	4th level hyst.	0 to 50 °C	10 °C

6.11.4 Fan output

The purpose of the fan output relays is to give a signal to the fan starter cabinet. The relay must be energised for the fan to run.

Select the Fan output under **Settings > Functions > Fan > Multiple fan start/stop > Fan outputs**.

Parameter	Text	Range	Default
6581	Fan A output	Not used Relay 5, 6 and 9 to 18 Limits	Not used
6582	Fan B output		
6583	Fan C output		
6584	Fan D output		

6.11.5 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.

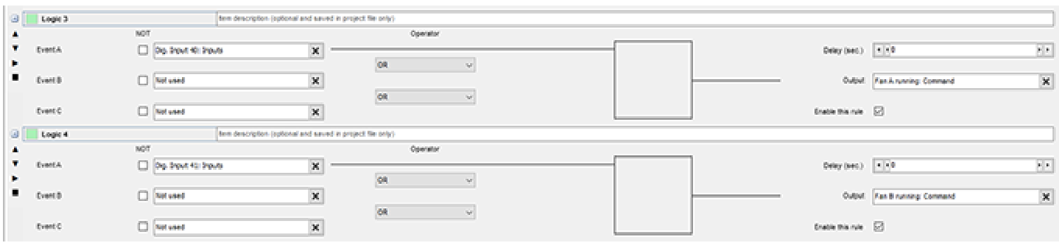
Configure the Fan start delay under **Settings > Functions > Fan > Multiple fan start/stop > Start delay**.

Parameter	Text	Range	Default
6586	Fan start delay	0 to 30 s	0

6.11.6 Fan running feedback

To make sure that the fan is running, it is possible to assign a digital input as a fan running feedback. The running feedback has to be programmed through M-Logic with the Utility Software.

Figure 6.3 Example



The Fan A/B/C/D running command output tells the controller that the fan is running.

6.11.7 Fan failure alarm

It is possible to activate an alarm for Fan A to D if the fan does not start. The fan failure alarm appears if the running feedback from the fan does not appear.

Configure the parameters for Fan A failures under **Settings > Functions > Fan > Multiple fan start/stop > Failures > Fan # failure**, where # is A to D.

Parameter	Text	Range	Default
6591, 6601, 6611 or 6621	Fan # timer	0.1 to 300.0 s	10.0 s
6592, 6602, 6612 or 6622	Output A	Not used Relay 5,6 and 9 to 18 Limits	Not used

Parameter	Text	Range	Default
6593, 6603, 6613 or 6623	Output B	Not used Relay 5,6 and 9 to 18 Limits	Not used
6594, 6604, 6614 or 6624	Enable	OFF ON	OFF
6595, 6605, 6615 or 6625	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning

6.11.8 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.

The running hours can be reset under **Settings > Functions > Fan > Multiple fan start/stop > Running hours**.

Parameter	Text	Range	Default
6585	Fan Run.H reset	OFF Fan A to D hours reset	OFF

Fan priority update

The fan priority update rate (hours between priority rearrange) is selected under **Settings > Functions > Fan > Multiple fan start/stop > Priority**.

Parameter	Text	Range	Default
6562	Fan prio update	0 to 200 hours	0 hours

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.

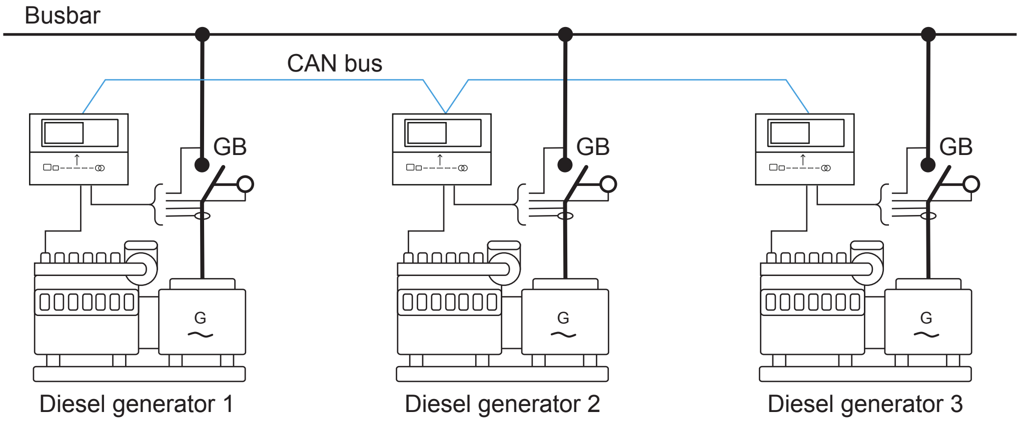
6.12 CAN share

6.12.1 CAN share/digital load share

CAN share/digital load share makes it possible to load share via the CAN bus. The function can be used in applications with two or more generators and without power management or mains.

With CAN share it is possible to load share between up to 128 generators with simple installation and setup.

Figure 6.4 Basic principle of communication between the controllers

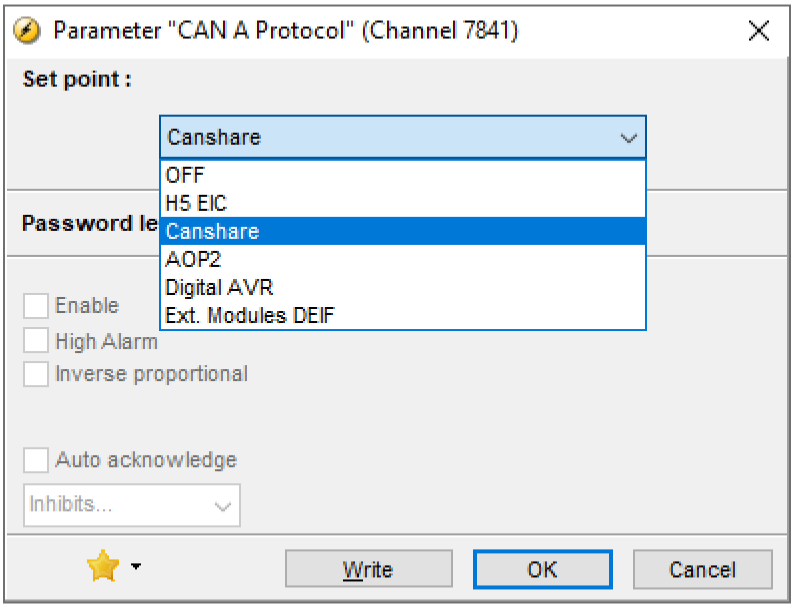


6.12.2 Configure CAN share/digital load share

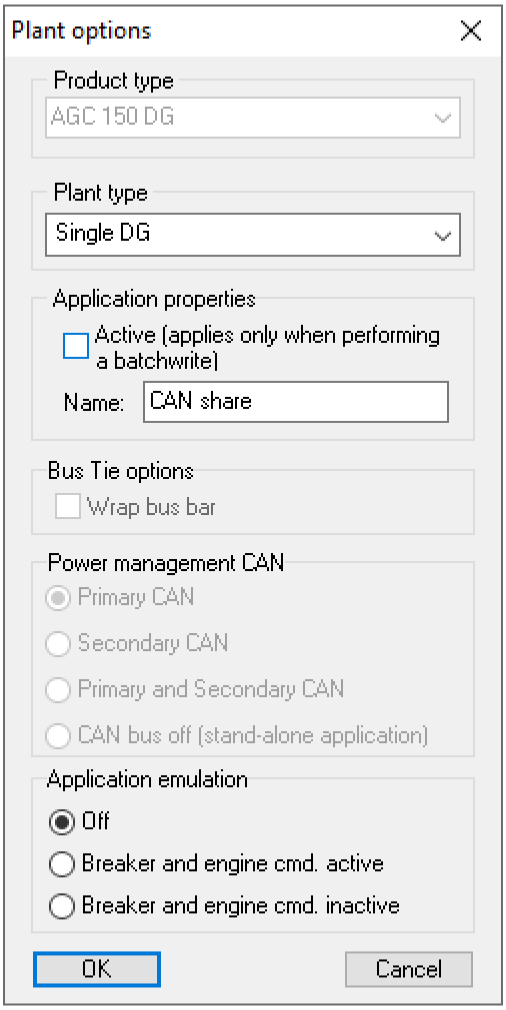
When configuring a controller for CAN share, the controller must be set up as a Single DG, because controllers in a CAN share system do not need to have an internal ID assigned. When connecting to the CAN bus line, the CAN share system automatically assigns the unit an available ID. When disconnecting from the CAN bus line, the system automatically removes the specific ID from the load sharing system.

The setup must be done in each controller from the DEIF Utility Software.

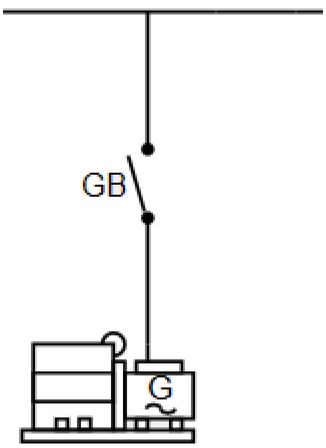
1. Select a CAN protocol to use for CAN share:
   - Parameter 7841 for CAN protocol A
   - Parameter 7842 for CAN protocol B
2. In the drop down menu, select Canshare:



3. Create a new plant configuration and select the plant type to **Single DG**:



4. Make an application drawing with a single generator:



5. Repeat 1 to 4 for each controller.

The system is now ready for CAN share/digital load share. More generators can be addded to the CAN share line without having to assign CAN IDs.

CAN share failure

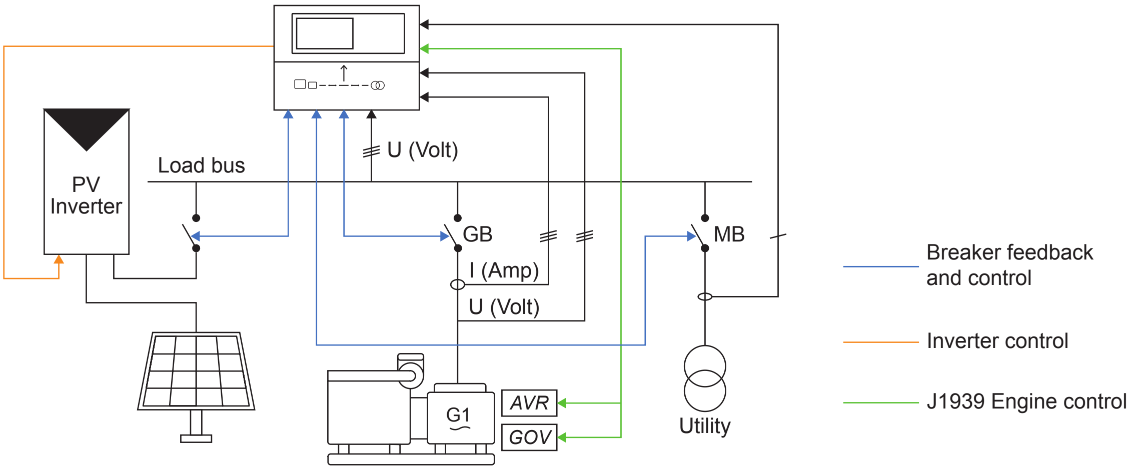
To set up an alarm for CAN share failure, see **Power management, CAN bus failure handling** in this document.

7. Hybrid

7.1 Hybrid applications

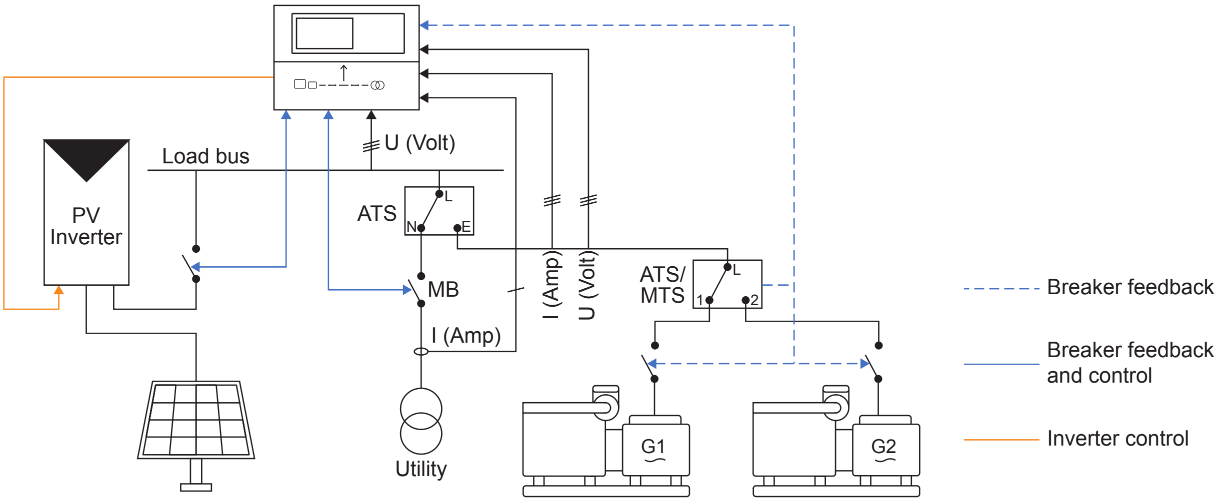
7.1.1 Single generator

In a hybrid setup with a single genset, the AGC 150 can fully control the generator in connection with AVR and GOV control.



7.1.2 Non-synchronising gensets

The AGC 150 comes with four sets of nominal settings. By switching between the nominal settings, the controller can adapt the minimum genset load to match the connected generator.



Example:

- G1 is ON = Nominal settings 1 is used.
- G2 is ON = Nominal settings 2 is used.

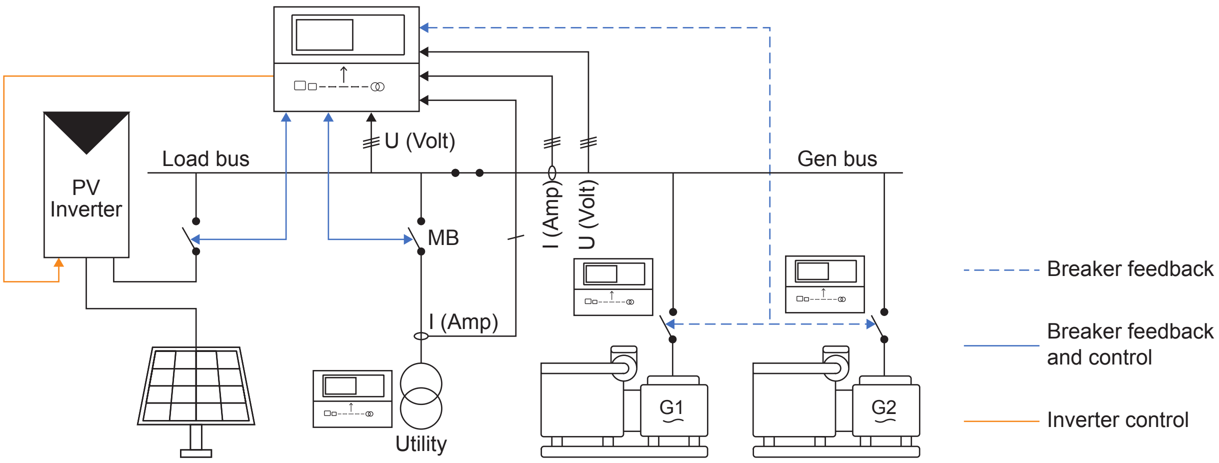
NOTE Max. four none sync generators (= four sets of nominal settings) in an application.

More information
See **Basic settings, Nominal settings** in this document for information about switching between the four sets of nominal settings.

7.1.3 Synchronising gensets

Max. two generators can be used in applications with synchronising gensets. The table shows the possible combinations:

Nominal settings	Generator 1 ON	Generator 2 ON	Generators 1 + 2 ON
Set 1	x	-	-
Set 2	-	x	-
Set 3	-	-	x



NOTE
- The AGC 150 is still measuring the total generator output.
- The generators and mains incomer has their own control system.
- No load on the genbus.

More information
See **Basic settings, Nominal settings** in this document for information about switching between the four sets of nominal settings.

7.1.4 Modes of operation

Off-grid applications

In an off-grid application, the AGC 150 can operate in Island mode.

Grid-tied applications

In a grid-tied application, the AGC 150 can operate in the following modes:

- MPE (Mains Power Export)
- Peak shaving
- Fixed power

Combination applications

In a combination application, the AGC 150 can operate in the following modes:

- Mains breaker open (Off-grid):
  - Island mode
  - AMF (Automatic Mains Failure)
  - LTO (Load Take Over)
- Mains breaker closed (Grid-tied):
  - MPE (Mains Power Export)
  - Peak shaving
  - Fixed power

7.2 Hybrid modes

7.2.1 Hybrid modes

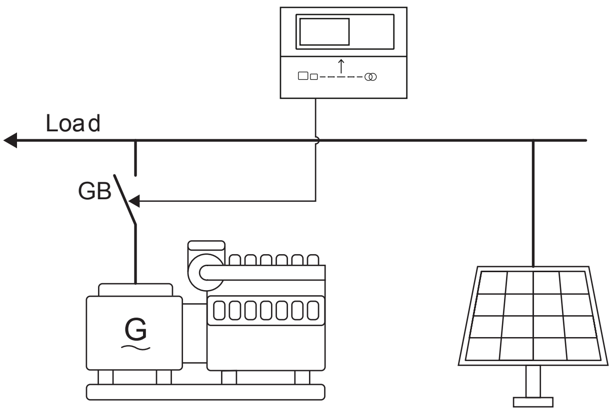
The AGC 150 can be operated in AUTO and SEMI-AUTO mode:

- In AUTO mode , the PV inverters will start automatically when voltage and frequency are available.
  - If a PV auto start signal is configured, the PV inverters will start if the signal is activated and voltage and frequency are available.
- In SEMI-AUTO mode, the PV inverters will start if given a start signal from the controller and voltage and frequency are available.

More information
See **Basic settings, Running mode description** in this document for more information about running modes.

7.2.2 PV Island operation

More information
See **Basic settings, Applications, Island operation** in this document for more information about this mode.



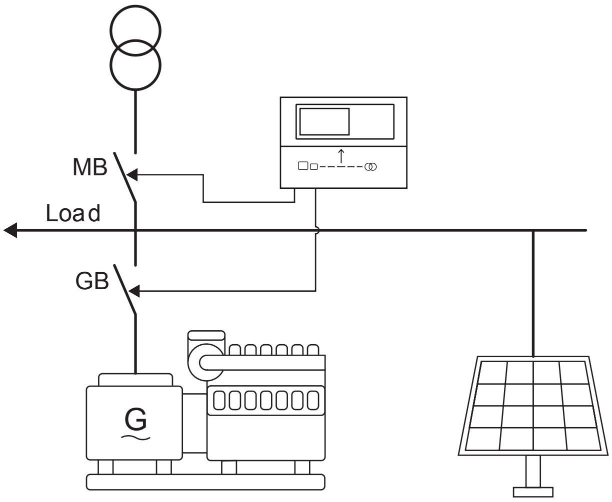
Start sequence in PV Island mode:

1. Activate a start signal:
   - AUTO mode: Auto start/stop.
   - SEMI-AUTO mode: Start the PV inverters from the Hybrid shortcut menu (see later in this chapter).
2. The genset starts and connects to the busbar.
3. The PV inverters start.
4. The genset takes full load.
5. When ready, the PV inverters attempt to take all load, and the genset ramps down to Minimum genset load*.
6. If the PV inverters are not able to take all load, the genset will take the rest.

More information
*See **Hybrid, General configuration, Minimum genset load** in this document for more information about Minimum genset load settings.

7.2.3 PV AMF (Automatic mains failure)

More information
See **Basic settings, Applications, AMF (Automatic mains failure)** in this document for more information about this mode.

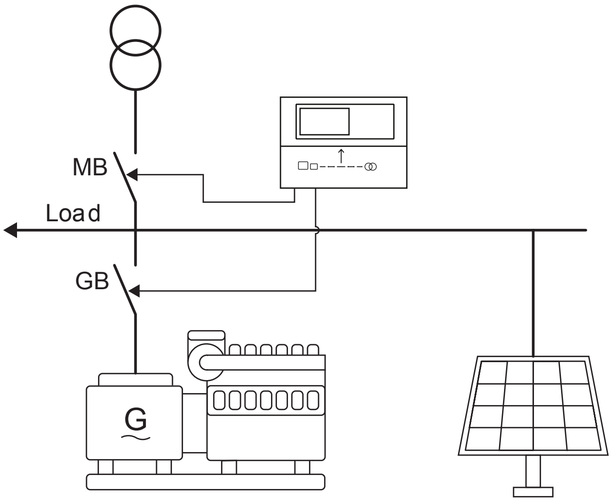


In AMF mode, the PV inverters attempt to take all the load to prevent any import or export of power.

Start sequence in PV AMF mode:
1. Set the controller in AUTO mode.
2. The PV inverters start.
3. The PV inverters attempt to take all load.
4. If the PV inverters are not able to take all load, the mains will take the rest.
5. If a Mains failure occurs:
   - The mains breaker opens.
   - The PV inverters stop taking load.
   - The genset starts, closes the GB, and takes all load.
   - The PV inverters take load.
   - The genset ramps down to Minimum genset load.

7.2.4 PV LTO (Load take-over)

More information
See **Basic settings, Applications, LTO (Load take-over)** in this document for more information about this mode.



In the LTO mode, the PV inverters attempt to take all the mains load to prevent any import or export of power.

AUTO mode:
1. The PV inverters start.

2. The PV inverters attempt to take all load.
3. If the PV inverters are not able to take all load, the rest is imported from mains.
4. If the Auto start/stop input is engaged:
   - The genset starts.
   - The GB closes.
   - The genset takes load.
   - The mains ramps down.
   - The mains breaker opens.

SEMI-AUTO mode:

1. Start the PV inverters from the Hybrid shortcut menu (see later in this chapter).
2. The PV inverters start.
3. The PV inverters attempt to take all load.
4. If the PV inverters are not able to take all load, the mains will take the rest according to the settings in **Basic settings, Applications, LTO (Load take-over)**.

7.2.5 PV Fixed power

More information
See **Basic settings, Applications, Fixed power/Base load** in this document for more information about this mode.

It is possible to configure a control set point for the PV Fixed power. If the controller is in AUTO mode or the PV inverter is started in SEMI-AUTO mode, the PV inverters will try to produce the amount of power according to the set point. If started, the generator will produce power according to the general Fixed power set point.

Start sequence in PV Fixed power mode:

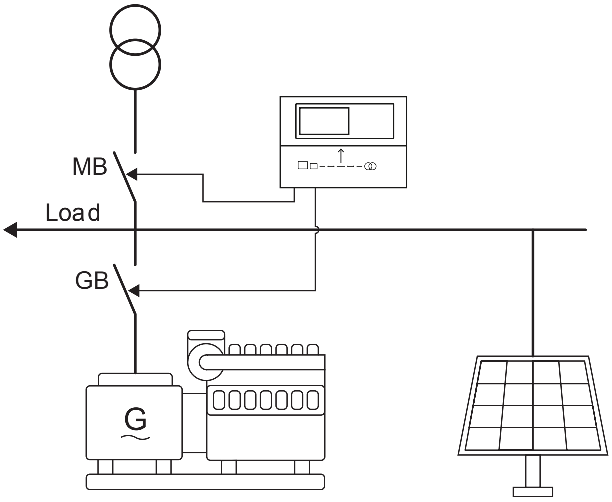
1. Activate a start signal:
   - AUTO mode: Auto start/stop.
   - SEMI-AUTO:
     - Press the *Start* button on the controller.
     - Press the *Shortcut* button on the controller.
     - Select **Hybrid > PV semi start**.
2. The PV inverters produce power up to the PV Fixed power set point (parameter 17131).
3. The genset produces power up to the general Fixed power set point (parameter 7051).
4. If more power is needed, it is imported from Mains.

Configure the PV Fixed power set point under **Settings > Hybrid > General configuration > PV fixed power set**.

Parameter	Text	Range	Default
17131	Power Set	0 to 100 %	100 %

7.2.6 PV MPE (Mains power export)

More information
See **Basic settings, Applications, MPE (Mains power export)** in this document for more information about this mode.



Start sequence in PV MPE mode:

1. Activate a start signal:
   - AUTO mode: Auto start/stop.
   - SEMI-AUTO mode: Press the *Start* button on AGC 150.
2. The PV inverters start.
3. The PV inverters attempt to take load up to the MPE kW set point (parameters 7001 and 7002).
4. If the PV inverters are not able to take all load, the mains and the genset sets in according to the settings below:
   - OFF:
     - The genset is running on Minimum genset load.
     - The mains takes load up to the Mains power set point.
     - The PV inverters take load up to PV max.
     - The genset takes load up to Minimum genset load set point.
     - The mains takes the rest.
   - PV Threshold:
     - The mains takes load up to the Mains power set point.
     - The PV inverters take load up to PV max.
     - The genset starts/stops according to the set points in parameters 17172/17174.
     - The genset takes load up to Minimum genset load set point.
     - If the load increases above PV max., the genset ramps up.
     - If the load increases above the capacity of the genset, the mains takes the rest.
   - Mains Threshold:
     - The mains takes load up to the Mains power set point.
     - The PV inverters take load up to PV max.
     - The genset starts/stops according to the set points in parameters 17176/17178.
     - The genset takes load up to Minimum genset load set point.
     - If the load increases above PV max., the genset ramps up.
     - If the load increases above the capacity of the genset, the mains takes the rest.

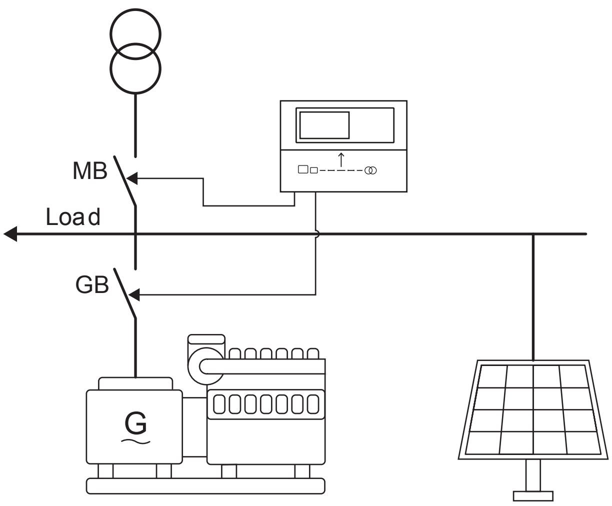
   The mains starts/stops taking load according to the set points in parameters 17176/17178, then the genset.

Configure the genset start mode under **Settings > Hybrid > General configuration > PV DG Start mode**.

Parameter	Text	Range	Default
17171	PV DG start selection	OFF PV Threshold Mains Threshold	OFF
17172	PV DG start load	0 to 110 %	90 %
17173	PV DG start load timer	2.0 to 999.9 s	5.0 s
17174	PV DG stop load	0 to 110 %	70 %
17175	PV DG stop load timer	2.0 to 999.9 s	5.0 s
17176	Mains DG start load	-30000 to 30000 kW	1000 kW
17177	Mains DG start load timer	2.0 to 999.9 s	5.0 s
17178	Mains DG stop load	-30000 to 30000 kW	700 kW
17179	Mains DG stop load timer	2.0 to 999.9 s	5.0 s

7.2.7 PV Peak shaving

More information
See **Basic settings, Applications, Peak shaving** in this document for more information about this mode.



In Peak shaving mode, the PV inverters attempt to take all the load. As long as the load is below the Peak shaving set points, the genset is stopped. When the load increases above the Peak shaving set point, the genset starts.

7.2.8 Hybrid shortcut menu

The AGC 150 has a shortcut menu for start/stop of the PV inverter in SEMI-AUTO mode. To activate the Hybrid shortcut menu, press the *Shortcut*  button.

DG BLOCKED FOR START

Jump
Mode
Test
Lamp test
Hybrid

Select PV semi start/PV semi stop with the *Up* and *Down* buttons, and select the menu with the *OK* button.

```
DG BLOCKED FOR START

PV semi start
PV semi stop
```

7.3 General configuration

7.3.1 PV Nominal settings

The PV Nominal settings are used in a number of key functions, for example protections. Many protection settings are based on a percentage of the nominal settings.

Configure the PV Nominal settings under **Settings > Hybrid > General configuration > PV Nominal settings**.

Parameter	Text	Range	Default
17001	PV Nom. P	10 to 20000 kW	480 kW
17002	PV Nom. Q	10 to 20000 kvar	480 kvar
17003	PV Nom. S	10 to 20000 kVA	480 kVA

7.3.2 PV Power dispatch

It is possible to define set points for minimum and maximum power dispatch from the PV inverters. Configure the settings for PV Power dispatch under **Settings > Hybrid > General configuration > Minimum dispatch**.

Parameter	Text	Range	Default
17051	Minimum dispatch	0 to 100 %	0 %
17052	Maximum dispatch	0 to 100 %	100 %

7.3.3 PV Ramp speed

PV P ramp

Configure the settings for PV P ramp speed under **Settings > Hybrid > General configuration > PV P ramp**.

Parameter	Text	Range	Default
17061	P ramp up speed	0.1 to 100.0 %/s	2.0 %/s
17062	P ramp down speed	0.1 to 100.0 %/s	2.0 %/s

PV Q ramp speed

Configure the settings for PV Q ramp speed under **Settings > Hybrid > General configuration > PV Q ramp**.

Parameter	Text	Range	Default
17071	Q ramp up speed	0.1 to 100.0 %/s	2.0 %/s
17072	Q ramp down speed	0.1 to 100.0 %/s	2.0 %/s

7.3.4 PV Power measurement

Configure the settings for PV Power measurement under **Settings > Hybrid > General configuration > PV power meas.**.

Parameter	Text	Range	Default
17151	PV power meas. input	PV communication DEIF open comm.	PV communication

7.3.5 PV Reactive power

PV Reactive power set points (kvar)

Configure the settings for the reactive power type in grid-tied modes under **Settings > Hybrid > General configuration > Q type grid tie**.

Parameter	Text	Range	Default
17161	Q type grid-tie	OFF Cosphi fixed Q fixed	OFF
17162	Cos phi set	0.60 to 1.00	0.90
17163	Cos phi type	Inductive Capacitive	Inductive
17164	Fixed reactive power set point	-20000 to 20000 kvar	500 kvar

Shared reactive power in Island mode (off-grid)

In Island mode (off-grid), the AGC 150 can be configured to share the reactive power between the PV inverters and the genset. Configure the settings under **Settings > Hybrid > General configuration > PV Q type island**.

Parameter	Text	Range	Default
17121	PV Q type island	OFF Q share	OFF

7.3.6 Enable PV references

Enable PV P and Q references under **Settings > Hybrid > General configuration > Enable PV references**.

Parameter	Text	Range	Default
17101	P PV ref Enable	OFF ON	ON
17102	Q PV ref Enable	OFF ON	ON

7.3.7 Enable closed loop

In applications with more PV inverters, the Closed loop function makes it possible for the AGC 150 to monitor and regulate the power production of the PV inverters, if a malfunction occurs on one or more PV inverters to prevent unwanted mains power import/export.

Example

- The application contains three PV inverters of 200 kW = 600 kW total.
- The PV nominal power set point is 600 kW.
- The load is 300 kW, so the AGC 150 asks the PV inverters to produce 50 % of P_{NOM}.

If one of the PV inverters malfunctions, the production will be 50 % of 400 kW = 200 kW:

- Closed loop OFF: The difference between load and production (100 kW) is imported from mains.
- Closed loop ON: The AGC 150 will ramp up the PV power production to 75 % to avoid importing from mains.

Enable Closed loop under **Settings > Hybrid > General configuration > Closed loop**.

Parameter	Text	Range	Default
17111	Closed loop Enable	OFF ON	OFF

7.3.8 Minimum genset load

To eliminate the risk of reverse power and engine problems caused by low load, a Minimum genset load set point can be configured in the AGC 150. This applies only for off-grid applications. In grid-tied applications, the Minimum load set point is defined by parameter 7023.

More information
See **Basic settings, Applications, Peak shaving** in this document for more information.

Configure the minimum genset load under **Settings > Hybrid > General configuration > Minimum DG load**.

Parameter	Text	Range	Default
17081	Min DG Load 01	-50 to 100 %	30 %
17082	Min DG load 02	-50 to 100 %	30 %
17083	Min DG Load set	Set 1 Set 2	Set 1

7.3.9 Curtailment

The AGC 150 has a counter that measures the curtailment of the PV penetration. The counter is seen in the USW or on the display view 16:

```
DG BLOCKED FOR START
PV E curta. total          0kWh
PV E curta. year           0kWh
PV E curta. month          0kWh
PV E curta. week           0kWh
PV E curta. day            0kWh
                          16/20
```

Curtailment is defined by assuming that there is overhead of PV availability if the penetration is less than the capacity of the PV capacity caused by the required set point being decreased.

The PV capacity is calculated based on the installed number of panels and their back of module temperatures. The irradiation is also affecting the total PV capacity.

Example:

- If the PV capacity is 100 kW and the set point requires 100 kW, the PV inverters are not curtailed.
- If the set point requires 80 kW and the AGC regulates the inverters to run at 80 kW and measures 80 kW, the curtailment is recorded in the curtailment counters as 20 kW (the difference between 80 and 100 kW).

Irradiation

If there is a change in the irradiation, the penetration changes. For example, during dusk hours, the capacity decreases. If the AGC 150 measures less power than required from the PV side, the curtailment counter is switched off because it is no longer possible for the PV inverter to dispatch the requested power.

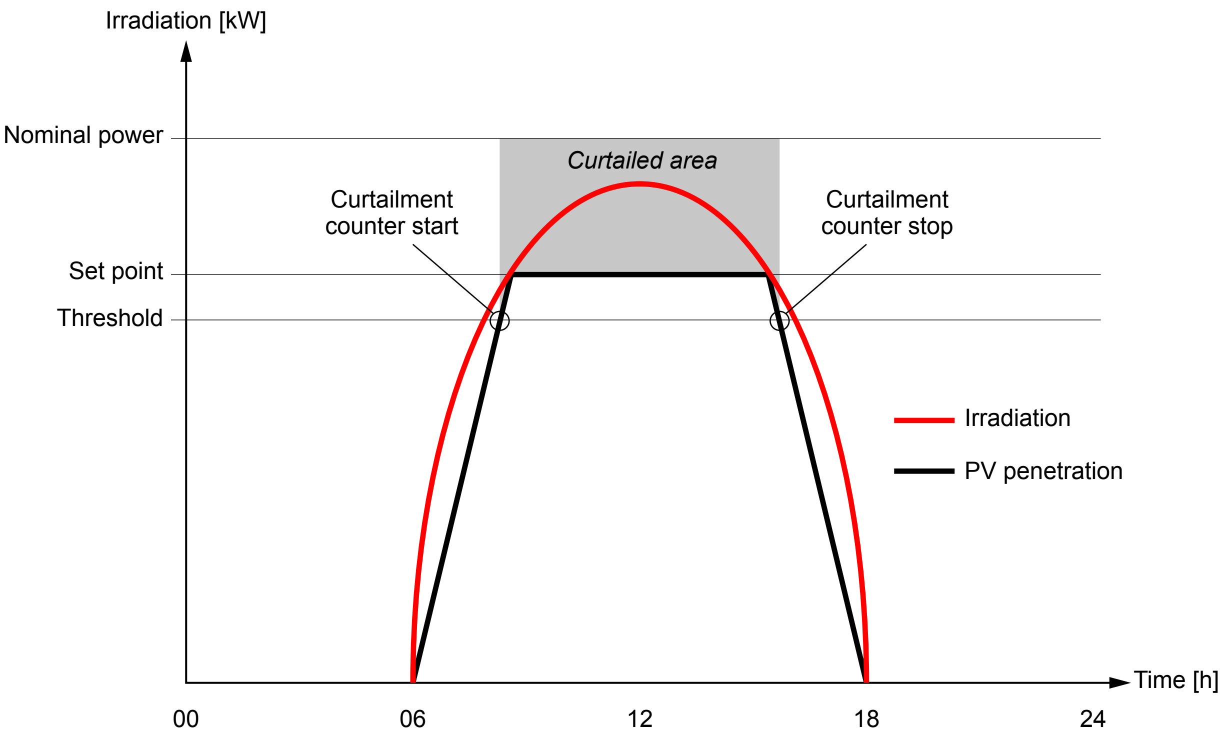
Curtailment threshold

If the output of the PV panels varies compared to the power measured by the AGC 150, there can be false or missing increments of the curtailment counter.

As an example, the AGC 150 transmits a request to the inverters to deliver 80 kW using the SunSpec Modbus communication. When the controller measures less than 80 kW, the curtailment counters are off. When the power reaches 80 kW, the curtailment counters are turned on, since it is assumed that more than 80 kW could be available.

The inverters produce the power requested by the controller. Note that a set point is transmitted, not a regulation signal. Therefore the controller measurement can differ from the PV measurement, for example, 79.8 instead of 80 kW. This can still be considered within the expected range.

The threshold can be adjusted to match the expected deviation between the two systems, so that the curtailment counter starts at the correct level. The curtailment threshold can be up to 100 %.



7.3.10 Weather data

The AGC 150 provides support of several analogue weather data sensors:

Sensor	Abbreviation	Function
3 x Plane of array	POA	POA is used for determining the maximum active P that the PV inverter can produce. There are three POA sensors and they can be weighted against each other. This could depend on the physical position of the PV modules.
3 x Back of module temperature	BOM	BOM measurements are used for determining the maximum active P that the PV inverter can produce. There are three POA sensors and they can be weighted

Sensor	Abbreviation	Function
		against each other. This could for instance depend on the physical position of the PV modules or the number of modules installed on each roof top
1 x Global horisontal irradiation	GHI irr.	Readings only
1 x Ambient temperature		Readings only
1 x Relative humidity		Readings only
1 x Barometric pressure		Readings only
1 x Wind speed		Readings only
1 x Wind direction		Readings only
1 x Rain fall		Readings only
1 x Snow depth		Readings only

The POA and BOM sensor can be weighted from 0 to 100 %. This is useful if the installation has two or three physical locations.

Location	Number of panels	Panel rating Wp	POA weight	BOM weight
South east	500	250	32 %	32 %
South west	450	250	28 %	28 %
South	600	265	40 %	40 %
Total		**396.5 kWp**		

Weather data settings

Configure the Weather data communication settings under **Settings > Hybrid > Communication > Weather comm ID**.

Parameter	Text	Range	Default
17421	Weather comm ID	1 to 247	3
17422	Weather protocol	OFF ABB VSN800 Delta Ohm	OFF

Configure the Weather communication error settings under **Settings > Hybrid > Communication > Weather comm error**.

Parameter	Text	Range	Default
17431	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
17432	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
17433	Enable	OFF ON	OFF
17434	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stopTrip MB/GB Controlled stop	Warning

Parameter	Text	Range	Default
		PV shutdown	

Plane of array (POA) settings

Configure the POA irradiation settings under **Settings > Hybrid > Weather > POA Irradiation**.

Parameter	Text	Range	Default
17501	POA irr. 1	Multi-input 20 to 23 PV communication DEIF Open Weather station comm	PV communication
17502	POA irr. 1 Enable	OFF ON	OFF
17503	POA irr. 2	Multi-input 20 to 23 PV communication DEIF Open Weather station comm	PV communication
17504	POA irr. 2 Enable	OFF ON	OFF
17505	POA irr. 3	Multi-input 20 to 23 PV communication DEIF Open Weather station comm	PV communication
17506	POA irr. 3 Enable	OFF ON	OFF

Configure the POA weighing factor under **Settings > Hybrid > Weather > POA/BOM weight**.

Parameter	Text	Range	Default
17521	POA irr. wgt. 1	0 to 100 %	100 %
17525	POA irr. wgt. 2	0 to 100 %	0 %
17526	POA irr. wgt. 3	0 to 100 %	0 %

Back of module (BOM) temperature settings

Configure the BOM temperature settings under **Settings > Hybrid > Weather > BOM Temperature**.

Parameter	Text	Range	Default
17511	BOM temp. 1	Multi-input 20 to 23 PV communication DEIF Open Weather station comm	PV communication
17512	BOM temp. 1 Enable	OFF ON	OFF
17513	BOM temp. 2	Multi-input 20 to 23 PV communication DEIF Open Weather station comm	PV communication
17514	BOM temp. 2 Enable	OFF ON	OFF
17515	BOM temp.. 3	Multi-input 20 to 23	PV communication

Parameter	Text	Range	Default
		PV communication DEIF Open Weather station comm	
17516	BOM temp. 3 Enable	OFF ON	OFF

Configure the BOM weighing factor under **Settings > Hybrid > Weather > POA/BOM weight**.

Parameter	Text	Range	Default
17524	BOM temp wgt. 1	0 to 100 %	100 %
17525	BOM temp wgt. 2	0 to 100 %	0 %
17526	BOM temp wgt. 3	0 to 100 %	0 %

Instant P max calculation

For calculating the possible Pmax with either the BOM or the POA sensors, a standard value will be used for the missing sensor (1000 W/M2) and (25 °C).

Configure the instant P max. under **Settings > Hybrid > Weather > Instant P max.**.

Parameter	Text	Range	Default
17531	Enable	OFF ON	OFF
17532	P temp. coeff.	-0.99 to 0.00	-0.38
17533	Inv. efficiency	80.0 to 100.0 %	100.0 %

Weather data settings

Configure the Weather data 1 under **Settings > Hybrid > Weather > Weather data 1**.

Parameter	Text	Range	Default
17541	GHI irradiation	Multi-input 20 to 23 PV communication DEIF Open Weather station comm	PV communication
17542	GHI irradiation Enable	OFF ON	OFF
17543	Ambient temperature	Multi-input 20 to 23 PV communication DEIF Open Weather station comm	PV communication
17544	Ambient temperature Enable	OFF ON	OFF
17545	Rel. humidity	Multi-input 20 to 23 PV communication DEIF Open Weather station comm	PV communication
17546	Rel. humidity Enable	OFF ON	OFF

Configure the Weather data 2 under **Settings > Hybrid > Weather > Weather data 2**.

Parameter	Text	Range	Default
17551	Barometric pressure	Multi-input 20 to 23 PV communication DEIF Open Weather station comm	PV communication
17552	Barometric pressure Enable	OFF ON	OFF
17553	Wind speed	Multi-input 20 to 23 PV communication DEIF Open Weather station comm	PV communication
17554	Wind speed Enable	OFF ON	OFF
17555	Wind direction	Multi-input 20 to 23 PV communication DEIF Open Weather station comm	PV communication
17556	Wind direction Enable	OFF ON	OFF

Configure the Weather data 3 under **Settings > Hybrid > Weather > Weather data 3**.

Parameter	Text	Range	Default
17561	Rain fall	Multi-input 20 to 23 PV communication DEIF Open Weather station comm	PV communication
17562	Rain fall Enable	OFF ON	OFF
17563	Snow depth	Multi-input 20 to 23 PV communication DEIF Open Weather station comm	PV communication
17564	Snow depth Enable	OFF ON	OFF

7.4 PV communication

7.4.1 PV communication protocol

The AGC 150 communicates with the inverters (or power converters) directly or through a gateway device. The standard communication follows the SunSpec protocol, which is a generic Modbus RTU protocol where the controller is the master device and the inverter (or power converter) is the slave.

Using this protocol, the AGC 150 transmits the references to the inverters (or power converters) using Modbus RS-485 or by using the Ethernet gateway.

Configure the PV communication under **Settings > Hybrid > Communication > PV protocol**.

Parameter	Name	Range	Default
17321	PV protocol	Off SMA FSC	Off

Parameter	Name	Range	Default
		SMA SunSpec v2.82 Fronius SunSpec v3.7.1-4 Schnieder Conext CL 36/60 DEIF Open SunSpec Generic ABB PVS800 Schnieder Conext CL 20/25 Gamesa E-series ABB TRIO ABB PRO-33 Delta RPI Sungrow SG10_60 Huawei SUN2000 8-28KTL Huawei SUN2000 33-40KTL Huawei smartlogger Goodwe DT series CI/Data Manager M INVT BG series HiQ solar truestring Ingeteam 3Play Ginlong Solis Solar Edge Vacon 8000 CPS SCA 50-60KTL CPS SCA 14-36KTL SMA Solid-Q 50 SMA Solid-Q PRO 60 KStar ABB Trio 50 Goodwe MT Series Huawei SUN2000 55-60 Huawei SUN 90-105KTL Delta RPI M88H Huawei SUN100-120KTL Huawei SUN2000 50-60 EVVO	

7.4.2 Tx write type

Two write types can be chosen:

- Unicast is used in point-to-point interfaces, where the AGC 150 communicates with one inverter/communication device. Communication supervision is possible, and a communication alarm can be raised in case communication is compromised. Operating status of the inverter can be taken into account, for example “stopping inverter” or “inverter ramping”. P and Q references are based on the rated size received/read from the inverter/device.
- Broadcast is used in interfaces with multiple inverters/devices. To obtain a satisfying control speed, the AGC 150 does not address each inverter directly, but broadcast the commands to all inverters. Communication supervision is not possible, and a communication alarm cannot be raised in case communication is compromised. Operating status of the inverter cannot be taken into account, because the inverters do not give status feedback.

Broadcast initialisation

Some protocols (SunSpec) may have an initialisation routine where the controller outlines the implementation in the inverter. This routine is performed on the inverter holding the ModbusID selected. Afterwards, the AGC 150 switch to Broadcast. When Broadcast is selected, the controller uses Broadcast Modbus ID0 in all write commands despite the actual setting of the ModbusID.

During the initialisation routine, communication supervision is possible and a communication alarm can be raised if communication is compromised.

P and Q references are based on the rated sizes set in the controller. The rated P and Q will need to be set to match the actual rated sizes of the total inverter installation.

Tx maximum rate

Here it is possible to select how fast the AGC 150 is allowed to transmit. The setting is added as some inverters cannot take in too much communication.

Configure the Tx settings under **Settings > Hybrid > Communication > PV protocol**.

Parameter	Name	Range	Default
17322	Tx write type	Unicast Broadcast	Unicast
17323	Tx maximum rate timer	0.1 to 10.0 s	0.5 s
17324	Tx write fnc.	Single register 0x06 Multiple register 0x10	Multiple register 0x10
17325	Monitoring of inverters	1 to 16	1
17326	Enable monitoring	OFF ON	OFF
17327	Monitoring ID	1 to 247	3

7.5 PV Alarm functions

7.5.1 PV Alarm functions

It is possible to configure a number of Hybrid alarms in AGC 150.

PV Communication failure

Configure the settings for PV Communication failure under **Settings > Hybrid > Communication > PV COMM error**.

Parameter	Text	Range	Default
17351	Timer	0.0 to 100.0 s	3.0 s
17352	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
17353	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
17354	Enable	OFF ON	OFF
17355	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning

Parameter	Text	Range	Default
		PV Shutdown	

PV Warning

Configure the settings for PV Warning under **Settings > Hybrid > Communication > PV Warning**.

Parameter	Text	Range	Default
17361	Timer	0.0 to 100.0 s	3.0 s
17362	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
17363	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
17364	Enable	OFF ON	OFF
17365	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop PV Shutdown	Warning

PV Shutdown

Configure the settings for PV Shutdown under **Settings > Hybrid > Communication > PV Shutdown**.

Parameter	Text	Range	Default
17371	Timer	0.0 to 100.0 s	3.0 s
17372	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
17373	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
17374	Enable	OFF ON	OFF
17375	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop PV Shutdown	PV Shutdown

PV Monitor failure

Configure the settings for PV Monitor failure under **Settings > Hybrid > Communication > PV monitor err.**.

Parameter	Text	Range	Default
17381	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
17382	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
17383	Enable	OFF ON	OFF
17384	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop PV Shutdown	Warning

Weather communication failure

Configure the settings for Weather communication failure under **Settings > Hybrid > Communication > Weather comm err**.

Parameter	Text	Range	Default
17431	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
17432	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
17433	Enable	OFF ON	OFF
17434	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop PV Shutdown	Warning

8. Protections

8.1 About protections

8.1.1 Protections in general

All protection settings are stated in percent of the nominal values.

Most of the protections are of the definite time type (a set point and time is selected). When the timer runs out, the output is activated. The operate time will be the delay setting + the reaction time.

When setting up the AGC 150, the measuring class of the controller and an adequate safety margin has to be taken into consideration, for example:

- A power generation system must not reconnect to a network when the voltage is 85 % of U_{NOM} ±0 % ≤ U ≤ 110 % ±0 %. In order to ensure reconnection within this interval, a controller's tolerance/accuracy has to be taken into consideration. It is recommended to set a controller'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.

General parameter ranges

For all protections, the following parameters are to be set within the ranges mentioned:

Parameter text	Range
Output A Output B	Not used 12 relays: 5, 6, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18 External I/O: 3 × 8 relays (CIO 208) Limits
Enable	OFF ON
Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop

Phase-neutral voltage trip

If the voltage alarms are to work based on phase-neutral measurements, the voltage detection type for both generator and busbar must be set to phase neutral.

Configure the voltage detection type for the generator under **Settings > Generator > Voltage protections > Voltage detect. type**.

Parameter	Text	Range	Default
1201	G U detection type	Phase - Phase Phase - Neutral	Phase - Phase

Configure the voltage detection type for the busbar under **Settings > Busbar > Voltage protections > Voltage detect. type**.

Parameter	Text	Range	Default
1202	BB U detection type	Phase - Phase	Phase - Phase

Parameter	Text	Range	Default
		Phase - Neutral	

As shown in the vector diagram below, there is a difference in voltage values at an error situation for the phase-neutral voltage and the phase-phase voltage.

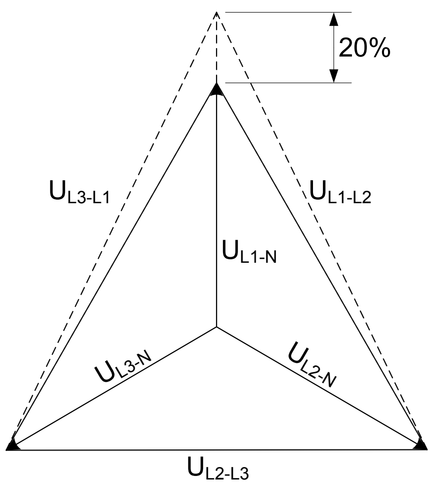
Table 8.1 Example: Actual measurements at a 10 % under-voltage situation in a 400/230 volt system

	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 %).

Table 8.2 Example



U_{NOM} = 400/230 V AC

Error situation:

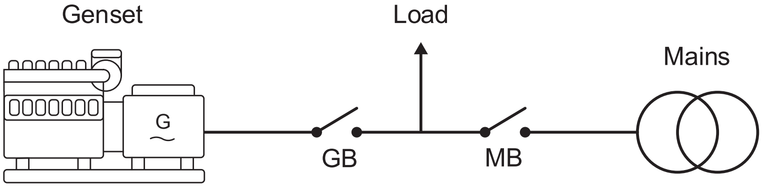
- U_{L1L2} = 360 V AC
- U_{L3L1} = 360 V AC
- U_{L1-N} = 185 V AC
- ΔU_{PH-N} = 20 %

8.1.2 Phase sequence error and phase rotation

The AGC 150 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 150 can monitor the rotation in both direction. From the alarm it is possible to set different fail classes, which give different possibilities.

Stand-alone applications

A stand-alone application is able to handle up to one genset, one generator breaker and one mains breaker.



When the AGC 150 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.

AGC 150 voltage terminals

- A-side voltage terminals: 62 to 65

- B-side voltage terminals: 66 to 69

AGC 150 has two alarms for phase sequence error with two different fail classes.

Configure the parameters for Generator Phase sequence error under **Settings > Generator > AC configuration > Phase sequence error**.

Parameter	Text	Range	Default
2151	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
2152	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
2153	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Block

Configure the Phase direction under **Settings > Generator > AC configuration > Phase direction**.

Parameter	Text	Range	Default
2154	Rotation	L1/L2/L3 L1/L3/L2	L1/L2/L3

Configure the parameters for Busbar Phase direction under **Settings > Busbar > AC configuration > Phase sequence error**.

Parameter	Text	Range	Default
2155	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
2156	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Block

Example: In a stand-alone application with GB and MB, the parameters are:

Parameter	Text	Setting
2151	Output A	Not used
2152	Output B	Not used
2153	Fail class	Trip+Stop

Parameter	Text	Setting
2154	Rotation	L1L2L3
2155	Output A	Not used
2156	Fail class	Trip MB

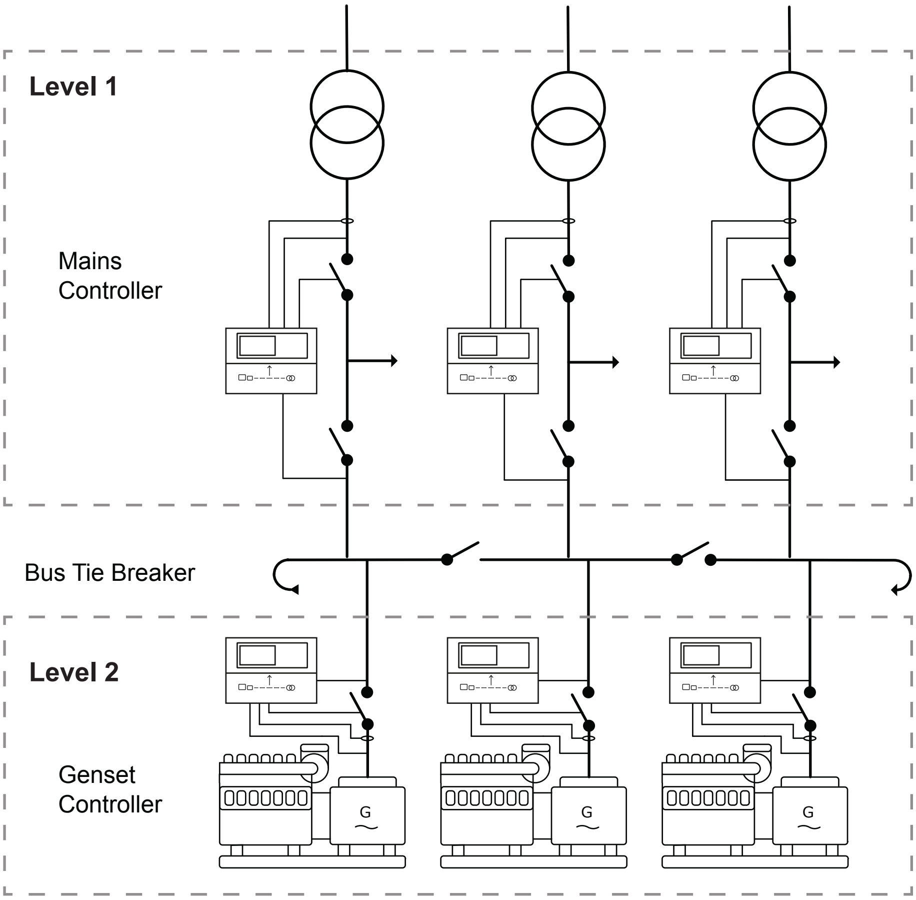
If the controller is set to Load take-over (LTO) and the start signal is given the genset will start up. If there have been performed a service of the alternator, and two of the phases have been switched when the alternator has been assembled again, AGC 150 will now discover a phase sequence fail. Since this is on the genset voltage terminals, the fail class set in parameter 2153 will be used. The fail class 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 execute 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 fail class in parameter 2156 will be used. At the moment there is a phase sequence error on the mains voltage terminals, and the fail class 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.

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 by accident switches two phases. When the fuses is set into place again, AGC 150 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.



When setting up the phase sequence alarms, it can be helpful to activate MB fail start in some of the mains controllers.

Example:

- If a Phase sequence error for Mains voltage appears, and the fail class is Trip MB, the gensets will start.

