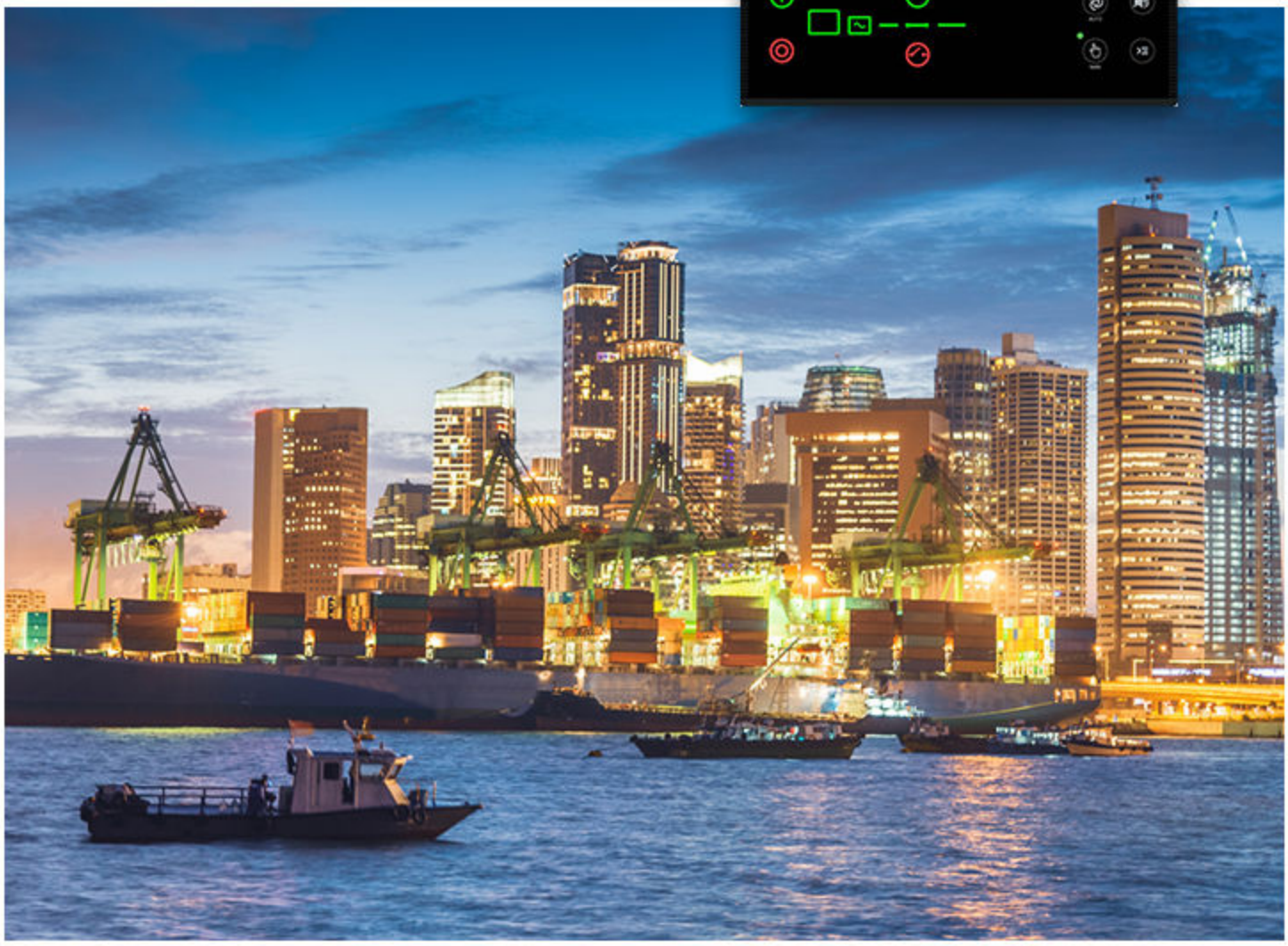
iE 150 Marine

4189341455-A

Generator Core

Designer's handbook

Improve Tomorrow



1. Introduction

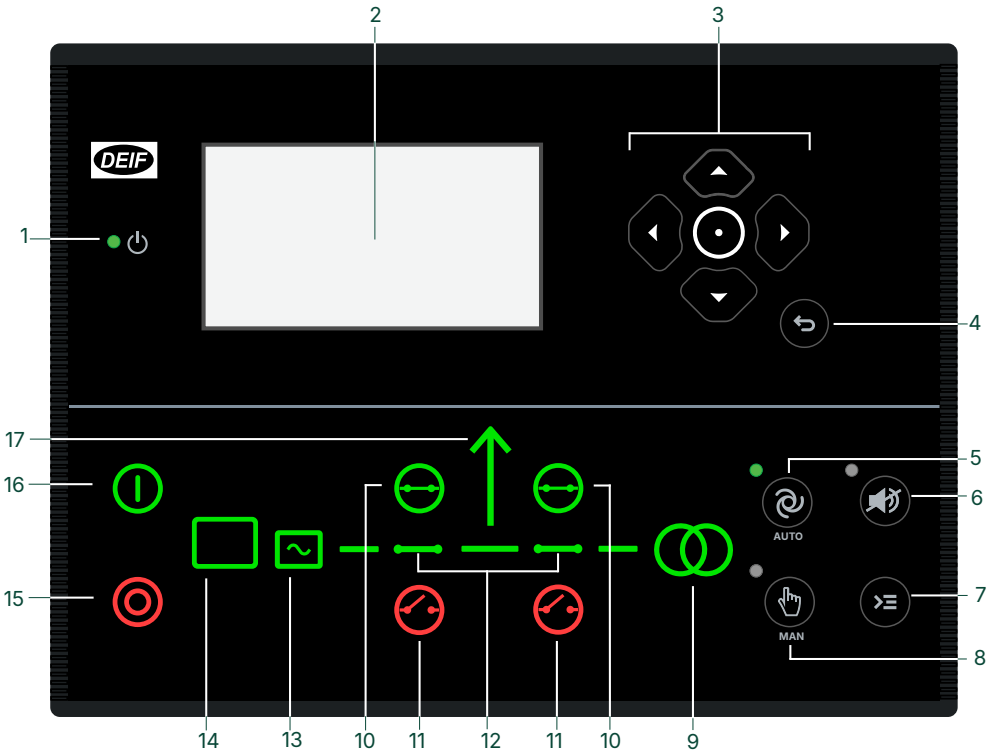
1.1 About

The iE 150 Marine Generator controller with Core software provides flexible protection and control for one genset in non-synchronising applications. The controller contains all the functions needed to protect and control the genset, the genset breaker, and also a tie breaker.

The iE 150 is a compact, all-in-one controller. Each iE 150 contains all necessary 3-phase measuring circuits.

The LCD display shows values and alarms and is sunlight-readable. Operators can easily control the genset and breakers from the display unit. Alternatively, use the communication options to connect to an HMI/SCADA system.

1.1.1 Display layout



No.	Name	Function
1	Power	Green: The controller power is ON. OFF: The controller power is OFF.
2	Display screen	Resolution: 240 x 128 px. Viewing area: 88.50 x 51.40 mm. Six lines, each with 25 characters.
3	Navigation	Move the selector up, down, left and right on the screen.
	Enter button	Go to the Menu system. Confirm the selection on the screen.
4	Back button	Go to the previous page.
5	AUTO mode	**Single genset (GEN)**: Use to switch to REMOTE mode. Remote equipment (digital inputs, Modbus commands, AOP-2 commands) controls the iE 150. The operator cannot control the iE 150 from the display. **Emergency genset (EDG)**:

No.	Name	Function
		Use to switch to AUTO mode. If there is a blackout, the controller automatically starts and connects the genset. No operator actions are needed. The controller also automatically opens and closes the tie breaker (open transitions, since there is no synchronisation).
6	Silence horn	Stops an alarm horn (if configured) and enters the Alarm menu.
7	Shortcut menu	Access the Jump menu, Mode selection, Test, and Lamp test.
8	MANUAL mode	**Single genset (GEN)**: Use to switch to LOCAL mode. The operator can use the display buttons to start and stop the engine as well as open and close the breaker. Remote equipment cannot start and stop the engine. **Emergency genset (EDG)**: Use to switch to MANUAL mode. The operator or an external signal can start, stop, connect or disconnect the genset. The generator controller cannot automatically perform these actions.
9	Mains symbol	This controller does not use this. It is only lit during a lamp test.
10	Close breaker	Push to close the breaker.
11	Open breaker	Push to open the breaker.
12	Breaker symbols	Green: Breaker is closed. Red: Breaker failure. OFF: The breaker is open.
13	Generator	Green: Generator voltage and frequency are OK. Green flashing: The generator voltage and frequency are OK, but the V&Hz OK timer is still running. The controller cannot close the breaker. Red: The generator voltage or frequency is outside the V/Hz OK window.
14	Engine	Green: There is running feedback. Green flashing: The engine is getting ready. Red: The engine is not running, or there is no running feedback.
15	Stop	**Single genset (GEN)**: Stops the genset if LOCAL mode is selected. **Emergency genset (EDG)**: Stops the genset if MANUAL mode is selected.
16	Start	**Single genset (GEN)**: Starts the genset if LOCAL mode is selected. **Emergency genset (EDG)**: Starts the genset if MANUAL mode is selected.
17	Load symbol	Green: The supply voltage and frequency are OK. Red: Supply voltage/frequency failure.

1.1.2 Controller types

MARINE configurations

Parameter	Setting	Controller type	Minimum software package
9101	Engine Drive Marine unit	Engine drive controller for marine use	Core
	Genset Marine unit	Non-sync Genset or Emergency genset controller (with TB control) for marine use	Core
	Genset Marine unit	Genset controller for marine use	Power management
	Shore Marine unit	Shore controller for marine use	Power management
	BTB Marine unit	BTB controller for marine use	Power management
	Battery Marine unit	Battery controller for marine use	Premium
	Solar Marine unit	Solar controller for marine use	Premium

Software packages and controller types

The controller software package determines which functions the controller can use.

- **Core**
  - **Core** software only supports non-synchronisation applications.
- **Power management (PM)**
  - You cannot change the controller type to any other controller type.
- **Premium**
  - You can change the controller type to any other controller type.
  - All functions are supported.

You can select the controller type under `Basic settings > Controller settings > Type`.

NOTE For iE 150 controllers for land, see www.deif.com/products/ie-150.

1.2 About the Designer's handbook

General purpose

This document gives information about the controller's functionality and its applications, and for configuring the controller.

CAUTION

Installation errors

Read this document before working with the controller. Failure to do this may result in human injury or damage to the equipment.

Intended users of the Designer's handbook

This Designer's handbook is primarily intended for the panel designer in charge. Based on this document, the panel designer can give the electrician the necessary information to install the controller, for example detailed electrical drawings.

The Designer's handbook can also be used during commissioning to check the parameters, and operators may find it useful for understanding the system and for troubleshooting.

List of technical documentation

Document	Contents
Product sheet	• Short description • Controller applications • Main features and functions • Technical data • Protections • Dimensions
Data sheet	• General description • Functions and features • Controller applications • Controller types and variants • Protections • Inputs and outputs • Technical specifications
Designer's handbook	• Principles • General controller sequences, functions and protections • Protections and alarms • Regulation • Hardware characteristics • Communication
Installation instructions	• Tools and materials • Mounting • Minimum wiring for the controller • Wiring information and examples
Operator's manual	• Controller equipment (buttons and LEDs) • Operating the system • Alarms and log
Modbus tables	• Modbus address list ◦ PLC addresses ◦ Corresponding controller functions • Descriptions for function codes, function groups

1.2.1 Software version

This document is based on the iE 150 software version 1.35.

1.3 Warnings and safety

1.3.1 Symbols for hazard statements

DANGER!

This shows dangerous situations.

If the guidelines are not followed, these situations will result in death, serious personal injury, and equipment damage or destruction.

WARNING

This shows potentially dangerous situations.

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

CAUTION

This shows low level risk situation.

If the guidelines are not followed, these situations could result in minor or moderate injury.

NOTICE

This shows an important notice

Make sure to read this information.

1.3.2 Symbols for general notes

NOTE This shows general information.

More information
This shows where you can find more information.

Example

This shows an example.

How to ...
This shows a link to a video for help and guidance.

Safety during installation and operation

Installing and operating the controller may require work with currents and voltages. The installation must only be carried out by authorised personnel who understand the risks involved in working with electrical equipment.

Factory settings

The controller is delivered pre-programmed from the factory with a set of default settings. These settings are based on typical values and may not be correct for your system. You must therefore check all parameters and settings before using the controller.

Electrostatic discharge

Electrostatic discharge can damage the controller terminals. You must protect the terminals from electrostatic discharge during the installation. When the controller is installed and connected, these precautions are no longer necessary.

Data security

To minimise the risk of data security breaches:

- As far as possible, avoid exposing controllers and controller networks to public networks and the Internet.
- Use additional security layers like a VPN for remote access, and install firewall mechanisms.
- Restrict access to authorised persons.

1.4 Legal information

Third party equipment

DEIF takes no responsibility for installation or operation of any third party equipment. In no event shall DEIF be liable for any loss of profits, revenues, indirect, special, incidental, consequential, or other similar damages arising out of or in connection with any incorrect installation or operation of any third party equipment.

Warranty

NOTICE

Warranty

The controller 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.

Copyright

2. Utility software

2.1 Download the utility software

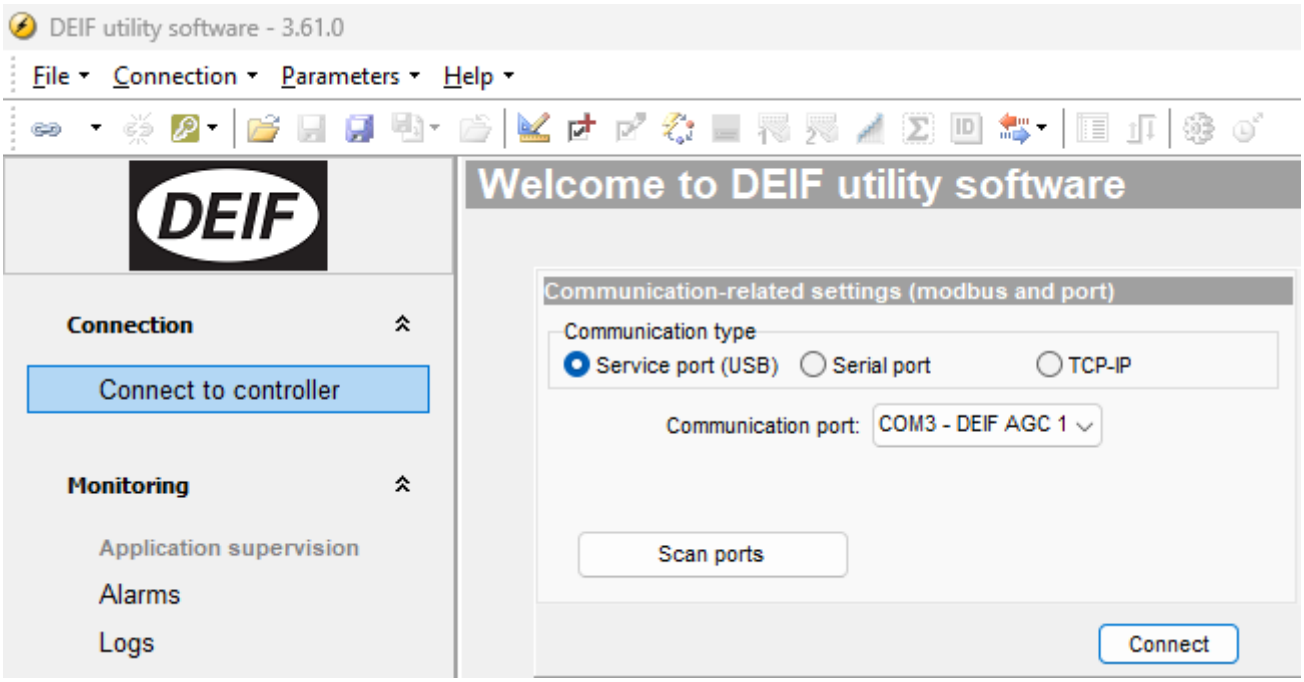
The **Multi-line 2 Utility Software v.3.x** is the software interface between a PC and the controller. The software is free of charge. Download it from www.deif.com

2.2 Connection

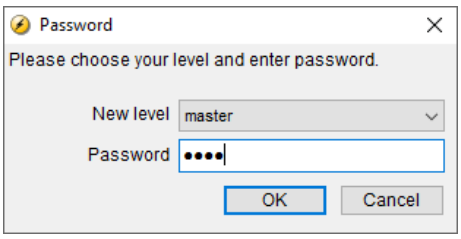
2.2.1 USB connection

You need a USB cable (USB A to B) to connect the controller to a PC.

1. Install the utility software on a PC.
2. Use the USB cable to connect the controller service port to the PC.
3. Start the utility software.



4. If needed, *Scan ports*, then select a service port option.
5. When prompted, select the access level, enter the password, and select OK.



More information
See **General functions, Password** for the default passwords.

2.3 Network connections

2.3.1 TCP connection

You can use TCP/IP communication to connect to the controller. This requires an Ethernet cable, or a connection to the network that includes the controller.

Default controller network address

- IP: 192.168.2.2
- Gateway: 192.168.2.1
- Subnet mask: 255.255.255.0

Configuring the controller IP address using the display unit or a USB connection

When connecting to a controller using TCP/IP, you must know the controller's IP address. Find the IP address on the display under: `Communication > Ethernet setup`.

You can use the display to change the controller's IP address.

Alternatively, you can use a USB connection or an Ethernet connection and the utility software to change the controller IP address.

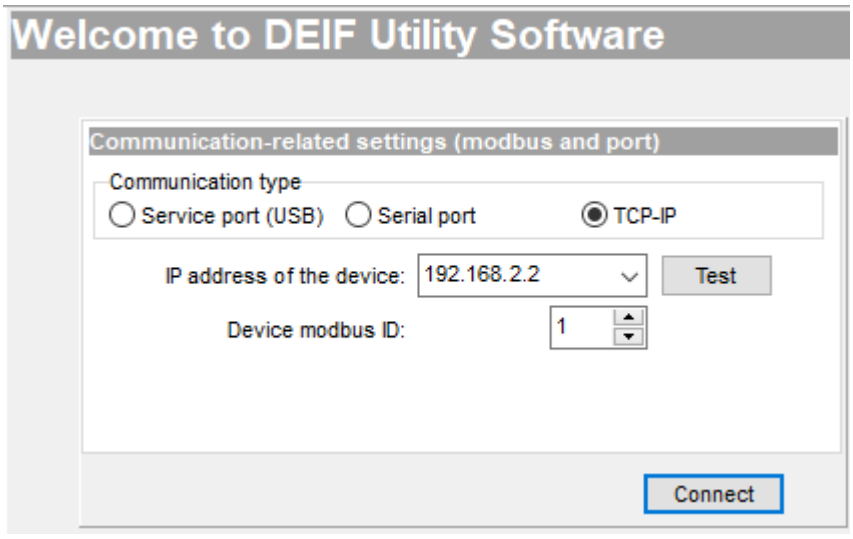
Point-to-point Ethernet connection to the controller

If you do not want to use the display unit or a USB connection to change the IP address, you can use a point-to-point Ethernet connection. The PC must have a static IP address. For the default controller network address, the PC static IP address must be 192.168.2.xxx, where xxx is a free IP-address in the network (note: xxx cannot be 2 (the controller IP address) or 1 (the gateway)).

If you change the controller address (for example, from 192.168.**2**.yyy to 192.168.**47**.yyy) the connection is lost. A new static IP for the PC is needed. In this case, 192.168.47.zzz, where zzz is a free IP-address in the network. The PC address, IP address, and gateway must be in the same subnet.

When the PC has the correct static IP address:

1. Use an Ethernet cable to connect the PC to the controller.
2. Start the utility software.
3. Select *TCP-IP*, and enter the controller IP address.

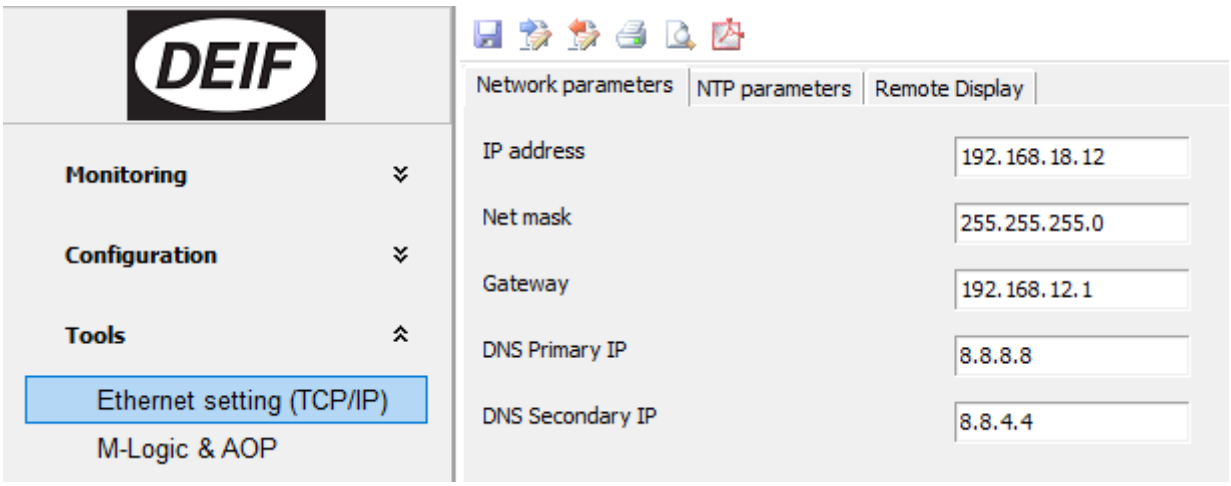


4. You can use the *Test* button to check if the connection is successful.
5. Select *Connect* to connect to the controller using TCP-IP.

Configuring the controller IP address using the utility software

1. Select *Connect* to connect to the controller using TCP-IP.
2. Select *Ethernet setting (TCP/IP).*

The *Network Parameters* window opens:



When the controller network parameters have been changed, press the *Write to device* button.

The controller receives the new network parameters and reboots the network hardware.

To connect to the controller again, use the new controller IP address (and a correct PC static IP address).

NOTE Please note that not all controllers support DNS and NTP settings. Features described in this document apply only if they are available on the controller.

Using a switch

For a system with multiple controllers, all controllers can be connected to a switch. Create a unique IP address for each controller in the network before connecting the controllers to a switch.

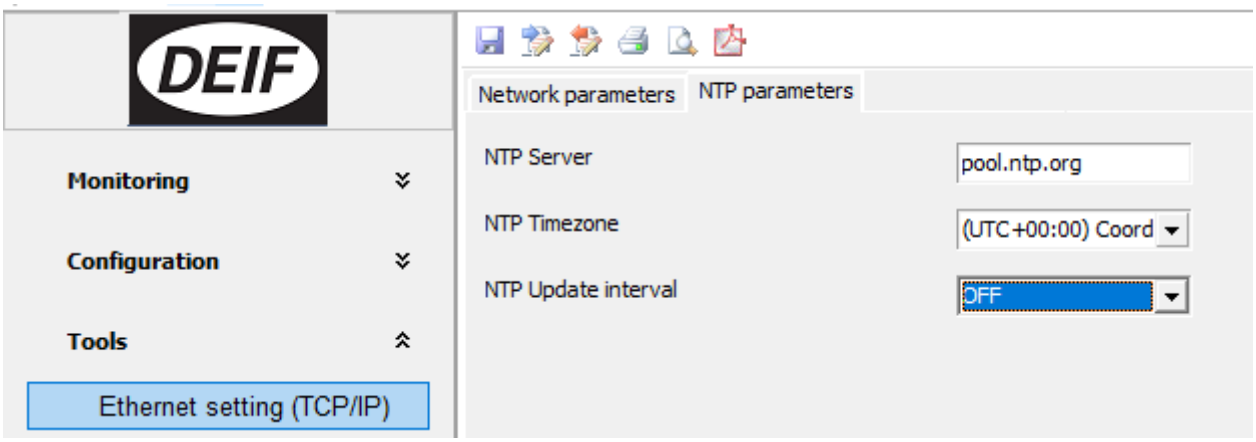
The PC can then be connected to the switch, and the Ethernet cable can be in the same port of the switch at all times. You can enter the controller IP address in the utility software.

The TCP-IP connection is faster than other connections. It also allows the user to shift between controllers in the application supervision window in the utility software.

2.3.2 Using NTP

To ensure that the controller always has the right time, you can use the network time protocol (NTP) function.

Select *Ethernet setting (TCP/IP)* in the Utility software, then select the *NTP parameters* tab in the *Network Parameters* window:



You can select an NTP server, a time zone and an update interval. Write the changes to the controller to activate the NTP function.

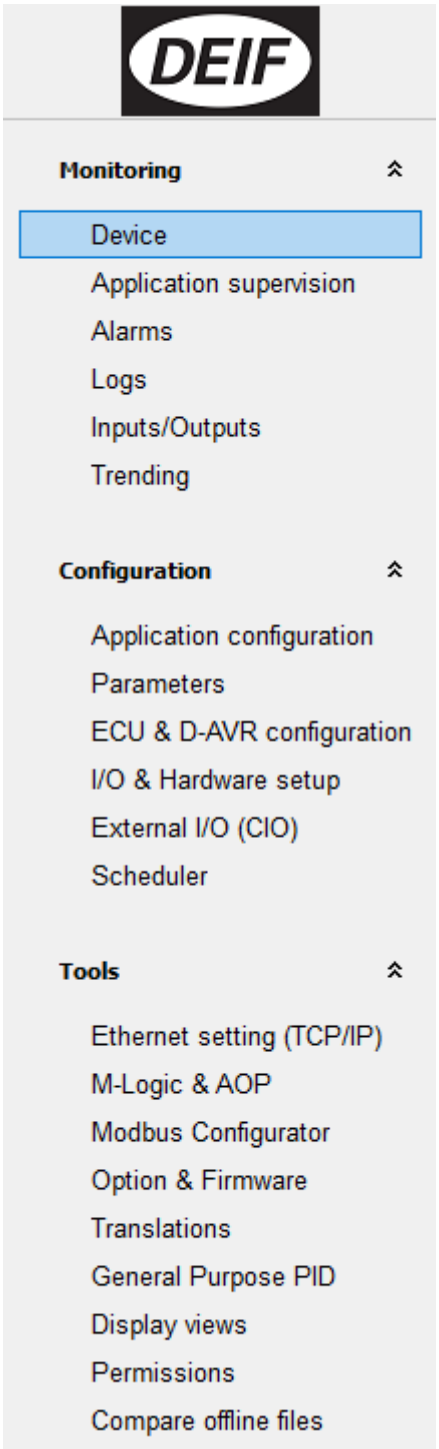
NOTE The selected NTP server must be available in the network.

2.4 Utility software interface

2.4.1 Top toolbar

1. Start communication with the device.
2. Disconnect from a controller.
3. Change your user level.
4. Application settings.
5. Upgrade options (create an option code and send it to support@deif.com).
6. Write new options (received from DEIF support).
7. Write a firmware to the device.
8. AOP 1: Not used for this controller.
9. AOP 2: Configure the AOP-2 buttons and LEDs (Additional Operator Panel).
10. Counters: Read the controller counters.
11. Identifiers: Information on the controller and the software.
12. Batch read and write: Read, write, backup, and restore the device.
13. Show/Hide the real-time readings window.
14. Send a command to the controller.
15. Synchronise the clock of the device with the connected PC.

2.4.2 Left menu



- **DEIF**
  - Link to www.deif.com
- **Monitoring**
  - Device
    - See operating information for the connected controller.
  - Application supervision
    - See the plant operation, including how much power each genset produces.
  - Alarms
    - An overview of the active alarms.
    - See the history for the alarms that are activated while the PC is connected.
  - Logs
    - See the alarms and events logs from the controller.
  - Inputs/Outputs
    - The controller input and output status.
  - Trending
    - See real-time operation.
    - Trending is possible when a PC is connected and the trending window is open. The controller cannot save the data.
- **Configuration**
  - Application configuration
    - Create the application single-line drawing(s).
  - Parameters
    - Configure and view parameters. You can view the parameters as a list or in a tree structure.
  - ECU & D-AVR configuration
    - EIC general configuration, for example Engine I/F and EIC start/stop.
    - ECU alarms
    - ECU regeneration
    - SPN ignore list
    - DAVR configuration
    - DAVR alarms
  - I/O & Hardware setup
    - Configure the inputs and outputs.
  - External I/O (CIO)
    - Detect and configure the external inputs and outputs.
- Scheduler
  -
- **Tools**
  - Ethernet setting (TCP/IP)
    - Configure Ethernet settings and communication.
  - M-Logic & AOP
    - Configure M-Logic and additional operator panels.
  - Modbus Configurator
    - Configure the configurable Modbus addresses.
  - Option & Firmware
    - See available options.

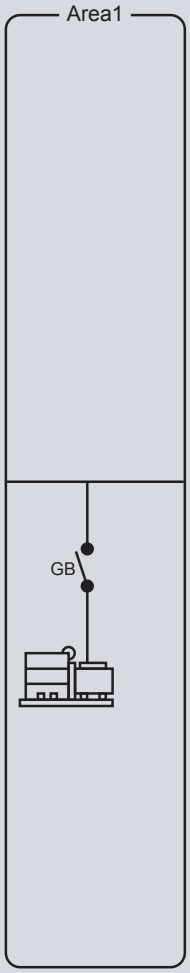
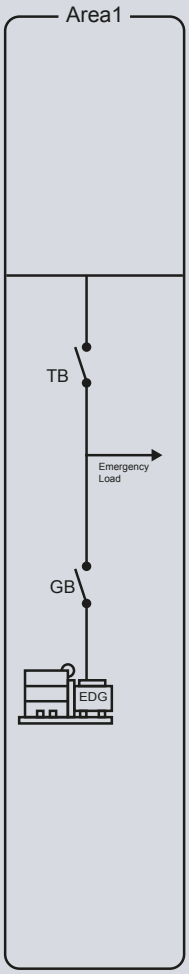
- Translations
  - Customise or translate the text in the controller.
- General Purpose PID
  - Configure the general purpose PID settings.
- Display views
  -
- Permissions
  - See and change the user permissions.
- Compare the offline files
  - Compare files.

2.5 Setup of applications

2.5.1 Applications in the controller

Application type	Plant type	Configuration characteristics
Stand-alone	Single controller	In a stand-alone application setup, the controller cannot communicate with other controllers. In a stand-alone application, a genset controller can operate one genset, one GB and one TB. There must be no other gensets or power sources.

The controller includes 4 pre-configured standard applications.

Genset controller Application 1	Genset controller Application 2
 Simple genset	 Emergency genset

The standard applications can be changed with the utility software.

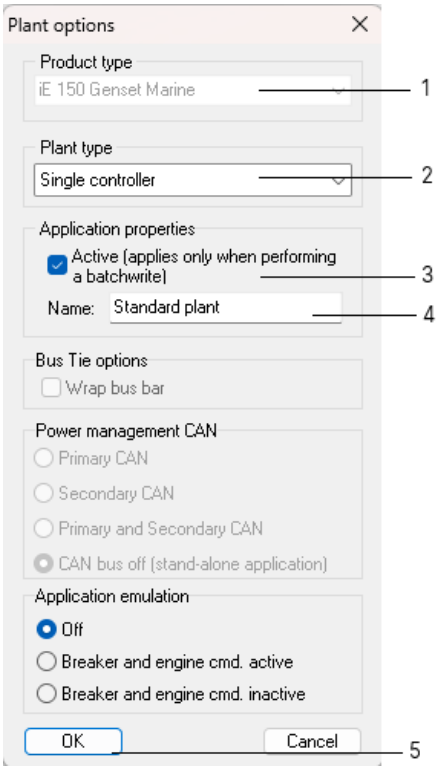
2.5.2 Setup of a stand-alone application

In a stand-alone application, the generator controller can control one genset, one generator breaker (GB), and one tie breaker (TB).

When connected to a controller with the utility software:

1. Select *Application configuration*
2. Select *New plant configuration*

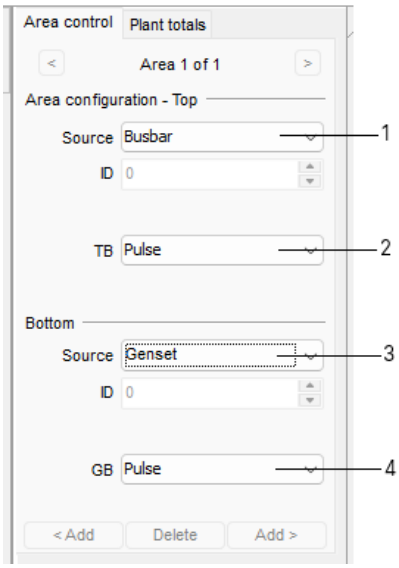
3. The *Plant options* window opens.



Select the plant options:

1. Select the *Product (controller) type*
   - Greyed out when already connected to a controller.
2. Select the *Plant type*: *Single controller*
3. Select to activate the application when it is written to the controller.
4. Write a name for the application.
5. Select OK to save the application.

Example



1. Select one of these types of power source to show in the top area:
   - None
   - Busbar
   - Genset
2. Select the breaker type for the tie breaker:
   - Pulse
   - Continuous NE
   - Compact
   - Ext*
   - None
   - Continuous ND
3. Select the power source to show in the bottom area:
   - None
   - Busbar
   - Genset
4. Select the breaker type for the generator breaker:
   - Pulse
   - Continuous NE
   - Compact
   - Ext*
   - None

NOTE * Externally controlled breaker

After the application drawing is created, press *Write plant configuration to device* to send the configuration to the connected controller.

