ASC 150 Storage

4189341323C

Designer's handbook

DEIF Improve Tomorrow

5. Energy management systems

10. General purpose PID

11. Inputs and outputs

12. Small rental application (ESS-Genset) example

1. Introduction

1.1 About ASC 150 Storage

Use the **ASC 150 Storage** as a **single** controller to add a storage system to an existing site, or with other DEIF controllers in a **power/energy management system**. The controller optimises the battery power, to **save fuel** and maximise green penetration.

Each controller controls and protects an energy storage system (ESS) with communication to a BMS, BCU, and/or a PCS. The controller is **plug-and-play**, and **easy to customise** (with the user-friendly M-Logic tool). You can **easily scale up** from a single controller, to a PMS with a variety of controllers and up to 16 storage controllers.

1.1.1 Controller types

Parameter	Setting	Controller type	Minimum software
9101	Genset unit	Generator controller	S2
	Genset unit	Generator Stand-alone controller	S1
	Mains unit	Mains controller	S2
	BTB unit	BTB controller	S2
	Genset HYBRID unit	Genset-Solar hybrid controller	S2
	ENGINE DRIVE unit	Engine drive controller	S1
	Remote unit	Remote display	None
	ENGINE DRIVE MARINE unit	Engine drive controller for marine use	S1
	Genset MARINE unit	Stand-alone genset controller for marine use	S1
	ASC 150 Storage*	Battery storage controller	S3
	ASC 150 Solar*	Solar controller	S3
	ATS unit	Automatic transfer switch (open transition)	S1
	ATS unit	Automatic transfer switch (closed transition)	S2
	Genset PMS LITE	PMS lite controller	S2

Software packages and controller types

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

- S1 = Stand-alone
  - You can change the controller type to any other controller that uses S1 software.
- S2 = Core
- S3 = Extended
  - You can change the controller type to any other controller type*.
    - * To change to an ASC 150, the controller must have the sustainability option (S10).
- S4 = Premium
  - You can change the controller type to any other controller type*.
    - * To change to an ASC 150, the controller must have the sustainability option (S10).
  - All functions are supported.

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

1.2 Terms and abbreviations

Term	Abbreviation	Explanation
Alternating current	AC	An electric current which periodically reverses direction. A power converter is used to convert alternating current to direct current to charge the batteries. The power converter also converts direct current from the batteries to alternating current.
Apparent power	S	The vector sum of active power (P) and reactive power (Q).
Automatic mains failure	AMF	The ESS automatically supplies power if there is a mains failure. See Automatic mains failure.
Automatic Sustainable Controller	ASC 150 Solar ASC-4 Solar	DEIF's controller to integrate photovoltaic power in an application with other power sources.
Automatic Sustainable Controller	ASC 150 Storage ASC-4 Battery	DEIF's controller to integrate an energy storage system in an application with other power sources.
AGC	AGC 150 AGC-4 Mk II AGC-4	DEIF controllers to control a genset (DG), bus tie breaker (BTB), or a mains (grid) connection.
Battery Control Unit	BCU	The control unit for the ESS. The BCU handles all the internal ESS controls. The BCU is the interface between the ESS and the energy management system.
Battery Management System	BMS	The monitoring system of the battery/energy clusters. The BMS monitors the SOC, and the maximum charge and discharge values. The BMS can also be the control unit for DC breakers and cluster breakers. The ASC can write commands to the BMS.
Brownfield		An installation that already has power generating equipment and controllers. The controllers may be from other suppliers. Therefore the brownfield system cannot be fully controlled by DEIF. For ASC Storage, you can add single controllers or open PMS controllers to a brownfield site. These added controllers can be fully controlled by DEIF.
Busbar	BB	The equipment for the electrical connection of all the sources and the loads. The busbar can also be connected to the mains (grid).
Charge		Power flows to the ESS.
Direct current	DC	A flow of electric charge in one direction. Batteries provide direct current, and are charged using direct current. The power converter converts direct current to alternating current. The power converter also converts alternating current to direct current.
Discharge		Power flows from the ESS.
Droop		For some energy storage systems, you can add droop to the battery regulation, to increase the system stability. See Battery droop.
Energy management	EM	The ASC and AGC controllers work together to follow the energy management rules. They work together to run at the configured set point. In this way, the PV, ESS, mains connection(s), and/or genset(s) run optimally.
Energy management system	EMS	The ASC controllers work with each other, as well as with AGC Genset and Mains controllers. The ASC Storage controllers charge and discharge according to the energy management rules. The AGC Genset controllers start, stop and run at the load required by energy management. The AGC Mains controllers connect and disconnect the mains as required. AGC Bus tie breaker controllers and ALC automatic load controllers can also be used.

Term	Abbreviation	Explanation
		Together, the controllers form an energy management system. This can also be called an integrated system.
Energy storage breaker	ESB	The breaker between the ESS and the conventional power system. The ASC Storage can control this breaker.
Energy storage system	ESS	A container-sized assembly that acts as a battery.
Fixed power		The ESS has a fixed power set point.
Greenfield		A new installation. Since there are no pre-existing controllers, the owner can choose to only use DEIF controllers. The new control system can then consist of ASC and AGC controllers working together for power/energy management.
Grid		National or local electricity grid. Also known as mains.
Grid-tied		The energy storage system is connected to grid/mains power.
Island operation		For island operation, the application is not connected to mains. See Island operation.
Load-dependent start or stop	LDSS	Controller settings that use the system load to determine when to start and stop gensets.
Mains breaker	MB	The breaker between the energy storage system and the grid/mains power.
Mains power export	MPE	This maintains a constant level of exported or imported power through the mains breaker. See Mains power export.
M-Logic		DEIF's PLC-like configurable logic tool.
Multi-line 150	ML 150	One of DEIF's controller series, which includes AGC 150, ASC 150 Storage, and ASC 150 Solar. The controllers work together to provide energy management. ML-2 controllers can also be used with these controllers.
Multi-line 2	ML-2	One of DEIF's controller series, which includes AGC-4, ASC-4 Battery, and ASC-4 Solar. The controllers work together to provide energy management. ML 150 controllers can also be used with these controllers.
Off-grid		The energy storage system is not connected to grid/mains power.
Open PMS		For brownfield energy management applications. Open PMS has ASC Solar and/or Battery/Storage controllers along with other controllers from other vendors. The ASC controllers get power measurements (required for energy management) from the other controllers and/or power meters.
Peak shaving	PS	The maximum mains import set point is not exceeded. See Peak shaving.
Photovoltaic	PV	A system that converts sunlight to electrical power. The system may consist of several solar panels and an inverter.
Power conversion system	PCS	The PCS controls the AC/DC power. During discharging, the power converter converts the direct current from the ESS to alternating current to supply the busbar. During charging, the power converter converts the alternating current from the busbar to direct current to charge the ESS. The PCS also ensures that the ESS is grid forming (island), grid following (grid tie), or has droop control (grid tie-grid V/f support).
Power DC-DC system	PDS	In a DC-coupled application, the PDS is between the PV and ESS.
Power management	PM	DEIF's name for energy management.
Radio Ripple Control Receiver	RRCR	Binary inputs are used for external set point control.
Single controller		The single controller operates based on its own measurements and inputs. The single controller can also use power measurements from other power sources.

Term	Abbreviation	Explanation
		However, single controllers are used in applications without power management.
Source	BA	A power source. This can be a PV system, an ESS, a mains connection, another busbar section, or a genset.
Spinning reserve		Partially loaded and synchronised power sources that can quickly respond to load changes.
State of charge	SOC	The charge in the ESS [%].
State of energy	SOE	The energy in the ESS [kWh].
State of health	SOH	The degree of degradation in the ESS. This could, for example, be based on the charge and discharge of the ESS.
Time of use	TOU	The amount charged for electricity changes according to the time of day.
Utility software	USW	DEIF's software to configure the application and controllers. The USW can also be used to monitor the application, as well as to configure M-Logic.
Virtual synchronous generator	VSG	A power source that follows a droop curve by using the system measurements to adjust its V/f or P/Q set points.

1.3 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

Document	Contents
	• Software variants • Protections • Inputs and outputs • Technical specifications
Designer's handbook	• Principles • Communication • Applications • Controller sequences and functions • Protections and alarms • Regulation • Examples
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

Communication	**ASC 150 Modbus server tables**
	• Modbus address list
	    ◦ PLC addresses
	    ◦ Corresponding controller functions
	• Descriptions for function codes, function groups
	ASC 150 Modbus server User manual
	• Communication and connections
	• Data tables, including Modbus configurator
	• Parameter setting
	• DEIF Open protocol
	ASC-4 Battery ASC 150 Storage Modbus client tables
	• Modbus address list for the *DEIF Generic* protocol (connection to energy storage system)
	• Descriptions for function codes, function groups
	ASC 150 Modbus client User manual
	• Communication and connections
	• Modbus client monitoring
	• DEIF Generic protocols

Application notes	**DEIF Hybrid controller compatibility**
	• Energy storage systems
	    ◦ BCU control
	    ◦ BCU and PCS control
	    ◦ BMS control
	    ◦ PDS control
	• Power measurements
	    ◦ Power meters
	    ◦ Genset controllers
	• PV systems
	• Weather stations and forecast systems
	ASC 150 Storage M-Logic

Document	Contents
	• M-Logic events, and when each events is activated • M-Logic outputs, and the effect of each output
Drawings	• 2D CAD drawing • 2D PDF • 3D STEP-file • 3D PDF • EPLAN

1.3.1 Software version

This document is based on the AGC 150 software version 1.30.

1.4 Warnings and safety

Safety during installation and operation

When you install and operate the equipment, you may have to work with dangerous currents and voltages. The installation must only be carried out by authorised personnel who understand the risks involved in working with electrical equipment.

DANGER!

Hazardous live currents and voltages

Do not touch any terminals, especially the AC measurement inputs or any relay terminals, as this could lead to injury or death.

Current transformer danger

DANGER!

Electrical shock and arc flash

Risk of burns and electrical shock from high voltage.

Short all current transformer secondaries before breaking any current transformer connections to the controller.

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 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.

1.5 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

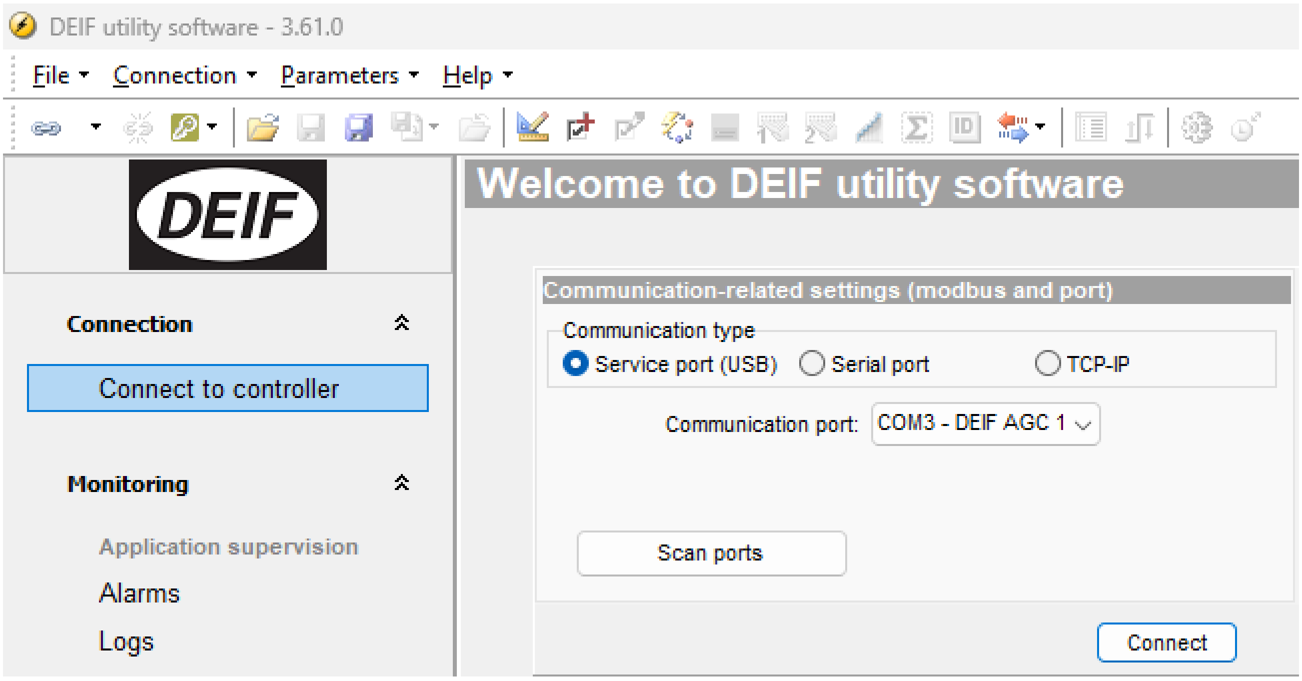
2.2 Connection

You can use a USB connection or TCP/IP to connect to the controller.

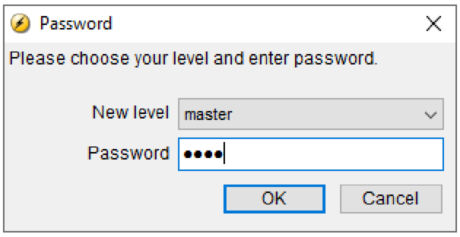
2.2.1 USB connection

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.

2.2.2 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.

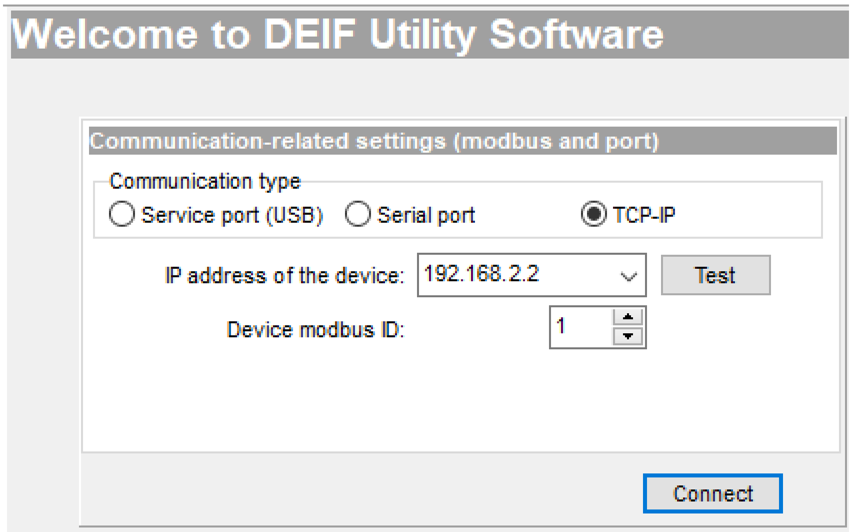
Point-to-point Ethernet connection to the controller

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.

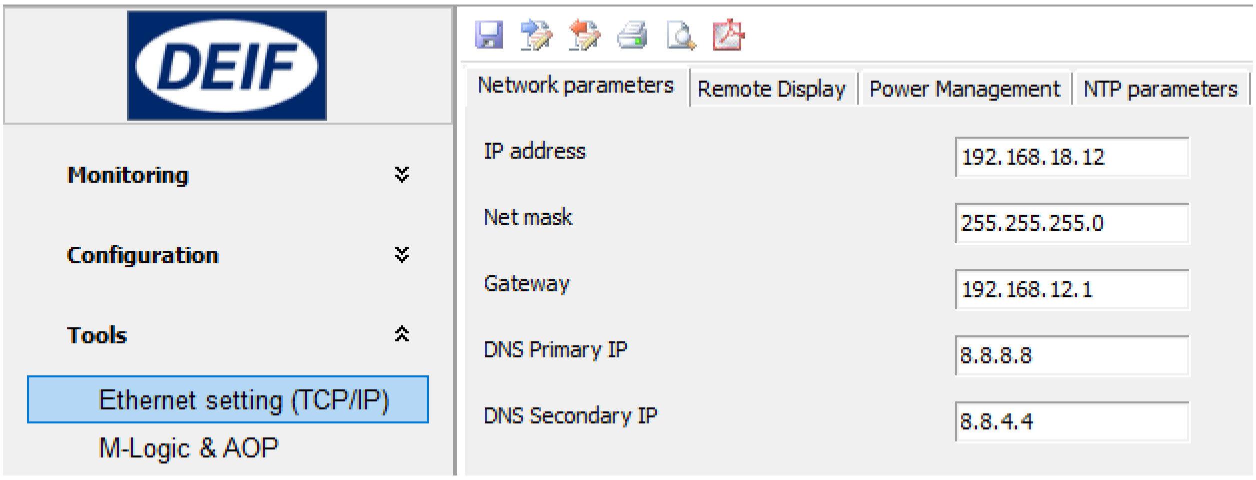


4. You can use the *Test* button to check if the connection is successful.
5. Select *Connect* to connect to the controller using TCP-IP.

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).

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.

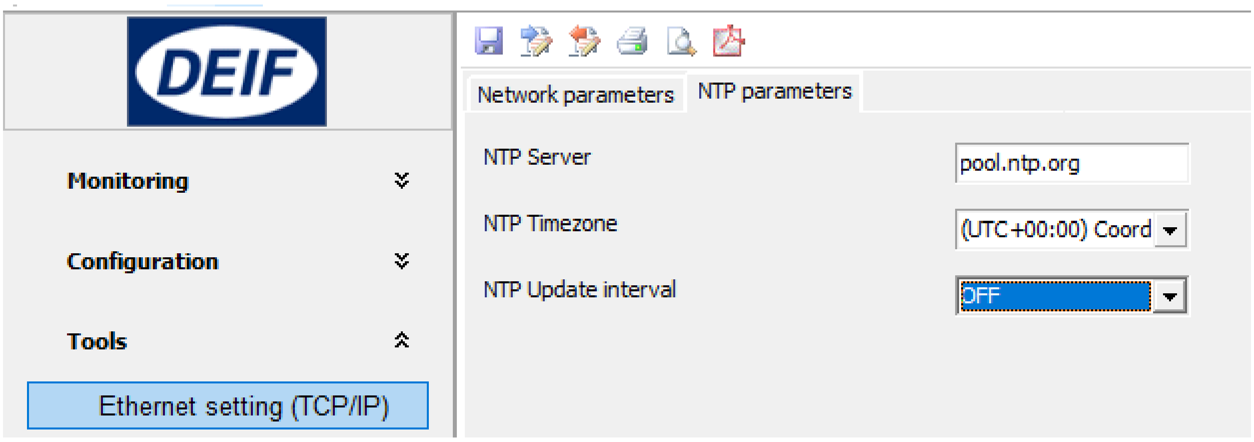
The PC can then be connected to the switch, and the Ethernet cable can be in the same port of the switch at all times. You can enter the controller IP address in the utility software.

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 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.

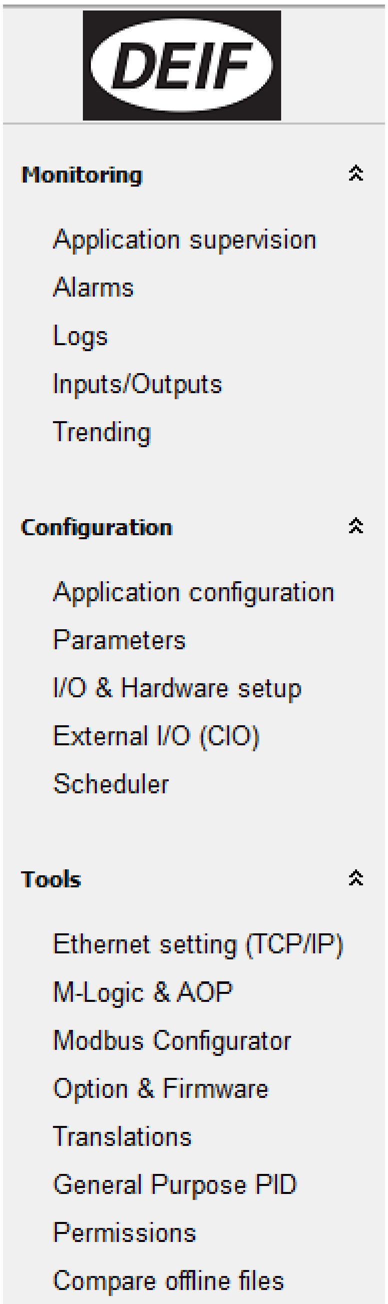
NOTE The selected NTP server must be available in the network.

2.4 Utility software interface

2.4.1 Top toolbar

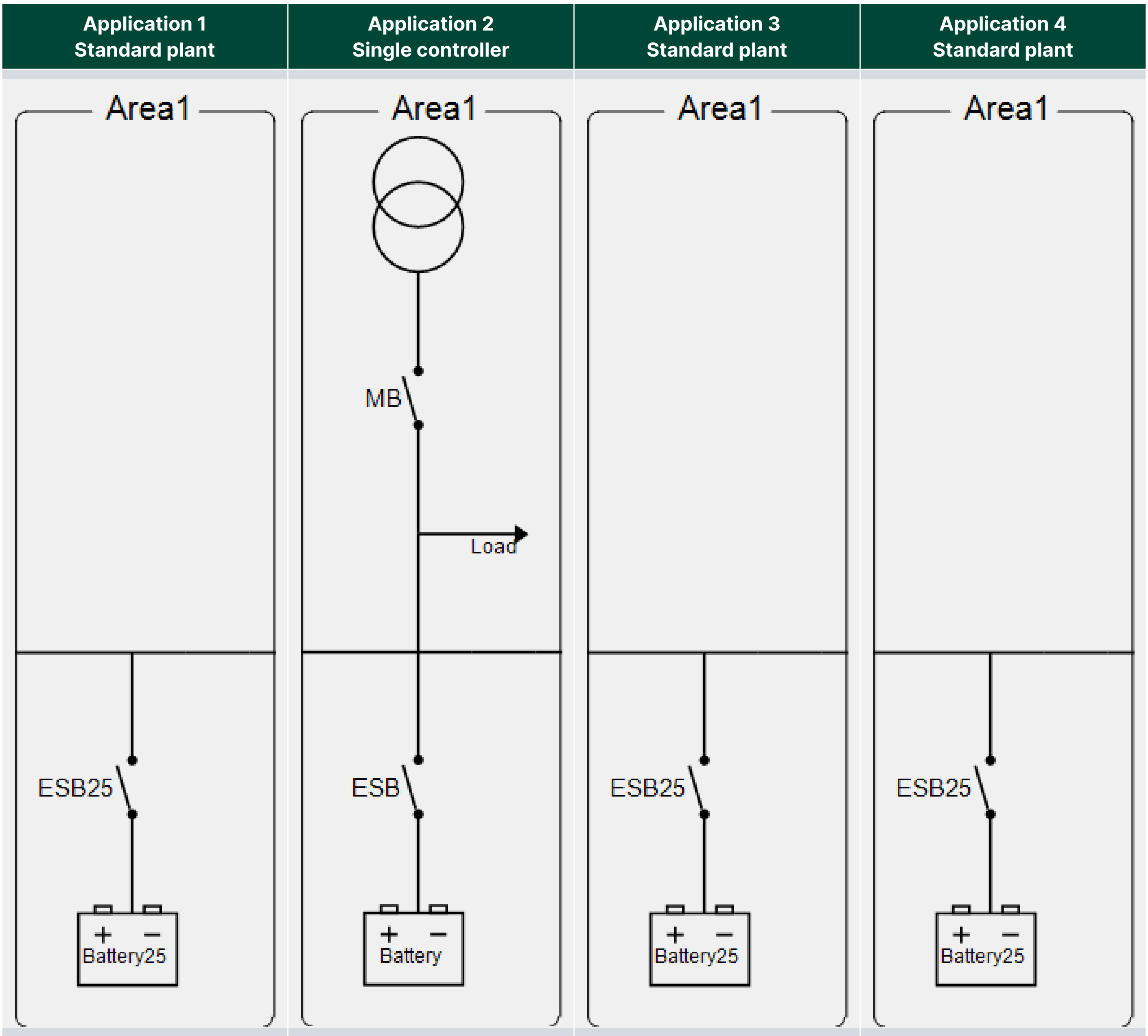
1. Connect to a controller.
2. Disconnect from a controller.
3. Permission level.
4. Application settings.
5. Add options (create an option code and send it to support@deif.com).
6. Enter an upgrade code (received from DEIF support).
7. Update the controller firmware.
8. Configure the display views.
9. Not used for the controller.
10. Configure the AOP-2 buttons and LEDs (Additional Operator Panel).
11. Radio ripple control receiver (RRCR).
12. Read the controller counters.
13. Information on the controller and the software.
14. Read, write, backup, and restore the device.
15. Data tracing (shows the max./min. of a value, as long as the data tracer window is open).
16. Send commands to the controller.
17. Synchronise the controller clock with the connected PC.

2.4.2 Left menu



- **DEIF**
  - Link to www.deif.com
- **Monitoring**
  - 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.
  - I/O & Hardware setup
    - Configure the inputs and outputs.
  - External I/O (CIO)
    - Detect and configure the external inputs and outputs.
- **Scheduler**
  - Configure schedules for the ASC modes and set points.
- **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.
  - Options & Firmware
    - See the available options.
  - Translations
    - Customise or translate (almost all of) the text in the controller.
  - General Purpose PID
    - Configure the general purpose PID settings.
  - Permissions
    - See and change the user permissions.
- Compare offline files
  - Compare utility software project files.

2.5 Set up applications



Select *Application configuration* in the left menu. The controller comes with four pre-configured standard applications. Standard applications 1, 3 and 4 are identical.

The applications can be changed with the utility software.

2.6 Emulation

You can use the utility software to emulate the application.

Requirements:

- One or more controllers, each with its own power supply.
- For multiple controllers, set up a network for PMS over Ethernet, or connect their power management CAN bus terminals.
- A USB or TCP/IP connection from one of the controllers to your PC.
- For each controller, disable the *Emergency STOP* alarm (menu 3490). Alternatively, activate digital input 4 (the emergency stop).

The operation and other inputs can be emulated.

NOTE During emulation, if the controller detects AC voltage, it activates the *Live voltage detected* alarm.

CAUTION

Emulation can start the ESS

During emulation, the controller uses the communication connection to the ESS. If communication is not disabled, the controller can send commands to the ESS. Be very careful about using emulation if the controller is mounted in a real installation.

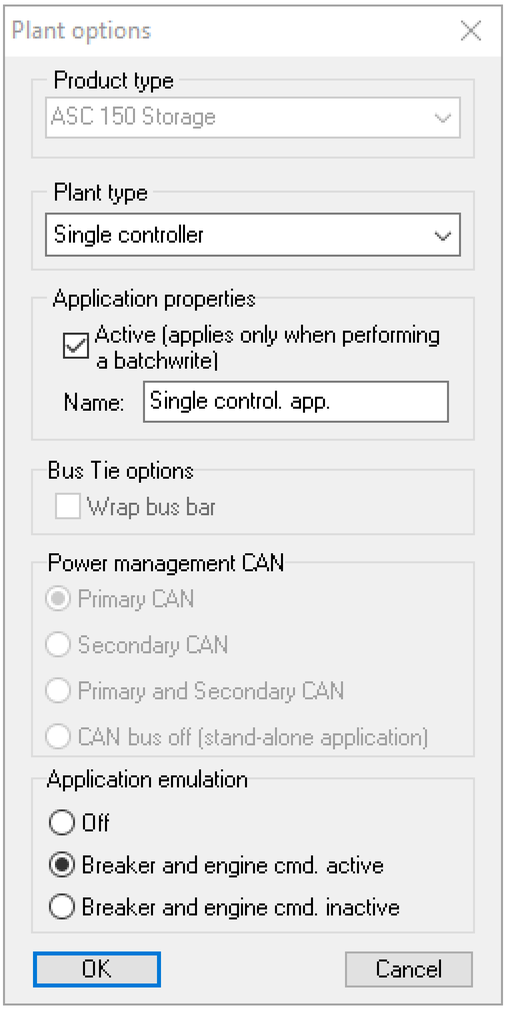
CAUTION

Emulation can activate relays

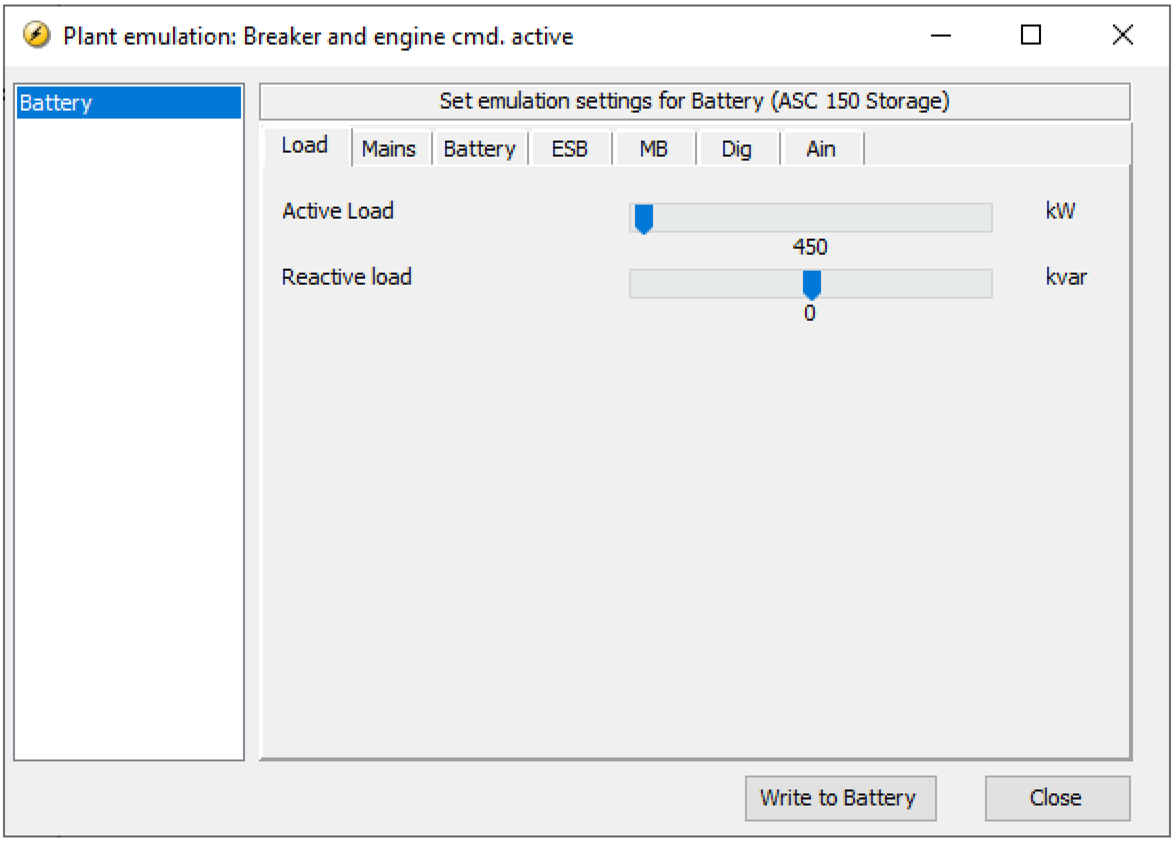
If you select *Breaker and engine cmd. active*, the controller activates its relays (for example, the relay to close a breaker). Be very careful about selecting this if the controllers are mounted in a real installation.

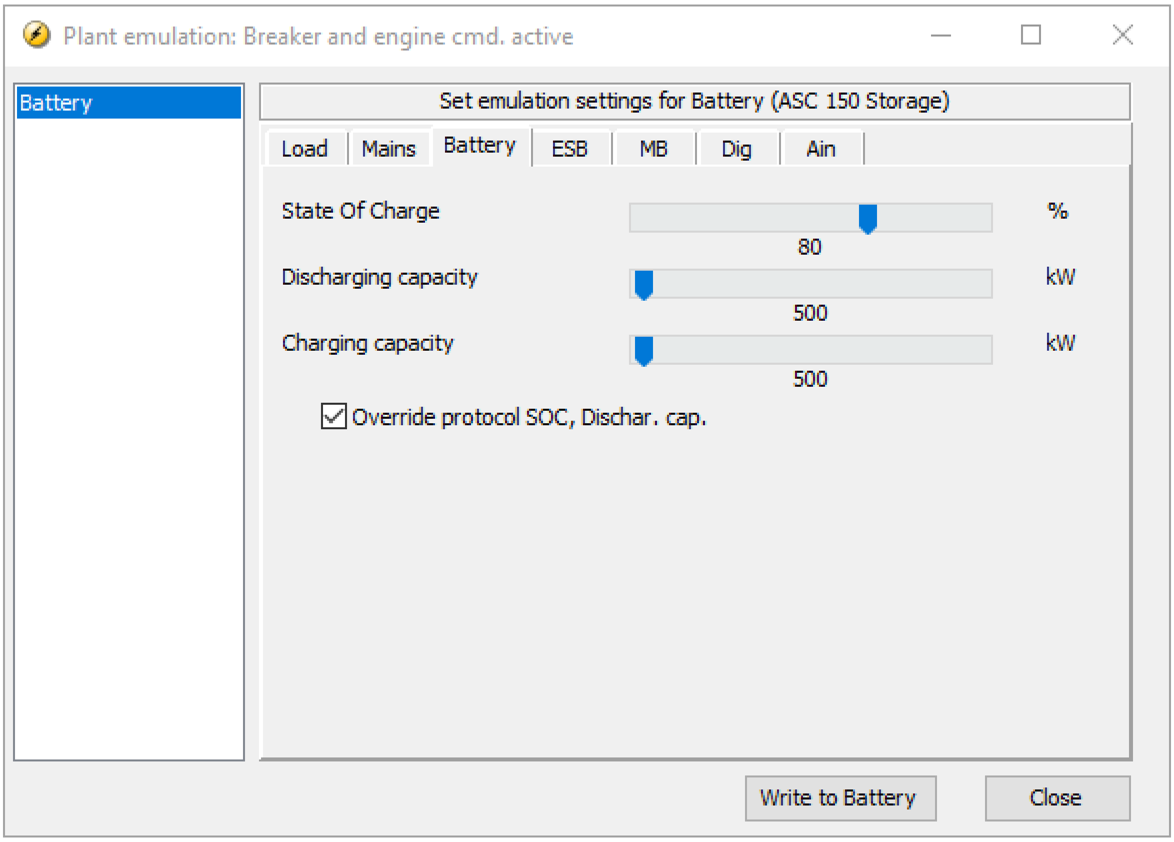
1. Under *Application configuration*, in *Plant options*, select *Breaker and engine cmd. active* or *Breaker and engine cmd. inactive*.
    - For *Breaker and engine cmd. active*, the controllers activate the relays and try to communicate with the ESS. If the controllers are mounted in a real installation, the breakers will open/close and the ESS start/stop.
    - The real installation is not affected if *Breaker and engine cmd. inactive* is selected.

    In real installations, emulation can be used during the commissioning. When the commissioning is done, select *Off* for *Application emulation*.



2. Under *Application supervision*, select *Emulation stimuli* to open the *Plant emulation* box. You can adjust a wide range of plant and input settings.





3. You can see the emulated effect on the plant diagram on the *Application supervision* page.

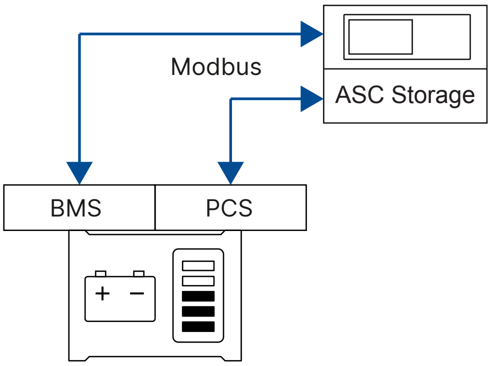
3. Communication

3.1 Overview

The ASC Storage is the link between the ESS and other power sources.

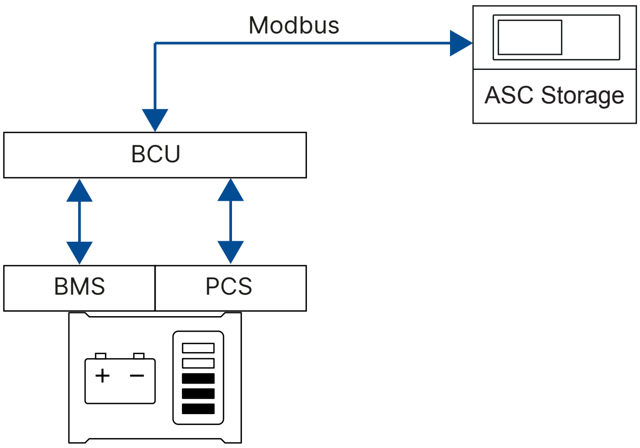
Communication with the battery management system and power conversion system

If the ESS does not have a BCU, the ASC communicates with the battery management system (BMS) over Modbus. The ASC also communicates with the power conversion system (PCS) over Modbus.



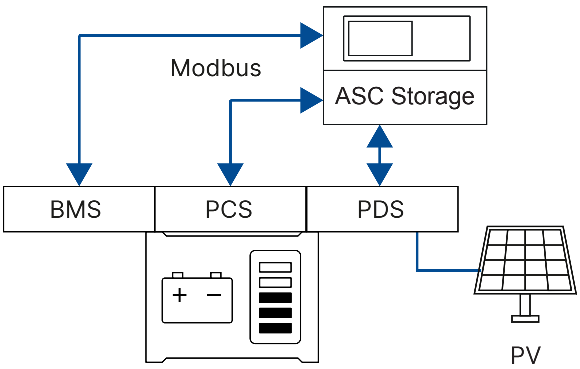
Communication with the battery control unit

If the ESS has a battery control unit (BCU), the ASC communicates with the BCU over Modbus.



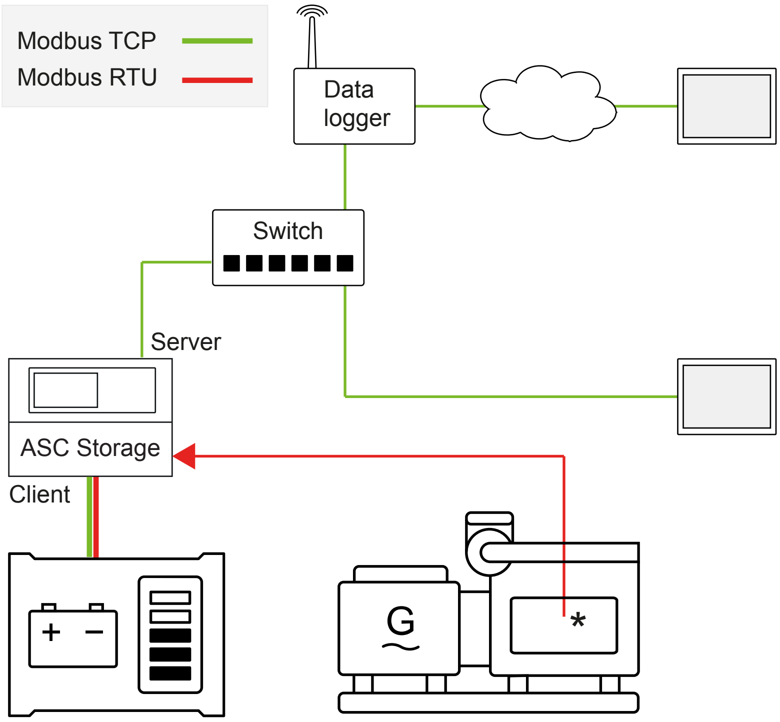
Communication with the BMS, PCS, and Power DC-DC system

If the ESS has a power DC-DC system (PDS), the ASC also communicates with the PDS over Modbus. The PDS can be a separate charger or DC from PV (solar).



3.2 ASC Storage communication

Example of ASC Storage communication for a single controller application



The ASC can communicate over Modbus as the client and/or server device. The ASC can communicate with the ESS using Modbus TCP and/or Modbus RTU. * The ASC reads from power meters or genset controllers using Modbus RTU.

3.2.1 Modbus client and Modbus server

ASC as Modbus client

The ASC can communicate with the energy storage system directly, or through a gateway device.

The ASC uses Modbus for its communication with the BCU, PCS, PDS, or BMS. The ASC is the client and the energy storage system is the server. The ASC transmits the references to the energy storage system using Ethernet (Modbus TCP/IP) or RS-485 (Modbus RTU).

ASC as Modbus server

The DEIF Open protocol uses Ethernet (Modbus TCP/IP) or RS-485 (Modbus RTU). The ESS controller is the client device. Using this protocol, the energy storage system can read the references from the ASC, which is the server device.

Other equipment, for example, a SCADA system or a PLC, can also be the client and use the ASC Modbus server to read operating data and adjust set points.

More information
See **ASC 150 Modbus server tables**, **ASC 150 Storage Modbus client tables**, and **DEIF hybrid controller compatibility**.

3.3 Hardware settings

3.3.1 RS-485

Communication > RS485 > RS485 [1 or 2] > Settings

Parameter	Name	Range	Default	Details
7511 or 7521	Ext. comm. ID [1 or 2]	1 to 247	3	Modbus communication ID for the ASC Modbus server. The external Modbus client uses this ID to communicate with the ASC.
7512 or 7522	Ext. comm.speed[1 or 2]	9600 Baud 19200 Baud 38400 Baud 115200 Baud	9600 Baud	Communication speed for RS-485 [1 or 2]

Communication > RS485 > RS485 [1 or 2] > Communication error

Parameter	Name	Range	Default	Details
7513 or 7523	Timer	1 to 100 s	10 s	Communication error for RS-485 [1 or 2]
7516 or 7526	Enable	OFF ON	OFF	
7517 or 7527	Fail class	Fail classes	Warning	

3.3.2 CAN bus

Communication > CAN protocols

Parameter	Name	Range	Default	Details
7841	CAN A protocol	OFF AOP2 Ext. Modules DEIF	OFF	**AOP2**: CAN [A or B] is connected to an AOP. **Ext. Module DEIF**: CAN [A or B] is connected to a CIO.
7842	CAN B protocol	OFF PMS Primary AOP2 PMS Secondary Ext. Modules DEIF	PMS Primary	
7843	VCAN C protocol	OFF PMS Primary PMS Secondary	OFF	See Using Ethernet for power management.

3.3.3 ESS Modbus TCP/IP settings

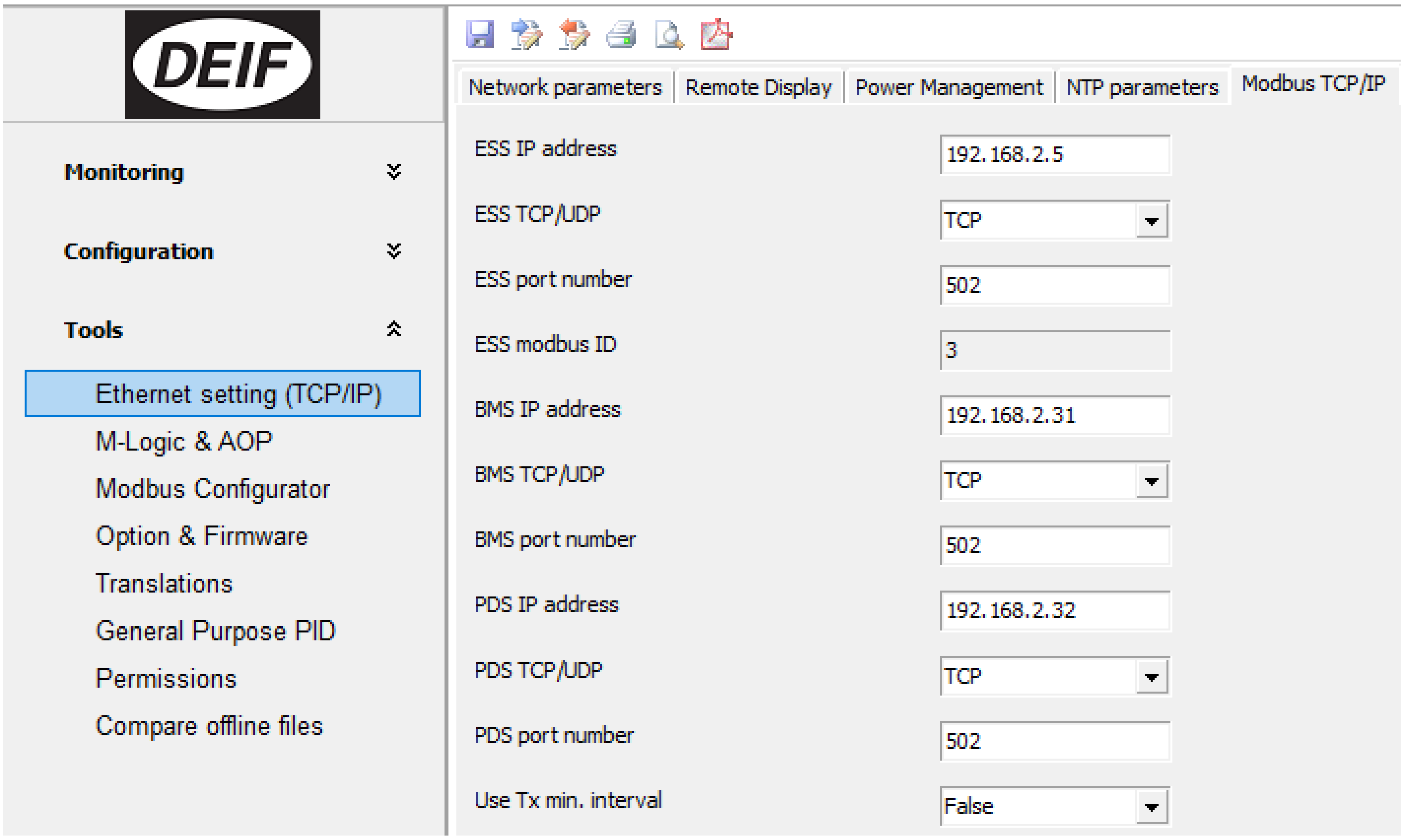
You can use Ethernet connections for Modbus communication to the ESS, BMS and/or PDS.

Display

Configure the ESS, BMS and PDS Modbus TCP/IP settings under `Settings > Modbus TCP/IP setup`

Utility software

On the *Ethernet setting (TCP/IP)* page in the utility software, select *Modbus TCP/IP*, then configure the settings.



Configure the IP addresses, communication type (TCP or UDP), and port numbers for the ESS, BMS and/or PDS.

3.3.4 Ethernet

Communication > Ethernet comm. error

Parameter	Name	Range	Default	Details
7901	Timer	1 to 100 s	10 s	Communication error for the Ethernet port.
7904	Enable	OFF ON	OFF	
7905	Fail class	Fail classes	Warning	

3.4 Protocol parameters

3.4.1 ESS parameters

Communication > ESS

Parameter	Name	Range	Default	Details
7541	ESS comm. intf.	Modbus RTU client 1 Modbus RTU client 2 Modbus TCP/IP client	Modbus RTU client 1	Select the ESS communication interface.
7545	ESS comm. ID	0 to 247	3	The ID given to the ESS to receive and transmit data.
7561	ESS protocol	**See DEIF Hybrid controller compatibility**	Off	Select the protocol that matches your ESS. If the ESS is not in the list, select Off. Additional protocols may be available. Contact DEIF for details.
7562	Tx write type	Unicast	Unicast	Only affects protocols where the ASC is the client.

Parameter	Name	Range	Default	Details
		Broadcast*		* Broadcast is not available yet.
7563	Tx min. interval	0.1 to 10 s	0.5 s	The time that the controller waits (after receiving a telegram) before it sends the next telegram. This only affects protocols where the ASC is the client. For TCP/IP this parameter is only active if *Ethernet setting (TCP/IP), Modbus TCP/IP, Use Tx min. interval* is **True**. If **False**, the communication is as fast as possible.
7564	Tx write fnc.	Single register 0×06 Multiple register 0×10	Multiple register 0×10	Select whether the controller sends Modbus telegrams with only a single register, or multiple registers. Only affects protocols where the ASC is the client.
7570	ESS comm. error	0 to 100 s	3 s, Warning	This alarm activates when there is no communication from the ESS.
7580	ESS warning	0 to 100 s	0 s, Warning	This alarm activates when a warning alarm is present on the ESS.
7590	ESS shutdown	0 to 100 s	0 s, Shutdown	This alarm activates when there is a shutdown alarm present on the ESS.

NOTE The ASC detects communication failure if the ESS does not respond to telegrams.

You can also configure these settings from the display, under `Settings > Communication > ESS`

3.4.2 BMS parameters

`Communication > BMS`

Parameter	Name	Range	Default	Details
7542	BMS comm. intf.	Modbus RTU client 1 Modbus RTU client 2 Modbus TCP/IP client	Modbus RTU client 1	Select the BMS communication interface.
7681	BMS comm. ID	1 to 247	5	The ID given to the PDS to receive and transmit data.
7682	BMS protocol	See **DEIF Hybrid controller compatibility**	OFF	Select the battery management protocol that matches your BMS. If no BMS is available, or the BMS is not in the list, select OFF.
7690	BMS comm. error	0 to 100 s	3 s, Warning	This alarm activates when there is no communication from the battery management system.
7610	BMS warning	0 to 100 s	0 s, Warning	This alarm activates when a warning alarm is present on the BMS.
7620	BMS shutdown	0 to 100 s	0 s, Shutdown	This alarm activates when a shutdown alarm is present on the BMS.

You can also configure these settings from the display, under `Settings > Communication > BMS`

3.4.3 PDS parameters

`Communication > PDS`

Parameter	Name	Range	Default	Details
7543	PDS comm. intf.	Modbus RTU client 1 Modbus RTU client 2 Modbus TCP/IP client	Modbus RTU client 1	Select the PDS communication interface.
7901	PDS comm. ID	1 to 247	5	The ID given to the PDS to receive and transmit data.
7912	PDS protocol	See **DEIF Hybrid controller compatibility**	OFF	Select the Power DC-DC system protocol that matches your PDS. If no PDS is available, or the PDS is not in the list, select OFF.
7910	PDS comm. error	0 to 100 s	3 s, Warning	
7920	PDS warning	0 to 100 s	0 s, Warning	
7930	PDS shutdown	0 to 100 s	0 s, Shutdown	

You can also configure these settings from the display, under `Settings > Communication > PDS`

3.4.4 Power meter parameters

`Communication > Power meter`

Parameter	Name	Range	Default	Details
7544	Meter comm. intf.	Modbus RTU client 1 Modbus RTU client 2	Modbus RTU client 1	Select the power meter communication interface.
7761	Pow. met. Tx min int	0.1 to 10 s	0.5 s	Minimum time between ASC telegrams to the power meters.
7721	DG meter prot.	See **DEIF Hybrid controller compatibility**	OFF	Select the power meter protocol that matches the power meter. Note that all genset power meters must use the same protocol.
7723	ESS meter prot.	See **DEIF Hybrid controller compatibility**	OFF	Select the power meter protocol that matches the power meter.
7725	Mains meter prot.	See **DEIF Hybrid controller compatibility**	OFF	Select the power meter protocol that matches the power meter.

These parameters are used for all the power meters connected to the controller.

More information
See **Power measurements and connection status** for the genset meter and mains meter parameters.

More information
See **Storage controller functions** for the ESS meter parameters.

3.4.5 Configurable power meter

You can use the *Configurable power meter* function to configure the Modbus communication to power meters. This function is useful for a power meter that is not included in the **DEIF Hybrid controller compatibility** list.

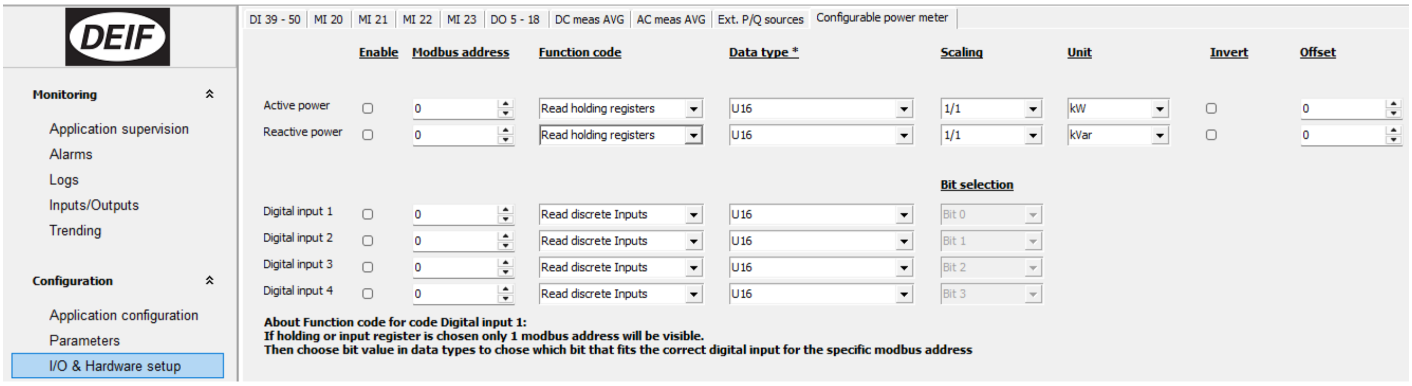
Parameters

For *DG meter prot.* (parameter 7721), *ESS meter prot.* (parameter 7723), and/or *Mains met. prot* (parameter 7725), select *Configurable power meter*.

NOTE You can only have one type of configurable power meter in an ASC 150 controller.

Configurable power meter setup

In the utility software, under *I/O & Hardware setup*, select the *Configurable power meter* tab.

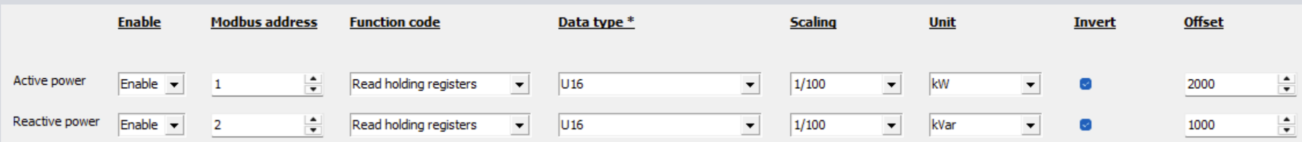


Configure the power measurements

1. Select **Enable** for the power measurements that the power meter supports.
2. For each power measurement, configure the Modbus address, function code, data type, scaling, and power unit. If the sign (positive or negative) of the value must be reversed, select *Invert*. If the measurement value is offset, configure the offset.

Example of power measurement configuration

The ASC has the following power measurement configuration:



If the value that the ASC reads from the power meter for active power is 19876, and the reactive power value is 12345:
Active power = - (19876 + 2000)/100 kW = -218.76 kW
Reactive power = - (12345 + 1000)/100 kvar = -133.45 kvar

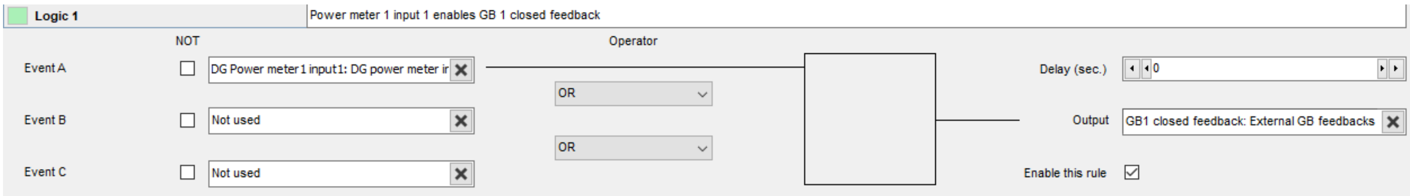
Configure the digital inputs

1. Select **Enable** for the digital inputs that the power meter supports.
2. For each digital input, configure the Modbus address, function code, and data type.
   a. If you select *Read holding registers* or *Read input registers* for the function code, you can only use the first Modbus address for the digital inputs.
   b. When the data type is *Bit value*, select the bit under *Bit selection*.

Connect the digital inputs to breaker feedback

If the breaker status is included in the power meter protocol, configure M-Logic to connect the output from the power meter to enable the corresponding equipment.

For example, in an Open PMS application, external source 1 is a genset. Digital input 1 from the power meter is activated when the generator breaker is closed:



Check the configuration

In the utility software, under *Application supervision*, select the *Power meter data* icon to open the *Power meter data* window. Here you can see the power measurement values, as well as the bit values for the digital inputs.

3.5 Troubleshooting

You can use the display to check whether the communication is connected for each external device. You can also see communication details from the display.

Under `Service view > Communication analysis`, you can see:

- Modbus client RTU port 1
- Modbus client RTU port 2
- Modbus client TCP/IP
- TCP/UDP multi node status

For each selection, you can see configuration and operating details. For example, for *Modbus client TCP/IP*, you can see:

- Details for each connected device (use *<Prev.* and *Next>* to navigate)
    - IDs, Rx and Tx info, IP address, connected (true or false), and so on.

More information
See **Modbus Troubleshooting** in the **ASC 150 Modbus client User manual** for a list of Rx status texts and their reasons.

3.6 Remote monitoring

3.6.1 Monitoring solutions

A range of remote monitoring solutions is possible.

For an existing system, you can use the Ethernet TCP/IP connection or one of the RS-485 ports of the ASC. All data in the Modbus protocol can then be polled from the device. The ASC acts as a server device in the system. For example, this solution can be used in HMI or SCADA systems.

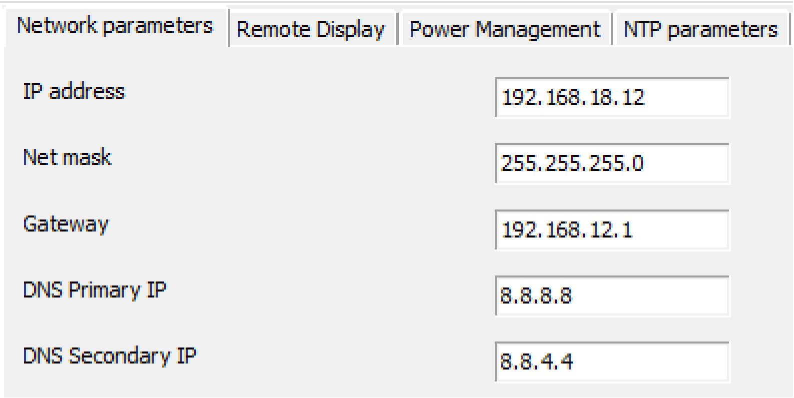
Another solution is to install a gateway, giving access to a cloud-based database. This gives an accessible front portal. Live data and log data are sent to a server (depending on the solution). **Insight** is DEIF's ready-made solution for remote monitoring.

Alternatively, the gateway can work as an actual remote gateway. In this solution, the DEIF PC utility software can be accessed with all the control and monitoring functions needed (control can be switched off, or made user level-dependent).

3.6.2 Modbus server TCP connection

The controller's Ethernet connection is used for remote or local monitoring.

You can use the utility software to see (or set up) the controller. On *the Ethernet setting (TCP/IP)* page, open *Network parameters*.



Alternatively, use the display: `Settings > Communication > Ethernet setup`

3.6.3 DEIF remote monitoring

The DEIF remote monitoring system is a hybrid monitoring system that provides ESS values and other relevant plant values. Values, alarms and logs can be seen from both the ASC and the BCU, PCS, PDS, and BMS. Alternatively, all the values, alarms and logs can be seen from the ASC.

3.6.4 ESS values

The controller includes a generic Modbus client that can access various values from the supported BCU, PCS, PDS, and BMS. The available values depend on the BCU, PCS, PDS, and BMS. For compatible systems, see **DEIF hybrid controller compatibility**.

The **ASC Modbus client tables** show which values are supported. Available ESS data can be read from the ASC Modbus server using the TCP/IP port.

4. Single-controller applications

4.1 Single controller

The ASC can operate as a single controller, that is, without power management communication to other DEIF controllers. Single controllers are particularly useful for brownfield applications (the ASC is installed in an existing plant). Single controllers can also be used in greenfield applications.

In a single-controller application, the ASC controller operates as the only DEIF controller in the system. The ASC is the link to the ESS.

To control the ESS power set point, the single controller must get the power measurements and breaker positions for the power sources in the rest of the application. You can use transducers, or the ASC can read Modbus values from power meters, external genset controllers, or a PLC.

ASC can be used in single controller applications that are off-grid, grid-tied, or a combination. There is a maximum of 16 grid connections, and there can be up to 16 gensets. If there is more than 1 grid connection, the ASC interacts with the grid connections as if there was only 1 grid connection.

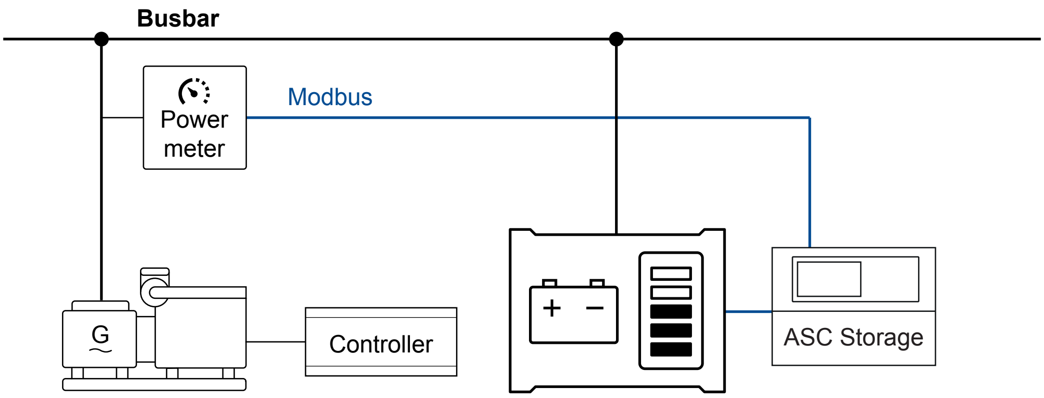
The ASC calculates the charging and discharging set points. The set points are determined by:
- The operating mode
- The system load and configuration
- The state of charge in the storage
- The maximum charge and discharge capacity for the storage
- The power readings from the other power source(s)
- The breaker position(s) of the other power source(s)

4.2 Modes of operation

4.2.1 Off-grid applications

In a single controller off-grid application, the ASC can only use island operation.

Single controller off-grid ESS application

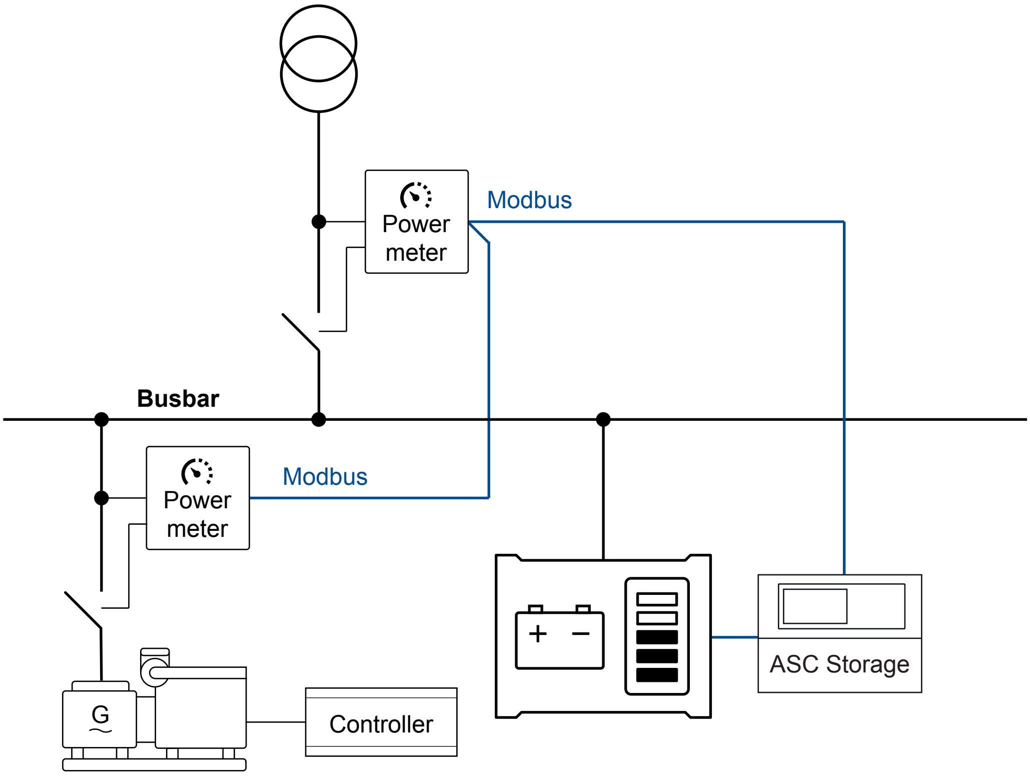


4.2.2 Grid-tied applications

In a single controller combination application, the ASC can have the following modes of operation:
- Mains breaker open (that is, off-grid):
  - Island mode
  - AMF (Automatic Mains Failure)
- Mains breaker closed (that is, grid-tied):

- MPE (Mains Power Export)
- Peak shaving
- Fixed power
- AMF (Automatic Mains Failure)

Single controller grid-tied ESS application



NOTE Gensets are not required in a grid-tied application.

4.3 Setup of a single controller application

In a single controller application, the ASC 150 Storage can control one ESS, one ESS breaker (ESB), and one mains breaker (MB). The ASC 150 can also send start and stop signals to gensets.

You can use the display or the utility software to set up a single controller application.

4.3.1 Application setup using the display

`Parameters > Functions > Quick setup`

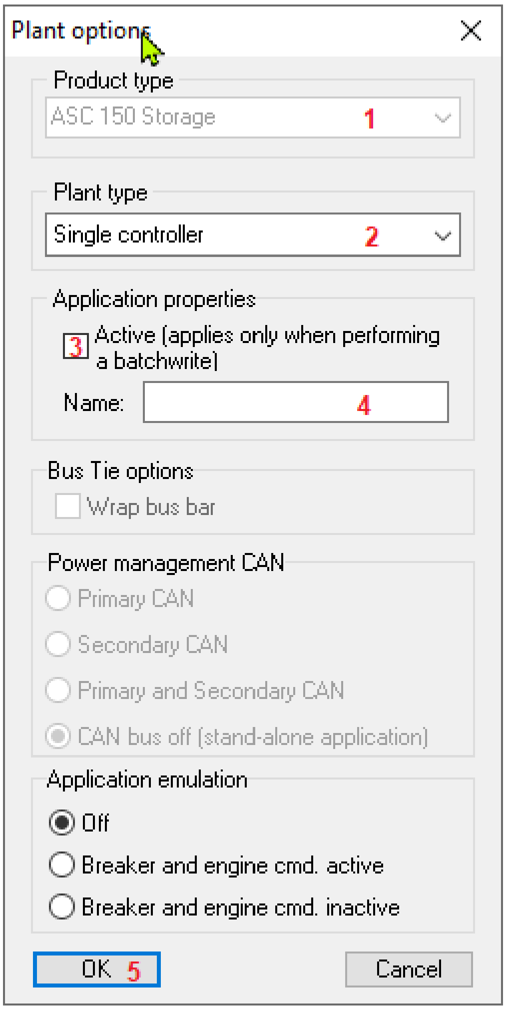
Name	Range	Default	Details
Mode	Off Setup stand alone Setup plant Adapt plant	Off	Select **Setup stand alone**.
CAN line	Off CAN PM Primary CAN PM Secondary	Off	Select **Off**.
MB	Pulse No breaker EXT/ATS Continuous ND Continuous NE	Pulse	Select the mains breaker type.

