DESCRIPTION OF OPTIONS

Option M4
Engine control and protection

- Functional description
- Modes and sequences
- General product information
- PID controller
- Additional functions

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1. Delimitation

1.1 Scope of option M4

1.1.1 Scope of option

This description of options covers the following products:

GPC-3/GPU-3 Hydro	SW version 3.08.x or later
GPU-3/PPU-3	SW version 3.08.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

DANGER!
This highlights dangerous situations. If the guidelines are not followed, these situations could result in death, serious personal injury, and equipment damage or destruction.

CAUTION
This highlights potentially dangerous situations. If the guidelines are not followed, these situations could result in personal injury or damaged equipment.

Notes

INFO
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.

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

Disclaimer

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

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

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.

DANGER!
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 terminal 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 option

3.1 Descriptions

3.1.1 Option M4

This document describes the functionality of engine control and measurements contained in option M4.

3.1.2 ANSI numbers

Function	ANSI no.
3 × multi-inputs (digital, 4 to 20 mA, 0 to 40 V DC, Pt100, Pt1000 or RMI)	77
1 × magnetic pickup input for RPM and alarms/shutdowns	12, 14, 77
7 × binary inputs for control and/or alarms/shutdowns	77
4 × relay outputs for start/stop control	62

3.1.3 Terminal description

Term.	Function	Technical data	Description/preconfiguration
98	+12/24 V DC	8 to 36 V DC	DC power supply
99	0 V DC		
100	MPU input	0.5 to 70 V AC/ 10 to 10000 Hz	Magnetic pickup (RPM)
101	MPU GND		
102	A	0(4) to 20 mA Digital w/wire break Pt100 Pt1000 RMI 0 to 40 V DC	Multi-input 1 Preselected to digital input with wire break detection
103	B		
104	C		
105	A		Multi-input 2 Preselected to digital input with wire break detection
106	B		
107	C		
108	A		Multi-input 3 Preselected to digital input with wire break detection
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	Shutdown override/configurable
115	Digital input 115	Optocoupler	Configurable
116	Digital input 116	Optocoupler	Running feedback/configurable
117	Digital input 117	Optocoupler	Configurable
118	Digital input 118	Optocoupler	Emergency stop and common for 119 and 120
119	NO	Relay 119, 24 V DC/5 A	Run coil/configurable
120	NO	Relay 120,	Start prepare/configurable

Term.	Function	Technical data	Description/preconfiguration
		24 V DC/5 A	
121	Com.	Relay 122, 24 V DC/5 A	Crank (starter)/configurable
122	NO		
123	Com.	Relay 124, 24 V DC/5 A	Stop coil w/wire break detection/configurable
124	NO		
A1	CAN-H	CAN bus interface	Option H7 J1939 engine interface
A2	CAN GND		
A3	CAN-L		
B1	CAN-H	CAN bus interface	Option H7 CAN bus external Axiomatic module interface
B2	CAN GND		
B3	CAN-L		

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

4. Functional description

4.1 Functions

4.1.1 Enable logic

The engine logic can be switched ON or OFF from the display or the utility software. From the display, this is done in menu 9080. It is only possible to access the menu using the “JUMP” push-button on the display. If engine logic is disabled, relays 119, 121, 120 and 123 are configurable. If the utility software is used to enable/disable the engine logic, a manual power cycle of the controller is required in order for relays to be unconfigurable/configurable.

Parameter 9080	Description	Comments
OFF	Input/output extension card	Standard delivery. Requires display without start/stop functions
ON (default)	Engine logic enabled	Requires display with start/stop functions

INFO
With option M4, the display will be without start/stop buttons unless specified. Refer to the data sheet.

INFO
Normally, it is not necessary to change this parameter.

4.1.2 Local/remote selection

The Multi-line 2 can be used in two different operation modes: Local or remote.

Selection between the modes can be done by activating the “Remote” or “Local” push-button on the display or by using digital inputs or external communication, for example Modbus. LEDs will indicate the selected mode.

Communication

If the Multi-line 2 has a communication option, it is possible to change mode through the communication lines as per the table below.

	Local	Remote
Modbus	Yes	Yes
Profibus	Yes	Yes

4.1.3 Not in remote

This function can be used for indication or to raise an alarm in case the system is not in remote. The function is set up in menu 6370.

4.1.4 Sequences

The following contains information about the start and stop sequences of the engine. These sequences are automatically initiated if:

Remote mode:	• "Start sync./control” is activated/deactivated • "Remote start” or “Remote stop” is activated
Local mode:	• Start/stop display push-buttons are activated

Start sequence conditions[1]

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

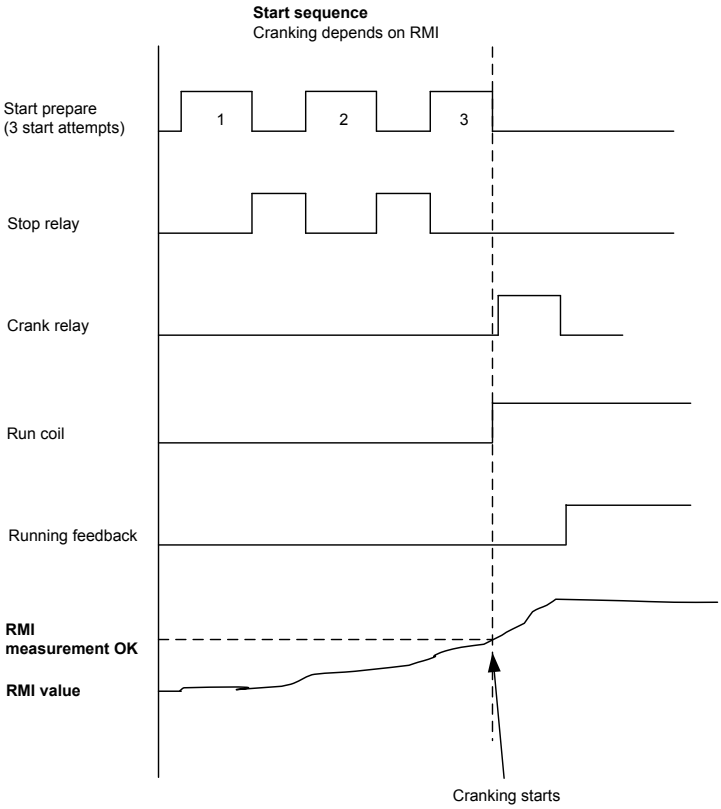
- RMI 102 (oil pressure)
- RMI 105 (fuel level)
- RMI 108 (water temperature)

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

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

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

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



Start/stop threshold[2]

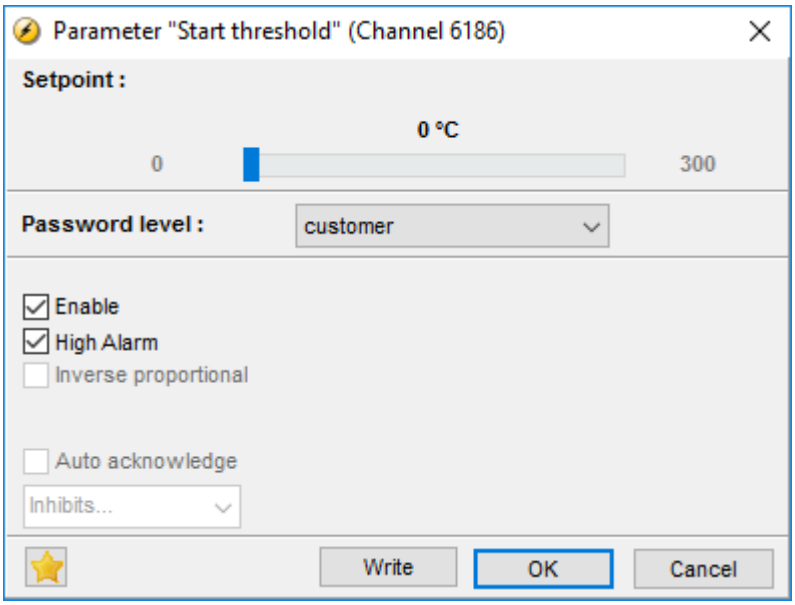
Start threshold allows the user to create a scenario where external requirements must be met before start is possible. If the external requirements are met, the stop threshold stops the DG immediately when in "cooling down".

The external measurement is accessed by using one of the multi-inputs, and in parameters 6185 and 6213 the specific multi-input is applied for the start/stop threshold function.

In parameters 6186 and 6214, the start and stop threshold function is enabled/disabled and the set point is adjusted.

In addition, the alarm can either be set to high ("High Alarm" checked) or low (unchecked). If "High Alarm" is checked, the measured external value must exceed the set point before start is possible, or before immediate stop when the "cooling down" timer is counting.

If "High Alarm" is unchecked, start/stop is possible when the measured value is below the set point



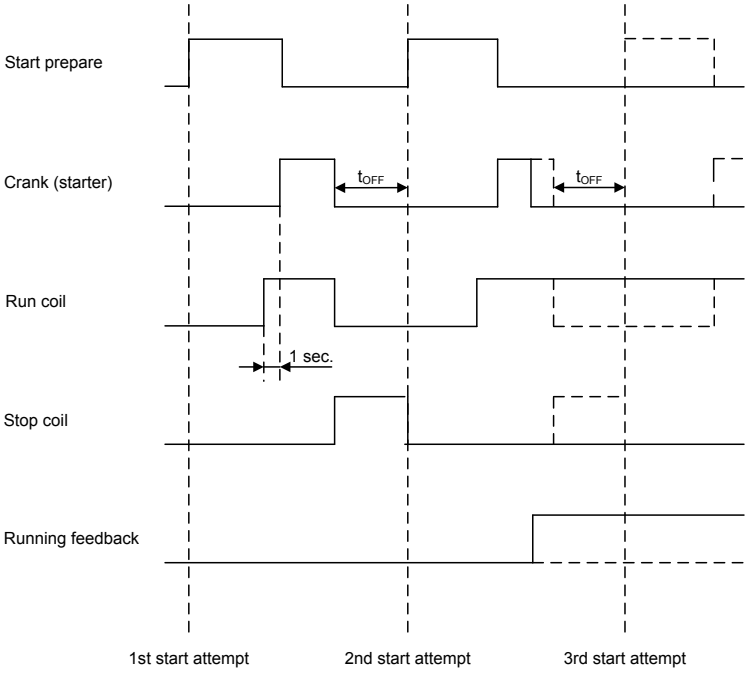
INFO
Commands marked X[1] do not apply to GPC-3.

