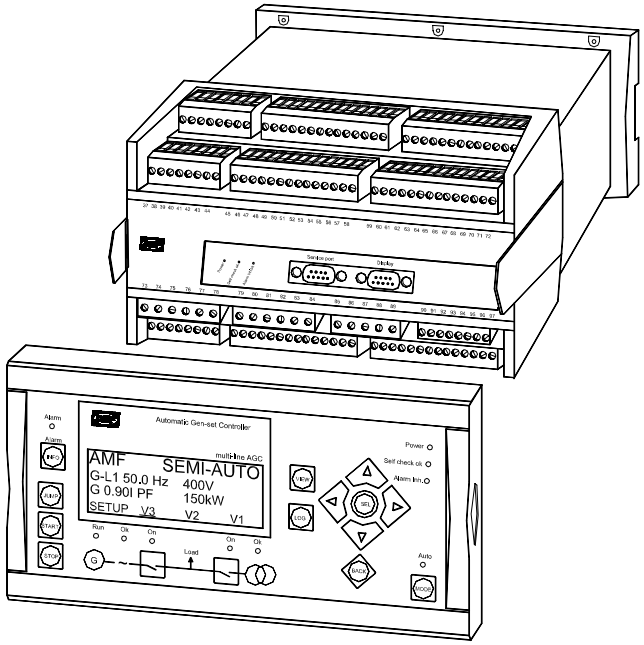
DEIF A/S

Description of options

Option G5,
Power management
Automatic Gen-set Controller

4189340340I
SW version 2.3X.X



- *Functional descriptions*
- *Display units*
- *Power management setup*
- *Power management functions*
- *Parameter lists*

DEIF A/S, *Frisenborgvej 33*
DK-7800 Skive, Denmark

Tel.: +45 9614 9614, Fax: +45 9614 9615
E-mail: deif@deif.com, URL: www.deif.com

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1. Warnings and legal information

Legal information and responsibility

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

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

Electrostatic discharge awareness

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

Safety issues

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

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

Notes

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

Notes

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

Warning

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

2. Description of option

G5 option

G5 is a combined software and hardware option. Besides the standard installed hardware a communication PCB is installed in slot no. 8. This PCB is only used for the power management communication and cannot be used communicating with a PLC.

A number of AGCs are being used in the power management application, i.e. one for the mains breaker (AGC mains unit) if installed and one for each generator (generator AGC unit).

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 the option G5, because this unit can be used in standard applications as well as G5 applications.

Terminal description

The communication PCB is installed in slot no. 8.

Term.	Function	Description
126	Not used	Internal communication
127	Not used	
128	Can-L	
129	GND	
130	Can-H	
131	Can-L	
132	GND	
133	Can-H	

Breaker feedbacks

Generator breaker

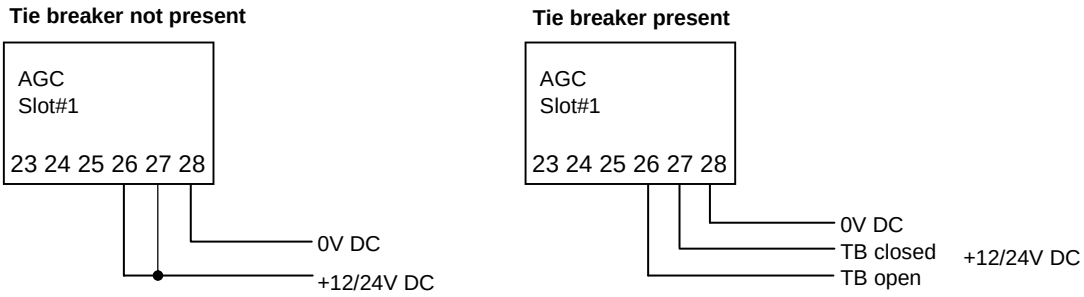
The feedbacks of the generator breaker must always be connected (terminals 26 and 27).

Mains breaker feedback

The feedbacks of the mains breaker must always be connected (terminals 24 and 25). If island mode is selected as the plant mode (menu 6060), then the MB open feedback must be activated at all times.

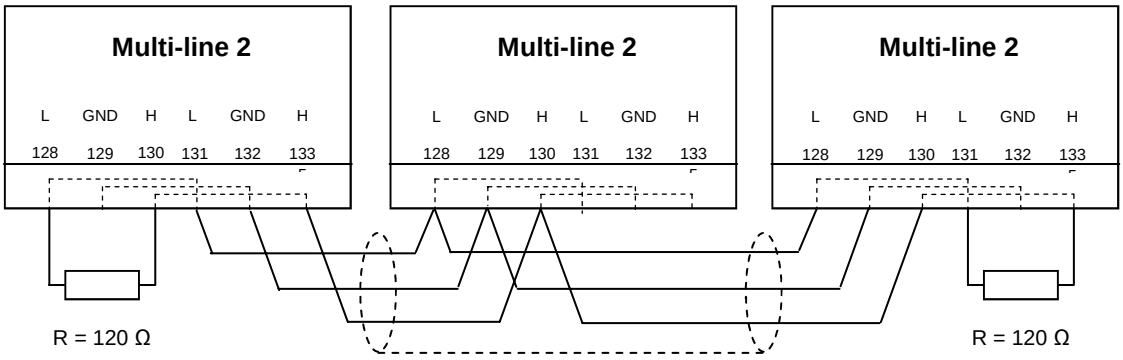
Tie breaker

This diagram shows the wiring of the tie breaker feedbacks on the AGC mains. If the tie breaker is not present there must be an input on *both* terminal 26 and terminal 27.



Wiring diagram

This diagram shows an example with three AGCs connected, e.g. one AGC mains and two generator AGCs.



3. Functional description

Power management functions

In the following chapter the power management functions of the AGC are listed.

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

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 take over (needs mains unit)
- Mains power export (needs mains unit)

Display

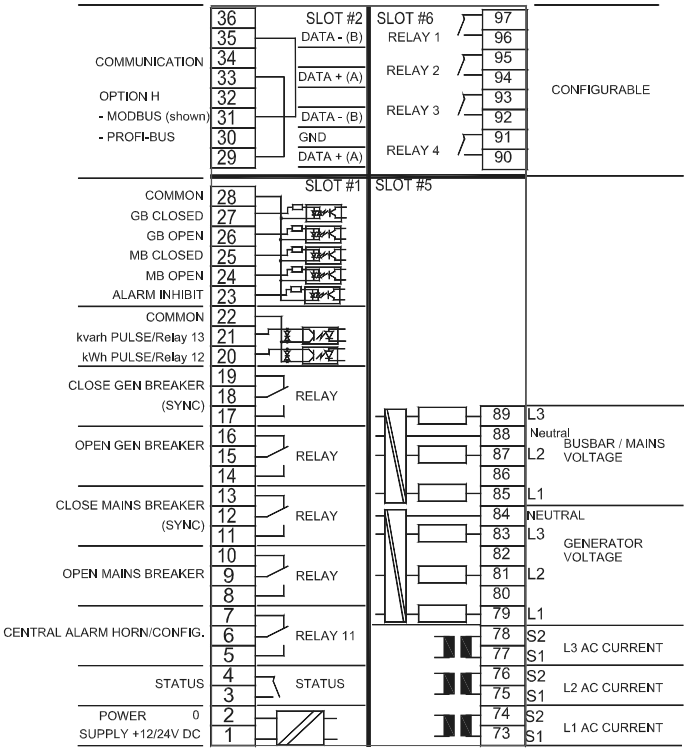
- Mains unit display showing mains breaker and tie breaker
- Generator unit showing generator and generator breaker

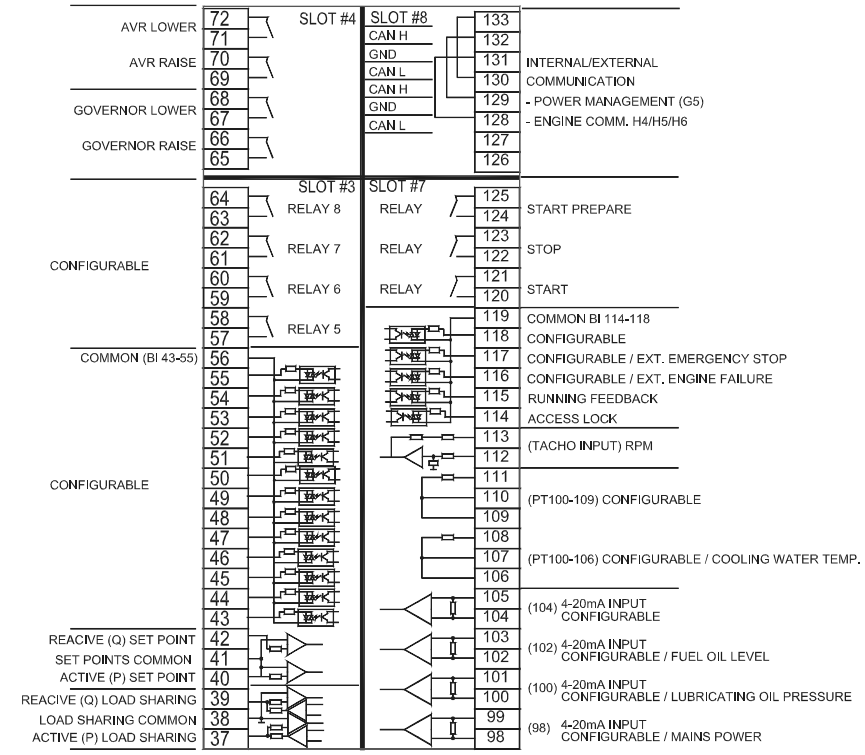
Power management functions

- 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

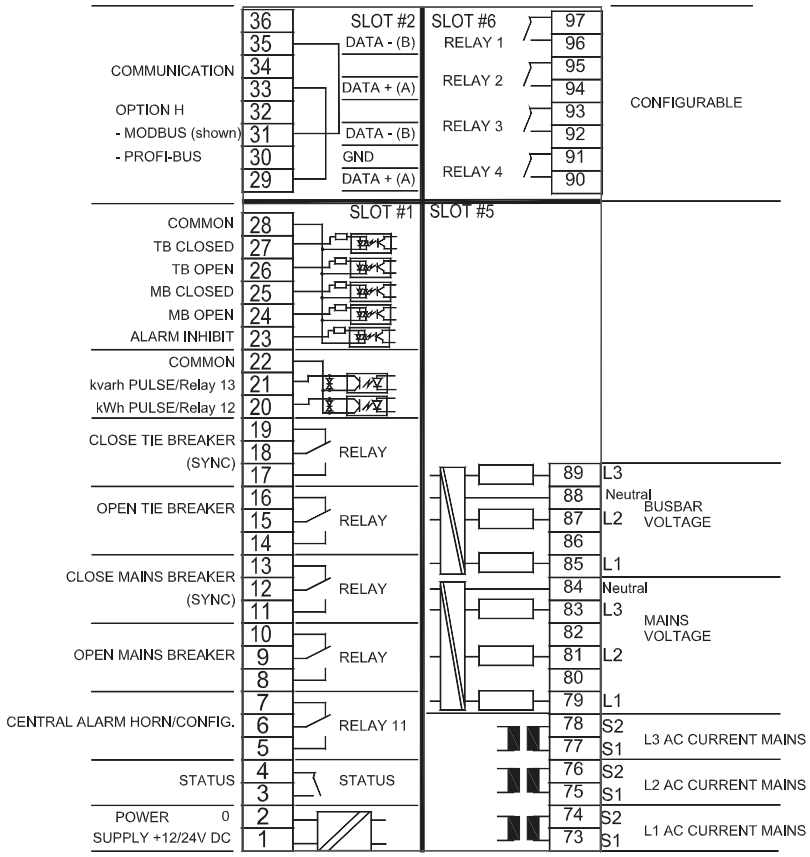
Terminal strip overview

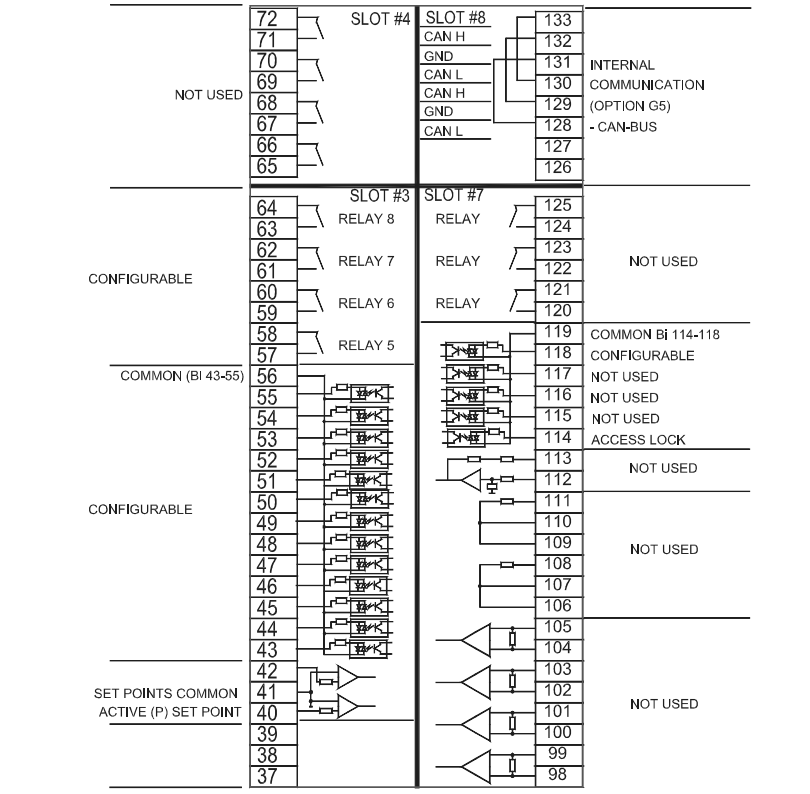
Generator unit





Mains unit


SLOT #2
SLOT #6
SLOT #1
SLOT #5
COMMUNICATION
OPTION H
- MODBUS (shown)
- PROFI-BUS
DATA - (B)
DATA + (A)
DATA - (B)
GND
DATA + (A)
RELAY 1
RELAY 2
RELAY 3
RELAY 4
CONFIGURABLE
COMMON
TB CLOSED
TB OPEN
MB CLOSED
MB OPEN
ALARM INHIBIT
COMMON
kvarh PULSE/Relay 13
kWh PULSE/Relay 12
CLOSE TIE BREAKER (SYNC)
OPEN TIE BREAKER
CLOSE MAINS BREAKER (SYNC)
OPEN MAINS BREAKER
CENTRAL ALARM HORN/CONFIG.
STATUS
POWER SUPPLY +12/24V DC
RELAY
RELAY 11
STATUS
L3
Neutral
L2
L1
BUSBAR VOLTAGE
MAINS VOLTAGE
L3 AC CURRENT MAINS
L2 AC CURRENT MAINS
L1 AC CURRENT MAINS


SLOT #4
SLOT #8
SLOT #3
SLOT #7
NOT USED
CAN H
GND
CAN L
INTERNAL COMMUNICATION (OPTION G5) - CAN-BUS
CONFIGURABLE
RELAY 8
RELAY 7
RELAY 6
RELAY 5
RELAY
NOT USED
COMMON (BI 43-55)
COMMON Bi 114-118
CONFIGURABLE
NOT USED
ACCESS LOCK
SET POINTS COMMON
ACTIVE (P) SET POINT

