AGC 150

4189341346C

Automatic transfer switch (ATS)

Designer's handbook

Improve Tomorrow

1. Introduction

2. Applications

3. Utility software

4. AC protections

5. General functions

1. Introduction

1.1 About

The AGC 150 Automatic Transfer Switch (ATS) controller can automatically transfer the power supply when it detects a failure. The controller can handle all types of power sources and the user can select how the controller should respond to a failure. The ATS can control up to three breakers, which means that you can use it in a wide range of emergency power solutions.

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

The values and alarms are shown on the LCD display screen, which is sunlight-readable. Operators can easily control the breakers from the display units. Alternatively, use the communication options to connect to an HMI/SCADA system.

1.1.1 Function overview

Operation modes

- Automatic mode
- SEMI-AUTO

Source 1 protections

- 2 x reverse power (ANSI 32R)
- 5 x overload (ANSI 32F)
- 4 x over-current (ANSI 50TD)
- 2 x over-voltage (ANSI 59P)
- 3 x under-voltage (ANSI 27P)
- 3 x over-frequency (ANSI 81O)
- 3 x under-frequency (ANSI 81U)
- Voltage dependent over-current (ANSI 51V)
- Unbalanced voltage (ANSI 47)
- Unbalanced current (ANSI 48)
- Under-excitation (ANSI 32RV)
- Over-excitation (ANSI 32FV)

Source 2 protections

- 3 x over-voltage (ANSI 59P)
- 4 x under-voltage (ANSI 27P)
- 3 x over-frequency (ANSI 81O)
- 3 x under-frequency (ANSI 81U)
- Unbalanced voltage (ANSI 47)

Digital inputs

- Multi-inputs (digital, 4-20 mA, 0-10 V DC, Pt100, RMI or binary/digital)
- Digital inputs

Display

- Remote display option
- Buttons for breaker operations
- Status texts
- Measurement readings
- Alarm indication

M-Logic

- Simple logic configuration tool
- Selectable input events
- Selectable output commands

1.1.2 Controller types

Parameter	Setting	Controller type	Minimum software
9101	DG unit	Generator controller	S2
	DG unit	Generator Stand-alone controller	S1
	Mains unit	Mains controller	S2
	BTB unit	BTB controller	S2
	DG 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
	DG 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
	DG 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 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 • Protections • Inputs and outputs • Technical specifications
Designer's handbook	• Principles • General controller sequences, functions and protections • Protections and alarms • Hardware characteristics • Communication
Installation instructions	• Tools and materials • Mounting • Minimum wiring for the controller • Wiring information and examples
Operator's manual	• Controller equipment (buttons and LEDs) • Operating the system • Alarms and log
Modbus tables	• Modbus address list ◦ PLC addresses ◦ Corresponding controller functions • Descriptions for function codes, function groups

1.2.1 Software version

This document is based on the AGC 150 software version 1.20.

1.3 Warnings and safety

1.3.1 Symbols for hazard statements

DANGER!

This shows dangerous situations.

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

WARNING

This shows potentially dangerous situations.

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

CAUTION

This shows low level risk situation.

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

NOTICE

This shows an important notice

Make sure to read this information.

1.3.2 Symbols for general notes

NOTE This shows general information.

More information
This shows where you can find more information.

Example

This shows an example.

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

Safety during installation and operation

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

Factory settings

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

Electrostatic discharge

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

Data security

To minimise the risk of data security breaches:

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

1.4 Legal information

Third party equipment

DEIF takes no responsibility for the installation or operation of any third party equipment, including the **genset**.

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.

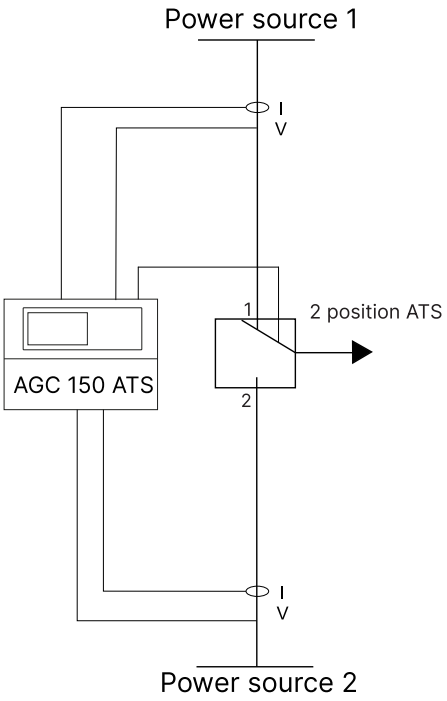
Copyright

2. Applications

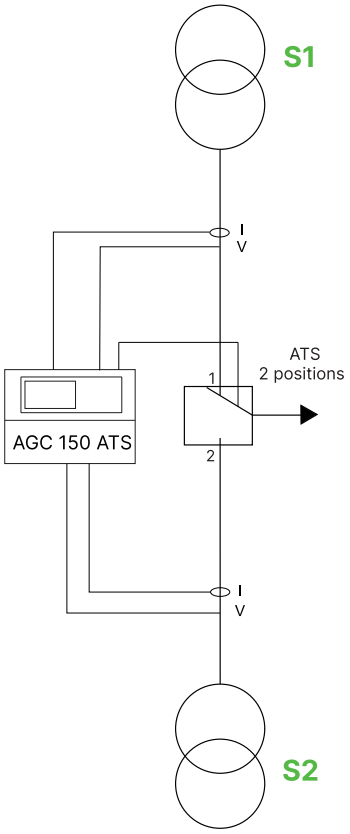
2.1 Applications with 1 breaker (ATS breaker)

You can configure 1-breaker applications with 2 positions (without neutral) or 3 positions (with neutral).

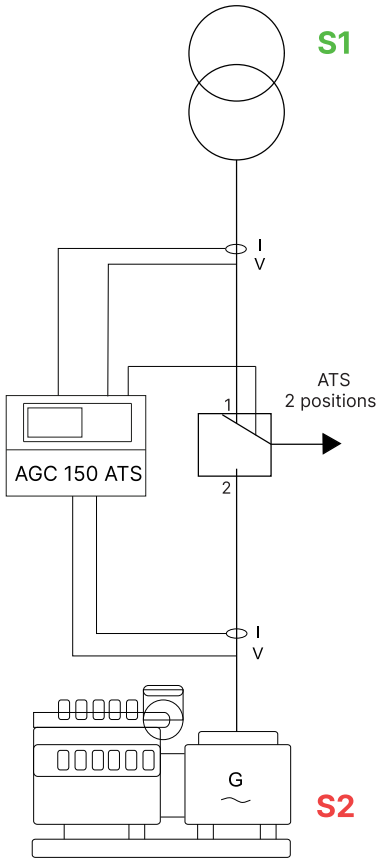
2.1.1 2 positions (without neutral)



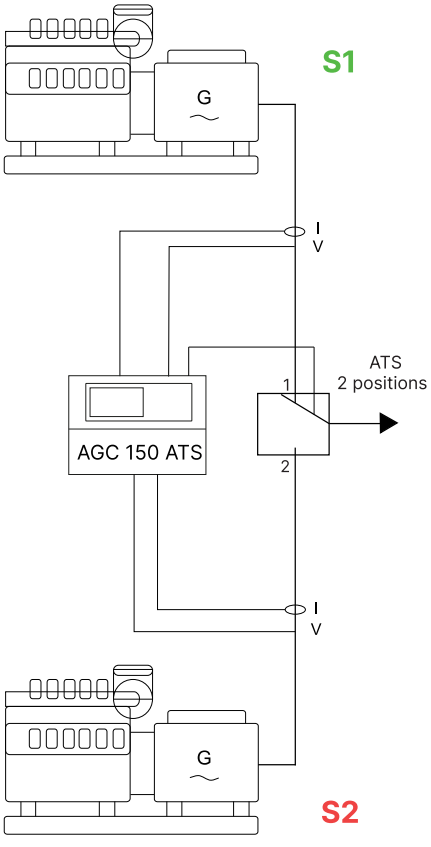
Mains-mains example



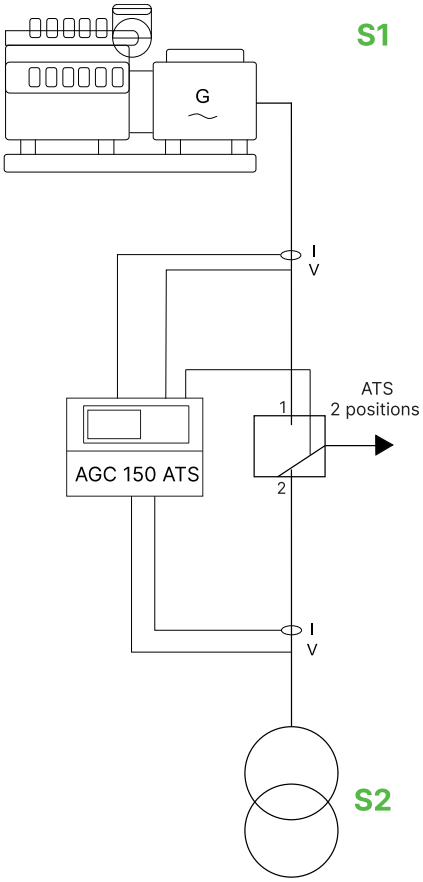
Mains-generator example

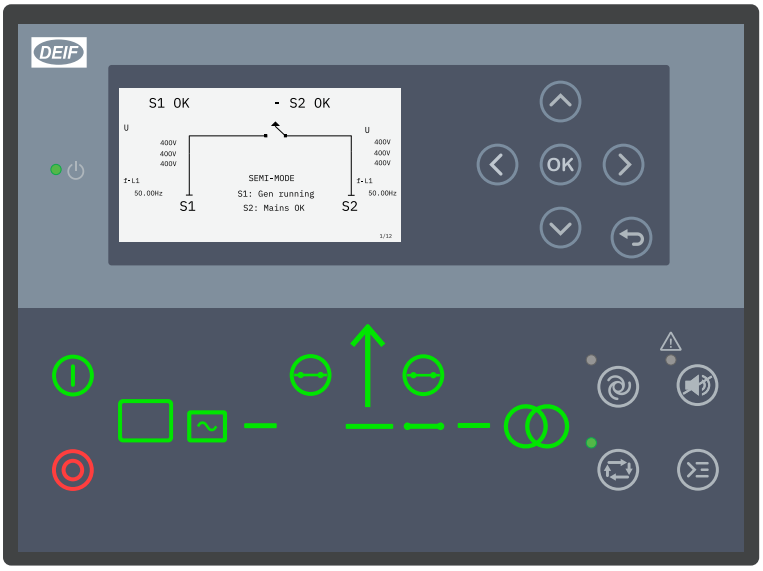


Generator-generator example

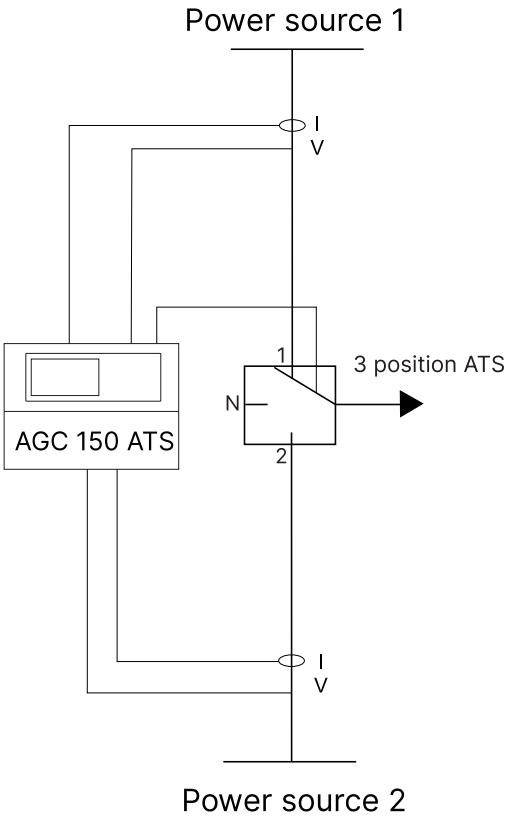


Generator-mains example

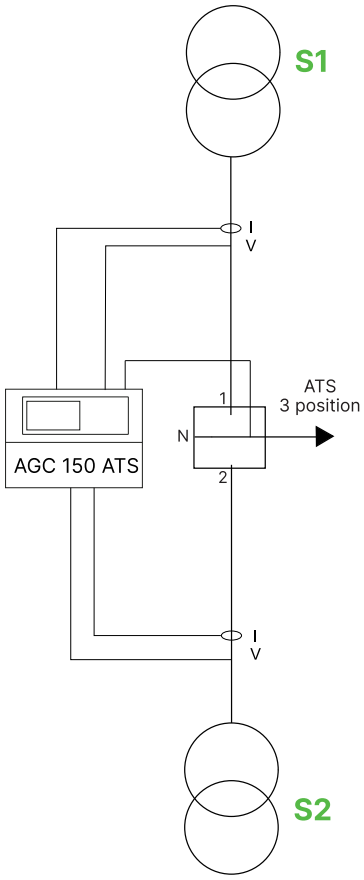


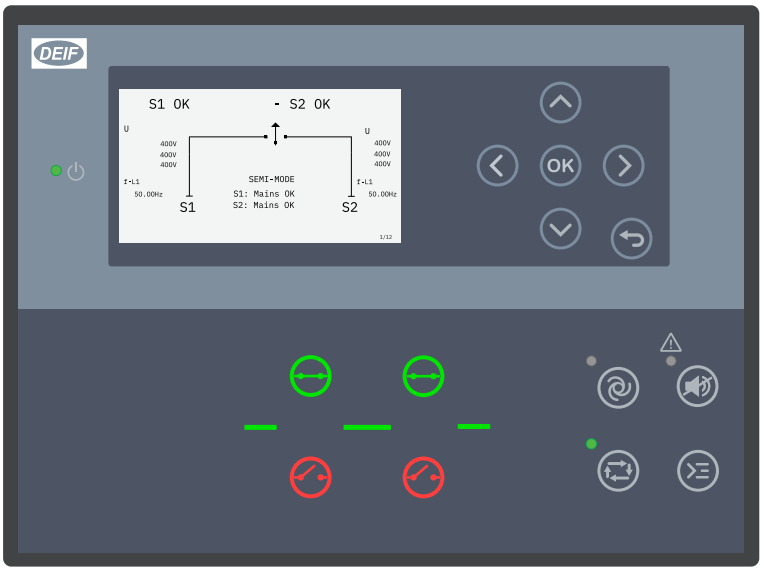


2.1.2 3 positions (with neutral)