Name	Range	Default	Details
	Compact		
ESB	Pulse No breaker External Continuous NE	Pulse	Select the ESS breaker type.
Mains	Mains present No mains present	Mains present	Select whether there is a mains connection.
ESS	Single controller Standard	Standard	Select **Single controller**.

4.3.2 Application setup using the utility software

When connected to the controller with the utility software:

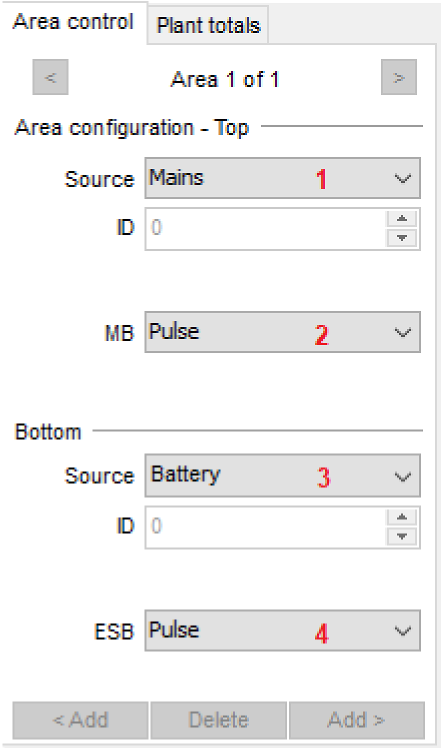
1. Select *Application configuration*
2. Select *New plant configuration*
3. The *Plant options* window opens.



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
   - Mains
   - Battery
2. Select the breaker type for the mains breaker:
   - Pulse
   - Continuous NE
   - Compact
   - Ext
   - None
   - Continuous ND
3. Select the power source to show in the bottom area:
   - None
   - Mains
   - Battery
4. Select the breaker type for the ESS breaker:
   - Pulse
   - Ext/ATS no control
   - Continuous NE
   - None

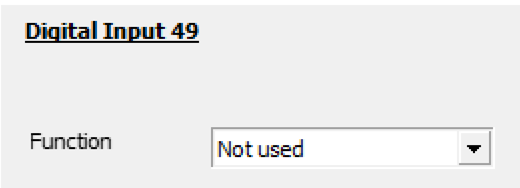
After the application drawing is created, press *Write plant configuration to device*  to send the configuration to the connected controller.

4.4 Breaker control

Single controller application without a breaker

If you created a single controller application without an ESS breaker, reset any ESS breaker feedback in the I/O setup list:

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

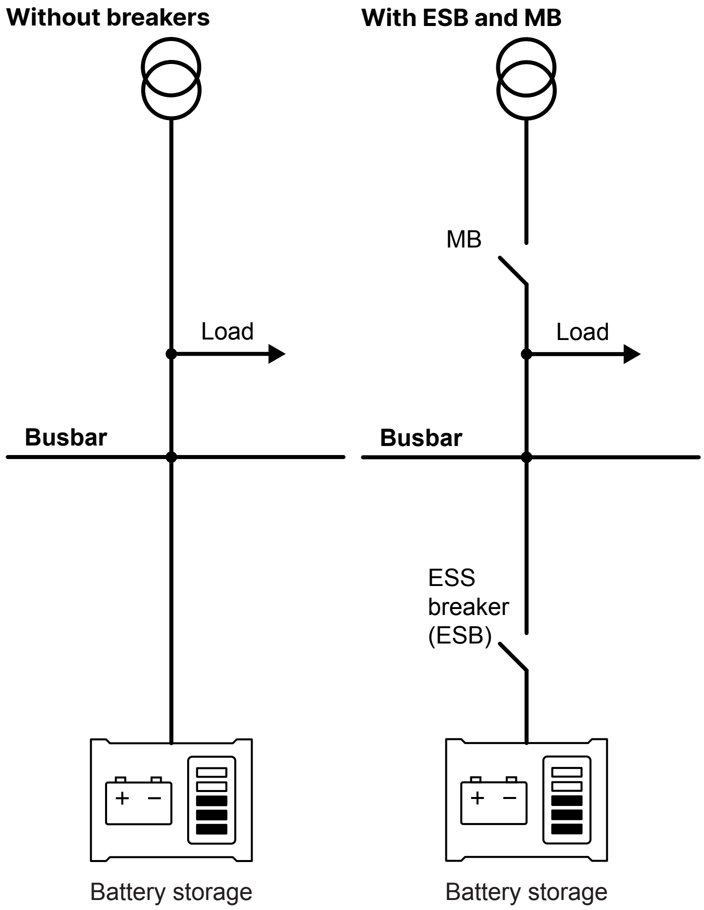


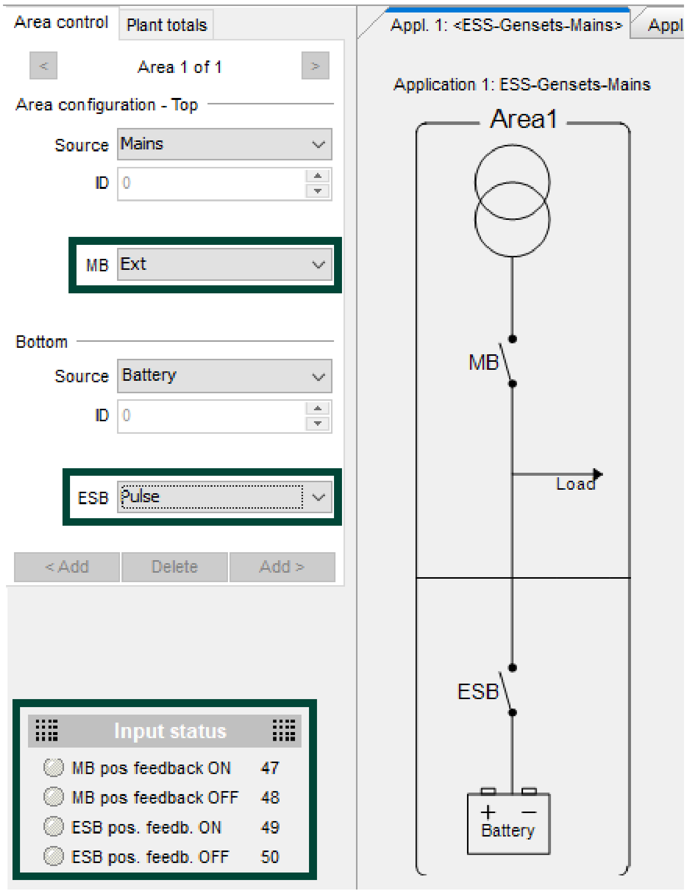
Single controller applications with breakers

In a single controller application, the ASC can control up to two breakers. This can be the ESB (energy storage breaker) and/or a mains breaker. If genset breakers are present, the ASC cannot control all three breakers. The ASC only receives the breaker feedback (open/closed).

Use the *Application configuration* page in the USW to add/remove the ESB and/or mains breaker to match the application. The controller automatically assigns digital inputs* for the breaker feedbacks and relays for the breaker control.

NOTE * To use breaker feedbacks from a mains power meter, configure these in M-Logic. Note that digital inputs are required if the ASC controls the breaker. See Mains power measurement from power meter communication.





4.5 Power measurements and connection status

For a single controller application, the ASC needs the active power from all the other power sources in the system. The ASC also needs the connection status of the other power sources.

The reactive power is optional, but is required if the ASC must control the reactive power. To control reactive power, the ASC must also have the premium software version.

There is a range of ways to get this information, using Modbus or analogue transducer signals.

	Active power (P)	Reactive power (Q)	Connection status
Power meter*	●	●	●
External genset controller*	●	●	●
DEIF open communication	●	●	●
Transducer (Modbus or analogue)*	●	●	-
ASC 4th current transformer**	●	●	-
Digital input	-	-	●

NOTE * Check the compatibility list to make sure that the power meter, external genset controller, or transducer supports all these measurements.

NOTE ** Only for a mains connection. The controller uses the single-phase current measurement to calculate the mains power.

4.5.1 Power meters and genset controllers

The ASC supports a wide range of power meters, as well as communication with genset controllers from other manufacturers.

More information
See the **DEIF hybrid controller compatibility** documents for a list of compatible power meters and genset controllers.

Connection status

If the power meter/genset controller does not include the connection status, you must configure a digital input.

4.5.2 Genset power measurement from power meter communication

For a single controller application, the genset active power and breaker positions must be monitored. Genset reactive power is optional, and is only required if the ASC must control reactive power. The application can include up to 16 gensets. There are a number of ways for the ASC to get the genset power measurements.

Genset power measurement from power meter communication is described here. Power meter communication includes power measurements and breaker feedback from power meters, or from genset controllers.

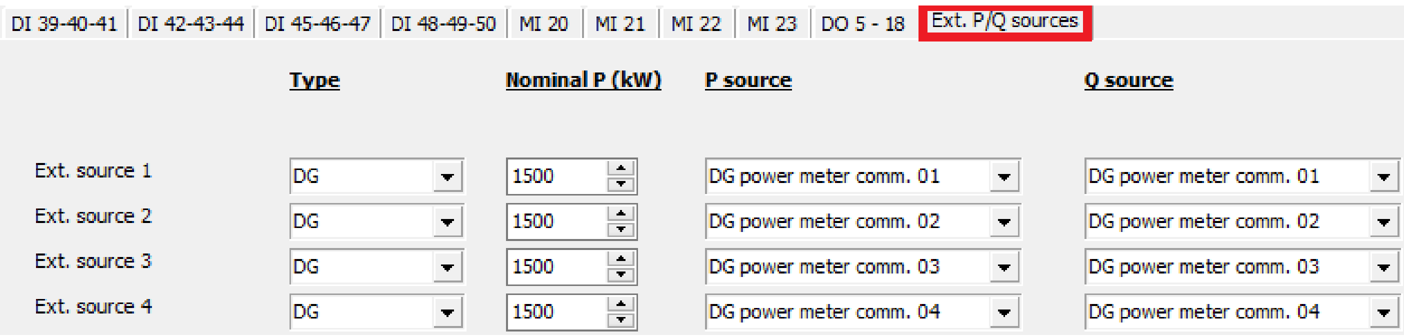
`Communication > Power meter > DG meter`

Parameter	Name	Range	Default	Details
7701	DG meter ID	1 to 247	3	Select the genset power meter ID.
7721	DG meter protocol	**See DEIF Hybrid controller compatibility**	Off	Select the protocol that matches your power meter. Additional protocols may be available. Contact DEIF for details.
7722	DG nbr. nodes	1 to 16	1	Number of nodes.
7730	DG meter err.	Fail classes	Warning	If enabled, this alarm activates when there is no communication from the genset power meter.

You can also configure these settings from the display, under `Settings > Communication > Power meter > DG meter settings`

Power measurement

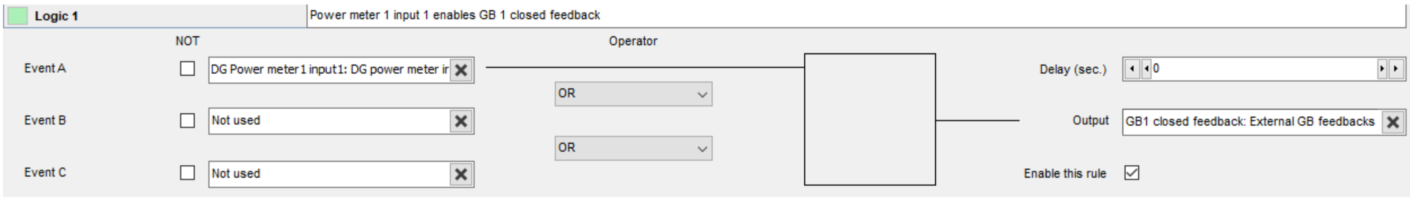
In the utility software, on the *I/O & Hardware* page, select *Ext. P/Q sources*. For up to 16 sources, select the type and nominal power. For each *P source* and *Q source*, select *DG power meter comm. xx*.



Gensets connected

The ASC also needs to know which gensets are connected. For some power meter protocols, this is included. See the **DEIF hybrid controller compatibility** document.

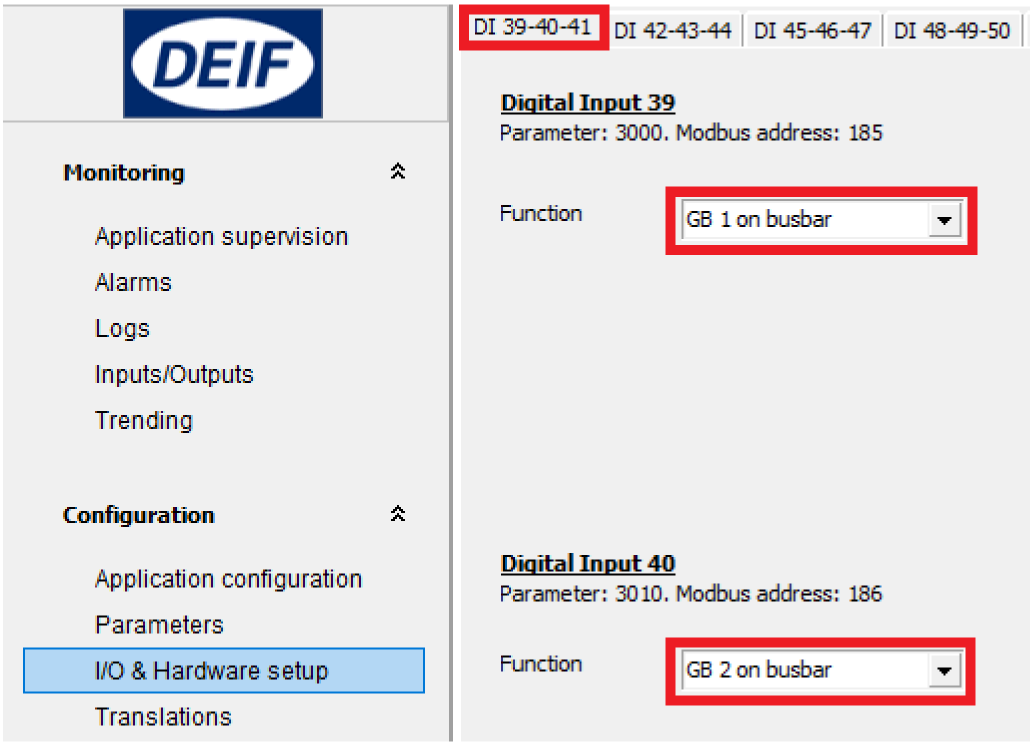
Genset breaker status from the power meter protocol



If the genset breaker status is included in the power meter protocol, configure M-Logic to connect the output from the power meter to enable the corresponding genset.

For DEIF genset controllers, Input 1 is always for GB closed. Input 3 is always for GB open.

Genset breaker status from digital inputs



If the genset breaker status is not included in the power meter protocol, configure a digital input for each breaker.

4.5.3 Mains power measurement from power meter communication

For a single controller application, the mains active power is needed. Mains reactive power is optional. There are a number of ways for the ASC to get the mains power measurements. Mains power measurement from power meter communication is described here.

If a mains breaker is included in the application drawing, the mains breaker position must be monitored. A single controller can control the breaker for one mains connection. Alternatively, the single controller can be used with up to 16 mains connections (no breaker control).

Operating modes and power measurement

For mains power export (MPE) and peak shaving operation, the mains power must be measured.

For fixed power operation, you must configure the mains power measurement, even though the mains power measurement is not used. If the mains power measurement is not connected, the ASC shows 0 kW for the mains power.

`Communication > Power meter > Mains meter`

Parameter	Name	Range	Default	Details
7703	Mains meter ID	1 to 247	3	Select the mains power meter ID.
7725	Mains meter protocol	**See DEIF Hybrid controller compatibility**	Off	Select the protocol that matches your power meter. Additional protocols may be available. Contact DEIF for details.
7726	Mains nbr. nodes	1 to 16*	1	Number of nodes.
7750	Mains meter err.	Fail classes	Warning	If enabled, this alarm activates when there is no communication from the mains power meter.

NOTE * If there are any mains nodes, you must have *Premium* software.

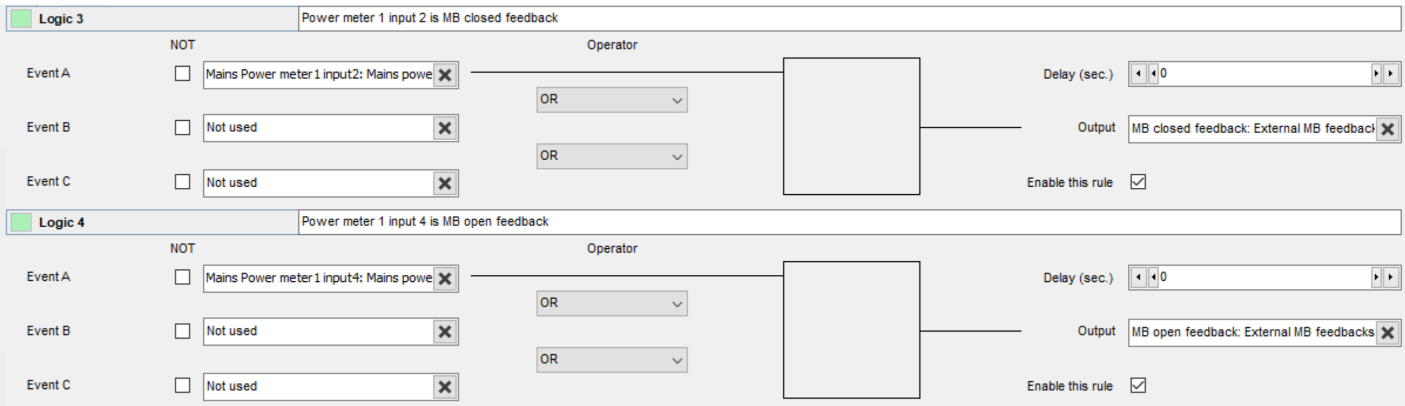
You can also configure these settings from the display, under `Settings > Communication > Power meter > Mains meter settings`

NOTE To use a mains meter for active power, select *Power meter comm.* in parameter 7005. For reactive power, select *Power meter comm.* in parameter 7009.

Mains connection

If a mains breaker is included in the application drawing, the mains breaker position must be monitored. For some power meter protocols, this is included. See the **DEIF hybrid controller compatibility** document.

Mains breaker status from the power meter protocol



If the mains breaker status is included in the power meter protocol, configure M-Logic to connect the output from the power meter to mains breaker feedbacks.

For DEIF mains controllers, Power meter input 2 is always used for MB closed. Power meter input 4 is always used for MB open.

Mains breaker status from digital inputs

If the mains breaker status is not included in the power meter protocol, you can configure a digital input for each breaker feedback. Digital inputs are also required if the ASC controls the mains breaker. Configure the inputs in the utility software, under *I/O & Hardware setup*.

You must use digital input 47 for *MB position on* and digital input 48 for *MB position off*.

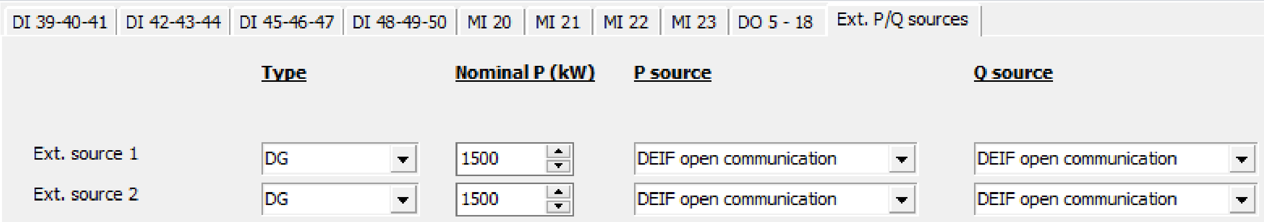
4.5.4 DEIF open communication

An external system (for example, a PLC) can use the ASC Modbus server to send the ASC the power measurements and connection status.

Example for two gensets

The application consists of two gensets (controlled by a PLC) and an ESS (controlled by a single ASC Storage controller).

1. In the utility software, on the *I/O & Hardware setup* page, under *Ext. P&Q sources*, configure two external sources. For *P source* and *Q source*, select *DEIF open communication*.



2. Configure the PLC to connect to the ASC Modbus server.
3. Configure the PLC to use the following:
   - *Genset 1 Active power*: PLC address 446151 (Modbus address 46150, function code 03)
   - *Genset 2 Active power*: PLC address 446152 (Modbus address 46151, function code 03)
   - *Genset 1 Reactive power*: PLC address 446167 (Modbus address 46166, function code 03)
   - *Genset 2 Reactive power*: PLC address 44618 (Modbus address 46167, function code 03)
   - *Genset breaker 1 Closed*: PLC address 446185, bit 0 (Modbus address 46184, bit 0, function code 03)
   - *Genset breaker 2 Closed*: PLC address 446185, bit 1 (Modbus address 46184, bit 1, function code 03)

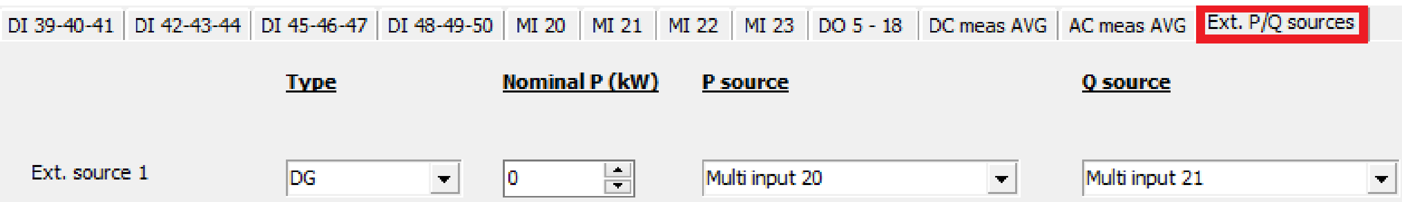
4.5.5 Measurement transducers for genset power

The genset power (active and reactive) can be measured with transducers, and received by ASC analogue inputs, multi inputs, or a CIO 308.

Selecting the measurement transducers

In the utility software, under *I/O & Hardware setup*, *Ext. P/Q sources*, select the inputs that the transducers are connected to.

In the following example, the *DG 1* power transducer is connected to Multi input 20. The reactive power transducer is connected to Multi input 21.



Configuring the multi-input

For a multi-input, under *I/O & Hardware setup*, select the multi-input. Select the input type and scaling (for example, for active power, this can be *kW 1/1* or *kW 1/10*). Configure the curve.

Connection status

Transducers always also need a digital input for connection status. If the power meter/genset controller does not include the connection status, you must configure a digital input.

4.5.6 Measurement transducers for mains power

The mains power (active and reactive) can be measured with transducers, and received by ASC analogue inputs, multi inputs, or a CIO 308.

Parameter	Name	Range	Default	Details
7003	Transducer range max	0 to 20000 kW	0 kW	If used, configure the mains power transducer range.
7004	Transducer range min	-20000 to 0 kW	0 kW	If used, configure the mains power transducer range.
7005	Mains power measure	Multi input 20 (transducer) 4th CT power meas (internal) DEIF open communication Power meter comm.	4th CT power meas (internal)	Select the mains power measurement.
7007	Transd. range max Q	-20000 to 20000 kvar	0 kvar	If used, configure the mains reactive power transducer range.
7008	Transd. range min Q	-20000 to 20000 kvar	0 kvar	If used, configure the mains reactive power transducer range.
7009	Mains Q measure	Multi input 22 (transducer) 4th CT power meas (internal) DEIF open communication Power meter comm.	4th CT power meas (internal)	Select the mains reactive power measurement.

Configuring the multi-input

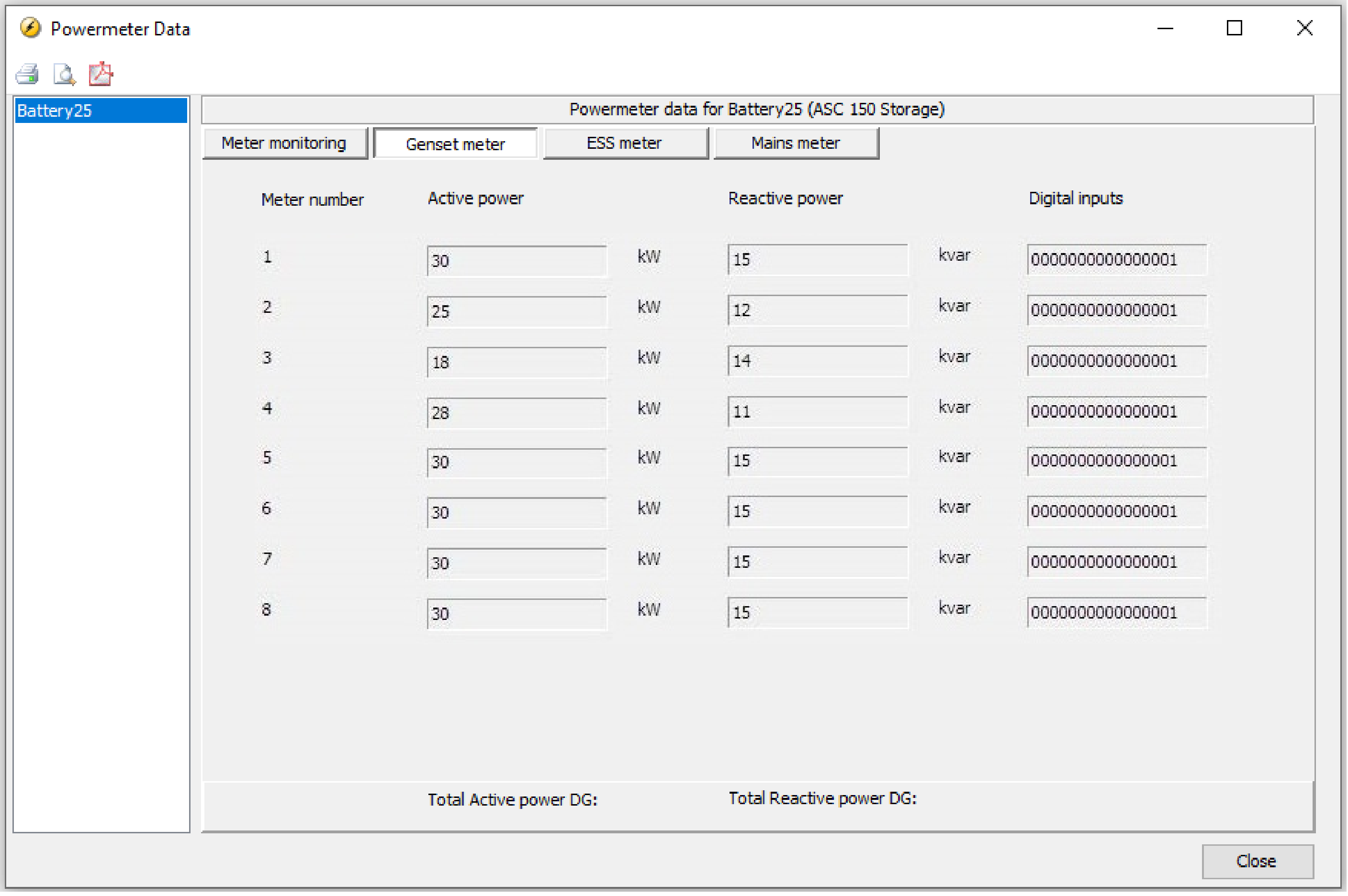
For a multi-input, under *I/O & Hardware setup*, select the multi-input. Select the input type and scaling (for example, for active power, this can be *kW 1/1* or *kW 1/10*). Configure the curve.

Connection status

When using transducers, you always also need a digital input for the connection status.

4.5.7 Power meter monitoring

In the utility software, under *Application supervision*, select *Power meter data*  to open the *Power meter data* window.



Digital inputs shows the breaker status.

For the *DEIF Genset Control* protocol, for genset breakers:

- **...0001**: The breaker is closed.
- **...0100**: The breaker is open.

For mains breakers (*AGC Genset single controller*, or *AGC Mains*):

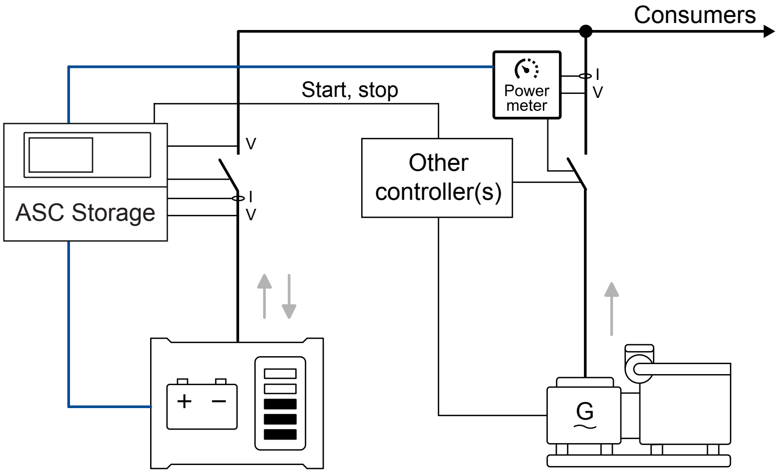
- **...0010**: The breaker is closed.
- **...1000**: The breaker is open.

4.6 Genset applications

4.6.1 Gensets and single storage controller (off-grid)

A single controller application is used if the gensets already have a control system (shown by *Other controller(s)* in the example).

The ASC requires the GB breaker feedbacks (open or closed), and the active power from the gensets. The reactive power is optional. See **Power measurements and connection status** for the range of ways to get this information.



Setting in ASC

Parameter	Name	Setting
6071	Operating mode	Island operation

4.6.2 Start and stop external gensets

You can configure the ASC Storage controller to activate an output to start and run external gensets based on the load and/or the ESS SOC. You can deactivate the output based on the load to ensure that the genset minimum load requirement is met. You can use start based on the load and/or the SOC to ensure that the load is supplied and the ESS gets enough power to charge.

When the ASC activates the output to start and run one or more external gensets (*Start/Stop Ext. DG*), the external generator controller must start the genset(s) (including synchronisation and generator breaker closing).

When the ASC needs to stop the external genset(s), the ASC regulates the ESS to take over the genset load. When the breaker open point is reached, the ASC deactivates the output to stop the last external genset. The external generator controller should bring the genset to a controlled stop. If required, this should include a load ramp down to unload the genset. After opening the generator breaker, the generator controller should ensure that there is a cooldown sequence before stopping the genset.

Start-stop output

On the *Inputs/Outputs* page in the USW, choose a digital output to use as the output. Select the *Start/Stop Ext. DG* function.

Alternative setup using M-Logic

You can also control the *Start/Stop Ext. DG* output by using M-Logic, for more flexibility. For example, the request to start the genset can be used in combination with the command timers. This enables scheduling of the genset start and stop. The request to stop the gensets from M-Logic overrules any start request from the SOC, system load, and M-Logic.

You can find the M-Logic functions under *Output, Command GEN*:

- Request ext. Gen to start
- Request ext. Gen to stop

External genset breaker open

`External control > External DG start/stop`

Parameter	Name	Range	Default	Description
15180	Ext. DG breaker open	0 to 100 % of total external genset nominal power	5 %	When the total external genset power reaches this point, the ASC deactivates the *Start/Stop Ext. DG* output.

External genset start/stop alarm

`External control > External DG start/stop`

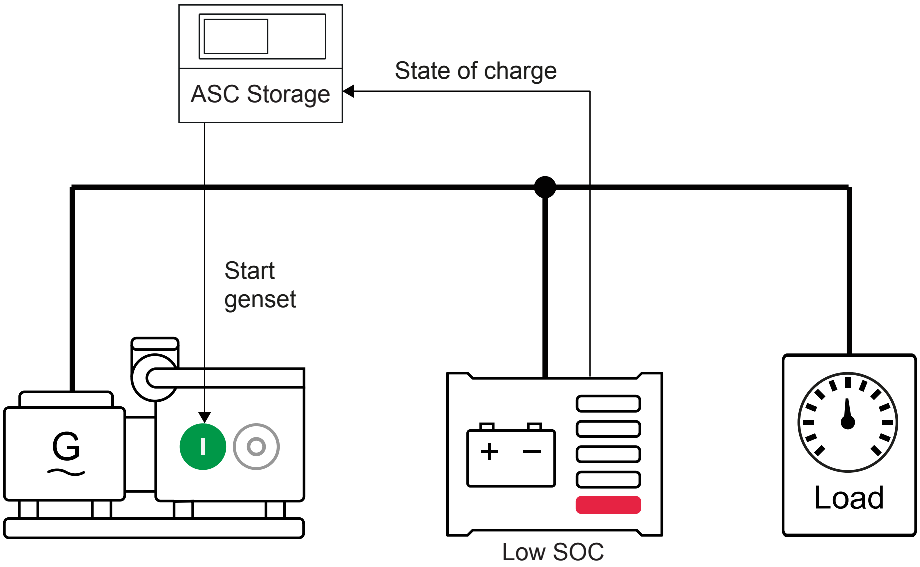
Parameter	Name	Range	Default	Description
15170	Ext. DG start error	1 to 1000 s	30 s	The alarm is activated if a genset start request is active, but the ASC has not received feedback from a genset. The alarm timer also starts running if the only genset connected to the busbar is disconnected.*

NOTE * If the ESS supports it, the system can run on battery power (grid-forming) either alone, or together with solar power.

4.6.3 State of charge genset control

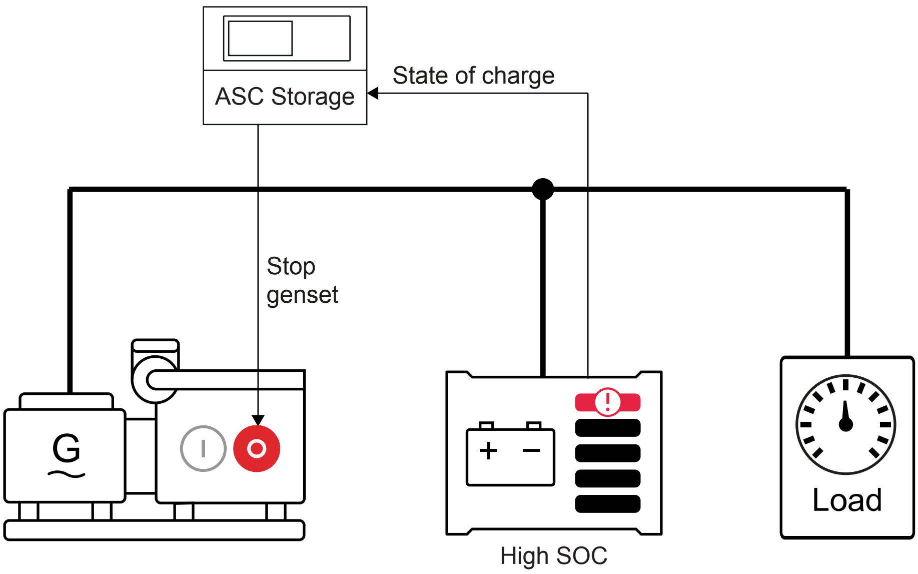
The ASC can start and stop the genset based on the ESS state of charge (SOC).

Low state of charge genset start



When the charge is low, start the generator to avoid depleting the battery, and make sure that there is enough power for the load and charging.

High state of charge genset stop



When the charge is high and the battery can supply the load without the generator, stop the generator.

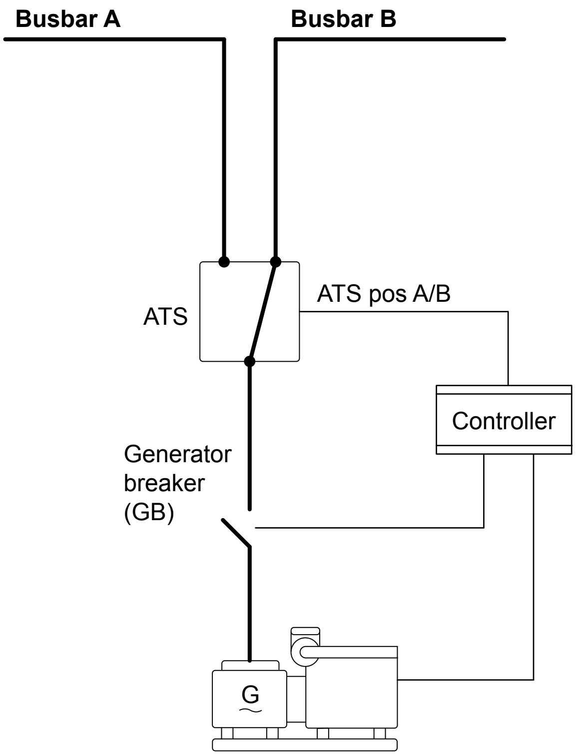
SOC start-stop parameters (for a single controller or a power management system)

`External control > External DG start/stop`

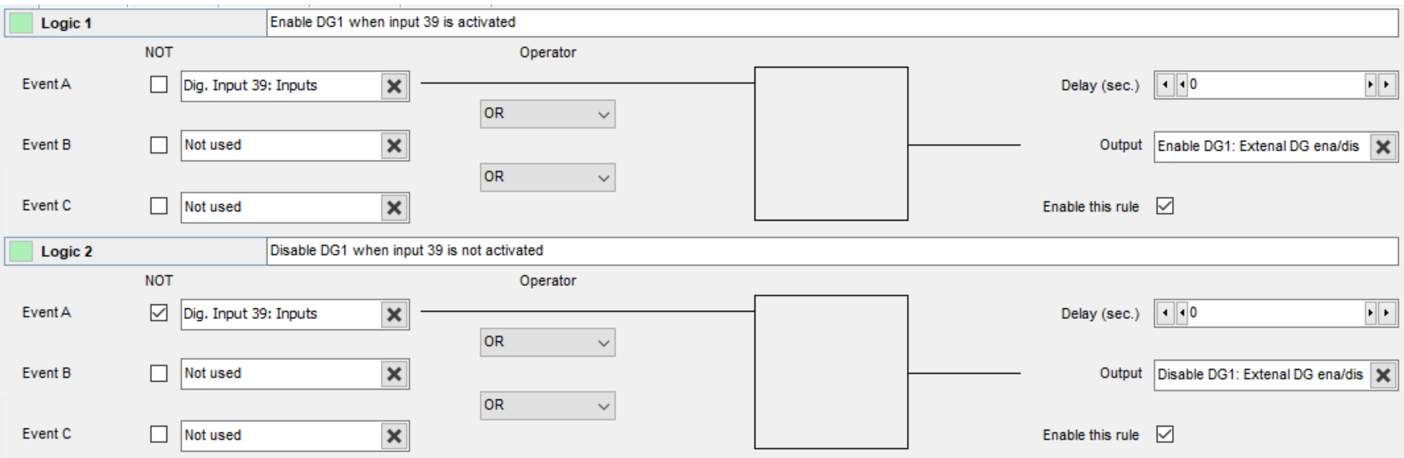
Parameter	Name	Range	Default	Description
15151	SOC DG start limit	0 to 100 % 0 to 3200 s	30 % 10 s	When the SOC goes below the start limit (and the timer has run out), the ASC activates the output.
15153	SOC DG stop limit	0 to 100 % 5 to 3200 s	50 % 15 s	When the SOC goes above the stop limit (and the timer has run out), the ASC deactivates the output. If the SOC DG stop limit is higher than SOC threshold 2, the controller shows the warning *SOC STOP LIM > THR 2*. The battery stops charging from the genset at SOC threshold 2. As a result, the battery charge never reaches the SOC DG stop limit, and the genset is never stopped.
15155	SOC DG control	Enabled Not enabled	Not enabled	Select *Enable* to activate the SOC DG start function.

4.6.4 Split busbar

In a single controller application, the generators can be enabled and disabled. This is useful if the generators can connect to two busbars.



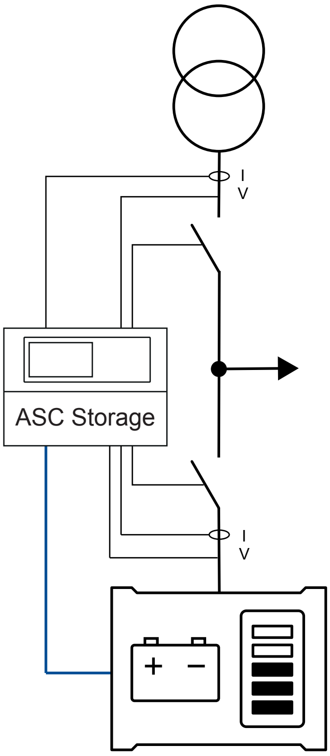
In the ASC in M-Logic, you can program whether the genset is connected to the ESS side (enabled) or connected to the side without the ESS (disabled):


Logic 1
Enable DG1 when input 39 is activated
NOT
Operator
Event A
Dig. Input 39: Inputs
Event B
Not used
Event C
Not used
OR
OR
Delay (sec.)
0
Output
Enable DG1: Extenal DG ena/dis
Enable this rule
Logic 2
Disable DG1 when input 39 is not activated
NOT
Operator
Event A
Dig. Input 39: Inputs
Event B
Not used
Event C
Not used
OR
OR
Delay (sec.)
0
Output
Disable DG1: Extenal DG ena/dis
Enable this rule

4.7 Mains applications

4.7.1 Mains and single storage controller (grid-tied)

This application is used to operate parallel to mains when no AGC mains is installed. The ASC needs inputs from the MB feedback (open/closed) and the active and reactive power from the mains (export or import). See **Power measurements and connection status** for the range of ways to get this information.



Setting in ASC

`Basic settings > Application type > Plant type > Plant mode`

Parameter	Name	Range
6071	Operating mode	Island operation Fixed power Peak shaving Main power export Automatic mains failure

4.7.2 Mains power measurement

For a single controller application, the mains active power (imported or exported) and breaker position must be measured. The reactive power is optional.

`Basic settings > Measurement setup > Wiring connection > Mains power measure`

Parameter	Name	Range	Default	Details
7005	Mains power measure	Multi input 20 (transducer) 4th CT power meas (internal) DEIF open communication Power meter communication	4th CT power meas (internal)	Select the measurement for the mains active power.
7009	Mains Q measure	Multi input 22 (transducer) 4th CT power meas (internal) DEIF open communication	4th CT power meas (internal)	Select the measurement for the mains reactive power.

Parameter	Name	Range	Default	Details
		Power meter communication		

More information
See **Power measurements and connection status** for the range of ways to get this information.

4.7.3 Mains breaker handling in single controller applications

The ASC can control one mains breaker in a single controller application. However, if there is more than one mains connection, the ASC cannot control a mains breaker.

Synchronising the mains breaker

To synchronise the mains breaker without a blackout:

- The battery must be grid-forming.
- Externally controlled gensets must be disconnected.
- Back synchronisation (parameter 7083) and sync. to mains (parameter 7084) must be enabled.

Busbar blackout rules

To close the mains breaker when there is no voltage or frequency on the busbar:

- For safety, the ASC checks that there is no voltage or frequency on the busbar. For example, voltage could come from externally controlled gensets.
- If there is an ESB, to confirm that there is no voltage, the ASC closes the ESB. The ASC can then use its AC measurements to check the busbar voltage and frequency.
- Once the ASC has confirmed that there is no voltage or frequency on the busbar, it can close the mains breaker.

Mains failure

You can configure the mains failure detection voltages (parameter 7063, 7064), frequencies (parameter 7073, 7074) and hysteresis (parameters 7091, 7092, 7093, 7094).

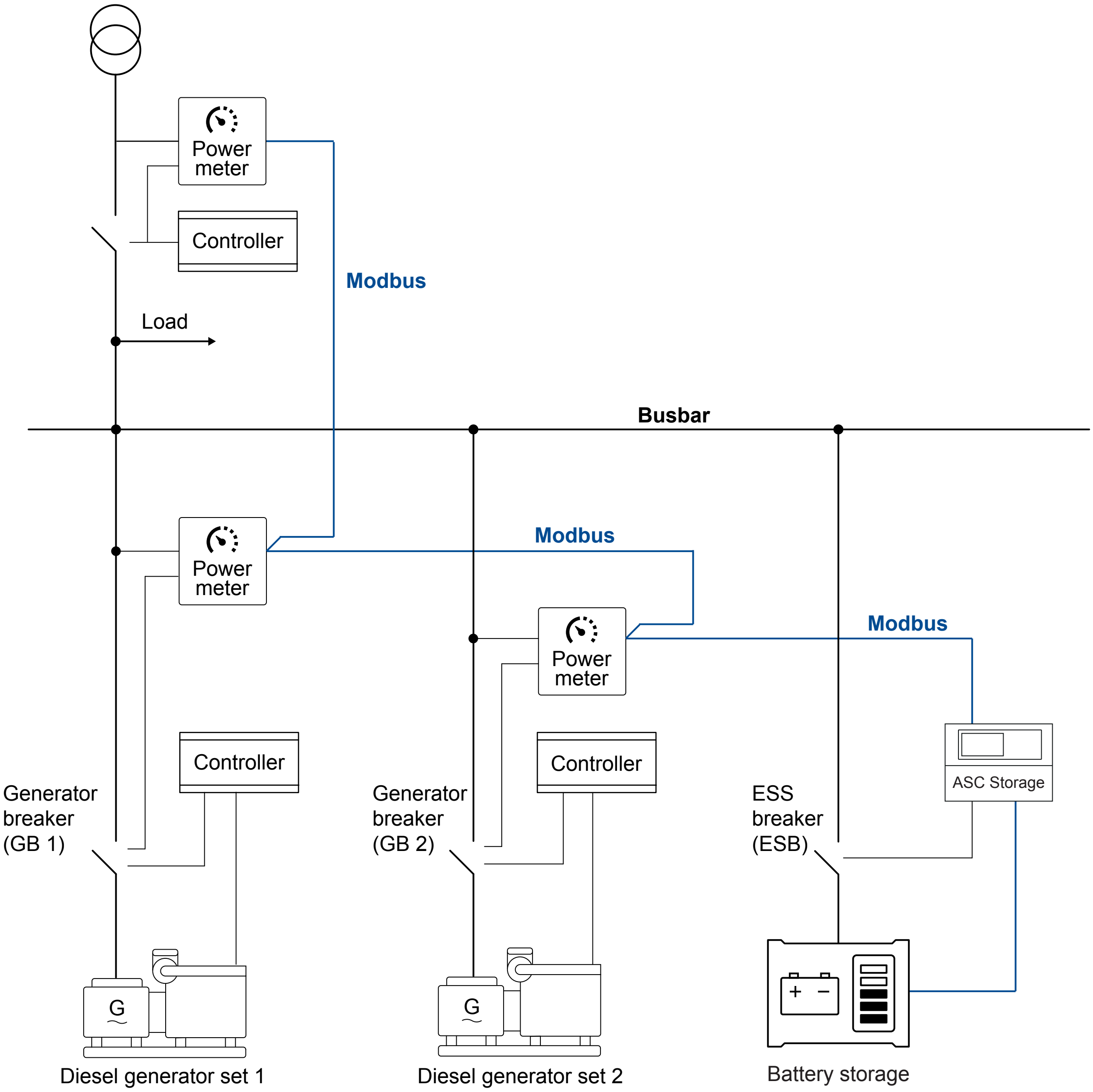
There are mains failure voltage (parameter 7061) and frequency (parameter 7071) alarms.

If the ASC 150 Storage must automatically open the mains breaker during a mains failure, you must enable mode shift (parameter 7081).

4.8 Combination (off-grid + grid-tied)

This application is used when a single controller application is used in both grid-tied and off-grid (islanded) modes. In this example, third party controllers are installed (shown by *Controller* in the diagram).

The ASC needs the mains power and reactive power, and the gensets power and reactive power. The ASC also needs feedback from the breakers (GBs and MB). See **Power measurements and connection status** for the range of ways to get this information.



Setting in ASC

`Basic settings > Application type > Plant type > Plant mode`

Parameter	Name	Range
6071	Operating mode	Island operation Fixed power Peak shaving Mains power export Automatic mains failure

From grid-tied to off-grid

If *Mode shift on* is selected (*Modeshift*, parameter 7081), then the controller automatically changes the operating mode. When the mains breaker is opened, the mode changes to *Island operation*. Note that you can use M-Logic to set parameter 7081.

NOTE If the battery is the only power source on the busbar, and if the PCS does not support seamless transfer between modes, there will be a short blackout during the mode transfer.

5. Energy management systems

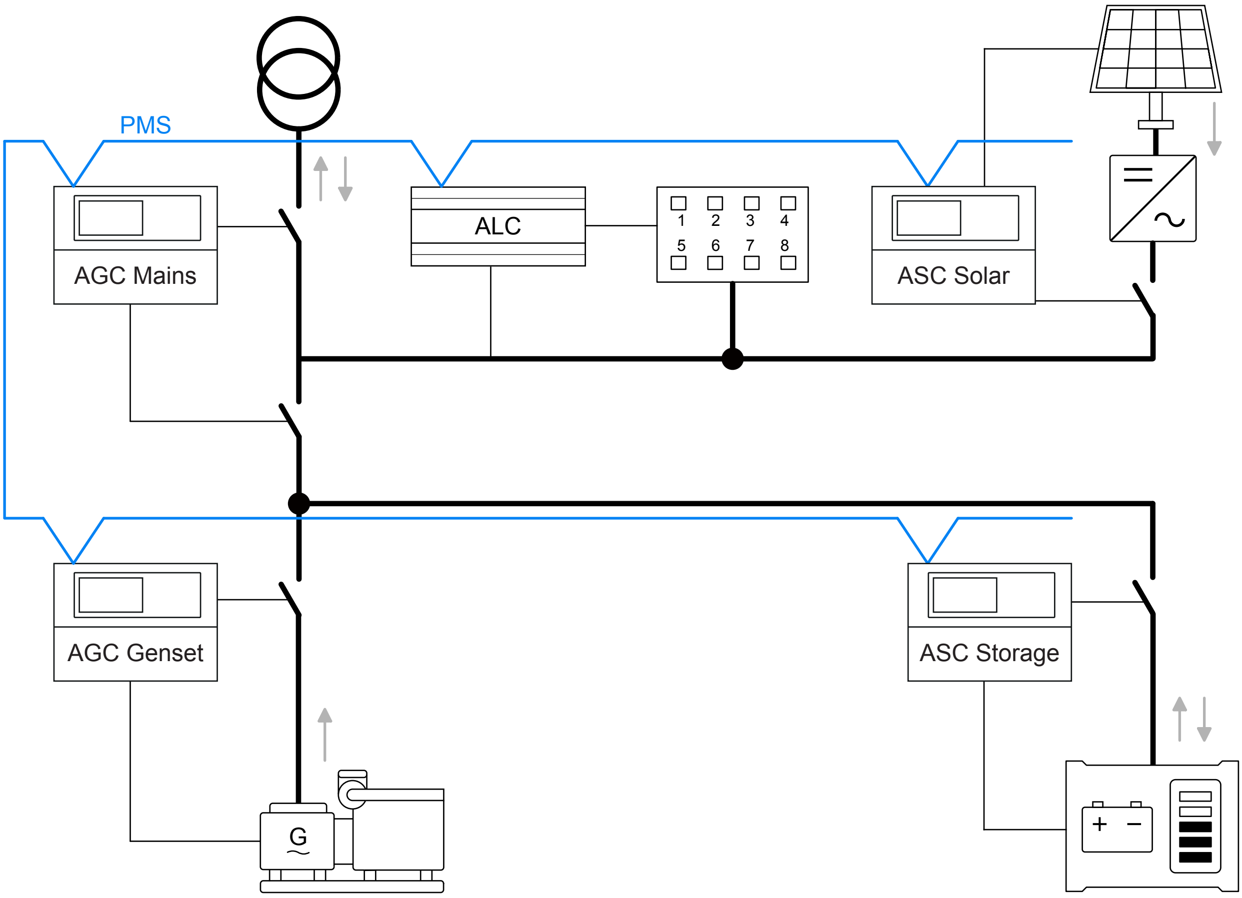
5.1 Overview

ASC Solar, ASC Storage, ASC Battery, AGC Genset, AGC Mains and ALC-4 can work together as an energy management system. The application configuration and controller parameters allow a wide range of applications.

The controllers use CAN bus to share the information needed for energy management. In AGC-4 Mk II and AGC-4, option G5 is required for energy management.

Quick overview
See DEIF - Hybrid Solutions for a quick introduction to energy management systems.

Example of energy management system



Controller functions

Controller	Controls	Functions
ASC Solar	PV	• P and Q control • Control photovoltaic (PV) breaker* • Inverter communication
ASC Storage/Battery	ESS	• P-Q control, V-f control, and droop (VSG) • Energy storage system charging and discharging • Control energy storage system (ESS) breaker* • Energy storage system communication
AGC Genset	Genset	• Governor control

Controller	Controls	Functions
		• AVR control • Control genset breaker • ECU communication
AGC Mains	Mains connection	• Power import or export • Control mains breaker*, tie breaker* • Synchronise the plant to the mains
ALC	Load groups	• Connect and disconnect load groups • Manage heavy consumer requests

NOTE * Optional.

5.2 Power management applications

The ASC can be included in power management (also known as energy management). This allows mains, gensets, PV and/or ESS to work together in an integrated system. Power management can include:

1. Automatic rotation of genset priority.
2. Fuel-optimised genset priority.
3. Control of plant spinning reserve.
4. Flexible application support with common grid-tied, combination, and off-grid applications.

ASC and ESS on the utility software application drawing

The ASC controls and monitors the ESS. In the application single line drawing, each ASC is shown as a battery.

Breaker control

The ASC can control an ESS breaker like an AGC controls a generator breaker. One ASC can control one ESS breaker.

If the ESS is grid-following, the ESS breaker can close when the busbar is live and Hz/voltage is normal. If the busbar is outside its limits, the ASC can open the ESS breaker but not close it. If the ASC is in AUTO mode, the ASC closes the breaker when the busbar is live. The ESS then starts. The ASC does not require a manual start signal if AUTO is selected.

In MANUAL mode, an operator must press the breaker close and start buttons on the display unit. Alternatively, this signal can be sent by Modbus, digital input, and so on.

5.2.1 Power management operation

The ASC follows the operation of the AGC mains: Island, fixed power, mains power export, peak shaving, or load take-over (grid-tied or off-grid). If there is no mains controller (AGC mains) in the application, the plant uses island operation (off-grid).

5.2.2 System limitations

When the ASC is used for power management, the number of controllers is limited.

	Maximum number
AGC Genset	32
AGC Mains	32
ASC Solar	16
ASC Storage/Battery	16

	Maximum number
ALC-4	8
AGC BTB/Externally-controlled BTB	8

Controller ID allocation and sharing

<table>
<tr><th>ID 1 to 24</th><th>ID 25 to 32</th><th>ID 33 to 40</th></tr>
<tr><td colspan="2">AGC Genset (1 to 32)</td><td></td></tr>
<tr><td colspan="2">AGC Mains (1 to 32)</td><td></td></tr>
<tr><td></td><td colspan="2">ASC Solar (25 to 40)</td></tr>
<tr><td></td><td colspan="2">ASC Storage/Battery (25 to 40)</td></tr>
<tr><td></td><td colspan="2">ALC-4 (25 to 40)</td></tr>
<tr><td></td><td></td><td>AGC BTB (33-40)</td></tr>
<tr><td></td><td></td><td>External BTB (33-40)</td></tr>
</table>

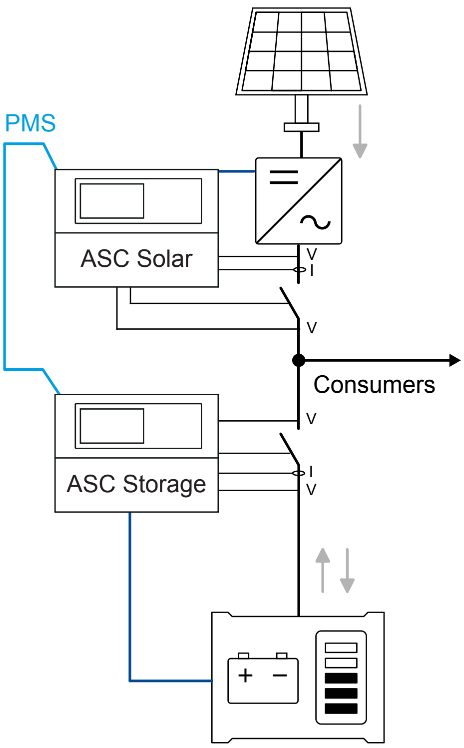
Example

If you have a system with one mains feeder, then you have (32 - 1) = 31 IDs left for the gensets. If you have two mains feeders, you have (32 - 2) = 30 IDs left for the gensets.

If you have a system with 14 ASC controllers, you can have (16 - 14) = 2 bus tie breakers.

5.2.3 Off-grid applications

5.2.3.1 Off-grid with solar and storage

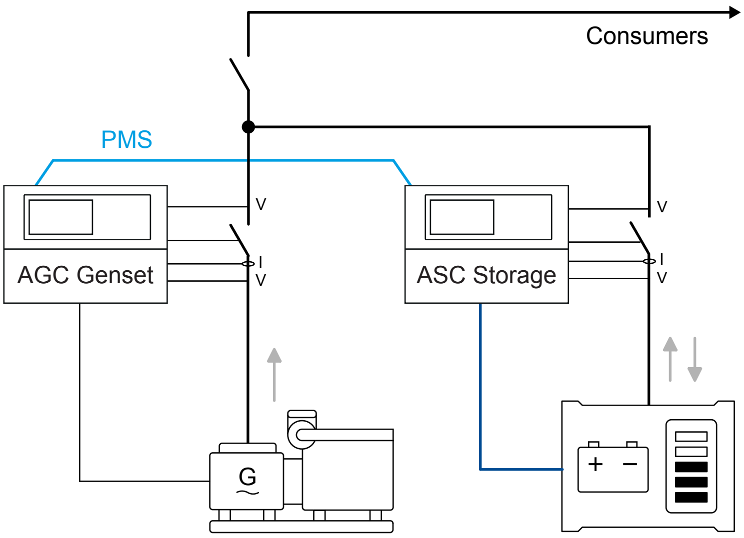


ASC Storage and ASC Solar configuration

Basic settings > Application type > Plant type > Plant mode

Parameter	Name	Setting
6071	Operating mode	Power management

5.2.3.2 Off-grid with genset(s) and storage



To improve power quality, the ESS can supply peak loads while gensets start. The ASC Storage controller can support the load, so that the genset can run at its optimal load point. If the ESS is designed to supply the busbar load, the ESS can be the only source connected to the busbar.

ASC Storage configuration

Basic settings > Application type > Plant type > Plant mode

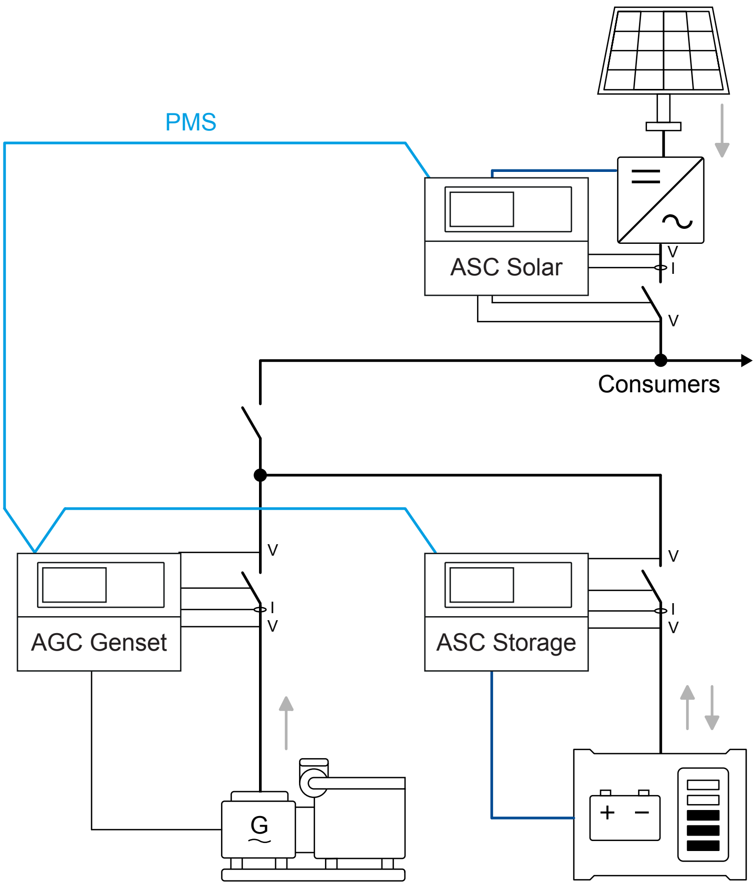
Parameter	Name	Setting
6071	Operating mode	Power management

AGC Genset configuration

Basic settings > Application type > Genset type > Genset/plant mode

Parameter	Name	Setting
6071	Operating mode	Power management

5.2.3.3 Off-grid with genset(s), solar and storage



ASC Storage and ASC Solar configuration

`Basic settings > Application type > Plant type > Plant mode`

Parameter	Name	Setting
6071	Operating mode	Power management

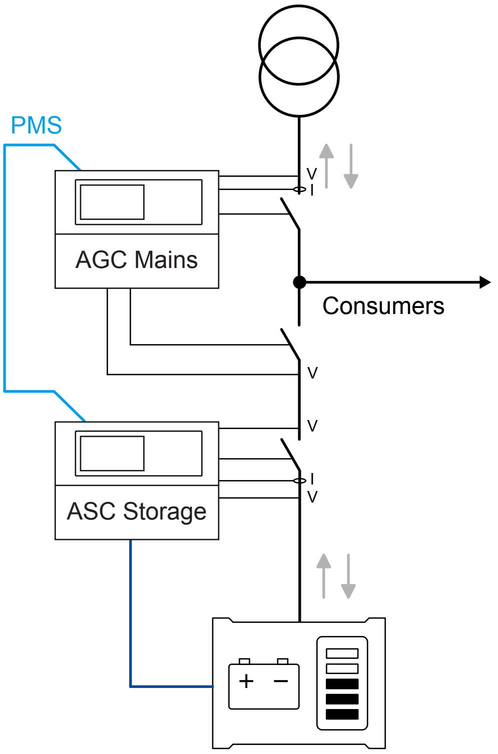
AGC Genset configuration

`Basic settings > Application type > Genset type > Genset/plant mode`

Parameter	Name	Setting
6071	Operating mode	Power management

5.2.4 Grid-tied applications

5.2.4.1 Grid-tied storage



ASC Storage configuration

`Basic settings > Application type > Plant type > Plant mode`

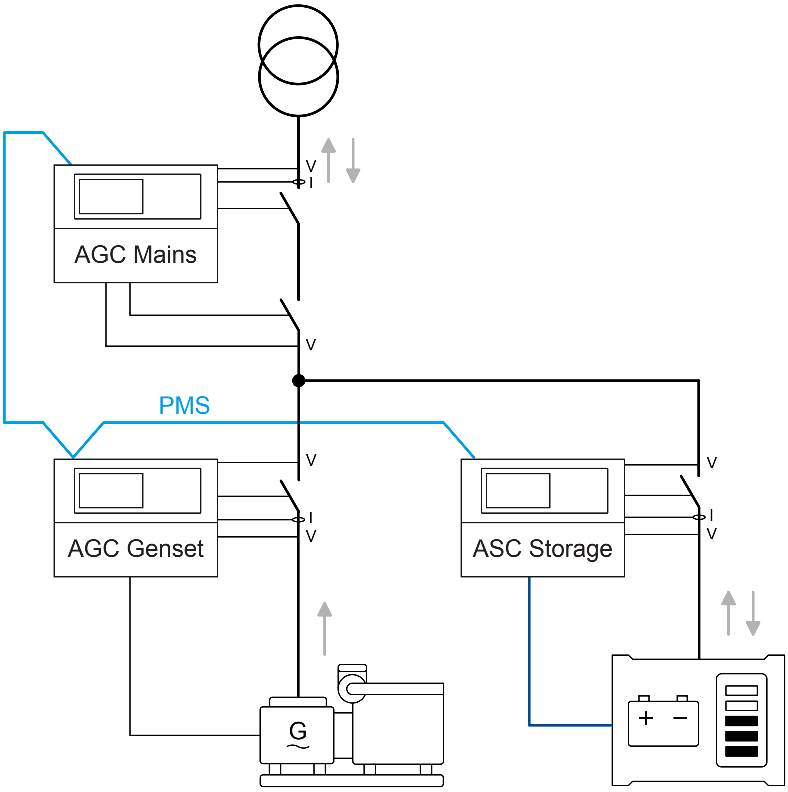
Parameter	Name	Setting
6071	Operating mode	Power management

AGC Mains configuration

`Basic settings > Application type > Plant type > Plant mode`

Parameter	Name	Setting
6070	Plant mode	Select a plant mode (in the AGC mains controller). For example, Mains Power Export.

5.2.4.2 Grid-tied genset-storage



ASC Storage configuration

`Basic settings > Application type > Plant type > Plant mode`

Parameter	Name	Setting
6071	Operating mode	Power management

AGC Genset configuration

`Basic settings > Application type > Genset type > Genset/plant mode`

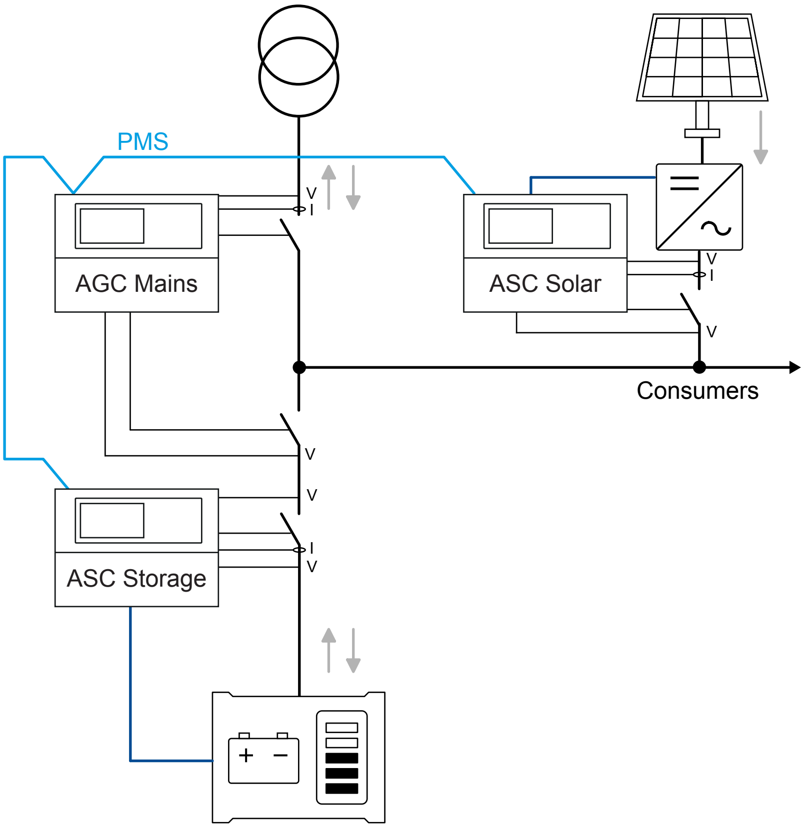
Parameter	Name	Setting
6071	Operating mode	Power management

AGC Mains configuration

`Basic settings > Application type > Plant type > Plant mode`

Parameter	Name	Setting
6070	Plant mode	Select a plant mode (in the AGC mains controller). For example, Mains Power Export.