Stand-alone application without a breaker

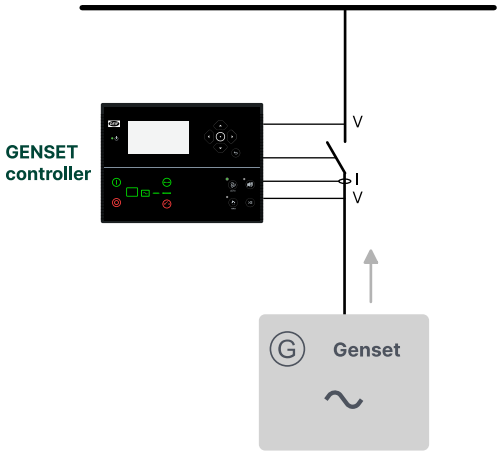
If you created a stand-alone application without a genset breaker, reset any GB feedback in the I/O setup list:

1. In the utility software, select *I/O setup*.
2. Change the function to *Not used* for the relevant I/Os, for example:

3. Applications

3.1 Single genset

Single genset

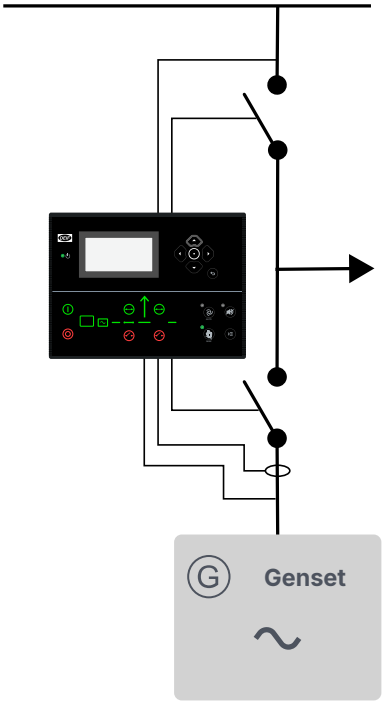


Single genset application is typically used in power plants that are isolated from other power generation systems.

NOTE You can disable breaker control.

3.2 Emergency genset

Emergency genset



If there is a significant loss of power or a total blackout in the main power generation system, the controller automatically changes the supply to the emergency generator. This makes sure that there is power during a failure and prevents damage to electrical equipment.

NOTE Alternatively, the breaker to the busbar can be externally controlled.

4. General functions

4.1 Password

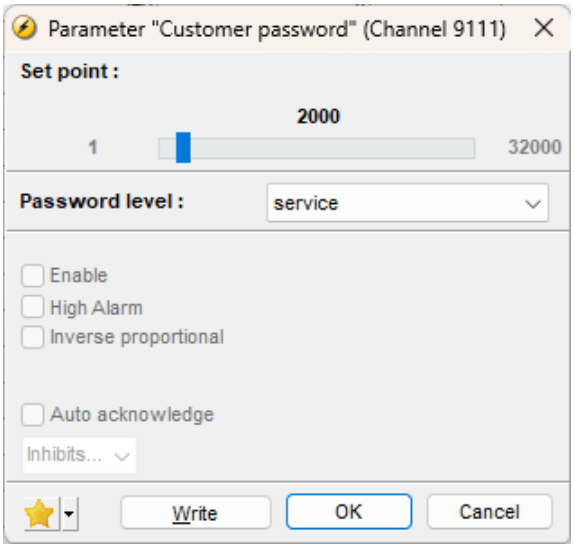
The controller has three password levels that can be configured on the controller or from the utility software. Parameter settings cannot be changed with a lower ranking password, but are shown on the display.

Parameters

`Basic settings > Controller settings > Password`

Parameter	Name	Range	Default	Customer access	Service access	Master access
9111	Customer password	00001 to 32000	2000	●		
9112	Service password	00001 to 32000	2001	●	●	
9113	Master password	00001 to 32000	2002	●	●	●

With the utility software it is possible to protect each parameter with a specific password level. Enter the parameter and select the correct password level.



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

1. Right-click the appropriate field in the Level column.
2. Select *Change access level*.
3. Select the required access level.
   - *Customer*
   - *Service*
   - *Master*

You can see and edit permissions in the utility software on the *Tools* > *Permissions* page.

4.2 AC measurement systems

The controller is designed for measurement of voltages in systems with nominal voltages between 100 and 690 V AC. The AC system can be three-phase, single-phase, or split phase.

More information
See the **Installation instructions** for how to wire the different systems.

CAUTION

Incorrect configuration is dangerous

Configure the correct AC configuration. If in doubt, contact the switchboard manufacturer for information.

Basic settings > Measurement setup > Wiring connection > AC configuration

Parameter	Text	Range	Default
9131	AC configuration	3 phase 3W4 3 phase 3W3 2 phase L1/L3* 2 phase L1/L2* 1 phase L1*	3 phase 3W4
9132	AC configuration BB	3 phase 3W4 3 phase 3W3	3 phase 3W4

NOTE * If this is selected, the same system is used for the busbar, and parameter 9132 is disabled.

4.2.1 Three-phase system

The three-phase system is the default setting for the controller. When this is used, all three phases must be connected to the controller.

The following configuration is required for three-phase measuring.

Basic settings > Nominal settings > Voltage > Generator/Busbar nominal U

Parameter	Text	Range	Adjust to value
6004	Nom. U 1	100 to 25000 V	U_{NOM}

Basic settings > Measurement setup > Voltage transformer > Generator/Busbar VT

Parameter	Text	Range	Adjust to value
6041	G primary U	100 to 25000 V	Primary VT
6042	G secondary U	100 to 690 V	Secondary VT

Basic settings > Nominal settings > Voltage > Busbar nominal U

Parameter	Text	Range	Adjust to value
6053	BB nominal U 1	100 to 25000 V	U_{NOM}

Basic settings > Measurement setup > Voltage transformer > Busbar VT

Parameter	Text	Range	Adjust to value
6051	BB primary U 1	100 to 25000 V	Primary VT
6052	BB second. U 1	100 to 690 V	Secondary VT

NOTE The controller has two sets of busbar transformer settings, which can be enabled individually in this measurement system.

4.2.2 Split-phase system

The split-phase system is a special application, where two phases and neutral are connected to the controller. The controller shows phases L1 and L2/L3 in the display. The phase angle between L1 and L3 is 180 °. Split-phase is possible between L1-L2 or L1-L3.

The following configuration is required for the split phase measuring (example 240/120 V AC).

Basic settings > Nominal settings > Voltage > Generator nominal U

Parameter	Text	Range	Adjust to value
6004	Nom. U 1	100 to 25000 V	120 V AC

Basic settings > Measurement setup > Voltage transformer > Generator VT

Parameter	Text	Range	Adjust to value
6041	G primary U	100 to 25000 V	U_{NOM}
6042	G secondary U	100 to 690 V	U_{NOM}

Basic settings > Nominal settings > Voltage > Busbar nominal U

Parameter	Text	Range	Adjust to value
6053	BB nominal U 1	100 to 25000 V	U_{NOM}

Basic settings > Measurement setup > Voltage transformer > Busbar VT

Parameter	Text	Range	Adjust to value
6051	BB primary U 1	100 to 25000 V	U_{NOM}
6052	BB second. U 1	100 to 690 V	U_{NOM}

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

NOTE The controller has two sets of busbar transformer settings, which can be enabled individually in this measurement system.

4.2.3 Single-phase system

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

The following configuration is required for the single-phase measuring (example 230 V AC).

Basic settings > Nominal settings > Voltage > Generator nominal U

Parameter	Text	Range	Adjust to value
6004	Nom. U 1	100 to 25000 V	230 V AC

Basic settings > Measurement setup > Voltage transformer > Generator VT

Parameter	Text	Range	Adjust to value
6041	G primary U	100 to 25000 V	$U_{NOM} \times \sqrt{3}$
6042	G secondary U	100 to 690 V	$U_{NOM} \times \sqrt{3}$

Basic settings > Nominal settings > Voltage > Busbar nominal U

Parameter	Text	Range	Adjust to value
6053	BB nominal U 1	100 to 25000 V	$U_{NOM} \times \sqrt{3}$

Basic settings > Measurement setup > Voltage transformer > Busbar VT

Parameter	Text	Range	Adjust to value
6051	BB primary U 1	100 to 25000 V	$U_{NOM} \times \sqrt{3}$
6052	BB second. U 1	100 to 690 V	$U_{NOM} \times \sqrt{3}$

NOTE The voltage alarms refer to U_{NOM} (for example, 230 V AC).

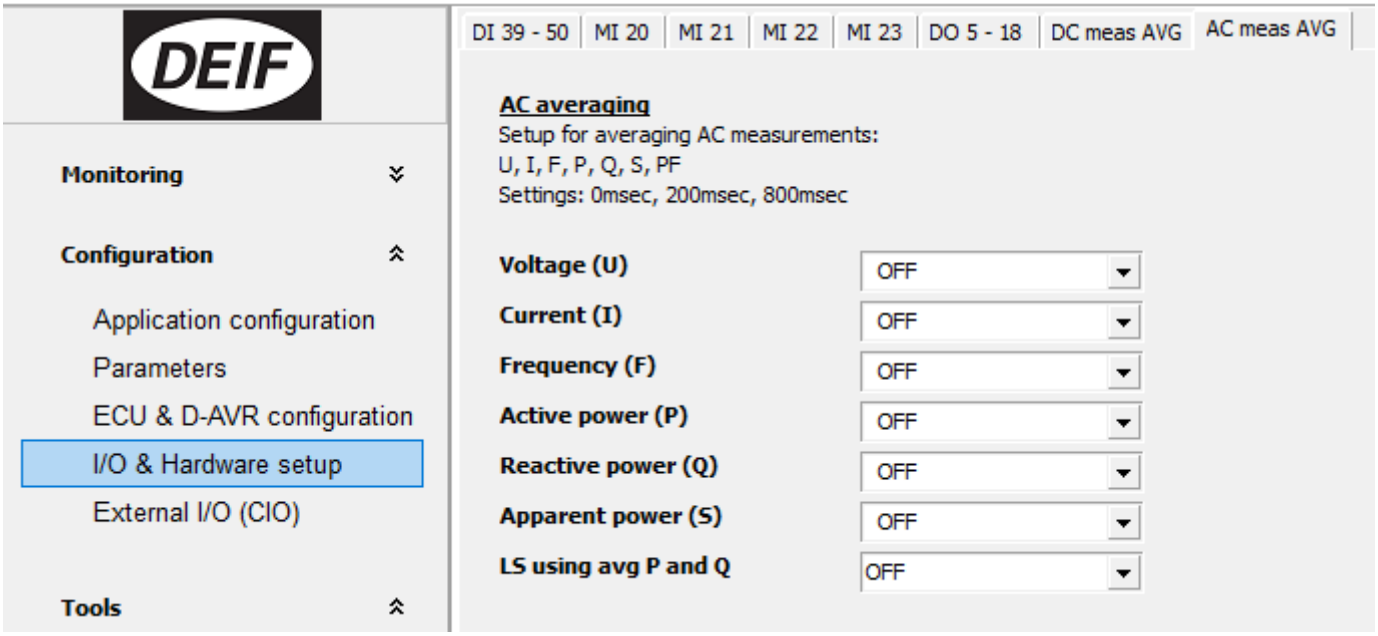
The controller has two sets of busbar transformer settings, which can be enabled individually in this measurement system.

4.2.4 AC measurement averaging

You can use the utility software to set up averaging for a number of AC measurements. The averaged values are then shown on the display unit and in the Modbus values. However, the controller continues to use real-time measurements.

In the utility software, under *I/O & Hardware setup*, select the *AC meas AVG* tab. For each measurement, you can select no averaging (0 ms), averages calculated over 200 ms, or averages calculated over 800 ms.

From the *AC meas AVG* tab, you can also set up averaging for load-sharing using active power (P) and reactive power (Q) measurements. Set *LS using avg P and Q* to ON, and select 200 ms or 800 ms for the *Active power (P)* and *Reactive power (Q)* measurements.



4.3 Nominal settings

The controller has four sets of nominal settings for the generator and two sets for the busbar. The four sets of nominal generator settings can be individually configured.

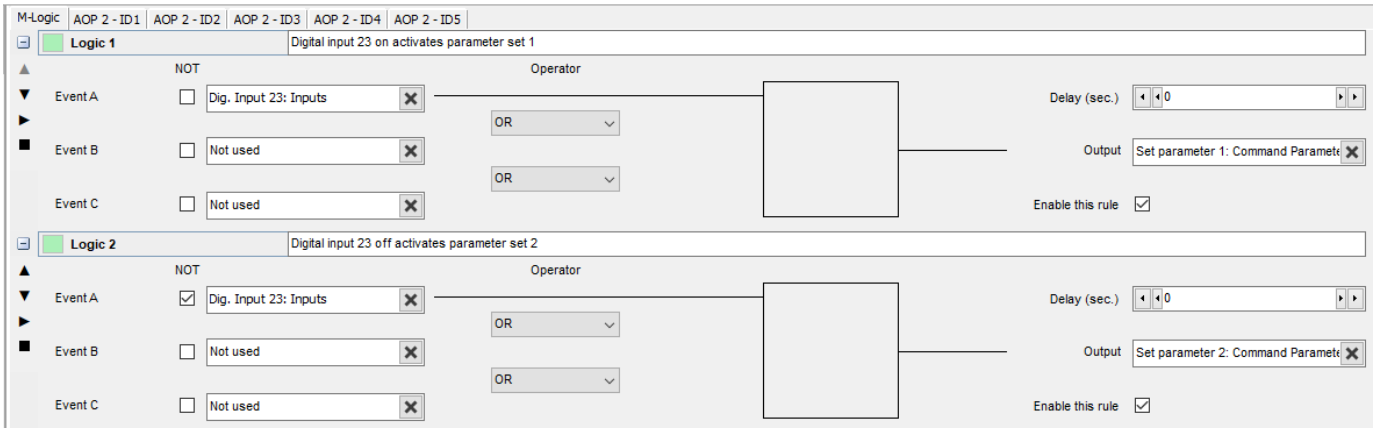
Alternative configuration > Generator nominal settings

Parameter	Text	Range	Default
6006	Enable nom. set	Nominal setting [1 to 4]	Nominal setting 1

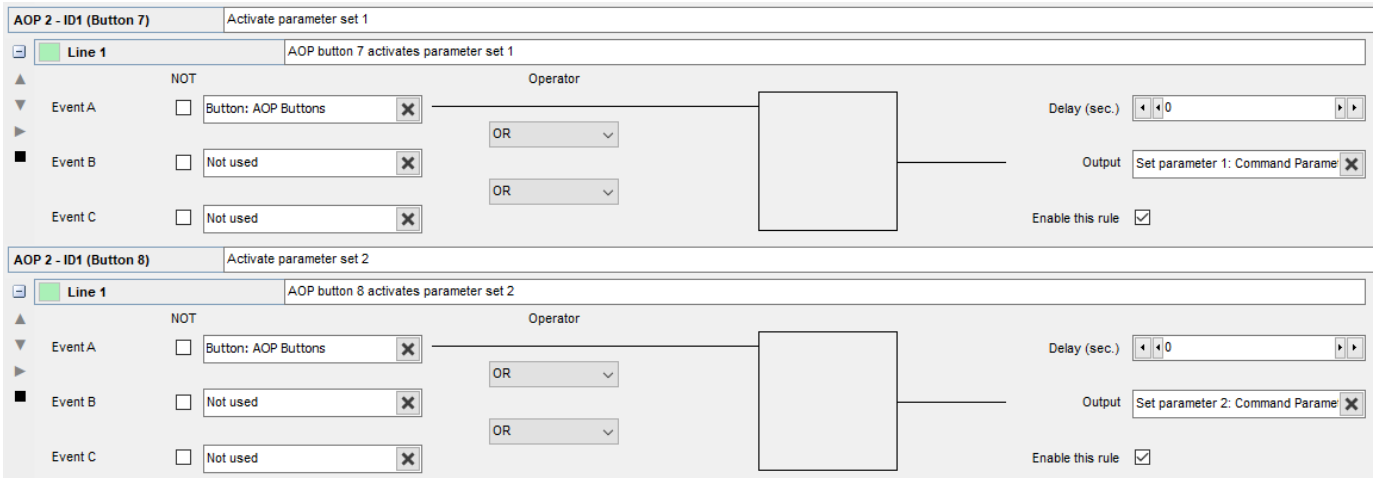
Switch between the nominal settings

You can use the following to switch between the four sets of nominal settings:

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



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



3. **Menu settings**: On the controller or with the utility software.

4.3.1 Default nominal settings

The default nominal settings are settings 1.

Basic settings > Nominal settings

Parameter	Text	Range	Default
6001	Nom. f 1	48.0 to 62.0 Hz	50 Hz
6002	Nom. P 1	10 to 20000 kW	480 kW
6003	Nom. I 1	0 to 9000 A	867 A
6004	Nom. U 1	100 to 25000 V	400 V
6005	Nom. RPM 1	100 to 4000 RPM	1500 RPM
6007	Nom. I E/N/BB 1	0 to 9000 A	867 A

Parameter	Text	Range	Default
6053	BB nominal U 1	100 to 25000 V	400 V
6055	4th CT nom. P 1	10 to 9000 kW	480 kW

4.3.2 Scaling

For applications above 25000 V and below 100 V, adjust the input range to match the actual value of the primary voltage transformer.

Changing the voltage scaling also affects the nominal power scaling.

`Basic settings > Measurement setup > Scaling`

Parameter	Text	Range	Default	Notes
9030	Scaling	10 to 2500 V 100 to 25000 V 10 to 160 kV 0.4 to 75 kV	100 to 25000 V	**10 to 2500 V**: This is recommended for power sources up to 150 kVA. The nominal power must be less than 900 kW. **100 to 25000 V**: This is recommended for power sources over 150 kVA.

NOTICE

Incorrect configuration is dangerous

Correct all nominal values and the primary VT settings after the scaling (parameter 9030) is changed.

4.4 Mode overview

Single genset (GEN)

- **REMOTE**: The operator has to initiate sequences remotely.
- **LOCAL**: The operator has to initiate sequences using the push buttons on the display.
- **TEST**: Used to verify functionality and diagnose issues without affecting normal operations.
- **BLOCK**: Used when maintenance work is carried out on the genset.

Emergency genset (EDG)

- **AUTO**: The controller operates automatically, and the operator cannot initiate any sequences manually.
- **MANUAL**: The operator has to initiate all sequences. This can be done using the buttons, Modbus commands or digital inputs. When started, the genset runs at nominal values.
- **SWBD**: When starting, the genset starts without any subsequent regulation.
- **TEST**: Used to verify functionality and diagnose issues without affecting normal operations.
- **BLOCK**: Used when maintenance work is carried out on the genset.

4.4.1 REMOTE mode

REMOTE mode uses command start sequences from digital inputs, utility software, Modbus, and/or M-Logic. Display push-buttons for sequences are ignored.

REMOTE mode commands

Command	Description	Notes
Start	The start sequence is started and continues until the engine starts or the maximum number of start attempts is reached.	
Stop	The engine is stopped. Without the running signal, the stop sequence continues to be active in the extended stop time period. The engine is stopped with cooling down time.	The cooling down time is cancelled if the *Stop* button is activated twice.

NOTE The controller is equipped with a limited number of digital inputs. If you need more digital inputs, you can use CIO 116. Please refer to **Digital inputs** in this document for additional information about availability.

4.4.2 LOCAL mode

The operator can start, stop, connect and disconnect the asset using the push buttons on the display. Remote commands for sequences are ignored.

More information
See **Display layout** for more information.

4.4.3 AUTO mode

In AUTO mode, the controller automatically initiates sequences based on system conditions. It will start and stop generators, control breakers, and manage load sharing without external signals.

Not in AUTO mode
This function activates an alarm if the system is not in AUTO mode.

`Functions > Not in Auto`

Parameter	Text	Range	Default
6541	Timer	10.0 to 900.0 s	300.0 s
6544	Enable	OFF ON	OFF
6545	Fail class	Fail classes	Warning

4.4.4 MANUAL mode

The controller can be operated in MANUAL mode. This means that the controller will not initiate any sequences automatically, as is the case with the AUTO mode. It will only initiate sequences, if external signals are given.

An external signal may be given in three ways:
1. Buttons on the display are used
2. Digital inputs are used
3. Modbus command

NOTE The controller has a limited number of digital inputs. See **Digital inputs** for availability.

When the genset is running in MANUAL mode, the controller controls the speed governor and the AVR.

MANUAL mode commands

Command	Description
Start engine	The start sequence is initiated and continues until the genset starts or the maximum number of start attempts is reached. The frequency (and voltage) will be regulated to make the GB ready to close.
Stop engine	The genset is stopped. Without the running signal, the stop sequence continues to be active in the Extended stop time period. The genset is stopped with cooling down time. The cooling down time is cancelled if the *Stop* button is activated twice.
GB close	The controller closes the generator breaker if the tie breaker is open. When EDG mode is selected, the controller will not regulate after breaker closure.
GB open	The controller opens the generator breaker.
TB close	The controller closes the tie breaker if the generator breaker is open.
TB open	The controller opens the tie breaker.
Alarm Acknowledge	Acknowledges all present alarms, and the alarm LED on the display stops flashing.
AUTO mode	Changes the running mode to AUTO.
Test mode	Changes the running mode to Test.

4.4.5 SWBD mode

In SWBD mode, the controller does not initiate any start or stop sequences. Breaker operations are also handled externally. The mode is intended for situations where full manual control is required, such as maintenance or troubleshooting.

NOTE Protective functions remain active in SWBD mode. However, no regulation and no power management is performed. Blackout recovery is active, if it is an emergency genset.

4.4.6 Block mode

When the block mode is selected, the controller is locked for certain actions. This means that the controller cannot start the genset or do any breaker operations.

To change the running mode from the display, the user will be asked for a password before the change can be made. It is not possible to select Block mode when running feedback is present.

If the digital inputs are used to change the mode, it is important that the input configured to *Block mode* is a constant signal:

- When the signal is ON, the controller is blocked.
- When the signal is OFF, the controller returns to the mode selected before block mode.

If block mode is selected using the display after the digital block input is activated, the controller will stay in block mode after the block input is deactivated. The block mode must now be changed using the display. The block mode can only be changed locally by display or digital input. Alarms are not influenced by block mode selection.

NOTE The genset shuts down if block mode is selected while the genset is running.

CAUTION

Be careful when starting the genset

Before the running mode is changed, check that people are clear of the genset and that the genset is ready for operation. If possible, start the genset from the local engine control panel (if installed), rather than local cranking and starting of the genset.

4.4.7 Test mode

The test mode is activated by select the test mode on the controller or by activating a digital input.

Configuration of test parameters on the controller

1. Push the *Shortcut*  button on the controller.
2. Select Jump to parameter.
3. Type in the menu number to configure the test parameters.

`Power set points > Test`

Parameter	Text	Range	Default
7041	Test	0.0 to 999.0 min	5.0 min
7043	Return mode	MANUAL mode AUTO mode	AUTO mode
7044	Test type	Engine test Full test (EDG)	Engine test

NOTE If the timer is set to 0.0 min., the test sequence is infinite.
NOTE If the genset controller is in the stop sequence in test mode and the mode is changed to MANUAL, the genset continues to run.

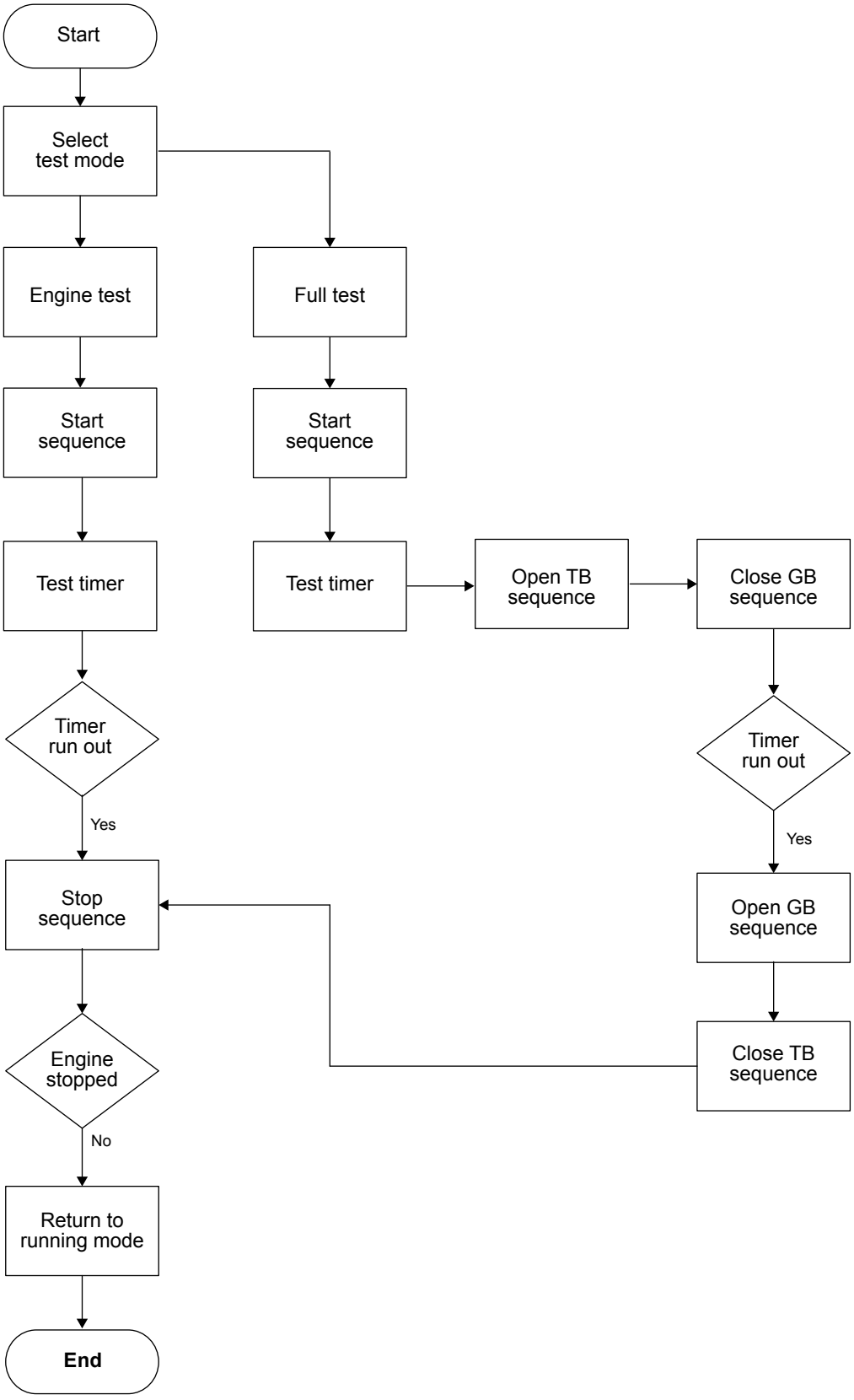
Engine test

The engine test will only start the genset and run it at nominal frequency with the generator breaker open. The test will run until the timer expires.

Full test

The full test starts the genset and runs it at nominal frequency. If possible, the generator breaker closes. When the test timer expires, the generator breaker is opened and the generator is stopped.
NOTE The full test is only applicable in EDG application.

Test sequence flowchart



4.5 Breakers

4.5.1 Breaker types

There are five breaker type settings. Set the breaker type with the utility software under *Application configuration*.

More information
See **Utility software** for how to set up applications.

Continuous NE and Continuous ND

Continuous NE is a normally energised signal, and *Continuous ND* is a normally de-energised signal. These settings are usually used in combination with a contactor.

The controller only uses the *Close breaker* output:

- Closed: This closes the contactor.
- Open: This opens the contactor.

The *Open breaker* output can be configured for another function.

Pulse

This setting is usually used in combination with a circuit breaker. The controller uses these outputs:

- To close the circuit breaker, the *Close breaker* output is activated (until there is breaker close feedback).
- To open the circuit breaker, the *Open breaker* output is activated (until there is breaker open feedback).

External

This setting is used to show the position of the breaker, but the breaker is not controlled by the controller.

Compact

This setting is usually used in combination with a direct controlled motor driven breaker. The controller uses these outputs:

- The *Close breaker* output closes briefly to close the compact breaker.
- The *Open breaker* output closes to open the compact breaker. The output stays closed long enough to recharge the breaker.

If the compact breaker is tripped externally, it is recharged automatically before next closing.

4.5.2 Breaker spring load time

To avoid breaker close failures in situations where the breaker close command is given before the breaker spring has been loaded, the spring load time can be adjusted.

Principle

You could have a close failure if:

1. A genset is in AUTO mode, the Auto start/stop input is active, the genset is running, and the GB is closed.
2. The Auto start/stop input is deactivated, the stop sequence is executed, and the GB is opened.
3. If the Auto start/stop input is activated again before the stop sequence is finished, the controller activates a GB close failure, since the GB needs time to load the spring before it is ready to close.

Ensuring time to reload

If the breaker needs time to reload the spring after it has opened, the controller can take this delay into account. This can be controlled through timers in the controller or through digital feedbacks from the breaker, depending on the breaker type:

1. **Timer-controlled.** A load time set point for the GB and TB control for breakers with no feedback indicating that the spring is loaded. After the breaker has been opened it will not be allowed to close again before the delay has expired. When the timer is running, the remaining time is shown in the display.
2. **Digital input.** Two configurable inputs are used for feedbacks from the breakers: One for GB spring loaded and one for TB spring loaded. After the breaker has been opened it cannot close before the configured inputs are active.

If both a timer and breaker feedbacks are used, both requirements must be met before the breaker is allowed to close.

If the breaker requires time to reload the spring after opening, the controller can account for this delay. The delay can be handled using timers in the controller or via digital feedback from the breaker, depending on the breaker type.

4.5.3 Breaker position failure

The breaker position failure alarm is activated if a controller has no breaker position feedback, or if both feedbacks from the breaker are high.

When a controller has a breaker position failure, genset is blocked for operation. The breaker is not closed and the genset cannot start. If genset is running and breaker is closed, it is possible to open breaker and stop engine.

You can assign a fail class to try to trip the faulty breaker when the controller discovers a breaker position failure.

4.6 Alarms

4.6.1 Fail classes

All activated alarms must have a fail class. The fail classes define the category of the alarms and the subsequent alarm action.

The fail class can be selected for each alarm function, either from the controller or using the utility software.

To change the fail class using the utility software, open the alarm in the parameter list, then select the fail class from the list.

Fail class/Action	Alarm horn relay	Alarm display	Trip GB	Trip TB	Cooling down genset	Stop genset
Block	●	●				
Warning	●	●				
Trip GB	●	●	●			
Trip + stop	●	●	●		●	●
Shutdown	●	●	●			●
Trip TB (EDG)	●	●		●		
Safety stop	●	●			●	●
Trip TB/GB (EDG)	●	●	(●)	●		
Controlled stop	●	●	●		●	●

The table shows the action of the fail classes. For example, if an alarm is configured with the *Shutdown* fail class, the following occurs:

- The alarm horn relay activates.
- The alarm is displayed on the alarm info screen.
- The generator breaker opens instantly.
- The genset is stopped instantly.
- The genset cannot be started from the controller (see next table).

In stand-alone applications, *Safety stop* has no effect.

Trip TB/GB only trips the generator breaker if the genset controller changes supply to the emergency generator (EDG). This means that a genset controller can only trip a tie breaker in a stand-alone application that contains a tie breaker. Otherwise, the fail class always trips the generator breaker.

When the engine is stopped

Fail class/Action	Block engine start	Block TB sequence	Block GB sequence
Block	●		●
Warning			
Trip GB	●		●
Trip + stop	●		●
Shutdown	●		●
Trip TB		●	
Trip TB/GB*	●	●	(●)
Controlled stop	●		●

NOTE *The fail class *Trip TB/GB* does not block *Start* and *Block GB* sequences if the genset controller is in a stand-alone application with a tie breaker.

4.6.2 Inhibits

You can use the utility software to configure inhibits for each alarm. Open the alarm in the parameter list, then select the inhibit(s) from the list.

Only alarms can be inhibited. Function inputs such as running feedback, remote start or access lock are never inhibited.

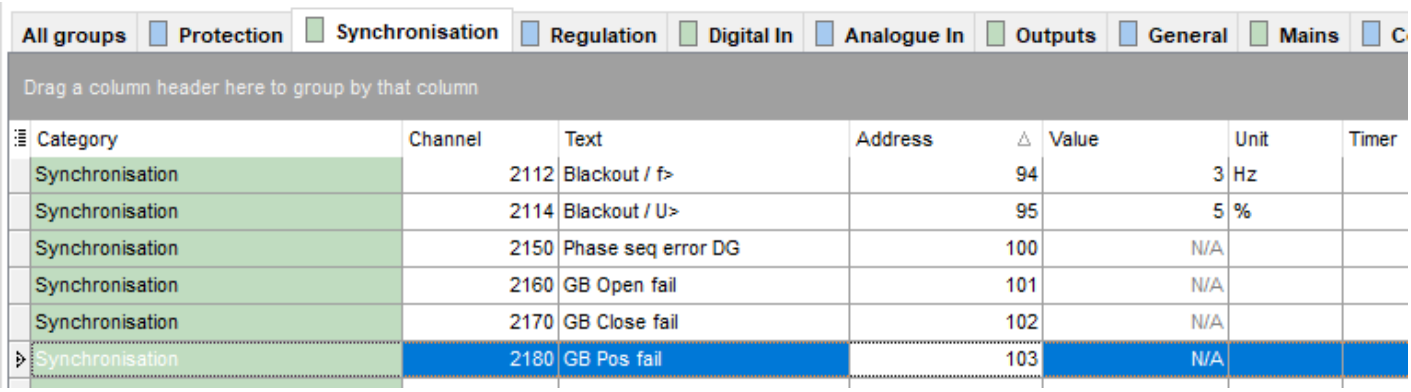
Function	Notes
Inhibit 1	M-Logic outputs: Conditions are programmed in M-Logic.
Inhibit 2	
Inhibit 3	
GB ON	The generator breaker is closed.
GB OFF	The generator breaker is open.
Run status	Running detected and the timer has expired*.
Not run status	Running not detected or the timer has not expired*.
Generator voltage > 30 %	Generator voltage is above 30 % of nominal.
Generator voltage < 30 %	Generator voltage is below 30 % of nominal.
TB ON (EDG)	The tie breaker is closed.
TB OFF (EDG)	The tie breaker is open.
Shutdown override	The shutdown override input is activated.

NOTE * The run status timer is configured under `Functions > Run status > Timer`. With binary running feedback the timer is not used.