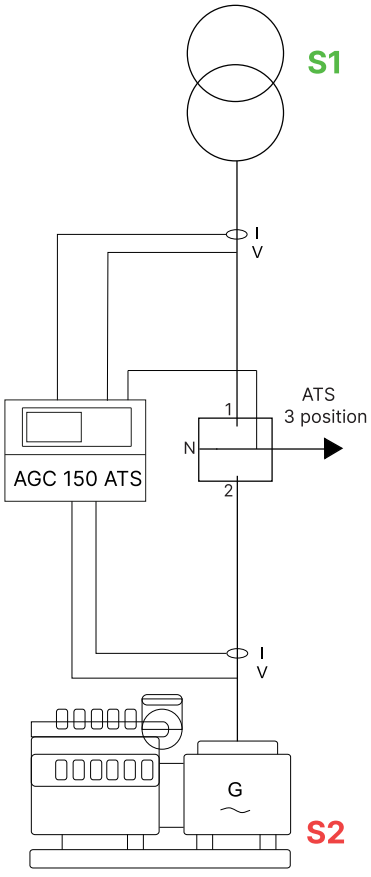


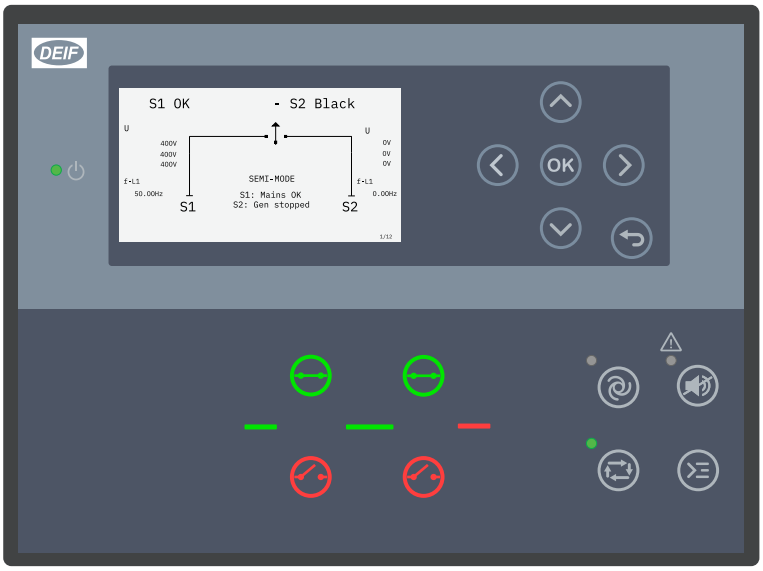
Mains-mains example



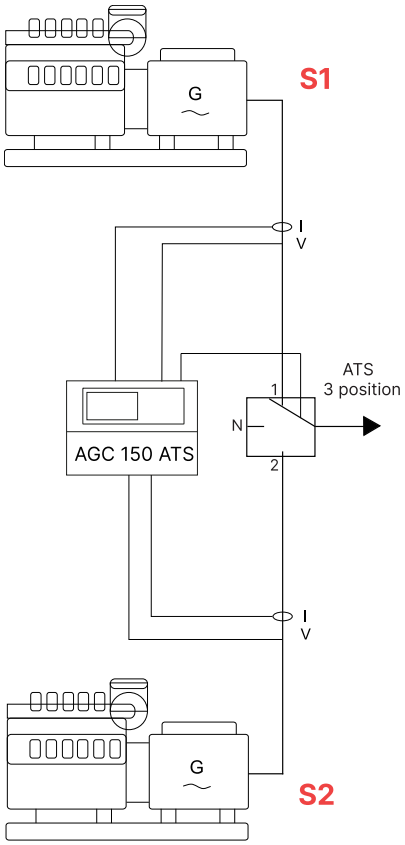


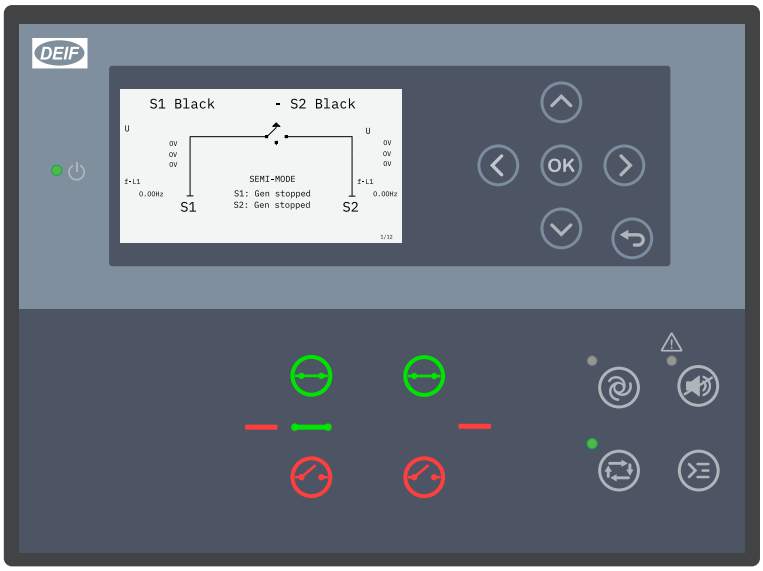
Mains-generator example



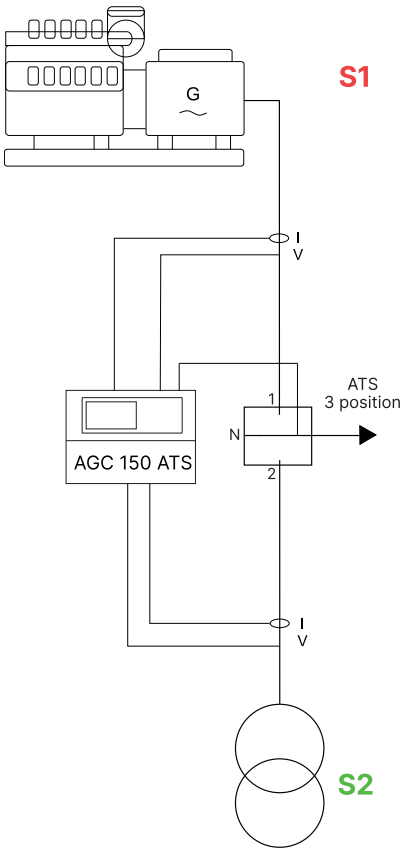


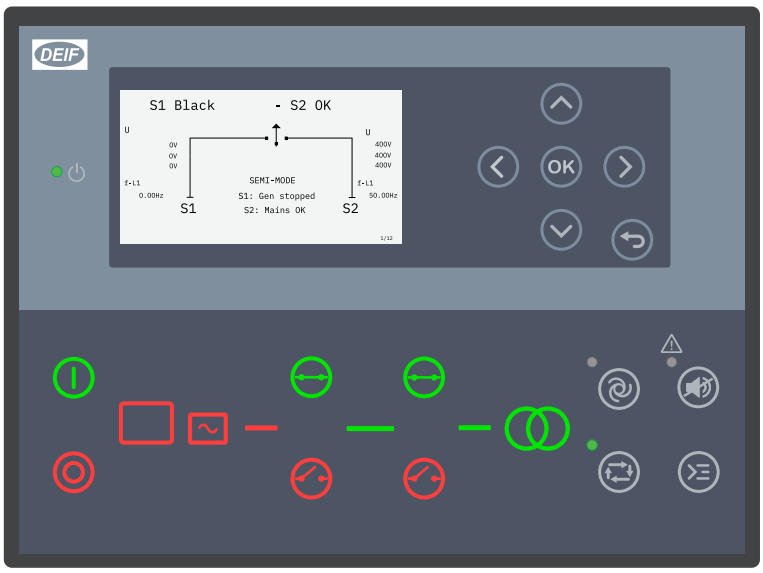
Generator-generator example



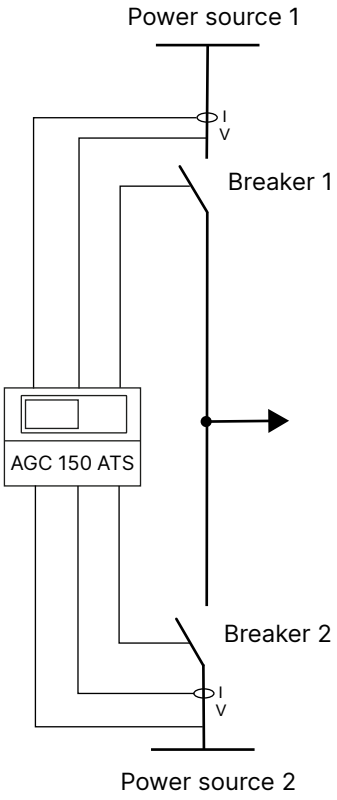


Generator-mains example



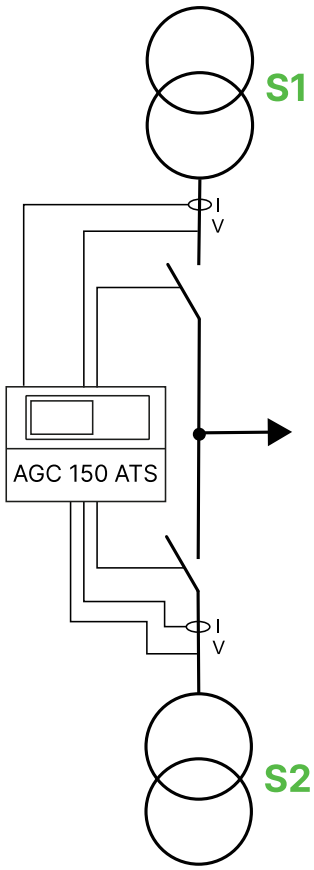


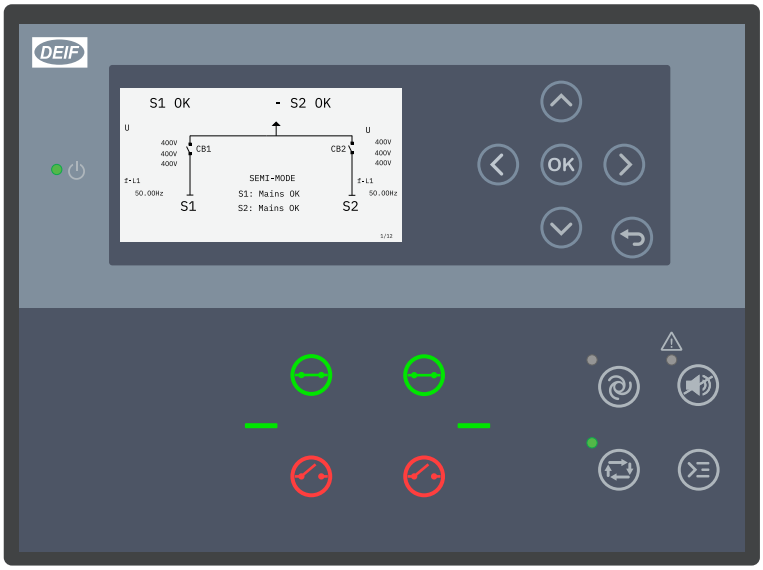
2.2 Applications with two breakers



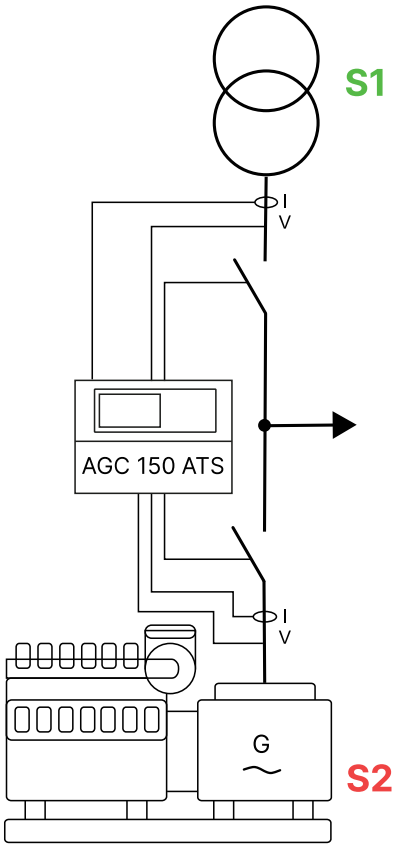
The controller automatically changes the supply if the primary supply fails.

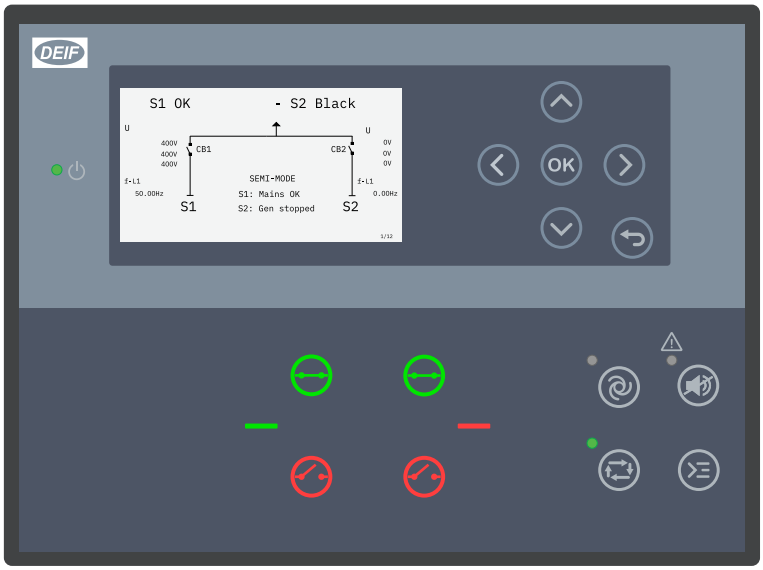
Mains-mains example



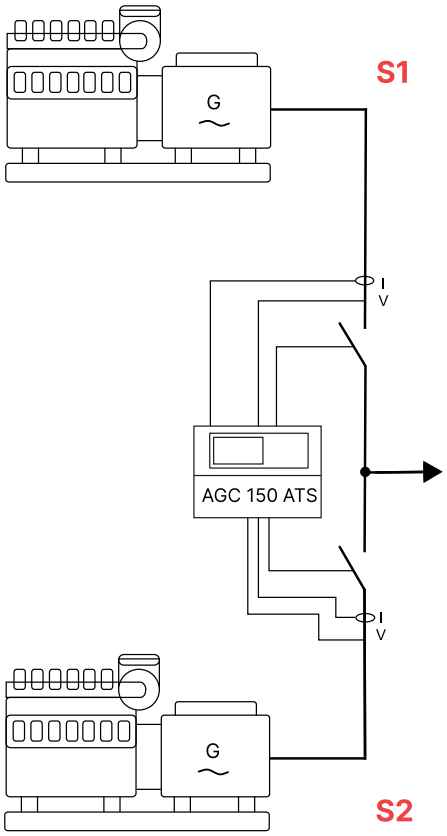


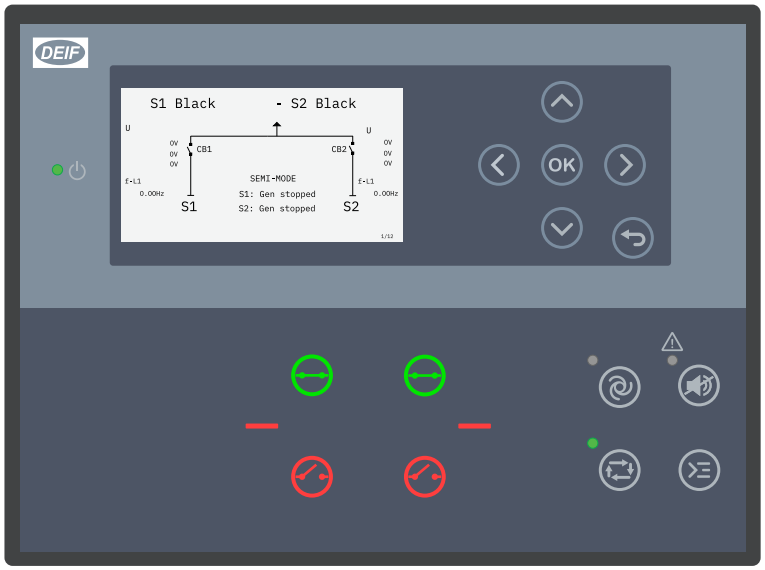
Mains-generator example



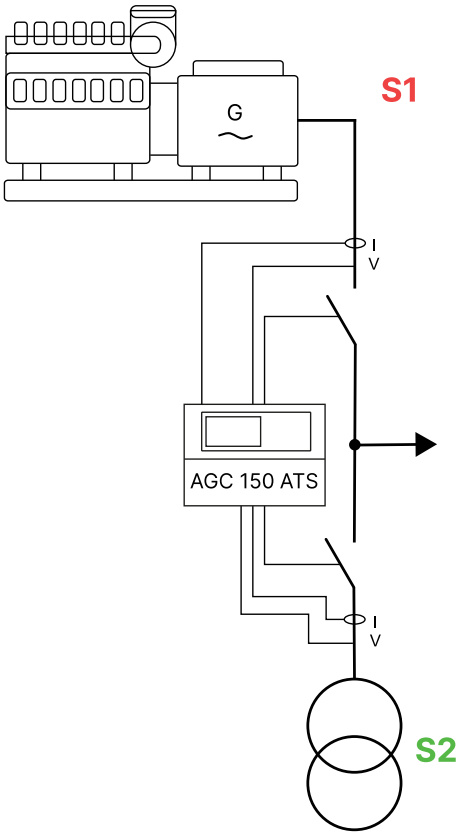


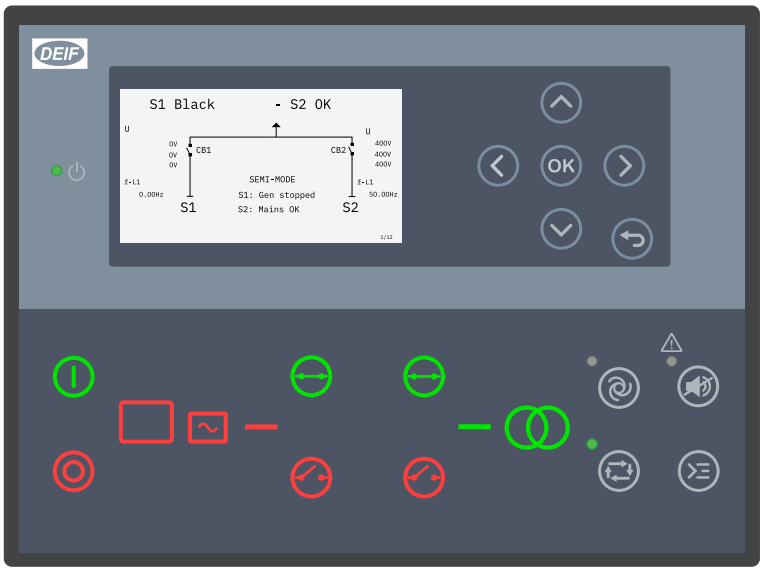
Generator-generator example



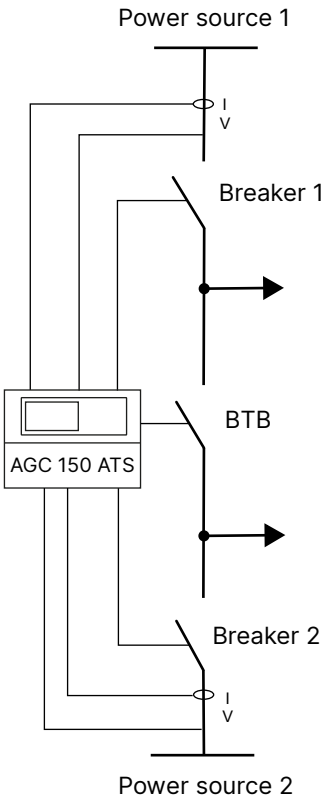


Generator-mains example



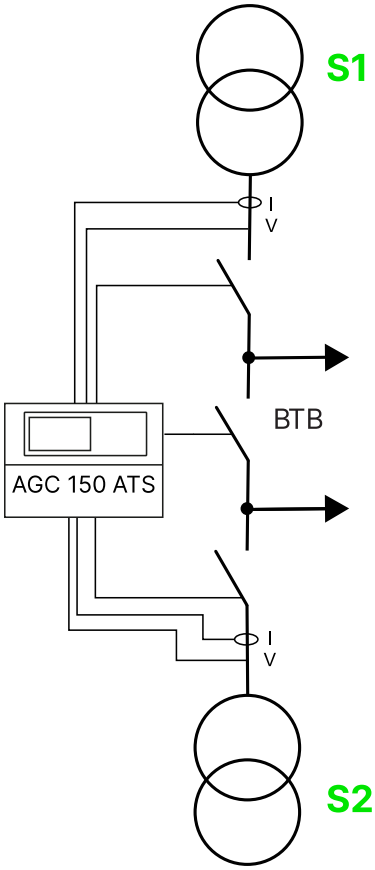


2.3 Applications with three breakers

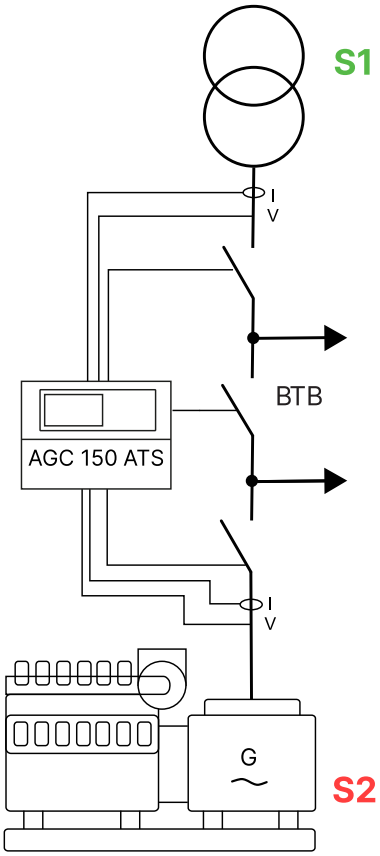


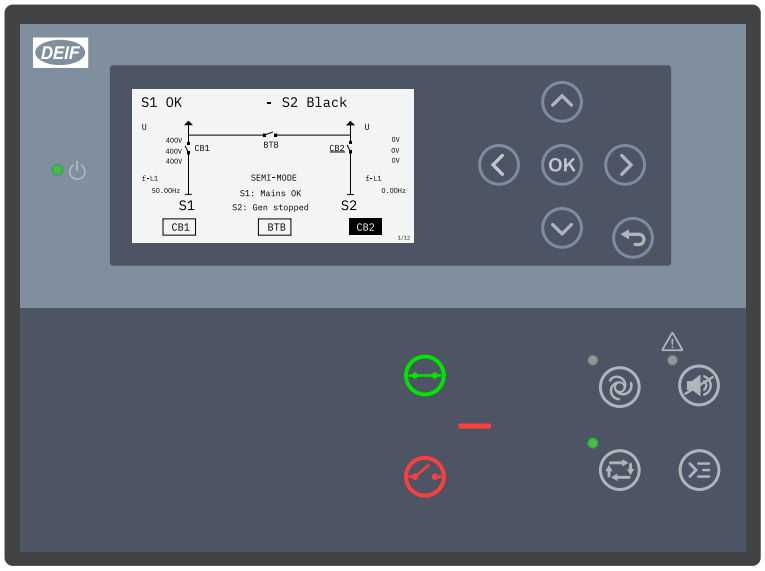
The 3-breaker setup is for two sources and two load points. It can be used in medium voltage ATS systems, such as in data centres. Source 1 or both can be set as the primary source.

Mains-mains example

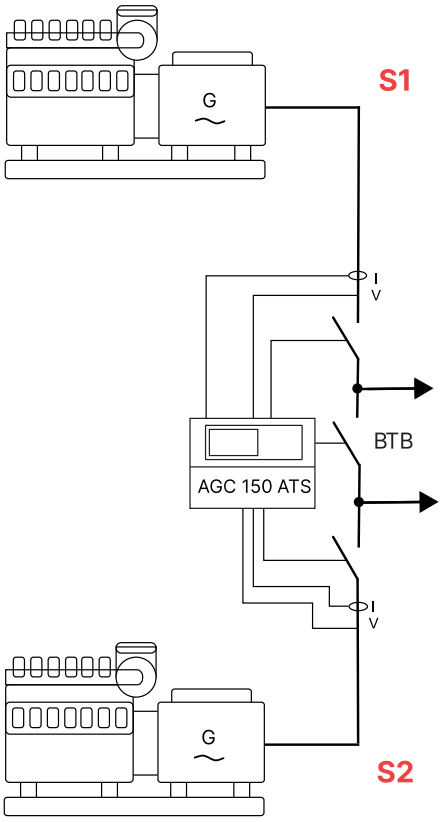


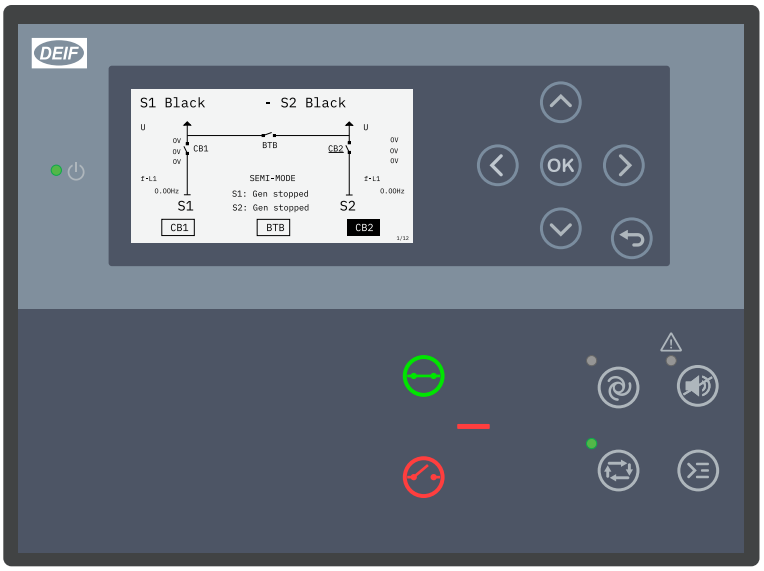
Mains-generator example



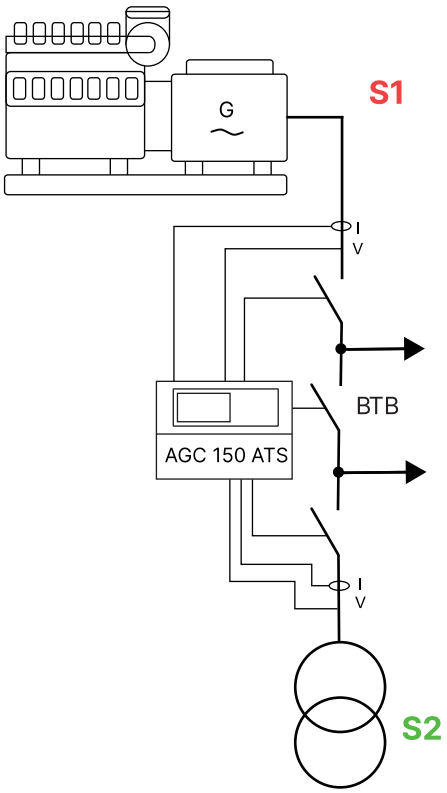


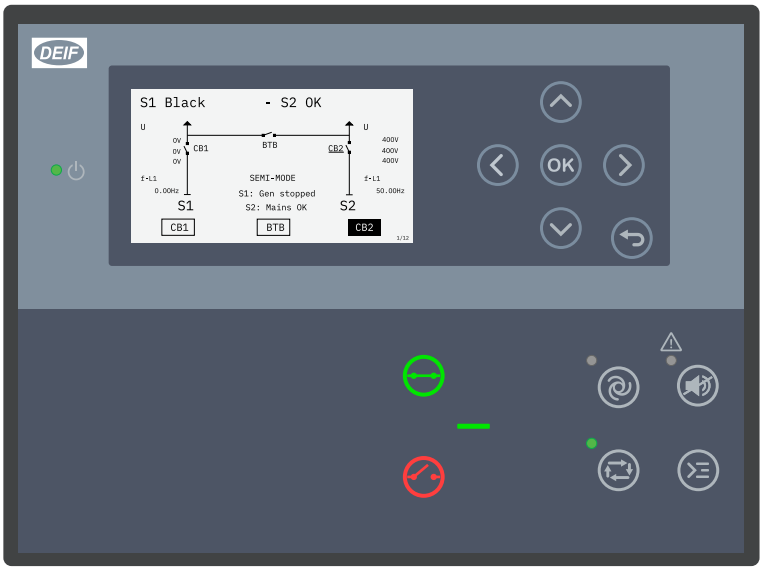
Generator-generator example





Generator-mains example





2.4 Set up AGC 150 ATS

Set up the number of breakers, ATS positions, and power supply type for the basic ATS configuration. You can configure these settings with the utility software or from the display.

2.4.1 Setting number of breakers

You can configure applications with 1, 2, or 3 breakers. If the application is configured with one breaker only, parallel operations are not possible. A blackout happens when the source is changed. Open in-phase transition is still possible with one breaker.

`ATS configuration > ATS basic config`

Parameter	Text	Range	Default
19022	ATS breakers	1, 2 to 3 breakers	2 breakers

2.4.2 ATS positions

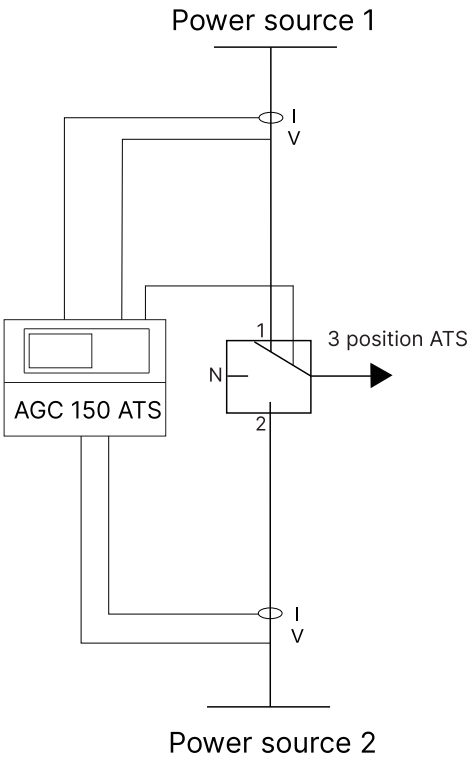
You can configure the AGC 150 ATS with either 2 positions or 3 positions in a 1-breaker/ATS breaker configuration.

