Automatic Genset Controller, AGC
DESCRIPTION OF OPTIONS



Options G4, G5 and G8
Power management

- Functional description
- Display units
- Power management setup
- Power management functions
- Parameter lists

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7. Power management functions

1. Delimitation

1.1 Scope of options G4, G5 and G8

This description of options covers the following products:

AGC-3	SW version 3.6x.x or later
AGC-4	SW version 4.5x.x or later
AGC 200	SW version 4.5x.x or later
AGC 100	SW version 4.5x.x or later

2. General information

2.1 Warnings, legal information and safety

2.1.1 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.

2.1.2 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.

2.1.3 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.

2.1.4 Electrostatic discharge awareness

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

2.1.5 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.

3. Description of options

3.1 ANSI numbers

3.1.1 ANSI

Function	ANSI no.
Power management	-

3.2 Options G4, G5 and G8

3.2.1 G4, G5 and G8

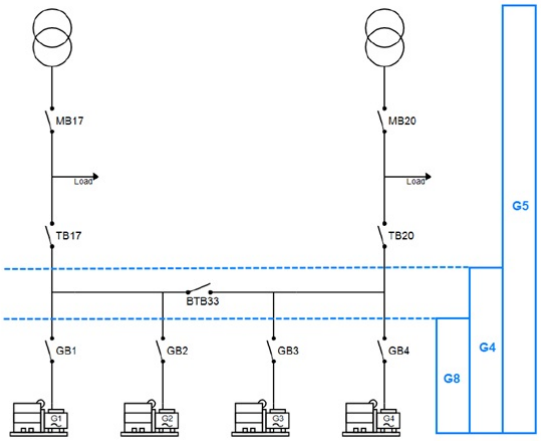
The options G4, G5 and G8 (power management) are software options and therefore not related to any hardware apart from the standard-installed hardware.

The options G4, G5 and G8 are alike in the basic functionality. In the below table the differences are shown:

Product	AGC gen.	AGC mains	AGC bus tie
Option G4	X		X
Option G5	X	X	X
Option G8	X		

This means that all functionalities available in the G4 and G8 options will also be available in the G5 option, but all power management functionalities regarding the mains connections and the sequences handling the mains are not available in the G4 option, and only generator functionality will be available in the G8 option.

As the basic power management functions are similar in the three options, it will be possible to mix controllers specified with one of the three options in the same application.



The options G4, G5 and G8 can be combined in the same application.

A number of AGC units are being used in the power management application, i.e. one for each mains breaker and tie breaker (AGC mains unit), if installed, one for each bus tie breaker (AGC bus tie unit) and one for each generator (AGC generator unit). All units communicate by means of an internal CANbus connection.

The AGC mains unit includes the power management option and can therefore only be used with option G5 applications. The generator AGC unit must be specified with either option G4, G5 or G8, because this unit can be used in single genset applications and in power management applications.

3.3 Terminal description

3.3.1 Description of terminals

The CANbus interface for the internal communication between AGC units in a G4/G5/G8 application is placed on the engine interface PCB in slot #7.

Term.	Function	Technical data	Description
98	+12/24V DC	12/24V DC +/-30%	DC power supply/common for 118
99	0V DC		
100	MPU input	2-70V AC/10-10.000 Hz	Magnetic pick-up
101	MPU GND		
102	A	0(4)-20 mA Digital Pt100 Pt1000 VDO 0-40V DC	Multi-input 1
103	B		
104	C		
105	A		Multi-input 2
106	B		
107	C		
108	A		Multi-input 3
109	B		
110	C		
111	Com.	Common	Common for terminals 112-117
112	Digital input 112	Optocoupler	Configurable
113	Digital input 113	Optocoupler	Configurable
114	Digital input 114	Optocoupler	Configurable
115	Digital input 115	Optocoupler	Ext. engine failure/configurable
116	Digital input 116	Optocoupler	Start enable/configurable
117	Digital input 117	Optocoupler	Running feedback/configurable
118	Digital input 118	Optocoupler	Emergency stop and common for 119 and 120
119	NO	Relay24V DC/5 A	Run coil
120	NO	Relay24V DC/5 A	Start prepare
121	Com.	Relay250V AC/8 A	Crank (starter)
122	NO		
123	Com.	Relay24V DC/5 A	Stop coil w/wire failure detection
124	NO		
A1	CAN-H		CANbus interface A
A2	GND		
A3	CAN-L		
B1	CAN-H		CANbus interface B
B2	GND		

Term.	Function	Technical data	Description
B3	CAN-L		

3.4 Breaker feedbacks

3.4.1 Generator breaker

The feedbacks of the generator breaker must always be connected (terminals 26 and 27).

3.4.2 Mains breaker (MB) feedback

MB present: The feedbacks of the mains breaker must always be connected (terminals 24 and 25).
MB not present: Selected in the application configuration (USW).

When no MB is represented, the MB open and close relays together with the inputs for MB open and close feedbacks (terminals 24 and 25) will be configurable.

3.4.3 Tie breaker (TB)

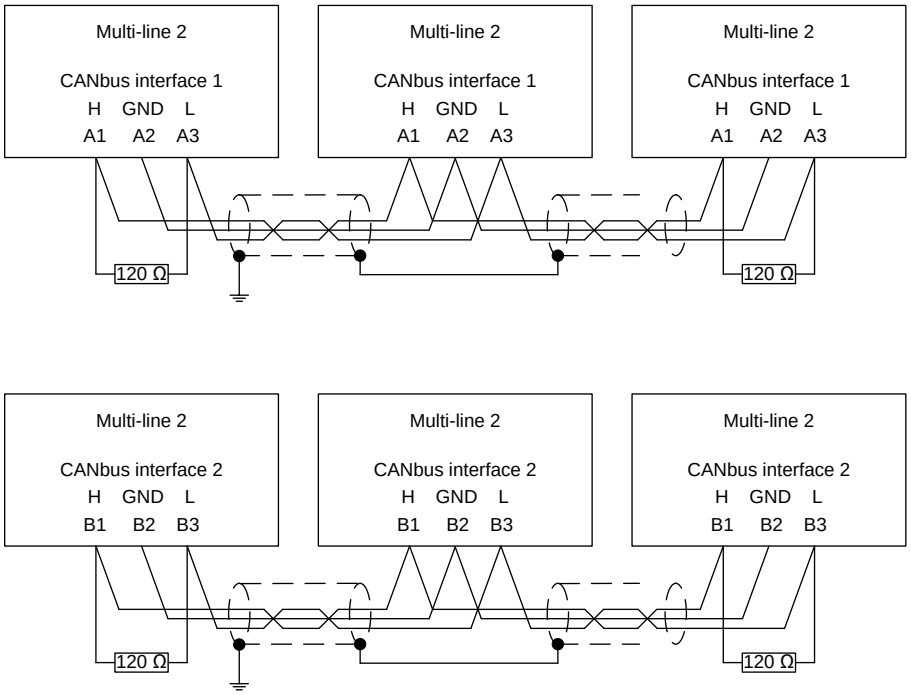
TB present: The feedbacks of the tie breaker must always be connected (terminals 26 and 27).
TB not present: Selected in the application configuration (USW)

When no TB is represented, the TB open and close relays together with the inputs for TB open and close feedbacks (terminals 26 and 27) will be configurable.

3.5 Wiring diagrams

3.5.1 Diagrams

The following diagrams show examples with three AGC units connected, e.g. one AGC mains and two generator AGC units.



For distances above 300 metres we recommend to use a CAN to fibre converter.

Do not connect the cable shield to the GND terminal of the AGC units.

4. Functional description

4.1 Power management functions

4.1.1 Description of functions

In the following chapter, the power management functions of the AGC 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)

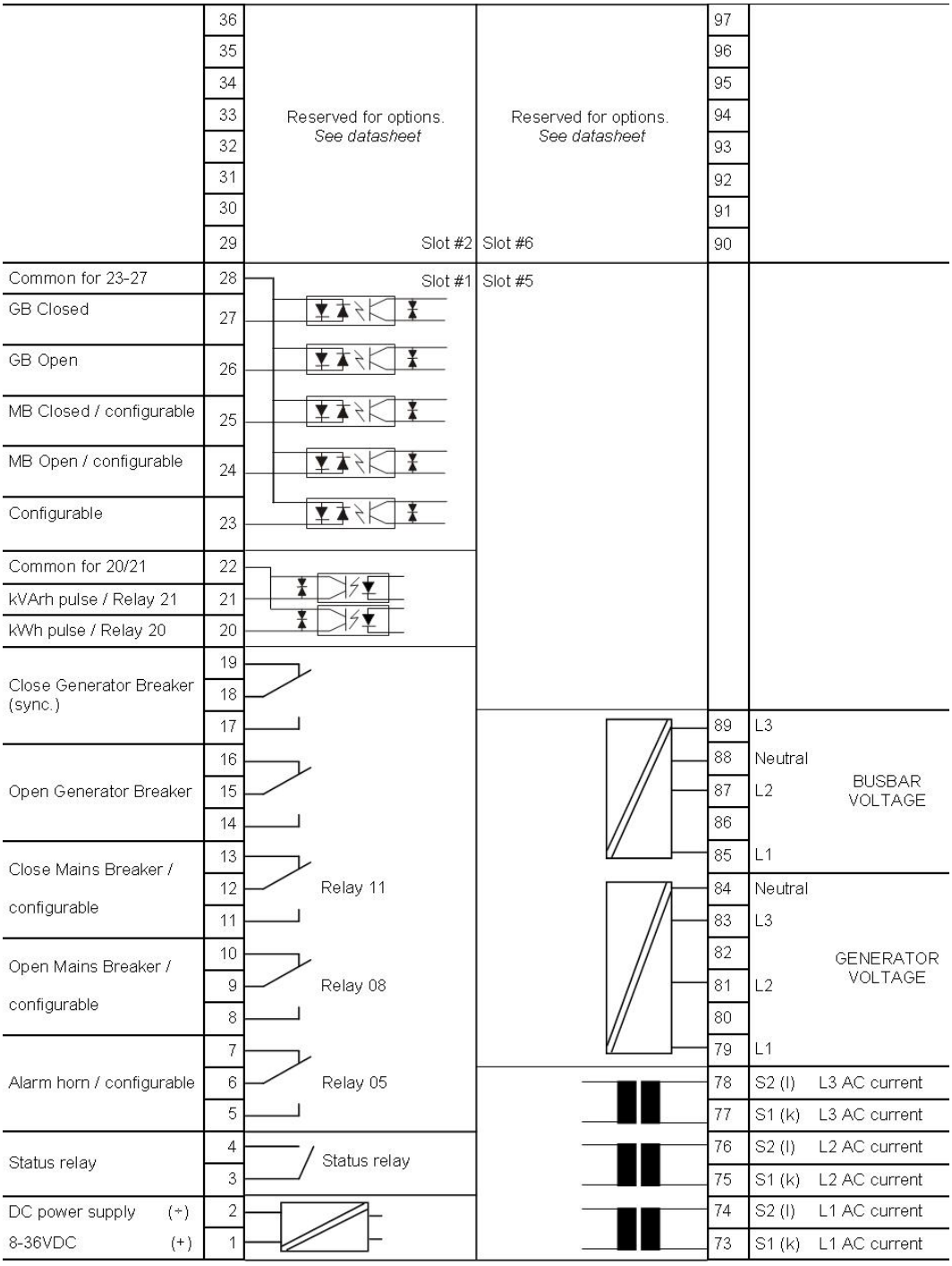
Display:
- Mains unit display showing mains breaker and tie breaker
- Generator unit showing generator and generator breaker

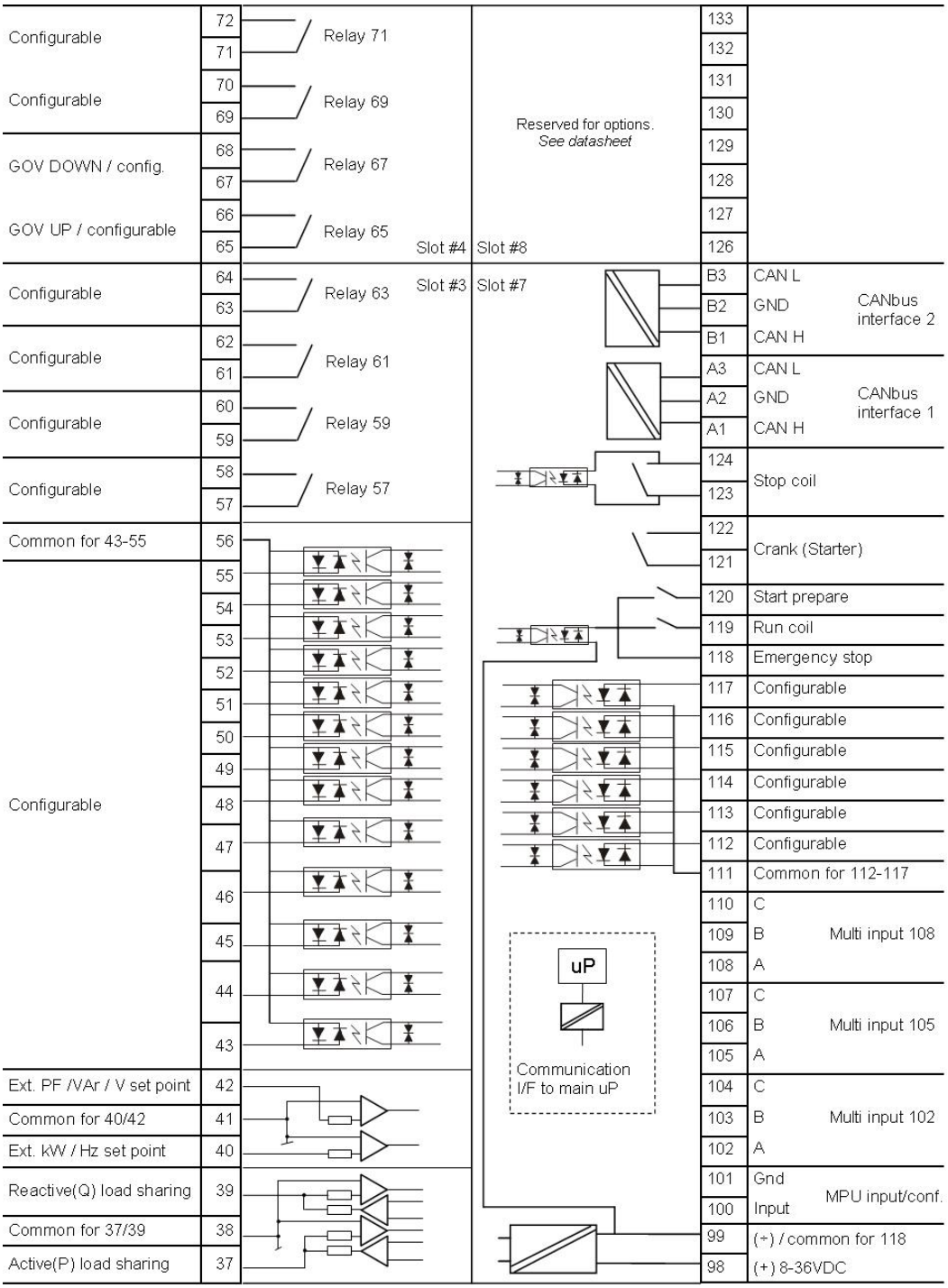
Power management functions:
- Load-dependent start/stop
- Priority selection
  - Manual
  - Running hours
  - Fuel optimisation
- Ground relay control
- ATS control
- Safety stop (fail class = trip and stop)
- Load management
- Multiple mains support
- Secured mode
- Quick setup/broadcast
- Base load
- Heavy consumer (HC)
- Asymmetric load sharing (LS)
- Common PF control
- CAN flags

Please refer to the Designer’s Reference Handbook for standard functions not relating to the power management option.