Applications

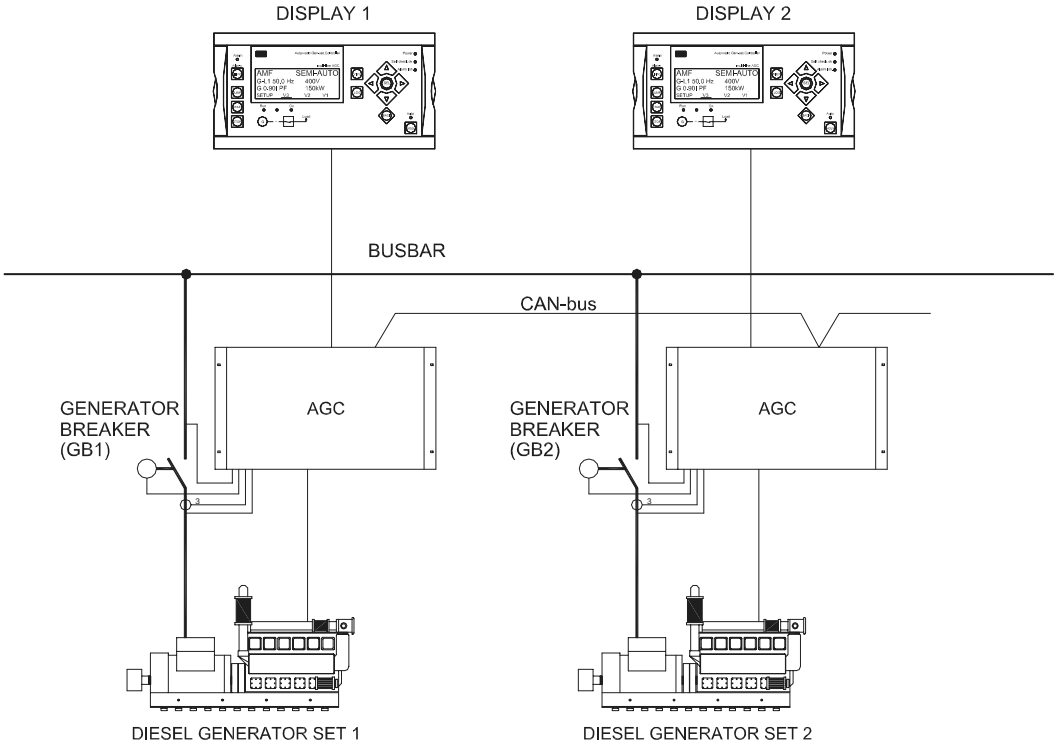
The G5 option can be used for the applications listed in the table below.

Application	Drawing below	Comment
Island operation	Island mode plant	Multiple gen-sets
Automatic Mains Failure	Parallel with mains plant	No back synchronising
Automatic Mains Failure	Parallel with mains plant	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 with mains plant	Also called base load
Mains power export	Parallel with mains plant	
Load take over	Parallel with mains plant	
Peak shaving	Parallel with mains plant	

Refer to the Designer's Reference Handbook for description of the individual gen-set modes.

Island operation plant

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



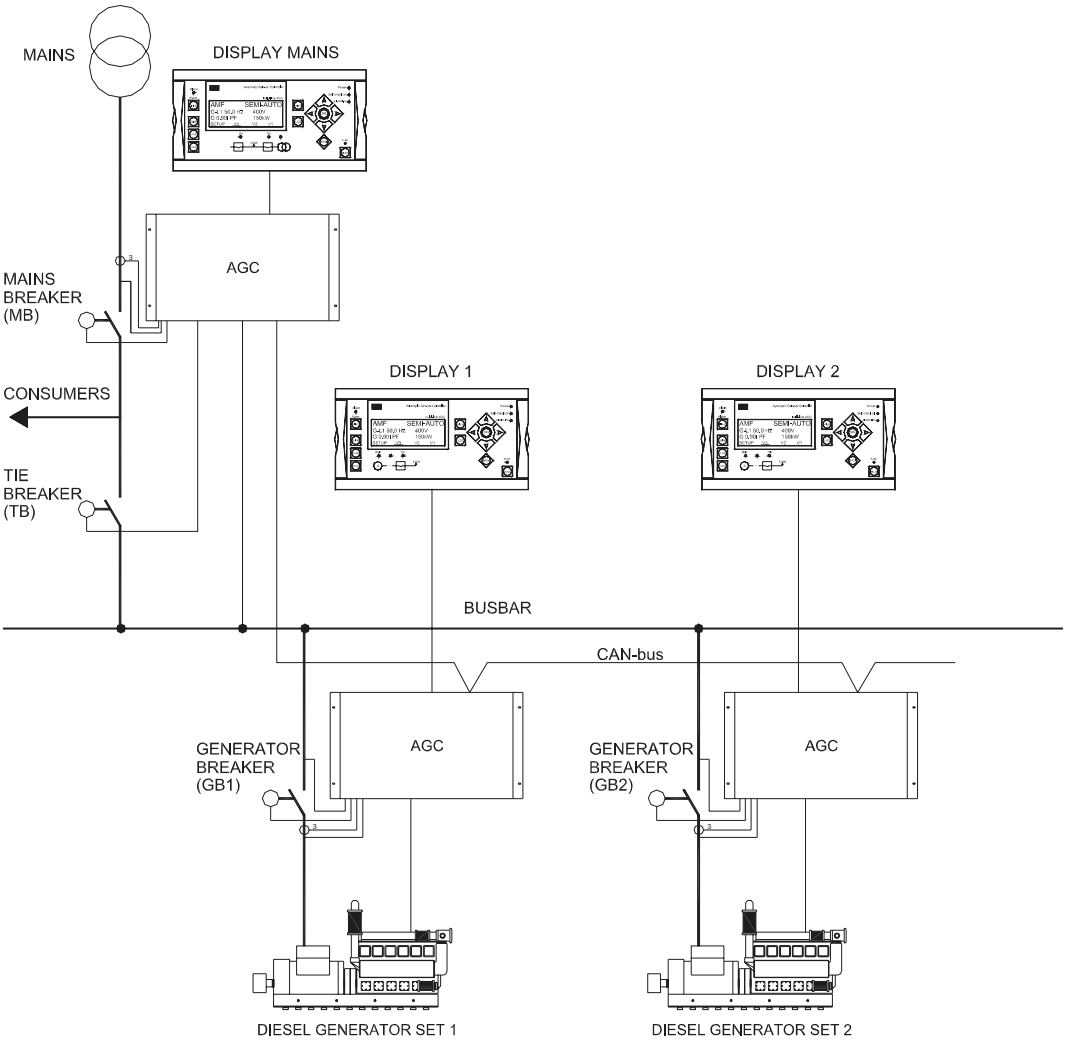
If a mains unit is installed and connected (e.g. for preparing future requirements to the application), the island mode operation is selected in the mains unit.

Parallel with mains plant

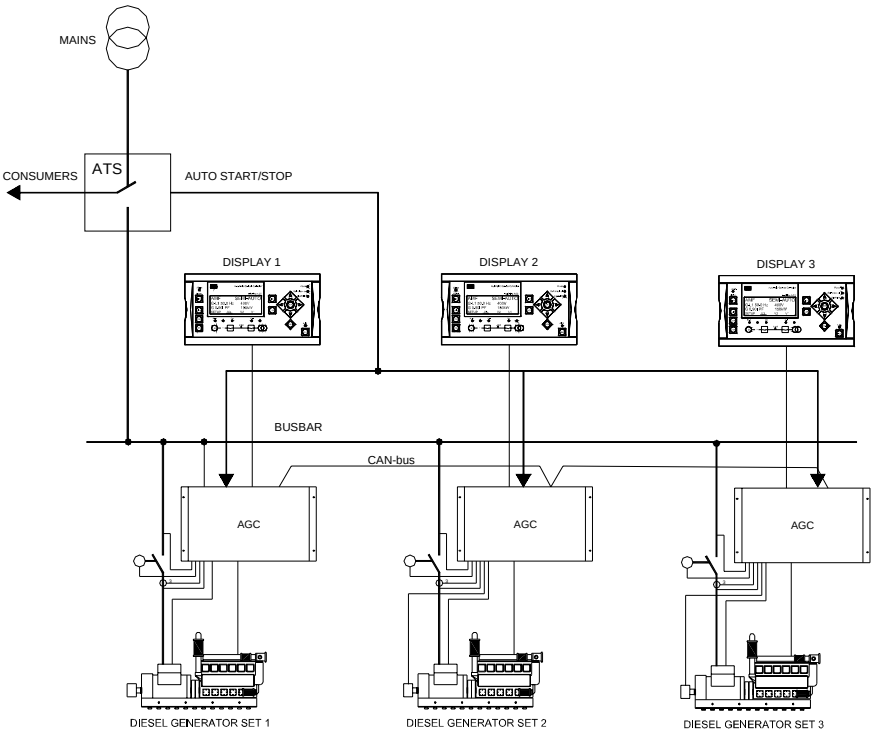
An application where a mains breaker is installed together with up to 16 gen-sets is shown below. The application is shown with a tie breaker, but it is also possible to use the application without a tie breaker.

The tiebreaker can only be placed as shown in the drawing below. The AGC only supports applications with no or just one mains incomer.

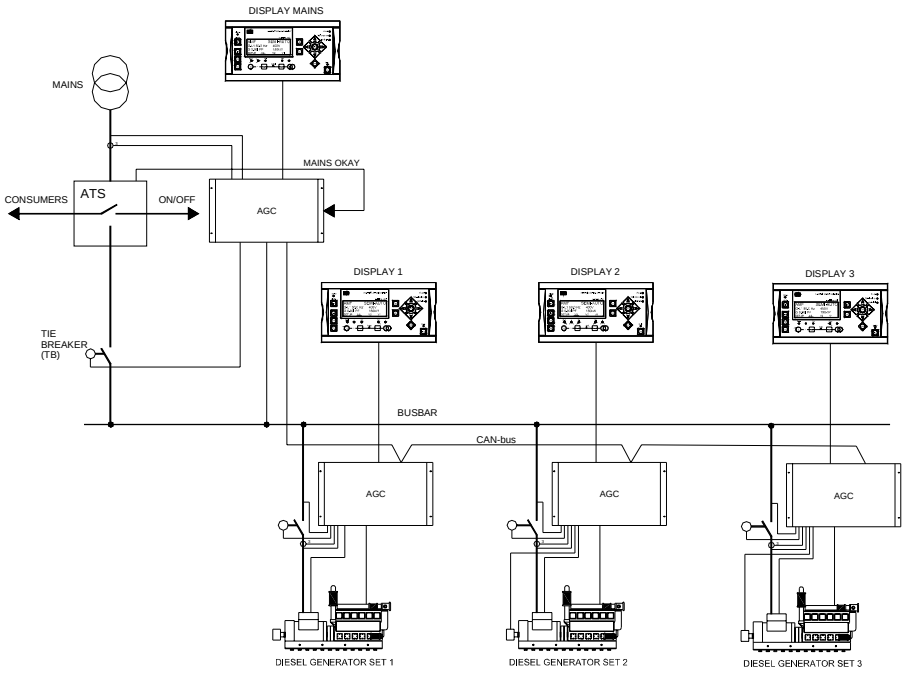
This one-line diagram is also valid for AMF plants without back synchronising and load take over plants without possibility of synchronising the gen-set to the mains.