`ATS configuration > ATS basic config`

Parameter	Text	Range	Default
19023	ATS positions	2 positions (S1/S2) 3 positions (S1/Neutral/S2)	3 positions (S1/Neutral/S2)

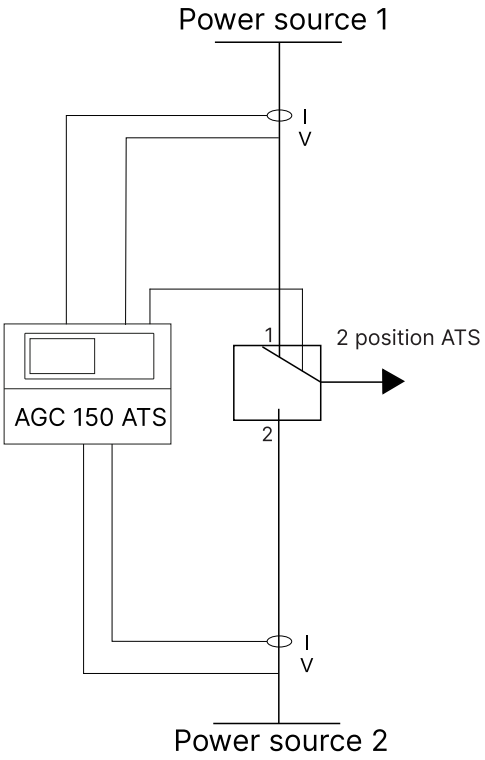
3 positions

For an AGC 150 ATS with 3 positions, the breaker always passes through neutral when switching between sources, for example S1 to neutral to S2 or S2 to neutral to S1. If a transfer time is configured (19010), this is the time at the neutral position. If both CB1 and CB2 are tripped, neutral is selected as the position.



2 positions

The 2-positions ATS is without neutral, so only with source 1 (S1) and source 2 (S2). One of the sources is always connected to the load. If both sources need to trip, the connected source stays connected to the load.



2.4.3 Power source types

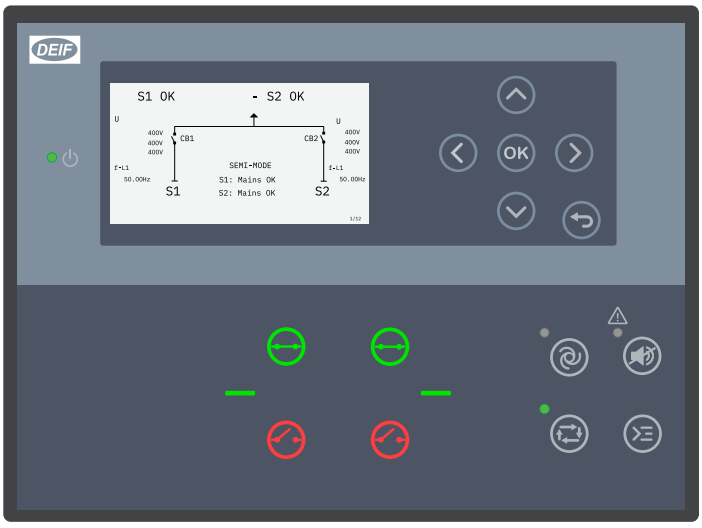
You can select four types of power source configurations:

- Mains/Mains
- Mains/Genset
- Genset/Genset
- Genset/Mains

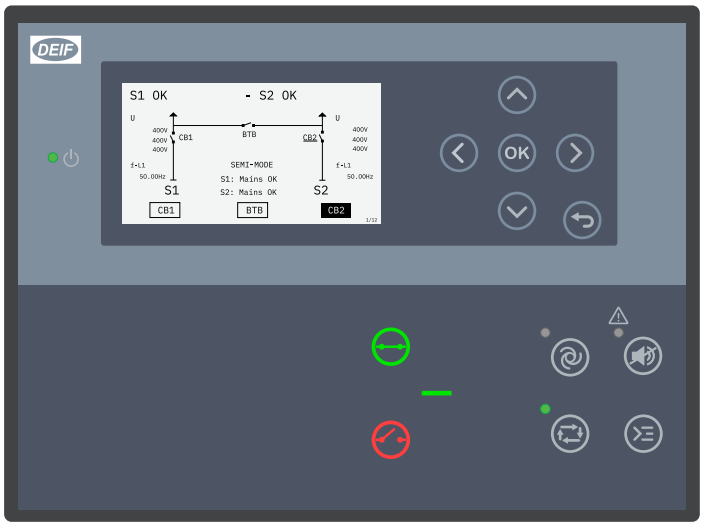
Mains/Mains

For the mains/mains application, the S1 open and close breaker buttons control mains 1, and the S2 open and close breaker buttons control mains 2.

Mains-mains display example for a 2-breaker ATS



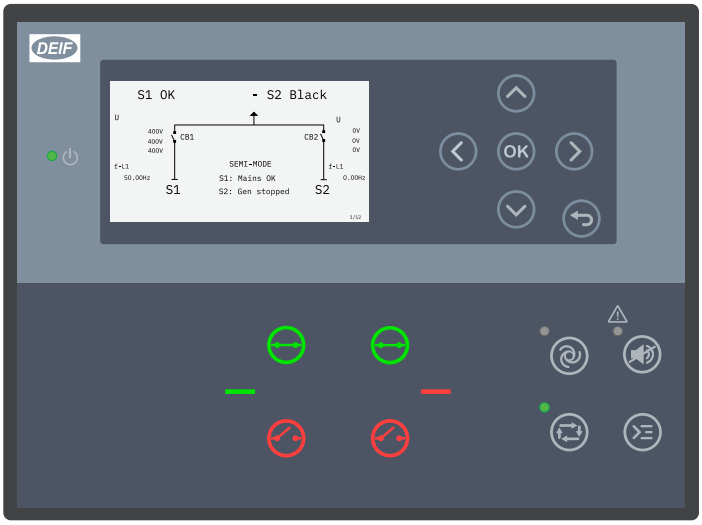
Mains-mains display example for a 3-breaker ATS



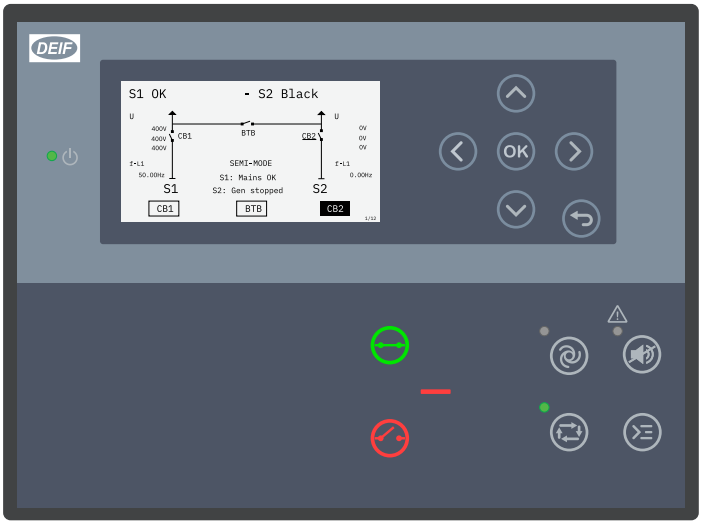
Mains/Genset

In a mains/genset application, you can start the genset and close the generator breaker with the S2 close breaker button. Use the S2 open breaker button to open the generator breaker and stop the genset. The mains breaker is opened and closed with the S1 breaker buttons.

Mains-generator display example for a 2-breaker ATS



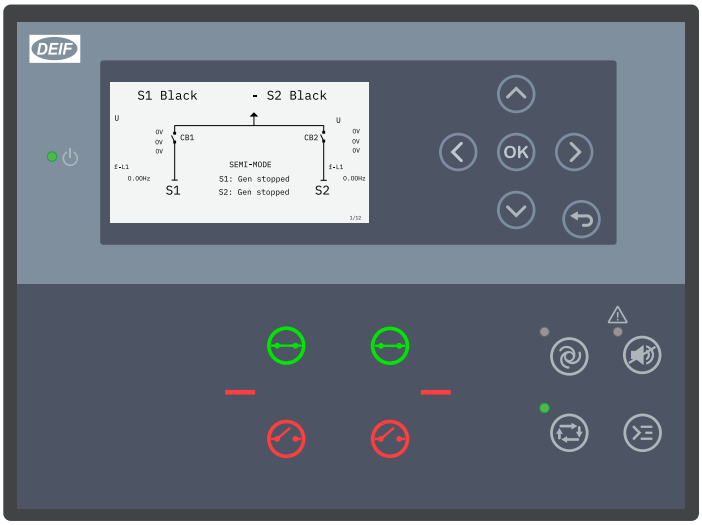
Mains-generator display example for a 3-breaker ATS



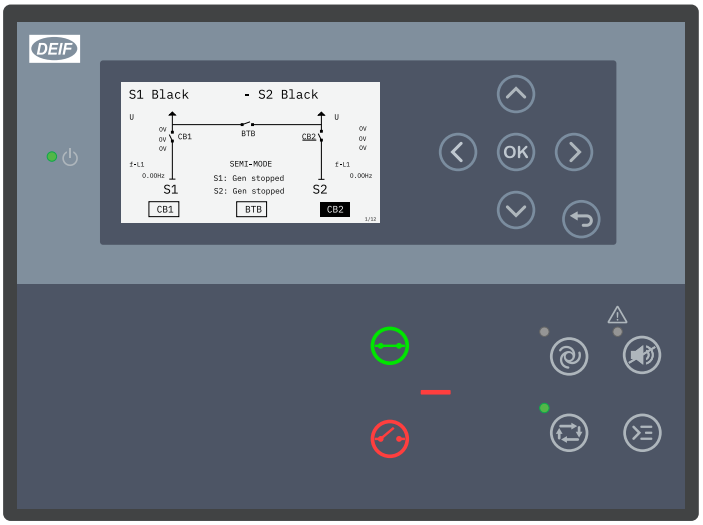
Genset/Genset

In a genset/genset application, the S1 open and close breaker buttons control genset 1, and the S2 open and close breaker buttons control genset 2.

Generator-generator display example for a 2-breaker ATS



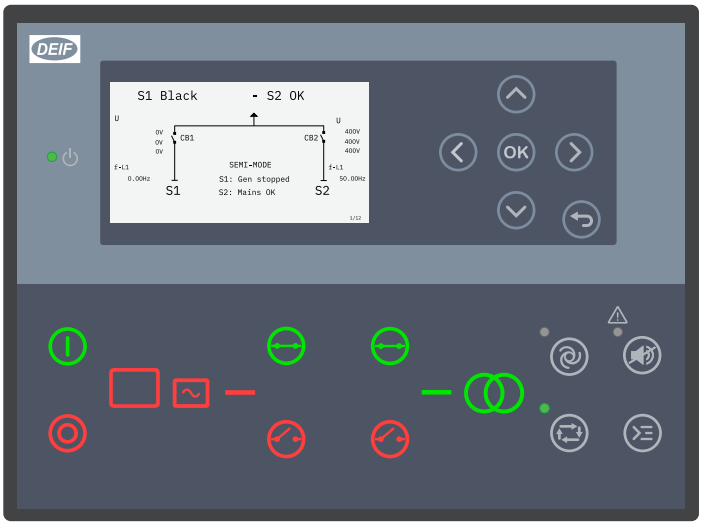
Generator-generator display example for a 3-breaker ATS



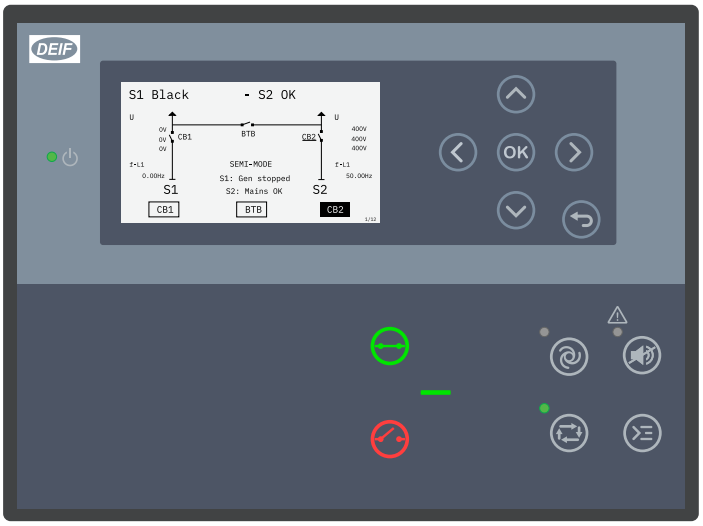
Genset/Mains

In a genset/mains application, you can start and stop the genset with the start and stop buttons on the display. The generator breaker can be opened and closed with the S1 breaker buttons on the display.

Generator-mains display example for a 2-breaker ATS



Generator-mains display example for a 3-breaker ATS



`ATS configuration > ATS basic config`

Parameter	Text	Range	Default
19024	ATS appl (S1/S2)	Mains/Mains Gen/Mains Mains/Gen Gen/Gen	Mains/Mains

2.5 Configuration

2.5.1 Transitions

By default, the controller uses an open transition to change the source. Configure the transition mode with parameter 19001. The timer is only used for closed transitions.

NOTE The transition function is only available with the **Core** software package.

`ATS configuration > ATS transfer config`

Parameter	Text	Range	Default
19001	Transition set point	Open transition Closed transition Open in-phase transition	Open transition
19002	Timer	0.1 to 320 s	0.3 s

Open transition

This is also referred to as a *break-before-make* switch, because the ATS opens the breaker for the first source, before it closes the breaker for the second source. There is a loss of power equal to the transition time.

Closed transition

This is also referred to as a *make-before-break* switch, because the ATS connects the second source before it disconnects from the first source. As the ATS is connected to both sources at the time of transition, there is no loss of power. Set the transition timer (19002) as low as possible to achieve the quickest transition.

Open in-phase transition

An open in-phase transition is where the ATS does not transition from one source to the other before all static synchronisation conditions fulfilled. The sources must also be in phase. When the sources are in phase, the ATS quickly makes the transition before the sources are out of phase. Both sources must be available before the ATS can make an open in-phase transition.

Delayed transition

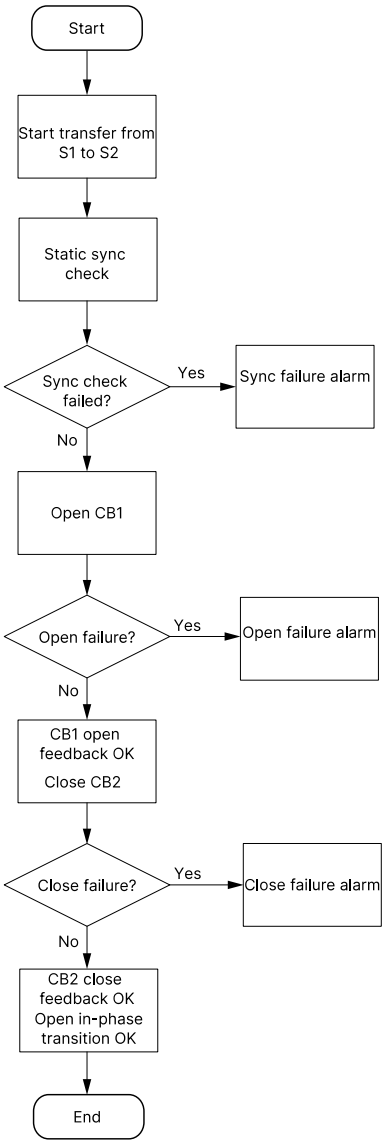
A delayed transition is similar to an open transition as there is a break between disconnecting one source and connecting the other source. This break is equal to the transition time, which you can configure in parameter 19010. For example, if you set this timer to 10 seconds, a blackout occurs for 10 seconds.

Closed transition with an adjustable overlap time

It is also possible to have closed transition with a higher adjustable overlap time, which can be used for soft unloading. Configure the time in parameter 19002.

For a synchronising controller, set *Transition* (parameter 19001) to *Closed transition*. Configure the synchronisation with parameters 2000 to 2120.

Open in-phase transition flowchart



If one of the mains has failed in applications with mains, the ATS transfer time is used. This is the time between one CB opening and the other CB closing. This means the busbar will stay black for the time set in this parameter.

ATS configuration > ATS transfer time

Parameter	Text	Range	Default
19010	ATS transfer time	0 to 100 s	0 s

Parallel alarm

If the parallel alarm is enabled and *Transition* (19001) is set to *Closed transition*, the controller enforces a maximum paralleling time for the two sources. The maximum time is configured with parameter 19001 and when this timer expires, the alarm is activated. An active alarm means the sources are parallel for longer than the configured timer and action must be taken. The alarm can, for example, be caused by a breaker open failure.

The default fail class is a warning, but you can also set the fail class to trip the breakers to avoid parallel operations in all modes.

ATS configuration > ATS transfer config

Parameter	Text	Range	Default
19003	Parallel alarm	Block Warning Trip CB1 Trip CB2 Trip CB1 + CB2	Warning

Parallel operation in SEMI-AUTO mode

You can configure whether parallel operation is allowed in SEMI-AUTO mode. If parameter 19120 (parallel in semi) is not enabled, parallel operation is not allowed and the controller shows a *NOT POSSIBLE* message on the display if sources attempt parallel operation. This function is only available in the CORE version.

Breaker failure: close breaker in SEMI-AUTO mode

Enable parameter 19122 to allow the breakers to close even if there is breaker failures. The controller must be in SEMI-AUTO mode for the function to work.

2.5.2 Setting prioritisation

ATS configuration > ATS basic config

Parameter	Text	Range	Default
19021	ATS breaker prio	Prioritize S1 Prioritize S2 Shift priority at blackout Prioritize both S1 and S2 Cyclic mode	Prioritise S1

Prioritise S1

If source 1 is okay, the controller closes CB1. The controller also closes the BTB in 3-breaker applications. If there is a source 1 failure, CB1 opens. If source 2 is okay, CB2 closes. When source 1 is okay again (including meeting the hysteresis requirements), the controller checks that source 1 remains okay for the required time. The breaker transition is configured in parameter 19001.

Prioritise S2

If source 2 is okay, the controller closes CB2. The controller also closes the BTB in 3-breaker applications. If there is a source 2 failure, CB2 opens. If source 1 is okay, CB1 closes. When source 2 is okay again (including meeting the hysteresis requirements), the controller checks that source 2 remains okay for the required time. The breaker transition is configured with parameter 19001.

Shift priority at blackout

One source breaker (CB-X) is closed, and the other source breaker (CB-Y) is open. The controller also closes the BTB in 3-breaker applications. If source X fails, then CB-X opens, and CB-Y closes. When the source X is okay again, the controller does not open CB-Y.

Prioritise both S1 and S2

In 3-breaker applications, if source 1 and source 2 are okay, CB1 and CB2 are both closed. The BTB stays open.

In 2-breaker applications, CB1 is always closed first and CB2 is synchronised unless CB2 is closed before the mode is changed. You need the CORE software package for the 2-breaker option.

Cyclic mode

Use cyclic mode to transfer the power supply from one source to the other. The power is transferred after an adjustable timer expires. Configure the timer with parameter 19110. To enable cyclic mode, set the ATS breaker priority to cyclic mode and then select AUTO mode. The timer is shown on the supervision display page.

2.5.3 Voltage and frequency settings

Source 1 failure

In parameters 7061 to 7094, configure the range and hysteresis for voltage and frequency. You can also configure timers for source 1 failure (minimum 0.5 s) and source 1 okay (minimum 2 s). If both sources fail but one of them recovers, the controller will skip this timer, ensuring loads are powered again in the shortest time possible.

Source 2 failure

In parameters 7101 to 7124, configure the range and hysteresis for voltage and frequency. You can also configure timers for source 2 failure (minimum 0.5 s) and source 2 okay (minimum 2 s). If both sources fail but one of them recovers, the controller will skip this timer, ensuring loads are powered again in the shortest time possible.

Source 1 OK and Source 2 OK timers

In parameters 6221 and 6222, configure a voltage and frequency OK delay time after detection of the voltage.

Parameter	Text	Range	Default
6221	S1 Hz/V OK	0 to 99 s	1 s
6222	S2 Hz/V OK	0 to 99 s	1 s

2.5.4 Genset settings

Start and stop outputs

To configure the start and stop outputs, go to *I/O & Hardware setup* in the utility software and select the *DO 5 - 18* tab. As default, output 5 is configured as start/stop for genset 1, and output 6 is for genset 2.

If there is an active alarm configured with the *Block* fail class, it is not possible to start the genset(s). If the emergency stop is activated, the gensets stop immediately.

Running detection

The running detection level is reached when the voltage and frequency are stabilised within a defined time. You can configure the voltage and frequency settings for source 1 with parameters 7063, 7064, 7073, and 7074. Use parameters 7103, 7104, 7113, and 7114 for source 2.

Start failure

There is a start failure when the genset does not start before the adjustable start failure timer expires. The timer starts when the start output is activated and stops when the engine receives running feedback. Configure the start failure settings with parameters 19095 and 19097.

Cooldown

The cooling down timer starts when a stop command is given. You can configure the timer with parameters 19081 and 19082. If the timer is set to 0 s, the cool down period is ignored. Push the *STOP* button in SEMI-AUTO to interrupt the cool down.

Stop failure

There is a stop failure if the genset does not stop before the adjustable stop timer expires. The timer starts when the stop output is activated and stops when running feedback is no longer present. Configure the stop failure settings with parameters 19091 and 19093.

Genset failure

A genset failure occurs when there is no running feedback when the genset is running, but a stop command has not been given. Configure the settings with parameters 19101 and 19103.

Genset output configuration

You can select if the genset start signal is normally low or high. Configure the genset set point with parameters 19181 and 19182.

Stop disconnected gensets

If gensets are not requested to start before a configurable timer expires, the gensets are disconnected. Configure and enable this timer with parameter 19200.

2.5.5 Setting breaker type

`ATS configuration > Breaker configuration`

Parameter	Text	Range	Default
19031	CB1 breaker type	Pulse Continuous NE Compact Continuous ND	Pulse
19032	CB2 breaker type	Pulse Continuous NE Compact Continuous ND	Pulse
19033	BTB breaker type	None Pulse Continuous NE Compact Continuous ND	None

Breaker supply type

You can select either *powered by external* or *powered by sources* as the supply type. *Powered by external* breakers are powered by a battery and *Powered by sources* breakers are powered by the sources. *Powered by sources* breakers are unable to open and close if both sources are inactive.

