MFR 500 Series

Manual | Multifunction Relay

MFR 500

Software Version 1.00xx or higher

37539B

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Brief Overview

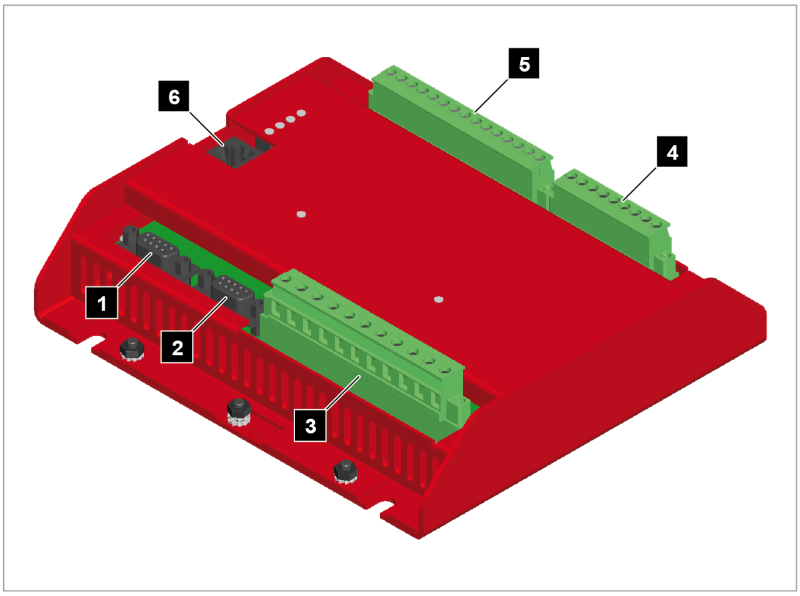


Fig. 1: MFR 500 (housing)

1 Interbus outgoing interface connector
2 Interbus incoming interface connector
3 Voltage PT terminal
4 Current CT terminal
5 Relay outputs terminal
6 Service port connector (USB/RS-232)[1]

[1] Optional configuration cable for ToolKit configuration software and external extensions/applications required:

- *USB connector: DPC-USB direct configuration cable – P/N 5417-1251*
- *RS-232 connector: DPC-RS-232 direct configura-tion cable – P/N 5417-557*

The MFR 500 is a multifunction relay which combines measuring and protection capabilities into one single system.

Sample application setup

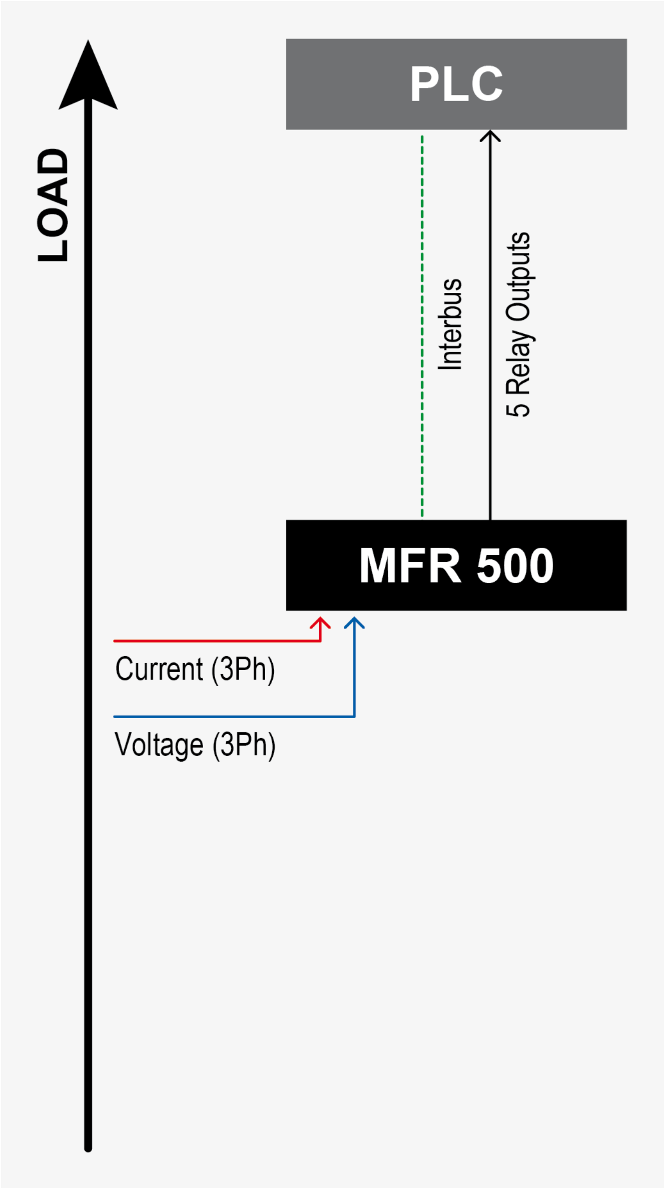


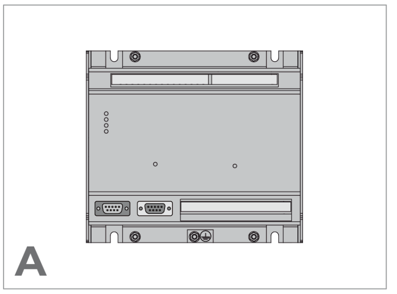
Fig. 2: Sample application setup

A typical application for the control unit is to use it as a power transducer for a PLC.

> *For a listing of additional applications and setups please refer to chapter* *➪ Chapter 6 "Application" on page 93.*

Scope of delivery

The following parts are included in the scope of delivery. Please check prior to the installation that all parts are present.



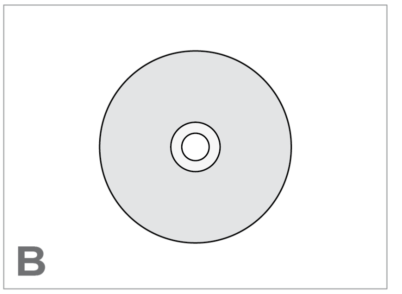


Fig. 3: Scope of delivery - schematic

A MFR 500 multifunction relay
B Product CD (configuration software and manual)

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1 General Information

1.1 About This Manual

1.1.1 Revision History

Rev.	Date	Editor	Changes
B	2013-09-21	GG	**Manual** Updated for ToolKit 4.3 installation instruction. Monitoring of overvoltage and undervoltage (ANSI# 59): hysteresis control became more detailed. Instead of 0.7% it now depends on the voltage threshold! If the voltage threshold is 35% or lower the hysteresis becomes decreased to 0.4%. ■ See undervoltage monitoring ➪ *Chapter 4.4.2 "Undervoltage (Level 1 & 2) ANSI# 27" on page 47* for detail.
A	2012-08-09	GG	**Manual** ■ Recommendation how to protect power supply input. Refert to ➪ *"Schematic and terminals" on page 26* for details.
NEW	2012-03-16	TE	**Manual** ■ Release The present publication (37539) replaces the following manual which will no longer be supported. ■ MFR 500 manual (37408) **New device features & updates** Requirements: MFR 500 multifunction relay with software version 1.02xx or higher. The described changes relate to the previous software version 1.01xx. New features ■ QV monitoring. Refer to ➪ *Chapter 4.4.12 "QV Monitoring" on page 65* for details. ■ Time-dependent voltage 3 and 4 monitoring. Refer to ➪ *Chapter 4.4.17 "Time-Dependent Voltage 3" on page 76* and ➪ *Chapter 4.4.18 "Time-Dependent Voltage 4" on page 78* for details. ■ Voltage increase monitoring. Refer to ➪ *Chapter 4.4.11 "Voltage Increase" on page 64* for details. ■ Overcurrent monitoring. Refer to ➪ *Chapter 4.4.13 "Overcurrent (Level 1, 2 & 3) ANSI# 50/51" on page 67* for details. ■ Ground fault monitoring. Refer to ➪ *Chapter 4.4.14 "Ground Fault (Level 1 & 2)" on page 69* for details. ■ Monitoring fallback delay. Refer to ➪ *Chapter 4.2.5 "Monitoring" on page 45* for details. Feature updates ■ Voltage monitoring. Refer to ➪ *Chapter 4.2.1 "Measurement" on page 39* for details. The setting range of "Voltage monitoring" (parameter 1770 ➪ p. 42) was extended to the entry "All". ■ Time-dependent voltage 1 and 2 monitoring. Refer to ➪ *Chapter 4.4.15 "Time-Dependent Voltage 1" on page 71* and ➪ *Chapter 4.4.16 "Time-Dependent Voltage 2" on page 73* for details. The time-dependent voltage monitoring can be configured to over- or undervoltage monitoring. The parameter "Monitoring at" (parameter 4953 ➪ p. 72 and 4957 ➪ p. 75) was added. ■ Voltage asymmetry monitoring. Refer to ➪ *Chapter 4.4.8 "Voltage Asymmetry (Level 1 & 2)" on page 59* for details. The voltage asymmetry monitoring was extended to a second monitoring level. The following parameters were added (parameter 3931 ➪ p. 60, 3932 ➪ p. 61, 3934 ➪ p. 61 and 3935 ➪ p. 61). ■ Overvoltage/undervoltage monitoring. Refer to ➪ *Chapter 4.4.1 "Overvoltage (Level 1 & 2) ANSI# 59" on page 46* and ➪ *Chapter 4.4.2 "Undervoltage (Level 1 & 2) ANSI# 27" on page 47* for details. The setting range of "Limit" (parameter 2004 ➪ p. 47, 2010 ➪ p. 47, 2054 ➪ p. 49 and 2060 ➪ p. 49) has been increased from 125.0 % to 150.0 %.

Rev.	Date	Editor	Changes
			■ Overfrequency/underfrequency monitoring. Refer to ␡ *Chapter 4.4.3 "Overfrequency (Level 1 & 2) ANSI# 81O" on page 49* and ␡ *Chapter 4.4.4 "Underfrequency (Level 1 & 2) ANSI# 81U" on page 51* for details. The setting range of "Limit" (parameter 1904 ␡ p. 51, 1910 ␡ p. 51, 1954 ␡ p. 53 and 1960 ␡ p. 53) has been increased from 130.0 % to 140.0 %. ■ df/dt (ROCOF) monitoring. Refer to ␡ *Chapter 4.4.10 "df/dt (ROCOF)" on page 63* for details. The setting range of "Limit" (parameter 3104 ␡ p. 63) has been lowered from 1.0 Hz/s to 0.1 Hz/s.

1.1.2 Depiction Of Notes And Instructions

Safety instructions

Safety instructions are marked with symbols in these instructions. The safety instructions are always introduced by signal words that express the extent of the danger.

DANGER!
This combination of symbol and signal word indicates an immediately-dangerous situation that could cause death or severe injuries if not avoided.

WARNING!
This combination of symbol and signal word indicates a possibly-dangerous situation that could cause death or severe injuries if it is not avoided.

CAUTION!
This combination of symbol and signal word indicates a possibly-dangerous situation that could cause slight injuries if it is not avoided.

NOTICE!
This combination of symbol and signal word indicates a possibly-dangerous situation that could cause property and environmental damage if it is not avoided.

Tips and recommendations

This symbol indicates useful tips and recommendations as well as information for efficient and trouble-free operation.

Additional markings

To emphasize instructions, results, lists, references, and other elements, the following markings are used in these instructions:

Marking	Explanation
⟶	Step-by-step instructions
⇨	Results of action steps
↳	References to sections of these instructions and to other relevant documents
■	Listing without fixed sequence
[Buttons]	Operating elements (e.g. buttons, switches), display elements (e.g. signal lamps)
"Display"	Screen elements (e.g. buttons, programming of function keys)

1.2 Copyright And Disclaimer

Disclaimer

All information and instructions in this operating manual have been provided under due consideration of applicable guidelines and regulations, the current and known state of the art, as well as our many years of in-house experience. Woodward GmbH assumes no liability for damages due to:

- Failure to comply with the instructions in this operating manual
- Improper use / misuse
- Willful operation by non-authorized persons
- Unauthorized conversions or non-approved technical modifications
- Use of non-approved spare parts

The originator is solely liable to the full extent for damages caused by such conduct. The agreed upon obligations in the delivery contract, the general terms and conditions, the manufacturer's delivery conditions, and the statutory regulations valid at the time the contract was concluded, apply.

Copyright

1.3 Service And Warranty

Our Customer Service is available for technical information. Please see page 2 for the contact data.

In addition, our employees are constantly interested in new information and experiences that arise from usage and could be valuable for the improvement of our products.

Warranty terms

Please enquire about the terms of warranty from your nearest Woodward representative.

For our contact search webpage please go to: http://www.woodward.com/Directory.aspx

1.4 Safety

1.4.1 Intended Use

The multifunction relay unit has been designed and constructed solely for the intended use described in this manual.

The multifunction relay unit must be used exclusively for power measurement applications.

- Intended use requires operation of the control unit within the specifications listed in *Chapter 8.1 "Technical Data" on page 97*.
- All permissible applications are outlined in *Chapter 6 "Application" on page 93*.
- Intended use also includes compliance with all instructions and safety notes presented in this manual.
- Any use which exceeds or differs from the intended use shall be considered improper use.
- No claims of any kind for damage will be entertained if such claims result from improper use.

NOTICE!

Damage due to improper use!

Improper use of the multifunction relay unit may cause damage to the control unit as well as connected components.

Improper use includes, but is not limited to:

– Operation outside the specified operation conditions.

1.4.2 Personnel

WARNING!

Hazards due to insufficiently qualified personnel!

If unqualified personnel perform work on or with the control unit hazards may arise which can cause serious injury and substantial damage to property.

– Therefore, all work must only be carried out by appropriately qualified personnel.

This manual specifies the personnel qualifications required for the different areas of work, listed below:

The workforce must only consist of persons who can be expected to carry out their work reliably. Persons with impaired reactions due to, for example, the consumption of drugs, alcohol, or medication are prohibited.

When selecting personnel, the age-related and occupation-related regulations governing the usage location must be observed.

1.4.3 General Safety Notes

Electrical hazards

DANGER!

Life-threatening hazard from electric shock!

There is an imminent life-threatening hazard from electric shocks from live parts. Damage to insulation or to specific components can pose a life-threatening hazard.

- Only a qualified electrician should perform work on the electrical equipment.
- Immediately switch off the power supply and have it repaired if there is damage to the insulation.
- Before beginning work at live parts of electrical systems and resources, cut the electricity and ensure it remains off for the duration of the work. Comply with the five safety rules in the process:
  - cut electricity;
  - safeguard against restart;
  - ensure electricity is not flowing;
  - earth and short-circuit; and
  - cover or shield neighbouring live parts.
- Never bypass fuses or render them inoperable. Always use the correct amperage when changing fuses.
- Keep moisture away from live parts. Moisture can cause short circuits.

Modifications

WARNING!

Hazards due to unauthorized modifications

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment.

Any unauthorized modifications:

- constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage
- invalidate product certifications or listings.

Electrostatic discharge

Protective equipment:
- ESD wrist band

> **NOTICE!**
> **Damage from electrostatic discharge**
> All electronic equipment sensitive to damage from electrostatic discharge, which can cause the control unit to malfunction or fail.
>
> – To protect electronic components from static damage, take the precautions listed below.

1. Avoid build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as easily as synthetics.

2. Before any maintenance work on the control unit, ground yourself by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.) to discharge any static electricity.

   Alternatively wear an ESD wrist band connected to ground.

3. Keep plastic, vinyl, and Styrofoam materials (such as plastic or Styrofoam cups, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, etc.) away from the control unit, modules and work area.

4. Opening the control cover may void the unit warranty. Do not remove the printed circuit board (PCB) from the control cabinet unless instructed by this manual.

> *If instructed by this manual to remove the PCB from the control cabinet, follow these precautions:*
>
> – *Ensure that the device is completely voltage-free (all connectors have to be disconnected).*
>
> – *Do not touch any part of the PCB except the edges.*
>
> – *Do not touch the electrical conductors, connectors, or components with conductive devices or with bare hands.*
>
> – *When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.*

For additional information on how to prevent damage to electronic components caused by improper handling, read and observe the precautions in:

– *"Woodward manual 82715, Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules".*

1.4.4 Protective Equipment And Tools

Protective gear

Personal protective equipment serves to protect risks to the safety and health of persons as well as to protect delicate components during work.

Certain tasks presented in this manual require the personnel to wear protective equipment. Specific required equipment is listed in each individual set of instructions.

The cumulative required personal protective equipment is detailed below:

ESD wrist band
The ESD (**e**lectro**s**tatic **d**ischarge) wrist band keeps the user's body set to ground potential. This measure protects sensitive electronic components from damage due to electrostatic discharge.

Tools

Use of the proper tools ensures successful and safe execution of tasks presented in this manual.

Specific required tools are listed in each individual set of instructions.

The cumulative required tools are detailed below:

Torque screwdriver
A torque-screwdriver allow fastening of screws to a precisely specified torque.

- Note the required torque range indiviually specified in the tasks listed in this manual.

2 System Overview

This chapter provides a basic overview of the control unit.

Refer to the comprehensive chapters indicated below to commission the control unit:

- ↳ *Chapter 3 "Installation" on page 23* provides information on how to mount the unit and setup connections.
- ↳ *Chapter 4 "Configuration" on page 39* provides information on basic setup and reference information on all configurable parameters.
- ↳ *Chapter 5 "Operation" on page 85* provides information on how to access the unit remotely using the ToolKit software provided by Woodward.
- ↳ *Chapter 6 "Application" on page 93* provides application examples as well as instructions for the corresponding required configuration.
- ↳ *Chapter 7 "Interfaces And Protocols" on page 95* provides reference information on the usage of the interfaces and protocols provided by the control unit.

2.1 Status Indicators

MFR 500 LEDs

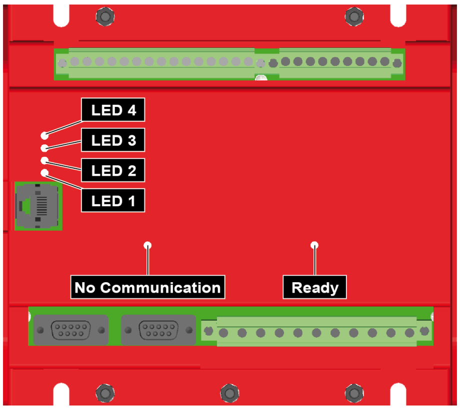


Fig. 4: Position of LEDs

The MFR 500 unit features six LEDs (Fig. 4) on the front plate.

The six LEDs indicate the following states:

State		Indication
	Illuminated red	No valid Interbus command is received for at least three seconds.

Table 1: No Communication

State		Indication
	Illuminated green	Unit is ready for operation.

Table 2: Ready

State		Indication
	Illuminated green	The /RESREG signal (Interbus reset inactive) from the Interbus controller is enabled.

Table 3: LED 1 (Interbus)

State		Indication
	Illuminated red	The RBDA signal (subsequent interface is deactivated) from the Interbus controller is enabled.

Table 4: LED 2 (Interbus)

State		Indication
	Illuminated green	The BA signal (Interbus active) from the Interbus controller is enabled.

Table 5: LED 3 (Interbus)

State		Indication
---	---	Intended for future enhancements.

Table 6: LED 4 (Interbus)

Please refer to the Interbus specifications for detailed information about the Interbus LED signals.

2.2 Hardware Interfaces (Terminals)

The MFR 500 (Fig. 5) provides the following terminals.

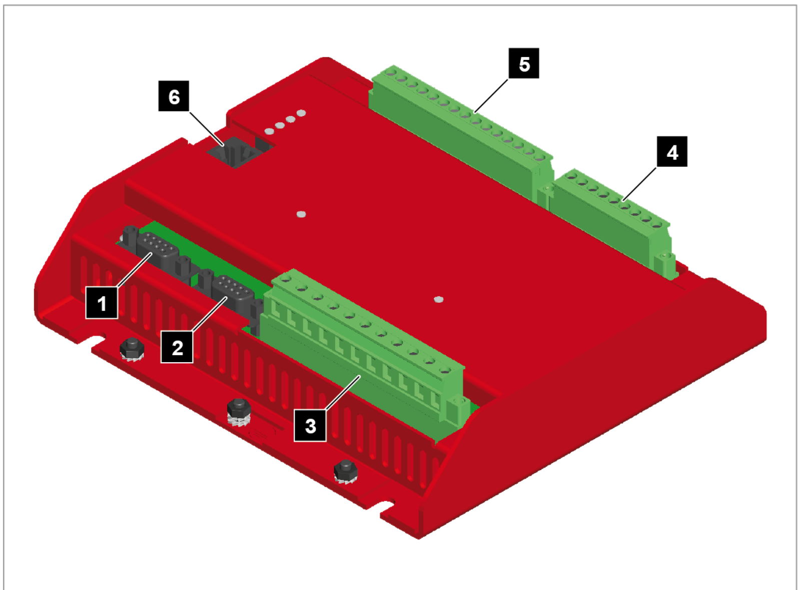


Fig. 5: MFR 500 (housing)

1 Interbus outgoing interface connector
2 Interbus incoming interface connector
3 Voltage PT terminal
4 Current CT terminal
5 Relay outputs terminal
6 Service port connector (USB/RS-232)[1]

[1] Optional configuration cable for ToolKit configuration software and external extensions/applications required:

- *USB connector: DPC-USB direct configuration cable – P/N 5417-1251*
- *RS-232 connector: DPC-RS-232 direct configuration cable – P/N 5417-557*

For information on how to setup connections refer to ↪ Chapter 3.2 “Setup Connections” on page 24.

For information on the interfaces and protocols refer to ↪ Chapter 7 “Interfaces And Protocols” on page 95.

2.3 Measuring Values

Measuring principle

The device measures alternating voltage/current utilizing a sampling measuring method. All values are sampled for each phase with a rate of 5 kHz, integrated over one period, and the RMS value is calculated. The real power RMS value is calculated by multiplying and integrating the current and voltage values. The frequency is established from the time intervals of the voltage passing through zero. The reactive power is calculated from the phase shift between current and voltage.

Measuring values

Measuring value	Definition
Voltage	Three-phase RMS value measuring of the wye and delta voltages.
Frequency	Frequency measurement is extracted from the digitally filtered measuring voltages. The frequency is measured if the measured voltage exceeds 5 % of the rated voltage (120 V or 690 V). If the system is configured for three phases, all three phases are used for measurement. However the frequency is still measured correctly even if voltage is only applied to one phase.
Current	Three-phase RMS value measuring. Instantaneous value of the current.
Real power	The real power RMS value is measured though real time multiplication and integration of the instantaneous values of the wye voltage and the conductor current for each cycle.
Reactive power	Three-phase measurement, calculated from the RMS values of voltage and current and the phase angle between voltage and current.
Power factor	Calculated from the phase angle between voltage and current.
Active energy	Active energy combines a time measurement with the measured positive and negative real power. The counter is incorporated in the non-volatile memory and only computes positive energy. The memory is updated every 3 minutes with a resolution of 0.1 kWh. This counter is not calibrated by the Physikalisch-Technische Bundesanstalt (PTB).
Inductive reactive energy	Reactive energy combines a time measurement with the measured positive and negative reactive power. The counter is incorporated in the non-volatile memory and only computes positive energy. The memory is updated every 3 minutes with a resolution of 0.1 kvarh. This counter is not calibrated by the Physikalisch-Technische Bundesanstalt (PTB).
Phase angle	Measuring of the phase angle between the single wye voltages.

3 Installation

3.1 Mount Unit

Dimensions

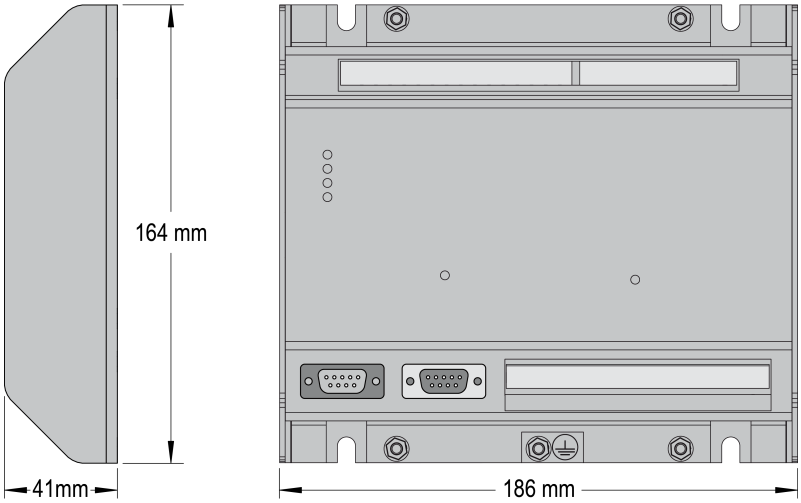


Fig. 6: Housing - dimensions

Mounting into a cabinet

Special tool:
- Torque screwdriver

Proceed as follows to install the unit using the screw kit:

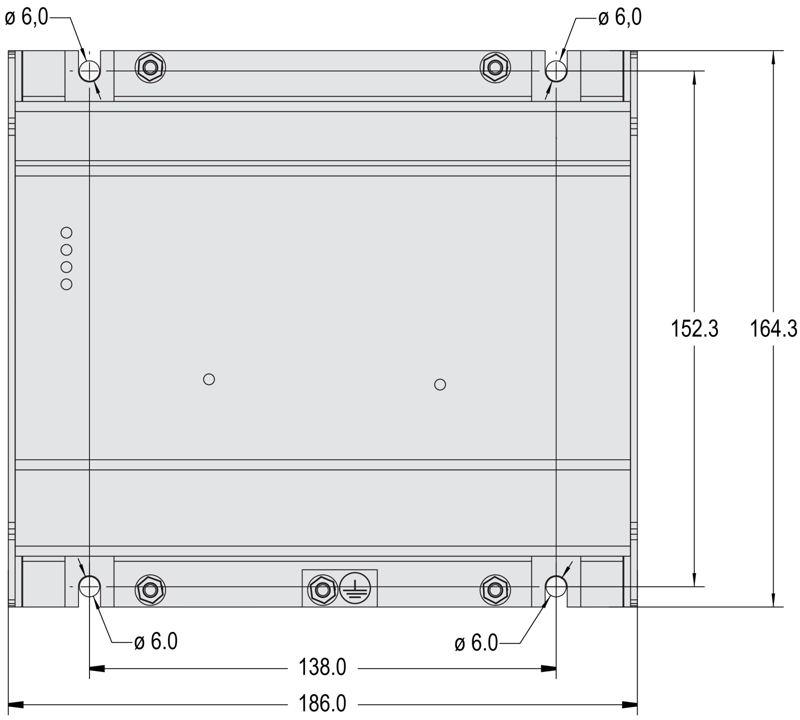


Fig. 7: Housing - drill plan

1. Drill the holes according to the dimensions in Fig. 7 (dimensions shown in mm).

> *Ensure sufficient clearance for access to the terminals (top and bottom).*

2. Mount the unit to the back panel and insert the screws.
3. Tighten the screws to a torque according to the quality class of the used screws.

> *Tighten the screws with a crosswise pattern to ensure even pressure distribution.*

> *If the thickness of the panel sheet exceeds 2.5 mm, be sure to use screws with a length exceeding the panel sheet thickness by 4 mm.*

3.2 Setup Connections

General notes

> **NOTICE!**
>
> **Malfunctions due to literal use of example values**
>
> All technical data and ratings indicated in this chapter are merely listed as examples. Literal use of these values does not take into account all actual specifications of the control unit as delivered.
>
> – For definite values please refer to chapter *Chapter 8.1 “Technical Data” on page 97*.
>
> – Connected inductances (e.g. operating current coils, undervoltage tripping devices, auxiliary contactors, and/or power contactors) must be wired with an appropriate interference protection.

Wire sizes

AWG	mm²	AWG	mm²	AWG	mm²	AWG	mm²	AWG	mm²	AWG	mm²
30	0.05	21	0.38	14	2.5	4	25	3/0	95	600MCM	300
28	0.08	20	0.5	12	4	2	35	4/0	120	750MCM	400
26	0.14	18	0.75	10	6	1	50	300MCM	150	1000MCM	500
24	0.25	17	1.0	8	10	1/0	55	350MCM	185		
22	0.34	16	1.5	6	16	2/0	70	500MCM	240		

Table 7: Conversion chart - wire sizes

3.2.1 Terminal Allocation

General notes

The device terminals are allocated as follows:

- Sheet metal housing - shown in Fig. 8

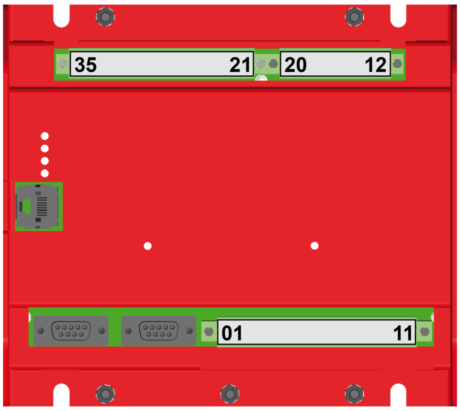


Fig. 8: Sheet metal housing

3.2.2 Wiring Diagram

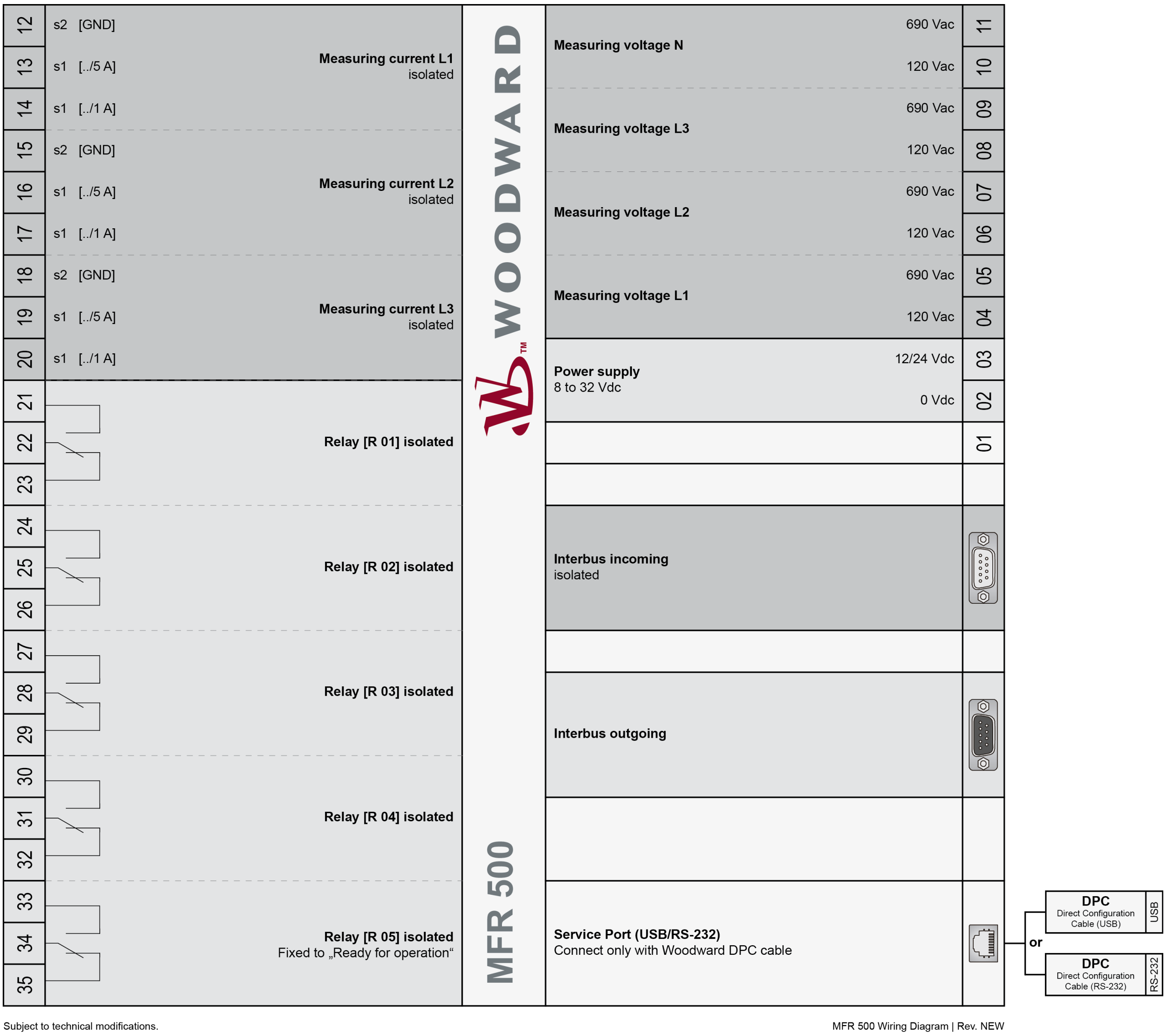


Fig. 9: Wiring diagram

3.2.3 Power Supply

General notes

> **WARNING!**
>
> **Risk of electric shock - sheet metal housing**
>
> – Connect Protective Earth (PE) to the unit to avoid the risk of electric shock.
>
> Use the protective earth (PE) connector located at the bottom center of the sheet metal housing.
>
> – The conductor providing the connection must have a wire larger than or equal to 2.5 mm² (14 AWG). The connection must be performed properly.

Schematic and terminals

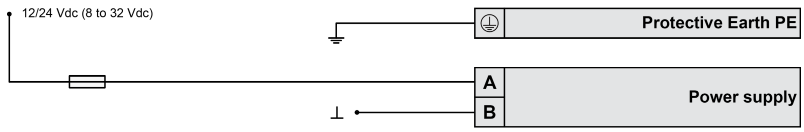


Fig. 10: Power supply - wiring

> *Woodward recommends protecting the 12/24 Vdc power supply input with a slow acting fuse rated for 4A or 6A*

Terminal		Description	A_{max}
A	03	12/24Vdc (8 to 32.0 Vdc)	2.5 mm²
B	02	0 Vdc	2.5 mm²

Table 8: Power supply - terminal assignment

3.2.4 Voltage Measuring

General notes

> **NOTICE!**
>
> **Incorrect readings due to improper setup**
>
> The control unit will not measure voltage correctly if the 120 V and 690 V inputs are utilized simultaneously.
>
> – Never use both sets of voltage measuring inputs.

> *Woodward recommends protecting the voltage measuring inputs with slow-acting fuses rated for 2 to 6 A.*

If parameter 1800 ↬ p. 43 ("PT secondary rated volt.") is configured with a value between 50 and 130 V, the 120 V input terminals must be used for proper measurement.

If parameter 1800 ↬ p. 43 ("PT secondary rated volt.") is configured with a value between 131 and 690 V, the 690 V input terminals must be used for proper measurement.

