Voltage Regulator TAPCON® 230 AVT

Operating Instructions

Table of Contents

List of Figures

List of Tables

1 Introduction

This technical file contains important information for the safe and correct packaging, transport, storage, mounting and commissioning of the product and for remedying simple faults yourself.

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 voltage regulator is manufactured by:

Maschinenfabrik Reinhausen GmbH

Falkensteinstrasse 8

93059 Regensburg, Germany

Tel.: (+49) 9 41/40 90-0

Fax: (+49) 9 41/40 90-70 01

E-mail: sales@reinhausen.com

Further information on the voltage regulator and copies of this technical file are available from this address or on our website at www.tapcon230.com if required.

1.2 Subject to change without notice

The information contained in this technical file comprises the technical specifications released at the time of printing. Significant modifications will be included in a new edition of the user manual. The document and version numbers for this manual are shown in the footer.

1.3 Completeness

This technical file is incomplete without the supporting documents.

1.4 Supporting documents

The quick reference guide, the operating instructions and the accompanying connection diagrams also apply in addition to this technical file. All documents are part of the scope of delivery.

In addition, generally applicable statutory and other binding regulations in European and national legislation and the regulations for accident prevention and environmental protection in force in the country of use must be complied with.

1.5 Safekeeping

This technical file and all supporting documents must be kept ready to hand and accessible for future use at all times.

1.6 Notation conventions

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

1.6.1 Abbreviations used

Abbreviation	Definition
°C	Degree Celsius
A	Ampere
AC	Alternating Current
B	Bandwidth
a/o	and/or
ca.	circa
CAN	Controller Area Network
CE	European conformity
CI	Communication Interface
COM	Computer Object Model
CPU	Central Processing Unit
i.e.	in other words
DC	Direct Current
DIN	Deutsches Institut für Normung (German Institute for Standardization)
DNP	Distributed Network Protocol
EMC	Electromagnetic compatibility
ESC	Escape
GPI	General Purpose Input
GPO	General Purpose Output
R/L	Raise / lower
HCS	Hard Clad Silica Optical Fiber
Hz	Hertz
I	Current
IEC	International Electrotechnical Commission
IP	Internet Protocol
kg	Kilogram
kV	Kilovolt
LDC	Line Drop Compensation
LED	Light Emitting Diode
OF	Optical Fiber
max.	Maximum
MB	Megabyte
MHz	Megahertz
min.	Minimum

Table 1 Abbreviations used

Abbreviation	Definition
MIO	Measurement Input/Output
mm	Millimetre
MMI	Man Machine Interface
ms	Millisecond
PIO	Parallel Input/Output
s	Second
SCADA	Supervisory Control and Data Acquisition
T	Time
TCP	Transmission Control Protocol
U	Voltage
e.g.	For example

Table 1 Abbreviations used

1.6.2 Hazard communication system

The warning notices in this technical file are structured as follows:

	SIGNAL WORD
	Danger **Consequences** ▸ Action ▸ Action

The following signal words are used:

Signal word	Hazard level	Consequence of failure to comply
Danger	Immediate threat of danger	Death or serious injury could occur
Warning	Possible threat of danger	Death or serious injury could occur
Attention	Possible dangerous situation	Minor or moderate injury may occur
Note	Possible dangerous situation	Material damage

Table 2 Signal words in safety instructions

Symbols are used to warn of dangers:

Symbol	Definition
	Danger
	Dangerous electrical voltage
	Fire hazard

Table 3 Symbols used in warning notices

Symbol	Definition
	Danger of tipping

Table 3 Symbols used in warning notices

1.6.3 Information system

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

	Important information.

1.6.4 Typographic conventions

The typographic conventions in this technical file are structured as follows:

Typographic conventions	Definition
...>...>...	Step of the procedure for software descriptions in the subsequent menu
UPPERCASE	Key labels e.g. "MENU key"

Table 4 Typographic conventions

2 Safety

2.1 General safety information

This technical file contains important information for the safe and correct packaging, transport, storage, mounting and commissioning of the product.

- Read this technical file through carefully to familiarize yourself with the product.
- Particular attention should be paid to the information given in this chapter.

2.2 Appropriate use

The product and associated equipment and special tools supplied with it comply with the relevant legislation, regulations and standards, particularly health and safety requirements, applicable at the time of delivery.

If used as intended in compliance with the specified requirements and conditions in this technical file as well as the warning notices in this technical file and attached to the product, then the product does not present any hazards for persons, property or the environment. This applies during the entire lifespan, from delivery through installation and operation to disassembly and disposal.

The operational quality assurance system ensures a consistently high quality standard, particularly when it comes to observance of the health and safety requirements.

Use is considered to be appropriate if

- the product is operated according to the agreed delivery conditions and technical data, and
- the associated equipment and special tools supplied with it are used solely for the intended purpose and in accordance with the specifications of this technical file.
- the product is used only for the application specified in the order.

2.3 Inappropriate use

Use is considered to be inappropriate if the product is used other than described in Chapter 2.2.

Maschinenfabrik Reinhausen does not accept liability for damage from unauthorized or inappropriate changes to the product. Unauthorized changes to the product without consultation with Maschinenfabrik Reinhausen can lead to personal injury, material damage and operational faults.

2.4 Personnel qualification

The product is designed solely for use in electrical or energy systems and facilities operated by appropriately trained staff. Specialists are those persons who are familiar with the setup, installation, commissioning and operation of such products.