- If then Auto switch is enabled 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, it will keep on supplying the load, and the gensets will not start.

More information
See **Power management, Multi-mains systems, MB fail start in 2-level applications** in this document for more information.

8.2 Generator standard protections

8.2.1 Generator standard protections

The protections comply with the protection functionality in IEC 61850-5 and IEC 61850-7-4, but not the communication requirements of IEC 61850.

The *operate time* is defined in IEV 447-05-05 (from the instant when the need for protection arises, to when the controller output has responded). For each protection, the *operate time* is given for the minimum user-defined time delay.

Table 8.3 Standard protections for the generator

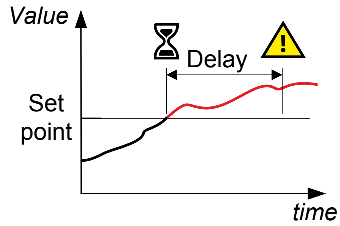
Protection	IEC symbol (IEC 60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time	Alarms
Over-voltage	U>, U>>	59	PTOV	< 200 ms	2
Under-voltage	U<, U<<	27	PTUV	< 200 ms	3
Voltage unbalance	UUB>	47	-	< 200 ms*	1
Negative sequence voltage		47	PNSC	< 200 ms*	1
Zero sequence voltage		59Uo	PZOV	< 200 ms*	1
Over-current	3I>, 3I>>	50TD	PTOC	< 100 ms	4
Fast over-current (short circuit)	3I>>>	50/50TD	PTOC	< 50 ms	2
Unbalance current	IUB>	46	-	< 200 ms*	2
Directional over-current		67	PTOC	< 100 ms	2
Inverse time over-current	It>	51	PTOC	-	1
Neutral inverse time over-current		51N		-	1
Earth fault inverse time-over current		51G		-	1
Negative sequence current		46	PUBC	< 200 ms*	1
Zero sequence current		51Io	PTOC	< 200 ms*	1
Over-frequency	f>, f>>	81O	PTOF	< 200 ms	3
Under-frequency	f<, f<<	81U	PTUF	< 200 ms	3
Overload	P>, P>>	32	PDOP	< 200 ms	5
Reverse power	P<, P<<	32R	PDRP	< 200 ms	2
Reactive power export (Over-excitation)	Q>, Q>>	40O	POEX	< 200 ms	1
Reactive power import/loss of excitation (under-excitation)	Q<, Q<<	40U	PUEX	< 200 ms	1

NOTE * These operate times include the minimum user-defined delay of 100 ms.

8.2.2 Over-voltage (ANSI 59)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Over-voltage	U>, U>>	59	PTOV	< 100 ms

The alarm response is based on the highest phase-to-phase voltage, or the highest phase-to-neutral voltage, from the source, as measured by the controller. The phase-to-phase voltage is the default.



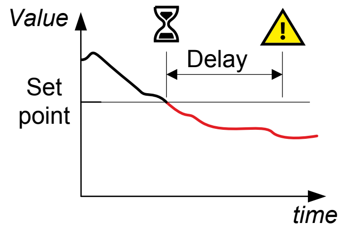
Configure the parameters under **Settings > Generator > Voltage protections > Over-voltage > G U> #**, where # is 1 or 2.

Parameter	Text	Range	G U> 1	G U> 2
1151 or 1161	Set point	100 to 130 %	103 %	105 %
1152 or 1162	Timer	0.1 to 100 s	10 s	5 s
1153 or 1163	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used
1154 or 1164	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used
1155 or 1165	Enable	OFF ON	OFF	OFF
1156 or 1166	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning	Warning

8.2.3 Under-voltage (ANSI 27)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Under-voltage	U<, U<<	27	PTUV	< 100 ms

The alarm response is based on the lowest phase-to-phase voltage, or the lowest phase-to-neutral voltage, from the source, as measured by the controller. The phase-to-phase voltage is the default.



Configure the parameters under **Settings > Generator > Voltage protections > Under-voltage > G U< #**, where # is 1 to 3.

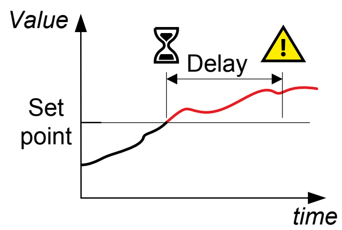
Parameter	Text	Range	G U< 1	G U< 2	G U< 3
1171, 1181 or 1191	Set point	40 to 100 %	97 %	95 %	95 %
1172, 1182 or 1192	Timer	0.1 to 100 s	10 s	5 s	5 s
1173, 1183 or 1193	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used	Not used
1174, 1184 or 1194	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used	Not used
1175, 1185 or 1195	Enable	OFF ON	OFF	OFF	OFF
1176, 1186 or 1196	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning	Warning	Warning

8.2.4 Voltage unbalance (ANSI 47)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Voltage unbalance (voltage asymmetry)	UUB>	47	-	< 200 ms*

*Note: This operate time includes the minimum user-defined delay of 100 ms.

The alarm response is based on the highest difference between any of the three phase-to-phase voltage or phase-to-neutral true RMS values and the average voltage, as measured by the controller. The phase-to-phase voltage is the default.
If phase-to-phase voltages are used, the controller calculates the average phase-to-phase voltage. The controller then calculates the difference between each phase-to-phase voltage and the average voltage. Finally, the controller divides the maximum difference by the average voltage to get the voltage unbalance.



Configure the parameters under **Settings > Generator > Voltage protections > Voltage unbalance > G Unbalance U**.

Parameter	Text	Range	Default
1511	Set point	0 to 50 %	10 %
1512	Timer	0.1 to 100 s	10 s
1513	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1514	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1515	Enable	OFF	OFF

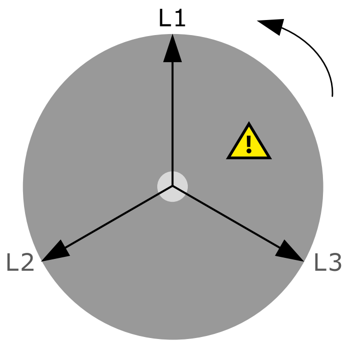
Parameter	Text	Range	Default
		ON	
1516	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Trip GB

8.2.5 Negative sequence voltage (ANSI 47)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Negative sequence voltage		47	PNSC	< 200 ms*

*Note: This operate time includes the minimum user-defined delay of 100 ms.

Negative sequence voltages arise when the virtual representation of the phase rotation for an unbalanced system appears negative.
Negative sequence voltages can occur where there are single phase loads, unbalanced line short circuits and open conductors, and/or unbalanced phase-to-phase or phase-to-neutral loads.
Negative sequence currents can cause overheating inside the generator. This is because these currents produce a magnetic field counter-rotating to the rotor. This field crosses the rotor at twice the rotor velocity, inducing double-frequency currents in the field system and in the rotor body.
The alarm response is based on the estimated phase-to-neutral voltage phasors, as measured from the source.



Configure the parameters for Generator sequence select under **Settings > Generator > Voltage protections > Negative seq. voltage > G neg. seq. U**.

Parameter	Text	Range	Default
1551	Set point	1 to 100 %	5 %
1552	Timer	0.2 to 100 s	0.5 s
1553	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1554	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1555	Enable	OFF ON	OFF
1556	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Trip MB

Configure the Negative sequence select under **Settings > Generator > Voltage protections > Negative seq. voltage > Neg. seq select**

Parameter	Text	Range	Default
1561	Type	G measurement BB measurement	G measurement

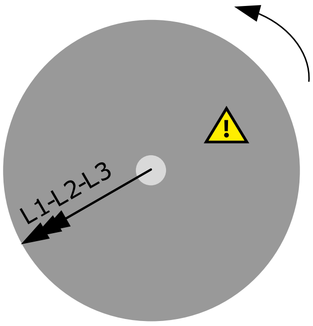
.

8.2.6 Zero sequence voltage (ANSI 59Uo)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Zero sequence voltage		59Uo	PZOV	< 200 ms*

*Note: This operate time includes the minimum user-defined delay of 100 ms.

Zero sequence voltages arise when the phases rotation is positive, but the vector zero value (star point) is displaced. This zero sequence voltage protection can be used instead of using zero voltage measurement or summation transformers (zero sequence transformers).
This protection is used for detecting earth faults.
The alarm response is based on the estimated phase-to-neutral voltage phasors, as measured from the source.



Configure the parameters under **Settings > Generator > Voltage protections > Zero sequence voltage > G zero seq. U**.

Parameter	Text	Range	Default
1581	Set point	0 to 100 %	5 %
1582	Timer	0.2 to 100 s	0.5 s
1583	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1584	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1585	Enable	OFF ON	OFF
1586	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Trip MB

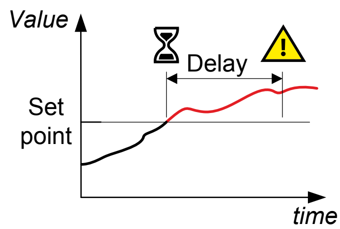
Configure the Zero sequence voltage type under **Settings > Generator > Voltage protections > Zero sequence voltage > Zero seq select**.

Parameter	Text	Range	Default
1591	Type	G measurement BB measurement	G measurement

8.2.7 Over-current (ANSI 50TD)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Over-current	3I>, 3I>>	50TD	PTOC	< 100 ms

The alarm response is based on the highest phase current true RMS value from the source, as measured by the controller.



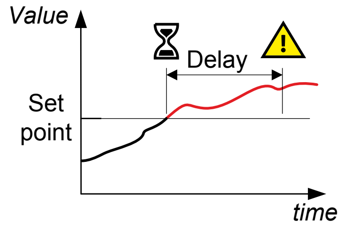
Configure the parameters under **Settings > Generator > Current protections > Over-current > I> #**, where # is 1 or 4.

Parameter	Text	Range	I> 1	I> 2	I> 3	I> 4
1031, 1041, 1051 or 1061	Set point	50 to 200 %	115 %	120 %	115 %	120 %
1032, 1042, 1052 or 1062	Timer	0.1 to 3200 s	10 s	5 s	10 s	5 s
1033, 1043, 1053 or 1063	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used	Not used	Not used
1034, 1044, 1054 or 1064	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used	Not used	Not used
1035, 1045, 1055 or 1065	Enable	OFF ON	ON	ON	ON	ON
1036, 046, 1056 or 1066	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning	Trip GB	Trip GB	Trip GB

8.2.8 Fast over-current (ANSI 50/50TD)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Fast over-current	3I>>>	50/50TD*	PIOC*	< 50 ms

*Note: ANSI 50 and IEC 61850-5 PIOC apply when the Delay parameter is 0 s.



The alarm response is based on the highest phase current true RMS values from the source, as measured by the controller.

Configure the parameters under **Settings > Generator > Current protections > Fast over-current > I>> #**, where # is 1 or 2.

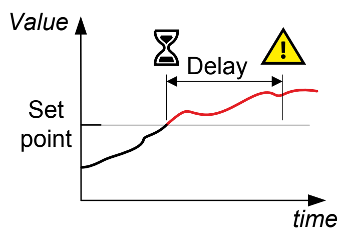
Parameter	Text	Range	I>> 1	I>> 2
1131 or 1141	Set point	150 to 350 %	150 %	200 %
1132 or 1142	Timer	0 to 100 s	2 s	0.5 s
1133 or 1143	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used
1134 or 1144	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used
1135 or 1145	Enable	OFF ON	OFF	OFF
1136 or 1146	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Trip GB	Trip GB

8.2.9 Unbalance current (ANSI 46)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Unbalance current	IUB>	46	-	< 200 ms*

*Note: This operate time includes the minimum user-defined delay of 100 ms.

The alarm response is based on the highest difference between any of the three phase current true RMS values, as measured by the controller. You can choose either the Average method (ANSI) or the Nominal method to calculate the Current unbalance.



Configure the parameters under **Settings > Generator > Current protections > Unbalance current > Unbalance I #**, where # is 1 or 2.

Parameter	Text	Range	Unbalance I 1	Unbalance I 2
1501 or 1711	Set point	0 to 100 %	30 %	40 %
1502 or 1712	Timer	0.1 to 100 s	10 s	10 s
1503 or 1713	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used
1504 or 1714	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used
1505 or 1715	Enable	OFF ON	OFF	OFF
1506 or 1716	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Trip GB	Trip GB

Calculation method

Select the calculation method under **Settings > Generator > Current protections > Unbalance current > Type**.

Parameter	Text	Range	Default
1203	Type	Nominal Average	Nominal

NOTE The *Average method* is very sensitive at low loads.

The Average method uses the ANSI standard calculation method to determine current unbalance. The controller calculates the average current for the three phases. The controller then calculates the difference between each phase current and the average current. Finally, the controller divides the maximum difference by the average current to get the current unbalance.

Average method example
The controller controls a genset with a nominal current of 100 A. The L1 current is 80 A, the L2 current is 90 A, and the L3 current is 60 A.
The average current is 76.7 A. The difference between the phase current and the average is 3.3 A for L1, 13.3 A for L2 and 16.7 A for L3.
The current unbalance is therefore 16.7 A / 76.7 A = 0.22 = 22 %.

With the Nominal method the controller calculates the difference between the phase with the highest current, and the phase with the lowest current. Finally, the controller divides the difference by the nominal current to get the current unbalance.

Nominal method example
The controller controls a genset with a nominal current of 100 A. The L1 current is 80 A, the L2 current is 90 A, and the L3 current is 60 A.
The current unbalance is (90 A - 60 A) / 100 A = 0.3 = 30 %.

8.2.10 Voltage dependent over-current (ANSI 51V)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Voltage dependent over-current	Iv>	51V	PTOC	-

This is a voltage dependent over-current alarm for generators without permanent magnets. This protection occurs when a short circuit is present and the voltage drops. The current rises briefly, before it falling to a lower level.

The short circuit current level can drop below the rated current of the generator, and thus the short circuit will not be tripped, if a standard ANSI 50/50TD is used. When the short circuit is present, the voltage will be low. This can be used for tripping at a lower current, when the voltage is low.

Configure the parameters for Voltage dependent over-current under **Settings > Generator > Current protections > Voltage dep. over-curr.**.

Parameter	Text	Range	Default
1101	G Iv> (50 %)	50 to 200 %	110 %
1102	G Iv> (60 %)	50 to 200 %	125 %
1103	G Iv> (70 %)	50 to 200 %	140 %
1104	G Iv> (80 %)	50 to 200 %	155 %
1105	G Iv> (90 %)	50 to 200 %	170 %
1106	G Iv> (100 %)	50 to 200 %	200 %
1110	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Trip GB

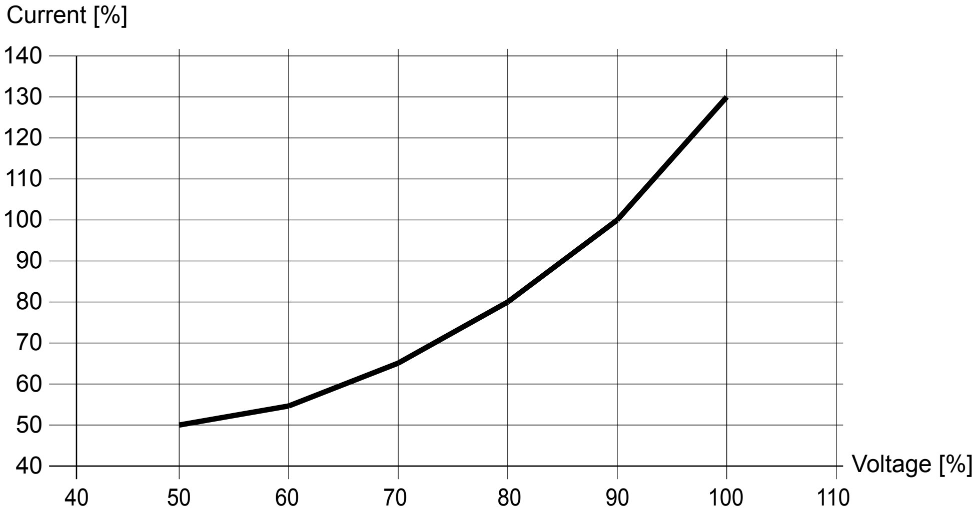
Example

The set points refers to six current and voltage levels. The voltage levels are pre-set, so only the current levels must be set. All values are in percentage of the nominal settings.

The six different set points have been set to the values shown in the table below.

Parameter	Voltage level (not adjustable)	Current level (adjustable)
1101	50 %	50 %
1102	60 %	55 %
1103	70 %	65 %
1104	80 %	80 %
1105	90 %	100 %
1106	100 %	130 %

The set points can be illustrated by a curve:

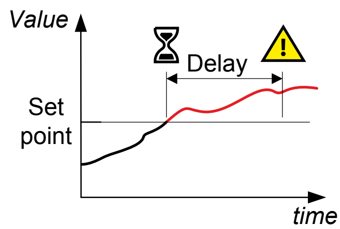


When the actual values represent a point above the curve, the breaker is tripped. The curve shows that the generator breaker will trip when the generator voltage is below 50 % of rated, and the current is above 50 % of rated.

8.2.11 Directional over-current (ANSI 67)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Directional over-current		67	PTOC	< 100 ms

The alarm response is based on the highest phase current true RMS value, with the direction from the active power from the source, as measured by the controller.



Configure the parameters under **Settings > Generator > Current protections > Direct. over-current > I>direct. #**, where # is 1 or 2.

Parameter	Text	Range	I> direct. 1	I> direct. 2
1601 or 1611	Set point	-200 to 200 %	120 %	130 %
1602 or 1612	Timer	0 to 100 s	0.1 s	0.1 s
1603 or 1613	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used
1604 or 1614	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used
1605 or 1615	Enable	OFF ON	OFF	OFF
1606 or 1616	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB	Trip MB	Trip MB

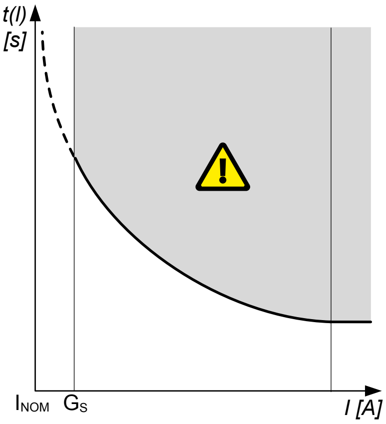
Parameter	Text	Range	I> direct. 1	I> direct. 2
		Safety stop Trip MB/GB Controlled stop		

NOTE For a positive set point, the alarm trigger level is *High*. When a negative set point is written to the controller, then the controller automatically changes the alarm trigger level to *Low*.

8.2.12 Inverse time over-current (ANSI 51)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Inverse time over-current	It>	51	PTOC	-

This is an inverse time over-current alarm.
The alarm response is based on the highest phase current true RMS values, as measured by the controller.
The alarm response time depends on an approximated integral of the current measurement over time. The integral is only updated when the measurement is above the activation threshold (dotted curve on the illustration). See the description below for more details.
Note: The diagram on the right is a simplified representation of this alarm. The diagram does not show the integral over time.



Inverse time over-current calculation method

The controller uses this equation from IEC 60255-151 to calculate the time that the current measurement may be over the set point before the inverse time over-current alarm is activated:

$$t(G) = TMS\left(\frac{k}{\left(\frac{G}{G_s}\right)^{\alpha} - 1} + c\right)$$

where:

- t(G) = Theoretical operating time value at G, in seconds
- k, c and α = Constants for the selected curve (*k* and *c* in seconds, *α* (alpha) has no unit)
- G = Measured value, that is, I_{phase}
- G_S = Alarm set point ($G_S = I_{nom} \cdot LIM / 100\ \%$)
- TMS = Time multiplier setting

Configure the parameters for Inverse time over-current under **Settings > Generator > Current protections > Inv. time over-current**.

Parameter	Text	Range	Default
1081	Type	IEC Inverse IEC Very Inverse IEC Extremely inverse IEEE Moderately Inv. IEEE Very Inverse IEEE Extremely Inv. Custom	IEC Inverse
1082	Set point LIM	50 to 200 %	110 %

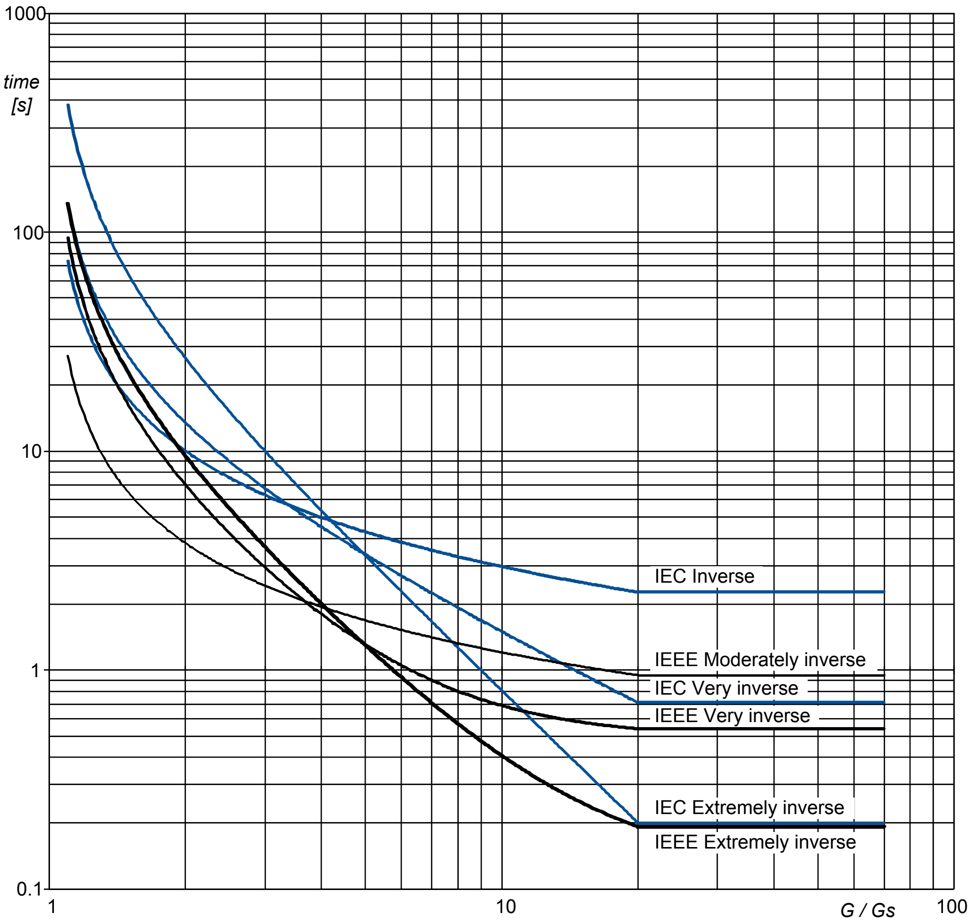
Parameter	Text	Range	Default
1083	Set point TMS	0.01 to 100.00	1.00
1084	Set point k	0.001 to 32.000 s	0.140 s
1085	Set point c	0.000 to 32.000 s	0.000 s
1086	Set point a	0.001 to 32.000 s	0.020 s
1087	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used

Standard inverse time over-current curves

The controller includes these standard inverse time over-current curves, in accordance with IEC 60255-151.

Curve name	k	c	alpha (α, or a)
IEC inverse	0.14 s	0 s	0.02
IEC very inverse	13.5 s	0 s	1
IEC extremely inverse	80 s	0 s	2
IEEE moderately inverse	0.0515 s	0.114 s	0.02
IEEE very inverse	19.61 s	0.491 s	2
IEEE extremely inverse	28.2 s	0.1217 s	2

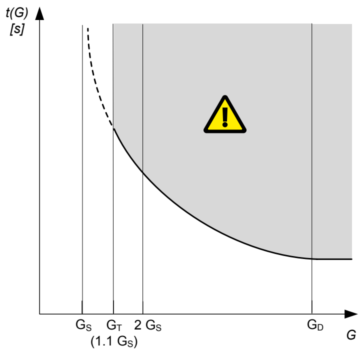
Figure 8.1 Standard curve shapes for inverse time over-current, with time multiplier setting (TMS) = 1



Definite time characteristic

G_D is the point where the alarm shifts from an inverse curve to a definite time characteristic, as the following graph shows. That is, after this point, the curve is flat, and a current increase does not have any effect on the alarm response time. In IEC60255, this point is defined as $G_D = 20 \times G_S$.

Figure 8.2 Inverse time over-current time characteristic graph



Influence of the CT primary current rating on G_D example
A current transformer has a primary rating of 500 A and a secondary rating of 5 A. The nominal current of the system is 350 A, and the three-phase inverse time over-current alarm *Limit* is 100 %.
G_D of the inverse time over-current characteristic graph according to IEC60255 is 7000 A.

- $G_D = 20 \times G_S = 20 \times (I_{nom} \times (\text{Limit} / 100)) = 20 \times (350 \times (1 / 1)) = 7000$ A

However, the highest G_D value where measurements can be made is 1500 A.

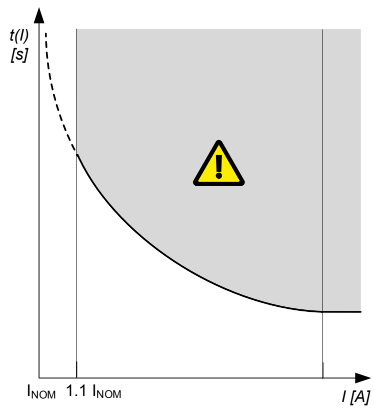
- Because the secondary current rating is 5 A, the formula to calculate the measurable G_D is $G_D = 3 \times I_{CT\ primary}$.
- $G_D = 3 \times I_{CT\ primary} = 3 \times 500 = 1500$ A

NOTE If the performance of the inverse time over-current protection is important, DEIF recommends using a current transformer that is rated for a 1 A secondary current (that is, -/1 A).

8.2.13 Neutral inverse time over-current (ANSI 51N)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Neutral inverse time over-current		51N		-

This is the inverse time over-current alarm for the neutral current measurement.
The alarm response is based on the unfiltered (except for anti-aliasing) neutral current, as measured by the 4th current measurement.
The alarm response time depends on an approximated integral of the current measurement over time. The integral is only updated when the measurement is above the activation threshold.
Note: The diagram on the right is a simplified representation of this alarm. The diagram does not show the integral over time.



Configure the parameters under **Settings > Generator > Current protections > Neut. inv. t. o-curr.**.

Parameter	Text	Range	Default
1721	Type	IEC Inverse IEC Very Inverse	IEC Inverse

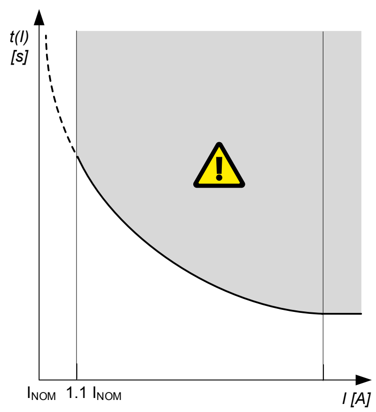
Parameter	Text	Range	Default
		IEC Extremely inverse IEEE Moderately Inv. IEEE Very Inverse IEEE Extremely Inv. Custom	
1722	Set point	2. to 120 %	30 %
1723	Set point TMS	0.01 to 100.00	1.00
1724	Set point k	0.001 to 32.000 s	0.140 s
1725	Set point c	0.000 to 32.000 s	0.000 s
1726	Set point a	0.001 to 32.000 s	0.020 s
1727	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1728	Enable	OFF ON	OFF
1729	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Trip GB

More information
See **Protections, Generator standard protections, Inverse time over-current (ANSI 51)** in this document for the calculation method, the standard curves, and information about the definite time characteristic.

8.2.14 Earth fault inverse time over-current (ANSI 51G)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Earth fault inverse time over-current		51G		-

This is the inverse time over-current alarm for the ground current measurement.
The alarm response is based on the ground current, as measured by the 4th current measurement filtered to attenuate the third harmonic (at least 18 dB).
Note: The diagram on the right is a simplified representation of this alarm. The diagram does not show the integral over time.



Configure the parameters under **Settings > Generator > Current protections > Earth f. inv t. o-curr**.

Parameter	Text	Range	Default
1731	Type	IEC Inverse IEC Very Inverse IEC Extremely inverse IEEE Moderately Inv. IEEE Very Inverse IEEE Extremely Inv. Custom	-
1732	Set point	2 to 120 %	10 %
1733	Set point TMS	0.01 to 100.00	1.00
1734	Set point k	0.001 to 32.000 s	0.140 s
1735	Set point c	0.000 to 32.000 s	0.000 s
1736	Set point a	0.001 to 32.000 s	0.020 s
1737	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1738	Enable	OFF ON	OFF
1739	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Trip GB

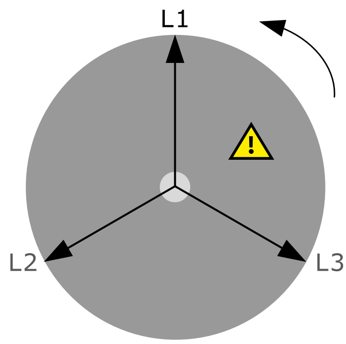
More information
See **Protections, Generator standard protections, Inverse time over-current (ANSI 51)** in this document for the calculation method, the standard curves, and information about the definite time characteristic.

8.2.15 Negative sequence current (ANSI 46)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Negative sequence current		46	PUBC	< 200 ms*

*Note: This operate time includes the minimum user-defined delay of 100 ms.

Negative sequence currents arise when the virtual representation of the phase rotation for an unbalanced system appears negative.
Negative sequence currents can occur where there are single phase loads, unbalanced line short circuits and open conductors, and/or unbalanced phase-phase or phase-neutral loads.
This protection is used to prevent the generator from overheating. Negative sequence currents produce a magnetic field in the generator counter-rotating to the rotor. This field crosses the rotor at twice the rotor velocity, inducing double-frequency currents in the field system and in the rotor body.
The alarm response is based on the estimated phase-to-neutral current phasors, from the source, as measured by the controller.



Configure the parameters under **Settings > Generator > Current protections > Negative seq. current > Negative. seq. I**.

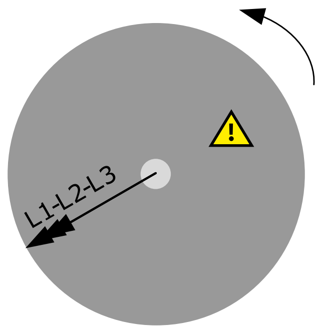
Parameter	Text	Range	Default
1541	Set point	1 to 100 %	20 %
1542	Timer	0.2 to 100 s	0.5 s
1543	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1544	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1545	Enable	OFF ON	OFF
1546	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Trip MB

8.2.16 Zero sequence current (ANSI 51Io)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Zero sequence current		51Io	PTOC	< 200 ms*

*Note: This operate time includes the minimum user-defined delay of 100 ms.

Zero sequence currents arise when the phases rotation is positive, but the vector zero value is displaced.
This protection is used for detecting earth faults.
The alarm response is based on the estimated current phasors from the source, as measured by the controller.



Configure the parameters under **Settings > Generator > Current protections > Zero sequence current > Zero seq. I**.

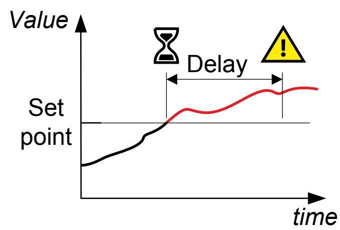
Parameter	Text	Range	Default
1571	Set point	0 to 100 %	20 %
1572	Timer	0.2 to 100 s	0.5 s
1573	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1574	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1575	Enable	OFF	OFF

Parameter	Text	Range	Default
		ON	
1576	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Trip MB

8.2.17 Over-frequency (ANSI 81O)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Over-frequency	f>, f>>	81O	PTOF	< 100 ms

The alarm response is based on the fundamental frequency (based on phase voltage), due to the selection made in parameter 1204.



Configure the parameters under **Settings > Generator > Frequency protections > Over-frequency > G f> #**, where # is 1 to 3.

Parameter	Text	Range	G f> 1	G f> 2	G f> 3
1211, 1221 or 1231	Set point	100 to 120 %	103 %	105 %	105 %
1212, 1222 or 1232	Timer	0.2 to 100 s	10 s	5 s	5 s
1213, 1223 or 1233	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used	Not used
1214, 1224 or 1234	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used	Not used
1215, 1225 or 1235	Enable	OFF ON	OFF	OFF	OFF
1216, 1226 or 1236	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning	Warning	Warning

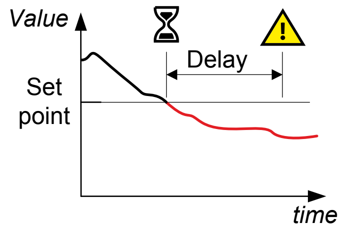
Configure the Frequency detection type under **Settings > Generator > Frequency protections > Frequency detect. type**.

Parameter	Text	Range	Default
1204	Type	L1 L2 L3 L1 or L2 or L3 L1 and L2 and L3	L1 or L2 or L3

8.2.18 Under-frequency (ANSI 81U)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Under-frequency	f<, f<<	81U	PTUF	< 100 ms

The alarm response is based on the highest fundamental frequency (based on phase voltage), from the source. This ensures that the alarm only activates when all of the phase frequencies are below the set point.



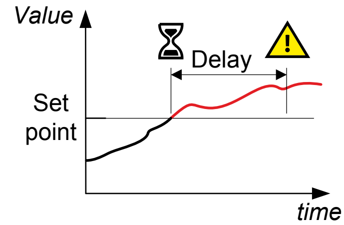
Configure the parameters under **Settings > Generator > Frequency protections > Under-frequency > G f< #**, where # is 1 to 3.

Parameter	Text	Range	G f< 1	G f< 2	G f< 3
1241, 1251 or 1261	Set point	80 to 100 %	97 %	95 %	95 %
1242, 1252 or 1262	Timer	0.2 to 100 s	10 s	5 s	5 s
1243, 1253 or 1263	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used	Not used
1244, 1254 or 1264	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used	Not used
1245, 1255 or 1265	Enable	OFF ON	OFF	OFF	OFF
1246, 1256 or 1266	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning	Warning	Warning

8.2.19 Overload (ANSI 32)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Overload	P>, P>>	32	PDOP	< 100 ms

The alarm response is based on the active power (all phases), from the source, as measured by the controller.



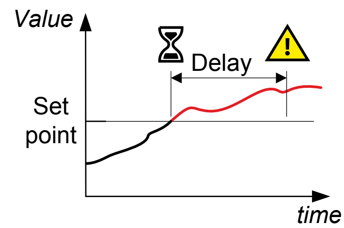
Configure the parameters under **Settings > Generator > Power protections > Overload > P> #**, where # is 1 to 5.

Parameter	Text	Range	P> 1	P> 2	P> 3	P> 4	P> 5
1451, 1461, 1471, 1481 or 1491	Set point	-200 to 200 %	100 %	110 %	100 %	110 %	100 %
1452, 1462, 1472, 1482 or 1492	Timer	0.1 to 3200 s	10 s	5 s	5 s	5 s	10 s
1453, 1463, 1473, 1483 or 1493	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used	Not used	Not used	Not used
1454, 1464, 1474, 1484 or 1494	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used	Not used	Not used	Not used
1455, 1465, 1475, 1485 or 1495	Enable	OFF ON	OFF	OFF	OFF	OFF	OFF
1456, 1466, 1476, 1486 or 1496	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning	Trip GB	Trip GB	Trip GB	Trip GB

8.2.20 Reverse power (ANSI 32R)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Reverse power	P<, P<<	32R	PDRP	< 100 ms

The alarm response is based on the active power (all phases), to the source, as measured by the controller.



Configure the parameters under **Settings > Generator > Power protections > Reverse power > -P> #**, where # is 1 or 2.

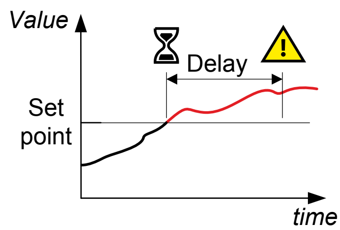
Parameter	Text	Range	G U> 1	G U> 2
1001 or 1011	Set point	-200 to 0 %	-5 %	-5 %
1002 or 1012	Timer	0.1 to 100 s	10 s	10 s

Parameter	Text	Range	G U> 1	G U> 2
1003 or 1013	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used
1004 or 1014	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used
1005 or 1015	Enable	OFF ON	ON	ON
1006 or 1016	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Trip GB	Trip GB

8.2.21 Reactive power export (ANSI 40O)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Reactive power export (over-excitation)	Q>, Q>>	40O	POEX	< 100 ms

The alarm response is based on the reactive power (Q) from the source, as measured and calculated by the controller. Reactive power export is when the generator is feeding an inductive load.



Configure the parameters under **Settings > Generator > Reactive power protect. > Overexcitation > Q>**.

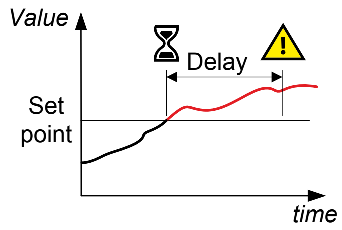
Parameter	Text	Range	Default
1531	Set point	0 to 100 %	60 %
1532	Timer	0.1 to 100 s	10 s
1533	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1534	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1535	Enable	OFF ON	OFF
1536	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop	Warning

Parameter	Text	Range	Default
		Trip MB/GB Controlled stop	

8.2.22 Reactive power import (ANSI 40U)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Reactive power import (loss of excitation/under-excitation)	Q<, Q<<	40U	PUEX	< 100 ms

The alarm response is based on the reactive power (Q) to the source, as measured and calculated by the controller. Reactive power import is when the generator is feeding a capacitive load.



Configure the parameters under **Settings > Generator > Reactive power protect. > Underexcitation > -Q>**.

Parameter	Text	Range	Default
1521	Set point	0 to 150 %	50 %
1522	Timer	0.1 to 100 s	10 s
1523	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1524	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1525	Enable	OFF ON	OFF
1526	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning

8.3 Busbar standard protections

8.3.1 Busbar standard protections

Table 8.4 Standard protections for the busbar

Protection	IEC symbol (IEC 60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time	Alarms
Over-voltage	U>, U>>	59	PTOV	< 50 ms	3
Under-voltage	U<, U<<	27	PTUV	< 50 ms	4

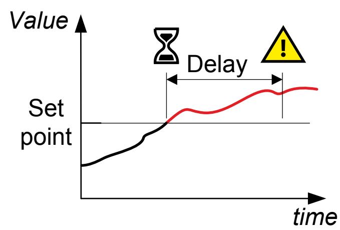
Protection	IEC symbol (IEC 60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time	Alarms
Voltage unbalance	UUB>	47	-	< 200 ms*	1
Positive sequence under-voltage	U_1<	27D	PTUV	< 40 ms	1
Over-frequency	f>, f>>	81O	PTOF	< 50 ms	3
Under-frequency	f<, f<<	81U	PTUF	< 50 ms	4
Vector shift	dφ/dt	78	PVEC	< 40 ms	1
Rate of change of frequency ROCOF (df/dt)	(df/dt)	81R	PFRC	< 120 ms	1

*Note: This operate time includes the minimum user-defined delay of 100 ms.

8.3.2 Busbar over-voltage (ANSI 59)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Over-voltage	U>, U>>	59	PTOV	< 50 ms

The alarm response is based on the highest phase-to-phase voltage, or the highest phase-to-neutral voltage, from the busbar, as measured by the controller.



Configure the parameters for Busbar over-voltage under **Settings > Busbar > Voltage protections > Over-voltage > BB U> #**, where # is 1 to 3.

Parameter	Text	Range	BB U> 1	BB U> 2	BB U> 3
1271, 1281 or 1291	Set point	100 to 120 %	103 %	105 %	105 %
1272, 1282 or 1292	Timer	0 to 99.99 s	10 s	5 s	5 s
1273, 1283 or 1293	Output A	Not used Relay 5, 6 and 9 to18 Limits	Not used	Not used	Not used
1274, 1284 or 1294	Output B	Not used Relay 5, 6 and 9 to18 Limits	Not used	Not used	Not used
1275, 1285 or 1295	Enable	OFF ON	OFF	OFF	OFF
1276, 1286 or 1296	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning	Warning	Warning

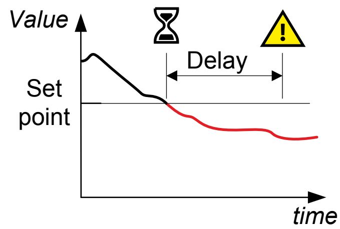
Configure the Busbar voltage detection type under **Settings > Busbar > Voltage protections > Voltage detect. type**.

Parameter	Text	Range	Default
1202	Type	Phase-Phase Phase - Neutral	Phase - Phase

8.3.3 Busbar under-voltage (ANSI 27)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Under-voltage	U<, U<<	27	PTUV	< 50 ms

The alarm response is based on the lowest phase-to-phase voltage, or the lowest phase-to-neutral voltage, from the busbar, as measured by the controller.



Configure the parameters for Busbar under-voltage under **Settings > Busbar > Voltage protections > Under-voltage > BB U< #**, where # is 1 to 4.

Parameter	Text	Range	BB U< 1	BB U< 2	BB U< 3	BB U< 4
1301, 1311, 1321 or 1331	Set point	40 to 100 %	97 %	95 %	97 %	95 %
1302, 1312, 1322 or 1332	Timer	0 to 99.99 s	10 s	5 s	10 s	5 s
1303, 1313, 1323 or 1333	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used	Not used	Not used
1304, 1314, 1324 or 1334	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used	Not used	Not used
1305, 1315, 1325 or 1335	Enable	OFF ON	OFF	OFF	OFF	OFF
1306, 1316, 1326 or 1336	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning	Warning	Warning	Warning

Configure the Busbar voltage detection type under **Settings > Busbar > Voltage protections > Voltage detect. type**.

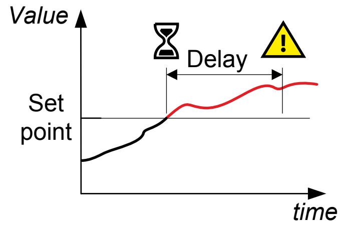
Parameter	Text	Range	Default
1202	Type	Phase-Phase Phase - Neutral	Phase - Phase

8.3.4 Busbar voltage unbalance (ANSI 47)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Voltage unbalance (voltage asymmetry)	UUB>	47	-	< 200 ms*

*Note: This operate time includes the minimum user-defined delay of 100 ms.

The alarm response is based on the highest difference between any of the three busbar phase-to-phase voltage or phase-to-neutral true RMS values and the average voltage, as measured by the controller. The phase-to-phase voltage is the default.
If phase-to-phase voltages are used, the controller calculates the average phase-to-phase voltage. The controller then calculates the difference between each phase-to-phase voltage and the average voltage. Finally, the controller divides the maximum difference by the average voltage to get the voltage unbalance. See the example.



Configure the parameters under **Settings > Busbar > Voltage protections > Voltage unbalance > BB Unbalance U**.

Parameter	Text	Range	Default
1621	Set point	0 to 50 %	6 %
1622	Timer	0.1 to 100 s	10 s
1623	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1624	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1625	Enable	OFF ON	OFF
1626	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning

Busbar voltage unbalance example
The busbar has a nominal voltage of 230 V. The L1-L2 voltage is 235 V, the L2-L3 voltage is 225 V, and the L3-L1 voltage is 210 V.
The average voltage is 223.3 V. The difference between the phase-to-phase voltage and the average is 12.7 V for L1-L2, 2.7 V for L2-L3 and 13.3 V for L3-L1.
The busbar voltage unbalance is 13.3 V / 223.3 V = 0.06 = 6 %

8.3.5 Positive sequence under-voltage (ANSI 27d)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Positive sequence under-voltage	U_2<	27d		< 40 ms

As a result of the generator's power production to the consumers, the positive sequence system represents the fault-free part of the voltages.
The controller measures the voltage state on the positive sequence voltage part of the voltage phasors of the busbar or mains.
The alarm response is based on the lowest positive voltage value measured at the zero crossing point of each phase.

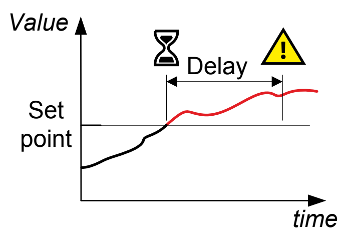
Configure the parameters under **Settings > Busbar > Voltage protections > Pos. seq. under-volt. > BB Pos seq volt**.

Parameter	Text	Range	Default
1441	Set point	10 to 110 %	70 %
1442	Timer	1 to 9 Periods	2 Periods
1443	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1444	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1445	Enable	OFF ON	OFF
1446	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Trip MB

8.3.6 Busbar over-frequency (ANSI 81O)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Over-frequency	f>, f>>	81O	PTOF	< 50 ms

The alarm response is based on the lowest fundamental frequency (based on phase voltage), from the busbar. This ensures that the alarm only activates when all of the phase frequencies are above the set point.



Configure the parameters under **Settings > Busbar > Frequency protections > Over-frequency > BB f> #**, where # is 1 to 3.

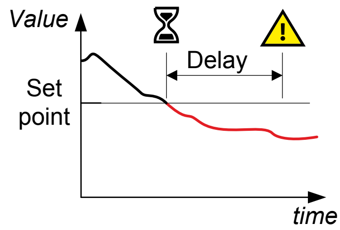
Parameter	Text	Range	BB f> 1	BB f> 2	BB f> 3
1351, 1361 or 1371	Set point	100 to 120 %	103 %	105 %	105 %
1352, 1362 or 1372	Timer	0 to 99.99 s	10 s	5 s	5 s
1353, 1363 or 1373	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used	Not used
1354, 1364 or 1374	Output B	Not used	Not used	Not used	Not used

Parameter	Text	Range	BB f> 1	BB f> 2	BB f> 3
		Relay 5, 6 and 9 to 18 Limits			
1355, 1365 or 1375	Enable	OFF ON	OFF	OFF	OFF
1356, 1366 or 1376	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning	Warning	Warning

8.3.7 Busbar under-frequency (ANSI 81U)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Under-frequency	f<, f<<	81U	PTUF	< 50 ms

The alarm response is based on the highest fundamental frequency (based on phase voltage), from the busbar. This ensures that the alarm only activates when all of the phase frequencies are below the set point.



Configure the parameters under **Settings > Busbar > Frequency protections > Under-frequency > BB f< #**, where # is 1 to 5.

Parameter	Text	Range	BB f< 1	BB f< 2	BB f< 3	BB f< 4	BB f< 5
1381, 1391, 1401, 1411 or 1931	Set point	80 to 100 %	97 %	95 %	97 %	95 %	95 %
1382, 1392, 1402, 1412 or 1932	Timer	0 to 99.99 s	10 s	5 s	10 s	5 s	5600 s
1383, 1393, 1403, 1413 or 1933	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used	Not used	Not used	Not used
1384, 1394, 1404, 1414 or 1934	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used	Not used	Not used	Not used
1385, 1395, 1405, 1415 or 1935	Enable	OFF ON	OFF	OFF	OFF	OFF	OFF
1386, 1396, 1406, 1416 or 1936	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB	Warning	Warning	Warning	Warning	Warning

Parameter	Text	Range	BB f< 1	BB f< 2	BB f< 3	BB f< 4	BB f< 5
		Controlled stop					

8.3.8 Vector shift (ANSI 78)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Vector shift	dφ/dt	78	PVEC	< 40 ms

Vector shifts can arise when a mains failure occurs while a generator is running parallel with the mains.
Vector shifts can occur because the stator magnetic field lags behind the rotor magnetic field. When a mains failure occurs, the phase angle between the stator and rotor magnetic fields changes. This change in the phase angle, is also known as a vector shift.
The alarm response is based on the change in the phase angle that occurred due to the mains failure. The alarm response can be based on the change in an individual phase, or on the change in all the phases.
In grids where fast automatic reconnection attempts are expected, this protection opens the breaker to prevent damaging failures.
Fast changes in frequency can also activate this alarm. Too sensitive configuration can lead to too many unwanted detections of vector shift.

Figure 8.3 Vector shift causes the instantaneous phase angle change (Δφ)

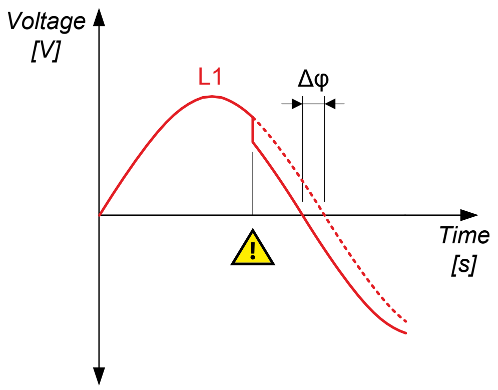


Figure 8.4 Vector shift in phase L1 only

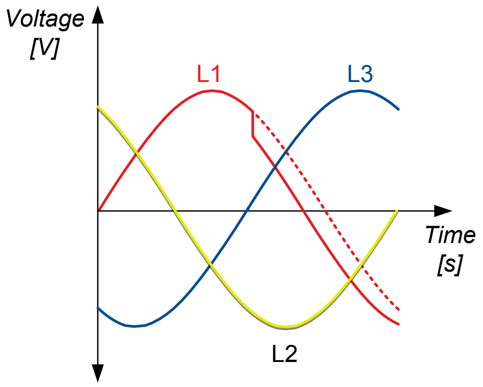
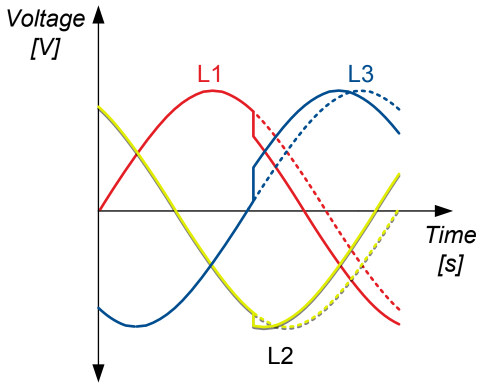


Figure 8.5 Vector shift in all phases



Configure the parameters for Vector jump under **Settings > Busbar > Additional protections > Vector shift**.

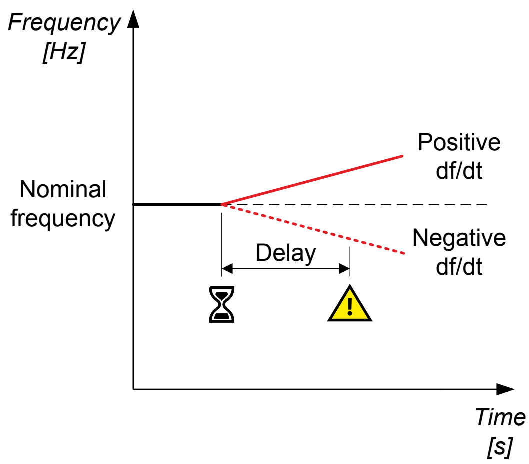
Parameter	Text	Range	Default
1431	Set point	1 to 90 °	10 °
1432	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1433	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1434	Enable	OFF ON	OFF
1435	Fail class	Block	Trip MB

Parameter	Text	Range	Default
		Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	
1436	Type	Individual phases All phases	All phases

8.3.9 Rate of change of frequency (ANSI 81R)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
ROCOF (df/dt)	df/dt	ANSI 81R	PFRC	Standard: < 120 ms

When a mains failure occurs, the measured frequency might change within a short period of time, if the generators are either instantly overloaded or instantly de-loaded.
If the generator overloads instantly, it slows down, and the generator frequency might decrease shortly. Similarly, if the generator de-loads instantly, it speeds up, and the generator frequency might increase shortly.
The alarm response is based on the rate of change of the measured frequency, within a specified time period.
In grids where fast automatic reconnection attempts are expected, this protection opens the breaker to prevent damaging failures.



Configure the parameters for ROCOF df/dt under **Settings > Busbar > Additional protections > df/dt (ROCOF)**.

Parameter	Text	Range	Default
1421	Set point	0.200 to 10.000 Hz/s	5.000 Hz/s
1422	Periods	3 to 20 Periods	6 Periods
1423	Timer	0.00 to 3.00 s	0.00 s
1424	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1425	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
1426	Enable	OFF ON	OFF
1427	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB	Trip MB

Parameter	Text	Range	Default
		Safety stop Trip MB/GB Controlled stop	

8.4 Additional protections

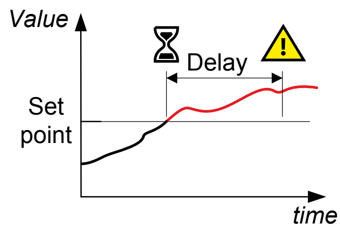
8.4.1 Additional protections

Table 8.5 Additional protections

Protection	IEC symbol (IEC 60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time	Alarms
Overspeed		12			2
Underspeed		14			1
Average over-voltage	-	59AVG	-	-	2

8.4.2 Overspeed

These alarms alerts for the operator that a genset is running too fast.
The alarm response is based on the engine speed as a percentage of the nominal speed. If the engine speed rises above the set point for the delay time, the alarm is activated.

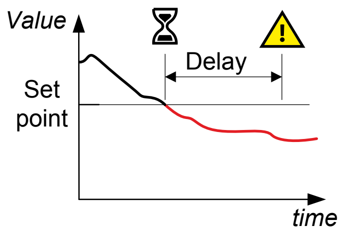


Configure the parameters under **Settings > Engine > Protections > RPM-based protections > Overspeed > Overspeed #**, where # is 1 or 2.

Parameter	Text	Range	Overspeed 1	Overspeed 2
4511 or 4521	Set point	100 to 150 %	110 %	120 %
4512 or 4522	Timer	0 to 100 s	5 s	1 s
4513 or 4523	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used
4514 or 4524	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used
4515 or 4525	Enable	OFF ON	OFF	OFF
4516 or 4526	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning	Shutdown

8.4.3 Underspeed

This alarm alerts the operator that a genset is running too slowly.
The alarm response is based on the engine speed as a percentage of the nominal speed. If the engine speed drops below the set point for the delay time, the alarm is activated.



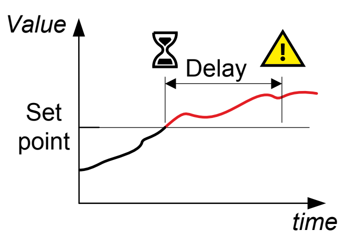
Configure the parameters under **Settings > Engine > Protections > RPM-based protections > Underspeed > Underspeed**.

Parameter	Text	Range	Default
4591	Set point	50 to 100 %	90 %
4592	Timer	0 to 100 s	5 s
4593	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
4594	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
4595	Enable	OFF ON	OFF
4596	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning

8.4.4 Average over-voltage (ANSI 59AVG)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time
Average over-voltage		59AVG	PAOV	-

The alarm response is based on the highest average phase-to-phase voltage, or the highest average phase-to-neutral voltage, from the busbar or source, averaged during the calculation time.
The average voltage calculation is based on the power quality approach in EN 61000-4.30. The root mean squared (RMS) voltage is measured and aggregated for 10 periods at 50 Hz nominal frequency (12 periods at 60 Hz). This result is then aggregated 15 times (that is, for a 3-second average). Finally, the 3-second averages are aggregated over the aggregate time.
For this protection, the average voltage is measured and calculated over a minimum of 30 seconds, and updated every 3 seconds.



Configure the parameters under **Settings > Mains > Protections > Voltage protections > Avg. U over-voltage BB > Avg U BB #**, where # is 1 or 2.

Parameter	Text	Range	Avg U BB> 1	Avg U BB> 2
7481 or 7491	Set point	100 to 120 %	110 %	110 %
7482 or 7492	Timer	0.1 to 3200 s	10 s	10 s
7483 or 7493	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used
7484 or 7494	Enable	OFF ON	OFF	OFF
7485 or 7495	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning	Warning
7486 or 7496	Timer	30 to 900 s	600 s	600 s

9. Power management

9.1 Introduction to Power management

9.1.1 Introduction to Power management

The purpose of the power management system is to supply the required power to the load in an efficient, safe and reliable way.

