DESIGNER'S REFERENCE HANDBOOK

Advanced Genset Controller, AGC 200

- Functional description
- Display menu structure
- PID controller
- Procedure for parameter setup

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1. General information

1.1 Warnings, legal information and safety

1.1.1 Warnings and notes

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

Warnings

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

Notes

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

1.1.2 Legal information and disclaimer

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

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

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

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

1.1.3 Safety issues

Installing and operating the Multi-line 2 unit may imply work with dangerous currents and voltages. Therefore, the installation should only be carried out by authorised personnel who understand the risks involved in working with live electrical equipment.

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

1.1.4 Electrostatic discharge awareness

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

1.1.5 Factory settings

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

1.2 About the Designer's Reference Handbook

1.2.1 General purpose

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

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

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

1.2.2 Intended users

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

1.2.3 Contents and overall structure

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

2. General product information

2.1 Introduction

The AGC 200 is part of the DEIF Multi-line 2 product family. Multi-line 2 is a complete range of multi-function generator protection and control products integrating all the functions you need into one compact and attractive solution.The concept of the AGC 200 is to offer a cost-effective solution to genset builders, who need a flexible generator protection and control unit for medium to large genset applications. Being part of the Multi-line product family, the standard functions can be supplemented with a variety of optional functions.

2.2 Type of product

The Advanced Genset Controller is a micro-processor based control unit containing all necessary functions for protection and control of a genset. It contains all necessary 3-phase measuring circuits, and all values and alarms are presented on the LCD display

2.3 Options

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

A full options list is included in the data sheet, document no. 4921240362. Please see www.deif.com

2.4 PC utility software warning

It is possible to remote control the genset from the PC utility software or M-Vision by use of a modem. To avoid personal injury, make sure that it is safe to remote control the genset.

3. Functional descriptions

3.1 Standard functions and application types

3.1.1 Standard functions and application types

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

3.2 Standard functions

3.2.1 Operation modes

- Automatic mains failure
- Island operation
- Fixed power/base load
- Peak shaving
- Load takeover
- Mains power export

3.2.2 Engine control and protection

- Start/stop sequences
- Run and stop coil
- Relay outputs for governor control
- J1939 engine communication and control
- Multi-inputs (digital, 4 to 20 mA, Pt100 or RMI)
- Digital inputs

3.2.3 Generator protections (ANSI)

- Over-current, 6 levels (51)
- Reverse power, 2 levels (32)
- Voltage-dependent over-current (92)
- Over-voltage, 2 levels (27)
- Under-voltage, 3 levels (59)
- Over-frequency, 3 levels (81)
- Under-frequency, 3 levels (81)
- Overload, 5 levels (32)
- Unbalanced current (46)
- Unbalanced voltage (60)
- Loss of excitation (40)
- Over-excitation (40)
- Non-essential load/load shedding, 3 levels (I, Hz, P>, P>>)

3.2.4 Busbar/mains protections (ANSI)

- Over-voltage, 2 levels (27)
- Under-voltage, 2 levels (59)
- Over-frequency, 2 levels (81)
- Under-frequency, 2 levels (81)
- Reverse power, 2 levels (32)
- Overload, 2 levels (32)

3.2.5 Display and unit front

- Push-buttons for start and stop
- Push-buttons for breaker operations
- Status texts

3.2.6 M-Logic

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

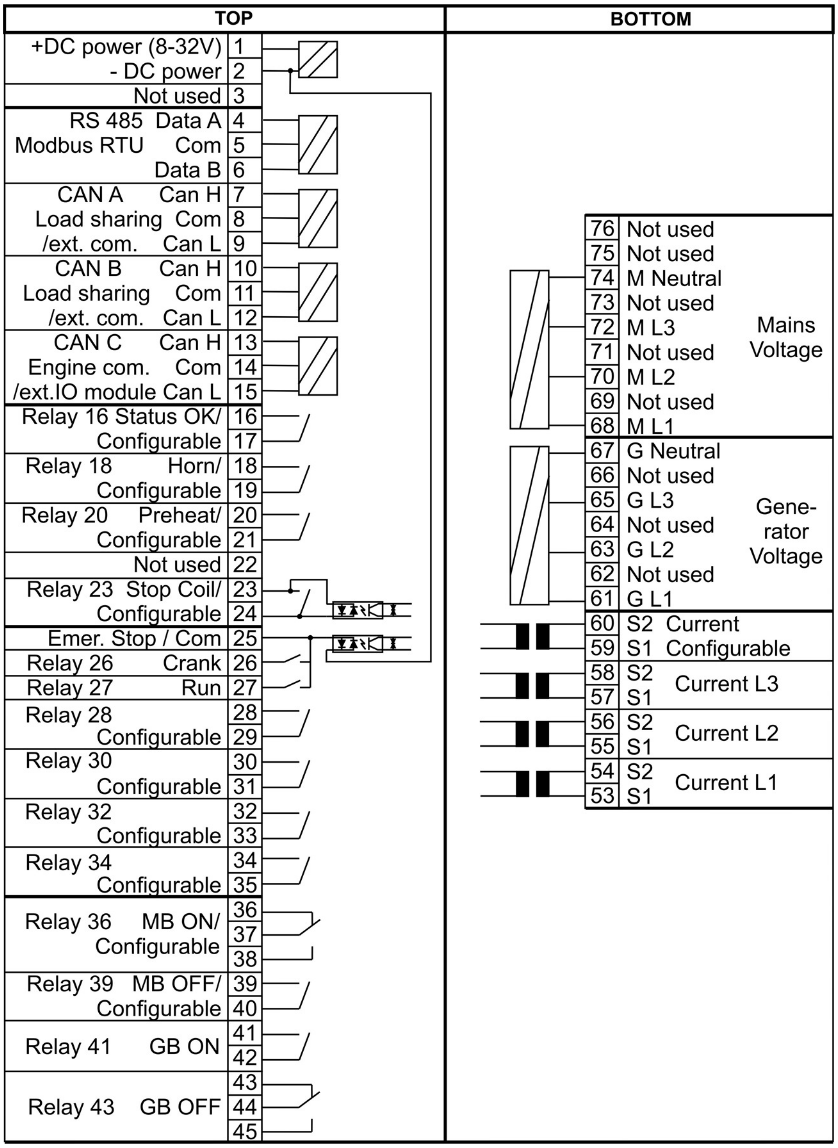
3.3 Terminal strip overview

3.3.1 Terminals

The terminal strip overview shows I/Os for selectable standard and optional hardware.

Please refer to the data sheet for accurate information about possible configurations of the AGC 200.

Please refer to the input/output lists in the installation instructions for detailed information about the I/Os.



LEFT	
Multi-in 1	46
Multi-in 2	47
Multi-in 3	48
Multi-in common	49
RPM MPU/tacho	50
RPM common	51
RPM W/NPN/PNP	52

RIGHT	
77	Di 77 Configurable
78	Di 78 Configurable
79	Di 79 Configurable
80	Di 80 Configurable
81	Di 81 Configurable
82	Di 82 Configurable
83	Di 83 Configurable
84	Di 84 Configurable
85	Di 85 Configurable
86	Di 86 Configurable
87	MB ON / Di 87
88	MB OFF / Di 88
89	GB ON
90	GB OFF
91	Common
92	Not used
93	D+ (charger gen.)

AGC 212/213: Relay outputs terminals 28-35 and CT terminal 59-60 are not available.

3.3.2 Available CAN ports

The table below shows available CAN ports and how each can be configured:

	CAN A	CAN B	CAN C
AGC 212, 213	Not available	Not available	OFF External I/O H5 EIC AOP2
AGC 222	Not available	OFF External I/O PM Secondary CANshare AOP2 PM Primary	OFF External I/O H5 EIC CANshare AOP2
AGC 232, 233	OFF External I/O CANshare AOP2	OFF External I/O CANshare AOP2	OFF External I/O H5 EIC CANshare AOP2
AGC 242, 243	OFF External I/O PM Primary CANshare AOP2 PM Secondary	OFF External I/O PM Secondary CANshare AOP2 PM Primary	OFF External I/O H5 EIC CANshare AOP2
AGC 245, 246	OFF External I/O PM Primary AOP2 PM Secondary	OFF External I/O PM Secondary AOP2 PM Primary	OFF External I/O H5 EIC AOP2

3.4 Measurement systems

The AGC is designed for measurement of voltages between 100 and 690 V AC on the terminals. If the voltage is higher, voltage transformers are required. For further reference, the AC wiring diagrams are shown in the Installation Instructions.

In menu 9130, the measurement principle can be changed; the options are three-phase, single phase and split phase.

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

3.4.1 Three-phase system

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

The table below contains the parameters to make the system ready for three-phase measuring.
The example below is with 230/400 V AC, which can be connected directly to the AGC's terminals without the use of a voltage transformer. If a voltage transformer is necessary, the nominal values of the transformer should be used instead.

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

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

3.4.2 Single phase system

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

The table below contains the parameters to make the system ready for single phase measuring.
The example below is with 230 V AC, which can be connected directly to the AGC's terminals without the use of a voltage transformer. If a voltage transformer is necessary, the nominal values of the transformer should be used instead.

Setting	Adjustment	Description	Adjust to value
6004	G nom. voltage	Phase-neutral voltage of the generator	230 V AC
6041	G transformer	Primary voltage of the G voltage transformer (if installed)	230 V AC
6042	G transformer	Secondary voltage of the G voltage transformer (if installed)	230 V AC
6051	BB transformer set 1	Primary voltage of the BB voltage transformer (if installed)	230 V AC
6052	BB transformer set 1	Secondary voltage of the BB voltage transformer (if installed)	230 V AC
6053	BB nom. voltage set 1	Phase-neutral voltage of the busbar	230 V AC

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

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

3.4.3 Split phase system

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

The table below contains the parameters to make the system ready for split phase measuring.
The example below is with 240/120 V AC, which can be connected directly to the AGC's terminals without the use of a voltage transformer. If a voltage transformer is necessary, the nominal values of the transformer should be used instead.

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

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

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

3.5 Nominal settings

3.5.1 Nominal settings

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

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

3.5.2 Switch between the nominal settings

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

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

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

Activation

Manual switching between the nominal set points can be done in three ways: digital input, AOP or menu 6006.

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

Digital input

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

Example:

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

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

AOP

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

Example:

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

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

Menu settings

In menu 6006, the switching between settings 1 to 4 is made simply by choosing the desired nominal setting.

Four nominal settings of GOV/AVR offsets

In menu 6006, the selection of nominal setting is made. The nominal setting of GOV/AVR offset will follow the setting in 6006, meaning: nominal setting 1 (6001 to 6005) will follow the GOV/AVR offset in 2550.

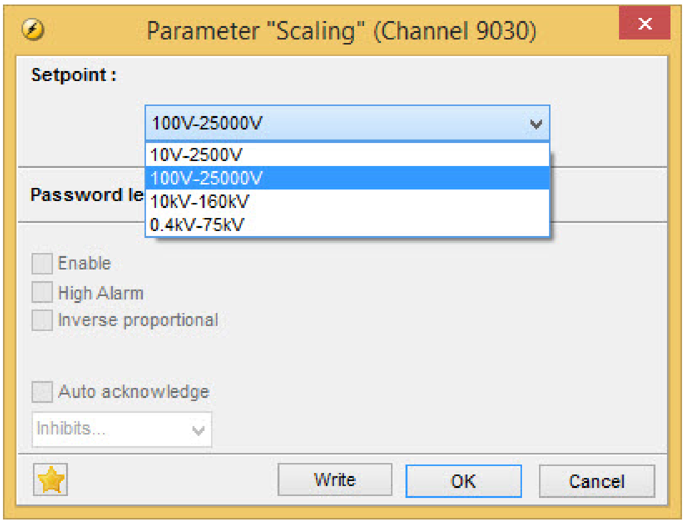
Reg	2550	GOV outp offset	133	50	%
Reg	2551	GOV outp offset	1633	50	%
Reg	2552	GOV outp offset	1634	50	%
Reg	2553	GOV outp offset	1635	50	%

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

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

3.5.3 Scaling

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



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

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

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

3.6 Applications

3.6.1 About applications

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

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

Application (Single Generator)	Comment
Automatic Mains Failure (no back sync.)	Standard
Automatic Mains Failure (with back sync.)	Standard
Island operation	Standard
Fixed power/base load	Standard
Peak shaving	Standard
Load takeover	Standard
Mains power export (fixed power to mains)	Standard

Application (multiple generators)	Comment
CANbus load sharing	AGC 222, 23x and 24x only
Power management	AGC 222 and 24x only

Genset Mode (Single Generator)	Running Mode				
	Auto	Semi	Test	Manual	Block
Automatic Mains Failure (no back sync.)	X	X	X	X	X
Automatic Mains Failure (with back sync.)	X	X	X	X	X
Island operation	X	X	X	X	X
Fixed power/base load	X	X	X	X	X
Peak shaving	X	X	X	X	X
Load takeover	X	X	X	X	X
Mains power export	X	X	X	X	X

	Running Mode				
	Auto	Semi	Test	Man	Block
Load sharing	X	X		X	X
Power management	X	X	X	X	X

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

3.6.2 AMF (no back synchronisation)

Auto mode description

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

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

In both cases, the generator breaker will be closed when the generator voltage and frequency is OK, and the mains breaker is open,
when the mains returns, the unit will switch back to mains supply and cool down and stop the genset. The switching back to mains supply is done without back synchronisation when the adjusted ”Mains OK delay” has expired.

Semi-auto mode description

When the generator breaker is closed, the unit will use the nominal frequency as the set point for the speed governor and nominal voltage for the AVR

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

3.6.3 AMF (with back synchronisation)

Auto mode description

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

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

In both cases, the generator breaker will be closed when the generator voltage and frequency is OK, and the mains breaker is open.
When the mains returns, the unit will synchronise the mains breaker to the busbar when the ”Mains OK delay” has expired. Then the genset cools down and stops.

The automatic mains failure mode can be combined with the ”overlap” function. In that case, the generator breaker and the mains breaker will never be closed at the same time for a longer period than the adjusted ”overlap” time.

Semi-auto mode description

When the generator breaker is closed and the mains breaker is opened, the unit will use the nominal frequency as the set point for the speed governor and the nominal voltage for the AVR.
When the generator is paralleled to the mains, the governor regulation will no longer be active. If AVR control is selected, then the set point will be the adjusted cos phi.

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

3.6.4 Island operation

Auto mode description

The unit automatically starts the genset and closes the generator breaker at a digital start command. When the stop command is given, the generator breaker is tripped and the genset will be stopped after a cooling-down period. The start and stop commands are used by activating and deactivating a digital input. If the time-dependent start/stop commands are to be used, then the auto mode must also be used. In this case, the digital input ”auto start/stop” cannot be used.

Semi-auto mode description

When the generator breaker is closed, the unit will use the nominal frequency as set point for the speed governor and the nominal voltage for the AVR.

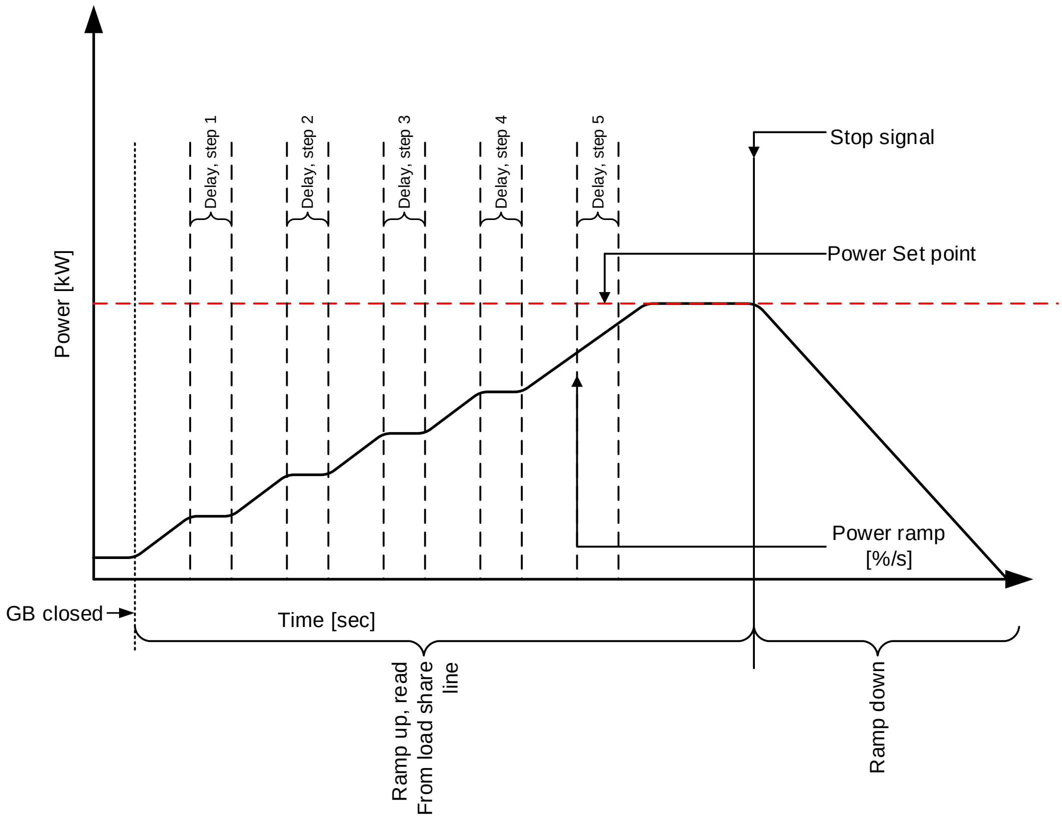
For a general description of the available running modes, please refer to the chapter ”Running mode description”.

3.6.5 Power ramp

"Power ramp up" (channel 261x) and "Power ramp down" (channel 262x) are used when the genset is connected to another supply source.

2610 Power ramp up	
Ramp speed 1	Defines the slope of ramp up 1
Delay point	At this point, the ramp up is cancelled until the delay has expired
Delay	When this delay has expired, the ramp up is continued from the delay point
Island ramp	Enable ramping in Island mode
Steps	Defines the number of ramp steps
Ramp speed 2	Defines the slope of ramp up 2

2620 Power ramp down	
Ramp speed 1	Defines the slope of ramp down 1 (used for de-load as well)
Breaker open point	The amount of power accepted when opening the breaker
Ramp speed 2	Defines the slope of ramp down 2 (not used for de-load)
Automatic ramp selection	When "Auto ramp select" is disabled, ramp 2 can only be enabled with M-Logic



Ramp up with load steps

When the GB is closed, the power set point continues to rise in ramp-up steps, determined by the number of steps in menu 2615. If the delay point is set to 20 % and the number of load steps is set to 3, the genset will ramp to 20 %, wait the configured delay time, ramp to 40 %, wait, ramp to 60 %, wait and then ramp to the present power set point.

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

1. The power ramp will stop at any point of the power ramp, and this set point will be maintained as long as the function is active.
2. If the function is activated while ramping from one delay point to another, the ramp will be fixed until the function is deactivated again.
3. If the function is activated while the delay timer is timing out, the timer will be stopped and will not continue until the function is deactivated again.

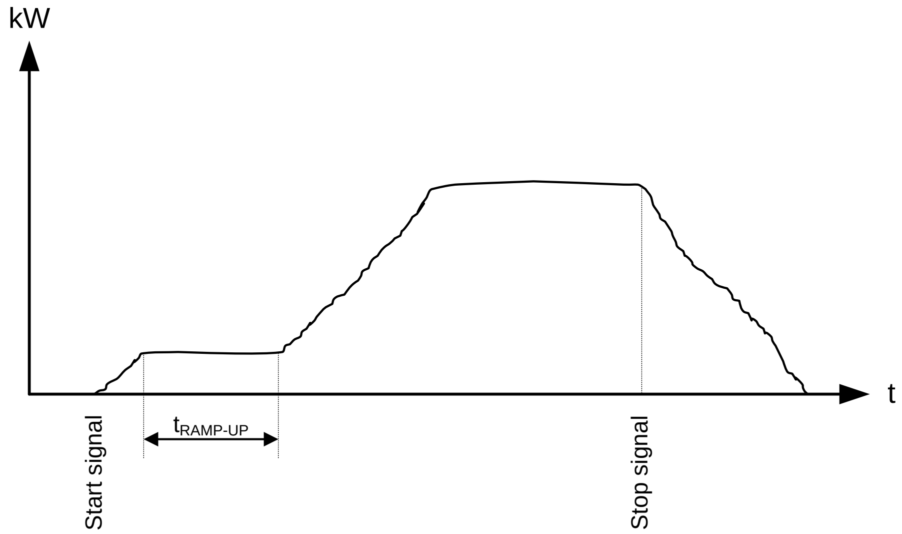
The delay starts running when the GB has been closed.

Power ramp 1
This 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
Channels 2616 and 2623 define the slope of the second power ramp. This is a secondary power ramp mostly used for "frequency-dependent power droop", but it can also be activated with any M-Logic event. Channel 2624 (automatic ramp selection) determines if the ramp 2 is activated by droop or M-Logic. If automatic "ramp selection" is activated, then the second ramp is enabled during power droop. If it is disabled, then the second ramp can only be activated by M-Logic.

3.6.6 Fixed power/base load

Auto mode description
The unit automatically starts the genset and synchronises to the mains when the digital input "auto start/stop" is activated. After the generator breaker closure, the unit 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 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.



Diagram, fixed power - principle

Semi-auto mode description
When the generator breaker is closed and the mains breaker is opened, the unit will use the nominal frequency as the set point for the speed governor. If AVR control (option D1) is selected, the nominal voltage is used as 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 (option D1) is selected, then the set point will be the adjusted power **(7050 Fixed power set).**

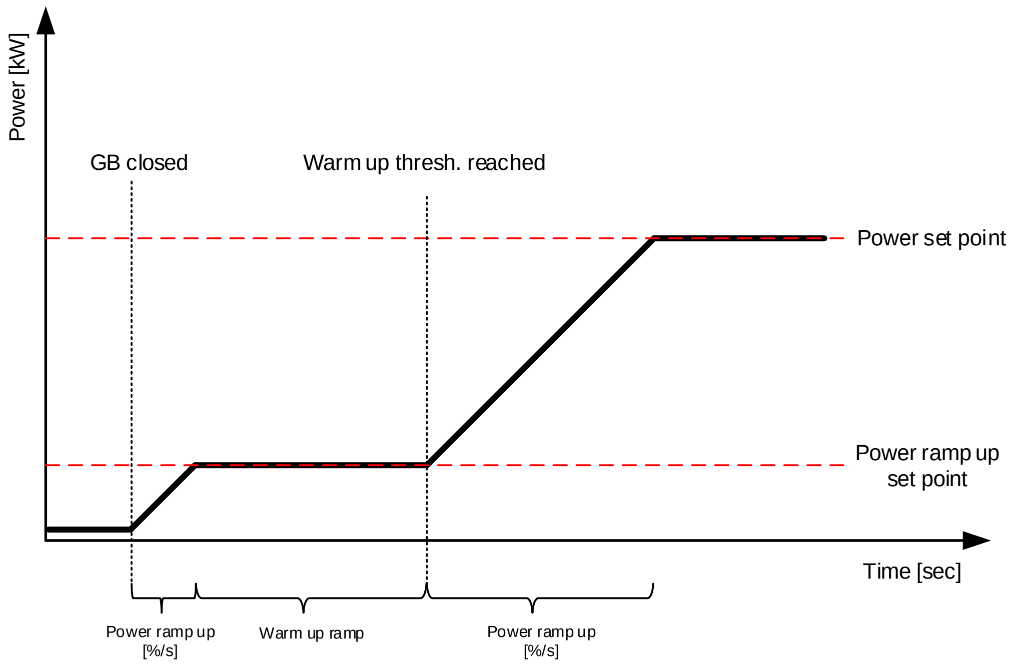
7050 Fixed Power Set	
Power set	The amount of power the genset will produce.

The values in 7052-7055 set the cos phi. This is not the PF value displayed in the display. Cos phi and PF are only equal if it is a true sinusoidal wave.

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

3.6.7 Warm up ramp

Warm up ramp is a function that limits the power output until a pre-configured condition has been met, like, for example, the engine has reached operating temperature which will greatly reduce stress on the engine.



The warm up ramp activation is enabled and the input is configured via "Warm up type" (channel 2961). The activation of the warm up ramp input limits the available power of the genset to the percentage level configured in "Power ramp up" (channel 2612).

If the type is configured as M-Logic, the input must go low before warm up ramp is deactivated. If the type is configured as a multi-input or an EIC temperature input, the deactivation occurs when the temperature is above the threshold configured in "Warm up thresh." (channel 2962).

When warm up ramp is activated, the standard function "Power ramp up" is replaced, which means that the load/steps and the timer are disabled.

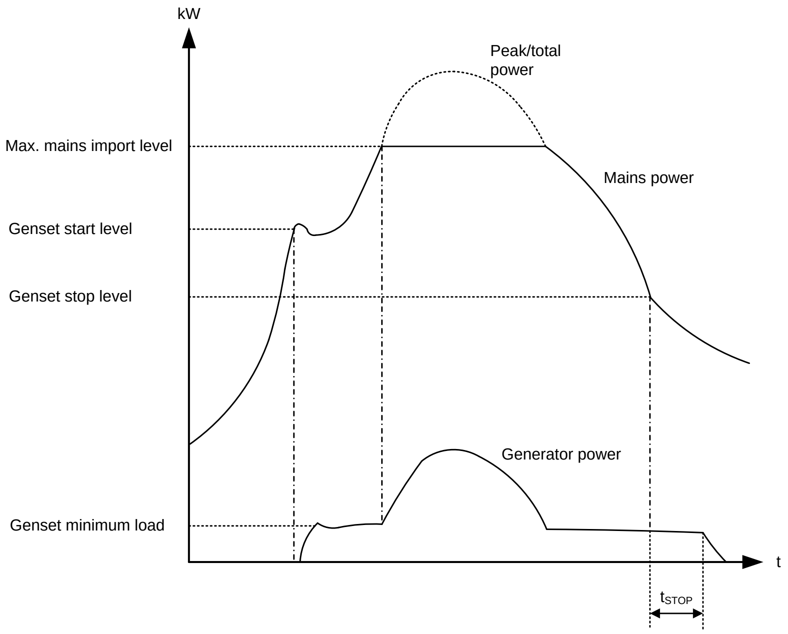
3.6.8 Peak shaving

Auto mode description

The genset will start at a predefined mains import level and run at a fixed minimum load, e.g. 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 decreases below the stop set point, the genset will cool down and stop.

The CT4 (measuring CT placed in phase L1) input can be used for indication of the power imported from the mains. Alternatively, a transducer connected to multi-input 46 can be used. This is a better solution if there is some distance from the measuring point to the AGC 200.



Semi-auto mode description

When the generator breaker is closed and the mains breaker is opened, the unit will use the nominal frequency as set point for the speed governor. If AVR control is selected, the nominal voltage is used as set point. When the generator is paralleled to the mains, the generator will be controlled according to the peak shaving set point. So the maximum mains import will not be exceeded in spite of the semi- auto mode. If AVR control is selected, the set point is the adjusted cos phi.

set points related to peak shaving

7000 Mains Power	
Day and night	The mains power import limits for the peak shaving
Tmax and Tmin	The transducer range in kW, corresponding to the 4-20 mA transducer signal connected on multi-input 46.

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

7020 Start generator	
Start set point	The start set point is in percent of the day and night settings in menu 7000 Mains power
Delay	The genset will start when the start set point has been exceeded and this delay has expired.
Load	The minimum load the genset will produce when parallel to mains.

7030 Stop generator	
Stop set point	The stop set point is in percent of the day and night settings in menu 7000 Mains power.
Delay	The genset will stop when the stop set point has been exceeded and this delay has expired.

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

3.6.9 Load takeover

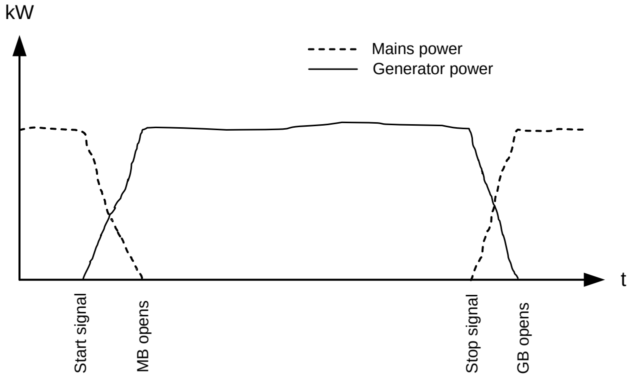
Auto mode description- *Back synchronising ON*

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

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

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

The CT4 (measuring CT placed in phase L1) input can be used for indication of the power imported from the mains. Alternatively, a transducer connected to multi-input 46 can be used. This is a better solution if there is some distance from the measuring point to the AGC 200.



Diagram, load takeover - example

The load takeover mode can be combined with the overlap function. In that case, the generator and the mains breakers will never be closed at the same time for a longer period than the adjusted ”overlap” time.

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

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

The CT4 (measuring CT placed in phase L1) input can be used for indication of the power imported from the mains. Alternatively, a transducer connected to multi-input 46 can be used. This is a better solution if there is some distance from the measuring point to the AGC 200.

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

Semi Auto mode description
When the generator breaker is closed and the mains breaker is opened, the unit will use the nominal frequency as set point for the speed governor. If AVR control 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 is the adjusted cos phi.

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

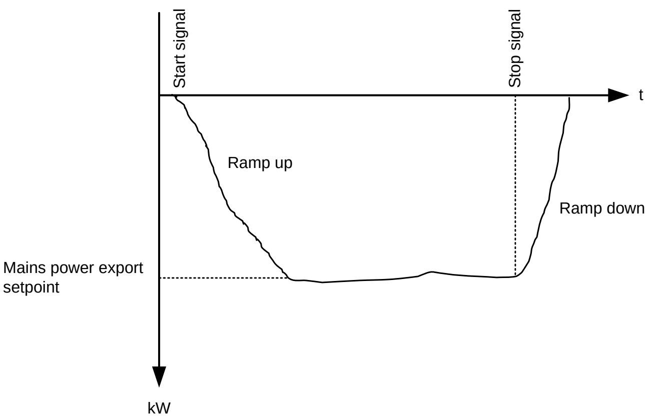
3.6.10 Mains power export (fixed power to mains)

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

If a fixed level of imported power must be used, it is still the mains power export mode that is to 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 stop command will cause the genset to deload and trip the generator breaker. Afterwards, it will cool down and stop.

The CT4 (measuring CT placed in phase L1) input can be used for indication of the power imported from the mains. Alternatively, a transducer connected to multi-input 46 can be used. This is a better solution if there is some distance from the measuring point to the AGC 200.



Diagram, mains power export - example

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

Semi-auto mode description
When the generator breaker is closed and the mains breaker is opened, the unit will use the nominal frequency as set point for the speed governor. If AVR control 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 is the adjusted cos phi.

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

3.7 Running mode description

3.7.1 Semi-auto mode

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

An external signal may be given in three ways:

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

3. Modbus command

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

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

The following sequences can be activated in semi-auto:

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

3.7.2 Test mode

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

The settings for the test function are set up in menu 7040.

Related parameters:
7040 Test

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

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

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

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

Power management (option G4): Test mode is not available.

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 the power typed in the set point in menu 7041. The test will run until the timer expires.

To run the load test, it is required that ”Sync. to mains” is enabled in menu 7084.

When running a load test sequence, the overlap function is ignored.

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

To run the full test, it is required that ”Sync. to mains” is enabled in menu 7084.

3.7.3 Manual mode

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

Command	Description	Comment
Start	The start sequence is initiated and continues until the genset starts or the maximum number of start attempts has been reached.	No regulation.
Stop	The genset will be stopped. After disappearance of the running signal, the stop sequence will continue to be active in the "extended stop time" period. The genset is stopped with cooling down time.	
Close GB	The unit will close the generator breaker if the mains breaker is open, and synchronise and close the generator breaker if the mains breaker is closed.	No regulation. Sync. failure is deactivated.
Open GB	The unit will open the generator breaker instantly.	
Close MB	The unit will close the mains breaker if the generator breaker is open, and synchronise and close the mains breaker if the generator breaker is closed.	No regulation. Sync. failure is deactivated.
Open MB	The unit will open the mains breaker instantly.	
Manual GOV UP	The unit gives increase signal to the speed governor.	
Manual GOV DOWN	The unit gives decrease signal to the speed governor.	
Manual AVR UP	The unit gives increase signal to the AVR.	For AGC-4, option D1 is required.
Manual AVR DOWN	The unit gives decrease signal to the AVR.	For AGC-4, option D1 is required.

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

3.7.4 Block mode (OFF button)

When block mode is selected, the unit is locked for certain actions. Block mode can either be selected by pressing the MODE button on the display or by using a digital input. If a digital input is used for block mode, it is important to keep in mind that the input configured to block mode is a constant signal. This means that when the input is ON the unit is in a blocked state, and when it is OFF the unit returns to the mode it was in before block mode was selected.
When activating BLOCK mode from the display on an AGC 200, it is as a minimum required to log in as customer.
When changing from BLOCK mode to any other operating modes from the AGC's display, it is as a minimum required to log in as customer.

Block mode on a genset controller

If the genset controller is in block mode, it cannot start the genset or perform any breaker operations. If the genset is running when block mode is selected, the breaker will be opened and the genset will shut down without cooling down.
The purpose of the block mode is to make sure that the genset does not start during maintenance work, for example.

Block mode on a mains controller
If the mains controller is in block mode, it cannot perform any breaker operations. If any breaker is closed when the mains controller is put into block mode, the mains breaker will be opened, but the tie breaker will remain closed to ensure the genset's ability to support the load.
The purpose of block mode is to make sure that the mains breaker cannot close onto a transformer that is momentarily non-functional due to performance of service. When block mode is used on a mains controller in a power management setup, the system will know that the blocked mains controller will not be available.

Block mode in single DG application
If a genset, which is running in a single DG application with an MB and a GB, is set in block mode, the DG will stop and the GB will open. When block mode is active the DG, the GB and the MB will not be operational, but if the MB was closed when block mode was activated, the MB will stay closed.

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

Alarms are not influenced by block mode selection.

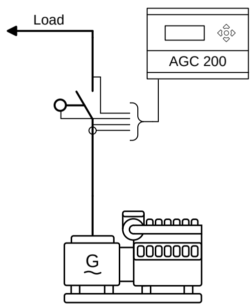
Before the running mode is changed, make sure that nobody is near the genset and that the genset is ready for operation.

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

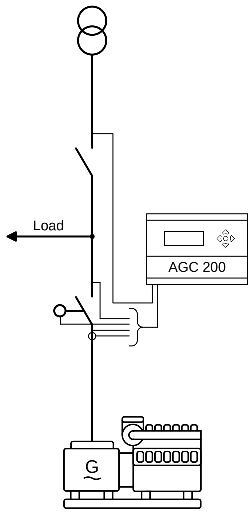
The genset will shut down if block mode is selected while the genset is running.

3.8 Single-line diagrams

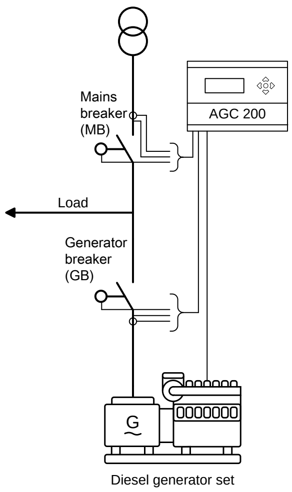
3.8.1 Island operation



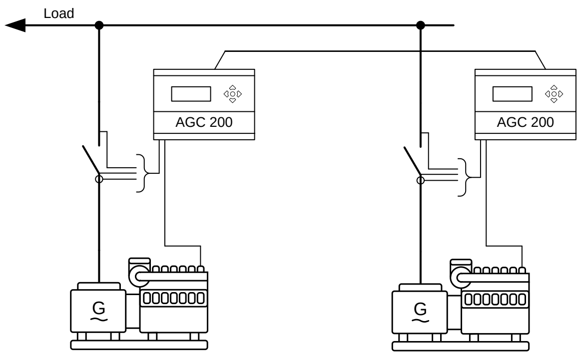
3.8.2 Automatic mains failure/fixed power/base load



3.8.3 Peak shaving/load takeover/mains power export



3.8.4 Multiple gensets, load sharing



3.9 Flowcharts

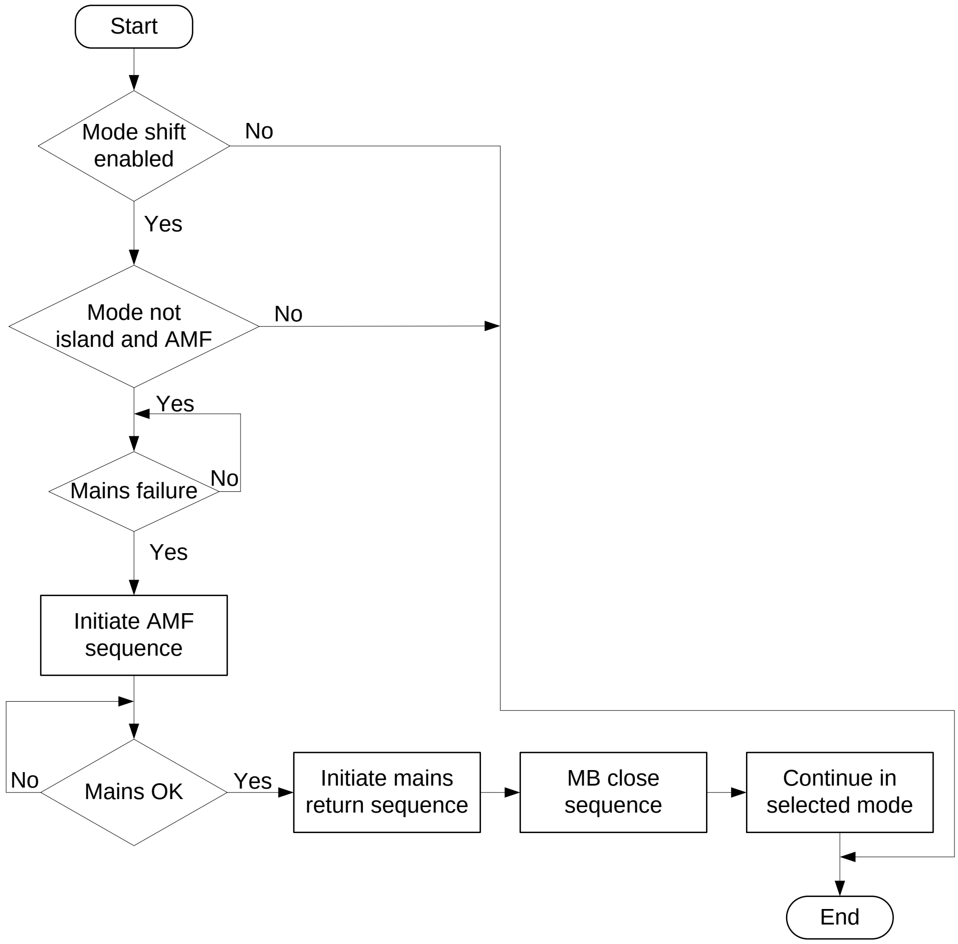
3.9.1 Flowcharts

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

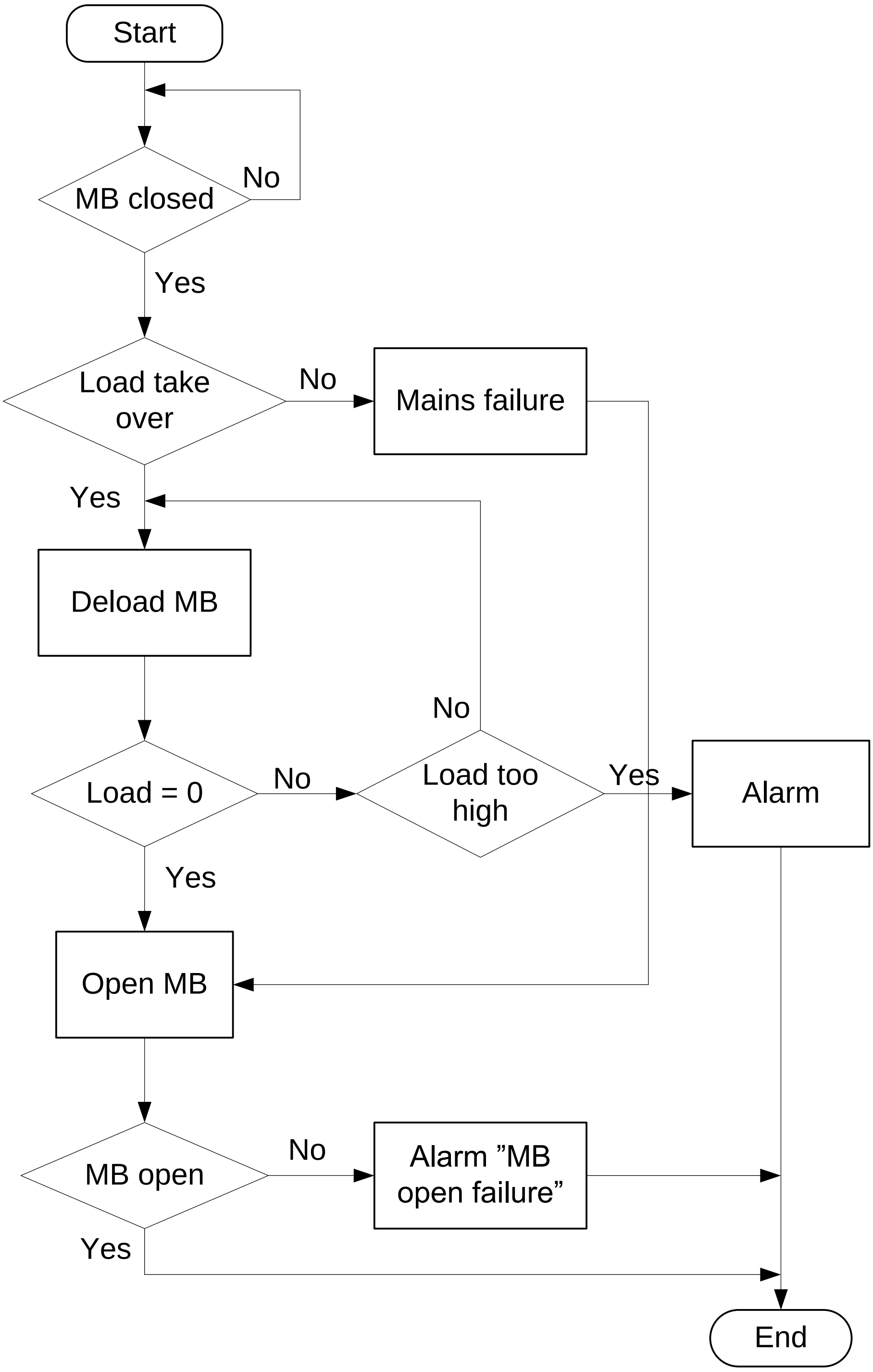
- Mode shift
- MB open sequence
- GB open sequence
- Stop sequence
- Start sequence
- MB close sequence
- GB close sequence
- Fixed power
- Load takeover
- Single generator/island operation
- Peak shaving
- Mains power export
- Automatic nains failure
- Test sequence

The following flowcharts are for guidance only. For illustrative purposes, the flowcharts are simplified.

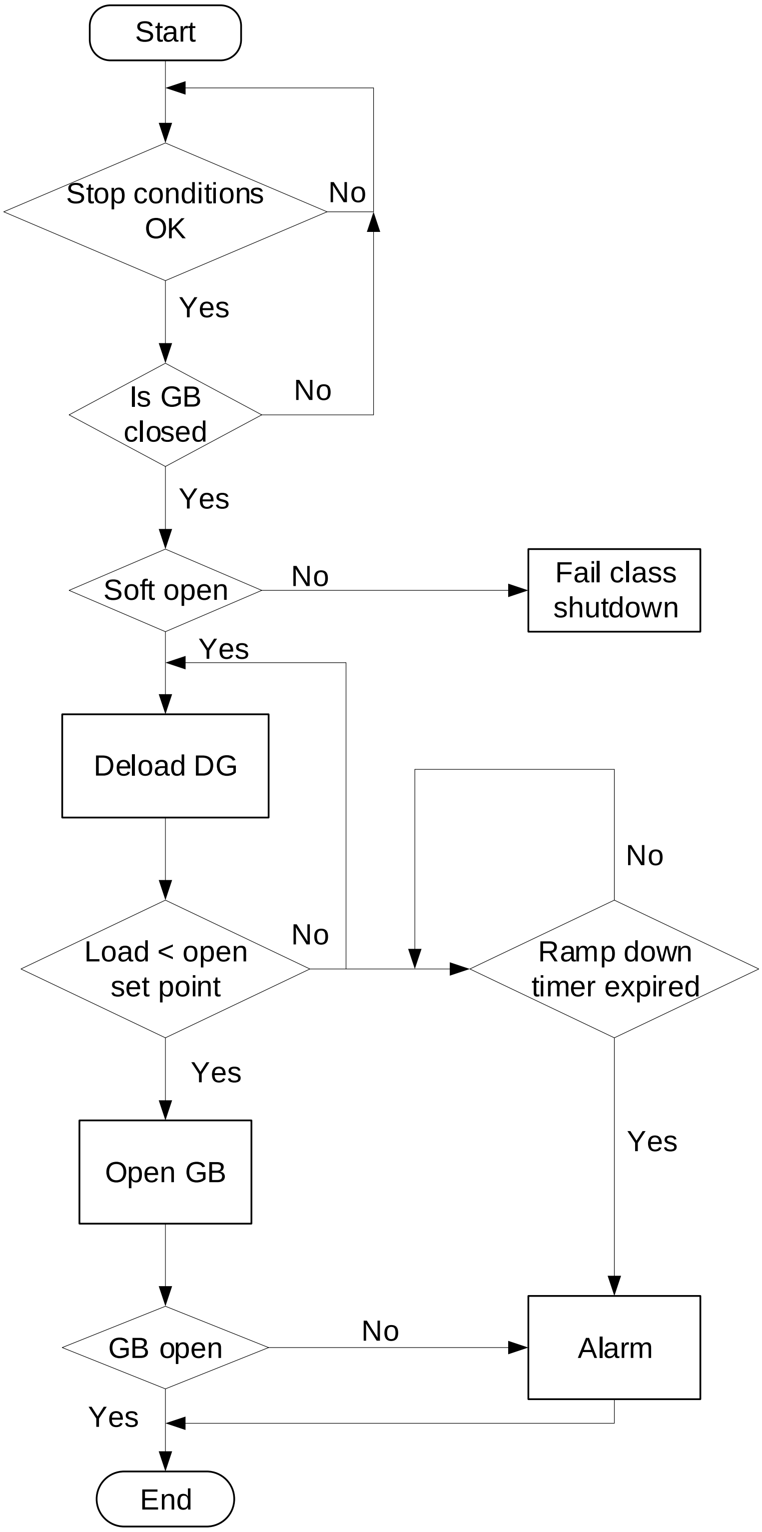
Mode shift


Start
Mode shift enabled
No
Yes
Mode not island and AMF
No
Yes
Mains failure
No
Yes
Initiate AMF sequence
No
Mains OK
Yes
Initiate mains return sequence
MB close sequence
Continue in selected mode
End

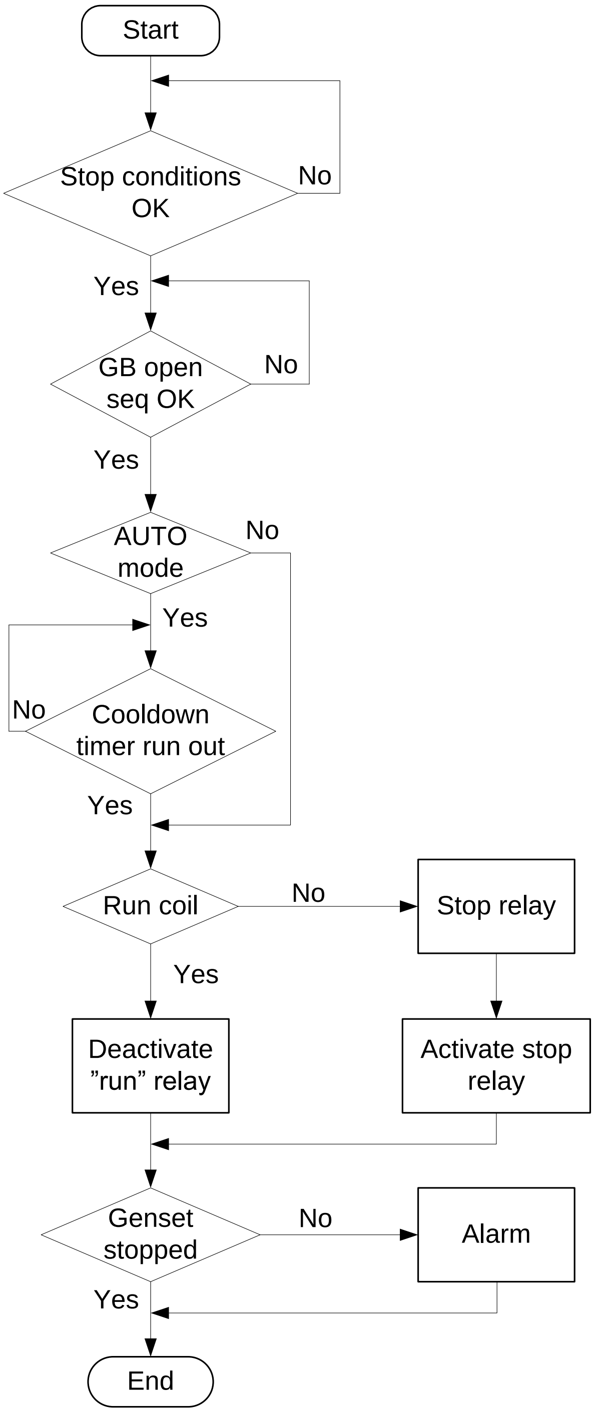
MB open sequence



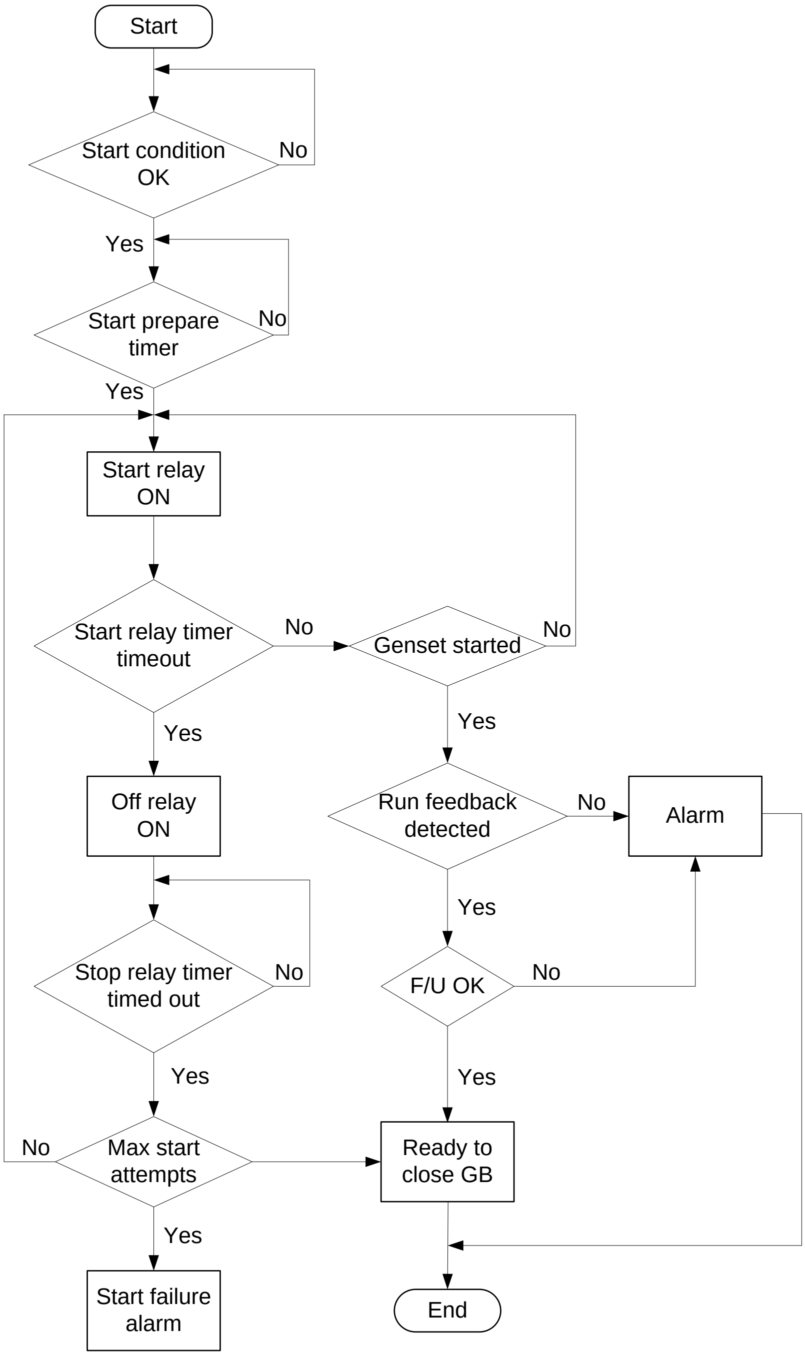
GB open sequence



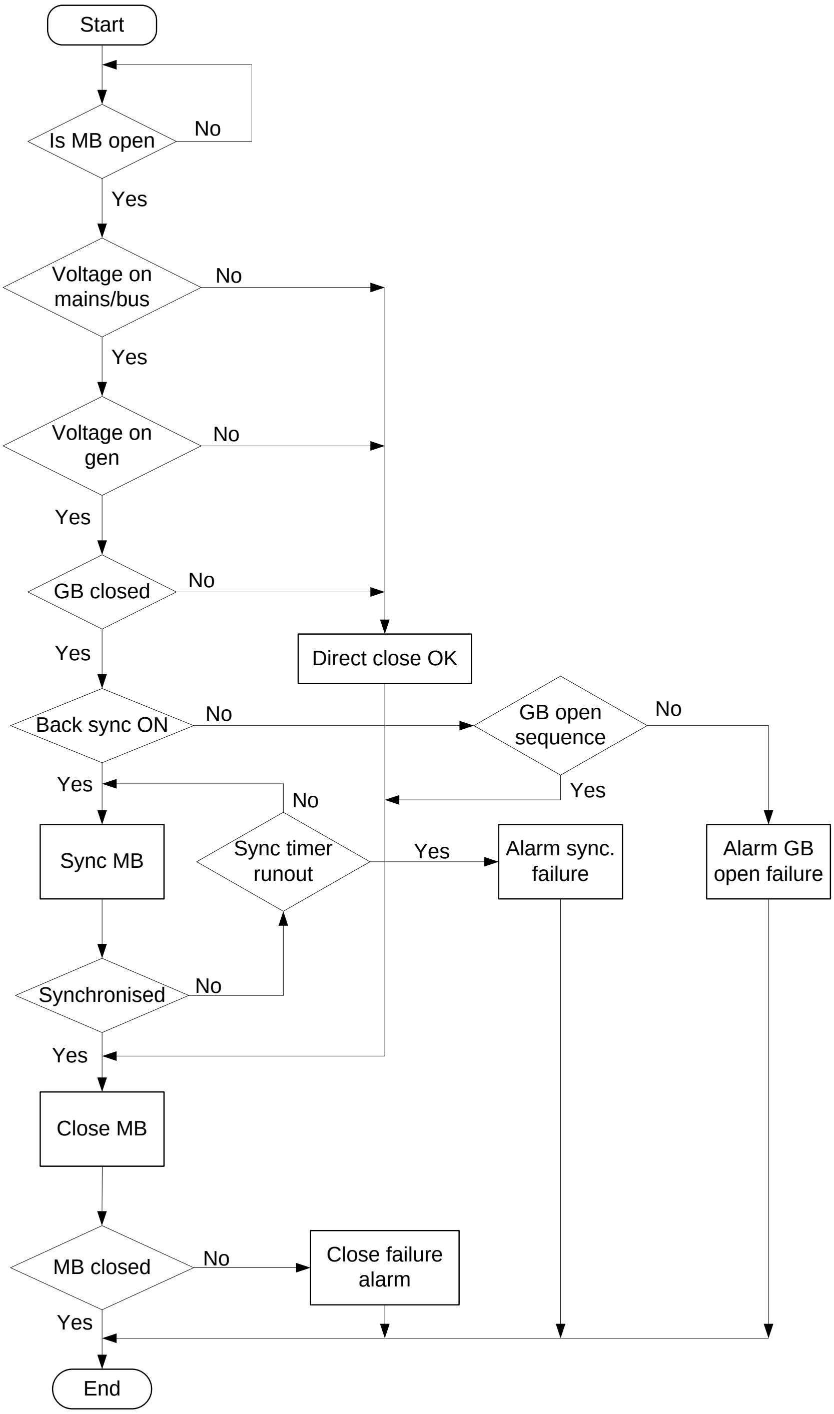
Stop sequence



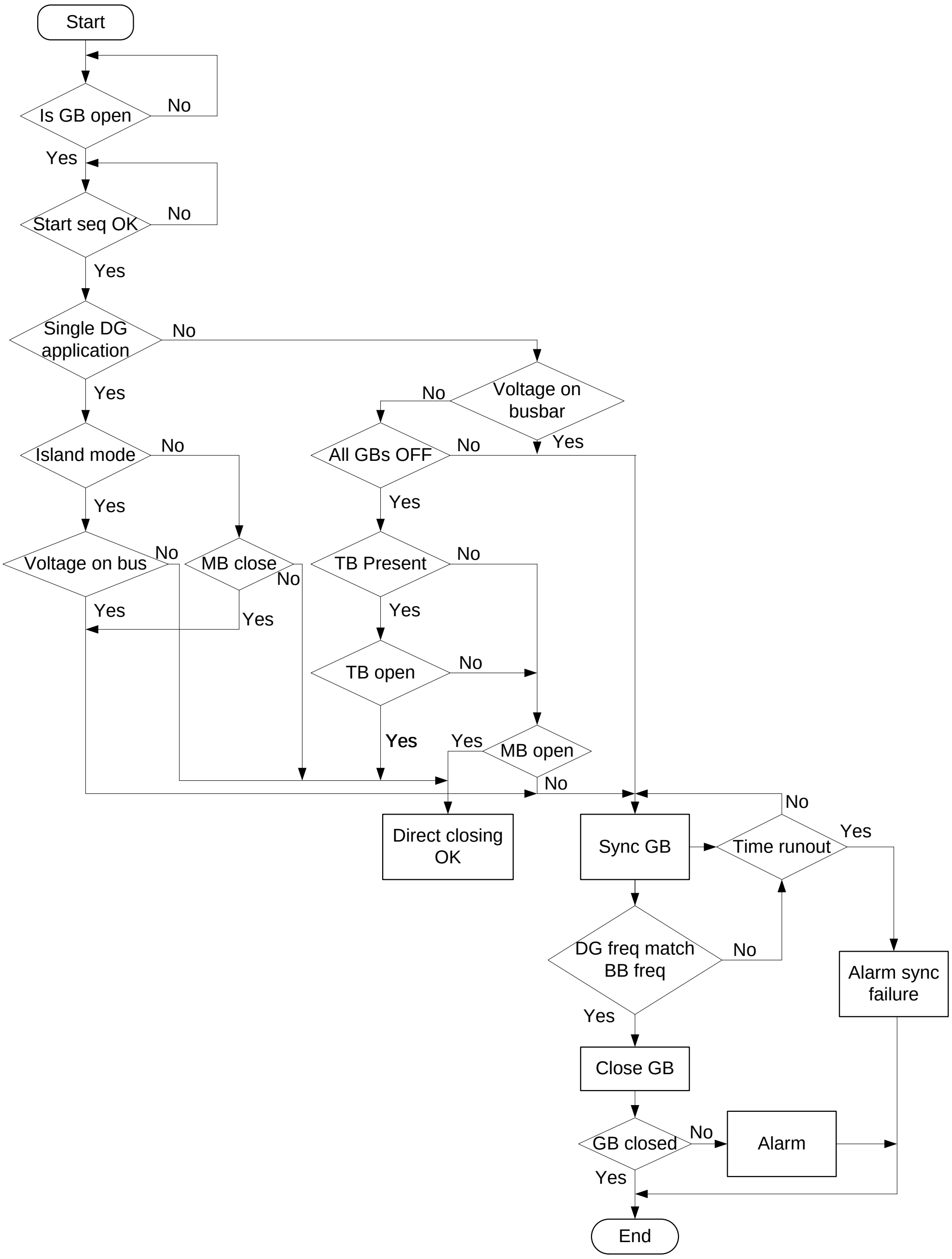
Start sequence



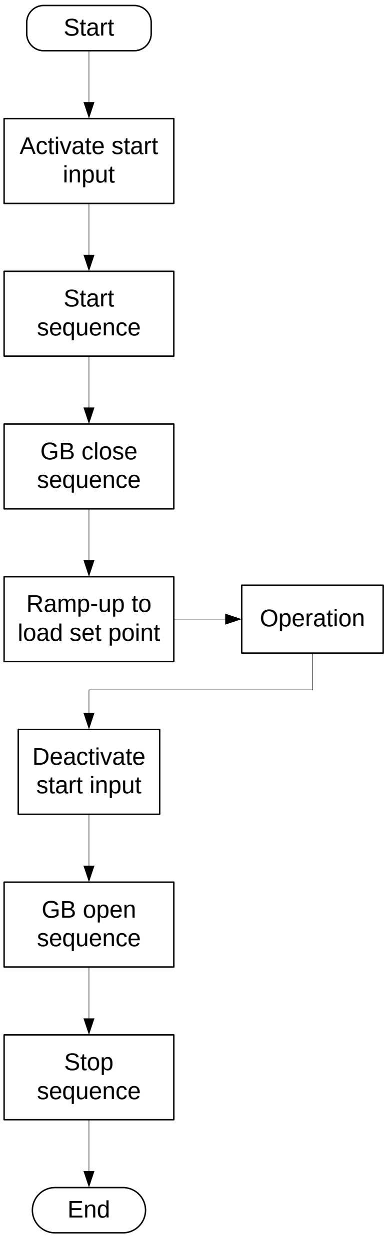
MB close sequence



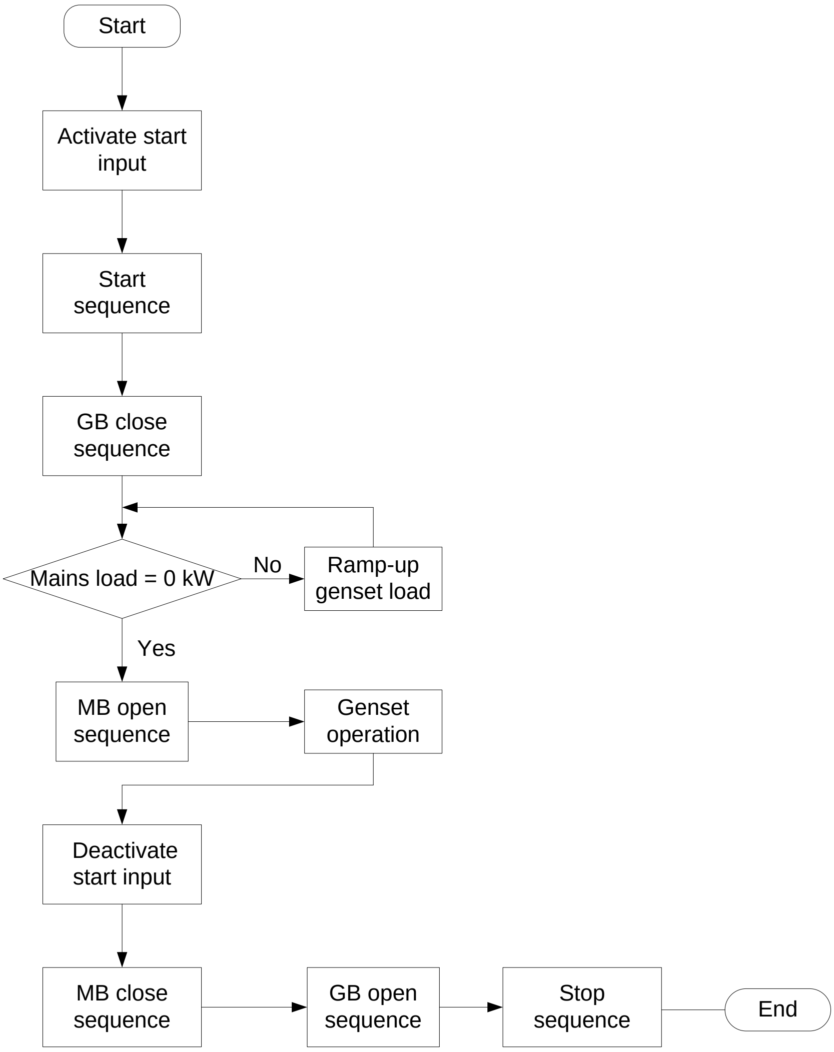
GB close sequence



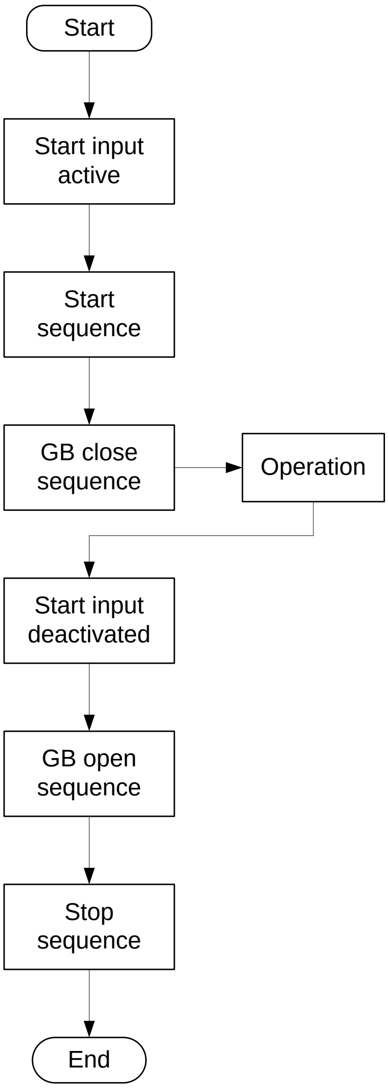
Fixed power


Start
Activate start input
Start sequence
GB close sequence
Ramp-up to load set point
Operation
Deactivate start input
GB open sequence
Stop sequence
End

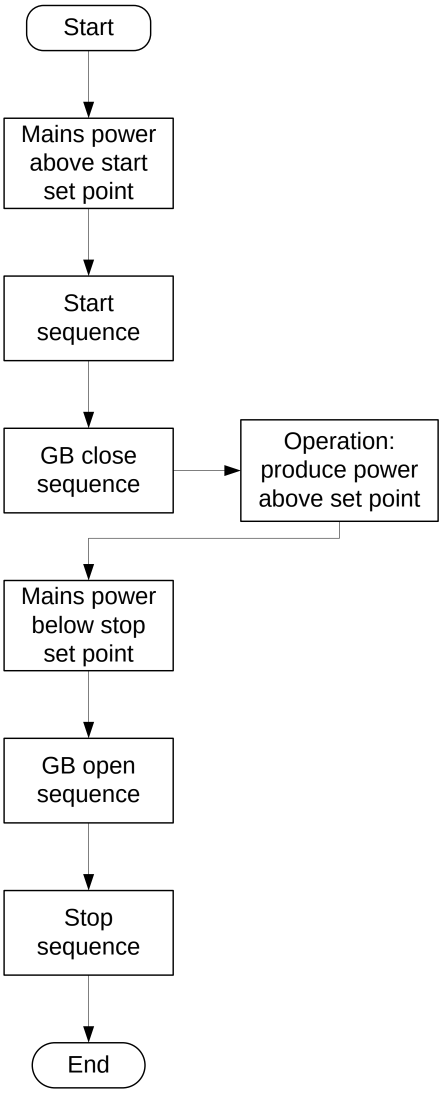
Load takeover



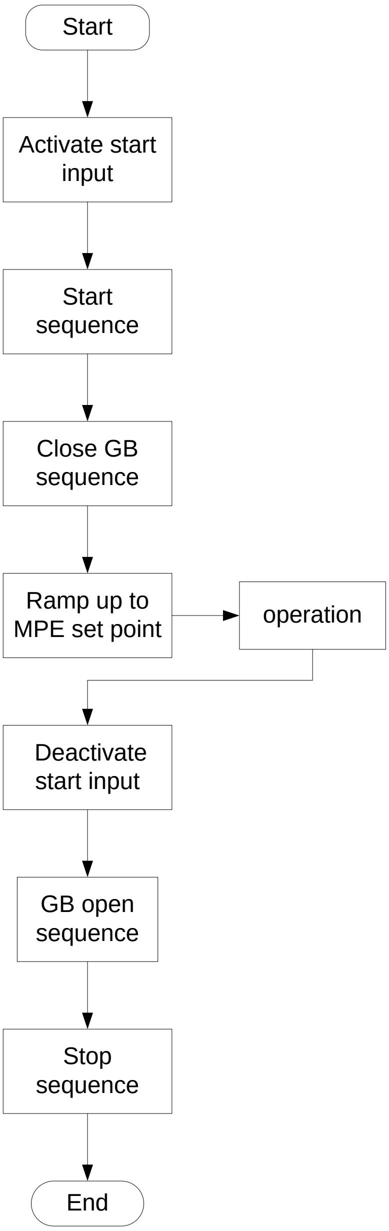
Single generator island operation



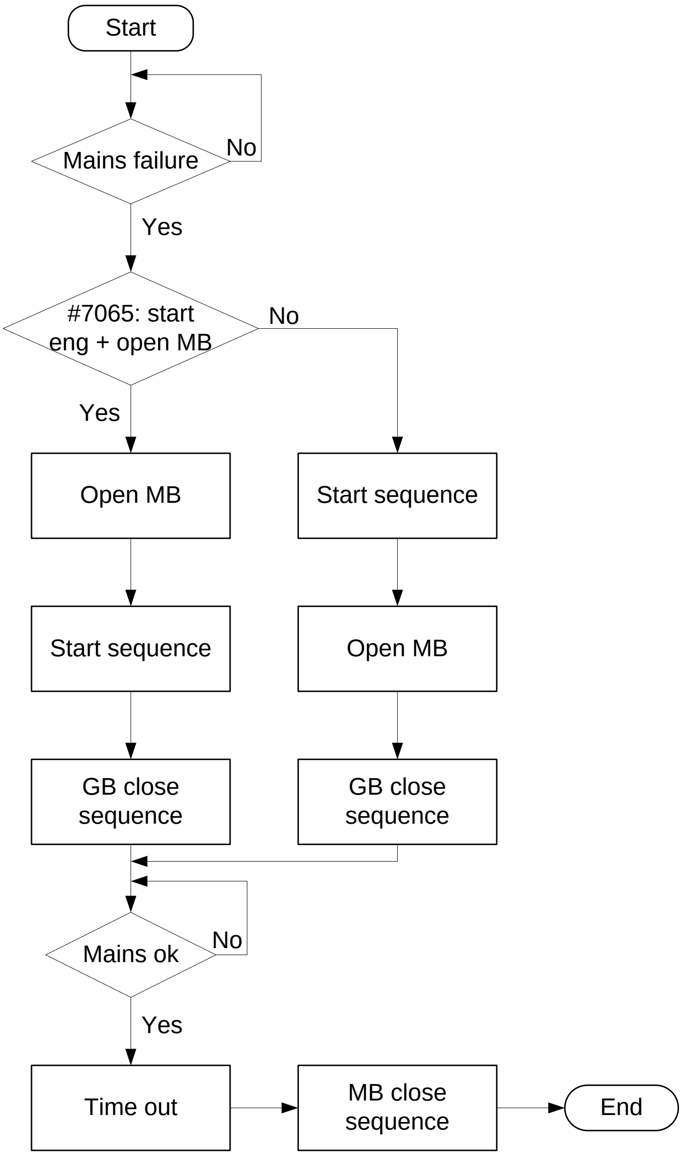
Peak shaving



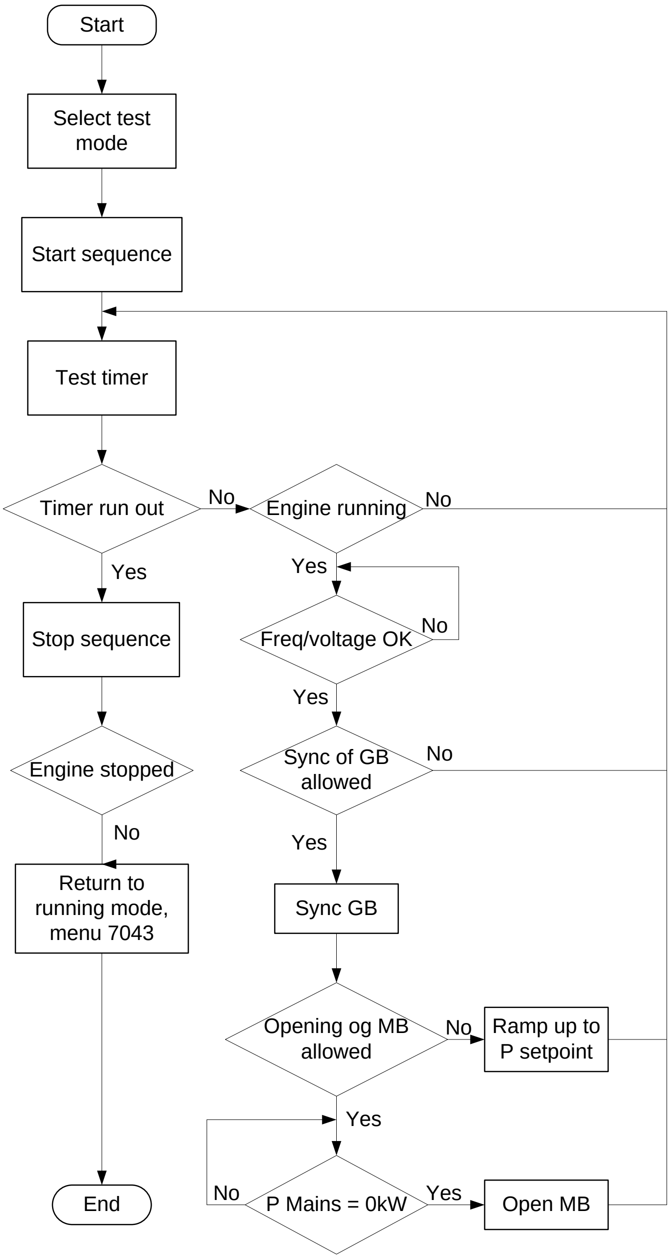
Mains power export



Automatic mains failure



Test sequence



3.10 Sequences

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

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

The following sequences will be illustrated below:

- START sequence
- STOP sequence
- Breaker sequences

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

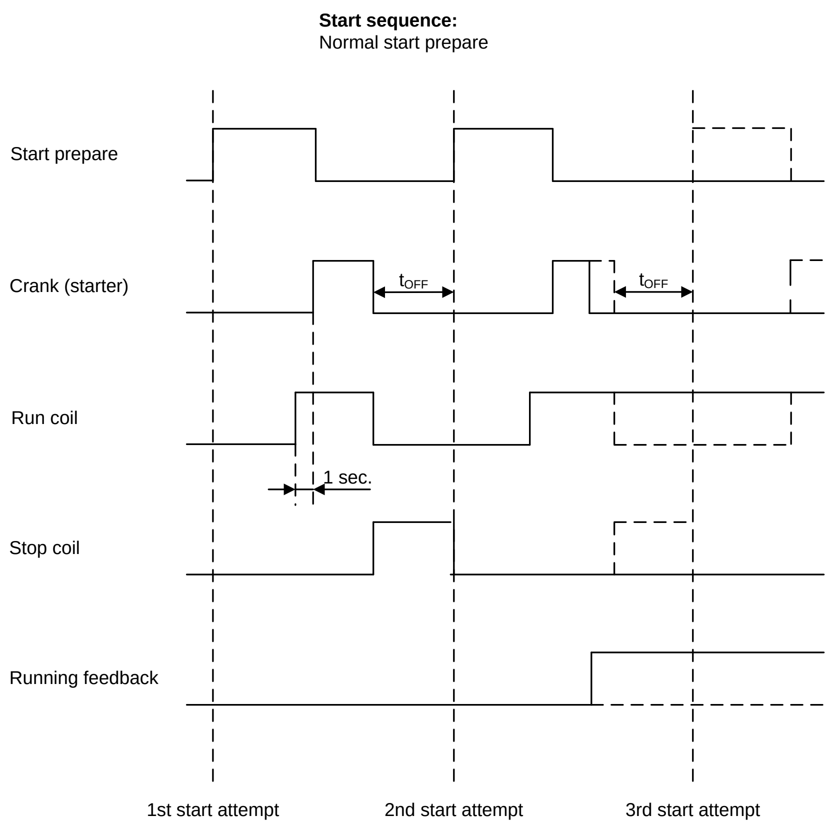
Refer to our application notes or installation instructions for information about the required breaker wiring.

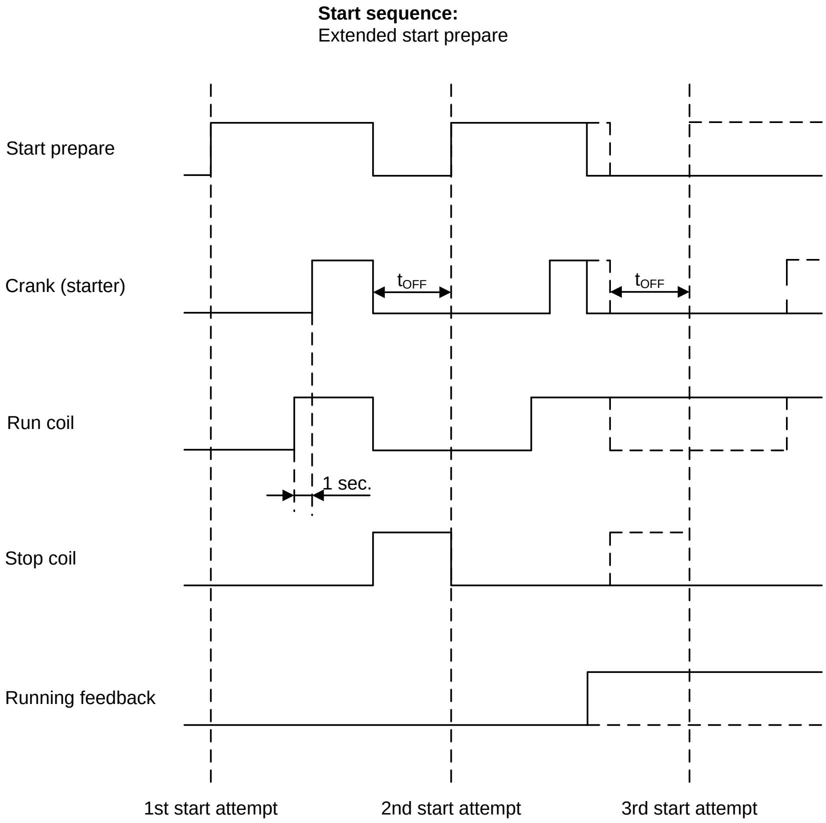
We recommend not using small relays for stop coil output. If small relays are used, a resistor must be mounted across the relay coil to prevent undesirable closing of the relay. This is caused by the wirebreak function.

3.10.1 Start sequence

The following drawings illustrate the start sequences of the genset with normal start prepare and extended start prepare.

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





Run coil can be activated from 1...600 sec. before crank (starter) will be executed. In the above example, the timer is set to 1 sec. (menu 6150).

3.10.2 Start sequence conditions

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

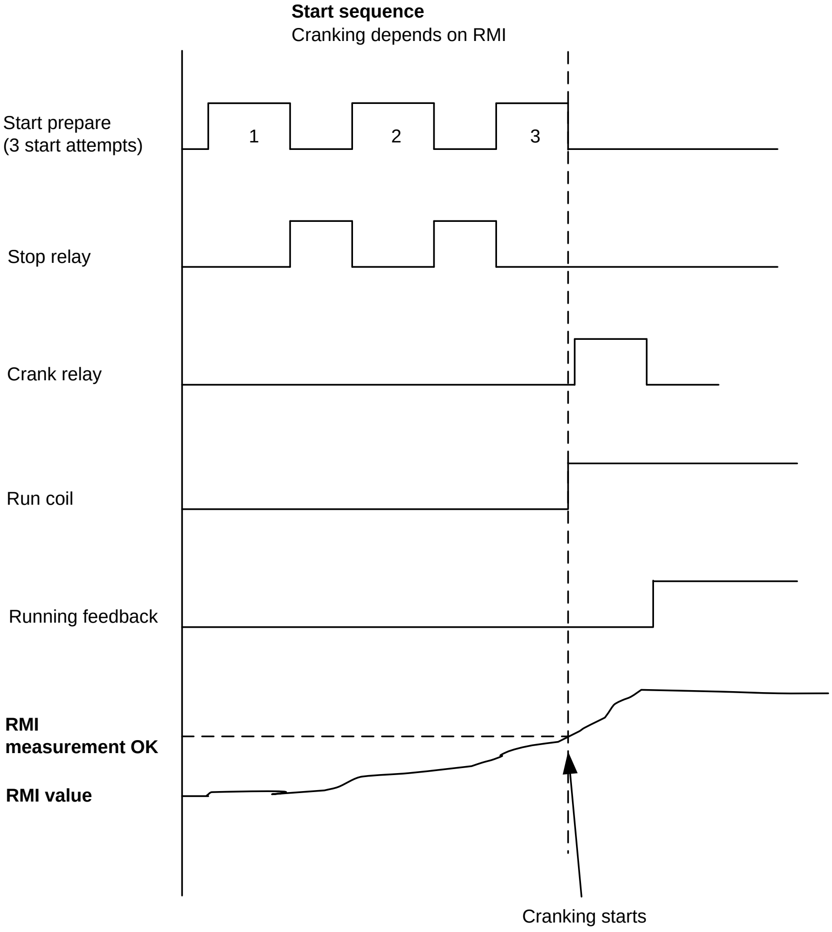
- Multi-input 102
- Multi-input 105
- Multi-input 108

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

The selection is made in setting 6185. For each of the RMI settings, the rule is that the value (oil pressure, fuel level or water temperature) must exceed the set point of setting 6186 before starting is initiated.

If the value in 6186 is set to 0.0, the start sequence is initiated as soon as it is requested.

The diagram below shows an example where the RMI signal builds up slowly and starting is initiated at the end of the third start attempt.



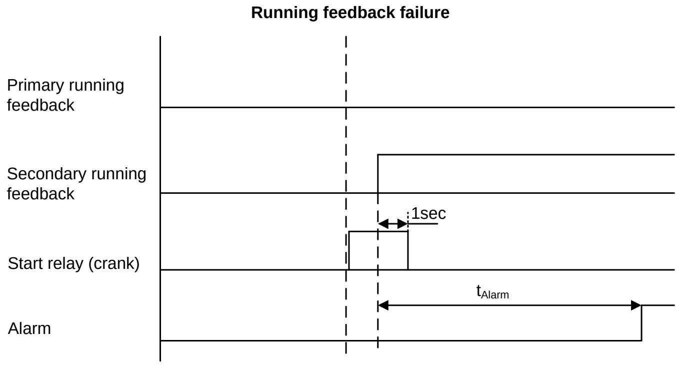
3.10.3 Running feedback

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

The running detection is made with a built-in safety routine. The running feedback selected is the primary feedback. All configured running feedbacks are used at all times. If, for some reason, the primary choice is not detecting any running feedback, the starter relay will stay activated for one additional second. If a running feedback is detected based on one of the secondary choices, the genset will start. This way, the genset will still be functional even though a tacho sensor is damaged or dirty.

As soon as the genset is running, no matter if the genset is started based on the primary or secondary feedback, the running detection will be made based on all available types.

The sequence is shown in the diagram below.



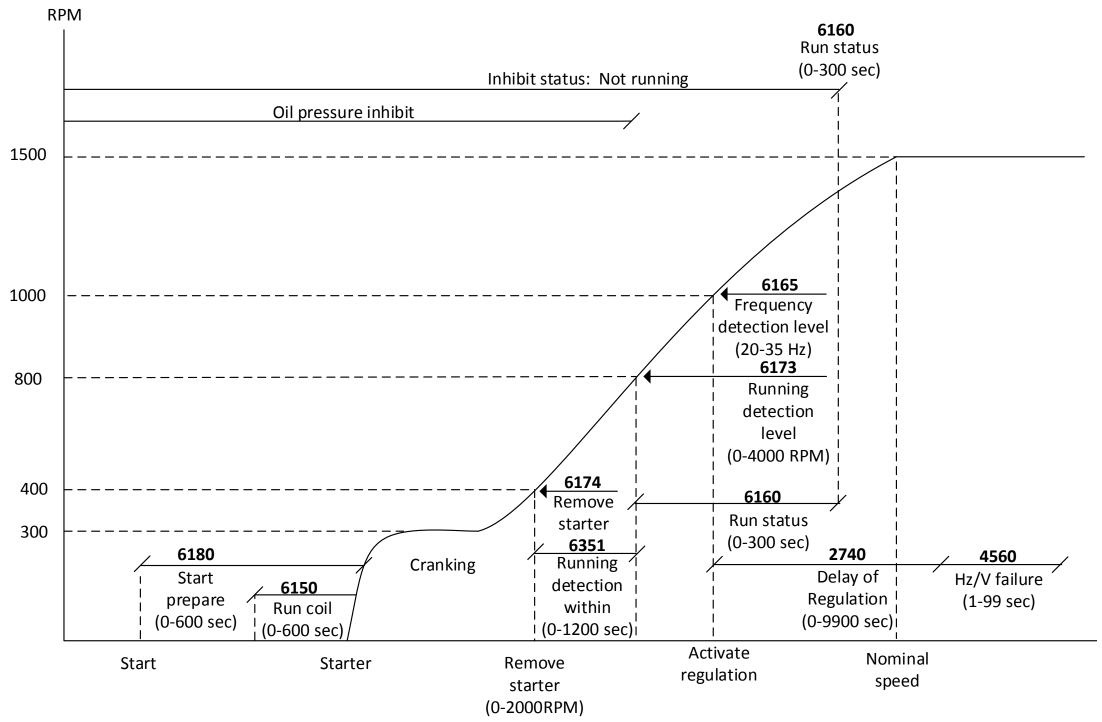
Interruption of start sequence
The start sequence is interrupted in the following situations:

Event	Comment
Stop signal	
Start failure	
Remove starter feedback	Tacho set point.
Running feedback	Digital input.
Running feedback	Tacho set point.
Running feedback	Frequency measurement above 32 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 (menu 6175).
Running feedback	EIC (engine communication) (option H5 or H7).
Emergency stop	
Alarm	Alarms with "shutdown" or "trip and stop" fail class.
Stop push-button on display	Only in semi-auto or manual mode.
Modbus stop command	Semi-auto or manual mode.
Binary stop input	Semi-auto or manual mode.
Deactivate the "auto start/ stop"	Auto mode in the following genset modes: Island operation, fixed power, load takeover or mains power export mode.
Running mode	Activating "BLOCK" while running will work in the same way as pushing the emergency stop, but it will also prevent the genset from starting afterwards.

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

The only protections that can stop the genset/interrupt the start sequence when the "shutdown override" input is activated, are the digital input "emergency stop" and the alarm "overspeed 2". Both of these must have the fail class "shut down".

3.10.4 Start-up overview



Set points related to the start sequence

- Start prepare **(6180 Starter)**

Normal prepare: The start prepare timer can be used for start preparation purposes, for example prelubrication or preglowing. The start prepare relay is activated when the start sequence is initiated and deactivated when the start relay is activated. If the timer is set to 0.0 s, the start prepare function is deactivated.

Extended prepare: The extended prepare will activate the start prepare relay when the start sequence is initiated and keep it activated when the start relay activates, until the specified time has expired. If the 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.

Start ON time: The starter will be activated for this period when cranking.

Start OFF time: The pause between two start attempts.

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

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

- Remove starter **(6174 Remove starter)**
The starter is removed when the RPM set point is reached. This will only work, if MPU or EIC RPM is selected in **6172 Run detect type**.

- Running detection RPM level **(6173 Running detection level)**
This is the set point where the running detection level is defined in RPM. This will only work, if MPU or EIC RPM is selected in **6172 Run detect type**.

- Running detection **(6351 Running detection)**
This timer can be set to the needed level. This will make sure that the engine goes from the RPM level set in **6174 Remove starter** and **6173 Running detection level**. If the timer is exceeded and the level is not reached, the start sequence will start over and will have used a start attempt. If all start attempts (**6190 Start attemps**) are used, the **4570 Start failure** will occur. This timer will only be active, if MPU or EIC RPM is selected in **6172 Run detect type**.

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

- Frequency level **(6165 Frequency detection level)**
This set point is in Hz and can be set to the needed level. When the level is reached, the regulators will start working and make sure to reach the nominal values. The regulators can be delayed using **2740 Delay of regulation**. See below.

- Run status **(6160 Run status)**
The timer in this set point is started when **6173 Running detection level** is reached, or when **6165 Frequency detection level** is reached. When the timer is exceeded, the inhibit status Not running will be deactivated, and the running alarms and failures will be enabled (see the related failures below).

- Delay of regulation **(2740 Delay of regulation)**
By using this timer, the regulation start can be delayed. The timer will start when **6165 Frequency detection level** is reached.

If the setup is running on nominal settings and 2740 Delay of regulation is set to 0, the genset will overshoot the nominal frequency on start-up, as the regulators start increasing as soon as they are turned on. If this timer is used, the regulation can wait until the genset is already at nominal frequency before starting to regulate.

Failures related to the start sequence

- Crank failure alarm **(4530 Crank failure)**
If MPU is chosen as the primary running feedback, this alarm will be raised if the specified RPM is not reached before the delay has expired.

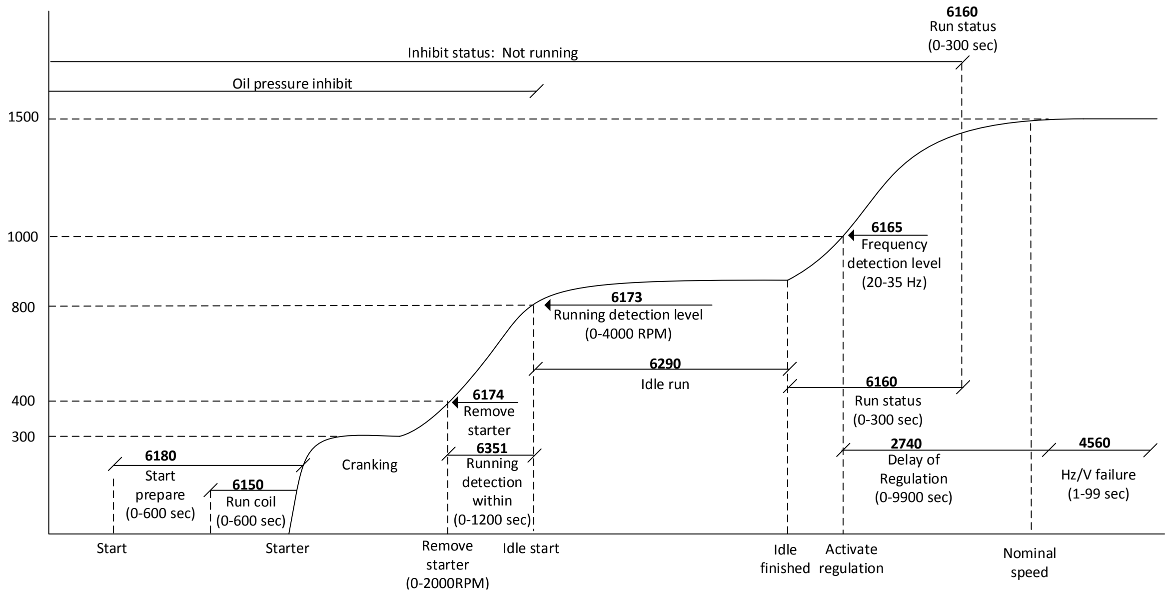
- Run feedback failure **(4540 Run feedb. fail)**
This is an alarm, in case there is no primary running feedback (6172), but the secondary feedback detects running. There is a failure on the primary running feedback, and therefore this alarm will be raised with a delay. The delay to be set is the time from the secondary running detection and until the alarm is raised.

- Hz/V failure **(4560 Hz/V failure)**
If the frequency and voltage are not within the limits set in **2110 Blackout df/dUmax** after the running feedback is received, this alarm is raised when the delay has expired.

- Start failure alarm **(4570 Start failure)**
The start failure alarm occurs, if the genset has not started after the number of start attempts set in menu 6190.

- Engine externally stopped **(6352 Ext. Eng. Stop)**
If running sequence is active and the engine goes below **6173 Running detection** and **6165 Frequency detection level** without any command from the AGC, it will set an alarm if this parameter is enabled.

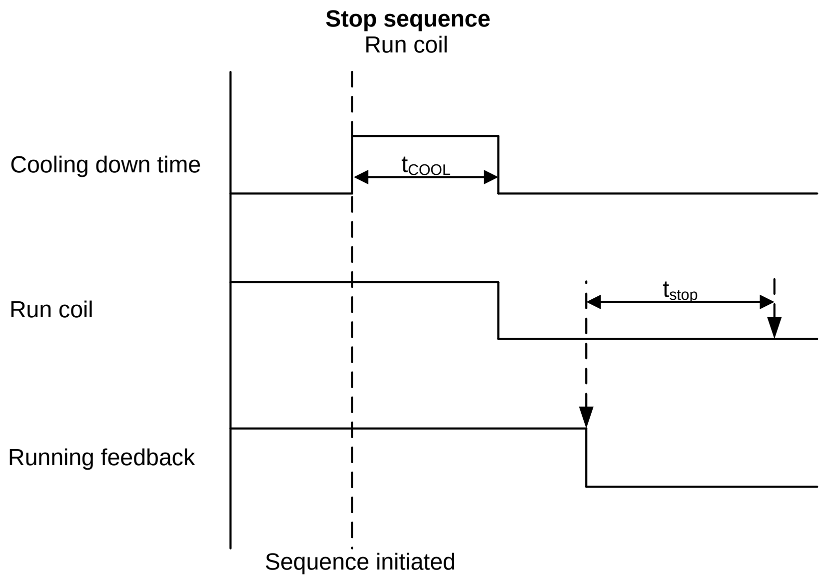
3.10.5 Start-up overview with idle run

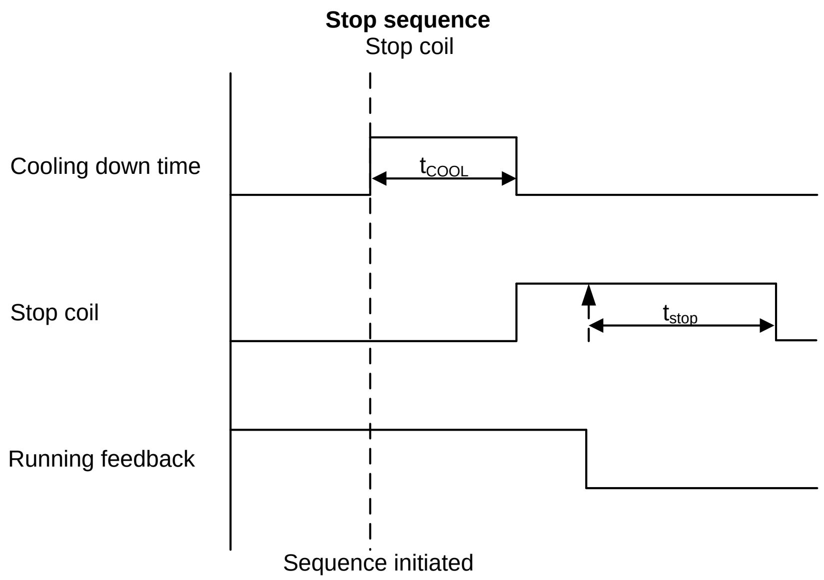


The set points and failures in this overview are the same as described in the chapter "Start-up overview", except for the idle run function. This function is described in the chapter "Idle running".

3.10.6 Stop sequence

The drawings illustrate the 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.

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

The stop sequence can only be interrupted during the cooling down period. Interruptions can occur in these situations:

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

The stop sequence can only be interrupted during the cooling down period.

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

set points related to the stop sequence

- Stop failure **(4580 Stop failure)**
A stop failure alarm will appear if the primary running feedback or the generator voltage and frequency are still present after the delay in this menu has expired.