2.5 Operator duty of care

To prevent accidents, faults 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:

- All warning and hazard notices are complied with.
- Personnel are instructed regularly in all relevant aspects of operational safety, this technical file and particularly the safety instructions contained therein.
- Regulations and technical files for safe working as well as the relevant instructions for staff procedures in the case of accidents and fires are kept to hand at all times and displayed in the workplace where applicable.
- The product is only used in a sound operational condition and safety equipment in particular is checked regularly for operational reliability.
- Only replacement parts approved by the manufacturer are used.
- Comply with the specified operating conditions and requirements of the installation location.
- All necessary equipment and personal protective equipment for each activity is available.
- The prescribed maintenance intervals and the relevant regulations are complied with.
- Fitting, electrical connection and commissioning of the product may only be carried out by qualified and trained personnel in accordance with this technical file.
- The operator must ensure appropriate use of the product.

3 Product description

3.1 Description of functions

The voltage regulation of transformers with on-load tap-changers is an important subject for energy utility companies.

The completely redesigned TAPCON® 230 AVT voltage regulator handles both simple control tasks and the complex requirements of a modern monitoring and control device.

The TAPCON® 230 AVT voltage regulator constantly checks the actual value V_{Actual} (transformer output voltage) against a specified or load-dependent set value V_{Target}, which can be determined by the user.

The TAPCON® 230 AVT provides the control pulse for the transformer on-load tap-changer, depending on the deviation of the actual from the set value.

The on-load tap-changer switches if the voltage level falls below or exceeds the specified tolerance band B (V_{Target} +/- B%). The minimum waiting time between two consecutive tap change operations is 60 s.

The voltage at the transformer is thus kept constant. Fluctuations within the permissible bandwidth have no influence on the control response or the tap change operation.

The voltage regulator parameters can be optimally adjusted to the line voltage behavior, so that a balanced control response with a minimum number of on-load tap changer operations is achieved.

Figure 1 shows an overview of voltage regulation using the TAPCON® 230 AVT.

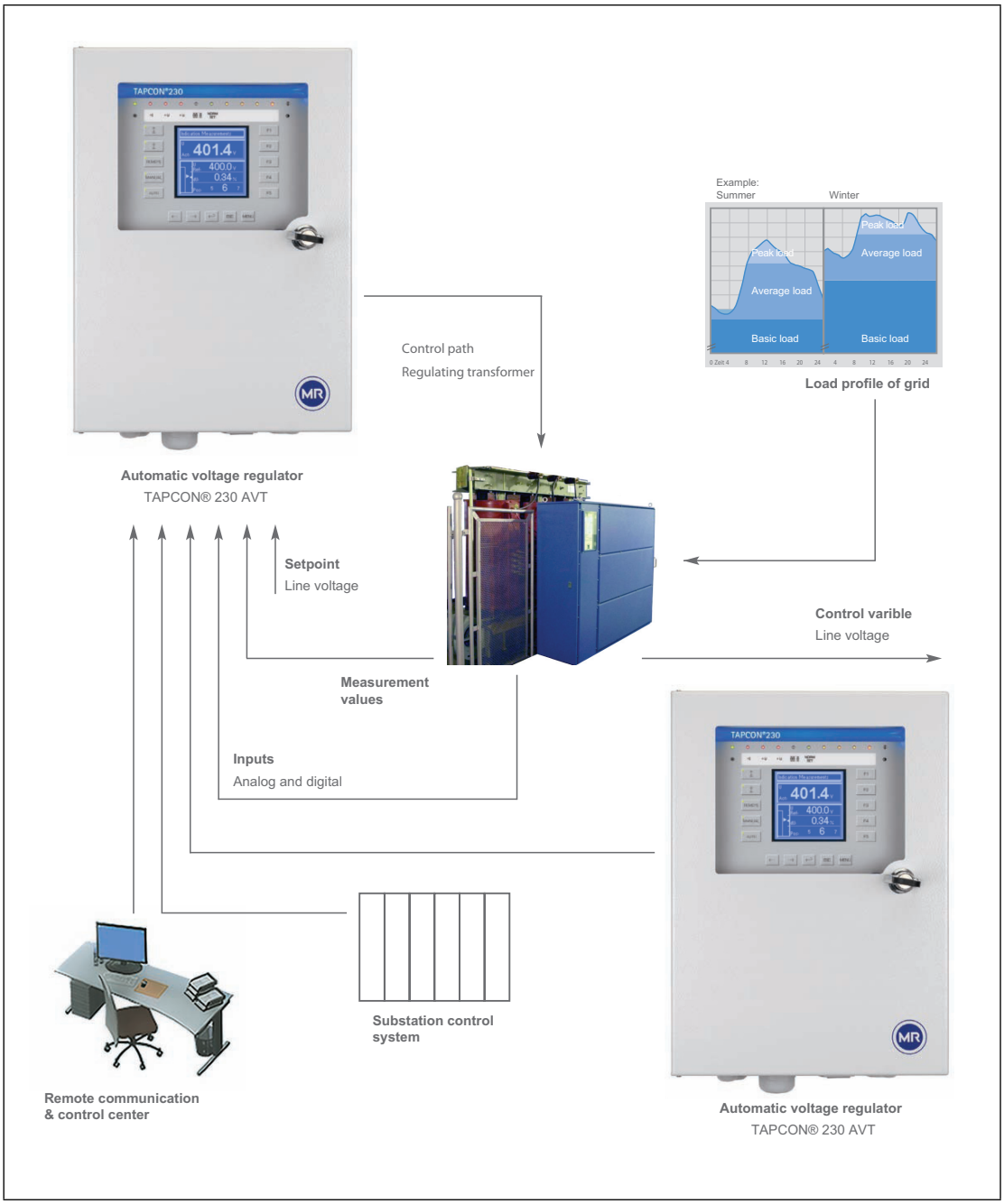


Figure 1Overview of voltage regulation using the TAPCON® 230 AVT

3.2 Features TAPCON® 230 AVT

The TAPCON® 230 AVT handles the control of tapped transformers with proven reliability.