INFO
Commands marked X[2] only apply to GPC-3.

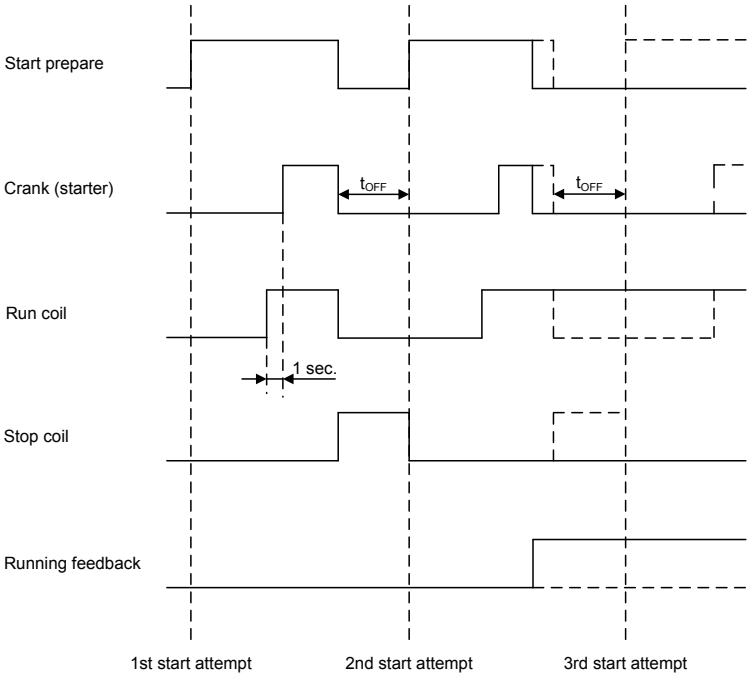
Start sequence

The drawings illustrate the start sequences of the genset.

Start sequence:
Normal start prepare



Start sequence:
Extended start prepare



Interruption of start sequence

The start sequence is interrupted in the following situations:

Event	Comment
Stop command	Deactivating “Start sync./control” or activating “Remote stop” through Modbus or Profibus
Start failure	
Running feedback	Digital input
Running feedback	Tacho set point

Event	Comment
Running feedback	Frequency measurement below 30 Hz The frequency measurement requires a voltage measurement of 30 % of UNOM The running detection based on the frequency measurement can replace the running feedback based on tacho or digital input or engine communication
Running feedback	Oil pressure set point (menu 6175)
Running feedback	EIC (engine communication) (option H5 or H7)
Emergency stop	
Alarm	Alarms with “Shutdown” or “Trip and stop” fail class
Stop push-button on display	Only in local

INFO
The only protections that can stop the genset/interrupt the start sequence when the “Shutdown override” input is activated, are the digital input “Emergency stop” and the alarm “Overspeed level 2”. These protections lie locally on the option M4 (engine board). If the input is set high and the main processor board is okay, the "Fast over-current protection level 2" will also shut down the genset. In order to do so, the fail class of these protections must be set to “Shutdown”. The shutdown override command can be ignored by the rest of the protections with fail class “Shutdown” using the "Ignore shutdown override" inhibit (see the Designer's reference handbook). This does not apply to the three protections mentioned above - these will always shut down the genset.

Set points related to the start sequence

- Start prepare **(6180 Starter)**

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

  Extended prepare: The extended prepare will activate the start prepare relay when the start sequence is initiated and keep it activated when the start relay activates, until the specified time has expired. If the extended prepare time exceeds the start ON time, the start prepare relay is deactivated when the start relay deactivates. If the timer is set to 0.0 s, the extended prepare function is deactivated.

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

  Start OFF time: The pause between two start attempts.
- Run coil timer **(6150 Run coil)**

  The timer for the run coil is a set point that determines how long the run coil will be activated before cranking the engine. This gives the ECU time to start up before cranking.
- Remove starter **(6174 Remove starter)**

  The starter is removed when the RPM set point is reached. This will only work if MPU or EIC RPM is selected in **6172 Run detect type**.
- Running detection RPM level **(6173 Running detection level)**

  This is the set point in which the running detection level is defined in RPM. This will only work if MPU or EIC RPM is selected in **6172 Run detect type**.
- Running detection **(6241 Running detection)**

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

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

- Frequency level **(6165 Frequency detection level)**

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

- Run status **(6160 Run status)**

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

- Delay of regulation **(2740 Delay of regulation)**

  By using this timer, the regulation start can be delayed. The timer will start when **6165 Frequency detection level** is reached.

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

Failures related to the start sequence

- Crank failure alarm **(4530 Crank failure)**

  If MPU is chosen as the primary running feedback, this alarm will be raised if the specified RPM is not reached before the delay has expired.

- Run feedback failure **(4540 Run feedb. fail)**

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

- Hz/V failure **(4560 Hz/V failure)**

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

- Start failure alarm **(4570 Start failure)**

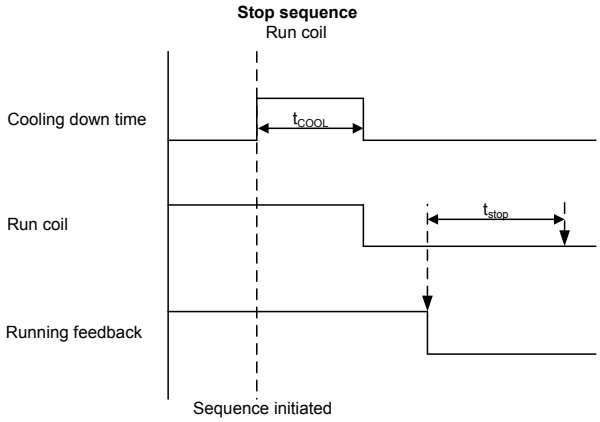
  The start failure alarm occurs, if the genset has not started after the number of start attempts set in menu 6190.

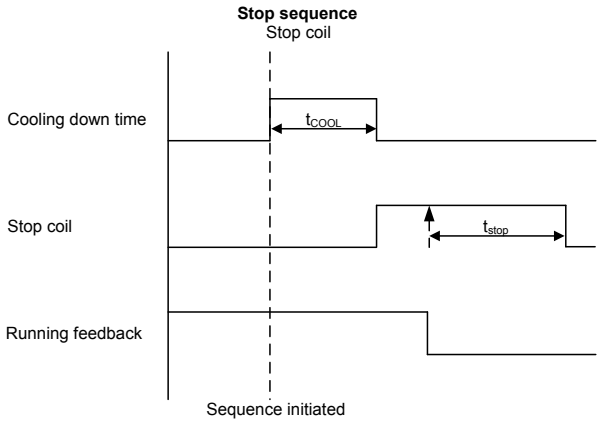
- Engine externally stopped **(6242 Ext. eng. stop)**

  If running sequence is active and the engine goes below **6173 Running detection** and **6165 Frequency detection level** without any command from the AGC, it will set an alarm if this parameter is enabled.

Stop sequence

The drawings illustrate the stop sequence.





Stop sequence, description

The stop sequence will be activated if a stop command is given. The stop sequence includes the cooling down time if the stop is a normal or controlled stop.

Description	Cooling down	Stop	Comment
Remote mode stop	X	X	Deactivate “Start sync./control” to stop or activate “Remote stop”
Stop button on display	X	X	Local mode
Trip and stop alarm	X	X	Alarm sequence
Emergency stop		X	GB opens and engine shuts down

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

Event	Comment
Start button is pressed	Local mode
Binary “Start sync./control” or “Remote start” input	Remote mode
CB close button is pressed	Local mode
Deactivating “Deload” or activating “Remote GB on” input	Remote mode

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

Set points related to the stop sequence

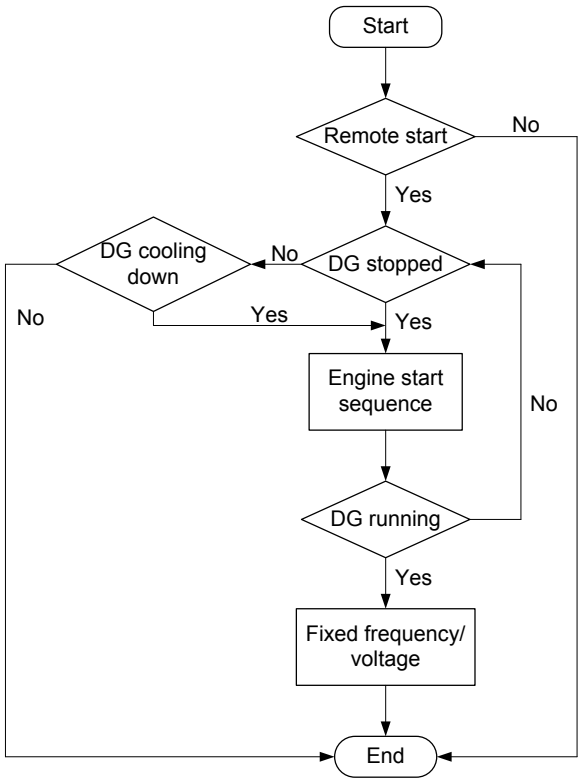
- Stop failure (4580 Stop failure) A stop failure alarm will appear if the primary running feedback or the generator voltage and frequency are still present after the delay in this menu has expired.
- Stop (6210 Stop) Cooling down: The duration of the cooling down period.
- Extended stop: The delay after the running feedback has disappeared until a new start sequence is allowed. The extended stop sequence is activated any time the Stop button is pressed.
- Cooling down controlled by engine temperature: The engine temperature-controlled cooling down is to ensure that the engine is cooled down below the set point in menu 6214 “Cool down temperature” before the engine is stopped. This is particularly beneficial if the engine has been running for a short period of time and therefore not reached normal cooling water temperature, as the cool down period will be very short or none at all. If the engine has been running for a long period, it will have reached normal running temperature, and the cool down period will be the exact time it takes to get the temperature below the temperature set point in menu 6214. If, for some reason, the engine cannot get the temperature below the temperature set point in 6214 within the time limit in parameter 6211, the engine will be shut down by this timer. The reason for this could be high ambient temperature.