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

Extended stop:
The delay after the running feedback has disappeared until a new start sequence is allowed. The extended stop sequence is activated any time the Stop button is pressed.

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

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

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

If the cooling down temperature is set to 0 deg., the cooling down sequence will be entirely controlled by the timer.

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

3.10.7 Breaker sequences

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

Mode	Genset mode	Breaker control
Auto	All	Controlled by the unit
Semi-auto	All	Push-button
Manual	All	Push-button
Block	All	None

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

set points related to MB control

7080 MB control

Mode shift: When enabled, the AGC will perform the AMF sequence in case of a mains failure regardless of the actual genset mode.

MB close delay: The time from GB OFF to MB ON when back synchronisation is OFF.

Back sync.: Enables synchronisation from mains to generator.

Sync. to mains: Enables synchronisation from generator to mains.

Load time: After opening of the breaker, the MB ON sequence will not be initiated before this delay has expired. Please refer to the description of "Breaker spring load time".

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

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

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

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

The possibilities in menu 7065 are:

Selection	Description
Start engine + open mains breaker	When a mains failure occurs, the mains breaker opens, and the engine starts at the same time.
Start engine	When a mains failure occurs, the engine starts. When the generator is running and the frequency and voltage are OK, the MB opens and the GB closes.

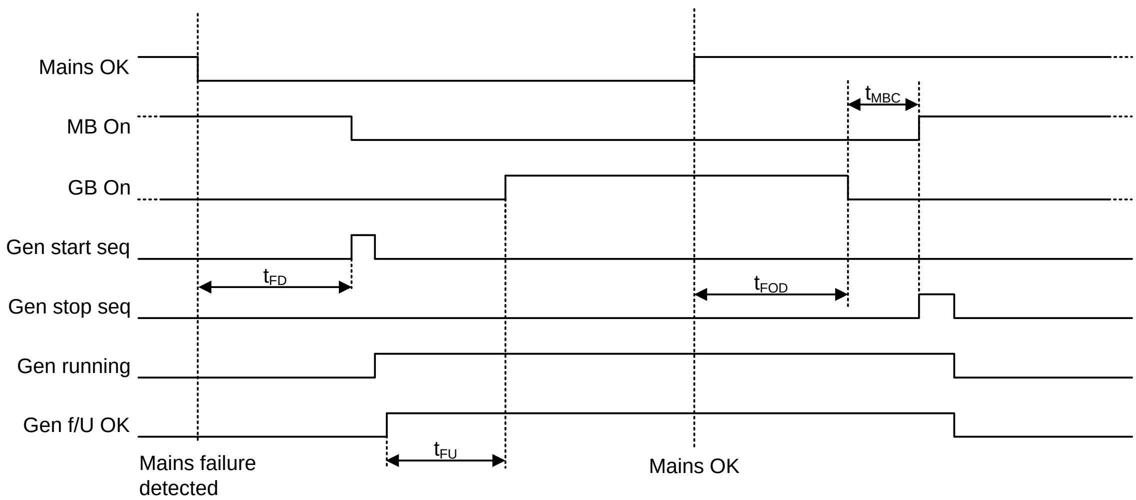
3.10.8 AMF timers and set points

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

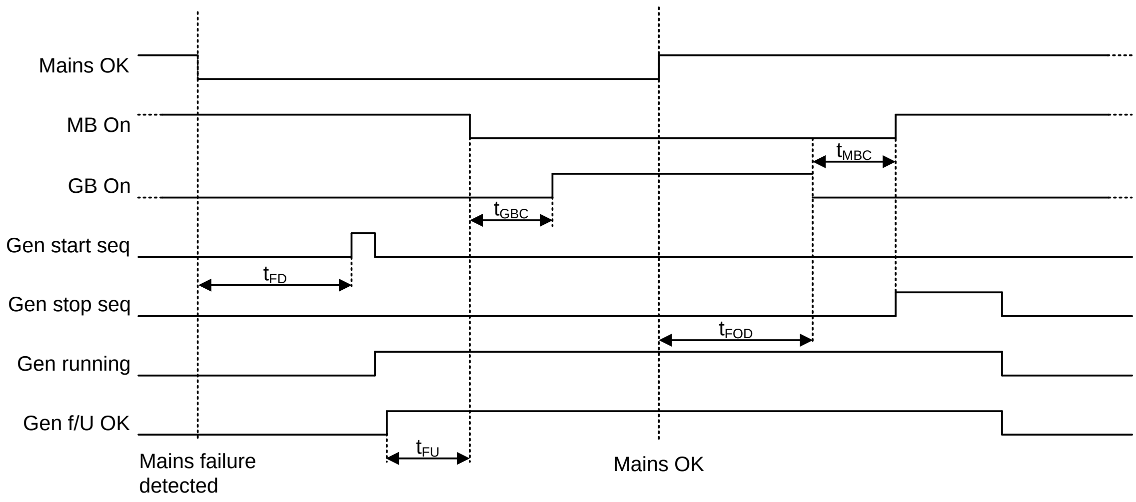
Timer	Description	Menu number
t_{FD}	Mains failure delay	**7071 f mains failure** **7061 U mains failure**
t_{FU}	Frequency/voltage OK	**6220 Hz/V OK**
t_{FOD}	Mains failure OK delay	**7072 f mains failure** **7062 U mains failure**
t_{GBC}	GB ON delay	**6231 GB control**
t_{MBC}	MB ON delay	**7082 MB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

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

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



Example 2:
7065 Mains fail control: Start engine



Set points for the AMF sequence
The timers must have some set points to indicate when they are to start. The Multi-line 2 product has different set points for the different situations. The limits that the mains voltage must be within before the failure timer starts, are set in parameters 7063 and 7064. There is a low (7063) and a high (7064) limit. Furthermore, the Multi-line 2 product has limits for the frequency. This also has a low limit (7073) and a high limit (7074). If the mains voltage or frequency has exceeded one of these limits and the relevant fail timer has expired, the AMF sequence will be started.

When the mains voltage/frequency has returned, some hystereses can be adjusted. The Multi-line 2 controller has four separate hystereses which are located in menu 7090. The first hysteresis is for the "low voltage limit". If the mains "low voltage" is set at 90 % (7063), the Multi-line 2 will start the "Automatic Mains Failure" sequence when the voltage is lower than 90 % of the nominal voltage. By default, the hysteresis is set at 0 % (7091), which means, in this example, that when the voltage has increased above 90 %, it is allowed to feed the load from the grid again. If the hysteresis had been set at 2 %, it would not be allowed to go back to grid until the mains voltage had increased above 92 %.

If, for example, the "mains low voltage" was set at 85 % and the hysteresis was set at 20 %, the calculation would imply that it was not allowed to go back to grid operation until the mains voltage was 105 %. The Multi-line 2 controller can be 100 % of nominal at the most. This is the same for "mains high voltage" and both frequency limits. The hysteresis can be at 100 % nominal at the most.

Conditions for breaker operations

The breaker sequences react depending on the breaker positions and the frequency/voltage measurements. The conditions for the ON and OFF sequences are described in the table below:

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

4. Standard protections

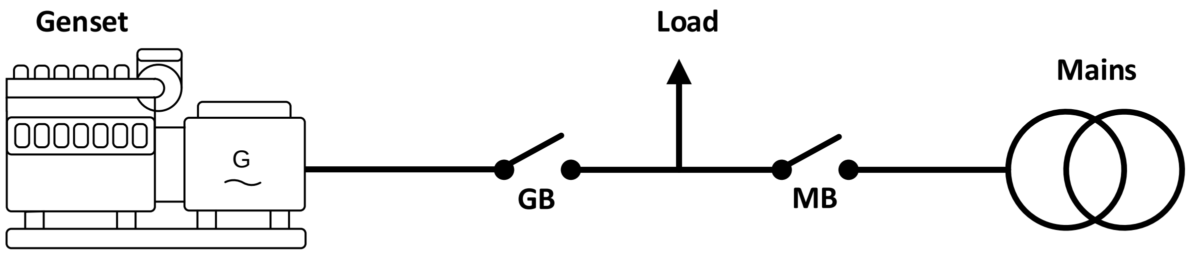
4.1 Phase sequence error and phase rotation

4.1.1 Phase sequence error and phase rotation

The AGCs 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 can monitor the rotation in both direction. From the alarm it is possible to set different failclasses, which give different possibilities. The documentation about phase sequence error can divided into two sections, where the first chapter will be about Single DG applications, and the other chapter will be about standard/multiple controller applications.

4.1.2 Single DG applications

A single DG application is able to handle up to one genset, one generator breaker and one mains breaker. An application like this is shown below:



When the AGC is mounted correctly, the gensets voltage measurements are mounted between the Generator Breaker (GB) and the genset. The other voltage measurements are mounted between the Mains Breaker (MB) and the incoming grid connection. On the different controllers the voltage terminals is shown below:

Controller type	Genset voltage terminals	Mains voltage terminals
AGC 100	33-38	28-32
AGC 200	61-67	68-74
AGC 3/4	79-84	85-89

The table above is only for Single DG application!

In the AGC there are two different alarms concerning the phase sequence error, and hereby two different failclasses. The alarm for phase sequence error and phase rotation is set in parameter 2150. The menu numbers is described in the table below:

Menu/ parameter no.	Menu text	Description
2151	Output A	Relay output if the AGC detecs a phase sequence error on the genset voltage terminals.
2152	Output B	Relay output if the AGC detects a phase sequence error on the genset voltage terminals.
2153	Failclass	Determines how the AGC reacts if the AGC sees a phase sequence error on the genset voltage terminals.
2154	Rotation	Determines the rotation of the voltages the AGC is measuring on. This is both for the Genset voltages and Mains voltages.
2155	Output A	Relay output if the AGC detects a phase sequence error on the mains voltage terminals. Since there is no output B on this alarm, it has been configured that output B is the same as output A.
2156	Failclass	Determines how the AGC reacts if the AGC sees a phase sequence error on the mains voltage terminals.

Example
In a SingleDG application with GB and MB (like the application shown on previous page), the parameters are set like in the table below:

Menu/parameter no.	Menu text	Description
2151	Output A	Not used
2152	Output B	Not used
2153	Failclass	Trip+Stop
2154	Rotation	L1L2L3
2155	Output A	Not used
2156	Failclass	Trip MB

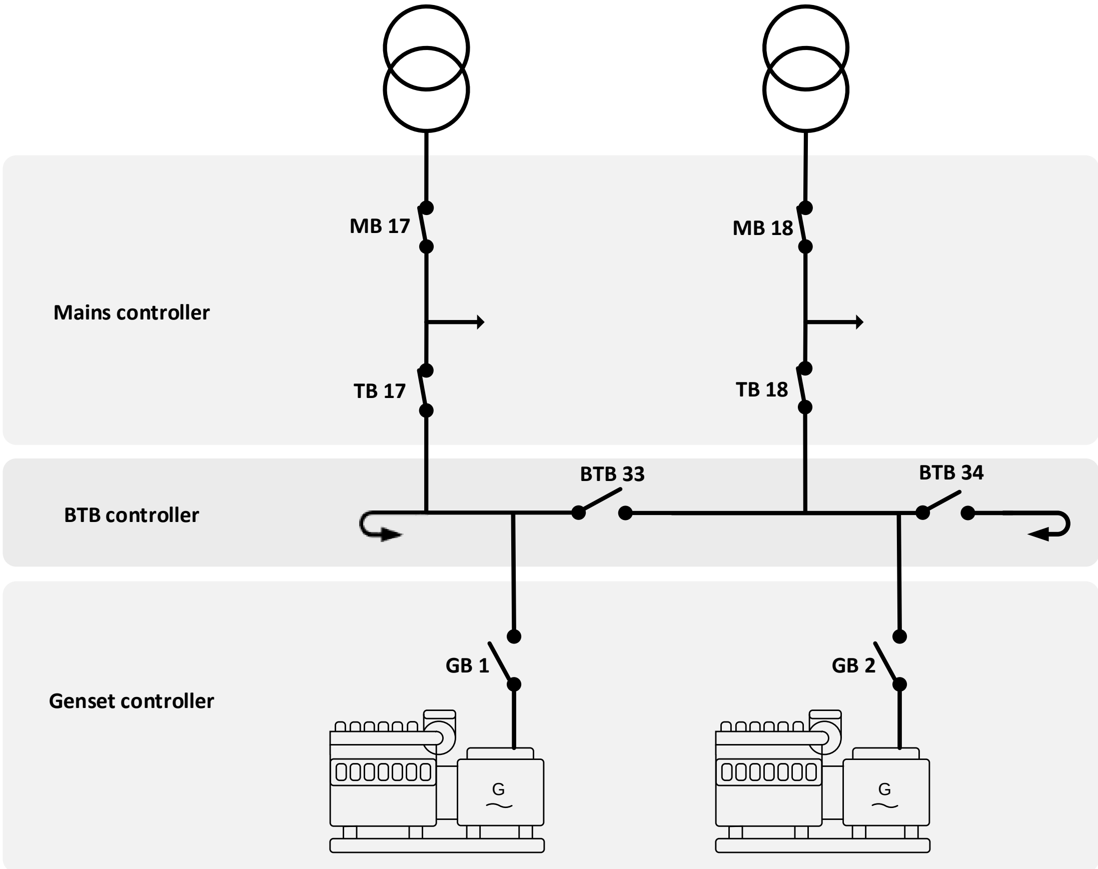
An alarm is activated if no relay output A/B is selected. Do not chose Limits/Limit relay if you want that an alarm is raised together with a relay output A/B.

If the controller is set to Load Take Over (LTO) and the start signal is given the genset will start up. If there have been performed a service of the alternator, and two of the phases have been switched when the alternator has been assembled again, the AGC will now discover a phase sequence fail. Since this is on the genset voltage terminals, the failclass set in parameter 2153 will be used. The failclass is set to Trip+Stop, which will trip the breaker (If the breaker is not closed, the controller will not send a trip signal), and then afterwards go into the stop sequence. If the alarm is acknowledged, the genset will start up again, if the start signal is still present.
In this plant there could be a situation where there is some changing in the grid. If the grid company is coupling in the grid, and the phase sequence in changed on the grid connection, and the Mains fail timers does not react on the small blackout, the failclass in parameter 2156 will be used. At the moment there is a phase sequence error on the mains voltage terminals, and the failclass is Trip MB. When the MB is tripped, the genset is started, since there is a trip alarm MB, and load does not have any power at the moment. In the same plant it can be possible to that a service of the transformer is going to happen. To test the Automatic Mains

Failure (AMF) sequence, the technician removes the fuses, and the AGC will then discover the voltage is not present and afterwards start up the genset and take the load. When the technician is assembling the transformer again he accidently switches two phases. When the fuses is set into place again, the AGC will discover a phase sequence error on the mains voltages, and by this it will still keep running, until the phase sequence has been fixed.

4.1.3 Standard/multiple controller applications

In these applications there are different types of controllers. The three different types are: Genset, Bus Tie Breaker (BTB) and Mains. The phase sequence alarms are located at parameter 2150. From here it is possible to configure both the alarms for phase sequence errors and also the phase rotation.
The alarms refer to different voltage terminals. The different types and models of controllers have different terminals. To know which voltage terminals the different alarms refers to, the drawing and tables below can be helpful.



For mains controllers the table below is applicable:

Controller type	Mains voltage terminals	Busbar voltage terminals
AGC 100	33-38	28-32
AGC 200 (245/246)	61-67	68-74
AGC 3/4	79-84	85-89

The table above is only for Mains controllers in standard plants!

For BTB controllers the table below is applicable:

Controller type	Bus A voltage terminals	Bus B voltage terminals
AGC 200 (244)	61-67	68-74
AGC 3/4	79-84	85-89

The table above is only for BTB controllers in standard plants!

For Genset controllers the table below is applicable:

Controller type	Genset voltage terminals	Mains voltage terminals
AGC 100	33-38	28-32
AGC 200 (242/243)	61-67	68-74
AGC 3/4	79-84	85-89

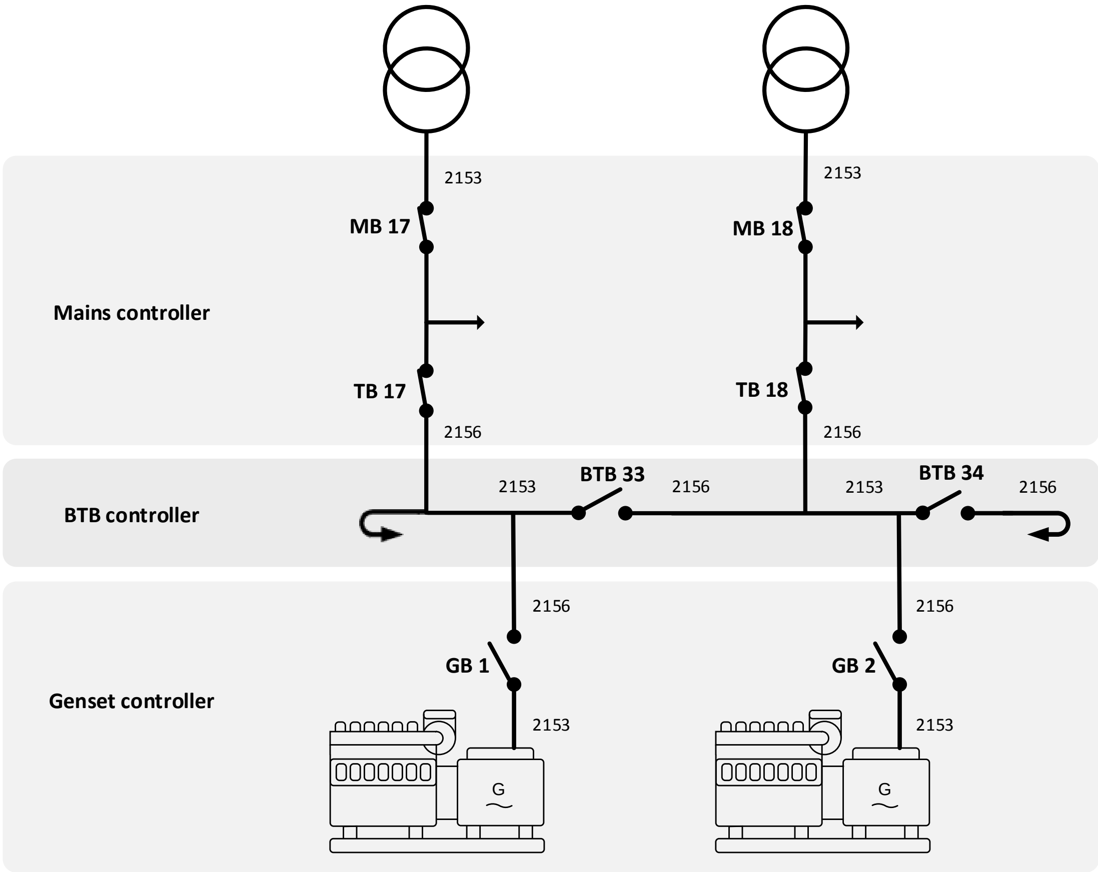
The table above is only for Genset controllers in standard plants!

Parameter 2150 is consisting of two alarms, and the phase rotation direction setting. The phase rotation setting is the same for the both terminal sets. The two alarms refer to the voltage terminals. To know which alarm refers to voltage measurement, the table below has been made to make an overview:

Menu/Parameter no.	Mains controller	BTB controller	Genset controller
2153	Mains voltage	Bus A voltage	Genset voltage
2156	Busbar voltage	Bus B voltage	Busbar voltage

The diagram made earlier, can be helpful in locating where the different location of each voltage measurement is made.

The table above shows on which terminal set the phase sequence error occurs to activate the failclass set in the parameter 2153 and 2156. This can also be shown in a diagram like this:



When setting up the phase sequence alarms, it can be helpful to activate MB fail start (8181) in some of the mains controllers. This gives the possibility if e.g. the phase sequence error for mains voltage (2153) appears, and the failclass is Trip MB, then the gensets will start. If then autoswitch is enabled also (8184) the other grid connection can supply as backup load, before the gensets will start. If the other mains do not have a phase sequence error, the other mains will keep on supplying the load, and the gensets will not start.

Example
On genset 1, parameter 2153 is set to trip+stop. Genset 1 has recently been out for service, and two phases has accidently been switched. A mains fail now occurs on mains 17, and genset 1 will start up. The controller for genset 1 sees a phase sequence error here, and activates its failclass. GB1 will never be closed. BTB33 will now close, and genset 2 will start up and supply the load. If there also is a phase sequence error on the B side of BTB33, and 2156 in BTB 33 is set to trip BTB, the system will close BTB34 instead, since this is a system with wrapped busbar.

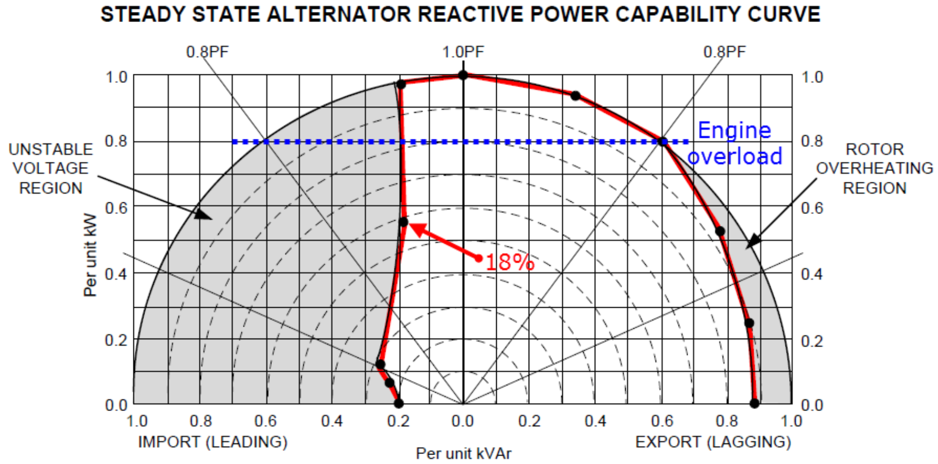
4.2 Loss of excitation

To prevent damage to the generator because of a pole slip, the AGC has a protection that can trip a breaker for example if loss of excitation occurs. The protection is located in parameters 1521 to 1526.

The percentage set in parameter 1521 is the maximum percentage of imported kvar compared to the nominal kW of the genset.

Example: The genset has a nominal of 1000 kW. The percentage in parameter 1521 is set to 15 %. This means that if the genset is 150 kvar capacitive or more, the timer set in parameter 1522 will start. When the timer has expired, an action will occur. This action/fail class is decided in parameter 1526.

To set the percentage correctly, a calculation must be made. For this purpose, the operating chart for the generator is needed. An operating chart for a generator is shown below.



The alternator 100 % load is the outer circle, and the engine 100 % load is the blue dotted line. With the operating chart it is possible to see where the alternator-safe line is closest to the 1.0 PF line. This is marked with a red arrow. In this operating chart each vertical line represents 10 %, and by this, the dot closets to 1.0 PF has been read to 18 %. With the nominal alternator values and the nominal engine values, the calculations can be made.

Example: The reading of 18 % is used. The alternator has a nominal power of 2500 kVA, and the engine has a nominal power of 2000 kW. The distance between the dot and the 1.0 PF line represents a power, and this is calculated to: 2500 *kVA**18 % = 450 *kvar*

The setting of parameter 1521 can now be calculated: 450 *kvar*/2000 *kW* = 22.5 %

4.3 Voltage-dependent over-current

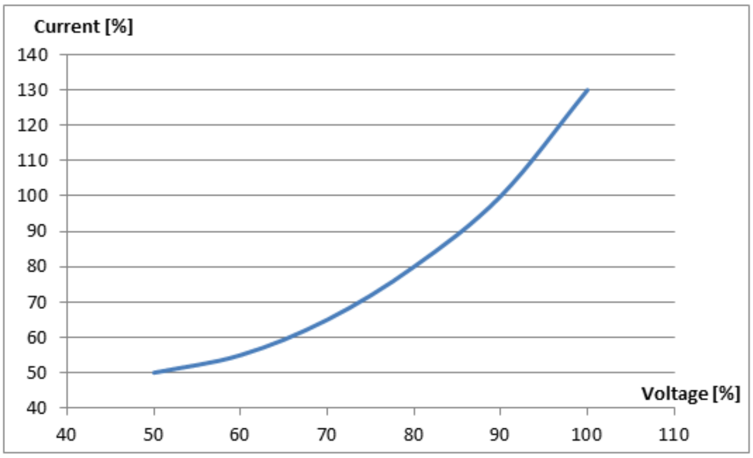
The voltage-dependent over-current is a protection for generators without permanent magnets. This protection occurs when a short circuit is present and the voltage drops. When a short circuit occurs, the voltage will make a drop and the current will rise for a very short period and then drop to a lower level afterwards. The short circuit current level can drop below the rated current of the generator, and thus the short circuit will not be tripped, which may result in personal injury or damaged equipment. 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.

The parameters for this are 1101 to 1115. The set points for the different levels are set in parameters 1101 to 1106. The set point refers to six different current levels and voltage levels. All values are in percentage to the rated values that are set in parameters 6000 to 6030. The six voltage levels are already determined, so only the current levels must be set. The six set points will create a curve, which will be explained by an example:

The six different set points have been set to the values shown in the table below.

Parameter	1101	1102	1103	1104	1105	1106
Voltage level (Fixed/not adjustable)	50	60	70	80	90	100
Current level (Set point/adjustable)	50	55	65	80	100	130

The six values can then be transferred to a curve, which is more readable:



When the actual values represent a point above the curve, the breaker should be tripped. The curve shows that the generator breaker will trip when two requirements are met: The generator voltage is below 50 % of rated, and the current is above 50 % of rated.

Timer, outputs, enable and fail class are set in parameters 1111 to 1115. The timer in 1111 decides how long the fault will exceed the limits, before an action will take place. The action/fail class is decided in parameter 1115 and can be set from a warning to a shutdown. As a default, this will be set to trip the generator breaker. The outputs can be used to activate a relay. This will make it possible to send a signal to external equipment regarding this specific alarm. It is possible to configure two relay outputs for the alarm. The protection function is activated as a default, but can be disabled in parameter 1114.

4.4 Unbalanced current

The generator can be in a situation where it is not delivering its rated load, but the current is very high in one of the phases. This can be caused by an unbalanced load. When a generator load is unbalanced, the stress on the generator will be higher than normal. The heat in one of the windings can also be very high. Unbalanced load can also develop if a cable has been damaged or dropped off, or if a fuse to a single phase has blown. To protect the generator from unnecessary stress, the protection against unbalanced load can be used. It is located in parameters 1501 to 1506. Parameter 1203 is also related to these parameters. Parameter 1203 defines how the calculations should be done, and it can be set to nominal or average.

If parameter 1203 is set to nominal, the AGC uses the maximum and the minimum current and subtracts the values. Then it will compare this to the nominal current typed in parameter 6003, 6013, 6023 or 6033, depending on which of the nominal settings is activated. The comparison to the nominal current will give a percentage that is related to parameter 1501.

Example: A genset is rated at 400 A and is supplying a load. The currents of the three phases are: 115 A, 110 A and 100 A. The AGC will use the maximum and the minimum current, in this case 115 A and 100 A. The calculation will now be: ((115 - 100)*100)/400 = 3.75 %. If parameter 1501 is set to 4 %, the genset will keep running. If parameter 1501 is set to 4 %, and the genset's rated current is 400 A, it can be calculated how unbalanced the genset is allowed to be: (4*400)/100 = 16 A. When the phases are loaded more than 16 A, the generator breaker will be tripped. This is independent of the size of the load.

Parameter 1203 can also be set to average. The AGC will then calculate an average of the phases and compare how unbalanced the load is between them.

Example: An genset is rated at 400 A and is supplying a load. The currents of the three phases are: 115 A, 110 A and 100 A. The AGC will now calculate an average of these currents, take the one that differs most from the average and calculate a percentage of deviation: (115 + 110 + 100)/3 = 108.3 A. Then the AGC will analyse which of the currents that differs most. In this example, it will be the 100 A. The maximum difference will be compared to the average current: ((108.3 - 100)*100)/108.3 = 7.7 %. If the load had been bigger, this calculated percentage would have been smaller. If the phase currents were 315 A, 310 A and 300 A, the average would be: (315 + 310 + 300)/3 = 308.3 A. This would give a deviation of:

((308.3 - 300)*100)/308.3 = 2.7 %.

4.5 Unbalanced voltage

As well as having an unbalanced current protection, the AGC also has an unbalanced voltage protection. The AGC will measure on each of the phase voltages and compare them to each other. If the genset is mounted in an application with capacitors to compensate and a failure occurs in one of the capacitors, a difference in voltage may appear. The windings for this phase will be overheated and thus exposed to heavy stress. To prevent this, the unbalanced voltage protection can be set.

The percentage set in parameter 1511 is a percentage of deviation compared to the average voltage in the three phases. The average comparison is described with an example below.

Example: Phase L1 to L2 is 431 V, phase L2 to L3 is 400 V and phase L3 to L1 is 410 V. The three voltages must be added up to find an average voltage: (431 + 400 + 410)/3 = 414 V. Now the voltage with the biggest voltage difference must be subtracted, in this case L1 to L2: 431 - 414 = 17 V. Now the biggest voltage deviation in percent can be calculated: (17/414)*100 = 4.1 %.

This means that if parameter 1511 is set to 4.1 %, it is allowed to have a voltage difference of 31 V in this application, before the unbalanced voltage protection can be activated.

In the example, phase-phase measurements have been used. Phase-phase is selected as default, but it can also be phase-neutral measurements, and this can be changed in parameter 1201. (Parameter 1201 will be described later).

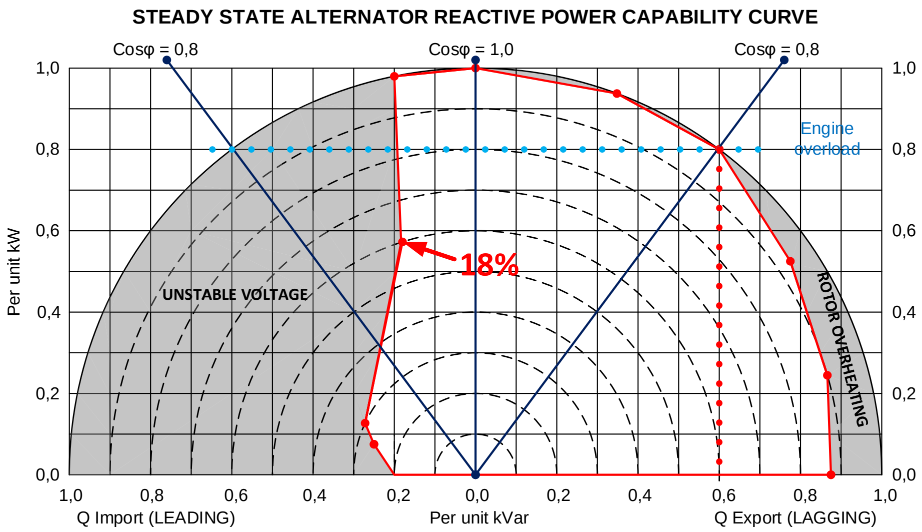
Be aware that when parameter 1201 is changed, it will influence other protections.

In parameter 1512 the timer can be set, and in parameter 1515 this protection is enabled. In parameter 1516 the fail class is decided. It is also possible to enable two relay outputs when the alarm occurs. The two relay outputs can be set in parameters 1513 and 1514.

4.6 Over-excitation

When heavy inductive loads are connected, an over-excitation of the generator can occur. Over-excitation can overheat windings in the generator and create a failure over time. Over-excitation can also occur if the load of a generator quickly changes from inductive to capacitive, or in an application with more than one generator in case one of the generators' exciter fails. To set the over-excitation protection correctly, the operating chart of the genset is requisite.

A random operating chart of a genset is shown below:



An example will be used to describe how the setting is made.

Example: The engine is of 2000 kW, and the alternator is of 2500 kVA. The engine represents the blue dotted line in the diagram above, and the alternator is the "outer circle". When this protection is set, a specific point should be pointed out. It is the point where the engine curve and the alternator curve intersect, and it is marked with a red arrow in the operating chart. It is requisite to calculate how many kvar the genset can export:

$Q = \sqrt{S^2 - P^2} = \sqrt{2500^2 - 2000^2} = 1500\ kvar.$ The kvar is used to calculate a percentage for parameter 1531. The percentage is calculated like this: kvar/kw = 1500/2000 = 75 %. When parameter 1531 is set to 75 %, the genset is allowed to export 1500 kvar all the time. The 75 % setting represents the red dotted line in the operating chart. It will be possible to set an alarm when the load has crossed the red dotted line for a certain period of time. The timer is set in parameter 1532.

4.7 Decision of measurements

The protection for unbalanced voltage, for example, can be set to either a phase-phase or a phase-neutral measurement. These settings also influence other protections and settings in the AGC. There are three parameters that can change how the measurements are done in the AGC: 1201, 1202 and 1203.

In parameter 1201 it can be set how the voltage measurements should be done for example on generator voltage protection. It can be set to either phase-phase or phase-neutral; by default it is set to phase-phase. When this parameter is set, it should be taken into account how the loads in the application are connected. If many of the loads are connected as phase-neutral, the setting of parameter 1201 should be set to phase-neutral. On a generator unit it will be the voltage measurements on the generator side of a breaker, and on a mains unit it will be the voltage measurements on the mains feeder side of the mains breaker.

Parameter 1201 influences:

1150, 1160	Generator over-voltage protection 1 and 2
1170, 1180, 1190	Generator under-voltage protection 1, 2 and 3
1510	Generator unbalanced voltage protection
1660, 1700	Mains time-dependent under-voltage 1 and 2 (Measured on mains feeder side of mains breaker. Only in mains units)

Parameter 1202 is similar to 1201. It is also considering how the measurements should be made. But this parameter refers to the other voltage measurements. On a generator unit it will be the busbar voltage measurements, and on a mains unit it will be the voltage measurements after the mains breaker. This parameter can also be set to phase-phase measurement or phase-neutral measurement.

Parameter 1202 influences:

1270, 1280, 1290	Busbar over-voltage protection 1 and 2
1300, 1310, 1320, 1330	Busbar under-voltage protection 1, 2 and 3
1620	Busbar unbalanced voltage protection
1660, 1700	Busbar time-dependent under-voltage 1 & 2 (Measured on busbar side of generator breaker. Only in generator units)
7480, 7490	Busbar over-voltage average protection 1 and 2

Parameter 1203 refers to the current measurement as described earlier in this chapter, under "Unbalanced current".

Parameter 1203 influences:

1500	Unbalanced current 1
1710	Unbalanced current 2

5. Display and menu structure

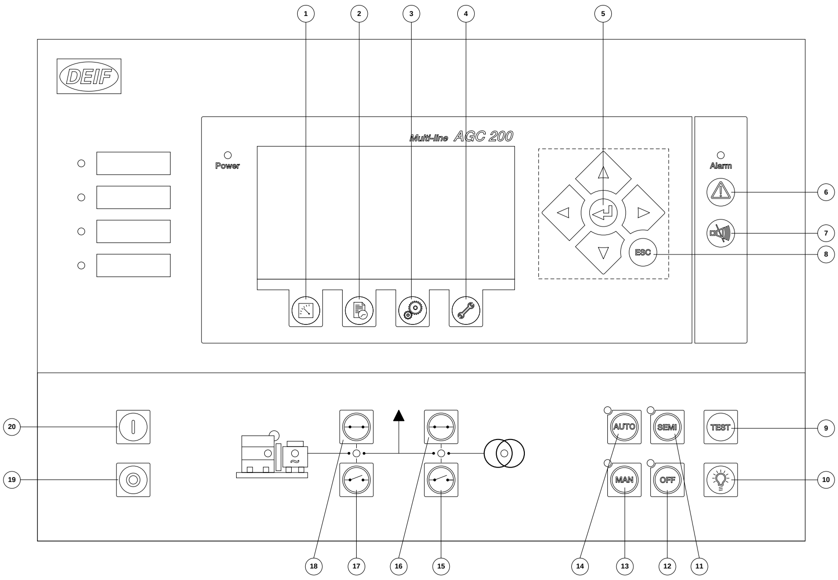
5.1 Display and menu stucture

5.1.1 Display unit

The display has six different lines, each with 25 characters, and holds a number of push-button functions which are presented below.

5.1.2 Push-button functions

The display unit has a number of push-button functions which are described below:

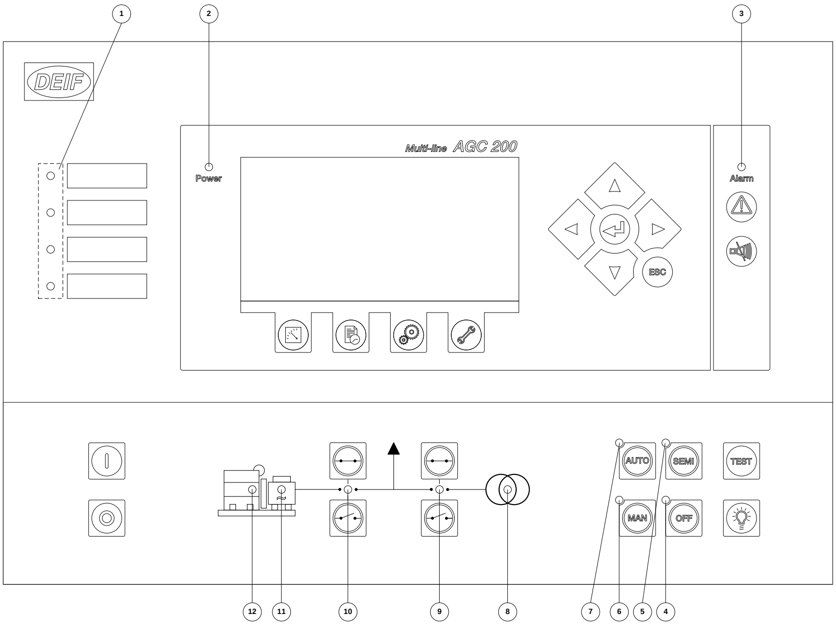


1. Shifts the display to the Measurements menu
2. Shifts the menu to the Log menu: Event, alarm and battery log
3. Shifts the display to menu for system settings
4. Shifts the display to the service menu
5. The arrows are used to manoeuvre in the menus and to shift views. Also used to change parameter settings
6. Alarm push-button. Used to show active alarms
7. This button is used to silence the horn
8. The ESC button is used to go back in menus or to exit
9. TEST mode is activated (see the previous chapter "Running mode description" for further description)
10. This push-button is used for lamp test. When pushed, the LEDs will flash in different colours. Used to control that the LEDs are working properly
11. SEMI-auto mode is activated (see the previous chapter "Running mode description" for further description)
12. BLOCK mode is activated (see the previous chapter "Running mode description" for further description)
13. Manual mode is activated (see the previous chapter "Running mode description" for further description)
14. AUTO mode is activated (see the previous chapter "Running mode description" for further description)
15. Manual activation of open breaker sequence if SEMI or MAN is selected
16. Manual activation of close breaker sequence if SEMI or MAN is selected
17. Manual activation of open breaker sequence if SEMI or MAN is selected

18. Manual activation of close breaker sequence if SEMI or MAN is selected
19. Stop of the genset if SEMI or MAN is selected
20. Start of the genset if SEMI or MAN is selected

5.1.3 LED functions

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



1. Four configurable LEDs. These can be configured with M-Logic
2. Indicates that the auxiliary supply is ON, while flashing new firmware the LED will be red
3. When this LED blinks, there is an (or more) unacknowledged alarm(s). When it glows there is an (or more) acknowledged alarm(s)
4. Indicates OFF mode
5. Indicates SEMI-auto mode
6. Indicates manual mode
7. Indicates AUTO mode
8. Glows green when mains is OK. Glows red when mains is not OK
9. Glows when breaker is closed
10. Glows when breaker is closed
11. Glows green when voltage and frequency are OK
12. Glows green when engine is running

5.1.4 Menu structure

The display includes two menu systems which can be used without password entry:

View menu system

This is the commonly used menu system. 20 windows are configurable and can be entered by using the arrow push-buttons.

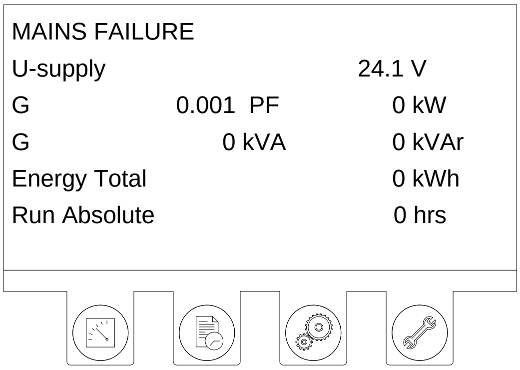
Setup menu system (not commonly used by the operator)

This menu system is used to set up the unit, and if the operator needs detailed information that is not available in the view menu system.
Changing of parameter settings is password-protected.

5.1.5 Entry window

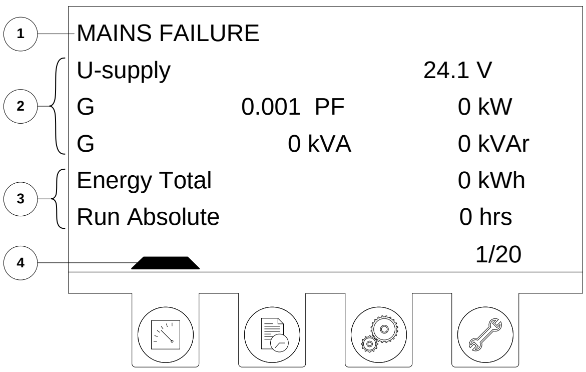
When the unit is powered up, an entry window appears. The entry window is the turning point in the menu structure and as such the gateway to the other menus. It can always be reached by pushing the BACK push-button three times.

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



5.1.6 View menu

The view menus (V1, V2 and V3) are the daily use menus for the operator.



In the view menus, various measured values are on display. The views contain up to 20 different windows which can be selected using the and push-buttons located on the right hand side of the display.

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

5.1.7 Display contrast

It is possible to adjust the contrast of the display in the parameter menu 9150. The contrast can be adjusted from the value -10 to +10. This feature can be used to compensate for the ambient lighting.

5.1.8 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		
READY ISLAND AUTO	Genset stopped in Auto	
ISLAND ACTIVE	Genset running in Auto	
AMF MAN	Genset stopped or running and no other action taking place	
AMF SEMI		
READY AMF AUTO	Genset stopped in Auto	
AMF ACTIVE	Genset running in Auto	
FIXED POWER MAN	Genset stopped or running and no other action taking place.	
FIXED POWER SEMI		
READY FIXED P AUTO	Genset stopped in Auto	
FIXED POWER ACTIVE	Genset running in Auto	
PEAK SHAVING MAN	Genset stopped or running and no other action taking place.	
PEAK SHAVING SEMI		
READY PEAK SHAV AUTO	Genset stopped in Auto	
PEAK SHAVING ACTIVE	Genset running in Auto	
LOAD TAKEOVER MAN	Genset stopped or running and no other action taking place	
LOAD TAKEOVER SEMI		
READY LTO AUTO	Genset stopped in Auto	
LTO ACTIVE	Genset running in Auto	
MAINS P EXPORT MAN	Genset stopped or running and no other action taking place	
MAINS P EXPORT SEMI		
READY MPE AUTO	Genset stopped in Auto	
MPE ACTIVE	Genset running in mains power export mode	
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	

Status text	Condition	Comment
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 timer in the "Idle run"' function is active	
COMPENSATION FREQ	Compensation is active	The frequency is not at the nominal setting
Aux. test ##.#V ####s	Battery test activated	
DELOAD	Decreasing the load of the genset in order to open the breaker	
START DG(s) IN ###s	The start genset set point is exceeded	
STOP DG(s) IN ###s	The stop genset set point is exceeded	
START PREPARE	The start prepare relay is activated	
START RELAY ON	The start relay is activated	
START RELAY OFF	The start relay is deactivated during the start sequence	
MAINS FAILURE	Mains failure and mains failure timer expired	
MAINS FAILURE IN ###s	Frequency or voltage measurement is outside the limits	The timer shown is the mains failure delay. Text in mains units
MAINS U OK DEL ####s	Mains voltage is OK after a mains failure	The timer shown is the mains OK delay
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		
PROGRAMMING LANGUAGE	This info is shown if the language file is downloaded from the PC utility software	

Status text	Condition	Comment
---xx-------- >00< ------------	Generator is synchronising	The "xx" marks the actual generator phase angle position in the synchronisation. When the "xx" is aligned over the 00 centre, the generator is in synchronism
TOO SLOW 00<-------------	Generator running too slow during synchronising	
-----------> 00 TOO FAST	Generator running too fast during synchronising	
EXT. START ORDER	A planned AMF sequence is activated	There is no failure on the mains during this sequence
SELECT GENSET MODE	Power management has been deactivated and no other genset mode has been selected	Option G5 must be available
QUICK SETUP ERROR	Quick setup of the application failed	
MOUNT CAN CONNECTOR	Connect the power management CAN line	
ADAPT IN PROGRESS	The AGC 200 is receiving the application, to which it has just been connected	
SETUP IN PROGRESS	The new AGC is being added to the existing application	
SETUP COMPLETED	Successful update of the application in all AGC units	
REMOVE CAN CONNECTOR	Remove the power management CAN lines	
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

5.1.9 Texts only related to power management (AGC 24x only)

Status text	Condition	Comment
	DG unit	
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 deload 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.	
Deloading TB XX	Displays that a tie breaker is being deloaded in semi-auto mode.	
	Mains unit	
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.
	BTB unit	
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-AUTO 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.
	All units	
BROADCASTING APPL. #	Broadcast of an application through the CAN line.	Broadcasts one of the four applications from one unit to the other AGCs in the power management system.

Status text	Condition	Comment
RECEIVING APPL. #	AGC 200 receiving an application.	
BROADCAST COMPLE-TED	Successful broadcast of an application.	
RECEIVE COMPLETED	Application received successfully.	
BROADCAST ABORTED	Broadcast terminated.	
RECEIVE ERROR	Application is not received correctly.	

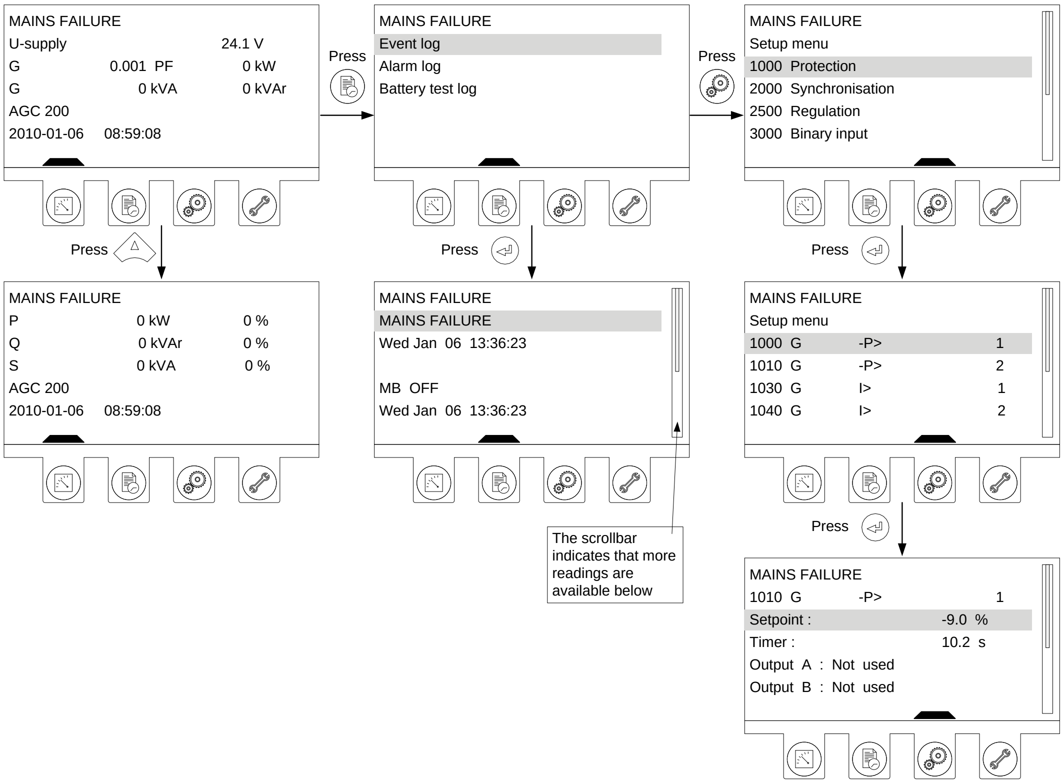
5.1.10 Available display views

View line configuration	
For generator	**For bus/mains**
G f-L1 frequency L1 (Hz)	M f-L1 frequency L1 (Hz)
G f-L2 frequency L2 (Hz)	M f-L2 frequency L2 (Hz)
G f-L3 frequency L3 (Hz)	M f-L3 frequency L3 (Hz)
Gen. active power (kW)	Mains active power (kW)
Gen. reactive power (kVAr)	Mains reactive power (kVAr)
Gen. apparent power (kVA)	Mains apparent power (kVA)
Power factor	Power factor
Voltage angle between L1-L2 (deg.)	Voltage angle between L1-L2 (deg.)
Voltage angle between L2-L3 (deg.)	Voltage angle between L2-L3 (deg.)
Voltage angle between L3-L1 (deg.)	Voltage angle between L3-L1 (deg.)
BB U-L1N	BB U-L1N
BB U-L2N	BB U-L2N
BB U-L3N	BB U-L3N
BB U-L1L2	BB U-L1L2
BB U-L2L3	BB U-L2L3
BB U-L3L1	BB U-L3L1
BB U-MAX	BB U-MAX
BB U-Min	BB U-Min
BB f-L1	BB f-L1
BB AngL1L2-180.0deg	BB AngL1L2-180.0deg
BB-G Ang -180.0deg	BB-M Ang -180.0deg
U-Supply (power supply V DC)	U-Supply (power supply V DC)
Energy counter, total (kWh)	Energy counter, total (kWh)
Energy counter, daily (kWh)	Energy counter, daily (kWh)
Energy counter, weekly (kWh)	Energy counter, weekly (kWh)
Energy counter, monthly (kWh)	Energy counter, monthly (kWh)
G U-L1N (voltage L1-N)	M U-L1N (voltage L1-N)
G U-L2N (voltage L2-N)	M U-L2N (voltage L2-N)
G U-L3N (voltage L3-N)	M U-L3N (voltage L3-N)
G U-L1L2 (voltage L1-L2)	M U-L1L2 (voltage L1-L2)
G U-L2L3 (voltage L2-L3)	M U-L2L3 (voltage L2-L3)
G U-L3L1 (voltage L3-L1)	M U-L3L1 (voltage L3-L1)
G U-Max (voltage max.)	M U-Max (voltage max.)
G U-Min (voltage min.)	M U-Min (voltage min.)

View line configuration	
G I-L1 (current L1)	M I-L1 (current L1)
G I-L2 (current L2)	M I-L2 (current L2)
G I-L3 (current L3)	M I-L3 (current L3)
Run abs. (absolute run time)	
Run rel. (relative run time)	
Next prio (next priority shift)	
Run ShtD O (shutdown override run time)	
Mains power A102	P TB A105
Number of GB operations	Number of TB operations
Start attempts	
Start att Std (start attempts standard)	
Start att Dbl (start attempts double)	
P available	P available
P mains	P mains
P DGs tot	P DGs tot
Number of MB operations	Number of MB operations
Service timer 1	
Service timer 2	
MPU	
Multi-input 46	Multi-input 46
Multi-input 47	Multi-input 47
Multi-input 48	Multi-input 48
View line configuration	
For generator	**For bus/mains**
Cos Phi	
	P tie breaker
Cos Phi (current)	
Power reference (actual)	
Power reference (current)	Power reference (current)
Fan A priority and hours	
Fan B priority and hours	
Fan C priority and hours	
Fan D priority and hours	
Parameter ID	
Governor regulator type	
AVR regulator type	
EIC readings	

View line configuration	
External analogue readings	

View menu example



5.1.11 Mode overview

The unit has four different running modes and one block mode. The modes are selected directly with push-buttons in the lower right corner of the unit front.

Auto

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

Semi-auto

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

Test

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

Manual

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

OFF

When the OFF mode is selected, the unit is not able to initiate any sequences, e.g. the start sequence.

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

5.1.12 Password

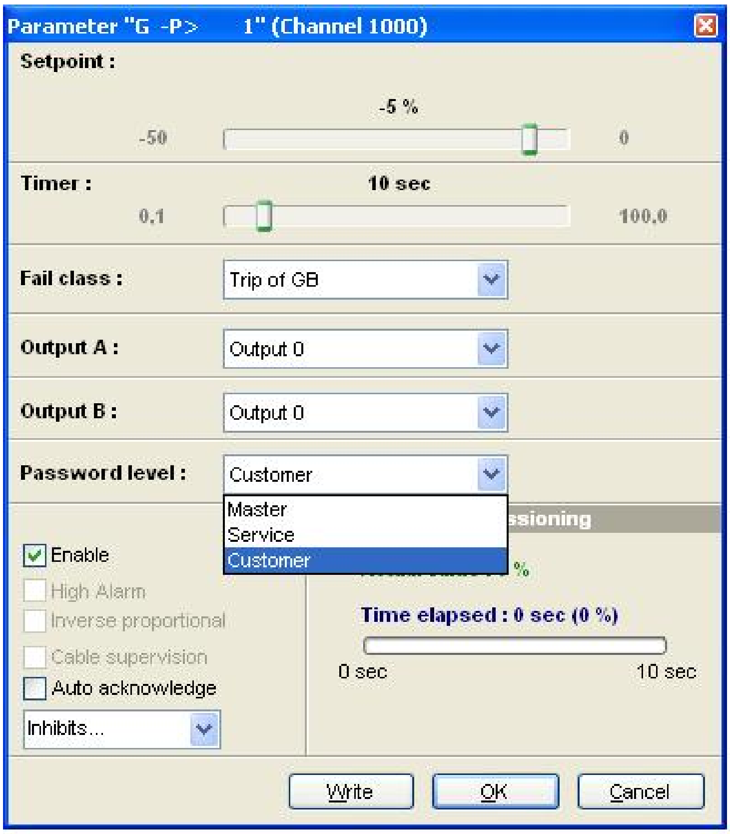
The unit includes three password levels. All levels can be adjusted in the PC software.

Available password levels:

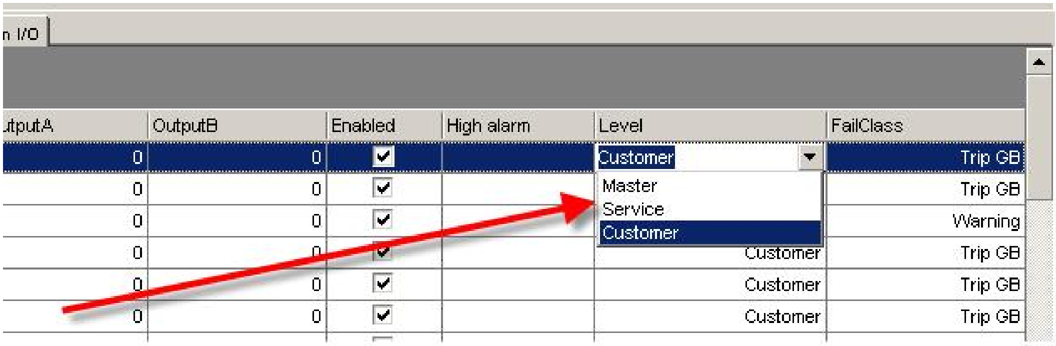
Password level	Factory setting	Access		
		Customer	Service	Master
Customer	2000	X		
Service	2001	X	X	
Master	2002	X	X	X

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

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



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



5.1.13 Parameter access

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

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

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

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

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

6. PID controller

6.1 PID controller

6.1.1 PID controller

The unit controller is a PID controller. It consists of a proportional regulator, an integral regulator and a differential regulator. The PID controller is able to eliminate the regulation deviation and can easily be tuned in.

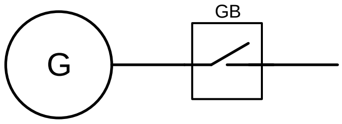
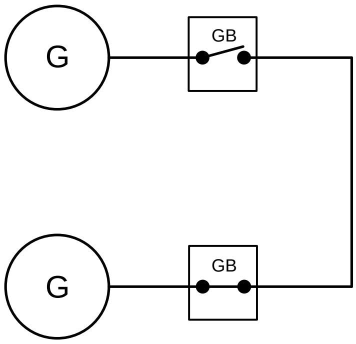
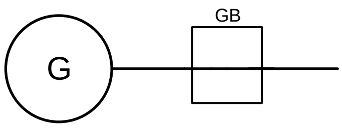
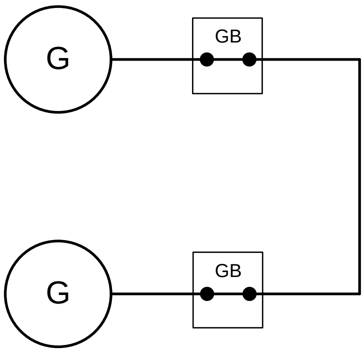
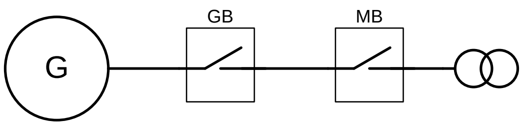
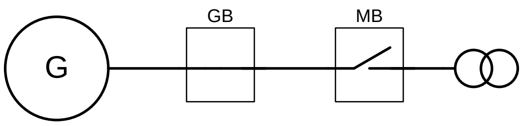
Please refer to the "General Guidelines for Commissioning".

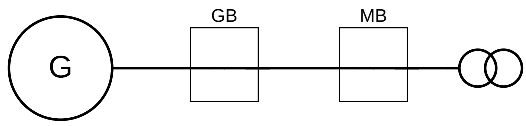
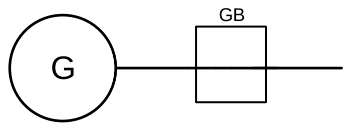
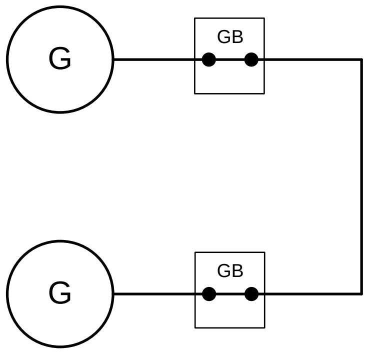
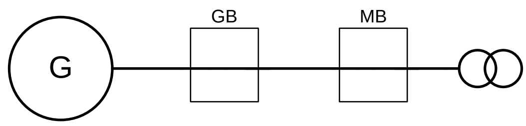
6.1.2 Controllers

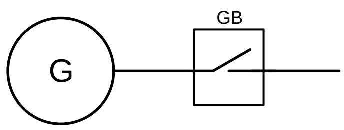
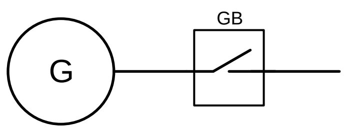
There are three controllers for the governor control and, if AVR control is selected, also three controllers for the AVR control. Furthermore, there are two controllers performing synchronisation.

Controller	GOV	AVR	Comment
Frequency	X		Controls the frequency
Power	X		Controls the power
P load sharing	X		Controls the active power load sharing
Voltage		X	Controls the voltage
var		X	Controls the cos phi
Q load sharing		X	Controls the reactive power load sharing
Sync	X		Controls the frequency when synchronising
Phase	X		Controls the frequency during static synchronisation when the frequencies are close to similar

The table below indicates when each of the controllers is active. This means that the controllers can be tuned in when the shown running situations are present.

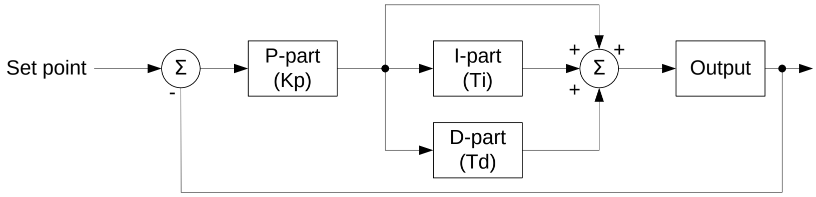
GOVERNOR			AVR			SCHEMATIC
Frequency	**Power**	**P LS**	**Voltage**	**var**	**Q LS**	
GB OPEN						
X			X			
X			X			
GB CLOSED						
		X			X	
		X			X	
SINGLE DG WITH MAINS CONNECTION						
X			X			
		X			X	

GOVERNOR			AVR			SCHEMATIC
	X			X		
DELOAD						
	X			X		
	X			X		
	X			X		

GOVERNOR					AVR			SCHEMATIC
Freq	**Pow**	**P LS**	**Sync**	**Phase**	**Volt**	**var**	**Q LS**	
SYNCHRONISING								
			X		X			------------Dynamic synchronisation------------ 
			X	X	X			------------Static synchronisation------------ 

6.1.3 Principle drawing

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



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

As illustrated in the above drawing and equation, each regulator (P, I and D) gives an output which is summarised to the total controller output.

The adjustable settings for the PID controllers in the AGC 200 unit are:

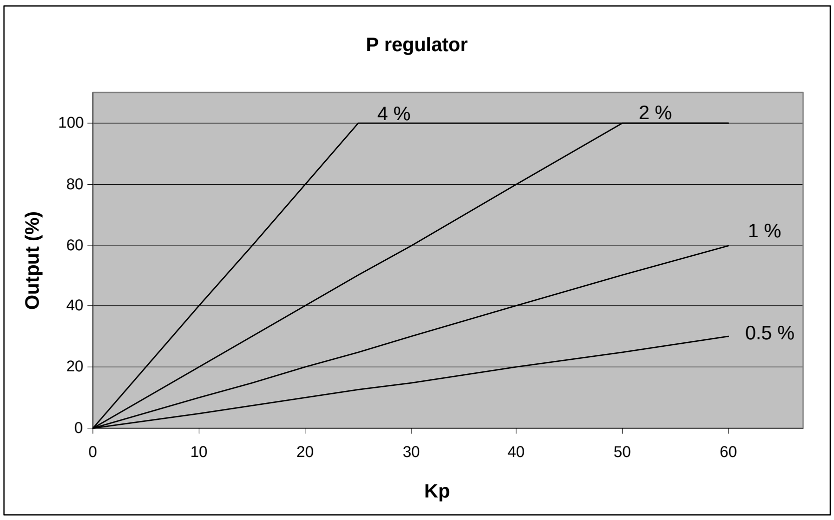
Kp :	The gain for the proportional part.
Ti :	The integral action time for the integral part.
Td :	The differential action time for the differential part.

The function of each part is described in the following.

6.1.4 Proportional regulator

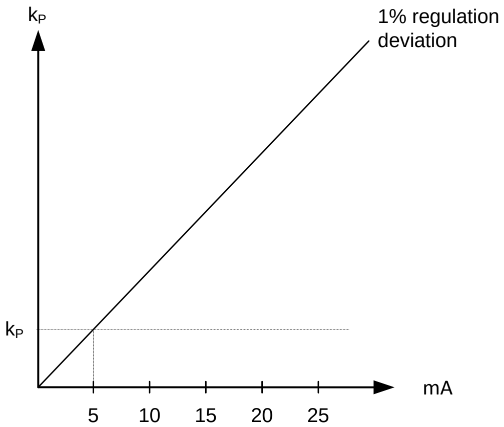
When the regulation deviation occurs, the proportional part will cause an immediate change of the output. The size of the change depends on the gain Kp.

The diagram shows how the output of the P regulator depends on the Kp setting. The change of the output at a given Kp setting will be doubled, if the regulation deviation doubles.



Speed range

Because of the characteristic 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.

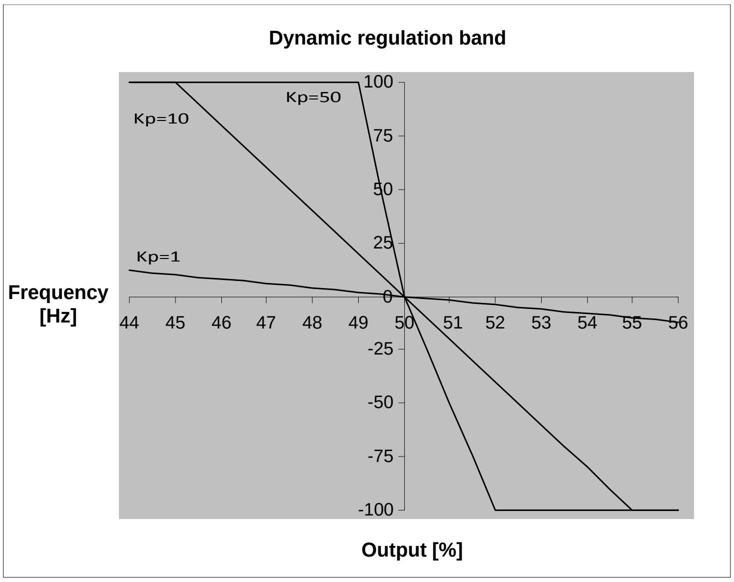


A 1% regulation deviation occurs. With the Kp setting adjusted, the deviation causes the output to change 20%. The table shows that the output of the AGC 200 changes relatively much if the maximum speed range is low.

Max. speed range	Output change		Output change in % of max. speed range
50%	20%	20/50*100%	40
100%	20%	20/100*100%	20

Dynamic regulation area

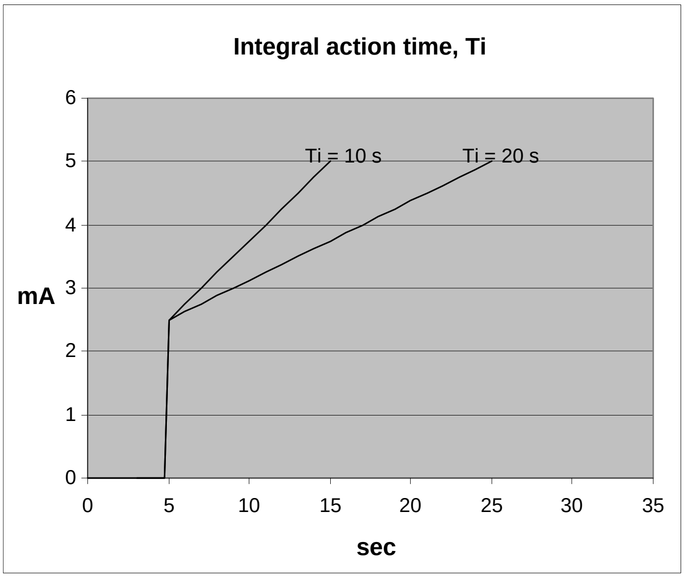
The drawing below shows the dynamic regulation area at given values of Kp. The dynamic area will be smaller if the Kp is adjusted to a higher value.



Integral regulator

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

In the drawing below, the proportional regulator causes an immediate change of 10%. The integral action time is then measured when the output reaches 2 x 10 = 20%.



As shown in the drawing, the output reaches 20% twice as fast at a Ti setting of 10 s than with a setting of 20 s.

The integrating function of the I regulator is increased if the integral action time is decreased. This means that a lower setting of the integral action time Ti results in a faster regulation.

If the Ti is adjusted to 0 s, the I regulator is switched OFF.

The integral action time Ti must not be too low. This will make the regulation hunt similar to a too high proportional action factor Kp.

Differential regulator

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

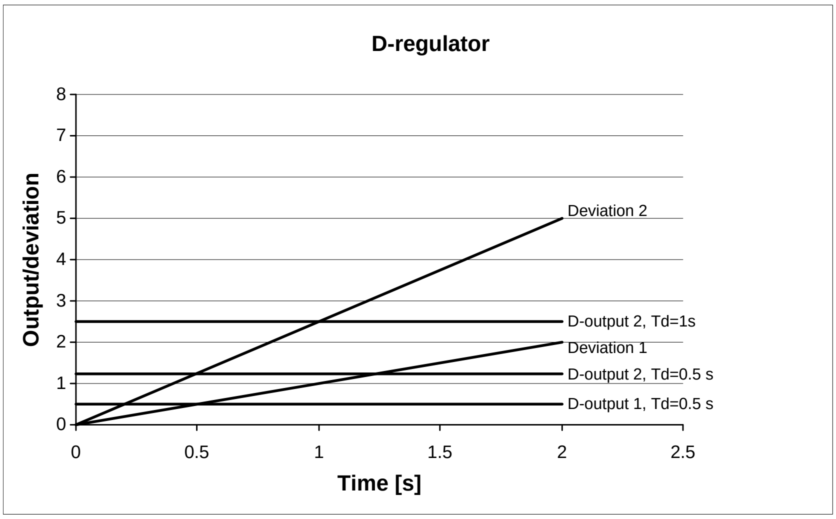
In most cases, the differential regulator is not needed; however, in case of very precise regulation situations, e.g. static synchronisation, it can be very useful.

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

D = Regulator output
Kp = Gain
de/dt = Slope of the deviation (how fast the deviation occurs)

This means that the D regulator output depends on the slope of the deviation, the Kp and the Td setting.

Example: In the following example, it is assumed that Kp = 1.



Deviation 1:	A deviation with a slope of 1
Deviation 2:	A deviation with a slope of 2.5 (2.5 times bigger than deviation 1
D output 1, Td=0.5 s:	Output from the D regulator when Td=0.5 s and the deviation is according to Deviation 1.
D output 2, Td=0.5 s:	Output from the D regulator when Td=0.5 s and the deviation is according to Deviation 2.
D output 2, Td=1 s:	Output from the D regulator when Td=1 s and the deviation is according to Deviation 2.

The example shows that the bigger the deviation and the higher the Td setting is, the bigger is the output from the D regulator. Since the D regulator is responding to the slope of the deviation, it also means that when there is no change, the D output will be zero.

When commissioning, please keep in mind that the Kp setting has influence on the D regulator output.

If the Td is adjusted to 0 s, the D regulator is switched OFF.

The differential action time Td must not be too high. This will make the regulation hunt similar to a too high proportional action factor Kp

6.1.5 Load share controller/var share controller

The load share controller and VAr share controller is used in the AGC 200 whenever load sharing/VAr sharing mode is activated. The controller is a PID controller similar to the other controllers in the system, and it handles frequency control as well as power control (load sharing) and voltage as well as reactive power control (VAr sharing).

Load share controller
Adjustment of the load share controller is done in menu 2540 (analogue control) or 2590 (relay control).

VAr share controller
Adjustment of the VAr share controller is done in menu 2660 (analogue control) or 2700 (relay control).

General
The primary purpose of the PID controllers is always frequency/voltage control because they are variable in a load sharing system, as well as the power/reactive power on the individual generator. Since the load sharing system requires power/reactive power regulation as well, the PID controllers can be affected by the power/ reactive power regulator. For this purpose, a so-called weight factor is used (P_{WEIGHT}/Q_{WEIGHT}).

The regulation deviation from the power/reactive power regulator can therefore have great or less influence on the PID controller. An adjustment of 0% means that the power/reactive power control is switched off. An adjustment of 100% means that the power/reactive power regulation is not limited by the weight factor. Any adjustment in between is possible.

The difference between adjusting the weight value to a high or low value is the speed at which the power/ reactive power regulation deviation is eliminated. So if a firm load sharing is needed, the weight factor must be adjusted to a higher value than if an easy load sharing is required.

An expected disadvantage of a high weight factor is that when a frequency/voltage deviation and a power/reactive power deviation exist, then hunting could be experienced. To avoid this, you can decrease either the weight factor or the parameters of the frequency/voltage regulator.

6.1.6 Synchronising controller

The synchronising controller is used in the AGC 200 whenever synchronising is activated. After a successful synchronisation, the frequency controller is deactivated and the relevant controller is activated. This could e.g. be the load sharing controller. The adjustments are made in menu 2050. For synchronising, voltage matching is carried out using the voltage controller (setting 2640).

Dynamic synchronising

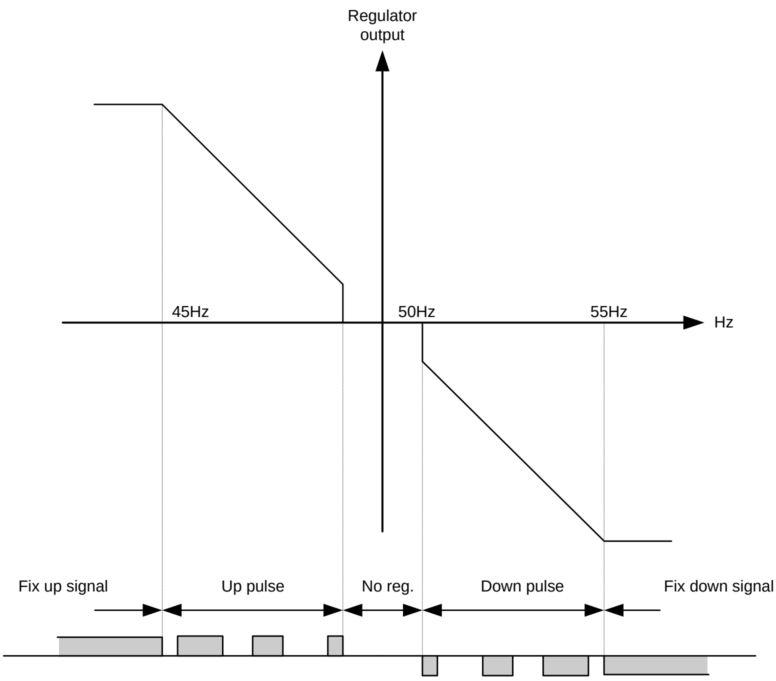
When dynamic synchronising is used, the controller ”2050 f_{SYNC} controller” is used during the entire synchronising sequence. One of the advantages of dynamic synchronising is that it is relatively fast. In order to improve the speed of the synchronising further, the generator will be sped up between 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.

Static synchronising

When synchronising is started, the synchronising controller ”2050 f_{SYNC} controller” is activated and the generator frequency is controlled towards the busbar/mains frequency. The phase controller takes over when the frequency deviation is so small that the phase angle can be controlled. The phase controller is adjusted in menu 2070 (”2070 phase controller”).

6.1.7 Relay control

When the relay outputs are used for control purposes, the regulation works like this:



The regulation with relays can be split up into five steps.

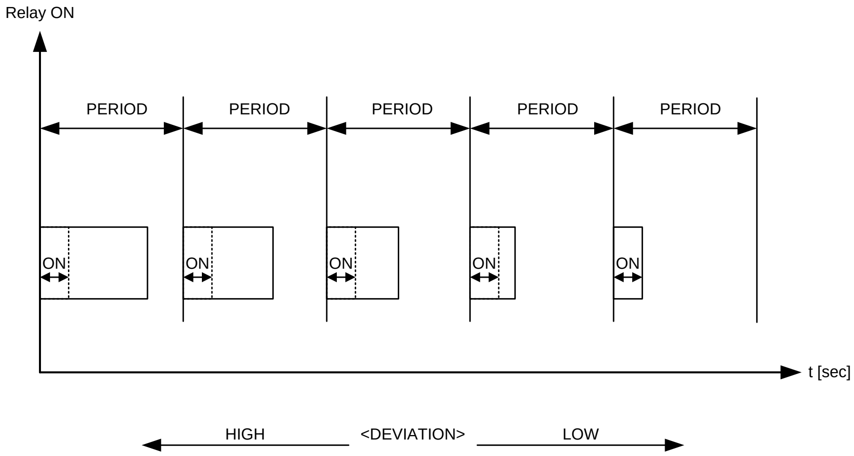
#	Range	Description	Comment
1	Static range	Fix up signal	The regulation is active, but the increase relay will be constantly activated because of the size of the regulation deviation.
2	Dynamic range	Up pulse	The regulation is active, and the increase relay will be pulsing in order to eliminate the regulation deviation.
3	Dead band area	No reg.	In this particular range, no regulation takes place. The regulation accepts a predefined dead band 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 dead band 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”. They are shown in the drawing below.

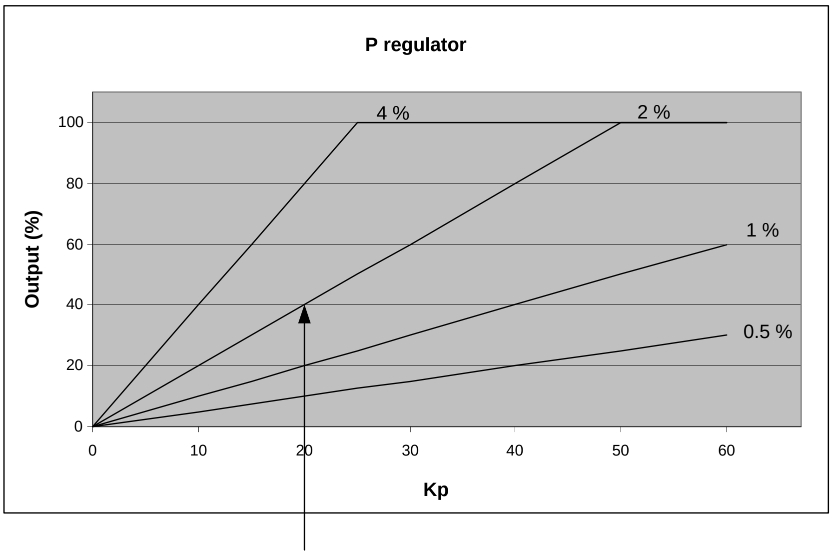
Adjustment	Description	Comment
Period time	Maximum relay time	The time between the beginnings of two subsequent relay pulses.
ON time	Minimum relay time	The minimum length of the relay pulse. The relays will never be activated for a shorter time than the ON time.

As it is indicated in the drawing below, the length of the relay pulse will depend on the actual regulation deviation. If the deviation is big, then the pulses will be long (or a continued signal). If the deviation is small, then the pulses will be short.



Signal length

The signal length is calculated compared to the adjusted period time. In the drawing below, the effect of the proportional regulator is indicated.



In this example, we have a 2 percent regulation deviation and an adjusted value of the Kp = 20. The calculated regulator value of the unit is 40%. Now, the pulse length can be calculated with a period time = 2500 ms:

$$e_{DEVIATION} / 100 * t_{PERIOD}$$

$$40 / 100 * 2500 = 1000\, ms$$

The length of the period time will never be shorter than the adjusted ON time.

Regulation failure
The governor/AVR regulation failure in menu 2560/2680 occurs when the regulation is activated but the set point cannot be reached.

The alarm will appear when the set point is reached. The deviation is calculated in percent:

Example:
UACTUAL = 400V AC
UNOMINAL = 440V AC
Difference in percent: (440-400)/440*100 = 9.1%

If the alarm setting is lower than 9.1% in this example, the alarm appears.

Adjust the alarm setting ”Dead band” to 100% to deactivate the alarm.

7. Synchronisation

7.1 Synchronisation

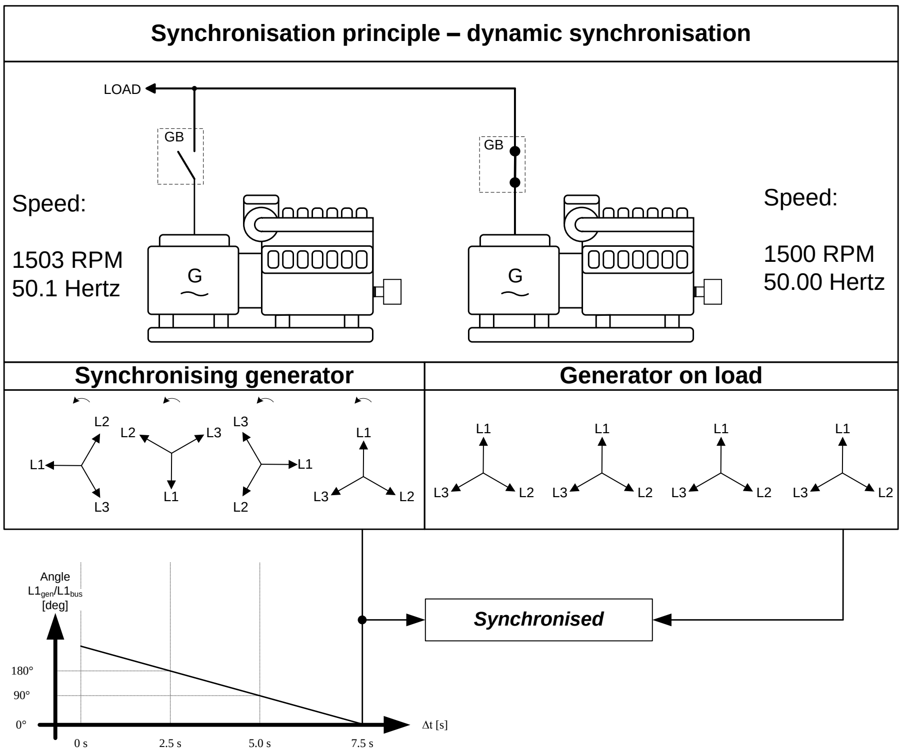
The unit can be used for synchronisation of generator and mains breaker (if installed). Two different synchronisation principles are available, namely static and dynamic synchronisation (dynamic is selected by default). This chapter describes the principles of the synchronisation functions and the adjustment of these.

In the following, the term "synchronisation" means "synchronising and closing of the synchronised breaker".

7.2 Dynamic synchronisation

In dynamic synchronisation, the synchronising genset is running at a different speed than the generator on the busbar. This speed difference is called *slip frequency*. Typically, the synchronising genset is running with a positive slip frequency. This means that it is running with a higher speed than the generator on the busbar. The objective is to avoid a reverse power trip after the synchronisation.

The dynamic principle is illustrated below.



In the example above, the synchronising genset is running at 1503 RPM ~ 50.1 Hz. The generator on load is running at 1500 RPM ~ 50.0 Hz. This gives the synchronising genset a positive slip frequency of 0.1 Hz.

The intention of the synchronising is to decrease the phase angle difference between the two rotating systems. These two systems are the three-phase system of the generator and the three-phase system of the busbar. In the illustration above, phase L1 of the busbar is always pointing at 12 o'clock, whereas phase L1 of the synchronising genset is pointing in different directions due to the slip frequency.

Of course both three-phase systems are rotating, but for illustrative purposes the vectors for the generator on load are not shown to be rotating. This is because we are only interested in the slip frequency for calculating when to release the synchronisation pulse.

When the generator is running with a positive slip frequency of 0.1 Hz compared to the busbar, the two systems will be synchronised every 10 seconds.

$$t_{SYNC} = \frac{1}{50.1 - 50.0} = 10\,\mathrm{sec}$$

Observe the chapter regarding PID controllers and the synchronising controllers.

In the illustration above, the difference in the phase angle between the synchronising set and the busbar gets smaller and will eventually be zero. Then the genset is synchronised to the busbar, and the breaker will be closed.

7.2.1 Close signal

The unit always calculates when to close the breaker to get the most accurate synchronisation. This means that the close breaker signal is actually issued before being synchronised (read L1 phases exactly at 12 o'clock).

The breaker close signal will be issued depending on the breaker closing time and the slip frequency (response time of the circuit breaker is 250 ms, and the slip frequency is 0.1 Hz):

$$\deg_{CLOSE} = 360 * t_{CB} * f_{SLIP}$$
$$\deg_{CLOSE} = 360 * 0.250 * 0.1$$
$$\deg_{CLOSE} = 9\ \deg$$

The synchronisation pulse is always issued, so the closing of the breaker will occur at the 12 o'clock position.

The length of the synchronisation pulse is the response time + 20 ms **(2020 Synchronisation).**

7.2.2 Load picture after synchronising

When the incoming genset has closed its breaker, it will take a portion of the load dependent on the actual position of the fuel rack. Illustration 1 below indicates that at a given *positive* slip frequency, the incoming genset will *export* power to the load. Illustration 2 below shows that at a given *negative* slip frequency, the incoming genset will *receive* power from the original genset. This phenomenon is called *reverse power*.

To avoid nuisance trips caused by reverse power, the synchronising settings can be set up with a positive slip frequency.

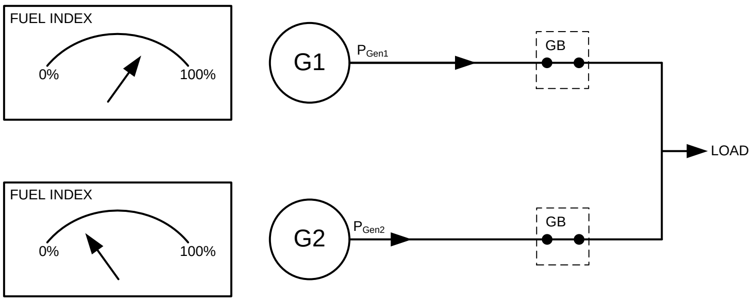


Illustration 1, POSITIVE slip frequency

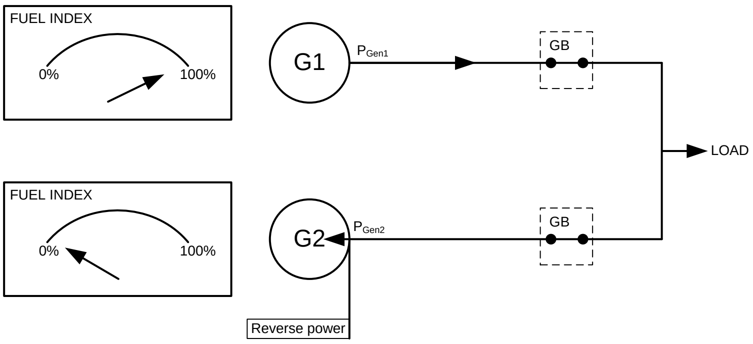


Illustration 2, NEGATIVE slip frequency

7.2.3 Adjustments

The dynamic synchroniser is selected in **2000 Sync. type** in the control setup and is adjusted in **2020 Synchronisation**.

Setting	Description	Comment
"Sync df_{MAX}" (channel 2021)	Maximum slip frequency	Adjust the maximum positive slip frequency where synchronising is allowed.
"Sync df_{MIN}" (channel 2022)	Minimum slip frequency	Adjust the maximum negative slip frequency where synchronising is allowed.
"Sync dU_{MAX}" (channel 2023)	Maximum voltage difference (+/- value)	The maximum allowed voltage difference between the busbar/mains and the generator.
"Sync t_{GB}" (channel 2024)	Generator breaker closing time	Adjust the response time of the generator breaker.
"Sync t_{MB}" (channel 2025)	Mains breaker closing time	Adjust the response time of the mains breaker.

The speed of the slip frequency is determined by two settings, "Sync df_{MAX}" and "Sync df_{MIN}". The calculation from the examples below illustrates why it is important to configure the slip frequency speed correctly.

Example 1: The slip frequency speed of the genset is 0.15 Hz faster than the frequency of the busbar or the grid that the genset is trying to synchronise to.
This means that the phase angle difference between the genset and the busbar or the grid will decrease and eventually be within the GB closing window.

Example 2: The slip frequency speed of the genset is 0 Hz.
This means that the phase angle difference between the genset and the busbar or the grid will not decrease. In this example, the genset will never reach the GB closing window because it will never catch up on the grid or the busbar.

$$Explanation: \frac{df_{MAX} + df_{MIN}}{2} = Slip\ frequency\ speed$$

$$Example\ 1: \frac{0.3Hz + 0.0Hz}{2} = +0.15Hz$$

$$Example\ 2: \frac{0.3Hz + (-0.3Hz)}{2} = +0Hz$$

It is obvious that this type of synchronisation is able to synchronise relatively fast because of the adjusted minimum and maximum slip frequencies. This actually means that when the unit is aiming to control the frequency towards its set point, synchronising can still occur as long as the frequency is within the limits of the slip frequency adjustments.

Dynamic synchronisation is recommended where fast synchronisation is required, and where the incoming gensets are able to take load just after the breaker has been closed.

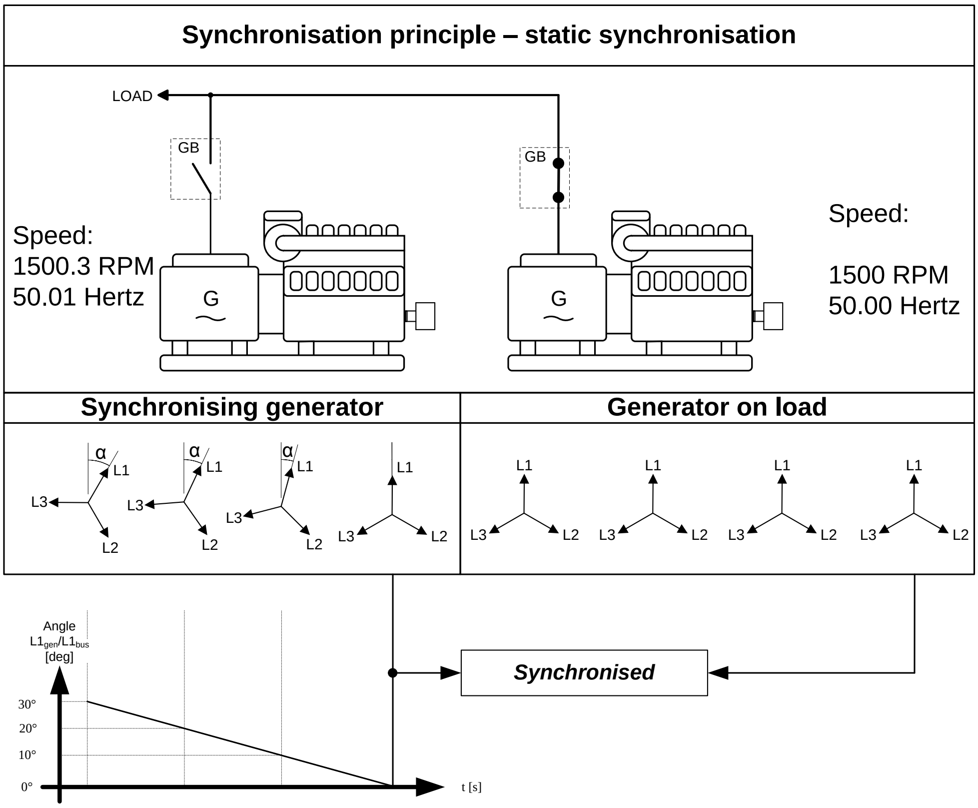
Static and dynamic synchronisation can be switched by using M-Logic.

7.3 Static synchronisation

In static synchronisation, the synchronising genset is running very close to the same speed as the generator on the busbar. The aim is to let them run at exactly the same speed and with the phase angles between the three-phase system of the generator and the three-phase system of the busbar matching exactly.

It is not recommended to use the static synchronisation principle when relay regulation outputs are used. This is due to the slower nature of the regulation with relay outputs.

The static principle is illustrated below.



7.3.1 Phase controller

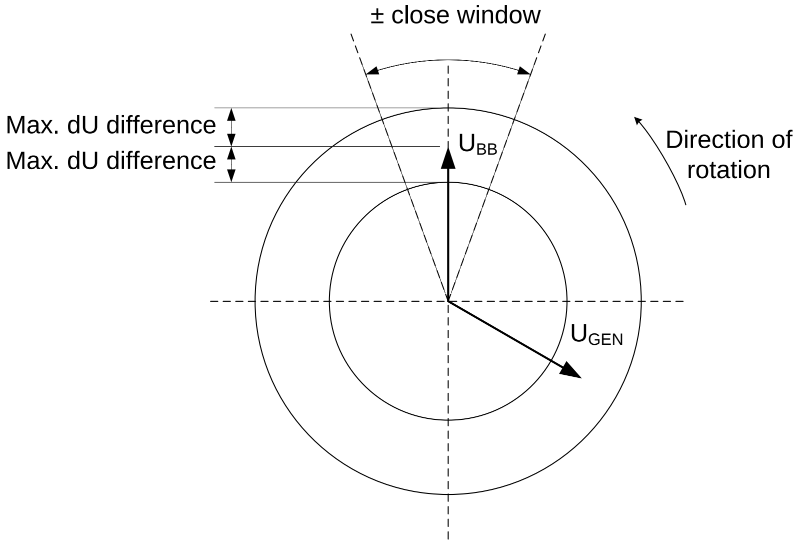
When the static synchronisation is used and the synchronising is activated, the frequency controller will bring the genset frequency towards the busbar frequency. When the genset frequency is within 50 mHz of the busbar frequency, the phase controller takes over. This controller uses the angle difference between the generator system and the busbar system as the controlling parameter.

This is illustrated in the example above where the phase controller brings the phase angle from 30 deg. to 0 deg.

7.3.2 Close signal

The close signal will be issued when phase L1 of the synchronising generator is close to the 12 o'clock position compared to the busbar which is also in 12 o'clock position. It is not relevant to use the response time of the circuit breaker when using static synchronisation, because the slip frequency is either very small or non-existing.

To be able to get a faster synchronisation, a "close window" can be adjusted. The close signal can be issued when the phase angle U_{GENL1}-U_{BBL1} is within the adjusted setpoint. The range is +/-0.1-20.0 deg. This is illustrated in the drawing below.



The synchronisation pulse is sent dependent on the settings in menu 2030. It depends on whether it is the GB or the MB that is to be synchronised.

7.3.3 Load picture after synchronisation

The synchronised genset will not be exposed to an immediate load after the breaker closure if the maximum df setting is adjusted to a low value. Since the fuel rack position almost exactly equals what is required to run at the busbar frequency, no load jump will occur.

If the maximum df setting is adjusted to a high value, then the observations in the section about "dynamic synchronisation" must be observed.

After the synchronising, the unit will change the controller setpoint according to the requirements of the selected genset mode.

Static synchronisation is recommended where a slip frequency is not accepted, for instance if several gensets synchronise to a busbar with no load groups connected.

Static and dynamic synchronisation can be switched by using M-logic.

7.3.4 Adjustments

The following settings must be adjusted if the static synchroniser is selected in menu 2000:

Setting	Description	Comment
2031 Maximum df	The maximum allowed frequency difference between the busbar/mains and the generator.	+/- value.
2032 Maximum dU	The maximum allowed voltage difference between the busbar/mains and the generator.	+/- value related to the nominal generator voltage.
2033 Closing window	The size of the window where the synchronisation pulse can be released.	+/- value.
2034 Static sync	Minimum time inside the phase window before sending a close command.	
2035 Static type GB	"Breaker" or "Infinite sync" can be chosen.	"Infinite sync" will close the MB to the busbar and run the generator in sync with the mains. The GB is not allowed to close.
2036 Static type MB	"Breaker" or "Infinite sync" can be chosen.	"Infinite sync" will close the GB to the busbar and run the generator in sync with the mains. The MB is not allowed to close.
2061 Phase K_P	Adjustment of the proportional factor of the PI phase controller.	Only used during analogue regulation output.
2062 Phase K_I	Adjustment of the integral factor of the PI phase controller.	
2070 Phase K_P	Adjustment of the proportional factor of the PI phase controller.	Only used during relay regulation output.

7.4 GB closing before excitation

It is possible to adjust the AGC to start up the genset with the excitation switched off. When the gensets are started up, the breakers will be closed and the excitation started. It is also possible to close the breaker before the engine is started. This function is called "Close Before Excitation" (CBE).

The purpose of the "close before excitation" is that the gensets are able to be ready for the load very quickly. All of the gensets will be connected to the busbar as soon as they are started, and as soon as the excitation is switched on, the gensets are ready for operation. This is faster than the normal synchronising, because in that case the breakers will not be closed until the generator voltage is in the synchronised position, and it takes some time to achieve that position.

The "close before excitation" 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 will be switched on after an adjustable delay.

The function can be used in the single AGC but also the AGC with option G4 or G5.

The excitation must be increased slowly when this function is used.