`ATS configuration > ATS breaker config > Breaker supply type`

Parameter	Text	Range	Default
19131	CB1 breaker supply	Powered by external	Powered by external

Parameter	Text	Range	Default
		Powered by sources	
19132	CB2 VDC/DAC breaker	Powered by external Powered by sources	Powered by external

Breaker load time

You can configure the time needed to charge the breakers before closing.

`ATS configuration > ATS breaker config > Breaker load time`

Parameter	Text	Range	Default
19191	CB1 Load time	0 to 30 s	0 s
19192	CB2 Load time	0 to 30 s	0 s
19193	BTB Load time	0 to 30 s	0 s

More information
See **Breaker spring load time** in the **AGC 150 Generator Mains BTB Designer's handbook** for a description of the principles.

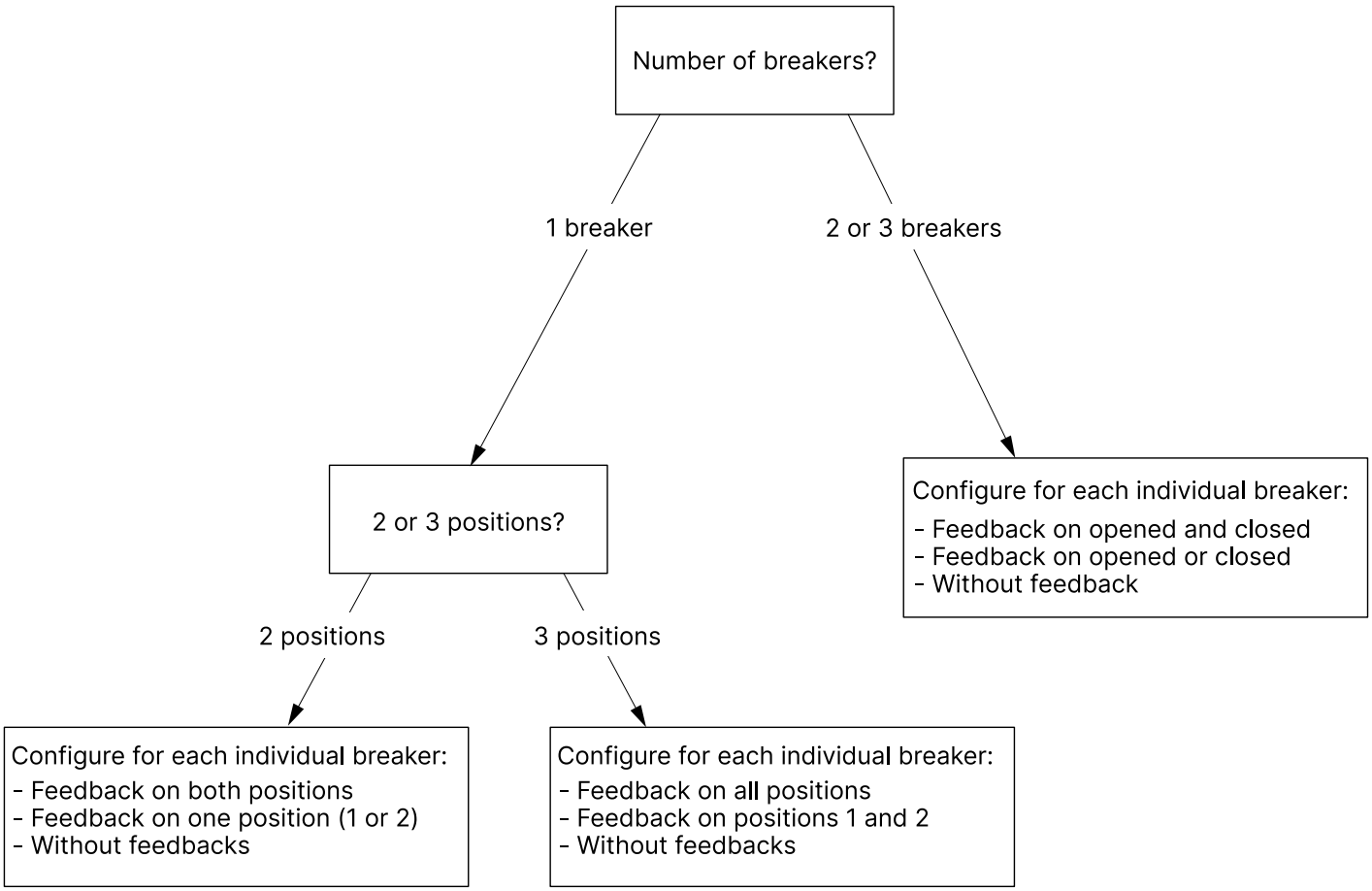
2.5.6 Breaker feedback

It is possible to run without breaker feedback(s). If there are no feedbacks, parameters 19161, 19162, 19163, and 19164 are used to set the pulse lengths and feedback delays. If you run without feedbacks, the transition must be set to open transition, otherwise an unsupported application alarm is activated.

WARNING

Breaker feedback

Running without feedbacks can be dangerous. The hardware must be able to support operating without feedback.



2.5.7 Breaker position failure

The breaker position failure alarm is activated if feedbacks are configured and both feedbacks from the breaker are high.

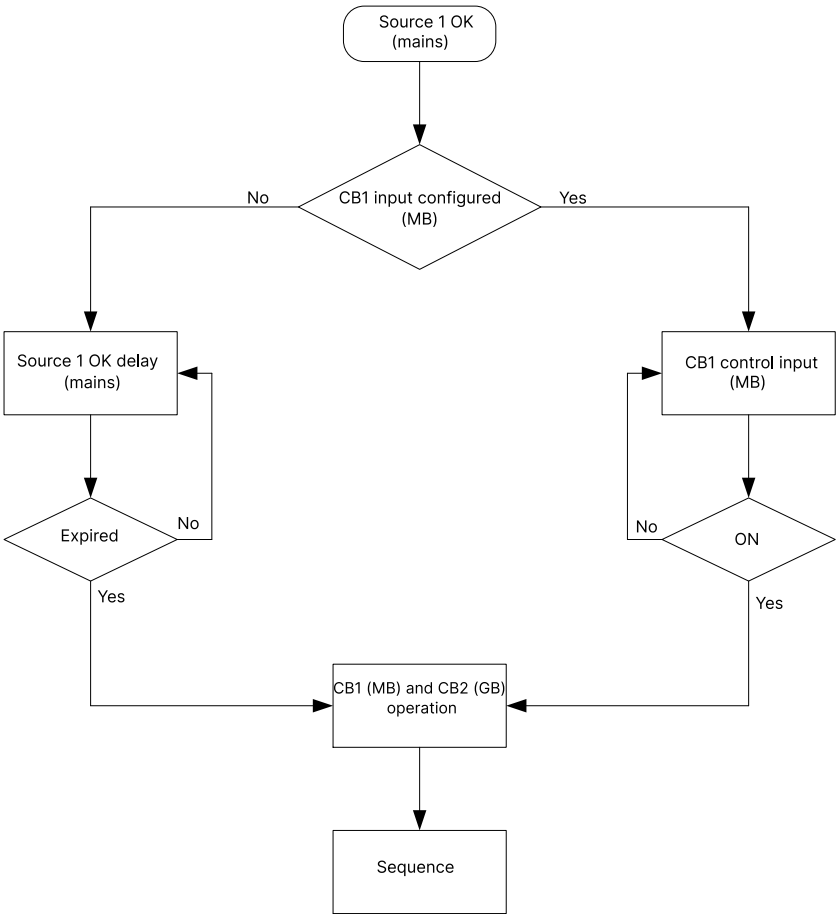
You can assign a fail class to try to trip the faulty breaker when the controller discovers a breaker position failure.

2.5.8 Digital input for mains breaker control

It is possible to configure the *Source 1 OK* or *Source 2 OK* digital input to be used to control the mains return sequence. The purpose of this function is to let an external device (for example, a PLC) or an operator control the mains return sequence.

The flowchart below shows that if the input is configured, it needs to be activated (by a pulse) to start the mains return sequence. In this example, the mains is source 1 and source 2 is generator supply. The load continues on generator supply if the input is not activated.

The source OK delay timer is not used when the *Mains OK* input is configured.



2.5.9 Synchronisation

The controller automatically checks that synchronisation is correct before closing a breaker.

NOTE The synchronisation function is only possible with the **Core** software package.

`Synchronisation > Static synchronisation`

Parameter	Text	Range	Default
2031	Maximum df	0 to 0.5 Hz	0.1 Hz
2032	Mazimum dU	1 to 10 %	5 %
2033	Closing window	0.1 to 20 degrees	10 degrees
2034	Static sync	0.1 to 99 s	1 s
2035	Static type ATS	Breaker Sync check Infinite sync	Breaker

`Synchronisation > Synchronisation failure > Deadbus closing`

Parameter	Text	Range	Default
2121	Sync Window	2 to 20 %	15 %
2122	Sync window	0.1 to 2 s	0.5 s

NOTE The voltage and frequency must be within this sync window of the nominal values for this time for the breaker to close on a dead bus.

2.5.10 Step-up transformer angle offset

In applications where the use of a generator with a step-up transformer is required, use parameters 9141 and 9142 for angle offset.

Synchronisation > Synchronisation failure> Angle offset

Parameter	Text	Range	Default
9141	Angle comp. S1/S2 1	-179° to 179°	0°
9142	Angle. comp. S1/S2	-179° to 179°	0°

More information
See the **AGC 150 Generator, Mains and BTB Designer's handbook** for details.

2.5.11 Fail classes

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

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

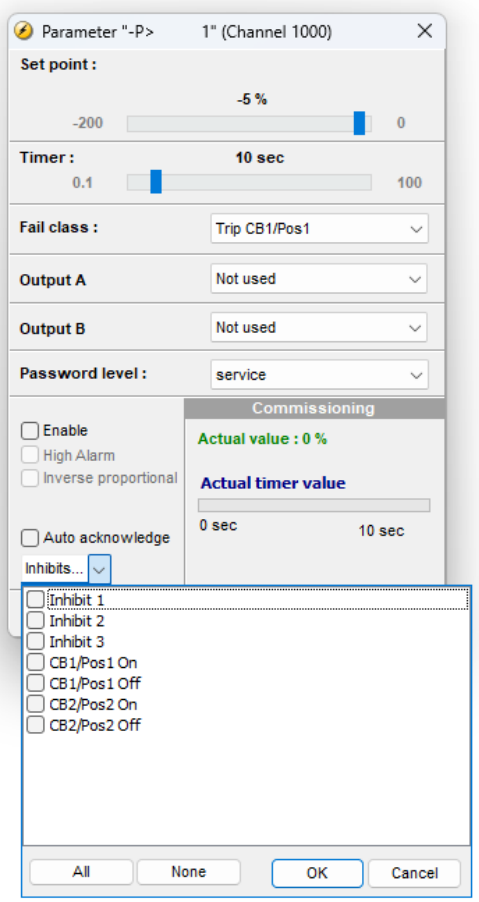
To change the fail class using the utility software, open the alarm in the parameter list, then select the fail class from the list.

Alarm fail classes

Fail class	Text
Block	It is not possible to close the breaker. A closed breaker will remain closed. If a breaker is opened, it cannot be closed again.
Warning	A warning is displayed.
Trip CB1	Breaker CB1 is opened.
Trip CB2	Breaker CB2 is opened.
Trip CB1 + CB2	Breaker CB1 and CB2 are opened.

2.5.12 Inhibits

With the utility software it is possible to configure inhibits for each alarm. When configuring the parameters for an alarm, inhibits can be selected in a drop-down window.



Function	Notes
Inhibit 1	M-Logic outputs: Conditions are programmed in M-Logic.
Inhibit 2	
Inhibit 3	
CB1/Pos 1 On	Breaker 1 is closed.
CB1/Pos 1 Off	Breaker 1 is open.
CB2/Pos 2 On	Breaker 2 is closed.
CB2/Pos 2 Off	Breaker 2 is open.

2.5.13 Genset-Genset start/stop function

The AGC 150 ATS controller has a generator-generator start/stop function.

To configure the function:

1. Go to `ATS configuration > ATS basic config > ATS appl (S1/S2)` and select `Gen/Gen` as the set point.
2. Go to the *I/O & Hardware setup* tab.
3. In the *DI 39 - 50* tab, select *Gen-Gen start/stop* as the function for input 39.
4. Go to the *DO 5 - 18* tab, make sure the start and stop outputs are configured for genset 1 and genset 2, respectively.
5. Select AUTO as the running mode.

The controller starts the genset when the configured input is activated. If the input is deactivated, the controller stops the genset.

You can also use M-Logic to configure the start/stop input and outputs.

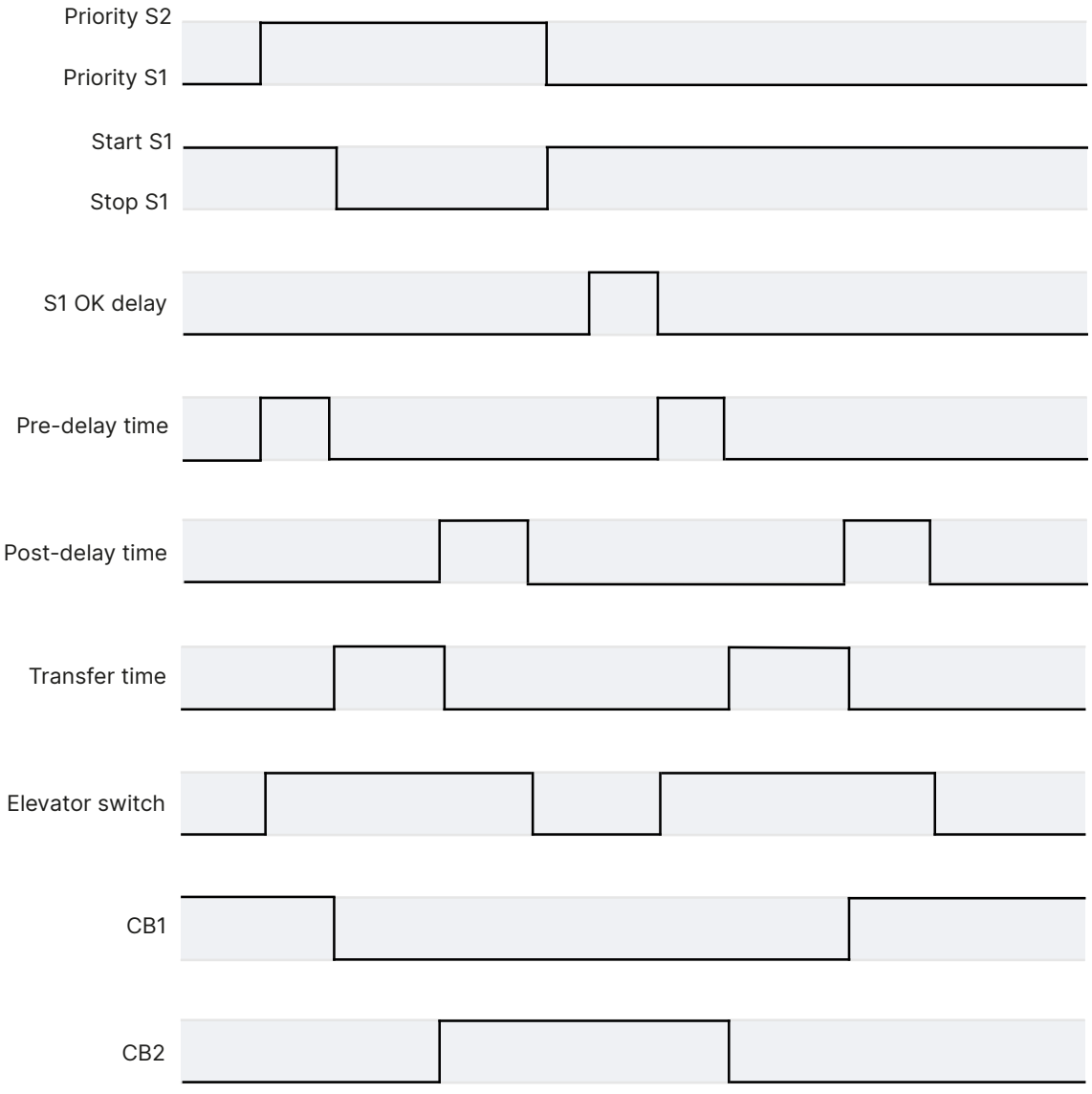
2.6 Elevator switch

The controller automatically switches to the backup source at a scheduled transfer of power after an adjustable pre-delay time. The transfer includes priority change, source recovery, and source change in cyclic mode.

Use this function for sensitive loads, for example elevators, to avoid disruption to the system during a transfer. The pre-delay time allows the elevator to move to the next floor and safely open the doors before the power is transferred.

Configure an output as elevator switch and enable the elevator switch function in parameter 19141. Configure the pre-delay and post-delay timers with parameters 19142 and 19143. Set the transition as an open transition in parameter 19000. Both sources must be OK, and there must not be active trip or failure alarms. If the inhibit CB close function is used, the circuit breaker (CB) must be closed if the inhibit close flag is set. The elevator switch is activated when there is a transfer of power.

Generator/Mains example



ATS configuration > ATS transfer config > Elevator-switch

Parameter	Text	Range	Default
19141	Elevator switch	On Off	Off
19142	Elevator pre-delay	0 to 999 s	10 s
19143	Elevator post-delay	0 to 999 s	10 s

2.7 Modes

2.7.1 AUTO mode

The controller is fully automatic in auto mode. The controller automatically switches to the backup source if it detects a mains failure or blackout. It does this by automatically connecting and disconnecting the breakers.

2.7.2 SEMI-AUTO mode

The operator or an external signal can connect or disconnect the breakers. The controller does not automatically connect or disconnect the breakers.

Block mode is also available.

2.7.3 Test mode

Activate the test mode from the *Shortcut* on the display, with a digital input, or M-Logic commands. If the timer is set to 0.0 min, the test runs until the breaker open button is pushed or the stop button in a genset/mains application.

`Functions > Test`

Parameter	Text	Range	Default
7041	Timer	0.0 to 999.0 min	0.0 min
7043	Return mode	Semi-auto mode Auto mode No mode change	No mode change
7044	Type	Simple test Load test (not 2 gensets)	Simple test

Simple test

The simple test only starts the genset and runs it at nominal frequency with the generator breaker open. The test runs until the timer expires.

Load test

The load test starts the genset and runs it at nominal frequency, synchronise the generator breaker and produce power according to the set point. The test runs until the timer expires. It is not possible to run the load test with a genset/genset application or if the genset breaker is unable to close.

It is not possible to run the test mode if:

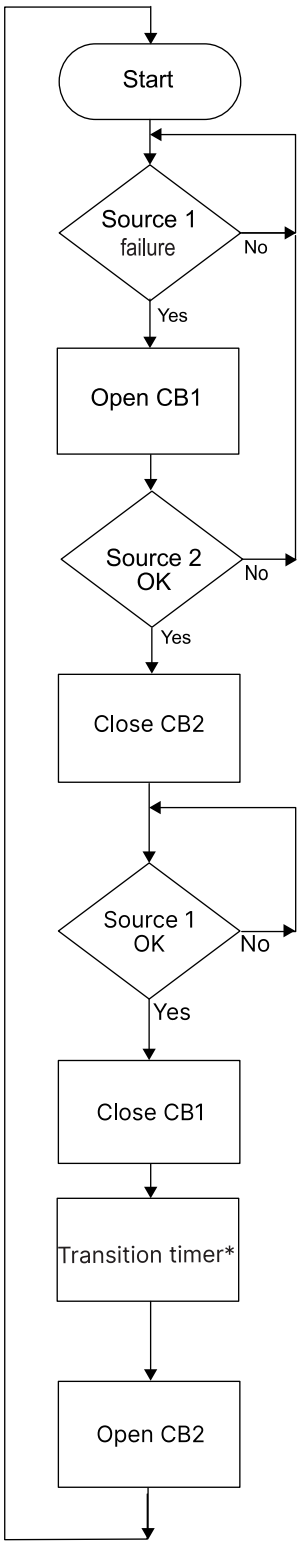
- A mains/mains application is active.
- The genset has a start failure.

2.8 Flowchart

The following flowchart is for a 2-breaker application, with closed transition (parameter 19001), where S1 is prioritised.

`ATS configuration > ATS configuration`

Parameter	Text	value
19021	ATS breaker prio	Prioritize S1
19022	ATS breakers	2 breakers



*parameter 19001

2.9 Alarms

The controller has alarms that have configurable set points, timer settings and fail classes.

Push the alarm button  to view all active alarms on the display. The active alarms are also accessible from Modbus. The alarms are in Modbus addresses 28000 to 28099 and these are not listed in the *Input register (04)*. The Modbus address for an active alarm corresponds to the address value in the utility software. For example, Modbus address 104 is equal to parameter 2160 CB1 Open fail as the address in the utility for this parameter is 104.

2.9.1 Voltage and frequency failures

Voltage failures

`Source 1 > U mains failure`

Parameter	Text	Range	Default
7061	S1 U failure	0.5 to 990 s	5 s
7062	S1 OK Delay U	2 to 9900 s	60 s
7063	S1 Low voltage	30 to 100 %	90 %
7064	S1 High voltage	100 to 120 %	110 %
7066	S1 Unbalanced Volt	2 to 100 %	100 %
7091	S1 Low Volt. Hyst.	0 to 70 %	0 %
7092	S1 High Volt Hyst.	0 to 20 %	0 %

`Source 2 > U mains failure`

Parameter	Text	Range	Default
7101	S2 U failure	0.5 to 990 s	5 s
7102	S2 OK Delay U	2 to 9900 s	60 s
7103	S2 Low voltage	30 to 100 %	90 %
7104	S2 High voltage	100 to 120 %	110 %
7106	S2 Unbalanced Volt	2 to 100 %	100 %
7121	S2 Low Volt Hyst.	0 to 70 %	0 %
7122	S2 High Volt Hyst.	0 to 20 %	0 %

Frequency failures

`Source 1 > f mains failure`

Parameter	Text	Range	Default
7071	S1 failure	0.5 to 990 s	5 s
7072	S1 OK Delay f	2 to 9900 s	60 s
7073	S1 Low Frequency	80 to 100 %	95 %
7074	S1 High Frequency	100 to 120 %	95 %
7093	S1 Low Freq. Hyst.	0 to 20 %	0 %
7094	S1 High Freq. Hyst.	0 to 20 %	0 %

Source 2 > f mains failure

Parameter	Text	Range	Default
7111	S2 failure	0.5 to 990 s	5 s
7112	S2 OK Delay f	2 to 9900 s	60 s
7113	S2 Low Frequency	80 to 100 %	95 %
7114	S2 High Frequency	100 to 120 %	95 %
7123	S2 Low Freq. Hyst.	0 to 20 %	0 %
7124	S2 High Freq. Hyst.	0 to 20 %	0 %

Hysteresis

Hysteresis can be set for alarms for high and low nominal voltages and frequencies.