ATS plant, multiple start



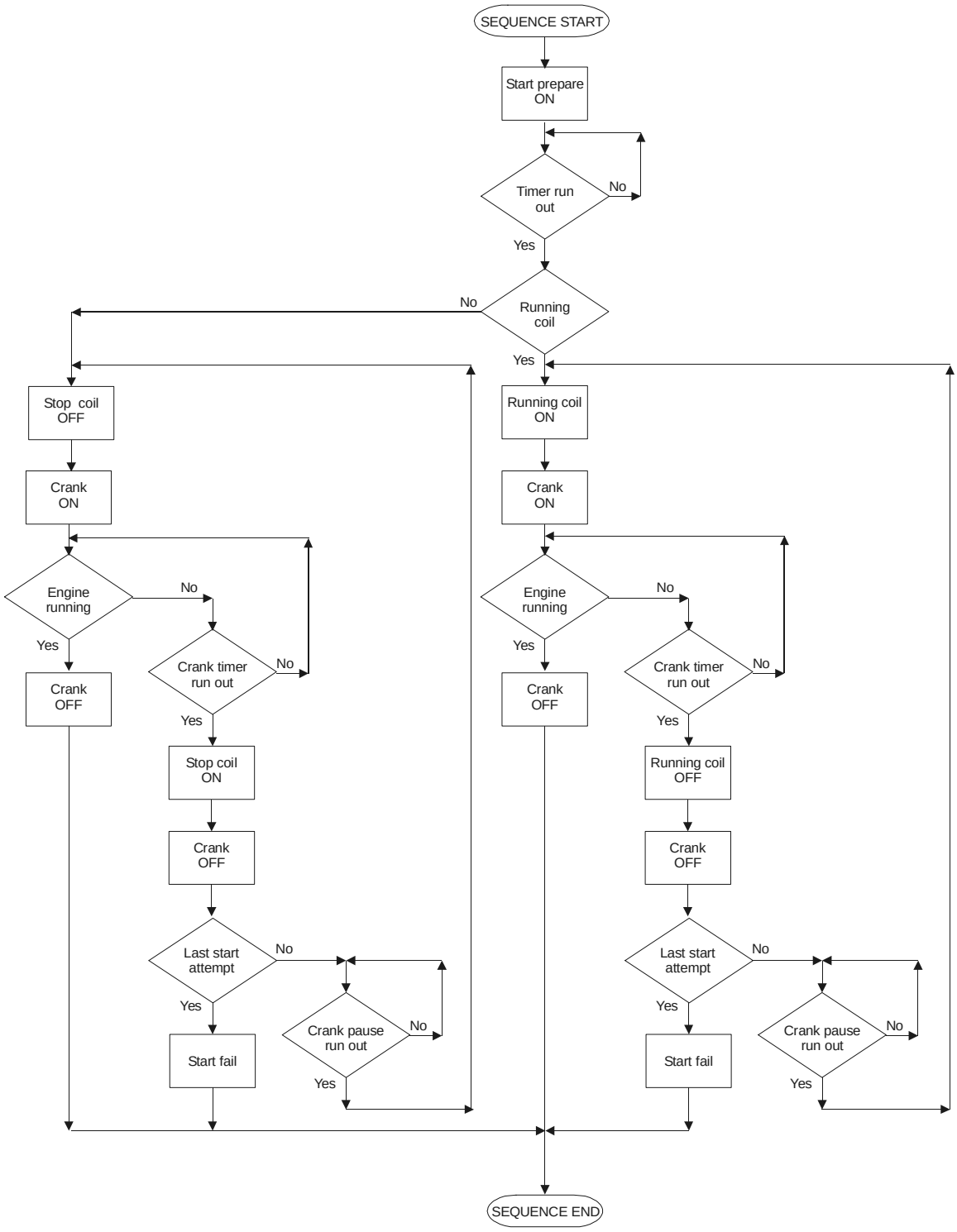
ATS plant, mains unit



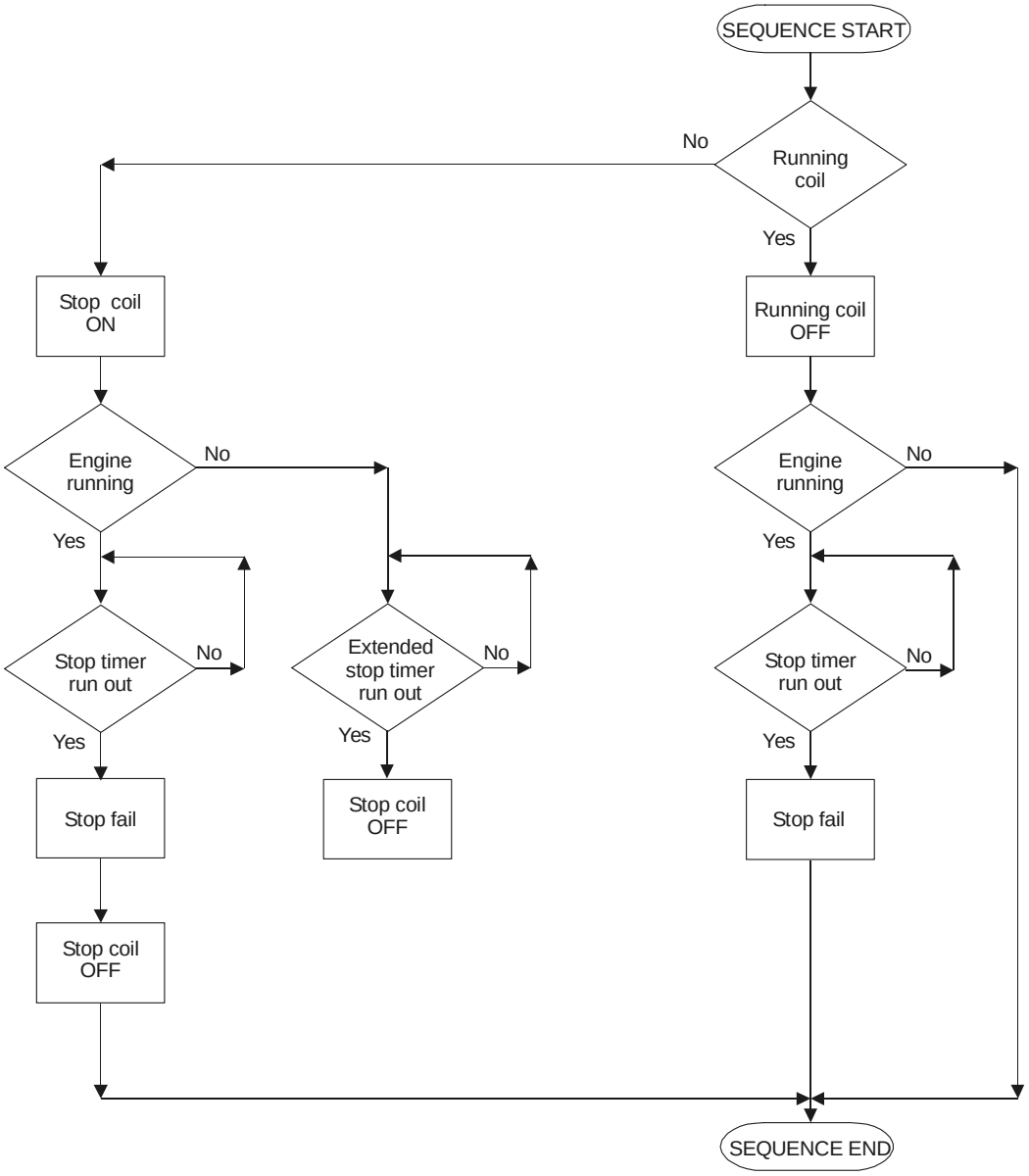
Flowcharts

The flowcharts below are for guidance only. For illustrative purposes the flowcharts are simplified in some extent.