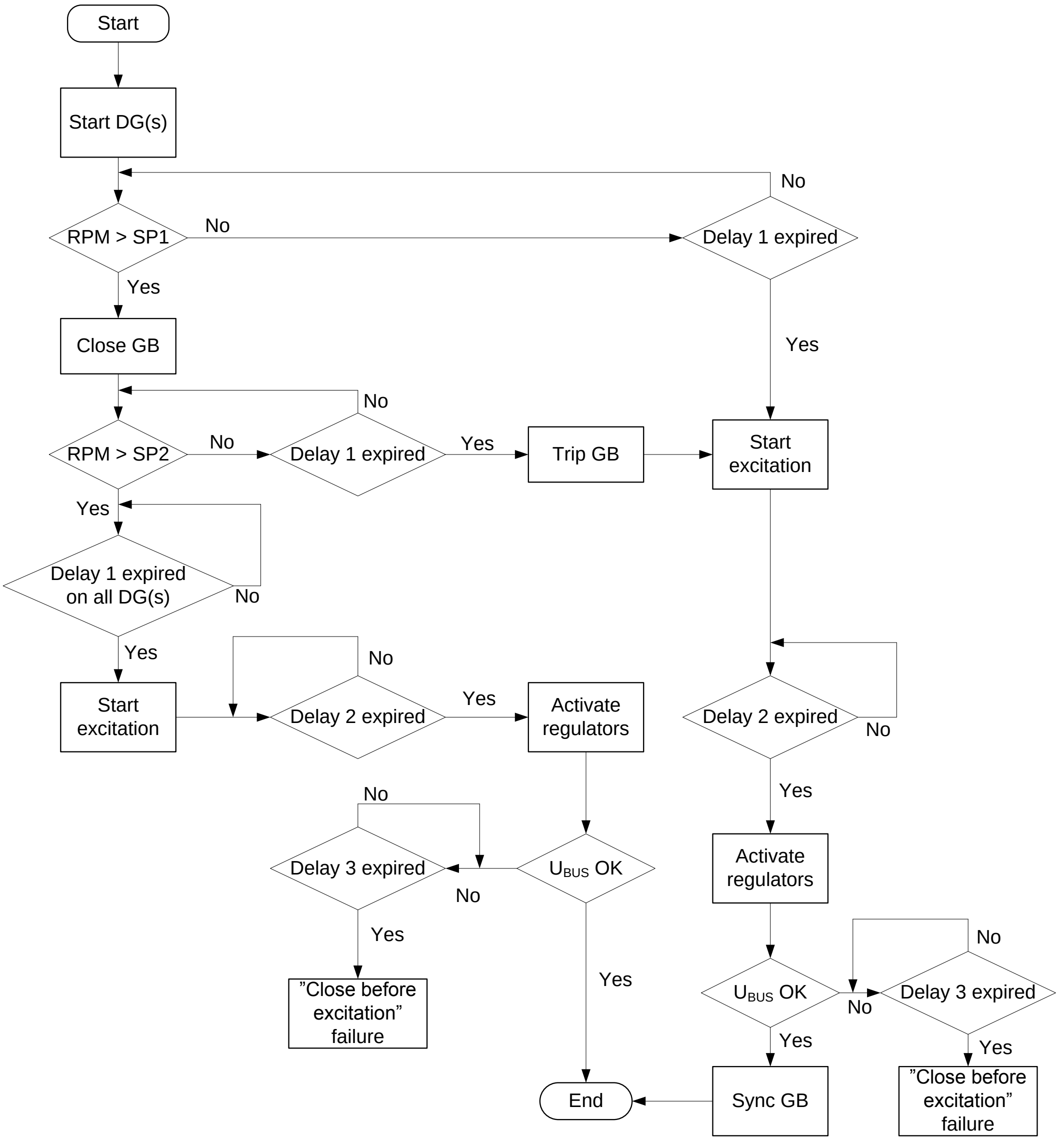
This function can only be used with a magnetic pickup (MPU) or EIC speed signal.

The principle is described in the flowcharts below.

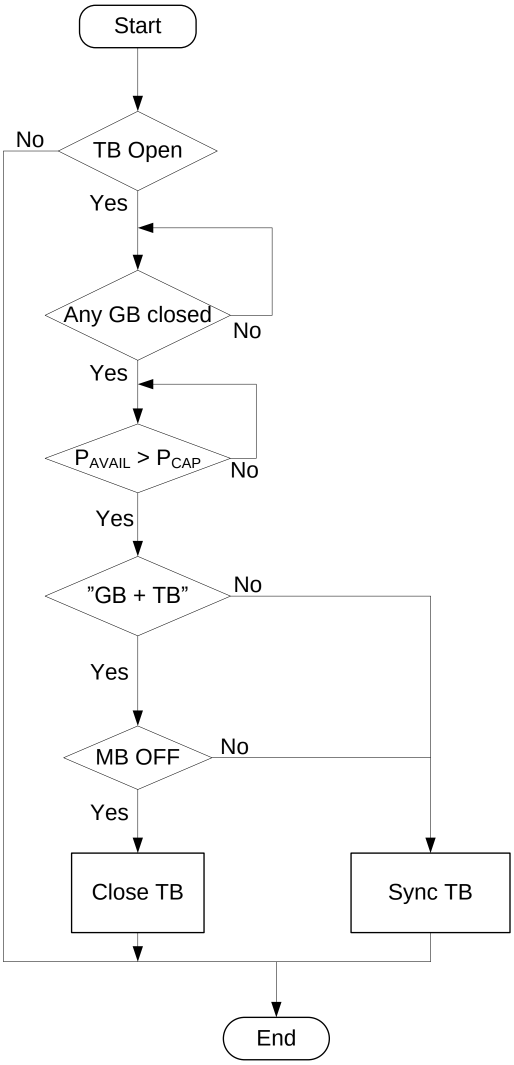
Flowchart abbreviations

Delay 1	=	Parameter 2252
Delay 2	=	Parameter 2262
Delay 3	=	Parameter 2271
SP1	=	Parameter 2251
SP2	=	Parameter 2263

7.4.1 Flowchart 1, GB handling



7.4.2 Flowchart 2, TB handling (AGC 246 only)

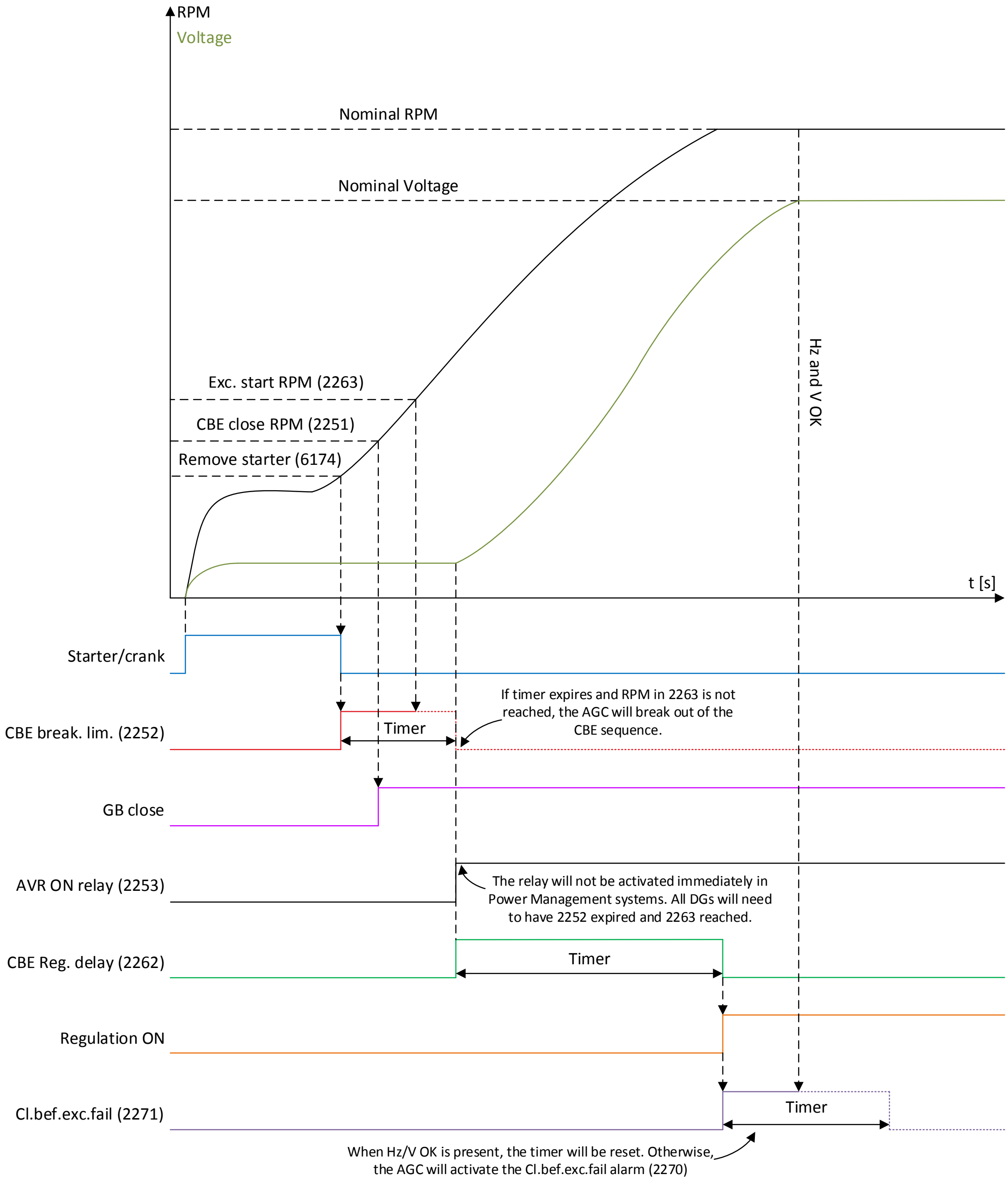


7.4.3 Genset start actions

The start sequence of the AGC is changed in order to achieve the function "close before excitation". The following parameters must be adjusted:

Menu	Description	Comment
2251	RPM setpoint for breaker closing	The generator breaker will close at the adjusted level. The range is from 0-400 RPM. If it is adjusted to 0, then the breaker will be closed when the start command is given. In the example below the setting is adjusted to 400.
2252	RPM timer	The genset must reach the setpoint (menu 2263) within the adjusted delay. When the delay expires and the RPM is above the setpoint, then the excitation will be started. If the RPM is below the setpoint, then the GB will be tripped.
2253	Output A	Select the relay output that must be used to start the excitation. Configure the relay to be a limit relay in the I/O setup.
2255	Enable	Enable the function "close before excitation".

The relay that is used for close before excitation must be a non-configured relay that is not used for anything else.



7.4.4 Breaker sequence

The "close before excitation" function can be used in three applications:

1. AGC single genset plant
2. AGC power management plant - no tie breaker present
3. AGC power management plant - tie breaker present

In one of the applications a tie breaker is present, and it must be adjusted in the menu 2261 whether only the generator breaker must be closed or both the generator breaker and also the tie breaker.

The breaker sequence adjustments are the following:

Menu	Description	Comment
2261	Breaker selection	Select breakers to close: GB or GB + TB.
2262	Timer	The timer defines the period from the excitation is started and until the regulation is activated. The alarms with inhibit set to "Not run status" will be activated after this timer has expired.
2263	Excitation start level	The setting defines at what minimum level of RPM the excitation can be started.
2264	Voltage discharge	This timer delays the closing of the GB after removing excitation. The intention of this delay is to let the voltage of the generator discharge, so that only remanence voltage is present when the GB is closed.

7.4.5 "Close before excitation" failure

If the starting of the genset does not succeed, then the alarm menu 2270 "Cl.bef.exc.fail" will occur, and the selected fail class will be executed.

7.4.6 "CBE configure relay/DVC" message on display

If the "CBE configure relay/DVC" message appears on the display or in the utility software, it means that CBE is enabled (in menu 2251), but you have not selected a "CBE relay" in menu 2253 or one of the supported digital AVRs in menu 7565 "Digital AVR.
As long as the "CBE configure relay/ DVC" message is active, synchronisation will happen in the usual way (static or dynamic) until the CBE parameters are fully set up for all gensets. The error messages appear on all controllers if one or more controllers are not fully configured.

7.4.7 Close before excitation – additional control parameters

If the application has been configured to use “Close Before Excitation” (CBE) during start, the Multi-line 2 unit can do additional things to handle the sequence correctly.

If, for example, the application is made for backup power (AMF), it can be chosen what the Multi-line 2 unit should do during cooldown. The Multi-line 2 unit is able to make a rerun, which means that if a new start request comes during cooldown, the genset(s) can perfom the CBE sequence again without stopping the genset(s). To handle the functionality for the rerun and cooldown, some parameters must be set correctly.

Excitation control during cooldown: At parameter 2266, it is possible to decide how the Multi-line 2 unit should react during cooldown. At this parameter, it is possible to select between three settings:

- Excitation follow busbar
- Excitation constant OFF
- Excitation constant ON

A short description of each selection is made below:

Excitation follow busbar: By default, the parameter is set to “Excitation follow busbar”. This means that if there is voltage on the busbar during cooldown of the specific genset, the excitation is ON. If the voltage on the busbar disappears, the excitation is shut OFF.

Excitation constant OFF: If the parameter is set to “Excitation constant OFF”, the excitation will be switched OFF, as soon as the GB is open during cooldown. This feature can be handy if the genset fans are pulled mechanically by the genset. Then the genset will be able to make a rerun faster.

Excitation constant ON: If the parameter is set to “Excitation constant ON”, the excitation will be ON until the genset stops or a new start request comes. This feature can be handy if the genset fans are driven by the voltage from the genset.

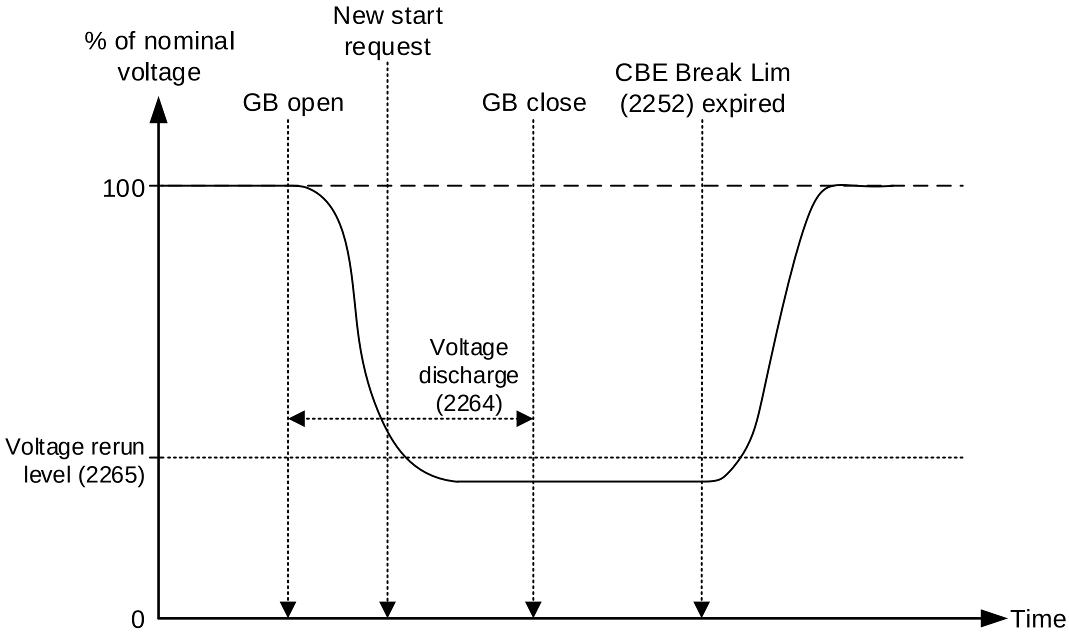
Parameter	Item	Range	Default	Note
2266	Excitation control during cooldown	Excitation follow busbar Excitation constant ON	Excitation follow busbar	Parameter is not shared between gensets!

Voltage rerun level:
At parameter 2265, it is set how low the voltage must be, before it is allowed to close the breaker during the rerun. If the voltage is not below the “voltage rerun level” before the “voltage discharge timer” has expired, the specific genset will be excluded from the CBE rerun sequence.

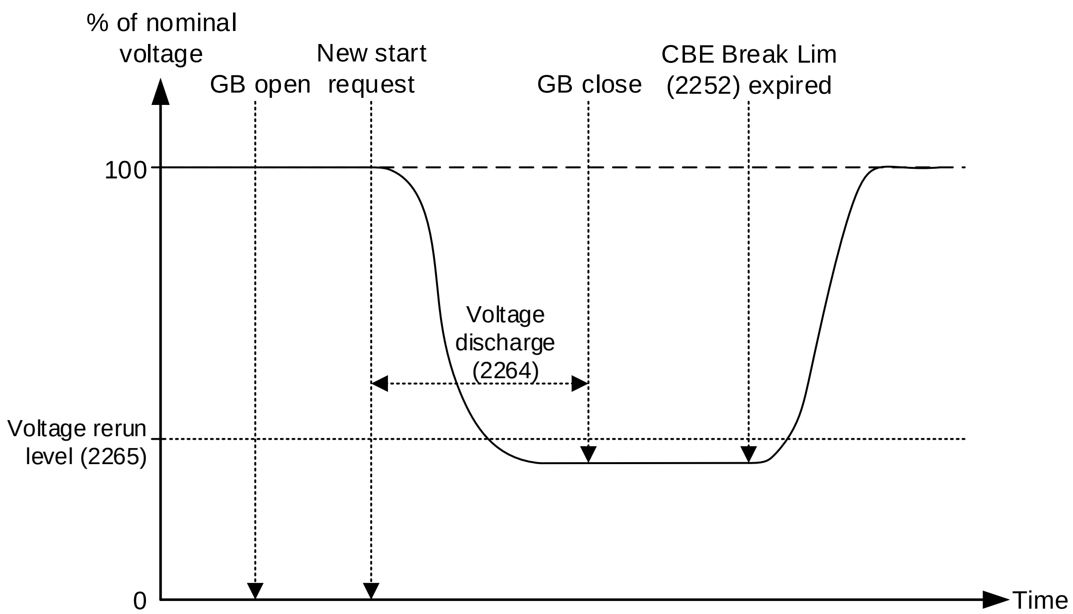
Parameter	Item	Range	Default	Note
2265	Voltage rerun level	30 % 100 %	30 %	Parameter is not shared between gensets!

Voltage discharge timer:
The timer can be found at parameter 2264 and represents how long time it takes from the excitation is removed until the voltage is below “voltage rerun level”. The voltage discharge timer can be started either from a new start request or from when the generator breaker opens. The different reactions are dependent on the

selection of “excitation control during cooldown”. The two rerun sequences shown below may enhance the understanding:



In the diagram above, the excitation is shut off as soon as the breaker is opened. Shortly after the breaker is opened, a new start request appears. The Multi-line 2 unit will wait with the closing of the GB until the “voltage discharge timer” has expired.



In the diagram above, the excitation is ON during cooldown. Then a new start request is made, which means that the excitation will be shut off. When the excitation is shut off, the voltage discharge timer starts. Comparing the two situations shows that the first example is the fastest. This is because the excitation is already off when the next start request appears. If the new start request had appeared a little later, the voltage discharge timer could already have expired. This means that the generator breaker could have closed very shortly after the new start request.

Parameter	Item	Range	Default	Note
2264	Voltage discharge timer	1.0 s 20.0 s	5.0 s	Parameter is not shared between gensets!

7.5 Separate synchronising relay

7.5.1 Separate synchronising relay

When the AGC 200 gives the synchronising command, the relays on terminal 17/18/19 (generator breaker) and terminal 11/12/13 (mains breaker) will activate, and the breaker must close when this relay output is activated.

This default function can be modified using a digital input and extra relay outputs depending on the required function. The relay selection is made in menu 2240, and the input is selected in the input settings in the utility software.

The table below describes the possibilities:

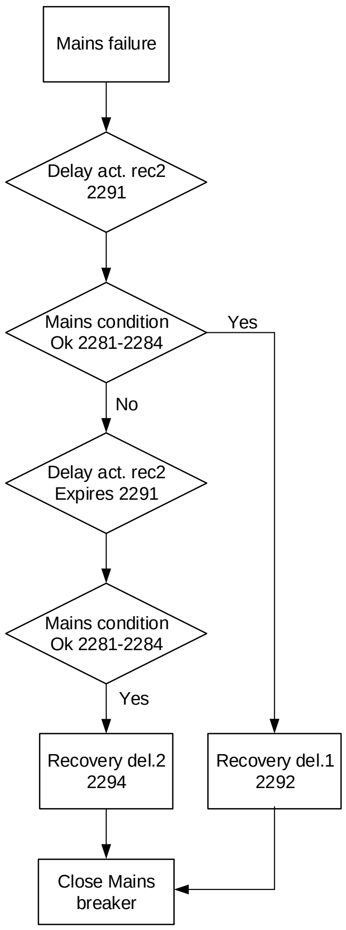
Input-Re-lays	Relay selected (Two relays used)	Relay not selected (One relay used)
Not used	**Synchronising:** The breaker ON relay and the sync. relay activate at the same time when synchronising is OK. **Blackout closing:** The breaker ON relay and the sync. relay activate at the same time when the voltage and frequency are OK.	**Synchronising:** The breaker ON relay activates when synchronising is OK. **Blackout closing:** The breaker ON relay activates when the voltage and frequency are OK. DEFAULT selection
Low	**Synchronising:** Not possible. **Blackout closing:** The breaker ON relay and the sync. relay activate at the same time when the voltage and frequency are OK.	**Synchronising:** Not possible. **Blackout closing:** The breaker ON relay activates when the voltage and frequency are OK.
High	**Synchronising:** The relays will activate in two steps when the synchronising is selected: 1. Breaker ON relay activates. 2. When synchronised, the sync. relay activates. *See note below!* **Blackout closing:** The breaker ON relay and the sync. relay activate at the same time when the voltage and frequency are OK.	**Synchronising:** Not possible. **Blackout closing:** The breaker ON relay activates when the voltage and frequency are OK.

When two relays are used together with the separate sync. input, then please notice that the breaker ON relay will be activated as soon as the GB ON/synchronising sequence is activated. Care must be taken that the GB ON relay cannot close the breaker, before the sync. signal is issued by the sync. relay.

The selected relay for this function must have the ”limit” function. This is adjusted in the I/O setup.

7.6 Inhibit conditions before synchronising mains breaker

This function is used to inhibit the synchronising of the mains breaker after blackout. After blackout, the timer in menu 2291 ("Delay activate recovery 2") will start to run, and if the mains voltage and frequency are inside the limits (2281/2282/2283/2284) before the timer runs out, the short interruption timer (menu 2292 "Recovery del. 1") will be started. When the timer has run out, the synchronising of the MB will start.



If the "Delay activate recovery 2" timer runs out, the long interruption timer (menu 2294 "Recovery del. 2") will start to run.

Examples:

Recovery timer 1 (short interruption timer)

Menu 2291 = 3 s
Menu 2292 = 5 s

That means: if the short interruption timer is set to $\leq$ 3 s, and the grid is back and voltage and frequency are inside the acceptable range stated above, then after 5 s the MB can be closed.

Recovery timer 2 (long interruption timer)

Menu 2291 = 3 s
Menu 2294 = 60 s

The long interruption timer will allow the MB to reconnect as soon as the mains voltage and frequency have been uninterrupted within the timer setting in menu 2294 ("Recovery del. 2"). Then the MB can be closed.

The inhibit parameters for synchronising the MB are disabled by default.

8. Engine communication

8.1 Engine communication

8.1.1 Engine communication

This function gives the possibility of communication between ML-2 and several engine types over the CAN-bus. AVR control is possible for selected digital voltage regulators.
The engine communication in the AGC 200 is the same as Option H5. When H5 is mentioned in the following pages, the information is also relevant for the engine communication for AGC 200.
The AGC 200 can be ordered with Option H13 (MTU ADEC module 501) which is a software option for the AGC 200.
The engine communication for AGC 200 is always on CAN port C (term. no. 13-15).

8.1.2 Modbus communication

If option H2 is present, it is possible to read engine data over the Modbus.

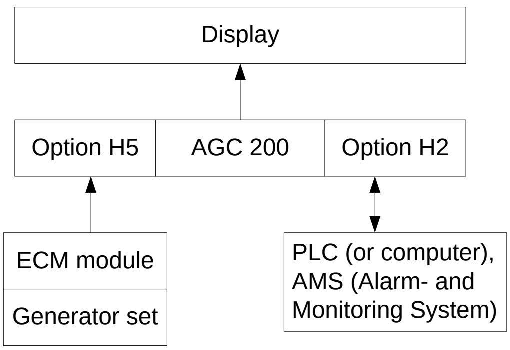
Please refer to the document ”Description of option H2”.

The Modbus data for the EIC relevant values are shown later in this chapter. Other Modbus data will have to be found at the "Description of option H2".

8.1.3 Wiring

For wiring details, please refer to the document ”Installation Instructions”.

8.1.4 Principle diagram



8.1.5 Setting up communication for AGC 200

The AGC 200 unit holds several CAN bus ports, so it is able to communicate with a lot of different components, in different scenarios.

The DVC 310 communicates via CAN bus on a J1939-based protocol. Many ECUs also communicate via a J1939-based protocol, which means that the AGC 200 unit can communicate to the ECU and DVC 310 via the same CAN bus port. If the AGC 200 unit is placed in an application with a DVC 310 and a CANopen-based ECU, the communication will have to be split into two different CAN bus ports on the unit. The CANopen-supported engine interfaces in the AGC 200 unit are MTU-MDEC and MTU-ADEC. Furthermore, the application can be a bit more complex if CIO modules are added into the system.

To give an overview of some of the combinations, the following examples can be helpful:

Description of setup:	**Settings:**
Analogue GOV DVC 310 (IOM 220/230)	● 2781 (Regulator output GOV): EIC ● 2783 (Regulator output AVR): EIC ● 7565 (Digital AVR interface): DEIF DVC 310 ● 7843 (CAN bus port C protocol): EIC
J1939-based ECU DVC 310	● 2781 (Regulator output GOV): EIC ● 2783 (Regulator output AVR): EIC ● 7561 (Engine interface): “Relevant J1939 protocol” ● 7565 (Digital AVR interface): DEIF DVC 310 ● 7843 (CAN bus port C protocol): EIC
J1939-based ECU DVC 310 DEIF CIO modules	● 2781 (Regulator output GOV): EIC ● 2783 (Regulator output AVR): EIC ● 7561 (Engine interface): “Relevant J1939 protocol” ● 7565 (Digital AVR interface): DEIF DVC 310 ● 7843 (CAN bus port C protocol): EIC ● 7891 (CIO enable): ON
Analogue GOV DVC 310 DEIF CIO modules (IOM 220/230)	● 2781 (Regulator output GOV): EIC ● 2783 (Regulator output AVR): EIC ● 7565 (Digital AVR interface): DEIF DVC 310 ● 7843 (CAN bus port C protocol): External modules DEIF ● 7891 (CIO enable): ON
CANopen-based ECU DVC 310 (DVC 310 mounted on CAN port B)	● 2781 (Regulator output GOV): EIC ● 2783 (Regulator output AVR): EIC ● 7561 (Engine interface): “Relevant CANopen protocol” ● 7565 (Digital AVR interface): DEIF DVC 310 ● 7842 (CAN bus port B protocol): DEIF DVC 310 ● 7843 (CAN bus port C protocol): EIC
CANopen-based ECU DVC 310 DEIF CIO modules (DVC 310 mounted on CAN port B) CIO modules mounted on CAN port C)	● 2781 (Regulator output GOV): EIC ● 2783 (Regulator output AVR): EIC ● 7561 (Engine interface): “Relevant CANopen protocol” ● 7565 (Digital AVR interface): DEIF DVC 310 ● 7842 (CAN bus port B protocol): DIGITAL AVR ● 7843 (CAN bus port C protocol): EIC ● 7891 (CIO enable): ON

When performing the initial setup of the DVC 310 with the EasyReg software, it is recommended not to have the CAN bus connected to the DVC 310.

8.2 Functional description

8.2.1 Electronic control module (ECM)

This communication extracts information from the Electronic Control Module (ECM) of an engine equipped with an ECM module with CANbus interface. The values can be used as display values, alarms/shutdown alarms and values to be transmitted through Modbus.

8.2.2 Engine types

Data can be transmitted between the ML-2 units and the following engine controllers/types:

Engine manufacturer	Engine controller/type	Comment	H5	H7	H12	H13
Caterpillar	ADEM III and A4/C4.4, C6.6, C9, C15, C18, C32	Rx/Tx	X	X	X	X
Cummins	CM 500/558/570/850/2150/2250, QSL, QSB5, QXL15 and 7, QSM11, QSK 19/23/50/60	Rx/Tx	X	X	X	X
Detroit Diesel	DDEC III and IV/Series 50, 60 and 2000	Rx/Tx	X	X	X	X
Deutz	EMR3[1], EMR 2 (EMR)/912, 913, 914 and L2011	Rx/Tx	X	X	X	X
-	Generic J1939	Rx/Tx	X	X	X	X
Iveco	EDC7 (Bosch MS6.2)/Series NEF, CURSOR and VECTOR 8	Rx/Tx	X	X	X	X
John Deere	JDEC/PowerTech M, E and Plus	Rx/Tx	X	X	X	X
MTU	MDEC, module M.302 or M.303/Series 2000 and 4000	Rx	X	-	X	X
MTU	MDEC, module M.201 or M.304/Series 2000 and 4000	Rx Select M. 303	X	-	X	X
MTU	ADEC/Series 2000 and 4000 MTU Px-Engines [2] (ECU7), with SAM module	Rx/Tx	X	X	X	X
MTU[1]	J1939 Smart Connect/Series 1600 (ECU8)	Rx/Tx	X	X	X	X
MTU[1]	ADEC/Series 2000 and 4000 (ECU7), without SAM module (software module 501)	Rx/Tx	-	-	-	X
Perkins	Series 850, 1100, 1200, 1300, 2300, 2500 and 2800.	Rx/Tx	X	X	X	X
Scania	EMS	Rx	X	X	X	X
Scania	EMS S6 (KWP2000)/Dx9x, Dx12x, Dx16x	Rx/Tx	X	X	X	X
Volvo Penta	EDC4	Rx Select EMR 2	X	X	X	X
Volvo Penta	EMS	Rx	X	X	X	X
Volvo Penta	EMS 2 and EDCIII/D6, D7, D9, D12 and D16 (GE and AUX variants only)	Rx/Tx	X	X	X	X

Rx/Tx: Please go to the section "Specific engine type descriptions" for details of data read and write.

For support of controller/engine types not listed, please contact DEIF A/S.

Protocols marked [1] do not apply to PPM-3.

The enigne type PX engines marked[2] requires the MTU SAM module is with updated J1939 protocol supporting DM1/DM2.

The parameter for setting the engine interface is shown in the table below:

Parameter	Item	Range	Default	Note
7561	Engine interface selection	OFF MTU Smart connect	OFF	Only in genset

8.2.3 AVR types

Data can be transmitted between the ML-2 units and the following AVRs

Engine manufacturer	AVR Types	Comment
Caterpillar	CDVR	Tx

AVR control requires option D1 in combination with option H5, H7 or H13.

AVR control only applies to AGC-3, AGC-4, GPC-3, PPU-3 and GPU-3.

The parameter for setting the AVR interface is shown in the table below:

Parameter	Item	Range	Default	Note
7565	AVR interface selection	OFF Caterpillar CDVR	OFF	Only in genset

8.2.4 Communication system

All these protocols are based on a CANbus communication system. Except for the MDEC and ADEC communication, all of them are based on the J1939. The MDEC and ADEC protocols are MTU-designed protocols. The Baud rate is fixed by the engine manufacturer at:

MDEC, ADEC	Caterpillar, Cummins, Detroit Diesel, Deutz, Iveco, John Deere, Perkins, MTU J1939 Smart Connect[1], Scania and Volvo Penta
125 kb/s	250 kb/s

Protocols marked [1] do not apply to PPM-3

8.2.5 EIC unit

The selection of the EIC unit (menu 10970) determines whether bar/Celsius or PSI/Fahrenheit is used. The selection affects display readings, values used for alarm evaluation (menu 76xx) and data readable by Modbus communication (option H2/N).

The parameter for setting the EIC units is shown in the table below:

Parameter	Item	Range	Default	Note
10970	EIC unit selection	bar/Celsius PSI/Fahrenheit	bar/Celsius	Only in genset. Can only be changed from the Utility Software.

8.2.6 Common for alarm functions

A number of alarms can be configured.

The following items can be configured to an alarm:

Menu number	Alarm	Comment
7570	EI comm. error	Communication error
7580	EIC warning	Any alarm listed as warning for the selected engine type in the section "Specific engine type descriptions".
7590	EIC shutdown	Any alarm listed as shutdown for the selected engine type in the section "Specific engine type descriptions".
7600	EIC overspeed	Actual RPM
7610/7620	EIC coolant t. (2 levels)	Actual temperature
7630/7640	EIC oil press. (2 levels)	Actual pressure
7650/7660	EIC oil temp. (2 levels)	Actual temperature
7670/7680	EIC coolant level (2 levels)[1]	Actual cooling water level

Alarms marked [1] do not apply to PPM-3.

8.2.7 J1939 measurement table

This is the common J1939 measurement overview showing which measurements are available. Note that not all measurements are supported by the individual engines; please refer to the specific engine description.

The table below shows which values can be displayed in the view menu. That is in V1, V2 and V3.

For information about the menu structure, please see the "Designer's Reference Handbook".

The display values corresponding to the engine communication have a description beginning with "EIC".

Error messages:

The following error messages can occur:

Message	Description
Engine I. value N.A.	The view is not selectable for the present engine type.
Value selected error	The value cannot be read due to sensor error, sub-system or module error.
"N.A."	The value is not supported by the engine, or due to communication error.

Object selection, J1939:
The view lines can be configured with these available values.

For Modbus scaling, please see the chapter "Modbus communication".

The engine is by default settings expected to use source address 0 which is also the most commonly used setting on ECUs. If a different source address is required, it can be changed in parameter 7562.

Object	PGN (Dec/Hex)	S	L	P	SPN	Unit	J1939-71 scaling
EngineAuxShutdownSW, MLogic[9]	61441/F001	4.5	2 bits	6	970	0..3	4 states/2 bit, 0 offset
EIC acc. pedal pos.	61443/F003	2	1	3/6	91	%	0.4%/bit, offset 0
EIC % load, c. speed	61443/F003	3	1	3/6	92	%	1%/bit, offset 0
EIC d.d.% torque	61444/F004	2	1	3/6	512	%	1%/bit, offset -125%
EIC actual % torque	61444/F004	3	1	3/6	513	%	1%/bit, offset -125%
EIC speed	61444/F004	4	2	3/6	190	rpm	0.125 rpm/bit, offset 0
AT1IntTNOx [9]	61454/F00E	1	2	6	3216	ppm	0.05 ppm/bit, -200 ppm offset
AT1OutLNOx [9]	61455/F00F	1	2	6	3226	ppm	0.05 ppm/bit, -200 ppm offset
AT2IntTNOx [9]	61456/F010	1	2	6	3255	ppm	0.05 ppm/bit, -200 ppm offset
AT2OutLNOx [9]	61457/F011	1	2	6	3265	ppm	0.05 ppm/bit, -200 ppm offset
AT1ExhFA.DQ [9]	61475/F023	1	2	3	4331	g/h	0.3 g/h per bit, 0 offset
AT1ExhFluDAB [9]	61475/F023	6	1	3	4334	kPa	8 kPa/bit, 0 offset
AT1ExhFluDRQ [9]	61476/F024	1	2	6	4348	g/h	0.3 g/h per bit, 0 offset
AT2ExhFA.DQ [9]	61478/F026	1	2	3	4384	g/h	0.3 g/h per bit, 0 offset
AT2ExhFluDAB [9]	61478/F026	6	1	3	4387	kPa	8 kPa/bit, 0 offset
AT2ExhFluDRQ [9]	61479/F027	1	2	3	4401	g/h	0.3 g/h per bit, 0 offset
Next Regen [9]	64697/FCB9	1	4	6	5978	s	1 s/bit
AT2SCRCInG [9]	64824/FD38	1	2	6	4413	°C	0.03125 deg C/bit, -273 deg C offset
AT2SCRCOuG [9]	64824/FD38	4	2	6	4415	°C	0.03125 deg C/bit, -273 deg C offset
AT2ExhFlu DT [9]	64827/FD3B	3	1	6	4390	°C	1 deg C/bit, -40 deg C offset
AT1SCRCInG [9]	64830/FD3E	1	2	5	4360	°C	0.03125 deg C/bit, -273 deg C offset
AT1SCRCOuG [9]	64830/FD3E	4	2	5	4363	°C	0.03125 deg C/bit, -273 deg C offset

Object	PGN (Dec/Hex)	S	L	P	SPN	Unit	J1939-71 scaling
AT1ExhFlu DT [9]	64833/FD41	3	1	6	4337	°C	1 deg C/bit, -40 deg C offset
EngOperatingState [9]	64914/FD92	1.1	4 bits	3	3543	0..15	16 states/4 bit, 0 offset
EngineAT1Regenera-tionStatus, MLogic[9]	64929/FDA1	7.5	2 bits	6	3483	0..3	4 states/2 bit, 0 offset
DPF OUTL T [9]	64947/FDB3	3	2	6	3246	°C	0.03125 deg C/bit, -273 deg C offset
EIC Air filter diff. pres-sure	64976/FDD0	1	1	6	2809	bar	0.05 kPa, offset 0
EIC Intake manifold #1 absolute pressure[1]	64976/FDD0	5	1	6	3563	bar	2 kPa/bit
Sp.Humidity [9]	64992/FDE0	3	2	6	4490	g/kg	0.01 g/kg per bit, 0 offset
EIC Exhaust gas temp. R manifold[2]	65031/FE07	1	2	6	2433	°C	0.03125ºC/bit, offset -273°C
EIC Exhaust gas temp. L manifold[2]	65031/FE07	3	2	6	2434	°C	0.03125ºC/bit, offset -273°C
DEF LEVEL [9]	65110/FE56	1	1	6	1761	%	0.4 %/bit, 0 offset
AT1ExhFluTank deg[9]	65110/FE56	2	1	6	3031	°C	1 deg C/bit, -40 deg C offset
bScrOprInducementActi-veLamp, MLogic[9]	65110/FE56	5.6	3 bits	6	5245	0 to 7	8 states/3 bit, 0 offset
SCR IND. SEV. [9]	65110/FE56	6.6	3 bits	6	5246	0 to 7	8 states/3 bit, 0 offset
No view, for Coolant wa-ter regulation[9]	65129/FE69	3	2	6	1637	°C	0.03125 deg C/bit, -273 deg C offset
EIC Fuel supply pump inlet pressure	65130/FE6A	2	1	6	1381	bar	2 kPa/bit offset 0
EIC Fuel filter (ss) diff. pressure	65130/FE6A	3	1	6	1382	bar	2 kPa/bit offset 0
EngineFuelLeak1, MLo-gic[9]	65169/FE91	1	2	7	1239	bit	00 no leakage de-tect. 01 leakage detect.
AuxCool Pr. [9]	65172/FE94	1	1	6	1203	kPa	4 kPa/bit gain, 0 kPa offset
T. Cool Aux [9]	65172/FE94	2	1	6	1212	°C	1 °C/bit gain, −40 °C offset
Tcharger 2 [9]	65179/FE9B	2	2	7	1169	rpm	4 rpm/bit gain, 0 rpm offset

Object	PGN (Dec/Hex)	S	L	P	SPN	Unit	J1939-71 scaling
Tcharger 3 [9]	65179/FE9B	4	2	7	1170	rpm	4 rpm/bit gain, 0 rpm offset
T-ECU [9]	65188/FEA4	3	2	6	1136	°C	0.03125 °C/bit gain, −273 °C offset
Intake Man T2 [9]	65189/FEA5	1	1	7	1131	°C	1 °C/bit gain, −40 °C offset
EIC trip fuel gaseous	65199/FEAF	1	4	7	1039	kg	0.5 kg/bit, offset 0
EIC total fuel used gaseous	65199/FEAF	5	4	7	1040	kg	0.5 kg/bit, offset 0
EIC Mean trip fuel consumption[1]	65203/FEB3	5	2	7	1029	l/h	0,05 [l/h]/bit
Est. Fan RPM [9]	65213/FEBD	1	1	6	975	%	0.4%/bit gain, 0% offset
EIC Nominal Power[1]	65214/FEBE	1	2	7	166	kW	0,5 kW/bit
Diagnostic message 1/2	65226/FECA	-	-	3/6/7	-	-	-
EIC faults[8]	65230/FECE	1	1	6	1218	-	1/bit, offset 0
Tcharger 1 [9]	65245/FEDD	2	2	6	103	rpm	4 rpm/bit gain, 0 rpm offset
Nom. Friction [9]	65247/FEDF	1	1	6	514	%	1%/bit gain, −125% offset
Desired [9]	65247/FEDF	2	2	6	515	rpm	0.125 rpm/bit gain, 0 rpm offset
EngineWaitToStart, Mlogic[9]	65252/FEE4	4.1	2 bits	6	1081	bit	00 off 01 on
EngineProtectSysShutdown, MLogic[9]	65252/FEE4	5.1	2 bits	6	1110	bit	00 yes 01 no
EngineProtectSysAproShutdown, MLogic[9]	65252/FEE4	5.3	2	6	1109	bit	00 not approaching 01 approaching
EngineAlarmAcknowledge, MLogic[9]	65252/FEE4	7.1	2 bits	6	2815	0..3	4 states/2 bit, 0 offset
EngineAirShutoffCommandStatus, MLogic[9]	65252/FEE4	7.5	2 bits	6	2813	0..3	4 states/2 bit, 0 offset
EngineOverspeedTest, MLogic[9]	65252/FEE4	7.7	2 bits	6	2812	0..3	4 states/2 bit, 0 offset
EngineShutoffStatus, MLogic[9]	65252/FEE4	8.3	2 bits	6	5404	0..3	4 states/2 bit, 0 offset
EIC engine hours	65253/FEE5	1	4	6	247	h	0.05 hrs/bit, offset 0, max: 32767 hrs

Object	PGN (Dec/Hex)	S	L	P	SPN	Unit	J1939-71 scaling
EIC engine trip fuel	65257/FEE9	1	4	6	182	L	0.5 L/bit, offset 0
EIC engine total fuel used	65257/FEE9	5	4	6	250	L	0.5 L/bit, offset 0
EIC coolant temp.[5]	65262/FEEE	1	1	3/6	110	°C	1 deg C/bit, offset -40°C
EIC fuel temp.	65262/FEEE	2	1	3/6	174	°C	1°C/bit, offset -40°C
EIC oil temp.[7]	65262/FEEE	3	2	3/6	175	°C	0.03125°C/bit, offset -273°C
EIC turbo oil temp.	65262/FEEE	5	2	3/6	176	°C	0.03125°C/bit, offset -273°C
EIC Intercooler tempera-ture[2]	65262/FEEE	7	1	3/6	52	°C	1°C/bit, offset -40°C
EIC fuel del. press.	65263/FEEF	1	1	6	94	bar	4 kPa/bit, offset 0
EIC oil level	65263/FEEF	3	1	6	98	%	0.4%/bit, offset 0
EIC oil pressure[6]	65263/FEEF	4	1	6	100	bar	4 kPa/bit, offset 0
EIC crankcase press.	65263/FEEF	5	2	6	101	bar	1/128 kPa/bit, offset -250 kPa
EIC coolant pressure	65263/FEEF	7	1	6	109	bar	2 kPa/bit, offset 0
EIC coolant level	65263/FEEF	8	1	6	111	%	0.4%/bit, offset 0
EIC fuel rate	65266/FEF2	1	2	6	183	l/h	0.05 l/h per bit, offset 0
EIC atmospheric press.	65269/FEF5	1	1	6	108	bar	0.5 kPa/bit, offset 0
EIC ambient air temp.	65269/FEF5	4	2	6	171	°C	0.03125°C/bit, offset -273°C
EIC air inlet temp.	65269/FEF5	6	1	6	172	°C	1°C/bit, offset -40°C
EIC particulate trap inlet	65270/FEF6	1	1	6	81	bar	0.5 kPa/bit, offset 0
EIC intake manifold #1 P.[3]	65270/FEF6	2	1	6	102	bar	2 kPa/bit, offset 0
EIC intake manifold 1 temp.[4]	65270/FEF6	3	1	6	105	°C	1°C/bit, offset -40°C

Object	PGN (Dec/Hex)	S	L	P	SPN	Unit	J1939-71 scaling
EIC air inlet pressure	65270/FEF6	4	1	6	106	bar	2 kPa/bit, offset 0
EIC air filter diff.	65270/FEF6	5	1	6	107	bar	0.05 kPa/bit, offset 0
EIC exhaust gas temp.	65270/FEF6	6	2	6	173	°C	0.03125°C/bit, offset -273°C
EIC coolant filter diff.	65270/FEF6	8	1	6	112	bar	0.5 kPa/bit, offset 0
EIC key switch battery potential	65271/FEF7	7	2	6	158	V DC	0.05V DC/bit, offset 0
EIC Fuel filter diff. pressure[2]	65276/FEFC	3	1	3/6	95	bar	2 kPa/bit. 0 offset
EIC oil filter diff. press.	65276/FEFC	4	1	3[1]/6	99	bar	0.5 kPa/bit, offset 0
EIC water in. fuel	65279/FEFF	1	2	6	97	-	00: No, 01: Yes, 10: Error, 11: Not available

PGN: Parameter group number
SPN: Suspect parameter number
P: J1939 priority
S: Object's start byte in CAN telegram
L: Object's length is normally written as byte, exceptions of length are written as "bit"
Unit: Unit in display (Bar/°C can be changed to PSI/°F)

Objects marked [1] do not apply to PPM-3.

Objects marked [2] only apply to AGC-4, AGC 200 and AGC PM.

Objects marked [3] also called EIC boost P.

Objects marked [4] also called EIC charge air temp.

Objects marked [5] EIC coolant temp.: PGN = 65282, priority = 6, start at byte 5, length = 1 byte, SPN = 110, same scale (only Iveco Vector 8 type)

Objects marked [6] EIC oil pressure. PGN = 65282, priority = 6, start at byte 7, length = 1 byte, 8 kPa/bit gain, 0 kPa offset, data range: 0 to +2000 kPa (only Iveco Vector 8 type)

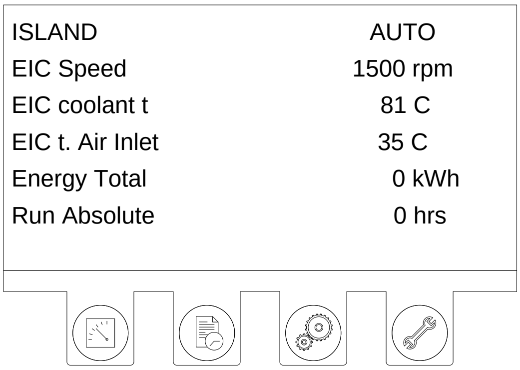
Objects marked [7] EIC oil temp.: PGN=65282, priority = 6, start at byte 6, length = 1byte, SPN = 175, same scale (only Iveco Vector 8 type)

Objects marked [8] EIC Faults: PGN=65284, priority = 6, start at byte 1, length = 2 byte (only MTU smart connect)

Objects marked [9] not supported by option H7

8.2.8 Engine values in display unit/autoview

It is possible to parameterise the AGC so all analogue values from the engine CANbus is shown in the display unit. This is an example where speed, inlet air and coolant temp. is shown. The number of available views is 20 views. The number can be increased with the auto view function.



The AGC is set up in one of two ways:

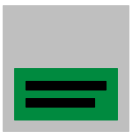
1. Use the function of the PC Utility SW: “configuration of the user views”. In this way, the 20 three-line views can be configured to show the desired.A total of 20 views is displayed (unless fewer is set up).
2. Use the auto view function in the communication setup. (Menu number 7564.) In this way, the 20 three-line views are kept with their present setup and all engine values are added to the list of the 20 three-line views. A total of 20+14 three-line views are available. The 20 lines are user-configurable but the 14 additional lines are dedicated to EIC values and cannot be modified by the user

The first option is useful when a few EIC values need to be shown and if all off the 20 user- configurable views are not already used to display requested values.

The second option is useful if it is requested to read all available EIC data from the ECU. It must be noted that all available data is shown when using this method until the additional 14 views are used. The number of extra display views depends on the available data from the specific engine controller connected to the controller.

Configuration of user views:

This configuration is done in PC Utility Software by pressing the user view icon in the horizontal toolbar



Activation of autoview:

The extra view lines are displayed if the menu 7564 ig switched to "ON" and the engine CANbus is active. Note that is might be necessary to start the engine before switching 7564 to "ON". The setting automatically returns to "OFF".

To de-activate the auto view function please follow below steps:
1. Adjust Engine I/F type to "OFF" (menu 7561)
2. Adjust EIC AUTOVIEW to "ON" (menu 7564)
3. Adjust EIC AUTOVIEW to "OFF" (menu 7564)
   (The menu is not reset automatically when no engine is selected)

The parameter for the autoview is shown below:

Parameter	**Item**	**Range**	**Default**	**Note**
7564	Autoview enable	OFF ON	OFF	Only in genset. Note that it automatically switches to OFF again.

8.2.9 Verification of J1939 objects

To verify the communication, various CAN PC tools can be used. Common for these are that they must be connected to the CANbus between the Multi-line 2 unit and the engine controller. When the tool is connected, it is possible to monitor the communication between the two units. For use of the CAN tool, please refer to the manual for the product used.

As an example, you may see the following telegram:

0xcf00400 ff 7d 7d e0 15 ff f0 ff
DATA BYTE: 1 2 3 4 5 6 7 8

- 0xc is the priority
- f004 is the PGN number (61444 in decimal value)
- The 8 bytes following the CAN ID (**0xcf00400**) are data, starting with byte 1

The priority needs to be converted to decimal. Note that the 3 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 e.g. 0x18fef200 (PGN 65266).

The formula to find the priority number (P) is to divide by 4:

0xc = 12 (Dec) => Priority 3

Priority	Decimal ID	Hexadecimal ID
1	4d	0x4
2	8d	0x8
3	12d	0xc
4	16d	0x10
5	20d	0x14
6	24d	0x18

Normally in SAE J1939, only priority 3 and 6 are used.

Hereafter the data can be read (PGN 61444):

0xcf00400 xD ff 7d 7d e0 15 ff f0 ff

Engine torque	(Data byte 1)	ff	Not available
Driver demand torque	(Data byte 2)	7d	
Actual engine torque	(Data byte 3)	7d	
Engine speed	(Data byte 4)	e0	
Engine speed	(Data byte 5)	15	
Source address	(Data byte 6)	ff	Not available
Engine starter mode	(Data byte 7)	f0	
Engine Demand	(Data byte 8)	ff	Not available

Calculation example:

RPM resolution is 0.125 RPM/bit, offset 0.
The result is then 15e0 (Hex) or 5600 (dec)*0.125 = 700 RPM.

8.2.10 Displaying of J1939 DM1/DM2, Scania KWP2000 and Caterpillar/ Perkins alarms

Besides some engine specific alarms, which are shown in the standard alarm list, the J1939 diagnostic messages DM1 (active alarms) and DM2 (historic alarm log list) as well as the Scania KWP 2000 alarms can all be shown on the display. In both cases, the alarms are accessed through the LOG list.

Press to enter the list:

MAINS FAILURE
Event log
Alarm log
Battery test log
EIC DM1 alarms
EIC DM2 alarms

Use the and buttons to scroll through the list, and select the alarm log you wish to see by pressing .For DM1 and DM2, the SPN (Suspect Parameter Number) and FMI (Failure Mode Indicator) will be shown along with a clear text.

In the DM2 list, if you wish to acknowledge, the entire alarm log list will be cleared. For safety reasons, this requires the master password (please see the password description in this document for details of passwords).

If the controller has no translation text of an SPN diagnostic number, “Text N/A.” will be shown. For information about particular SPN numbers, please 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 and buttons to scroll through the list.

Under the "KWP 2000 diagnostic" title in the log list, there is a title called "KWP 2000 clear all". If you choose this, the entire alarm log list will be cleared. For safety reasons, this requires the master password (please see the password description in this document for details of passwords).

Caterpillar/Perkins

Press the button for 2 seconds. That will bring the alarm log on the display. Caterpillar and Perkins have a primary and a secondary DM1 log as well as one DM2 log.

The primary DM1 log shows alarms from the ADEM III/IV engine controllers. The secondary DM1 log shows alarms from the EMCP 3.x genset controller. Similar to the J1939 protocol, the DM2 log shows the historical alarms. Use the and buttons to scroll through the list.

CLRALL: By pressing , the entire alarm log list will be cleared. For safety reasons, this requires the master password.

8.2.11 Control commands sent to the engine

The table below shows the engine types with the possibility to send commands to the ECM via the CANbus communication line.
Necessary options for these commands are option H5, H7, H12.

Engine type / Command	Detroit Diesel DDEC	John Deere JDEC	Cater-pillar	Per-kins	Cum-mins	Generic J1939	Deutz EMR	Iveco	Iveco Vector 8
Preheat	-	-	-	-	-	-	-	-	-
Start/Stop	-	-	X[1, 5]	X[1, 5]	-	-	-	-	-
Run/Stop (fuel)	-	-	-	-	X[4]	-	-	-	-
Speed Bias	X	X	X	X	X[1, 2]	X[1]	X	X	X
Nominal fre-quency	-	-	-	-	X	-	-	-	-
Governor gain	-	-	-	-	X	-	-	-	-
Idle speed	X[1]	X[1]	X[1]	X[1]	X	X[1]	X[1]	X[1]	-
MTU Alternate Droop Setting (M-Logic)	-	-	X[1]	X[1]	X	-	-	-	-
Shutdown override	-	-	-	-	X	-	-	-	-
Engine over-speed test	-	-	-	-	-	-	-	-	-
Enable cylinder cut out	-	-	-	-	-	-	-	-	-
Intermittent oil priming	-	-	-	-	-	-	-	-	-
Engine operat-ing mode	-	-	-	-	-	-	-	-	-
Demand switch	-	-	-	-	-	-	-	-	-
Trip counter re-set	-	-	-	-	-	-	-	-	-
Engine speed GOV parame-ter command	-	-	-	-	-	-	-	-	-

Engine type Command	MTU MDEC	MTU ADEC	MTU ADEC M501	MTU J1939 Smart Connect	Scania EMS	Scania EMS S6	Volvo Penta	Volvo Penta EMS 2
Preheat	-	-	-	-	-	-	-	X
Start/Stop	-	X	X	X[1, 5]	-	X	-	X
Run/Stop (fuel)	-	-	-	-	-	-	-	-
Speed Bias	-	X	X	X[1,5]	-	X	-	X
Nominal frequency	-	X	X	X[1]	-	X	-	X
Governor gain	-	-	-	-	-	-	-	-
Idle speed	-	X[1]	X[1]	X[1]	-	X	-	X
MTU Alternate Droop Setting (M-Logic)	-	X[1]	X[1]	X[1,5]	-	X	-	X
Shutdown override	-	X[1]	X[1]	X[1]	-	X	-	X[1]
Engine overspeed test	-	-	-	X[1]	-	-	-	-
Enable cylinder cut out	-	X[1]	X[1]	X[1]	-	-	-	-
Intermittent oil priming	-	-	-	X[1]	-	-	-	-
Engine operating mode	-	-	-	X[1]	-	-	-	-
Demand switch	-	X[1]	X[1]	X[1]	-	-	-	-
Trip counter reset	-	X[1]	X[1]	X[1]	-	-	-	-
Engine speed GOV parameter command	-	-	-	X[1]	-	-	-	-
Reset trip fuel value	X[3]	-	-	-	-	-	-	-

For engine types not mentioned, CANbus control is not supported. In these cases start/stop etc. must be sent to the controller using hardwired connections.

The menu number 7563 has to be used for enabling or disabling the transmission of all the Multi-line 2 unit EIC control frames listed in the above table.

Commands marked X[1] do not apply to PPM-3.

Commands marked X[2] do not apply to AGC 100, CGC 400, GC-1F and GC-1F/2.

Commands marked X[3] only apply to AGC-4, AGC 200 and AGC PM together with MDEC 303.

Commands marked X^4 only apply to Cummins CM570 ECU.

Commands marked X^5 not possible with option H7.

Option H7 does not support ECU9

The table below shows the parameter to set ON, if the engine is to be controlled from the Multi-line 2 unit:

Parameter	Item	Range	Default	Note
7563	EIC control	OFF ON	OFF	Only in genset.

EIC 50 Hz - 60 Hz switch:
If the set point $f_{nominal}$ is changed in the ML-2 between 50 and 60 Hz then the change is made with a frequency ramp of 2 Hz per second. This frequency ramp is used when switching between nominal settings 1-4 or if the parameter of the nominal frequency is changed between 50 and 60 Hz.

EIC droop:
There are two ways of obtaining a speed droop:

For engines where the droop command or setpoint can be sent to the engine controller, the droop setting in parameter 2771 is the actual droop that is being used and this setpoint is sent to the ECU. This method is referred to as "EIC droop".

For engines where the droop command or setpoint cannot be sent to the engine controller, the droop setting in parameter 2771 is used for droop emulation in the ML-2. This method is referred to as "EIC droop emulation". EIC droop emulation is a generic function developed by DEIF which it is possible to use on every engine type.

In both cases, the droop function is activated in the M-Logic (EIC droop/EIC droop emulation) command output.

In the table below, it is shown which engine types support EIC droop with a command or setpoint.

Engine type/protocols	Command	Setpoint
Scania	X	X
Cummins	X	X
Iveco	X	-
Perkins	X	-
Caterpillar	X	-
Volvo	X	-
MTU	-	-
DDEC (Detroit Diesel)	-	-
JDEC (John Deere)	-	-
EMR (Deutz)	-	-
Generic J1939	-	-

The parameters for the EIC Droop command and setpoints are shown in the table below:

Parameter	Item	Range	Default	Note
2771	EIC Droop	0.0 % 25.0 %	0.0 %	Only in genset.
2772	Scania RPM	User Low idle	User	Only in genset.
2773	Cummins gain- Kp	0.00 10.0	5.00	Only in genset.

EIC inhibit:
The EIC alarms can be inhibited through M-Logic. This would typically be necessary during stopping of the engine. The following alarm can be inhibited:

- EIC red alarm
- EIC yellow alarm
- EIC malfuction
- EIC protection

EIC Idle:
The "Idle" function of the ML-2 is activated in menu 6290. If this is used with engines whit speed control from CAN bus communication the speed is defined to be 700 rpm.

TSC1 SA "Torque Speed Control":
TSC1 which is "Torque Speed Control 1" is the speed bias control signal transmitted from the DEIF controller towards the engine ECU. The DEIF controller will choose the expected source address for known protocols when parameter 7566 is set to -1 (default value). It is possible to change parameter 7566 to a specific source address. Consult your engine manufacturer verification of TSC1 source address if in doubt. TSC1 is only relevant for J1939 protocols.

8.3 Specific engine type description

8.3.1 About type descriptions

The J1939 warnings/shutdowns with corresponding SPN and FMI numbers in this chapter refer to those that will automatically appear in the alarm list. The alarms can be acknowledged from the display.

The available alarms vary from engine type to engine type. Besides these, the entire log list can be read in the engine controller by holding the "LOG"/ button for 3 seconds.

8.3.2 Caterpillar/Perkins (J1939)

Object selection:

The view lines can be configured with these available values.

For Modbus scaling, please see the chapter "Modbus communication".

EIC Exhaust Gas P1...P16 are fixed to the source address 241. The remaining entries in the below table are fixed to source address 0.

Object	PGN	P	S	L	SPN	Unit	J1939-71 scaling
EIC Exhaust Gas P1 Temp	65187	7	1	2	1137	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P2 Temp	65187	7	3	2	1138	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P3 Temp	65187	7	5	2	1139	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P4 Temp	65187	7	7	2	1140	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P5 Temp	65186	7	1	2	1141	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P6 Temp	65186	7	3	2	1142	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P7 Temp	65186	7	5	2	1143	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P8 Temp	65186	7	7	2	1144	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P9 Temp	65185	7	1	2	1145	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P10 Temp	65185	7	3	2	1146	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P11 Temp	65185	7	5	2	1147	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P12 Temp	65185	7	7	2	1148	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P13 Temp	65184	7	1	2	1149	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P14 Temp	65184	7	3	2	1150	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P15 Temp	65184	7	5	2	1151	°C	0.03125 °C/bit, -273°C offset
EIC Exhaust Gas P16 Temp	65184	7	7	2	1152	°C	0.03125 °C/bit, -273°C offset
EIC Coolant Temp 2	64870	6	1	1	4076	°C	1 °C/bit, -40 °C offset
EIC Coolant Temp 3	64870	6	8	1	6209	°C	1 °C/bit, -40 °C offset
EIC Coolant Pump Outlet Temp	64870	6	2	1	4193	°C	1 °C/bit, -40 °C offset
EIC Filtered Fuel Delivery Pressure	64735	6	2	1	5579	kPa	4 kPa/bit, 0 offset
EIC Auxiliary Coolant Temp	65172	6	2	1	1212	kPa	4 kPa/bit, 0 offset
EIC Turbo 1 Intake Temp	65176	6	1	2	1180	°C	0.03125 °C/bit, -273°C offset
EIC Turbo 2 Intake Temp	65176	6	3	2	1181	°C	0.03125 °C/bit, -273°C offset

PGN: Parameter group number
P: J1939 priority
S: Object's start byte in CAN telegram
L: Object's length (byte)
Unit: Unit in display (Bar/°C can be changed to PSI/°F)

The table above only applies for AGC-4, AGC 200 and AGC PM.

Readings from display:

SAE name	Displayed text
Engine Exhaust Gas Port 1 Temperature	Exh.P T01
Engine Exhaust Gas Port 2 Temperature	Exh.P T02
Engine Exhaust Gas Port 3 Temperature	Exh.P T03
Engine Exhaust Gas Port 4 Temperature	Exh.P T04
Engine Exhaust Gas Port 5 Temperature	Exh.P T05
Engine Exhaust Gas Port 6 Temperature	Exh.P T06
Engine Exhaust Gas Port 7 Temperature	Exh.P T07
Engine Exhaust Gas Port 8 Temperature	Exh.P T08
Engine Exhaust Gas Port 9 Temperature	Exh.P T09
Engine Exhaust Gas Port 10 Temperature	Exh.P T10
Engine Exhaust Gas Port 11 Temperature	Exh.P T11
Engine Exhaust Gas Port 12 Temperature	Exh.P T12
Engine Exhaust Gas Port 13 Temperature	Exh.P T13
Engine Exhaust Gas Port 14 Temperature	Exh.P T14
Engine Exhaust Gas Port 15 Temperature	Exh.P T15
Engine Exhaust Gas Port 16 Temperature	Exh.P T16
Engine Coolant Temperature 2	T. Coolant2
Engine Coolant Temperature 3	T. Coolant3
Engine Coolant Pump Outlet Temperature	T. Cool PO
Engine Filtered Fuel Delivery Pressure	P. FilFuel
Engine Auxiliary Coolant Temperature	T. Cool Aux
Engine Turbocharger 1 Turbine Intake Temperature	Turb.int1
Engine Turbocharger 2 Turbine Intake Temperature	Turb.int2

Warnings and shutdowns:

Warning/shutdown list	J1939 codes		
	SPN	FMI warning	FMI shutdown
Low oil pressure	100	17	1
Intake manifold #1 P	102	15	-
Coolant temperature	110	15	1
High inlet air temp.	172	15	-
Fuel temperature	174	15	-
Overspeed	190	15	0
EIC yellow lamp	-	X	-
EIC red lamp	-	-	X
EIC malfunction[1]	-	X	-
EIC protection[1]	-	X	-

FMI indication " – " means that the alarm in question is not supported.

Warnings and shutdowns marked [1] do not apply to PPM-3.

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (ex: speed, start/stop, etc.) are enabled in setting 7563 (EIC Controls).
- Engine speed
  CANbus ID for speed control: 0x0c000000. J1939 TSC1.
- M-Logic commands are available to enable/disable start/stop and speed controls
  - EIC start/stop enable[1]
  - EIC speed control inhibit[1]

The speed regulation is enabled in setting 2781 (Reg. output) and 7563 (EIC Controls).

Commands marked [1] do not apply to PPM-3.

Write commands to AVR:

- AVR control
  All write commands to the AVR (voltage control) are enabled in menu 7563 (EIC controls). If engine controls are needed but not the AVR control the latter can be disabled through menu 7565.

Write commands to AVR only applies to AGC-3, AGC-4, AGC 200 and AGC PM, GPC-3, PPU-3 and GPU-3.

8.3.3 Cummins CM850-CM570 (J1939)

Warnings and shutdowns:

Warning/shutdown list	J1939 codes		
	SPN	FMI warning	FMI shutdown
Low oil pressure	100	18	1
Coolant temperature	110	16	0
Oil temperature	175	16	0
Intake manifold temp	105	16	0
Fuel temperature	174	16	0
Coolant level low	111	18	1
Overspeed	190	-	16
Crankcase pressure high	101	-	0
Coolant pressure low	109	-	1
EIC yellow lamp	-	X	-
EIC red lamp	-	-	X
EIC malfunction[1]	-	X	-
EIC protection[1]	-	X	-

FMI indication " – " means that the alarm in question is not supported.

Warnings and shutdowns marked [1] do not apply to PPM-3.

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (ex: speed, start/stop, etc.) are enabled in setting 7563 (EIC Controls).

  M-Logic commands are available to enable/disable speed controls:
  - EIC speed control inhibit[1].

- Engine speed
  CANbus ID for speed control: 0x00FF69DC. For Cummins proprietary "Engine governing" EG telegram, the source address of the ML-2 controller is 0xDC/220 dec).

- Engine speed (engine with PCC controller)[1, 2]
  CAN bus ID for speed control: 0x00FF5FDC. For Cummins propietary "Engine governing" EG telegram the source address og 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 setting 2781 (Reg. output) and 7563 (EIC Controls).

- Frequency selection
  Nominal frequency is written automatically based on the frequency nominal setting. 50 Hz is written if fNOM < 55 Hz, 60 Hz is written if fNOM is > 55 Hz.
- Gain setting
  Gain is set in menu 2773.
- Shut down override*

This command can be used in order to prevent shut down actions from the ECU. The function follows the standard AGC function "shutdown override" (digital input on the AGC)

Commands marked [1] do not apply to PPM-3.

Commands marked [2] do not apply to AGC 100, CGC 400, GC-1F and GC-1F/2.

Cummins after treatment:
If Cummnins After Treatment 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-1 or AOP-2 diplay unit.

Status indicator	Diesel particulate filter regeneration status	Diesel particulate filter status	Particulate filter lamp	High exhaust system temp.	Regeneration disabled
State					
OFF	-	-	X	X	-
ON solid	-	-	X	X	-
ON fast blink	-	-	X	-	-
Inhibited	-	-	-	-	X
Not inhibited	-	-	-	-	X
Not Active	X	-	-	-	-
Active	X	-	-	-	-
Regeneration needed	X	-	-	-	-
Regeneration not needed	-	X	-	-	-
Regeneration lowest level	-	X	-	-	-
Regeneration moderate level	-	X	-	-	-
---Regeneration highest level	-	X	-	-	-

Besides the lamp and status indicators two 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.

Cummins after treatment does not apply to PPM-3.

8.3.4 Detroit Diesel DDEC (J1939)

Warnings and shutdowns:

Warning/shutdown list	J1939 codes		
	SPN	FMI warning	FMI shutdown
EIC yellow lamp	-	X	-
EIC red lamp	-	-	X
EIC malfunction[1]	-	X	-
EIC protection[1]	-	X	-

FMI indication " – " means that the alarm in question is not supported.

Warnings and shutdowns marked [1] do not apply to PPM-3.

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (ex: speed, start/stop, etc.) are enabled in setting 7563 (EIC Controls).
- Engine speed
  CANbus ID for speed control: 0x0c000003. J1939 TSC1.
  M-Logic commands are available to enable/disable start/stop and speed controls
  - EIC speed control inhibit[1]

The speed regulation is enabled in setting 2781 (Reg. output) and 7563 (EIC Controls).

Commands marked [1] do not apply to PPM-3.

8.3.5 Deutz EMR 2 - EMR 3 (J1939)

Warnings and shutdowns:

Warning/shutdown list	J1939 codes		
	SPN	FMI warning	FMI shutdown
Low oil pressure	100	-	1
Coolant temperature	110	-	0
Overspeed	190	-	0
EIC yellow lamp	-	X	-
EIC red lamp	-	-	X
EIC malfunction[1]	-	X	-
EIC protection[1]	-	X	-

FMI indication " – " means that the alarm in question is not supported.

Warnings and shutdowns marked [1] do not apply to PPM-3.

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (ex: speed, start/stop, etc.) are enabled in setting 7563 (EIC Controls).
- Engine speed
  CANbus ID for speed control: 0xc000003. For J1939 TSC1, the source address of the ML-2 controller is 3.

  M-Logic commands are available to enable/disable speed controls:
  - EIC speed control inhibit[1]

The speed regulation is enabled in setting 2781 (Reg. output) and 7563 (EIC Controls).

Commands marked [1] do not apply to PPM-3.

8.3.6 Generic J1939 (J1939)

Warnings and shutdowns:

Warning/shutdown list	J1939 codes		
	SPN	**FMI warning**	**FMI shutdown**
EIC yellow lamp	-	X	-
EIC red lamp	-	-	X
EIC Malfunction[1]	-	X	-
EIC Protection[1]	-	X	-

FMI indication " – " means that the alarm in question is not supported.

Warnings and shutdowns marked [1] do not apply to PPM-3.

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (ex: speed, start/stop, etc.) are enabled in setting 7563 (EIC Controls).
- Engine speed
  CANbus ID for speed control: 0x0c000003. J1939 TSC1.
  M-Logic commands are available to enable/disable start/stop and speed controls
  - EIC speed control inhibit[1]

The speed regulation is enabled in setting 2781 (Reg. output) and 7563 (EIC Controls).

Commands marked [1] do not apply to PPM-3.

8.3.7 Iveco (J1939)

Warnings and shutdowns:

Warning/shutdown list	J1939 codes		
	SPN	**FMI warning**	**FMI shutdown**
Low oil pressure	100	17	1
Intake manifold #1 P	102	15	-
Coolant temperature	110	15	0
High inlet air temp.	172	15	-
Fuel temperature	174	15	-
Overspeed	190	15	0
EIC yellow lamp	-	X	-
EIC red lamp	-	-	X
EIC malfunction[1]	-	X	-
EIC protection[1]	-	X	-

FMI indication " – " means that the alarm in question is not supported.

Warnings and shutdowns marked [1] do not apply to PPM-3.

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (ex: speed, start/stop, etc.) are enabled in setting 7563 (EIC Controls).
- Engine speed
  CANbus ID for speed control: 0xc000003.
  For J1939 TSC1, the source address of the ML-2 controller is 3.
  For the Iveco Vector 8 type only: CANbus ID for speed control: 0xcFF0027.
  M-Logic commands are available to enable/disable start/stop and speed controls:
  - EIC speed control inhibit[1]

The speed regulation is enabled in setting 2781 (Reg. output) and 7563 (EIC Controls).

Commands marked [1] do not apply to PPM-3.

8.3.8 John Deere JDEC (J1939)

Warnings and shutdowns:

Warning/shutdown list	J1939 codes		
	SPN	FMI warning	FMI shutdown
Low oil pressure	100	18	1
Intake manifold	105	16	-
Coolant temperature	110	16	0
Fuel injection pump	1076	10	6
Fuel temperature	174	-	16
ECU failure	2000	-	6
EIC yellow lamp	-	X	-
EIC red lamp	-	-	X
EIC malfunction[1]	-	X	-
EIC protection[1]	-	X	-

FMI indication " – " means that the alarm in question is not supported.

Warnings and shutdowns marked [1] do not apply to PPM-3.

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (ex: speed, start/stop, etc.) are enabled in setting 7563 (EIC Controls).
- Engine speed
  CANbus ID for speed control: 0x0c000003. J1939 TSC1.
  M-Logic commands are available to enable/disable start/stop and speed controls
  - EIC speed control inhibit[1]

The speed regulation is enabled in setting 2781 (Reg. output) and 7563 (EIC Controls).

Commands marked [1] do not apply to PPM-3.

8.3.9 MTU ADEC (CANopen)

The MTU ADEC is not a part of the J1939, therefore the reading of values, alarms and shut-downs are different.

Readings from the display:

Display readings
Battery
EIC faults
Engine power[1]
Fuel rate
Mean T. fuel
Nom. power[1]
Operation
P. Aux 1
P. Aux 2
P. Boost
P. Fuel
P. Oil
Speed
T. Charg A
T. Coolant
T. Exh. L
T. Exh. R
T. Fuel
T. Int. Co.
T. Oil
T. Winding 1
T. Winding 2
T. Winding 3
Trip fuel

The Modbus addresses are read-only (function code 04h), and are only available if option H2/N Modbus RTU is implemented.

Objects marked [1] only apply to AGC 100, AGC-4, AGC 200, AGC PM and CGC 400.

Warning:
Below is a list of warnings that can be shown on the display. The warnings will be shown as an alarm in the alarm window. The alarms can be acknowledged from the display, but they will be visible until the alarm disappears in the ECM module.

Warning list	Display list
Coolant temp. high	HI T-Coolant
Charge air temp. high	HI T-Charge Air
Intercooler coolant temp. high	HI T-Coolant Interc
Lube oil temp. high	HI T-Lube Oil
ECU temp. high	HI T-ECU
Engine speed too low	SS Engine Speed Low
Prelube fail.	AL Prelub. Fail
Start speed not reached	AL Start Spe. N. Re.
Common alarm (yellow)	AL Com. Alarm Yellow
Lube oil pressure low	LO P-Lube Oil
Coolant level low	LO Coolant Level
Intercooler coolant level low	LO Interc. Cool. L.
ECU defect	AL ECU Defect
Speed demand failure	AL Speed Demand Def.
Power supply low voltage	LO Power Supply
Power supply high voltage	HI Power supply
Overspeed	SS Overspeed
Lube oil pressure low low	LOLO P-Lube Oil
Coolant temp. high high	HIHI T-Coolant
Lube oil temp. high high	HIHI T-Lube Oil
Charge air temp. high high	HIHI T-Charge Air
ECU power supply high high	HIHI ECU PS Voltage
ECU power supply low low	LOLO ECU PS Voltage
Generator temp. high	T-Generator Warning
Holding tank high level	HI Level Day-Tank
Holding tank low level	LO Level Day-Tank
Generator winding 1 high temp.	HI T-Winding 1
Generator winding 2 high temp.	HI T-Winding 2
Generator winding 3 high temp.	HI T-Winding 3
Ambient temp. high	HI T-Ambient
Water in fuel 1	AL Water I F. Pref. 1
Water in fuel 2	AL Water I F. Pref. 2
Fuel temp. high	HI T-Fuel
Exhaust bank A high temp.	HI T-Exhaust A
Exhaust bank B high temp.	HI T-Exhaust B
Fuel high pressure 1	HI Pressure 1
Fuel high pressure 2	HI Pressure 2

Warning list	Display list
Day tank high level	HI L. Holding-Tank
Day tank low level	LO L. Holding-Tank
Run-up speed not reached	AL Runup. Speed N. Re
Idle speed not reached	AL Idle Speed N. Re

Shutdown:
Below is a shutdown value that can be shown on the display. It is possible to configure "EIC shutdown" in the system setup to put the unit in a shutdown state and/or to activate relay outputs if necessary. The shutdown state is present, until it disappears in the ECM module.

Shutdown list	Display text
AL Com. Alarm Red	AL Com. Alarm Red

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (ex: speed, start/stop, etc.) are enabled in setting 7563 (EIC Controls).
- Engine speed
  CANbus ID for speed control: 0x300+ADEC ID – speed demand telegram (ADEC ID is selected in menu 7562, default ID is 6: 0x306).

  M-Logic commands are available to enable/disable start/stop and speed controls:
  - EIC start/stop enable[1]

The speed regulation is enabled in setting 2781 (Reg. output) and 7563 (EIC Controls). Commands marked [1] do not apply to PPM-3.

- Start/Stop command
- Frequency selection
  Nominal frequency is written automatically based on the frequency nominal setting. 50 Hz is written if fNOM < 55 Hz, 60 Hz is written if fNOM is > 55 Hz.

The CANopen node ID no is selected in setting 7562. The default value (6) usually matches the ADEC setting.

- Demand switch*
  Set method of speed control between digital ("Up/down ECU" with ralay controls), analogue ("Analog ECU Relative" for analogue VDC control) or from J1939 commands ("Analog CAN"). This is selected in menu 2790. Please refer to the MTU documentation for the ECU8 for further information about switching between normal and emergency operation in local or remote.
- Trip counter*
  This command resets the trip fuel consumption counter. The command is activated through M-logic.
- Enable Cylinder Cutout
  The command can be used to engage all cylinders if the engine is running with one bank only. The command is activated through M-logic.

- Shutdown override
  This command can be used in order to prevent shutdown actions from the ECU. The function follows the standard AGC function "shutdown override" (digital input on the AGC)

8.3.10 MTU ADEC module 501, without SAM module (CANopen)(Option H13)

The MTU ADEC module 501 is not a part of the J1939, therefore the reading of values, alarms and shutdowns are different.

Readings from the display:

Display readings
Act-Droop
Battery
Camshaft
ECU Stop activated 1
F speed an
INJECT-QUAN
MDEC Faults
Mean T. fuel
Nom power[1]
Operation[1]
P L Oil Lo
P L Oil Lolo
P. Ch. Air
P. Fuel
P. Oil
Speed
Speed D SW[1]
T. Ch. Air[1]
T. Coolant[1]
T. Fuel[1]
T. Oil[1]
TCOOL-HIHI[1]
T-ECU[1]
T-INTERC[1]
T-LUBE-HI[1]
T-LUBE-HIHI[1]
Total fuel[1]
Trip fuel[1]

The Modbus addresses are read-only (function code 04h), and are only available if the option H2/N Modbus RTU is implemented.

Objects marked [1] only apply to AGC-4, AGC 200 and AGC PM.

Alarms:

Below is a list of alarms that can be shown on the display. The alarms will be shown in the alarm window. The alarms can be acknowledged from the display, but they will be visible until the alarm disappears in the ECM module.

Alarm list	Display text	Warning	Shutdown
ADEC yellow alarm	EIC yellow lamp WA	X	-
ADEC red alarm	EIC red lamp SD.	-	X
High high engine speed	Overspeed shutdown	X	-
Low low lube oil pressure	L Oil Pres. Shutdown	X	-
High high coolant temperature	H Coolant T Shutdown	X	-
High intercooler temperature	H Interc. T Warning	X	-
Sensor Defect Coolant Level	SD Coolant Level	X	-
Low low coolant level	L Cool. Lev. Shutdown	X	-
ADEC ECU failure	MDEC ECU Failure	X	-
Low Lube oil pressure[1]	L Oil Pres. Warning	X	-
Low Common rail fuel pressure[1]	LO P-Fuel Com-Rail	X	-
High Common rail fuel pressure[1]	HI P-Fuel Com-Rail	X	-
Low preheat temperature[1]	AL Preheat Temp. Low	X	-
Low low Charge air coolant level[1]	SS Cool Level Ch-Air	X	-
Power amplifier 1 failure[1]	AL Power Amplifier 1	X	-
Power amplifier 2 failure[1]	AL Power Amplifier 2	X	-
Transistor output status[1]	AL Status Trans-Outp	X	-
Low ECU power supply voltage[1]	LO ECU Power Supply	X	-
High ECU power supply voltage[1]	HI ECU Power	X	-
High charge air temperature[1]	HI T-Charge Air	X	-
High Lube oil temperature[1]	HI T-Lube Oil	X	-
High ECU temperature[1]	HI T-ECU	X	-
Low engine speed[1]	SS Eng. Speed Low	X	-
Check error code[1]	AL Check Error Code	X	-
Common rail leakage[1]	AL Com. Rail Leakage	X	-
Automatic engine stop[1]	AL Aut. Engine Stop	X	-
MG Start speed not reached[1]	MG Start Speed Fail	X	-
MG runup speed not reached[1]	MG Runup Speed Fail	X	-
MG idle speed reached[1]	MG Idle Speed Fail	X	-
Low low ECU power supply voltage[1]	LOLO ECU Pow. Supply	X	-
High high ECU power supply voltage[1]	HIHI ECU Pow. Supply	X	-
Sensor Defect coolant level charge air[1]	SD Cool Level Ch-Air	X	-
High fuel temperature[1]	HI T-Fuel	X	-
Override feedback from ECU[1]	SS Override	X	-

Alarm list	Display text	Warning	Shutdown
High high lube oil temperature[1]	H Oil Temp. Shutdown	X	-
Speed demand defected[1]	AL Speed demand Def.	X	-
High coolant temperature[1]	H Coolant T Warning	X	-
High high temperature charge air[1]	H Ch. Air T Shutdown	X	-
Low fuel oil pressure[1]	LO P-Fuel Oil	X	-
Low low fuel oil pressure[1]	SS P-Fuel Oil	X	-

MDEC indication " – " means that the alarm in question is not supported.

Alarms marked [1] only apply to AGC-4, AGC 200 and AGC PM.

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (ex: speed, start/stop, etc.) are enabled in setting 7563 (EIC Controls).
- Engine speed
  M-Logic commands are available to enable/disable start/stop and speed controls:
  - EIC start/stop enable[1]
  - EIC speed control inhibit[1]
- Manual speed control (up/down)

The speed regulation is enabled in setting 2781 (Reg. output) and 7563 (EIC Controls).

- Start/Stop command
- Frequency selection
  Nominal frequency is written automatically based on the frequency nominal setting. 50 Hz is written if fNOM < 55 Hz, 60 Hz is written if fNOM is > 55 Hz.
- 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

Commands marked [1] do not apply to PPM-3.

8.3.11 MTU J1939 Smart Connect (J1939)

This protocol is available with MTU series 1600 with ECU8/ECU9/Smart Connect.

This protocol does not apply to PPM-3.

Alarm texts for ECU9 can be found in the Appendix under "MTU Smart Connect ECU9".

Warnings and shutdowns:

Warning/shutdown list	J1939 codes		
	SPN	**FMI warning**	**FMI shutdown**
EIC yellow lamp	-	X	-
EIC red lamp	-	-	X
EIC malfunction	-	X	-
EIC protection	-	X	-

FMI indication " – " means that the alarm in question is not supported.

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (e.g. speed, start/stop etc.) are enabled in setting 7563 (EIC controls).
- Engine speed
  CAN bus ID for speed control: 0x0c0000ea.J1939TSC1.
  M-Logic commands are available to enable/disable start/stop and speed controls:
  - EIC start/stop enable
  - EIC speed control inhibt

The speed regulation is enabled in setting 2781 (Reg. output) and 7563 (EIC controls).

- Frequency selection
  Normal frequency is written automatically based on the frequency nominal setting. 50 Hz is written if $f_{nominal}$ <55Hz, 60 Hz is written if $f_{nominal}$ 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.
- 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
  Engage 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 VDC control) or from J1939 commands ("Analog CAN"). This is selected in menu 2790. Please refer to the MTU documentation for the ECU8 for further information about switching between normal and emergency operation in local or remote.
If the MTU ECU is unable to detect a valid speed demand signal, it will issue the "Al Speed deman def.". This alarm indicates that the MTU ECU may see a CAN speed bias signal, and is setup to 3 - ADEC Analog Relative or that 4 - ADEC Analog relative is used and the signal is out of range (not connected, etc.). When this happens, check the settings on the MTU ECU,
PR500 (MTU SAM/Diasys reference)
0 - Default dataset ADEC
1 - ADEC Increase/Decrease Input
2 - CAN Increase/Decrease Input
3 - ADEC Analog Absolute
4 - ADEC Analog Relative
5 - ADEC Frequency Input
6 - CAN Analog
7 - CAN Speed Demand Switch

- Speed gov. param command
  Parameter switch for selection between: Default and Variant 1 M-Logic is used to select variant 1 parameters.
- Trip counter reset
  This command resets the trip fuel consumption counter. The command is activated through M-Logic.
- Idle Run
  This command activates Idle speed.
- Speed Increase
  This command increases the speed of the engine by a small amount. The command is activated through M-Logic.
- Speed Decrease
  This command decreases the speed of the engine by a small amount. The command is activated through M-Logic.
- Alternate Droop Setting
  This command activates alternate droop setting. The command is activated through M-Logic.
- Start
  This command starts the genset.
- Stop
  This command stops the genset.

Demand switch:
For the ECU8/9/Smart connect, the AGC holds some parameters where it is possible to make a switch between different inputs on the ECM for the speed signal/bias. The setting in the parameters can be chosen between:

Setting	Description
Analog CAN	Commands the ECM to receive the speed signal/bias via the CAN bus. The signal will be a digital signal that is similar to an analogue regulation signal. This can be considered as “analogue regulation via CAN bus”.
Up/Down ECU	Commands the ECM to receive the speed signal/bias via digital inputs. To control the ECM from the AGC, this will have to be done with relay regulation. This can be considered as “normal relay regulation”.
Up/Down CAN	Commands the ECM to receive the speed signal/bias via the CAN bus. The signal will be a digital signal. The AGC will send commands to increase or decrease to the ECM. This can be considered as “relay regulation via CAN bus”.
Analog ECU	Commands the ECM to receive the speed signal/bias via analogue input. To control the ECM from the AGC, it will have to be done via analogue regulation. With this setting, the ECM will regulate the whole engine range on the analogue signal. This could be e.g. 0-5 V DC equals 700 rpm – 2000 rpm. This can be considered as “analogue regulation with a big regulation range”.
Analog ECU Relative	Commands the ECM to receive the speed signal/bias via analogue input. To control the ECM from the AGC, it will have to be done via analogue regulation. With this setting, the ECM will be regulated in a smaller range. This could be e.g. 0-5 V DC equals 1350 rpm – 1650 rpm. This gives a higher resolution in the regulation area. This can be considered as “analogue regulation with a narrow range”.
Frequency	Commands the ECM to receive the speed signal/bias via a frequency/PWM input.

The ECU8/9 can be in 4 different states. The 4 different states are:
- Local, Normal operation (2791)
- Local, Emergency operation (2792)
- Remote, Normal operation (2793)
- Remote, Emergency operation (2794)

The AGC has the possibility to set which type of speed signal should be used for each state. The parameters for each state are shown in the table below:

Parameter	Item	Range	Default	Note
2791	Local, Normal operation – Speed signal	Analog CAN Frequency	Analog CAN	Only in genset
2792	Local, Emergency operation – Speed signal	Analog CAN Frequency	Analog CAN	Only in genset
2793	Remote, Normal operation – Speed signal	Analog CAN Frequency	Analog CAN	Only in genset
2794	Remote, Emergency operation – Speed signal	Analog CAN Frequency	Analog CAN	Only in genset

When changing one of the parameters above, parameter 7563 (EIC control) to ON. Otherwise the command will not be send.
If the AGC is showing an alarm with "AL speed dem. def.", it means that there is a mismatch between the speed signal/bias. The ECM has been set for running with a speed signal from one source, but detecting something on another source. Maybe because ECM module has been configured to have the speed signal from one source, and the AGC is sending the AGC speed signal from another.

8.3.12 MTU MDEC module 302/303 (CANopen)

The MTU MDEC is not a part of the J1939, therefore the reading of values, alarms and shutdowns are different.

Readings from display:

Display readings
Act-Droop
Battery
Camshaft
ECU Stop activated 1
F speed an
Fuel Rate
INJECT-QUAN
MDEC Faults
Mean T. fuel
Nom power
Operation
P L Oil Lo
P LOil Lolo
P. Ch. Air
P. Fuel
P. Oil
Speed
Speed D SW[1]
T. Ch. Air[1]
T. Coolant[1]
T. Fuel[1]
T. Oil[1]
T-COOL-HI[1]
TCOOL-HIHI[1]
T-ECU[1]
T-INTERC[1]
T-LUBE-HI[1]
T-LUBE-HIHI[1]
Total fuel[1]
Trip fuel[1]

The Modbus addresses are read-only (function code 04h), and are only available if the option H2/N Modbus RTU is implemented.

Objects marked [1] only apply to AGC-4, AGC 200, AGC PM and CGC 400.

Alarms:

Below is a list of alarms that can be shown on the display. The alarms will be shown in the alarm window. The alarms can be acknowledged from the display, but they will be visible until the alarm disappears in the ECM module.

Alarm list	Display text	Warning	Shutdown
MDEC yellow alarm	EIC yellow lamp	X	-
MDEC red alarm	EIC red lamp SD.	-	X
High high engine speed	Overspeed shutdown	-	X
Low low lube oil pressure	L Oil Pres. Shutdown	X	X
High high coolant temperature	H Coolant T Shutdown	X	X
High high lube oil temperature	H Oil Temp. Shutdown	-	X
High intercooler temperature	H Interc. T Warning	X	-
Sensor Defect Coolant Level	SD Coolant Level	X	-
Low low coolant level	L Cool. Lev. Shutdown	-	X
MDEC ECU failure	MDEC ECU Failure	-	X
Low fuel oil pressure[1]	LO P-Fuel Oil	X	-
Low Lube oil pressure[1]	L Oil Pres. Warning	X	-
Low Common rail fuel pressure[1]	LO P-Fuel Com-Rail	X	-
High Common rail fuel pressure[1]	HI P-Fuel Com-Rail	X	-
Override feedback from ECU[1]	SS Override	X	-
Low preheat temperature[1]	AL Preheat Temp. Low	X	-
Low low Charge air coolant level[1]	SS Cool Level Ch-Air	X	-
Power amplifier 1 failure[1]	AL Power Amplifier 1	X	-
Power amplifier 2 failure[1]	AL Power Amplifier 2	X	-
Transistor output status[1]	AL Status Trans-Outp	X	-
Low ECU power supply voltage[1]	LO ECU Power Supply	X	-
High ECU power supply voltage[1]	HI ECU Power	X	-
High charge air temperature[1]	HI T-Charge Air	X	-
High Lube oil temperature[1]	HI T-Lube Oil	X	-
High ECU temperature[1]	HI T-ECU	X	-
Low engine speed[1]	SS Eng. Speed Low	X	-
Check error code[1]	AL Check Error Code	X	-
Common rail leakage[1]	AL Com. Rail Leakage	X	-
Automatic engine stop[1]	AL Aut. Engine Stop	X	-
MG Start speed not reached[1]	MG Start Speed Fail	X	-
MG runup speed not reached[1]	MG Runup Speed Fail	X	-
MG idle speed reached[1]	MG Idle Speed Fail	X	-
Low low ECU power supply voltage[1]	LOLO ECU Pow. Supply	X	-
High high ECU power supply voltage[1]	HIHI ECU Pow. Supply	X	-

Alarm list	Display text	Warning	Shutdown
Sensor Defect coolant level charge air[1]	SD Cool Level Ch-Air	X	-
High fuel temperature[1]	Hi T-Fuel	X	-

MDEC indication " – " means that the alarm in question is not supported.

Alarms marked [1] only apply to AGC-4, AGC 200 and AGC PM.

Write commands to engine controller:
None.

8.3.13 Scania EMS (J1939)

Warnings and shutdowns:
None.

Write commands to engine controller:
None.

8.3.14 Scania EMS 2 S6 (J1939)

Scania EMS 2 S6 does not use the J1939 SPN/FMI (Suspect Parameter Number/Failure Mode Indicator) system for alarm handling. Instead the DNL2 system is used. For this reason, the alarm handling is also different.

Warnings and shutdowns (DNL2 alarms):

Below is a list of warnings and shutdowns that can be shown on the display. They will be shown as an alarm in the alarm window. The alarms can be acknowledged from the display, but they will be visible until the alarm disappears in the ECM module.

Warning/shutdown list	DNL2 warning	DNL2 shutdown
EMS warning	X	-
Low oil pressure	X	-
High coolant temp	X	-
Stop limit exceeded	-	X
Charge 61	X	-
EIC yellow lamp	X	-
EIC red lamp	-	X
EIC malfunction[1]	X	-
EIC protection[1]	X	-

DNL2 indication " – " means that the alarm in question is not supported.

Handling of alarms is only active when the engine is running.

Warnings and shutdowns marked [1] do not apply to PPM-3.

Error log:
t 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 (please refer to the engine documentation).

For option H5 or H13, the EMS S6 software version and engine number is automatically retrieved when CANbus communication is established.

Flash code	ML-2 displayed text	Description
11	Overreving	One or both engine speed sensors have indicated above 3000 rpm
12	Speed sensor 1	Engine sensor 1
13	Speed sensor 2	Engine sensor 2
14	Water T sen.	Engine coolant temperature sensor
15	Char. air T sen	Charge air temperature sensor
16	Char. air P sen	Charge air pressure sensor
17	Oil temp. sen.	Oil temperature sensor
18	Oil pres. sen.	Oil pressure sensor
23	Fault in cor.	Fault in coordinator
25	Throttle pedal	CAN message for fine tune nominal speed out of range
27	Emerg. stop o.r	Engine stop overridden
31	Oil pres. prot	Oil pressure protection activated
32	Wrong parameter	Wrong parameter setting for defect CAN communication
33	Battery voltage	Battery voltage out of range
37	Emerg. stop cor	Emergency stop switch activated
43	CAN cir. defect	CAN circuit defect
48	CAN mess. DLN1	CAN message from the coordinator missing or not correct
49	Wrong CAN ver.	Non-matching CAN version in EMS and coordinator
51	Un. inj. cyl. 1	Unit injector cylinder 1
52	Un. inj. cyl. 2	Unit injector cylinder 2
53	Un. inj. cyl. 3	Unit injector cylinder 3
54	Un. inj. cyl. 4	Unit injector cylinder 4
55	Un. inj. cyl. 5	Unit injector cylinder 5
56	Un. inj. cyl. 6	Unit injector cylinder 6
57	Un. inj. cyl. 7	Unit injector cylinder 7
58	Un. inj. cyl. 8	Unit injector cylinder 8
59	Extra ana. inp.	Voltage out of range on extra analogue input pin
61	System shutdown	System shut down incorrectly
66	Coola. l. prot.	Low engine coolant level
86	HW watchdog	Hardware watchdog
87	Fault in RAM	The EMS has detected that the fault code memory is not functioning correctly
89	Seal	The programme in the EMS has been altered in a prohibited manner
94	Coola. shut off	Engine coolant temperature/oil pressure shutdown
96	Overheat prot.	Overheat protection activated
99	Fault in TPU	Error in TPU Timer Processor Unit

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (ex: speed, start/stop, etc.) are enabled in setting 7563 (EIC Controls)
- Droop
- Engine speed

CANbus ID:	Offset: 0xcfff727
Speed	0x0cff8027

  M-Logic commands are available to enable/disable start/stop and speed controls:
  - EIC start/stop enable[1]
  - EIC speed control inhibit[1]

- Frequency selection
  Nominal speed/frequency is selected in 2772. If "User" is selected, nominal speed/frequency is written automatically, based on the frequency nominal setting.
- Start/stop command

The speed regulation is enabled in setting 2781 (Reg. output) and 7563 (EIC Controls).

It is only possible to write commands to the engine when the Scania Coordinator is NOT mounted.

Commands marked [1] do not apply to PPM-3.

Control:
In the parameter 2770, it is possible to configure the droop setting and the initial speed setting.

8.3.15 Volvo Penta EMS (J1939)

Warnings and shutdowns:

Warning/shutdown list	J1939 codes		
	SPN	FMI warning	FMI shutdown
Low oil pressure	100	5	-
Intake manifold #1 P	102	-	-
Coolant temperature	110	5	-
High inlet air temp.	172	5	-
Fuel temperature	174	-	-
Fuel pressure	94	5	-
Oil level	98	5	-
Overspeed	190	-	0
Coolant level low	111	-	1
EIC yellow lamp	-	X	-
EIC red lamp	-	-	X
EIC malfunction[1]	-	X	-
EIC protection[1]	-	X	-

Warnings and shutdowns marked [1] do not apply to PPM-3.

Write commands to engine controller:
None.

8.3.16 Volvo Penta EMS 2 (J1939)

EMS 2 and EDCIII/D6, D7, D9, D12 and D16 (GE and AUX variants only).

Warnings and shutdowns:

Warning/shutdown list	J1939 codes		
	SPN	FMI warning	FMI shutdown
Low oil pressure	100	5	-
Intake manifold #1 P	102	-	-
Coolant temperature	110	5	-
High inlet air temp.	172	5	-
Fuel temperature	174	-	-
Fuel pressure	94	5	-
Oil level	98	5	-
Overspeed	190	-	0
Coolant level low	111	-	1
EIC yellow lamp	-	X	-
EIC red lamp	-	-	X
EIC malfunction[1]	-	X	-
EIC protection[1]	-	X	-

FMI indication " – " means that the alarm in question is not supported.

Warnings and shutdowns marked [1] do not apply to PPM-3.

Write commands to engine controller:

- Engine controls
  All the write commands to the engine controller (ex: speed, start/stop, etc.) are enabled in setting 7563 (EIC Controls)
- Engine speed
  CANbus ID for speed control: 0x0cff4611 – Volvo Penta proprietary telegram
  M-Logic commands are available to enable/disable start/stop and speed controls:
  - EIC start/stop enable[1]
  - EIC speed control inhibt[1]
- Preheat
- Start/stop

Commands marked [1] do not apply to PPM-3.

Readable states:

- Preheat and running

The speed regulation is enabled in setting 2781 (Reg. output) and 7563 (EIC Controls).

Selection of primary or secondary speed is selected in setting 2774.

8.4 Modbus communication

8.4.1 Additional information for H2/N

This chapter is to be considered as additional information for option H2/N (Modbus RS 485 RTU). Please refer to the ECM (Engine Communication Module) user manuals for more information about the ECM protocol technical description and the details of each communication value. If option H2/N is installed, the data can be transmitted to a PLC, a computer, the alarm-and-monitoring system or a Scada system.

Please refer to the option H2/N technical documentation for more information about our standard external Modbus communication.