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

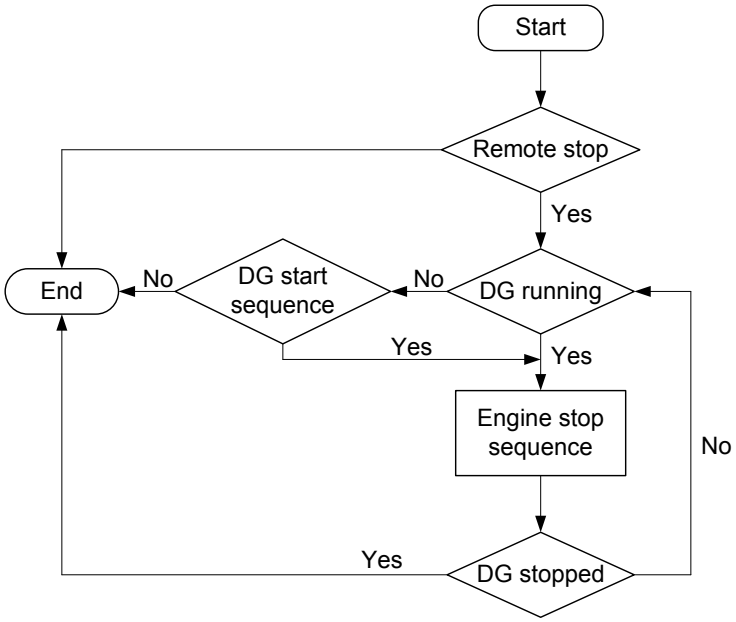
INFO
If the cooling down temperature is set to 0 deg., or in case of wire break detection on the analogue input, the cooling down sequence will be entirely controlled by the timer.

4.1.5 Flowcharts

Remote start



Remote stop



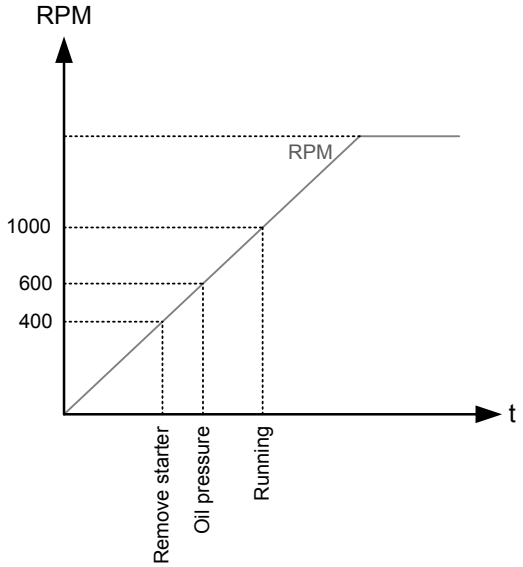
4.1.6 Start functions

The unit will start the genset when the start command is given. The start sequence is deactivated when the remove starter event occurs or when the running feedback is present.

The reason for having two possibilities of deactivating the start relay is to be able to delay the alarms with run status.

If it is not possible to activate the run status alarms at low revolutions, the remove starter function must be used.

An example of a critical alarm is the oil pressure alarm. Normally, it is configured according to the shutdown fail class. But if the starter motor has to disengage at 400 RPM, and the oil pressure does not reach a level above the shutdown set point before 600 RPM, then, obviously, the genset would shut down if the specific alarm was activated at the preset 400 RPM. In that case, the running feedback must be activated at a higher number of revolutions than 600 RPM.

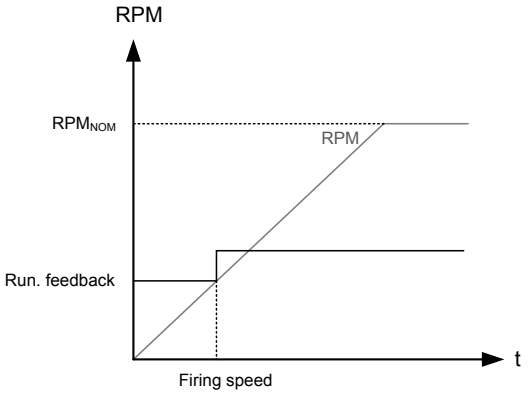


Digital feedbacks

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

Running feedback

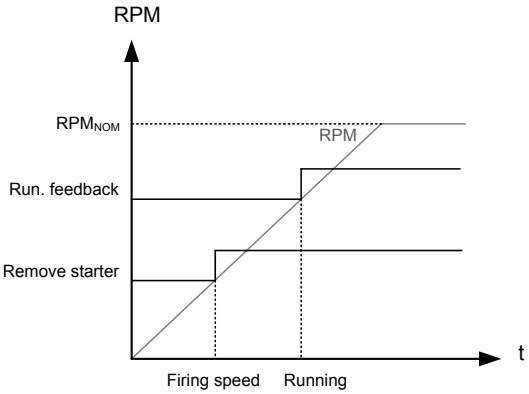
When the digital running feedback is active, the start relay is deactivated and the starter motor will be disengaged.



The diagram illustrates how the digital running feedback is activated when the engine has reached its firing speed.

Remove starter

When the digital remove starter input is present, the start relay is deactivated and the starter motor will be disengaged.



The diagram illustrates how the remove starter input is activated when the engine has reached its firing speed. At the running speed, the digital running feedback is activated.

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

INFO
The running feedback is detected by either the digital input (see the diagram above), frequency measurement above 32 Hz, RPM measured by magnetic pickup or EIC (option H5/H7).

Analogue tacho feedback

When a magnetic pickup (MPU) is being used, the specific level of revolutions for deactivation of the start relay can be adjusted.

If the engine is operating at slow speed and there is a small number of teeth on the flywheel, the default capture rate (100 ms) of the MPU feedback measurement might not give a stable measurement.

To avoid an unstable measurement in this situation, an M-Logic command is available to make the capture rate of the MPU feedback measurement adapt to the actual number of teeth and the nominal RPM setting. The command is called “Low speed RPM”.

Enabling this command means that the capture rate of the measurement will be changed from the default value (100 ms) to fit the result of nominal RPM * teeth on the flywheel according to the intervals in the table below.

No. of teeth * nominal RPM	Capture rate
Above 400001	100 ms
200001 to 400000	200 ms
100001 to 200000	400 ms
50001 to 100000	800 ms
25001 to 50000	1600 ms
12501 to 25000	2000 ms
0 to 12500	2500 ms

DANGER!
Notice that when using this command the capture rate is increased, so the alarms related to the tacho feedback will become slower.

An added delay must be expected as a consequence of the increased capture rate. The added delay can be calculated from the below formula (worst-case).

Added delay = capture rate – default capture rate

Example:

If the nominal speed of an engine is 1500 RPM and the number of teeth on the flywheel is 141, the interval will be 200001 to 400000 according to the calculation below:

Value = 1500 * 141

Value = 211500

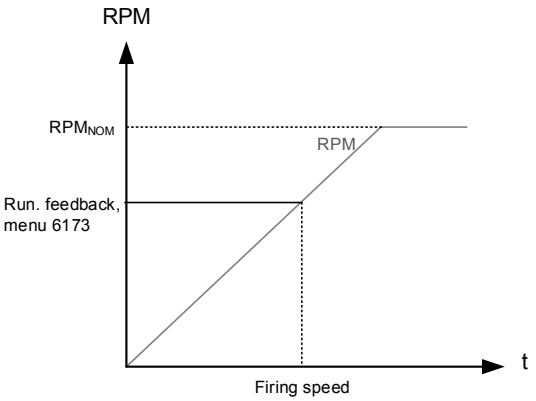
This means that the capture rate will be 200 ms. The worst-case added delay will then be:

Added delay = 200 ms – 100 ms

Added delay = 100 ms

Running feedback

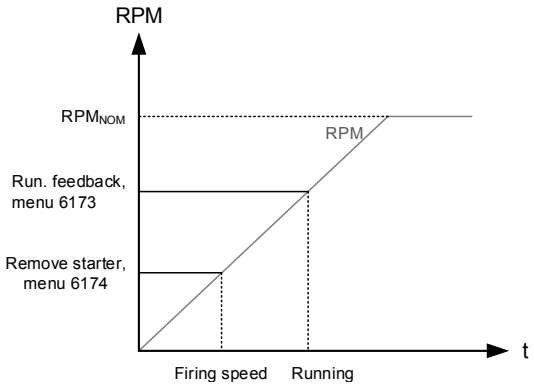
The diagram below shows how the running feedback is detected at the firing speed level. The factory setting is 1000 RPM **(6170 Running detect.).**



DANGER!
Notice that the factory setting of 1000 RPM is higher than the RPM level of starter motors of typical design. Adjust this to a lower value to avoid damage of the starter motor.