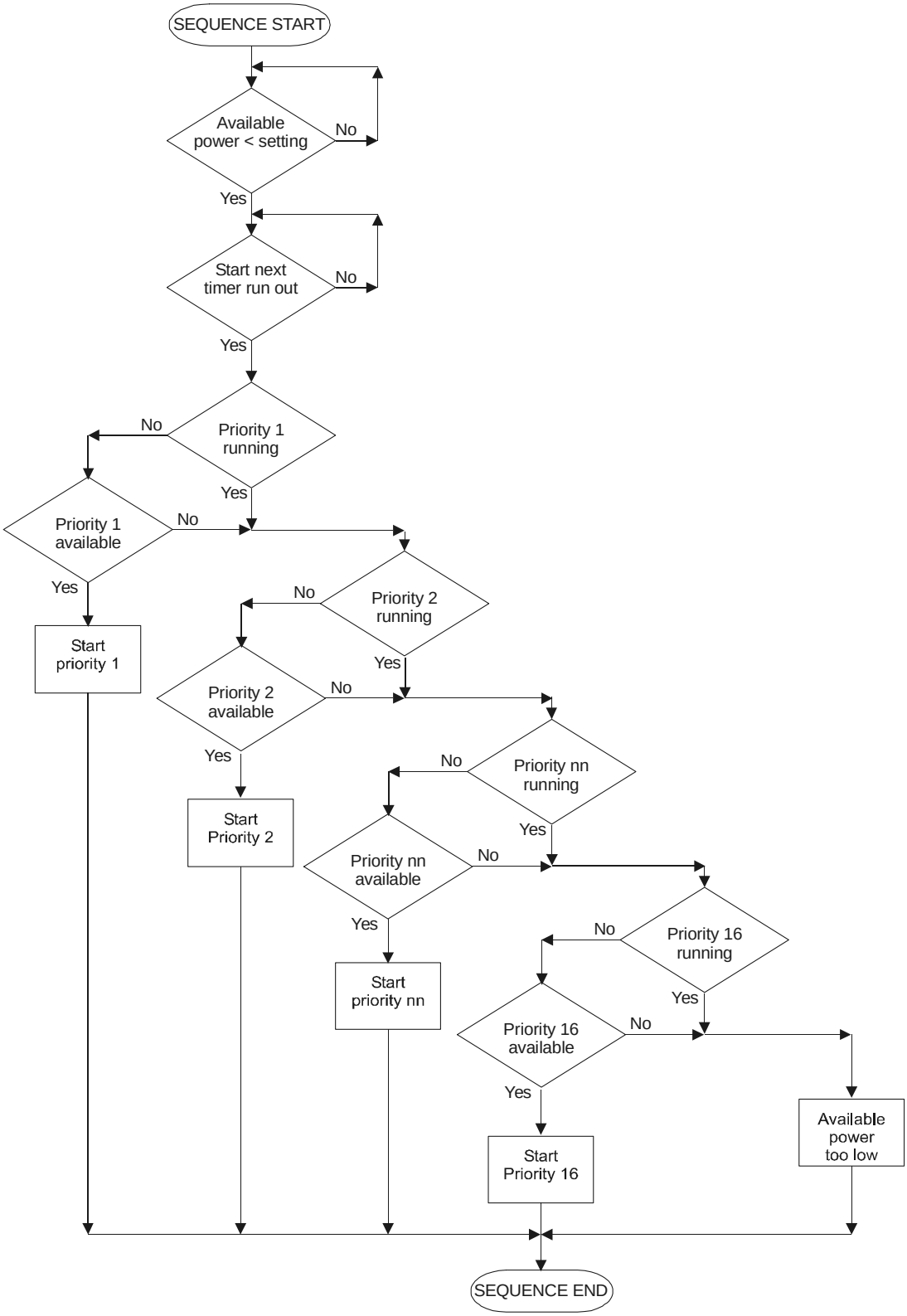
Engine start sequence



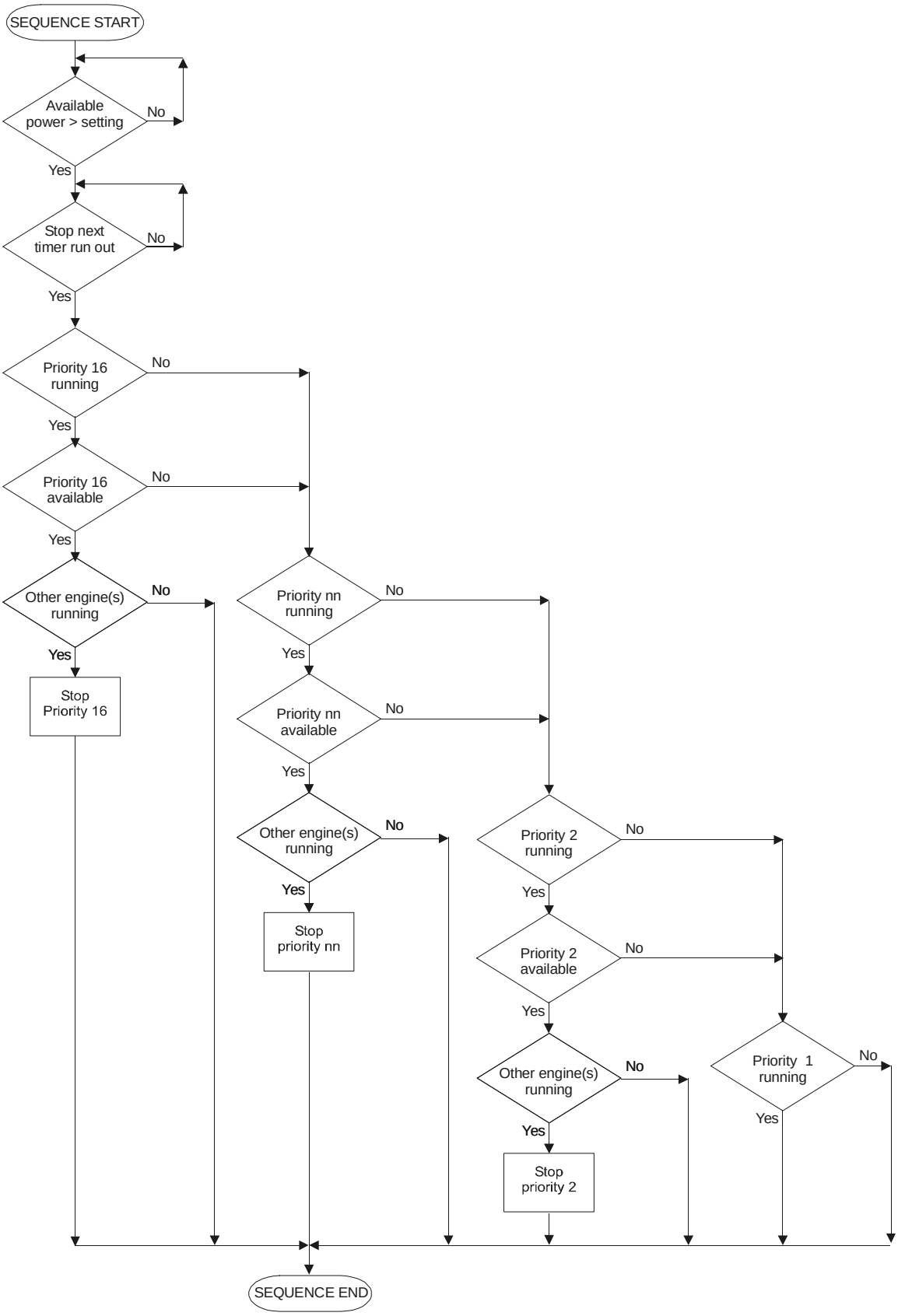
Engine stop sequence



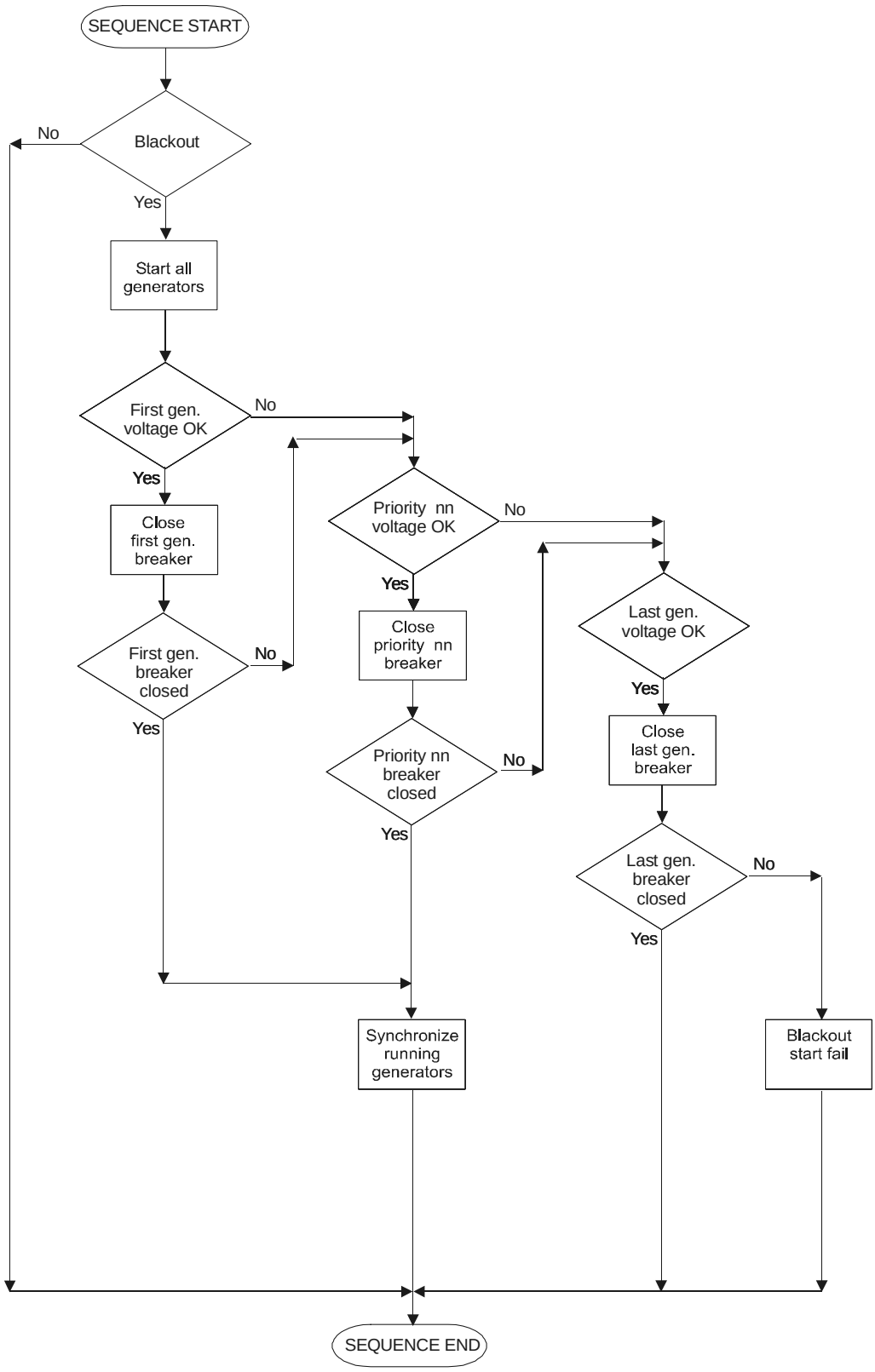
Load dependent start



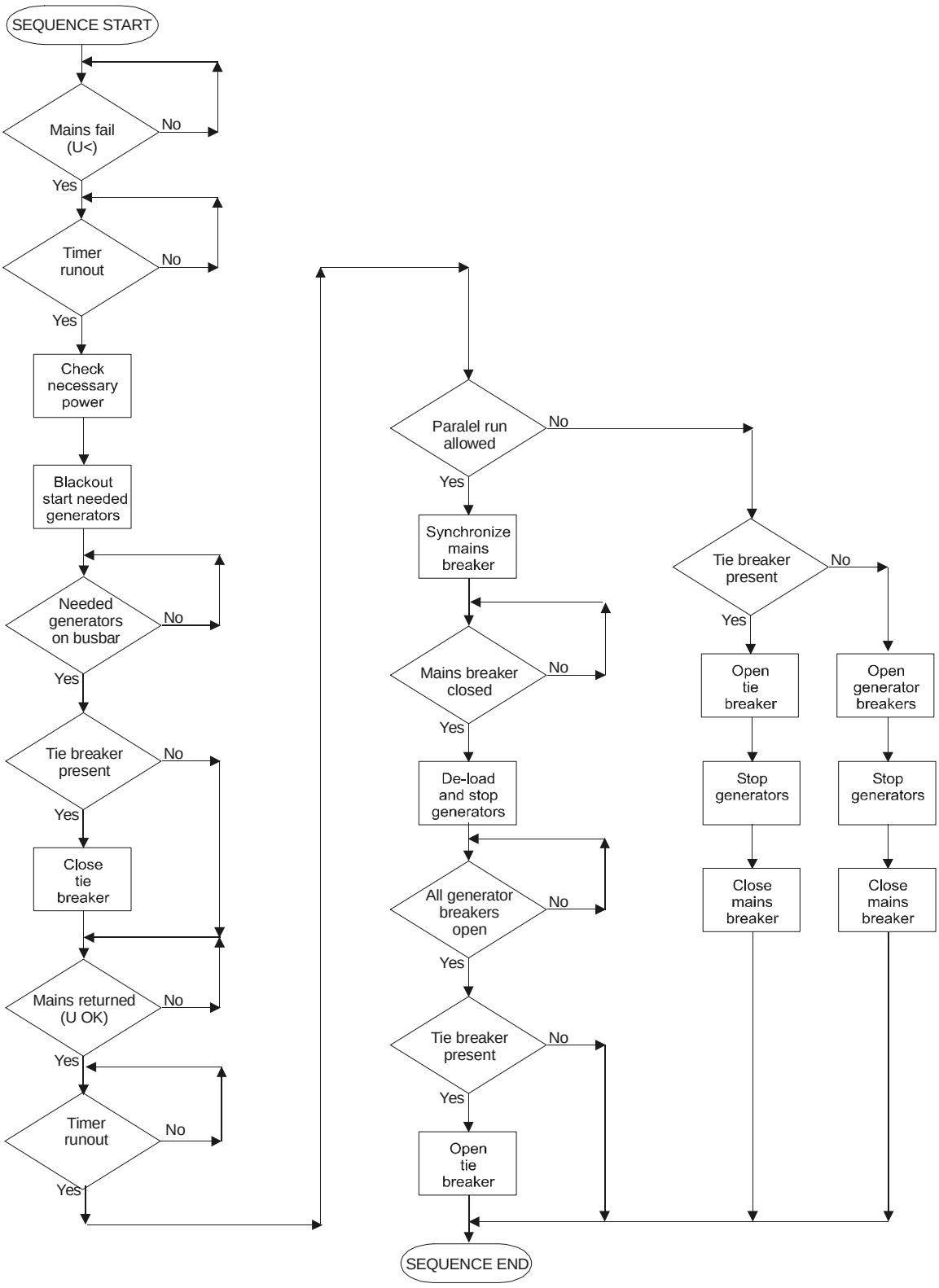
Load dependent stop



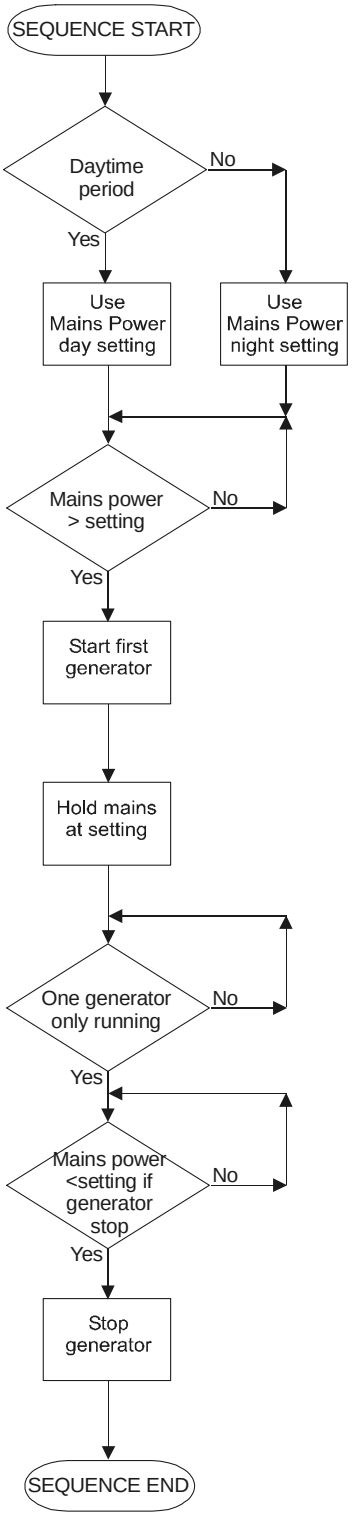
Blackout start



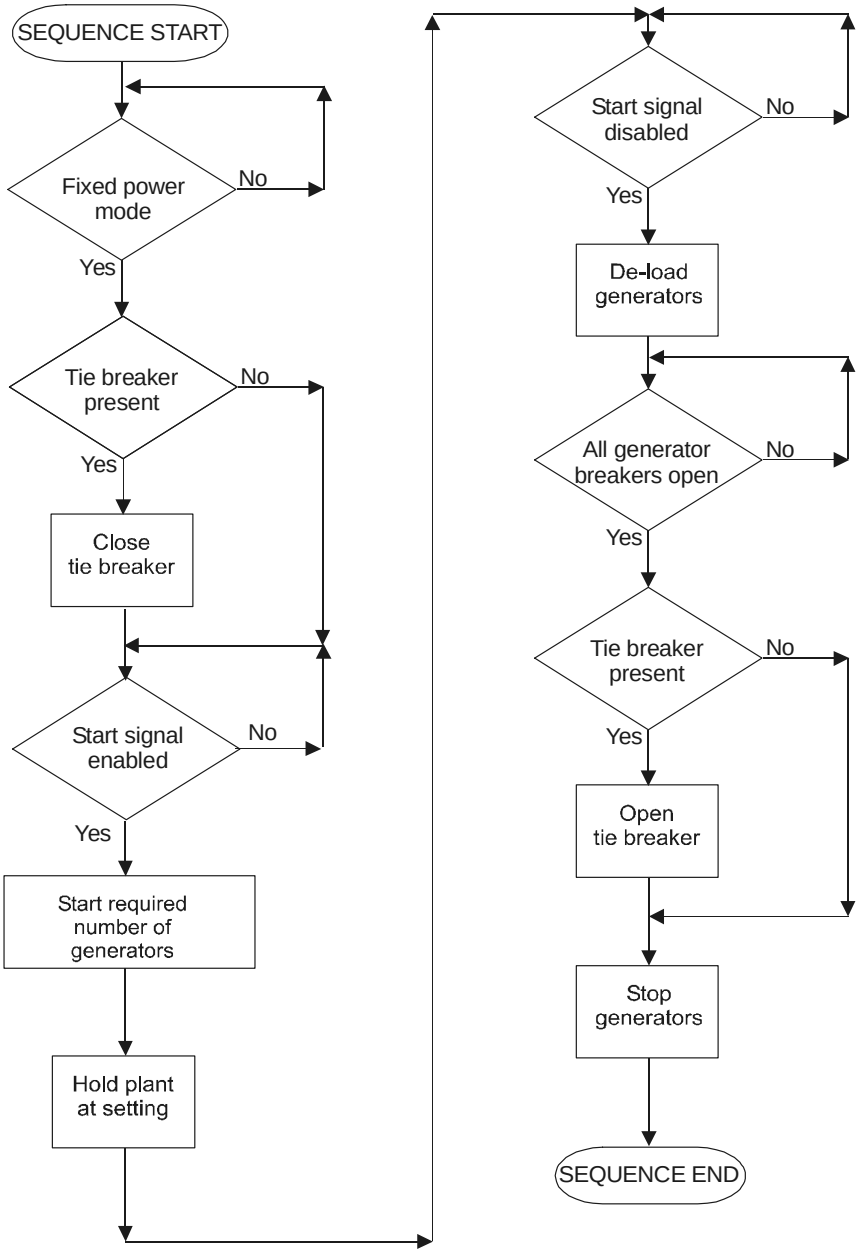
Automatic Mains Failure



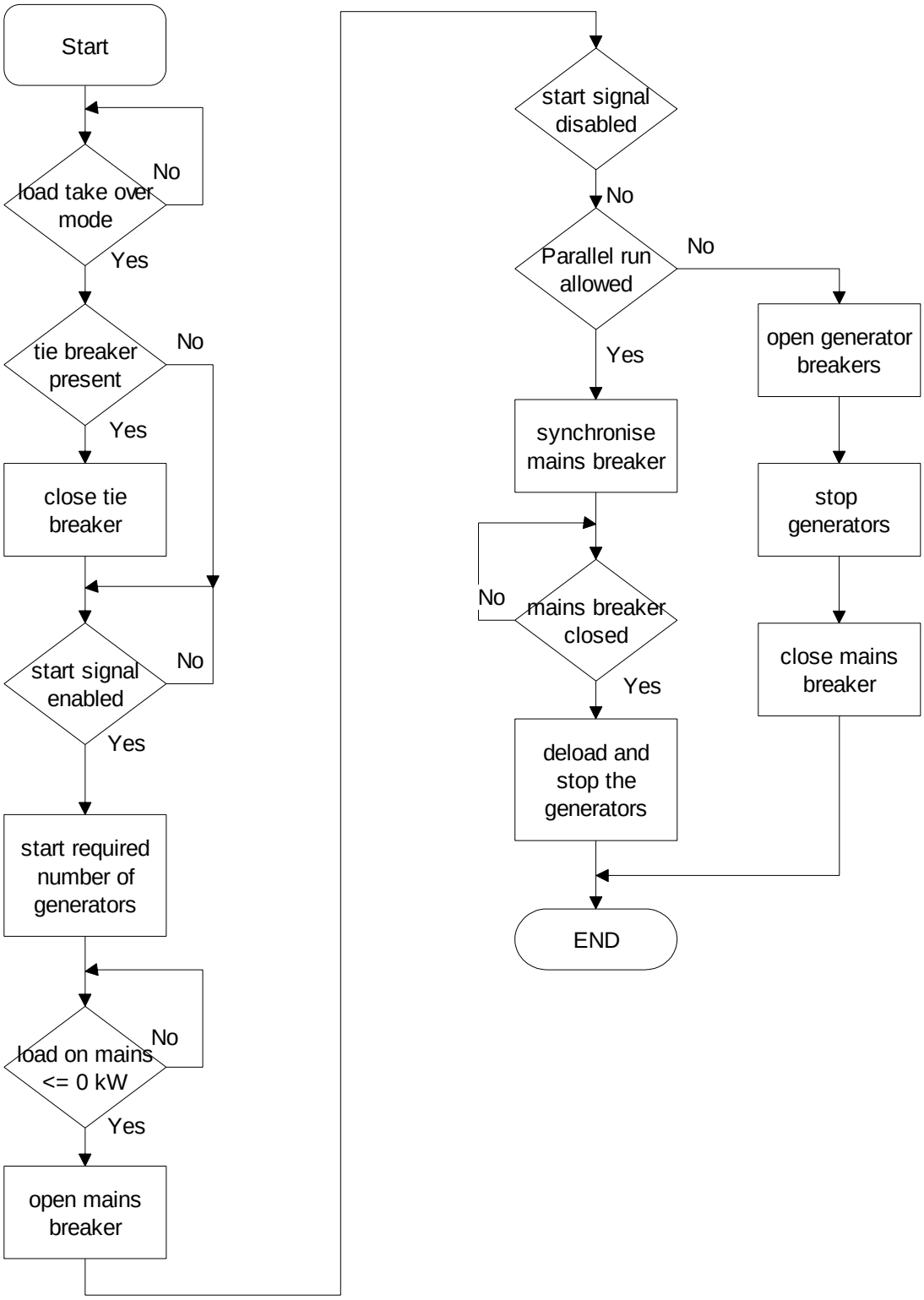
Peak shaving



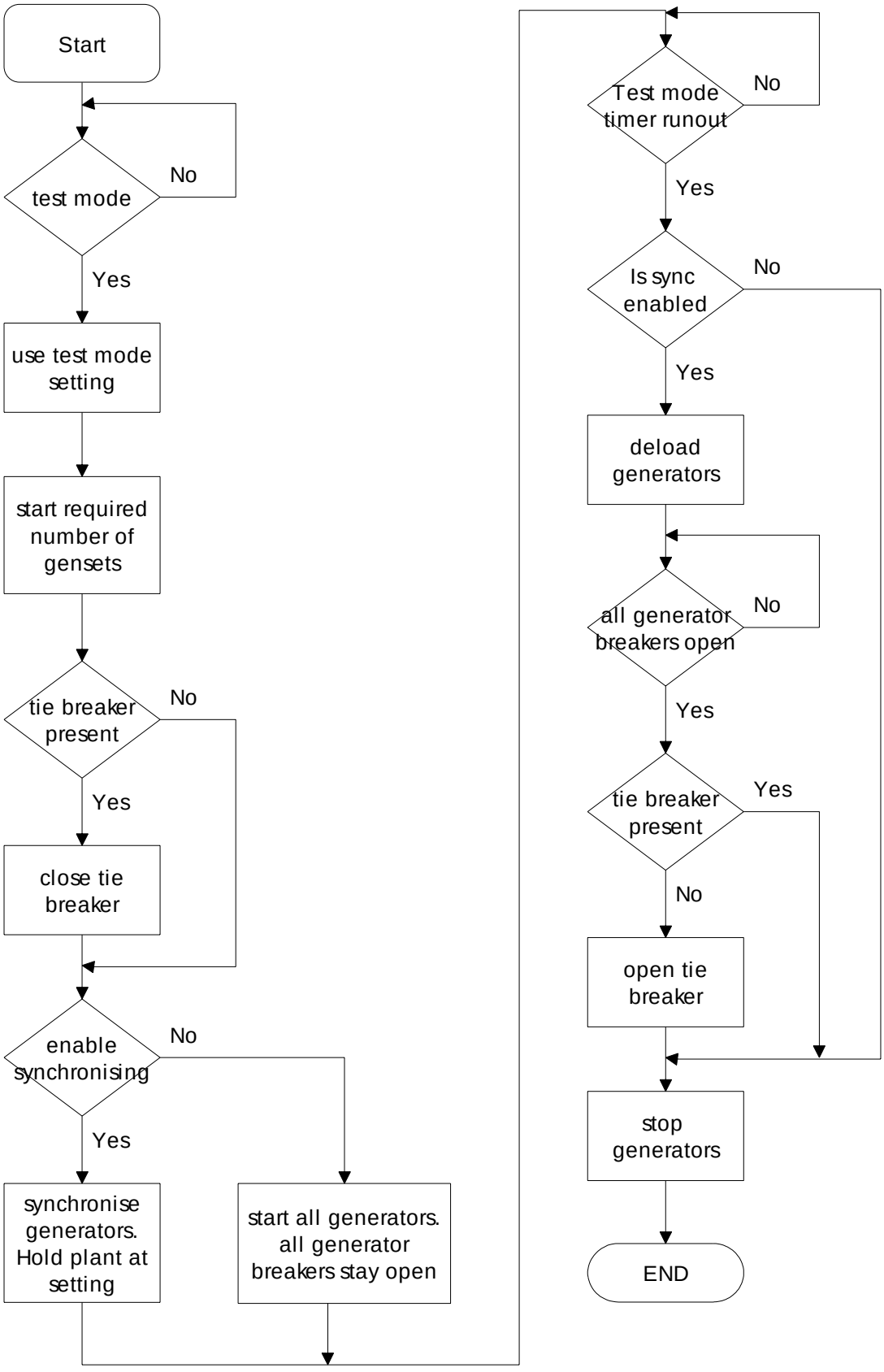
Fixed power


SEQUENCE START
Fixed power mode
No
Yes
Tie breaker present
No
Yes
Close tie breaker
Start signal enabled
No
Yes
Start required number of generators
Hold plant at setting
Start signal disabled
No
Yes
De-load generators
All generator breakers open
No
Yes
Tie breaker present
No
Yes
Open tie breaker
Stop generators
SEQUENCE END