Schematic and terminals

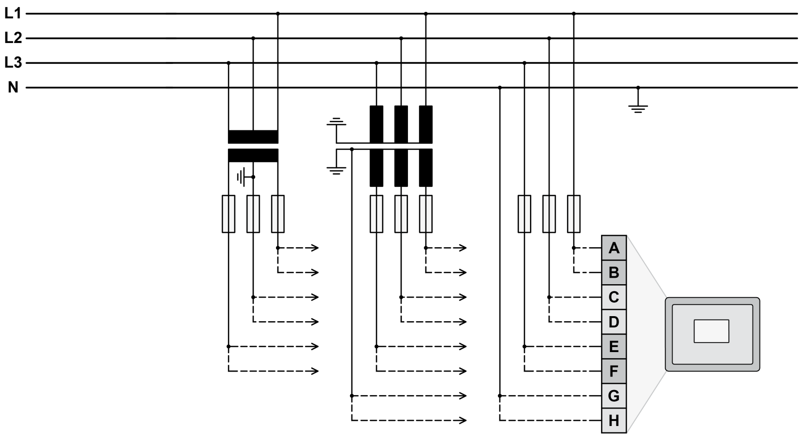


Fig. 11: Voltage measuring - wiring

Terminal		Description		A_{max}
A	04	Measuring voltage L1	120 Vac	2.5 mm²
B	05		690 Vac	2.5 mm²
C	06	Measuring voltage L2	120 Vac	2.5 mm²
D	07		690 Vac	2.5 mm²
E	08	Measuring voltage L3	120 Vac	2.5 mm²
F	09		690 Vac	2.5 mm²
G	10	Measuring voltage N	120 Vac	2.5 mm²
H	11		690 Vac	2.5 mm²

Table 9: Voltage measuring - terminal assignment

3.2.4.1 Parameter Setting '3Ph 4W' (3-phase, 4-wire)

Generator windings

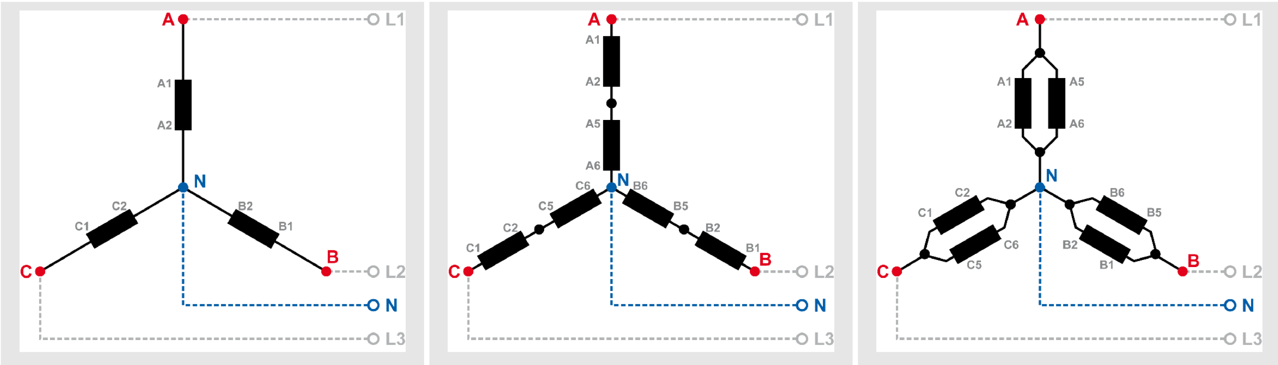


Table 10: Generator windings - 3Ph 4W

Measuring inputs

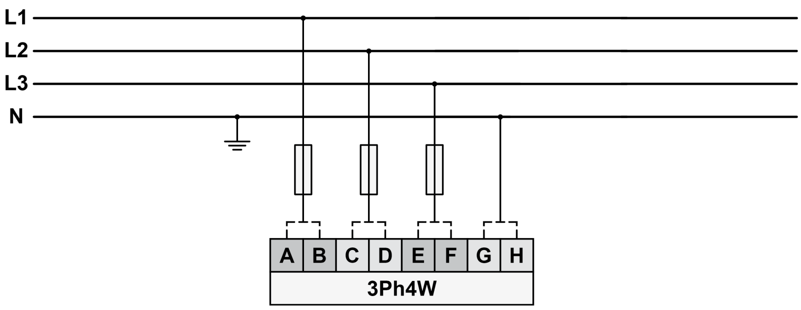


Fig. 12: Measuring inputs - 3Ph 4W

Terminal assignment

3Ph 4W	Wiring terminals							
Rated voltage (range)	120 V (50 to 130 $V_{eff.}$)				690 V (131 to 690 $V_{eff.}$)			
Measuring range (max.)	0 to 150 Vac				0 to 800 Vac			
Terminal	A	C	E	G	B	D	F	H
	04	06	08	10	05	07	09	11
Phase	L1	L2	L3	N	L1	L2	L3	N

For different voltage systems, different wiring terminals have to be used.

Incorrect measurements are possible, if both voltage systems use the same N terminal.

3.2.4.2 Parameter Setting '3Ph 3W' (3-phase, 3-wire)

Generator windings

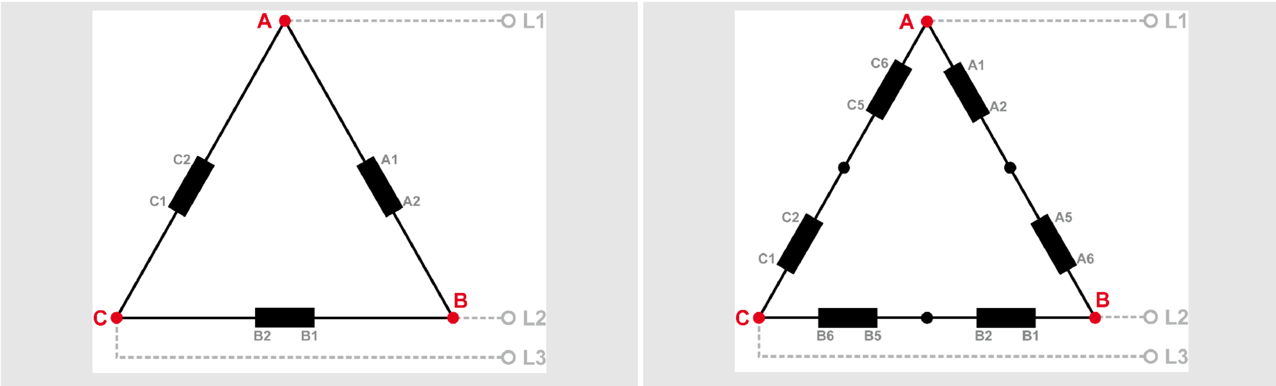


Table 11: Generator windings - 3Ph 3W

Measuring inputs

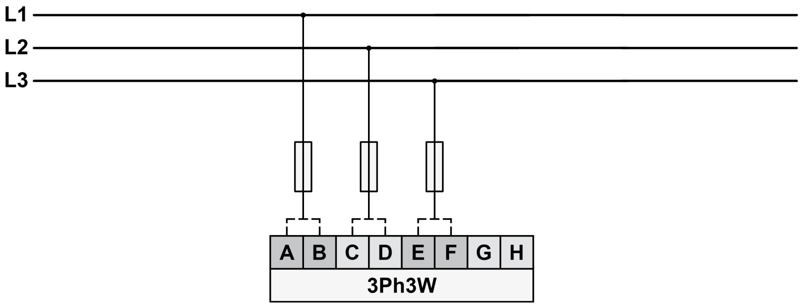


Fig. 13: Measuring inputs - 3Ph 3W

Terminal assignment

3Ph 3W	**Wiring terminals**							
Rated voltage (range)	120 V (50 to 130 $V_{eff.}$)				690 V (131 to 690 $V_{eff.}$)			
Measuring range (max.)	0 to 150 Vac				0 to 800 Vac			
Terminal	A	C	E	G	B	D	F	H
	04	06	08	10	05	07	09	11
Phase	L1	L2	L3	---	L1	L2	L3	---

For different voltage systems, different wiring terminals have to be used.

If L1, L2 or L3 are connected to PE or N the single reactive powers VL1-I1, VL2-I2 and VL3-I3 cannot be calculated correctly. So the overall reactive power does not fit. The apparent power is calculated out of the reactive power and cannot be correct too.

The at all active power and the single currents are calculated all the time correct.

3.2.4.3 Parameter Setting '1Ph 3W' (1-phase, 3-wire)

Generator windings

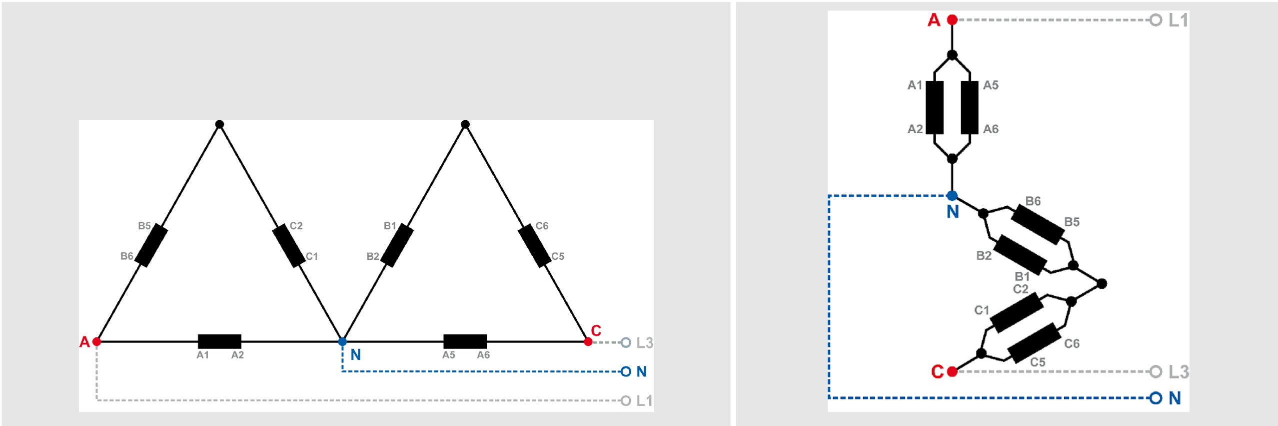


Table 12: Generator windings - 1Ph 3W

Measuring inputs

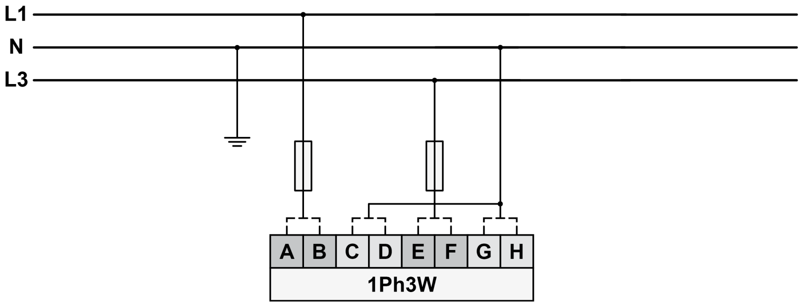


Fig. 14: Measuring inputs - 1Ph 3W

Terminal assignment

1Ph 3W	Wiring terminals							
Rated voltage (range)	120 V (50 to 130 $V_{eff.}$)				690 V (131 to 690 $V_{eff.}$)			
Measuring range (max.)	0 to 150 Vac				0 to 800 Vac			
Terminal	A	C	E	G	B	D	F	H
	04	06	08	10	05	07	09	11
Phase	L1	N	L3	N	L1	N	L3	N

For different voltage systems, different wiring terminals have to be used.

Incorrect measurements are possible, if both voltage systems use the same N terminal.

3.2.4.4 Parameter Setting '1Ph 2W' (1-phase, 2-wire)

*The 1-phase, 2-wire measurement may be performed **phase-neutral** or **phase-phase**.*

– *Please note to configure and wire the device consistently.*

3.2.4.4.1 '1Ph 2W' Phase-Neutral Measuring

Generator windings

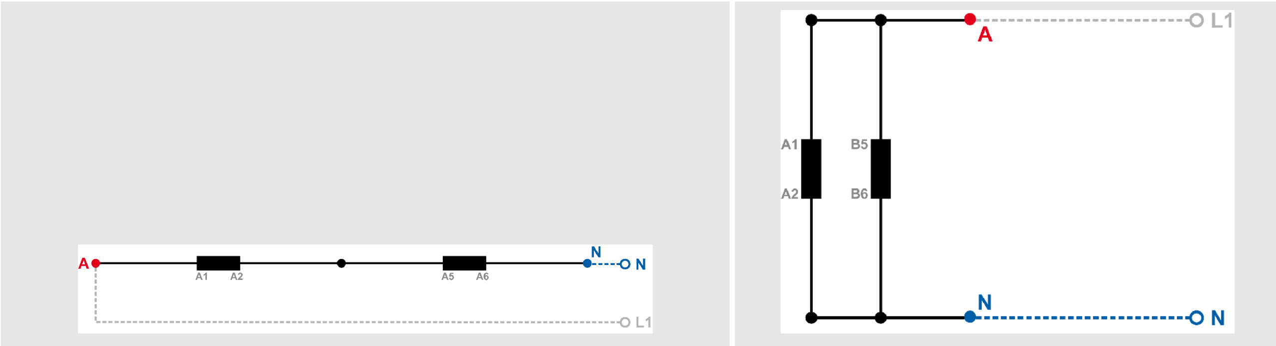


Table 13: Generator windings - 1Ph 2W (phase neutral)

Measuring inputs

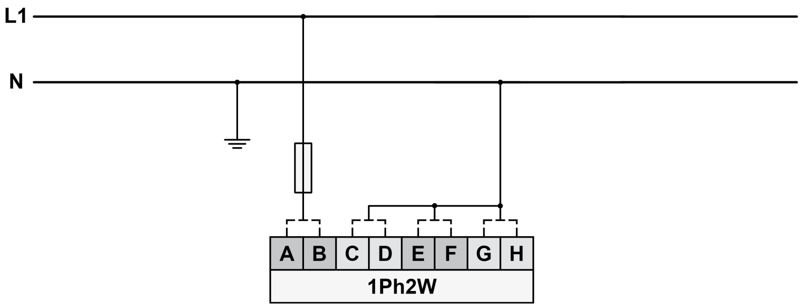


Fig. 15: Measuring inputs - 1Ph 2W (phase neutral)

Terminal assignment

1Ph 2W	Wiring terminals							
Rated voltage (range)	120 V (50 to 130 $V_{eff.}$)				690 V (131 to 690 $V_{eff.}$)			
Measuring range (max.)	0 to 150 Vac				0 to 800 Vac			
Terminal	A	C	E	G	B	D	F	H
	04	06	08	10	05	07	09	11
Phase	L1	N	N	N	L1	N	N	N

For different voltage systems, different wiring terminals have to be used.

Incorrect measurements are possible if both voltage systems use the same N terminal.

3.2.4.4.2 '1Ph 2W' Phase-Phase Measuring

Generator windings

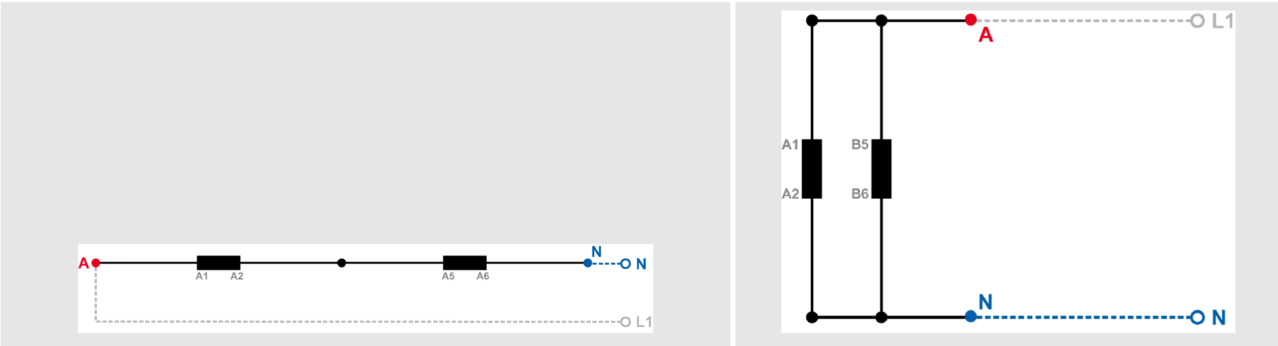


Table 14: Generator windings - 1Ph 2W (phase-phase)

Measuring inputs

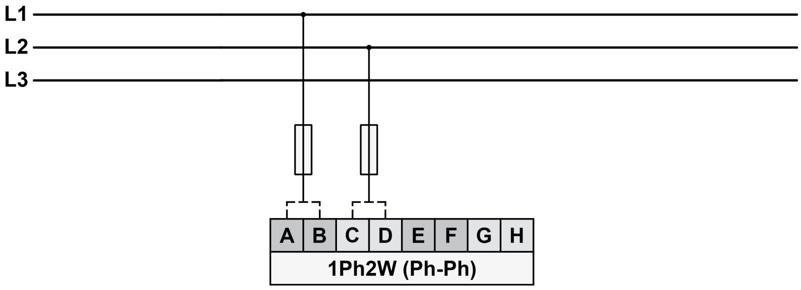


Fig. 16: Measuring inputs - 1Ph 2W (phase-phase)

Terminal assignment

1Ph 2W	Wiring terminals							
Rated voltage (range)	120 V (50 to 130 $V_{eff.}$)				690 V (131 to 690 $V_{eff.}$)			
Measuring range (max.)	0 to 150 Vac				0 to 800 Vac			
Terminal	A	C	E	G	B	D	F	H
	04	06	08	10	05	07	09	11
Phase	L1	L2	---	---	L1	L2	---	---

For different voltage systems, different wiring terminals have to be used.

3.2.5 Current Measuring

General notes

WARNING!
The unit described here is provided with two sets of current measuring inputs (1 A and 5 A).

DO NOT use both sets of current measuring inputs. Mistaking the current measuring inputs may cause personal injury and/or damage to the product. Use the 1 A inputs for 1 A CTs and the 5 A inputs for 5 A CTs.

WARNING!
Dangerous voltages due to missing load
– Before disconnecting the device, ensure that the current transformer (CT) is short-circuited.

Generally, one line of the current transformers secondary must be grounded close to the CT.

Schematic and terminals

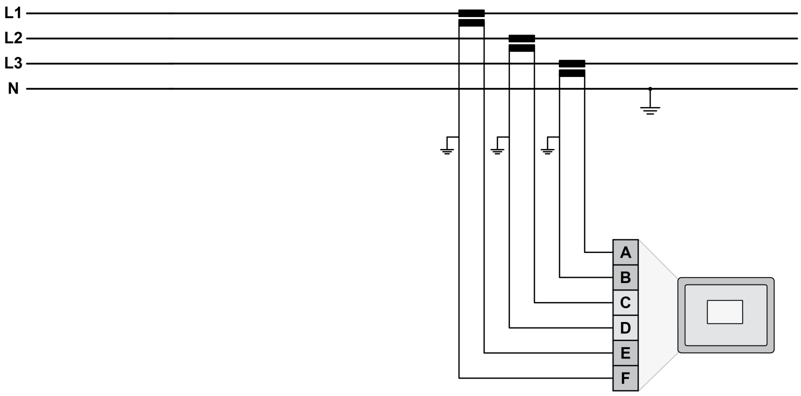


Fig. 17: Current measuring - wiring

Terminal		Description	A_{max}
A	20	Measuring current - L3 - transformer terminal s1 (k) | **1 A**	2.5 mm²
	19	Measuring current - L3 - transformer terminal s1 (k) | **5 A**	
B	18	Measuring current - L3 - transformer terminal s2 (l) | **GND**	2.5 mm²
C	17	Measuring current - L2 - transformer terminal s1 (k) | **1 A**	2.5 mm²
	16	Measuring current - L2 - transformer terminal s1 (k) | **5 A**	
D	15	Measuring current - L2 - transformer terminal s2 (l) | **GND**	2.5 mm²

Terminal		Description	A_{max}
E	14	Measuring current - L1 - transformer terminal s1 (k) | **1 A**	2.5 mm²
	13	Measuring current - L1 - transformer terminal s1 (k) | **5 A**	
F	12	Measuring current - L1 - transformer terminal s2 (l) | **GND**	2.5 mm²

Table 15: Current measuring - terminal assignment

3.2.5.1 Parameter Setting 'L1 L2 L3'

Schematic and terminals

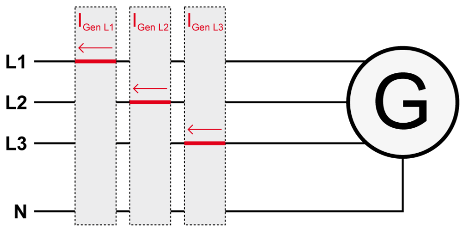


Fig. 18: Current measuring, L1 L2 L3

	Wiring terminals					
	F	E	D	C	B	A
L1 L2 L3						
Terminal	12	13/14	15	16/17	18	19/20
Phase	s2 (l) L1	s1 (k) L1	s2 (l) L2	s1 (k) L2	s2 (l) L3	s1 (k) L3
Phase L1 and L3						
Terminal	12	13/14	15	16/17	18	19/20
Phase	s2 (l) L1	s1 (k) L1	---	---	s2 (l) L3	s1 (k) L3

"Phase L1 and L3" applies if the voltage measurement is configured to 1Ph 3W (Chapter 3.2.4.3 " Parameter Setting '1Ph 3W' (1-phase, 3-wire)" on page 30).

3.2.5.2 Parameter Setting 'Phase L1' 'Phase L2' 'Phase L3'

Schematic and terminals

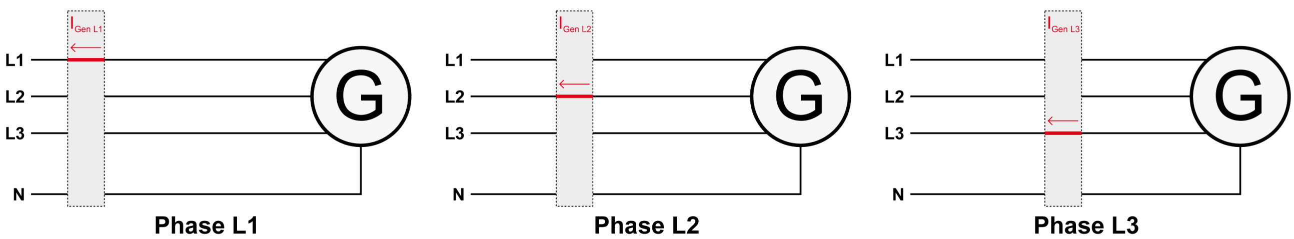


Fig. 19: Current measuring, 'Phase L1' 'Phase L2' 'Phase L3'

	Wiring terminals					
	F	E	D	C	B	A
Phase L1						

	Wiring terminals					
Terminal	12	13/14	15	16/17	18	19/20
Phase	s2 (l) L1	s1 (k) L1	---	---	---	---
Phase L2						
Terminal	12	13/14	15	16/17	18	19/20
Phase	---	---	s2 (l) L2	s1 (k) L2	---	---
Phase L3						
Terminal	12	13/14	15	16/17	18	19/20
Phase	---	---	---	---	s2 (l) L3	s1 (k) L3

3.2.6 Relay Outputs

General notes

CAUTION!
The discrete output "Ready for operation" may be wired in series with an emergency stop function and used in conjunction with an alarm function to ensure that the proper actions are initiated upon activation of this output, i.e. a failure of the unit.

Schematic and terminals

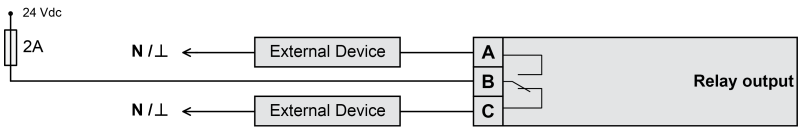


Fig. 20: Relay outputs - schematic

Terminal			Description		A_{max}
N.O.	**Common**	**N.C.**			
A	**B**	**C**	**Form C**		
21	22	23	Relay output [R 01]	---	2.5 mm²
24	25	26	Relay output [R 02]	---	2.5 mm²
27	28	29	Relay output [R 03]	---	2.5 mm²
30	31	32	Relay output [R 04]	---	2.5 mm²
33	34	35	Relay output [R 05]	Fixed to "Ready for operation"	2.5 mm²

Notes

***N.O.**: normally open (make) contact*

***N.C.**: normally closed (break) contact*

3.2.7 Serial Interface

3.2.7.1 Interbus Interface

Pin assignment - incoming connection

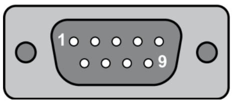


Fig. 21: SUB-D connector - pins

Terminal	Signal	Description
1	DO1	Data out
2	DI1	Data in
3	GND	Ground
4	-	Reserved
5	-	Reserved
6	/DO1	/Data out
7	/DI1	/Data in
8	-	Reserved
9	-	Reserved

Table 16: Pin assignment - incoming connection

Pin assignment - outgoing connection

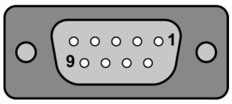


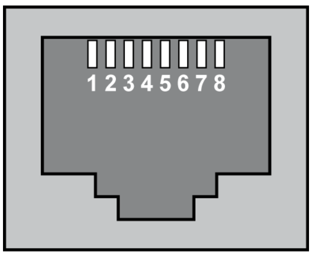
Fig. 22: SUB-D connector - pins

Terminal	Signal	Description
1	DO2	Data out
2	DI2	Data in
3	GND	Ground
4	-	Reserved
5	+5 V	Supply voltage
6	/DO2	/Data out
7	/DI2	/Data in
8	-	Reserved
9	RBST	RBST signal

Table 17: Pin assignment - outgoing connection

3.2.8 Service Port

Service port connector



The Woodward specific service port is a connector (RJ-45) to extend the interfaces of the controller.

*The service port can be **only** used in combination with an optional Woodward direct configuration cable (DPC).*

Fig. 23: Service port connector (RJ-45)

Direct configuration cable (DPC)

The DPC cable is used to configure the device with the ToolKit configuration software and external extensions/applications.

There are two versions available:

- DPC-USB direct configuration cable
- DPC-RS-232 direct configuration cable

DPC-USB direct configuration cable

Use the DPC-USB direct configuration cable if you want to connect the Woodward controller to an external device (master) which is equipped with an USB port.

Order item number:

- DPC-USB direct configuration cable – P/N 5417-1251

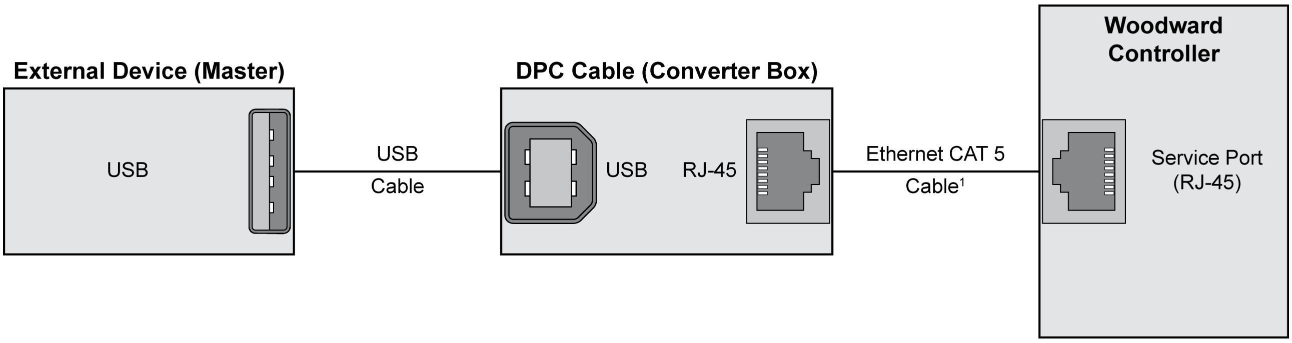


Fig. 24: DPC-USB wiring - schematic

> *[1] Use the Ethernet CAT 5 cable which is supplied with the DPC-USB converter. The maximum cable length must not exceed 0.5 m.*

DPC-RS-232 direct configuration cable

Use the DPC-RS-232 direct configuration cable if you want to connect the Woodward controller to an external device (master) which is equipped with an RS-232 port.

Order item number:

- DPC-RS-232 direct configuration cable – P/N 5417-557

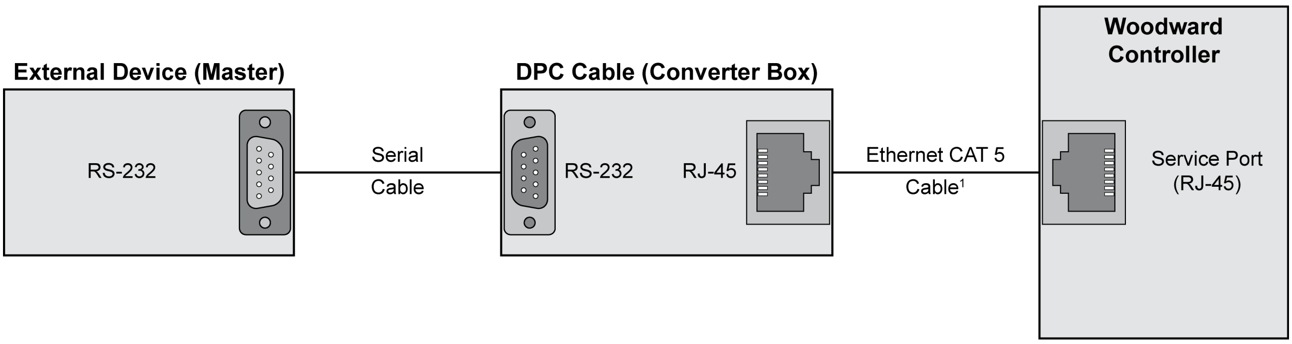


Fig. 25: DPC-RS-232 wiring - schematic

[1] Use the Ethernet CAT 5 cable which is supplied with the DPC-RS-232 converter. The maximum cable length must not exceed 0.5 m.

For a continuous operation with the direct configuration cable DPC-RS-232 (e.g. remote control of controller), it is required to use at least revision F (P/N 5417-557 Rev. F) of the DPC-RS-232. When using a DPC-RS-232 of an earlier revision, problems may occur in continuous operation. The shield connector (6.3 mm tab connector) at the DPC-RS-232 of revision F (P/N 5417-557 Rev. F) and above must be connected to ground.

4 Configuration

All parameters are assigned a unique parameter identification number.

The parameter identification number may be used to reference individual parameters listed in this manual.

> *This parameter identification number is also displayed in the ToolKit configuration screens next to the respective parameter.*

4.1 Homepage

General notes

The ToolKit “Homepage” gives an overview of all measured values, the state of the relays and the state of the monitoring.

The “Homepage” is only used to display values. The values cannot be adjusted here. The configuration of the parameters is done in the other menu sections on the left hand side. The following chapters describe all menus in detail.

> *Please refer to ⇨ Chapter 5.1 “Access Via PC (ToolKit)” on page 85 for details about the operation of the device via ToolKit.*

Fig. 26: Homepage

4.2 Configuration

4.2.1 Measurement

General notes

The setpoints for specific parameters will differ depending upon the hardware version, indicated on the data plate.

Dependencies

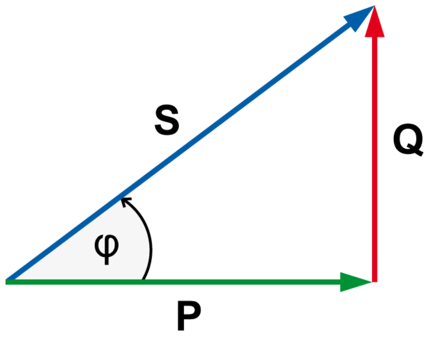


Fig. 27: AC power triangle

PF Power Factor
P Active Power [kW]
S Apparent power [kVA]
Q Reactive Power [kvar]

The AC power triangle illustrates the dependencies between active power, apparent power, reactive power and power factor.

- PF = P/S = cos Φ
- Q = √(S²-P²)
- S = √(P²+Q²)
- P = S * PF

ID	Parameter	CL	Setting range [Default]	Description
1750	**System rated frequency**	4	50 / 60 Hz **[50 Hz]**	The rated frequency of the system is used as a reference figure for all frequency related functions, which use a percentage value, like frequency monitoring.
1766	**Rated voltage**	4	50 to 650000 V **[690 V]**	This value refers to the rated voltage of the source and is the voltage measured on the potential transformer primary. The rated voltage is used as a reference figure for all voltage related functions, which use a percentage value, like voltage monitoring.
1754	**Rated current**	4	5 to 32000 A **[300 A]**	This value specifies the source rated current, which is used as a reference figure for related functions.
1752	**Rated active power [kW]**	4	0.5 to 200000.0 kW **[200.0 kW]**	This value specifies the source rated active power, which is used as a reference figure for related functions. The rated active power is the power factor multiplied by the apparent power.
1758	**Rated react. power [kvar]**	4	0.5 to 200000.0 kvar **[200.0 kvar]**	This value specifies the source rated reactive power, which is used as a reference figure for related functions.
1850	**Current measuring**	4	**[L1 L2 L3]**	All three phases are monitored. Measurement, display and protection are adjusted according to the rules for 3-phase measurement. Monitoring refers to the following currents: IL1, IL2, IL3
			Phase L{1/2/3}	Only one phase is monitored. Measurement, display and protection are adjusted according to the rules for single-phase measurement. Monitoring refers to the selected phase.
				Notes This parameter is only effective if the voltage measuring (parameter 1851 ➪ p. 41) is configured to "3Ph 4W" or "3Ph 3W". For information on measuring principles refer to ➪ *Chapter 3.2.5 “Current Measuring” on page 33.*

ID	Parameter	CL	Setting range [Default]	Description
1851	**Voltage meas-uring**	4	**[3Ph 4W]**	Measurement is performed Line-Neutral (WYE connected system) and Line-Line (Delta connected system). The protection depends on the setting of parameter 1770 ↳ p. 42. Phase voltages and the neutral must be connected for proper calculation. Measurement, display and protection are adjusted according to the rules for WYE connected systems. Monitoring refers to the following voltages: ■ VL12, VL23, and VL31 (parameter 1770 ↳ p. 42 configured to "Phase-phase") ■ VL1N, VL2N and VL3N (parameter 1770 ↳ p. 42 configured to "Phase-neutral") ■ VL12, VL23, VL31, VL1N, VL2N and VL3N (parameter 1770 ↳ p. 42 configured to "All")
			3Ph 3W	Measurement is performed Line-Line (Delta connected system). Phase voltages must be connected for proper calculation. Measurement, display and protection are adjusted according to the rules for Delta connected systems. Monitoring refers to the following voltages: ■ VL12, VL23, VL31
			1Ph 2W	Measurement is performed Line-Neutral (WYE connected system) if parameter 1858 ↳ p. 42 is configured to "Phase - neutral" and Line-Line (Delta connected system) if parameter 1858 ↳ p. 42 is configured to "Phase - phase". Measurement, display and protection are adjusted according to the rules for phase-phase systems. Monitoring refers to the following voltages: ■ VL1N, VL12
			1Ph 3W	Measurement is performed Line-Neutral (WYE connected system) and Line-Line (Delta connected system). The protection depends on the setting of parameter 1770 ↳ p. 42. Measurement, display, and protection are adjusted according to the rules for single-phase systems. Monitoring refers to the following voltages: ■ VL13 (parameter 1770 ↳ p. 42 configured to "Phase-phase") ■ VL1N, VL3N (parameter 1770 ↳ p. 42 configured to "Phase-neutral") ■ VL1N, VL3N (parameter 1770 ↳ p. 42 configured to "All")
				Notes If this parameter is configured to 1Ph 3W, the rated voltage (parameter 1766 ↳ p. 40) must be entered as Line-Line (Delta).
3954	**Phase rotation**	4	**[CW]**	The three-phase measured voltage is rotating CW (clock-wise; that means the voltage rotates in L1-L2-L3 direction; standard setting).
			CCW	The three-phase measured voltage is rotating CCW (counter clock-wise; that means the voltage rotates in L1-L3-L2 direction).
				Notes This parameter is important for a correct unbalanced load monitoring (refer to ↳ *Chapter 4.4.7 "Unbalanced Load (Level 1 & 2) ANSI# 46" on page 57* for details).