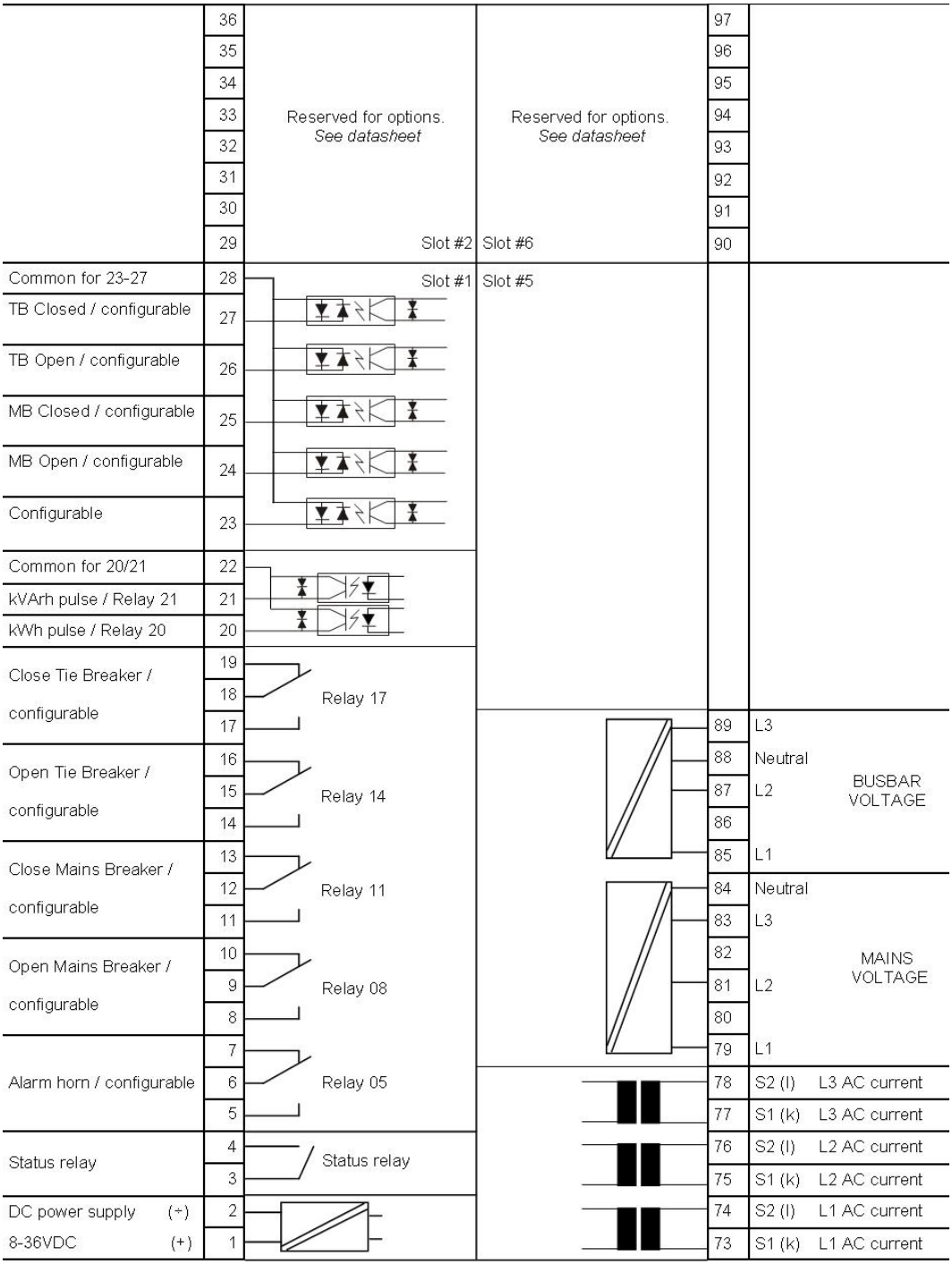
4.2 Terminal strip overview

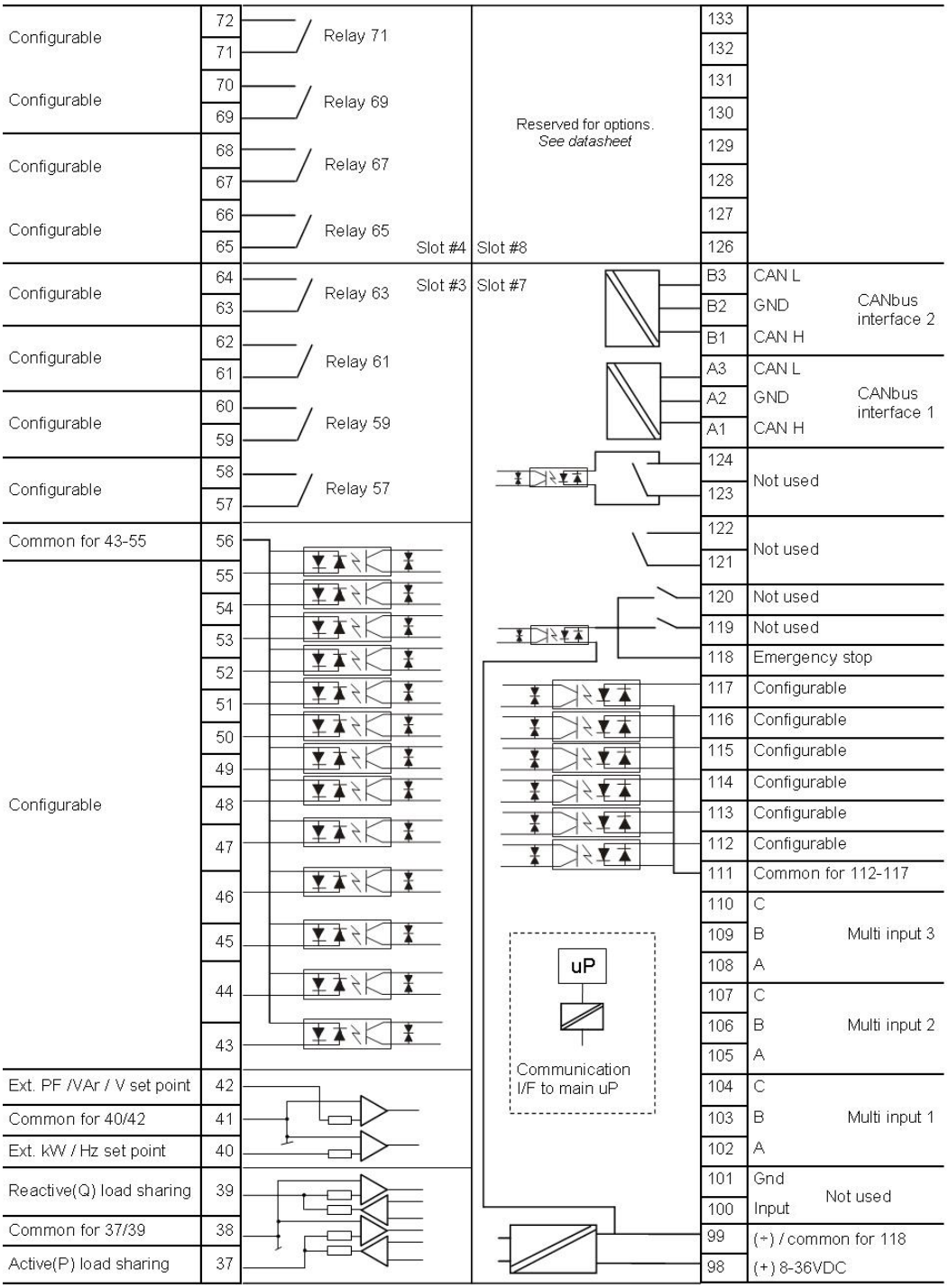
4.2.1 AGC generator unit



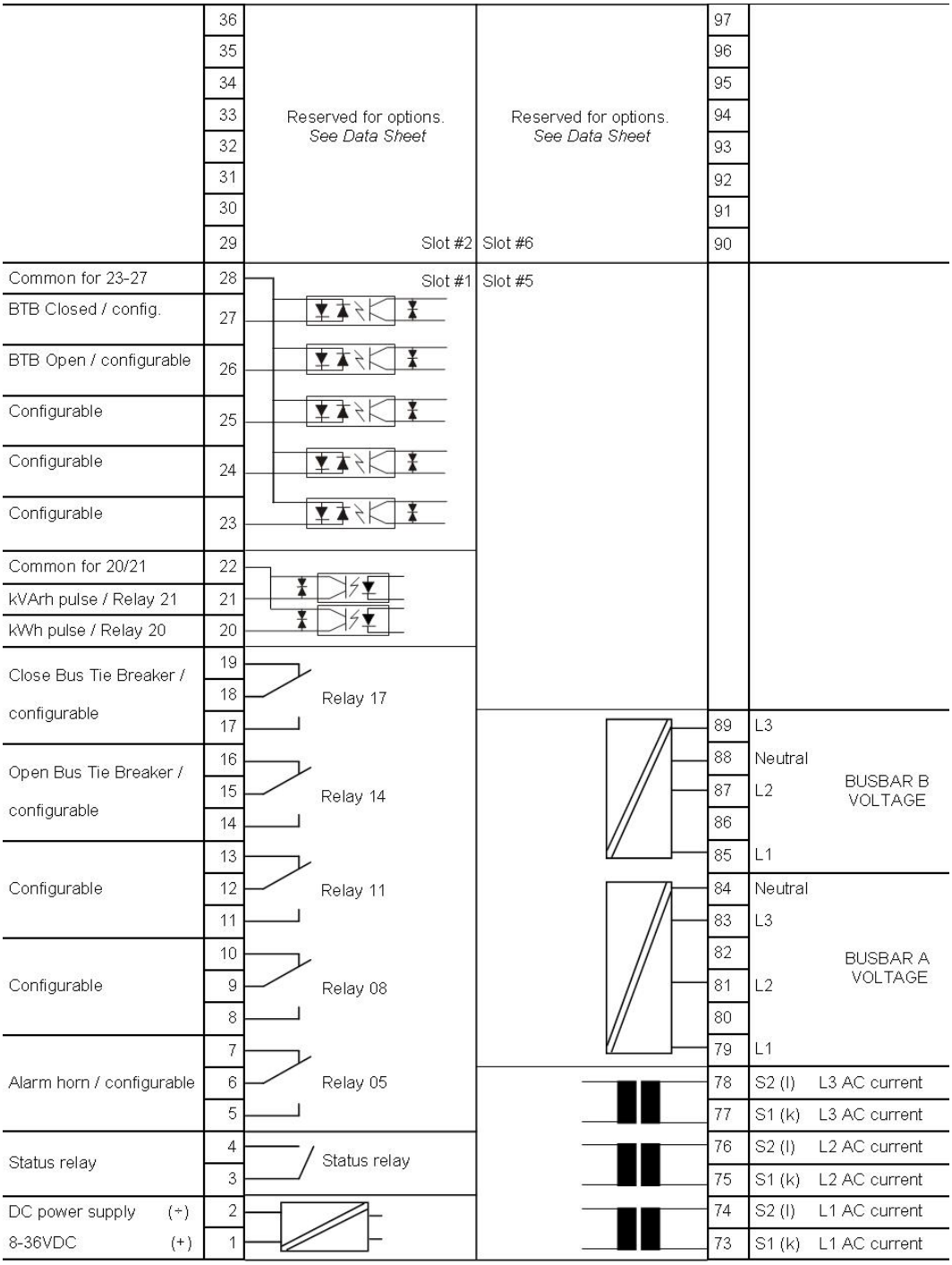

Configurable
72
71
Relay 71
Configurable
70
69
Relay 69
GOV DOWN / config.
68
67
Relay 67
GOV UP / configurable
66
65
Relay 65
Slot #4
Slot #8
Reserved for options.
See datasheet
133
132
131
130
129
128
127
126
Configurable
64
63
Relay 63
Slot #3
Slot #7
Configurable
62
61
Relay 61
Configurable
60
59
Relay 59
Configurable
58
57
Relay 57
Common for 43-55
56
Configurable
55
54
53
52
51
50
49
48
47
46
45
44
43
Ext. PF /VAr / V set point
42
Common for 40/42
41
Ext. kW / Hz set point
40
Reactive(Q) load sharing
39
Common for 37/39
38
Active(P) load sharing
37
B3
B2
B1
CAN L
GND
CAN H
CANbus interface 2
A3
A2
A1
CAN L
GND
CAN H
CANbus interface 1
124
123
Stop coil
122
121
Crank (Starter)
120
Start prepare
119
Run coil
118
Emergency stop
117
Configurable
116
Configurable
115
Configurable
114
Configurable
113
Configurable
112
Configurable
111
Common for 112-117
110
109
108
C
B
A
Multi input 108
107
106
105
C
B
A
Multi input 105
104
103
102
C
B
A
Multi input 102
101
100
Gnd
Input
MPU input/conf.
99
98
(-) / common for 118
(+) 8-36VDC
uP
Communication
I/F to main uP

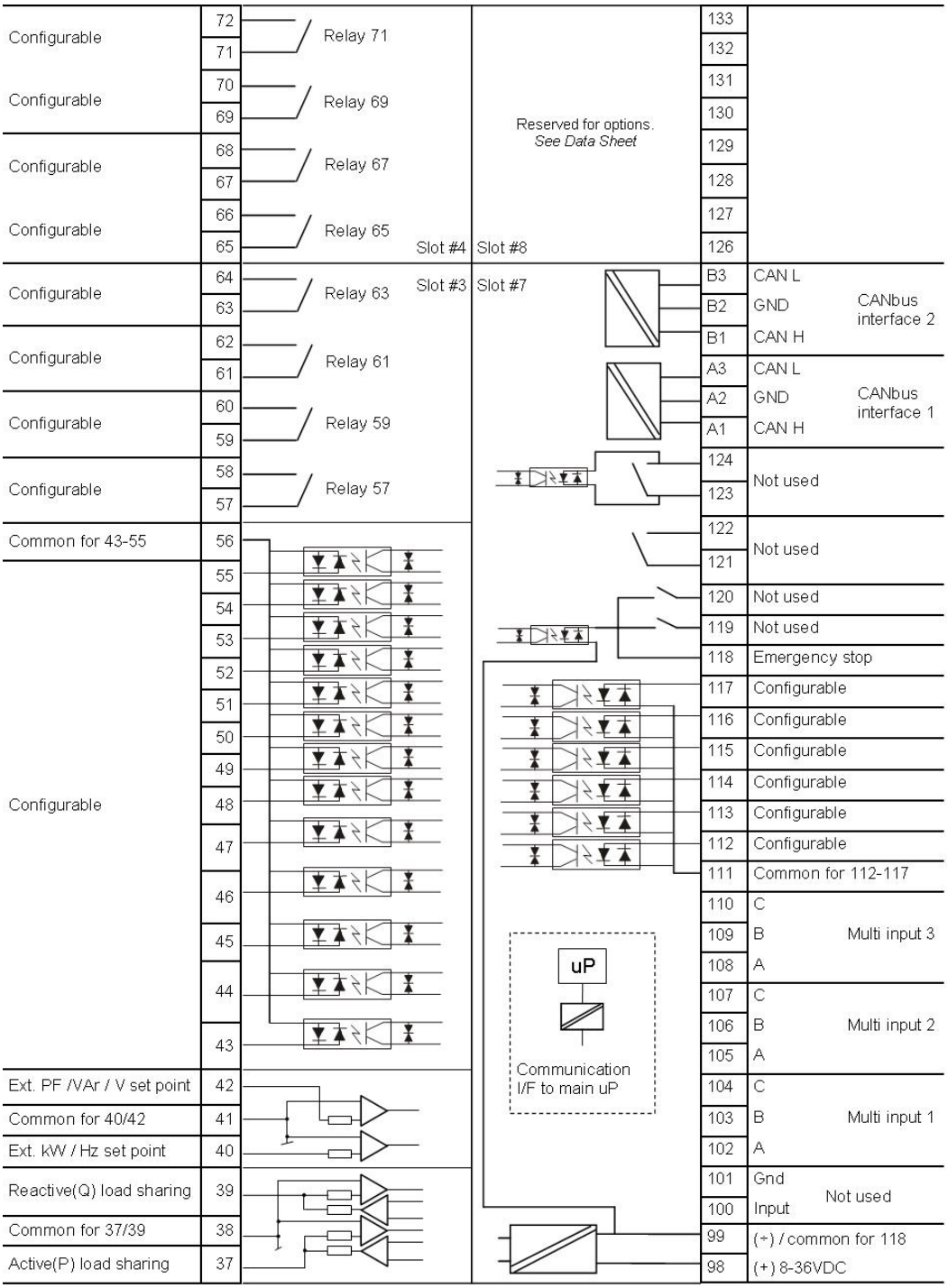
4.2.2 AGC mains unit




Configurable
72
71
Relay 71
Configurable
70
69
Relay 69
Configurable
68
67
Relay 67
Configurable
66
65
Relay 65
Slot #4
Slot #8
Reserved for options.
See datasheet
133
132
131
130
129
128
127
126
Configurable
64
63
Relay 63
Configurable
62
61
Relay 61
Configurable
60
59
Relay 59
Configurable
58
57
Relay 57
Slot #3
Slot #7
B3 CAN L
B2 GND
B1 CAN H
CANbus interface 2
A3 CAN L
A2 GND
A1 CAN H
CANbus interface 1
124
123
Not used
122
121
Not used
Common for 43-55
56
120 Not used
119 Not used
118 Emergency stop
117 Configurable
116 Configurable
115 Configurable
114 Configurable
113 Configurable
112 Configurable
111 Common for 112-117
Configurable
55
54
53
52
51
50
49
48
47
46
45
44
43
110 C
109 B
108 A
Multi input 3
107 C
106 B
105 A
Multi input 2
104 C
103 B
102 A
Multi input 1
uP
Communication
I/F to main uP
Ext. PF /VAr / V set point
42
Common for 40/42
41
Ext. kW / Hz set point
40
Reactive(Q) load sharing
39
101 Gnd
100 Input
Not used
Common for 37/39
38
Active(P) load sharing
37
99 (-) / common for 118
98 (+) 8-36VDC

4.2.3 AGC bus tie unit




Configurable
72
71
Relay 71
Configurable
70
69
Relay 69
Configurable
68
67
Relay 67
Configurable
66
65
Relay 65
Slot #4
Slot #8
Reserved for options.
See Data Sheet
133
132
131
130
129
128
127
126
Configurable
64
63
Relay 63
Configurable
62
61
Relay 61
Configurable
60
59
Relay 59
Configurable
58
57
Relay 57
Slot #3
Slot #7
B3
B2
B1
CAN L
GND
CAN H
CANbus interface 2
A3
A2
A1
CAN L
GND
CAN H
CANbus interface 1
124
123
Not used
122
121
Not used
Common for 43-55
56
120
Not used
119
Not used
118
Emergency stop
117
Configurable
116
Configurable
115
Configurable
114
Configurable
113
Configurable
112
Configurable
111
Common for 112-117
Configurable
55
54
53
52
51
50
49
48
47
46
45
44
43
uP
Communication
I/F to main uP
110
C
109
B
108
A
Multi input 3
107
C
106
B
105
A
Multi input 2
104
C
103
B
102
A
Multi input 1
Ext. PF /VAr / V set point
42
Common for 40/42
41
Ext. kW / Hz set point
40
Reactive(Q) load sharing
39
101
Gnd
100
Input
Not used
Common for 37/39
38
99
(÷) / common for 118
Active(P) load sharing
37
98
(+) 8-36VDC

4.3 Applications

4.3.1 Application possibilities

The options G4 and G5 can be used for the applications listed in the table below. The option G8 alone can only be used for an island application with DG units.

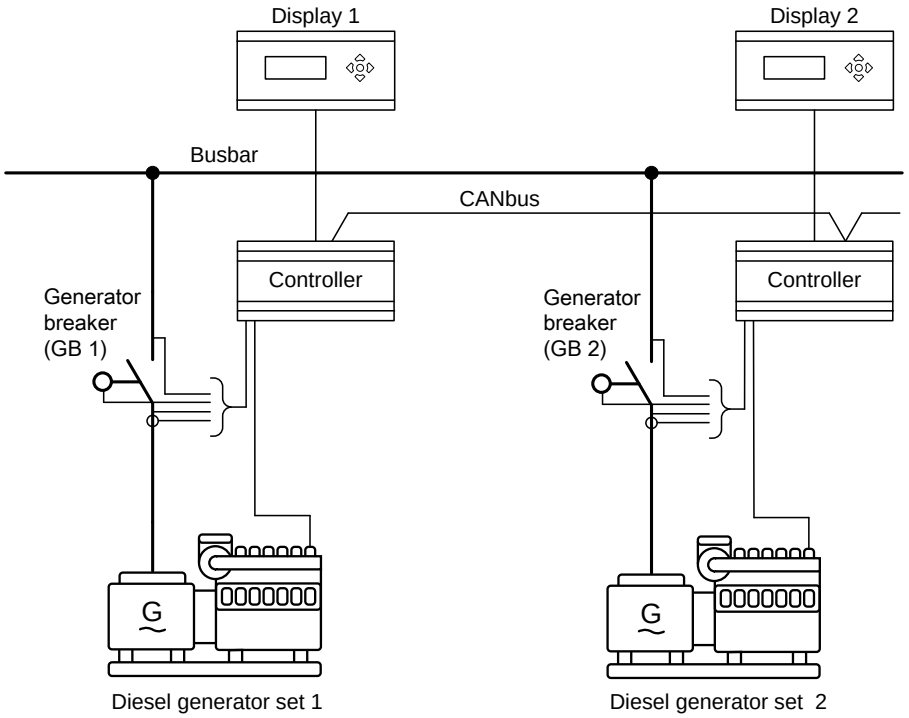
Application	Drawing below	Comment
Island operation	Island mode plant	Multiple gensets
Automatic Mains Failure	Parallel with 1-16 mains	No back synchronising
Automatic Mains Failure	Parallel with 1-16 mains	With back synchronising
Automatic Mains Failure	ATS plant, multiple start	Multiple start system
Automatic Mains Failure	ATS plant, mains unit	Mains unit installed
Fixed power	Parallel	Also called base load 1-16 mains units
Mains power export	Parallel	1-16 mains units
Load takeover	Parallel	1-16 mains units
Peak shaving	Parallel	1-16 mains units

Refer to the Designer's Reference Handbook for description of the individual genset modes.

Regarding AC and DC connections for the individual applications, please refer to the Installation Instructions.

4.3.2 Island operation plant

In an application where up to 16 gensets are installed, the AGC will automatically operate in an island mode with load-dependent starting and stopping.

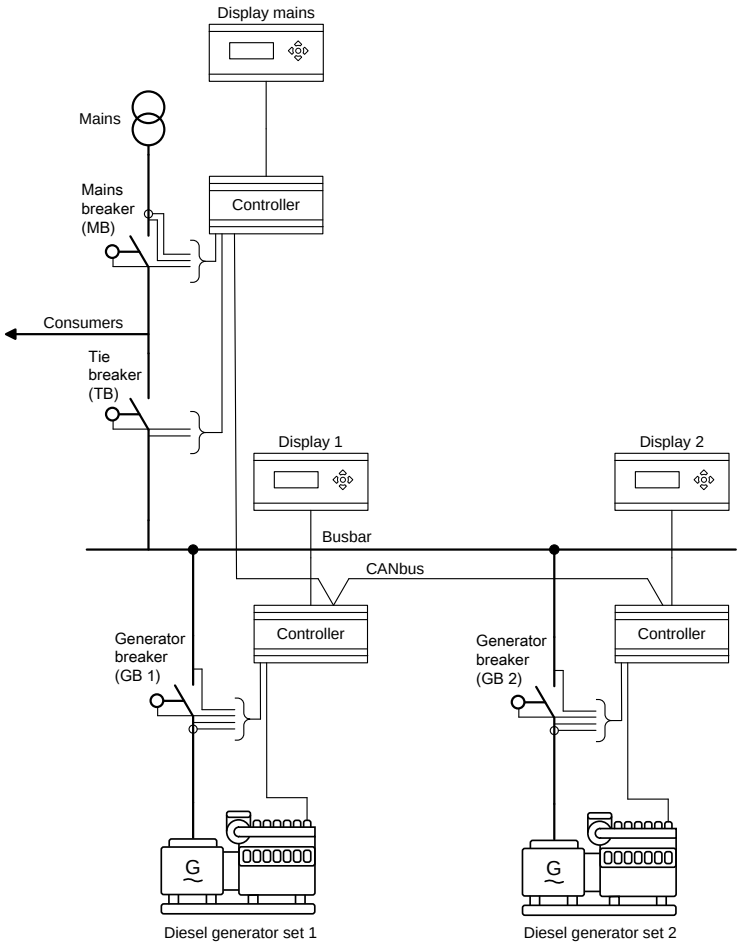


If a mains unit is installed and connected (e.g. for preparing future requirements to the application), the island mode operation is selected in the mains unit.

4.3.3 Parallel with mains plant

An application where a mains breaker is installed together with up to 16 gensets is shown below.

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.

If no CTs are installed on the AGC mains, a 4-20 mA power transducer TAS-331 can be used instead.

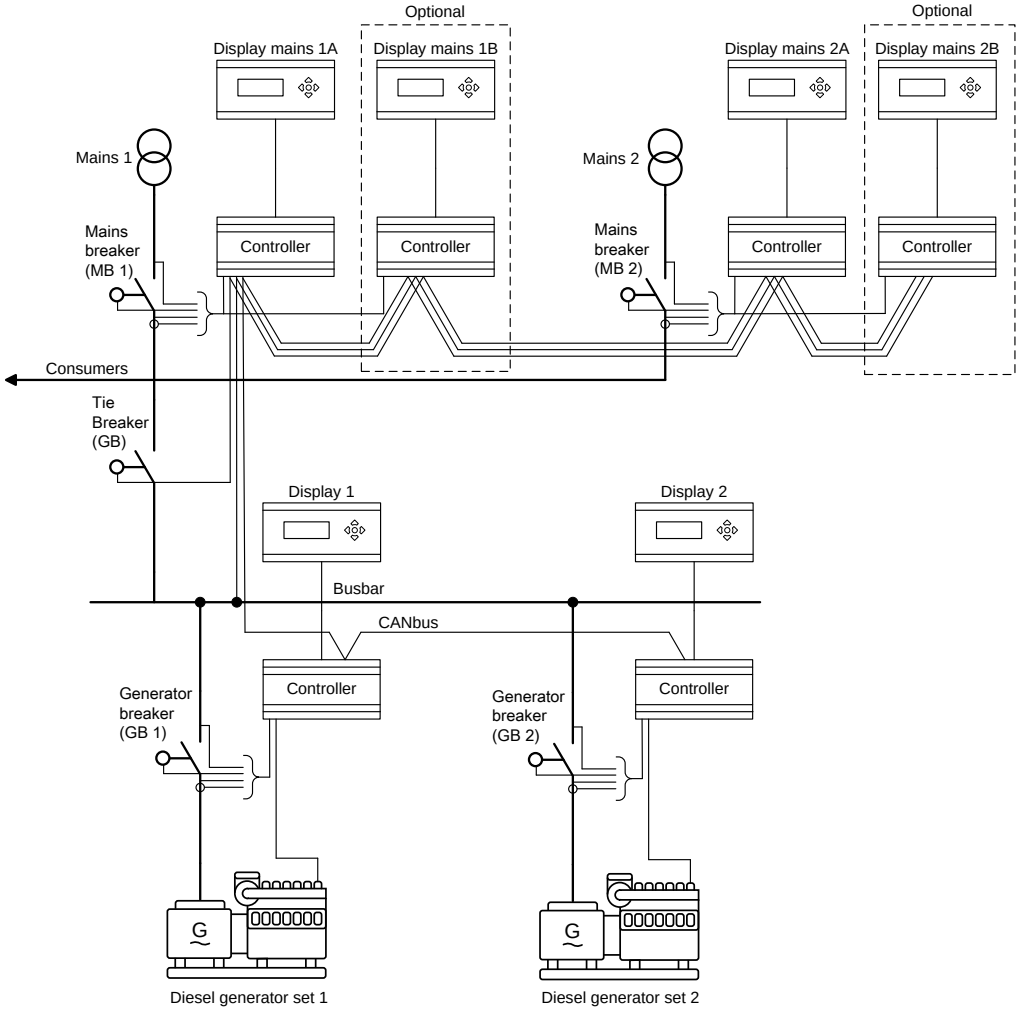
The CT measurements are used when the transducer setup is 4/20 mA = 0/0 kW. The transducer is used when the transducer setup is changed from 0/0 kW (parameter 7003 and 7004).

4.3.4 Dual mains plant (only available in AGC-3)

An application with two mains breakers installed together with up to 16 gensets is shown below.

The application also supports redundant AGC mains units.

The application is shown with a tie breaker, but it is also possible to use the application without a tie breaker.



Dual mains is only possibly in AGC-3

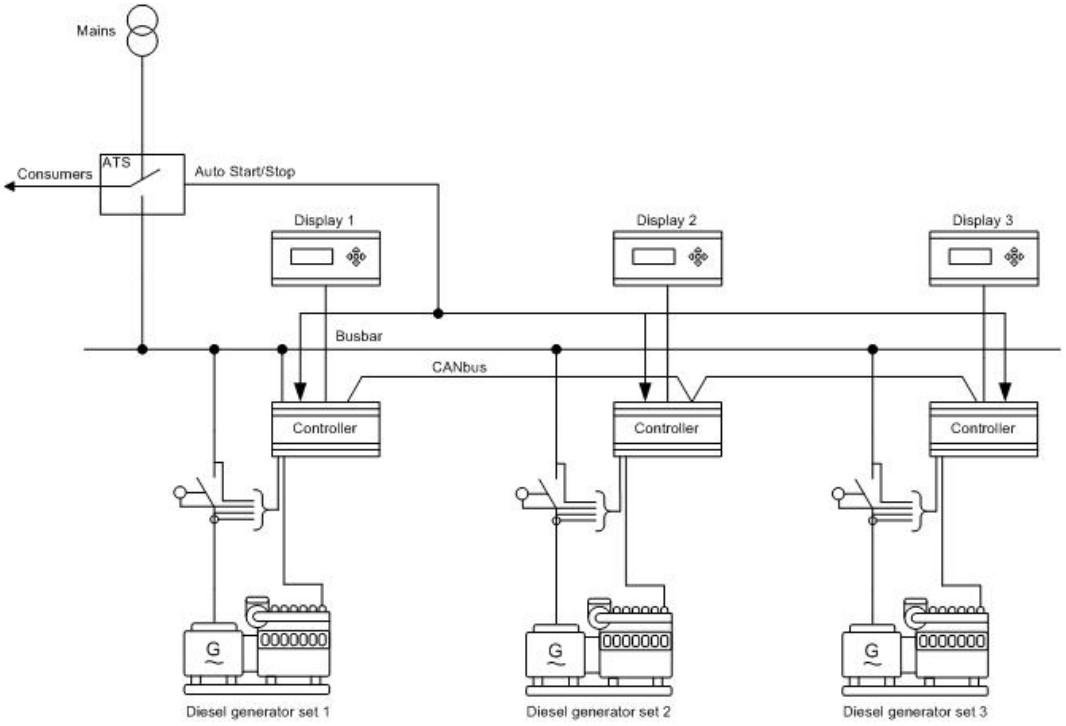
The tie breaker can only be placed as shown in the drawing.

In this application it will not be possible to synchronise the tie breaker.