Load take over



Test

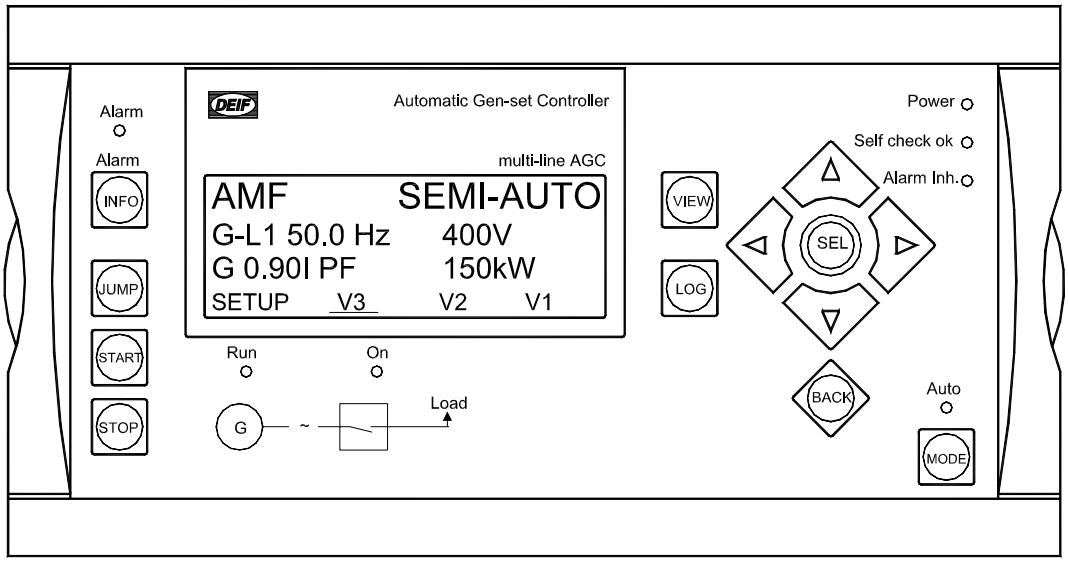

Start
test mode
No
Yes
use test mode setting
start required number of gensets
tie breaker present
No
Yes
close tie breaker
enable synchronising
No
Yes
synchronise generators. Hold plant at setting
start all generators. all generator breakers stay open
Test mode timer runout
No
Yes
Is sync enabled
No
Yes
deload generators
all generator breakers open
No
Yes
tie breaker present
Yes
No
open tie breaker
stop generators
END

4. Display units

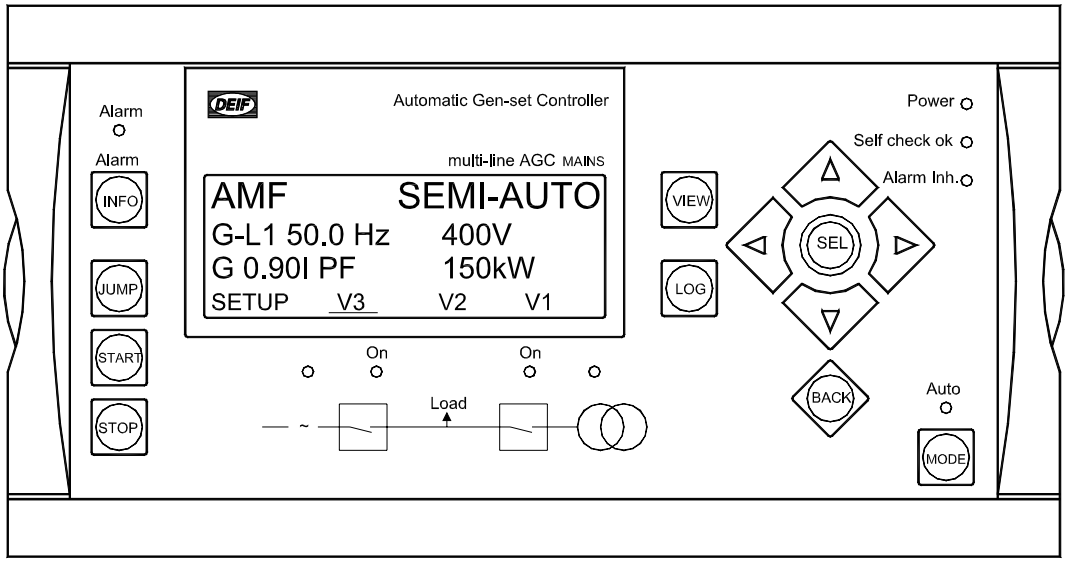
Two displays exist for the G5 option.

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

Generator unit display



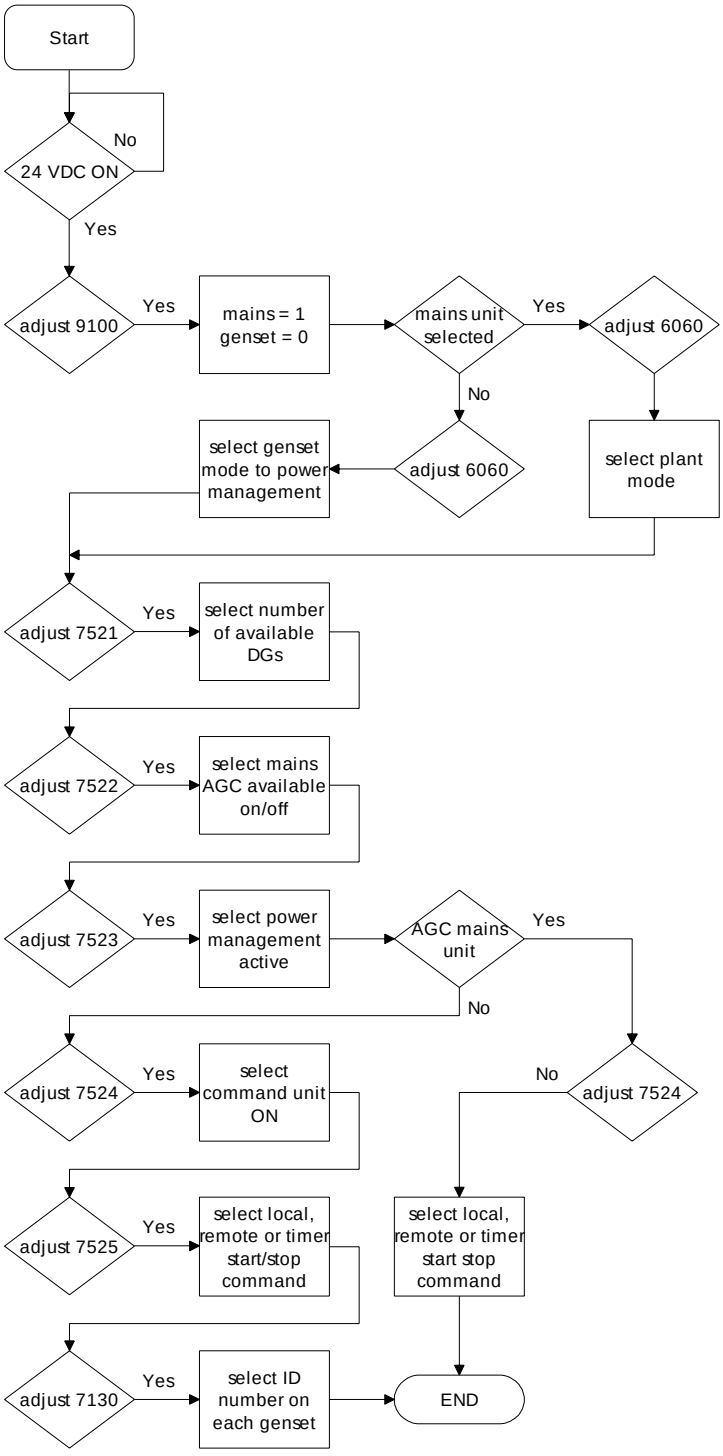
Mains unit display



5. Power management setup

Initial power management setup

This flowchart describes the initial setup of the AGC unit. This is only the initial settings. When this has been done the AGC is in power management mode, and the additional power management functions can be set up.



Remove unit from PM

If one or more units have to be taken out of the power management system, the following possibilities exist depending on the situation.

Auxiliary supply OFF

The auxiliary supply must be removed from the AGC. This means that a can bus alarm occurs, e.g. 'CAN ID 4 is missing'. The power management functions will not be working, until the specific ID number is disabled on the AGC mains as well as the rest of the gen-set AGCs. This is done in the menus 7540-7560.

When the AGC is reconnected, the ID will automatically be enabled again in the other units when the ID has been recognised. If the AGC that is reconnected is a new unit with the factory settings set in the parameter file, a 'Duplicate CAN ID' error message will appear. When an ID is chosen for the new unit, and the ID chosen is already active in another device, the error message 'CAN ID not available' will appear, and the ID is reset to the start value.

Auxiliary supply ON

If the auxiliary supply is connected, the AGC can be adjusted to another mode than AUTO. In that case the gen-set will not take part in the power management routines.

If AUTO mode is selected on the AGC mains, then the AGC in question will also be changed into AUTO mode. Automatic start is then possible!

The only exception to this is when BLOCK mode is selected on a gen-set AGC.

CAN failure

In case of a CAN failure on the internal CAN controlling the power management, the system can be set up in different ways. In menu 7130 it is decided how the power management system will react in case of a CAN failure.

1. If 'MANUAL' is selected, all AGC units will change mode to manual mode, and this way the regulators will have no reaction, and it will not be possible to close any breakers.

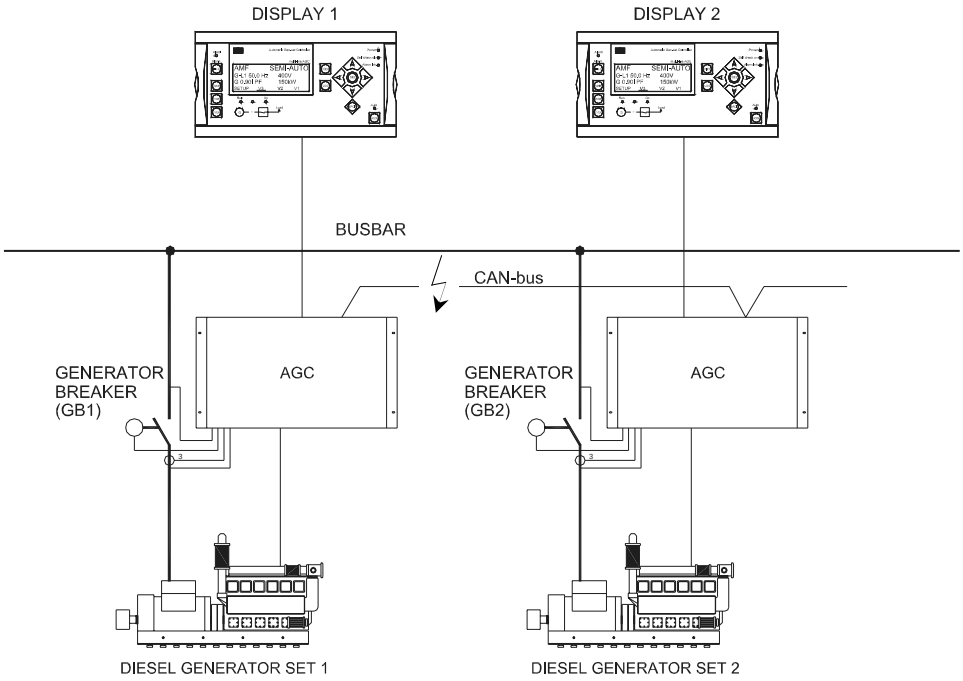
Example 1:

- A break on the CAN line is made between ID1 and ID2 shown below.
- Both gen-sets are running and all breakers are closed.

When the break occurs, the regulators will stop on both gen-sets, but they will stay online. As the gen-sets have no valid information about the other unit over time a blackout can occur, as no load sharing is active between the units.

If for example 6 gen-sets are available in an island application, and the CAN failure happens between ID3 and ID4, the load sharing will still be disabled between all units as it is the manual mode which is activated.

If the CAN error happens when no gen-sets are running, it will block the whole system and it will not be possible to start any gen-sets, before the CAN error has been fixed.



2. If 'SEMI-AUTO' is selected, all AGC units will change mode to semi-auto mode, and this way the regulators will continue to regulate the load on the gen-sets which are still 'visible' on the internal CAN communication. This means that in the example with 6 gen-sets the load sharing will continue between the units which are still connected (ID1-ID3 and ID4-ID6).

If the CAN error happens when no gen-sets are running it will not block the whole system, and it will be possible to start all the gen-sets in SEMI-AUTO mode, even though the CAN error has not been fixed.

A message will be shown in the status line 'Black BUS enable' on the display, if the BUS is black.

If the CAN error is present and no generator breakers are closed, it will be possible to close 2 breakers on the same BUS, which <u>may</u> result in fatal damage to the whole system.

It is recommended to use the analogue load sharing (option G3) and an interlock system to prevent this situation.

6. Power management functions

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.

Load dependent starting and stopping

The purpose of this function is to ensure that sufficient power is always available on the busbar. This means that the gen-sets will automatically be started and stopped in order to let only the sufficient number of gen-sets 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 gen-sets is automatically carried out according to the adjusted set points and priority selection.