Apart from control tasks, the TAPCON® 230 AVT provides additional functions such as:

- Integrated protection functions:
  - Undervoltage and overcurrent blocking
  - Overvoltage detection with high-speed return
  - Defined minimum waiting period of 60 s between two consecutive tap change operations
- Digital inputs and outputs can be individually programmed on-site by the user
- Additional indicators using LEDs external to the display for freely selectable functions
- Display of all measured values such as voltage, current, active power, apparent power or reactive power, cos φ
- Cable connection using modern plug terminals
- Selection of 3 different set values
- Tap position input can be selected on site between
  - analog signal 4 - 20 mA
  - analog signal over resistor contact series
  - digital signal using BCD or Gray code
- Additional digital inputs and outputs which can be freely parameterized by the customer
- Parallel operation of up to 6 transformers in 2 groups using the methods
  - Master / Follower
  - Circulating reactive current minimization

The CAN bus ensures error-free data exchange between all TAPCON® devices with parallel operation over a distance of up to two kilometers.

The regulators automatically detect which transformers are in parallel operation without any supplementary equipment. By activating the binary inputs for Master/Follower/Independent or using the menu settings, the position of a transformer can be quickly selected with certainty.

For particularly demanding requirements the TAPCON® 230 AVT also provides connection to a superordinate control system with protocols as shown in **Table 5**. RS232 and RS485 are standard and freely selectable.

	RS232	RS458	ETHERNET
MODBUS ASCII	X	X	
MODBUS RTU	X	X	X

Table 5 Interfaces available for control system communication

Further information on the TAPCON® 230 AVT is available on our web site at:
www.tapcon230.com

3.3 Scope of delivery

The following items are included in the delivery:

Scope of delivery
Voltage Regulator TAPCON® 230 AVT
Control panel bracket pre-mounted on housing
2 x mounting bracket for wall mounting
Covering strip for door
Allen key, wrench 3
Key for door
Folder with all device documentation
Quick reference guide DIN A6 in pocket in the regulator door
Optional
DIN rail clip

Table 6 Scope of delivery

Please note:

1. Check the delivery for completeness against the dispatch documents.
2. Store components in a dry place before installation.

The functional range of the product is dependent on the equipment ordered or the version and not the content of this technical file.

3.4 Hardware description

The TAPCON® 230 AVT is presented in a flat housing only 135 mm deep and can be secured to any wall without taking up space.

There is also the option for flush panel or DIN rail mounting.

An LCD graphic display, LEDs and function keys are integrated in the front panel of the TAPCON® 230 AVT.

The device is controlled by a microcontroller and includes isolated optocoupler inputs and floating output relay contacts in addition to the voltage and current transformers (**Figure 2**).

