Voltage Regulator TAPCON® 250

Operating Instructions

297/08 EN

Table of contents

1 Introduction

This technical file contains detailed descriptions on the safe and proper installation, connection, commissioning and monitoring of the product.

It also includes safety instructions and general information about the product.

This technical file is intended solely for specially trained and authorized personnel.

1.1 Manufacturer

The product is manufactured by:

Reinhausen Manufacturing Inc.

2549 North 9th Avenue
Humboldt, Tennessee 38343, USA
Tel.: (+1) 731/784-7681
Fax: (+1) 731/784-7682
E-mail: sales@us.reinhausen.com

Further information on the product and copies of this technical file are available from the address listed above or at www.tapcon250.com.

1.2 Completeness

This technical file is incomplete without the further applicable documentation.

The following documents apply to this product:

- Operating instructions
- Connection diagrams

1.3 Safekeeping

Keep this technical file and all supporting documents ready at hand and accessible for future use at all times.

1.4 Notation conventions

This section contains an overview of the symbols and textual emphasis used.

1.4.1 Hazard communication system

Warnings in this technical file are displayed as follows.

1.4.1.1 Warning relating to section

Warnings relating to sections refer to entire chapters or sections, sub-sections or several paragraphs within this technical file. Warnings relating to sections use the following format:

⚠ WARNING

Type of danger!

Source of the danger and outcome.

- ► Action
- ► Action

1.4.1.2 Embedded warning information

Embedded warnings refer to a particular part within a section. These warnings apply to smaller units of information than the warnings relating to sections. Embedded warnings use the following format:

⚠ DANGER! Instruction for avoiding a dangerous situation.

1.4.1.3 Signal words and pictograms

The following signal words are used:

Signal word	Meaning
DANGER	Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
WARNING	Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a hazardous situation which, if not avoided, could result in injury.
NOTICE	Indicates measures to be taken to prevent damage to property.

Table 1: Signal words in warning notices

Pictograms warn of dangers:

Pictogram	Meaning
	Warning of a danger point
	Warning of dangerous electrical voltage
	Warning of combustible substances
	Warning of danger of tipping

Table 2: Pictograms used in warning notices

1.4.2 Information system

Information is designed to simplify and improve understanding of particular procedures. In this technical file it is laid out as follows:

Important information.

1.4.3 Instruction system

This technical file contains single-step and multi-step instructions.

Single-step instructions

Instructions which consist of only a single process step are structured as follows:

Aim of action

✓ Requirements (optional).

► Step 1 of 1.

⇨ Result of step (optional).

⇨ Result of action (optional).

Multi-step instructions

Instructions which consist of several process steps are structured as follows:

Aim of action

✓ Requirements (optional).

1. Step 1.

⇨ Result of step (optional).

2. Step 2.

⇨ Result of step (optional).

⇨ Result of action (optional).

1.4.4 Typographic conventions

The following typographic conventions are used in this technical file:

Typographic convention	Purpose	Example
UPPERCASE	Operating controls, switches	ON/OFF
[Brackets]	PC keyboard	[Ctrl] + [Alt]
Bold	Software operating controls	Press **Continue** button
…>…>…	Menu paths	Parameter > Control parameter
Italics	System messages, error messages, signals	*Function monitoring* alarm triggered
[► Number of pages].	Cross reference	[► 41].

Table 3: Typographic conventions

2 Safety

2.1 Appropriate use

The TAPCON® keeps the output voltage of a transformer with an on-load tap-changer constant. The product is designed solely for use in stationary large-scale electrical energy systems and facilities.

If used as intended, in compliance with the requirements and conditions specified in this technical file and observing the warning notices in this technical file and attached to the product, the product does not pose risk of injury or damage to property or the environment. This applies across the entire service life of the product, from delivery to installation and operation through to disassembly and disposal.

The following is considered appropriate use:

- You will find the standard valid for the product and the year of issue on the nameplate.
- Operate the product in accordance with this technical file, the agreed-upon delivery conditions and the technical data.
- Ensure that all necessary work is performed by qualified personnel only.
- Only use the equipment and special tools included in delivery for the intended purpose and in accordance with the specifications of this technical file.
- Only operate the product in industrial areas.
- Observe the notices in this technical file regarding electromagnetic compatibility and the technical data.

2.2 Fundamental Safety Instructions

To prevent accidents, disruptions and damage as well as unacceptable adverse effects on the environment, those responsible for transport, installation, operation, maintenance and disposal of the product or parts of the product must ensure the following:

Personal protective equipment

Loosely worn or unsuitable clothing increases the danger of becoming trapped or caught up in rotating parts and the danger of getting caught on protruding parts. This increases the danger to life and limb.

- All necessary devices and personal protective equipment required for the specific task, such as a hard hat, safety footwear, etc. must be worn. Observe the section "Personal protective equipment" [► 15].
- Never wear damaged personal protective equipment.
- Never wear rings, necklaces, or other jewelry.
- If you have long hair, wear a hairnet.

Work area

Untidy and poorly lit work areas can lead to accidents.

- Keep the work area clean and tidy.
- Make sure that the work area is well lit.
- Observe the applicable laws for accident prevention in the relevant country.

Working during operation

The product may be operated only in a sound, operational condition. Otherwise it poses a danger to life and limb.

- Regularly check the operational reliability of safety equipment.
- Comply with the inspection work, maintenance work and maintenance intervals described in this technical file.

Invisible laser radiation

Looking directly into the beam or the reflected beam can cause eye damage. The beam is emitted at the optical connections or at the end of the fiber-optic cables connected to them on the assemblies. Read the chapter "Technical Data" [► 149] for further information.

- Never look directly into the beam or the reflected beam.
- Never look into the beam with the aid of optical instruments such as a magnifying glass or a microscope.
- In the event that the laser beam strikes your eyes, close your eyes immediately and move your head out of the path of the beam.

Working with current transformers

Dangerous high voltages may occur when a current transformer is operated with an open secondary circuit. This can lead to injuries and property damage.

- Never operate a current transformer with an open secondary circuit; short-circuit the current transformer to prevent this.
- Observe the information in the current transformer operating instructions.

Explosion protection

Highly flammable or explosive gases, vapors and dusts can cause serious explosions and fire.

- Do not install or operate the product in areas where a risk of explosion is present.

Safety markings

Warning signs and safety information plates are safety markings on the product. They are an important aspect of the safety concept.

- Observe all safety markings on the product.
- Make sure all safety markings on the product remain intact and legible.
- Replace safety markings that are damaged or missing.

Ambient conditions

To ensure reliable and safe operation, the product must only be operated under the ambient conditions specified in the technical data.

- Observe the specified operating conditions and requirements for the installation location.

Modifications and conversions

Unauthorized or inappropriate changes to the product may lead to personal injury, material damage and operational faults.

- Only modify the product after consultation with the manufacturer.

Spare parts

Spare parts not approved by the manufacturer may lead to physical injury, damage to the product and operational faults.

- Only use spare parts approved by the manufacturer.
- Contact the manufacturer.

2.3 Personnel qualification

The person responsible for assembly, commissioning, operation, maintenance and inspection must ensure that the personnel are sufficiently qualified.

Electrically skilled person

The electrically skilled person has a technical qualification and therefore has the required knowledge and experience, and is also conversant with the applicable standards and regulations. The electrically skilled person is also proficient in the following:

- Can identify potential dangers independently and is able to avoid them.
- Is able to perform work on electrical systems.

- Is specially trained for the working environment in which (s)he works.
- Must satisfy the requirements of the applicable statutory regulations for accident prevention.

Electrically trained persons

An electrically trained person receives instruction and guidance from an electrically skilled person in relation to the tasks undertaken and the potential dangers in the event of inappropriate handling as well as the protective devices and safety measures. The electrically trained person works exclusively under the guidance and supervision of an electrically skilled person.

Operator

The operator uses and operates the product in line with this technical file. The operating company provides the operator with instruction and training on the specific tasks and the associated potential dangers arising from improper handling.

Technical Service

We strongly recommend having maintenance, repairs and retrofitting carried out by our Technical Service department. This ensures that all work is performed correctly. If maintenance is not carried out by our Technical Service department, please ensure that the personnel who carry out the maintenance are trained and authorized by Maschinenfabrik Reinhausen GmbH to carry out the work.

Authorized personnel

Authorized personnel are trained by Maschinenfabrik Reinhausen GmbH to carry out special maintenance.

2.4 Personal protective equipment

Personal protective equipment must be worn during work to minimize risks to health.

- Always wear the personal protective equipment required for the job at hand.
- Never wear damaged personal protective equipment.
- Observe information about personal protective equipment provided in the work area.

Personal protective equipment to be worn at all times

	**Protective clothing** Close-fitting work clothing with a low tearing strength, with tight sleeves and with no protruding parts. It mainly serves to protect the wearer against being caught by moving machine parts.
	**Safety shoes** To protect against falling heavy objects and slipping on slippery surfaces.

Special personal protective equipment for particular environments

	**Safety glasses** To protect the eyes from flying parts and splashing liquids.
	**Visor** To protect the face from flying parts and splashing liquids or other dangerous substances.
	**Hard hat** To protect from falling and flying parts and materials.
	**Hearing protection** To protect from hearing damage.
	**Protective gloves** To protect from mechanical, thermal, and electrical hazards.

3 Product description

This chapter contains an overview of the design and function of the product.

3.1 Scope of delivery

The following items are included in the delivery:

- TAPCON® 250
- CD MR-Suite (contains the TAPCON®-trol program)
- Technical files
- Serial cable RS232
- USB adapter with installation CD (optional)

Please note the following:

- Check the shipment for completeness on the basis of the shipping documents.
- Store the parts in a dry place until installation.

3.2 Function description of the voltage regulation

The TAPCON® keeps the output voltage of a transformer with an on-load tap-changer constant.

The TAPCON® compares the transformer's measured voltage (U_{actual}) with a defined reference voltage ($U_{desired}$). The difference between U_{actual} and $U_{desired}$ is the control deviation dU.

The TAPCON® parameters can be optimally adjusted to the line voltage behavior to achieve a balanced control response with the on-load tap-changer only making a small number of tap-change operations.

3.3 Performance features

The TAPCON® is responsible for controlling tapped transformers.

Apart from control tasks, the TAPCON® provides additional functions such as:

- Integrated monitoring functions:
  - Undervoltage blocking and overvoltage blocking
  - Overvoltage detection with high-speed return
  - Oscillation messaging
- 4 digital inputs and 1 digital output can be individually programmed on-site by the customer
- Additional indicators using LEDs outside the display for freely selectable functions

- Display of all measured values such as voltage, current, active power, apparent power or reactive power, power factor (cos φ)
- Selection of 4 different desired values
- Desired value setting by means of analog signals (optional)
- Tap position capture (optional):
  - Using analog signal 4…20 mA, 0…1 mA, 0…20 mA
  - Using analog signal via resistor contact series
- Tap position output by means of analog signals (optional)
- Parallel operation of up to 6 transformers in 2 groups using the following methods:
  - Master/follower
  - Circulating reactive current minimization
- SCADA:
  - DNP3
  - Modbus ASCII
  - Modbus RTU

3.4 Operating modes

The device can be operated in the following operating modes:

Auto mode (AUTO)

In auto mode, the voltage is automatically controlled in accordance with the set parameters. You cannot change further device settings in auto mode. There is no active management by a higher level control system in this operating mode.

Manual mode (MANUAL)

In manual mode, there is no automatic control. The motor-drive unit can be controlled via the device's operating panel. You can change the device settings.

Local mode (LOCAL)

There is no active management by a superordinate control system in this operating mode.

Remote mode (REMOTE)

In remote mode, you can execute commands via an external control level. In this case, manual operation of the RAISE, LOWER, MANUAL and AUTO keys is disabled.

	AUTO + LOCAL	AUTO + REMOTE	MANUAL + LOCAL	MANUAL + REMOTE
Automatic regulation	Yes	Yes	No	No
Tap-change operation via operating controls	No	No	Yes	No
Tap-change operation via inputs	No	No	No	Yes
Tap-change operation via SCADA	No	No	No	Yes
Value adjustment via SCADA*	No	Yes	No	Yes

Table 4: Overview of operating modes

*) Optional when connecting TAPCON® to a control system (SCADA)

3.5 Hardware

The individual assemblies are mounted in optimized, EMC-protected housings. The front plate contains the operating controls, the display and the LEDs.

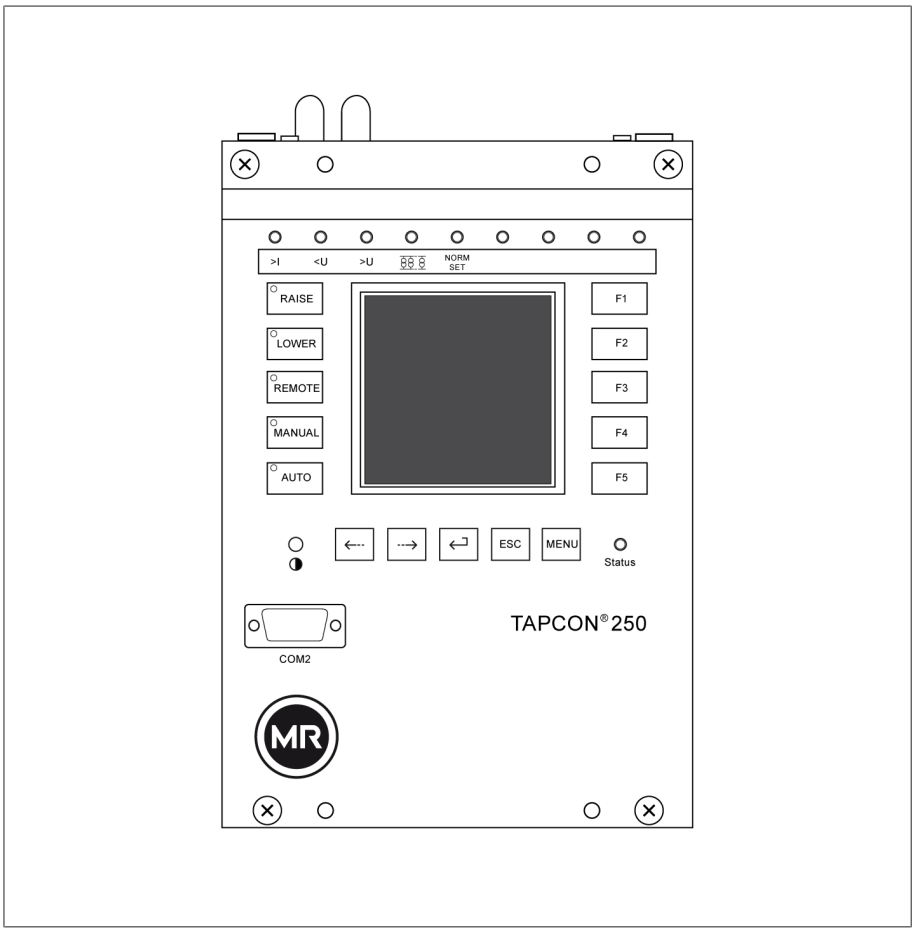


Figure 1: Front view

3.5.1 Name plate

The nameplate can be found on the rear side of the device and contains the following information:

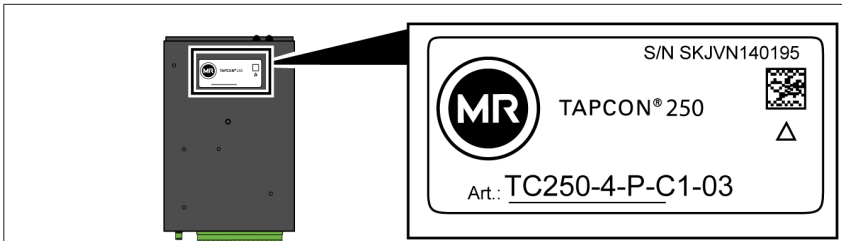


Figure 2: Example appearance of the nameplate

S/N	Serial number (e.g. SKJVN140195)
Art.:	Article number in accordance with configuration (e.g. TC250-4-P-C1-03)

Article number

The article number is composed in accordance with your order and is constructed using the following system: `TC250-V-W-XY-ZZ`

Scheme	Possible parameters
TC250	-
V	Analog tap position capture (AI module) ▪ 0: No AI module ▪ 1: Input 0...1 mA; output 0...1 mA or 4...20 mA (available for selection) ▪ 2: Input 0...20 mA; output 0...1 mA or 4...20 mA (available for selection) ▪ 4: Input 4...20 mA; output 0...1 mA or 4...20 mA (available for selection) ▪ P: Potentiometer, output 0...1 mA or 4...20 mA (available for selection)
W	Parallel operation ▪ 0: No parallel operation ▪ P: Parallel operation

Scheme	Possible parameters
X	SCADA (CI module) ▪ 0: No CI module ▪ C: CI module with RS232 and RS485 ▪ E: CI module with RS232, RS485 and RJ45 (Ethernet) ▪ M: CI module with RS232, RS485 and RJ45 (modem)
Y	Optional fiber-optic cable (CI module) ▪ 0: No fiber-optic cable ▪ 1: Fiber-optic cable
ZZ	Reserved for special applications

Table 5: Article number scheme

3.5.2 Operating controls

The device has 15 pushbuttons. The illustration below is an overview of all the device's operating controls.

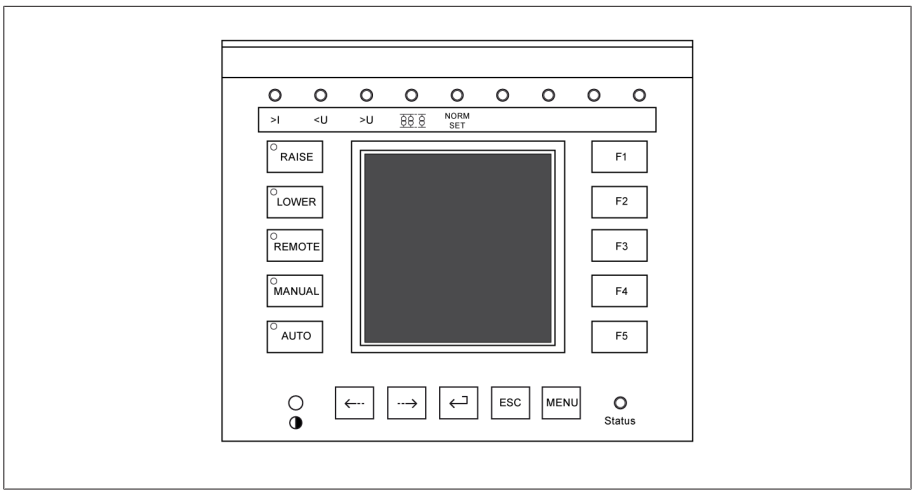


Figure 3: Operating controls

RAISE	RAISE key: In manual mode, send a control command to the motor-drive unit to increase the voltage.
LOWER	LOWER key: In manual mode, send a control command to the motor-drive unit to reduce the voltage.
REMOTE	REMOTE key: Activate/deactivate "Remote" operating mode. When you deactivate this operating mode, the "Local" operating mode is automatically activated.
MANUAL	MANUAL key: Activate "Manual mode" operating mode.
AUTO	AUTO key: Activate "Auto mode" operating mode.
←··	PREV key: Change measured value display and switch to previous parameters.
··→	NEXT key: Change measured value display and switch to next parameters.
↵	ENTER key: Confirm selection and save modified parameters.
ESC	ESC key: Exit current menu and select previous menu levels.
MENU	MENU key: Select main menu.
F1	F1 to F5 function keys: Select functions displayed on the screen.

3.5.3 Display elements

The device has a graphics display and 15 LEDs, which indicate the various operating statuses or events.

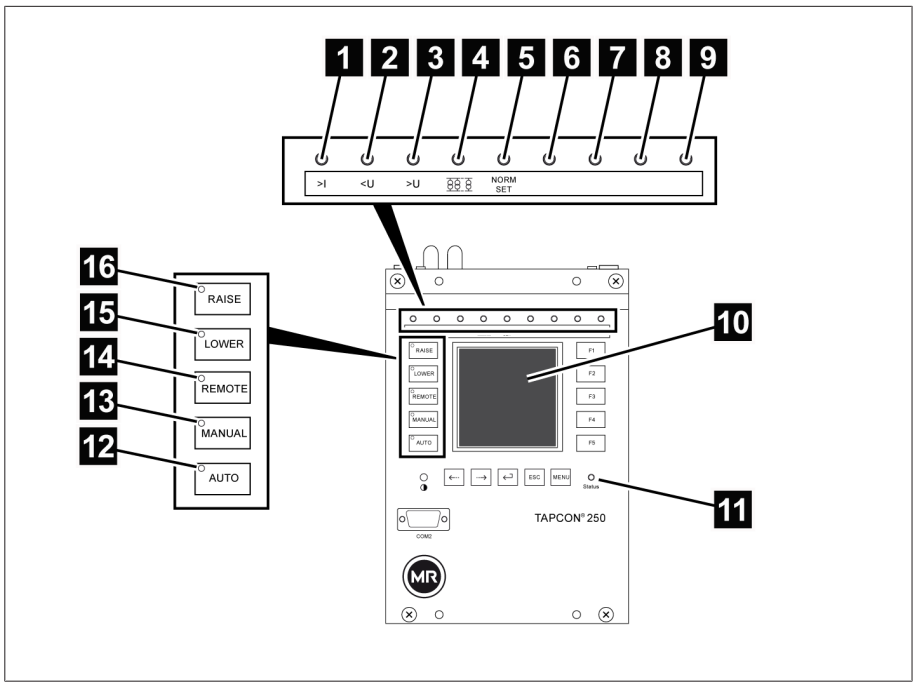


Figure 4: Display elements

1	*Overcurrent blocking* LED, red	9	LED 4, function can be freely assigned, green/yellow/red
2	*Undervoltage blocking* LED, red	10	Graphics display
3	*Overvoltage blocking* LED, red	11	*Operating status* LED, green
4	*Parallel operation active* LED, green	12	*Auto mode active* LED
5	*NORMset active* LED, green	13	*Manual mode active* LED
6	LED 1, function can be freely assigned, yellow	14	*Remote* operating mode *active* LED
7	LED 2, function can be freely assigned, yellow	15	*Lower tap-change active* LED
8	LED 3, function can be freely assigned, yellow	16	*Raise tap-change active* LED

3.5.4 Serial interface

The parameters for the device can be set using a PC. The COM 2 (RS232) serial interface on the front panel is provided for this purpose. You can use the connection cable supplied to establish a connection to your PC via the RS232 or USB port (using the optional USB adapter).

TAPCON®-trol software is needed for parameterization via the serial interface. The software and the related user guide can be found on the CD provided.

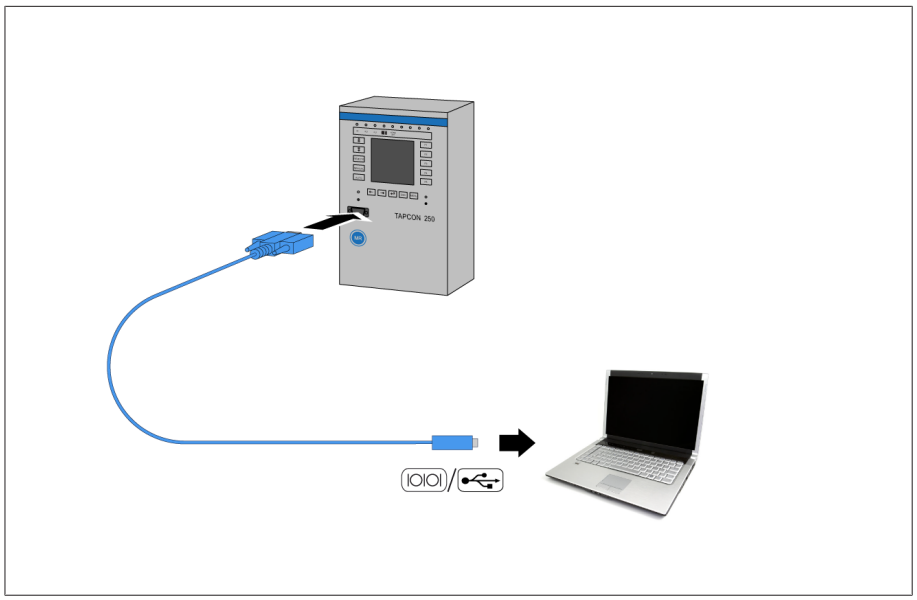


Figure 5: Device connection to a PC

3.5.5 Assemblies

Depending on configuration, the device may have various assemblies which perform the functions required. The functions of the assemblies are described in the following sections. You can find more information about the assemblies in the Technical data [► 149] section.

3.5.5.1 AI module

The AI module lets you capture the tap position of the on-load tap-changer as an analog signal. As an alternative to the tap position, you can also specify the desired value as an analog signal.

Furthermore, you can forward the tap position as an analog signal via the AI module analog output (e.g. for an external tap position display).

3.5.5.2 CI module (optional)

The optional CI module makes 4 additional communication interfaces available:

- RS232
- RS485
- Ethernet/modem
- Fiber-optic cable

You can tether the device to a control system using these communication interfaces.

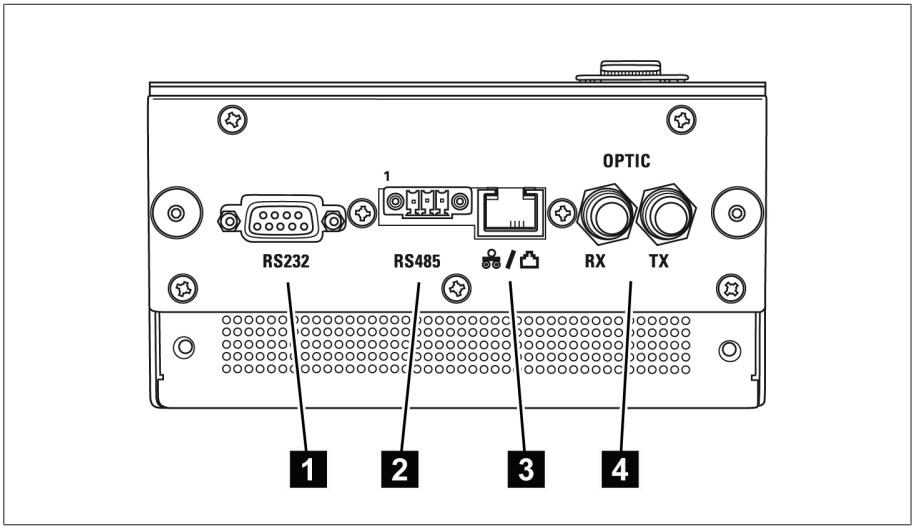


Figure 6: CI module

1 RS232	3 RJ45 (Ethernet/modem)
2 RS485	4 Fiber-optic cable

3.5.5.3 Adapter plate (optional)

The adapter plates available as an option are used to replace various types of voltage regulators with a TAPCON® 250 through simple exchange. Observe the associated supplement for further information on the adapter plate.

4 Packaging, transport and storage

4.1 Packaging

The products are sometimes supplied in a sealed packaging and sometimes in a dry state depending on requirements.

A sealed packaging surrounds the packaged goods on all sides with plastic foil. Products that have also been dried are identified by a yellow label on the sealed packaging.

The information in the following sections should be applied as appropriate.

4.1.1 Purpose

The packaging is designed to protect the packaged goods during transport, loading and unloading as well as periods of storage in such a way that no (detrimental) changes occur. The packaging must protect the goods against permitted transport stresses such as vibration, knocks and moisture (rain, snow, condensation).

The packaging also prevents the packaged goods from moving impermissibly within the packaging. The packaged goods must be prepared for shipment before actually being packed so that the goods can be transported safely, economically and in accordance with regulations.

4.1.2 Suitability, structure and production

The goods are packaged in a sturdy cardboard box. This ensures that the shipment is secure when in the intended transportation position and that none of its parts touch the loading surface of the means of transport or touch the ground after unloading.

The box is designed for a maximum load of 10 kg.

Inlays inside the box stabilize the goods, preventing impermissible changes of position, and protect them from vibration.

4.1.3 Markings

The packaging bears a signature with instructions for safe transport and correct storage. The following symbols apply to the shipment of non-hazardous goods. Adherence to these symbols is mandatory.

				
Protect against moisture	Top	Fragile	Attach lifting gear here	Center of mass

Table 6: Shipping pictograms

4.2 Transportation, receipt and handling of shipments

In addition to oscillation stress, jolts must also be expected during transportation. In order to prevent possible damage, avoid dropping, tipping, knocking over and colliding with the product.

If a crate tips over, falls from a certain height (e.g. when slings tear) or is subject to an unbroken fall, damage must be expected regardless of the weight.