The power management system is used to
- Optimise the fuel consumption
- Balance the loads in the system
- Implement plant logic
- Ensure safety

The controller can be used in simple or advanced power plant projects or a wide range of applications. The applications can include projects with synchronising gensets, critical power, emergency standby, or power production.

The complete power management system is monitored from a graphical supervision page. The supervision page can for example show running status, hours in operation, breaker status, condition of mains and busbars, and fuel consumption.

Multi-master system

The power management system is designed as a multi-master system for increased reliability. In a multi-master system all vital data is transmitted between the controllers, giving all units knowledge of the power management status (calculations and position) in the application. This means that the application is not dependent on a single master controller and makes the controller suitable for all types of applications, for example emergency standby or critical power applications.

9.2 CAN bus failure handling

9.2.1 CAN failure mode

The system can be configured to handle a failure on the CAN bus controlling the power management in different ways.

Set the CAN failure mode under **Settings > Power management > Communication failures**.

Parameter	Text	Range	Default
7532	CAN fail mode	MANUAL SEMI-AUTO No mode change	MANUAL

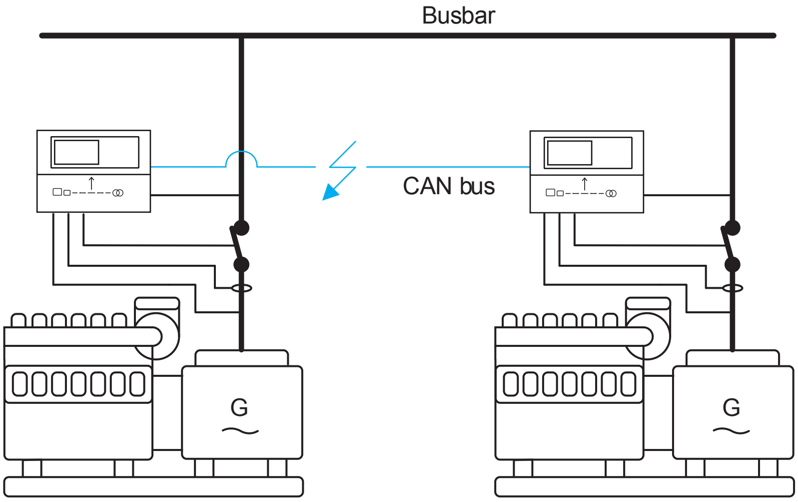
Set the parameters for CAN Share failure under **Settings > Power management > Communication failures > CAN Share failure**.

Parameter	Text	Range	Default
7861	Timer	0.0 to 100.0 s	0.0 s
7862	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
7863	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
7864	Enable	OFF ON	OFF

Parameter	Text	Range	Default
7865	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning
7866	CAN Sha fail mode	MANUAL SEMI-AUTO No mode change	MANUAL

Manual mode

If Manual is selected in all the AGC 150 controllers, the controller that has the Missing all units or Fatal CAN error alarm will change to Manual mode. This means that the regulators do not react, and it is not 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 150 is still able to make a shutdown or a trip of a breaker.

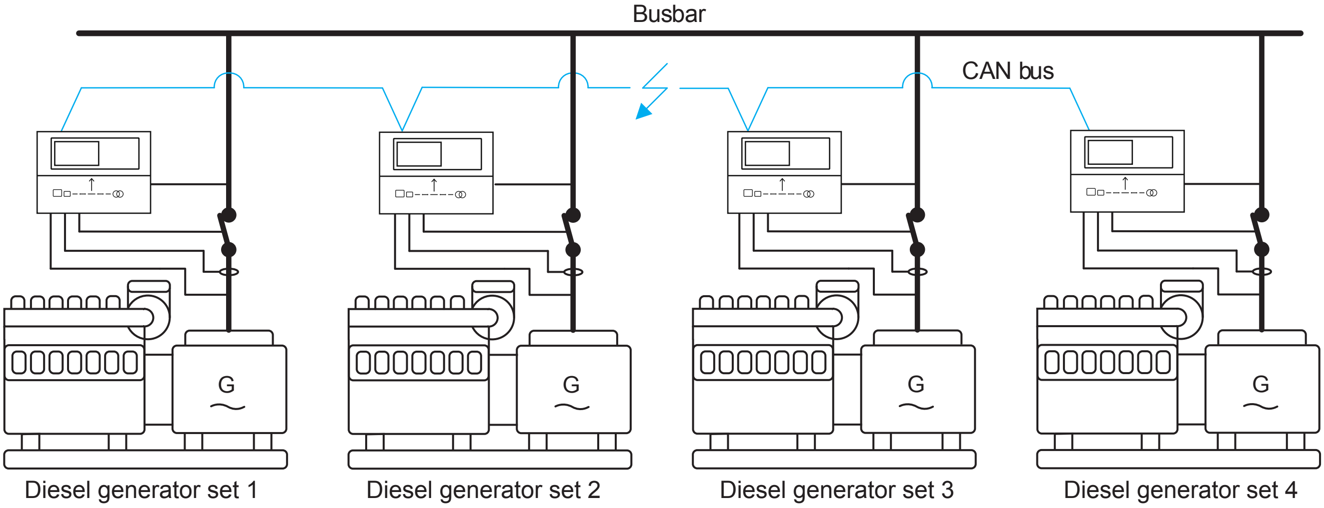


- If the wire break occurs before the engine is started, the power management system will not start the controller that has changed from AUTO to Manual. If more than one genset is present in an application and Manual mode is selected, the faulty one will not be able to share the load with the other(s). Only the protections are active. If more than two gensets are present, the others will be able to share the load with each other. Only the faulty one can share the load, 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 AGC 150 controller is switched into Manual, it is necessary to adjust the droop on the governor.

SEMI-AUTO mode

If SEMI-AUTO is selected, the AGC 150 controllers will change to SEMI-AUTO mode when the Missing all units or More than one controller is missing alarms occur.

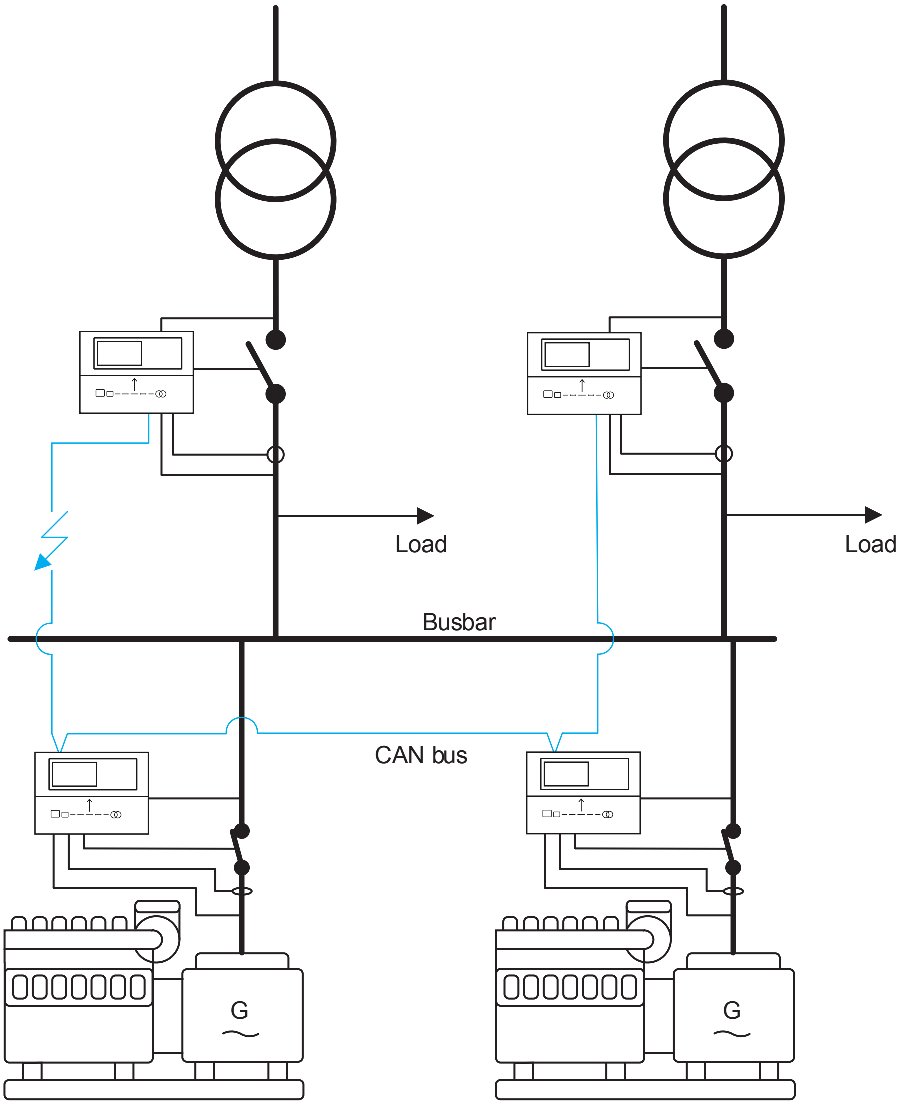
In SEMI-AUTO mode, the regulators in the AGC 150 controllers are still active. This means that gensets visible to each other can make load sharing. This is explained by an example:



- 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 share the load 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 to 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 150 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 150 controllers 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. If one of the fail classes in the isolated controller has been set for Trip MB, the rest of the system will be able to continue in AUTO.

9.2.2 CAN bus communication failures

The AGC 150 controllers have different alarms for CAN bus communication failures. For 2-level applications, the following communication failures can be executed:

- Missing all units: Appears only when a controller cannot see any other controllers on the CAN bus line.
- Fatal CAN error: Appears when two or more controllers are not visible, while others are still visible.
- Any DG missing: Appears when at least one genset controller is missing.
- Any mains missing: Appears when at least one mains controller is missing.
- Any BTB missing: Appears when at least one BTB is missing.

Set the alarms for CAN bus communication failures under **Settings > Power management > Communication failures**.

Parameter	Text	Range	Default
7533	Missing all units	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning
7534	Fatal CAN error		
7535	Any DG missing		
7536	Any mains missing		

9.2.3 CAN bus alarms

The following alarms can be displayed on AGC 150 in case of CAN bus communication failures:

- CAN ID X P missing: AGC 150 has lost CAN bus communication to CAN ID on the PM CAN primary line.
- CAN ID X S missing: AGC 150 has lost CAN bus communication to mains with ID X on the PM CAN secondary line.
- CAN setup CH: 784x: The controller 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.

NOTE 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.

9.3 Easy connect

9.3.1 Easy connect

Easy connect is a fast and easy way of connecting multiple gensets together in a new or existing plant. Easy connect can only be used with gensets.

Enable Easy connect under **Settings > Power management > Easy connect**.

Parameter	Text	Range	Default
8023	Easy connect	OFF ON	OFF

After checking the PMS CAN line for activity, the first controller in a plant prompts Start new plant with the option to select:

- **Yes**: The controller starts a new plant that only includes itself until additional gensets are added to the setup. The first controller in the setup keeps its the CAN ID.
- **No**: The controller enters Stand-alone mode, and the controller changes to DG blocked for start. This command is chosen if the genset is leaving the plant.

To add additional gensets to the setup, Easy connect must be enabled in each controller. After connecting the CAN bus line and powering up the additional genset, the controller checks the CAN bus communication. If the controller finds another controller, the additional genset prompts Add DG to CAN PMS, and the controller gets the lowest free CAN ID. If the CAN bus communication is broken, Setup stand-alone is shown in the genset with the missing communication.

It is only possible to enter Stand-alone mode, when the engine is stopped. All other gensets are prompted with Remove DG X. By selecting Yes, the alarms are cleared and the setup is running as usual with one genset less. The genset with the missing communication continues running.

To use a breaker type other than pulse, configure the breaker type under **Settings > Functions > Quick setup**.

Parameter	Text	Range	Default
9184	Quick setup GB type	Pulse Continuous Compact	Pulse

NOTE
- Only a stopped genset can be added in a running plant.
- Running gensets can not be removed from the plant.
- Easy connect commands can be issued through M-Logic and Modbus.

9.4 Quick setup

9.4.1 Quick setup

This function provides an easy user interface for applications where it is vital for the end-user to be able to change the application quickly and easily. It is often applications for the rental market that need this flexibility, and therefore there are some limitations that have to be considered when using the quick setup menu:

- The Quick setup function only supports up to 16 gensets.
- It is not possible to have any AGC 150 bus tie controllers in the application.
- It is not possible to set up a dual mains application through the quick setup menu.

The following applications can be handled through the quick setup menu:

Figure 9.1 Island applications

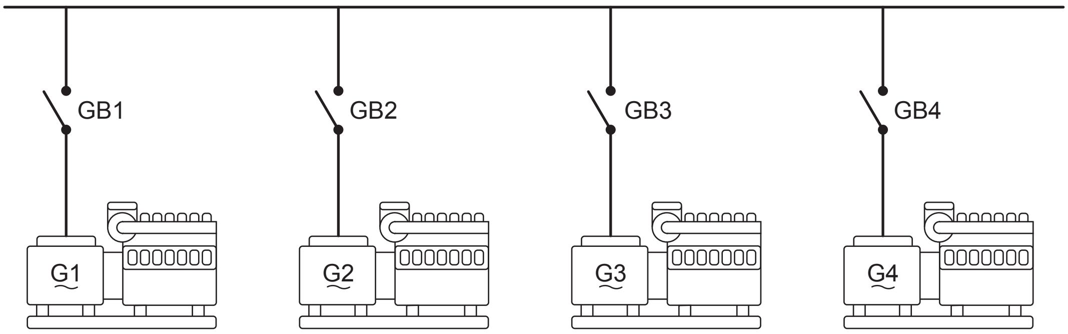
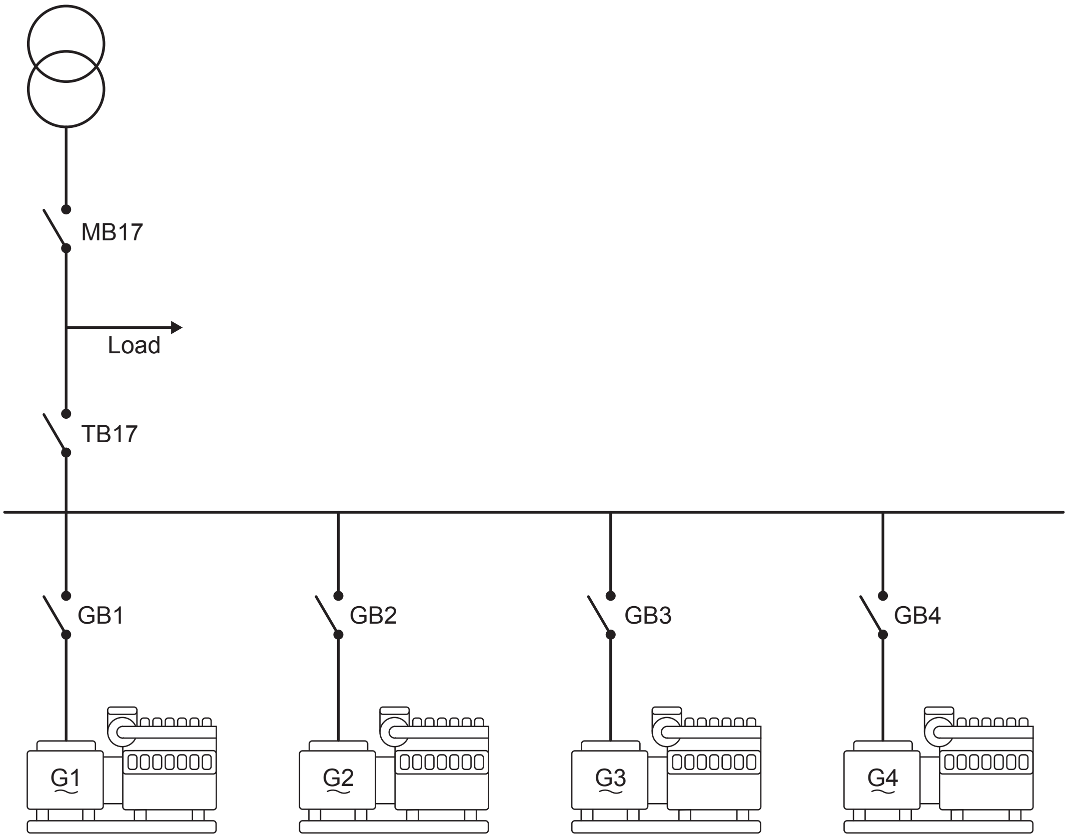


Figure 9.2 Simple applications with connection to one mains



Configure Quick setup under **Settings > Functions > Quick setup**.

Parameter	Text	Range	Default
9181	Mode	OFF Setup Stand Alone Setup Plant	OFF
9182	CAN line	OFF CAN Primary CAN Secondary	OFF
9183	MB type	Pulse No breaker Continuous Compact	Pulse
9184	GB Type	Pulse Continuous Compact	Pulse
9185	Mains setup	Mains Present No Mains Present	Mains Present
9186	DG setup	Single DG Standard	Standard

Mode

OFF: The existing application that is about to have this genset included will not look for the new genset. This gives the operator time to connect all wiring and to do the basic setup of the genset.

Setup Stand Alone: AGC 150 changes the application configuration, so it will no longer be a part of the application. When the ID is removed from the application, the new application will be broadcast to the other controllers. The existing gensets in

the application will maintain their IDs, as a rearrangement could lead to unnecessary starting and stopping of the gensets.
If the genset that is to be removed is running, it will not be possible/allowed to continue the process until the genset has stopped. If it is attempted to disconnect, an info text, Quick setup error, appears.

Setup Plant: The new AGC 150 receives the application configuration from the other controllers in the plant, and then notifies the rest of the application that a new ID is available on the line. If the ID of the new controller already exists, it gets the highest ID + 1 assigned. The new ID is included in the application configuration in all the controllers. During this process, the existing application will continue running without being affected by the system upgrade.
The new controller is automatically set to Block mode. When the setup is done, the end user must decide the running mode for the added genset.

NOTE
- If a BTB is detected in the application, an Appl. not possible alarm is shown.
- Change of setup from standard to single genset controller: When disconnecting AGC 150 from a system, it is important to change the Plant setup. After disconnecting, AGC 150 changes to a single DG.

9.4.2 Application broadcast

This function makes it possible to broadcast an application over the CAN bus line from AGC 150 to all controllers in the application. It takes one operation to activate the broadcast function:

1. By sending the application.
2. By sending the application and activating it.

Configure the Application broadcast under **Settings > Functions > Quick setup**.

Parameter	Text	Range	Default
9191	Application Broadcast type	OFF Broadcast Broadcast + Activate	OFF
9192	Application Broadcast number	Application 1 Application 2 Application 3 Application 4	Application 1

Application Broadcast type

OFF: No broadcast will be made.

Broadcast: Broadcast of the selected application number is sent to the controllers in the application.

Broadcast + Activate: Broadcast is activated and the application number is broadcast and activated in all controllers.

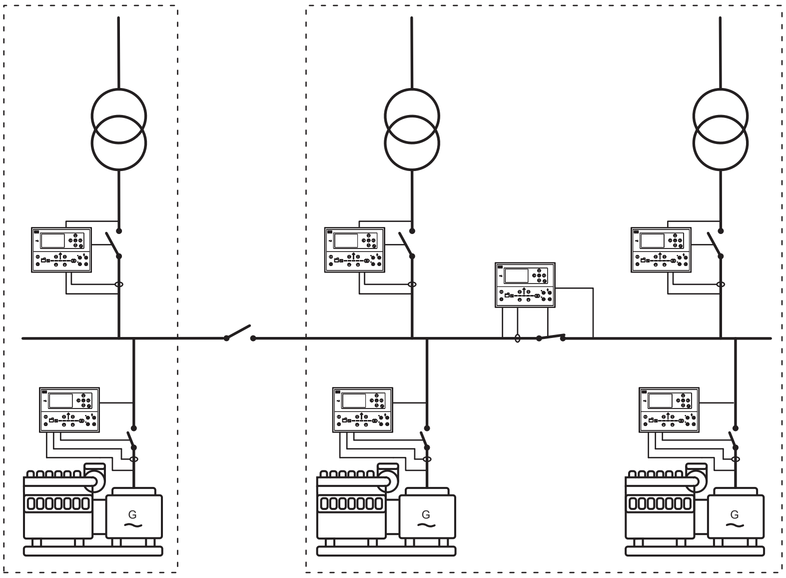
9.5 Power management principles and rules

9.5.1 Static and dynamic sections

The power management application can be divided into sections, using Bus Tie Breakers (BTBs). If a BTB is open, the two sections can almost be considered as separate applications.

The BTB can be controlled with a BTB controller. If only the status is required, the feedback can be wired to a different controller in the system.

The diagram below shows the difference between a static and a dynamic section:



Static section Dynamic section

Static section: This part of the application can not be divided further by BTBs. If there are no BTBs in the application, the whole application will be a static section.

Dynamic section: A dynamic section consists of at least two static sections. A dynamic section will always include a closed BTB, because this defines a dynamic section.

9.5.2 Settings in applications with BTBs

When changing settings in applications with BTBs it is strongly recommended to open all the BTBs, before any settings are changed. If settings are changed while a BTB is closed, some of the settings might be lost, when the BTB is opened.

If it is necessary to change settings while a BTB is closed, it is possible to save the settings with M-Logic. The configuration is made with the Utility Software (a controller on each side of the BTB must have a spare input):

Use the Store common settings command in a controller on each side of the BTB that is about to be opened.

Any spare input can be used. When the settings are saved, the input must be activated for at least one second. The input must be activated before a BTB is opened to make sure that the settings are saved.

9.5.3 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.

For example, if the auxiliary supply is switched off, and this was the command unit, then the next available unit will take over the command functions.

The command unit cannot be selected by the operator. It is automatically selected when a power management setting is accessed.

9.5.4 Plant running modes

The AGC 150 can work in different operating modes, also known as genset mode or plant mode.

The operating mode for all applications that are not a stand-alone applications, should be set to *Power Management*. Then the operating mode will be dictated from a Mains controller. If there is no Mains controller, the operating mode will change to *Island operation*.

When the gensets are set for power management, they are capable of load sharing via CAN bus.

Configure the operating mode under **Settings > Basic settings > Application type > Genset type > Genset mode**.

Parameter	Text	Range	Default
6071	Type	Island operation Auto Mains Failure Peak shaving Fixed power Mains power export Load take-over Power management Dry alternator Ventilation	Island operation

Automatic Mains Failure (AMF)

Used when the plant is going to start automatically at a mains failure. By default, a genset will not start in this situation and will have to be programmed. The genset will be able to make load-dependent start/stop, if the load is small enough for this, or increasing. The AGC 150 is able to synchronise back to grid, when the grid returns, and afterwards de-load the breakers.

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 150. 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. Common for all the applications is that the limits and timers are set from the same parameter numbers.

Configure the timers for Automatic Mains Failure under **Settings > Mains > AMF functions > AMF timers**.

Parameter	Text	Range	Default
7061	U mains fail delay	0.5 to 990.0 s	5.0 s
7062	Mains OK delay U	2 to 9900 s	60 s
7071	f mains fail delay	0.5 to 990.0 s	5.0 s
7072	Mains OK delay f	2 to 9900 s	60 s

Configure the voltage limits for Automatic Mains Failure under **Settings > Mains > Voltage and freq. limits > Voltage settings**.

Parameter	Text	Range	Default
7063	U< (low voltage)	30 to 100 %	90 %
7064	U> (high voltage)	100 to 120 %	110 %
7066	Unbalance voltage	2 to 100 %	100 %

Configure the frequency limits for Automatic Mains Failure under **Settings > Mains > Voltage and freq. limits > Frequency settings**.

Parameter	Text	Range	Default
7073	f< (low frequency)	80 to 100 %	95 %
7074	f> (high frequency)	100 to 120 %	105 %

In parameter 7065, there is a selection on what the AGC 150 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 parameter 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 parameter is set to Start engine instead, the Mains Breaker is 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.

Configure the start sequence for Automatic Mains Failure under **Settings > Mains > AMF functions > Start seq. in AMF mode**.

Parameter	Text	Range	Default
7065	Mains fail ctrl	Start engine + Open MB Start engine Open MB when engine ready	Start engine + Open MB

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.

Set the Synchronisation options under **Settings > Synchronisation > Mains parallel settings**.

Parameter	Text	Range	Default
7083	Mains back synchronisation	OFF ON	OFF
7084	Sync. to mains	OFF ON	OFF

Load take-over (LTO)

Can be used if the operator wants to synchronise to the grid, then de-load 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 de-load 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 mode, the AGC 150 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 Start signal is deselected.

If a mains failure occurs during an LTO sequence, the gensets stay connected even though the LTO start signal is removed in order not to disconnect the load unnecessarily. In this situation Mode shift must be activated. Activate Mode shift under **Settings > Mains > AMF functions > AMF timers**.

Parameter	Text	Range	Default
7081	Mode	Mode shift OFF Mode shift ON	Mode shift OFF

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 made for supporting a load, and the AGC 150 will try to maintain the nominal frequency and voltage in this mode. If there is a Mains controller, it will still be possible to run in Island mode. If no Mains controller is present, the gensets and groups will automatically change to 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 must be configured as Island mode. The application configuration must hold a mains connection, even if there isn't any.

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 150 can automatically start and stop the gensets. The power is controlled from the controller placed in the top layer. 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 150 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 % nominal load.

In applications with more than one mains, the AGC 150 can be parallel to all of them at one time. This requires that the grid connections are allowed to be parallel, and the AGC 150 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 controllers are placed in an application, the mains with "ID to run" will control the fixed power set point.

In applications with an open BTB, and a mains on each side, the AGC 150 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 150 is placed in a stand-alone application, the fixed power set point is in percentage instead.

Configure the Fixed power set point under **Settings > Power set points > Fixed power**.

Parameter	Text	Range	Default
7051	Fixed power set point	0 to 20000 kW	500 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, it is possible to export to all the grid connections. The grid has to be allowed to be parallel, and afterwards the AGC 150 has to be set to Run all Mains. In this situation, the mains 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 150 will need the 4th CT or 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).

Configure the Mains power export under **Settings > Power set points > MPE/Peak shaving > Day/Night power set.**.

Parameter	Text	Range	Default
7001	Mains power, Day	-20000 to 20000 kW	750 kW
7002	Mains power, Night	-20000 to 20000 kW	1000 kW

Configure the Day and Night under **Settings > Power set points > MPE/Peak shaving > Day/Night settings**.

Parameter	Text	Range	Default
7011	Daytime period, Start hour	0 to 23	8
7012	Daytime period, Start min.	0 to 59	0
7013	Daytime period, Stop hour	0 to 23	16
7014	Daytime period, Stop min.	0 to 59	0

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 150 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 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 example at 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. The mains controller will then use the load-dependent start/stop settings, from the genset(s).

When the peak shaving method is used in applications with more mains controllers, the "ID to Run" also has an influence on the AGC 150. The power set in the peak shaving power set point is the load for all 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 mainswith "ID to Run".

Configure Peak shaving under **Settings > Power set points > MPE/Peak shaving > Day/Night power set.**.

Parameter	Text	Range	Default
7001	Mains power, Day	-20000 to 20000 kW	750 kW
7002	Mains power, Night	-20000 to 20000 kW	1000 kW

Configure the Day and Night under **Settings > Power set points > MPE/Peak shaving > Day/Night settings**.

Parameter	Text	Range	Default
7011	Daytime period, Start hour	0 to 23	8
7012	Daytime period, Start min.	0 to 59	0
7013	Daytime period, Stop hour	0 to 23	16
7014	Daytime period, Stop min.	0 to 59	0

If the peak shaving is to be used in a stand-alone application, the 4th CT or a mains transducer has to be used. Otherwise the AGC 150 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.

Configure Peak shaving in stand-alone applications under **Settings > Power set points > MPE/Peak shaving > Day/Night power set.**.

Parameter	Text	Range	Default
7021	Start generator set point	5 to 100 %	80 %
7022	Start delay	0.0 to 990.0 s	10.0 s

Parameter	Text	Range	Default
7023	Min. load	0 to 100 %	5 %
7031	Stop generator set point	0 to 80 %	60 %
7032	Stop delay	0.0 to 990.0 s	30.0 s

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	

9.5.5 Controller operation modes

In the AGC 150, 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, which can involve different things. 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 for example mains failure situations (if the mains controller is also in AUTO). If a genset is not in AUTO, the operator can experience problems with for example the power capacity function.
- **SEMI-AUTO:** If an AGC 150 is in SEMI-AUTO mode, the controller will not start by itself, or start up if other gensets are requesting help. When an AGC 150 is in SEMI-AUTO, the regulators are still active and capable of load sharing, 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-AUTO, and the *GB close* button is activated, the AGC 150 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-AUTO mode, none of the AUTO sequences will be initiated.
- **Manual:** If the genset is set into Manual mode, the regulators are switched off. So it will not be load sharing, but the protections are still active. When in Manual, the genset will have to be stopped from the display or via inputs. When a genset is in Manual, 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 150 in block mode will not be able to start from inputs, the display or from the power management system.

9.5.6 Start and stop of the plant

The start signal for the plant can be given from a controller, or from a remote signal, for example a digital input or a Modbus command:

- If configured as Local, the start signal must come from a controller.
- If configured as Remote, the start signal must be a digital input or a Modbus command.

Select Local or Remote start/stop signal under **Settings > Power management > Start/Stop for Island**.

Parameter	Text	Range	Default
8021	Start/stop	Remote Local	Remote

Some running modes require a start signal, while others start up automatically due to different events.

2-level application start signal

The start signal in a 2-level application will have to be given to a mains controller. If no mains controller is present in the application, the start signal is given to a genset controller.

NOTE Be aware if there are bus tie breakers in the application, since the start signal is not necessarily shared across these!

9.5.7 Test mode in 2-level applications

The AGC 150 holds three different test modes, which give different possibilities:

- **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 150 should return to, when the genset(s) is stopped. The selections are between SEMI-AUTO and AUTO mode. If the active multi-start is set to auto calculation, the AGC 150 will use the kW set point to calculate how many gensets should be started in simple test mode. For example, if 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 island 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 150 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), de-load the MB(s) and be powering with all the load. When the full test is started, the AGC 150 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 de-load 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.

For example, if 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 150 should return to, when the test has expired. The selections are between SEMI-AUTO and AUTO mode.

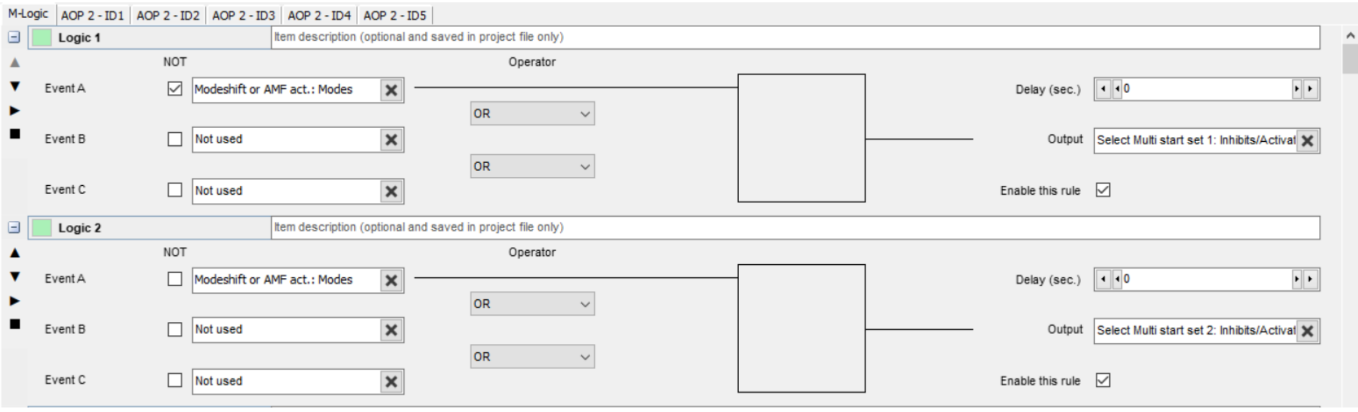
Configure the Test parameters under **Settings > Power setpoints > Test**.

Parameter	Text	Range	Default
7041	Test set point	1 to 100	1
7042	Test timer	0.0 to 999.0 min	0.0 min
7043	Test return mode	SEMI-AUTO AUTO No mode change Manual	No mode change
7044	Test type	Simple test Load test Full test	Simple test

9.6 Basic functions

9.6.1 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 150, 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 150 should start all gensets. With the programming above, the AGC 150 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. For example, this gives the possibility of a 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 five 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.

Configure the parameters for multi-start under **Settings > Power management > Multi start set**.

Parameter	Text	Range	Default
8922	Multistart 1 – genset to start	Auto calculation DG 1 to 32	Auto calculation
8923	Multistart 1 – gensets running	0 to 32	1
8924	Select multistart	Multi-start 1 Multi-start 2	Multi-start 1
8925	Multi-start 2 – genset to start	Auto calculation DG 1 to 32	Start DG 16
8926	Multi-start 2 – gensets running	0 to 32	1

9.6.2 Local update/update all in 2-level applications

AGC 150 can be configured for either Local update or Update all. If a controller is set to Local update, it will only be possible to switch between SEMI-AUTO and AUTO from the controller, or via a Modbus.

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-AUTO 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-AUTO 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-AUTO to AUTO, or from AUTO to SEMI-AUTO, all controllers with Update all will change to the same mode.

If a BTB is placed in the application, the information about AUTO and SEMI-AUTO is not shared across an open BTB.

Configure the parameters for update mode under **Settings > Power management > Additional PM settings**.

Parameter	Text	Range	Default
8022	Update mode	Local update Update all	Update all

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

9.7.1 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.

Configure the Load-dependent Start/stop parameters under **Settings > Power management > Load dep Strt/Stp conf**.

Parameter	Text	Range	Default
8881	Unit selection	kW kvA	kW
8882	Set point type	Value Percentage	Value
8006	Scaling	1 kW : 1 kW 1 kW : 10 kW 1 kW : 100 kW 1 kW : 1000 kW	1 kW : 1 kW
8141	Stop noncon. DG	10.0 to 600.0 s	60.0 s

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.

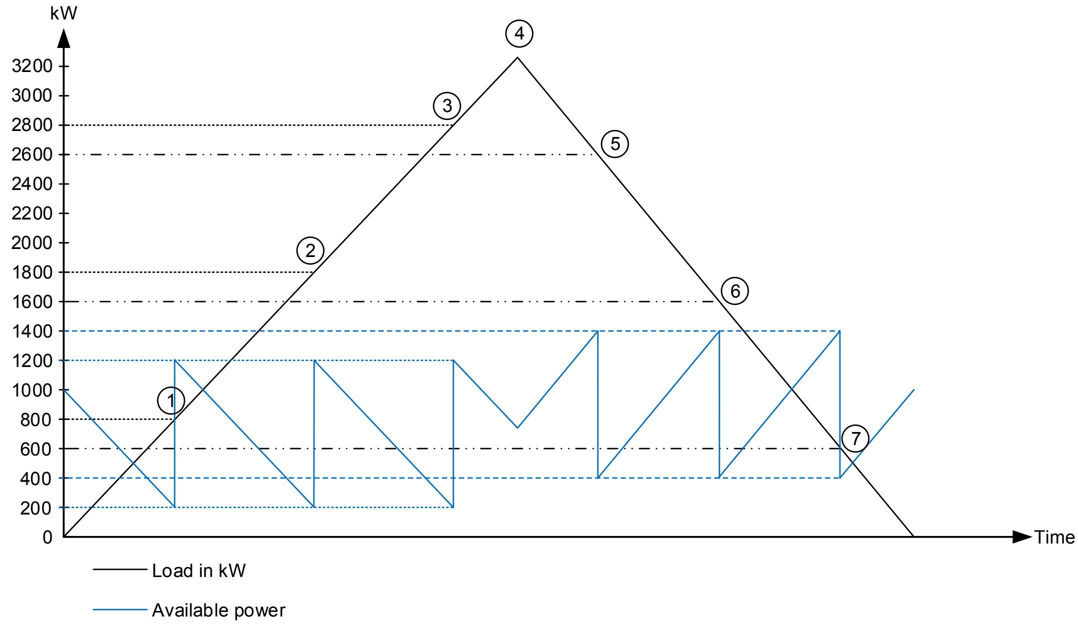
Configure the Start/stop method parameter under **Settings > Power management > Start/Stop for Island**.

Parameter	Text	Range	Default
8021	Start/stop method	Remote Local	Remote

9.7.2 Power set point

The load-dependent start stop function is best 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:

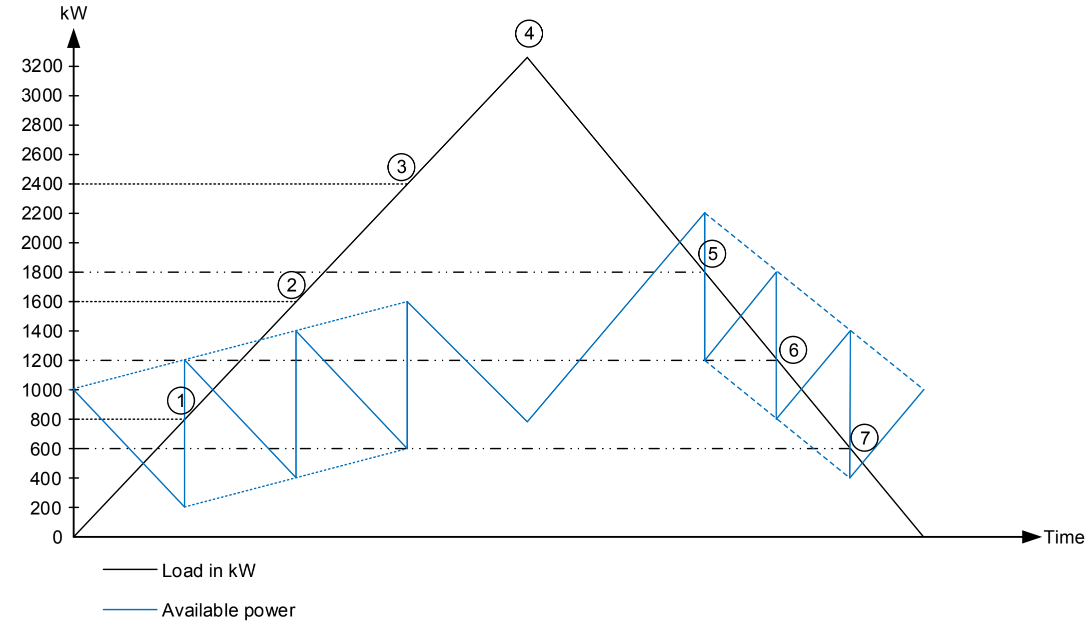


1. The load is increasing, and when it has reached 800 kW, the next genset will start. It starts because the available power has come below 200 kW, which is the set point.
2. The load is still increasing, and now it reaches 1800 kW. This means that the available power has come below 200 kW once again, 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.

9.7.3 Percentage set point

The load-dependent start stop function is best explained by an example:

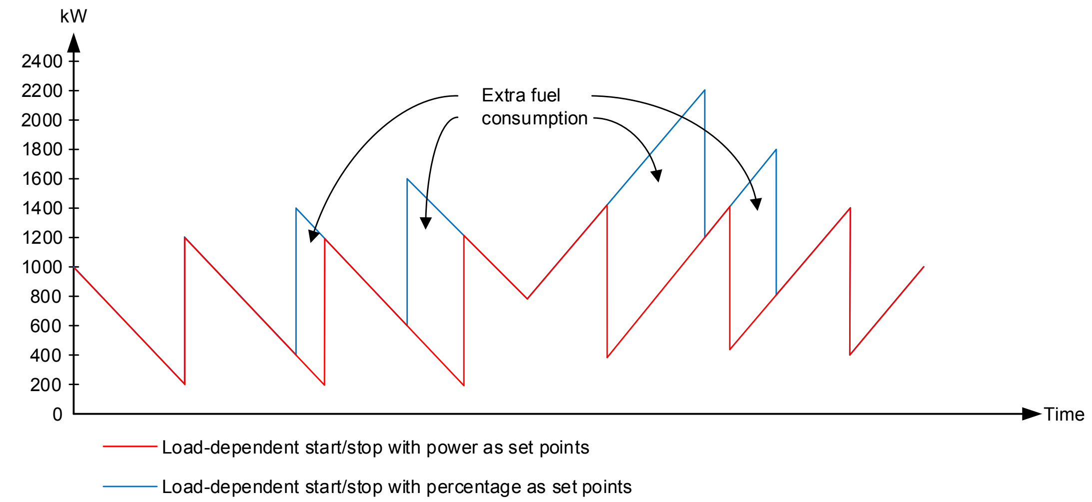
Four gensets with a nominal power of 1000 kW can connect to the same busbar. The start limit is set to 80 %, and the stop limit is set to 60%. If one genset is started, running with the load, the power increases and the load comes higher than 800 kW, the next genset will start (80 %), because the genset 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.

9.7.4 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. As the diagram shows, the more gensets, the more spinning reserve. Also, if the gensets have different rating, it can be an advantage to use the percentage method.
- 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.

In general, a standby power plant should use the percentage method and the prime power plant the value method.

9.7.5 Load-dependent start and stop in island and parallel

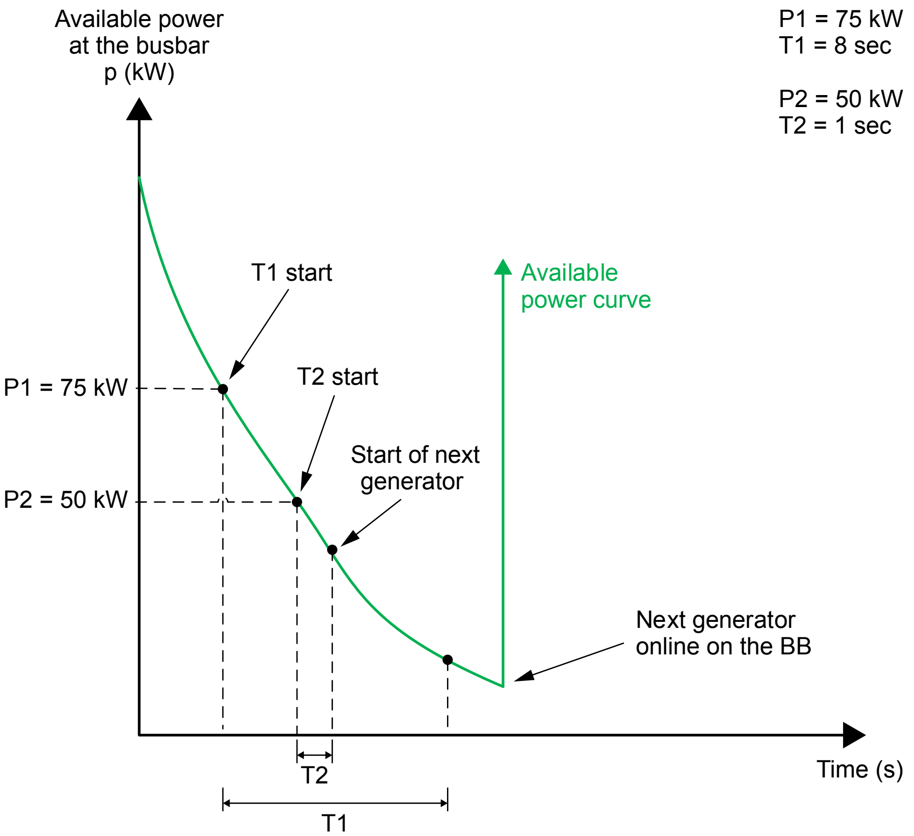
The AGC 150 has two sets of parameters for load-dependent start and stop, which enables the genset to act different on different load curves. For example, if the load increases fast, it is possible to configure a short timer and a low P set point to get the genset online faster without being overloaded. If the load increases at a slower rate, it is possible to use the other set of set points with a longer timer and a higher P.

Both parameter sets are always active, when set 2 is enabled. When the available power has reached the set point, the timer starts, and when the timer runs out, the genset starts.

The examples below show available power on the busbar, so the curve goes down when the load increases.

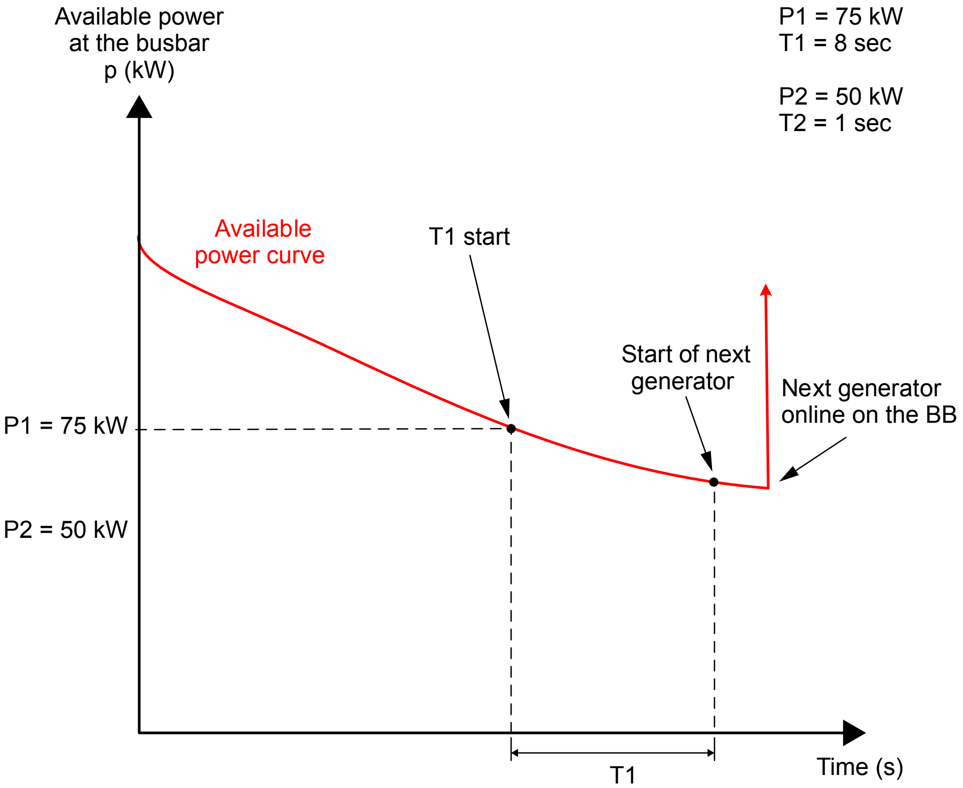
Example 1: Load dependent start

- Timer 1 starts at 75 kW and timer 2 starts at 50 kW.
- Because timer 2 runs out before timer 1, it is timer 2 that starts the genset.



Example 2: Load dependent start

- Timer 1 starts at 75 kW. When timer 1 runs out the genset starts.
- Timer 2 will not start, because the load does not go under 50 kW.



NOTE The examples show load-dependent start. The principle for load-dependent stop is the same.

The AGC 150 can be operated in six different modes, where the Load-dependent start/stop can be used. 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.

Table 9.1 Overview of modes

Island modes	Parallel to the grid modes
Island	Fixed Power
Automatic Mains Failure	Peak Shaving
Load take-over	Mains Power Export

The parameters for Load dependent start 1 are configured under **Settings > Power management > Load dependent start 1**.

Parameter	Text	Range	Default
8001	Start limit P	1 to 20000 kW	100 kW
8002	Start limit S	1 to 20000 kva	100 kva
8003	Start limit %	1 to 100 %	90 %
8004	Start delay timer	0.0 to 990.0 s	10.0 s

The parameters for Load dependent stop 1 are configured under **Settings > Power management > Load dependent stop 1**.

Parameter	Text	Range	Default
8011	Stop limit P	1 to 20000 kW	200 kW
8012	Stop limit S	1 to 20000 kva	200 kva
8013	Stop limit %	1 to 100 %	70 %
8014	Stop delay timer	5.0 to 990.0 s	30.0 s

The parameters for Load dependent start 2 are configured under **Settings > Power management > Load dependent start 2**.

Parameter	Text	Range	Default
8301	Start limit P	1 to 20000 kW	100 kW
8302	Start limit S	1 to 20000 kva	100 kva
8303	Start limit %	1 to 100 %	90 %
8304	Start delay timer	0.0 to 990.0 s	10.0 s
8305	Enable	OFF ON	OFF

The parameters for Load dependent stop 2 are configured under **Settings > Power management > Load dependent stop 2**.

Parameter	Text	Range	Default
8311	Stop limit P	1 to 20000 kW	200 kW
8312	Stop limit S	1 to 20000 kva	200 kva
8313	Stop limit %	1 to 100 %	70 %
8314	Stop delay timer	5.0 to 990.0 s	30.0 s
8315	Enable	OFF ON	OFF

9.8 CAN bus load sharing

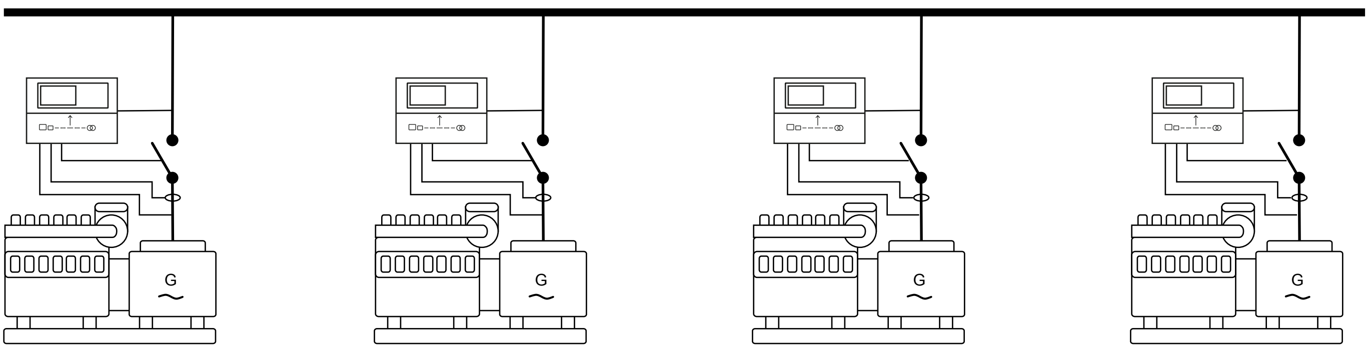
9.8.1 Principles

When the power management communication is running, the load sharing is done via the CAN bus between the controllers.

The AGC 150 can use analogue load sharing instead, if this is 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.

9.8.2 Asymmetrical load sharing in 2-level applications

The AGC 150 can make the gensets load sharing asymmetrically. This means 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 sharing set point is 80 %, the AGC 150 will balance the load between them as below:



P_{NOM} = 1000 kW
Asym. LS set point = 80 %
Priority no. 1
Actual load = 800 kW

P_{NOM} = 1000 kW
Asym. LS set point = 80 %
Priority no. 2
Actual load = 800 kW

P_{NOM} = 1000 kW
Asym. LS set point = 80 %
Priority no. 3
Actual load = 800 kW

P_{NOM} = 1000 kW
Asym. LS set point = 80 %
Priority no. 4
Actual load = 800 kW

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.

Configure the parameters under **Settings > Power management > Asymmetric loadshare**.

Parameter	Text	Range	Default
8281	Value	1 to 100 %	80 %
8282	Enable	OFF ON	OFF

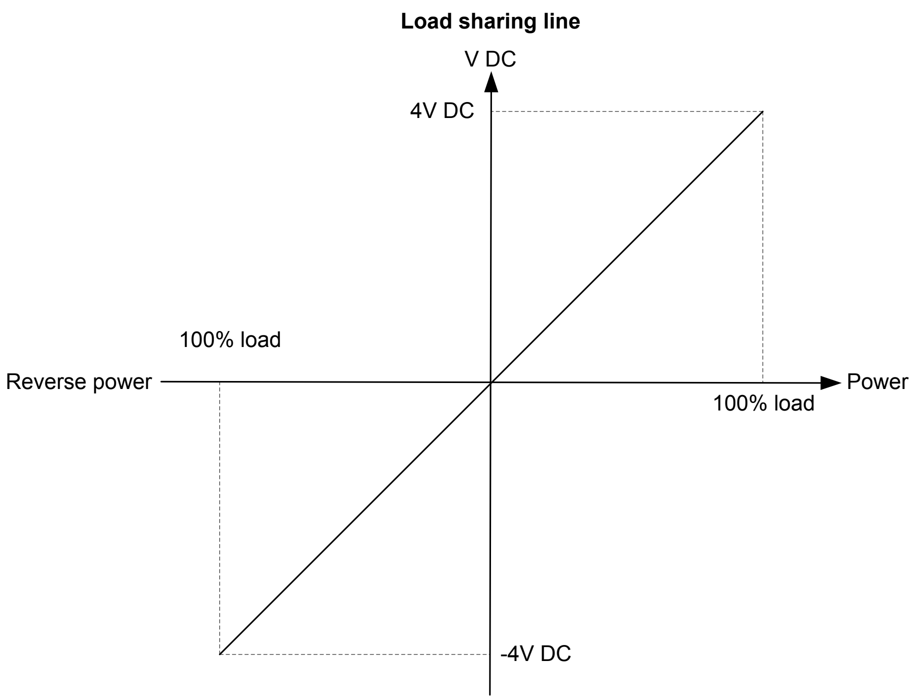
9.9 Analogue load sharing

9.9.1 Principle

The analogue load sharing enables AGC 150 to share the active and the 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 %, 0 V DC is sent to the load sharing line. When the load is 100 %, the voltage will be 4 V 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.

9.9.2 Working principle

The controller will supply a voltage on the load sharing line equal to the actual load. This voltage comes from an IOM 230 (or external module). 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 IOM 230 (or external module), the controller will increase the load in order to match the voltage on the load sharing line.

If the measured voltage is lower than the voltage from the IOM 230 (or external module), the controller will decrease the 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 IOM 230 (or external module), if two or more controllers are connected to the load sharing line.

When the AGC is running in a stand-alone application, the load sharing 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 sharing line to keep the frequency regulator active. To disable the load sharing line, use the M-Logic category output/inhibits in the 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 CAN bus communication as the primary choice, but if a CAN bus 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 %	4 V DC
Generator 2	0 %	0 V DC

The voltage level on the load sharing line can be calculated to: U_{LS}: (4 + 0) / 2 = 2.0 V DC

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

The new load sharing situation will be:

Generator	Actual load	Voltage on load sharing line
Generator 1	50 %	2.0 V DC
Generator 2	50 %	2.0 V 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	2.0 V DC
Generator 2	100 kW	50 kW	2.0 V DC

Both generators are supplying 50 % of their nominal power.

9.9.3 Analogue load sharing type

AGC 150 can be adjusted to work with different types of load sharing modules and ranges of the load sharing signal.

The signal level is used to adjust the maximum output of the load sharing lines. The default range is 0-4 V DC, and therefore 4 V DC is the voltage applied to the load sharing line at 100 % load. If the AGC 150 is interfacing to another product with a different max. range, the set point can be changed in parameter 6392. To be able to adjust the max. range the parameter 6391 must be set to Adjustable.

Configure the Analogue load share under **Settings > I/O settings > External I/O > IOM 2x0 > Analogue loadsharing > Analog loadshare**.

Parameter	Text	Range	Default
6391	Type	Adjustable Selco T4800 Cummins PCC Woodward SPM-11	Adjustable
6392	Set point	1.0 to 5.0 V	4.0 V

When either Selco T4800, Cummins PCC or Woodward SPM-11 is selected, the adjustable range is ignored. AGC 150 to modify the signal level of the load sharing lines to adapt to the specific brand of controller/load sharing unit.