5.2.4.3 Grid-tied solar-storage



ASC Storage and ASC Solar configuration

`Basic settings > Application type > Plant type > Plant mode`

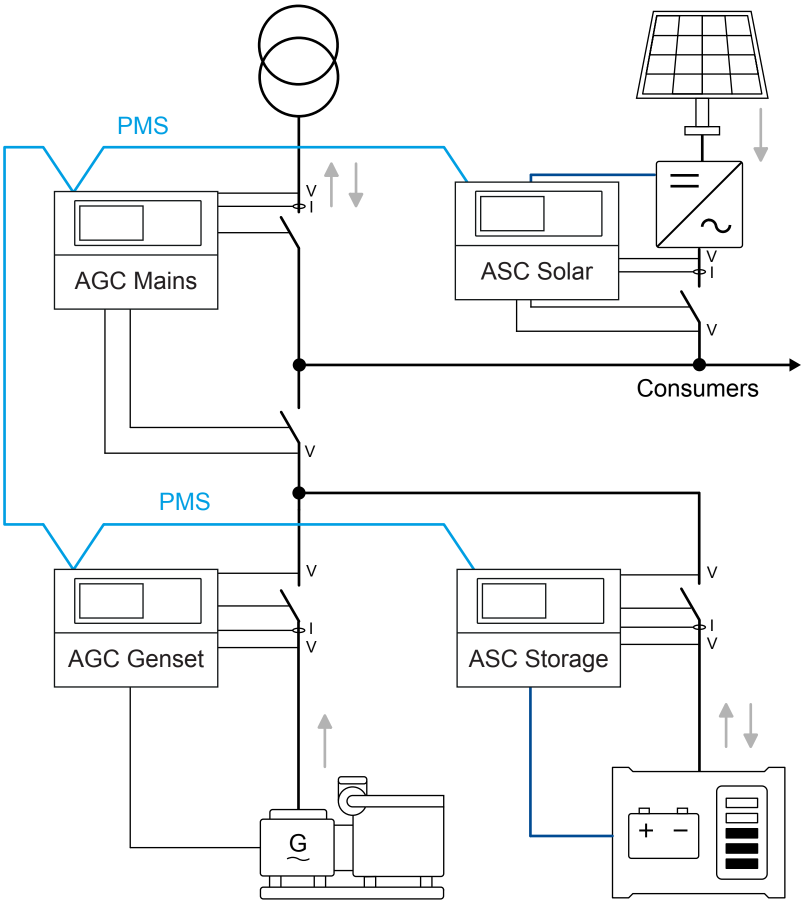
Parameter	Name	Setting
6071	Operating mode	Power management

AGC Mains configuration

`Basic settings > Application type > Plant type > Plant mode`

Parameter	Name	Setting
6070	Plant mode	Select a plant mode (in the AGC mains controller). For example, Mains Power Export.

5.2.4.4 Grid-tied solar-genset-storage



ASC Storage, ASC Solar, and AGC Genset configuration

`Basic settings > Application type > Plant type > Plant mode`

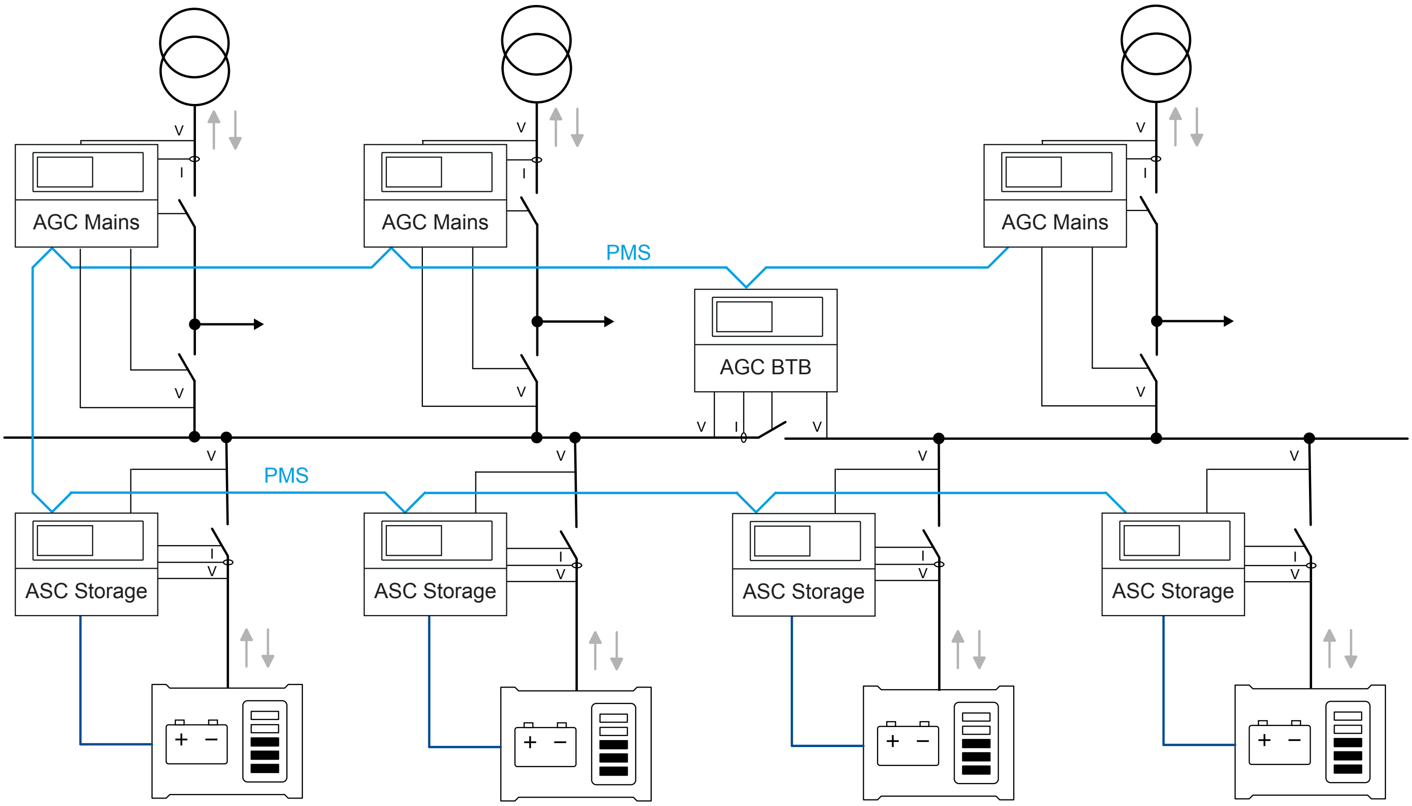
Parameter	Name	Setting
6071	Operating mode	Power management

AGC Mains configuration

`Basic settings > Application type > Plant type > Plant mode`

Parameter	Name	Setting
6070	Plant mode	Select a plant mode (in the AGC mains controller). For example, Mains Power Export.

5.2.4.5 Multi-mains with storage



ASC Storage configuration

`Basic settings > Application type > Plant type > Plant mode`

Parameter	Name	Setting
6071	Operating mode	Power management

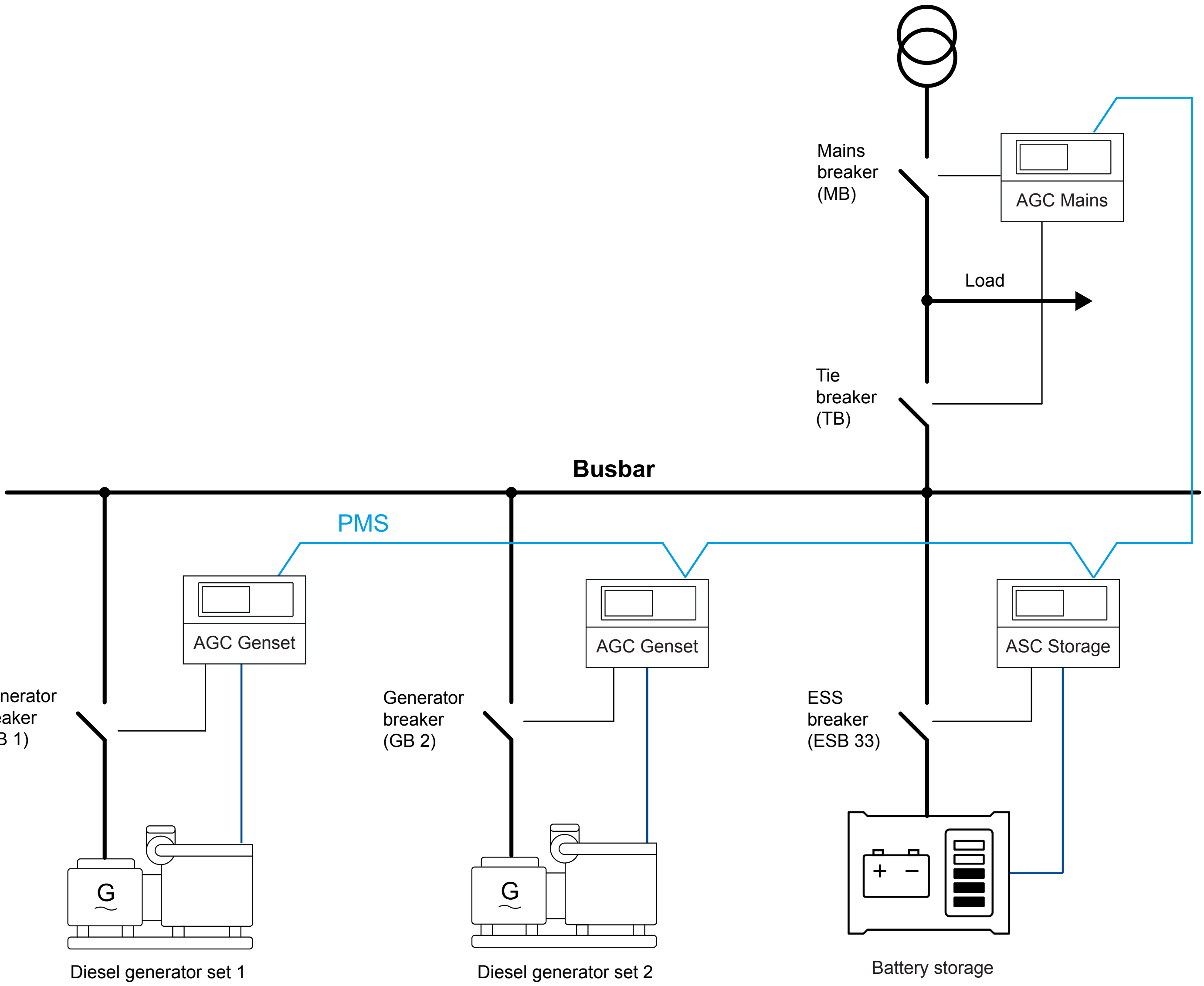
AGC Mains configuration

`Basic settings > Application type > Plant type > Plant mode`

Parameter	Name	Setting
6070	Plant mode	Select a plant mode (in the AGC mains controller). For example, Mains Power Export.

5.2.5 Combination (off-grid + grid-tied)

This application is used for grid-tied and off-grid (islanded) modes.



In a power management combination application, the ASC can have the following modes of operation:

- Mains breaker open (that is, off-grid):
  - Island operation
  - AMF (Automatic Mains Failure)
- Mains breaker closed (that is, grid-tied):
  - MPE (Mains Power Export)
  - Peak shaving
  - Fixed power

ASC Storage and AGC Genset configuration

`Basic settings > Application type > Plant type > Plant mode`

Parameter	Name	Setting
6071	Operating mode	Power management

AGC Mains configuration

`Basic settings > Application type > Plant type > Plant mode`

Parameter	Name	Setting
6071	Plant mode	Select a plant mode (in the AGC mains controller). For example, Mains Power Export.

5.3 Configure power management

5.3.1 Power management communication

5.3.1.1 CAN connections

The CAN line wiring between controllers must be a daisy chain connection. The line must be a continuous communication bus, and it cannot be mixed with the other communication.

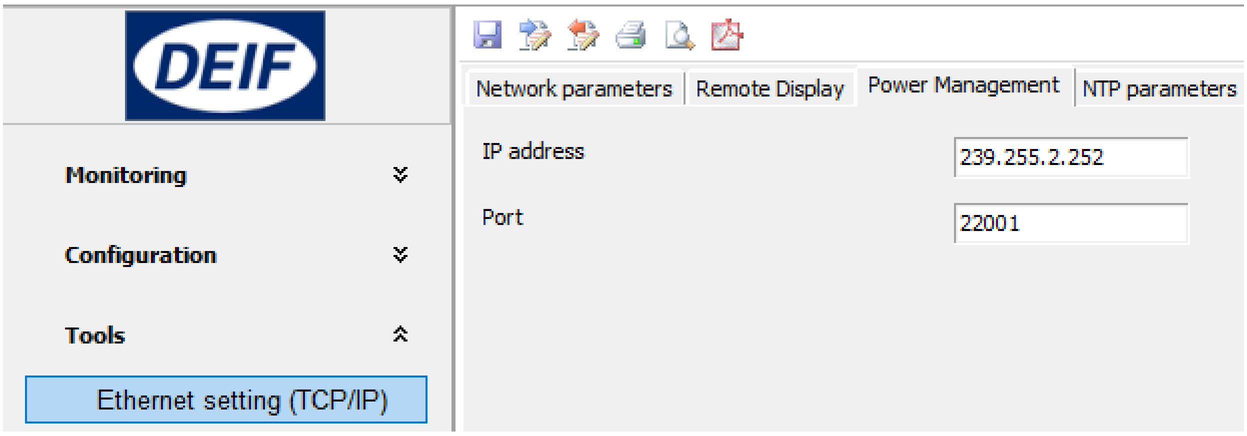
More information
See **CAN bus power management system** in the **Installation instructions** for wiring recommendations.

For *CAN B protocol* (parameter 7842) (under `Communication > CAN protocols`), select either *PM Primary* or *PM Secondary*. The *CAN B protocol* selection must be the same in all controllers. The power management functions are the same for *PM Primary* and *PM Secondary*.

5.3.1.2 Using Ethernet for power management

You can use Ethernet connections for power management communication redundancy.

In the utility software, on the *Ethernet setting (TCP/IP)* page, select *Power management*.



For each controller in the power management system:
1. Select the same IP address for the controllers to broadcast to, and the port.
    - The IP address must be in the range 239.255.xxx.xxx.
2. In parameter 7843 (*VCAN C Protocol*), select *PMS Primary* or *PMS Secondary*.

5.3.2 Easy connect

If the application consists of only genset, storage and/or solar controllers, Easy connect is a fast and easy way to add more controllers to a new or existing application. Easy connect commands normally come from the display, but they can also be sent from M-Logic and Modbus. You can also use Easy connect to remove genset, storage and/or solar controllers.

Preconditions
- All controllers in the application have the same software version.

    - You can use Easy connect for an application with a mix of AGC-4 Mk II, AGC-4, AGC 150, and ASC 150. All the controllers must support the same Easy connect functions.
- Easy connect is enabled in all controllers in parameter 8023, or *M-Logic Output, Easy connect, Enable Easy connect*.
- For genset controllers, in *Quick setup mode* (parameter 9186), select *Setup plant*.
- For storage and solar controllers, in *Quick setup mode* (parameter 9181), select *Setup plant*.
- The genset, ESS or PV to be added or removed is not running.

Activate Easy connect

If the preconditions are met, the Easy connect sequence is activated whenever:

- Easy connect is enabled in parameter 8023.
- A controller powers up.
- The CAN conditions change (that is, if a controller is added or removed).

`Power management > Easy connect`

Parameter	Text	Range	Default
8023	Easy connect	OFF ON	OFF

Using Easy connect

Once the Easy connect sequence starts, the operator cannot use the display unit to change parameters. Configure the parameters as required before the sequence starts, or use the utility software.

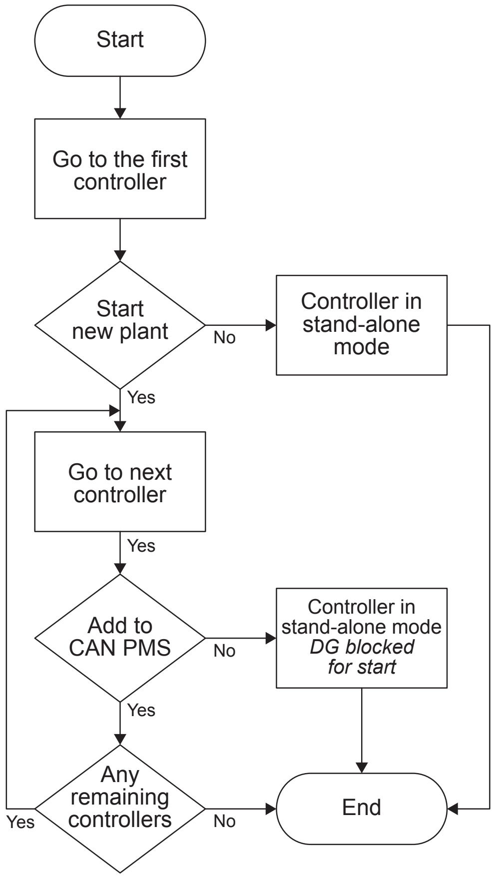
If a controller must be removed and another controller must be added to the plant, always first remove the controller then add the new controller.

NOTICE

Give the controllers enough time to make changes

When a controller is added or removed, the controllers use approx. one minute time to apply the change. When *Receiving application* is shown, do not add or remove more controllers. Making multiple simultaneous changes can reset the application.

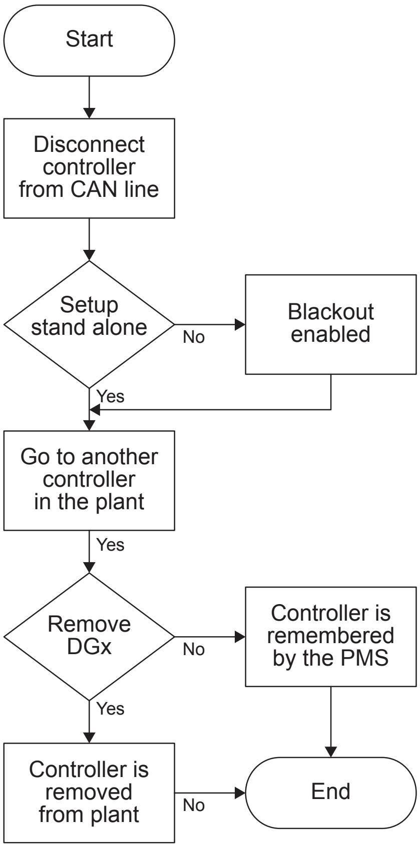
Configuring a new application or adding new genset controllers



1. The preconditions are met, and the Easy connect sequence is activated.
2. **Go to the first controller:** The first controller keeps its CAN ID and is *DG1*.
3. **Start new plant:** The display unit for the first controller prompts *START NEW PLANT?*:
   - Select *Yes*: The first controller starts a new application configuration.
   - Select *No*: The first controller goes into stand-alone mode with *DG blocked for start*.
4. **Go to next controller:** The operator can connect the CAN line and power up the next controller.
5. **Add to CAN PMS:** The new controller checks the PMS CAN line for another controller. The new controller gets the lowest available CAN ID. The new controller prompts *ADD DG TO CAN PMS?*.
   - Select *Yes*: The controller is added to the application.
   - Select *No*: The controller goes into stand-alone mode with *DG blocked for start*.
6. If additional controllers are detected, steps 4 and 5 repeat. Otherwise, the sequence ends.

NOTE If you need to add another controller later, that controller must not be powered before the CAN line is connected. When the controller power is connected, Easy connect is activated, and the controller can be added to the application.

Removing genset controllers



1. **Disconnect controller from CAN line:** The controller to be removed from the plant is disconnected from the CAN bus, or the controller is powered down.
2. **Setup stand-alone:** If still powered, the disconnected controller prompts *SETUP STAND-ALONE?*:
   - Select *Yes*: The controller is disconnected from the plant.
   - Select *No*: The controller waits to be reconnected to the CAN line. When this happens, the controller automatically reestablishes the CAN PMS connection.
3. **Go to another controller in the plant:** The displays of all the remaining controllers in the plant prompt *REM. DG ## CAN PMS?*.
4. **Remove DG ##:** From the display of any remaining controller:
   - Select *Yes*: The disconnected controller is removed from the plant. The related alarms are cleared from all the remaining controllers.
   - Select *No*: The other controllers wait for the disconnected controller to be reconnected to the CAN line. When this happens, the controllers automatically reestablish the CAN PMS connection.

M-Logic commands and events

As an alternative to using the display for Easy connect, the following commands are available under *M-Logic, Output, Easy connect*:

Controller	Command	Description
Genset only	Add DG	The user can connect multiple genset controllers to the CAN bus, then use this command to add each genset controller to the application.
Genset only	Remove DG	The user can use this command to remove a genset controller from the application, without the need to disconnect the CAN bus.
Storage only	Add ESS	The user can connect multiple storage controllers to the CAN bus, then use this command to add each storage controller to the application.
Storage only	Remove ESS	The user can use this command to remove a storage controller from the application, without the need to disconnect the CAN bus.
Solar only	Add PV	The user can connect multiple solar controllers to the CAN bus, then use this command to add each solar controller to the application.
Solar only	Remove PV	The user can use this command to remove a solar controller from the application, without the need to disconnect the CAN bus.
All	Select yes on display	This command selects YES if there is a "YES/NO" prompt on the display.
All	Select no on display	This command selects NO if there is a "YES/NO" prompt on the display.
All	Enable Easy connect	The user can activate the Easy connect function with this command.
All	Disable Easy connect	The user can deactivate the Easy connect function with this command.

The following events are available under *M-Logic, Events, Easy connect*:

Event	Description
Plant active	Activated for an Easy connect plant.
Stand alone	Activated for a stand-alone (single controller) application.

Setting up the controller for a single controller application

You can also use Easy Connect to set up the controller for a single controller application.

- For genset controllers, in *Quick setup mode* (parameter 9186), select *Setup stand alone*.
- For storage and solar controllers, in *Quick setup mode* (parameter 9181), select *Setup stand alone*.

5.3.3 Using utility software to create the application

5.3.3.1 Controller IDs

After connecting the CAN bus communication, each controller must have a unique internal communication ID. With Easy Connect, the controllers set the IDs automatically.

For manual setup, you must set the controller ID in each controller.

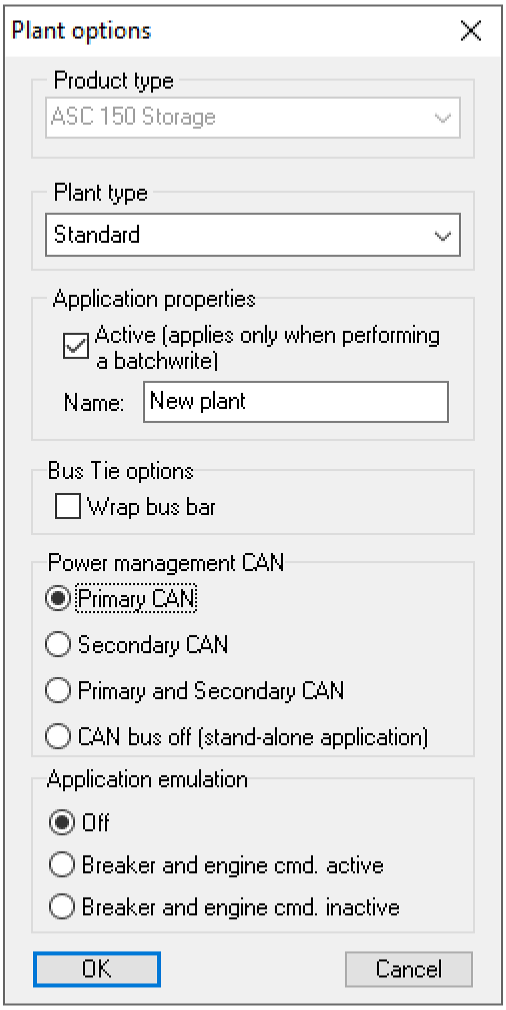
`Communication > Power management ID`

Parameter	Text	Range	Default
7531	PM CAN ID	25 to 40	25

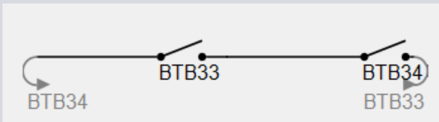
5.3.3.2 Application configuration

When the IDs are configured, you can configure the application with the utility software.

Connect to a controller with the PC utility software, then select *Application configuration*. In the top taskbar, select *New plant configuration* . The *Plant options* window opens.

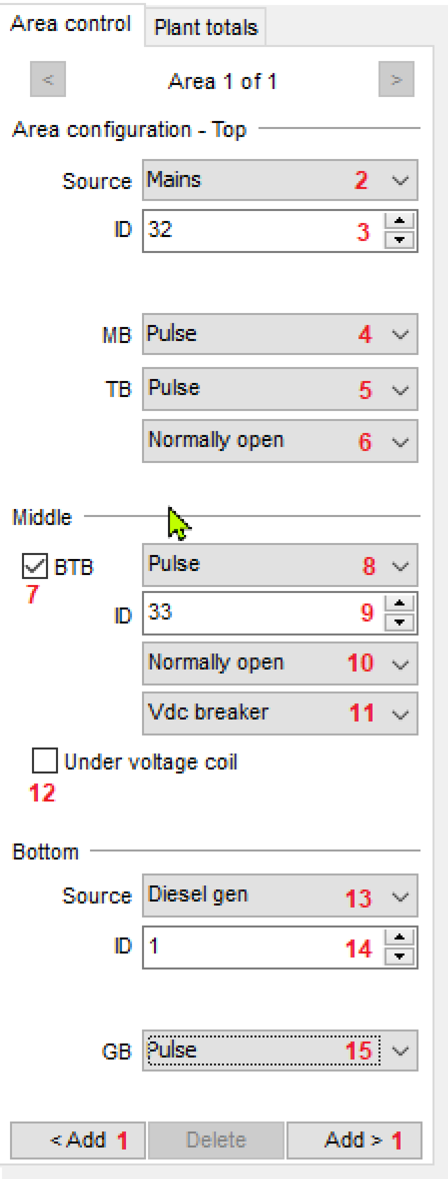


Plant options

	Description	Comments
Product type	The controller type is selected here.	This function is greyed out if a controller is already connected.
Plant type	• Single controller • Standard	Select *Standard* for power management systems. If *Single controller* is selected, the CAN ports for power management communication are turned off.
Application properties	The application is activated when it is written to the controller. Name the application.	Naming the application can be helpful, if the controller is in a plant where the controller will switch between applications. The controllers can switch between four different applications. Controllers connected to each other by CAN bus communication cannot have different applications or numbers.
Bus tie options	Select the *Wrap bus bar* option.	Activate this option if the busbar is connected as a ring connection in the application. When the wrap busbar is selected, it is shown like this: 
Power management CAN	Primary CAN Secondary CAN Primary and secondary CAN CAN bus off	*Primary CAN* must be used, if the Power Management CAN bus is wired to CAN port B on each controller. *Primary and secondary CAN* is only used for redundant CAN bus communication lines for power management. If this setting is selected and only one line is present, an alarm is activated. This alarm cannot be cleared. Note: Select *Primary and secondary CAN* if you are using Ethernet for power management communication redundancy.

	Description	Comments
		CAN bus off should only be used if the controller is in a single controller application.
Application emulation	Off Breaker and engine cmd. active Breaker and engine cmd. inactive	Turn on emulation here.

You can now create the application drawing in the controllers. From the left side of the page, you can add controllers to the configuration. You can also select the type of breakers in the application.

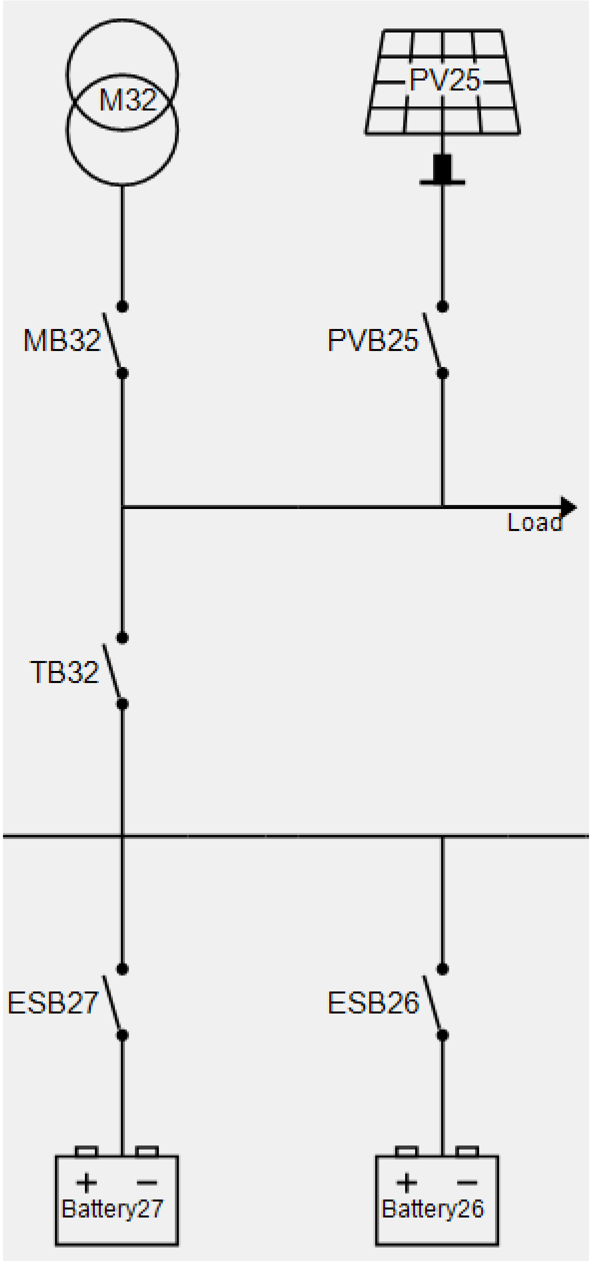


Plant configuration options

No.	Name	Description
1	Add/Delete	Add and delete areas. Adding areas makes the application configuration/plant bigger.
2	Source	Select the type of power source for the top area (None, Mains, Diesel gen, Photovoltaic, LG or Battery).
3	ID	Set the ID. This ID should correspond to the internal communication ID (parameter 7531) in the controller.

No.	Name	Description
4	MB	Mains is selected as the source (no. 2), so it is possible to select the type of breaker for the mains breaker (Pulse, Ext/ATS no control, Continuous NE, Compact, None, Continuous ND).
5	TB	Mains is selected as the source (no. 2), so it is possible to select the type of breaker for the tie breaker (Pulse, Continuous NE, Compact, None).
6	-	Select whether the tie breaker is *Normally open* or *Normally closed*.
7	BTB	Select to add a BTB controller.
8	-	The type of bus tie breaker (Pulse, Ext, Continuous NE, Compact). Select *Ext* for an externally controlled BTB, that is, there is no AGC BTB controller. The bus tie breaker position feedbacks must be connected to any controller in the power management system.
9	ID	Set the ID. This ID should correspond to the internal communication ID (parameter 7531) in the controller.
10	-	Select whether the BTB is *Normally open* or *Normally closed*.
11	-	If *Vdc breaker* is selected, the breaker can open and close when there is no voltage on the busbar. If *Vac breaker* is selected, voltage must be present on the busbar before the breaker can be handled.
12	Under voltage coil	Select this if the BTB has an under-voltage coil.
13	Source	Select the type of power source for the bottom area (None, Mains, Diesel gen, Photovoltaic, LG or Battery).
14	ID	Set the ID. This ID should correspond to the internal communication ID (parameter 7531) in the controller.
15	GB	In this example, diesel genset is selected as the source (no. 13), so it is possible to select the type of breaker for the genset breaker (Pulse, Continuous NE, Compact).

Application configuration example



After you have created the application, send it to the controllers. Select *Write plant configuration to the device* . After this, only the controller connected to the PC utility software has the application configuration.

The application configuration can then be sent from this controller to all the other controllers. Select *Broadcast plant application*

5.4 Power management functions

5.4.1 ESS power reference

The energy storage system (ESS) gets a power reference from the ASC controller. The ASC can transmit the power reference to the ESS. Alternatively, the ESS can read the power reference from the ASC (DEIF Open).

Calculating the ESS power reference

The ESS power reference is based on the ESS state of charge, the ESS operation, the ASC parameters, and the operation of the energy management.

More information
See **Storage controller functions** for information on the ESS state of charge, ESS operation, and ASC parameters.

More information
See **Storage controller functions, Regulation, Power reference** for information on the ESS power reference.

Stop all gensets

In grid-tied modes (for example, peak shaving or fixed power), the plant can be set up to stop all engines. For the AGC Genset controllers, configure the minimum number of gensets to run (multi-start) as **0**.

More information
See the **AGC Parameter list** for the genset multi-start parameters.

5.4.2 Spinning reserve

Spinning reserve ensures that the power management system is always able to supply the required power. Spinning reserve is the power that is immediately available.

You can configure spinning reserve in an ASC Storage controller. This is a global parameter. That is, the power management system shares this value to the genset and storage controllers to ensure that the spinning reserve is available.

NOTE The ASC storage spinning reserve is not related to the ASC solar spinning reserve.

Available power

The power management system uses **available power** in its genset start and stop calculations.

Available power = Genset nominal power - Load. Available power is thus power from gensets.

To be included in the available power, a genset must be:

- Controlled by an AGC in AUTO mode
- Running and connected to the busbar

Spinning reserve

The *Total available power* in the system, including the generating capacity of batteries, is useful to the plant. This is the **spinning reserve**.

Spinning reserve = (Genset) Available power + Battery generating capacity

To be included in the spinning reserve:

- The battery must be controlled by an ASC Storage controller in AUTO mode.
- The ESS must be ready.
- Discharging the battery must be allowed.

Parameters

`Power management > Spinning reserve`

Parameter	Name	Range	Default	Details
8930	Spinning Res.	0 to 30000 kW	100 kW	This is a global power management system parameter, shared with all the other controllers. This ensures that if the ASC Storage controller breaks down, the rest of the system compensates for the lack of energy from the battery.

External control > DG reverse power alarms

Parameter	Name	Range	Default	Details
15070	DG P<1	-200 to 100 % 0.1 to 3200 s	-5 % 10 s	This alarm is activated if the genset power falls below the set point.
15080	DG P<2	-200 to 100 % 0.1 to 3200 s	-5 % 10 s	This alarm is activated if the genset power falls below the set point.

External control > DG spinning reserve alarms

Parameter	Name	Range	Default	Details
15090	Spinning res. 1	0 to 100 % 0.1 to 3200 s	30 % 10 s	Activate the alarm if the spinning reserve falls below this percentage of the value set in parameter 8931.
15100	Spinning res. 2	0 to 100 % 0.1 to 3200 s	10 % 10 s	Activate the alarm if the spinning reserve falls below this percentage of the value set in parameter 8931.

Example: Off-grid genset and battery application

One battery and five gensets
Battery generating capacity = 0.4 MW
Nominal power for each genset = 1.5 MW
Spinning reserve required = 1.0 MW
Genset load-dependent start set point = 90 %
Genset load-dependent stop set point = 85 %

1. Site load = 3.5 MW, three gensets running.
   - Available power = 3 x 1.5 MW - 3.5 MW = 4.5 MW - 3.5 MW = 1 MW.
   - Available spinning reserve = 1 MW + 0.4 MW = 1.4 MW.
   - The spinning reserve requirement is met.
2. A load of 0.5 MW is suddenly added.
   - Site load = 4.0 MW.
   - Genset load = 4.0 MW / 4.5 MW = 89 %. The genset load-dependent start requirement is not met.
   - Available spinning reserve = 4.5 MW - 4.0 MW + 0.4 MW = 0.9 MW. The spinning reserve requirement is not met. The power management system therefore starts another genset.
   - Available spinning reserve = 4 x 1.5 MW - 4.0 MW + 0.4 MW = 2.4 MW. The spinning reserve requirement is met. No more gensets start.
3. The total site load falls to 3.6 MW.
   - Can a genset stop?
     - If one genset stopped, the load on the remaining three gensets would be 3.6 MW / 4.5 MW, or 80 %. A load-dependent stop is therefore possible, subject to the spinning reserve requirement.
     - If one genset stopped, the available spinning reserve would be 4.5 MW - 3.6 MW + 0.4 MW = 1.3 MW.
     - The spinning reserve requirement would therefore also be met if the genset stopped.
     - The genset can therefore stop.

Example: Off-grid genset and energy storage system; half of storage capacity trips

Two 1 MW batteries, and ten gensets
Total battery generating capacity = 2 MW
Nominal power for each genset = 1.5 MW
Spinning reserve required = 3.5 MW
Genset load-dependent start set point = 90 %
Genset load-dependent stop set point = 70 %

1. Site load = 10 MW, eight gensets running.
   - Site load = 10 MW

- Available spinning reserve = 8 x 1.5 MW - 10 MW + 2 MW = 4 MW.
- The spinning reserve requirement is met.

2. One of the batteries trips, and can therefore no longer be included in the spinning reserve. The total battery generating capacity is now 1 MW.
   - Available spinning reserve = 12 MW - 10 MW + 1 MW = 3 MW
   - The spinning reserve requirement is not met, and so the power management system must start another genset.

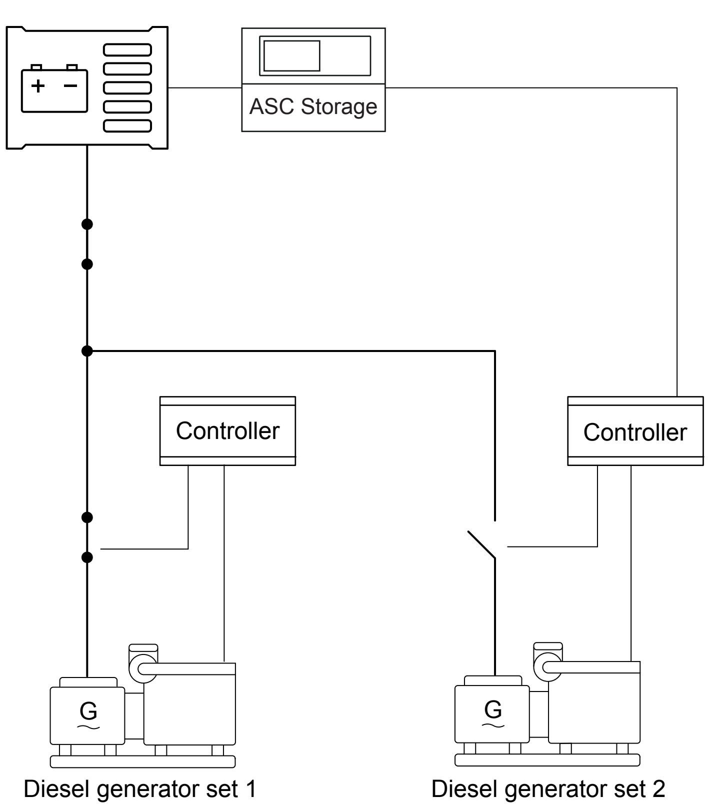
5.4.2.1 Alarms for spinning reserve

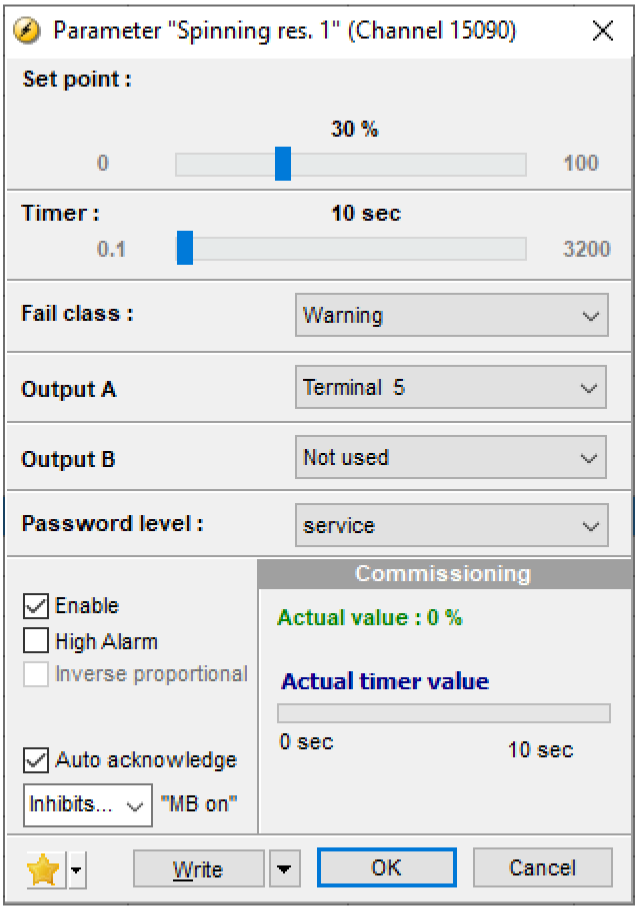
Two alarms are available for the spinning reserve function (menus 15090 and 15100). These alarms can be used in power management applications or single controller applications.

The alarms can be configured to activate above or below the set point, along with a set point, timer, and fail class.

Using the spinning reserve alarm to start the next genset

If there is no power management system, you can configure one of the spinning reserve alarm's outputs to send a start command to the next genset. This is shown in the diagram and screenshot below. The digital output on terminal 5 of the ASC is configured to activate if the spinning reserve is too low. ASC terminal 5 is wired as a start input to the genset controller.





NOTE Select *Auto acknowledge* to automatically deactivate the output when the spinning reserve required is available again. Select *Enable* to enable the alarm.

Using the spinning reserve alarm for load management

You can configure the spinning reserve alarm to send a signal to disconnect load groups.

5.4.3 Set points in multi-ASC applications

If more than one ASC is present, the energy production is balanced between the energy storage systems that are running or ready to start. The load sharing is firstly based on the ESS state of charge (SOC). That is, the ESS that needs to charge/ discharge more to reach the required SOC is given priority. If both ESS have the same SOC stage, the load sharing is based on nominal apparent power.

Example of battery load sharing

The system consists of two battery systems and three gensets. The battery systems are used to ensure that the gensets run at the minimum load (40 % of nominal power). The nominal apparent power for battery system A is 500 kVA, and for battery system B it is 200 kVA. The nominal power for each genset is 500 kW.

The plant load is 300 kW, and two gensets are running. The battery state of charge conditions allow charging, and the SOC is the same in both systems. Battery system A has a charging capacity of 150 kW, while battery system B has a charging capacity of 50 kW.

For the gensets run at the minimum load, each genset must run at 40 % x 500 kW = 200 kW. In total, the gensets must run at 2 x 200 kW = 400 kW. The batteries therefore need to use 400 kW - 300 kW = 100 kW for charging.

Battery system A therefore uses 100 kW x 150 kW / (150 kW + 50 kW) = 75 kW to charge, while battery system B uses 25 kW to charge.

5.4.4 ESS is the isochronous source

The ESS can act as the isochronous source in grid-forming mode in an application with gensets. This function is used in PMS applications that are off-grid (mains breaker open).

This function can be activated using parameter 8041 (see below) or M-Logic `Output > Command Battery > Enable ESS isochronous mode` (and deactivated by `Disable ESS isochronous mode`).

Parameters

`Power management > PMS isochronous master`

Parameter	Name	Range	Default	Details
8041	PMS Isochr. master	Not enabled, Enabled	Not enabled	**Enabled**: The ASC regulates the ESS to be the controlling isochronous master in an off-grid application with gensets. This means that the system voltage and frequency are set by the ESS, and the genset controllers use fixed power regulation. If this parameter is enabled in more than one ASC in the application, then the ASC with the lowest PMS ID is the isochronous master. **Not enabled**: For the off-grid application, the genset controllers use island regulation.
8042	PMS Isochr. mode req	V/f mode only V/f or droop mode	V/f mode only	**V/f mode only** (recommended): The ESS must be in voltage-frequency mode before starting to run as the isochronous source. **V/f or droop mode***: The ESS can run in voltage-frequency mode or droop mode before starting to run as the isochronous source.

NOTE * This is only recommended for advanced customers. To avoid producing power at the wrong voltage and/or frequency, extra regulation and tuning may be required in the PCS.

5.4.5 Genset management

5.4.5.1 Genset load-dependent start and stop

The genset load-dependent start and stop (LDSS) parameters are configured in the AGC Genset controller. You can configure two sets of LDSS parameters in each AGC Genset controller.

If the ESS is available, the energy management system can be configured to tell the AGC Genset to use the first set of LDSS parameters. These parameters can therefore be set higher, since the ESS contributes to the spinning reserve. For example, the load-dependent start point can be 95 %, while the load-dependent stop is 75 %.

If the ESS is not available, the energy management system can be configured to tell the AGC Genset to use the second set of LDSS parameters. The ESS is not available if the state of charge is below the minimum, or if it is out of service. The LDSS must be set lower, so that there is enough spinning reserve. For example, the load-dependent start point can be 85 %, while the load-dependent stop is 65 %.

More information
See **Genset functions, Load-dependent start and stop** in the **Option G5 Power management AGC-4 Mk II** for more information and examples.

NOTE If the ESS supports it, the system can run on battery power (grid-forming) without gensets or a mains connection. The battery can run alone, or together with solar power.

5.4.5.2 Genset set points (kW)

In power management mode, the controllers force the gensets that are connected to the busbar to operate at or above a minimum load. This is to reduce the risk of engine problems, for example wet-stacking, fouling, or other issues caused by idling at low loads.

Island operation

During island operation the connected genset load can be between -50 and 100 % of engine nominal power. The *Min DG load 1/2* parameters (15011 to 15013) on the ASC are shared parameters that ensure that all engines connected to the busbar do not go below the minimum load.

If the gensets are in frequency control mode, the energy storage system regulates the power. If the gensets are loaded more than the parameter set point, then the energy storage system is regulated up to take over load from the gensets and vice versa.

Parallel to grid operation

Gensets that operate in parallel to the ESS are always loaded to at least their *Minimum Load*, to protect them.

The power management system uses the ESS according to the charge scheme, and starts and stops gensets as required while taking the minimum genset load into account.

5.4.6 Ground relay

The ground relay function ensures that the star point of only one connected power source is connected to ground during island operation. This prevents circulating currents between the power sources.

NOTE The relay for this function must be selected in each controller (that is, in all the genset controllers and storage controllers).

How it works

The ground relay function follows the following principles:

- If the ESS is not connected to the busbar, the ground relay does not consider the rest of the system.
    - If the close condition is met, the ground relay is closed.

    - If the open condition is met, the ground relay is open.
- If more than one power source is connected to the busbar, then power management ensures that only the ground relay of the biggest power source stays closed. The ground relays of all other power sources are opened.
    - If the power sources are the same size, then the ground relay of the connected power source with the highest priority is closed.
- A new power source can connect to the busbar. If it is bigger (or the same size and a higher priority) than the power source with the closed ground relay, the new power source keeps its ground relay closed. The other power source opens its ground relay.
- The close condition, open condition and ground relay type are configurable.

Safety

The ground relay function is NOT supported in a **Single controller** application, even if the controller has power management.

`Power management > Ground relay > Ground relay`

Parameter	Text	Range	Default	Description
8121	Output A	Not used Relay 5, 6 and 9 to 18 Limits	Not used	If a pulse breaker is chosen (see 8126), use this for ground relay open.
8122	Output B		Not used	If a pulse breaker is chosen (see 8126), use this for ground relay close.
8123	Enable	OFF ON	OFF	Enable the ground relay function.
8124	Timer	1.0 to 30.0 s	1.0 s	An alarm for the unusual situation where power management expects a power source's ground relay to close, but it does not. This may be due to a physical fault with the ground relay.
8125	Fail class	Fail classes	Trip ESB	
8126	Ground relay type	Continuous Pulse	Continuous	**Continuous**: When the ground relay must be closed, the *Output A* relay selected in 8121 is activated continuously. **Pulse**: Configure *Output A* to open and *Output B* to close the ground relay. Ground relay breaker feedback is required.

`Power management > Ground relay > Gnd breaker setting`

Parameter	Text	Range	Default	Description
8151	Gnd close conf	Hz/V OK Start active	Hz/V OK	Ground relay close condition. **Hv/V OK**: The ground relay closes if the ESS voltage and frequency (parameters 2111 to 2114) are okay. **Start active**: The ground relay closes when the ESS start is active.
8152	Gnd priority	DG priority ESS priority	DG priority	**DG priority**: For the same nominal power, gensets have first priority for the ground relay function. **ESS priority**: For the same nominal power, energy storage systems have first priority for the ground relay function.

Ground relay with breaker position

Position feedbacks from the ground relay are required for a pulse relay.

- In the utility software, select *I/O & Hardware setup*.
- In the *Preconfigured function* list, select the required feedback:
    - *Ground breaker on*

- *Ground breaker off*

`Power management > Ground relay > Gnd Break fail`

Parameter	Text	Range	Default	Description
8131	Gnd Open fail, Timer	1.0 to 30.0 s	1.0 s	Ground relay open failure. The controller deactivated its output, but the ground relay did not open before the timer ran out.
8132	Gnd open fail, Fail class	Fail classes	Trip ESB	
8133	Gnd Close fail, Timer	1.0 to 30.0 s	1.0 s	Ground relay close failure. The controller activated its output, but the ground relay did not close before the timer ran out.
8134	Gnd Close fail, fail class	Fail classes	Shutdown	
8135	Gnd Pos fail, Timer	1.0 to 30.0 s	1.0 s	Ground relay position failure. The breaker feedbacks are inconsistent for the specified time.
8136	Gnd Pos fail, Fail class	Fail classes	Trip ESB	

NOTE There is always an overlap where both ground relays are connected when transferring the ground relay from one power source to another.

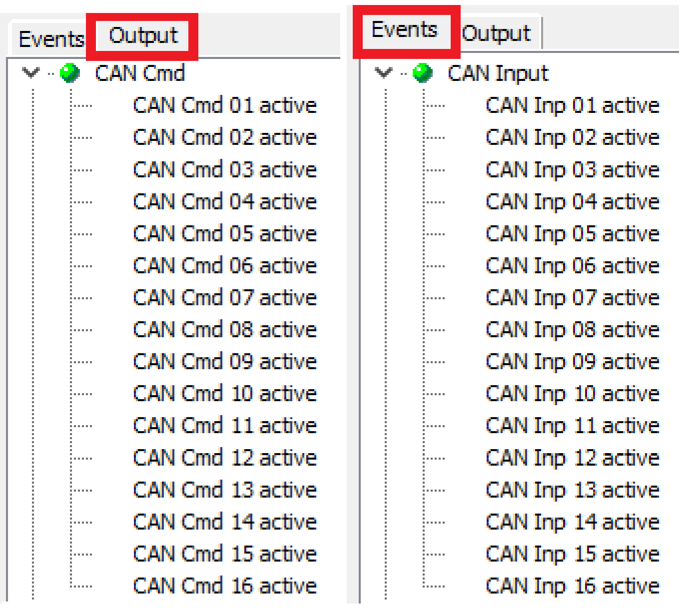
5.5 More power management communication

5.5.1 CAN flags (M-Logic)

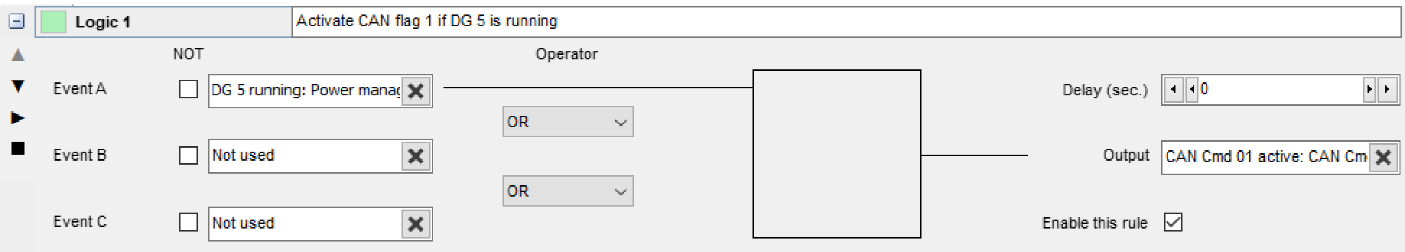
M-Logic has 16 CAN flags for CAN commands. They are like digital inputs. When a CAN command is sent from one controller, the corresponding CAN flag is activated in all the controllers. No wire is needed, as the CAN flags are communicated over the power management CAN bus.

NOTE Only use continuous signals from digital inputs or AOP buttons to activate the CAN inputs. AOP buttons are pulse inputs, so a latch function must be used to create a continuous signal.

M-Logic CAN flag outputs and events



M-Logic CAN command example



CAN Cmd 01 is activated when DG 5 is running. *CAN Inp 01 active* is then activated in all controllers in the power management system.

5.5.2 CAN bus setup

If it is critical for the application to have the fastest possible inter-controller communication, configure parameters 9171 and 9172 from the controller display.

Press *Shortcut menu* , select Jump and enter the parameter number:

Parameter	Text	Range	Default
9171	Int CAN units *	≤ 15 units ≤ 20 units ≤25 units ≤ 30 units ≤ 35 units ≤ 40 units	≤ 20 units
9172	Int CAN baud **	125k 250k	125k

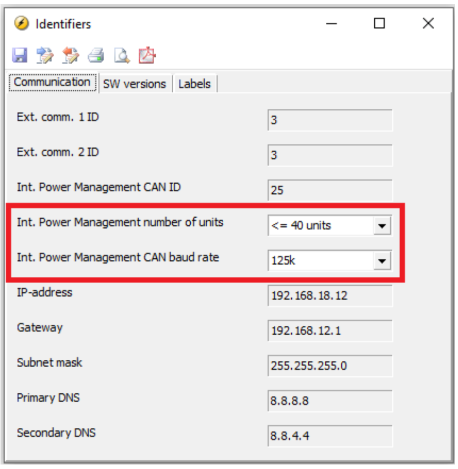
NOTE * The lower the number of units, the faster the power management.

** 125 kbit baud allows cable length up to 300 m, 250 kbit baud allows cable length up to 150 m.

All controllers in the system must have the same settings in parameters 9171 and 9172, otherwise an *Appl. hazard* alarm is displayed. A *Unit number Error* entry is created in the event log, and the controller with the different baud rate is tagged with the alarm value 100 in the alarm log.

The parameters can also be configured with the utility software:

1. In the task bar, select *Identifiers*
2. In the pop-up window, change *Int. Power Management number of units* and *Int. Power Management CAN BAUD rate*.



5.5.3 CAN failure mode

If there is a failure on the CAN controlling the power management, the system can be set up to respond in a variety of ways.

Power management > Communication failures

Parameter	Text	Range	Default	Details
7532	CAN fail mode	No reg MANUAL No mode change	No reg	The controller mode if there is a CAN failure. See below.
7533	Miss. all units	Fail classes	Warning	The controller cannot detect any other controllers.
7534	Fatal CAN error	Fail classes	Warning	More controllers are missing than configured in parameter 8800.
7535	Any DG missing	Fail classes	Warning	The controller cannot detect at least one genset controller.
7536	Any mains missing	Fail classes	Warning	The controller cannot detect at least one mains controller.
7871	Any BTB miss.	Fail classes	Warning	The controller cannot detect at least one BTB controller.
7874	Any LG miss.	Fail classes	Warning	The controller cannot detect at least one load group controller.
7875	Any PV miss.	Fail classes	Warning	The controller cannot detect at least one solar controller.
7876	Any Bat miss.	Fail classes	Warning	The controller cannot detect at least one storage/battery controller.
8800	CAN miss amount	2 to 32	2	The setting for the fatal CAN error.

No reg mode

If *No reg* mode is selected, the controllers change to no regulation mode when a fatal CAN error occurs. There is a risk of blackout, since there is no load sharing in no regulation mode.

MANUAL mode

If *MANUAL* mode is selected, the controllers change to MANUAL mode when a fatal CAN error occurs. The regulators in the controllers are still active. This means that power sources (for example, gensets) that are visible to each other are able to share load.

CAUTION

Unsynchronised gensets or energy storage systems can be connected

If a fatal CAN error is present, it is possible to start two gensets or energy storage systems and close the breakers onto the busbar at the same time (even though they are not synchronised).

No mode change

If *No mode change* is selected, the controllers are kept in the mode they were in before the fatal CAN error occurred. In an application with several controller types, if one power source controller is not visible anymore, the rest of the system can still behave almost like normal and continue in AUTO mode.

5.5.4 CAN bus alarms

Alarm	Description
Any DG missing	Activated when one or more genset controllers are missing. Activates the fail class in parameter 7535.
Any mains missing	Activated when one or more mains controllers are missing. Activates the fail class in parameter 7536 (also used when a BTB controller is missing).

Alarm	Description
Appl. Hazard	The application configuration is not the same in all the controllers in the system. The power management system cannot operate correctly. If enabled, this alarm activates the fail class in parameter 7872.
Duplicate CAN ID	Activated when two or more controllers have the same internal communication ID. The power management system cannot operate.
Missing all units	Activated only when a controller cannot "see" any other controllers on the CAN bus line. Activates the fail class in parameter 7533.
CAN bus communication failures	The *XXX missing* alarms, the alarm is activated on all other controllers in the application.
CAN ID X P missing	The controller has lost CAN bus communication to CAN ID on *PM Primary*.
CAN MAINS X P missing	The controller has lost CAN bus communication to a mains controller with ID X on *PM Primary*.
CAN BTB X P missing	The controller has lost CAN bus communication to a BTB controller with ID X on *PM Primary*.
CAN ID X S missing	The controller has lost CAN bus communication to CAN ID on *PM Secondary*.
CAN MAINS X S missing	The controller has lost CAN bus communication to a mains controller with ID X on *PM Secondary*.
CAN BTB X S missing	The controller has lost CAN bus communication to a BTB controller with ID X on *PM Secondary*.
CAN setup CH: 784x	The controller can detect power management communication on a CAN port, but the correct protocol is not set. For a genset controller, this alarm also monitors the CAN setup between the engine communication protocol and CAN port.

6. Open PMS applications

6.1 Open PMS

Open PMS is a power management system that consists of solar and/or storage controllers (ASC 150 and/or ASC-4). Open PMS can also include a mains controller. The ASC controller(s) get power measurements from the externally controlled power source(s). You can therefore use open PMS to add power management to a brownfield application with third party gensets.

Open PMS automatically supplies the power that is necessary for the load efficiently, safely and reliably:

- Automatically maximises PV power
- Automatically optimises ESS power
- Automatically closes and opens breakers
- Balances the loads in the system
- Deploys logic

The open PMS operating data can be shown graphically on the controller display. You can also monitor open PMS from a graphical supervision page in the utility software.

Open PMS features

Open PMS features	Extended	Premium
Power management operation limits: • External generator controllers per solar/storage controller • Mains controllers* • External mains connections • Solar controllers* • Storage (BESS) controllers*	 4 32 1 16 16	 16 32 1 16 16
EasyConnect	●	●
External sources included in the available power: • Supply the busbar load • Charge batteries • Minimum and optimal genset load	● ● ● ●	● ● ● ●

*Restrictions on controllers

ID 1 to 24	ID 25 to 32	ID 33 to 40
AGC Mains (1 to 32)		
	ASC Solar (25 to 40)	
	ASC Storage/Battery (25 to 40)	

Plant modes with a mains controller

With a mains controller, open PMS supports:

- Configurable mains power set point
- Configurable mains operating mode
- Auto-start signal for the application to the mains controller
- Standard AGC mains PMS features, including cos phi set points, and mains breaker control

Standard plant modes	Applications
Island mode	Power plant with synchronising generators.
Automatic Mains Failure	Critical power/emergency standby plants, black start generator.

Standard plant modes	Applications
Fixed power	Power plant with fixed kW set point (including building load).
Peak shaving	Power plant where generator supplies peak load demand paralleled to the mains.
Load take-over	Plant mode where the load is moved from mains to generator. For example, peak demand periods, or periods with a risk of power outages.
Mains power export	Power plant with fixed kW set point (excluding building load).

Plant modes with an external mains

The ASC that is connected to the external mains operates as an *AGC mains lite* and controls the mains mode.

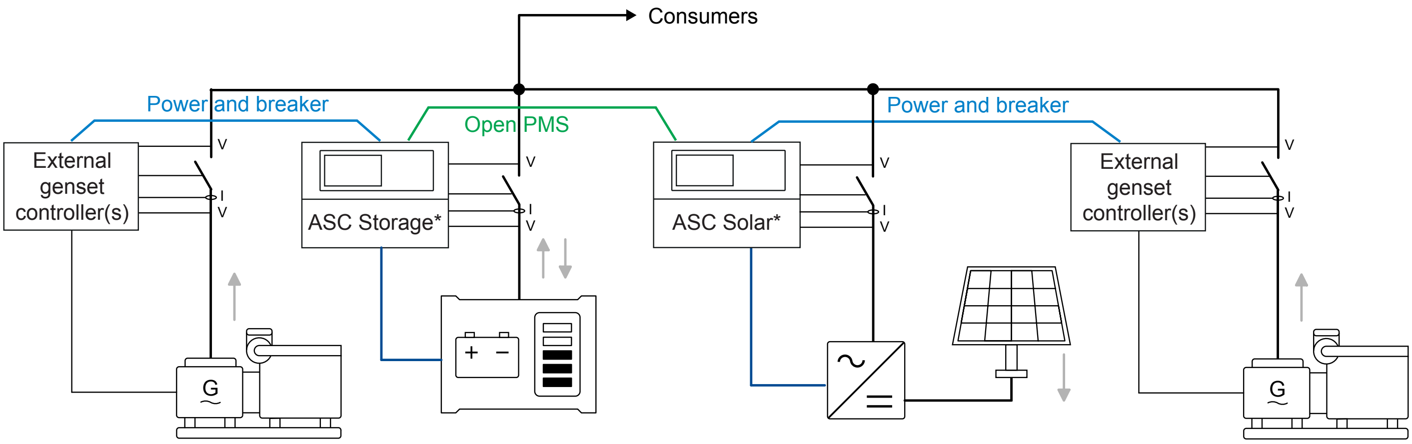
Standard plant modes	Applications
Fixed power	Power plant with fixed kW set point (including building load).
Peak shaving	Power plant where generator supplies peak load demand paralleled to the mains.
Mains power export	Power plant with fixed kW set point (excluding building load).

NOTE For an open external mains breaker, open PMS cannot synchronise so that the mains breaker can close. That is, open PMS runs in island mode and cannot back sync.