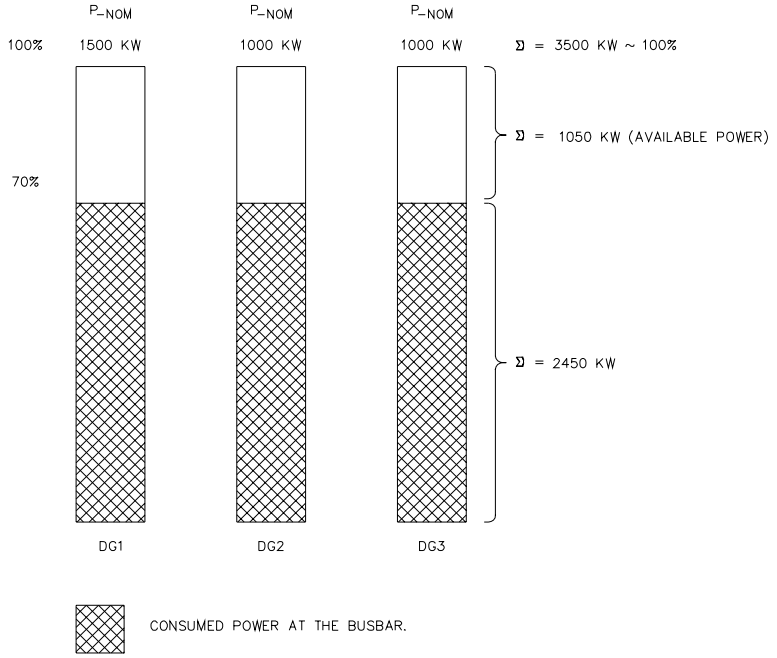
Terminology

The table shows the abbreviations used.

Short	Description	Comment
$P_{AVAILABLE}$	Available power	P_{TOTAL} - $P_{PRODUCED}$
P_{TOTAL}	Total power	$\sum P_{NOMINAL}$ of running sets with GBs closed
$P_{PRODUCED}$	Produced power	
$P_{NOMINAL}$	Nominal power	
$P_{NOMINAL-STOP}$	Nominal power of the gen-set to stop	Priority dependent

Description

This drawing illustrates the terms used.



Nominal power

The nominal power is the rated power of the gen-set 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 gen-set. In the example above the plant consists of 3 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 gen-sets = 2450 kW.

Available power

The available power is the difference between the maximum possible power produced by the gen-sets and the actual produced power.

In the example above the plant consists of three gen-sets, 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 gen-sets can handle this load should it be added to the busbar.

Principle

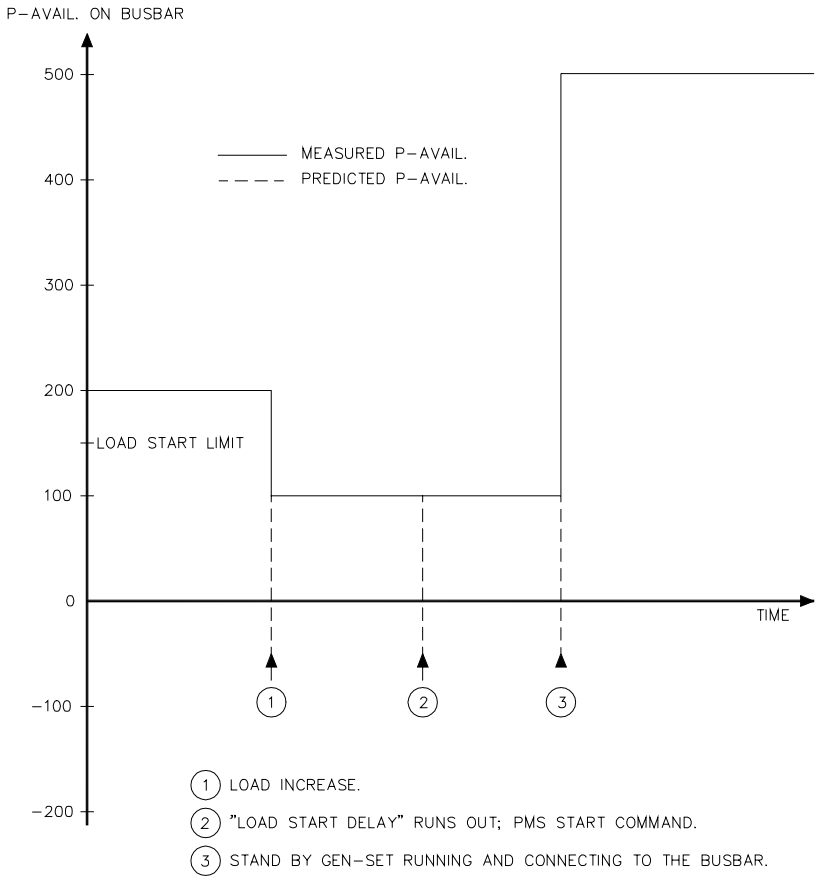
One gen-set is running and is supplying the load. The load increases which means that the available power decreases. At a certain time the load has increased so much that only a little amount of power is available, and the next priority gen-set will be started in order to increase the amount of available power.

When the load drops, the available power will increase. When the available power has increased above the stop level plus the nominal power of the last priority gen-set, then the last priority gen-set will be stopped. Please note that the nominal power of the gen-set to be stopped is added to the adjusted stop level. The reason for that is that otherwise the available power would immediately drop below the start level again.

> ***Example:***
> *If the adjusted stop level is 200 kW (P_{STOP} = 200 kW), and the gen-set 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 gen-set is stopped.*

Adjusting load dependent start

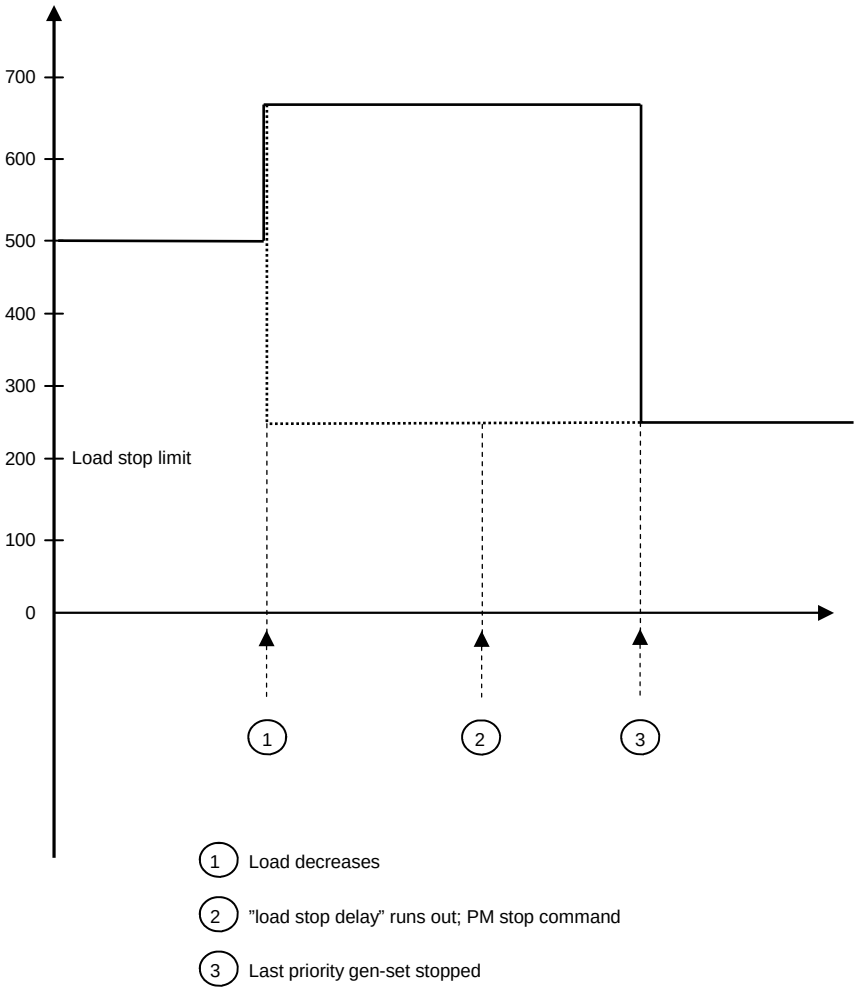
In the example below the available power is 200 kW. When the load increases, the available power drops below the start limit. The stand by gen-set will start when the start timer runs out, and after the synchronising the available power increases (in this example to 500 kW).



Adjusting load dependent stop

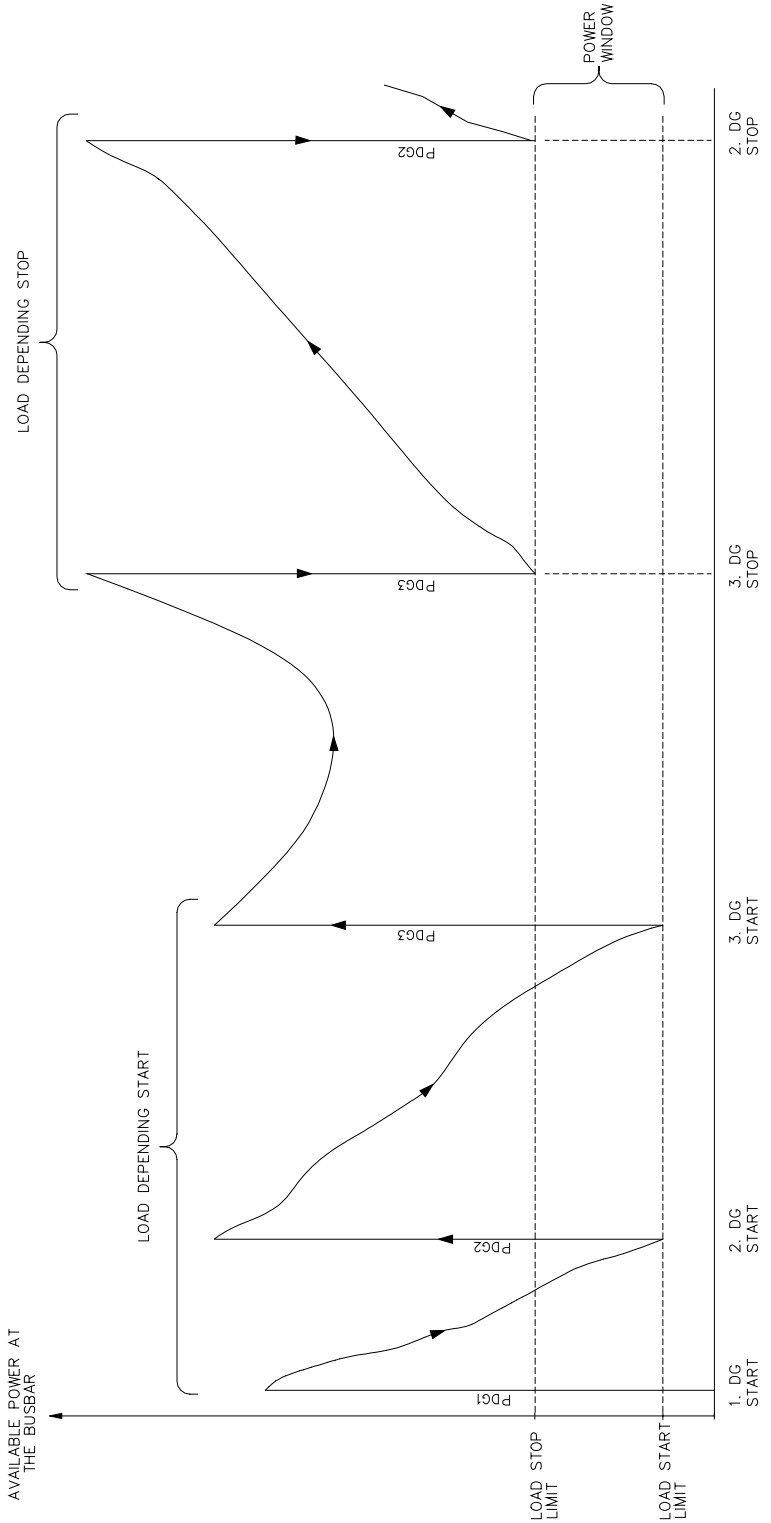
In the example below the available power is 500 kW. When the load decreases, the available power increases to 750 kW. The AGC now calculates what happens, if the last priority gen-set is stopped. In the example below the last priority gen-set is 400 kW which means that it can be stopped, because the 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 gen-set, which now has the last priority, is 50 kW, it can be stopped!



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:



Load management

In the menus 7680 and 7690 it is possible to activate a load management function. 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 gen-sets of the emergency power plant are running.

In each of the gen-sets two levels can be adjusted:

- Available power 1
- Available power 2

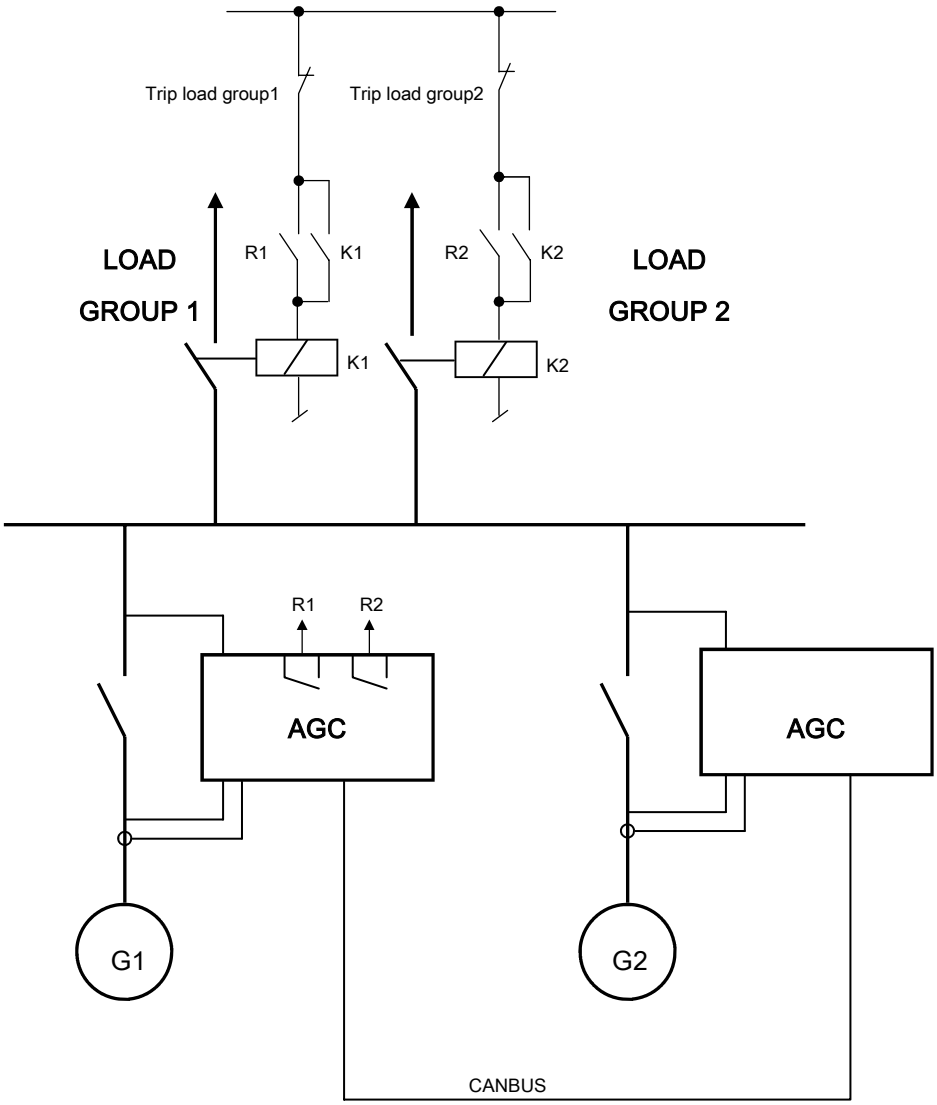
Both of these set points can activate a relay when the specific amount of available power is reached. The relay output can be used for connecting load groups when sufficient power is available. The relays will activate when the available power is higher than the set point, but be aware that when the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

The number of available relays is option dependent.