Every delivered shipment must be checked for the following by the recipient before acceptance (acknowledgment of receipt):

- Completeness based on the delivery slip
- External damage of any type

The checks must take place after unloading when the crate or transport container can be accessed from all sides.

Visible damage

If external transport damage is detected on receipt of the shipment, proceed as follows:

- Immediately record the transport damage found in the shipping documents and have this countersigned by the carrier.
- In the event of severe damage, total loss or high damage costs, immediately notify the sales department at Maschinenfabrik Reinhausen and the relevant insurance company.
- After identifying damage, do not modify the condition of the shipment further and retain the packaging material until an inspection decision has been made by the transport company or the insurance company.
- Record the details of the damage immediately onsite together with the carrier involved. This is essential for any claim for damages!

- If possible, photograph damage to packaging and packaged goods. This also applies to signs of corrosion on the packaged goods due to moisture inside the packaging (rain, snow, condensation).
- Be absolutely sure to also check the sealed packaging.

Hidden damage

When damages are not determined until unpacking after receipt of the shipment (hidden damage), proceed as follows:

- Make the party responsible for the damage liable as soon as possible by telephone and in writing, and prepare a damage report.
- Observe the time periods applicable to such actions in the respective country. Inquire about these in good time.

With hidden damage, it is very hard to make the transportation company (or other responsible party) liable. Any insurance claims for such damages can only be successful if relevant provisions are expressly included in the insurance terms and conditions.

4.3 Storage of shipments

When selecting and setting up the storage location, ensure the following:

- Protect stored goods against moisture (flooding, water from melting snow and ice), dirt, pests such as rats, mice, termites and so on, and against unauthorized access.
- Store the crates on timber beams and planks as a protection against rising damp and for better ventilation.
- Ensure sufficient carrying capacity of the ground.
- Keep entrance paths free.
- Check stored goods at regular intervals. Also take appropriate action after storms, heavy rain or snow and so on.

5 Mounting

This chapter describes how to correctly install and connect the device. Observe the connection diagrams provided.

⚠ DANGER

Electric shock!

Risk of fatal injury due to electrical voltage. Always observe the following safety regulations when working in or on electrical equipment.

- ► Disconnect the equipment.
- ► Lock the equipment to prevent an unintentional restart.
- ► Make sure all poles are de-energized.
- ► Ground and short-circuit.
- ► Cover or cordon off adjacent energized parts.

⚠ WARNING

Electric shock!

Dangerous high voltages may occur when a current transformer is operated with an open secondary circuit. This can lead to death, injuries and property damage.

- ► Never operate a current transformer with an open secondary circuit; short-circuit the current transformer to prevent this.
- ► Observe the information in the current transformer operating instructions.

NOTICE

Damage to the device!

Electrostatic discharge may cause damage to the device.

- ► Take precautionary measures to prevent the build-up of electrostatic charges on work surfaces and personnel.

5.1 Mounting device

You can mount the device in the following installation versions:

- Mounting kit for wall mounting
- Adapter plate for flush panel mounting

You can replace existing voltage regulators quickly and easily using the available adapter plates. When doing so, observe the corresponding technical documentation for the adapter plates.

You can find more information on the available mounting kits and adapter plates at www.tapcon250.com.

5.2 Connecting device

The following section describes how to establish the electrical connection to the device.

⚠ WARNING

Electric shock!

Connection errors can lead to death, injury or property damage.

- ► Ground the device with a protective conductor using the grounding screw on the housing.
- ► Note the phase difference of the secondary terminals for the current transformer and voltage transformer.
- ► Connect the output relays correctly to the motor-drive unit.

Supply the voltage via separators and ensure that current paths can be short circuited. Fit the separator, clearly labeled, close to the device's power supply so that it is freely accessible. This ensures that the device can be replaced with ease in the event of a defect.

Wiring information

Note this procedure for the wiring:

- ✓ To obtain a better overview when connecting cables, only use as many leads as necessary.
- ✓ Note the connection diagram.
- ✓ Use only the specified cables for wiring. Note the cable recommendation [► 32].
- ✓ Wire the leads to the system periphery [► 37].

1. Strip insulation from leads and wires.
2. Crimp stranded wires with wire end sleeves.

5.2.1 Cable recommendation

Please note the following recommendation from Maschinenfabrik Reinhausen when wiring the device.

Excessive line capacitance can prevent the relay contacts from breaking the contact current. In control circuits operated with alternating current, take into account the effect of the line capacitance of long control cables on the function of the relay contacts.

Cable	Terminal	Cable type	Conductor cross-section	Max. length	Max. permissible torque
CAN bus	P1	Shielded 80 Ω/mile (50 Ω/km)	AWG 18 (1.0 mm²)	1.2 miles (2000 m)	4.5 lb in (0.5 Nm)
Voltage measurement, current measurement	P2.1...P2.6	Unshielded	AWG 12...24 (0.2....3.3 mm²)	-	4.5 lb in (0.5 Nm)
Digital inputs/outputs	P2.7...P2.32	Unshielded	AWG 12...24 (0.2....3.3 mm²)	-	4.5 lb in (0.5 Nm)
Analog inputs/outputs	P2.33...P2.27	Shielded	AWG 12...24 (0.2....3.3 mm²)	-	4.5 lb in (0.5 Nm)
Auxiliary voltage	P3	Unshielded	AWG 12...24 (0.2....3.3 mm²)	-	4.5 lb in (0.5 Nm)

Table 7: Recommendation for connection cables

Use a wire end sleeve for all cables (e.g. TYCO/AMP 131331)

5.2.2 Electromagnetic compatibility

The device has been developed in accordance with applicable EMC standards. The following points must be noted in order to maintain the EMC standards.

5.2.2.1 Wiring requirement of installation site

Note the following when selecting the installation site:

- The system's overvoltage protection must be effective.
- The system's ground connection must comply with all technical regulations.
- Separate system parts must be joined by a potential equalization.
- The device and its wiring must be at least 10 m away from circuit-breakers, load disconnectors and busbars.

5.2.2.2 Wiring requirement of operating site

Note the following when wiring the operating site:

- Route the connecting leads in grounded metal cable ducts.
- Do not route lines which cause interference (e.g. power lines) and lines susceptible to interference (e.g. signal lines) in the same cable duct.

- Maintain a distance of more than 100 mm between lines which cause interference and those which are susceptible to interference.

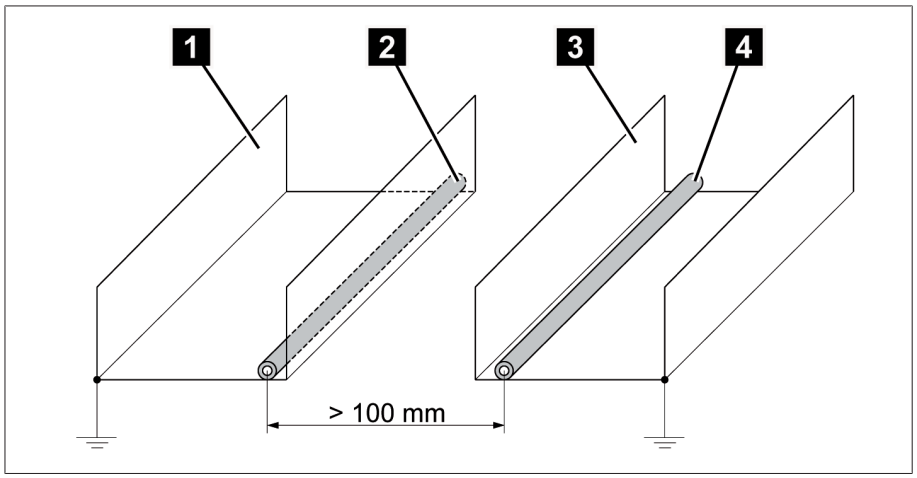


Figure 7: Recommended wiring

1	Cable duct for lines causing interference	3	Cable duct for lines susceptible to interference
2	Line causing interference (e.g. power line)	4	Line susceptible to interference (e.g. signal line)

- Short-circuit and ground reserve lines.
- Never connect the device with a multi-wire collective pipe.
- For signal transmission, use shielded lines with individual conductors (outgoing conductor / return conductor) twisted in pairs.
- Connect full surface of shielding (360°) to device or to a nearby grounding bar.

Using single conductors may limit the effectiveness of the shielding. Connect close-fitting shielding to cover all areas.

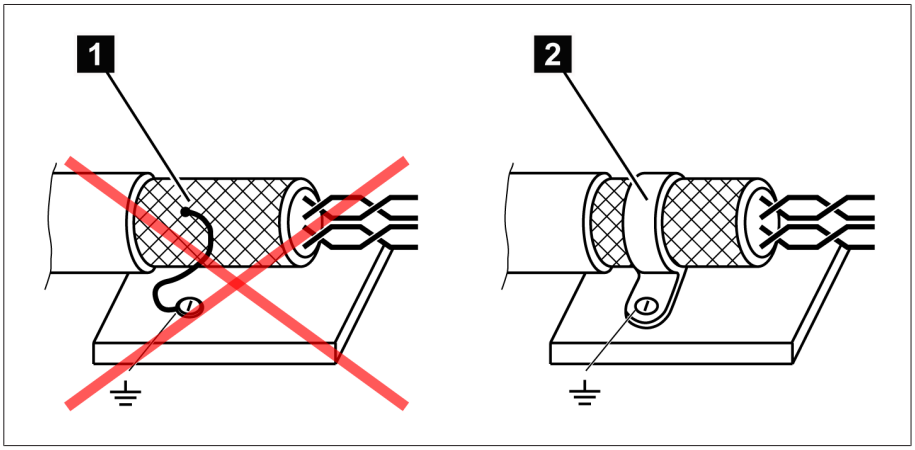


Figure 8: Recommended connection of the shielding

1 Connection of the shielding via a single conductor	2 Full-surface connection of the shielding

5.2.2.3 Wiring requirement in control cabinet

Note the following when wiring the control cabinet:

- The control cabinet where the device will be installed must be prepared in accordance with EMC requirements:
  - Functional division of control cabinet (physical separation)
  - Constant potential equalization (all metal parts are joined)
  - Line routing in accordance with EMC requirements (separation of lines which cause interference and those susceptible to interference)
  - Optimum shielding (metal housing)
  - Overvoltage protection (lightning protection)
  - Collective grounding (main grounding rail)
  - Cable bushings in accordance with EMC requirements
  - Any contactor coils present must be interconnected
- The device's connection cables must be laid in close contact with the grounded metal housing or in metallic cable ducts with a ground connection.
- Signal lines and power lines/switching lines must be laid in separate cable ducts.
- The device must be grounded at the screw provided, the protective grounding connection, using a ground strap (cross-section min. 8 mm²).

5.2.2.4 Information about shielding the CAN bus

In order for the CAN bus to operate faultlessly, you have to connect the shielding using one of the following variants. If you are not able to use any of the variants detailed below, we recommend using fiber-optic cables. Fiber-optic cables decouple the devices and are not sensitive to electromagnetic interference (surge and burst).

NOTICE

Damage to the device!

If you connect the CAN bus cable to devices with different potentials, current may flow across the shielding. This current may damage the device.

► Connect the devices to a potential equalization rail to equalize the potential.

► If both devices have different potentials, only connect the CAN bus cable shielding to one device.

Variant 1: The connected devices share the same potential

If the devices to be connected share the same potential, proceed as follows:

1. Connect all devices to a potential equalization rail to equalize the potential.
2. Connect the CAN bus cable shielding to all connected devices.

Variant 2: The connected devices have different potentials

Note that the shielding is less effective with this variant.

If the devices to be connected have different potentials, proceed as follows:

► Connect the CAN bus cable shielding **to just one** device.

5.2.3 Information about laying fiber-optic cable

To ensure the smooth transfer of data via the fiber-optic cable, you must ensure that mechanical loads are avoided when laying the fiber-optic cable and later on during operation. Also observe the information from the manufacturer of the fiber-optic cable and the following instructions:

- Radii must not fall below the minimum permissible bend radii (do not bend fiber-optic cable).
- The fiber-optic cables must not be over-stretched or crushed. Observe the permissible load values.
- The fiber-optic cables must not be twisted.

- Be aware of sharp edges because they can damage the fiber-optic cable's coating during laying or can place mechanical loads on the coating later on.
- Provide a sufficient cable reserve near distributor cabinets. Lay the reserve such that the fiber-optic cable is neither bent nor twisted when tightened.

5.2.4 Connecting cables to the system periphery

To obtain a better overview when connecting cables, only use as many leads as necessary.

To connect cables to the system periphery, proceed as follows:

✓ Use only the specified cables for wiring. Note the cable recommendation.

► Connect the lines to be wired to the device to the system periphery as shown in the connection diagrams supplied.

5.2.5 Wiring device

To obtain a better overview when connecting cables, only use as many leads as necessary.

To wire the device, proceed as follows:

✓ Only use the specified cables for wiring. Note the cable recommendation [► 32].

✓ Wire the leads to the system periphery [► 37].

► Wire the device according to the connection diagram.

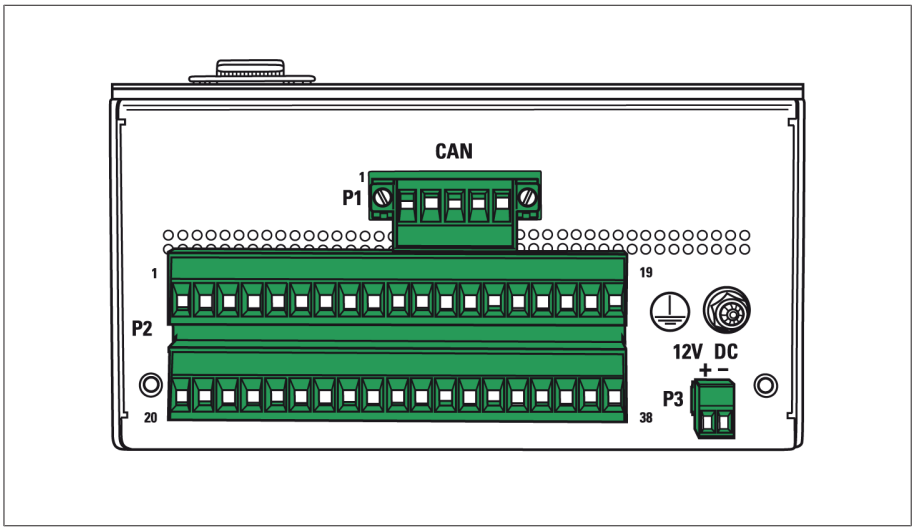


Figure 9: Connection terminals of the device

5.2.5.1 Terminal P1: CAN bus

Terminal P1 is for connecting the device to the CAN bus. You can use the CAN bus to operate several TAPCON® units in parallel.

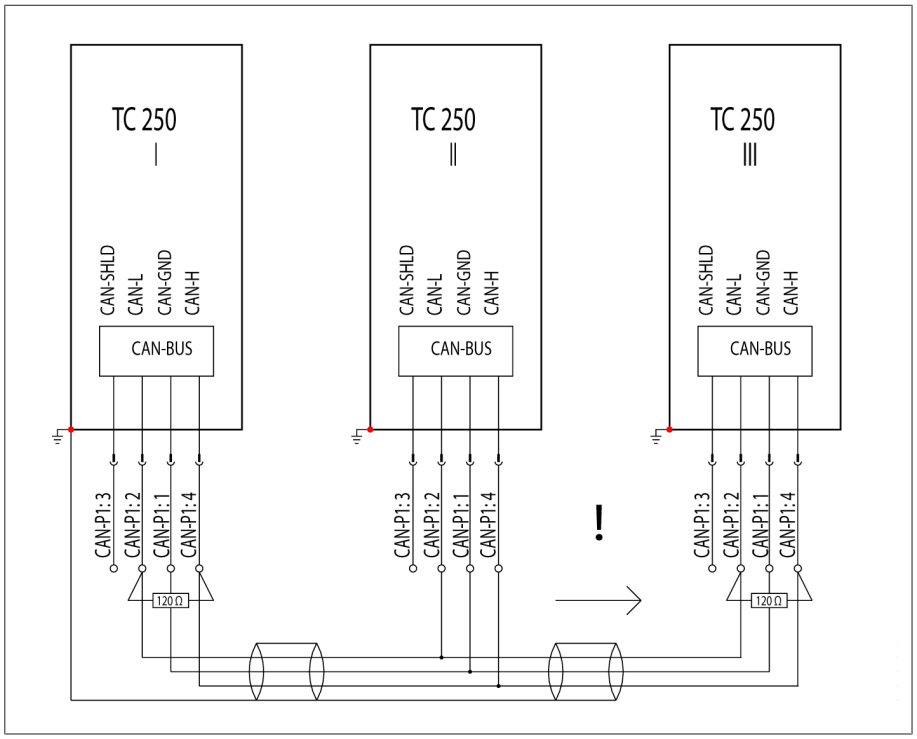


Figure 10: Connection diagram for parallel operation of several TAPCON® 250 units via CAN bus.

You must connect a 120 Ω terminating resistor between connections P1.2 and P1.4 at both ends of the CAN bus (first and last voltage regulators).

Additionally, observe the directions on shielding the CAN bus [▶ 36].

The terminal P1 is assigned as follows:

- P1.1: GND
- P1.2: CAN low
- P1.3: Not connected
- P1.4: CAN high
- P1.5: Not connected (for special applications only)

5.2.5.2 Terminal P2: External connections

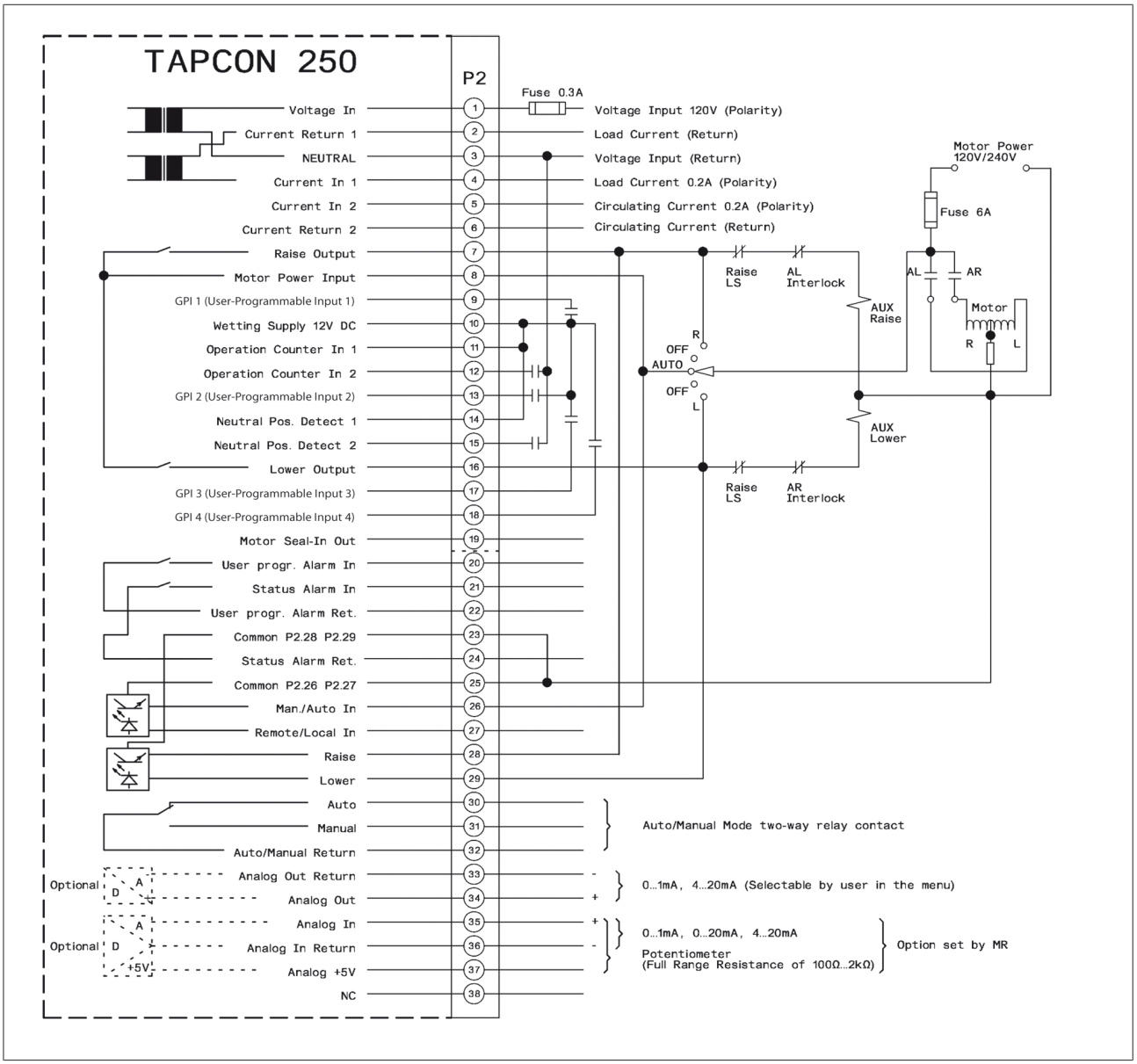


Figure 11: Connection diagram for terminal P2 connections

Note that the two input groups P2.26 (MANUAL/AUTO) and P2.27 (LOCAL/REMOTE), and P2.28 (RAISE) and P2.29 (LOWER) have their own reference potentials. In order to prevent any damage, the signal voltages of the two input groups must therefore refer to the same reference potential.

Connection P2.1, voltage input

Input for voltage measurement and supplying the TAPCON® 250. Permissible voltage range of 85...140 V AC. The power consumption of the TAPCON® 250 is 6...12 VA (depending on the product version). The voltage is in reference to the neutral conductor (P2.3).

If using the device without an adapter plate, you must protect the power supply circuit with a fuse with the following rated value: 250 V, 300 mA, and with a "fast-acting" characteristic (e. g. LITTELFUSE #312300).

Connection P2.2, load current (return conductor)

Connection for the current transformer return conductor.

Connection P2.3, neutral

Return conductor for the *voltage input* (P2.1) and the 12 V DC supply voltage (P2.10).

Connection P2.4, load current (outgoing conductor)

Input for load current measurement. Permissible current range 0...420 mA (200 mA continuous). Load current measurement is used for the "line drop compensation (LDC)" function and for measured value calculation.

Connections P2.5 and P2.6

Connections P2.5 and P2.6 are not used and are bridged.

Connection P2.7, tap changer raise output

This switched output connects the raise winding of the motor-drive unit to the source of the motor supply (connection P2.8). The maximum switching capacity for the output is 6 A at 120/240 V AC.

Connection P2.8, input for supplying the motor-drive unit

Connection for supplying the motor-drive unit. Maximum permissible voltage of 240 V AC.

Connections P2.9 GPI1, P2.13 GPI2, P2.17 GPI3, P2.18 GPI4

You can link these inputs up to various voltage regulator functions (see [► 94]). The inputs are activated with 12 V DC from connection P2.10.

Connection P2.10, 12 V DC auxiliary voltage output

Auxiliary voltage output (12 V DC) for wiring the general purpose inputs (GPI). Depending on the voltage at P2.1 and the connected load, the output voltage is 10...18 V DC and the maximum current is 100 mA. Note that the output is not internally protected.

Connections P2.11 and P2.12, operations counter

Digital input for recording the number of tap-change operations. The input is electrically isolated so that a main switching contact can be connected in-line to the auxiliary voltage at P2.10 (12 VDC) or to an external control voltage (<24 VDC) at P2.11. The operations counter is increased each time the connection P2.12 is switched to ground/neutral without current via the N/O contact.

Connections P2.14 and P2.15, input for neutral position detection

Digital inputs for capturing the neutral position. The connections are isolated so that you can connect the switch in-line to the supply voltage or the neutral conductor. Connection P2.14 is normally connected to the auxiliary supply voltage P2.10.

Connection P2.16, tap changer lower output

This switched output connects the lower winding of the motor-drive unit to the source of the motor supply (connection P2.8). The maximum switching capacity for the output is 6 A at 120/240 V AC.

Connection P2.19

Connection P2.19 is reserved for special application cases.

Connections P2.20 and P2.22, freely configurable alarm

This connection pair is a relay to the alarm signal (6 A at 120 V AC) that operates in accordance with the open-circuit principle. The relay closes if the requirements for the alarm configured in the voltage regulator are met. Setting user-defined collective message [► 96]

Connections P2.21 and P2.24, alarm signal self-test

This connection pair is a relay to the alarm signal (6 A at 120 V AC) that operates in accordance with the closed-circuit principle. The relay closes in the event of a fault in the voltage supply or the microcontroller.

Connection P2.23, common P2.28 and P2.29

This is the common connection for inputs P2.28 and P2.29.

Connection P2.25, common P2.26 and P2.27

This is the common connection for inputs P2.26 and P2.27.

Connection P2.26, MANUAL/AUTO input

This input is used for connecting an external MANUAL/AUTO switch. You can activate the voltage regulator's Auto operating mode with this switch. The Auto operating mode is active if you apply 120 V AC. The Manual operating mode is active if there is no voltage applied at the input.

Connection P2.27, Local/Remote input

This input is used for connecting an external remote switch. You can activate the voltage regulator's Remote operating mode with this switch. (e. g. for operation via a control system). The Remote operating mode is active if you apply 120 V AC. The Local operating mode is active if there is no voltage applied at the input.

Connections P2.28 and P2.29, raise/lower tap-change operation display input

These inputs are used for displaying Raise or Lower tap-change operations. They are commonly connected to connections P2.7 and P2.16 in order to detect Raise/Lower tap-change operations triggered by the device or Raise/Lower tap-change operations through external switches.

Connections P2.30 and P2.31, Auto/Manual status output

This connection pair is a relay for outputting the current operating mode (Auto/Manual) If the device is de-energized, the relay is in the Manual position.

Connection P2.32

This connection is the source contact of relay P2.30/31.

Only use shielded cables for connecting analog signals (pins P2.33...P2.37). Place the shield only on the housing of the TACON® 250.

Connection P2.33, tap position (-) analog output, optional

Negative pole for analog tap position output.

Connection P2.34, tap position (+) analog output, optional

Positive pole for analog tap position output 0...1 mA or 4...20 mA (adjustable). Requires the AI module.

Connection P2.35, tap position (+) analog input, optional

Input (+) for tap position capture as 0...1 mA or 4...20 mA analog signal. When using a potentiometer, this is the connection for the "tapping".

The total resistance between pins P2.36 and P2.37 must not be greater than 2 kΩ. Take this into consideration when selecting the cables.

Connection P2.36, tap position (-) analog input, optional

Input (+) for tap position capture as an analog signal. When using a potentiometer, this is the connection for "minimum".

Connection P2.37, supply for potentiometer (+5 V) analog input, optional

Internal voltage output +5 VDC. When using a potentiometer, this is the connection for "maximum".

Connection P2.38

The connection P2.38 is not used.

5.2.5.3 Terminal P3: Auxiliary supply voltage

The device is normally supplied by the voltage transformer. Alternatively, you can supply the device via an external auxiliary voltage 12 V DC, 1 A to ensure operation of the device even when the transformer is switched off.

Proceed as follows to supply the device with auxiliary voltage:

► Connect the auxiliary voltage to terminal P3 (P3.1 = +, P3.2 = -).

5.2.6 Checking functional reliability

To ensure that the device is wired correctly, check its functionality.

NOTICE

Damage to device and system periphery

An incorrectly connected device can lead to damages in the device and system periphery.

► Check the entire configuration before commissioning.

► Prior to commissioning, be sure to check the actual voltage and operating voltage.

Check the following:

- Once you have connected the device to the grid, the screen displays the MR logo and then the operating screen.
- The green *Operating display* LED at the bottom right of the device's front panel lights up.

The device is fully mounted and can be configured. The actions required for this are described in the following chapter.

6 Commissioning

You need to set several parameters and perform function tests before commissioning the device. These are described in the following sections.

NOTICE

Damage to device and system periphery

An incorrectly connected device can lead to damages in the device and system periphery.

- ► Check the entire configuration before commissioning.
- ► Prior to commissioning, be sure to check the actual voltage and operating voltage.

We recommend using a device for industrial instrumentation to record the actual transformer voltage value in order to evaluate how the device is functioning.

6.1 Function tests

Before switching from manual mode to auto mode, Maschinenfabrik Reinhausen recommends carrying out function tests. These function tests are described in the following sections. Note the following points for all function tests:

- You must ensure that REMOTE mode is disabled before you can control the on-load tap-changer manually in manual mode.
- You can only activate the on-load tap-changer manually in manual mode using the RAISE and LOWER keys.
- During the function test, you must set the most important parameters. Details on the parameters listed can be found in the Operation [► 55] chapter.