Remove starter input

The drawing below shows how the set point of the remove starter is detected at the firing speed level. The factory setting is 400 RPM **(6170 Running detect.).**



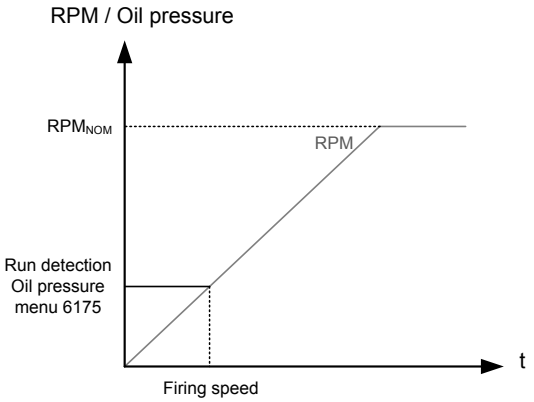
INFO
The number of teeth on the flywheel must be adjusted in menu 6170 when the MPU input is used.

Oil pressure

The multi-inputs on terminals 102, 105 and 108 can be used for the detection of running feedback. The terminal in question must be configured as a RMI input for oil pressure measurement.

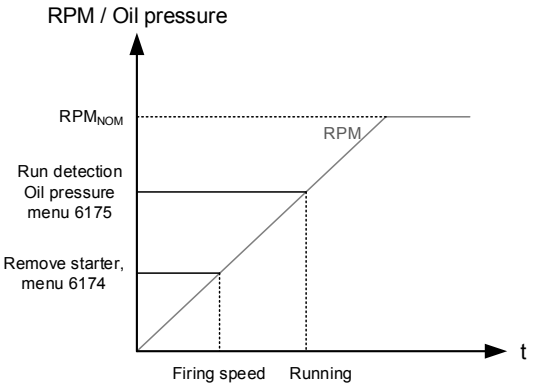
When the oil pressure increases above the adjusted value **(6175 Pressure level),** the running feedback is detected and the start sequence is ended.

Running feedback



Remove starter input

The drawing below shows how the set point of the remove starter input is detected at the firing speed level. The factory setting is 400 RPM **(6170 Running detect.).**



INFO
The remove starter function can use the MPU or a digital input.

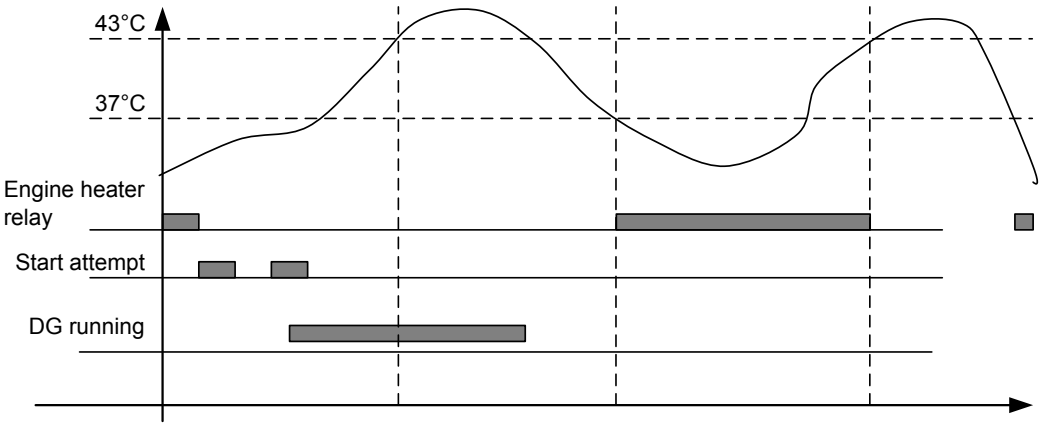
4.1.7 Engine heater

This function is used to control the temperature of the engine. A sensor measuring the cooling water temperature is used to activate an external heating system to keep the engine at a minimum temperature.

The set points adjusted in menu 6320 are:

Set point:	This set point +/- the hysteresis is the start and stop points for the engine heater.
Output A:	The relay output for the engine heater
Input type:	Multi-input to be used for temperature measurement.
Hysteresis:	This decides the needed deviation from the set point in order to activate/deactivate the engine heater.
Enable:	Enables the engine heater function.

Principle diagram:



INFO
The engine heater function is only active when the engine is stopped.

Engine heater alarm

If the temperature keeps dropping after the start set point has been exceeded, an alarm will be raised if configured in menu 6330.

4.1.8 Diode compensation

In case a diode is mounted in the DC supply, the voltage measured by the unit will be lower than the actual supply voltage because of the voltage drop across the diode. To compensate for this voltage drop, an offset can be applied to the DC supply measurement in menu 6350.

4.1.9 Generator type

Closing of a breaker for an asynchronous generator (also called induction generator) can be selected in menu 6361 where the selection of generator type is made. When the generator type is set to asynchronous, the closing of the breaker is based on the MPU signal only.

INFO
Refer to the Designer's reference handbook for details.

INFO
The GPU requires option G2 to be able to synchronise.

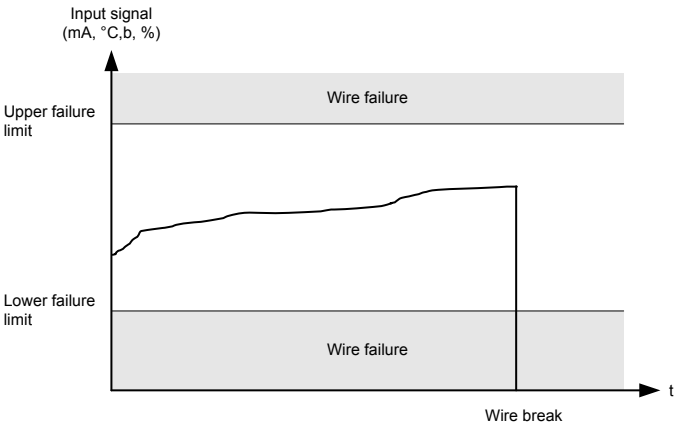
4.1.10 Wire fail detection

If it is necessary to supervise the sensors/wires connected to the multi-inputs and analogue inputs, it is possible to enable the wire break function for each input. If the measured value on the input is outside the normal dynamic area of the input, it will be detected as if the wire has made a short circuit or a break. An alarm with a configurable fail class will be activated.

Input	Wire failure area	Normal range	Wire failure area
4 to 20 mA	< 3 mA	4 to 20 mA	> 21 mA
0 to 40 V DC	≤ 0 V DC	-	N/A
RMI oil, type 1	< 10.0 ohm	-	> 184.0 ohm
RMI oil, type 2	< 10.0 ohm	-	> 184.0 ohm
RMI temp., type 1	< 22.4 ohm	-	> 291.5 ohm
RMI temp., type 2	< 18.3 ohm	-	> 480.7 ohm
RMI temp., type 3	< 7.4 ohm	-	> 69.3 ohm
RMI fuel, type 1	< 1.6 ohm	-	> 78.8 ohm
RMI fuel, type 2	< 3.0 ohm	-	> 180.0 ohm
RMI configurable	< lowest resistance	-	> highest resistance
Pt100	< 82.3 ohm	-	> 194.1 ohm
Pt1000	< 823 ohm	-	> 1941 ohm
Level switch	Only active if the switch is open		

Principle

The illustration below shows that when the wire of the input breaks, the measured value will drop to zero. Then the alarm will occur.



MPU wire break (menu 4550)

The MPU wire break function is only active when the genset is not running. In this case, an alarm will be raised if the wire connection between the controller and MPU breaks.

Stop coil wire break (menu 6270)

The alarm will occur when the stop coil is not activated (generator is running) and the wire break detection on the stop coil is de-energised.

4.1.11 Multi-inputs

The PCB has three multi-inputs which can be configured to be used as the following input types:

- 4 to 20 mA
- 0 to 40 V DC
- Pt100
- Pt1000
- RMI oil
- RMI water
- RMI fuel
- Digital

INFO
The function of the multi-inputs can only be configured in the PC utility software.

For each input, two alarm levels are available. The menu numbers of the alarm settings for each multi-input are controlled by the configured input type as shown in the table below.

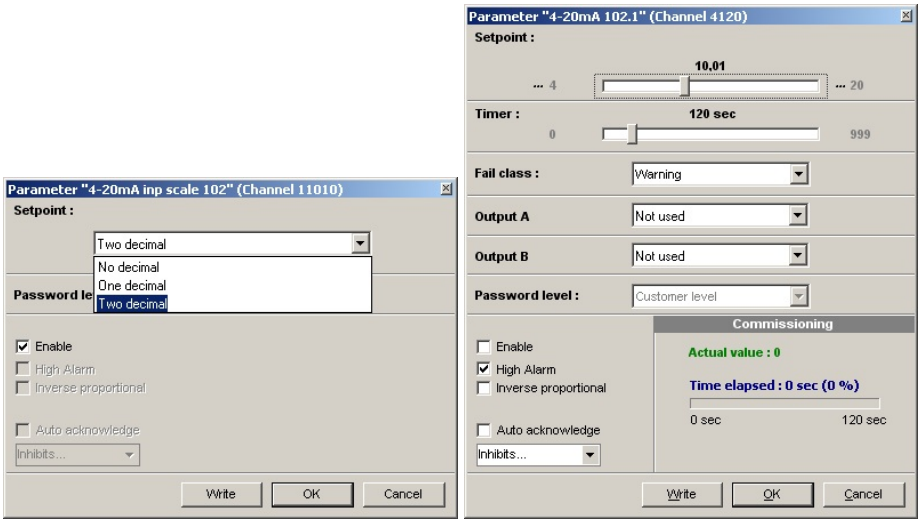
Input type	Multi-input 102	Multi-input 105	Multi-input 108
4 to 20 mA	4120/4130	4250/4260	4380/4390
0 to 40 V DC	4140/4150	4270/4280	4400/4410
Pt100/Pt1000	4160/4170	4290/4300	4420/4430
RMI oil	4180/4190	4310/4320	4440/4450
RMI water	4200/4210	4330/4340	4460/4470
RMI fuel	4220/4230	4350/4360	4480/4490
Digital	3400	3410	3420

INFO
Only one alarm level is available for the digital input type.