The function is not depending on the running modes. The relays will activate in all modes including block. However, the activation can be selected to ON or RUN, which means that if RUN is selected, then the relays of the stopped gen-set do not activate, even though the available power is above the set point.

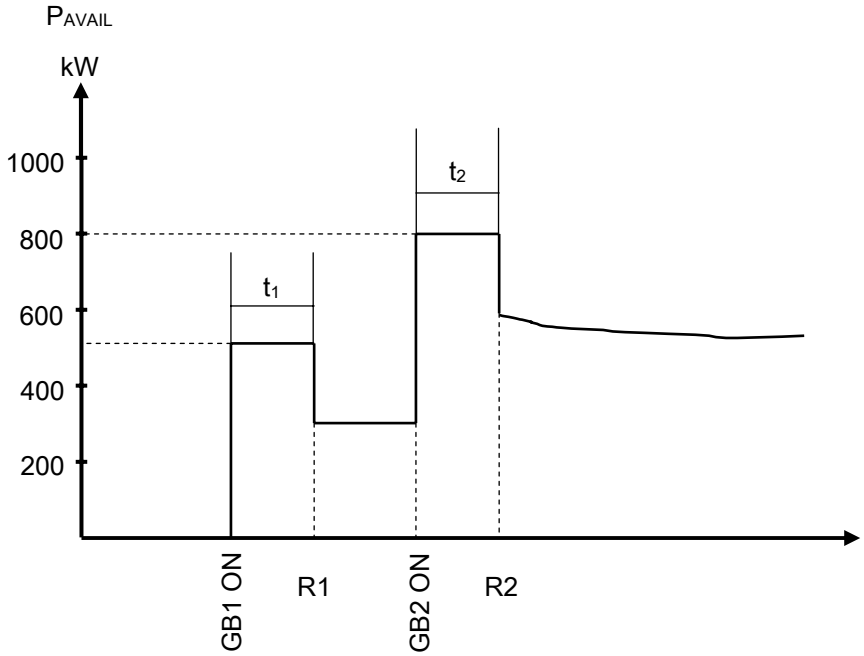
It is possible to adjust different levels of available power in all gen-sets. This gives the possibility to use several load groups if this is necessary.

Example:
In the example below generator #1 is started followed by generator #2. The simplified diagram shows the two gen-sets and two load groups that are being connected by the available power relays R1 and R2 on AGC1.



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 AGCs only. This depends on the number of load groups that need to be connected and also on whether the function has been given ON or RUN status.

Load sharing

The load sharing between the gen-sets is done by using the CAN communication between the units. If the CAN communication is interrupted, the analogue load share line will continue the load sharing. This means that the power management will be lost, but the gen-sets already running will stay stable. The option G3 has to be active to have the backup of the load share.

ATS applications

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

AGC mains installed

See single line diagram on page 11.

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, then the AGC has no control over the ATS ('mains breaker').

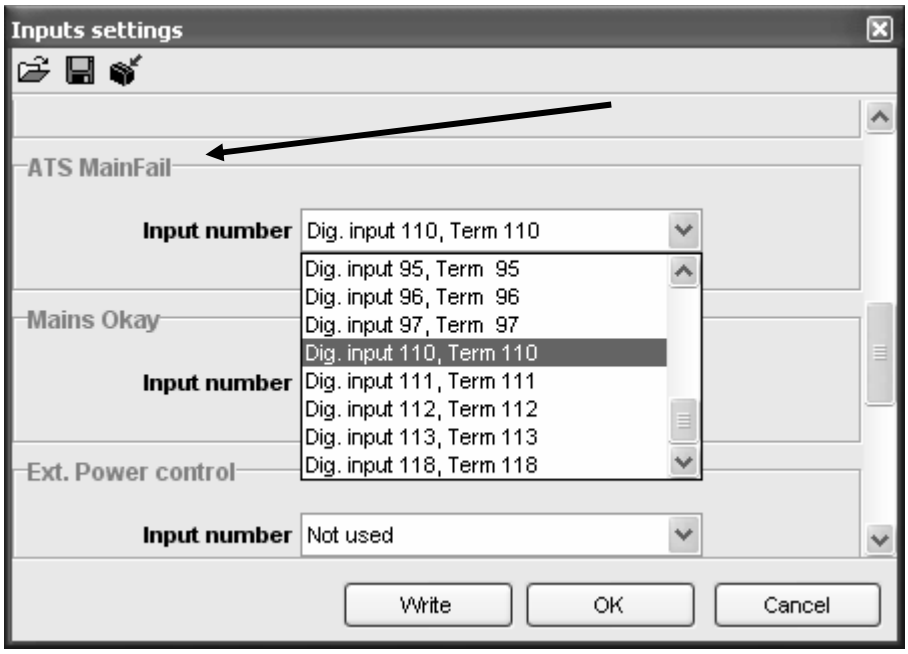
Description

Normally the AGC detects a mains failure based on the voltage and frequency measurement on the mains. However, when ATS is selected it is necessary to use the digital input as well. So now there are two requirements:

1. Digital mains failure signal
2. Low/high measurements of the voltage and frequency

This extra input is called ATS mains failure. In the example below the digital input number 110 is selected for this function.

It is not possible to detect a mains failure, if both requirements are not met.



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 gen-sets need to be started before supplying the load, because the tie breaker will not close, until the required number of gen-sets are available. Please see the description of the multi start function in this handbook.

ATS island mode

See single line diagram on page 11.

If this application is needed, the gen-sets can be started by activating the 'auto start/stop' input. The gen-sets 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 gen-set to close on the busbar can carry the load. If the load is too high, the gen-set will be overloaded.

This application can be combined with the multi start function.

Fail class

The fail classes described in the Designer's Reference Handbook are still valid when the power management option is selected. The only exception is that the 'trip and stop' fail class has been modified to be a 'safety stop'.

This means that when a trip + stop alarm occurs, the faulty gen-set will stay on the busbar, until the next priority gen-set is started and synchronised to the bus. When the incoming gen-set has taken the load, the faulty gen-set will ramp down the power, followed by trip of the breaker, cool down of the engine and finally stop.

If the faulty gen-set has the last priority, or no stand by gen-sets are available, then it will stay on the busbar and will not trip.

If no gen-set can start in a safety stop situation, then the faulty gen-set will not be stopped. Therefore it is important that the safety stop is backed up by a shutdown alarm.

If the 'safety stop' functionality is not needed in a power management application, it can be disabled by using M-logic in the PC utility software.

Local/remote timer operation

The plant can be adjusted to local or remote operation. This selection is done in the command unit, i.e. one of the generator units.

The setting is a basic setting that must be set up during the commissioning.

The purpose of the selection is to decide whether the plant can be started from the display (local operator) or from remote (e.g. PLC). Remote means that the control can be carried out by activating the digital input or through modbus communication.

Local selection

All operation is carried out on the display. In island operation any generator unit display can be used, and in load take over/mains power export/fixed power the mains unit display must be used. The plant mode must be AUTO.

Remote selection

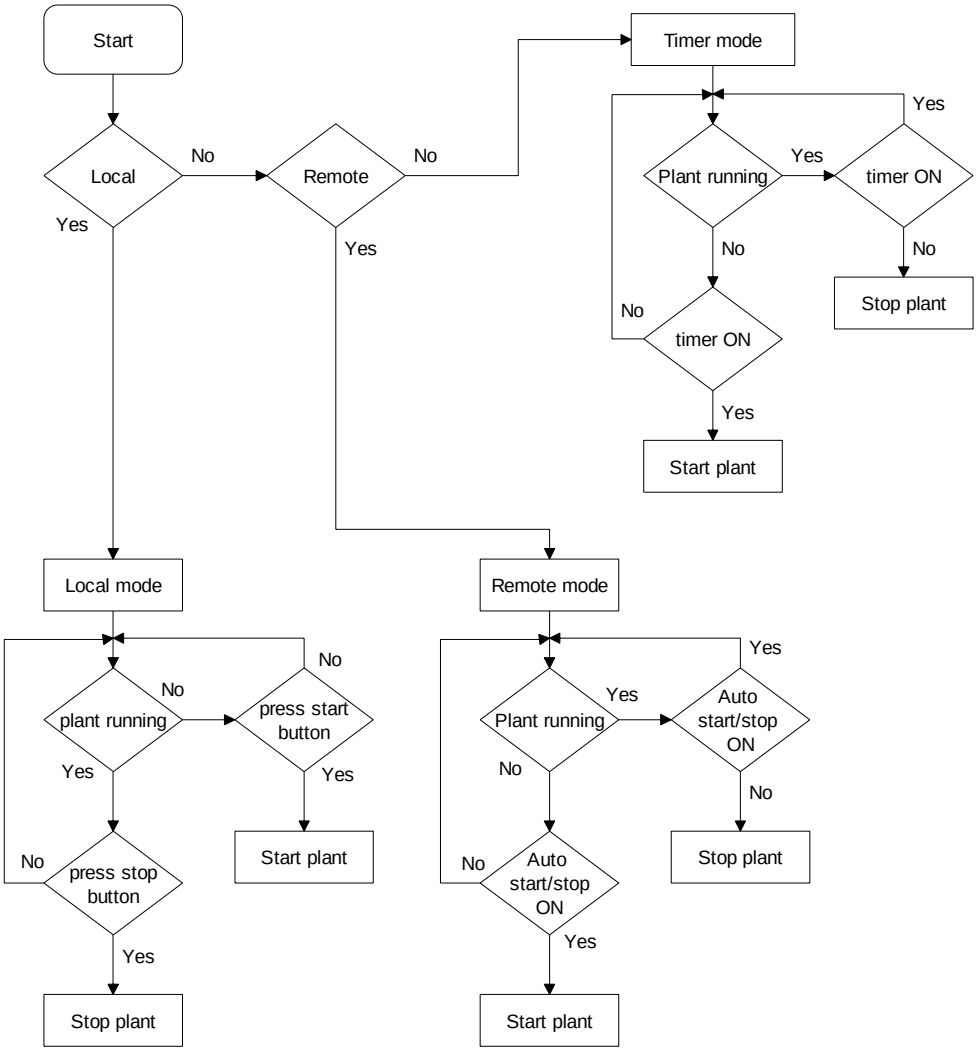
The operation of the plant is carried out using the digital input 'auto start/stop' when remote is selected. In island mode the auto start/stop input on any generator AGC can be used. In load take over/mains power export/fixed power mode the auto start/stop input on the mains unit must be used.

In island operation any running mode can be selected on the generator units, and the remote control is still working. In load take over/mains power export/fixed power the mains unit must be in auto mode.

Plant operation

Selection / Plant mode	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 take over	Display on mains unit	Auto start/stop on mains unit

Principle



Multi-starting gen-sets

The multi-start function can be used to determine the number of gen-sets to start. This means that when the start sequence is initiated through push-button, digital input or automatic start, then the adjusted numbers of gen-sets will start.

This function is typically used e.g. together with applications where a certain number of gen-sets 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.

Enable the multi-start function in menu 7534.

Numbers to start

The number to start (menu 7532) can be selected depending on the number of DGs available (menu 7521). 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.

If it is needed to delay the load dependent start and stop function, it can be done through the M-logic function.

Minimum numbers running

The multi-starting function can be combined with the setting of a minimum number of running gen-sets (menu 7533). This means that the load dependent stop function is disregarded when only the specific number is running. This is also the situation, even though the load would justify a load dependent stop.

This setting can only be modified, if the 'number to start' has been modified.

Priority selection

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

Manual

The manual selection gives a possibility to adjust the order of priority between the adjusted numbers of available DGs (menu 7521). This means that each gen-set always has a specific priority setting.

The adjustment is made in the menus 7570 (P1-P5), 7580 (P6-P11) and 7590 (P12-P16). In this example the order of priority is DG3, DG1, DG2, DG4.

Priority \ Gen-set		DG1	DG2	DG3	DG4
Menu 7571	**P1**			X	
Menu 7572	**P2**	X			
Menu 7573	**P3**		X		
Menu 7574	**P4**				X

These settings are only adjusted in the command unit. After the adjustment the order of priority must be transmitted manually to the other gen-sets using the transmit function in menu 7576.

Running hours

The purpose of the priority selection based on running hours is to let all the gen-sets have the same or nearly the same amount of running hours.

Every time the adjusted period in menu 7601 is reached, a new order of priority is determined, and the gen-sets with first priorities will be started (if not already running), and the gen-sets 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 gen-set which already has many

running hours, or if an AGC is replaced.

Absolute running hours

All gen-sets participate in the priority routine based on the principle shown in the table below. This means that the gen-sets with the lowest number of running hours will be running. This can be a disadvantage for instance if the application consists of old gen-sets together with new gen-sets. In that situation the new gen-sets will be the first priorities, until they have reached the same number of running hours as the old gen-sets. To avoid this the priority routine called relative running hours can be used instead.

The actual number of running hours is adjusted in each gen-set AGC in the menu 6081, typically at the commissioning. The purpose of the menu is to have the correct number of running hours displayed.

Relative running hours

When 'relative' is selected, then all gen-sets will participate in the priority routine independently of the number of running hours adjusted in the menu 6081. This means that all gen-sets 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 the menu 7603, the relative running hour counters in the AGCs 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 7601) are adjusted to 24 hours. In this example only one gen-set 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	DG 3 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 7601 is the time between each priority calculation.

Fuel optimisation

The purpose of the fuel optimisation routine is to always let the gen-sets run in the best combination at any given loads 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 can be set up in the menus 7671-7675.

Menu number	Menu text	Description	Comment
7671	Set point	Load with best fuel economy (% of P_{NOM})	The units will optimise around this gen-set load
7672	Swap set point	Initiate optimising	The improvement in nominal power must be better than this set point to initiate fuel optimising
7673	Delay	Time delay	Optimal combination must be present during this period, before optimising is initiated
7674	Hour	Running hours	Maximum allowed difference in running hours
7675	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:

- 7511 Load dependent stop = 200 kW (extended with 10% in this function)
- 7671 Set point = 100%
- 7672 Swap percentage = 200 kW

Situation 1:
The two 1000 kW gen-sets must operate. The load is too big for one 1000 kW and one 500 kW gen-set.

Situation 2:
Since the load has decreased to 1400 kW, it would be enough with one 1000 kW and one 500 kW gen-set. The improvement is 500 kW which is better than 200 kW (menu 7672). The problem is that only 100 kW would be available. The load dependent stop requires 220 kW available, so no swapping can take place.