S1 high voltage example

A high voltage alarm has a set point of 110 % of nominal voltage for S1 and a S1 high voltage hysteresis of 7 %. This means the alarm cannot be reset until the S1 value falls below 103 % of the nominal voltage.

S2 low voltage example

A low voltage alarm with a set point of 70 % of the nominal voltage and a S1 low voltage hysteresis of 5.0 %. The alarm is only reset when the value is above 75.0 % of the nominal voltage.

2.9.2 Synchronisation failures

Synchronisation > Synchronisation failure

Parameter	Text	Range	Default
2130	CB1 Sync fail	5 to 999.9 s	5 s
2140	CB2 Sync fail	5 to 999.9 s	60 s
19070	BTB Sync failure	5 to 999.9 s	60 s
2240	Sep Sync relay		Not used

2.9.3 Breaker failures

Breakers > CB1

Parameter	Text	Range	Default
2161	CB1 Open fail	1 to 10 s	2 s
2165	CB1 Open fail	Fail classes	Warning

Parameter	Text	Range	Default
2171	CB1 Close fail	1 to 20 s	2 s
2175	CB1 Close fail	Fail classes	Warning

Parameter	Text	Range	Default
2181	CB1 Pos fail	1 to 5 s	1 s
2185	CB1 Pos fail	Fail classes	Warning

Parameter	Text	Range	Default
1981	CB1 Ext. tripped	Fail classes	Warning

Breakers > CB2

Parameter	Text	Range	Default
2201	CB2 Open fail	1 to 10 s	2 s
2205	CB2 Open fail	Fail classes	Warning

Parameter	Text	Range	Default
2211	CB2 Close fail	1 to 20 s	2 s
2215	CB2 Close fail	Fail classes	Warning

Parameter	Text	Range	Default
2221	CB2 Pos fail	1 to 5 s	5 s
2225	CB2 Pos fail	Fail classes	Warning

Parameter	Text	Range	Default
1983	CB2 Ext. tripped	Fail classes	5 s

Breakers > BTB

Parameter	Text	Range	Default
19040	BTB Open fail fail	1 to 10 s	2 s
19040	BTB Open fail	Fail classes	Warning

Parameter	Text	Range	Default
19050	BTB Close fail	1 to 20 s	2 s
19050	BTB Close fail	Fail classes	Warning

Parameter	Text	Range	Default
19060	BTB Pos fail	1 to 5 s	1 s
19060	BTB Pos fail	Fail classes	Warning

Parameter	Text	Range	Default
1985	BTB Ext. tripped	Fail classes	Warning

3. Utility software

3.1 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

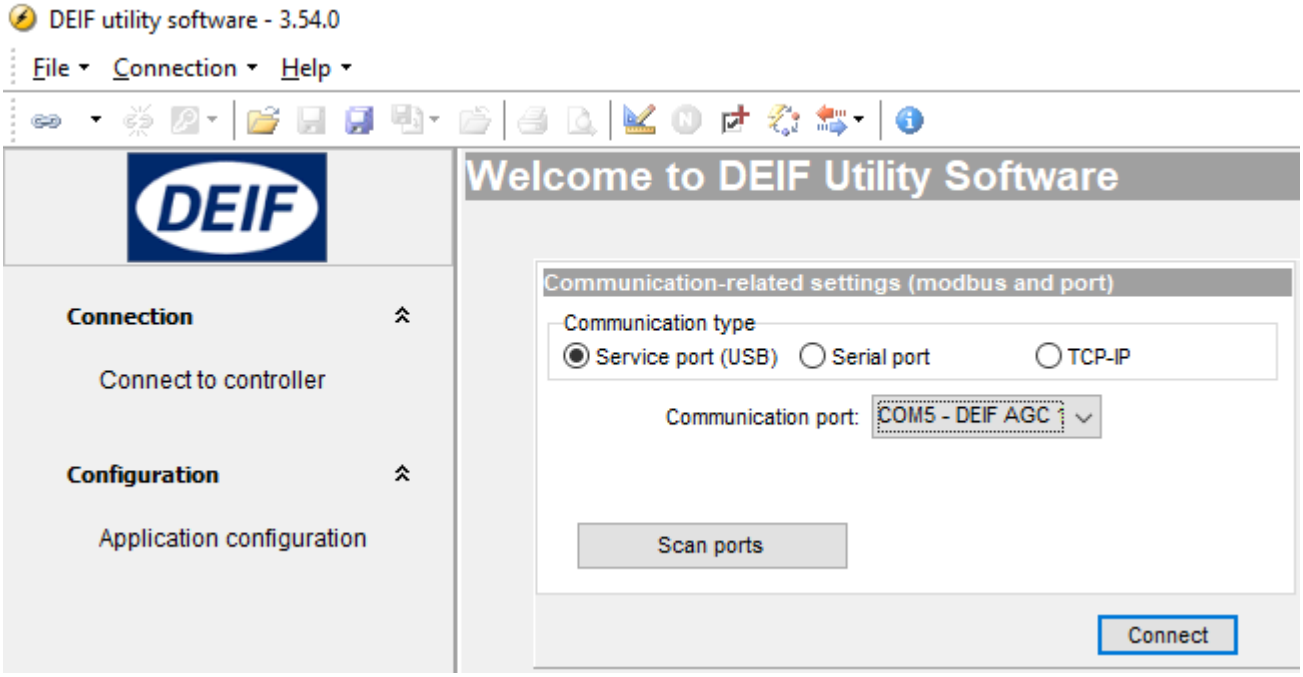
3.2 Connection

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

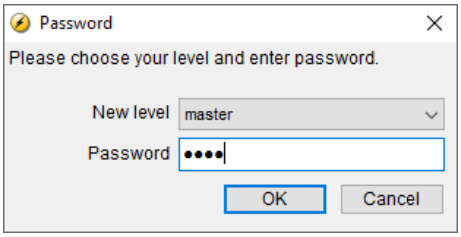
3.2.1 USB connection

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. Select the service port (USB) option.
5. Select the communication port.
6. When prompted, select the access level, enter the password, and select OK.



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

3.3 Network connections

3.3.1 TCP connection

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

Default controller network address

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

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

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

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

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

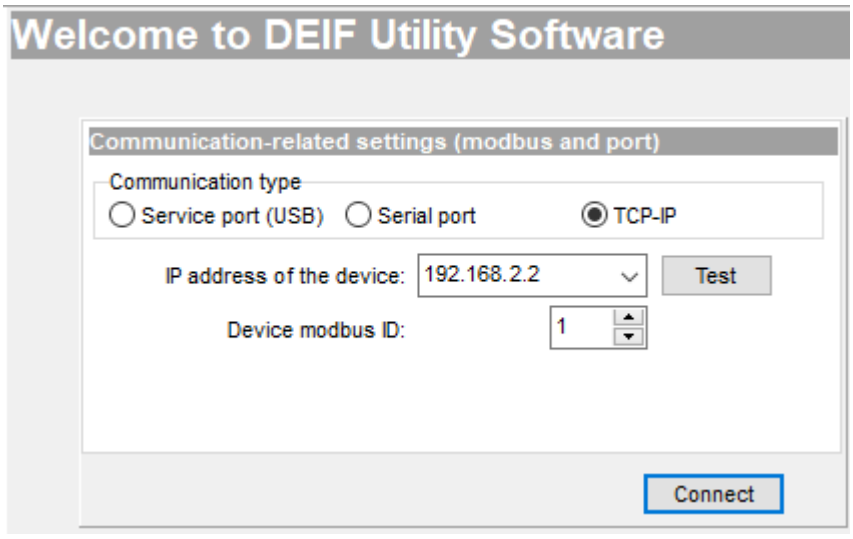
Point-to-point Ethernet connection to the controller

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

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

When the PC has the correct static IP address:

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

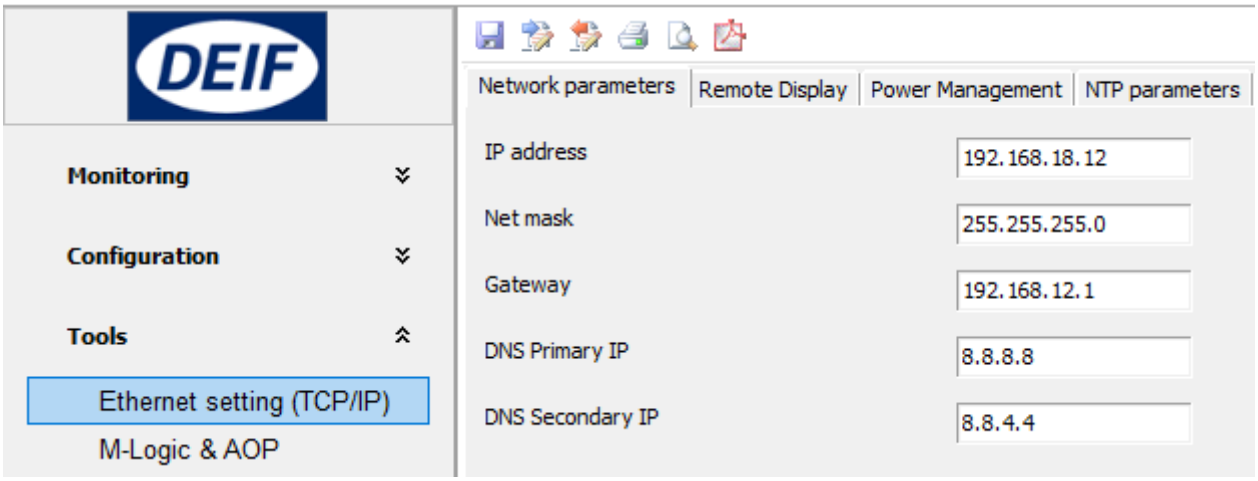


4. You can use the *Test* button to check if the connection is successful.
5. Select *Connect* to connect to the controller using TCP-IP.

Configuring the controller IP address using the utility software

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

The *Network Parameters* window opens:



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

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

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

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.

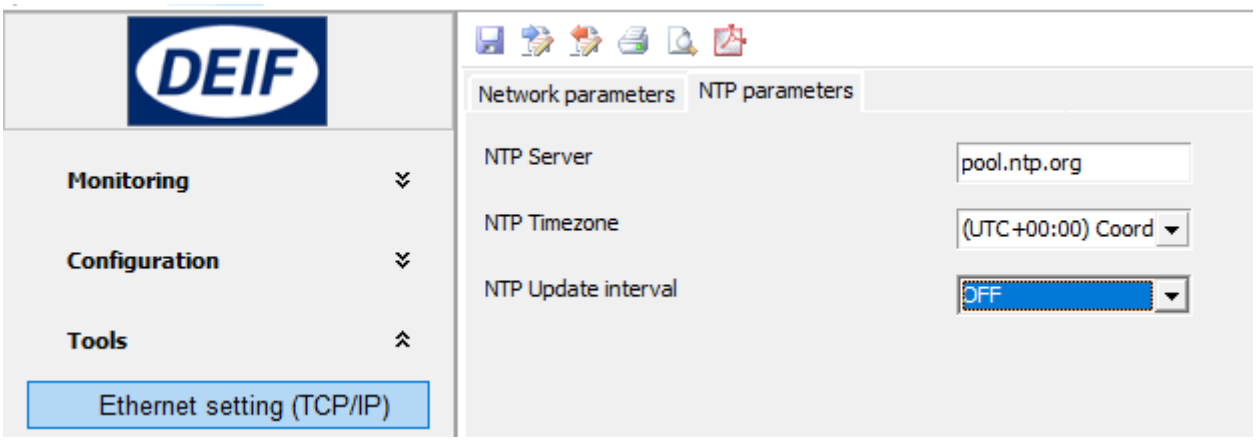
The PC can then be connected to the switch, and the Ethernet cable can be in the same port of the switch at all times. You can enter the controller IP address in the utility software.

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.

3.3.2 Using NTP

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

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



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

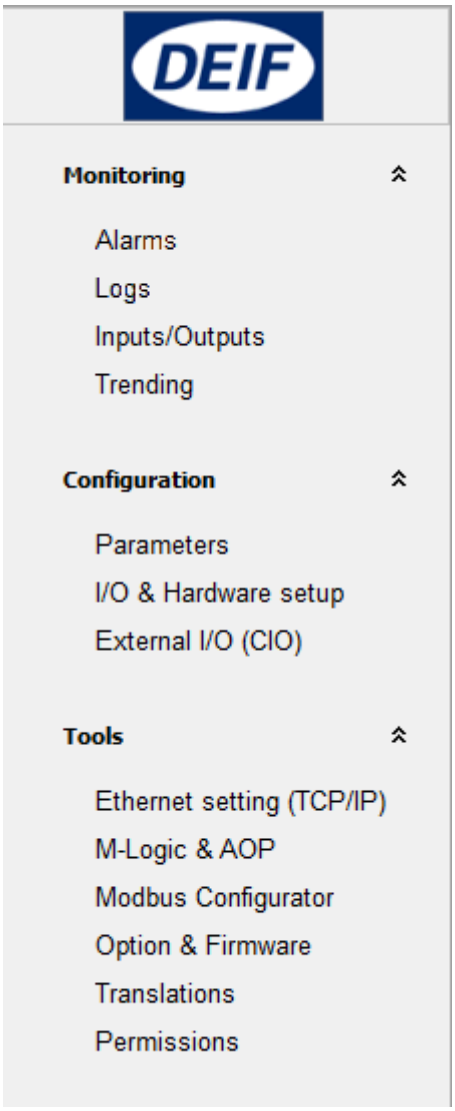
NOTE The selected NTP server must be available in the network.

3.4 Utility software interface

3.4.1 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. Read the controller counters.
12. Information on the controller and the software.
13. Read, write, backup, and restore the device.
14. Data tracing (shows the max./min. of a value, as long as the data tracer window is open).
15. Send commands to the controller.
16. Synchronise the controller clock with the connected PC.

3.4.2 Left menu



- **DEIF**
  - Link to www.deif.com
- **Monitoring**
  - 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
    - See the status of inputs and outputs.
  - 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**
  - Parameters
    - Configure and view parameters.
  - I/O & hardware setup
    - Configure the inputs and outputs.
  - External I/O (CIO)
    - Configure CAN bus input/output modules.
- **Tools**
  - Ethernet setting (TCP/IP)
    - Configure Ethernet settings and communication.
  - M-Logic & AOP
    - Configure M-Logic and additional operator panels.
  - Modbus Configurator
    - Configure the configurable Modbus addresses.
  - Option & Firmware
    - Upgrade options and new firmware.
  - Translations
    - Customise or translate (almost all of) the text in the controller.
  - Permissions
    - Configure read & write permissions.

4. AC protections

4.1 About protections

4.1.1 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.

4.1.2 Phase-neutral voltage trip

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

`Source 1 > Voltage protections > Voltage detect. type`

Parameter	Text	Range	Default
1201	S1 U detection type	Phase - Phase Phase - Neutral	Phase - Phase

`Source 2 > Voltage protections > Voltage detect. type`

Parameter	Text	Range	Default
1202	S2 U detection type	Phase - Phase Phase - Neutral	Phase - Phase

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

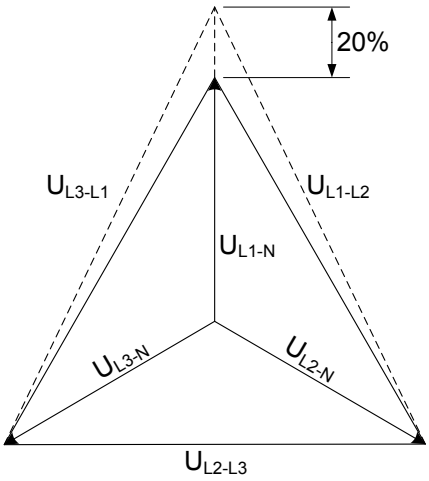
Example: Actual measurements at a 10 % under-voltage situation in a 400/230 volt system

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

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

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

Example



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

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

4.1.3 Phase sequence error and phase rotation

Voltage terminals

- A-side voltage terminals: 62 to 65
- B-side voltage terminals: 66 to 69

The controller has two alarms for phase sequence error (with different fail classes).

Source 2 > AC configuration > Phase sequence error

Parameter	Text	Range	Default
2155	Phase seq error B	Fail classes	Block

Source 1 > AC configuration > Phase direction

Parameter	Text	Range	Default
2154	Phase rotation	L1/L2/L3 L1/L3/L2	L1/L2/L3

Source 1 > AC configuration > Phase sequence error

Parameter	Text	Range	Default
2150	Phase seq error A	Fail classes	Block

4.2 Source 1 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.

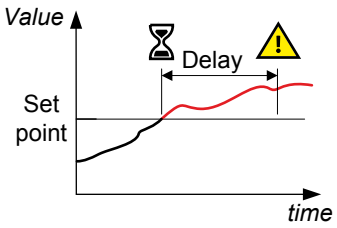
Protections	Alarms	ANSI	Operate time
Over-voltage	2	59	<200 ms
Under-voltage	3	27P	<200 ms
Over-frequency	3	81O	<300 ms
Under-frequency	3	81U	<300 ms
Unbalanced voltage	1	47	<200 ms
Under-voltage and reactive power, U and Q	2	27 + 32RV	<250 ms

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

4.2.1 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.



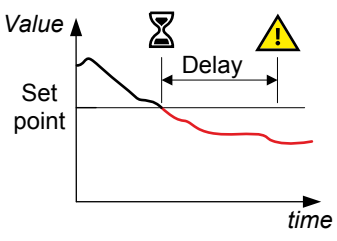
Source 1 > Voltage protections > Over-voltage > S U> [1 or 2]

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

4.2.2 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.



Source 1 > Voltage protections > Under-voltage > S1 U< [1 to 3]

Parameter	Text	Range	S1 U< 1	S1 U< 2	S1 U< 3
1170, 1180 or 1190	Set point	40 to 100 %	97 %	95 %	95 %
	Timer	0.1 to 100 s	10 s	5 s	5 s
	Enable	OFF ON	OFF	OFF	OFF
	Fail class	Fail classes	Warning	Warning	Warning

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

4.2.3 Under-voltage with reverse vars (ANSI 27 + 32RV)

Source 1 > Voltage protections > Under-voltage with reverse vars> U and Q < [1 or 2]

Parameter	Text	Range	U and Q < 1	U and Q < 2
1960 or 1960	Set point	40 to 100 %	103 %	105 %
	Timer	0.1 to 3200 s	0.5 s	0.5 s
	Fail class	Fail classes	Warning	Warning

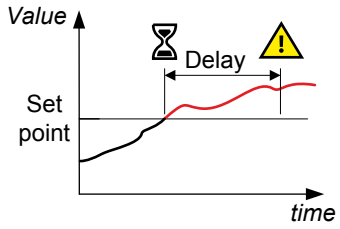
4.2.4 Voltage unbalance (ANSI 47)

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.



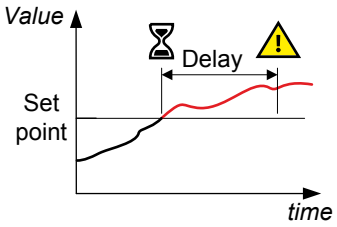
Source 1 > Voltage protections > Voltage unbalance > S1 Unbalance U

Parameter	Text	Range	Default
1510	Set point	0 to 50 %	10 %
	Timer	0.1 to 100 s	10 s
	Enable	OFF ON	OFF
	Fail class	Fail classes	Trip CB1

4.2.5 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.



Source 1 > Frequency protections > Over-frequency > S1 f> [1 to 3]

Parameter	Text	Range	S1 f> 1	S1 f> 2	S1 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

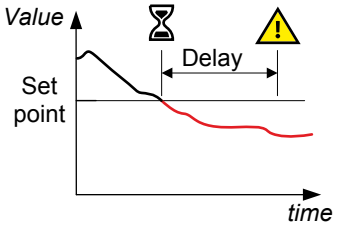
Source 1 > Frequency protections > Frequency detect. type

Parameter	Text	Range	Default
1204	Type	L1 L2 L3 L1 or L2 or L3 L1 and L2 and L3	L1 or L2 or L3

4.2.6 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.



Source 1> Frequency protections > Under-frequency > S1 f< [1 to 3]

Parameter	Text	Range	S1 f< 1	S1 f< 2	S1 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
1245, 1255 or 1265	Enable	OFF ON	OFF	OFF	OFF
1246, 1256 or 1266	Fail class	Fail classes	Warning	Warning	Warning

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

4.3 Source 2 protections

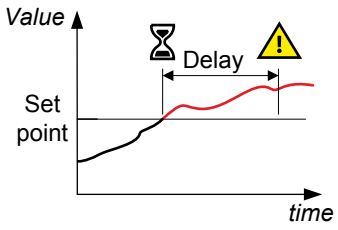
Protection	IEC symbol (IEC 60617)	ANSI (IEEE C37.2)	Operate time	Alarms
Over-voltage	U>, U>>	59	< 50 ms	3
Average over-voltage	-	59AVG	-	2
Under-voltage	U<, U<<	27	< 50 ms	4
Voltage unbalance	UUB>	47	< 200 ms*	1
Positive sequence under-voltage	U_1<	27D	< 40 ms	1
Over-frequency	f>, f>>	81O	< 50 ms	3
Under-frequency	f<, f<<	81U	< 50 ms	4

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

4.3.1 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 source, as measured by the controller.



Source 2 > Voltage protections > Over-voltage > S2 U> [1 to 3]

Parameter	Text	Range	S2 U> 1	S2 U> 2	S2 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

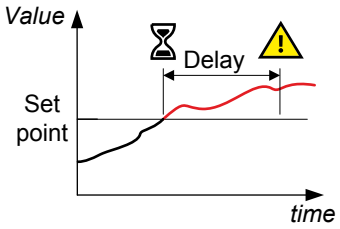
Source 2 > Voltage protections > Voltage detect. type

Parameter	Text	Range	Default
1202	Type	Phase-Phase Phase-Neutral	Phase-Phase

4.3.2 Average over-voltage (ANSI 59AVG)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Average over-voltage		59AVG	-

The alarm response is based on the highest average phase-to-phase voltage, or the highest average phase-to-neutral voltage, from the mains or source, averaged during the calculation time.