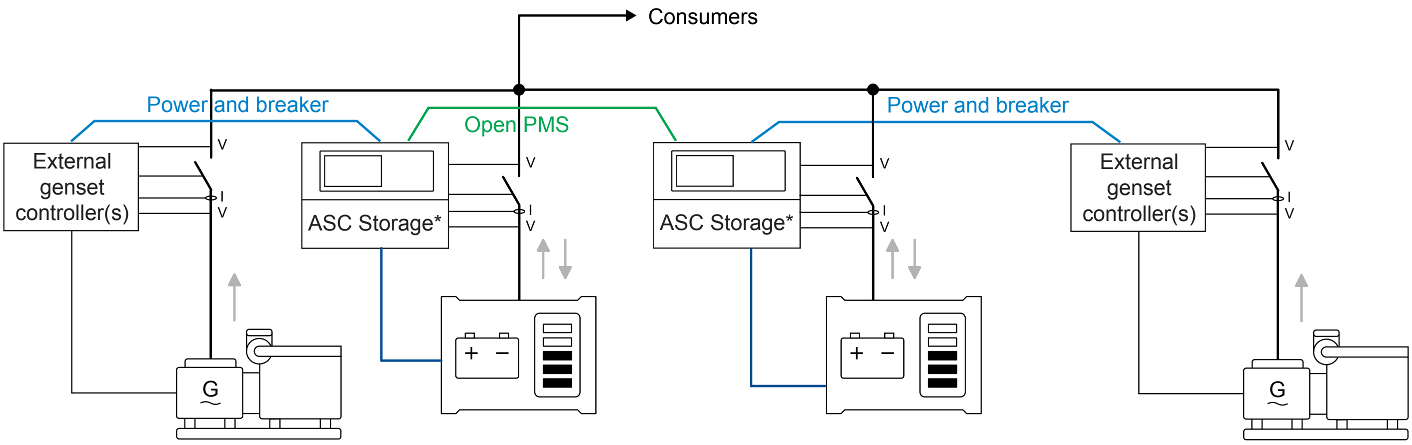
6.2 Single-line application diagrams for open PMS

6.2.1 Off-grid open PMS

Off-grid solar, storage and external genset(s)



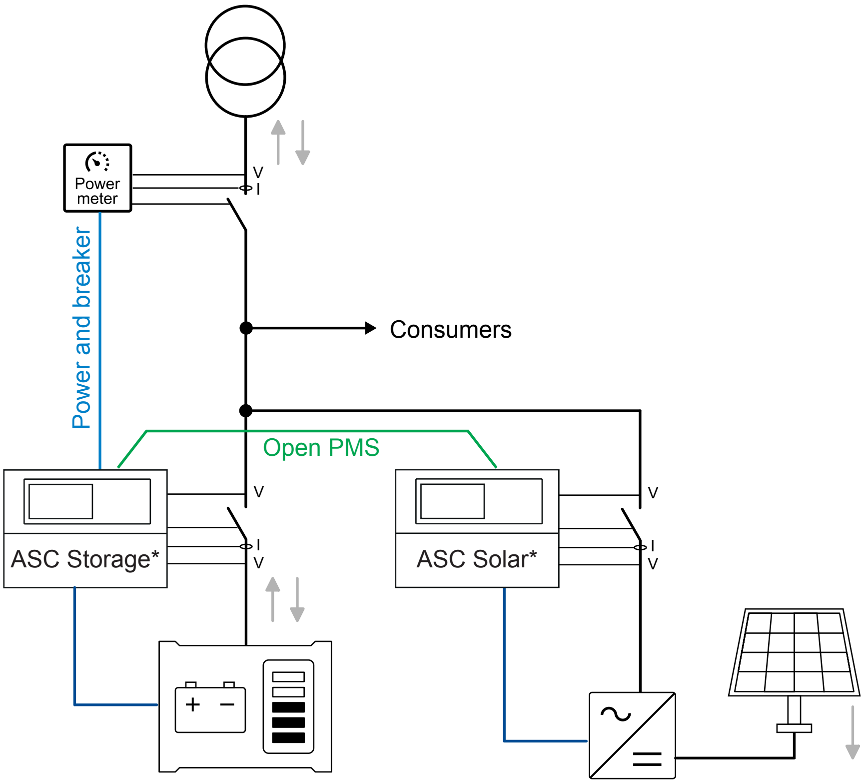
Off-grid storage(s) and external genset(s)



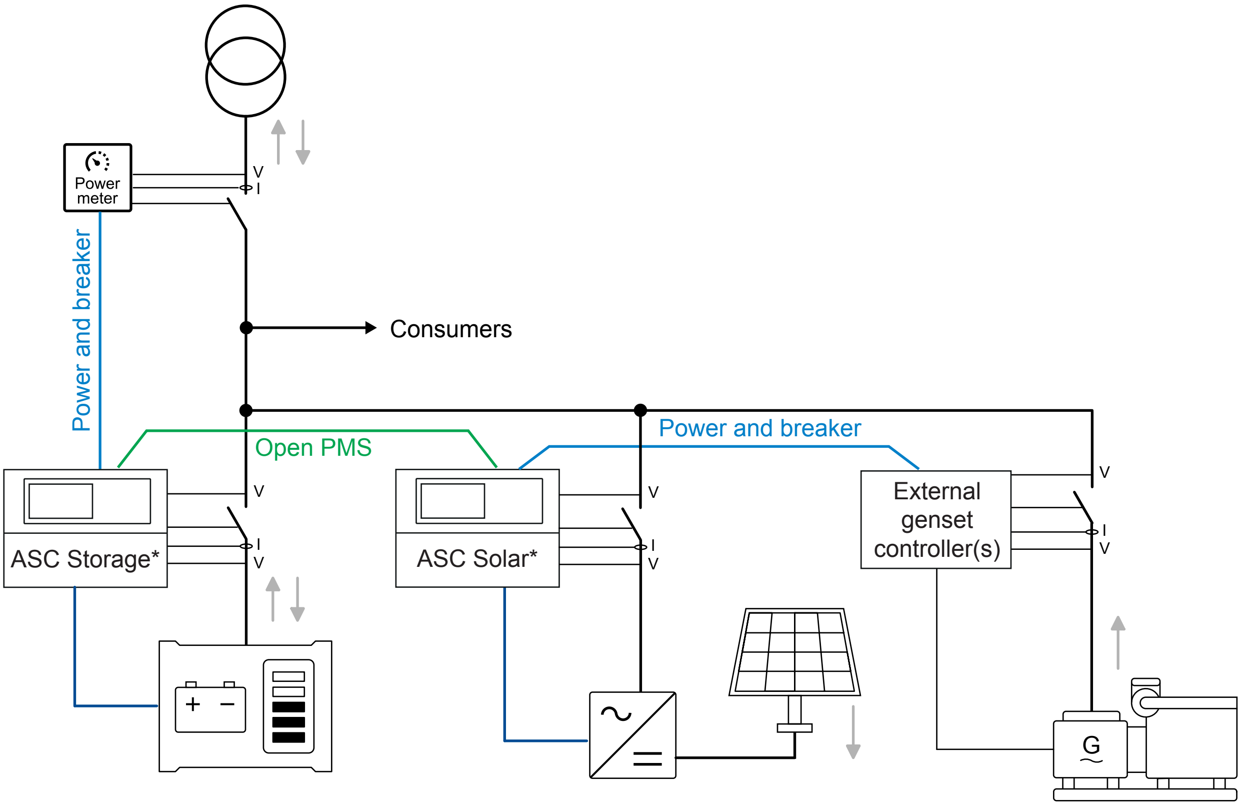
NOTE * You can use multiple controllers in the application. Power measurements can be connected to the closest ASC controller.

6.2.2 Grid-tied open PMS

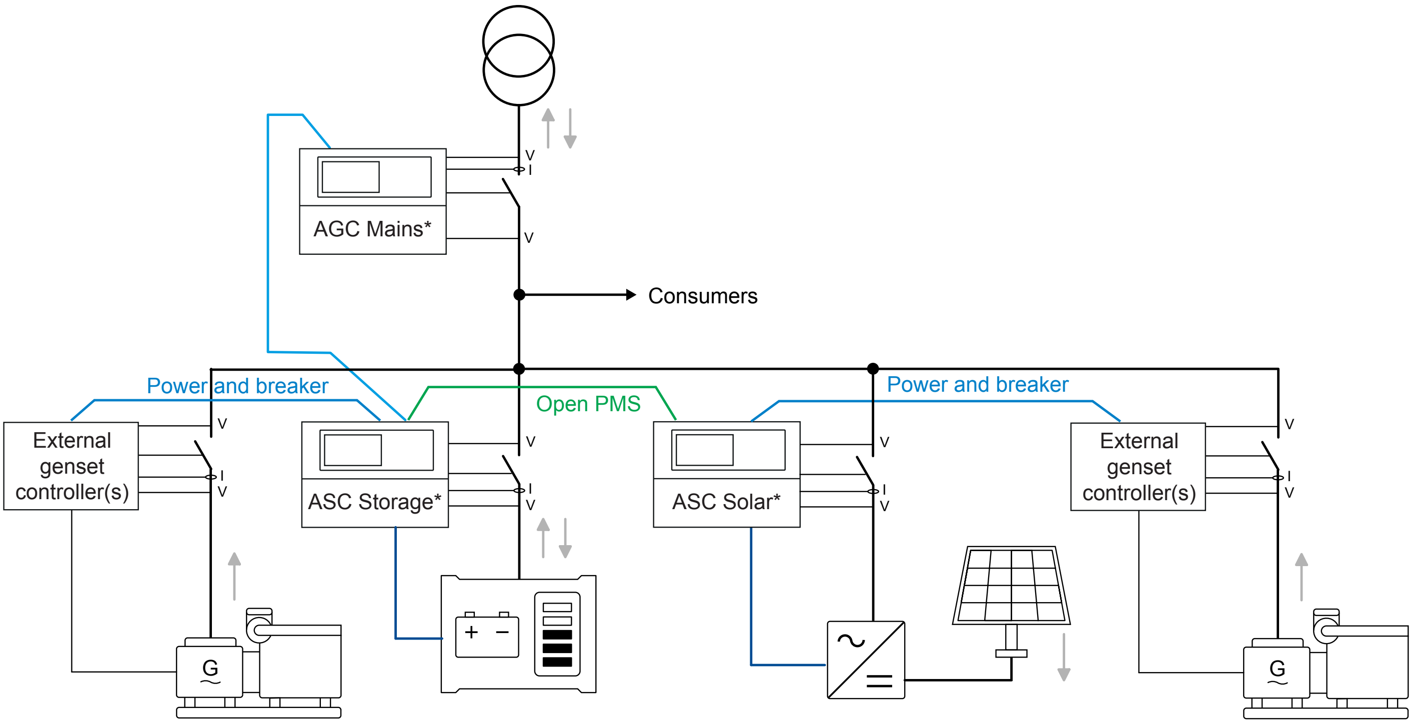
Grid-tied solar, storage and external mains



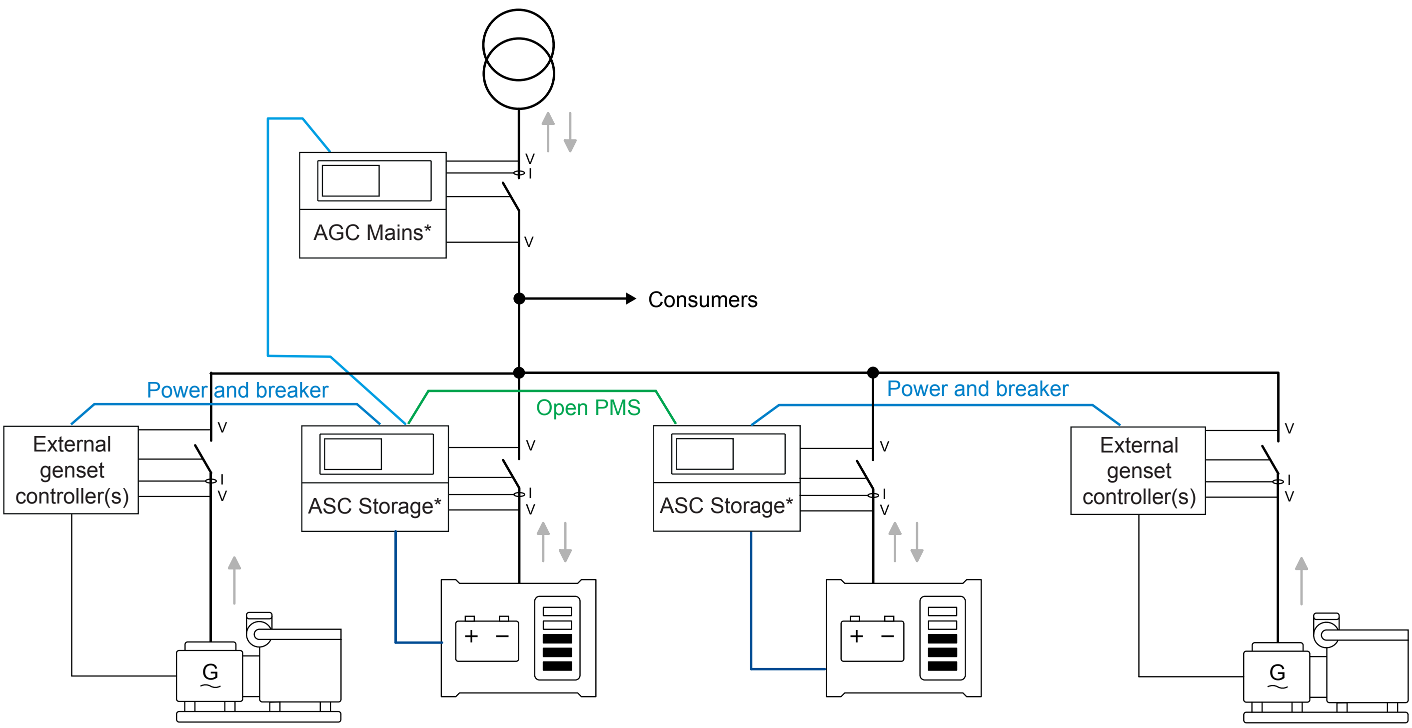
Grid-tied solar, storage, external genset(s) and external mains



Grid-tied solar, storage, mains and external genset(s)



Grid-tied storage(s), mains and external genset(s)



NOTE * You can use multiple controllers in the application. Power measurements can be connected to the closest ASC controller.

6.3 Setup of an open PMS application

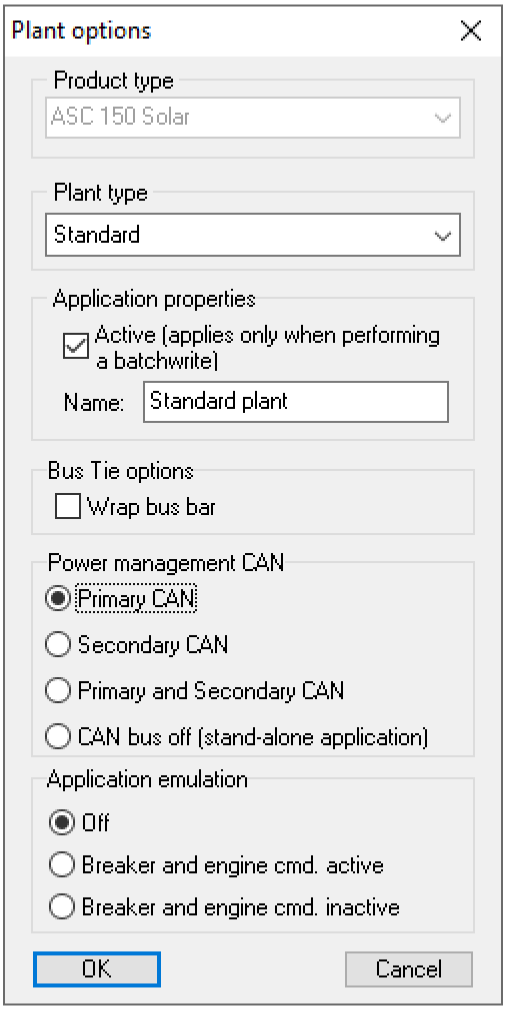
You must set the controller ID in each open PMS controller.

`Communication > Power management ID`

Parameter	Text	Range	Default
7531	PM CAN ID	25 to 40	25

When the IDs are configured, you can configure the application with the utility software.

Connect to a controller with the PC utility software, then select *Application configuration*. In the top taskbar, select *New plant configuration* . The *Plant options* window opens.



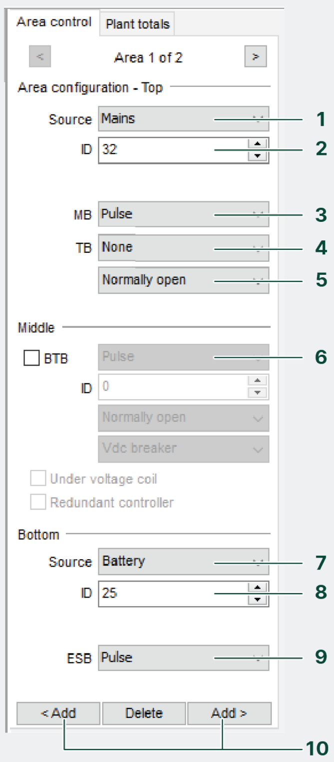
Plant options

	Description	Comments
Product type	The controller type is selected here.	This function is greyed out when a controller is connected.
Plant type	• Single controller • Standard	Select *Standard* for open PMS.
Application properties	The application is activated when it is written to the controller. Name the application.	Naming the application can be helpful, if the controller is in a plant where the controller will switch between applications. The controllers can switch between four different applications. Controllers that are connected to each other cannot have different applications or numbers.
Bus tie options	Not relevant.	You cannot use this for open PMS.
Power management CAN	Primary CAN Secondary CAN	Use *Primary CAN* if the Power Management CAN bus is wired to CAN port B on each controller.

	Description	Comments
	Primary and secondary CAN CAN bus off	Only use *Primary and secondary CAN* if there is redundant CAN bus communication for power management. If this setting is selected and only one communication line is present, an alarm is activated. This alarm cannot be cleared.
Application emulation	Off Breaker and engine cmd. active Breaker and engine cmd. inactive	You can turn on emulation here, for testing the system or training operators. **NOTE** Do not use emulation when the controller is connected to power generating equipment.

You can now create the application drawing in the controllers. From the left side of the page, you can add the ASC controllers and/or the mains controller to the configuration. You can also select the type of breakers in the application.

Plant configuration options



No.		Name	Description
	1	Source	Select the type of power source for the top area (None, Mains, Photovoltaic, or Battery).
	2	ID	Set the ID. This ID should correspond to the internal communication ID (parameter 7531) in the controller.
	3	MB	Mains is selected as the source (no. 2), so it is possible to select the type of breaker for the mains breaker (Pulse, Ext/ATS no control, Continuous NE, Compact, None, Continuous ND).
	4	TB	Open PMS does not support TB. You must therefore select *None*.
	5	-	Select whether the tie breaker is *Normally open* or *Normally closed*.
	6	BTB	You cannot select a BTB in open PMS.
	7	Source	Select the type of power source for the bottom area (None, Mains, Photovoltaic, or Battery).
	8	ID	Set the ID. This ID should correspond to the internal communication ID (parameter 7531) in the controller.
	9	ESB	In this example, battery is selected as the source (no. 13), so it is possible to select the type of breaker (Pulse, Ext/ATS no control, Continuous NE, None).
	10	Add/Delete	Add and delete areas. Adding areas makes the application configuration/ plant bigger.

Restrictions

Do not include the external genset(s) or an external mains in the open PMS application. These are configured separately as external P/Q sources.

Do not include genset(s) with AGC controllers in the open PMS application. If present, these are also configured separately as external P/Q sources.

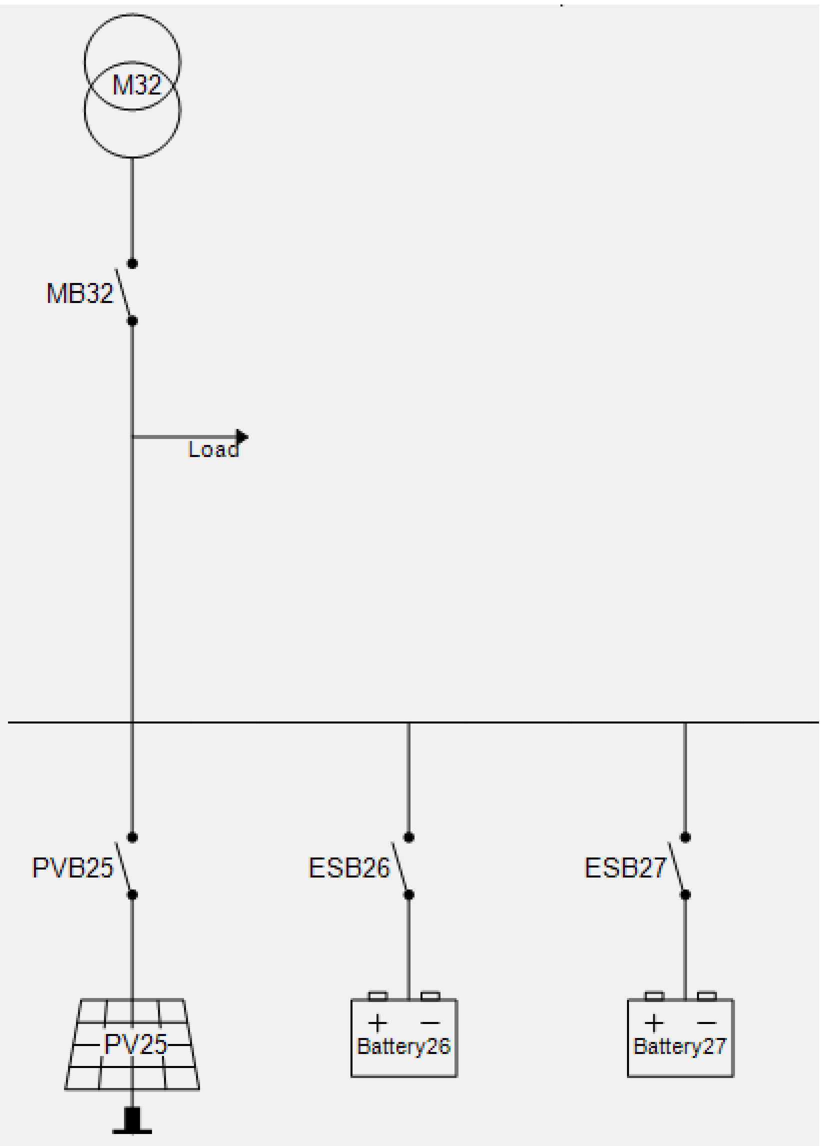
Mains controller(s) cannot have tie breakers in an open PMS application.

- As a result, there is no mains load point on an open PMS application diagram. For open PMS, the **ASC solar controller** is therefore shown as connected to the busbar.

Do not include bus tie breakers (BTB) or load groups (LG) in the open PMS application. These are not supported by open PMS.

NOTE Use a DEIF **Energy management system** if the application cannot comply with these restrictions.

Application configuration example



After you have created the application, send it to the controllers. Select *Write plant configuration to the device* . After this, only the controller connected to the PC utility software has the application configuration.

The application configuration can then be sent from this controller to all the other controllers. Select *Broadcast plant application*

6.3.1 ASC open PMS parameters

You can use open PMS with ASC 150 Solar, ASC 150 Storage, ASC-4 Solar, ASC-4 Battery, AGC 150 Mains and/or AGC-4 Mk II Mains.

To use open PMS, you must configure these parameters in each ASC.

ASC parameters

Parameter	Name	Range	Default	Details
6071	Operation mode	(See the software - only *Power*	Power management	This parameter must be **Power management**.

Parameter	Name	Range	Default	Details
		management is relevant)		
8022	Mode update	Update local Update all	Update all	**Update all**: When the mode is changed in the controller, the mode is changed in all open PMS controllers. **Update local**: When the mode is changed in the controller, the other open PMS controllers are not affected.
8351	**Open PMS**	Not enabled, Enabled	Not enabled	To use open PMS, this parameter must be **Enabled**.
8352	Open PMS mode	Peak shaving Fixed power Mains Power Export	Mains Power Export	If this controller is connected to an external mains measurement, use this parameter to set the open PMS mode. If this controller is not connected to an external mains measurement, this parameter is ignored.

More information
See **Using an external mains** for the configuration and parameters required when using an external mains in open PMS.

More information
See **Using an AGC mains** for the configuration and parameters required when using an AGC mains controller in open PMS.

NOTE If the application does not include any mains, the controller with the lowest ID is the plant controller.

6.3.2 Using external gensets

You can use open PMS with external gensets. For each ASC controller, you can configure and connect up to 16 external genset power measurements and breaker feedbacks.

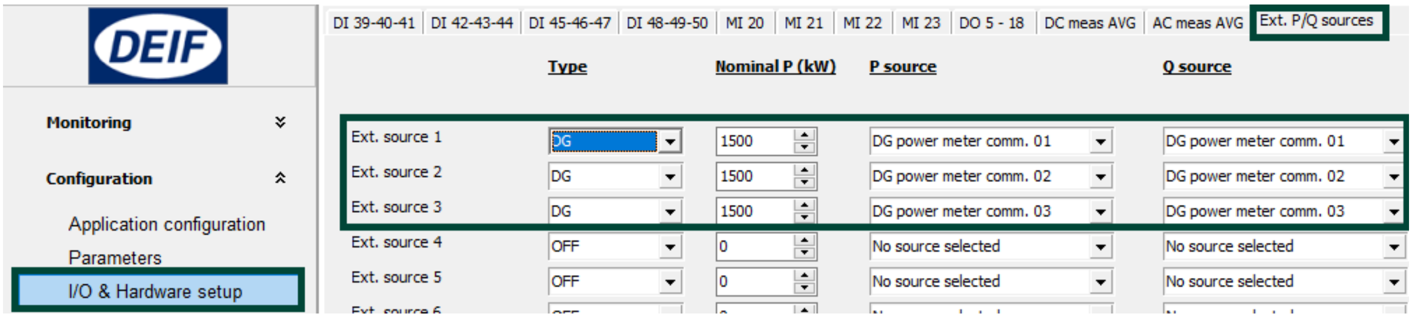
Application configuration

The application configuration must not include a *Genset* source. Open PMS detects that external genset(s) are present when:

- *Open PMS* (parameter 8351) is *Enabled* in the ASC.
- In the utility software, under *I/O & Hardware setup > Ext. P/Q sources*, *Ext. source [1 to 16]*:
  - *Type* is *DG*
  - The nominal power is configured
  - The *P source* (required) is selected
  - The *Q source* (optional) is selected.

If you need to use AGC genset controllers in open PMS, select *DG power comm [1 to 16]*. In *DG meter prot.* (parameter 7721), select *DEIF genset control*.

Example of external genset configuration



Genset power measurements

The setup of the genset power measurements and breaker feedbacks for open PMS is the same as the setup for single-controller applications.

More information

See Power measurements and connection status for how to set up the genset power measurements and breaker feedback.

Different types of gensets or power meters

For each ASC controller, you can only have one genset meter protocol (parameter 7721). If the application has more than one set of genset and/or power meter types, connect each set to separate ASC controllers.

Alternatively, if you have a PLC, you can use the DEIF open protocol. The PLC can read the genset power from the different genset and/or power meter types, then write it to the ASC.

6.3.3 Start and stop external gensets

You can configure the ASC Storage controller to activate an output to start and run external gensets based on the load and/or the ESS SOC. You can deactivate the output based on the load to ensure that the genset minimum load requirement is met. You can use start based on the load and/or the SOC to ensure that the load is supplied and the ESS gets enough power to charge.

When the ASC activates the output to start and run one or more external gensets (*Start/Stop Ext. DG*), the external generator controller must start the genset(s) (including synchronisation and generator breaker closing).

When the ASC needs to stop the external genset(s), the ASC regulates the ESS to take over the genset load. When the breaker open point is reached, the ASC deactivates the output to stop the last external genset. The external generator controller should bring the genset to a controlled stop. If required, this should include a load ramp down to unload the genset. After opening the generator breaker, the generator controller should ensure that there is a cooldown sequence before stopping the genset.

Start-stop output

On the *Inputs/Outputs* page in the USW, choose a digital output to use as the output. Select the *Start/Stop Ext. DG* function.

Alternative setup using M-Logic

You can also control the *Start/Stop Ext. DG* output by using M-Logic, for more flexibility. For example, the request to start the genset can be used in combination with the command timers. This enables scheduling of the genset start and stop. The request to stop the gensets from M-Logic overrules any start request from the SOC, system load, and M-Logic.

You can find the M-Logic functions under *Output, Command GEN*:

- Request ext. Gen to start
- Request ext. Gen to stop

External genset breaker open

`External control > External DG start/stop`

Parameter	Name	Range	Default	Description
15180	Ext. DG breaker open	0 to 100 % of total external genset nominal power	5 %	When the total external genset power reaches this point, the ASC deactivates the *Start/Stop Ext. DG* output.

External genset start/stop alarm

`External control > External DG start/stop`

Parameter	Name	Range	Default	Description
15170	Ext. DG start error	1 to 1000 s	30 s	The alarm is activated if a genset start request is active, but the ASC has not received feedback from a genset. The alarm timer also starts running if the only genset connected to the busbar is disconnected.*

NOTE * If the ESS supports it, the system can run on battery power (grid-forming) either alone, or together with solar power.

6.3.4 Using an external mains

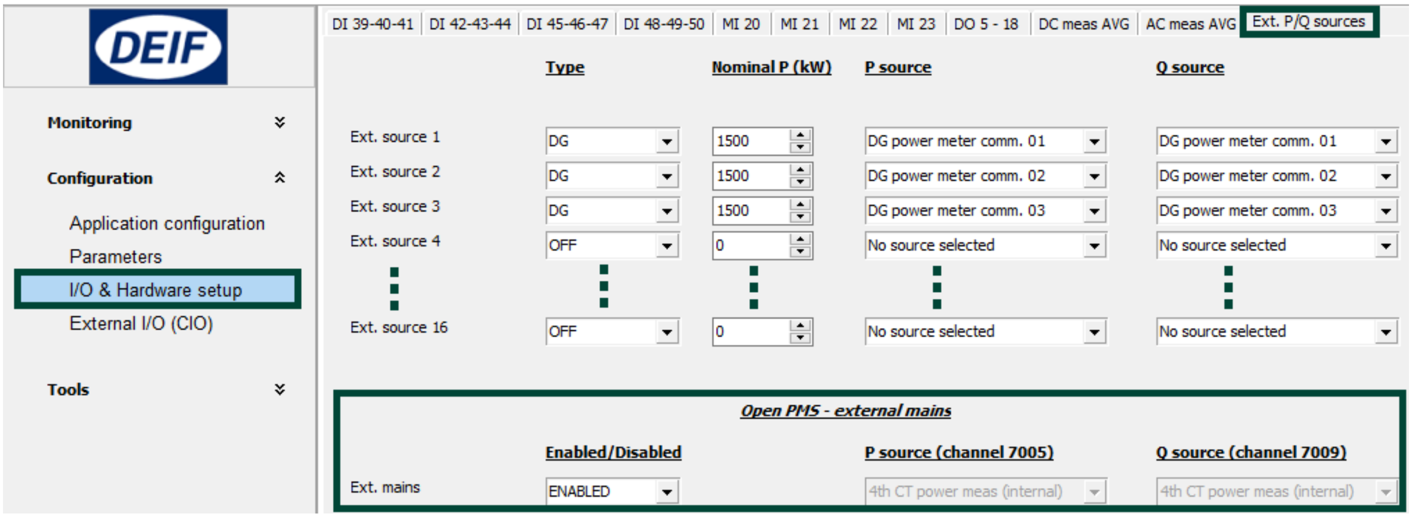
You can use open PMS with an external mains. Configure and connect the external mains power measurement and breaker feedback to one ASC controller. The set points in this ASC controller are used as the open PMS plant set points.

Application configuration

For an external mains, the application configuration must not include a *Mains* source. Open PMS detects that an external mains is present when:

- *Open PMS* (parameter 8351) is *Enabled* in the ASC.
- *Mains power measure* (parameter 7005): A mains power measurement is selected.
- *Mains Q measure* (parameter 7009) (optional): A mains reactive measurement is selected.
- In the utility software, under *I/O & Hardware setup > Ext. P/Q sources > Open PMS - external mains*, *Ext. mains* is *ENABLED*.

Example of external main configuration



Auto start/stop

To start the application automatically, the ASC with the external mains power measurement must get an *Auto start/stop* signal. This can be from a digital input, M-Logic (*Output > Command*), or Modbus communication.

NOTE For *Local* (in *Start/stop*, parameter 8021), the operator can use the display push-button to start the application.

Operation for an external mains

For an external mains, the open PMS operating mode is configured in the ASC controller that is connected to the external mains measurement. This ASC operates as an *AGC mains lite* controller. The open PMS application uses the ASC set point from the ASC controller that is connected to the external mains measurement. The ASC controller that is connected to the external mains measurement sends power references to the other open PMS controllers.

Open PMS supports three power management modes.

For an external mains, it is not possible for the open PMS to synchronise the mains breaker. That is, back sync is not possible.

Parameters for the ASC with an external mains

Parameter	Name	Range	Default	Details
6071	Operation mode	See the software.	Power management	This parameter must be **Power management**.
7001, 7002, 7006, 7011-7014	Peak shaving and mains power export parameters	-	-	If *Peak shaving* or *Mains power export* is selected in parameter 8352, open PMS uses these set points for the plant.
7051	Fixed power	0 to 20000 kW	500 kW	If *Fixed power* is selected in parameter 8352, open PMS uses this set point for the plant.
8022	Mode update	Update local Update all	Update all	**Update all**: When the mode is changed in the controller, the mode is changed in all open PMS controllers. **Update local**: When the mode is changed in the controller, the other open PMS controllers are not affected.
8351	**Open PMS**	Not enabled, Enabled	Not enabled	To use open PMS, this parameter must be **Enabled**.
8352	Open PMS mode	Peak shaving Fixed power Mains Power Export	Mains Power Export	Use this parameter to set the open PMS mode. If the controller is not connected to an external mains measurement, this parameter is ignored.

Mains power measurements

The setup of the mains power measurements and breaker feedbacks for open PMS is the same as the setup for single-controller applications.

More information
See Power measurements and connection status for how to set up the mains power measurements and breaker feedback.

NOTE For power meter communication, there can be up to 16 mains nodes (parameter 7726).
NOTE If digital inputs are used for the external mains breaker feedback, you must use digital input 47 for *MB position on* and digital input 48 for *MB position off*.
NOTE For external mains, the mains breaker position feedbacks do not activate the position failure alarm.

6.3.5 Using an AGC mains

You can use open PMS with an AGC 150 mains or AGC-4 Mk II mains controller.

Application configuration

For open PMS, the configuration of the AGC mains is the same as for standard power management. No additional configuration is needed.

The AGC mains must have a controller ID and be included in the application configuration.

Auto start/stop

To start the application automatically, the AGC mains must get an *Auto start/stop* signal. This can be from a digital input, M-Logic (*Output > Command Power management*), or Modbus communication.

NOTE For *Local* (in *Start/stop*, parameter 8021), the operator can use the display push-button to start the application.

Operation

The open PMS operating mode is configured in the AGC mains controller. The open PMS application uses the AGC mains set point.

Open PMS supports the standard AGC mains power management functions, including cos phi set points and mains breaker control.

AGC mains parameters

Parameter	Name	Range	Default	Details
6070	Plant mode	Auto mains failure Peak shaving Fixed power Mains power export Load take over	Auto mains failure	Use this parameter to set the plant mode.
7001 to 7253	Mains parameters	-	-	Configure these parameters as required for the application and plant mode.
7842	CAN B Protocol	OFF PMS Primary AOP2 PMS Secondary Ext. Modules DEIF	PMS Primary	Select **PMS Primary** or **PMS Secondary**. Select the same protocol in the ASC controllers.
8021	Start/stop	Remote, Local	Remote	**Remote**: For auto start/stop using a Modbus command, M-Logic, or a digital input. **Local**: Start/stop the application using the display start/stop buttons.

6.4 Open PMS in operation

When the application is running, open PMS automatically supplies the power that is necessary. This includes active (required) and reactive (optional) power. As a power management system, open PMS supplies power efficiently, safely and reliably.

Power from the external power sources (gensets and/or mains) is included in the available power. Open PMS uses the available power to supply the load.

For maximum efficiency, open PMS automatically maximises the PV power. Open PMS charges and uses the batteries according to the configured settings. As far as possible, open PMS makes sure that the gensets are not run below the minimum load. Rather, open PMS tries to use the mains, solar and storage power so that the gensets run at the optimal genset load.

Open PMS balances the load between the open PMS controllers.

In AUTO mode, open PMS controllers automatically close and open their breakers.

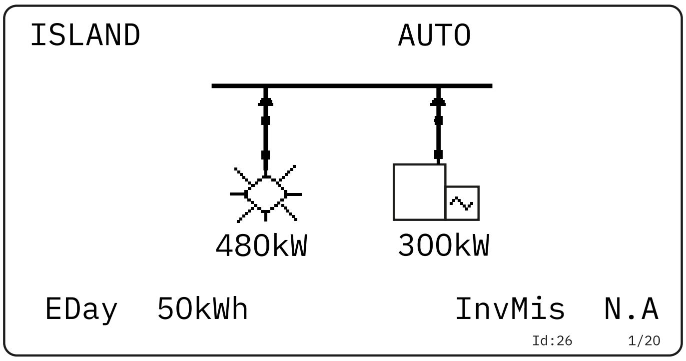
Finally, if there is M-Logic, open PMS deploys the M-Logic in the controller(s).

NOTE Open PMS does not control the load sharing, or the connection of the external gensets. Open PMS indirectly controls the power of the external gensets by adjusting the solar, storage and mains set points.

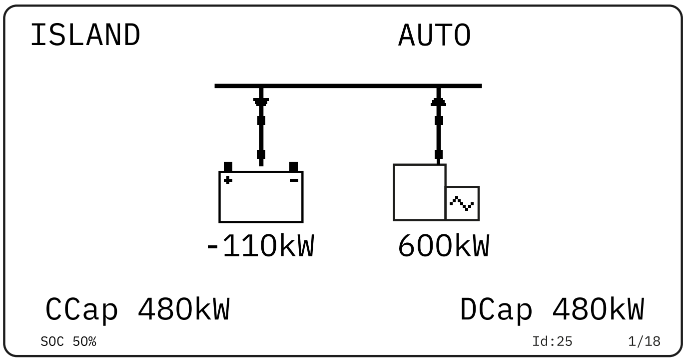
Examples of ASC 150 displays for open PMS

Island

ASC 150 Solar
(connected to genset(s))

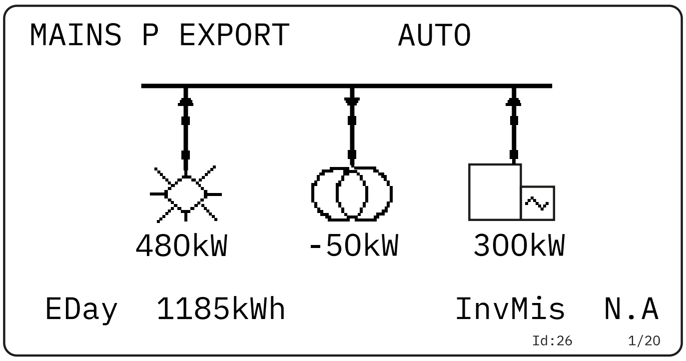


ASC 150 Storage
(connected to genset(s))

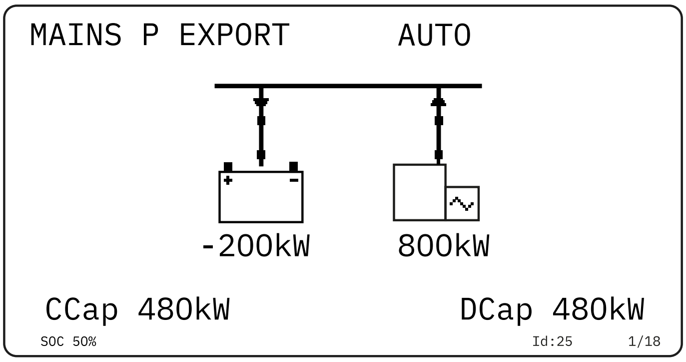


Grid-tied with external mains

ASC 150 Solar
(connected to mains and genset(s))

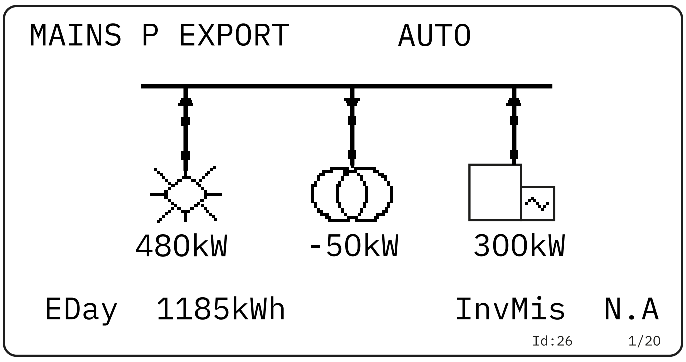


ASC 150 Storage
(connected to genset(s))

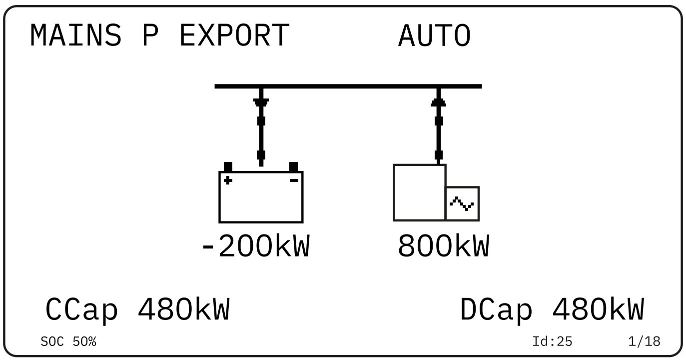


Grid-tied with AGC mains

ASC 150 Solar



ASC 150 Storage
(connected to gensets)



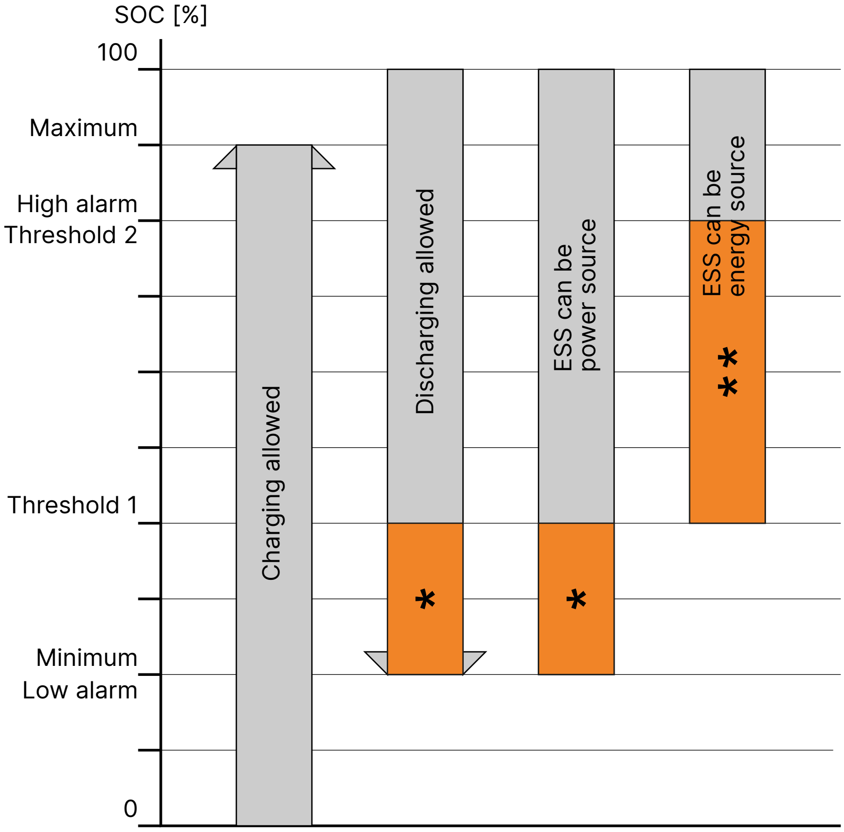
7. Storage controller functions

7.1 Managing charging and discharging

7.1.1 State of charge

The ASC reads the state of charge from the ESS. The controller ensures that the state of charge (SOC) conditions are met.

State of charge conditions



NOTE The drawing is based on the default parameter values.

Charging: If the SOC is below maximum, the ESS can charge. See **ESS charging source** for more information.

Discharging: If the SOC is above minimum, the ESS can discharge. *Below threshold 1: The ESS can discharge until the SOC reaches the minimum. The ESS must then recharge to threshold 1 before it can discharge again.

Power source operation: The ESS can be a power source if the SOC is above threshold 1. *Below threshold 1: The ESS can discharge as a power source until the SOC reaches the minimum. The ESS must then recharge to threshold 1 before it can discharge again.

Energy source operation: The ESS can be an energy source if the SOC is above threshold 2. **Below threshold 2: The ESS can discharge as an energy source until the SOC reaches threshold 1. The ESS must recharge to threshold 2 before it can be an energy source again.

State of charge parameters

`Storage > SOC settings`

Parameter	Name	Range	Default	Details
17055	SOC Settings	SOC Setting [1 to 3]	SOC Setting 1	The ASC has three sets of state of charge parameters. This parameter selects which set to use.

`Storage > SOC/SOH alarms > SOC alarms`

Parameter	Name	Range	Default	Details
17110	SOC Low	0 to 100 %	20 %	The SOC low alarm.
17120	SOC High	0 to 100 %	80 %	The SOC high alarm.

`Storage > SOC settings > SOC setting [1 to 3]`

Parameter	Name	Range	Default	Details
17051, 17061, 17071	SOC. Minimum [1 to 3]	0 to 100 %	20 %	The ESS must not discharge when this minimum is reached. The ESS is not allowed to provide any power until the SOC reaches threshold 1.
17053, 17063, 17073	SOC. Thr. 1.[1 to 3]	0 to 100 %	40 %	Below threshold 1, the ESS can discharge as a power source until the SOC reaches the minimum. The ESS must then recharge to threshold 1 before it can discharge again. Below threshold 1, the ESS cannot discharge as an energy source. The ESS must recharge to threshold 2 before it can be an energy source again.
17054, 17064, 17074	SOC. Thr. 2.[1 to 3]	0 to 100 %	80 %	Below threshold 2, the ESS can discharge as a power source until the SOC reaches the minimum. The ESS must then recharge to threshold 1 before it can discharge again. Below threshold 2, the ESS can discharge as an energy source until the SOC reaches threshold 1. The ESS must recharge to threshold 2 before it can be an energy source again.
17052, 17062, 17072	SOC. Maximum [1 to 3]	0 to 100 %	90 %	The ESS must not charge when this maximum is reached. The ESS can be a power or energy source.

7.1.2 Charging the ESS

The energy management system automatically manages the ESS charging when the conditions for charging are met.

Charging rules

Between SOC threshold 1 and the maximum (if neither of the thresholds has been crossed), the ASC uses this rule:

> If the system requires power, the ESS reduces charging.
> If power is still required, the ESS stops charging and supplies the load.

Maximum rate

The ESS will charge at the maximum rate, unless you configure the maximum charge rate for the ESS. If there are charge restrictions from other sources, the ASC uses the lowest charge rate that is referenced.

Negative numbers indicate flow into the battery (charge the ESS), and positive numbers indicate flow out of the battery (discharge the ESS).

`Storage > Dispatch limits`

Parameter	Name	Range	Default	Details
17093	Minimum dispatch	-100 to 100 % of the ESS nominal apparent power (S)	-100 %	The maximum charge rate for the ESS.

`Storage > DC protection`

Parameter	Name	Range	Default	Details
17161	Max charge volt.	0 to 3200 V Not enabled, Enabled	960 V, Not enabled	**Enabled**: The ASC uses this value to overwrite the maximum allowed DC charge voltage read from the BMS. **Not enabled**: The ASC does not change the maximum allowed DC charge voltage.

7.1.3 Discharging from the ESS

The energy management system automatically manages the ESS discharging when the conditions for discharging are met.

Discharging rules

Between the SOC maximum and threshold 1 (if neither of the thresholds has been crossed), the ASC uses the following rules:

1. If the ESS is an energy source, the ESS discharges.
2. If the ESS is a power source and there is peak load demand, the ESS discharges.
3. If the system has excess power, the ASC reduces the power that the ESS supplies. If there is still excess power, the ESS can start charging.

Maximum rate

The ESS will discharge at the maximum rate, unless you configure the maximum discharge rate for the ESS. If there are discharge restrictions from other sources, the ASC uses the lowest discharge rate that is referenced.

Negative numbers indicate flow into the battery (charge the ESS), and positive numbers indicate flow out of the battery (discharge the ESS).

`Storage > Dispatch limits`

Parameter	Name	Range	Default	Details
17094	Maximum dispatch	-100 to 100 % of the ESS nominal apparent power (S)	100 %	The maximum discharging rate for the ESS.

`Storage > DC protection`

Parameter	Name	Range	Default	Details
17163	Min charge volt.	0 to 3200 V Not enabled, Enabled	720 V, Not enabled	**Enabled**: The ASC uses this value to overwrite the minimum allowed DC charge voltage read from the BMS. **Not enabled**: The ASC does not change the minimum allowed DC charge voltage.

7.1.4 Force charging/discharging

You can use M-Logic commands to force ESS charging (*Output > Command Battery > Force charging*) or discharging (*Output > Command Battery > Force discharging*). Force charging/discharging is active as long as the M-Logic command is active.

Force charging

Force charging is used to only allow battery charging. The controller charges the battery as much as it can, while complying with the state of charge thresholds and charging source requirements.

For example, if the battery is under SOC threshold 2, it charges as much as it can from PV, mains and/or genset(s), while complying with the charging source priority and other requirements. When the battery is over SOC threshold 2, it charges as much as it can from PV until SOC maximum.

If charging is not possible, the controller keeps P ref at 0 kW.

When the M-Logic *Force charging* command is no longer active, the controller returns to its condition before force charging was activated (unless a threshold was crossed during the forced charging).

Force discharging

Force discharging is used to only allow battery discharging. The controller discharges the battery as much as it can, while complying with the minimum state of charge threshold and the mains set point.

If discharging is not possible, the controller keeps P ref at 0 kW.

7.1.5 Freeze charging/discharging

You can use M-Logic commands to freeze charging (*Output > Command Battery > Freeze charging*) or discharging (*Output > Command Battery > Freeze discharging*). These commands pause the battery charging/discharging. Freeze charging/discharging is active as long as the M-Logic command is active.

Freeze charging/discharging is similar to force charging/discharging. However, if the system needs energy from the battery, the battery can discharge during *freeze charging*. Similarly, if the system needs the battery to take up energy, the battery can charge during *freeze discharging*.

NOTE When *Freeze charging* is active, the battery charging power is zero (and discharging is allowed). Similarly, when *Freeze discharging* is active, the battery discharging power is zero (and charging is allowed).

7.1.6 Maintenance charge

The ESS SOC is an estimate of the state of charge in the energy storage system. SOC is generally suitable for ESS charging and discharging. However, to refresh and rebalance the ESS, it is sometimes necessary to allow charging above 100 % SOC.

Maintenance charge allows the ASC to charge the ESS based only on the maximum charge capacity value from the BMS.

`Storage > Maintenance charge`

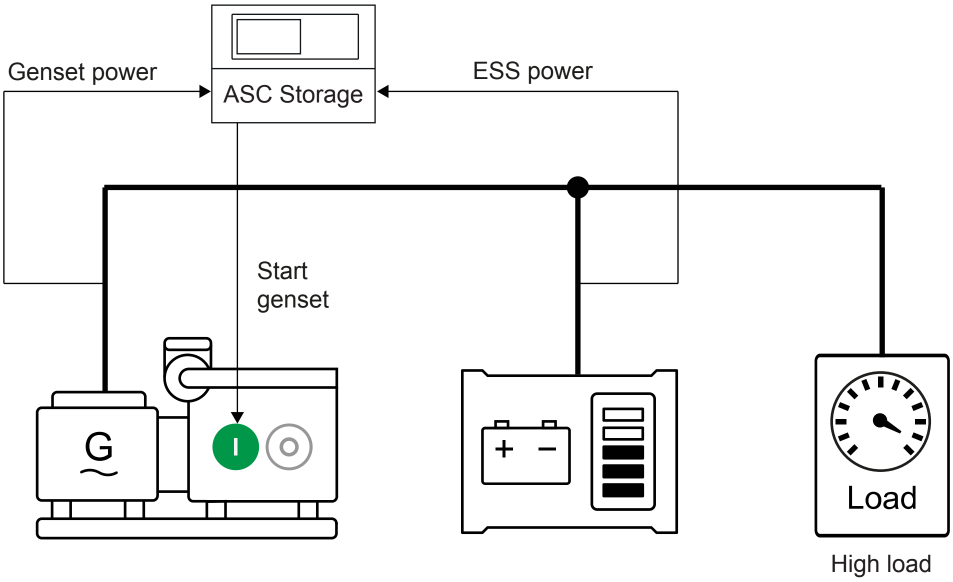
Parameter	Name	Range	Default	Details
17400	Maintenance charge	Not enabled, Enabled	Not enabled	**Enabled**: The ASC ignores the SOC and charges the ESS based only on the maximum charge capacity from the BMS. The ASC attempts to charge the battery until reaching the setting in parameter 17401.
17401	Charge cap. thr	0 to 20000 kW	0 kW	Maintenance charging stops when the maximum charge capacity from the BMS decreases to this value.

NOTE If the *SOC high* alarm action is *Shutdown*, *Trip ESB*, or *Trip MB*, you need to disable this alarm during maintenance charging.

7.1.7 System power genset control

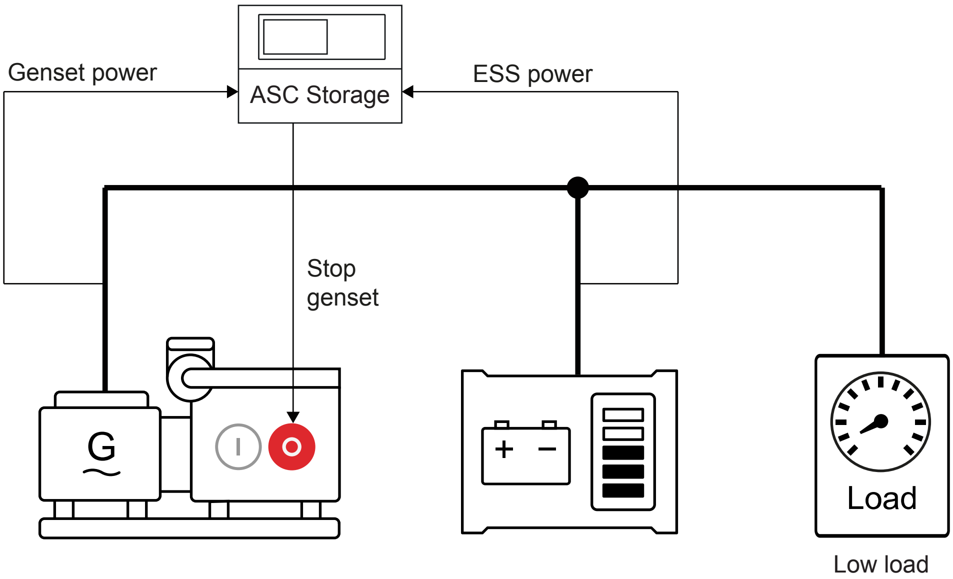
The ASC can start and stop the genset based on the system load. The ASC calculates the system load from the ESS and genset power.

High load genset start



When the load is high, start the generator to make sure that there is enough power.

Low load genset stop



When the load is low, stop the generator, so that it does not run at a low load.

System power parameters

`External control > External DG start/stop`

Parameter	Name	Range	Default	Description
15161	Sys P DG start limit	0 to 20000 kW 0 to 3200 s	200 kW 10 s	When the system load is above the start limit (and the timer has run out), the ASC activates the output.
15163	Sys P DG stop limit	0 to 20000 kW 5 to 3200 s	50 kW 15 s	When the system load is below the stop limit (and the timer has run out), the ASC deactivates the output.
15165	Sys P DG control	Enabled Not enabled	Not enabled	Select *Enable* to activate the Sys P DG start function.

7.2 Energy source or power source operation

The energy and power source functions determine the source priority. The source functions are not directly related to grid-forming and grid-following.

A mains connection does not have any effect on the source priorities. With a mains connection, the controllers use the power sources to meet the mains set point.

7.2.1 Energy source operation

For energy source (plant-leading) operation, the ASC prioritises battery power over genset power. As a result, the system uses as much battery power as possible before starting any genset.

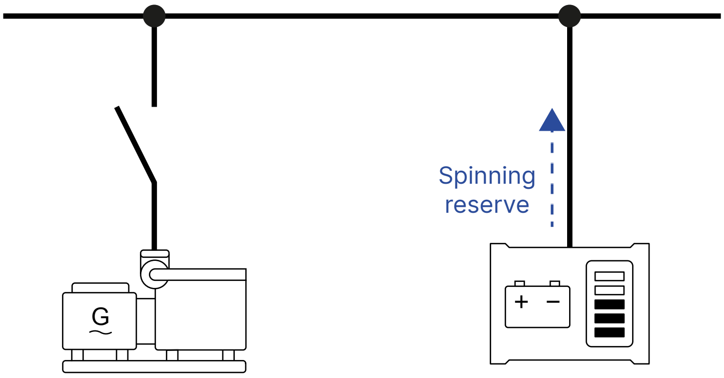
Battery Energy Source operation

The ESS is designed to supply the load, and can be the only grid-forming source connected to the busbar. Selecting *Battery Energy Source* gives the ESS the higher priority (after PV, if this is present).

The ASC Battery controller includes the ESS generation capacity in the spinning reserve. If there is enough spinning reserve, the power management system can stop all the gensets.

If both a generator and an ESS are connected (and the optimum genset load function is not activated), the ESS supplies the load so that the generator runs at its minimum load.

ESS acts as a battery energy source



If the state of charge falls below *Threshold 1*, the ASC automatically changes to power source operation, and starts the required number of gensets. The ASC remains in power source operation until the state of charge reaches *Threshold 2*.

NOTE For Battery Energy Source operation, the ESS must be able to do grid-forming operation.

7.2.2 Power source operation

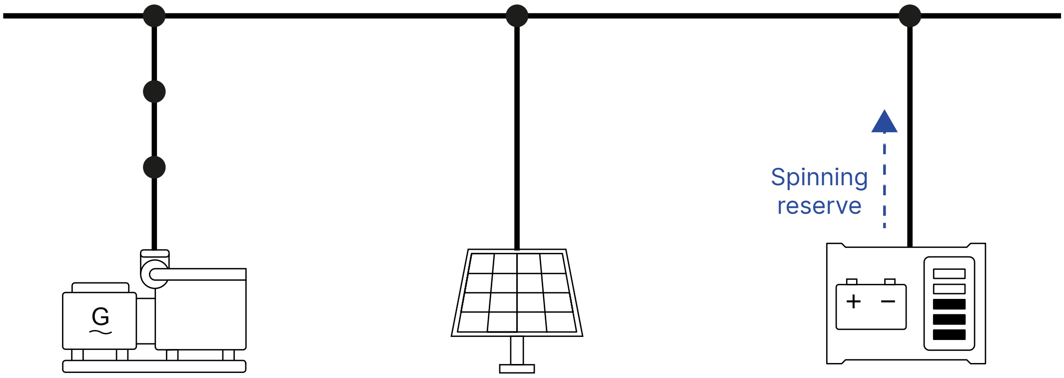
For power source (plant assist) operation, the ASC controller operates parallel to other sources. Genset power is prioritised over battery power. This mode is used to ensure that spinning reserve requirements are met

Battery Power Source operation

The ESS is used to supply peak loads while additional gensets are starting, and to improve power quality. The ESS is not designed to be the only grid-forming source connected to the busbar. Selecting *Battery Power Source* gives the gensets the higher priority (after PV, if this is present).

The power management system includes the ESS generation capacity in the spinning reserve requested from PV. This stops the system from connecting excessive gensets.

ESS acts as a battery power source



7.2.3 Energy or power source parameter

`Storage > Operation modes`

Parameter	Name	Range	Default
17081	Operation mode	Battery Energy Source Battery Power Source	Battery Power Source

7.2.4 ESS black busbar start

If the energy source requirements are met, the ESS can start and supply the load alone. This includes a black busbar start. Other sources do not have to be connected.

7.2.5 ESS as the only energy source

If the energy source requirements are met, the ESS can supply the load alone. Other sources do not have to be connected.

If the ESS discharges so that the energy source requirements are not met, the controller changes to power source operation. The controller then requests that other power sources start and connect.

7.3 ESS charging source

The ESS can recharge from PV, gensets and/or mains. Use the ASC parameters to configure which function to use for charging, as well as the maximum charging rate.

7.3.1 Charging from PV

When enabled, and charging is allowed, charging from PV has the highest priority. That is, charging from genset and/or mains charging is only possible if the battery is charging as much as possible from PV, and the battery still has charging capacity.

`Storage > Charge scheme`

Parameter	Name	Range	Default	Details
17041	PV charging	0 to 100 % of the excess PV power Not enabled, Enable	100 %, Not enabled	**Enabled**: The ESS can recharge from PV. The set point is the maximum charging rate. **Not enabled**: The ESS cannot recharge from PV.

7.3.2 Charging from gensets

The ASC can charge the ESS from connected gensets so that the gensets can run at their minimum load. These conditions must be met:

1. If charging from PV is enabled, the ESS must charge as much as possible from the PV, and still have charging capacity.
2. The plant must be in island operation. That is, the plant must not run in parallel to mains.
   - In a PMS application, the ASC operation mode (parameter 6071) must be *Power management*.
   - In a single controller application, the ASC operation mode (parameter 6071) can be *Island operation* or *Automatic mains failure* (but not *Fixed power*).
3. The ESS state of charge (SOC) must be below the *SOC maximum* and below *SOC Threshold 2*.
4. *DG Charge mode* (parameter 17033) must be *Enabled*.

`Storage > Charge scheme`

Parameter	Name	Range	Default	Details
17031	DG Charge pct	0 to 100 % of the connected genset(s) nominal power	100 %	The set point is the maximum charging rate from gensets in percent. This is only active if parameter 17033 is enabled and set to *Percent*. Consider the load-dependent start-stop settings when selecting this set point. If you want to minimise genset starts, this set point should be below the load-dependent start setting. If you want genset(s) to start when charging is needed, this set point must be above the load-dependent start setting. Note that this parameter does not take other loads into account. When the connected load is high, the ESS might not be able to charge.
17032	DG Charge P	0 to 5000 kW	200 kW	This power must be available as spinning reserve while the ESS is recharging. This should be above the genset start limit. This is only active if parameter 17033 is enabled and set to *Power*.
17033	DG Charge Mode	DG Charge in Percent DG Charge in Power Not enabled, Enabled	DG Charge in Percent, Not enabled	**Enabled**: The ESS can recharge from the gensets. This parameter determines whether parameter 17031 (Percent) or 17032 (Power) is used. **Not enabled**: The ESS cannot recharge from the gensets.

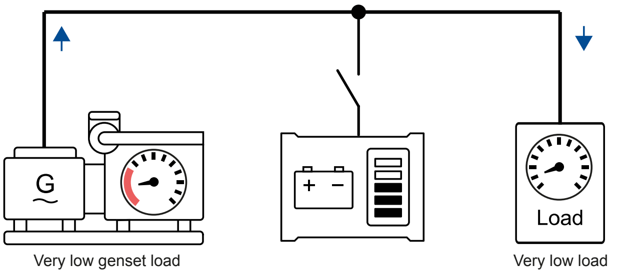
7.3.3 Genset minimum load

If the state of charge (SOC) and SOC settings allow battery charging, the ASC can ensure that the load on the connected genset(s) does not fall below the minimum load. This function can be used in both single controller and energy management system applications.

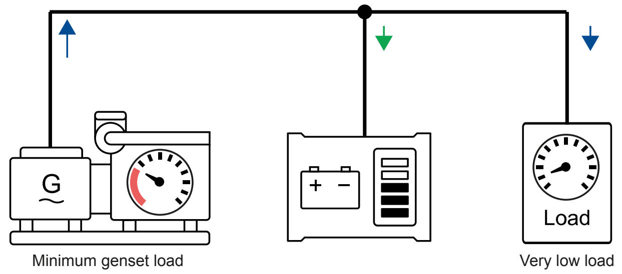
`External control > Min. DG load settings`

Parameter	Name	Range	Default	Description
15011	Min DG load 1	0 to 100 %	30 % of the genset's nominal power	The ASC calculates the ESS power set point to ensure that the load on the connected genset(s) does not fall below the minimum load.
15012	Min DG load 2	0 to 100 %	30 % of the genset's nominal power	
15013	Min DG load set	Min. DG load set 1 Min. DG load set 2	Min. DG load set 1	This determines whether the ASC uses the setting in parameter 15011 or 15012.

Using battery charging for minimum genset load (very low power consumption)



Very low genset load, without battery



Genset minimum load, with battery charging

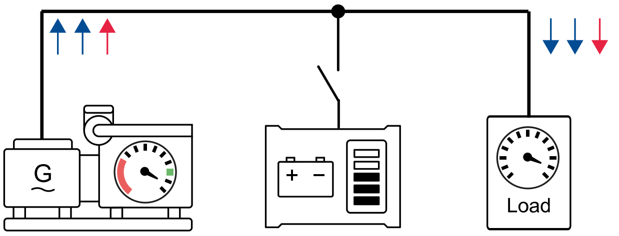
7.3.4 Genset optimum load

The ASC can ensure that the connected genset(s) run at their optimum load (as far as possible). For optimum genset load, during high power consumption, the state of charge (SOC) and SOC settings must allow battery discharging. During low power consumption, the SOC and SOC settings must allow battery charging. This function can be used for both single controller and energy management system applications.

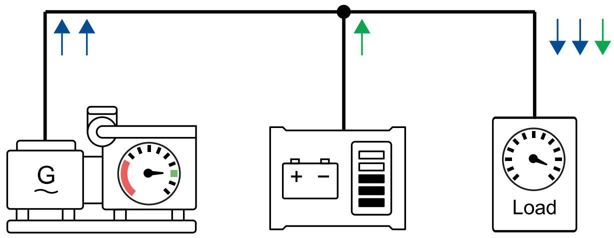
`External control > Optimal DG load settings`

Parameter	Name	Range	Default	Description
15014	Opt DG load % 1	0 to 100 %	80 % of the genset's nominal power	The ASC calculates the ESS power set point to ensure that the load on the connected genset(s) is optimum.
15015	Opt DG load % 2	0 to 100 %	70 % of the genset's nominal power	
15016	Opt DG load set	Optimal DG load set off Optimal DG load set pct 1 Optimal DG load set pct 2	Optimal DG load set off	This determines whether the ASC uses the optimal DG load function, or the setting in parameter 15014 or 15015.

Using battery discharging for optimum genset load (high power consumption)

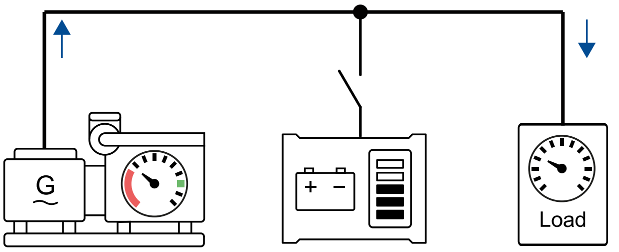


High power consumption, without battery

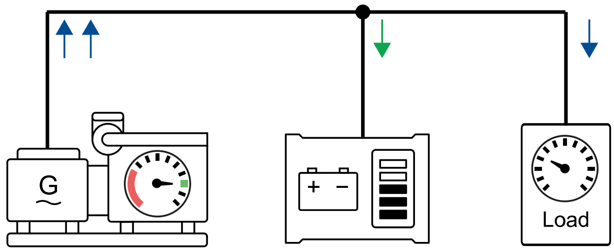


High power consumption, with battery discharging

Using battery charging for optimum genset load (low power consumption)



Low power consumption, without battery



Low power consumption, with battery charging

NOTE The battery charging rate is governed by the set point for charging (parameter 17031). If this is the same as the optimal load point (parameter 15014), you will have the operation shown above.

7.3.5 Charging from mains

The ASC can charge the ESS from mains to help create the negative load required to meet the mains set point. For example, the ESS can help reach negative MPE set points, or ensure that no power is exported. These conditions must be met:

1. If charging from PV is enabled, the ESS must charge as much as possible from the PV, and still have charging capacity.
2. The ESS state of charge (SOC) must be below the *Threshold 2*.
3. *Operation mode* (parameter 17081) must be *Battery Energy Source*.
4. *Mains charging* (parameter 17022) must be *Enabled*.
5. *Mains charge mode* (parameter 17025) must be *SOC + plant assist charging*.

If *SOC-based charging only* is selected in parameter 17025, the ASC does not try to help to meet the mains set point. Instead, the ASC charges from the mains based on the ESS SOC. *SOC-based charging only* is recommended if the battery has limited charge cycles.

`Storage > Charge scheme`

Parameter	Name	Range	Default	Details
17022	Mains Charging	0 to 100 % of battery nominal power Not enabled, Enabled	100 %, Not enabled	**Enabled**: The ESS can recharge from mains. The set point is the maximum charging rate. If the ESS is running as an energy function, it will not recharge from mains. **Not enabled**: The ESS cannot recharge from mains.
17024	PS charging limit	Not enabled, Enabled	Not enabled	If enabled, for peak shaving operation, the ASC uses the peak shaving set point as the mains charging limit.
17025	Mains charge mode	SOC-based charging only SOC + plant assist charging	SOC + plant assist charging	For plant assist charging, if the state of charge allows, the battery discharges as required to help meet the plant set points. For example, for peak shaving, the battery can discharge to prevent consumption that exceeds the set point.

7.4 Grid-forming or grid-following

These modes are controlled by the ASC controller using the PCS and BCU.

Grid-forming

Grid-forming is also called island, or V/f mode. For grid-forming mode, the ASC controller can act as the only energy source. The battery can provide the grid-forming power in island operation, and work together with non-grid-forming sources, like solar and wind.

If the system includes gensets, these are stopped if the load level, battery capacity, and state of charge conditions are fulfilled. When the battery is discharged or the load increases beyond the battery capacity, the gensets are reconnected. The controller can also suppress genset starts from solar controller spinning reserve requests.