Selco T4800 load sharer

The signal level is ±1 V DC, so the AGC 150 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.

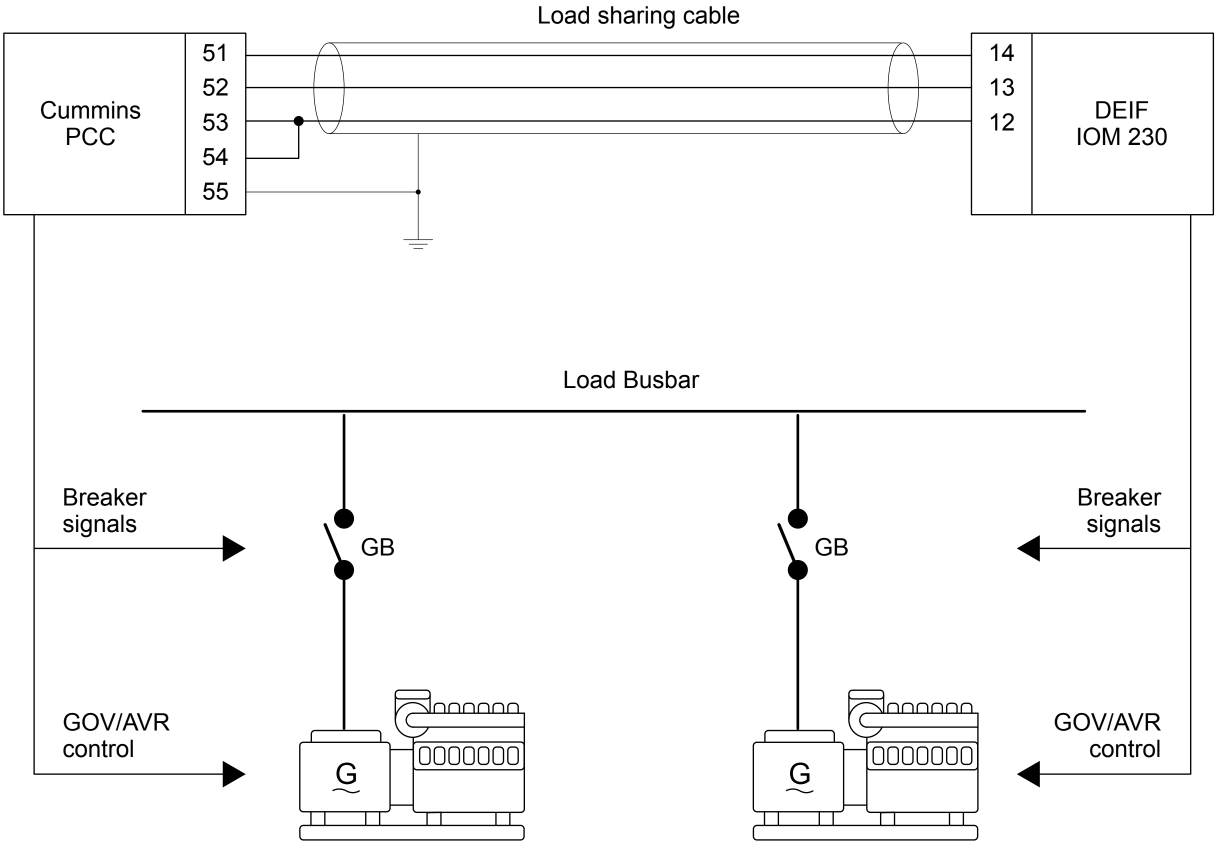
Cummins PCC 3100 and 3201

The signal level is 0.3 to 2.1 V DC, so the AGC 150 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

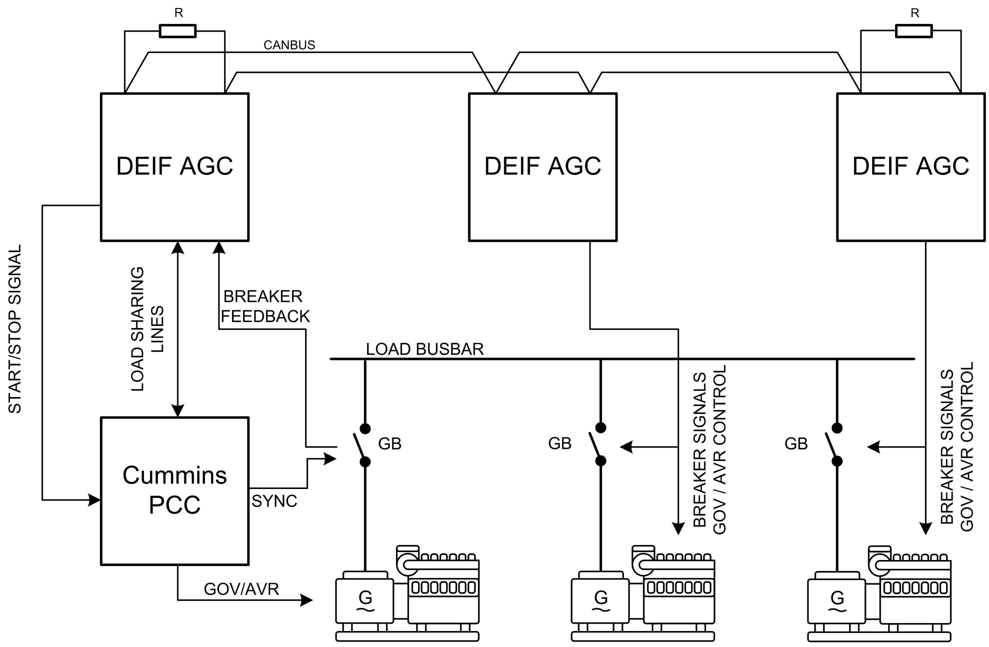
When AGC 150 is being used, it is possible to interface directly with the PCC using the terminal numbers as mentioned above.

Figure 9.3 PCC interface to AGC 150



PCC in DEIF power management system

Notice that if the AGC 150 is part of a power management system, it is possible to enable the analogue load sharing lines in M-Logic by activating the command Use Ana LS instead of CAN. If the CAN bus communication is used for load sharing, the analogue LS line is still updated, so the Cummins PCC will be able to adjust the load level according to the load level of the controller. This is useful if the controller is placed on all gensets only sending start and stop commands to the PCC. This means that the Cummins ILSI unit is not necessary.



9.10 Priority selection

9.10.1 Principle

An important part of the power management system is the priority selection. With prioritisation 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 set to letting the power management system do the prioritisation automatically.

Configure the Priority selection under **Settings > Power management > Priority > Type**.

Parameter	Text	Range	Default
8031	Type	Manual abs. Running hours abs. Fuel optimisation Manual rel. Running hours rel. Fuel opti. + Run Hrs	Manual abs.

9.10.2 Running hours priority

When parameter 8031 is configured to Running hours priority, AGC 150 automatically updates the priority based on the running hours of each genset.

It is possible to configure:

- How often the AGC 150 should make new prioritisations.
- The running hours type
  - Total (the genset's total running hours)
  - Trip (running hours after the latest reset in parameter 8113)
  - Load profiled (the prioritisation based on previous load profiles)*

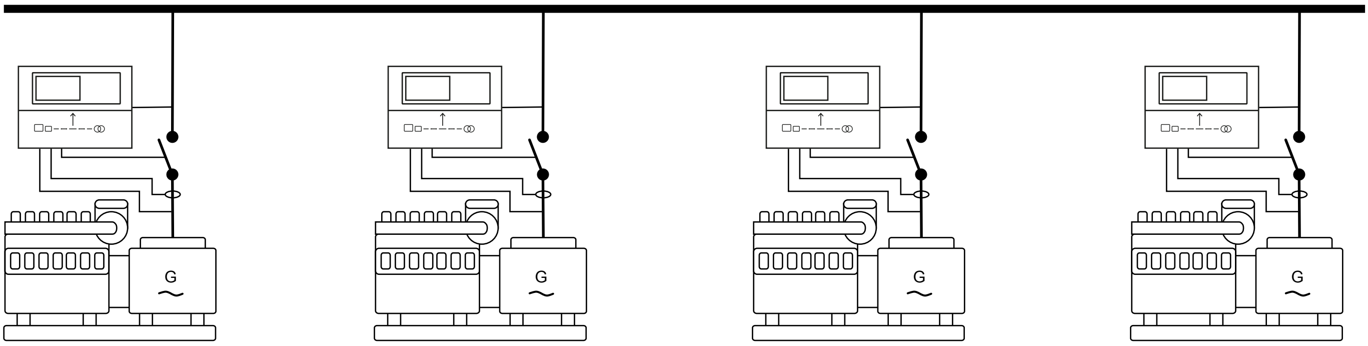
*The prioritisation is based on how loaded each genset has been.

Configure the parameters for Running hours priority under **Settings > Power management > Priority > Running hours**.

Parameter	Text	Range	Default
8111	Running hours	1 to 20000 h	175 h
8112	Running hours type	Total Trip Load profiled	Trip
8113	Rel. counter reset	OFF ON	OFF

9.10.3 Fuel optimisation

Parameter 8031 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:



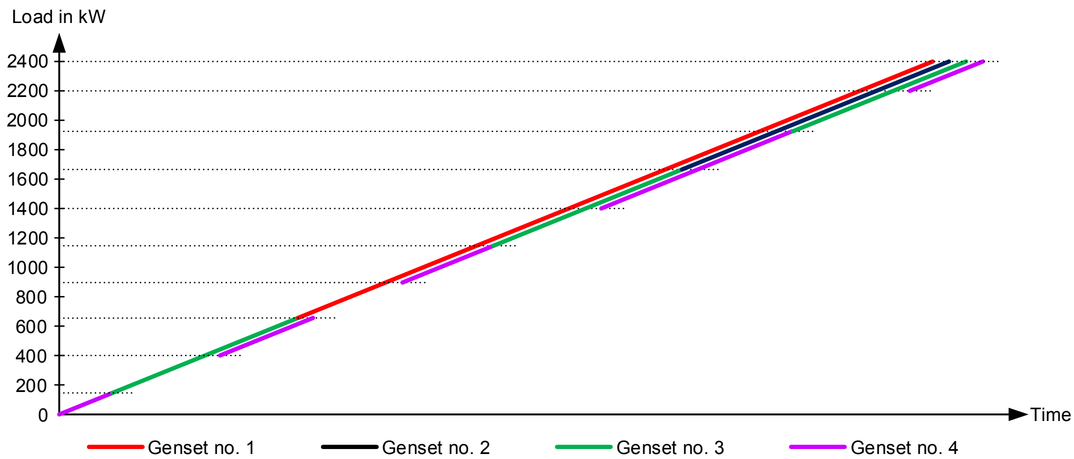
Genset no. 1
P nominal = 1000 kW

Genset no. 2
P nominal = 800 kW

Genset no. 3
P nominal = 500 kW

Genset no. 4
P nominal = 250 kW

Above is shown an example with four gensets with different nominal powers. Fuel optimisation is activated, so there are no priorities. The AGC 150 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 load sharing, or normal load sharing.

9.10.4 Manual selection from parameters

In parameters 8106 and 8321 to 8343 it is possible to make the priorities for all the gensets in a 2-level application, or 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, the controller must be configured for Manual Priority.

Set AGC 150 to Manual priority under **Settings > Power management > Priority > Type**.

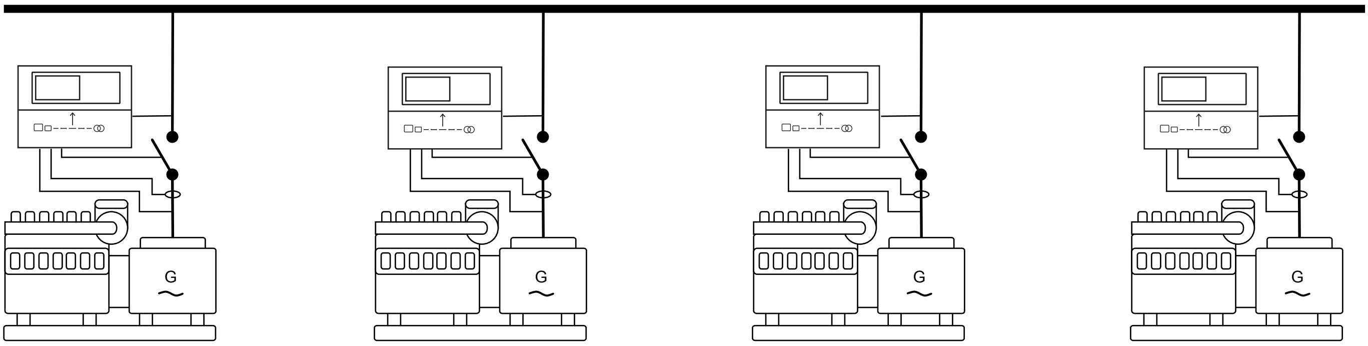
Parameter	Text	Range	Default
8031	Priority selection type	Manual abs. Running hours abs. Fuel optimisation Manual rel. Running hours rel. Fuel opti. + Run Hrs	Manual abs.

Configure the Manual priorities under **Settings > Power management > Priority > Manual**.

Parameter	Text	Range	Default
8086	Transmit	OFF Manual update Running hour update	OFF
8081	P1: Int. comm ID	1 to 32	1
8082	P2: Int. comm ID	1 to 32	2
8083	P3: Int. comm ID	1 to 32	3
8084	P4: Int. comm ID	1 to 32	4
8085	P5: Int. comm ID	1 to 32	5
8091	P6: Int. comm ID	1 to 32	6
8092	P7: Int. comm ID	1 to 32	7
8093	P8: Int. comm ID	1 to 32	8
8094	P9: Int. comm ID	1 to 32	9
8095	P10: Int. comm ID	1 to 32	10
8096	P11: Int. comm ID	1 to 32	11
8101	P12: Int. comm ID	1 to 32	12
8102	P13: Int. comm ID	1 to 32	13
8103	P14: Int. comm ID	1 to 32	14
8104	P15: Int. comm ID	1 to 32	15
8105	P16: Int. comm ID	1 to 32	16
8106	P17: Int. comm ID	1 to 32	17
8321	P18: Int. comm ID	1 to 32	18
8322	P19: Int. comm ID	1 to 32	19
8323	P20: Int. comm ID	1 to 32	20
8324	P21: Int. comm ID	1 to 32	21
8325	P22: Int. comm ID	1 to 32	22
8326	P23: Int. comm ID	1 to 32	23
8331	P24: Int. comm ID	1 to 32	24
8332	P25: Int. comm ID	1 to 32	25
8333	P26: Int. comm ID	1 to 32	26
8334	P27: Int. comm ID	1 to 32	27
8335	P28: Int. comm ID	1 to 32	28
8336	P29: Int. comm ID	1 to 32	29
8341	P30: Int. comm ID	1 to 32	30
8342	P31: Int. comm ID	1 to 32	31
8343	P32: Int. comm ID	1 to 32	32

Example

In this example the priority 1 to 4 is set.



CAN ID = 1
Priority = 1
Priority after transmit = 2

CAN ID = 2
Priority = 2
Priority after transmit = 3

CAN ID = 3
Priority = 3
Priority after transmit = 4

CAN ID = 4
Priority = 4
Priority after transmit = 1

ID 1 has the priority 1, ID 2 has the priority 2, and so on. The operator then changes the priority configuration:

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

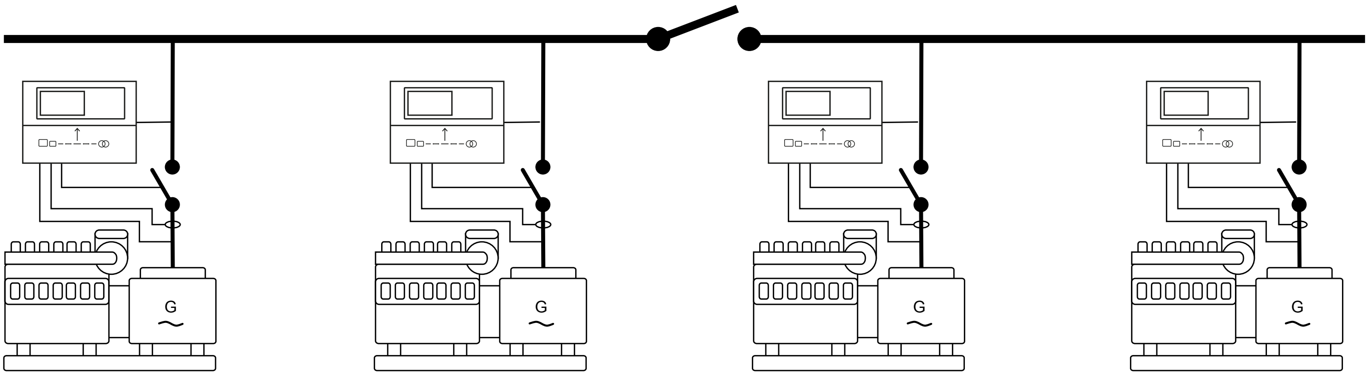
With the new setting ID 4 has priority 1, ID 1 has priority 2, and so on. The operator can now set parameter 8086 to ON, and the new priority will be transmitted to all controllers. After the transmission the parameter 8086 automatically changes to OFF.

9.10.5 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).

9.10.6 Priorities in applications with BTBs

If the AGC 150 is located in an application with BTBs, the priorities will be remembered across the BTBs. This is best explained by an example:



Priority, closed BTB = 1
Priority, open BTB = (1)

Priority, closed BTB = 3
Priority, open BTB = (2)

Priority, closed BTB = 2
Priority, open BTB = (1)

Priority, closed BTB = 4
Priority, open BTB = (2)

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.

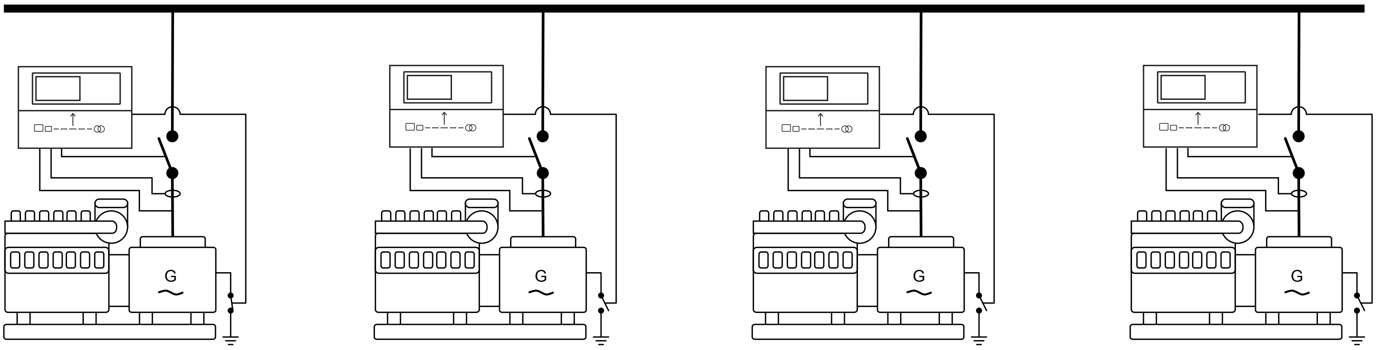
Parameter	Text	Range	Default
8031	Priority selection type	Manual abs. Running hours abs. Fuel optimisation	Manual abs.

Parameter	Text	Range	Default
		Manual rel. Running hours rel. Fuel opti. + Run Hrs	
8081	Priority 1	PM CAN ID 1 to ID 32	PM CAN ID 1
8082	Priority 2	PM CAN ID 1 to ID 32	PM CAN ID 2
8083	Priority 3	PM CAN ID 1 to ID 32	PM CAN ID 3
8084	Priority 4	PM CAN ID 1 to ID 32	PM CAN ID 4
8085	Priority 5	PM CAN ID 1 to ID 32	PM CAN ID 5
8086	Transmit the priorities	OFF Manual update Running hour update	OFF
8111	Running hours update	1 to 20000 h	175 h
8112	Running hours type	Total Trip Load profiled	Total
8113	Trip counter	OFF ON	OFF

9.11 Ground relay

9.11.1 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:



CAN ID = 1
Priority = 1
Nom. power = 1000 kW

CAN ID = 2
Priority = 2
Nom. power = 1000 kW

CAN ID = 3
Priority = 3
Nom. power = 500 kW

CAN ID = 4
Priority = 4
Nom. power = 500 kW

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.

INFO
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 150 is operated in SEMI-AUTO 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.

9.11.2 Configuration of the ground relay

To make the ground relay function work correctly, all the gensets need to have an earth connection.

Configure the Ground relay under **Settings > Power management > Ground relay > Ground relay**.

Parameter	Text	Range	Default
8121	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
8122	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
8123	Enable	OFF ON	OFF
8124	Timer	1.0 to 30.0 s	1.0 s
8125	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Trip GB
8126	Ground relay type	Continuous Pulse	Continuous

Configure the Ground breaker settings under **Settings > Power management > Ground relay > Gnd breaker setting**.

Parameter	Text	Range	Default
8151	Ground relay close configuration	Hz/V OK RPM MPU level RPM EIC level Start active	Hz/V OK
8152	Ground relay open configuration	After cooldown After extended stop	After cooldown
8153	Ground relay close RPM	0 to 4000 RPM	1000 RPM

Configure the Ground relay fail timers under **Settings > Power management > Ground relay**.

Parameter	Text	Range	Default
8131	Ground relay open fail timer	1.0 to 30.0 s	1.0 s
8133	Ground relay close fail timer	1.0 to 30.0 s	1.0 s

More information
See **Digital inputs, DI, About digital inputs** in this document for more information about setup of breaker feedback.

9.12 Set points and power across the plant

9.12.1 Power reference scaling

In AGC 150, different power references can be scaled to make it easier and faster to change a power set point.

Configure the scaling for MPE/Peak shaving set points under **Settings > Power set points > MPE/Peak shaving > Day/Night power set**.

Parameter	Text	Range	Default
7006	MPE/Peak shaving reference scaling	1 kW: 1 kW 1 kW : 10 kW 1 kW : 1000 kW 1 kW: 1000 kW	1 kW: 1 kW

Configure the scaling for Load dependent start/stop under **Settings > Power management > Load dep Strt/Stp conf**.

Parameter	Text	Range	Default
8006	Load dependent start/stop reference scaling	1 kW: 1 kW 1 kW : 10 kW 1 kW : 1000 kW 1 kW: 1000 kW	1 kW: 1 kW

9.12.2 Cos phi control in two-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 defines how the AGC 150 should react and what the cos phi should be at the different locations.

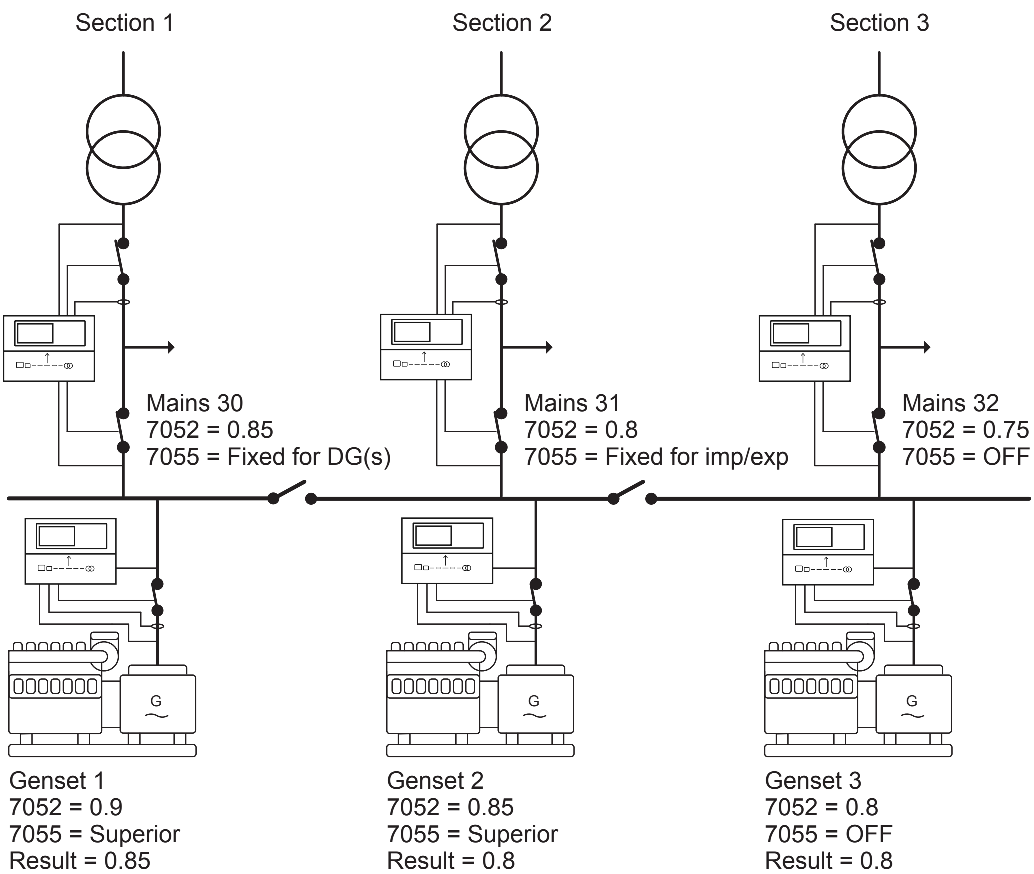
Table 9.2 Settings for cos phi control in a genset controller

Parameter 7055	Notes
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.
Superior (PMS)	Allow the controller placed 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).
Fixed Q (DG parallel)	The controller has a fixed reactive effect (kvar).

Table 9.3 Settings for cos phi control in a mains controller

Parameter 7055	Notes
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.

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



In the drawing above, the cos phi and the setting for parameter 7055 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. In the drawing above, the cos phi and the setting for parameter 7055 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 7055 is set to superior. This means that it allows the controller above to control the cos phi. In the mains controller, parameter 7055 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 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 7055 is set to superior, which means that the genset allows the controller above to decide the cos phi. In the mains controller, parameter 7055 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 7055 was set to OFF, the extra genset will keep the cos phi located in the

controller. The AGC 150 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).

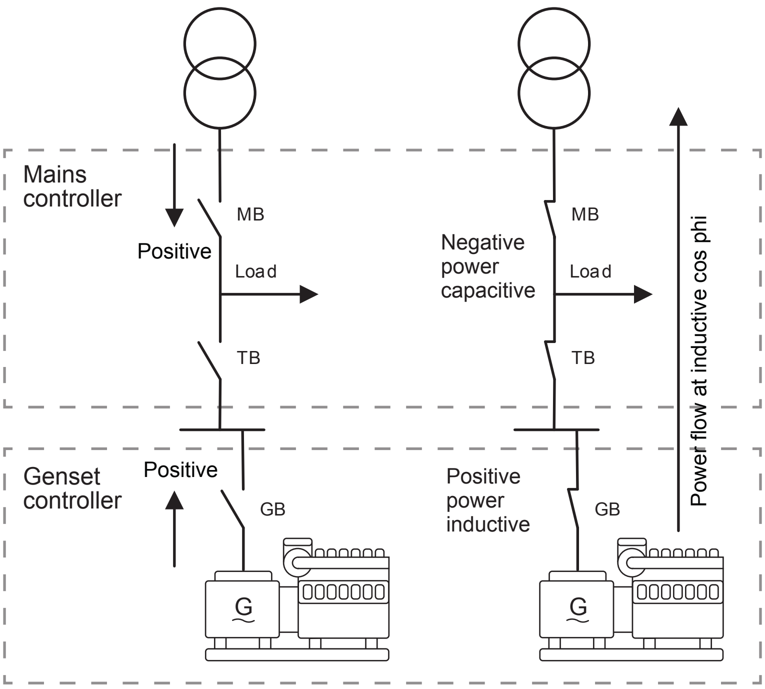
- **Section 3:** In this section, the gensets parameter 7055 is set to OFF. This means that the cos phi set point in the genset will always be the ones set in the gensets, and it will be a cos phi across the generator breaker. So it does not matter what has been set in the mains controller, since the genset will ignore this because it is set to OFF. If there was another genset in this section, and parameter 7055 was set to superior, this cos phi set in the genset controller would still be used, since the mains controller's parameter 7055 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.

9.12.3 Additional information for cos phi control

AGC 150 can measure 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:

Figure 9.4 2-level application



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 7053, 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 7053 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.

Cos phi control - Genset controller in a power management system

Configure the parameters for genset Cos phi control under **Settings > Power set points > Cos phi or Q**.

Parameter	Text	Range	Default
7052	Cos phi set point	0.60 to 1.00	0.90
7053	Type	Inductive Capacitive	Inductive
7054	Reactive power set point	-100 to 100 %	0 %
7055	Power reference location	OFF Superior (PMS) Fixed Q (DG parallel)	Superior (PMS)

Cos phi control - Mains controller

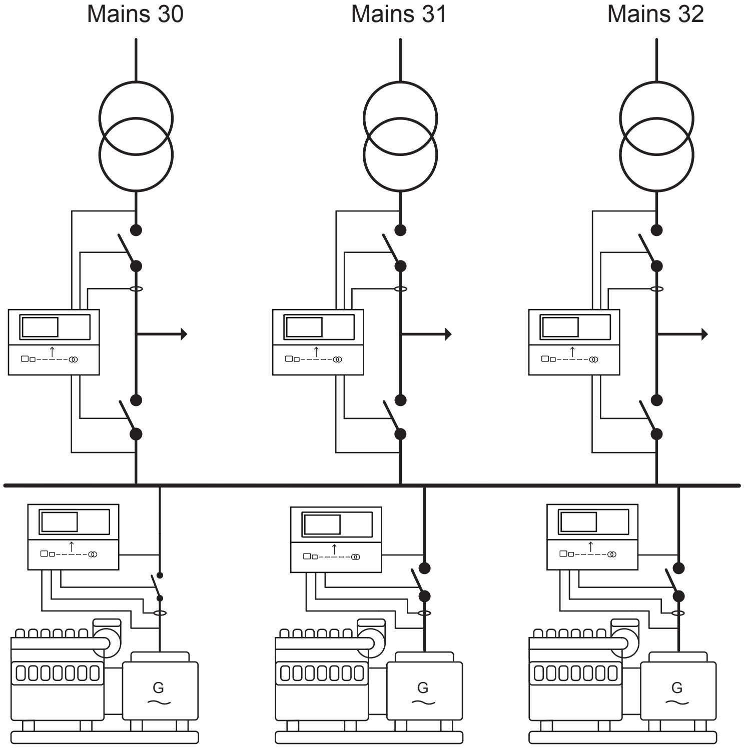
Configure the parameters for mains Cos phi control under **Settings > Power set points > Cos phi**.

Parameter	Text	Range	Default
7052	Cos phi set point	0.60 to 1.00	0.90
7053	Type	Inductive Capacitive	Inductive
7054	Enable	OFF Fixed for DG(s) Fixed for imp/exp	OFF
7055	Scaling	1 kW : 1 kW 1 kW : 10 kW 1 kW : 100 kW 1 kW : 1000 kW	1 kW : 1 kW

9.12.4 Power offset

In the AGC 150, 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.

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. The power set point is determined by the controller with “ID to run” (8186).

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.

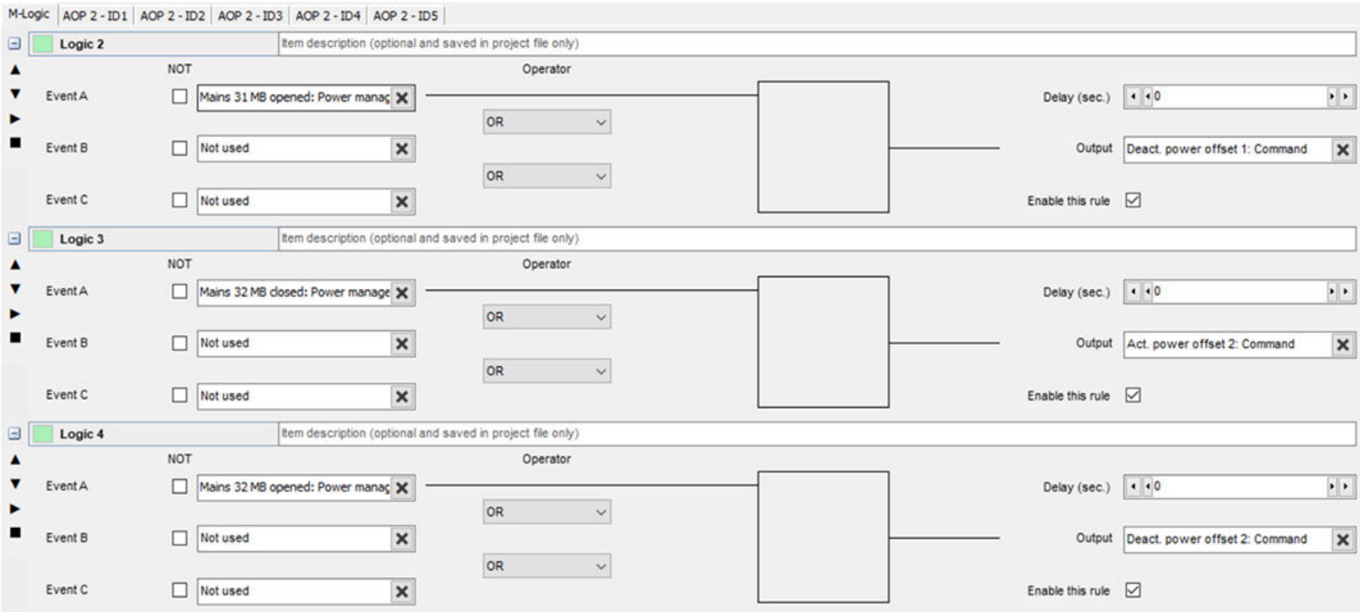
Now some digital inputs can be programmed to the controller with “ID to run”. The power set points in the different situations are wanted like shown below:

- When only MB40 is closed = 1500 kW
- When MB30 and MB31 are closed = 3000 kW
- When MB31, MB31 and MB32 are closed = 4000 kW

The fixed power set point should then be 1500 kW 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 1500 kW, and MB32 is closed, the new set point will be 2500 kW. If MB31 is closed afterwards, the power set point will then be 4000 kW (1500 + 1000 + 1500).

Configure the Power offset under **Settings > Power set points > Offset > Power offset**.

Parameter	Text	Range	Default
7221	Power offset 1 set point	-20000 to 20000 kW	0 kW
7222	Power offset 1 activation	OFF ON	OFF
7223	Power offset 2 set point	-20000 to 20000 kW	0 kW
7224	Power offset 2 activation	OFF ON	OFF
7225	Power offset 3 set point	-20000 to 20000 kW	0 kW
7226	Power offset 3 activation	OFF ON	OFF

9.12.5 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.

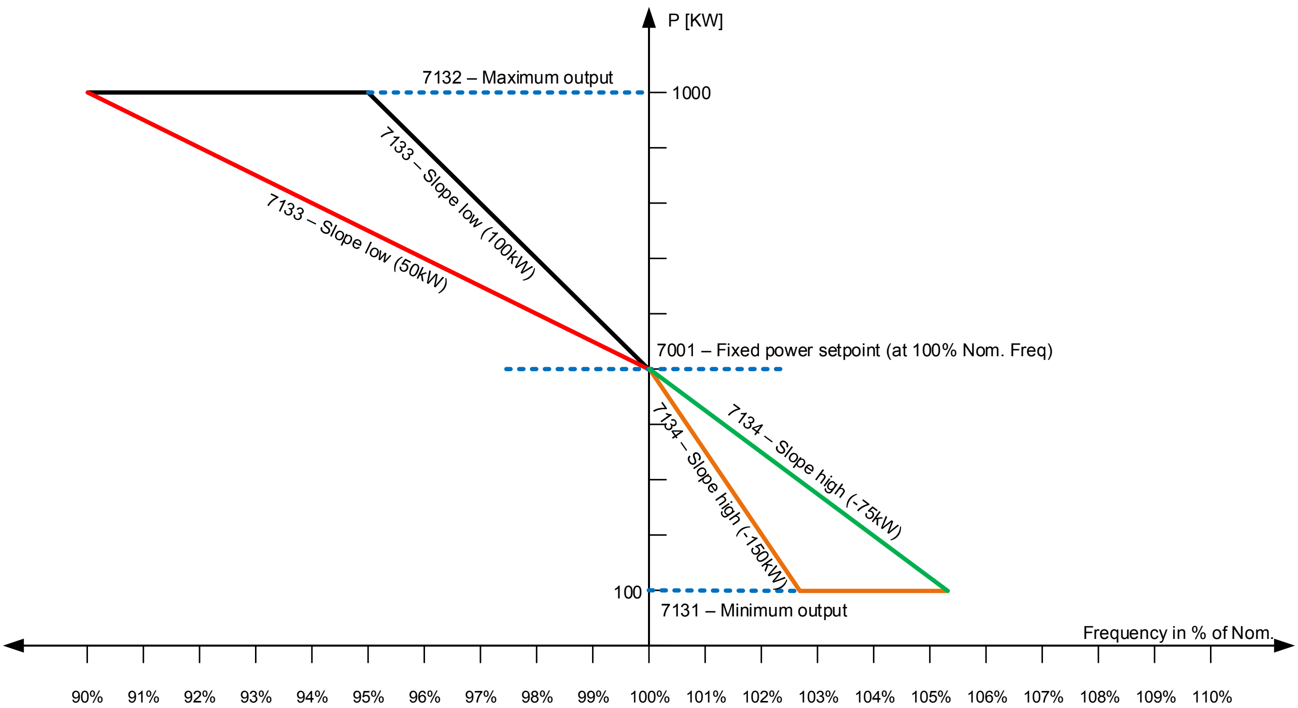
Note that if a positive value is set in the parameters, this value will be added to the cos phi set point. It is not the new cos phi set point, but a value to be added or subtracted.

Configure the parameters for cos phi offset under **Settings > Power set points > Offset > Cos phi offset**.

Parameter	Text	Range	Default
7241	Cos phi offset 1	-0.80 to 0.80	0.00
7242	Cos phi offset 1 activation	OFF ON	OFF
7243	Cos phi offset 2	-0.80 to 0.80	0.00
7244	Cos phi offset 2 activation	OFF ON	OFF
7245	Cos phi offset 3	-0.80 to 0.80	0.00
7246	Cos phi offset 3 activation	OFF ON	OFF

9.12.6 Frequency support/frequency-dependent droop

As the AGC 150 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.

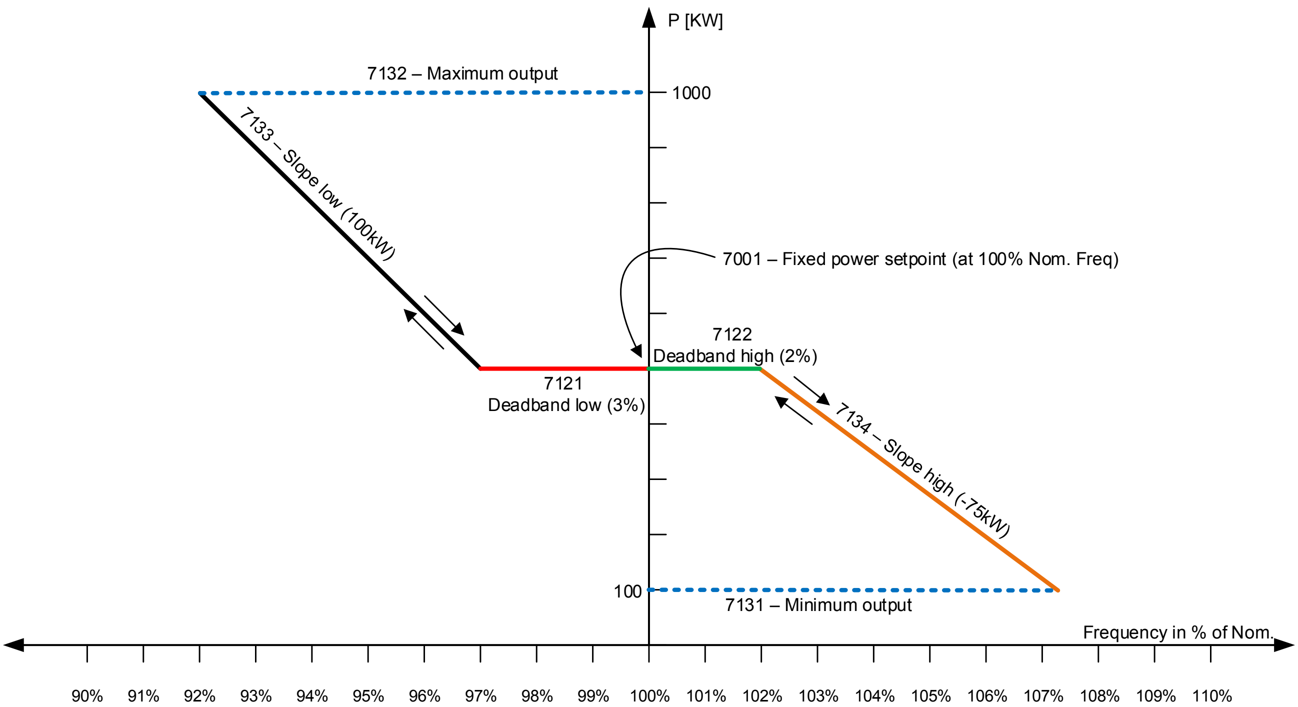


Parameter	Name	Setting	Description
7001	Fixed power set point	50 %/500 kW	Defines the power set point, when the frequency is at nominal.
7131	Minimum output	100 kW	Defines the minimum output of the fixed power. If the minimum is reached, it will flatten out (like the orange curve above).

Parameter	Name	Setting	Description
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).

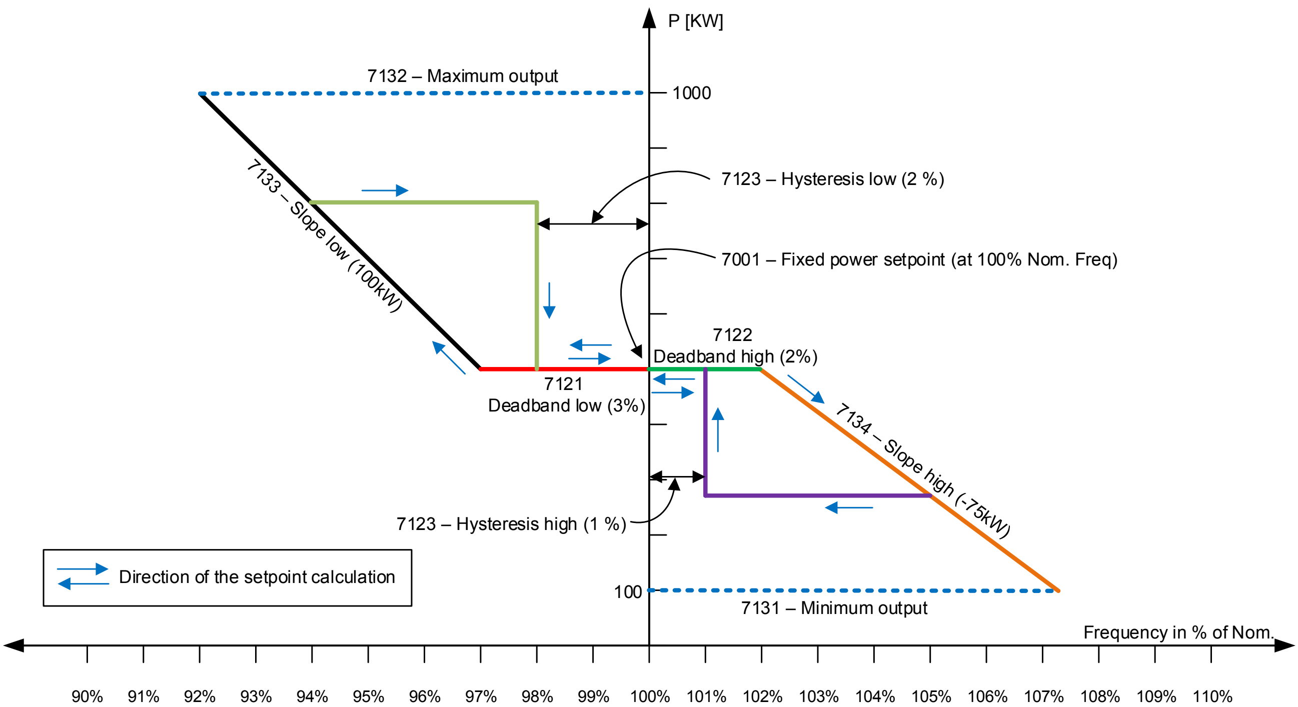


In the diagram above, the hysteresis is also used. The setting for the curve above is shown in the table below:

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 150 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).
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 150 holds two different hysteresis, and these can be set independently of each other. The blue arrows in the diagram show how the AGC 150 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 150 is now using the olive green line. The AGC 150 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.

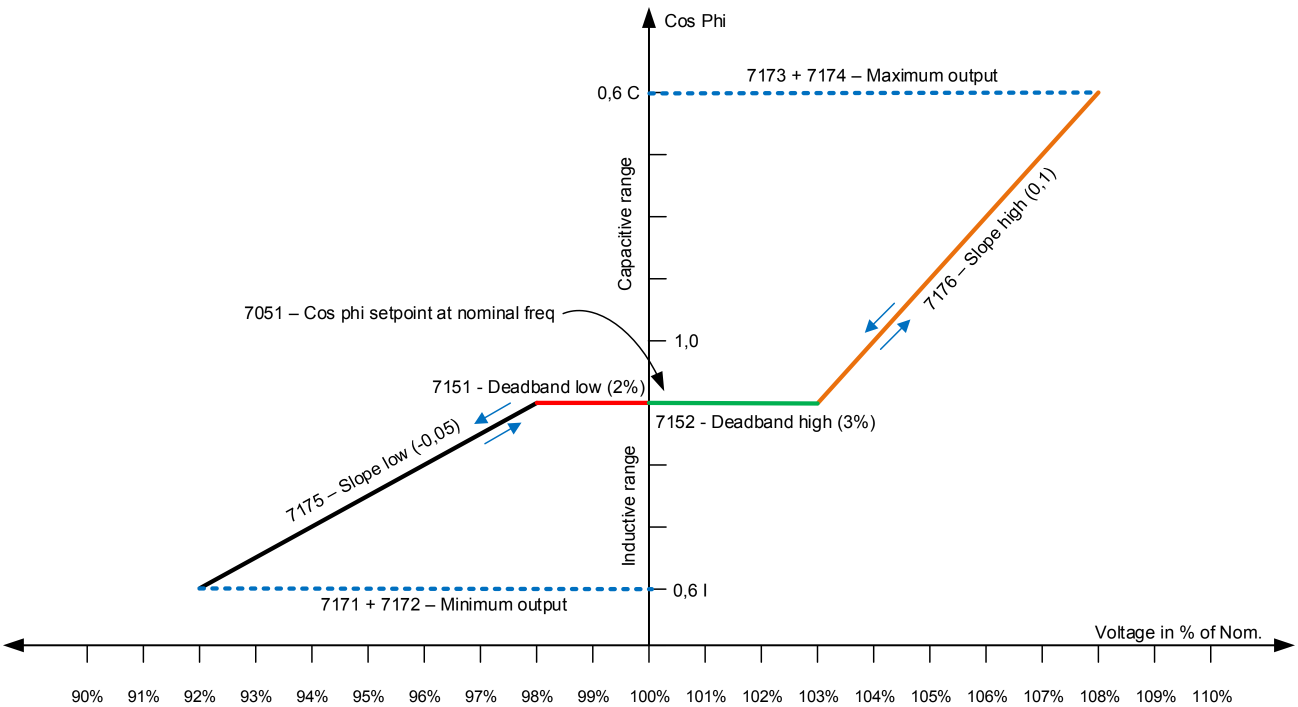
Table 9.4 Parameters for frequency-dependent droop

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

9.12.7 Voltage support/voltage-dependent PF/Q control

As the AGC 150 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 150, it is either set if it should droop on the Q-power or cos phi. The AGC 150 can either be controlled on the cos phi or on the Q-power. The AGC 150 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):



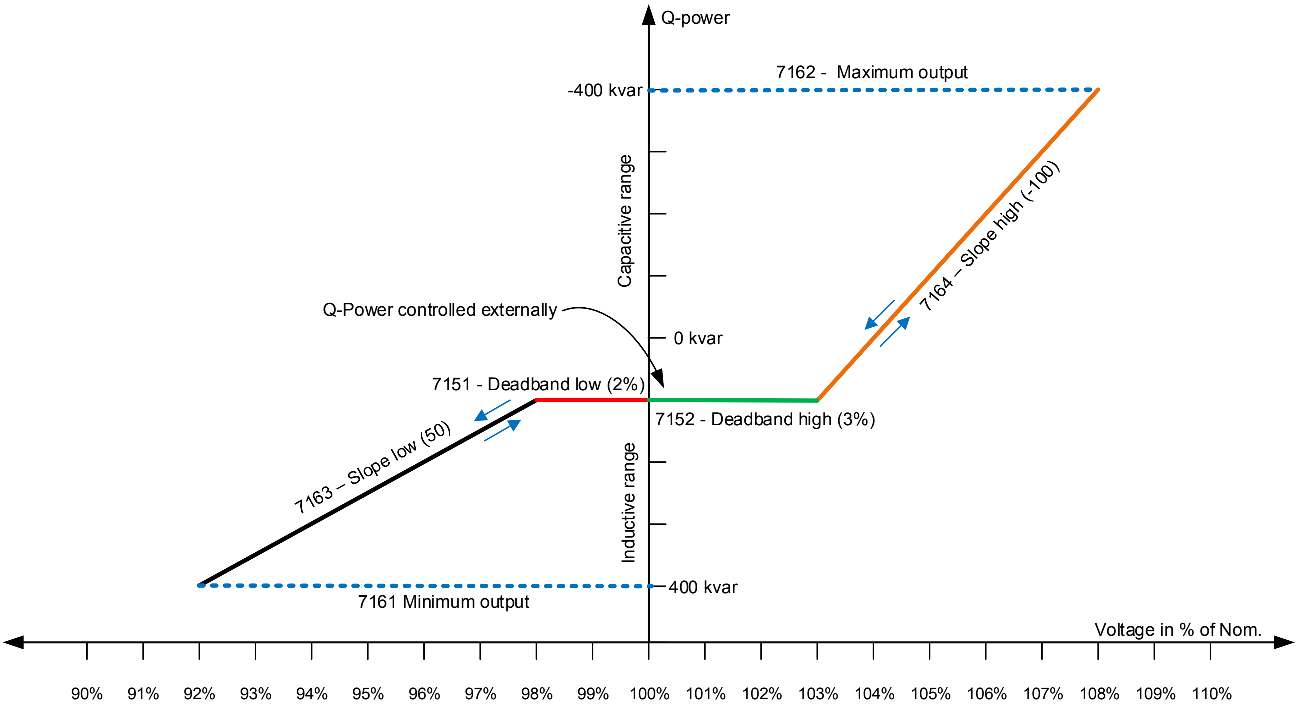
The settings used for making this curve are shown in the table below:

Parameter	Name	Setting	Notes
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.

Parameter	Name	Setting	Notes
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	Notes
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.

Parameter	Name	Setting	Notes
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	Text	Range	Default
7151	Deadband low	0.00 to 99.99 %	2.00 %
7152	Deadband high	0.00 to 99.99 %	2.00 %
7153	Hysteresis low	0.00 % 99.99 %	2.10 %
7154	Hysteresis high	0.00 to 99.99 %	2.10 %
7161	Minimum output of Q-droop	-20000 to 20000 kvar	200 kvar
7162	Maximum output of Q-droop	-20000 to 20000 kvar	480 kvar
7163	Slope low in Q-droop	-20000 to 20000 kvar	50 kvar
7164	Slope high in Q-droop	-20000 to 20000 kvar	-50 kvar
7171	Minimum output of cos phi droop – value	0.10 to 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 to 1.00	1.0
7174	Maximum output of cos phi droop – reference	Inductive Capacitive	Inductive
7175	Slope low in cos phi droop	-1.00 to 1.00	-0.05
7176	Slope high in cos phi droop	-1.00 to1.00	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

9.13 Additional power management functions

9.13.1 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 150 that can help to solve the situation. Instead of the genset stopping shortly afterwards again, the AGC 150 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 controls how long the genset should be running before it is stopped. The 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.

Configure the Stop of non-connected gensets under **Settings > Power management > Load dep Strt/Stp conf > Stop noncon. DG**.

Parameter	Text	Range	Default
8141	Timer	10.0 to 600.0 s	60.0 s

9.13.2 Secured mode in 2-level applications

In the AGC 150, 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, for example if one side of an open BTB is supporting a critical load, and the other side of the BTB is not as critical.

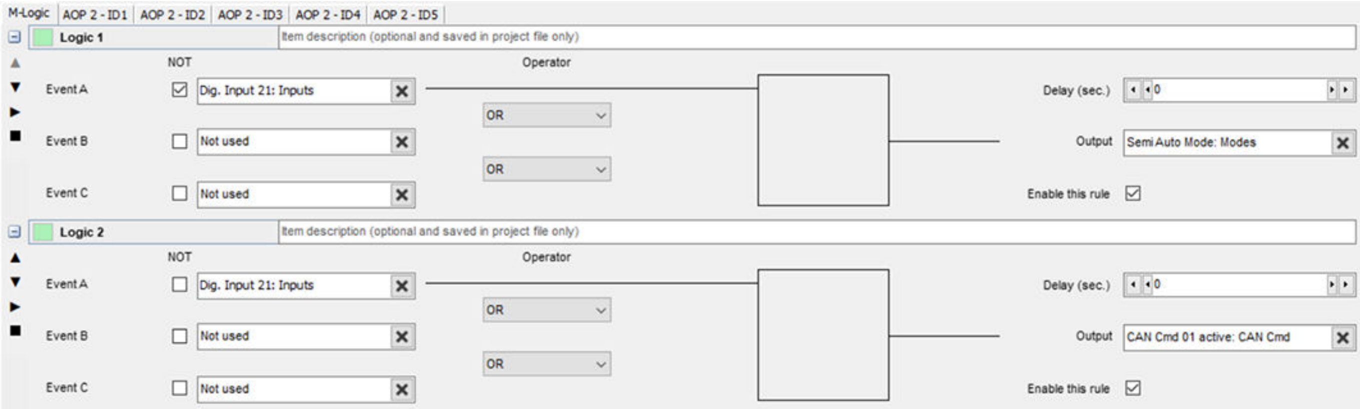
Configure the parameters under **Settings > Power management > Secured mode**.

Parameter	Text	Range	Default
8921	Secured mode	Secured mode OFF Secured mode ON	Secured mode OFF

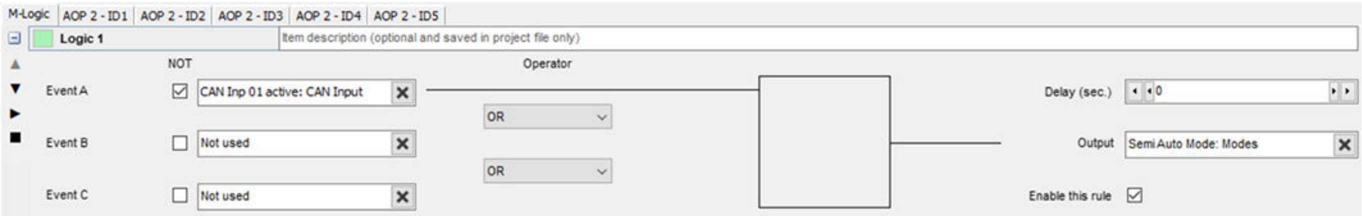
9.13.3 CAN commands in 2-level applications

When the AGC 150 is placed in an application where there is more than one AGC 150 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-AUTO mode, only the specific controller changes to SEMI-AUTO. The operator now wants a button, so if this is pressed, all controllers are changed to SEMI-AUTO. Now a CAN command can be used in M-Logic. If a button is wired to digital input 21 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-AUTO 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. When this CAN command is high, the controllers will change into SEMI-AUTO (when the input is high, it is not possible to change the running mode to AUTO).