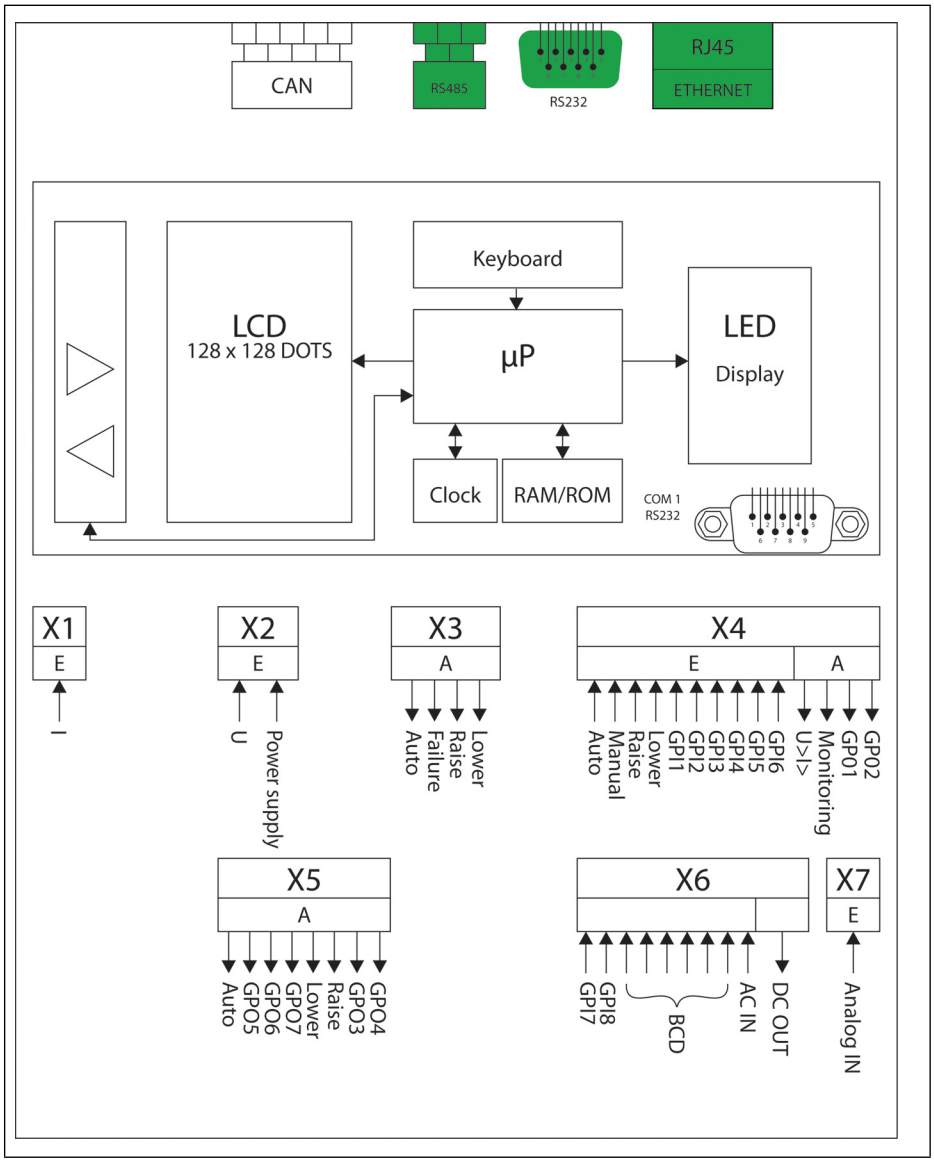


Figure 2 Block diagram for TAPCON® 230 AVT*

The TAPCON® 230 AVT can be parameterized with a PC via a COM 1 (RS232) inter-face that is integrated in the regulator and located on the front panel. The rele-vant software can be obtained from Maschinenfabrik Reinhausen.

The TAPCON® 230 AVT also features a CI card (highlighted in green in **Figure 2**). The TAPCON® 230 AVT can also be parameterized using this additional interface. Parameterization using the CI card requires the relevant menu settings. The additional communication interfaces are shown in **Figure 3**.

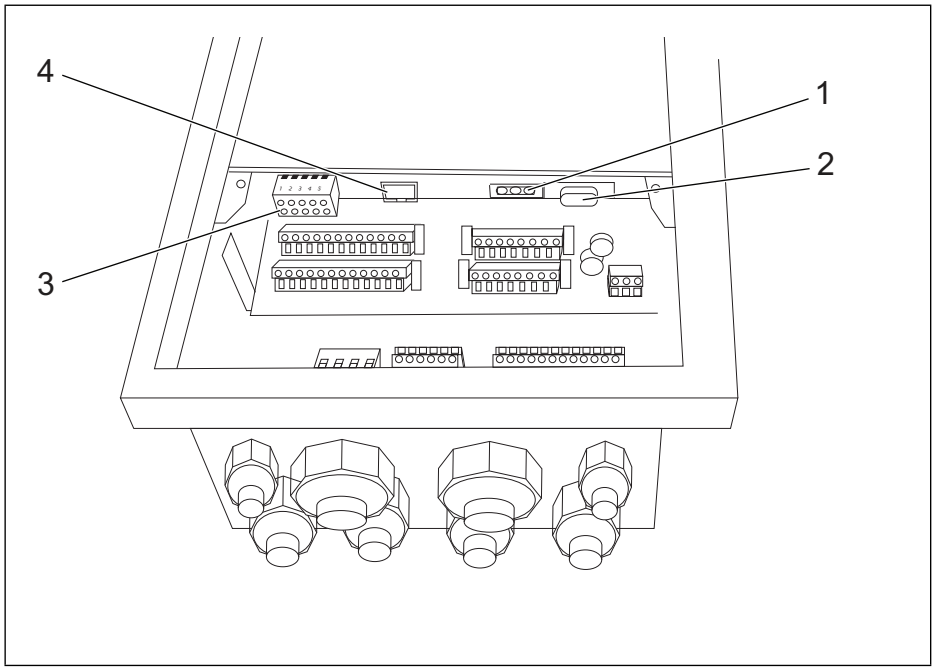


Figure 3 Additional communication interfaces in TAPCON® 230 AVT

1 RS485 connection

2 RS232 connection

3 CAN bus connection

4 RJ45 connection

The functions of the TAPCON® 230 AVT voltage regulator are compatible with earlier regulator generations to a large extent.

Function keys	Manual / Automatic Raise / lower Local/Rem. Menu keys

Table 7 Information about hardware

Display	Monochromatic display with graphics capabilities, 128 x 128 dot 6 LED green for operating status 3 LED red for limit values U >, U <, I > 1 LED green for parallel operation active 1 LED green for NORMset active 2 LED yellow for random assignment 1 LED yellow/green for random assignment 1 LED yellow/red for random assignment
Power supply	110 (-20%)...350 V DC 88...265 V AC Power consumption approx. 5.0 VA
Protective housing	Steel plate housing with inspection window (lockable) Dimensions (W x H) 198 x 310 mm Depth 135.5 mm Door (W x H) 242 x 343 mm Weight 6.8...7.0 kg Protection degree IP 54 according to IEC 60529
Operating temperature	-25°C...+70°C
Storage temperature	-40°C...+85°C

Table 7 Information about hardware

3.5 Description of the front panel

Figure 4 shows the front panel of the TAPCON® 230 AVT with a description of the keys. Further information on the function keys is given in **Section 3.7**.