4.6.3 Alarm list monitoring

Alarm list monitoring allows you to view all active alarms using Modbus, which is useful for remote monitoring and touch screen devices, for example AGI and SCADA/BMS systems. The alarms are in Modbus addresses 28000 to 28099 and these are not listed in the *Input register (04)*.

The Modbus address for an active alarm corresponds to the address value in the utility software. For example, Modbus address 103 is equal to parameter 2180 GB Pos fail as the address in the utility for this parameter is 103.



Category	Channel	Text	Address	Value	Unit	Timer
Synchronisation	2112	Blackout / f>	94	3	Hz	
Synchronisation	2114	Blackout / U>	95	5	%	
Synchronisation	2150	Phase seq error DG	100	N/A		
Synchronisation	2160	GB Open fail	101	N/A		
Synchronisation	2170	GB Close fail	102	N/A		
Synchronisation	2180	GB Pos fail	103	N/A		

4.7 M-Logic

The main purpose of M-Logic is to give the operator/designer more flexibility.

M-Logic is used to execute different commands at predefined conditions. M-Logic is not a PLC but substitutes one, if only very simple commands are needed.

M-Logic is a simple tool based on logic events. One or more input conditions are defined, and at the activation of those inputs, the defined output will occur. A great variety of inputs can be selected, such as digital inputs, alarm conditions and running conditions. A variety of the outputs can also be selected, such as relay outputs, change of modes.

You can configure M-Logic in the utility software.

4.7.1 General shortcuts

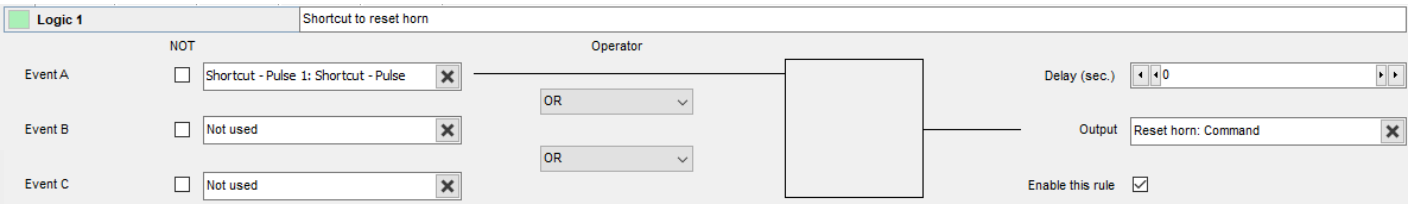
You can configure your own shortcuts with M-Logic in the utility software. You can see the configured shortcuts when you push the *Shortcut* button and select *General shortcuts*. If you have not configured a shortcut, then the *General shortcuts* menu is empty.

For a pulse shortcut, the command is sent each time you select the shortcut and press OK in the display menu.

For a switch shortcut, the switch is toggled (on/off) each time you select the shortcut.

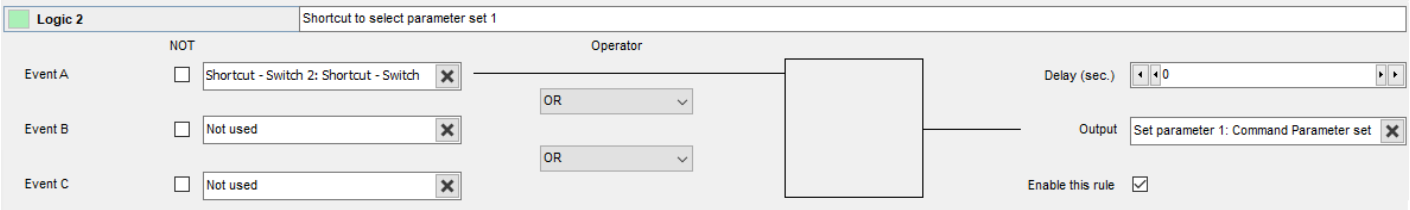
Use the *Translations* interface to rename the shortcut.

Example of shortcut pulse



Rename *SC Pulse 1* to *Reset horn*.

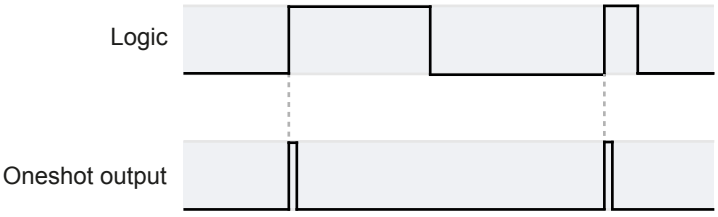
Example of shortcut switch



Rename *SC Switch 2 on* to *Use parameter set 1*.

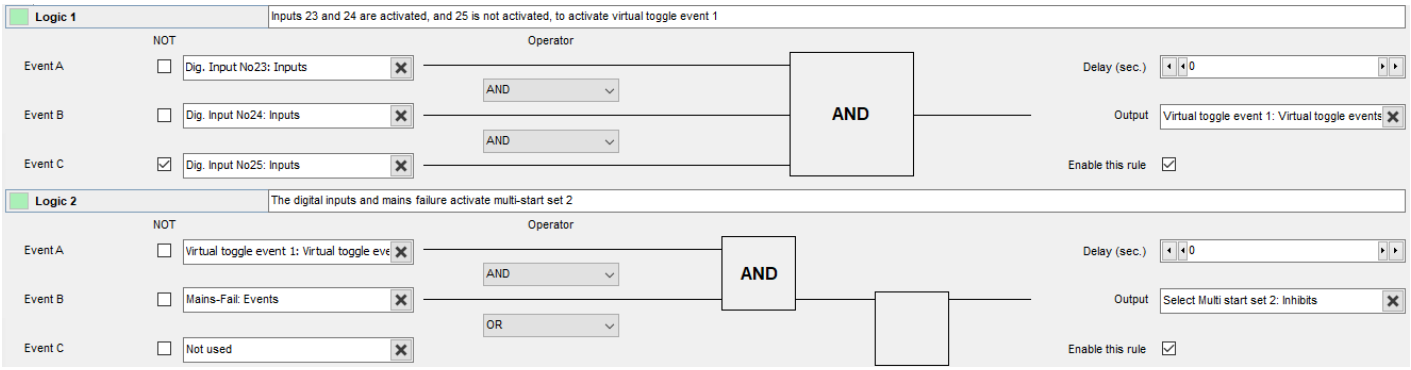
4.7.2 Oneshots

Description	Notes
Oneshot set [1-16]	The oneshot is activated for a short time (about 100 ms) when the logic is true. If the logic remains true, the oneshot is not activated again. When the logic is false, the function is reset.



4.7.3 Virtual event outputs

Virtual event outputs are used to expand the number of outputs in a logic sequence. For example, the output of Logic 1 can be used to continue the sequence in Logic 2.



- The *Logic 1* output is set to *Virtual event output 1*.
- *Event A* in *Logic 2* is *Virtual event output 1*.

Up to five outputs that can be used in this logic sequence (A + B + C in Logic 1 and B + C in Logic 2).

4.7.3.1 Virtual event outputs

Description	Notes
Virtual event output [1-96]*	Virtual event outputs 1 to 96 can be activated by Modbus. They can also be used in multiple lines of logic to increase the number of events possible in one sequence.

NOTE * Previously *Virtual toggle event [1-96]*.

4.7.4 Flip flop function

The flip flop function makes it easy for a pulse input to latch an output, for example a relay.

The Event selects a flip flop output [1-16], and the Output selects the output function:

- Flip flop set [1-16] = Change the flip flop output state to High.
- Flip flop reset [1-16] = Change the flip flop output state to Low.
- Flip flop toggle [1-16] = Shift the flip flop output state from Low to High or from High to Low.

Example

The example shows how flip flop set 1 could be configured to set relay 8:

- Logic 1: Flip flop output 1 is selected to set the relay output.
- Logic 2: Digital input 23 is used to trigger flip flop set 1 and thus sets the relay output active.
- Logic 3: Digital input 24 is used to deactivate the relay output by triggering flip flop reset 1.
- Logic 4: Digital input 25 is used to toggle the flip flop output state.
- Relay 8 must be set to *M-Logic / Limit relay*.

If reset and set are active at the same time, the flip flop will prioritise the reset command. The set or reset function may not be active when the toggle function is used.

The flip flops are also accessible from Modbus.

4.7.5 Virtual toggle outputs

Description	Notes
Virtual toggle output [1-32] *	Virtual toggle outputs 1 to 32 can be activated by Modbus. They can also be used in multiple lines of logic to increase the number of events possible in one sequence.

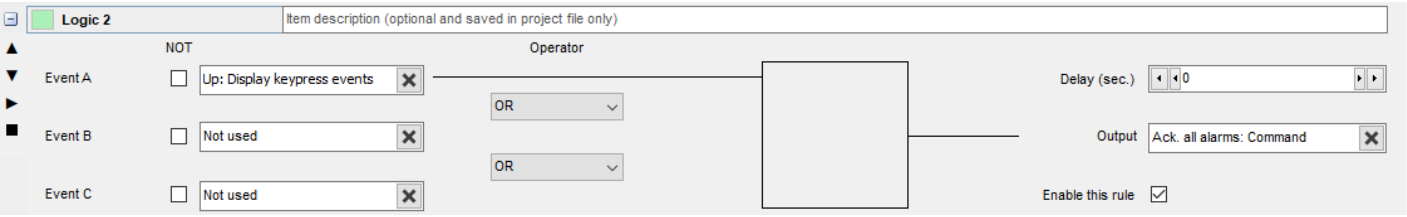
NOTE * Previously *Virtual switch event [1-32]*

4.7.6 M-Logic event counters

Description	Notes
M-logic event counter limit [1-8]	The event counter has reached the limit selected in the *Counters > M-logic event counter* window.
M-logic event reset counter [1-8]	The event counter has been reset. The reset conditions are in the *Counters > M-logic event counter* window.

4.7.7 Display keypress events

Use the display keypress events to activate an output with the display buttons. For example, you can configure the *UP* button to acknowledge all alarms when you push it.



The function can also be used to detect when a button is pushed.

4.8 Timers and counters

4.8.1 Command timers

Command timers are used to execute a command at a specific time. For example, to start and stop the genset automatically at specific times on certain weekdays.

Up to four command timers can be configured with M-Logic. Each command timer can be set for the following time periods:

- Individual days (MO, TU, WE, TH, FR, SA, SU)
- MO, TU, WE, TH
- MO, TU, WE, TH, FR
- MO, TU, WE, TH, FR, SA, SU
- SA, SU

To start in AUTO mode, the Auto start/stop command can be programmed in M-Logic or in the input settings. The time-dependent commands are flags that are activated when the command timer is in the active period.

4.8.2 Diagnostics timer

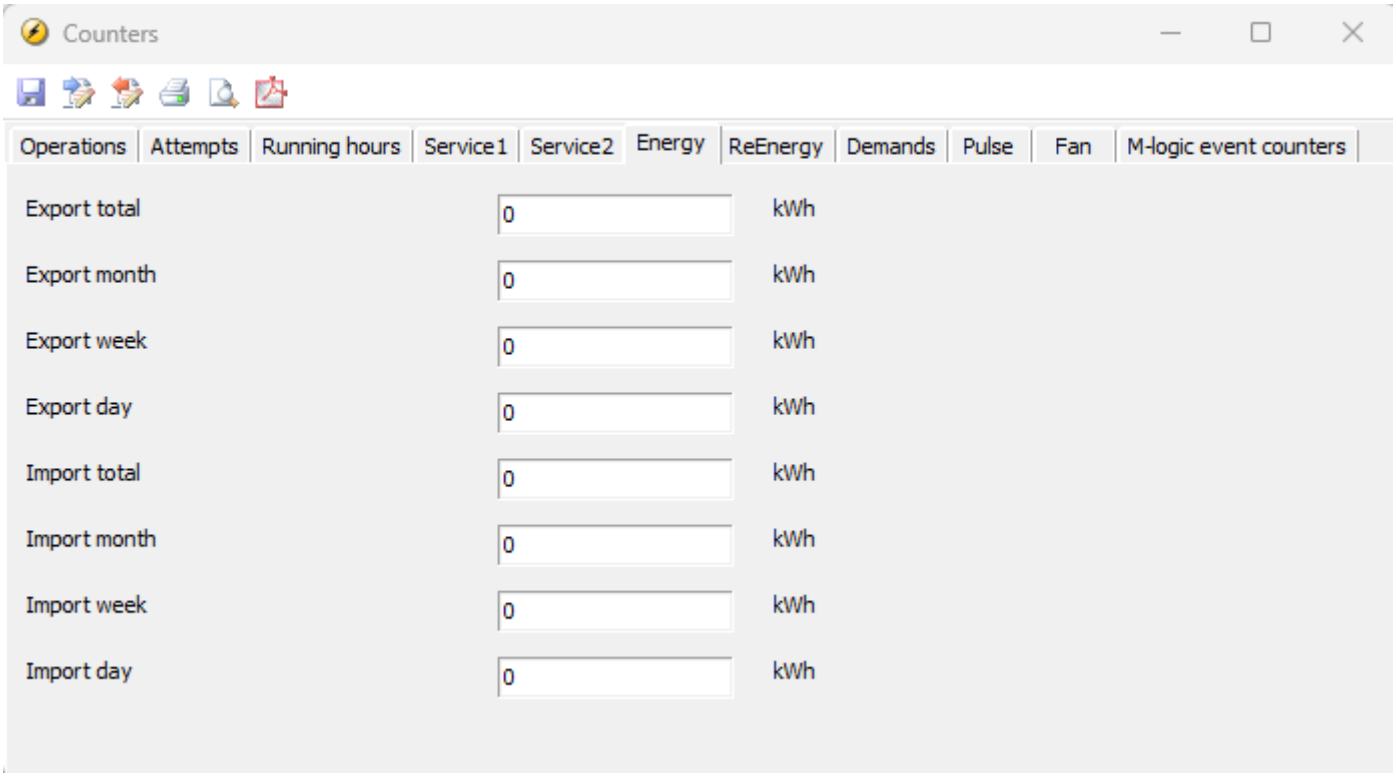
This function is useful when the ECU power is connected to the run coil. The function activates the run coil. This allows the controller to communicate with the ECU and read information even though the engine is not running.

Diagnostics mode is activated when the diagnostics timer expires, and continues until the stop button is pressed. To configure the timer and enable diagnostics, go to *Parameters* in the utility software, and select parameter 6701.

4.8.3 USW counters

You can view and adjust a number of counters using the USW. Click the **Σ** icon to open the counters window.

Generator core controller counters example



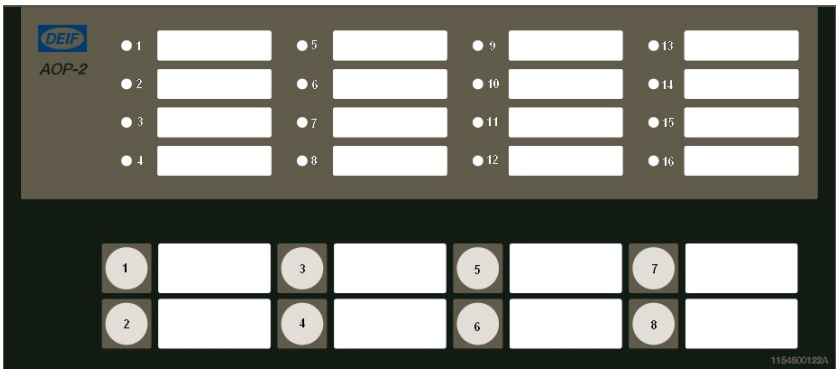
The **Import** counters show the ESS charged energy, while the **Export** counters show the ESS discharged energy.

Counters	Details
Operations	Breaker operations
Attempts	
Running hours	Genset running hours
Service1	
Service2	
Energy	Energy from the genset
ReEnergy	Reactive energy from the genset
Demands	
Pulse	
Fan	
M-logic event counters	

4.9 Interfaces

4.9.1 Additional operator panel, AOP-2

The AOP-2 is an additional operator panel that can be connected to the controller using a CAN bus communication port. It can be used as an interface to the controller for indication of status and alarms together, and with buttons for, for example, alarm acknowledge and mode selection.



The configurable LEDs are named 1 to 16, and the buttons are named 1 to 8.

CAN Node ID configuration

The CAN Node ID for the AOP-2 can be set to 1-9:

1. Press buttons 7 and 8 simultaneously to activate the CAN ID change menu. The LED for the present CAN ID number is ON, and LED 16 is flashing.
2. Use button 7 (increase) and button 8 (decrease) to change the CAN ID according to the table below.
3. Press button 6 to save the CAN ID and return to normal operation.

CAN ID	Indication of CAN ID selection
0	LED 16 flashes (CAN bus OFF)
1	LED 1 ON. LED 16 flashes (default value).
2	LED 2 ON. LED 16 flashes.
3	LED 3 ON. LED 16 flashes.
4	LED 4 ON. LED 16 flashes.
5	LED 5 ON. LED 16 flashes.

Programming

Use the utility software to program the AOP-2. See the **Help** in the utility software.

4.9.2 Access lock

With the access lock on, the operator cannot change controller parameters or running modes. The input to be used for the access lock function is defined in the utility software.

Access lock is typically activated from a key switch installed behind the door of the switchboard cabinet. As soon as access lock is activated, changes from the display cannot be made.

Access lock only locks the display and does not lock any AOP or digital input. AOP can be locked by using M-Logic. It is still possible to read all parameters, timers and the state of inputs in the service menu.

You can read alarms, but not acknowledge them when access lock is activated. Nothing can be changed from the display.

This function is ideal for rental or critical equipment. The operator cannot change anything. If there is an AOP-2, the operator is still able to change up to 8 different predefined things.

4.9.3 Language selection

The controller can show several languages. The default master language is English, which cannot be changed. Different languages can be configured with the utility software.

`Basic settings > Controller settings > Language`

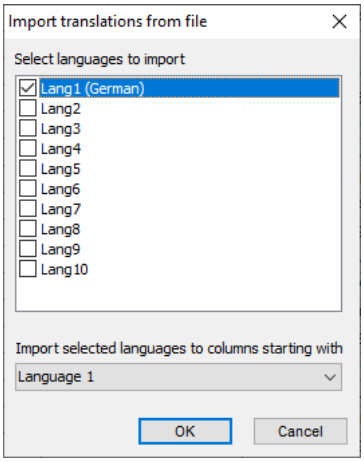
Parameter	Text	Range	Default
6081	Language selection	English Language [1 to 11]	English

4.9.4 Translations

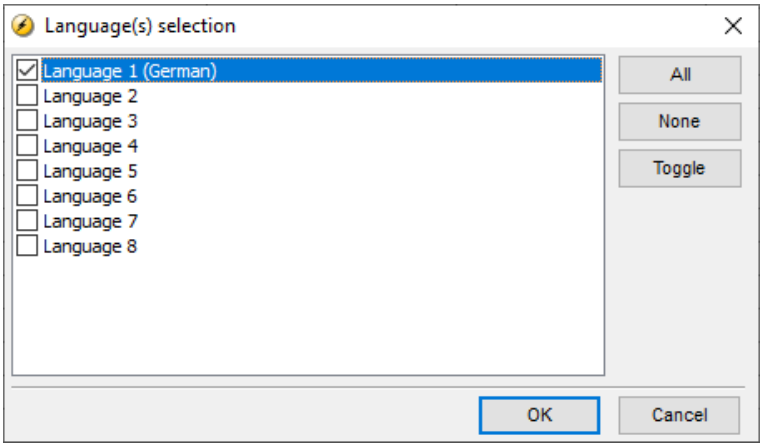
You can translate and customise the text in the controller with the utility software.

Translate the text in the controller

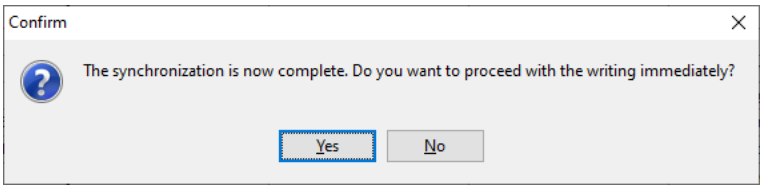
1. Go to the *Translations* tab in the left toolbar.
2. Click the *Import translations from file* icon.
3. From the pop-up window, select the language file you want to import.
4. Select the language to import (lang1), and select the column to import the translations to.



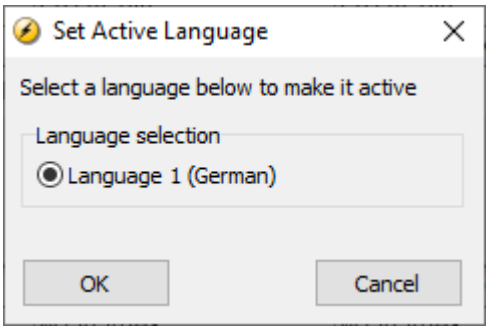
5. Once the translations are imported, you might get a warning stating that *Some translations were not imported*. Click *OK*.
6. To write the imported translations to the controller, click the *Write to controller* icon.
7. In the pop-up window, select the language you want to write to the controller.



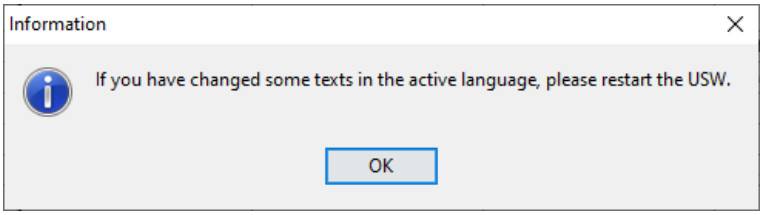
8. Click *OK*.
9. Select *Yes* to confirm you want to continue the writing procedure.



10. In the pop-up window, select the language you want to activate and click *OK*.



11. Click the *OK* button on the information message and if necessary, restart the utility software.



12. The text in the controller is now updated.

Customise the translations

To customise the translations, click on the cell with the text you want to edit. You can now edit the text. The text is automatically saved when you have finished editing.

You can also double-click on the phrase or word you want to edit in the *Master language* column. In the pop-up window, you can edit that particular phrase for all the language columns.

Change the placement of the translations

1. Select the *Edit language sequence* icon.
2. From the list on the left, select the language you want as the first in the sequence (after the master language), and click the > button to move the selected language.
3. Repeat step 2 for the remaining languages in the current sequence.
4. To change the position of a language in the new sequence, click on the language you want to move, and use the *Up* and *Down* buttons to move the language.
5. Click *OK* when you have finished.

NOTE You cannot edit the Master language.

5. Engine functions

5.1 Engine sequences

The engine START and STOP sequences are started automatically in EDG if:

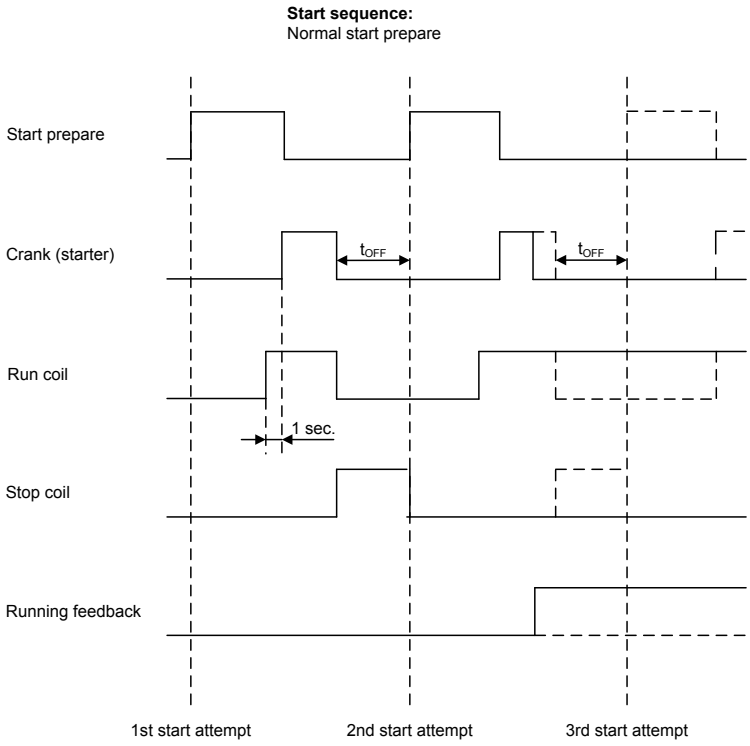
- AUTO mode is selected.
- MANUAL mode: The command is selected.
  - Only the selected sequence is started. For example, when the *START* button is pressed, the engine starts.

5.2 Engine start functions

5.2.1 Start sequence

Normal start prepare or extended start prepare are the possible start sequences for the engine. In both cases, the running coil is activated 1 s before the start relay (starter).

Normal start prepare sequence



The run coil opens between the start attempts, because the run coil type is set to pulse. When the engine receives running feedback, the run coil is closed until the stop sequence is started. If the run coil type is set to continuous, the run coil is closed between the start attempts until start failure, or the stop sequence opens it.

`Engine > Start sequence > Before crank > Run coil`

Parameter	Text	Range	Default
6151	Run coil delay	0.0 to 600.0 s	1.0 s
6152	Run coil type	Pulse Continuous	Pulse

Engine > Start sequence > Before crank > Start prepare

Parameter	Text	Range	Default
6181	Start prepare	0.0 to 600.0 s	5.0 s
6182	Ext. start prepare	0.0 to 600.0 s	0.0 s

Double starter

In some emergency installations, the prime mover is equipped with an extra start motor. Dependent on the configuration, the double starter function can toggle between the two starters or try several attempts with the standard starter before switching to the *double starter*. The function is set up in parameters 6191 and 6192, and a relay for cranking with the alternative starter is chosen in the *I/O & Hardware setup*.

Engine > Start sequence > Crank > Start attempts

Parameter	Text	Range	Default
6191	Starter attempts	1 to 100	3
6192	Double starter	0 to 10	0

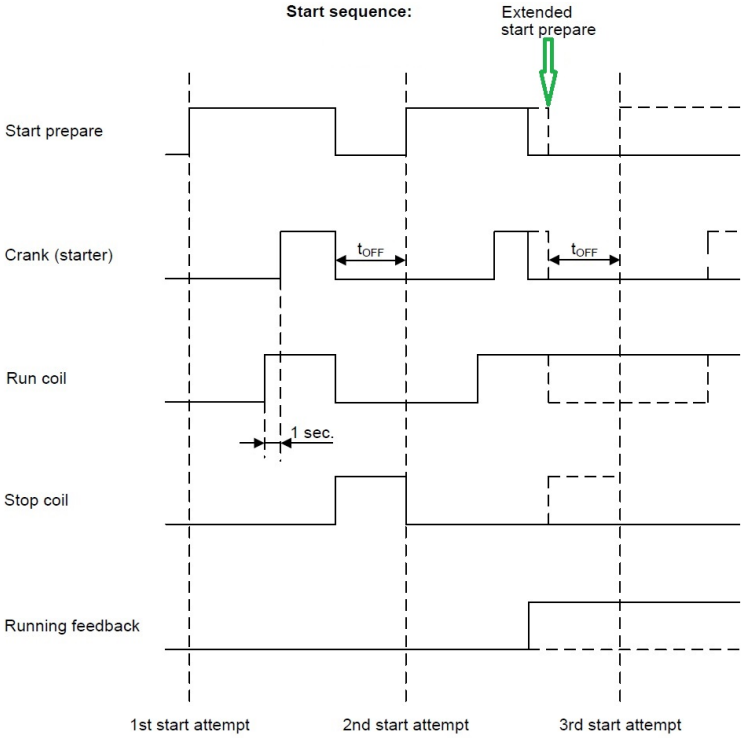
Choose a value that is more than zero in parameter 6192. This value determines the amount of attempts on each starter before switching to the next. The standard starter has first priority. When the maximum allowed number of attempts is reached, the start attempts stop and the alarm Start failure appears. Select the maximum number of attempts with parameter 6191.

- A value of 1 in parameter 6192 results in a toggle function with 1 attempt on each starter between toggling.
- A value of 2 in parameter 6192 results in a toggle function with 2 attempt on each starter between toggling.

Engine > Start sequence > Crank > Crank timers

Parameter	Text	Range	Default
6183	Start ON time	1.0 to 600.0 s	5.0 s
6184	Start OFF time	1.0 to 99.0 s	5.0 s

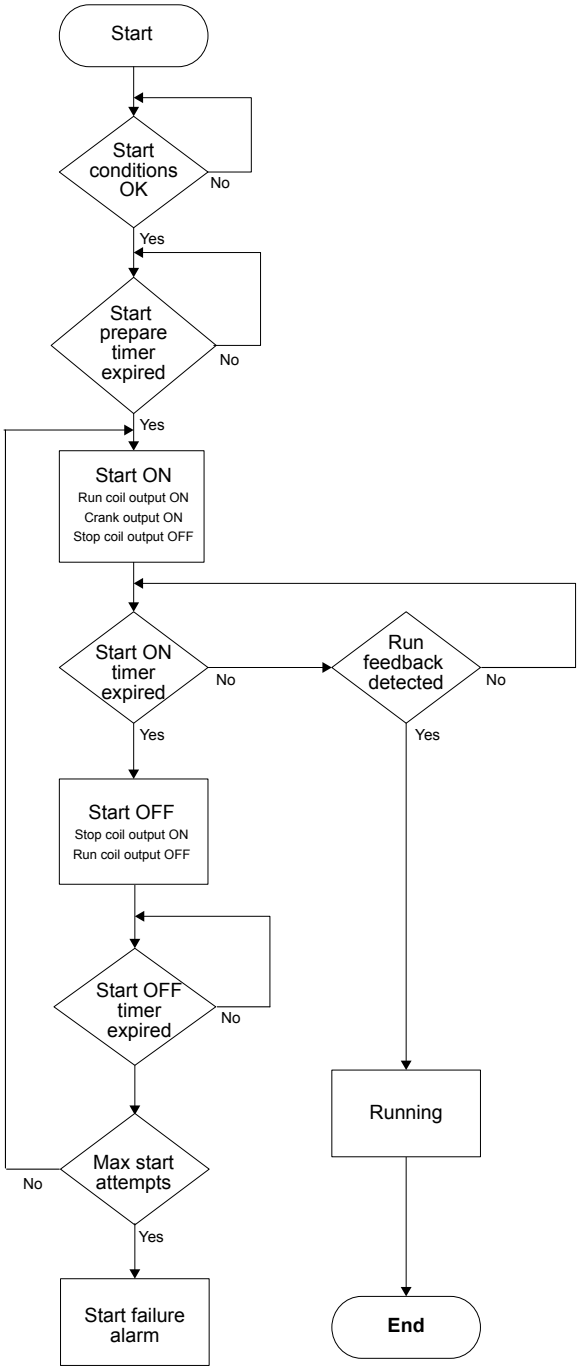
Extended start prepare sequence



You can activate the run coil 0 to 600 s before crank (starter) is executed. In this example, the timer is set to 1.0 s.

The extended start prepare function keeps the start prepare relay closed until remove starter or running detection is reached. This function is helpful if booster pumps for start fuel are used, because they are kept on until the engine is running.

Start sequence flowchart



5.2.2 Start sequence conditions

The start sequence initiation is controlled by these multi-input conditions:

- RMI oil pressure
- RMI water temperature
- RMI fuel level
- RMI Custom
- Binary input

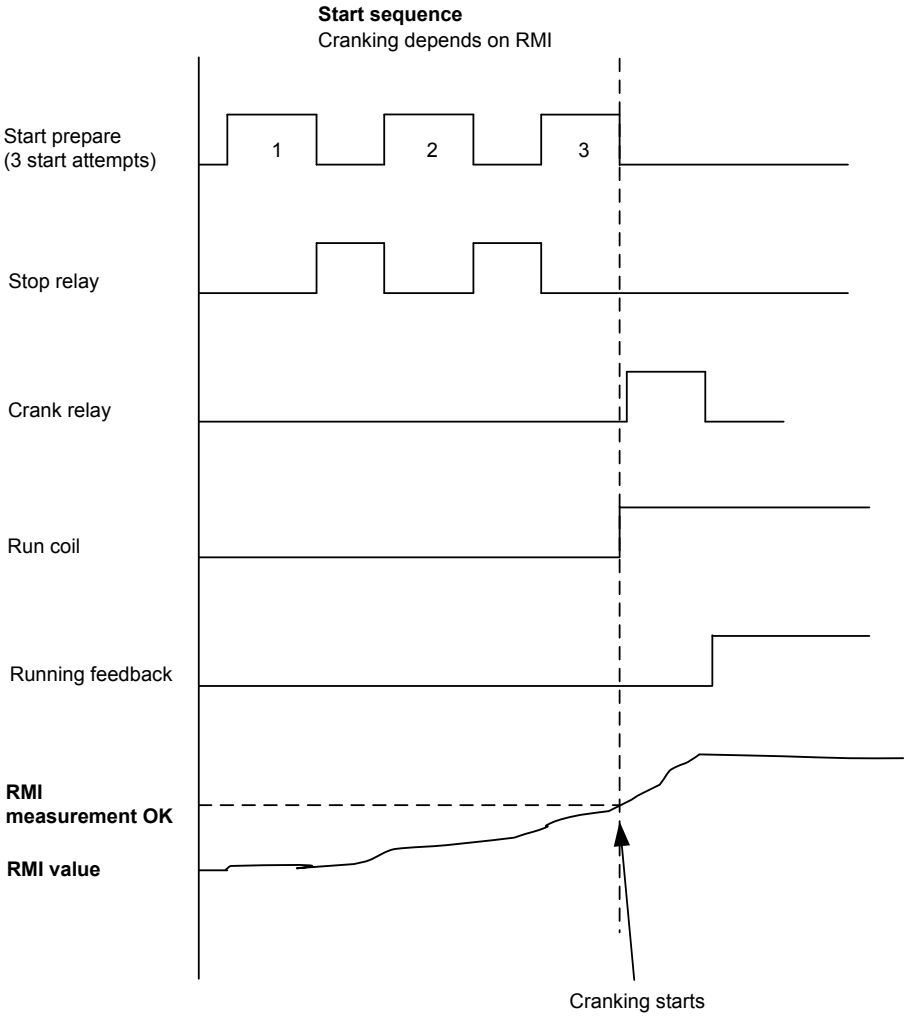
This means that if, for example, the oil pressure is not primed to the sufficient value, the crank relay will not engage the starter motor.