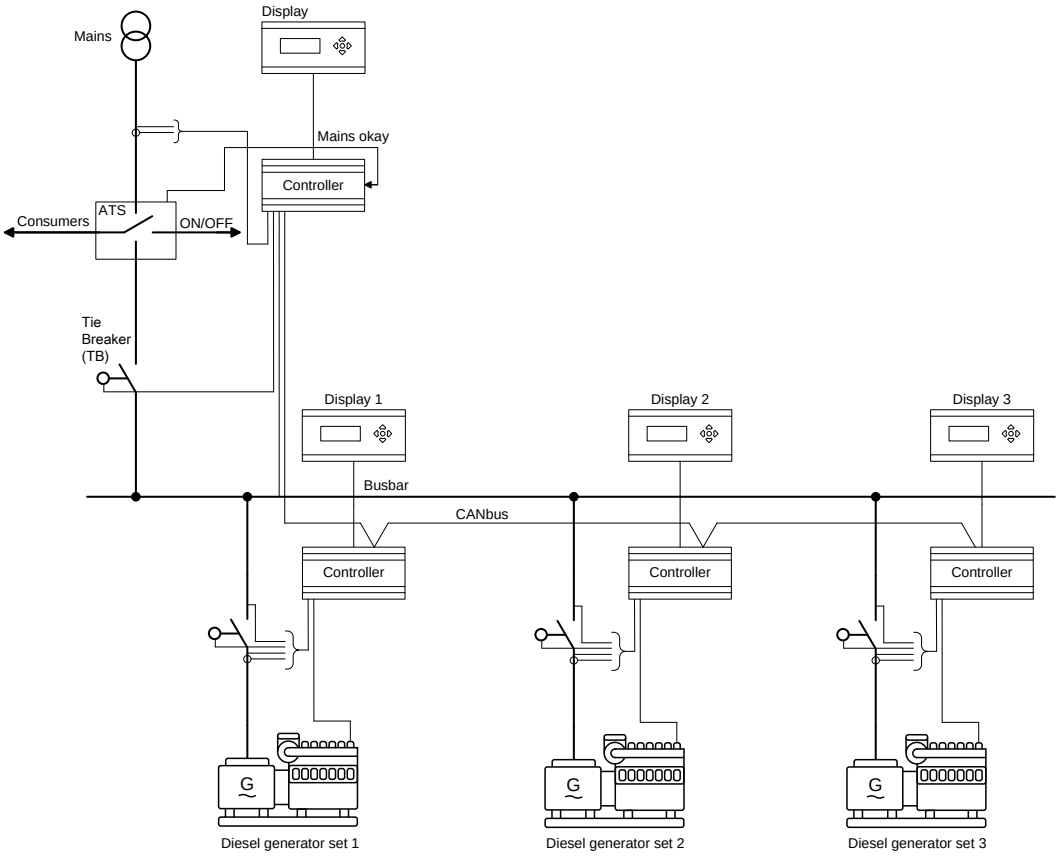
4.3.5 ATS plant

Applications that use an ATS for switching between mains supply and generator supply are supported as well. Two application examples which use an ATS are shown below.

4.3.6 ATS plant, multiple start

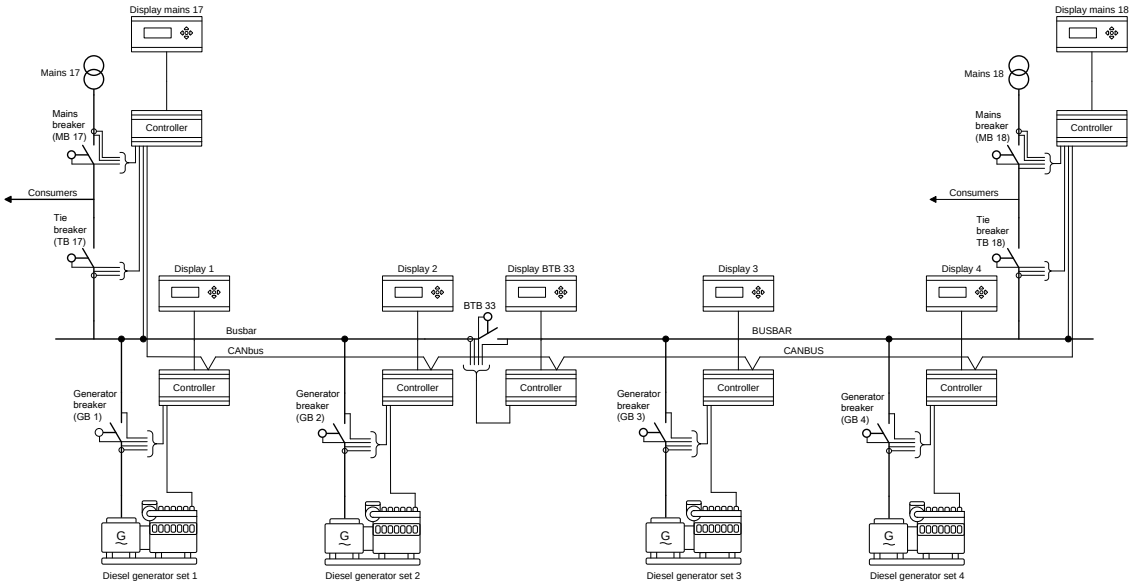


4.3.7 ATS plant, mains unit



4.3.8 Multiple mains

An example of a multiple mains plant is shown below. This is just an example; please refer to the chapter on multiple mains for further information about the possible combinations.



5. Display units

5.1 DU for option G5

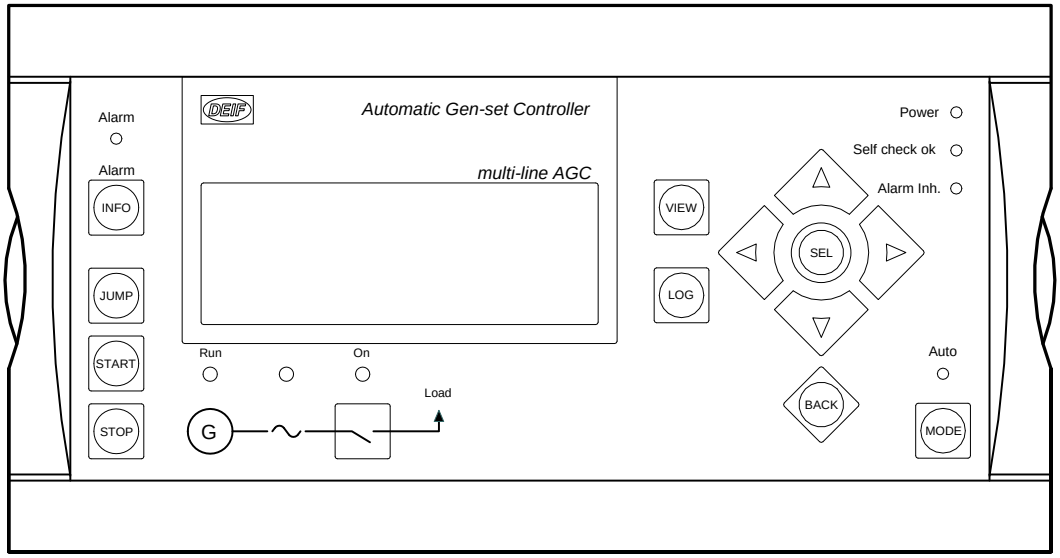
5.1.1 Option G5 displays

Three displays exist for the option G5.

See the Designer's Reference Handbook or the Operator's Manual for detailed information about push-button functions and LED indication.

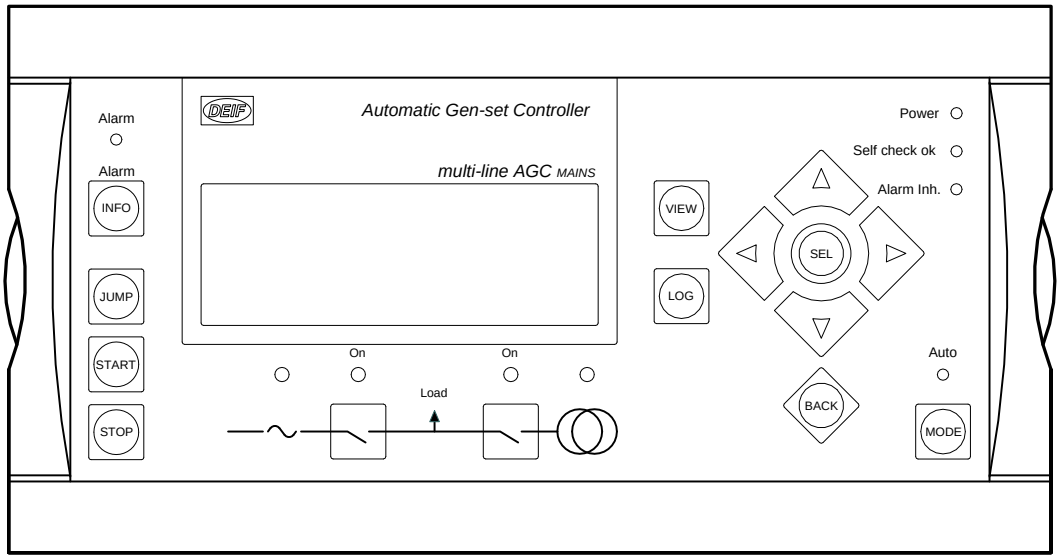
5.2 Generator unit display

5.2.1 Display



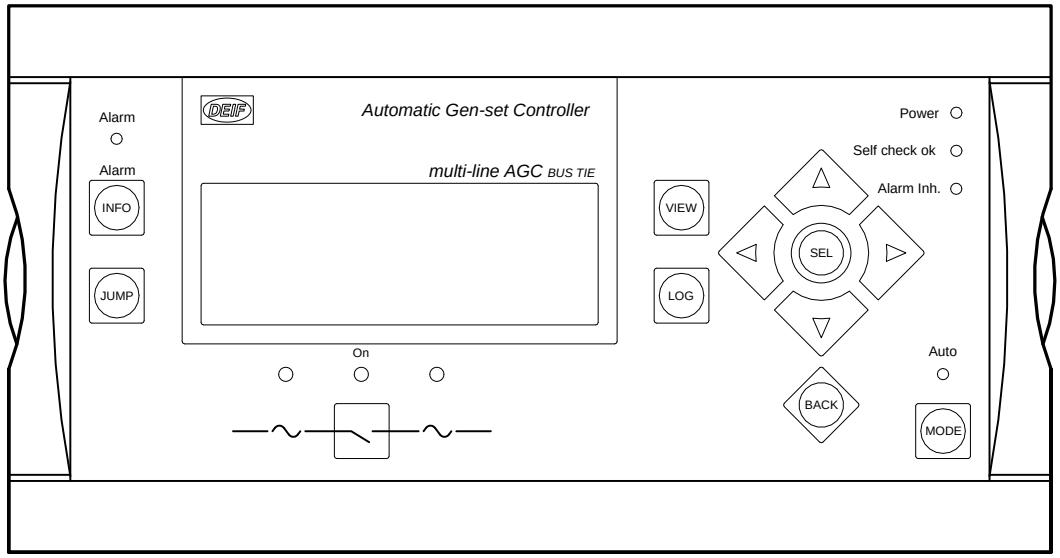
5.3 Mains unit display

5.3.1 Display



5.4 BTB unit display

5.4.1 Display



6. Power management setup

6.1 Initial power management setup

6.1.1 How to set up

The AGC is set up using the display and the PC utility software.

6.1.2 Display setup

Enter the menu 9100 using the JUMP push-button. Select one of the following AGC types:

1. Mains unit
2. DG unit
3. BTB unit

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

6.1.3 CAN bus setup

Enter the menu 9170 using the. Select "CAN protocol 2" for a multi mains functionality. Select "CAN protocol 1" for dual mains or single applications.

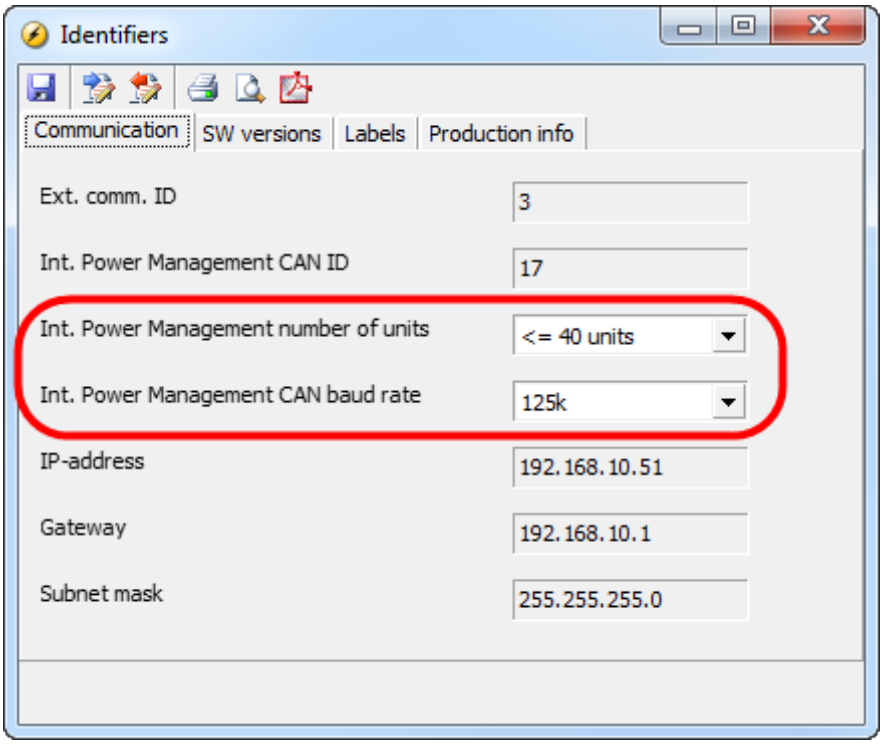
An alarm appears if CAN protocol 2 is needed.

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.

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:



6.1.4 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.

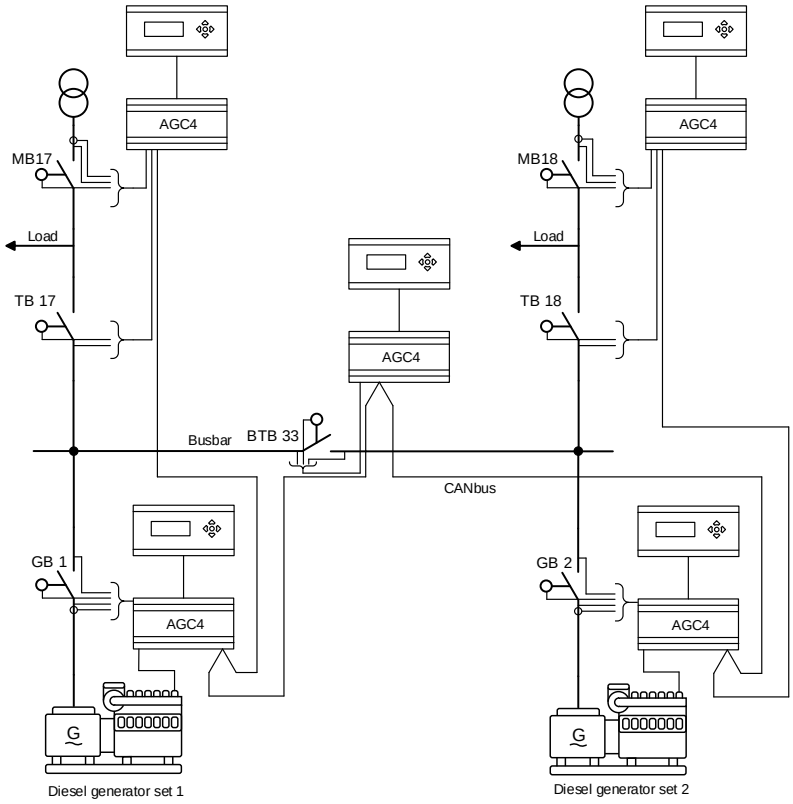
First, you must follow the CANbus lines and decide which one should be named PM CAN primary, and which one should be named PM CAN secondary.

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

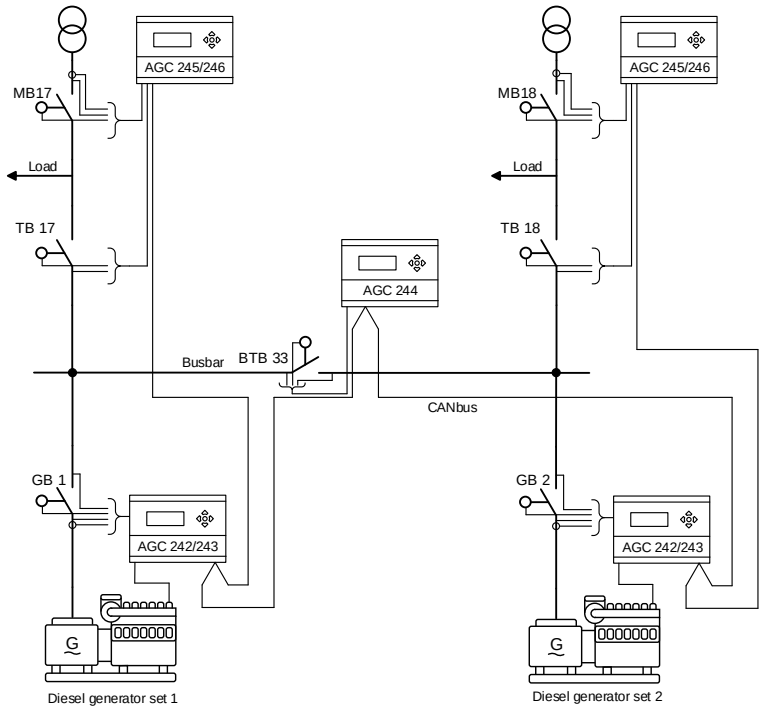
It is now possible to select whether the CANbus line should be named PM CAN primary or PM CAN secondary. It does not make a difference which one is selected when the application only has one CANbus line, as long as it is the same in all controllers. In this example, PM CAN primary is selected. It is 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

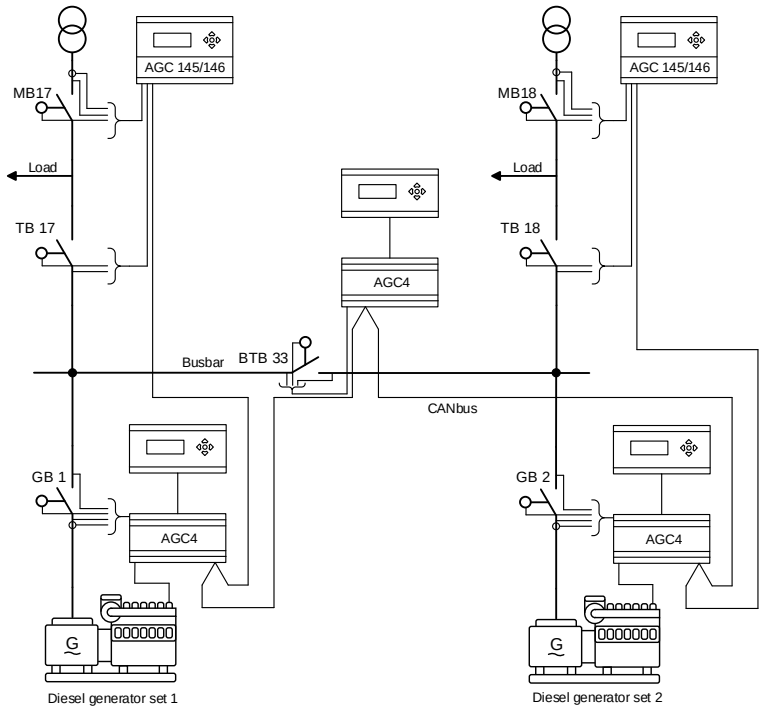
It is now possible to select whether the CANbus line should be named PM CAN primary or PM CAN secondary. It does not make a difference which one is selected, as long as it is the same in all controllers. In this example, PM CAN primary is selected. It is then required to go to parameter 7840 in all controllers 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:

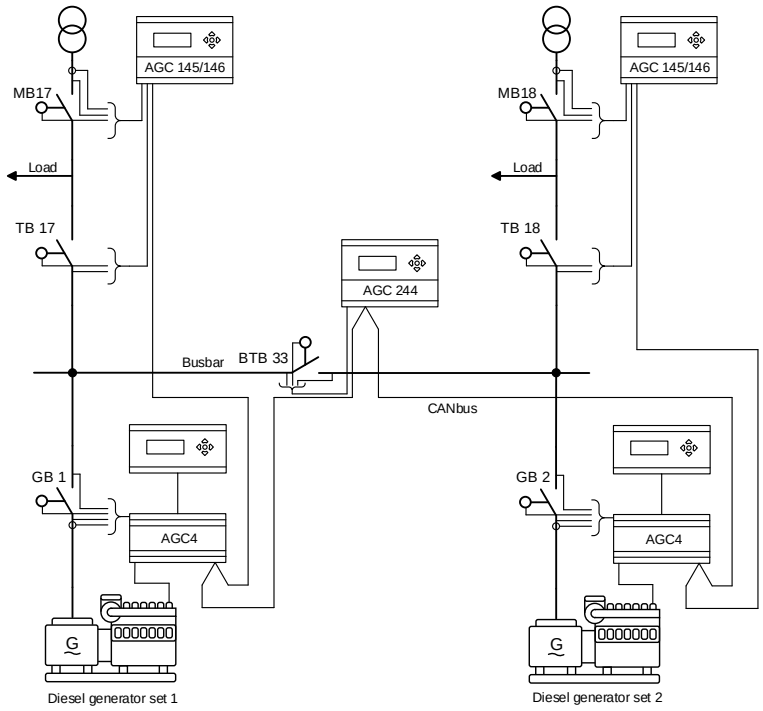


In this example, the application consists of a mix of AGC 100 units and AGC-4 units. The application is an H-coupling with two mains, two gensets and one BTB. The application only has one CANbus line between the units. The CANbus line goes to the terminal numbers shown in the table below:

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	1-16
Mains	AGC-4 with option G5 AGC 245 or AGC 246 AGC 145 or AGC 146	17-32
BTB	AGC-4 with option G5 or G4 AGC 244	33-40

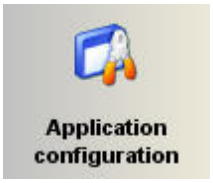
The different controllers cannot have the same ID.

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

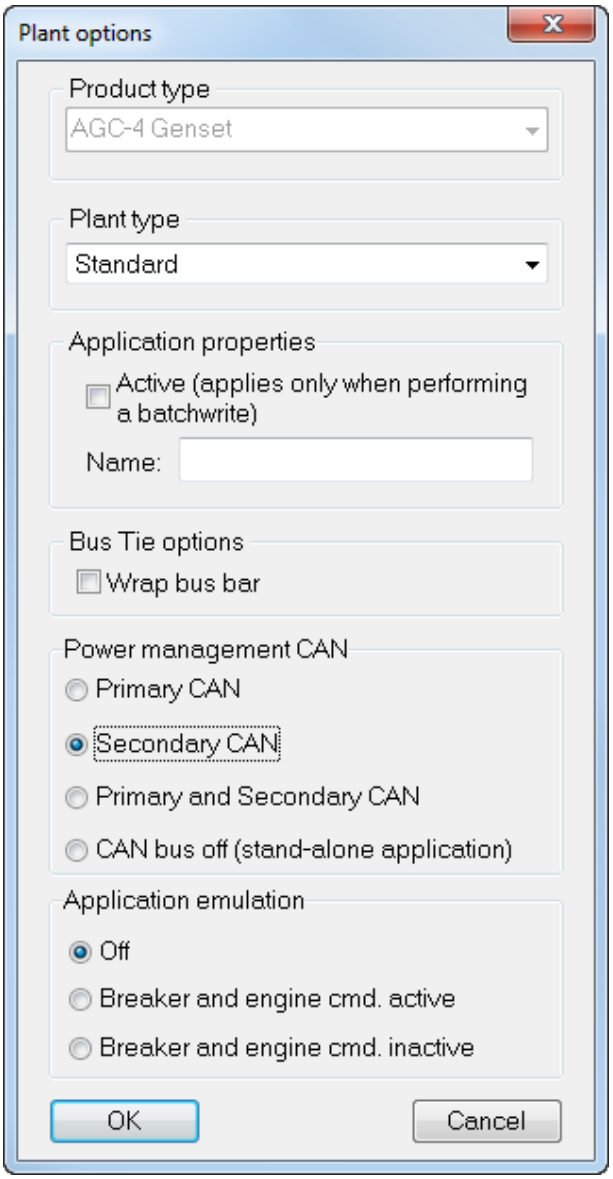
The selected IDs are set in parameter 7530 in each controller. Now it is possible to use the utility software and make the actual application design for the controllers. The controllers must know the application design in order to operate correctly in different auto sequences.