A certain amount of engine data can be transmitted from the engine communication module to the controller unit. They can be transmitted through Modbus option H2/N.

The available values depend on the selected type of engine communication.

The data readable by the Modbus communication are converted into the chosen unit in menu 10970.

8.4.2 Readings via Modbus - Analogue values

The reading of values is independent of engine type, so all readings below are available in the Modbus protocol.

The availability of data from the individual engine types is dependent on the specific engine. Please refer to the engine manual in question.

These data refer to the common J1939 display reading list as well as the overview of readings in the MTU ADEC (CANopen) and MTU MDEC (MTU protocol).

Measurement table (read only) function code 04h.						
Addr	**Content**	**Unit**	**Scaling**			**Description**
			J1939	**ADEC**	**MDEC**	
593	EIC speed	[RPM]	1/1	1/1	1/1	Speed
594	EIC coolant temp.	[deg] [F]	1/10	1/10	1/10	Coolant temperature
595	EIC oil pressure	[bar] [psi]	1/100	1/100	1/100	Engine oil pressure
596	EIC no of faults	[Faults]	1/1	1/1	1/1	Number of faults
597	EIC oil temp.	[deg] [F]	1/10	1/10	1/10	Engine oil temperature
598	EIC fuel temp.	[deg] [F]	1/1	1/10	1/10	Fuel temperature
599	EIC intake manifold #1 P	[bar] [psi]	1/100	1/100	-	Intake manifold #1 P
600	EIC air inlet temp.	[deg] [F]	1/1	-	-	Air inlet temperature
601	EIC coolant level	[%]	1/10	-	-	Coolant level
602	EIC fuel rate	[L/h]	1/10	1/1	-	Fuel rate
603	EIC charge air press	[bar] [psi]	-	-	1/100	Charge air press
604	EIC intake manifold 1 T (or EIC charge air T)	[deg] [F]	1/1	-	1/10	Intake manifold 1 tempera-ture
605	EIC d.d. % torque	[%]	1/1	-	-	Driver’s demand engine - percent torque
606	EIC actual % torque	[%]	1/1	-	-	Actual engine - percent torque
607	EIC acc. pedal pos.	[%]	1/1	-	-	Accelerator pedal position
608	EIC % load, c. speed	[%]	1/1	-	-	Percent load at current speed
609	EIC air inlet pressure	[bar] [psi]	1/100	-	-	Air inlet pressure
610	EIC exhaust gas temp.	[deg] [F]	1/10	-	-	Exhaust gas temperature
611	EIC engine hours	[H]	1/1	1/1	1/1	ENGINE HOURS
612	EIC oil filter diff. press.	[bar] [psi]	1/100	-	-	Oil filter diff press
613	EIC battery voltage	[V]	1/10	1/10	-	Keyswitch battery potential
614	EIC fuel del. press.	[bar] [psi]	1/100	1/100	-	Fuel delivery pressure
615	EIC oil level	[%]	1/10	-	-	Engine oil level
616	EIC crankcase press.	[bar] [psi]	1/100	-	-	Crankcase pressure
617	EIC coolant pressure	[bar] [psi]	1/100	-	-	Coolant pressure
618	EIC water in fuel	[2 bits]	1/1	-	-	Water in fuel (1 = Yes, 0 =NO)
619	Reserved	-	-	-	-	-
620	Reserved	-	-	-	-	-
621	Reserved	-	-	-	-	-
622	Reserved	-	-	-	-	-
623	EIC turbo oil temp.	[deg] [F]	1/10	-	-	Turbo oil temp.

Measurement table (read only) function code 04h.						
Addr	**Content**	**Unit**	**Scaling**			**Description**
			J1939	**ADEC**	**MDEC**	
624	EIC trap inlet	[bar] [psi]	1/100	-	-	Trap inlet
625	EIC Air filter diff press	[bar] [psi]	1/1000	-	-	Air filter diff press
626	EIC Cool filter diff press	[bar] [psi]	1/100	-	-	Cool filter diff press
627	EIC Atm press	[bar] [psi]	1/100	-	-	Atmospheric pressure
628	EIC Ambient air temp	[deg] [F]	1/10	-	-	Ambient air temp [F/10]
629	EIC exch. temp A	[deg] [F]	1/10	1/10	-	Exch. temp bank A
630	EIC exch. temp B	[deg] [F]	1/10	1/10	-	Exch. temp bank B
631	EIC Winding 1 temp	[deg] [F]	-	1/1	-	Gen winding 1 temp
632	EIC Winding 2 temp	[deg] [F]	-	1/1	-	Gen winding 2 temp
633	EIC Winding 3 temp	[deg] [F]	-	1/1	-	Gen winding 3 temp
634	Reserved	-	-	-	-	-
635	Reserved	-	-	-	-	-
636	EIC T. Charge A	[deg] [F]	-	1/10	-	Turbo Charger Air temp
637	EIC Intercooler temp	[deg][F]	-	1/10	-	Intercooler temp
638	EIC engine trip fuel	[L]	1/1	1/1	-	Engine trip fuel
639	EIC engine total fuel used	[kL]	1/10	-	-	Engine total fuel used
640	EIC trip fuel_gaseous	[kg]	1/1	-	-	Trip fuel, gaseous
641	EIC total fuel used_gaseous	[ton]	1/10	-	-	Total fuel used, gaseous
850[3]	AT2ExhFluDRQ	[g/h]	1/10	-	-	Aftertreatment 2 Diesel Exhaust Fluid Dosing Requested Quantity
851[3]	AT2SCRCInG	[deg] [F]	1/10	-	-	Aftertreatment 2 SCR Catalyst Intake Gas Temperature
852[3]	AT2SCRCOuG	[deg] [F]	1/10	-	-	Aftertreatment 2 SCR Catalyst Outlet Gas Temperature
853	EIC Engine Oil-Filter Outlet Pressure	[bar] [psi]	1/100	-	-	Engine Oil-Filter Outlet Pressure
854[3]	EngOperatingState	-	1/1	-	-	Engine Operating State
855	EIC SA of Controlling Device	-	1/1	-	-	Source Address of Controlling Device
856	EIC Engine Rated Speed	[RPM]	1/1	-	-	Engine Rated Speed
857	EIC Engine Speed At Idle, Point 1	[RPM]	1/1	-	-	BAM message: Engine Speed At Idle, Point 1 (Engine Configuration)
858	EIC Engine Controller 5	-	1/1	-	-	MTU only: Engine Controller 5

Measurement table (read only) function code 04h.						
Addr	**Content**	**Unit**	**Scaling**			**Description**
			J1939	**ADEC**	**MDEC**	
859	EIC Fuel Consumption	[g/kWh]	1/1	-	-	MTU only: Fuel Consumption
860	EIC UREA Level	[%]	1/10	-	-	Scania only: UREA Level
861[3]	SCR IND. SEV		1/1	-	-	Severity status of the operator inducement system
862[3]	Next Regen	[deg] [F]	1/10	-	-	Time to activate next regeneration for diesel particulate filter
900	EIC trip average fuel rate	[L/h]	-	1/10	-	Average fuel rate (trip)
901[1]	EIC nominal power	[Kwm]	1/1	1/1	-	Nominal power of the engine
902	EIC trip fuel liquid	[L]	1/2	1/10	-	High word
903	EIC trip fuel liquid	[L]	1/2	1/10	-	Low word
904	EIC total fuel liquid	[L]	1/2	1/10	-	High word
905	EIC total fuel liquid	[L]	1/2	1/10	-	Low word
906	EIC mean trip fuel consumption	[L/h]	-	1/1000	-	High word
907	EIC mean trip fuel consumption	[L/h]	-	1/1000	-	Low word
908[1]	EIC engine power	[Kwm]	-	1/1	-	Nominal power of the engine (ADEC)
911[1]	EIC intake manifold #1 absolute pressure	Bar or psi	1/100	-	-	*Only MTU J1939 Smart Connect
912	EIC Air filter diff. pressure	Bar or psi	1/100	-	-	Change in engine air system pressure
913	EIC Fuel supply pump inlet pressure	Bar or psi	1/100	-	-	Absolute pressure of fuel at the fuel supply pump intake
914	EIC Fuel filter (suction side) diff. pressure	Bar or psi	1/100	-	-	Differential pressure measured across the fuel filter between the fuel tank and the supply pump
915[2]	EIC Fuel filter diff. pressure	Bar or psi	1/100	-	-	Diff pressure
932[2]	EIC Speed Demand source	Digit	-	-	-	Identifies speed demand source
933[2]	EIC lube oil pressure LO limit	mbar	-	-	1/100	Lubrication oil pressure limit 1
934[2]	EIC lube oil pressure LOLO limit	mbar	-	-	1/100	Lubrication oil pressure limit 2

Measurement table (read only) function code 04h.						
Addr	**Content**	**Unit**	**Scaling**			**Description**
			J1939	**ADEC**	**MDEC**	
935[2]	EIC fuel pressure	bar	-	-	1/100	Fuel pressure
936[2]	EIC coolant limit HI	[deg] [F]	-	-	1/10	Coolant high limit temp. 1
937[2]	EIC coolant limit HIHI	[deg] [F]	-	-	1/10	Coolant high limit temp. 2
938[2]	EIC intercooler coolant	[deg] [F]	-	-	1/10	Intercooler coolant temperature
939[2,3]	T-ECU	[deg] [F]	-	-	1/10	ECU temperature
940[2]	EIC actual droop	%	-	-	1/10	Actual droop percentage
941[2]	EIC act. inject. Quantity	%	-	-	1/10	Injection quantity Act. DBR %
942[2]	EIC camshaft	[RPM]	-	1/1	-	Camshaft speed
943[2]	EIC Temp lube HI	[deg] [F]	-	1/10	-	Lube oil temperature HI
944[2]	EIC Temp lube HIHI	[deg] [F]	-	1/10	-	Lube oil temperature HIHI
945[2]	EIC speed demand analog	Digit	-	1/1	-	Speed demand analog
946[2]	EIC act. inject Quantity	[bit]	-	-	-	1: Stop activated, 0: Stop not activated
971[3]	T. Cool Aux	[deg] [F]	1/1	-	-	Coolant temperature of intercooler which is located after the turbocharger
974	EIC Engine Auxiliary Coolant Pressure	[bar] [psi]	1/100	-	-	Engine Auxiliary Coolant Pressure
975[3]	Sp.Humidity	[g/kg]	1/10	-	-	Ambient Conditions 2 Specific Humidity
976[3]	Tcharger 2	[RPM]	1/1	-	-	Engine Turbocharger 2 Speed
977[3]	Tcharger 3	[RPM]	1/1	-	-	Engine Turbocharger 3 Speed
978	EIC Trip Engine Running Time	[h]	1/1	-	-	Trip Engine Running Time
979	EIC Trip Idle Time	[h]	1/1	-	-	Trip Idle Time
980	EIC Estimated Percent Fan Speed	[%]	1/10	-	-	Estimated Percent Fan Speed
981[3]	Tcharger 1	[RPM]	1/1	-	-	Engine Turbocharger 1 Speed
982	EIC Nominal Friction - Percent Torque	[%]	1/1	-	-	Nominal Friction - Percent Torque
983	EIC Engine's Desired Operating Speed	[RPM]	1/1	-	-	Engine's Desired Operating Speed

Measurement table (read only) function code 04h.						
Addr	Content	Unit	Scaling			Description
			J1939	ADEC	MDEC	
984	EIC Engine Intake Manifold 2 Temperature	[deg] [F]	1/1	-	-	Engine Intake Manifold 2 Temperature
985[3]	EIC DEF LEVEL	[%]	1/10	-	-	Aftertreatment 1 Diesel Exhaust Fluid Tank Level
986[3]	EIC DEF temperature	[deg] [F]	1/1	-	-	Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature
987[3]	AT1IntTNOx	[ppm]	1/10	-	-	Aftertreatment 1 Intake NOx
988[3]	AT1OutLNOx	[ppm]	1/10	-	-	Aftertreatment 1 Outlet NOx
989[3]	AT1ExhFA.DQ	[g/h]	1/10	-	-	Aftertreatment 1 Diesel Exhaust Fluid Actual Dosing Quantity
990[3]	AT1ExhFluDAB	[bar] [psi]	1/100	-	-	Aftertreatment 1 Diesel Exhaust Fluid Dosing Absolute Pressure
991[3]	AT1ExhFlu DT	[deg] [F]	1/1	-	-	Aftertreatment 1 SCR Dosing Air Assist Valve
992[3]	AT1ExhFlu DT	[g/h]	1/1	-	-	Aftertreatment 1 Diesel Exhaust Fluid Dosing Requested Quantity
993[3]	AT1SCRCInG	[deg] [F]	1/10	-	-	Aftertreatment 1 SCR Catalyst Intake Gas Temperature
994[3]	AT1SCRCOuG	[deg] [F]	1/10	-	-	Aftertreatment 1 SCR Catalyst Outlet Gas Temperature
995[3]	AT2IntTNOx	[ppm]	1/10	-	-	Aftertreatment 2 Intake NOx
996[3]	AT2OutLNOx	[ppm]	1/10	-	-	Aftertreatment 2 Outlet NOx
997[3]	AT2ExhFA.DQ	[g/h]	1/10	-	-	Aftertreatment 2 Diesel Exhaust Fluid Actual Dosing Quantity
998[3]	AT2ExhFluDAB	[bar] [psi]	1/100	-	-	Aftertreatment 2 Diesel Exhaust Fluid Dosing Absolute Pressure
999[3]	AT2ExhFlu DT	[deg] [F]	1/1	-	-	Aftertreatment 2 SCR Dosing Air Assist Valve

Measurement table (read only) function code 04h.						
Addr	Content	Unit	Scaling			Description
			J1939	ADEC	MDEC	
1819[3]	Intake Man T2	[deg] [F]	1/1	-	-	Temperature of pre-combustion air found in intake manifold of engine air supply system

Addresses marked [1] only apply to AGC 100, AGC-3, AGC-4, AGC 200, AGC PM and CGC 400.

Addresses marked [2] only apply to AGC-4, AGC 200, AGC PM and CGC 400.

Addresses marked [3] are not supported for option H7.

8.4.3 Readings via Modbus - Analogue values specific for CAT and Perkins Protocol

Measurement table (read only) function code 04h.						
Addr	**Content**	**Unit**	**Scaling**			**Description**
			J1939	**ADEC**	**MDEC**	
947	EIC Exhaust Gas P1 Temp	[deg] [F]	1/10	-	-	
948	EIC Exhaust Gas P2 Temp	[deg] [F]	1/10	-	-	
949	EIC Exhaust Gas P3 Temp	[deg] [F]	1/10	-	-	
950	EIC Exhaust Gas P4 Temp	[deg] [F]	1/10	-	-	
951	EIC Exhaust Gas P5 Temp	[deg] [F]	1/10	-	-	
952	EIC Exhaust Gas P6 Temp	[deg] [F]	1/10	-	-	
953	EIC Exhaust Gas P7 Temp	[deg] [F]	1/10	-	-	
954	EIC Exhaust Gas P8 Temp	[deg] [F]	1/10	-	-	
955	EIC Exhaust Gas P9 Temp	[deg] [F]	1/10	-	-	
956	EIC Exhaust Gas P10 Temp	[deg] [F]	1/10	-	-	
957	EIC Exhaust Gas P11 Temp	[deg] [F]	1/10	-	-	
958	EIC Exhaust Gas P12 Temp	[deg] [F]	1/10	-	-	
959	EIC Exhaust Gas P13 Temp	[deg] [F]	1/10	-	-	
960	EIC Exhaust Gas P14 Temp	[deg] [F]	1/10	-	-	
961	EIC Exhaust Gas P15 Temp	[deg] [F]	1/10	-	-	
962	EIC Exhaust Gas P16 Temp	[deg] [F]	1/10	-	-	
967	EIC Filtered Fuel DeliveryPress	[bar] [psi]	1/100	-	-	
968	EIC Coolant Temp 2	[deg] [F]	1/1	-	-	
969	EIC Coolant Temp 3	[deg] [F]	1/1	-	-	
970	EIC Coolant Pump Outlet Temp	[deg] [F]	1/1	-	-	
971	EIC Auxiliary Coolant Temp	[deg] [F]	1/1	-	-	
972	EIC Turbo 1 Intake Temp	[deg] [F]	1/10	-	-	
973	EIC Turbo 2 Intake Temp	[deg] [F]	1/10	-	-	

8.4.4 Readings via Modbus - Diagnostic codes

To interpret an SPN and/or FMI number, refer to the documentation of the engine manufacturer.

SPN means "Suspect Parameter Number". E.g. if the coolant water temperature becomes too high, the SPN code "110" will be shown.

FMI means "Failure Mode Indicator". E.g. if the temperature in the above example is at shutdown level, the FMI code "0" will be shown.

Oc means "occurrence counter" and it indicates how many times a specific alarm has occurred. E.g. if the specific alarm in the above example (SPN 100, FMI 0) has occurred 2 times, the oc code "2" will be shown.

In the table below a specific SPN number is linked to the same FMI and oc number.

Active Diagnostic Code (DM1/SPN)		
Addr.	**Content**	**Description**
1370	SPN diagnostic no. 1	Lo word
1371	SPN diagnostic no. 2	Lo word
1372	SPN diagnostic no. 3	Lo word
1373	SPN diagnostic no. 4	Lo word
1374	SPN diagnostic no. 5	Lo word
1375	SPN diagnostic no. 6	Lo word
1376	SPN diagnostic no. 7	Lo word
1377	SPN diagnostic no. 8	Lo word
1378	SPN diagnostic no. 9	Lo word
1379	SPN diagnostic no. 10	Lo word
1380	SPN diagnostic no. 1	Hi word
1381	SPN diagnostic no. 2	Hi word
1382	SPN diagnostic no. 3	Hi word
1383	SPN diagnostic no. 4	Hi word
1384	SPN diagnostic no. 5	Hi word
1385	SPN diagnostic no. 6	Hi word
1386	SPN diagnostic no. 7	Hi word
1387	SPN diagnostic no. 8	Hi word
1388	SPN diagnostic no. 9	Hi word
1389	SPN diagnostic no. 10	Hi word
1390-1401	Not used	Reserved

Active Fail Mode Identifier (DM1/FMI)		
Addr.	**Content**	**Description**
1402	FMI diagnostic no. 1	-
1403	FMI diagnostic no. 2	-
1404	FMI diagnostic no. 3	-
1405	FMI diagnostic no. 4	-
1406	FMI diagnostic no. 5	-
1407	FMI diagnostic no. 6	-
1408	FMI diagnostic no. 7	-
1409	FMI diagnostic no. 8	-
1410	FMI diagnostic no. 9	-
1411	FMI diagnostic no. 10	-
1412-1417	Not used	Reserved

Active Occurrence Counter (DM1/OC)		
Addr.	**Content**	**Description**
1418	Occurrence counter diagnostic no. 1	-
1419	Occurrence counter diagnostic no. 2	-
1420	Occurrence counter diagnostic no. 3	-
1421	Occurrence counter diagnostic no. 4	-
1422	Occurrence counter diagnostic no. 5	-
1423	Occurrence counter diagnostic no. 6	-
1424	Occurrence counter diagnostic no. 7	-
1425	Occurrence counter diagnostic no. 8	-
1426	Occurrence counter diagnostic no. 9	-
1427	Occurrence counter diagnostic no. 10	-
1428-1433	Not used	Reserved

Active Diagnostic Codes (DM2/SPN)		
Addr.	**Content**	**Description**
1434	SPN diagnostic no. 1	Lo word
1435	SPN diagnostic no. 2	Lo word
1436	SPN diagnostic no. 3	Lo word
1437	SPN diagnostic no. 4	Lo word
1438	SPN diagnostic no. 5	Lo word
1439	SPN diagnostic no. 6	Lo word
1440	SPN diagnostic no. 7	Lo word
1441	SPN diagnostic no. 8	Lo word
1442	SPN diagnostic no. 9	Lo word
1443	SPN diagnostic no. 10	Lo word
1444	SPN diagnostic no. 1	Hi word
1445	SPN diagnostic no. 2	Hi word
1446	SPN diagnostic no. 3	Hi word
1447	SPN diagnostic no. 4	Hi word
1448	SPN diagnostic no. 5	Hi word
1449	SPN diagnostic no. 6	Hi word
1450	SPN diagnostic no. 7	Hi word
1451	SPN diagnostic no. 8	Hi word
1452	SPN diagnostic no. 9	Hi word
1453	SPN diagnostic no. 10	Hi word
1454-1465	Not used	Reserved

Active Fail Mode Identifier (DM2/FMI)		
Addr.	**Content**	**Description**
1466	FMI diagnostic no. 1	-
1467	FMI diagnostic no. 2	-
1468	FMI diagnostic no. 3	-
1469	FMI diagnostic no. 4	-
1470	FMI diagnostic no. 5	-
1471	FMI diagnostic no. 6	-
1472	FMI diagnostic no. 7	-
1473	FMI diagnostic no. 8	-
1474	FMI diagnostic no. 9	-
1475	FMI diagnostic no. 10	-
1476-1481	Not used	Reserved

Active Occurrence Counter (DM2/OC)		
Addr.	**Content**	**Description**
1482	Occurrence counter diagnostic no. 1	-
1483	Occurrence counter diagnostic no. 2	-
1484	Occurrence counter diagnostic no. 3	-
1485	Occurrence counter diagnostic no. 4	-
1486	Occurrence counter diagnostic no. 5	-
1487	Occurrence counter diagnostic no. 6	-
1488	Occurrence counter diagnostic no. 7	-
1489	Occurrence counter diagnostic no. 8	-
1490	Occurrence counter diagnostic no. 9	-
1491	Occurrence counter diagnostic no. 10	-
1492-1499	Not used	Reserved

8.4.5 Alarms via Modbus - Caterpillar/Perkins

Alarm, status and measurement table (read only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 7570 EIC communication error
		Bit 1 7580 EIC warning
		Bit 2 7590 EIC shutdown
		Bit 3 7600 EIC overspeed
		Bit 4 7610 EIC coolant water temperature 1
		Bit 5 7620 EIC coolant water temperature 2
		Bit 6 7630 EIC oil pressure 1
		Bit 7 7640 EIC oil pressure 2
		Bit 8 7650 EIC oil temp. 1
		Bit 9 7660 EIC oil temp. 2
		Bit 10 7670 EIC coolant level 1[1]
		Bit 11 7680 EIC coolant level2[1]
1024	EIC alarms, engine controller (DM1)	Bit 1 EIC low oil pressure, warning
		Bit 2 EIC low oil pressure, shutdown
		Bit 3 EIC boost pressure, warning
		Bit 4 EIC high coolant temperature, warning
		Bit 5 EIC low coolant level, shutdown
		Bit 6 EIC high inlet air temperature, warning
		Bit 7 EIC fuel temperature, warning
		Bit 8 EIC ECM yellow lamp, warning
		Bit 9 EIC ECM red lamp, shutdown
		Bit 10 EIC overspeed, warning
		Bit 11 EIC overspeed, shutdown
		Bit 12 EIC protection[1]
		Bit 13 EIC malfunction[1]

Bits marked [1] do not apply to PPM-3.

8.4.6 Alarms via Modbus - Cummins

Alarm, status and measurement table (read only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 7570 EIC communication error
		Bit 1 7580 EIC warning
		Bit 2 7590 EIC shutdown
		Bit 3 7600 EIC overspeed
		Bit 4 7610 EIC coolant water temperature 1
		Bit 5 7620 EIC coolant water temperature 2
		Bit 6 7630 EIC oil pressure 1
		Bit 7 7640 EIC oil pressure 2
		Bit 8 7650 EIC oil temp. 1
		Bit 9 7660 EIC oil temp. 2
		Bit 10 7670 EIC coolant level 1[1]
		Bit 11 7680 EIC coolant level 2[1]
1023	EIC alarms, engine controller (DM1)	Bit 0 EIC yellow[1]
		Bit 1 Red*
		Bit 2 EIC protection[1]
		Bit 3 EIC malfunction[1]
1024	EIC alarms, engine controller (DM1)	Bit 0 EIC DEC communication error
		Bit 1 EIC low oil pressure, warning
		Bit 2 EIC low oil pressure, shutdown
		Bit 3 EIC high coolant temp, warning
		Bit 4 EIC high coolant temperature, shutdown
		Bit 5 EIC low coolant level, warning
		Bit 6 EIC low coolant level, shutdown
		Bit 7 EIC intake manifold temp, warning
		Bit 8 EIC intake manifold, shutdown
		Bit 9 EIC fuel temp., warning
		Bit 10 EIC fuel temp, shutdown
		Bit 11 EIC coolant pressure, shutdown
		Bit 12 EIC oil temp., warning
		Bit 13 EIC oil temp., warning
		Bit 14 EIC overspeed shutdown
		Bit 15 EIC crankcase press., shutdown

Bits marked [1] do not apply to PPM-3.

8.4.7 Alarms via Modbus - DDEC – Detroit engines

Alarm, status and measurement table (read only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 7570 EIC communication error
		Bit 1 7580 EIC warning
		Bit 2 7590 EIC shutdown
		Bit 3 7600 EIC overspeed
		Bit 4 7610 EIC coolant water temperature 1
		Bit 5 7620 EIC coolant water temperature 2
		Bit 6 7630 EIC oil pressure 1
		Bit 7 7640 EIC oil pressure 2
		Bit 8 7650 EIC oil temp. 1
		BIt 9 7660 EIC oil temp. 2
		Bit 10 7670 EIC coolant level 1[1]
		Bit 11 7680 EIC coolant level 2[1]
1024	EIC alarms, engine controller (DM1)	Bit 0 EIC communication error, warning
		Bit 1 EIC warning
		Bit 2 EIC shutdown
		Bit 3 EIC protection[1]
		Bit 4 EIC malfunction[1]

Bits marked [1] do not apply to PPM-3.

8.4.8 Alarms via Modbus - EMR 2 – EMR 3 - Deutz engines

Alarm, status and measurement table (read only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 7570 EIC communication error
		Bit 1 7580 EIC warning
		Bit 2 7590 EIC shutdown
		Bit 3 7600 EIC overspeed
		Bit 4 7610 EIC coolant water temperature 1
		Bit 5 7620 EIC coolant water temperature 2
		Bit 6 7630 EIC oil pressure 1
		Bit 7 7640 EIC oil pressure 2
		Bit 8 7650 EIC oil temp. 1
		Bit 9 7660 EIC oil temp. 2
		Bit 10 7670 EIC coolant level 1[1]
		Bit 11 7680 EIC coolant level 2[1]
1024	EIC alarms, engine controller (DM1)	Bit 0 EIC high coolant temperature, shutdown
		Bit 1 EIC low oil pressure, shutdown
		Bit 2 EIC overspeed, shutdown
		Bit 3 EIC EMR shutdown (LS: lamp status)
		Bit 4 EIC EMR warning (LS: lamp status)
		Bit 5 EIC communication error
		Bit 6 EIC protection[1]
		Bit 7 EIC malfunction[1]

Bits marked [1] do not apply to PPM-3.

8.4.9 Alarms via Modbus - Generic J1939

Alarm, status and measurement table (read only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 7570 EIC communication error
		Bit 1 7580 EIC warning
		Bit 2 7590 EIC shutdown
		Bit 3 7600 EIC overspeed
		Bit 4 7610 EIC coolant water temperature 1
		Bit 5 7620 EIC coolant water temperature 2
		Bit 6 7630 EIC oil pressure 1
		Bit 7 7640 EIC oil pressure 2
		Bit 8 7650 EIC oil temp. 1
		Bit 9 7660 EIC oil temp. 2
		Bit 10 7670 EIC coolant level 1[1]
		Bit 11 7680 EIC coolant level 2[1]
1024	EIC alarms, engine controller (DM1)	Bit 0 EIC communication error[1]
		Bit 1 EIC yellow[1]
		Bit 2 EIC red[1]
		Bit 3 EIC protection[1]
		Bit 4 EIC malfunction[1]

Bits marked [1] do not apply to PPM-3.

8.4.10 Alarms via Modbus - Iveco

Alarm, status and measurement table (read only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 7570 EIC communication error
		Bit 1 7580 EIC warning
		Bit 2 7590 EIC shutdown
		Bit 3 7600 EIC overspeed
		Bit 4 7610 EIC coolant water temperature 1
		Bit 5 7620 EIC coolant water temperature 2
		Bit 6 7630 EIC oil pressure 1
		Bit 7 7640 EIC oil pressure 2
		Bit 8 7650 EIC oil temp. 1
		Bit 9 7660 EIC oil temp. 2
		Bit 10 7670 EIC coolant level 1[1]
		Bit 11 7680 EIC coolant level 2[1]
1024	EIC alarms, engine controller (DM1)	Bit 0 EIC communication error
		Bit 1 EIC low oil pressure, warning
		Bit 2 EIC low oil pressure, shutdown
		Bit 3 EIC boost pressure, warning
		Bit 4 EIC high coolant temperature, warning
		Bit 5 EIC low coolant level, shutdown
		Bit 6 EIC high inlet air temperature, warning
		Bit 7 EIC fuel temperature, warning
		Bit 8 EIC ECM yellow lamp, warning
		Bit 9 EIC ECM red lamp, shutdown
		Bit 10 EIC overspeed, warning
		Bit 11 EIC overspeed, shutdown
		Bit 12 EIC protection[1]
		Bit 13 EIC malfunction[1]

Bits marked [1] do not apply to PPM-3.

8.4.11 Alarms via Modbus - JDEC – John Deere engines

Alarm, status and measurement table (read-only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 7570 EIC communication error
		Bit 1 7580 EIC warning
		Bit 2 7590 EIC shutdown
		Bit 3 7600 EIC overspeed
		Bit 4 7610 EIC coolant water temperature 1
		Bit 5 7620 EIC coolant water temperature 2
		Bit 6 7630 EIC oil pressure 1
		Bit 7 7640 EIC oil pressure 2
		Bit 8 7650 EIC oil temp. 1
		Bit 9 7660 EIC oil temp. 2
		Bit 10 7670 EIC coolant level 1[1]
		Bit 11 7680 EIC coolant level 2[1]
1024	EIC alarms, engine controller (DM1)	Bit 0 EIC high coolant temperature, shutdown
		Bit 1 EIC low oil pressure, shutdown
		Bit 2 EIC fuel temperature, shutdown
		Bit 3 EIC fuel control valve, shutdown
		Bit 4 EIC ECU failure, shutdown
		Bit 5 EIC oil pressure, warning
		Bit 6 EIC intake manifold, warning
		Bit 7 EIC coolant temperature, warning
		Bit 8 EIC fuel injection pump, warning
		Bit 9 EIC JDEC shutdown (LS: lamp status)
		Bit 10 EIC JDEC warning (LS: lamp status)
		Bit 11 EIC communication error[1]
		Bit 12 EIC protection[1]
		Bit 13 EIC malfunction[1]

Bits marked [1] do not apply to PPM-3.

8.4.12 Alarms via Modbus - MTU ADEC

Alarm, status and measurement table (read only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 EIC 7570 communication error
		Bit 2 EIC 7590 shutdown
		Bit 3 EIC 7600 overspeed
		Bit 4 EIC 7610 coolant water temperature 1
		Bit 5 EIC 7620 coolant water temperature 2
		Bit 6 EIC oil pressure 1
		Bit 7 EIC 7640 oil pressure 2
		Bit 8 EIC 7650 oil temp. 1
		Bit 9 EIC 7660 oil temp. 2
		Bit 10 EIC 7670 coolant level 1[1]
		Bit 11 EIC 7680 coolant level 2[1]
1022	EIC alarms, engine controller	Bit 0 EIC ECU power supp voltage LoLo
		Bit 1 EIC Fuel high temp
		Bit 2 EIC Exhaust A high temp
		Bit 3 EIC Exhaust B high temp
		Bit 4 EIC Pressure 1 high (Aux 1)
		Bit 5 EIC Pressure 2 high (Aux 2)
		Bit 6 EIC Day tank high level
		Bit 7 EIC Day tank low level
		Bit 8 EIC Run-up speed not reached
		Bit 9 EIC Idle speed not reached
1023	EIC alarms, engine controller	Bit 0 EIC Common alarm red
		Bit 1 EIC Overspeed
		Bit 2 EIC Lube oil press LowLow
		Bit 3 EIC Coolant temperature HiHi
		Bit 4 EIC Lube oil temp HiHi
		Bit 5 EIC Charge air temp HiHi
		Bit 6 EIC ECU power supp voltage HiHi
		Bit 7 EIC Generator temp high warning
		Bit 8 EIC Holding tank high level
		Bit 9 EIC Holding tank low level
		Bit 10 EIC Winding 1 temp high
		Bit 11 EIC Winding 2 temp high
		Bit 12 EIC Winding 3 temp high

Addr.	Content	Type
		Bit 13 EIC Ambient temp high
		Bit 14 EIC Water in fuel 1
		Bit 15 EIC Water in fuel 2
1024	EIC alarms, engine controller	Bit 0 EIC Coolant high temp
		Bit 1 EIC Charge air high temp
		Bit 2 EIC Intercooler coolant high temp
		Bit 3 EIC Lube oil high temp
		Bit 4 EIC ECU high temp
		Bit 5 EIC Engine speed low
		Bit 6 EIC Prelube fail
		Bit 7 EIC Start speed not reached Common alarm
		Bit 8 EIC yellow
		Bit 9 EIC Lube oil pressure low
		Bit 10 EIC Coolant level low
		Bit 11 EIC Intercooler coolant level low
		Bit 12 EIC ECU defect
		Bit 13 EIC Speed demand defect
		Bit 14 EIC Power supply low voltage
		Bit 15 EIC Power supply high voltage

Bits marked 1 do not apply to PPM-3.

8.4.13 Alarms via Modbus - MTU ADEC module 501, without SAM module

Alarm, status and measurement table (read only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 EIC communication error
		Bit 2 EIC shutdown
		Bit 3 EIC overspeed
		Bit 4 EIC coolant water temperature 1
		Bit 5 EIC coolant water temperature 2
		Bit 6 EIC oil pressure 1
1022	EIC alarms, engine controller	Bit 0 EIC Automatic engine stop[1]
		Bit 1 EIC MG start speedfail[1]
		Bit 2 EIC Runup speedfail1
		Bit 3 EIC Idle speedfail[1]
		Bit 4 EIC ECU power supply voltage low limit2[1]
		Bit 5 EIC ECU power supply voltge high limit2[1]
		Bit 6 EIC Aftercooler coolant level sensor defect[1]
		Bit 7 EIC Fuel temperature high limit 2[1]
1023	EIC alarms, engine controller	Bit 0 EIC Common rail fuel pressure limit 1[1]
		Bit 1 EIC Common rail fuel pressure limit 2[1]
		Bit 2 EIC Override[1]
		Bit 3 EIC Preheat temperature low[1]
		Bit 4 EIC Charge air coolant level 2[1]
		Bit 5 EIC Power amplifier 1[1]
		Bit 6 EIC Power amplifier 2[1]
		Bit 7 EIC Transistor output status, TAA1 to TAA6[1]
		Bit 8 EIC ECU Power supply voltage low limit1[1]
		Bit 9 EIC ECU Power supply voltage high limit1[1]
		Bit 10 EIC Charge air temperature limit1[1]
		Bit 11 EIC Lube oil temperature limit1[1]
		Bit 12 EIC ECU temperature limit1[1]
		Bit 13 EIC Engine speed low limit1[1]
		Bit 14 EIC Check error code[1]
		Bit 15 EIC Common rail leakage[1]
1024	EIC alarms, engine controller	Bit 0 EIC overspeed, shutdown
		Bit 1 EIC low oil pressure, warning

Addr.	Content	Type
		Bit 2 EIC low oil pressure, shutdown
		Bit 3 EIC low coolant level, shutdown
		Bit 4 EIC ADEC ECU failure, shutdown
		Bit 5 EIC high coolant temperature, warning
		Bit 6 EIC high coolant temperature, shutdown
		Bit 7 EIC high intercooler coolant temp, warning
		Bit 8 EIC high oil temperature, shutdown
		Bit 9 EIC high charge air temperature, shutdown
		Bit 10 EIC defect coolant level switch, warning
		Bit 11 EIC ADEC yellow alarm, warning
		Bit 12 EIC ADEC red alarm, shutdown
		Bit 13 EIC communication error[1]
		Bit 14 EIC fuel delivery pressure limit1[1]
		Bit 15 EIC fuel delivery pressure limit2[1]

Bits marked [1] only apply to AGC-4, AGC 200 and AGC PM.

8.4.14 Alarms via Modbus - MTU Smart Connect

Alarms, status and measurement table (read only) function code 04h.

This protocol does not apply to PPM-3.

Addr.	Content	Type
1020	EIc alarms, DEIF controller	Bit 0 7570 EIC communication error
		Bit 1 7580 EIC warning
		Bit 2 7590 EIC shutdown
		Bit 3 7600 EIC overspeed
		Bit 4 7610 EIC coolant water temp. 1
		Bit 5 7620 EIC coolant water temp. 2
		Bit 6 7630 EIC oil pressure level 1
		Bit 7 7640 EIC oil pressure level 2
		Bit 8 7650 EIC oil temp. 1
		Bit 9 7660 EIC oil temp. 2
		Bit 10 7670 EIC coolant level 1
		Bit 11 7680 EIC coolant level 2
1024	EIC alarms, engine controller (DM1)	Bit 0 EIC communication error
		Bit 1 EIC yellow
		Bit 2 EIC red
		Bit 3 EIC protection
		Bit 4 EIC malfunction

8.4.15 Alarms via Modbus - MTU MDEC series - 2000/4000 - module 302 & 303

Alarm, status and measurement table (read-only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 EIC communication error
		Bit 2 EIC shutdown
		Bit 3 EIC overspeed
		Bit 4 EIC coolant water temperature 1
		Bit 5 EIC coolant water temperature 2
		Bit 6 EIC oil pressure 1
		Bit 7 EIC oil pressure 2
1022	EIC alarms, engine controller	Bit 0 EIC Automatic engine stop[1]
		Bit 1 EIC MG start speed fail[1]
		Bit 2 EIC Runup speed fail[1]
		Bit 3 EIC Idle speed fail[1]
		Bit 4 EIC ECU power supply voltage low limit 2[1]
		Bit 5 EIC ECU power supply voltage high limit 2[1]
		Bit 6 EIC Aftercooler coolant level sensor defect[1]
		Bit 7 EIC Fuel temperature high limit 2[1]
1023	EIC alarms, engine controller	Bit 0 EIC Common rail fuel pressure limit 1[1]
		Bit 1 EIC Common rail fuel pressure limit 2[1]
		Bit 2 EIC Override[1]
		Bit 3 EIC Preheat temperature low[1]
		Bit 4 EIC Charge air coolant level 2[1]
		Bit 5 EIC Power amplifier 1[1]
		Bit 6 EIC Power amplifier 2[1]
		Bit 7 EIC Transistor output status, TAA1 to TAA6[1]
		Bit 8 EIC ECU Power supply voltage low limit 1[1]
		Bit 9 EIC ECU Power supply voltage high limit 1[1]
		Bit 10 EIC Charge air temperature limit 1[1]
		Bit 11 EIC Lube oil temperature limit 1[1]
		Bit 12 EIC ECU temperature limit 1[1]
		Bit 13 EIC Engine speed low limit 1[1]
		Bit 14 EIC Check error code[1]
		Bit 15 EIC Common rail leakage[1]

Addr.	Content	Type
1024	EIC alarms, engine controller	Bit 0 EIC overspeed, shutdown
		Bit 1 EIC low oil pressure, warning
		Bit 2 EIC low oil pressure, shutdown
		Bit 3 EIC low coolant level, shutdown
		Bit 4 EIC MDEC ECU failure, shutdown
		Bit 5 EIC high coolant temperature, warning
		Bit 6 EIC high coolant temperature, shutdown
		Bit 7 EIC high intercooler coolant temp, warning
		Bit 8 EIC high oil temperature, shutdown
		Bit 9 EIC high charge air temperature, shutdown
		Bit 10 EIC defect coolant level switch, warning
		Bit 11 EIC MDEC yellow alarm, warning
		Bit 12 EIC MDEC red alarm, shutdown
		Bit 13 EI communication error[1]
		Bit 14 EIC fuel delivery pressure limit 1[1]
		Bit 15 EIC fuel delivery pressure limit 2[1]

Bits marked [1] only apply to AGC-4, AGC 200, AGC PM and CGC 400.

8.4.16 Alarms via Modbus - Scania

Alarm, status and measurement table (read-only) function code 04h.

Addr.	Content	Type
1026	EIC alarms (KWP 2000)	Bit 0 EIC overreving
		Bit 1 EIC speed sensor 1
		Bit 2 EIC speed sensor 2
		Bit 3 EIC water temp. sensor
		Bit 4 EIC charge air temp. sensor
		Bit 5 EIC charge air pressure sensor
		Bit 6 EIC oil temp. sensor
		Bit 7 EIC oil pressure sensor
		Bit 8 EIC fault in cor.
		Bit 9 EIC throttle pedal
		Bit 10 EIC emergency stop override
		Bit 11 EIC oil pressure prot.
		Bit 12 EIC wrong parameter
		Bit 13 EIC battery voltage
		Bit 14 EIC oil pressure prot.
		Bit 15 EIC emergency stop cor.
1027	EIC alarms (KWP 2000)	Bit 0 EIC CAN cir. defect
		Bit 1 EIC CAN mess. DLN1
		Bit 2 EIC Wrong CAN version
		Bit 3 EIC un. inj. cyl. 1
		Bit 4 EIC un. inj. cyl. 2
		Bit 5 EIC un. inj. cyl. 3
		Bit 6 EIC un. inj. cyl. 4
		Bit 7 EIC un. inj. cyl. 5
		Bit 8 EIC un. inj. cyl. 6
		Bit 9 EIC un. inj. cyl. 7
		Bit 10 EIC un. inj. cyl. 8
		Bit 11 EIC extra ana. inp.
		Bit 12 EIC system shutdown
		Bit 13 EIC coola. L. prot.
		Bit 14 EIC HW watchdog
		Bit 15 EIC fault in RAM
1028	EIC alarms (KWP 2000)	Bit 0 EIC seal
		Bit 1 EIC coola. shut OFF

Addr.	Content	Type
		Bit 2 EIC overheat prot.
		Bit 3 Fault in TPU
		Bit 4 Not used
		Bit 5 Not used
		Bit 6 Not used
		Bit 7 Not used
		Bit 8 Not used
		Bit 9 Not used
		Bit 10 Not used
		Bit 11 Not used
		Bit 12 Not used
		Bit 13 Not used
		Bit 14 Not used
		Bit 15 Not used

8.4.17 Alarms via Modbus - Volvo Penta

Alarm, status and measurement table (read-only) function code 04h.

Addr.	Content	Type
1020	EIC alarms, DEIF controller	Bit 0 7570 EIC communication error
		Bit 1 7580 EIC warning
		Bit 2 7590 EIC shutdown
		Bit 3 7600 EIC overspeed
		Bit 4 7610 EIC coolant water temperature 1
		Bit 5 7620 EIC coolant water temperature 2
		Bit 6 7630 EIC oil pressure 1
		Bit 7 7640 EIC oil pressure 2
		Bit 8 7650 EIC oil temp. 1
		Bit 9 7660 EIC oil temp. 2
		Bit 10 7670 EIC coolant level 1*
		Bit 11 7680 EIC coolant level 2*
1024	EIC alarms (DM 1)	Bit 0 EIC overspeed, warning
		Bit 1 EIC oil pressure, warning
		Bit 2 EIC oil temperature, warning
		Bit 3 EIC high coolant temperature, warning
		Bit 4 EIC low coolant level, warning
		Bit 5 EIC fuel pressure, warning
		Bit 6 EIC ECM yellow lamp, warning
		Bit 7 EIC ECM red lamp, shutdown
		Bit 8 EIC high inlet air temperature, warning
		Bit 10 EIC battery voltage, warning
		Bit 11 EIC low oil level, warning
		Bit 12 EIC protection*
		Bit 13 EIC malfunction*

Bits marked * do not apply to PPM-3.

8.5 Appendix

8.5.1 MTU Smart connect ECU9 - Alarm texts

DEIF Display	MTU	SPN	FMI
SD Feedback Thrott A	SD Feedback Throttle A	51	11
Al Req Angle Throt A	Al Req Angle Throttle A	51	15
AL mixture throt A f	AL mixture throttle A fault	51	31
SS T-Coolant Interco	SS T-Coolant Intercooler	52	0
SD T-Coolant InterC	SD T-Coolant Intercooler	52	11
HI T-Coolant Interco	HI T-Coolant Intercooler	52	15
SS P-Fuel	SS P-Fuel	94	1
SD P-Fuel before Fil	SD P-Fuel before Filter	94	11
LO P-Fuel	LO P-Fuel	94	17
SS P-Diff-Fuel	SS P-Diff-Fuel	95	0
SD P-Diff Fuel	SD P-Diff Fuel	95	11
HI P-Diff-Fuel	HI P-Diff-Fuel	95	15
SD Level W.Fuel PreF	SD Level Water Fuel Prefilter	97	11
HI Level W.Fuel PreF	HI Level Water Fuel Prefilter	97	15
AL L2 Level Lube oil	AL L2 Level Lube Oil J1939	98	1
SD Level Lube oil	SD Level Lube Oil J1939	98	11
SD Level Lube oil	SD Level Lube Oil	98	11
AL L1 Level Lube Oil	AL L1 Level Lube Oil J1939	98	17
SS P-Diff-Lube Oil	SS P-Diff-Lube Oil	99	0
SD P-Diff Lube Oil	SD P-Diff Lube Oil	99	11
HI P-Diff-Lube Oil	HI P-Diff-Lube Oil	99	15
SS P-Lube Oil	SS P-Lube Oil	100	1
SD P-Lube Oil	SD P-Lube Oil	100	11
LO P-Lube Oil	LO P-Lube oil	100	17
SS P-Crank Case	SS P-Crank Case	101	0
LOLO P-Crank Case	LOLO P-Crank Case	101	1
SD P-CrankCase	SD P-CrankCase	101	11
HI P-Crank Case	HI P-Crank Case	101	15
LO P-Crank Case	LO P-Crank Case	101	17
HIHI P-Charge Mix A	HIHI P-Charge Mix A	102	0
SD P-Charge Mix A	SD P-Charge Mix A	102	11
SS ETC1 Overspeed	SS ETC1 Overspeed	103	0
SD Charger 1 Speed	SD Charger 1 Speed	103	11
HI ETC1 Overspeed	HI ETC1 Overspeed	103	15

DEIF Display	MTU	SPN	FMI
AL L2 P-Lubeoil ETCA	AL L2 P-Lubeoil ETC A	104	1
SD-P-Lubeoil ETC A	SD-P-Lubeoil ETC A	104	11
AL L1 P-Lubeoil ETCA	AL L1 P-Lubeoil ETC A	104	17
HIHI T-Charge Mix	HIHI T-Charge Mix	105	0
HIHI T-Intake Air	HIHI T-Intake Air	105	0
SS T-Charge Air	SS T-Charge Air	105	0
SD T-Charge Air	SD T-Charge Air	105	11
SD T-Charge Mix	SD T-Charge Mix	105	11
HI T-Charge Mix	HI T-Charge Mix	105	15
HI T-Charge Air	HI T-Charge-air	105	15
HI T-Intake Air	HI T-Intake Air	105	15
LO T-Charge Mix	LO T-Charge Mix	105	17
SD P-Intake Air Filt	SD P-Intake Air Filter Diff.	107	11
SD P-AmbientAirT2800	SD P-Ambient Air (HDT2800)	108	11
SS P-Coolant	SS P-Coolant	109	1
SD P-Coolant	SD P-Coolant	109	11
HI P-Coolant	HI P-Coolant	109	15
LO P-Coolant	LO P-Coolant	109	17
SS T-Coolant L4	SS T-Coolant L4	110	0
SD T-Coolant	SD T-Coolant	110	11
HI T-Coolant	HI T-Coolant	110	15
SS T-Coolant	SS T-Coolant	110	16
ALL2 Lev Cool. Water	AL L2 Level Coolant Water	111	1
SD Level Coolant W.	SD Level Coolant Water	111	11
ALL1 Lev Coola Water	AL L1 Level Coolant Water	111	17
LO Coolant Level	LO Coolant Level	111	17
SD P-Coolant Diff	SD P-Coolant Diff	112	11
LO P-Coolant Diff	LO P-Coolant Diff	112	17
SD P-HD	SD P-HD	157	11
HI P-Fuel (ComRail)	HI P-Fuel (Common Rail)	157	15
LO P-Fuel (ComRail)	LO P-Fuel (Common Rail)	157	17
HIHI ECU PS Voltage	HIHI ECU Power Supply Voltage	158	0
LOLO ECU PS Voltage	LOLO ECU Power Supply Voltage	158	1
SD ECU PS Voltage	SD ECU Power Supply Voltage	158	11
HI ECU PS Voltage	HI ECU Power Supply Voltage	158	15
LO ECU PS Voltage	LO ECU Power Supply Voltage	158	17
SD T0-AmbientAir	SD T0-Ambient Air (HDT2800)	171	11

DEIF Display	MTU	SPN	FMI
LOLO T-Intake Air	LOLO T-Intake Air	172	1
SD T-Intake Air	SD T-Intake Air	172	11
LO T-Intake Air	LO T-Intake Air	172	17
SD-T-Exh. after Eng.	SD-T-Exh. after Engine	173	11
AL L1 T-Exh. aft.Eng	AL L1 T	173	17
AL L2 T-Fuel b.Eng.	AL L2 T-Fu	174	0
SS T-Fuel	SS T-Fuel	174	0
AL T-Gas L2	AL T-Gas L2	174	1
SD T-Fuel	SD T-Fuel	174	11
SD T-Fuel b.Engine	SD T-Fu	174	11
SD T-Gas	SD T-Gas	174	11
AL L1 T-Fuel b.Eng.	AL L1 T-Fu	174	15
HI T-Fuel	HI T-Fuel	174	15
AL T-Gas L1	AL T-Gas L1	174	17
SS T-Lube Oil	SS T-Lube Oil	175	0
SD T-Lube Oil	SD T-Lube Oil	175	11
HI T-Lube Oil	HI T-Lube Oil	175	15
AL L2 T-Lubeoil ETC	AL L2 T-Lubeoil ETC	176	0
SD-T-Lubeoil ETC	SD-T-Lubeoil ETC	176	11
AL L1 T-Lubeoil ETC	AL L1 T-Lubeoil ETC	176	15
SS Idle Sp.N Reac	SS Idle Speed Not Reached	188	1
SS Engine Overspeed	SS Engine Overspeed	190	0
SS Engine Speed tooL	SS Engine Speed too Low	190	1
AL Eng Hours Cnt def	AL Eng Hours Counter Defect	247	31
AL Fuel Cons.Cnt def	AL Fuel Cons. Counter Defect	250	31
AL L1 T-Aux 1	AL L1 T-Aux 1	441	15
AL L2 T-Aux2	AL L2 T-Aux2	442	0
AL L1 T-Aux 2	AL L1 T-Aux 2	442	15
AL Comb. Alarm Red	AL Comb. Alarm Red (Plant)	623	31
AL Comb. Alarm Yel	AL Comb. Alarm Yel (Plant)	624	31
SD Speed Demand	SD Speed Demand	898	11
AL Develop PR Set	AL Develop PR Set	966	31
AL L2 Aux1	AL L2 Aux1	1083	0
SD AUX 1	SD AUX 1	1083	11
AL L1 Aux 1	AL L1 Aux 1	1083	15
AL L2 Aux2	AL L2 Aux2	1084	0
SD AUX 2	SD AUX 2	1084	11

DEIF Display	MTU	SPN	FMI
AL L1 Aux 2	AL L1 Aux 2	1084	15
AL HIHI T-ChargeAirB	AL HIHI T-Charge Air B	1131	0
SD T-Charge Air B	SD T-Charge Air B	1131	11
AL HI T-Charge Air B	AL HI T-Charge Air B	1131	15
SD T-ECU	SD T-ECU	1136	11
HI T-ECU	HI T-ECU	1136	15
AL L2 P-Lubeoil ETCB	AL L2 P-Lubeoil ETC B	1168	1
AL L1 P-Lubeoil ETCB	AL L1 P-Lubeoil ETC B	1168	17
SD P-Lube Oil (R2)	SD P-Lube Oil (R2)	1168	31
SD-P-Lubeoil ETC B	SD-P-Lubeoil ETC B	1168	31
SS ETC2 Overspeed	SS ETC2 Overspeed	1169	0
SD Charger 2 Speed	SD Charger 2 Speed	1169	11
HI ETC2 Overspeed	HI ETC2 Overspeed	1169	15
SS ETC3 Overspeed	SS ETC3 Overspeed	1170	0
SD Charger 3 Speed	SD Charger 3 Speed	1170	11
HI ETC3 Overspeed	HI ETC3 Overspeed	1170	15
SS ETC4 Overspeed	SS ETC4 Overspeed	1171	0
SD Charger 4 Speed	SD Charger 4 Speed	1171	11
HI ETC4 Overspeed	HI ETC4 Overspeed	1171	15
ALL2TExh.bef.TurbA1	AL L2 T-Exh. bef. HP Turbine A1	1172	1
ALL1TExh.bef.TurbA1	AL L1 T-Exh. bef. HP Turbine A1	1172	17
AL L2 P-IntakeA a.FA	AL L2 P-Intake Air after Filter A	1176	1
AL L1 P-IntakeA a.FA	AL L1 P-Intake Air after Filter A	1176	17
AL L2 P-IntakeA a.FB	AL L2 P-Intake Air after Filter B	1177	1
AL L1 P-IntakeA a.FB	AL L1 P-Intake Air after Filter B	1177	17
SS P-Coolant InterC	SS P-Coolant InterCooler	1203	1
SD P-Coolant InterC	SD P-Coolant Intercooler	1203	11
LO P-Coolant InterC	LO P-Coolant InterCooler	1203	17
SD P-Lube Oil bef. F	SD P-Lube Oil before Filter	1208	11
AL Override applied	AL Override applied	1237	31
SD Level Leak. Fuel	SD Level Leakage Fuel	1239	11
HI Level LeakageFuel	HI Level Leakage Fuel	1239	15
SD P-HD2	SD P-HD2	1349	11
SD-P-Fuel before Eng	SD-P-Fuel before Engine	1349	11
HI P-Fuel 2(ComRail)	HI P-Fuel 2 (Common Rail)	1349	15
AL L1 P-Fuel bef.Eng	AL L1 P-Fuel before Engine	1349	17
LO P-Fuel 2(ComRail)	LO P-Fuel 2 (Common Rail)	1349	17

DEIF Display	MTU	SPN	FMI
SD-Level Oil Refill	SD-Level Oil Refill Tank	1380	11
LO Oil Level Refill	LO Oil Level Refill	1380	17
AL L2 T-Aux1	AL L2 T-Aux1	1385	0
SD T-AUX 1	SD T-AUX 1	1385	11
SD T-AUX 2	SD T-AUX 2	1386	11
AL L2 P-Aux1	AL L2 P-Aux1	1387	1
SD P-AUX 1	SD P-AUX 1	1387	11
AL L1 P-Aux 1	AL L1 P-Aux 1	1387	17
AL L2 P-Aux2	AL L2 P-Aux2	1388	1
SD P-AUX 2	SD P-AUX 2	1388	11
AL L1 P-Aux 2	AL L1 P-Aux 2	1388	17
Niveau RM Tank	Niveau RM Tank	1761	11
SS T-Exhaust B	SS T-Exhaust B	2433	0
SD T-Exhaust B	SD T-Exhaust B	2433	11
HI T-Exhaust B	HI T-Exhaust B	2433	15
SS T-Exhaust A	SS T-Exhaust A	2434	0
SD T-Exhaust A	SD T-Exhaust A	2434	11
HI T-Exhaust A	HI T-Exhaust A	2434	15
SD P-Ch MixbefThrott	SD P-Charge Mix before Throttle	2631	11
SD T-RM Tank	SD T-RM Tank	3031	11
HIHI Nox Value	HIHI Nox Value	3226	0
LOLO Nox Value	LOLO Nox Value	3226	1
SD Smart NOx Oxi.Fac	SD Smart NOx Oxidation Factor O2	3226	11
HI Nox Value	HI Nox Value	3226	15
LO Nox Value	LO Nox Value	3226	17
AL NOx ATO1Comm.lost	AL NOx ATO1 Communication Lost	3226	31
AL L2 T-Exhaust Bef.	AL L2 T-Exhaust Before DPF	3242	0
SD T-Exhaust bef.DPF	SD T-Exhaust before DPF A	3242	11
AL L1 T-Exhaust Bef.	AL L1 T-Exhaust Before DPF	3242	15
AL L2 T-ExhaustAfter	AL L2 T-Exhaust After DPF	3246	0
SD T-Exhaust a. DPF	SD T-Exhaust after DPF A	3246	11
AL L1 T-ExhaustAfter	AL L1 T-Exhaust After DPF	3246	15
AL L2 P-DPF Diff.	AL L2 P-DPF Difference	3251	0
SD P-DeltaExhaustDPF	SD P-DeltaExhaust DPF A	3251	11
AL L1 P-DPF Diff.	AL L1 P-DPF Difference	3251	15
SS T-Fuel B	SS T-Fuel B	3468	0
SD-T-Fuel B	SD-T-Fuel B	3468	11

DEIF Display	MTU	SPN	FMI
HI T-Fuel B	HI T-Fuel B	3468	15
AL Urea Qua Release	AL Urea Quality Release	3516	31
AL turning activated	AL turning activated	3543	31
HIHI P-Charge Mix B	HIHI P-Charge Mix B	3562	0
SD P-Charge Mix B	SD P-Charge Mix B	3562	11
SS P-Charge Air	SS P-Charge Air	3563	0
SD P-Charge Air	SD P-Charge Air	3563	11
HI P-Charge Air	HI P-Charge Air	3563	15
SD Level Cool.InterC	SD Level Coolant Intercooler	3668	11
LO Coolant LevelIntC	LO Coolant Level Intercooler	3668	17
SD Feedback Thrott B	SD Feedback Throttle B	3673	11
Al Req Angle Throt B	Al Req Angle Throttle B	3673	15
AL mix throt B fault	AL mixture throttle B fault	3673	31
AL DPF Rigorous TM S	AL DPF Rigorous TM Suppression	3703	11
SD T-Coolant (R2)	SD T-Coolant (R2)	4076	31
SS T-Coolant bef Eng	SS T-Coolant before Engine	4193	0
SD T-Coolant b.Engin	SD T-Coolant b.Engine	4193	11
HI T-Coolant bef Eng	HI T-Coolant before Engine	4193	15
SD EngRPM 3rd Sensor	SD Engine Speed 3rd Sensor	4202	31
AL SCR F1 SU AdBlueQ	AL SCR F1 SU AdBlue Quantity	4348	15
AL L2 T-Exh.Bef.SCR1	AL L2 T-Exhaust Before SCR F1	4360	0
SD T-Exh bef. SCR F1	SD T-Exh before SCR F1	4360	11
SD T-Exh bef. SCR F3	SD T-Exh before SCR F3	4360	11
AL L1 T-Exh.Bef.SCR1	AL L1 T-Exhaust Before SCR F1	4360	15
AL F1 T-Exh bef.SCRL	AL F1 T-Exh before SCR too LOW	4360	17
AL L2 T-Exh.Aft.SCR1	AL L2 T-Exhaust After SCR F1	4363	0
SD T-Exh a. SCR F1	SD T-Exh after SCR F1	4363	11
SD T-Exh aft. SCR F3	SD T-Exh after SCR F3	4363	11
AL L1 T-Exh.Aft.SCR1	AL L1 T-Exhaust After SCR F1	4363	15
AL F1 T-Exh aft.SCRL	AL F1 T-Exh after SCR too LOW	4363	17
AL SCR F1 SU Rev. Ra	AL SCR F1 SU Revolution Range	4375	31
AL SCR F2 SU AdBlueQ	AL SCR F2 SU AdBlue Quantity	4401	15
AL L2 T-Exh.Bef.SCR2	AL L2 T-Exhaust Before SCR F2	4413	0
SD T-Exh bef. SCR F1	SD T-Exh before SCR F2	4413	11
AL L1 T-Exh.Bef.SCR2	AL L1 T-Exhaust Before SCR F2	4413	15
AL F2 T-Exh bef.SCRL	AL F2 T-Exh before SCR too LOW	4413	17
AL L2 T-Exh.Aft.SCR2	AL L2 T-Exhaust After SCR F2	4415	0

DEIF Display	MTU	SPN	FMI
SD T-Exh a. SCR F2	SD T-Exh after SCR F2	4415	11
AL L1 T-Exh.Aft.SCR2	AL L1 T-Exhaust After SCR F2	4415	15
AL F2 T-Exh aft.SCRL	AL F2 T-Exh after SCR too LOW	4415	17
AL SCR F2 SU Rev. Ra	AL SCR F2 SU Revolution Range	4441	31
SD Air Humidity	SD Air Humidity	4490	11
SD Air Humidity	SD Air Humidity (HDT2800)	4490	11
AL Rel. Humidity L1	AL Rel. Humidity L1	4490	15
AL L2 T-Exhaust Bef.	AL L2 T-Exhaust Before DOC	4765	0
SD T-Exhaust bef.DOC	SD T-Exhaust before DOC A	4765	11
AL L1 T-Exhaust Bef.	AL L1 T-Exhaust Before DOC	4765	17
AL Battery Not Charg	AL Battery Not Charging	4990	31
AL L2 P-Charge Air B	AL L2 P-Charge Air B	5422	1
AL L1 P-Charge Air B	AL L1 P-Charge Air B	5422	17
SD-P-Fuel Returnpath	SD-P-Fuel Return path	5571	11
AL L1 P-FuelRet.Path	AL L1 P-Fuel Return Path	5571	17
SD P-L Oil aft L. Pu	SD-P-Lube Oil aft Level Pump	520406	11
AL L1 P-OilNivPump	AL L1 P-OilNivPump	520406	17
AL Wiring TO 1	AL Wiring TO 1	520872	31
AL Selected Mode NV	AL Selected Mode not Valid	520873	31
AL No Valid ModeSw.S	AL No Valid Mode Switch Signal	520874	11
AL Speed Demand Fail	AL Speed Demand Failure	520875	31
AL SD Stop Button	AL SD Stop Button	520876	11
AL SD Start Button	AL SD Start Button	520877	11
AL SD Up Button	AL SD Up Button	520878	11
AL SD Down Button	AL SD Down Button	520879	11
AL SD Ext. Speed D_S	AL SD Ext. Speed Demand Switch	520880	11
AL SD Speed D Inc	AL SD Speed Demand Increase	520881	11
AL SD Bin Speed Lim	AL SD Binary Speed Limitation	520882	11
AL SD Droop 2 Switch	AL SD Droop 2 Switch	520883	11
AL SD Frequency SW	AL SD Frequency Switch	520884	11
AL SD Test Overspeed	AL SD Test Overspeed	520885	11
AL SD Override Butto	AL SD Override Button	520886	11
AL SD Alarm Reset	AL SD Alarm Reset	520887	11
AL SD Cylin CutOut	AL SD Cylinder Cut Out	520888	11
AL SD Request BinOut	AL SD Request BinOut Test	520889	11
AL SD Ext.Engine Pro	AL SD Ext. Engine Protection	520890	11
AL SD Prelubri. Sig.	AL SD Prelubrication Signal	520891	11

DEIF Display	MTU	SPN	FMI
AL SD Ext.IncIdleBin	AL SD Ext. Increased Idle Bin	520892	11
AL SD Request P. DBR	AL SD Request Plant DBR	520893	11
AL Wiring Cylind.A1	AL Wiring Cylinder A1	520900	31
AL Wiring Cylind.A2	AL Wiring Cylinder A2	520901	31
AL Wiring Cylind.A3	AL Wiring Cylinder A3	520902	31
AL Wiring Cylind.A4	AL Wiring Cylinder A4	520903	31
AL Wiring Cylind.A5	AL Wiring Cylinder A5	520904	31
AL Wiring Cylind.A6	AL Wiring Cylinder A6	520905	31
AL Wiring Cylind.A7	AL Wiring Cylinder A7	520906	31
AL Wiring Cylind.A8	AL Wiring Cylinder A8	520907	31
AL Wiring Cylind.A9	AL Wiring Cylinder A9	520908	31
AL Wiring Cylind.A10	AL Wiring Cylinder A10	520909	31
AL Wiring Cylind.B1	AL Wiring Cylinder B1	520910	31
AL Wiring Cylind.B2	AL Wiring Cylinder B2	520911	31
AL Wiring Cylind.B3	AL Wiring Cylinder B3	520912	31
AL Wiring Cylind.B4	AL Wiring Cylinder B4	520913	31
AL Wiring Cylind.B5	AL Wiring Cylinder B5	520914	31
AL Wiring Cylind.B6	AL Wiring Cylinder B6	520915	31
AL Wiring Cylind.B7	AL Wiring Cylinder B7	520916	31
AL Wiring Cylind.B8	AL Wiring Cylinder B8	520917	31
AL Wiring Cylind.B9	AL Wiring Cylinder B9	520918	31
AL Wiring Cylind.B10	AL Wiring Cylinder B10	520919	31
SS T-Coolant L3	SS T-Coolant L3	520923	0
AL Power too high	AL Power too high	520924	15
AL Open L.Cylind.A1	AL Open Load Cylinder A1	520930	31
AL Open L.Cylind.A2	AL Open Load Cylinder A2	520931	31
AL Open L.Cylind.A3	AL Open Load Cylinder A3	520932	31
AL Open L.Cylind.A4	AL Open Load Cylinder A4	520933	31
AL Open L.Cylind.A5	AL Open Load Cylinder A5	520934	31
AL Open L.Cylind.A6	AL Open Load Cylinder A6	520935	31
AL Open L.Cylind.A7	AL Open Load Cylinder A7	520936	31
AL Open L.Cylind.A8	AL Open Load Cylinder A8	520937	31
AL Open L.Cylind.A9	AL Open Load Cylinder A9	520938	31
AL Open L.Cylind.A10	AL Open Load Cylinder A10	520939	31
AL Open L.Cylind.B1	AL Open Load Cylinder B1	520940	31
AL Open L.Cylind.B2	AL Open Load Cylinder B2	520941	31
AL Open L.Cylind.B3	AL Open Load Cylinder B3	520942	31

DEIF Display	MTU	SPN	FMI
AL Open L.Cylind.B4	AL Open Load Cylinder B4	520943	31
AL Open L.Cylind.B5	AL Open Load Cylinder B5	520944	31
AL Open L.Cylind.B6	AL Open Load Cylinder B6	520945	31
AL Open L.Cylind.B7	AL Open Load Cylinder B7	520946	31
AL Open L.Cylind.B8	AL Open Load Cylinder B8	520947	31
AL Open L.Cylind.B9	AL Open Load Cylinder B9	520948	31
AL Open L.Cylind.B10	AL Open Load Cylinder B10	520949	31
AL Wiring TOP 1	AL Wiring TOP 1	520952	31
AL Wiring TOP 2	AL Wiring TOP 2	520953	31
AL Wiring TOP 3	AL Wiring TOP 3	520954	31
AL Wiring TOP 4	AL Wiring TOP 4	520955	31
AL Open Load DI 1	AL Open Load Digital Input 1	520958	31
AL Open Load DI 2	AL Open Load Digital Input 2	520959	31
AL Open Load DI 3	AL Open Load Digital Input 3	520960	31
AL Open Load DI 4	AL Open Load Digital Input 4	520961	31
AL Open Load DI 5	AL Open Load Digital Input 5	520962	31
AL Open Load DI 6	AL Open Load Digital Input 6	520963	31
AL Open Load DI 7	AL Open Load Digital Input 7	520964	31
AL Open Load DI 8	AL Open Load Digital Input 8	520965	31
AL Wiring PWM_CM1	AL Wiring PWM_CM1	520970	31
AL Wiring PWM_CM2	AL Wiring PWM_CM2	520971	31
AL Wiring PWM_CM3	AL Wiring PWM_CM3	520972	31
AL Wiring PWM_CM4	AL Wiring PWM_CM4	520973	31
AL Wiring PWM_CM5	AL Wiring PWM_CM5	520974	31
AL Wiring PWM_CM6	AL Wiring PWM_CM6	520975	31
AL Wiring PWM_CM7	AL Wiring PWM_CM7	520976	31
AL Wiring PWM_CM8	AL Wiring PWM_CM8	520977	31
AL Wiring PWM_CM9	AL Wiring PWM_CM9	520978	31
AL Wiring PWM_CM10	AL Wiring PWM_CM10	520979	31
HIHI U-PDU	HIHI U-PDU	520982	0
LOLO U-PDU	LOLO U-PDU	520982	1
SD U-PDU	SD U-PDU	520982	11
HI U-PDU	HI U-PDU	520982	15
LO U-PDU	LO U-PDU	520982	17
AL Wiring Suct. Res1	AL Wiring Suction Restrictor 1	520983	31
AL Wiring Suct. Res2	AL Wiring Suction Restrictor 2	520984	31
AL Wiring Pres.CV 1	AL Wiring Pressure Control Valve 1	520985	31

DEIF Display	MTU	SPN	FMI
AL Wiring Pres.CV 2	AL Wiring Pressure Control Valve 2	520986	31
AL Crash Rec. Init.	AL Crash Rec. Init. Error	520990	31
AL ECUPower OFF/ON R	AL ECU Power OFF/ON Required	520991	31
AL OL ASO FlapFeedbB	AL OL ASO Flap Feedback B	520994	11
AL ASOFlapB cl. Aerr	AL ASO Flap B closed, A failed	520995	11
AL OL ASO FlapFeedbA	AL OL ASO Flap Feedback A	520996	31
AL ASOFlapA cl. Aerr	AL ASO Flap A closed, B failed	520997	31
AL ASO Flaps Closed	AL ASO Flaps Closed	520998	31
AL ASOFlaps open/err	AL ASO Flaps open / failed to close	520999	31
AL ASO Flap A Not Cl	AL ASO Flap A Not Closed by ECU	521000	31
AL Rail Leakage	AL Rail Leakage	521001	31
SS Release Sp.N Reac	SS Release Speed Not Reached	521002	1
SS Starter Sp.N Reac	SS Starter Speed Not Reached	521003	1
SS T-Preheat	SS T-Preheat	521004	1
LO T-Preheat	LO T-Preheat	521004	17
AL ASO Flap B Not Cl	AL ASO Flap B Not Closed by ECU	521005	31
AL CAN1 Node Lost	AL CAN1 Node Lost	521006	31
AL CAN2 Node Lost	AL CAN2 Node Lost	521007	31
AL CAN Wrong Param.	AL CAN Wrong Parameters	521008	31
AL CAN No PU-Data	AL CAN No PU-Data	521009	31
AL CAN PU-Data Flash	AL CAN PU-Data Flash Error	521010	31
AL CAN1 Bus Off	AL CAN1 Bus Off	521011	31
AL CAN1 Error Pass.	AL CAN1 Error Passive	521012	31
AL CAN2 Bus Off	AL CAN2 Bus Off	521013	31
AL CAN2 Error Pass.	AL CAN2 Error Passive	521014	31
AL Stop Camsh. S def	AL Stop Camshaft Sensor Defect	521016	31
SD Crankshaft Speed	SD Crankshaft Speed	521017	11
SD Camshaft Speed	SD Camshaft Speed	521018	11
SD Frequency Input	SD Frequency Input	521019	11
AL Power Stage Low	AL Power Stage Low	521020	31
AL Power Stage High	AL Power Stage High	521021	31
AL Stop Power Stage	AL Stop Power Stage	521022	31
AL L2 Aux1 Plant	AL L2 Aux1 Plant	521023	0
AL L1 Aux1 Plant	AL L1 Aux1 Plant	521023	15
AL Stop MVWiring GND	AL Stop MV-Wiring Ground	521023	31
AL Open Load Emerg.	AL Open Load Emerg. Stop Input ESI	521024	31
SD Idle/End-TorqueIN	SD Idle/End-Torque Input [%]	521025	11

DEIF Display	MTU	SPN	FMI
SS Power Reduct. Act	SS Power Reduction Active	521026	31
AL Stop SD	AL Stop SD	521027	31
AL Wiring FO	AL Wiring FO	521028	31
AL Wiring PWM_CM2	AL Wiring PWM_CM2	521028	31
AL Ext. Engine Prot.	AL Ext. Engine Protection	521029	31
AL Starter Not Engag	AL Starter Not Engaged	521030	31
AL Power Cut-Off det	AL Power Cut-Off detected	521031	31
AL ESCM Override	AL ESCM Override	521032	31
AL MD CANReq Idle S.	AL MD CAN Request Idle Speed	521033	31
AL MD CAN Speed Limi	AL MD CAN Speed Limitation	521034	31
AL L2 PRV Defect	AL L2 PRV Defect	521035	0
AL L1 PRV Defect	AL L1 PRV Defect	521035	15
AL L1 PRV Defect	AL L1 PRV Defect	521036	31
AL L2 PRV Defect	AL L2 PRV Defect	521037	31
SD ETC1+ETC2	SD ETC1+ETC2	521038	11
AL Doub.Nod. Lost1+2	AL Double Nodes Lost CAN 1 + 2	521039	31
AL EIL Protection	AL EIL Protection	521040	31
AL EIL Error	AL EIL Error	521041	31
AL EGR Throttle ADef	AL EGR Throttle A Defect	521042	31
AL Bypass Throt. Def	AL Bypass Throttle Defect	521043	31
AL Dispen. Throt.Def	AL Dispenser Throttle Defect	521044	31
SD P-Exhaust Lambda	SD P-Exhaust Lambda	521045	11
SD P-Charge Air B	SD P-Charge Air B	521046	11
SD Smart NOx HeaterE	SD Smart NOx Heater Element	521047	11
SD Smart NOx Concent	SD Smart NOx Concentration	521048	11
AL Emission Fault	AL Emission Fault	521050	31
SD P-Fuel	SD P-Fuel	521052	11
AL L2L Voltage ASO	AL L2L Voltage ASO	521053	1
AL SD Voltage ASO	AL SD Voltage ASO	521053	11
AL L1L Voltage ASO	AL L1L Voltage ASO	521053	17
SD P-Ambient Air	SD P-Ambient Air	521060	11
AL Emerg. Stop fail	AL Emergency Stop Failed	521061	31
AL CAN Engine St.Loc	AL CAN Engine Start Lock	521062	31
SD P-Fuel bef. Add.s	SD P-Fuel bef. Add.sec.fuelfilter	521063	11
AL L1 P-Fuel Add.sec	AL L1 P-Fuel Add.sec.fuelfilt. Diff	521063	15
AL L2 P-Fuel b.o.F.	AL L2 P-Fuel b.o.F.	521064	0
SD P-Fuel b.o.F.	SD P-Fuel b.o.F.	521064	11

DEIF Display	MTU	SPN	FMI
AL L1 P-Fuel b.o.F.	AL L1 P-Fuel b.o.F.	521064	15
AL Emission Warning	AL Emission Warning	521067	31
AL Gas Path Warning	AL Gas Path Warning	521068	31
AL Gas Path Fault	AL Gas Path Fault	521069	31
AL GPE Lambda v.inva	AL GPE Lambda value invalid	521070	31
AL NOx value invalid	AL NOx value invalid	521071	31
AL Thermal Manag.Act	AL Thermal Management active	521072	31
AL p5 ctrlvar LO Act	AL p5 ctrlvar lower limit active	521073	31
AL p5 ctrlvar max BO	AL p5 ctrlvar max BOI min active	521074	31
AL Lambda ctrlvar li	AL Lambda ctrlvar limit min active	521075	31
AL Lambda ctrlvar ma	AL Lambda ctrlvar max BOI min act	521076	31
AL Nox p5 min BOI ma	AL Nox p5 min BOI max active	521077	31
AL NOx p5 max BOI mi	AL NOx p5 max BOI min active	521078	31
AL GPS p5 ctrlvar ma	AL GPS p5 ctrlvar max active	521080	31
AL GPS p5 ctrlvar mi	AL GPS p5 ctrlvar min active	521081	31
AL GPS p5 ctrlvar mi	AL GPS p5 ctrlvar min active	521082	31
AL Bypass Throttle 2	AL Bypass Throttle 2 Defect	521083	31
AL Bypass Valve Def.	AL Bypass Valve Defect	521084	31
AL Intake AirThrottl	AL Intake AirThrottle Defect	521085	31
SD Bosch LSU LambdaS	SD Bosch LSU Lambda Sensor	521086	11
AL EGR Throttle BDef	AL EGR Throttle B Defect	521087	31
AL L2 Delta T-NT Int	AL L2 Delta T-NT Intercooler	521088	0
AL L1 Delta T-NT Int	AL L1 Delta T-NT Intercooler	521088	17
AL Lim T-Coolant LT	AL Lim T-Coolant LT Fan	521089	31
AL ETC2 CutIn Failur	AL ETC2 CutIn Failure	521091	31
AL Prelubrication	AL Prelubrication Fault	521092	31
AL MCR exceeded 1h	AL MCR exceeded 1 hour	521093	31
AL EMU Parameter Not	AL EMU Parameter Not Supported	521094	31
SD Spinning Value	SD Spinning Value	521095	11
AL MCR exceeded	AL MCR exceeded	521096	31
AL Rail 2 Leakage	AL Rail 2 Leakage FMI-	521097	31
HI T-Exhaust EMU	HI T-Exhaust EMU	521098	15
LO T-Exhaust EMU	LO T-Exhaust EMU	521098	17
HI T-Coolant EMU	HI T-Coolant EMU	521099	15
SD Coil Current	SD Coil Current	521100	11
AL ETC4 CutIn Failur	AL ETC4 CutIn Failure	521103	31
AL ETC3 CutIn Failur	AL ETC3 CutIn Failure	521104	31

DEIF Display	MTU	SPN	FMI
AL Wiring POM Starte	AL Wiring POM Starter 1	521105	11
AL Wiring POM Starte	AL Wiring POM Starter 2	521106	11
AL Open Load POM Alt	AL Open Load POM Alternator	521107	11
AL L1 T-Raw W a. Pum	AL L1 T-Raw water after Pump	521108	17
AL CAN POM Node Lost	AL CAN POM Node Lost	521109	11
AL Low Starter Volta	AL Low Starter Voltage	521110	1
AL POM Error	AL POM Error	521111	31
AL Wrong POM-ID	AL Wrong POM-ID	521112	31
Write Error Flash	Write Error Flash	521113	31
Oillevel Calibration	Oillevel Calibration Error	521114	31
SD P-Intake Air a.FA	SD P-Intake Air after Filter A	521115	11
SD P-Intake Air a.FB	SD P-Intake Air after Filter B	521116	11
SS Engine Oversp. CS	SS Engine Overspeed Camshaft	521117	0
SD T-Lube Oil Pan	SD T-Lube Oil Pan	521118	11
AL T-Lube Oil Pan LO	AL T-Lube Oil Pan Low	521118	17
SD P-Oil Refill Pump	SD P-Oil Refill Pump	521119	11
LO P-Oil Refill Pump	LO P-Oil Refill Pump	521119	17
SD T-Exhaust A+B	SD T-Exhaust A+B	521120	11
SD T-Lube Oil Pan	SD T-Lube Oil Pan J1939	521121	11
AL MB Valve error	AL MB Valve error	521122	31
AL L2 P-DPF Norm Dif	AL L2 P-DPF Norm Difference	521123	0
AL L4 P-DPF Norm Dif	AL L4 P-DPF Norm Difference	521123	1
AL L1 P-DPF Norm Dif	AL L1 P-DPF Norm Difference	521123	15
AL L3 P-DPF Norm Dif	AL L3 P-DPF Norm Difference	521123	17
AL DPF Rigorous TM A	AL DPF Rigorous TM Aborted	521124	11
AL DPF Periodic Rigo	AL DPF Periodic Rigorous TM	521125	11
AL DPF Flash ReadErr	AL DPF Flash Read Error	521126	11
AL DEF Nozzle Damage	AL DEF Nozzle Damage	521127	11
AL SmartConnect Lost	AL Smart Connect Lost	521128	11
SD-T-Sea water a.Pum	SD-T-Sea water after Pump	521129	11
SD-P-LOil, HP Pump A	SD-P-Lube Oil at HP Pump A	521131	11
SD-P-LOil, HP Pump B	SD-P-Lube Oil at HP Pump B	521132	11
SD Charger 5 Speed	SD Charger 5 Speed	521133	11
AL F1 NOx bef. SCR	AL F1 NOx before SCR SensorDefect	521134	11
AL F1 NOx bef. SCR	AL F1 NOx before SCR Comm Lost	521134	31
AL F1 NOx a. SCR	AL F1 NOx after SCR SensorDefect	521135	11
AL F1 NOx a. SCR C	AL F1 NOx afterSCR Comm Lost	521135	31

DEIF Display	MTU	SPN	FMI
AL F2 NOx bef. SCR	AL F2 NOx before SCR SensorDefect	521136	11
AL F2 NOx bef. SCR	AL F2 NOx before SCR Comm Lost	521136	31
AL F2 NOx a. SCR	AL F2 NOx after SCR SensorDefect	521137	11
AL F2 NOx a. SCR	AL F2 NOx after SCR Comm Lost	521137	31
AL F3 NOx bef. SCR	AL F3 NOx before SCR SensorDefect	521138	11
AL F3 NOx bef. SCR	AL F3 NOx before SCR Comm Lost	521138	31
AL F3 NOx a. SCR	AL F3 NOx after SCR SensorDefect	521139	11
AL F3 NOx a. SCR	AL F3 NOx after SCR Comm Lost	521139	31
HI ETC1 Idle Speed H	HI ETC1 Idle Speed too High	521140	31
HI ETC2 Idle Speed H	HI ETC2 Idle Speed too High	521141	31
HI ETC3 Idle Speed H	HI ETC3 Idle Speed too High	521142	31
HI ETC4 Idle Speed H	HI ETC4 Idle Speed too High	521143	31
HI ETC5 Idle Speed H	HI ETC5 Idle Speed too High	521144	31
AL ETC1 Speed Dev.	AL ETC1 Speed Deviation	521145	31
AL ETC2 Speed Dev.	AL ETC2 Speed Deviation	521146	31
AL ETC3 Speed Dev.	AL ETC3 Speed Deviation	521147	31
AL ETC4 Speed Dev.	AL ETC4 Speed Deviation	521148	31
AL ETC5 Speed Dev.	AL ETC5 Speed Deviation	521149	31
AL ETC Job Rotation	AL ETC Job Rotation	521150	31
AL EIL Different Eng	AL EIL Different Engine Number	521151	31
AL ash volume	AL ash volume	521152	31
AL HIHI T-ChargeAEGR	AL HIHI T-Charge Air before EGR	521153	0
AL HI T-ChargeAirEGR	AL HI T-Charge Air before EGR	521153	15
SD T-Charge Air bef.	SD T-Charge Air before EGR	521153	31
AL HIHI T-Char.ADAB	AL HIHI T-Charge Air Diff AB	521154	0
AL HI T-ChargeAirDAB	AL HI T-Charge Air Diff AB	521154	15
AL Ext.Start, HD HI	AL External Start and HD too high	521155	31
AL Max. BlankShot TE	AL Max. Blank Shot time expired	521156	31
AL HSB1 Comm. lost	AL HSB1 Communication Lost	521157	31
AL HSB1 Actuat. def.	AL HSB1 Actuator defect	521158	31
AL NOx ATO1 Sen. Def	AL NOx ATO1 Sensor Defect	521159	31
AL HSB2 Comm. lost	AL HSB2 Communication Lost	521160	31
AL HSB2 Actuator def	AL HSB2 Actuator defect	521161	31
Defect DEFPsns/act S	Defect in DEF pipe sns/act system	521162	31
DEF Tank ht. sns/act	DEF Tank ht. sns/act defect	521163	31
AL HSB3 Comm. lost	AL HSB3 Communication Lost	521164	31
AL HSB3 Actuator def	AL HSB3 Actuator defect	521165	31

DEIF Display	MTU	SPN	FMI
AL HSB4 Comm. lost	AL HSB4 Communication Lost	521166	31
AL HSB4 Actuator def	AL HSB4 Actuator defect	521167	31
AL MB Valve defect 2	AL MB Valve defect 2	521168	31
AL EGR A Ref.learn	AL EGR A Reference learn failed	521169	31
AL Urea Tank L.Empty	AL Urea Tank Level Empty	521170	31
AL EGR B Ref. learn	AL EGR B Reference learn failed	521171	31
AL Bypass A Ref.	AL Bypass A Reference learn failed	521172	31
AL Bypass B Fast lea	AL Bypass B Fast learn failed	521173	31
AL Dispenser Ref.lea	AL Dispenser Reference learn failed	521174	31
AL Intake Thr. Ref L	AL Intake Throttle Ref learn failed	521175	31
AL SCR AdBlue press.	AL SCR AdBlue pressure	521176	31
AL Flow1 SU 1 Comm L	AL Flow 1 Supply Unit 1 Comm Lost	521177	31
AL Flow1 SU 2 Comm L	AL Flow 1 Supply Unit 2 Comm Lost	521178	31
AL Flow2 SU 1 Comm L	AL Flow 2 Supply Unit 1 Comm Lost	521179	31
AL Flow2 SU 2 Comm L	AL Flow 2 Supply Unit 2 Comm Lost	521180	31
AL Flow3 SU 1 Comm L	AL Flow 3 Supply Unit 1 Comm Lost	521181	31
AL Flow3 SU 2 Comm L	AL Flow 3 Supply Unit 2 Comm Lost	521182	31
AL Trican Comm. Lost	AL Trican Communication Lost	521183	31
AL OLT Comm. Lost	AL OLT Communication Lost	521184	31
AL SD T Coolant Cy.H	AL SD T Coolant at cylinder head	521187	11
HI T-Coolant Cy.Head	HI T-Coolant Cylinder Head	521187	15
SS T-Coolant Cyl. H	SS T-Coolant Cylinder Head	521187	16
AL F1 DEF consump.	AL F1 DEF consumption error	521188	31
AL F1 DEF balance	AL F1 DEF balance error	521189	31
AL F1 Raw gas emissi	AL F1 Raw gas emission error	521190	31
AL F1 NOx Annaeherun	AL F1 NOx Annaeherung error	521191	31
AL Texh bef SCR F1F2	AL T-Exh bef SCR between F1 and F2	521192	31
AL F1 Erw Tabg v SCR	AL F1 Erw T-Abg vor SCR Error	521193	31
AL F1Exp TExh af SCR	AL F1 Exp T-Exh aft SCR error	521194	31
AL F1 gr TExh bf SCR	AL F1 grad T-Exh bef SCR error	521195	31
AL F2 gr TExh bf SCR	AL F2 grad T-Exh bef SCR error	521196	31
AL F1 gr TExh af SCR	AL F1 grad T-Exh aft SCR error	521198	31
AL F2 gr TExh af SCR	AL F2 grad T-Exh aft SCR error	521199	31
AL SCR F3 T-Exh aft.	AL SCR F3 T-Exh after gradient	521200	31
AL L2 T-Exh.Bef.SCR3	AL L2 T-Exhaust Before SCR F3	521201	0
AL L1 T-Exh.Bef.SCR3	AL L1 T-Exhaust Before SCR F3	521201	15
AL L2 T-Exh.Aft.SCR3	AL L2 T-Exhaust After SCR F3	521202	0

DEIF Display	MTU	SPN	FMI
AL L1 T-Exh.Aft.SCR3	AL L1 T-Exhaust After SCR F3	521202	15
AL SCR oper. T TooLO	AL SCR operating temperature too-LOW	521203	17
AL Cataly conv. F1	AL Cataly conversion too lowF1	521204	17
AL Cataly conv. F2	AL Cataly conversion too lowF2	521205	17
AL Cataly conv. F3	AL Cataly conversion too lowF3	521206	17
AL Invalid LSI Ch.Co	AL Invalid LSI Channel Config	521207	31
AL SCR SU fault(s)	AL SCR SU fault(s) exist	521208	31
AL ETC0 CutIn Fail	AL ETC0 CutIn Failure	521209	31
AL ETC1 CutIn Fail	AL ETC1 CutIn Failure	521210	31
AL SCR SU fault(s)F2	AL SCR SU fault(s) exist F2	521211	31
AL SCR SU Prim. RF1	AL SCR SU Priming Request F1	521213	31
AL SCR SU Prim. RF2	AL SCR SU Priming Request F2	521214	31
AL L1 P-Oil bef. PuA	AL L1 P-Oil before HD Pump A	521216	17
AL L1 P-Oil bef. PuB	AL L1 P-Oil before HD Pump B	521217	17
SD Loadp.Analog filt	SD Loadp.Analog filt	521218	11
SD T-Intake Air B	SD T-Intake Air B	521219	11
SS P-Coolant befEng	SS P-Coolant before Engine	521220	1
SD P-Coolant b.Engin	SD P-Coolant b.Engine	521220	11
LO P-Coolant befEngi	LO P-Coolant before Engine	521220	17
SD P-Charge Mix Diff	SD P-Charge Mix Diff	521221	11
HI P-Charge Mix Diff	HI P-Charge Mix Diff	521221	31
HIHI P-ChargeMixDiff	HIHI P-Charge Mix Diff	521221	31
SD ele. Eng powerAI2	SD electr. engine power AI2	521222	31
AL CR Trig. Eng.Stop	AL CR Trigger Engine Stop	521223	31
HIHI Power Diff	HIHI Power Difference	521224	0
LOLO Power Diff	LOLO Power Difference	521224	1
AL GasControlCheck	AL GasControlCheck Fault	521225	31
AL Ignition Fault	AL Ignition Fault	521226	31
AL GasValve Fault	AL GasValve Fault	521227	31
AL EngineSpeedCollap	AL EngineSpeedCollapse Fault	521228	31
AL SAM Missing Data	AL SAM Missing Data Fault	521229	31
L3 Al CANMaxRetar. T	L3 Al CAN Max. Retarded Timing	521235	0
L1 Al CANMaxRetar. T	L1 Al CAN Max. Retarded Timing	521235	15
L2 Al CANMaxRetar. T	L2 Al CAN Max. Retarded Timing	521235	16
AL Cir. Break closed	AL Circuit Breaker Closed	521236	31
AL Hut Changespeed M	AL Hut Changespeed	521237	31
HIHI Actual Value Hu	HIHI Actual Value Hu	521238	0

DEIF Display	MTU	SPN	FMI
LOLO Actual Value Hu	LOLO Actual Value Hu	521238	1
HI Actual Value Hu	HI Actual Value Hu	521238	15
LO Actual Value Hu	LO Actual Value Hu	521238	17
Al Knock Intensity	Al Knock Intensity	521239	31
AL Preheating Error	AL Preheating Error	521240	31
AL GET Comm Lost	AL GET Comm Lost	521241	31
AL IC92x Comm Lost	AL IC92x Comm Lost	521242	31
AL FSeries Comm Lost	AL FSeries Comm Lost	521243	31
AL TecJet Comm Lost	AL TecJet Comm Lost	521244	31
AL ProActA Comm Lost	AL ProActA Comm Lost	521245	31
AL ProActB Comm Lost	AL ProActB Comm Lost	521246	31
AL NOxA Comm Lost	AL NOxA Comm Lost	521247	31
AL NOxB Comm Lost	AL NOxB Comm Lost	521248	31
AL Oil Refill Error	AL Oil Refill Error	521249	31
AL GET Yellow	AL GET Yellow	521250	31
AL IC92x Yellow	AL IC92x Yellow	521251	31
AL FSeries Yellow	AL FSeries Yellow	521252	31
AL TecJet Yellow	AL TecJet Yellow	521253	31
AL ProActA Yellow	AL ProActA Yellow	521254	31
AL ProActB Yellow	AL ProActB Yellow	521255	31
AL NOxA Yellow	AL NOxA Yellow	521256	31
AL NOxB Yellow	AL NOxB Yellow	521257	31
AL GET Red	AL GET Red	521258	31
AL IC92x Red	AL IC92x Red	521259	31
AL FSeries Red	AL FSeries Red	521260	31
AL TecJet Red	AL TecJet Red	521261	31
AL ProActA Red	AL ProActA Red	521262	31
AL ProActB Red	AL ProActB Red	521263	31
AL NOxA Red	AL NOxA Red	521264	31
AL NOxB Red	AL NOxB Red	521265	31
AL Lube Oil Min	AL Lube Oil Min	521266	31
AL Lube Oil Max	AL Lube Oil Max	521267	31
LO Oil Refill	LO Oil Refill	521268	31
HI Oil Refill	HI Oil Refill	521269	31
HI Lube Oil L. Ref	HI Lube Oil Level refill	521270	31
AL ActFuelValvePosL1	AL ActFuelValvePos L1	521271	31
AL MIC5 Yellow	AL MIC5 Yellow	521272	31

DEIF Display	MTU	SPN	FMI
AL MIC5 Red	AL MIC5 Red	521273	31
AL MIC5 Comm Lost	AL MIC5 Comm Lost	521274	31
AL ESI activated	AL ESI activated	521275	31
AL MIC5 Sign. diff	AL MIC5 Signature difference	521276	31
AL CAN3 Bus Off	AL CAN3 Bus Off	521277	31
AL CAN3 Error Pas	AL CAN3 Error Passive	521278	31
AL CAN4 Bus Off	AL CAN4 Bus Off	521279	31
AL CAN4 Error Pas	AL CAN4 Error Passive	521280	31
HIHI Delta NOx (A-B)	HIHI Delta NOx (A-B)	521297	0
HI Delta NOx (A-B)	HI Delta NOx (A-B)	521297	15
HI Delta p5 for NOx	HI Delta p5 for NOx	521298	15
AL MIC5 para. DL act	AL MIC5 parameter download active	521299	31
AL F2 DEF consumptio	AL F2 DEF consumption error	521332	31
AL F2 DEF balance	AL F2 DEF balance error	521333	31
AL F2 Raw gas emissi	AL F2 Raw gas emission error	521334	31
AL F2 Nox Annaeherun	AL F2 NOx Annaeherung error	521335	31
AL TExh af. SCR F1F2	AL T-Exh aft SCR between F1 and F2	521336	31
AL F2Exp TExh bf SCR	AL F2 Exp T-Exh bef SCR error	521337	31
AL F2Exp TExh af SCR	AL F2 Exp T-Exh aft SCR error	521338	31
AL SCRSU AdBlue Pres	AL SCR SU AdBlue Pressure	521350	31
AL Check Sum IIG	AL Check Sum IIG	521351	31
SS ETC5 Overspeed	SS ETC5 Overspeed	521352	0
HI ETC5 Overspeed	HI ETC5 Overspeed	521352	15
AL NOxATO2 Sens Def.	AL NOx ATO2 Sensor Defect	521353	11
AL Nox ATO2 Comm.err	AL NOx ATO2 Communication Lost	521353	19
AL DEF Tank Lev. low	AL DEF Tank Level low	521354	17
AL T.Breakd.NOx sen.	AL Total breakdown NOx sensors	521355	31
AL Redun.lossNOx sen	AL Redundancy loss NOx sensors	521356	31
AL Engine Cold Activ	AL Engine Cold Active	521357	31
AL Engine Cool. T.SD	AL Engine Coolant Temperature SD	521358	11
AL Intake Air T. SD	AL Intake Air Temperature SD	521359	11
AL DEF Tank T. SD	AL DEF Tank Temperature SD	521360	11
AL Engine Cool.V.DEF	AL Engine Coolant Valve Defect(DEF)	521361	31
AL Fl.EgrA Comm.lost	AL Flap Egr A Communication Lost	521362	31
AL Fl.EgrA T.t. high	AL Flap Egr A Temperature too high	521363	0
AL Fl.EgrA Targ.pos	AL Flap Egr A Targetposition	521364	31
AL Fl.EgrB Comm.lost	AL Flap Egr B Communication Lost	521365	31

DEIF Display	MTU	SPN	FMI
AL Fl.EgrB T.t. high	AL Flap Egr B Temperature too high	521366	0
AL Fl.EgrB Targ.pos	AL Flap Egr B Targetposition	521367	31
AL Fl.By.A Comm.lost	AL Flap BypassA Communication Lost	521368	31
AL Fl.By.A T.to.high	AL Flap BypassA Temperature too high	521369	0
AL Fl. By. A Tar.pos	AL Flap Bypass A Targetposition	521370	31
AL Fl.By B comm.lost	AL Flap BypassB Communication Lost	521371	31
AL Fl.Byp.B. T. high	AL Flap BypasB Temperature too high	521372	0
AL Fl.Byp B Tar.pos.	AL Flap Bypass B Targetposition	521373	31
AL Fl.Disp.Comm.lost	AL Flap Dispens Communication Lost	521374	31
AL Fl.Disp.T.toohigh	AL Flap DispensTemperature too high	521375	0
AL Fl. Disp. Tar.pos	AL Flap Dispenser Targetposition	521376	31
AL Fl. Int.Comm.lost	AL Flap Intake Communication Lost	521377	31
AL Fl.Int.T.too high	AL Flap Intake Temperature too high	521378	0
AL Fl.int.A Tar.pos.	AL Flap Intake Air Targetposition	521379	31
AL Fl.EgrA Calibr.Dr	AL Flap Egr A Calibration Drive Err	521380	31
AL Fl.EgrB Calibr.Dr	AL Flap Egr B Calibration Drive Err	521381	31
AL Fl.ByA Calibr. Dr	AL Flap BypassA Calibr. Drive Err	521382	31
AL Fl.Byp Calibr. Dr	AL Flap BypassB Calibr. Drive Err	521383	31
AL Fl.Disp.Calibr Dr	AL Flap Dispenser Calibr Drive Err	521384	31
AL Fl.Int.A.Cali. Dr	AL Flap Intake Air Calibr Drive Err	521385	31
AL L2 PCV Defect	AL L2 PCV Defect	521386	0
AL L1 PCV Defect	AL L1 PCV Defect	521386	15
AL L2 PCV2 Defect	AL L2 PCV2 Defect	521387	0
AL L1 PCV2 Defect	AL L1 PCV2 Defect	521387	15
AL Short Cir.Ana.O 1	AL Short Circuit Analog Out 1	521388	6
AL Short Cir.Ana.O 2	AL Short Circuit Analog Out 2	521389	6

9. Power management

9.1 Power management

9.1.1 Power management functions

In the following chapter, the power management functions of the AGC 200 are listed.