You can only configure these multi-input conditions with the utility software.

More information
See Inputs and outputs for how to configure the inputs.

If the binary start threshold is used, the input is chosen from the I/O list in the utility software.

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

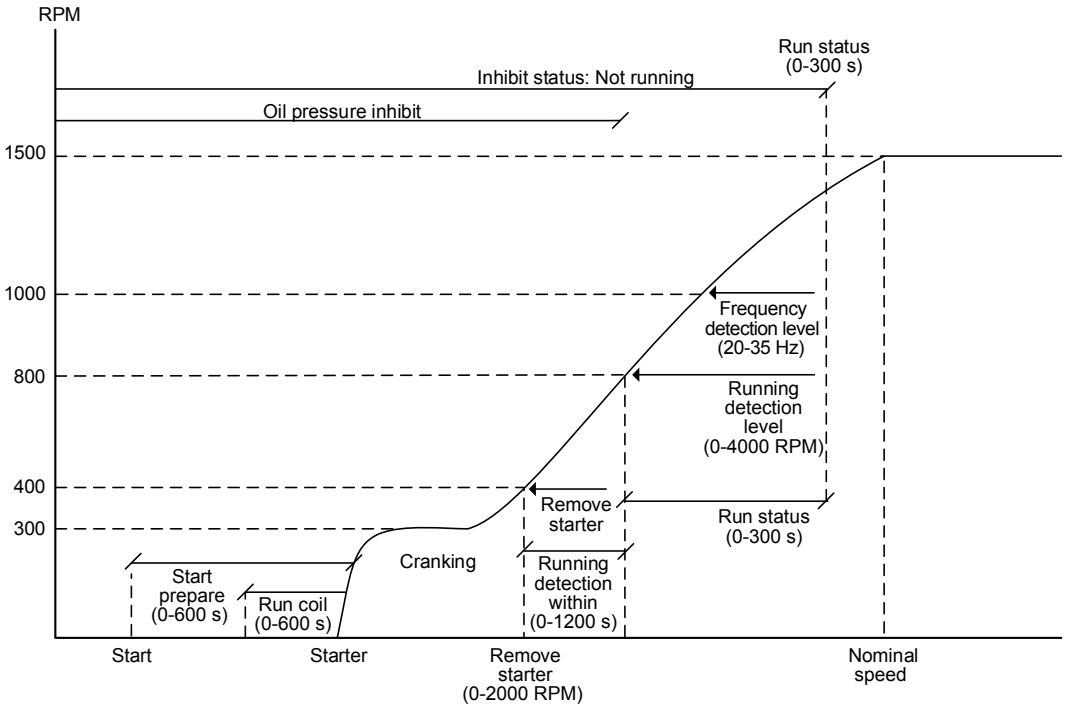


The start is initiated as soon as the start threshold limit is reached. By default, the controller waits until the start prepare timer is over and the start threshold conditions are correct before the crank relay/start is initiated. You can configure this in parameter 6185. You can change the start prepare type to interrupt start prepare, which means the controller is permitted to interrupt the start prepare and initiate the start when the start threshold conditions are correct.

`Engine > Start sequence > Before crank > Start threshold`

Parameter	Text	Range	Default
6185	Start threshold type	Multi-input [20 to 23]	Multi-input 20
6186	Start threshold	0.0 to 300.0	0.0

5.2.3 Start-up overview



Set points related to the start sequence

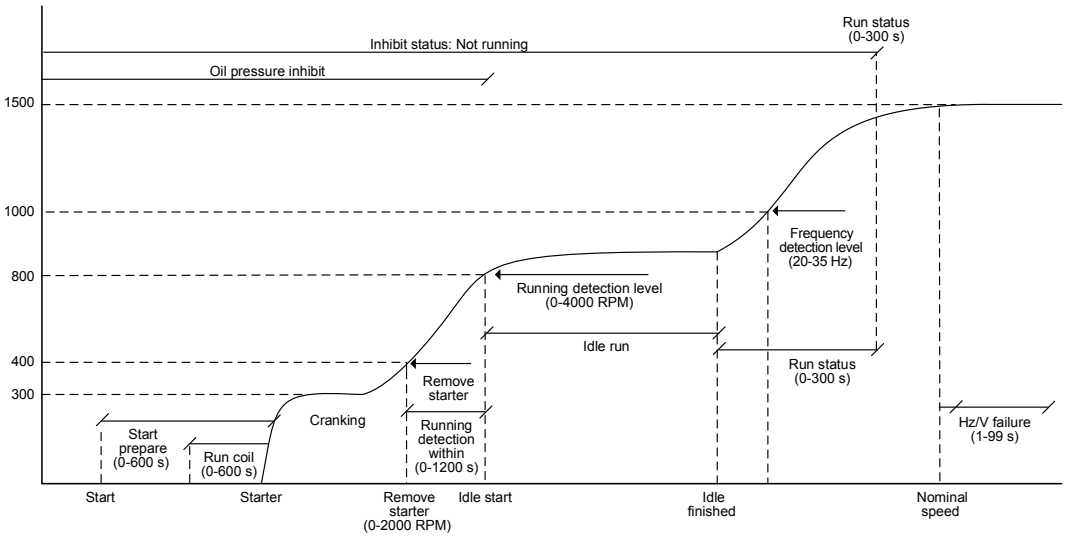
Parameter	Text	Description
6181	Start prepare	Start prepare is used for start preparation, for example pre-lubrication or pre-glowing. The start prepare relay is activated when the start sequence is initiated, and deactivated when the start relay is activated. If the timer is set to 0.0 s, the start prepare function is deactivated.
6182	Extended prepare	Extended prepare activates the *Start prepare* relay when the start sequence is initiated. The relay is activated 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.
6183	Start ON time	The starter is activated for this period when cranking.
6184	Start OFF time	The pause between two start attempts.
6151	Run coil timer	The timer for the run coil is a set point for how long the run coil will be activated before cranking the engine. This gives the ECU time to start up before cranking.
6174	Remove starter	The starter is removed, when the RPM set point is reached. This function is only active if the running detection type is configured as either MPU or EIC RPM. For MPU, if the configured number of teeth is 0, the controller calculates the genset speed from the frequency.
6173	Running detection RPM level	The set point defines the running detection level in RPM (only when the running detection type is configured as either MPU or EIC RPM).
6351	Run detection	This timer is set to make sure that the engine goes from the RPM level, Remove starter and Running detection level (only when the running detection type is configured as either MPU or EIC RPM). If other running detection types than MPU or EIC RPM are used, the starter is ON until the frequency detection level is reached. If the timer is exceeded, and the level is not reached, the start sequence is repeated, using a start attempt. If all start attempts are used, the *Start failure* alarm is activated.
6160	Run status	The timer starts when the running detection/frequency detection level is reached.

Parameter	Text	Description
		When the timer runs out, the *Not running* inhibit is deactivated, and the running alarms and failures are enabled.

Alarms related to the start sequence

Parameter	Text	Description
4530	Crank failure alarm	This alarm is activated, if MPU is configured as the primary running feedback and the specified RPM is not reached before the delay has expired.
4540	Run feedback failure alarm	This alarm is activated, if there is a failure on the primary running feedback. For example, if the primary running feedback is configured to digital input without running detection, and an active secondary running feedback detects the engine to be running. The delay to be set is the time from the secondary running detection until the alarm is activated.
4560	Hz/V failure alarm	This alarm is activated, if the frequency and voltage are not within the limits configured in Blackout df/dUmax, after the running feedback is received.
6352	Engine externally stopped	This alarm is activated, if the running sequence is active and the engine is below the running detection and frequency detection level without any command from the controller.

Start up overview with idle run



The set points and alarms are the same as above, except for the idle run function.

More information
See Idle running.

5.2.4 Start functions

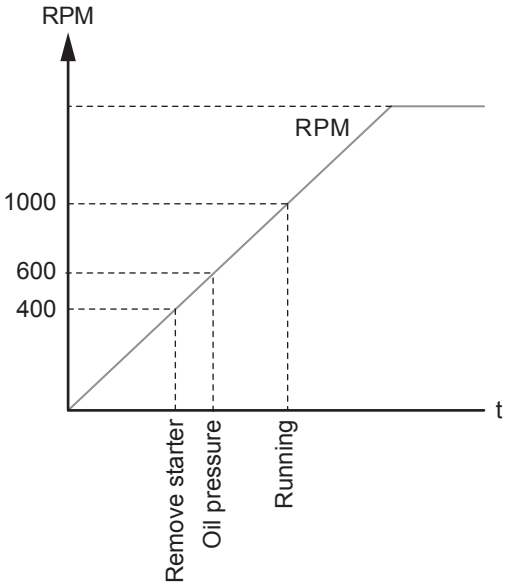
The controller starts the engine when the start command is given. The start sequence is deactivated when the remove starter event occurs or when the running feedback is present.

The reason for having two possibilities to deactivate 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. However, 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 the engine shuts down if the specific alarm is activated at the preset 400 RPM. In that case, the running feedback must be activated at a higher number of revolutions than 600 RPM.

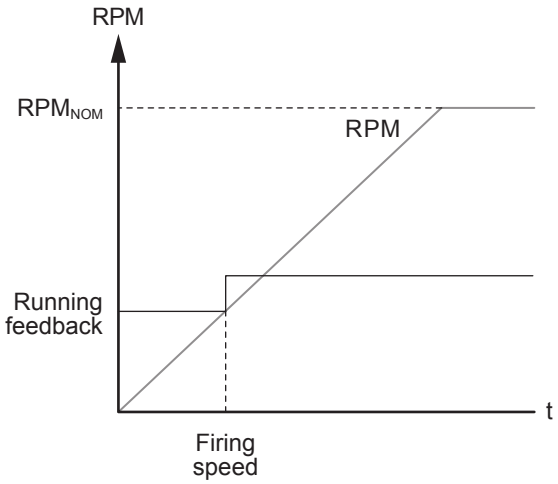


5.2.5 Digital feedbacks

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

Running feedback

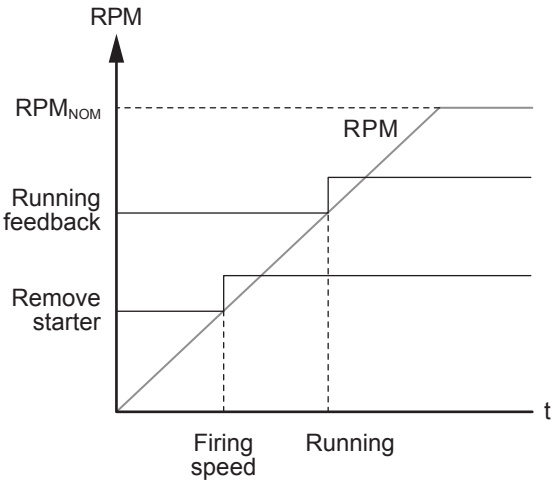
When the digital running feedback is active, the start relay is deactivated and the starter motor will be disengaged.



The diagram shows 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 shows 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.

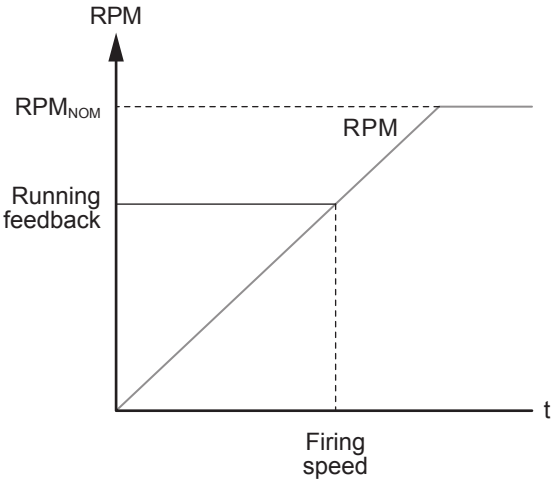
NOTE The remove starter input must be configured from a number of available digital inputs.

5.2.6 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.

Running feedback

The diagram shows how the running feedback is detected at the firing speed level. The factory setting is 1000 RPM.



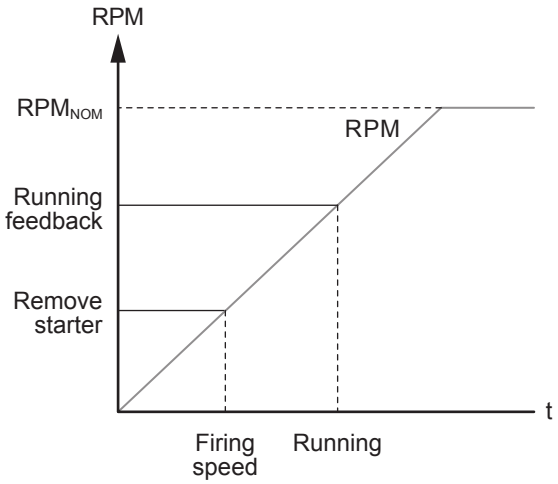
CAUTION

Caution

The factory setting of 1000 RPM is higher than the RPM level of typical starter motors. Adjust the setting to a lower value to avoid damage of the starter motor.

Remove starter input

The diagram shows how the set point of the remove starter is detected at the firing speed level. The factory setting is 400 RPM.



The number of teeth on the flywheel must be configured when the MPU input is used. If zero, for the remove starter function, the controller calculates the speed from the genset frequency.

`Engine > Start sequence > After crank > Remove starter`

Parameter	Text	Range	Default
6174	Remove start	1 to 2000 RPM	400 RPM

NOTE The *Remove starter* function can use the MPU or a digital input.

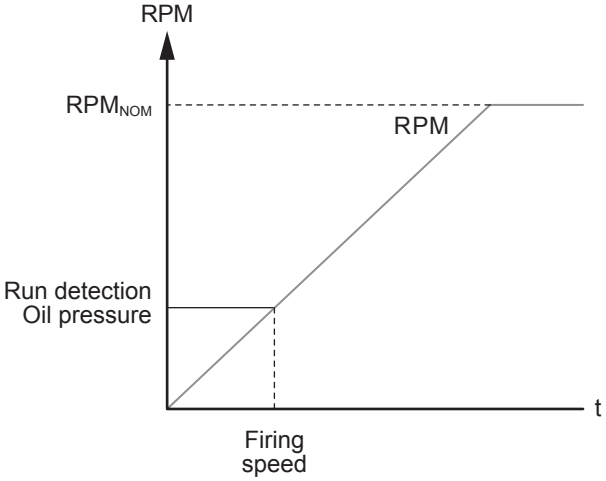
5.2.7 Oil pressure

The multi-inputs on terminals 20, 21, 22 and 23 can be used for the detection of running feedback. The terminal in question must be configured as an RMI input for oil pressure measurement. This is done with the utility software:

1. Select *I/O & Hardware setup* tab.
2. Select the relevant multi-input tab.
3. For *Input type*, select *RMI oil pressure*.

When the oil pressure increases above the adjusted value, running is detected, and the start sequence is ended.

Running feedback



More information
See **Running feedback** for how to configure the parameters.

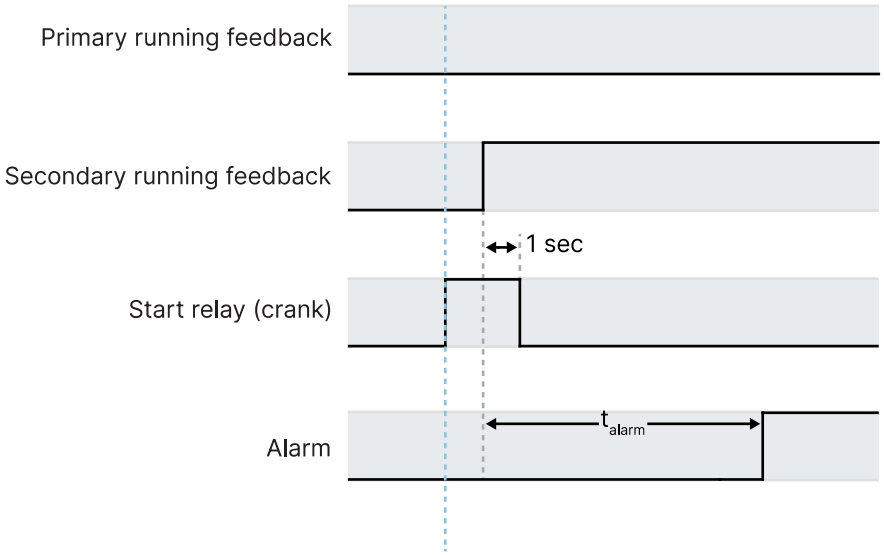
5.3 Running feedback

The controller uses running feedback to detect whether the engine is running:

- A digital input
- RPM, measured by magnetic pick-up (set point 0 to 4000 RPM)
- EIC
- Frequency measurement (20 to 35 Hz)

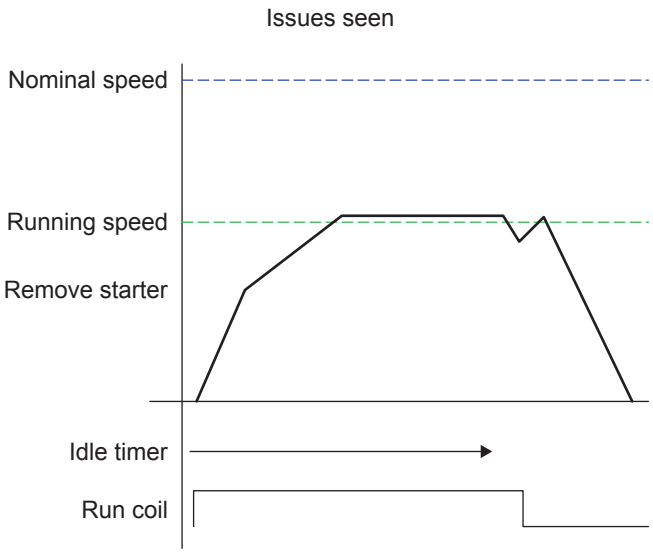
The selected running feedback is the primary feedback. However, all available running feedback is used for running detection. If the primary running feedback does not detect any running feedback, the starter relay stays activated for one additional second.

5.3.1 Start sequence running feedback



- If a running feedback is detected based on one of the secondary choices, the engine will start.
- If no running feedback is detected, the start sequence is interrupted.
- In parameter 6176 you can configure a delay time, before the start sequence is stopped.

5.3.2 Not running delay time



The engine will still be functional, even though a tacho sensor is damaged or dirty.

As soon as the engine is running, the running detection will be based on all available types.

5.3.3 Interruption of the start sequence

The start sequence is interrupted in the following situations:

Event	Notes
Start failure	
Remove starter feedback	Tacho set point.
Running feedback	Digital input.
Running feedback	Tacho set point.
Running feedback	Frequency measurement is between 30.0 and 35.0 Hz. The frequency measurement requires a voltage measurement of 30 % of U_{NOM}. The running detection based on the frequency measurement can replace the running feedback based on tacho or digital input or engine communication.
Running feedback	Oil pressure set point.
Running feedback	EIC (engine communication).
Emergency stop	
Alarm	Alarms with Shutdown or Trip and stop fail class.
Stop button on the display	**Single genset**: LOCAL mode. **Emergency genset**: MANUAL mode.
Modbus stop command	**Single genset**: REMOTE mode. **Emergency genset**: MANUAL mode.
Digital stop input	**Single genset**: REMOTE mode. **Emergency genset**: MANUAL mode.
Running mode	It is not possible to change the running mode to Block as long as the genset is running.

`Engine > Running detection`

Parameter	Text	Range	Default
6171	Number of teeth	0 to 500 teeth	0 teeth*
6172	Run detect type	Binary input MPU input Frequency EIC Multi-input 20 to 23	Frequency
6173	Running detection	0 to 4000 RPM	1000 RPM
6175	Oil pressure level	0.0 to 150.0 bar	0.0 bar
6176	Not running delay	0.0 to 5.0 s	0.0 s

NOTE * If there is no MPU (that is, parameter 6171 is 0), the controller calculates the genset speed from the frequency. This value is used for the remove starter function, and the overspeed and underspeed protections.

5.3.4 MPU wire break

The MPU wire break function is only active when the engine is not running. In this case, an alarm is activated if the wire connection between the controller and the MPU breaks. The MPU wire alarm is activated, when there is more than 400 kΩ.

Engine > Running detection > MPU wirebreak

Parameter	Text	Range	Default
4551	MPU sensor type	Tacho sensor Hall sensor*	Tacho sensor
4552	MPU wirebreak	Fail classes	Warning

NOTE * There is no wire break on a Hall sensor.

5.3.5 D+ (Charger generator fail)

When the D+ function is enabled, the start relay is deactivated. The D+ turns off when the start disengages. The alarm is activated if there is no D+ feedback from the charging alternator after the delay time runs out.

Engine > Running detection > Charger Gen fail

Parameter	Text	Range	Default
4990	Set point	5.50 to 30.00 V	6.00 V
	Timer	0.0 to 999.0 s	10.0 s
	Output A	Relays and M-Logic	Not used
	Output B	Relays and M-Logic	Not used
	Enable	OFF ON	OFF
	Fail class	Fail classes	Warning

Engine > Start sequence > After crank > Remove starter

Parameter	Text	Range	Default
6174	Remove starter	1 to 2000 RPM	400 RPM

5.3.6 Running output

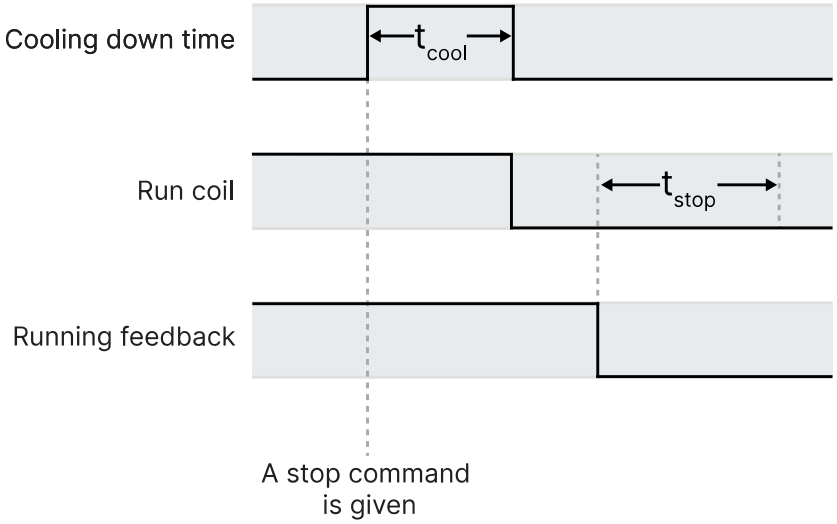
The run status timer can be configured to activate a digital output when the engine is running.

Configure the run status under `Functions > Run status` (parameter 6160). Configure the timer for the time that running detection must be present before *Run status* is activated. If the timer for run status is changed, it also affects the alarm inhibit for *Not run status*.

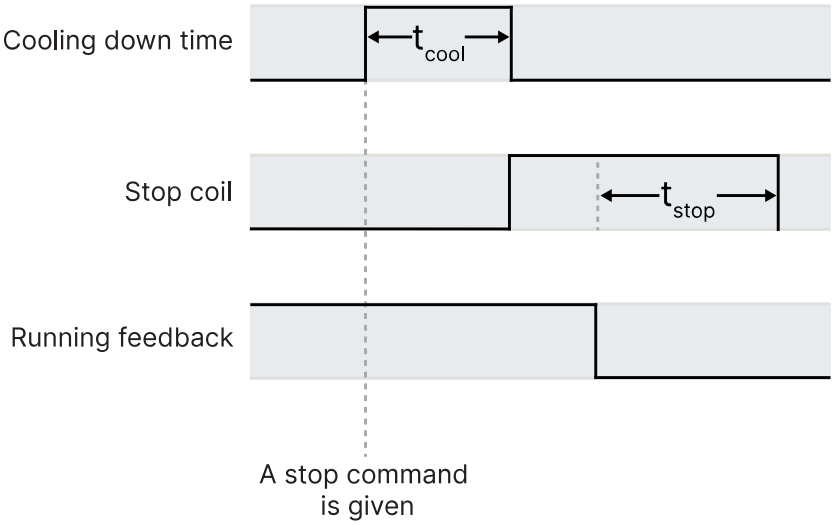
5.4 Engine stop functions

5.4.1 Stop sequence

Stop sequence: Run coil



Stop sequence: Stop coil



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

`Engine > Stop sequence > Cooldown`

Parameter	Text	Range	Default
6211	Cooldown time	0 to 9900 s	240 s

5.4.2 Stop sequence commands for the generator

Description	Cooling down	Stop	Notes
AUTO mode stop	●	●	
Trip and stop alarm	●	●	
Stop button on the display	(●)	●	**Single genset**: LOCAL mode. **Emergency genset**: MANUAL mode. Cooling down is interrupted if the *Stop* button is activated twice.
Emergency stop		●	GB opens and engine shuts down.

Interruption of the stop sequence can only occur during the cooling down period. If the status of the genset is engine stopping, then starting a new start sequence is only possible when the genset is stopped.

Interruption of the cool down period can occur in these situations:

Event	Notes
Main busbar failure	**Emergency genset**: AUTO mode selected.
Start button is pressed/remote command is given	**Emergency genset**: MANUAL mode: Engine will run at idle/nominal speed.
Digital start input	**Emergency genset**: MANUAL mode
GB close button is pressed/remote command is given	**Emergency genset**: MANUAL mode

5.4.3 Set points related to the stop sequence

`Engine > Stop sequence > Stop failure`

Parameter	Text	Range	Default
4580	Stop failure timer	10.0 to 120.0 s	30.0 s
	Stop failure, Output A	Relays and M-Logic	Not used
	Stop failure, Output B	Relays and M-Logic	Not used
	Activation of the stop failure alarm	OFF ON	ON
	Stop failure alarm fail class	Fail classes	Shutdown

`Engine > Stop sequence > Extended stop`

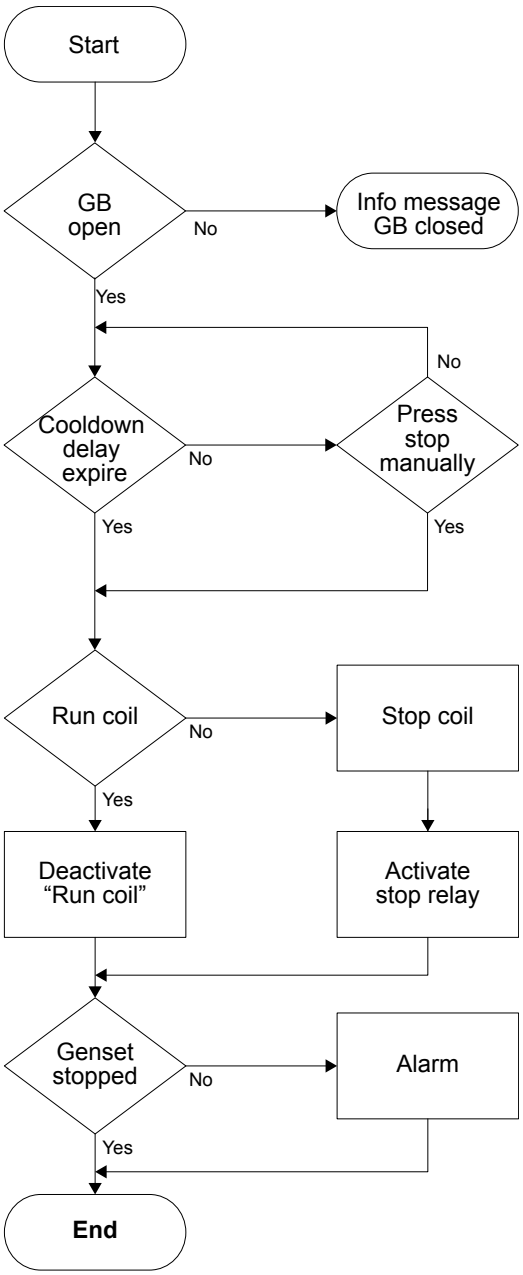
Parameter	Text	Range	Default
6212	Extended stop time	0 to 300.0 s	5.0 s

`Engine > Stop sequence > Stop threshold`

Parameter	Text	Range	Default
6213	Stop threshold type	Multi input 20 to 23 M-Logic EIC temp. inputs	Multi input 20
6214	Stop threshold	0 to 482 °	0 °

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

5.4.4 Stop sequence flowchart



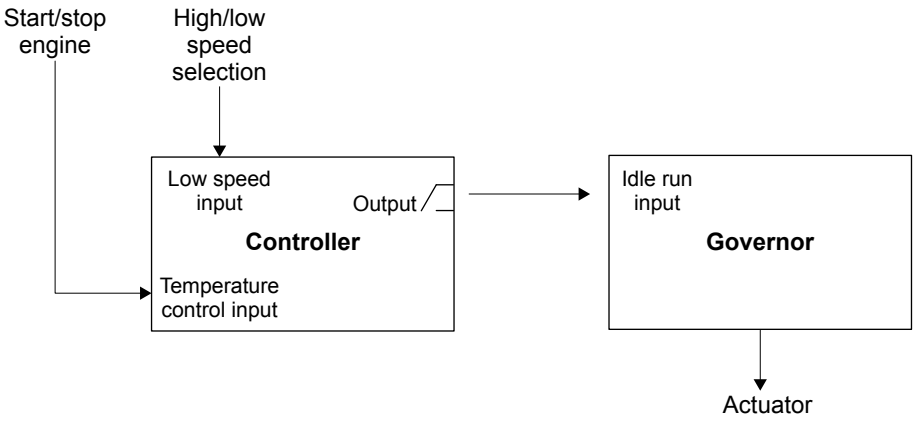
5.5 Idle running

Idle running changes the start and stop sequences so the engine can run at low temperature conditions.

The function is typically used in installations where the engine has to operate at low temperatures. This can cause starting problems or damage the engine. You can also use the function when the engine has to run at low RPM until a specified temperature is reached.

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

You must prepare the speed governor for the idle run function using a digital signal from the controller.



When the function is enabled, two digital inputs are used for control purposes:

1. Low speed input. This input is used to change between idle speed and nominal speed. This input does not prevent the engine from stopping. It is only a selection between idle and nominal speed.
2. Temperature control input. When this input is activated, the engine starts. It is not able to stop as long as this input is activated.

You can use the low speed input together with a timer to select the idle run function. If an input and a timer are used at the same time, the digital input is prioritised. For example, if the idle run function is activated with the low speed input and the start timer is enabled, the idle run function is still active if the timer expires before the digital input is deactivated.

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

`Engine > Start sequence > Idle run`

Parameter	Text	Range	Default
6291	Idle start timer	0.0 to 999.0 min	300.0 min
6292	Idle start enable	OFF ON	OFF
6295	Output A	Relays and M-Logic	Not used
6296	Enable idle run	OFF ON	OFF

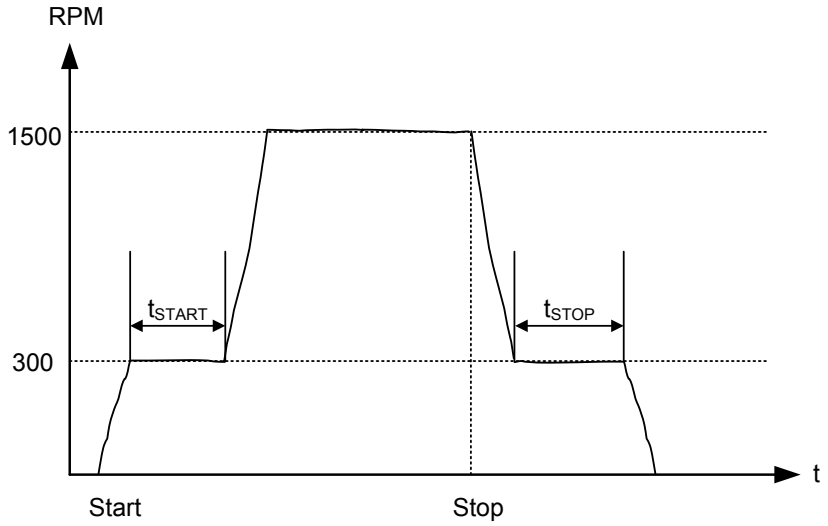
`Engine > Stop sequence > Idle stop`

Parameter	Text	Range	Default
6293	Stop timer	0.0 to 999.0 min	300.0 min
6294	Enable stop	OFF ON	OFF

Examples

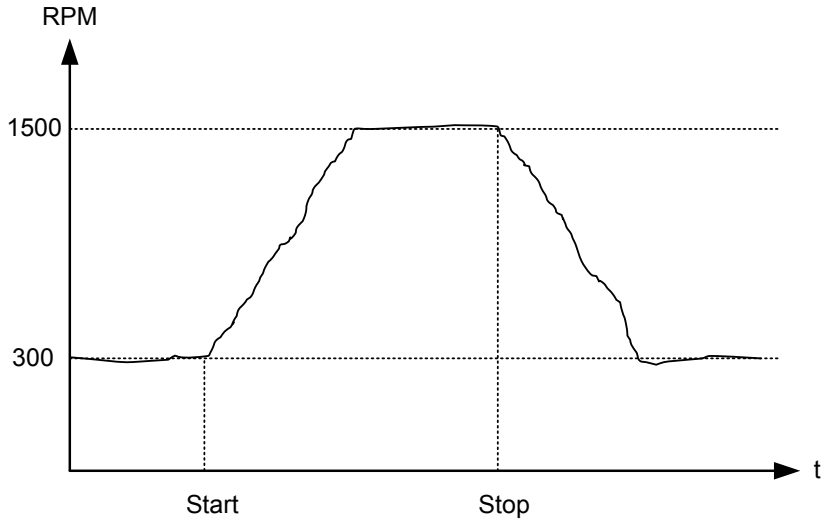
Idle speed during starting and stopping

- Both the start and the stop timers are activated.
- The start and stop sequences are changed to let the engine stay at the idle level before speeding up.
- It also decreases the speed to the idle level for a specified delay time before stopping.



Idle speed with a digital input configured to low speed

- The idle speed with low speed activated runs in idle speed until the low speed input is deactivated, and then the engine regulates to nominal values.
- To prevent the engine from stopping, then the digital input *Temp control* must be left ON at all times. The engine speed-time curve then looks like this:



NOTE The oil pressure alarm (RMI oil) is enabled during idle run if set to ON.