ID	Parameter	CL	Setting range [Default]	Description
1858	**1Ph2W voltage measuring**	4	**[Phase - phase]**	The unit is configured for measuring phase-phase voltages if 1Ph 2W measuring is selected.
			Phase - neutral	The unit is configured for measuring phase-neutral voltages if 1Ph 2W measuring is selected.
				Notes For information on measuring principles refer to ↳ *Chapter 3.2.4 “Voltage Measuring” on page 26*
1859	**1Ph2W phase rotation**	4	**[CW]**	A clockwise rotation field is considered for 1Ph 2W measuring .
			CCW	A counter-clockwise rotation field is considered for 1Ph 2W measuring.
				Notes For information on measuring principles refer to ↳ *Chapter 3.2.4 “Voltage Measuring” on page 26* This parameter is important for power factor and reactive power calculation.
1770	**Voltage monitoring**	4		The unit can either monitor the wye voltages (phase-neutral) or the delta voltages (phase-phase). The monitoring of the wye voltage is above all necessary to avoid earth-faults in a compensated or isolated network resulting in the tripping of the voltage protection.
			[Phase - phase]	The phase-phase voltage will be monitored and all subsequent parameters concerning voltage monitoring are referred to this value (VL-L).
			Phase - neutral	The phase-neutral voltage will be monitored and all subsequent parameters concerning voltage monitoring are referred to this value (VL-N).
			All	The phase-phase **and** phase-neutral voltage will be monitored and all subsequent parameters concerning voltage monitoring are referred to this value (VL-L & VL-N). This setting is only effective if "Voltage measuring" (parameter 1851 ↳ p. 41) is configured to "3Ph 4W".
				Notes WARNING: This parameter influences the protective functions. Please be aware that if "Voltage monitoring" (parameter 1770 ↳ p. 42) is configured to "All" and the function ↳ *Chapter 4.4.11 “Voltage Increase” on page 64* is used, that this function only monitors "Phase - neutral".
1788	**Disable underfrequency monitoring with low voltage**	4		Blocks the underfrequency monitoring, if the voltage is below 12.5% of nominal to avoid an alarm if the voltage drops to zero. This affects both underfrequency monitoring thresholds.
			Yes	Underfrequency monitoring with low voltage is disabled.
			[No]	Underfrequency monitoring with low voltage is enabled.
1801	**PT primary rated voltage** (Potential transformer primary voltage rating)	4	50 to 650000 V **[690 V]**	The primary source voltage in V. The control utilizes the value entered in this parameter along with the measured voltage of the PT secondaries to calculate the voltage.

ID	Parameter	CL	Setting range [Default]	Description
1800	**PT secondary rated volt.** (Potential trans-former secon-dary voltage rating)	4	50 to 800 V **[690 V]**	The secondary source voltage in V, which is used as a reference figure for related functions.
1806	**CT primary rated current** (Current trans-former primary rating)	4	1 to 32000 A/x **[500 A/x]**	The input of the current transformer ratio is necessary for the indication and control of the actual monitored value. The current transformers ratio should be selected so that at least 60 % of the secondary current rating can be measured when the monitored system is at 100 % of operating capacity (i.e. at 100 % of system capacity a 5 A CT should output 3 A). If the current transformers are sized so that the percentage of the output is lower, the loss of resolution may cause inaccuracies in the monitoring and control functions and affect the functionality of the control.
				Notes Current transformer ratio for the source.

4.2.2 Discrete Outputs

General notes

The discrete outputs of this control device have a "Normally Open" (N.O.) as well as a "Normally Closed" (N.C.) function.

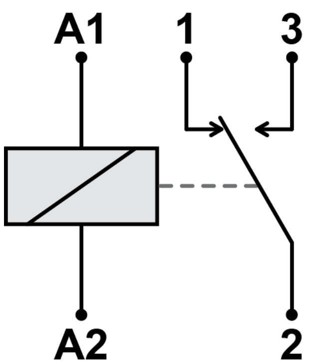


Fig. 28: Normally Open/Closed contacts - schematic

Normally Open (N.O.) contacts

– *The relay (discrete output) must be energized to close the contact.*

Normally Closed (N.C.) contacts

– *The relay (discrete output) must be de-energized to open the contact.*

ID	Parameter	CL	Setting range [Default]	Description
6920 6921 6922 6923	**Relay {x} function** [x = 1 to 4]	4	**[N.O.]**	The relay will be energized when an alarm occurs.
			N.C	The relay will be de-energized when an alarm occurs.
				Notes The fallback delay of the relays can be configured with parameter 8855 ↳ p. 45.

4.2.3 Interbus

ID	Parameter	CL	Setting range [Default]	Description
994	**Interbus protocol**	4	0 to 65535 **[4560]**	A data protocol may be selected by entering the data protocol ID here. Possible data protocol IDs are:
			4550	Data telegram
			4560	Data telegram
993	**Interbus baudrate**	4	500 kBaud / 2000 KBaud **[500 kBaud]**	This parameter defines the baud rate for communications. Please note, that all participants on the bus must use the same baud rate.
				Notes Changing this parameter becomes only effective after restarting the unit.

4.2.4 Counters

ID	Parameter	CL	Setting range [Default]	Description
2515	**Counter value preset**	4	0 to 999,999,99 **[0]**	This value is utilized to set the following counters: ■ kWh counter ■ kvarh counter The number entered into this parameter is the number that will be set to the parameters listed above when they are enabled.
2510	**Active energy [0.0 kWh]**	4	Yes	The current value of this counter is overwritten with the value configured in "Counter value preset" (parameter 2515 ↳ p. 44). After the counter has been (re)set, this parameter changes back to "No" automatically.
			[No]	The value of this counter is not changed.
				Example ■ The counter value preset (parameter 2515 ↳ p. 44) is configured to "3456". ■ If this parameter is set to "Yes", the "Active energy" counter will be set to 345.6 kWh.
2512	**Active energy - [0.0 kWh]**	4	Yes	The current value of this counter is overwritten with the value configured in "Counter value preset" (parameter 2515 ↳ p. 44). After the counter has been (re)set, this parameter changes back to "No" automatically.
			[No]	The value of this counter is not changed.
				Example ■ The counter value preset (parameter 2515 ↳ p. 44) is configured to "3456". ■ If this parameter is set to "Yes", the "Active energy -" counter will be set to 345.6 kWh.
2511	**React.energy [0.0 kvarh]**	4	Yes	The current value of this counter is overwritten with the value configured in "Counter value preset" (parameter 2515 ↳ p. 44). After the counter has been (re)set, this parameter changes back to "No" automatically.
			[No]	The value of this counter is not changed.

ID	Parameter	CL	Setting range [Default]	Description
				Example ■ The counter value preset (parameter 2515 ⤷ p. 44) is configured to "3456". ■ If this parameter is set to "Yes", the "Reactive energy" counter will be set to 345.6 kvarh.
2513	**React.energy - [0.0 kvarh]**	4	Yes	The current value of this counter is overwritten with the value configured in "Counter value preset" (parameter 2515 ⤷ p. 44). After the counter has been (re)set, this parameter changes back to "No" automatically.
			[No]	The value of this counter is not changed.
				Example ■ The counter value preset (parameter 2515 ⤷ p. 44) is configured to "3456". ■ If this parameter is set to "Yes", the "Reactive energy -" counter will be set to 345.6 kvarh.
2520	**Pos. act. energy**	---	Info	Displays the accumulated positive energy (kWh).
2524	**Neg. act. energy**	---	Info	Displays the accumulated negative energy (kWh).
2522	**Pos. react. energy**	---	Info	Displays the accumulated positive reactive energy (kvarh).
2526	**Neg. react. energy**	---	Info	Displays the accumulated negative reactive energy (kvarh).

4.2.5 Monitoring

ID	Parameter	CL	Setting range [Default]	Description
8855	**Monitoring fall-back delay**	0	0.0 to 500.0 s **[0.2 s]**	This parameter defines the fallback time of all alarms and hence the fallback time of the relays.

4.3 Interbus

General notes

Please refer to ⤷ Chapter 9.1.1.2.4.2 "Scaling Parameter" on page 127 for details.

4.4 Monitoring

4.4.1 Overvoltage (Level 1 & 2) ANSI# 59

General notes

Voltage is monitored according to how the parameter "Voltage measuring" (parameter 1851 ↳ p. 41) is configured. This controller provides the user with two alarm levels for overvoltage. Both alarms are definite time alarms.

Monitoring for overvoltage faults is performed in two steps.

The diagram listed below shows a frequency trend and the associated pickup times and length of the alarms.

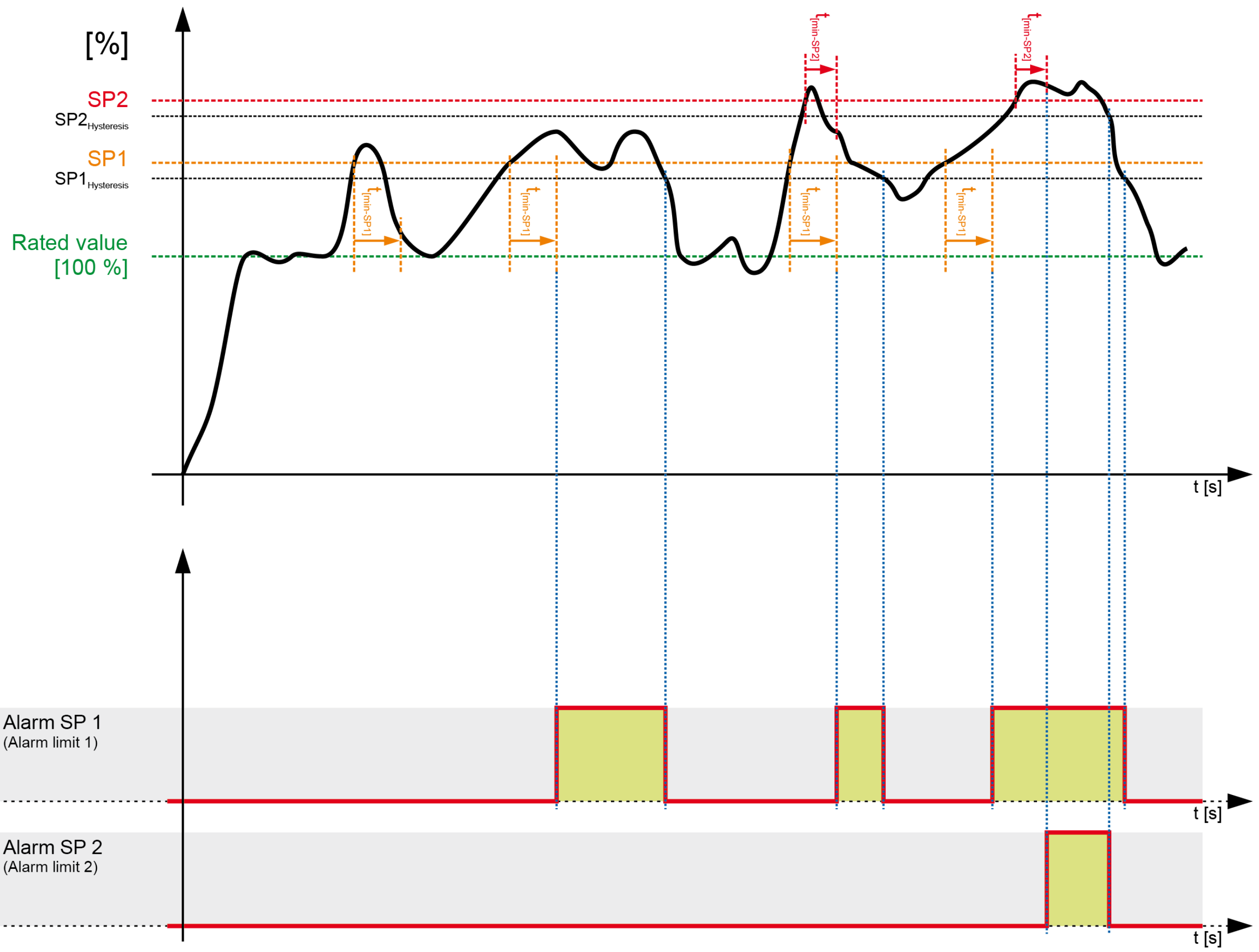


Fig. 29: Overvoltage monitoring

The hysteresis is depending on the voltage threshold.

The hysteresis is 0.7% of the primary transformer delta voltage.

The parameter limits listed below have identical setting ranges. Each parameter may be configured with different settings to create unique trip characteristics for specific thresholds.

ID	Parameter	CL	Setting range [Default]	Description
2000 2006	**Monitoring**	2	**[On]**	Overvoltage monitoring is carried out according to the following parameters. Monitoring is performed at two levels. Both values may be configured independent from each other (prerequisite: Level 1 limit < limit 2).
			Off	Monitoring is disabled for Level 1 limit and/or Level 2 limit.
2004 2010	**Limit**	2	50.0 to 150.0 % 2004: **[108.0 %]** 2010: **[112.0 %]**	The percentage values that are to be monitored for each threshold limit are defined here. If this value is reached or exceeded for at least the delay time without interruption, the specified relay will be energized.
				Notes This value refers to the "Rated voltage" (parameter 1766 ➪ p. 40).
2005 2011	**Delay**	2	0.02 to 300.00 s 2005: **[5.00 s]** 2011: **[0.30 s]**	If the monitored voltage exceeds the threshold value for the delay time configured here, an alarm will be issued.
				Notes If the monitored voltage falls below the threshold (minus the hysteresis) before the delay expires the time will be reset.
2014 2015	**AND characteristics**	2	On	Each phase has to be over the threshold for tripping.
			[Off]	At least one phase has to be over the threshold for tripping.
2001 2007	**Relay**	2	None / Relay 1 / Relay 2 / Relay 3 / Relay 4 2001: **[Relay 1]** 2007: **[Relay 2]**	The relay configured here is activated if the respective monitoring functions triggers. If "None" is configured here, no relay is activated in this case.
				Notes Whether the relay is energized or de-energized depends on the configuration of the relay function (parameter 6920 ➪ p. 43 , 6921 ➪ p. 43, 6922 ➪ p. 43 and 6923 ➪ p. 43).

4.4.2 Undervoltage (Level 1 & 2) ANSI# 27

General notes

Voltage is monitored according to how the parameter "Voltage measuring" (parameter 1851 ➪ p. 41) is configured. This controller provides the user with two alarm levels for undervoltage. Both alarms are definite time alarms.

Monitoring for undervoltage faults is performed in two steps.

The diagram listed below shows a frequency trend and the associated pickup times and length of the alarms.

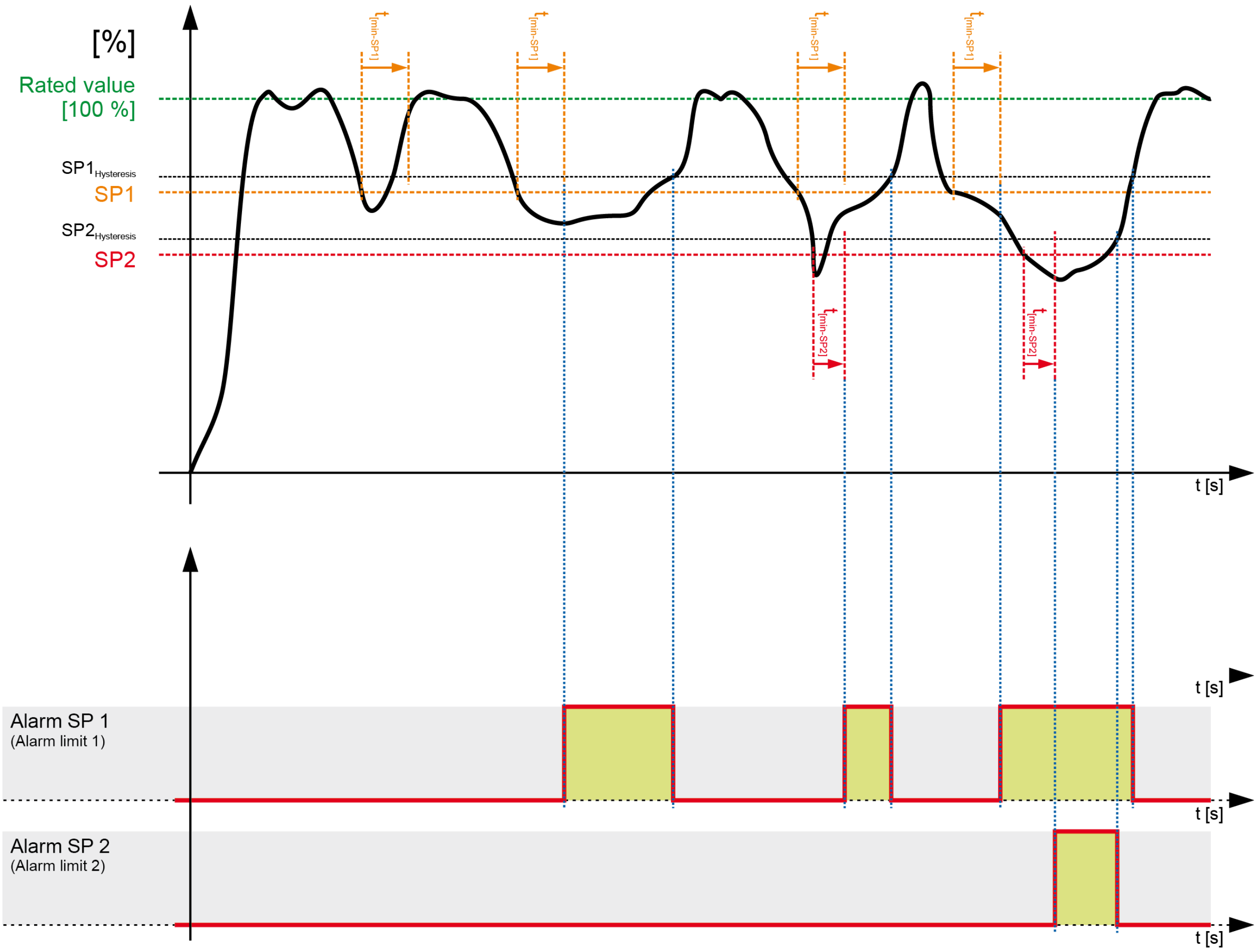


Fig. 30: Undervoltage monitoring

> *The hysteresis is depending on the voltage threshold.*
>
> *The hysteresis is ...*
>
> – *... 0.7% of the primary transformer delta voltage if the voltage threshold is higher than 35% or*
> – *... 0.4% of the primary transformer delta voltage if the voltage threshold is lower than 20%.*
> – *Between 20% and 35% the hysteresis increases linearly from 0.4% to 0.7%.*

> *The parameter limits listed below have identical setting ranges. Each parameter may be configured with different settings to create unique trip characteristics for specific thresholds.*

ID	Parameter	CL	Setting range [Default]	Description
2050 2056	**Monitoring**	2	**[On]**	Undervoltage monitoring is carried out according to the following parameters. Monitoring is performed at two levels. Both values may be configured independent from each other (prerequisite: Level 1 limit > limit 2).
			Off	Monitoring is disabled for Level 1 limit and/or Level 2 limit.
2054 2060	**Limit**	2	5.0 to 150.0 % 2054: **[92.0 %]** 2060: **[88.0 %]**	The percentage values that are to be monitored for each threshold limit are defined here. If this value is reached or fallen below for at least the delay time without interruption, the specified relay will be energized.
				Notes This value refers to the "Rated voltage" (parameter 1766 → p. 40).
2055 2061	**Delay**	2	0.02 to 300.00 s 2055: **[5.00 s]** 2061: **[0.30 s]**	If the monitored voltage falls below the threshold value for the delay time configured here, an alarm will be issued.
				Notes If the monitored voltage exceeds the threshold (plus the hysteresis) again before the delay expires the time will be reset.
2064 2065	**AND characteristics**	2	On	Each phase has to be under the threshold for tripping.
			[Off]	At least one phase has to be under the threshold for tripping.
2051 2057	**Relay**	2	None / Relay 1 / Relay 2 / Relay 3 / Relay 4 2051: **[Relay 1]** 2057: **[Relay 2]**	The relay configured here is activated if the respective monitoring functions triggers. If "None" is configured here, no relay is activated in this case.
				Notes Whether the relay is energized or de-energized depends on the configuration of the relay function (parameter 6920 → p. 43 , 6921 → p. 43, 6922 → p. 43 and 6923 → p. 43).

4.4.3 Overfrequency (Level 1 & 2) ANSI# 81O

General notes

This controller provides the user with two alarm levels for overfrequency. Both alarms are definite time alarms.

Monitoring for overfrequency faults is performed in two steps.

The diagram listed below shows a frequency trend and the associated pickup times and length of the alarms.

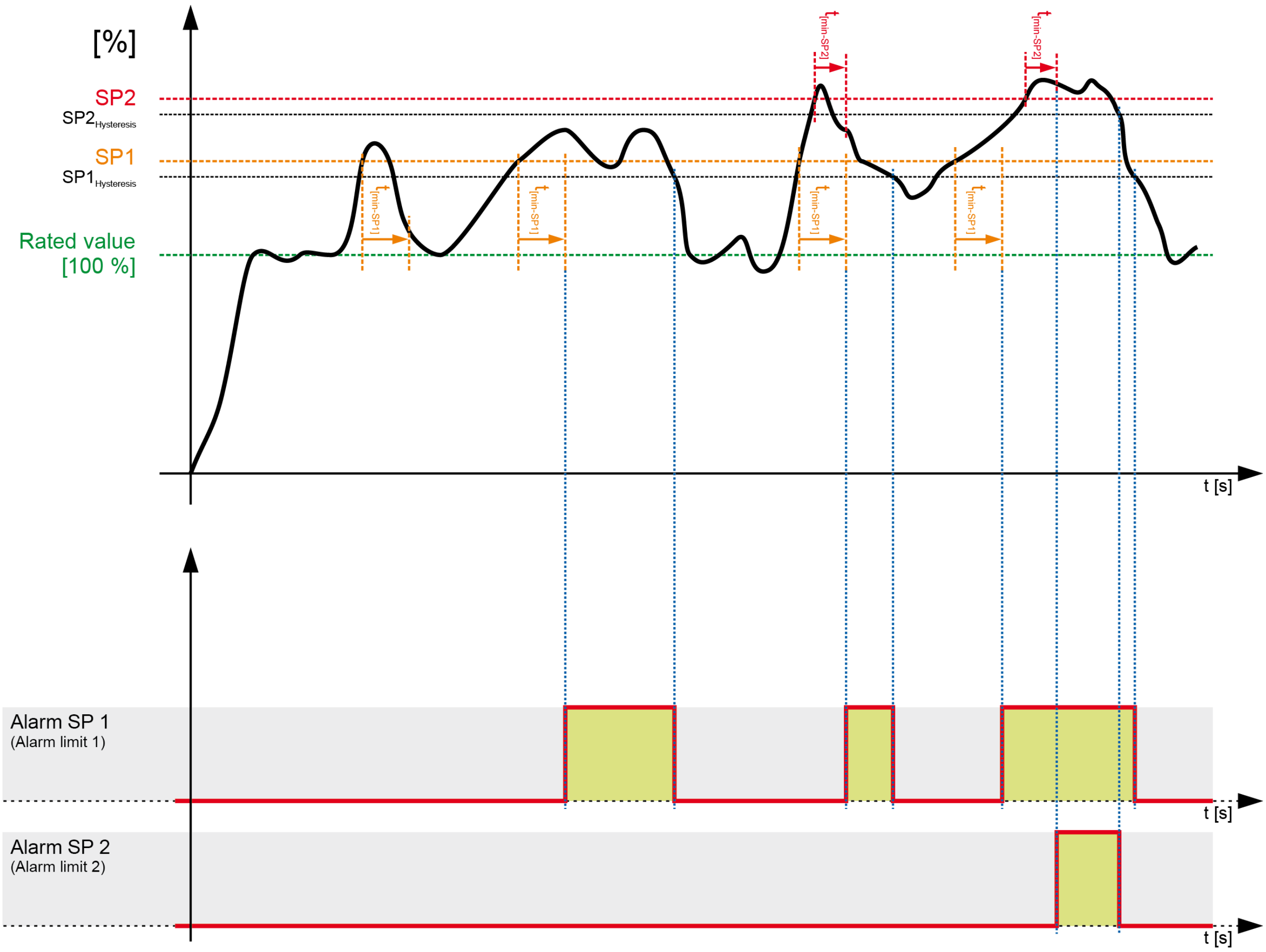


Fig. 31: Overfrequency monitoring

The hysteresis is 0.05 Hz.

The parameter limits listed below have identical setting ranges. Each parameter may be configured with different settings to create unique trip characteristics for specific thresholds.

ID	Parameter	CL	Setting range [Default]	Description
1900 1906	**Monitoring**	2	**[On]**	Overfrequency monitoring is carried out according to the following parameters. Monitoring is performed at two levels. Both values may be configured independent from each other (prerequisite: Level 1 limit < limit 2).
			Off	Monitoring is disabled for Level 1 limit and/or Level 2 limit.

ID	Parameter	CL	Setting range [Default]	Description
1904 1910	**Limit**	2	50.0 to 140.0 % 1904: **[110.0 %]** 1910: **[115.0 %]**	The percentage values that are to be monitored for each threshold limit are defined here. If this value is reached or exceeded for at least the delay time without interruption, the specified relay will be energized.
				Notes This value refers to the "Rated system frequency" (parameter 1750 ➪ p. 40).
1905 1911	**Delay**	2	0.02 to 300.00 s 1905: **[1.50 s]** 1911: **[0.30 s]**	If the monitored frequency value exceeds the threshold value for the delay time configured here, an alarm will be issued.
				Notes If the monitored frequency falls below the threshold (minus the hysteresis) before the delay expires the time will be reset.
1901 1907	**Relay**	2	None / Relay 1 / Relay 2 / Relay 3 / Relay 4 1901: **[Relay 1]** 1907: **[Relay 2]**	The relay configured here is activated if the respective monitoring functions triggers. If "None" is configured here, no relay is activated in this case.
				Notes Whether the relay is energized or de-energized depends on the configuration of the relay function (parameter 6920 ➪ p. 43 , 6921 ➪ p. 43, 6922 ➪ p. 43 and 6923 ➪ p. 43).

4.4.4 Underfrequency (Level 1 & 2) ANSI# 81U

General notes

This controller provides the user with two alarm levels for underfrequency. Both alarms are definite time alarms.

Monitoring for underfrequency faults is performed in two steps.

The diagram listed below shows a frequency trend and the associated pickup times and length of the alarms.

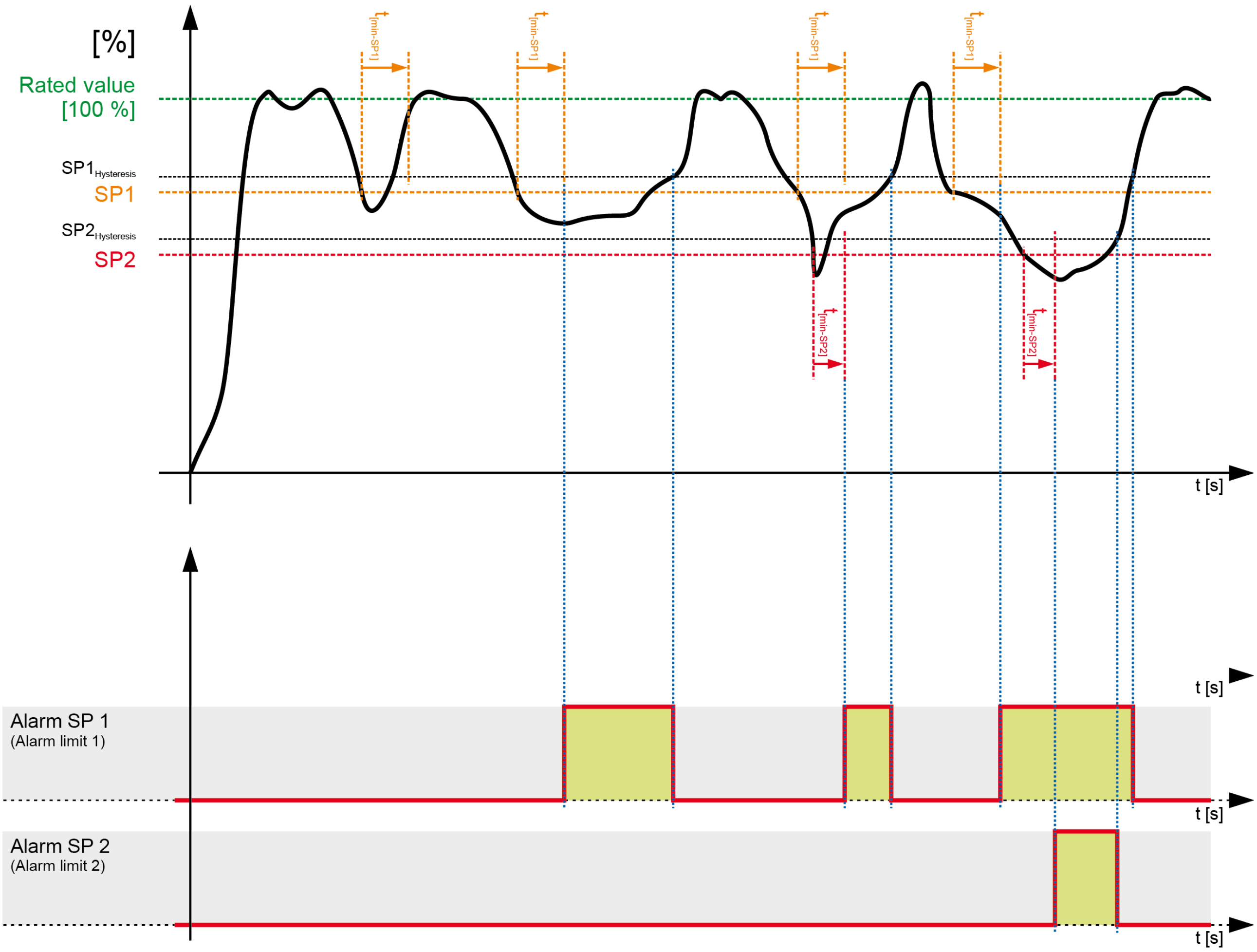


Fig. 32: Underfrequency monitoring

> *The hysteresis is 0.05 Hz.*

> *The parameter limits listed below have identical setting ranges. Each parameter may be configured with different settings to create unique trip characteristics for specific thresholds.*

ID	Parameter	CL	Setting range [Default]	Description
1950 1956	**Monitoring**	2	**[On]**	Underfrequency monitoring is carried out according to the following parameters. Monitoring is performed at two levels. Both values may be configured independent from each other (prerequisite: Level 1 limit > limit 2).
			Off	Monitoring is disabled for Level 1 limit and/or Level 2 limit.

ID	Parameter	CL	Setting range [Default]	Description
1954 1960	**Limit**	2	50.0 to 140.0 % 1954: **[90.0 %]** 1960: **[84.0 %]**	The percentage values that are to be monitored for each threshold limit are defined here. If this value is reached or fallen below for at least the delay time without interruption, the specified relay will be energized.
				Notes This value refers to the "Rated system frequency" (parameter 1750 ➪ p. 40).
1955 1961	**Delay**	2	0.02 to 300.00 s 1955: **[5.00 s]** 1961: **[0.30 s]**	If the monitored frequency value falls below the threshold value for the delay time configured here, an alarm will be issued.
				Notes If the monitored frequency exceeds the threshold (plus the hysteresis) again before the delay expires the time will be reset.
1951 1957	**Relay**	2	None / Relay 1 / Relay 2 / Relay 3 / Relay 4 1951: **[Relay 1]** 1957: **[Relay 2]**	The relay configured here is activated if the respective monitoring functions triggers. If "None" is configured here, no relay is activated in this case.
				Notes Whether the relay is energized or de-energized depends on the configuration of the relay function (parameter 6920 ➪ p. 43 , 6921 ➪ p. 43, 6922 ➪ p. 43 and 6923 ➪ p. 43).

4.4.5 Positive Load (Level 1 & 2) ANSI# 32

General notes

The power is monitored depending on parameter "Voltage measuring" (parameter 1851 ➪ p. 41) and parameter "Current measuring" (parameter 1850 ➪ p. 40).

If the single- or three-phase measured real power exceeds the configured limit, the alarm will be issued.

Both alarm limits may either be positive or negative.