Plant modes:
- Island mode (no mains unit)
- Automatic Mains Failure (needs mains unit)
- Fixed power/base load (needs mains unit)
- Peak shaving (needs mains unit)
- Load takeover (needs mains unit)
- Mains power export (needs mains unit)

Display:
- Mains unit display showing mains breaker and tie breaker
- Generator unit showing generator and generator breaker

Power management functions:
- 16 mains, 16 gen-sets and 8 BTB's
- Load-dependent start/stop
- Priority selection
    - Manual
    - Running hours
    - Fuel optimisation
- Ground relay control
- ATS control
- Safety stop (fail class = trip and stop)
- Load management
- Single mains support
- Multi mains support
- Secured mode
- Quick setup/broadcast
- Base load
- Heavy consumer (HC)
- Asymmetric load sharing (LS)
- Common cos phi control
- CAN flags

9.1.2 CAN bus setup

Enter the menu 9170 using the JUMP push-button. Select "CAN protocol 2" for a multi mains functionality. Select "CAN protocol 1" for dual mains or single applications.

An alarm appears if CAN protocol 2 is needed.

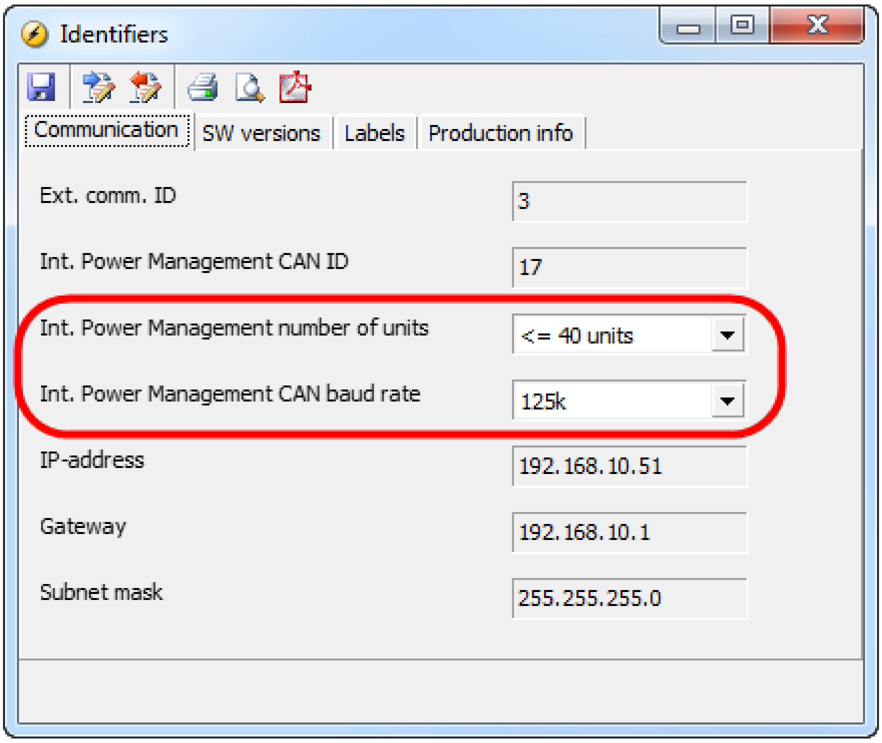
If it is critical for the application that the fastest possible inter-controller communication is established, the following two settings can be changed:

Enter the menu 9171. Select "Int CAN units" to choose the maximum number of units that are intended to be used in the application. The lower the number of chosen units, the faster the communication.

All units in the system must have the same setting, otherwise an "Appl. hazard" alarm will be displayed. This "Appl. hazard" alarm will also make a "Unit number Error" entry in the Event log.
If the CAN Baud rate is not identical on all controllers, an "Appl. hazard" alarm will appear on all controllers. The one controller, on which the Baud rate has been changed so that it is no longer identical with the other controllers, will be tagged with the alarm value 100 in the alarm log.

Enter the menu 9172. Select "Int CAN baud" to choose the Baud rate of the power management CAN bus communication line. With 125 kbit Baud rate chosen, a physical total CAN bus cable length of 300 metres can be installed. With 250 kbit Baud rate chosen, a physical total CAN bus cable length of 150 metres can be installed.

Menus 9171 and 9172 can also be changed through the USW:

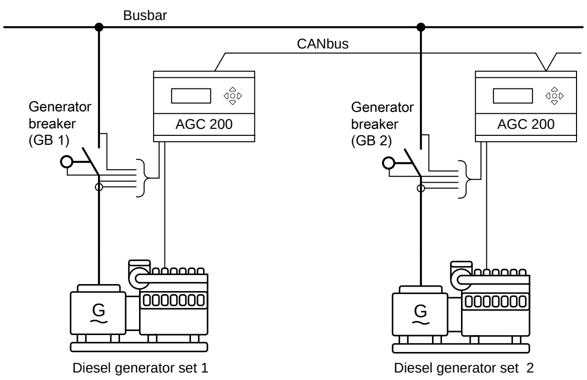


9.1.3 Applications

Application	Drawing below	Comment
Island operation	Island mode plant	Multiple gensets
Automatic Mains Failure	Parallel with 1 to 32 mains	No back synchronising
Automatic Mains Failure	Parallel with 1 to 32 mains	With back synchronising
Automatic Mains Failure	ATS plant, multiple start	Multiple start system
Automatic Mains Failure	ATS plant, mains unit	Mains unit installed
Fixed power	Parallel	Also called base load. Needs mains unit
Mains power export	Parallel	Needs mains unit
Load takeover	Parallel	Needs mains unit
Peak shaving	Parallel	Needs mains unit

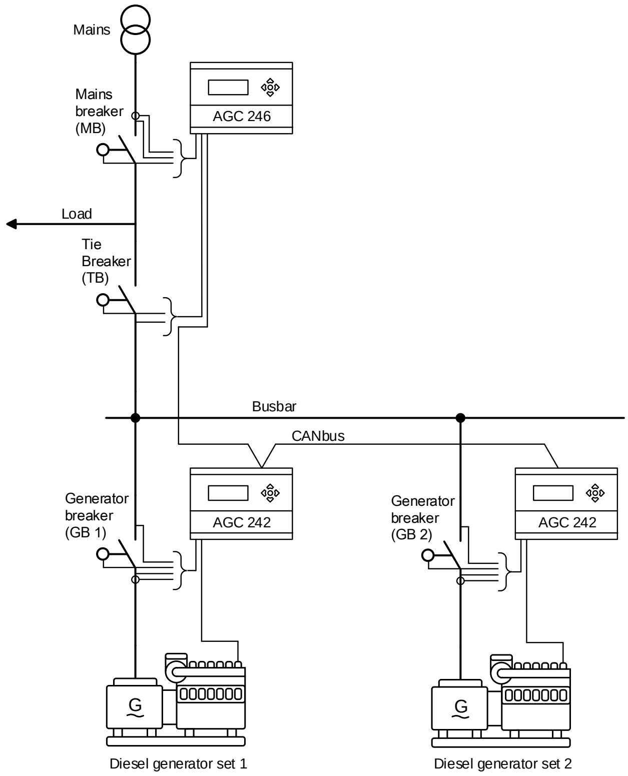
Regarding AC and DC connections for the individual applications, please refer to the Installation Instructions.

Island operation plant
In an application where up to 32 gensets are installed, the AGC 200 will automatically operate in an island mode with load-dependent starting and stopping.



If a mains unit is installed and connected (for example for preparing future requirements to the application), the island mode operation is selected in the mains unit.

Parallel with mains plant
An application where a mains breaker is installed together with up to 32 gensets is shown below.
The application also supports a redundant mains unit.
The application is shown with a tie breaker, but it is also possible to use the application without a tie breaker.
The tie breaker can only be placed as shown in the drawing below.

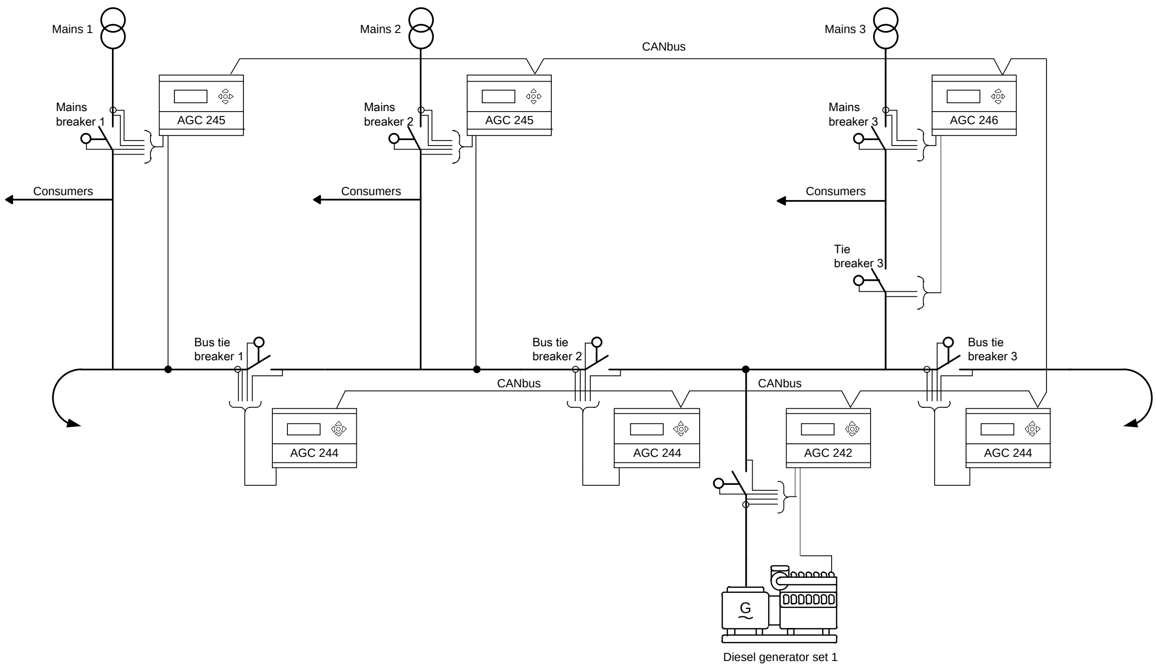


This one-line diagram is also valid for AMF plants without back synchronising and load take-over plants without possibility of synchronising the genset to the mains.

Multi-mains plant

Below is an example of a multi-mains plant with 3 mains, 3 BTBs and 1 generator.

It is possible to have up to 32 mains or generator controllers and 8 BTB controllers in one power management system (a maximum of 40 units in a system in total).

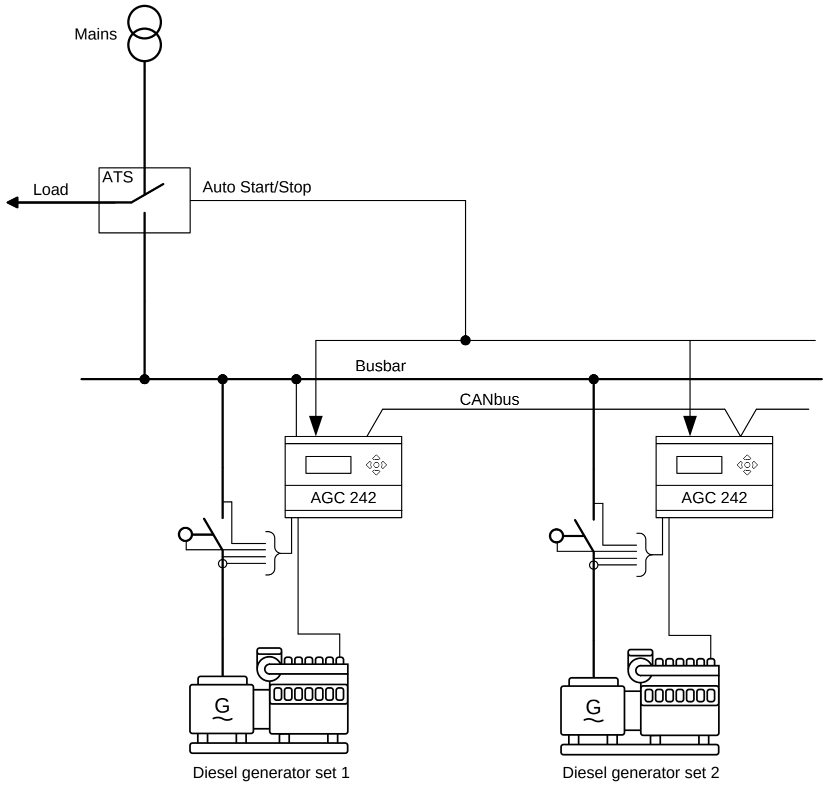


For further information about multi-mains, see the chapter "Multiple mains".

ATS plant

Applications that use an ATS for switching between mains supply and generator supply are supported as well. An application example using an ATS is shown below.

ATS plant, multiple start



9.1.4 Initial power management setup

The AGC 200 is set up using the display and the PC utility software.

9.1.5 Application design

The application design with AGC units consists of different power management types: Genset, mains and BTB.

The AGC-4 controller has the flexibility to change the type of controller that is required. For example, the unit can be changed from a mains controller to a BTB or genset controller. The only requirement is that the unit is an AGC-4 with option G5. On an AGC 200, the type of unit is fixed and cannot be changed. But an AGC 245 can operate as an AGC 246, and vice versa. (In that case, the front foil will not be correct, but the function will work). On the AGC-4 platform, the controller type can be changed by pressing the jump button on the display and going to menu 9000.

The different types of controllers and requirements are shown in the table below:

Platform	Controller	Requirements
AGC-4	AGC-4 - Mains	Option G5
AGC-4	AGC-4 - BTB	Option G5 or G4
AGC-4	AGC-4 - Genset	Option G5, G4 or G8
AGC 200	AGC 200 - Mains	AGC 245 or AGC 246
AGC 200	AGC 200 - BTB	AGC 244
AGC 200	AGC 200 - Genset	AGC 222, AGC 242 or AGC 243
AGC 100	AGC 100 - Mains	AGC 145 or AGC 146

Be aware that when you change the unit type in menu 9000, all settings will be changed back to default.

The power management communication between the units is configured through the utility software. The power management communication is CANbus communication, and, consequently, it must follow the standards for CANbus communication.

Before configuring the power management, it is necessary to identify which terminals the communication lines go to. To simplify the installation, the CAN lines will normally run from CAN A to CAN A, but it is possible to mix the CAN lines on application software newer than 4.5x (AGC-4, AGC 200 and AGC 100). On AGCs, the power management lines can for example go from CAN port A on an AGC-4 (terminal numbers A1 and A3) on the first controller to CAN port A on an AGC 200 (terminal numbers 7 and 9) on the next controller. It is important that the wiring is a daisy chain connection and that it is identified to which terminals the communication bus goes on each controller. The power management communication lines can be redundant, in which case they are named PM CAN primary and PM CAN secondary. The line must be a continuous communication bus, and it cannot be mixed with the other communication bus for power management.

The power management communication can be on different terminals, dependent on which options the controller has been delivered with. The different terminals are shown below:

Terminal no.	CAN port	Controller	Note
A1 - CAN High A3 - CAN Low	A	AGC-4	Can be occupied by option H7.
7 - CAN High 9 - CAN Low	A	AGC 24x	CAN A does not exist on AGC 22x. Redundant CANbus communication is not possible on AGC 200.
53 - CAN High 55 - CAN Low	A	AGC 14x	Redundant CANbus communication is not possible on AGC 100.
B1 - CAN High B3 - CAN Low	B	AGC-4	Can be occupied by option H7.
10 - CAN High 12 - CAN Low	B	AGC 22x or AGC 24x	Redundant CANbus communication is not possible on AGC 200.
57 - CAN High 59 - CAN Low	B	AGC 14x	Redundant CANbus communication is not possible on AGC 100.

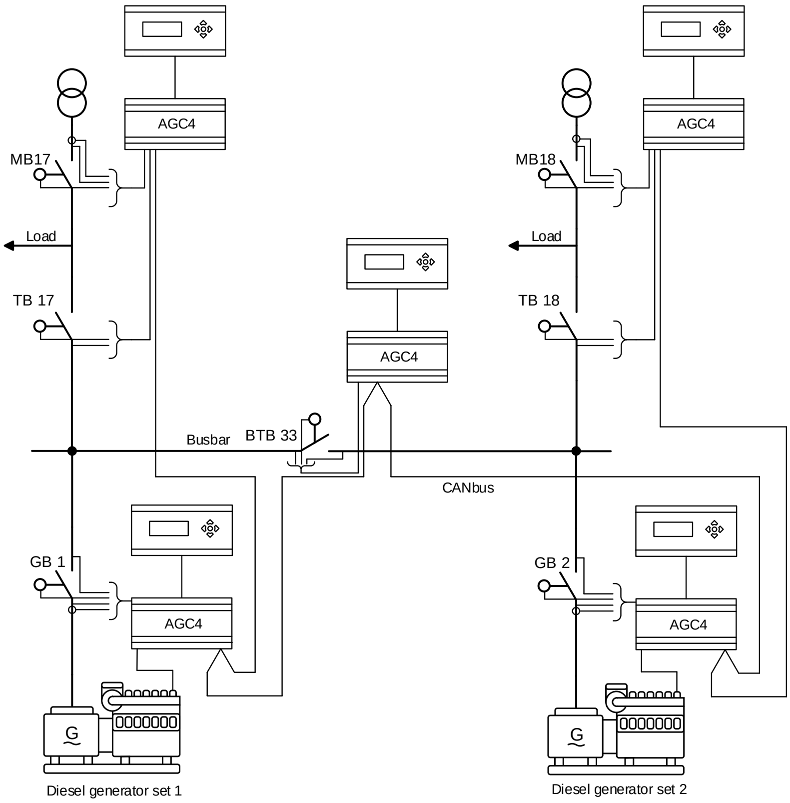
First, you must follow the CANbus lines and decide which one should be named PM CAN primary, and which one should be named PM CAN secondary.

There is no difference in functionality between the PM CAN primary and PM CAN secondary, but the lines cannot be mixed up with each other.

If only one CANbus line is present, it is insignificant whether PM CAN primary or PM CAN secondary is selected. If PM CAN primary is selected, this will have to be selected in all controllers. The same goes for PM CAN secondary.

When the CAN ports on each controller have been selected, this will have to be set in the controller. To facilitate comprehension, some examples are given.

Example with AGC-4 units:



In this example, the application consists solely of AGC-4 units. The application is an H-coupling with two mains, two gensets and one BTB. The application only has one CANbus line between the units. The CANbus line goes to the terminal numbers shown in the table below:

Controller	Terminal no.	CAN port	CAN protocol
Genset 1 - AGC-4	A1 and A3	A	PM CAN primary
Genset 2 - AGC-4	A1 and A3	A	PM CAN primary
Mains 17 - AGC-4	A1 and A3	A	PM CAN primary
Mains 18 - AGC-4	A1 and A3	A	PM CAN primary
BTB 33 - AGC-4	A1 and A3	A	PM CAN primary

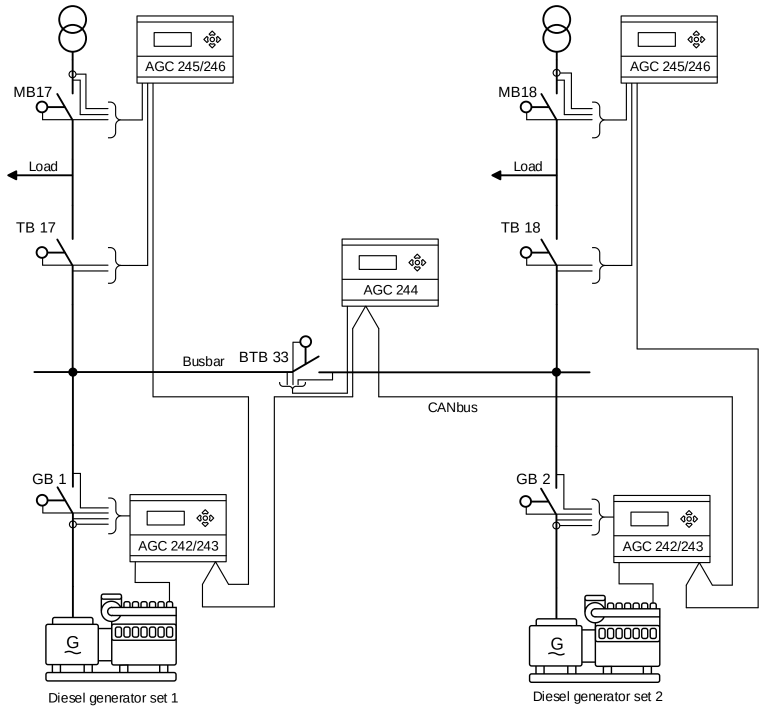
It is now possible to select whether the CANbus line should be named PM CAN primary or PM CAN secondary. It does not make a difference which one is selected when the application only has one CANbus line, as long as it is the same in all controllers. In this example, PM CAN primary is selected. It is then required to go to parameter 7840 in all controllers and set the corresponding CAN port to PM CAN primary.

It is also possible to mix the CAN ports on the AGC-4, but only on controllers with newer software (4.5x.x or newer). In this way, it will be possible to make an application where the CAN lines are as shown in the table below:

Controller	Terminal no.	CAN port	CAN protocol
Genset 1 - AGC-4	A1 and A3	A	PM CAN secondary
Genset 2 - AGC-4	B1 and B3	B	PM CAN secondary
Mains 17 - AGC-4	A1 and A3	A	PM CAN secondary
Mains 18 - AGC-4	B1 and B3	B	PM CAN secondary
BTB 33 - AGC-4	A1 and A3	A	PM CAN secondary

The order of the CAN ports is not important, as long as the settings in the controllers are correct. But it is always recommended to use the same CAN port on each controller. This can be helpful when troubleshooting, and it can also facilitate commissioning. In the last example, it does not matter whether PM CAN primary or PM CAN secondary is selected, the function will be the same. It is only important that it is PM CAN primary in all controllers or PM CAN secondary in all controllers.

Example with AGC 200 units:



In this example, the application consists solely of AGC 200 units. The application is an H-coupling with two mains, two gensets and one BTB. The application only has one CANbus line between the units. The CANbus line goes to the terminal numbers shown in the table below:

Controller	Terminal no.	CAN port	CAN protocol
Genset 1 - AGC 242/243	10 and 12	B	PM CAN primary
Genset 2 - AGC 242/243	10 and 12	B	PM CAN primary
Mains 17 - AGC 245/246	10 and 12	B	PM CAN primary
Mains 18 - AGC 245/246	10 and 12	B	PM CAN primary
BTB 33 - AGC 244	10 and 12	B	PM CAN primary

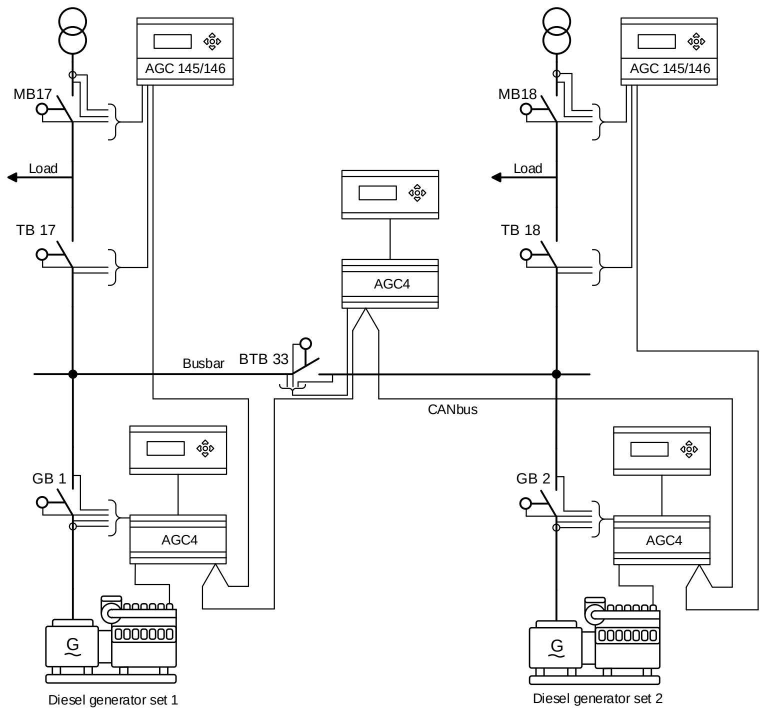
It is now possible to select whether the CANbus line should be named PM CAN primary or PM CAN secondary. It does not make a difference which one is selected, as long as it is the same in all controllers. In this example, PM CAN primary is selected. It is then required to go to parameter 7840 in all controllers and set the corresponding CAN port to PM CAN primary.

It is also possible to mix the CAN ports on the AGC 200, but only on controllers with newer software (4.5x.x or newer). In this way, it will be possible to make an application where the CAN lines are as shown in the table below:

Controller	Terminal no.	CAN port	CAN protocol
Genset 1 - AGC 242/243	10 and 12	B	PM CAN secondary
Genset 2 - AGC 242/243	10 and 12	B	PM CAN secondary
Mains 17 - AGC 245/246	10 and 12	B	PM CAN secondary
Mains 18 - AGC 245/246	7 and 9	A	PM CAN secondary
BTB 33 - AGC 244	7 and 9	A	PM CAN secondary

The order of the CAN ports is not important, as long as the settings in the controllers are correct. But it is always recommended to use the same CAN port on each controller. This can be helpful when troubleshooting, and it can also facilitate commissioning. In the last example, it does not matter whether PM CAN primary or PM CAN secondary is selected, the function will be the same. It is only important that it is PM CAN primary in all controllers, or PM CAN secondary in ally controllers.

Example with AGC-4 and AGC 100 units:

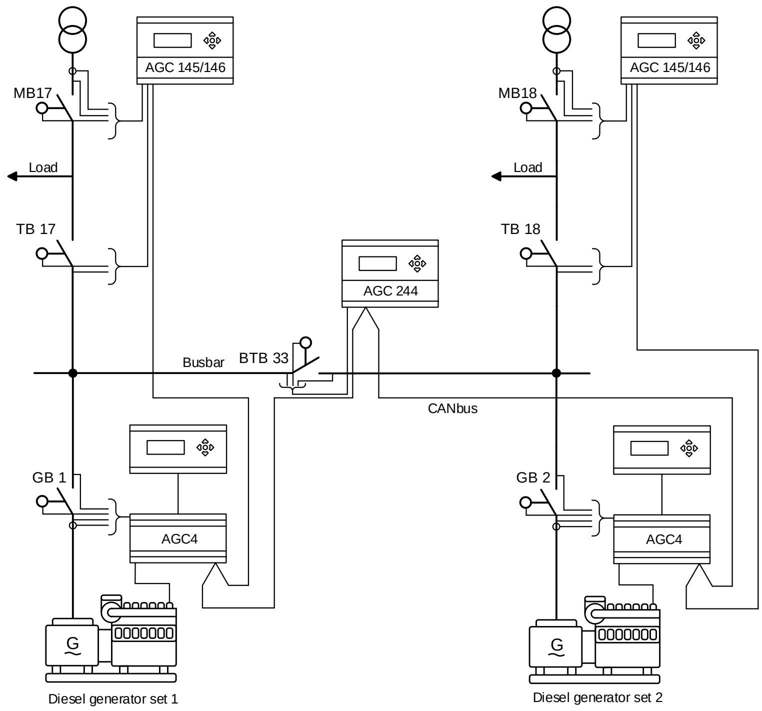


In this example, the application consists of a mix of AGC 100 units and AGC-4 units. The application is an H-coupling with two mains, two gensets and one BTB. The application only has one CANbus line between the units. The CANbus line goes to the terminal numbers shown in the table below:

Controller	Terminal no.	CAN port	CAN protocol
Genset 1 - AGC-4	B1 and B3	B	PM CAN secondary
Genset 2 - AGC-4	B1 and B3	B	PM CAN secondary
Mains 17 - AGC 145/146	53 and 55	A	PM CAN secondary
Mains 18 - AGC 145/146	53 and 55	A	PM CAN secondary
BTB 33 - AGC-4	A1 and A3	A	PM CAN secondary

It is now possible to select whether the CANbus line should be named PM CAN primary or PM CAN secondary. It does not make a difference which one is selected, as long as it is the same in all controllers. In this example, PM CAN secondary is selected. It is then required to go to parameter 7840 in all controllers and set the corresponding CAN port to PM CAN secondary.

Example with AGC-4, AGC 200 and AGC 100 units:



In this example, the application consists of different AGC units. The application is an H-coupling with two AGC 100 mains, two AGC-4 gensets and one AGC 200 BTB. The application only has one CANbus line between the units. The CANbus line goes to the terminal numbers shown in the table below:

Controller	Terminal no.	CAN port	CAN protocol
Genset 1 - AGC-4	A1 and A3	A	PM CAN primary
Genset 2 - AGC-4	A1 and A3	A	PM CAN primary
Mains 17 - AGC 145/146	53 and 55	A	PM CAN primary
Mains 18 - AGC 145/146	53 and 55	A	PM CAN primary
BTB 33 - AGC 244	7 and 9	A	PM CAN primary

It is now possible to select whether the CANbus line should be named PM CAN primary or PM CAN secondary. It does not make a difference which one is selected, as long as it is the same in all controllers. In this example, PM CAN primary is selected. It is then required to go to parameter 7840 in all controllers and set the corresponding CAN port to PM CAN primary.

It has now been shown how the different controllers can be combined in an application.

Afterwards, all controllers must have an internal communication ID. This is set in parameter 7530 in all controllers. The different types of controllers will have different IDs numbers. The available IDs are shown in the table below:

Controller type	Controller	Available IDs (7530)
Genset	AGC-4 with option G5, G4 or G8 AGC 22x, AGC 242 or AGC 243	1-32
Mains	AGC-4 with option G5 AGC 245 or AGC 246 AGC 145 or AGC 146	1-32
BTB	AGC-4 with option G5 or G4 AGC 244	33-40

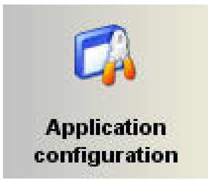
Multiple units cannot have the same ID.

In the examples, the selected IDs will be:

Diesel generator set 1 - ID 1
Diesel generator set 2 - ID 2
Mains 17 - ID 17
Mains 18 - ID 18
BTB - ID 33

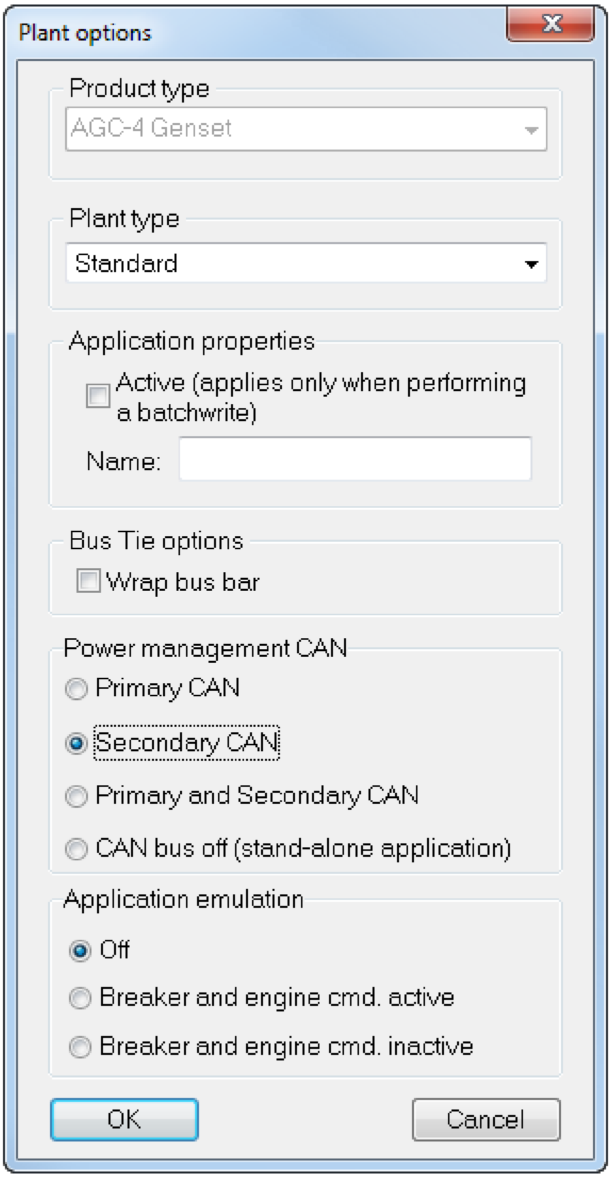
The selected IDs are set in parameter 7530 in each controller. Now it is possible to use the utility software and make the actual application design for the controllers. The controllers must know the application design in order to operate correctly in different auto sequences.

To enter the application configuration when connected to a controller with the utility software, press the Application configuration tab in the lower left corner. The tab looks like this:

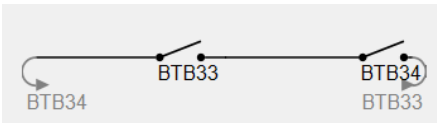


An empty window will appear. To make an application design for the controller, press the New plant configuration button shown below.

The Plant options window shown below will appear.

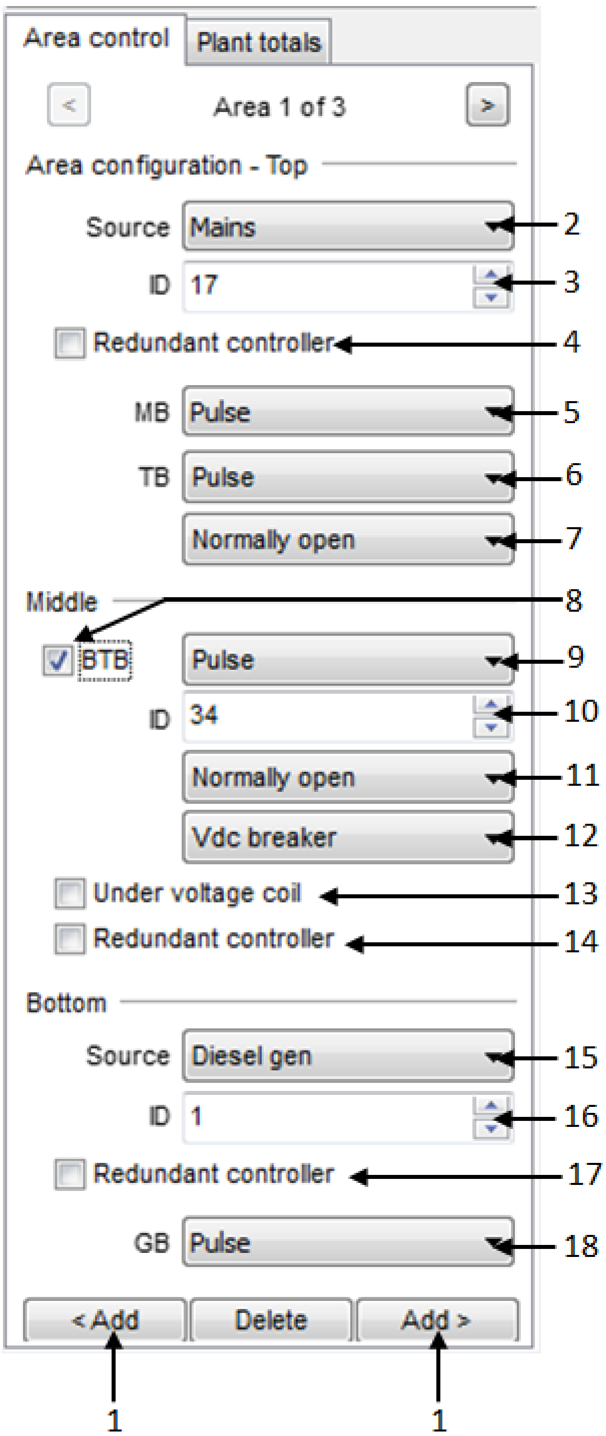


The plant options are described in the table below:

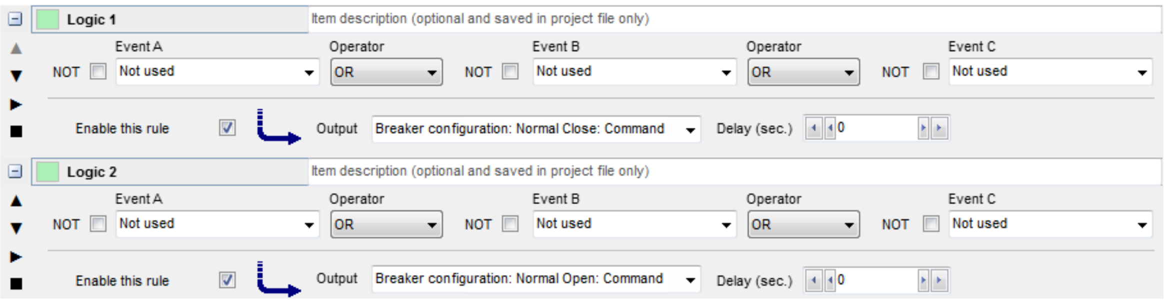
	Description	Comments
Product type	Controller type is selected here.	This function is greyed out if a controller is already connected.
Plant type	Select between • Single DG • Standard • Genset group plant • Genset group	"Standard" should be selected for power management systems. If "Single DG" is selected, the CAN ports for power management communication will be turned off. "Genset group plant" and "Genset Group" are only relevant for controllers with plant management. Plant management is for power plants consisting of 17-256 gensets in the same application. Contact support@deif.com for further information.
Application properties	The application is activated when it is written to the controller. The application can also be named here.	It can be helpful to give the application a name if the controller is in a plant where it will switch between application designs. The controllers are able to switch between four different application designs. Controllers that are connected to each other via the CANbus communication cannot be activated to different application designs or numbers.
Bus tie options	The "Wrap busbar" option can be selected here.	Activate this option if the busbar is connected like a ring connection in the plant. When the wrap busbar option is set, it will be shown in the application supervision like this: 
Power management CAN	Primary CAN Secondary CAN Primary and secondary CAN CAN bus off	The CAN protocol selected here should be identical to the settings in the unit. So if PM CAN primary is selected in the units, this must be selected in the plant settings as well. The setting called primary and secondary CAN is only used when redundant CANbus communication lines for power management are present. If this setting is selected and only one line is present, an alarm will appear in the display. This alarm cannot be cleared. The setting for CANbus off should only be used if the AGC is in a stand-alone application.
Application emulation	Off Breaker and engine cmd. active Breaker and engine cmd. inactive	The emulation is started here if the units have option I1. When Breaker and engine cmd. active is set, the units will activate the relays and try to communicate with an ECU. If the units are mounted in a real installation, the breakers will open/close and the engine start/stop. This will not happen if the Breaker and engine cmd. inactive is selected. In real installations, the emulation can be used during the commissioning. But when the commissioning is done, the emulation should be switched off.

When the selections in the plant options window have been made, it is possible to make the application drawing in the units.

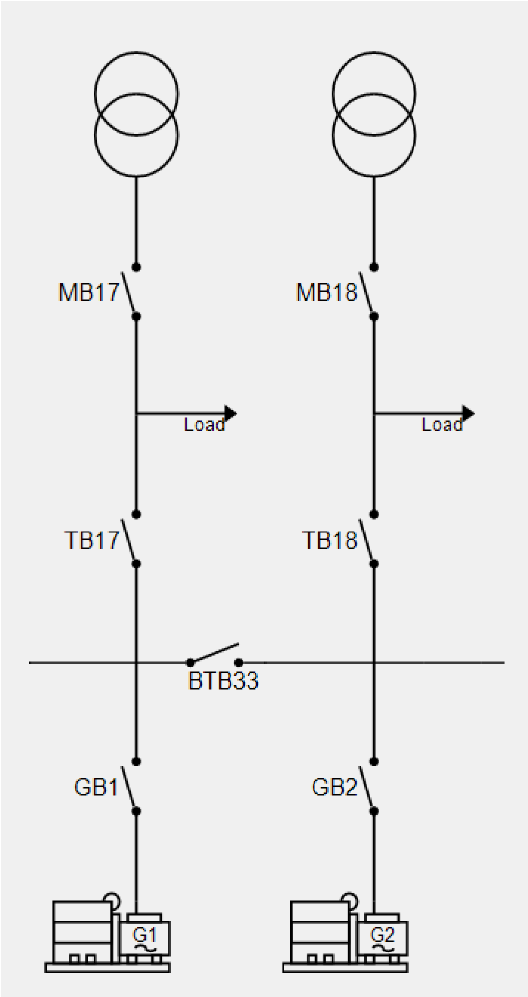
Now, controllers can be added to the design, and it can be selected which type of breakers is present in the application. This is done from the left side of the utility software.


Area control
Plant totals
Area 1 of 3
Area configuration - Top
Source
Mains
ID
17
Redundant controller
MB
Pulse
TB
Pulse
Normally open
Middle
BTB
Pulse
ID
34
Normally open
Vdc breaker
Under voltage coil
Redundant controller
Bottom
Source
Diesel gen
ID
1
Redundant controller
GB
Pulse
< Add
Delete
Add >
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

The table below describes the plant configuration options that are shown in the window above.

No.	Description
1	Add and delete areas. Adding areas will make the application design/plant bigger.
2	Select which type of power source should be represented in the top of the area. Only mains or diesel genset can be selected.
3	Set the internal command ID. This ID should correspond to the ID set in the controller.
4	Requires option T1 (critical power). Makes it possible to have redundant controller.
5	Because mains has been selected in the source (no. 2), it is possible to select which type of breaker to use for mains breaker. The options are: Pulse, Externally controlled/ATS no control, Continuous ND, Continuous NE, Compact or none.
6	Because mains has been selected in the source (no. 2), it is possible to select which type of breaker to use for tie breaker. The options are: Pulse, Continuous NE, Compact or none.
7	Select whether the tie breaker should be normally open or normally closed.
8	BTB controllers can be added.
9	The type of breaker that is used for BTB operation. The options are: Pulse, Continuous NE, Compact or Externally controlled. (Externally controlled BTB means that no controller is present. Breaker position inputs can be made to another controller in the power management system).
10	Set the ID for the specific BTB controller.
11	Select whether the BTB must be normally open or normally closed. If needed, this setting can be changed through M-Logic. The intention is that the normal state of the breaker is selected in the application configuration, and the opposite setting is then applied through M-Logic. 
12	If Vdc breaker is selected, the breaker can open and close when there is no voltage on the busbar. If Vac breaker is selected, voltage must be present on the busbar before the breaker can be handled.
13	If the BTB has an under-voltage coil, it is set here.
14	Requires option T1 (critical power). Makes it possible to have redundant controller.
15	Select which type of power source should be represented in the bottom of the area. Only mains or diesel genset can be selected.
16	Set the internal command ID. This ID should correspond to the ID set in the controller.
17	Requires option T1 (critical power). Makes it possible to have redundant controller.
18	Because diesel genset has been selected in the power source (no. 15), it is possible to select which type of breaker to use for generator breaker. The options are: Pulse, Continuous NE or Compact.

The application drawing/design for the example will be like this:



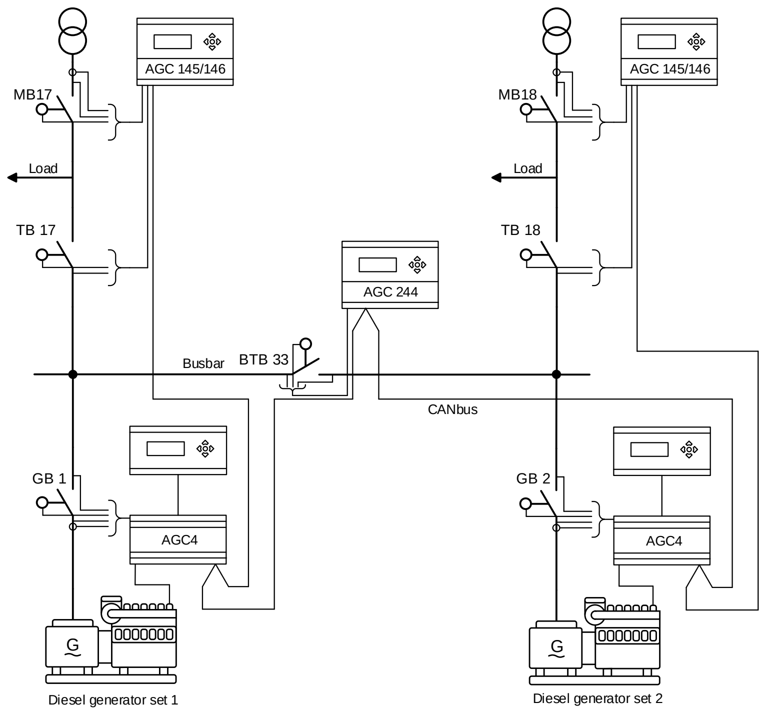
Subsequently, the configuration for the plant must be sent to the units. This can be done by pressing the Write plant configuration to the device button, which looks like this: 

After pressing the button, only the one controller, to which you are connected, knows the actual application configuration. The application configuration can then be sent from this controller to all the other controllers by pressing the Broadcast button in the top of the utility software: 

If the AGC is to fit into an application with AGC units with older software, this can also be done. But some restrictions must be fulfilled before the system will work correctly. On older software, the communication lines (CAN protocols) are called CAN A and CAN B. By default, these are set to a CAN port and cannot be switched. In the table below, this is shown for the different controllers.

Controller	CAN port	Note
AGC-4	A and B	CAN port A is CAN A CAN port B is CAN B If option H7 is set, only CAN B can be used for power management. If two CAN ports are desired for power management communication, and the governor and AVR interfacing is to be done by EIC, then option H5.8 is required.
AGC 200	A and B	CAN port A is CAN A CAN port B is CAN B AGC 200 can only use one port at a time for power management communication (redundant CAN is not possible).
AGC 100	A and B	CAN port A is CAN A CAN port B is CAN B AGC 100 can only use one port at a time for power management communication (redundant CAN is not possible).

When handling controllers with older software, be aware that the settings in older software do not allow the controllers to use other ports for power management than the ports that are set default. On older software, it is not possible to mix the used CAN ports. If CAN port A is used, this should be used on all older controllers. The same goes for CAN port B on older controllers. It is possible to mix newer controllers' and older controllers' power management communication. The easiest way to explain this is with an example:



The setup shown above is the same as used in the example earlier. But the controllers now have different software versions. The CAN ports used are shown in the table below:

Controller	Terminal no.	CAN port	CAN protocol
Genset 1 - AGC-4 (older software)	A1 and A3	A	CAN A
Genset 2 - AGC-4 (newer software)	B1 and B3	B	PM CAN primary
Mains 17 - AGC 145/146 (newer software)	57 and 59	B	PM CAN primary
Mains 18 - AGC 145/146 (older software)	53 and 55	A	CAN A
BTB 33 - AGC 244 (newer software)	7 and 9	A	PM CAN primary

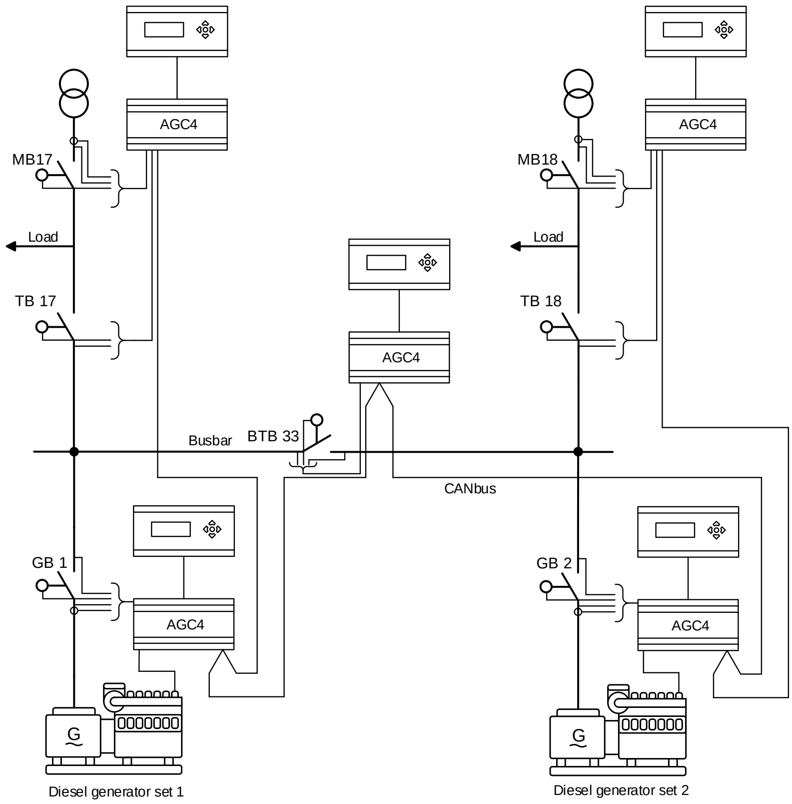
Note that all controllers with older software (4.4x or older) use the same CAN port. When the controller with older software uses CAN port A for power management communication, the setting in the controller with newer software should be PM CAN primary.

If the controllers with older software had used CAN port B instead, the setting in the controller with newer software should be PM CAN secondary.

An overview is shown in the table below:

CAN port on controller with older software	CAN port on controller with newer software	Setting in controller with newer software
A	Does not matter	PM CAN primary
B	Does not matter	PM CAN secondary

The AGC-4 is capable of using redundant power management CAN lines. These could be used in an application like this:



The application shown above consists solely of AGC-4 units with redundant CAN lines for power management. The controllers are a mix of newer and older software. The CAN lines go to these terminal numbers:

Controller	Terminal no. (1)	CAN port (1)	Terminal no. (2)	CAN port (2)
Genset 1 - AGC-4 (older software)	A1 and A3	A	B1 and B3	B
Genset 2 - AGC-4 (newer software)	B1 and B3	B	A1 and B3	A
Mains 17 - AGC-4 (newer software)	57 and 59	B	A1 and A3	A
Mains 18 - AGC-4 (older software)	A1 and A3	A	B1 and B3	B
BTB 33 - AGC-4 (newer software)	7 and 9	A	A1 and A3	A

Controllers with older software use the same CAN port for each CAN line.

When the controllers are mixed with software and CAN ports, the controllers with the older software determine the settings in parameter 7840 for the controllers with newer software. If the CAN line on the controller with older software goes to CAN port A, the setting for the controllers with newer software should be PM CAN primary. The settings from the example are shown below. To facilitate comprehension, the CAN lines are divided into two tables:

Table for CAN line A/PM CAN primary
(The table shows which CAN ports should be set to PM CAN primary on the controllers with newer software):

Controller	CAN line A/PM CAN primary setting (7840)
Genset 1 - AGC-4 (older software)	Not adjustable
Genset 2 - AGC-4 (newer software)	B
Mains 17 - AGC-4 (newer software)	B
Mains 18 - AGC-4 (older software)	Not adjustable
BTB 33 - AGC-4 (newer software)	A

Table for CAN line B/PM CAN secondary
(The table shows which CAN ports should be set to PM CAN secondary on the controllers with newer software):

Controller	CAN line B/PM CAN secondary setting (7840)
Genset 1 - AGC-4 (older software)	Not adjustable
Genset 2 - AGC-4 (newer software)	A
Mains 17 - AGC-4 (newer software)	A
Mains 18 - AGC-4 (older software)	Not adjustable
BTB 33 - AGC-4 (newer software)	B

If one of the CAN lines should break, there are alarms related to this which can be helpful when troubleshooting. This is described in the chapter CANbus failure handling.

9.1.6 Remove a unit from the power management system

If one or more units have to be taken out of the power management system, the following steps can be performed.

The first step is to remove the auxiliary supply of the AGC. This means that a CANbus alarm occurs on the other AGC units. These alarms appear on ID 1 in a 2 DG plant where ID 2 is powered down:

Alarm	Functioning unit (ID 1)
System alarm	CAN ID 2 P/S missing
Menu 7533	Missing all units
Menu 7535	Any DG missing

The mode changes according to the setting in CAN failure mode (7532).

The alarms will be present as long as the failure is present. A reconfiguration of the power plant is required to remove the alarms. The reconfiguration can be done in two ways: By means of quick setup or by means of the utility software.

Please refer to the chapter Application design for instructions for using the utility software to design an application configuration.

The application can also be reconfigured from the quick setup menu (9180). The quick setup should only be used for small applications. It is also normally used for small applications for rental gensets. If the quick setup is used, utility software is not required.

For more details, please refer to the chapter Quick setup.

9.1.7 Add a unit to the power management system

If the same 2 DG plants as mentioned earlier are used, and the controller with ID 2 is switched to a brand new controller with default settings, both controllers will get two alarms: "Duplicate CAN ID" and "Appl. hazard".

The "Duplicate CAN ID" alarm indicates that there are at lease two units with the same internal communication ID (7530). These numbers cannot be similar, since the system cannot handle this correctly.

The "Appl. Hazard" alarm indicates that not all controllers in the system have matching "application configurations". The system will not be able to operate correctly, because there is a mismatch between the units in the system. To clear this alarm, it is required to go to the application configuration in the utility software or to use the quick setup to reconfigure the application in the controllers.

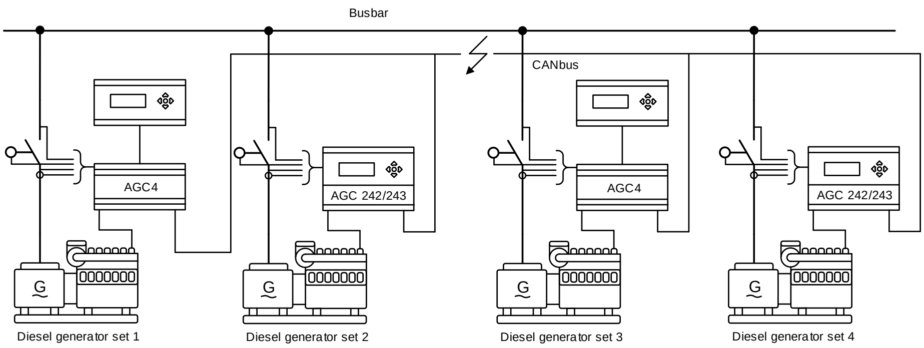
If, instead, the DG2 has been switched off and then switched on again, the alarms will disappear, but this is only because the CAN IDs (7530) and the application configuration were correct before the unit was switched off.

9.1.8 CAN failure mode

The system behaviour can be set up in different ways to handle a CAN failure on the CAN controlling the power management.
In menu 7530, a fail class can be chosen, for example shutdown or trip MB, depending on the CAN failure.
There are four scenarios where the fail class can be selected: Missing all units, fatal CAN error, any DG missing and any mains missing.
When a controller has lost communication to two or more controllers in the power management system, the "Fatal CAN error" alarm appears. In parameter 7532 it can be chosen what mode to go to in case of a fatal CAN error.
There are three selectable modes the controllers should change to in case of a fatal CAN error:

1. **Manual:**
   If "MANUAL" is selected, all the AGC units will change mode to manual mode. In this way, the regulators will be frozen, and it will not be possible to close any breakers (unless the breakers are already within the limits for the sync. window or black busbar). Manual mode is not selectable in BTB 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 is still able to make a shutdown or a trip of a breaker.
   Be aware that when a fatal CAN error is present, the risk of blackout is also present, since load sharing does not take place in manual mode.

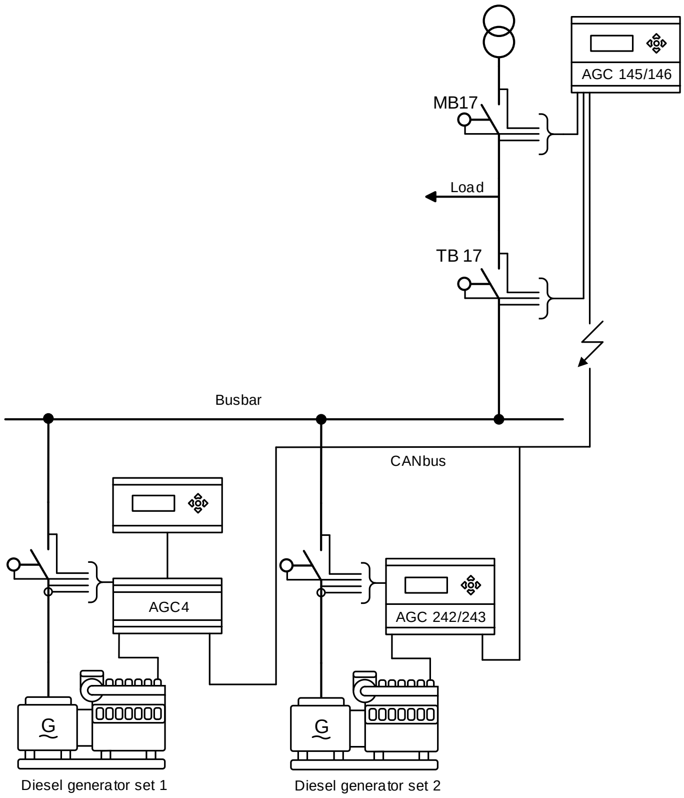
2. **Semi-auto:**
   If "SEMI-AUTO" is selected, the AGC units will change to semi-auto mode when a fatal CAN error occurs.
   In semi-auto mode, the regulators in the AGC units are still active. This means that the gensets that are visible to each other are able to share load. This is explained by an 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 share load with each other, and gensets 3 and 4 are able to share 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 very loaded.
If a fatal CAN error occurs when the gensets are stopped, they will not be blocked, and in this way it will be possible to start them.

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

3. **No mode change:**
If "No mode change" is selected, all the AGC units will be kept in the mode they were in before the fatal CAN error 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 the mains controller when the mains fails. But since the CAN bus has a failure between the mains controller and the gensets, the gensets will never know when the mains fails and will therefore never start. If this setting is used, it is recommended to use the CAN bus fail class settings (7530) in order for the system to handle the situation correctly.
In the example above, it is only the mains controller that gets a fatal CAN error. The genset controllers only have one controller missing, which is not enough to trigger a fatal CAN error. It is possible to use M-Logic to make a mode shift or take other actions in such a situation.

9.1.9 CAN bus fail classes

The AGC units have different CAN bus alarms, which are triggered in different situations:

- Missing all units:
  Appears only when a controller cannot "see" any other units on the CAN bus line. The fail class selected in parameter 7533 will be executed.
- Fatal CAN error:
  Appears when two or more units are not visible, but one or some units are still visible. The fail class selected in parameter 7534 will be executed.
- Any DG missing:
  Appears when only one genset controller is missing. The fail class selected in parameter 7535 will be executed.
- Any mains missing:
  Appears when only one mains controller is missing. The fail class selected in parameter 7533 will be executed. The fail class selected here is also used when a BTB is missing.

9.1.10 CAN bus alarms

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

- CAN ID X P missing
  The AGC unit has lost CAN bus communication to CAN ID on PM CAN primary.
- CAN MAINS X P missing
  The AGC unit has lost CAN bus communication to mains with ID X on PM CAN primary.
- CAN BTB X P missing
  The AGC unit has lost CAN bus communication to BTB with ID X on PM CAN primary.
- CAN ID X S missing
  The AGC unit has lost CAN bus communication to CAN ID on PM CAN secondary.
- CAN MAINS X S missing
  The AGC unit has lost CAN bus communication to mains with ID X on PM CAN secondary.
- CAN BTB X S missing
  The AGC unit has lost CAN bus communication to BTB with ID X on PM CAN secondary.
- CAN setup CH: 784x
  The unit can sense power management communication on a CAN port, but the correct protocol is not set. This alarm is also monitoring the CAN setup between engine communication protocol (H5, H7, H13) and CAN port.

For a general description of "Fail class", please refer to the description of fail classes in the relevant chapter in the Designer's Reference Handbook.

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.

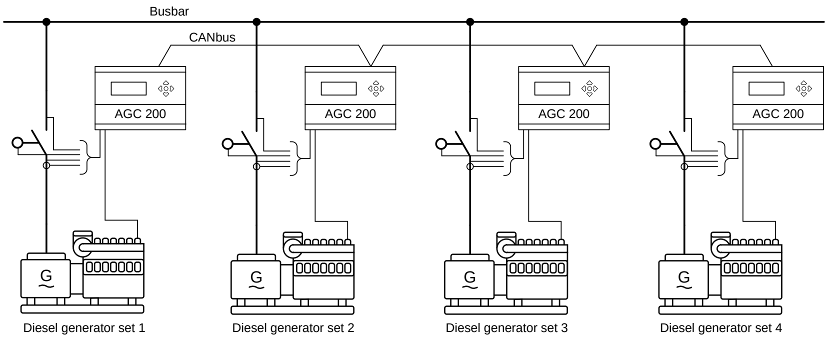
9.1.11 Quick setup

This function is made to provide an easy user interface for applications where it is vital for the end-user to be able to change the application quickly and easily.

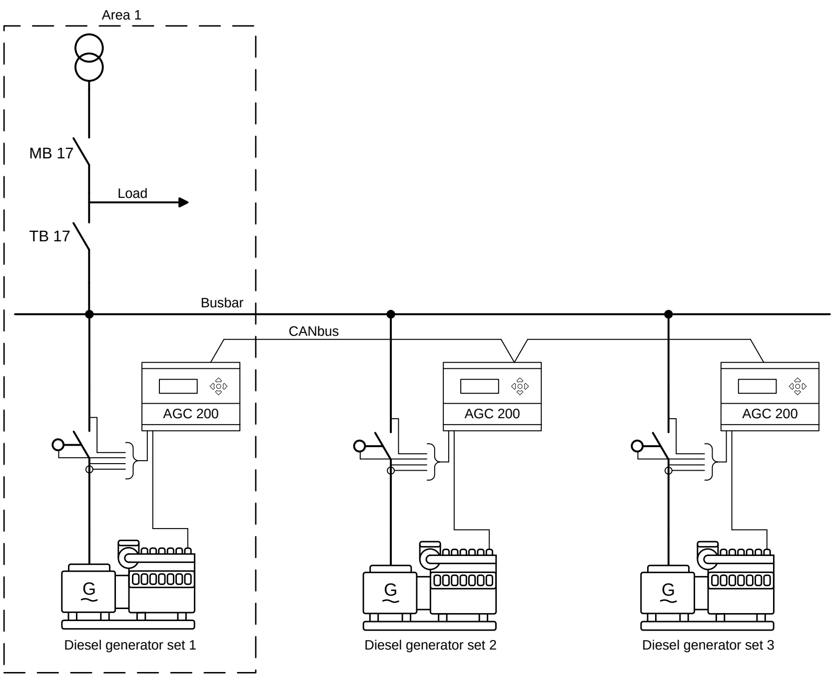
It is often applications for the rental market that need this flexibility, and therefore there are some limitations as to which applications that can be handled through the quick setup menu.

The following applications can be handled through the quick setup menu.

Island Applications



Simple applications with connection to one mains



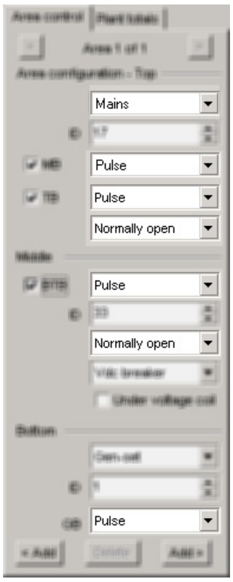
Limitations:

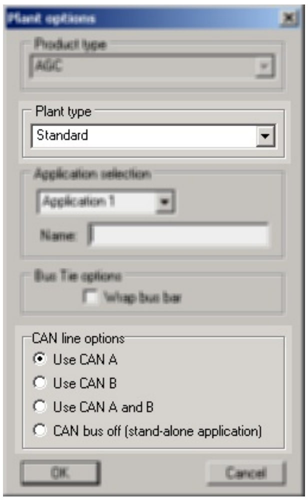
In most cases, the rental applications are very simple applications, and therefore there are some limitations that have to be considered when using the quick setup menu:

- It will not be possible to have any AGC 200 bus tie units in the application.

This function is made to facilitate change of a plant configuration without AGC 200 BTB units. Entering the quick setup menu 9180 via the DU-2 display makes it possible to add or remove a genset without the use of utility software. It is only possible to do the same basic setup as through the ”application configuration” in the utility software.

The functions marked with clear text in the screenshots below can be accessed through the quick setup menu.





9.1.12 9180 Quick setup

9181 Mode

OFF: When the mode menu is set to "OFF", the existing application that is about to have this genset included will not look for this new genset. This will give the operator time to connect all wiring and to do the basic setup of the genset.

Setup Plant: When the mode menu is set to "Setup Plant", the new AGC will receive the application configuration from the other units in the plant. The new AGC will then notify the rest of the application that a new ID is available on the line. If the ID of the new AGC already exists, the new AGC will – based on the ID numbers in the application configuration – have the highest ID + 1 assigned. This new ID will then be included in the application configuration in all the other AGCs. During this process, the existing application will be able to continue running and will not be affected by the upgrade of the system.

The new AGC will automatically go to block mode to ensure that it is in a safe mode. When the setup is done, the end-user must decide in which running mode the added genset is to run.

If there is already 16 gensets on the CAN line and a new AGC tries to connect to the plant, an alarm text, "No IDs available", will appear. (The quick setup function only supports 16 gensets).

Setup Stand-alone: When the mode menu is set to "Setup Stand-alone", the AGC will change 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 broadcasted to the other AGCs. 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", will appear.

If "Setup Stand-alone" is activated when the genset is running, an info text, "Quick setup error", will appear.

If an AGC BTB is detected in the application, an indicating alarm, "Appl. not possible", will appear.

Change of setup from standard to single DG unit: When disconnecting a standard AGC unit in a system, it is important to change the menu 9181, plant setup. After disconnecting, the AGC unit will become a single DG.

9.1.13 9190 Application broadcast

This function makes it possible to broadcast an application over the CAN line from one AGC to all units present in the application. It takes one operation to activate the broadcast function. It can be done in two ways:

1. By sending the application.
2. By sending the application and activating it.

Menu 9191 Enable

OFF:	When it is set to OFF, no broadcast will be made.
Broadcast:	Broadcast of the selected application in menu 9192 will be sent to the units in the application.
Broadcast + Activate	Broadcast is activated and the application in menu 9192 will be broadcasted and activated in all units.

Menu 9192 Application
Applications 1-4 can be drawn in the utility software.

The following pop-up windows in the utility software will guide you through the broadcast.

9.1.14 Command unit

The power management system is a multi-master system. In a multi-master system, the available generator units automatically perform the power management control. This means that the system never depends on only one master unit.

If for instance one unit ID is disabled, and this was the command unit, then the next available unit will take over the command functions.

The above also applies to the AGC 245/246 mains units – in that case the command unit is called Mains Command Unit (MCU).

The command unit cannot be selected by the operator. It is automatically selected when a power management setting is accessed.

9.1.15 Load-dependent starting and stopping

The purpose of this function is to ensure that sufficient power is always available on the busbar. 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. The starting and stopping of the gensets is automatically carried out according to the adjusted set points and priority selection.

The load-dependent start/stop function can be selected as:

- Rated power set point (P) [kW]
- Apparent power set point (S) [kVA]
- Actual or load percentage value [%]

The load-dependent starting and stopping can be selected to base on either produced power calculation (%) or available power calculation (P or S).

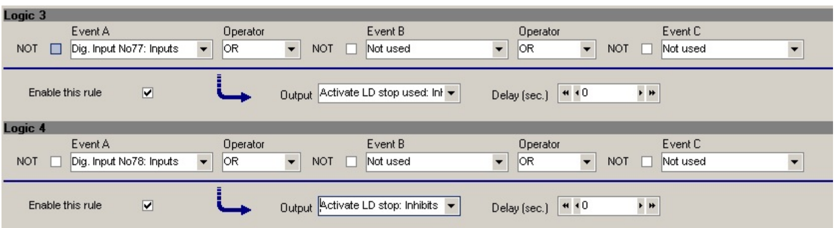
The easiest way is to use produced power calculation; however, this method is not suited for systems with three or more generators as regards fuel savings and saving running hours.

Terminology
The table shows the abbreviations used.

Short	Description	Comment
$P_{AVAILABLE}$	Available power	P_{TOTAL} - $P_{PRODUCED}$
P_{TOTAL}	Total power	$\sum P_{NOMINAL}$ of running sets with GBs closed
$P_{PRODUCED}$	Produced power	
$P_{NOMINAL}$	Nominal power	
$P_{NOMINAL-STOP}$	Nominal power of the genset to stop	Priority dependent

Deactivate load-dependent stop:
The load-dependent stop can be deactivated through M-Logic, should this be preferred. This is necessary e.g. to allow operators to start the factory load after a blackout before the normal load-dependent operation can be started.

In the example below, the function is activated with terminal 77. Now the operator can switch the load-dependent stop ON or OFF with a switch connected to terminal 78.

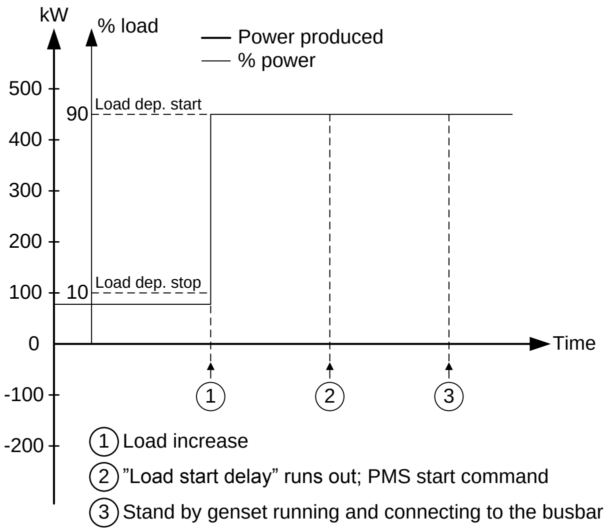


Produced power method:
This method is in effect if % power is selected in menu 8880 as basis for the start/stop calculation.

If the load % of a generator exceeds the ”Start next” set point, the start sequence of the lowest priority generator in stand-by will be initiated.

If the load % of a generator drops below the ”Stop next” set point, the stop sequence of the running generator with the highest priority number will be initiated.

If the load of the plant decreases so much that the generator with the highest priority number can be stopped and an available power of at least the stop set point in % is available, then the stop sequence of this generator will be initiated.

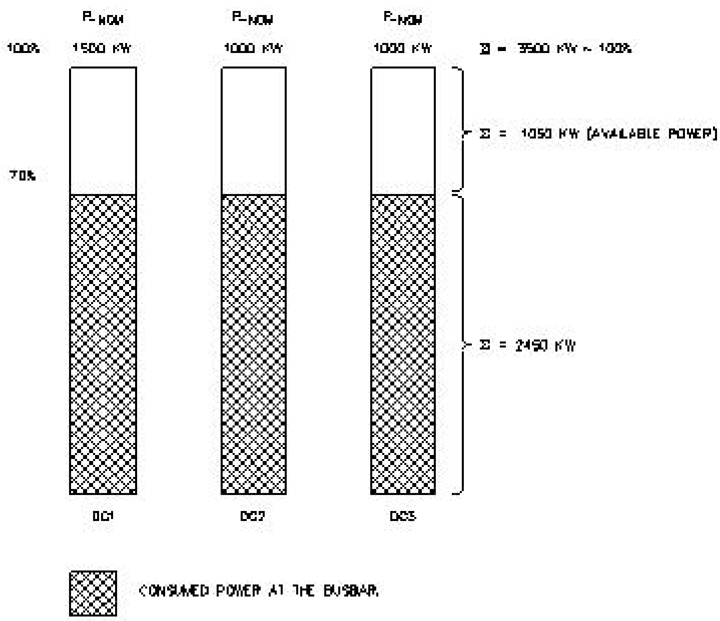


Available power method:
This method is in effect if P [kW] or S [kVA] is selected as basis for the start/stop calculation.

Independent of the selection (P [kW] or S [kVA]), the functionality is basically identical; therefore the example of the functionality below will be given for the load-dependent start function with selected rated power (P) value.

The apparent power set point is typically selected, if the connected load has an inductive character and the cos phi is below 0.7.

Description:
This drawing illustrates the terms used.



Nominal power:
The nominal power is the rated power of the genset that can be read on the type plate of the generator.

Total power:
The total power is the summation of the rated nominal power of each individual genset. In the example above, the plant consists of three DGs:

DG 1 =	1500kW
DG 2 =	1000kW
DG 3 =	1000kW
That is a total of	**3500 kW**

Produced power:
The produced power is defined as the existing load on the busbar. In the example above, the produced power is indicated as the hatched area, and the total of the three gensets = 2450 kW.

Available power:
The available power is the difference between the maximum possible power produced by the gensets and the actual produced power.
In the example above, the plant consists of three gensets, in total 3500 kW. The load consumes 2450 kW in total. Since the total load PTOTAL is 3500 kW, and the produced load PPRODUCED is 2450 kW, then the available power PAVAILABLE is 1050 kW, meaning that the gensets can handle this load if it should be added to the busbar.

Principle – available power method:
One genset is running and is supplying the load. The load increases which means that the available power/apparent power decreases. At a certain time, the load has increased so much that only a little amount of power/apparent power is available, and the next priority genset will be started in order to increase the amount of available power/apparent power.

When the load drops, the available power/apparent power will increase. When the available power/apparent power has increased above the stop level plus the nominal power of the last priority genset, then the last priority genset will be stopped. Please note that the nominal power of the genset to be stopped is added to the adjusted stop level. The reason is that otherwise the available power/apparent power would immediately drop below the start level again.

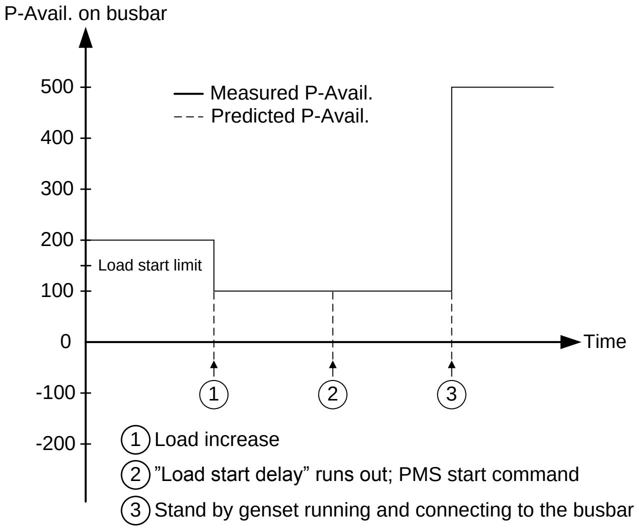
Example:If the adjusted stop level is 200 kW (PSTOP = 200 kW), and the genset with the last priority is 1000 kW, it is necessary that the available power reaches 1200 kW, because the available power will be reduced with 1000 kW immediately after the last priority genset is stopped.

Principle – percentage method:
One genset is running and is supplying the load. The load increases which means that the % load increases. At a certain time, the load has increased so much that the load % start will start up the next priority genset in order to take some of the load.

When the load drops, the produced power will decrease. When the produced power has decreased below the stop level plus the nominal power of the last priority genset, then the last priority genset will be stopped. Please note that the nominal power of the genset to be stopped is added to the adjusted stop level. The reason is that otherwise the produced power would immediately drop below the start level again.

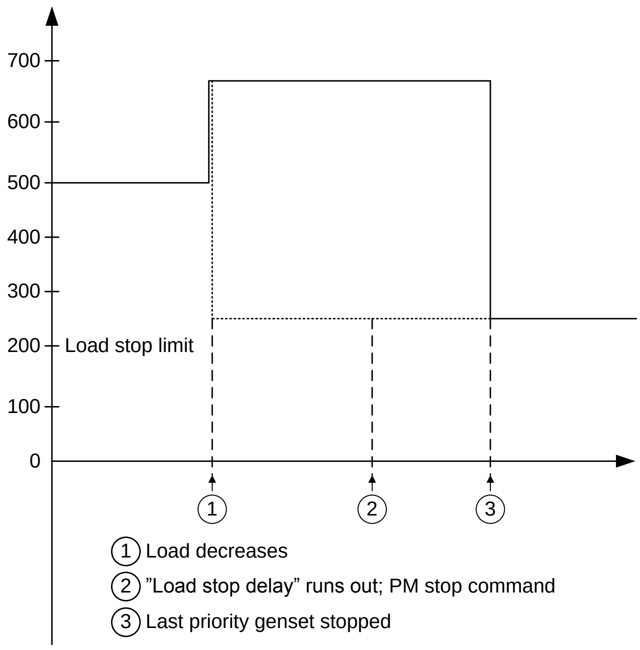
Example:If the adjusted stop level is 10% (100 kW produced power), and the genset with the last priority is 1000 kW, it is necessary that the produced power reaches 1100 kW, because the produced power will be reduced with 1000 kW immediately after the last priority genset is stopped.

Adjusting load-dependent start:
In the example below, the available power is 200 kW. When the load increases, the available power drops below the start limit. The stand-by genset will start when the start timer runs out, and after the synchronising the available power increases (in this example to 500 kW).



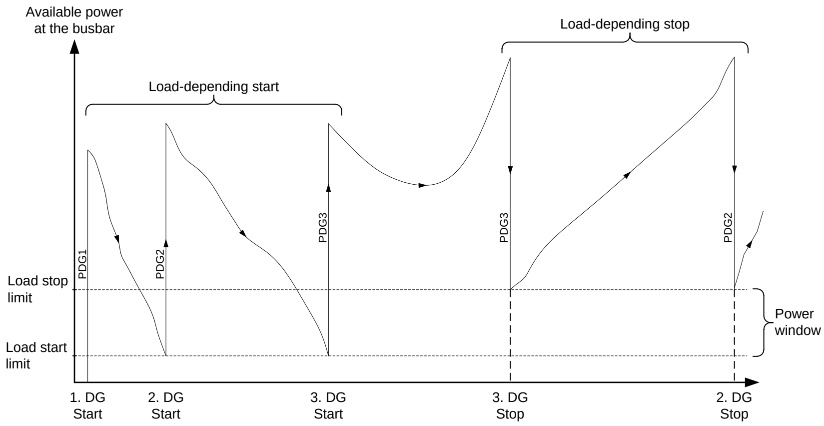
Adjusting load-dependent stop:
In the example below, the available power is 500 kW. When the load decreases, the available power increases to 750 kW. The AGC 200 now calculates what happens if the last priority genset is stopped. In the example below, the last priority genset is 400 kW which means that it can be stopped, because the available power will still be above the stop level.

Now the difference between the stop level and the available power is 50 kW. This means that only if the genset, which now has the last priority, is 50 kW, it can be stopped!



If the order of priority is changed, the following must be observed: If the priority does not seem to change as expected, it is because the load-dependent stop function is not able to stop the lowest priority after having started the new first priority. That would cause two DGs to be running at low load instead of one DG.

Power window:
The difference between the programmed load-dependent start and stop limits forms the power hysteresis between the start and stop. This is shown in the diagram below:

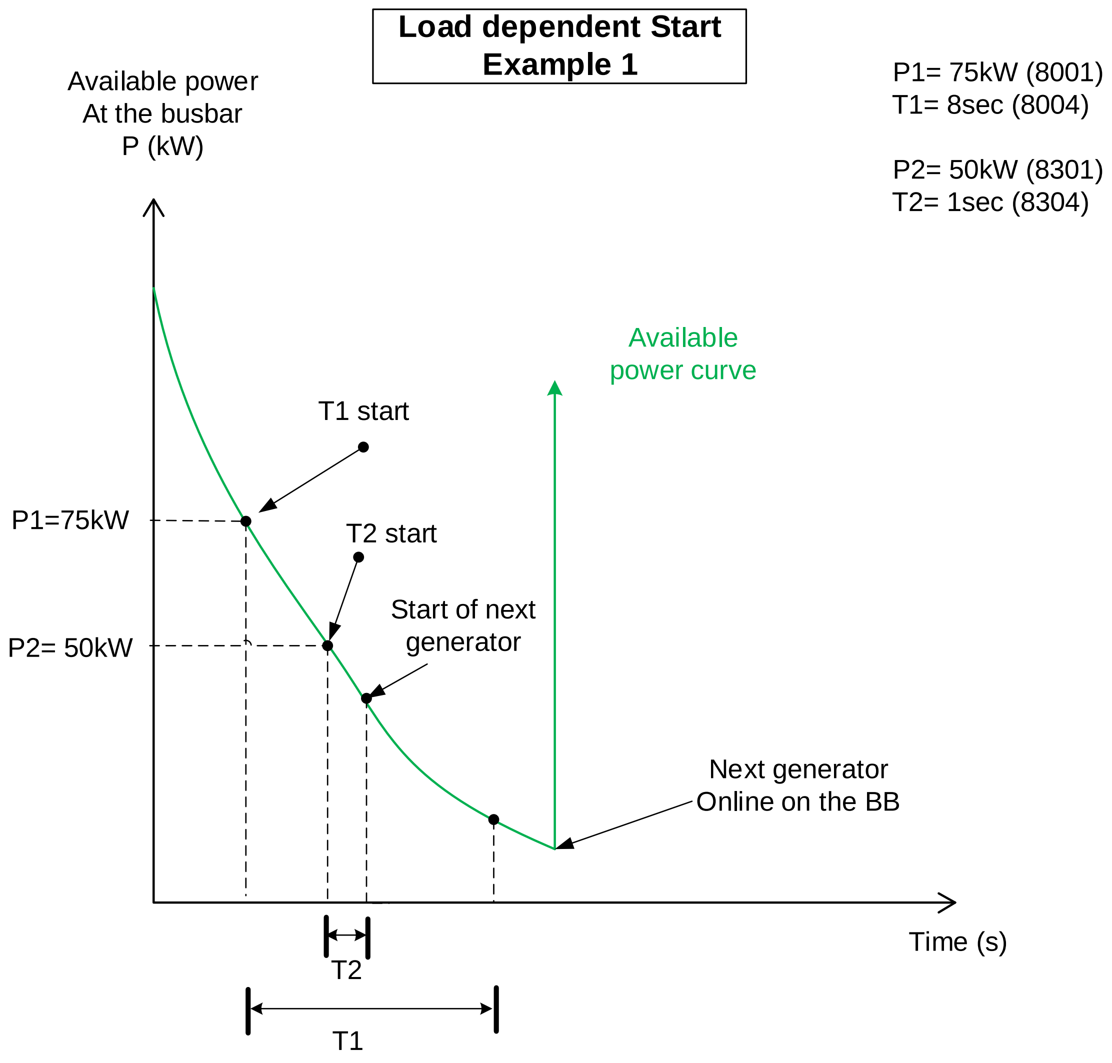


Two sets of parameters for load-dependent starting and stopping
There are two sets of parameters for load-dependent starting and stopping. The available parameters are:

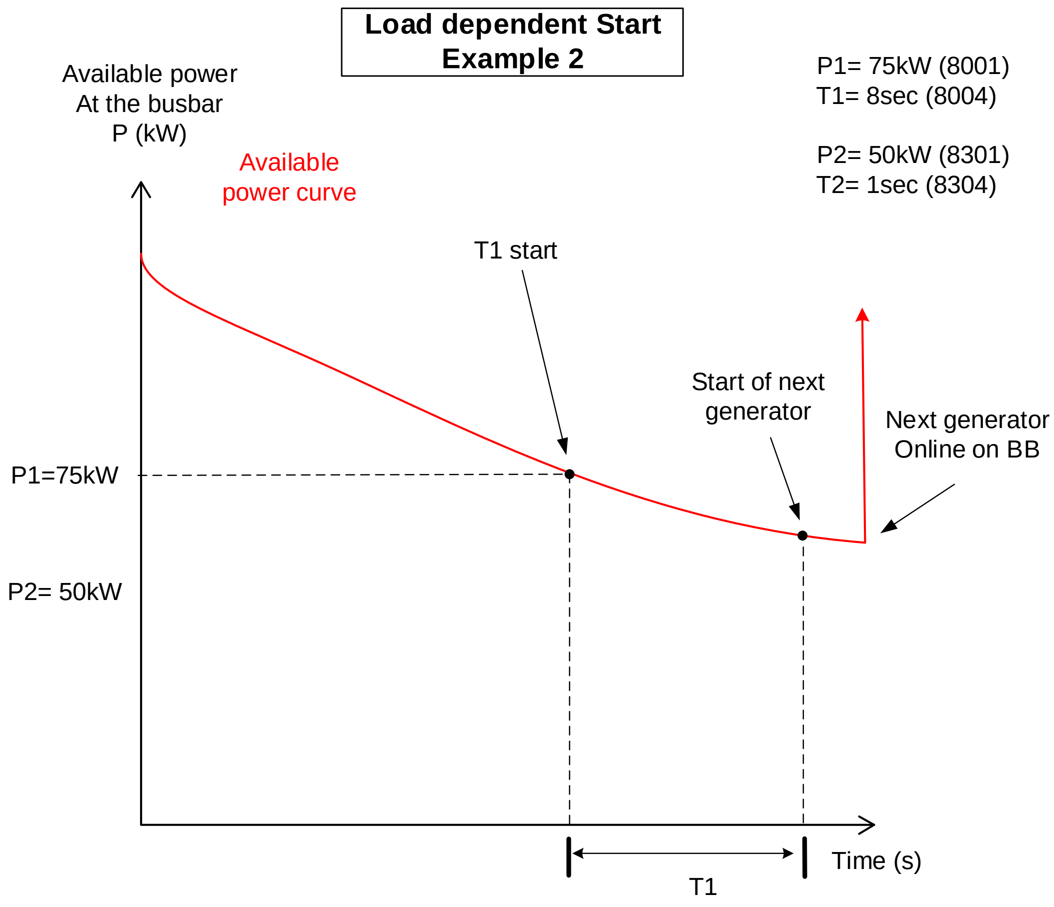
Set 1: 8001 to 8015
Set 2: 8301 to 8314

The reason for having two sets of parameters is that in that way the genset can act differently on different load curves. If, for example, the load increases fast, it is possible to configure a short timer (s) and a low P (kW) set point, so the genset gets online faster, and the result is that the genset is not overloaded. In another situation the load will increase slower, and then it is possible to use the other set of set points with a longer timer (s) and a higher P (kW).

The two sets of set points are always active. When the available power has reached the set point the timer starts, and when the timer runs out the genset starts. See the diagrams below for examples of how the configuration can be done. Be aware that the examples show available power on the BB, and that is why the curve goes down when the load increases.



The above example 1 shows that timer 1 will start at 75 kW and timer 2 will start at 50 kW, and because timer 2 runs out before timer 1, it is timer 2 that starts the genset.



The above example 2 shows that timer 1 will start at 75kW, and when timer 1 runs out the genset will start. Timer 2 will not be started, because the load does not go under 50 kW (P2).

The diagrams above show load-dependent start; the principle for load-dependent stop is the same.

Be aware that it is only set 1 (parameters 8001 to 8015) that can be used for the "fuel optimisation" function.

9.1.16 Load management

The function is used to activate a relay when a specific amount of power is available. The purpose of this function is to be able to connect load groups when the gensets of the emergency power plant are running.

In each of the gensets, five levels can be adjusted (menus 8220-8260):

- Available power 1
- Available power 2

- Available power 3
- Available power 4
- Available power 5

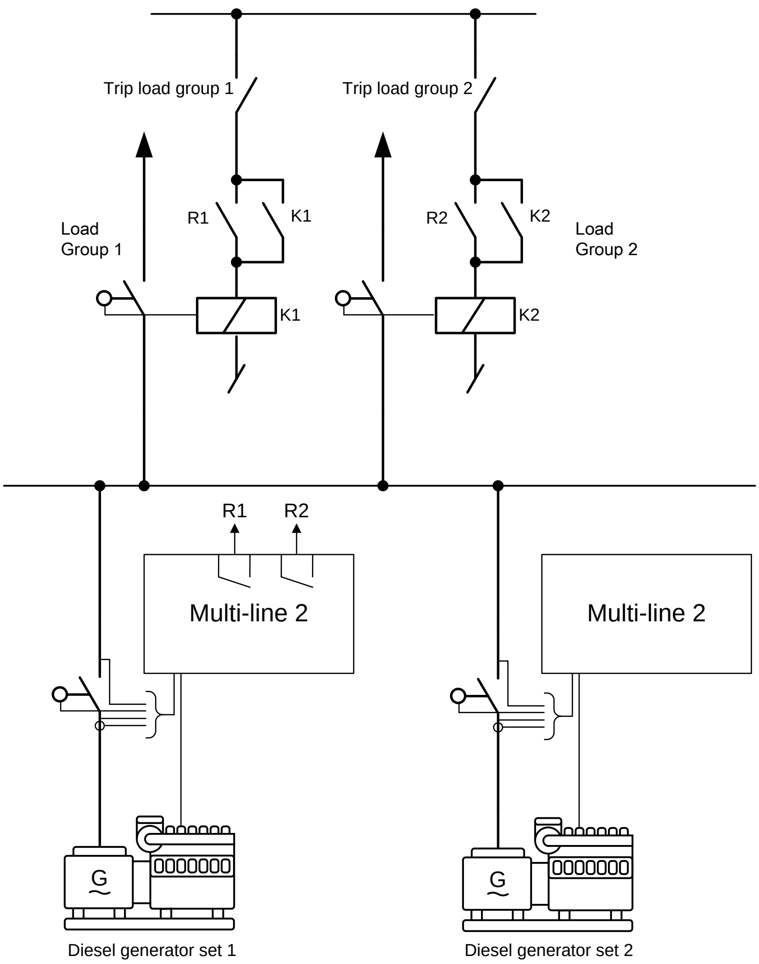
These set points can activate a relay when the specific amount of available power is reached. The relay output can be used to connect load groups when sufficient power is available. The relays will activate when the available power is higher than the set point, but be aware that when the load groups are being connected, the available power will decrease and the relay(s) deactivate again if the available power is below the set point. So it is necessary to make an external holding circuit.

The number of available relays is limited.

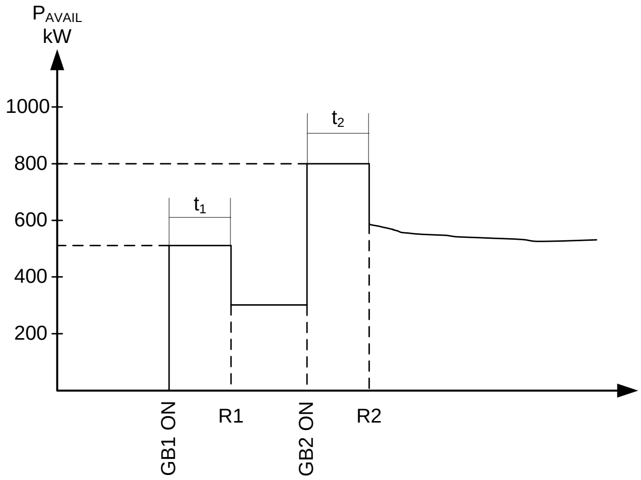
The function is not depending on the running modes. The relays will activate in all modes including block. To avoid activation, e.g. when the genset is stopped, the inhibit function should be used.

It is possible to adjust different levels of available power in all gensets. This gives the possibility to use several load groups if this is necessary.

Example: In the example below, generator #1 is started, followed by generator #2. The simplified diagram shows the two gensets and two load groups that are being connected by the available power relays R1 and R2 on the first AGC 200.



Functionality description: (refer to the diagram below)
The generator #1 is started, and the timer t1 starts running when the GB1 closes. When the t1 has expired, the selected relay activates (R1) and in the example, a 200 kW load group is connected. Now the available power falls to 300 kW. After some time, the generator #2 is started and its generator breaker is synchronised. When the GB2 closes, the timer t2 runs. When the timer t2 expires, the selected relay activates (R2) and the second load group of 200 kW is connected. Now the available power falls to 600 kW.



To connect the load groups, individual relays can be selected on each AGC 200 or on one of the AGC 200 units only

9.1.17 Load sharing

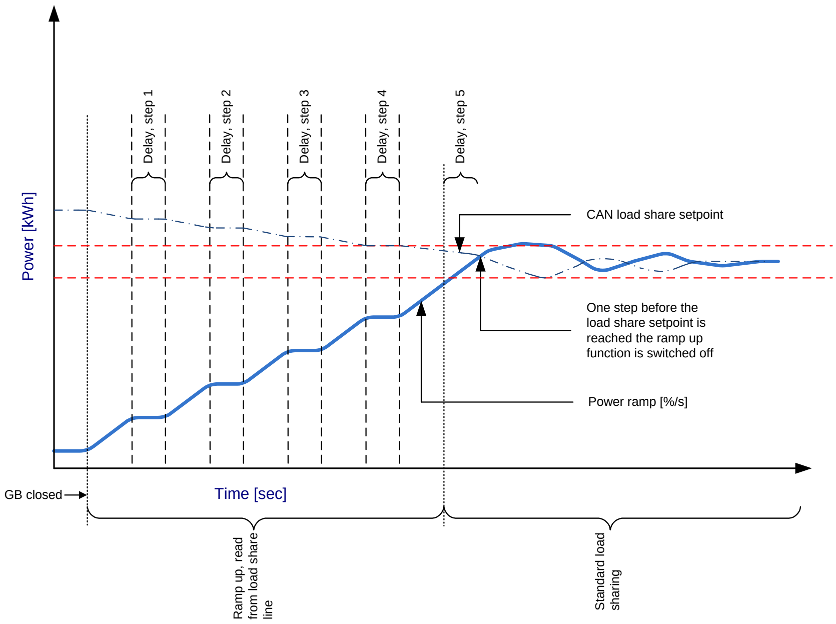
When the power management communication is running, the load sharing between the gensets is done by using the CANbus communication between the AGC 200 units.

If the power management CANbus line is disconnected or faulty, the AGC 200 units do not automatically switch over to analogue load sharing or CAN share. This has to be set up in M-Logic with the following commands:

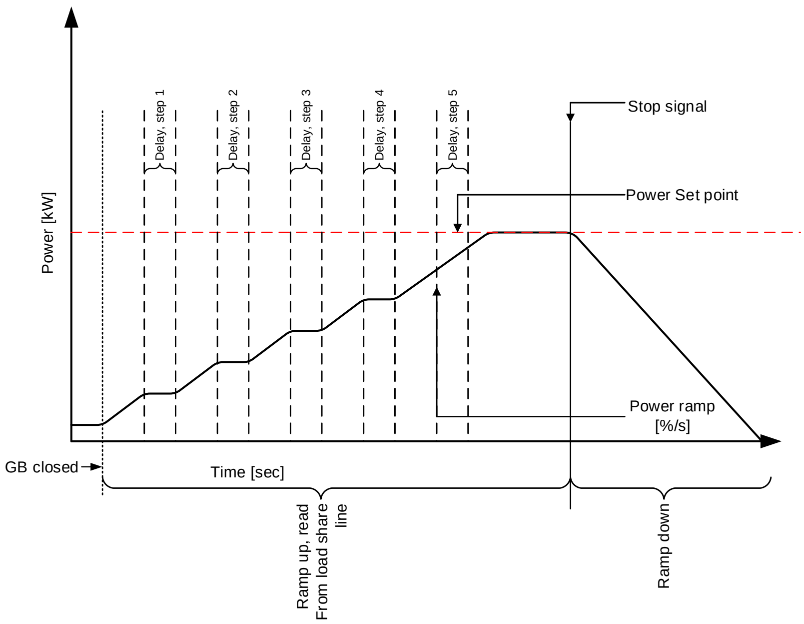
M-Logic output command	Description
Use alternative LS instead of PM	Now the load sharing continues using CAN share. This means that the power management will be lost, but the gensets already running will stay stable.
Enable analogue LS	Now the load sharing continues based on the IOM 230 module (analogue load sharing). This means that the power management will be lost, but the gensets already running will stay stable.
"Use alternative LS instead of PM" and "Enable analogue LS"	With both enabled, the load sharing will switch to analogue LS if CAN share fails. This means that if power management fails, and both of the mentioned M-Logic commands are/become active, the analogue load sharing will be prioritised first.