5.5.1 Temperature-dependent idle start-up

This is an example of a system that will start up in idle run, if the coolant temperature is below a specified value. When the temperature exceeds the specified value, the engine will ramp up to nominal values.

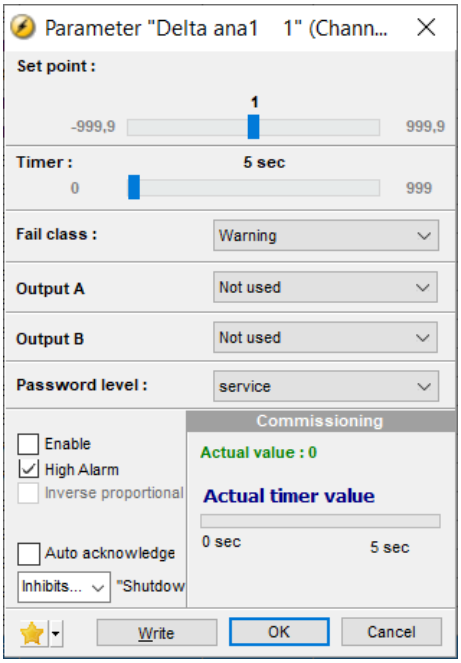
For this function to work, you must turn idle running ON and configure the digital output.

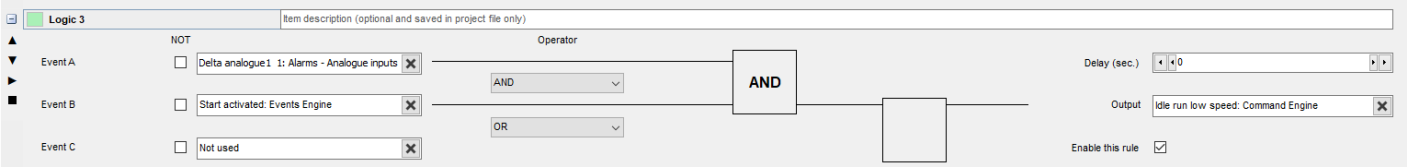
`Engine > Start sequence > Idle run`

Parameter	Text	Range	Set value to
6295	Idle active	OFF ON	ON

Example

The function uses delta analogue 1 (parameters 4601, 4602, 4610 and 4620) and one M-Logic line. After starting, when the coolant temperature is below 110 °C, the controller idles. Once the temperature reaches 110 °C, the controller automatically ramps up to full speed.





5.5.2 Inhibit

The alarms that are deactivated by the inhibit function are inhibited in the usual manner, except for the oil pressure alarms, RMI oil 20, 21, 22 and 23. These alarms are active during Idle run as well.

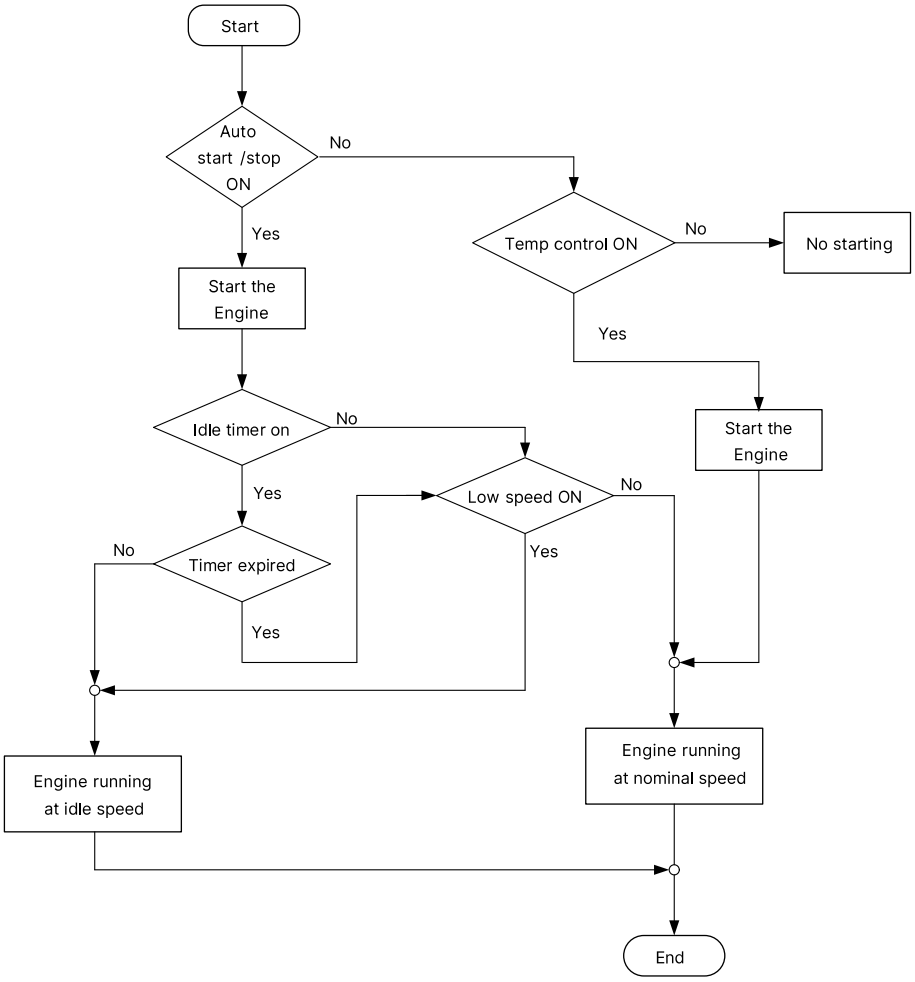
5.5.3 Running signal

You must activate the running feedback when the engine is running in idle mode.

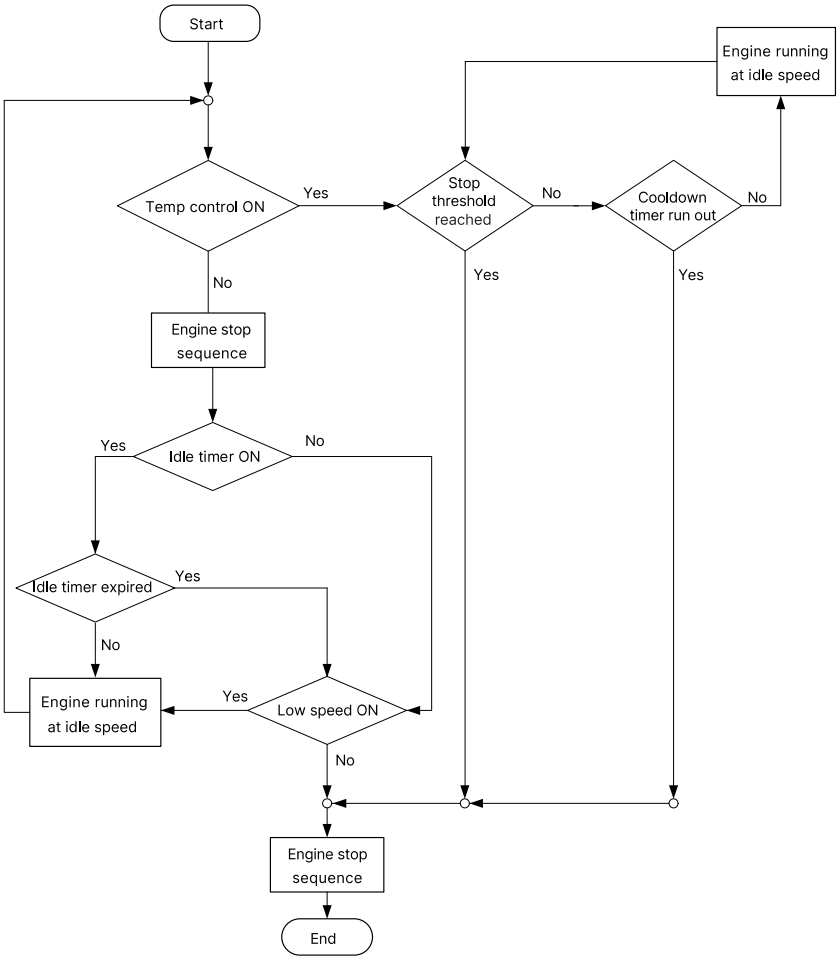
5.5.4 Idle speed flowcharts

The flowcharts show the start and stop of the engine by the inputs *Temp control* and *Low speed*.

Start flowchart



Stop flowchart



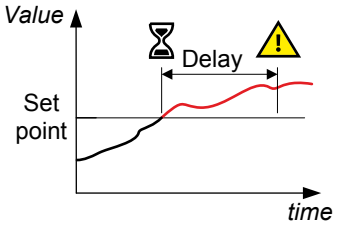
5.6 Engine protections

Protection	IEC symbol (IEC 60617)	ANSI (IEEE C37.2)	Operate time	Alarms
Over-speed	-	12	-	2
Under-speed	-	14	-	1

5.6.1 Overspeed

These alarms alert the operator that the engine is running too fast.

The alarm response is based on the engine speed as a percentage of the nominal speed. If the engine speed rises above the set point for the delay time, the alarm is activated.



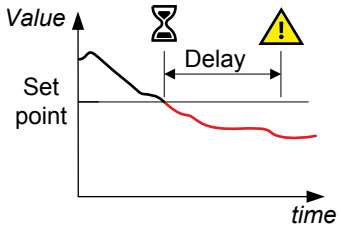
Engine > Protections > RPM-based protections > Overspeed > Overspeed [1 or 2]

Parameter	Text	Range	Overspeed 1	Overspeed 2
4510 or 4520	Set point	100 to 150 %	110 %	120 %
	Timer	0 to 3200 s	5 s	1 s
	Output A	Relays and M-Logic	Not used	Not used
	Output B	Relays and M-Logic	Not used	Not used
	Enable	OFF ON	OFF	OFF
	Fail class	Fail classes	Warning	Shutdown

5.6.2 Underspeed

This alarm alerts the operator that the engine is running too slowly.

The alarm response is based on the engine speed as a percentage of the nominal speed. If the engine speed drops below the set point for the delay time, the alarm is activated.



Engine > Protections > RPM-based protections > Underspeed > Underspeed

Parameter	Text	Range	Default
4590	Set point	50 to 100 %	90 %
	Timer	0 to 3200 s	5 s
	Output A	Relays and M-Logic	Not used
	Output B	Relays and M-Logic	Not used
	Enable	OFF ON	OFF
	Fail class	Fail classes	Warning

5.6.3 EIC Overspeed

EIC overspeed (parameter 7600) alarm can be activated on the ECU & D-AVR configuration tab on the left menu in the USW.

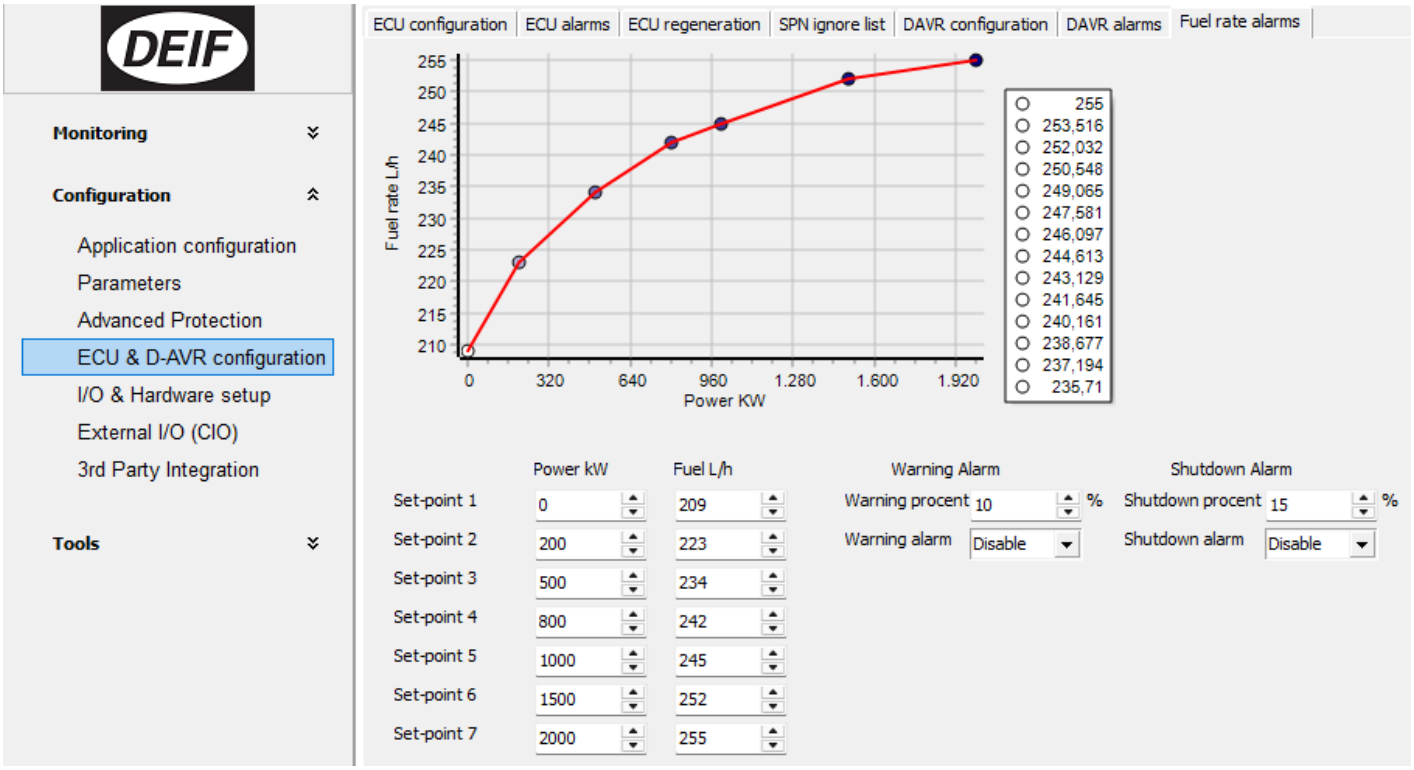
5.7 Fuel rate alarm

To ensure that the fuel consumption remains within the expected range, the controller has alarms for the fuel rate.

The fuel rate function lets you configure the expected fuel use relative to the generator power. If the fuel rate is above the expected range, the controller can activate alarms. The controller uses the fuel rate from the ECU.

Use the utility software to configure the fuel rate-power curve. You can define the ranges that activate the warning alarm and shutdown alarm.

ECU & DAVR configuration > Fuel rate alarms



5.8 Engine communication

The controller supports J1939 and can communicate with any engine that uses generic J1939. In addition, the controller can communicate with a wide range of ECUs and engines.

More information
See **iE 150 AGC 150 Engine communication** for a full list of supported ECUs and engines, along with detailed information for each protocol.

Exhaust after-treatment (Tier 4/Stage V)

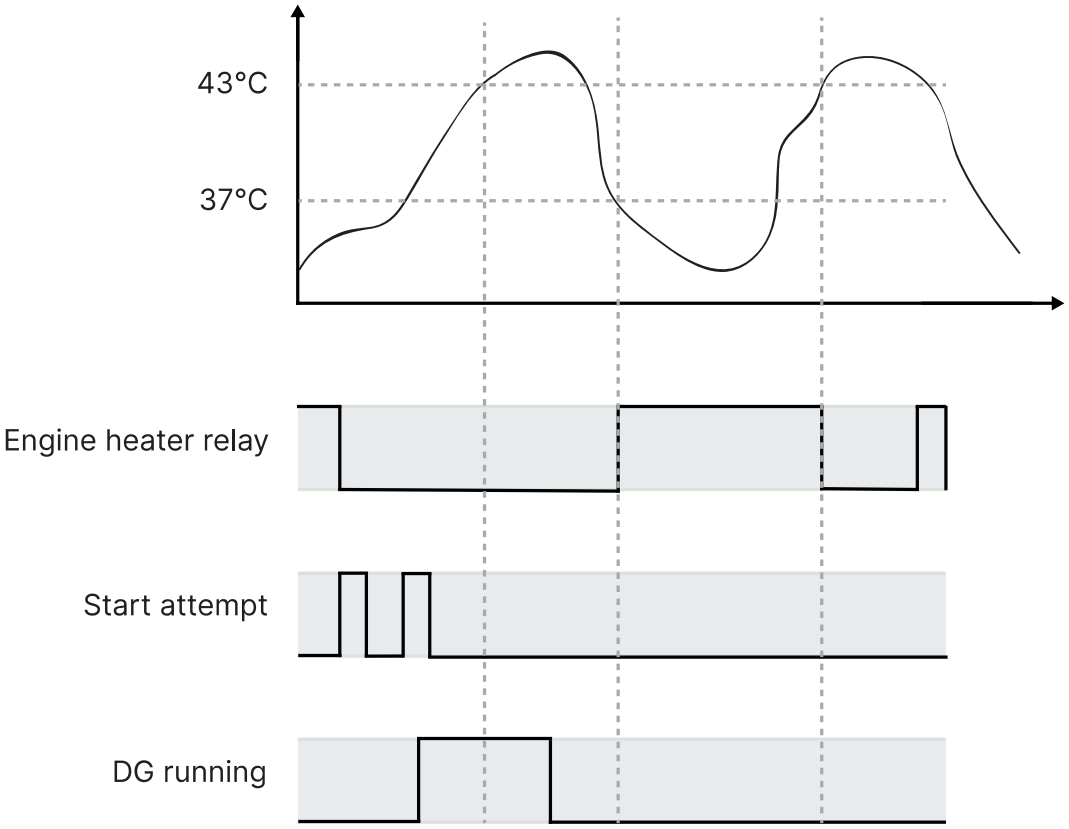
The controller supports Tier 4 (Final)/Stage V requirements. It provides monitoring and control of the exhaust after-treatment system, as required by the standard.

More information
See the **Operator's manual** for a description of the exhaust after-treatment.

5.9 Engine pre-heater

This function is used to control the temperature of the engine. A temperature sensor is used to activate an external heating system to keep the engine at a minimum temperature. This function is only active when the engine is stopped.

Example: Engine pre-heater sequence



The function includes a set point and a hysteresis. In the example, the set point is 40 °C with a hysteresis of 3 °C. The controller opens the engine heater relay when the engine has reached 43 °C, and closes when the engine temperature is 37 °C.

A relay must be chosen for the engine heater. If a slave relay of the chosen relay is wanted, this can be programmed in M-Logic.

If the engine heater is active, and the manual control command has been activated, the engine heater relay is opened. When the command is activated again, the heater relay closes if the temperature is below the set point.

`Functions > Engine heater`

Parameter	Text	Range	Default
6321	Engine heater setp	20 to 250 °C	40 °C
6322	Engine heater relay	Relays and M-Logic	Not used
6323	Engine heater input	Multi-input 20 to 23 EIC temp. inputs	Multi-input 20
6324	Engine heater hyst	1 to 70 °C	3 °C

5.9.1 Engine heater alarm

The engine heater alarm has a temperature set point and a timer. If the temperature gets below the set point, and the engine heater relay is closed, the timer starts. If the timer expires, and the temperature is below the set point, the alarm is activated.

Functions > Engine heater > Engine heater 1

Parameter	Text	Range	Default
6330	Set point	10 to 250 °C	30 °C
	Timer	1.0 to 300.0 s	10.0 s
	Output A	Relays and M-Logic	Not used
	Output B	Relays and M-Logic	Not used
	Enable	OFF ON	OFF
	Fail class	Fail classes	Warning

5.10 Ventilation

The ventilation function is used to control the cooling of the engine. The purpose is to use a multi-input for measuring the cooling water temperature. This way an external ventilation is activated to keep the engine below a maximum temperature.

Select the type of input to use in parameter 6323 *Engine heater*.

Functions > Fan > Single fan start/stop > Fan configuration > Max ventilation

Parameter	Text	Range	Default
6460	Max ventilation setp	20 to 250 °C	90 °C
6461	Max ventilation conf	Terminals and limits	Not used
	Enable	ON OFF	OFF
6463	Max ventilation hyst	1 to 70 °C	5 °C

5.10.1 Max. ventilation alarms

There are two ventilation alarms.

Functions > Fan > Single fan start/stop > Fan Alarms

Parameter	Text	Range	Default
6470 and 6480	Set point	20 to 250 °C	95 °C
	Timer	0 to 60 s	1 s
	Output A	Terminals and limits	Not used
	Output B	Terminals and limits	Not used
	Enable	ON OFF	OFF
	Fail class	Fail classes	Warning

5.11 Pump logic

5.11.1 Fuel pump logic

The fuel pump logic is used to start and stop the fuel supply pump to keep the fuel in the service tank at the required level. The fuel level is detected from one of the three multi-inputs.

`Functions > Fuel`

Parameter	Name	Range	Default	Details
6551	Fuel pump log. start	0 to 100 % 1 to 10 s	20 % 1 s	Fuel transfer pump start point.
6552	Fuel pump log. stop	0 to 100 %	80 %	Fuel transfer pump stop point.
6553	Fuel fill check	0.1 to 999.9 s Fail classes	60 s Warning	Fuel transfer pump alarm timer and fail class. The alarm is activated if the fuel pump relay is activated, but the fuel level does not increase by 2 % within the delay time.
6554	Fuel pump log. input	Multi input [20 to 23], Ext. Ana. In [1 to 8], Auto detection	Auto detection	The multi-input or external analogue input for the fuel level sensor. Configure the input in the utility software under *I/O & Hardware setup*. Select the multi-input if 4-20 mA is used. Select *Auto detection* if a multi input with RMI fuel level is used.
6557	Fuel fill slope	1 to 10%	2%	The fuel fill slope percentage.

Relay output

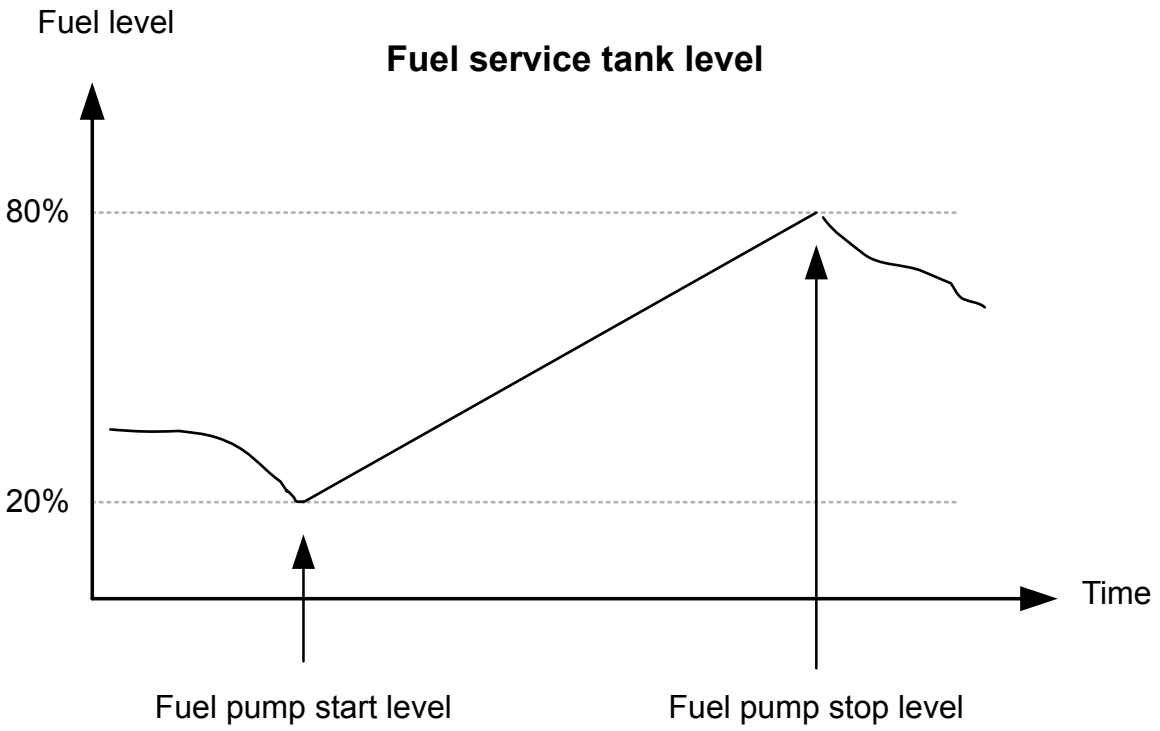
In the utility software under *I/O & Hardware setup*, select the output relay to control the fuel pump, as shown in the following example. If you do not want an alarm whenever the output is activated, configure the output relay as a limit relay.

The controller activates the relay when the fuel level is below the start limit. The controller deactivates the relay when the fuel level is above the stop limit.

NOTE The fuel pump relay can be activated using M-Logic (`Output > Command > Activate Fuel Pump`).

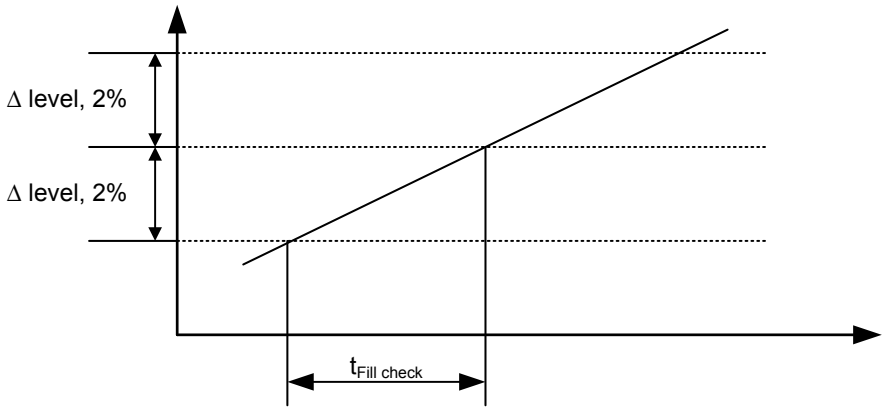
How it works

The diagram below shows how the fuel pump is started when the fuel level is 20 % and stopped again when the level is 80 %.



Fuel fill check

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 %, the controller deactivates the fuel pump relay and activates a **Fuel fill alarm**.



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

5.11.2 DEF pump logic

The DEF pump logic can start and stop the DEF pump to keep the DEF at the required level. For this function, engine interface communication (EIC) must provide the DEF level. If the EIC cannot provide the DEF level, you can use the generic fluid pump logic instead.

`Functions > Diesel Exhaust Fluid`

Parameter	Name	Range	Default	Details
6721	DEF pump log. start	0 to 100 % 1 to 10 s	20 % 1 s	DEF transfer pump start point.
6722	DEF pump log. stop	0 to 100 %	80 %	DEF transfer pump stop point.
6723	DEF fill check	0.1 to 999.9 s Fail classes	60 s Warning	DEF transfer pump alarm timer and fail class. The alarm is activated if the DEF pump relay is activated, but the DEF level

Parameter	Name	Range	Default	Details
				does not increase by the DEF fill slope (see 6724) within the delay time.
6724	DEF fill slope	1 to 10 %	2 %	When the DEF pump relay is activated, this is the amount by which the DEF level must increase in the time defined in 6723.

Relay output

In the utility software under *I/O & Hardware setup*, select the output relay to control the DEF pump, as shown in the following example. If you do not want an alarm whenever the output is activated, configure the output relay as a limit relay.

The controller activates the relay when the DEF level is below the start limit. The controller deactivates the relay when the DEF level is above the stop limit.

NOTE The DEF pump relay can be activated using M-Logic (`Output > Command > Activate DEF Pump`).

5.11.3 Generic pump logic

The fluid pump logic can start and stop a pump to keep any fluid at the required level.

`Functions > Generic Fluid`

Parameter	Name	Range	Default	Details
6731	Fluid pump start	0 to 100 % 1 to 10 s	20 % 1 s	Fluid transfer pump start point.
6732	Fluid pump stop	0 to 100 %	80 %	Fluid transfer pump stop point.
6733	Fluid check	0.1 to 999.9 s Fail classes	60 s Warning	Fluid transfer pump alarm timer and fail class. The alarm is activated if the fluid pump relay is activated, but the fluid level does not increase by the fluid fill slope (see 6735) within the delay time.
6734	Fluid pump log.	Multi input [20 to 23], Ext. Ana. In [1 to 8]	Multi input 20	Select the analogue input for the fluid level. Configure the input in the utility software under *I/O & Hardware setup*.
6735	Fluid fill slope	1 to 10 %	2 %	When the fluid pump relay is activated, this is the amount by which the fluid level must increase in the time defined in 6733.

Relay output

In the utility software under *I/O & Hardware setup*, select the output relay to control the fluid pump, as shown in the following example. If you do not want an alarm whenever the output is activated, configure the output relay as a limit relay.

The controller activates the relay when the fluid level is below the start limit. The controller deactivates the relay when the fluid level is above the stop limit.

NOTE The fluid pump relay can be activated using M-Logic (`Output > Command > Activate Generic Pump`).

5.12 SDU 104 integration

The Shut Down Unit 104 (SDU 104) provides safety and redundancy for marine engines. It keeps the engine running if the main controller fails and can safely shut it down when overspeed or emergency conditions occur. SDU 104 also prepares the engine for start but cannot start the engine. You can use the SDU 104 together with the following controllers:

Controller	Variant
iE 150 Marine	Generator, Engine drive
iE 150	Generator
AGC 150 Marine	Generator, Engine drive
AGC 150	Generator

How to configure the controller for use with the SDU 104

1. Go to the *I/O & Hardware setup* tab.
2. Select the *DI 39-40-41* tab.
3. Configure the digital inputs:
   - Digital input 39: SDU comm error
   - Digital input 40: SDU status OK
   - Digital input 41: SDU warning
4. Go to the *DO 5 - 18* tab.
5. Configure *Output 13* and *Output 14*:
   - Output 13: SDU watchdog
   - Output 14: SDU fault reset
6. Go to the *Parameters* tab to configure SDU parameters 18000, 18010, and 18020. These parameters are the alarms for the digital inputs.

By default, digital output 11 is configured as *Status OK*. This output must be configured for the SDU watchdog output to work.

More information
See the **SDU 104 Installation instructions** for how to connect the SDU 104 to the controller. You can also see how to configure the SDU 104.

5.13 Other functions

5.13.1 Service timers

The controller has two service timers to monitor maintenance intervals. Click the Σ icon in the utility software to see the service timers.

The timer function is based on running hours. When the adjusted time expires, the controller displays an alarm. The running hours are counted when there is running feedback. An alarm occurs when the running hours or days expires.

The controller remembers the last reset on each service timer.

Engine > Maintenance > Service timer [1 to 2]

Parameter	Text	Range	Default
6111 or 6121	Service timer [1 to 2] hour	0 to 9000 hours	500 hours
6113 or 6123	Service timer [1 to 2] day	1 to 1000 days	365 days
6116 or 6126	Service timer [1 to 2] res	OFF ON	OFF

5.13.2 Keyswitch

Output function

Under **I/O & Hardware setup, DO**, configure the *Keyswitch* function.

Wiring

Wire the keyswitch relay output to the ECU power. When the keyswitch relay is open, the ECU has no power.

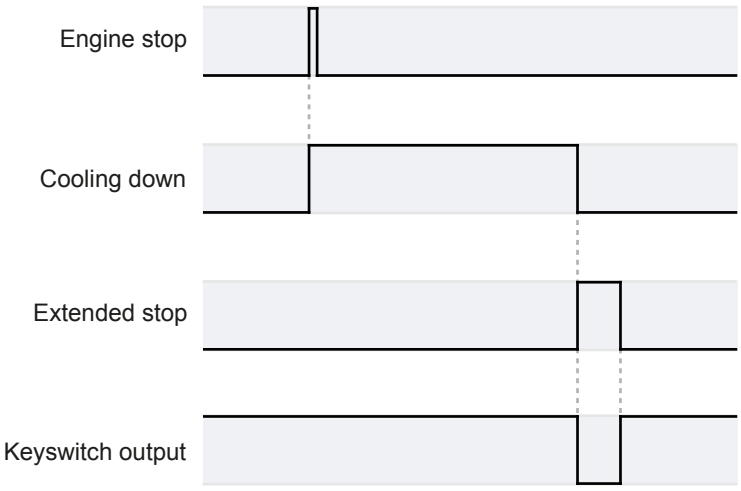
How it works

For the first 5 seconds after the controller is powered on, the keyswitch relay is open.

When the keyswitch relay is open, the controller inhibits the engine interface communication error alarm.

The keyswitch function works as follows:

1. There is an engine stop command.
2. The *Cooling down* (parameter 6211) timer starts.
3. When the cooling down timer runs out, the controller starts the *Extended stop* (parameter 6212) timer, and opens the keyswitch relay.
4. The keyswitch relay stays open until the extended stop timer runs out.



NOTE The keyswitch function does not require engine communication.

5.13.3 No governor regulation

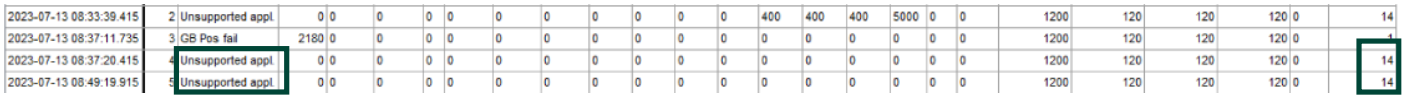
The controller does not regulate the engine's governor. However, the controller still supports idle mode.

5.13.4 Unsupported application

The controller has configuration limitations. If a configuration rule is broken, the controller activates the *Unsupported application* alarm or *Wrong breaker config.* alarm. The alarm value shows which rule was broken. You can see the alarm value in the alarm log in the utility software.

Alarm value	Configuration rule
2	It is not possible to configure a single controller application with a shore controller or a BTB controller.
7	Unknown application type.
8	The controller must have the emulation option enabled to activate emulation.
12	For single controller applications with an external generator breaker both feedbacks must be configured.
13	For single controller applications with an external tie breaker both feedbacks must be configured.
14	Single controller applications with no generator breaker or external generator are not supported by controllers with option S4.
17	For a non-sync application with two breakers, both breakers cannot be prioritised.
46	For iE 150 Marine Generator Core, you cannot use power management.
47	For a power management application, you cannot have an EDG.