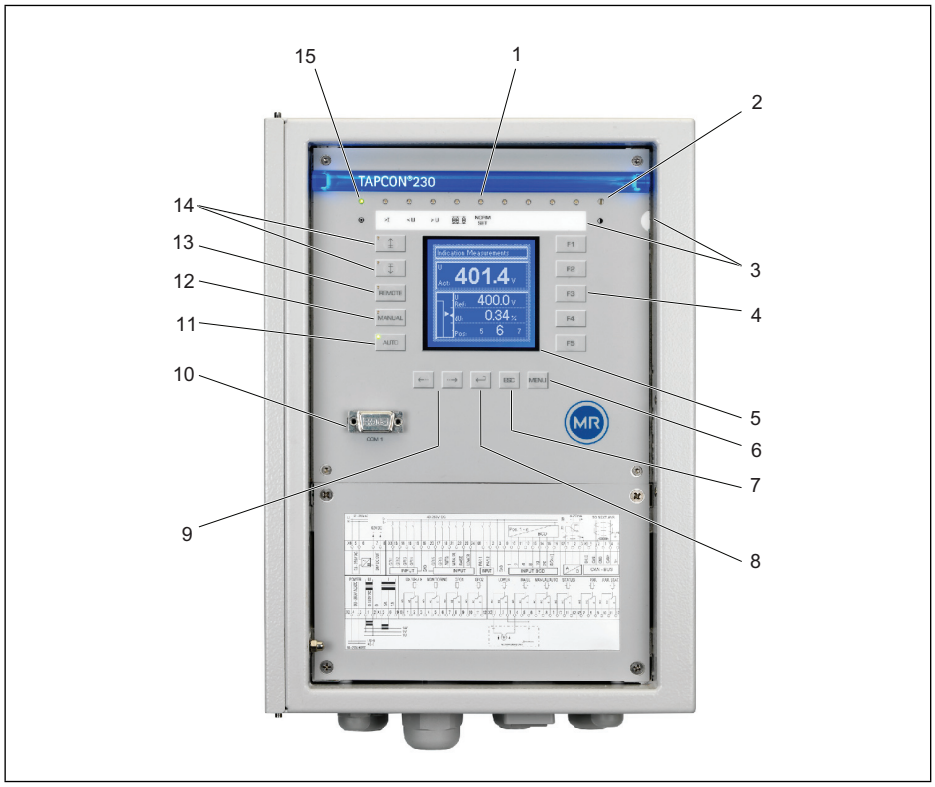


Figure 4 Front panel of the TAPCON® 230 AVT with control panel

1 LEDs 1...10

2 Setting options for display contrast

3 Labeling strip for LEDs

4 F1 - F5: Function and menu selection keys

5 Display 128X128 LCD module negative blue, LED background white

6 Menu selection

7 Escape

8 Accept entry

9 Switching windows inside a menu level

10 Parametering interface COM 1 (RS232)

11 Automatic voltage regulation (with auto mode LED green)

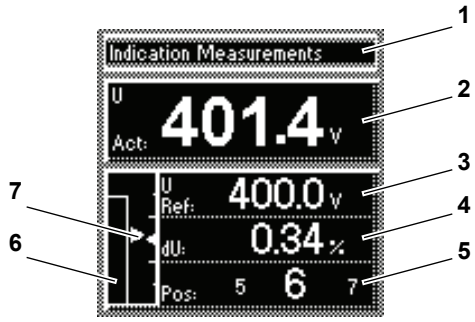
12 Manual mode (with manual control LED green)

13 Remote control (with Local/Remote LED green)

14 Control for RAISE/LOWER

15 Status LED

3.6 Description of the display

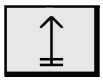
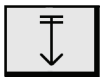
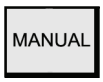
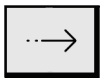
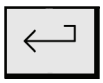


1 Status line
2 Actual value display
3 Target value display
4 Control deviation
5 Tap position display
6 Time bar
7 Target value deviation trend

Figure 5 Main screen

In the case of a particular event or a setting, the comments on this are displayed in the status line (display text "Events").

3.7 Description of key functions

Key	Symbol	Function
RAISE		In manual mode the motor drive unit can be operated directly using the RAISE key. Using RAISE, the motor drive unit changes the on-load tap-changer and therefore the step voltage.
LOWER		In manual mode the motor drive unit can be operated directly using the LOWER key. By switching lower, the motor drive unit changes the on-load tap-changer and therefore the step voltage.
REMOTE		In the "Remote" operating mode, commands from an external control interface are executed. In this case, manual operation of the RAISE, LOWER, MANUAL and AUTO keys is disabled.
MANUAL		Manual mode. For manual control of the motor-drive unit and parameterization of the TAPCON® 230 AVT.
AUTO		Automatic mode. Voltage is controlled automatically.
Arrow keys NEXT/ PREVIOUS	 	In auto and manual mode the measured value display can be set using the arrow keys. They can also be used to switch between windows in the sub-menus. After switching on the device, the control deviation dV is always displayed in the measured value display. The arrow keys can be used to switch between the following readings: • Control deviation (dV:) • Current (I:) • Apparent power (Powr.:) • Active power (P:) • Reactive power (Q:) • Phase angle (Phase:) • Cosine (Cos:)
ENTER		Confirms or saves a changed parameter in the parameter menu.

ESC		Pressing the ESC key takes you to the menu level above, in other words, always back one menu level.
MENU		Pressing this key displays the menu selection win-dow.
F1-F5	 	The function keys are menu selection keys. They are also used to scroll through the menu subgroups and to mark dec-imal points which can be set by the user.
COM 1 Interface		TAPCON® 230 AVT connection to a computer. The parameterization software is not included in the scope of delivery.

The parameters can only be changed in manual mode, see MANUAL key in the table above and **Figure 4**.

3.8 TAPCON® 230 AVT operating safety

The voltage regulator is equipped with a key lock as the default factory setting for protection against unintentional operation. To activate or deactivate, press the ESC and F5 keys (**Figure 4**) simultaneously. The key lock can be switched off using the menu.