Grid-following

Grid-following is also called parallel, or P/Q mode. For grid-following mode, the ASC controller is always connected to another grid-forming source, like a mains or genset. The battery can be used as power buffer, providing spinning reserve and peak shaving. The battery can also be used for time of use (TOU) applications.

Droop mode/VSG mode

If the ESS supports this, the ASC controller can run the ESS in droop mode for both Grid-forming and Grid-following. The controller controls the storage charge and discharge using V/f or P/Q set points from the configured droop curve (that is, like a virtual synchronous generator (VSG)).

7.4.1 Battery droop (VSG)

When the protocol selected in parameter 7561 supports droop, you can configure droop for the ASC. Adding droop to the battery regulation increases the system stability.

NOTE If ASC droop parameters are used, make sure that the droop parameters in the PCS matches the ASC parameters.

More information
See **DEIF hybrid controller compatibility** for the systems that support droop.

`Regulation > Droop`

Parameter	Name	Range	Default	Details
2801	Droop config.	ASC parameters BESS comm. reading	ASC parameters	**BESS comm. reading**: This function applies for all protocols, except ATESS Growatt. Parameters 2803 and 2804 are ignored.
2803	Droop f slope	0 to 200 %P/Hz	40 %P/Hz	Change the energy storage system frequency set point in response to load deviations from the nominal load.
2804	Droop U slope	0 to 200 %Q/V	5 %Q/V	Change the energy storage system voltage set point in response to reactive load deviations from the nominal reactive load.
2805	Droop f offset	-10 to 10 Hz	0 Hz	A constant offset to the frequency droop slope while a mains or genset(s) is connected. You can use this to compensate for PCS measurement errors.
2806	Droop U offset	-10 to 10 V	0 V	A constant offset to the voltage droop slope while a mains or genset(s) is connected. You can use this to compensate for PCS measurement errors.

Power-frequency droop example

Settings: Nominal P = 1000 kW, Nominal f = 60 Hz, Droop f slope (2803) = 60 %P/Hz. Power reference = - 50 kW.

Frequency offset = Power reference / (Nominal power x Droop slope) + Nominal frequency
Frequency offset = -50 kW / (1000 kW x 0.60 P/Hz) + 60 Hz = -0.08 Hz + 60 Hz = 59.92 Hz

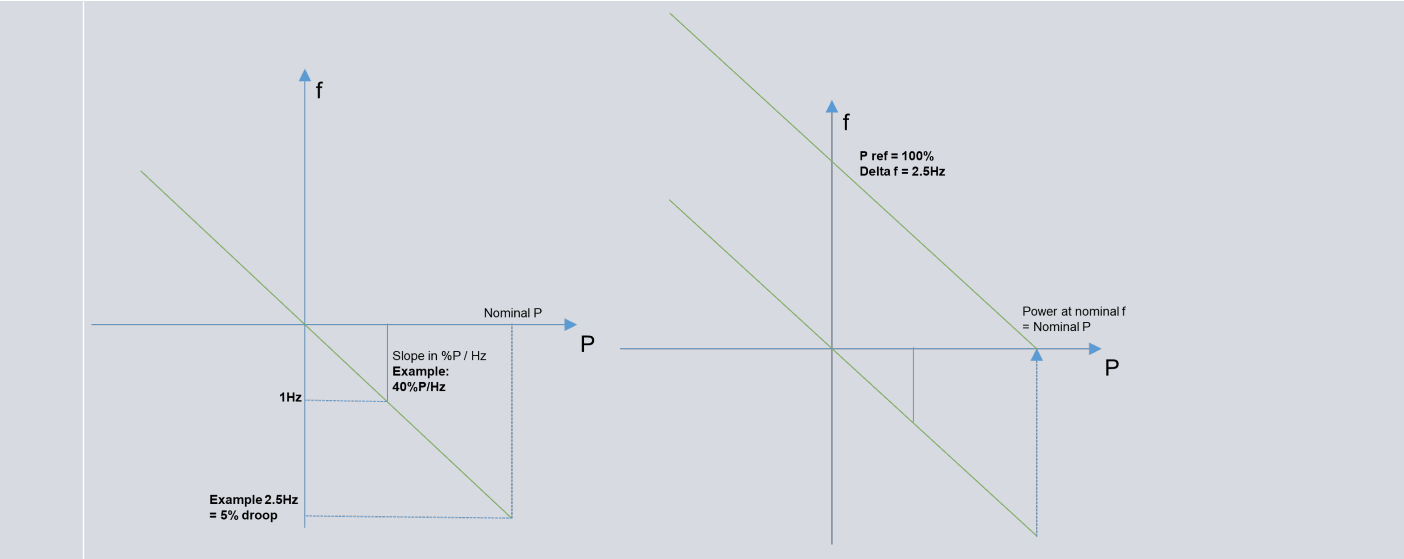
Reactive power-voltage droop example

Settings: Nominal Q = 1000 kvar, Nominal U = 400 V, Droop U slope (2804) = 5 %Q/V. Reactive power reference = 100 kvar.

Voltage offset = Reactive power reference / (Nominal reactive power x Droop slope) + Nominal voltage
Voltage offset = 100 kvar / (1000 kvar x 0.05 Q/Hz) + 400 V = 2 V + 400 V = 402 V

Droop curve example

The left diagram shows the droop slope. The right diagram shows the frequency offset due to the droop.



7.4.2 Setting the mode

The controller dynamically changes the mode based on the configuration and operating conditions. You can override the mode from M-Logic. Under *Output, Command Battery*, you can select:

- **Set mode to Droop**: The ESS runs in droop mode.
- **Set mode to P/Q**: The ESS runs in grid-following mode.
- **Set mode to V/f**: The ESS runs in grid-forming mode.

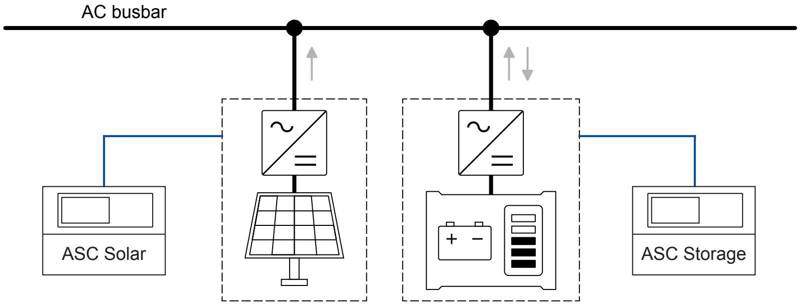
7.5 AC- or DC-coupled

7.5.1 AC-coupled connections

The system can include PV (controlled by ASC Solar) and an ESS (controlled by ASC Storage). These can each be connected to the AC busbar separately.

You can then configure parameters for the ESS charging and discharging. You can also determine which sources (for example, PV, mains and/or gensets) can charge the ESS.

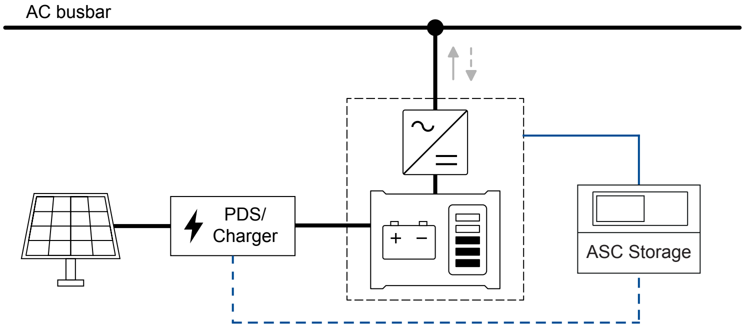
PV and ESS with separate AC connections to the busbar



7.5.2 DC-coupled connections

Alternatively, the photovoltaic and energy storage systems can have a DC power connection to each other. They then only have one AC connection to the grid, and only need one power converter. The PV system does not need an inverter, only a charger for the ESS. To control the ESS charging, the ASC Storage controller must control the PDS.

PV and ESS with one AC connection to the busbar



7.5.3 AC- or DC-coupled parameter

`Storage > Operation modes`

Parameter	Name	Range	Default	Description
17082	Operation mode	DC-Coupled Battery AC-Coupled Battery	AC-Coupled Battery	For DC-Coupled Battery, the PV is not connected to the busbar, but supplies the ESS directly. The ESS power is based on the ASC parameters. For example, if the ESS is charging from the busbar, then the current from the PDS is reduced.

7.5.4 PDS spinning reserve

You can configure a local PDS spinning reserve in the ASC. This reserved power can be used to power the load if the PV suddenly fails.

Two spinning reserve parameters are available. For example, one spinning reserve parameter can be used during the day, and the other at night.

Storage > PDS operation

Parameter	Name	Range	Default	Details
17201	PDS spin. res. %1	0 to 100 %	90 %	For the default setting, 90 % of the battery power is reserved for a PV failure. Only 10 % is available to the power management system.
17202	PDS spin. res. %2	0 to 100 %	60 %	For the default setting, 60 % of the battery power is reserved for a PV failure. 40 % of the battery power is available to the power management system.
17203	PDS spin. res. set	PDS Spinning reserve pct 01, PDS Spinning reserve pct 02	PDS Spinning reserve pct 01	Select the PDS spinning reserve parameter to use.

7.6 Using nominal settings

The controller uses the nominal settings as the basis for control (including power management) and protection. That is, set points are configured as a percentage of the nominal setting.

You can have more than one set of nominal settings. Using sets of nominal settings allow users to quickly move equipment to new applications.

More information
See Nominal settings for general nominal settings information.

7.6.1 Setting the nominal apparent power (S)

The nominal apparent power (S) is the basis of all the PMS calculations. The nominal apparent power is the AC capacity of the power converter. The controller calculates the power converter set point from the nominal apparent power. The maximum power converter set point is the nominal apparent power.

For parameter set 1, configure *Nom. S 1* (parameter 6006). Use the power converter nameplate apparent power (S).

7.6.2 Setting the nominal reactive power (Q)

The nominal reactive power (Q) limits the reactive power that the ESS generates.

For parameter set 1, configure *Nom. Q 1* (parameter 6005). Use the power converter nameplate reactive power (Q).

7.6.3 Setting the nominal power (P)

The nominal power (P) is the total DC capacity of the power converter.

The controller reads the charging capacity (CC) and generating capacity (GC) from the BMS. The controller compares this with the PCS capacity and nominal power. The lowest value is used for the set point for charging and discharging.

For parameter set 1, configure *Nom. P 1* (parameter 6002). Use the power converter nameplate power (P).

7.7 Flowcharts

7.7.1 Functions

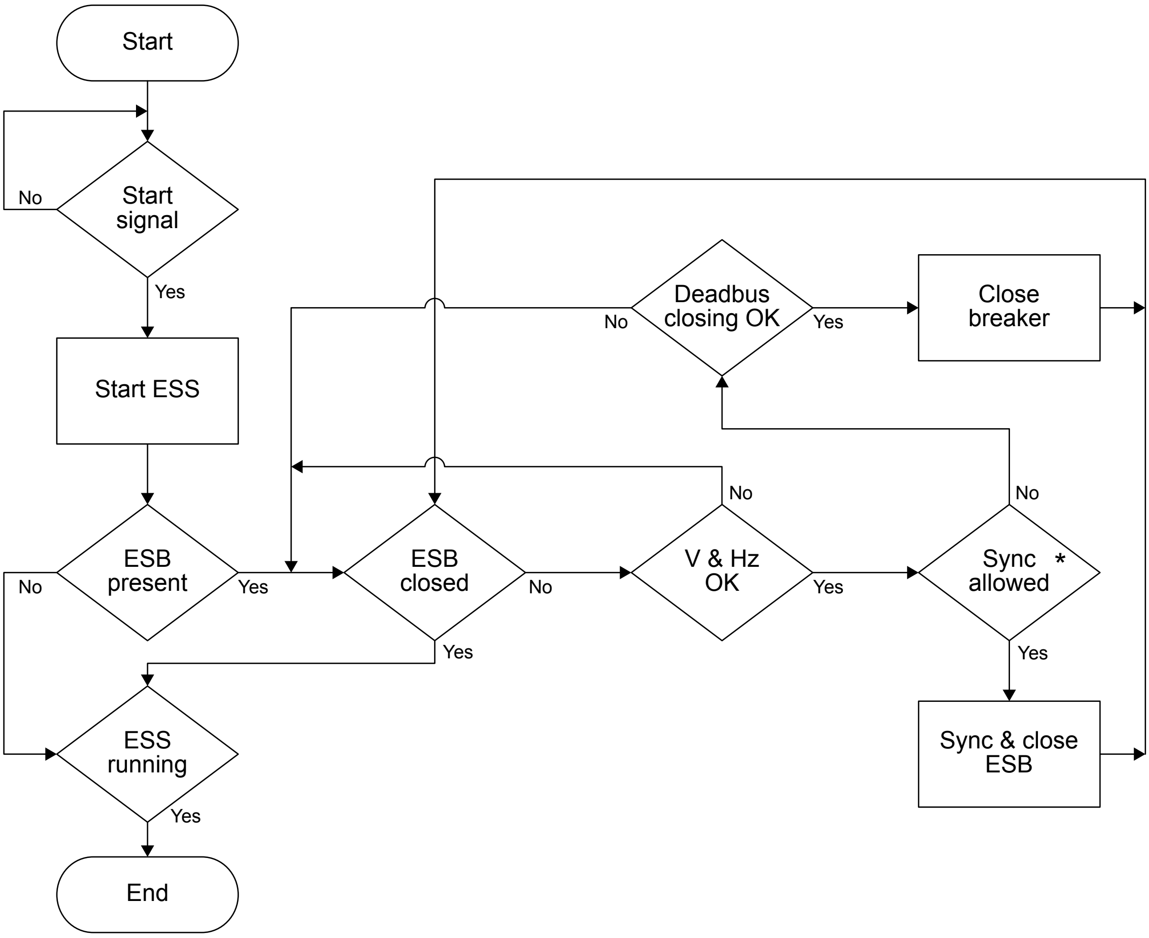
The following flowcharts show the most important function principles. The functions included are:

- Start sequence
- Stop sequence

Flowcharts for the mode descriptions are in the **AGC Designer's handbook**.

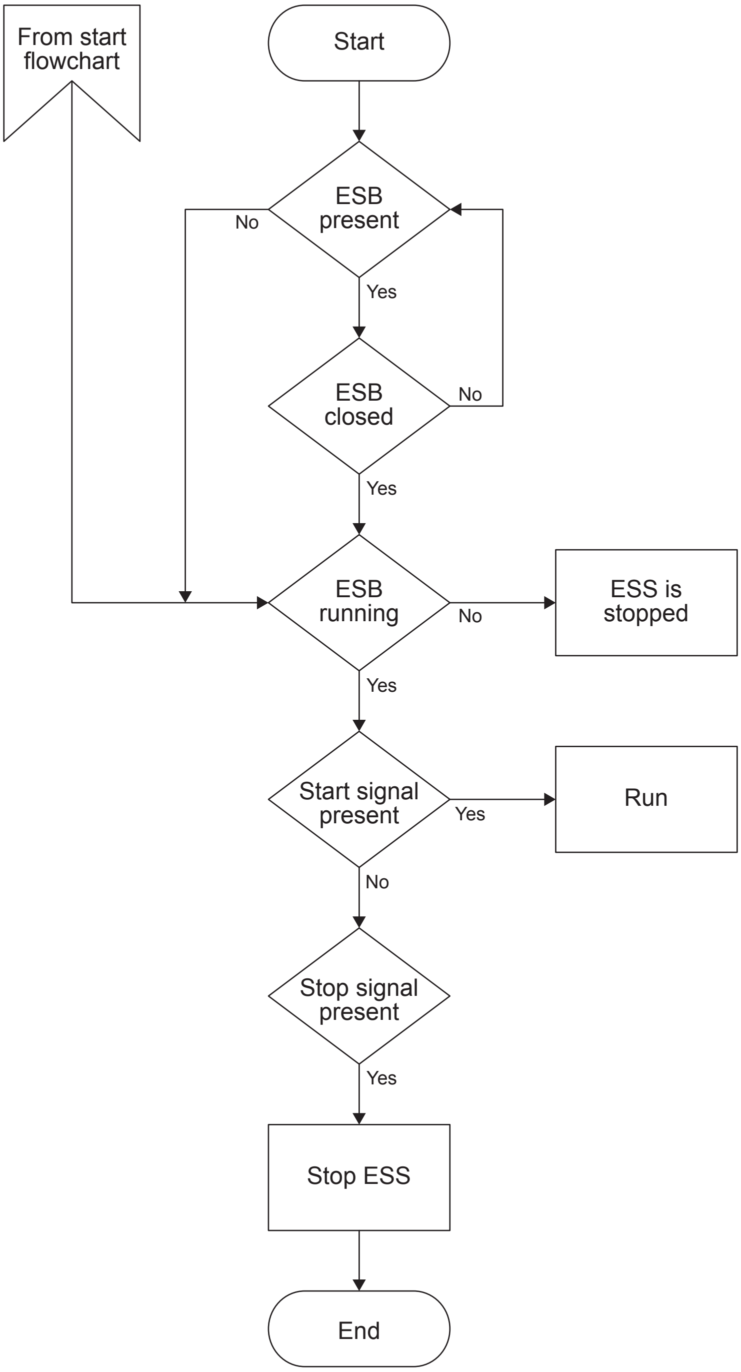
NOTE These simplified flowcharts are only for guidance.

7.7.2 Start sequence



NOTE * Use *ESB close seq.* (parameter 2350) to enable automatic closing or wait for ESS OK.

7.7.3 Stop sequence



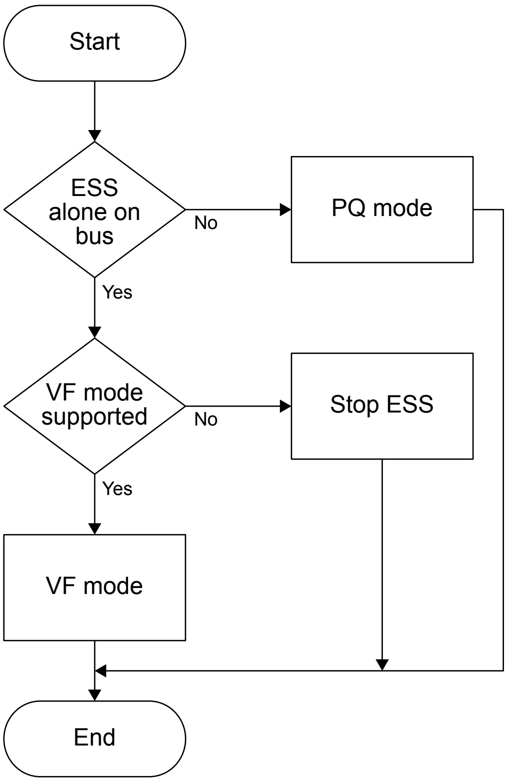
7.8 Modes of operation

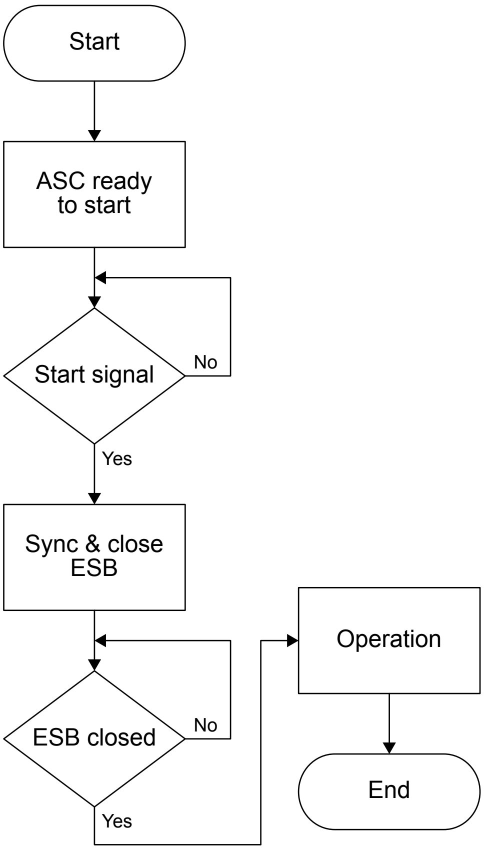
7.8.1 ESS operation

The ASC can be operated in automatic mode (remote) or manual (local). In automatic, the system will close the ES breaker (if present) and start ESS charging or discharging if the plant has a start signal.

Rules for ESS operation:

- The ESS can only be alone on the busbar if V-f mode (voltage and frequency) or droop mode is supported by the PCS.
- The ESB can only be closed if the busbar voltage and frequency are inside the defined window.
- If the ESB is open, the ESS is stopped.





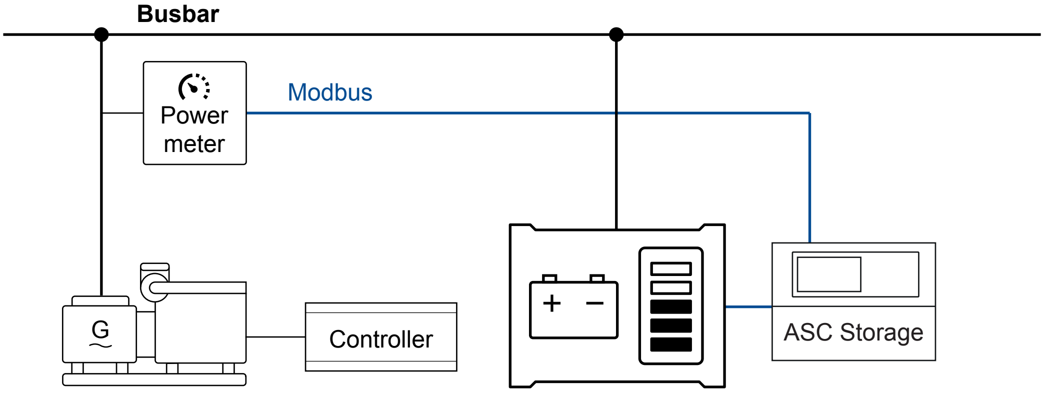
Operation

Once configured, the ASC can run automatically. Alternatively, the display unit allows an operator to start and stop the ESS, and open and close the ES breaker.

NOTE In some cases, the ASC does not control the ESS stop. If an ESS stop is required, the ASC sends a power set point of 0 kW to the ESS. This effectively stops the ESS.

7.8.2 Island operation

Single-line diagram



NOTE If island operation is selected, the *MB closed* digital input must not be activated.

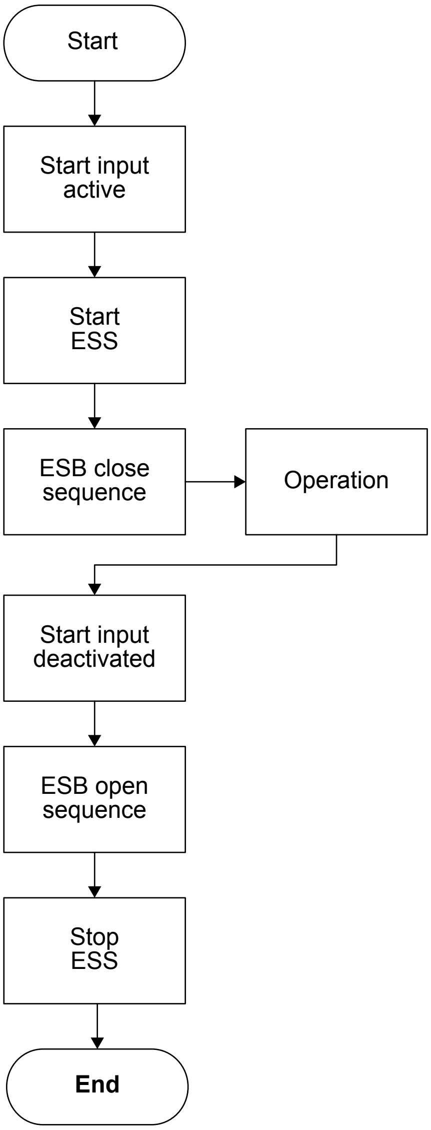
AUTO mode

The controller automatically starts the ESS and closes the ESS breaker at a digital start command. When the stop command is given, the ESS breaker is tripped, and the ESS is stopped. The start and stop commands are used by activating and deactivating a digital input or with the time-dependent start/stop commands. If time-dependent start/stop commands are used, then AUTO mode must also be used. The display buttons cannot be used in AUTO mode.

MANUAL mode

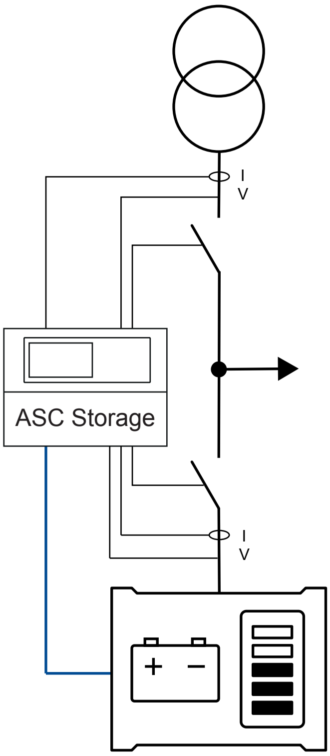
The operator can use the display buttons to start the ESS, close the ESS breaker, open the ESS breaker, and stop the ESS.

Island operation flowchart (AUTO mode)



7.8.3 Peak shaving

Single-line diagram



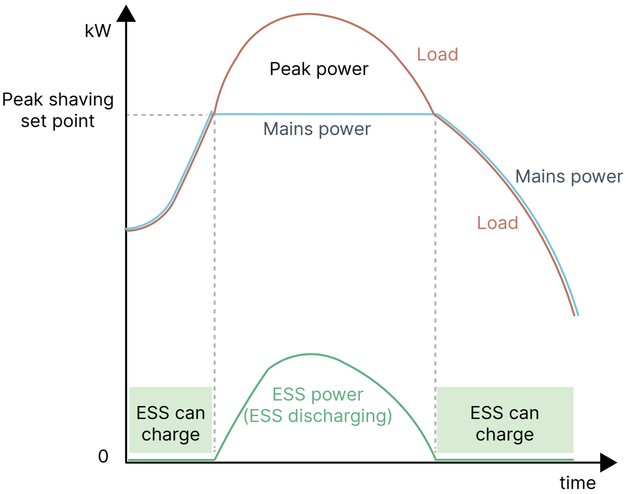
AUTO mode

When the mains import increases above the maximum mains import set point, the ESS supplies the extra load, to keep the mains import at the maximum import level.

When the load drops below the maximum mains import set point, the ESS can recharge.

The mains power measurement is required. See **Mains power measurement**.

Peak shaving example



MANUAL mode

When the ESS is parallel to the mains, the ESS is controlled according to the peak shaving set point. The maximum mains import is not exceeded in spite of the MANUAL mode.

`Power set points > Mains power export and peak shaving > Day/night power set point`

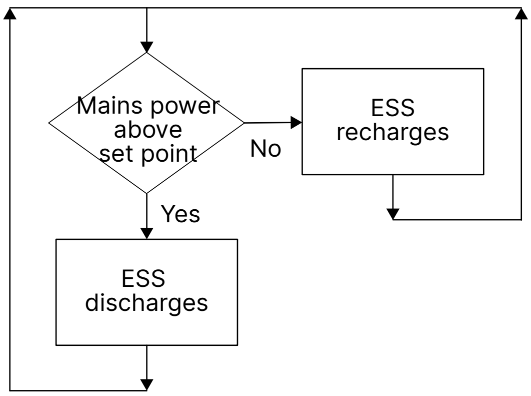
Parameter	Text	Range	Default
7001	Day setting	-20000 to 20000kW	750 kW
7002	Night setting	-20000 to 20000kW	1000 kW
7006	MPE/PS scale	1kW:1kW 1kW:10kW 1kW:100kW 1kW:1000kW	1kW:1kW

You can also adjust these parameters from the utility software. Under *Application supervision*, open the *Plant settings* window.

`Power set points > Mains power export and peak shaving > Day/night settings`

Parameter	Text	Range	Default
7011	Start hour	0 to 23	8
7012	Start minute	0 to 59	0
7013	Stop hour	0 to 23	16
7014	Stop minute	0 to 59	0

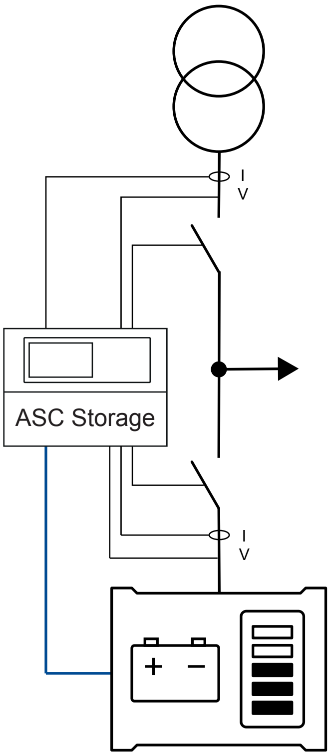
Peak shaving flowchart



NOTE You can enable a Peak shaving charging limit in parameter 17024.

7.8.4 Mains power export

Single-line diagram



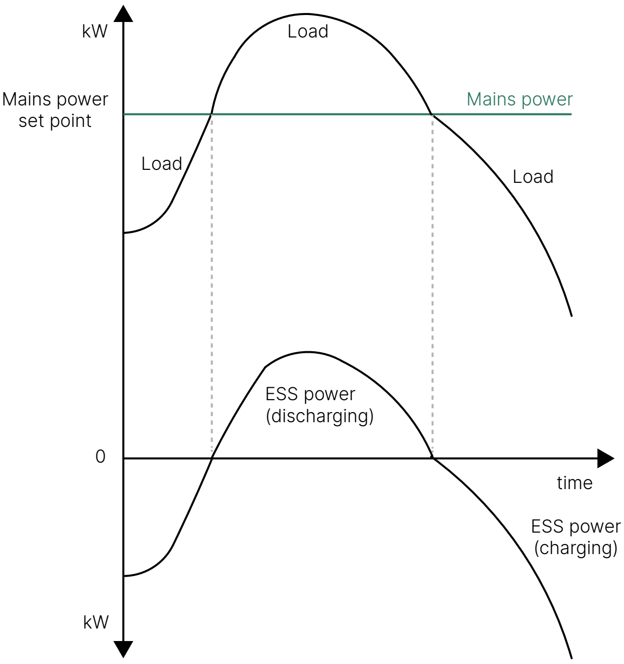
AUTO mode

The mains power export mode can be used to maintain a constant level of exported or imported power through the mains breaker.

The ASC monitors the mains power. As required, the ESS charges or discharges to keep the mains power at a fixed level regardless of the load.

The mains power measurement is required. See **Mains power measurement**.

Mains power export example



NOTE The set point of the mains power export can be set to 0 kW. This means that the ESS is parallel to the mains but there is no power import or export.

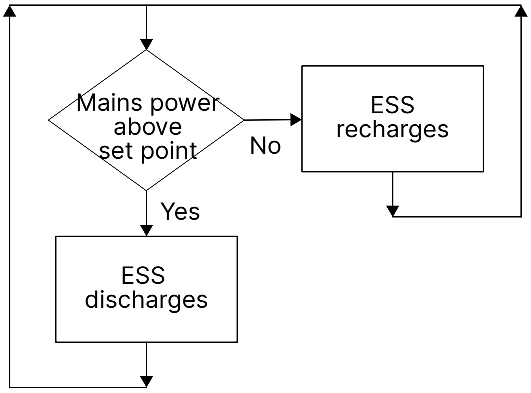
MANUAL mode

When the ESS is paralleled to the mains, it is controlled according to the mains power export set point.

Parameters

See **Peak shaving**.

Mains power export flowchart



7.8.5 Automatic mains failure

The ESS can automatically supply power if there is a mains failure (see the flowchart below). The ESS does this if the ASC operation mode parameter (6071) if *Auto*. *Mains Failure*. Alternatively the mode shift parameter (7081) can be used to change the mode to AMF if there is a mains failure.

The ASC starts the AMF function when the mains voltage or frequency are outside the configured range for the configured time. Depending on the ESS breaker auto close condition parameter (2360), the ASC can keep the mains breaker closed until the ESS is ready to take over.

The ESS power supply during AMF cannot be below the minimum dispatch or above the maximum dispatch.

For the ASC to stop the AMF function, the mains voltage and frequency must be within the hysteresis range for the configured time. If the back synchronisation parameter (7084) is enabled, the ASC can close the mains breaker while the ESS is still running.

Mains failure parameters

`Mains > AMF functions > Modeshift`

Parameter	Name	Range	Default
7081	Mode shift	Mode shift off Mode shift on	Mode shift off

`Mains > Voltage and frequency limits > Voltage settings`

Parameter	Name	Range	Default
7063	Low voltage	30 to 100 % of nominal voltage	90 %
7064	High voltage	100 to 120 % of nominal voltage	110 %

`Mains > AMF functions > AMF voltage timers`

Parameter	Name	Range	Default
7061	U mains failure	0.5 to 990 s	5 s

Mains > Voltage and frequency limits > Frequency settings

Parameter	Name	Range	Default
7073	Low frequency	80 to 100 % of nominal frequency	95 %
7074	High frequency	100 to 120 % of nominal frequency	105 %

Mains > AMF functions > AMF frequency timers

Parameter	Name	Range	Default
7071	f mains failure	0.5 to 990 s	5 s

Operation during AMF parameters

Storage > Dispatch limits

Parameter	Name	Range	Default
17093	Minimum dispatch	-100 to 100 % of ESS nominal power	-100 %
17094	Maximum dispatch	-100 to 100 % of ESS nominal power	100 %

Mains OK parameters

Mains > Voltage and frequency limits > Voltage settings

Parameter	Name	Range	Default
7091	Low volt. hyst.	0 to 70 % of nominal voltage	0 %
7092	High volt. hyst.	0 to 20 % of nominal voltage	0 %

Mains > AMF functions > AMF voltage timers

Parameter	Name	Range	Default
7062	Mains OK delay U	2 to 9900 s	60 s

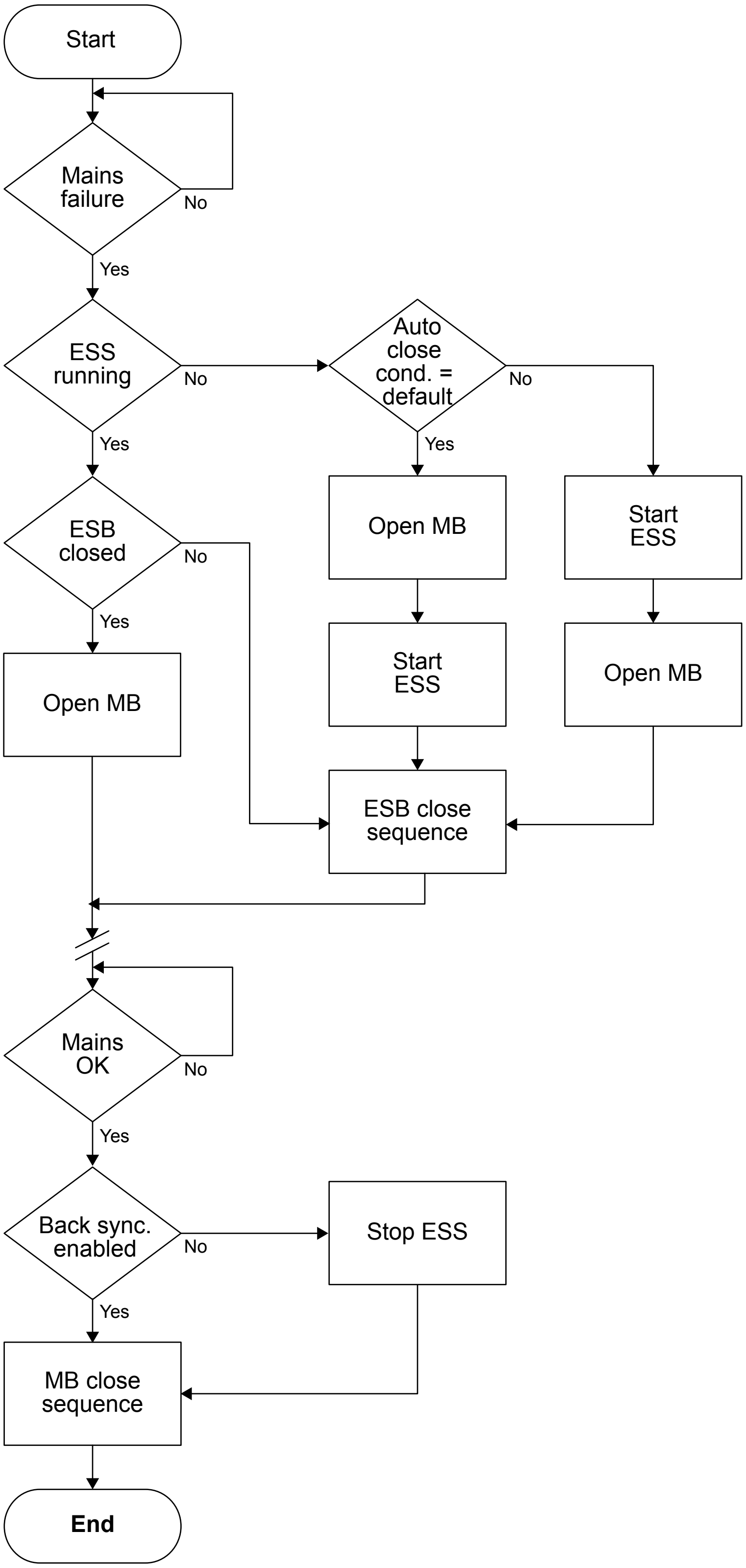
Mains > Voltage and frequency limits > Frequency settings

Parameter	Name	Range	Default
7093	Low freq. hyst.	0 to 20 % of nominal frequency	0 %
7094	High freq. hyst.	0 to 20 % of nominal frequency	0 %

Mains > AMF functions > AMF frequency timers

Parameter	Name	Range	Default
7072	Mains OK delay f	2 to 9900 s	60 s

AMF flowchart



7.9 Regulation

7.9.1 ESS power reference

The power reference is the value that the ASC sends to the ESS to regulate the power produced by the ESS. You can enable an active power (P) and/or a reactive power (Q) reference. To accommodate the ESS's self-consumption, you can also specify a constant and/or a dynamic gain for the P reference.

Regulation > Enable regulation

Parameter	Name	Range	Default	Details
2781	P reference	Not enabled, Enabled	Enabled	**Enabled**: The ASC sends the active power reference to the ESS. **Not enabled**: Only if parameter 7564 is **Single register 0×06**, the ASC does not send the active power reference to the ESS.
2782	Q reference	Not enabled, Enabled	Enabled	**Enabled**: The ASC sends the reactive power reference to the ESS. **Not enabled**: Only if parameter 7564 is **Single register 0×06**, the ASC does not send the reactive power reference to the ESS.

Regulation > P reference gain

Parameter	Name	Range	Default	Details
2671	P ref. const. gain	0 to 10 % of nominal apparent power (S)	0 %	Adds a percentage of the nominal apparent power to the active power reference. You can use this parameter to compensate for a constant power loss.
2672	P ref. dyn. gain	0 to 10 % of the P reference	0 %	Dynamically adds a percentage of the power reference to the power reference. You can use this parameter to compensate for a dynamic power loss.

Example of P reference gain

The ESS nominal power is 1500 kW, and the apparent power is 1875 kVA.

If parameter 2671 is 1 %, the ASC always adds 187.5 kW to the power reference. If parameter 2672 is 10 %, the ASC multiplies the power reference by 110 %.

For example, without the gain, the power reference is 500 kW. With the gain, the ASC sends a power reference of (500 x 1.1 + 187.5) kW = 737.5 kW to the ESS.

7.9.2 Voltage reference

`Regulation > U/f ref. origin`

Parameter	Name	Range	Default	Description
2661	U ref. origin	Nominal value Busbar measurement	Nominal value	By default, the ASC uses the nominal voltage as the regulation voltage reference. To improve regulation and avoid high Q when closing the ESB, you can configure the ASC to use the busbar voltage measurement when the mains is connected.
2663	Uf origin config	Mains on busbar Mains or DG on busbar Any voltage source on busbar	Mains on busbar	This parameter determines when the voltage and frequency reference parameters are active.
2664	U ref. gain	-100 to 100 %	0	You can set a custom voltage reference gain. This gain is added the nominal voltage. This can be useful for adjusting the voltage for the internal transformers of the PCS.

7.9.3 Frequency reference

`Regulation > U/f ref. origin`

Parameter	Name	Range	Default	Description
2662	f ref. origin	Nominal value	Nominal value	By default, the ASC uses the nominal frequency as the regulation frequency reference. To improve regulation and

Parameter	Name	Range	Default	Description
		Busbar measurement		avoid high frequency when closing the ESB, you can configure the ASC to use the busbar frequency measurement when the mains is connected.

7.9.4 Reactive power (kvar)

You can use a variety of reactive power regulation methods to regulate the reactive power from the energy storage system.

There are parameters for grid-tied and off-grid modes:

`Power set points > Fixed power`

Parameter	Name	Range	Default	Grid-tied	Off-grid	Details
7052	Cosphi ref	0.6 to 1	0.9	●		Use this parameter to configure the fixed power cos phi set point. When the ESS is running in parallel to the utility with fixed cos phi reference, it follows this set point.

`Power set points > Q ref. grid-tied`

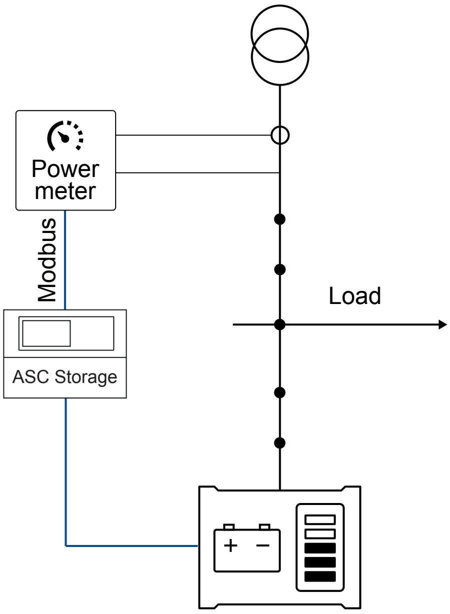
Parameter	Name	Range	Default	Details
7053	Cosphi ref	Inductive, Capacitive	Inductive	This parameter makes it possible to select inductive or capacitive reference from the cos phi dispatch.
7054	Contr. sett. Q	-20000 to 20000 kvar	500 kvar	For a fixed Q [kvar], the power converter uses the set point in this parameter.
7055	Q type grid-tie	See below.	Cosphi superior	See the section below.

`Power set points > Q ref. off-grid`

Parameter	Name	Range	Default	Details
7031	DG cosphi lim I	0.1 to 1	0.8	The limit of the genset cos phi on the inductive side. For example, if set to 0.95, the genset will only deliver reactive load up to a maximum of 0.95 inductive. If the actual load has characteristic of 0.9, the power converter carries the remainder from 0.95 to 0.9. If there are multiple ASC controllers in the application, the set point for this parameter must be the same in each controller.
7032	DG cosphi lim C	0.10 to 1.00	0.80	The limit of the genset cos phi on the capacitive side. If set to for example 1.00, the genset will not be able to operate with the capacitive power factor (under-excited). If the menu 7031 is set to 1.00 and 7032 is set to 1.00, the genset will not carry any Q at all. The power converter supplies all Q (under the assumption they support it). If there are multiple ASC controllers in the application, the set point for this parameter must be the same in each controller.
7033	Q type off-grid	Off, Q share	Off	**Q share**: Equal var sharing (in percent) between the gensets and the power converter is enabled. **Off**: The settings in parameters 7031 or 7032 (that is, the DG cosphi limit) is used. The ESS produces reactive power to help the genset within the cosphi limits.
7034	DG cosphi min I	Not enabled, Enabled 0.00 to 1.00	Not enabled, 1.00	When enabled, the ASC adds reactive power to the ESS to ensure that this is the minimum inductive power factor for the gensets. The ASC only uses this parameter during off-grid operation.

7055, Method of var regulation

- **Off**: No Q control when the MB is closed or when fixed power mode is selected.
- **Cosphi fixed**: The power converter maintains a fixed cos phi (set in parameter 7052).
- **Cosphi imp/exp**: The power converter is regulated against a cos phi set point in parameter 7052.
  - **Measured at the point of connection**: A power meter or measurement transducers are needed to measure the reactive power imported to or exported from the plant. The power converter is regulated accordingly.



- **Cosphi superior**: This is used if the application is a power management application and the cos phi set point is controlled at the AGC mains controller. If one or several ASC controllers are used, it is often more convenient to adjust the cos phi set point from a central point. That is, the AGC mains adjusts the set point, and then transmits the set point to the ASC(s). All ASCs with this setting will follow the AGC mains. If one or several ASCs do not use this setting, they may, for example, use a fixed cos phi set point.
- **Q fixed**: The ASC uses the setting in parameter 7054.
- **Q imp/exp**: This requires a power meter/transducer (see **Cosphi imp/exp**) and the Q ref will maintain measure at the point of connection.

7.9.5 Peak shaving charging limit

When the ASC Storage peak shaving limit is enabled, if the power from the mains is above the peak shaving set point, the ESS cannot charge from the mains. Instead, the ASC Storage tries to use the remaining SOC to produce power, to get the mains power below the peak shaving set point. For power management, the peak shaving set point is configured in the AGC Mains controller.

ASC Storage configuration

`Storage > Charge scheme`

Parameter	Name	Range	Default	Details
17024	PS charging limit	Not enabled Enabled	Not enabled	To optimally charge the ESS in peak shaving operation, enable this parameter.

AGC Mains configuration

Parameter	Name	Range	Default	Details
7011	Peak Shaving	-20000 to 20000 kW	750 kW	The peak shaving set point.

More information
See **Charging from mains** for how to use energy from the battery (discharging) to help to meet the plant set points.

7.9.6 External set point control

Power set points > External power set point

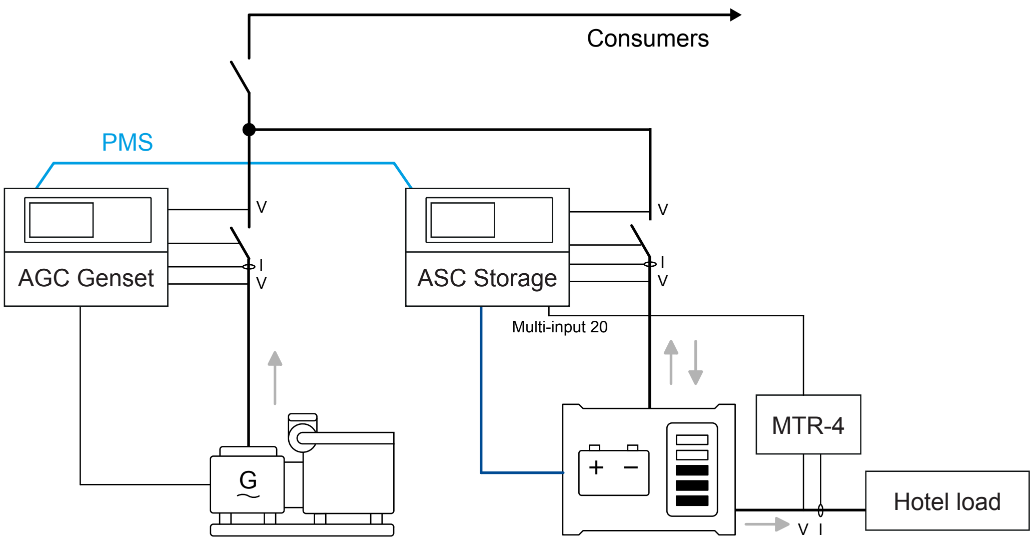
Parameter	Name	Range	Default	Details
7501	Comm. bus control P	Enabled Not enabled	Not enabled	**Enabled**: Allows the **P reference** value to be changed over Modbus. **Not enabled**: The **P reference** value cannot be changed over Modbus.
7502	Comm. bus ctrl cosphi	Enabled Not enabled	Not enabled	**Enabled**: Allows the **cosphi reference** value to be changed over Modbus. **Not enabled**: The **cosphi reference** value cannot be changed over Modbus.
7503	Comm. bus control Q	Enabled Not enabled	Not enabled	**Enabled**: Allows the **Q reference** value to be changed over Modbus. **Not enabled**: The **Q reference** value cannot be changed over Modbus.
7504	Comm. bus P Q scale	1% 0.1% 0.01%	1%	Change the scale of the external P and Q set points.

7.9.7 Hotel load

You can use the hotel load function to compensate for the power consumption that is outside the ASC control. The ASC adjusts the ESS power reference and nominal power to make sure that there is enough power for the hotel load. The hotel load can be ESS self-consumption, and/or a load can be connected directly the ESS.

To use the hotel load function, the ASC needs a measurement of the load from a transducer.

Example of hotel load application



Parameters

Parameter	Name	Range	Default	Details
2821	Hotel load setup	Multi input [20 to 23], Not enabled, Enabled	Multi input 20, Not enabled	When enabled, the ASC uses the selected multi-input to calculate the hotel load.
2823	Hotel load range max	0 to 20 000 kW	0 kW	The load that corresponds to the multi-input maximum.

Hotel load example

The ASC is in a power management system. The ESS nominal power is 480 kW. The transducer measuring the hotel load is connected to Multi input 20. The hotel load range max is 100 kW. Multi input 20 is configured for a 4-20 mA signal (so 4 mA corresponds to a hotel load of 0 kW, and 20 mA corresponds to 100 kW).

The power management system requires 200 kW, and the hotel load is 50 kW (12 mA).

- For the power management system calculations, the ASC adjusts the ESS nominal power to 480 kW - 50 kW = 430 kW.
- For the power reference to the ESS, the ASC uses 200 kW + 50 kW = 250 kW.

Counters

In the *Counters* window, under the *Hotel load* tab, you can see the total hotel load. You can also see the hotel load for the past day, week, month, and year.

7.9.8 Load ramps

To avoid oscillations, load ramps (up and down) can be configured for both power and reactive power.

`Regulation > ESS loading and deloading > Ramp up rates`

Parameter	Name	Range	Default	Details
2611	P ramp up	0.1 to 20 % of ESS nominal P/s	2 %/s	Limits the rate of power increase from the battery.
2641	Q ramp up	0.1 to 100 % of ESS nominal Q/s	2 %/s	Limits the rate of reactive power increase from the battery.

`Regulation > ESS loading and deloading > Ramp down and offload rates`

Parameter	Name	Range	Default	Details
2621	P ramp down	0.1 to 20 % of ESS nominal P/s	2 %/s	Limits the rate of power decrease from the battery.
2622	Ramp open point	1 to 20 % of ESS nominal P	5 %	The breaker cannot open after the ramp down until the load is below this point.
2651	Q ramp down	0.1 to 100 % of ESS nominal Q/s	2 %/s	Limits the rate of reactive power decrease from the battery.

`Regulation > ESS loading and deloading`

Parameter	Name	Range	Default	Details
2612	Island ramp	Enabled, Not enabled	Not enabled	**Not enabled**: The battery will always ramp up to the full load.

Parameter	Name	Range	Default	Details
				Enabled: If the battery is in an island PMS and not other power sources are connected, it will take the full load immediately.
2642	Q ramp lim. max	1 to 110 % of ESS nominal Q	90 %	The controller ignores the ramp if the reactive power is above this limit.
2652	Q ramp lim. min	-20 to 50 % of ESS nominal Q	-10 %	The controller ignores the ramp if the reactive power is below this limit.

The reactive power ramp rates are adjusted according to the nominal rating of the power converters (S=[kVA]).

If the genset has reverse power, the ramps are ignored.

7.9.9 Heartbeat

`Regulation > Heartbeat timer`

Parameter	Name	Range	Default	Details
2810	Heartbeat timer	0 to 28800 s Not enabled, Enabled	20 s, Enabled	**Enabled**: The ASC transmits this value to the PCS. If the PCS does not receive a heartbeat signal for this amount of time, the PCS activates an error. **Not enabled**: The timeout value is not transmitted to the PCS.

7.10 Fail class

All activated alarms must be configured with a fail class. The fail classes define the category of the alarms and the subsequent alarm action. The following tables show the action of each fail class when the energy storage system is running or stopped.

7.10.1 Energy storage system running

Fail class/action	Alarm horn relay	Alarm display	Trip ES breaker	Stop energy storage system
Warning	●	●		
Trip ESB	●	●	●	
Shutdown	●	●	●	●
Trip MB	●	●		

Example: An alarm with the fail class *Shutdown* is activated:

- The ASC activates the alarm horn relay.
- The ASC displays the alarm on the alarm info screen.
- The ASC opens the ES breaker immediately.
- The ASC stops the energy storage system immediately.
- The energy storage system cannot be started from the ASC (see next table).

7.10.2 Energy storage system stopped

Fail class/action	Alarm horn relay	Alarm display	Block energy storage system start	Block ESB sequence
Warning	●	●		
Trip ESB	●	●		●

Fail class/action	Alarm horn relay	Alarm display	Block energy storage system start	Block ESB sequence
Shutdown	●	●	●	●
Trip MB	●	●		

7.11 Alarm inhibit

To limit when the alarms are active, each alarm has configurable inhibit settings. The inhibits are only available in the USW.

Each alarm has a drop-down window where you can select which conditions have to be present to inhibit the alarm. You can select more than one inhibit. The alarm is inhibited as long as at least one of the selected inhibits is active.

Inhibit	Description
Inhibit 1	M-Logic outputs: The conditions are programmed in M-Logic.
Inhibit 2	
Inhibit 3	
ESB ON	The ESS breaker is closed.
ESB OFF	The ESS breaker is open.
Run status	The ESS voltage and frequency is okay, and the timer in parameter 6160 has expired.
Not run status	The ESS is off, or the timer in parameter 6160 has not expired.
ESS voltage > 30 %	The ESS voltage is above 30 % of the nominal voltage.
ESS voltage < 30 %	The ESS voltage is below 30 % of the nominal voltage.
MB on	The mains breaker is closed (single controller application).
MB off	The mains breaker is open (single controller application).
Parallel	Both the ESB and MB are closed.
Not parallel	Either the ESB or MB can be closed, but not both.

NOTE Function inputs such as remote start or access lock are never inhibited. Only alarm inputs can be inhibited.

7.12 Mode overview

The controller has four running modes and one block mode:

- **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 ESS runs at the nominal values.

7.12.1 MANUAL mode

The controller can be operated in MANUAL mode. This means that the controller does not initiate any sequences automatically. It only initiates sequences if external signals are given.

An external signal may be given by:

1. Buttons on the display
2. Digital inputs*
3. Modbus commands

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

MANUAL mode commands

Command	Description
Start	The ESS start sequence is initiated
Stop	The ESS is stopped.
Close ESB	The controller closes the energy storage system breaker if the mains breaker is open, or synchronise and close the energy storage system breaker if the mains breaker is closed.
Open ESB	The controller ramps down and opens the energy storage system breaker at the breaker open point if the mains breaker is closed. The controller opens the energy storage system breaker instantly if the mains breaker is open or the ASC is in island mode.
Close MB	The controller closes the mains breaker if the energy storage system breaker is open, or synchronises and closes the mains breaker if the energy storage system breaker is closed.
Open MB	The controller opens the mains breaker instantly.

NOTE Before software version 1.30, MANUAL mode was called SEMI-AUTO mode.

7.12.2 Not in AUTO mode

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

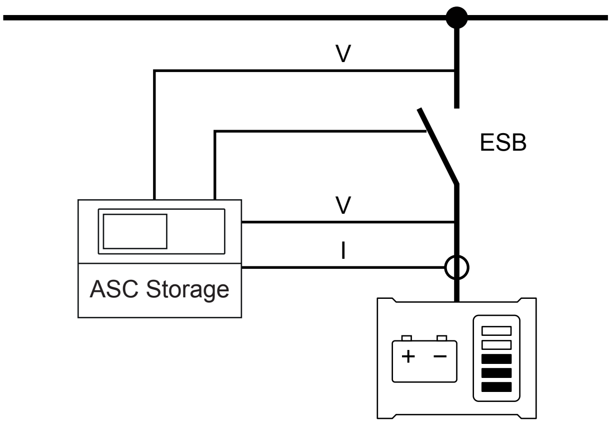
`Functions > Not in Auto`

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

7.13 ESS power measurements

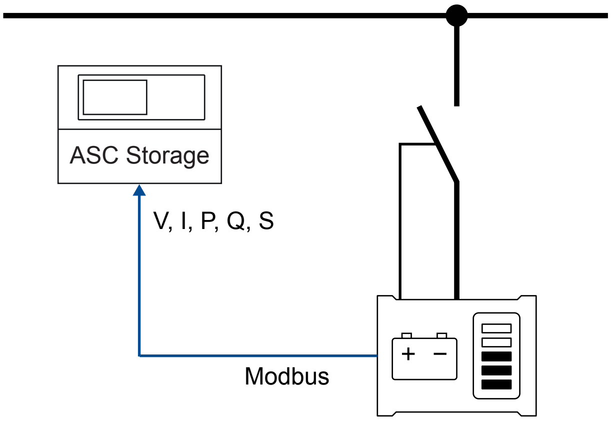
The ASC terminals can be connected to measure the AC power from the ESS. This is the default configuration.

ASC does the AC measurements



Alternatively, the ASC can receive the AC power measurements from the ESS. Select *ESS communication* in parameter 7021.

ASC gets the AC measurements from the ESS



`Basic settings > Measurement setup > Wiring connection > Power measure origin`

Parameter	Name	Range	Default	Details
7021	ESS power measures	ASC measurements ESS communication DEIF open communication Power meter comm. ASC measurements average	ASC measurements	**DEIF open communication**: The ASC receives the ESS power values over Modbus.

You can also get the busbar/ESS voltage and frequency measurements from the ESS communication.

`Basic settings > Measurement setup > Wiring connection > Busbar/ESS measures`

Parameter	Name	Range	Default	Details
7022	BB/ESS V/f meas.	ASC measurements ESS communication	ASC measurements	**ASC measurements**: The ASC uses its own measurements for the busbar/ESS voltage and frequency. **ESS communication**: The ASC uses the ESS measurements for the busbar/ESS voltage and frequency.
7023	V/f from com. fail	0 to 100 s	3 s	This alarm is activated if ESS communication fails and the alarm timer runs out.

7.13.1 ESS meter

To use an ESS meter, select *Power meter comm.* in parameter 7021.

`Communication > Power meter > ESS meter`

Parameter	Name	Range	Default	Details
7702	ESS meter ID	1 to 247	3	Select the ESS power meter ID.
7723	ESS protocol	**See DEIF Hybrid controller compatibility**	Off	Select the protocol that matches your power meter. Additional protocols may be available. Contact DEIF for details.
7740	ESS meter err.	Fail classes	Warning	If enabled, this alarm activates when there is no communication from the ESS power meter.

You can also configure these settings from the display, under `Settings > Communication > Power meter > ESS meter settings`

NOTE You can only use an ESS meter if you have *Premium* software.

7.14 Breaker control

7.14.1 Energy storage breaker control

If the ESS allows this, the ESB can close before there is voltage and frequency on the busbar.

`Breakers > ES breaker > Breaker configuration`

Parameter	Name	Range	Default	Description
2360	Auto close cond	Default Auto start and running	Default	**Default**: The ESB can close when any of these conditions are met: • The BESS is running and an auto start signal is activated. • A mains is connected. • A genset in auto mode is connected. **Auto start and running**: The ESB can only close when the BESS is running and an auto start signal is activated.

7.14.2 No ESS breaker control

If the ASC does not control the ESS breaker, this affects the mains breaker control. The ASC acts as if the ESS breaker is always closed.

Requirements for mains breaker closing

To close the mains breaker, either the ESS must stop, or back synchronising must be enabled in the ASC.

`Synchronisation > Mains parallel settings`

Parameter	Name	Range	Default
7083	Back synchronising	Not enabled, Enabled	Not enabled

Requirements for AMF

When mains power is restored after a mains failure, the ASC stops the ESS briefly so that the mains breaker can close.

7.14.3 No mains breaker control

If the ASC does not control the mains breaker, this affects the ESS breaker control. The ASC acts as if the mains breaker is always closed. For the ESB to close, synchronisation to mains must be enabled.

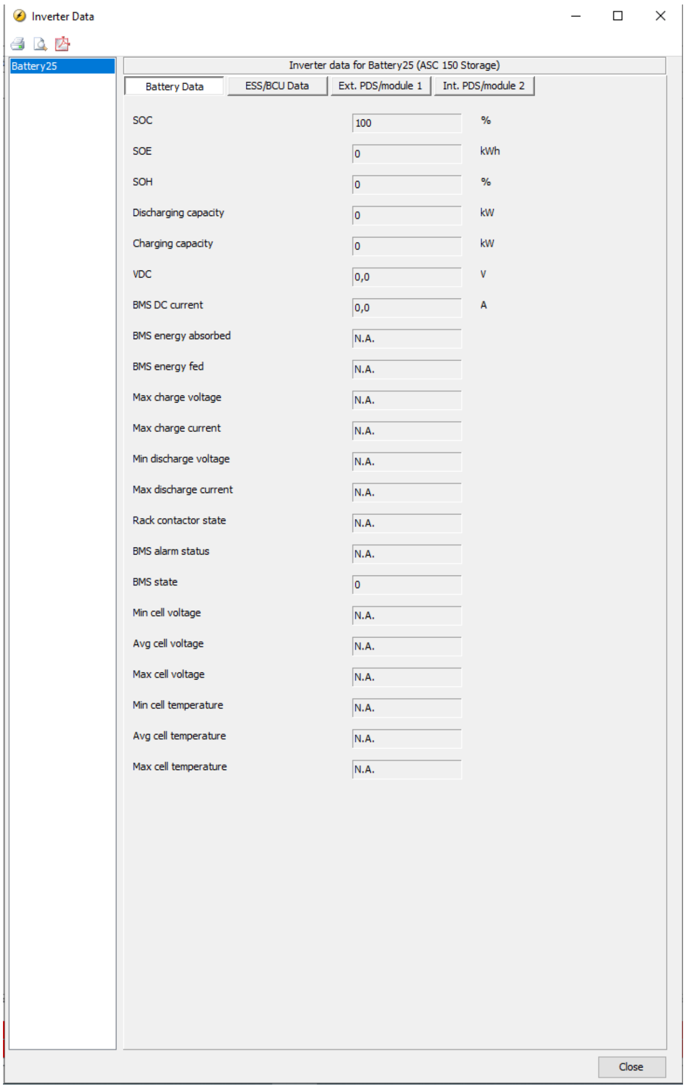
`Synchronisation > Mains parallel settings`

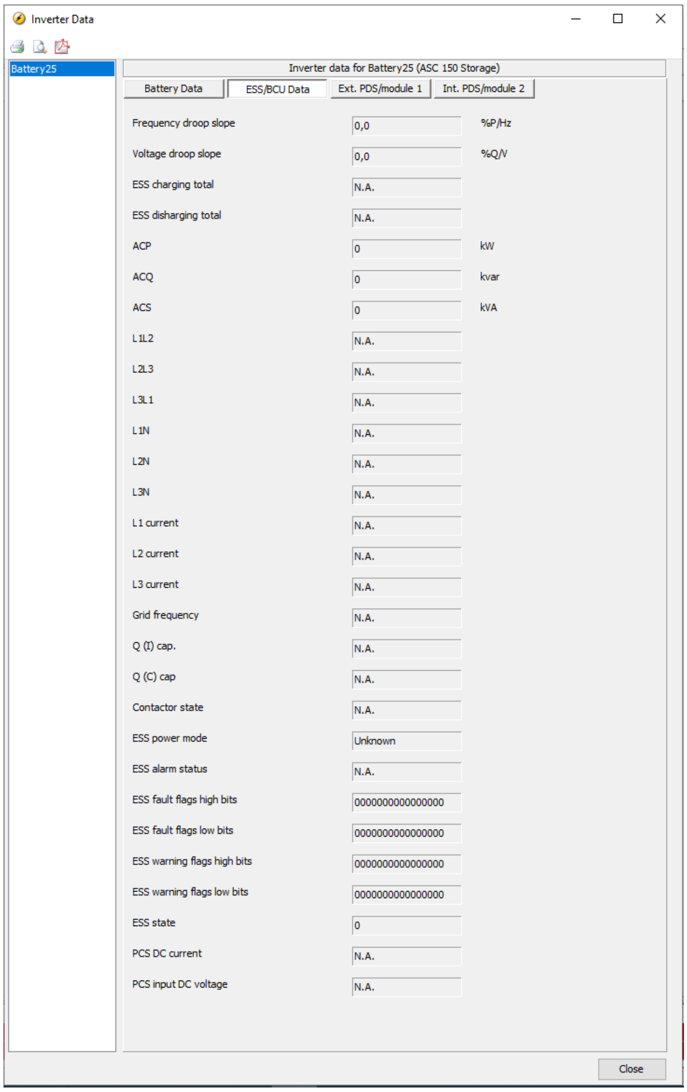
Parameter	Name	Range	Default
7084	Sync. to mains	Not enabled, Enabled	Enabled

7.15 Monitoring the ESS

7.15.1 ESS data

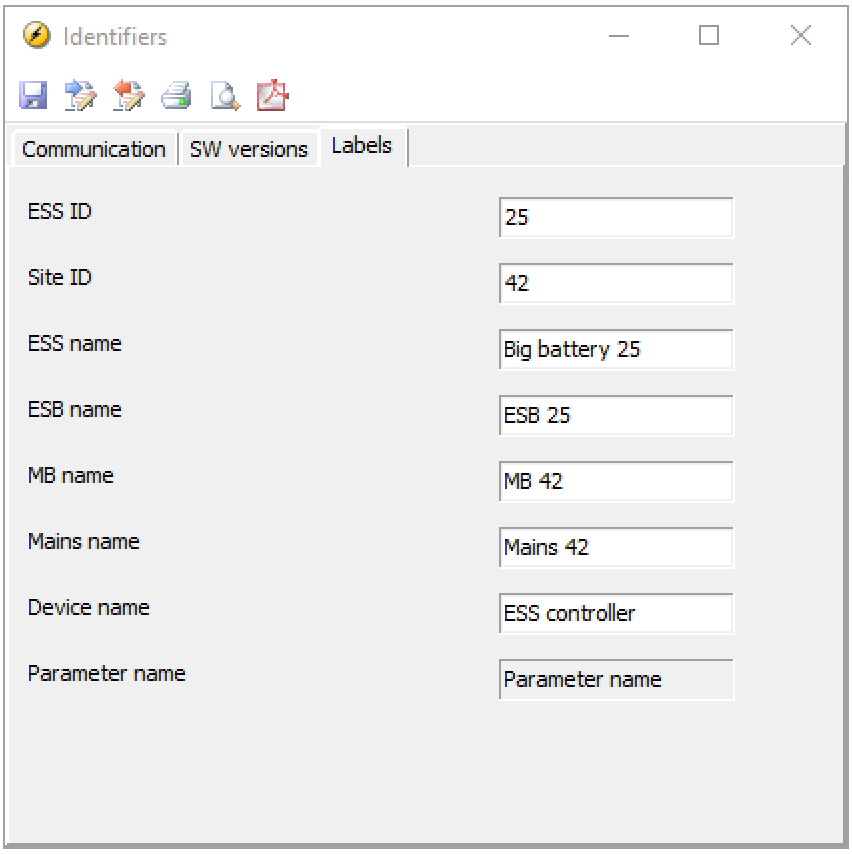
In the utility software, under *Application supervision*, select *Inverter data*  to open the *Inverter data* window.