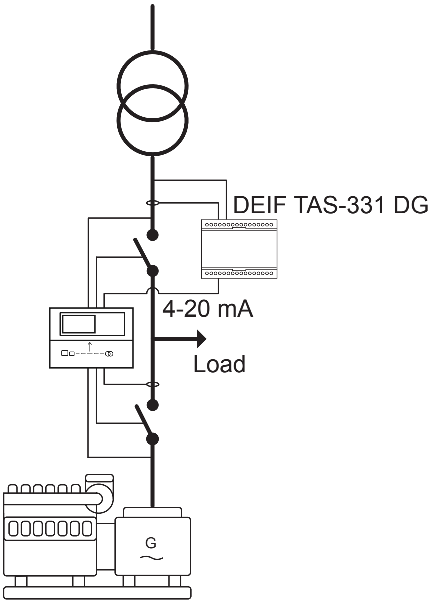
9.14 Power transducers

9.14.1 Principle

The AGC 150 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 150 is that the physical current transformers are placed far away from the AGC 150. 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 150 is shown in the installation instructions chapter. Be aware that mains power transducers have to be wired to multi-input 20, and tie breaker transducers will have to be wired to multi-input 21.

9.14.2 Mains transducer in stand-alone applications

If the AGC 150 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 150 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 20 in this case. The AGC 150 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 150. This is done at parameter 7003 and 7004, where 7003 is how many kW it means when the transducer gives 20 mA, and 7004 is how many kW the transducer measures when it has an output of 4 mA.

9.14.3 Mains transducer in 2-level applications

In 2-level applications, a mains power transducer can also be used.

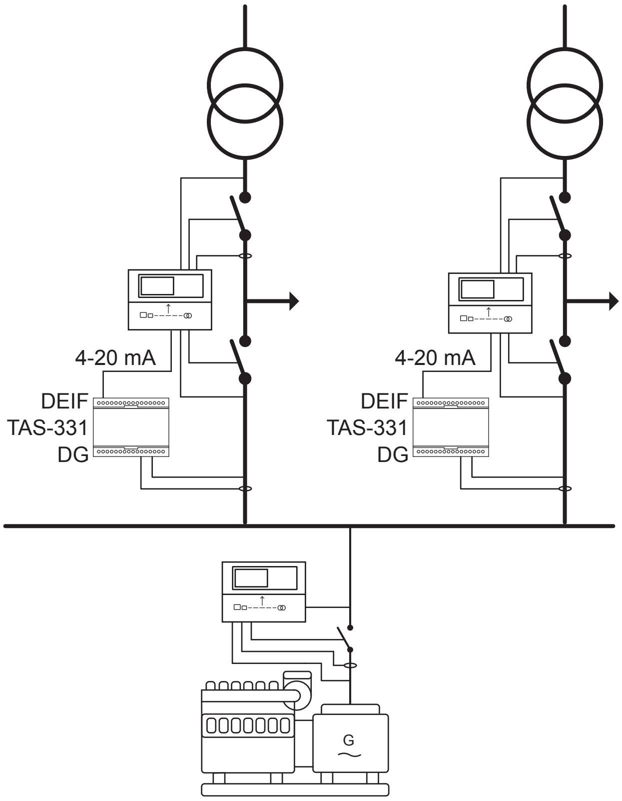
Normally on the mains controllers, the current and voltage inputs are used, and by this a power is calculated. But if the current transformers are placed far away from the AGC 150 mains controller, a transducer can be used instead.

AGC 150 uses voltage measurements for synchronising the breakers. If a transducer is used for mains power measurement, it must be wired to multi-input 20. When the transducer has been wired to multi-input 20, 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 7003 and 7004. In parameter 7003, it is set how many kW the 20 mA signal equals, and in parameter 7004 it is set how much 4 mA is in kW.

In 2-level applications, it is possible to have just one mains 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.

9.14.4 Tie breaker power transducer in 2-level applications

In 2-level applications with tie breakers, the AGC 150 can be configured so there is a power measurement across the tie breaker. With a TB power measurement, the AGC 150 is able to de-load the TB before it is opened. This can be a good idea in applications like the one below:



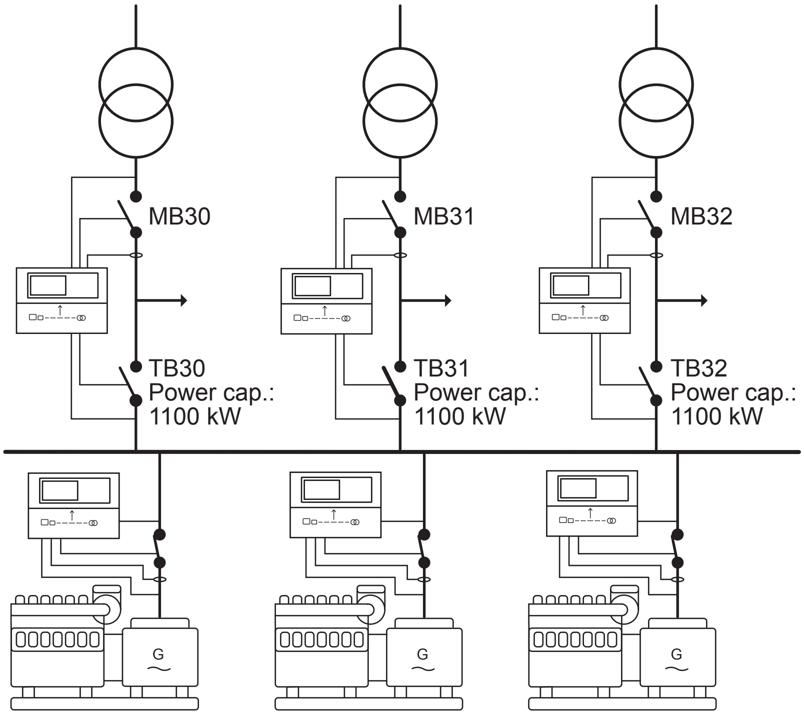
The application consists of two mains controllers, with TB power measurements, and a genset. If the genset works as backup power at mains failures, the genset can be in a situation where it is carrying all the load (grid fail). If the mains power comes back again, the AGC 150 can back-synchronise the 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 150 is able to de-load the TB before it is opened. Afterwards, it will close the other MB, and then de-load the generator breaker. In the application above, all the powers across the breakers are known, so the AGC 150 is able to de-load all breakers before they are opened.

To set up the TB power transducer correctly, it is required that it is wired to multi-input 21, 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 150 is programmed from parameters 8271 and 8272. In parameter 8271, it is set how much 20 mA equals and in 8272 it is set how much 4 mA is in kW.

9.15 Tie breaker functions

9.15.1 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 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, for example if the power capacities are set so high that they cannot be fulfilled, or if a genset is having start failure.

NOTE Make sure that power capacity is active in all plant modes!

The sequence in how the TBs should close can be changed in the AGC 150. 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.

The multi-start settings must be adjusted to have enough gensets starting. The default setting is Auto calculate, which can be changed to for example start of 32 gensets.

Configure the Power capacity under **Settings > Breakers > Tie breaker > Power capacity**.

Parameter	Text	Range	Default
8192	Power capacity	1 kW to 20000 kW	50 kW

9.15.2 Tie breaker power capacity overrule in 2-level applications

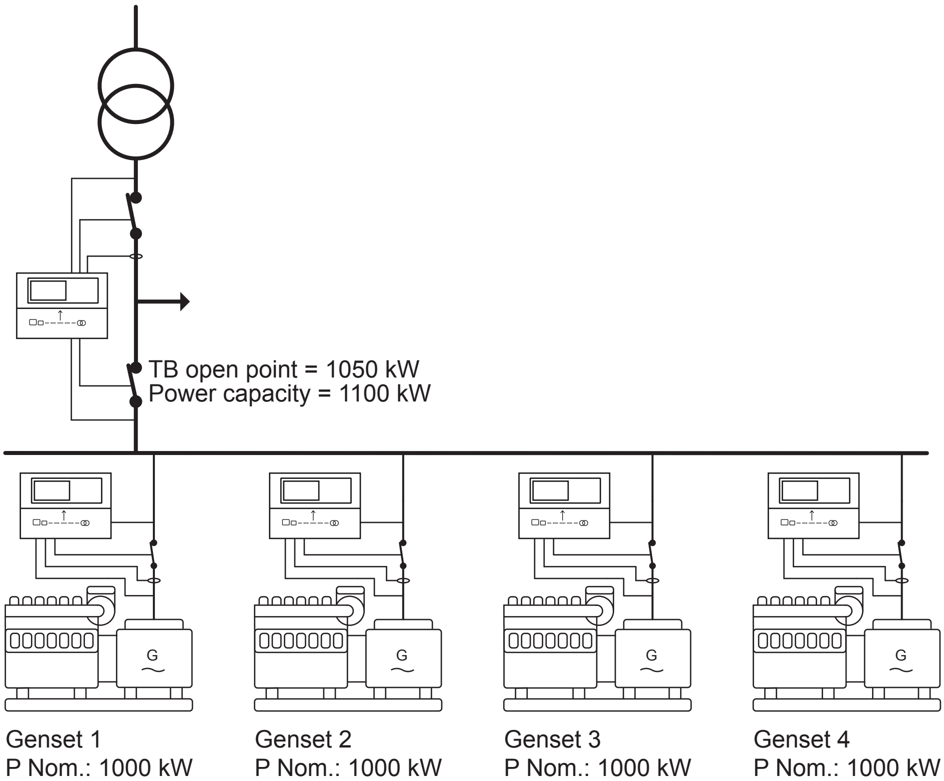
If the power capacity function is used, an overrule function can be handy in some fail scenarios. If for instance a genset does not start, or the emergency stop is pressed, the sequence can move on. The overrule function is made so the power capacity value may not be present at a certain time, but a 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.

Configure the Power capacity under **Settings > Breakers > Tie breaker > Power capacity**.

Parameter	Text	Range	Default
8193	Overrule timer	0.0 to 999.9 s	30.0 s
8194	Enable	OFF ON	OFF

9.15.3 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 150 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 for example can be caused by 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.

Configure the Tie breaker open point under **Settings > Breakers > Tie breaker > Breaker configuration**.

Parameter	Text	Range	Default
8191	TB open point	0 to 20000 kW	50 kW

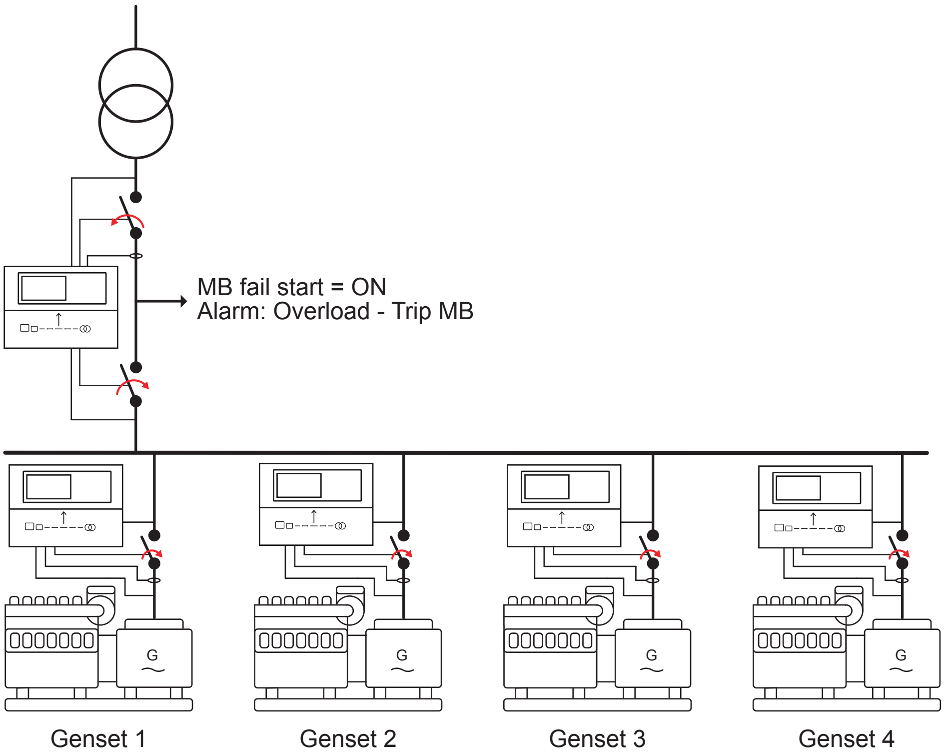
9.16 Multi-mains systems

9.16.1 MB fail start in 2-level applications

The AGC 150 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 for example be caused by 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.

NOTE When the MB fail start is enabled, Mode shift is automatically set to ON.

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), de-load the breakers and stop. If the mains controller will have the alarm once again during the de-load 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 de-load sequence, the gensets will take the load, and continue to supply the load until the alarm is acknowledged once again.

Configure the MB fail start under **Settings > Mains > AMF functions > Start seq. in AMF mode**.

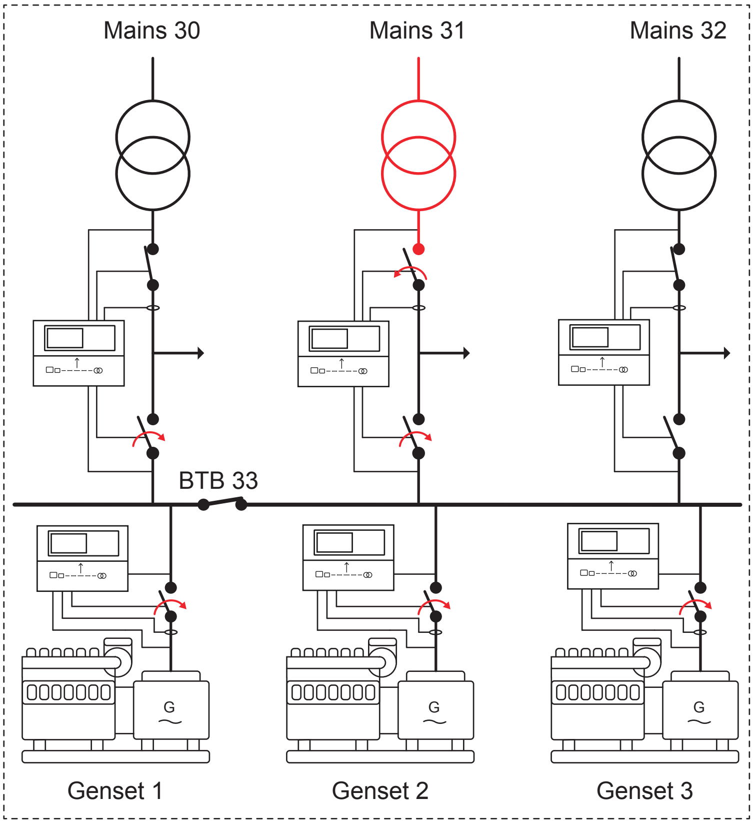
Parameter	Text	Range	Default
8181	MB fail. start	OFF ON	OFF

9.16.2 Auto switch in 2-level applications

The AGC 150 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 8184.

OFF

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

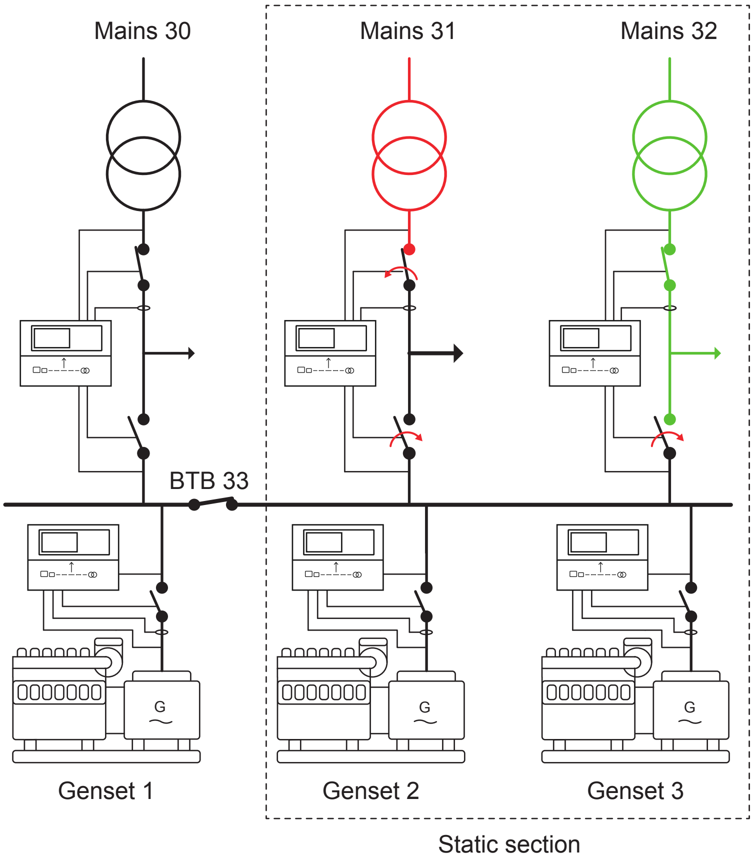


Dynamic section

In the application above, the auto switch function is disabled/set to OFF, so the AGC 150 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 150 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:

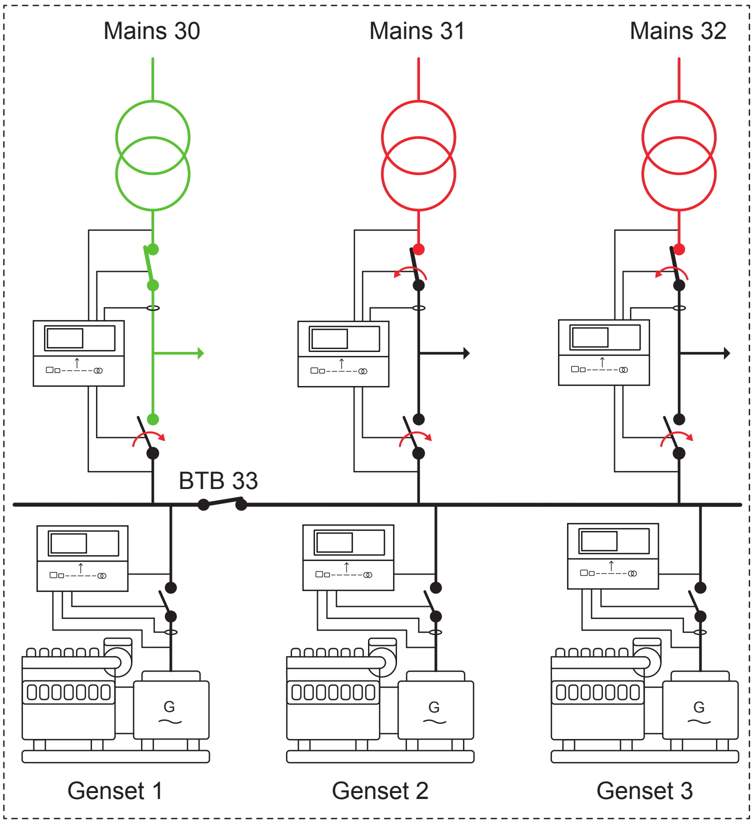


When the grid at mains 31 is failing, the AGC 150 has been allowed to use another mains as backup. In this case, the AGC 150 has been set for static section, which means it is allowed to use mains 32 as backup, since it is located in the same static section. TB32 will be closed, and afterwards TB31 will 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 150 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 150 will seek out to use Mains 32 as backup feeder. If Mains 32 fails afterwards, the AGC 150 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.

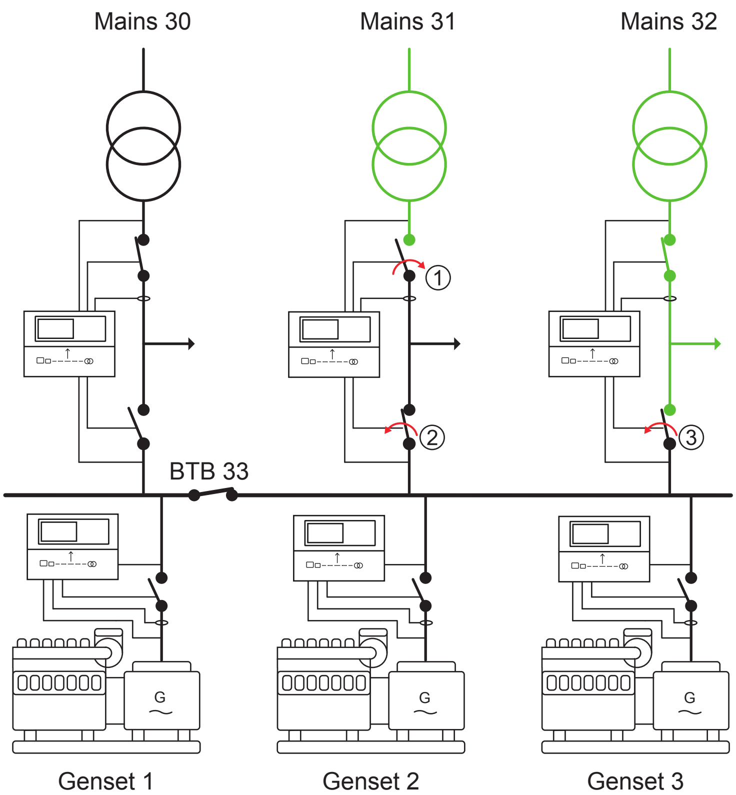
If the setting is Dynamic section, Mains 30 can be used because the BTB is closed. If the BTB was open, the gensets 2 and 3 would be started to supply the load. If the mains failure on Mains 31 and Mains 32 persists and the genset feeds the load, then be careful about closing the BTB. This is because if the BTB is closed, the dynamic section expands to include the section of Mains 30, Mains 31 and Mains 32, and then the conditions of the auto switch is fulfilled so the Mains 30 will feed the loads of Mains 31 and Mains 32, and the gensets will be stopped. Therefore, be sure that Mains 30 can handle the load level if the BTB is closed.

Configure the Auto switch under **Settings > Power management > Plant operating set.**.

Parameter	Text	Range	Default
8184	Auto switch	OFF Static section Dynamic section All sections	OFF

9.16.3 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.

Configure No break transfer under **Settings > Power management > Plant operating set.**.

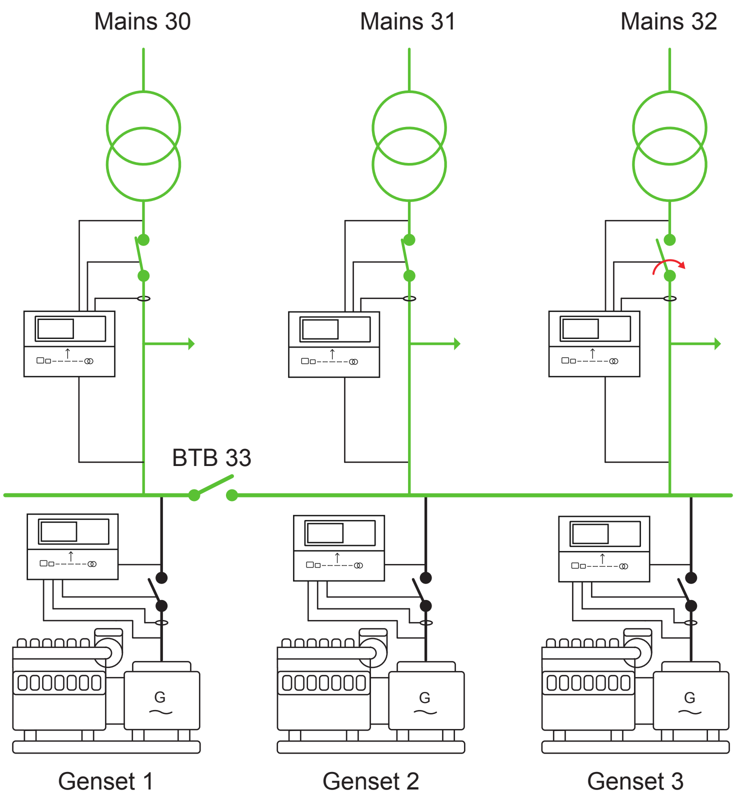
Parameter	Text	Range	Default
8183	No break transfer	OFF ON	OFF

9.16.4 Parallel in 2-level applications

The parallel function in the AGC 150 allows mains feeders to be long-time parallel. This function is intended to be used when the AGC 150 is in applications where the mains feeders can be long-time parallel. It could for example be mains power export or in applications, where there are no tie breakers.

NOTE When MB fail start is enabled, Mode shift is automatically set to ON.

An application with no tie breakers could look like this:



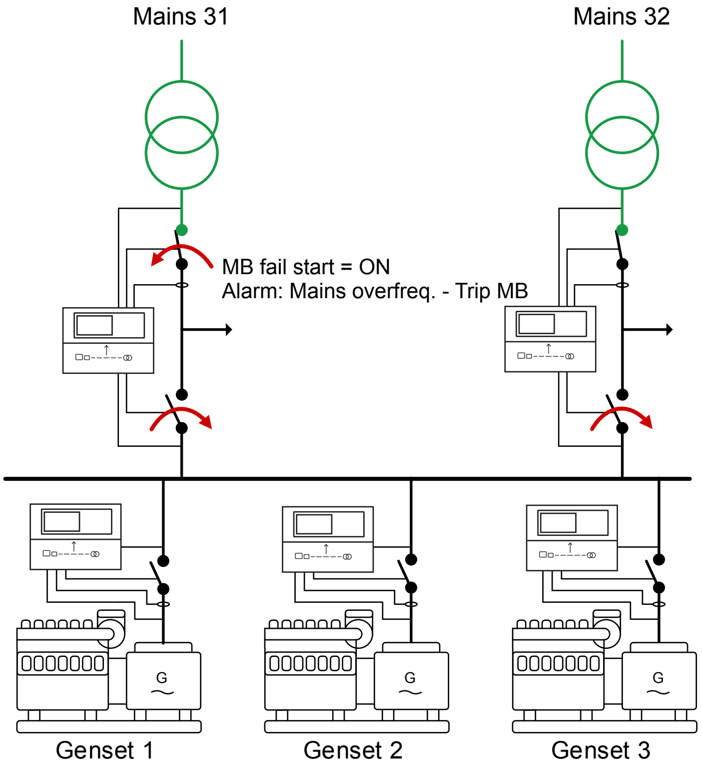
Above is shown an application with 3 mains feeders. The BTB is open, so the application is divided into two static sections. Since the application does not have any tie breakers (TB), the two mains feeders on the right side will have to be parallel if they are both to be used to support the load. Before 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.

Configure the parameter for Parallel operation under **Settings > Power management > Plant operating set.**.

Parameter	Text	Range	Default
8182	Parallel	OFF ON	OFF

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

In the AGC 150, the MB fail start and Auto switch 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:



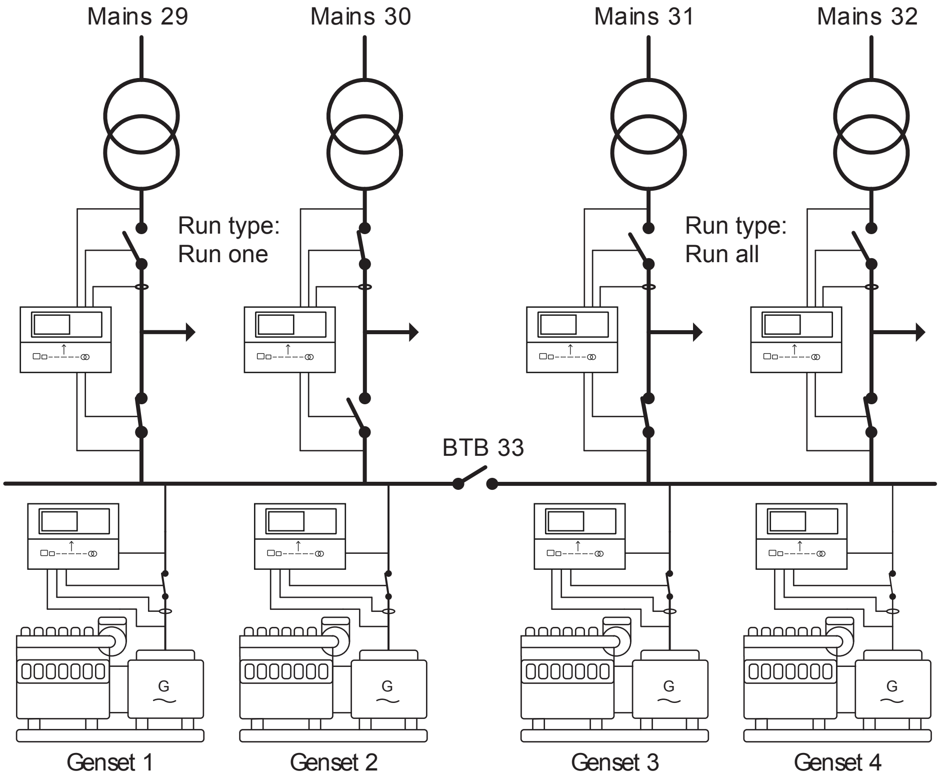
In the application above, the two mains feeders are supporting the load independently of each other. The mains controllers have configured an over-frequency alarm with the fail class of Trip MB. For example, when the frequency is high on Mains 31, and the fail class has been configured to Trip MB, MB 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.

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

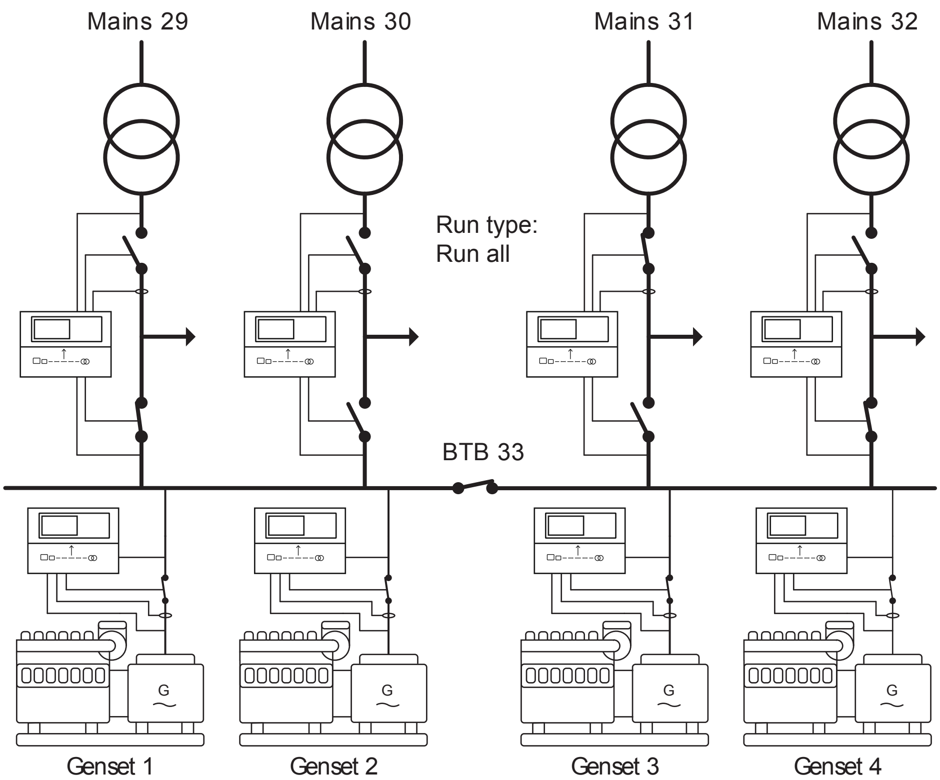
AGC 150 holds the possibility for selection of Run type: Run one or Run all. The setting for Run type determines what will happen in different situations. The different settings are described based on the application below:



In the application above, the BTB is open, so the application is at the moment two static sections. The AGC 150 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 de-loaded and afterwards opened. The MB that will be de-loaded is decided by the ID to run in parameter 8186.

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 de-loaded. When the run type is set to Run all, the AGC 150 use the chosen plant mode on all the mains feeders.

If the AGC 150 is placed in a setup with several mains feeders, and not all the mains feeders are intended to be de-loaded, 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 de-loaded. If a mains feeder is not intended to be de-loaded, 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 8196 or from M-Logic. When parameter 8196 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 8196 to either ON or OFF, dependent on which command is used.

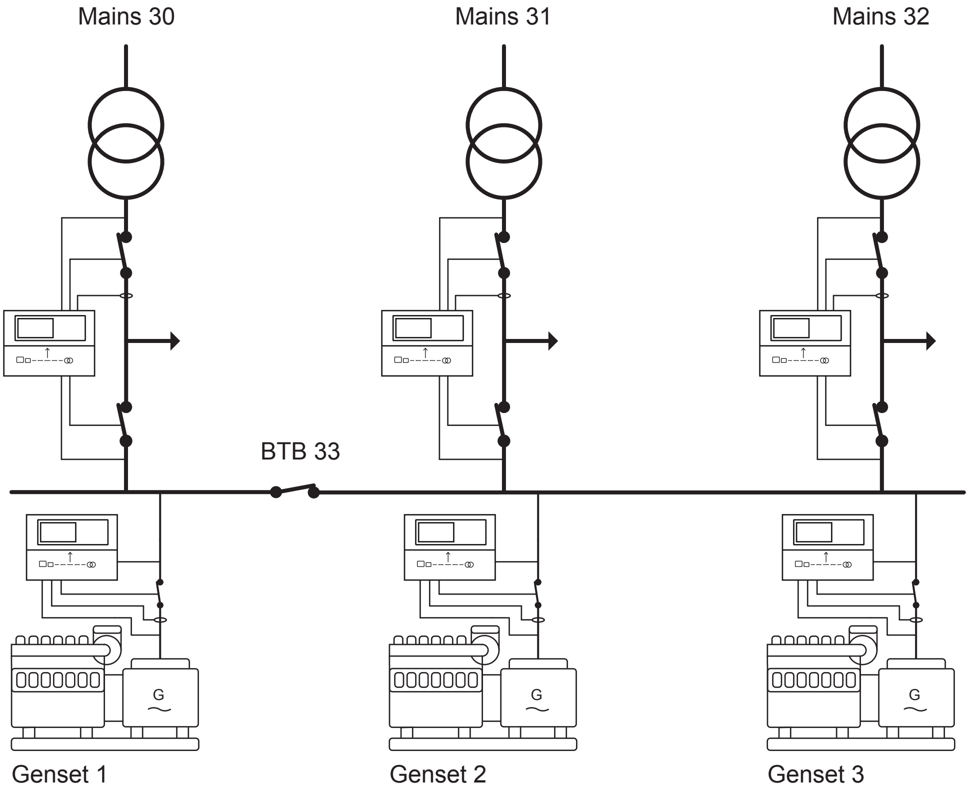
If the AGC 150 is set to Mains Power Export mode, and the run type is run all, the AGC 150 add all the exported power together, so the total exported power is equivalent to the power set in the AGC 150 with ID to run. If the parallel is not enabled, the AGC 150 will synchronise to the mains with the lowest CAN ID and export the power set in the set point in the mains controller with ID to run.

Configure Run type under **Settings > Power management > Plant operating set**.

Parameter	Text	Range	Default
8185	Run Type	Run one mains Run all mains	Run one mains
8196	Exclude from Run All	OFF ON	OFF

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

When the AGC 150 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 system's 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 150 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 150 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”.

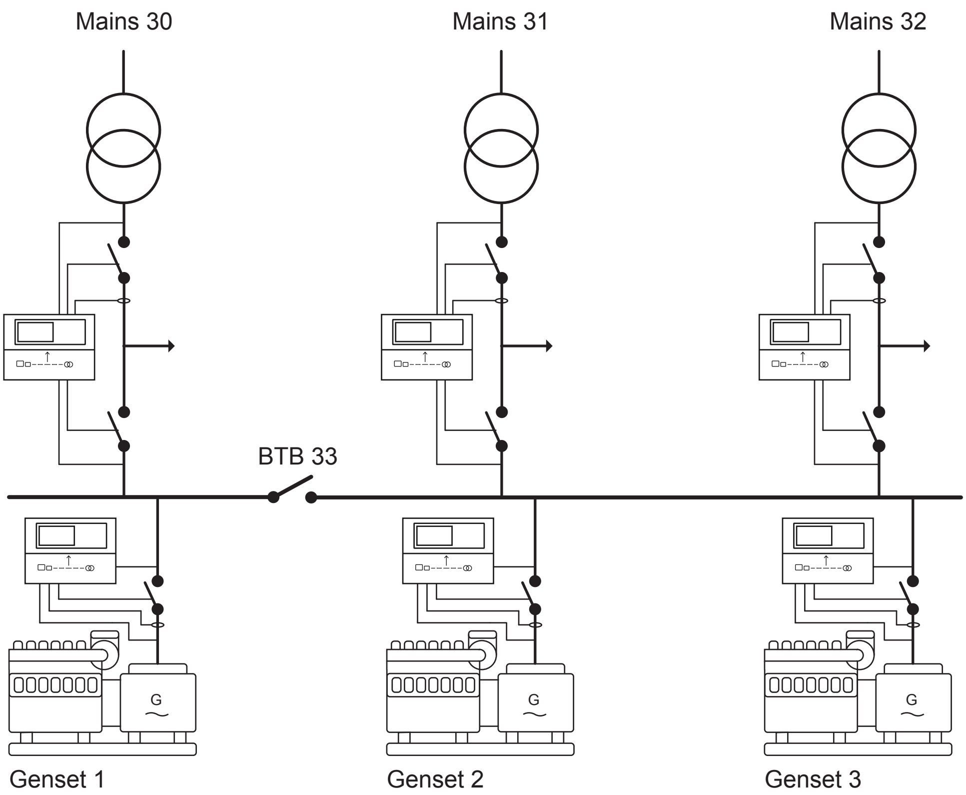
Load take-over: When the start signal is given, the gensets will start up and synchronise all the TBs at once, and de-load all the mains feeders at the same time. Each mains controller will open the MB, when it is de-loaded. If the parallel is disabled, the AGC 150 will be synchronised to one mains feeder 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.

9.16.8 ID to run in 2-level applications

AGC 150 holds an ID to Run parameter for choosing between which mains parameters should be used, and which feeder the power should be exported to. 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 three mains feeders are divided by two open BTBs (one in between each mains feeder), the system will need to have three different IDs to Run.

If two mains feeders are located in the same section, the ID to Run will be broadcast to the other mains in the section. An AGC 150 can have an ID to Run, which is not located in the section. This is described below:



If BTB 33 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 ID 31 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 configuration 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 de-loaded 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.

Configure ID to run under **Settings > Power management > Plant operating set.**.

Parameter	Text	Range	Default
8186	ID to Run	1 to 32	32

10. Synchronisation

10.1 Synchronisation principles

10.1.1 Synchronisation principles

AGC 150 can be used for synchronisation of the generator and the mains breaker (if installed).

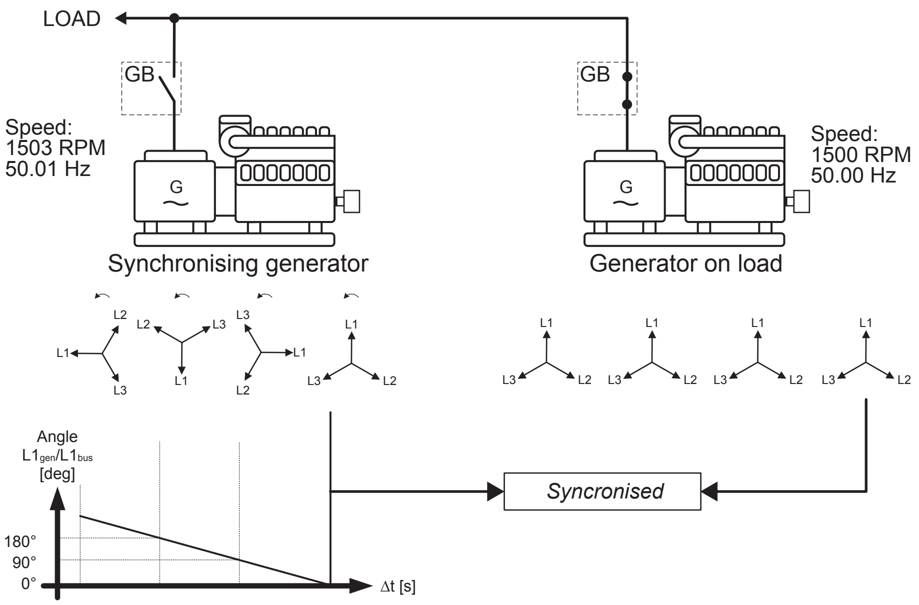
Two different synchronisation principles are available: static and dynamic synchronisation. Dynamic synchronisation is the default setting. Change to static synchronisation under **Settings > Synchronisation > Sync. type**.

10.2 Dynamic synchronisation

10.2.1 Dynamic synchronisation

With 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 has a positive slip frequency (a higher speed than the generator on the busbar). The objective is to avoid a reverse power trip after the synchronisation.

Figure 10.1 The dynamic principle



In this example, 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.

Synchronising means to decrease the phase angle difference between the two rotating systems, the three-phase generator system and the three-phase busbar system. 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.

NOTE Both three-phase systems are rotating, but for illustrative purposes the vectors for the generator on load are not shown to be rotating.

When the generator is running with a positive slip frequency of 0.1 Hz compared to the busbar, the two systems can be synchronised every 10 seconds.

$$t_{SYNC} = \frac{1}{50.1 - 50.0} = 10\,\text{sec}$$

In the example above, the phase angle difference 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.

10.2.2 Settings for dynamic synchronisation

Configure the parameters for dynamic synchronisation under **Settings > Synchronisation > Dynamic sync.**.

Parameter	Text	Range	Default
2021	Maximum slip frequency, dfMax	0.0 to 0.5 Hz	0.3 Hz
2022	Minimum slip frequency, dfMin	-0.5 to 0.3 Hz	0.0 Hz
2023	Maximum voltage difference, dUMax	2 to 10 %	5 %
2024	Minimum voltage difference, dUMin	-10 to 0 %	-5 %
2025	GB response time	40 to 300 ms	50 ms
2026	MB response time	40 to 300 ms	50 ms

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.

Dynamic synchronisation is relatively fast because of the adjusted minimum and maximum slip frequencies. When the controller is aiming to control the frequency towards the set point, synchronising can still occur as long as the frequency is within the limits of the slip frequency settings.

NOTE Static and dynamic synchronisation can be switched by using M-Logic.

More information
See **Engine/Generator/Mains, PID controller, [Topic]** in this document for more information about PID controllers.

10.2.3 Close signal

The controller 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):

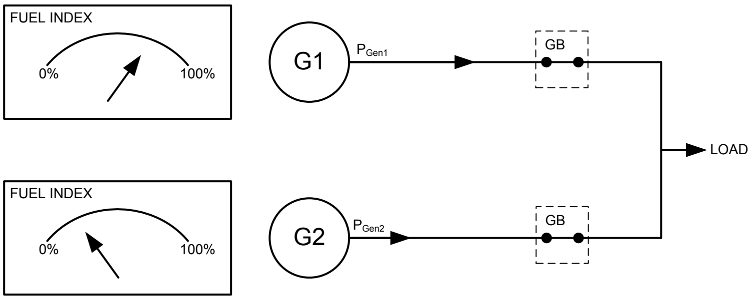
- deg close = 360*tCB*fSLIP
- deg close = 360*0.250*0.1
- deg close = 9 deg

The length of the synchronisation pulse is the response time + 20 ms. The synchronisation pulse is always issued, so the closing of the breaker will occur at the 12 o'clock position.

10.2.4 Load picture after synchronising

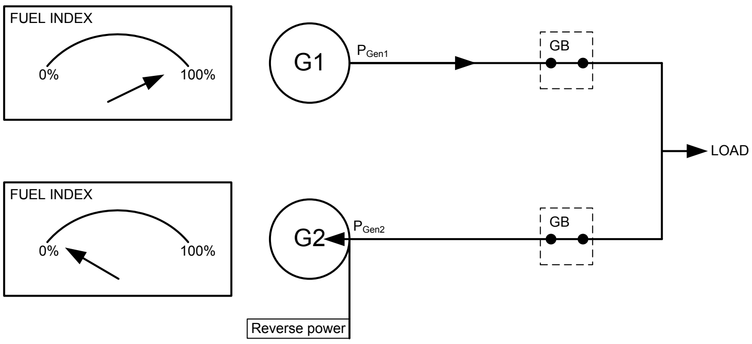
When the incoming genset has closed its breaker, it will take a portion off the load depending on the actual position of the fuel rack.

Positive slip frequency



The illustration shows that at a given positive slip frequency, the incoming genset will *export* power to the load.

Negative slip frequency



The illustration shows that at a given negative slip frequency, the incoming genset will *receive* power from the original genset (reverse power).

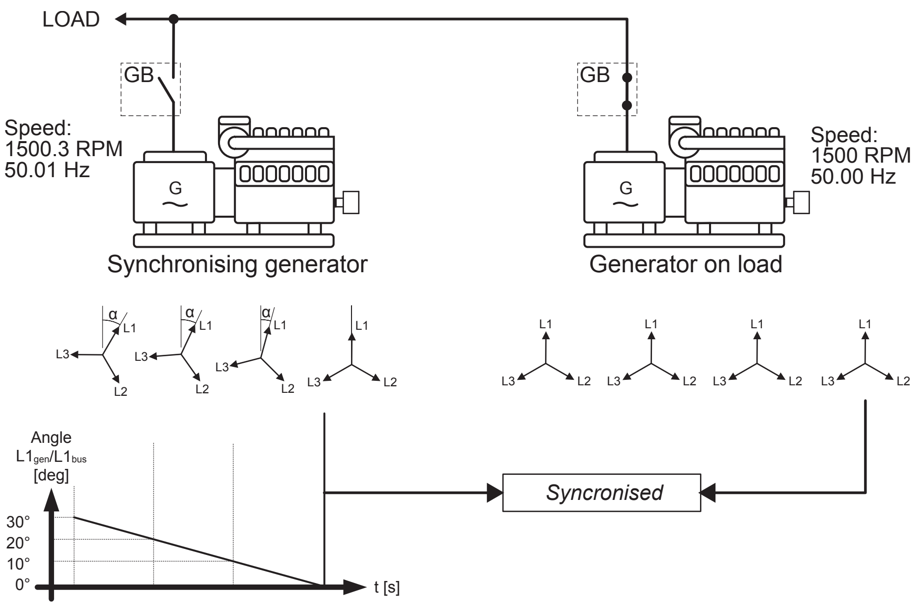
NOTE To avoid nuisance trips caused by reverse power, the synchronising settings can be configured with a positive slip frequency.

10.3 Static synchronisation

10.3.1 Static synchronisation

When static synchronisation 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, the phase controller takes over.

Figure 10.2 The static principle



The frequency controller uses the angle difference between the generator system and the busbar system as control parameter. This is illustrated in the example above, where the phase controller brings the phase angle from 30 to 0 °.

10.3.2 Settings for static synchronisation

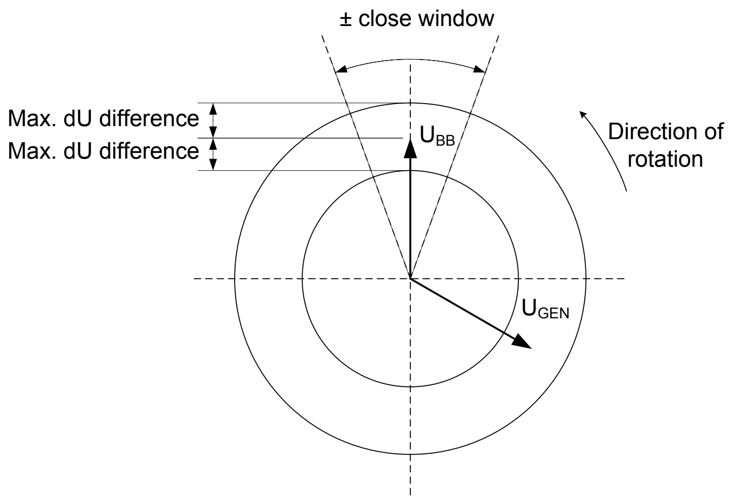
Configure the parameters for static synchronisation under **Settings > Synchronization > Static sync > Static sync**.

Parameter	Text	Range	Default
2031	Maximum df	0.00 to 0.50 Hz	0.10 Hz
2032	Maximum dU	1 to 10 %	5 %
2033	Close window	0.1 to 20.0 °	10°
2034	Static sync timer	0.1 to 99.0 s	1.0 s
2035	GB breaker sync	Breaker sync Infinite sync	Breaker sync
2036	MB breaker sync	Breaker sync Infinite sync	Breaker sync

10.3.3 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 to 20.0 °. This is illustrated in the drawing below.



The pulse is issued in accordance with the settings for static synchronisation, depending on whether the GB or the MB is to be synchronised.

10.3.4 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 a low value. Since the fuel rack position almost equals what is required to run at the busbar frequency, no load jump will occur.

After synchronising, the controller 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 with M-Logic.

10.4 GB closing before excitation

10.4.1 GB closing before excitation

AGC 150 can be configured to start the genset with the excitation switched off. When the gensets are started, the breakers will be closed and the excitation started.

With the Close before excitation function, it is possible to close the breaker before the engine is started, which make the gensets ready for the load very quickly. All gensets will be connected to the busbar, as soon as they are started, and when the excitation is switched on, the gensets are ready for operation.

This function makes the synchronisation faster, because the breakers will not be closed until the generator voltage is in the synchronised 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, the regulators of the AGC 150 will be switched on after an adjustable delay.

The excitation must be increased slowly when this function is used, and it can only be used with a magnetic pick-up or J1939 speed signal.

The principle is described in the following flowcharts.

Abbreviations:

- Delay 1 = Menu 2252
- Delay 2 = Menu 2262
- Delay 3 = Menu 2271
- SP1 = Menu 2251
- SP2 = Menu 2263

Figure 10.3 GB handling

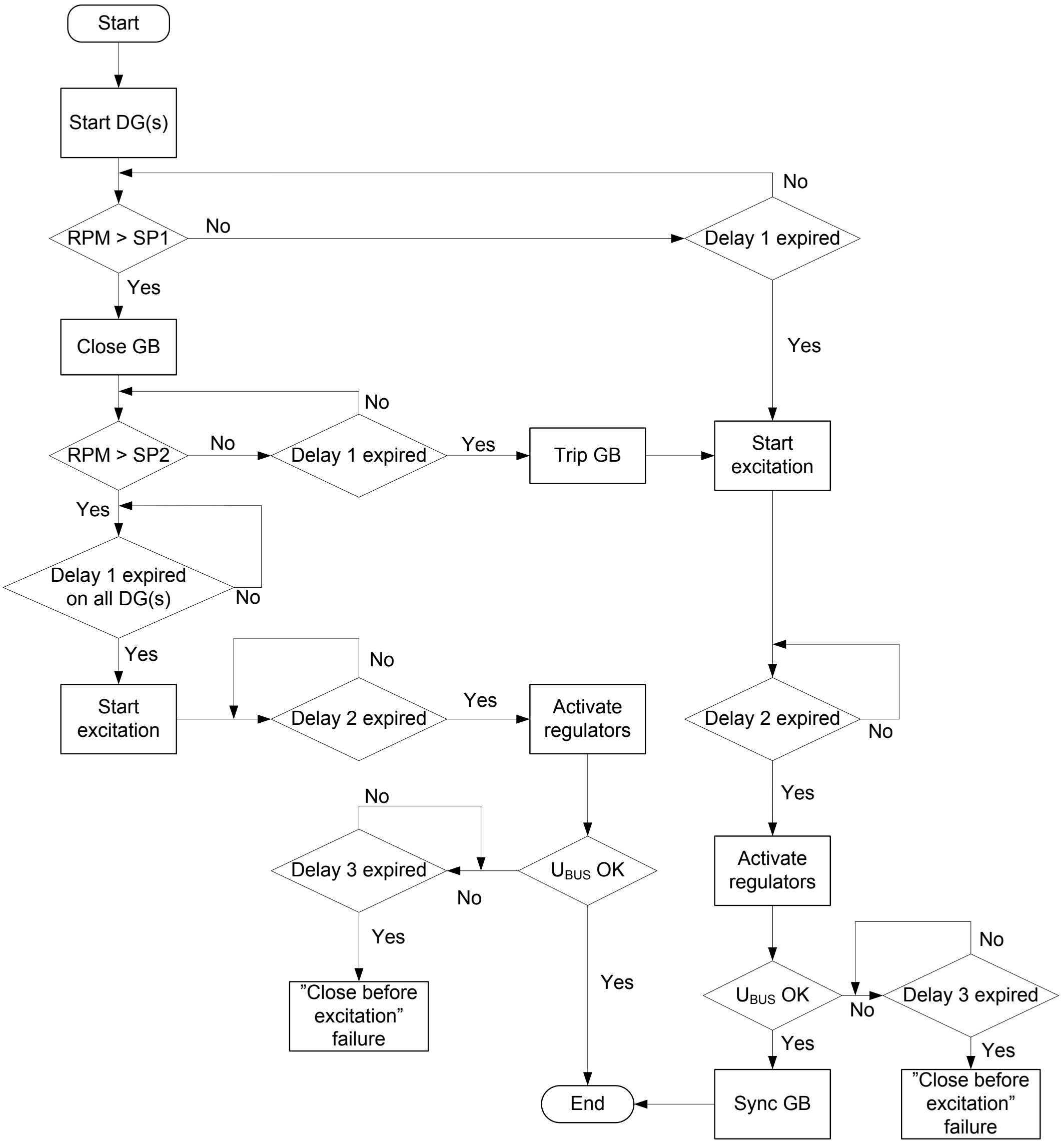
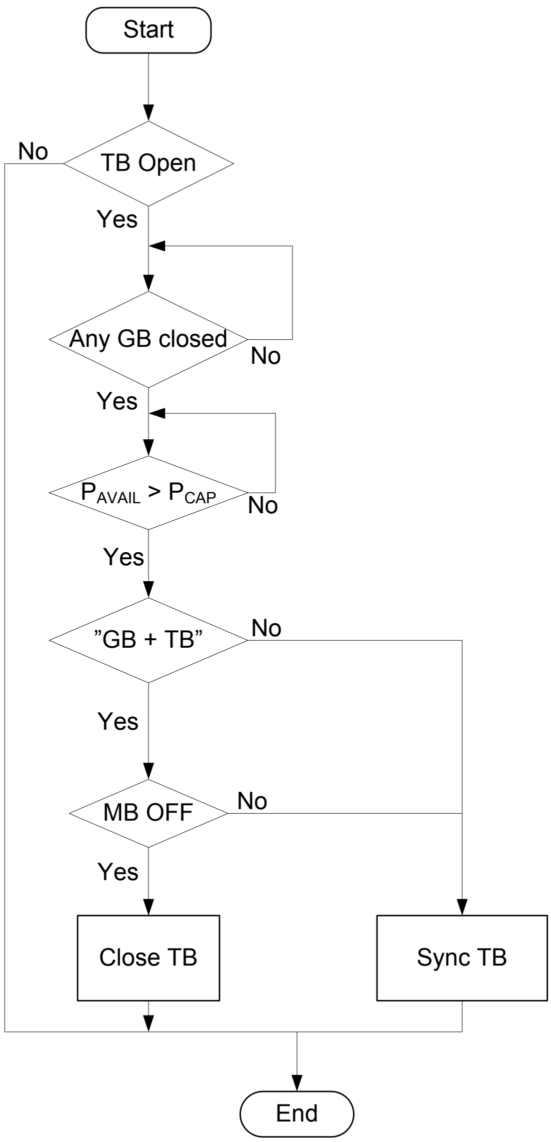


Figure 10.4 TB handling

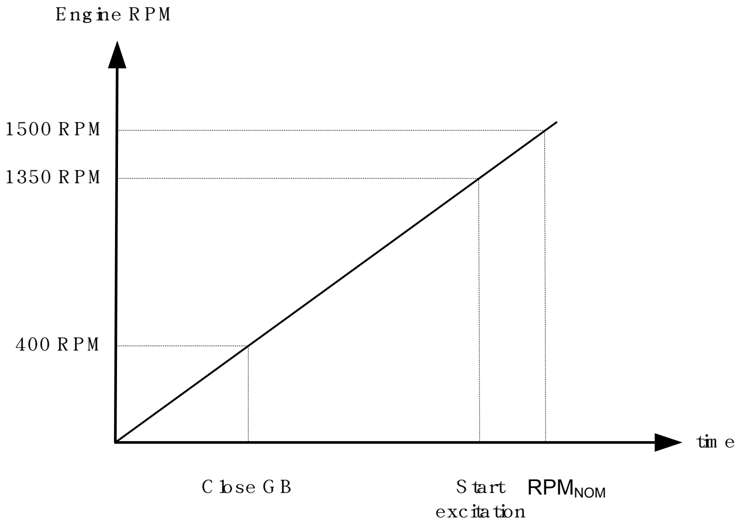


10.4.2 Genset start actions

The start sequence of the AGC 150 must be changed to achieve the Close before excitation function.