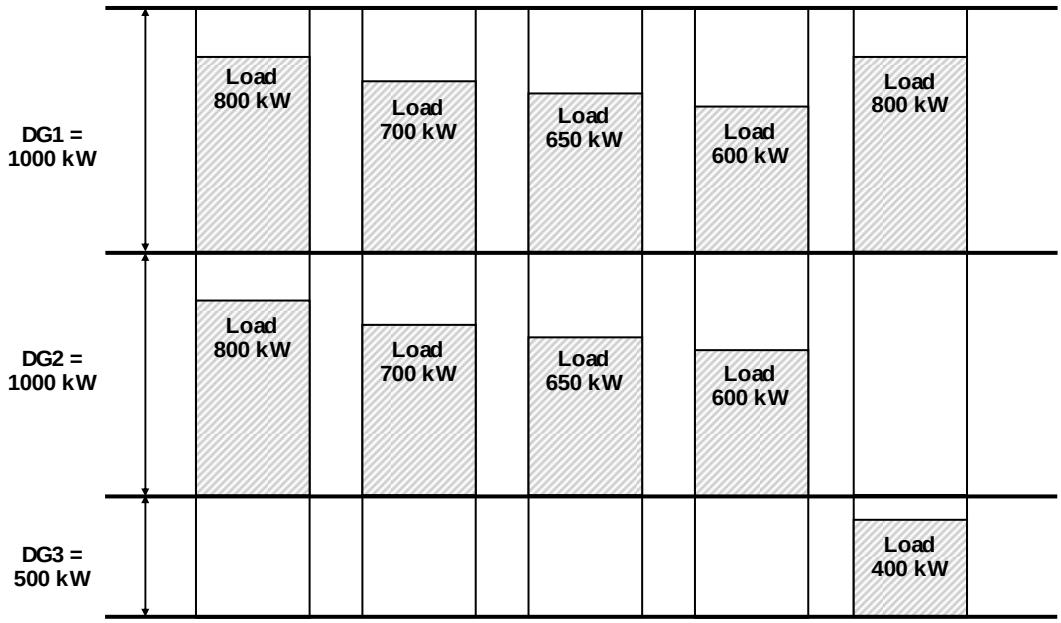
Situation 3:
Now the load has decreased to 1300 kW. It would be enough with one 1000 kW and one 500 kW gen-set. The improvement is 500 kW which is better than 200 kW (menu 7672). The problem is that only 200 kW would be available. The load dependent stop requires 220 kW available, so no swapping can take place.

Situation 4:
Now the load has decreased to 1200 kW. It would be enough with one 1000 kW and one 500 kW gen-set. The improvement is 500 kW which is better than 200 kW (menu 7672). This means

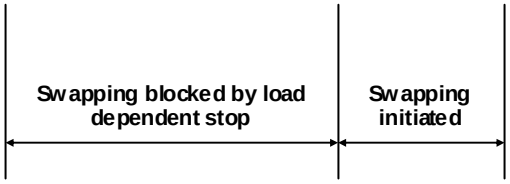
that 300 kW would be available, so the load dependent stop does not interfere with the fuel optimising.

Fuel optimising is initiated!

Situation 5:
Now DG3 has been started and is running with 400 kW. This is the best combination at this time, and no swapping takes place with this load.



	Situation 1	Situation 2	Situation 3	Situation 4	Situation 5
P_{DG1}	800 kW	700 kW	650 kW	600 kW	800 kW
P_{DG2}	800 kW	700 kW	650 kW	600 kW	0 kW
P_{DG3}	0 kW	0 kW	0 kW	0 kW	400 kW
Present P_{AVAIL}	400 kW	600 kW	700 kW	800 kW	300 kW
New P_{AVAIL}	-100 kW	100 kW	200 kW	300 kW	800 kW
Improve kW	none	500 kW	500 kW	500 kW	none
Improvement	-	v	v	v	-



The set point (menu 7671) 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 the menu 7675. 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 gen-set reaches the adjusted amount of running hours, then it will be given quarantine. This means that it will just rest until it has the lowest number of running hours. The only exception to this is if there is no alternative combination. Then it will be used but will still be in quarantine.

Ground relay

The purpose of this function is to always let the star point of only one gen-set be connected to ground during island mode operation.

The number of available configurable relays is option dependent. The relay for this function is selected in each AGC unit, not the command unit.

The AGC which has the lowest can ID and where the generator breaker is closed will close its ground relay. Should this gen-set stop, it will open its ground relay when the generator breaker opens, and the ground relay of the generator which now has the lowest can ID closes its ground relay instead.

The ground relay function is enabled in the command unit.

The function is adjusted in menu 7610.

Stop of non-connected gen-sets

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

The function 'stop of non-connected DGs' (menu 7640) will make sure that the gen-sets stop after the adjusted time.

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 gen-sets and the load bus.

Tie breaker selection

In the menu 7630 the tie breaker can be selected ON (present) or OFF (not present).

Tie breaker open point

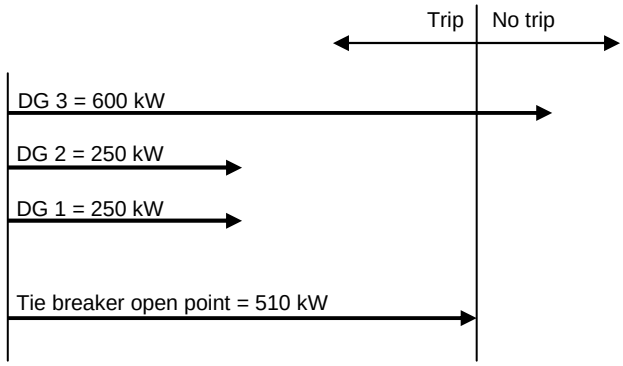
If the gen-sets are running parallel to mains and the mains breaker trips, e.g. due to a mains failure, it can be necessary to trip the tie breaker as well.

This depends on the total nominal power of the running gen-sets. If the gen-sets cannot supply the amount of load which is adjusted in the 'tie breaker open point' menu 7650, then the tie breaker will open. It will close again when the power capacity set point menu 7620 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 gen-sets in the application.

Power capacity

The power capacity setting in menu 7620 is used in AMF applications to determine how much power must be available, before the tie breaker can close. When the gen-sets are started the generator breakers will close, and when sufficient power is available, then the tie breaker will be closed.

7. Parameter lists

For correct order of the settings, please refer to chapter 5.

Common settings

In the command unit the common settings can be adjusted. Before starting to adjust the common settings it is necessary to change the unit where the adjustment is being made to be a command unit. This is done in menu 7524 (select ON).

Only the generator units can be command unit.

These are the common settings:

Menu	Description
6400	Master clock
7132	CAN fail mode
7500	Load dependent start
7510	Load dependent stop
7521	DGs available
7522	Mains available
7523	Power management active
7524	Local remote selection (mains unit)
7525	Local remote selection (gen. unit)
7530	Priority select. / multistart function
7570	Manual priority selection (1-5)
7580	Manual priority selection (6-11)
7590	Manual priority selection (12-16)
7601	Running hours setting
7602	Running hour type selection
7610	Ground relay (enable only)
7670	Fuel optimisation
####	8 command timers (programmed through the utility software)
2110	Close before excitation
2120	Breaker sequence

Plant and gen-set mode

6060 Plant mode

No.	Setting		Possible setting	Factory setting
6061	Plant mode	Type	Island operation	
		Type	Auto. Mains Failure	Auto. Mains Failure
		Type	Peak shaving	
		Type	Fixed power	
		Type	Mains power export	
		Type	Load take over	

To be adjusted in the mains unit.

6060 Gen-set mode

No.	Setting		Possible setting	Factory setting
6061	Plant mode	Type	Island operation	
		Type	Auto. Mains Failure	Auto. Mains Failure
		Type	Peak shaving	
		Type	Fixed power	
		Type	Mains power export	
			Power management	

To be adjusted in the generator units. It will automatically be adjusted to power management when this function is switched on (menu 7523).

Test mode

6540 Test running

No.	Setting		Min. setting	Max. setting	Factory setting
6541	Test	Set point	1 kW	500 kW	20000 kW
6542	Test	Timer	0.5 min.	999.0 min.	5.0 min.
6544	Test	Return	Semi-auto	Auto	Auto

Internal CAN ID number

7130 Int. communication ID

No.	Setting		Min. setting	Max. setting	Factory setting
7131	Int. communication ID	ID	1	16	1
7132	Int. communication ID	CAN fail. mode	Manual mode	Semi-auto mode	Manual mode

Before the internal ID can be adjusted, the number of DGs must be adjusted in menu 7521.

Power management setup

7500 Load dependent start

No.	Setting		Min. setting	Max. setting	Factory setting
7501	Load dep. start	Set point	0 kW	20000 kW	100 kW
7502	Load dep. start	Time	0.0 s	990.0 s	10.0 s
7503	Load dep. start	Min. load	0 kW	20000 kW	20 kW

7510 Load dependent stop

No.	Setting		Min. setting	Max. setting	Factory setting
7511	Load dep. stop	Set point	0 kW	20000 kW	180 kW
7512	Load dep. stop	Time	0.0 s	990.0 s	30.0 s

7520 Power management configuration

No.	Setting		Min. setting		Max. setting	Factory setting
7521	PM config.	DGs available	1		16	1
7522	PM config.	Mains available	OFF		ON	OFF
7523	PM config.	Power management active	OFF		ON	OFF
7524	PM config.	Command unit	OFF		ON	ON
7525	PM config.	Start/stop enable	Remote	Local	Timer	Remote

7530 Priority selection

No.	Setting		Min. setting	Max./second setting	Third setting	Factory setting
7531	Priority select.	Priority	Manual	Running hours	Fuel optimising	Manual
7532	Priority select.	Multi start	1	16	-	1
7533	Priority select.	Minimum running	1	16	-	1
7534	Priority select.	Enable	OFF	ON	-	OFF

7540 Number of IDs

No.	Setting		Min. setting	Max. setting	Factory setting
7541	Number of IDs	Enable mains	OFF	ON	OFF
7542	Number of IDs	Enable ID 01	OFF	ON	OFF
7543	Number of IDs	Enable ID 02	OFF	ON	OFF
7544	Number of IDs	Enable ID 03	OFF	ON	OFF
7545	Number of IDs	Enable ID 04	OFF	ON	OFF
7546	Number of IDs	Enable ID 05	OFF	ON	OFF

7550 Number of IDs

No.	Setting		Min. setting	Max. setting	Factory setting
7551	Number of IDs	Enable ID 06	OFF	ON	OFF
7552	Number of IDs	Enable ID 07	OFF	ON	OFF
7553	Number of IDs	Enable ID 08	OFF	ON	OFF
7554	Number of IDs	Enable ID 09	OFF	ON	OFF
7555	Number of IDs	Enable ID 10	OFF	ON	OFF
7556	Number of IDs	Enable ID 11	OFF	ON	OFF

7560 Number of IDs

No.	Setting		Min. setting	Max. setting	Factory setting
7561	Number of IDs	Enable ID 12	OFF	ON	OFF
7562	Number of IDs	Enable ID 13	OFF	ON	OFF
7563	Number of IDs	Enable ID 14	OFF	ON	OFF
7564	Number of IDs	Enable ID 15	OFF	ON	OFF
7565	Number of IDs	Enable ID 16	OFF	ON	OFF

7570 Priority selection (1-5)

No.	Setting		Min. setting	Max. setting	Factory setting
7571	Priority 1	ID	1	16	1
7572	Priority 2	ID	1	16	2
7573	Priority 3	ID	1	16	3
7574	Priority 4	ID	1	16	4
7575	Priority 5	ID	1	16	5
7576	Transmit new priority		OFF	ON	OFF

7580 Priority selection (6-11)

No.	Setting		Min. setting	Max. setting	Factory setting
7581	Priority 6	ID	1	16	6
7582	Priority 7	ID	1	16	7
7583	Priority 8	ID	1	16	8
7584	Priority 9	ID	1	16	9
7585	Priority 10	ID	1	16	10
7586	Priority 11	ID	1	16	11

7590 Priority selection (12-16)

No.	Setting		Min. setting	Max. setting	Factory setting
7591	Priority 12	ID	1	16	12
7592	Priority 13	ID	1	16	13
7593	Priority 14	ID	1	16	14
7594	Priority 15	ID	1	16	15
7595	Priority 16	ID	1	16	16

7600 Running hours

No.	Setting		Min. setting	Max. setting	Factory setting
7601	Running hours	Set timer	1	20000	175
7602	Running hours	Type	Absolute run hours	Relative run hours	Absolute run hours
7603	Running hours	Reset	OFF	ON	OFF

7610 Ground relay

No.	Setting		Min. setting	Max. setting	Factory setting
7611	Ground relay	Output A	Relay 0		Relay 0
7612	Ground relay	Output B	Relay 0		Relay 0
7613	Ground relay	Enable	OFF	ON	OFF

7620 Power capacity

No.	Setting		Min. setting	Max. setting	Factory setting
7621	Power capacity	Set point	1 kW	20000 kW	50 kW

7630 Tie breaker

No.	Setting		Min. setting	Max. setting	Factory setting
7631	Tie breaker	Enable	OFF	ON	OFF

7640 Stop non-connected DGs

No.	Setting		Min. setting	Max. setting	Factory setting
7641	Stop non-con. DGs	Timer	10.0 s	600.0 s	60.0 s

7650 TB open point

No.	Setting		Min. setting	Max. setting	Factory setting
7651	Tie breaker	Set point	0 kW	20000 kW	50 kW

7660 MB/ATS selection

No.	Setting		Min. setting	Max. setting	Factory setting
7661	MB/ATS selection	Type	MB	ATS	MB

7670 Fuel optimisation

No.	Setting		Min. setting	Max. setting	Factory setting
7671	Fuel optimisation	Set point	30%	100%	80%
7672	Fuel optimisation	Swap set point	50 kW	20000 kW	200 kW
7673	Fuel optimisation	Delay	0 s	999 s	10 s
7674	Fuel optimisation	Hours	1 h	20000 h	175 h
7675	Fuel optimisation	Enable hour	OFF	ON	OFF

7680 Available power 1

No.	Setting		Min. setting	Max./second setting	Third setting	Factory setting
7681	Avail. power 1	Set point	10 kW	20000 kW	-	1000 kW
7682	Avail. power 1	Timer	1 s	9999 s	-	10 s
7683	Avail. power 1	Relay output A	R0 (none)	Option dependent	-	R0 (none)
7684	Avail. power 1	Relay output B	R0 (none)		-	R0 (none)
7685	Avail. power 1	Enable	OFF	ON	RUN	OFF

7690 Available power 2

No.	Setting		Min. setting	Max. setting	Third setting	Factory setting
7691	Avail. power 2	Set point	10 kW	20000 kW	-	1000 kW
7692	Avail. power 2	Timer	1 s	9999 s	-	10 s
7693	Avail. power 2	Relay output A	R0 (none)	Option dependent	-	R0 (none)
7694	Avail. power 2	Relay output B	R0 (none)		-	R0 (none)
7695	Avail. power 2	Enable	OFF	ON	RUN	OFF

AGC mains selection

9100 Application

No.	Setting		Min. setting	Max. setting	Factory setting
9100	Application	Mains	0	1	0

DEIF A/S reserves the right to change any of the above