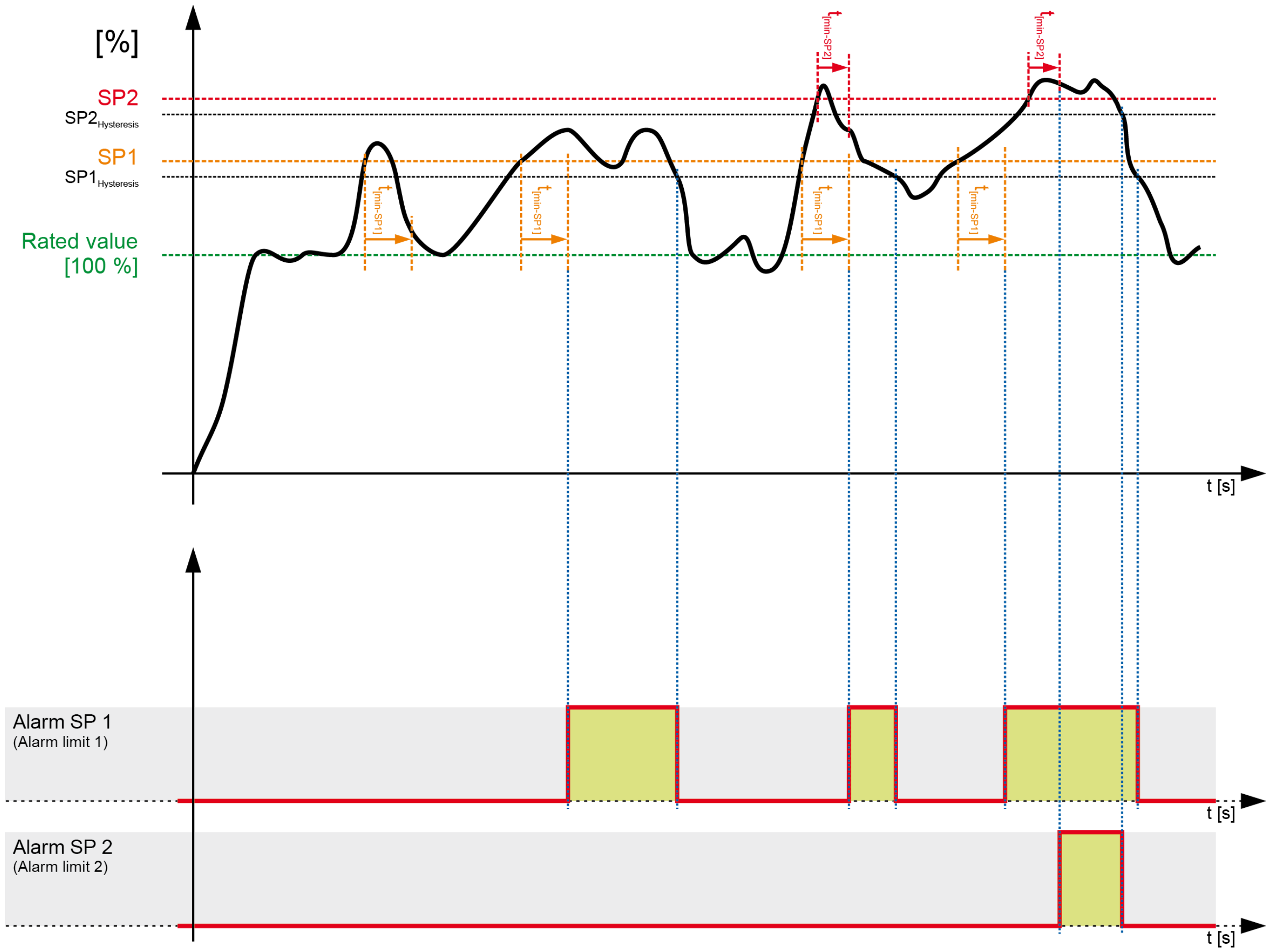


Fig. 33: Positive load monitoring

> *The hysteresis is 1.0 % of the power calculated from primary transformer delta voltage and primary CT current.*

ID	Parameter	CL	Setting range [Default]	Description
2300 2306	**Monitoring**	4	**[On]**	Positive load monitoring is carried out according to the following parameters. Monitoring is performed at two levels. Both values may be configured independent from each other (prerequisite: Level 1 limit < limit 2).
			Off	Monitoring is disabled for Level 1 limit and/or Level 2 limit.
2304 2310	**Limit**	4	-300.0 to 300.0 % 2304: **[110.0 %]** 2310: **[120.0 %]**	The percentage values that are to be monitored for each threshold limit are defined here. If this value is reached or exceeded for at least the delay time without interruption, the specified relay will be energized.
				Notes This value refers to the "Rated active power" (parameter 1752 🔗 p. 40).

ID	Parameter	CL	Setting range [Default]	Description
2305 2311	**Delay**	4	0.02 to 300.00 s 2305: **[11.00 s]** 2311: **[0.10 s]**	If the monitored load exceeds the threshold value for the delay time configured here, an alarm will be issued.
				Notes If the monitored load falls below the threshold (minus the hysteresis) before the delay expires the time will be reset.
2301 2307	**Relay**	4	None / Relay 1 / Relay 2 / Relay 3 / Relay 4 2301: **[Relay 1]** 2307: **[Relay 2]**	The relay configured here is activated if the respective monitoring functions triggers. If "None" is configured here, no relay is activated in this case.
				Notes Whether the relay is energized or de-energized depends on the configuration of the relay function (parameter 6920 ➪ p. 43 , 6921 ➪ p. 43, 6922 ➪ p. 43 and 6923 ➪ p. 43).

4.4.6 Negative Load (Level 1 & 2) ANSI# 32R/F

General notes

The power is monitored depending on parameter "Voltage measuring" (parameter 1851 ➪ p. 41) and parameter "Current measuring" (parameter 1850 ➪ p. 40).

If the single- or three-phase measured real power is below the configured limit, the alarm will be issued.

Both alarm limits may either be positive or negative.

The negative load monitoring follows the same principle as the positive load monitoring, but triggers when the value falls below the threshold.

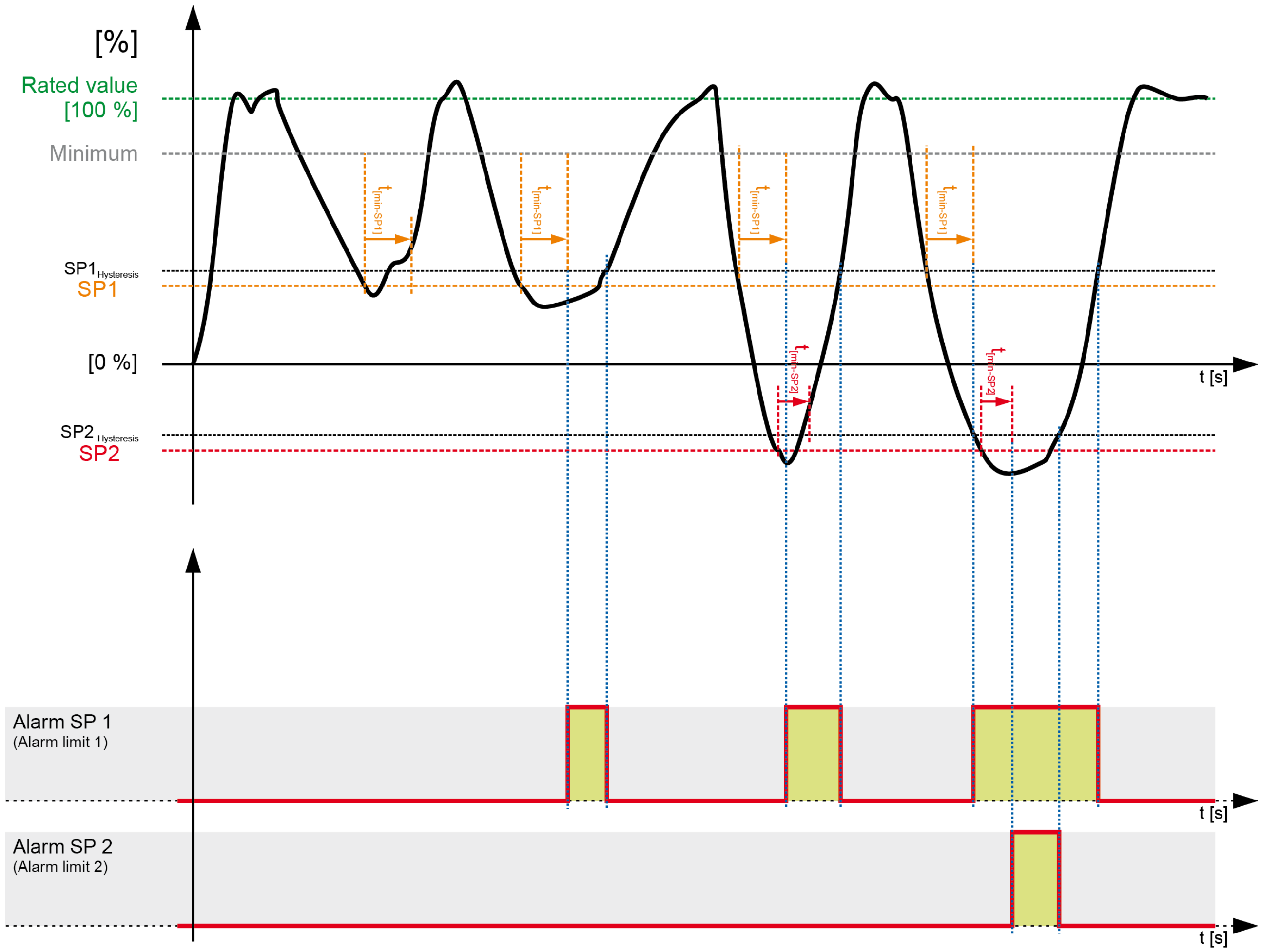


Fig. 34: Negative load monitoring

> *The hysteresis is 1.0 % of the power calculated from primary transformer delta voltage and primary CT current.*

ID	Parameter	CL	Setting range [Default]	Description
2250 2256	**Monitoring**	4	**[On]**	Negative load monitoring is carried out according to the following parameters. Monitoring is performed at two levels. Both values may be configured independent from each other (prerequisite: Level 1 limit > limit 2).
			Off	Monitoring is disabled for Level 1 limit and/or Level 2 limit.
2254 2260	**Limit**	4	-300.0 to 300.0 % 2254: **[-3.0 %]** 2260: **[-5.0 %]**	The percentage values that are to be monitored for each threshold limit are defined here. If this value is reached or fallen below for at least the delay time without interruption, the specified relay will be energized.

ID	Parameter	CL	Setting range [Default]	Description
				Notes This value refers to the "Rated active power" (parameter 1752 ➷ p. 40). A negative value refers to a negative load, i.e. reverse load and a positive load is considered as a reduced load.
2255 2261	**Delay**	4	0.02 to 300.00 s 2255: **[5.00 s]** 2261: **[3.00 s]**	If the monitored load falls below the threshold value for the delay time configured here, an alarm will be issued.
				Notes If the monitored load exceeds the threshold (plus the hysteresis) again before the delay expires the time will be reset.
2251 2257	**Relay**	4	None / Relay 1 / Relay 2 / Relay 3 / Relay 4 2251: **[Relay 1]** 2257: **[Relay 2]**	The relay configured here is activated if the respective monitoring functions triggers. If "None" is configured here, no relay is activated in this case.
				Notes Whether the relay is energized or de-energized depends on the configuration of the relay function (parameter 6920 ➷ p. 43 , 6921 ➷ p. 43, 6922 ➷ p. 43 and 6923 ➷ p. 43).

4.4.7 Unbalanced Load (Level 1 & 2) ANSI# 46

General notes

Unbalanced load is monitored according to how the parameters "Voltage measuring" (parameter 1851 ➷ p. 41), "Current measuring" (parameter 1850 ➷ p. 40) and "Phase rotation" (parameter 3954 ➷ p. 41) are configured.

The unbalanced load alarm is a phase imbalance alarm. Unbalanced load is determined by calculating the negative sequence component of a three phase system. This value is derived from the three current components and the angle between them. Unbalanced load monitoring is only active if "Current measuring" (parameter 1850 ➷ p. 40) is configured to "L1 L2 L3" and "Voltage measuring" (parameter 1851 ➷ p. 41) is either configured to "3Ph 4W" or "3Ph 3W". The threshold is defined as the percentage of that value relative to the nominal current. The protective function is triggered if this percentage value is exceeded.

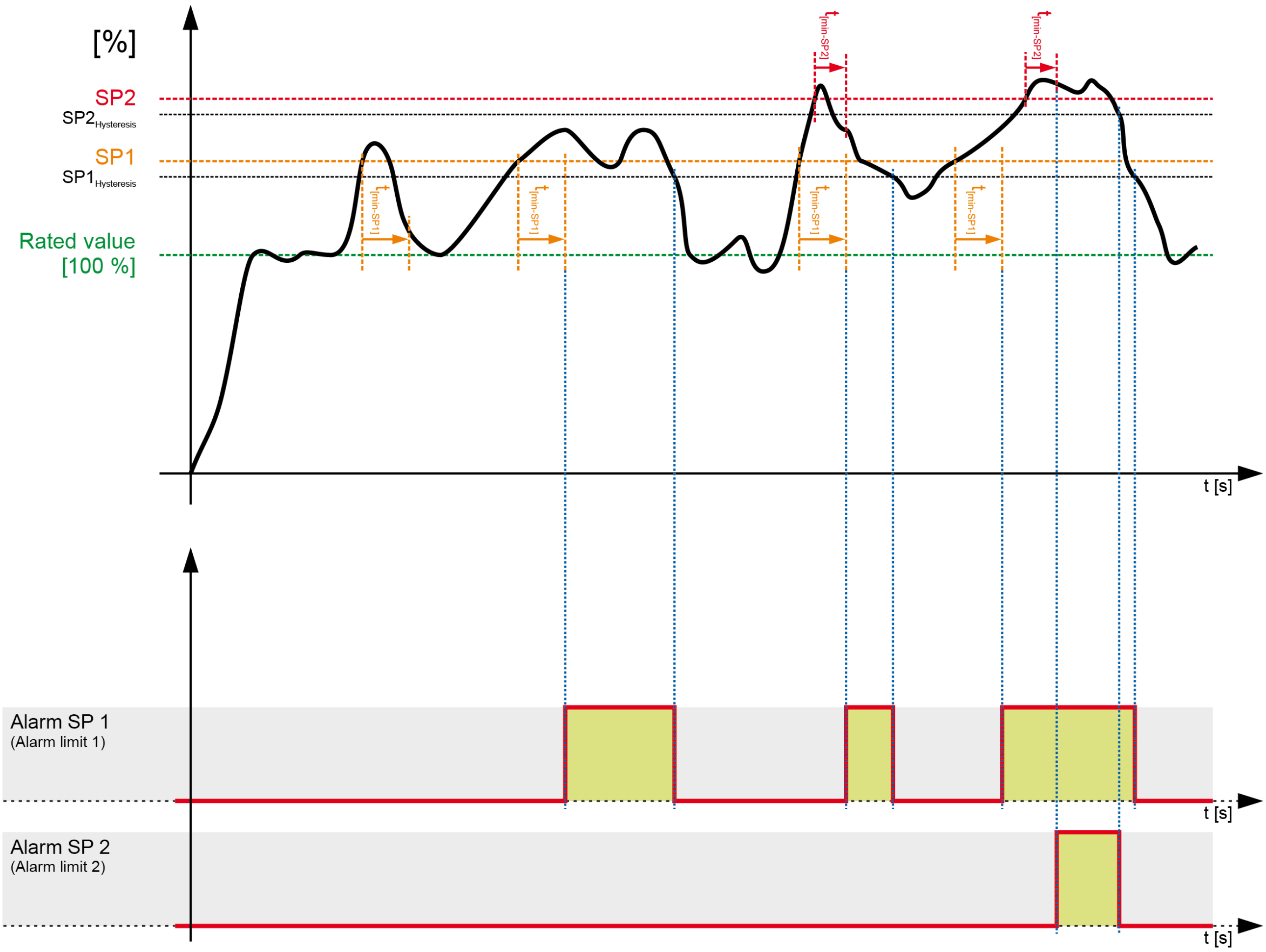


Fig. 35: Unbalanced load monitoring

The hysteresis is 0.5 % of the CT primary current.

This monitoring function is only enabled when "Voltage measuring" (parameter 1851 ➪ p. 41) is configured to "3Ph 4W" or "3Ph 3W" and "Current measuring" (parameter 1850 ➪ p. 40) is configured to "L1 L2 L3".

The "Phase rotation" (parameter 3954 ➪ p. 41) must be configured correctly for a proper operation.

ID	Parameter	CL	Setting range [Default]	Description
2400 2406	**Monitoring**	4	**[On]**	Unbalanced load monitoring is carried out according to the following parameters. Monitoring is performed at two levels. Both values may be configured independent from each other (prerequisite: Level 1 limit < limit 2).
			Off	Monitoring is disabled for Level 1 limit and/or Level 2 limit.

ID	Parameter	CL	Setting range [Default]	Description
2404 2410	**Limit**	4	5.0 to 100.0 % 2404: **[10.0 %]** 2410: **[15.0 %]**	The percentage values that are to be monitored for each threshold limit are defined here. If this value is reached or exceeded for at least the delay time without interruption, the specified relay will be energized.
				Notes This value refers to the "Rated current" (parameter 1754 ➪ p. 40).
2405 2411	**Delay**	4	0.02 to 300.00 s 2405: **[10.00 s]** 2411: **[1.00 s]**	If the monitored load exceeds the threshold value for the delay time configured here, an alarm will be issued.
				Notes If the monitored load exceeds or falls below the threshold (minus the hysteresis) before the delay expires the time will be reset.
2401 2407	**Relay**	4	None / Relay 1 / Relay 2 / Relay 3 / Relay 4 2401: **[Relay 1]** 2407: **[Relay 2]**	The relay configured here is activated if the respective monitoring functions triggers. If "None" is configured here, no relay is activated in this case.
				Notes Whether the relay is energized or de-energized depends on the configuration of the relay function (parameter 6920 ➪ p. 43 , 6921 ➪ p. 43, 6922 ➪ p. 43 and 6923 ➪ p. 43).

4.4.8 Voltage Asymmetry (Level 1 & 2)

General notes

Voltage asymmetry is determined by calculating the negative sequence component of a three-phase system. This value is derived from the three delta voltages (phase-phase). Voltage asymmetry monitoring is only active if "Voltage measuring" (parameter 1851 ➪ p. 41) is configured to "3Ph 4W" or "3Ph 3W". The threshold is defined as the percentage of that value relative to the nominal delta voltage. The protective function is triggered if this percentage value is exceeded.

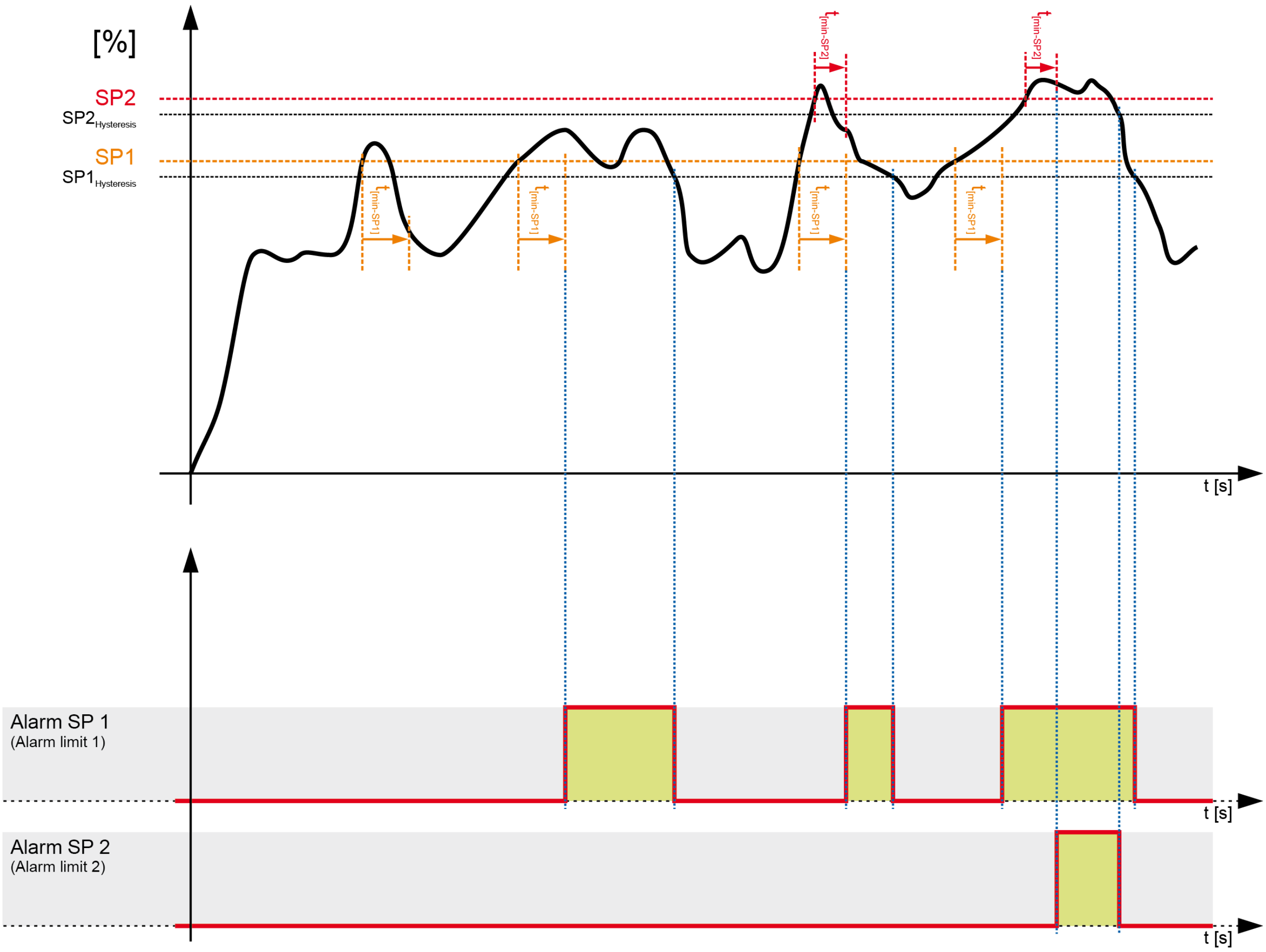


Fig. 36: Voltage asymmetry monitoring

> *The hysteresis is 0.5 % of the primary transformer delta voltage.*

> *This monitoring function is only enabled if "Voltage measuring" (parameter 1851 ⇨ p. 41) is configured to "3Ph 4W" or "3Ph 3W".*

ID	Parameter	CL	Setting range [Default]	Description
3900 3931	**Monitoring**	2	3900: **[On]**	Voltage asymmetry monitoring is carried out according to the following parameters.
			3931: **[Off]**	No monitoring is carried out.

ID	Parameter	CL	Setting range [Default]	Description
3903 3934	**Limit**	2	0.5 to 99.9 % 3903: **[10.0 %]** 3934: **[15.0 %]**	The percentage values that are to be monitored for each threshold limit are defined here. If this value is reached or exceeded for at least the delay time without interruption, the specified relay will be energized.
				Notes This value refers to the "Rated voltage" (parameter 1766 ⇘ p. 40).
3904 3935	**Delay**	2	0.02 to 300.00 s 3904: **[5.00 s]** 3935: **[3.00 s]**	If the monitored voltage asymmetry exceeds the threshold value for the delay time configured here, an alarm will be issued.
				Notes If the monitored voltage asymmetry falls below the threshold (minus the hysteresis) before the delay expires the time will be reset.
3901 3932	**Relay**	2	None / Relay 1 / Relay 2 / Relay 3 / Relay 4 3901: **[Relay 1]** 3932: **[Relay 2]**	The relay configured here is activated if the respective monitoring functions triggers. If "None" is configured here, no relay is activated in this case.
				Notes Whether the relay is energized or de-energized depends on the configuration of the relay function (parameter 6920 ⇘ p. 43 , 6921 ⇘ p. 43, 6922 ⇘ p. 43 and 6923 ⇘ p. 43).

4.4.9 Phase Shift

General notes

A vector/phase shift is defined as the sudden variation of the voltage curve which may be caused by a major source load change.

The unit measures the duration of a cycle, where a new measurement is started with each voltage passing through zero. The measured cycle duration will be compared with an internal quartz-calibrated reference time to determine the cycle duration difference of the voltage signal.

A vector/phase shift as shown in Fig. 37 causes a premature or delayed zero passage. The determined cycle duration difference corresponds with the occurring phase shift angle.

The monitoring may be carried out three-phase or one/three-phase. The monitoring can be configured in different ways. The vector/phase shift monitor can also be used as an additional method to decouple from the grid. Vector/phase shift monitoring is only enabled after the monitored voltage exceeds 50% of the PT secondary rated voltage.

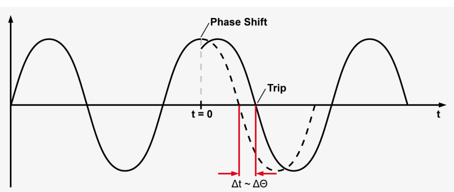


Fig. 37: Phase shift

> ***Function "Voltage cycle duration not within the permissible range"***
> *The voltage cycle duration exceeds the configured limit value for the phase/vector shift.*

> *3-phase - phase shift monitoring is only enabled if "Voltage measuring" (parameter 1851 ➪ p. 41) is configured to "3Ph 4W" or "3Ph 3W".*

ID	Parameter	CL	Setting range [Default]	Description
3050	**Monitoring**	4	**[On]**	Phase shift monitoring is carried out according to the following parameters.
			Off	No monitoring is carried out.
3053	**Monitoring**	4	**[1- and 3-phase]**	During single-phase voltage phase/vector shift monitoring, tripping occurs if the phase/vector shift exceeds the configured threshold value (parameter 3054 ➪ p. 62) in at least one of the three phases.
			3-phase	During three-phase voltage phase/vector shift monitoring, tripping occurs only if the phase/vector shift exceeds the specified threshold value (parameter 3055 ➪ p. 62) in all three phases within 2 cycles.
				Notes If a phase/vector shift occurs in one or two phases, the single-phase threshold value (parameter 3054 ➪ p. 62) is taken into consideration; if a phase/vector shift occurs in all three phases, the three-phase threshold value (parameter 3055 ➪ p. 62) is taken into consideration. Single phase monitoring is very sensitive and may lead to nuisance tripping if the selected phase angle settings are too small.
3054	**Limit 1-phase**	4	3 to 30° **[20°]**	If the electrical angle of the voltage shifts more than this configured value in any single phase, the relay configured in parameter 3051 ➪ p. 62 energizes.
				Notes This parameter is only active, if phase shift "Monitoring" (parameter 3053 ➪ p. 62) is configured to "1- and 3-phase". Since one phase monitoring is more sensible than three phase monitoring, it should be always be configured to a significantly higher threshold than phase shift "Limit 3-phase" (parameter 3055 ➪ p. 62).
3055	**Limit 3-phase**	4	3 to 30° **[8°]**	If the electrical angle of the voltage shifts more than this configured value in all three phases, the relay configured in parameter 3051 ➪ p. 62 energizes.
3051	**Relay**	4	None / Relay 1 / Relay 2 / Relay 3 / Relay 4 **[Relay 1]**	The relay configured here is activated if the respective monitoring functions triggers. If "None" is configured here, no relay is activated in this case.
				Notes Whether the relay is energized or de-energized depends on the configuration of the relay function (parameter 6920 ➪ p. 43 , 6921 ➪ p. 43, 6922 ➪ p. 43 and 6923 ➪ p. 43).

4.4.10 df/dt (ROCOF)

General notes

df/dt (rate of change of frequency) monitoring measures the stability of the frequency. The frequency of a source will vary due to changing loads and other effects. The rate of these frequency changes due to the load variances is relatively high compared to those of a large network.

Function "Rate of change of frequency not within permissible limits"

The control unit calculates the unit of measure per unit of time. The df/dt is measured over 4 sine waves to ensure that it is differentiated from a phase shift. This results in a minimum response time of approximately 100ms (at 50 Hz).

The hysteresis is 0.1 Hz/s.

ID	Parameter	CL	Setting range [Default]	Description
3100	**Monitoring**	4	On	df/dt monitoring is carried out according to the following parameters.
			[Off]	No monitoring is carried out.
3104	**Limit**	4	0.1 to 9.9 Hz/s **[2.6 Hz/s]**	The df/dt threshold is defined here. If this value is reached or exceeded for at least the delay time without interruption, the relay configured in parameter 3101 ↳ p. 63 will be energized.
3105	**Delay**	4	0.10 to 2.00 s **[0.10 s]**	If the monitored rate of df/dt exceeds the threshold value for the delay time configured here, the relay configured in parameter 3101 ↳ p. 63 will be energized. If the monitored df/dt falls below the threshold (minus the hysteresis) before the delay expires the time will be reset.
3101	**Relay**	4	None / Relay 1 / Relay 2 / Relay 3 / Relay 4 **[Relay 1]**	The relay configured here is activated if the respective monitoring functions triggers. If "None" is configured here, no relay is activated in this case.
				Notes Whether the relay is energized or de-energized depends on the configuration of the relay function (parameter 6920 ↳ p. 43 , 6921 ↳ p. 43, 6922 ↳ p. 43 and 6923 ↳ p. 43).

4.4.11 Voltage Increase

General notes

Voltage is monitored depending on parameter "Monitoring" (parameter 8806 ↳ p. 64). This function allows the monitoring of the voltage quality over a longer time period. It is realized as a 10 minute moving average. The function is only active, if the frequency is larger than 60 % of the nominal frequency. If "Voltage measuring" (parameter 1851 ↳ p. 41) is configured to a three-phase measurement, the slow voltage increase alarm is monitoring the individual three-phase voltages according to parameter “AND characteristics” (parameter 8849 ↳ p. 65).

If this protective function is triggered, the configured relay is energized (parameter 8831 ↳ p. 65).

The average is set to "Rated voltage" (parameter 1766 ↳ p. 40) if:

- *Frequency is smaller than 60 % nominal frequency OR*
- *Monitoring (parameter 8806 ↳ p. 64) is "Off" OR*
- *Monitoring is tripped AND the measured voltage is again below the limit*

The relay is de-energized, if:

- *The 10 minute average value is smaller than the defined limit AND*
- *The actual measured value frequency is smaller than 60 % of nominal frequency*
- *After a tripping has occurred AND the voltage falls below the threshold*

The hysteresis is 0.7 % of the primary transformer delta voltage.

Please be aware that if "Voltage monitoring" (parameter 1770 ↳ p. 42) is configured to "All" and the voltage increase monitoring (parameter 8806 ↳ p. 64) is used, that this function only monitors "Phase - neutral".

ID	Parameter	CL	Setting range [Default]	Description
8806	**Monitoring**	4	On	Voltage increase monitoring is carried out according to the following parameters.
			[Off]	No monitoring is carried out.
8807	**Limit**	4	100 to 150 % **[110 %]**	The percentage voltage value that is to be monitored is defined here. If the average voltage over 10 minutes is higher, the specified relay will be energized.

ID	Parameter	CL	Setting range [Default]	Description
				Notes This value refers to the "Rated voltage" (parameter 1766 ➪ p. 40).
8849	**AND characteristics**	4	On	If the 10 minute voltage averages of **all** phases exceed the limit, the monitoring is tripping.
			[Off]	If the 10 minute voltage average of **at least one** phase exceeds the limit, the monitoring is tripping.
8831	**Relay**	4	None / Relay 1 / Relay 2 / Relay 3 / Relay 4 **[Relay 1]**	The relay configured here is activated if the respective monitoring functions triggers. If "None" is configured here, no relay is activated in this case.
				Notes Whether the relay is energized or de-energized depends on the configuration of the relay function (parameter 6920 ➪ p. 43 , 6921 ➪ p. 43, 6922 ➪ p. 43 and 6923 ➪ p. 43).

4.4.12 QV Monitoring

General notes

In case of undervoltage some grid codes require a special monitoring function to avoid the import of inductive reactive power at the interchange point. The QV monitoring is a function of voltage and reactive power. To prevent malfunction, a "Minimum current" (parameter 3287 ➪ p. 67) must be configured.

QV monitoring is triggered if the following conditions are fulfilled: (Refer to Fig. 38 for details)

- QV monitoring is configured to "On" (parameter 3292 ➪ p. 67)
- Measured reactive power is higher than the configured “Reactive power threshold” (parameter 3291 ➪ p. 67)
- Measured average current is higher than the configured “Minimum current” (parameter 3287 ➪ p. 67)
- Measured voltages are below the configured “Limit undervoltage” (parameter 3285 ➪ p. 67)

As a result Timer 1 and Timer 2 are starting. If the delay time "Delay step 1" (parameter 3283 ➪ p. 67) has exceeded, the specified relay for step 1 is energized. If the delay time "Delay step 2" (parameter 3284 ➪ p. 67) has exceeded, the specified relay for step 2 is energized.