Alarm log example



2023-07-13 08:33:39.415	2	Unsupported appl.	0	0	0	0	0	0	0	0	0	0	0	0	400	400	400	5000	0	0	1200	120	120	120	0	14
2023-07-13 08:37:11.735	3	GB Pos fail	2180	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1200	120	120	120	0	
2023-07-13 08:37:20.415	4	Unsupported appl.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1200	120	120	120	0	14
2023-07-13 08:49:19.915	5	Unsupported appl.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1200	120	120	120	0	14

6. Generator functions

6.1 Generator breaker

6.1.1 Application modes

The controller can be used for the following standard applications:

Genset	REMOTE	LOCAL	AUTO	MANUAL	Test	SWBD	Block
Single genset (GEN)	●	●			●		●
Emergency genset (EDG)			●	●	●	●	●

6.1.2 Breaker settings

`Breakers > Generator breaker > Breaker configuration`

Parameter	Text	Range	Default
6231	GB close delay	0.0 to 30.0 s	2.0 s
6232	Load time	0.0 to 30.0 s	0.0 s
6234	GB reclose attempts	No reclose attempts 1 reclose attempt 2 reclose attempt 3 reclose attempt	No reclose attempt

6.1.3 Breaker sequences

The controller activates the breaker sequences according to the selected mode.

Controller operation modes

Controller operation mode	Plant running mode	Breaker control
REMOTE	GEN	Remote command
LOCAL	GEN	Button command
AUTO	EDG	Controlled by the controller
MANUAL	EDG	Button/remote command
SWBD	EDG	Button/remote command
Block	GEN/EDG	None (only possible to open breakers)

Voltage and frequency OK

Before closing the breakers, the voltage and frequency must be stabilised within a defined time frame.

`Generator > AC configuration > Voltage and freq. OK > Hz/V OK`

Parameter	Text	Range	Default
6220	Hz/V OK timer	0.0 to 99.0 s	5.0 s

Generator > AC configuration > Voltage and freq. OK > Blackout / Hz/V OK*

Parameter	Text	Range	Default
2111	Blackout / f<	0.0 to 5.0 Hz	3.0 Hz
2112	Blackout / f>	0.0 to 5.0 Hz	3.0 Hz
2113	Blackout / U<	2 to 20 %	5 %
2114	Blackout / U>	2 to 20 %	5 %

NOTE * The settings are used for both Hz/V OK and Blackout.

Generator > AC configuration > Voltage and freq. OK > Hz/V failure

Parameter	Text	Range	Default
4560	Timer	1.0 to 99.0 s	30.0 s
	Output A	Relays and M-Logic	Not used
	Output B	Relays and M-Logic	Not used
	Enable	OFF ON	OFF
	Fail class	Fail classes	Shutdown

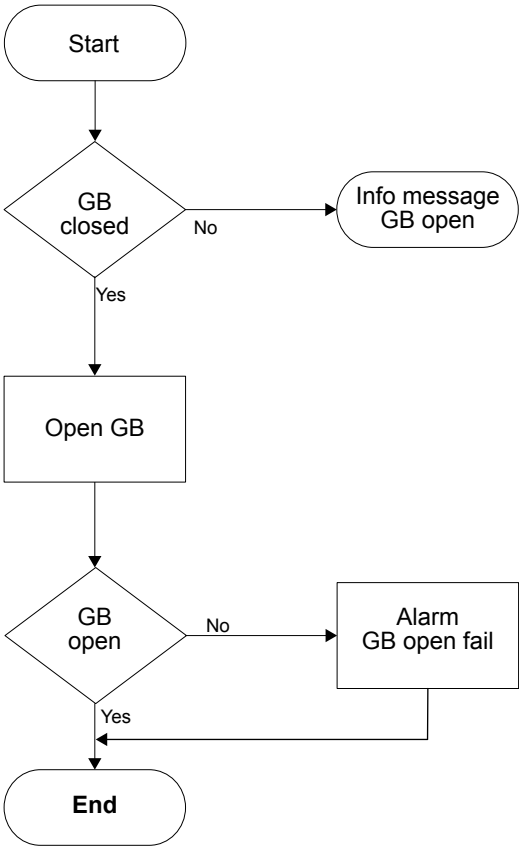
Conditions for breaker operations

The breaker sequences depend on the breaker positions and the frequency/voltage measurements.

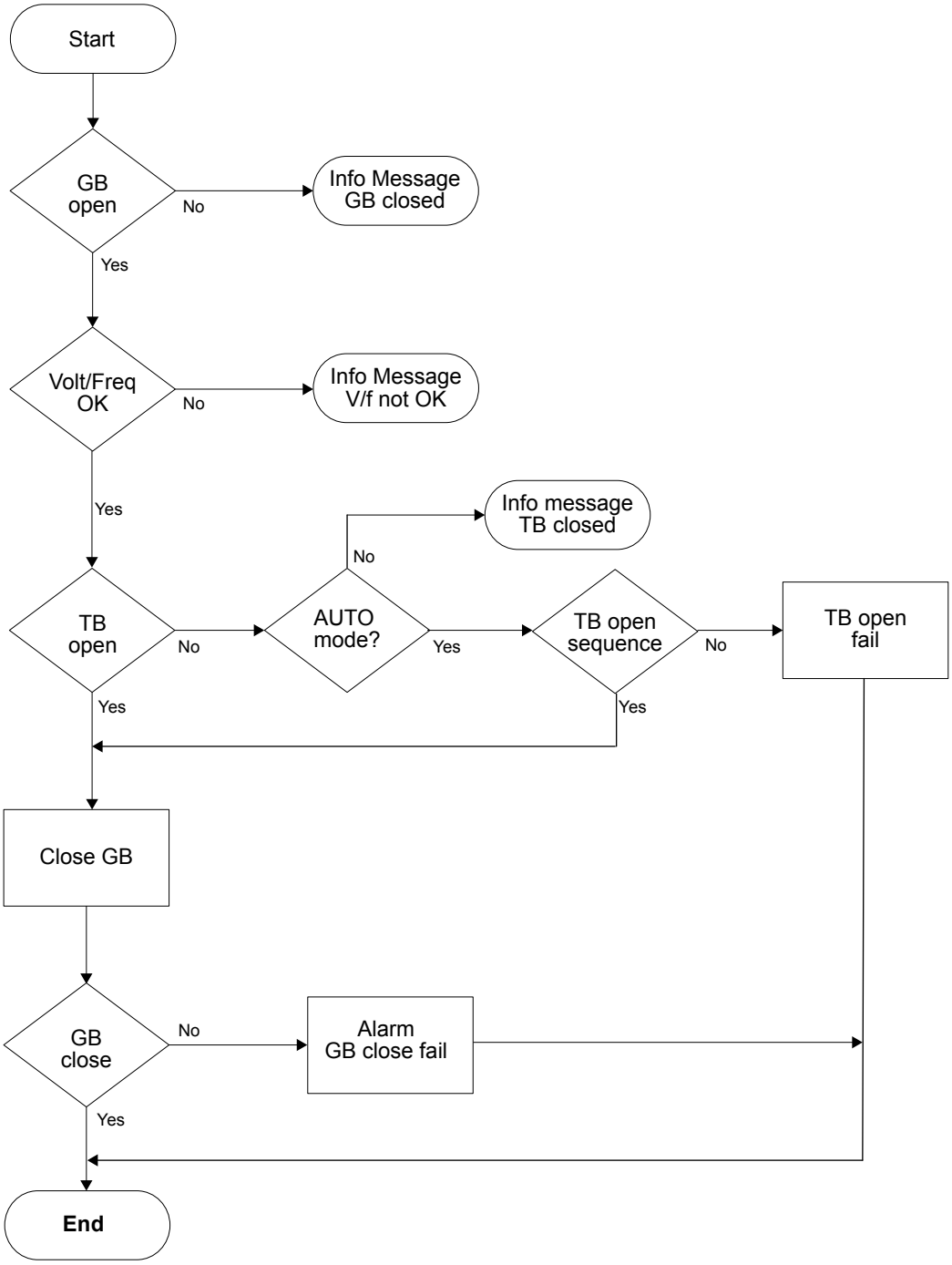
Sequence	Condition
GB ON, direct closing	Running feedback Generator frequency/voltage OK TB open
GB OFF, direct opening	TB open

6.1.4 Flowcharts

GB open sequence flowchart



GB close sequence (EDG) flowchart



6.1.5 Breaker failures

Breakers > Generator breaker > Breaker monitoring > GB Open fail

Parameter	Text	Range	Default
2160	Timer	1.0 to 10.0 s	2.0 s
	Output A	Relays and M-Logic	Not used
	Output B	Relays and M-Logic	Not used
	Enable	ON	ON
	Fail class	Fail classes	Warning

Breakers > Generator breaker > Breaker monitoring > GB Close fail

Parameter	Text	Range	Default
2170	Timer	1.0 to 10.0 s	900 s
	Output A	Relays and M-Logic	Not used
	Output B	Relays and M-Logic	Not used
	Enable	ON	ON
	Fail class	Fail classes	Warning

Breakers > Generator breaker > Breaker monitoring > GB Pos fail

Parameter	Text	Range	Default
2180	Timer	1.0 to 5.0 s	1.0 s
	Output A	Relays and M-Logic	Not used
	Output B	Relays and M-Logic	Not used
	Enable	ON	ON
	Fail class	Fail classes	Warning

6.2 Other functions

6.2.1 No AVR regulation

The controller does not regulate the generator's AVR.

7. Emergency genset functions

7.1 Tie breaker

7.1.1 Breaker settings

`Breakers > Tie breaker > Breaker configuration`

Parameter	Text	Range	Default
7082	TB close delay	0.0 to 30.0 s	0.5 s
7085	TB Load time	0.0 to 30.0 s	0.0 s

7.1.2 Breaker sequences

Set points for TB control

Parameter	Text	Description
7082	TB close delay	The time from GB OFF to TB ON.
7085	TB Load time	After opening the breaker, the TB ON sequence is not initiated before this delay has expired.

If there is no TB in the application drawing (see *Application configuration* in the utility software), then the relays for opening/closing and inputs for feedbacks normally used for TB control/supervision become configurable.

Main busbar TB opening

If the controller operates in Main busbar (MBB), it is necessary to select the functionality of the tie breaker opening function. This can be helpful, when the TB can only be operated with voltage on the main busbar.

`EDG Bus > Main Busbar fail functions > Start seq. in Main busbar fail mode`

Parameter	Text	Range	Default
7065	Busbar fail ctrl	Start engine + open TB Start engine Open TB when engine ready	Start engine + open TB

Main busbar failure control sequences (parameter 7065)

Setting	Sequence with no failure	Sequence with start failure
Start engine + open TB	1. Main busbar failure delay timer expired. 2. Tie breaker opens. 3. Engine starts. 4. Volt/Hz OK timer expired. 5. Generator breaker closes.	1. Main busbar failure delay timer is running. 2. Tie breaker opens. 3. Engine tries to start. 4. Generator start failure.
Start engine	1. Main busbar failure delay timer expired. 2. Engine starts. 3. Volt/Hz OK timer expired. 4. Tie breaker opens. 5. Generator breaker closes.	1. Main busbar failure delay timer is running. 2. Engine tries to start. 3. Generator start failure. 4. Tie breaker opens.
Open TB when engine ready	1. Main busbar failure delay timer expired.	1. Main busbar failure delay timer is running.

Setting	Sequence with no failure	Sequence with start failure
	2. Engine starts. 3. Volt/Hz OK timer expired. 4. Tie breaker opens. 5. Generator breaker closes.	2. Engine tries to start. 3. Generator start failure. 4. Tie breaker stays closed.

EDG bus > Main Busbar fail functions > Main busbar timer

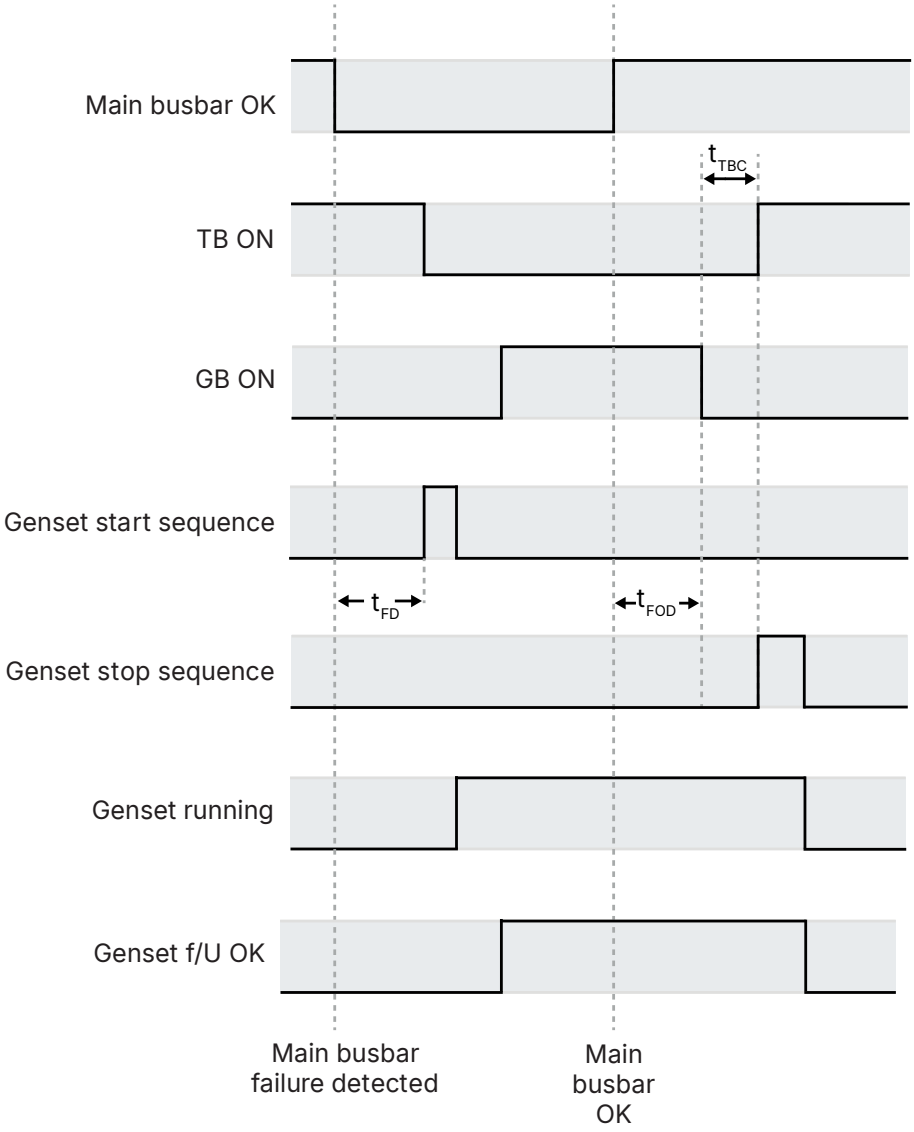
Parameter	Text	Range	Default
7061	U busbar failure	0.5 to 990.0 s	5.0 s
7062	Busbar OK Del. U	2 to 9900 s	60 s
7071	f busbar failure	0.5 to 990.0 s	5.0 s
7072	Busbar OK Del. f	2 to 9900 s	60 s

EDG Bus > Voltage and frequency limits > Voltage settings

Parameter	Text	Range	Default
7066	U unbalance	2 to 100 %	100 %

The voltage unbalance must be below the unbalance set point before the controller can treat the voltage as okay. The lower the set point, the less voltage imbalance is accepted before a main busbar failure occurs.

Example 1: Main busbar fail control (Start engine and open TB)



Example 2: Main busbar fail control (Start engine)

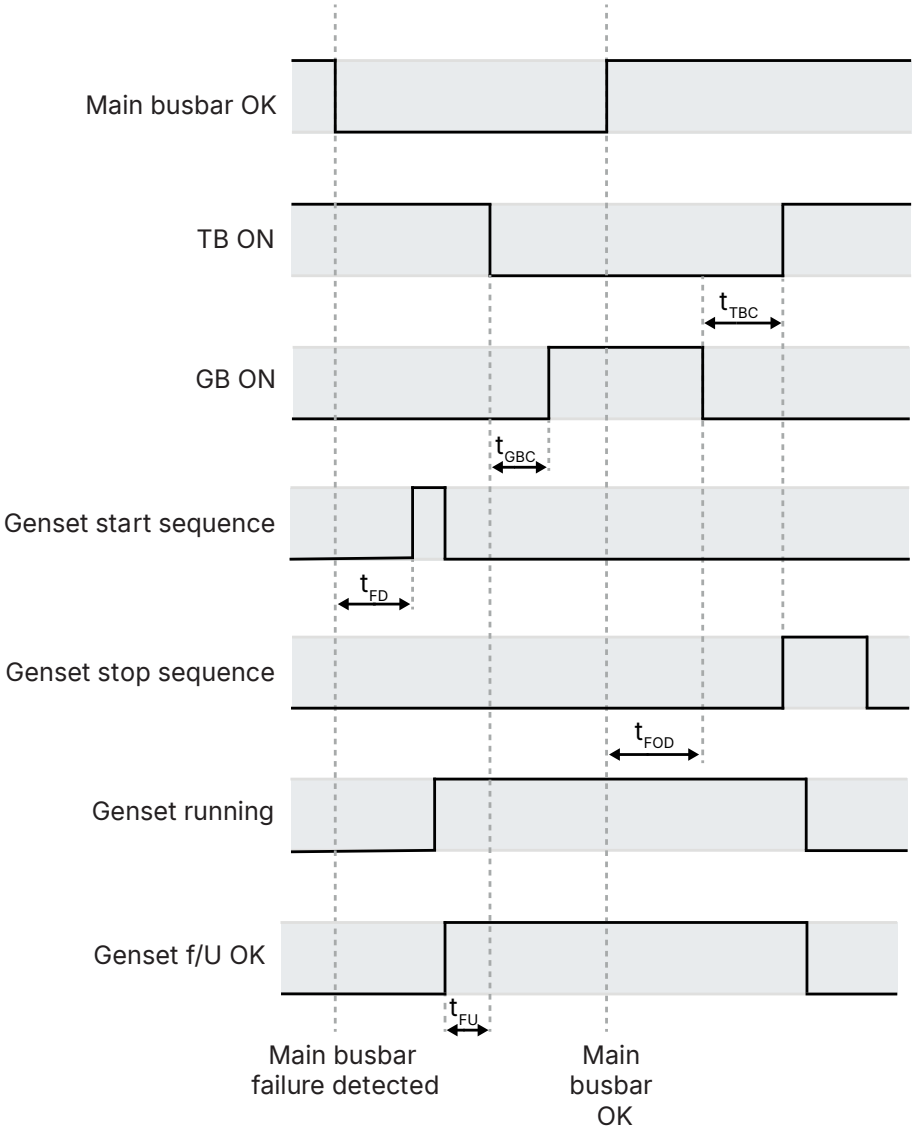


Table 7.1

Timing parameter	Description
t_{FD}	Delay from main busbar failure detection to genset start command.
t_{FU}	Delay before genset frequency/voltage is considered OK.
t_{GBC}	Time from genset start sequence to generator breaker closing.
t_{FOD}	Delay before initiating genset stop sequence after main busbar OK.
t_{TBC}	Time from tie breaker ON to tie breaker OFF.

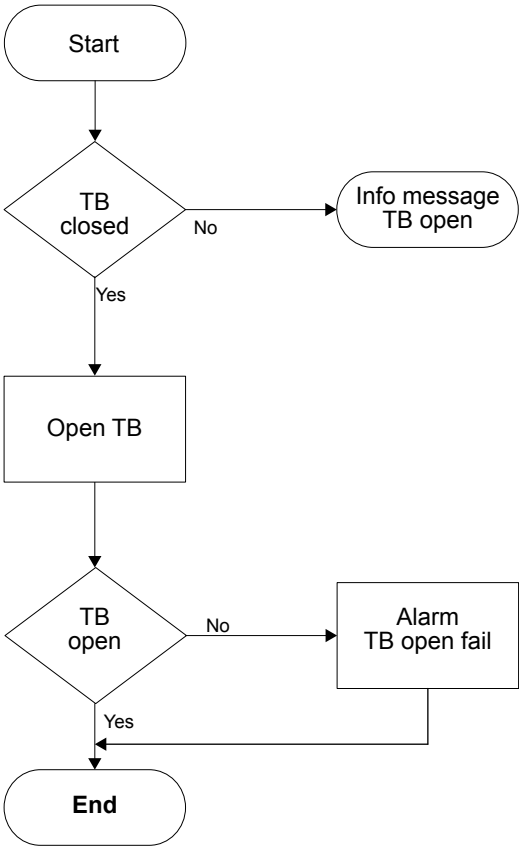
Conditions for breaker operations

The breaker sequences depend on the breaker positions and the frequency/voltage measurements.

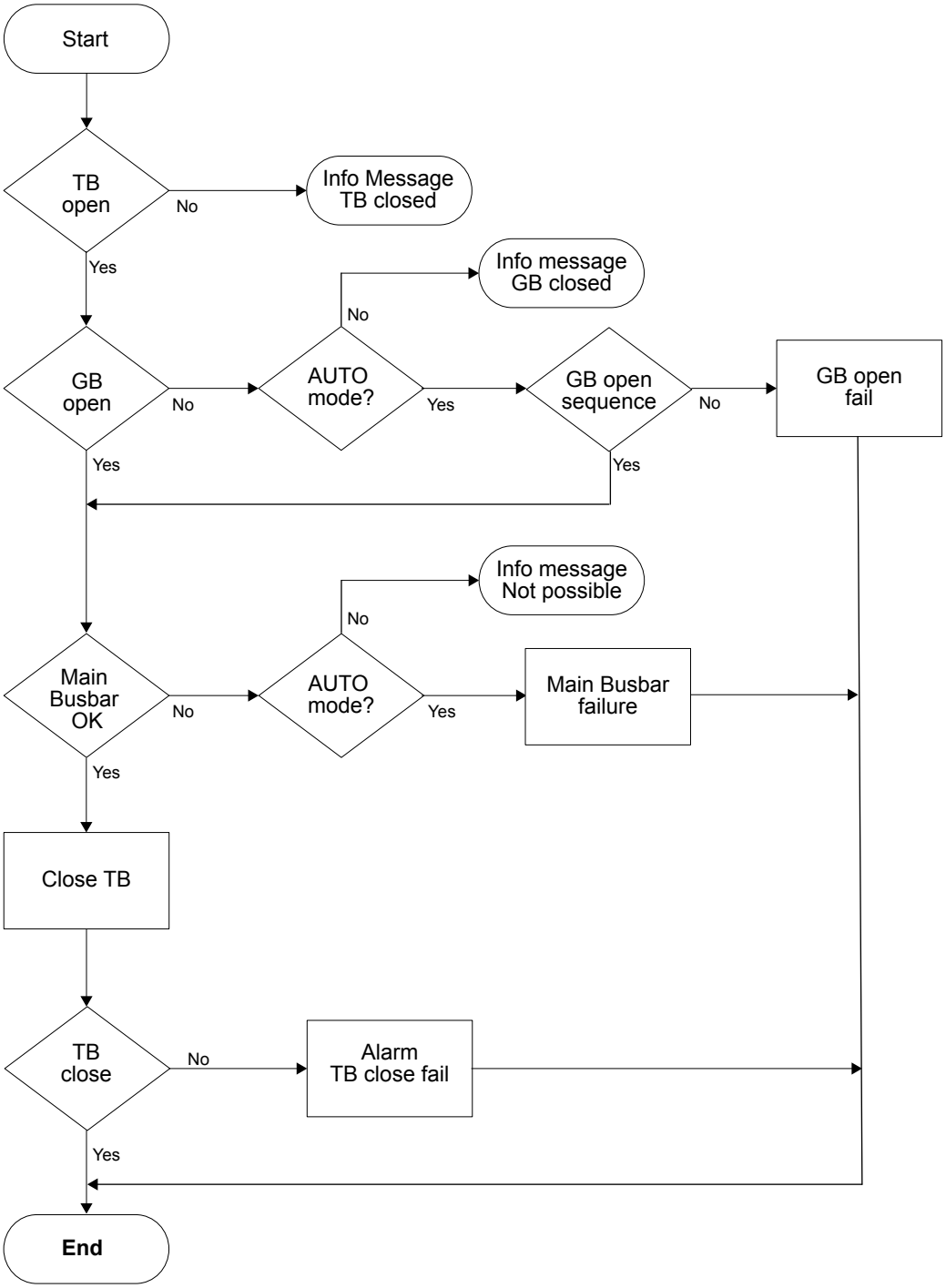
Sequence	Condition
TB ON, direct closing	Main busbar frequency/voltage OK GB open
TB OFF, direct opening	Alarms with fail classes: Shut down or Trip TB alarms

7.1.3 Flowcharts

TB open sequence flowchart



TB close sequence flowchart



7.1.4 Breaker failures

`Breakers > Tie breaker > Breaker monitoring > TB Open fail`

Parameter	Text	Range	Default
2200	Timer	1.0 to 10.0 s	2.0 s
	Output A	Relays and M-Logic	Not used
	Output B	Relays and M-Logic	Not used
	Enable	ON	ON
	Fail class	Fail classes	Warning

Breakers > Tie breaker > Breaker monitoring > TB Close fail

Parameter	Text	Range	Default
2210	Timer	1.0 to 5.0 s	2.0 s
	Output A	Relays and M-Logic	Not used
	Output B	Relays and M-Logic	Not used
	Enable	ON	ON
	Fail class	Fail classes	Warning

Breakers > Tie breaker > Breaker monitoring > TB Pos fail

Parameter	Text	Range	Default
2220	Timer	1.0 to 5.0 s	1.0 s
	Output A	Relays and M-Logic	Not used
	Output B	Relays and M-Logic	Not used
	Enable	ON	ON
	Fail class	Fail classes	Warning

8. AC protections

8.1 About protections

8.1.1 Protections in general

All protection set points are a percentage of the nominal values.

For most of the protections a set point and time delay is selected. When the timer runs out, the output is activated. The operate time is the delay setting + the reaction time.

When setting up the controller, the measuring class of the controller and an adequate safety margin has to be taken into consideration, for example:

- A power generation system must not reconnect to a network when the voltage is < 85 % of U_{NOM} ±0 % or > 110 % ±0 %. To ensure reconnection within this interval, the controller's tolerance/accuracy has to be taken into consideration. If the reconnection tolerance is ±0 %, set a controller's set points 1-2 % higher/lower than the actual set point.

General parameter ranges for protections

Setting	Range
Output A	Not used 12 relays: 5, 6, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18 External I/O: Relays available in the connected CIO(s) Limits
Output B	
Enable	OFF ON
Fail class	See the controller type

Inhibits

You can only select inhibits using the utility software. Each alarm has a selection list for the inhibit conditions. Inhibit of the alarm is active as long as one of the selected inhibit functions are active.

8.1.2 Phase-neutral voltage trip

If the voltage alarms are to work based on phase-neutral measurements, the voltage detection type for both generator and busbar must be set to phase-neutral.

`Generator > Voltage protections > Voltage detect. type`

Parameter	Text	Range	Default
1201	G U detection type	Phase - Phase Phase - Neutral	Phase - Phase

`Busbar > Voltage protections > Voltage detect. type`

Parameter	Text	Range	Default
1202	BB U detection type	Phase - Phase Phase - Neutral	Phase - Phase

As shown in the vector diagram below, there is a difference in voltage values at an error situation for the phase-neutral voltage and the phase-phase voltage.

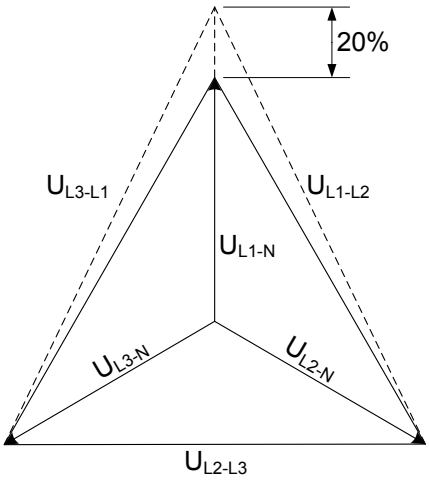
Example: Actual measurements at a 10 % under-voltage situation in a 400/230 volt system

	Phase-neutral	Phase-phase
Nominal voltage	400/230	400/230
Voltage, 10 % error	380/207	360/185

The alarm will occur at two different voltage levels, even though the alarm set point is 10 % in both cases.

The 400 V AC system below shows that the phase-neutral voltage must change 20 %, when the phase-phase voltage changes 40 volts (10 %).

Example



U_{NOM} = 400/230 V AC
Error measurements

- U_{L1L2} = 360 V AC
- U_{L3L1} = 360 V AC
- U_{L1-N} = 185 V AC
- ΔU_{PH-N} = 20 %

8.1.3 Phase sequence error and phase rotation

The controller monitors the rotation of the voltage, and activates an alarm if the voltage is rotating in the wrong direction. The controller can monitor the rotation in both directions.

However, these protections are not relevant, since the stand-alone controller does not synchronise and connect power sources.

8.2 A-side protections

A-side protections refer to protective functions for the **generator A side** of the system. The parameter is located under **Generator** in the controller menu.

The number of protections depend on the software option.

More information
See the **Data sheet** for the protections for each software option.

The *operate time* is defined in IEV 447-05-05 (from the instant when the need for protection arises, to when the controller output has responded). For each protection, the *operate time* is given for the minimum user-defined time delay.

A-side protections

Protection	IEC symbol (IEC 60617)	ANSI (IEEE C37.2)	Operate time	Alarms
Over-voltage	U>, U>>	59	< 200 ms	2
Under-voltage	U<, U<<	27P	< 200 ms	3
Voltage unbalance	UUB>	47	< 200 ms*	1

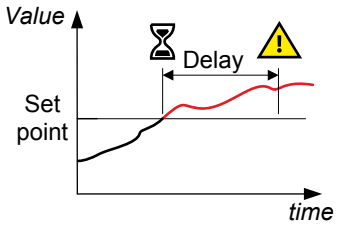
Protection	IEC symbol (IEC 60617)	ANSI (IEEE C37.2)	Operate time	Alarms
Over-current	3I>, 3I>>	50TD	< 200 ms	4
Fast over-current	3I>>>	50P	< 40 ms	2
Current unbalance	IUB>	46	< 200 ms*	1
Directional over-current		67	< 100 ms	2
Voltage dependent over-current	Iv>	50V	-	1
Inverse time filtered neutral over-current	IfiltN>	50G	< 100 ms	1
Inverse time neutral over-current	In>	50N	< 100 ms	1
Over-frequency	f>, f>>	81O	< 300 ms	3
Under-frequency	f<, f<<	81U	< 300 ms	3
Overload	P>, P>>	32F	< 200 ms	4
Low power	-	-	< 100 ms	1
Reverse power	P<, P<<	32R	< 200 ms	2
Over-excitation or reactive power export	Q>, Q>>	32FV	< 200 ms	1
Under-excitation or reactive power import	Q<, Q<<	32RV	< 200 ms	1

NOTE * These operate times include the minimum user-defined delay of 100 ms.

8.2.1 Over-voltage (ANSI 59)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Over-voltage	U>, U>>	59	< 100 ms

The alarm response is based on the highest phase-to-phase voltage, or the highest phase-to-neutral voltage, from the source, as measured by the controller. The phase-to-phase voltage is the default.



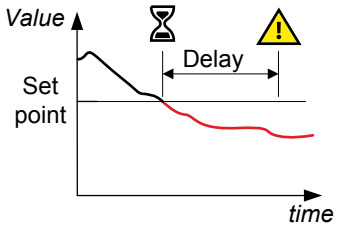
Generator > Voltage protections > Over-voltage > G U> [1 or 2]

Parameter	Text	Range	G U> 1	G U> 2
1150 or 1160	Set point	100 to 130 %	103 %	105 %
	Timer	0.1 to 100 s	10 s	5 s
	Enable	OFF ON	OFF	OFF
	Fail class	Fail classes	Warning	Warning

8.2.2 Under-voltage (ANSI 27P)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Under-voltage	U<, U<<	27P	< 100 ms

The alarm response is based on the lowest phase-to-phase voltage, or the lowest phase-to-neutral voltage, from the source, as measured by the controller. The phase-to-phase voltage is the default.



Generator > Voltage protections > Under-voltage > G U< [1 to 3]

Parameter	Text	Range	G U< 1	G U< 2	G U< 3
1170, 1180 or 1190	Set point	40 to 100 %	97 %	95 %	95 %
	Timer	0.1 to 100 s	10 s	5 s	5 s
	Enable	OFF ON	OFF	OFF	OFF
	Fail class	Fail classes	Warning	Warning	Warning

NOTE Under-voltage protection is inhibited, when the controller is in idle mode.

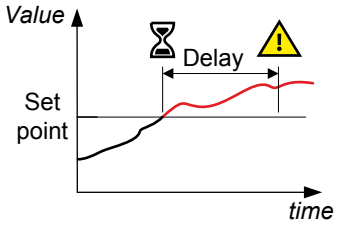
8.2.3 Voltage unbalance (ANSI 47)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Voltage unbalance (voltage asymmetry)	UUB>	47	< 200 ms*

NOTE * The operate time includes the minimum user-defined delay of 100 ms.

The alarm response is based on the highest difference between any of the three phase-to-phase voltage or phase-to-neutral true RMS values and the average voltage, as measured by the controller. The phase-to-phase voltage is the default.

If phase-to-phase voltages are used, the controller calculates the average phase-to-phase voltage. The controller then calculates the difference between each phase-to-phase voltage and the average voltage. Finally, the controller divides the maximum difference by the average voltage to get the voltage unbalance.



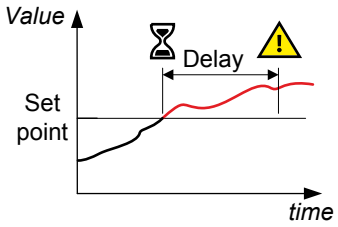
Generator > Voltage protections > Voltage unbalance > G Unbalance U

Parameter	Text	Range	Default
1510	Set point	0 to 50 %	10 %
	Timer	0.1 to 100 s	10 s
	Enable	OFF ON	OFF
	Fail class	Fail classes	Trip GB

8.2.4 Over-current (ANSI 50TD)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Over-current	3I>, 3I>>	50TD	< 100 ms

The alarm response is based on the highest phase current true RMS value from the source, as measured by the controller.