7.15.2 ESS labels

In the utility software, select *Identifiers*  to open the *Identifiers* window. Select *Labels* to see and edit the label names.



7.15.3 State of health

The ASC reads the state of health (SOH) from the ESS. The ASC activates an alarm if the SOH goes below the configured value.

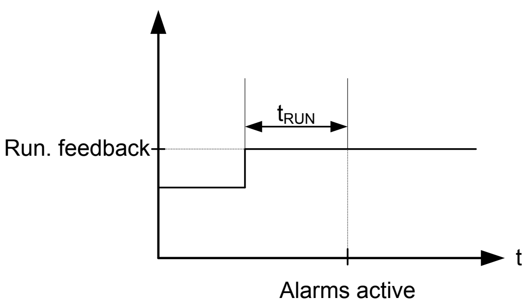
Storage > SOC/SOH alarms > SOH alarms

Parameter	Name	Range	Default	Details
17130	SOH minimum 01	0 to 100 %	20 %	SOH alarm 1
17140	SOH minimum 02	0 to 100 %	15 %	SOH alarm 2

7.15.4 Run status alarm

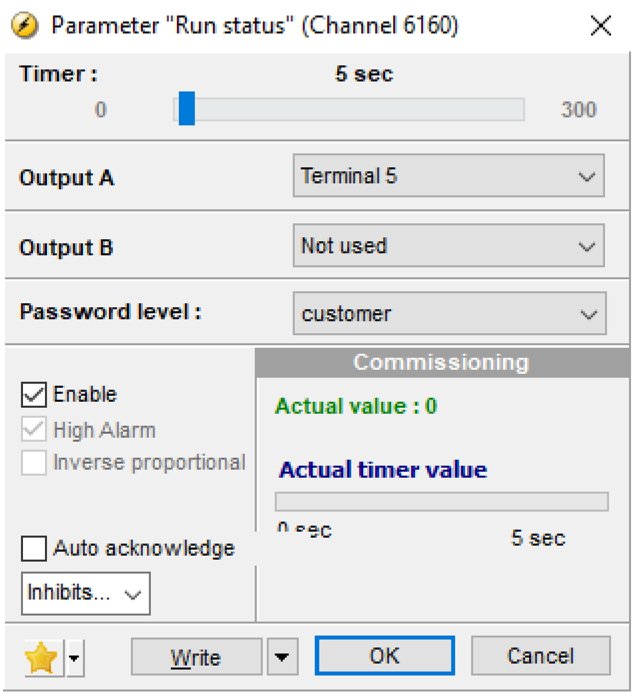
An alarm can be configured to activate when the running feedback is active and a time delay has expired.

The diagram shows that after the running feedback is activated, the run status delay expires. When the delay expires, the *Run status* alarm (6160) is activated.

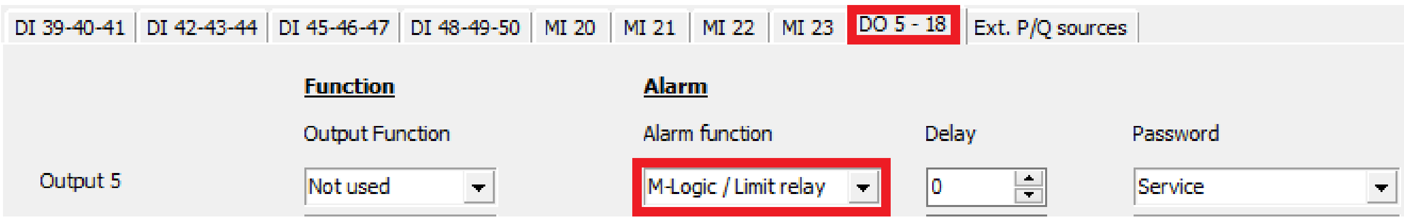


NOTE The timer is ignored if digital running feedback is used.

7.15.5 Running output



You can configure **6160 Run status** to activate a digital output when the ESS is running. Select the relay in *Output A*, and select *Enable*.



In the relay menu, the relay set point must be *M-Logic / Limit relay*. If the ESS is running, the relay activates, but an alarm is not activated.

If the relay function is not *M-Logic / Limit relay*, an alarm is activated whenever there is running feedback from the ESS.

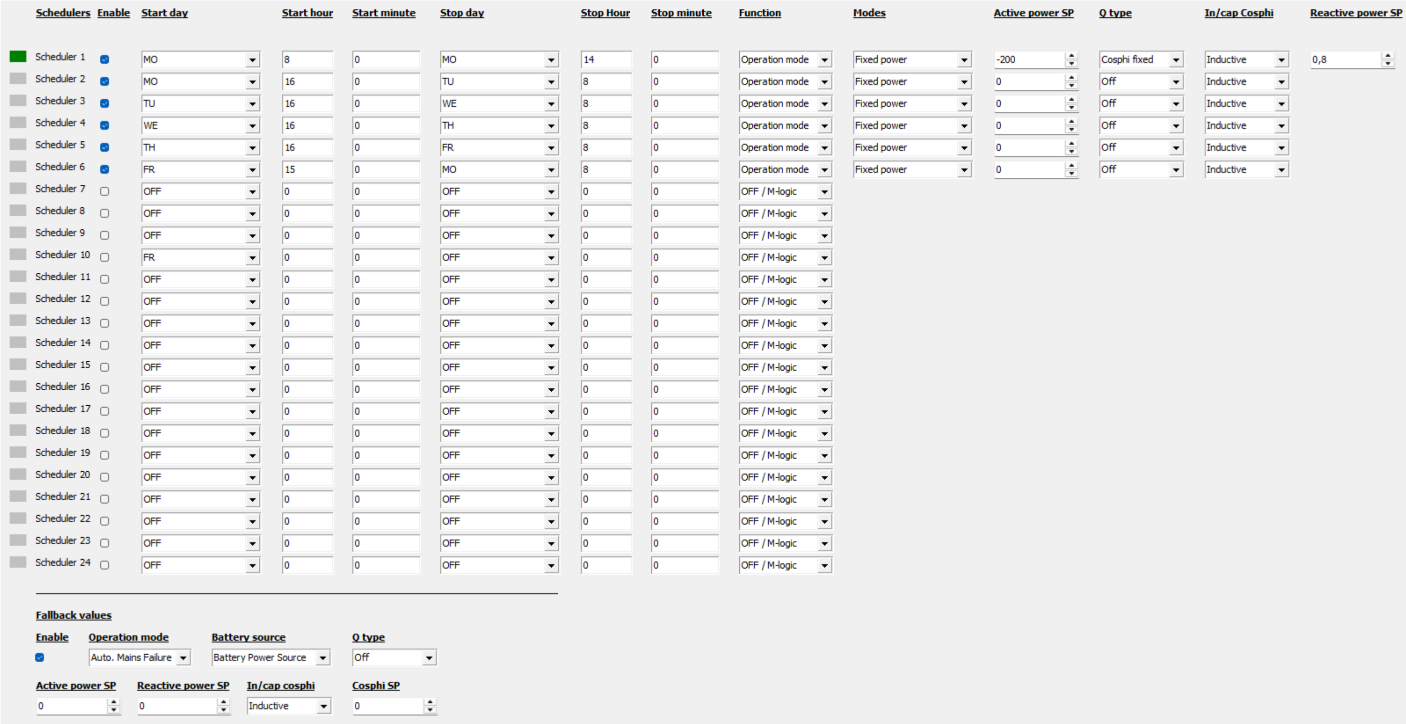
7.16 Command schedulers

You can use the scheduler to configure up to 24 schedules for the ASC modes and set points.

You can view active scheduler from the display unit (from *Service view*) or from the utility software (select *Scheduler* and *Turn ON Live data*). When the schedulers are enabled and active, the corresponding M-Logic events are also activated.

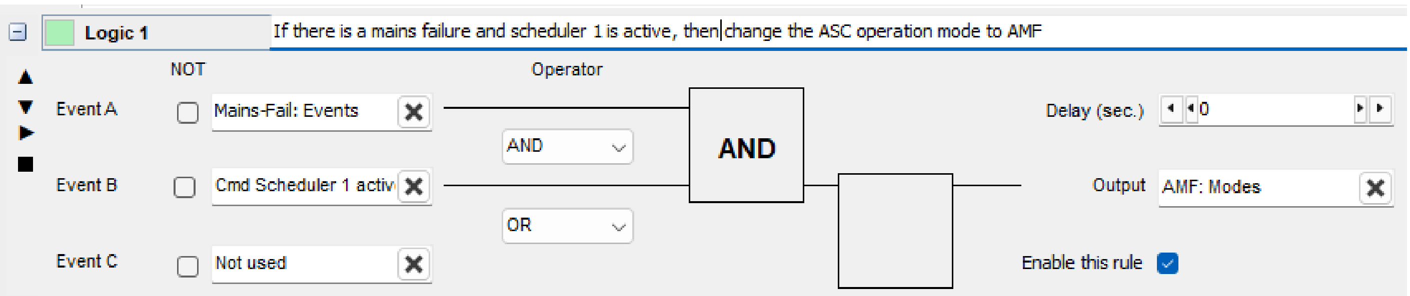
To configure the schedulers, in the utility software, select *Scheduler*.

Example of Scheduler configuration



This business has an ESS that supplies power if there is a mains failure during business hours. This is configured by enabling the fallback values and selecting *Auto. Mains Failure* (AMF). On Mondays at 08h00, the ASC set points are changed to make sure that the ESS charge is topped up (scheduler 1). The green block shows that this scheduler is currently active.

To make sure that AMF is not activated if the power fails after business hours, schedulers 2 to 6 are used to change the settings to fixed power, with the set point at 0. The mode shift parameter (7081) is also *Mode shift off* to stop the ASC from changing to AMF during a mains failure. Finally, if there is a mains failure on a Monday morning while the ESS is being topped up, M-Logic is used to change the ASC operation mode to AMF.



If the ASC operation mode or set points need to be changed at any time, the operator can do so. When the schedulers are activated, they will still change the ASC mode and set points.

How it works

When each scheduler starts, the ASC changes its parameters according to the values configured for that scheduler. If a scheduler ends and no other scheduler starts, if the fallback values are enabled, the ASC uses the fallback values to change its parameters.

If their functions are different, two schedulers can run and be active on the same time. If two schedulers with the same function are active at the same time, the scheduler with the higher number takes priority.

Conflicting schedulers

Schedulers 10 and 20 are configured to be active at the same time, and both have the *Operation mode* function. However, scheduler 10 is configured for *Fixed power*, while scheduler 20 is configured for *Peak shaving*.

Since there is a conflict, scheduler 20 takes priority, since it has a higher number. The ASC therefore only changes the *Operation mode* set point to *Peak shaving* when the schedulers are activated.

7.17 M-Logic for storage

More information
See the **Application notes, ASC 150 Storage M-Logic** spreadsheet for a complete list of the M-Logic functions in the ASC 150 Storage controller.

7.17.1 Battery events

Events > Events - Battery

Event	Activated when ...
Power functionality OK	The power function is activated and the battery is assisting the plant.
Energy functionality OK	The energy function is activated and the battery is leading the plant.
Battery fully charged	The SOC is at or above the maximum.
Battery AC coupled selected	Parameter 17082 is *AC-coupled battery*.
Battery DC coupled selected	Parameter 17082 is *DC-coupled battery*.
Battery SOC parameter set [1-3] selected	Parameter 17055 is *SOC setting [#]*, and the ASC uses the corresponding set of state-of-charge settings.
Battery Energy source selected	The energy function is activated and the battery is leading the plant.
Battery Power source selected	The power function is activated and the battery is assisting the plant.
P/Q mode active	The ESS is running in grid-following mode.
V/f mode active	The ESS is running in grid-forming mode.
Droop mode active	The ESS is running in droop mode.
Custom output [1-3] from ESS	The ESS has activated custom output [#].
Custom output from BMS	The BMS has activated the custom output.
Mains charge parameter enabled	*Mains charging* (parameter 17022) is *Enabled*.
DG charge parameter enabled	*DG charge mode* (parameter 17033) is *Enabled*.
PV charge parameter enabled	*PV charging* (parameter 17041) is *Enabled*.
Boost charging activated	The ASC is sending a command to the ESS to boost charging.
PDS spin. res. pct [1-2] selected	Parameter 17203 is *PDS spinning reserve pct 0[#]*, and the ASC uses the corresponding PDS spinning reserve parameter.
SOC Above or Equal to SOC Min	The state of charge is at or above the minimum for the activated SOC settings (parameter 17051/17061/17071).
SOC Above or Equal to Threshold [1-2]	The stage of charge is at or above threshold [#] for the activated SOC settings (parameter 17053/17063/17073 or 17054/17064/17074).
SOC Above or Equal to SOC Max	The state of charge is at or above the maximum for the activated SOC settings (parameter 17052/17062/17072).

7.17.2 Battery commands

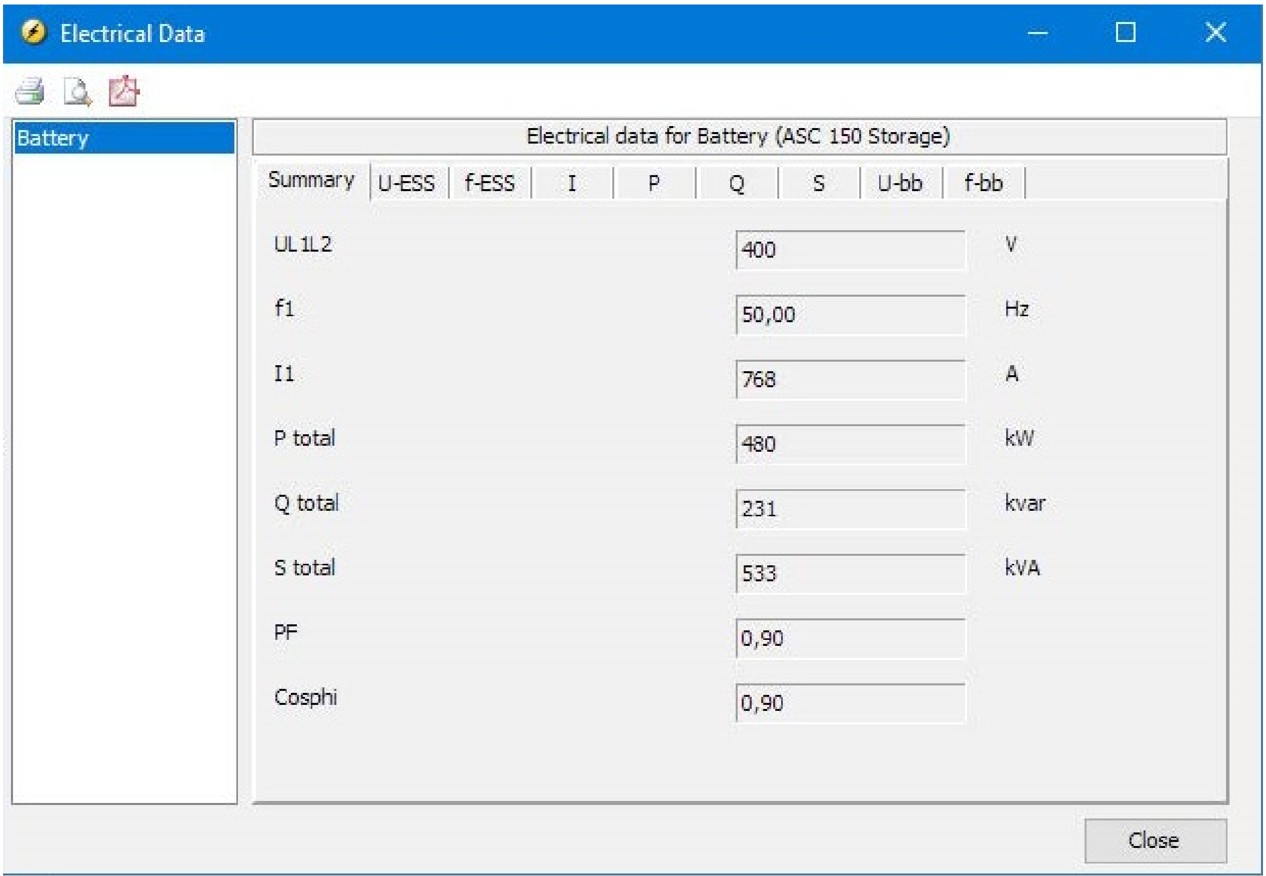
Output > Command Battery

Command	Effect when activated
Custom input to ESS	The ASC activates a custom function in the ESS protocol. For example, this command could activates a low ripple current charging mode.
Reset Power Functionality	The ASC resets its use of the power function.
Set Power Functionality	The ASC ignores the SOC thresholds history and uses the power function.
Reset Energy Functionality	The ASC resets its use of the energy function.
Set Energy Functionality	The ASC ignores the SOC thresholds history and uses the energy function.
Set AC Coupling	Parameter 17082 is changed to *AC-coupled battery*.
Set DC Coupling	Parameter 17082 is changed to *DC-coupled battery*.
Set SOC setting [1-3]	Parameter 17055 is changed to *SOC setting [#]*, so that the ASC uses the corresponding set of state-of-charge settings.
Set Battery mode - Energy Source	Parameter 17081 is changed to *Battery energy source* (plant-leading).
Set Battery mode - Power Source	Parameter 17081 is changed to *Battery power source* (plant assist).
Request ESS to Sync MB (Tesla)	For the *Tesla* protocol, the ASC requests the ESS to synchronise to the mains breaker.
Request ESS to Open MB (Tesla)	For the *Tesla* protocol, the ASC requests the ESS to open the mains breaker.
Enable mains charge parameter	*Mains charging* (parameter 17022) is changed to *Enabled*.
Disable mains charge parameter	*Mains charging* (parameter 17022) is changed to *Not enabled*.
Enable DG charge parameter	*DG charge mode* (parameter 17033) is changed to *Enabled*.
Disable DG charge parameter	*DG charge mode* (parameter 17033) is changed to *Not enabled*.
Enable PV charge parameter	*PV charging* (parameter 17041) is changed to *Enabled*.
Disable PV charge parameter	*PV charging* (parameter 17041) is changed to *Not enabled*.
Force BMS Shutdown	The ASC sends a command to the BMS to shut down.
Set mode to Droop	The ESS runs in droop mode.
Set mode to P/Q	The ESS runs in grid-following mode.
Set mode to V/f	The ESS runs in grid-forming mode.
Freeze charging	The ASC keeps the charging set point for the ESS constant while this command is active.
Freeze discharging	The ASC keeps the discharging set point for the ESS constant while this command is active.
Force charging	The ASC sends a charging set point to the ESS while this command is active.
Force discharging	The ASC sends a discharging set point to the ESS while this command is active.
Ack. alarms on ESS	The ASC sends a command to the ESS to acknowledge the alarms.
Ack. alarms on BMS	The ASC sends a command to the BMS to acknowledge the alarms.
Ack. alarms on PDS	The ASC sends a command to the PDS to acknowledge the alarms.
Request boost charging	For supported systems, the ASC sends a command to the ESS to activate boost charging while this command is active.
PDS spin. res. set pct [1-2]	Parameter 17203 is changed to *PDS Spinning reserve pct 0[#]*, so that the ASC uses the corresponding PDS spinning reserve parameter.

7.18 Additional functions

7.18.1 Electrical data monitoring

In the utility software, under *Application supervision*, select *Electrical Data* to open the *Electrical Data* window.



7.18.2 Allow PCS to inhibit MB, TB, or ESB opening

The ASC lets the PCS delay the MB, TB, or ESB opening sequence until the PCS has the required grid mode active. If required, you can use parameter 7086 to disable this function.

NOTE During a mains failure, this function does not delay the MB, TB, or ESB opening sequence.

`Breakers > ESS inhibit MB/TB`

Parameter	Name	Range	Default
7086	Inhibit MB/TB open	Not enabled, Enabled	Enabled

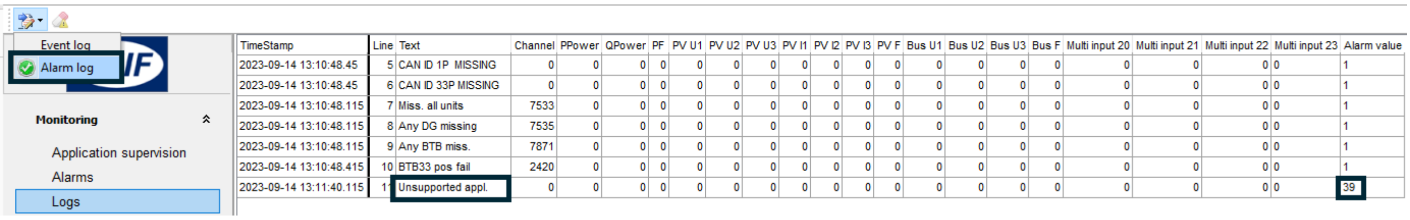
7.18.3 Unsupported application alarm

The ASC 150 Storage controller has configuration limitations. If a configuration rule is broken, the controller activates the *Unsupported application* 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
19	For a single storage controller, the application includes an energy storage system breaker, a mains breaker, and external generators. • The ASC cannot synchronise to the busbar in this configuration.

Alarm value	Configuration rule
	• If there is no energy storage system breaker, the unsupported application alarm is not activated.
20	The ASC controller must have option S3 (extended software package) or S4 (premium software package).
21	For a single storage controller with option S3 (extended software package), there is a mains connection on the application configuration diagram.
22	For a single ASC controller with option S3 (extended software package), the mains breaker open and close relays are configured.
32	If more than one mains is connected, the ASC controller cannot control the mains breaker.
38	For open PMS, the plant can only have one mains connection (external mains or AGC mains).
39	For open PMS, only one controller can be connected to an external mains.
40	For an open PMS application, *Diesel gen* cannot be included as a power source.
41	For an open PMS application, bus tie breakers are not allowed.

Alarm log example



TimeStamp	Line	Text	Channel	PPower	QPower	PF	PV U1	PV U2	PV U3	PV I1	PV I2	PV I3	PV F	Bus U1	Bus U2	Bus U3	Bus F	Multi input 20	Multi input 21	Multi input 22	Multi input 23	Alarm value
2023-09-14 13:10:48.45	5	CAN ID 1P MISSING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2023-09-14 13:10:48.45	6	CAN ID 33P MISSING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2023-09-14 13:10:48.115	7	Miss. all units	7533	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2023-09-14 13:10:48.115	8	Any DG missing	7535	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2023-09-14 13:10:48.115	9	Any BTB miss.	7871	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2023-09-14 13:10:48.415	10	BTB33 pos fail	2420	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2023-09-14 13:11:40.115	11	Unsupported appl.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	39

8. General functions

8.1 Introduction

This chapter describes the general functions for AGC 150 and ASC 150. For ASC 150, replace references to generator with ESS.

8.2 Password

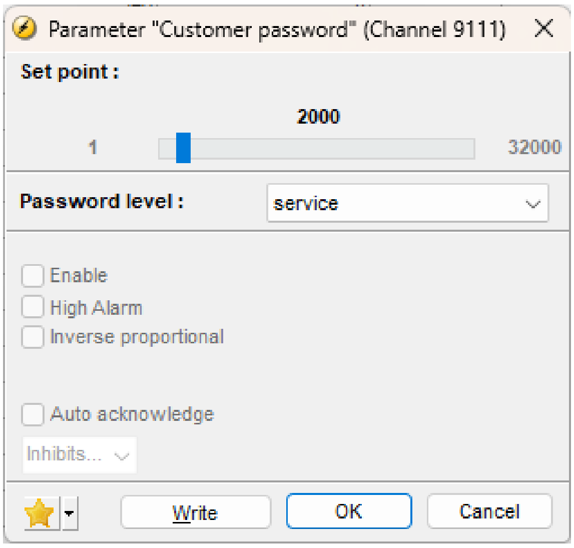
The controller has three password levels that can be configured on the controller or from the utility software. Parameter settings cannot be changed with a lower ranking password, but are shown on the display.

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.

8.3 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.

8.3.1 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 > ESS nominal U

Parameter	Text	Range	Default	Adjust to value
6004	Nom. U 1	100 to 25000 V	400 V	U_{NOM}. Phase-phase voltage of the source. For example, for a 400/230 V AC system, use 400 V AC.

Basic settings > Measurement setup > Voltage transformer > ESS VT

Parameter	Text	Range	Default	Adjust to value
6041	ES primary U	100 to 25000 V	400 V	Primary VT
6042	ES secondary U	100 to 690 V	400 V	Secondary VT

Basic settings > Nominal settings > Voltage > Busbar nominal U

Parameter	Text	Range	Default	Adjust to value
6053	BB nominal U 1	100 to 25000 V	400 V	U_{NOM}

`Basic settings > Measurement setup > Voltage transformer > Busbar VT`

Parameter	Text	Range	Default	Adjust to value
6051	BB primary U 1	100 to 25000 V	400 V	Primary VT
6052	BB secondary U 1	100 to 690 V	400 V	Secondary VT

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

8.3.2 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 > ESS nominal U`

Parameter	Text	Range	Adjust to value
6004	Nom. U 1	100 to 25000 V	U_{NOM} (120 V AC)

`Basic settings > Measurement setup > Voltage transformer > ESS VT`

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

8.3.3 Single-phase system

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

The following configuration is required for the single-phase measuring.

`Basic settings > Nominal settings > Voltage > ESS nominal U`

Parameter	Text	Range	Adjust to value
6004	Nom. U 1	100 to 25000 V	Phase-neutral voltage of the source. For example, for a 230 VAC system, use 230 V AC.

`Basic settings > Measurement setup > Voltage transformer > ESS VT`

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

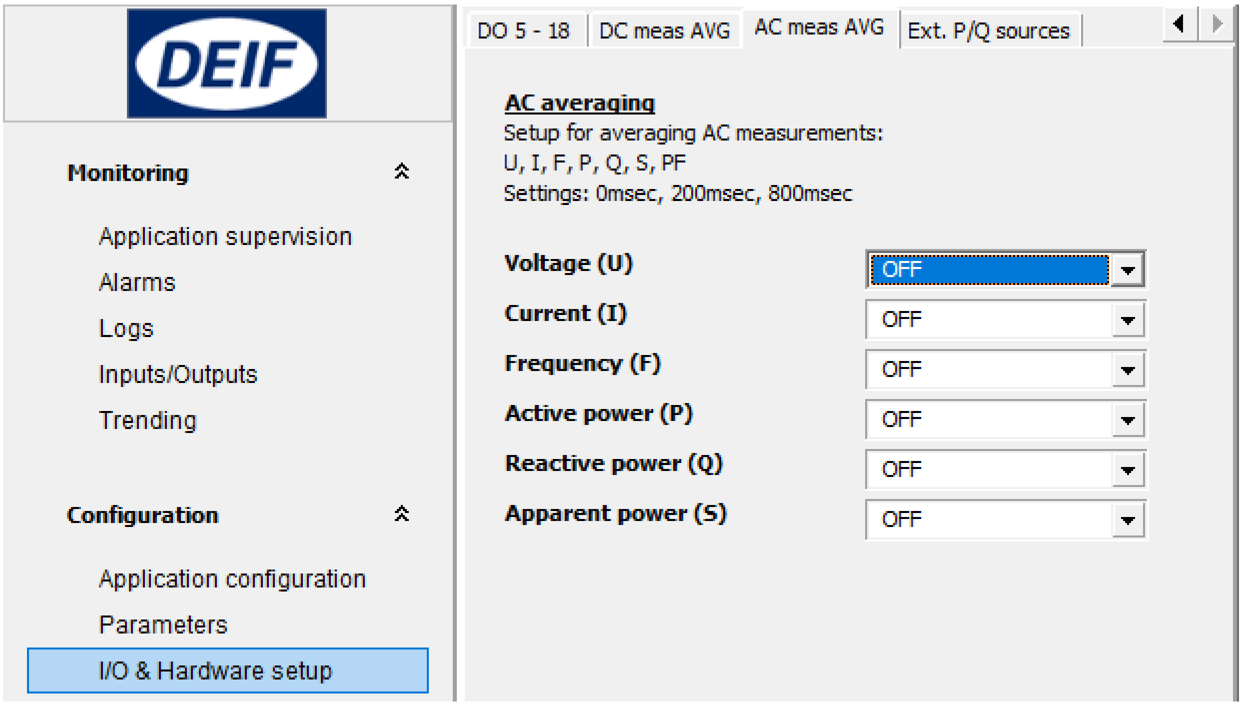
NOTE The voltage alarms refer to U_{NOM} (for example, 230 V AC).

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

8.3.4 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.



8.4 Nominal settings

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

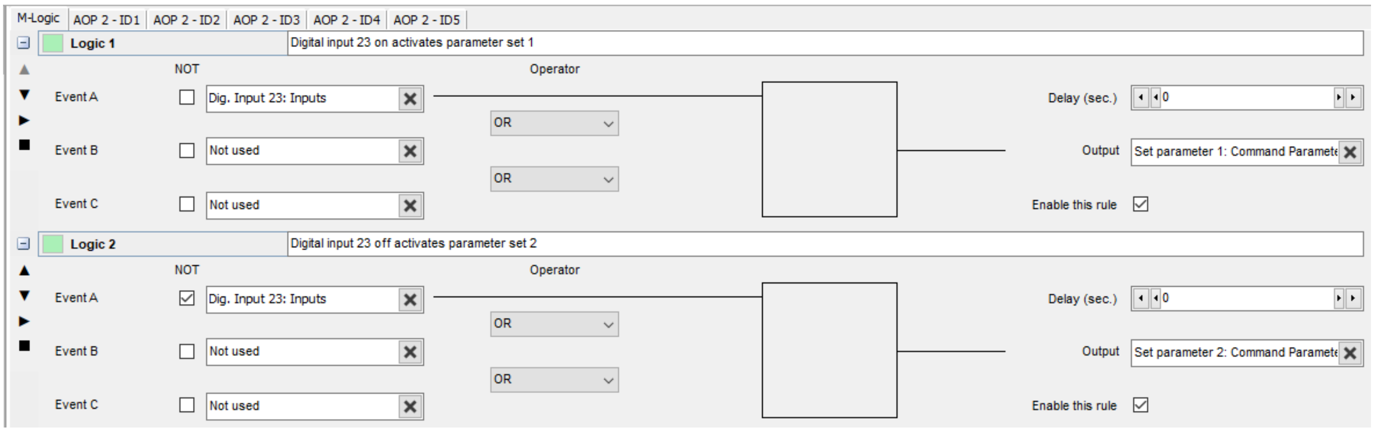
`Alternative configuration > ESS nominal settings`

Parameter	Text	Range	Default
6007	Enable nom. set	Nominal setting [1 to 4]	Nominal setting 1

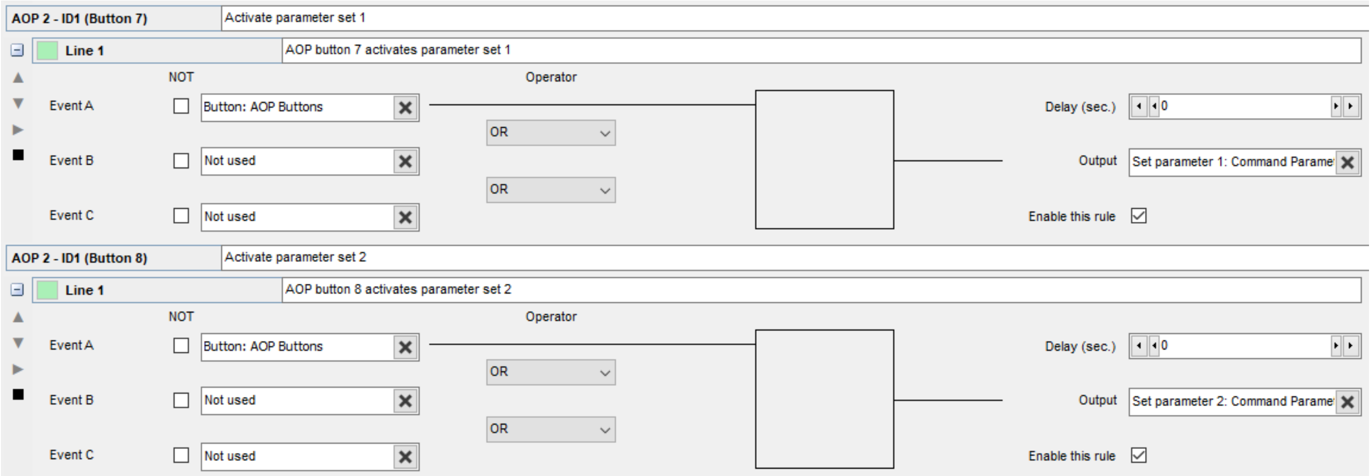
Switch between the nominal settings

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.

8.4.1 Default nominal settings

The default nominal settings are settings 1. To use another set of nominal settings, use the parameters under `Alternative configuration`.

`Basic settings > Nominal settings > Voltage > ESS nominal U`

Parameter	Text	Range	Default
6004	Nom. U 1	100 to 25000 V	400 V

`Basic settings > Nominal settings > Voltage > Busbar nominal U`

Parameter	Text	Range	Default
6053	BB nominal U 1	100 to 25000 V	400 V

`Basic settings > Nominal settings > Current > 3 phase nominal`

Parameter	Text	Range	Default
6003	Nom. I 1	0 to 9000 A	867 A

`Basic settings > Nominal settings > Current > 4th CT nominal`

Parameter	Text	Range	Default
6007	Nom. I E/N/M 1	0 to 9000 A	867 A

`Basic settings > Nominal settings > Frequency`

Parameter	Text	Range	Default
6001	Nom. f 1	48.0 to 62.0 Hz	50 Hz

`Basic settings > Nominal settings > Power > 3 phase nominal`

Parameter	Text	Range	Default
6002	Nom. P 1	10 to 20000 kW	480 kW
6005	Nom. Q 1	10 to 20000 kvar	480 kvar
6006	Nom. S 1	10 to 20000 kVA	480 kVA

`Basic settings > Nominal settings > Power > 4th`

Parameter	Text	Range	Default
6055	4th CT nom. P 1	10 to 9000 kW	480 kW

8.4.2 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
9031	Scaling	10 to 2500 V 100 to 25000 V 10 to 160000 V 0.4 to 75000 V	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.

8.5 Step-up and step-down transformers

8.5.1 Step-up transformer

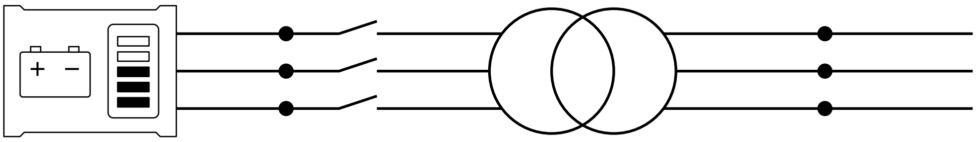
In certain cases, the use of a battery with step-up transformer (called a block) is required. This may be to adapt to the closest grid voltage or to step up the voltage to minimise the losses in cables and also to bring down the cable size. Applications that need a step-up transformer are supported by the controller.

The available functions are:

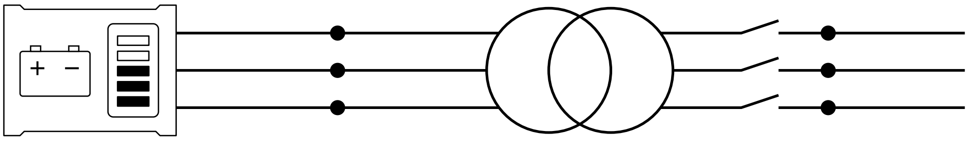
1. Synchronising with or without phase angle compensation
2. Voltage measurement displayed
3. Battery protections
4. Busbar protections

Typically, the synchronising breaker is on the high voltage (HV) side, and there is no breaker (or only a manually operated one) on the low voltage (LV) side. In some applications, the breaker could also be placed on the LV side. This does not influence the setting in the controller, as long as the breaker and the step-up transformer are both placed between the measuring points used by the controller. The measuring points are shown as black dots.

Battery-transformer block, breaker on LV side



Battery-transformer block, breaker on HV side



The phase angle compensation would not be an issue if there was no phase angle shift across the step-up transformer, but in many cases there is. In Europe, the phase angle shift is described using the vector group description. Instead of vector group, this could also be called clock notation or phase shift.

NOTE When voltage measurement transformers are used, these must be included in the total phase angle compensation.

Example

A 10000 V/400 V step-up transformer is installed after a battery with the nominal voltage of 400 V. The nominal voltage of the busbar is 10000 V. Now, the voltage of the busbar is 10500 V. The battery is running 400 V before synchronising starts, but when attempting to synchronise, the voltage set point will be changed to: $U_{BUS\text{-}MEASURED} \cdot U_{BAT\text{-}NOM}/U_{BUS\text{-}NOM}$ = 10500 · 400/10000 = **420 V**

8.5.2 Vector group for step-up transformer

Vector group definition

The vector group is defined by two letters and a number:

- The first letter is an upper case D or Y, defining whether the HV side windings are in Delta or Wye configuration.
- The second letter is a lower case d, y or z, defining whether the LV side windings are in delta, wye or zigzag configuration.
- The number is the vector group number, defining the phase angle shift between HV and LV side of the step-up transformer. The number is an expression of the LV side lag compared to the HV side voltage. The number is an expression of the lag angle divided by 30 °.

Example

Dy11 = HV side: Delta, LV side: Wye, vector group 11: Phase shift = 11x (-30) = -330 °.

Typical vector groups

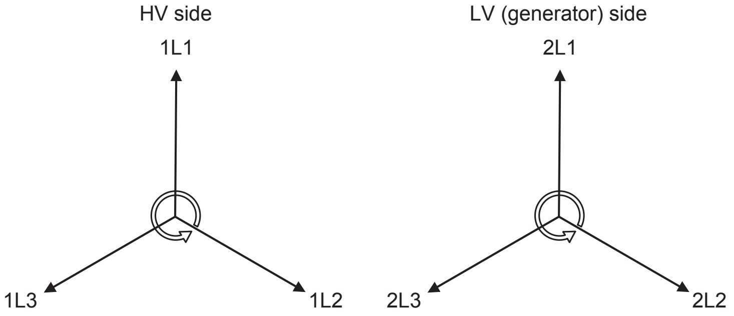
Vector group	Clock notation	Phase shift	LV lag degrees compared to HV
0	0	0 °	0 °
1	1	-30 °	30 °
2	2	-60 °	60 °
4	4	-120 °	120 °
5	5	-150 °	150 °
6	6	-180 °/180 °	180 °
7	7	150 °	210 °
8	8	120 °	240 °
10	10	60 °	300 °
11	11	30 °	330 °

Parameter	Name	Range	Default	
9141	Angle comp. BB/ESS 1	-179.0 to 179.0 °	0.0 °	Angle compensation for busbar parameter set 1 (selected in parameter 6054)
9142	Angle comp. BB/ESS 2	-179.0 to 179.0 °	0.0 °	Angle compensation for busbar parameter set 2 (selected in parameter 6054)

Vector group 0

The phase angle shift is 0 ° (parameter setting: 0 °).

Yy0 example

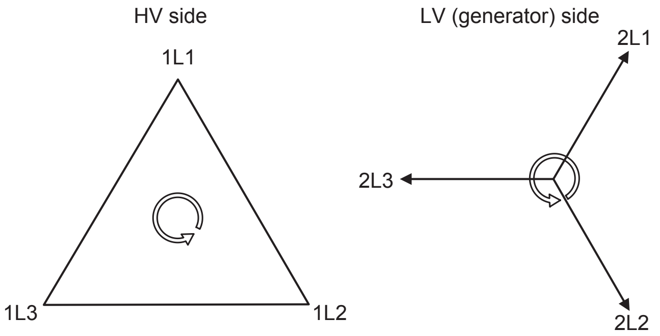


1L1 to 2L1 phase angle is 0 °.

Vector group 1

The phase angle shift is -30 ° (parameter setting: 30 °).

Dy1 example

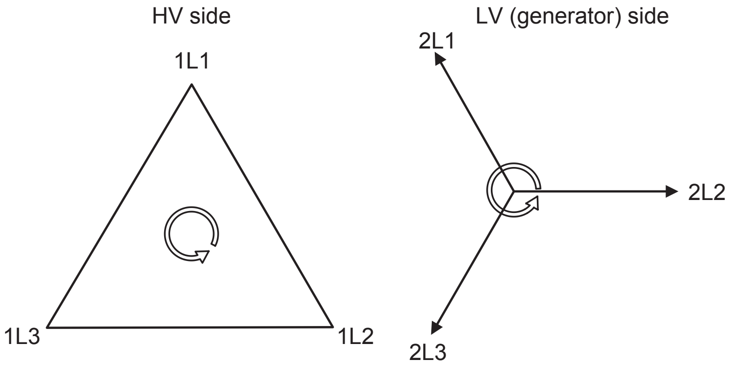


1L1 to 2L1 phase angle is -30 °.

Vector group 11

The phase angle shift is 11 x (-30) = -330/+30 ° (parameter setting: -30 °).

Dy11 example

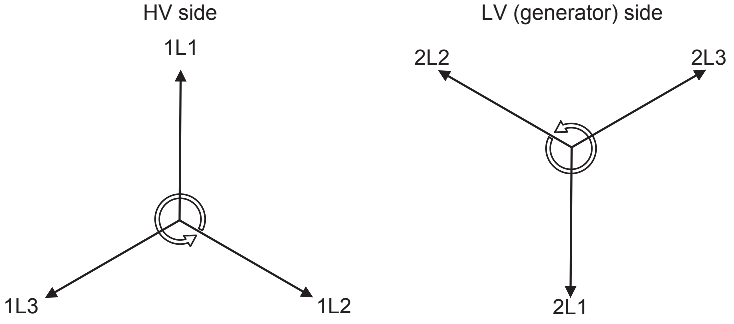


1L1 to 2L1 phase angle is -330/+30 °.

Vector group 6

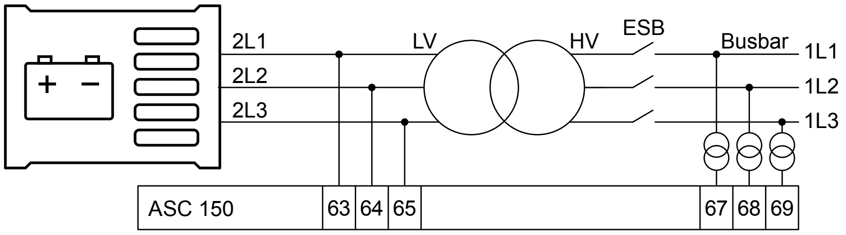
The phase angle shift is 6 x 30 = 180 ° (parameter setting: 180 °).

Yy6 example



1L1 to 2L1 phase angle is -180/+180 °.

Wiring



- The wiring shown in the diagram should always be used when the controller is used for an energy storage system.
- Select 179 ° in parameter 9141 when vector group 6 is used.

Comparison table between different terminologies

Vector group	Clock notation	Phase shift	LV lag degrees compared to HV	LV side lagging	LV side leading
0	0	0 °	0 °	0 °	
1	1	-30 °	30 °	30 °	
2	2	-60 °	60 °	60 °	
4	4	-120 °	120 °	120 °	
5	5	-150 °	150 °	150 °	
6	6	-180 °/180 °	180 °	180 °	180 °
7	7	150 °	210 °		150 °
8	8	120 °	240 °		120 °
10	10	60 °	300 °		60 °
11	11	30 °	330 °		30 °

Table to read parameter 9141 compared to a step-up transformer

Vector group	Step-up transformer types	Parameter 9141
0	Yy0, Dd0, Dz0	0 °
1	Yd1, Dy1, Yz1	30 °
2	Dd2, Dz2	60 °
4	Dd4, Dz4	120 °

Vector group	Step-up transformer types	Parameter 9141
5	Yd5, Dy5, Yz5	150 °
6	Yy6, Dd6, Dz6	180 °
7	Yd7, Dy7, Yz7	-150 °
8	Dd8, Dz8	-120 °
10	Dd10, Dz10	-60 °
11	Yd11, Dy11, Yz11	-30 °

NOTE DEIF does not take responsibility for the compensation being correct. Before closing the breaker, always validate that systems are aligned.

The settings shown in the table above do not include any phase angle shift made by measurement transformers.

The settings shown in the table above are not correct if a step-down transformer is used (see **Setup of step-down and measurement transformers**).

8.5.3 Setup of step-up and measurement transformers

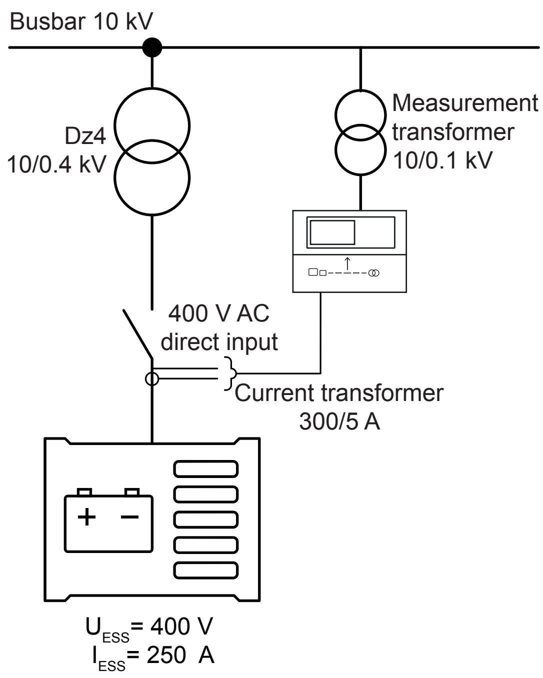
If the HV side of the transformer transforms the voltage up to a voltage level higher than 690 V AC, you must use measurement transformers. Set up all these parameters from the utility software.

Example

The transformer is a Dz4 step-up transformer with nominal settings of 10/400 V. The energy storage system (ESS) has a nominal voltage of 400 V, a nominal current of 250 A and a nominal power of 140 kW. The measurement transformer has a nominal voltage of 10/100 V and no phase angle twist. The nominal voltage of the busbar (BB) is 10000 V.

Since the ESS nominal voltage is 400 V, there is no need for a voltage measurement transformer on the LV side in this example. The controller can handle up to 690 V, but current transformers must still be set up on the LV side.

In this example, the current transformers have a nominal current of 300/5 A. Because the step-up transformer is a Dz4, there is a phase angle twist of -120 °.



Parameters for step-up and measurement transformers example

Parameter	Path	Comment	Setting
6002	`Basic settings > Nominal settings > Current > 3 phase nominal`	ESS nominal power	140
6003	`Basic settings > Nominal settings > Power > 3 phase nominal`	ESS nominal current	250
6004	`Basic settings > Nominal settings > Voltage > ESS nominal U`	ESS nominal voltage	400

Parameter	Path	Comment	Setting
6041	`Basic settings > Measurement setup > Voltage transformer > ESS VT > ES primary U`	ESS voltage transformer primary side	400
6042	`Basic settings > Measurement setup > Voltage transformer > ESS VT > ES secondary U`	ESS voltage transformer secondary side	400
6043	`Basic settings > Measurement setup > Current transformer > 3 phase CT > ES Primary I`	ESS current transformer primary side	300
6044	`Basic settings > Measurement setup > Current transformer > 3 phase CT > ES Secondary I`	ESS current transformer secondary side	5
6051	`Basic settings > Measurement setup > Voltage transformer > Busbar VT > BB primary U 1`	Busbar voltage transformer primary side	10000
6052	`Basic settings > Measurement setup > Voltage transformer > Busbar VT > BB second. U 1`	Busbar voltage transformer secondary side	100
6053	`Basic settings > Nominal settings > Voltage > Busbar nominal U`	Busbar nominal voltage	10000
9141	`Synchronisation > Angle offset > Angle comp. BB/ESS 1`	Phase angle compensation BB/ESS	120 °

The controller can handle nominal voltage levels between 100 and 690 V. If the voltage level in the application is higher or lower, you must use measurement transformers to transform the voltage so that it is between 100 and 690 V.

8.5.4 Vector group for step-down transformer

In some applications, a step-down transformer can also be used. This could be to transform a grid voltage down, so the load can handle the voltage level. The controller is able to synchronise the busbar with the mains, even if there is a step-down transformer with a phase angle shift. The transformer must be between the measuring points for the controller.

If a step-down transformer is used, these settings must be set in parameter 9141 to compensate the phase angle shift.

Vector group	Step-down transformer types	Parameter 9141
0	Yy0, Dd0, Dz0	0 °
1	Yd1, Dy1, Yz1	-30 °
2	Dd2, Dz2	-60 °
4	Dd4, Dz4	-120 °
5	Yd5, Dy5, Yz5	-150 °
6	Yy6, Dd6, Dz6	180 °
7	Yd7, Dy7, Yz7	150 °
8	Dd8, Dz8	120 °
10	Dd10, Dz10	60 °
11	Yd11, Dy11, Yz11	30 °

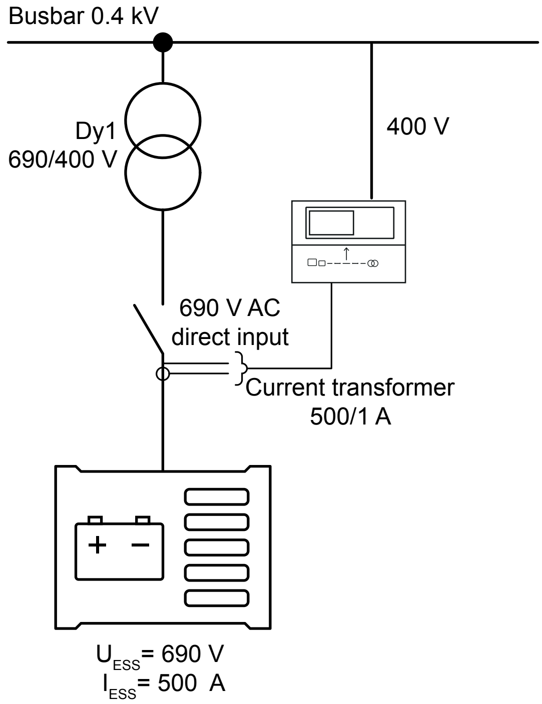
8.5.5 Setup of step-down and measurement transformers

If the HV side of the transformer has a voltage level higher than 690 V AC, measurement transformers are needed. In this example, the HV side is 690 V, and therefore there is no need for a measurement transformer. The step-down transformer can have a phase angle twist that needs to be compensated for.

Example

The transformer is a Dy1 step-down transformer with nominal settings of 690/400 V. The ESS has a nominal voltage of 690 V, a nominal current of 500 A and a nominal power of 480 kW. There is no measurement transformer in this application, because the controller can measure the voltage levels directly. The nominal voltage of the busbar (BB) is 400 V.

Current transformers are required. In this example, the current transformers have a nominal current of 500/1 A. The step-down transformer is a Dy1, and there is a phase angle twist of +30 °.



Parameters for step-down and measurement transformers example

Parameter	Path	Comment	Setting
6002	Basic settings > Nominal settings > Current > 3 phase nominal	ESS nominal power	480
6003	Basic settings > Nominal settings > Power > 3 phase nominal	ESS nominal current	500
6004	Basic settings > Nominal settings > Voltage > ESS nominal U	ESS nominal voltage	690
6041	Basic settings > Measurement setup > Voltage transformer > ESS VT > ESS primary U	ESS voltage transformer primary side	690
6042	Basic settings > Measurement setup > Voltage transformer > ESS VT > ESS secondary U	ESS voltage transformer secondary side	690
6043	Basic settings > Measurement setup > Current transformer > 3 phase CT > ES primary I	ESS current transformer primary side	500
6044	Basic settings > Measurement setup > Current transformer > 3 phase CT > ES secondary I	ESS current transformer secondary side	1
6051	Basic settings > Measurement setup > Voltage transformer > Busbar VT > BB primary U 1	Busbar voltage transformer primary side	400
6052	Basic settings > Measurement setup > Voltage transformer > Busbar VT > BB second. U 1	Busbar voltage transformer secondary side	400
6053	Basic settings > Nominal settings > Voltage > Busbar nominal U	Busbar nominal voltage	400
9141	Synchronisation > Angle offset > Angle comp. BB/ESS 1	Phase angle compensation BB/G 1	-30 °

8.6 Breakers

8.6.1 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/ATS no control

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.

8.6.2 Breaker spring load time

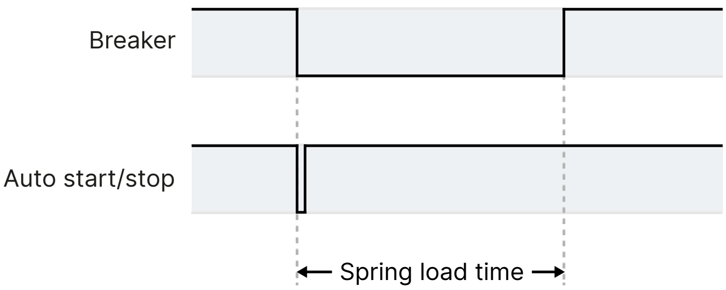
To avoid breaker close failures in situations where the breaker close command is given before the breaker spring has been loaded, the spring load time can be adjusted.

Principle

You could have a close failure if:

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

The diagram shows an example where a single ESS in island mode is controlled by the Auto start/stop input.



- When the Auto start/stop input deactivates, the breaker opens.
- The Auto start/stop is re-activated immediately after the breaker has opened, for example by the operator using a switch in the switchboard.
- The controller waits a while before sending the close signal again, because the spring load time must expire.

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 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.** A configurable input is used for feedback from the breaker. 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.

8.6.3 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, it informs the other controllers in the application. The system then blocks the section with the breaker position failure. Sections that are not affected by the breaker position failure can continue to operate.

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

8.7 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.

8.7.1 General shortcuts

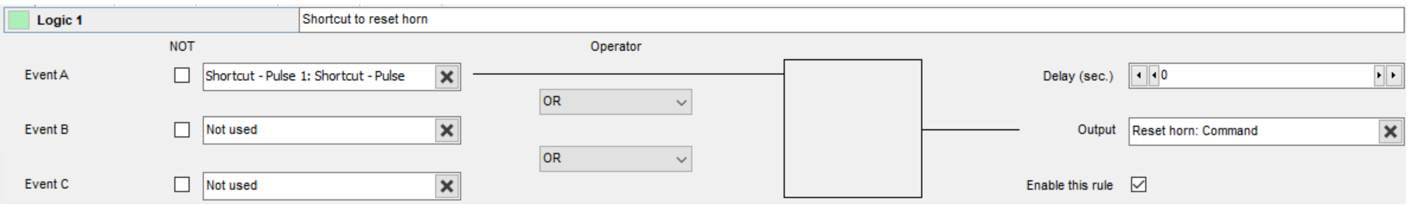
You can configure your own shortcuts with M-Logic in the utility software. You can see the configured shortcuts when you push the *Shortcut* button and select *General shortcuts*. If you have not configured a shortcut, then the *General shortcuts* menu is empty.

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.

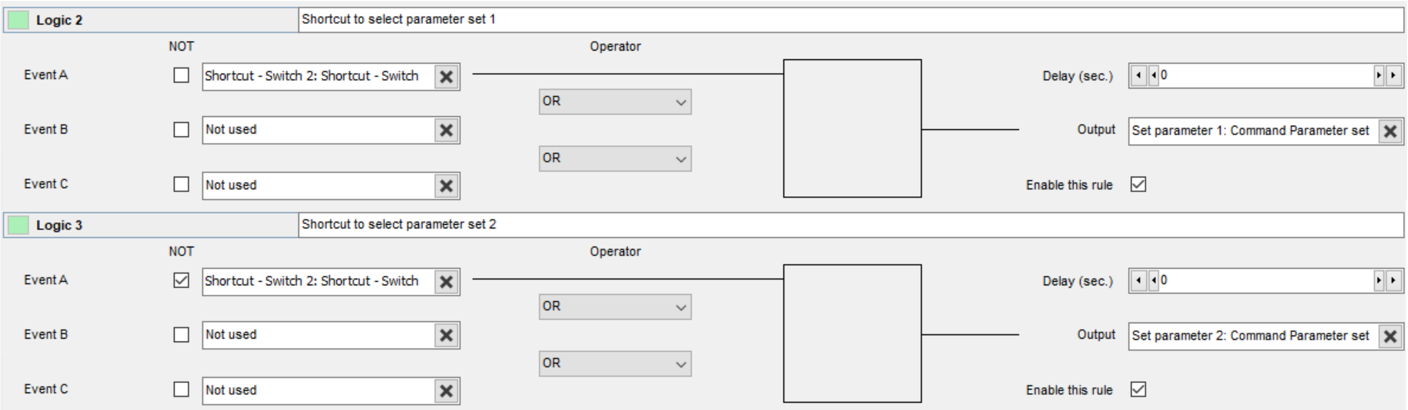
Use the *Translations* interface to rename the shortcut.

Example of shortcut pulse



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

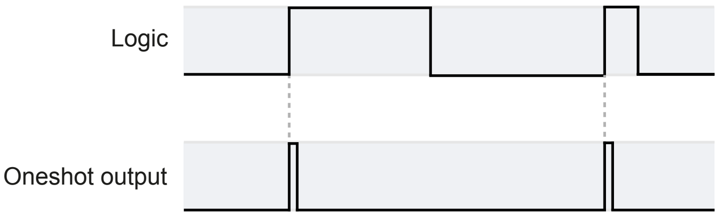
Example of shortcut switch



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

8.7.2 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.



Oneshots

Description	Notes
Oneshot output [1-16]	The event is active when the oneshot output is activated.

8.8 Timers and counters

8.8.1 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. In AUTO mode, this function is available in island operation, load take-over, mains power export, and fixed power operation.

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

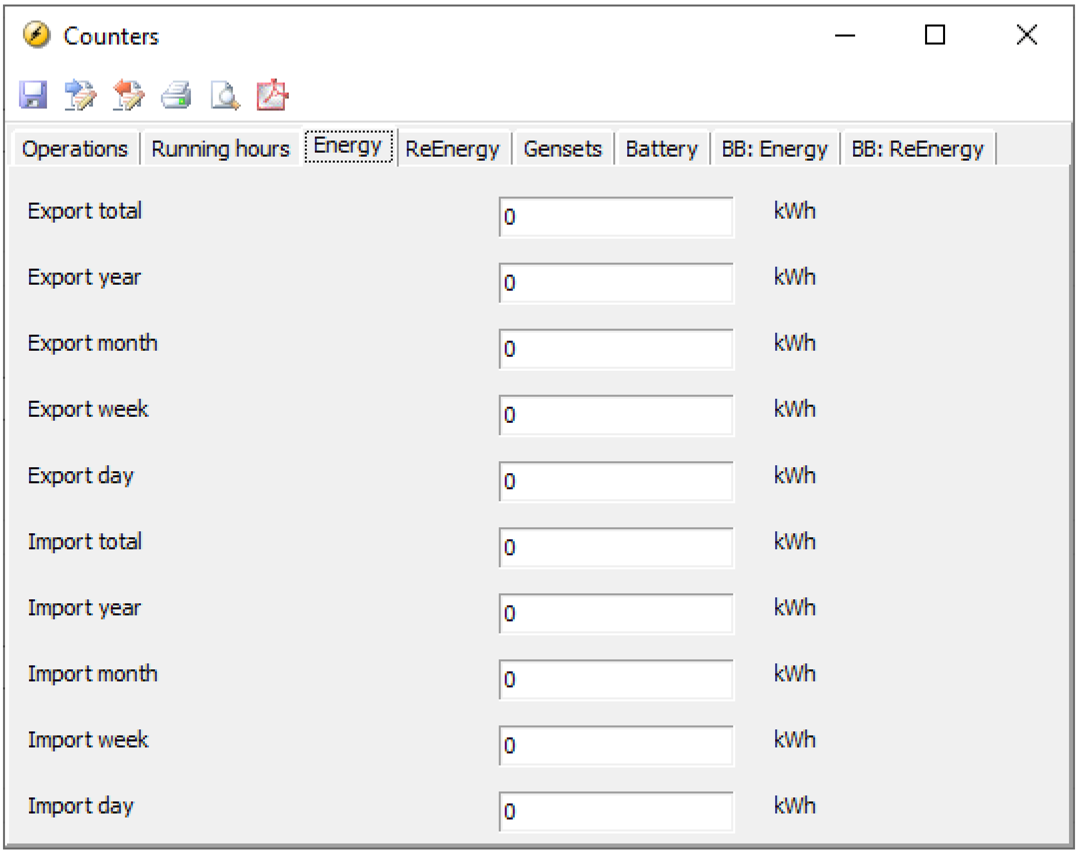
- Individual days (MO, TU, WE, TH, FR, SA, SU)
- MO, TU, WE, TH
- MO, TU, WE, TH, FR
- MO, TU, WE, TH, FR, SA, SU
- SA, SU

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.

8.8.2 USW counters

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

ASC counters example



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

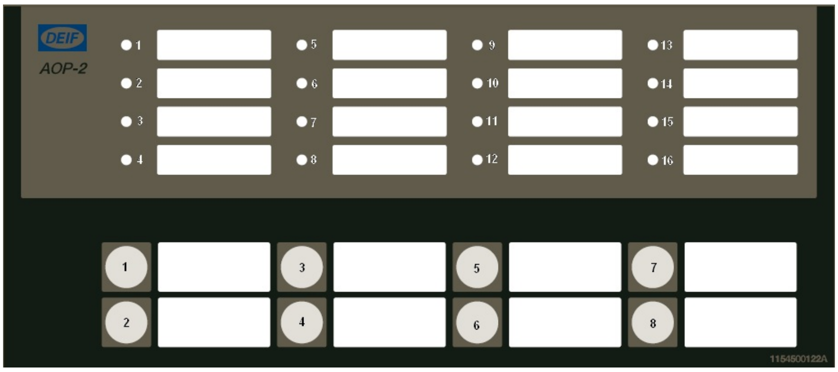
Counters	Details
Operations	Breaker operations
Running hours	ESS running hours

Counters	Details
Energy	Energy to/from the ESS
ReEnergy	Reactive energy to/from the ESS
Gensets	Energy from the gensets
Battery	Counters for each state of charge threshold
BB: Energy	Energy to/from the mains
BB: ReEnergy	Reactive energy to/from the mains

8.9 Interfaces

8.9.1 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.

8.9.2 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.

NOTE The *Stop* button is not active in MANUAL mode when the access lock is activated. For safety reasons, an emergency stop switch is recommended.

8.9.3 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 10]	English

8.10 RRCR external set point control

The grid can use a Radio Ripple Control Receiver (RRCR) for load management. The ASC can use the RRCR signals for power and reactive power regulation.

You can use four binary inputs (from an external RRCR) to configure 16 signal combinations. Each of the 16 signal combinations can used for a set point for *Power*, and a set point for *Reactive Power* or *cos phi*.

You can also make combined set points, for example, *Power* and *Reactive Power*, using the same inputs.

You can use four relay outputs to configure 16 signal combinations for communication with the inverters. These outputs can only be used to represent the *Power* set point.

More information
See **RRCR configuration** in the **AGC-4 Mk II Designer's handbook** for how to use the utility software to configure RRCR.

9. AC protections

9.1 About protections

9.1.1 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.

9.1.2 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.

`AC configuration and protections > Voltage protections > Voltage detect. type`

Parameter	Text	Range	Default
1201	ES U detection type	Ph-Ph Ph-N	Ph-Ph

`Busbar > Voltage protections > Voltage detect. type`

Parameter	Text	Range	Default
1202	BB U detection type	Ph-Ph Ph-N	Ph-Ph

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.

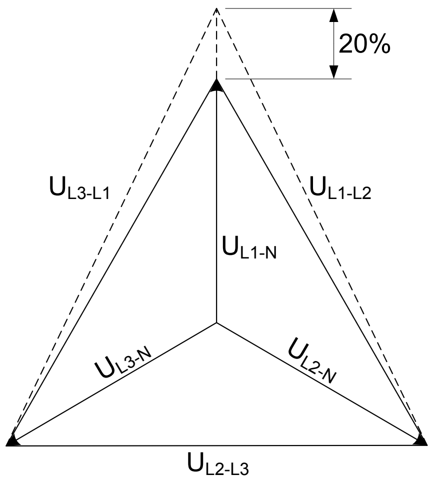
Example: Actual measurements at a 10 % under-voltage situation in a 400/230 volt system

	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 %

9.1.3 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.

`AC configuration and protections > AC configuration > Phase sequence error ES`

Parameter	Text	Range	Default
2153	Fail class	Fail classes	Warning

`AC configuration and protections > AC configuration > Phase rotation`

Parameter	Text	Range	Default
2154	Set point	L1L2L3 L1L3L2	L1L2L3

`Busbar > AC configuration > Phase sequence error BB`

Parameter	Text	Range	Default
2156	Fail class	Fail classes	Warning

9.1.4 4th current transformer input

The 4th current transformer input (terminals 60-61) can be used for one of these functions:

- **Mains power measurement**: Place the CT on L1 of the mains connection.
- **Neutral line over-current protections**: Place the CT on the N line from the genset.

- **Earth current (ground fault) protections**: Place the CT on the ESS star point ground connection. The function includes third harmonics filtering of the signal.

Basic settings > Measurement setup > Current transformer > 4th CT

Parameter	Text	Range	Default
6045	E/N/M I primary	5 to 9000 A	1000 A
6046	E/N/M I secondary	1 A 5 A	1 A

4th CT input selection

Select what the 4th current transformer input is used for.

Basic settings > Measurement setup > 4th CT protection > 4th CT trip selector

Parameter	Text	Range	Default
14201	4th CT trip select	OFF Mains/BB current Neutral current Earth fault current	OFF

9.2 ESS protections

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.

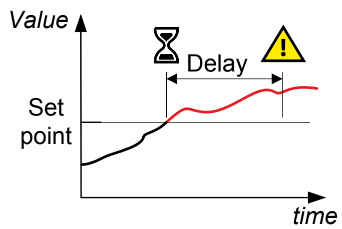
Protection	IEC symbol (IEC 60617)	ANSI (IEEE C37.2)	Operate time	Alarms
Over-voltage	U>, U>>	59	< 200 ms	2
Under-voltage	U<, U<<	27	< 200 ms	3
Voltage unbalance	UUB>	47	< 200 ms*	1
Negative sequence voltage		47	< 200 ms*	1
Zero sequence voltage		59Uo	< 200 ms*	1
Over-current	3I>, 3I>>	50TD	< 100 ms	4
Fast over-current (short circuit)	3I>>>	50/50TD	< 50 ms	2
Unbalance current	IUB>	46	< 200 ms*	2
Directional over-current		67	< 100 ms	2
Inverse time over-current	It>	51	-	1
Neutral inverse time over-current		51N	-	1
Earth fault inverse time-over current		51G	-	1
Negative sequence current		46	< 200 ms*	1
Zero sequence current		51Io	< 200 ms*	1
Over-frequency	f>, f>>	81O	< 200 ms	3
Under-frequency	f<, f<<	81U	< 200 ms	3
Overload	P>, P>>	32	< 200 ms	5
Reverse power	P<, P<<	32R	< 200 ms	2
Reactive power export (Over-excitation)	Q>, Q>>	40O	< 200 ms	1
Reactive power import/loss of excitation (under-excitation)	Q<, Q<<	40U	< 200 ms	1

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

9.2.1 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.