6.1.1 Checking control functions

This section describes how you can check the device's control functions:

✓ Supply voltage must be present.

1. Press MANUAL to select manual mode.
2. Set transmission ratio for voltage transformer, current transformer and measuring set-up.
3. Measure actual voltage and compare with the measured value displayed on the device's main screen.

4. Press [···→] key several times to display the operating values for current, power and phase angle and compare them with values of service instruments.
5. Control the on-load tap-changer manually with the [RAISE] or [LOWER] keys until the measured voltage (U_{actual}) reaches the desired voltage ($U_{desired}$) set in the next stage.
6. Set desired value 1 to the value you want.
7. Set bandwidth depending on step voltage [► 72].
8. Set delay time T1 to 20 seconds [► 75].
9. Set control response T1 to linear [► 76].
10. Press [RAISE] to raise the on-load tap-changer 1 step.
11. Press [AUTO] to select auto mode.
    ⇨ After 20 seconds, the device returns the on-load tap-changer to the original operating position.
12. Press [MANUAL] to select manual mode.
13. Press [LOWER] to lower the on-load tap-changer 1 step.
14. Press [AUTO] to select auto mode.
    ⇨ After 20 seconds, the device returns the on-load tap-changer to the original operating position.
15. Press [MANUAL] to select manual mode.
16. Set delay time T2 to 10 seconds [► 77].
17. Activate delay time T2.
18. Press [RAISE] twice to raise the on-load tap-changer 2 steps.
19. Press [AUTO] to select auto mode.
    ⇨ After 20 seconds, the device lowers the on-load tap-changer one step and after another 10 seconds another step.
20. Press [MANUAL] to select manual mode.
21. Set delay time T1 [► 75] and delay time T2 [► 77] to the desired value.

We recommend a temporary setting of 100 seconds for **delay time T1** when commissioning the transformer. Depending on the operating conditions, you can also specify the delay time following a longer observation period. In this regard, it is useful to register how the actual voltage progresses and the number of tap-change operations per day.

6.1.2 Checking additional functions

This section describes how you can check the following additional functions:

- Undervoltage blocking
- Overvoltage blocking
- R&X compensation
- Z compensation
- Desired value 2, 3 and 4

Checking undervoltage blocking U<

✓ The measured voltage is 120 V.

1. Press MANUAL to select manual mode.
2. Set the desired value 1 parameter to 130 V.
3. Set the undervoltage U< parameter to 125 V.
4. Set the U< blocking parameter to On.
   ⇨ The *Undervoltage U<* LED will light up.
   ⇨ The *undervoltage* message appears in the display after approx. 10 seconds.
5. Press AUTO to select auto mode.
   ⇨ The device blocks and does not issue any control commands.
6. Press MANUAL to select manual mode.
7. Reset the **desired value 1** and **undervoltage U<** parameters to the desired operating values.

⇨ The function test for undervoltage blocking is complete.

Checking overvoltage blocking U>

✓ The measured voltage is 120 V.

1. Press MANUAL to select manual mode.
2. Set the desired value 1 parameter to 110 V.
3. Set the overvoltage U> parameter to 115 V.
   ⇨ The *overvoltage U>* LED will light up.
   ⇨ The *overvoltage* message appears in the display.
4. Press AUTO to select auto mode.
   ⇨ The LOWER output relay emits a control command every 1.5 seconds.
5. Press MANUAL to select manual mode.

6. Reset the operating values for **desired value 1** and **overvoltage U>** to the desired operating values.

⇨ The function test for overvoltage blocking is complete.

Checking R&X compensation

If you want to use R&X compensation, you need to run this function test. A load current of ≥ 10% of the nominal transformer current must flow for the following function tests.

1. Press MANUAL to select manual mode.
2. Set all parameters for R&X compensation and Z compensation to 0.
3. Press ESC until the main screen is displayed.
4. If necessary, press ···→ until the control deviation **dU** is shown.
   ⇨ The measured voltage must be within the bandwidth.
5. Set line drop compensation Ur parameter to 20.0 V.
6. Press ESC until the main screen is displayed.
7. If necessary, press ···→ until the control deviation **dU** is shown.
   ⇨ The value for control deviation dU must be negative.
8. Set line drop compensation Ur parameter to -20.0 V.
9. Press ESC until the main screen is displayed.
10. If necessary, press ···→ until the control deviation **dU** is shown.
    ⇨ The value for control deviation **dU** must be positive.

If the control deviation appears in the opposite direction, change the polarity of the current transformer.

11. Set the **line drop compensation Ur** and **line drop compensation Ux** parameters to the desired operating values.

⇨ The function test for line drop compensation is complete.

Checking Z compensation

If you want to use Z compensation, you need to run this function test. A load current of ≥ 10 % of the nominal transformer current is needed for the following function test .

1. Press MANUAL to select manual mode.
2. Set all parameters for R&X compensation and Z compensation to 0.
3. Press ESC until the main screen is displayed.

4. If necessary, press [···→] until the control deviation **dU** is shown.
   ⇨ The measured voltage must be within the bandwidth.
5. Set the Z compensation parameter to 15.0 V.
6. Press [ESC] until the main screen is displayed.
7. If necessary, press [···→] until the control deviation **dU** is shown.
   ⇨ The control deviation dU must be negative.

If the control deviation appears in the opposite direction, change the polarity of the current transformer.

8. Set the **Z compensation** and **Z compensation limit value** parameters to the desired operating values.

⇨ The function test for Z compensation is complete.

Checking the changeover to desired value 2, 3, and 4

To check the changeover to the desired value 2, 3 and 4, proceed as follows:

✓ The inputs GPI 1 (P2.9) and GPI 2 (P2.13) are connected to the +12 VDC supply voltage by means of a switch.

1. Press [MANUAL] to select manual mode.
2. Assign the function AVL2 to input GPI 1 [► 94].
3. Assign the function AVL3 to input GPI 2.
4. Set the parameters for desired value 1, desired value 2, desired value 3, and desired value 4 to various values [► 69].
5. To apply a signal at GPI 1, close the switch.
   ⇨ The value set for desired value 2 is displayed on the main screen (U_{ref}).
6. Close the switch in order to apply a signal at GPI 2.
   ⇨ The value set for the desired value 3 is displayed on the main screen (U_{ref}).
7. To apply a signal at GPI 1 and GPI 2, close the switch.
   ⇨ The value set for the desired value 4 is displayed on the main screen (U_{ref}).
8. Open the switches.

⇨ The value set for the desired value 1 is displayed on the main screen (U_{ref}). The function test is complete.

6.2 Setting parameters

To commission the device, you must set the following parameters. For more detailed information about the parameters, refer to the respective sections.

6.2.1 Setting the language

You can use this parameter to set the display language for the device. The following languages are available:

English	Spanish
German	Portuguese
French	

To set the language, proceed as follows:

1. MENU > F4 Configuration > F3 General.
   ⇨ Language
2. Press F1 or F5 to select the required language.
3. Press ↵.

⇨ The language is set.

6.2.2 Setting date and time

You must set the system date and system time on the device. You must set the date and time in the following formats:

Date	Time
DD.MM.YY	HH:MM:SS

Table 8: Formats

The time does not switch from daylight saving time to standard time and back automatically. You have to change the time manually.

Time

To set the time, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F5 Continue > F4 Memory > Press ⇢ until the desired display appears.
   ⇨ Time
2. Press F4 to highlight a digit.
   ⇨ The desired position is highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ↵.

⇨ The time is set.

Date

To set the date, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F5 Continue > F4 Memory > Press ⇢ until the desired display appears.
   ⇨ Date
2. Press F4 to highlight a digit.
   ⇨ The desired position is highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ↵.

⇨ The date is set.

6.2.3 Setting further parameters

Set further parameters to commission the device. You will find more detailed information about the respective parameters in the Operation [► 55] chapter.

Setting transformer data [► 88]

Set the transformer data and phase difference of the current transformer and voltage transformer:

1. Set primary transformer voltage.
2. Set secondary transformer voltage.
3. Set primary transformer current.
4. Select transformer circuit.

Setting NORMset [► 64]

If you want to commission voltage regulation quickly, you can activate NORMset mode. If you want to set the parameters yourself, continue with "Setting control parameters".

► Activate NORMset and set the relevant parameters.

Setting control parameters [► 66]

Set the following control parameters:

1. Set desired value 1.
2. Set the bandwidth.
3. Set delay time T1.

Setting R&X compensation (optional)

If you need R&X compensation [► 84], you must set the parameters required for this:

1. Set the ohmic voltage drop Ur.
2. Set the inductive voltage drop Ux.

Setting Z compensation (optional)

If you need Z compensation [► 87], you must set the parameters required for this:

1. Set voltage increase.
2. Set voltage limit value.

Setting parallel operation (optional)

If you need parallel operation, you must set the parameters required for this. You will find more information on parallel operation in the "Parallel operation [► 97]" section.

Setting tap position capture via analog input (optional)

If you want to capture the tap position via the analog input, you must set the parameters [► 124] required for this

Setting the desired voltage level remotely (optional)

If you want to set the desired voltage level remotely, you must set the parameters required for this.

- Desired value selection by means of customer input [► 94]
- Desired value setting by means of analog input [► 69]

Setting control system protocol (optional)

If you require a control system protocol, you must set the parameters [► 117] required for this.

7 Operation

This chapter describes all the functions and setting options for the device.

7.1 General

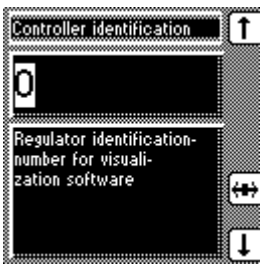
You can undertake general settings on the device in the **General** menu item.

- Language [► 51]
- Device ID
- Baud rate (COM2 setting)
- Voltage display V/kV
- Electrical current display unit
- Switching pulse time
- Consumption interval
- Motor runtime
- Behavior in the event of negative power flow
- Local/Remote and Manual/Auto signal type

7.1.1 Setting device ID

You can use the device ID parameter to assign a 4-digit ID to the device. This ID is used to uniquely identify the device in the TAPCON®-trol software.

To set the device ID, proceed as follows:



1. MENU > F4 Configuration > F3 General > Press ⋯→ until the desired parameter is displayed.
   ⇨ Regulator ID.
2. Press F1 to change the first digit.
   ⇨ If you wish to enter a multi-digit sequence, proceed to step 3. If you do not wish to enter additional digits, proceed to step 7.
3. Press F1 (digit > 9) until another digit position appears.
4. If necessary, press F4 in order to highlight the digit position.
   ⇨ The required digit is highlighted and can be changed.
5. Press F1 or F5 to change the digit.
6. Repeat steps 3 to 5 until all required digits have been entered.
7. Press ↵.

⇨ The device ID is set.

7.1.2 Setting the baud rate

You can use this parameter to set the COM2 interface's baud rate. You can select the following options:

- 9.6 kilobaud
- 19.2 kilobaud
- 38.4 kilobaud
- 57.6 kilobaud

To set the baud rate, proceed as follows:

1. MENU > F4 Configuration > F3 General > Press ⇢ until the desired parameter is displayed.
   ⇨ Baud rate
2. Press F1 or F5 to select the required baud rate.
3. Press ↵.

⇨ The baud rate is set.

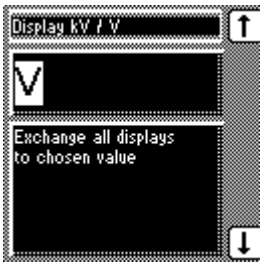
7.1.3 Setting the voltage display kV/V

This parameter sets how the measured voltage is displayed and used. You can select the following options:

- V: The secondary voltage of the system's voltage transformer is displayed in V and is the reference value for the control parameters.
- kV: The primary voltage of the system's voltage transformer is displayed in kV and is the reference value for the control parameters.

The voltage transformer's primary voltage is calculated by the device. For correct functions, you must set the transformer data.

To change the desired unit for the voltage display, proceed as follows:



1. Press MENU > F4 Configuration > F3 General > ⇢ until the desired parameter is displayed.
   ⇨ Display kV/V.
2. Press F1 or F5 to select kV or V units.
3. Press ↵.

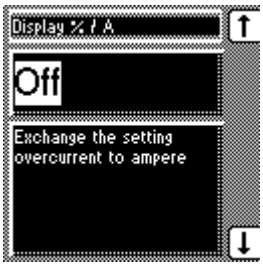
⇨ The required unit is set for the voltage display.

7.1.4 Setting current display unit

In this display, you can set the unit for the limit values displayed for overcurrent and undercurrent as a percentage ("%") or absolute value ("A").

It is only possible to change from % to A if all the transformer data have previously been entered.

To set the desired unit for the current display, proceed as follows:



1. Press MENU > F4 Configuration > F3 General > ⋯→ until the desired parameter is displayed.
   ⇨ Display %/A
2. Press F1 or F5 to select % or A units.
3. Press ↵.

⇨ The required unit is set for the current display.

7.1.5 Setting the switching pulse time

You can use this parameter to set the duration of the switching pulse for the motor-drive unit.

If you set the switching pulse time to 0 s, the motor-drive unit is activated with a continuous signal. The signal then remains active for as long as the or keys are pressed.

Switching pulse in normal mode

If you set the switching pulse time to 1.5 seconds for example, after the set **delay time T1** or **delay time T2** 1 there will be a switching pulse of 1.5 seconds 2.

The waiting time between 2 consecutive switching pulses corresponds to the set **delay time T1** or **delay time T2** **1**.

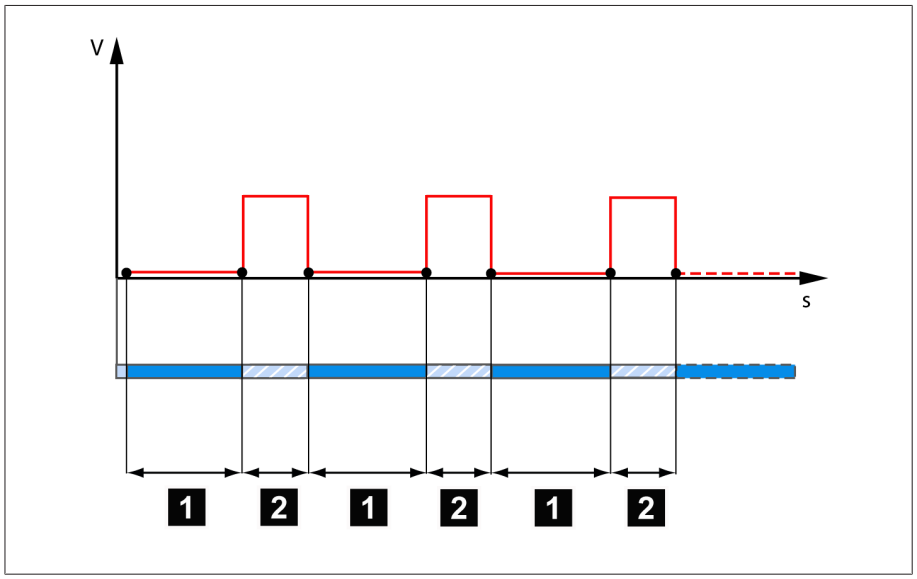


Figure 19: Switching pulse time in normal mode

1 Set delay time T1 or T2	2 Set switching pulse time (for example 1.5 seconds)

If the motor-drive unit does not start with the factory setting (1.5 seconds), you need to extend the raise switching pulse time / lower switching pulse time.

Switching pulse for rapid return control

If you set the raise switching pulse time or lower switching pulse time to 1.5 seconds, for example **2**, the next earliest switching pulse occurs in rapid return control mode **3** 1.5 seconds after the previous switching pulse ended.

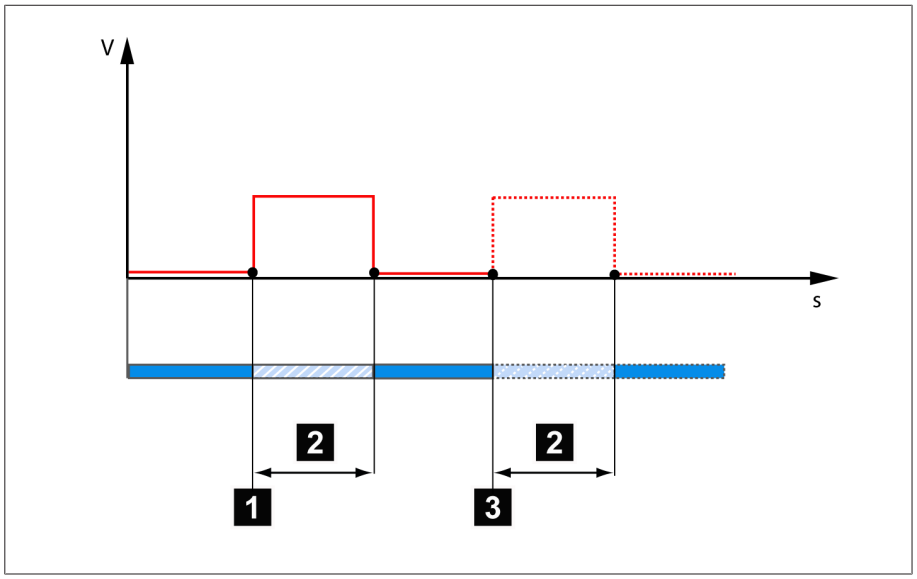
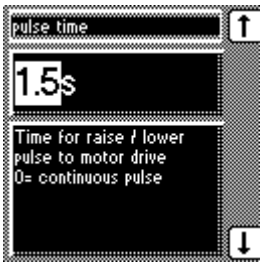


Figure 20: Switching pulse in rapid return control mode

1 Start of first raise switching pulse/lower switching pulse	3 Earliest time for the next raise switching pulse/lower switching pulse (for example 1.5 seconds)
2 Set switching pulse time (for example 1.5 seconds)	



To set the pulse duration, proceed as follows:

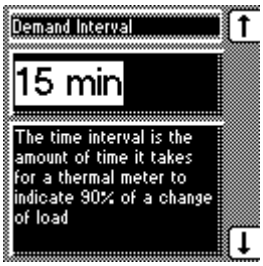
1. MENU > F4 Configuration > F3 General > Press ⋯→ until the desired parameter is displayed.
   ⇨ R/L pulse duration.
2. Press F1 or F5 to select the pulse duration you want.
3. Press ↵.

⇨ The R/L pulse duration is now set.

7.1.6 Setting the consumption interval

You can use this parameter to set the time constant for simulating an analog wattmeter. This time constant displays the time after which 90% of a charge change has been reached. This setting has an influence on the peak display and the average value display in the *Information* menu.

To set the consumption interval, proceed as follows:



1. MENU > F4 Configuration > F3 General > Press ⋯→ until the desired parameter is displayed.
   ⇨ Consumption interval.
2. Press F1 or F5 to select the desired consumption interval.
3. Press ↵.

⇨ The consumption interval is set.

7.1.7 Setting motor runtime monitoring

You can use this motor runtime parameter to set the motor runtime. The motor-drive unit's runtime can be monitored by the device. This function is used to identify motor-drive unit malfunctions during the tap-change operation and to trigger any actions needed.

Behavior

The motor-drive unit issues the *Motor-drive unit running* signal during the tap-change operation. This signal is present until the tap-change operation is complete. The device compares the duration of this signal with the set motor runtime. If the set motor runtime is exceeded, the device triggers the following actions:

1. *Motor runtime monitoring* message is issued
2. Continuous signal via output relay *Motor-drive unit runtime exceeded* (optional)
3. Pulse signal via *Trigger motor protective switch* output relay (optional)

Parameterizing control input

To use runtime monitoring, you need to correctly wire the corresponding control input and parameterize to *Motor running*. The motor runtime must also be set.

Wiring control input/output relay

If you want to monitor the motor runtime, the device and motor-drive unit must be connected and parameterized as shown below.

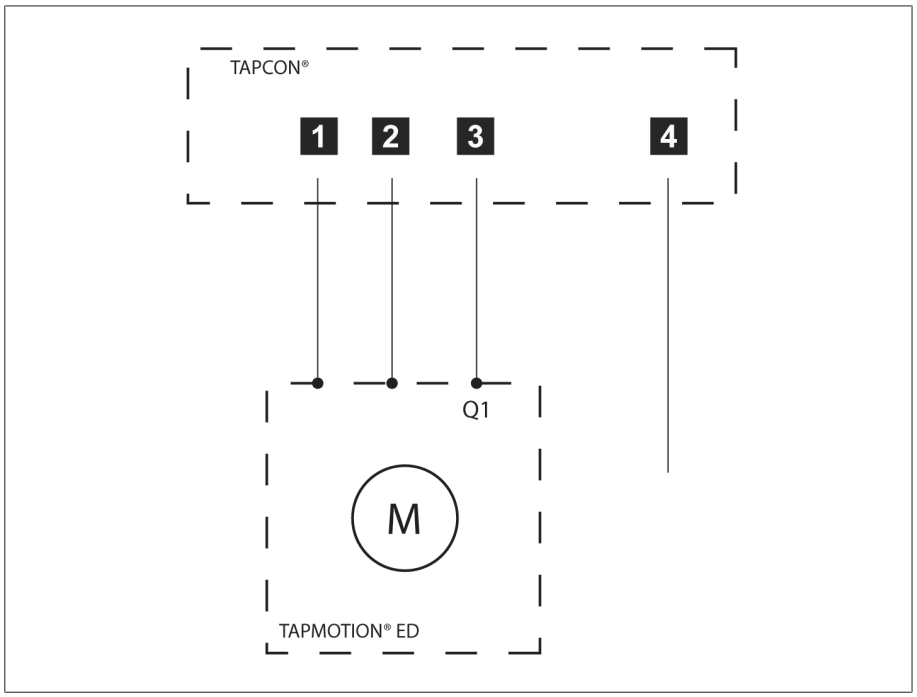


Figure 23: Wiring for motor runtime monitoring

1 *Motor running* control input I/O	3 *Motor protective switch* output relay I/O (optional)
2 *Motor protective switch triggered* control input I/O (optional)	4 *Motor-drive unit runtime exceeded* output relay I/O (optional)

If you want to use the output relay, the feedback from the motor-drive unit *Motor protective switch triggered* must also be wired to a control input and parameterized. This message resets the *Motor runtime exceeded* output relay when the motor protective switch is switched back on and activates the *Motor protective switch triggered* message.

If the runtime monitoring is set to 0.0 seconds this equates to it being switched off.

To set the motor runtime, proceed as follows:

1. MENU > F4 Configuration > F3 General > Press ⇢ until the desired parameter is displayed.
   ⇨ Motor runtime.
2. Press F4 to highlight the position.
   ⇨ The desired position is highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ↵.

⇨ The motor runtime is set.

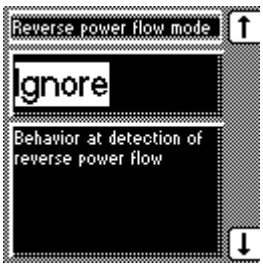
7.1.8 Setting the behavior in the event of negative active power flow

You can use this parameter to set the behavior of the device in the event of negative active power flow.

You can set the following options:

Option	Description
Ignore	Off
Block	Automatic voltage regulation blocked
To neutral	Switch the on-load tap-changer to the "neutral" position

Table 9: Options in the event of negative active power flow



To set the behavior in the event of negative active power flow, proceed as follows:

1. MENU > F4 Configuration > F3 General > Press ⇢ until the desired parameter is displayed.
   ⇨ Reverse power flow behavior
2. Press F1 or F5 to select the option you want.
3. Press ↵.

⇨ The behavior in the event of negative active power flow is set.

7.1.9 Defining the signal type

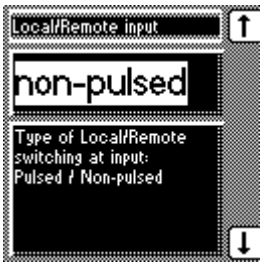
You can use this parameter to define the behavior of the inputs. You can change the operating modes Local/Remote and Manual/Auto using the inputs.

You can set the following signal types:

Signal type	Description
Pulsed	▪ Set up the pulse signal to switch from Manual to Auto or from Local to Remote. ▪ Operating controls can be used.
Not pulsed	▪ Apply a continuous signal to switch from Manual to Auto or from Local to Remote. ▪ If a continuous signal is applied, switching is not possible by means of the operating controls.

Table 10: Signal type

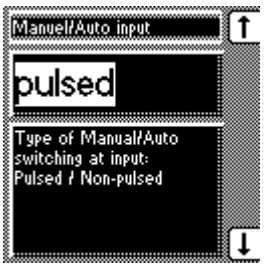
To set the signal type of the Local/Remote input, proceed as follows:



1. MENU > F4 Configuration > F3 General > Press ⇢ until the desired parameter is displayed.
   ⇨ Local/Remote input.
2. Press F1 or F5 to select the signal type.
3. Press ↵.

⇨ The signal type is set.

To set the signal type of the Manual/Automatic input, proceed as follows:



1. MENU > F4 Configuration > F3 General > Press ⇢ until the desired parameter is displayed.
   ⇨ Manual/Automatic input.
2. Press F1 or F5 to select the signal type.
3. Press ↵.

⇨ The signal type is set.

7.2 Key lock

The device is equipped with a key lock to prevent unintentional operation. You can only set or change the parameters when the key lock is deactivated in manual mode.

Activating key lock

To activate the key lock, proceed as follows:

► Press ESC and F5 at the same time.

⇨ A confirmation appears in the display for a brief period. The key lock is activated. Parameters can no longer be entered.

Deactivating key lock

To deactivate the key lock, proceed as follows:

► Press ESC and F5 at the same time.

⇨ The key lock is deactivated. Parameters can be entered.

7.3 NORMset

NORMset mode is used for quickly starting voltage regulation. In NORMset mode, the bandwidth and delay time parameters are automatically adapted to the requirements of the grid.

To start NORMset mode, you must set the following parameters:

- Normset activation
- Desired value 1
- Primary voltage
- Secondary voltage

Line drop compensation cannot be performed in NORMset mode.

Set the following parameters to operate the device in NORMset mode.

Activating/deactivating NORMset

You can use this parameter to activate NORMset mode.

A manual tap-change operation is required to activate NORMset. This is how the voltage regulator determines the bandwidth required.

If the transformer is switched off, another manual tap-change operation is required.

To activate/deactivate NORMset mode, proceed as follows:

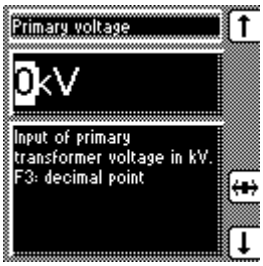
1. MENU > F2 NORMset
   ⇨ NORMset activation.
2. Press F1 or F5 to activate NORMset by selecting **On** or to deactivate NORMset by selecting **Off**.
3. Press ↵.

⇨ NORMset is activated/deactivated.

Setting the primary voltage

With this parameter, you can set the voltage transformer's primary voltage.

Proceed as follows to set the primary voltage:



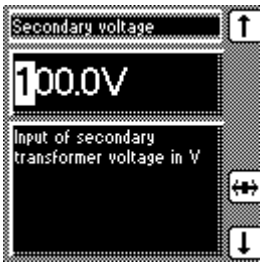
1. MENU > F2 NORMset > Press ⇢ until the desired parameter is displayed.
   ⇨ Primary voltage.
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵.

⇨ The primary voltage is set.

Setting the secondary voltage

With this parameter, you can set the voltage transformer's secondary voltage.

Proceed as follows to set the secondary voltage:



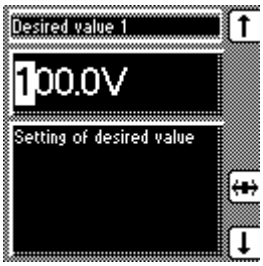
1. MENU > F2 NORMset > Press ⇢ until the desired parameter is displayed.
   ⇨ Secondary voltage.
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵.

⇨ The secondary voltage is set.

Setting desired value 1

With this parameter, you can set the desired value for automatic voltage regulation. You can enter the desired value in V or in kV. If you enter the desired value in V, the value relates to the voltage transformer's secondary voltage. If you set the desired value in kV, the value relates to the voltage transformer's primary voltage.

Settings in kV are only possible if you have previously entered the parameters for primary and secondary voltage.



To set the desired value, proceed as follows:

1. MENU > F2 NORMset > Press ···→ until the desired parameter is displayed.
   ⇨ Desired value 1.
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵.

⇨ The desired value is set.