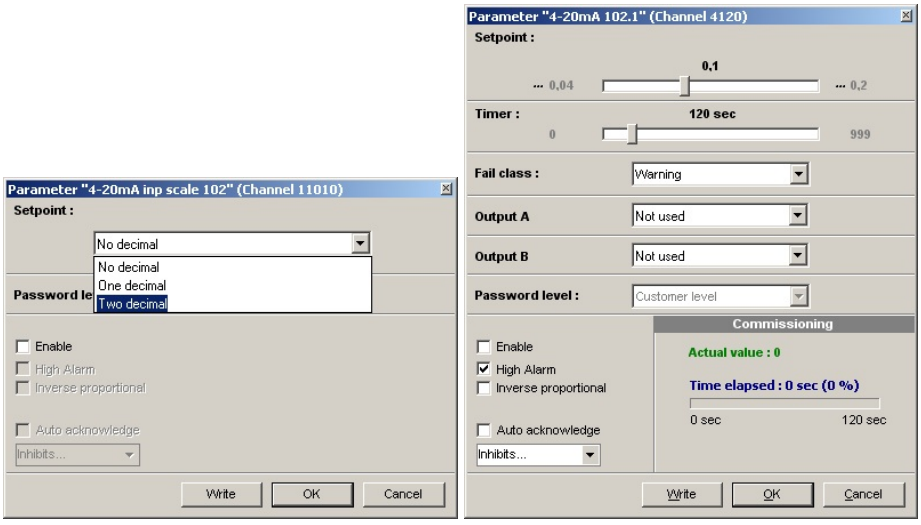
4 to 20 mA

If one of the multi-inputs has been configured as 4 to 20 mA, the unit and range of the measured value corresponding to 4 to 20 mA can be changed in the PC utility software in order to get the correct reading in the display.

Scaling of 4 to 20 mA input: 11010/11020/11030.



INFO
"Enable" selected will auto-scale associated "min." and "max." values in 4120/4130/4250/4260/4380/4390 with two decimals after the decimal point.



INFO
If "Enable" is deselected, then auto-scale of associated "min." and "max." values in 4120/4130/4250/4260/4380/4390 will have two decimals in front of the decimal point.

INFO
"Enable" is normally only deselected if pre-programmed USW files are used. This is done to prevent unwanted auto-scaling of predefined input ranges.

0 to 40 V DC

The 0 to 40 V DC input has primarily been designed to handle the battery asymmetry test.

Pt100/1000

This input type can be used for heat sensor, for example for cooling water temperature. The unit of the measured value can be changed from Celsius to Fahrenheit in the PC utility software (USW) in order to get the desired readings in the USW. To get the same view in the display unit, changes can be made in parameter 6920.

RMI inputs

The unit can contain up to three RMI inputs. The inputs have different functions, as the hardware design allows for several RMI types.

These various types of RMI inputs are available for all multi-inputs:

RMI oil	Oil pressure
RMI water	Cooling water temperature
RMI fuel	Fuel level sensor

For each type of RMI input, it is possible to select between different characteristics including a configurable one.

RMI oil

This RMI input is used to measure the lubricating oil pressure.

		RMI sensor type		
Pressure		Type 1	Type 2	Type configurable
Bar	psi	Ω	Ω	Ω
0	0	10.0	10.0	
0.5	7	27.2		
1.0	15	44.9	31.3	
1.5	22	62.9		
2.0	29	81.0	51.5	
2.5	36	99.2		
3.0	44	117.1	71.0	
3.5	51	134.7		
4.0	58	151.9	89.6	
4.5	65	168.3		
5.0	73	184.0	107.3	
6.0	87		124.3	
7.0	102		140.4	
8.0	116		155.7	
9.0	131		170.2	
10.0	145		184.0	

INFO
The configurable type is configurable with eight points in the range 0 to 480 Ω. The resistance as well as the pressure can be adjusted.

INFO
If the RMI input is used as a level switch, then be aware that no voltage must be connected to the input. If any voltage is applied to the RMI input, it will be damaged. Refer to the Application notes for further wiring information.

RMI water

This RMI input is used to measure the cooling water temperature.

		RMI sensor type			
Temperature		Type 1	Type 2	Type 3	Type 4
°C	°F	Ω	Ω	Ω	Ω
40	104	291.5	480.7	69.3	
50	122	197.3	323.6		
60	140	134.0	222.5	36.0	
70	158	97.1	157.1		
80	176	70.1	113.2	19.8	
90	194	51.2	83.2		
100	212	38.5	62.4	11.7	
110	230	29.1	47.6		
120	248	22.4	36.8	7.4	
130	266		28.9		
140	284		22.8		
150	302		18.2		

INFO
The configurable type is configurable with eight points in the range 0 to 480 Ω. The temperature as well as the resistance can be adjusted.

INFO
If the RMI input is used as a level switch, then be aware that no voltage must be connected to the input. If any voltage is applied to the RMI input, it will be damaged. Refer to the Application notes for further wiring information.

RMI fuel

This RMI input is used for the fuel level sensor.

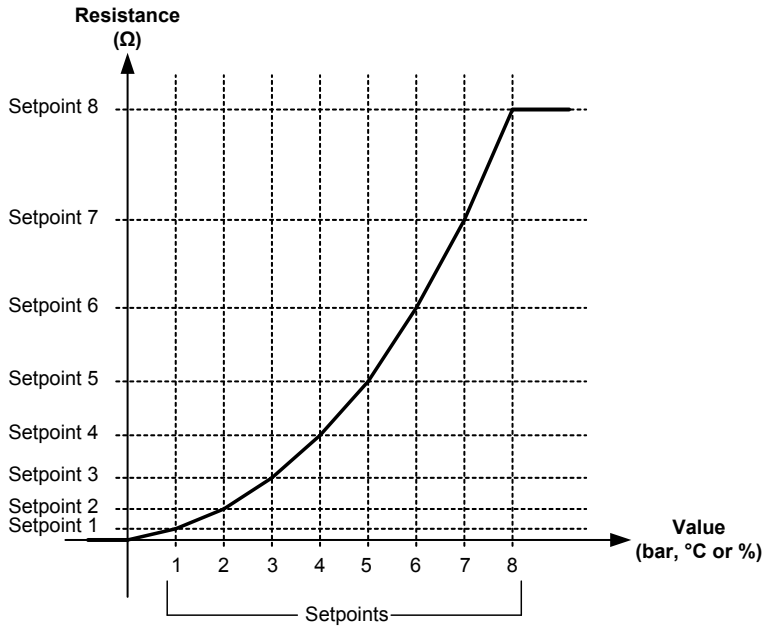
	RMI sensor type
	Type 1
Value	Resistance
0 %	78.8 Ω
100 %	1.6 Ω

INFO
If the RMI input is used as a level switch, then be aware that no voltage must be connected to the input. If any voltage is applied to the RMI input, it will be damaged. Refer to the Application notes for further wiring information.

	RMI sensor type
Value	Type configurable
%	Resistance
0	
10	
20	
30	
40	
50	
60	
70	
80	
90	
100	

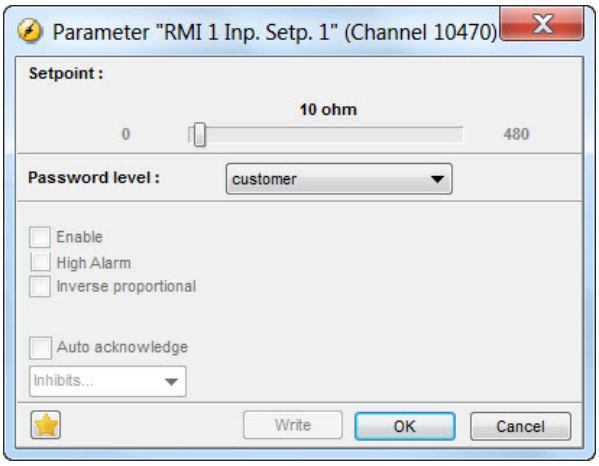
INFO
The configurable type is configurable with eight points in the range 0 to 480 Ω. The value as well as the resistance can be adjusted.

Illustration of configurable inputs



Configuration

The 8-curve settings for the configurable RMI inputs cannot be changed in the display, but only in the PC utility software. The alarm settings can be changed both in the display and in the PC utility software. In the PC utility software, the configurable inputs are adjusted in this dialogue box:



Adjust the resistance of the RMI sensor at the specific measuring value. In the example above, the adjustment is 10 Ω at 0.0 bar.

Digital

If the multi-inputs are configured to “Digital”, they become available as a configurable input with wire break detection.

4.1.12 Differential measurement

The option M4 provides six different differential measurements between two analogue input values.

The differential measurement functionality relates to the hardware supporting configurable analogue inputs or engine communication.

Setup and functional description are specified in the Designer’s reference handbook (DRH) for the respective products listed below.

Product	DRH doc. no.
GPC-3	4189340587
GPU-3	4189340584
PPU-3	4189340583

INFO
Differential measurements are available in GPC-3, GPU-3 and PPU-3 from version 3.08.0.

4.1.13 Service timers

The unit is able to monitor the maintenance intervals. Two service timers are available to cover different intervals. The service timers are set up in menus 6110 and 6120.

The function is based on running hours. When the adjusted time expires, the unit will display an alarm. The running hours are counting, when the running feedback is present.

Set points available in menus 6110 and 6120:

Enable	Enable/disable the alarm function.
Running hours	The number of running hours to activate the alarm
Day	The number of days to activate the alarm – if the running hours are not reached before this number of days, the alarm will be raised.

Fail class	The fail class of the alarm.
Output A	Relay to be activated when the alarm is raised.
Reset	Enabling this will reset the service timer to zero. This has to be done when the alarm is activated.

4.1.14 Double starter

If the engine is running both as a generator and a fire pump, it is normally equipped with two start motors.

