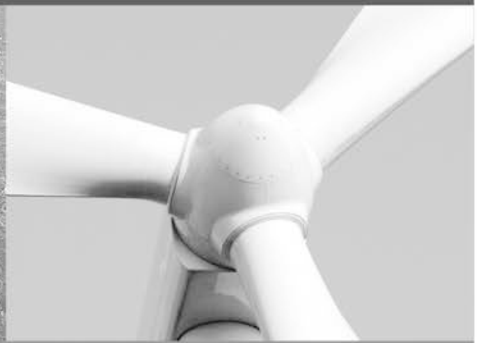
Delomatic 4
DM-4 Land/DM-4 Marine





Commissioning guide
Part 2, chapter 27

DEIF A/S · Frisenborgvej 33 · DK-7800 Skive · Tel.: +45 9614 9614 · Fax: +45 9614 9615 · info@deif.com · www.deif.com

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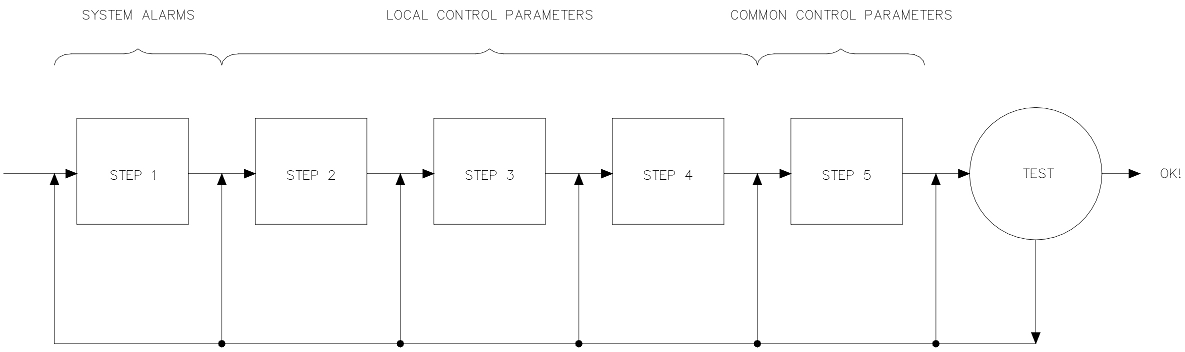
27. Commissioning guide

The purpose of the commissioning guide is to help the Operator to carry out the commissioning of the DELOMATIC system as quickly and efficiently as possible by means of a number of general advices and hints.

In order to achieve this, the following is suggested when planning the commissioning.

The commissioning plan provides two main achievements:

- A structured step-by-step debugging/programming of the DELOMATIC system
- Minimise the number of confusing and irrelevant alarm messages during the commissioning tests



The suggested plan for programming and commissioning of the DELOMATIC system

The commissioning plan consists of initiating five steps:

- Step 1: Troubleshooting of all active system alarms (if any)
- Step 2: Check if the fundamental AC settings are programmed to the correct value
- Step 3: Programming of parameters for the local generator protective functions
- Step 4: Programming of parameters for automatic generator set control functions
- Step 5: Programming of parameters for the common PMS control functions
- *The final commissioning test(s)*

Altogether, by observing the precautions and hints given in the commissioning guide, the commissioning engineers may save valuable time during programming (setup), but certainly also during the acceptance tests.

To minimise the work when testing the system, a special test mode can be entered. Especially when checking the transfer of alarm-indication from Deloamtic to Alarm and Monitoring-systems the feature is handy to use.

- VTA structure **"TEST MODE"**

The alarm which ID is selected in the setup will be trigged, whenever the test mode is activated.

However, the test mode is at maximum activated the time given in the VTA. Then the TEST Mode is automatically reset.

Debug the system alarms before programming the DELOMATIC

The DELOMATIC system *may* generate a number of alarms, when power supply is impressed at the DGUs for the first time. Some of the alarms *may* be system alarms.

Step 1 of the commissioning plan is *to identify, if any system alarms are active* and subsequently debug the originating alarm conditions. This is important, as active system alarms indicate that the DGU(s) has (have) an internal or external failure (e.g. in the wiring etc.), which may disable safe and/or correct operation of the DELOMATIC system.