7.4 Control parameters

All of the parameters required for the regulation function are described in this section. For voltage regulation, you can set the following parameters:

- Desired values 1…4
- Bandwidth
- Delay time T1
- Control response T1
- Delay time T2

For voltage regulation, you can set delay time T1 and also delay time T2. The following sections describe how the regulation function responds in both cases:

Behavior only with delay time T1

If the measured voltage U_{actual} 5 is within the set bandwidth 6, no control commands are issued to the motor-drive unit for the tap-change operation. Control commands will also not be issued to the motor-drive unit if the measured voltage returns to the tolerance bandwidth 6 within the set delay time T1 4. However, if the measured voltage deviates from the set bandwidth for a long period C, a tap-change command D occurs after expiration of the set delay time T1. The on-load tap-changer carries out a tap-change in a raise or lower direction to return to the tolerance bandwidth.

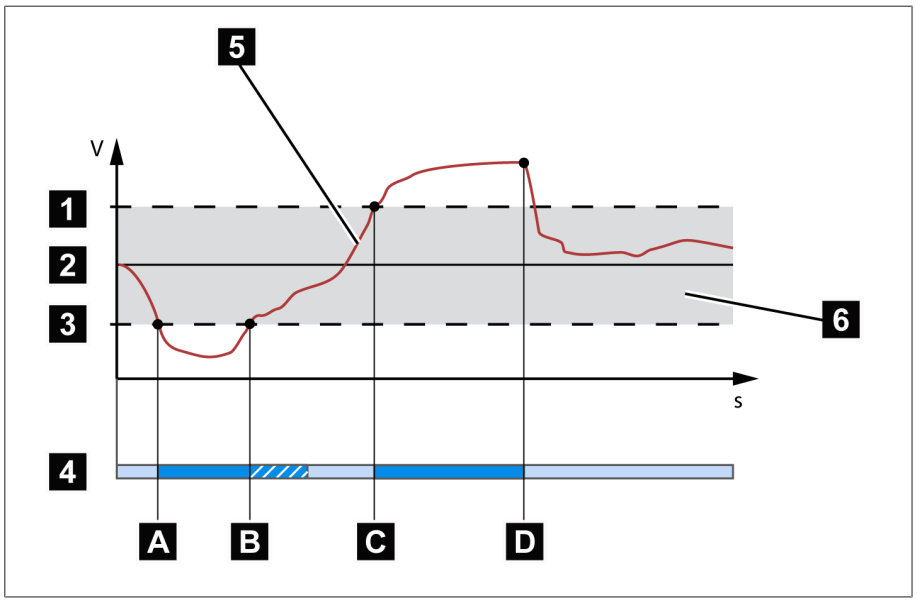


Figure 27: Behavior of the regulation function with delay time T1

1	+ B %: Upper limit	4	Set delay time T1
2	$U_{desired}$: Desired value	5	U_{actual}: Measured voltage
3	- B %: Lower limit	6	B%: Tolerance bandwidth
A	U_{actual} is outside the bandwidth. Delay time T1 starts.	B	U_{actual} is within the bandwidth before delay time T1 is complete.
C	U_{actual} is outside the bandwidth. Delay time T1 starts.	D	U_{actual} is still outside the bandwidth when delay time T1 is complete. Tap-change operation is initiated.

Behavior with delay times T1 and T2

Delay time T2 can be used to correct major control deviations more quickly. Ensure that you set a lower value in the "Delay time T2" parameter than in the "Delay time T1" parameter.

If the measured voltage U_{actual} **5** deviates from the set bandwidth for a long period **A**, a control impulse is output to the motor-drive unit after the set delay time T1 **B**. If the measured voltage U_{actual} is still outside the bandwidth, delay time T2 **B** starts once delay time T1 is complete. Once delay time T2 is complete, a control impulse is again output to the motor-drive unit for the tap change **C** to return to the tolerance bandwidth.

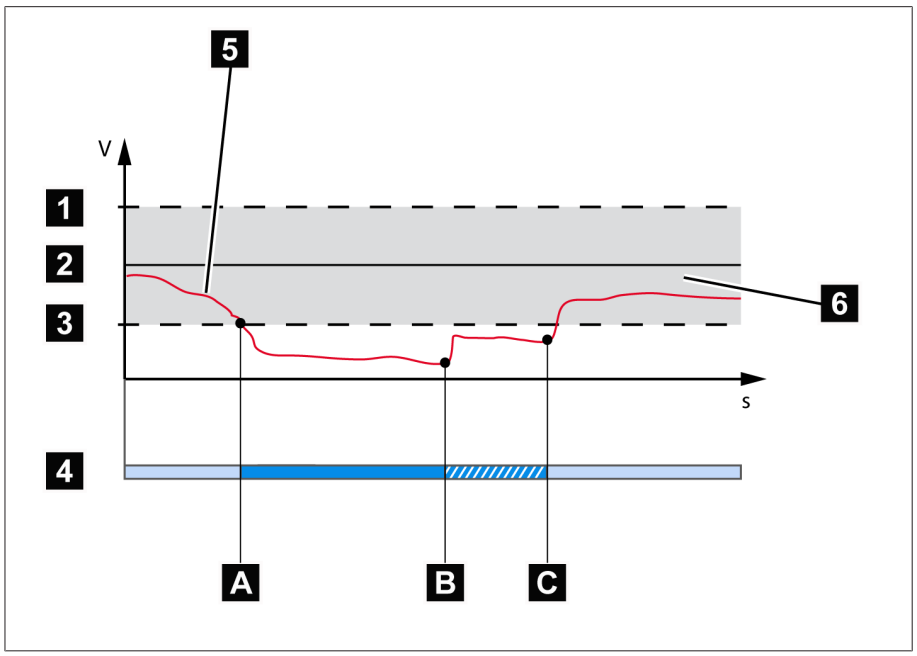


Figure 28: Behavior of the regulation function with delay times T1 and T2

1	+ B %: Upper limit	4	Set delay times T1 and T2.
2	$U_{desired}$: Desired value	5	U_{actual}: Measured voltage
3	- B %: Lower limit	6	B%: Tolerance bandwidth
A	U_{actual} is outside the bandwidth. Delay time T1 starts.	B	Delay time T1 complete. Tap change triggered.
C	Delay time T2 complete. Tap change triggered.		

The following sections describe how to set the relevant control parameters.

7.4.1 Setting desired value 1...4

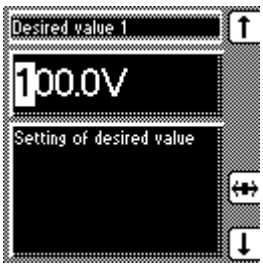
You can use these parameters to set up to 4 desired voltage values $U_{desired}$. The desired voltage value is specified as a fixed value. The desired value **1** is the default desired value.

The desired values 2 and 3 are activated by selecting the correct function for the customer inputs (GPI) and applying a continuous signal to the input. For desired value 4, note that you have to apply a continuous signal to the inputs for desired value 2 and desired value 3.

Reference of kV and V for voltage transformer

Desired values set in kV refer to the primary voltage of the voltage transformer. Desired values set in V refer to the secondary voltage of the voltage transformer. The transformer data must be entered correctly for this display.

To set the desired value, proceed as follows:



1. MENU > F3 Parameter > F2 Control parameter > Press ⋯→ until the desired parameter is displayed.
2. If you have already entered the transformer data, press F3 to select the unit you want: "V" or "kV".
3. Press F4 to highlight the position.
   ⇨ The desired position is highlighted and the value can be changed.
4. Press F1 to increase the value or F5 to reduce it.
5. Press ↵.

⇨ The desired value is set.

7.4.2 Analog setting of the desired value (optional)

If the device is equipped with an AI module, you can set the desired voltage value by means of analog signal. To do so, you must configure the analog input (P2.35 and P2.36) accordingly.

You can use the analog input (P2.35 and P2.36) either for capturing the tap position or for setting the desired voltage level remotely. You cannot use both functions simultaneously.

To set the desired value by means of an analog signal, you must enter the following parameter values:

- Set desired voltage level remotely
- AI lower limit
- AI upper limit
- Min. remote desired value
- Max. remote desired value

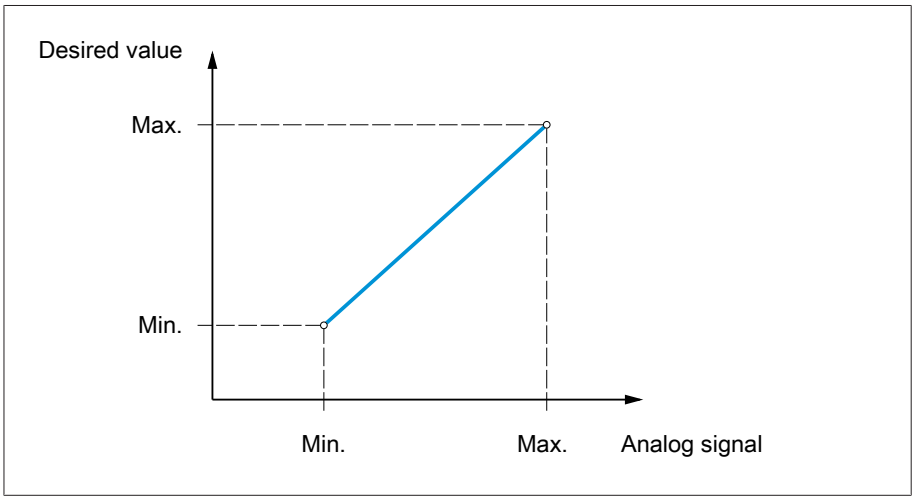


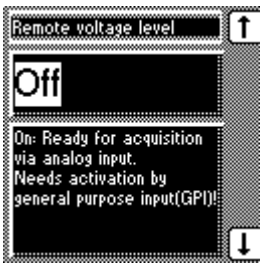
Figure 29: Analog setting of the desired value

Min. desired value	Min. remote desired value (e.g. 100 V)
Max. desired value	Max. remote desired value (e.g. 135 V)
Min. analog signal	AI lower limit (e.g. 4 mA)
Max. analog signal	AI upper limit (e.g. 20 mA)

Activating/deactivating setting the desired voltage level remotely

You can use this parameter to activate or deactivate setting the desired voltage level remotely. If you activate setting the desired voltage level remotely, the parameter for capturing the tap position via analog signal is deactivated automatically.

To activate/deactivate setting the desired voltage level remotely, proceed as follows:



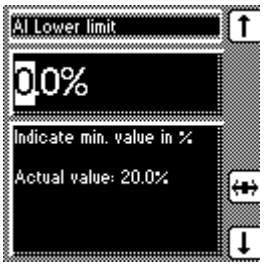
1. MENU > F4 Configuration > 3x F5 Continue > F4 Set desired voltage level remotely > Press ⋯→ until the desired parameter is displayed.
   ⇨ Set desired voltage level remotely.
2. Press F1 or F5 to activate (On) or deactivate (Off) setting the desired voltage level remotely.
3. Press ↵.

⇨ Setting the desired voltage level remotely has been activated/deactivated.

Setting AI lower limit

You can use this parameter to set the minimum value of the analog signal. The setting is made as a percentage based on the 20 mA measuring range.

Example: If you would like to use a 4...20 mA signal, you must set the parameter to 20% (20% x 20 mA = 4 mA).



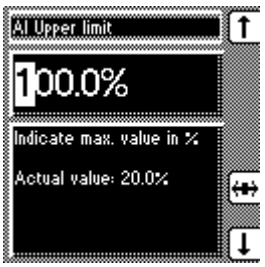
1. MENU > F4 Configuration > 3x F5 Continue > F4 Set desired voltage level remotely > Press ⇢ until the desired parameter is displayed.
   ⇨ AI lower limit.
2. Press F4 to highlight a digit.
   ⇨ The desired position is highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ↵.

⇨ The analog value for the minimum desired value is set.

Setting AI upper limit

You can use this parameter to set the maximum value of the analog signal. The setting is made as a percentage based on the 20 mA measuring range.

Example: If you would like to use a 4...20 mA signal, you must set the parameter to 100% (100% x 20 mA = 20 mA).

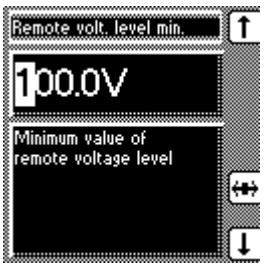


1. MENU > F4 Configuration > 3x F5 Continue > F4 Set desired voltage level remotely > Press ⇢ until the desired parameter is displayed.
   ⇨ AI upper limit.
2. Press F4 to highlight a digit.
   ⇨ The desired position is highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ↵.

⇨ The analog value for the maximum desired value is set.

Setting min. remote desired value

You can use this parameter to set the desired value that corresponds to the minimum level of the analog signal.



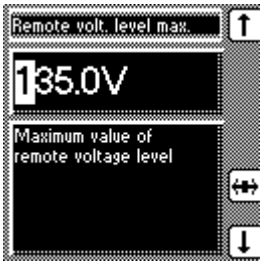
1. MENU > F4 Configuration > 3x F5 Continue > F4 Set desired voltage level remotely > Press ⇢ until the desired parameter is displayed.
   ⇨ Min. remote desired value
2. Press F4 to highlight a digit.
   ⇨ The desired position is highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.

4. Press [↵].

⇨ The minimum desired value is set.

Setting max. remote desired value

You can use this parameter to set the desired value that corresponds to the maximum level of the analog signal.



1. [MENU] > [F4] Configuration > 3x [F5] Continue > [F4] Set desired voltage level remotely > Press [→] until the desired parameter is displayed.
   ⇨ Max. remote desired value
2. Press [F4] to highlight a digit.
   ⇨ The desired position is highlighted and the value can be changed.
3. Press [F1] to increase the value or [F5] to reduce it.
4. Press [↵].

⇨ The maximum desired value is set.

7.4.3 Bandwidth

You can use this parameter to set the maximum permissible deviation in measured voltage U_{Act}. The deviation relates to the activated desired value. The following sections describe how you determine and set the bandwidth required.

7.4.3.1 Determining bandwidth

In order to set the correct value, the transformer's step voltage and nominal voltage must be known.

Too small/large a bandwidth

You have to set the bandwidth in such a way that the output voltage of the transformer (U_{Act}) returns to within the specified tolerance bandwidth after the tap change. If too small a bandwidth is defined, the output voltage exceeds the bandwidth selected and the device immediately issues a tap-change command in the opposite direction. If a very large bandwidth is selected, this results in a major control deviation.

The following value is recommended for the bandwidth setting:

$$[\pm B\%] \geq 0{,}6 \cdot \frac{U_{n-1} - U_n}{U_{nom}} \cdot 100\%$$

Figure 35: Recommended bandwidth

U_{n-1}	Step voltage of tap position n-1
U_n	Step voltage of tap position n
U_{nom}	Nominal voltage

The following transformer values are used to determine the recommended bandwidth:

Nominal voltage U_{nom} = 11,000 V

Step voltage in tap position 4 U_{Step4} = 11,275 V

Step voltage in tap position 5 U_{Step5} = 11,000 V

$$[\pm B\%] \geq 0{,}6 \cdot \frac{U_{Step4} - U_{Step5}}{U_{nom}} \cdot 100\%$$

$$[\pm B\%] \geq 0{,}6 \cdot \frac{11275\,V - 11000\,V}{11000\,V} \cdot 100\%$$

$$[\pm B\%] \geq 1{,}5\%$$

The following section describes how you can set the bandwidth.

7.4.3.2 Setting the bandwidth

You can set the bandwidth of the absolute value in V or as a relative value as a percentage.

Absolute bandwidth

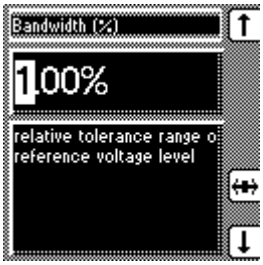
You can use this parameter to set the bandwidth as an absolute value (V) or as a relative value (%).

To do so, proceed as follows:

1. MENU > F3 Parameter > F2 Control parameter > Press ⇢ until the desired parameter is displayed.
2. Press F1 or F5 to select the option you want.
3. Press ↵.

⇨ The parameter is set.

Setting the bandwidth as a percentage

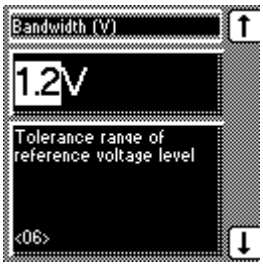


To enter the determined bandwidth as a percentage, proceed as follows:

1. MENU > F3 Parameter > F2 Control parameter > Press ⇢ until the desired parameter is displayed.
2. Press F4 to highlight the position.
   ⇨ The desired position is highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ↵.

⇨ The bandwidth is set.

Setting the bandwidth in V



To enter the determined bandwidth in V, proceed as follows:

1. MENU > F3 Parameter > F2 Control parameter > Press ⇢ until the desired parameter is displayed.
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵.

⇨ The bandwidth is set.

7.4.3.3 Visual display

The deviation from the set bandwidth is shown visually in the device's display. The measured voltage **3** highlighting shows whether the measured voltage is above, within or below the set bandwidth **1**. Progress of delay time T1 is indicated by the gradual filling of the time bar **2**. The seconds display **5** above this indicates the remaining delay time T1.

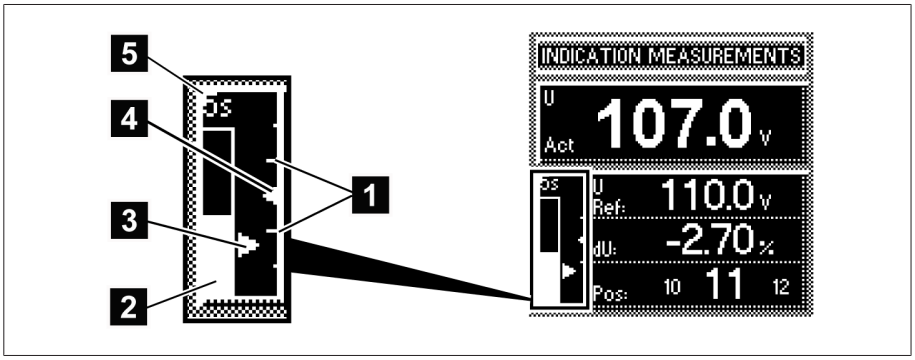
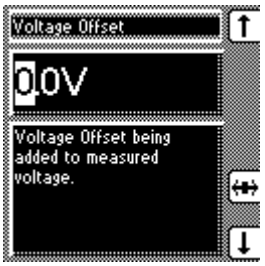


Figure 39: Visual display of deviation from desired value

1 Bandwidth (upper and lower limit)	4 Desired voltage value $U_{desired}$
2 Time bar for delay time T1	5 Remaining delay time T1
3 Measured voltage U_{actual}	

7.4.4 Setting voltage balance

You can use this parameter to set a voltage balance in order to compensate for deviations through the measuring section. The measured voltage is increased by the set value.

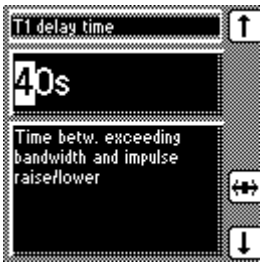


1. MENU > F3 Parameter > F2 Control parameter > Press ⇢ until the desired parameter is displayed.
   ⇨ Voltage balance.
2. Press F4 to highlight the position.
   ⇨ The desired position is highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ↵.

⇨ The voltage balance is set.

7.4.5 Setting delay time T1

Use this parameter to set delay time T1. This function delays the issuing of a tap-change command for a defined period. This prevents unnecessary tap-change operations if the tolerance bandwidth is exited.



To set the delay time T1, proceed as follows:

1. MENU > F3 Parameter > F2 Control parameter > Press ⇢ until the desired parameter is displayed.
2. Press F4 to highlight the position.
   ⇨ The desired position is highlighted and the value can be changed.
3. Press F1 to increase the time or F5 to reduce it.
4. Press ↵.

⇨ The delay time T1 is set.

7.4.6 Setting control response T1

The control response T1 can be set to linear or integral.

Linear control response T1

With linear control response, the device responds with a constant delay time regardless of the control deviation.

Integral control response T1

With integral control response, the device responds with a variable delay time depending on the control deviation. The greater the control deviation (ΔU) in relation to the set bandwidth (B), the shorter the delay time. The delay time can therefore be reduced down to 1 second. This means that the device responds faster to large voltage changes in the grid. Regulation accuracy improves as a result but the frequency of tap-changes increases too.

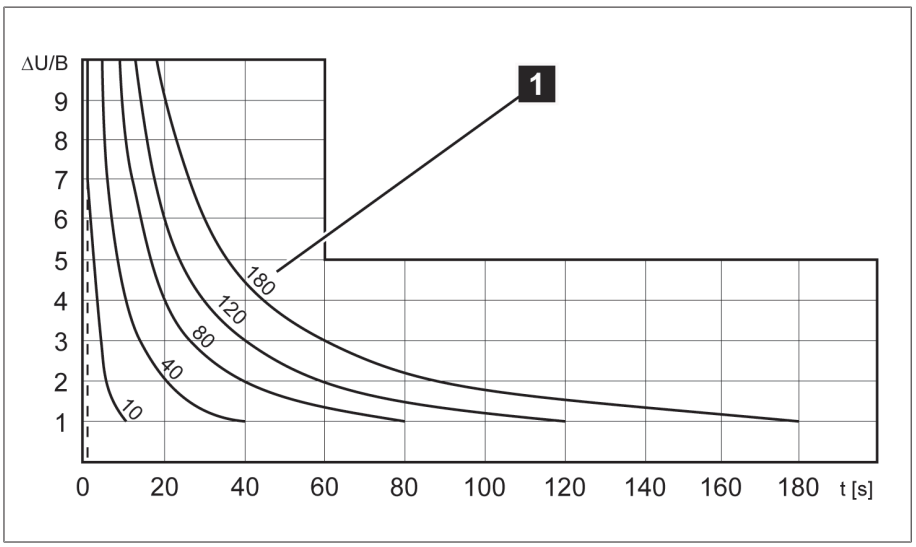
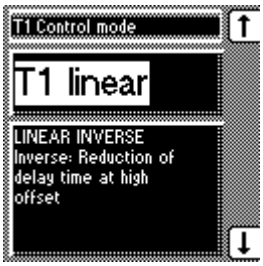


Figure 41: Diagram showing integral control response

ΔU/B	Control deviation "ΔU" as % of desired value as ratio to the set bandwidth "B" as % of desired value
1	"Delay time T1" parameter



To set the control response T1, proceed as follows:

1. MENU > F3 Parameter > F2 Control parameter > Press ⋯→ until the desired parameter is displayed.
2. Press F1 or F5 to set the response you want.
3. Press ↵.

⇨ The control response T1 is set.

7.4.7 Setting delay time T2

With this parameter, you can set delay time T2. Delay time T2 is used to compensate for large control deviations faster.

The delay time T2 only takes effect if more than one tap-change operation is required to return the voltage to within the set bandwidth. The first output pulse occurs after the set delay time T1. After the set tap-change delay time T2 has elapsed, additional pulses occur in order to correct the existing control deviation.

The following requirements must be noted to set delay time T2:

- The delay time T2 must be greater than the switching pulse time.
- The delay time T2 must be greater than the maximum operating time of the motor-drive unit.
- The delay time T2 must be less than the value set for delay time T1.

To set the delay time T2, proceed as follows:

1. MENU > F3 Parameter > F2 Control parameter > Press until the desired parameter is displayed.

   ⇨ Delay time T2.
2. Press F1 to increase the time or F5 to reduce it.
3. Press ↵.

⇨ The delay time T2 is set.

Activating/deactivating delay time T2

To activate/deactivate delay time T2 , proceed as follows:

1. MENU > F3 Parameter > F2 Control parameter > Press ⋯→ until the desired parameter is displayed.

   ⇨ T2 activation.
2. Press F5 or F1 to activate/deactivate T2.

3. Press ↵.

⇨ The delay time T2 is activated/deactivated.

7.5 Limit values

In the Limit values menu item, you can set all the parameters needed for limit value monitoring as relative or absolute values. You can set three limit values:

- Undervoltage U<
- Overvoltage U>
- Overcurrent I>

Limit value monitoring is used to reduce damage to the system periphery. The following sections describe how you can set the parameters.

7.5.1 Setting undervoltage monitoring V<

You can use these parameters to set the limit values for an undervoltage. Undervoltage monitoring prevents tap-change operations if there is a power cut.

Behavior

If the measured voltage U_{actual} 7 falls below the set limit value 4, the red LED *U*< lights up . The switching pulses to the motor-drive unit are blocked at the same time provided you have activated the blocking undervoltage U< parameter. Once the set signaling delay time [► 80] 6 has passed, the signaling relay activates. The *Undervoltage U*< B message appears in the display. The message is reset as soon as the measured voltage U_{actual} again exceeds the limit value for undervoltage E. If the measured voltage U_{actual} falls below 30 V C (for example when the transformer is switched off), the *undervoltage* message is also displayed. You can however suppress [► 81] this message.

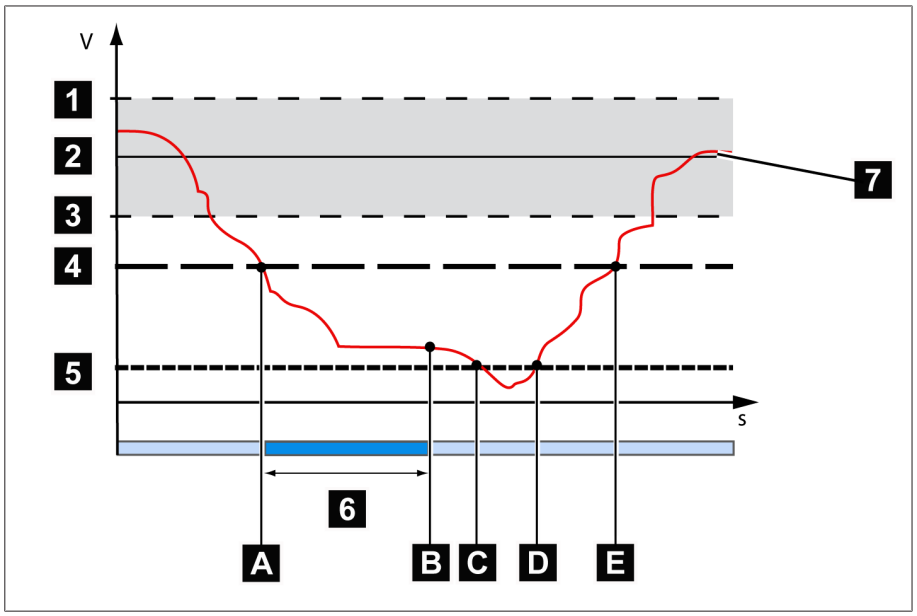


Figure 42: Response to value falling below limit value

1	+ B%: Upper limit	7	U_{actual}: Measured voltage
2	$U_{desired}$: Desired value	A	Value falls below limit value
3	- B%: Lower limit	B	*Undervoltage U*< message is displayed
4	Set limit value for undervoltage U<	C	Voltage falls below 30 V
5	Limit value for suppressing alarms below 30 V	D	Voltage exceeds 30 V again
6	Set signaling delay time for limit value for undervoltage U<	E	Value exceeds limit value

Setting undervoltage U< in V/kV

You can use this parameter to set the limit value as an absolute value in the V or kV units. If you use the F3 key to change the display to unit **kV**, this value relates to the primary transformer voltage. If you change the display to **V**, this relates to the secondary voltage.

To set the absolute limit value for undervoltage U<, proceed as follows:

1. MENU > F3 Parameter > F3 Limit values > Press ⇢ until the desired parameter is displayed.
2. If necessary press F3 to select the unit you want, "V" or "kV".
3. Press F1 to increase the value or F5 to reduce it.
4. Press ↵.

⇨ The limit value is set.

Setting signaling delay for undervoltage U<

You can use this parameter to set the delay time after which the *Undervoltage* relay is to activate and the event message appear on the display. This can be used to prevent messages from being issued when the value briefly falls below the limit value. The undervoltage LED always lights up immediately regardless.

Proceed as follows to set the delay time for this message:

1. MENU > F3 Parameter > F3 Limit values > Press ⇢ until the desired parameter is displayed.
2. Press F4 to highlight the position.
   ⇨ The desired position is highlighted and the value can be changed.
3. Press F1 to increase the time or F5 to reduce it.
4. Press ↵.

⇨ The signaling delay time for undervoltage U< is set.

Activating/deactivating undervoltage blocking

You can use this parameter to set how the device behaves if the voltage falls below the undervoltage limit. You can select the following options:

Setting	Function
On	Automatic regulation is blocked.
Off	Automatic regulation remains active.