The start sequence is normal when using the double starter function, but for the number of start attempts set in menu 6192 the start signal is redirected. First it will switch to starter motor no. 2, then back to no. 1, and so on, until the total number of start attempts is used and a start failure is activated.

Set points available in menu 6190:

Start attempts	Accepted total number of start attempts before a start failure is activated.
Change starter	The number of start attempts before redirecting the start signal.
Output A	Alternative start relay. If set to “Not used”, the double starter function is disabled.

4.1.15 Derate genset

The purpose of the derate function is to be able to reduce the maximum output power of the genset if specific conditions require this. An example of such a condition is the ambient temperature. If the ambient temperature increases to a level where the cooling water coolers decrease in cooling capacity, it will be necessary to reduce the power of the genset. If the genset is not derated, alarms and shutdown events are very likely to occur.

INFO
The derate function is typically used when cooling problems are expected.

Input selection

The derate function can be configured to one of the following inputs:

Input	Comment
Multi-input 102	0 to 40 V DC 4 to 20 mA Pt100/1000 RMI Digital
Multi-input 105	
Multi-input 108	
EIC	
M-Logic	

Select the needed input in **6260 Power derate**.

INFO
Refer to the type label for information about engine interface selection.

Derate parameters

The parameters that define the derate characteristics are the following:

Start derate point (6260 Power derate)

This is the setting where the derating must start. The setting can be in mA (max. 20 mA) or in centigrades ºC (max. 200 ºC).

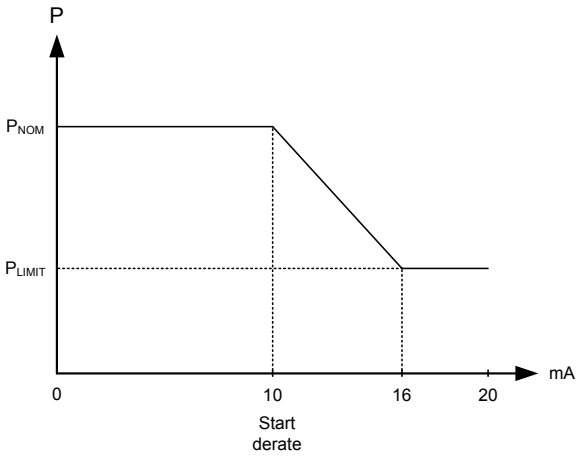
Slope (6260 Power derate)

Adjusts the derating speed. The adjustment is in per cent per unit, that is if the 4 to 20 mA input is used, the derating will be in %/mA, and if the Pt100/Pt1000/RMI input is used, the derating will be in %/C.

INFO
Be aware that the 4 to 20 mA input can be configured with different minimum and maximum settings. In this case, the settings “Start derate point” and “Slope” use these new settings.

Derate limit (6260 Power derate)

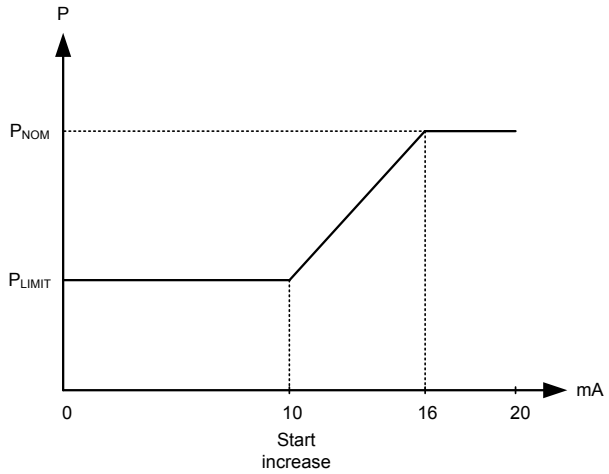
This is the lowest derate level.



Derate characteristic

It can be selected whether the characteristic of the derating should be proportional or inverse proportional. The drawing above shows the inverse characteristic.

The proportional characteristic is illustrated below.



The genset is derated when the control value is lower than the set point (in the example above, the control value is an mA signal).

Parameters for derate:

Setting	Display text	Utility software	Remark, utility software
6261	Input	Input	The tick box "Enable" is for setting 6265 (ticked = enabled)
6262	Start derate	Start derate	
6263	Slope	Slope	
6264	Proportional	No separate setting	See 6261
6265	Enable	No separate setting	See 6266
6266	Limit	Limit	The tick box "Enable" is for setting 6264 (ticked = proportional)

4.1.16 Fuel pump logic

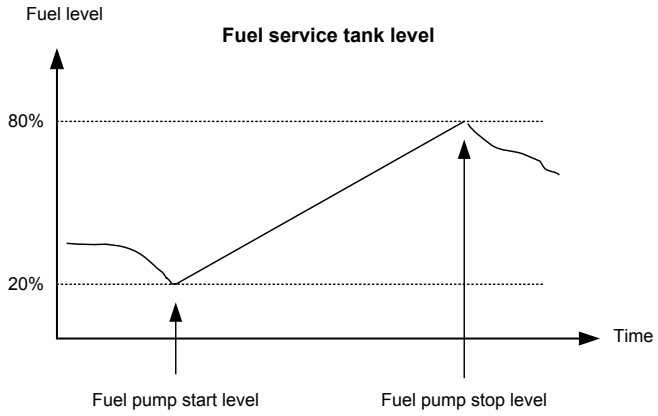
The fuel pump logic is used to start and stop the fuel supply pump to maintain the fuel level in the service tank at predefined levels. The start and stop limits are detected from one of the three multi-inputs.

Set points available in menu 6550:

Set point 1	Start level
Set point 2	Stop level
Delay	If the fuel level has not increased by 2 % within this delay, a “Fuel fill alarm” will be raised
Output A (OA)	The relay to be used for control of the fuel pump. The selected relay activates below the start limit and deactivates above the stop level
Type	The multi-input to be used for the fuel level sensor
Fail class	The fail class of the “Fuel fill alarm”

INFO
The output relay should be configured as a limit relay, otherwise an alarm will be raised whenever the output is activated.

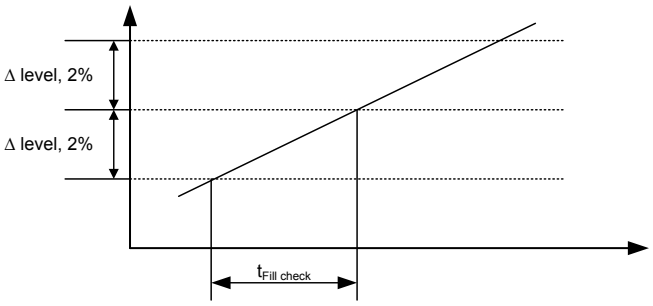
The drawing below shows how the fuel pump is activated when the level reaches 20 % and stopped again when the level has reached 80 %.



Fuel fill check

The fuel pump logic includes a “Fuel fill check” function.

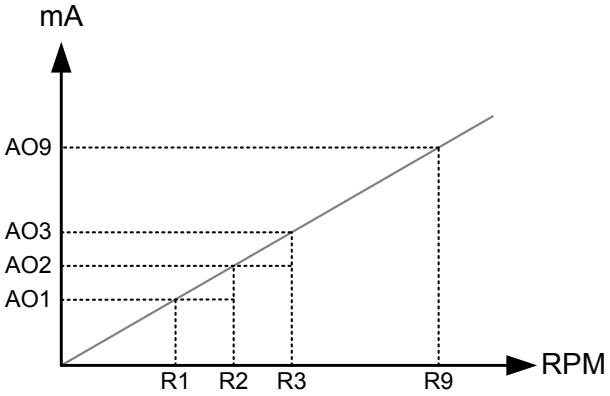
When the fuel pump is running, the fuel level must increase by 2 % within the fuel fill check timer set in menu 6553. If the fuel level does not increase by 2 % within the adjusted delay time, then the fuel pump relay deactivates and a fuel fill alarm occurs.



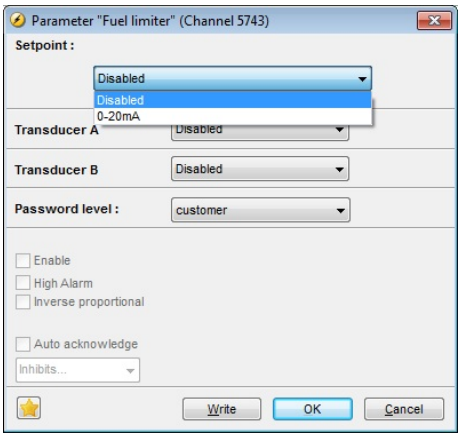
INFO
The level of increase is fixed at 2 % and cannot be changed.

4.1.17 Fuel limiter output

Fuel limitation output logic enables the use of configurable analogue output corresponding to engine speed (RPM). The link between engine RPM (R1 to R9) and 0 to 20 mA (AO1 to AO9) output is configured as shown below.



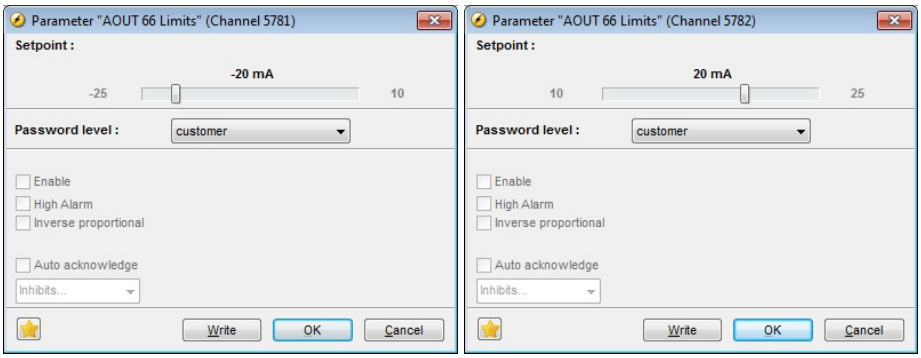
Configuration of the fuel limitation output is done in menu 5743, with the possibility of two analogue outputs, A and B.