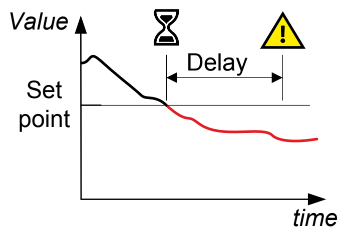
`AC configuration and protections > Voltage protections > Over-voltage > ES U> [1 or 2]`

Parameter	Text	Range	ES U> 1	ES U> 2
1151 or 1161	Set point	100 to 130 %	103 %	105 %
1152 or 1162	Timer	0.1 to 100 s	10 s	5 s
1155 or 1165	Enable	OFF ON	OFF	OFF
1156 or 1166	Fail class	Fail classes	Warning	Warning

9.2.2 Under-voltage (ANSI 27)

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



`AC configuration and protections > Voltage protections > Under-voltage > ES U< [1 to 3]`

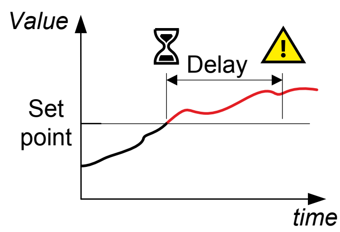
Parameter	Text	Range	ES U< 1	ES U< 2	ES U< 3
1171, 1181 or 1191	Set point	40 to 100 %	97 %	95 %	95 %
1172, 1182 or 1192	Timer	0.1 to 100 s	10 s	5 s	5 s
1175, 1185 or 1195	Enable	OFF ON	OFF	OFF	OFF
1176, 1186 or 1196	Fail class	Fail classes	Warning	Warning	Warning

9.2.3 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.

AC configuration and parameters > Voltage protections > Voltage unbalance > ES Unbalance U

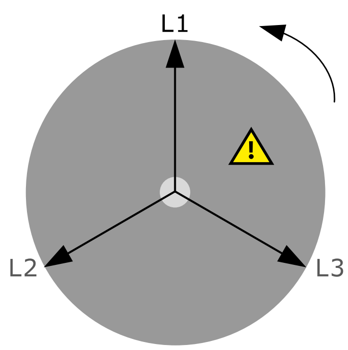
Parameter	Text	Range	Default
1511	Set point	0 to 50 %	10 %
1512	Timer	0.1 to 100 s	10 s
1515	Enable	OFF ON	OFF
1516	Fail class	Fail classes	Trip ESB

9.2.4 Negative sequence voltage (ANSI 47)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Negative sequence voltage		47	< 200 ms*

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

Negative sequence voltages arise when the virtual representation of the phase rotation for an unbalanced system appears negative.



Negative sequence voltages can occur where there are single phase loads, unbalanced line short circuits and open conductors, and/or unbalanced phase-to-phase or phase-to-neutral loads.

The alarm response is based on the estimated phase-to-neutral voltage phasors, as measured from the source.

AC configuration and protections > Voltage protections > Negative seq. voltage > ES neg. seq. U

Parameter	Text	Range	Default
1551	Set point	1 to 100 %	5 %
1552	Timer	0.2 to 100 s	0.5 s
1555	Enable	OFF	OFF

Parameter	Text	Range	Default
		ON	
1556	Fail class	Fail classes	Trip MB

AC configuration and protections > Voltage protections > Negative seq. voltage > Neg. seq select

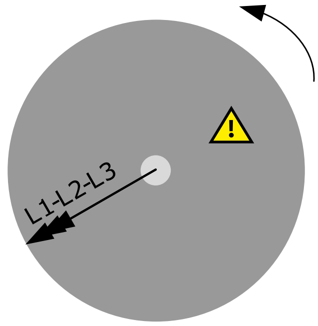
Parameter	Text	Range	Default
1561	Set point	ESS measurement BB measurement	ESS measurement

9.2.5 Zero sequence voltage (ANSI 59Uo)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Zero sequence voltage		59Uo	< 200 ms*

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

Zero sequence voltages arise when the phases rotation is positive, but the vector zero value (star point) is displaced. This zero sequence voltage protection can be used instead of using zero voltage measurement or summation transformers (zero sequence transformers).



This protection is used for detecting earth faults.

The alarm response is based on the estimated phase-to-neutral voltage phasors, as measured from the source.

AC configuration and protections > Voltage protections > Zero sequence voltage > ES zero seq. U

Parameter	Text	Range	Default
1581	Set point	0 to 100 %	5 %
1582	Timer	0.2 to 100 s	0.5 s
1585	Enable	OFF ON	OFF
1586	Fail class	Fail classes	Trip MB

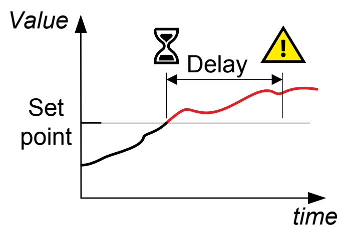
AC configuration and protections > Voltage protections > Zero sequence voltage > Zero seq select

Parameter	Text	Range	Default
1591	Type	ESS measurement BB measurement	ESS measurement

9.2.6 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.



AC configuration and protections > Current protections > Over-current > I> [1 to 4]

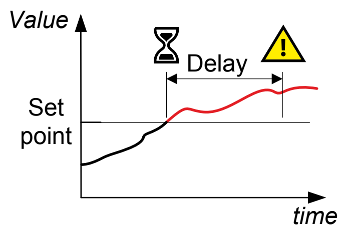
Parameter	Text	Range	I> 1	I> 2	I> 3	I> 4
1031, 1041, 1051 or 1061	Set point	50 to 200 %	115 %	120 %	115 %	120 %
1032, 1042, 1052 or 1062	Timer	0.1 to 3200 s	10 s	5 s	10 s	5 s
1035, 1045, 1055 or 1065	Enable	OFF ON	ON	ON	ON	ON
1036, 1046, 1056 or 1066	Fail class	Fail classes	Warning	Trip ESB	Trip ESB	Trip ESB

9.2.7 Fast over-current (ANSI 50/50TD)

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



AC configuration and protections > Current protections > Fast over-current > I>> [1 or 2]

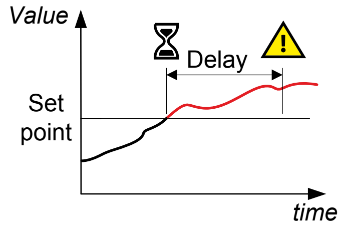
Parameter	Text	Range	I>> 1	I>> 2
1131 or 1141	Set point	150 to 300 %	150 %	200 %
1132 or 1142	Timer	0 to 3200 s	2 s	0.5 s
1135 or 1145	Enable	OFF ON	OFF	OFF
1136 or 1146	Fail class	Fail classes	Trip ESB	Trip ESB

9.2.8 Unbalance current (ANSI 46)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Unbalance current	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.



AC configuration and protections > Current protections > Unbalance current > Unbalance I [1 or 2]

Parameter	Text	Range	Unbalance I 1	Unbalance I 2
1501 or 1711	Set point	0 to 100 %	30 %	40 %
1502 or 1712	Timer	0.1 to 100 s	10 s	10 s
1505 or 1715	Enable	OFF ON	OFF	OFF
1506 or 1716	Fail class	Fail classes	Trip ESB	Trip ESB

AC configuration and protections > Current protections > Unbalance current > Type

Parameter	Text	Range	Default
1203	Type	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 an ESS 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 an ESS 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 %.

9.2.9 Voltage-dependent over-current (ANSI 51V)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Voltage-dependent over-current	Iv>	51V	-

This protection is activated 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 ESS, 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.

`AC configuration and protections > Current protections > Voltage dependent over-current`

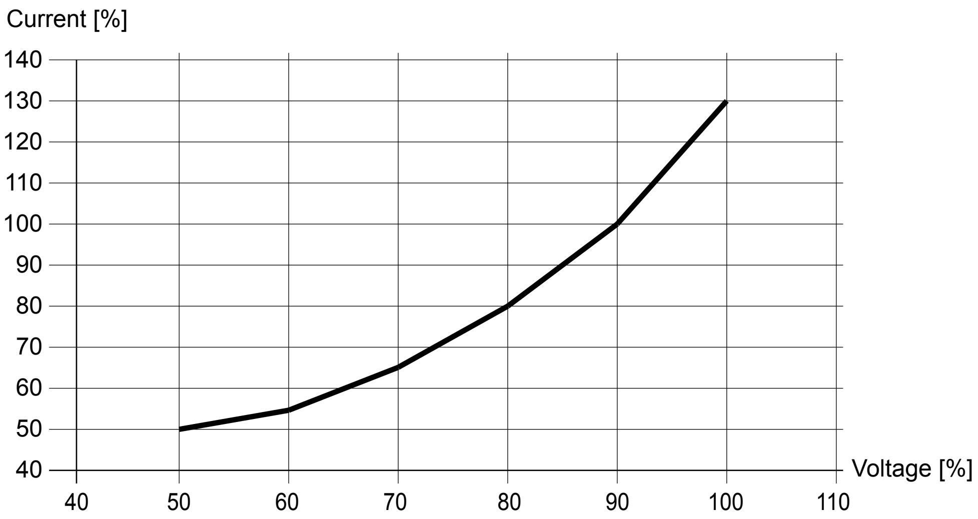
Parameter	Text	Range	Default
1101	ES Iv> (50 %)	50 to 200 %	110 %
1102	ES Iv> (60 %)	50 to 200 %	125 %
1103	ES Iv> (70 %)	50 to 200 %	140 %
1104	ES Iv> (80 %)	50 to 200 %	155 %
1105	ES Iv> (90 %)	50 to 200 %	170 %
1106	ES Iv> (100 %)	50 to 200 %	200 %
1110	Fail class	Fail classes	Trip ESB

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:

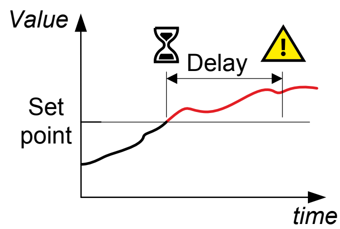


When the operating values are above the curve, the breaker is tripped. The ESB also trips when the ESS voltage is below 50 % of rated, and the current is above 50 % of rated.

9.2.10 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.



`AC configuration and protections > Current protections > Directional over-current > I>direct. [1 or 2]`

Parameter	Text	Range	I> direct. 1	I> direct. 2
1601 or 1611	Set point	-200 to 200 %	120 %	130 %
1602 or 1612	Timer	0 to 3200 s	0.1 s	0.1 s
1605 or 1615	Enable	OFF ON	OFF	OFF
1606 or 1616	Fail class	Fail classes	Trip MB	Trip MB

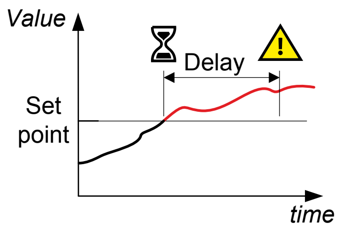
NOTE For a positive set point, the alarm trigger level is *High*. When a negative set point is written to the controller, then the controller automatically changes the alarm trigger level to *Low*.

9.2.11 Neutral over-current (4th CT)

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

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.



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

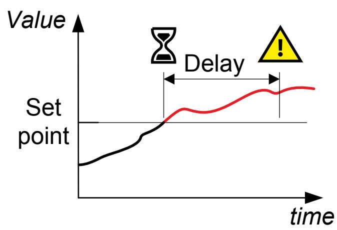
Parameter	Text	Range	In> 1	In> 2
14210 or 14220	Enable	OFF ON	OFF	OFF
14211 or 14221	Set point	2 to 120 %	30 %	30 %
14212 or 14222	Timer	0.1 to 3200 s	10 s	10 s
14213 or 14223	Fail class	Fail classes	Warning	Warning

9.2.12 Earth fault over-current (4th CT)

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

This is the over-current alarm for the earth 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).



AC configuration and protections > Current protections > Earth fault over-current (4th CT) > 4th CT Ie> [1 or 2]

Parameter	Text	Range	Ie> 1	Ie> 2
14230 or 14240	Enable	OFF ON	OFF	OFF
14231 or 14241	Set point	2 to 120 %	10 %	10 %
14232 or 14242	Timer	0.1 to 3200 s	10 s	10 s
14233 or 14243	Fail class	Fail classes	Warning	Warning

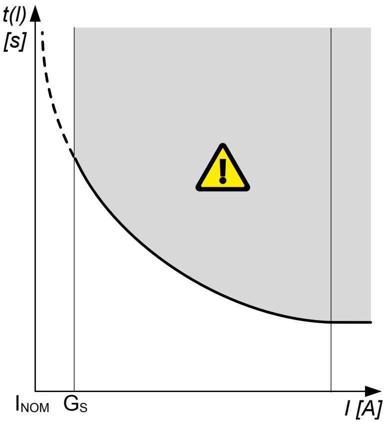
9.2.13 Inverse time over-current (ANSI 51)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Inverse time over-current	It>	51	-

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

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 (dotted curve on the diagram). See the description below for more details.

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



Inverse time over-current calculation method

The controller uses this equation from IEC 60255-151 to calculate the time that the current measurement may be over the set point before the inverse time over-current alarm is activated:

$$t(G) = TMS\left(\frac{k}{\left(\frac{G}{G_s}\right)^{\alpha} - 1} + c\right)$$

where:

- t(G) = Theoretical operating time value at G, in seconds
- k, c and α = Constants for the selected curve (*k* and *c* in seconds, *α* (alpha) has no unit)
- G = Measured value, that is, I_{phase}
- G_S = Alarm set point ($G_S = I_{nom} \bullet Limit / 100\ \%$)
- TMS = Time multiplier setting

AC configuration and protections > Current protections > Inverse time over-current

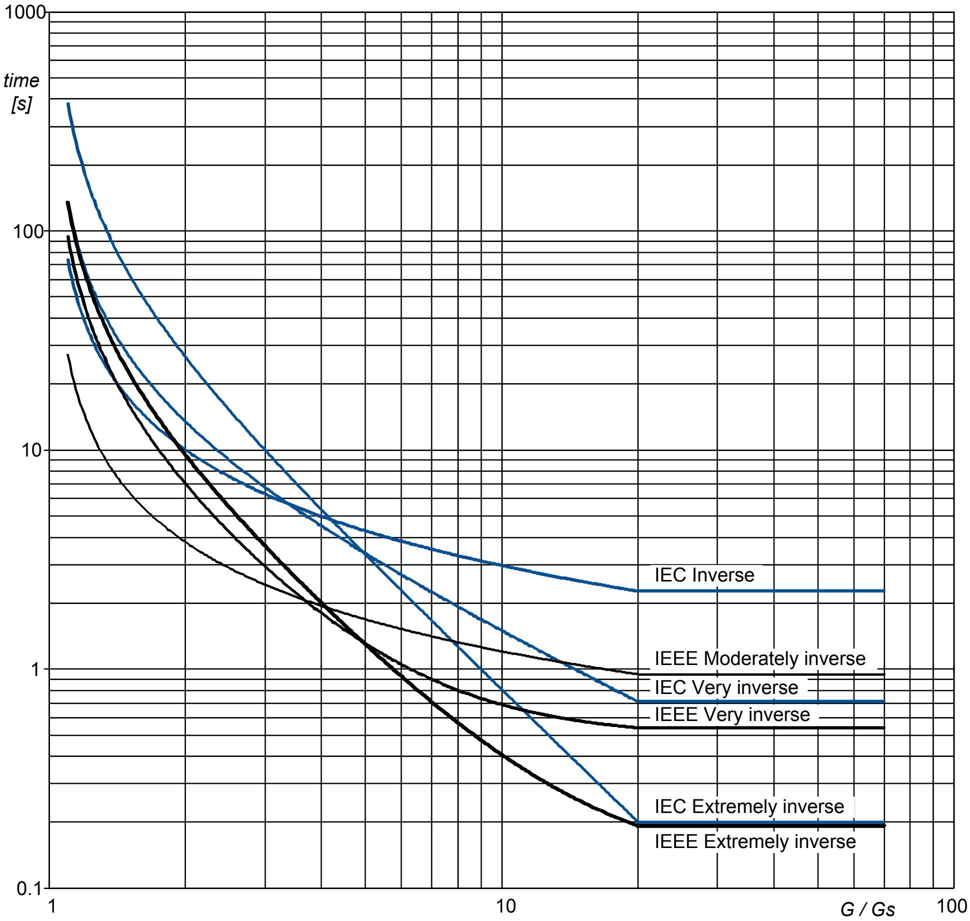
Parameter	Text	Range	Default
1081	I> inverse type	IEC Inverse IEC Very Inverse IEC Extremely inverse IEEE Moderately Inv. IEEE Very Inverse IEEE Extremely Inv. Custom	IEC Inverse
1082	I> inverse Limit	50 to 200 %	110 %
1083	I> inverse TMS	0.01 to 100.00	1.00
1084	I> inverse k	0.001 to 32.000 s	0.140 s
1085	I> inverse c	0.000 to 32.000 s	0.000 s
1086	I> inverse a	0.001 to 32.000 s	0.020 s
1088	Enable	OFF ON	ON
1089	Fail class	Fail classes	Trip ESB

Standard inverse time over-current curves

The controller includes these standard inverse time over-current curves, in accordance with IEC 60255-151.

Curve name	k	c	alpha (α, or a)
IEC inverse	0.14 s	0 s	0.02
IEC very inverse	13.5 s	0 s	1
IEC extremely inverse	80 s	0 s	2
IEEE moderately inverse	0.0515 s	0.114 s	0.02
IEEE very inverse	19.61 s	0.491 s	2
IEEE extremely inverse	28.2 s	0.1217 s	2

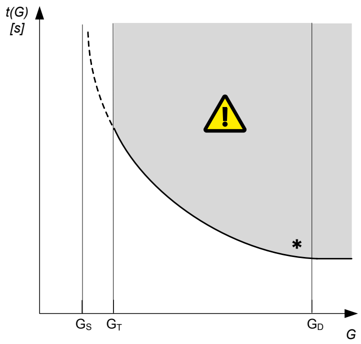
Standard curve shapes for inverse time over-current, with time multiplier setting (TMS) = 1



Definite time characteristic

G_D is the point where the alarm shifts from an inverse curve to a definite time characteristic, as the following graph shows. That is, after this point, the curve is flat, and a current increase does not have any effect on the alarm response time. In IEC60255, this point is defined as $G_D = 20 \times G_S$.

Inverse time over-current time characteristic graph



Influence of the CT primary current rating on G_D example

A current transformer has a primary rating of 500 A and a secondary rating of 5 A. The nominal current of the system is 350 A, and the three-phase inverse time over-current alarm *Limit* is 100 %.

G_D of the inverse time over-current characteristic graph according to IEC60255 is 7000 A.

- $G_D = 20 \times G_S = 20 \times (I_{nom} \times (Limit / 100)) = 20 \times (350 \times (1 / 1)) = 7000$ A

However, the highest G_D value where measurements can be made is 1500 A.

- Because the secondary current rating is 5 A, the formula to calculate the measurable G_D is $G_D = 3 \times I_{CT\ primary}$.
- $G_D = 3 \times I_{CT\ primary} = 3 \times 500 = 1500$ A

NOTE If the performance of the inverse time over-current protection is important, use a current transformer that is rated for a 1 A secondary current (that is, -/1 A).

9.2.14 Neutral inverse time over-current (ANSI 51N)

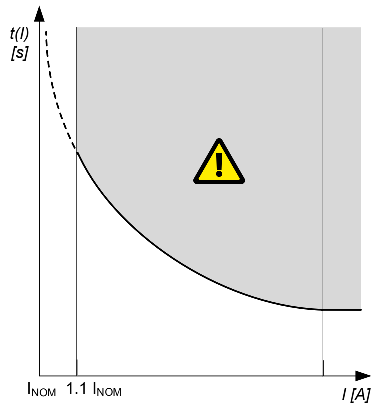
Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Neutral inverse time over-current		51N	-

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.



AC configuration and protections > Current protections > Neutral inverse time over-current

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
1728	Enable	OFF ON	OFF
1729	Fail class	Fail classes	Trip ESB

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

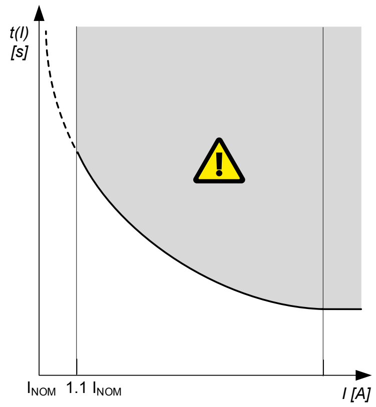
9.2.15 Earth fault inverse time over-current (ANSI 51G)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Earth fault inverse time over-current		51G	-

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.



`AC configuration and protections > Current protections > Earth fault inverse time over-current`

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
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
1738	Enable	OFF ON	OFF
1739	Fail class	Fail classes	Trip ESB

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

9.2.16 Negative sequence current (ANSI 46)

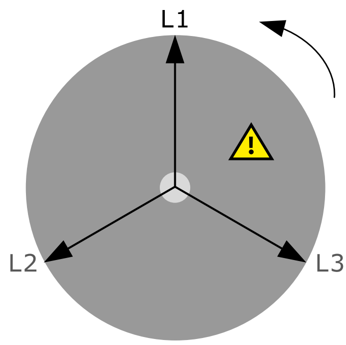
Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Negative sequence current		46	< 200 ms*

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

Negative sequence currents arise when the virtual representation of the phase rotation for an unbalanced system appears negative.

Negative sequence currents can occur where there are single phase loads, unbalanced line short circuits and open conductors, and/or unbalanced phase-phase or phase-neutral loads.

The alarm response is based on the estimated phase-to-neutral current phasors, from the source, as measured by the controller.



AC configuration and protections > Current protections > Negative sequence current > Negative. seq. I.

Parameter	Text	Range	Default
1541	Set point	1 to 100 %	20 %
1542	Timer	0.2 to 100 s	0.5 s
1545	Enable	OFF ON	OFF
1546	Fail class	Fail classes	Trip MB

9.2.17 Zero sequence current (ANSI 51Io)

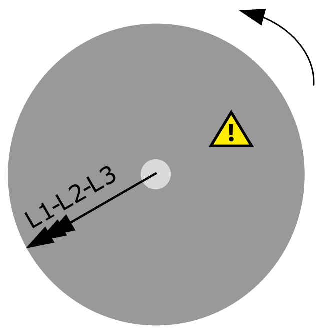
Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Zero sequence current		51Io	< 200 ms*

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

Zero sequence currents arise when the phases rotation is positive, but the vector zero value is displaced.

This protection is used for detecting earth faults.

The alarm response is based on the estimated current phasors from the source, as measured by the controller.



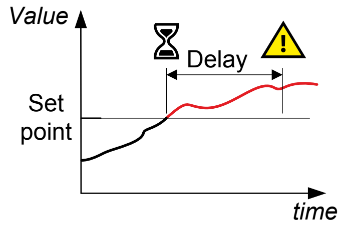
AC configuration and protections > Current protections > Zero sequence current > Zero seq. I

Parameter	Text	Range	Default
1571	Set point	0 to 100 %	20 %
1572	Timer	0.2 to 100 s	0.5 s
1575	Enable	OFF ON	OFF
1576	Fail class	Fail classes	Trip MB

9.2.18 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.



AC configuration and protections > Frequency protections > Over-frequency > ES f> [1 to 3]

Parameter	Text	Range	ES f> 1	ES f> 2	ES f> 3
1211, 1221 or 1231	Set point	100 to 120 %	103 %	105 %	105 %
1212, 1222 or 1232	Timer	0.2 to 100 s	10 s	5 s	5 s
1215, 1225 or 1235	Enable	OFF ON	OFF	OFF	OFF
1216, 1226 or 1236	Fail class	Fail classes	Warning	Warning	Warning

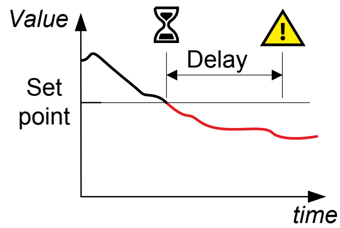
AC configuration and protections > Frequency protections > Frequency detection type

Parameter	Text	Range	Default
1204	Type	L1 L2 L3 L1 or L2 or L3 L1 and L2 and L3	L1 or L2 or L3

9.2.19 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.



AC configuration and protections > Frequency protections > Under-frequency > ES f< [1 to 3]

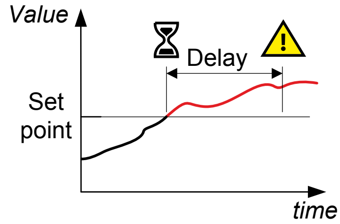
Parameter	Text	Range	ES f< 1	ES f< 2	ES f< 3
1241, 1251 or 1261	Set point	80 to 100 %	97 %	95 %	95 %
1242, 1252 or 1262	Timer	0.2 to 100 s	10 s	5 s	5 s

Parameter	Text	Range	ES f< 1	ES f< 2	ES f< 3
1245, 1255 or 1265	Enable	OFF ON	OFF	OFF	OFF
1246, 1256 or 1266	Fail class	Fail classes	Warning	Warning	Warning

9.2.20 Overload (ANSI 32)

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

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



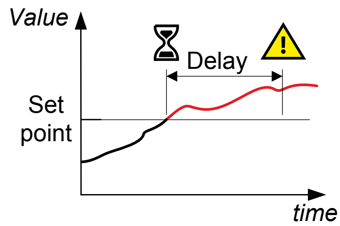
AC configuration and protections > Power protections > Overload > P> [1 to 5]

Parameter	Text	Range	P> 1	P> 2	P> 3	P> 4	P> 5
1451, 1461, 1471, 1481 or 1491	Set point	-200 to 200 %	100 %	110 %	100 %	110 %	100 %
1452, 1462, 1472, 1482 or 1492	Timer	0.1 to 3200 s	10 s	5 s	10 s	5 s	10 s
1455, 1465, 1475, 1485 or 1495	Enable	OFF ON	OFF	OFF	OFF	OFF	OFF
1456, 1466, 1476, 1486 or 1496	Fail class	Fail classes	Warning	Trip ESB	Trip ESB	Trip ESB	Trip ESB

9.2.21 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.



AC configuration and protections > Power protections > Reverse power > -P> [1 to 3]

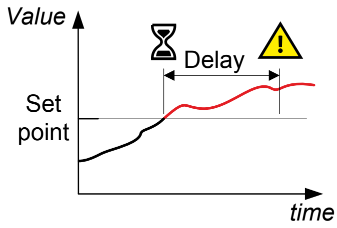
Parameter	Text	Range	-P> 1	-P> 2	-P > 3
1001, 1011 or 1071	Set point	-200 to 0 %	-5 %	-5 %	-5 %
1002, 1012 or 1072	Timer	0.1 to 100 s	10 s	10 s	10 s
1005, 1015 or 1075	Enable	OFF	ON	ON	OFF

Parameter	Text	Range	-P> 1	-P> 2	-P > 3
		ON			
1006, 1016 or 1076	Fail class	Fail classes	Trip ESB	Trip ESB	Trip ESB

9.2.22 Reactive power export (ANSI 40O)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Reactive power export (over-excitation)	Q>, Q>>	40O	< 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 ESS is feeding an inductive load.



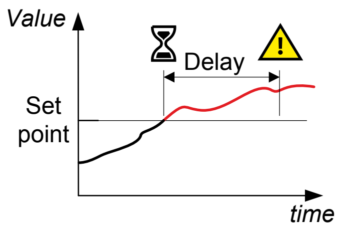
AC configuration and protections > Reactive power protect. > Overexcitation > Q>

Parameter	Text	Range	Default
1531	Set point	0 to 100 %	60 %
1532	Timer	0.1 to 100 s	10 s
1535	Enable	OFF ON	OFF
1536	Fail class	Fail classes	Warning

9.2.23 Reactive power import (ANSI 40U)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Reactive power import (loss of excitation/under-excitation)	Q<, Q<<	40U	< 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 ESS is feeding a capacitive load.



AC configuration and protections > Reactive power protect. > Underexcitation > -Q>

Parameter	Text	Range	Default
1521	Set point	0 to 150 %	50 %
1522	Timer	0.1 to 100 s	10 s
1525	Enable	OFF ON	OFF
1526	Fail class	Fail classes	Warning

9.3 Busbar standard protections

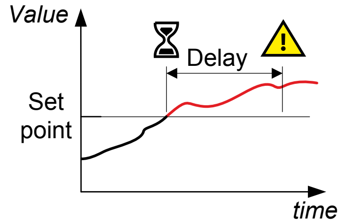
Protection	IEC symbol (IEC 60617)	ANSI (IEEE C37.2)	Operate time	Alarms
Over-voltage	U>, U>>	59	< 50 ms	3
Under-voltage	U<, U<<	27	< 50 ms	4
Voltage unbalance	UUB>	47	< 200 ms*	1
Positive sequence under-voltage	U_1<	27D	< 40 ms	1
Over-frequency	f>, f>>	81O	< 50 ms	3
Under-frequency	f<, f<<	81U	< 50 ms	4
Vector shift	dφ/dt	78	< 40 ms	1
Rate of change of frequency ROCOF (df/dt)	(df/dt)	81R	< 120 ms	1

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

9.3.1 Busbar over-voltage (ANSI 59)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Over-voltage	U>, U>>	59	< 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
1271, 1281 or 1291	Set point	100 to 120 %	103 %	105 %	105 %
1272, 1282 or 1292	Timer	0.04 to 99.99 s	10 s	5 s	5 s
1275, 1285 or 1295	Enable	OFF ON	OFF	OFF	OFF
1276, 1286 or 1296	Fail class	Fail classes	Warning	Warning	Warning

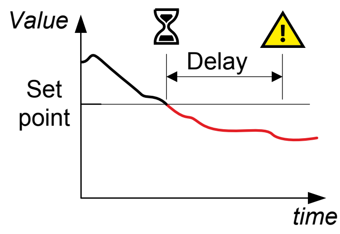
Busbar > Voltage protections > Voltage detect. type

Parameter	Text	Range	Default
1202	Type	Phase-Phase Phase-Neutral	Phase-Phase

9.3.2 Busbar under-voltage (ANSI 27)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Under-voltage	U<, U<<	27	< 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
1301, 1311, 1321 or 1331	Set point	40 to 100 %	97 %	95 %	97 %	95 %
1302, 1312, 1322 or 1332	Timer	0.04 to 99.99 s	10 s	5 s	10 s	5 s
1305, 1315, 1325 or 1335	Enable	OFF ON	OFF	OFF	OFF	OFF
1306, 1316, 1326 or 1336	Fail class	Fail classes	Warning	Warning	Warning	Warning

Busbar > Voltage protections > Voltage detect. type

Parameter	Text	Range	Default
1202	Type	Phase-Phase Phase-Neutral	Phase-Phase

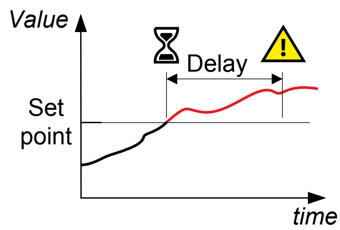
9.3.3 Busbar voltage unbalance (ANSI 47)

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
1621	Set point	0 to 50 %	6 %
1622	Timer	0.1 to 100 s	10 s
1625	Enable	OFF ON	OFF
1626	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 %

9.3.4 Positive sequence under-voltage (ANSI 27d)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Positive sequence under-voltage	U_2<	27d	< 40 ms

As a result of the generator's power production to the consumers, the positive sequence system represents the fault-free part of the voltages.

The controller measures the voltage state on the positive sequence voltage part of the voltage phasors of the busbar or mains. The alarm response is based on the lowest positive voltage value measured at the zero crossing point of each phase.

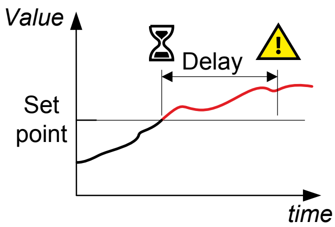
`Busbar > Voltage protections > Pos. seq. under-volt. > BB Pos seq volt`

Parameter	Text	Range	Default
1441	Set point	10 to 110 %	70 %
1442	Timer	1 to 9 Periods	2 Periods
1445	Enable	OFF ON	OFF
1446	Fail class	Fail classes	Trip MB

9.3.5 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
1351, 1361, 1371 or 1921	Set point	100 to 120 %	103 %	105 %	105 %	102 %
1352, 1362, 1372 or 1922	Timer	0.04 to 99.99 s	10 s	5 s	5 s	5600 s*
1355, 1365, 1375 or 1925	Enable	OFF	OFF	OFF	OFF	OFF

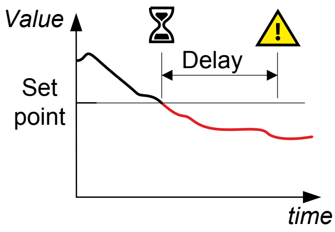
Parameter	Text	Range	BB f> 1	BB f> 2	BB f> 3	BB f> 4
		ON				
1356, 1366, 1376 or 1926	Fail class	Fail classes	Warning	Warning	Warning	Warning

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

9.3.6 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
1381, 1391, 1401, 1411 or 1931	Set point	80 to 100 %	97 %	95 %	97 %	95 %	95 %
1382, 1392, 1402, 1412 or 1932	Timer	0.04 to 99.99 s	10 s	5 s	10 s	5 s	5600 s*
1385, 1395, 1405, 1415 or 1935	Enable	OFF ON	OFF	OFF	OFF	OFF	OFF
1386, 1396, 1406, 1416 or 1936	Fail class	Fail classes	Warning	Warning	Warning	Warning	Warning

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

9.3.7 Vector shift (ANSI 78)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Vector shift	dφ/dt	78	< 40 ms

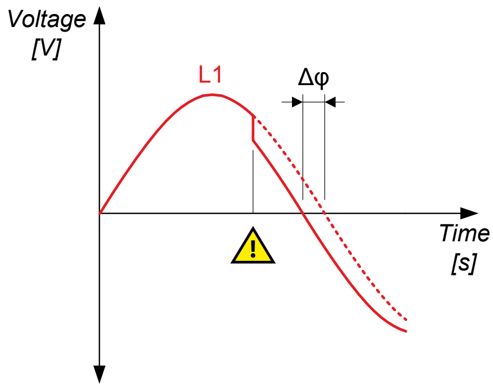
Vector shifts can arise when a mains failure occurs while a generator is running parallel with the mains.

Vector shifts can occur because the stator magnetic field lags behind the rotor magnetic field. When a mains failure occurs, the phase angle between the stator and rotor magnetic fields changes. This change in the phase angle, is also known as a vector shift.

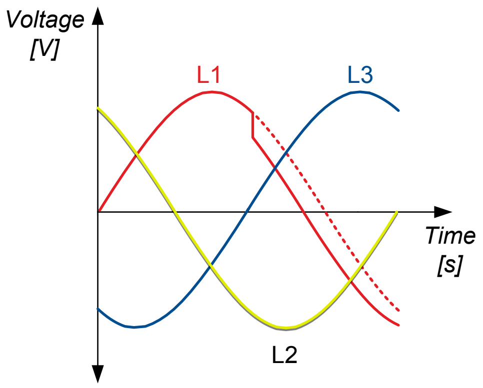
The alarm response is based on the change in the phase angle that occurred due to the mains failure. The alarm response can be based on the change in an individual phase, or on the change in all the phases.

In grids where fast automatic reconnection attempts are expected, this protection opens the breaker to prevent damaging failures. Fast changes in frequency can also activate this alarm. Too sensitive configuration can lead to too many unwanted detections of vector shift.

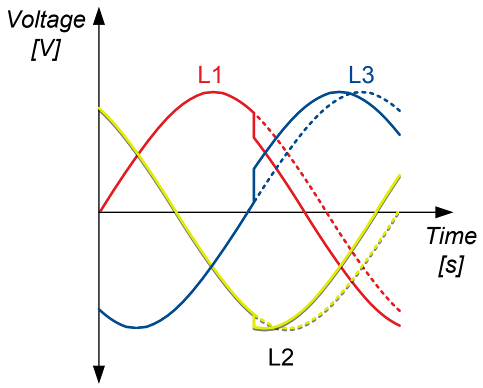
Vector shift causes the instantaneous phase angle change (Δφ)



Vector shift in phase L1 only



Vector shift in all phases



`Busbar > Additional protections > Vector shift`

Parameter	Text	Range	Default
1431	Set point	1 to 90 °	10 °
1434	Enable	OFF ON	OFF
1435	Fail class	Fail classes	Trip MB
1436	Type	Individual phases All phases	All phases

9.3.8 Rate of change of frequency (ANSI 81R)

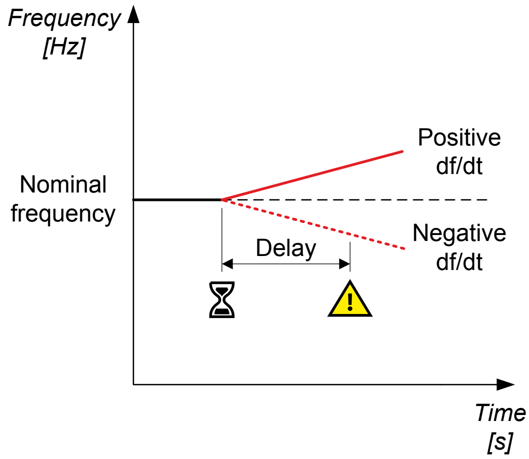
Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
ROCOF (df/dt)	df/dt	ANSI 81R	Standard: < 120 ms

When a mains failure occurs, the measured frequency might change within a short period of time, if the generators are either instantly overloaded or instantly deloaded.

If the generator overloads instantly, it slows down, and the generator frequency might decrease shortly. Similarly, if the generator deloads instantly, it speeds up, and the generator frequency might increase shortly.

The alarm response is based on the rate of change of the measured frequency, within a specified time period.

In grids where fast automatic reconnection attempts are expected, this protection opens the breaker to prevent damaging failures.



`Busbar > Additional protections > df/dt (ROCOF)`

Parameter	Text	Range	Default
1421	Set point	0.200 to 10.000 Hz/s	5.000 Hz/s
1422	Periods	3 to 20 Periods	6 Periods
1423	Timer	0.00 to 3.00 s	0.00 s
1426	Enable	OFF ON	OFF
1427	Fail class	Fail classes	Trip MB

10. General purpose PID

10.1 Introduction

The general purpose PID controllers are principally similar to the PID controllers for regulation. They consist of a proportional, an integral and a differential part, and the integral and differential parts are dependent on the proportional gain.

The general purpose PIDs are slightly less responsive. They are meant to control temperature, fans and so on. Configuration of the general purpose PIDs is documented by describing the possibilities of the general purpose PID interface, and with examples of configuration for different purposes.

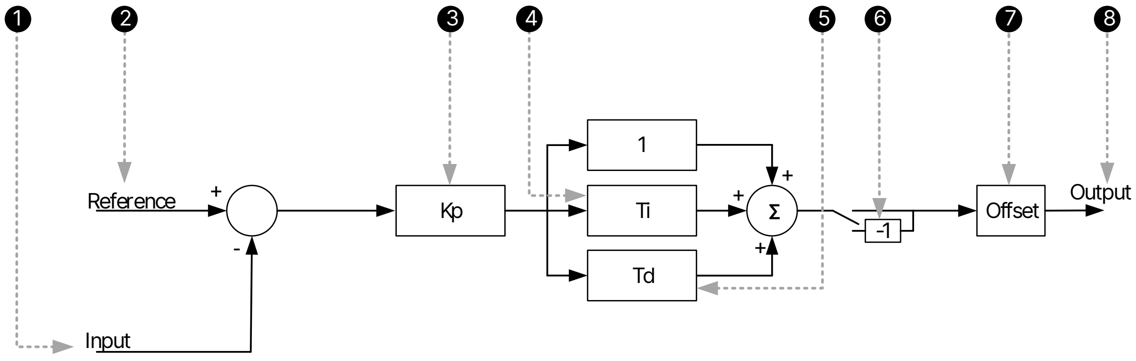
10.1.1 General purpose PID controllers in the ASC

You can use the general purpose PID controller to supplement the default ASC control. You can control several set points, including these:

- Reference 1 (power reference sent to the ESS)
- ESS actual frequency
- ESS voltage
- ESS active power
- ESS reactive power
- Busbar frequency
- Busbar voltage
- ESS frequency reference
- ESS voltage reference
- ESS active power ramped reference
- ESS reactive power ramped reference

10.1.2 General purpose PID analogue loop

The analogue regulation in the general purpose PIDs is handled by a PID loop. The diagram below shows which elements the PID loop consists of.

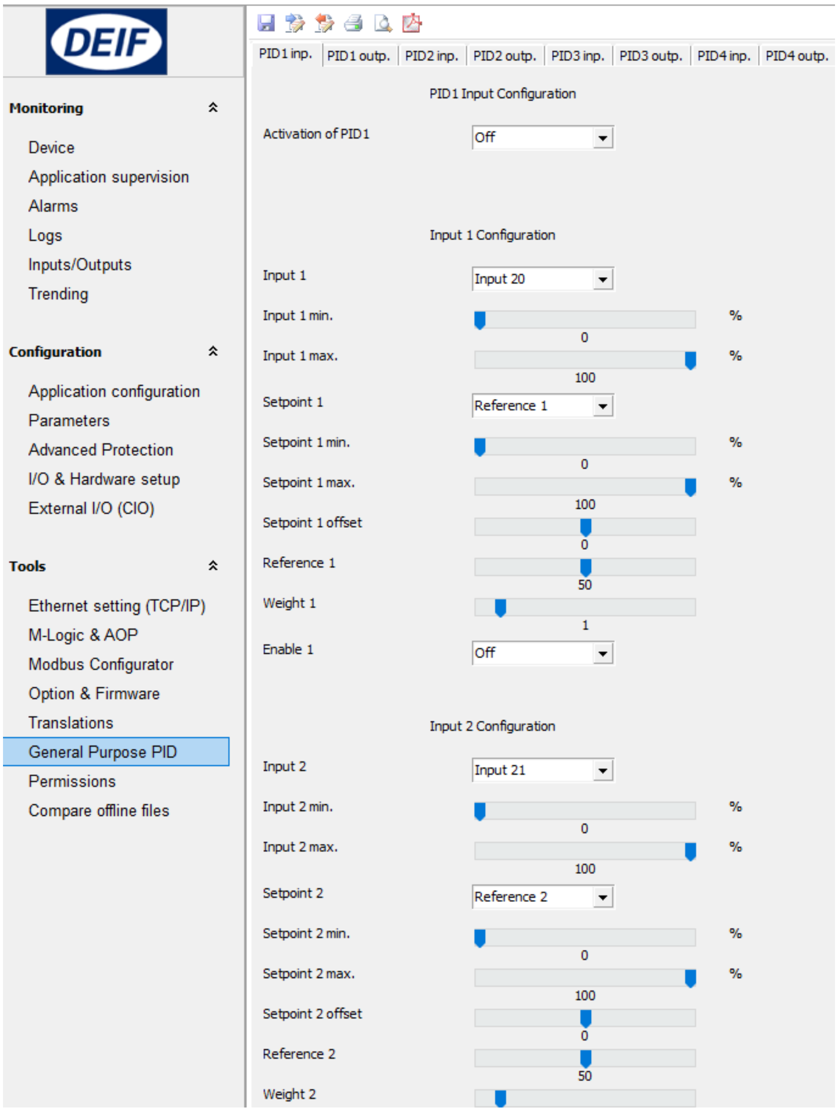


1. **Input:** This is the analogue input that measures the process the controller is trying to regulate.
2. **Reference:** This is the set point that the controller is trying to bring the input to match.
3. **Kp:** The proportional gain of the PID loop.
4. **Ti:** The integral gain of the PID loop.
5. **Td:** The derivative gain of the PID loop.
6. **Inverse:** Enabling inverse will give the output a negative sign.
7. **Offset:** The offset is added on the function and displaces the regulation range.

8. **Output:** This is the final output from the PID, controlling the transducer.

10.1.3 General purpose PID interface in the utility software

Configure the four general purpose PID's input and output settings using the PID interface in the utility software. This it cannot be done from the controller.



10.2 Inputs

Each output can have up to three inputs. Only one input at a time is used for calculation of the output signal.

Explanation of general purpose PID settings

1. **Activation**: Enable the PID, or allow it to be enabled from M-Logic.
2. **Input 1**: Select the source of this input here.
3. **Input 1 min. and Input 1 max.**: Define the scale of the input value evaluated.
4. **Setpoint 1**: Select **Reference 1** to define the set point in this box. Alternatively, select a set point source (from the same options as Input 1).
5. **Setpoint 1 min. and Setpoint 1 max.**: Define the scale of the set point value evaluated.
6. **Setpoint 1 offset**: The offset for set point 1.
7. **Reference 1**: Select the set point for this input. **Reference 1** must be selected for **Setpoint 1**.
8. **Weight 1**: The input value is multiplied by the weight factor.
   - A weight factor of 1 means that the real input value is used in calculations.
   - A weight factor of 3 means that the input value is treated as three times as big in calculations.
9. **Enable**:
   - On: This input will be evaluated.
   - Off: This input will not be evaluated.

10.2.1 Dynamic input selection

Each general purpose PID holds the possibility of up to three active inputs. All activated inputs are evaluated constantly, and the input causing the greatest or smallest output is selected. Priority of great or small output is selected in the output settings.

Example: Dynamic input selection Ventilation of a container fitted with a genset inside is a realistic example for use of the dynamic input selection. The following three variables depend on the ventilation, hence it makes sense to let them share the output.

- The container is fitted with a temperature sensor for internal container temperature. Due to lifetime of electronics inside the container, maximum maintained temperature is desired to be 30 °C. (Input 1).
- The engine air intake is located inside the container, hence turbo compressor inlet temperature depends on the air temperature in the container. Maximum maintained intake air temperature is 32 °C. (Input 2).
- The alternator is cooled by air in the container, hence the alternator winding temperature depends on the air temperature in the container. Maximum maintained winding temperature is 130 °C. (Input 3).

This is the data that is used to configure the inputs in the screenshot in the previous paragraph (Inputs). All inputs are configured with both full range of measurement (0 to 100 %) and a weight factor of 1. The common output to the ventilator speed drive is configured to prioritise maximum output as explained in the next chapter, “Output”. This configuration is meant to ensure that none of the input set points are continuously exceeded, unless maximum ventilation is reached.

A scenario of operation could be that the controller has been using input 1, and a temperature of 30 °C is maintained in the container. At a point, the air filter housing is heated by radiation from the engine, causing input 2 to rise more above 32 °C than input 1 is above 30 °C. This means that input 2 now has the greatest positive deviation. All inputs are configured with a weight factor of 1 and maximum output is prioritised, hence the greatest positive deviation results in maximum output, or, to put it in another way, input 2 is now the one selected.

The genset is running at full load with a maximum of reactive load, and the alternator windings heat up beyond the 130 °C set point due to high currents. At some point, input 3 will result in maximum output and hence be selected as the input used in output calculation. Ventilation is increased and the winding temperature may reach a steady state of 130 °C with a container room temperature of 27 °C and a compressor inlet temperature of 30 °C. As long as this is the situation, input 3 will remain the selected input, as this is the input causing the greatest output.

In case of high ambient temperatures, the ventilation might not be able to influence the temperature enough, and the temperatures start to rise above set point. The output will stay at 100 % as long as any of the inputs are continuously above their set points.

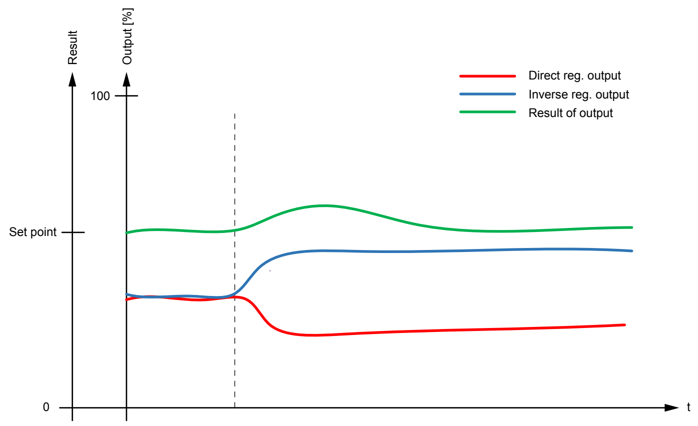
Weight factor applies to dynamic input selection as well. In the event that different weight factors have been configured for any of the three inputs, maximum deviation cannot be equated to maximum output. If two inputs with similar deviation to their respective set points are configured with weight factors of 1 and 2 respectively, the latter will result in twice the output as the first.

10.3 Outputs

10.3.1 Explanation of output settings

Explanation of general purpose PID settings

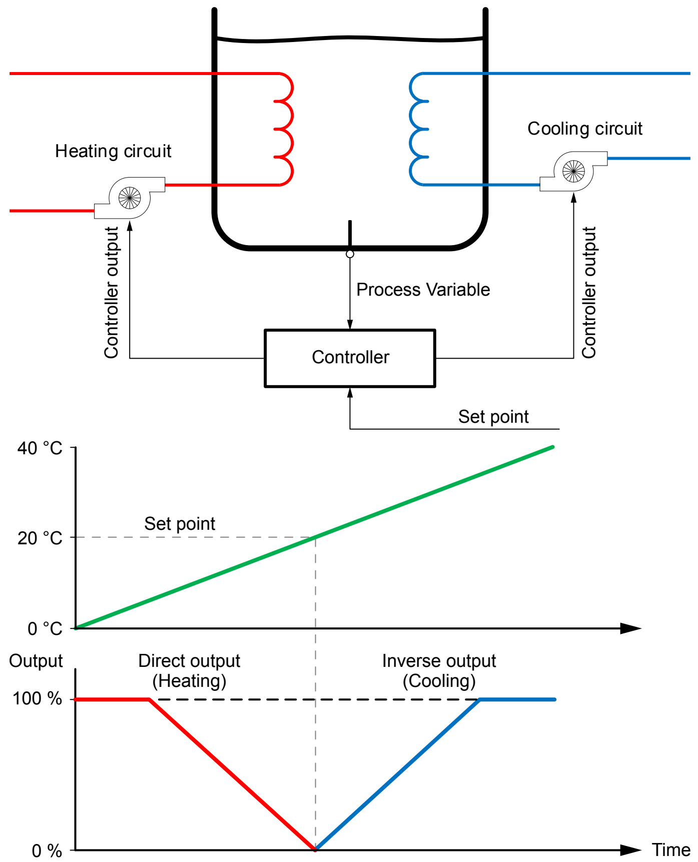
1. **Priority**: This setting determines whether the min. or max. output that is prioritised. This setting is used for the dynamic input selection feature. Maximum output results in selection of the input that gives the greatest output. Minimum output results in selection of the input that gives the smallest output.
2. **Output type**: Choose between relay or analogue output. The following parameters marked “analogue” only apply to the use of analogue regulation, in the same way as parameters marked “relay” only apply to relay regulation.
3. **Analogue Kp**: This is the proportional gain value. Increase this to give a more aggressive reaction. Adjusting this value also affects the integral and derivative output. If Kp needs adjustment without affecting the Ti or Td part, adjust these accordingly.
4. **Analogue Ti**: Increase the Ti for a less aggressive integral action.
5. **Analogue Td**: Increase the Td for a more aggressive derivative action.
6. **Analogue output**: Choose the physical internal or external output.
7. **Analogue output inverse**: Enable this to invert the output function.



Direct error = SP - PV
Direct output is used in applications where a rise in analogue output increases the process variable.

Inverse error = PV - SP
Inverse output is used in applications where a rise in analogue output decreases the process variable.

Example explaining direct and indirect regulation

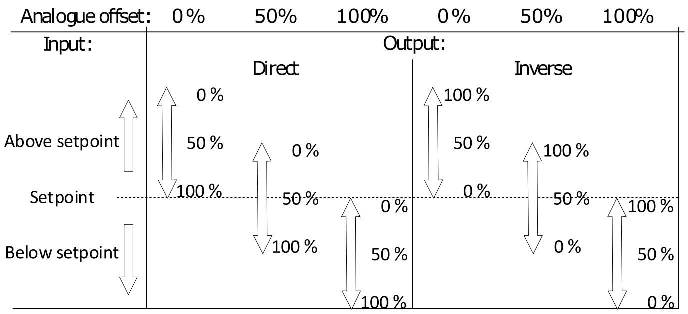


Typically, heating applications use direct output and cooling applications use inverse output. Imagine a container of water, which must be kept at a set point of 20 °C at all times. The container can be exposed to temperatures between 0 and 40 °C, hence it is fitted with both a heating coil and a cooling coil. See the diagrams that show this below.

For this application, two controllers must be configured: one with direct output for the heating pump and one with inverse output for the cooling pump. To achieve the inverse output shown, an offset of 100 % is needed. See **Analogue offset** below for more information.

Temperatures below 20 °C then result in a positive output for the heating pump, in the same way as temperatures above 20 °C result in a positive output for the cooling pump, and the temperature is maintained around the set point.

8. **Analogue offset**: Determines the output starting point. The full range of output can be seen as values in the range between 0 and 100 %. The offset displaces this range. 50 % offset centres the range of output at the set point. 0 and 100 % offset result in having the full range of output above or below the set point. See below for how the output behaves according to the input and with different offsets.



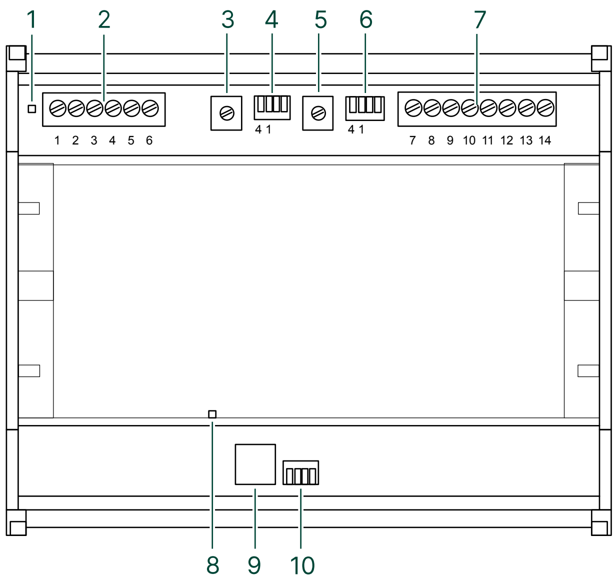
100 % offset is commonly used with inverse output, like in the previous cooling example.

9. **M-Logic min event set point**: The controller activates *Events > General Purpose PID > PID# at min output* in M-Logic.
10. **M-Logic max event set point**: The controller activates *Events > General Purpose PID > PID# at max output* in M-Logic.
11. **Relay Db**: Deadband setting for relay control.
12. **Relay Kp**: Proportional gain value for relay control.
13. **Relay Td**: Derivative output for relay control.
14. **Relay min on-time**: Minimum output time for relay control. Set this to the minimum time that is able to activate the controlled actuator.
15. **Relay period time**: Total time for a relay activation period. When the regulation output is above this period time, the relay output is constantly activated.
16. **Relay increase**: Choose the terminal for the relay used for positive activation.
17. **Relay decrease**: Choose the terminal for the relay used for negative activation.

10.3.2 Additional analogue outputs with IOM 230

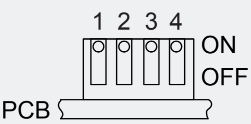
The controller includes two built-in analogue outputs. The controller also supports up to two IOM 230 analogue interface modules, which can provide four additional analogue outputs.

IOM 230 overview



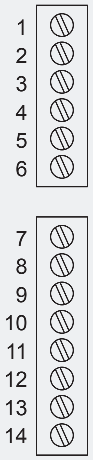
1. IOM 230 status LED (green = system OK, red = system failure)
2. Terminals 1 to 6
3. GOV adjustment
4. GOV output selector
5. AVR adjustment
6. AVR output selector
7. Terminal 7 to 14
8. CAN status LED (green = system OK, red = system failure)
9. PC port
10. IOM 230 CAN ID selector

GOV and AVR output selector settings

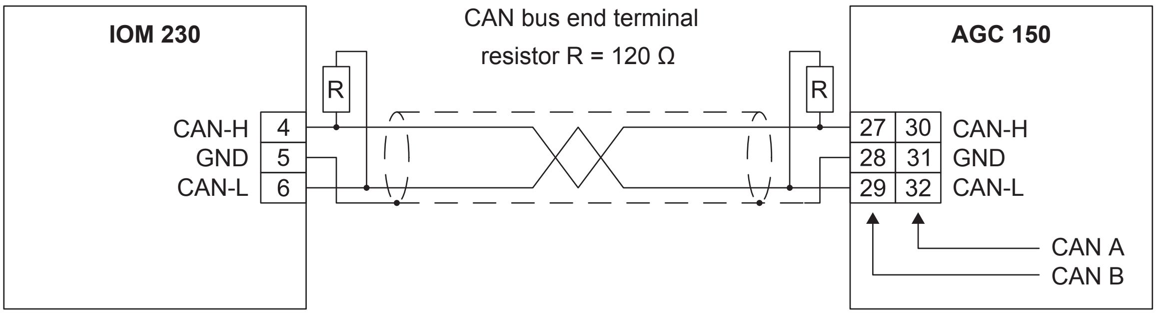
	Output	Switch 1	Switch 2	Switch 3	Switch 4
	+/-25 mA	ON	OFF	Not used	OFF
	0 to 20 mA	OFF	ON		OFF
	+/-12 V DC	ON	OFF		ON
	0 to 10 V DC	OFF	ON		ON

NOTE Switch 1 and 2 cannot have the same position.

IOM 230 Terminals

	Terminal	Description	Comment
	1	+12/24V DC	Power supply
	2	0V DC	
	3	Not used	-
	4	CAN-H	CAN bus interface
	5	CAN-GND	
	6	CAN-L	
	7	GOV out	Governor analogue interface
	8	GOV com	
	9	AVR out	AVR analogue interface
	10	AVR com	
	11	Not used	-
	12	VAr share out	Load sharing lines
	13	Common	
	14	P share out	

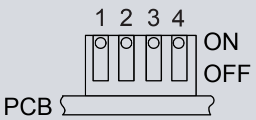
CAN bus connections



The cable shield must not be connected to ground, only to the GND terminals.

Use different CAN addresses for the different IDs. Only ID0 participate in the load share functionality.

IOM 230 CAN ID selector settings

	IOM ID	Switch 1	Switch 2	Switch 3	Switch 4
	ID0	OFF	OFF	OFF	OFF
	ID1*	ON	OFF	OFF	OFF
	ID2*	OFF	ON	OFF	OFF

All other combinations = ID0.

NOTE * ID1 is used for PID1 and PID2. ID2 is used for PID3 and PID4.

10.4 M-Logic

All functions of the general purpose PIDs can be activated and deactivated using M-Logic. In the following, events and commands regarding the general purpose PIDs are described.

Events

- **PID active**: This event is active when the related PID is activated.
- **PID at min output**: This event is active when the output is below the output parameter M-Logic min event set point.
- **PID at max output**: This event is active when the output is above the output parameter M-Logic max event set point.
- **PID using input 1**: This event is active when dynamic input selection has selected input 1 for output calculation.
- **PID using input 2**: This event is active when dynamic input selection has selected input 2 for output calculation.
- **PID using input 3**: This event is active when dynamic input selection has selected input 3 for output calculation.
- **PID Modbus control**: This event is active when remote Modbus control of this PID is requested.

Commands

- **PID activate**: This command activates the PID controller.
- **PID force min. outp.**: This command forces the output to the value set in the output parameter *M-logic min event setpoint*.
- **PID force max. outp.**: This command forces the output to the value set in the output parameter *M-logic max event setpoint* (for example, for post-cooling purposes).
- **PID reset**: This command forces the output to the value set in the output parameter Analogue offset.
- **PID Freeze**: This command freezes the output at the current value.

10.5 Using general purpose PIDs for ESS regulation

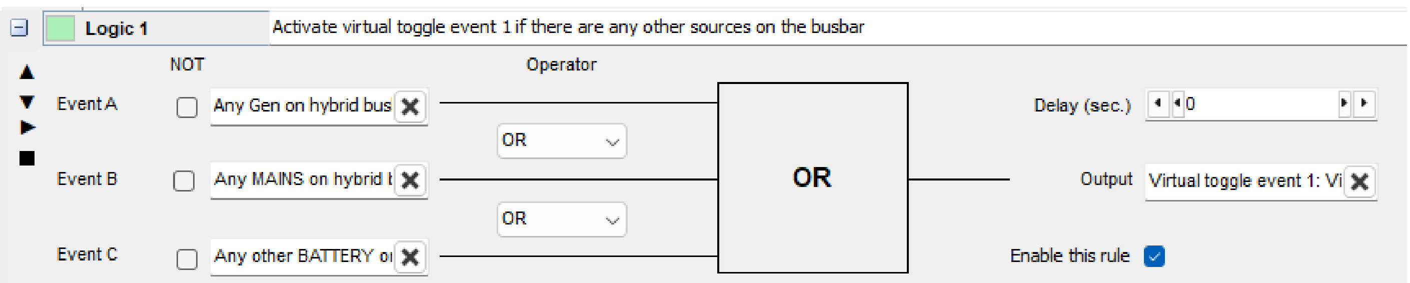
You can use the general purpose PIDs (GPPIDs) to regulate the ESS set points for voltage and frequency, or for the power and reactive power. This may be necessary if the measurements at the ESS are different from the rest of the system due to internal isolation transformers and/or long power cables. Using the GPPIDs allows the ESS response to match the actual measurements.

If the ESS is the only power source on the busbar, the ASC regulates the voltage and frequency from the ESS. If there are other power sources, the ASC must regulate the ESS power and reactive power. There are separate GPPIDs for each regulated value.

Using M-Logic to detect other power sources on the busbar

You can use M-Logic to detect the operating configuration and set a virtual toggle event. You can then use the virtual toggle event to activate and deactivate the relevant GPPID.

The following M-Logic detects whether there are any other sources on the busbar. If there are other sources on the busbar, the ASC activates a virtual toggle event.



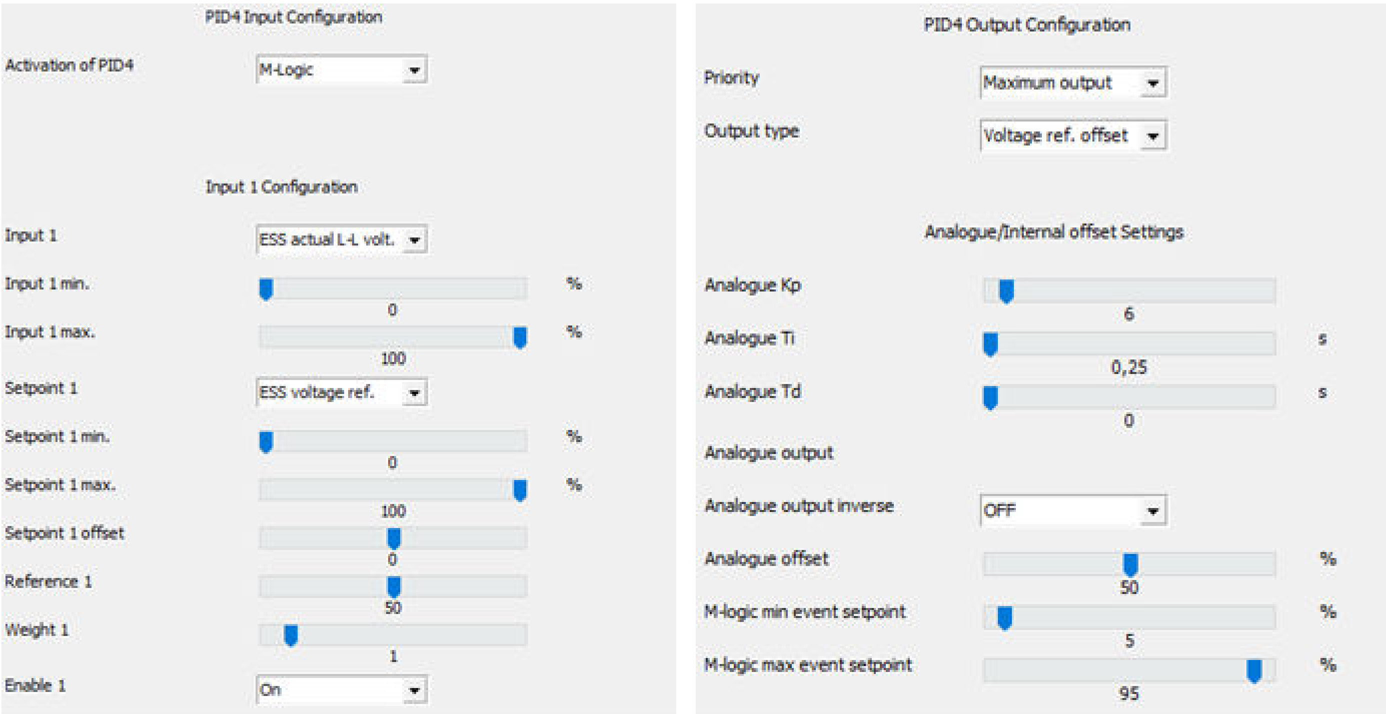
Logic 1	Operator	Category	Name
Event A	OR	Events	Any Gen on hybrid busbar
Event B	OR	Events	Any MAINS on hybrid busbar

Logic 1	Operator	Category	Name
Event C	OR	Events	Any other BATTERY on hybrid busbar
Output		Virtual toggle events	Virtual toggle event 1

10.5.1 Voltage regulation

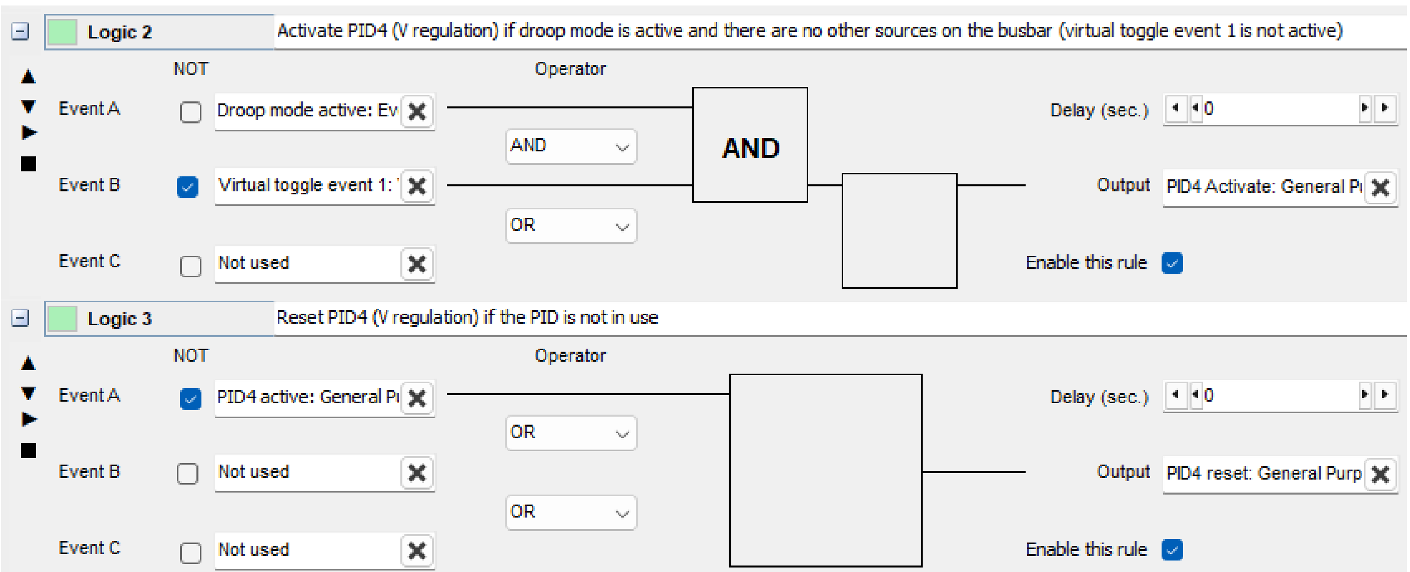
The PID can use the difference between the actual voltage from the ESS and the ESS reference voltage as inputs. The PID controller output is a voltage reference offset. This offset is added to the voltage reference that the ASC sends to the ESS.