The average voltage calculation is based on the power quality approach in EN 61000-4.30. The root mean squared (RMS) voltage is measured and aggregated for 10 periods at 50 Hz nominal frequency (12 periods at 60 Hz). This result is then aggregated 15 times (that is, for a 3-second average). Finally, the 3-second averages are aggregated over the aggregate time.

For this protection, the average voltage is measured and calculated over a minimum of 30 seconds, and updated every 3 seconds.

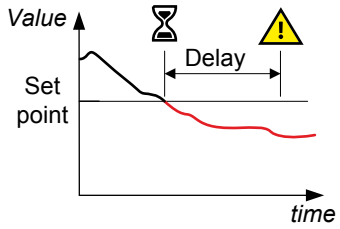
Source 2 > Voltage protections > Avg. U over-voltage BB > Avg U BB [1 or 2]

Parameter	Text	Range	Avg U BB> 1	Avg U BB> 2
7481 or 7491	Set point	100 to 120 %	110 %	110 %
7482 or 7492	Timer	0.1 to 3200 s	10 s	10 s
7484 or 7494	Enable	OFF ON	OFF	OFF
7485 or 7495	Fail class	Fail classes	Warning	Warning
7486 or 7496	Timer	30 to 900 s	600 s	600 s

4.3.3 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 source, as measured by the controller.



Source 2 > Voltage protections > Under-voltage > S2 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

Source 2 > Voltage protections > Voltage detect. type

Parameter	Text	Range	Default
1202	Type	Phase-Phase Phase-Neutral	Phase-Phase

4.3.4 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 source or mains. The alarm response is based on the lowest positive voltage value measured at the zero crossing point of each phase.

Source 2 > Voltage protections > Pos. seq. under-volt. > S2 Pos seq volt

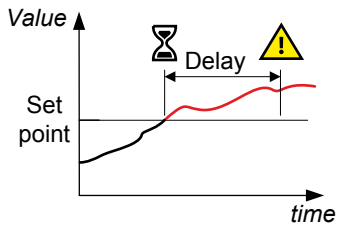
Parameter	Text	Range	Default
1441	Set point	10 to 110 %	70 %
1442	Timer	1 to 9 Periods	2 Periods
1445	Enable	OFF ON	OFF
1446	Fail class	Fail classes	Trip MB

4.3.5 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 source 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.

Source 2 > Voltage protections > Voltage unbalance >S2 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

Voltage unbalance example

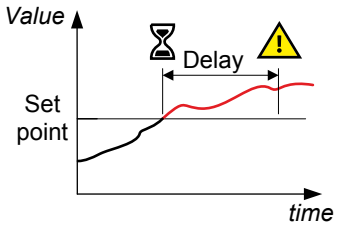
The source has a nominal voltage of 230 V. The L1-L2 voltage is 235 V, the L2-L3 voltage is 225 V, and the L3-L1 voltage is 210 V.

	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 source voltage unbalance is 13.3 V / 223.3 V = 0.06 = 6 %

4.3.6 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 source. This ensures that the alarm only activates when all of the phase frequencies are above the set point.



Source 2 > Frequency protections > Over-frequency > S2 f> [1 to 4]

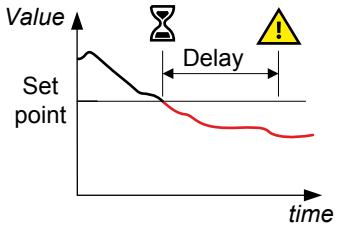
Parameter	Text	Range	S2 f> 1	S2 f> 2	S2 f> 3	S2 f> 4
1351, 1361, 1371 or 1921	Set point	100 to 120 %	103 %	105 %	105 %	102 %
1352, 1362, 1372 or 1922	Timer	0.04 to 99.99 s	10 s	5 s	5 s	5600 s*
1355, 1365, 1375 or 1925	Enable	OFF ON	OFF	OFF	OFF	OFF
1356, 1366, 1376 or 1926	Fail class	Fail classes	Warning	Warning	Warning	Warning

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

4.3.7 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 source. This ensures that the alarm only activates when all of the phase frequencies are below the set point.



Source 2 > Frequency protections > Under-frequency > S2 f< [1 to 5]

Parameter	Text	Range	S2 f< 1	S2 f< 2	S2 f< 3	S2 f< 4	S2 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*

Parameter	Text	Range	S2 f< 1	S2 f< 2	S2 f< 3	S2 f< 4	S2 f< 5
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.

4.4 Common protections

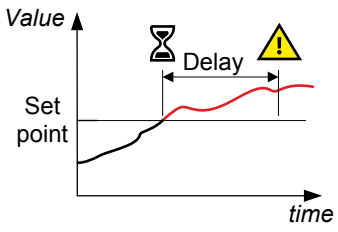
Protections	Alarms	ANSI	Operate time
Reverse power	2	32R	<200 ms
Fast over-current	2	50P	<40 ms
Over-current	4	50TD	<200 ms
Voltage dependent over-current	1	50V	
Unbalanced current	1	46	<200 ms
Loss of excitation or reactive power import	1	32RV	<200 ms
Over-excitation or reactive power export	1	32FV	<200 ms
Overload	5	32F	<200 ms
Earth fault inverse time over-current	1	50G	<100 ms
Neutral inverse time over-current	1	50N	<100 ms
Vector shift	1	78	<40 ms
Directional over-current	2	67	<100 ms
Negative sequence voltage high	1	47	<400 ms
Rate of change of frequency ROCOF (df/dt)	(df/dt)	81R	<120 ms
IEC/IEEE inverse time over-current	1	51	-

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

4.4.1 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.



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

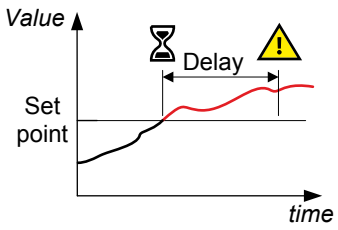
Parameter	Text	Range	I> 1	I> 2	I> 3	I> 4
1030, 1040, 1050 or 1060	Set point	50 to 200 %	115 %	120 %	115 %	120 %
	Timer	0.1 to 3200 s	10 s	5 s	10 s	5 s
	Enable	OFF ON	ON	ON	ON	ON
	Fail class	Fail classes	Warning	Trip CB1	Trip CB1	Trip CB1

4.4.2 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.



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

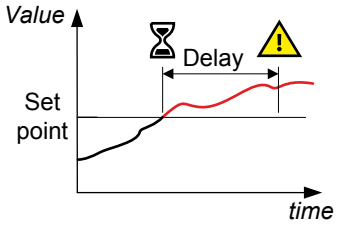
Parameter	Text	Range	I>> 1	I>> 2
1130 or 1140	Set point	150 to 300 %	150 %	200 %
	Timer	0 to 3200 s	2 s	0.5 s
	Enable	OFF ON	OFF	OFF
	Fail class	Fail classes	Trip CB1	Trip CB1

4.4.3 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.



Common protect > Current protections > Unbalance current > I [1 or 2]

Parameter	Text	Range	Unbalance I 1	Unbalance I 2
1500 or 1710	Set point	0 to 100 %	30 %	40 %
	Timer	0.1 to 100 s	10 s	10 s
	Enable	OFF ON	OFF	OFF
	Fail class	Fail classes	Trip CB1	Trip CB1

Common protect > Current protections > Unbalance current

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

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

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

Average method example

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

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

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

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

Nominal method example

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

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

4.4.4 Voltage dependent over-current (ANSI 50V)

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

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

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

Common protection > Current protections > Voltage dep. over-curr.

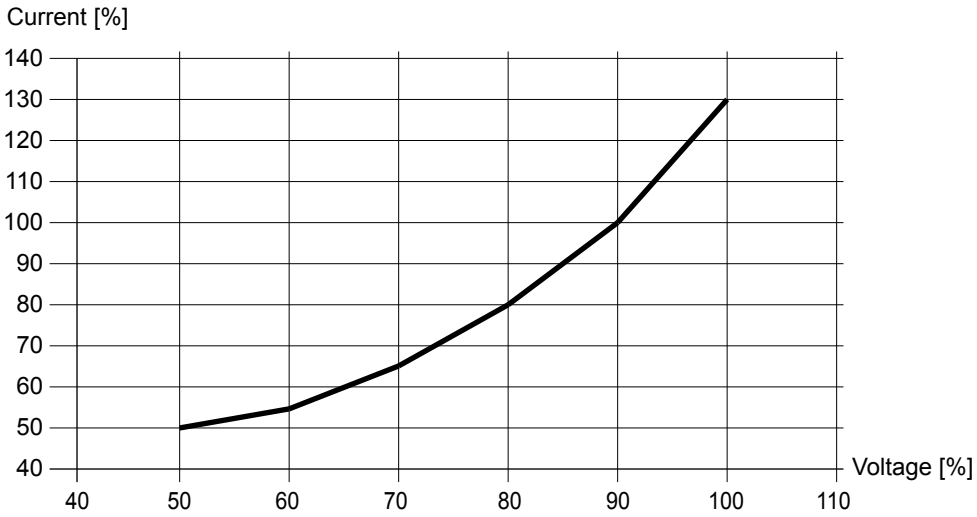
Parameter	Text	Range	Default
1101	S1 Iv> (50 %)	50 to 200 %	110 %
1102	S1 Iv> (60 %)	50 to 200 %	125 %
1103	S1 Iv> (70 %)	50 to 200 %	140 %
1104	S1 Iv> (80 %)	50 to 200 %	155 %
1105	S1 Iv> (90 %)	50 to 200 %	170 %
1106	S1 Iv> (100 %)	50 to 200 %	200 %
1110	Fail class	Fail classes	Trip CB1

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 %	110 %
1102	60 %	125 %
1103	70 %	140 %
1104	80 %	155 %
1105	90 %	170 %
1106	100 %	200 %

The set points can be shown on a curve:

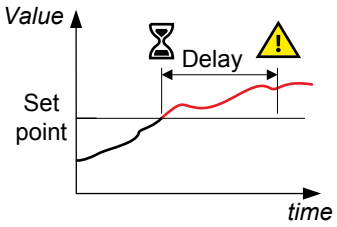


When the operating values are above the curve, the breaker is tripped. The generator breaker also trips when the generator voltage is below 50 % of rated, and the current is above 50 % of rated.

4.4.5 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.



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

Parameter	Text	Range	I> direct. 1	I> direct. 2
1600 or 1610	Set point	-200 to 200 %	120 %	130 %
	Timer	0 to 3200 s	0.1 s	0.1 s
	Enable	OFF ON	OFF	OFF
	Fail class	Fail classes	Trip CB2	Trip CB2

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*.

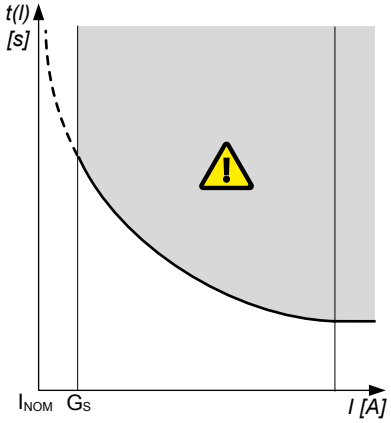
4.4.6 Inverse time over-current (ANSI 51)

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 ($G_S = I_{nom} \bullet LIM / 100\ \%$)
- TMS = Time multiplier setting

Common protections > Neutral inverse time over-current > Inv. time over-current

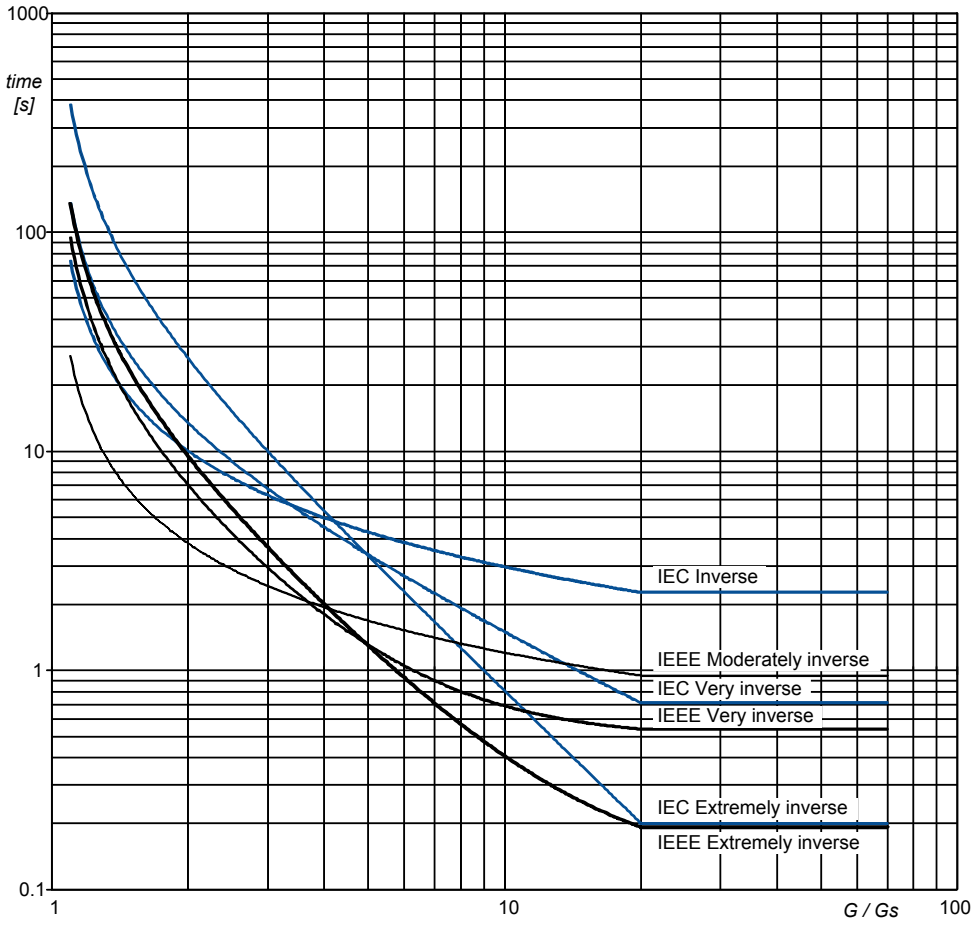
Parameter	Text	Range	Default
1721	In> inverse Type	IEC Inverse IEC Very Inverse IEC Extremely Inv. IEEE Moderately Inv. IEEE Very Inverse IEEE Extremely Inv. Custom	IEC Inverse
1722	In> inverse Limit	2 to 120 %	30 %
1723	In> inverse TMS	0.01 to 100.00	1.00
1724	In> inverse k	0.001 to 32.000 s	0.140 s
1725	In> inverse c	0.000 to 32.000 s	0.000 s
1726	In> inverse a	0.001 to 32.000 s	0.020 s
1727	In> inverse	Fail classes	Trip CB1

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

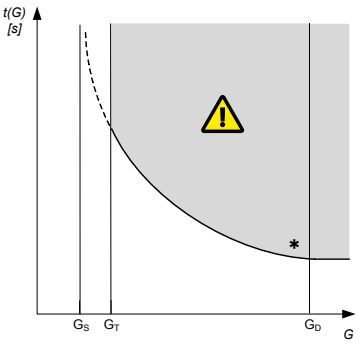
Standard curve shapes for inverse time over-current, with time multiplier setting (TMS) = 1



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.

- $G_D = 20 \times G_S = 20 \times (I_{nom} \times (\text{Limit} / 100)) = 20 \times (350 \times (1 / 1)) = 7000$ 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).

4.4.7 Neutral inverse time over-current (ANSI 50N)

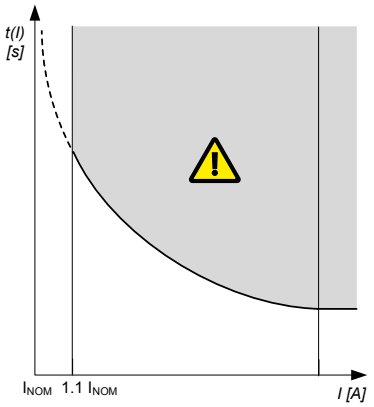
Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Neutral inverse time over-current		50N	-

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

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

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

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



Common protect > Current protections > Neut. inv. t. o-curr.

Parameter	Text	Range	Default
1721	Type	IEC Inverse IEC Very Inverse IEC Extremely Inv. IEEE Moderately Inv. IEEE Very Inverse IEEE Extremely Inv. Custom	IEC Inverse
1722	Set point	2 to 120 %	30 %
1723	Set point TMS	0.01 to 100.00 s	1.00
1724	Set point k	0.001 to 32.000 s	0.140 s
1725	Set point c	0.000 to 32.000 s	0.000 s
1726	Set point a	0.001 to 32.000 s	0.020 s
1728	Enable	OFF ON	OFF
1727	Fail class	Fail classes	Trip CB1

More information
See **Inverse time over-current (ANSI 51)** in the **AGC 150 Generator, Mains and BTB Designer's Handbook** for the calculation method, the standard curves, and information about the definite time characteristic.

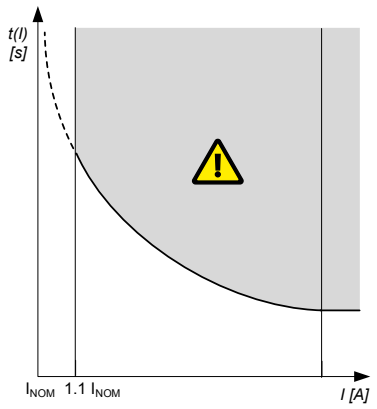
4.4.8 Earth fault inverse time over-current (ANSI 50G)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Earth fault inverse time over-current		50G	-

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

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

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



Common protect > Current protections > Earth f. inv t. o-curr.

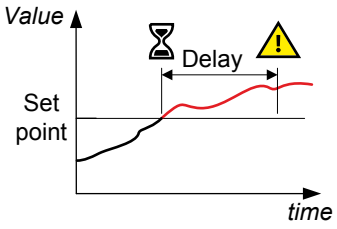
Parameter	Text	Range	Default
1731	Type	IEC Inverse IEC Very Inverse IEC Extremely Inv. IEEE Moderately Inv. IEEE Very Inverse IEEE Extremely Inv. Custom	IEC Inverse
1732	Set point Limit	2 to 120 %	10 %
1733	Set point TMS	0.01 to 100.00	1.00
1734	Set point k	0.001 to 32.000 s	0.140 s
1735	Set point c	0.000 to 32.000 s	0.000 s
1736	Set point a	0.001 to 32.000 s	0.020 s
1738	Enable	OFF ON	OFF
1737	Fail class	Fail classes	Trip CB1

More information
See **Inverse time over-current (ANSI 51)** in the AGC 150 Generator, Mains and BTB Designer's manual for the calculation method, the standard curves, and information about the definite time characteristic.

4.4.9 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.



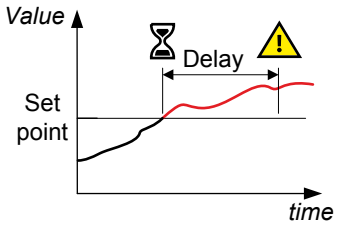
Common protect > Power protections > Overload > P> [1 to 5]

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 CB1	Trip CB1	Trip CB1	Trip CB1

4.4.10 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.



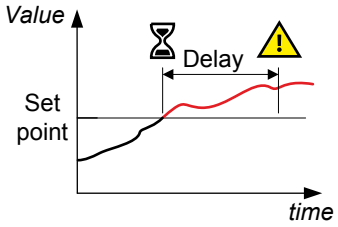
Common protect > Power protections > Reverse power > -P> [1 to 3]

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	ON	OFF
1006, 1016 or 1076	Fail class	Fail classes	Trip CB1	Trip CB1	Trip CB1

4.4.11 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 generator is feeding an inductive load.



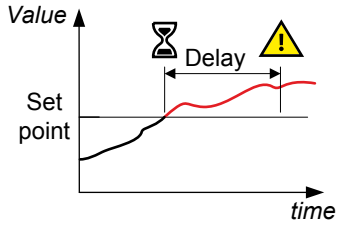
Common protect > Reactive power protect. > React. power export > Overexcitation > Q>

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

4.4.12 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 generator is feeding a capacitive load.



Common protect > Reactive power protect. > Loss of excitation > -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

4.4.13 Vector shift (ANSI 78)

Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
Vector shift	dφ/dt	78	< 40 ms

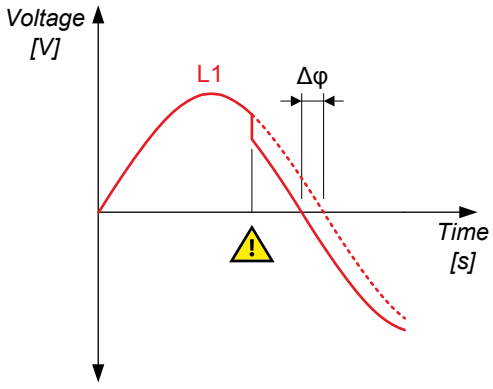
Vector shifts can arise when a mains failure occurs while a generator is running parallel with the mains.

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.

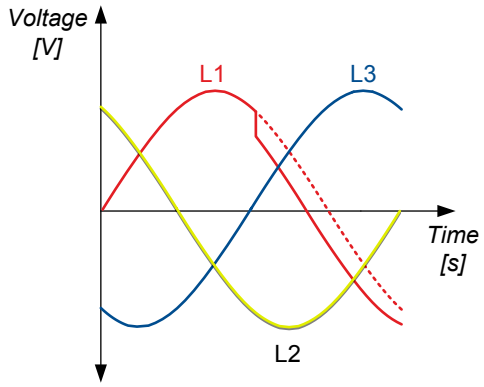
In grids where fast automatic reconnection attempts are expected, this protection opens the breaker to prevent damaging failures.

Vector shift causes the instantaneous phase angle change (Δφ)

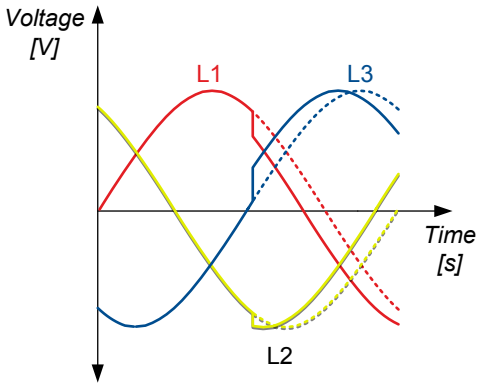


Fast changes in frequency can also activate this alarm. Too sensitive configuration can lead to too many unwanted detections of vector shift.