System alarms are generated by the DELOMATIC internal system supervision functions such as:

- ARC network supervision
- Supervision of the communication between the DGUs and DUs
- Supervision of the circuit breaker(s) position feedback signals
- Supervision of the hardware configuration in the DGUs (I/O supervision)
- The power supply supervision
- Supervision of the multi-transducer units in SCM modules
- Cable supervision

The active DELOMATIC internal system supervision functions are described in the paragraph GENERATOR SET CONTROL.

To be able to test all the implemented alarms and functions, the following set point can be activated at any time simply by adjusting the desired alarm number. The alarm function relating to the adjusted alarm number will then be activated.

- VTA structure **"ALARM TEST"**

Debugging the system alarms

System alarms may be caused by numerous different failures, e.g.:

- Failures in the wiring of the DGUs
- A misunderstanding of the functionalism of an input signal
- Failures in the ARC network installation or connections

Each system supervision function has a corresponding alarm message with information about the system failure. Please follow the below-mentioned step-by-step procedure in order to debug all the system alarm messages (failures).

1. Toggle through all the alarm messages in the alarm stack and identify the system alarms. Please refer to the *alarm list* in order to find out which alarm messages are system alarms and which are not. (Remember to acknowledge the system alarms).

   HINT! Make a list of all active system alarms.

2. Refer to the *alarm list* for information about the meaning of each alarm message. Furthermore each alarm message has a corresponding reference, indicating where to find a description of the originating alarm conditions in the user's manual.

3. Troubleshoot all active system alarms one by one. In order for the user to be able to carry out the troubleshooting, it is highly recommended to read the corresponding description of each system alarm, as these give an understanding of the originating alarm conditions.

4. When the troubleshooting of the system alarms has been completed, check if all the system alarms have disappeared. Toggle through the alarm messages again in order to

see if any new system alarms have appeared during troubleshooting of the previously discovered system alarms and repeat the procedure if necessary.

Programming the fundamental AC settings

Step 2 of the commissioning plan is to check, if the fundamental AC settings are programmed to the characteristic values of the power plant.

The DELOMATIC system operates according to the settings of the fundamental AC settings. The fundamental AC settings are important set points of reference used by *all* functions implemented in the DELOMATIC system, e.g. the busbar supervision function and the integrated generator protective functions.

Fundamental AC settings for SCM modules

The following fundamental AC settings are *always* available in the DELOMATIC system:

- The nominal phase-phase voltage
- The nominal complex power
- The nominal power factor
- The primary CT value
- The secondary CT value
- The primary VT value
- The secondary VT value

Please refer to the paragraph GENERATOR SET CONTROL for detailed information.

Programming the generator protective functions

Step 3 of the commissioning plan is to program the supervision and protective measures according to the desired limits and subsequently ensure the desired selectivity between the implemented functions.

It is possible to achieve

- value (limit) selectivity
- time selectivity

or

- both at the same time

All the below-mentioned protective and supervision functions may be available in each DGU:

- Alarm inhibit of the engine supervision - paragraph GENERATOR SET PROTECTION
- The integrated busbar supervision - paragraph GENERATOR SET PROTECTION
- The integrated generator protective functions - paragraph GENERATOR SET PROTECTION
- Short circuit protection - paragraph GENERATOR SET PROTECTION
- Trip of the Non Essential Load groups - paragraph GENERATOR SET PROTECTION

There are two types of supervised system values, which may have especially many interactive supervision and protective functions:

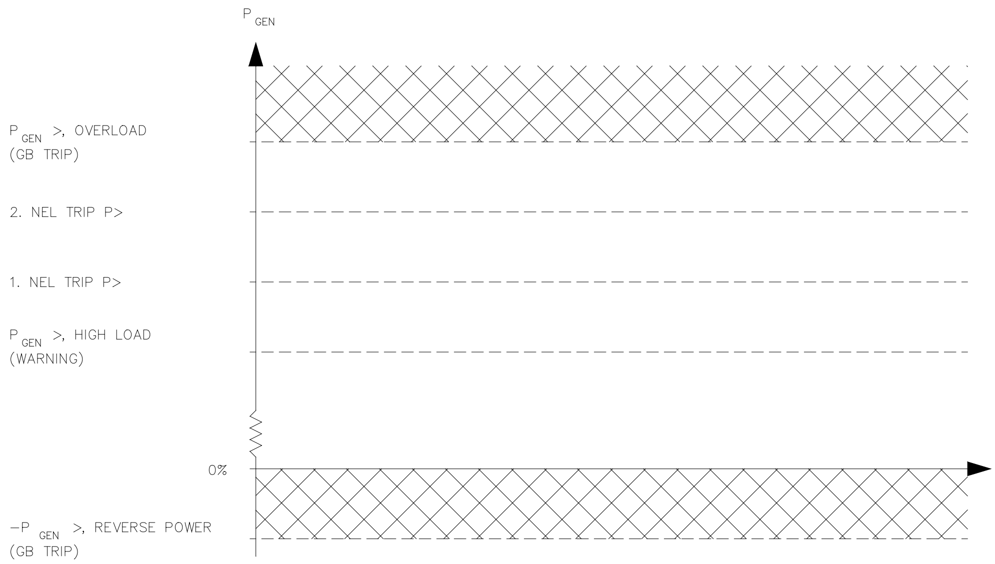
- The generator real power
- The busbar frequency

Programming selectivity of the real power protection

The following functions all carry out supervision or protection of the *generator real power production*:

- Supervision and protection of the generator real power
  P_{GEN}> (4 steps), *warning and trip of GB*
- The reverse power protection
  -P_{GEN}>, *trip of GB*
- Trip of Non Essential Load groups due to a too high load at the generator

The illustration below shows in which sequence the busbar supervision protective measures *may* be programmed in order to achieve real power (value) selectivity.



A suggestion on how to achieve selectivity between the real power protective functions

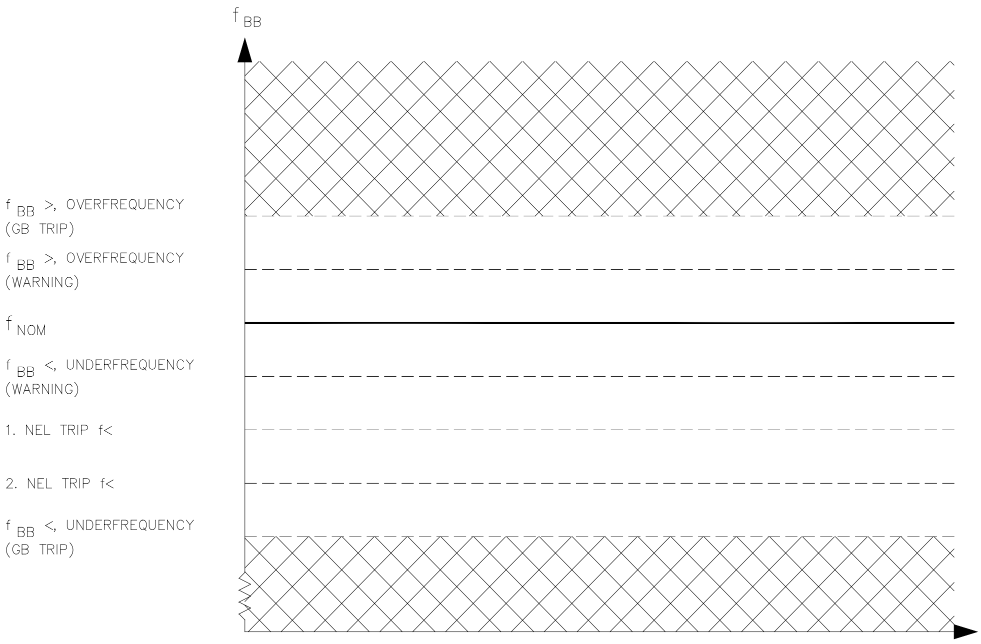
Besides the real power selectivity, it is also possible to program time selectivity by means of the corresponding alarm timers.