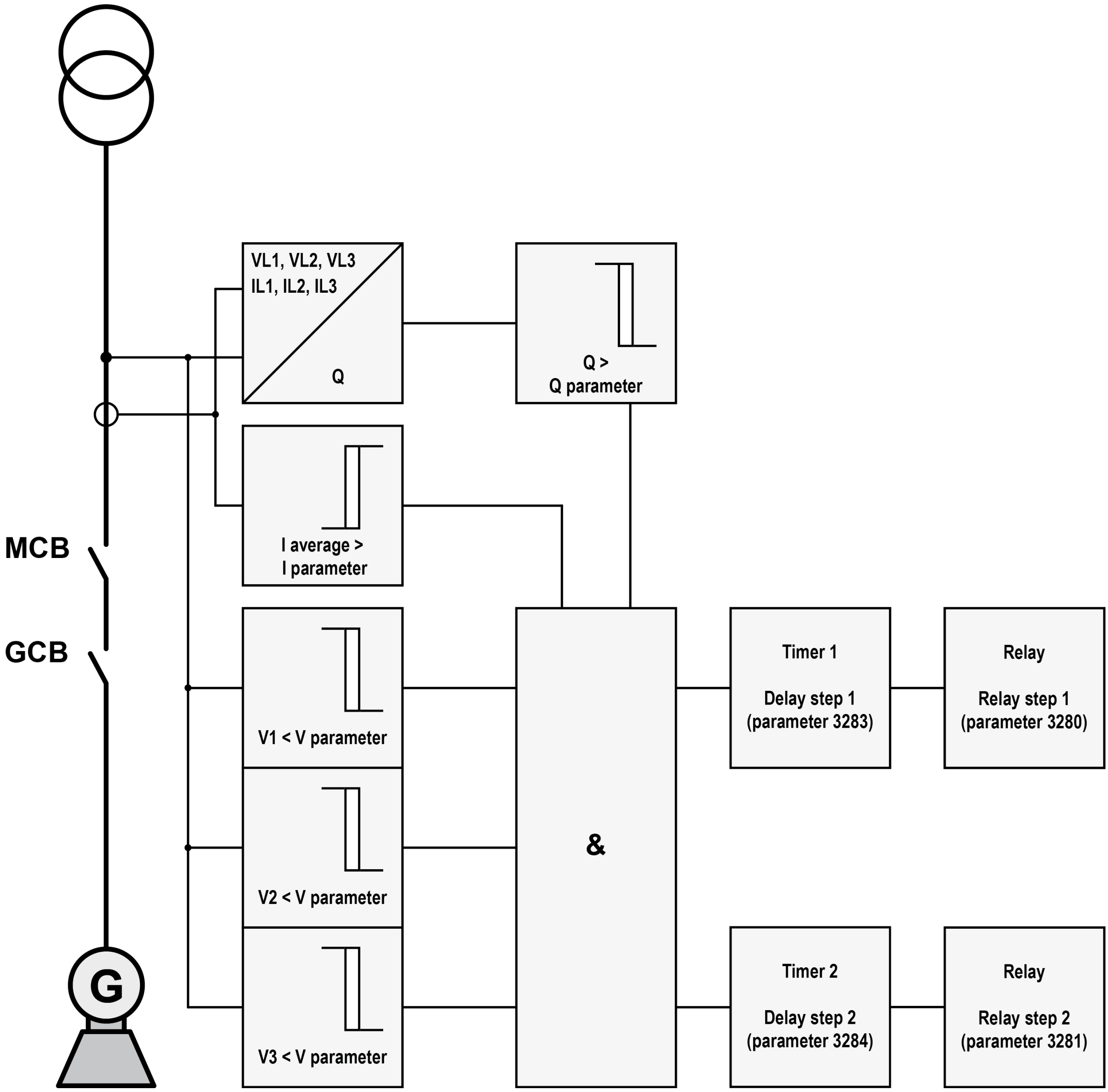


Fig. 38: QV monitoring - schematic

As QV monitoring is a combined protection function the following hystereses are included:

- *Voltage: 0.7 % of primary transformer delta voltage*
- *Current: 1.0 % of CT primary current*
- *Reactive power: 1.0 % of power calculated from primary transformer delta voltage and primary CT current*

ID	Parameter	CL	Setting range [Default]	Description
3292	**Monitoring**	2	On	QV monitoring is carried out according to the following parameters.
			[Off]	No monitoring is carried out.
3285	**Limit under-voltage**	2	45 to 150 % **[85 %]**	The percentage voltage value that is to be monitored is defined here. If the voltages of all phases (one phase in 1Ph 2W system) are below this limit, the voltage condition for tripping the monitoring function is TRUE.
				Notes This value refers to the "Rated voltage" (parameter 1766 ➷ p. 40).
3291	**Reactive power threshold**	2	2 to 100 % **[5 %]**	The percentage reactive value that is to be monitored is defined here. If the absolute value of reactive power Q is higher than this threshold, the reactive power condition for tripping the monitoring function is TRUE.
				Notes This value refers to the "Rated react. power [kvar]" (parameter 1758 ➷ p. 40).
3287	**Minimum cur-rent**	2	0 to 100 % **[10 %]**	The percentage current value that is to be monitored is defined here. If the average current has been exceeded this limit, the current condition for tripping the monitoring function is TRUE.
				Notes This value refers to the "Rated current" (parameter 1754 ➷ p. 40).
3283 3284	**Delay step {x}** [x = 1 to 2]	2	0.10 to 99.99 s 3283: **[0.50 s]** 3284: **[1.50 s]**	If the QV monitoring conditions are met, for the delay time configured here, the specified relay will be energized.
3280 3281	**Relay step {x}** [x = 1 to 2]	2	None / Relay 1 / Relay 2 / Relay 3 / Relay 4 3280: **[Relay 1]** 3281: **[Relay 2]**	The relay configured here is activated if the respective monitoring functions triggers. If "None" is configured here, no relay is activated in this case.
				Notes Whether the relay is energized or de-energized depends on the configuration of the relay function (parameter 6920 ➷ p. 43 , 6921 ➷ p. 43, 6922 ➷ p. 43 and 6923 ➷ p. 43).

4.4.13 Overcurrent (Level 1, 2 & 3) ANSI# 50/51

General notes

Current is monitored according to how the parameter "Current measuring" (parameter 1850 ➷ p. 40) is configured. This controller provides the user with three definite time alarm levels for overcur-rent faults.

Monitoring of the maximum phase current is performed in three steps. Every step can be provided with a delay time independent of the other steps.

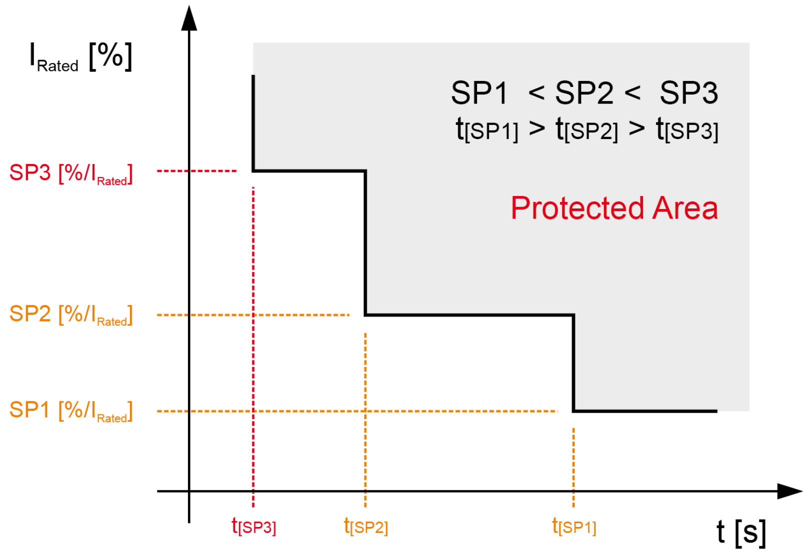


Fig. 39: Overcurrent monitoring

The hysteresis is 1.0 % of the primary CT current.

If this protective function is triggered, the relays configured to "Overcurrent level 1", "Overcurrent level 2", or "Overcurrent level 3" are energized.

ID	Parameter	CL	Setting range [Default]	Description
2200 2206 2212	**Monitoring**	2	On	Overcurrent monitoring is carried out according to the following parameters. Monitoring is performed at three levels. All three values may be configured independent from each other (prerequisite: Level 1 < Level 2 < Level 3).
			[Off]	Monitoring is disabled for Level 1 limit, Level 2 limit, and/or Level 3 limit.
2204 2210 2216	**Limit**	2	50.0 to 300.0 % 2204: **[110.0 %]** 2210: **[150.0 %]** 2216: **[250.0 %]**	The percentage values that are to be monitored for each threshold limit are defined here. If this value is reached or exceeded for at least the delay time without interruption, the specified relay will be energized.
				Notes This value refers to the "Rated current" (parameter 1754 p. 40).
2205 2211 2217	**Delay**	2	0.02 to 300.00 s 2205: **[30.00 s]** 2211: **[1.00 s]** 2217: **[0.40 s]**	If the monitored current exceeds the threshold value for the delay time configured here, an alarm will be issued.
				Notes If the monitored current falls below the threshold (minus the hysteresis) before the delay expires the time will be reset.

ID	Parameter	CL	Setting range [Default]	Description
2201 2207 2213	**Relay**	2	None / Relay 1 / Relay 2 / Relay 3 / Relay 4 2201: **[Relay 1]** 2207: **[Relay 2]** 2213: **[Relay 2]**	The relay configured here is activated if the respective monitoring functions triggers. If "None" is configured here, no relay is activated in this case.
				Notes Whether the relay is energized or de-energized depends on the configuration of the relay function (parameter 6920 ➪ p. 43 , 6921 ➪ p. 43, 6922 ➪ p. 43 and 6923 ➪ p. 43).

4.4.14 Ground Fault (Level 1 & 2)

Calculated ground fault

The current is monitored depending on how parameter "Current measuring" (parameter 1850 ➪ p. 40) is configured. The measured three conductor currents IL1, IL2 and IL3 are vectorially totaled (IS = IL1 + IL2 + IL3) and compared with the configured fault limit (the calculated actual value is indicated in the configuration software). If the measured value exceeds the fault threshold limit, the configured relay is energized.

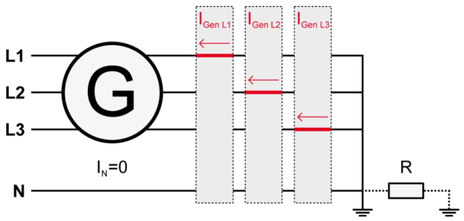


Fig. 40: Ground fault - schematic

The ground fault protection zone is determined by the location where current transformers are physically installed.

Test

- Short-circuit one of the three current transformers under load.
  - ⇨ The measured current should read 100 % of rated on the two phases that do not have their current transformers short-circuited.

The ground current calculation does not take current on the neutral conductor into consideration. In order for the controller to be able to perform calculated ground fault current protection accurately, the neutral conductor must not conduct current.

The fault threshold value is configured as a percentage. This percentage threshold refers to the "Rated current" (parameter 1754 ➪ p. 40). Due to accuracy restrictions the system will always calculate a ground current of about 3 % of the nominal current. The threshold has to be sufficiently higher than that.

Calculation

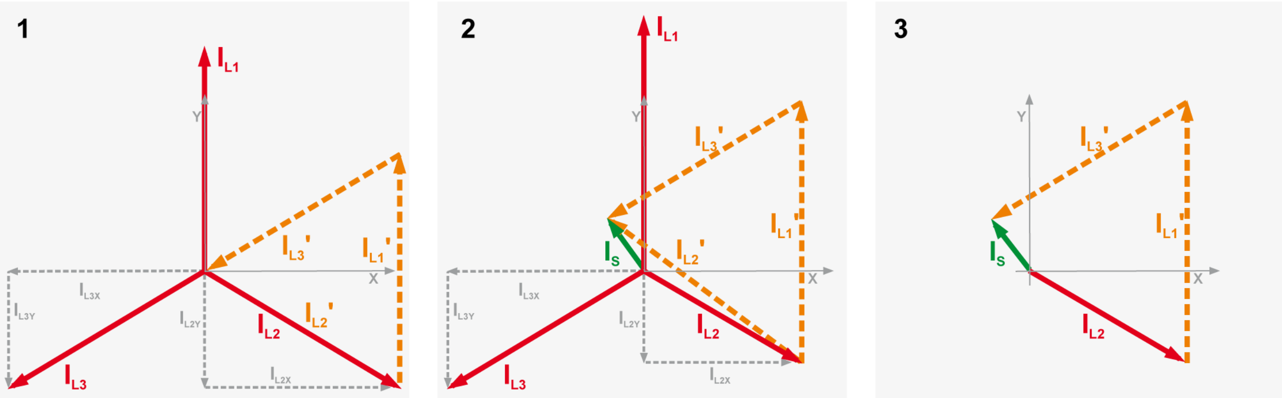


Fig. 41: Generator ground fault - calculation

1 No ground fault
2 Ground fault (with vectorial calculation)
3 Ground fault (I_S = ground fault current)

The ground current I_S is calculated geometrically/vectorially. The pointers for phase currents IL1 and IL2 are parallel shifted and lined up as shown in (Fig. 41/1).

The pointer between the neutral point and the point of the shifted pointer I_{L2}' results is the sum current I_S as shown in (Fig. 41/2).

In order to be able to add the pointers vectorially, these must be divided into their X- and Y-coordinates (IL2X, IL2Y, IL3X and IL3Y).

The ground fault current may be calculated using the following formula:

- $(I_{L1rated} + I_{L2rated} + I_{L3rated}) - (I_{L1measured} + I_{L2measured} + I_{L3measured}) / 1.73 = I_S$
- (7 A + 7 A + 7 A) – (7A + 6.5 A + 6 A) / 1.73 = 0.866 A

Results of a calculation example:

- Phase current $I_{L1} = I_{Rated}$ = 7 A
- Phase current I_{L2} = 6.5 A
- Phase current I_{L3} = 6 A

The hysteresis is 1.0 % of the primary CT current.

ID	Parameter	CL	Setting range [Default]	Description
3250 3256	**Monitoring**	2	On	Ground current monitoring is carried out according to the following parameters. Monitoring is performed at two levels. Both values may be configured independent from each other (prerequisite: Level 1 < Level 2).
			[Off]	Monitoring is disabled for Level 1 limit and/or Level 2 limit.

ID	Parameter	CL	Setting range [Default]	Description
3254 3260	**Limit**	2	0 to 300 % 3254: **[10 %]** 3260: **[30 %]**	The percentage values that are to be monitored for each threshold limit are defined here. If this value is reached or exceeded for at least the delay time without interruption, the specified relay will be energized.
				Notes This value refers to the "Rated current" (parameter 1754 ➡ p. 40). The ground fault threshold shall not exceed the current measuring range (approx. 1.5 × I_{rated}; ➡ *Chapter 8.1 “Technical Data” on page 97*).
3255 3261	**Delay**	2	0.02 to 300.00 s 3255: **[0.20 s]** 3261: **[0.10 s]**	If the monitored ground fault exceeds the threshold value for the delay time configured here, an alarm will be issued.
				Notes If the monitored ground fault falls below the threshold (minus the hysteresis) before the delay expires the time will be reset.
3251 3257	**Relay**	2	None / Relay 1 / Relay 2 / Relay 3 / Relay 4 3251: **[Relay 1]** 3257: **[Relay 2]**	The relay configured here is activated if the respective monitoring functions triggers. If "None" is configured here, no relay is activated in this case.
				Notes Whether the relay is energized or de-energized depends on the configuration of the relay function (parameter 6920 ➡ p. 43 , 6921 ➡ p. 43, 6922 ➡ p. 43 and 6923 ➡ p. 43).

4.4.15 Time-Dependent Voltage 1

General notes

Voltage is monitored depending on parameter "Voltage measuring" (parameter 1851 ➡ p. 41). It can be configured either as undervoltage or overvoltage monitoring (parameter 4953 ➡ p. 72). If the measured voltage of at least one phase falls below/exceeds the configured "Initial threshold" (parameter 4970 ➡ p. 72), the time-dependent voltage monitoring sequence starts and the voltage threshold will change in time according to the configured threshold curve points. If the measured voltage falls below/exceeds this curve, the monitoring function triggers and the configured relay will energize. If the measured voltage falls below/exceeds the configured "Fallback threshold" (parameter 4978 ➡ p. 73) for at least the configured "Fallback time" (parameter 4968 ➡ p. 73), the time-dependent voltage monitoring sequence will be reset.

The threshold curve results from seven configurable points and a linear interpolation between these points. Fig. 42 shows a threshold curve with standard values for time-dependent voltage monitoring 1. These standard values form an FRT (fault ride-through) monitoring function according to the grid code requirements for wind turbines. The time points should always have an ascending order. The fallback threshold should always be configured to a value higher/lower than the init threshold.

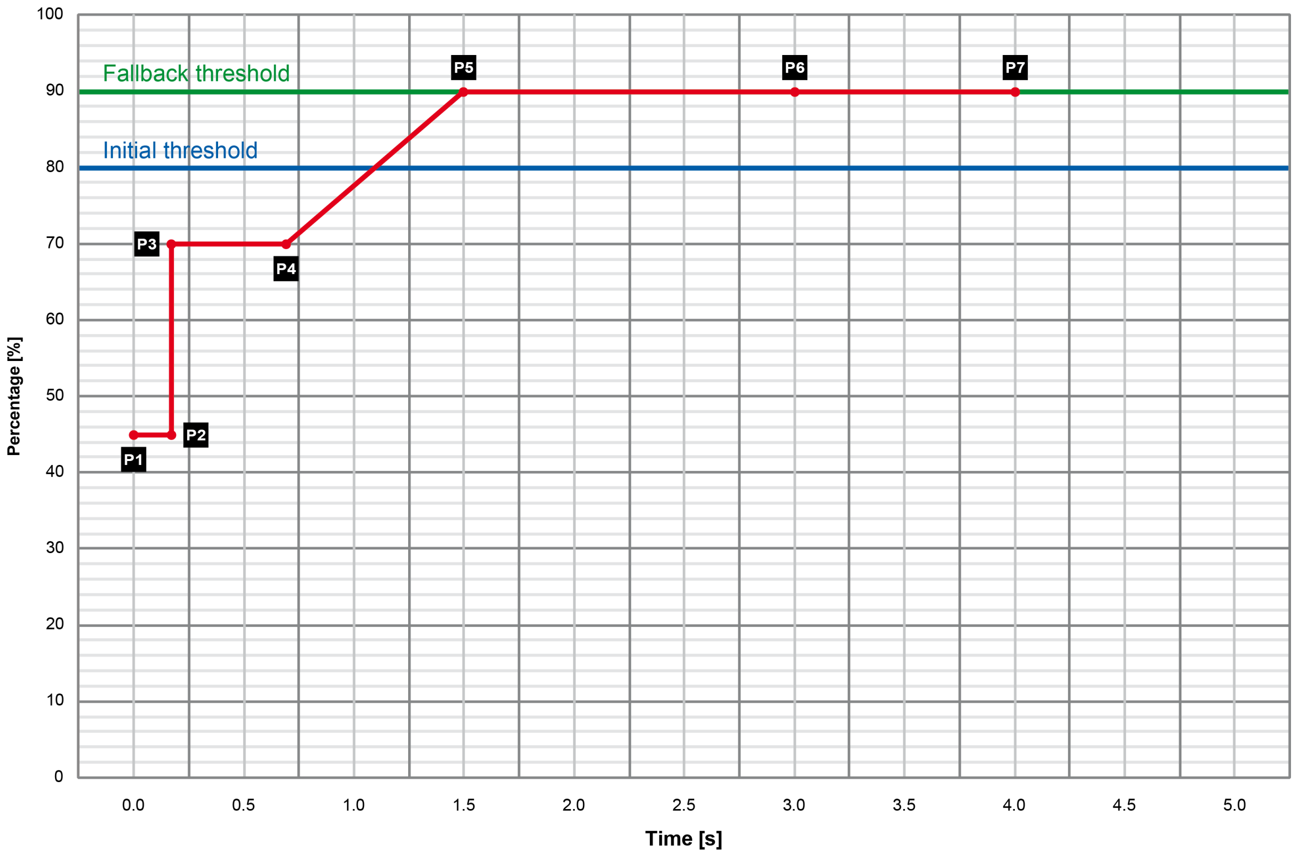


Fig. 42: Time-dependent voltage monitoring 1

P1	0.00 s → 45.0 %
P2	0.15 s → 45.0 %
P3	0.15 s → 70.0 %
P4	0.70 s → 70.0 %
P5	1.50 s → 90.0 %
P6	3.00 s → 90.0 %
P7	4.00 s → 90.0 %
Fallback voltage	90.0 %
Initial threshold	80.0 %
Fallback time	1.00 s

ID	Parameter	CL	Setting range [Default]	Description
4950	**Monitoring**	2	**[On]**	Time-dependent voltage monitoring 1 is carried out according to the following parameters.
			Off	No monitoring is carried out.
4952	**AND characteristics**	2	On	Each phase falls below/exceeds the threshold for tripping.
			[Off]	At least one phase falls below/exceeds the threshold for tripping.
4953	**Monitoring at**	2		Selects whether the system shall do over- or undervoltage monitoring.
			[Underrun]	The undervoltage monitoring is carried out.
			Overrun	The overvoltage monitoring is carried out.
4970	**Init threshold**	2	0.0 to 200.0 % **[80.0 %]**	The time-dependent voltage monitoring initial threshold is configured here. If the measured voltage of at least one phase falls below/exceeds this threshold, the monitoring sequence starts and the voltage threshold will change in time according to the configured threshold curve points. If the measured voltage falls below/exceeds this curve, the monitoring function triggers and the configured relay will energize.

ID	Parameter	CL	Setting range [Default]	Description
4968	**Fallback time**	2	0.00 to 320.00 s **[1.00 s]**	The time-dependent voltage monitoring fallback time is configured here. If the measured voltage falls below/exceeds the configured "Fallback threshold" (parameter 4978 ➪ p. 73) for at least the time configured here, the monitoring sequence will be reset.
4978	**Fallback threshold**	2	0.0 to 200.0 % **[90.0 %]**	The time-dependent voltage monitoring fallback voltage is configured here. If the measured voltage falls below/exceeds the voltage configured here for at least the configured "Fallback time" (parameter 4968 ➪ p. 73), the monitoring sequence will be reset.
				Notes This parameter should always be configured to a value higher/lower than the "Init threshold" (parameter 4970 ➪ p. 72) for proper operation.
4961 4962 4963 4964 4965 4966 4967	**Time point {x}** [x = 1 to 7]	2	0.00 to 320.00 s 4961: **[0.00 s]** 4962: **[0.15 s]** 4963: **[0.15 s]** 4964: **[0.70 s]** 4965: **[1.50 s]** 4966: **[3.00 s]** 4967: **[4.00 s]**	The time values of time-dependent voltage monitoring time points are configured here.
4971 4972 4973 4974 4975 4976 4977	**Voltage point {x}** [x = 1 to 7]	2	0.0 to 200.0 % 4971: **[45.0 %]** 4972: **[45.0 %]** 4973: **[70.0 %]** 4974: **[70.0 %]** 4975: **[90.0 %]** 4976: **[90.0 %]** 4977: **[90.0 %]**	The voltage values of time-dependent voltage monitoring voltage points are configured here.
4951	**Relay**	2	None / Relay 1 / Relay 2 / Relay 3 / Relay 4 **[Relay 1]**	The relay configured here is activated if the respective monitoring functions triggers. If "None" is configured here, no relay is activated in this case.
				Notes Whether the relay is energized or de-energized depends on the configuration of the relay function (parameter 6920 ➪ p. 43 , 6921 ➪ p. 43, 6922 ➪ p. 43 and 6923 ➪ p. 43).

4.4.16 Time-Dependent Voltage 2

General notes

Voltage is monitored depending on parameter "Voltage measuring" (parameter 1851 ➪ p. 41). It can be configured either as undervoltage or overvoltage monitoring (parameter 4957 ➪ p. 75). If the measured voltage of at least one phase falls below/exceeds the configured "Initial threshold" (parameter 4990 ➪ p. 75), the time-dependent voltage monitoring sequence starts and the voltage threshold will change in time according to the configured threshold curve points. If the measured voltage falls below/exceeds this curve, the monitoring function triggers and the configured relay will energize. If the measured voltage falls below/exceeds the configured "Fallback threshold" (parameter 4998 ⇘ p. 75) for at least the configured "Fallback time" (parameter 4988 ⇘ p. 75), the time-dependent voltage monitoring sequence will be reset.

The threshold curve results from seven configurable points and a linear interpolation between these points. Fig. 43 shows a threshold curve with standard values for time-dependent voltage monitoring 2. These standard values form an STI (short-term interruption) monitoring function according to the grid code requirements for wind turbines. The time points should always have an ascending order. The fallback threshold should always be configured to a value higher/lower than the init threshold.

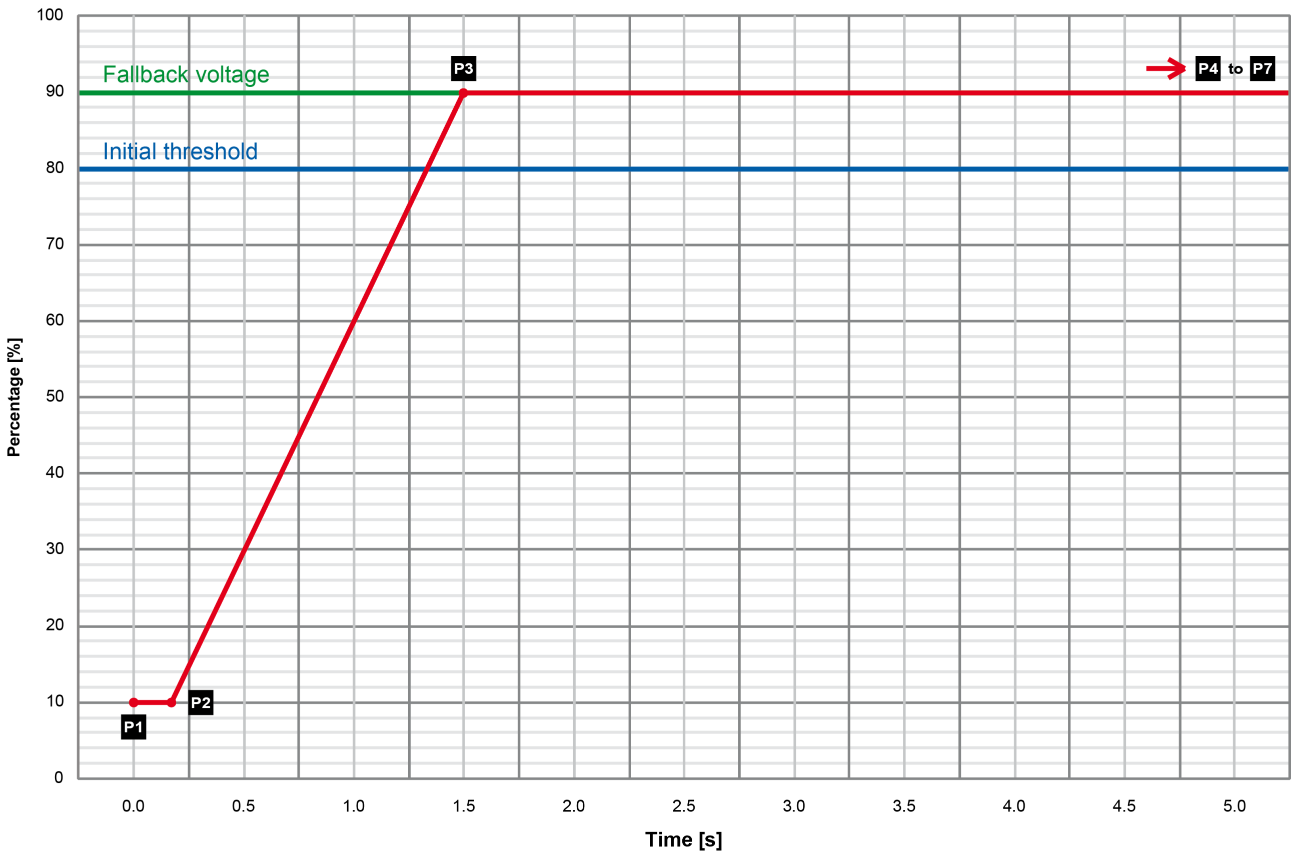


Fig. 43: Time-dependent voltage monitoring 2

P1	0.00 s → 10.0 %	P6	30.00 s → 90.0 %
P2	0.15 s → 10.0 %	P7	40.00 s → 90.0 %
P3	1.50 s → 90.0 %	Fallback voltage	90.0 %
P4	10.00 s → 90.0 %	Initial threshold	80.0 %
P5	20.00 s → 90.0 %	Fallback time	1.00 s

ID	Parameter	CL	Setting range [Default]	Description
4954	**Monitoring**	2	**[On]**	Time-dependent voltage monitoring 2 is carried out according to the following parameters.
			Off	No monitoring is carried out.
4956	**AND characteristics**	2	On	Each phase falls below/exceeds the threshold for tripping.
			[Off]	At least one phase falls below/exceeds the threshold for tripping.

ID	Parameter	CL	Setting range [Default]	Description
4957	**Monitoring at**	2		Selects whether the system shall do over- or undervoltage monitoring.
			[Underrun]	The undervoltage monitoring is carried out.
			Overrun	The overvoltage monitoring is carried out.
4990	**Init threshold**	2	0.0 to 200.0 % **[80.0 %]**	The time-dependent voltage monitoring initial threshold is configured here. If the measured voltage of at least one phase falls below/exceeds this threshold, the monitoring sequence starts and the voltage threshold will change in time according to the configured threshold curve points. If the measured voltage falls below/exceeds this curve, the monitoring function triggers and the configured relay will energize.
4988	**Fallback time**	2	0.00 to 320.00 s **[1.00 s]**	The time-dependent voltage monitoring fallback time is configured here. If the measured voltage falls below/exceeds the configured "Fallback threshold" (parameter 4998 ⇘ p. 75) for at least the time configured here, the monitoring sequence will be reset.
4998	**Fallback threshold**	2	0.0 to 200.0 % **[90.0 %]**	The time-dependent voltage monitoring fallback voltage is configured here. If the measured voltage falls below/exceeds the voltage configured here for at least the configured "Fallback time" (parameter 4988 ⇘ p. 75), the monitoring sequence will be reset.
				Notes This parameter should always be configured to a value higher/lower than the "Init threshold" (parameter 4990 ⇘ p. 75) for proper operation.
4981 4982 4983 4984 4985 4986 4987	**Time point {x}** [x = 1 to 7]	2	0.00 to 320.00 s 4981: **[0.00 s]** 4982: **[0.15 s]** 4983: **[1.50 s]** 4984: **[10.00 s]** 4985: **[20.00 s]** 4986: **[30.00 s]** 4987: **[40.00 s]**	The time values of time-dependent voltage monitoring time points are configured here.
4991 4992 4993 4994 4995 4996 4997	**Voltage point {x}** [x = 1 to 7]	2	0.0 to 200.0 % 4991: **[10.0 %]** 4992: **[10.0 %]** 4993: **[90.0 %]** 4994: **[90.0 %]** 4995: **[90.0 %]** 4996: **[90.0 %]** 4997: **[90.0 %]**	The voltage values of time-dependent voltage monitoring voltage points are configured here.
4955	**Relay**	2	None / Relay 1 / Relay 2 / Relay 3 / Relay 4 **[Relay 2]**	The relay configured here is activated if the respective monitoring functions triggers. If "None" is configured here, no relay is activated in this case.
				Notes Whether the relay is energized or de-energized depends on the configuration of the relay function (parameter 6920 ⇘ p. 43 , 6921 ⇘ p. 43, 6922 ⇘ p. 43 and 6923 ⇘ p. 43).

4.4.17 Time-Dependent Voltage 3

General notes

Voltage is monitored depending on parameter "Voltage measuring" (parameter 1851 ↳ p. 41). It can be configured either as under-voltage or overvoltage monitoring (parameter 9133 ↳ p. 77). If the measured voltage of at least one phase falls below/exceeds the configured "Initial threshold" (parameter 9148 ↳ p. 77), the time-dependent voltage monitoring sequence starts and the voltage threshold will change in time according to the configured threshold curve points. If the measured voltage falls below/exceeds this curve, the monitoring function triggers and the configured relay will energize. If the measured voltage falls below/exceeds the configured "Fallback threshold" (parameter 9156 ↳ p. 77) for at least the configured "Fallback time" (parameter 9147 ↳ p. 77), the time-dependent voltage monitoring sequence will be reset.

The threshold curve results from seven configurable points and a linear interpolation between these points. Fig. 44 shows a threshold curve with standard values for time-dependent voltage monitoring 3. These standard values form an FRT (fault ride-through) monitoring function according to the grid code requirements for wind turbines. The time points should always have an ascending order. The fallback threshold should always be configured to a value higher/lower than the init threshold.

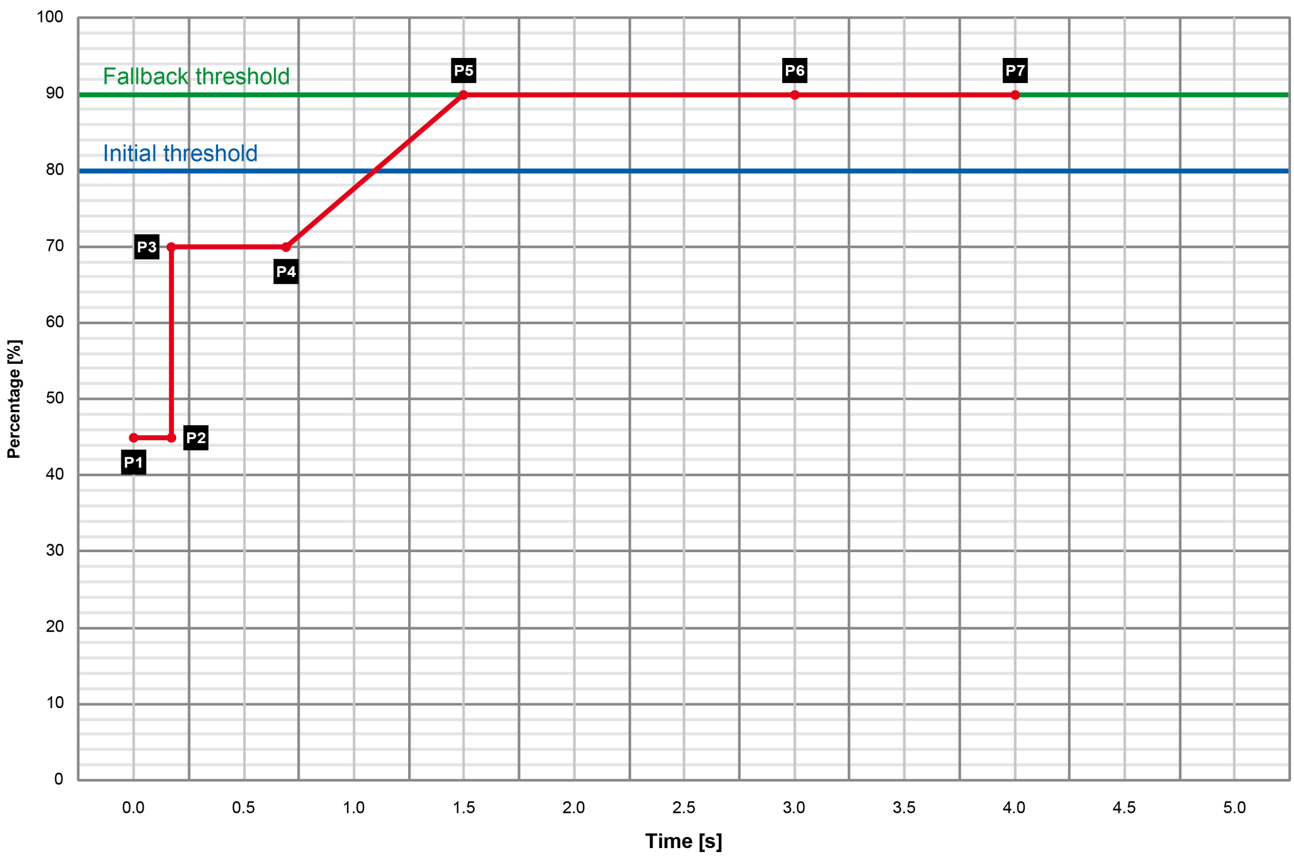


Fig. 44: Time-dependent voltage monitoring 3

P1	0.00 s → 45.0 %	P6	3.00 s → 90.0 %
P2	0.15 s → 45.0 %	P7	4.00 s → 90.0 %
P3	0.15 s → 70.0 %	Fallback voltage	90.0 %
P4	0.70 s → 70.0 %	Initial threshold	80.0 %
P5	1.50 s → 90.0 %	Fallback time	1.00 s

ID	Parameter	CL	Setting range [Default]	Description
9130	**Monitoring**	2	On	Time-dependent voltage monitoring 3 is carried out according to the following parameters.
			[Off]	No monitoring is carried out.
9132	**AND character-istics**	2	On	Each phase falls below/exceeds the threshold for tripping.
			[Off]	At least one phase falls below/exceeds the threshold for tripping.
9133	**Monitoring at**	2		Selects whether the system shall do over- or undervoltage monitoring.
			[Underrun]	The undervoltage monitoring is carried out.
			Overrun	The overvoltage monitoring is carried out.
9148	**Init threshold**	2	0.0 to 200.0 % **[80.0 %]**	The time-dependent voltage monitoring initial threshold is configured here. If the measured voltage of at least one phase falls below/exceeds this threshold, the monitoring sequence starts and the voltage threshold will change in time according to the configured threshold curve points. If the measured voltage falls below/exceeds this curve, the monitoring function triggers and the configured relay will energize.
9147	**Fallback time**	2	0.00 to 320.00 s **[1.00 s]**	The time-dependent voltage monitoring fallback time is configured here. If the measured voltage falls below/exceeds the configured "Fallback threshold" (parameter 9156 ➪ p. 77) for at least the time configured here, the monitoring sequence will be reset.
9156	**Fallback threshold**	2	0.0 to 200.0 % **[90.0 %]**	The time-dependent voltage monitoring fallback voltage is configured here. If the measured voltage falls below/exceeds the voltage configured here for at least the configured "Fallback time" (parameter 9147 ➪ p. 77), the monitoring sequence will be reset.
				Notes This parameter should always be configured to a value higher/lower than the "Init threshold" (parameter 9148 ➪ p. 77) for proper operation.
9140 9141 9142 9143 9144 9145 9146	**Time point {x}** [x = 1 to 7]	2	0.00 to 320.00 s 9140: **[0.00 s]** 9141: **[0.15 s]** 9142: **[0.15 s]** 9143: **[0.70 s]** 9144: **[1.50 s]** 9145: **[3.00 s]** 9146: **[4.00 s]**	The time values of time-dependent voltage monitoring time points are configured here.
9149 9150 9151 9152 9153 9154 9155	**Voltage point {x}** [x = 1 to 7]	2	0.0 to 200.0 % 9149: **[45.0 %]** 9150: **[45.0 %]** 9151: **[70.0 %]** 9152: **[70.0 %]** 9153: **[90.0 %]** 9154: **[90.0 %]** 9155: **[90.0 %]**	The voltage values of time-dependent voltage monitoring voltage points are configured here.