Vector shift in phase L1 only



Vector shift in all phases



Common protect > Vector shift

Parameter	Text	Range	Default
1431	Set point	1 to 90 °	10 °
1434	Enable	OFF ON	OFF
1435	Fail class	Fail classes	Trip CB1
1436	Type	Individual phases All phases	All phases

4.4.14 Rate of change of frequency (ANSI 81R)

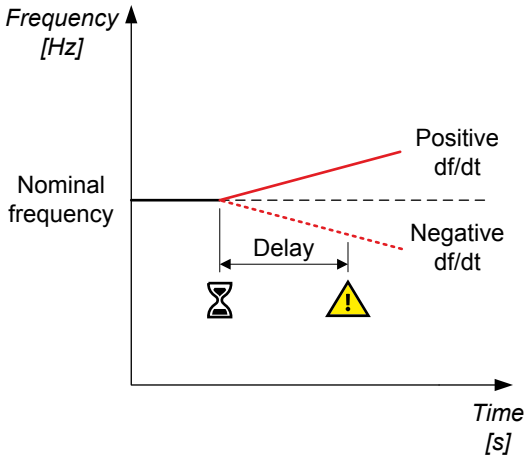
Protection	IEC symbol (IEC60617)	ANSI (IEEE C37.2)	Operate time
ROCOF (df/dt)	df/dt	ANSI 81R	Standard: < 120 ms

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.



Common protect > 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

Parameter	Text	Range	Default
1423	Timer	0.00 to 3.00 s	0.00 s
1426	Enable	OFF ON	OFF
1427	Fail class	Fail classes	Trip CB2

4.5 Other protections

Protections	Alarms	ANSI	Operate time
Breaker 1 (CB1) external trip	1		
Breaker 2 (CB2) external trip	1		
BTB breaker external trip (only for 3-breaker applications)	1		
Synchronisation failure alarms			
Breaker 1 (CB1) open failure	3	52BF	
Breaker 2 (CB2) open failure			
Breaker 1 (CB1) close failure	3	52BF	
Breaker 2 (CB2) close failure			
Breaker 1 (CB1) position failure	3	52BF	
Breaker 2 (CB2) position failure			
Phase sequence error	1	47	
Hz/V failure	1		
Not in Auto	1		

4.6 AC average

This function is intended for giving an alarm if the average of a specific measurement exceeds a set point in a certain time frame.

The AC average is calculated based on the RMS value of the three phases. For example, every time the main voltage measurement updates.

The parameters for AC average can only be configured from the utility software.

NOTE When the controller is in idle mode, AC average protection is inhibited.

`Average protections > Average L-L AC RMS voltage high [1 or 2]`

Parameter		Range	Avg. S1 U> L-L 1	Avg. S1 U> L-L 2
14000 or 14010	Set point	100.0 to 120.0 %	103.0 %	105.0 %
14002 or 14012	Timer	0.1 to 100.0 s	10.0 s	10.0 s
14005 or 14015	Enable	OFF ON	OFF	OFF
14006 or 14016	Fail class	Fail classes	Warning	Warning

Average protections > Average L-L AC RMS voltage low [1 or 2]

Parameter	Text	Range	Avg. S1 U< L-L 1	Avg. S1 U< L-L 2
14020 or 14030	Set point	100.0 to 120.0 %	97.0 %	95.0 %
14022 or 14032	Timer	0.1 to 100.0 s	10.0 s	5.0 s
14025 or 14035	Enable	OFF ON	OFF	OFF
14026 or 14036	Fail class	Fail classes	Warning	Warning

Average protections > Average L-N AC RMS voltage high [1 or 2]

Parameter	Text	Range	Avg. S1 U> L-N 1	Avg. S1 U> L-N 2
14040 or 14050	Set point	100.0 to 120.0 %	103.0 %	105.0 %
14042 or 14052	Timer	0.1 to 100.0 s	10.0 s	5.0 s
14045 or 14055	Enable	OFF ON	OFF	OFF
14046 or 14056	Fail class	Fail classes	Warning	Warning

Average protections > Average L-N AC RMS voltage low [1 or 2]

Parameter	Text	Range	Avg. S1 U< L-N 1	Avg. S1 U< L-N 2
14060 or 14070	Set point	100.0 to 120.0 %	97.0 %	95.0 %
14062 or 1472	Timer	0.1 to 100.0 s	10.0 s	5.0 s
14065 or 1475	Enable	OFF ON	OFF	OFF
14066 or 1476	Fail class	Fail classes	Warning	Warning

Average protections > Average AC frequency high [1 or 2]

Parameter	Text	Range	Avg. S1 f> 1	Avg. S1 f> 2
14080 or 14090	Set point	100.0 to 120.0 %	103.0 %	105.0 %
14082 or 14092	Timer	0.1 to 100.0 s	10.0 s	5.0 s
14085 or 14095	Enable	OFF ON	OFF	OFF
14086 or 14096	Fail class	Fail classes	Warning	Warning

Average protections > Average AC frequency low [1 or 2]

Parameter	Text	Range	Avg. S1 f< 1	Avg. S1 f< 2
14100 or 14110	Set point	100.0 to 120.0 %	97.0 %	95.0 %
14102 or 14112	Timer	0.1 to 100.0 s	10.0 s	5.0 s
14105 or 14115	Enable	OFF ON	OFF	OFF
14106 or 14116	Fail class	Fail classes	Warning	Warning

Average protections > Average AC current high [1 or 2]

Parameter	Text	Range	Avg. I> 1	Avg. I> 2
14120 or 14130	Set point	50.0 to 200.0 %	115.0 %	120.0 %
14122 or 14132	Timer	0.1 to 3200.0 s	10.0 s	5.0 s

Parameter	Text	Range	Avg. I> 1	Avg. I> 2
14125 or 14135	Enable	OFF ON	OFF	OFF
14126 or 14136	Fail class	Fail classes	Warning	Warning

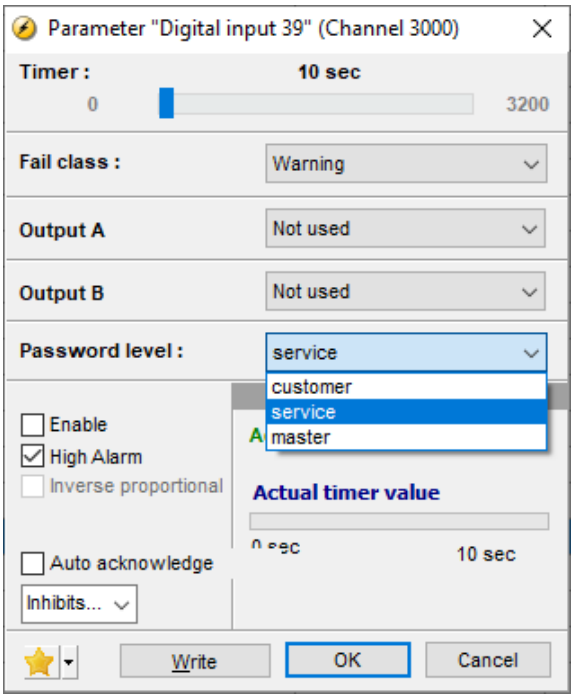
5. General functions

5.1 Password

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

Password level	Default password	Customer access	Service access	Master access
Customer	2000	●		
Service	2001	●	●	
Master	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.

5.2 AC measurement systems

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

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

CAUTION

Incorrect configuration is dangerous

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

Basic settings > Measurement setup > Wiring connection > AC configuration

Parameter	Text	Range	Default
9131	AC configuration	3 phase 3W4 S1 3 phase 3W3 S1 2 phase L1/L3* 2 phase L1/L2* 1 phase L1*	3 phase 3W4 S1
9132	AC configuration S2	3 phase 3W4 S2 3 phase 3W3 S2	3 phase 3W4 S2

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

5.2.1 Three-phase system

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

The following configuration is required for three-phase measuring.

Basic settings > Nominal settings > Voltage > Source 1 nominal U

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

Basic settings > Measurement setup > Voltage transformer > Source 1 VT

Parameter	Text	Range	Adjust to value
6041	S1 primary U	100 to 25000 V	Primary VT
6042	S1 secondary U	100 to 690 V	Secondary VT

Basic settings > Nominal settings > Voltage > Source 2 nominal U

Parameter	Text	Range	Adjust to value
6053	S2 Nominal U 1	100 to 25000 V	U_{NOM}

Basic settings > Measurement setup > Voltage transformer > Source 2 VT

Parameter	Text	Range	Adjust to value
6051	S2 primary U 1	100 to 25000 V	Primary VT
6052	S2 second. U 1	100 to 690 V	Secondary VT

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

5.2.2 Split-phase system

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

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

Basic settings > Nominal settings > Voltage > Source 1 nominal U

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

Basic settings > Measurement setup > Voltage transformer > Source 1 VT

Parameter	Text	Range	Adjust to value
6041	S1 primary U	100 to 25000 V	U_{NOM}
6042	S1 secondary U	100 to 690 V	U_{NOM}

Basic settings > Nominal settings > Voltage > Source 2 Nominal U

Parameter	Text	Range	Adjust to value
6053	S2 Nominal U 1	100 to 25000 V	U_{NOM}

Basic settings > Measurement setup > Voltage transformer > Source 2 VT

Parameter	Text	Range	Adjust to value
6051	S2 primary U 1	100 to 25000 V	U_{NOM}
6052	S2 second. U 1	100 to 690 V	U_{NOM}

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

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

5.2.3 Single-phase system

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

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

Basic settings > Nominal settings > Voltage > Source 1 nominal U

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

Basic settings > Measurement setup > Voltage transformer > Source 1VT

Parameter	Text	Range	Adjust to value
6041	S1 primary U	100 to 25000 V	$U_{NOM} \times \sqrt{3}$
6042	S1 secondary U	100 to 690 V	$U_{NOM} \times \sqrt{3}$

Basic settings > Nominal settings > Voltage > Source 2 nominal U

Parameter	Text	Range	Adjust to value
6053	S2 Nominal U 1	100 to 25000 V	$U_{NOM} \times \sqrt{3}$

Basic settings > Measurement setup > Voltage transformer > Source 2 VT

Parameter	Text	Range	Adjust to value
6051	S2 primary U 1	100 to 25000 V	$U_{NOM} \times \sqrt{3}$
6052	S2 second. U 1	100 to 690 V	$U_{NOM} \times \sqrt{3}$

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

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

5.3 Nominal settings

The controller has four sets of nominal settings for source 1, and two sets of nominal settings for source 2. The four sets of source 1 settings can be individually configured.

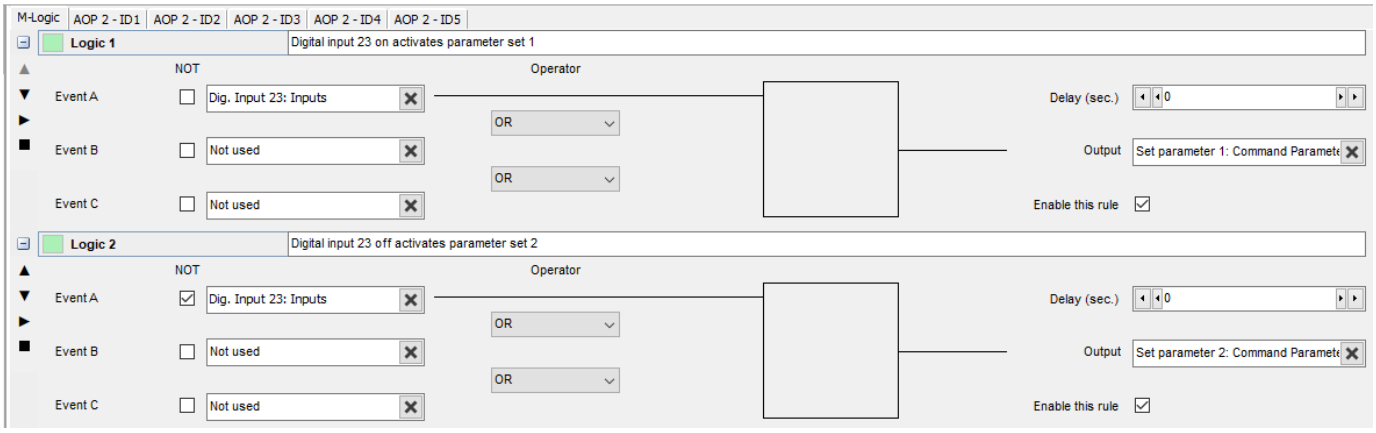
Alternative configuration > Source nominal settings

Parameter	Text	Range	Default
6005	Enable nom. set	Nominal setting [1 to 4]	Nominal setting 1

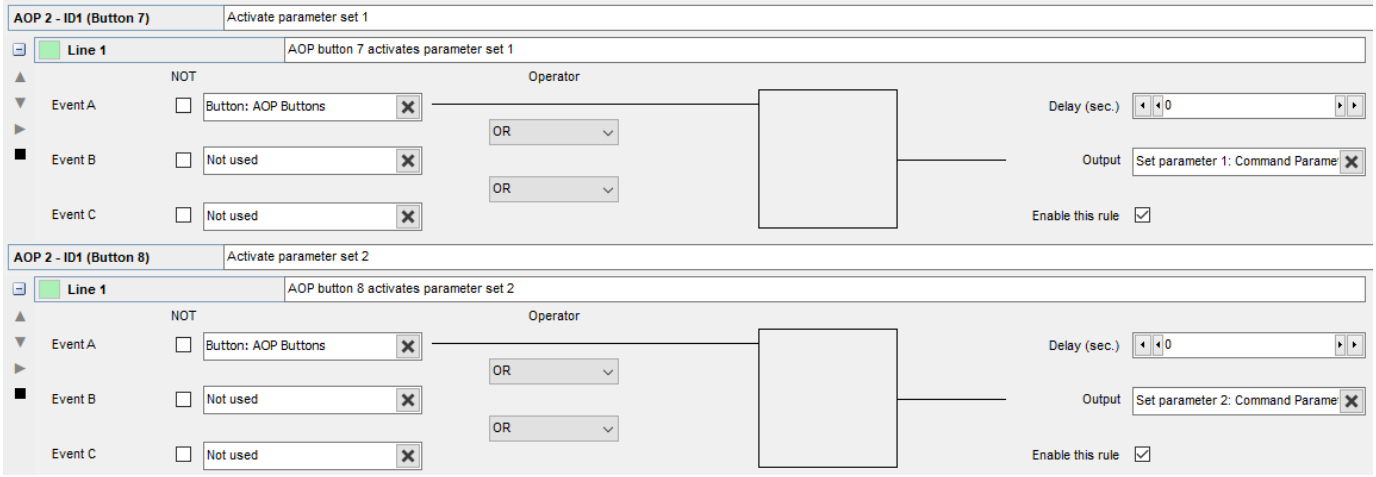
Switch between the nominal settings

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.

5.3.1 Default nominal settings

The default nominal settings are settings 1.

Basic settings > Nominal settings > Voltage

Parameter	Text	Range	Default
6004	Voltage Nom. U 1	100 to 25000 V	400 V
6053	Voltage S2 Nominal U 1	100 to 25000 V	400 V

Basic settings > Nominal settings > Current

Parameter	Text	Range	Default
6003	Current Nom. I 1	0 to 9000 A	867 A
6006	Current Nom. I E/N/M 1	0 to 9000 A	867 A
6001	Frequency Nom. f 1	48.0 to 62.0 Hz	50 Hz

Basic settings > Nominal settings > Power

6055	Power 4th CT nom. P 1	0 to 9000 kW	480 kW

5.3.2 Alternative nominal settings

Alternative configuration > Source 1 nominal settings

Parameter	Text	Range	Default
6005	Enable nom. set		Nominal setting 1

Alternative configuration > Source 1 Nominal settings > Nominal settings 2

Parameter	Text	Range	Default
6011	Nom. f 2	48 to 62 Hz	50 Hz
6012	Nom. P 2	10 to 20000 kW	230 kW

Parameter	Text	Range	Default
6013	2 Nom. I 2	0 to 9000 A	345 A
6014	Nom. U 2	100 to 25000 V	480 V
6015	Nom. I E/N/M 2	0 to 9000 A	867 A

Alternative configuration > Source 1 Nominal settings > Nominal settings 3

Parameter	Text	Range	Default
6021	Nom. f 3	48 to 62 Hz	60 Hz
6022	Nom. P 3	10 to 20000 kW	230 kW
6023	Nom. I 3	0 to 9000 A	345 A
6024	Nom. U 3	100 to 25000 V	480 V
6025	Nom. I E/N/M 3	0 to 9000 A	867 A

Alternative configuration > Source 1 Nominal settings > Nominal settings 4

Parameter	Text	Range	Default
6031	Nom. f 4	48 to 62 Hz	60 Hz
6032	Nom. P 4	10 to 20000 kW	230 kW
6033	Nom. I 4	0 to 9000 A	345 A
6034	Nom. U 4	100 to 25000 V	480 V
6035	Nom. I E/N/M 4	0 to 9000 A	867 A

Alternative configuration > Source 2 Nominal settings

Parameter	Text	Range	Default
6005	Enable nom. set		Nominal setting 1
6011	Nom. f 2	48 to 62 Hz	50 Hz
6012	Nom. P 2	10 to 20000 kW	230 kW
6013	Nom. I 2	0 to 9000 A	345 A
6014	2 Nom. U 2	100 to 25000 V	480 V
6015	Nom. I E/N/M 2	0 to 9000 A	867 A

Alternative config. > Source 2 nominal settings > Nominal set selection

Parameter	Text	Range	Default
6054	S2 nom. set	Parameter set 1 Parameter set 2 S1 Unom = S2 Unom	Parameter set 1

Alternative config. > Source 2 nominal settings > Nominal settings 2

Parameter	Text	Range	Default
6061	S2 primary U 2	10 to 25000 V	400 V
6062	S2 second. U 2	100 to 690 V	400 V

Parameter	Text	Range	Default
6063	S2 Nominal U 2	100 to 25000 V	400 V
6064	4th CT nom. P 2	0 to 9000 kW	230 kW

5.3.3 Scaling

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

Changing the voltage scaling also affects the nominal power scaling.

`Basic settings > Measurement setup > Scaling`

Parameter	Text	Range	Default	Notes
9030	Scaling	10 to 2500 V 100 to 25000 V 10 to 160000 V 0.4 to 75000 V	100 to 25000 V	**10 to 2500 V**: This is recommended for generators up to 150 kVA. The nominal power must be less than 900 kW. **100 to 25000 V**: This is recommended for generators over 150 kVA.

NOTICE

Incorrect configuration is dangerous

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

5.4 Step-up and step-down transformers

Applications that need a step-up or a step-down transformer are supported by the controller.

In some applications, a step-down transformer can also be used.

More information
See the **AGC 150 Generator, Mains and BTB Designer's handbook** for details.

5.5 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.

5.5.1 General shortcuts

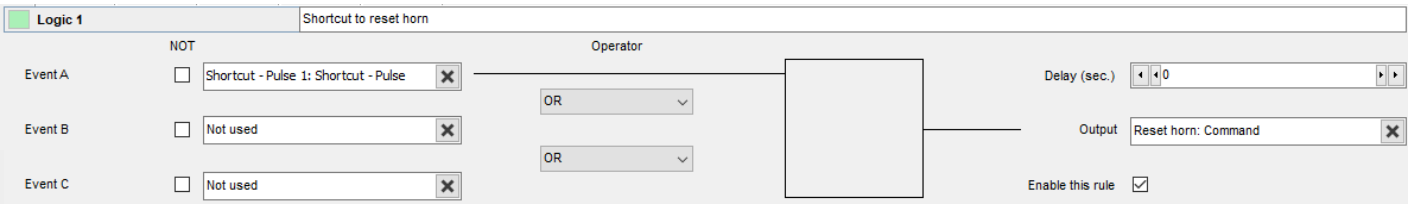
You can configure your own shortcuts with M-Logic in the utility software. You can see the configured shortcuts when you push the *Shortcut* button and select *General shortcuts*. If you have not configured a shortcut, then the *General shortcuts* menu is empty.

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.

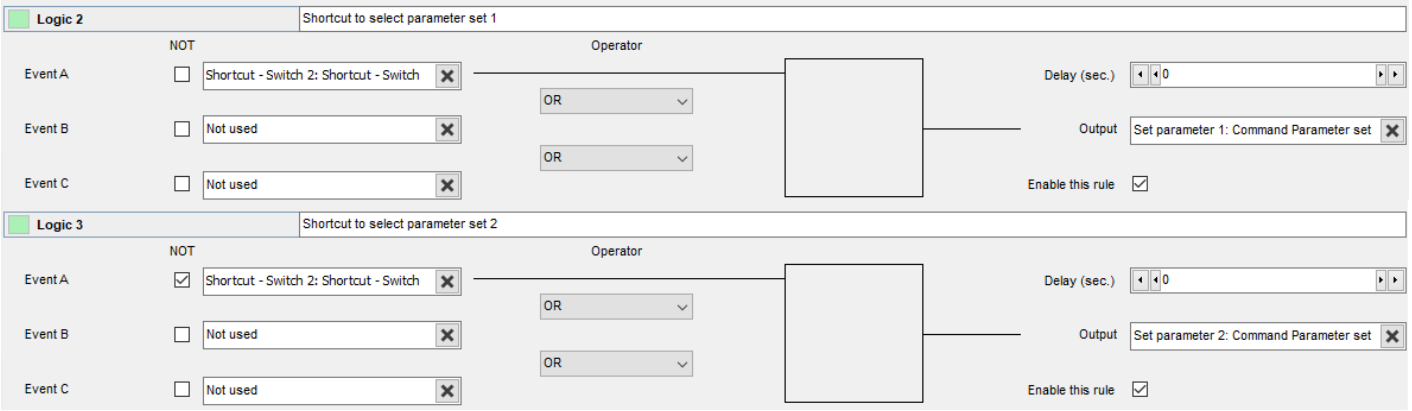
Use the *Translations* interface to rename the shortcut.