Example of general purpose PID settings for voltage regulation



M-Logic to activate and reset PID4

You can use M-Logic to detect when to activate PID4. You can also use M-Logic to automatically reset PID4 when PID4 is not active.



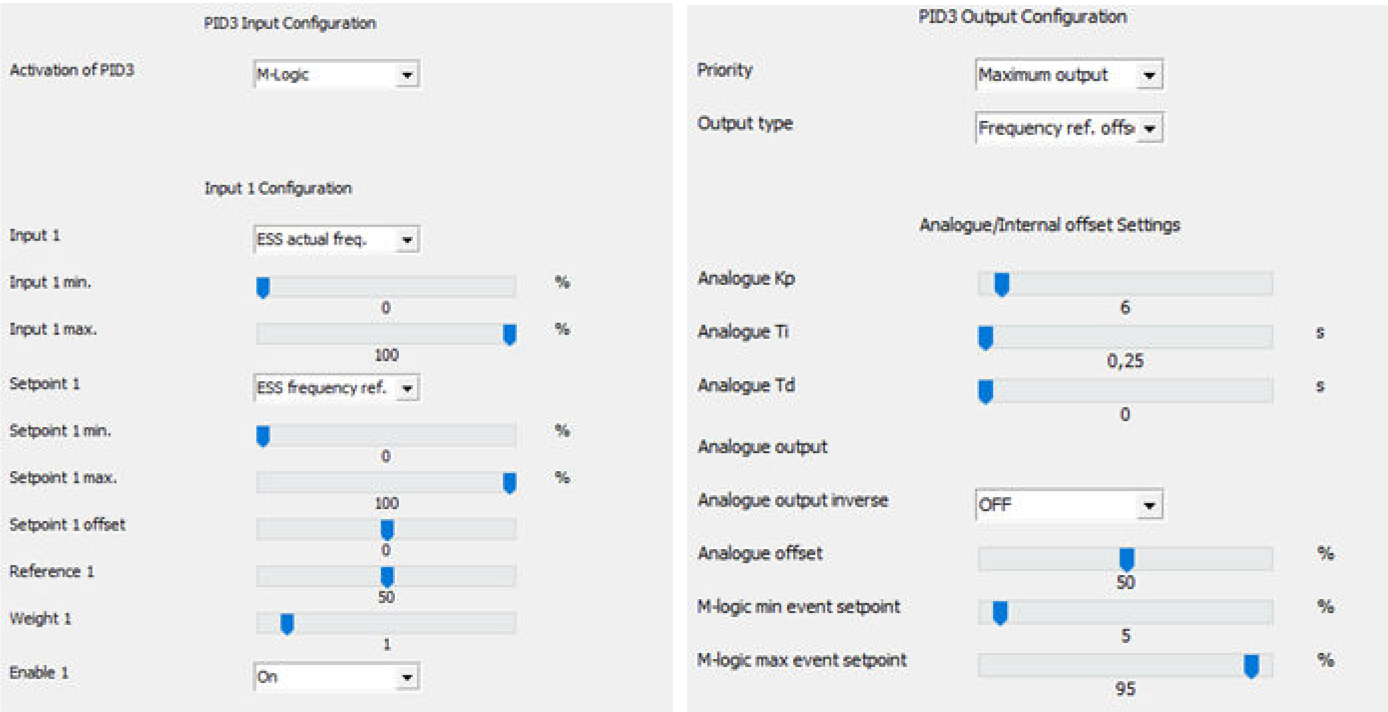
Logic 2	Operator	Category	Name
Event A	AND	Events - Battery	Droop mode active
Event B	Not, AND	Virtual toggle events	Virtual toggle event 1
Output		General Purpose PID commands	PID4 Activate

Logic 3	Operator	Category	Name
Event A	Not	General Purpose PID	PID4 Active
Output		General Purpose PID commands	PID4 reset

10.5.2 Frequency regulation

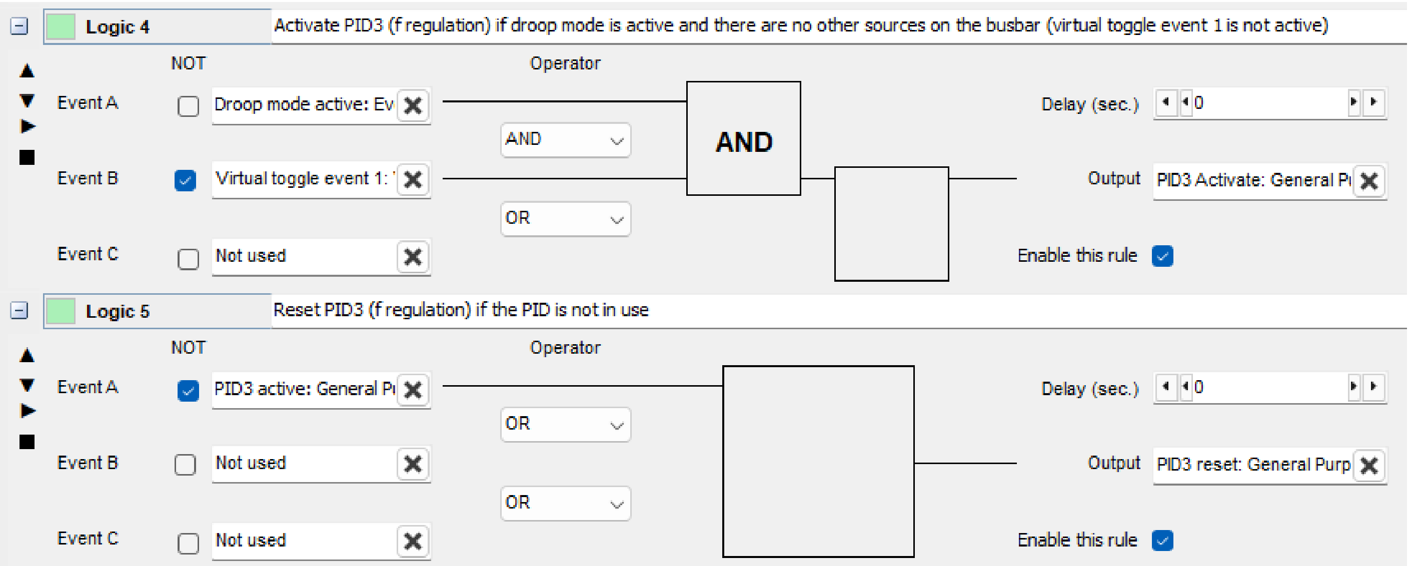
The PID can use the difference between the actual frequency from the ESS and the ESS reference frequency as inputs. The PID controller output is a frequency reference offset. This offset is added to the frequency reference that the ASC sends to the ESS.

Example of general purpose PID settings for frequency regulation



M-Logic to activate and reset PID3

You can use M-Logic to detect when to activate PID3. You can also use M-Logic to automatically reset PID3 when PID3 is not active.



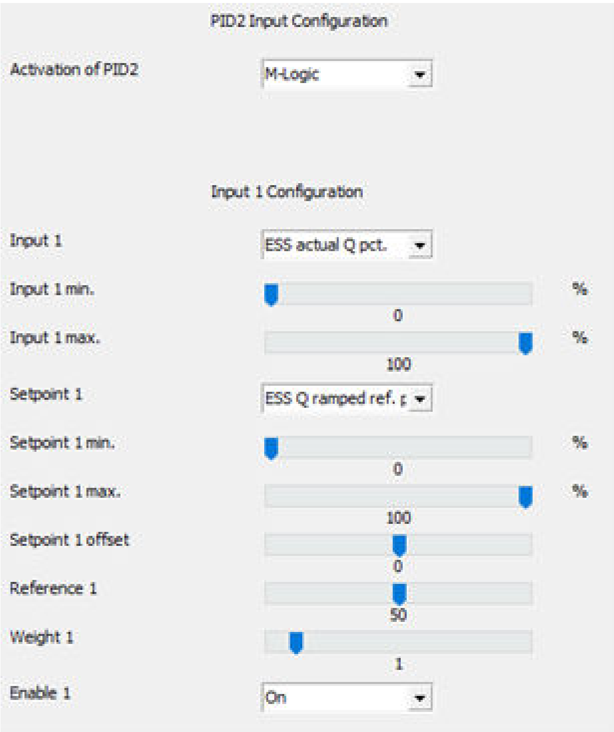
Logic 4	Operator	Category	Name
Event A	AND	Events - Battery	Droop mode active
Event B	Not, AND	Virtual toggle events	Virtual toggle event 1
Output		General Purpose PID commands	PID3 Activate

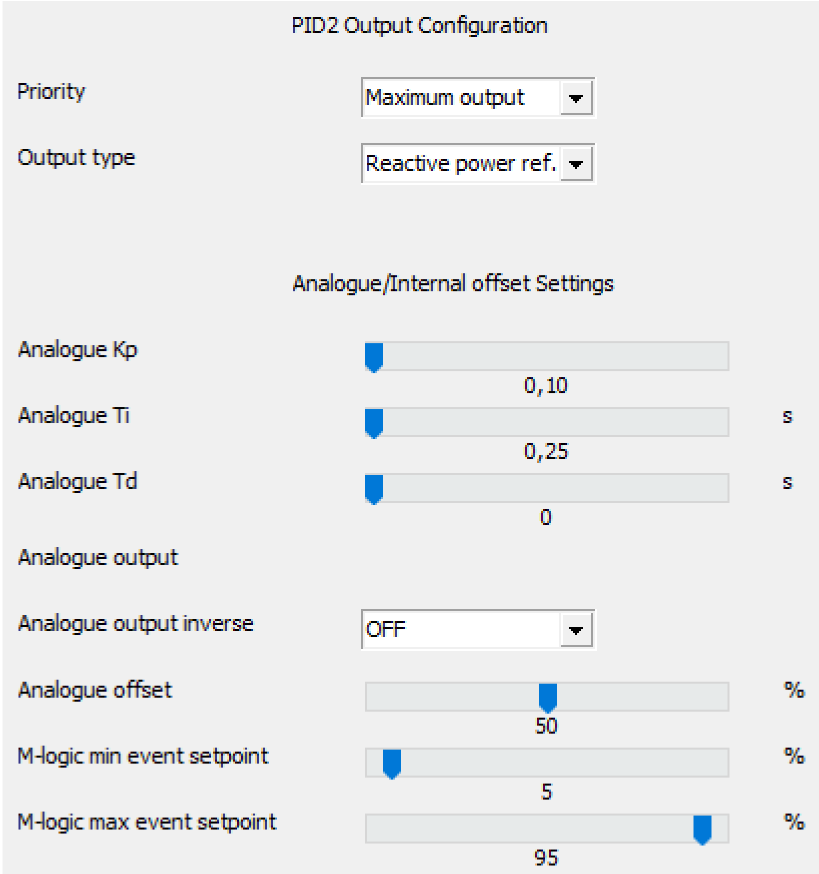
Logic 5	Operator	Category	Name
Event A	Not	General Purpose PID	PID3 Active
Output		General Purpose PID commands	PID3 reset

10.5.3 Reactive power regulation

The PID can use the difference between the actual reactive power from the ESS and the ESS reference reactive power as inputs. The PID controller output is a reactive power reference offset. This offset is added to the reactive power reference that the ASC sends to the ESS.

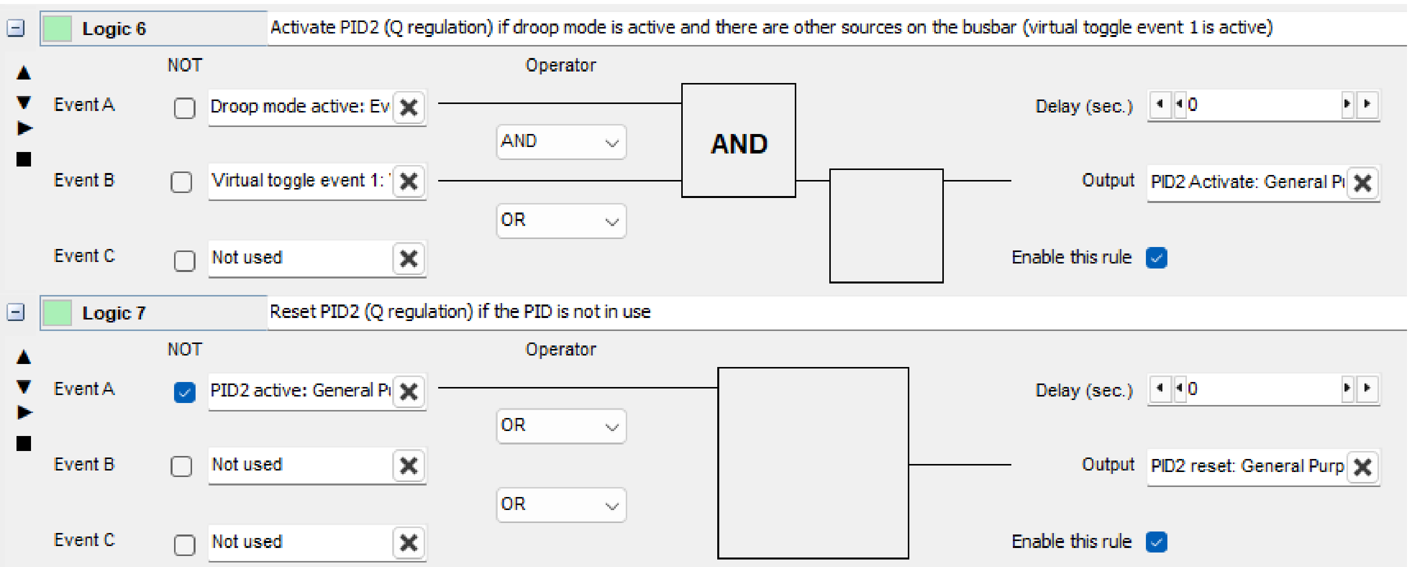
Example of general purpose PID settings for reactive power regulation





M-Logic to activate and reset PID2

You can use M-Logic to detect when to activate PID2. You can also use M-Logic to automatically reset PID2 when PID2 is not active.



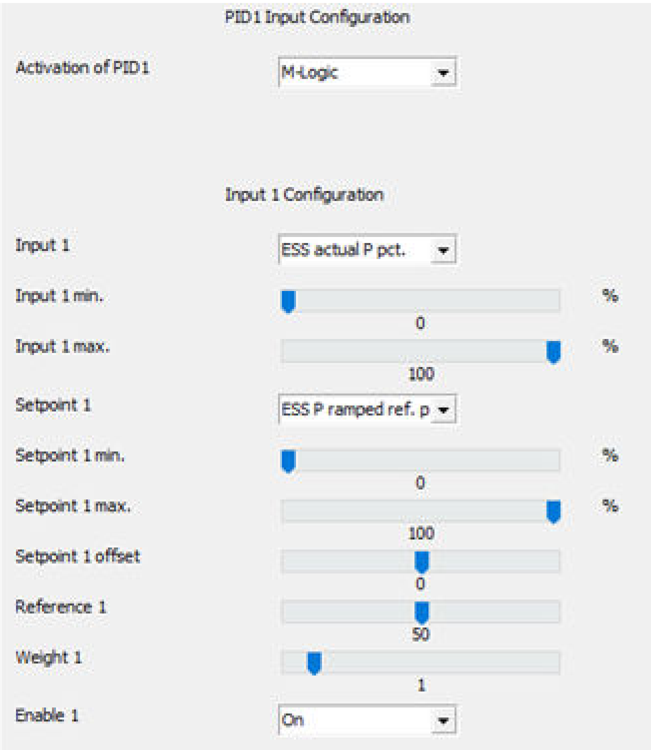
Logic 6	Operator	Category	Name
Event A	AND	Events - Battery	Droop mode active
Event B	AND	Virtual toggle events	Virtual toggle event 1
Output		General Purpose PID commands	PID2 Activate

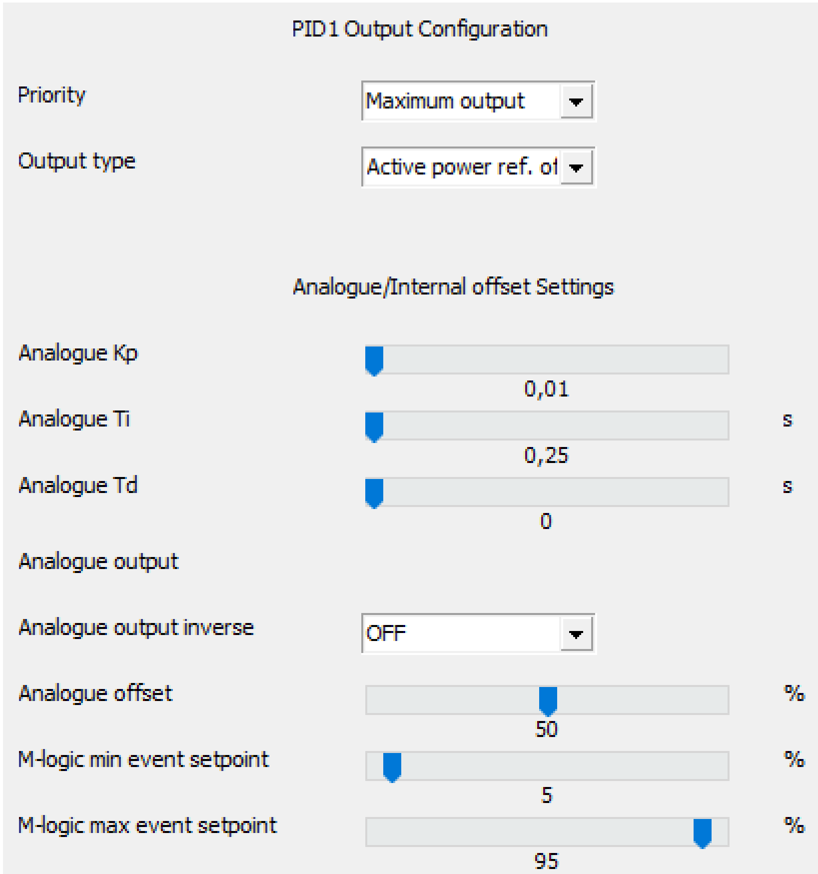
Logic 7	Operator	Category	Name
Event A	Not	General Purpose PID	PID2 Active
Output		General Purpose PID commands	PID2 reset

10.5.4 Power regulation

The PID can use the difference between the actual power from the ESS and the ESS reference power as inputs. The PID controller output is an active power reference offset. This offset is added to the power reference that the ASC sends to the ESS.

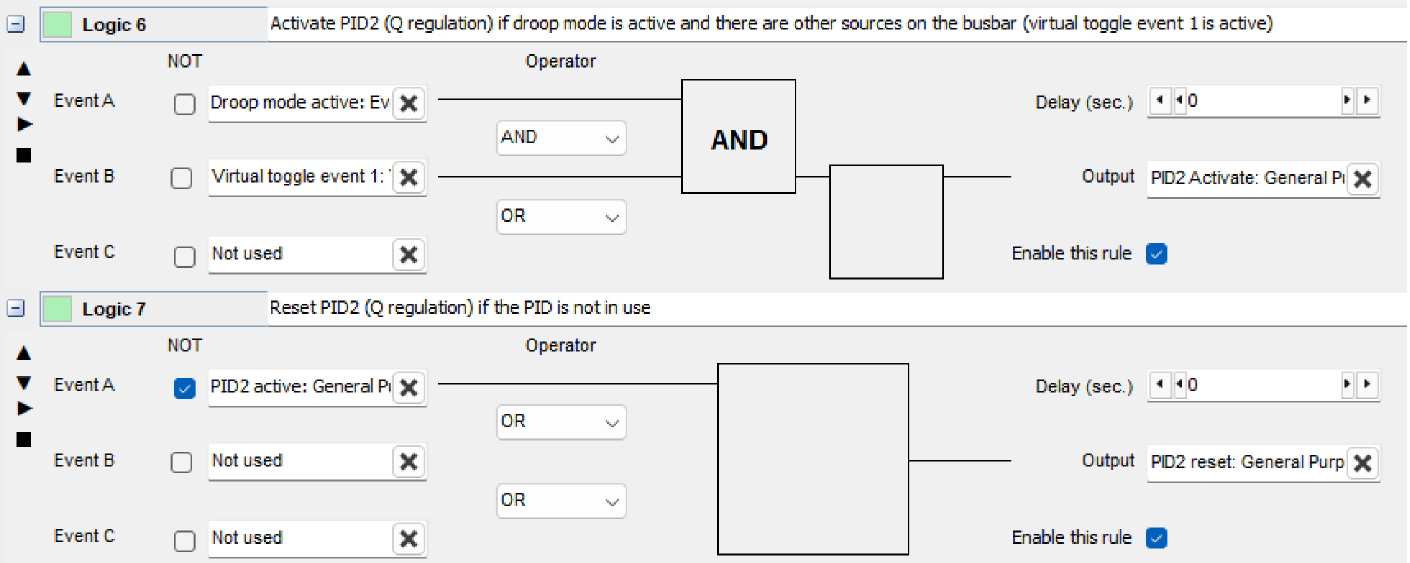
Example of general purpose PID settings for power regulation





M-Logic to activate and reset PID1

You can use M-Logic to detect when to activate PID1. You can also use M-Logic to automatically reset PID1 when PID1 is not active.



Logic 6	Operator	Category	Name
Event A	AND	Events - Battery	Droop mode active
Event B	AND	Virtual toggle events	Virtual toggle event 1
Output		General Purpose PID commands	PID1 Activate

Logic 7	Operator	Category	Name
Event A	Not	General Purpose PID	PID1 Active
Output		General Purpose PID commands	PID1 reset

11. Inputs and outputs

11.1 Digital inputs

11.1.1 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	In	Configurable	Negative switching only, < 100 Ω
40	In	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	MB position on*	Configurable (application dependent)	Negative switching only, < 100 Ω
48	MB position off*	Configurable (application dependent)	Negative switching only, < 100 Ω
49	ESB position on	Configurable (application dependent)	Negative switching only, < 100 Ω
50	ESB position off	Configurable (application dependent)	Negative switching only, < 100 Ω

NOTE * For a single controller application with a mains breaker.

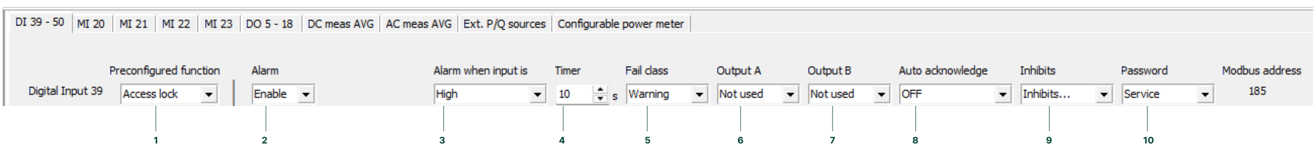
11.1.2 Configuring digital inputs

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.

No.	Text	Description
5	Fail class	Select the required fail class from the list. When the alarm occurs, the controller reacts according to the selected fail class.
6	Output A	Select the terminal (or *Limits*) to be activated by an alarm. Limits makes the alarm useable as an input event in M-Logic.
7	Output B	Select the terminal (or *Limits*) to be activated by an alarm. Limits makes the alarm useable 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.

11.2 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	Default setting
Relay 05	No default
Relay 06	No default

Relay outputs, group 2

Electrical characteristics

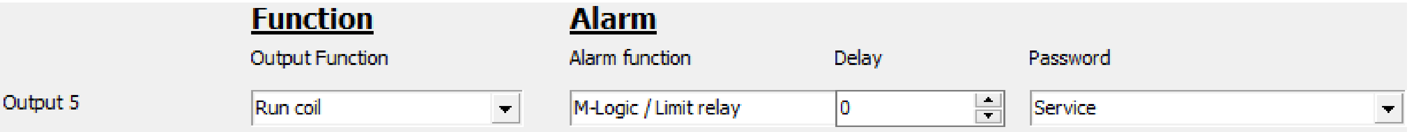
- Voltage: 4.5 to 36 V DC
- Current: 2 A DC inrush, 0.5 A DC continuous

Relay	Default setting
Relay 09	No default
Relay 10	No default
Relay 11	Status OK
Relay 12	No default
Relay 13	No default
Relay 14	No default
Relay 15	MB ON relay*
Relay 16	MB OFF relay*
Relay 17	ESB ON relay**
Relay 18	ESB OFF relay**

NOTE * For a single controller application with a mains breaker. If there is no breaker, these outputs are configurable.
NOTE ** If there is no breaker, these outputs are configurable.

11.2.1 Configure a relay output

Use the utility software, under *I/O 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).

11.3 Analogue inputs

11.3.1 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.

11.3.2 Application description

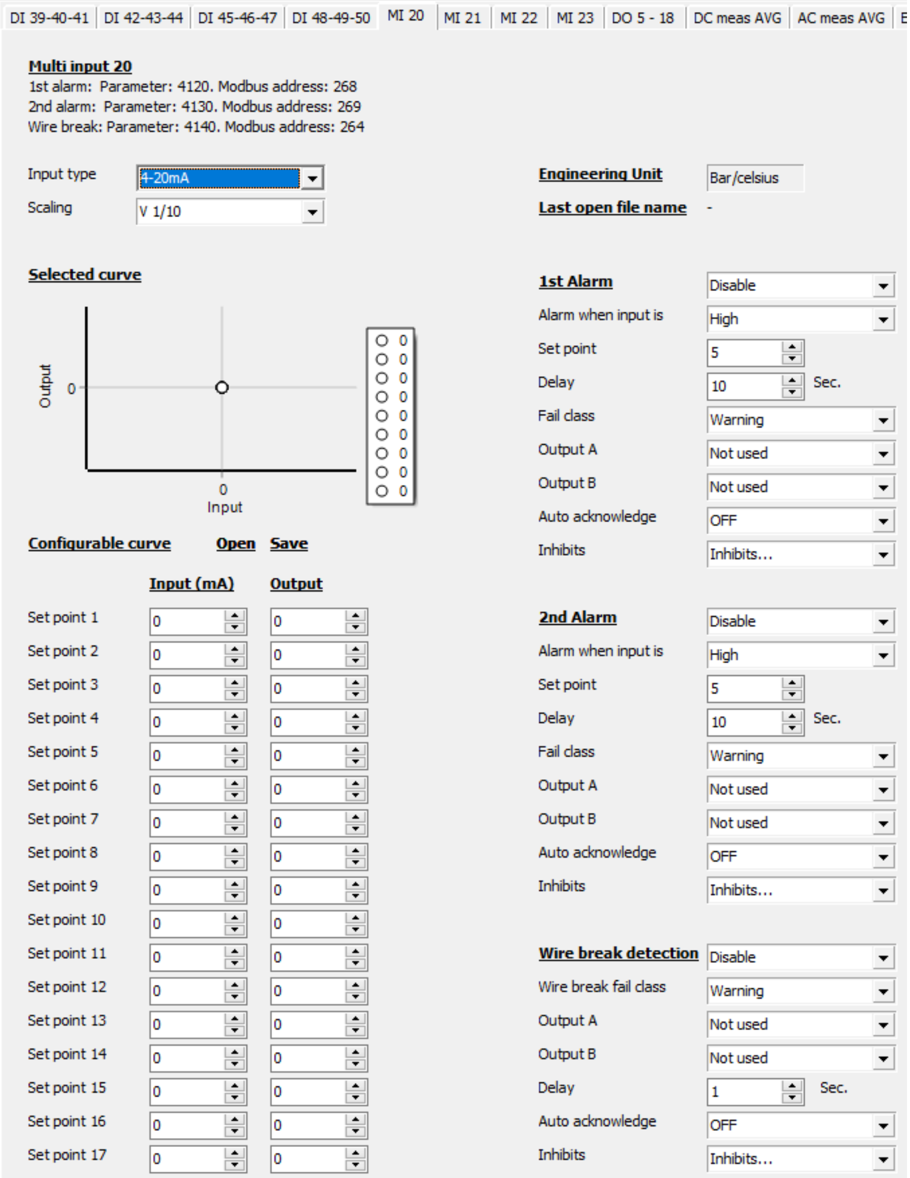
The multi-inputs can be used in different applications. For example:
- Power transducer. If you want to measure the power from another power source, a power transducer sending a 4-20 mA signal could be connected to multi-input 20.

- 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. For more information, see the **AGC 150 Genset Mains BTB Designer's handbook**.
- An extra button. If the input is configured as digital, it works like an extra digital input.
- Differential measurement can be used to activate an alarm when two values are too far apart.

11.3.3 Configuring multi-inputs

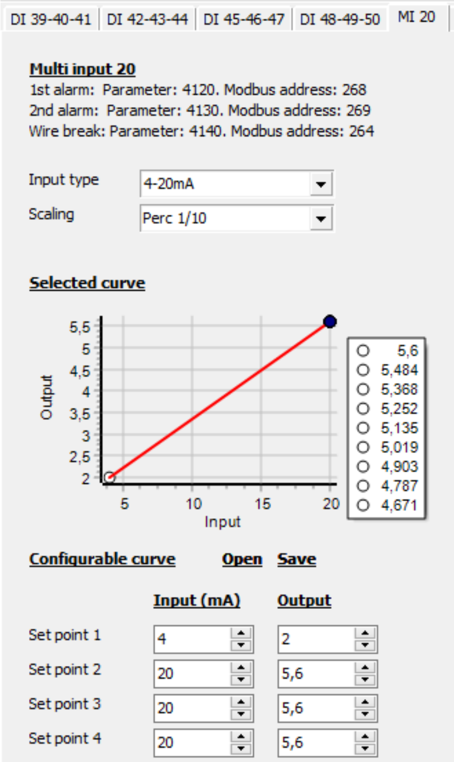
Configure each multi-input to match the connected sensor.

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

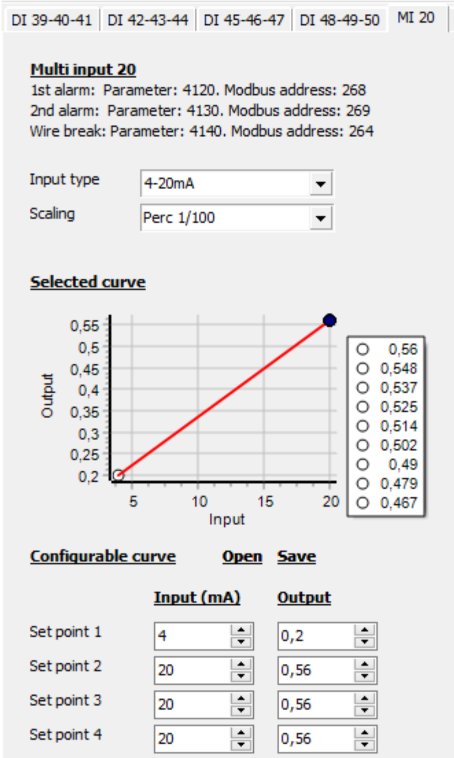


2. Select the appropriate *Scaling*.

Examples



Scaling 1/10

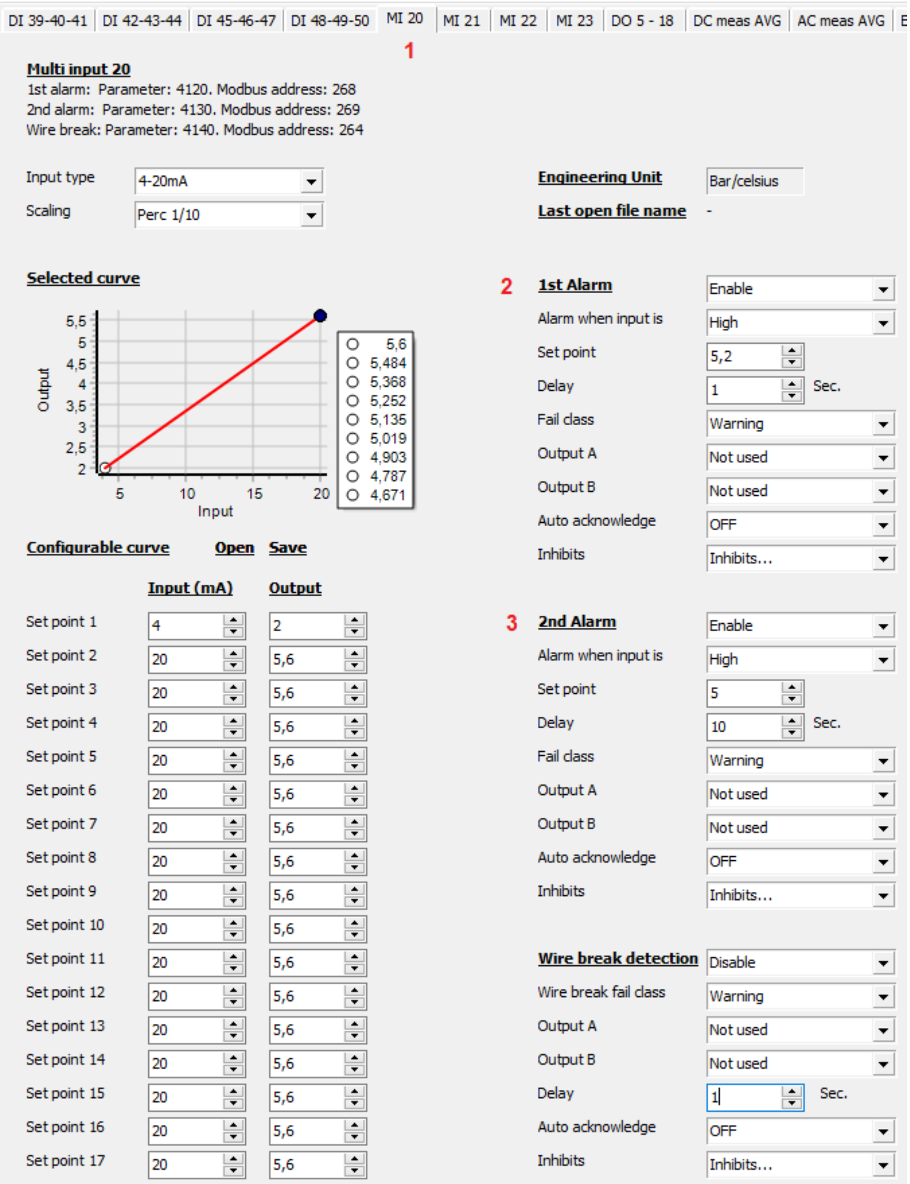


Scaling 1/100

11.3.4 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

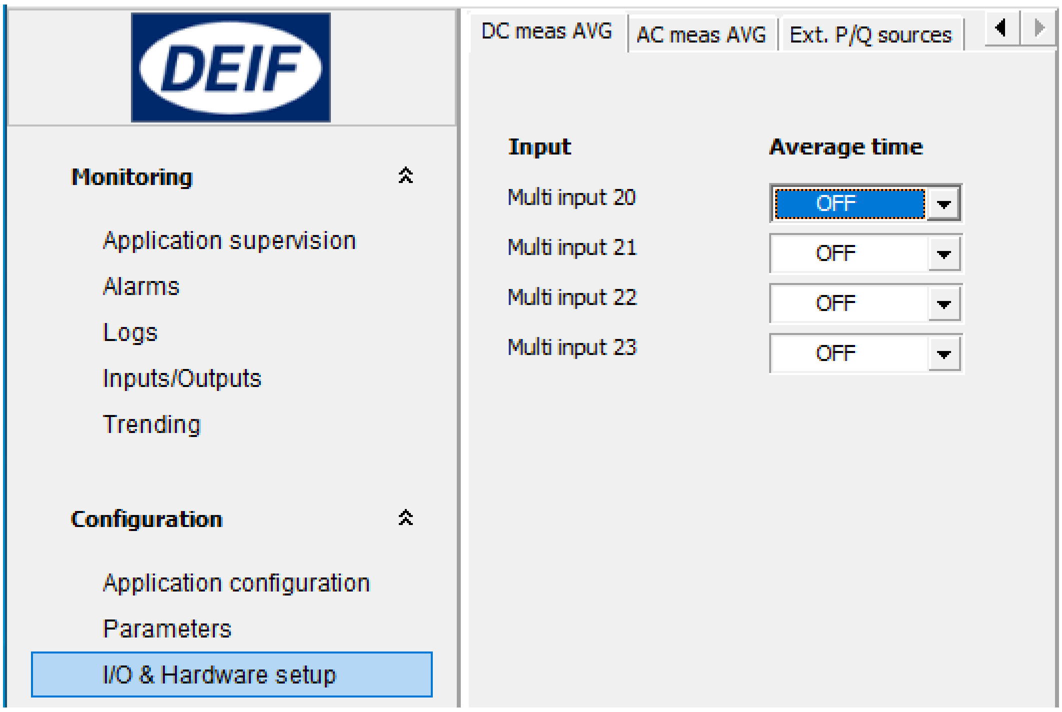
Configuring multi-input alarms from the display

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`

11.3.5 DC measurement averaging

You can use the utility software to set up averaging for the DC measurements (Multi input 20 to 23). 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 *DC meas AVG* tab. For each measurement, you can select OFF, or averages calculated over 100 ms to 10 s.



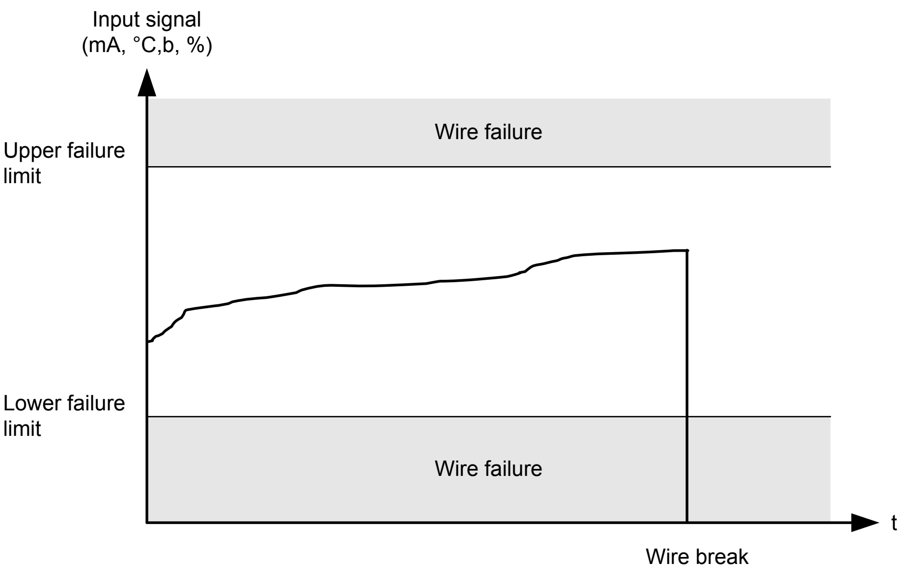
11.3.6 Wire break

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]`

11.3.7 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.

Using differential measurement to create an extra analogue alarm

If the same measurement is selected for input A and input B, the controller uses the value of the input for the differential measurement alarm.

`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

Parameter	Text	Range	Default
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		

Differential measurement examples

High ESS voltage alarm

Configure the alarm:

- In parameters 4601 and 4602, select *Voltage DC*.
- In menu 4610, select *25.0* for the set point, select *1.0 s* for the timer, and select *ON*.

If the battery voltage rises above 25.0 V for at least 1 second, the controller activates the *Delta ana1 1* warning alarm. Use the translation function to change the alarm text to *High ESS voltage*.

Low state of charge output

Configure the output:

- In parameter 4603 and 4604, select *SOC*.
- In menu 4630:
  - Set point: *30.0*
  - Timer: *1.0 s*
  - Output A: *Terminal 14*
  - Output B: *Limits*
  - Enable: Select
  - High alarm: De-select

If the state of charge drops below 30.0 % for at least 1 second, the controller activates the terminal 14 relay. The differential alarm is not activated.

11.4 Analogue outputs

The controller has two analogue outputs that are active and galvanically separated. No external supply can be connected.

11.4.1 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.

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.

Transducer range

`I/O settings > Outputs > Transducer > Output [52 or 55] limits`

Parameter	Name	Range	Details
5802 or 5812	AOUT [52 or 55] limits	-10.5 to 5 V	The transducer minimum limit.
5803 or 5813	AOUT [52 or 55] limits	-5 to 10.5 V	The transducer maximum limit.

Transducer configuration example: Power output

`I/O settings > Outputs > Transducer > kW > P output actual`

Parameter	Name	Range	Details
5823	P1 output type	**Set point** Disabled -10 to 10 V **Transducer A** Disabled Transducer 52 Transducer 55	Select the output.
5824	P1 output max	0 to 20000 kW	ESS active power maximum for the transducer
5825	P1 output min	-9999 to 20000 kW	ESS active power minimum for the transducer

Other transducer values

Parameter	Name	Details
5693, 5694, 5695	P ref	The controller's power set point.
5853, 5854, 5855	S	ESS apparent power
5863, 5864, 5865	Q	ESS reactive power
5873, 5874, 5875	PF	Power factor of the power from the ESS
5883, 5884, 5885	f (ESS)	ESS frequency
5893, 5894, 5895	U (ESS)	ESS L1-L2 voltage
5903, 5904, 5905	I	ESS L1 current
5913, 5914, 5915	U BB	Busbar/mains L1-L2 voltage
5923, 5924, 5925	f BB	Busbar/mains 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.

11.5 Additional inputs and outputs

If more inputs and/or outputs (IOs) are needed, you can use CIO modules with the ASC 150. When the CIOs are installed and the IOs are configured, the CIO IOs act like IOs on the ASC 150.

To use CIOs, in *CIO Enable* (parameter 7891) select *ON*.

More information
See the **CIO 116 Installation and Commissioning guide** under www.deif.com/products/cio-116.

See the **CIO 208 Installation and Commissioning guide** under www.deif.com/products/cio-208.

See the **CIO 308 Installation and Commissioning guide** under www.deif.com/products/cio-308.

12. Small rental application (ESS-Genset) example

12.1 Introduction

As this handbook shows, you can use the application drawing, inputs and outputs, parameters and M-Logic to use the ASC 150 Storage controller in a wide variety of applications. To help you to set up a single ASC 150 Storage controller quickly, this chapter here an example of a specific, simple, single controller application.

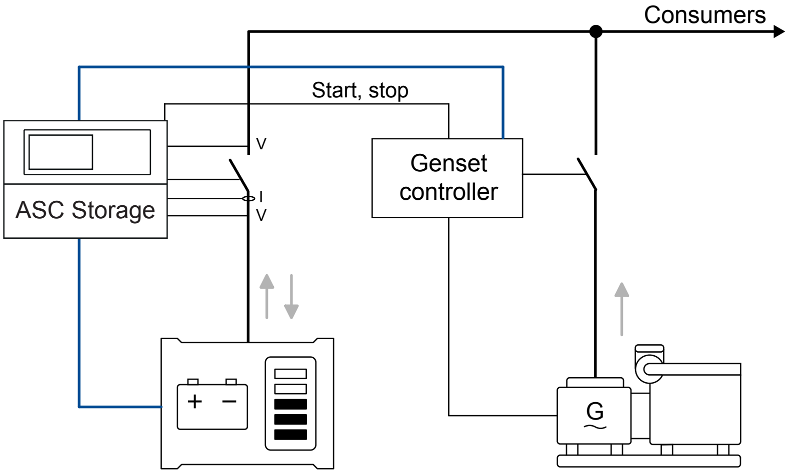
DANGER!

Incorrect configuration is dangerous

Only allow authorised personnel, who understand the risks involved in working with electrical systems, to do the installation and configuration. The configuration given here is an example. Do not blindly follow this example. Be careful to create a configuration that is suitable for your electrical system instead.

12.2 Application setup

Single-line diagram for the application example

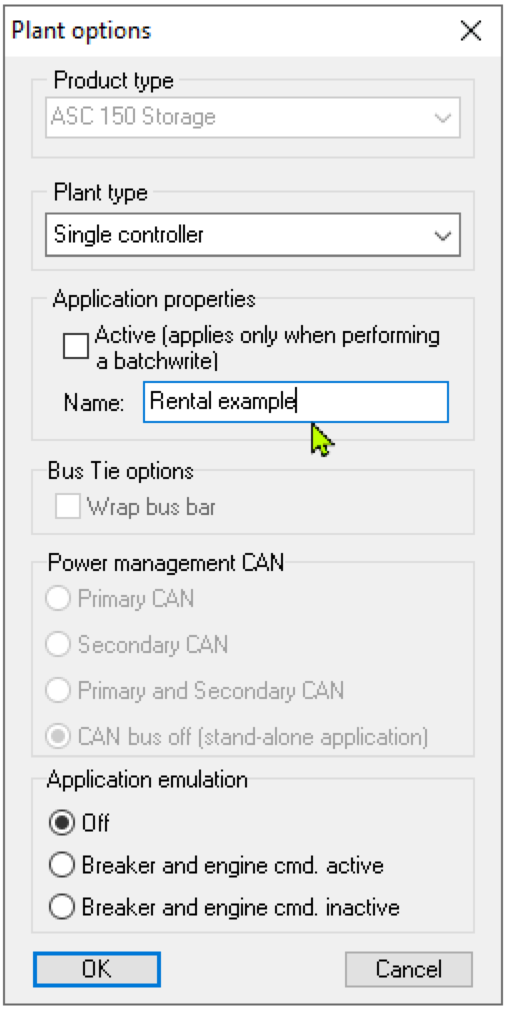


System information

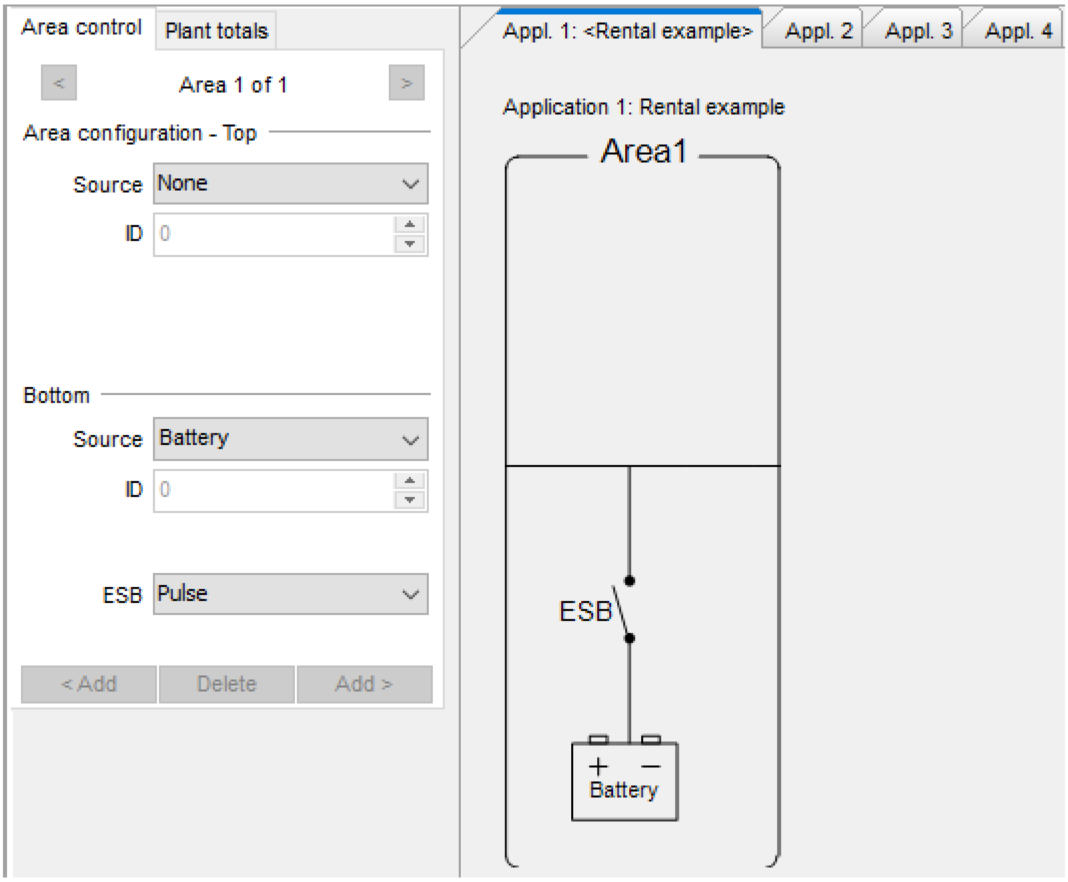
- Three-phase system, 50 Hz, 400 V phase-phase
- Storage system: Danfoss Vacon NXP, with Modbus TCP PCS communication
- Genset: 1500 kW, with a DSE 8xxx controller
- Application: Supply power at a building site on weekdays from 07h00 to 19h00:
    - During the day, the battery supplements the genset, and makes sure that the genset runs optimally.
    - At night, and over weekends, the battery supplies power for lighting and the security system. The genset is off.
- Operation strategy:
    - From 07h00 to 18h00, the state of charge parameters (set 1) ensure optimum genset operation.
    - From 18h00 to 19h00, the state of charge parameters (set 2) ensure that the battery is charged (to supply power through the night).
    - From 19h00, the state of charge parameters (set 3) allow the battery to run down (so that the genset does not have to start).

Creating the application drawing in the USW

1. On the *Application configuration* page, use *New plant configuration* to open a *Plant options* window to create a new application.



2. Under *Area control*, remove Mains from the top area. Since the ASC controls the ESB in this example, add the ESB breaker type in the bottom area.



3. Use *Write plant configuration to the device* to write the configuration to the controller.

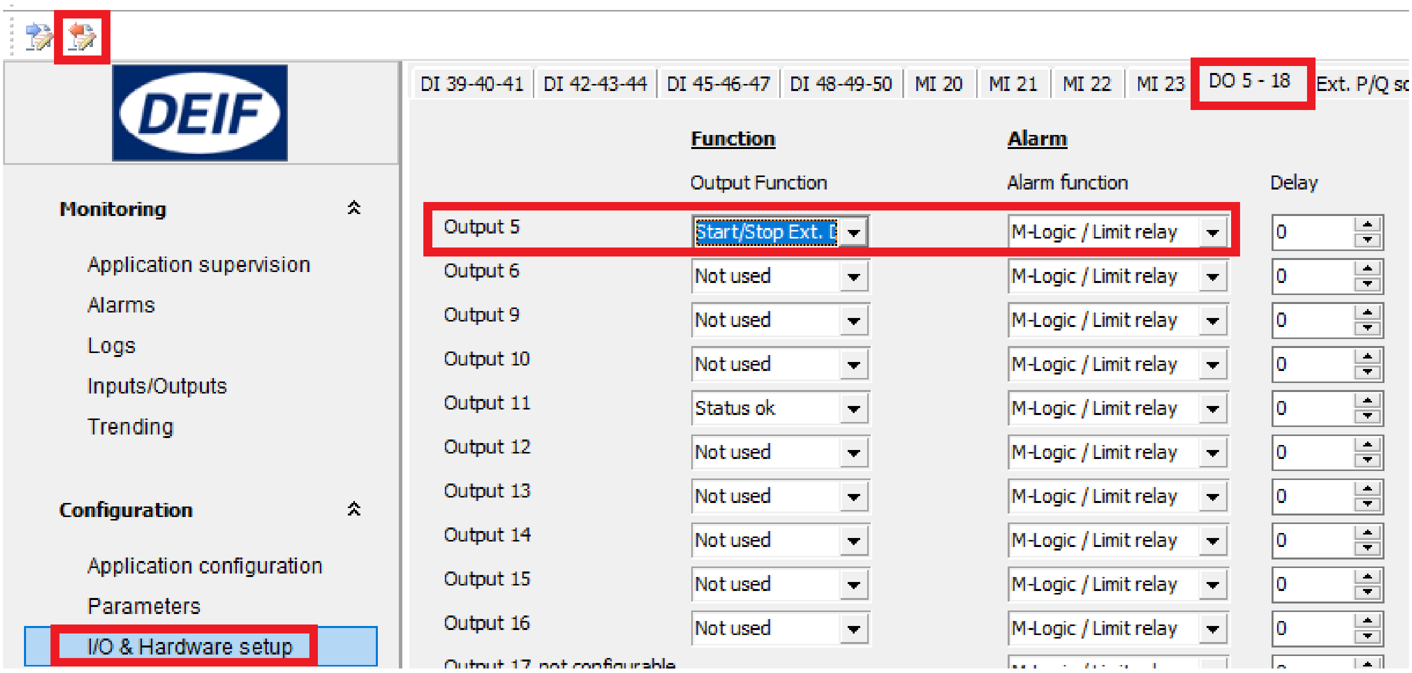
12.3 Inputs/Outputs

Set up the inputs in the utility software.

Set up the relay to start/stop the genset

On the *I/O & Hardware setup* page, select *DO 5 - 18*.

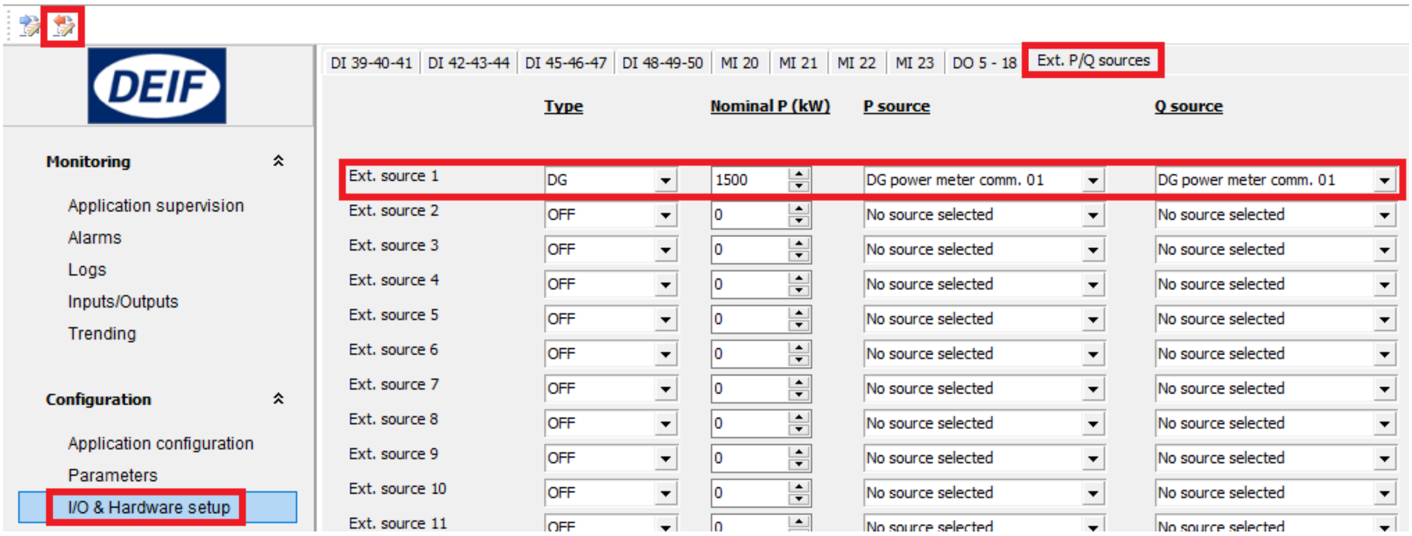
For *Output 5*, select *Start/Stop Ext. DG* and *M-Logic /Limit relay*, then write to the controller.



Set up the measurements from the genset controller

On the *I/O & Hardware setup* page, select *Ext. P/Q sources*.

For *Ext. source 1*, select *DG*, *1500*, *DG power meter comm. 01* and *DG power meter comm. 01*, then write to the controller.



12.4 Wiring

The minimum required wiring is listed in the following table.

More information
See the **Installation instructions** for complete wiring information.

Terminal(s)	Function	Details
1-2	Power supply	6.5 to 36 V DC, power for the controller
1-4	Emergency stop	Digital input
1-5	Start-stop genset	Maximum 36 V DC/3 A relay.

Terminal(s)	Function	Details
		Connect these terminals to the genset controller. The genset must start when the relay is activated, and stop when the relay is deactivated.
8-17	Close ESS breaker	Maximum 36 V DC/0.5 A relay
8-18	Open ESS breaker	Maximum 36 V DC/0.5 A relay
33	Genset comm DATA + (A)	Connect these terminals to the genset controller Modbus RTU terminals.
35	Genset comm DATA - (B)	
49	ESS breaker closed	+36 V DC with respect to plant supply negative -24 V DC with respect to plant supply negative
50	ESS breaker open	
	Common	
56	S1 (k) L1 AC current	Use an x/1 A or x/5 A current transformer.
59	S2 (l) L1 AC current	
57	S1 (k) L2 AC current	Use an x/1 A or x/5 A current transformer.
59	S2 (l) L2 AC current	
58	S1 (k) L3 AC current	Use an x/1 A or x/5 A current transformer.
59	S2 (l) L3 AC current	
63	L1 ESS voltage	Maximum 690 V AC phase-phase
64	L2 ESS voltage	Maximum 690 V AC phase-phase
65	L3 ESS voltage	Maximum 690 V AC phase-phase
67	L1 Busbar voltage	Maximum 690 V AC phase-phase
68	L2 Busbar voltage	Maximum 690 V AC phase-phase
69	L3 Busbar voltage	Maximum 690 V AC phase-phase
Ethernet	Ethernet	Connect the Ethernet to the storage system.

12.5 Parameters

For this example, set the following parameters. Select *Write parameters to the device* when you have finished.

NOTE Not all parameters are shown in the list below. Parameters with factory defaults that are suitable for this example are not included. Irrelevant parameters are not included either.

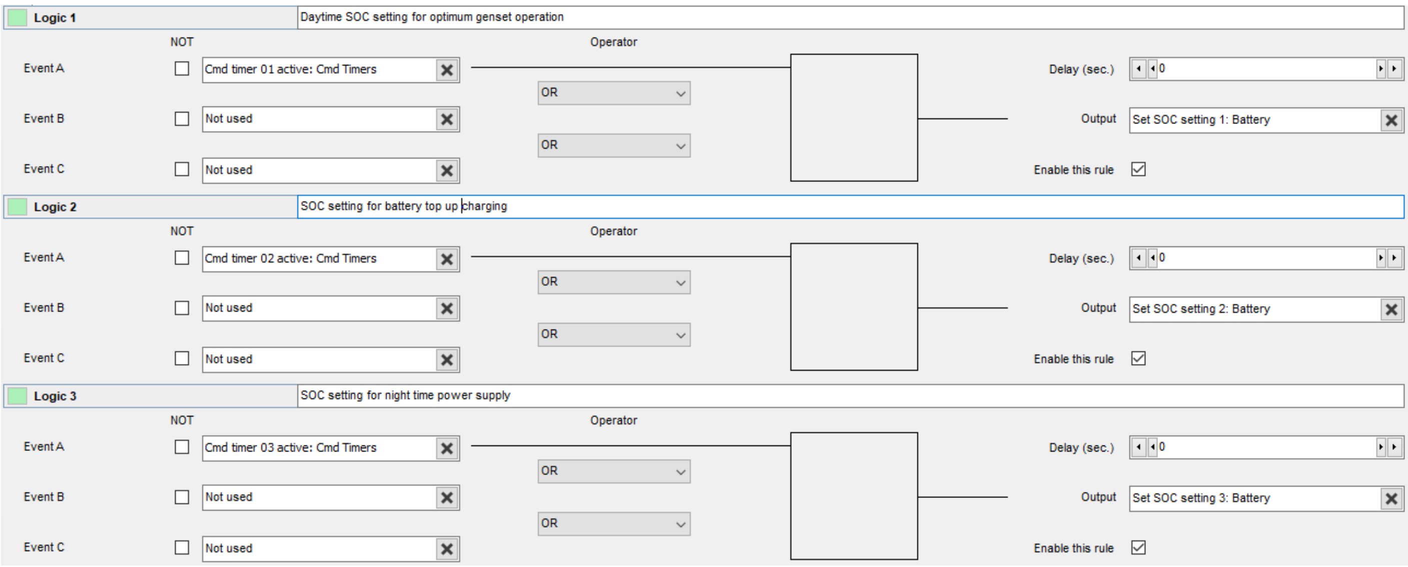
Parameter	Name	Description
6001	Nom. f 1	Select *50 Hz*.
6002	Nom. P 1	Use the ESS information to configure the nominal power set point.
6003	Nom. I 1	Use the ESS information to configure the nominal current set point.
6004	Nom. U 1	Use the ESS information to configure the nominal voltage set point.
6005	Nom. Q 1	Use the ESS information to configure the nominal reactive power set point.
6006	Nom. S 1	Use the ESS information to configure the nominal apparent power set point.
6041	ES primary U	The ESS primary voltage. If necessary, adjust this set point.
6042	ES secondary U	The ESS secondary voltage. If necessary, adjust this set point.
6043	ES Primary I	The ESS primary current. If necessary, adjust this set point.
6044	ES secondary I	The ESS secondary current. If necessary, adjust this set point.
6051	BB primary U 1	The busbar primary voltage. If necessary, adjust this set point.

Parameter	Name	Description
6052	BB second. U 1	The busbar secondary voltage. If necessary, adjust this set point.
6053	BB nominal U 1	The busbar nominal voltage. If necessary, adjust this set point.
6071	Operation mode	Select *Island operation*
6961	Start timer 1	Select *MO-TU-WE-TH-FR*
6962	Start timer 1	Select *7 Hours*
6964	Stop timer 1	Select *MO-TU-WE-TH-FR*
6965	Stop timer 1	Select *18 HOURS*
6971	Start timer 2	Select *MO-TU-WE-TH-FR*
6972	Start timer 2	Select *18 Hours*
6974	Stop timer 2	Select *MO-TU-WE-TH-FR*
6975	Stop timer 2	Select *19 HOURS*
6981	Start timer 3	Select *MO-TU-WE-TH-FR*
6982	Start timer 3	Select *19 Hours*
6984	Stop timer 3	Select *MO-TU-WE-TH-FR*
6985	Stop timer 3	Select *7 HOURS*
7541	ESS comm. intf.	Select *Modbus TCP/IP client*
7561	ESS protocol	Select *Danfoss Vacon NXP*.
7681	BMS comm. ID	If necessary, adjust this set point.
7701	DG meter ID	If necessary, adjust this set point.
7721	DG meter prot.	Select *DSE 8xxx, 7xxx, 6xxx and 4xxx*
15011	Min DG load 1	If necessary, adjust this set point.
15014	Opt. DG load % 1	If necessary, adjust this set point.
15151	SOC DG start limit	If necessary, adjust this set point.
15153	SOC DG stop limit	If necessary, adjust this set point.
15155	SOC DG control	Select *Enable*.
15161	Sys P DG start limit	If necessary, adjust this set point.
15163	Sys P DG stop limit	If necessary, adjust this set point.
15165	Sys P DG control	Select *Enable*.
17031	DG charge pct	If necessary, adjust this set point.
17032	DG charge P	If necessary, adjust this set point.
17033	DG charge mode	Select *Enable*, and as relevant, select percent or power.
17051	SOC minimum 1	If necessary, adjust this set point.
17052	SOC maximum 1	If necessary, adjust this set point.
17053	SOC thr. 1.1	If necessary, adjust this set point.
17054	SOC thr. 2.1	If necessary, adjust this set point.
17061	SOC minimum 2	Adjust this set point to make sure that the battery is charged up.
17062	SOC maximum 2	Adjust this set point to make sure that the battery is charged up.
17063	SOC thr. 1.2	Adjust this set point to make sure that the battery is charged up.
17064	SOC thr. 2.2	Adjust this set point to make sure that the battery is charged up.

Parameter	Name	Description
17071	SOC minimum 3	Adjust this set point to allow the battery to discharge as it supplies power through the night.
17072	SOC maximum 3	Adjust this set point to allow the battery to discharge as it supplies power through the night.
17073	SOC thr. 1.3	Adjust this set point to allow the battery to discharge as it supplies power through the night.
17074	SOC thr. 2.3	Adjust this set point to allow the battery to discharge as it supplies power through the night.
17081	Operation mode	Select *Battery Energy Source*, so that the ESS can supply energy when the genset is not running.
17110	SOC low	If necessary, adjust this set point.
17120	SOC high	If necessary, adjust this set point.

12.6 Timer logic

The utility software screenshot below shows simple logic to change the state of charge parameter set based on the command timers.



You can also create more complex logic. For example, you can configure a switch to override the timers.

12.7 Commissioning

DANGER!

Incorrect wiring and configuration are dangerous

Before using the system, check that the wiring and parameters are correct for the application.

Before starting operation, check that all the wiring is correct.

Check that the parameters are correct for the application.

Check that the controller can communicate with the ESS and the genset controller.

12.8 Operation

Press the AUTO button on the controller. When the controller is in AUTO mode, the LED next to the AUTO button is green.

The controller automatically ensures that the ESS runs according to its charge scheme, and supplies the required power.

At 07h00, the controller changes to state of charge parameter set 1. If necessary, the controller automatically starts the genset. The controller changes the ESS set point to ensure that the genset never runs below its minimum load. As far as possible, the controller ensures that the genset runs at its optimum load.

At 18h00, the controller changes to state of charge parameter set 2. If necessary, the controller automatically starts the genset to top up the battery charge for the night.

At 19h00, the controller changes to state of charge parameter set 3. The battery is allowed to run down as it supplies a small amount of power for security and lighting.