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:

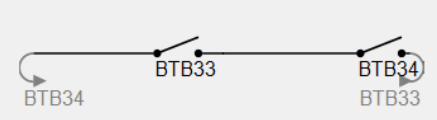


An empty window will appear. To make an application design for the controller, press the New plant configuration button shown below.

The Plant options window shown below will appear.

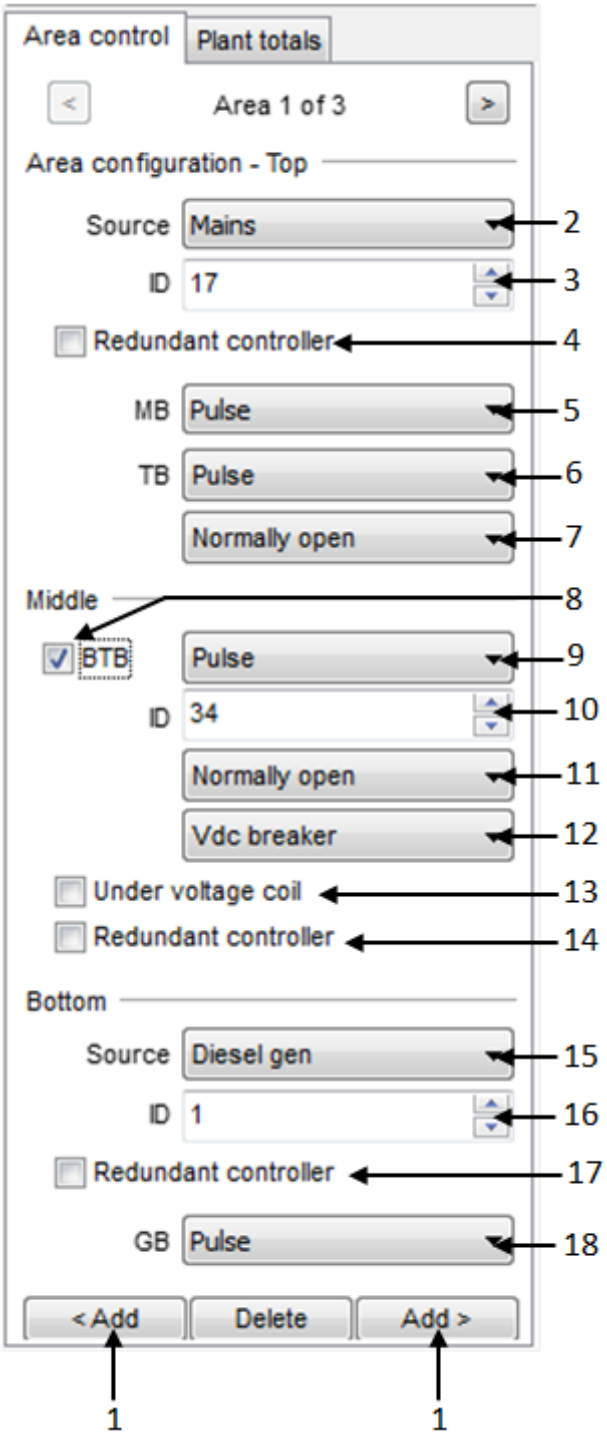


The plant options are described in the table below:

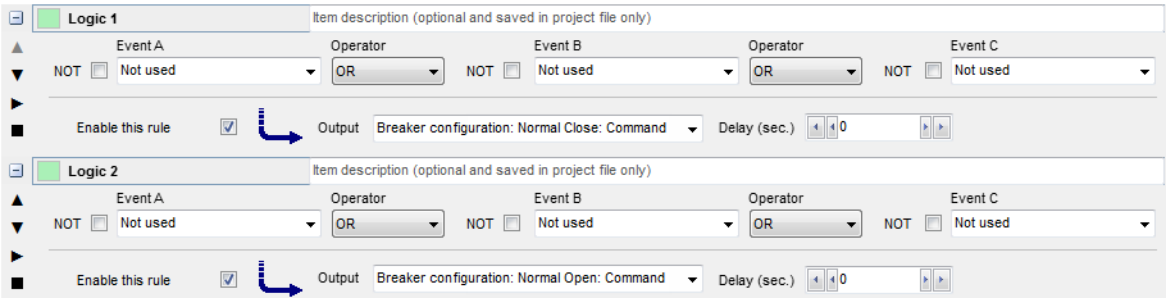
	Description	Comments
Product type	Controller type is selected here.	This function is greyed out if a controller is already connected.
Plant type	Select between ● Single DG ● Standard ● Genset group plant ● Genset group	"Standard" should be selected for power management systems. If "Single DG" is selected, 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 standalone 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.

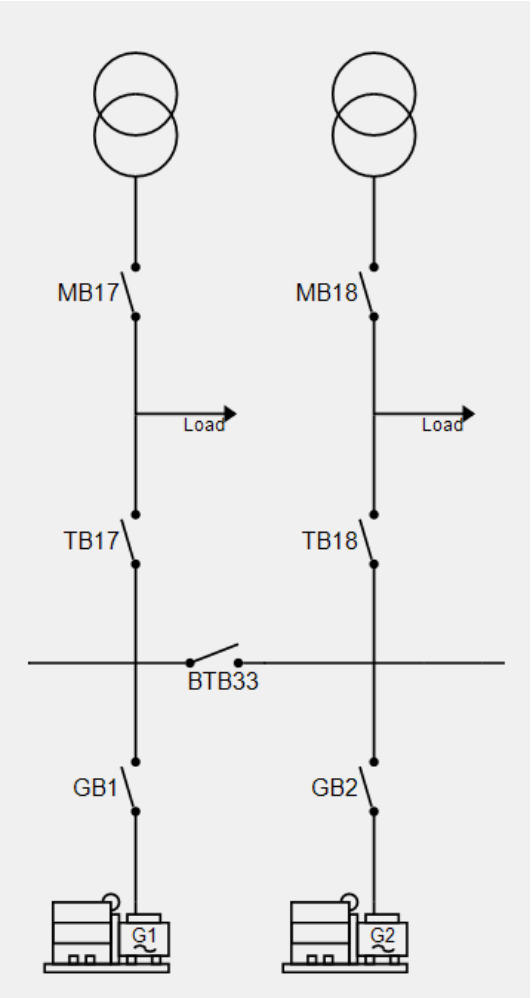
Now, controllers can be added to the design, and it can be selected which type of breakers is present in the application. This is done from the left side of the utility software.


Area control
Plant totals
Area 1 of 3
Area configuration - Top
Source
Mains
2
ID
17
3
Redundant controller
4
MB
Pulse
5
TB
Pulse
6
Normally open
7
Middle
8
BTB
Pulse
9
ID
34
10
Normally open
11
Vdc breaker
12
Under voltage coil
13
Redundant controller
14
Bottom
Source
Diesel gen
15
ID
1
16
Redundant controller
17
GB
Pulse
18
< Add
Delete
Add >
1
1

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:



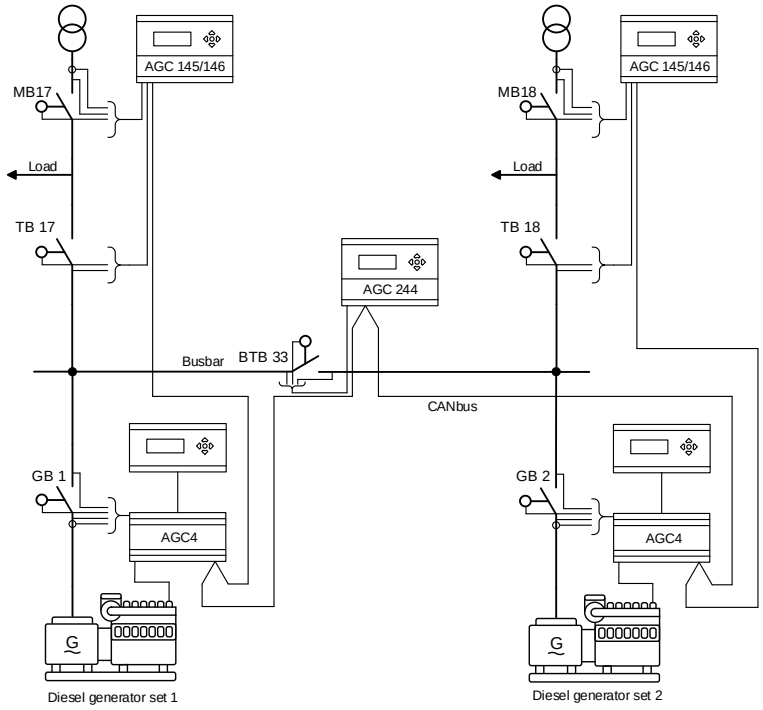
Subsequently, the configuration for the plant must be sent to the units. This can be done by pressing the Write plant configuration to the device button, which looks like this: 

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.

Control-ler	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

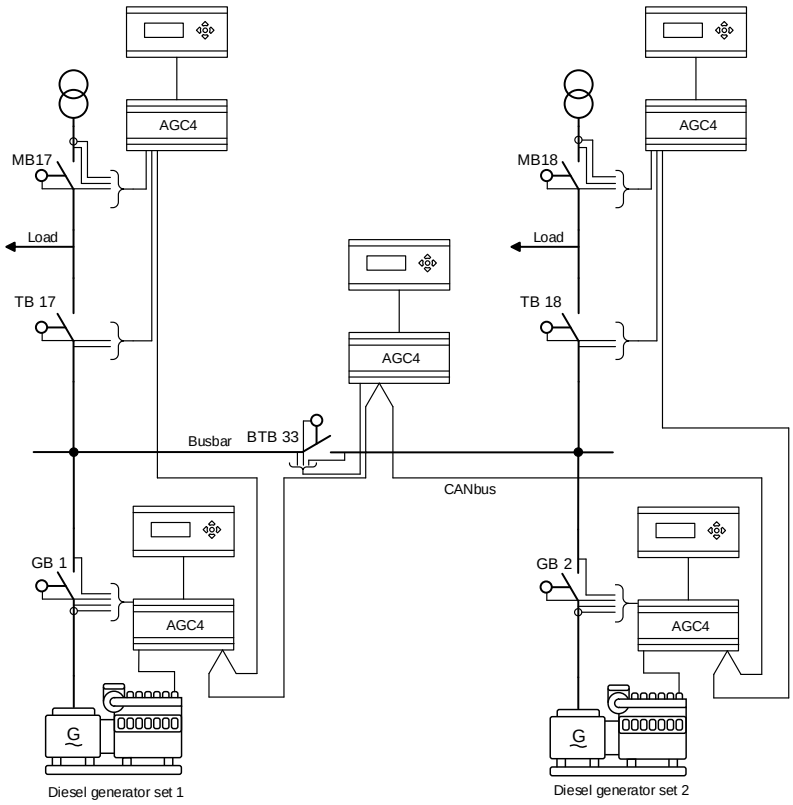
Note that all controllers with older software (4.4x or older) use the same CAN port. When the controller with older software uses CAN port A for power management communication, the setting in the controller with newer software should be PM CAN primary.

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

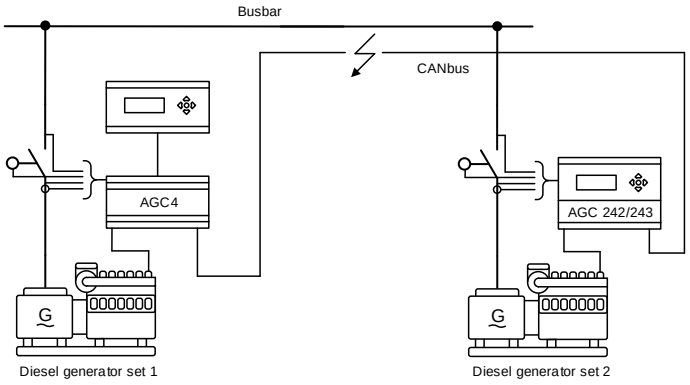
If one of the CAN lines should break, there are alarms related to this which can be helpful when troubleshooting. This is described in the chapter CANbus failure handling.

6.2 CANbus failure handling

6.2.1 CAN failure mode

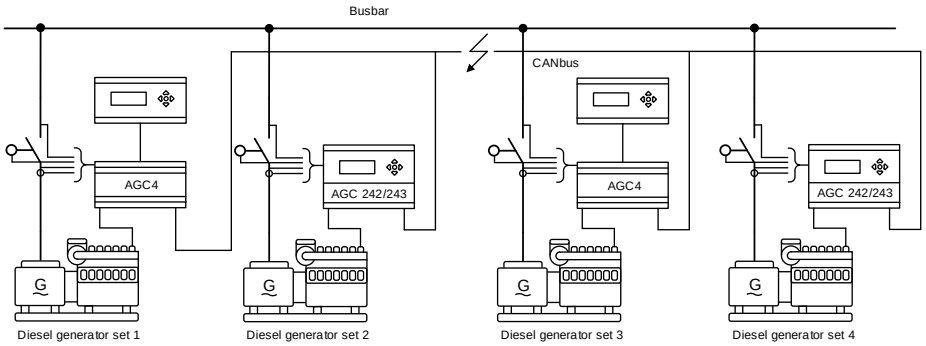
The system behaviour can be set up in different ways to handle a CAN failure on the CAN controlling the power management. In menu 7530, it is decided how the power management system will react in case of a CAN failure. There are three selectable modes the controllers should change to in case of a CANbus failure:

1. **Manual:**
   If "MANUAL" is selected, all the AGC units will change mode to manual mode. In this way, the regulators will have no reaction, and it will not be possible to close any breakers (unless the breakers are already within the limits for the sync. window or black busbar). Manual mode is not selectable in 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.
   Manual mode can also be described with an example:



   If the wire break occurs before the engine is started, the controller is not allowed to start the engines. If more than two gensets are present in an application and manual is selected, none of the gensets will be able to loadshare. Only the protections are active.
   Be aware that when a CANbus failure is present, the risk of blackout is also present, since load sharing does not take place in manual mode.

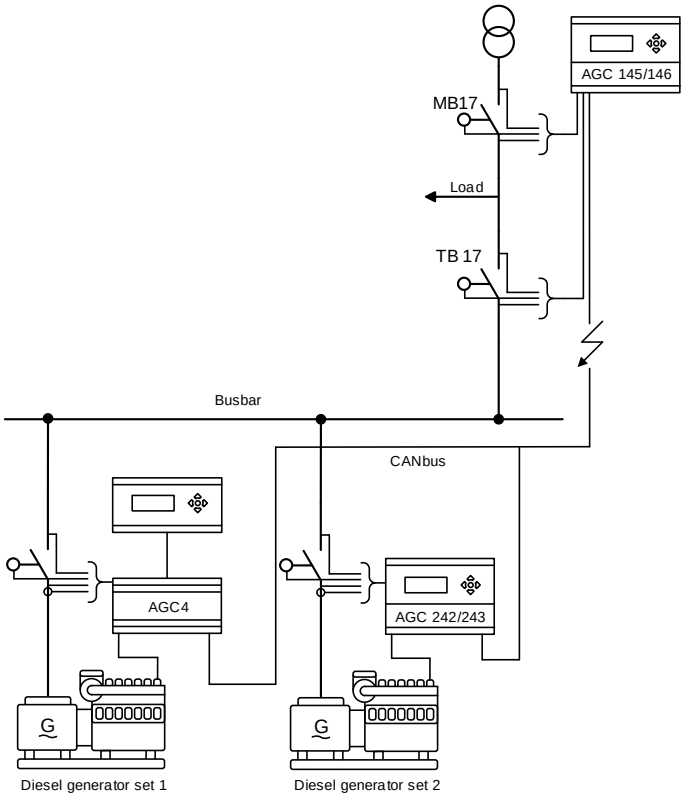
2. **Semi-auto:**
If "SEMI-AUTO" is selected, the AGC units will change to semi-auto mode when a CANbus failure alarm occurs.
In semi-auto mode, the regulators in the AGC units are still active. This means that the gensets that are visible to each other are able to loadshare. This is explained by an example:



In the diagram above, the CANbus 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 loadshare with each other, and gensets 3 and 4 are able to loadshare 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 CANbus failure occurs when the gensets are stopped, they will not be blocked, and in this way it will be possible to start them.

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

3. **No mode change:**
If "No mode change" is selected, all the AGC units will be kept in the mode the where in before the CANbus failure occurred. In an application with several mains, BTBs and several gensets, if one genset is not visible anymore, the rest of the system can still behave almost like normal and in auto mode. But if the CANbus 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 CANbus failure will be a problem, since the gensets will receive a start signal from the mains controller when the mains fails. But since the CANbus 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 CANbus fail class settings (7530) in order for the system to handle the situation correctly.

6.2.2 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.

6.2.3 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.

6.3 Remove and add units

6.3.1 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.

6.3.2 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.

6.4 Quick setup

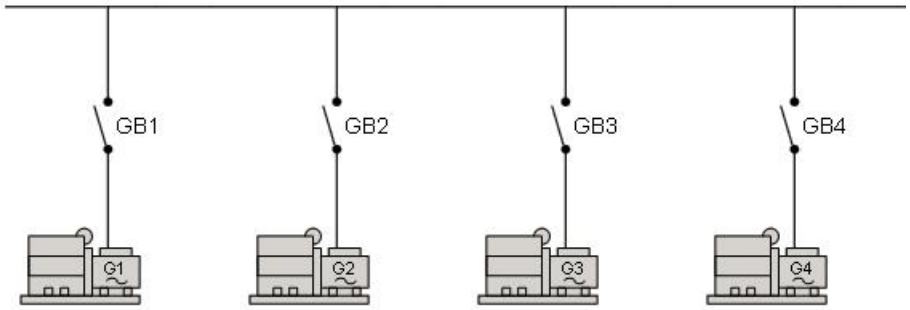
6.4.1 Quick setup

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.

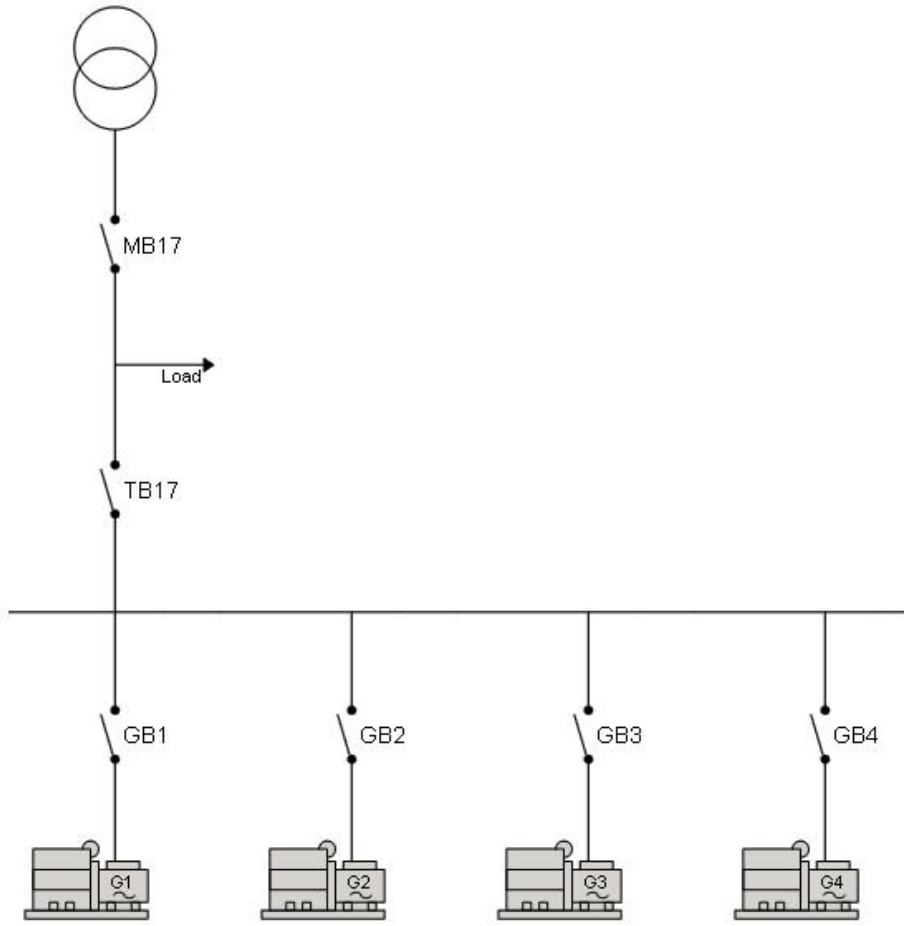
It is often applications for the rental market that need this flexibility, and therefore there are some limitations as to which applications that can be handled through the quick setup menu.

The following applications can be handled through the quick setup menu.

Island applications



Simple applications with connection to one mains



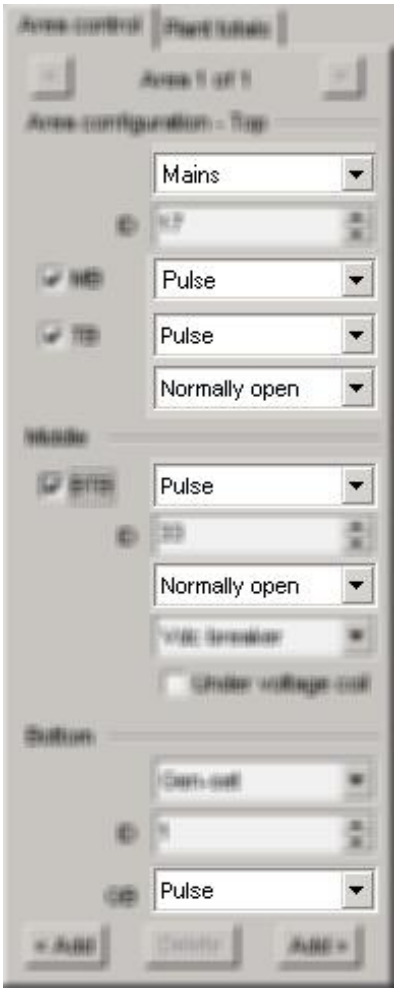
6.4.2 Limitations

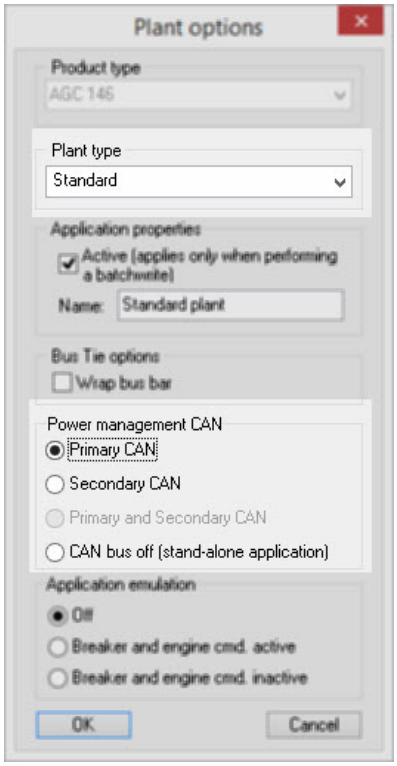
In most cases, the rental applications are very simple applications, and therefore there are some limitations that have to be considered when using the quick setup menu:

- It will not be possible to have any AGC bus tie units in the application.
- It will not be possible to set up a "dual mains" application through the quick setup menu.

This function is made to facilitate change of a plant configuration without AGC 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 screen shots below can be accessed through the quick setup menu.