Example of shortcut pulse



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

Example of shortcut switch



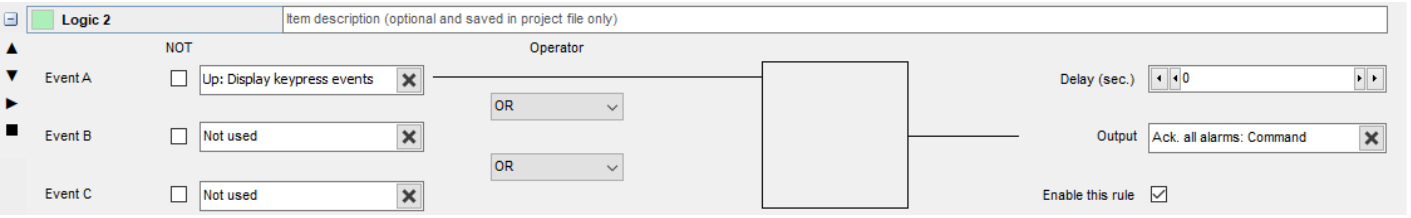
Rename *SC Switch 2 on* to *Use parameter set 1*. Rename *SC Switch 2 off* to *Use parameter set 2*.

5.5.2 M-Logic event counters

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

5.5.3 Display keypress events

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



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

5.6 Timers and counters

5.6.1 Command timers

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

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

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

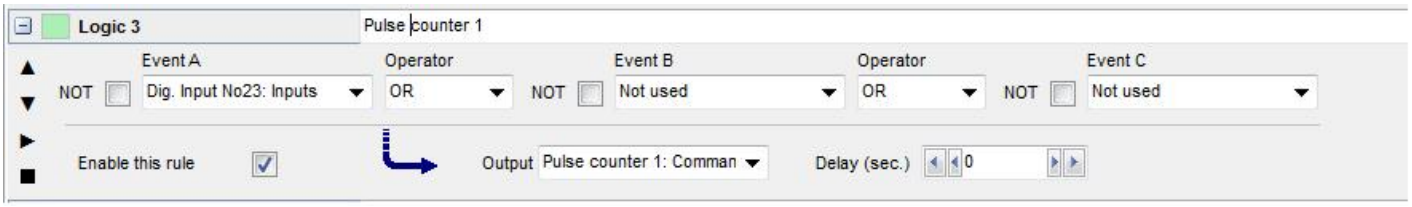
You can also configure the command timers for a specific week in a month:

- All weeks in a month
- First week (1 - 7)
- Second week (8 - 14)
- Third week (15 - 21)
- Fourth week (22 - 28)

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.

5.6.2 Pulse input counters

Two configurable digital inputs can be used for counter inputs. The two counters can for example be used for fuel consumption or heat flow. The two digital inputs can only be configured for pulse inputs using M-Logic, as shown in the example below.



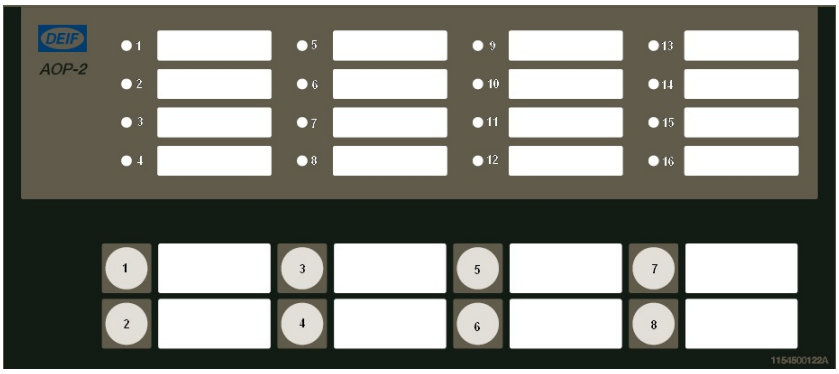
Functions > Pulse counters

Parameter	Text	Range	Default
6851 or 6861	Value	0 to 1000	1
6852 or 6862	Unit type	Unit/pulse Pulse/unit	Unit/pulse
6853 or 6863	Decimal type	No decimals One decimal Two decimals Three decimals	No decimals

5.7 Interfaces

5.7.1 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.

5.7.2 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 SEMI-AUTO mode when the access lock is activated. For safety reasons, an emergency stop switch is recommended.

5.7.3 Language selection

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

`Basic settings > Controller settings > Language`

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

6. Inputs and outputs

6.1 Digital inputs

6.1.1 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	Digital input	Configurable	Negative switching only, < 100 Ω
40	Digital input	Configurable	Negative switching only, < 100 Ω
41	Digital input	Configurable	Negative switching only, < 100 Ω
42	Digital input	Configurable	Negative switching only, < 100 Ω
43	Digital input	Configurable	Negative switching only, < 100 Ω
44	Digital input	Configurable	Negative switching only, < 100 Ω
45	Digital input	Configurable (ATS BTB Position On*)	Negative switching only, < 100 Ω
46	Digital input	Configurable (ATS BTB Position Off*)	Negative switching only, < 100 Ω
47	Digital input	Configurable Preconfigured: ATS CB2 Position On	Negative switching only, < 100 Ω
48	Digital input	Configurable Preconfigured: ATS CB2 Position Off	Negative switching only, < 100 Ω
49	Digital input	Configurable Preconfigured: ATS CB1 Position On	Negative switching only, < 100 Ω
50	Digital input	Configurable Preconfigured: ATS CB1 Position Off	Negative switching only, < 100 Ω

* When controller set to 3 breakers

6.1.2 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).

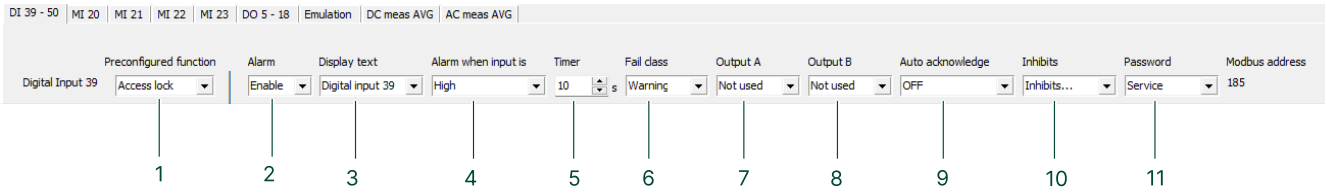
`I/O settings > Inputs > Digital input > Digital input [39 to 50]`

Parameter	Text	Range	Default
3001, 3011, 3021, 3031, 3041, 3051, 3061, 3071, 3081, 3091, 3101 or 3111	Delay	0.0 to 3200 s	10.0 s
3002, 3012, 3022, 3032, 3042, 3052, 3062, 3072, 3082, 3092, 3102 or 3112	Output A	Relays and M-Logic	Not used
3003, 3013, 3023, 3033, 3043, 3053, 3063, 3073, 3083, 3093, 3103 or 3113	Output B	Relays and M-Logic	Not used
3004, 3014, 3024, 3034, 3044, 3054, 3064, 3074, 3084, 3094, 3104 or 3114	Alarm	Disable Enable	Disable

Parameter	Text	Range	Default
3005, 3015, 3025, 3035, 3045, 3055, 3065, 3075, 3085, 3095, 3105 or 3115	Fail class	Fail classes	Warning
3006, 3016, 3026, 3036, 3046, 3056, 3066, 3076, 3086, 3096, 3106 or 3116	Type	High Low	High

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	Activates or deactivates the alarm function.
3	Display text	Select the display text. This is also shown on the display.
4	High alarm	The alarm is activated when the signal is high.
5	Timer	The timer setting is the time from the alarm level is reached until the alarm occurs.
6	Fail class	Select the required fail class from the list. When the alarm occurs, the controller reacts according to the selected fail class.
7	Output A	Select the terminal (or the limit option) to be activated by an alarm. Limit makes the alarm useable as an input event in M-Logic.
8	Output B	Select the terminal (or the limit option) to be activated by an alarm. Limit makes the alarm useable as an input event in M-Logic.
9	Auto acknowledge	If this option is set, the alarm is automatically acknowledged if the signal related to the alarm disappears.
10	Inhibits	Select the exceptions to when an alarm must be activated. To select when the alarms are to be active, each alarm has a configurable inhibit setting.
11	Password level	Select the password level that is needed to modify this parameter (cannot be edited by a user with lower privileges).

Click on the *Write to device* button to write the settings to the controller.

6.1.3 Digital input functions

The controller has a number of digital input functions, as shown in the following tables.

Default

Function	Details	AUTO mode	SEMI-AUTO mode	Test mode	Block mode	Type[1]
CB2/Pos 2 Position On	The input function is used as an indication of breaker 2 position. The controller requires this feedback when the breaker is closed or a position failure alarm occurs.	●	●	●	●	C
CB2 Position Off	The input function is used as an indication of breaker 2 position. The controller requires this feedback when the breaker is opened or a position failure alarm occurs.	●	●	●	●	C
CB1/Pos 1 Position On	The input function is used as an indication of breaker 1 position. The controller requires this feedback when the breaker is closed or a position failure alarm occurs.	●	●	●	●	C
CB1 Position Off	The input function is used as an indication of breaker 1 position. The controller requires this feedback when the breaker is opened or a position failure alarm occurs.	●	●	●	●	C

Configurable

Function	Details	AUTO mode	SEMI-AUTO mode	Test mode	Block mode	Type[1]
Remote CB1/Pos 1 On	The breaker 1 close sequence is initiated and the breaker synchronises if breaker 2 is closed, or close without synchronising if breaker 2 is open.		●			P
Remote CB1/Pos 1 Off	The breaker 1 open sequence is initiated. If breaker 2 is open, then breaker 1 opens instantly. If breaker 2 is closed, the generator load is deloaded to the breaker open limit followed by a breaker opening.		●			P
Remote CB2/Pos 2 On	The breaker 2 close sequence is initiated and the breaker synchronises if breaker 1 is closed, or close without synchronising if breaker 1 is open.		●			P
Remote CB2/Pos 2 Off	The breaker 2 open sequence is initiated. If breaker 1 is open, then breaker 2 opens instantly. If breaker 1 is closed, the generator load is deloaded to the breaker open limit followed by a breaker opening.		●			P
Remote BTB On	The BTB close sequence is initiated and the breaker synchronises if the BTB is closed, or close without synchronising if the BTB is open. This function is only available in a 3-breaker ATS.		●			P
Remote BTB Off	The BTB open sequence is initiated, and the breaker opens instantly. This function is only available in a 3-breaker ATS.		●			P
CB1/Pos 1 close inhibit	When this input is activated, breaker 1 cannot close.	●	●	●	●	C
CB2/Pos 2 close inhibit	When this input is activated, breaker 2 cannot close.	●	●	●	●	C
BTB close inhibit	When this input is activated, the BTB breaker cannot close.	●	●	●	●	C
Semi auto mode	Changes the running mode to SEMI-AUTO.	●		●	●	P
Auto mode	Changes the running mode to AUTO.		●	●	●	P

Function	Details	AUTO mode	SEMI-AUTO mode	Test mode	Block mode	Type[1]
Block mode	Changes the running mode to Block.	●	●	●		C
Test mode	Changes the running mode to Test.	●	●		●	P
Access lock	Activating the access lock input deactivates the control display buttons. It is only possible to view measurements, alarms and the log.	●	●	●	●	C
ATS BTB Position On	The input function is used as an indication of the ATS BTB breaker position. The controller requires this feedback when the breaker is closed or a position failure alarm occurs.	●	●	●	●	C
ATS BTB Position Off	The input function is used as an indication of the ATS BTB breaker position. The controller requires this feedback when the breaker is opened or a position failure alarm occurs.	●	●	●	●	C
ATS Neutral pos On	The input function is used as an indication of the neutral position in a 1-breaker ATS with three positions. The controller requires this feedback when the breaker is closed or a position failure alarm occurs.					
Remote Alarm Ack	Acknowledges all activated alarms, and the alarm LED on the display stops flashing.	●	●	●	●	C
Prioritize source S1	When this input is activated, S1 is prioritised.	●				C
Prioritize source S2	When this input is activated, S2 is prioritised.	●				C
Prioritize both sources	When this input is activated, both S1 and S2 are prioritised.	●				C
Shift priority at blackout	When this input is activated, priority is shifted at blackout. If one source fails, the corresponding breaker opens, and the other breaker closes.	●				C
Cyclic mode	This input activates cyclic mode.	●				C
Source 1 ok	Disables the Source 1 OK delay timer. The source 1 breaker can only close if the input is activated.	●	●	●	●	C
Source 2 ok	Disables the Source 2 OK delay timer. The source 2 breaker can only close if the input is activated.	●	●	●	●	C
CB1/Pos 1 spring loaded	The controller does not send a close signal before this feedback is present.	●	●	●	●	C
CB2/Pos 2 spring loaded	The controller does not send a close signal before this feedback is present.	●	●	●	●	C
BTB spring loaded	The controller does not send a close signal before this feedback is present.	●	●	●	●	C
Gen-Gen start/stop	If the controller is in AUTO mode and the application is set to *Gen/gen*, the genset starts when this input is activated. The gensets stop if the input is deactivated.	●				C
Simulate start button push	This input is used to simulate the start button being pushed.		●	●		P
Simulate stop button push	This input is used to simulate the stop button being pushed.		●	●		P
Simulate CB1 close button push	This input is used to simulate the close CB1 button being pushed.		●	●		P

Function	Details	AUTO mode	SEMI-AUTO mode	Test mode	Block mode	Type[1]
Simulate CB1 open button push	This input is used to simulate the open CB1 button being pushed.		●	●		P
Simulate CB2 close button push	This input is used to simulate the close CB2 button being pushed.		●	●		P
Simulate CB2 open button push	This input is used to simulate the open CB2 button being pushed.		●	●		P
Simulate AUTO mode button push	This input is used to simulate the AUTO mode button being pushed.		●	●		P
Simulate MANUAL mode button push	This input is used to simulate the MANUAL mode button being pushed.		●	●		P
Simulate alarm list button push	This input is used to simulate the alarms button being pushed.		●	●		P

Note [1)] C = Continuous, P = Pulse.

[2)] Can only be used in manual mode.

6.2 DC relay outputs

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

The outputs of relays 5 to 14 are configurable.

The outputs of relays 15 to 18 are not configurable.

Relay outputs, group 1

Electrical characteristics

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

Relay	ATS default setting
Relay 05	Not used
Relay 06	Not used

Relay outputs, group 2

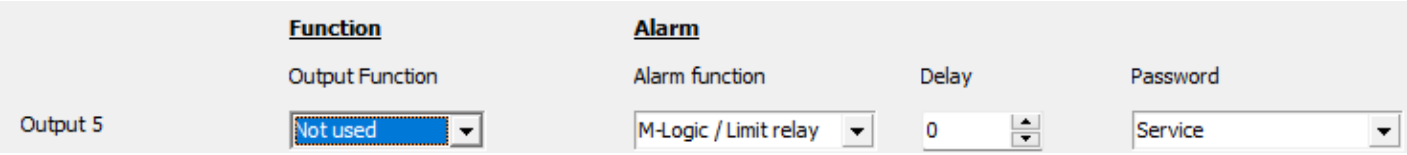
Electrical characteristics

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

Relay	ATS default setting
Relay 09	Not used
Relay 10	Not used
Relay 11	Status OK
Relay 12	Horn
Relay 13	Not configurable
Relay 14	Not configurable
Relay 15	Not configurable
Relay 16	Not configurable
Relay 17	Not configurable
Relay 18	Not configurable

6.2.1 Configure a relay output

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



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

6.2.2 Relay output functions

Function	Activated when
Not used	The digital output is not used.
Status ok	The controller status is okay.
Horn	An alarm is activated and not silenced.
Siren	An alarm is activated and not silenced.
Genset 1 start/stop	The genset starts. The output is deactivated when the genset stops.
Genset 2 start/stop	The genset starts. The output is deactivated when the genset stops.
Elevator switch	The elevator switch function is active.
Semi mode	SEMI-AUTO mode is activated.
Auto mode	AUTO mode is activated.
Test mode	Test mode is activated.
Block mode	Block mode is activated.

Function	Activated when
Source 1 OK	Source 1 is okay.
Source 2 OK	Source 2 is okay.
Open transition	When open transition is used to change the source.
Closed transition	When closed transition is used to change the source.
Open in-phase transition	When open in-phase transition is used to change the source.
Any alarm present	When there is an active alarm.

6.3 Analogue inputs

6.3.1 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.

Multi-inputs

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

More information
See the **AGC 150 Generator Mains BTB Designers handbook** for examples of wiring and for details about multi-input application, configuration and associated alarms.

6.3.2 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
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		

6.3.3 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 source 2 busbar B 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	Select the output.
		Transducer A Disabled Transducer 52 Transducer 55	
5824	P1 output max	0 to 20000 kW	Busbar A active power maximum for the transducer
5825	P1 output min	-9999 to 20000 kW	Busbar A active power minimum for the transducer

Other transducer values

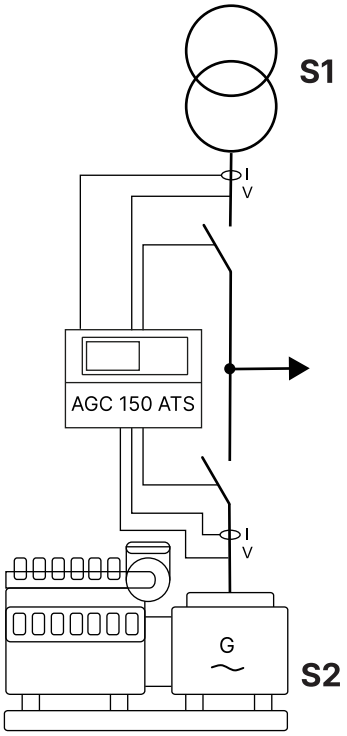
Parameter	Name	Details
5853, 5854, 5855	S	Apparent power busbar A
5863, 5864, 5865	Q	Reactive power busbar A
5873, 5874, 5875	PF	Power factor
5883, 5884, 5885	f	Busbar A frequency
5893, 5894, 5895	U	Busbar A voltage
5903, 5904, 5905	I	L1 current
5913, 5914, 5915	U S2	Busbar B voltage
5923, 5924, 5925	f S2	Busbar B 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.

7. ATS application example

7.1 Introduction

In this chapter, a specific example of how to set up an ATS controller is shown. The ATS controls a mains breaker and a genset breaker, and monitors the two sources. The ATS is part of an emergency system that supplies power to elevators.

7.2 Application setup



System information

- Three-phase system, 50 Hz, 400 V phase-phase
- 1 genset: 1500 kW
- Mains
- The ATS is part of an emergency system that supplies power for elevator operation.
  - The controller monitors the two sources and checks the voltage and frequency of the mains (primary source) to make sure the source is OK. If there is a loss of power or anomalies are detected in the voltage or frequency, the ATS switches to the genset (backup source). The ATS can also switch to the backup source in case of scheduled transfers.
- Operation strategy:
  - The ATS operates as an open transition switch with an elevator switch function activated. Pre-delay and post-delay timers are configured for the elevator function. If the controller detects a change in voltage or frequency, or a loss of the primary source, the controller switches to the genset (backup source). When the mains returns, the pre-delay time allows the elevator to move to the nearest floor before power is transferred back to the mains. This is to avoid disruptions to the system and allow any passengers to safely get off the elevator.

Create the application with the utility software

1. Go to `ATS configuration > ATS basic config` and configure these parameters:
   a. ATS CB priority (19021): Prioritize S1
   b. ATS CBs (19022): 2 breakers
   c. ATS application (S1/S2) (19024): Mains/Gen
2. Go to `ATS configuration > ATS transfer config` and set parameter 19001 to open transition.

Configure the elevator switch function

1. Go to `ATS configuration > ATS transfer config > Elevator switch .`
2. Enable the elevator switch function in parameter 19141.
3. In parameter 19142, set the elevator pre-delay timer to 60 seconds.
4. In parameter 19143, set the post-delay timer to 10 seconds.

7.3 Inputs and outputs

The *Genset2 start/stop* digital output is a default setting and should already be configured. Go to `I/O & Hardware setup > DO 5 - 18 > Output 6` to see the genset 2 settings.

Set up the elevator switch output

On the *I/O & Hardware setup* page, select *DO 5 - 18*. Set *Output 13* as *Elevator switch*.

7.4 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 35 V DC power for the controller
6	Genset 2 start/stop	Digital output to start and stop genset 2
8-13	Elevator switch	Digital output for elevator switch
8-15	Close GB breaker	Maximum 500 mA relay
8-16	Open GB breaker	Maximum 500 mA relay
8-17	Close MB breaker	
8-18	Open MB breaker	
47	GB breaker closed	Negative switching only, < 100 Ω
48	GB breaker open	Negative switching only, < 100 Ω
49	MB breaker closed	
50	MB breaker open	
56	S1 L1 AC current	Use an x/1 A or x/5 A current transformer
59	S2 L1 AC current	Use an x/1 A or x/5 A current transformer
57	S1 L2 AC current	Use an x/1 A or x/5 A current transformer
59	S1 L2 AC current	Use an x/1 A or x/5 A current transformer
58	S1 L3 AC current	Use an x/1 A or x/5 A current transformer
59	S1 L3 AC current	Use an x/1 A or x/5 A current transformer
63	L1 Mains voltage	Maximum 690 V AC phase-phase
64	L2 Mains voltage	Maximum 690 V AC phase-phase
65	L3 Mains voltage	Maximum 690 V AC phase-phase
67	L1 Genset voltage	Maximum 690 V AC phase-phase
68	L2 Genset voltage	Maximum 690 V AC phase-phase
69	L3 Genset voltage	Maximum 690 V AC phase-phase

7.5 Parameters

For this example, set the following parameters. You can do this on the display or with the utility software.

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
19082	ATS G2 cooldown	Select 60 seconds
19093	ATS G2 stop failure	Select 60 seconds for the timer. Select *Warning* as the fail class
19097	ATS G2 start failure	Select 60 seconds for the timer. Select *Warning* as the fail class
19103	ATS G2 failure	Select 15 seconds for the timer. Select *Warning* as the fail class

7.6 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.

7.7 Operation

Push 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 closes the priority 1 breaker, which in this application is the mains breaker.

The ATS controller monitors the voltage and frequency for both sources. If there is a sudden loss of mains power, the ATS immediately checks the voltage and frequency of the genset to make sure it is safe to transfer the load. The ATS then

sends a start signal to the generator control, and closes the genset breaker. The application, which is an elevator system, now operates on the backup power.

When the mains returns, the pre-delay timer starts and power is not transferred back to the mains until this timer expires. This is to allow the elevator to move to the nearest floor and avoid any further disruptions. Once the pre-delay timer expires, the ATS transfers the load back to the mains. . The post-delay timer starts when the pre-delay timer expires, and the pre-delay signal is active until the post-delay timer expires.