Programming selectivity of the frequency protection

The following functions all carry out supervision or protection of the *busbar frequency*:

- The function for supervision of overfrequency at the busbar
  Warning and trip of GB
- The function for supervision of underfrequency at the busbar
  Warning and trip of GB
- Trip of Non Essential Load groups due to a too low frequency at the busbar

The illustration below shows in which sequence the busbar supervision protective measures *may* be programmed in order to achieve frequency (value) selectivity.

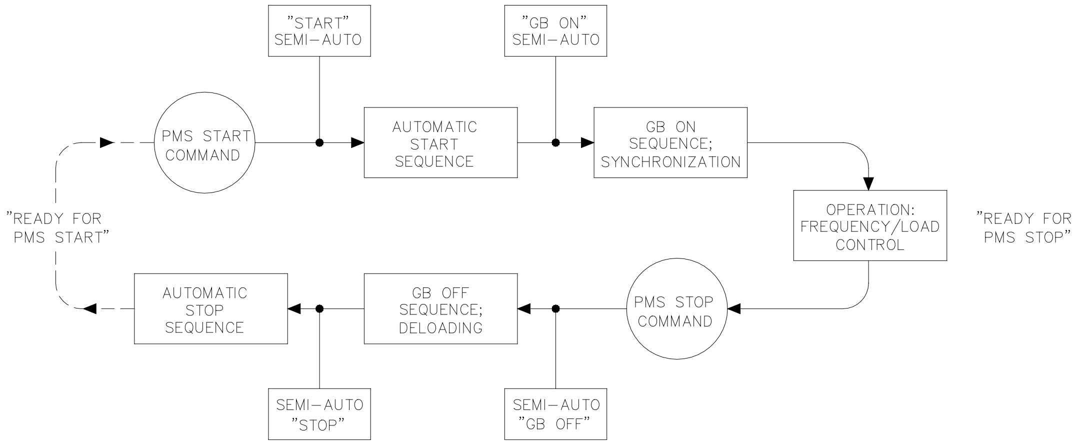


A suggestion on how to achieve value selectivity between the frequency protective functions

Besides the frequency selectivity, it is also possible to program time selectivity by means of the corresponding alarm timers.

Programming the automatic generator set control functions

Step 4 of the commissioning plan is to program the automatic sequences, which are used to implement the distributed control of each generator set.



The automatic sequences contained in the cycle of operation for a generator set

When programming the automatic generator control functions, please refer to paragraph GENERATOR SET CONTROL for detailed information about:

- The start sequence
- The GB ON sequence
- Frequency/load control during operation
- The GB OFF sequence
- The stop sequence

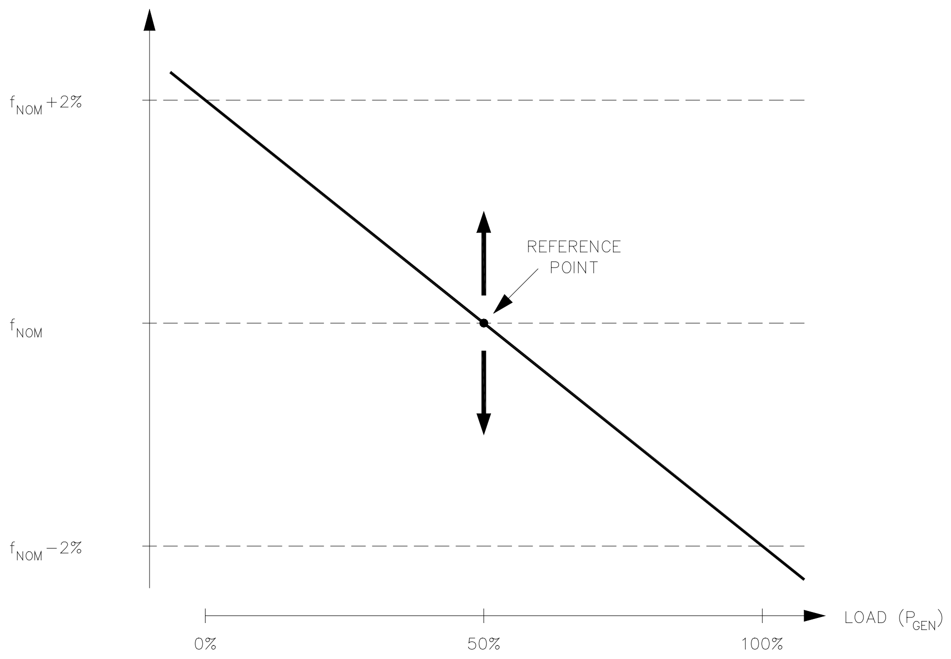
Due to the complexity of the frequency/load control during operation, the programming of the frequency and load controllers is elaborated in the following text:

- Setting of the speed droop in the speed governors
- How the superior frequency/load control is handled by the DELOMATIC system
- Programming the frequency/load controllers in the DGUs:
  - Recommended starting point settings when operating with electronic speed governors
  - Recommended starting point settings when operating with mechanical speed governors

Setting the speed droop in the speed governors

Both the frequency and load controllers are only able to operate, if their corresponding speed governors have an available *speed droop mode*.

The DGUs control the frequency and load by changing the reference point in either upward or downward direction (frequency-wise).



Recommended setting of the speed droop range in the speed governors

The speed droop range is recommended to be set to at least 4% of the nominal frequency (f_{NOM}).

A lower speed droop range than the recommended 4% may result in a fast (maybe too fast) dynamic control loop and thus an unstable power plant.

A higher speed droop range than the recommended 4% may result in a slow (maybe too slow) dynamic control loop.

Coherence between the frequency and load controllers

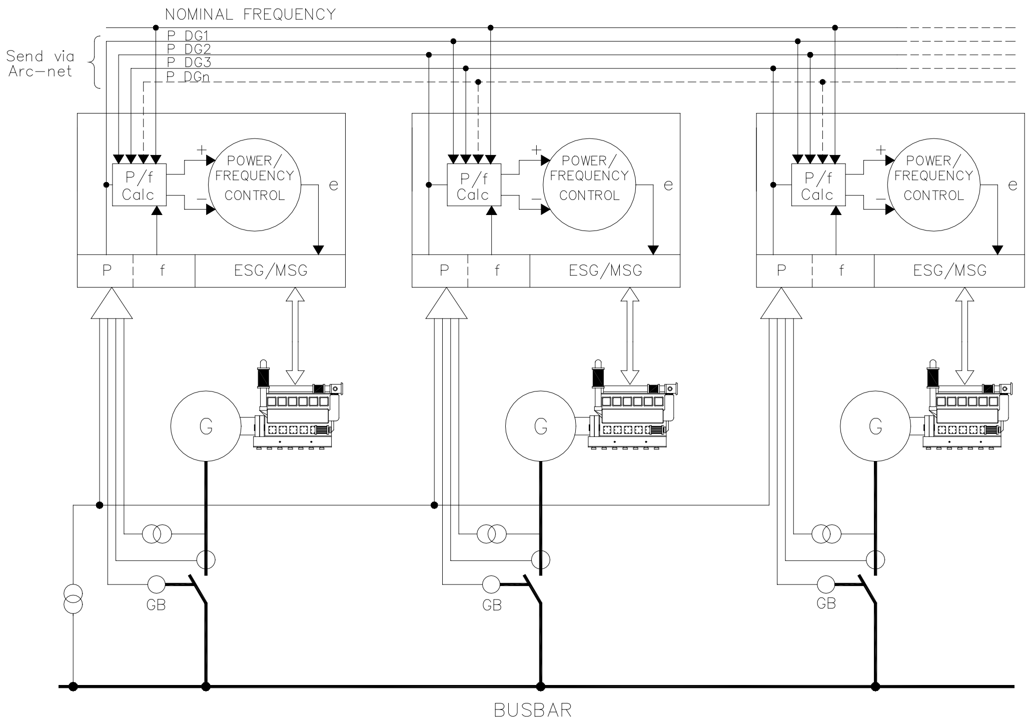
Each DGU has:

- a frequency controller, *which is used when the DGU carries out the superior frequency control and during synchronisation*

and

- a load controller, *which is used when the DGU carries out load control*

Superior frequency and load sharing control of the power plant is handled by all of the running DGUs by transmission of the power from each DGU, a power reference point is calculated in each running DGUs.