6.5 9180 Quick setup

6.5.1 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 are 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.

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 IDs of the existing gensets in the application will maintain their ID, 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.

6.5.2 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

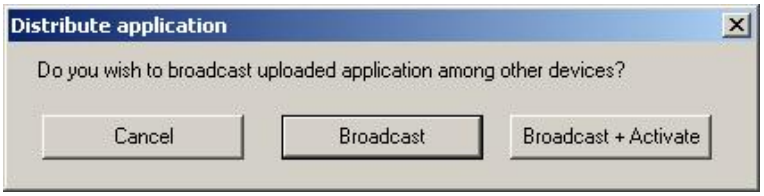
OFF: When it is set to OFF, no broadcast will be made.

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.



7. Power management functions

7.1 Command unit

7.1.1 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 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.

7.2 Load-dependent starting and stopping

7.2.1 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 setpoints and priority selection.

The load-dependent start/stop function can be selected as:

- Rated power setpoint (P) [kW]
- Apparent power setpoint (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.

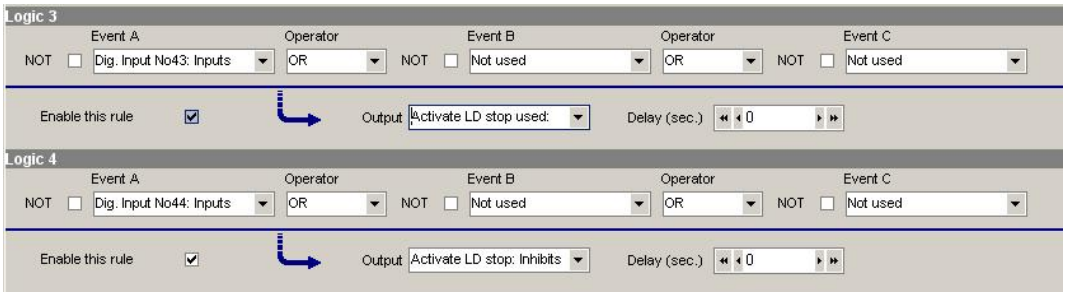
7.2.2 Terminology

The table shows the abbreviations used.

Short	Description	Comment
$P_{AVAILABLE}$	Available power	P_{TOTAL} - $P_{PRODUCED}$
P_{TOTAL}	Total power	$\Sigma P_{NOMINAL}$ 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 43. Now the operator can switch the load-dependent stop ON or OFF with a switch connected to terminal 44.

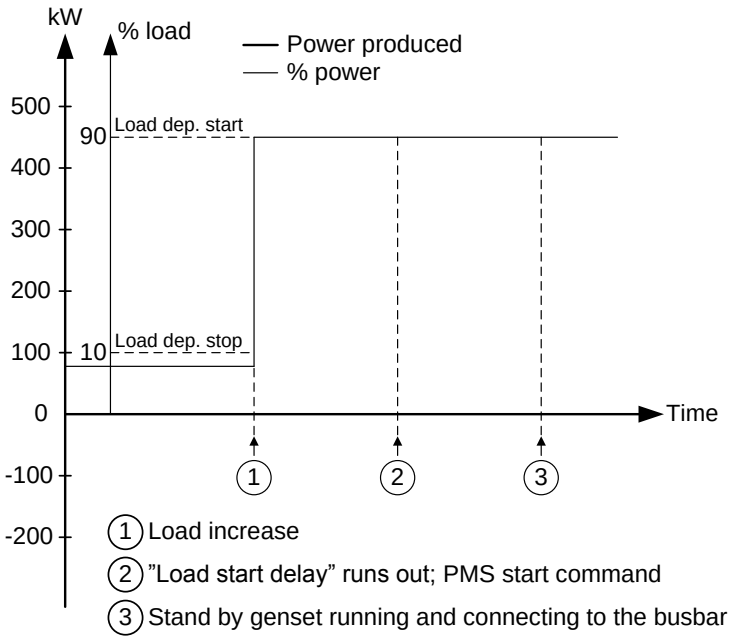


Produced power method
This method is in effect if % power is selected in menu 8880 as basis for the start/stop calculation.

If the load % of a generator exceeds the "Start next" setpoint, 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" setpoint, 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 setpoint in % is available, then the stop sequence of this generator will be initiated.

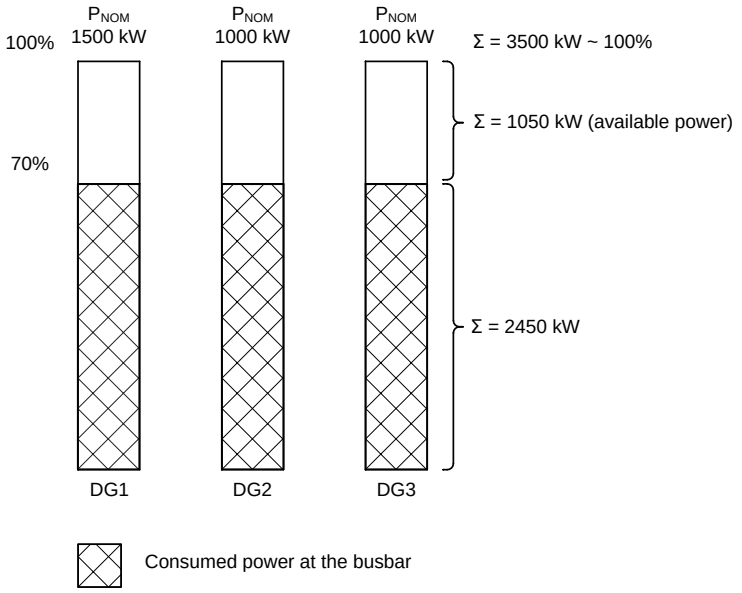


Available power method
This method is in effect if P [kW] or S [kVA] is selected as basis for the start/stop calculation.

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 setpoint is typically selected if the connected load has an inductive character and the power factor 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:

DG1 =	1500 kW
DG2 =	1000 kW
DG3 =	1000 kW
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 P_{TOTAL} is 3500 kW, and the produced load $P_{PRODUCED}$ is 2450 kW, then the available power $P_{AVAILABLE}$ is 1050 kW, meaning that the gensets can handle this load if it should be added to the busbar.

7.2.3 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 (P_{STOP} = 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.

7.2.4 Principle – percentage method

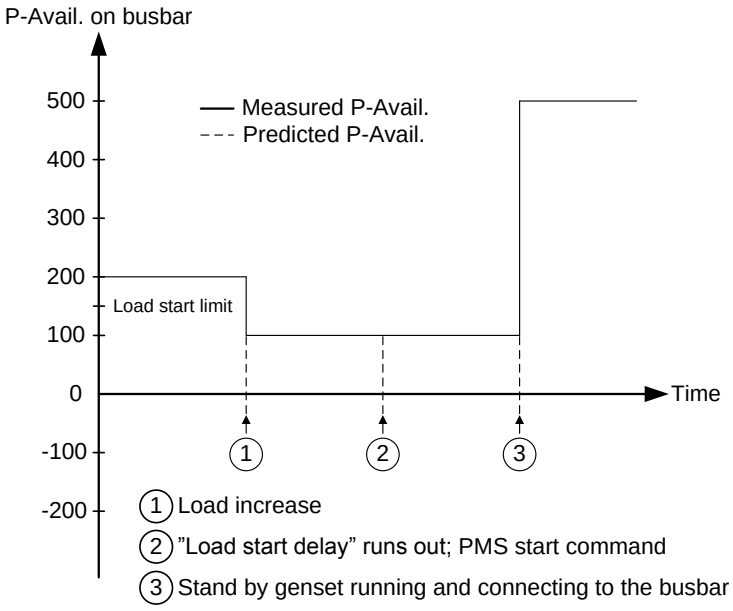
One genset is running and is supplying the load. The load increases which means that the % load increases. At a certain time the load has increased so much that the load % start will start up the next priority genset in order to take some of the load.

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, the last priority generator will produce 20% (200 W) after stop. It is necessary that the start level is above this value, otherwise an ongoing starting and stopping will take place.

7.2.5 Adjusting load-dependent start

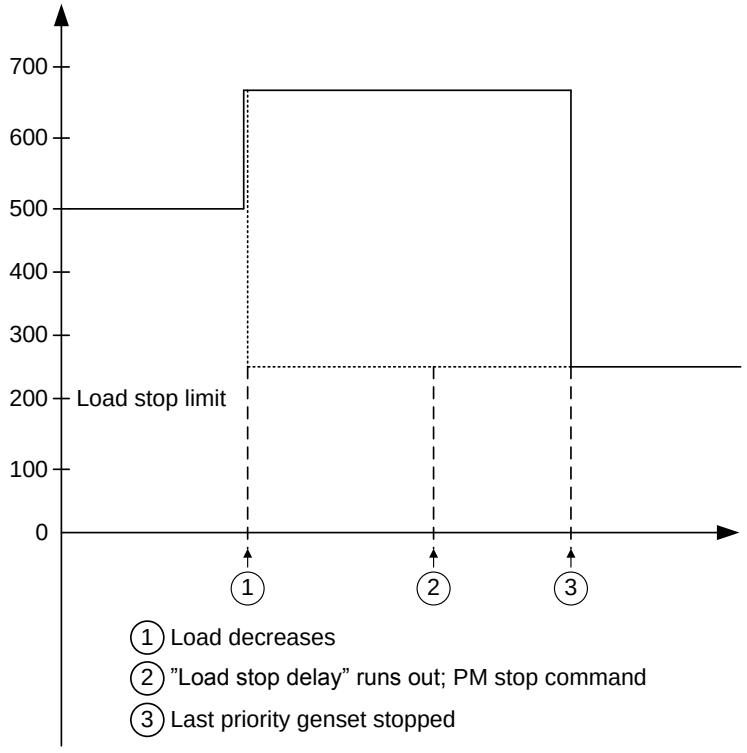
In the example below the available power is 200 kW. When the load increases, the available power drops below the start limit. The stand-by genset will start when the start timer runs out, and after the synchronising the available power increases (in this example to 500 kW).



7.2.6 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 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!

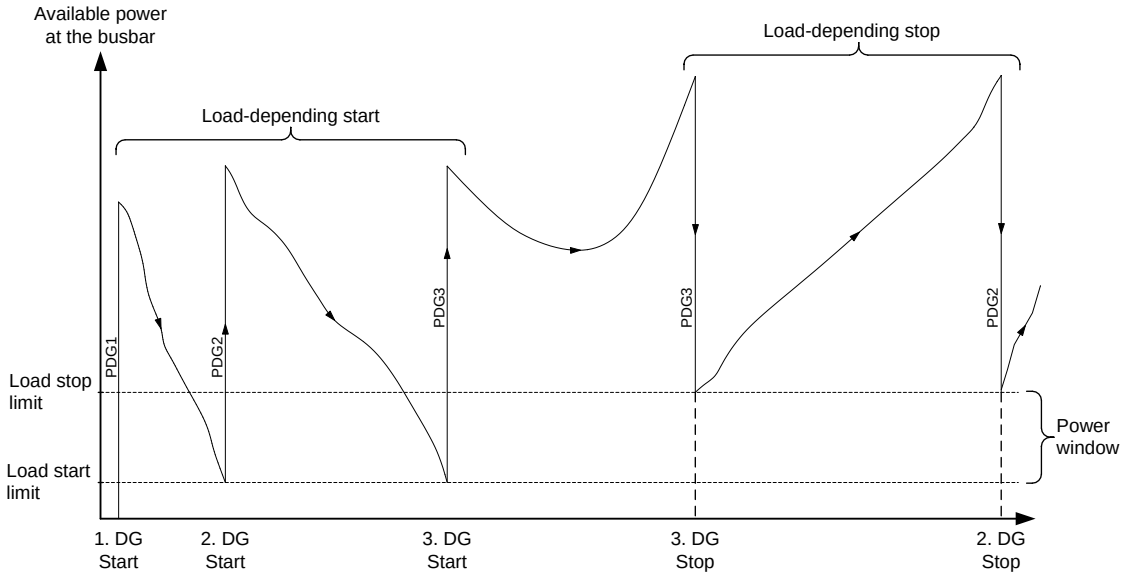


If the order of priority is changed, the following must be observed:

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.

7.2.7 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:



7.3 Load management

7.3.1 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

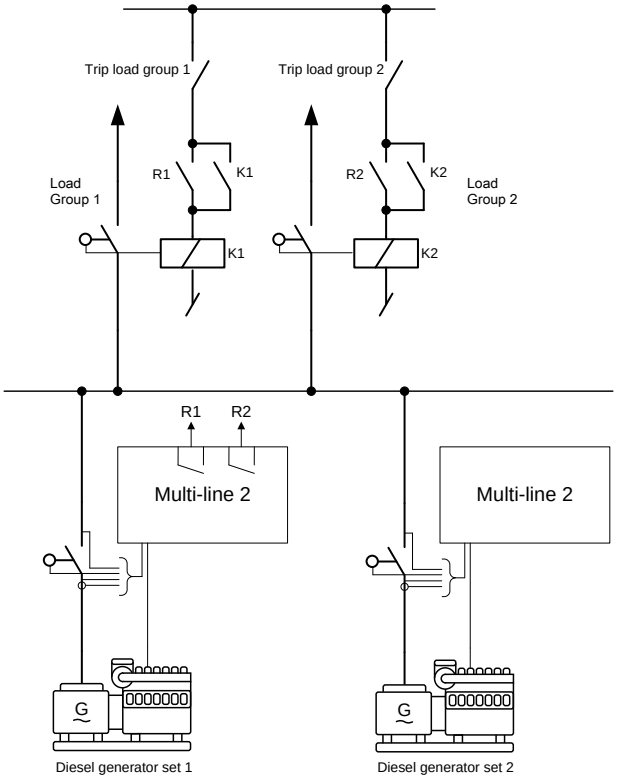
These setpoints can activate a relay when the specific amount of available power is reached. The relay output can be used for connecting load groups when sufficient power is available. The relays will activate when the available power is higher than the setpoint, but be aware that when the load groups are being connected, the available power will decrease and the relay(s) deactivate again if the available power is below the setpoint. So it is necessary to make an external holding circuit.

The number of available relays is option-dependent.

Regarding the inhibit function, please refer to the Designer's Reference Handbook.

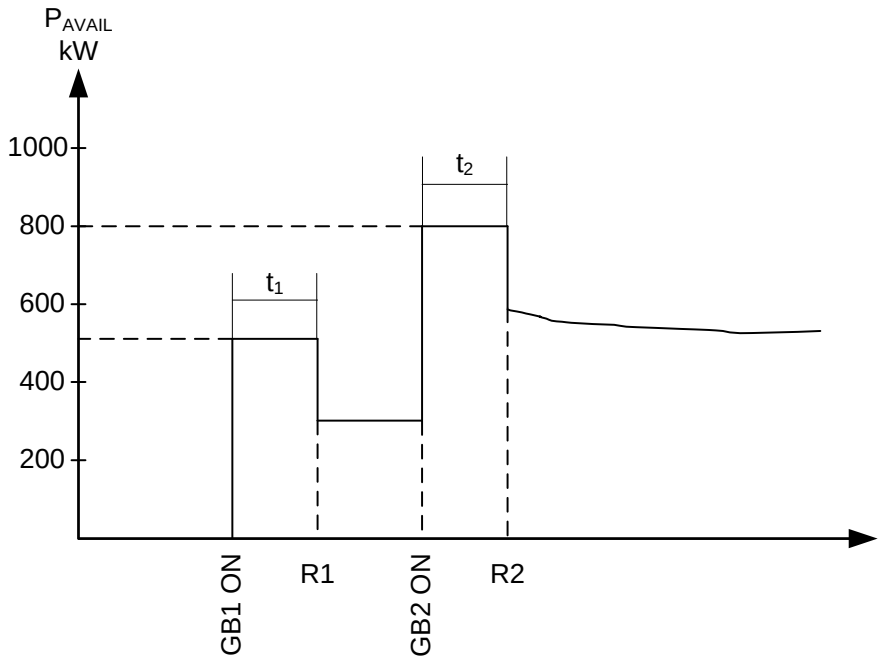
It is possible to adjust different levels of available power in all gensets. This gives the possibility to use several load groups if this is necessary.

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 AGC1.



7.3.2 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 is 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 or on one of the AGC units only.

7.4 Load sharing

7.4.1 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 units.

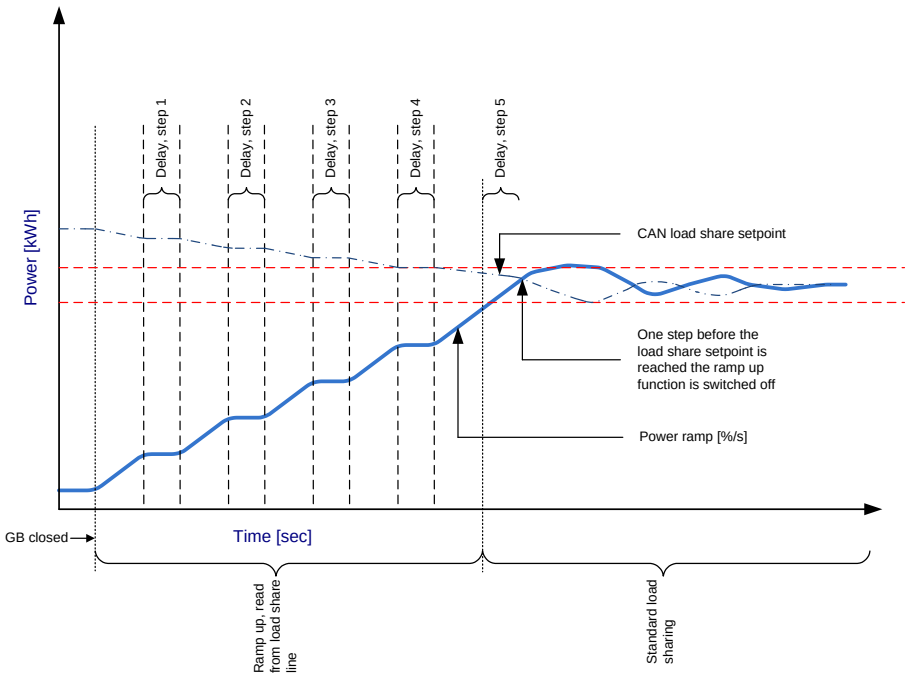
If both CANbus ports are being used (A1-A3 and B1-B3), the communication automatically switches to the other port if e.g. A1-A3 is disconnected or faulty. (Please refer to the description of redundant CANbus).

If both CANbus lines are disconnected or faulty, the AGCs do not automatically switch over to analogue load sharing. This has to be set up in M-logic: Use the command "Force analogue loadshare". Now the load sharing continues based on the signals from terminals 37/38/39. This means that the power management will be lost, but the gensets already running will stay stable.

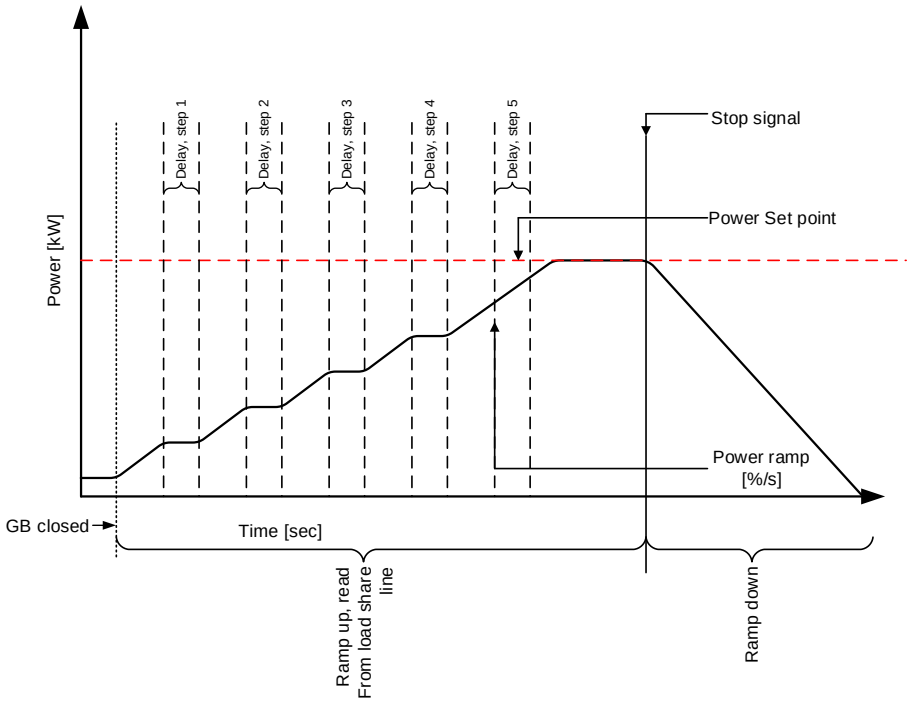
The option G3 has to be active to have the backup of the analogue load share line.

7.5 Island ramp up

7.5.1 Island ramp up with load steps



7.6 Fixed power ramp up with load steps



When menu 2614 is enabled, the power setpoint continues to rise in ramp up steps, determined by menu 2615, towards the load sharing setpoint. The delay time between each ramp up step will be determined by menu 2613. The ramp up will continue until the load sharing setpoint 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 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 system setpoint. If the setpoint is at 50%, the ramp will stop at 50%.

7.7 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 setpoint 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.

7.8 ATS applications

Two possibilities are available; the mains unit can either be installed or not.

7.8.1 AGC mains installed

See single line diagram for "Parallel with mains plant".

In an AMF application the AGC 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 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 has no control over the ATS ("mains breaker").

Description
Normally the AGC 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 measurements but by the following two requirements:

1. Alternative start input ON
2. ATS (MB) feedback OFF

To make the AGC 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.

7.8.2 ATS island mode

See single line diagram for "Island operating plant".

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.

7.9 Fail class

The fail classes described in the Designer's Reference Handbook are still valid when the power management option is selected. In addition to these fail classes the safety stop can be used in the AGC 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 standby 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.

7.10 Local/remote 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

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/Profibus communication.

7.10.1 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.

7.10.2 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 generator AGCs can be used for starting the plant. However, DEIF recommends to wire up the "auto start/stop" input to all of the AGCs 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).

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 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 for starting the plant.