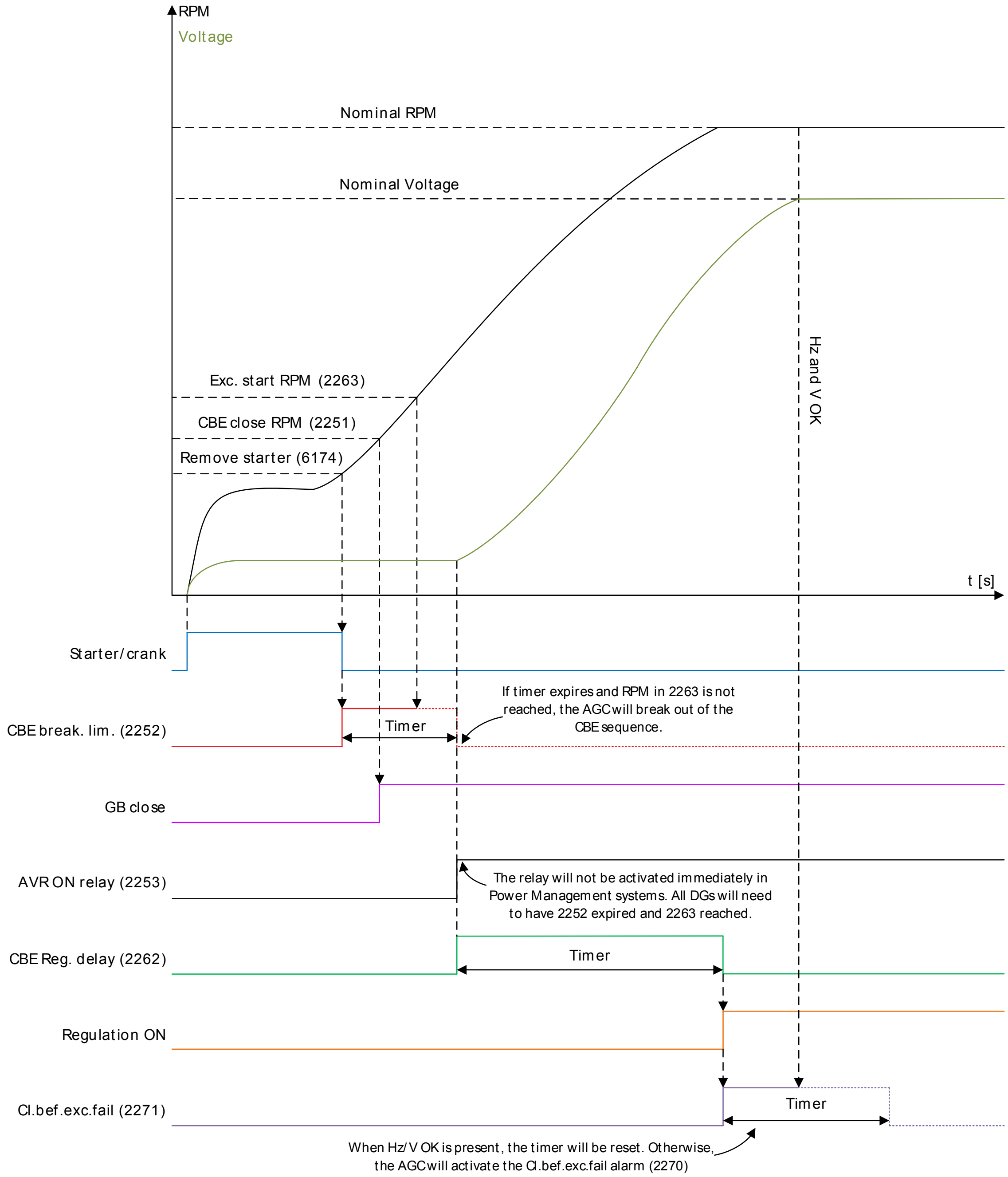
Table 10.1 Genset start sequence settings

Parameter	Text	Description
2251	RPM set point	The generator breaker will close at the adjusted level. The range is from 0-4000 RPM. If adjusted to 0, the breaker closes 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 within the adjusted delay. When the delay expires and the RPM is above the set point, the excitation will be started. If the RPM is below the set point, 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.



The diagram above shows that the GB will be closed at 400 RPM. When the engine RPM has reached the set point (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:



Configure the parameters for Genset start sequence under **Settings > Synchronisation > CBE**.

Parameter	Text	Range	Default
2251	Close breaker RPM	0 to 4000 rpm	400 rpm
2252	CBE release	0.1 to 999.0 s	5.0 s
2253	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
2254	Enable	OFF ON	OFF
2261	Close GB sequence	Close GB Close GB+TB	Close GB
2262	CBE regulation delay	0.0 to 999.0 s	5.0 s

Parameter	Text	Range	Default
2263	CBE excitation start relay	0 to 4000 rpm	1450 rpm
2264	Voltage discharge	1.0 to 20.0 s	5.0 s
2265	Voltage re-run level	30 to 100 %	30 %
2266	Excitation control cooldown	Exc. follow busbar voltage Exc. constant ON	Exc. follow busbar voltage

10.4.3 Breaker sequence

The GB close before start function can be used in different applications, such as:

1. Stand-alone applications.
2. 2-level application without tie breaker.
3. 2-level application with tie breaker.

Table 10.2 Breaker sequence settings

Parameter	Text	Description
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 residual voltage is present when the GB is closed.

10.4.4 Close before excitation failure

If start up of the genset does not succeed, an alarm will occur, and the selected fail class will be executed.

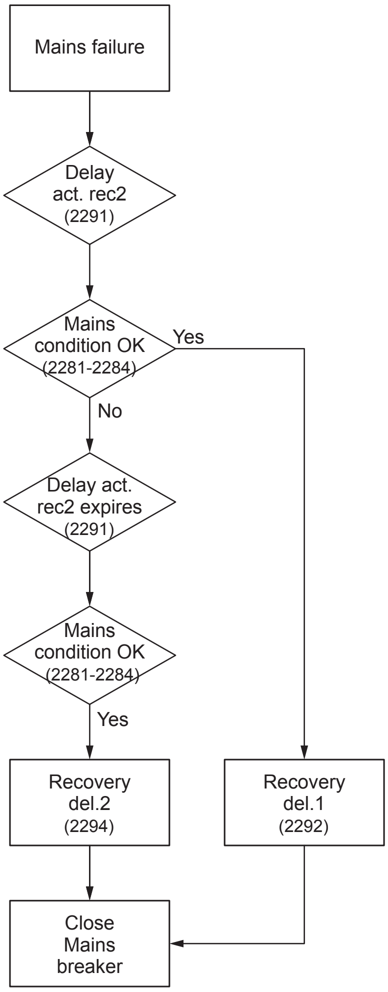
Configure the parameters for Close before excitation failure under **Settings > Synchronisation > CBE > CBE fail**.

Parameter	Text	Range	Default
2271	CBE Timer	0.0 to 999.0 s	5.0 s
2272	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
2273	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
2274	CBE Enable	OFF ON	OFF
2275	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning

10.5 Inhibit conditions before synchronising mains breaker

10.5.1 Inhibit conditions before synchronising mains breaker

This function is used to inhibit the synchronising of the mains breaker after blackout. After blackout a timer will start to run, and if the mains voltage and frequency are inside the limits before the timer runs out, the short interruption timer will be started. When the timer has run out, the synchronising of the MB will start.



Configure the Mains sync inhibit parameters under **Settings > Synchronisation > Mains sync inhibits**.

Parameter	Text	Range	Default
2281	Min. voltage, U<	80 to 100 %	85 %
2282	Max. voltage, U>	100 to 120 %	110 %
2283	Min. frequency, f<	90.0 to 100.0 %	95.0 %
2284	Max. frequency, f>	100.0 to 110.0 %	101.0 %
2285	Enable	OFF ON	OFF
2286	Fail class	-	Trip GB

If the Delay activate recovery 2 timer runs out, the long interruption timer will start to run.

Configure the Delay timers under **Settings > Synchronisation > Mains sync inhibits**.

Parameter	Text	Range	Default
2291	Delay activate recovery 2 timer	0.0 to 20.0 s	3.0 s
2292	Recovery delay 1 timer	0.0 to 60.0 s	5.0 s
2294	Recovery delay 2 timer	0.0 to 900.0 s	60.0 s

Example 1: Recovery timer 1 (short interruption timer)

- Delay activate recovery 2 timer = 3 s
- Recovery delay 1 timer = 5 s
- If the short interruption timer is set to ≤ 3 s, and the grid is back and voltage and frequency are inside the acceptable range, then after 5 s the MB can be closed.

Example 2: Recovery timer 2 (long interruption timer)

- Delay activate recovery 2 timer = 3 s
- Recovery delay 2 timer = 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 Recovery delay 2 timer. Then the MB can be closed.

11. General purpose PID

11.1 Introduction

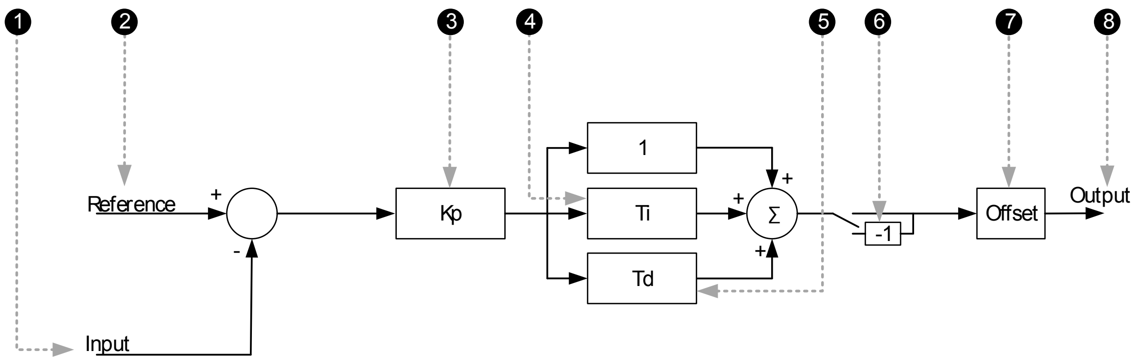
11.1.1 Introduction

The general purpose PID controllers are principally similar to the PID controllers for AVR and governor controllers. They consist of a proportional, an integral and a differential part, and the integral and differential parts are dependent on the proportional gain.

The general purpose PIDs are slightly less responsive. They are meant for purposes such as temperature regulation, controlling fans, valves, and so on. Configuration of the general purpose PIDs is documented by describing the possibilities of the general purpose PID interface, and with examples of configuration for different purposes.

11.1.2 General purpose PID analogue loop

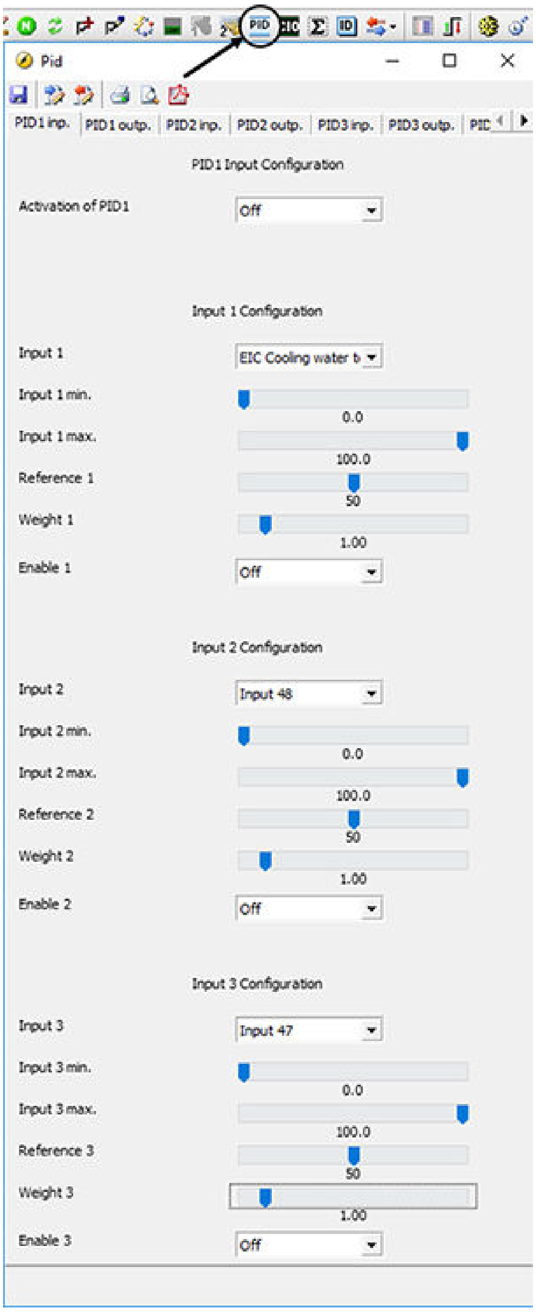
The analogue regulation in the general purpose PIDs is handled by a PID loop. The diagram below shows which elements the PID loop consists of.



1. **Input:** This is the analogue input that measures the process the controller is trying to regulate.
2. **Reference:** This is the set point that the controller is trying to bring the input to match.
3. **Kp:** The proportional gain of the PID loop.
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.
7. **Offset:** The offset is added on the function and displaces the regulation range.
8. **Output:** This is the final output from the PID, controlling the transducer.

11.1.3 General purpose PID interface in the Utility Software

Configuration of the four general purpose PID’s input and output settings is done with the PID interface in the Utility Software, it cannot be done from the controller.



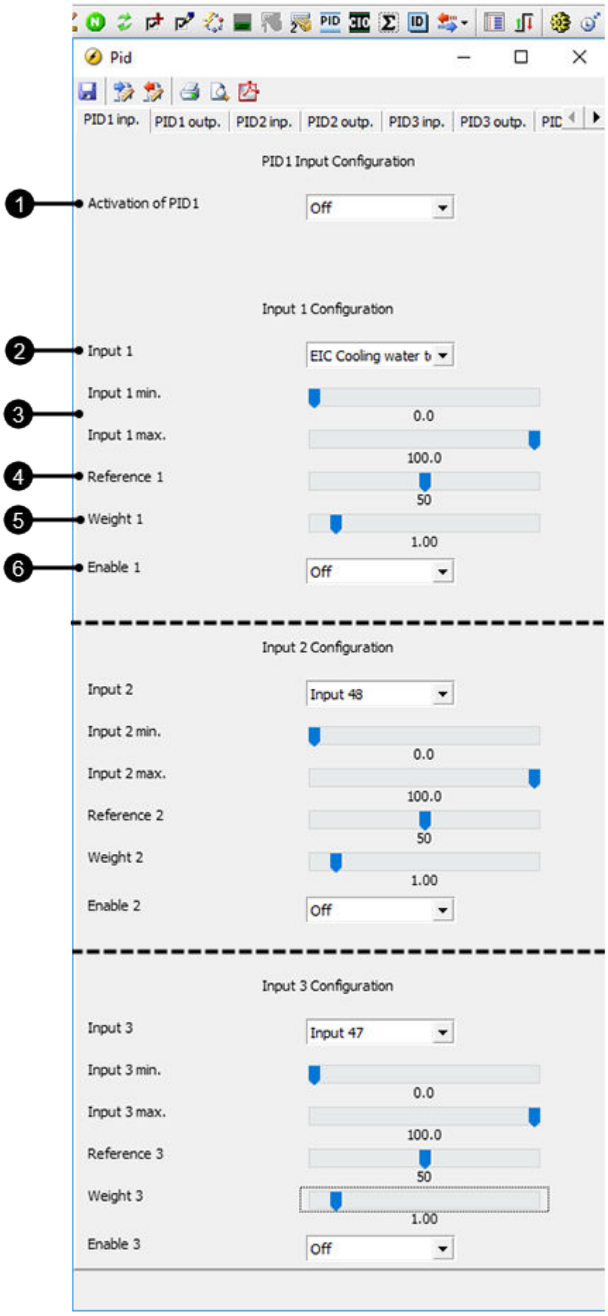
11.2 Inputs

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 the output signal.

More information
See **General purpose PID, Inputs, Dynamic input selection** in this document for more information.

Explanation of general purpose 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 general purpose 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: 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.

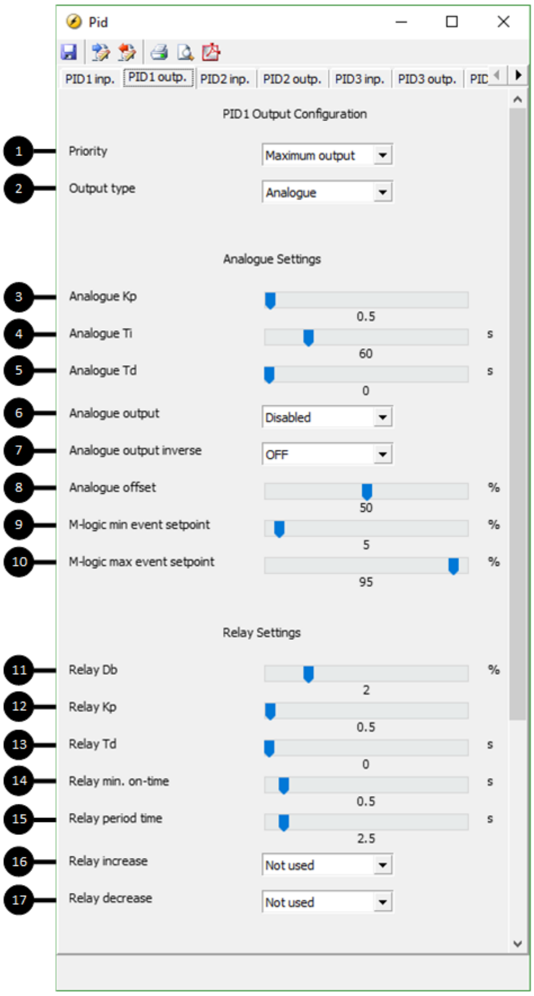
In case of high ambient temperatures, the ventilation might not be able to influence the temperature enough, and the temperatures start to rise above set point. The output will stay at 100 % as long as any of the inputs are continuously above their set points.

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.

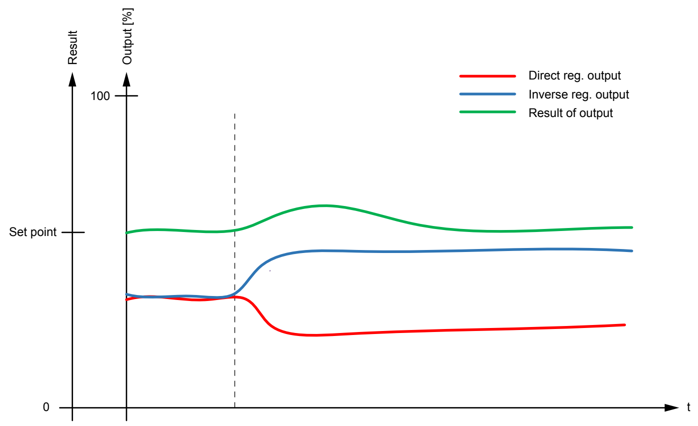
11.3 Output

11.3.1 Explanation of output settings

Explanation of general purpose PID settings

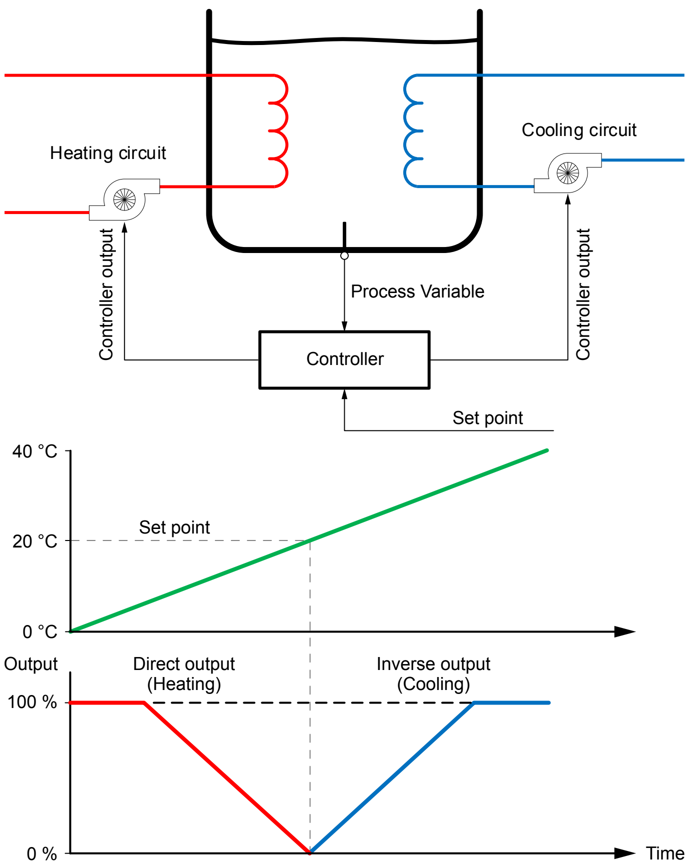


1. **Priority**: This setting determines whether it is min. or max. output that is prioritised. This setting is used for the dynamic input selection feature. Maximum output results in selection of the input that gives the greatest output. Minimum output results in selection of the input that gives the 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.



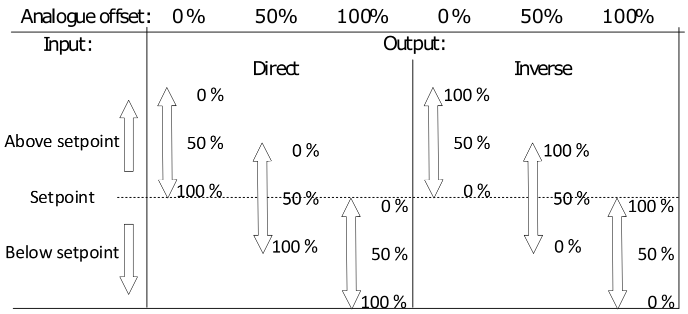
Direct error = SP - PV
Inverse error = PV - SP
Direct output is used in applications where a rise in analogue output increases the process variable.
Inverse output is used in applications where a rise in analogue output decreases the process variable.

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.



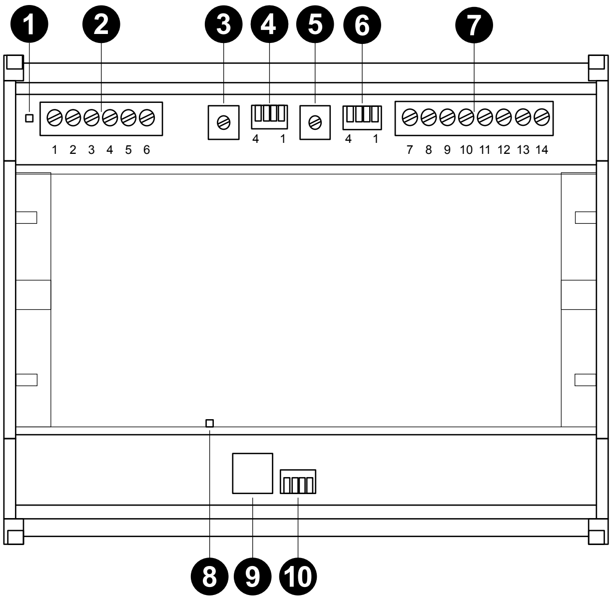
100 % offset is commonly used with inverse output, like in the previous cooling example.

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.
16. **Relay increase**: Choose the terminal for the relay used for positive activation.
17. **Relay decrease**: Choose the terminal for the relay used for negative activation.

11.3.2 Additional analogue outputs with IOM 230

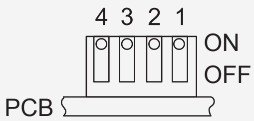
AGC 150 comes with two built-in analogue outputs. The controller also supports up to two IOM 230 analogue interface modules, which can provide four additional analogue outputs.

Table 11.1 IOM 230 overview



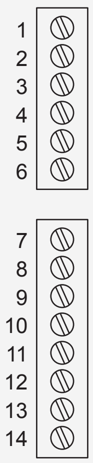
1. IOM 230 status LED (green = system OK, red = system failure)
2. Terminals 1 to 6
3. GOV adjustment
4. GOV output selector
5. AVR adjustment
6. AVR output selector
7. Terminal 7 to 14
8. CAN status LED (green = system OK, red = system failure)
9. PC port
10. IOM 230 CAN ID selector

Table 11.2 GOV and AVR output selector settings

	Output	Switch 1	Switch 2	Switch 3	Switch 4
	+/-25 mA	ON	OFF	Not used	OFF
	0 to 20 mA	OFF	ON		OFF
	+/-12 V DC	ON	OFF		ON
	0 to 10 V DC	OFF	ON		ON

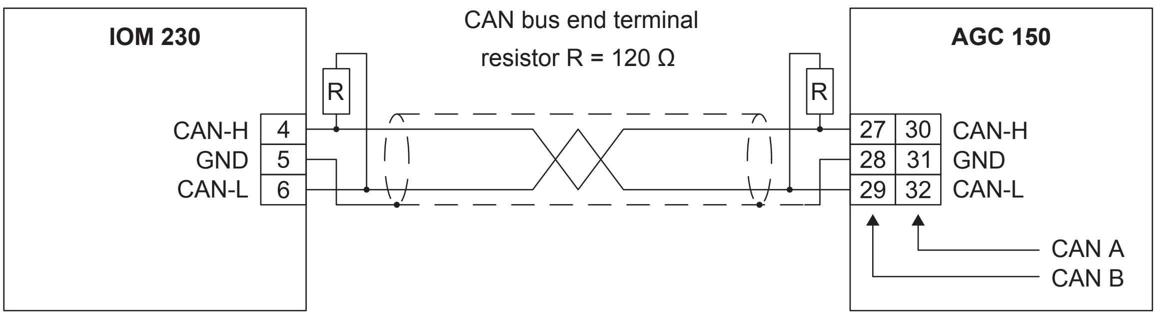
NOTE Switch 1 and 2 cannot have the same position.

Table 11.3 IOM 230 Terminals

	Terminal	Description	Comment
	1	+12/24V DC	Power supply
	2	0V DC	
	3	Not used	-
	4	CAN-H	CAN bus interface
	5	CAN-GND	
	6	CAN-L	
	7	GOV out	Governor analogue interface
	8	GOV com	
	9	AVR out	AVR analogue interface
	10	AVR com	
	11	Not used	-
	12	VAr share out	Load sharing lines
	13	Common	
	14	P share out	

CAN bus connections

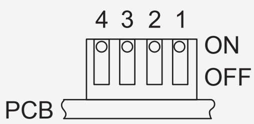
Figure 11.1 Example of CAN bus connections



The cable shield must not be connected to ground, only to the GND terminals.

Use different CAN adresses for the different IDs. Only ID0 participate in the load share functionality

Table 11.4 IOM 230 CAN ID selector settings

	IOM ID	Switch 1	Switch 2	Switch 3	Switch 4
	ID0	OFF	OFF	OFF	OFF
	ID1*	ON	OFF	OFF	OFF
	ID2*	OFF	ON	OFF	OFF

All other combinations = ID0.

NOTE *ID1 is used for PID1 and PID2. ID2 is used for PID3 and PID4.

More information
See **IOM 200 analogue interface for AGC 200 Application notes** for more information about IOM 230.

11.4 Kp gain compensation

11.4.1 Introduction

Kp gain compensation is intended to be used when the AGC 150 is controlling the cooling water system for the genset.

There are two situations where the engine can begin to oscillate, which 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:

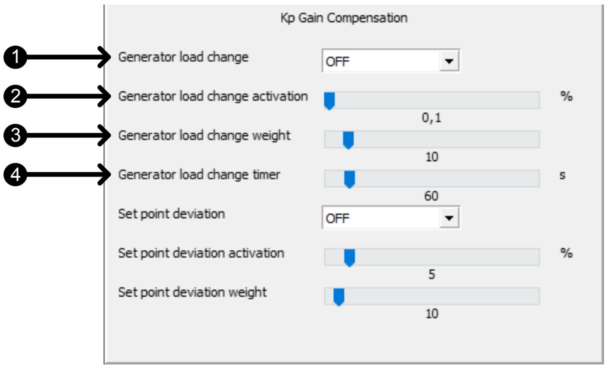
1. The load change gain compensation.
2. Set point deviation compensation.

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

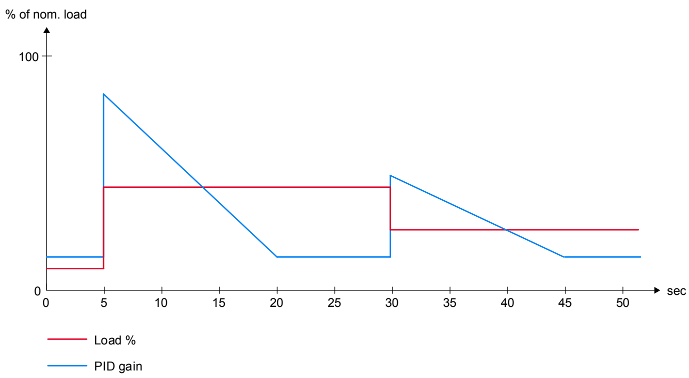
In case of large load impacts or rejections, it can create large deviation in the need of cooling, and thereby create some instability in the cooling system. To alleviate some of this instability, the load change gain compensation will instantaneously increase the gain in relation to the load gain. Larger 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.

Table 11.5 Example of load change gain compensation

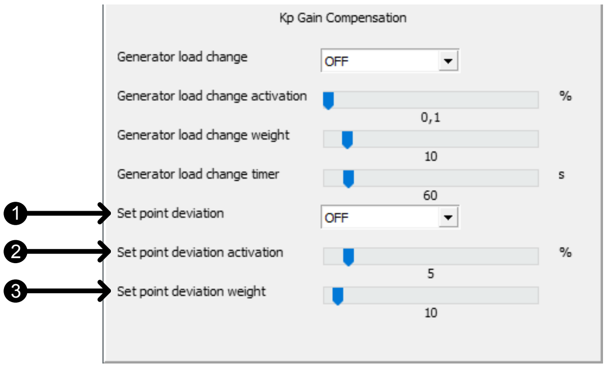


This diagram shows the reaction of the gain, based on two load changes.
In the first situation, there is a large load impact that triggers the load change gain compensation and increases the gain instantaneously. This increase will decrease, in this case over 15 seconds, and bring the gain back to nominal.
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

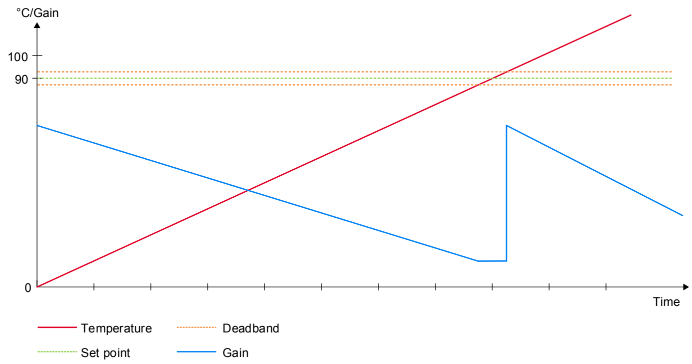
This function is intended to help minimise overshoots. Especially in a cooling water system where the set point is often very close to the shutdown limit, it is difficult for a slow system to react in time to avoid a shutdown. This function will drastically increase the gain when the actual value overshoots 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.

Table 11.6 Example of set point deviation compensation



This diagram 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 M-Logic

All functions of the general purpose PIDs can be activated and deactivated by means of M-Logic. In the following, events and commands regarding the general purpose PIDs are described.

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.

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.

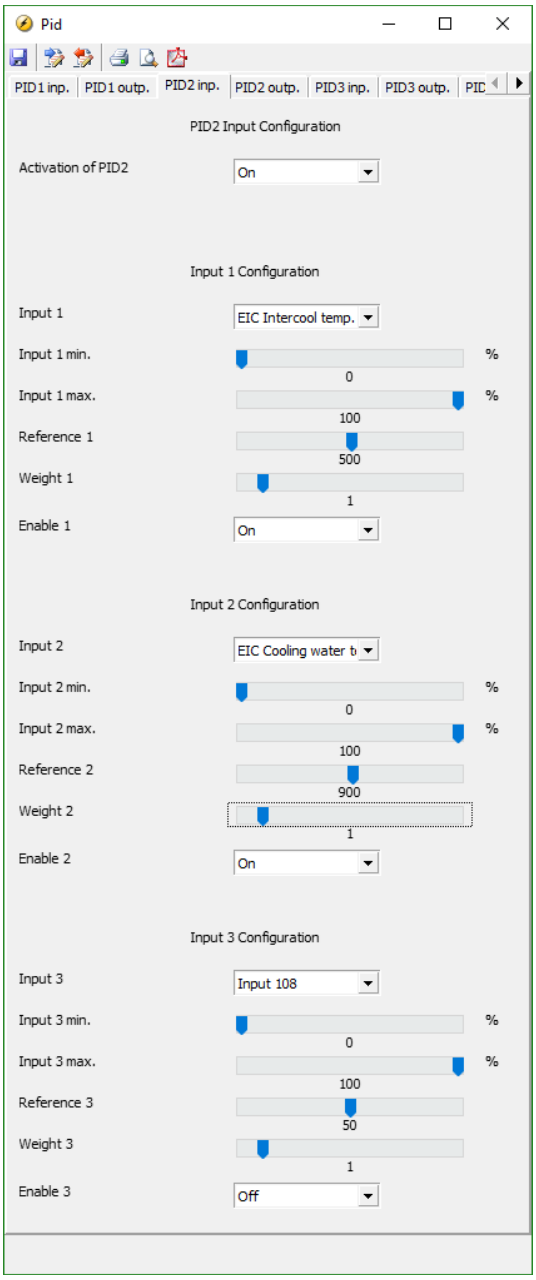
- **PID force max. outp.**: This command forces the output to the value set in the output parameter Analogue max outp. (for example, for post-cooling purposes).
- **PID reset**: This command forces the output to the value set in the output parameter Analogue offset.
- **PID Freeze**: This command freezes the output at the current value.

11.6 Example

11.6.1 Example: Use of a general purpose PID

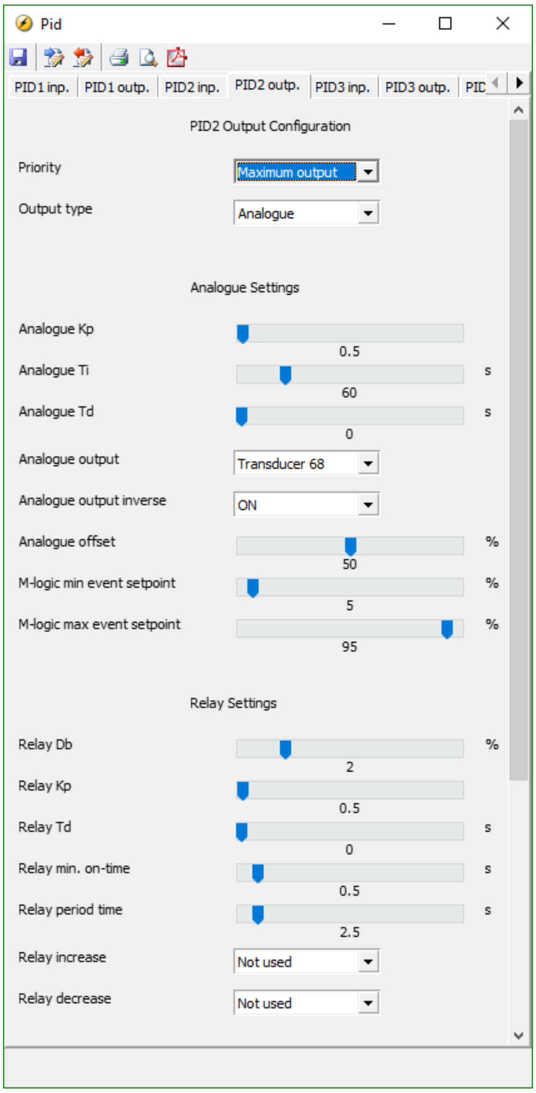
In this example a general purpose PID is used for analogue fan control.

The fan 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.



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).

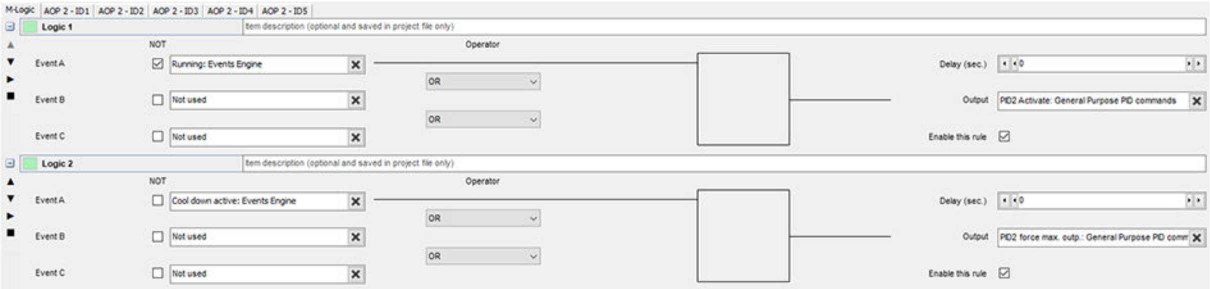
EIC Intercool temp. is selected as input 1, and EIC Cooling water temp. as input 2. Min. and max. values are configured for full range. Input 1 reference set point is set at 500 to achieve a temperature set point of 50.0 °C for intercooler coolant. Input 2 has a reference set point set at 900 to achieve 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:

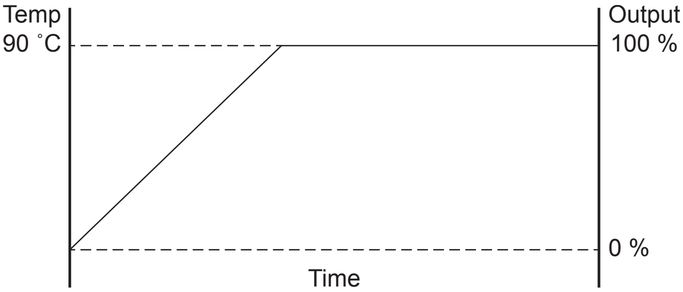
- Analogue is selected as output type, and the physical output is selected to be transducer 68.
- Inverse output is activated to obtain a rise in analogue output to the fan when the temperature rises.
- An offset of 100 % is chosen to achieve 100 % output at the set point.
- Full range of output is selected. 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.



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 About digital inputs

12.1.1 DI list and explanation

AGC 150 has a number of digital inputs, as shown in the following tables.

Table 12.1 Digital inputs for genset controller

DI function	DI explanation	AUTO mode	SEMI-AUTO mode	Test mode	Man. mode	Block mode	Type[1]
Start enable	This 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		C
Auto start/ stop	The genset will start when this input is activated. The genset will stop if the input is deactivated. The input can be used when the controller is in island operation, fixed power, load take-over or mains power export and the auto running mode is selected.	x					C
Remote start	This input initiates the start sequence of the genset when SEMI-AUTO or Manual mode is selected.		x		x		C
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		C
Alternative start	This input is used to simulate an AMF failure and this way run a full AMF sequence without a mains failure actually being present	x	x	x	x	x	C
Remove starter	The start sequence is deactivated. This means the start relay deactivates, and the starter motor will disengage.	x	x	x	x		C
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	x		C
Binary running detection	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	C
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				P
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 de-loaded to the breaker open limit followed by a breaker opening.		x				P
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				P
Remote MB OFF	The mains breaker OFF sequence will be initiated, and the breaker will open instantly.		x				P
GB position ON[2]	The input function is used as an indication of the generator breaker position. The controller requires this feedback when the breaker is closed or a position failure alarm occurs.	x	x	x	x	x	C

DI function	DI explanation	AUTO mode	SEMI-AUTO mode	Test mode	Man. mode	Block mode	Type[1]
GB position OFF[2]	The input function is used as an indication of the generator breaker position. The controller requires this feedback when the breaker is opened or a position failure alarm occurs.	x	x	x	x	x	C
GB close inhibit	When this input is activated, the generator breaker cannot close.	x	x	x	x	x	C
MB close inhibit	When this input is activated, the mains breaker cannot close.	x	x	x	x	x	C
GB racked out	The breaker will be considered as racked out when pre-requirements are met and this input is activated.		x		x		C
MB racked out	The breaker will be considered as racked out when pre-requirements are met and this input is activated.		x		x		C
GB spring loaded	AGC 150 will not send a close signal before this feedback is present.	x	x	x	x	x	C
MB spring loaded	AGC 150 will not send a close signal before this feedback is present.	x	x	x	x	x	C
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				P
Enable GB black close	When the input is activated, AGC 150 is allowed to close the generator on a black busbar, providing that the frequency and voltage are inside the limits in parameter 2110.	x	x	x	x	x	C
Enable sep. sync	Activate to split the breaker close and the breaker synchronisation functions in two different relays. The breaker close function remain on the relays dedicated for breaker control. The synchronisation function will be moved to a configurable relay.	x	x	x	x	x	C
SEMI-AUTO mode	Changes the present running mode to SEMI-AUTO.	x		x	x	x	P
Test mode	Changes the present running mode to test.	x	x		x	x	P
AUTO mode	Changes the present running mode to AUTO.		x	x	x	x	P
Manual mode	Changes the present running mode to Manual.		x	x		x	P
Block mode	Changes the present running mode to Block.	x	x	x	x		C
Total test	This input will be logged in the event log to indicate that a planned mains failure has been made.	x	x	x	x	x	C
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 parameter 7081 (Mode shift) is disregarded.	x	x	x	x	x	C
De-load	A running genset will start to ramp down the power.	x					C
Man. GOV up[3]	If Manual mode is selected, then the governor output will be increased.	x	x	x	x		C
Man. GOV down[3]	If Manual mode is selected, then the governor output will be decreased.	x	x	x	x		C
Man. AVR up[3]	If Manual mode is selected, then the AVR output will be increased.	x	x	x	x		C
Man. AVR down[3]	If Manual mode is selected, then the AVR output will be decreased.	x	x	x	x		C

DI function	DI explanation	AUTO mode	SEMI-AUTO mode	Test mode	Man. mode	Block mode	Type[1]
Reset Ana GOV output	Reset analogue GOV/AVR outputs. The analogue ±20 mA controller outputs will be reset to 0 mA.	x	x	x	x	x	C
Access lock	Activating the access lock input deactivates the control display buttons. It will only be possible to view measurements, alarms and the log.	x	x	x	x	x	C
Remote alarm ack.	Acknowledges all present alarms, and the alarm LED on the display stops flashing.	x	x	x	x	x	C
Shutdown override	This input deactivates all protections except the overspeed protection and the emergency stop input. A special cool down timer is used in the stop sequence after activation of this input.	x	x	x	x		C
Battery test	Activates the starter without starting the genset. If the battery is weak, the test will cause the battery voltage to drop more than acceptable, and an alarm will occur.	x	x				P
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			C
Switchboard error	The input will stop or block the genset, depending on running status.	x	x	x	x	x	C
Secured mode 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	P
Secured mode 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	P
Base load	The generator set will run base load (fixed power) and not participate in frequency control. Should the plant power requirement drop, the base load will be lowered so the other generator(s) on line produces at least 10% power.		x				C
Ground breaker ON[4]	Feedback from ground breaker when this is active.	x	x	x	x	x	C
Ground breaker OFF[4]	Feedback from ground breaker when this is inactive.	x	x	x	x	x	C

Table 12.2 Digital inputs for mains controller

DI function	DI explanation	AUTO mode	SEMI-AUTO mode	Test mode	Man. mode	Block mode	Type[1]
Auto start/ stop	The genset will start when this input is activated. The genset will stop if the input is deactivated. The input can be used when the controller is in island operation, fixed power, load take-over or mains power export and the auto running mode is selected.	x					C
Alternative start	This input is used to simulate an AMF failure and this way run a full AMF sequence without a mains failure actually being present	x	x	x	x	x	C

DI function	DI explanation	AUTO mode	SEMI-AUTO mode	Test mode	Man. mode	Block mode	Type[1]
Remote TB 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 opened.		x				P
Remote TB Off	The generator breaker OFF sequence will be initiated. If the mains breaker is opened,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				P
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				P
Remote MB Off	The mains breaker OFF sequence will be initiated, and the breaker will open instantly.		x				P
TB close inhibit	When this input is activated, the tie breaker cannot close.	x	x	x	x	x	C
MB close inhibit	When this input is activated, the mains breaker cannot close.	x	x	x	x	x	C
TB racked out	The breaker will be considered as racked out when pre-requirements are met and this input is activated.		x		x		C
MB racked out	The breaker will be considered as racked out when pre-requirements are met and this input is activated.		x		x		C
TB spring loaded	AGC 150 will not send a close signal before this feedback is present.	x	x	x	x	x	C
MB spring loaded	AGC 150 will not send a close signal before this feedback is present.	x	x	x	x	x	C
Ext. MB open	Choose the terminal used for ext. MB open.						
Enable separate sync.	Activate to split the breaker close and the breaker synchronisation functions in two different relays. The breaker close function remain on the relays dedicated for breaker control. The synchronisation function will be moved to a configurable relay.	x	x	x	x	x	C
SEMI-AUTO mode	Changes the present running mode to SEMI-AUTO.	x		x	x	x	P
Test mode	Changes the present running mode to test.	x	x		x	x	P
AUTO mode	Changes the present running mode to AUTO.		x	x	x	x	P
Block mode	Changes the present running mode to Block.	x	x	x	x		P
Total test	This input will be logged in the event log to indicate that a planned mains failure has been made.	x	x	x	x	x	C
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 parameter 7081 (Mode shift) is disregarded.	x	x	x	x	x	C
Mains Okay	Disables the Mains OK delay timer. The synchronisation of the mains breaker will only happen when the input is activated.	x	x	x	x	x	C
Access lock	Activating the access lock input deactivates the controller display buttons. It will only be possible to view measurements, alarms and the log.	x	x	x	x	x	C

DI function	DI explanation	AUTO mode	SEMI-AUTO mode	Test mode	Man. mode	Block mode	Type[1]
Remote alarm ack	Acknowledges all present alarms, and the alarm LED on the display stops flashing.	x	x	x	x	x	C
Switchboard error	The input will stop or block the genset, depending on running status.	x	x	x	x	x	C

Table 12.3 Digital inputs for BTB controller

DI function	DI explanation	AUTO mode	SEMI-AUTO mode	Test mode	Man. mode	Block mode	Type[1]
Remote BTB On	The BTB ON sequence will be initiated and the breaker will synchronise if the BTB is closed, or close without synchronising if the BTB is opened.		x				P
Remote BTB Off	The BTB OFF sequence will be initiated and the breaker will open instantly.		x				P
BTB close inhibit	When this input is activated, the bus tie breaker cannot close.	x	x	x	x	x	C
BTB racked out	The breaker will be considered as racked out when pre-requirements are met and this input is activated.		x		x		C
BTB spring loaded	AGC 150 will not send a close signal before this feedback is present.	x	x	x	x	x	C
Enable separate sync.	Activate to split the breaker close and the breaker synchronisation functions in two different relays. The breaker close function remain on the relays dedicated for breaker control. The synchronisation function will be moved to a configurable relay.	x	x	x	x	x	C
SEMI-AUTO mode	Changes the present running mode to SEMI-AUTO.	x		x	x	x	P
AUTO mode	Changes the present running mode to AUTO.		x	x	x	x	P
Block mode	Changes the present running mode to Block.	x	x	x	x		P
Access lock	Activating the access lock input deactivates the controller display buttons. It will only be possible to view measurements, alarms and the log.	x	x	x	x	x	C
Remote alarm ack	Acknowledges all present alarms, and the alarm LED on the display stops flashing.	x	x	x	x	x	P

Note[1]: C = Constant, P = Pulse

Note[2]: Not configurable

Note[3]: Can only be used in Manual mode.

Note[4]: Configured with the Utility Software.

12.1.2 Standard digital inputs

AGC 150 has as standard 12 digital inputs, located on the terminals 39 to 50. All inputs are configurable.

Table 12.4 Digital inputs

Input	Text	Function	Technical data
39	In	Configurable	Negative switching only, < 100 Ω
40	In	Configurable	Negative switching only, < 100 Ω
41	In	Configurable	Negative switching only, < 100 Ω
42	In	Configurable	Negative switching only, < 100 Ω
43	In	Configurable	Negative switching only, < 100 Ω
44	In	Configurable	Negative switching only, < 100 Ω
45	In	Configurable	Negative switching only, < 100 Ω
46	In	Configurable	Negative switching only, < 100 Ω
47	MB on	Configurable (application dependent)	Negative switching only, < 100 Ω
48	MB off	Configurable (application dependent)	Negative switching only, < 100 Ω
49	GB/TB on	Configurable (application dependent), also used for BTB ON	Negative switching only, < 100 Ω
50	GB/TB off	Configurable (application dependent), also used for BTB OFF	Negative switching only, < 100 Ω

12.1.3 Configure a digital input

The digital inputs can be configured from the controller or with the Utility Software (some parameters can only be accessed with the Utility Software).

Configure a digital input from the controller

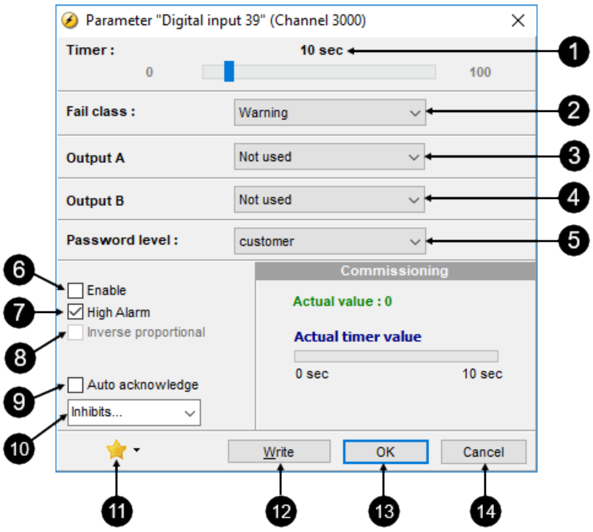
Configure a digital input under **Settings > I/O settings > Inputs > Digital input > Digital input #**, where # is 39 to 50.

Parameter	Text	Range	Default
3001, 3011, 3021, 3031, 3041, 3051, 3061, 3071, 3081, 3091, 3101 or 3111	Timer	0.0 to 100.0 s	10.0 s
3002, 3012, 3022, 3032, 3042, 3052, 3062, 3072, 3082, 3092, 3102 or 3112	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
3003, 3013, 3023, 3033, 3043, 3053, 3063, 3073, 3083, 3093, 3103 or 3113	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
3004, 3014, 3024, 3034, 3044, 3054, 3064, 3074, 3084, 3094, 3104 or 3114	Enable	OFF ON	OFF
3005, 3015, 3025, 3035, 3045, 3055, 3065, 3075, 3085, 3095, 3105 or 3115	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning
3006, 3016, 3026, 3036, 3046, 3056, 3066, 3076, 3086, 3096, 3106 or 3116	Type	N/C N/O	N/O

Configure a digital input with the Utility Software

With the Utility Software, select the digital input to configure and press the *Edit all settings for the parameter* button.

A window appears with the following parameter settings:



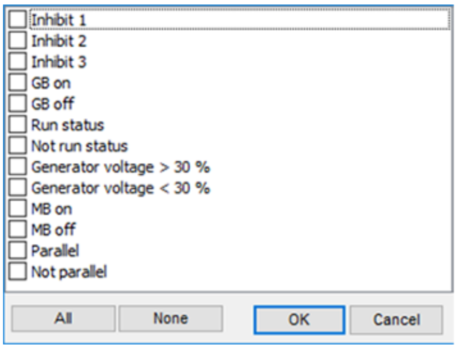
No.	Text	Description
1	Timer	The timer setting is the time from the alarm level is reached until the alarm occurs.
2	Fail class	Select the required fail class from the drop-down list. When the alarm occurs, the controller will react according to the selected fail class.
3	Output A	Select the terminal to be activated by an alarm. Select a terminal number or the Limit option in the drop down list. Limit makes the alarm useable as an input event in M-Logic.
4	Output B	Select the terminal to be activated by an alarm. Select a terminal number or the Limit option in the drop down list. Limit makes the alarm useable as an input event in M-Logic.
5	Password level	Select the password level that is needed to modify this parameter (can not be edited by a user with lower privileges).
6	Enable	Activates/deactivates the alarm function related this parameter.
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	Not used for digital inputs.
9	Auto acknowledge	If this option is set, the alarm is automatically acknowledged if the signal related to the alarm disappears.
10	Inhibits*	Used to express exceptions to when an alarm must be triggered. In order to select when the alarms are to be active, each alarm has a configurable inhibit setting.
11	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.
12	Write	Press to write the actually selected changes to the AGC 150.
13	OK	Press to confirm after each writing to the AGC 150.
14	Cancel	Quits the selected changes without writing to the AGC 150.

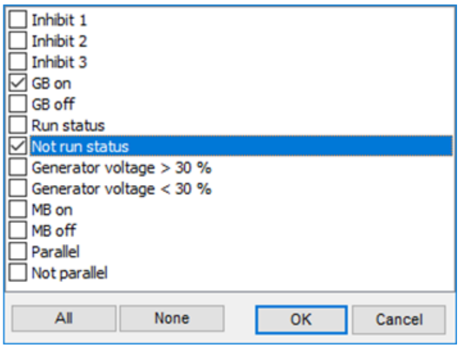
*Inhibits

The inhibit functionality is only available via the 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 parameter 6160 has expired
Not run status	Running not detected and the timer in parameter 6160 has 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

Inhibit of the alarm is active as long as one of the selected inhibit functions are active.





In the example, inhibit is set to GB On and Not run status. 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.

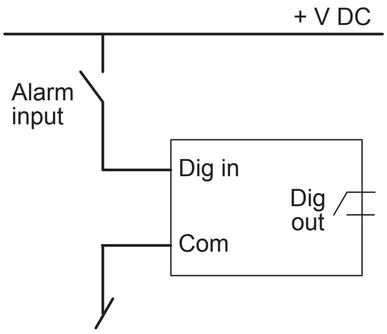
- Function inputs such as running feedback, remote start or access lock are never inhibited. Only alarm inputs can be inhibited.
- If an alarm is configured to activate a limit relay, the relay will activate despite that the inhibit input is ON.
- The bus tie breaker controller has no running detection to 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 %).

12.2 Input function selection

12.2.1 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 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.