Generator > Current protections > Over-current > I> [1 to 4]

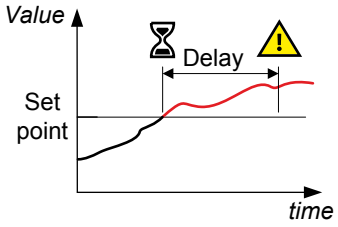
Parameter	Text	Range	I> 1	I> 2	I> 3	I> 4
1030, 1040, 1050 or 1060	Set point	50 to 200 %	115 %	120 %	115 %	120 %
	Timer	0.1 to 3200 s	10 s	5 s	10 s	5 s
	Enable	OFF ON	ON	ON	ON	ON
	Fail class	Fail classes	Warning	Trip GB	Trip GB	Trip GB

8.2.5 Fast over-current (ANSI 50P)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Fast over-current	3I>>>	50P*	< 40 ms

NOTE * ANSI 50 applies when the Delay parameter is 0 s.

The alarm response is based on the highest phase current true RMS values from the source, as measured by the controller.



Generator > Current protections > Fast over-current > I>> [1 or 2]

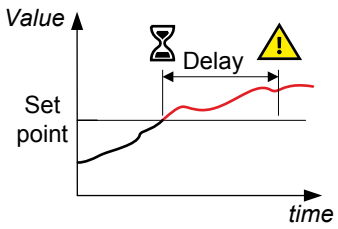
Parameter	Text	Range	I>> 1	I>> 2
1130 or 1140	Set point	150 to 300%	150%	200%
	Timer	0 to 3200 s	2 s	0.5 s
	Enable	OFF ON	OFF	OFF
	Fail class	Fail classes	Trip GB	Trip GB

8.2.6 Current unbalance (ANSI 46)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Current unbalance	IUB>	46	< 200 ms*

NOTE * The operate time includes the minimum user-defined delay of 100 ms.

The alarm response is based on the highest difference between any of the three phase current true RMS values, as measured by the controller. You can choose either the *Average* method (ANSI) or the *Nominal* method to calculate the current unbalance.



Generator > Current protections > Unbalance current > Unbalance I [1 or 2]

Parameter	Text	Range	Unbalance I 1	Unbalance I 2
1500 or 1710	Set point	0 to 100 %	30 %	40 %
	Timer	0.1 to 100 s	10 s	10 s
	Enable	OFF ON	OFF	OFF
	Fail class	Fail classes	Trip GB	Trip GB

Generator > Current protections > Unbalance current > Type

Parameter	Text	Range	Default
1203	Unbalance I	Ref. to Nominal Ref. to Average	Ref. to Nominal

NOTE The *Average method* is very sensitive at low loads.

The average method uses the ANSI standard calculation method to determine current unbalance. The controller calculates the average current for the three phases. The controller then calculates the difference between each phase current and the average current. Finally, the controller divides the maximum difference by the average current to get the current unbalance.

Average method example

The controller controls a genset with a nominal current of 100 A. The L1 current is 80 A, the L2 current is 90 A, and the L3 current is 60 A.

The average current is 76.7 A. The difference between the phase current and the average is 3.3 A for L1, 13.3 A for L2 and 16.7 A for L3.

The current unbalance is therefore 16.7 A / 76.7 A = 0.22 = 22 %.

With the nominal method the controller calculates the difference between the phase with the highest current, and the phase with the lowest current. Finally, the controller divides the difference by the nominal current to get the current unbalance.

Nominal method example

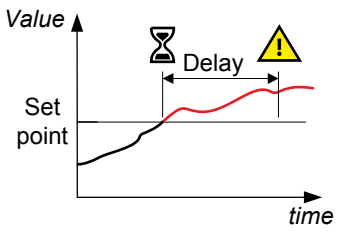
The controller controls a genset with a nominal current of 100 A. The L1 current is 80 A, the L2 current is 90 A, and the L3 current is 60 A.

The current unbalance is (90 A - 60 A) / 100 A = 0.3 = 30 %.

8.2.7 Directional over-current (ANSI 67)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Directional over-current		67	< 100 ms

The alarm response is based on the highest phase current true RMS value, with the direction from the active power from the source, as measured by the controller.



Generator > Current protections > Direct. over-current > I> direct. [1 or 2]

Parameter	Text	Range	I> direct. 1	I> direct. 2
1600 or 1610	Set point	-200 to 200 %	120 %	130 %
	Timer	0 to 3200 s	0.1 s	0.1 s
	Enable	OFF ON	OFF	OFF
	Fail class	Fail classes	Trip TB (EDG)	Trip TB (EDG)

NOTE For a positive set point, the alarm trigger level is *High*. When a negative set point is written to the controller, then the controller automatically changes the alarm trigger level to *Low*.

8.2.8 Voltage dependent over-current (ANSI 50V)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Voltage-dependent over-current	Iv>	50V	-

This is a voltage-dependent over-current alarm for generators without permanent magnets. This protection occurs when a short circuit is present and the voltage drops. The current rises briefly, before it falling to a lower level.

The short circuit current level can drop below the rated current of the generator, and thus the short circuit will not be tripped, if a standard ANSI 50/50TD is used. When the short circuit is present, the voltage will be low. This can be used for tripping at a lower current, when the voltage is low.

Generator > Current protections > Voltage dep. over-curr.

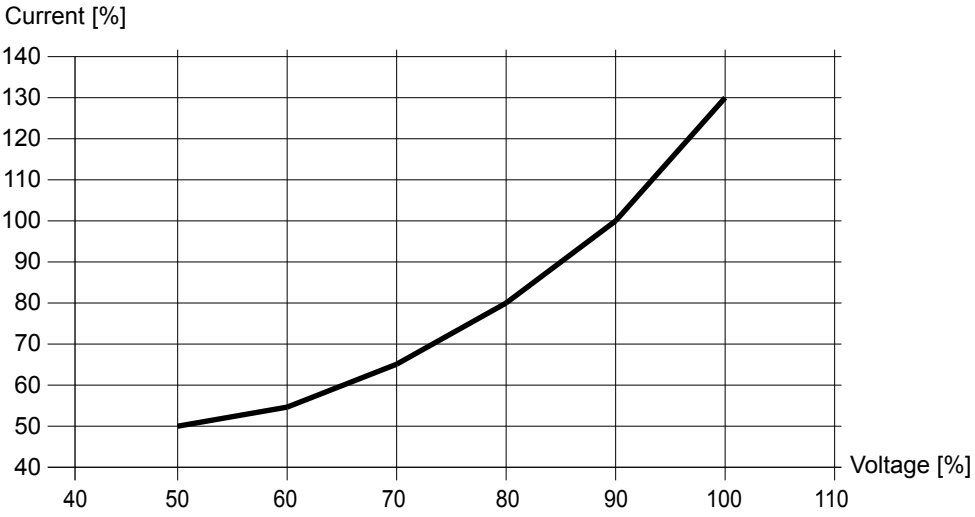
Parameter	Text	Range	Default
1101	G Iv> (50 %)	50 to 200 %	110 %
1102	G Iv> (60 %)	50 to 200 %	125 %
1103	G Iv> (70 %)	50 to 200 %	140 %
1104	G Iv> (80 %)	50 to 200 %	155 %
1105	G Iv> (90 %)	50 to 200 %	170 %
1106	G Iv> (100 %)	50 to 200 %	200 %
1110	Fail class	Fail classes	Trip GB

Example

There are six current and voltage level set points. The voltage levels are pre-set, so only the current levels must be set. All values are in percentage of the nominal settings. The default values are shown in the table below.

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

The set points can be shown on a curve:



When the operating values are above the curve, the breaker is tripped. The generator breaker also trips when the generator voltage is below 50 % of rated, and the current is above 50 % of rated.

8.2.9 Inverse time neutral over-current (ANSI 50N)

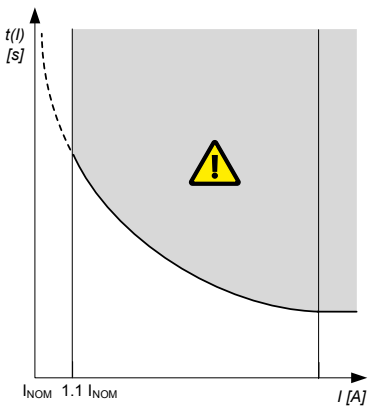
Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Inverse time neutral over-current		50N	-

This is the inverse time over-current alarm for the neutral current measurement.

The alarm response is based on the unfiltered (except for anti-aliasing) neutral current, as measured by the 4th current measurement.

The alarm response time depends on an approximated integral of the current measurement over time. The integral is only updated when the measurement is above the activation threshold.

NOTE The diagram on the right is a simplified representation of this alarm. The diagram does not show the integral over time.



Generator > Current protections > Neutral inverse time over-current (4th CT)

Parameter	Text	Range	Default
1721	In> inverse Type	IEC Inverse IEC Very Inverse IEC Extremely inverse IEEE Moderately Inv. IEEE Very Inverse IEEE Extremely Inv. Custom	IEC Inverse
1722	In> inverse Limit	2. to 120 %	30 %
1723	In> inverse TMS	0.01 to 100.00	1.00
1724	In> inverse k	0.001 to 32.000 s	0.140 s
1725	In> inverse c	0.000 to 32.000 s	0.000 s
1726	In> inverse a	0.001 to 32.000 s	0.020 s
1727	Enable	OFF ON	OFF
	Fail class	Fail classes	Trip GB

More information
See **Inverse time over-current (ANSI 51)** for the calculation method, the standard curves, and information about the definite time characteristic.

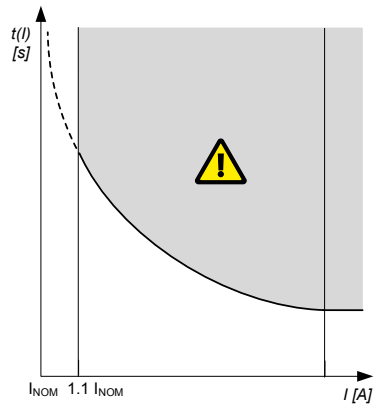
8.2.10 Inverse time filtered neutral over-current (ANSI 50G)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Inverse time filtered neutral over-current		50G	-

This is the inverse time over-current alarm for the ground current measurement.

The alarm response is based on the ground current, as measured by the 4th current measurement filtered to attenuate the third harmonic (at least 18 dB).

NOTE The diagram on the right is a simplified representation of this alarm. The diagram does not show the integral over time.



Generator > Current protections > Filtered neutral inverse time over-current (4th CT)

Parameter	Text	Range	Default
1731	Ie> inverse Type	IEC Inverse IEC Very Inverse IEC Extremely inverse IEEE Moderately Inv. IEEE Very Inverse IEEE Extremely Inv. Custom	-
1732	Ie> inverse Limit	2 to 120 %	10 %
1733	Ie> inverse TMS	0.01 to 100.00	1.00

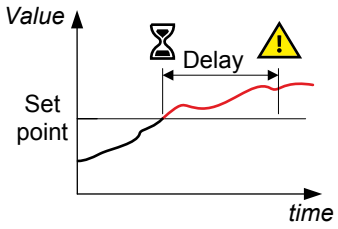
Parameter	Text	Range	Default
1734	Ie> inverse k	0.001 to 32.000 s	0.140 s
1735	Ie> inverse c	0.000 to 32.000 s	0.000 s
1736	Ie> inverse a	0.001 to 32.000 s	0.020 s
1737	Enable	OFF ON	OFF
	Fail class	Fail classes	Trip GB

More information
See **Inverse time over-current (ANSI 51)** for the calculation method, the standard curves, and information about the definite time characteristic.

8.2.11 Over-frequency (ANSI 81O)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Over-frequency	f>, f>>	81O	< 100 ms

The alarm response is based on the fundamental frequency (based on phase voltage), due to the selection made in parameter 1204.



Generator > Frequency protections > Over-frequency > G f> [1 to 3]

Parameter	Text	Range	G f> 1	G f> 2	G f> 3
1210, 1220 or 1230	Set point	100 to 120 %	103 %	105 %	105 %
	Timer	0.2 to 100 s	10 s	5 s	5 s
	Enable	OFF ON	OFF	OFF	OFF
	Fail class	Fail classes	Warning	Warning	Warning

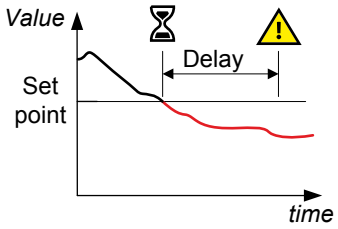
Generator > Frequency protections > Frequency detect. type

Parameter	Text	Range	Default
1204	Freq. detect type	L1 L2 L3 L1 or L2 or L3 L1 and L2 and L3	L1 or L2 or L3

8.2.12 Under-frequency (ANSI 81U)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Under-frequency	f<, f<<	81U	< 100 ms

The alarm response is based on the highest fundamental frequency (based on phase voltage), from the source. This ensures that the alarm only activates when all of the phase frequencies are below the set point.



Generator > Frequency protections > Under-frequency > G f< [1 to 3]

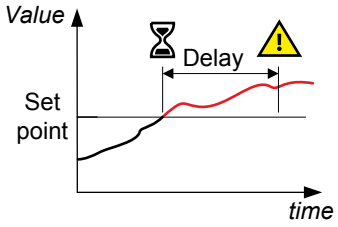
Parameter	Text	Range	G f< 1	G f< 2	G f< 3
1240, 1250 or 1260	Set point	80 to 100 %	97 %	95 %	95 %
	Timer	0.2 to 100 s	10 s	5 s	5 s
	Enable	OFF ON	OFF	OFF	OFF
	Fail class	Fail classes	Warning	Warning	Warning

NOTE Under-frequency protection is inhibited, when the controller is in idle mode.

8.2.13 Overload (ANSI 32F)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Overload	P>, P>>	32F	< 100 ms

The alarm response is based on the active power (all phases), from the source, as measured by the controller.



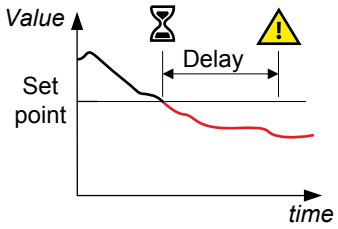
Generator > Power protections > Overload > P> [1 to 4]

Parameter	Text	Range	P> 1	P> 2	P> 3	P> 4
1450, 1460, 1470 or 1480	Set point	-200 to 200 %	100 %	110 %	100 %	110 %
	Timer	0.1 to 3200 s	10 s	5 s	10 s	5 s
	Enable	OFF ON	OFF	OFF	OFF	OFF
	Fail class	Fail classes	Warning	Trip GB	Trip GB	Trip GB

8.2.14 Low power

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Low power	-	-	< 100 ms

The alarm response is based on the active power (all phases), from the source, as measured by the controller.



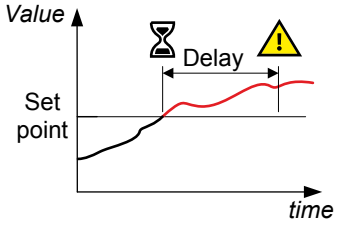
AC configuration and protections > Power protections > Overload > P< 5

Parameter	Text	Range	P< 5
1490	Set point	-200 to 200 %	30 %
	Timer	0.1 to 3200 s	3200 s
	Enable	OFF ON	OFF
	Fail class	Fail classes	Trip GB

8.2.15 Reverse power (ANSI 32R)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Reverse power	P<, P<<	32R	< 100 ms

The alarm response is based on the active power (all phases), to the source, as measured by the controller.



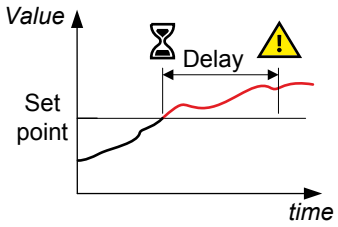
Generator > Power protections > Reverse power > -P> [1 to 3]

Parameter	Text	Range	-P> 1	-P> 2	-P > 3
1000, 1010 or 1070	Set point	-200 to 0 %	-5 %	-5 %	-5 %
	Timer	0.1 to 100 s	10 s	10 s	10 s
	Enable	OFF ON	ON	ON	OFF
	Fail class	Fail classes	Trip GB	Trip GB	Trip GB

8.2.16 Over-excitation or reactive power export (ANSI 32FV)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Over-excitation or reactive power export	Q>, Q>>	32FV	< 100 ms

The alarm response is based on the reactive power (Q) from the source, as measured and calculated by the controller. Reactive power export is when the generator is feeding an inductive load.



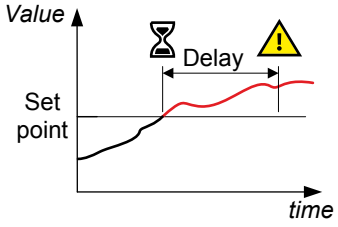
Generator > Reactive power protect. > Overexcitation > Q>

Parameter	Text	Range	Default
1530	Set point	0 to 100 %	60 %
	Timer	0.1 to 100 s	10 s
	Enable	OFF ON	OFF
	Fail class	Fail classes	Warning

8.2.17 Under-excitation or reactive power import (ANSI 32RV)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Under-excitation or reactive power import	Q<, Q<<	32RV	< 100 ms

The alarm response is based on the reactive power (Q) to the source, as measured and calculated by the controller. Reactive power import is when the generator is feeding a capacitive load.



Generator > Reactive power protect. > Underexcitation > -Q>

Parameter	Text	Range	Default
1520	Set point	0 to 150 %	50 %
	Timer	0.1 to 100 s	10 s
	Enable	OFF ON	OFF
	Fail class	Fail classes	Warning

8.3 B-side standard protections

B-side protections refer to protective functions for the **load** or **busbar side** of the system.
NOTE Depending on the controller, the parameter is located under **Busbar** or **Busbar B** in the controller menu.

Protection	IEC symbol (IEC 60617)	ANSI (IEEE C37.2)	Operate time	Alarms
Over-voltage	U>, U>>	59P	< 50 ms	3
Under-voltage	U<, U<<	27P	< 50 ms	4
Voltage unbalance	UUB>	47	< 200 ms*	1

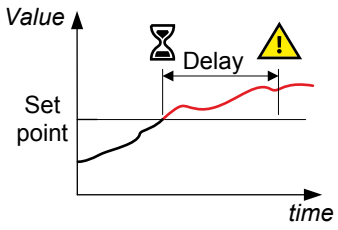
Protection	IEC symbol (IEC 60617)	ANSI (IEEE C37.2)	Operate time	Alarms
Over-frequency	f>, f>>	81O	< 50 ms	3
Under-frequency	f<, f<<	81U	< 50 ms	3

NOTE * The operate time includes the minimum user-defined delay of 100 ms.

8.3.1 Busbar over-voltage (ANSI 59P)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Over-voltage	U>, U>>	59P	< 50 ms

The alarm response is based on the highest phase-to-phase voltage, or the highest phase-to-neutral voltage, from the busbar, as measured by the controller.



Busbar > Voltage protections > Over-voltage > BB U> [1 to 3]

Parameter	Text	Range	BB U> 1	BB U> 2	BB U> 3
1270, 1280 or 1290	Set point	100 to 120 %	103 %	105 %	105 %
	Timer	0.04 to 99.99 s	10 s	5 s	5 s
	Enable	OFF ON	OFF	OFF	OFF
	Fail class	Fail classes	Warning	Warning	Warning

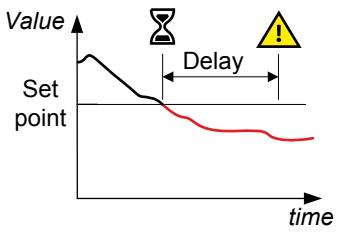
Busbar > Voltage protections > Voltage detect. type

Parameter	Text	Range	Default
1202	BB U detect. type	Phase-Phase Phase-Neutral	Phase-Phase

8.3.2 Busbar under-voltage (ANSI 27P)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Under-voltage	U<, U<<	27P	< 50 ms

The alarm response is based on the lowest phase-to-phase voltage, or the lowest phase-to-neutral voltage, from the busbar, as measured by the controller.



Busbar > Voltage protections > Under-voltage > BB U< [1 to 4]

Parameter	Text	Range	BB U< 1	BB U< 2	BB U< 3	BB U< 4
1300, 1310, 1320 or 1330	Set point	40 to 100 %	97 %	95 %	97 %	95 %
	Timer	0.04 to 99.99 s	10 s	5 s	10 s	5 s
	Enable	OFF ON	OFF	OFF	OFF	OFF
	Fail class	Fail classes	Warning	Warning	Warning	Warning

Busbar > Voltage protections > Voltage detect. type

Parameter	Text	Range	Default
1202	BB U detect. type	Phase-Phase Phase-Neutral	Phase-Phase

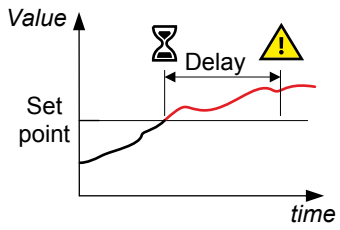
8.3.3 Busbar voltage unbalance (ANSI 47)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Voltage unbalance (voltage asymmetry)	UUB>	47	< 200 ms*

NOTE * The operate time includes the minimum user-defined delay of 100 ms.

The alarm response is based on the highest difference between any of the three busbar phase-to-phase voltage or phase-to-neutral true RMS values and the average voltage, as measured by the controller. The phase-to-phase voltage is the default.

If phase-to-phase voltages are used, the controller calculates the average phase-to-phase voltage. The controller then calculates the difference between each phase-to-phase voltage and the average voltage. Finally, the controller divides the maximum difference by the average voltage to get the voltage unbalance. See the example.



Busbar > Voltage protections > Voltage unbalance > BB Unbalance U

Parameter	Text	Range	Default
1620	Set point	0 to 50 %	6 %
	Timer	0.1 to 100 s	10 s
	Enable	OFF ON	OFF
	Fail class	Fail classes	Warning

Busbar voltage unbalance example

The busbar has a nominal voltage of 230 V. The L1-L2 voltage is 235 V, the L2-L3 voltage is 225 V, and the L3-L1 voltage is 210 V.

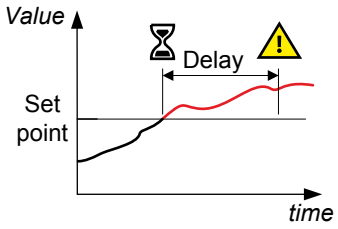
The average voltage is 223.3 V. The difference between the phase-to-phase voltage and the average is 12.7 V for L1-L2, 2.7 V for L2-L3 and 13.3 V for L3-L1.

The busbar voltage unbalance is 13.3 V / 223.3 V = 0.06 = 6 %

8.3.4 Busbar over-frequency (ANSI 81O)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Over-frequency	f>, f>>	81O	< 50 ms

The alarm response is based on the lowest fundamental frequency (based on phase voltage), from the busbar. This ensures that the alarm only activates when all of the phase frequencies are above the set point.



Busbar > Frequency protections > Over-frequency > BB f> [1 to 4]

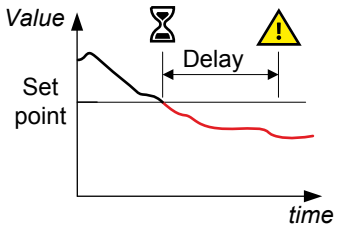
Parameter	Text	Range	BB f> 1	BB f> 2	BB f> 3	BB f> 4
1350, 1360, 1370 or 1920	Set point	100 to 120 %	103 %	105 %	105 %	102 %
	Timer	0.04 to 99.99 s	10 s	5 s	5 s	5600 s*
	Enable	OFF ON	OFF	OFF	OFF	OFF
	Fail class	Fail classes	Warning	Warning	Warning	Warning

NOTE * The range for this alarm is 1500 to 6000 s.

8.3.5 Busbar under-frequency (ANSI 81U)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Under-frequency	f<, f<<	81U	< 50 ms

The alarm response is based on the highest fundamental frequency (based on phase voltage), from the busbar. This ensures that the alarm only activates when all of the phase frequencies are below the set point.



Busbar > Frequency protections > Under-frequency > BB f< [1 to 5]

Parameter	Text	Range	BB f< 1	BB f< 2	BB f< 3	BB f< 4	BB f< 5
1380, 1390, 1400, 1410 or 1930	Set point	80 to 100 %	97 %	95 %	97 %	95 %	95 %
	Timer	0.04 to 99.99 s	10 s	5 s	10 s	5 s	5600 s*
	Enable	OFF ON	OFF	OFF	OFF	OFF	OFF
	Fail class	Fail classes	Warning	Warning	Warning	Warning	Warning

NOTE * The range for this alarm is 1500 to 6000 s.

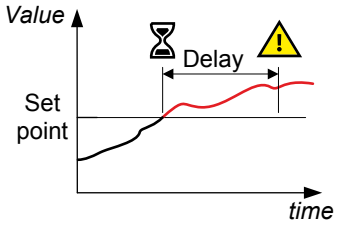
8.4 Other protections

Protection	IEC symbol (IEC 60617)	ANSI (IEEE C37.2)	Operate time	Alarms
EDG Busbar over-current (4th CT)	I>	-	-	2
Neutral over-current (4th CT)	In>	-	-	2
Filtered neutral over-current	Ie>	-	-	2
Reverse power (4th CT)	-P>	-	-	2
Overload (4th CT)	P>	-	-	2

8.4.1 EDG Busbar over-current (4th CT)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
EDG Busbar over-current (4th CT)	I>	-	-

This is the over-current alarm for the busbar current measurement using the fourth current transformer (CT).
The alarm response is based on the busbar current, as measured by the 4th CT.



Generator > Current protections > EDG Busbar over-current (4th CT) > 4th CT I> [1 or 2]

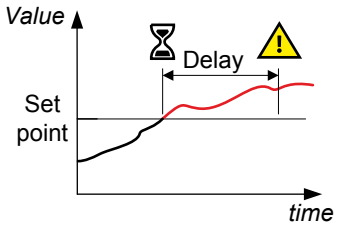
Parameter	Text	Range	I> 1	I> 2
14250 or 14260	Enable	OFF ON	OFF	OFF
	Set point	2 to 120 %	30 %	30 %
	Timer	0.1 to 3200 s	10 s	10 s
	Fail class	Fail classes	Warning	Warning

8.4.2 Neutral over-current (4th CT)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Neutral over-current (4th CT)	In>	-	-

This is the over-current alarm for the neutral current measurement.

The alarm response is based on the unfiltered neutral current, as measured by the 4th current.



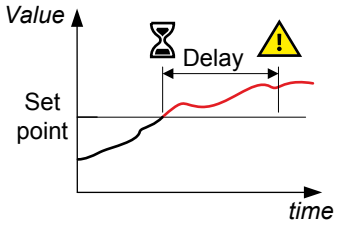
Generator > Current protections > Neutral over-current (4th CT) > 4th CT In> [1 or 2]

Parameter	Text	Range	In> 1	In> 2
14210 or 14220	Enable	OFF ON	OFF	OFF
	Set point	2 to 120 %	30 %	30 %
	Timer	0.1 to 3200 s	10 s	10 s
	Fail class	Fail classes	Warning	Warning

8.4.3 Filtered neutral fault over-current (4th CT)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Filtered neutral fault over-current (4th CT)	IfiltN>	-	-

This is the over-current alarm for the neutral current measurement.
The alarm response is based on the neutral current, as measured by the 4th current measurement filtered to attenuate the third harmonic (at least 18 dB).



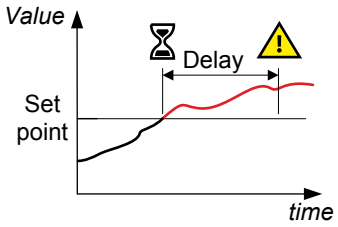
Generator > Current protections > Filtered neutral fault over-current (4th CT) > 4th CT IfiltN> [1 or 2]

Parameter	Text	Range	Ie> 1	Ie> 2
14230 or 14240	Enable	OFF ON	OFF	OFF
	Set point	2 to 120 %	10 %	10 %
	Timer	0.1 to 3200 s	10 s	10 s
	Fail class	Fail classes	Warning	Warning

8.4.4 Reverse power (4th CT)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Reverse power	P<, P<<	-	-

The alarm response is based on the active power (all phases), to the source, as measured by the controller.



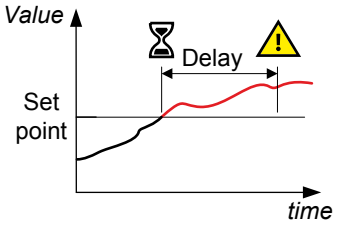
EDG bus > Protections > Power protections (4th CT) > 4th CT -P> [1 to 2]

Parameter	Text	Range	-P> 1	-P> 2
14270 or 14280	Set point	-200 to 0 %	-5 %	-5 %
	Timer	0.1 to 100 s	10 s	10 s
	Enable	OFF ON	OFF	OFF
	Fail class	Fail classes	Warning	Warning

8.4.5 Overload (4th CT)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Overload	P>, P>>	-	-

The alarm response is based on the active power (all phases), from the source, as measured by the controller.



EDG bus > Protections > Power protections (4th CT) > 4th CT P> [1 to 2]

Parameter	Text	Range	P> 1	P> 2
14290 or 14300	Set point	-200 to 200 %	100 %	110 %
	Timer	0.1 to 3200 s	10 s	5 s
	Enable	OFF ON	OFF	OFF
	Fail class	Fail classes	Warning	Warning

9. Inputs and outputs

9.1 Digital inputs

9.1.1 Standard digital inputs

The controller has as standard 12 digital inputs, located on the terminals 39 to 50. All inputs are configurable.

Digital inputs

Input	Text	Function	Technical data
39	Remote Start	Configurable	Negative switching only, < 100 Ω
40	Remote Stop	Configurable	Negative switching only, < 100 Ω
41	In	Configurable	Negative switching only, < 100 Ω
42	In	Configurable	Negative switching only, < 100 Ω
43	In	Configurable	Negative switching only, < 100 Ω
44	In	Configurable	Negative switching only, < 100 Ω
45	In	Configurable	Negative switching only, < 100 Ω
46	In	Configurable	Negative switching only, < 100 Ω
47	TB Position On (EDG)	Configurable (application dependent)	Negative switching only, < 100 Ω
48	TB Position Off (EDG)	Configurable (application dependent)	Negative switching only, < 100 Ω
49	GB Position On	Configurable (application dependent)	Negative switching only, < 100 Ω
50	GB Position Off	Configurable (application dependent)	Negative switching only, < 100 Ω

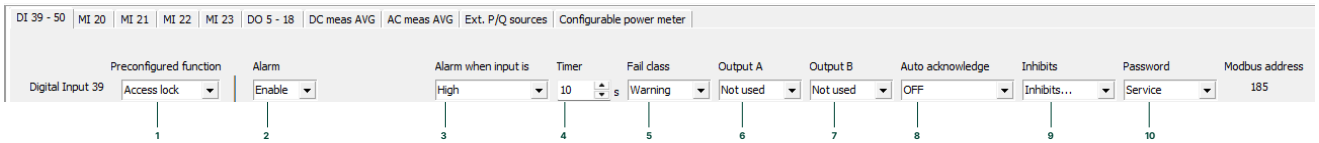
9.1.2 Configuring digital inputs

The digital inputs can be configured from the controller or with the utility software (some parameters can only be accessed with the utility software).

NOTE The configuration of digital inputs 39 to 50 has been moved from parameters 3001 to 3116 to *I/O & Hardware setup*.

Configure a digital input with the utility software

In the utility software, in *I/O & Hardware setup*, select the digital input to configure.



No.	Text	Description
1	Preconfigured function	Select a function for the digital input.
2	Alarm	Enable the alarm function.
3	Alarm when input is	The alarm is activated when the input is high or low.
4	Timer	The timer setting is the time from the alarm level is reached until the alarm occurs.
5	Fail class	Select the required fail class from the list. When the alarm occurs, the controller reacts according to the selected fail class.

No.	Text	Description
6	Output A	Select the terminal (or *Limits*) to be activated by an alarm. Limits make the alarm usable as an input event in M-Logic.
7	Output B	Select the terminal (or *Limits*) to be activated by an alarm. Limits make the alarm usable as an input event in M-Logic.
8	Auto acknowledge	ON: The alarm is automatically acknowledged when the alarm conditions are no longer met.
9	Inhibits	Select the exceptions to when the alarm must be activated.
10	Password level	Select the password level that is needed to modify this parameter.

Select *Write to device*  to write the settings to the controller.