About analogue load sharing, please refer to the application notes “IOM 200 analogue interface for AGC 200”, document no. 4189340614, for details.

9.1.18 Island ramp-up with load steps



9.1.19 Fixed power ramp-up with load steps



When menu 2614 is enabled, the power set point continues to rise in ramp-up steps, determined by menu 2615, towards the load sharing set point. The delay time between each ramp-up step will be determined by menu 2613. The ramp-up will continue until the load sharing set point is reached and then switch the regulator to standard load sharing mode. If the delay point is set to 20% and the number of load steps is set to three, the genset will ramp to 20%, wait the configured delay time, ramp to 40%, wait, ramp to 60%, wait and then ramp to the system set point. If the set point is at 50%, the ramp will stop at 50%.

9.1.20 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:

1. The power ramp will stop at any point of the ramp, and this set point will be kept as long as the function is active.
2. If the function is activated while ramping from one delay point to the other, the ramp will be fixed until the function is deactivated again.
3. If the function is activated while the delay timer is timing out, the timer will be stopped and will not continue until the function is deactivated again.

9.1.21 ATS applications

Two possibilities are available: The mains unit can either be installed or not installed.

AGC 200 mains installed:

In an AMF application, the AGC 200 mains will normally operate the mains breaker and thereby make sure that the supply is coming from the mains if this is healthy.

This function allows the AGC 200 to be used in an application where an automatic transfer switch is installed. This is known as an ATS.

In the applications shown as one-line diagrams in the chapter ”Functional description” it can be seen that the ATS will take care of the switching between the generator supply and the mains supply.

If ATS is selected, the AGC 200 has no control over the ATS (”mains breaker”).

Description:

Normally, the AGC 200 detects a mains failure based on the voltage and frequency measurement on the mains. However, when ATS is selected in menu 7085 it is necessary to use a digital input together with the position feedbacks from the ATS. Thus, the mains failure is not detected by the AGC 200 measurements, but by the following two requirements:

1. Alternative start input ON
2. ATS (MB) feedback OFF

To make the AGC 200 detect a mains failure, the alternative start input has to be ON and the MB OFF feedback has to be active.

The input used as ”Alternative start” function is configured in the PC utility software (USW).

The mains unit will not try to operate the ATS (mains breaker) at all. But it is still necessary that position feedbacks are wired up.

It is possible to have a tie breaker installed. This is useful if more gensets need to be started before supplying the load, because the tie breaker will not close until the required number of gensets is available.

ATS island mode:
If this application is needed, the gensets can be started by activating the ”auto start/stop” input. The gensets will be started and stopped according to the power demand. That is, they will operate in load-dependent start/stop mode.

Be aware that since no tie breaker is installed, it is important that the first genset to close on the busbar can carry the load. If the load is too high, the genset will be overloaded.

This application can be combined with the multi-start function.

9.1.22 Fail class

The fail classes are still valid when the power management is active. In addition to these fail classes, the safety stop can be used in the AGC 200 units with power management.

This means that when a trip + stop alarm occurs, the faulty genset will stay on the busbar until the next priority genset is started and synchronised to the bus. When the incoming genset has taken the load, the faulty genset will ramp down the power, followed by trip of the breaker, cooling down of the engine and finally stop.

If the faulty genset has the last priority, or no stand-by gensets are available, then it will stay on the busbar and will not trip.

If no genset can start in a safety stop situation, then the faulty genset will not be stopped. Therefore it is important that the safety stop is backed up, e.g. by a trip and stop alarm or a shutdown alarm.

9.1.23 Local/remote/timer operation

The plant can be adjusted to local, remote or timer operation (menu 8021). This selection is done in the command unit, i.e. one of the generator units.

The setting defines how the plant is started while it is in AUTO mode.

The settings can be changed in M-Logic and via display or PC utility software.

	Display	**Utility SW(parameter setup)**	**M-Logic**
Local	X	X	X
Remote start	X	X	X
Timer start	X		-

The purpose of the selection is to decide whether the plant can be started from the display (local operator), from remote (e.g. PLC) or by an internal timer. Remote means that the control can be carried out by activating the digital input or through Modbus communication.

Local selection:

All operation is carried out on the display. In island operation, any generator unit display can be used, and in load takeover, mains power export and fixed power, the mains unit display must be used. The plant mode must be AUTO.

Remote selection:
The plant is started using the digital input ”auto start/stop” when ”remote” is selected.

Island mode:
In island mode, the ”auto start/stop” input on any of the AGC 200 units can be used to start the plant. However, DEIF recommends to wire up the ”auto start/stop” input to all of the AGC 200 units to be sure that the automatic operation is able to continue even though one of the DGs is taken out for service (power supply disconnected to the AGC 200).

In island mode, any running mode (MAN, AUTO, SEMI, BLOCK) can be selected on the generator units, and the remote start signal is still working for the remaining AGC 200 which is still in AUTO mode.

Parallel to mains mode
In load takeover, mains power export and fixed power mode, the ”auto start/stop” input on the mains unit must be used to start the plant.

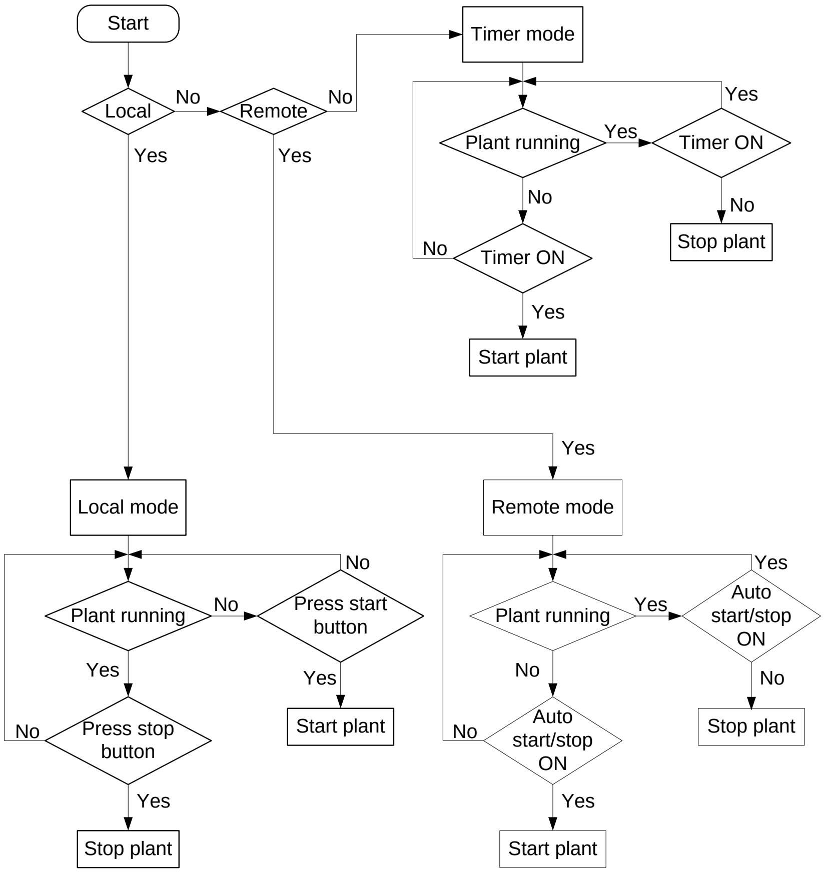
Plant operation:
The table shows how the plant is started:

Plant mode\ Selection	Local	Remote
Island mode	Display on generator units	Auto start/stop on gen. units
Fixed power mode	Display on mains unit	Auto start/stop on mains unit
Mains power export	Display on mains unit	Auto start/stop on mains unit
Load takeover	Display on mains unit	Auto start/stop on mains unit

In peak shaving and AMF, the automatic operation starts automatically depending on the imported power (peak shaving) or mains failures (AMF).

Timer selection:
The operation of the plant is controlled by up to eight internal command timers which are programmed using the PC utility software (USW). The function can be used in load takeover, mains power export and fixed power, and the mains unit has to be in auto.

Principle



9.1.24 Priority selection

It is possible to use one of three types of priority selection.

Manual

The manual selection gives a possibility to adjust the order of priority between the adjusted numbers of available DGs. This means that each genset always has a specific priority setting.
The adjustment is made in the menus 8080 (P1-P5), 8090 (P6-P11) and 8100 (P12-P16). In this example, the order of priority is DG3, DG1, DG2, DG4.

Priority		Genset	DG1	DG2	DG3	DG4
Menu 8081	P1				X	
Menu 8082	P2		X			
Menu 8083	P3			X		
Menu 8084	P4					X

These settings are only adjusted in the generator units. After the adjustment, the order of priority must be transmitted manually to the other gensets using the transmit function in menu 8086.

Running hours:
The purpose of the priority selection based on running hours is to let all the gensets have the same or nearly the same amount of running hours.

Every time the adjusted period in menu 8111 is reached, a new order of priority is determined and the gensets with first priorities will be started (if not already running), and the gensets with the last priorities will stop.

There are two possibilities of operating the priority routine based on the running hours: Absolute or relative. The selection between the absolute and relative routine defines whether the offset adjustment of the running hours is taken into consideration in the priority calculation. The offset adjustment is used for example when the AGC 200 is installed on an old genset which already has many running hours, or if an AGC 200 is replaced.

Absolute running hours:
All gensets participate in the priority routine based on the principle shown in the table below. This means that the gensets with the lowest number of running hours will be running. This can be a disadvantage, for instance if the application consists of old gensets together with new gensets. In that situation, the new gensets will be the first priorities until they have reached the same number of running hours as the old gensets. To avoid this, the priority routine called relative running hours can be used instead.

The actual number of running hours is adjusted in each AGC 200 in menus 6101 and 6102, typically at the commissioning. The purpose of the menu is to have the correct number of running hours displayed.

Relative running hours:
When relative is selected, all gensets will participate in the priority routine independently of the number of running hours adjusted in menus 6101 and 6102. This means that all gensets in AUTO mode participate in the priority routine. The relative selection gives a possibility of resetting the priority routine.

When the reset is activated in menu 8113, the relative running hour counters in the AGC 200 units will be reset to 0 hours, and at the next priority selection, the calculation is based on the reset values.

Principle for priority routine:
The principle for the priority routine is described in the following table where the running hours (menu 8111) are adjusted to 24 hours. In this example, only one genset is required by the load.

		DG1(int. ID 3)	DG2(int. ID 2)	DG3(int. ID 4)	DG4(int. ID 1)	Comment
Mon day	0	1051 h	**1031 h**	1031 h	1079 h	DG2 will start due to the lowest internal ID number
Tuesday	24	1051 h	**1055 h**	**1031 h**	1079 h	DG 3 will be started, and DG2 will be stopped
Wednes-day	48	**1051 h**	1055 h	**1055 h**	1079 h	DG1 will be started, and DG3 will be stopped
Thursday	72	**1075 h**	**1055 h**	1055 h	1079 h	DG2 will be started due to the lowest internal ID num-ber, and DG1 will be stop-ped
Friday	96	1075 h	**1079 h**	**1055 h**	1079 h	DG3 will be started, and DG 2 will be stopped
Saturday	120	**1075 h**	1079 h	**1079 h**	1079 h	DG1 will be started, and DG3 will be stopped
Sunday	144	**1099 h**	1079 h	1079 h	**1079 h**	DG4 will be started due to the lowest internal ID num-ber… and so on

The time adjusted in menu 8111 is the time between each priority calculation.

Fuel optimisation:
The purpose of the fuel optimisation routine is to always let the gensets run in the best combination at any given load, based on their actual nominal powers.

The settings are adjusted in the command unit.

The multi-start function cannot be used together with the fuel optimising routine.

Description:
The function is set up in the following menus:

Menu number	Menu text	Description	Comment
8171	Set point	Load with best fuel economy (% of P_{NOM})	The units will optimise around this genset load
8172	Swap set point	Initiate optimising	The improvement in nominal power must be better than this set point to initiate fuel optimising
8173	Delay	Time delay	Optimal combination must be present during this period before optimising is initiated
8174	Hour	Running hours	Maximum allowed difference in running hours
8175	Enable	Activate running hours	Activates the dependency of the running hours

The function is best described with an example. An example with three DGs is shown below.

- DG1 = 1000 kW
- DG2 = 1000 kW
- DG3 = 500 kW

Settings used in the fuel optimising function in this example:

- 8011 Load-dependent stop = 220 kW
- 8171 Set point = 100 %
- 8172 Swap set point = 200 kW

Situation 1:
The two 1000 kW gensets must operate. The load is too big for one 1000 kW and one 500 kW genset.

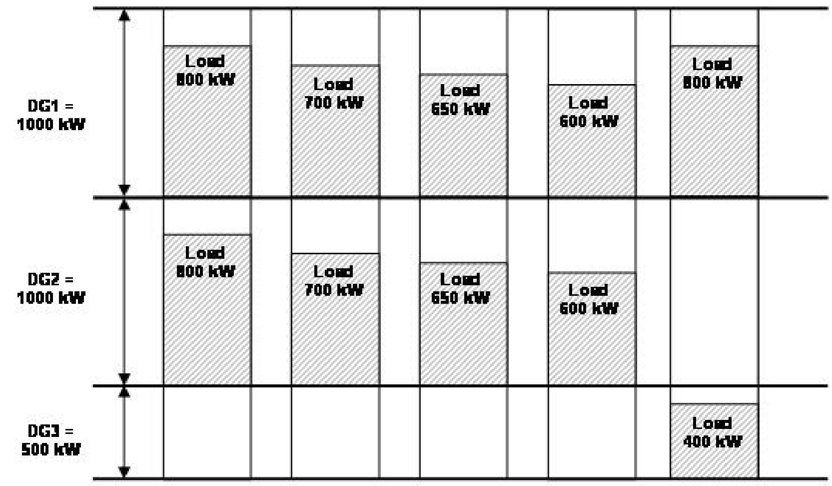
Situation 2:
Since the load has decreased to 1400 kW, it would be enough with one 1000 kW and one 500 kW genset. The improvement is 500 kW which is better than 200 kW (menu 8172). The problem is that only 100 kW would be available. The load-dependent stop requires 220 kW available, so no swapping can take place.

Situation 3:
Now the load has decreased to 1300 kW. It would be enough with one 1000 kW and one 500 kW genset. The improvement is 500 kW which is better than 200 kW (menu 8172). The problem is that only 200 kW would be available. The load-dependent stop requires 220 kW available, so no swapping can take place.

Situation 4:
Now the load has decreased to 1200 kW. It would be enough with one 1000 kW and one 500 kW genset. The improvement is 500 kW which is better than 200 kW (menu 8172). This means that 300 kW would be available, so the load-dependent stop does not interfere with the fuel optimising.

Fuel optimising is initiated!

Situation 5:
Now DG3 has been started and is running with 400 kW. This is the best combination at this time, and no swapping takes place with this load.



	Situation 1	Situation 2	Situation 3	Situation 4	Situation 5
P_{DG1}	800 kW	700 kW	650 kW	600 kW	800 kW
P_{DG2}	800 kW	700 kW	650 kW	600 kW	0 kW
P_{DG3}	0 kW	0 kW	0 kW	0 kW	400 kW
Present P_{AVAIL}	400 kW	600 kW	700 kW	800 kW	300 kW
New P_{AVAIL}	-100 kW	100 kW	200 kW	300 kW	800 kW
Improve kW	none	500 kW	500 kW	500 kW	none
Improvement	-	v	v	v	-

Swapping blocked by load dependent stop

Swapping initiated

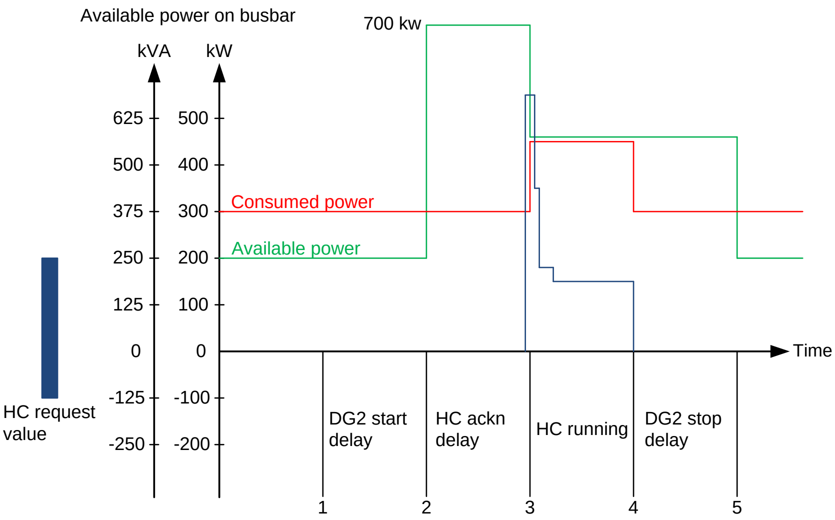
The set point (menu 8171) in percent is typically set to 80 to 85 % for optimum fuel economy.

Running hours:
It is possible to combine the fuel optimising with the running hours. This is enabled in menu 8175. If this setting is OFF, the fuel optimising will be active but the running hours will not be included in the calculation.

If the function ”running hours” is enabled, the principle is the following: If one genset reaches the adjusted amount of running hours, then it will be given quarantine. This means that it will just rest until it has the lowest number of running hours. The only exception to this is if there is no alternative combination. Then it will be used, but it will still be in quarantine.

9.1.25 Conditional connection of heavy consumers

Each diesel generator unit is able to handle two heavy consumers (HC). When a heavy consumer is requested, the function for conditional connection of heavy consumers reserves the programmed HC requested value (parameter 8201/8211) on the busbar and blocks for engagement of the heavy consumer until sufficient predicted available power is present at the busbar.



HC request value: 375 kVA
HC nominal load: 150 kW
DG nominal power: 500 kW
Cos phi: 0.8
Load-dep. start value 90%
Load-dep. stop value 70%

1 Request HC
2 Connect DG2
3 Acknowledge HC
4 Disable request HC
5 Disconnect DG2

When the available power is above the requested HC power, the heavy consumer is subsequently blocked until the programmed HC acknowledge delay runs out (fixed delay of 4 sec.).

The ”DELAY ACK. HC” may be necessary in order to allow the recently started generator set to take load and thus actually increase the available power at the busbar before engagement of the HC.

The heavy consumers (HCs) are connected according to their priority. This means that if two or more heavy consumers request start acknowledgement at the same time, the HC with the highest priority is handled first, and subsequently HCs with lower priority, etc.

HC 1.1 (1st HC in DG unit with CAN ID no. 1) is designated the highest priority. This means that HC 1.1 is handled before HC 1.2, and HC 2.1 is handled before HC 2.2 if they are requested for start at the same time. If there are any preferential HCs, they must be connected to the hardware interface for the 1st HC in order to ensure first priority handling.

The power management system carries out the following systematic sequence when a heavy consumer is requested for start

a) The programmed ”HC n REQ. VALUE” is reserved at the busbar (parameter 8201/8211).
b) A PMS start command is transmitted to the next stand-by generator set if the predicted available power is below the programmed ”LOAD START LIMIT”.
c) When sufficient available power is present at the busbar, the timer ”DELAY ACK. HC n” starts running (fixed delay time of 4 sec.).
d) The start acknowledge signal is transmitted to the HC in question when the timer ”DELAY ACK. HC n” runs out and sufficient available power is still measured at the busbar.
e) The nominal HC power value (parameter 8202/8212) is used for load-dependent start/stop calculation after the acknowledge signal is given.

Power feedback from the heavy consumer

The AGC 200 is able to handle two types of power feedback:

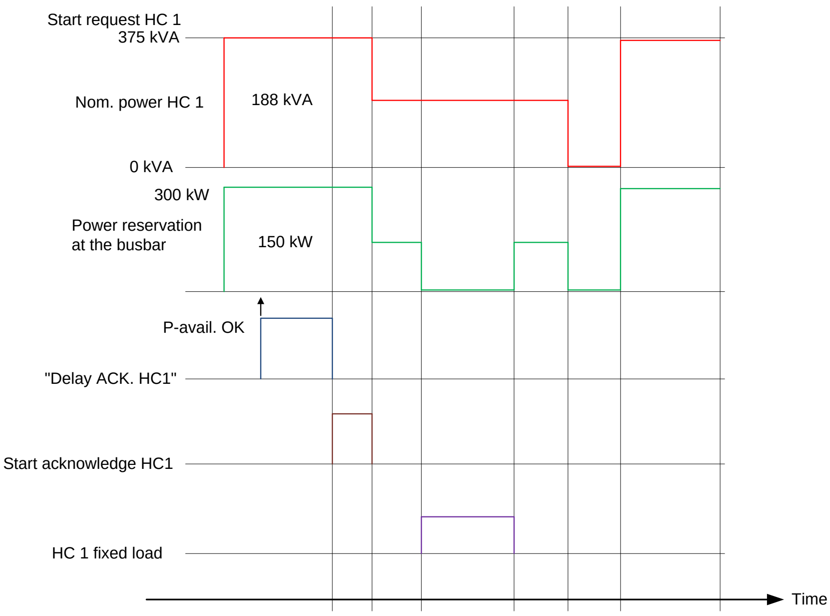
- Binary feedback
- Analogue feedback

The two types of power feedback signals are handled the same way by the conditional connection of heavy consumers function.

Changing the power feedback type is done by a parameter (8203/8213) in each generator unit.

Activating the corresponding start request binary input activates the HC engagement sequence. The AGC 200 system transmits a start acknowledge signal when sufficient predicted available power is present at the busbar.

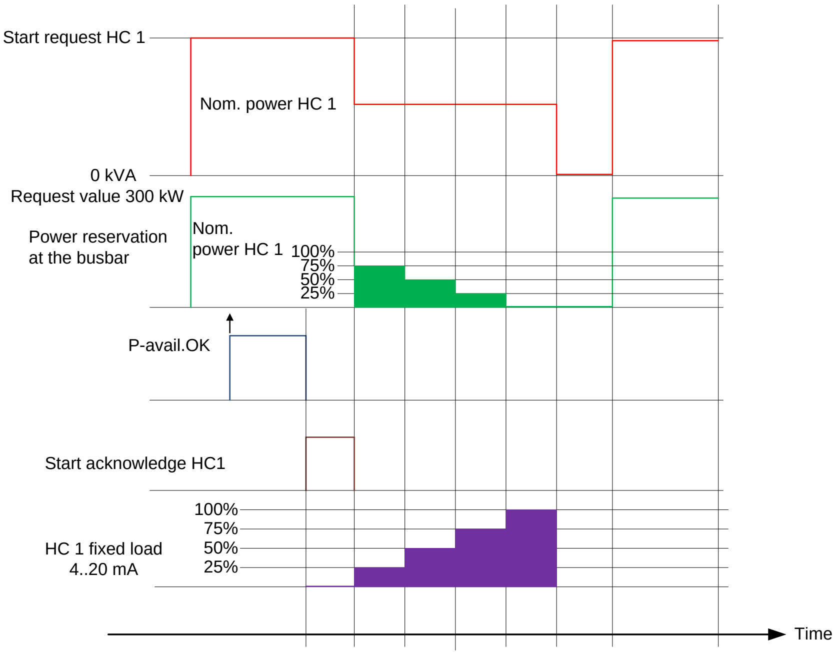
HC with binary power feedback signal:



Engagement sequence for HCs with fixed load

The power reservation by means of the feedback "HCx fixed load" input is enabled as long as the start request signal is active. An OFF status (indicates that the HC is not operating) of the power feedback signal results in a 100% power reservation at the busbar.

An ON status (indicates that the HC is operating) at the power feedback signal results in a 0% power reservation at the busbar. HC with analogue power feedback signal:



The analogue power feedback for the heavy consumer is intended for a power transducer with a 4-20 mA output corresponding to 0-100% load. If the heavy consumer is of 400 kW, the power transducer has to be calibrated to 0-400 kW = 4-20 mA, and the setting has to be set at 400 kW

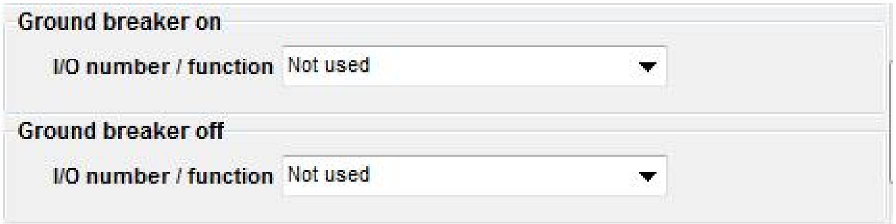
9.1.26 Ground relay

The purpose of this function is to always let the star point of only one genset be connected to ground during island mode operation. The reason for this is to avoid circulating currents between the generators. The function is adjusted in menu 8120.

If the gensets nominal power (Pnom) are equal, the AGC which has the first priority will activate its ground relay when Hz/V is inside the acceptable range (menu 2111 + 2112). Should this genset stop when other gensets are connected, it will open its ground relay when the generator breaker opens. The ground relay of the generator which now has the next priority will close its ground relay instead. In case only one genset is connected to the busbar and the breaker is tripped, it will keep the ground relay closed as long as the voltage/frequency is ok.

If any gensets with higher Pnom. (menu 60xx) are going to connect to the busbar, the ground relay of the running genset with first priority will deactivate, and the incoming genset will instead close its grounding relay.

Ground relay with breaker position:
It is possible to use position feedbacks from the ground relay, they can be selected in the input list:



Ground relay failure
Three alarms are related to the position of the ground breaker/relay. The handling of the alarm depends on the chosen fail class, e.g. tripping the generator breaker.

Name	Description	Parameter number
Gnd Open fail	Used for ground relay open failure with related fail class.	8131
Gnd Close fail	Used for ground relay close failure with related fail class	8132
Gnd Pos fail	Used for ground relay position failure with related fail class	8133

The relay for this function is selected in each AGC unit.

The ground relay function will NOT be supported in a "Single DG" application, even if the unit has power management.

9.1.27 Stop of non-connected gensets

If peak shaving is selected and the imported power increases above the start set point, the genset(s) will start. If the load now drops below the start set point, it will remain disconnected from the busbar but will not stop, because the imported power is higher than the stop set point.

The function ”stop of non-connected DGs” (menu 8140) will make sure that the gensets stop after the adjusted time.

In other modes, the generator will also be stopped if it is in automatic without the GB closed.

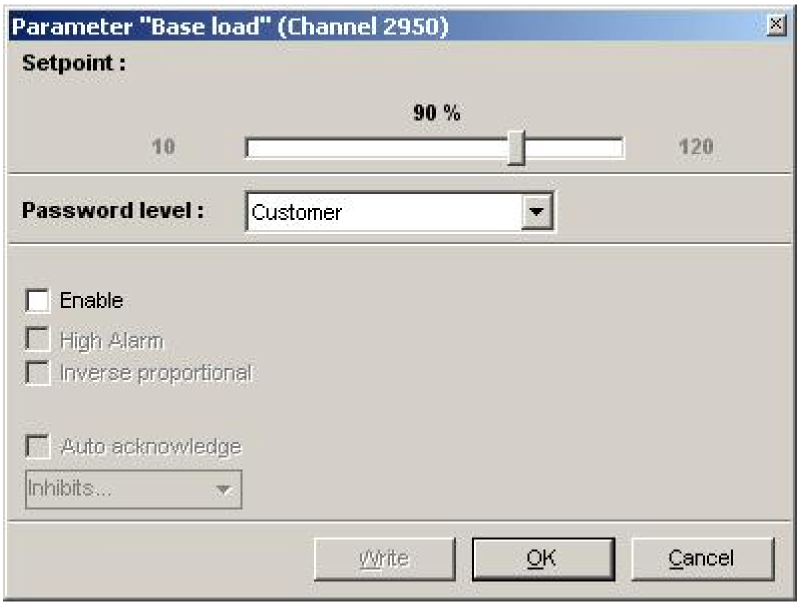
9.1.28 Secured mode

Secured mode adds an extra generator to the power management system. This means that one genset more than calculated in load-dependent start will be running.
It is only possible to activate secured mode if the genset is in auto mode.
Secured mode can be activated/deactivated by means of digital inputs, via M-Logic or in parameter 8921.

The extra generator running in secured mode will be selected, so it is possible to replace the largest running generator if this should fail.

9.1.29 Base load

One genset unit in a power management system can be selected as running with base load (2952). This can be done from the display unit, via M-Logic or via a binary input. If the unit is selected to run with base load, the status message ”FIXED POWER” will be indicated. The fixed power value can be adjusted with parameter 2951.



If a generator runs in base load and the total load decreases to a point below the base load set point, the system will lower the fixed power set point. This is to prevent frequency control problems, as the generator running in base load does not participate in the frequency control.
When the generator breaker is closed, the generator power will be increased to the fixed power set point.
If AVR control is selected, the set point will be the adjusted cos phi.

The unit selected for base load operation will automatically be set in SEMI-AUTO. Only one generator per independent busbar can run with base load.

The busbar has to be active with one or more DG units running, before the unit with the lowest ID can activate base load.

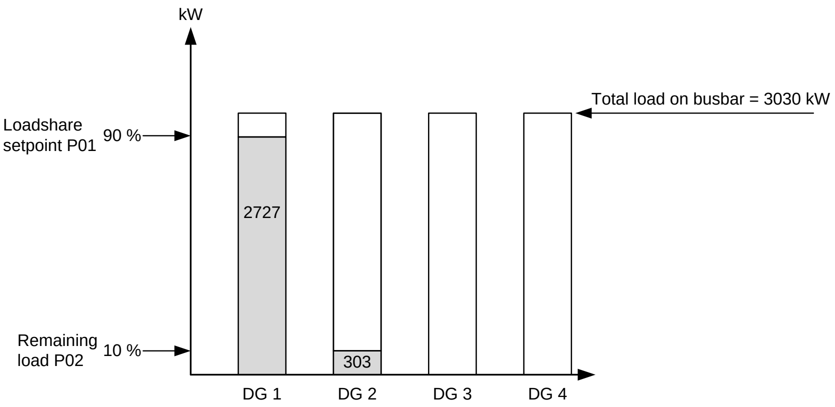
Only one AGC 200 unit at a time can run in base load. The unit with the lowest ID will be allowed to run in base load.

9.1.30 Asymmetric load sharing (LS)

When asymmetric LS is enabled in menu 8282, the "normal" G5 load sharing is deactivated in all AGC 200 units in the system. The AGC 200 units will then load share according to the asymmetric LS set point in menu 8281.

Example: Four DGs able to produce 2800 kW each as nominal power. Asymmetric LS set point = 90%. Load on the busbar is 3030 kW.

The generator with priority 01 will start up first, taking 90% of the load = 2727 kW. The generator with priority 02 will take the rest of the load = 303 kW.



If the asymmetric LS set point in menu 8281 “kW value” is higher than the nominal power of the generators, the whole system will switch back to symmetric.

9.1.31 Tie breaker configuration

The AGC 246 can be used with a tie breaker, i.e. a breaker connected between the gensets and the load bus.

Tie breaker selection

In menu 8191, the tie breaker can be selected to be ON (present) or OFF (not present).

Tie breaker control

It can be selected whether the tie breaker should be open or closed when the generators are stopped. This depends on the application and the auxiliaries. If auxiliary load is connected to the generator bus, the tie breaker must be closed, but if no load is connected to the generator bus, then the tie breaker is often preferred to be open when the generators are stopped.

The tie breaker will open or close depending on the setting in the menu 8191 (”TB open point”).

The tie breaker only opens or closes depending on the selection in menu 8191, and it is not depending on the selected mode whether it should open or close.

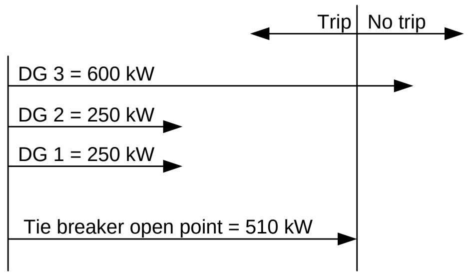
Tie breaker open point

If the gensets are running parallel to mains and the mains breaker trips, e.g. due to a mains failure, it can be necessary to trip the tie breaker as well.

This depends on the total nominal power of the running gensets. If the gensets cannot supply the amount of load which is adjusted in the ”tie breaker open point” menu 8192, then the tie breaker will open. It will close again when the power capacity set point menu 8193 is reached.

This delay time can be used to trip non essential load groups.

Example: In the example illustrated below it is shown that the tie breaker will trip if DG1 or DG2 is connected to the load, because they are smaller than 510 kW. If DG1 and DG2 are running together, the tie breaker will also trip, because the total nominal power is still below 510 kW. If, however, DG3 is running alone or together with one of the two smaller DGs, then the tie breaker will not trip, because the total nominal power will be higher than 510 kW.

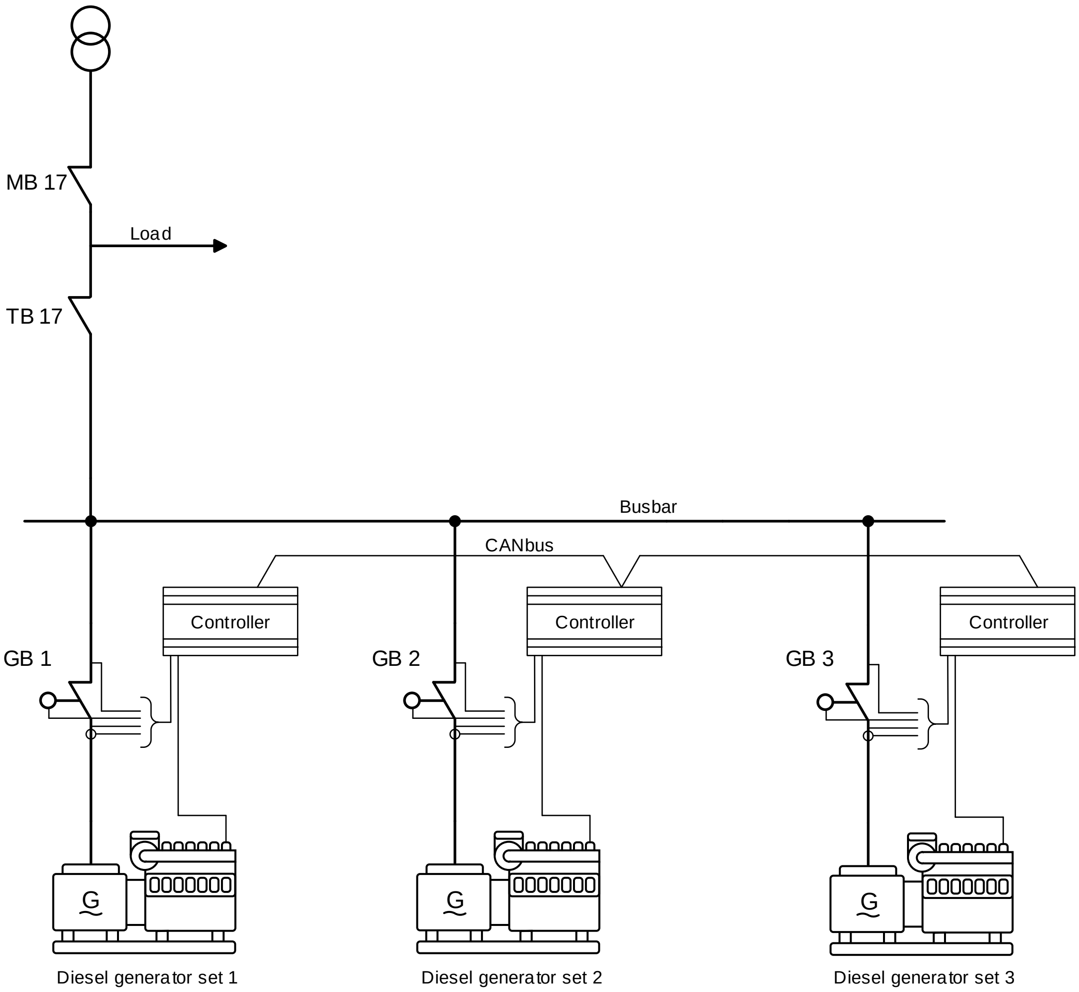


The powers mentioned above are nominal powers of the gensets in the application.

It is possible to deload the tie breaker semi-auto mode with the M-Logic command "Act TB de-load".

9.1.32 De-load sequence

This paragraph describes how a de-load sequence in a power management system functions when changing from generator to grid connection as power supply.
This could be relevant when reconnecting to the mains after an AMF situation, or when an auto start/stop signal has been removed from a peak shaving setup, fixed power setup, and so on.
The diagram illustrates the explanations below on the two different ways of de-loading where either the GB or the TB opens first.



GB de-load sequence (standard)
The GBs will open when the “Power ramp down” set point is reached while de-loading; when all the GBs have been opened the TB will open.

Step 1: Auto start/stop signal has been removed/leaving AMF sequence
Step 2: Diesel generator set 1, 2 and 3 de-load
Step 3: GB 1, 2 and 3 open when “Power ramp down” set point is reached
Step 4: TB 17 opens

Controller type	Description	Comment
AGC-4 DG	"Power ramp down" (channel 2622)	Maximum load on GB before open
AGC 200 DG	"Power ramp down setp" (channel 2622)	Maximum load on GB before open

TB de-load sequence
When "Deload TB back sync." is enabled, the generators will de-load and when “TB open point” is reached, the TB will open before the GB. This prevents the available power from decreasing on the BB until the TB is opened.

Step 1: Auto start/stop signal has been removed/leaving AMF sequence
Step 2: Diesel generator set 1, 2 and 3 de-load
Step 3: TB 17 opens when “TB open point” is reached
Step 4: GB 1, 2 and 3 open

Controller type	Description	Comment
AGC-4 MAINS	"Deload TB back sync." (channel 8273)	Enable/disable
AGC 200 MAINS	"TB Power meas" (channel 8273)	Type: Multi-input 47/4th CT
AGC 200 MAINS	"TB Power meas" (channel 8274)	Enable/disable
AGC-4 and AGC 200 MAINS	"TB open point" (channel 8191)	Maximum load on TB before open

If the input type for the TB de-load function has not been configured, the TB will open without de-loading.

9.1.33 Busbar Hz/V OK

Mains
The voltage and frequency on the busbar must be continuously within the limits of the delay timer in menu 6220, before the breaker can be closed.

Genset
The generator voltage and frequency must be continuously within the limits of the delay timer in menu 6220, before the breaker can be closed.

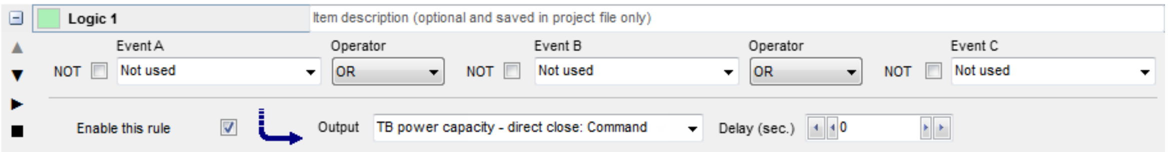
9.1.34 Power capacity

The power capacity setting in menu 8193 is used in AMF applications to determine how much power must be available, before the tie breaker can close. When the gensets are started, the generator breakers will close, and when sufficient power is available, then the tie breaker will be closed.

If there is more than one tie breaker in the power management system, it will close the one with the lowest power capacity setting first.

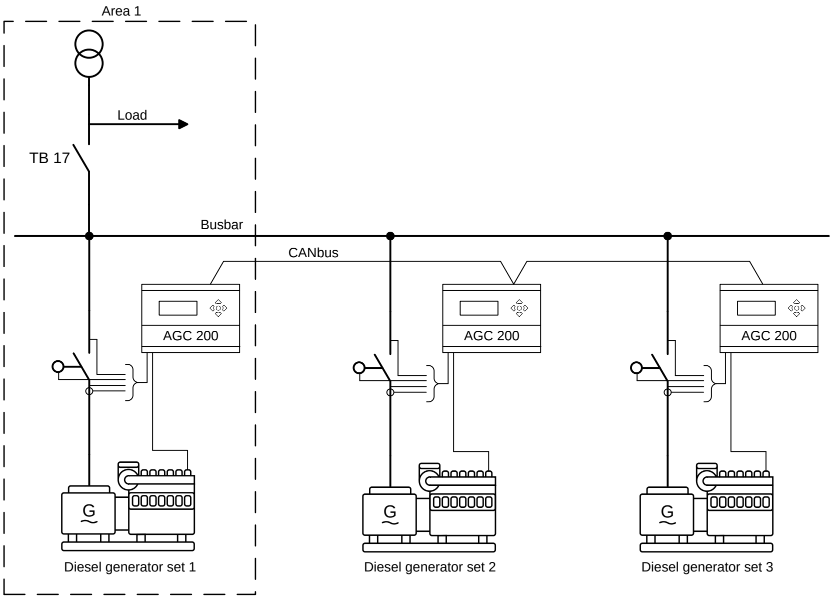
Power capacity overrule:
In case some of the generators fail to start and the power capacity set point is not reached, the tie breaker will never be closed. Because of this, it is possible to overrule the power capacity set point after a period of time set in menu 8194. The power capacity overrule timers start after one of the gensets has a fault with a fail class that will stop the genset from connecting to the busbar. The function "power capacity overrule" is enabled in menu 8195.

Tie breaker power capacity - direct close:
In some cases it is necessary to bypass the power capacity function completely. This direct close function will allow the tie breaker to close after the busbar Hz/V timer runs out and not wait on any additional timers. It is important to understand that this function only allows the controller to bypass the power capacity function, and therefore it is not a close command signal. The function "Tie breaker power capacity - direct close" is enabled through M-Logic in the mains controller.



Use this function with great caution in relation to the load and stability of the generators.

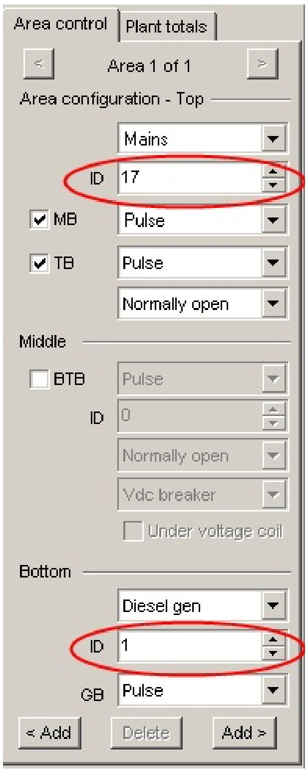
9.1.35 Island application with TB



A tie breaker in the mains unit can be operated in an island application. It is controlled in the same way as in the AMF situation described above. The power capacity set point menu 8193 is used to ensure that the generators produce enough power to take the load. This is done to protect the generators from going into overload.

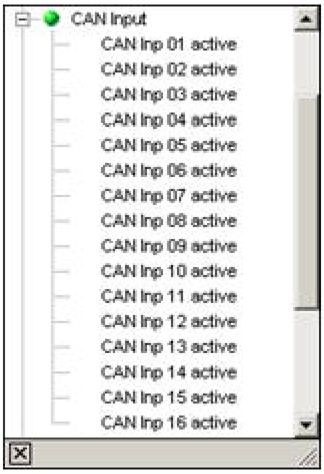
9.1.36 Configurable CAN IDs

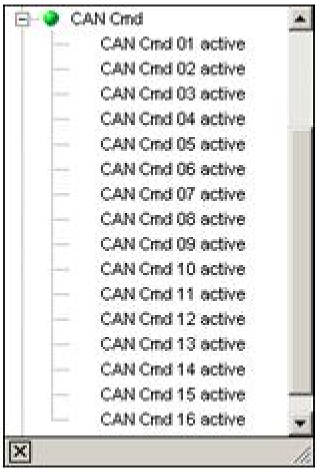
CAN IDs can be configured as desired, as a mix of DG, mains and BTB units:
32 gensets IDs 1-32
32 mains IDs 1-32
8 bus tie breakers IDs 33-40
This makes a total of 40 CAN IDs.

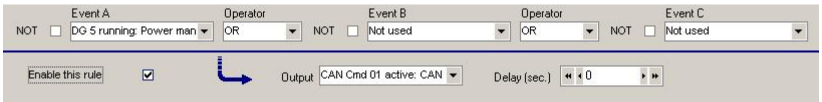


9.1.37 CAN flags

16 CAN flags can be accessed in M-Logic. They can be used in the same way as digital inputs. CAN flags can be set active when a CAN command is sent from one unit to another. The benefit is that no wire is needed, as the CAN flags are activated via the G5 CANbus.







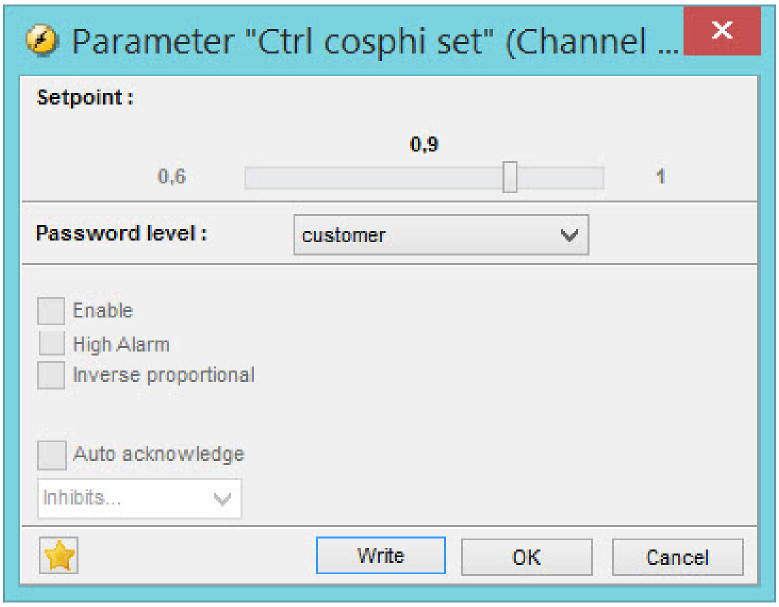
Example:
CAN cmd 01 will be active when DG 5 is running. All units in the power management system will receive "CAN input 01 active" and then be able to act on this information.

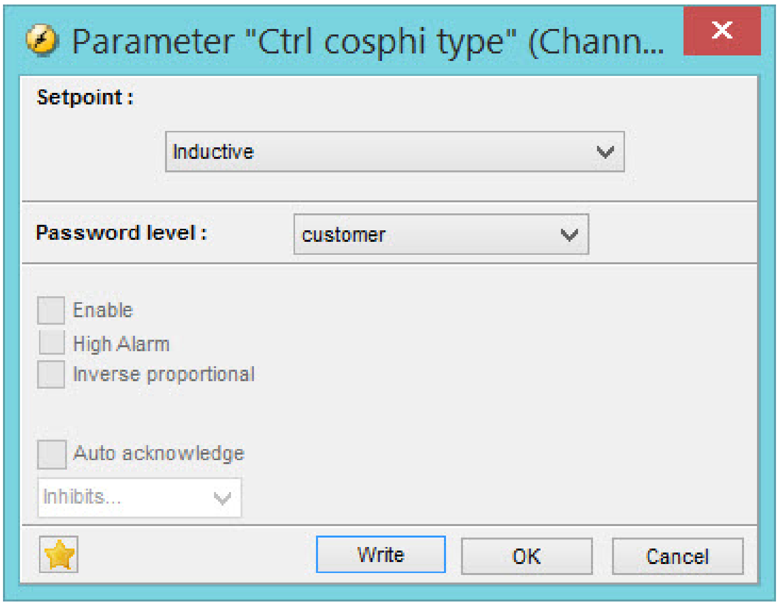
Only use of constant signals from digital inputs or AOP buttons can activate the CAN inputs. AOP buttons are pulse inputs, so a latch function must be made to make similar functionality as constant signals.

9.1.38 Common cos phi control

A common cos phi value can be set in menu 7052, and menu 7053 can be set to either "Inductive" or "Capacitive". To activate the common cos phi control, menu 7054 must be enabled. These set points can only be handled from the AGC 200 mains unit and then sent through the power management CANbus to all the DG units in the system. The DG units will then adjust their individual cos phi control according to the received set point

Inductive/capacitive set points can be set up from M-Logic.





9.1.39 Parameter lists, common settings

Power management relates to the parameters 2250, 2260, 2270, 2761, 2950, 6071, 6400, 7011-7014, 7041-7044, 7051-7054, 7061-7084, 7531-7536, 7871-7873, 8000-8120, 8170-8175, 8181-8195, 8201-8213, 8220-8225, 8230-8272, 8280-8282, 8880-8882, 9160, 9170, 9180-9186 and 9190-9192.

For further information, please see the separate Parameter List:

AGC 200 document number 4189340605.

9.2 Multi start gensets

The multi start function can be used to determine the number of gensets to start. This means that when the start sequence is initiated via push-button, digital input or automatic start, then the adjusted numbers of gensets will start.

This function is typically used, for example, together with applications where a certain number of gensets is required to supply the load.

> **Example:**
> In an AMF application with a tie breaker, the tie breaker must not close before the maximum power is available (power capacity set point).

The multi start function is adjusted in menu 8922-8926.

9.2.1 Multi start configuration

The multi start function can be adjusted to operate with two different settings. These settings consist of set points for how many gensets to start and the minimum number of running gensets.

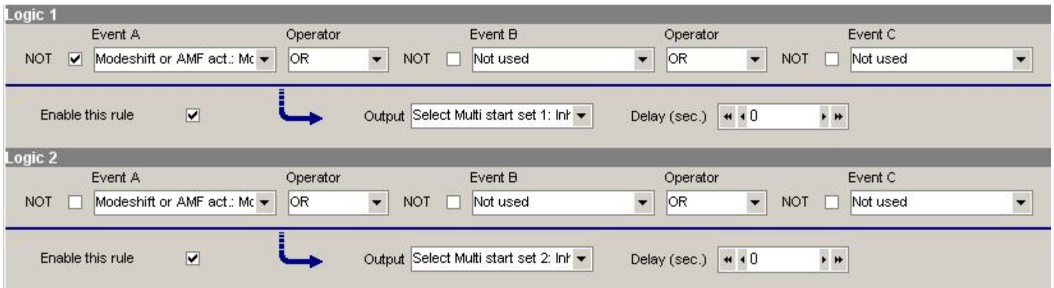
It is possible to switch between the settings using M-Logic or menu 8924.

	Set point 1	Set point 2
Multi start (numbers to start)	8922	8925
Min no. running	8923	8926

Default setting

	Start condition	Set point 1	Set point 2	Default setting of DGs to start
Emergency operation	Mains failure	-	X	Start all DGs
Normal operation	No mains failure	X	-	Auto calculate

The default setting of the selection between set point 1 and set point 2 is made so the set point 1 is adjusted to "Auto calculation" and is used in all modes except for AMF. Set point 2 will automatically be selected in case a mains failure occurs (this is adjusted in M-Logic). Set point 2 is by default configured to 32 gensets, which means that all available gensets will start when the mains failure occurs.



The default setting can be changed, if convenient.

9.2.2 Numbers to start

The numbers to start (menu 8922/8925) can be selected depending on the number of DGs available. The load-dependent start and stop function will be active as soon as the generator breakers are closed or, if a tie breaker is installed, as soon as the tie breaker is closed. It is possible to adjust the number of gensets, or an auto calculation can be selected.

If it is needed to delay the load-dependent start and stop function, it can be done through the M-Logic function.

Auto calculation
When auto calculation is selected, the sufficient number of gensets will be started as soon as the start command is given. This is not dependent on the plant mode.

Example:
In a four DG plant, each generator is rated with 1000 kW. The set point for load-dependent start (menu 8001) is adjusted to 100 kW.

Example:

If a start command is given in fixed power mode and the set point is 2000 kW, then three gensets will be started immediately and the fourth genset will remain stopped. Three gensets will be started because two gensets are requested to supply the load (2*1000 = 2000 kW) and the load-dependent start function requests the third genset.

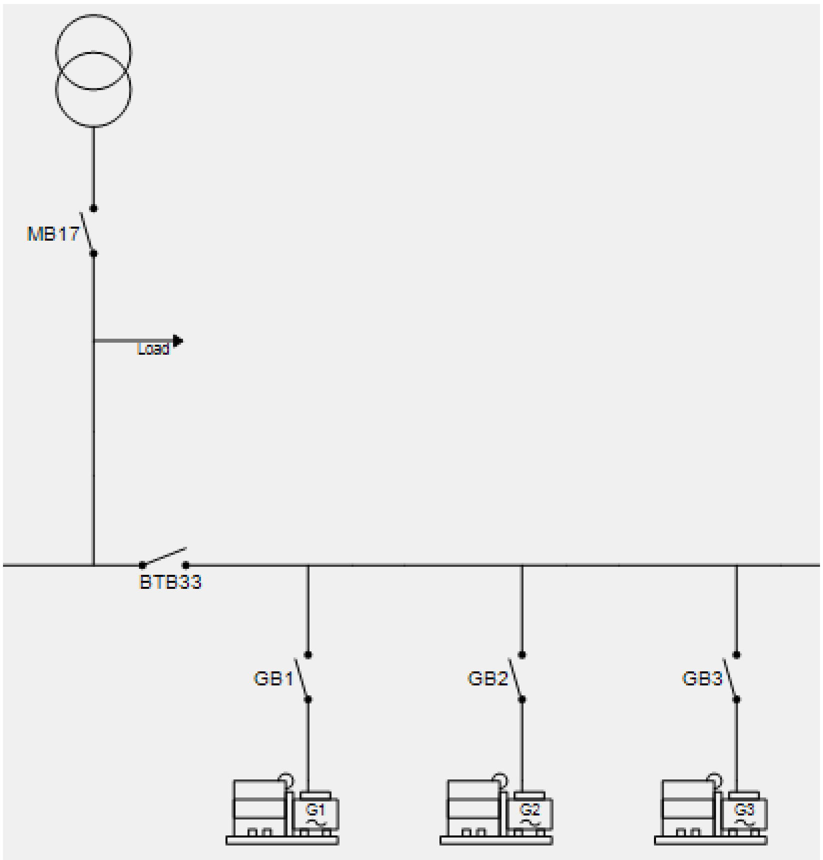
9.2.3 Minimum numbers running

The multi starting function can be combined with the setting of a minimum number of running gensets (menu 8923/8926). This means that the load-dependent stop function is disregarded when only the specific number of gensets is running. This is also the situation even though the load would justify a load-dependent stop.

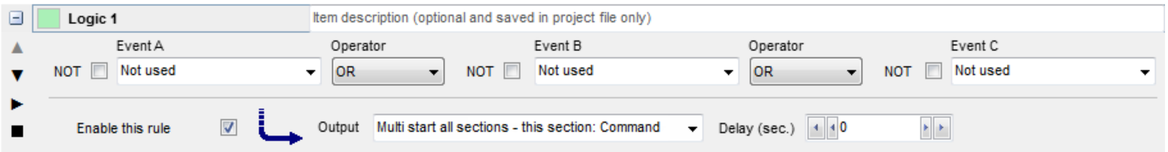
"Numbers to start" (menu 8922/8925) and "Minimum numbers running" (menu 8923/8926) are available for all modes.

9.2.4 Multi start all sections

If the application includes BTBs and the generators are in a section with no mains controller, like the picture below, this function can be used to start the generator section faster or to force the section to start.



The function is enabled through M-Logic in a DG controller.



It is the normal multi start setting described in the previous paragraphs that will determine how many generators that will start in the section. The generators will only start with this function if they are in island mode and it is a MAINS controller in AMF that is requesting help.

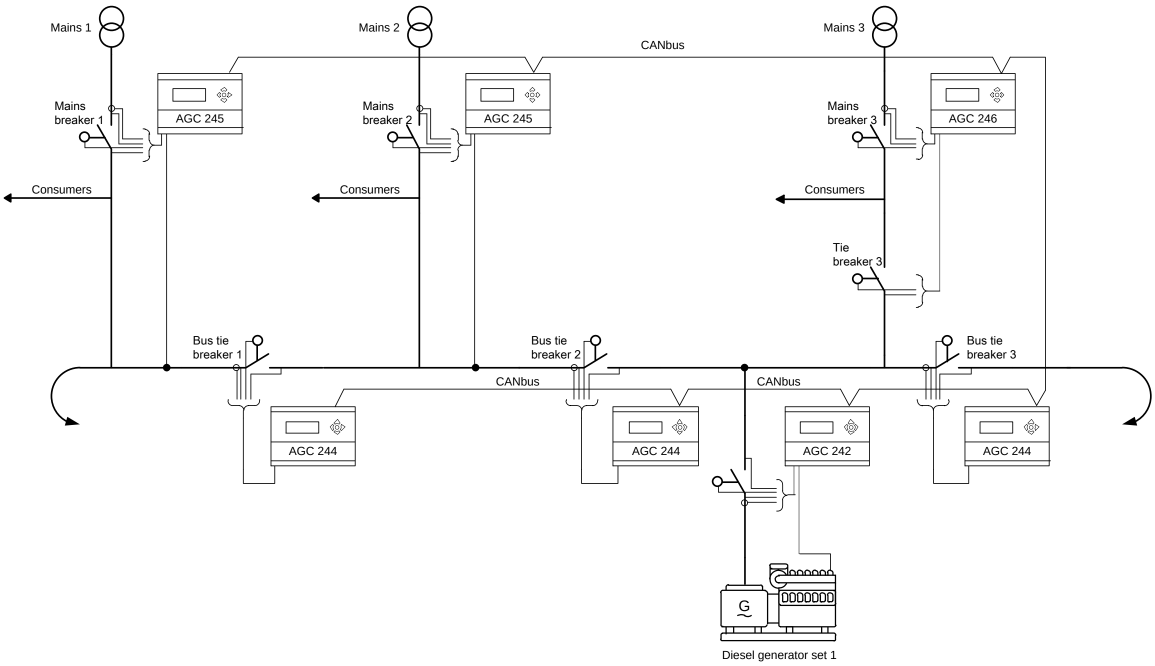
9.3 Multiple mains

The AGC 200 can be used in an application with multiple mains incomers. Each application can handle:

0 to 32 mains in the same application
0 to 32 gensets in the same application
0 to 8 bus tie breakers

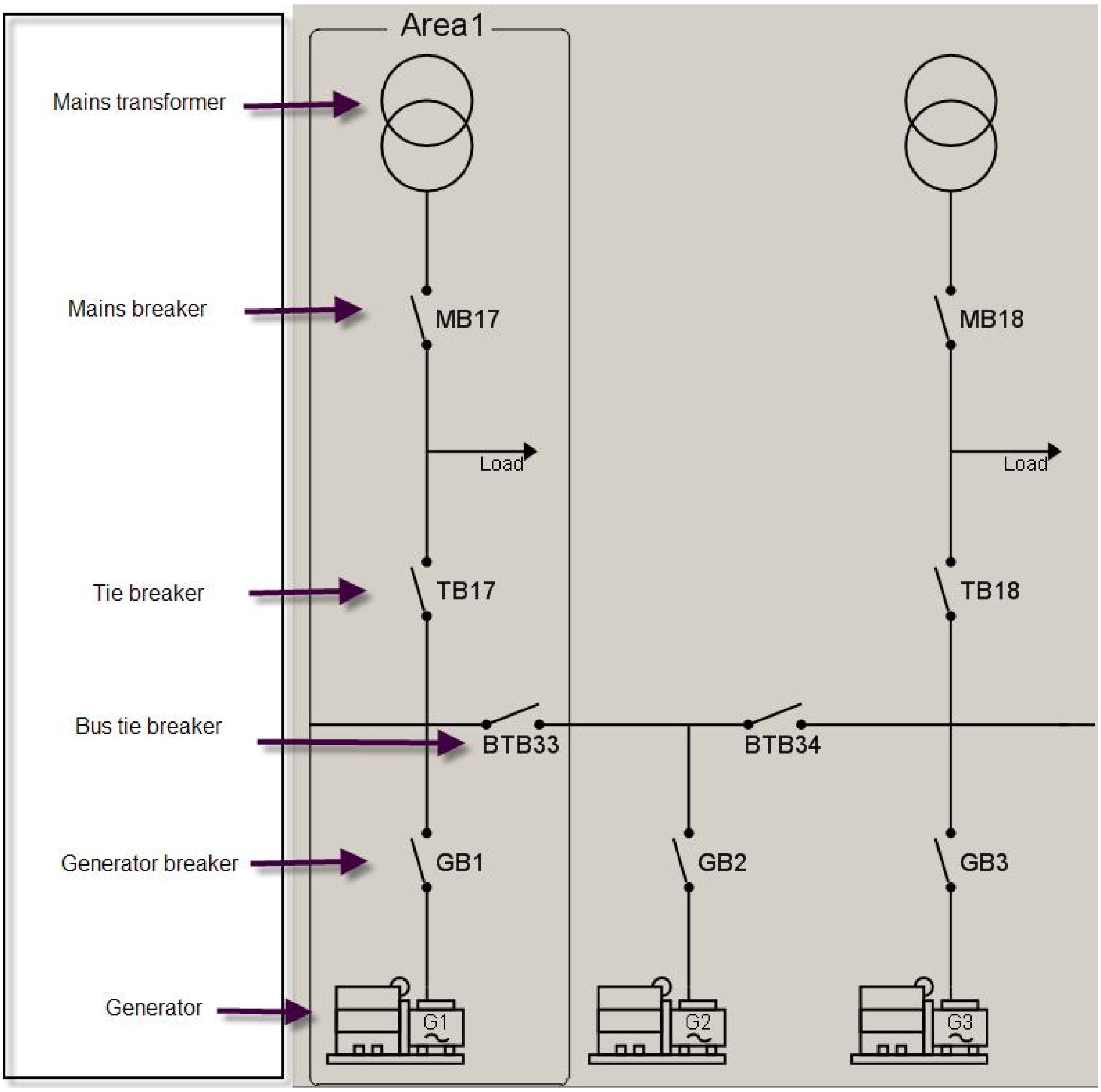
The CAN IDs will be distributed in the following way: Gensets 1 to 32, mains 1 to 32 and BTBs 33 to 40.

This is an example of the multiple mains application:



9.3.1 Definitions

A multiple mains application consists of feeders and generators plus a number of GBs, TBs, BTBs and MBs.



Sections

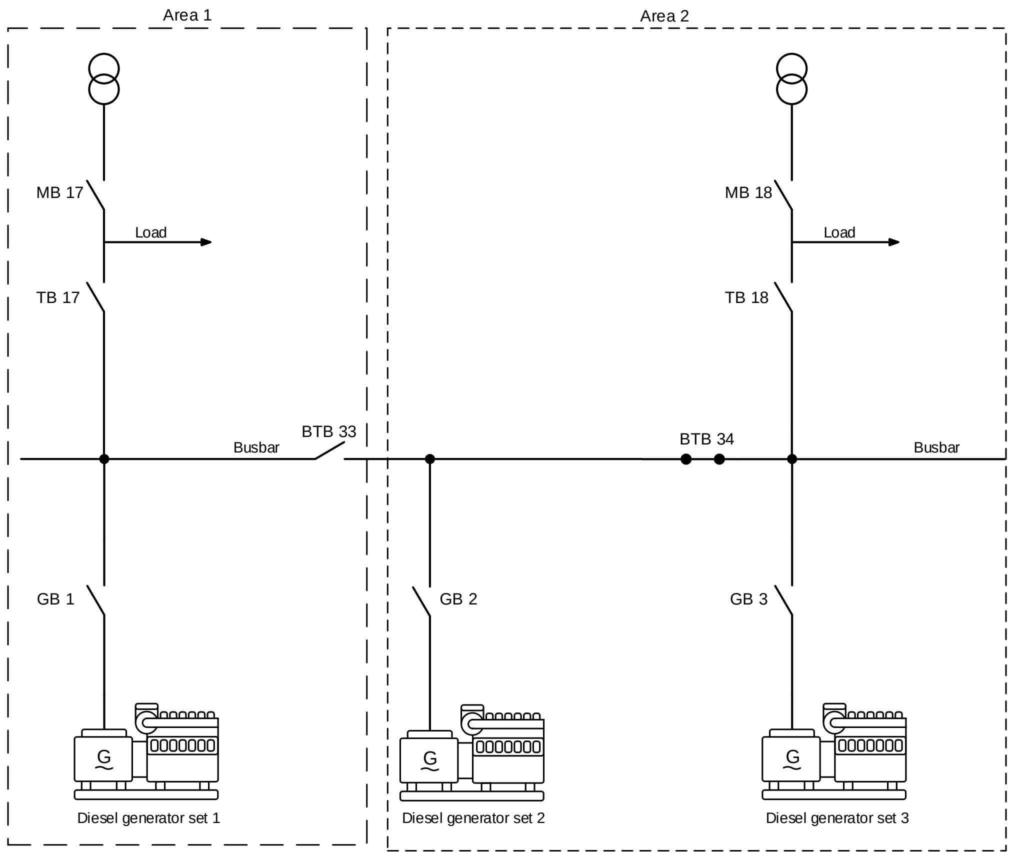
The application consists of static and dynamic sections if one or more BTBs are installed. The definition of a section is given in the table below.

Section	Definition
Static section	Part of the total application which is separated by one or two open BTBs. There will be no closed BTBs within this section. A static section can also be a dynamic section, but not vice versa.
Dynamic section	Part of the total application which is separated by one or two open BTBs. There may be one or more closed BTBs within this section.

If no BTBs are installed, the application consists of a static section only.

Only use remote start signal in island application with BTB units.

The diagram below shows the different section types - a static section to the left and a dynamic section to the right. If BTB 34 opens, the dynamic section will be divided into two static sections, because there are no further BTBs to open. If BTBs 33 and 34 are closed, the application will consist of one dynamic section.



9.3.2 Plant mode handling

Basically, six menus are available for setting up the functionality of the application.

No.	Setting		Min. setting		Max. setting		Factory setting
8181	MB failure start	Enable	OFF		ON		OFF
8182	Parallel	Enable	OFF		ON		OFF
8183	No break transfer	Enable	OFF		ON		OFF
8184	Auto switch	Enable	OFF	Static	Dynamic	All	OFF
8185	Run type	Run one/all mains	Run all mains		Run one mains		Run one mains
8186	Run type	ID to run	17		32		17

MB failure start:
This setting determines whether a start of the DGs should be executed if an MB close failure occurs.

If "MB failure start" is activated, the mode shift functionality will automatically be enabled.

In peak shaving, fixed power, mains power export and load takeover, the function is only active when menu 7081 "Mode shift" is set to ON.

MB parallel:
This setting determines whether the mains connections (MBs) should be able to run in parallel or not.

The setting of "MB parallel" affects the function of the "Auto switch" setting.

No break transfer:
This setting determines whether switching between the mains connections (MBs) should be executed as a black coupling or a synchronised coupling.

If the TBs in a section are adjusted to normally closed and "MB parallel" is switched OFF, then only one of the TBs can be closed at the time.

The system will try to keep the ID selected in menu 8186 ("My ID to Run") to keep its TB closed. If, however, the selected ID does not have a TB configured as a normally closed breaker, or if it fails to close it, it will be the mains unit holding the lowest ID without TB failures present that will close.

If "My ID to Run" is changed during operation, then the MB parallel setting will decide whether a black or a synchronised changeover will take place.

If "MB parallel" is activated, the "No break transfer" will automatically be enabled.

Auto switch:
This setting determines whether a mains unit detecting a mains failure will try to get the connected load supplied by another mains or by the available DGs.

	Description
OFF	The auto switch functionality is switched OFF.
Static section	The backup power is recovered within its own static section.
Dynamic section	The backup power is recovered within its own dynamic section. The application will never try to synchronise/close a BTB to get help in an AMF situation.
All sections	The backup power is recovered within all available sections.

Sections are divided by bus tie breakers. If no BTBs are installed, then the settings static/dynamic/all have the same auto switch function.

If dynamic is selected, then please be aware that one mains unit will be requested to carry all load from the dynamic section without any help from the DGs.

Therefore, the remaining mains feeders must be able to carry the load from the entire section.

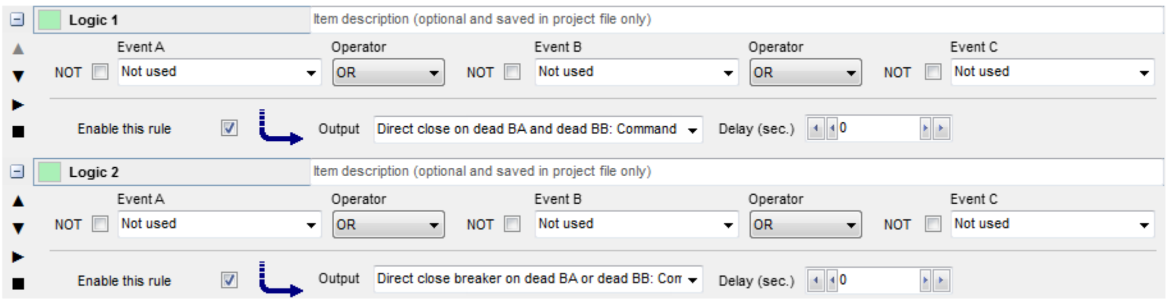
Run type:
This setting determines how the system in a dynamic section reacts in all the plant modes except island and AMF.

	Description	Comment
Run one mains	Only one mains breaker is allowed to be closed at the time.	"My ID to Run" (menu 8186) determines which mains feeder is allowed to operate parallel to the mains. If other TBs are closed, they will be tripped in order to only have the TB of "My ID to Run" closed. If no TB is available in the section, the MB will be tripped (causing a blackout).
Run all mains	All mains breakers are allowed to be closed at the time.	

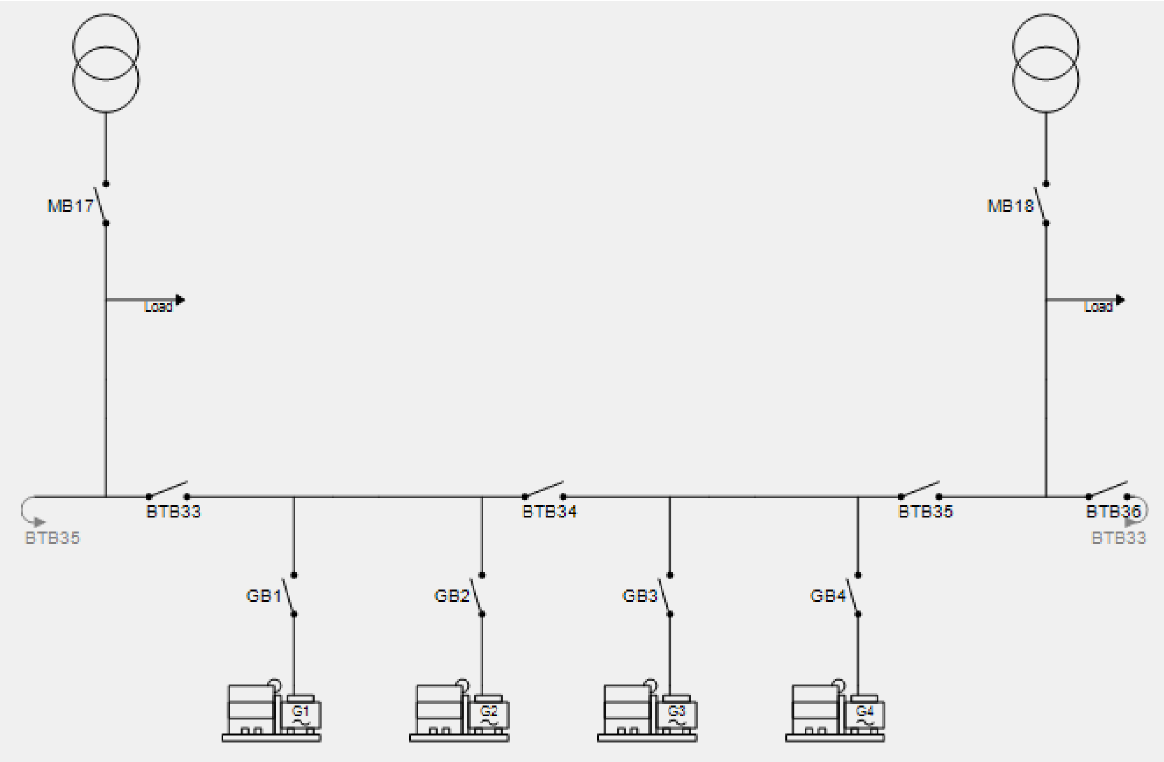
This setting can be handled from M-Logic.

9.3.3 Special M-Logic function - BTB direct close

This function will bypass normal BTB close check procedure. The function can be enabled through M-Logic.

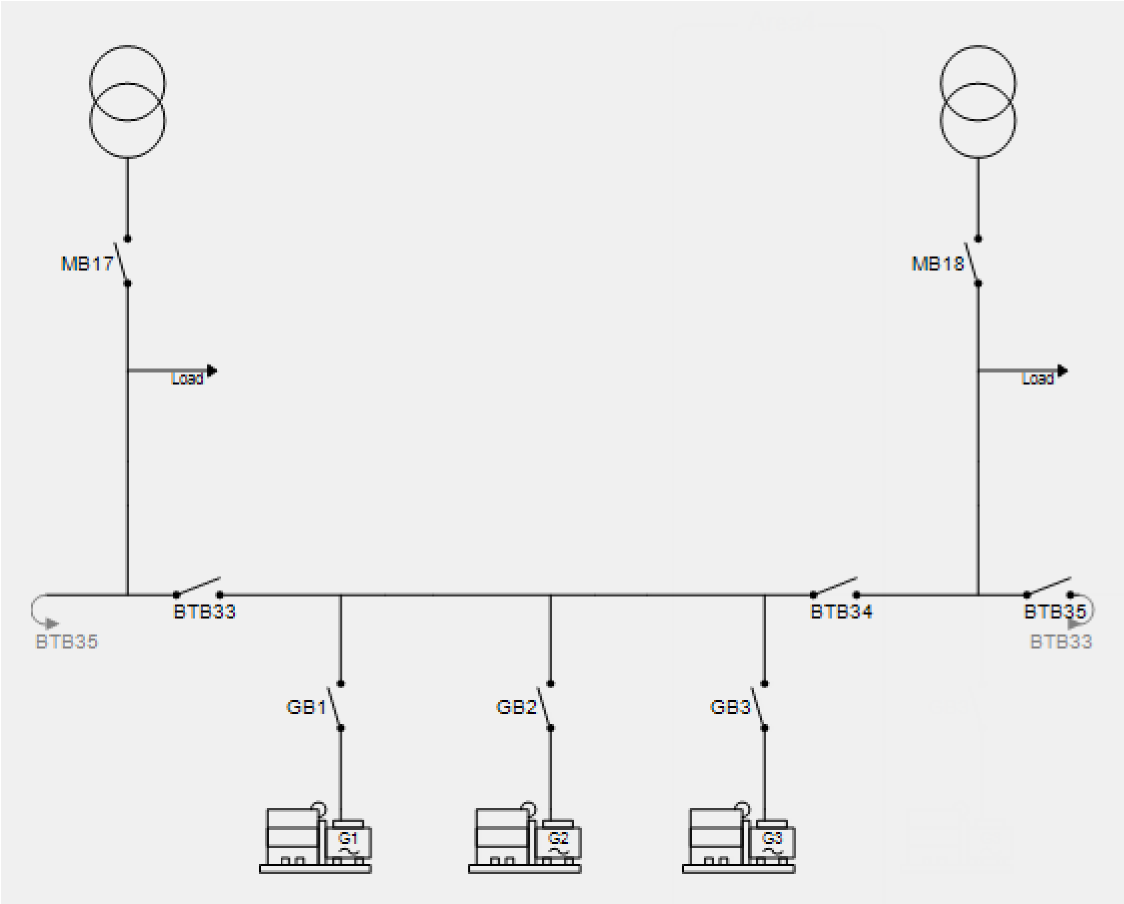


This function has two different M-Logic commands, as seen above. The command that is shown in Line 1 is intended to be used when a fast close of a BTB is needed, and there is no voltage present on any side of the BTB when the closing is intended. This could be in an application as shown in the picture below. It could be that the two genset sections are closed together before a CBE start of all the gensets. The direct close function detects a dead BB below 10 % of nominal values.



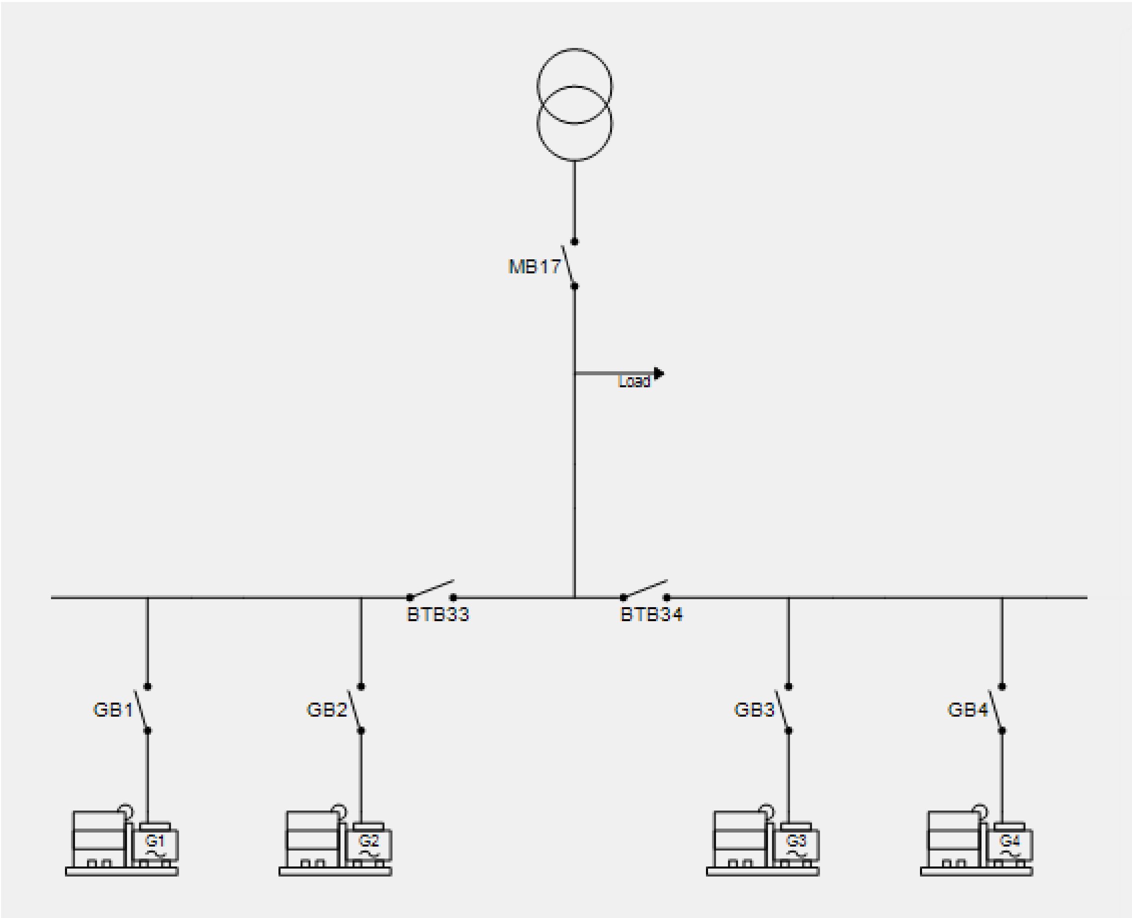
It is important to understand that it can be very dangerous to use M-Logic Line 2 in this application, because two generator sections are present.

The second function shown in M-Logic Line 2 is intended to be used when a fast close of a BTB is needed, and where one of the sides of the BTB has a voltage present when the closing is intended. This could be in an application as shown in the picture below. It could be that the genset sections are started and when Hz/V is OK, BTB33 and BTB34 are closed at the same time.



It is important to understand that it is okay to use M-Logic Line 2 in this application, because only one generator section is present.

To highlight the danger, another example is shown below. This application has two genset islands with BTB in front of them. If M-Logic Line 2 (Dead busbar A OR Dead busbar B) is used, and they get a close signal at the same time, a bad synchronisation will occur. This is because both BTBs are looking at a dead busbar and direct close is enabled. There are two ways of avoiding this: Either do not use M-Logic Line 2, or use interlock on BTB breakers.



In all applications it is important to be sure that while the BTB or BTBs are asked to close, no MB can close. Since the normal BTB close check procedure is bypassed, two different energy sources can be closed together without sync. check through a dead bus. Interlocking has to be made by the designer of the system.

10. Additional functions

10.1 Additional functions

10.1.1 Start functions

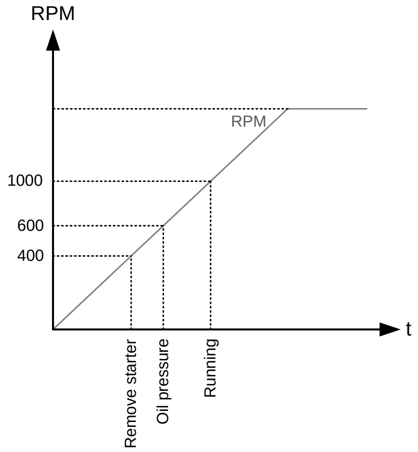
The unit will start the genset when the start command is given. The start sequence is deactivated when the remove starter event occurs or when the running feedback is present.

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

Please refer to chapter 4 for detailed information about start sequence.

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

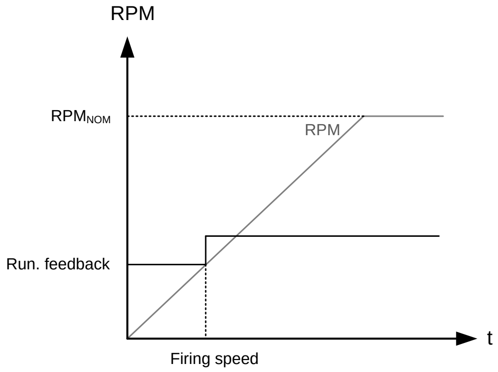


Digital feedbacks

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

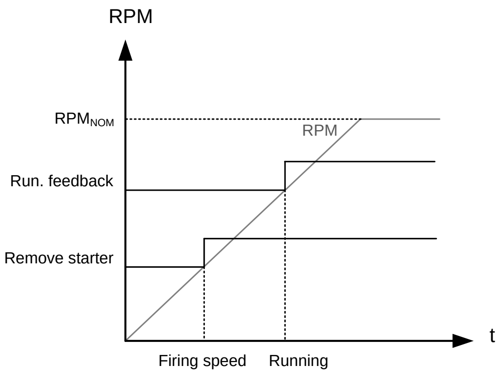
Running feedback

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



The diagram illustrates how the digital running feedback (terminal 93) is activated, when the engine has reached its firing speed.

Remove starter
When the digital remove starter input is present, the start relay is deactivated and the starter motor will be disengaged.



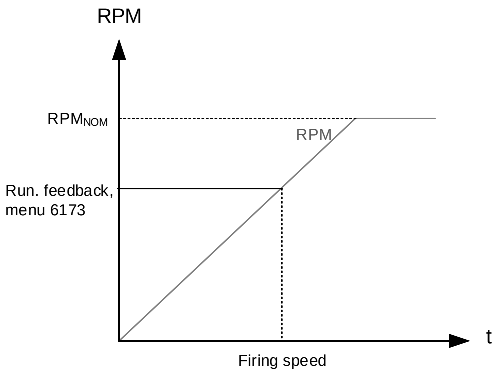
The diagram illustrates how the remove starter input is activated, when the engine has reached its firing speed. At the running speed, the digital running feedback is activated.

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

The running feedback is detected by either the digital input (see diagram above), frequency measurement (frequency level is adjustable in parameter 6165), RPM measured by magnetic pickup, EIC (option H5) or by multi-inputs 46, 47 or 48 (only for oil pressure).

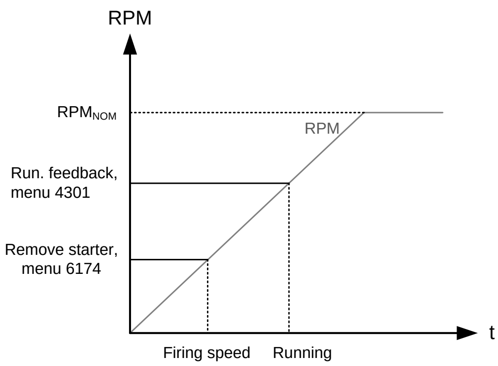
Analogue tacho feedback
When a magnetic pick-up (MPU) is being used, the specific level of revolutions for deactivation of the start relay can be adjusted.

Running feedback
The diagram below shows how the running feedback is detected at the firing speed level. The factory setting is 1000 RPM (6173 Running detect.).



Please notice that the factory setting of 1000 RPM is higher than the RPM level of starter motors of typical design. Adjust this value to a lower value to avoid damage of the starter motor.

Remove starter input
The drawing below shows how the set point of the remove starter is detected at the firing speed level. The factory setting is 400 RPM (6174 Remove starter).

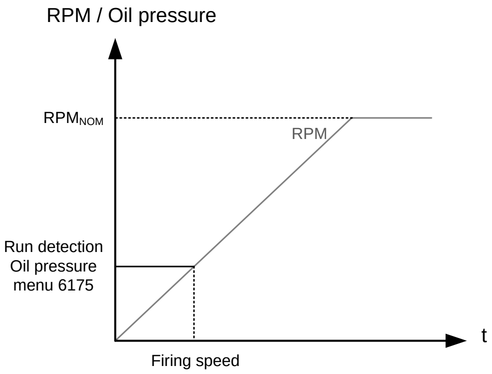


The number of teeth on the flywheel must be adjusted in menu 6170 when the MPU input is used

Oil pressure
The multi-inputs on terminals 46, 47 and 48 can be used for the detection of running feedback. The terminal in question must be configured as a RMI input for oil pressure measurement.

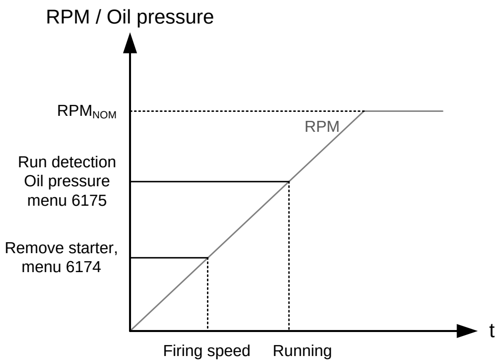
When the oil pressure increases above the adjusted value (6175 Pressure level), the running feedback is detected and the start sequence is ended.

Running feedback



Remove starter input

The drawing below shows how the set point of the ”remove starter input” is detected at the firing speed level. The factory setting is 400 RPM **(6174 Remove starter).**



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

10.1.2 Breaker types

There are three possible selections for the setting of breaker type for both mains breaker and generator breaker.

Continuous NE and Continuous ND

This type of signal is most often used combined with a contactor. When using this type of signal, the AGC 200 will only use the close breaker relays. The relay will be closed for closing of the contactor and will be opened for opening of the contactor. The open relay can be used for other purposes. Continuous NE is a normally energised signal, and Continuous ND is a normally de-energised signal.

Pulse

This type of signal is most often used combined with circuit breaker. With the setting pulse, the AGC 200 will use the close command and the open command relay. The close breaker relay will close for a short time for closing of the circuit breaker. The open breaker relay will close for a short time for opening of the breaker.

External/ATS no control
This type of signal is used to indicate the position of the breaker, but the breaker is not controlled by the AGC.

Compact
This type of signal will most often be used combined with a compact breaker, a direct controlled motor driven breaker. With the setting compact, the AGC 200 will use the close command and the open command relay. The close breaker relay will close for a short time for the compact breaker to close. The breaker off relay will close for the compact breaker to open and hold it closed long enough for the motor in the breaker to recharge the breaker. If the compact breaker is tripped externally, it is recharged automatically before next closing. The time setting for this function is 2160 (GB open fail.) for generator breaker and 2200 (MB open fail.) for mains breaker.

10.1.3 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 and MB.

The function applies to pulse and compact types of breaker control.

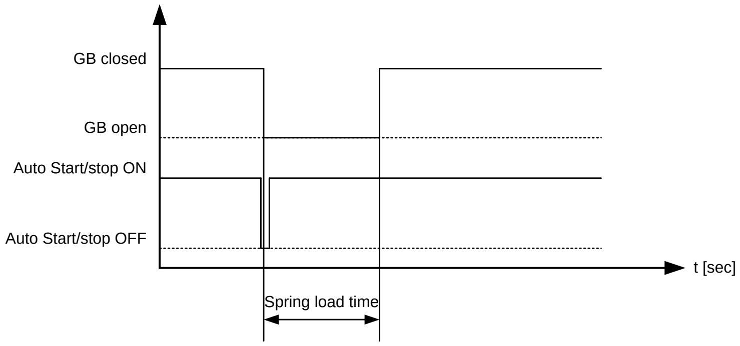
The following describes a situation where you risk getting a close failure:
1. The genset is in auto mode, the auto start/stop input is active, the genset is running and the GB is closed.
2. The auto start/stop input is deactivated, the stop sequence is executed and the GB is opened.
3. If the auto start/stop input is activated again before the stop sequence is finished, the GB will give a GB close failure as the GB needs time to load the spring before it is ready to close.

Different breaker types are used and therefore there are two available solutions:
1. Timer controlled - A load time set point for the GB and MB control for breakers with no feedback indicating that the spring is loaded. After the breaker has been opened, it will not be allowed to close again before the delay has expired. The set points are found in menus 6230 and 7080.
2. Digital input - -Two configurable inputs are to be used for feedbacks from the breakers: One for GB spring loaded and one for MB spring loaded. After the breaker has been opened, it will not be allowed to close again before the configured inputs are active. The inputs are configured in the ML-2 utility software. When the timers are counting, the remaining time is shown in the display. If the two solutions are used together, both requirements are to be met before closing of the breaker is allowed. .

Breaker LED indication
To alert the user that the breaker close sequence has been initiated but is waiting for permission to give the close command, the LED indication for the breaker will be flashing yellow in this case.

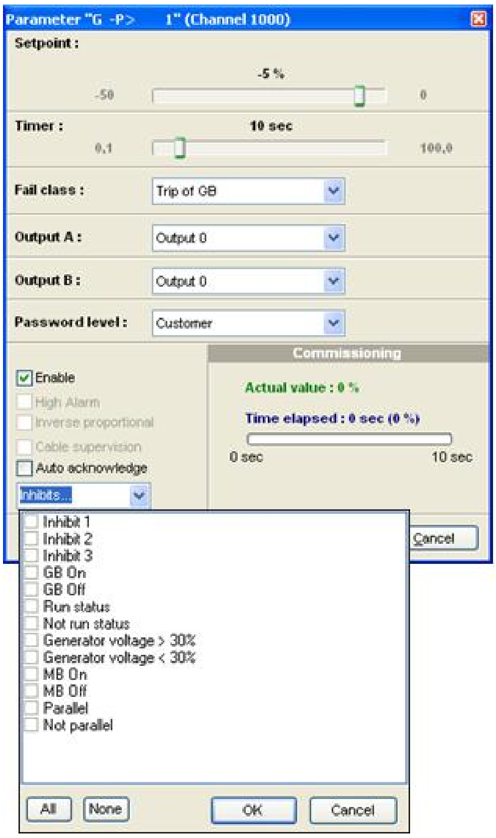
Principle
The diagram shows an example where a single AGC 200 in island mode is controlled by the auto start/stop input.

This is what happens: When the auto start/stop input deactivates, the GB opens. The auto start/stop is reactivated immediately after the GB has opened, e.g. by the operator through a switch in the switchboard. However, the AGC 200 waits a while before it issues the close signal again, because the spring load time must expire (or the digital input must be activated – not shown in this example). Then the AGC 200 issues the close signal



10.1.4 Alarm inhibit

In order to select when the alarms are to be active, a configurable inhibit setting for every alarm has been made. The inhibit functionality is only available via the PC utility software. For every alarm, there is a drop-down window where it is possible to select which signals that have to be present in order to inhibit the alarm.

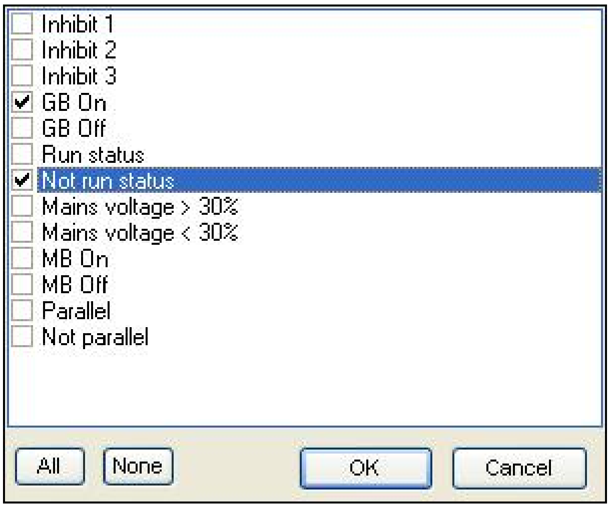


Selections for alarm inhibit:

Function	Description
Inhibit 1	M-Logic outputs: Conditions are programmed in M-Logic
Inhibit 2	
Inhibit 3	
GB ON	The generator breaker is closed
GB OFF	The generator breaker is open
Run status	Running detected and the timer in menu 6160 expired
Not run status	Running not detected or the timer in menu 6160 not expired
Generator voltage > 30%	Generator voltage is above 30% of nominal
Generator voltage < 30%	Generator voltage is below 30% of nominal
MB ON	The mains breaker is closed
MB OFF	The mains breaker is open
Parallel	Both GB and MB are closed
Not parallel	Either GB or MB is closed, but not both

The timer in 6160 is not used if binary running feedback is used.

Inhibit of the alarm is active as long as one of the selected inhibit functions is active.



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

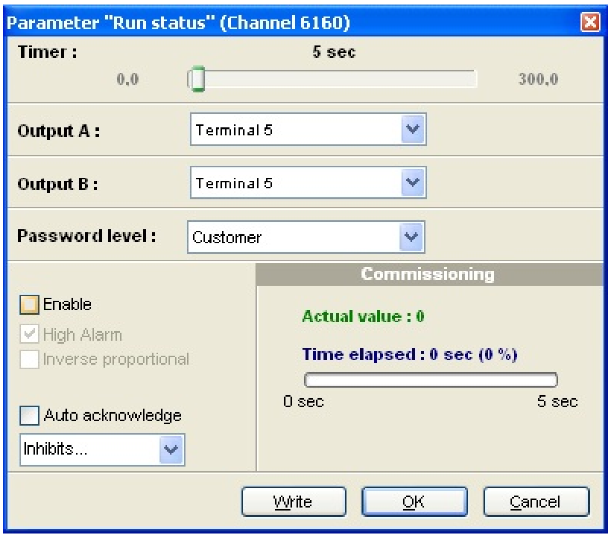
The inhibit LED on the unit and on the display will activate when one of the inhibit functions is active.

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

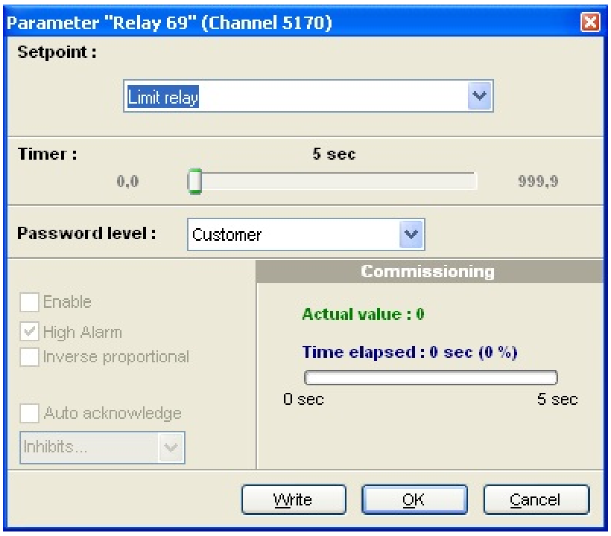
The tie breaker unit has no running detection that can be configured, so the only inhibit functions are the binary input and the TB position.

Run status (6160)

Alarms can be adjusted to activate only when the running feedback is active and a specific time delay has expired.

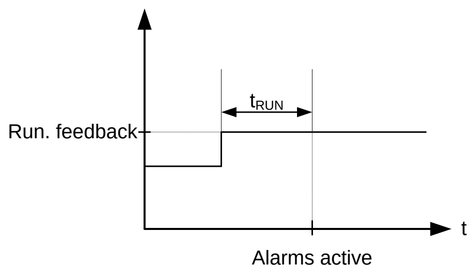


Select the correct relay number both in output A and output B and enable the function. Change the relay function to ”limit” in the I/O menu. Then the relay will activate, but no alarm will appear.