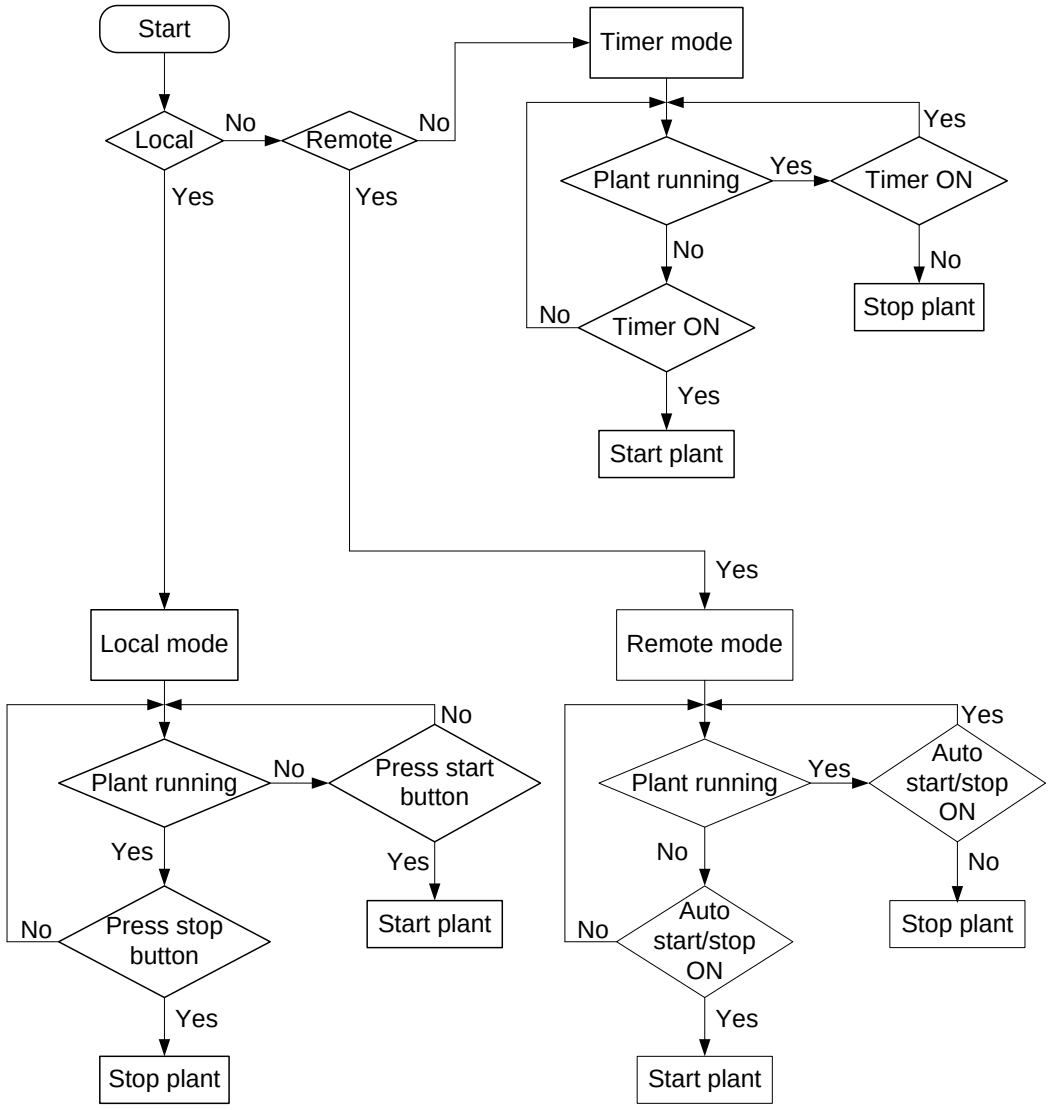
7.10.3 Plant operation

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).

7.10.4 Principle



7.11 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 through push-button, digital input or automatic start, then the adjusted numbers of gensets will start.

This function is typically used e.g. 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 setpoint).

The multi start function is adjusted in menu 8922-8926.

7.11.1 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.

	Setpoint 1	**Setpoint 2**
Multi start (numbers to start)	8922	8925
Min no. running	8923	8926

Default setting

	Start condition	**Setpoint 1**	**Setpoint 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 setpoint 1 and setpoint 2 is made so the setpoint 1 is adjusted to "Auto calculation" and is used in all modes except for AMF. Setpoint 2 will automatically be selected in case a mains failure occurs (this is adjusted in M-logic). Setpoint 2 is adjusted to 16 gensets which means that all available gensets will start when the mains failure occurs.

The default setting can be changed, if convenient.

7.11.2 Numbers to start

The numbers to start (menu 8922/8925) can be selected depending on the number of DGs available. The load-depending 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 depending on the plant mode.

Example:
In a four DG plant each generator is rated with 1000 kW. The setpoint for load-dependent start (menu 8001) is adjusted to 100 kW.

If a start command is given in fixed power mode and the setpoint 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.

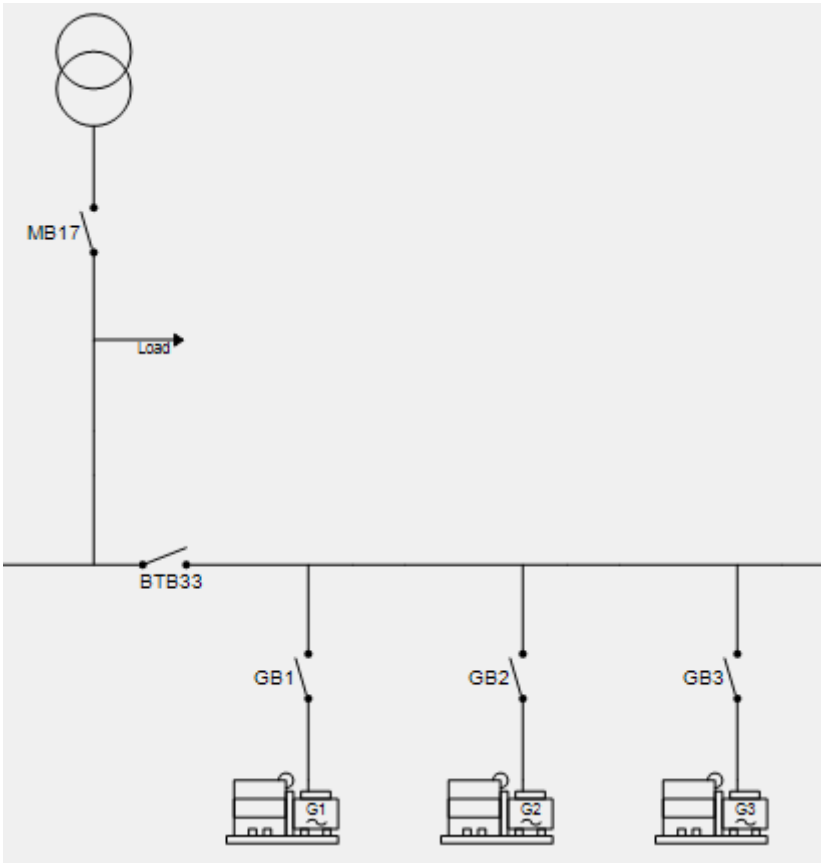
7.11.3 Minimum numbers running

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.

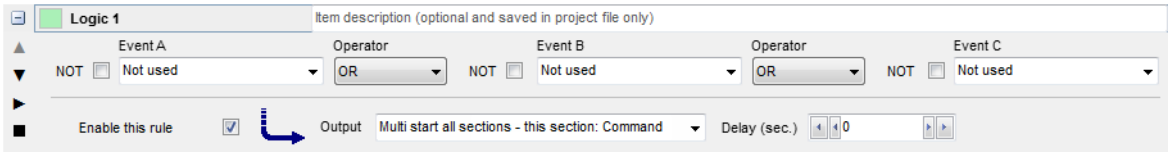
"Numbers to start" (menu 8922/8925) and "Minimum numbers running" (menu 8923/8926) are available for all modes.

7.11.4 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.

7.11.5 Fast start of engine

In some situations, a fast response of the power management system is desirable. This feature, "Fast start of engine", gives the possibility to initiate the start sequence of the engine with a minimum of time delay.
One scenario could be an AMF system, in which it is desirable to minimise blackout time after a mains failure.
Another scenario could be an island system, in which the fastest possible start-up is desirable.

For "Fast start of engine" to be activated, some requirements in DG controllers must be met; these are listed below:

General requirements in the DG controller for "Fast start of engine":
- Option M4 with protocol interface version 1.01.4 or higher (check in jump menu 9070)
- Run coil setup delay, parameter 6151: Timer must be set to 0.0 sec.
- Start prepare delay timer, parameter 6181: Timer must be set to 0.0 sec.
- DG controller in AUTO
- Parameter 6070: Power management

General recommendations in the DG controller for "Fast start of engine":
- MultiStart: Set to 16 DG (both 8922 and 8925)

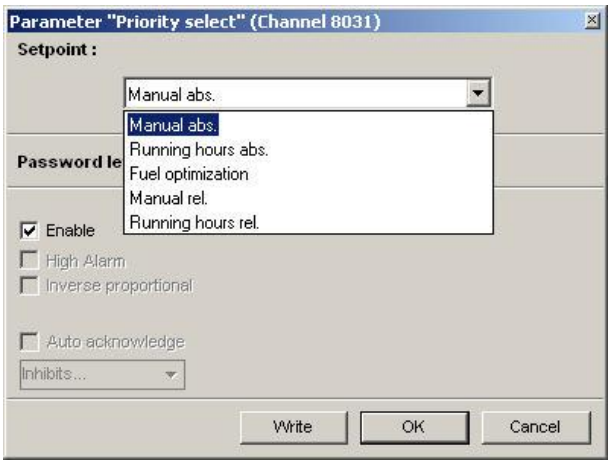
Power management, DG display showing "READY ISLAND - AUTO" :
- Digital input 117 must be configured as "Auto start/stop" via "I/O list" in the USW
- M-Logic output activated: "Fast start sequence from Auto start/stop via Digital input 117"

Power management, AMF with MAINS controllers:
- M-Logic output activated: "Fast start sequence from Mains via Power management"
- M-Logic output activated: "MultiStart all sections - this section"

To verify that the "Fast start of engine" feature is active, two events related to this feature can be found in M-Logic events in a DG controller:
- "Fast start sequence from Auto start/stop via Digital input 117 READY"
- "Fast start sequence from Mains via Power management READY"

7.12 Priority selection

It is possible to use one of five types of priority selection.



The parameter for each of the five priority selections will only be enabled (visible) when one of the five options is selected via the USW channel 8031, or by using the display parameter 8030 Priority select.

7.12.1 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.

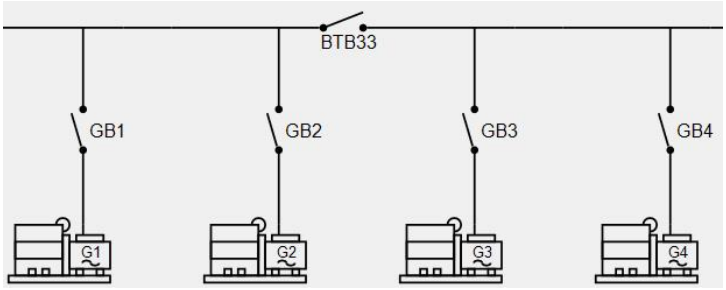
The adjustment is made in the menus 8080 (P1-P5), 8090 (P6-P11) and 8100 (P12-P16). In this example the order of priority is DG3, DG1, DG2, DG4.

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.

Manual abs. (absolute)
Scenario:
The four gensets in the drawing below are set up to have the same priority and ID (genset 1 has priority 1, etc.).

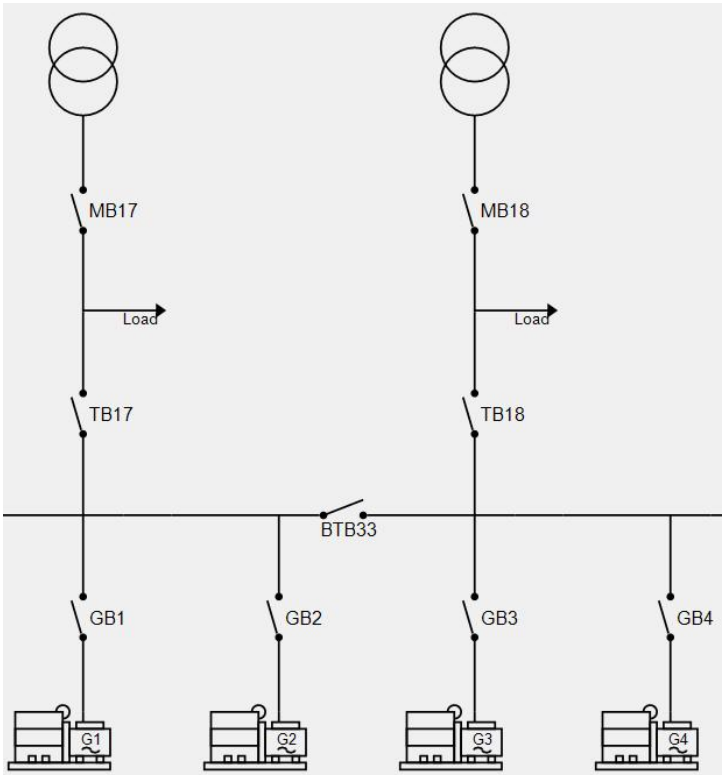
When sections are separated with a BTB and the gensets are in AUTO, the “Manual abs” setup will at all times keep the priority adjusted for each controller. If the BTB is open the four gensets can start and stop as two independent applications. E.g. if a genset is running on each side of the BTB, genset 1 and genset 3 will be running as the first priority gensets. If the BTB is synchronised and closed the genset 2 will start and take over the load from genset 3. When this is done, genset 3 is stopped and the application is now considered as one common application with four gensets.



Manual rel. (relative)
Scenario:
The four gensets in the drawing below are set up to have the same priority and ID (genset 1 has priority 1, etc.). “Manual relative” makes sense if there is a mains connection on each side of the BTB as shown in the picture below.

When sections are separated with a BTB and the gensets are in AUTO, the “Manual rel” setup will auto-change the priority depending on the position of the BTB and depending on which mains ID has the “ID to run” function activated.

If the BTB is open the four gensets can start and stop as two independent applications. E.g. if the gensets 3 and 4 are running on the right side of the BTB and the BTB is synchronised and closed, the gensets 1 and 2 will not start and take over the load from gensets 3 and 4 as they are seen as new gensets being available in an already running application, and gensets 1 and 2 will now become priority 3 and 4.



7.12.2 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 for 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 e.g. when the AGC is installed on an old genset which already has many running hours, or if an AGC is replaced.

Running hours abs. (absolute)
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 genset AGC in menus 6101 and 6102, typically at the commissioning. The purpose of the menu is to have the correct number of running hours displayed.

Running hours rel. (relative)
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 to reset the priority routine. When the reset is activated in menu 8113, the relative running hour counters in the AGC 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. ID3)	DG2 (int. ID2)	DG3 (int. ID4)	DG4 (int. ID1)	Comment
Monday	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	DG3 will be started, and DG2 will be stopped
Wednesday	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 number, and DG1 will be stopped
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 number… and so on

The time adjusted in menu 8111 is the time between each priority calculation.

7.12.3 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	Setpoint	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 setpoint 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. Below an example with three DGs is shown.

- 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 Setpoint = 100%
- 8172 Swap percentage = 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.

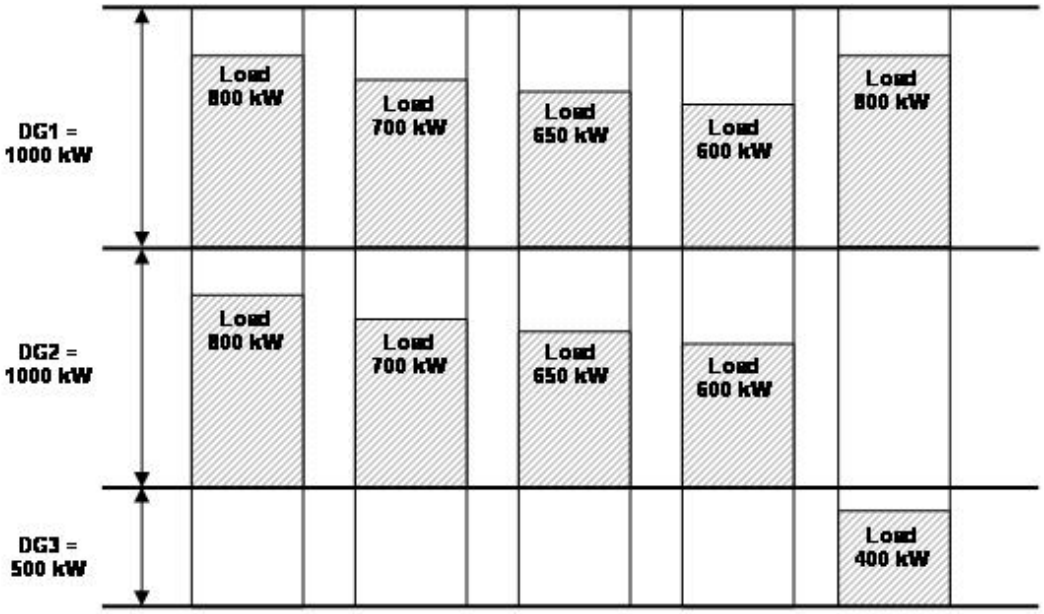
Situation 2:
Since the load has decreased to 1400 kW, it would be enough with one 1000 kW and one 500 kW genset. The improvement is 500 kW which is better than 200 kW (menu 8172). The problem is that only 100 kW would be available. The load-dependent stop requires 220 kW available, so no swapping can 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.

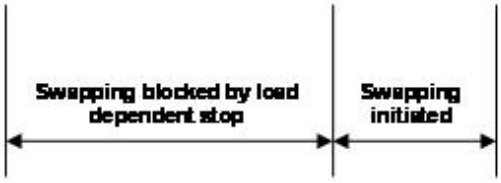
Situation 4:
Now the load has decreased to 1200 kW. It would be enough with one 1000 kW and one 500 kW genset. The improvement is 500 kW which is better than 200 kW (menu 8172). This means that 300 kW would be available, so the load-dependent stop does not interfere with the fuel optimising.

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_{GD1}	800 kW	700 kW	650 kW	600 kW	800 kW
P_{GD2}	800 kW	700 kW	650 kW	600 kW	0 kW
P_{GD3}	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	-



The setpoint (menu 8171) in percent is typically set to 80-85% for optimum fuel economy.

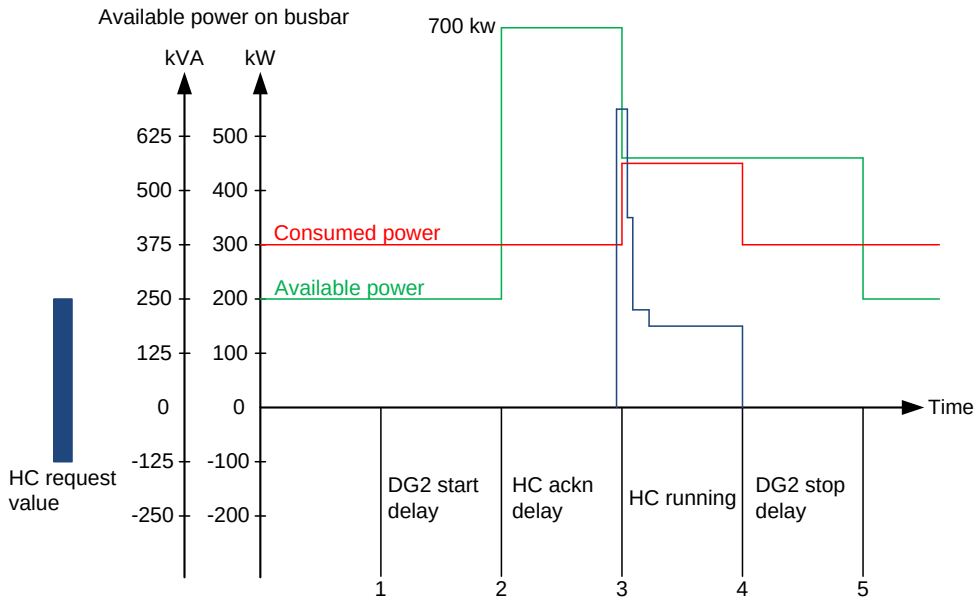
Running hours

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, 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 will still be in quarantine.

7.13 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 (HC) 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.

7.13.1 Power feedback from the heavy consumer

The AGC is able to handle two types of power feedback:

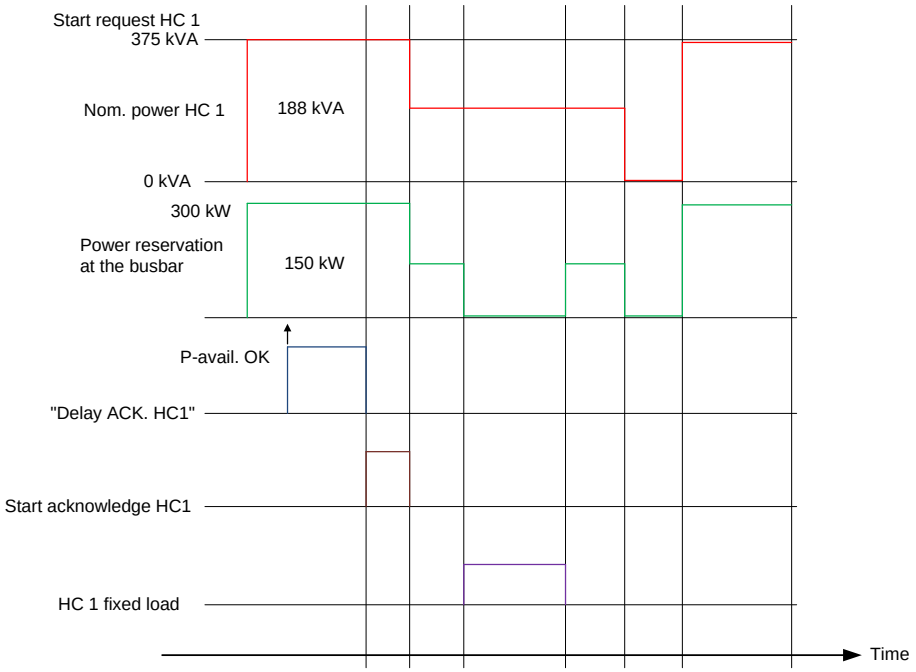
- Binary feedback
- Analogue feedback

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 system transmits a start acknowledge signal when sufficient predicted available power is present at the busbar.

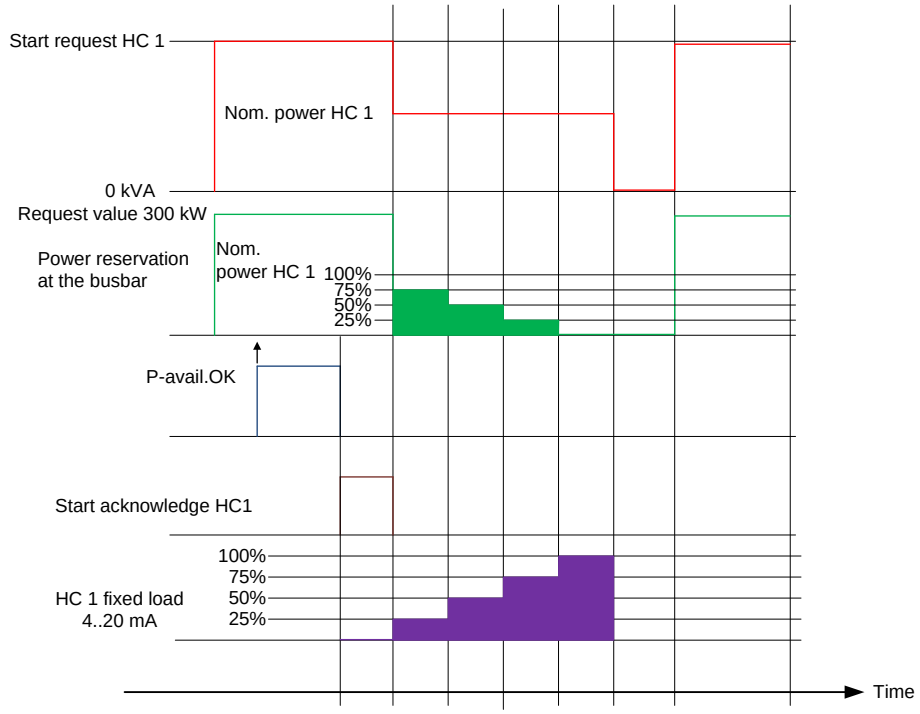
HC with binary power feedback signal:



7.13.2 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 for 400 kW.

7.14 Ground relay

7.14.1 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.

7.15 Stop of non-connected gensets

If peak shaving is selected and the imported power increases above the start setpoint, the genset(s) will start. If the load now drops below the start setpoint, it will remain disconnected from the busbar but will not stop, because the imported power is higher than the stop setpoint.

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.

7.16 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.