ID	Parameter	CL	Setting range [Default]	Description
9131	**Relay**	2	None / Relay 1 / Relay 2 / Relay 3 / Relay 4 **[Relay 1]**	The relay configured here is activated if the respective monitoring functions triggers. If "None" is configured here, no relay is activated in this case.
				Notes Whether the relay is energized or de-energized depends on the configuration of the relay function (parameter 6920 ➪ p. 43 , 6921 ➪ p. 43, 6922 ➪ p. 43 and 6923 ➪ p. 43).

4.4.18 Time-Dependent Voltage 4

General notes

Voltage is monitored depending on parameter "Voltage measuring" (parameter 1851 ➪ p. 41). It can be configured either as undervoltage or overvoltage monitoring (parameter 9137 ➪ p. 79). If the measured voltage of at least one phase falls below/exceeds the configured "Initial threshold" (parameter 9165 ➪ p. 79), the time-dependent voltage monitoring sequence starts and the voltage threshold will change in time according to the configured threshold curve points. If the measured voltage falls below/exceeds this curve, the monitoring function triggers and the configured relay will energize. If the measured voltage falls below/exceeds the configured "Fallback threshold" (parameter 9173 ➪ p. 80) for at least the configured "Fallback time" (parameter 9164 ➪ p. 80), the time-dependent voltage monitoring sequence will be reset.

The threshold curve results from seven configurable points and a linear interpolation between these points. Fig. 45 shows a threshold curve with standard values for time-dependent voltage monitoring 4. These standard values form an STI (short-term interruption) monitoring function according to the grid code requirements for wind turbines. The time points should always have an ascending order. The fallback threshold should always be configured to a value higher/lower than the init threshold.

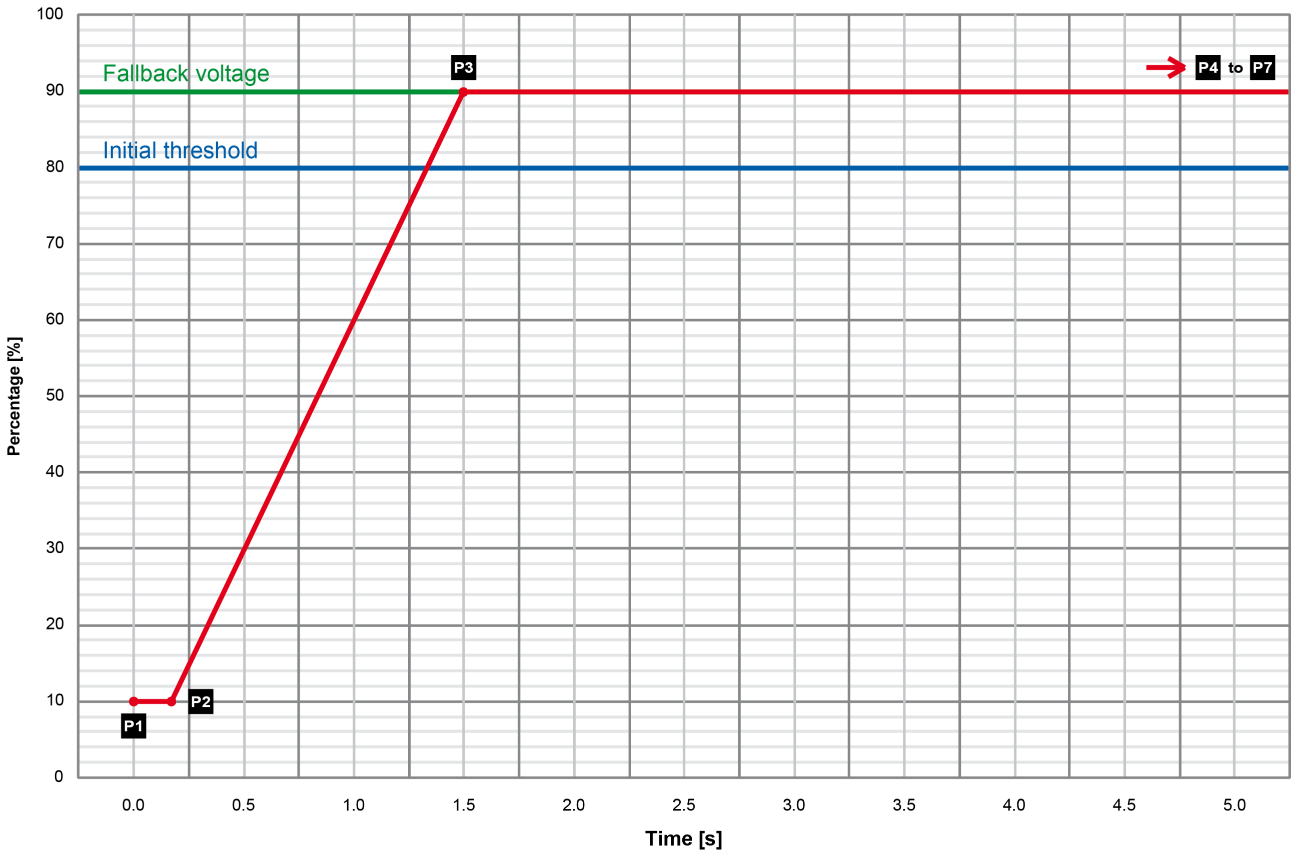


Fig. 45: Time-dependent voltage monitoring 4

P1	0.00 s → 10.0 %	P6	30.00 s → 90.0 %
P2	0.15 s → 10.0 %	P7	40.00 s → 90.0 %
P3	1.50 s → 90.0 %	Fallback voltage	90.0 %
P4	10.00 s → 90.0 %	Initial threshold	80.0 %
P5	20.00 s → 90.0 %	Fallback time	1.00 s

ID	Parameter	CL	Setting range [Default]	Description
9134	**Monitoring**	2	On	Time-dependent voltage monitoring 4 is carried out according to the following parameters.
			[Off]	No monitoring is carried out.
9136	**AND characteristics**	2	On	Each phase falls below/exceeds the threshold for tripping.
			[Off]	At least one phase falls below/exceeds the threshold for tripping.
9137	**Monitoring at**	2		Selects whether the system shall do over- or undervoltage monitoring.
			[Underrun]	The undervoltage monitoring is carried out.
			Overrun	The overvoltage monitoring is carried out.
9165	**Init threshold**	2	0.0 to 200.0 % **[80.0 %]**	The time-dependent voltage monitoring initial threshold is configured here. If the measured voltage of at least one phase falls below/exceeds this threshold, the monitoring sequence starts and the voltage threshold will change in time according to the configured threshold curve points. If the measured voltage falls below/exceeds this curve, the monitoring function triggers and the configured relay will energize.

ID	Parameter	CL	Setting range [Default]	Description
9164	**Fallback time**	2	0.00 to 320.00 s **[1.00 s]**	The time-dependent voltage monitoring fallback time is configured here. If the measured voltage falls below/exceeds the configured "Fallback threshold" (parameter 9173 ➪ p. 80) for at least the time configured here, the monitoring sequence will be reset.
9173	**Fallback threshold**	2	0.0 to 200.0 % **[90.0 %]**	The time-dependent voltage monitoring fallback voltage is configured here. If the measured voltage falls below/exceeds the voltage configured here for at least the configured "Fallback time" (parameter 9164 ➪ p. 80), the monitoring sequence will be reset.
				Notes This parameter should always be configured to a value higher/lower than the "Init threshold" (parameter 9165 ➪ p. 79) for proper operation.
9157 9158 9159 9160 9161 9162 9163	**Time point {x}** [x = 1 to 7]	2	0.00 to 320.00 s 9157: **[0.00 s]** 9158: **[0.15 s]** 9159: **[1.50 s]** 9160: **[10.00 s]** 9161: **[20.00 s]** 9162: **[30.00 s]** 9163: **[40.00 s]**	The time values of time-dependent voltage monitoring time points are configured here.
9166 9167 9168 9169 9170 9171 9172	**Voltage point {x}** [x = 1 to 7]	2	0.0 to 200.0 % 9166: **[10.0 %]** 9167: **[10.0 %]** 9168: **[90.0 %]** 9169: **[90.0 %]** 9170: **[90.0 %]** 9171: **[90.0 %]** 9172: **[90.0 %]**	The voltage values of time-dependent voltage monitoring voltage points are configured here.
9135	**Relay**	2	None / Relay 1 / Relay 2 / Relay 3 / Relay 4 **[Relay 2]**	The relay configured here is activated if the respective monitoring functions triggers. If "None" is configured here, no relay is activated in this case.
				Notes Whether the relay is energized or de-energized depends on the configuration of the relay function (parameter 6920 ➪ p. 43 , 6921 ➪ p. 43, 6922 ➪ p. 43 and 6923 ➪ p. 43).

4.5 System Management

4.5.1 Factory Settings

ID	Parameter	CL	Setting range [Default]	Description
1704	**Factory default settings**	0	Yes	Enables the parameter "Reset factory default values" (parameter 1701 ↳ p. 81).
			[No]	Disables the parameter "Reset factory default values" (parameter 1701 ↳ p. 81).
1701	**Reset factory default values**	0	Yes	All parameters, which the enabled access code grants privileges to, will be restored to factory default values.
			[No]	All parameters will remain as currently configured.
				Notes The function will only be executed if parameter 1704 ↳ p. 81 is configured to “Yes”. It will reset itself automatically.

4.5.2 Password System

General notes

The controller utilizes a password protected multi-level configuration access hierarchy. This permits varying degrees of access to the parameters being granted by assigning unique passwords to designated personnel.

A distinction is made between the access levels as follows:

Code level	
Code level CL0 (User Level) Standard password = none	This code level permits for monitoring of the system. Configuration of the control is not permitted. The unit powers up in this code level.
Code level CL1 (Service Level) Standard password = "0 0 0 1"	This code level entitles the user to change selected non-critical parameters. The user may also change the password for level CL1. Access granted by this password expires two hours after the password has been entered and the user is returned to the CL0 level.

Code level	
Code level CL2 (Temporary Commissioning Level) No standard password available	This code level grants temporary access to most of the parameters. The password is calculated from the random number generated when the password is initially accessed. It is designed to grant a user one-time access to a parameter without having to give him a reusable password. The user may also change the password for level CL1. Access granted by this password expires two hours after the password has been entered and the user is returned to the CL0 level. The password for the temporary commissioning level may be obtained from the vendor.
Code level CL3 (Commissioning Level) Standard password = "0 0 0 3"	This code level grants complete and total access to most of the parameters. In addition, the user may also change the passwords for levels CL1, CL2 and CL3. Access granted by this password expires two hours after the password has been entered and the user is returned to the CL0 level.

Once the code level is entered, access to the configuration menus will be permitted for two hours or until another password is entered into the control. If a user needs to exit a code level then code level, CL0 should be entered. This will block unauthorized configuration of the control.

A user may return to CL0 by allowing the entered password to expire after two hours or by changing any one digit on the random number generated on the password screen and entering it into the unit.

4.5.3 Password Entry

ID	Parameter	CL	Setting range [Default]	Description
10418	**Password system**	4	On	The standard password system is used.
			[Off]	The password system is set permanently to code level CL5 (Supercommissioning level).
10406	**Actual code level**	---	Info **[-]**	This value displays the code level which is currently enabled for the access via ToolKit.
10401	**Password**	0	0 to 9999 **[0]**	The password to configure the device needs to be entered here.

4.5.4 Passwords

General notes

The following passwords grant varying levels of access to the parameters.

Each individual password can be used to access the appropriate configuration level through multiple access methods and communication protocols (via serial Interbus interface).

The values from parameter 10411 ↳ p. 83 to parameter 10415 ↳ p. 83 are not readable in ToolKit if the actual code level is lower than the parameters code level.

ID	Parameter	CL	Setting range [Default]	Description
10415	**Basic code level**	1	0 to 9999 **[-]**	The password for the code level "Service" is defined in this parameter. Refer to ↳ *Chapter 4.5.2 "Password System" on page 81* for default values.
10414	**Temp. commissioning code level**	3	0 to 9999 **[-]**	The algorithm for calculating the password for the code level "Temporary Commissioning" is defined in this parameter.
10413	**Commissioning code level**	3	0 to 9999 **[-]**	The password for the code level "Commission" is defined in this parameter. Refer to ↳ *Chapter 4.5.2 "Password System" on page 81* for default values.
10412	**Temp. supercomm. level code**	5	0 to 9999 **[-]**	The algorithm for calculating the password for the code level "Temporary Supercommissioning" is defined in this parameter.
10411	**Supercommissioning level code**	5	0 to 9999 **[-]**	The password for the code level "Supercommissioning" is defined in this parameter. Refer to ↳ *Chapter 4.5.2 "Password System" on page 81* for default values.

4.5.5 Parameter Set

General notes

The MFR 500 provides a feature to mark the current parameter set as "consistent" and to detect whether changes are made to this consistent parameter set.

This function is described in a separate document. Please refer to your distributor for this manual (37411).

5 Operation

The MFR 500 can be operated, monitored and configured using the following access methods:

- External access with a PC using the ToolKit configuration software.
  ↳ *Chapter 5.1.1 "Install ToolKit" on page 85*
- External command access using Interbus
  ↳ *Chapter 7 "Interfaces And Protocols" on page 95*

5.1 Access Via PC (ToolKit)

Version

> *Woodward's ToolKit software is required to access the unit via PC.*
>
> – *Required version: 4.3.x or higher*
> – *For information on how to obtain the latest version see ↳ "Load from the website" on page 85.*

5.1.1 Install ToolKit

Load from CD

1. Insert the product CD (as supplied with the unit) in the CD-ROM drive of your computer.

⇨ The HTML menu is opened automatically in a browser.

> *The 'autostart' function of your operating system needs to be activated.*
>
> *Alternately open the document "start.html" in the root directory of the CD in a browser.*

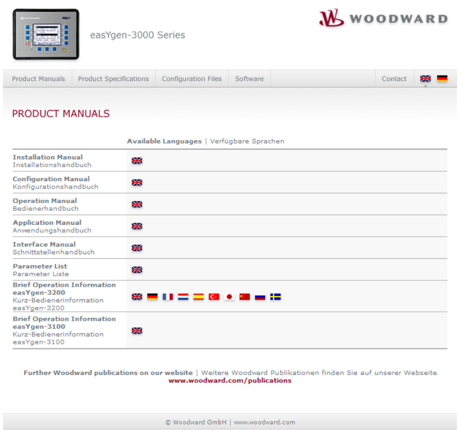


Fig. 46: Product CD - HTML menu

2. Go to section *"Software"* and follow the instructions described there.

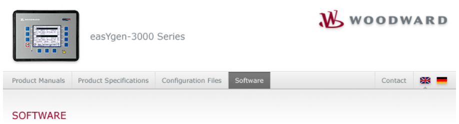


Fig. 47: HTML menu section 'Software'

Load from the website

> *The latest version of the ToolKit software can be obtained from our website.*
>
> *The latest version of Microsoft .NET Framework can be obtained from Microsoft website.*

To get the software from the website:

1. Go to *http://www.woodward.com/software*
2. Select ToolKit in the list and click the *"Go"* button.
3. Click *"More Info"* to get further information about ToolKit.
4. Choose the preferred software version and click *"Download"*.
5. Login with your e-mail address or register first.
   ⇨ The download will start immediatly.

Minimum system requirements

- Microsoft Windows® 7, Vista, XP (32- & 64-bit; support for XP will end on 2014-April-8)
- Microsoft .NET Framework Ver. 4.0
- 1 GHz Pentium® CPU
- 512 MB of RAM
- Screen
  – Resolution: 800 by 600 pixels
  – Colors: 256
- Serial Port
- Serial Extension Cable
- CD-ROM drive

Microsoft .NET Framework 4.0 must be installed on your computer to be able to install ToolKit.

– *If not already installed, Microsoft .NET Framework 4.0 will be installed automatically (internet conection required).*
– *Alternatively use the .NET Framework 4.0 installer found on the Product CD.*

Installation

To install ToolKit:

- Run the self-extracting installation package and follow the on-screen steps to install.

5.1.2 Install ToolKit Configuration Files

Load from CD

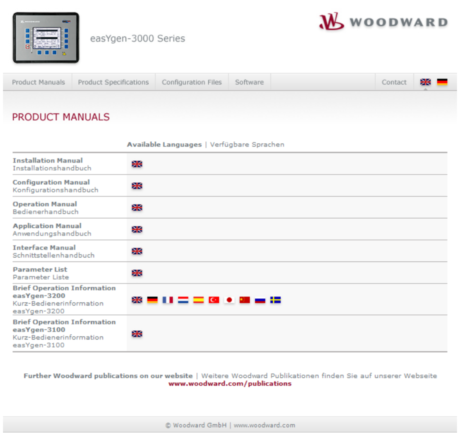


Fig. 48: Product CD - HTML menu

1. Insert the product CD (as supplied with the unit) in the CD-ROM drive of your computer.
   ⇨ The HTML menu is opened automatically in a browser.

> *The 'autostart' function of your operating system needs to be activated.*
>
> *Alternately open the document "start.html" in the root directory of the CD in a browser.*
>
> *Details of your current product CD menu may differ because of updates.*

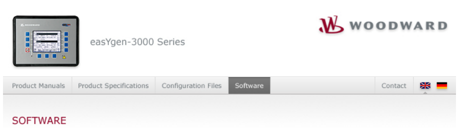


Fig. 49: HTML menu section 'Software'

2. Go to section *"Configuration Files"* and follow the instructions described there.

Load from the website

> *The latest version of the ToolKit software can be obtained from our website.*

To get the software from the website:

1. Go to *http://www.woodward.com/software/configfiles*
2. Insert the part number (P/N) and revision of your device into the corresponding fields.
3. Select "ToolKit" in the *"application type"* list.
4. Click *"Search"*.
5. Download the file displayed in the search result.
   ⇨ The file is a ZIP archive which must be extracted for use in ToolKit.

ToolKit files

***.WTOOL**	
File name composition:	[P/N1][1]-[Revision]_[Language ID]_[P/N2][2]-[Revision]_[# of visualized gens].WTOOL
Example file name:	8440-1234-NEW_US_5418-1234-NEW.WTOOL
File content:	Display screens and pages for online configuration, which are associated with the respective *.SID file.

***.SID**	
File name composition:	[P/N2][2]-[Revision].SID
Example file name:	5418-1234-NEW.SID
File content:	All display and configuration parameters available in ToolKit.

***.WSET**	
File name composition:	[user defined].WSET
Example file name:	device_settings.WSET
File content:	Default settings of the ToolKit configuration parameters provided by the SID file or user-defined settings read from the unit.

- [1] P/N1 = Part number of the unit
- [2] P/N2 = Part number of the software in the unit

5.1.3 Configure ToolKit

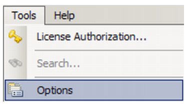


Fig. 50: Tools menu

To change ToolKit settings:

1. Select *"Tools ➔ Options"*.

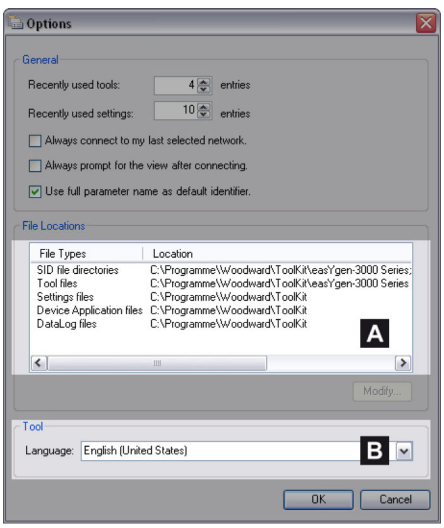


Fig. 51: Options window

⇨ The *"Options"* windows is displayed.

2. Adjust settings as required.

> *For more information on the individual settings refer to the ToolKit online help.*

⇨ Changes take effect after klicking *"OK"*.

> *Please do not change the default installation folder! Otherwise the language selection will not work properly.*

A File locations
B Language setting for tools

5.1.4 Connect ToolKit

Standard connection

To connect ToolKit and the MFR unit:

1. *The USB/RS-232 serial interface is only provided via the optional Woodward DPC (direct configuration cable), which must be connected to the service port.*

   – *For additional information refer to ➪ Chapter 3.2.8 "Service Port" on page 36.*

   Plug the DPC cable into the service port. Use a USB cable/ null modem cable to connect the USB/RS-232 serial port of the DPC to a serial USB/COM port of the PC with.

   If the PC does not have a serial port to connect the null modem cable to, use a USB to serial adapter.

2. Open ToolKit from the Windows Start Menu path *"Programs ➔ Woodward ➔ ToolKit X.x"*.
3. From the main ToolKit window, select *"File ➔ Open Tool..."* click the *"Open Tool"* icon on the tool bar.
4. Locate and select the desired tool file (`*.WTOOL`) in the ToolKit data file directory and click *"Open"*.
5. From the main ToolKit window, click Device then click "Connect", or select the Connect icon on the toolbar.

   ⇨ The connect dialog will open if the option is enabled.

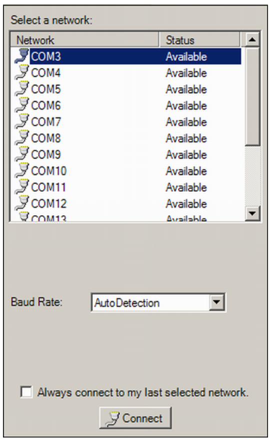


Fig. 52: Connect dialog

6. Select the COM port that is connected to the communication cable.
7. Click the *"Connect"* button.

   ⇨ The identifier of the device that ToolKit is connected to, will display in the status bar.

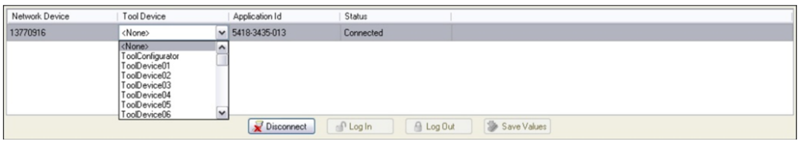


Fig. 53: Communications window

8. If the communications window opens, select *"ToolConfigurator"* from the *"Tool Device"* list and close the communications window.

   ⇨ If the device is security enabled, the login dialog will appear.

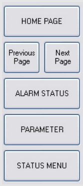
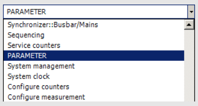
9. Enter the login data if required.
   ⇨ Now you are able to edit the device parameters in the main window.

> *Any changes are written automatically to the control unit's memory after pressing [Enter] to confirm them..*

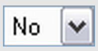
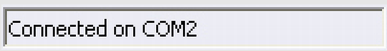
5.1.5 View And Set Values In ToolKit

Basic navigation

ToolKit offers the following graphical elements for basic navigation:

Graphical element	Caption	Description
	Navigation buttons	Select main and subordinate configuration pages
	Navigaton list	To directly select a configuration page based on its name
	Buttons *"Previous page"* and *"Next page"*	To go to the previous/next configuration page (as ordered in the list)

Value and status fields

Graphical element	Caption	Description
	Value field	To directly input (alpha)numeric values
	Option field	To select from a preset list of options
	Connection status field	Displays active port and unit connection status

To change the value of a value or option field:

1. Enter the value or select an option from the drop-down list.
2. Press *[Enter]* to confirm.
   ⇨ The new value is written directly to the unit.

Visualization

> *Values displayed by visualization graphical elements cannot be changed.*

Graphical element	Caption	Description
	Status indicator	Displays status [**on**/off]
	Error indicator	Displays error [**on**/off]

Search

To find specific parameters, settings and monitoring values more easily, ToolKit includes a full-text search function.

To find a parameter/setting/monitoring value:

1. Select *"Tools ➔ Search"* from the menu.
   ⇨ The *"Search"* dialog opens.
2. Enter a search term and press *[Enter]*.
   ⇨ The results are displayed in the table.
3. Double-click a table entry to go to the visualization/configuration page that includes this parameter/setting/monitoring value.

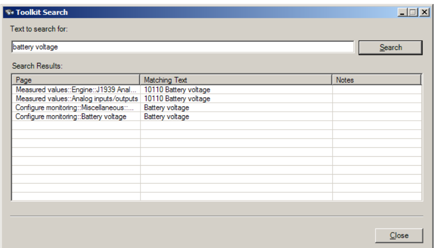


Fig. 54: Search dialog

Value trending

The value trending view can chart up to eight values over time.

To select values for trending screen:

1. Right-click an analog value field on any configuration/visualisation page and select *"Add to trend"* from the context-menu.
2. Select *"Tools ➔ Trending"* from the menu.
   ⇨ The trending screen opens.
3. Click the *"Start"* button to initiate charting.
4. Click the *"Stop"* button to stop charting the values.

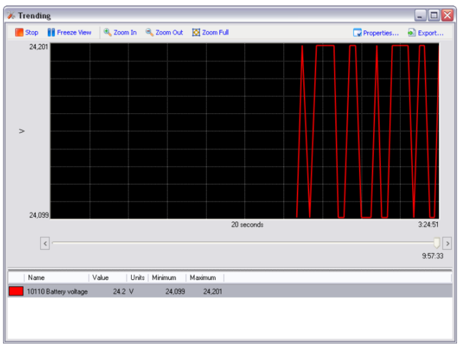
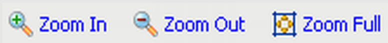


Fig. 55: Trending screen

5. To store the tracked data select *"Export"*

⇨ The tracked data is exported to a `.CSV` (comma separated values) file which can be viewed/edited/analysed in external applications (e.g. MS Excel/OpenOffice.org Calc).

Graphical element	Caption	Description
	*"Start"*	Start value charting
	*"Stop"*	Stop value charting
	Zoom controls	Adjust detail of value chart
	*"Export"*	Export to `.CSV`
	*"Properties"*	Change scale limits, sample rate, time span, colors

6 Application

6.1 General Application

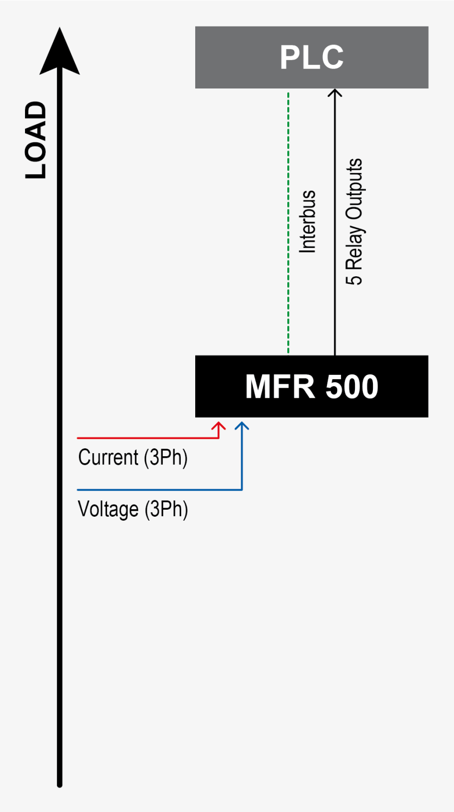


Fig. 56: General application

In this general application the device is used as a transducer with monitoring functions. The control does not operate any breaker.

- PLC measuring data V, f, I, P_{act}, P_{react}
- Monitoring V, f, I, P_{act}, P_{react}

6.2 Generator Application

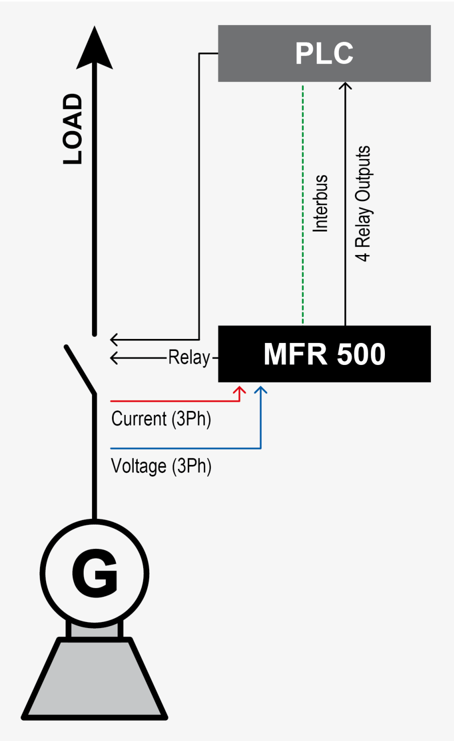


Fig. 57: Generator application

In this generator related application the device is used as a transducer with monitoring functions. The control can be used to open a breaker.

- Generator measuring data V, f, I, P_{act}, P_{react}
- Monitoring V, f, I, P_{act}, P_{react}

6.3 Mains Application

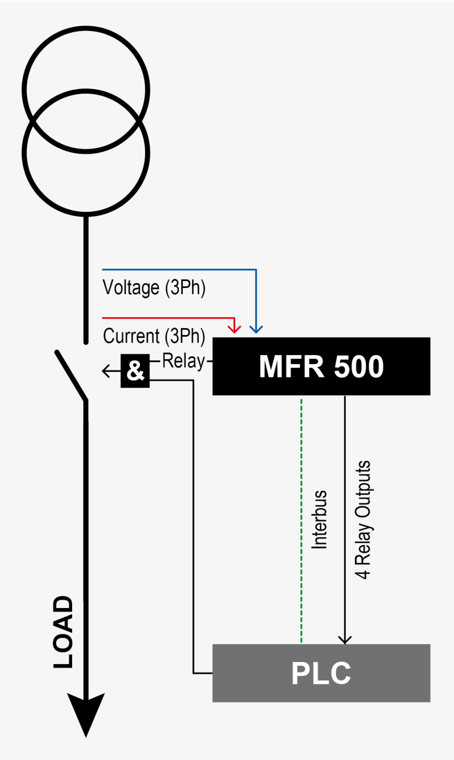


Fig. 58: Mains application

In this mains related application the device is used as a transducer with monitoring functions. The control can be used to open a breaker.

- Mains measuring data V, f, I, P_{act}, P_{react}
- Monitoring V, f, I, P_{act}, P_{react}

7 Interfaces And Protocols

7.1 Interfaces Overview

Interfaces and protocols

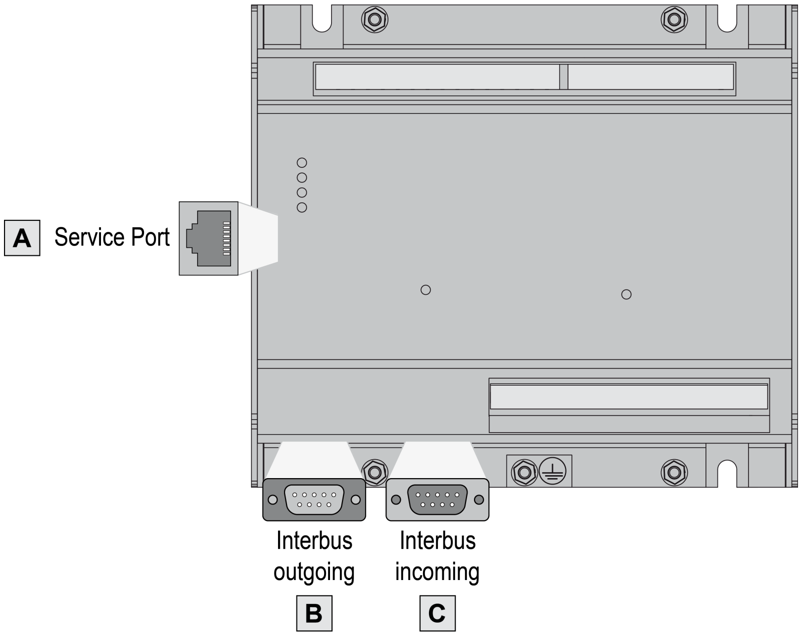


Fig. 59: MFR 500 interfaces

The MFR 500 (Fig. 59) provides the following interfaces, which are supporting different protocols.

Figure	Interface	Protocol
A	Service Port (USB/RS-232)[1]	ToolKit
B	Interbus outgoing	Interbus
C	Interbus incoming	Interbus

[1] Please refer to ✐ Chapter 3.2.8 "Service Port" on page 36.

7.2 Serial Interfaces

7.2.1 Service Port (RS-232/USB)

The Woodward specific service port can be used to extend the interfaces of the controller.

In conjunction with the direct configuration cable the service port allows service access for configuring the unit and visualize measured data.

Fig. 60: Service Port

*[1] The service port can be **only** used in combination with an optional Woodward direct configuration cable (DPC), which includcdes a converter box to provide either an USB or a RS-232 interface.*

– *For additional information refer to ✎ Chapter 3.2.8 "Service Port" on page 36.*

7.3 Interbus Interface

A freely configurable Interbus interface is provided to add PLC connectivity. It is also possible to configure the unit, visualize measured data and alarm messages.

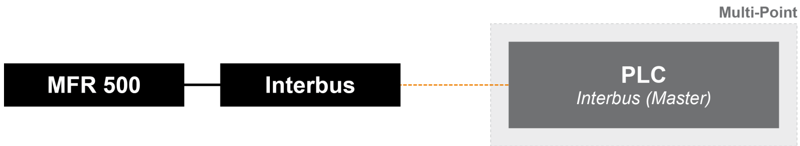


Fig. 61: Interbus interface

7.4 Interbus Protocol

The open Interbus fieldbus system for modern automation seamlessly connects all the I/O and field devices commonly used in control systems. The serial bus cable can be used to network sensors and actuators, to control machine and system parts, to network production cells, and to connect higherlevel systems such as control rooms.