Operating principle of the superior frequency/load control handled by the DELOMATIC system

The settings of the frequency controller determine the dynamic behaviour of the real power reference point.

It is thus recommended to program the load controller(s) with approx. 2 times faster dynamical response than the frequency controller(s).

Programming the frequency and load controllers

Each frequency (f-) and load (P-) controller has 3 different programmable set points.

	F controller	P controller	Description
•	DG f-GAIN IDLE	-	The proportional gain of the controller (the amplification of the controller) Only used when the generator breaker is open
•	DG f-GAIN	DG P-GAIN	The proportional gain of the controller (the amplification of the controller)
•	DG f/P-PULS TIME	DG f/P-PULS TIME	The time duration between each update of the controller output(s) (determines the internal scan frequency)
•	DG f-DEAD BAND	DG P-DEAD BAND	The neutral zone (no regulation will take place in this range)

When adjusting the system's dynamic response, it is highly recommended only to adjust one type of set point at a time, preferably the "DG f-GAIN IDLE", "DG f-GAIN" and the "DG P-GAIN".

If the system has a too fast frequency response, please try decreasing the "DG f-GAIN" values in all the DGUs.

If the system has a too slow frequency response, please try increasing the "DG f-GAIN" values in all the DGUs.

If one or more generator set(s) have a too fast load share response, please try decreasing the "DG P-GAIN" value(s) in the DGU(s) in question.

If one or more generator set(s) have a too slow load share response, please try increasing the "DG P-GAIN" value(s) in the DGU(s) in question.

Recommended start settings if using electronic speed governors

If the corresponding speed governor is an electronic governor, it is recommended to use the following settings as starting points:

- DG f-GAIN 30
- DG f-PULS TIME 250 ms

- DG P-GAIN 50
- DG P-PULS TIME 250 ms

By using the above settings as starting points, it should in most cases be possible to tune the power plant only by means of the "DG f-GAIN" and the "DG P-GAIN" set points.

Recommended start settings if using mechanical speed governors

If the corresponding speed governor is a mechanical governor, it is recommended to use the following settings as starting points:

- DG f-GAIN 30
- DG f-PULS TIME 1000 ms

- DG P-GAIN 50
- DG P-PULS TIME 1000 ms

The "ratio" between frequency and S_{NOM}, when the generator is inside the neutral zone, is dependent on the speed droop "slope".

Programming the common parameters for PMS control

Step 5 of the commissioning plan is to program the common parameters for PMS functions, which are used to implement the common control of the DELOMATIC system.

When programming the generator control functions, please refer to the paragraph POWER MANAGEMENT UNIT for detailed information about:

- The load depending start/stop function
- Selection of start/stop priority
- Asymmetrical load share (if available)
- Blackout sequence
- Conditional connection of heavy consumers (if available)

Due to the importance of the blackout start sequence, the coherence between the "DEAD BUSBAR" delay and the busbar supervision functions is elaborated in the text below.

Ensuring selectivity between blackout start and busbar alarms

Any generator sets which have an active DG block, Trip of GB and Shutdown alarm sequence will *not* be started or synchronised during the blackout sequence.

It is therefore very important that the blackout sequence is initiated, before any other alarms will be generated due to the blackout situation which is present on the busbar, *as they will block for engagement of the generator sets*.

This is ensured by always keeping the delay of the common blackout detection smaller than the below-mentioned alarm timers:

- VTA structure "f-BB< SUPERV."
- VTA structure "f-BB> SUPERV."
- VTA structure "U-BB< SUPERV."
- VTA structure "U-BB> SUPERV."
- VTA structure "f-BB< PROT."
- VTA structure "f-BB> PROT."
- VTA structure "U-BB< PROT."
- VTA structure "U-BB> PROT."

The alarm timer is delivered with factory settings.