Table 11: Behavior

Proceed as follows to activate/deactivate the undervoltage blocking:

1. MENU > F3 Parameter > F3 Limit values > Press ⇢ until the desired parameter is displayed.
   ⇨ U< blocking.
2. Press F1 for **On** setting or F5 for **Off** setting.
3. Press ↵.

⇨ Undervoltage blocking is activated/deactivated.

Activating/deactivating message for voltages below 30 V

You can use this parameter to set whether the *Undervoltage* message is to be suppressed at a measured value of less than 30 V. This setting is used to ensure that no event message appears when the transformer is switched off. You can select the following options:

Setting	Function
On	The *Undervoltage* message is also displayed when the measured value is less than 30 V.
Off	The *Undervoltage* message is no longer displayed when the measured value is less than 30 V.

Table 12: Response

Proceed as follows to activate/deactivate the message:

1. MENU > F3 Parameter > F3 Limit values > Press ⇢ until the desired parameter is displayed.
   ⇨ U< also below 30 V.
2. Press F1 for **On** setting or F5 for **Off** setting.
3. Press ↵.

⇨ The message is activated/deactivated.

7.5.2 Setting overvoltage monitoring V>

You can use these parameters to set the limit values for overvoltage monitoring. This overvoltage monitoring triggers tap-change operations to return to the desired operating status. If the operating status can no longer be corrected, a message is triggered by the *Function monitoring* relay.

Response to high-speed return

If the measured voltage U_{actual} exceeds the set limit value **1**, the red LED *U>* and associated signaling relay activate. The *Overvoltage U>* message appears in the display. At the same time, the high-speed return function is activated without delay time T1. Once the set switching pulse time **5** has

passed, the tap position is lowered C by activating the motor-drive unit until the measured voltage U_{actual} 6 again falls below the limit value B. The *Overvoltage U>* message is reset.

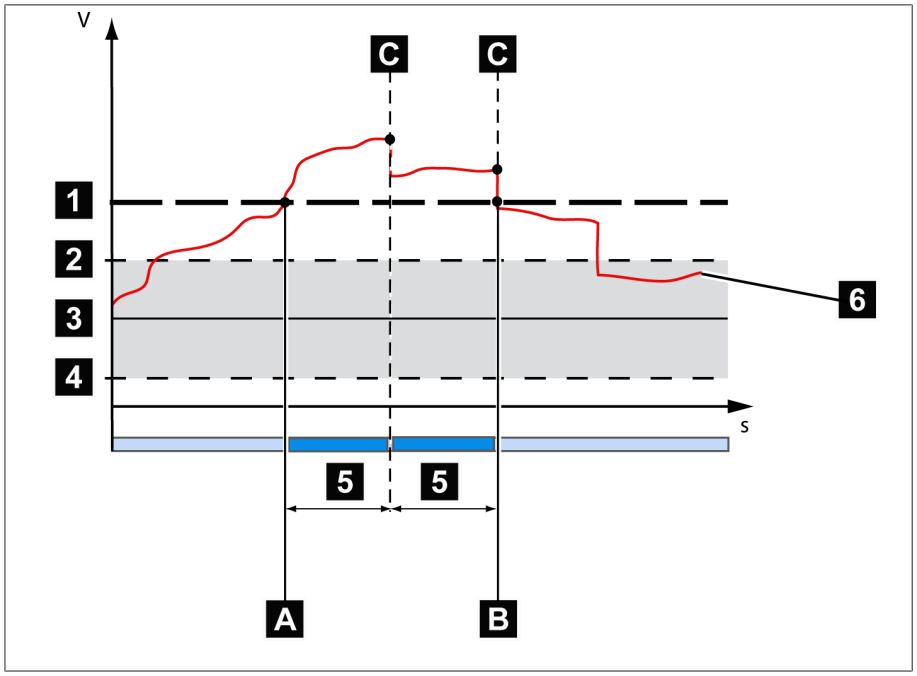


Figure 43: Response to limit value being exceeded

1	Set limit value for overvoltage U>	6	U_{actual}: Measured voltage
2	+ B %: Upper limit	A	Value exceeds limit value
3	$U_{desired}$: Desired value	B	Value falls below limit value
4	- B %: Lower limit	C	High-speed return is started (lower tap-change)
5	Set switching pulse time		

Setting overvoltage U> in V/kV

You can use this parameter to set the limit value as an absolute value in the V or kV units. If you use the F3 key to change the display to unit **kV**, this value relates to the primary transformer voltage. If you change the display to **V**, this relates to the secondary transformer voltage.

Proceed as follows to set the absolute limit value for overvoltage U>:

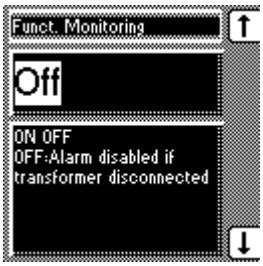
1. MENU > F3 Parameter > F3 Limit values > Press ⇢ until the desired parameter is displayed.
2. If necessary press F3 to select the unit you want, **V** or **kV**.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ↵.

⇨ The limit value is set.

7.5.3 Activating/deactivating function monitoring

If the measured value leaves the current bandwidth (desired value +/- bandwidth) for more than 15 minutes without a tap-change operation taking place, the function monitoring relay is activated. This results in a message on the display which is only reset when the measured value returns to within the current bandwidth.

If the measured voltage is below 30 V, then the measured value is outside the bandwidth and the relevant relay is also activated after 15 minutes. You can deactivate this function if you want to avoid a function monitoring message when the transformer is switched off:



1. MENU > F3 Parameter > F3 Limit values > Press ⇢ until the desired parameter is displayed.
2. Press F1 or F5 to select the option you want.
3. Press ↵.

⇨ Function monitoring is activated/deactivated.

7.5.4 Setting hunting alarm limit

You can use this parameter to specify the number of tap-change operations within 24 hours after which the *Hunting alarm limit* event message is to be issued. If you select 0, there is no monitoring.

To set the alarm limit, proceed as follows:

1. MENU > F3 Control parameter > F3 Limit values > Press ⇢ until the desired parameter is displayed.

   ⇨ Hunting alarm limit.
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵.

⇨ The alarm limit is set.

7.6 Compensation

You can use the "Compensation" function to compensate for the load-dependent voltage drop between the transformer and consumer. The device provides 2 methods of compensation for this purpose:

- R&X compensation (line drop compensation)
- Z compensation

You can use R&X compensation and Z compensation at the same time. If you do not want to use one method, you have to set the associated parameters to 0.

If you are using the IEC 61850 control system protocol, you can only activate one of the two compensation methods at any one time. A control system command is available for this.

7.6.1 R&X compensation

R&X compensation (LDC) requires exact cable data. Line voltage drops can be compensated very accurately using LDC.

To set R&X compensation correctly, you need to calculate the ohmic and inductive voltage drop in V with reference to the secondary side of the voltage transformer. You also need to correctly set the transformer circuit used.

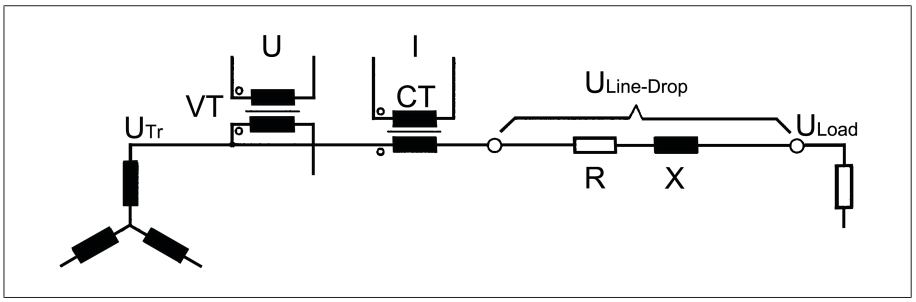


Figure 45: Equivalent circuit

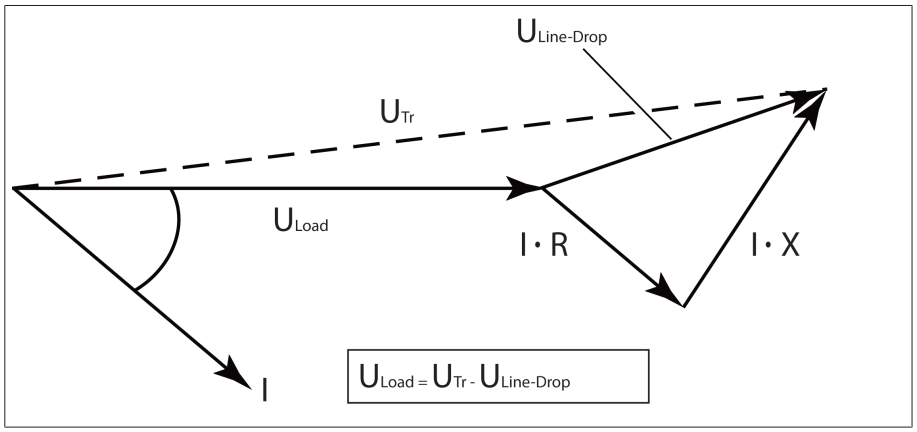


Figure 46: Phasor diagram

You can calculate the ohmic and inductive voltage drop using the following formulas. This voltage drop calculation relates to the relativized voltage on the secondary side of the voltage transformer.

Formula for calculating the ohmic voltage drop:

$$U_r = I_N \bullet \frac{k_{CT}}{k_{VT}} \bullet r \bullet L \bullet K \text{ [V]}$$

Formula for calculating the inductive voltage drop:

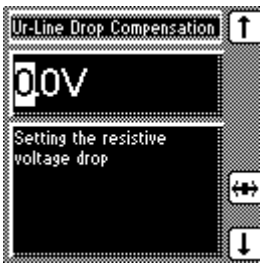
$$U_x = I_N \bullet \frac{k_{CT}}{k_{VT}} \bullet x \bullet L \bullet K \text{ [V]}$$

U_r	Voltage drop in V due to ohmic line resistance
U_x	Voltage drop in V due to inductive line resistance
I_N	Nominal current (amps) of selected current-transformer connection on device:1 A; 5 A
k_{CT}	Current transformer ratio
k_{VT}	Voltage transformer ratio
r	Ohmic resistance load in Ω/km per phase
x	Inductive resistance load in Ω/km per phase
L	Length of line in km
K	Nominal current factor

7.6.1.1 Setting the ohmic voltage drop Vr

You can use this parameter to set the ohmic voltage drop (ohmic resistance load).

If you do not want to use line drop compensation, you have to set the value 0.0 V.



To set the ohmic voltage drop Vr, proceed as follows:

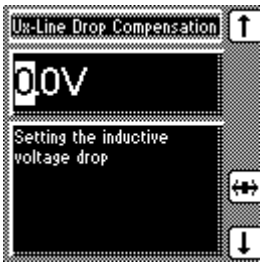
1. MENU > F3 Parameter > F4 Compensation.
   ⇨ Vr line drop compensation.
2. Press F4 to highlight the position.
   ⇨ The desired position is highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ↵.

⇨ The ohmic voltage drop Vr is set.

7.6.1.2 Setting the inductive voltage drop Vx

You can use this parameter to set the inductive voltage drop (inductive resistance load). The compensation effect can be rotated by 180° in the display using a plus or minus sign.

If you do not want to use line drop compensation, you have to set the value 0.0 V.



To set the inductive voltage drop Vx, proceed as follows:

1. MENU > F3 Parameter > F4 Compensation > Press ⇢ until the desired parameter is displayed.
   ⇨ Vx line drop compensation.
2. Press F4 to highlight the position.
   ⇨ The desired position is highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ↵.

⇨ The inductive voltage drop Vx is set.

7.6.2 Z compensation

To keep the voltage constant for the consumer, you can use Z compensation to activate a current-dependent increase in voltage. Z compensation is not dependent on the phase angle φ and should only be used for small changes in phase angle.

You can also define a limit value to avoid excess voltage on the transformer.

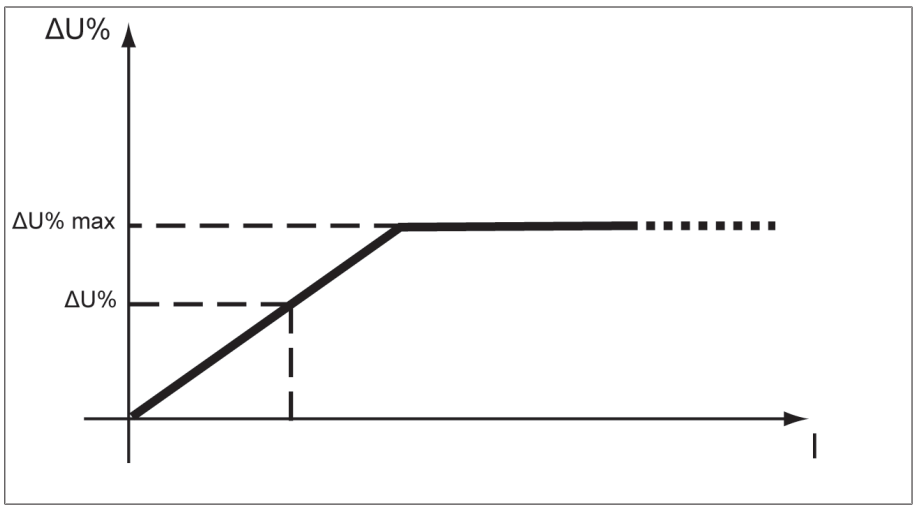


Figure 47: Z compensation

To use Z compensation, you need to calculate the increase in voltage (ΔV) taking the current into account. Use the following formula for this purpose:

$$\Delta U = 100 \bullet \frac{U_{Tr} - U_{Load}}{U_{Load}} \bullet \frac{I_N \bullet k_{CT}}{I}$$

ΔV	Voltage increase	I	Load current in A
V_{Tr}	Transformer voltage with current I	I_N	Nominal current of current transformer connection in A (1 A; 5 A)
V_{Load}	Voltage on line end with current I and on-load tap-changer in same operating position	k_{CT}	Current transformer ratio

Sample calculation: V_{Tr} = 100.1 V, V_{Load} = 100.0 V, I_N = 5 A k_{CT} = 200 A/5 A, I = 100 A

Produces a voltage increase ΔV of 0.2%

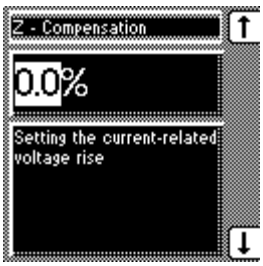
The following sections describe how you can set the parameters you need for Z compensation.

7.6.2.1 Setting Z compensation

This parameter sets the voltage increase ΔU previously calculated.

If you do not want to use Z compensation, you have to set the value 0.0 %.

To set the Z compensation, proceed as follows:



1. MENU > F3 Parameter > F4 Compensation > Press ⇢ until the desired parameter is displayed.
   ⇨ Z compensation.
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵.

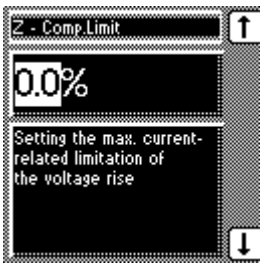
⇨ The Z compensation is set.

7.6.2.2 Setting the Z compensation limit value

You can use this parameter to define the maximum permissible voltage increase to avoid excess voltage on the transformer.

If you do not want to use a limit value, you have to set the value 0.0 %.

To set the limit value, proceed as follows:



1. MENU > F3 Parameter > F4 Compensation > Press ⇢ until the desired parameter is displayed.
   ⇨ Z comp. limit value.
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵.

⇨ The limit value is set.

7.7 Transformer data

The transformation ratios and measuring set-up for the voltage and current transformers used in the system can be set with the following parameters. The device uses this information to calculate the corresponding measured values on the primary side of the current transformer (and therefore the transformer) from the recorded measured values. These are then displayed.

The following parameters are available for this purpose:

- Primary voltage
- Secondary voltage
- Primary current
- Transformer circuit

Note that the electrical current input of the TAPCON® 250 is specified at 200 mA. You can purchase a current transformer with the ratio of 8.66 A : 2 A or 5 A : 2 A from Reinhausen Manufacturing upon request.

The measured values displayed for the device are influenced by the settings for the above parameters. Note the table below.

Parameter set			Measured value display		
Primary voltage	**Secondary voltage**	**Primary current**	**Voltage (main screen)**	**Current (main screen)**	**Current (info screen)**
-	Yes	-	Secondary voltage [V]	-	Secondary current [A]
Yes	Yes	-	Primary voltage [kV]	-	Secondary current [A]
Yes	Yes	Yes	Primary voltage [kV]	Primary current [A]	Secondary current [A]

Table 13: Influence of transformer data on measured value display

7.7.1 Setting the phase difference for the current transformer/voltage transformer

You can use this parameter to set the phase difference of the current transformer and voltage transformer. You can set the common transformer circuits as follows:

Tap-change operation	Setting	Measurement method	Phase difference
A	0 1PH	1 phase	0°
B	0 3PHN	3 phase	0°
C	0 3PH	3 phase	0°
D	90 3PH	3 phase	90°
E	30 3PH	3 phase	30°
F	-30 3PH	3 phase	-30°

Table 14: Set values for transformer circuit

Note the following sample circuits to select the correct transformer circuit.

Circuit A: 1-phase measurement in 1-phase grid

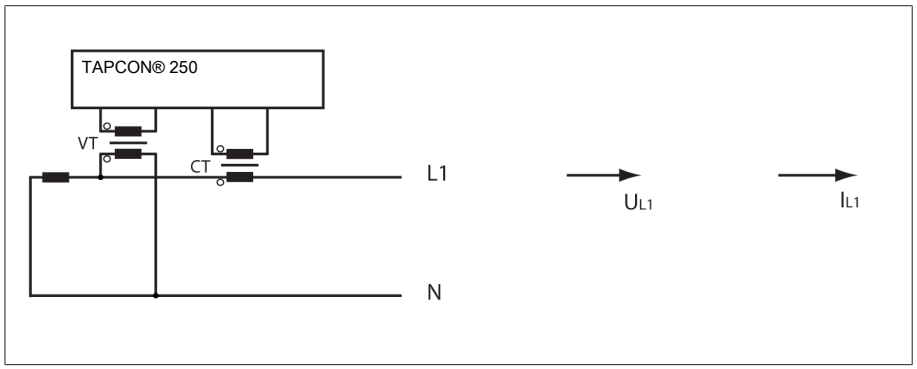


Figure 48: Phase difference 0 1PH

- The voltage transformer VT is connected to the outer conductor and neutral conductor.
- The current transformer CT is looped into the outer conductor.
- The voltage U_{L1} and current I_{L1} are in phase.
- The voltage drop on an outer conductor is determined by the current I_{L1}.

Circuit B: 1-phase measurement in 3-phase grid

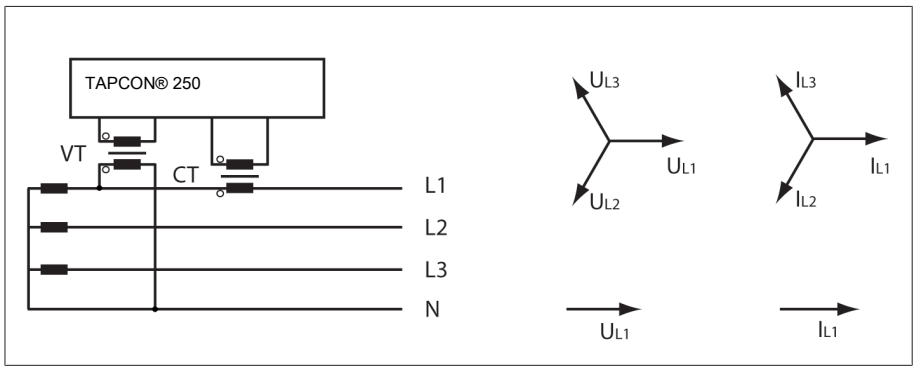


Figure 49: Phase difference 0 3PHN

- The voltage transformer VT is connected to the outer conductors L1 and neutral.
- The current transformer CT is looped into the outer conductor L1.
- The voltage U and current I are in phase.
- The voltage drop on an outer conductor is determined by the current I_{L1}.

Circuit C:

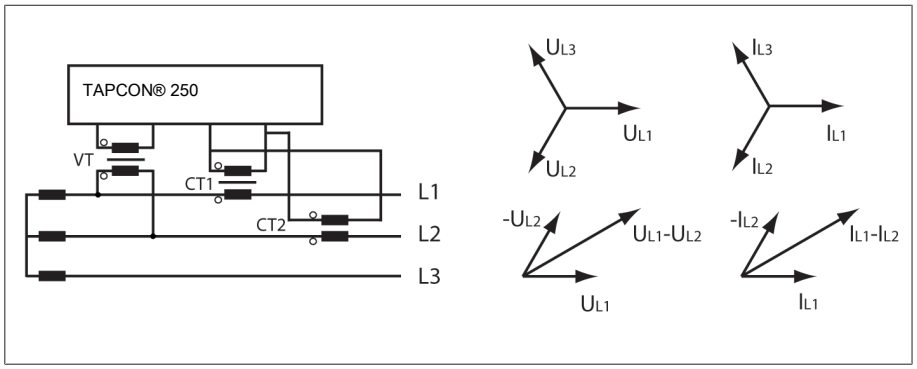


Figure 50: Phase difference 0 3PH

- The voltage transformer VT is connected to the outer conductors L1 and L2.
- The current transformer CT1 is looped into the outer conductor L1 and CT2 into the outer conductor L2.
- The current transformers CT1 and CT2 are connected crosswise in parallel (total current = $I_{L1} + I_{L2}$).
- The total current $I_{L1} + I_{L2}$ and voltage U_{L1}-U_{L2} are in phase.
- The voltage drop on an outer conductor is determined by the current: $(I_{L1} + I_{L2}) / \sqrt{3}$.

Circuit D

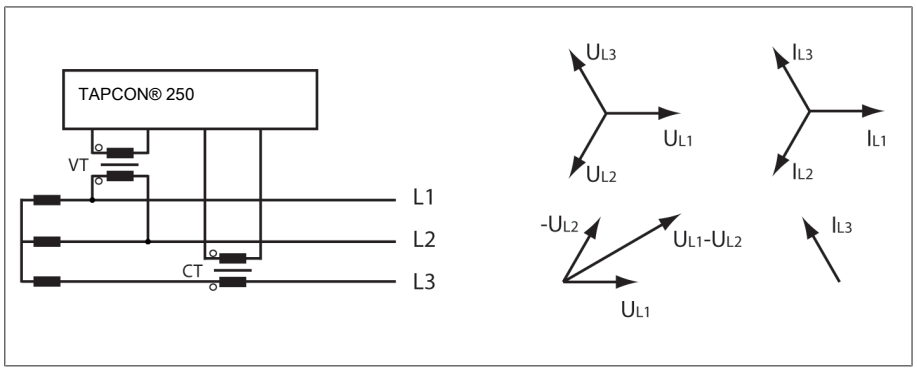


Figure 51: Phase difference 90 3PH

- The voltage transformer VT is connected to the outer conductors L1 and L2.
- The current transformer CT is looped into the outer conductor L3.
- The current I_{L3} is ahead of voltage U_{L1}-U_{L2} by 90°.
- The voltage drop on an outer conductor is determined by the current I_{L3}.

Circuit E

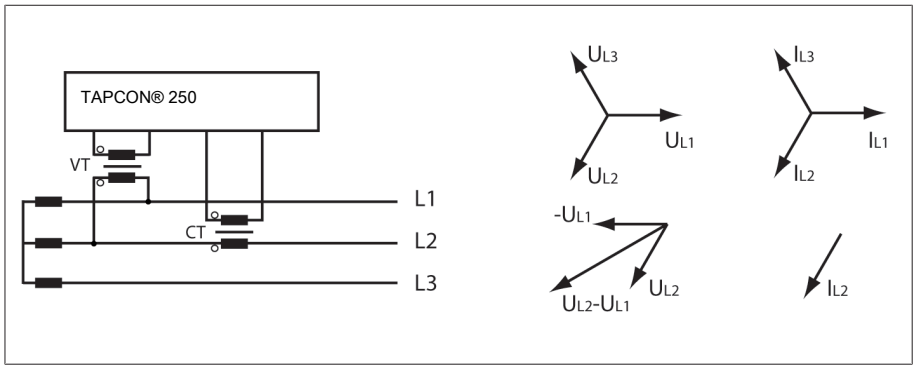


Figure 52: Phase difference 30 3PH

- The voltage transformer VT is connected to the outer conductors L1 and L2.
- The current transformer CT is looped into the outer conductor L2.
- The current I_{L2} is ahead of voltage U_{L2}-U_{L1} by 30°.
- The voltage drop on an outer conductor is determined by the current I_{L2}.

Circuit F

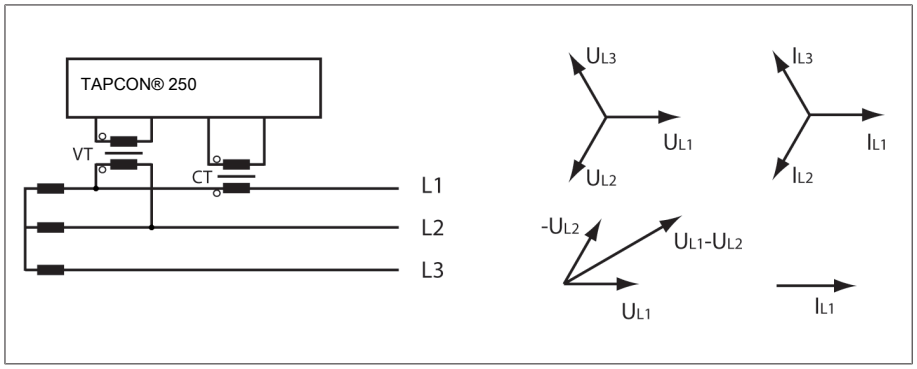
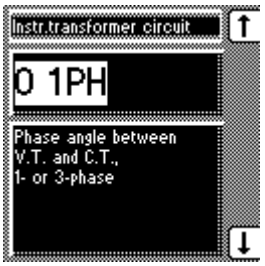


Figure 53: Phase difference -30 3PH

- The voltage transformer VT is connected to the outer conductors L1 and L2.
- The current transformer CT is looped into the outer conductor L1.
- The current I_{L1} lags behind U_{L1}-U_{L2} by 30°. This corresponds to a phase shift of -30°.
- The voltage drop on an outer conductor is determined by the current I_{L1}.

To set the phase difference for the transformer circuit, proceed as follows:



1. MENU > F4 Configuration > F2 Transformer data > Press ⇢ until the desired parameter is displayed.
   ⇨ Transformer circuit.
2. Press F1 or F5 to select the required phase difference.
3. Press ↵.

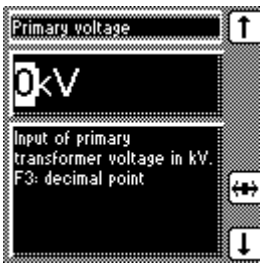
⇨ The phase difference is set.

7.7.2 Setting the primary transformer voltage

This parameter can be used to set the primary transformer voltage in kV. When you are setting the primary transformer voltage, the device shows the primary voltage rather than the secondary voltage in the main screen and you can also set the control parameters in kV.

If a setting of 0 kV is chosen, no primary transformer voltage is displayed.

To set the primary transformer voltage, proceed as follows:



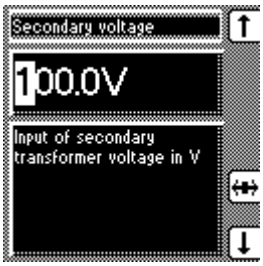
1. MENU > F4 Configuration > F2 Transformer data.
   ⇨ Primary voltage.
2. Press F3 to highlight the decimal place.
   ⇨ The decimal place is defined and the value can be changed.
3. Press F4 to highlight the position.
   ⇨ The desired position is highlighted and the value can be changed.
4. Press F1 to increase the value or F5 to reduce it.
5. Press ↵.

⇨ The primary transformer voltage is set.

7.7.3 Setting the secondary transformer voltage

This parameter can be used to set the secondary transformer voltage in V.

To set the secondary transformer voltage, proceed as follows:



1. MENU > F4 Configuration > F2 Transformer data > Press ⋯→ until the desired parameter is displayed.
   ⇨ Secondary voltage.
2. Press F4 to highlight the position.
   ⇨ The desired position is highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ↵.

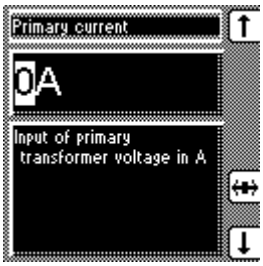
⇨ The secondary transformer voltage is set.