NOTE The digital output function can be selected to be ND (Normally De-energised), NE (Normally Energised) or Limit.

13. Multi-inputs

13.1 About multi-inputs

13.1.1 Introduction

The AGC 150 has four multi-inputs: Multi-input 20, multi-input 21, multi-input 22 and multi-input 23.

The multi-inputs can be configured as:

- 4-20 mA
- 0-10 V DC
- Pt100
- RMI oil pressure
- RMI water temperature
- RMI fuel level
- Binary/digital input

The function of the multi-inputs can only be configured with the Utility Software.

13.1.2 Application description

The multi-inputs can be used in different applications, for example:

- 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 20.
- Temperature sensor. Pt100 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 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

Wiring of the inputs depends on the type of measurement: current, voltage or resistance.

More information
See the chapter **Wirings** in the Installation instructions for more information.

13.1.4 Wire break

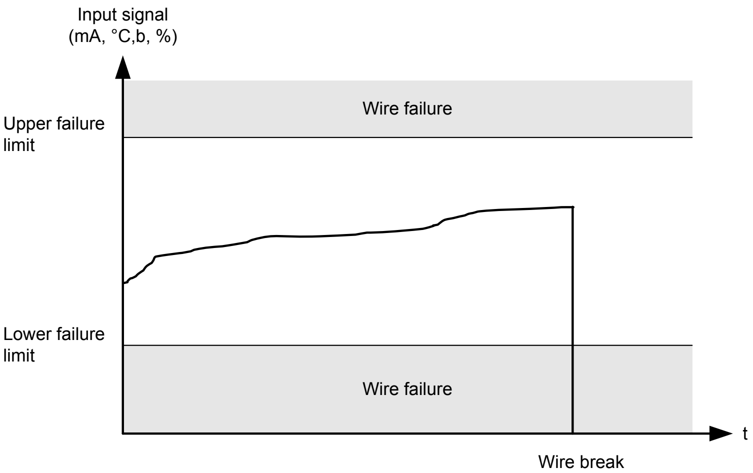
If it is necessary to supervise the sensors/wires connected to the multi-inputs and analogue inputs, then it is possible to enable the wire break function for each input. If the measured value on the input is outside the normal dynamic area of the input, it will be detected as if the wire has made a short circuit or a break. An alarm with a configurable fail class will be activated.

Input	Wire failure area	Normal range	Wire failure area
4-20 mA	<3 mA	4-20 mA	>21 mA
0-10 V DC	≤0 V DC	-	N/A
RMI Oil, type 1	<10.0 Ω	-	>184.0 Ω
RMI Oil, type 2	<10.0 Ω	-	>184.0 Ω

Input	Wire failure area	Normal range	Wire failure area
RMI Temp, type 1	<22.4 Ω	-	>291.5 Ω
RMI Temp, type 2	<18.3 Ω	-	>480.7 Ω
RMI Temp, type 3	<7.4 Ω	-	>69.3 Ω
RMI Fuel, Type 1	<1.6 Ω	-	>78.8 Ω
RMI Fuel, Type 2	<3.0 Ω	-	>180.0 Ω
RMI configurable	<lowest resistance	-	>highest resistance
Pt100	<82.3 Ω	-	>194.1 Ω
Level switch	Only active if the switch is open		

Principle

The illustration shows that when the wire of the input breaks, the measured value will drop to zero, and the alarm will occur.

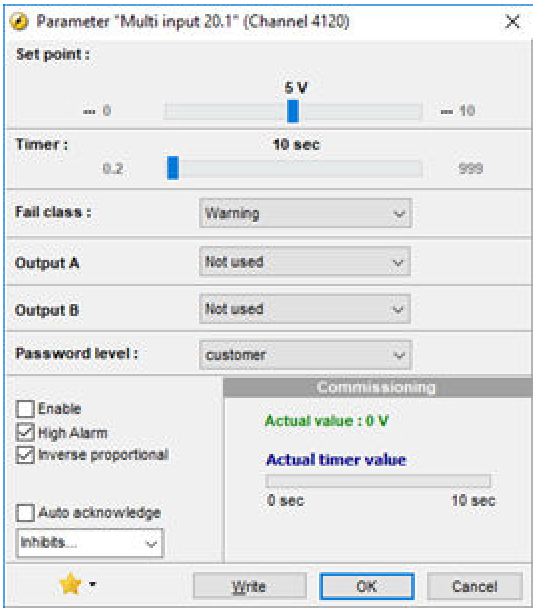


Configure the parameters for Wire break under **Settings > I/O settings > Inputs > Multi input > Wire fail #**, where # is 20, 21, 22 or 23.

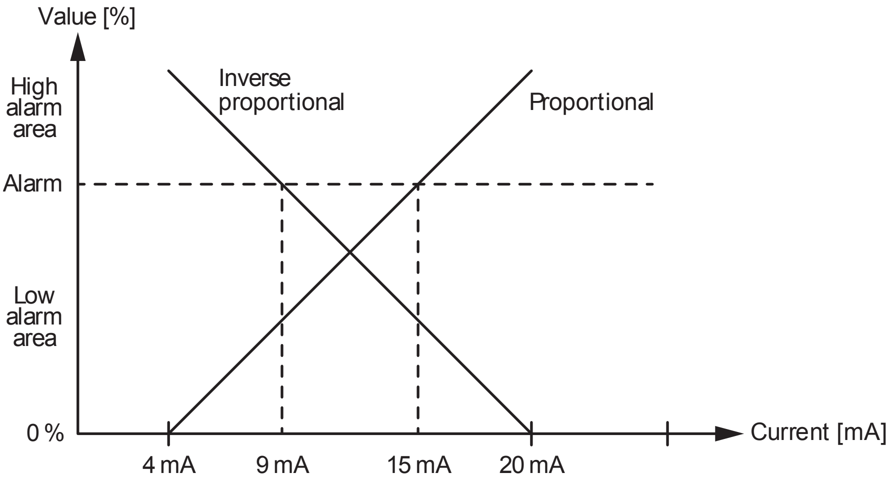
Parameter	Text	Range	Default
4141, 4171, 4201 or 4231	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
4142, 4172, 4202 or 4232	Output B		
4143, 4173, 4203 or 4233	Enable	OFF ON	OFF
4144, 4174, 4204 or 4234	Fail class	Block Warning Trip GB Trip ? Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning

13.1.5 Inverse proportional

If the input signal is reversed, the *Inverse proportional* selection can be activated with the Utility Software. 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.



13.1.6 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.

Configure the Delta alarms under **Settings > Functions > Delta alarms > Set #**, where # is 1 to 6.

Parameter	Text	Range	Default
4601	Input A for comparison set 1	Multi-input 20 to 23 EIC Oil pressure EIC Water temperature EIC Oil temperature EIC Ambient temperature EIC Intercooler temperature EIC Fuel temperature EIC Fuel deliv. pressure EIC Air f1 diff. pressure EIC Air f2 diff. pressure EIC Fuel pump pressure EIC Fuel f diff. s pressure EIC Oil f diff. pressure EIC Exhaust left temperature EIC Exhaust right temperature EIC Fuel f diff. pressure T. Winding Highest T. Winding Lowest T Winding 1 to 3 DEF Level DEF Temp	Multi-input 20
4602	Input B for comparison set 1		
4603	Input A for comparison set 2		
4604	Input B for comparison set 2		
4605	Input A for comparison set 3		
4606	Input B for comparison set 3		
4671	Input A for comparison set 4		
4672	Input B for comparison set 4		
4673	Input A for comparison set 5		
4674	Input B for comparison set 5		
4675	Input A for comparison set 6		
4676	Input B for comparison set 6		

Configure the Delta analogue inputs under **Settings > Functions > Delta alarms > Set # > Delta ana# 1 or 2**, where # is 1 to 6.

Parameter	Text	Range	Default
4611, 4631, 4651, 4681, 4701 or 4721	Set point 1	-999.9 to 999.9	1.0
4621, 4641, 4661, 4691, 4711 or 4731	Set point 2	-999.9 to 999.9	1.0
4612, 4632, 4652, 4682, 4702 or 4722	Timer 1	0.0 to 999.0 s	5.0 s
4622, 4642, 4662, 4692, 4712 or 4732	Timer 2	0.0 to 999.0 s	5.0 s
4613, 4633, 4653, 4683, 4703 or 4723	Output A set 1	Not used Relay 5, 6 and 9 to 18 Limits	-
4623, 4643, 4663, 4693, 4713 or 4733	Output A set 2		
4614, 4634, 4654, 4684, 4704 or 4724	Output B set 1		
4624, 4644, 4664, 4694, 4714 or 4734	Output B set 2		
4615, 4635, 4655, 4685, 4705 or 4725	Enable set 1	OFF ON	OFF
4625, 4645, 4665, 4695, 4715 or 4735	Enable set 2		
4616, 4636, 4656, 4686, 4706 or 4726	Fail class set 1	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning
4626, 4646, 4666, 4696, 4716 or 4736	Fail class set 2		

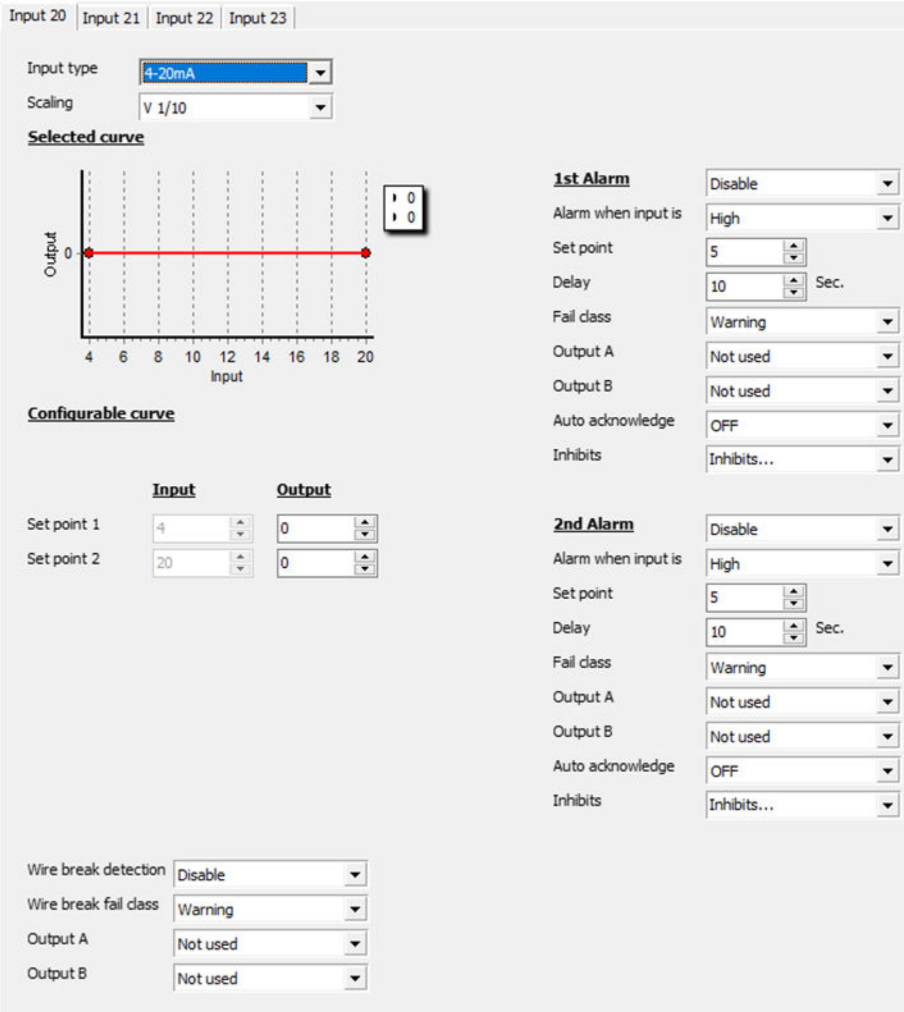
13.1.7 Scaling of multi-input readings

Scaling of the multi-input readings is made to change the reading resolution to fit the connected sensor.

Scaling is made with the Utility Software:

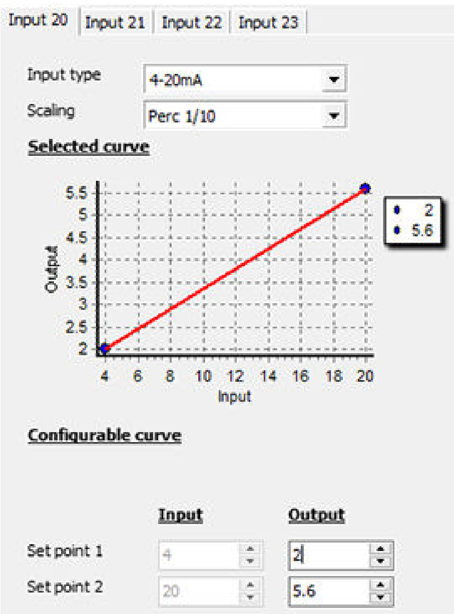
1. In the left menu bar, select Multi input.

2. Configure the parameters for the multi-input.

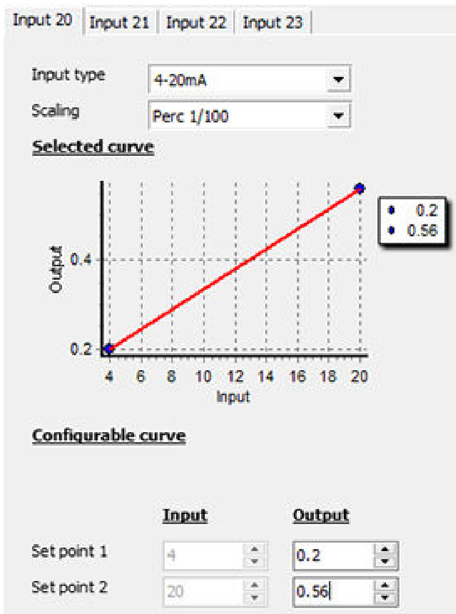


3. Select the appropriate value in the Scaling menu.

Example



Scaling 1/10



Scaling 1/100

13.2 Multi-inputs 20, 21, 22 and 23

13.2.1 Terminals

The four multi-inputs are connected to following terminals:

- Terminal 19: Common GND
- Terminal 20: Multi-input 20
- Terminal 21: Multi-input 21
- Terminal 22: Multi-input 22
- Terminal 23: Multi-input 23

13.2.2 Alarms

For each multi-input, two alarm levels are available. With two alarms it is possible to have the first alarm reacting slow, while the second alarm can react faster. For example, if the sensor measures generator current as protection against overload, a small overload is acceptable for a shorter period, but in case of a large overload, the alarm should activate quickly.

The configuration of the multi-input alarms is made with the Utility Software. In the left menu, press the *Multi Input*  button to go to the Multi-input page.

1. Select the desired multi-input tab.
2. Configure the parameters for 1st alarm.
3. Configure the parameters for 2nd alarm.

Sensors with max. output less than 20 mA

If a sensor has a maximum output less than 20 mA, it is necessary to calculate what a 20 mA signal would indicate.

Example: A pressure sensor gives 4 mA at 0 bars and 12 mA at 5 bar.

- (12 - 4) mA = 8 mA = 5 bar
- 1 mA = 5 bar/8 = 0.625 bar
- 20 - 4 mA = 16 × 0.625 bar = 10 bar

13.2.3 RMI sensor types

The standard multi-inputs can be configured as RMI inputs. The inputs have different functions, as the hardware design allows for several RMI types.

The available RMI input types are:

- RMI oil pressure
- RMI water temperature
- RMI fuel level

For each type of RMI input, it is possible to select between different characteristics, including a configurable. The configurable type can be configured with eight set points in the range 0 to 480 Ω. The resistance and the pressure can be adjusted.

Table 13.1 RMI Oil pressure default set points

Pressure (Bar)	Pressure (psi)	RMI sensor type 1 (Ω)	RMI sensor type 2 (Ω)	RMI sensor type 4 (Ω)
0	0	10.0	10.0	240.0
0.5	7.3	27.2	-	-
1.0	14.5	44.9	31.3	-
1.4	20.3	-	-	165.0
2.0	29.0	81.0	-	-
2.1	30.5	-	-	135.0
3.0	43.5	117.1	71.0	-
3.4	49.3	-	-	103.0
3.5	50.8	134.7	-	-
4.0	58.0	151.9	89.6	-
4.1	59.5	-	-	88.0
5.0	72.5	184.0	107.3	-
5.5	79.8	-	-	60.0
6.2	89.9	-	-	47.0
6.9	100.1	-	-	33.0
7.0	101.5	-	140.4	-
9.0	13.5	-	170.2	-
10.0	145.0	-	184.0	-

Table 13.2 RMI water temperature default set points

Temperature (°C)	Temperature (°F)	RMI water temp. type 1 (Ω)	RMI water temp. type 2 (Ω)	RMI water temp. type 3 (Ω)	RMI water temp. type 4 (Ω)
20	68	-	-	-	2500
40	104	292	481	69	1029
50	122	197	-	-	-
60	140	134	223	36	460
70	158	97	157	-	-
80	176	-	-	20	227
90	194	51	83	-	-
100	212	39	62	12	120
110	230	29	-	-	-
120	248	22	37	7	74
130	266	-	-	-	52
140	284	-	23	-	40
150	302	-	18	-	-

Table 13.3 RMI fuel level default set points

Fuel level (%)	RMI fuel level type 1 (Ω)	RMI fuel level type 2 (Ω)	RMI fuel level type 4 (Ω)
0	78.8	3.0	240.0
14.3	67.8	28.3	-
25.0	-	-	147.0
28.6	56.7	53.6	-
42.9	45.7	78.9	-
50.0	-		103.0
57.1	34.7	104.1	-
71.4	23.7	129.4	-
75.0	-	-	60.0
85.7	12.6	154.7	-
100.0	1.6	180 .0	33.0

NOTE 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.

13.2.4 Parameters for multi-inputs

The available menus depend on the input type. The input type is set with the Utility Software.

Configure the parameters for multi-input alarm 1 under **Settings > I/O settings > Inputs > Multi input > Multi input #.1**, where # is 20 to 23.

Parameter	Text	Input type	Range	Default
4121, 4151, 4181 or 4211	Set point	4-20 mA	4 to 20 mA	10 mA
		0-10 V DC	0.0 to 10.0 V	5.0V
		Pt 100	0 to 100 °C	50 °C
		RMI Oil pressure	0.0 to 10.0 bar	5.0 bar
		RMI Water temp.	-32768 to 32767 °C	50 °C
		RMI Fuel level	-32768 to 32767 %	50 %
4122, 4152, 4182 or 4212	Timer	4-20 mA	0.0 to 999.0 s	120 s
		0-10 V DC	0.2 to 999.0 s	10.0 s
		Pt 100	0.0 to 999.0 s	5.0 s
		RMI Oil pressure	0.2 to 999.0 s	10.0 s
		RMI Water temp.	0.2 to 999.0 s	10.0 s
		RMI Fuel level	0.2 to 999.0 s	10.0 s
4123, 4153, 4183 or 4213	Output A	All	Not used Relay 5, 6 and 9 to 18 Limits	Not used
4124, 4154, 4184 or 4214	Output B	All		
4125, 4155, 4185 or 4215	Enable	All	OFF ON	OFF
4126, 4156, 4186 or 4216	Fail class	All	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning

Configure the parameters under **Settings > I/O settings > Inputs > Multi input > Multi input #.2**, where # is 20 to 23.

Parameter	Text	Input type	Range	Default
4131, 4161, 4191 or 4221	Set point	4-20 mA	4 to 20 mA	10 mA
		0-10 V DC	0.0 to 10.0 V	5.0V
		Pt 100	0 to 100 °C	50 °C
		RMI Oil pressure	0.0 to 10.0 bar	5.0 bar
		RMI Water temp.	-32768 to 32767 °C	50 °C
		RMI Fuel level	-32768 to 32767 %	50 %
4132, 4162, 4192 or 4222	Timer	4-20 mA	0.0 to 999.0 s	120 s
		0-10 V DC	0.2 to 999.0 s	10.0 s
		Pt 100	0.0 to 999.0 s	5.0 s
		RMI Oil pressure	0.2 to 999.0 s	10.0 s
		RMI Water temp.	0.2 to 999.0 s	10.0 s
		RMI Fuel level	0.2 to 999.0 s	10.0 s
4133, 4163, 41893 or 4223	Output A	All	Not used Relay 5, 6 and 9 to 18 Limits	Not used

Parameter	Text	Input type	Range	Default
4134, 4164, 4194 or 4224	Output B	All	Not used Relay 5, 6 and 9 to 18 Limits	Not used
4135, 4165, 4195 or 4225	Enable	All	OFF ON	OFF
4136, 4166, 4196 or 4226	Fail class	All	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning

14. DC relay outputs

14.1 Relay outputs and explanations

14.1.1 Standard relay outputs

The AGC 150 has 12 relay outputs as standard. The outputs are divided in two groups with different electrical characteristics.

All outputs are configurable, unless other stated.

Relay outputs, group 1

Electrical characteristics

- Voltage: 0 to 36 V DC
- Current: 15 A DC inrush, 3 A DC continuous

Relay	Genset default setting	Mains default setting	BTB default setting
Relay 05	Run coil	No default	No default
Relay 06	Crank	No default	No default

Relay outputs, group 2

Electrical characteristics

- Voltage: 4.5 to 36 V DC
- Current: 2 A DC inrush, 0.5 A DC continuous

Relay	Genset default setting	Mains default setting	BTB default setting
Relay 09	Start prepare	No default	No default
Relay 10	Stop coil relay	No default	No default
Relay 11	Status OK	Status OK	Status OK
Relay 12	Horn	Horn	Horn
Relay 13	No default	No default	No default
Relay 14	No default	No default	No default
Relays 15	No default	MB ON relay*	No default
Relay 16	No default	MB OFF relay*	No default
Relay 17	GB ON relay*	TB ON relay*	BTB ON relay*
Relay 18	GB OFF relay*	TB OFF relay*	BTB OFF relay*

*Note: Not configurable.

15. Analogue outputs for regulation

15.1 Analogue outputs for regulation

15.1.1 Analogue outputs

AGC 150 has two analogue outputs that are active and galvanically separated. No external supply can be connected.

Table 15.1 ANSI codes

Function	ANSI no.
Selectable ±10 V DC or relay output for speed control (governor)	77
Selectable ±10 V DC or relay output for voltage control (AVR)	77
PWM speed control output for CAT® engines	77

15.1.2 Duty cycle

The PWM signal has a frequency of 500 Hz ±50 Hz. The resolution of the duty cycle is 10,000 steps. The output is an open collector output with a 1 kΩ pull-up resistor. Frequency and amplitude are configurable.

Configure the PWM signal under **Settings > Engine > GOV > General configuration > PWM 52 setup**.

Parameter	Text	Range	Default
5721	Limits minimum	0 to 50 %	10 %
5722	Limits maximum	50 to 100 %	90 %
5723	GOV type	Adjustable Caterpillar: 6 V/500 Hz	Adjustable
5724	Amplitude set point	1.0 to 10.5 V	5.0 V
5725	Frequency set point	1 to 2500 Hz	500 Hz

Figure 15.1 Duty cycle (min. level 0 to 0.05 V, max. level 5.7 to 6.0 V)

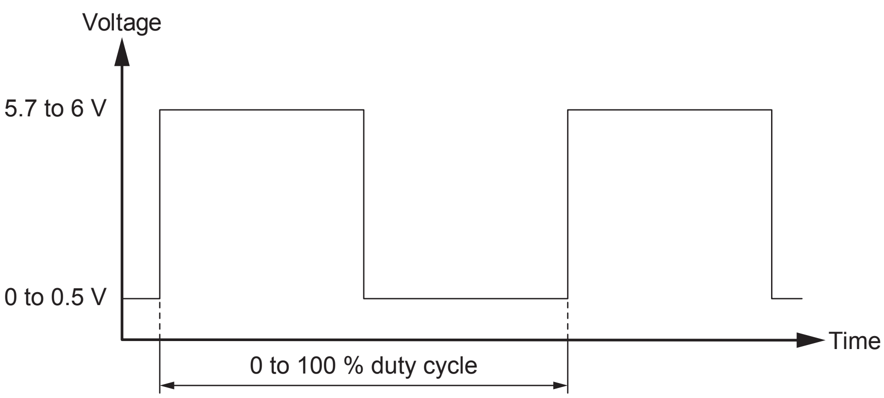


Figure 15.2 Example: 10 % duty cycle

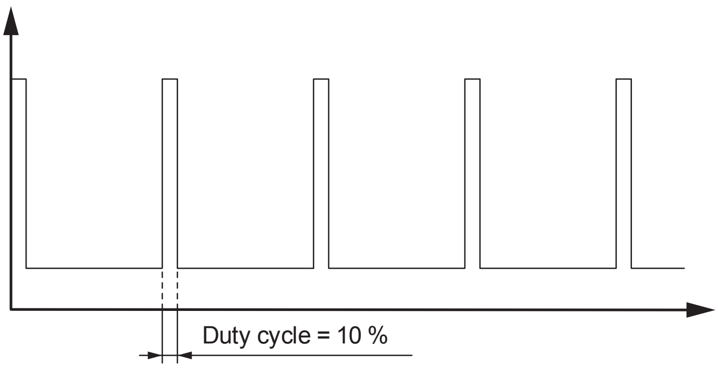
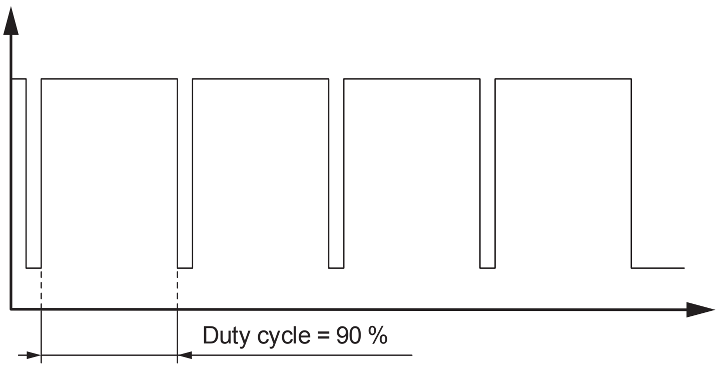


Figure 15.3 Example: 90 % duty cycle



16. Engine communication

16.1 Introduction to engine communication

16.1.1 Engine communication

The engine communication makes it possible to communicate between an AGC 150 and several engine types over CAN bus. With the engine communication, it is possible to read different information from the engine's ECM, and on some ECMs also regulate and send different commands.

16.1.2 Modbus communication

Some of the engine data can be read via Modbus. The Modbus data is found in the Modbus tables.

More information
See the document **Modbus tables** on deif.com.

16.1.3 Terminal description

The engine communication in the AGC 150 is made via these terminals:

Terminal	Function	Description
27	CAN A High	CAN bus card Engine Interface communication
28	CAN A GND	
29	CAN A Low	

16.2 Functional description

16.2.1 Electronic control module (ECM)

This communication retrieves information from the engine's Electronic Control Module (ECM) with CAN bus interface. The values can be used as display values, alarms/shutdown alarms and values to be transmitted via Modbus.

16.2.2 Engine types

AGC 150 can communicate with the following engine controllers/types:

Engine manufacturer	Engine controller/type	Comment
Caterpillar	ADEM III and A4/C4.4, C6.6, C9, C15, C18, C32	Rx/Tx
Cummins	CM 500/558/570/850/2150/2250, QSL, QSB5, QSX15 and 7, QSM11, QSK 19/23/50/60	Rx/Tx
Detroit Diesel	DDEC III and IV/Series 50, 60 and 2000	Rx/Tx
Deutz	EMR3, EMR 2 (EMR)/912, 913, 914 and L2011	Rx/Tx
-	Generic J1939	Rx/Tx
Iveco	EDC7 (Bosch MS6.2)/Series NEF, CURSOR and VECTOR 8	Rx/Tx
John Deere	JDEC/PowerTech M, E and Plus	Rx/Tx
MTU	MDEC, module M.302 or M.303/Series 2000 and 4000	Rx
MTU	MDEC, module M.201 or M.304/Series 2000 and 4000	Rx Select M.303

Engine manufacturer	Engine controller/type	Comment
MTU	ADEC/Series 2000 and 4000 (ECU7), MTU PX-Engines[2], with SAM module	Rx/Tx
MTU	J1939 Smart Connect/Series 1600 (ECU8)	Rx/Tx
MTU	ADEC/Series 2000 and 4000 (ECU7), without SAM module (software module 501)	Rx/Tx
Perkins	Series 850, 1100, 1200, 1300, 2300, 2500 and 2800	Rx/Tx
PSI/Power Solutions	PSI/Power Solutions	Rx/Tx
Scania	EMS	Rx
Scania	EMS S6 (KWP2000)/Dx9x, Dx12x, Dx16x	Rx/Tx
Volvo Penta	EDC4	Rx
Volvo Penta	EMS	Rx
Volvo Penta	EMS 2 and EDCIII/D6, D7, D9, D12 and D16 (GE and AUX variants only)	Rx/Tx

NOTE For support of controller/engine types not listed, contact DEIF A/S.

More information
See **Engine communication, Specific engine type descriptions** in this document for more information on data read and write.

Configure the Engine interface settings under **Settings > Engine > GOV > EIC configuration > Engine type**.

Parameter	Text	Range	Default
7561	Engine interface selection	OFF DDEC EMR JDEC Iveco Perkins Caterpillar Volvo Penta Volvo Penta EMS 2 Scania EMS Scania EMS 2 S6 MDEC 2000/4000 M.302 MDEC 2000/4000 M.303 MTU ADEC Cummins Generic J1939 IOM-220/230 MTU J1939 Smart Conn MTU ADEC Module 501 PSI/Power solutions	OFF

16.2.3 AVR types

AGC 150 can communicate with some AVRs. Configure the AVR interface settings under **Settings > Generator > AVR > DAVR configuration > DAVR type > Digital AVR**.

Parameter	Text	Range	Default
7565	DAVR type	OFF Caterpillar CDVR Leroy Somer D510C DEIF DVC310	OFF

16.2.4 Communication system

The protocols are based on a CAN bus communication system on the J1939, with the exceptions of the MDEC and ADEC communication. The MDEC and ADEC protocols are MTU-designed protocols.

The Baud rate is fixed by the engine manufacturer at:

Engine manufacturer	Baud rate
ADEC	125 kb/s
MDEC	125 kb/s
Caterpillar	250 kb/s
Cummins	250 kb/s
Detroit Diesel	250 kb/s
Deutz	250 kb/s
Iveco	250 kb/s
John Deere	250 kb/s
MTU J1939 Smart Connect	250 kb/s
Perkins	250 kb/s
Scania	250 kb/s
Volvo Penta	250 kb/s

16.2.5 Common for all alarm functions

A number of items can be configured to an alarm.

Configure the Communication failure under **Settings > Engine > GOV > EIC configuration > Communication failure**.

Parameter	Text	Range	Default
7571	Timer	0.0 to 100.0 s	0.0 s
7572	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
7573	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
7574	Enable	OFF ON	OFF
7575	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning

Configure the EIC Warning under **Settings > Engine > Protections > EIC-based protections > EIC status lamp > EIC Warning**.

Parameter	Text	Range	Default
7581	Timer	0.0 to 100.0 s	0.0 s
7582	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
7583	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
7584	Enable	OFF ON	OFF
7585	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning

Configure the EIC Shutdown under **Settings > Engine > Protections > EIC-based protections > EIC status lamp > EIC Shutdown**.

Parameter	Text	Range	Default
7591	Timer	0.0 to 100.0 s	0.0 s
7592	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
7593	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used
7594	Enable	OFF ON	OFF
7595	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Shutdown

Configure the EIC Overspeed under **Settings > Engine > Protections > EIC-based protections > Overspeed > EIC Overspeed**.

Parameter	Text	Range	Default
7601	Set point	100.0 to 150.0 %	110.0 %
7602	Timer	0.0 to 100.0 s	5.0 s
7603	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used
7604	Output B	Not used	Not used

Parameter	Text	Range	Default
		Relay 5, 6 and 9 to 18 Limits	
7605	Enable	OFF ON	OFF
7606	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning

Configure the first EIC Coolant temperature under **Settings > Engine > Protections > EIC-based protections > Coolant > EIC Coolant T.#**, where # is 1 or 2.

Parameter	Text	Range	Default T.1	Default T.2
7611 or 7621	Set point	-40 to 410 °C	100 °C	110 °C
7612 or 7622	Timer	0.0 to 100.0 s	5.0 s	5.0
7613 or 7623	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used
7614 or 7624	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used
7615 or 7625	Enable	OFF ON	OFF	OFF
7616 or 7626	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning	Warning

Configure the first EIC Coolant level under **Settings > Engine > Protections > EIC-based protections > Coolant > EIC Coolant L.#**, where # is 1 or 2.

Parameter	Text	Range	Default L.1	Default L.2
7671 or 7681	Set point	0.0 to 100.0 %	20.0 %	10.0 %
7672 or 7682	Timer	0.0 to 100.0 s	5.0 s	5.0 s
7673 or 7683	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used
7674 or 7684	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used
7675 or 7685	Enable	OFF	OFF	OFF

Parameter	Text	Range	Default L.1	Default L.2
		ON		
7676 or 7686	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning	Shutdown

Configure the first EIC Oil pressure under **Settings > Engine > Protections > EIC-based protections > Oil > EIC Oil pres. #**, where # is 1 or 2.

Parameter	Text	Range	Default 1	Default 2
7631 or 7641	Set point	0.0 to 145.0 bar	2.0 bar	1.0 bar
7632 or 7642	Timer	0.0 to 100.0 s	5.0 s	5.0 s
7633 or 7643	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used
7634 or 7644	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used
7635 or 7645	Enable	OFF ON	OFF	OFF
7636 or 7646	Fail class	Block Warning Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop	Warning	Shutdown

Configure the first EIC Oil temperature under **Settings > Engine > Protections > EIC-based protections > Oil > EIC Oil temp. #**, where # is 1 or 2.

Parameter	Text	Range	Default 1	Default 2
7651 or 7661	Set point	0 to 410 °C	40 °C	50 °C
7652 or 7662	Timer	0.0 to 100.0 s	5.0 s	5.0 s
7653 or 7663	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used
7654 or 7664	Output B	Not used Relay 5, 6 and 9 to 18 Limits	Not used	Not used
7655 or 7665	Enable	OFF ON	OFF	OFF
7656 or 7666	Fail class	Block Warning	Warning	Shutdown

Parameter	Text	Range	Default 1	Default 2
		Trip GB Trip + Stop Shutdown Trip MB Safety stop Trip MB/GB Controlled stop		

16.2.6 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; please refer to the specific engine description.

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 the values shown in the table below. The engine uses by default source address 0, which is the most commonly used setting on ECUs. If a different source address is required, it can be changed in parameter 7562.

More information
See **Engine communication, Modbus communication** in this document for more information about Modbus scaling.

Object	PGN* (Dec/Hex)	S*	L*	P*	SPN*	Unit*	J1939-71 scaling
EngineAuxShutdownSW, MLogic	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, 0 offset
EIC % load, c. speed	61443/F003	3	1	3/6	92	%	1 %/bit, 0 offset
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, 0 offset
Engine Demand - Torque	61444/F004	8	1	3	2432	%	1 %/bit, -125 % offset
AT1IntTNOx	61454/F00E	1	2	6	3216	ppm	0.05 ppm/bit, -200 ppm offset
Aftertreatment 1 Intake Oxygen	61454/F00E	3	2	6	3217	%	0.000514 %/bit, -12 % offset
AT1OutLNOx	61455/F00F	1	2	6	3226	ppm	0.05 ppm/bit, -200 ppm offset
Aftertreatment 1 Outlet Oxygen	61455/F00F	3	2	6	3227	%	0.000514 %/bit, -12 % offset

Object	PGN* (Dec/Hex)	S*	L*	P*	SPN*	Unit*	J1939-71 scaling
AT2IntTNOx	61456/F010	1	2	6	3255	ppm	0.05 ppm/bit, -200 ppm offset
Throttle Actuator Control	61466/F01A	1	2	4	3464	%	0.0025 %/bit, 0 offset
AT2OutLNOx	61457/F011	1	2	6	3265	ppm	0.05 ppm/bit, -200 ppm offset
AT1ExhFA.DQ	61475/F023	1	2	3	4331	g/h	0.3 g/h per bit, 0 offset
AT1ExhFluDAB	61475/F023	6	1	3	4334	kPa	8 kPa/bit, 0 offset
AT1ExhFluDRQ	61476/F024	1	2	6	4348	g/h	0.3 g/h per bit, 0 offset
AT2ExhFA.DQ	61478/F026	1	2	3	4384	g/h	0.3 g/h per bit, 0 offset
AT2ExhFluDAB	61478/F026	6	1	3	4387	kPa	8 kPa/bit, 0 offset
AT2ExhFluDRQ	61479/F027	1	2	3	4401	g/h	0.3 g/h per bit, 0 offset
Next Regen	64697/FCB9	1	4	6	5978	s	1 s/bit
Battery Charger 1 State	64788/FD14	1.1	4 bits	6	4990	bit	16 states/4 bit
Battery Charger 1 Power Line State	64788/FD14	1.5	2 bits	6	4991	bit	4 states/2 bit
Battery Charger 1 Output Voltage	64788/FD14	2	2	6	4992	V	0.05 V/bit
Battery Charger 1 Output Current	64788/FD14	4	2	6	4993	A	0.05 A/bit
AT2SCRCInG	64824/FD38	1	2	6	4413	°C	0.03125 deg C/bit, -273 °C offset
AT2SCRCOuG	64824/FD38	4	2	6	4415	°C	0.03125 deg C/bit, -273 °C offset
AT2ExhFlu DT	64827/FD3B	3	1	6	4390	°C	1 deg C/bit, -40 °C offset
AT1SCRCInG	64830/FD3E	1	2	5	4360	°C	0.03125 deg C/bit, -273 °C offset
AT1SCRCOuG	64830/FD3E	4	2	5	4363	°C	0.03125 deg C/bit, -273 °C offset
AT1ExhFlu DT	64833/FD41	3	1	6	4337	°C	1 deg C/bit, -40 °C offset
Long-term Fuel Trim	64841/FD49	1	2	6	4237	%	0.1 %/bit, -100 % offset
Short-term Fuel Trim	64841/FD49	3	2	6	4236	%	0.1 %/bit, -100 % offset
Exhaust Gas Oxygen Sensor Status	64841/FD49	5.1	4 bits	6	4240	bit	16 states/4 bit, 0 offset
AT1ExhAvrCons	64878/FD6E	1	2	6	3826	l/h	0.05 l/h per bit, 0 offset
EngOperatingState	64914/FD92	1.1	4 bits	3	3543	0..15	16 states/4 bit, 0 offset
Engine Derate Request	64914/FD92	8	1	3	3644	%	0.4 %/bit, 0 offset
EngineAT1RegenerationStatus, MLogic	64929/FDA1	7.5	2 bits	6	3483	0..3	4 states/2 bit, 0 offset
DPF OUTL T	64947/FDB3	3	2	6	3246	°C	0.03125 deg C/bit, -273 °C offset
EIC Air filter diff. pressure	64976/FDD0	1	1	6	2809	bar	0.05 kPa, offset 0
EIC Intake manifold #1 absolute pressure	64976/FDD0	5	1	6	3563	bar	2 kPa/bit

Object	PGN* (Dec/Hex)	S*	L*	P*	SPN*	Unit*	J1939-71 scaling
Sp.Humidity	64992/FDE0	3	2	6	4490	g/kg	0.01 g/kg per bit, 0 offset
EIC Exhaust gas temp. R manifold	65031/FE07	1	2	6	2433	°C	0.03125 °C/bit, offset -273 °C
EIC Exhaust gas temp. L manifold	65031/FE07	3	2	6	2434	°C	0.03125 °C/bit, offset -273 °C
DEF LEVEL	65110/FE56	1	1	6	1761	%	0.4 %/bit, 0 offset
AT1ExhFluTank deg	65110/FE56	2	1	6	3031	°C	1 °C/bit, -40 °C offset
bScrOprInducementActiveLamp, MLogic	65110/FE56	5.6	3 bits	6	5245	0 to 7	8 states/3 bit, 0 offset
SCR IND. SEV.	65110/FE56	6.6	3 bits	6	5246	0 to 7	8 states/3 bit, 0 offset
No view, for Coolant water regulation	65129/FE69	3	2	6	1637	°C	0.03125 °C/bit, -273 °C offset
EIC Fuel supply pump inlet pressure	65130/FE6A	2	1	6	1381	bar	2 kPa/bit, 0 offset
EIC Fuel filter (ss) diff. pressure	65130/FE6A	3	1	6	1382	bar	2 kPa/bit, 0 offset
Engine Desired Ignition Timing	65159/FE87	1	2	7	1433	deg	1/128 deg/bit, -200 deg offset
Engine Actual Ignition Timing	65159/FE87	7	2	7	1436	deg	1/128 deg/bit, -200 deg offset
EngineFuelLeak1, MLogic	65169/FE91	1	2	7	1239	bit	• 00: No leakage detect • 01: Leakage detect
AuxCool Pr.	65172/FE94	1	1	6	1203	kPa	4 kPa/bit gain, 0 kPa offset
T. Cool Aux	65172/FE94	2	1	6	1212	°C	1 °C/bit gain, −40 °C offset
Tcharger 2	65179/FE9B	2	2	7	1169	rpm	4 rpm/bit gain, 0 rpm offset
Tcharger 3	65179/FE9B	4	2	7	1170	rpm	4 rpm/bit gain, 0 rpm offset
T-ECU	65188/FEA4	3	2	6	1136	°C	0.03125 °C/bit gain, −273 °C offset
Intake Man T2	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	65203/FEB3	5	2	7	1029	l/h	0,05 [l/h]/bit
Est. Fan RPM	65213/FEBD	1	1	6	975	%	0.4 %/bit gain, 0 % offset
EIC Nominal Power	65214/FEBE	1	2	7	166	kW	0.5 kW/bit
Diagnostic message 1/2	65226/FECA	-	-	3/6/7	-	-	-
EIC faults6)	65230/FECE	1	1	6	1218	-	1/bit, offset 0
Number of Software Identification Fields	65242/FEDA	1	1	6	965	step	1 count/bit, 0 offset
Software Identification	65242/FEDA	2	Variable	6	234	SCII	ASCII, 0 offset
Tcharger 1	65245/FEDD	2	2	6	103	rpm	4 rpm/bit gain, 0 rpm offset
Nom. Friction	65247/FEDF	1	1	6	514	%	1 %/bit gain,

Object	PGN* (Dec/Hex)	S*	L*	P*	SPN*	Unit*	J1939-71 scaling
							−125 % offset
Desired	65247/FEDF	2	2	6	515	rpm	0.125 rpm/bit gain, 0 rpm offset
EngineWaitToStart, MLogic	65252/FEE4	4.1	2 bits	6	1081	bit	• 00: OFF • 01: ON
EngineProtectSysShutdown, MLogic	65252/FEE4	5.1	2 bits	6	1110	bit	• 00: Yes • 01: No
EngineProtectSysApproShutdown, MLogic	65252/FEE4	5.3	2	6	1109	bit	• 00: Not approaching • 01: Approaching
EngineAlarmAcknowledge, MLogic	65252/FEE4	7.1	2 bits	6	2815	0..3	4 states/2 bit, 0 offset
EngineAirShutoffCommandStatus, MLogic	65252/FEE4	7.5	2 bits	6	2813	0..3	4 states/2 bit, 0 offset
EngineOverspeedTest, MLogic	65252/FEE4	7.7	2 bits	6	2812	0..3	4 states/2 bit, 0 offset
EngineShutoffStatus, MLogic	65252/FEE4	8.3	2 bits	6	5404	0..3	4 states/2 bit, 0 offset
EIC engine hours	65253/FEE5	1	4	3/6	247	h	0.05 hrs/bit, offset 0, max. 32767 hrs
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.[3)]	65262/FEEE	1	1	3/6	110	°C	1 °C/bit, offset -40 °C
EIC fuel temp.	65262/FEEE	2	1	3/6	174	°C	1 °C/bit, offset -40 °
EIC oil temp.[5)]	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	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[4)]	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. [1)]	65270/FEF6	2	1	6	102	bar	2 kPa/bit, offset 0

Object	PGN* (Dec/Hex)	S*	L*	P*	SPN*	Unit*	J1939-71 scaling
EIC intake manifold 1 temp.[2]	65270/FEF6	3	1	6	105	°C	1 °C/bit, offset -40 °C
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	0.05 V DC/bit, offset 0
EIC Fuel filter diff. pressure	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
ENG CAC T	64617/FC69	7	2	6	2630	°C	0.03125 °C/bit, offset -273 °C
DPF Soot Load	64891/FD7B	1	1	6	3719	%	1 %/bit, offset 0

*Abbreviations:

- PGN = Parameter group number.
- S = Object's start byte in CAN telegram.
- L = Object's length is normally written as byte, exceptions of length are written as "bit".
- P = J1939 priority.
- SPN = Suspect parameter number.
- Unit = Unit in display (bar/°C can be changed to PSI/°F).

NOTE

- [1] also called EIC boost P.
- [2] also called EIC charge air temp.
- [3] EIC coolant temp.: PGN = 65282, priority = 6, start at byte 5, length = 1 byte, SPN = 110, same scale (only Iveco Vector 8 type).
- [4] 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).
- [5] EIC oil temp.: PGN = 65282, priority = 6, start at byte 6, length = 1 byte, SPN = 175, same scale (only Iveco Vector 8 type).
- [6] EIC Faults: PGN = 65284, priority = 6, start at byte 1, length = 2 byte (only MTU SmartConnect).

16.2.7 Engine values in the display

AGC 150 can show all values from the engine CAN bus in the display. The number of available views is 20, but the number can be increased with the Autoview function.

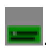
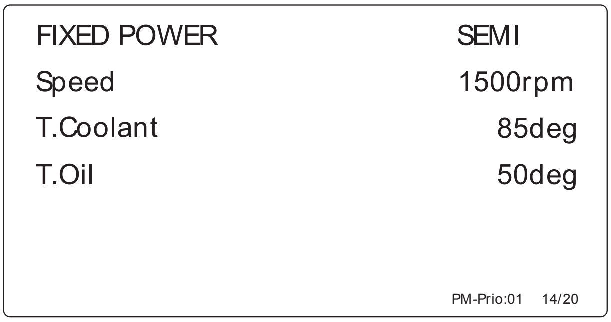
Up to 20 views can be configured with the Utility Software. Press the Utility Software button *Configuration of the user views* .

Figure 16.1 Example of view with speed, coolant and oil temperature.



EIC Auto view

With the EIC Auto view function activated the 20 display views are kept, and all engine values are added to the view list. The 20 display views are user configurable, but the additional views are dedicated to EIC and cannot be modified by the user.

Activate the EIC Auto view under **Settings > Basic settings > Controller settings > Display > EIC Auto view**.

Parameter	Text	Range	Default
7564	Auto view enable	OFF ON	OFF

NOTE The engine CAN bus must be active. It can be necessary to start the engine before activating the EIC Auto view.

16.2.8 Verification

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 AGC 150 controller and the engine controller. When the tool is connected, it is possible to monitor the communication between the two controllers. For use of the CAN tool, refer to the manual for 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 eight bytes following the CAN ID (**0xcf00400**) are data, starting with byte 1

The priority needs to be converted to decimal. 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
7	28d	0x1c

Normally in SAE J1939, only priority 3 and 6 are used.

Now the data can be read (PGN 61444): 0xcf00400 xD ff 7d 7d e0 15 ff f0 ff

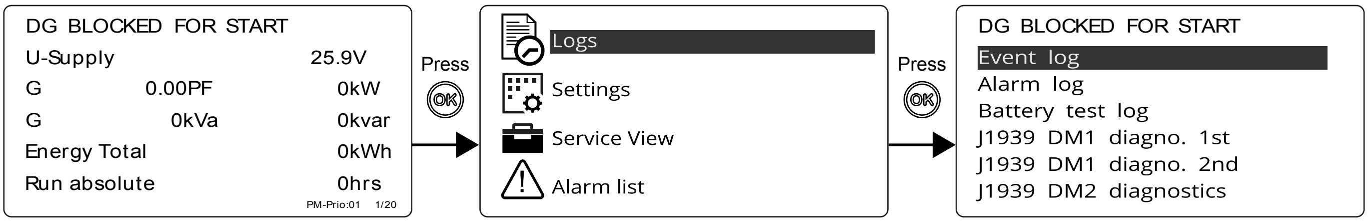
Engine torque	(Data byte 1)	ff	Not available
Driver demand torque	(Data byte 2)	7d	
Actual engine torque	(Data byte 3)	7d	
Engine speed	(Data byte 4)	e0	
Engine speed	(Data byte 5)	15	
Source address	(Data byte 6)	ff	Not available
Engine starter mode	(Data byte 7)	f0	
Engine Demand	(Data byte 8)	ff	Not 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.

16.2.9 Displaying of J1939 DM1/DM2, Scania KWP2000 and Caterpillar/Perkins alarms

Besides some engine specific alarms, which are shown in the Alarm list, the J1939 diagnostic messages DM1 (active alarms) and DM2 (historical alarm log list), as well as the Scania KWP 2000 alarms can all be shown on the display. In both cases, the alarms are accessed through the LOG list:

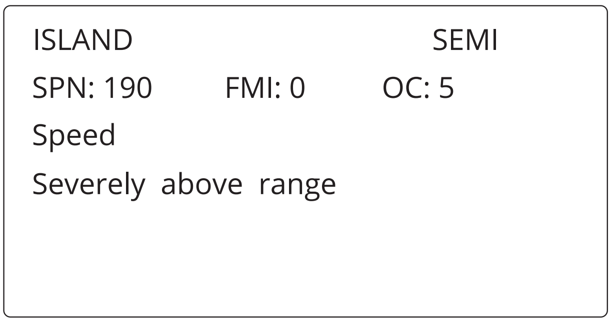


Use the *Up* and *Down* buttons to scroll through the list. Select the desired Log list with the *OK* button.

J1939 example

For DM1 and DM2, the SPN (Suspect Parameter Number) and FMI (Failure Mode Indicator) are shown along with a clear text. In the DM2 list, if you wish to acknowledge, the entire Log list is erased. For safety reasons, this requires the master password.

Figure 16.2 J1939 example:



NOTE 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.

Scania KWP 2000

The Scania KWP 2000 log shows active and passive alarms in a mix. Use the *Up* and *Down* buttons to scroll through the list. Select the desired Log list with the *OK* button.

Under the KWP 2000 diagnostic in the Log list, select KWP 2000 clear all to erase the entire Log list. For safety reasons, this requires the master password.

Caterpillar/Perkins

Caterpillar and Perkins have a primary and a secondary DM1 log, as well as one DM2 log. 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 historicala larms.

Use the *Up* and *Down* buttons to scroll through the list. Select the desired Log list with the *OK* button.

16.2.10 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.

Engine type	Detroit Diesel DDEC	John Deere JDEC	Caterpillar	Perkins	Cummins	Generic J1939	Deutz EMR	Iveco	Iveco Vector 8
Preheat	-	-	-	-	-	-	-	-	-
Start/Stop	-	-	x	x	-	x	-	-	-
Run/Stop (fuel)	-	-	-	-	x[1)]	-	-	-	-
Speed bias	x	x	x	x	x	x	x	x	x
Nominal frequency	-	-	-	-	x	-	-	-	-
Governor gain	-	-	-	-	x	-	-	-	-
Idle speed	x	x	x	x	x	x	x	x	-
MTU alternate droop setting (M-Logic)	-	-	x	x	x	-	-	-	-
Shutdown override	-	-	-	-	x	x	-	-	-
Engine overspeed test	-	-	-	-	-	-	-	-	-
Enable cylinder cut out	-	-	-	-	-	-	-	-	-
Intermittent oil priming	-	-	-	-	-	-	-	-	-
Engine operating mode	-	-	-	-	-	-	-	-	-
Demand switch	-	-	-	-	-	-	-	-	-
Trip counter reset	-	-	-	-	-	-	-	-	-
Engine speed GOV parameter command	-	-	-	-	-	-	-	-	-

Engine type	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	-	x	-	x
Run/Stop (fuel)	-	-	-	-	-	-	-	-
Speed bias	-	x	x	x	-	x	-	x
Nominal frequency	-	x	x	x	-	x	-	x
Governor gain	-	-	-	-	-	-	-	-
Idle speed	-	x	x	x	-	x	-	x
MTU alternate droop setting (M-Logic)	-	x	x	x	-	x	-	x
Shutdown override	-	x	x	x	-	x	-	x
Engine overspeed test	-	-	-	x	-	-	-	-
Enable cylinder cut out	-	x	x	x	-	-	-	-
Intermittent oil priming	-	-	-	x	-	-	-	-
Engine operating mode	-	-	-	x	-	-	-	-
Demand switch	-	x	x	x	-	-	-	-
Trip counter reset	-	x	x	x	-	-	-	-
Engine speed GOV parameter command	-	-	-	x	-	-	-	-
Reset trip fuel value	x	-	-	-	-	-	-	-

NOTE [1)] only apply to Cummins CM570 ECU.

For other engine types, CAN bus control is not supported. In these cases start/stop and other commands must be sent to the controller using hardwired connections.

To enable or disable the transmission of all the EIC control frames listed in the above table, set the EIC Controls to ON under **Settings > Engine > GOV > EIC configuration > EIC Controls**, if the engine is to be controlled by AGC 150.

Parameter	Text	Range	Default
7563	EIC Controls	OFF ON	OFF

16.3 Specific engine type descriptions

16.3.1 About type descriptions

The J1939 warnings and 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.

16.3.2 Caterpillar/Perkins (J1939)

Object selection

The view lines can be configured with these available values.

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

NOTE EIC Exhaust Gas P1 to P16 are fixed to the source address 241. The remaining entries in the table below are fixed to source address 0.

More information

See **Engine communication, Modbus communication** in this document for more information about Modbus scaling.

Readings from the 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	SPN (J1939)	FMI warning (J1939)	FMI shutdown (J1939)
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	*	x	*
EIC protection	*	x	*

*Note: Not supported.

Write commands to engine controller

Engine controls:

- All the EIC commands to the engine controller (ex: speed, start/stop, etc.) are enabled in parameter 7563.

Engine speed:

- CAN bus ID for speed control: 0x0c000000. J1939 TSC1.
- The speed regulation is enabled in parameters 2781 (Reg. output) and 7563 (EIC Controls).

M-Logic commands are available to enable/disable start/stop and speed controls:

- EIC start/stop enable.
- EIC speed control inhibit.

16.3.3 Cummins CM850-CM570 (J1939)

Warnings and shutdowns

Warning/shutdown	SPN (J1939)	FMI warning (J1939)	FMI shutdown (J1939)
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	*	x	*
EIC protection	*	x	*

*Note: Not supported.

Write commands to engine controller

Engine controls:

- All the EIC commands to the engine controller (ex: speed, start/stop, etc.) are enabled in parameter 7563.
- M-Logic commands are available to enable/disable speed controls: EIC speed control inhibit.

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):

- 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-logig function EIC select Cummins PCC1301.
- The speed regulation is enabled in parameters 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 f_{NOM} < 55 Hz, 60 Hz is written if f_{NOM} is > 55 Hz.

Gain setting:

- Gain is set in parameter 2773.

Shut down override:

- This command can be used in order to prevent shut down actions from the ECU. The function follows the standard function Shutdown override (digital input on the AGC 150).

Cummins Aftertreatment

If Cummins 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 after treatment. The states can be reached through M-Logic and can be shown on a DEIF AOP-2 display unit.

Status indicator	Diesel particulate filter regeneration status	Diesel particulate filter status	Particulate filter lamp	High exhaust system temp.	Regeneration disabled
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 after treatment switches for control of the regeneration are available. These can be reached through M-Logic in the command group.