9.1.3 Digital input functions (Single genset)

Default

Function	Details	REMOTE	LOCAL	Test	Block	Type*
Remote start	This input initiates the start sequence of the genset when MANUAL mode is selected.	●				C
Remote stop	This input initiates the stop sequence of the genset when MANUAL mode is selected. The genset stops without cooling down.	●				C
GB position ON	The input function is used as an indication of the generator breaker position. The controller requires this feedback when the breaker is closed or a position failure alarm occurs.	●		●	●	C
GB position OFF	The input function is used as an indication of the generator breaker position. The controller requires this feedback when the breaker is opened or a position failure alarm occurs.	●		●	●	C

Configurable

Function	Details	REMOTE	LOCAL	Test	Block	Type*
Start enable	This input must be activated to be able to start the engine. When the genset is started, the input can be removed.	●		●		C
Remove starter	The start sequence is deactivated. This means the start relay deactivates, and the starter motor disengages.	●		●		C
Low speed	Disables the regulators and keeps the genset running at a low RPM. The governor must be prepared for this function.	●				C
Binary running detection	The input is used as a running indication of the engine. When the input is activated, the start relay is deactivated.	●		●	●	C
Oil pressure alarm	The oil pressure alarm is activated if the oil pressure exceeds the set point. The function automatically sets *Not run status* as the inhibit, the alarm input as *Low*, and *Shutdown* as the fail class.	●		●	●	C

Function	Details	REMOTE	LOCAL	Test	Block	Type*
Water temperature alarm	The water temperature alarm is activated if the water temperature exceeds the set point. The function automatically sets *Shutdown override* as the inhibit, the alarm input as *Low*, and *Shutdown* as the fail class.	●		●	●	C
Remote GB On	The generator breaker close sequence is initiated.	●				p
Remote GB Off	The generator breaker open sequence is initiated.	●				p
Remote start and GB close	Manual start command.	●				p
Remote GB open and stop	Manual de-load, open breaker and stop.	●				p
GB close inhibit	When this input is activated, the generator breaker cannot close.	●		●	●	C
GB racked out	The breaker is considered as racked out when pre-requirements are met and this input is activated.	●				C
GB spring loaded	The controller does not send a close signal before this feedback is present.	●		●	●	C
GB OFF and block	The generator breaker opens, and the genset activates the stop sequence. When the genset is stopped, it is blocked for start.	●				P
Enable GB black close	When the input is activated, the controller is allowed to close the generator on a black busbar, providing that the frequency and voltage are inside the limits in parameter 2110.	●		●	●	C
LOCAL mode	Changes the running mode to LOCAL.	●		●		P
REMOTE mode	Changes the running mode to REMOTE.		●	●		P
Test mode	Changes the running mode to Test.	●			●	P
PID1 Manual Up	The speed control output will be increased.	●		●		C
PID1 Manual Down	The speed control output will be decreased.	●		●		C
PID1 Manual regulation On	This input activates PID regulation.	●		●		C
Access lock	Activating the access lock input deactivates the control display buttons. It is only possible to view measurements, alarms and the log.	●		●	●	C
Remote alarm ack.	Acknowledges all activated alarms, and the alarm LED on the display stops flashing.	●		●	●	C
Shutdown override	This input deactivates all protections except the over-speed protections, the emergency stop input, the fast over-current protection, and the EIC over-speed protection. A			●		C

Function	Details	REMOTE	LOCAL	Test	Block	Type*
	special cool down timer is used in the stop sequence after activation of this input. Active alarms for deactivated protections are shown in the alarm list and log, but the failclass is still inhibited.					
Battery test	Activates the starter without starting the genset. If the battery is weak, the test makes the battery voltage to drop more than acceptable, and an alarm is activated.					P
Temperature control	This input is part of the idle mode function. When the input is high, the genset starts. It starts at high or low speed, depending on the activation of the low speed input. When the input is deactivated, the genset goes to idle mode (low speed = ON), or it stops (low speed = OFF).			●		C
SDU status OK	Status of the shutdown unit (SDU).	●	●	●	●	C
SDU warning	Warning status from the shutdown unit (SDU).	●	●	●	●	C
SDU comm error	Shutdown unit communication error.	●	●	●	●	C
Allow safe regeneration	Refer to **iE 150 AGC 150 Engine communication** for details.	●	●	●		C
Simulate start button push	This input is used to simulate the start button being pushed.	●		●		P
Simulate stop button push	This input is used to simulate the stop button being pushed.	●		●		P
Simulate GB close button push	This input is used to simulate the close breaker (generator) button being pushed.	●		●		P
Simulate GB open button push	This input is used to simulate the open breaker (generator) button being pushed.	●		●		P
Simulate alarm list button push	This input is used to simulate the alarms button being pushed.	●	●	●		P

NOTE * C = Continuous, P = Pulse

More information
See iE 150 AGC 150 Engine communication for digital inputs for specific engine protocols.

9.1.4 Digital input functions (Emergency genset)

Default

Function	Details	AUTO	MANUAL	Test	SWBD	Block	Type*
Remote start	This input initiates the start sequence of the genset when MANUAL mode is selected.		●				C
Remote stop	This input initiates the stop sequence of the genset when MANUAL mode is		●				C

Function	Details	AUTO	MANUAL	Test	SWBD	Block	Type*
	selected. The genset stops without cooling down.						
TB position ON	The input function is used as an indication of the tie breaker position. The controller requires this feedback when the breaker is closed or a position failure alarm occurs.	●	●	●		●	C
TB position OFF	The input function is used as an indication of the tie breaker position. The controller requires this feedback when the breaker is opened or a position failure alarm occurs.	●	●	●		●	C
GB position ON	The input function is used as an indication of the generator breaker position. The controller requires this feedback when the breaker is closed or a position failure alarm occurs.	●	●	●		●	C
GB position OFF	The input function is used as an indication of the generator breaker position. The controller requires this feedback when the breaker is opened or a position failure alarm occurs.	●	●	●		●	C

Configurable

Function	Details	AUTO	MANUAL	Test	SWBD	Block	Type*
Start enable	This input must be activated to be able to start the engine. When the genset is started, the input can be removed.	●	●	●			C
Remove starter	The start sequence is deactivated. This means the start relay deactivates, and the starter motor disengages.	●	●	●			C
Low speed	Disables the regulators and keeps the genset running at a low RPM. The governor must be prepared for this function.	●	●				C
Binary running detection	The input is used as a running indication of the engine. When the input is activated, the start relay is deactivated.	●	●	●		●	C
Oil pressure alarm	The oil pressure alarm is activated if the oil pressure exceeds the set point. The function automatically sets *Not run status* as the inhibit, the alarm input as *Low*, and *Shutdown* as the fail class.	●	●	●		●	C
Water temperature alarm	The water temperature alarm is activated if the water temperature exceeds the set point. The function automatically sets *Shutdown override* as the inhibit, the alarm input as *Low*, and *Shutdown* as the fail class.	●	●	●		●	C

Function	Details	AUTO	MANUAL	Test	SWBD	Block	Type*
Remote GB On	The generator breaker close sequence is initiated.		●				p
Remote GB Off	The generator breaker open sequence is initiated. If the tie breaker is open, then the generator breaker opens instantly.		●				p
Remote TB On	The tie breaker close sequence is initiated.		●				p
Remote TB Off	The tie breaker open sequence is initiated.		●				p
Remote start and GB close	Manual start command.		●				p
Remote GB open and stop	Manual de-load, open breaker and stop.		●				p
GB close inhibit	When this input is activated, the generator breaker cannot close.	●	●	●		●	C
TB close inhibit	When this input is activated, the tie breaker cannot close.	●	●	●		●	C
GB racked out	The breaker is considered as racked out when pre-requirements are met and this input is activated.		●				C
TB racked out	The breaker is considered as racked out when pre-requirements are met and this input is activated.		●				C
GB spring loaded	The controller does not send a close signal before this feedback is present.	●	●	●		●	C
TB spring loaded	The controller does not send a close signal before this feedback is present.	●	●	●		●	C
GB OFF and block	The generator breaker opens, and the genset activates the stop sequence. When the genset is stopped, it is blocked for start.		●				P
Enable GB black close	When the input is activated, the controller is allowed to close the generator on a black busbar, providing that the frequency and voltage are inside the limits in parameter 2110.	●	●	●		●	C
MANUAL mode	Changes the running mode to MANUAL.	●		●		●	P
Test mode	Changes the running mode to Test.	●	●			●	P
AUTO mode	Changes the running mode to AUTO.		●	●		●	P
Block mode	Changes the running mode to Block.	●	●	●			C
Total test	This input is logged in the event log to show that there was a planned main busbar failure.	●	●	●		●	C
PID1 Manual Up	The speed control output will be increased.		●	●	●		C

Function	Details	AUTO	MANUAL	Test	SWBD	Block	Type*
PID1 Manual Down	The speed control output will be decreased.		●	●	●		C
PID1 Manual regulation On	This input activates PID regulation.		●	●	●		C
Access lock	Activating the access lock input deactivates the control display buttons. It is only possible to view measurements, alarms and the log.	●	●	●	●	●	C
Remote alarm ack.	Acknowledges all activated alarms, and the alarm LED on the display stops flashing.	●	●	●	●	●	C
Shutdown override	This input deactivates all protections except the over-speed protections, the emergency stop input, the fast over-current protection, and the EIC over-speed protection. A special cool down timer is used in the stop sequence after activation of this input. Active alarms for deactivated protections are shown in the alarm list and log, but the failclass is still inhibited.	●	●	●	●		C
Battery test	Activates the starter without starting the genset. If the battery is weak, the test makes the battery voltage to drop more than acceptable, and an alarm is activated.	●	●				P
Temperature control	This input is part of the idle mode function. When the input is high, the genset starts. It starts at high or low speed, depending on the activation of the low speed input. When the input is deactivated, the genset goes to idle mode (low speed = ON), or it stops (low speed = OFF).	●	●	●			C
SDU status OK	Status of the shutdown unit (SDU).	●	●	●		●	C
SDU warning	Warning status from the shutdown unit (SDU).	●	●	●		●	C
SDU comm error	Shutdown unit communication error.	●	●	●		●	C
Allow safe regeneration	Refer to **iE 150 AGC 150 Engine communication** for details.	●	●	●			C
Simulate start button push	This input is used to simulate the start button being pushed.		●	●			P
Simulate stop button push	This input is used to simulate the stop button being pushed.		●	●			P
Simulate GB close button push	This input is used to simulate the close breaker (generator) button being pushed.		●	●			P
Simulate GB open button push	This input is used to simulate the open breaker (generator) button being pushed.		●	●			P

Function	Details	AUTO	MANUAL	Test	SWBD	Block	Type*
Simulate TB close button push	This input is used to simulate the close breaker (tie) button being pushed.		●	●			P
Simulate TB open button push	This input is used to simulate the open breaker (tie) button being pushed.		●	●			P
Simulate AUTO mode button push	This input is used to simulate the AUTO mode button being pushed.		●	●			P
Simulate MANUAL mode button push	This input is used to simulate the MANUAL mode button being pushed.		●	●			P
Simulate alarm list button push	This input is used to simulate the alarms button being pushed.	●	●	●			P

NOTE * C = Continuous, P = Pulse

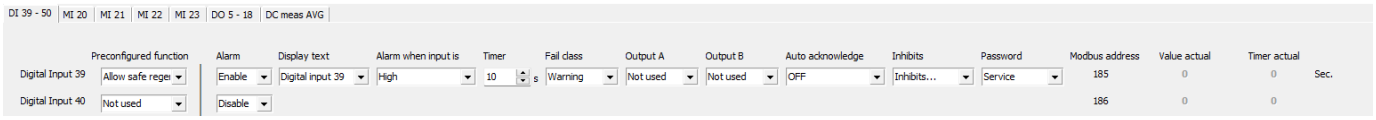
More information
See iE 150 AGC 150 Engine communication for digital inputs for specific engine protocols.

9.1.5 Custom alarms

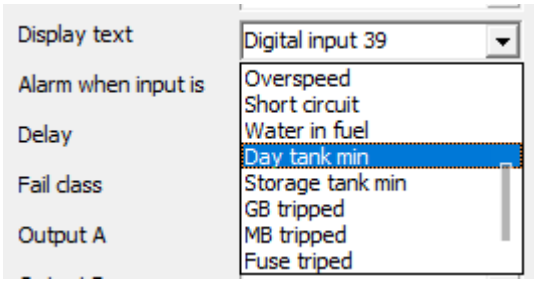
You can configure custom alarms for the digital inputs using the utility software or on the controller.

In the utility software

1. Select the *I/O & Hardware setup* tab.
2. Select one of the digital input tabs.
3. You can configure custom alarms for each active digital input. You must select *Enable* from the *Alarm* drop-down menu to see the alarm options.

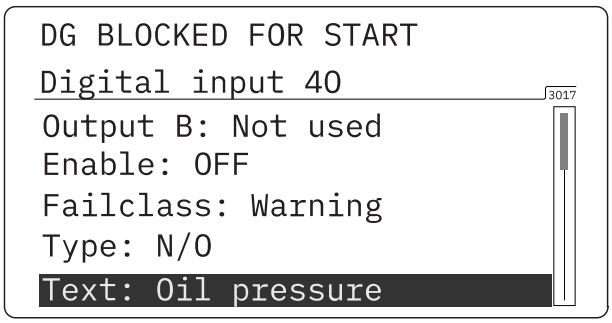


4. Pre-defined display text options are available for the custom alarms:



On the controller

Go to `Parameters > I/O settings > Inputs > Digital inputs > Digital input XX > Text`. Select from a range of pre-defined text options.



9.2 DC relay outputs

The controller has 12 x DC relay outputs as standard. The outputs are divided in two groups with different electrical characteristics.

All outputs are configurable, unless other stated.

Relay outputs, group 1

Electrical characteristics

- Voltage: 0 to 36 V DC
- Current: 15 A DC inrush, 3 A DC continuous

Relay	Genset default setting
Relay 05	Run coil
Relay 06	Starter (Crank)

Relay outputs, group 2

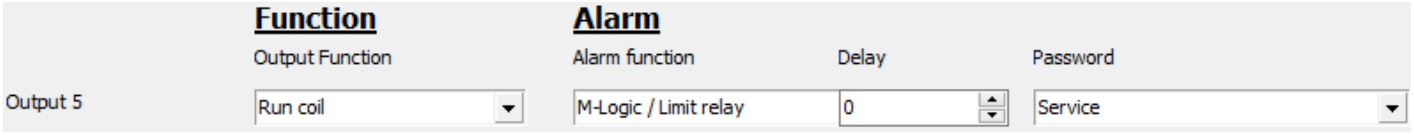
Electrical characteristics

- Voltage: 4.5 to 36 V DC
- Current: 2 A DC inrush, 0.5 A DC continuous

Relay	Default setting
Relay 09	Start prepare
Relay 10	Stop coil
Relay 11	Status OK
Relay 12	Horn
Relay 13	No default
Relay 14	No default
Relay 15	**GEN**: Configurable **EDG**: TB ON relay
Relay 16	**GEN**: Configurable **EDG**: TB OFF relay
Relay 17	GB ON relay
Relay 18	GB OFF relay

9.2.1 Configure a relay output

Use the utility software, under *I/O & Hardware setup, DO 5 - 18* to configure the relay outputs.



Setting	Description
Output function	Select an output function.
Alarm function	Alarm relay NE M-Logic / Limit relay Alarm relay ND
Delay	The alarm timer.
Password	Select the password level to modify this configuration (cannot be edited by a user with lower privileges).

9.2.2 Relay output functions

Function	Activated when
Not used	The digital output is not used.
Status ok	The controller status is okay.
Horn	An alarm is activated and not silenced.
Start prepare	The start sequence activates the start prepare.
Starter (Crank)	The start sequence activates the crank.
Run coil	The start sequence activates the run coil.
Stop coil	The stop sequence activates the stop coil.
Double starter	The start sequence activates the double starter.
Siren	An alarm is activated and not silenced.
Keyswitch	The controller has had power for 5 seconds, and the extended stop timer is not running.
SDU fault reset	This output activates the fault reset input on the SDU 104.
SDU watchdog	This output activates the watchdog input on the SDU 104.
DEF tank output	This output controls the DEF pump. The controller activates the relay when the DEF level is below the start limit.
Fuel tank output	This relay controls the fuel pump. The controller activates the relay when the fuel level is below the start limit.
MANUAL Mode (EDG)	MANUAL mode is activated.
LOCAL Mode (GEN)	LOCAL mode is activated.
AUTO Mode (EDG)	AUTO mode is activated.
REMOTE Mode (GEN)	REMOTE mode is activated.
BLOCK Mode (EDG)	BLOCK mode is activated.
SWBD Mode (EDG)	SWBD mode is activated.
Any alarm present	One or more of the controller alarms are activated.
Hz/V OK expired	Output is activated when acceptable frequency and voltage have not been detected within the configured time limit.
Inducement buzzer	Output is activated when an emission inducement condition is active, causing the inducement buzzer to sound.
In Sync	The voltage, frequency, and phases are synchronised across the breaker.

9.3 Analogue inputs

9.3.1 Introduction

The controller has four analogue inputs (also known as multi-inputs): Multi-input 20, multi-input 21, multi-input 22, and multi-input 23. Terminal 19 is the common ground for the multi-inputs.

The multi-inputs can be configured as:

- 4-20 mA
- 0-10 V DC
- Pt100
- RMI oil pressure
- RMI water temperature
- RMI fuel level
- RMI Custom
- Binary/digital input

The function of the multi-inputs can only be configured with the utility software.

Wiring

The wiring depends on the measurement type (current, voltage, or resistance).

More information
See **Wiring** in the **Installation instructions** for examples of wiring.

9.3.2 Application description

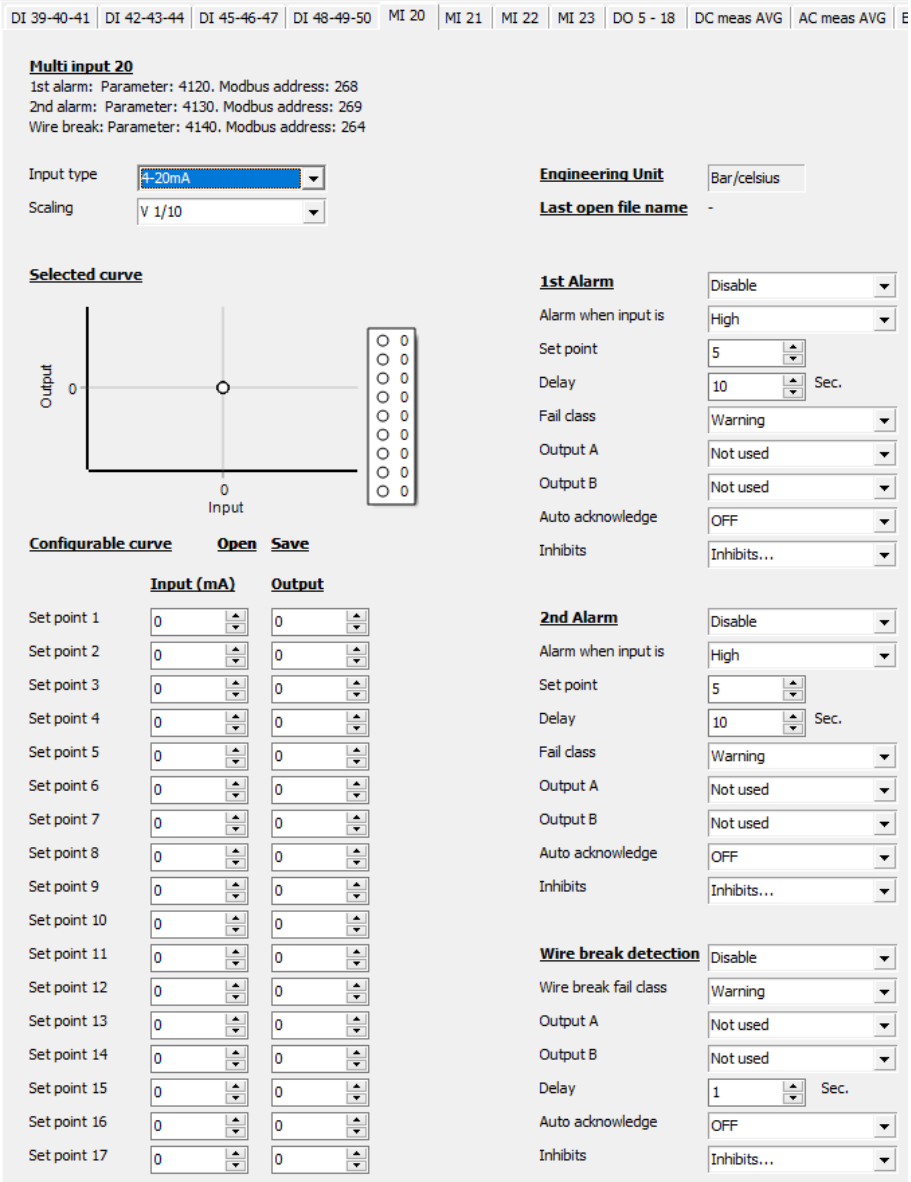
The multi-inputs can be used in different applications, for example:

- Temperature sensor. Pt100 resistors are often used to measure temperature. In the utility software, you can choose whether the temperature should be shown as Celsius or Fahrenheit.
- RMI inputs. The controller has three RMI types; oil, water and fuel. It is possible to choose different types within each RMI type. There is also a configurable type.
- An extra button. If the input is configured as digital, it works like an extra digital input.
- Max. difference between ambient and generator temperature. Differential measurement can be used to give an alarm, if two values are too far apart.

9.3.3 Configuring multi-inputs

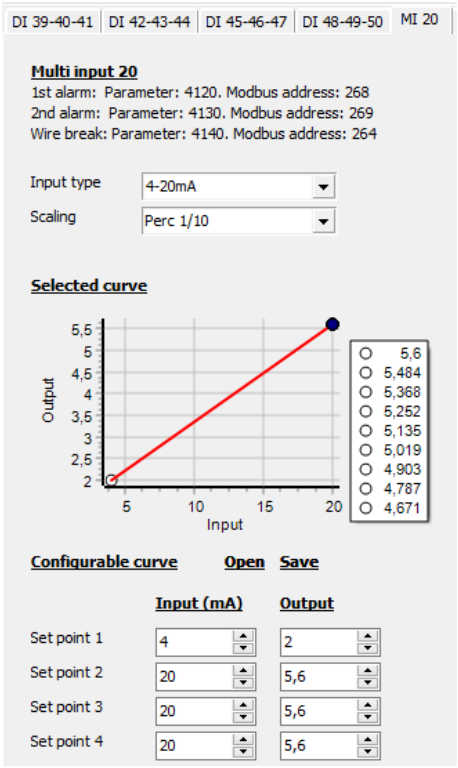
Configure each multi-input to match the connected sensor.

1. In the utility software, select *I/O & Hardware setup*, then select *MI 20 / 21 / 22 / 23*.

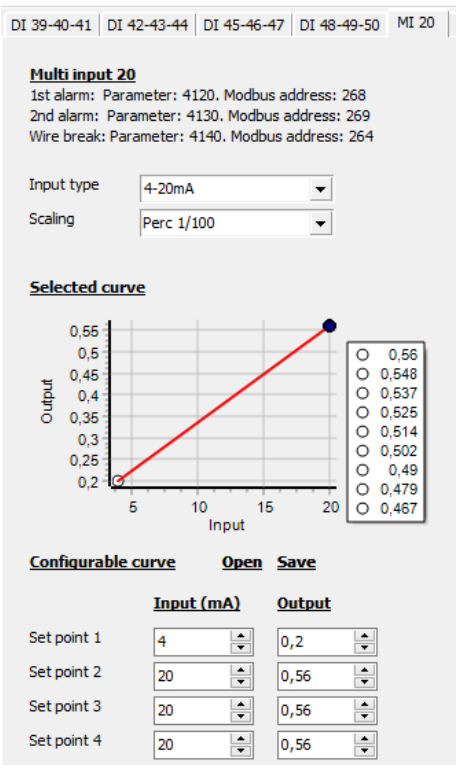


2. Select the appropriate *Scaling*.

Examples



Scaling 1/10

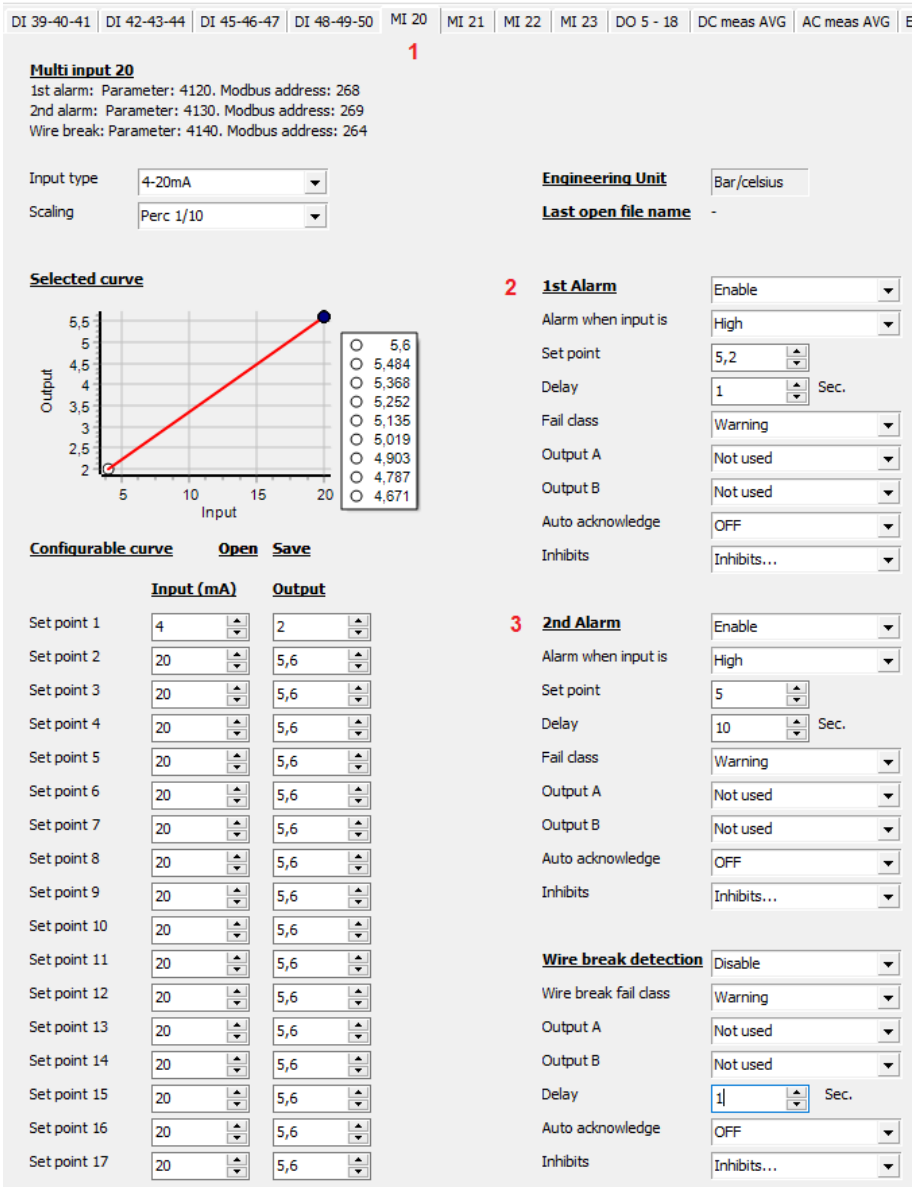


Scaling 1/100

9.3.4 Alarms

For each multi-input, two alarm levels are available. With two alarms it is possible to have the first alarm reacting slow, while the second alarm can react faster. For example, if the sensor measures generator current as protection against overload, a small overload is acceptable for a shorter period, but in case of a large overload, the alarm should activate quickly.

Use the utility software to configure the multi-input alarms. Select *I/O & Hardware setup*, then select *MI 20 / 21 / 22 /23*.



1. Select the desired multi-input tab.
2. Configure the parameters for 1st alarm.
3. Configure the parameters for 2nd alarm.

Sensors with max. output less than 20 mA

If a sensor has a maximum output less than 20 mA, it is necessary to calculate what a 20 mA signal would indicate.

Example: A pressure sensor gives 4 mA at 0 bars and 12 mA at 5 bar.

- (12 - 4) mA = 8 mA = 5 bar
- 1 mA = 5 bar/8 = 0.625 bar
- 20 - 4 mA = 16 × 0.625 bar = 10 bar

Configuring multi-input alarms from the display

Alternatively, you can use the display to configure the multi-input alarms: `I/O settings > Inputs > Multi input > Multi input [20 to 23].1 / 2`

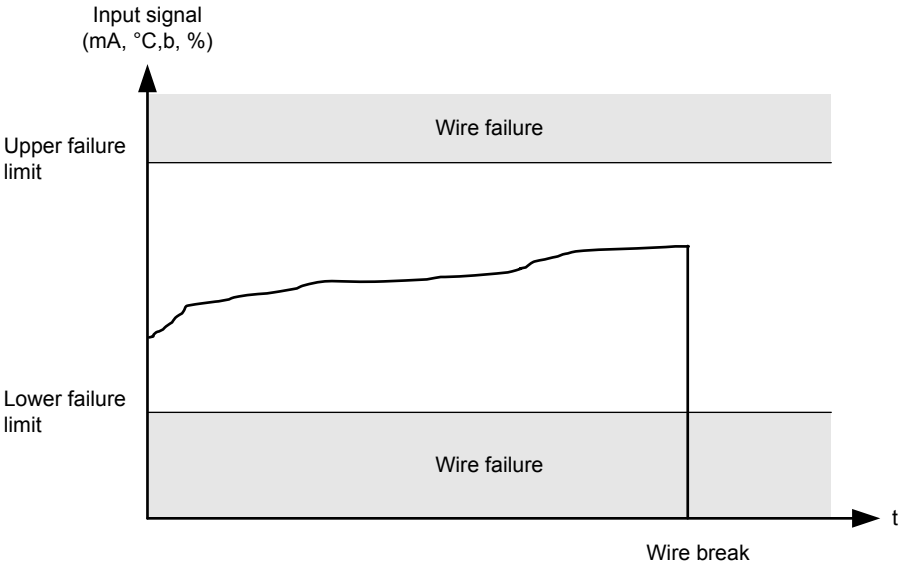
9.3.5 Wire break

To supervise the sensors/wires connected to the multi-inputs and analogue inputs, you can 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 is detected as a short circuit or a break. An alarm with a configurable fail class is activated.

Input	Wire failure area	Normal range	Wire failure area
4-20 mA	<3 mA	4-20 mA	>21 mA
0-10 V DC	≤0 V DC	-	N/A
RMI Oil, type 1	<10.0 Ω	-	>184.0 Ω
RMI Oil, type 2	<10.0 Ω	-	>184.0 Ω
RMI Oil, type 4	<33.0 Ω	-	240.0 Ω
RMI Temp, type 1	<10.0 Ω	-	>1350.0 Ω
RMI Temp, type 2	<18.2 Ω	-	>2400.0 Ω
RMI Temp, type 3	<3.6 Ω	-	>250.0 Ω
RMI Temp, type 4	<32.0 Ω	-	>2500.0 Ω
RMI Fuel, Type 1	<1.6 Ω	-	>78.8 Ω
RMI Fuel, Type 2	<3.0 Ω	-	>180.0 Ω
RMI Fuel, type 4	<33.0 Ω	-	>240.0 Ω
RMI configurable	<lowest resistance	-	>highest resistance
RMI Custom	<lowest resistance	-	>highest resistance
Pt100	<82.3 Ω	-	>194.1 Ω
Level switch	Only active if the switch is open		

Principle

The diagram shows that when the wire of the input breaks, the measured value drops to zero, and the alarm is activated.



Configuring wire break alarms from the utility software or display

You can use the utility software to configure wire break alarms. Alternatively, you can use the display to configure wire break alarms: `I/O settings > Inputs > Multi input > Wire fail [20 to 23]`

9.3.6 RMI sensor types

The multi-inputs can be configured as RMI inputs.

The available RMI input types are:

- RMI oil pressure

- RMI water temperature
- RMI fuel level
- RMI Custom

For each RMI input type, you can select different curves, including a configurable curve. The configurable curve has up to 20 set points. The resistance and the pressure can be adjusted.

NOTE The sensor range is 0 to 2500 Ω.

NOTE If the RMI input is used as a level switch, then no voltage must be connected to the input. If any voltage is applied to the RMI inputs, it will be damaged.

9.3.7 Differential measurement

Differential measurement compares two measurements, and gives an alarm or trip if the difference between two measurements become too large (or too small). To have the alarm activate if the difference between the two inputs is lower than the alarm's set point, remove the check mark from *High Alarm* in the alarm configuration.

It is possible to have up to six comparisons. Two alarms can be configured for each comparison.

`Functions > Delta alarms > Set [1 to 6]`

Parameter	Text	Range	Default
4601, 4603, 4605, 4671, 4673 or 4675	Input A for comparison set [1 to 6]	See the controller	Multi-input 20
4602, 4604, 4606, 4672, 4674 or 4676	Input B for comparison set [1 to 6]		

`Functions > Delta alarms > Set [1 to 6] > Delta ana[1 to 6] [1 or 2]`

Parameter	Text	Range	Default
4611, 4631, 4651, 4681, 4701 or 4721	Set point 1	-999.9 to 999.9	1.0
4621, 4641, 4661, 4691, 4711 or 4731	Set point 2	-999.9 to 999.9	1.0
4612, 4632, 4652, 4682, 4702 or 4722	Timer 1	0.0 to 999.0 s	5.0 s
4622, 4642, 4662, 4692, 4712 or 4732	Timer 2	0.0 to 999.0 s	5.0 s
4613, 4633, 4653, 4683, 4703 or 4723	Output A set 1	Relays and M-Logic	-
4623, 4643, 4663, 4693, 4713 or 4733	Output A set 2		
4614, 4634, 4654, 4684, 4704 or 4724	Output B set 1		
4624, 4644, 4664, 4694, 4714 or 4734	Output B set 2		
4615, 4635, 4655, 4685, 4705 or 4725	Enable set 1	OFF ON	OFF
4625, 4645, 4665, 4695, 4715 or 4735	Enable set 2		
4616, 4636, 4656, 4686, 4706 or 4726	Fail class set 1	Fail classes	Warning
4626, 4646, 4666, 4696, 4716 or 4736	Fail class set 2		

9.4 Using an analogue output as a transducer

You can configure transducers 52 and/or 55 to transmit values to an external system. The values include the controller's set points, and AC measurements. The transducer output range is -10 to 10 V.

You can select a scale for some of the values. For example, for the busbar voltage (parameter 5913), select the minimum in 5915, and select the maximum in 5914.

NOTE These values are also available using Modbus.

Parameters for using an analogue output as a transducer

Parameter	Value	Details
5823, 5824, 5825	P1	Genset active power
5853, 5854, 5855	S	Genset apparent power
5863, 5864, 5865	Q	Genset reactive power
5873, 5874, 5875	PF	Power factor of the power from the genset
5883, 5884, 5885	f	Genset frequency
5893, 5894, 5895	U	Genset L1-L2 voltage
5903, 5904, 5905	I	Genset L1 current
5913, 5914, 5915	U BB	Busbar L1-L2 voltage
5923, 5924, 5925	f BB	Busbar frequency
5933, 5934, 5935	Input 20	The value received by analogue input 20.
5943, 5944, 5945	Input 21	The value received by analogue input 21.
5953, 5954, 5955	Input 22	The value received by analogue input 22.

Power transducer setup example

To set up transducer 55 to transmit the genset power (0 to 2 MW) as a -10 to 10 V signal:

In menu 5823, for *Set point*, select **-10 to 10 V**. For *Transducer A*, select **Transducer 55**.
In menu 5824, select the maximum value (this corresponds to 10 V), that is, **2000 kW**.
In menu 5825, select the minimum value (this corresponds to -10 V), that is, **0 kW**.