The operating panel on the TAPCON® 230 AVT is divided into two different levels.

These are the operation control level and the level for parameterization and configuration.

The keys for operating the device are completely separate from those used for parameterization. On the operation control level, activating the keys is signalled visually by means of the LEDs.

The LEDs integrated in the RAISE/LOWER keys are illuminated during the entire tap change operation of the on-load tap-changer if "motor running" is signaled at the status input. This signal requires that it has previously be parameterized.

This visual monitoring option makes operation of the TAPCON® 230 AVT easier.

4 Packaging, transport and storage

4.1 Packaging

4.1.1 Purpose

The packaging is designed to protect the packaged goods both during transport and for loading and unloading as well as during 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 undesired changes during storage of the packaged goods within the packaging. Before the actual packaging the products must be prepared for shipping in order to ensure that they can be transported safely, properly, and economically.

4.1.2 Suitability, structure and material

The goods are packaged in a stable cardboard box. This ensures that the consignment is secured in the intended transport position and that none of its components touches the load platform during transport or the floor after it is unloaded.

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

Inlays inside the box stabilize the goods against undue changes of position and protect them from vibration.

4.1.3 Labeling

The packaging bears symbols with instructions for safe transport and correct storage. The following symbols apply to the dispatch (of non-hazardous goods) (**Figure 6**). These labels must be complied with.

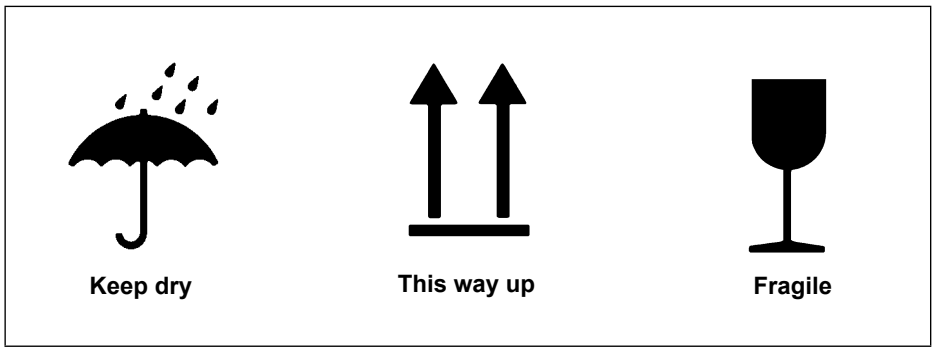


Figure 6 Dispatch symbols

4.2 Transport, reception and handling of shipments

During transport the product may be subjected to stress from vibration, shock and pressure. In order to prevent possible damage the product must be protected from being dropped, falling, tipping, and impact.

If a box is subject to a fall above a certain height or an unbroken fall, then damage will occur, irrespective of the weight involved.

Before acceptance, all deliveries must be checked by the recipient (acknowledgement of receipt) for

- completeness based on the delivery note
- external damage of any type.

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

- Immediately record the transport damage in the shipping documents and have this countersigned by the carrier.
- In the event of severe damage, total loss and high damage costs immediately notify the distribution division of Maschinenfabrik Reinhausen and the relevant insurance company.
- After identifying the damage do not modify the condition of the shipment further and retain the packaging material for inspection by the transport company or the insurance company.
- Record the details of the damage immediately together with the carrier involved. This is essential for any claim for damages.
- Take photographs of any damage to the packaging and product if possible. This also applies to signs of corrosion on the product due to moisture inside the packaging (rain, snow, condensation).
- List the damaged parts.

For concealed damage, i.e. damage that only becomes apparent after receipt of the shipment and during unpacking, proceed as follows:

- Make the party responsible for the damage liable asap by telephone and in writing, and prepare a damage report.
- Check and observe the relevant deadlines applicable in the respective country.

In the case of concealed damage, recourse to the transport company (or other parties that may be responsible for the damage) may be difficult. Any claims for such damages can only be successful if associated provisions are specified in the insurance terms and conditions.

4.3 Storage of shipments

Selection and arrangement of the storage location should meet the following requirements:

- Stored items must be protected against moisture (flooding, melt water from snow and ice), contaminants, pests such as rats, mice, termites etc. and against unauthorized access.
- Store the box on timber beams and planks as a protection against rising damp and for better ventilation.
- The surface must have adequate load carrying capability.
- Unobstructed access must be available.

Check stored items at regular intervals, and additionally after gales, heavy rain, significant snowfall etc., and take appropriate action.

5 Functions and Settings

This chapter describes all the functions and setting options for the voltage regulator. The setting values appear in the relevant sections or in summary in the table on Page 134.

The chapters are laid out following the menu structure of the device; see **Figure 7**.

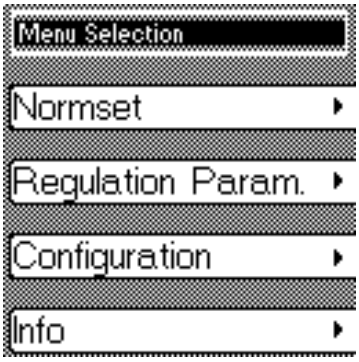


Figure 7 Menu

The voltage regulator functions are set using the keys on the device. Settings can only be carried out in manual mode with deactivated key lock. The key lock is activated and deactivated by pressing ESC + F5.

The key lock is activated by the voltage regulator after 15 minutes if no key has been pressed during this period. Automatic key locking requires that the function "Key lock" (see **Section 5.3.1** on Page 66) is activated.

The submenus are arranged in a continuous loop. For modifying functions or values, press either the F1 or F5 keys or the NEXT or PREV keys, depending on what is required.