Configuration is done in menus 5751 to 5776.

5751	Fuel Limiter 1	1728	834	RPM
5752	Fuel Limiter 1	1737	0	mA
5753	Fuel Limiter 2	1729	963	RPM
5754	Fuel Limiter 2	1738	0.1	mA
5755	Fuel Limiter 3	1730	1085	RPM
5756	Fuel Limiter 3	1739	3.3	mA
5761	Fuel Limiter 4	1731	1214	RPM
5762	Fuel Limiter 4	1740	6.4	mA
5763	Fuel Limiter 5	1732	1351	RPM
5764	Fuel Limiter 5	1741	9.3	mA
5765	Fuel Limiter 6	1733	1486	RPM
5766	Fuel Limiter 6	1742	12.2	mA
5771	Fuel Limiter 7	1734	1639	RPM
5772	Fuel Limiter 7	1743	14.8	mA
5773	Fuel Limiter 8	1735	1793	RPM
5774	Fuel Limiter 8	1744	17.5	mA
5775	Fuel Limiter 9	1736	1800	RPM
5776	Fuel Limiter 9	1745	20	mA

The configurable analogue scale is defined in menus 5781 to 5782 and 5791 to 5792 for each of the two outputs.



4.1.18 Idle running

The purpose of the idle run function is to change the start and stop sequences to allow the genset to operate under low temperature conditions.

It is possible to use the idle run function with or without timers. Two timers are available: one is used in the start sequence, and the other is used in the stop sequence.

INFO
The speed governor must be prepared for the idle run function if this function is to be used.

The function is typically used in installations where the genset is exposed to low temperatures which could generate starting problems or damage the genset.

Description

The function is enabled and configured in 6290 “Idle running”. It must be noted that the governor itself must handle the idle speed based on a digital signal from the unit (see the principle diagram below).

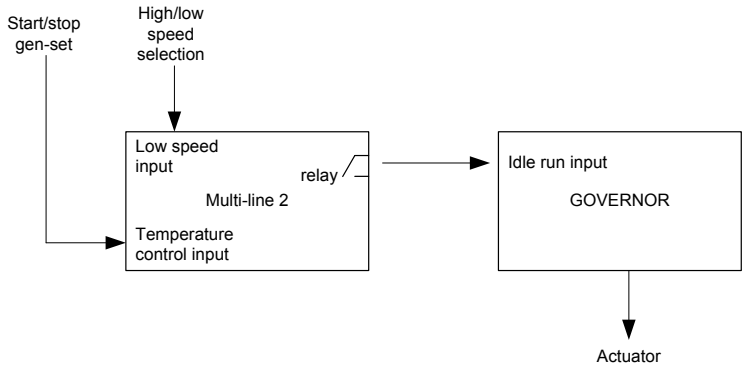
When the function is enabled, a digital input can be used for control purposes:

No.	Input	Description
1	Low speed input	This input is used to change between idle speed and nominal speed.

INFO
If the idle run function is selected by means of timer, the low speed input is overruled.

INFO
The input must be configured through the PC software at commissioning.

INFO
Turbo chargers not originally prepared for operating in the low speed area can be damaged if the genset is running in idle run for too long.

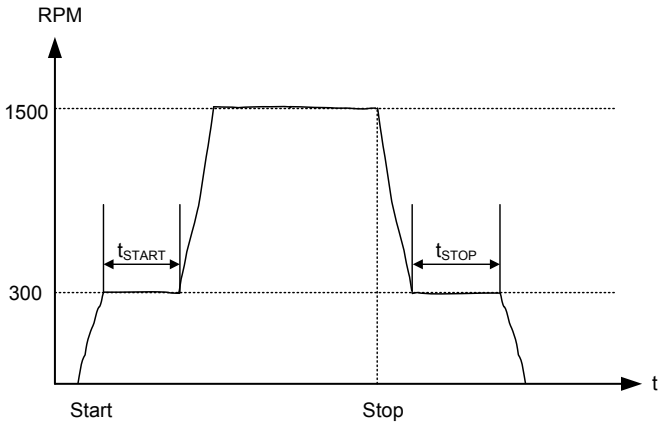


Examples

Idle speed during starting and stopping

In this example, both the start and the stop timers are activated.

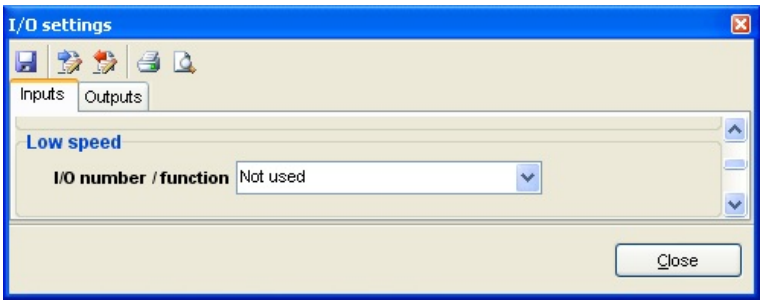
The start and stop sequences are changed in order to let the genset stay at the idle level before speeding up. It also decreases the speed to the idle level for a specified delay time before stopping.



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

Configuration of digital input

The digital input is configured via the PC software.



Inhibit

The alarms that are deactivated by the inhibit function are inhibited in the usual manner, except the oil pressure alarms RMI oil 102, 105 and 108 which are active during idle run as well.

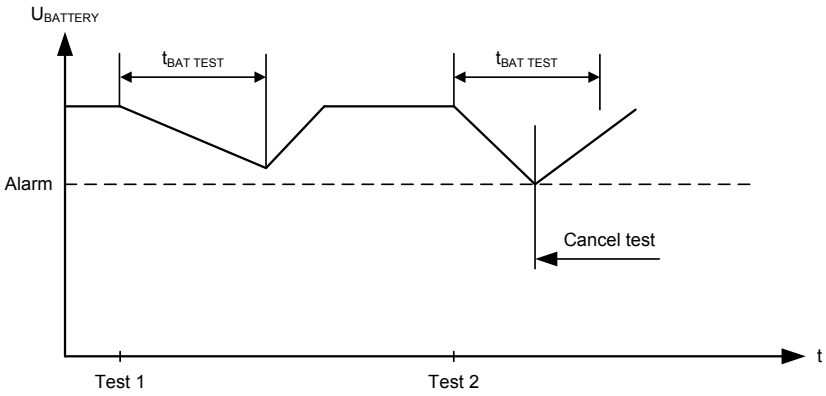
Running signal

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

4.1.19 Battery test

This function gives the possibility to test the condition of the battery. The battery test can be initiated with a digital input and is available when the genset is in remote mode.

During the test, the battery voltage will decrease and an alarm will occur if it drops to the set point.



The drawing shows that test #1 is carried out without a large voltage drop of the battery voltage, whereas test #2 reaches the alarm set point.

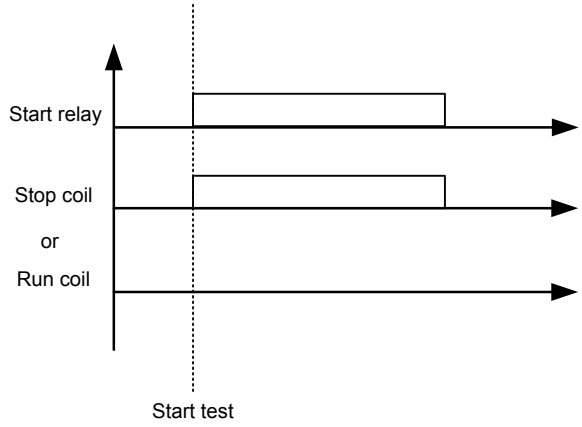
As there is no reason to wear the battery down even more, the test stops when the battery test alarm occurs.

The test is typically used at periodical intervals, for example once every week. The engine must be at a standstill when the test is started. Otherwise the test command will be ignored.

The stop relay will act depending on the coil type:

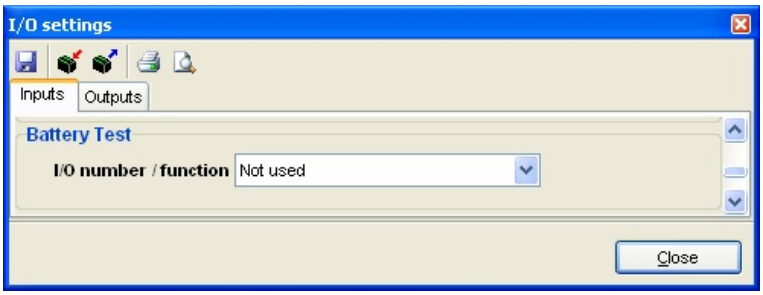
Stop coil	The relay activates during the test.
Run coil	The relay stays deactivated during the test.

The drawing below shows that when the test is started, the start relay activates, making the engine turn.



Input configuration

If this function is to be used, it is necessary to configure a digital input that initiates the function. This is done in the dialogue box below.



Auto configuration

If the automatic battery test is used, the function must be enabled in menu 6420. When the function is enabled, the battery test will be carried out at a specified interval, for example once a week. Completed battery tests will be logged in a separate battery test log.

INFO
The factory setting in menu 6424 is 52 weeks. This means that the automatic battery test will be executed once a year.

INFO
If application 3, 6 or 7 is used, it is expected that one of the multi-inputs is used for the battery test of the starter battery.

INFO
It is expected that the multi-inputs used for the battery test are configured to “0 to 40 V DC”.

Battery asymmetry (6430 Batt. asymmetry)

The reason for making the battery asymmetry test is to determine if one of the batteries is getting weak. The battery asymmetry is a combination of measurements and calculations.