7.7.4 Setting primary transformer current

This parameter can be used to set the primary transformer current.

- When you are setting the primary transformer current, the measured value is displayed in the main screen.
- If you set a value of 0, no measured value is displayed in the main screen.

Proceed as follows to set the primary transformer current:



1. MENU > F4 Configuration > F2 Transformer data > Press ⋯→ until the desired parameter is displayed.
   ⇨ Primary current.
2. Press F4 to highlight the position.
   ⇨ The desired position is highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ↵.

⇨ The primary transformer current is set.

7.8 Configurable inputs and outputs

You can individually configure 4 digital inputs (GPI) and one output for a collective message.

7.8.1 Linking inputs with functions

You can control the inputs with a continuously applied input signal (status: high-level). For this purpose, use the device's +12 V voltage source (pin P2.10).

You can assign one of the following functions to each of the digital inputs (GPI 1...4):

Function	Description
Off	No function selected.
AVL2	Activate desired value 2.
AVL3	Activate desired value 3
ParGroup1	Assign parallel operation group 1.
ParGroup2	Assign parallel operation group 2.
Master/follower	Define master/follower mode. Signal on: Master mode active. Signal off: Follower mode active.
Set desired voltage level remotely	Activate setting the desired voltage level remotely via the analog input P2.35 and P2.36.
Rapid tap-change operation	Activate rapid tap-change operation. The delay times T1 and T2 are ignored and a tap-change operation is performed immediately if the bandwidth is exceeded. Do not use this function for master/follower parallel operation.
Auto inhibit	Block automatic voltage regulation.
Trans Alarm*	Collective message for transformer errors, only for forwarding via control system (SCADA).
Cooling stage 1*	Cooling stage 1 input signal
Cooling stage 2*	Cooling stage 2 input signal

Table 15: Functions for digital inputs (GPI 1 to 8)

*) only with special firmware

If you assign the same functionality to two inputs, the device produces an event message. This also applies if you assign the same functionality via a static input and via a pulsed input.

If you simultaneously activate desired value 2 and desired value 3, desired value 4 is activated automatically.

Simultaneously activating parallel operation group 1 and parallel operation group 2 leads to a parallel operation error.

To assign a function to a digital input or to deactivate it, proceed as follows:

1. MENU > F4 Configuration > F3 Customer inputs/outputs.
   ⇨ GPI
2. Press F1 or F5 until the desired function is displayed.
3. Press ↵.

⇨ The function is set.

Functions can be assigned to all other GPIs as described above.

7.8.2 Setting user-defined collective message

You can use this parameter to set the requirements for the user-defined collective message. If a requirement is fulfilled, the device issues a signal at output P2.20/22.

You can configure the following requirements for the collective message:

Bit	Alarm
1	Undervoltage
2	Overvoltage
3	Lower tap position blocking
4	Raise tap position blocking
5	Overcurrent
6	Reversal of power flow
7	Alternative desired value active
8	AI module sensor defective
9	Parallel operation error
10	Analog input error (tap position or setting the desired voltage level remotely)
11	Hunting limit value exceeded
12*	Annun Reset: Reset lamp panel with test lamps in the cabinet.

Table 16: Requirements for the user-defined collective message

*) only with special firmware

To set the user-defined collective message, proceed as follows:

1. MENU > F4 Configuration > F4 User inputs > Press ⇢ until the desired parameter is displayed.
   ⇨ Programmable alarm.
2. Press F4 to highlight the desired bit.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ↵.

⇨ The user-defined collective message is set.

7.9 Parallel operation

In the**Parallel operation** menu item, you can set the parameters needed for parallel transformer operation. Parallel transformer operation is used to increase the throughput capacity or short-circuit capacity in one place.

Conditions for parallel operation

Compliance with the following general conditions is required for operating transformers in parallel:

- Identical rated voltages
- Transformer power ratio (< 3 : 1)
- Maximum deviation of short-circuit voltages (U_K) for transformers connected in parallel < 10%
- Same number of switching groups
- The same current-transformer connection has to be used for all devices running in parallel

You can control up to 16 transformers connected in parallel in one or 2 groups without detecting the system topology. Information is swapped between the voltage regulators operating in parallel using the CAN bus. Parallel operation is activated using one of 2 status inputs or the control system.

Parallel operation method

The device supports parallel operation following the methods described below:

- Parallel operation following the "Circulating reactive current minimization" principle
- Parallel operation following the "Tap synchronization" (master/follower) principle

You must select the same parallel operation method (circulating reactive current minimization or tap synchronization) for all voltage regulators operating in parallel. Otherwise you cannot operate the devices in parallel.

The following sections describe how you can set the parameters. Ensure that you have set the following parameters when activating parallel operation:

- CAN bus address

7.9.1 Assigning CAN bus address

You can use this parameter to assign a CAN bus address to the device. So that all devices can communicate using the CAN bus, each device requires a unique identifier. If the value is set to **0**, then no communication takes place.

To enter the CAN bus address, proceed as follows:

1. MENU > F4 Configuration > F4 Parallel operation > Press ⋯→ until the desired parameter is displayed.
   ⇨ CAN address.
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵.

⇨ The CAN bus address is saved.

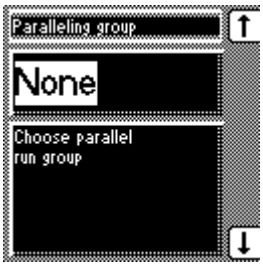
7.9.2 Assigning a parallel operation group

You can use this parameter to assign a transformer group to the device. You can create a total of 2 groups. The parallel operation group can be selected only if you have not programmed an allocation using a *GPI* control input.

The following groupings are possible:

Parameter	Function
None	Device not assigned to any parallel operation group
Group 1	Device assigned to parallel operation group 1
Group 2	Device assigned to parallel operation group 2
Group 1 and group 2	Device assigned to parallel operation groups 1 and 2

Table 17: Parallel operation groups



To assign the device to a parallel operation group, proceed as follows:

1. MENU > F4 Configuration > F4 Parallel operation > Press ⇢ until the desired parameter is displayed.
   ⇨ Parallel operation group.
2. Press F1 or F5 until the desired setting is displayed.
3. Press ↵.

⇨ The device is assigned to a parallel operation group.

7.9.3 Selecting parallel operation method

You can use this parameter to select a parallel operation method. Two different methods can be assigned to the device.

- Circulating reactive current minimization
- Tap synchronization (master/follower)

You must select the same parallel operation method for all voltage regulators operating in parallel.

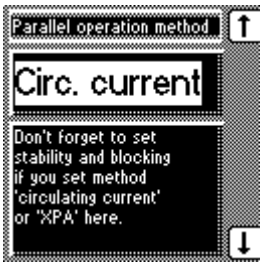
The following sections describe how you can set the parameters for a parallel operation method.

7.9.3.1 Setting circulating reactive current method

When the **circulating reactive current** parallel operation method is selected, then parallel operation is carried out using the circulating reactive current minimization method. The circulating reactive current is calculated from the transformer currents and their phase angles. A voltage proportional to the circulating reactive current is added to the independently operating voltage regulators as a correction for the measurement voltage. This voltage correction can be reduced or increased using the circulating reactive current sensitivity setting.

The circulating reactive current method is suited to transformers connected in parallel with a similar nominal output and short-circuit voltage U_K and to vector groups with the same and different step voltages. This does not require any information about the tap position.

To set the **circulating reactive current** parallel operation method, proceed as follows:



1. MENU > F4 Configuration > F4 Parallel operation.
   ⇨ Parallel operation method
2. Press F1 or F5 until **circulating reactive current** appears in the display.
3. Press ↵.

⇨ The parallel operation method is set.

When using the **circulating reactive current** parallel operation method, you have to set the parameters for the **circulating reactive current sensitivity** and **circulating reactive current blocking**.

Setting circulating reactive current sensitivity

The circulating reactive current sensitivity is a measure of its effect on the behavior of the voltage regulator. At a setting of 0 % no effect is present. With circulating reactive current relating to the rated current of the current transformer, if you set the value to 10 % for example, this would cause the voltage in the voltage regulator to be corrected by 10 %. This correction to the voltage can be increased or decreased with this setting to attain the optimum value.

As soon as you change the circulating reactive current sensitivity value, the value for the result changes in the help text in the display.

To set the circulating reactive current sensitivity, proceed as follows:

1. MENU > F4 Configuration > F4 Parallel operation > Press ⋯→ until the desired parameter is displayed.
   ⇨ Circulating reactive current sensitivity
2. Press F1 to increase the value or F5 to reduce it.
3. If necessary, press F3 to highlight the decimal place.
   ⇨ The decimal place is now highlighted and the value can be changed.
4. Press ↵.

⇨ The circulating reactive current sensitivity is set.

You can set the circulating reactive current sensitivity for parallel operation group 1 and parallel operation group 2 independently of one another.

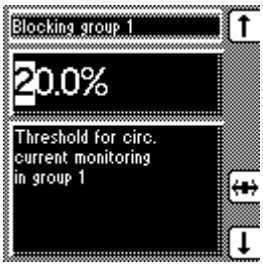
Setting circulating reactive current blocking

You can use this parameter to set the limit value for the maximum permissible circulating reactive current. If, during parallel operation, the circulating reactive current exceeds the set limit value, then the following event is activated:

- Parallel operation error

All devices operating in parallel are blocked. Depending on the set delay time for the parallel operation error message, the signaling relay Parallel operation error is activated.

To set the blocking limit for the maximum permitted circulating reactive current, proceed as follows:



1. MENU > Configuration > F4 Parallel operation > Press F4 until the desired parameter is displayed.
   ⇨ Circulating reactive current blocking
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵.

⇨ The blocking limit for the maximum permitted circulating reactive current is set.

You can set the blocking limit for the permissible circulating reactive current for parallel operation group 1 and parallel operation group 2 independently of one another.

7.9.3.2 Setting tap synchronization

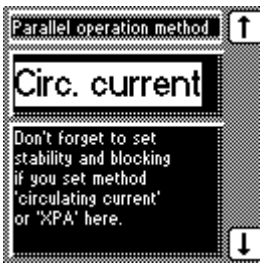
With the tap synchronization method, you need to designate one voltage regulator as the master and all others as followers. The master handles voltage regulation and transmits its latest tap positions to all followers via the CAN bus. The followers compare the tap position received with their own tap position. If the set permissible tap difference between the tap position received and their own position is exceeded, the followers switch to the tap position received from the master. This ensures that the transformers operating in parallel are always in the same tap position.

For the tap synchronization method, you can select the following options:

Option	Description
Master	The voltage regulator is designated as the master.
Follower	The voltage regulator is designated as the follower.
Sync.auto	Automatic assignment of master or follower. If no master is detected, the voltage regulator with the lowest CAN bus address is automatically designated as the master. All other voltage regulators are designated as followers.

Table 18: Tap synchronization method

In parallel operation, an individual CAN bus address must be assigned to each voltage regulator. Up to 16 CAN participants are supported.



To set the tap synchronization method, proceed as follows:

1. MENU > F4 Configuration > F4 Parallel operation > Press ⇢ until the desired parameter is displayed.
   ⇨ Parallel operation method
2. Press F1 or F5 until the desired parameter is displayed.
3. Press ↵.

⇨ The tap synchronization method is set.

7.9.4 Setting delay time for parallel operation error messages

You can use this parameter to set the delay time for a parallel operation error message so that brief fault messages are not received if the motor-drive units involved in the parallel operation have different runtimes. Once the set delay time has elapsed, the event is issued at the output relay.

To set the delay time for the parallel operation error message, proceed as follows:

1. MENU > F4 Configuration > F4 Parallel operation > Press ⇢ until the desired parameter is displayed.
   ⇨ Error message.
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵.

⇨ The delay time for the parallel operation error message is set.

7.9.5 Setting the follower tapping direction

With this parameter, you can set how the follower behaves in the event of a raise or lower tap change.

As in "Tap synchronization (master/follower)" parallel operation the tap positions of the transformers which are running in parallel are compared, it is absolutely essential that these transformers have the same position designation. Ensure that all higher tap change operations or lower tap change operations produce the same voltage change in all transformers.

You can select the following options:

Option	Description
Standard dV>0 = tapping direction toward position 1	Follower sends a raise tap change command to increase the voltage. Follower sends a raise tap change command to increase the voltage.
	Follower sends a lower tap change command to reduce the voltage. Follower sends a lower tap change command to reduce the voltage.
Swapped dV>0 = tapping direction toward position n	Follower sends a raise tap change command to increase the voltage. Follower sends a lower tap change command to reduce the voltage.
	Follower sends a lower tap change command to reduce the voltage. Follower sends a raise tap change command to reduce the voltage.

Table 19: Device behavior

Please note whether the voltage regulator is defined as master or follower when setting the tapping direction. The tapping direction can only be swapped for a follower.

To select the tapping direction, proceed as follows:

1. MENU > F4 Configuration > F4 Parallel operation > Press ⋯→ until the desired parameter is displayed.
   ⇨ Follower tapping direction
2. Press F1 or F5 to select the required tapping direction.
3. Press ↵.

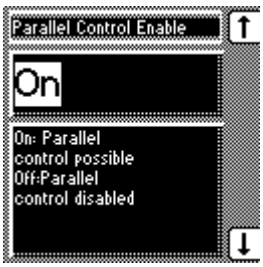
⇨ The tapping direction is selected.

7.9.6 Activating/deactivating parallel operation

This parameter can be used to activate or deactivate parallel operation. When activating parallel operation, make sure you have configured the following parameters:

- CAN bus address
- Assigning a parallel operation group

To deactivate parallel operation, proceed as follows:



1. MENU > F4 Configuration > F4 Parallel operation.
   ⇨ Parallel operation activation.
2. Press F1 or F5 to activate parallel operation by selecting **On** or deactivate parallel operation by selecting **Off**.
3. Press ↵.

⇨ Parallel operation is deactivated.

7.9.7 Setting the behavior in the event of CAN bus error

You can use this parameter to set the behavior of the device when a CAN bus error occurs. You can select the following options:

- Blocking: Automatic voltage regulation is blocked.
- Independent: Automatic voltage regulation is continued in simplex mode.

To set the behavior in the event of a CAN bus error, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F3 Parallel operation > Press ⋯→ until the desired parameter is displayed.
   ⇨ Behavior in the event of CAN bus error.
2. Press F1 or F5 to select the option you want.

3. Press ↵.

⇨ The behavior in the event of CAN bus error is set.

7.10 LED selection

You can use this parameter to assign functions to the free LEDs which light up when an event occurs. You can use labeling strips to label the LED.

Depending on your device configuration, the following parameters can be used by MR for special functions. In this case, these parameters are pre-assigned. You may not be able to view or freely assign these parameters.

7.11 Memory

With this you can undertake measured value memory settings. This configures the event memory and recorder function. The device has a memory capacity of 8 MB. The memory is split into 2 areas:

Average value memory

In the average value memory, all measured and calculated values are averaged and saved using the average value intervals you set. You can set [► 108] the average value intervals in stages between 1 and 40 seconds.

Event memory

Data is always saved to the event memory at the highest resolution without first being averaged. You can also determine how much memory space is to be made available exclusively for the event memory [► 108].

Triggering event The data recorder can trigger an event depending on the undervoltage and/or overvoltage limit value that you can set. The data recorded here are stored in the measured value memory's event memory.

Chronological sequence To allow instances where values exceed or fall below the limit values to be better evaluated, the chronological sequence for the measured and calculated values also includes the last 10 seconds before values actually exceed or fall below the limit value. Each event is saved for a maximum of 5 minutes.

When an event is active, only the chronological sequence of the measured and calculated values is stored in the event memory.

As soon as there is no more free space in the event memory, the oldest values are overwritten by the new values measured. You can access information about the current event memory content via the Info menu.

Data recorder

The data-recorder module can be used to save the data listed below and display and evaluate it either on the display or using the TAPCON®-trol visualization software on a PC.

The following values are displayed:

- Measured values
  - On-load tap-changer position
  - Voltage
  - Active current
  - Reactive current
- Calculated values
  - Active power
  - Reactive power
  - Apparent power
  - Output factor

Calculation of the values stated depends on the measured values captured and the parameters set, for example:

- Current measuring circuit
- Primary current
- Voltage transformer data from primary and secondary sides

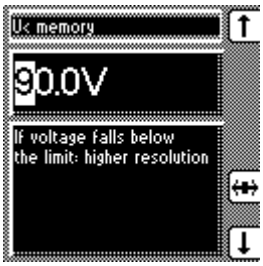
A correct calculation can only be undertaken if you have correctly entered the configuration data in full.

7.11.1 Setting undervoltage threshold

You can use these parameters to set the undervoltage threshold as an absolute value. If the voltage falls below the set undervoltage threshold, high-resolution measured values are saved for as long as this situation prevails.

Absolute value

Entries can be made either in V or kV. If you enter the absolute value in V, it relates to the secondary transformer voltage. If you enter the absolute value in KV, it relates to the primary voltage.



To set the undervoltage threshold, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F5 Continue > F3 Memory > Press ⋯→ until the desired parameter is displayed.
   ⇨ U< memory.
2. If necessary press F3 to select the unit you want, **V** or **kV**.
3. If **V** is selected, press F4 to highlight the decimal place.
   ⇨ The decimal place is now highlighted and the value can be changed.
4. Press F1 to increase the value or F5 to reduce it.
5. Press ↵.

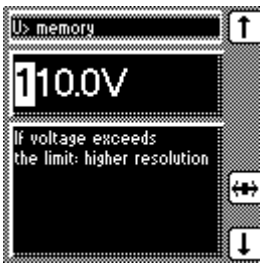
⇨ The undervoltage threshold is set.

7.11.2 Setting overvoltage threshold

You can use these parameters to set the overvoltage threshold as an absolute value. If the voltage exceeds the set overvoltage threshold, high-resolution measured values are saved for as long as this situation prevails.

Absolute value

Entries can be made either in V or kV. If you enter the absolute value in V, it relates to the secondary transformer voltage. If you enter the absolute value in KV, it relates to the primary voltage.



To set the overvoltage threshold, proceed as follows:

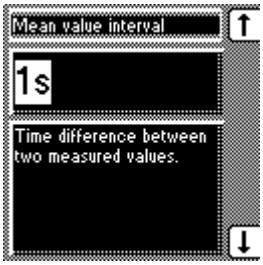
1. MENU > F4 Configuration > F5 Continue > F5 Continue > F3 Memory > Press ⋯→ until the desired parameter is displayed.
   ⇨ U> memory.
2. If necessary press F3 to select the unit you want, **V** or **kV**.
3. If **V** is selected, press F4 to highlight the decimal place.
   ⇨ The decimal place is now highlighted and the value can be changed.
4. Press F1 to increase the value or F5 to reduce it.
5. Press ↵.

⇨ The surge threshold is set.

7.11.3 Setting time difference of average value interval

You can use this parameter to set the long-term memory for the device. The memory is split into the average value memory and event memory. Depending on the setting, intervals of 1; 2; 4; 10; 20 or 40 seconds are saved in the average value memory.

When you set the average value interval, the complete memory is cleared once the change is confirmed.



To set the average value interval, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F5 Continue > F3 Memory > Press ···→ until the desired parameter is displayed.
   ⇨ Average value interval.
2. Press F1 to increase the time or F5 to reduce it.
3. Press ↵.

⇨ The average value interval is set.

7.11.4 Setting event memory size

You can use this parameter to configure the event memory size. The event memory stores instances of values exceeding or falling below the preset threshold values (U> and U<). It stores this information in high resolution. The maximum number of events depends on the size of the event memory:

Event memory size	256 kB	512 kB	1024 kB	2048 kB
Maximum number of events	20	40	80	160

Table 20: Event memory size

Event lasting less than 5 minutes

If the event lasts less than 5 minutes, the event is recorded with high-resolution **1**. The high-resolution data is first recorded 10 seconds **A** before the event **B**. If the voltage has returned to the bandwidth **C**, the event is still recorded until the overrun time of 10 seconds **D** has passed.

At a low resolution 2, the entire process is saved.

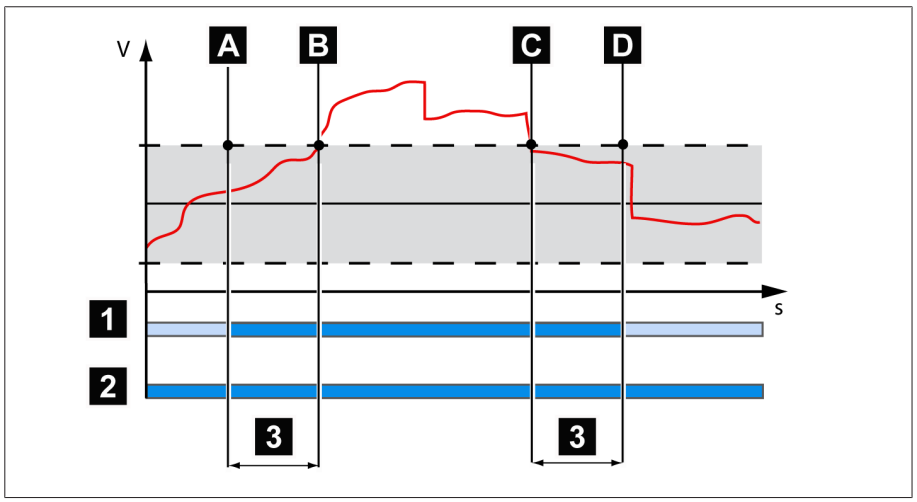


Figure 66: Event duration (<5 minutes)

1 Saving at high resolution	B Event occurs (voltage departs from bandwidth)
2 Saving at low resolution	C Event occurs (voltage returns to bandwidth)
3 Run-in time/overrun time; duration: 10 seconds	D End of event's overrun time
A Start of event's run-in time	

Event lasting longer than 5 minutes

The high-resolution 1 data is first recorded 10 seconds A before the event B. If the event is still active after 5 minutes C, the data continues to be recorded with low resolution 2. If the voltage returns to the bandwidth E, this is considered a new event. The high-resolution recording of new data commences at the start of the 10-second run-in time D and ends after the 10-second overrun time F.

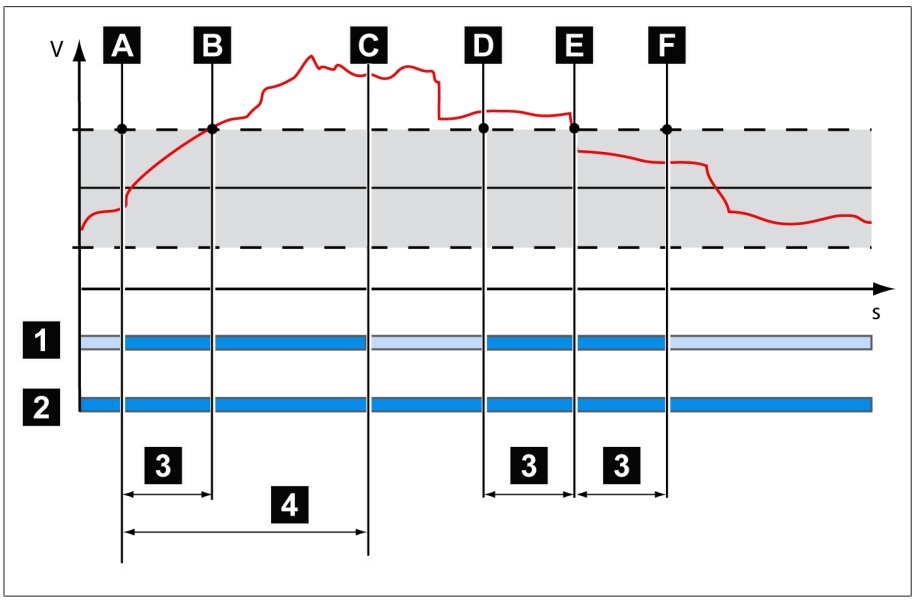


Figure 67: Event duration (more than 5 minutes)

1	High-resolution recording	B	Event occurs (voltage departs from bandwidth)
2	Low-resolution recording	C	End of high-resolution recording; start of low-resolution recording
3	Duration: 10 seconds	D	Start of event's run-in time
4	Duration of high-resolution recording: 5 minutes	E	Event occurs (voltage returns to bandwidth)
A	Start of event's run-in time	F	End of event's overrun time

The table below shows the memory time. Depending on the average value interval and the size of the event memory, it is a maximum of 401 days.

Mean value interval	Size of event memory			
	256 kB	512 kB	1024 kB	2048 kB
1 s	10 d	9 d	8 d	7 d
2 s	20 d	19 d	17 d	14 d
4 s	40 d	38 d	35 d	29 d
10 s	100 d	96 d	89 d	73 d
20 s	201 d	193 d	178 d	147 d
40 s	401 d	386 d	356 d	295 d

Table 21: Memory time of measured value memory

When you set the event memory size, the complete memory is cleared as soon as you confirm the change.

To set the event memory size, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F5 Continue > F3 Memory > Press ⋯→ until the desired parameter is displayed.
   ⇨ Event memory.
2. Press F1 or F5 to set the event memory size you want.
3. Press ↵.

⇨ The event memory size is set.

7.11.5 Time plotter

The **Info** menu item is where you'll find the time plotter function. The actual voltage and desired value you have set is displayed here. The units of voltage per unit are defined automatically and you can change them at any time. You can undertake the following settings in the time plotter function:

- Division of time axis
- Voltage range
- Retrace time
- Retrace date

The following sections describe how you can access the time plotter.

7.11.5.1 Visual display of time plotter function

The time plotter is displayed as follows:

Symbols

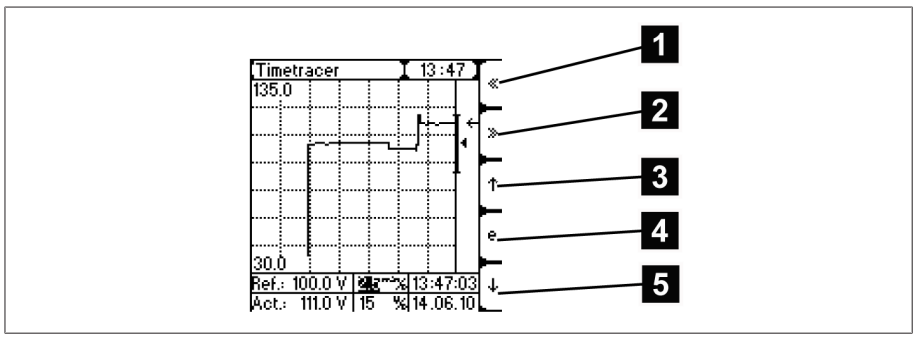


Figure 68: Time plotter symbols

1 Move time axis back	4 Select values to set
2 Move time axis forward	5 Decrease set values by one unit
3 Increase set values by one unit	

Desired/actual voltage value display

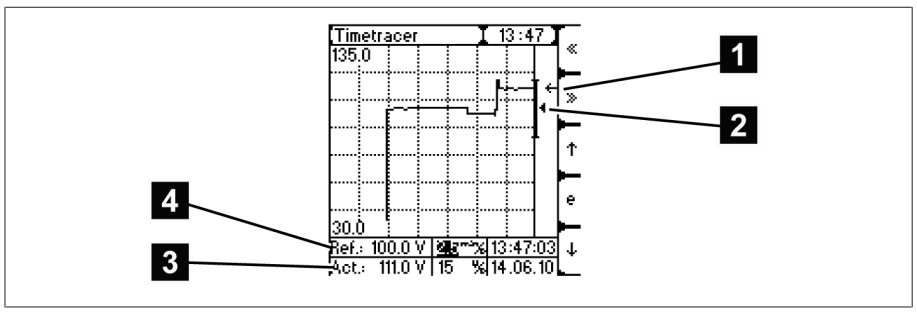


Figure 69: Desired/actual value

1 Set desired voltage value display	3 Actual voltage value display
2 Actual voltage value display	4 Set desired voltage value display

Overvoltage/undervoltage display

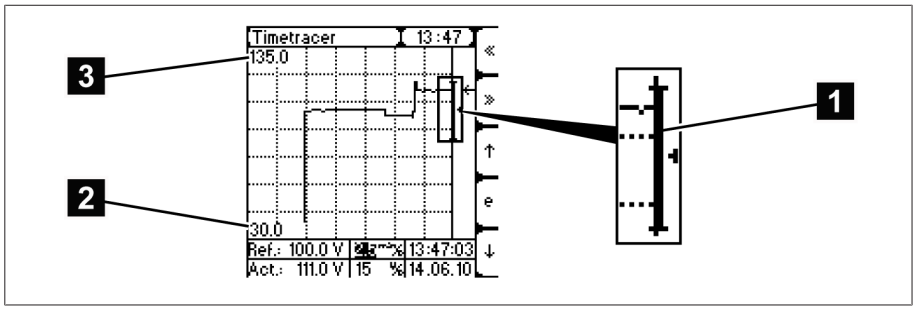


Figure 70: Overvoltage/undervoltage

1 Overvoltage bar/undervoltage bar	3 Upper voltage value
2 Lower voltage value	

7.11.5.2 Moving time axis

You can set the reporting times in the setting box in the time plotter. Refer to the table for the time axis division and the resulting duration of the range shown.