If the relay function is not changed to ”limit”, an alarm will appear at every running situation.

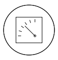
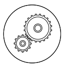
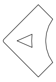
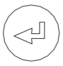
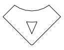
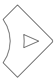
The diagram below illustrates that after activation of the running feedback, a run status delay will expire. When the delay expires, alarms with Run status will be activated



The timer is ignored if binary running feedback is used.

10.1.5 Access lock

The purpose of access lock is to deny the operator the possibility of configuring the unit parameters and changing the running modes.
The input to be used for the access lock function is defined in the ML-2 PC utility software (USW).
Access lock will typically be activated from a key switch installed behind the door of the switchboard cabinet.
It is possible to enter the setup menu and read all the parameters and timers, but it is not possible to change any of them.

Button	Button status	Comment
	Active	It is possible to read all alarms, but it is not possible to acknowledge any of them
	Not active	The horn cannot be silenced
START	Not active	
STOP	Not active	
GB ON/OFF	Not active	
MB ON/OFF	Not active	
	Active	Reading of all values is possible
	Active	The log can be read
	Active	System setup can be entered, but no changes can be made
	Active	The tools can be read, but no commands can be sent
	Active	
	Active	
	Active	It is possible to enter all the parameters, but it is not possible to change any of them
	Active	
BACK	Active	
	Active	
AUTO SEMI MAN OFF TEST	Not active	If the access lock is activated, the button is not active

After three minutes, the display returns to the view menu system. The setup menu system can only be entered again if the access lock is deactivated.

The stop push-button is not active in any modes when the access lock is activated. For safety reasons, it is recommended to install an emergency stop switch.

The following digital input functions are affected when access lock is activated:

Input name	Input status	Comment
Remote start	Not active	
Remote stop	Not active	
Semi-auto	Not active	
Test	Not active	
Auto	Not active	
Manual	Not active	
Block	Not active	
Remote GB ON	Not active	
Remote GB OFF	Not active	
Remote MB ON	Not active	
Remote MB OFF	Not active	

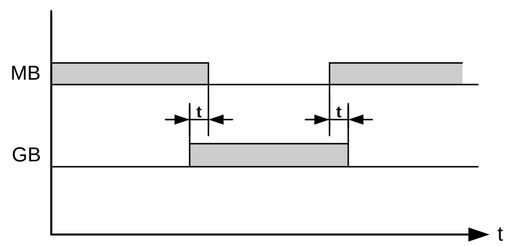
AOP buttons are not locked when access lock is activated.

10.1.6 Overlap (short time parallel)

The purpose of the overlap function is to be able to define a maximum paralleling time between the generator and the mains supply.

The function is typically used if there are local requirements to maximum allowed paralleling time.

The overlap function is only available in the automatic mains failure and load takeover genset modes.



The diagram shows that when the generator breaker is synchronised, the mains breaker will be opened automatically after a time delay (t). Later the mains breaker is synchronised, and the generator breaker is opened after the time delay (t).

The time delay is measured in seconds and can be adjusted from 0.10 to 99.90 seconds.

The same time delay is used for both generator and mains breaker synchronisation.

The time delay typed in the set point is a maximum time. This means that if 0.10 seconds are used, the two breakers will never be closed at the same time for a longer delay than the set point.

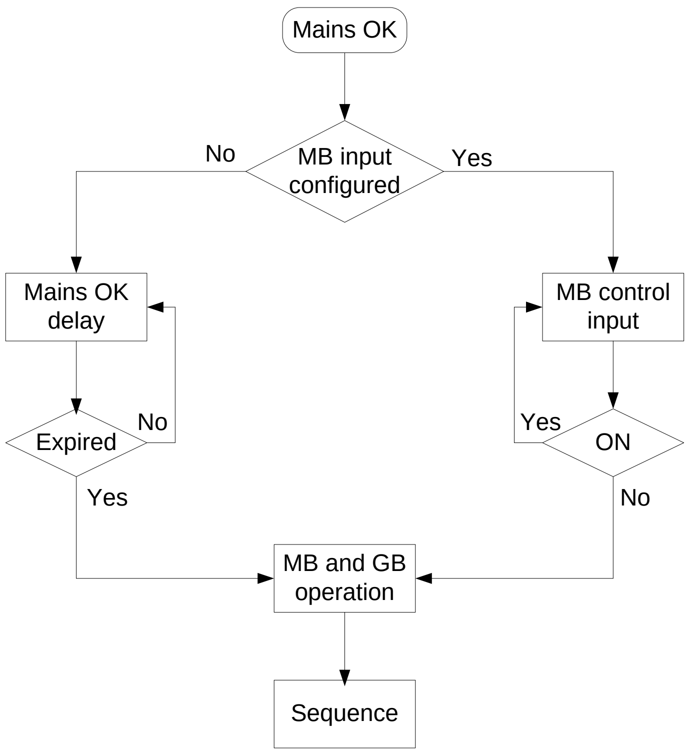
The short time parallel function is set up in menu 2760 Overlap.

10.1.7 Digital mains breaker control

The unit will normally execute the automatic mains failure sequence based on the settings adjusted in the system setup. Besides these settings, it is possible to configure a digital input that can be used to control the mains return sequence. This input is the ”mains OK” input. The purpose of this function is to let an external device or an operator control the mains return sequence. The external device can e.g. be a PLC.

The flowchart below shows that if the input is configured, it needs to be deactivated in order to initiate the mains return sequence. The load will continue on generator supply if the input is still activated.

The mains OK delay is not used at all when the ”Mains OK” input is configured.



10.1.8 Command timers (time-dependent start/stop)

The purpose of the time-dependent start/stop function is to be able to start and stop the genset automatically at specific times each weekday or certain weekdays. If auto mode is activated, this function is available in island operation, load takeover, mains power export and fixed power operation. Up to eight command timers can be used for either start or stop. All command timers can be configurated in menu 6960- 6990. Each command 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

The command timers are to be used in M-Logic as events to set the command (start/stop).

The digital input ”Auto start/stop” cannot be used when this function is enabled.

The time-dependent start and stop commands are pulses that are not sent until the moment the adjusted time is reached.

When using a batch file from SW 3.X.X and writing it to SW 4.X.X, then command timer settings will not be updated.

10.1.9 Start/stop next generator

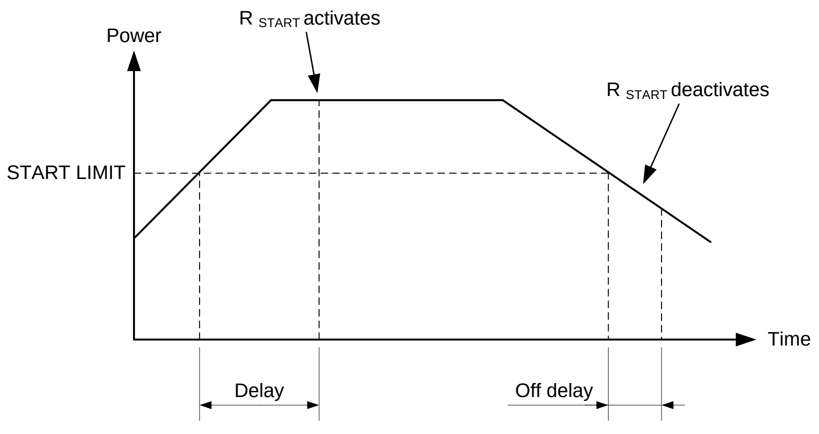
The load-dependent start/stop functionality uses one relay for **“start next generator”** and one relay for **“stop next generator”.** It is also possible to use only one of the functions if it is not desired to use both the start and the stop function.

The function load-dependent start and stop does not give the possibilities of a power management system, such as priority selection and available power calculations. This means that the switchboard manufacturer must take care of starting and stopping the next genset(s) and their priority.

As an example, the relays can be used as inputs for the power management system.

Start next generator (high load) (menu 6520)

The diagram below shows that the delay for the start relay starts when the load exceeds the adjusted start limit. The relay will deactivate again when the load decreases below the start limit and the off delay has expired.

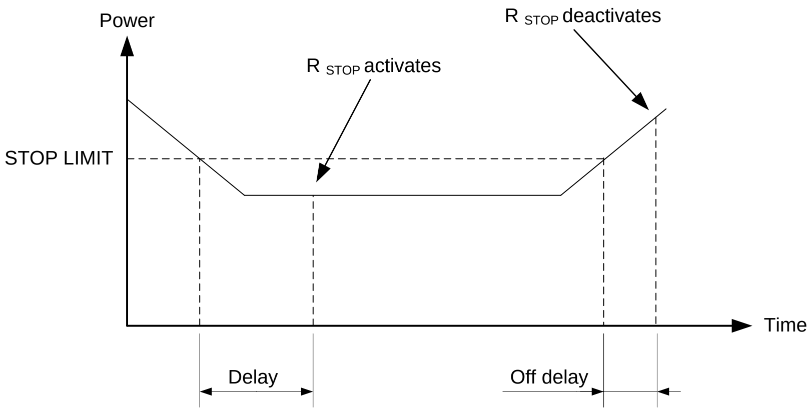


The load-dependent start relay reacts based on the power measurement of the AGC 200 together with the breaker closed feedback.

Stop next generator (low load) (menu 6530)

The diagram shows that the stop relay activates after a delay. The timer starts when the load drops below the adjusted stop level, and when the delay has expired, the relay activates.

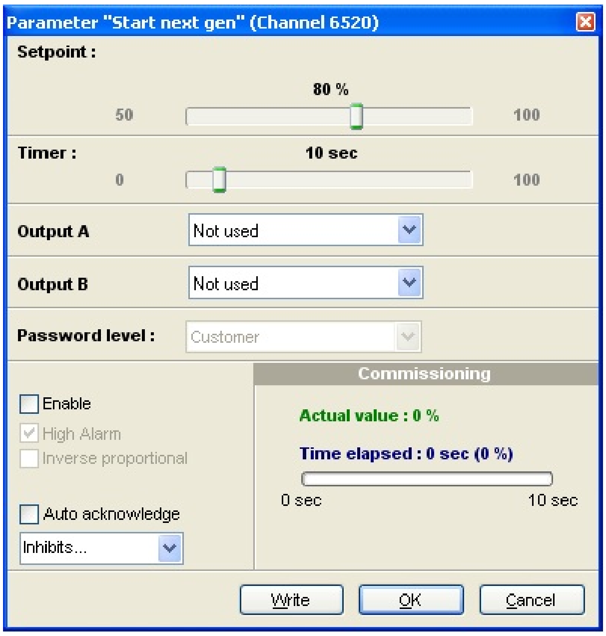
The relay deactivates when the load exceeds the stop level after the off delay has expired. The off delay is adjustable.



The load-dependent start relay reacts based on the power measurement of the AGC 200 together with the breaker closed feedback.

Configuration
The settings are configured through the display or through the PC utility software.

PC utility software configuration
Configuration of “Start next gen":



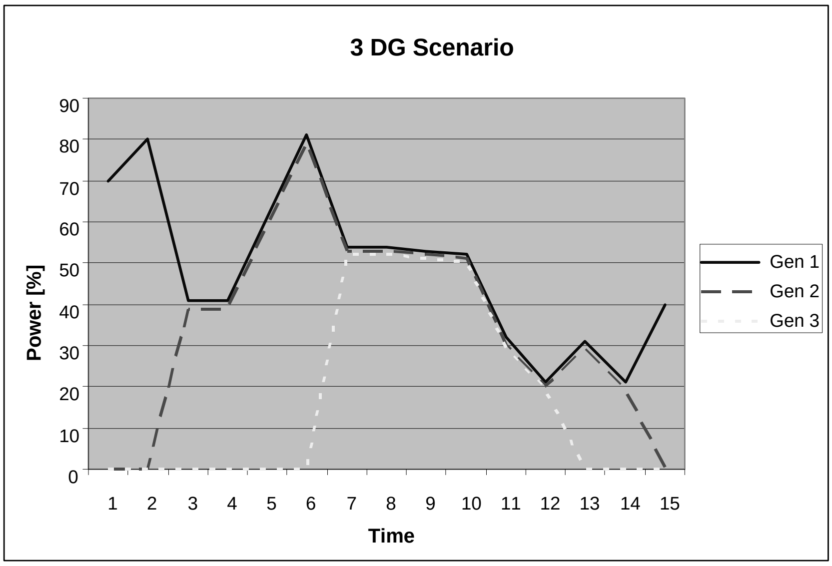
Output A and output B must be adjusted to the same relay to avoid alarms when the set point is reached.

When a relay has been selected for this function, it cannot be used for other relay functions.

Start/stop scenario
This diagram shows a (simplified) scenario where three DGs are started and stopped depending on the load-dependent start/stop relays.

The scenario shows that genset 2 starts when genset 1 reaches 80%. The next genset to start is DG3, and the three sets load share at 53%.

When the load of all three gensets drops to the stop limit, which is 20%, then the load-dependent stop relay activates and a genset (genset 3 in this example) can be stopped. The load continues to drop, and at 20% load the next genset to stop is genset 2.



The above is a simplified scenario.

10.1.10 Derate genset

The purpose of the derate function is to be able to reduce the maximum output power of the genset if specific conditions require this. An example of such a condition is the ambient temperature. If the ambient temperature increases to a level where the cooling water coolers decrease in cooling capacity, it will be necessary to reduce the power of the genset. If the genset is not derated, alarms and shutdown events are very likely to occur.

The derate function is typically used when cooling problems are expected.

Input selection
The derate function can be configured to one of the following inputs:

Input	Comment
Multi-input 46	4-20 mA Pt100/1000 RMI Digital
Multi-input 47	
Multi-input 48	
EIC	
M-Logic	

Select the needed input in 6260 Power derate

Refer to the type label for information about engine interface selection.

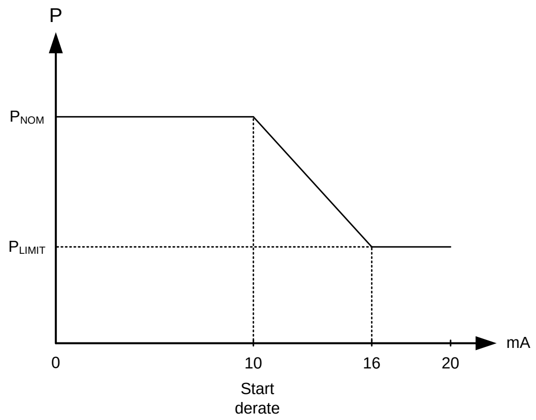
Derate parameters
The parameters that define the derate characteristics are the following:

Start derate point (6260 Power derate)
This is the setting where the derating must start. The setting can be in mA (max. 20 mA) or in centigrades ºC (max. 200ºC).

Slope (6260 Power derate)
Adjust the derating speed. The adjustment is in percent per unit, i.e. if the 4-20 mA input is used, then the derating will be in %/mA, and if the Pt100/Pt1000/RMI input is used, then the derating will be in %/C.

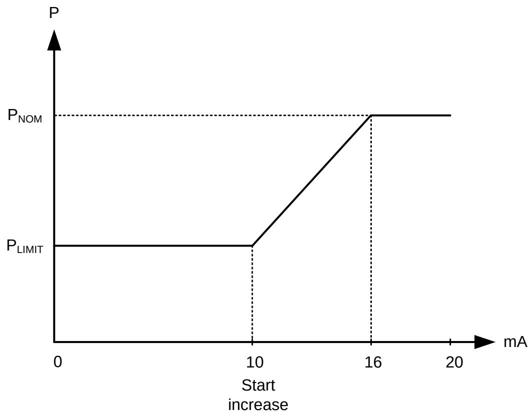
Be aware that the 4-20 mA input can be configured with different minimum and maximum settings. In this case, the settings ”start derate point” and ”slope” use these new settings.

Derate limit (6260 Power derate)
This is the lowest derate level



Derate characteristic
It can be selected whether the characteristic of the derating should be proportional or inverse proportional. The drawing above shows the inverse characteristic.

The proportional characteristic is illustrated below.



The genset is derated when the control value is lower than the set point (in the example above, the control value is an mA signal).

The derate characteristic is selected in setting 6261 Power derate.

Enable OFF: Inverse characteristic
Enable ON: Proportional characteristic

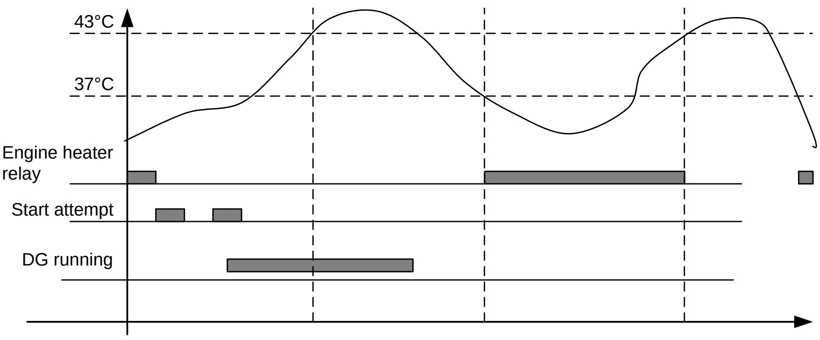
10.1.11 Engine heater

This function is used to control the temperature of the engine. A sensor measuring the cooling water temperature is used to activate an external heating system to keep the engine at a minimum temperature.

The set points adjusted in menu 6320 are:

set point: This set point +/- the hysteresis is the start and stop points for the engine heater.
Output A: The relay output for the engine heater.
Input type: Multi-input to be used for temperature measurement.
Hysteresis: This decides how big a deviation from the set point is needed to activate/deactivate the engine heater.
Enable: Enables the engine heater function.

Principle diagram:



The engine heater function is only active when the engine is stopped.

Engine heater alarm
If the temperature keeps dropping after the start set point has been exceeded, an alarm will be raised if configured in menu 6330.

10.1.12 Master clock

The purpose of the master clock is to control the frequency of the genset in order to obtain the correct number of periods.

This function can only be used if island operation is selected.

In a 50 Hz system, one period lasts 20 ms. If this changes, e.g. due to the dead band setting of the frequency controller, a difference will exist between the actual number of periods and the theoretical number of periods.

Equipment that works based on the zero crossings will be affected by the surplus or missing zero crossings. The most common example of such equipment is alarm clocks.

The unit’s internal clock is a timekeeper which is included in the battery backed memory circuit. The timekeeper function works based on an oscillating crystal instead of zero crossings of the AC measurements. Due to the accuracy of the timekeeper, it is recommended to synchronise the clock on a regular basis, e.g. once every month.

Setting	Description	Comment
6401 Start	Start time.	The compensation period starts at the adjusted time.
6402 Stop	Stop time.	The compensation period stops at the adjusted time.
6403 Difference	The set point in seconds that initiates the compen-sation.	
6404 Compensation	Frequency difference when the compensa-tion is ini-tiated.	+/- value.
6405 Enable	Enables the function	

If the power management option is selected (option G5), then the adjustment is made in the command unit.

The compensation frequency must be adjusted to a value higher than the dead band setting.

Compensation time
The time for the compensation can easily be calculated at a given adjustment of 6403 and 6404 (example):

- 6403 = 30 seconds
- 6404 = ± 0.1 Hz

$t_{TOTAL} = t_{SET} /(1-f_{NOM}/f_{DIFF})$
$t_{TOTAL} = 30_S /(1-50 \text{ Hz}/50.1 \text{ Hz})$
$t_{TOTAL} = 15030_S \sim 4.1 \text{ hours}$

10.1.13 Ventilation

This function can be used to control the cooling of the engine. The purpose is to use a multi- input to measure the cooling water temperature and that way activate an external ventilation system to keep the engine below a maximum temperature. The functionality is shown in the diagram below.

set points available **(6460 Max. ventilation):**
set point: The limit for activation of the relay set in OA.

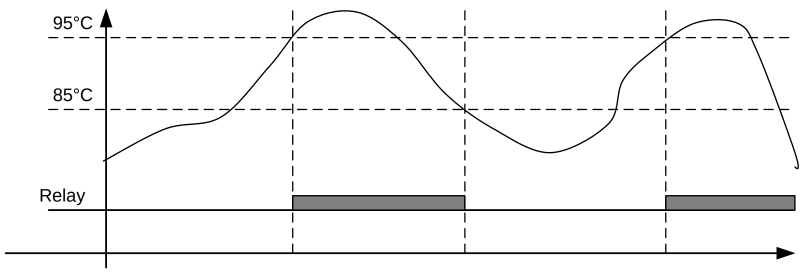
Output A (OA): The relay activated when the set point is exceeded.

Hysteresis: The number of degrees the temperature has to be above the set point to activate and below the set point to deactivate the relay set in OA.

Enable: Enable/disable the ventilation function.

The type of input to use for the temperature measurement is selected in menu 6323 Engine heater.

Example: The set point is 90oC, the hysteresis is 5oC



Max. ventilation alarm
Two alarms can be set up in menu 6470 and menu 6480 to activate if the temperature keeps rising after the start set point has been reached.

10.1.14 Summer/winter time

This function is used to make the AGC 200 unit adjust the clock in the unit automatically according to summer and winter time. The function is enabled in menu 6490.

The function only supports the Danish rules.

10.1.15 Switchboard error

The switchboard error function is handled in two different menus: 6500 ”Block swbd error” and 6510 ”Stop swbd error”. The functions are activated by using one configurable input (switchboard error) which is configured with the PC utility software.

The functionality of the ”switchboard error” input is active as soon as the input is configured. The ”enable” in menus 6500 and 6510 only refers to the alarm function.

Block swbd error (menu 6500)
When activated, this function will block the start sequence of the genset in case the genset is not running.

set points available:

Delay: When the input is active, the alarm will be activated when this delay has expired.

Parallel:
OFF: Only AMF start sequence is blocked when the input is active.
ON: All start sequences, regardless of running mode, are blocked when the input is active.

Output A: Relay to activate when the delay has expired.

Output B: Relay to activate when the delay has expired.

Enable: Enable/disable the alarm function.

Fail class: The fail class of the alarm.

Stop swbd error (menu 6510)
When activated, this function will stop the genset if the genset is running in Auto mode.

set points available:

Delay: When the input is active and the delay has expired, the genset will trip the breaker, cool down and stop. The function is active regardless of the ”Enable” setting.

Output A: Relay to activate when the delay has expired.

Output B: Relay to activate when the delay has expired.

Enable: Enable/disable the alarm function.

Fail class: The fail class of the alarm.

10.1.16 Not in Auto

This function can be used for indication or to raise an alarm in case the system is not in Auto. The function is set up in menu 6540.

10.1.17 4th current transformer input

Not available in AGC 212/213/222.

The 4th current transformer input (terminals 59-60) can be used for three different purposes:

- Mains power measurement by placing a CT in the mains L1 connection. This is selected in menu 7005 (Mains power meas.). Select “internal”.
- Neutral line over-current protection. This is selected by activating the alarm in setting 1720.
- Generator earth current (ground fault) measured in the generator star point ground connection. The function includes a 3rd harmonics filtering of the signal. This is selected by activating the alarm in setting 1730.

For all three functions, the setting of the CT is made in setting 6045 (primary) and 6046 (secondary).

If the input is not used for mains power, but the measurement is needed anyway, select "multi-input 46 (transducer)" instead. In this case, a separate transducer is needed to measure the mains power.

Note that only one of the three functions can be used, combinations are not possible.

10.1.18 Neutral line and ground fault inverse over-current

These are configurable inverse alarms, based on predefined or user-configurable curve shapes. Settings are found in parameter 1720 (G In> Inverse) and 1730 (G Ie> Inverse).

Formula and settings used

The inverse time over-current is based on IEC 60255 part 151.

The function used is dependent time characteristic, and the formula used is:

$$t(G) = TMS \left(\frac{k}{\left(\frac{G}{G_S}\right)^{\alpha} - 1} + C \right)$$

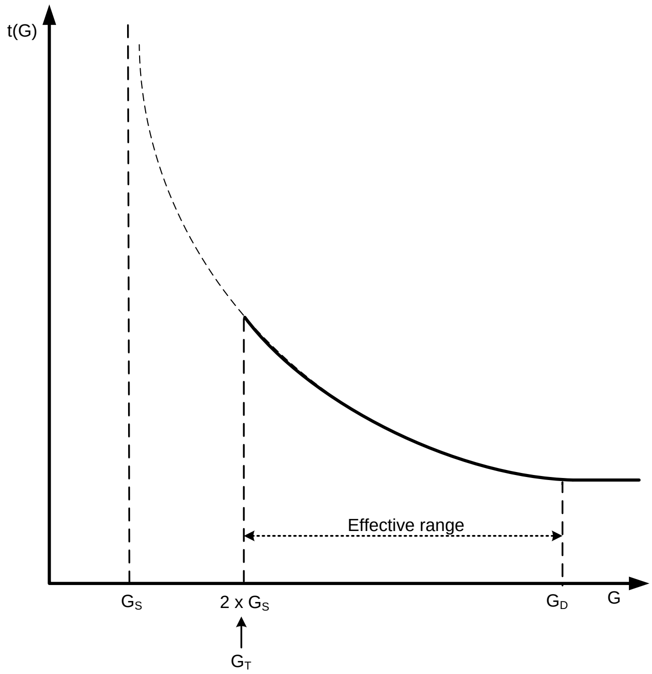
where
t(G) is the theoretical operating time constant value of G in seconds
k, c, α are the constants characterising the selected curve
G is the measured value of the characteristic quantity
GS is the setting value
TMS is the time multiplier setting

The constants k and c have a unit of seconds, α has no dimension.

There is no intentional delay on reset. The function will reset when G < 2 x GS.

Curve shapes

Time characteristic



In the AGC 200, the value 2 x GS is called Limit.

There is a choice between seven different curve shapes, of which six are pre-defined and one is user-definable:

IEC Inverse
IEC Very Inverse
IEC Extremely Inverse
IEEE Moderately Inverse
IEEE Very Inverse
IEEE Extremely Inverse
Custom

Common settings for all types:

Setting	Parameter no.	Factory setting value	Equals
Limit	1722/1732	30/10%	2 x G_S
TMS	1723/1733	1.0	Time multiplier setting

The following constants apply to the predefined curves:

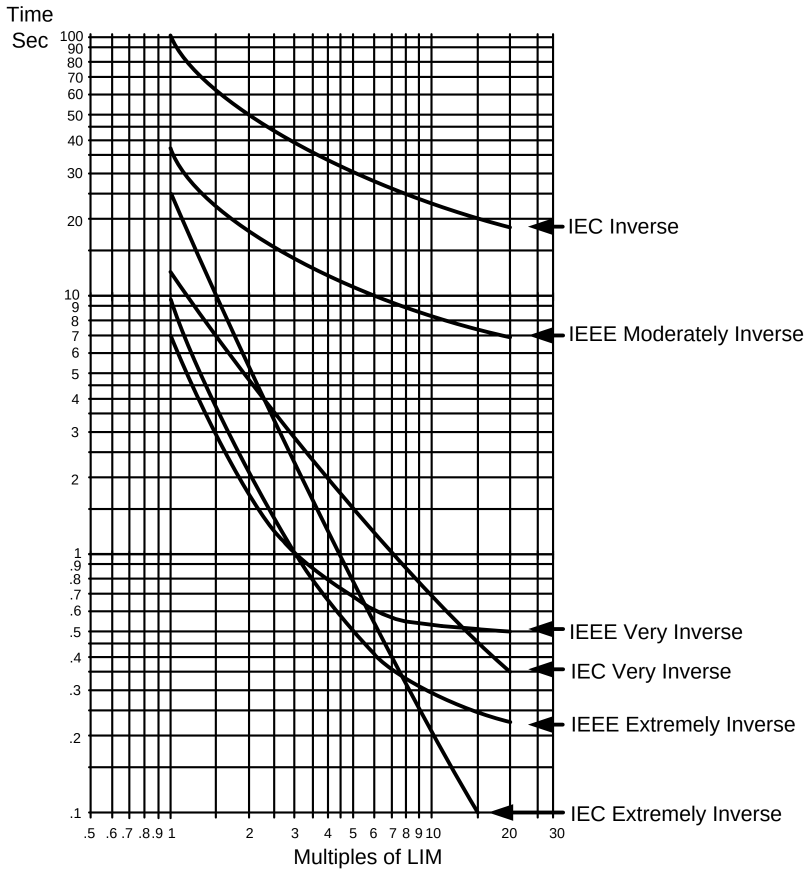
Curve type	k	c	α
IEC Inverse	0.14	0	0.02
IEC Very Inverse	13.5	0	1
IEC Extremely Inverse	80	0	2
IEEE Moderately Inverse	0.515	0.1140	0.02
IEEE Very Inverse	19.61	0.491	2
IEEE Extremely Inverse	28.2	0.1217	2

For the custom curve, these constants can be defined by the user:

Setting	Parameter no.	Factory setting value	Equals
k	1724/1734	0.140 s	k
c	1725/1735	0.000 s	c
α (a)	1726/1736	0.020	α

For the actual setting ranges, please see the parameter list.

Standard curves



The curves are shown for TMS = 1.

10.1.19 Trip of non-essential load (NEL)

Not available in AGC 212/213.

The two terms ”trip of non-essential load” and ”load shedding” describe the same functionality.

The trip of non-essential load (NEL) groups (load shedding) is carried out in order to protect the busbar against an imminent blackout situation due to either a high load/current or overload on a generator set or a low busbar frequency.

The unit is able to trip three NEL groups due to:
- the measured load of the generator set (high load and overload)
- the measured current of the generator set
- the measured frequency at the busbar

The load groups are tripped as three individual load groups. This means that the trip of load group no. 1 has no direct influence on the trip of load group no. 2. Only the measurement of either the busbar frequency or the load/current on the generator set is able to trip the load groups.

Trip of the NEL groups due to the load of a running generator set will reduce the load on the busbar and thus reduce the load percentage on the running generator set. This may prevent a possible blackout at the busbar caused by an overload on the running generator set. The current trip will be selected in case of inductive loads and unstable cos phi (cos phi <0.7) where the current is increased.

Trip of the NEL groups due to a low busbar frequency will reduce the real power load at the busbar and thus reduce the load percentage on the generator set. This may prevent a possible blackout at the busbar.

For output setup, please refer to the description of outputs.

10.1.20 Service timers

The unit is able to monitor the maintenance intervals. Two service timers are available to cover different intervals. The service timers are set up in menu 6110 and 6120.

The function is based on running hours. When the adjusted time expires, the unit will display an alarm.

The running hours is counting when the running feedback is present.

set points available in menus 6110 and 6120:

Enable: Enable/disable the alarm function.

Running hours: The number of running hours to activate the alarm. The service timer alarm will be activated as soon as the running hours have been reached.

Day: The number of days to activate the alarm – if the running hours are not reached before this number of days, the alarm will still be activated. The service timer alarm will be activated at 8:00 AM on the day the alarm expires.

Fail class: The fail class of the alarm.

Output A: Relay to be activated when the alarm is activated.

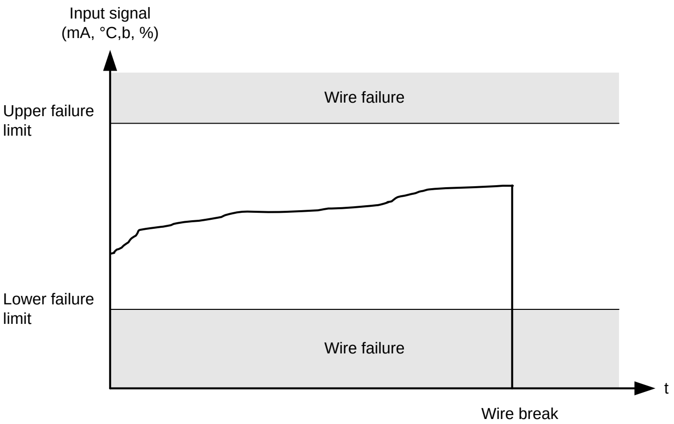
Reset: Enabling this will reset the service timer to zero. This must be done when the alarm is activated.

10.1.21 Wire fail detection

If it is necessary to supervise the sensors/wires connected to the multi-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
RMI Oil, type 1	< 10.0 ohm	-	> 184.0 ohm
RMI Oil, type 2	< 10.0 ohm	-	> 184.0 ohm
RMI Temp, type 1	< 22.4 ohm	-	> 291.5 ohm
RMI Temp, type 2	< 18.3 ohm	-	> 480.7 ohm
RMI Temp, type 3	< 7.4 ohm	-	> 69.3 ohm
RMI Fuel, type 1	< 1.6 ohm	-	> 78.8 ohm
RMI Fuel, type 2	< 3.0 ohm	-	> 180.0 ohm
RMI configurable	< lowest resistance	-	> highest resistance
Pt100	< 82.3 ohm	-	> 194.1 ohm
Level switch	Only active if the switch is open		

Principle
The illustration below shows that when the wire of the input breaks, the measured value will drop to zero. Then the alarm will occur.



MPU wire break (menu 4550)
The MPU wire break function is only active when the genset is not running. In this case, an alarm will be raised if the wire connection between the AGC 200 and MPU breaks.

Stop coil wire break (menu 6270)
The alarm will occur when the stop coil is not activated (generator is running) and the input is de-energised.

10.1.22 Digital inputs
The unit has a number of binary inputs, some of which are configurable and some are not.

Available digital inputs– not configurable	Available digital inputs– configurable
4	12

	Input function	Auto	Semi	Test	Man.	Block	Configurable	Input type
1	Shutdown override	X	X	X	X	X	Configurable	Constant
2	Access lock	X	X	X	X	X	Configurable	Constant
3	Running feedback	X	X	X	X	X	Configurable	Constant
4	Remote start		X		X		Configurable	Pulse
5	Remote stop		X		X		Configurable	Pulse
6	Semi-auto	X		X	X	X	Configurable	Pulse
7	Test	X	X		X	X	Configurable	Pulse
8	Auto		X	X	X	X	Configurable	Pulse
9	Manual		X	X		X	Configurable	Pulse
10	Block	X	X	X	X		Configurable	Constant
11	Remote GB ON		X				Configurable	Pulse
12	Remote GB OFF		X				Configurable	Pulse
13	Remote MB ON		X				Configurable	Pulse
14	Remote MB OFF		X				Configurable	Pulse
15	Remote alarm acknowledge	X	X	X	X	X	Configurable	Constant
16	Auto start/stop	X					Configurable	Constant
17	Remove starter	X	X	X	X		Configurable	Constant
18	Reset analogue GOV/AVR outputs	X	X	X	X	X	Configurable	Pulse
19	Manual GOV up	X	X	X	X		Configurable	Constant
20	Manual GOV down	X	X	X	X		Configurable	Constant
21	Manual AVR up	X	X	X	X		Configurable	Constant
22	Manual AVR down	X	X	X	X		Configurable	Constant
23	GB position ON	X	X	X	X	X	Configurable*	Constant
24	GB position OFF	X	X	X	X	X	Configurable*	Constant
25	MB position ON	X	X	X	X	X	Configurable**	Constant
26	MB position OFF	X	X	X	X	X	Configurable**	Constant
27	Emergency stop	X	X	X	X	X	Not configurable	Constant
28	Low speed	X	X	X			Configurable	Constant
29	Temperature control	X	X	X			Configurable	Constant
30	Battery test	X	X				Configurable	Pulse
31	Mains OK	X	X	X	X	X	Configurable	Constant
32	MB close inhibit	X	X	X	X	X	Configurable	Constant
33	Enable mode shift	X	X	X	X	X	Configurable	Constant
34	Enable GB black close	X	X	X	X	X	Configurable	Constant
35	Enable sep. sync.	X	X	X	X	X	Configurable	Constant
36	Start enable	X	X		X		Configurable	Constant

	Input function	Auto	Semi	Test	Man.	Block	Configurable	Input type
37	Alternative start	X	X	X	X	X	Configurable	Constant
38	Switchboard error	X	X	X	X	X	Configurable	Constant
39	Total test	X	X	X	X	X	Configurable	Constant
40	GB spring loaded	X	X	X	X	X	Configurable	Constant
41	MB spring loaded	X	X	X	X	X	Configurable	Constant
42	1st priority mains	X	X	X	X	X	Configurable	Constant
43	Ext. MB pos. OFF	X	X	X	X	X	Configurable	Constant
44	Heavy consumer 1 request	X	X	X	X	X	Configurable	Constant
45	Heavy consumer 2 request	X	X	X	X	X	Configurable	Constant
46	Deload	X					Configurable	Constant
47	GB OFF and BLOCK		X				Configurable	Pulse
48	HC 1 fixed load feedback	X	X	X	X	X	Configurable	Constant
49	HC 2 fixed load feedback	X	X	X	X	X	Configurable	Constant
50	Secured mode ON	X	X	X	X	X	Configurable	Pulse
51	Secured mode OFF	X	X	X	X	X	Configurable	Pulse
52	Base load	X	X	X	X	X	Configurable	Constant
53	D+	X	X	X	X	X	Not configurable	Constant

Columns marked with * indicate that it is only AGC 222 which has configurable GB pos. feedbacks; see further explanation below, in rows 23 and 24.

Columns marked with ** indicate that configurable MB feedback applies only to variants without MB.

Functional description

1. *Shutdown* overrideThis input deactivates all protections except the overspeed protection and the emergency stop input. The number of start attempts is seven by default, but it can be configured in menu 6201 Shutdown override. Also a special cool down timer is used in the stop sequence after an activation of this input.
2. *Access lock* Activating the access lock input deactivates the control display push-buttons. It will only be possible to view measurements, alarms and the log.
3. *Running feedback* The input is used as a running indication of the engine. When the input is activated, the start relay is deactivated.
4. *Remote start* This input initiates the start sequence of the genset when semi-auto or manual mode is selected.
5. *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.
6. *Semi-auto* Changes the present running mode to semi-auto.
7. *Test* Changes the present running mode to test.
8. *Auto* Changes the present running mode to auto.
9. *Manual* Changes the present running mode to manual.
10. *Block* Changes the present running mode to block.

When block mode is selected, the running mode cannot be changed by activating the digital inputs.

11. *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 opened.
12. *Remote GB 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.
13. *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 opened.
14. *Remote MB OFF* The mains breaker OFF sequence will be initiated and the breaker will open instantly.
15. *Remote alarm acknowledge* Acknowledges all present alarms, and the alarm LED on the display stops flashing.
16. *Auto start/stop* The genset will start when this input is activated. The genset will be stopped if the input is deactivated. The input can be used when the unit is in island operation, fixed power, load takeover or mains power export, and the auto running mode is selected.
17. *Remove starter* The start sequence is deactivated. This means the start relay deactivates, and the starter motor will disengage.
18. *Reset analogue* GOV/AVR outputs The analogue +/-20 mA controller outputs will be reset to 0 mA.

All analogue controller outputs are reset. That is the governor output and the AVR output.If an offset has been adjusted in the control setup, then the reset position will be the specific adjustment.

19. *Manual GOV up* If manual mode is selected, then the governor output will be increased.
20. *Manual GOV down* If manual mode is selected, then the governor output will be decreased.
21. *Manual AVR up* If manual mode is selected, then the AVR output will be increased.
22. *Manual AVR down* If manual mode is selected, then the AVR output will be decreased.

The manual governor and AVR increase and decrease inputs can only be used in manual mode.

23. *Generator breaker closed feedback (GB position ON)*The input function is used as an indication of the generator breaker position. The unit requires this feedback when the breaker is closed or a position failure alarm occurs.

In AGC 222 it is possible to configure GB pos. ON to "not used", so the input can be used for other purposes. It is done by selecting"not used" in the I/O list in the USW after which this input is free for other purposes. Be aware that when GB pos. ON is selected in the I/O list, it can ONLY be configured to input 89.

24. *Generator breaker open feedback (GB position OFF)* The input function is used as an indication of the generator breaker position. The unit requires this feedback when the breaker is opened or a position failure alarm occurs.

In AGC 222 it is possible to configure GB pos. OFF to "not used", so the input can be used for other purposes. It is done by selecting "not used" in the I/O list in the USW after which this input is free for other purposes. Be aware that when GB pos. OFF is selected in the I/O list, it can ONLY be configured to input 90.

25. *Mains breaker closed feedback (MB position ON)* The input function is used as an indication of the mains breaker position. The unit requires this feedback when the breaker is closed or a position failure alarm occurs.
26. *Mains breaker open feedback (MB position OFF)* The input function is used as an indication of the mains breaker position. The unit requires this feedback when the breaker is opened or a position failure alarm occurs.
27. *Emergency stop* The input shuts down the engine immediately. At the same time, it opens the generator breaker.

The shutdown fail class must be selected.

28. *Low speed* Disables the regulators and keeps the genset running at a low RPM.

The governor must be prepared for this function.

29. *Temperature control* This input is part of the idle mode function. When the input is high, then the genset starts. It starts at high or low speed, depending on the activation of the low speed input. When the input is deactivated, then the genset goes to idle mode (low speed = ON) or it stops (low speed = OFF).
30. *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.

Battery test is not supported by all engines using J1939/CANbus communication. Volvo engines with ECM2.2 supports a fuel disable request through the CAN communication.

31. *Mains OK* Disables the “mains OK delay” timer. The synchronisation of the mains breaker will only happen when the input is activated.
32. *MB close inhibit* When this input is activated, the mains breaker cannot close.
33. *Enable mode shift* The input activates the mode shift function, and the AGC 200 will perform the AMF sequence in case of a mains failure. When the input is configured, the setting in menu 7081 (mode shift ON/OFF) is disregarded.
34. *Enable GB black close* When the input is activated, the AGC 200 is allowed to close the generator on a black busbar, providing that the frequency and voltage are inside the limits set up in menu 2110.
35. *Enable separate sync.* Activating this input will split the breaker close and breaker synchronisation functions into two different relays. The breaker close function will remain on the relays dedicated for breaker control. The synchronisation function will be moved to a configurable relay dependent on the options configuration. Please refer to the description.

This function is option-dependent. Option M12 or M14.x is required.

36. *Start enable* The input must be activated to be able to start the engine.

When the genset is started, the input can be removed.

37. *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.
38. *Switchboard error* The input will stop or block the genset, depending on running status.
39. *Total test* This input will be logged in the event log to indicate that a planned mains failure has been made.
40. *GB spring loaded* The AGC 200 will not send a close signal before this feedback is present.
41. *MB spring loaded* The AGC 200 will not send a close signal before this feedback is present.
42. *1st priority mains* This input is used in G5 applications with two mains connections to select which mains connection has the 1st priority.
43. *Ext. MB pos.* OFF This input is used in G5 applications with two mains connections to tell the AGC 200 mains units that the mains breaker not controlled by them has been tripped.
44. *Heavy consumer 1 request* This input is used in G5 applications with two generators or more to request heavy consumer 1 to start.
45. *Heavy consumer 2 request* This input is used in G5 applications with two generators or more to request heavy consumer 2 to start.
46. *Deload* A running genset will start to ramp down the power.
47. *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.
48. *HC 1 fixed load feedback* HC 1 is running and consuming 100% power.
49. *HC 2 fixed load feedback* HC 2 is running and consuming 100% power.
50. *Secured mode ON* Secured mode adds an extra generator to the system, i.e. one generator too many will be running when comparing with the actual power requirement.

51. *Secured mode OFF* Ends secured running mode.
52. *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.
53. *D+* is running feedback from the charger generator.

The input functions are set up with the PC utility software, please refer to ”Help” in this.

10.1.23 Multi-inputs

The AGC 200 unit has three multi-inputs which can be configured to be used as the following input types:

1. 4-20 mA
2. Pt100
3. RMI oil
4. RMI water
5. RMI fuel
6. Digital

The function of the multi-inputs can only be configured in the PC utility software.

Two alarm levels are available for each input. The menu numbers of the alarm settings for each multi-input are controlled by the configured input type as seen in the following table.

Input type	Multi-input 46	Multi-input 47	Multi-input 48
4-20 mA	4120/4130	4250/4260	4380/4390
Pt100	4160/4170	4290/4300	4420/4430
RMI oil	4180/4190	4310/4320	4440/4450
RMI water	4200/4210	4330/4340	4460/4470
RMI fuel	4220/4230	4350/4360	4480/4490
Digital	3400	3410	3420

Only one alarm level is available for the digital input type.

In the event that the number of alarms is not sufficient, it is possible to use delta (differential measurement) alarms as configurable alarms.

4-20 mA

If one of the multi-inputs has been configured as 4-20 mA, the unit and range of the measured value corresponding to 4-20 mA can be changed in the PC utility software in order to get the correct reading in the display.

Pt100

This input type can be used for heat sensor, e.g. cooling water temperature. The unit of the measured value can be changed from Celsius to Fahrenheit in the PC utility software in order to get the desired reading in the display.

Offset parameters are used for compensation of wire resistance in a 2-wire setup.

Pt100 offset can be configered in the following parameters:

- Multi-input 46: 4167
- Multi-input 47: 4297

- Multi-input 48: 4427

RMI inputs
The unit can contain up to three RMI inputs. The inputs have different functions as the hardware design allows for several RMI types.
These various types of RMI inputs are available for all multi-inputs:
- RMI oil: Oil pressure
- RMI water: Cooling water temperature
- RMI fuel: Fuel level sensor

For each type of RMI input it is possible to select between different characteristics including a configurable.

RMI oil
This RMI input is used to measure the lubricating oil pressure

		RMI sensor type		
Pressure		**Type 1**	**Type 2**	**Type configurable**
Bar	**psi**	**Ω**	**Ω**	**Ω**
0	0	10.0	10.0	
0.5	7	27.2		
1.0	15	44.9	31.3	
1.5	22	62.9		
2.0	29	81.0	51.5	
2.5	36	99.2		
3.0	44	117.1	71.0	
3.5	51	134.7		
4.0	58	151.9	89.6	
4.5	65	168.3		
5.0	73	184.0	107.3	
6.0	87		124.3	
7.0	102		140.4	
8.0	116		155.7	
9.0	131		170.2	
10.0	145		184.0	

The configurable type is configurable with eight points in the range 0-2500 Ω. The resistance as well as the pressure can be adjusted.

If the RMI input is used as a level switch, then please be aware that no voltage must be connected to the input. If any voltage is applied to the RMI input, it will be damaged. Please refer to the Application Notes for further wiring information.

RMI water
This RMI input is used to measure the cooling water temperature.

Temperature		RMI sensor type			
°C	**°F**	**Type 1- Ω**	**Type 2- Ω**	**Type 3- Ω**	**Type Configurable- Ω**
40	104	291.5	480.7	69.3	
50	122	197.3	323.6		
60	140	134.0	222.5	36.0	
70	158	97.1	157.1		
80	176	70.1	113.2	19.8	
90	194	51.2	83.2		
100	212	38.5	62.4	11.7	
110	230	29.1	47.6		
120	248	22.4	36.8	7.4	
130	266		28.9		
140	284		22.8		
150	302		18.2		

The configurable type is configurable with eight points in the range 0-2500 Ω. The temperature as well as the resistance can be adjusted.

If the RMi input is used as a level switch, then please be aware that no voltage must be connected to the input. If any voltage is applied to the RMI input, it will be damaged. Please refer to the Application Notes for further wiring information.

RMI fuel
This RMI input is used for the fuel level sensor.

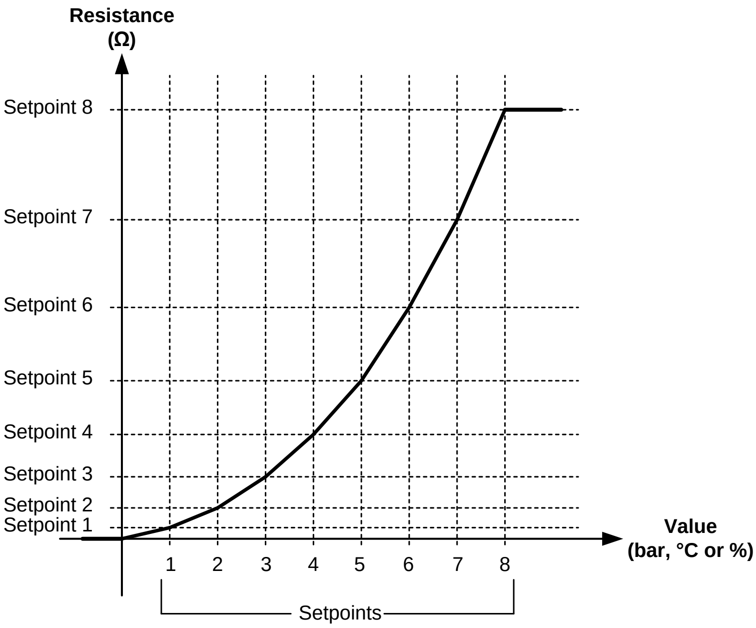
Value	RMI sensor type	
	Type 1	**Type 2**
	Resistance	**Resistance**
0%	78.8 Ω	3 Ω
100%	1.6 Ω	180 Ω

If the RMI input is used as a level switch, then please be aware that no voltage must be connected to the input. If any voltage is applied to the RMI input, it will be damaged. Please refer to the Application Notes for further wiring information.

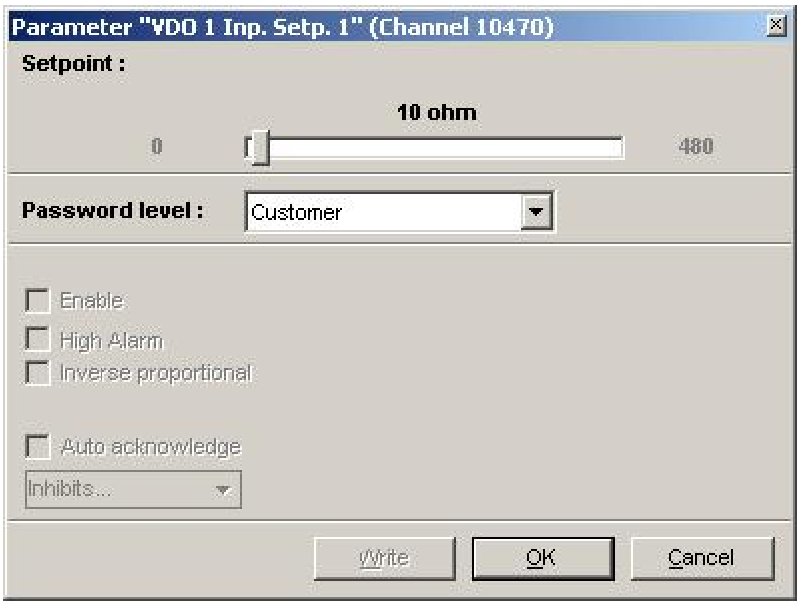
Value	RMI sensor type
	Type configurable
%	Resistance
0	
10	
20	
30	
40	
50	
60	
70	
80	
90	
100	

The configurable type is configurable with eight points in the range 0-2500 Ω. The value as well as the resistance can be adjusted.

Illustration of configurable inputs



Configuration
The eight curve settings for the configurable RMI inputs cannot be changed in the display, **only** in the PC utility software. The alarm settings can be changed both in the display and in the PC utility software. In the PC utility software, the configurable inputs are adjusted in this dialogue box:



Adjust the resistance of the RMI sensor at the specific measuring value. In the example above, the adjustment is 10 Ω at 0.0 bar.

Digital
If the multi-inputs are configured to ”Digital”, they become available as a configurable input.

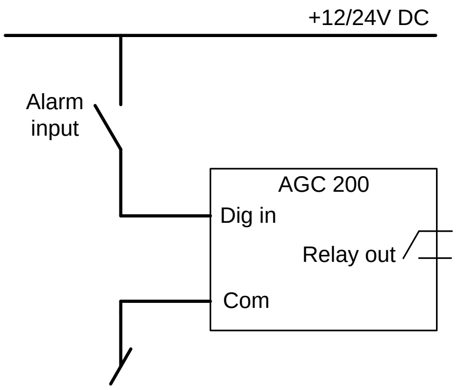
10.1.24 Input function selection

Digital input alarms can be configured with a possibility to select when the alarms are to be activated. The possible selections of the input function are normally open or normally closed.

The drawing below illustrates a digital input used as an alarm input.

1. Digital input alarm configured to NC, normally closed. *This will initiate an alarm when the signal on the digital input disappears.*
2. Digital input alarm configured to NO, normally open. *This will initiate an alarm when the signal on the digital input appears.*

The relay output function can be selected to be ND (Normally De-energised, NE (Normally Energised), Limit, or Horn.



10.1.25 Outputs

The unit has a number of output functions which can be configured to any available relay.

S.N.	Output function	Auto	Semi	Test	Man.	Block	Configurable	Output type
1	HC 1 ack.	X					Configurable	Pulse
2	HC 2 ack.	X					Configurable	Pulse
3	Trip NEL 1	X	X	X	X	X	Configurable	Pulse
4	Trip NEL 2	X	X	X	X	X	Configurable	Pulse
5	Trip NEL 3	X	X	X	X	X	Configurable	Pulse

Functional description

1. HC 1 ack.
   This output is used in G5 applications with two or more generators to acknowledge the heavy consumer requested.
2. HC 2 ack.
   This output is used in G5 applications with two or more generators to acknowledge the heavy consumer requested.
3. Trip NEL 1
   This output is used to trip load groups.
4. Trip NEL 2
   This output is used to trip load groups
5. Trip NEL 3
   This output is used to trip load groups.

Please refer to the description of NEL.

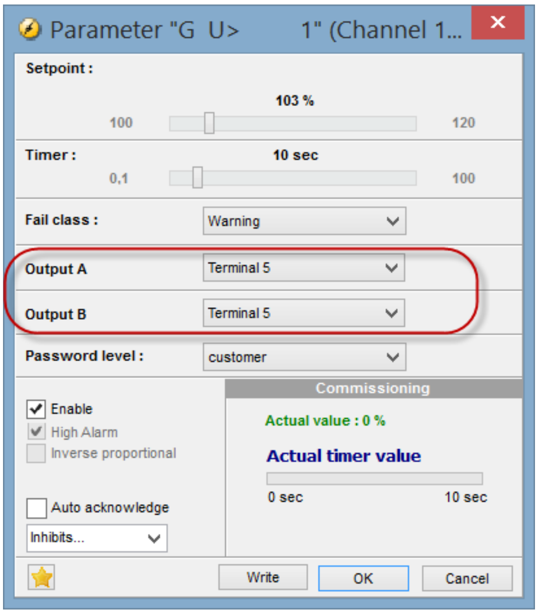
10.1.26 Limit relay

For all alarm functions, it is possible to activate one or two output relays as shown below. This paragraph explains how to use an alarm function to activate an output without any indication of alarm. ON and OFF delay timers are described as well.

If no alarm is needed, it is possible to do one of the following things:

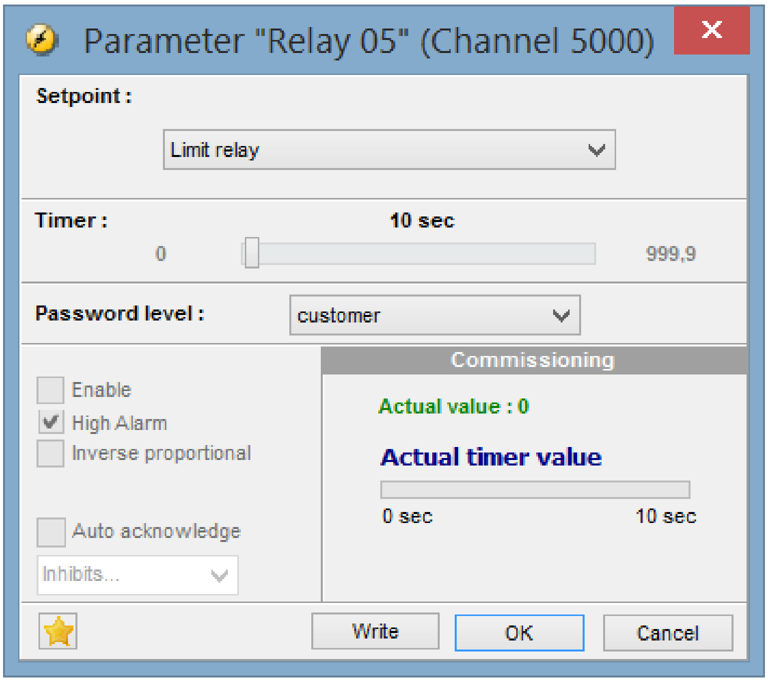
1. Set both output A and output B to Limit.
2. Set both output A and output B to the same specific terminal. If terminal alarm is not required, the set point in the specific relay is set to Limit relay.

In the example below, the relay will close when the generator voltage is above 103 % for 10 seconds, and no alarm will appear on the screen because both output A and output B are configured to relay 5, which is configured as "Limit relay".



The timer configured in the alarm window is an ON delay that determines the time during which the alarm conditions must be met before activation of any alarms or outputs.

When a relay is selected (relay on terminal 5 in this example), it must be set up as a limit relay as shown below, otherwise an alarm indication will still appear.



The timer in the image above is an OFF delay, meaning that when the alarm level is OK again, the relay will remain activated until the timer runs out. The timer is only effective when it is configured as "Limit relay". If it is configured to any "Alarm relay", the relay is deactivated instantly when the alarm conditions disappear and it is acknowledged.

10.1.27 Manual governor and AVR control

This function can be activated by activating the digital inputs or AOP buttons for governor or AVR control in manual/semi-auto mode. The function has to be configured through M-Logic. The intention of this function is to give 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 in parameter 2783 and 2784.
Manual GOV and AVR control only works in manual and semi-auto mode, it will not be active in test and auto mode. The regulator that is manually regulated 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 pushed for manual GOV up, the RPM for the genset will increase for five seconds. The AGC's governor regulator is deactivated for five seconds. When the five seconds have expired, the normal regulator in the AGC will regulate the genset down to nominal set point again.

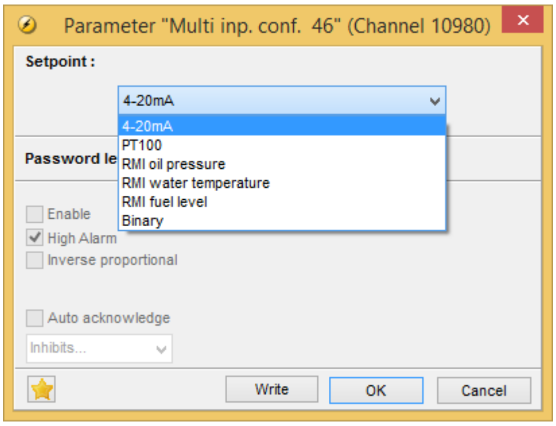
Regarding AOP setup, please refer to ”Help” in the PC utility software.

10.1.28 External governor and AVR control

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: 4 to 20 mA or variable resistance (potentiometer). The utility software must be used to configure these inputs, it cannot be done using the display. A few examples of configuring the different options are shown below.

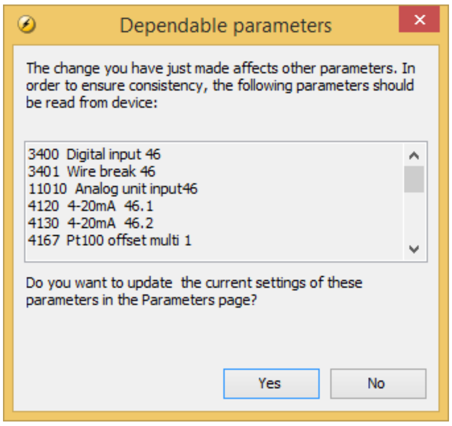
How to set up "External power control" using a 4 to 20 mA signal on input 46

Type of signal



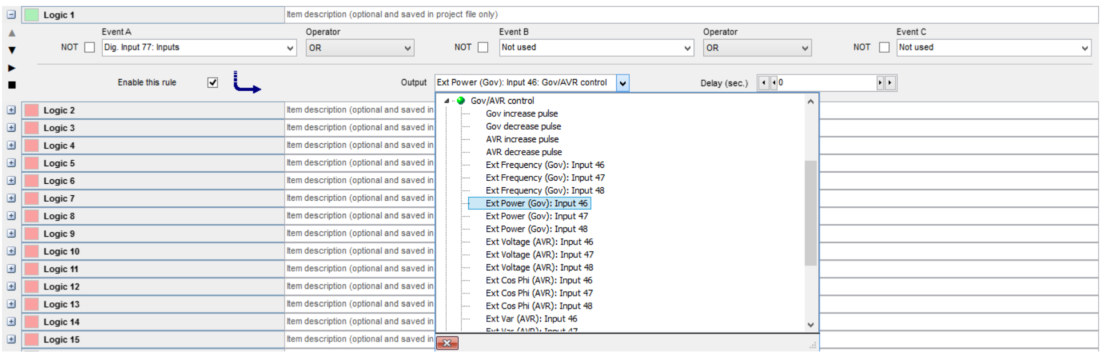
The type of signal applied to the input 46 should be selected in channel 10980. When using 4 to 20 mA signal, additional configuration of input 46 is unnecesary.

Pop-up box



When you write the new configuration, accept the "Dependable parameters" pop-up box.

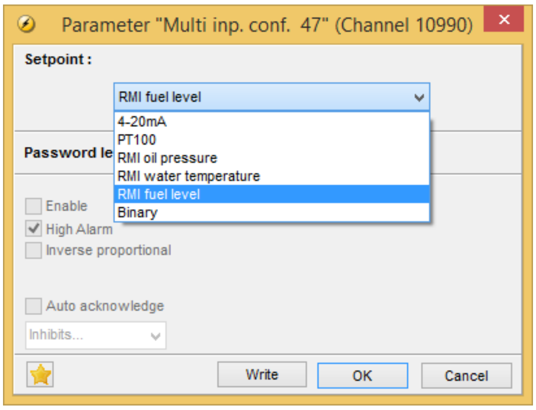
Configuring M-Logic



In M-Logic, external power control from input 46 is enabled as an output by using the command "Ext Power (Gov): Input 46". Commands relevant for external governor/AVR control are found under the "Gov/AVR control" headline. Any relevant events can be used to activate the command. This example uses digital input 77.

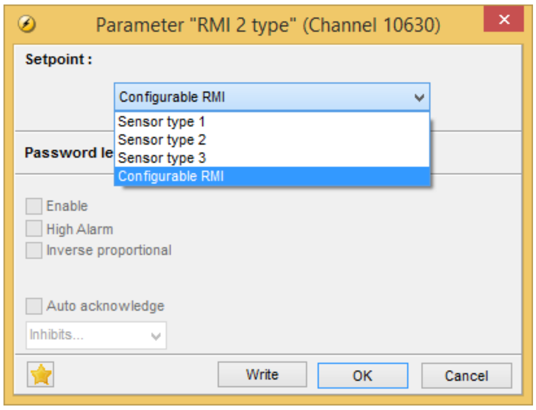
How to set up "External voltage control" using a potentiometer (variable resistance)

Type of signal



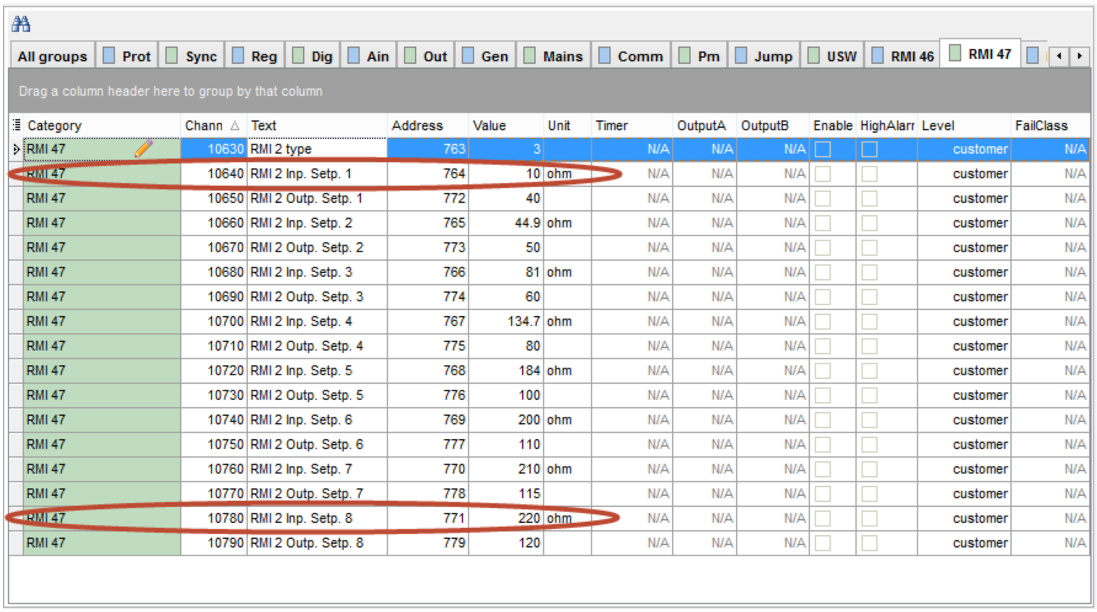
The type of signal applied to the input 47 should be selected in channel 10990. Choose one of the RMI signals (oil pressure, water temperature or fuel level). When you write the new configuration, accept the "Dependable parameters" pop-up box.

Configurable RMI



Use the tab "RMI 47" to configure the resistance values. Select "Configurable RMI" in channel 10630. The resistance values are configured as explained under the next screenshot.

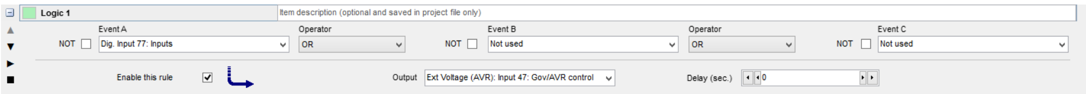
Defining the active resistance area



Category	Chann	Text	Address	Value	Unit	Timer	OutputA	OutputB	Enable	HighAlarr	Level	FailClass
RMI 47	10630	RMI 2 type	763	3		N/A	N/A	N/A			customer	N/A
RMI 47	10640	RMI 2 Inp. Setp. 1	764	10	ohm	N/A	N/A	N/A			customer	N/A
RMI 47	10650	RMI 2 Outp. Setp. 1	772	40		N/A	N/A	N/A			customer	N/A
RMI 47	10660	RMI 2 Inp. Setp. 2	765	44.9	ohm	N/A	N/A	N/A			customer	N/A
RMI 47	10670	RMI 2 Outp. Setp. 2	773	50		N/A	N/A	N/A			customer	N/A
RMI 47	10680	RMI 2 Inp. Setp. 3	766	81	ohm	N/A	N/A	N/A			customer	N/A
RMI 47	10690	RMI 2 Outp. Setp. 3	774	60		N/A	N/A	N/A			customer	N/A
RMI 47	10700	RMI 2 Inp. Setp. 4	767	134.7	ohm	N/A	N/A	N/A			customer	N/A
RMI 47	10710	RMI 2 Outp. Setp. 4	775	80		N/A	N/A	N/A			customer	N/A
RMI 47	10720	RMI 2 Inp. Setp. 5	768	184	ohm	N/A	N/A	N/A			customer	N/A
RMI 47	10730	RMI 2 Outp. Setp. 5	776	100		N/A	N/A	N/A			customer	N/A
RMI 47	10740	RMI 2 Inp. Setp. 6	769	200	ohm	N/A	N/A	N/A			customer	N/A
RMI 47	10750	RMI 2 Outp. Setp. 6	777	110		N/A	N/A	N/A			customer	N/A
RMI 47	10760	RMI 2 Inp. Setp. 7	770	210	ohm	N/A	N/A	N/A			customer	N/A
RMI 47	10770	RMI 2 Outp. Setp. 7	778	115		N/A	N/A	N/A			customer	N/A
RMI 47	10780	RMI 2 Inp. Setp. 8	771	220	ohm	N/A	N/A	N/A			customer	N/A
RMI 47	10790	RMI 2 Outp. Setp. 8	779	120		N/A	N/A	N/A			customer	N/A

Type the lowest resistance value in channel 10640 (curve step 1) and the highest resistance value in channel 10780 (curve step 8). When the low and the high resistances are specified, they will be represented by a linear function between low and high. Curve steps 2 to 7 are inactive.

Configuring M-Logic



In M-Logic, external voltage control from input 47 is enabled as an output by using the command "Ext Voltage (AVR): Input 47". Commands relevant for external gov/AVR control are found under the "Gov/AVR control" headline. Any relevant events can be used to activate the command. This example uses digital input 77.

When for example an RMI fuel level is selected, the external control value will be displayed as fuel level!

M-Logic outputs that activate external Gov/AVR control

M-Logic output: GOV/AVR control	Multi-input selection
Ext. frequency (Gov): Input (when mA is selected, a 4 to 20 mA signal is used for control and the nominal frequency is located at 12 mA)	46/47/48
Ext. power (Gov): Input (when mA is selected, a 12 to 20 mA signal is used for control/0 to 100 %)	46/47/48
Ext. voltage (AVR): Input (when mA is selected, a 4 to 20 mA signal is used for control)	46/47/48
Ext. cos phi (AVR): Input (when mA is selected, a 12 to 20 mA signal is used for control)	46/47/48
Ext. var (AVR): Input (when mA is selected, a 4 to 20 mA signal is used for control)	46/47/48

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

Alarms regarding external gov/AVR control
When one or more multi-inputs are configured for external gov/AVR control, it is possible to use the associated alarms listed in the table below.

Input no.	Input 46	Input 47	Input 48
Alarm channels	Channels 4120 to 4240	Channels 4350 to 4370	Channels 4460 to 4500

10.1.29 Language selection

The unit has the possibility to display different languages. It is delivered with one master language which is English. This is the default language, and it cannot be changed. In addition to the master language, 11 different languages can be configured. This is done via the PC utility software.

The languages are selected in the system setup **menu 6080**. The language can be changed when connected to the PC utility software. It is not possible to make language configuration from the display, but the already configured languages can be selected.

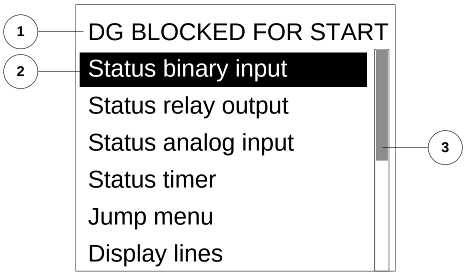
After selecting a language, the unit aux. power must be cycled before the selection takes effect.

10.1.30 Tools menu

The purpose of the tools menu is to give information about the present operating condition of the genset. The tools menu is entered using the push-button.

Use the tools menu for easy troubleshooting in connection with commissioning.

Entry window
The entry window shows the possible selections in the service menu



If is pressed, the highlighted entry will be chosen.The scrollbar indicates that more selections than those shown are available. Scroll through the list using the or button.

Available selections
Status binary input:
Shows the status of the binary inputs.

Status relay output:
Shows the status of the relay outputs.

Status analogue input:
Shows analogue input values.

Status timers:
Shows actual alarm timer values.

Jump menu:
Shows parameters that can only be accessed by entering this display menu. Available parameters are:

9000 Software version
Information about the actual software (firmware) version present in the unit.

911x Password
9111 Customer password
9112 Service password
9113 Master password

9130 AC config.
Entering this parameter gives you:

9131 AC configuration
Selections:
3-phase L1L2L3 (factory setting)
2-phase L1L3
2-phase L1L2
1-phase L1

9140 Angle comp. BB/gen.
Here, a compensation angle for a step-up transformer between generator and generator breaker can be entered, in case the step-up transformer creates a phase angle shift between low and high voltage sides

This setting has an impact on the synchronising phase angle control. Be very careful to verify that the synchronising pulse is issued correctly before enabling automatic synchronising.

9160 Application
Selection between the four predefinable applications set in the ”Utility software application setting” section.

9180 Quick setup
This menu makes it possible to set up a power management application without using the application configuration tool in the PC utility software. The following parameters can be adjusted:

9181 Mode (OFF/stand-alone/plant)
9182 CAN (CAN A/CAN B/CAN A + B)
9183 Mains breaker (none/pulse/continuous/compact)
9184 Generator breaker (none/pulse/continuous/compact)
9185 Mains (present/not present) 9186 DG (single DG/standard)

9190 Application broadcast
This menu makes it possible to broadcast an application between all AGC 200 units connected to the CAN A or CAN B line. Selections are:

9191 Type (OFF/ON). Set to ON for broadcast
9192 Application (select application 1-4)

Display lines:
Shows the available texts of the display.

Ethernet setup:
Setup of the Ethernet (option N) IP address, gateway address and MAC address.

10.1.31 Event and alarm log

The logging of data is divided into groups:
- Event log containing 150 loggings.
- Alarm log containing 150 loggings.
- Battery test log containing 52 loggings.
- Engine interface alarm log

The logs can be viewed in the display or in the PC utility software. When the individual logs are full, each new event will overwrite the oldest event following the ”first in – first out” principle.

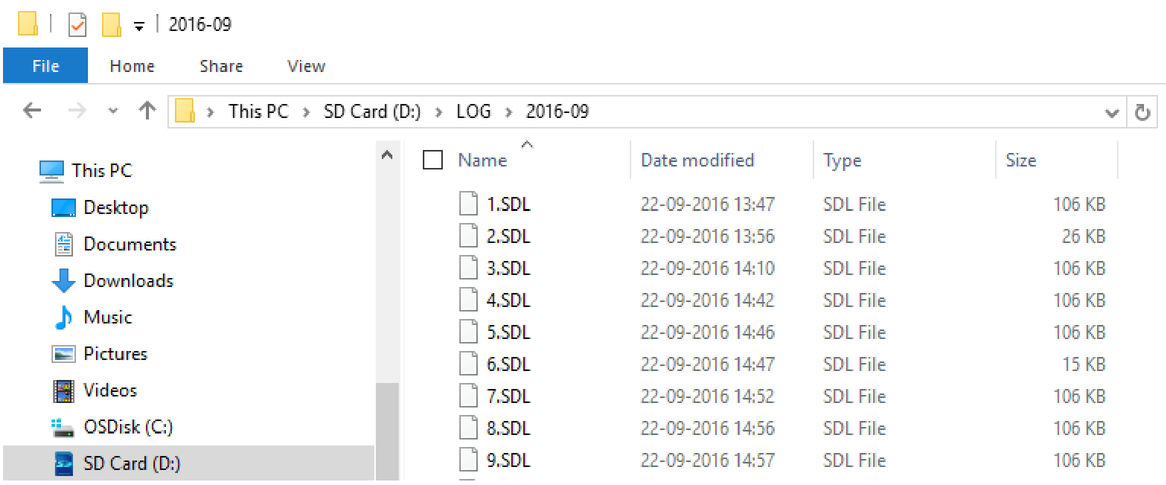
To enter the log list:

1. Press
2. Select the needed list by using the and push-buttons (move the highlight of the list), and press the push-button.

10.1.32 Saving and reading alarm log on a SD card

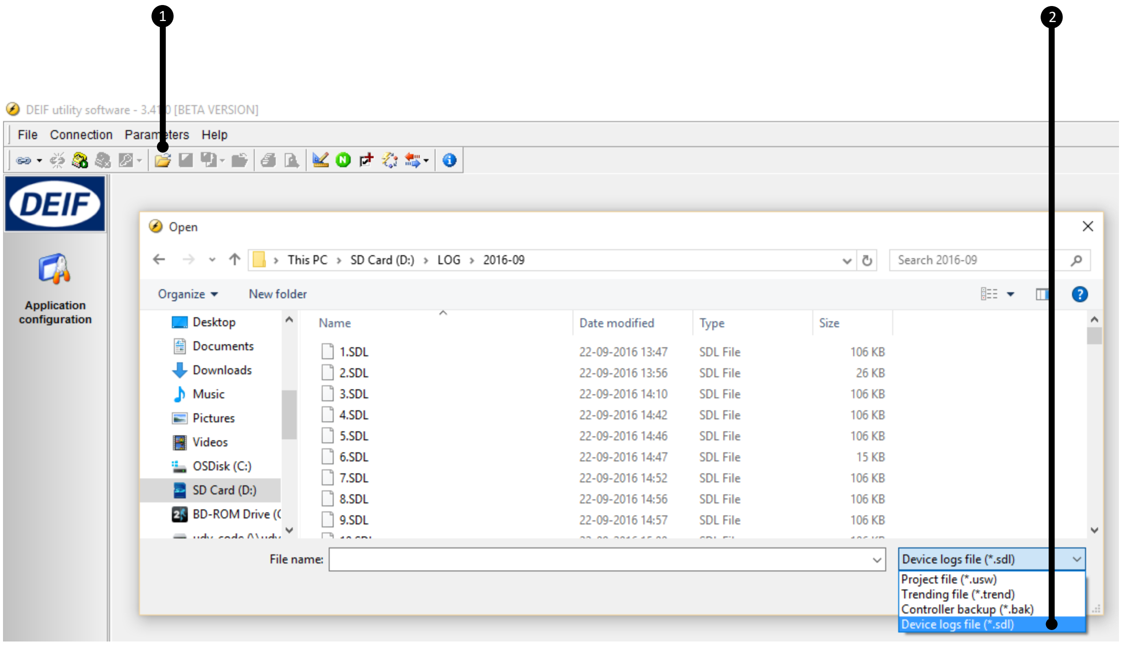
The AGC 200 can max store 150 logs in the alarm log, but it is possible to insert an SD card into the SD card slot, where more logs can be stored. The slot is located on the right side of the controller when you stand in front of the display.

On the SD card, a folder called "LOG" will be created, and in that folder some new folders will be created with the year and month as name of the folder, for example "2016-09" would be the name of the folder, where the logs can be found for September 2016. The first 150 alarms will be saved in a file called "1" and the next 150 alarms will be saved in a file called "2" and so on. Below is a screenshot from an SD card folder.



The AGC 200 accepts standard SD card size (32x24x2.1 mm). DEIF recommends using the SD cards that can be bought at DEIF as these are industrial-approved.

To see the logs, you have to open the utility software, click Open (item 1 on the illustration below), select "Device logs file (*.sdl)" in the dropdown menu (item 2) and then navigate to the log file you want to open.



10.1.33 Counters

Counters for various values are included, and some of these can be adjusted if necessary, for instance if the unit is installed on an existing genset or a new circuit breaker has been installed.

The table shows the adjustable values and their function in menu 6100:

Description	FunctionComment	Comment
6101 Running time	Offset adjustment of the total running hours counter.	Counting when the running feedback is present.
6102 Running time	Offset adjustment of the total running thousand hours counter.	Counting when the running feedback is present.
6103 GB operations	Offset adjustment of the number of generator breaker operations.	Counting at each GB close command.
6104 MB operations	Offset adjustment of the number of mains breaker operations.	Counting at each MB close command.
6105 kWh reset	Resets the kWh counter.	Automatically resets to OFF after the reset. The reset function cannot be left active.
6106 Start attempts	Offset adjustment of the number of start attempts.	Counting at each start attempt.

10.1.34 M-Logic

M-Logic functionality is included in the unit and is not an option-dependent function, however, selecting additional options can increase the functionality.

M-Logic is used to execute different commands at predefined conditions. M-Logic is not a PLC but substitutes one if only very simple commands are needed.

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

The M-Logic is part of the PC utility software, and as such it can only be configured in the PC utility software and not via the display.

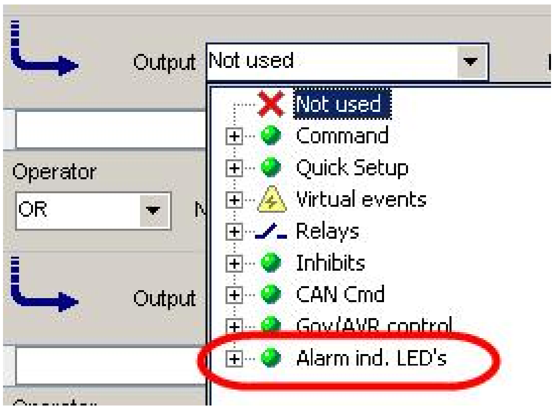
The main purpose of M-Logic is to give the operator/designer more flexible possibilities of operating the generator control system.

Please refer to the "Help" function in the PC utility software for a full description of this configuration tool.

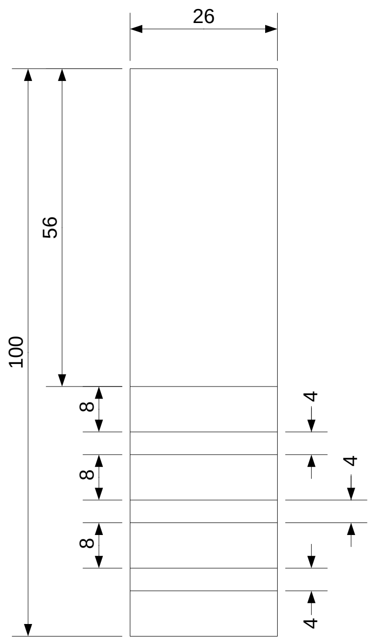
Please refer to the application note "M-Logic" for further functional details.

10.1.35 Configurable alarm LEDs

The four LEDs on the left side of the display can be controlled via M-Logic. For each LED there is a choice between three colours (red, green and yellow) with or without blinking.



For each LED there is a text box, where the indication of the function can be written. This must be done on a piece of stiff paper or a plastic transparent, as the texts are to be slided into a slot at the top of the AGC 200 unit. The slide-in paper/transparent template looks like this:



The above template is scale 1:1 when printing on A4 paper size.

10.1.36 USW communication

It is possible to communicate with the unit via the PC utility software. The purpose is to be able to remote monitor and control the genset application.

It is possible to remote control the genset from the PC utility software if a TCP/IP router is used. Take precautions that it is safe to remote operate the genset to avoid personal injury or death.

Application settings

Please refer to the PC utility software help file.

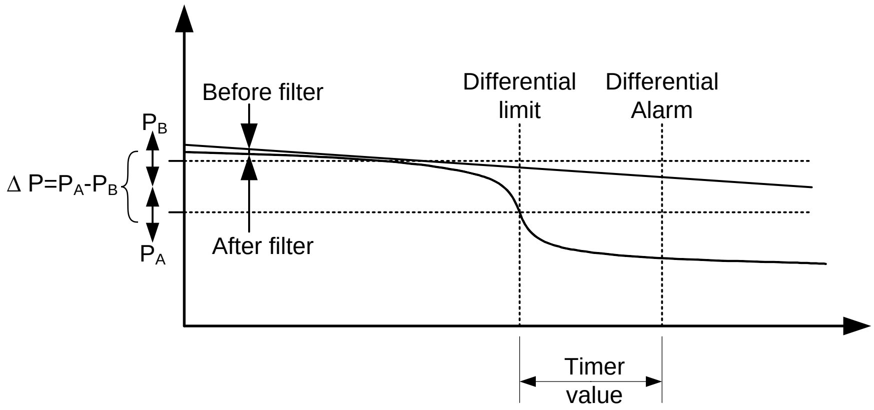
Safety

If communication fails, the unit will operate according to the received data. If e.g. only half of the parameter file has been downloaded when the communication is interrupted, the unit will use this actual data.

10.1.37 Differential measurement

With the differential measurement function, it is possible to compare two analogue inputs and trigger on the difference between the two values.

If the differential function is for example air filter check, the timer will be activated if the set point between PA (analogue A) and PB (analogue B) is exceeded. If the differential value drops below the set point value before the timer runs out, then the timer will be stopped and reset.



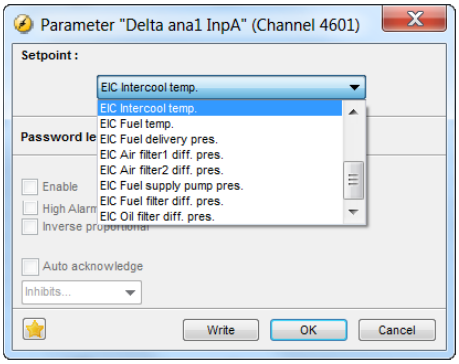
Six different differential measurements between two analogue input values can be configured.

Differential measurements between two sensors can be configured in menus 4600-4606 and 4670-4676. As an example, the figure below shows the two parameters for input selection for differential measurement 1.

Ain	4601	Delta ana1 InpA	1482	4	
Ain	4602	Delta ana1 InpB	1483	4	

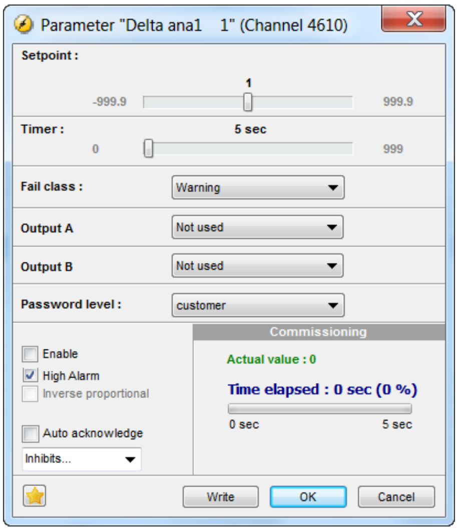
Inputs are selected from the input list as shown below, avaible inputs are:

- Multi-inputs
- EIC measurements
- External inputs (option H8)
- Analogue input (M15.X, only AGC-4)
- Multi-input (M16.X, only AGC-4)



The relevant alarm set point is chosen in parameters 4610-4660 and 4680-4730. Each alarm can be configured in two alarm levels for each differential measurement between analogue input A and input B. The figure below shows the two parameters to configure alarm level 1 and 2, for differential measurement 1.

Ain	4610	Delta ana1 1		1488	1
Ain	4620	Delta ana1 2		1489	1

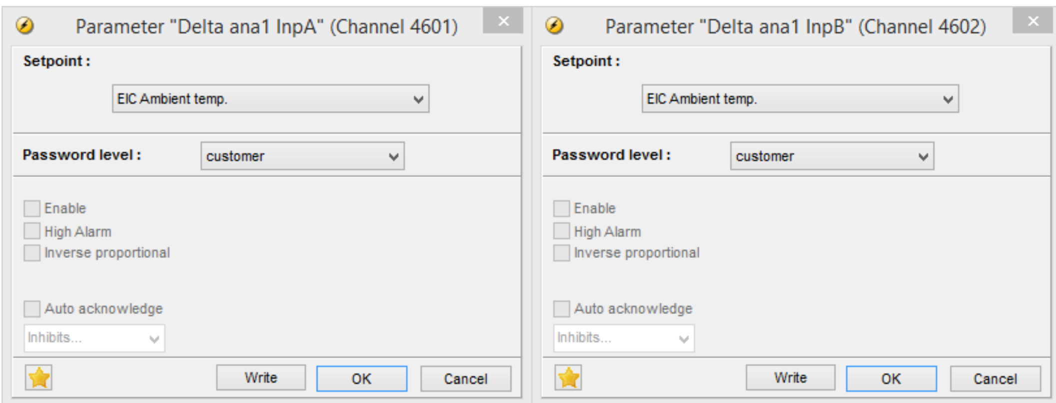


10.1.38 Configurable alarms

The alarms associated to the differential measurements are not locked as delta alarms. It is possible to use these six inputs, with two alarms each, as configurable alarms. The alarms can be configured to: Multi-inputs, external analogue inputs and some EIC values. When the same input is used for both "inpA" and "inpB" in the channels 4601 to 4606 and 4672 to 4676, the differential measurement will be disabled, and this allows 12 configurable alarms over up to six different inputs.

How to configure an alarm for "EIC Ambient temp." on "Delta ana1":

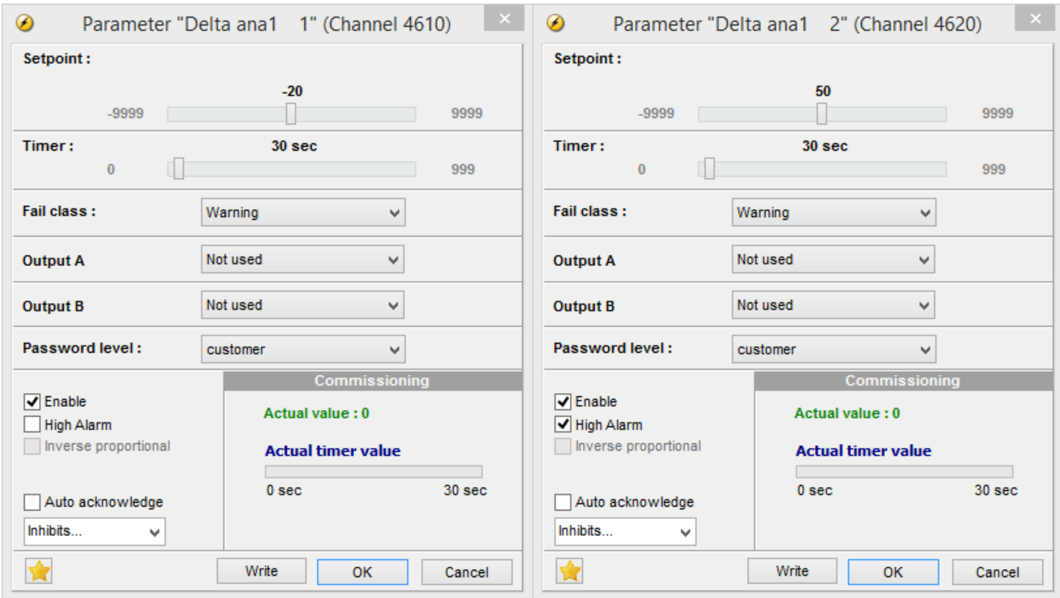
Choose identical inputs



How to configure an alarm for "EIC Ambient temp." on "Delta ana1":

Set "inpA" and "inpB" to the same desired value. This will disable the differential measurement, and the alarms associated to the channel are now depending on the actual value.

Each input has two associated configurable alarms



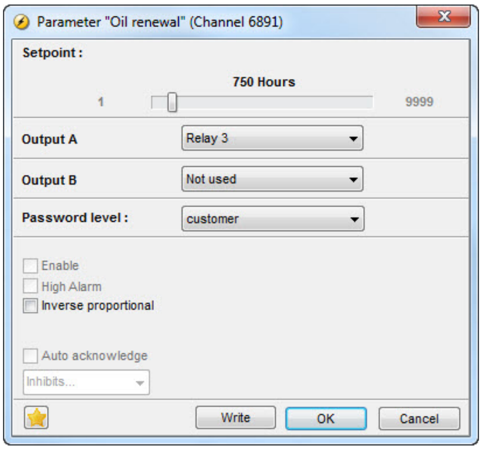
Configure the associated alarms as desired. In this case the first alarm is set to give a warning when the ambient temperature has been below -20 degrees for more than 30 seconds. The second alarm is set to give a warning when the ambient temperature has been above 50 degrees for more than 30 seconds.

10.1.39 Oil renewal function

The purpose of the oil renewal function is to make it possible to exchange a small portion of the lubricating oil of the engine with fresh or new oil. This means that the quality of the oil is kept at a satisfactory level without significant deterioration of the oil quality in the entire period between oil changes.

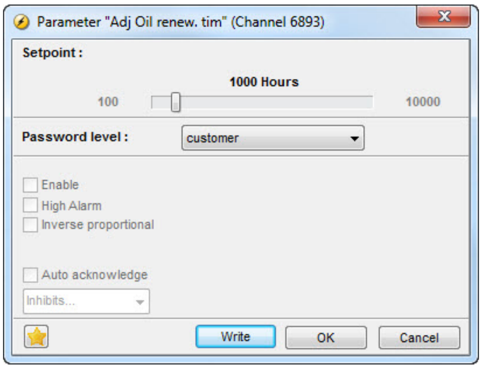
The time interval between oil changes is assumed to be 1000 hours (default set point) of operation; this set point can be changed in menu 6893. The renewal function will read the engine hours from the engine interface communication (EIC). The running hours counter in the AGC is only used if the EIC counter is not available.

The function in the AGC is to activate a relay under defined conditions. Then the relay must be used for the oil renewal system (not part of the DEIF scope of supply), where lubricating oil is removed and added to the engine. Any freely configurable relay is available for this feature. In parameter 6891, a set point is available, which can be set between 1 and 9999 hours to define when the relay should close, and it is possible to select which relay is to be used. Furthermore, this parameter can be inversed, meaning that the relay will close from 0 hours until the set point is reached.



If menu 6893 is set to 1000 hours, the AGC will reset the hours just for the oil renewal function when the running hours counter has reached 1000 hours. If for example menu 6891 has been set to 750 hours and inverse is not enabled, the relay will close at 750 hours and remain closed until 1000 hours is reached, and then the hours counter starts from 0 hours again.

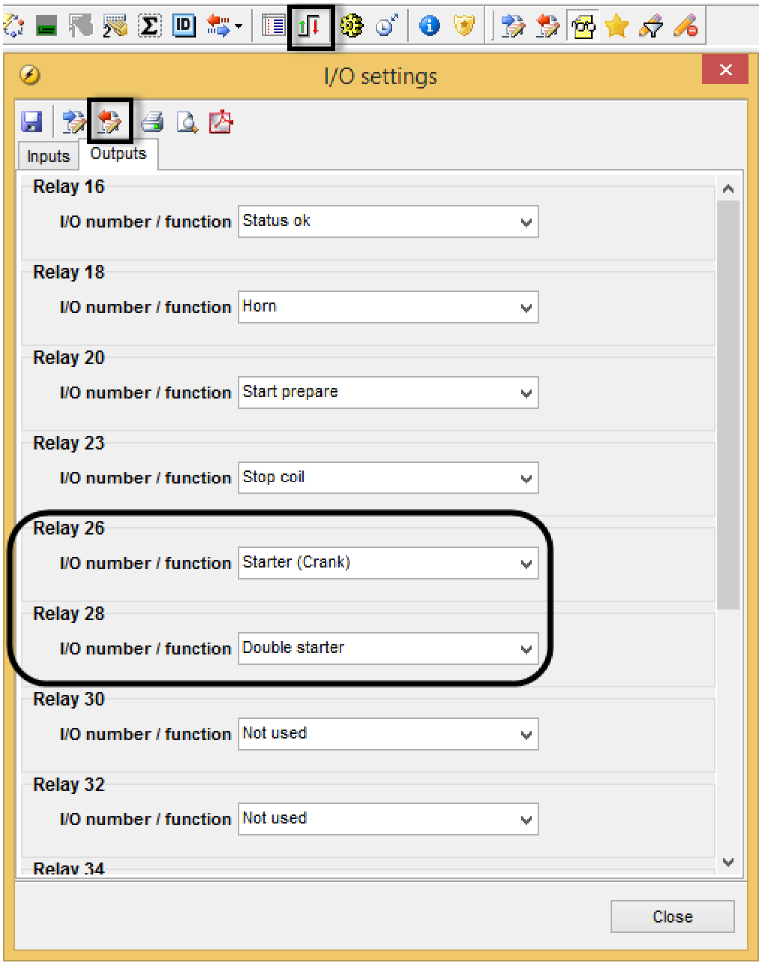
Below it is shown for menu 6893.



10.1.40 Double starter

In some emergency installations, the prime mover is equipped with an extra start motor. Dependent on the configuration, the "Double starter" function can toggle between the two starters or try several attempts with the standard starter before switching to the "Double starter".

The "Double starter" function is set up in channel 6191-6192, and a relay for cranking with the alternative starter is chosen in the configuration of inputs/outputs.



Remember to write the settings when changing the I/O configuration.

Channel	Menu text	Explanation
6191	Standard attempts	Accepted total number of start attempts before a "start failure" alarm is activated
6192	Double attempts	The number of start attempts before redirecting the start signal

The "Double starter" function is enabled by choosing a value higher than zero in channel 6192. This value determines the amount of attempts on each starter before switching to the next. The "standard starter" has first priority. When the maximum allowed number of attempts, defined in channel 6191, is reached, the start attempts stop and the alarm "Start failure" appears.

- A value of 1 in channel 6192 results in a toggle function with 1 attempt on each starter between toggling.
- A value of 2 in channel 6192 results in a toggle function with 2 attempts on each starter between toggling.

Examples:

6191 Std attempts	6192 Dbl attempts	1st attempt	2nd attempt	3rd attempt	4th attempt	5th attempt
3	1	Standard	Double	Standard	Alarm	-
5	1	Standard	Double	Standard	Double	Standard
5	2	Standard	Standard	Double	Double	Standard
4	5	Standard	Standard	Standard	Standard	Alarm

10.2 Fail class

10.2.1 Fail class

All activated alarms must be configured with a fail class. The fail classes define the category of the alarms and the subsequent alarm action.

Nine different fail classes can be used. The tables below illustrate the action of each fail class when the engine is running or stopped.

All fail classes trigger the alarm "Warning", which is shown in the active alarm log.