In terms of topology, Interbus is a ring system, i.e., all devices are actively integrated in a closed transmission path. Each device amplifies the incoming signal and sends it on, allowing higher transmission rates at longer distances.

Detailed information about the Interbus protocol is available on the following website:

- *http://www.interbusclub.com*

PCP transmission is not supported by the MFR 500.

Please refer to ✎ Chapter 9.1.1 "Interbus" on page 103 for details.

8 Technical Specifications

8.1 Technical Data

Product label

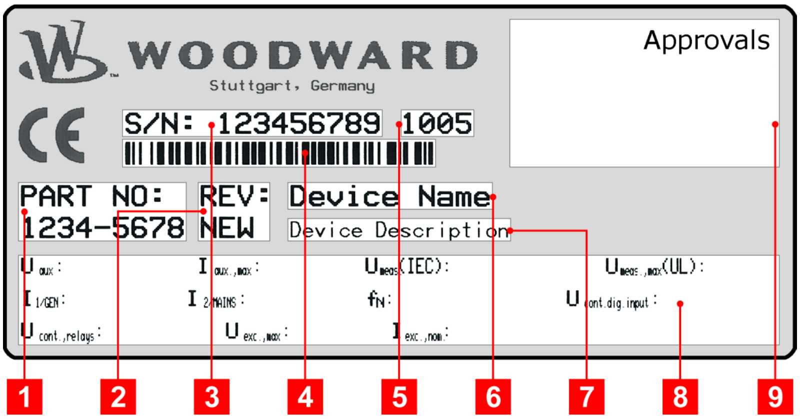


Fig. 62: Product label

1	P/N	Item number
2	REV	Item revision number
3	S/N	Serial number (numerical)
4	S/N	Serial number (barcode)
5	S/N	Date of production (year-month)
6	Type	Description (short)
7	Type	Description (long)
8	Details	Technical data
9	Approval	Approvals

8.1.1 Measuring Values

Voltages

Measuring voltage ⅄ / △	**120 V**	
Rated value (V_{rated})		69/120 Vac
Maximum value (V_{max})		max. 86/150 Vac
Rated voltage phase – ground		150 Vac
Rated surge voltage (V_{surge})		2.5 kV
Measuring voltage ⅄ / △	**690 V**	
Rated value (V_{rated})		400/690 Vac
Maximum value (V_{max})		max. 500/862 Vac
Rated voltage phase – ground		600 Vac
Rated surge voltage (V_{surge})		6.0 kV
Linear measuring range		1.25 × V_{rated}

Measuring frequency		50/60 Hz (45.0 to 65.0 Hz)
Accuracy		Class 0.5
Input resistance per path	**120 V**	0.522 MΩ
	690V	2.0 MΩ
Maximum power consumption per path		< 0.15 W

Currents

Measuring inputs		Isolated
Measuring current	[1] Rated value (I_{rated})	../1 A
	[5] Rated value (I_{rated})	../5 A
Accuracy	Class 0.5	
Linear measuring range		3.0 × I_{rated}
Maximum power consumption per path	< 0.15 VA	
Rated short-time current (1 s)	[1]	50.0 × I_{rated}
	[5]	10.0 × I_{rated}

8.1.2 Ambient Variables

Power supply	12/24 Vdc (8 to 32.0 Vdc)
Intrinsic consumption	max. 5 W
Degree of pollution	2
Maximum elevation	3,000 m ASL
Reverse voltage protection	Fully supply range
Input capacitance	440 uF

8.1.3 Inputs/Outputs

Discrete outputs

Discrete outputs		Potential free
Contact material		AgCdO
General purpose (GP) ($V_{cont, relays}$)	AC	2.00 Aac@250 Vdc
	DC	2.00 Adc@24 Vdc
		0.36 Adc@125 Vdc
		0.18 Adc@250 Vdc
Pilot duty (PD) ($V_{cont, relays}$)	AC	B300
	DC	1.00 Adc@24 Vdc
		0.22 Adc@125 Vdc
		0.10 Adc@250 Vdc

8.1.4 Interface

Service Port interface

Service Port interface	Not isolated
Proprietary interface	Connect only with Woodward DPC cable

Interbus interface

Interbus interface outgoing	Not isolated
Interbus interface incoming	Isolated
Insulation test voltage (≥ 5 s)	1,187 V_{Rms} 50/60 Hz

8.1.5 Housing

Housing type

Type		Custom Sheet metal - Cabinet mounting
Dimensions (W × H × D)		186 × 164 × 41 mm
Wiring	Screw-plug-terminals	2.5 mm²
Recommended locked torque	4 inch pounds / 0.5 Nm Use 60/75 °C copper wire only Use class 1 wire only or equivalent	
Weight		approx. 690 g

Protection

Protection system		IP20

8.1.6 Approvals

EMC test (CE)	Tested according to applicable EN guidelines
Listings	CE marking UL / cUL, Ordinary Locations, File No.: 231544

8.1.7 Generic Note

Accuracy	Referred to full scale value

8.2 Environmental Data

Vibration

Frequency range - sine sweep	5 Hz to 100 Hz
Acceleration	4 G
Standards	EN 60255-21-1 (EN 60068-2-6, Fc)
	Lloyd’s Register, Vibration Test2

Frequency range - random	10 Hz to 500 Hz
Power intensity	0.015 G²/Hz
RMS value	1.04 Grms
Standards	MIL-STD 810F, M514.5A, Cat.4,
	Truck/Trailer tracked-restrained
	Cargo, Fig. 514.5-C1

Shock

Shock	40 G, Saw tooth pulse, 11 ms
Standards	EN 60255-21-2
	MIL-STD 810F, M516.5, Procedure 1

Temperature

Cold, Dry Heat (storage)	-40 °C (-40 °F) / 85 °C (185 °F)
Cold, Dry Heat (operating)	-20 °C (-4 °F) / 70 °C (158 °F)
Standards	IEC 60068-2-2, Test Bb and Bd
	IEC 60068-2-1, Test Ab and Ad

Humidity

Humidity	95 %, not condensing
Standards	IEC 60068-2-30, Test Db

8.3 Accuracy

Measuring value	Range	Accuracy	Measuring start	Notes
Frequency	40.0 to 80.0 Hz	0.1 % (of 80 Hz)	5 % (of PT secondary voltage setting)[1]	
Voltage				
Wye generator / mains / busbar	0 to 650 kV	0.5 % (of 150/600 V)[2]	1.5 % (of PT secondary voltage setting)[1]	
Delta generator / mains / busbar			2 % (of PT secondary voltage setting)[1]	
Current				
Generator	0 to 32,000 A	0.5 % (of 1.3/6.5 A)[3]	1 % (of 1.3/6.5 A)[3]	
Max. value				
Mains/ground current				

Measuring value	Range	Accuracy	Measuring start	Notes
Real power				
Actual total real power value	-2 to 2 GW	1 % (of 150/600 V * 1.3/6.5 A)[2/3]	Measuring starts when voltage is recognized	
Reactive power				
Actual value in L1, L2, L3	-2 to 2 Gvar	1 % (of 150/600 V * 1.3/6.5 A)[2/3]	Measuring starts when voltage is recognized	
Power factor				
Actual value power factor L1	lagging 0.00 to 1.00 to leading 0.00	2 %	2 % (of 1.3/6.5 A)[3]	1.00 is calculated for measuring values below the measuring start
Miscellaneous				
Real energy	0 to 42,000 GWh			Not calibrated
Reactive energy	0 to 42,000 Gvarh			Not calibrated
Phase angle	-180 to 180°		2.00 % (of PT secondary volt. setting)	180° is displayed for measuring values below measuring start

[1] Setting of the parameter for the PT secondary rated voltage

[2] Depending on the used measuring inputs (120/690 V)

[3] Depending on the CT input hardware (1/5 A) of the respective unit

Reference conditions

The reference conditions for measuring the accuracy are listed below.

Input voltage	Sinusoidal rated voltage
Input current	Sinusoidal rated current
Frequency	Rated frequency +/- 2 %
Power supply	Rated voltage +/- 2 %
Power factor (cos φ)	1.00
Ambient temperature	23 °C +/- 2 K
Warm-up period	20 minutes

9 Appendix

9.1 Data Protocols

9.1.1 Interbus

9.1.1.1 Protocol 4550 (Visualization)

This protocol is downward compatible with the Interbus protocol of the Woodward MFR 13 unit. The unit evaluates only byte 1 of each data telegram of the bus master; all other bytes are usually 0 and will be ignored. The bus master uses byte 1 to request a channel number, which again specifies 4 data words, which are to be sent back by the unit. At the moment, the channel numbers 1 through 3 are defined. The number 0 is not used as channel number for security reasons. If the bus master requests a channel with the transmission of byte 1, which is higher than 3 or equal 0, the unit replies 4 data words with the value 0.

Data format

The unit sends reply data telegrams with a length of 4 words to the bus master. A data word consists of 3 bits for a channel number and 13 bits for the payload. The channel number is encoded in the 3 most significant bits of the word and contained in each of the 4 data words of the telegram. *"Data format" Table on page 103* shows the structure of a data word.

Channel number			**Payload**												
Data word n (n = [1 to 4])															
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Data byte m (m = [0 to 6])								**Data byte m+1 (m = [0 to 6])**							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0

Table 18: Data format

Data sent

The following data may be sent by the unit as payload:

- Telegram identifier
- Frequency L1-L2
- Monitoring state 1
- Monitoring state 2
- Voltage L1-L2
- Voltage L2-L3
- Voltage L3-L1
- Current L1
- Current L2
- Current L3
- Active load
- Reactive load

There are 3 channels, each with 4 data words, defined (= 12 different data). The data words are assigned to the channel number as shown in *"Channel assignment" Table on page 104*.

	Payload of data words (channel number 1 to 3)			
Channel number	Data word 1	Data word 2	Data word 3	Data word 4
	Byte (0,1)	Byte (2,3)	Byte (4,5)	Byte (6,7)
1	Telegram identifier (always 4550 [dec])	Frequency L1-L2	Monitoring state 1	Monitoring state 2
2	Voltage L1-L2	Voltage L2-L3	Voltage L3 -L1	Current L1
3	Current L2	Current L3	Active power (signed)	Reactive power (signed)

Table 19: Channel assignment

Each data word has 13 bits available for payload. This enables to represent the unsigned integers 0 to 8,191 and the signed integers (two's complement) –4,096 to 4,095. The usage of these 13 bits differs for different data types and is described in the following section.

Telegram identifier

The telegram identifier is transmitted in channel 1, data word 1 as integer. The telegram identifier is a fix value.

- Value = 4550 [dec] = 11C6 [hex] = 1000111000110 [bin]

Frequency

The frequency values are transmitted in channel 1, data word 2.

Resolution	0.015625 Hz per bit step	
Sign	Unsigned	
Range	0.00 Hz to 127.98 Hz	(↔ 0 to 8,191)

Monitoring state

The bitwise encoded states of six different monitoring functions are contained in the data words 3 (monitoring state 1) and 4 (monitoring state 2) of channel 1. Bit 12 is not used and always 0. 12 bits are available for six monitoring functions, i.e. 2 bits per monitoring function. *"Data format" Table on page 104* shows the structure of a monitoring state data word.

Data word 3 or 4 (channel 1)															
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Data byte m								**Data byte m+1**							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0

Data word 3 or 4 (channel 1)															
0	0	1	0	b_1	b_0	b_1	b_0	b_1	b_0	b_1	b_0	b_1	b_0	b_1	b_0
Channel number (= 1)			---	Monitoring function		Monitoring function		Monitoring function		Monitoring function		Monitoring function		Monitoring function	

Table 20: Data format

- *b_1 = 0 and b_0 = 1 ↔ Monitoring function has **NOT tripped**.*
- *b_1 = 1 and b_0 = 0 ↔ Monitoring function has **tripped**.*

"Monitoring state 1" Table on page 105 shows the monitoring functions contained in data word 3 of channel 1 (monitoring state 1).

Monitoring functions in data word 3 (channel 1)											
Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Data byte 4						**Data byte 5**					
3	2	1	0	7	6	5	4	3	2	1	0
Time-dependent undervoltage 2		Time-dependent undervoltage 1		Overfrequency level 2		Underfrequency level 2		Overvoltage level 2		Undervoltage level 2	

Table 21: Monitoring state 1

"Monitoring state 2" Table on page 105 shows the monitoring functions contained in data word 4 of channel 1 (monitoring state 2).

Monitoring functions in data word 4 (channel 1)											
Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Data byte 6						**Data byte 7**					
3	2	1	0	7	6	5	4	3	2	1	0
Voltage assymmetry		Phase shift		Overfrequency level 1		Underfrequency level 1		Overvoltage level 1		Undervoltage level 1	

Table 22: Monitoring state 2

Voltage

The voltage values are transmitted in channel 2, data words 1, 2, and 3.

Resolution	0.2 V per bit step	
Sign	Unsigned	
Range	0.0 V to 1,638.2 V	(↔ 0 to 8,191)

Current

The current values are transmitted in channel 2, data word 4, and channel 3, data words 1 and 2.

Resolution	2 A per bit step	
Sign	Unsigned	
Range	0 A to 16,382 A	(↔ 0 to 8,191)

Power

The power values are transmitted in channel 3, data words 3 and 4.

Resolution	1 kW or 1 kvar per bit step	
Sign	Signed (bit 12 is a sign bit, negative values as two's complement)	
Range	-4,096 kW to 4,095 kW	(↔ –4,096 to 4,095)
	-4,096 kvar to 4,095 kvar	

9.1.1.2 Protocol 4560 (Visualization And Configuration)

9.1.1.2.1 Data Format

General notes

"General command telegram" Table on page 106 shows the data format of a command telegram, which is sent cyclically by the Interbus master.

Word 1		Word 2		Word 3		Word 4	
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0	Chan-nel	X	X	X	X	0	0

Table 23: General command telegram

The channel defines the type of the expected answer telegram. The units sends an answer message immediately (in the next Interbus cycle). It is necessary that an answer message contains a reference to the command telegram (the channel), to which it replies to, in its data content for reasons of safety and data consistency.

Depending on the channel transmitted in the command telegram, this reference appears in two different ways.

Answer replying (channels 0 to 7)

The highest bits in each word (corresponding with the highest bits in byte 0, 2, 4, 6) are used to identify the telegram here. They inform about the command telegram to which this answer telegram is replying.

Word 1 (1+15 bit)		Word 2 (1+15 bit)		Word 3 (1+15 bit)		Word 4 (1+15 bit)	
Byte 0 (1+7 bit)	Byte 1	Byte 2 (1+7 bit)	Byte 3	Byte 0 (1+7 bit)	Byte 1	Byte 2 (1+7 bit)	Byte 3

Table 24: Answer replying (channels 0 to 7)

"Channel identification" Table on page 107 shows how the channel is identified in the answer telegram if the highest bit in word 1 is K1, the highest bit in word 2 is K2 and so on. Please note, that K1 is always 0 here. This is used to identify this group of answer messages. If the highest bit of byte 0 is set to 0, the answer refers to the channels 0 to 7.

Channel	K1	K2	K3	K4	Comment
0	0	0	0	0	Not used
1	0	0	0	1	
2	0	0	1	0	
3	0	0	1	1	
4	0	1	0	0	
5	0	1	0	1	
6	0	1	1	0	Not used
7	0	1	1	1	Not used

Table 25: Channel identification

Answer replying (channels 8 to 127)

The first byte (byte 0) of the answer telegram contains the reference to the command telegram here. The highest bit is always set, allowing to distinguish this group of answer messages from the answers to channel 0 through 7.

Word 1		Word 2		Word 3		Word 4	
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x80 + channel							

Table 26: Answer replying (channels 8 to 127)

Channel 1 - predefined telegram 1

"Command message - channel 1" Table on page 108 shows the data format of a command telegram, which requests the predefined telegram 1 from the unit. The bytes marked with an "X" have no importance.

Word 1		Word 2		Word 3		Word 4	
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
X	1	X	X	X	X	X	X

Table 27: Command message - channel 1

“Answer telegram - channel 1” Table on page 108 shows the answer telegram with the predefined telegram 1 from the unit. Refer to the signal table section for detailed information about the transmitted values.

Word 1 (lower 15 bits)	Word 2 (lower 15 bits)	Word 3 (lower 15 bits)	Word 4 (lower 15 bits)
Signal number 0	Signal number 1	Signal number 2	Signal number 3
Protocol number	Voltage L1-L2	Voltage L2-L3	Voltage L3-L1

Table 28: Answer telegram - channel 1

Channel 2 - predefined telegram 2

“Command message - channel 2” Table on page 108 shows the data format of a command telegram, which requests the predefined telegram 2 from the unit. The bytes marked with an "X" have no importance.

Word 1		Word 2		Word 3		Word 4	
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
X	2	X	X	X	X	X	X

Table 29: Command message - channel 2

“Answer telegram - channel 2” Table on page 108 shows the answer telegram with the predefined telegram 2 from the unit. Refer to the signal table section for detailed information about the transmitted values.

Word 1 (lower 15 bits)	Word 2 (lower 15 bits)	Word 3 (lower 15 bits)	Word 4 (lower 15 bits)
Signal number 60	Signal number 13	Signal number 14	Signal number 15
Error flags 1	Current L1	Current L2	Current L3

Table 30: Answer telegram - channel 2

Channel 3 - predefined telegram 3

“Command message - channel 3” Table on page 109 shows the data format of a command telegram, which requests the predefined telegram 3 from the unit. The bytes marked with an "X" have no importance.

Word 1		Word 2		Word 3		Word 4	
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
X	3	X	X	X	X	X	X

Table 31: Command message - channel 3

"Answer telegram - channel 3" Table on page 109 shows the answer telegram with the predefined telegram 3 from the unit. Refer to the signal table section for detailed information about the transmitted values.

Word 1 (lower 15 bits)	Word 2 (lower 15 bits)	Word 3 (lower 15 bits)	Word 4 (lower 15 bits)
Signal number 61	Signal number 22	Signal number 26	Signal number 39
Error flags 2	Active power L123	Reactive power L123	Frequency

Table 32: Answer telegram - channel 3

Channel 4 - reading out selectable data

"Command message - channel 4" Table on page 109 shows the data format of a command telegram, which requests two freely selectable values from the unit using channel 4. Signal number A and signal number B may be selected from the available signals. The bytes marked with an "X" have no importance.

Word 1		Word 2		Word 3		Word 4	
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
X	4	X	Signal number A	X	Signal number B	X	X

Table 33: Command message - channel 4

"Answer telegram - channel 4" Table on page 109 shows the answer telegram with the two selected values from the unit. Refer to the signal table section for detailed information about the transmitted values.

Word 1 (lower 15 bits)		Word 2 (lower 15 bits)		Word 3 (lower 15 bits)		Word 4 (lower 15 bits)	
Byte 0 (lower 7 bits)	Byte 1	Byte 2 (lower 7 bits)	Byte 3	Byte 4 (lower 7 bits)	Byte 5	Byte 6 (lower 7 bits)	Byte 7
0	Signal number A	Signal A		0	Signal number B	Signal B	

Table 34: Answer telegram - channel 4

The signal number repeats the identifier from the command telegram. The signal is a 15 bit value [0 to 32,767].

Channel 5 - reset value in signal table

"Command message - channel 5" Table on page 110 shows the data format of a command telegram, which requests to reset a selected measured value using channel 5. The signal number may be selected from the available signals. The bytes marked with an "X" have no importance.

Word 1		Word 2		Word 3		Word 4	
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
X	5	X	Signal number	X	X	X	X

Table 35: Command message - channel 5

"Answer telegram - channel 5" Table on page 110 shows the answer telegram.

Word 1 (lower 15 bits)		Word 2 (lower 15 bits)		Word 3 (lower 15 bits)		Word 4 (lower 15 bits)	
Byte 0 (lower 7 bits)	Byte 1	Byte 2 (lower 7 bits)	Byte 3	Byte 4 (lower 7 bits)	Byte 5	Byte 6 (lower 7 bits)	Byte 7
0	Signal number	0	0	0	0	0	0

Table 36: Answer telegram - channel 5

The signal number repeats the identifier from the command telegram. The command has only effect on signals marked as resetable. For other signals it has no effect.

Channel 8 - write integer values

"Command message - channel 8" Table on page 110 shows the data format of a command telegram, which requests to write an integer value to a parameter using channel 8. The parameter identification number (ID) is a unique index for the parameter to be written and described in the parameter list. 16 bit values are only written to the low data word. 32 bit values are written to the low data word (low 16 bit of the value) and high data word (high 16 bit of the value). The bytes marked with an "X" have no importance. Negative values need to be written in two's complement format.

Word 1		Word 2		Word 3		Word 4	
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
X	8	Parameter ID of the value to be written		High data word to be written (only for 32 bit values)		Low data word to be written	

Table 37: Command message - channel 8

"Answer telegram - channel 8" Table on page 111 shows the answer telegram with the confirmation of the write command.

Word 1		Word 2		Word 3		Word 4	
Byte 0	Byte 1	Byte 2	Byte 3	Byte 0	Byte 1	Byte 2	Byte 3
0x88	Busy	Parameter ID		0		0	

Table 38: Answer telegram - channel 8

If "Busy" is not equal 0, the system is busy at the moment with a previous write command and was not able to process the write command.

The parameter ID repeats word 2 of the command telegram. If an Interbus master tries to write a parameter, the following errors may occur:

- The system is busy with a previous write command: if this happens, the system sets the "Busy" byte of the answer telegram to a value not equal 0.
- The value to be written is either too low or too high: if this happens, the system will set the "Parameter access failed" flag in the first error register.
- The parameter ID was invalid or was not permitted to be written: if this happens, the system will set a "Parameter access failed" flag in the first error register.

Channel 9 - read integer values

"Command message - channel 9" Table on page 111 shows the data format of a command telegram, which requests to read an integer value from a parameter using channel 9. The parameter ID is a unique index for the parameter to be read. The bytes marked with an "X" have no importance.

Word 1		Word 2		Word 3		Word 4	
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
X	9	Parameter ID of the value to be read		X		X	

Table 39: Command message - channel 9

"Answer telegram - channel 9" Table on page 111 shows the answer telegram with the read value.

Word 1		Word 2		Word 3		Word 4	
Byte 0	Byte 1	Byte 2	Byte 3	Byte 0	Byte 1	Byte 2	Byte 3
0x89	Error	Parameter ID		High data word		Low data word	

Table 40: Answer telegram - channel 9

If "Error" is not equal 0, this parameter ID does not exist. The parameter ID repeats word 2 of the command telegram. High data word are the high 16 bits of a 32 bit value as two's complement. Low data word are the low 16 bits of a 32 bit value or a 16 bit value as two's complement.

If an Interbus master tries to read a parameter, the following errors may occur:

- The parameter ID was invalid or was not permitted to be written: if this happens, the system will set the "Error" byte of the answer telegram to a value not equal 0 and the "Parameter access failed" flag in the first error register.

9.1.1.2.2 Signal Table

General notes

The signal table (*“Signal table” Table on page 112*) lists each data point, which is accessible via Interbus channels 1 to 5. Each one has an individual address, called a "Signal number". Interbus commands (channel 4 and channel 5) refer to this signal number when accessing the data.

The "Range" describes the maximum permissible unscaled value. The actual value transmitted via Interbus is only 16 bit. Therefore, an appropriate scaling has to be performed before. The system does not cut off values, which exceed the range. Therefore, higher values may be transmitted, but they shall not be considered as valid.

Signal number	Name	Range	Unit	Scaleable	Reset-table	Comment
0	Interbus protocol number					Fixed to 4560
1	Voltage L1-L2	0 to 420000	V	Yes		Can be filtered
2	Voltage L2-L3	0 to 420000	V	Yes		
3	Voltage L3-L1	0 to 420000	V	Yes		
4	Voltage L-L average	0 to 420000	V	Yes		
5	Voltage L-L minimum	0 to 420000	V	Yes	R[1]	Slave pointer
6	Voltage L-L maximum	0 to 420000	V	Yes		
7	Voltage L1-N	0 to 250000	V	Yes		
8	Voltage L2-N	0 to 250000	V	Yes		
9	Voltage L3-N	0 to 250000	V	Yes		
10	Voltage L123-N average	0 to 250000	V	Yes		
11	Voltage L123-N minimum	0 to 250000	V	Yes	R[1]	Slave pointer
12	Voltage L123-N maximum	0 to 250000	V	Yes		
13	Current L1	-10000 to 10000	A	Yes		Can be filtered
14	Current L2	-10000 to 10000	A	Yes		
15	Current L3	-10000 to 10000	A	Yes		
16	Current L123 average	-10000 to 10000	A	Yes		
17	Current L123 minimum	-10000 to 10000	A	Yes	R[1]	Slave pointer
18	Current L123 maximum	-10000 to 10000	A	Yes		
19	Active power L1	-70000 to 70000	kW	Yes		
20	Active power L2	-70000 to 70000	kW	Yes		
21	Active power L3	-70000 to 70000	kW	Yes		
22	Active power L123	-200000 to 200000	kW	Yes		

Signal number	Name	Range	Unit	Scaleable	Reset-table	Comment
23	Reactive power L1	-70000 to 70000	kvar	Yes		
24	Reactive power L2	-70000 to 70000	kvar	Yes		
25	Reactive power L3	-70000 to 70000	kvar	Yes		
26	Reactive power L123	-200000 to 200000	kvar	Yes		
27	Apparent power L1	0 to 85000	kVA	---		
28	Apparent power L2	0 to 85000	kVA	---		
29	Apparent power L3	0 to 85000	kVA	---		
30	Apparent power L123	0 to 250000	kVA	---		
31	Power factor L1	-0.5 to 1.0 to 0.5		---		-0.5 → -0.9 → 1.0 → 0.9 → 0.5
32	Power factor L2	-0.5 to 1.0 to 0.5		---		
33	Power factor L3	-0.5 to 1.0 to 0.5		---		
34	Power factor L123	-0.5 to 1.0 to 0.5		---		
35	Phase angle L1	-50 to 50	°	---		
36	Phase angle L2	-50 to 50	°	---		
37	Phase angle L3	-50 to 50	°	---		
38	Phase angle L123	-50 to 50	°	---		
39	Frequency	40 to 70	Hz	---		Can be filtered
40 to 59	reserved					Return 0 and set an error flag.
60	Error flags 1				R[1]	A set of 15 error flags. Some of them are resettable. Detailed descriptions are in a separate table.
61	Error flags 2					A set of 15 error flags. Detailed descriptions are in a separate table.
62	Error flags 3					A set of 15 error flags. Detailed descriptions are in a separate table.
63 to 255	reserved					Return 0 and set an error flag.

Table 41: Signal table

[1] Each signal indicated as resettable will be reset by a channel 5 command. The slave pointers indicate the smallest or largest, respectively, average value encountered so far and can be reset to the corresponding average value.

9.1.1.2.3 Error Flags

General notes

The system has three sets of error flags which describe AC monitoring results and internal alarms.

Error flags 1

"Error flags 1" Table on page 114 lists the error flags 1. These flags consist of internal Interbus flags, which are set, if the respective Interbus error has occurred, and monitoring flags, which are set, if the respective monitoring function has triggered. These flags can be read using the predefined telegram 2 on channel 2. If the error flags 1 are reset using channel 5, all flags, which can be reset, will be reset.

Bit	Name	Comment
0		
1	Wrong scaling	A scaled value was requested and one of the following problems occurred: ■ Value < maximum scale value ■ Value > maximum scale value ■ Minimum scale value ≥ maximum scale value This bit can be reset via Interbus.
2	Signal not used	There was an attempt to access an empty element in the signal table. This bit can be reset via Interbus.
3	Measurement invalid	The measured AC delta voltage is smaller than 5 % of the configured primary transformer value.
4	No write access	There was an attempt to write/reset an element in the signal table which has no write access. This bit can be reset via Interbus.
5	Data set inconsistent	The current dataset is not consistent
6	Parameter access failed	Will be set, if: ■ There was a write attempt via channel 8 and the parameter does not exist or is not permitted to be written. ■ There was a read attempt via channel 9 and the parameter does not exist or is not permitted to be read This bit can be reset via Interbus.
7	Voltage asymmetry threshold 2	
8	QV monitoring step 1	
9	QV monitoring step 2	
10	Voltage increase	
11	Overfrequency threshold 1	
12	Overfrequency threshold 2	
13	Underfrequency threshold 1	
14	Underfrequency threshold 2	
15	---	This bit can not be used.

Table 42: Error flags 1

Error flags 2

"Error flags 2" Table on page 115 lists the error flags 2. These flags consist of monitoring flags, which are set, if the respective monitoring function has triggered. These flags can be read using the predefined telegram 3 on channel 3.

Bit	Name	Comment
0	Overvoltage threshold 1	
1	Overvoltage threshold 2	
2	Undervoltage threshold 1	
3	Undervoltage threshold 2	
4	Negative load threshold 1	
5	Negative load threshold 2	
6	Positive load threshold 1	
7	Positive load threshold 2	
8	Unbalanced load threshold 1	
9	Unbalanced load threshold 2	
10	Voltage asymmetry threshold 1	
11	Phase shift	
12	df/dt	
13	Time-dependent undervoltage 1	
14	Time-dependent undervoltage 2	
15	---	This bit can not be used.

Table 43: Error flags 2

Error flags 3

"Error flags 3" on page 115 lists the error flags 3. These flags consist of monitoring flags, which are set, if the respective monitoring function has triggered.

Bit	Name	Comment
0	Overcurrent threshold 1	
1	Overcurrent threshold 2	
2	Overcurrent threshold 3	
3	Ground fault threshold 1	
4	Ground fault threshold 2	
5	Time-dependent undervoltage 3	
6	Time-dependent undervoltage 4	
7		
8		
9		

Bit	Name	Comment
10		
11		
12		
13		
14		
15	---	This bit can not be used.

Table 44: Error flags 2

9.1.1.2.4 Parameter List

General notes

The following lists contain all permitted parameters with their unique ID. These parameters are described in detail in the *Chapter 4 "Configuration" on page 39*.

The parameters have different data types. They are described as follows.

Data type	Description
Uint16	Unsigned 16 bit value with a maximum range of 0 to 65,535
Int16	Signed two's complement 16 bit integer with a maximum range of –32,768 to 32,768
Uint32	Unsigned 32 bit value with a maximum range of 0 to 429,496,729
Int32	Signed two's complement 32 bit integer with a maximum range of –2,147,483,648 to 2,147,483,647
Enum	Enumeration based selection, which is handled as a 16 bit unsigned value; the selectable settings are enumerated starting with zero

Examples

- Parameter ID 1750, Rated system frequency, with "Enum" data type has two selectable settings, 0, which corresponds with a setting of 50 Hz, and 1, which corresponds with a setting of 60 Hz.
- Parameter ID 1752, Rated active power, with "Uint32" data type can be configured from 0.5 to 99,999.9 A, where a value of 2,350 corresponds with 235.0 A for example.

Configuration Parameter

Measurement

ID	Data type	Comment
1750	Enum	Please refer to parameter 1750 p. 40 for details. Setting: 0 [50 Hz]; 1 [60 Hz]
1766	Uint32	Please refer to parameter 1766 p. 40 for details.
1754	Uint16	Please refer to parameter 1754 p. 40 for details.
1752	Uint32	Please refer to parameter 1752 p. 40 for details.

ID	Data type	Comment
1850	Enum	Please refer to parameter 1850 ➜ p. 40 for details. Setting: 0 [L1L2L3]; 1 [L1]; 2 [L2]; 3 [L3]
1851	Enum	Please refer to parameter 1851 ➜ p. 41 for details. Setting: 0 [3Ph 4W]; 1 [3Ph 3W]; 2 [1Ph 2W]; 3 [1Ph 3W]
3954	Enum	Please refer to parameter 3954 ➜ p. 41 for details. Setting: 0 [CW]; 1 [CCW]
1858	Enum	Please refer to parameter 1858 ➜ p. 42 for details. Setting: 0 [Phase-neutral], 1 [Phase-phase]
1859	Enum	Please refer to parameter 1859 ➜ p. 42 for details. Setting: 0 [CW]; 1 [CCW]
1770	Enum	Please refer to parameter 1770 ➜ p. 42 for details. Setting: 0 [Phase-neutral], 1 [Phase-phase]; 2 [All]
1788	Enum	Please refer to parameter 1788 ➜ p. 42 for details. Setting: 0 [No]; 1 [Yes]
1801	Uint32	Please refer to parameter 1801 ➜ p. 42 for details.
1800	Uint16	Please refer to parameter 1800 ➜ p. 43 for details.
1806	Uint16	Please refer to parameter 1806 ➜ p. 43 for details.

Table 45: Measurement

Counters

ID	Data type	Comment
2515	Uint32	Please refer to parameter 2515 ➜ p. 44 for details.
2510	Enum	Please refer to parameter 2510 ➜ p. 44 for details. Setting: 0 [No]; 1 [Yes]
2512	Enum	Please refer to parameter 2512 ➜ p. 44 for details. Setting: 0 [No]; 1 [Yes]
2511	Enum	Please refer to parameter 2511 ➜ p. 44 for details. Setting: 0 [No]; 1 [Yes]
2513	Enum	Please refer to parameter 2513 ➜ p. 45 for details. Setting: 0 [No]; 1 [Yes]

Table 46: Counters

Frequency monitoring

ID	Data type	Comment
Overfrequency level 1		
1900	Enum	Please refer to parameter 1900 ➜ p. 50 for details. Setting: 0 [Off]; 1 [On]
1904	Uint16	Please refer to parameter 1904 ➜ p. 51 for details.

ID	Data type	Comment
1905	Uint16	Please refer to parameter 1905 ↳ p. 51 for details.
1901	Enum	Please refer to parameter 1901 ↳ p. 51 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]
Overfrequency level 2		
1906	Enum	Please refer to parameter 1906 ↳ p. 50 for details. Setting: 0 [Off]; 1 [On]
1910	Uint16	Please refer to parameter 1910 ↳ p. 51 for details.
1911	Uint16	Please refer to parameter 1911 ↳ p. 51 for details.
1907	Enum	Please refer to parameter 1907 ↳ p. 51 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]
Underfrequency level 1		
1950	Enum	Please refer to parameter 1950 ↳ p. 52 for details. Setting: 0 [Off]; 1 [On]
1954	Uint16	Please refer to parameter 1954 ↳ p. 53 for details.
1955	Uint16	Please refer to parameter 1955 ↳ p. 53 for details.
1951	Enum	Please refer to parameter 1951 ↳ p. 53 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]
Underfrequency level 2		
1956	Enum	Please refer to parameter 1956 ↳ p. 52 for details. Setting: 0 [Off]; 1 [On]
1960	Uint16	Please refer to parameter 1960 ↳ p. 53 for details.
1961	Uint16	Please refer to parameter 1961 ↳ p. 53 for details.
1957	Enum	Please refer to parameter 1957 ↳ p. 53 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]

Table 47: Frequency monitoring

Voltage monitoring

ID	Data type	Comment
Overvoltage level 1		
2000	Enum	Please refer to parameter 2000 ↳ p. 47 for details. Setting: 0 [Off]; 1 [On]
2014	Enum	Please refer to parameter 2014 ↳ p. 47 for details. Setting: 0 [Off]; 1 [On]
2004	Uint16	Please refer to parameter 2004 ↳ p. 47 for details.
2005	Uint16	Please refer to parameter 2005 ↳ p. 47 for details.