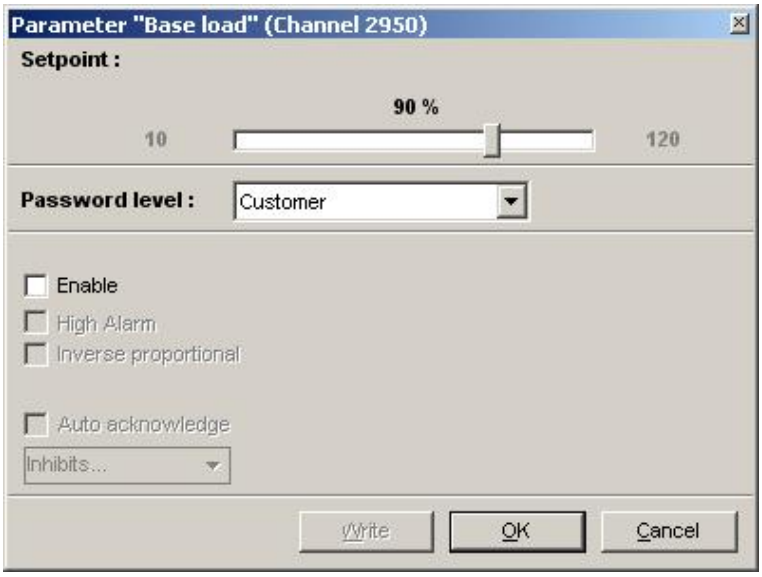
It is only possible to activate secured mode if the genset is in auto mode.

Secured mode can be activated/deactivated by means of digital inputs or via M-logic.

The extra generator running in secured mode will be selected, so it is possible to replace the largest running generator if this should fail.

7.17 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 setpoint, the system will lower the fixed power setpoint. 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 setpoint.

If AVR control (option D1) is selected, the setpoint will be the adjusted power factor.

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.

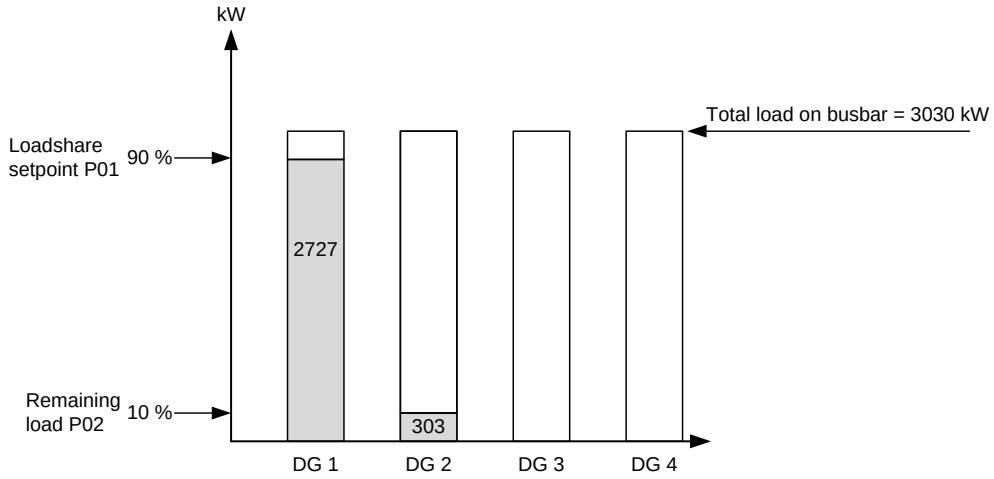
Only one AGC unit at a time can run in base load. The unit with the lowest ID will be allowed to run in base load.

7.18 Asymmetric load sharing (LS)

When asymmetric LS is enabled in menu 8282, the "normal" G5 load sharing is deactivated in all AGC units in the system. The AGC units will then load share according to the asymmetric LS setpoint in menu 8281.

Example: Four DGs able to produce 2800 kW each as nominal power. Asymmetric LS setpoint = 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 setpoint in menu 8281 "kW value" is higher than the nominal power of the generators, the whole system will switch back to symmetric.

7.19 Tie breaker configuration

7.19.1 Tie breaker configuration

Some of the possible applications of the AGC with option G5 can be used with a tie breaker, i.e. a breaker connected between the gensets and the load bus.

7.19.2 Tie breaker selection

In menu 8191, the tie breaker can be selected ON (present) or OFF (not present).

7.19.3 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.

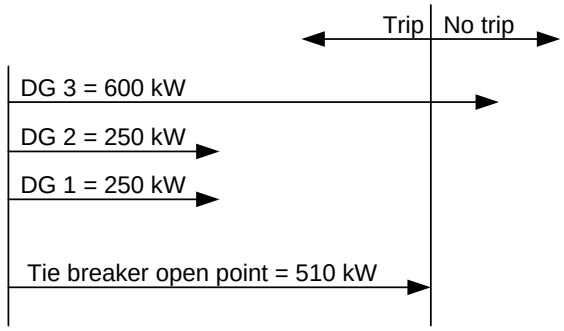
7.19.4 Tie breaker open point

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 setpoint menu 8193 is reached.

This delay time can be used to trip non-essential load groups.

Example
In the example illustrated below it can be seen 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"

7.19.5 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.

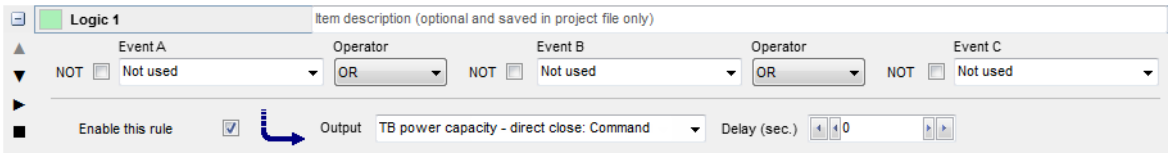
7.19.6 Power capacity

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.

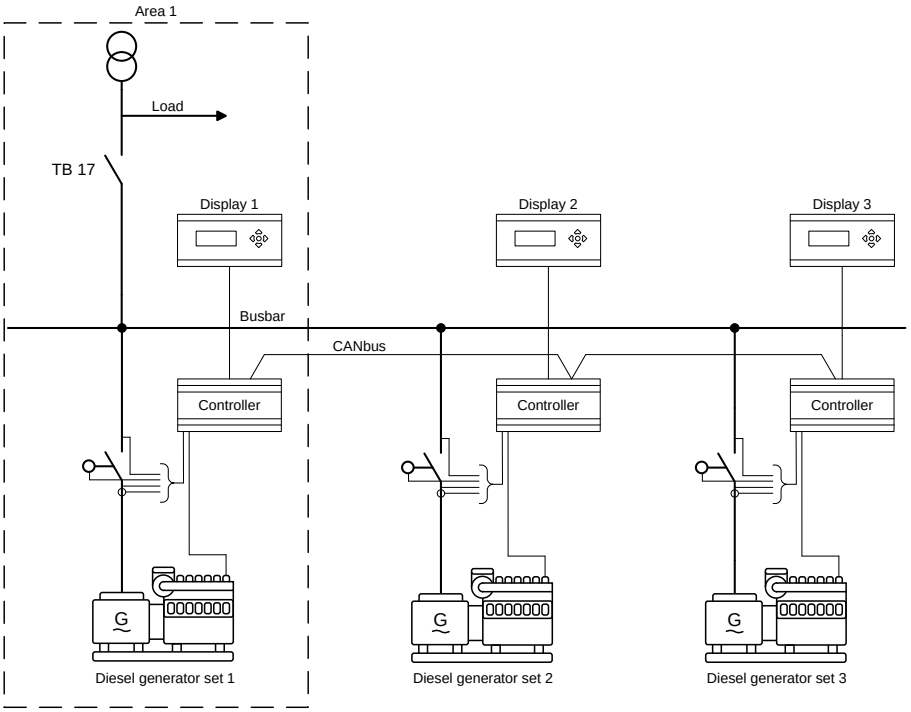
Power capacity overrule:
In case some of the generators fail to start and the power capacity set point is not reached, the tie breaker will never be closed. Because of this, it is possible to overrule the power capacity set point after a period of time set in menu 8194. The power capacity overrule timers 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.

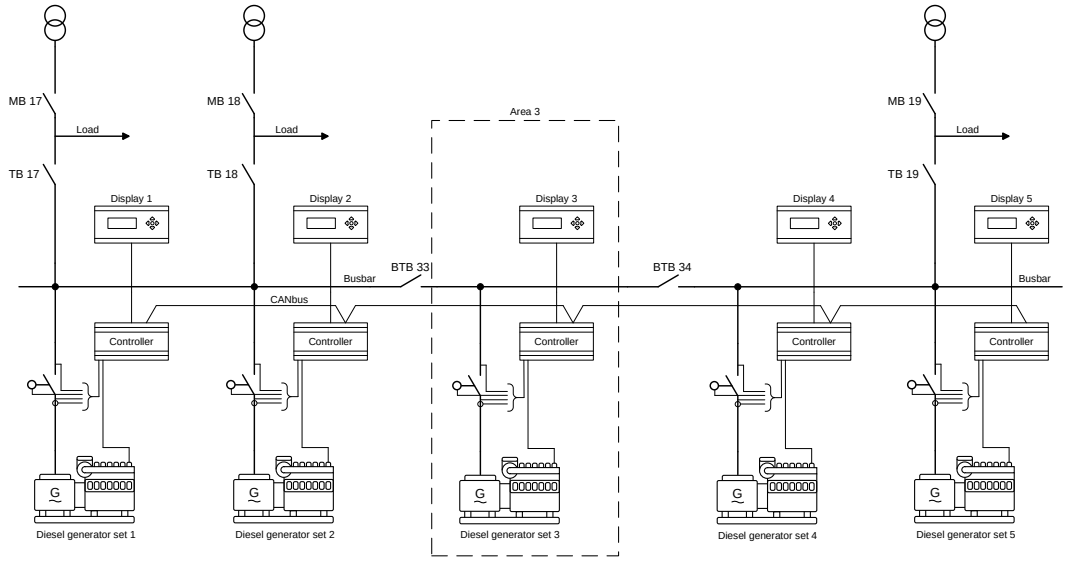
7.20 Island application with TB



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 setpoint 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.

7.21 Multiple mains

The AGC can be used in an application with multiple mains incomers. This is an example of the multiple mains application:



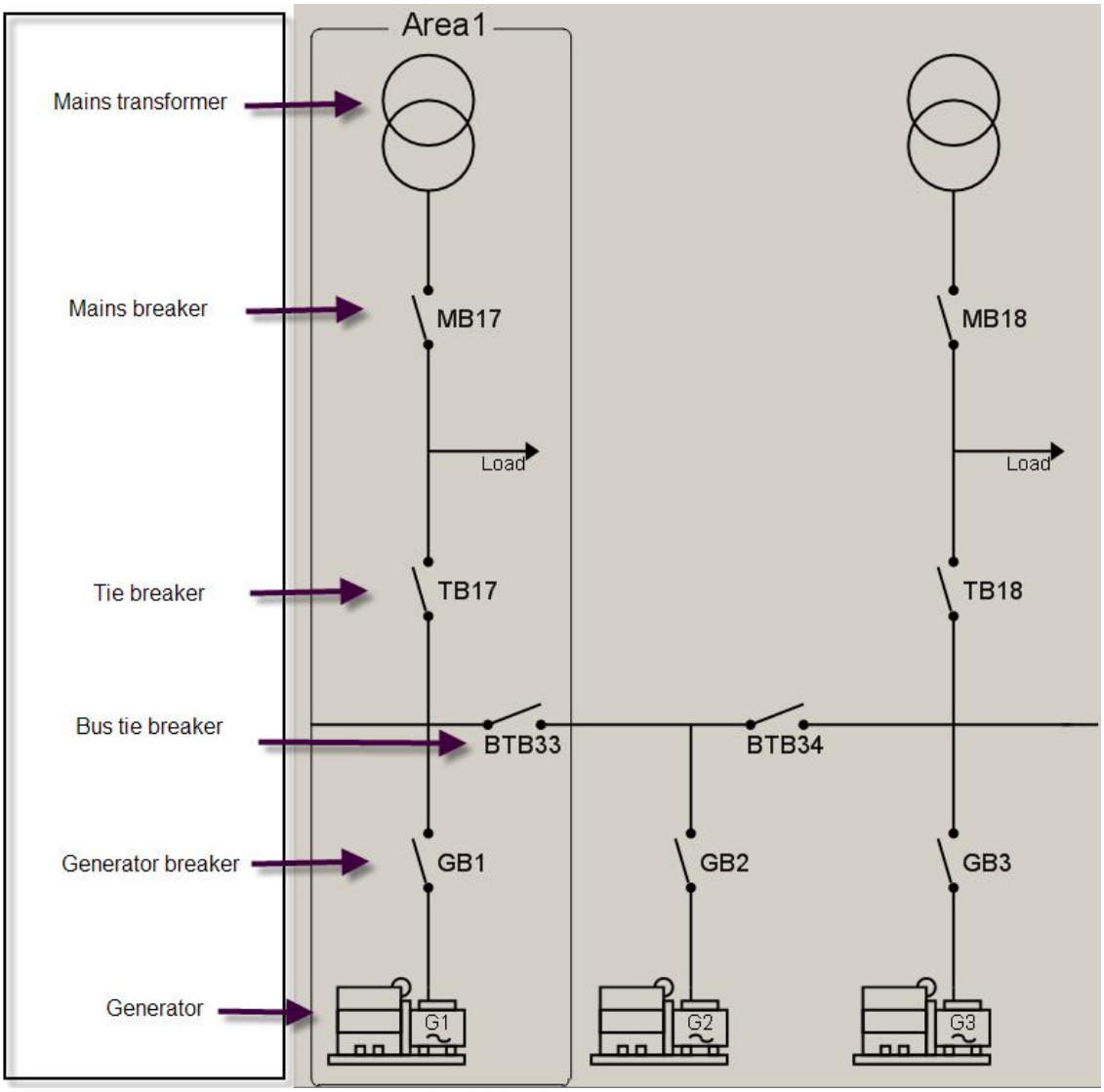
Each application can handle:

- 0-16 mains feeders in the same application
- 0-16 gensets in the same application
- 8 bus tie breakers

The multiple mains functionality covers a great variety of different applications. Please contact DEIF support (support@deif.com) for questions concerning the functionality.

7.21.1 Definitions

A multiple mains application consists of feeders and generators + a number of GBs, TBs, BTBs and MBs.



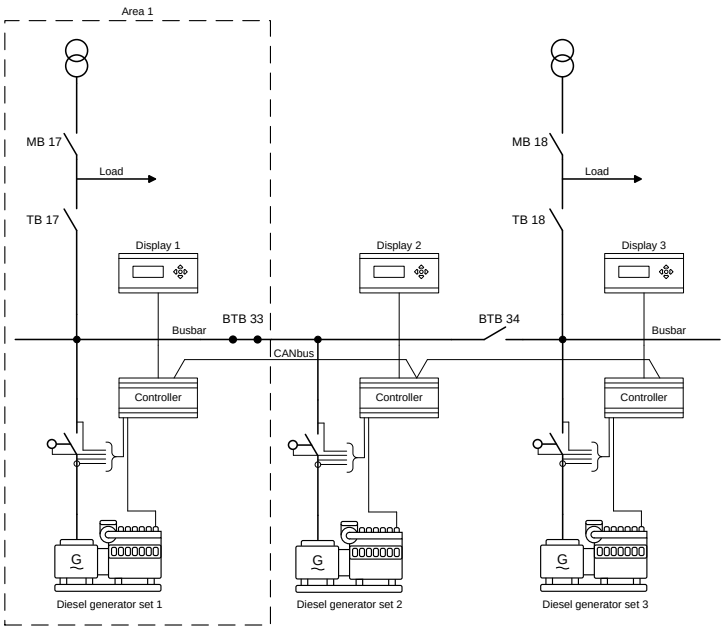
Sections

The application consists of static and dynamic sections if one or more BTBs are installed. The definition of a section is mentioned 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.

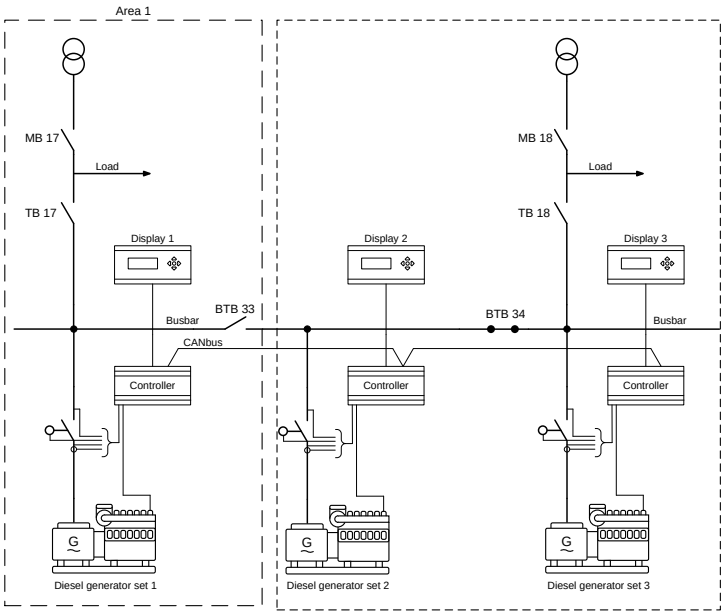
If no BTBs are installed, the application consists of a static section only.

Only use remote start signal in island application with BTB units.



Static section:
The BTB 33 is in open position. Therefore the indicated section is a static section.

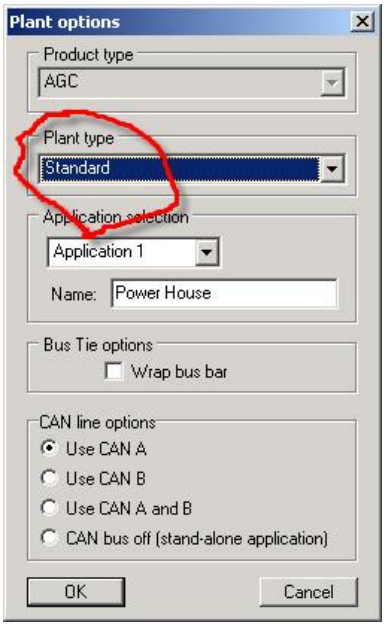
Dynamic section:
The section is separated by an open BTB, so this is a dynamic section.



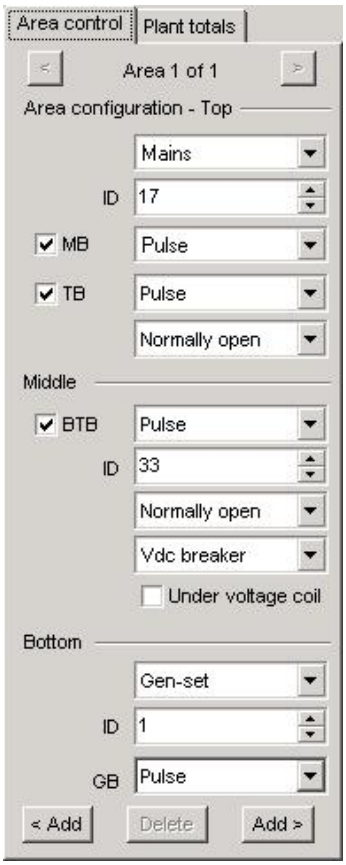
Dynamic section:
The BTB 34 is in closed position. Therefore the indicated section is a dynamic section.

7.21.2 Configuration

Please select "Standard" in the plant configuration tool to configure this application.



Now the application can be configured using the section control panel.



7.21.3 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 close failure start:
This setting determines whether a start of the DGs should be executed if an MB close failure occurs.

If "MB close 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 change-over 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	**Section description**
OFF	The auto switch functionality is switched OFF.	
Static section	The back-up power is recovered within its own static section.	Page 69
Dynamic section	The back-up 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.	Page 69
All sections	The back-up 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.

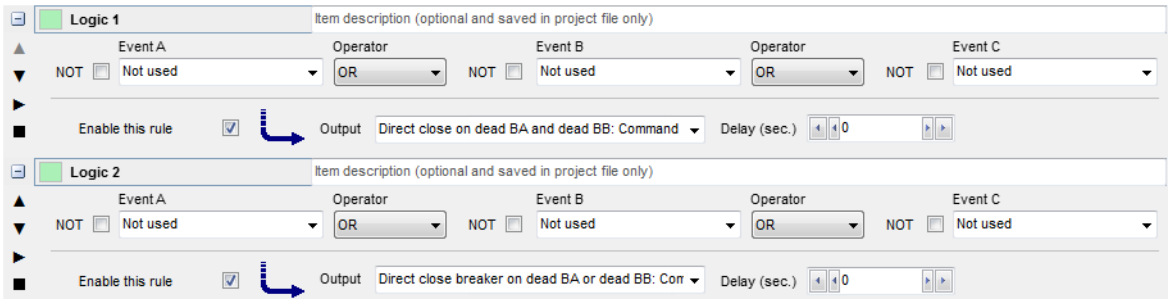
Run type:
This setting determines how the system in a dynamic section reacts in all the plant modes except island and AMF.

	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.	

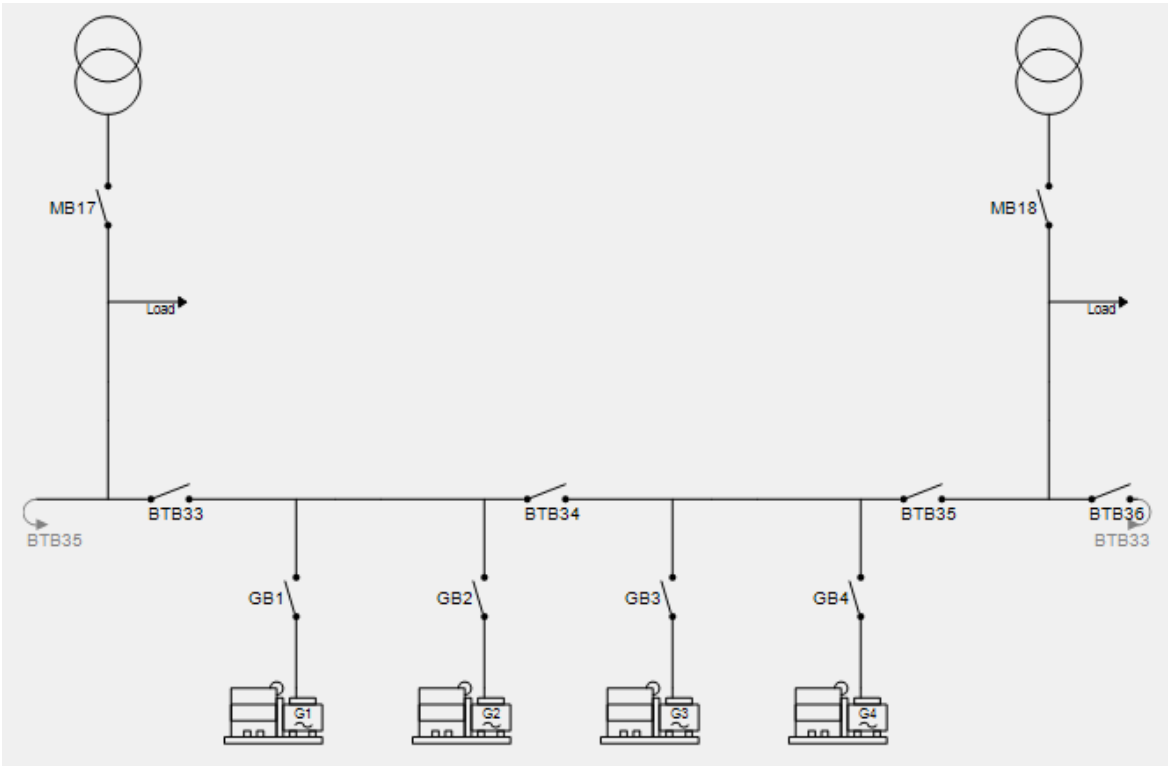
This setting can be handled from M-logic.

7.21.4 Special M-Logic function - BTB direct close

This function will bypass normal BTB close check procedure. The function can be enabled through M-Logic.