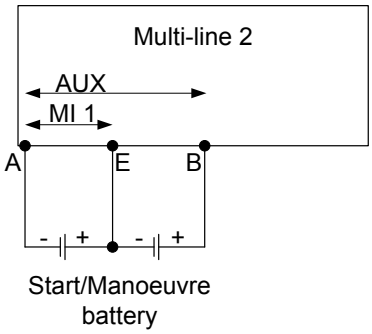
Set points available:

T1	The input type to be used for calculation of battery asymmetry 1.
RF1	Reference of asymmetry measurement no. 1.

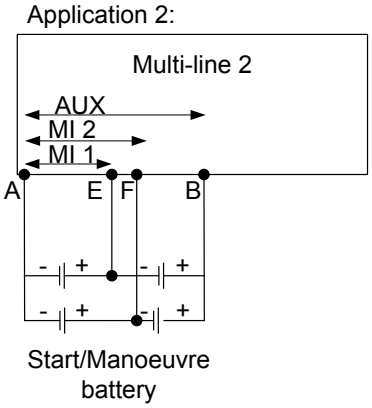
T2	The input type to be used for calculation of battery asymmetry 2.
RF2	Reference of asymmetry measurement no. 2.

The following seven battery applications are supported. The shown applications are merely examples – the choice of multi-input (MI) or power supply input is configurable in menu 6410.

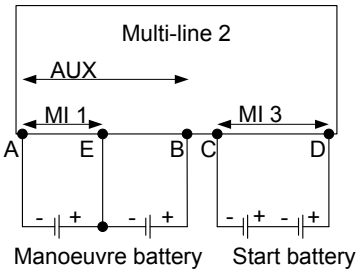
Application 1:



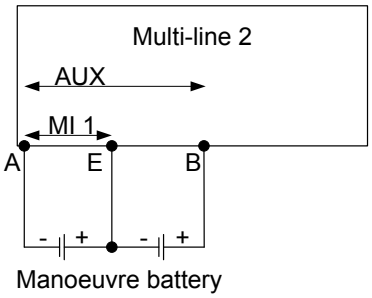
Application 2:



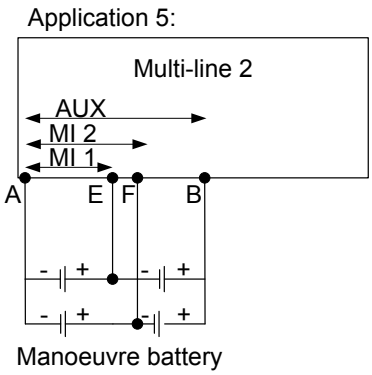
Application 3:



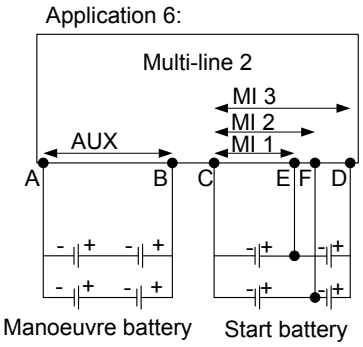
Application 4:



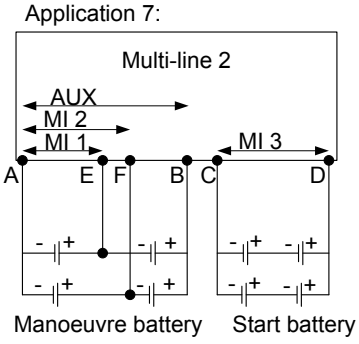
Application 5:



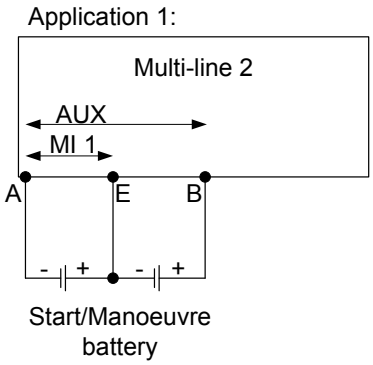
Application 6:



Application 7:



Looking at battery application 1 as an example:



The power supply measurement is used as the reference RF1 (point A and B) in menu 6432, and multi-input 1 is used as the type T1 (point A and E) in menu 6431. By making these measurements it is possible to calculate the voltage between E and B. This gives a full picture of battery voltages, for example:

Measured value A/B (RF1) = 21 V DC

Measured value A/E (T1) = 12 V DC

Calculated value E/B (RF1 – T1) = 9 V DC

Battery asymmetry = E/B – (RF1*1/2) = 9 – (21*1/2) = -1.5 V DC

INFO
It is expected that the multi-inputs used for the battery asymmetry are configured to “0 to 40 V DC”.

INFO
The selection power supply is referring to the supply on terminals 1 and 2.

Battery asymmetry alarm

Alarms for battery asymmetry 1 and 2 are set up in menus 6440 and 6450

INFO
The set point in menus 6440 and 6450 is only set in positive values; however, it will also trigger if the battery asymmetry calculation results in a negative value.

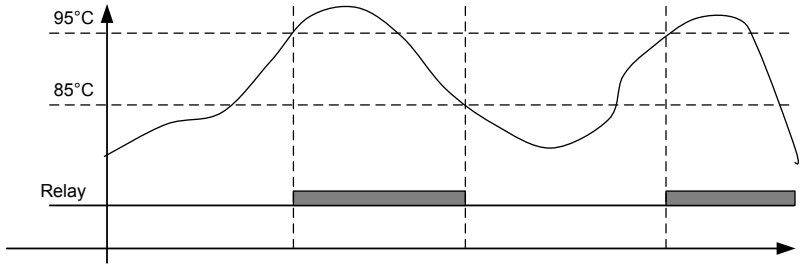
4.1.20 Ventilation

This function can be used to control the cooling of the engine. The purpose is to use a multi-input to measure the cooling water temperature and in that way activate an external ventilation system to keep the engine below a maximum temperature. The functionality is shown in the diagram below.

Set points available (6460 Max. ventilation):

Set point	The limit for activation of the relay set in OA.
Output A (OA)	The relay activates when the set point is exceeded.
Hysteresis	The number of degrees the temperature has to be below the set point in order to deactivate the relay set in OA.
Enable	Enable/disable the ventilation function.

INFO
The type of input to use for the temperature measurement is selected in menu 6323 “Engine heater”.



Max. ventilation alarm

In menus 6470 and 6480, two alarms can be set up to activate if the temperature keeps rising after the start set point has been reached.

4.1.21 Separate microprocessor

The control functions of option M4 are divided between the processor on the engine logic board and divided with the main processor.

Function	Terminals	Main processor	Option M4 processor
Multi-function inputs with alarms	98-106		X
RPM input with alarms	107-108		X
CAN bus	A1-A3		X
Binary inputs used as alarms	110-116		X
Binary inputs used as commands	110-116		X
Engine start/stop logic	-	X	
Stop coil wire break monitoring	123-124		X

This division of functions is made to enable the use of the option M4 as redundant (independent) engine protection, making the Multi-line unit compliant with marine approval requirements for two independent systems.

The binary and analogue inputs of option M4 are 100 % independently controlled by the built-in M4 processor, and the shutdown functions of these inputs will continue, even if the main processor fails.

Detection of the main processor failing is done with the status output relay (term. 3 to 4).

4.1.22 Processor failure handling

Since the M4 processor is to cooperate with the main processor, a number of rules is set between them.

Main processor failure

The status output relay (term. 3 to 4) will open. The M4 processor detects the failure by loss of communication to the main processor, but it remains active in the sense that all the M4 board protective functions are operating. No relay output activities will appear on the M4 board due to the main processor failure. A power supply failure in the main unit will also trigger this.

If a shutdown appears during main processor fail and the main processor returns to normal status, the shutdown will be carried through by the M4 processor. The main processor shutdown timer for the alarm in question will start from 0, but will NOT reset the

shutdown/make the time delay longer. Once the M4 and the main processor timers have both run out, the main processor takes full control again.

M4 processor failure

The main processor will detect this and an “Int. comm. fail” alarm will be activated. A power supply failure in the M4 option will also trigger this. All activated relays on the M4 board will reset.

Processor fail during start sequence

The main processor controls the start/stop logic. If either of the processors fail during start sequence, the start sequence halts. All activated relay outputs on the M4 board reset.

Functions

The parameters and functions related to the M4 inputs are all handled by the main processor. In this way, the M4 processor monitoring will still be active even if the main processor is lost.

Multi-functional inputs

All the setting values are handled by the main processor and transmitted to the M4 processor. Relays selected for alarms/limits which are not placed on the M4 PCB are triggered by sending the command to the main processor which then controls the relays. Relays selected that are on the M4 PCB are handled directly by the M4 processor and are therefore not dependent on the status of the main processor.

RPM input

The RPM input is fully handled by the M4 processor. The values for running speed and nominal speed are handled by the main processor since they are used for start/stop and regulation purposes. The M4 processor transmits the RPM value to the main processor.

Over-/underspeed alarms

All the setting values are handled by the M4 processor.

Digital inputs

All the setting values are handled by the M4 processor, except the “start enable” input status which is transmitted via the M4 to the main processor.

Fail classes with engine start/stop logic

The fail classes are handled by the M4 processor for the inputs on the M4 PCB. If the fail class includes breaker trip, this signal is sent to the main processor which carries out the trip.

In case the main processor fails the breaker trip cannot take place, but in case this is critical, the main processor status output can be used to trip the breaker in case of main processor failure. This will not affect a running engine which is still protected by the M4 processor.

All other inputs are handled by the main processor. In case the main processor wants to carry out a shutdown, the signal is transmitted to the M4 processor which carries out the relay control. In case the M4 processor fails, the “Int. comm. fail” alarm issued by the main processor can be used to carry out any function needed (warning, shutdown...).

Fail classes without engine start/stop logic

All active fail classes are handled by the main processor, and M4 relay activation/deactivation commands are sent to the M4 processor from the main processor. For the inputs on the M4 PCB, the status is transmitted to the main processor from the M4 processor.