10.2.2 Engine running

Fail class	Action	Alarm horn relay	Alarm display	De-load	Trip of gen. breaker	Trip of mains breaker	Cooling-down genset	Stop genset
1 Block		X	X					
2 Warning		X	X					
3 Trip GB		X	X		X			
4 Trip + stop		X	X		X		X	X
5 Shutdown		X	X		X			X
6 Trip MB		X	X			X		
7 Safety stop*		X	X	(X)	X		X	X
8 Trip MB/GB		X	X		(X)	X		
9 Controlled stop*		X	X	X	X		X	X

*** In the table above, Safety stop and Controlled stop are illustrated to be identical, but they will act differently: Safety stop will de-load and stop the genset if other power sources are able to take the load, if not, the genset will not stop. Controlled stop will de-load the genset, but if no other power sources are available to take the load, the genset will trip the breaker and stop. This means that Controlled stop will prioritise to protect the genset whereas Safety stop will prioritise the load.**

The table illustrates the action of the fail classes. If, for example, an alarm has been configured with the "Shutdown" fail class, the following actions occur.

- The alarm horn relay will activate
- The alarm will be displayed in the alarm info screen
- The generator breaker will open instantly
- The genset is stopped instantly
- The genset cannot be started from the unit (see next table)

The fail class "Safety stop" will only de-load the genset before opening the breaker if option G4 or G5 (power management) is used. If power management is not active, the "Safety stop" will have the same function as "Trip and stop".

The fail class "Trip MB/GB" will only trip the generator breaker if there is no mains breaker present.

10.2.3 Engine stopped

Fail class	Action	Block engine start	Block MB sequence	Block GB sequence
1 Block		X		
2 Warning				
3 Trip GB		X		X
4 Trip + stop		X		X
5 Shutdown		X		X
6 Trip MB			X	
7 Safety stop		X		
8 Trip MB/GB		(X)	X	(X)
9 Controlled stop		X		X

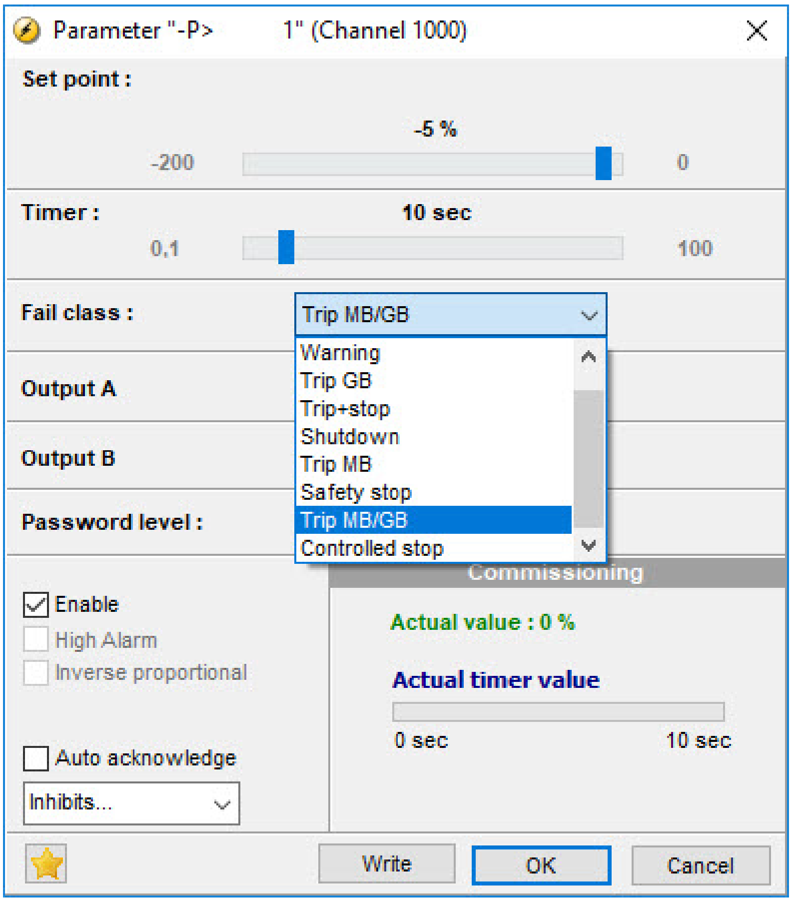
In addition to the actions defined by the fail classes, it is possible to activate one or two relay outputs if additional relays are available in the unit.

The fail class "Trip MB/GB" will only block engine start and GB sequence if there is no mains breaker present.

10.2.4 Fail class configuration

The fail class can be selected for each alarm function either via the display or the PC software.

To change the fail class via the PC software, the alarm function to be configured must be selected. Select the desired fail class in the fail class roll-down panel.

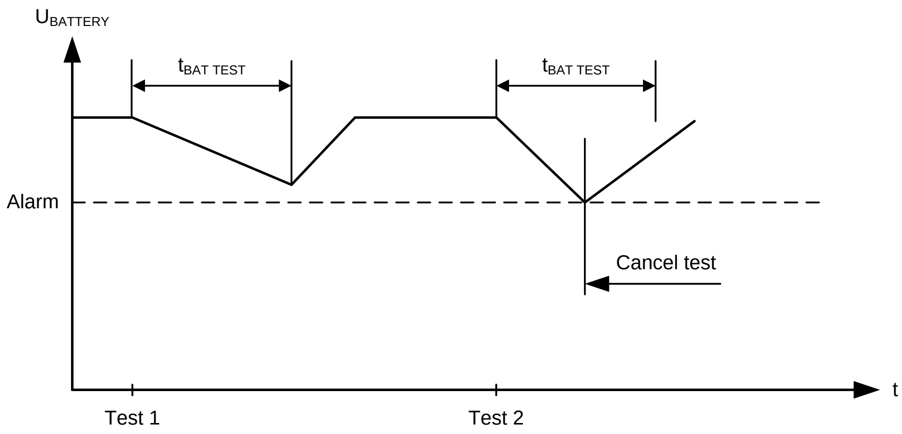


10.3 Battery test

This function gives the possibility to test the condition of the battery. The battery test can be initiated with a digital input and is available when the genset is in semi-auto and auto mode.

If a mains failure occurs during the battery test sequence, the test will automatically be interrupted, and the automatic mains failure start up sequence will be activated.

During the test, the battery voltage will decrease and an alarm will occur if it drops to the set point that has been configured in "Battery test" (channel 6411).



The drawing shows that test #1 is carried out without a large voltage drop of the battery voltage, whereas test #2 reaches the alarm set point.

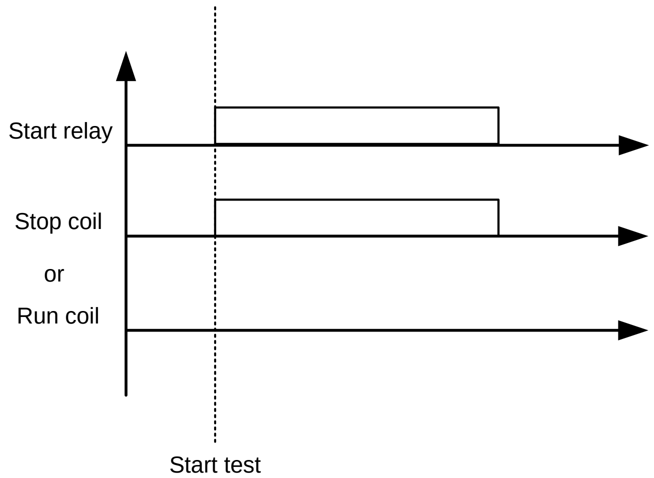
As there is no reason to wear the battery down even more, the test stops when the battery test alarm occurs.

The test is typically used at periodical intervals, for example, once every week. The engine must be at a standstill when the test is started. Otherwise, the test command will be ignored.

The stop relay will act depending on the coil type:

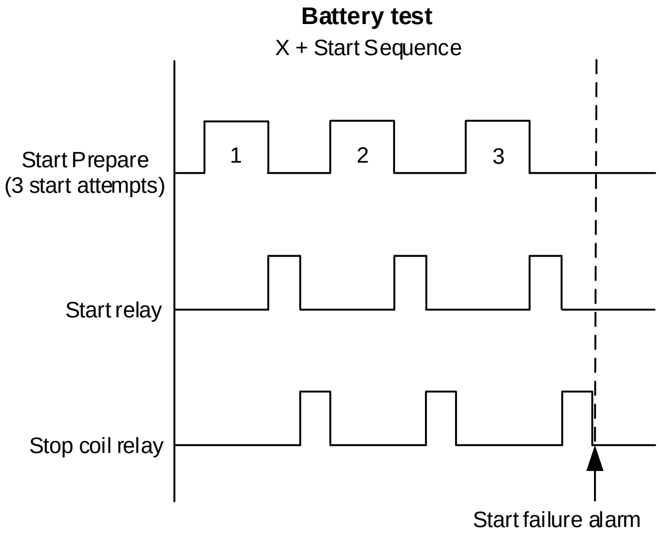
Stop coil: *The stop relay activates during the test.*
Run coil: *The stop relay stays deactivated during the test.*

The drawing below shows that when the test is started, the start relay activates, making the engine turn. The engine will turn in the time period that has been configured in "Battery test" (channel 6412).



Battery test “X + Start sequence”

If the set point in "Battery test" (channel 6413) has been configured to "X + Start sequence", the genset will run the defined start attempts (without activating run coil). This function is used to test that the battery can withstand more than one start attempt.



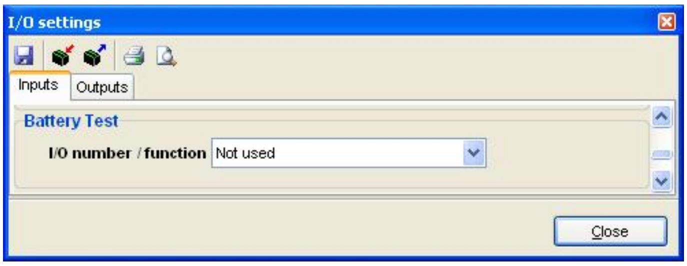
A battery test configured as “X + Start sequence”, as shown in the above example, will use: “Start prepare” timer, “Start on time” and “Start off time”. In this example, the genset will crank three times with “Start prepare” and “Start off time” delay in between each crank. When the test has finished, a start failure alarm will be present.
If at any point the battery voltage is lower than the set point “Battery test” (channel 6411), the test will be cancelled.

Description	Comments
“Battery test” (channel 6411)	Minimum voltage level
“Battery test” (channel 6413)	Set point: X + Start sequence
“Battery test” (channel 6415)	Enable/disable
“Battery test” (channel 6416)	Fail class
“Start Prepare” (channel 6181)	Timer before crank
“Start on Time” (channel 6183)	Start relay ON timer
“Start off Time” (channel 6184)	Stop coil relay ON timer
“Start attempts” (channel 6190)	Number of start attempts

For normal operation, the start failure alarm must be acknowledged after the test has ended.

10.3.1 Input configuration

If this function is to be used, it is necessary to configure a digital input that initiates the function. This is done in the dialogue box below.



If AUTO mode is selected, the mains failure sequence will be initiated if a mains failure occurs during the battery test.

10.3.2 Auto configuration

If the automatic battery test is used, the function must be enabled in menu 6420. When the function is enabled, the battery test will be carried out with a specified interval, for example, once a week. Completed battery tests will be logged in a separate battery test log.

The factory setting in menu 6424 is 52 weeks. This means that the automatic battery test will be executed once a year.

If "Battery test" (channel 6413) is configured to "X + Start Sequence", the alarm "Start failure" (channel 4570) will occur at the end. If the alarm is left unacknowledged, the genset will not be operational.

10.4 Idle running

The purpose of the idle run function is to change the start and stop sequences to allow the genset to operate under low temperature conditions.

It is possible to use the idle run function with or without timers. Two timers are available. One timer is used in the start sequence, and one timer is used in the stop sequence.

The main purpose of the function is to prevent the genset from stopping. The timers are available to make the function flexible.

The speed governor must be prepared for the idle run function if this function is to be used.

The function is typically used in installations where the genset is exposed to low temperatures which could generate starting problems or damage the genset.

10.4.1 Description

The function is enabled and configured in 6290 Idle running. It has to be noted that the governor itself must handle the idle speed based on a digital signal from the unit (see the principle diagram below).

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

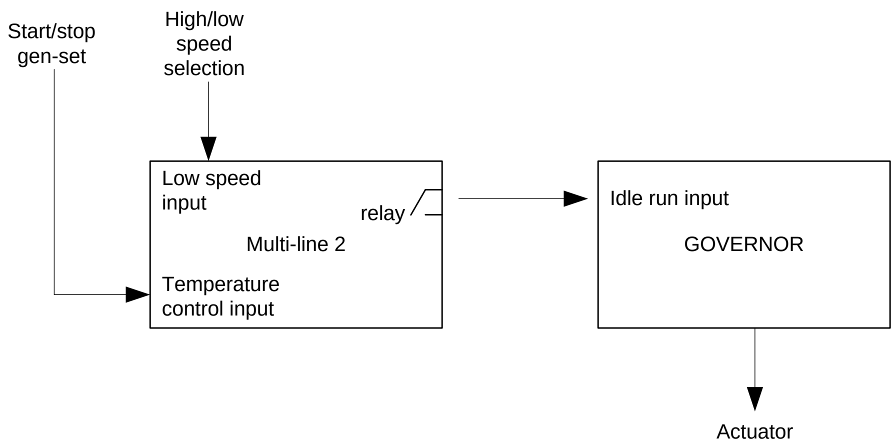
No.	Input	Description
1	Low speed input	This input is used to change between idle speed and nominal speed. This input does not prevent the genset from stopping - it is only a selection between idle and nominal speed.
2	Temperature control input	When this input is activated, the genset will start. It will not be able to stop as long as this input is activated.

If the idle run function is selected by means of timer, the low speed input is overruled.

The input must be configured through the PC software at commissioning.

One extra relay output must be available on the unit. Notice that this is option-dependent.

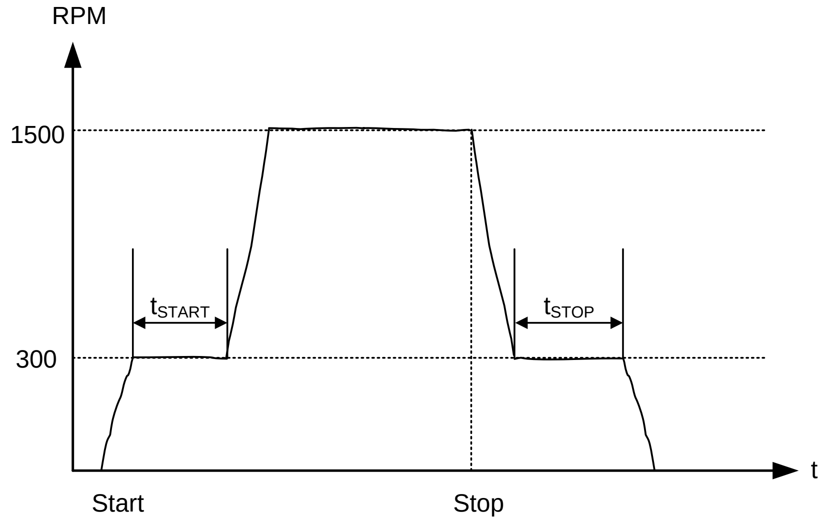
Turbo chargers not originally prepared for operating in the low speed area can be damaged if the genset is running in "idle run" for too long.



10.4.2 Examples

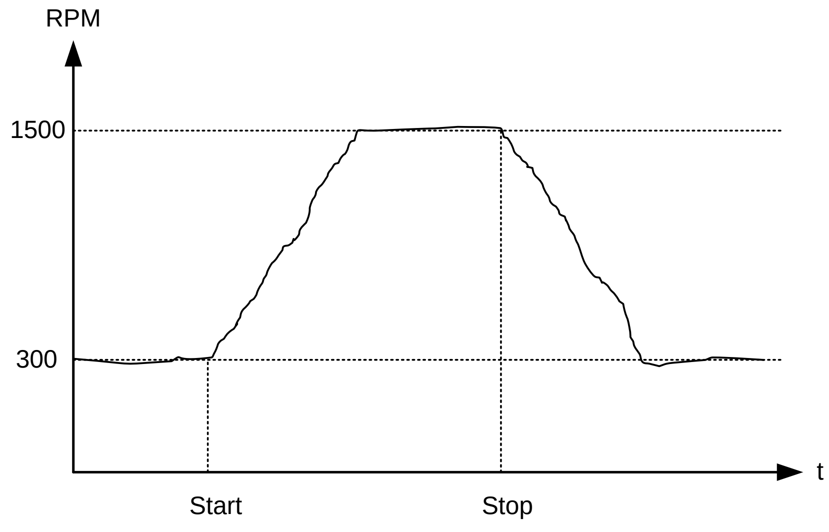
Idle speed during starting and stopping
In this example both the start and the stop timers are activated.

The start and stop sequences are changed in order to let the genset stay at the idle level before speeding up. It also decreases the speed to the idle level for a specified delay time before stopping.



Idle speed with a digital input configured to low speed
In this example, both timers must be deactivated. The idle speed with low speed activated will run in idle speed until the low speed input is deactivated, and subsequently the genset will regulate to nom. values.

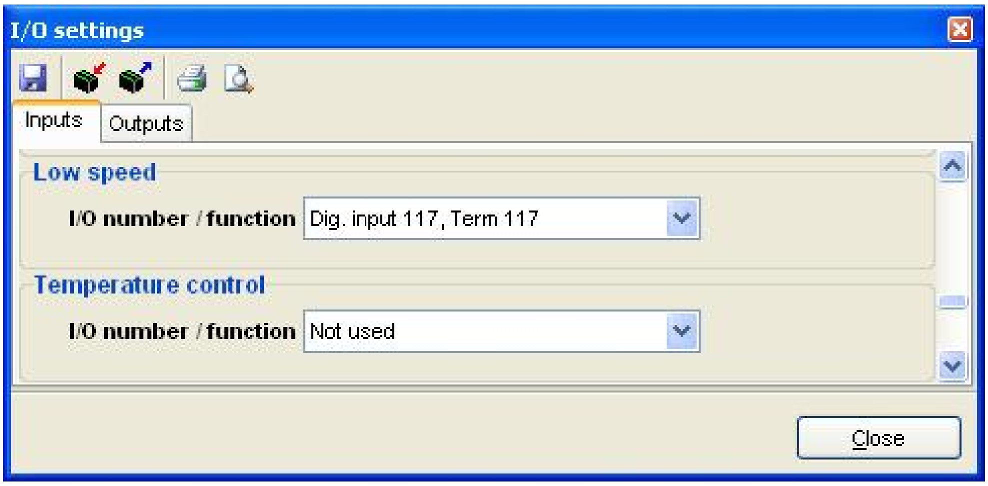
If the genset is to be prevented from stopping, then the digital input "temp control" must be left ON at all times. In that case the characteristic looks like this:



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

10.4.3 Configuration of digital input

The digital input is configured via the PC software.

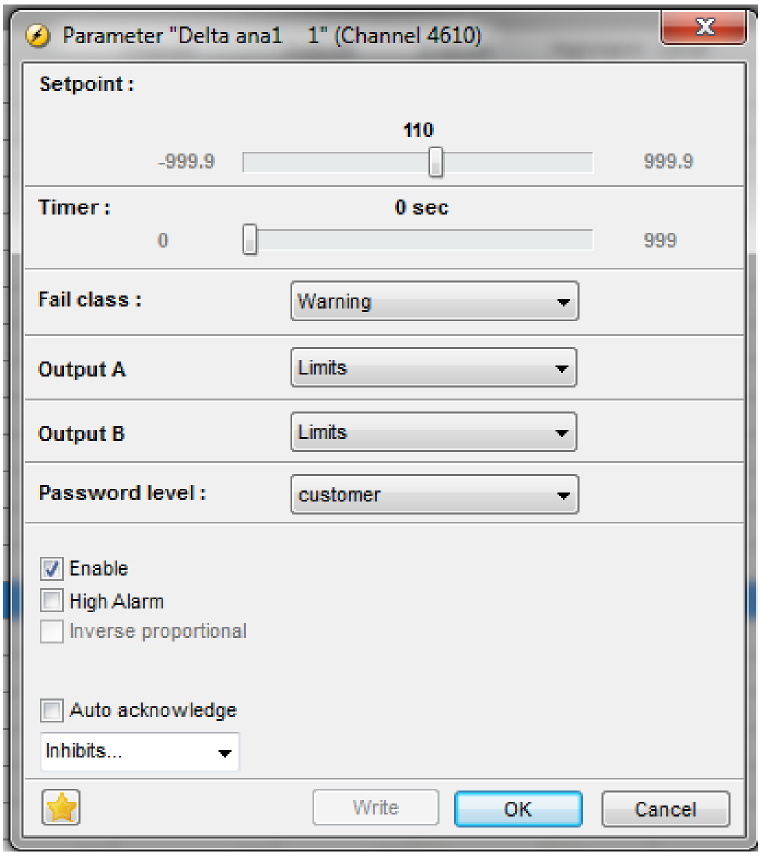


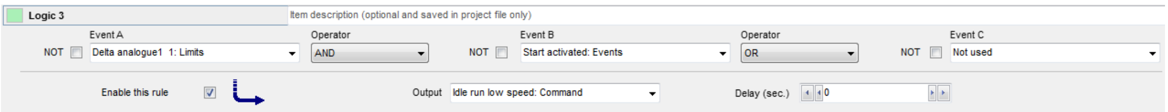
10.4.4 Temperature-dependent idle start-up

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

Example

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





In order for this function to work, **6295 Idle active** must be enabled, and the relay output must be configured. Otherwise the low speed function will not work.

10.4.5 Inhibit

The alarms that are deactivated by the inhibit function are inhibited in the usual manner, except for the oil pressure alarms; RMI oil 102, 105 and 108 which are active during "idle run" as well.

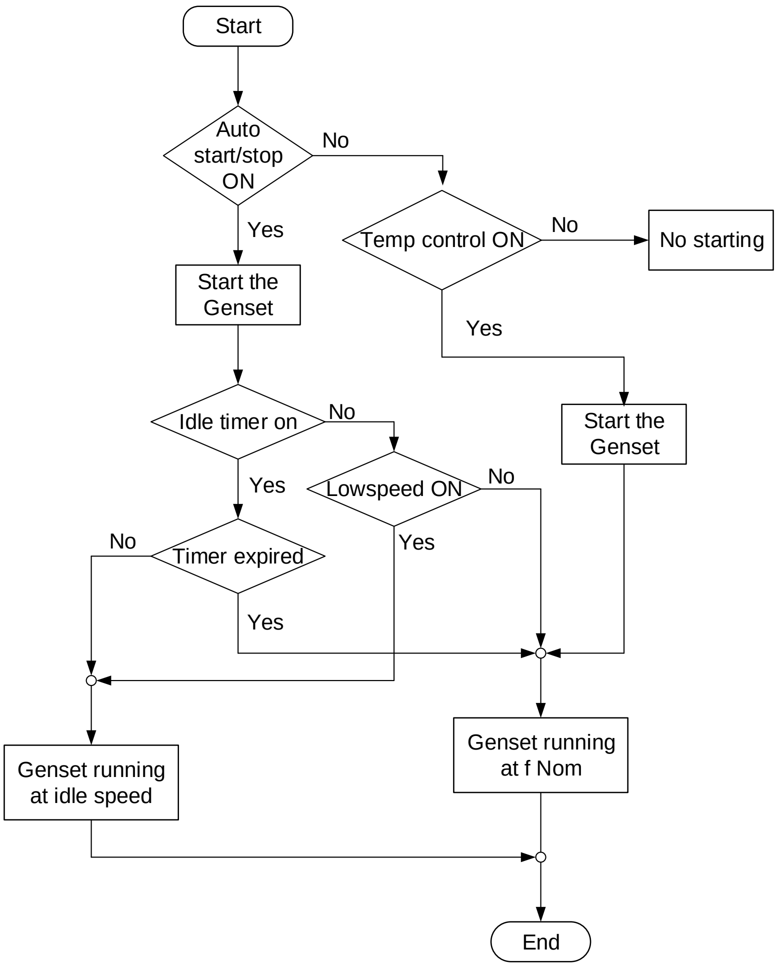
10.4.6 Running signal

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

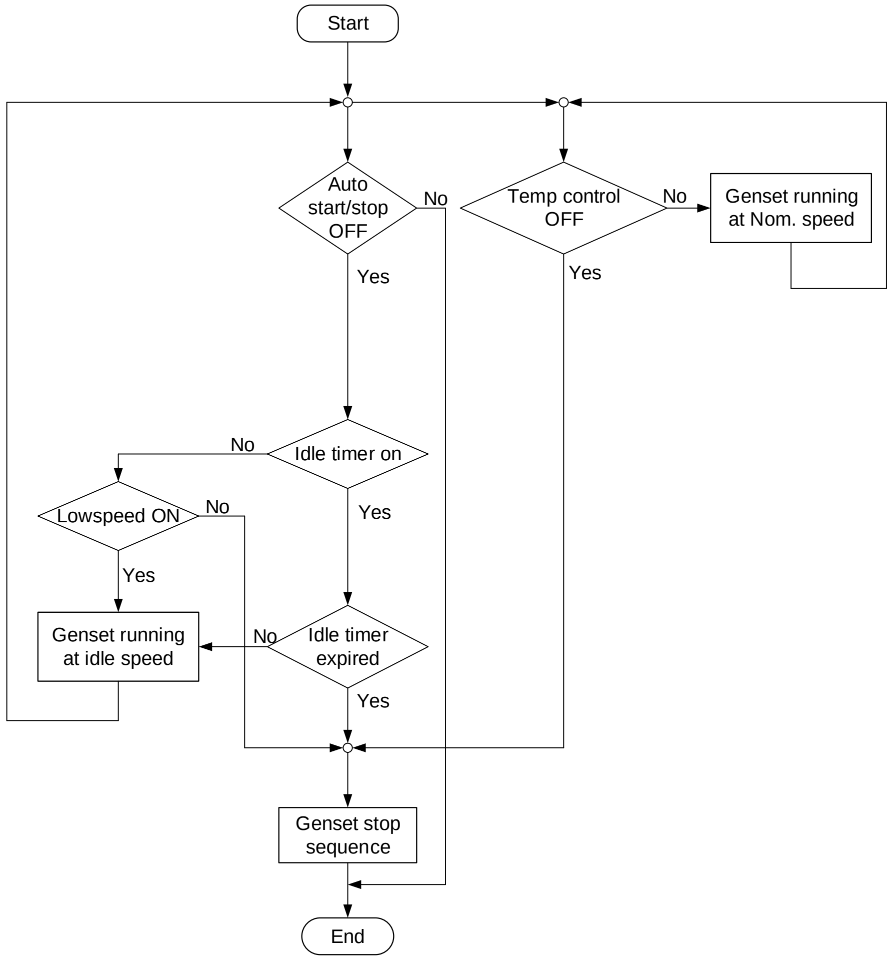
10.4.7 Idle speed flowcharts

The flowcharts illustrate the starting and stopping of the genset by use of the inputs "temp control" and "low speed".

10.4.8 Start


Start
Auto start/stop ON
No
Yes
Temp control ON
No
No starting
Start the Genset
Yes
Idle timer on
No
Start the Genset
Yes
Lowspeed ON
No
No
Timer expired
Yes
Yes
Genset running at idle speed
Genset running at f Nom
End

10.4.9 Stop

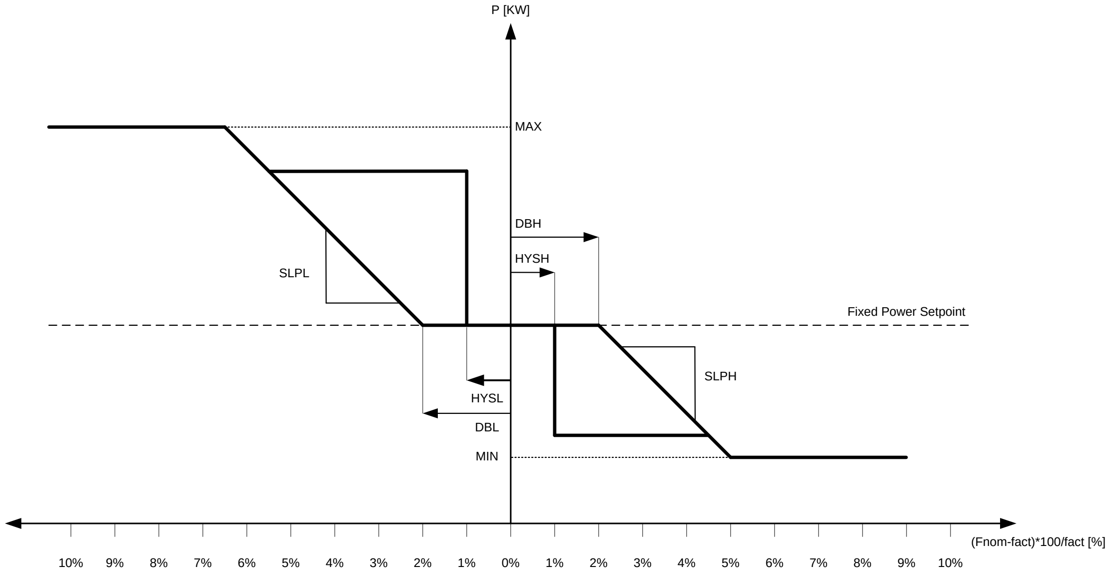


10.5 Mains-dependent droop functions

10.5.1 Frequency-dependent droop

This droop function is a mains aid function. It can be used when the genset is running parallel to the mains in the following modes: "Fixed power", "Mains power export" and "Peak shaving". In case the frequency drops or rises due to instability of the mains, the curve for frequency-dependent droop is made to compensate the power set point. The power set point will be reduced with greater mains frequency and increased when the mains frequency is lower than specified.

Example:
This example and diagram is based on the parameters from the table below. With a nominal frequency of 50 Hz and an actual frequency of 51.5 Hz, there is a deviation of 1.5 Hz which is equal to a 3 % deviation from the nominal setting. The genset will then droop to 400 kW according to the below diagram.



The curve can be designed inside MIN/MAX [kW] area.

Menu	Settings	Name	Description
7051	450	kW	Fixed power set point.
7121	2	DBL[%]	Deadband low in percentages of nominal frequency.
7122	2	DBH[%]	Deadband high in percentages of nominal frequency.
7123	1	HYSL[%]	Hysteresis low in percentages of nominal frequency. If HYSL is set above DBL, the hysteresis low is disabled.
7124	1	HYSH[%]	Hysteresis high in percentages of nominal frequency. If HYSH is set above DBH, the hysteresis high is disabled.
7131	150	MIN[kW]	Minimum output of droop handling.
7132	900	MAX[kW]	Maximum output of droop handling.
7133	50	SLPL[kW/%]	Slope low. The setting determines the increase/decrease of power reference per percentage the actual frequency drops below nominal frequency.
7134	-50	SLPH[kW/%]	Slope high. The setting determines the increase/decrease of power reference per percentage the actual frequency rises above nominal frequency.
7143	ON	Enable	Enable droop curve function.

This droop function is performed based on the actual value for the power set point in the moment the droop is activated. If the function for an example is activated during ramping and the actual power value at this moment is 200 kW, the droop is performed based on 200 kW as the "Fixed Power Setpoint" stated in the diagram.

The slopes (7133/7134) are used, as long as the mains frequency has a direction away from nominal settings. When the mains is starting to recover and the frequency is heading towards the nominal settings, the power set point is waiting to be restored until the frequency is within the hysteresis limits. If the hysteresis is disabled, the power set point will simply be restored using the slope.

When drooping, the slopes will be scaled based on size of the actual power at the droop start, compared to the specified nominal power. For example, if a DG of nominal 1000 kW is producing 500 kW when droop is activated, then only 50 % of the slope values will be used. To achieve a nominal droop of 40 % per Hz, a 1000 kW (50 Hz) DG should be configured with slopes of 200 kW/%. If DG then only is producing 500 kW when droop is activated, the actual slope will be experienced as 100 kW/%.

If "Auto ramp selection" is enabled (channel 2624), the secondary pair of ramps will be used during frequency-dependent power droop. In order to prevent a new situation with faulty mains, it may be advantageous to use slower ramps in or after a situation with an unstable mains. The secondary ramps will automatically be disabled again when the frequency-dependent power droop is no longer active, and the specified power set point is reached. If "Auto ramp selection" is disabled, it is only possible to activate the secondary ramps using M-Logic. Parameters used for the secondary ramps are stated in the table below.

Menu	Default	Name	Description
2616	0.1[%/s]	Ramp up speed 2	Slope of ramp 2 when ramping up
2623	0.1[%/s]	Ramp down speed 2	Slope of ramp 2 when ramping down (not used for deload)
2624	ON	Auto ramp selection	Activate or disable automatic selection of secondary ramps

10.5.2 Voltage support

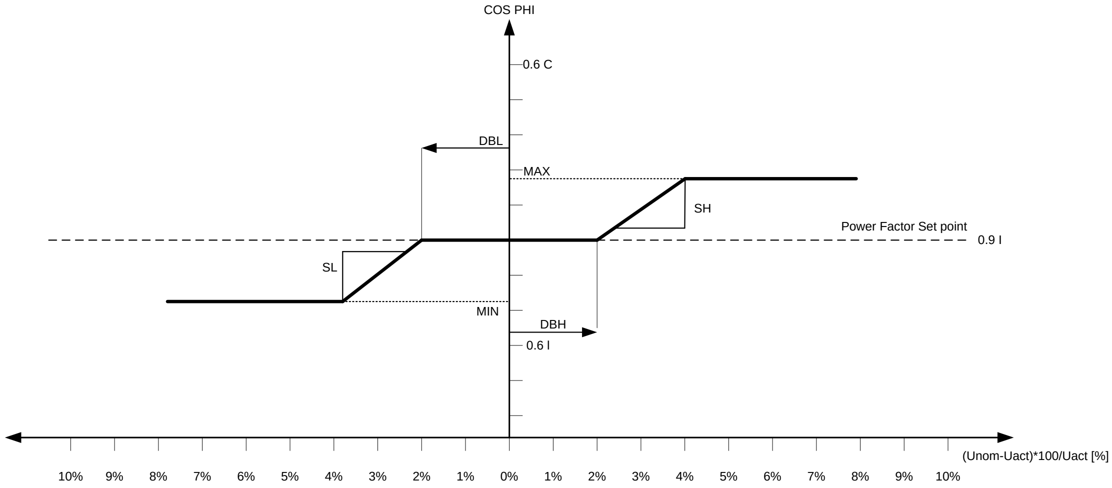
The voltage support function is also referred to as "Voltage-dependent cos phi/Q control (y2(x2) droop)". The function changes the cos phi or the kvar set point of the generators if the mains voltage changes beyond certain values in order to suport the mains voltage. The idea is that if the mains voltage drops, the generators increase their excitation and support the mains voltage. If the mains voltage increases, the excitation of the DGs decreases in order to produce a smaller amount of var.

This function is used when the generators are paralleling to the mains and running one of following modes: "Fixed power", "Mains power export" or "Peak shaving". It cannot be used in island mode applications.

Functional description

The diagram below shows the principle. The dotted line illustrates the x-axis (voltage deviation), and the vertical line (cos phi) is the y-axis. The cos phi set point is 0.90 in this example, but the voltage support works around any set point that is adjusted.

From SW version 4.52.x: The output in the exact moment the droop is launched will be frozen and used as set point for the droop actions as long as the droop is active. (Illustrated as "cos phi set point" in the diagram below).



The diagram illustrates the following areas:

Zone	Voltage	Cos phi	Menu
Minimum cos phi Limit	90 to 96 %	Min. limit	7171
Decreasing slope Low	96 to 98 %	Sloping	7175
Deadband	98 to 102 %	0.90	7151-7152
Increasing slope High	102 to 104 %	Sloping	7176
Maximum cos phi Limit	104 to 110 %	Max. limit	7173

Parameters
The above diagram is configured with the following parameter settings:

Menu	Settings	Name	Description
7052	0.9	cos phi	cos phi set point 0.6-1.
7053	Inductive	cos phi	Inductive/capacitive.
7151	2.00	DBL [%]	Deadband low in percentage of nominal X2.
7152	2.00	DBH [%]	Deadband high in percentage of nominal X2.
7153	1.00	HYSL [%]	Hysteresis low in percentage of nominal X2. If HYSL is set above DBL, the hysteresis low is disabled. (Not shown in the diagram).
7154	1.00	HYSH [%]	Hysteresis high in percentage of nominal X2. If HYSH is set above DBH, the hysteresis high is disabled. (Not shown in the diagram).
7171	0.8	MI	Minimum output of droop handling. This setting is related to the setting in 7172.
7172	Inductive	I/C	Minimum output of droop handling.
7173	1.00	MA	Maximum output of droop handling. This setting is related to the setting in 7174.
7174	Inductive	I/C	Maximum output of droop handling.
7175	-0.05	SL [cos phi/%]	Slope low. The setting determines the increase/decrease of cos phi reference per percent the actual X2 drops below nominal X2.
7176	0.05	SH [cos phi/%]	Slope high. The setting determines the increase/decrease of cos phi reference per percent the actual X2 rises above nominal X2.
7181	cos phi(X2)	Y2(X2)	Output type for curve 2. Selections currently available: "Reactive power" and "cos phi".
7182	U	X2	Input type for curve 2. Selections currently available: "Power" and "Voltage".
7183	ON	ENA	Enabling/disabling of curve 2.

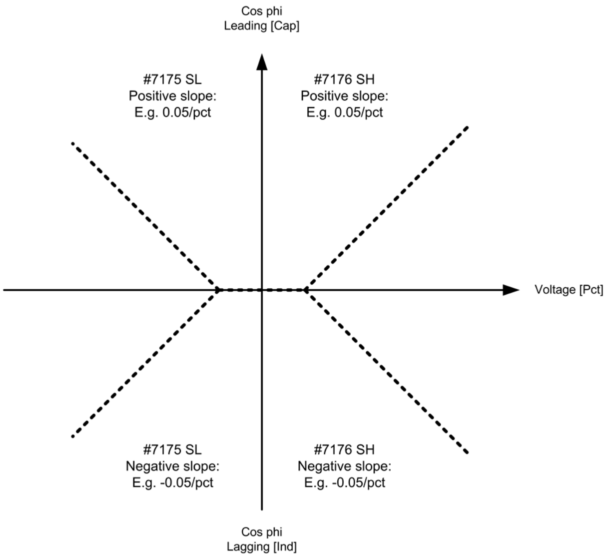
Hysteresis
In addition to the mentioned settings, a hysteresis can also be used. The function of the hysteresis is that the cos phi set point stays at the drooped value if the voltage returns towards nominal, until the adjusted hysteresis is reached.

If for example the voltage drops, the cos phi set point follows the slope to for example 0.82. If the voltage now recovers, the cos phi set point stays at the mentioned 0.82 (in our example) until the voltage reaches 99 %, and then it moves back to our set point of 0.90. (1 % is the set point of the hysteresis).

If the hysteresis is adjusted to a higher value than the deadband, it is not in effect. Therefore, if the hysteresis is not used, please adjust it higher than the DB.

Slope
Two settings for the slope are available, namely the "Slope Low" (SL) and the "Slope High" (SH). The name of the settings refer to the voltage being lower or higher than the nominal voltage (100 %). The slope is adjusted with a sign (positive or negative). The positive sign is the leading (capacitive) range, and the negative sign is the lagging (inductive) range.

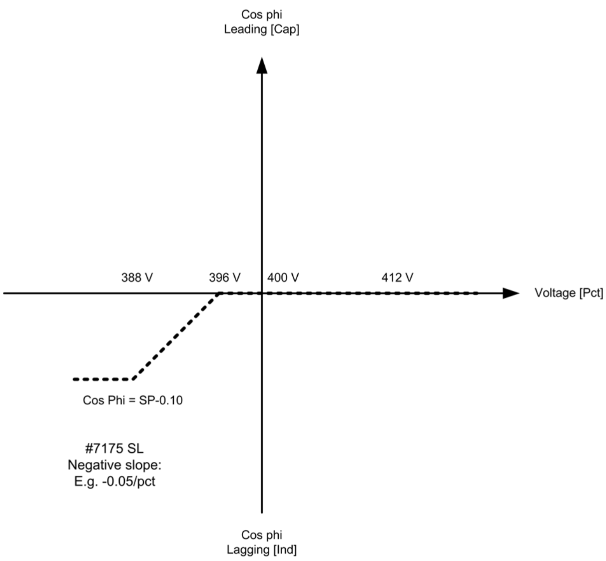
In order to explain when to adjust positive or negative sign, the following coordinate system is used.



When the requirement of the voltage support is known, it can be decided whether the slope is positive or negative. This is best illustrated with an example:

If the voltage drops compared to the nominal voltage, the generator is requested to increase the excitation and thereby the produced kvars (in order to support the grid). If the set point (SP) is 1.00 and a deadband setting is 1 %, the cos phi set point will decrease from 1.00 to 0.90 (SL setting is -0.05). See the calculation and diagram below.

$SP_{NEW\ 388\ V\ AC}$ = 1.00 - (((396-388)/400)*100) × 0.05 = 0.90 (simplified)



Capacitive range
Even though the function is normally used to support a low mains voltage, it is possible to adjust it so it decreases the excitation if the voltage increases (leading cos phi).

To avoid pole slip and damage of the generators, make sure that the capability curve of the generators is respected and that the generators are not running under-excited or without excitation.

10.5.3 Example of voltage-dependent cos phi

Voltage-dependent cos phi control is a function that gives a dynamic cos phi control in a parallel to mains system based on the mains voltage. The purpose is to support the mains voltage locally behind a transformer by minimising the reactive current flow to the mains.

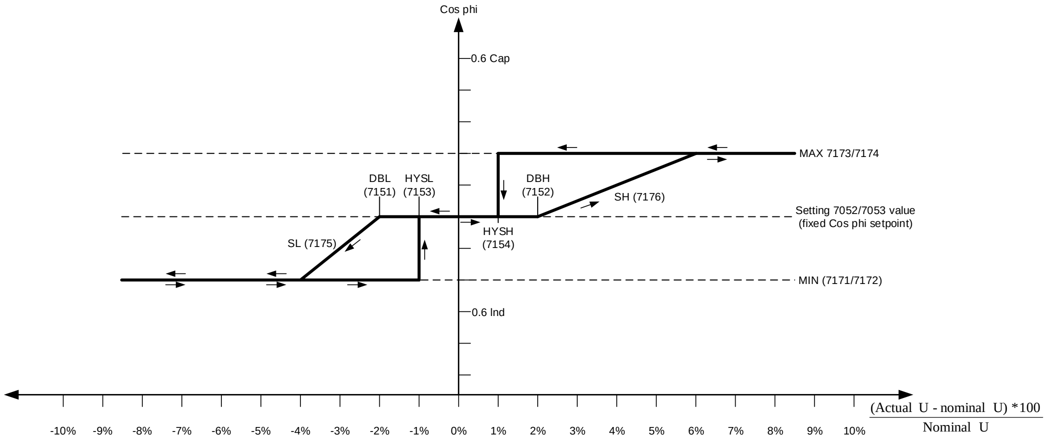
These settings are only relevant if: Menu 7182 is set to "U", and menu 7183 is set to "ON".

Menu	Settings	Name	Description
7052	0.9	cos phi	Fixed cos phi set point 0.6-1.
7053	Inductive	cos phi	Fixed cos phi inductive/capacitive selection.
7151	2.00	DBL[%]	Deadband low in percentages of nominal voltage.
7152	2.00	DBH[%]	Deadband high in percentages of nominal voltage.
7153	1.00	HYSL[%]	Hysteresis low in percentages of nominal voltage. If HYSL is set to 0 or above the value of 7151(DBL), the hysteresis low is disabled.
7154	1.00	HYSH[%]	Hysteresis high in percentages of nominal voltage. If HYSH is set to 0 or above the value of 7152(DBH), the hysteresis high is disabled.
7171	0.7	MI	Minimum output of droop handling (voltage decreasing). This setting is related to the setting in 7172.
7172	Inductive	I/C	Minimum output of droop handling (inductive/capacitive selection).
7173	0.9	MA	Maximum output of droop handling (voltage increasing). This setting is related to the setting in 7174.
7174	Capacitive	I/C	Maximum output of droop handling (inductive/capacitive selection).
7175	-0.1	SL[cos phi/%]	Slope low. The setting determines the increase/decrease of cos phi reference per percentage the actual voltage drops below nominal.
7176	0.05	SH[cos phi/%]	Slope high. The setting determines the increase/decrease of cos phi reference per percentage the actual voltage rises above nominal.
7181	cos phi(X2)	Y2(X2)	Output type for curve 2. Selections currently available: "Reactive power" and "cos phi".

If reactive power control is selected in setting 7181, the programming is similar to that of frequency droop (y1(x1)). Please refer to the Designer's Reference Handbook explanation of frequency droop.

With a nominal voltage of 400 V and an actual voltage of 412 V, there is a deviation of 12 V which is equal to a 3 % deviation from the nominal setting. The genset will then droop to a cos phi of 0.95 inductive according to the above settings.

Voltage-dependent cos phi droop curve



The settings of MA and MI can be reversed, meaning that the reactive power will move in the inductive direction with increasing voltage.

The system measures and reacts based on the mains voltage measurement. The function will make a dynamic voltage-dependent cos phi that is used to support the mains voltage. The ramp has a configurable deadband (DBL/DBH) that can be used with reference to the nominal voltage of the mains to deactivate the ramp functionality.
This is to have a normal operation band where a normal voltage fluctuation does not create disturbance on the mains. If the deadband is set to 0, the deadband is removed and the ramp will be active at any time.

When the mains measurement is outside the deadband, the voltage deviation is taken into consideration and a new cos phi value is calculated. The cos phi regulator of the generator will then adjust the cos phi and thereby change the var import/export of the plant.

The calculation is based on the fixed cos phi set point value.

From SW version 4.52.x: The output in the exact moment the droop is launched will be frozen and used as set point for the droop actions as long as the droop is active. (Illustrated as "fixed cos phi set point" in the diagram above).

The system is able to run the generator with a capacitive and an inductive cos phi lowering or raising the mains voltage.

The system is made with only one active regulator on the generator and a variable curve defining the set point to the regulator. This ensures that there are no hunting problems with two to three regulators in cascade.

The ramp slope is set in % per unit [%/u] where the unit is in V AC, meaning that the nominal setting for slope low, 10 %/u means 10 % increase of cos phi per volt AC deviation.

10.5.4 Example of power-dependent cos phi control

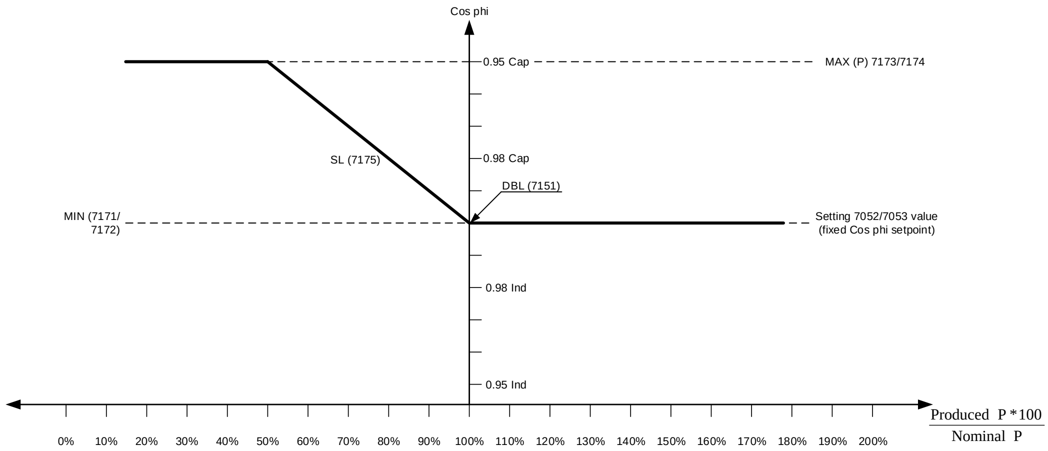
Power-dependent cos phi control is a function that gives a dynamic cos phi control in a parallel to mains system based on the generator-produced power. The purpose is to support the mains voltage locally behind a transformer by minimising the reactive current flow in the grid.

These settings are only relevant if: Menu 7182 is set to "P", and menu 7183 is set to "ON".

Menu	Settings	Name	Description
7052	1.0	cos phi	Fixed cos phi set point 0.6-1.
7053	Inductive	cos phi	Fixed cos phi inductive/capacitive selection.
7151	0.00	DBL[%]	Deadband low in percentages of nominal power. In this example set to 0 to disable the deadband.
7152	50.00	DBH[%]	Deadband high in percentages of nominal power. In this example the deadband is set high as the droop is not expected to be used.
7153	1.00 %	HYSL[%]	Hysteresis high in percentages of nominal power. If HYSL is set above the value of 7152(DBH), the hysteresis high is disabled.
7154	51.00	HYSH[%]	Hysteresis high in percentages of nominal power. If HYSL is set above the value of 7152(DBH), the hysteresis high is disabled. In this example the hysteresis is disabled.
7171	1.0	MI	Minimum output of droop handling (voltage decreasing). This setting is related to the setting in 7172. If the power increases above 100 %, the cos phi is kept at 1.0.
7172	Inductive	I/C	Minimum output of droop handling (inductive/capacitive selection).
7173	0.95	MA	Maximum output of droop handling (voltage increasing). This setting is related to the setting in 7174.
7174	Capacitive	I/C	Maximum output of droop handling (inductive/capacitive selection).
7175	0.001	SL[cos phi/%]	Slope low. The setting determines the increase/decrease of cos phi reference per percentage the actual voltage drops below nominal.
7176	0.000	SH[cos phi/%]	Slope high. The setting determines the increase/decrease of cos phi reference per percentage the actual voltage rises above nominal. In this example, the cos phi is kept at the nominal cos phi when the power is increasing above 100 %.
7181	cos phi(X2)	Y2(X2)	Output type for curve 2. Selections currently available "Reactive power" and "cos phi".

If reactive power control is selected in setting 7181, the programming is similar to that of frequency droop (y1(x1)). Please refer to the Designer's Reference Handbook explanation of frequency droop.

cos phi droop curve



The system measures and reacts based on the generator power measurement. The function will make a dynamic power-dependent cos phi that is used to support the mains voltage/compensate the voltage impact of the power produced. The ramp has a configurable deadband (DBH) that can be used with reference to the nominal power of the generator to deactivate the ramp functionality.
This is to have a normal operation band where a normal power variation does not create disturbance on the mains. If the deadband is set to 0, the deadband is removed and the ramp will be active at any time.

When the power measurement is outside the deadband, the power production is taken into consideration and a new cos phi value is calculated. The cos phi regulator of the generator will then adjust the cos phi and thereby change the var import/export of the plant.

The calculation is based on the fixed cos phi set point value.

From SW version 4.52.x: The output in the exact moment the droop is launched will be frozen and used as set point for the droop actions as long as the droop is active. (Illustrated as "fixed cos phi set point" in the diagram above).

The system is able to run the generator with a capacitive and an inductive cos phi to compensate for mains voltage.

The system is made with only one active regulator on the generator and a variable curve defining the set point to the regulator. This ensures that there are no hunting problems with two to three regulators in cascade.

10.6 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 three multi-inputs.

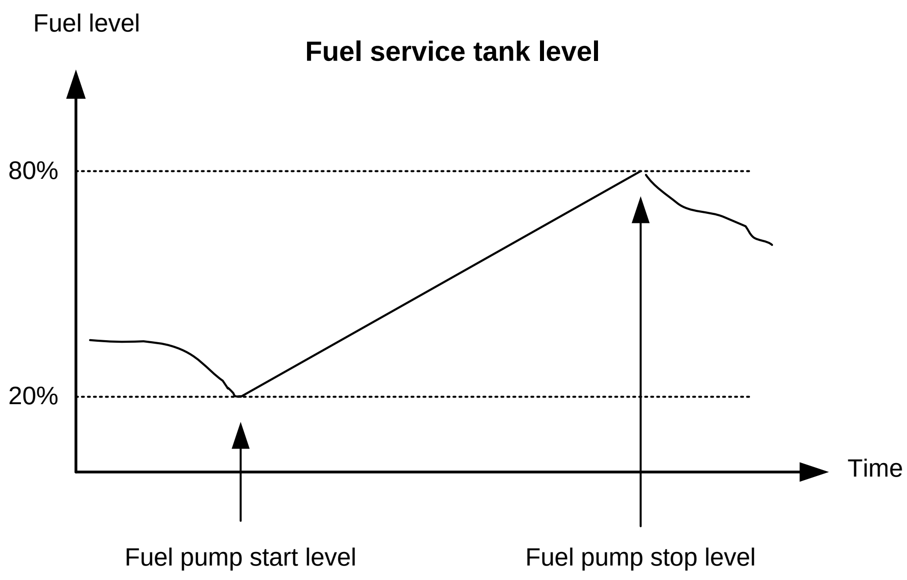
Set points available in menu 6550:

Parameter	Name	Function
6551	Fuel pump log. start	Fuel transfer pump starting point in percentage.
6552	Fuel pump log. stop	Fuel transfer pump stopping point in percentage.
6553	Fuel fill check	Delay timer before fuel fill check alarm is activated.
6554	Output A	The output relay to be used for control of the fuel pump. The selected relay activates below the start limit and deactivates above the stop level.
6555	Type	The multi-input or external analogue input to be used for the fuel level sensor. **Choose multi-input if 4 to 20 mA is used.** **Choose "auto detection" if an RMI is used.**
6556	Fail class	The fail class of the fuel fill alarm.
6557	Fuel fill check slope	This parameter defines the slope for the fuel fill check alarm.

The fuel pump relay can be activated via M-Logic.

The output relay should be configured as a limit relay. Otherwise, an alarm will be raised whenever the output is activated.

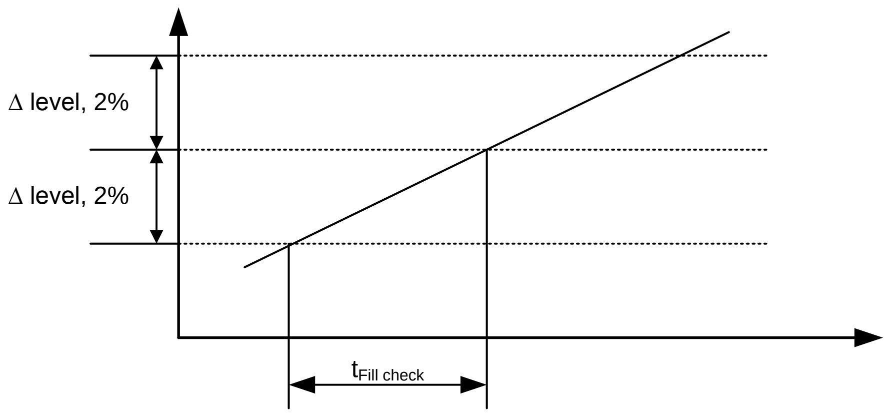
The drawing below shows how the fuel pump is activated when the level reaches 20 % and stopped again when the level has reached 80 %.



10.6.1 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 relay deactivates and a **fuel fill alarm** occurs. The **fuel fill alarm** can be enabled/disabled in menu 6553.



The level of increase of 2 % that is shown above is just an example and can be changed in parameter 6557 (fuel fill slope).

10.7 Fan logic

The AGC is able to control four different fans. This could for example be air supply fans for supplying air to a genset in a closed enclosure, or radiator fans for switching on and off cooling fans for air coolers.

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

1. Priority rearranging depending on running hours of the fans
2. Temperature-dependent start and stop

A priority routine ensures that the running hours of the available fans are evened out and the priority shifts between them.

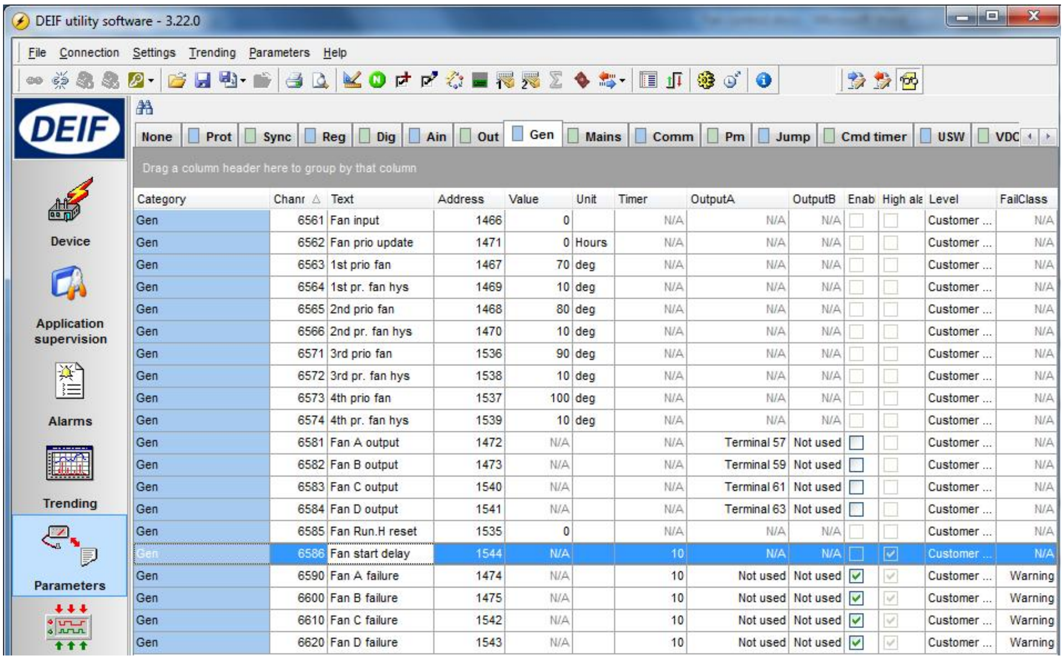
The functionality behind the temperature-dependent start/stop is that the AGC measures a temperature, for example cooling water temperature, and based on this temperature it switches on and off relays that must be used for engaging the fan(s) itself.

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

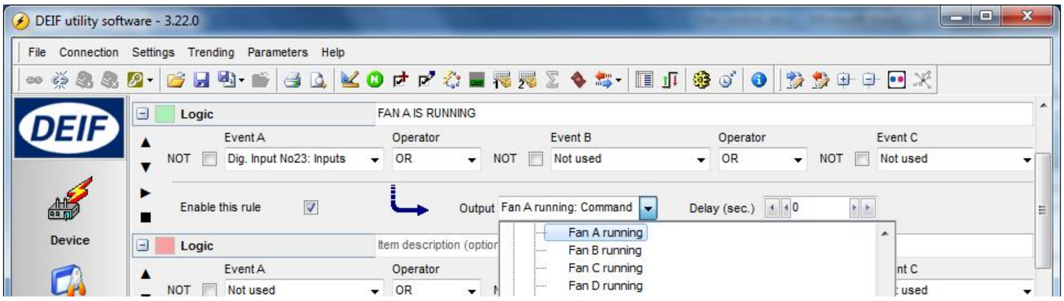
10.7.1 Fan parameters

Each fan has a group of parameters that defines their scheme of operation. It is recommended to use the PC utility SW for the setup, because then it is possible to see all parameters. The setup of the fan control is done in the menus 6561-6620 and by using M-Logic in the PC utility SW.

Parameters:



M-Logic:



10.7.2 Input for fan control

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

Fan temperature input is set up in parameter 6561, and this input can be selected between these inputs:

- Three multi-inputs in slot #7 are available
- EIC measurement (engine interface communication)
- External analogue input 1-8 (H8.X)
- Analogue inputs (M15.X)
- Multi-inputs (M16.X)

The multi-inputs can be configured to e.g. 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.

10.7.3 Fan start/stop

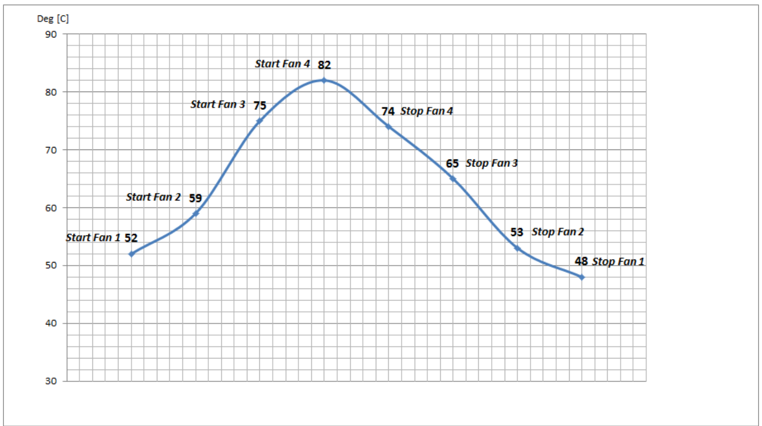
The start and stop settings of the fan(s) are set up in parameters 6563 to 6574. With the settings in the table below, the illustrative curve can be observed.

A hysteresis (abbreviation: hyst.) ensures that there is a range between the start and stop.

6563	1st level fan setp.	50	deg
6564	1st level fan hyst.	2	deg
6565	2nd level fan setp.	56	deg
6566	2nd level fan hyst.	3	deg
6571	3rd level fan setp.	70	deg
6572	3rd level fan hyst.	5	deg
6573	4th level fan setp.	78	deg
6574	4th level fan hyst.	4	deg

Fan	Setp.	hys.	Start	Stop
1	50	2	52	
2	56	3	59	
3	70	5	75	
4	78	4	82	
4	78	4		74
3	70	5		65
2	56	3		53
1	50	2		48

The following start/stop curve will be generated if a bow setting is used:



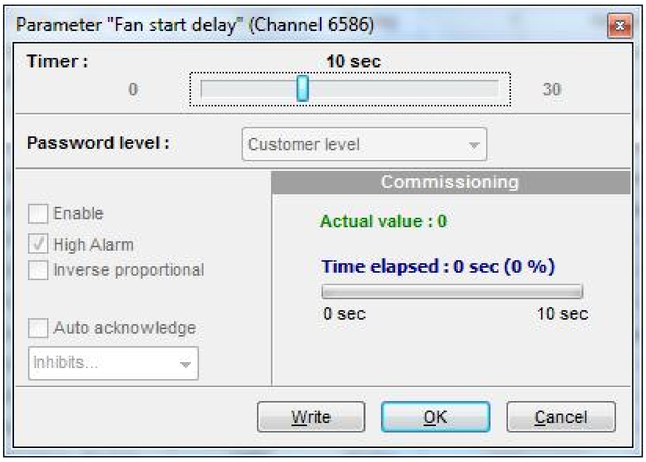
10.7.4 Fan output

At parameter 6581 to 6584, the output relays for fans A to D are selected. The purpose of these relays is to issue a signal to the fan starter cabinet. The relay must be energised for the fan to run.

Gen	6581	Fan A output	1472	N/A		N/A	Terminal 57
Gen	6582	Fan B output	1473	N/A		N/A	Terminal 59
Gen	6583	Fan C output	1540	N/A		N/A	Terminal 61
Gen	6584	Fan D output	1541	N/A		N/A	Terminal 63

10.7.5 Fan start delay

If two or more fans are requested to be started at the same time, it is possible to add a start delay between each fan start. The reason for this is to limit the peak start current, so all fans will not contribute with a start current at the same time. This delay is adjusted in the menu 6586.



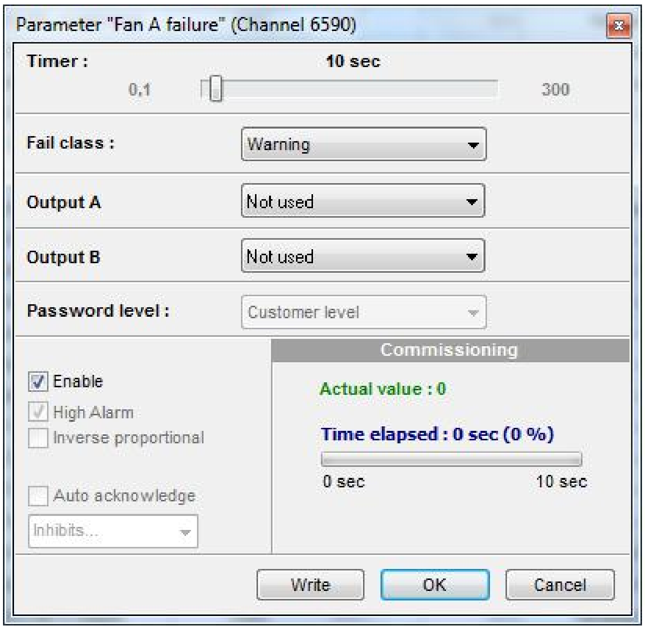
10.7.6 Fan running feedback

To make sure that the fan is running, it is possible to assign a digital input as a running feedback. The running feedback has to be programmed through M-Logic, below is an example of how to programme it.

The "Fan A/B/C/D running command" output tells the AGC that the fan is running. The output is found under Output and Command as shown in the screenshot above.

10.7.7 Fan failure

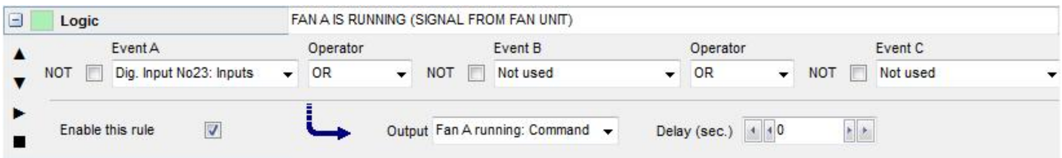
It is possible to activate an alarm if the fan does not start. The fan failure alarm appears if the running feedback from the fan does not appear. In parameters 6590 to 6620, the fan failure alarms are set up for fans A to D.



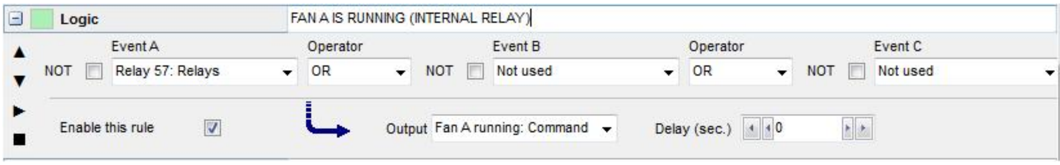
10.7.8 Fan priority (running hours)

The priority of the fans A to D rotates automatically from 1^{st} to 4^{th} priority. This is done automatically, because the running hours of the fans are detected and are used for the rearranging.

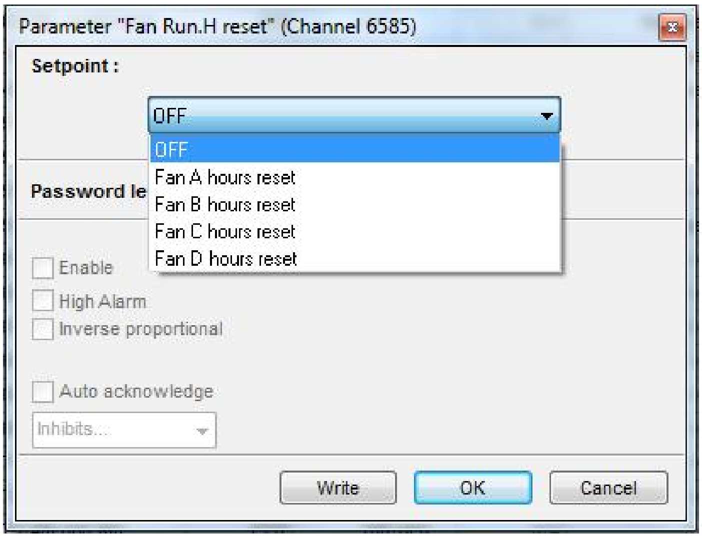
M-Logic setup:
If the fan unit is raising a signal that is led to a digital input on the AGC when it is running, the following M-Logic must be programmed:



When it is not possible to get a running feedback from the fan unit, the internal relay of the AGC must be used to indicate that the fan is running. If, for example, R57 is the relay for FAN A, the following M-Logic must be programmed:



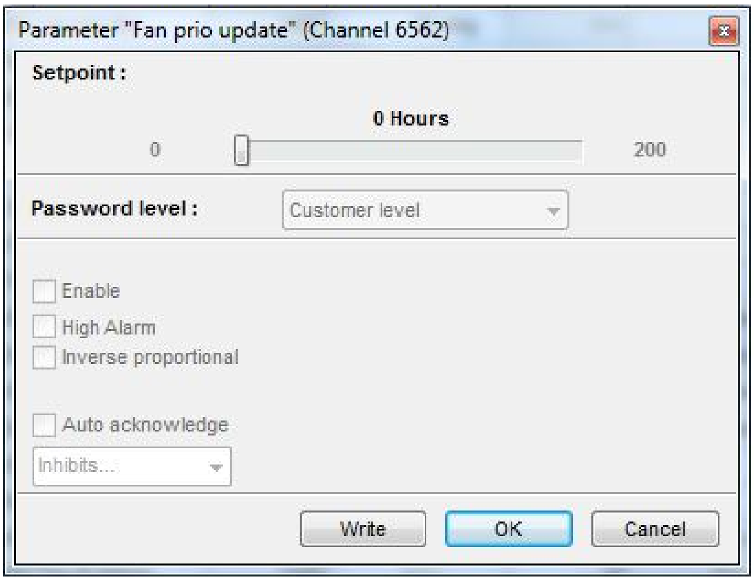
The running hour can be reset by entering parameter 6585 and then selecting the desired fan hours to be reset.



Only reset is possible. It is not possible to add an offset to the run hour counter.

10.7.9 Fan priority update

In parameter 6562, the priority update rate (hours between priority rearrange) is selected:

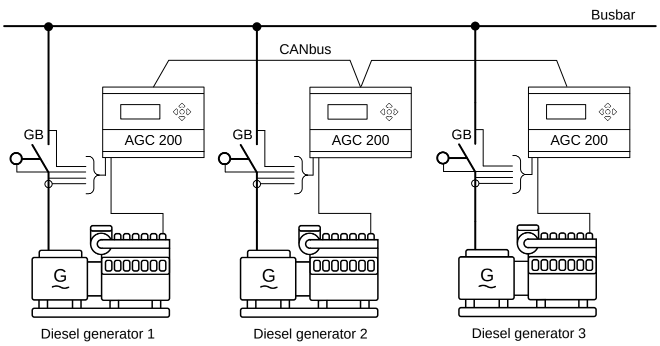


If the fan priority update is set to 0 hours, the order of priority will be fixed at: Fan A, fan B, fan C and fan D.

10.8 CAN share

10.8.1 Description of function

The function CAN share, or digital load sharing as it is also referred to, gives the opportunity to load share via the CANbus. It can be used in applications with two or more generators where power management features are not needed and mains are not present. With CAN share, it is possible to load share between up to 128 generators with simple installation and setup.
The drawing below shows the basic principle of communication between the controllers.



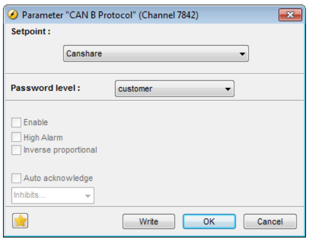
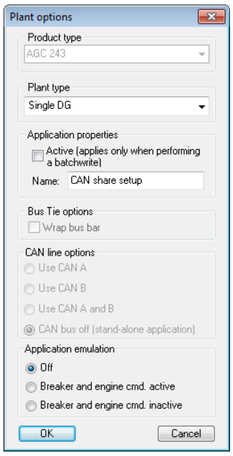
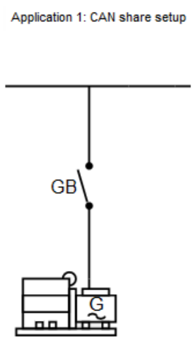
CAN share is only available in the AGC 200 variants: 222, 23x, 24x

10.8.2 How to set up

When configuring the controller for CAN share, it is important to notice that, as shown below, it has to be a Single DG drawing. The reason for this is that the controllers in a CAN share system do not need to have an internal ID assigned as in a power management system. When connecting to the CANbus line, the CAN share system automatically assigns the unit an available ID. This is handled by the internal CANbus communication, and the user will not be able to choose an ID for the unit. When disconnecting a unit from the CANbus line, the system automatically detects this and removes the specific ID from the load sharing system.

For CANbus wiring details, please refer to the "AGC 200 installation instructions 4189340610".

The table below shows the steps to set up the controller for CAN share, the setup must be done in each controller.
For details about how to use the utility software, please refer to the help function (F1) in the utility software.

	Description	Image	Reference
1.	Select which CAN port to use for CAN share and select Canshare in the drop down menu.		Parameter numbers for CAN ports: CAN A: 7841 CAN B: 7842 CAN C: 7843
2.	Create a new plant configuration and select the plant type to be **Single DG**		Utility software application configuration or quick setup
3.	Make an application drawing with a single generator.		Utility software application configuration or quick setup
4.	After configuring this in each controller, the system is ready for CAN share and more generators can be addded to the CAN share line without having to assign CAN IDs.		

10.8.3 CAN share failure

If a failure occours on the CAN share line, it is possible to display an alarm using the parameters for CAN share failure in menu 7860. The alarm includes a timer (7861), fail class (7865) and the option to activate relays (7863,7864) in case of a failure. Furthermore it is possible to chose if the controller should change mode (7866) in case of a failure on the CAN share line.

CAN share when power management is down

It is possible to use CAN share for backup in a power management application with the M-Logic command "Use alternative LS instead of PMS". Please see the topic "Load sharing" in the "Power management" chapter located in this document.

Please refer to the "AGC 200 parameter list 4189340605" for further details about parameters.

10.9 Droop mode

10.9.1 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).

Droop regulation parameters

Parameter number	Name	Description
2514	f droop	Droop setting for frequency regulator with analogue output
2573	f droop relay	Droop setting for frequency regulator with relay regulation
2644	U droop	Droop setting for voltage regulator with analogue output
2693	U droop relay	Droop setting for voltage regulator with relay regulation

When using droop mode, the frequency PID (f) and voltage PID (U) is active

Activating droop regulation

The following M-Logic commands are used to activate droop regulation. This gives more options to activate the regulation i.e. a digital input, AOP button or an event.

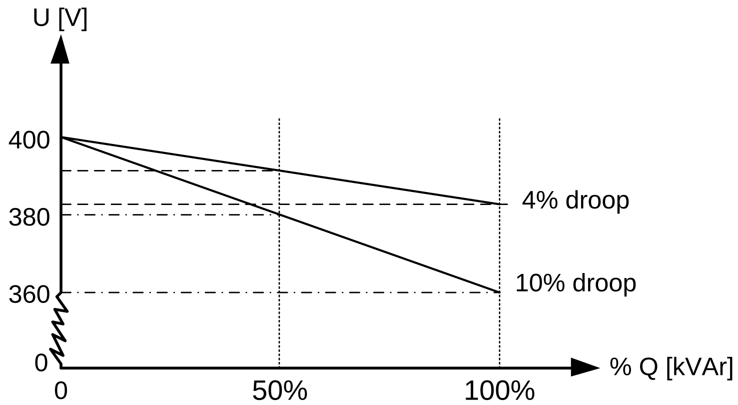
M-Logic output	M-Logic command	Description
GOV/AVR control	Act. frequency droop regulation	Activates the use of frequency droop parameters mentioned above
GOV/AVR control	Act. voltage droop regulation	Activates the use of voltage droop parameters mentioned above

Application configuration

When operating in droop mode, the AGC has to be configured with a **Single DG** application drawing. This is done through the utility software or with quick setup.
Please see the utility software help function (F1) for details about application configuration.

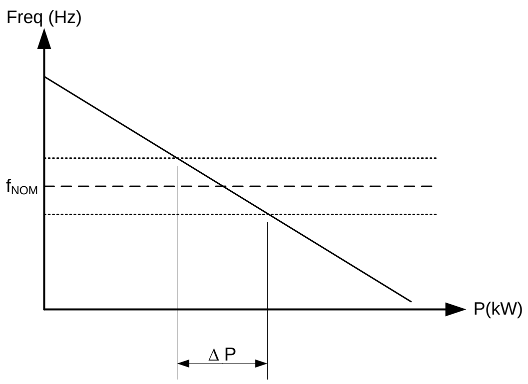
10.9.2 Voltage droop example

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.



10.9.3 High droop setting

To illustrate the influence of a high droop setting, the diagram below shows how a frequency variation gives a change in the load, the principle is the same with voltage regulation. The load change is marked as ΔP.

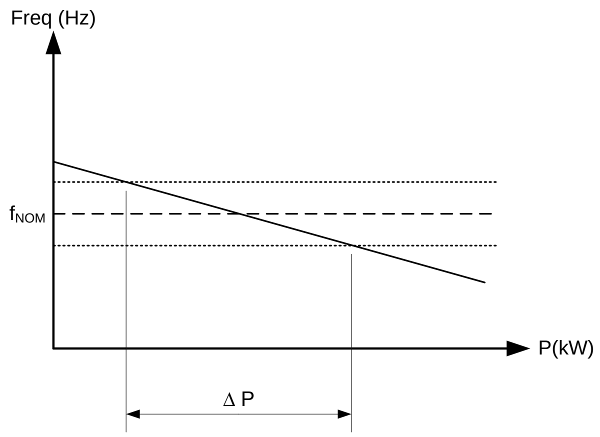


This can be used if the generator must operate base-loaded.

10.9.4 Low droop setting

To illustrate the influence of a low droop setting, the diagram below shows how a frequency variation gives a change in the load, the principle is the same with voltage droop regulation. The load change is marked as ΔP.

In this diagram, the load change (ΔP) is larger than before. This means that the generator will vary more in loading than with the higher droop setting.



This can be used if the generator must operate as a peak load machine.

10.9.5 Compensation for isochronous governors

When the genset is equipped with a governor only providing isochronous operation, the droop setting can be used to compensate for the missing droop setting possibility on the governor.

10.10 Step-up transformer

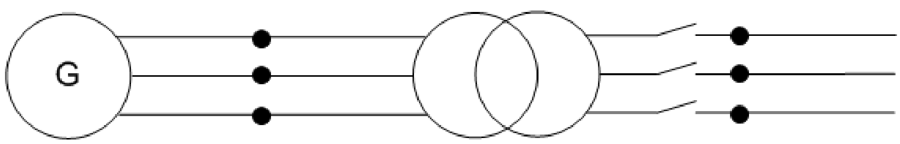
10.10.1 Step-up transformer

In certain cases, the use of a generator with step-up transformer (called a block) is required. This may be to adapt to the closest grid voltage or to step up the voltage to minimise the losses in cables and also to bring down the cable size. The applications where a step-up transformer is needed, is supported by the ML-2. The functions available in this application are:

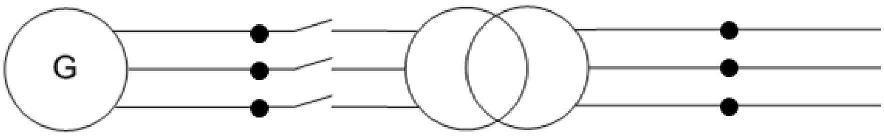
1. Synchronising with or without phase angle compensation
2. Voltage measurement displayed
3. Generator protections
4. Busbar protections

A diagram of a block is shown below

Generator/transformer block:



Typically the synchronising breaker is on the high voltage (HV) side, and there is no breaker (or only a manually operated one) on the low voltage (LV) side. In some applications, the breaker could also be placed on the LV side. But this does not influence on the setting in the ML-2, as long as the breaker and the step-up transformer are both placed between the measuring points for the ML-2. The measuring points are shown as black dots in the figures above and below.



The phase angle compensation would not be an issue if there was no phase angle shift across the step-up transformer, but in many cases there is. In Europe, the phase angle shift is described using the vector group description. Instead of vector group, this could also be called clock notation or phase shift.

When voltage measurement transformers are used, these must be included in the total phase angle compensation.

When an ML-2 is used for synchronising, the device uses the ratio of the nominal voltages for the generator and the busbar, to calculate a set point for the AVR and the voltage synchronising window (dU_{MAX}).

Example:
A 10000 V/400 V step-up transformer is installed after a generator with the nominal voltage of 400 V. The nominal voltage of the busbar is 10000 V. Now, the voltage of the busbar is 10500 V. The generator is running 400 V before synchronising starts, but when attempting to synchronise, the AVR set point will be changed to:
$U_{BUS\text{-}MEASURED} * U_{GEN\text{-}NOM}/U_{BUS\text{-}NOM}$ = 10500 * 400/10000 = **420 V**

10.10.2 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 if the HV side windings are in delta or wye configuration.
The second letter is a lower case d, y or z, defining if the LV side windings are in delta, wye or zigzag configuration.
The number is the vector group number, defining the phase angle shift between HV and LV side of the step-up transformer. The number is an expression of the LV side lag compared to the HV side voltage. The number is an expression of the lag angle divided by 30 degrees.

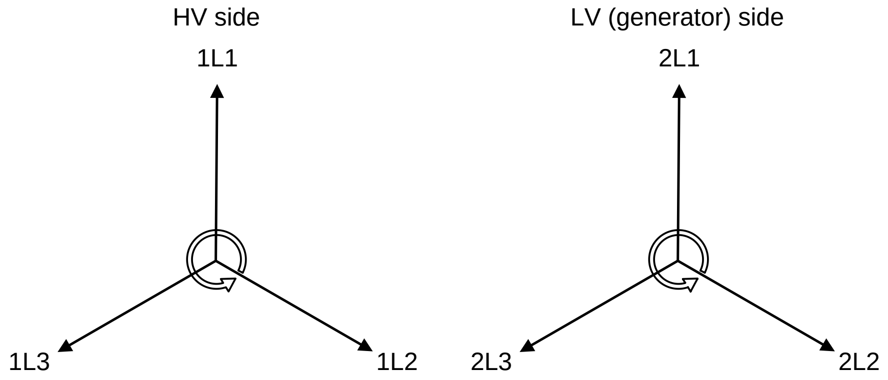
Example:
Dy11 = HV side: Delta, LV side: Wye, vector group 11: Phase shift = 11 × (–30) = -330 degrees.

Typical vector groups

Vector group	Clock notation	Phase shift	LV lag degrees compared to HV
0	0	0 °	0 °
1	1	-30 °	30 °
2	2	-60 °	60 °
4	4	-120 °	120 °
5	5	-150 °	150 °
6	6	-180 °/180 °	180 °
7	7	150 °	210 °
8	8	120 °	240 °
10	10	60 °	300 °
11	11	30 °	330 °

Vector group 0
The phase shift is 0 degrees.

Yy0 example:

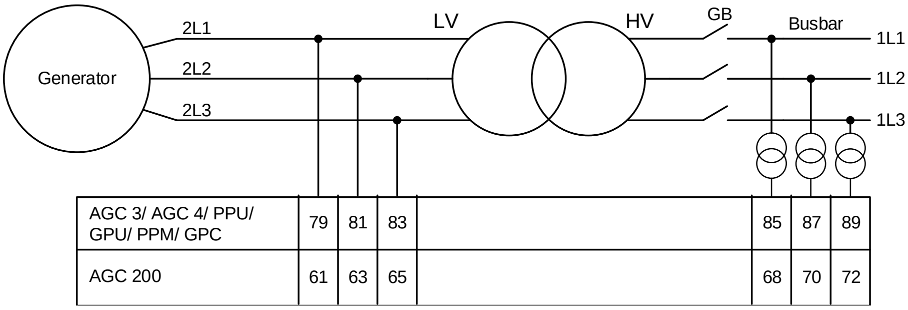


1L1 to 2L1 phase angle is 0 degrees

Phase compensation setting:

Parameter	Function	Setting
9141	BB (mains)/generator angle compensation	0 degrees

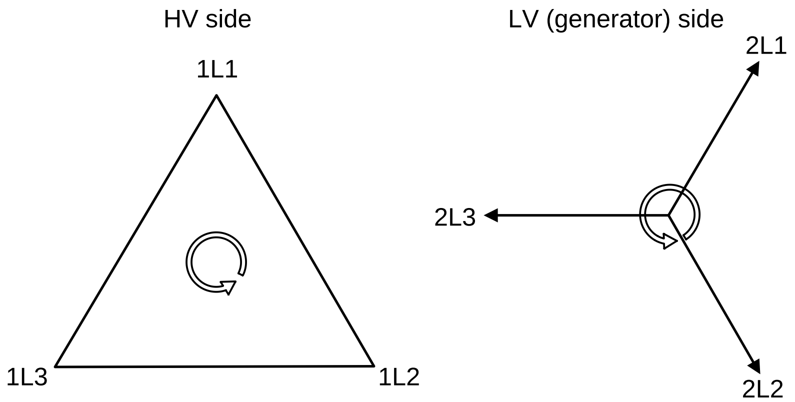
Connections:



The connection shown in the diagram should always be used when an ML-2 is used for a genset.

Vector group 1
The phase shift is -30 degrees.

Dy1 example:

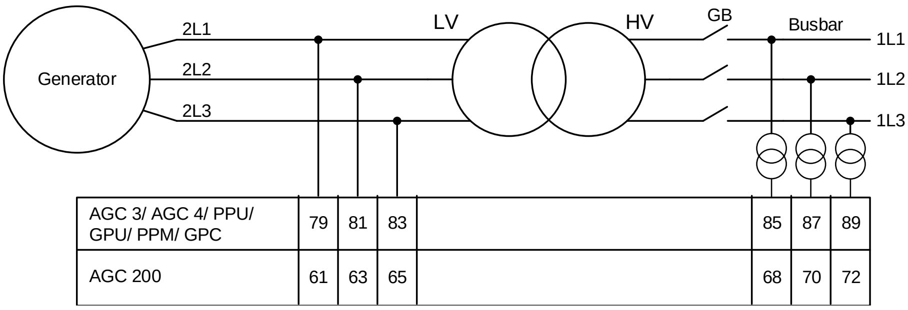


1L1 to 2L1 phase angle is -30 degrees.

Phase compensation setting:

Parameter	Function	Setting
9141	BB (mains)/generator angle compensation	30 degrees

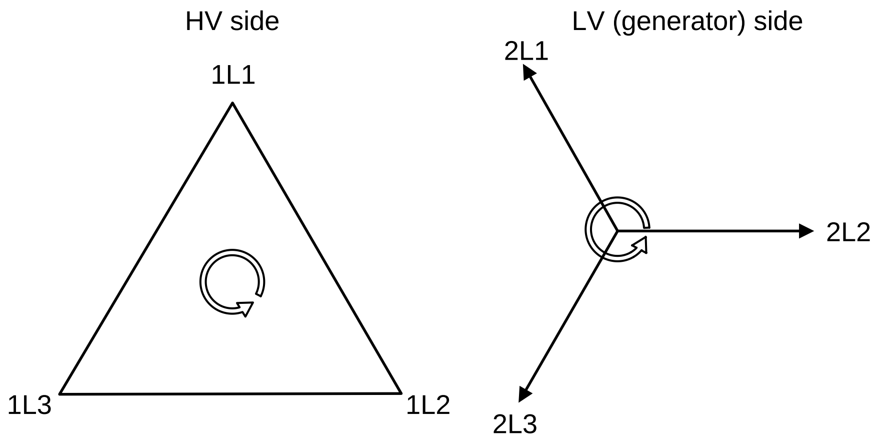
Connections:



The connection shown in the diagram should always be used when an ML-2 is used for a genset.

Vector group 11
The phase angle shift is 11 × (-30) = -330/+30 degrees.

Dy11 example:

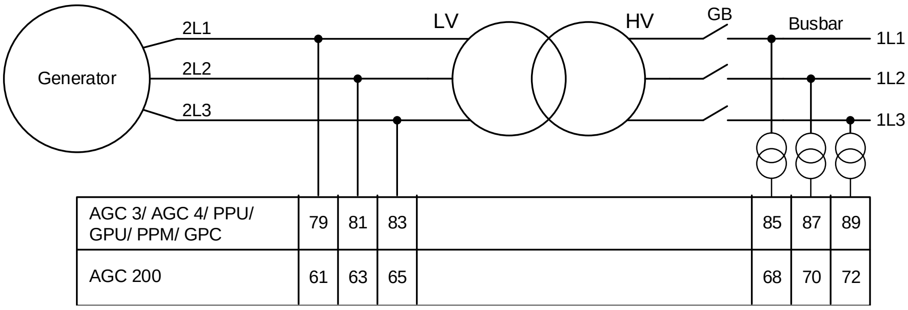


1L1 to 2L1 phase angle is -333/+30 degrees.

Phase compensation setting:

Parameter	Function	Setting
9141	BB (mains)/generator angle compensation	-30 degrees

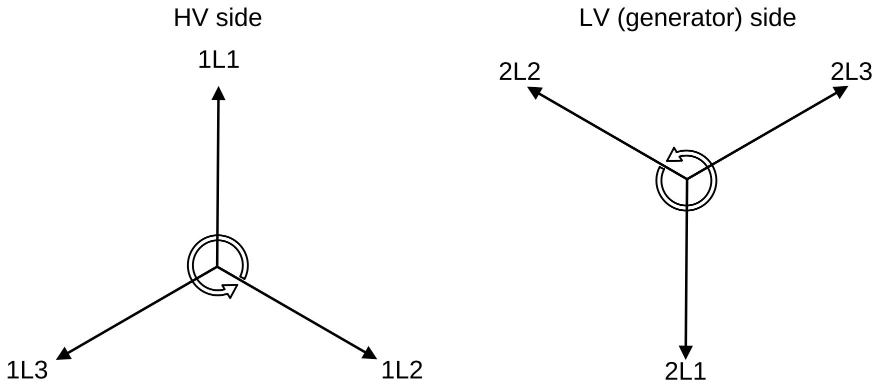
Connections:



The connection shown in the diagram should always be used when an ML-2 is used for a genset.

Vector group 6
The phase angle shift is 6 × 30 = 180 degrees.

Yy6 example:

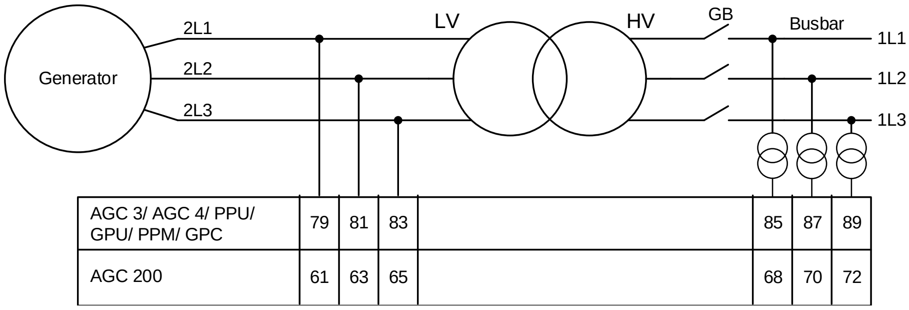


1L1 to 2L1 phase angle is -180/+180 degrees.

Phase compensation setting:

Parameter	Function	Setting
9141	BB (mains)/generator angle compensation	180 degrees

Connections:



The connection shown in the diagram should always be used when an ML-2 is used for a gen-set.

Select 179 degrees in parameter 9141 when vector group 6 is used.

Comparison table between different terminologies:

Vector group	Clock notation	Phase shift	LV lag degrees compared to HV	LV side lagging	LV side leading
0	0	0 °	0 °	0 °	
1	1	-30 °	30 °	30 °	
2	2	-60 °	60 °	60 °	
4	4	-120 °	120 °	120 °	
5	5	-150 °	150 °	150 °	
6	6	-180 °/180 °	180 °	180 °	180 °
7	7	150 °	210 °		150 °
8	8	120 °	240 °		120 °
10	10	60 °	300 °		60 °
11	11	30 °	330 °		30 °

In the following, the name vector group will be used.

Table to read parameter 9141 compared to a step-up transformer:

Vector group	Step-up transformer types	Parameter 9141
0	Yy0, Dd0, Dz0	0 °
1	Yd1, Dy1, Yz1	30 °
2	Dd2, Dz2	60 °
4	Dd4, Dz4	120 °
5	Yd5, Dy5, Yz5	150 °
6	Yy6, Dd6, Dz6	180 °
7	Yd7, Dy7, Yz7	-150 °
8	Dd8, Dz8	-120 °
10	Dd10, Dz10	-60 °
11	Yd11, Dy11, Yz11	-30 °

DEIF does not take responsibility that the compensation is correct. Before closing the breaker, DEIF recommends that customers always measure the synchronisation themselves.

If voltage measurement is connected incorrectly, the setting in parameter 9141 will be wrong.

The setting shown in the table above does not include any phase angle twist made by measurement transformers.

The settings shown in the table above are not correct if a step-down transformer is used. These settings are shown later.

10.11 Demand of peak currents

10.11.1 I max. demand

The second readout is called I maximum demand, and shortened in the unit, I max. demand. The readout displays the newest maximum peak current value. When a new maximum peak current is detected, the value is saved in the display. The value can be reset in menu 6843. If the value is reset, it will be logged in the event log.

The two reset functions will also be available as commands through M-Logic.

Display readout is updated with an interval of 6 seconds.

10.11.2 I thermal demand

This measurement is used to simulate a bimetallic system, known from the Maximum Demand ammeter, which is specifically suited for indication of thermal loads in conjunction with cables, transformers, and so on.

It is possible to have two different readouts shown in the display. The first readout is called I thermal demand. This readout shows the average **maximum** peak current over an adjustable time interval.

Be aware that the calculated average is NOT the same as the average current over time. The I thermal demand value is an average of the MAXIMUM PEAK current in the adjustable time interval.

The measured peak currents are sampled once every second, and every 6 seconds an average peak value is calculated. If the peak value is higher than the previous maximum peak value, it is used to calculate a new average. The thermal demand period will provide an exponential thermal characteristic.

The time interval in which the average maximum peak current is calculated can be adjusted in parameter 6840. The value can also be reset. If the value is reset, it will be logged in the event log and the readout in the display is reset to 0.

10.12 Power and cos phi offsets

10.12.1 Power offsets

This function is for making a power offset from Pnom, 3 offsets are available. It is possible to enable offsets in M-Logic, where offsets can be used as an event or an output where offsets can be activated or deactivated. The offset can be set in menu 7220-7225. The enabled power offsets will be added/subtracted from the fixed power setpoint in menu 7051, which refers to Pnom.

The adjusted fixed power setpoint will be limited to be inside the values in menu 7023 "Minimum load", and maximum value is Pnom.

10.12.2 Cos phi offsets

This function is for making a power offset from Pnom, 3 offsets are available. It is possible to enable offsets via M-Logic, where offsets can be used as an event or an output where offsets can be activted or deactivated. The cos phi offsets can be set in menu 7241-7245. The enabled cos phi offsets will be added/subtracted from the fixed cos phi setpoint in menu 7052.

The adjusted fixed cos phi setpoint will be limited to be inside the values in menu 7171 "Cos phi (x2)", and maximum value is in menu 7173 "Cos phi (x2)".

The values in 7052-7055 set the cos phi. This is not the PF value displayed in the display. cos phi and PF are only equal if it is a true sinusoidal wave.

11. Procedure for parameter setup

11.1 Procedure for parameter setup

11.1.1 Procedure for parameter setup

This chapter deals with the procedure to be followed when the parameters of the unit are set up from the initial point of finding the individual parameter description in this handbook to the actual setup. By use of various illustrations, the following will guide the user through the whole procedure for parameter setup step by step.

11.1.2 Finding the selected parameter

The first step in the parameter setup is to find the correct parameter descriptions.

You can find all parameters in the document ”AGC 200 Parameter List”.

11.1.3 Parameter descriptions

Each parameter description is structured according to the same principles. Under the parameter title heading, the detailed parameter descriptions are illustrated and presented. First, a table indicating the parameter facts related to the individual parameter title is presented:

1000 G-P> 1

No.	Setting	Min. setting	Max. setting	Factory setting
1001	set point	-50.0%	0.0%	-5.0%
1002	Timer	0.1 s	100.0 s	10.0 s
1003	Relay output A	Not used	R3 (relay 3)	Not used
1004	Relay output B	Not used	R3 (relay 3)	Not used
1005	Enable	OFF	ON	ON
1006	Fail class	1	5	3

Due to the character of the parameters, small differences may exist between the individual tables.

The first column indicates the menu number in the display.

The second column indicates the changeable setting in the display.

The third and fourth columns indicate the minimum/maximum set point available for this setting.

The fifth column indicates the default set point of the unit from the factory. When it is necessary, additional information will be supplied after the table in order to make the individual parameter descriptions as informative as possible.

11.1.4 Setup

At this point of the process, you will have located the specific parameter description that you were looking for. Now, follow the menu structure presented earlier in this handbook in order to set up the individual parameters. (In this overall example, we have chosen to change the set point of the parameter **1000 G -P>).**

Step 1: Enter the parameter menu by pressing the button.

Step 2: Use the and push-buttons to locate the selected parameter group, in this case ”1000 Protection”. Press .

Step 3: Use the and push-buttons to locate the selected parameter. Press .

Step 4: Enter password to change the set point

Step 5: Use the and push-buttons to increase/decrease the set point setting.

Step 6: Press ; the new set point setting has now been saved.

12. Parameter list

12.1 Parameter list

12.1.1 Parameter list

Please see the separate document "AGC 200 Parameter List", document no. 4189340605.