Before carrying out the parameterization, proceed as follows:

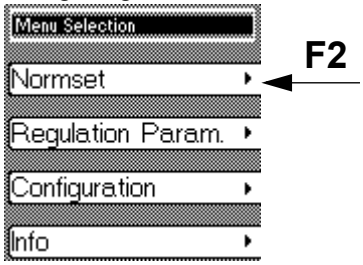
1. Deactivate the key lock if necessary. Press the ESC + F5 keys.
2. Activate manual mode: Press the MANUAL key.
3. Select main menu: Press the MENU key.

   ↳ The voltage regulator main menu is displayed.

The required function can now be set.

5.1 NORMset

Instead of parameterizing the voltage regulator manually, the NORMset mode enables easy and user-friendly commissioning of the voltage regulator with a limited set of parameters. When this mode is selected, the factory settings for voltage regulation are transferred.



When commissioning the voltage regulator in NORMset mode, the following parameters must be set:

- Voltage level 1

When these parameters have been set, the regulator is ready to operate.

After the voltage level has been entered, if NORMset is activated the voltage regulator checks the grid conditions and automatically adapts additional settings, composed partly of predefined parameters and default values.

All other parameters required for simple voltage regulation are predefined in the factory.

The procedure for activating or deactivating the NORMset mode is described in the following sections.

A manual tap-change operation is required once NORMset has been activated. This is how the voltage regulator determines the bandwidth required.

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

5.1.1 Activating NORMset

When the NORMset mode is activated, the NORMset LED on the voltage regulator control panel is illuminated.

When NORMset is activated, the voltage regulator's bandwidth and T1 delay time are set automatically.
The present settings for these parameters are not taken into account by the voltage regulator.

The following regulation parameters must be set in NORMset mode:

- Voltage level 1

The following parameters are not set automatically using the NORMset mode:

- Undervoltage limit
- Overvoltage limit
- Undercurrent limit
- Overcurrent limit

If required, these parameters must be set manually (see **Section 5.2.2** “Limit values” on page 56).

To activate the NORMset mode, proceed as follows:

1. MENU key > Normset
   ↳<00> Normset Activation
2. To activate Normset, press the F1 or F5 keys to select "On".
3. Press ENTER.
4. Press the RAISE or LOWER key to perform a manual tap-change operation.

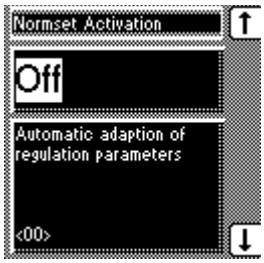
The Normset mode is now activated.

5.1.2 Deactivating NORMset

The voltage regulator NORMset mode can be deactivated and any desired additional settings made directly.

To deactivate the NORMset mode, proceed as follows:

After NORMset has been deactivated, all control parameters must be checked and set manually if necessary.



1. MENU key > Normset
   ↳<00> Normset Activation
2. To deactivate Normset, press the F1 or F5 key to select "Off".
3. Press ENTER.

The NORMset mode is now deactivated.

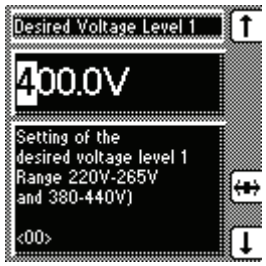
5.1.3 Setting voltage level 1

The TAPCON® 230 AVT is designed for operation within the voltage ranges of 220 V to 265 V and 380 V to 440 V.

Setting range	Step size	Factory setting
220 V...440 V	0.1 V	400 V

Table 8 Setting range for voltage level 1 in V in NORMset mode

To set voltage level 1, proceed as follows:



1. MENU key > Normset > 1x NEXT
   ↳<01> Voltage Level 1

2. Press F4 in order to highlight the decimal place.
   ↳The required place is now highlighted and the value can be changed.

3. Press the F1 key to increase the voltage level or F5 to decrease it.

4. Press ENTER.

Voltage level 1 is now set.

The range between 265 V and 380 V is not intended for entering the voltage level and will result in the error message: "Voltage level not in permitted range of measurements".

If this happens, automatic mode is no longer subject to regulation. Tap-change operations can still take place in manual mode.

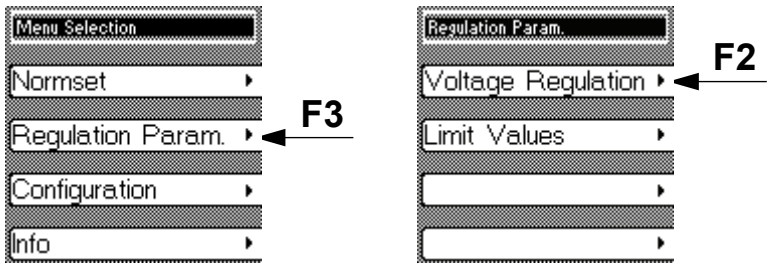
5.2 Control parameters

This section describes all the functions, parameters and recommended setting ranges for voltage regulation using the TAPCON® 230 AVT. To make it easier to find specific parameters, the description refers to subgroups of functionally related individual parameters.

5.2.1 Voltage regulation

This submenu contains all the parameters required for the control function.

MENU key > Regulation Param. > Voltage Regulation



5.2.1.1 Setting voltage levels

The voltage level, Vtarget is specified as a fixed value. The voltage level can be entered using the voltage regulator user interface, both in the NORMset mode subgroup and in the parameter mode subgroup.