Steps which can be set (grid width)	15 s	30 s	1 min	2.5 min	5 min	10 min
Displayed range (in full display)	3.5 min	7 min	14 min	35 min	70 min	140 min

Table 22: Duration of range displayed

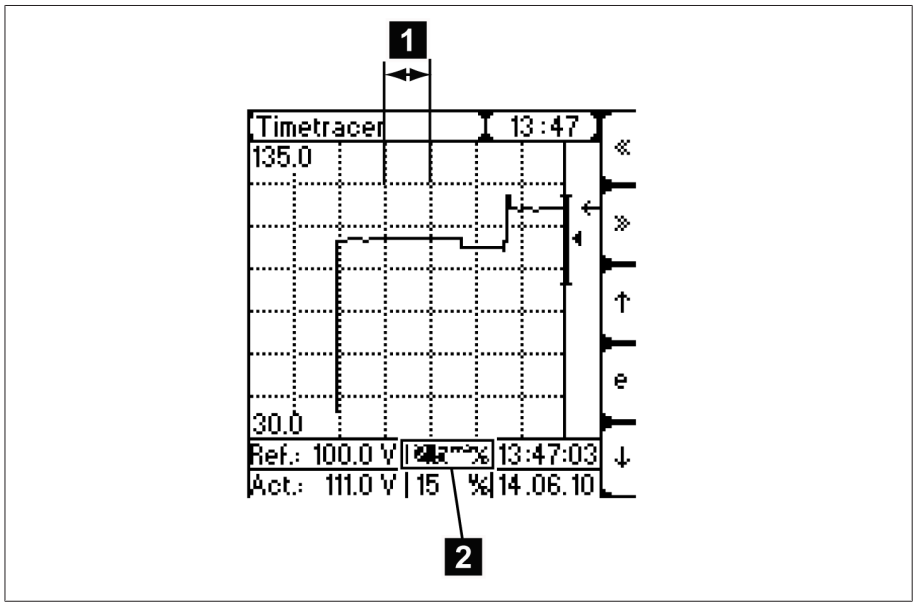


Figure 71: Time axis

1 Horizontal grid lines (the set reporting time range is between the horizontal grid lines)	2 Setting box for reporting times displayed

To undertake settings, proceed as follows:

1. MENU > F5 Info > Press ←·· until the desired display appears.
   ⇨ Time plotter.
2. Press F4 to highlight the setting box for reporting times.
   ⇨ The setting box is now highlighted and the value can be changed.
3. Press F3 to move the display forwards one step or F5 to move it back one step.

⇨ The time axis is set.

7.11.5.3 Setting voltage range

In this display the voltage range is shown in the area between the horizontal grid lines. You can restrict the area between the horizontal grid lines in the corresponding setting box. Depending on the display setting, you can display the voltage range to be displayed in V or kV. The voltage range to be displayed is divided as follows:

Division	0.5 V	1 V	2 V	5 V	10 V	15 V	-	-
	0.1 kV	0.2 kV	0.5 kV	1 kV	2 kV	5 kV	10 kV	20 kV

Table 23: Voltage range between the horizontal grid lines

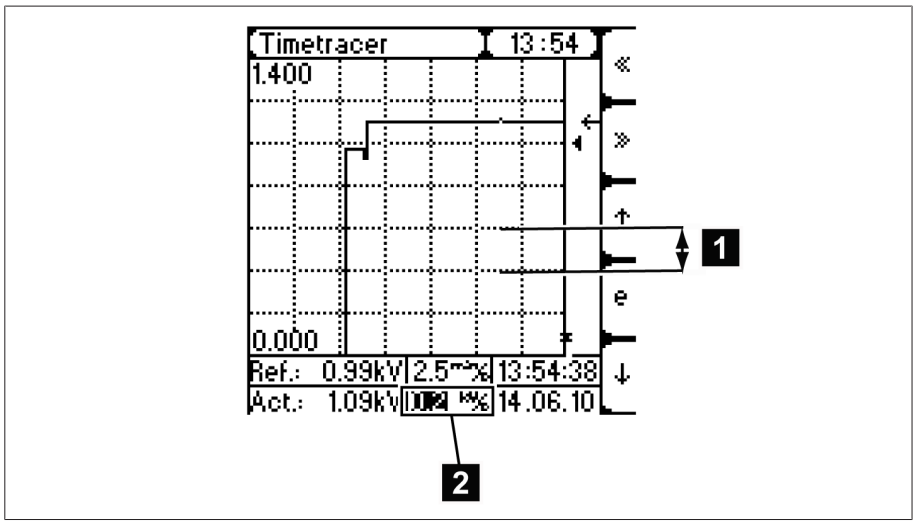


Figure 72: Voltage range

1 Horizontal grid lines (the set voltage range is between the horizontal grid lines)	2 Setting box for voltage range displayed

To set the voltage range, proceed as follows:

1. MENU > F5 Info > Press ←··· until the desired display appears.
   ⇨ Time plotter.
2. Press F4 until the setting box for the voltage range is highlighted.
   ⇨ The setting box is now highlighted and the value can be changed.
3. Press F3 to advance one unit or F5 to move back one unit.

⇨ The voltage range is set.

7.11.5.4 Setting retrace time

This function allows you to move the sequence to a precise time in order to trace how voltage has behaved in the past.

Any time between the present time and the oldest time in the memory can be set. The time is entered in the following format: **HH:MM:SS**

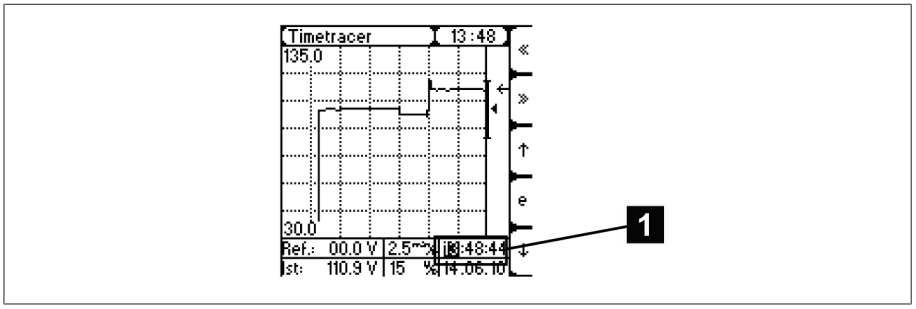


Figure 73: Retrace time

1 Time

To move the sequence to a precise time, proceed as follows:

1. MENU > F5 Info > Press ←·· until the desired display appears.
   ⇨ Time plotter.
2. Press F4 until the setting box for the retrace time is highlighted.
   ⇨ The setting box is now highlighted and the value can be changed.
3. Press F3 to advance the time or F5 to move it back.

⇨ The retrace time is set. The sequence for the specified time appears in the display.

7.11.5.5 Setting retrace date

This function allows you to display the sequences of measured values for a time or date you have selected in order to trace how voltage has behaved in the past.

Any date between the present date and the oldest time in the memory can be set. The date is entered in the following format: **DD.MM.YY**

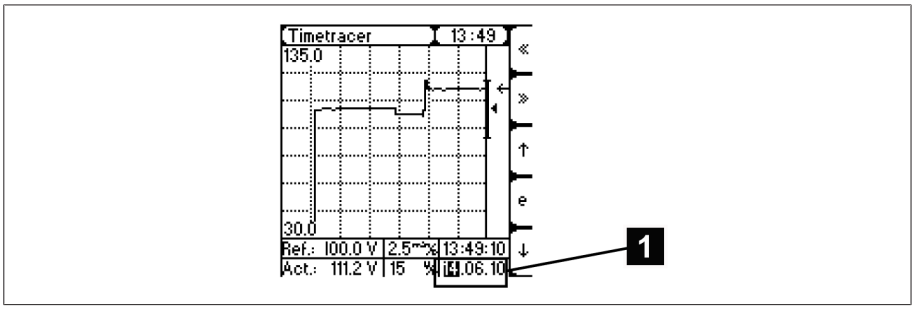


Figure 74: Retrace date

1 Date

To move the sequence to a precise time, proceed as follows:

1. MENU > F5 Info > Press ←·· until the desired display appears.
   ⇨ Time plotter.
2. Press F4 until the setting box for the retrace date is highlighted.
   ⇨ The setting box is now highlighted and the value can be changed.
3. Press F3 to advance the date by one digit or F5 to move it back one digit.

⇨ The retrace date is set. The sequence for the specified day appears in the display.

7.12 Communication interface

7.12.1 Selecting the communication protocol

You can activate one of the following communication protocols::

- TAPCON-trol® (visualization software)
- DNP3
- MODBUS ASCII
- MODBUS RTU

Only one communication protocol can be selected. Simultaneous use of several communication protocols is not possible.

To select the communication protocol, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F5 Continuer > F5 Comm. interface.
   ⇨ CI protocol.
2. Press F1 or F5 to set the desired option.
3. Press ↵.

⇨ The communication portal is selected.

7.12.2 Selecting communication port

This allows the physical interface to be activated The following options are available:

- RS232
- RS485
- Ethernet
- Modem
- Fiber-optic cable

You can only select one communication port. It is not possible to use several communication ports at the same time.

To select the communication port, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F5 Continuer > F5 Comm. interface. > Press ⇢ until the desired parameter is displayed.
   ⇨ CI port.
2. Press F1 or F5 to set the desired option.
3. Press ↵.

⇨ The communication port is selected.

7.12.3 Selecting communication baud rate

You can use this parameter to set the desired baud rate for the communication interface. You can select the following options:

- 9.6 kilobaud
- 19.2 kilobaud
- 38.4 kilobaud
- 57.6 kilobaud

The baud rate of 57.6 kilobaud is only active for communication interfaces RS232, RS485 and fiber-optic cable.

A baud rate of 57.6 kilobaud cannot be used for Ethernet.

This parameter is only provided for the following control system protocols:

- DNP3
- MODBUS ASCII/RTU

To set the communication interface baud rate, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F5 Continuer > F5 Comm. interface. > Press ⇢ until the desired parameter is displayed.
   ⇨ CI baud rate.
2. Press F1 or F5 to set the desired option.
3. Press ↵.

⇨ The baud rate is selected.

7.12.4 Assigning network address

You can use this parameter to assign a network address (IPv4) to the device. If you want to connect the device by means of Ethernet, you need to set a valid network address.

To assign the network address, proceed as follows:

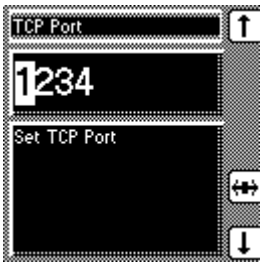
1. MENU > F4 Configuration > F5 Continue > F5 Continuer > F5 Comm. interface. > Press ⇢ until the desired parameter is displayed.
   ⇨ Network address
2. Press F4 in order to highlight the position.
   ⇨ The position is highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ↵.

⇨ The network address is assigned.

7.12.5 Assigning TCP port

You can use this parameter to assign a TCP port to the device. If you want to connect the device by means of Ethernet, you need to set a valid TCP port.

To assign the TCP port, proceed as follows:



1. MENU > F4 Configuration > F5 Continue > F5 Continuer > F5 Comm. interface. > Press →| until the desired parameter is displayed.
   ⇨ TCP port
2. Press F4 in order to highlight the position.
   ⇨ The position is highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ↵.

⇨ The TCP port is assigned.

7.12.6 Setting fiber-optic cable transmission behavior

You can use this parameter to set the device's transmission behavior, when you connect the device via optical fiber (OF). This determines whether or not the transmit LED lights up when the signal (logical 1) is active.

Setting	Logical 1	Logical 0
ON	Light on	Light off
OFF	Light off	Light on

Table 24: Transmission behavior for various parameter settings

To set the transmission behavior, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F5 Continuer > F5 Comm. interface. > Press →| until the desired parameter is displayed.
   ⇨ OF inversion.
2. Press F1 or F5 to set the desired option.
3. Press ↵.

⇨ The transmission behavior is set.

7.12.7 Setting CI address

You can use this parameter to assign a SCADA address to the device. You have to define this parameter if the device is to communicate via the control system protocol.

To set the SCADA address, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F5 Continue > F5 Comm. interface > Press ⋯→ until the desired parameter is displayed.
   ⇨ CI address.
2. Press F1 to change the first digit.
   ⇨ If you wish to enter a multi-digit sequence, proceed to step 3. If you do not wish to enter additional digits, proceed to step 7.
3. Press F1 until another digit position appears.
4. Press F4 to highlight a digit position.
   ⇨ The required digit is highlighted and can be changed.
5. Press F1 or F5 to change the digit.
6. Repeat steps 3 to 5 until all required digits have been entered.
7. Press ↵.

⇨ The CI address is set.

7.12.8 Setting SCADA master address

You can use this parameter to set the SCADA address for the master station. When the device is restarted, the device data is sent to this master station without prompting.

To set the SCADA master address, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F5 Continuer > F5 Comm. interface. > Press ⋯→ until the desired display appears.
   ⇨ Master address
2. Press F1 to change the first digit.
   ⇨ If you wish to enter a multi-digit sequence, proceed to step 3. If you do not wish to enter additional digits, proceed to step 7.
3. Press F1 until another digit position appears.
4. Press F4 to highlight a digit position.
   ⇨ The required digit is highlighted and can be changed.
5. Press F1 or F5 to change the digit.
6. Repeat steps 3 to 5 until all required digits have been entered.
7. Press ↵.

⇨ The master address is set.

7.12.9 Enabling unsolicited messages

When using the control system protocol DNP3, you can release the unsolicited data transmission through the device with this parameter. Data is transferred when a corresponding event occurs.

The device must be restarted after changing this setting.

Parameter	Function
On	Unsolicited messages are transmitted
Off	Unsolicited messages are not transmitted

Table 25: Setting range for unsolicited messages

To enable or block unsolicited messages, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F5 Continue > F5 Comm. interface > Press ···→ until the desired parameter is displayed.
   ⇨ Unsolicited messages
2. Press F1 or F5 to enable (**On**) or block (**Off**) unsolicited messages.
3. Press ↵.

⇨ Unsolicited messages are enabled or blocked.

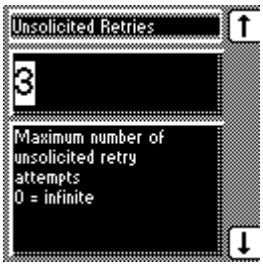
7.12.10 Setting number of attempts to transmit unsolicited messages

This parameter is used to set the maximum number of attempts to transmit unsolicited messages.

If the device receives no release for data transmission through the Master (for example, in case of transmission errors), then the data transmission is repeated in accordance with the set maximum number of send attempts.

If the value **0** is set, then an infinite number of attempts is made to transmit.

To set the maximum number of attempts to transmit unsolicited messages, proceed as follows:



1. MENU > F4 Configuration > F5 Continue > F5 Continue > F5 Comm. interface > Press ⋯→ until the desired parameter is displayed.
   ⇨ Unsolicited retries.
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵.

⇨ The maximum number of attempts to transmit unsolicited messages is set.

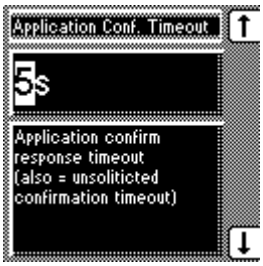
7.12.11 Timeout for application confirm responses

You can use this parameter to define the permissible time which the device waits for the following feedback from the master device:

- Application confirmation response
- Confirmation of unsolicited message

If the permissible time is exceeded, another transmission request is sent to the master device. The number of requests sent is dependent on the set number of attempts to transmit unsolicited messages [► 122].

To set the timeout for application confirm responses, proceed as follows:



1. MENU > F4 Configuration > F5 Continue > F5 Continue > F5 Comm. interface > Press ⋯→ until the desired parameter is displayed.
   ⇨ Application conf. Timeout.
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵.

⇨ The timeout for application confirm responses is set.

7.12.12 Setting transmission delay time for RS485 interface

You can use this parameter to set a send delay for the interface, for example, to compensate for the reaction time of an external RS485/RS232 transformer when changing between transmitting and receiving operation.

To set the transmission delay time for the RS485 interface, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F5 Continue > F5 Comm. interface > Press →| until the desired parameter is displayed.
   ⇨ Transmission delay time.
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵.

⇨ The transmission delay time for the RS485 interface is set.

7.13 Tap positions

7.13.1 Analog tap position capture (optional)

If the device is equipped with an AI module, you can capture the current tap position of the on-load tap-changer by means of analog signal. To do so, you must configure the analog input (P2.35 and P2.36) accordingly.

You can set the following options:

- Off: No tap position capture active
- Keep Track: tap position capture by means of the "Keep Track" function
- AI (optional): Tap position capture by means of analog signal

You can use the following tap position transmitters:

	AI module (P2.35 and P2.36)
Resistor contact series	100...2,000 ohms
Injected current	0...1 mA, 0/4...20 mA

Table 26: Analog tap position capture

Adjustment to the existing tap position transmitter must be carried out during commissioning.

To select an analog tap position capture, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F5 Continue > F3 Tap position
   ⇨ Tap pos. capture
2. Press F1 or F5 to set the desired option.
3. Press ↵.

⇨ The tap position capture is set.

Setting lower tap position

You can use this parameter to set the lower value of the tap position.

To set the lowest tap position, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F5 Continue > F3 Tap position > Press ⋯→ until the desired parameter is displayed.
   ⇨ Tap min.
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵.

⇨ The lowest tap position is set.

Setting upper tap position

You can use this parameter to set the upper value of the tap position.

To set the highest tap position, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F5 Continue > F3 Tap position > Press ⋯→ until the desired parameter is displayed.
   ⇨ Tap max.
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵.

⇨ The highest tap position is set.

Setting tap position for the Keep Track application

You can use this parameter to set the current tap position for the Keep Track application.

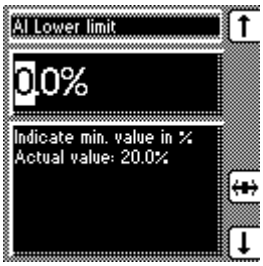
To set the current tap position Keep Track, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F5 Continue > F3 Tap position > Press ⋯→ until the desired parameter is displayed.
   ⇨ Current tap position.
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵.

⇨ The current tap position is set.

Setting lower AI limit

You can use this parameter to set the lower limit value of the AI module.



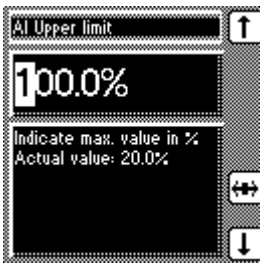
To set the lower AI limit, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F5 Continue > F3 Tap position > Press ⋯→ until the desired parameter is displayed.
   ⇨ AI lower limit.
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵.

⇨ The lower limit value of the AI module is set.

Setting upper AI limit

You can use this parameter to set the upper limit value of the AI module.



To set the upper AI limit, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F5 Continue > F3 Tap position > Press ⋯→ until the desired parameter is displayed.
   ⇨ AI upper limit.
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵.

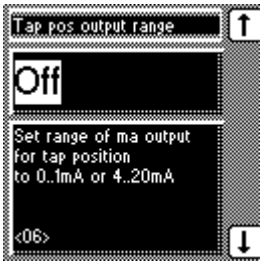
⇨ The upper limit value of the AI module is set.

7.13.2 Tap position output

You can use this parameter to set the range of the tap position output.

You can choose between the following options:

- Off
- 0...1 mA
- 4...20 mA



To set the range of the tap position output, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F5 Continue > F4 Tap position > Press ⋯→ until the desired parameter is displayed.
   ⇨ Tap position output range.
2. Press F1 or F5 to set the desired option.
3. Press ↵.

⇨ The tap position output range is set.

7.13.3 Permitted tap positions

You can use the parameters described below to restrict the permissible range of tap positions in auto mode.

In manual mode, for manual tap changes on the motor-drive unit or for remote tap changes via a SCADA system, monitoring of the step limits is not active. This may result in the set limits being exceeded.

When switching from manual mode to auto mode, the tap changer should be within the permitted tap positions.

7.13.3.1 Setting the tap position blocking mode

You can set the tap position blocking mode in relation to the upper and lower tap position blocking limits:

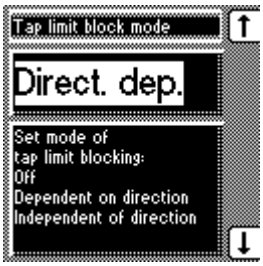
Setting	Behavior
Off	The tap position blocking mode is deactivated
Directional	During raise and lower tap changes, the device blocks as soon as the defined upper/lower tap position limit is reached or exceeded. Further tap changes are prevented.
Non-directional	The device blocks in both directions as soon as the defined lower/upper tap position limit is reached or exceeded. Further tap changes are prevented.

Table 27: Tap position blocking mode

To set the tap position blocking mode, proceed as follows:

✓ Press MANUAL to select manual mode.

✓ Press to change back manually into the defined tap position limits.



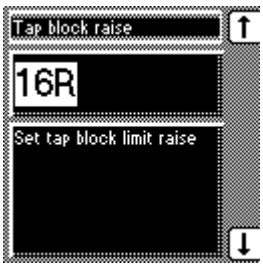
1. MENU > F4 Configuration > F5 Continue > F5 Continue > F3 Tap position > Press ⋯→ until the desired parameter is displayed.
   ⇨ Tap Pos Limit Block Mode
2. Press F1 or F5 to set the desired option.
3. Press ↵.

⇨ The tap position blocking mode is set.

7.13.3.2 Setting highest tap position blocking limit

You can define an upper tap position blocking limit to limit the number of tap positions available in operation. When the tap position defined as the upper tap position blocking limit is reached, tap position blocking is activated. This prevents any further tap change upwards.

To define the upper tap position blocking limit, proceed as follows:



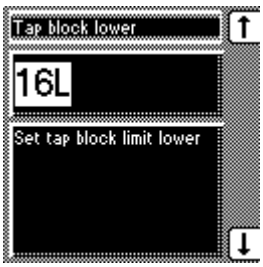
1. MENU > F4 Configuration > F5 Continue > F5 Continue > F3 Tap position > Press ⋯→ until the desired parameter is displayed.
   ⇨ Highest tap position
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵.

⇨ The upper blocking limit is defined.

7.13.3.3 Setting the lowest tap position blocking limit

You can define a lower tap position blocking limit to limit the number of tap positions available in operation. When the tap position defined as lower tap position blocking limit is reached, tap position blocking is activated. This prevents any further tap change downwards.

To define the lower tap position blocking limit, proceed as follows:



1. MENU > F4 Configuration > F5 Continue > F5 Continue > F3 Tap position > Press ⋯→ until the desired parameter is displayed.
   ⇨ Lowest tap position
2. Press F1 to increase the value or F5 to reduce it.
3. Press ↵.

⇨ The lower tap position blocking limit is defined.

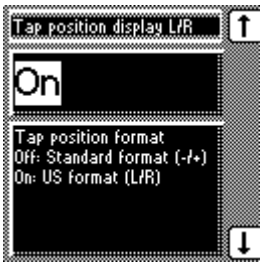
7.13.4 Tap-position indication

You can use this parameter to set the display of the tap position.

You can set the following options:

Option	Description
Off	Standard format -/+
On	US format L (lower) / R (raise)

Table 28: Options for tap-position indication



To set the tap-position indication, proceed as follows:

1. MENU > F4 Configuration > F5 Continue > F5 Continue > F3 Tap position > Press ⋯→ until the desired parameter is displayed.
   ⇨ L-R tap-position indication.
2. Press F1 or F5 to select the option you want.
3. Press ↵.

⇨ Tap-position indication is set.

7.14 Displaying information about device

The next section describes how you can display information about the device.

7.14.1 Displaying the info screen

Information about the device can be viewed here.

The following information is displayed:

- Device model
- Firmware version number and date
- EEPROM memory
- RAM
- Flash memory

To display the info screen, proceed as follows:

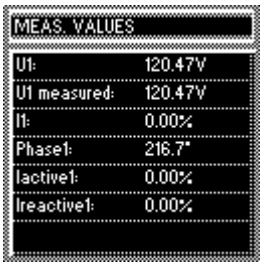
► MENU > F5 Info

⇨ Info.

7.14.2 Displaying measured values

The current measured values are shown in this display. The following measured values can be displayed:

To display the measured values, proceed as follows:



► MENU > F5 Info > Press ···→ until the desired measurement parameter is displayed.

⇨ Measured values.

7.14.3 Carrying out LED test

You can check whether the LEDs are functioning properly. To do this, press the relevant function key to illuminate an LED:

Key	LED no.
F1 ... F5	LED 1...LED 5
F1 + F5 ... F4 + F5	LED 6...LED 9
↵	All LEDs

Table 29: Arrangement of keys for the LED test

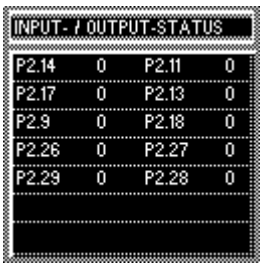
This function will only test the functional reliability of the respective LED. The function of the device linked to the LED is not tested.

To carry out the LED test, proceed as follows:

1. MENU > F5 Info > Press ···→ until the desired measurement parameter is displayed.
   ⇨ LED test.
2. To carry out the function test, press any F key for the LED you want to test.

7.14.4 Display of the IO status

The status of the inputs is shown in this display. As soon as a continuous signal is present at the input, status **1** is displayed. **0** indicates no signal at the input.



Proceed as follows to display the status:

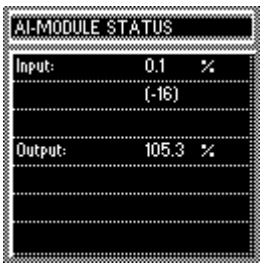
► MENU > F5 Info > Press ⋯→ until the desired display appears.

⇨ Input/output status

7.14.5 Displaying status of the AI card

The status of the analog inputs and outputs is shown in this display:

- Input: Percentage measured value, based on the measuring range (0...20 mA) and calculated value (e.g. tap position). If the measured value is not within the permitted measuring range, "?" is displayed.
- Output: Percentage value of the output signal, based on the signal range (0...20 mA)



Proceed as follows to display the status:

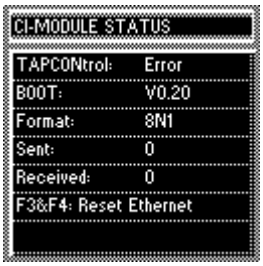
► MENU > F5 Info > Press ⋯→ until the desired display appears.

⇨ AI card status

7.14.6 Displaying status of the CI card

The status of the CI card is shown in this display:

- Protocol
- Software version
- Data format
- You can also reset the SCADA Ethernet connection.



To display the information, proceed as follows:

► MENU > F5 Info > Press ⋯→ until the desired display appears.

⇨ CI card status.

► If necessary, press F3 and F4 at the same time to reset the Ethernet connection.

⇨ The Ethernet connection is reset.

7.14.7 Resetting parameters

With this display you can reset your settings to the factory settings . It also shows whether all parameters are saved correctly.

Resetting the parameters to the factory settings permanently deletes your settings.

To reset all the set parameters, proceed as follows:

1. Press MENU > F5 Info > ⋯→ until the desired measurement parameter is displayed.
   ⇨ Parameters.
2. Press F3 and F4 at the same time.
3. Press ↵.

⇨ All parameters have been reset to the factory settings.

7.14.8 Displaying real-time clock

An operations counter is started when the device is first switched on. This continues to run even if the device is switched off. Each of the operations counter's times is overwritten with that of the PC to visualize the measured values.

To display the real-time clock, proceed as follows:

► Press MENU > F5 Info > ⋯→ until the desired measurement parameter is displayed.

⇨ RTC.

7.14.9 Displaying parallel operation

This display indicates the regulator number (CAN bus address) for parallel operation and the number of voltage regulators which are currently operating in parallel.

To display the parallel operation data, proceed as follows:

► MENU > F5 Info > Press ⇢ until the desired display appears.

⇨ Parallel operation.

7.14.10 Displaying data on CAN bus

The CAN bus data of the connected devices is shown in this display.