1. Cummins paticulate filter manual (non-mission) regeneration initiate.
2. Cummins paticulate filter regeneration.

16.3.4 Detroit Diesel DDEC (J1939)

Warnings and shutdowns

Warning/shutdown list	SPN	FMI warning	FMI shutdown
EIC yellow lamp	-	x	Not supported
EIC red lamp	-	Not supported	x

Warning/shutdown list	SPN	FMI warning	FMI shutdown
EIC malfunction	-	x	Not supported
EIC protection	-	x	Not supported

Write commands to engine controller:

- Engine controls: All the EIC commands to the engine controller (ex: speed, start/stop, etc.) are enabled in parameter 7563.
- 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

16.3.5 Deutz EMR 2 and EMR 3 (J1939)

Warnings and shutdowns

Warning/shutdown list	SPN	FMI warning	FMI shutdown
Low oil pressure	100	-	1
Coolant temperature	110	-	0
Overspeed	190	-	0
EIC yellow lamp	-	x	Not supported
EIC red lamp	-	Not supported	x
EIC malfunction	-	x	Not supported
EIC protection	-	x	Not supported

Write commands to engine controller:

- Engine controls: All the EIC commands to the engine controller (ex: speed, start/stop, etc.) are enabled in parameter 7563.
- 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

16.3.6 Generic (J1939)

Warnings and shutdowns

Warning/shutdown list	SPN	FMI warning	FMI shutdown
EIC yellow lamp	-	x	Not supported
EIC red lamp	-	Not supported	x
EIC malfunction	-	x	Not supported
EIC protection	-	x	Not supported

Write commands to engine controller:

- Engine controls: All the EIC commands to the engine controller (ex: speed, start/stop, etc.) are enabled in parameter 7563.
- 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

16.3.7 Iveco (J1939)

Warnings and shutdowns

Warning/shutdown list	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 temperature	172	15	-
Fuel temperature	174	15	-
Overspeed	190	15	0
EIC yellow lamp	-	x	Not supported
EIC red lamp	-	Not supported	x
EIC malfunction	-	x	Not supported
EIC protection	-	x	Not supported

Write commands to engine controller:

- Engine controls: All the EIC commands to the engine controller (ex: speed, start/stop, etc.) are enabled in parameter 7563.
- Engine speed: CAN bus ID for speed control: 0x0c000003.
    - 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

16.3.8 John Deere JDEC (J1939)

Warnings and shutdowns

Warning/shutdown list	SPN	FMI warning	FMI shutdown
Low oil pressure	100	18	1
Intake manifold	105	16	Not supported
Coolant temperature	110	16	0
Fuel injection pump	1076	10	6
Fuel temperature	174	Not supported	16
ECU failure	2000	Not supported	6
EIC yellow lamp	-	x	Not supported
EIC red lamp	-	Not supported	x
EIC malfunction	-	x	Not supported
EIC protection	-	x	Not supported

Write commands to engine controller:

- Engine controls: All the EIC commands to the engine controller (ex: speed, start/stop, etc.) are enabled in parameter 7563.
- 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

16.3.9 MTU ADEC (CANopen)

The MTU ADEC is not a part of the J1939, therefore the reading of values, alarms and shutdowns are different.

Display readings

The following readings can be displayed:

- Ambient temperature
- Battery
- EIC faults
- Engine power
- Fuel rate
- Mean T. fuel
- Nom. power
- 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

Warnings

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.

The following warnings can be displayed:

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

Warning list	Display list
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
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

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.

The following shutdown value can be displayed:

Shutdown list	Display text
AL Com. Alarm Red	AL Com. Alarm Red

Write commands to engine controller:

- Engine controls: All the EIC commands to the engine controller (ex: speed, start/stop, etc.) are enabled in parameter 7563.
- Engine speed: CAN bus ID for speed control: 0x300+ADEC ID – speed demand telegram (ADEC ID is selected in parameter 7562, default ID is 6: 0x306).

M-Logic commands are available to enable/disable start/stop and speed controls:

- EIC start/stop enable: The speed regulation is enabled in parameters 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 f_{NOM} < 55 Hz, 60 Hz is written if f_{NOM} is > 55 Hz.

16.3.10 MTU ADEC module 501, without SAM module

The MTU ADEC module 501 is not a part of the J1939, therefore the reading of values, alarms and shutdowns are different.

Display readings

The following readings can be displayed:

- Act-Droop
- Battery
- Camshaft
- ECU Stop activated
- F speed on
- INJECT-QUAN
- MDEC Faults
- Mean T. fuel
- Nom power
- Operation
- P L Oil Lo
- P L Oil Lolo
- P. Ch. Air
- P. Fuel
- Speed
- Speed D SW
- T. Ch. Air
- T. Coolant
- T. Fuel
- T. Oil
- TCOOL-HIHI
- T-ECU
- T-INTERC
- T-LUBE-HI
- T-LUBE-HIHI
- Total fuel
- Trip fuel

Alarms

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.

The following alarms can be displayed:

Alarm list	Display text	Warning	Shutdown
ADEC yellow alarm	EIC yellow lamp WA	x	Not supported
ADEC red alarm	EIC red lamp SD	Not supported	x
High high engine speed	Overspeed shutdown	x	Not supported
Low low lube oil pressure	L Oil Pres. Shutdown	x	Not supported
High high coolant temperature	H Coolant T Shutdown	x	Not supported
High intercooler temperature	H Interc. T Warning	x	Not supported
Sensor Defect Coolant Level	SD Coolant Level	x	Not supported
Low low coolant level	L Cool. Lev. Shutdown	x	Not supported
ADEC ECU failure	MDEC ECU Failure	x	Not supported
Low Lube oil pressure	L Oil Pres. Warning	x	Not supported
Low Common rail fuel pressure	LO P-Fuel Com-Rail	x	Not supported
High Common rail fuel pressure	HI P-Fuel Com-Rail	x	Not supported
Low preheat temperature	AL Preheat Temp. Low	x	Not supported
Low low Charge air coolant level	SS Cool Level Ch-Air	x	Not supported
Power amplifier 1 failure	AL Power Amplifier 1	x	Not supported
Power amplifier 2 failure	AL Power Amplifier 2	x	Not supported
Transistor output status	AL Status Trans-Outp	x	Not supported
Low ECU power supply voltage	LO ECU Power Supply	x	Not supported
High ECU power supply voltage	HI ECU Power	x	Not supported
High charge air temperature	HI T-Charge Air	x	Not supported
High Lube oil temperature	HI T-Lube Oil	x	Not supported
High ECU temperature	HI T-ECU	x	Not supported
Low engine speed	SS Eng. Speed Low	x	Not supported
Check error code	AL Check Error Code	x	Not supported
Common rail leakage	AL Com. Rail Leakage	x	Not supported
Automatic engine stop	AL Aut. Engine Stop	x	Not supported
MG Start speed not reached	MG Start Speed Fail	x	Not supported
MG runup speed not reached	MG Runup Speed Fail	x	Not supported
MG idle speed reached	MG Idle Speed Fail	x	Not supported
Low low ECU power supply voltage	LOLO ECU Pow. Supply	x	Not supported
High high ECU power supply voltage	HIHI ECU Pow. Supply	x	Not supported
Sensor Defect coolant level charge air	SD Cool Level Ch-Air	x	Not supported
High fuel temperature	HI T-Fuel	x	Not supported
Override feedback from ECU	SS Override	x	Not supported
High high lube oil temperature	H Oil Temp. Shutdown	x	Not supported
Speed demand defected	AL Speed demand Def.	x	Not supported
High coolant temperature	H Coolant T Warning	x	Not supported
High high temperature charge air	H Ch. Air T Shutdown	x	Not supported

Alarm list	Display text	Warning	Shutdown
Low fuel oil pressure	LO P-Fuel Oil	x	Not supported
Low low fuel oil pressure	SS P-Fuel Oil	x	x

Write commands to engine controller:

- Engine controls: All the EIC commands to the engine controller (ex: speed, start/stop, etc.) are enabled in parameter 7563.
- Engine speed. M-Logic commands are available to enable/disable start/stop and speed controls:
  - EIC start/stop enable
  - EIC speed control inhibit
- Manual speed control (up/down): The speed regulation is enabled in parameters 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 f_{NOM} < 55 Hz, 60 Hz is written if f_{NOM} is > 55 Hz.
- Shut down override: This command can be used with a digital input in order to override shut down 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: Engage the pre-lubrication oil pump if installed. The command is activated through M-Logic.
- Priming on engine start

16.3.11 MTU J1939 Smart Connect (J1939)

This protocol is available with MTU series 1600 with ECU8/ECU9/Smart Connect.

Warnings and shutdowns

Warning/shutdown list	SPN	FMI warning	FMI shutdown
EIC yellow lamp	-	x	Not supported
EIC red lamp	-	Not supported	x
EIC malfunction	-	x	Not supported
EIC protection	-	x	Not supported

Write commands to engine controller:

- Engine controls: All the EIC commands to the engine controller (ex: speed, start/stop, etc.) are enabled in parameter 7563.
- 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 start/stop enable.
- EIC speed control inhibit: The speed regulation is enabled in parameters 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_{NOM} <55 Hz, 60 Hz is written if f_{NOM} 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 J1939 commands (Analog CAN) in parameter 2790 (refer to the MTU documentation of theECU8 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 150 holds some parameters, in which it is possible to make a switch between different inputs on the ECM for the speed signal/bias:

Setting	Description
Analogue 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 150, 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 analogue input. To control the ECM from the AGC 150, 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, 0to 5 V DC equals 700 RPM – 2000 RPM. This can be considered as “analogue regulation with a big regulation range”.
Analog ECU	Commands the ECM to receive the speed signal/bias via analogue input. To control the ECM from the AGC 150, 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, 0to 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 150, 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 1350RPM – 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:

- Local, Normal operation (2791)
- Local, Emergency operation (2792)
- Remote, Normal operation (2793)
- Remote, Emergency operation (2794)

AGC 150 can configure the type of speed signal to be used for each state under **Settings > Engine > GOV > EIC configuration > Additional EIC features**.

Parameter	Text	Range	Default
2791	Local, Normal operation – Speed signal	Analog CAN Frequency	Analog CAN
2792	Local, Emergency operation – Speed signal	Analog CAN Frequency	Analog CAN
2793	Remote, Normal operation – Speed signal	Analog CAN Frequency	Analog CAN
2794	Remote, Emergency operation – Speed signal	Analog CAN Frequency	Analog CAN

When changing one of the parameters above, the EIC control in parameter 7563 must be ON. Otherwise the command will not be sent.

If AGC 150 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 signal comes from another.

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

DEIF display	MTU	SPN	FMI
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
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

DEIF display	MTU	SPN	FMI
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
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

DEIF display	MTU	SPN	FMI
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
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

DEIF display	MTU	SPN	FMI
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
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

DEIF display	MTU	SPN	FMI
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
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

DEIF display	MTU	SPN	FMI
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
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

DEIF display	MTU	SPN	FMI
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
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

DEIF display	MTU	SPN	FMI
AL Open L.Cylind.B3	AL Open Load Cylinder B3	520942	31
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
AL Wiring Pres.CV 2	AL Wiring Pressure Control Valve 2	520986	31

DEIF display	MTU	SPN	FMI
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
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

DEIF display	MTU	SPN	FMI
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
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

DEIF display	MTU	SPN	FMI
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
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

DEIF display	MTU	SPN	FMI
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
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

DEIF display	MTU	SPN	FMI
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
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

DEIF display	MTU	SPN	FMI
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
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

DEIF display	MTU	SPN	FMI
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
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
AI Knock Intensity	AI 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

DEIF display	MTU	SPN	FMI
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
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

DEIF display	MTU	SPN	FMI
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
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

DEIF display	MTU	SPN	FMI
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

16.3.12 MTU MDEC module 302/303 (MTU)

The MTU MDEC is not a part of the J1939, therefore the reading of values, alarms and shutdowns are different.

Display readings

The following readings can be displayed:

- Act-Droop
- Battery
- Camshaft
- ECU Stop activated
- F speed on
- Fuel rate
- INJECT-QUAN
- MDEC Faults
- Mean T. fuel
- Nom power
- Operation
- P L Oil Lo
- P L Oil Lolo
- P. Ch. Air
- P. Fuel
- Speed
- Speed D SW
- T. Ch. Air
- T. Coolant
- T. Fuel
- T. Oil
- T-COOL-HI
- TCOOL-HIHI
- T-ECU
- T-INTERC
- T-LUBE-HI
- T-LUBE-HIHI
- Total fuel
- Trip fuel

Alarms

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.

The following alarms can be displayed:

Alarm list	Display text	Warning	Shutdown
MDEC yellow alarm	EIC yellow lamp	x	Not supported
MDEC red alarm	EIC red lamp SD.	Not supported	x
High high engine speed	Overspeed shutdown	Not supported	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	Not supported	x
High intercooler temperature	H Interc. T Warning	x	Not supported
Sensor Defect Coolant Level	SD Coolant Level	x	Not supported
Low low coolant level	L Cool. Lev. Shutdown	Not supported	x
MDEC ECU failure	MDEC ECU Failure	Not supported	x
Low fuel oil pressure[1]	LO P-Fuel Oil	x	Not supported
Low Lube oil pressure[1]	L Oil Pres. Warning	x	Not supported
Low Common rail fuel pressure[1]	LO P-Fuel Com-Rail	x	Not supported
High Common rail fuel pressure[1]	HI P-Fuel Com-Rail	x	Not supported
Override feedback from ECU[1]	SS Override	x	Not supported
Low preheat temperature[1]	AL Preheat Temp. Low	x	Not supported
Low low Charge air coolant level[1]	SS Cool Level Ch-Air	x	Not supported
Power amplifier 1 failure[1]	AL Power Amplifier 1	x	Not supported
Power amplifier 2 failure[1]	AL Power Amplifier 2	x	Not supported
Transistor output status[1]	AL Status Trans-Outp	x	Not supported
Low ECU power supply voltage[1]	LO ECU Power Supply	x	Not supported
High ECU power supply voltage[1]	HI ECU Power	x	Not supported
High charge air temperature[1]	HI T-Charge Air	x	Not supported
High Lube oil temperature[1]	HI T-Lube Oil	x	*
High ECU temperature[1]	HI T-ECU	x	Not supported
Low engine speed[1]	SS Eng. Speed Low	x	Not supported
Check error code[1]	AL Check Error Code	x	Not supported
Common rail leakage[1]	AL Com. Rail Leakage	x	Not supported
Automatic engine stop[1]	AL Aut. Engine Stop	x	Not supported
MG Start speed not reached[1]	MG Start Speed Fail	x	Not supported
MG runup speed not reached[1]	MG Runup Speed Fail	x	Not supported
MG idle speed reached[1]	MG Idle Speed Fail	x	Not supported
Low low ECU power supply voltage[1]	LOLO ECU Pow. Supply	x	Not supported
High high ECU power supply voltage[1]	HIHI ECU Pow. Supply	x	Not supported
Sensor Defect coolant level charge air[1]	SD Cool Level Ch-Air	x	Not supported
High fuel temperature[1]	Hi T-Fuel	x	Not supported

16.3.13 Scania EMS (J1939)

Warnings and shutdowns: None.

Write commands to engine controller: None.

16.3.14 Scania EMS 2 S6 (J1939)

Scania EMS 2 S6 does not use the J1939 SPN/FMI system for alarm handling. Instead the DNL2 system is used which makes the alarm handling different.

Warnings and shutdowns (DNL2 alarms)

Warnings and shutdowns are shown as alarms 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.

The following warnings and shutdowns can be displayed:

Table 16.1 Warnings and shutdowns

Warning/shutdown list	DNL2 warning	DNL2 shutdown
EMS warning	x	Not supported
Low oil pressure	x	Not supported
High coolant temp	x	Not supported
Stop limit exceeded	Not supported	x
Charge 61	x	Not supported
EIC yellow lamp	x	Not supported
EIC red lamp	Not supported	x
EIC malfunction[1]	x	Not supported
EIC protection[1]	x	Not supported

NOTE Handling of alarms is only active when the engine is running.

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 which can be read by the flash combination of the diagnostics lamp on the EMS S6 (refer to the engine manufacturer's documentation).

Table 16.2 EMS S6 flash codes

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

Flash code	ML-2 displayed text	Description
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 the engine controller

- Engine controls: All the write commands to the engine controller (ex: speed, start/stop, etc.) are enabled in parameter 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
  - EIC speed control inhibit
- Frequency selection. Nominal speed/frequency is selected in parameter 2772. If *User* is selected, nominal speed/frequency is written automatically, based on the frequency nominal setting.
- Start/stop command

NOTE • The speed regulation is enabled in parameters 2781 (Reg. output) and 7563 (EIC Controls).

- It is only possible to write commands to the engine, when the Scania Coordinator is **not** mounted.

Control

In parameter 2770 it is possible to configure the droop setting and the initial speed setting.

16.3.15 Volvo Penta EMS (J1939)

Warnings and shutdowns

Warning/shutdown list	SPN	FMI warning	FMI shutdown
Low oil pressure	100	5	Not supported
Intake manifold #1 P	102	Not supported	Not supported
Coolant temperature	110	5	Not supported
High inlet air temperature	172	5	Not supported
Fuel temperature	174	Not supported	Not supported
Fuel pressure	94	5	Not supported
Oil level	98	5	Not supported
Overspeed	190	Not supported	0
Coolant levl low	111	Not supported	1
EIC yellow lamp	-	x	Not supported
EIC red lamp	-	Not supported	x
EIC malfunction	-	x	Not supported
EIC protection	-	x	Not supported

Write commands to engine controller: None.

16.3.16 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	SPN	FMI warning	FMI shutdown
Low oil pressure	100	5	Not supported
Intake manifold #1 P	102	Not supported	Not supported
Coolant temperature	110	5	Not supported
High inlet air temperature	172	5	Not supported
Fuel temperature	174	Not supported	Not supported
Fuel pressure	94	5	Not supported
Oil level	98	5	Not supported
Overspeed	190	Not supported	0
Coolant level low	111	Not supported	1
EIC yellow lamp	-	x	Not supported
EIC red lamp	-	Not supported	x
EIC malfunction	-	x	Not supported
EIC protection	-	x	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 parameter 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 and EIC speed control inhibit.
- Pre-heat.
- Start/stop.

Readable states:

- Pre-heat and running.

16.4 Modbus communication

16.4.1 Readings via Modbus, analogue values

Reading of the values is independent of the engine type. All readings in the table are available in the Modbus protocol.

The available data from each engine type depends on the engine. For more information, refer to the manual for the specific engine. 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).

Table 16.3 Measurement table (read only) function code 04h

Address	Content	Unit	Scaling, J1939	Scaling, ADEC	Scaling, MDEC	Notes
593	EIC speed	[RPM]	1/1	1/1	1/1	Speed (SPN 190)
594	EIC coolant temp.	[C] [F]	1/10	1/10	1/10	Coolant temperature (SPN 110)
595	EIC oil pressure	[bar] [psi]	1/100	1/100	1/100	Engine oil pressure (SPN 100)
596	EIC no of faults	[Faults]	1/1	1/1	1/1	Number of faults (SPN 1218)
597	EIC oil temp.	[C] [F]	1/10	1/10	1/10	Engine oil temperature (SPN 175)
598	EIC fuel temp.	[C] [F]	1/1	1/10	1/10	Fuel temperature (SPN 174)
599	EIC intake manifold #1 P	[bar] [psi]	1/100	1/100	-	Intake manifold #1 P (SPN 102)
600	EIC air inlet temp.	[C] [F]	1/1	-	-	Air inlet temperature (SPN 172)
601	EIC coolant level	[%]	1/10	-	-	Coolant level (SPN 111)
602	EIC fuel rate	[L/h]	1/10	1/1	-	Fuel rate (SPN 183)
603	EIC charge air press	[bar] [psi]	-	-	1/100	Charge air press
604	EIC intake manifold 1 T (or EIC charge air T)	[C] [F]	1/1	-	1/10	Intake manifold 1 temperature (SPN 105)
605	EIC d.d. % torque	[%]	1/1	-	-	Driver’s demand engine - percent torque (SPN 512)
606	EIC actual % torque	[%]	1/1	-	-	Actual engine - percent torque (SPN 513)

Address	Content	Unit	Scaling, J1939	Scaling, ADEC	Scaling, MDEC	Notes
607	EIC acc. pedal pos.	[%]	1/1	-	-	Accelerator pedal position (SPN 91)
608	EIC % load, c. speed	[%]	1/1	-	-	Percent load at current speed (SPN 92)
609	EIC air inlet pressure	[bar] [psi]	1/100	-	-	Air inlet pressure (SPN 106)
610	EIC exhaust gas temp.	[C] [F]	1/10	-	-	Exhaust gas temperature (SPN 173)
611	EIC engine hours	[H]	1/1	1/1	1/1	ENGINE HOURS (SPN 247)
612	EIC oil filter diff. press.	[bar] [psi]	1/100	-	-	Oil filter diff press (SPN 99)
613	EIC battery voltage	[V]	1/10	1/10	-	Keyswitch battery potential (SPN 158)
614	EIC fuel del. press.	[bar] [psi]	1/100	1/100	-	Fuel delivery pressure (SPN 94)
615	EIC oil level	[%]	1/10	-	-	Engine oil level (SPN 98)
616	EIC crankcase press.	[bar] [psi]	1/100	-	-	Crankcase pressure (SPN 101)
617	EIC coolant pressure	[bar] [psi]	1/100	-	-	Coolant pressure (SPN 109)
618	EIC water in fuel	[2 bits]	1/1	-	-	Water in fuel (1 = Yes, 0 =NO, SPN 97)
619	Reserved	-	-	-	-	-
620	Reserved	-	-	-	-	-
621	Reserved	-	-	-	-	-
622	Reserved	-	-	-	-	-
623	EIC turbo oil temp.	[C] [F]	1/10	-	-	Turbo oil temp. (SPN 176)
624	EIC trap inlet	[bar] [psi]	1/100	-	-	Trap inlet (SPN 81)
625	EIC Air filter diff press	[bar] [psi]	1/1000	-	-	Air filter diff press (SPN 107)
626	EIC Cool filter diff press	[bar] [psi]	1/100	-	-	Cool filter diff press (SPN 112)
627	EIC Atm press	[bar] [psi]	1/100	-	-	Atmospheric pressure (SPN 108)
628	EIC Ambient air temp	[C] [F]	1/10	-	-	Ambient air temp [F/10] (SPN 171)
629	EIC exch. temp A	[C] [F]	1/10	1/10	-	Exch. temp bank A (SPN 2433)
630	EIC exch. temp B	[C] [F]	1/10	1/10	-	Exch. temp bank B (SPN 2434)
631	EIC Winding 1 temp	[C] [F]	-	1/1	-	Gen winding 1 temp
632	EIC Winding 2 temp	[C] [F]	-	1/1	-	Gen winding 2 temp
633	EIC Winding 3 temp	[C] [F]	-	1/1	-	Gen winding 3 temp
634	Reserved	-	-	-	-	-

Address	Content	Unit	Scaling, J1939	Scaling, ADEC	Scaling, MDEC	Notes
635	Reserved	-	-	-	-	-
636	EIC T. Charge A	[C] [F]	-	1/10	-	Turbo Charger Air temp
637	EIC Intercooler temp	[C] [F]	-	1/10	-	Intercooler temp (SPN 52)
638	EIC engine trip fuel	[L]	1/1	1/1	-	Engine trip fuel (SPN 182)
639	EIC engine total fuel used	[kL]	1/10	-	-	Engine total fuel used (SPN 250)
640	EIC trip fuel_gaseous	[kg]	1/1	-	-	Trip fuel, gaseous (SPN 1039)
641	EIC total fuel used_gaseous	[ton]	1/10	-	-	Total fuel used, gaseous (SPN 1040)
850	AT2ExhFluDRQ	[g/h]	1/10	-	-	Aftertreatment 2 Diesel Exhaust Fluid Dosing Requested Quantity (SPN 4401)
851	AT2SCRCInG	[C] [F]	1/10	-	-	Aftertreatment 2 SCR Catalyst Intake Gas Temperature (SPN 4413)
852	AT2SCRCOuG	[C] [F]	1/10	-	-	Aftertreatment 2 SCR Catalyst Outlet Gas Temperature (SPN 4415)
853	EIC Engine Oil-Filter Outlet Pressure	[bar] [psi]	1/100	-	-	Engine Oil-Filter Outlet Pressure (SPN 3549)
854	EngOperatingState	-	1/1	-	-	Engine Operating State (SPN 3543)
855	EIC SA of Controlling Device	-	1/1	-	-	Source Address of Controlling Device (SPN 1483)
856	EIC Engine Rated Speed	[RPM]	1/1	-	-	Engine Rated Speed (SPN 199)
857	EIC Engine Speed At Idle, Point 1	[RPM]	1/1	-	-	BAM message: Engine Speed At Idle, Point 1 (Engine Configuration, SPN188)
858	EIC Engine Controller 5	-	1/1	-	-	MTU only: Engine Controller 5
859	EIC Fuel Consumption	[g/kWh]	1/1	-	-	MTU only: Fuel Consumption
860	EIC UREA Level	[%]	1/10	-	-	Scania only: UREA Level
861	SCR IND. SEV	-	1/1	-	-	Severity status of the operator inducement system (SPN 5246)
862	DPF OUTL T	[C] [F]	1/10	-	-	Temperature of engine combustion byproducts leaving the diesel particulate filter exhaust in exhaust bank 1. (SPN 3246)
863	Next Regen	[h]	1/10	-	-	Time to activate next regeneration for diesel particulate filter (SPN 5978)
864	ENG CAC T	[C] [F]	1/10	-	-	Temperature of combustion air after it exits from the Charge Air Cooler 1 but before any mixing of recirculated exhaust gas. (SPN 2630)
865	DPF Soot Load	[%]	1/1	-	-	Aftertreatment 1 Diesel Particulate Filter Soot Load Percent (SPN 3719)
900	EIC trip average fuel rate	[L/h]	-	1/10	-	Average fuel rate (trip, SPN 1029)
901	EIC nominal power	[Kwm]	1/1	1/1	-	Nominal power of the engine (SPN 166)
902	EIC trip fuel liquid	[L]	1/2	1/10	-	High word (SPN 182)

Address	Content	Unit	Scaling, J1939	Scaling, ADEC	Scaling, MDEC	Notes
903	EIC trip fuel liquid	[L]	1/2	1/10	-	Low word (SPN 182)
904	EIC total fuel liquid	[L]	1/2	1/10	-	High word (SPN 250)
905	EIC total fuel liquid	[L]	1/2	1/10	-	Low word (SPN 250)
906	EIC mean trip fuel consumption	[L/h]	-	1/1000	-	High word (SPN 1029)
907	EIC mean trip fuel consumption	[L/h]	-	1/1000	-	Low word (SPN 1029)
908	EIC engine power	[Kwm]	-	1/1	-	Nominal power of the engine (ADEC)
911	Int Man abs	[bar] [psi]	1/100	-	-	Engine intake manifold #1 Absolute pressure (SPN 3563)
912	EIC Air filter diff. pressure	[bar] [psi]	1/100	-	-	Change in engine air system pressure (SPN 2809)
913	EIC Fuel supply pump inlet pressure	[bar] [psi]	1/100	-	-	Absolute pressure of fuel at the fuel supply pump intake (SPN 1381)
914	EIC Fuel filter (suction side) diff. pressure	[bar] [psi]	1/100	-	-	Differential pressure measured across the fuel filter between the fuel tank and the supply pump (SPN 95)
915	EIC Fuel filter diff. pressure	[bar] [psi]	1/100	-	-	Diff pressure (SPN 1382)
932	EIC Speed Demand source	Digit	-	-	1/1	Identifies speed dem. source: • 0, Default Dataset ADEC • 1, ADEC Incr./Decr. Input • 2, CAN Incr./Decr. Input • 3, ADEC Analog Absolute • 4, ADEC Analog Relative • 5, ADEC Frequency Input • 6, CAN analog
933	EIC lube oil pressure LO limit	mbar	-	-	1/100	Lubrication oil pressure limit 1
934	EIC lube oil pressure LOLO limit	mbar	-	-	1/100	Lubrication oil pressure limit 2
935	EIC fuel pressure	bar	-	-	1/100	Fuel pressure
936	EIC coolant limit HI	[C] [F]	-	-	1/10	Coolant high limit temp. 1
937	EIC coolant limit HIHI	[C] [F]	-	-	1/10	Coolant high limit temp. 2
938	EIC intercooler coolant	[C] [F]	-	-	1/10	Intercooler coolant temperature
939	T-ECU	[C] [F]	1/10	-	1/10	ECU temperature (SPN 1136)
940	EIC actual droop	%	-	-	1/10	Actual droop percentage
941	EIC act. inject. Quantity	%	-	-	1/10	Injection quantity Act. DBR %
942	EIC camshaft	[RPM]	-	1/1	-	Camshaft speed
943	EIC Temp lube HI	[C] [F]	-	1/10	-	Lube oil temperature HI

Address	Content	Unit	Scaling, J1939	Scaling, ADEC	Scaling, MDEC	Notes
944	EIC Temp lube HIHI	[C] [F]	-	1/10	-	Lube oil temperature HIHI
945	EIC speed demand analog	Digit	-	1/1	-	Speed demand analog
946	ECU Stop activated #	[bit]	-	-	Boolean	• 1: Stop activated • 0: Stop not activated
971	T. Cool Aux	[C] [F]	1/1	-	-	Coolant temperature of intercooler which is located after the turbocharger (SPN 1212)
974	EIC Engine Auxiliary Coolant Pressure	[C] [F]	1/100	-	-	Engine Auxiliary Coolant Pressure (SPN 1203)
975	Sp.Humidity	[g/kg]	1/10	-	-	Ambient Conditions 2 Specific Humidity (SPN 4490)
976	Tcharger 2	[RPM]	1/1	-	-	Engine Turbocharger 2 Speed (SPN 1169)
977	Tcharger 3	[RPM]	1/1	-	-	Engine Turbocharger 3 Speed (SPN 1170)
978	EIC Trip Engine Running Time	[h]	1/1	-	-	Trip Engine Running Time (SPN 1036)
979	EIC Trip Idle Time	[h]	1/1	-	-	Trip Idle Time (SPN 1037)
980	EIC Estimated Percent Fan Speed	[%]	1/10	-	-	Estimated Percent Fan Speed (SPN 975)
981	Tcharger 1	[RPM]	1/1	-	-	Engine Turbocharger 1 Speed (SPN 103)
982	EIC Nominal Friction - Percent Torque	[%]	1/1	-	-	Nominal Friction - Percent Torque (SPN 514)
983	EIC Engine's Desired Operating Speed	[RPM]	1/1	-	-	Engine's Desired Operating Speed (SPN 515)
984	EIC Engine Intake Manifold 2 Temperature	[C] [F]	1/1	-	-	Engine Intake Manifold 2 Temperature (SPN 1131)
985	EIC DEF LEVEL	[%]	1/10	-	-	Aftertreatment 1 Diesel Exhaust Fluid Tank Level (SPN 1761)
986	EIC DEF temperature	[C] [F]	1/1	-	-	Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature (SPN 3031)
987	AT1IntTNOx	[ppm]	1/10	-	-	Aftertreatment 1 Intake NOx (SPN 3216)
988	AT1OutLNOx	[ppm]	1/10	-	-	Aftertreatment 1 Outlet NOx (SPN 3226)
989	AT1ExhFA.DQ	[g/h]	1/10	-	-	Aftertreatment 1 Diesel Exhaust Fluid Actual Dosing Quantity (SPN 4331)
990	AT1ExhFluDAB	[bar] [psi]	1/100	-	-	Aftertreatment 1 Diesel Exhaust Fluid Dosing Absolute Pressure (SPN 4334)
991	AT1ExhFlu DT	[C] [F]	1/1	-	-	Aftertreatment 1 SCR Dosing Air Assist Valve (SPN 4337)
992	AT1ExhFlu DT	[g/h]	1/1	-	-	Aftertreatment 1 Diesel Exhaust Fluid Dosing Requested Quantity (SPN 4348)
993	AT1SCRCInG	[C] [F]	1/10	-	-	Aftertreatment 1 SCR Catalyst Intake Gas Temperature (SPN 4360)
994	AT1SCRCOuG	[C] [F]	1/10	-	-	Aftertreatment 1 SCR Catalyst Outlet Gas Temperature (SPN 4363)
995	AT2IntTNOx	[ppm]	1/10	-	-	Aftertreatment 2 Intake NOx (SPN 3255)

Address	Content	Unit	Scaling, J1939	Scaling, ADEC	Scaling, MDEC	Notes
996	AT2OutLNOx	[ppm]	1/10	-	-	Aftertreatment 2 Outlet NOx (SPN 3265)
997	AT2ExhFA.DQ	[g/h]	1/10	-	-	Aftertreatment 2 Diesel Exhaust Fluid Actual Dosing Quantity (SPN 4384)
998	AT2ExhFluDAB	[bar] [psi]	1/100	-	-	Aftertreatment 2 Diesel Exhaust Fluid Dosing Absolute Pressure (SPN 4387)
999	AT2ExhFlu DT	[C] [F]	1/1	-	-	Aftertreatment 2 SCR Dosing Air Assist Valve (SPN 4390)
1819	Intake Man T2	[C] [F]	1/1	-	-	Temperature of pre-combustion air found in intake manifold of engine air supply system (SPN 1131)

16.4.2 Readings via Modbus, analogue values specific for CAT and Perkins protocol

Table 16.4 Measurement table (read only) function code 04h

Address	Content	Unit	Scaling, J1939	Scaling, ADEC	Scaling, MDEC
947	EIC Exhaust Gas P1 Temp	[C] [F]	1/10	-	-
948	EIC Exhaust Gas P2 Temp	[C] [F]	1/10	-	-
949	EIC Exhaust Gas P3 Temp	[C] [F]	1/10	-	-
950	EIC Exhaust Gas P4 Temp	[C] [F]	1/10	-	-
951	EIC Exhaust Gas P5 Temp	[C] [F]	1/10	-	-
952	EIC Exhaust Gas P6 Temp	[C] [F]	1/10	-	-
953	EIC Exhaust Gas P7 Temp	[C] [F]	1/10	-	-
954	EIC Exhaust Gas P8 Temp	[C] [F]	1/10	-	-
955	EIC Exhaust Gas P9 Temp	[C] [F]	1/10	-	-
956	EIC Exhaust Gas P10 Temp	[C] [F]	1/10	-	-
957	EIC Exhaust Gas P11 Temp	[C] [F]	1/10	-	-
958	EIC Exhaust Gas P12 Temp	[C] [F]	1/10	-	-
959	EIC Exhaust Gas P13 Temp	[C] [F]	1/10	-	-
960	EIC Exhaust Gas P14 Temp	[C] [F]	1/10	-	-
961	EIC Exhaust Gas P15 Temp	[C] [F]	1/10	-	-
962	EIC Exhaust Gas P16 Temp	[C]	1/10	-	-

Address	Content	Unit	Scaling, J1939	Scaling, ADEC	Scaling, MDEC
		[F]			
963	EIC Exhaust Gas P17 Temp	[C] [F]	1/10	-	-
964	EIC Exhaust Gas P18 Temp	[C] [F]	1/10	-	-
965	EIC Exhaust Gas P19 Temp	[C] [F]	1/10	-	-
966	EIC Exhaust Gas P20 Temp	[C] [F]	1/10	-	-
967	EIC Filtered Fuel DeliveryPress	[bar] [psi]	1/100	-	-
968	EIC Coolant Temp 2	[C] [F]	1/1	-	-
969	EIC Coolant Temp 3	[C] [F]	1/1	-	-
970	EIC Coolant Pump Outlet Temp	[C] [F]	1/1	-	-
971	EIC Auxiliary Coolant Temp	[C] [F]	1/1	-	-
972	EIC Turbo 1 Intake Temp	[C] [F]	1/10	-	-
973	EIC Turbo 2 Intake Temp	[C] [F]	1/10	-	-

16.4.3 Readings via Modbus, diagnostic codes

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 Indicator*. For example, if the temperature in the above example is at shutdown level, the FMI code 0 will be shown.

Oc means *occurrence counter*, which shows how many times a specific alarm has occurred. For example, if the specific alarm in the above example (SPN 100, FMI 0) has occurred two times, the oc code 2 is shown.

To interpret an SPN or FMI number, refer to the documentation of the engine manufacturer.

In the tables a specific SPN number is linked to the same FMI and oc number.

Active Diagnostic Code (DM1/SPN)		
Address	**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

Active Diagnostic Code (DM1/SPN)		
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 Fail Mode Identifier (DM1/FMI)		
Address	**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)		
Address	**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	-

Active Occurrence Counter (DM1/OC)		
1426	Occurrence counter diagnostic no. 9	-
1427	Occurrence counter diagnostic no. 10	-
1428-1433	Not used	Reserved

Active Diagnostic Codes (DM2/SPN)		
Address	**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 Fail Mode Identifier (DM2/FMI)		
Address	**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	-

Active Fail Mode Identifier (DM2/FMI)		
1475	FMI diagnostic no. 10	-
1476-1481	Not used	Reserved

Active Occurrence Counter (DM2/OC)		
Address	**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

16.4.4 Alarms via Modbus - Caterpillar/Perkins

Alarm, status and measurement table (read only) function code 04h.

Address	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, 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 Bit 13 EIC malfunction

16.4.5 Alarms via Modbus - Cummins

Alarm, status and measurement table (read only) function code 04h.

Address	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
1023	EIC alarms, engine controller (DM1)	Bit 0 EIC yellow Bit 1 Red Bit 2 EIC protection Bit 3 EIC malfunction
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

16.4.6 Alarms via Modbus - DDEC/Detroit engines

Alarm, status and measurement table (read only) function code 04h.

Address	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, engine controller (DM1)	Bit 0 EIC communication error, warning Bit 1 EIC warning

Address	Content	Type
		Bit 2 EIC shutdown Bit 3 EIC protection Bit 4 EIC malfunction

16.4.7 Alarms via Modbus - EMR 2/EMR 3/Deutz engines

Alarm, status and measurement table (read only) function code 04h.

Address	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, 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 Bit 7 EIC malfunction

16.4.8 Alarms via Modbus - Generic J1939

Alarm, status and measurement table (read only) function code 04h.

Address	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, engine controller (DM1)	Bit 0 EIC communication error Bit 1 EIC yellow Bit 2 EIC red Bit 3 EIC protection Bit 4 EIC malfunction

16.4.9 Alarms via Modbus - Iveco

Alarm, status and measurement table (read only) function code 04h.

Address	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, 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 Bit 13 EIC malfunction

16.4.10 Alarms via Modbus - JDEC/John Deere engines

Alarm, status and measurement table (read only) function code 04h.

Address	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, 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, shutdownBit 5 EIC oil pressure, warning Bit 6 EIC intake manifold, warning Bit 7 EIC coolant temperature, warning

Address	Content	Type
		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 Bit 12 EIC protection Bit 13 EIC malfunction

16.4.11 Alarms via Modbus - MTU ADEC

Alarm, status and measurement table (read only) function code 04h.

Address	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
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 LowLowBit 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 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

Address	Content	Type
		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

16.4.12 Alarms via Modbus - MTU ADEC module 501, without SAM module

Alarm, status and measurement table (read only) function code 04h.

Address	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 Bit 1 EIC MG start speedfail Bit 2 EIC Runup speedfail Bit 3 EIC Idle speedfail Bit 4 EIC ECU power supply voltage low limit2 Bit 5 EIC ECU power supply voltage high limit2 Bit 6 EIC Aftercooler coolant level sensor defect Bit 7 EIC Fuel temperature high limit 2
1023	EIC alarms, engine controller	Bit 0 EIC Common rail fuel pressure limit 1 Bit 1 EIC Common rail fuel pressure limit 2 Bit 2 EIC Override Bit 3 EIC Preheat temperature low Bit 4 EIC Charge air coolant level 2 Bit 5 EIC Power amplifier 1 Bit 6 EIC Power amplifier 2 Bit 7 EIC Transistor output status, TAA1 to TAA6 Bit 8 EIC ECU Power supply voltage low limit1 Bit 9 EIC ECU Power supply voltage high limit1 Bit 10 EIC Charge air temperature limit1 Bit 11 EIC Lube oil temperature limit1 Bit 12 EIC ECU temperature limit1 Bit 13 EIC Engine speed low limit1 Bit 14 EIC Check error code Bit 15 EIC Common rail leakage
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 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

Address	Content	Type
		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 Bit 14 EIC fuel delivery pressure limit1 Bit 15 EIC fuel delivery pressure limit2

16.4.13 Alarms via Modbus - MTU Smart Connect

Alarm, status and measurement table (read only) function code 04h.

Address	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, engine controller (DM1)	Bit 0 EIC communication error Bit 1 EIC yellow Bit 2 EIC red Bit 3 EIC protection Bit 4 EIC malfunction

16.4.14 Alarms via Modbus - MTU MDEC series 2000/4000 (module 302 & 303)

Alarm, status and measurement table (read-only) function code 04h.

Address	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
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

16.4.15 Alarms via Modbus - Scania

Alarm, status and measurement table (read only) function code 04h.

Address	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 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

16.4.16 Alarms via Modbus - Volvo Penta

Alarm, status and measurement table (read only) function code 04h.

Address	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, engine controller (DM1)	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

17. Step-up and step-down transformers

17.1 Step-up and step-down transformers

17.1.1 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. Applications that need a step-up transformer are supported by the AGC 150.

The available functions are:

1. Synchronising with or without phase angle compensation
2. Voltage measurement displayed
3. Generator protections
4. Busbar protections

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. This does not influence the setting in AGC 150, as long as the breaker and the step-up transformer are both placed between the measuring points used by the controller. The measuring points are shown as black dots.

Figure 17.1 Generator/transformer block, breaker on LV side

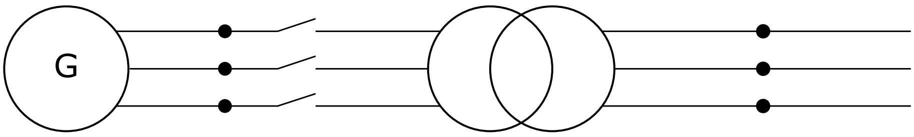
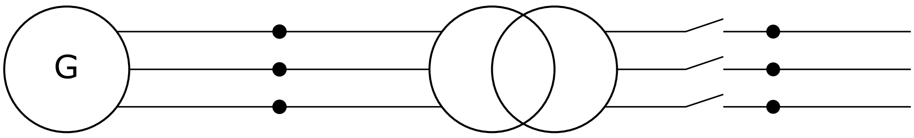


Figure 17.2 Generator/transformer block, breaker on HV side



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.

NOTE When voltage measurement transformers are used, these must be included in the total phase angle compensation.

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: $U_{BUS\text{-}MEASURED} \cdot U_{GEN\text{-}NOM}/U_{BUS\text{-}NOM}$ = 10500 · 400/10000 = **420 V**

17.1.2 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 °.

Example

Dy11 = HV side: Delta, LV side: Wye, vector group 11: Phase shift = 11x (-30) = -330 °.

Table 17.1 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 °

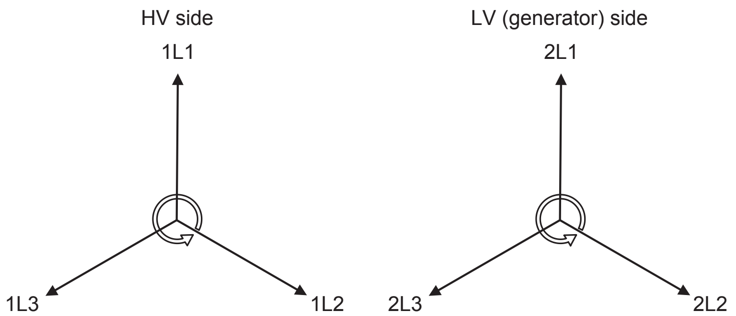
Configure the parameter for phase compensation under **Settings > Synchronisation > Angle offset: GEN/BB**.

Parameter	Text	Range	Default
9141	BB (mains)/generator angle compensation 1	-179.0 to 179.0 °	0.0 °
9142	BB (mains)/generator angle compensation 2	-179.0 to 179.0 °	0.0 °

Vector group 0

The phase angle shift is 0 ° (parameter setting: 0 °).

Yy0 example

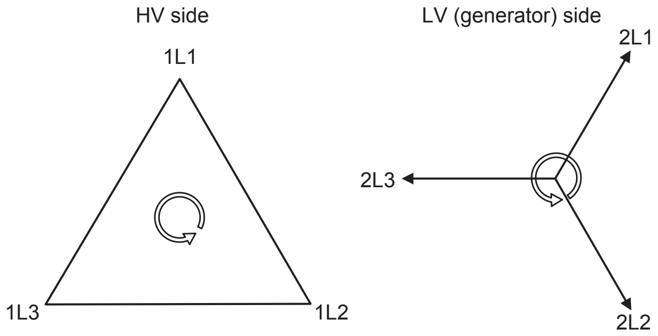


- 1L1 to 2L1 phase angle is 0 °.

Vector group 1

The phase angle shift is -30 ° (parameter setting: 30 °).

Dy1 example

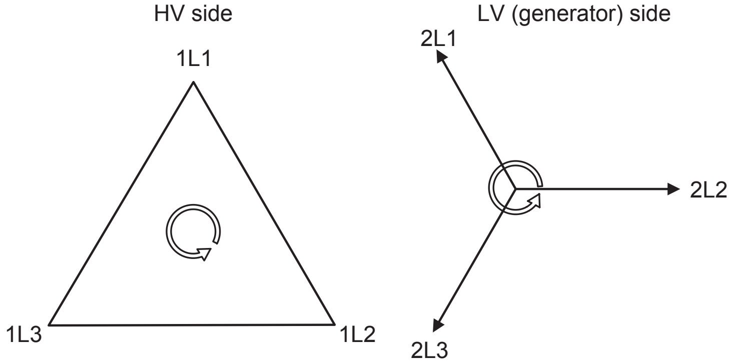
- 

- 1L1 to 2L1 phase angle is -30 °.

Vector group 11

The phase angle shift is 11 x (-30) = -330/+30 ° (parameter setting: -30 °).

Dy11 example

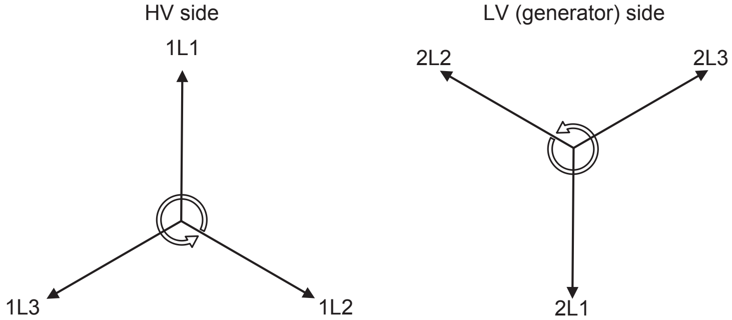
- 

- 1L1 to 2L1 phase angle is -330/+30 °.

Vector group 6

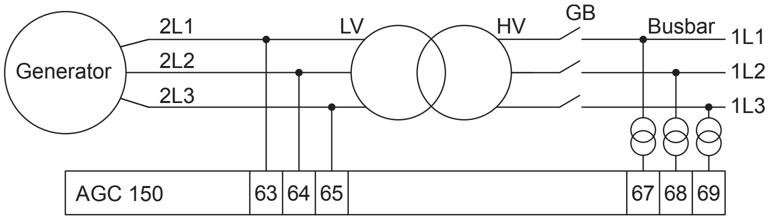
The phase angle shift is 6 x 30 = 180 ° (parameter setting: 180 °).

Yy6 example

- 

- 1L1 to 2L1 phase angle is -180/+180 °.

Connections

- 

- The connection shown in the diagram should always be used when an AGC 150 is used for a genset.
- Select 179 ° in parameter 9141 when vector group 6 is used.

Table 17.2 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 °

Table 17.3 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 °

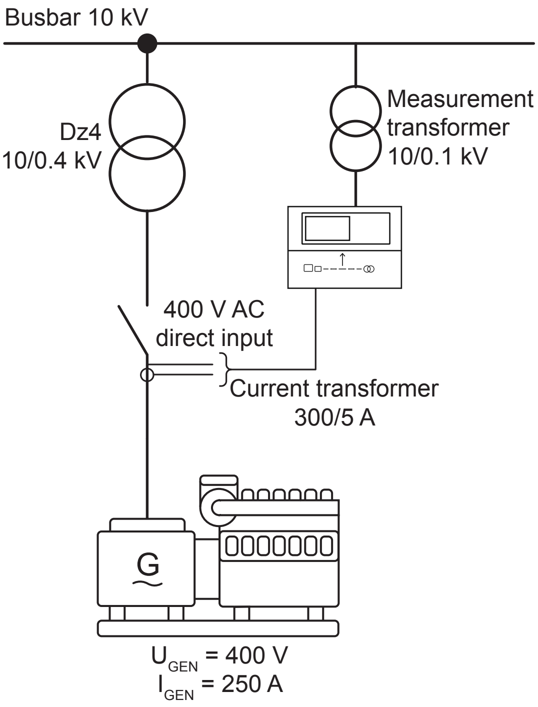
NOTE

- DEIF does not take responsibility for the compensation being correct. Before closing the breaker, DEIF recommends always to validate that systems are aligned.
- The settings shown in the table above does not include any phase angle shift made by measurement transformers.
- The settings shown in the table above are not correct if a step-down transformer is used (see **Setup of step-down and measurement transformers** later in this chapter).

17.1.3 Setup of step-up and measurement transformers

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.

Example



The transformer is a Dz4 step-up transformer with nominal settings of 10/400 V. The generator has a nominal voltage of 400 V, a nominal current of 250 A and a nominal power of 140 kW. The measurement transformer has a nominal voltage of 10/100 V and no phase angle twist. The nominal voltage of the busbar (BB) is 10000 V. 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 AGC 150 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. Because the step-up transformer is a Dz4, there is a phase angle twist of -120 °.

These settings can be programmed on the display or by the Utility Software. The settings must be put into the parameters shown in the table below:

Table 17.4 Parameters for step-up and measurement transformers

Parameter	Parameter path	Comment	Setting
6002	Settings > Basic settings > Nominal settings > Current > 3 phase nominal	Generator nominal power	140
6003	Settings > Basic settings > Nominal settings > Power > 3 phase nominal	Generator nominal current	250
6004	Settings > Basic settings > Nominal settings > Voltage > Generator nominal U	Generator nominal voltage	400
6041	Settings > Basic settings > Measurement setup > Voltage transformer > Generator VT > U primary	Generator voltage transformer primary side	400
6042	Settings > Basic settings > Measurement setup > Voltage transformer > Generator VT > U secondary	Generator voltage transformer secondary side	400
6043	Settings > Basic settings > Measurement setup > Current transformer > 3 phase CT > I primary	Generator current transformer primary side	300
6044	Settings > Basic settings > Measurement setup > Current transformer > 3 phase CT > I secondary	Generator current transformer secondary side	5
6051	Settings > Basic settings > Measurement setup > Voltage transformer > Busbar VT > U primary	Busbar voltage transformer primary side	10000
6052	Settings > Basic settings > Measurement setup > Voltage transformer > Busbar VT > U secondary	Busbar voltage transformer secondary side	100

Parameter	Parameter path	Comment	Setting
6053	Settings > Basic settings > Nominal settings > Voltage > Busbar nominal U	Busbar nominal voltage	10000
9141	Settings > Synchronisation > Angle offset: GEN and BB > ANGLE	Phase angle compensation BB/G 1	120 °
9142	Settings > Synchronisation > Angle offset: GEN and BB > ANGLE	Phase angle compensation BB/G 2	120 °

NOTE The AGC 150 controller can handle nominal 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.

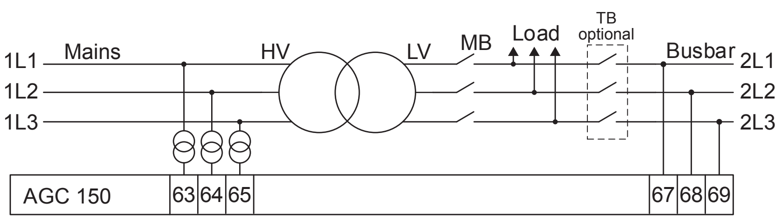
17.1.4 Vector group for step-down transformer

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 AGC 150 controller is able to synchronise the busbar with the mains, even if there is a step-down transformer with a phase angle shift. The transformer must be between the measuring points for the controller.

If a step-down transformer is used, these settings must be set in parameter 9141 to compensate the phase angle shift.

Vector group	Step-down 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 °

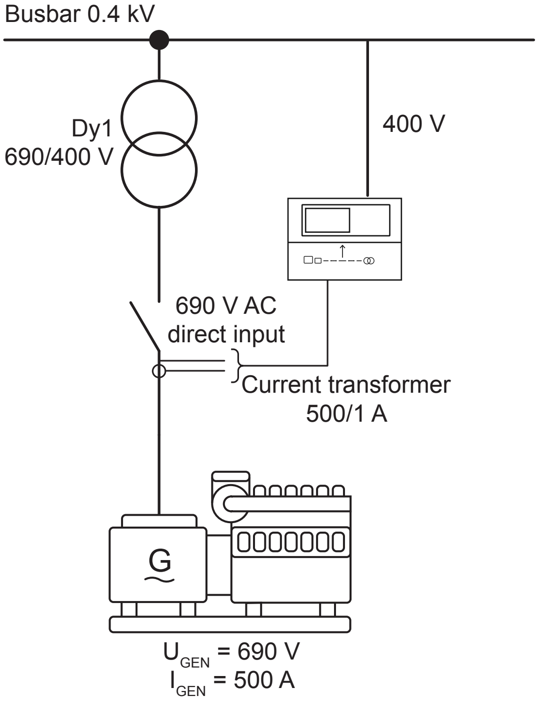
If a step-down transformer and an AGC 150 for the mains breaker are mounted, the measurements must be connected to the controller.



17.1.5 Setup of step-down and measurement transformers

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.

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 AGC 150 is able to handle the voltage levels directly. The nominal voltage of the busbar (BB) is 400 V. It is required to set up current transformers. In this example, the current transformers have a nominal current of 500/1 A. The step-down transformer is a Dy1, there is a phase angle twist of +30 °.

These settings can be programmed by the display or by the Utility Software. The settings must be put into the parameters shown in the table below:

Table 17.5 Parameters for step-down and measurement transformers

Parameter	Parameter path	Comment	Setting
6002	Settings > Basic settings > Nominal settings > Current > 3 phase nominal	Generator nominal power	480
6003	Settings > Basic settings > Nominal settings > Power > 3 phase nominal	Generator nominal current	500
6004	Settings > Basic settings > Nominal settings > Voltage > Generator nominal U	Generator nominal voltage	690
6041	Settings > Basic settings > Measurement setup > Voltage transformer > Generator VT > U primary	Generator voltage transformer primary side	690
6042	Settings > Basic settings > Measurement setup > Voltage transformer > Generator VT > U secondary	Generator voltage transformer secondary side	690
6043	Settings > Basic settings > Measurement setup > Current transformer > 3 phase CT > I primary	Generator current transformer primary side	500
6044	Settings > Basic settings > Measurement setup > Current transformer > 3 phase CT > I secondary	Generator current transformer secondary side	1
6051	Settings > Basic settings > Measurement setup > Voltage transformer > Busbar VT > U primary	Busbar voltage transformer primary side	400
6052	Settings > Basic settings > Measurement setup > Voltage transformer > Busbar VT > U secondary	Busbar voltage transformer secondary side	400
6053	Settings > Basic settings > Nominal settings > Voltage > Busbar nominal U	Busbar nominal voltage	400

Parameter	Parameter path	Comment	Setting
9141	Settings > Synchronisation > Angle offset: GEN and BB > ANGLE	Phase angle compensation BB/G 1	-30 °
9142	Settings > Synchronisation > Angle offset: GEN and BB > ANGLE	Phase angle compensation BB/G 2	-30 °