ID	Data type	Comment
2001	Enum	Please refer to parameter 2001 ↳ p. 47 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]
Overvoltage level 2		
2006	Enum	Please refer to parameter 2006 ↳ p. 47 for details. Setting: 0 [Off]; 1 [On]
2015	Enum	Please refer to parameter 2015 ↳ p. 47 for details. Setting: 0 [Off]; 1 [On]
2010	Uint16	Please refer to parameter 2010 ↳ p. 47 for details.
2011	Uint16	Please refer to parameter 2011 ↳ p. 47 for details.
2007	Enum	Please refer to parameter 2007 ↳ p. 47 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]
Undervoltage level 1		
2050	Enum	Please refer to parameter 2050 ↳ p. 49 for details. Setting: 0 [Off]; 1 [On]
2064	Enum	Please refer to parameter 2064 ↳ p. 49 for details. Setting: 0 [Off]; 1 [On]
2054	Uint16	Please refer to parameter 2054 ↳ p. 49 for details.
2055	Uint16	Please refer to parameter 2055 ↳ p. 49 for details.
2051	Enum	Please refer to parameter 2051 ↳ p. 49 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]
Undervoltage level 2		
2056	Enum	Please refer to parameter 2056 ↳ p. 49 for details. Setting: 0 [Off]; 1 [On]
2065	Enum	Please refer to parameter 2065 ↳ p. 49 for details. Setting: 0 [Off]; 1 [On]
2060	Uint16	Please refer to parameter 2060 ↳ p. 49 for details.
2061	Uint16	Please refer to parameter 2061 ↳ p. 49 for details.
2057	Enum	Please refer to parameter 2057 ↳ p. 49 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]

Table 48: Voltage monitoring

Voltage asymmetry and unbalanced load monitoring

ID	Data type	Comment
Unbalanced load level 1		
2400	Enum	Please refer to parameter 2400 ↳ p. 58 for details. Setting: 0 [Off]; 1 [On]

ID	Data type	Comment
2404	Uint16	Please refer to parameter 2404 ↳ p. 59 for details.
2405	Uint16	Please refer to parameter 2405 ↳ p. 59 for details.
2401	Enum	Please refer to parameter 2401 ↳ p. 59 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]
Unbalanced load level 2		
2406	Enum	Please refer to parameter 2406 ↳ p. 58 for details. Setting: 0 [Off]; 1 [On]
2410	Uint16	Please refer to parameter 2410 ↳ p. 59 for details.
2411	Uint16	Please refer to parameter 2411 ↳ p. 59 for details.
2407	Enum	Please refer to parameter 2407 ↳ p. 59 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]
Voltage asymmetry level 1		
3900	Enum	Please refer to parameter 3900 ↳ p. 60 for details. Setting: 0 [Off]; 1 [On]
3903	Uint16	Please refer to parameter 3903 ↳ p. 61 for details.
3904	Uint16	Please refer to parameter 3904 ↳ p. 61 for details.
3901	Enum	Please refer to parameter 3901 ↳ p. 61 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]
Voltage asymmetry level 2		
3931	Enum	Please refer to parameter 3931 ↳ p. 60 for details. Setting: 0 [Off]; 1 [On]
3934	Uint16	Please refer to parameter 3934 ↳ p. 61 for details.
3935	Uint16	Please refer to parameter 3935 ↳ p. 61 for details.
3932	Enum	Please refer to parameter 3932 ↳ p. 61 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]

Table 49: Voltage asymmetry and unbalanced load monitoring

Load monitoring

ID	Data type	Comment
Negative load level 1		
2250	Enum	Please refer to parameter 2250 ↳ p. 56 for details. Setting: 0 [Off]; 1 [On]
2254	Uint16	Please refer to parameter 2254 ↳ p. 56 for details.
2255	Uint16	Please refer to parameter 2255 ↳ p. 57 for details.

ID	Data type	Comment
2251	Enum	Please refer to parameter 2251 ↳ p. 57 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]
Negative load level 2		
2256	Enum	Please refer to parameter 2256 ↳ p. 56 for details. Setting: 0 [Off]; 1 [On]
2260	Uint16	Please refer to parameter 2260 ↳ p. 56 for details.
2261	Uint16	Please refer to parameter 2261 ↳ p. 57 for details.
2257	Enum	Please refer to parameter 2257 ↳ p. 57 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]
Positive load level 1		
2300	Enum	Please refer to parameter 2300 ↳ p. 54 for details. Setting: 0 [Off]; 1 [On]
2304	Uint16	Please refer to parameter 2304 ↳ p. 54 for details.
2305	Uint16	Please refer to parameter 2305 ↳ p. 55 for details.
2301	Enum	Please refer to parameter 2301 ↳ p. 55 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]
Positive load level 2		
2306	Enum	Please refer to parameter 2306 ↳ p. 54 for details. Setting: 0 [Off]; 1 [On]
2310	Uint16	Please refer to parameter 2310 ↳ p. 54 for details.
2311	Uint16	Please refer to parameter 2311 ↳ p. 55 for details.
2307	Enum	Please refer to parameter 2307 ↳ p. 55 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]

Table 50: Load monitoring

Phase shift monitoring

ID	Data type	Comment
3050	Enum	Please refer to parameter 3050 ↳ p. 62 for details. Setting: 0 [Off]; 1 [On]
3053	Enum	Please refer to parameter 3053 ↳ p. 62 for details. Setting: 0 [3-phase]; 1 [1- and 3-phase]
3054	Uint16	Please refer to parameter 3054 ↳ p. 62 for details.

ID	Data type	Comment
3055	Uint16	Please refer to parameter 3055 ↳ p. 62 for details.
3051	Enum	Please refer to parameter 3051 ↳ p. 62 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]

Table 51: Phase shift monitoring

df/dt (ROCOF) monitoring

ID	Data type	Comment
3100	Enum	Please refer to parameter 3100 ↳ p. 63 for details. Setting: 0 [Off]; 1 [On]
3104	Uint16	Please refer to parameter 3104 ↳ p. 63 for details.
3105	Uint16	Please refer to parameter 3105 ↳ p. 63 for details.
3101	Enum	Please refer to parameter 3101 ↳ p. 63 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]

Table 52: df/dt (ROCOF) monitoring

Time-dependent voltage monitoring 1

ID	Data type	Comment
4950	Enum	Please refer to parameter 4950 ↳ p. 72 for details. Setting: 0 [Off]; 1 [On]
4953	Enum	Please refer to parameter 4953 ↳ p. 72 for details. Setting: 0 [Overrun]; 1 [Underrun]
4952	Enum	Please refer to parameter 4952 ↳ p. 72 for details. Setting: 0 [Off]; 1 [On]
4951	Enum	Please refer to parameter 4951 ↳ p. 73 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]
4970	Uint16	Please refer to parameter 4970 ↳ p. 72 for details.
4978	Uint16	Please refer to parameter 4978 ↳ p. 73 for details.
4968	Uint16	Please refer to parameter 4968 ↳ p. 73 for details.
4961	Uint16	Please refer to parameter 4961 ↳ p. 73 for details.
4971	Uint16	Please refer to parameter 4971 ↳ p. 73 for details.
4962	Uint16	Please refer to parameter 4962 ↳ p. 73 for details.
4972	Uint16	Please refer to parameter 4972 ↳ p. 73 for details.
4963	Uint16	Please refer to parameter 4963 ↳ p. 73 for details.
4973	Uint16	Please refer to parameter 4973 ↳ p. 73 for details.
4964	Uint16	Please refer to parameter 4964 ↳ p. 73 for details.
4974	Uint16	Please refer to parameter 4974 ↳ p. 73 for details.

ID	Data type	Comment
4965	Uint16	Please refer to parameter 4965 ⇘ p. 73 for details.
4975	Uint16	Please refer to parameter 4975 ⇘ p. 73 for details.
4966	Uint16	Please refer to parameter 4966 ⇘ p. 73 for details.
4976	Uint16	Please refer to parameter 4976 ⇘ p. 73 for details.
4967	Uint16	Please refer to parameter 4967 ⇘ p. 73 for details.
4977	Uint16	Please refer to parameter 4977 ⇘ p. 73 for details.

Table 53: Time-dependent voltage monitoring 1

Time-dependent voltage monitoring 2

ID	Data type	Comment
4954	Enum	Please refer to parameter 4954 ⇘ p. 74 for details. Setting: 0 [Off]; 1 [On]
4957	Enum	Please refer to parameter 4957 ⇘ p. 75 for details. Setting: 0 [Overrun]; 1 [Underrun]
4956	Enum	Please refer to parameter 4956 ⇘ p. 74 for details. Setting: 0 [Off]; 1 [On]
4955	Enum	Please refer to parameter 4955 ⇘ p. 75 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]
4990	Uint16	Please refer to parameter 4990 ⇘ p. 75 for details.
4998	Uint16	Please refer to parameter 4998 ⇘ p. 75 for details.
4988	Uint16	Please refer to parameter 4988 ⇘ p. 75 for details.
4981	Uint16	Please refer to parameter 4981 ⇘ p. 75 for details.
4991	Uint16	Please refer to parameter 4991 ⇘ p. 75 for details.
4982	Uint16	Please refer to parameter 4982 ⇘ p. 75 for details.
4992	Uint16	Please refer to parameter 4992 ⇘ p. 75 for details.
4983	Uint16	Please refer to parameter 4983 ⇘ p. 75 for details.
4993	Uint16	Please refer to parameter 4993 ⇘ p. 75 for details.
4984	Uint16	Please refer to parameter 4984 ⇘ p. 75 for details.
4994	Uint16	Please refer to parameter 4994 ⇘ p. 75 for details.
4985	Uint16	Please refer to parameter 4985 ⇘ p. 75 for details.
4995	Uint16	Please refer to parameter 4995 ⇘ p. 75 for details.
4986	Uint16	Please refer to parameter 4986 ⇘ p. 75 for details.
4996	Uint16	Please refer to parameter 4996 ⇘ p. 75 for details.
4987	Uint16	Please refer to parameter 4987 ⇘ p. 75 for details.
4997	Uint16	Please refer to parameter 4997 ⇘ p. 75 for details.

Table 54: Time-dependent voltage monitoring 2

Time-dependent voltage monitoring 3

ID	Data type	Comment
9130	Enum	Please refer to parameter 9130 ␓ p. 77 for details. Setting: 0 [Off]; 1 [On]
9133	Enum	Please refer to parameter 9133 ␓ p. 77 for details. Setting: 0 [Overrun]; 1 [Underrun]
9132	Enum	Please refer to parameter 9132 ␓ p. 77 for details. Setting: 0 [Off]; 1 [On]
9131	Enum	Please refer to parameter 9131 ␓ p. 78 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]
9148	Uint16	Please refer to parameter 9148 ␓ p. 77 for details.
9156	Uint16	Please refer to parameter 9156 ␓ p. 77 for details.
9147	Uint16	Please refer to parameter 9147 ␓ p. 77 for details.
9140	Uint16	Please refer to parameter 9140 ␓ p. 77 for details.
9149	Uint16	Please refer to parameter 9149 ␓ p. 77 for details.
9141	Uint16	Please refer to parameter 9141 ␓ p. 77 for details.
9150	Uint16	Please refer to parameter 9150 ␓ p. 77 for details.
9142	Uint16	Please refer to parameter 9142 ␓ p. 77 for details.
9151	Uint16	Please refer to parameter 9151 ␓ p. 77 for details.
9143	Uint16	Please refer to parameter 9143 ␓ p. 77 for details.
9152	Uint16	Please refer to parameter 9152 ␓ p. 77 for details.
9144	Uint16	Please refer to parameter 9144 ␓ p. 77 for details.
9153	Uint16	Please refer to parameter 9153 ␓ p. 77 for details.
9145	Uint16	Please refer to parameter 9145 ␓ p. 77 for details.
9154	Uint16	Please refer to parameter 9154 ␓ p. 77 for details.
9146	Uint16	Please refer to parameter 9146 ␓ p. 77 for details.
9155	Uint16	Please refer to parameter 9155 ␓ p. 77 for details.

Table 55: Time-dependent voltage monitoring 3

Time-dependent voltage monitoring 4

ID	Data type	Comment
9134	Enum	Please refer to parameter 9134 ␓ p. 79 for details. Setting: 0 [Off]; 1 [On]
9137	Enum	Please refer to parameter 9137 ␓ p. 79 for details. Setting: 0 [Overrun]; 1 [Underrun]
9136	Enum	Please refer to parameter 9136 ␓ p. 79 for details. Setting: 0 [Off]; 1 [On]

ID	Data type	Comment
9135	Enum	Please refer to parameter 9135 ↳ p. 80 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]
9165	Uint16	Please refer to parameter 9165 ↳ p. 79 for details.
9173	Uint16	Please refer to parameter 9173 ↳ p. 80 for details.
9164	Uint16	Please refer to parameter 9164 ↳ p. 80 for details.
9157	Uint16	Please refer to parameter 9157 ↳ p. 80 for details.
9166	Uint16	Please refer to parameter 9166 ↳ p. 80 for details.
9158	Uint16	Please refer to parameter 9158 ↳ p. 80 for details.
9167	Uint16	Please refer to parameter 9167 ↳ p. 80 for details.
9159	Uint16	Please refer to parameter 9159 ↳ p. 80 for details.
9168	Uint16	Please refer to parameter 9168 ↳ p. 80 for details.
9160	Uint16	Please refer to parameter 9160 ↳ p. 80 for details.
9169	Uint16	Please refer to parameter 9169 ↳ p. 80 for details.
9161	Uint16	Please refer to parameter 9161 ↳ p. 80 for details.
9170	Uint16	Please refer to parameter 9170 ↳ p. 80 for details.
9162	Uint16	Please refer to parameter 9162 ↳ p. 80 for details.
9171	Uint16	Please refer to parameter 9171 ↳ p. 80 for details.
9163	Uint16	Please refer to parameter 9163 ↳ p. 80 for details.
9172	Uint16	Please refer to parameter 9172 ↳ p. 80 for details.

Table 56: Time-dependent voltage monitoring 4

Voltage increase monitoring

ID	Data type	Comment
8806	Enum	Please refer to parameter 8806 ↳ p. 64 for details. Setting: 0 [Off]; 1 [On]
8849	Enum	Please refer to parameter 8849 ↳ p. 65 for details. Setting: 0 [Off]; 1 [On]
8807	Uint16	Please refer to parameter 8807 ↳ p. 64 for details.
8831	Enum	Please refer to parameter 8831 ↳ p. 65 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]

Table 57: Voltage increase monitoring

QV monitoring

ID	Data type	Comment
3292	Enum	Please refer to parameter 3292 ↳ p. 67 for details. Setting: 0 [Off]; 1 [On]
3291	Uint16	Please refer to parameter 3291 ↳ p. 67 for details.

ID	Data type	Comment
3285	Uint16	Please refer to parameter 3285 ↳ p. 67 for details.
3287	Uint16	Please refer to parameter 3287 ↳ p. 67 for details.
3283	Uint16	Please refer to parameter 3283 ↳ p. 67 for details.
3284	Uint16	Please refer to parameter 3284 ↳ p. 67 for details.
3280	Enum	Please refer to parameter 3280 ↳ p. 67 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]
3281	Enum	Please refer to parameter 3281 ↳ p. 67 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]

Table 58: QV monitoring

Overcurrent monitoring

ID	Data type	Comment
Overcurrent level 1		
2200	Enum	Please refer to parameter 2200 ↳ p. 68 for details. Setting: 0 [Off]; 1 [On]
2204	Uint16	Please refer to parameter 2204 ↳ p. 68 for details.
2205	Uint16	Please refer to parameter 2205 ↳ p. 68 for details.
2201	Enum	Please refer to parameter 2201 ↳ p. 69 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]
Overcurrent level 2		
2206	Enum	Please refer to parameter 2206 ↳ p. 68 for details. Setting: 0 [Off]; 1 [On]
2210	Uint16	Please refer to parameter 2210 ↳ p. 68 for details.
2211	Uint16	Please refer to parameter 2211 ↳ p. 68 for details.
2207	Enum	Please refer to parameter 2207 ↳ p. 69 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]
Overcurrent level 3		
2212	Enum	Please refer to parameter 2212 ↳ p. 68 for details. Setting: 0 [Off]; 1 [On]
2216	Uint16	Please refer to parameter 2216 ↳ p. 68 for details.
2217	Uint16	Please refer to parameter 2217 ↳ p. 68 for details.
2213	Enum	Please refer to parameter 2213 ↳ p. 69 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]

Table 59: Overcurrent monitoring

Ground fault monitoring

ID	Data type	Comment
Ground fault level 1		
3250	Enum	Please refer to parameter 3250 ↳ p. 70 for details. Setting: 0 [Off]; 1 [On]
3254	Uint16	Please refer to parameter 3254 ↳ p. 71 for details.
3255	Uint16	Please refer to parameter 3255 ↳ p. 71 for details.
3251	Enum	Please refer to parameter 3251 ↳ p. 71 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]
Ground fault level 2		
3256	Enum	Please refer to parameter 3256 ↳ p. 70 for details. Setting: 0 [Off]; 1 [On]
3260	Uint16	Please refer to parameter 3260 ↳ p. 71 for details.
3261	Uint16	Please refer to parameter 3261 ↳ p. 71 for details.
3257	Enum	Please refer to parameter 3257 ↳ p. 71 for details. Setting: 0 [None]; 1 [Relay 1]; 2 [Relay 2]; 3 [Relay 3]; 4 [Relay 4]

Table 60: Ground fault monitoring

Discrete outputs

ID	Data type	Comment
6920	Enum	Please refer to parameter 6920 ↳ p. 43 for details. Setting: 0 [N.O.]; 1 [N.C.]
6921	Enum	Please refer to parameter 6921 ↳ p. 43 for details. Setting: 0 [N.O.]; 1 [N.C.]
6922	Enum	Please refer to parameter 6922 ↳ p. 43 for details. Setting: 0 [N.O.]; 1 [N.C.]
6923	Enum	Please refer to parameter 6923 ↳ p. 43 for details. Setting: 0 [N.O.]; 1 [N.C.]

Table 61: Discrete outputs

Scaling Parameter

General notes

These parameters define the scaling of the visualization values described in the signal table (↳ *"Signal table" Table on page 112*). The scaling of each visualization value is defined by four parameters:

- Mantissa_EUMin
- Mantissa_EUMax
- Exponent_EUMin
- Exponent_EUMax

These parameters are used by the system to calculate two scaling values:

- ScaleLow = Mantissa_EUMin * 10^Exponent_EUMin
- ScaleHigh = Mantissa_EUMax * 10^Exponent_EUMax

These two scaling values are used again to calculate the scaled value:

- ScaledValue = 32,767 / (ScaleHigh - ScaleLow) * (ActualValue - ScaleLow) + 0.5

The error handling is as follows:

- ActualValue < ScaleLow then ScaledValue = 0
- ActualValue > ScaleHigh then ScaledValue = 32,767
- ScaleLow ≥ ScaleHigh then ScaledValue = 0

In all these three cases an error flag “Wrong scaling” in the “Error flags 1” register is set. The flag is only set if such a wrongly scaled value is requested.

The following tables list the scaling parameters of the visualization values:

Voltage phase-phase

ID	Data type	Description	Format	Range
7500	Int16	Mantissa V12 EUMin	00000	-32,768 to 32,767
7501	Int16	Exponent V12 EUMin	000	-16 to 15
7502	Int16	Mantissa V12 EUMax	00000	-32,768 to 32,767
7503	Int16	Exponent V12 EUMax	000	-16 to 15
7504	Int16	Mantissa V23 EUMin	00000	-32,768 to 32,767
7505	Int16	Exponent V23 EUMin	000	-16 to 15
7506	Int16	Mantissa V23 EUMax	00000	-32,768 to 32,767
7507	Int16	Exponent V23 EUMax	000	-16 to 15
7508	Int16	Mantissa V31 EUMin	00000	-32,768 to 32,767
7509	Int16	Exponent V31 EUMin	000	-16 to 15
7510	Int16	Mantissa V31 EUMax	00000	-32,768 to 32,767
7511	Int16	Exponent V31 EUMax	000	-16 to 15
7512	Int16	Mantissa VLLAve EUMin	00000	-32,768 to 32,767
7513	Int16	Exponent VLLAve EUMin	000	-16 to 15
7514	Int16	Mantissa VLLAve EUMax	00000	-32,768 to 32,767
7515	Int16	Exponent VLLAve EUMax	000	-16 to 15
7516	Int16	Mantissa VLLMin EUMin	00000	-32,768 to 32,767
7517	Int16	Exponent VLLMin EUMin	000	-16 to 15
7518	Int16	Mantissa VLLMin EUMax	00000	-32,768 to 32,767
7519	Int16	Exponent VLLMin EUMax	000	-16 to 15
7520	Int16	Mantissa VLLMax EUMin	00000	-32,768 to 32,767
7521	Int16	Exponent VLLMax EUMin	000	-16 to 15

ID	Data type	Description	Format	Range
7522	Int16	Mantissa VLLMax EUMax	00000	-32,768 to 32,767
7523	Int16	Exponent VLLMax EUMax	000	-16 to 15

Table 62: Voltage phase-phase

Voltage phase-neutral

ID	Data type	Description	Format	Range
7524	Int16	Mantissa V1N EUMin	00000	-32,768 to 32,767
7525	Int16	Exponent V1N EUMin	000	-16 to 15
7526	Int16	Mantissa V1N EUMax	00000	-32,768 to 32,767
7527	Int16	Exponent V1N EUMax	000	-16 to 15
7528	Int16	Mantissa V2N EUMin	00000	-32,768 to 32,767
7529	Int16	Exponent V2N EUMin	000	-16 to 15
7530	Int16	Mantissa V2N EUMax	00000	-32,768 to 32,767
7531	Int16	Exponent V2N EUMax	000	-16 to 15
7532	Int16	Mantissa V3N EUMin	00000	-32,768 to 32,767
7533	Int16	Exponent V3N EUMin	000	-16 to 15
7534	Int16	Mantissa V3N EUMax	00000	-32,768 to 32,767
7535	Int16	Exponent V3N EUMax	000	-16 to 15
7536	Int16	Mantissa VNAve EUMin	00000	-32,768 to 32,767
7537	Int16	Exponent VNAve EUMin	000	-16 to 15
7538	Int16	Mantissa VNAve EUMax	00000	-32,768 to 32,767
7539	Int16	Exponent VNAve EUMax	000	-16 to 15
7540	Int16	Mantissa VNMin EUMin	00000	-32,768 to 32,767
7541	Int16	Exponent VNMin EUMin	000	-16 to 15
7542	Int16	Mantissa VNMin EUMax	00000	-32,768 to 32,767
7543	Int16	Exponent VNMin EUMax	000	-16 to 15
7544	Int16	Mantissa VNMax EUMin	00000	-32,768 to 32,767
7545	Int16	Exponent VNMax EUMin	000	-16 to 15
7546	Int16	Mantissa VNMax EUMax	00000	-32,768 to 32,767
7547	Int16	Exponent VNMax EUMax	000	-16 to 15

Table 63: Voltage phase-neutral

Current

ID	Data type	Description	Format	Range
7548	Int16	Mantissa I1 EUMin	00000	-32,768 to 32,767
7549	Int16	Exponent I1 EUMin	000	-16 to 15

ID	Data type	Description	Format	Range
7550	Int16	Mantissa I1 EUMax	00000	-32,768 to 32,767
7551	Int16	Exponent I1 EUMax	000	-16 to 15
7552	Int16	Mantissa I2 EUMin	00000	-32,768 to 32,767
7553	Int16	Exponent I2 EUMin	000	-16 to 15
7554	Int16	Mantissa I2 EUMax	00000	-32,768 to 32,767
7555	Int16	Exponent I2 EUMax	000	-16 to 15
7556	Int16	Mantissa I3 EUMin	00000	-32,768 to 32,767
7557	Int16	Exponent I3 EUMin	000	-16 to 15
7558	Int16	Mantissa I3 EUMax	00000	-32,768 to 32,767
7559	Int16	Exponent I3 EUMax	000	-16 to 15
7560	Int16	Mantissa IAve EUMin	00000	-32,768 to 32,767
7561	Int16	Exponent IAve EUMin	000	-16 to 15
7562	Int16	Mantissa IAve EUMax	00000	-32,768 to 32,767
7563	Int16	Exponent IAve EUMax	000	-16 to 15
7564	Int16	Mantissa IMin EUMin	00000	-32,768 to 32,767
7565	Int16	Exponent IMin EUMin	000	-16 to 15
7566	Int16	Mantissa IMin EUMax	00000	-32,768 to 32,767
7567	Int16	Exponent IMin EUMax	000	-16 to 15
7568	Int16	Mantissa IMax EUMin	00000	-32,768 to 32,767
7569	Int16	Exponent IMax EUMin	000	-16 to 15
7570	Int16	Mantissa IMax EUMax	00000	-32,768 to 32,767
7571	Int16	Exponent IMax EUMax	000	-16 to 15

Table 64: Current

Active power

ID	Data type	Description	Format	Range
7572	Int16	Mantissa P1 EUMin	00000	-32,768 to 32,767
7573	Int16	Exponent P1 EUMin	000	-16 to 15
7574	Int16	Mantissa P1 EUMax	00000	-32,768 to 32,767
7575	Int16	Exponent P1 EUMax	000	-16 to 15
7576	Int16	Mantissa P2 EUMin	00000	-32,768 to 32,767
7577	Int16	Exponent P2 EUMin	000	-16 to 15
7578	Int16	Mantissa P2 EUMax	00000	-32,768 to 32,767
7579	Int16	Exponent P2 EUMax	000	-16 to 15
7580	Int16	Mantissa P3 EUMin	00000	-32,768 to 32,767
7581	Int16	Exponent P3 EUMin	000	-16 to 15

ID	Data type	Description	Format	Range
7582	Int16	Mantissa P3 EUMax	00000	-32,768 to 32,767
7583	Int16	Exponent P3 EUMax	000	-16 to 15
7584	Int16	Mantissa P123 EUMin	00000	-32,768 to 32,767
7585	Int16	Exponent P123 EUMin	000	-16 to 15
7586	Int16	Mantissa P123 EUMax	00000	-32,768 to 32,767
7587	Int16	Exponent P123 EUMax	000	-16 to 15

Table 65: Active power

Reactive power

ID	Data type	Description	Format	Range
7588	Int16	Mantissa Q1 EUMin	00000	-32,768 to 32,767
7589	Int16	Exponent Q1 EUMin	000	-16 to 15
7590	Int16	Mantissa Q1 EUMax	00000	-32,768 to 32,767
7591	Int16	Exponent Q1 EUMax	000	-16 to 15
7592	Int16	Mantissa Q2 EUMin	00000	-32,768 to 32,767
7593	Int16	Exponent Q2 EUMin	000	-16 to 15
7594	Int16	Mantissa Q2 EUMax	00000	-32,768 to 32,767
7595	Int16	Exponent Q2 EUMax	000	-16 to 15
7596	Int16	Mantissa Q3 EUMin	00000	-32,768 to 32,767
7597	Int16	Exponent Q3 EUMin	000	-16 to 15
7598	Int16	Mantissa Q3 EUMax	00000	-32,768 to 32,767
7599	Int16	Exponent Q3 EUMax	000	-16 to 15
7600	Int16	Mantissa Q123 EUMin	00000	-32,768 to 32,767
7601	Int16	Exponent Q123 EUMin	000	-16 to 15
7602	Int16	Mantissa Q123 EUMax	00000	-32,768 to 32,767
7603	Int16	Exponent Q123 EUMax	000	-16 to 15

Table 66: Reactive power

Apparent power

ID	Data type	Description	Format	Range
7604	Int16	Mantissa S1 EUMin	00000	-32,768 to 32,767
7605	Int16	Exponent S1 EUMin	000	-16 to 15
7606	Int16	Mantissa S1 EUMax	00000	-32,768 to 32,767
7607	Int16	Exponent S1 EUMax	000	-16 to 15
7608	Int16	Mantissa S2 EUMin	00000	-32,768 to 32,767
7609	Int16	Exponent S2 EUMin	000	-16 to 15

ID	Data type	Description	Format	Range
7610	Int16	Mantissa S2 EUMax	00000	-32,768 to 32,767
7611	Int16	Exponent S2 EUMax	000	-16 to 15
7612	Int16	Mantissa S3 EUMin	00000	-32,768 to 32,767
7613	Int16	Exponent S3 EUMin	000	-16 to 15
7614	Int16	Mantissa S3 EUMax	00000	-32,768 to 32,767
7615	Int16	Exponent S3 EUMax	000	-16 to 15
7616	Int16	Mantissa S123 EUMin	00000	-32,768 to 32,767
7617	Int16	Exponent S123 EUMin	000	-16 to 15
7618	Int16	Mantissa S123 EUMax	00000	-32,768 to 32,767
7619	Int16	Exponent S123 EUMax	000	-16 to 15

Table 67: Apparent power

Power factor

ID	Data type	Description	Format	Range
7620	Int16	Mantissa PF1 EUMin	00000	-32,768 to 32,767
7621	Int16	Exponent PF1 EUMin	000	-16 to 15
7622	Int16	Mantissa PF1 EUMax	00000	-32,768 to 32,767
7623	Int16	Exponent PF1 EUMax	000	-16 to 15
7624	Int16	Mantissa PF2 EUMin	00000	-32,768 to 32,767
7625	Int16	Exponent PF2 EUMin	000	-16 to 15
7626	Int16	Mantissa PF2 EUMax	00000	-32,768 to 32,767
7627	Int16	Exponent PF2 EUMax	000	-16 to 15
7628	Int16	Mantissa PF3 EUMin	00000	-32,768 to 32,767
7629	Int16	Exponent PF3 EUMin	000	-16 to 15
7630	Int16	Mantissa PF3 EUMax	00000	-32,768 to 32,767
7631	Int16	Exponent PF3 EUMax	000	-16 to 15
7632	Int16	Mantissa PF123 EUMin	00000	-32,768 to 32,767
7633	Int16	Exponent PF123 EUMin	000	-16 to 15
7634	Int16	Mantissa PF123 EUMax	00000	-32,768 to 32,767
7635	Int16	Exponent PF123 EUMax	000	-16 to 15

Table 68: Power factor

Phase angle

ID	Data type	Description	Format	Range
7636	Int16	Mantissa WI1 EUMin	00000	-32,768 to 32,767
7637	Int16	Exponent WI1 EUMin	000	-16 to 15

ID	Data type	Description	Format	Range
7638	Int16	Mantissa WI1 EUMax	00000	-32,768 to 32,767
7639	Int16	Exponent WI1 EUMax	000	-16 to 15
7640	Int16	Mantissa WI2 EUMin	00000	-32,768 to 32,767
7641	Int16	Exponent WI2 EUMin	000	-16 to 15
7642	Int16	Mantissa WI2 EUMax	00000	-32,768 to 32,767
7643	Int16	Exponent WI2 EUMax	000	-16 to 15
7644	Int16	Mantissa WI3 EUMin	00000	-32,768 to 32,767
7645	Int16	Exponent WI3 EUMin	000	-16 to 15
7646	Int16	Mantissa WI3 EUMax	00000	-32,768 to 32,767
7647	Int16	Exponent WI3 EUMax	000	-16 to 15
7648	Int16	Mantissa WI123 EUMin	00000	-32,768 to 32,767
7649	Int16	Exponent WI123 EUMin	000	-16 to 15
7650	Int16	Mantissa WI123 EUMax	00000	-32,768 to 32,767
7651	Int16	Exponent WI123 EUMax	000	-16 to 15

Table 69: Phase angle

Frequency

ID	Data type	Description	Format	Range
7652	Int16	Mantissa Freq EUMin	00000	-32,768 to 32,767
7653	Int16	Exponent Freq EUMin	000	-16 to 15
7654	Int16	Mantissa Freq EUMax	00000	-32,768 to 32,767
7655	Int16	Exponent Freq EUMax	000	-16 to 15

Table 70: Frequency

Filter Parameter

General notes

All measured values which are transmitted on the Interbus channels 1, 2, and 3 can be filtered individually. The filters have a PT1 characteristic. The filter time can be between 0.00 s (unfiltered) and 5.00 s.

Filtering only affects the values transmitted on the Interbus. Internal functions (monitoring) use unfiltered values.

ID	Data type	Description	Format	Range
7656	Int16	Filter time V12	0.00 s	0.00 to 5.00 s
7657	Int16	Filter time V23	0.00 s	0.00 to 5.00 s
7658	Int16	Filter time V31	0.00 s	0.00 to 5.00 s

ID	Data type	Description	Format	Range
7659	Int16	Filter time I1	0.00 s	0.00 to 5.00 s
7660	Int16	Filter time I2	0.00 s	0.00 to 5.00 s
7661	Int16	Filter time I3	0.00 s	0.00 to 5.00 s
7662	Int16	Filter time P123	0.00 s	0.00 to 5.00 s
7663	Int16	Filter time Q123	0.00 s	0.00 to 5.00 s
7664	Int16	Filter time Freq	0.00 s	0.00 to 5.00 s

Table 71: Filter time constant

Internal Parameter

General notes

- *Parameter 1701 ➪ p. 81 sets all parameters to factory defaults.*
- *The parameters 993 ➪ p. 44 and 994 ➪ p. 44 may only be read via Interbus.*
- *Valid values for parameter 994 ➪ p. 44 are "4550" and "4560".*

ID	Data type	Description	Format	Range
995	Uint16	ID of parameter set	00000	0 to 65535
996	Uint16	CRC of parameter set	00000	0 to 65535
1701	Enum	Reset factory default values	0.00 s	0 [No] 1 [Yes]
994	Uint16	Interbus protocol	00000	0 to 65535 (valid are 4550 or 4560)
993	Enum	Interbus baudrate		0 [500 kBaud] 1 [2000 kBaud]

Table 72: Internal parameter

10 Glossary And List Of Abbreviations

CB	Circuit Breaker
CL	Code Level
CT	Current Transformer
DI	Discrete Input
DO	Discrete (Relay) Output
GCB	Generator Circuit Breaker
I	Current
MCB	Mains Circuit Breaker
N.C.	Normally Closed (break) contact
N.O.	Normally Open (make) contact
P	Real power
P/N	Part Number
PF	Power Factor
PLC	Programmable Logic Control
PT	Potential (Voltage) Transformer
Q	Reactive power
S	Apparent power
S/N	Serial Number
V	Voltage

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