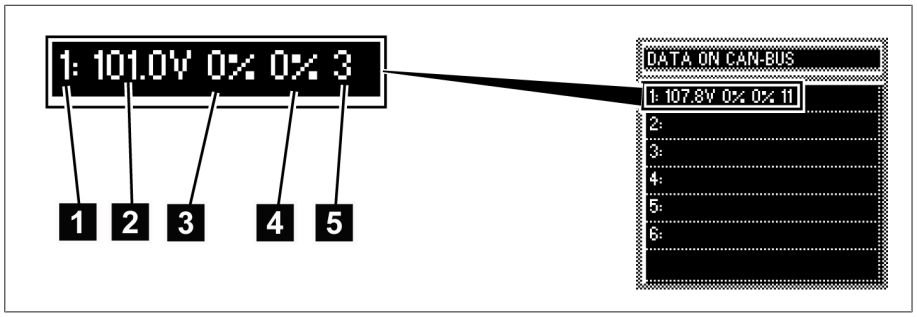


Figure 102: CAN bus data

1 CAN bus address of device	4 Reactive current in %
2 Voltage in V	5 Current tap position
3 Active current in %	

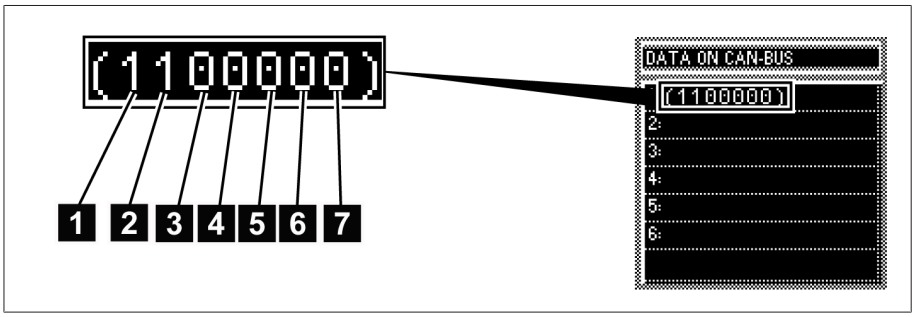


Figure 103: Other CAN bus data

1 Group input 1	5 **Follower** tap synchronization (0 = deactivated; 1 = activated)
2 Group input 2	6 **Auto** tap synchronization (0 = deactivated; 1 = activated)
3 Circulating reactive current parallel operation (0 = deactivated; 1 = activated)	7 Device blocks group because parallel operation is experiencing a fault (0 = is not blocked; 1 = is blocked)
4 **Master** tap synchronization (0 = deactivated; 1 = activated)	

To display the CAN bus data, proceed as follows:

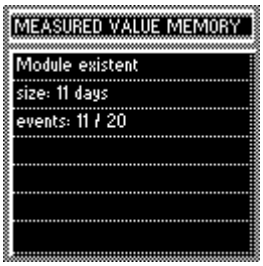
1. Press MENU > F5 Info > ···→ until the desired measurement parameter is displayed.
   ⇨ DATA ON CAN BUS.
2. Press and hold F1 to display more data.

⇨ The additional information is displayed until you release the key.

7.14.11 Displaying measured value memory

As an option, the device can be equipped with a long-term memory module. You can display information about the memory in this window.

To display the measured value memory, proceed as follows:



► MENU > F5 Info > Press ⇢ until the desired measurement parameter is displayed.

⇨ MEASURED VALUE MEMORY

7.14.12 Displaying peak memory

The minimum and maximum values as well as the time of occurrence are shown in this display for the following measured values:

- Voltage
- Tap position
- Apparent current
- Apparent power
- Active power (P)
- Reactive power (Q)

The minimum and maximum values continue to be stored in an internal fixed value memory even in the event of power failure. The time and date are displayed in the following format: HH:MM:SS, DD:MM:YY.

To display the peak memory, proceed as follows:

► MENU > F5 Info > Press ⇢ until the desired measurement parameter is displayed.

⇨ Peak memory.

7.14.13 Displaying the operations counters

The status of the number of tap-change operations is shown in this display:

- Hunting counter: Number of tap-change operation per day. Automatically resets after 24 hours and can be manually reset.
- Operations counter: Number of tap-change operations. Can be manually reset.
- Total tap-change operation counter: Total number of tap-change operations. Cannot be manually reset.

To display the operations counter, proceed as follows:

1. MENU > F5 Info > Press ⋯→ until the desired display appears.
   ⇨ Operations counter
2. If necessary press F1 and F2 simultaneously to reset the hunting counter.
3. If necessary press F3 and F4 simultaneously to reset the operations counter.

7.14.14 Displaying upcoming messages

This display shows upcoming messages, such as:

- Undervoltage
- Overvoltage
- Fault in parallel operation
- etc.

To display the upcoming messages, proceed as follows:

► Press MENU > F5 Info > ⋯→ until the desired measurement parameter is displayed.

⇨ UPCOMING MESSAGES

7.14.15 Display of the consumption

You can display the consumption at present (average value) and the maximum consumption. For this purpose, the device uses a simulation of a wattmeter.

Consumption at present

The consumption at present is shown in this display.

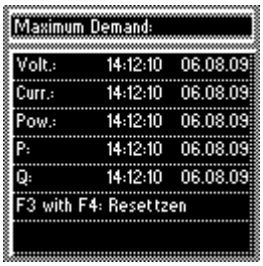
To display the consumption at present, proceed as follows:

► MENU > F5 Info > Press ⋯→ until the desired display appears.

⇨ Consumption at present.

Highest consumption

The highest amount of consumption and the time of occurrence is shown in this display.



To display the highest consumption, proceed as follows:

1. MENU > F5 Info > Press ···→ until the desired display appears.
   ⇨ Highest consumption.
2. If necessary press F3 and F4 simultaneously to reset the highest consumption.

8 Fault elimination

This chapter describes how to rectify simple operating faults.

8.1 No regulation in AUTO mode

Characteristics/detail	Cause	Remedy
Device control commands have no effect. RAISE/LOWER LEDs light up periodically	LOCAL/REMOTE switch in motor-drive unit switched to LOCAL.	Check operating mode. Correct if necessary.
	No connection	Check wiring as per connection diagram.
Blocking	Reverse power lock active.	Check parameters. Correct if necessary.
	Negative power flow	Check current transformer polarity.
	Function assigned to several GPIs.	Check parameterization of GPIs. Correct if necessary.
	One of the GPIs is parameterized with "Blocking" and has an appropriate input signal.	Check parameterization and status in "Info" menu. Correct if necessary.
	NORMset active	Carry out manual tap-change operation with or keys.
	Undercurrent blocking active	Check parameters. Correct if necessary.
Blocking U< LED illuminated	Undervoltage blocking active	Check parameters. Correct if necessary.
Blocking U> LED illuminated	Overvoltage blocking active	Check parameters. Correct if necessary.
Blocking I> LED illuminated	Overcurrent blocking active	Check parameters. Correct if necessary.
Bandwidth set too high	-	Determine the recommended bandwidth

Table 30: No regulation in AUTO mode

8.2 Unexplained tap change

Characteristics/detail	Cause	Remedy
Compensation activated	Setting: ▪ Line drop compensation ▪ Z compensation	Check parameters. Correct if necessary.

Table 31: Unexplained tap change

8.3 Man-machine interface

Characteristics/details	Cause	Remedy
Keys ▪ MANUAL/AUTO operating mode cannot be changed	REMOTE operating mode active and LED in key REMOTE illuminated.	Press REMOTE to activate LOCAL mode.
Keys ▪ LEDs in keys MANUAL and AUTO not illuminated.	Parameter error	Reset parameters to factory settings [▶ 132].
Display ▪ No display.	Contrast incorrectly set.	Set contrast.
	Power supply interrupted.	Check the voltage supply.
	Fuse faulty.	Contact Maschinenfabrik Reinhausen.
LEDs ▪ Freely configurable LED lights up	Customized LED parameterization.	Check parameters.
LEDs ▪ LED flashing	Input signal not constant.	Check input signal.
COM 2 ▪ Cannot be connected to PC using TAPCON®-trol.	Different baud rates set.	Check baud rate set on device and PC.

Table 32: Man-machine interface

8.4 Incorrect measured values

Characteristics/detail	Cause	Remedy
Measured voltage ▪ No measured value.	Connection has no contact in the plug terminal.	Check wiring and plug terminal.
	Insulation trapped	
	Wire not inserted far enough.	
	Circuit breaker tripped.	Check fuse.
Measured voltage ▪ Measured value too low.	Voltage drop on measuring lead.	Check measured voltage at plug terminal P2.1.
Measured voltage ▪ Measured value fluctuates.	Possible sources of fault: ▪ Leads laid in parallel. ▪ Tap-change operations.	Check measured voltage at plug terminal P2.1.
		Increase distance from source of interference.
		Install filter if necessary.
Measured current ▪ No measured value.	Line to current transformer interrupted.	Check wiring.
	Short-circuiting jumper in current transformer not removed.	Remove short-circuiting jumper.
Measured current ▪ Measured value too high.	Transmission ratio not correctly parameterized.	Correct parameterization.
▪ Measured value too low.	Incorrect input connected.	Remove short-circuiting jumper.
Phase angle ▪ U/I.	Fault in external transformer circuit.	Check transformer circuit.
	Transformer circuit incorrectly parameterized.	Compare with system connection diagram. Correct parameters.
		Compare measurement values on info screen.
		Transpose current transformer connection.
		Check polarity of transformer circuit. Correct if necessary.
		Check circuit. Correct if necessary.
		Check measurement points. Correct if necessary.

Table 33: Incorrect measured values

8.5 Parallel operation faults

Characteristics/detail	Cause	Remedy
Parallel operation cannot be activated. ▪ LED not lit up.	"Parallel operation method" parameter deactivated.	Set parallel operation method parameters.
	CAN bus address of device set to "0".	Set CAN bus address (anything but 0).
Problem with CAN bus. ▪ Device not listed.	Device incorrectly connected (plug twisted, offset).	Check connections. Connect as shown in connection diagram.
	Devices have the same CAN bus addresses.	Set different CAN bus addresses.

Table 34: Parallel operation faults

8.6 Customized GPIs/GPOs

Characteristics/detail	Cause	Remedy
Function expected from the factory setting does not take place	Parameterization has been overwritten manually or via TAPCON®-trol.	Check active parameters
Signal discontinuous.	Intermittent DC voltage.	Check source of DC voltage.
		Check signal transmitter.
		Check wiring.
No signal Info screens "Bandwidth!, "Delay time T1", "Control response T1", "Delay time T2" display 0.	Supply voltage too low	Reset parameters to factory settings.

Table 35: Fault elimination: GPIs and GPOs

8.7 General faults

Characteristics/detail	Cause	Remedy
No function ▪ *Operating status* LED does not illuminate	No power supply	Check the power supply
	Fuse tripped	Contact Maschinenfabrik Reinhausen GmbH
Relays chatter	Supply voltage too low	Check the supply voltage
	High EMC load	Use shielded cables or external filters
	Poor grounding	Check protective ground

Table 36: General faults

8.8 Other faults

If you cannot resolve a problem, please contact Maschinenfabrik Reinhausen. Please have the following data on hand:

- Serial number
  - Name plate (Outer right side when viewed from the front)
  - Info screen (MENU > F5 Info)

Please provide answers to the following questions:

- Has a firmware update been carried out?
- Has there previously been a problem with this device?
- Have you previously contacted Maschinenfabrik Reinhausen about this issue? If yes, then who was the contact?

9 Disposal

Observe the national requirements applicable in the country of use.

10 Overview of parameters

This section contains an overview of the relevant menus and parameters. The availability of individual parameters varies depending on your device function.

Parameter	Setting range	Factory setting	Current setting
NORMset			
Normset activation	On/Off	Off	
Desired value 1	100 to 135 V	120 V	
Primary voltage	0...9999 kV	0 kV	
Secondary voltage	100 to 135 V	120 V	
Parameter > Control parameter			
Desired value 1	100 to 135 V	120.0 V	
Desired value 2	100 to 135 V	120.0 V	
Desired value 3	100 to 135 V	120.0 V	
Desired value 4	100 to 135 V	120.0 V	
Absolute bandwidth	On/Off	Off	
Bandwidth (%)	0.5...9 %	1.00 %	
Bandwidth (V)	0.5 to 10 V	1.2 V	
Voltage offset	0 to 20 V	0.0 V	
T1 delay time	0...600 s	40 s	
T1 control response	T1 linear/T1 integral	T1 linear	
T2 activation	T2 on/T2 off	T2 off	
T2 delay time	1...60 s	10.0 s	
Parameter > Limit values			
U< Undervoltage (V)	95 to 135 V	110.0 V	
U> Overvoltage (V)	100 to 140 V	130.0 V	
I> Overcurrent	50...210 %	110 %	
Monitoring Monitoring	On/Off	Off	
U< delay	0...20 s	10.0 s	
U< blocking	On/Off	On	
U< also under 30 V	On/Off	Off	
Hunting alarm limit	0...100	50	
Parameter > Compensation			

Parameter	Setting range	Factory setting	Current setting
Ur line drop compensation	-25 to 25 V	0.0 V	
Ux line drop compensation	-25 to 25 V	0.0 V	
Z compensation	0...15 %	0.0 %	
Z comp. limit value	0...15 %	0.0 %	
Configuration > Transformer data			
Primary voltage	0...9999 kV	0 kV	
Secondary voltage	100 to 135 V	120.0 V	
Primary current	0...10000 A	0 a	
Transformer circuit	See [▶ 89]	0 1PH	
Configuration > General			
Language	See [▶ 51]	German	
Regulator ID	See [▶ 55]	0000	
COM1 setting	9.6 kilobaud; 19.2 kilobaud; 38.4 kilobaud; 57.6 kilobaud	57.6 kilobaud	
Display kV/V	kV/V	V	
Display % / A	On/Off	Off	
R/L pulse duration	0...10 s	1.5 s	
Consumption interval	15 min; 30 min; 1 h	15 min	
Motor runtime	0...30 s	0.0 s	
Reverse power flow behavior	Ignore; block; to neutral	Ignore	
MANUAL/AUTOMATIC input	Pulsed / not pulsed	Not pulsed	
Local/Remote input	Pulsed / not pulsed	Not pulsed	
Configuration > User In/Outputs			
GPI 1	See [▶ 94]	Desired value 3	
GPI 2	See [▶ 94]	Parallel group 1	
GPI 3	See [▶ 94]	Blocking	
GPI 4	See [▶ 94]	Desired value 2	
Programmable alarm	0...2047	0	
Configuration > Parallel operation			
Parallel operation allowed	On/Off	On	

Parameter	Setting range	Factory setting	Current setting
Parallel operation method	Circulating reactive current; master; follower; auto synchronization;	Circulating reactive current	
Parallel operation group	None; group 1; group 2	None	
CAN address	0...16	1	
Group 1 stability	0...100 %	0.0 %	
Group 1 blocking	0.5...40 %	20.0 %	
Group 2 stability	0...100 %	0.0 %	
Group 2 blocking	0.5...40 %	20.0 %	
Error message	1...99 s	10 s	
Tapping direction Swapped	Standard; swapped	Standard	
CAN bus error behavior	Independent; blocking	Blocking	
Configuration > LED selection			
LED1	See [► 105]	Off	
LED2		Off	
LED3		Off	
LED4 green		Off	
LED4 red		Off	
Configuration > Memory			
U< memory	95 to 135 V	110.0 V	
U> memory	100 to 140 V	130.0 V	
Mean value interval	See [► 108]	1 s	
Event memory	256 k; 512 k; 1024 k, 2048 k	256 k	
Configuration > Comm. interface			
CI protocol	TAPCONtrol; DNP3, Modb. ASCII; Modbus RTU	TAPCONtrol	
CI port	See [► 118]	RS232	
CI baud rate	9.6 kilobaud; 19.2 kilobaud; 38.4 kilobaud; 57.6 kilobaud	9.6 kilobaud	
Network address	0.0.0.0… 255.255.255.255	0.0.0.0	

Parameter	Setting range	Factory setting	Current setting
TCP port	0…32767	1234	
OF inversion	On/Off	On	
CI Address	0...9999	1	
Master address	0…9999	0	
Unsolicited messages	On/Off	On	
Unsolicited retries	0…100	3	
Application conf. Timeout	1...60 s	5 s	
Send delay time	0…254 ms	5 ms	
Configuration > Set desired voltage level remotely.			
Set desired voltage level remotely	On/Off	Off	
AI lower limit	0...100 %	0.0%	
AI upper limit	0...100 %	100.0%	
Minimum desired value	100 to 135 V	100 V	
Maximum desired value	100 to 135 V	135 V	
Configuration - Tap position options			
Tap pos. capture	Off; Keep Track; AI	Off	
Tap min.	9...16L	16L	
Tap max.	16...23R	16R	
Current tap position	0; 1...7R	0	
AI lower limit	0...100 %	0.0%	
AI upper limit	0...100 %	100.0%	
Range of the tap position output	Off, 0...1 mA, 4...20 mA	Off	
Blocking behavior	Off; direction dependent; direction independent	Direction dependent	
Lower tap position blocking	-50L...1R or -50...+1	16L	
Upper tap position blocking	1L...140R or 1...140	16R	
Tap position indication L/R	On/Off	On	
Info			
Info			
Measured values			

Parameter	Setting range	Factory setting	Current setting
LED test			
Input/output status			
AI card status			
CI card status			
Parameter			
Real-time clock			
Parallel operation			
Data on CAN bus			
Measured value memory			
Peak memory			
Operations counter			
Upcoming messages			
Current consumption			
Highest consumption			
Time plotter			

Table 37: Overview of parameters

Also refer to

Setting the phase difference for the current transformer/voltage transformer [▶ 89]

11 Technical data

11.1 Display elements

Display	LCD, monochrome, graphics-capable 128 x 128 pixels
LEDs	15 LEDs for operation display and messages, of which 4 LEDs are freely programmable (3x yellow, 1x yellow/green/red)

Table 38: Display elements

11.2 Voltage supply

Permissible voltage range	85…140 VAC 12 VDC
Permissible frequency range	50 / 60 Hz
Power consumption	6…12 VA (depending on the extensions)

Table 39: Voltage supply

11.3 Voltage measurement and current measurement

Voltage measurement	U_N (RMS): 120 V AC Measuring range (RMS): 85...140 V AC Measuring accuracy < ± 0.5% Intrinsic consumption: < 1 VA
Current measurement	I_N: 200 mA Measuring range: 2...420 mA Overload capacity: 200 mA (continuous), 420 mA (for 2 h) 4.0 A (for 1 s) Measuring accuracy < ± 0.5% Intrinsic consumption: < 1 VA

Table 40: Voltage measurement and current measurement

Interfaces

Pin	Description
P2.1	Voltage input for phase L
P2.3	Voltage input for neutral conductor

Table 41: Voltage measurement

Pin	Description
P2.2	Current output for phase L
P2.4	Current input for phase L

Table 42: Current measurement

11.4 Digital inputs and outputs

Inputs	Quantity	10 (4x AC, 6x DC)
	Logical 0	0...5 V AC (RMS) 0...1 V DC
	Logical 1	7...240 V AC (RMS) 1.2...30 V DC
	Input current	< 60 mA (AC) < 18 mA (DC)
Outputs	Quantity	6
	Contact loadability	Max. AC: 120/240 VAC; 6 A

Table 43: Technical data for digital inputs and outputs

Interfaces

Pin	Description
P2.7	Make contact (NO) 120/240 VAC
P2.8	Source contact 240 VAC
P2.9	Input 12 VDC
P2.10	Voltage output +12 VDC, max. 100 mA
P2.11	Source contact 12 VDC
P2.12	Make contact 12 VDC
P2.13	Input 12 VDC
P2.14	Source contact 12 VDC
P2.15	Make contact 12 VDC

Pin	Description
P2.16	Make contact (NO) 120/240 VAC
P2.17	Input 12 VDC
P2.18	Input 12 VDC
P2.19	-
P2.20	Make contact (NO) 120 VAC
P2.21	Make contact (NO) 120 VAC
P2.22	Source contact 120 VAC
P2.23	Source contact 240 VAC
P2.24	Source contact 120 VAC
P2.25	Source contact 240 VAC
P2.26	Input 120/240 VAC
P2.27	Input 120/240 VAC
P2.28	Input 120/240 VAC
P2.29	Input 120/240 VAC
P2.30	Make contact (NC) 120 VAC
P2.31	Make contact (NO) 120 VAC
P2.32	Source contact 120 VAC

Table 44: Digital inputs and outputs

11.5 Analog inputs and outputs (AI module)

Input	Measuring range	0...1 mA 0...20 mA 4...20 mA Potentiometer: maximum resistance 100 Ω...2 kΩ
	Load resistance	0...1 mA: < 3 kΩ 0...20 mA: < 150 Ω 4...20 mA: < 150 Ω
Output	Signal range	0...1 mA 4...20 mA
	Load resistance	0...1 mA: max. 10 kΩ 4...20 mA: max. 500 Ω

Table 45: Technical data for AI module

Interfaces

Pin	Description
P2.35	Current input +
P2.36	Current output -
P2.37	Current output +5 V

Table 46: Analog input

Pin	Description
P2.33	Current input -
P2.34	Current output +

Table 47: Analog output

11.6 System networking (CI module)

RS232	9-pin SUB-D connector Pin 2: TxD Pin 3: RxD Pin 5: GND
RS485	3-pin socket from Phoenix (MC1.5/3 GF 3.5) Pin 1: A (non-inverted) Pin 2: B (inverted) Pin 3: GND
RJ45 (Ethernet/Modem)	Pin1: Tx+ Pin2: Tx- Pin3: Rx+ Pin6: Rx-
Fiber-optic cable	F-ST (850 nm)

Table 48: Technical data for CI module

11.7 Dimensions and weight

Housing (W x H x D)	5.81 x 8.5 x 3.08 in (147.6 x 216 x 78.2 mm)
Weight	Approx. 6.2 lbs (2.8 kg)

Table 49: Dimensions and weight

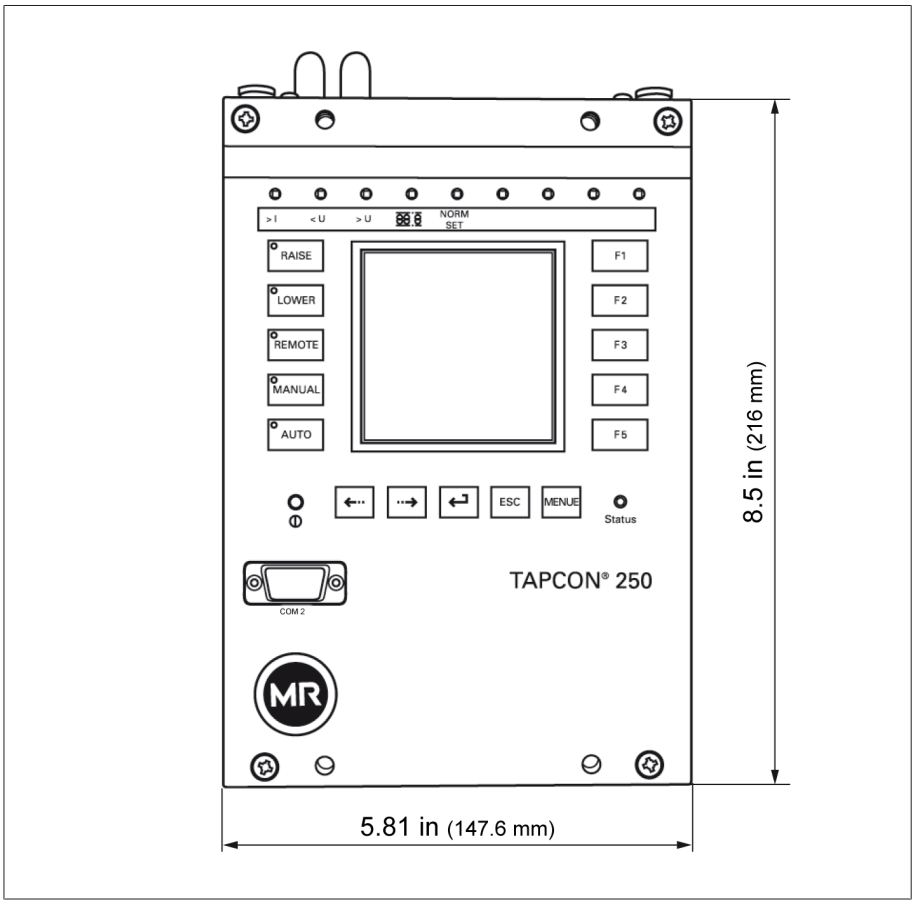


Figure 109: Front view

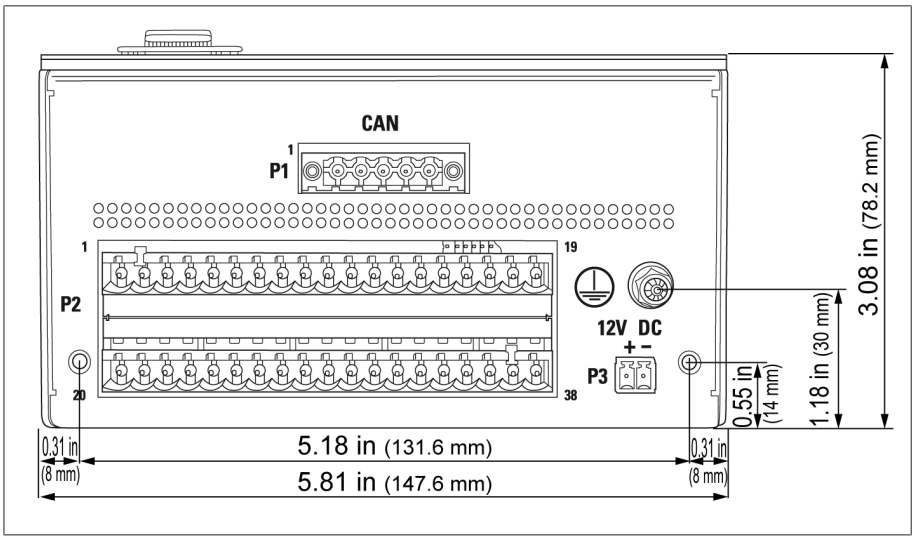


Figure 110: View from below

11.8 Ambient conditions

Operating temperature	-13 °F…158 °F (-25 °C…+70 °C)
Storage temperature	-40 °F…176 °F (-40 °C...+80 °C)

Table 50: Ambient conditions

11.9 Electromagnetic compatibility

High voltage	1500 VAC RMS to ground for 1 minute at a fault current≤ 15 mA (except for communication interfaces, CAN bus terminal P1 and terminals P.2.33…P2.37)
IEC 61000-4-2	Electrostatic discharges (ESD) 8 kV / 15 kV
IEC 61000-4-3	Electromagnetic fields (HF) 10 V/m 80...4000 MHz
IEC 61000-4-4	Fast transients (burst) 4 kV at 2.5 kHz (1 min)
IEC 61000-4-5	Immunity to transients (surge) 2 kV (phase conductor / phase conductor), 4 kV (phase conductor / ground)
IEC 61000-4-6	HF interference immunity (lines) 10 V, 150 kHz...80 MHz
IEC 61000-4-8	Immunity to magnetic fields 1000 A/m, 60 Hz, continuous
IEEE C37.90.1-2002	Fast transients (burst) 4 kV

Table 51: Electromagnetic compatibility

11.10 Environmental durability tests

DIN EN 60529	Determination of protection class for "protection against contact, ingress of foreign objects and water for electrical equipment" Level IP54
IEC 60068-2-1	Dry cold -13 °F / 96 hours
IEC 60068-2-2	Dry heat 158 °F / 96 hours

IEC 60068-2-3	Damp heat at a constant 104 °F / 93% / 96 hours
IEC 60068-2-30	Cyclic moist heat (12 + 12 hours) 131 °F / 6 cycles

Table 52: Environmental durability tests

11.11 Mechanical stability

IEC 60255-21-1 Class 1	Bounce test
IEC 60255-21-2 Class 1	Shock and bump test
IEC 60255-21-3 Class 1	Seismic test

Table 53: Mechanical stability

Glossary

EMC

Electromagnetic compatibility

LDC

Line drop compensation

MR

Maschinenfabrik Reinhausen GmbH

OF

Abbreviation for fiber-optic cable

R/L

Raise/lower

RTC

Real-time clock

SCADA

Technical processes are monitored and controlled using a computer system (Supervisory Control and Data Acquisition)

List of key words

O

P

R

S

T

U

V

W

Z

MR worldwide

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