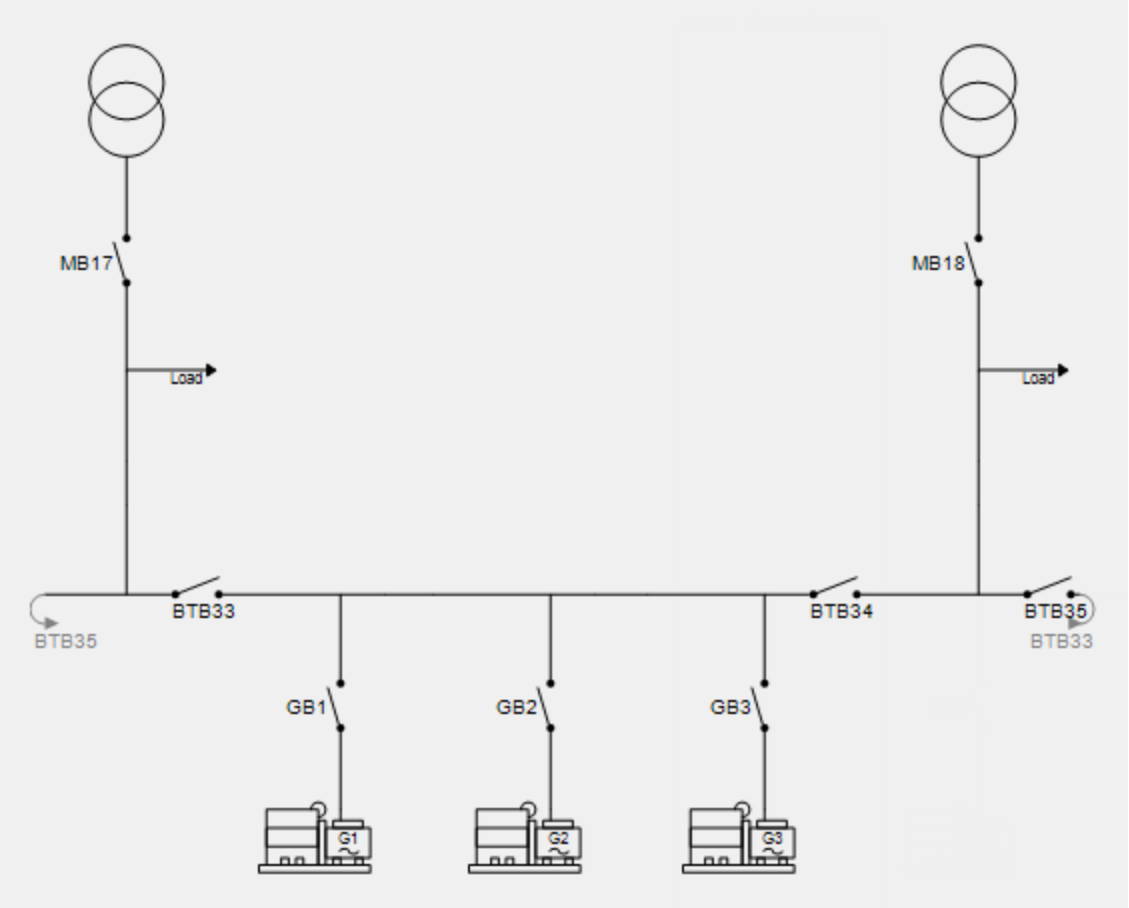


This function has two different M-Logic commands, as seen above. The command that is shown in Line 1 is intended to be used when a fast close of a BTB is needed, and there is no voltage present on any side of the BTB when the closing is intended. This could be in an application as shown in the picture 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.



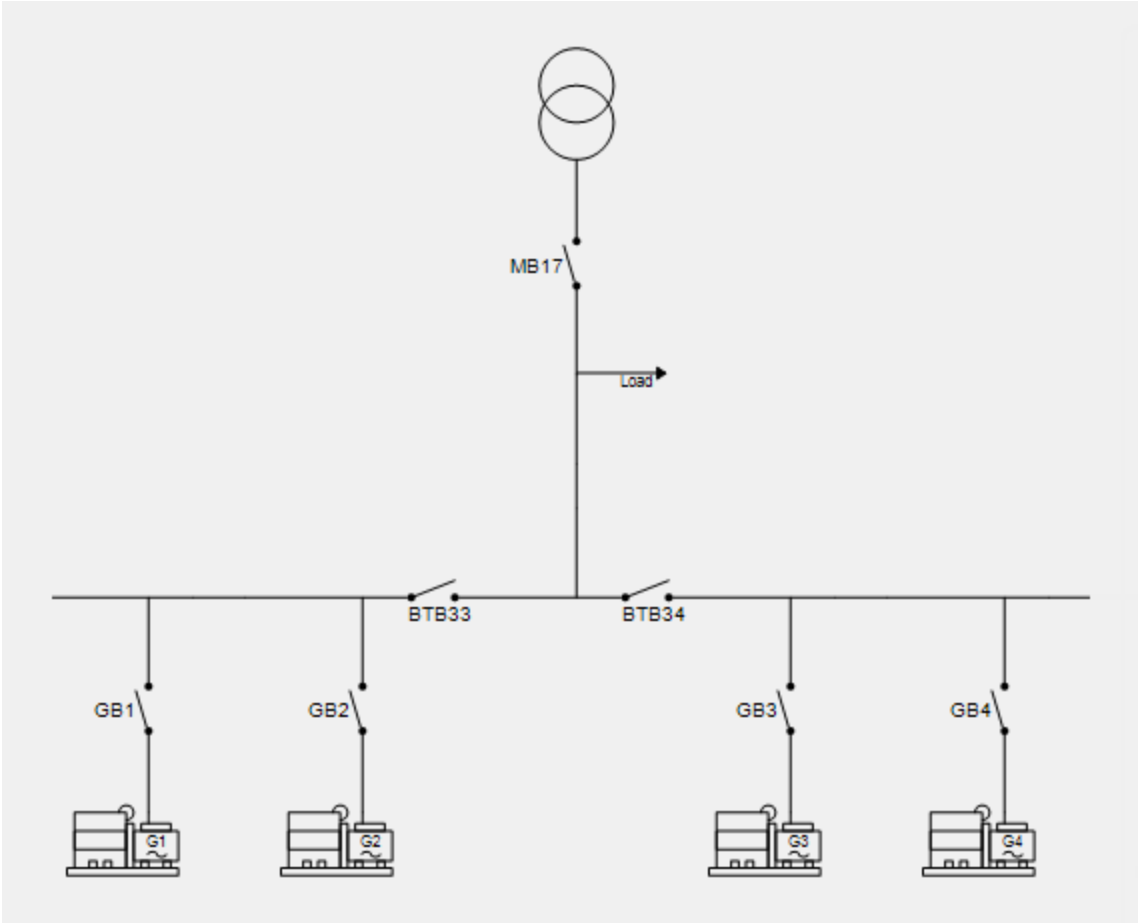
It is important to understand that it can be very dangerous to use M-Logic Line 2 in this application, because two generator sections are present.

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.



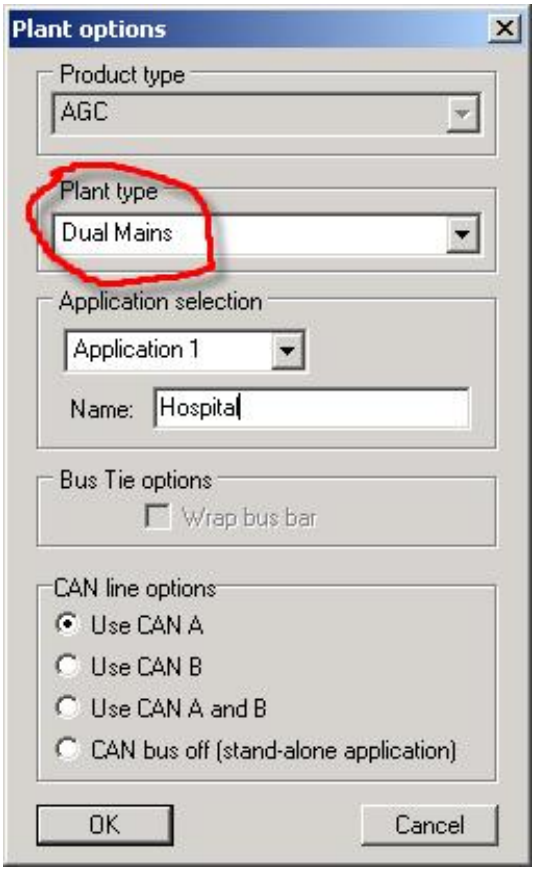
In all applications it is important to be sure that while the BTB or BTBs are asked to close, no MB can close. Since the normal BTB close check procedure is bypassed, two different energy sources can be closed together without sync. check through a dead bus. Interlocking has to be made by the designer of the system.

7.22 Dual mains

If the AGCs are configured with two mains units, the settings for the dual mains application must be adjusted.

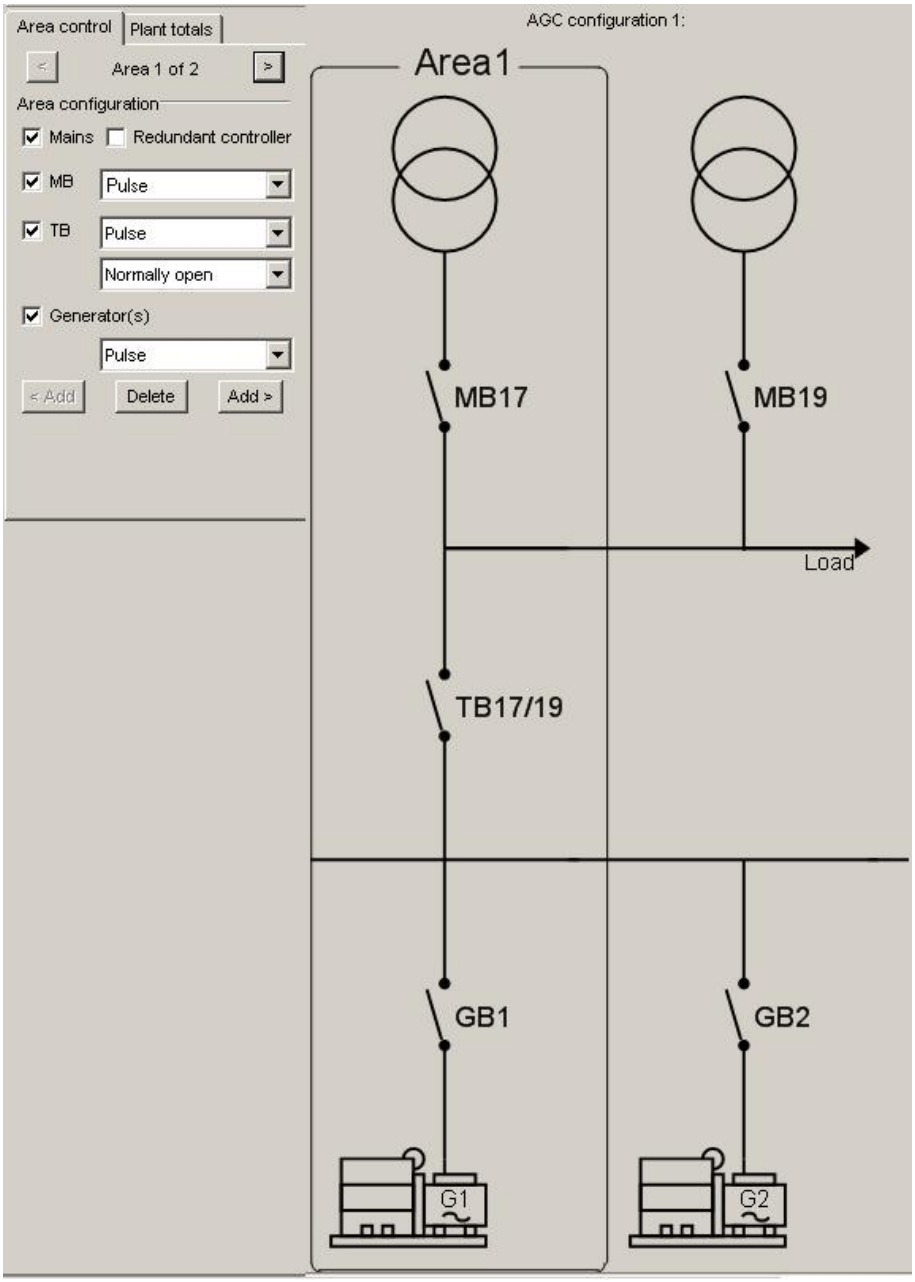
7.22.1 Configuration

Please select "Dual mains" in the plant configurator tool to configure this application.



7.22.2 Plant mode handling

This is an illustration of the dual mains application.



Four additional settings have been specified to determine the behaviour of the system. The settings are to be set in one of the AGC mains units and are then communicated via the CANbus to the other mains unit. The four additional settings in menu 8180 are:

	Description	Dual mains relevance
8181	MB close failure start	X
8182	MB parallel	X
8183	No break transfer	X
8184	Auto switch	X
8185	Run one/all mains	Not relevant
8186	ID to run	Not relevant

The menus 8185 and 8186 are ignored in the dual mains application.

MB close failure start:
This setting determines whether a start of the DGs should be executed if an MB close failure occurs.

If "MB close 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.

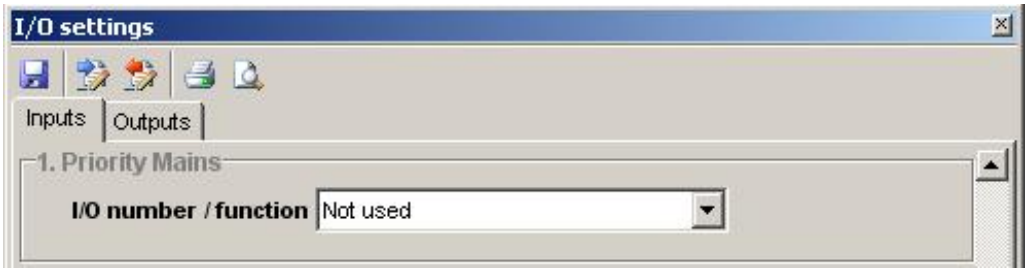
MB parallel:
This setting determines whether the two mains connections (MBs) should be able to run in parallel or not.

The setting of "MB parallel" affects the function of the "Auto switch" setting.

No break transfer:
This setting determines whether a priority switch between the two mains connections (MBs) should be executed as a black coupling or a synchronised coupling.

If "MB parallel" is activated, the "No break transfer" will automatically be enabled.

1st priority mains:
The configurable input "1st priority mains" determines which of the mains connections to consider the first priority. The binary input must be configured via the PC utility software (USW). The priority of the mains connections can then be altered by switching the input status on the AGC mains units.



The "1st priority" input has to be active on one of the mains units at all times.

Auto switch:

MB parallel OFF:
- If "Auto switch" is ON, an attempt will be made to switch to the 2nd priority mains if a mains failure occurs on the 1st priority mains before the generators are started.
- If "Auto switch" is OFF, no attempt will be made to switch to the 2nd priority in case of a mains failure.

MB parallel ON:
- If "Auto switch" is OFF, the two mains will act as one meaning that both mains breakers have to be closed at all times, since one mains connection is not enough to supply the load. A mains failure on either of the mains will cause a trip of both mains breakers and subsequently start of the gen-sets.
- If "Auto switch" is ON, both mains breakers will be closed in case both mains are OK. If a mains failure occurs on one of the mains, the mains breaker in question will be tripped, but an AMF start of the gensets will only happen when a mains failure is present on both mains.

If "Auto switch" is enabled (ON), mode shift (menu 7081) must also be enabled (ON).

7.22.3 Internal CAN ID

The internal CAN ID for the AGC mains units can be set between 17 and 32 when multiple mains has been selected (otherwise the system only expects one mains and the ID is set to 17 as default). The selection of the CAN ID cannot be made randomly but must be made with caution. The reason for this is that the system expects ID 17 and ID 18 as a couple controlling the mains breaker for one mains connection, i.e. the ID 18 unit acts as a redundant unit to ID 17. In the same manner, the system expects ID 19 and ID 20 as a couple controlling the mains breaker for one mains connection, i.e. the ID 20 unit acts as a redundant unit to ID 19. This means that when no redundant mains units are present, the ID selected for the two AGC mains units must be ID 17 and 19.

Setting of the CAN ID in multiple mains applications:

AGC mains unit	ID no.	Comment
1A	17	Required
1B	18	Not required, redundant to 1A
2A	19	Required
2B	20	Not required, redundant to 2A

Please refer to the drawing above for the location of the AGC mains units.

7.22.4 AGC mains unit redundancy

It is possible to install a redundant AGC mains unit for each mains connection. If this is done, the redundant AGC mains unit will automatically take control if:

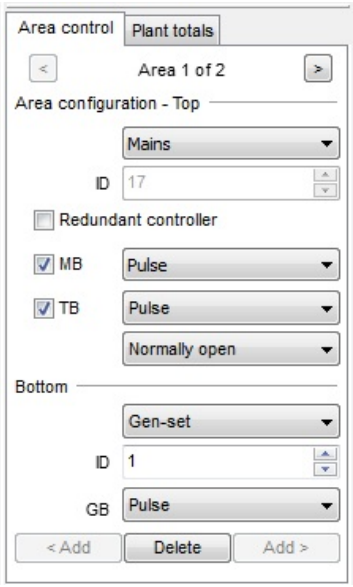
- a mains breaker failure occurs on the primary control unit
- the primary control unit is suddenly missing on the CAN line due to a CAN error
- the primary control unit is put into semi-auto

When the alarm situation on the primary control unit has been reset, the control is switched back to this AGC mains unit.

The primary control units are ID 17 and ID 19.

Be aware that if "ID to run" is active, the mains unit to run must have higher nominal power than the load on the busbar to prevent overload.

The redundant controller is selected in the configuration window (section control).



7.22.5 Tie breaker configuration

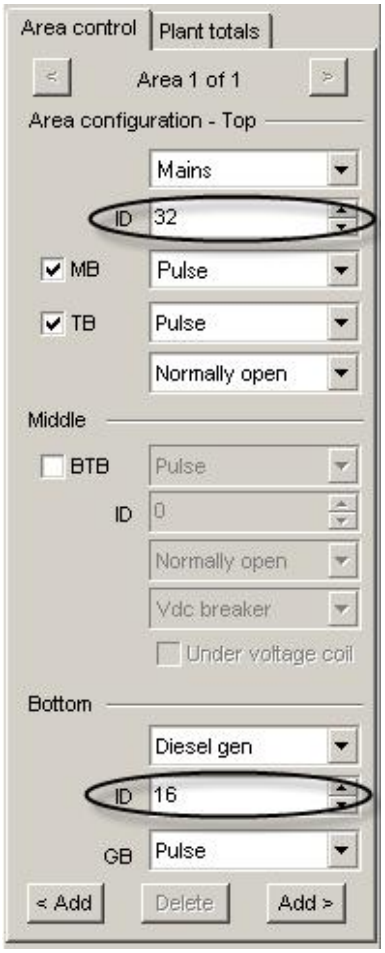
In applications with two mains connections, the tie breaker is handled by the AGC mains unit fulfilling the following conditions:

- Holding the lowest CAN ID
- No tie breaker error
- Not in semi-auto

If the AGC mains unit controlling the tie breaker is not able to open the tie breaker, the tie breaker handling is moved to the next AGC mains unit fulfilling the conditions above. This will continue until the tie breaker is opened or all the AGC mains units have tried to open the tie breaker.

Because of the AC wiring it is not possible to synchronise the tie breaker in applications supporting two mains connections.

7.23 Configurable CAN IDs



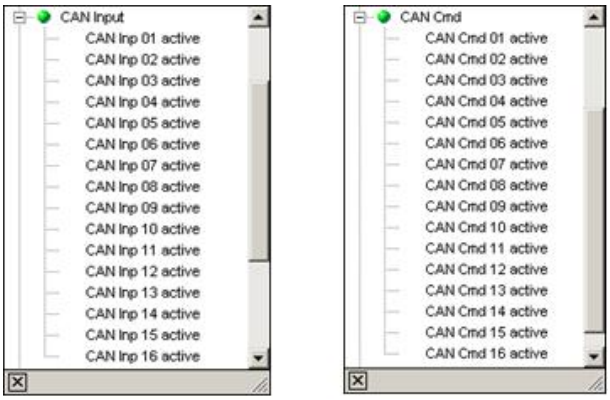
Can IDs can be configured as desired, as a mix of DG, mains and BTB units:

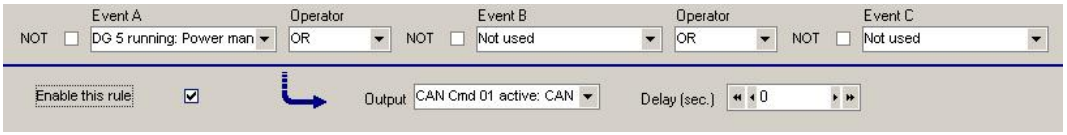
16 gensets	IDs 1-16
16 mains	IDs 17-32
8 bus tie breakers	IDs 33-40

This makes a total of 40 CAN IDs.

7.24 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.





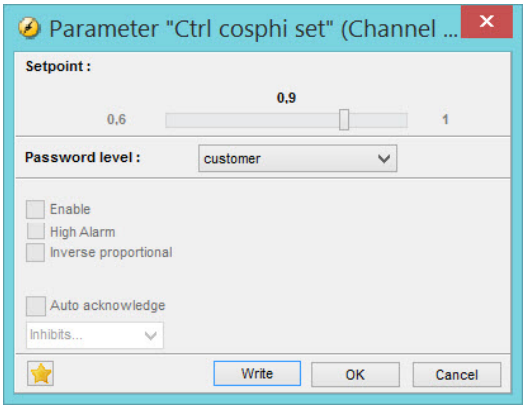
Example: CAN cmd 01 will be active when DG 5 is running. All units in the power management system will receive "CAN input 01 active" and then be able to act on this information.

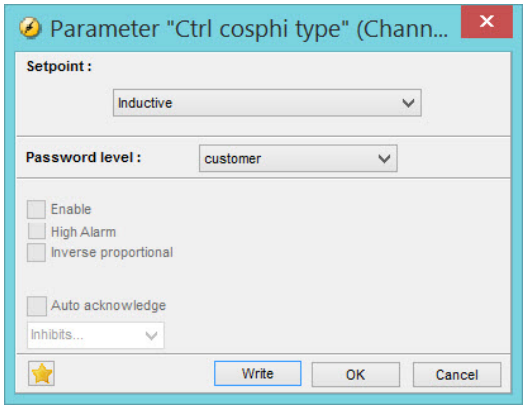
Only use of constant signals from digital inputs or AOP buttons can activate the CAN inputs. AOP buttons are pulse inputs, so a latch function must be made to make similar functionality as constant signals.

7.25 Common PF control

A common PF value can be set in menu 7052, and menu 7053 can be set to either "Inductive" or "Capacitive". To activate the common PF control, menu 7054 must be enabled. These setpoints can only be handled from the AGC 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 PF control according to the received setpoint.

Inductive/capacitive setpoints can be set up from M-logic.


Parameter "Ctrl cosphi set" (Channel ...
Setpoint :
0,9
0,6
1
Password level :
customer
Enable
High Alarm
Inverse proportional
Auto acknowledge
Inhibits...
Write
OK
Cancel


Parameter "Ctrl cosphi type" (Chann...
Setpoint :
Inductive
Password level :
customer
Enable
High Alarm
Inverse proportional
Auto acknowledge
Inhibits...
Write
OK
Cancel

8. Parameter lists

8.1 Common settings

The options G4 and G5 relate 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, 9190-9192.

For further information, please see the separate parameter list:

AGC-3	Document number 4189340705
AGC-4	Document number 4189340688
AGC 200	Document number 4189340605
AGC 100	Document number 4189340764