In addition, the TAPCON® 230 pro/expert provides the option of changing the voltage level during operation if this is necessary.

The voltage levels are activated using binary inputs. Up to 3 voltage levels can be entered in the parameter mode:

- Voltage level 1
- Voltage level 2
- Voltage level 3

Voltage level 1 is the default set value. Voltage levels 2 or 3 are activated if there is a continuous signal at GPI 5 or GPI 6 (factory preset). If there is a signal at both inputs simultaneously, voltage level 2 is active.

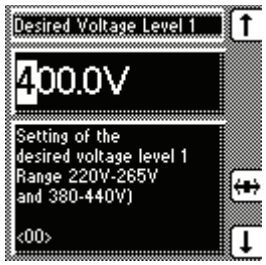
The following sections describe how to set the voltage levels.

5.2.1.1.1 Setting voltage level 1.

Setting range	Step size	Factory setting
220 V...440 V	0.1 V	400 V

Table 9 Setting range for voltage level 1 in V - voltage regulation

To set voltage level 1, proceed as follows:



1. MENU key > Regulation Param. > Voltage Regulation
   ↳<00> Voltage Level 1
2. Press F4 in order to highlight the decimal place.
   ↳The required place is now highlighted and the value can be changed.
3. Press F1 to increase voltage level or F5 to decrease it.
4. Press ENTER.

Voltage level 1 is now set.

The range between 265 V and 380 V is not intended for entering the voltage level and will result in the error message: "Voltage level not in permitted range of measurements".

If this happens, automatic mode is no longer subject to regulation. Tap-change operations can still take place in manual mode.

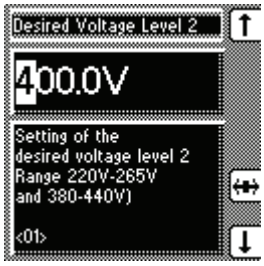
5.2.1.1.2 Setting voltage level 2

Voltage level 2 is activated if there is a continuous signal at GPI 5, as long as the GPI was previously programmed for this. **Section 5.5** describes how to program a GPI.

Setting range	Step size	Factory setting
220 V...440 V	0.1 V	400 V

Table 10 Setting range for voltage level 2 in V - voltage regulation

To set voltage level 2, proceed as follows:



1. MENU key > Regulation Param. > Voltage Regulation> 1x NEXT
   ↳<01> Voltage Level 2
2. Press F4 in order to highlight the decimal place.
   ↳The required place is now highlighted and the value can be changed.
3. Press F1 to increase voltage level or F5 to decrease it.
4. Press ENTER.

Voltage level 2 is now set.

The range between 265 V and 380 V is not intended for entering the voltage level and will result in the error message: "Voltage level not in permitted range of measurements".

If this happens, automatic mode is no longer subject to regulation. Tap-change operations can still take place in manual mode.

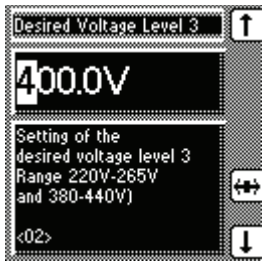
5.2.1.1.3 Setting voltage level 3

Voltage level 3 is activated if there is a continuous signal at GPI 6, as long as GPI 6 was previously programmed for this. **Section 5.5** describes how to program a GPI.

Setting range	Step size	Factory setting
220 V...440 V	0.1 V	400 V

Table 11 Setting range for voltage level 3 in V - voltage regulation

To set voltage level 3, proceed as follows:



1. MENU key > Regulation Param. > Voltage Regulation> 2x NEXT
   ↳<02> Voltage Level 3
2. Press F4 in order to highlight the decimal place.
   ↳The required place is now highlighted and the value can be changed.
3. Press F1 to increase voltage level or F5 to decrease it.
4. Press ENTER.

Voltage level 3 is now set.

The range between 265 V and 380 V is not intended for entering the voltage level and will result in the error message: "Voltage level not in permitted range of measurements".

If this happens, automatic mode is no longer subject to regulation. Tap-change operations can still take place in manual mode.

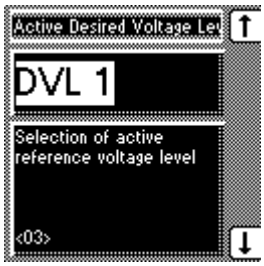
5.2.1.1.4 Selecting voltage level

Selecting voltage level can be used to select an active voltage level via the screen menu. The options are Voltage Level 1, Voltage Level 2 and Voltage Level 3. Once you have chosen one of the 3 voltage levels, the voltage regulator orientates itself towards this level.

If the voltage level is selected using a correspondingly configured GPI, the setting from the "Selecting voltage level" menu is ignored.

Chapter 5.5 contains more information on programming GPIs.

To select the desired active voltage level, proceed as follows:



1. MENU key > Regulation Param. > Voltage Regulation> 3x NEXT
   ↳<03> Select Voltage Level
2. Press the F1 or F5 key to select an active voltage level.
3. Press ENTER.

The desired active voltage level is now selected.

5.2.1.2 Bandwidth

The bandwidth is the permitted deviation of the measured voltage from the selected voltage level. If the measured voltage is inside the bandwidth, then no control commands are issued to the on-load tap-changer.

If the measured voltage deviates from the specified bandwidth, a tap-change command occurs after the set delay time T1. The on-load tap-changer carries out a switching operation in a positive or negative direction.

If the level is persistently above or below the bandwidth, the "Function monitoring" message alert is triggered after 15 minutes. The corresponding relay is also activated. The message alert is only reset when the measured voltage returns within the set bandwidth.

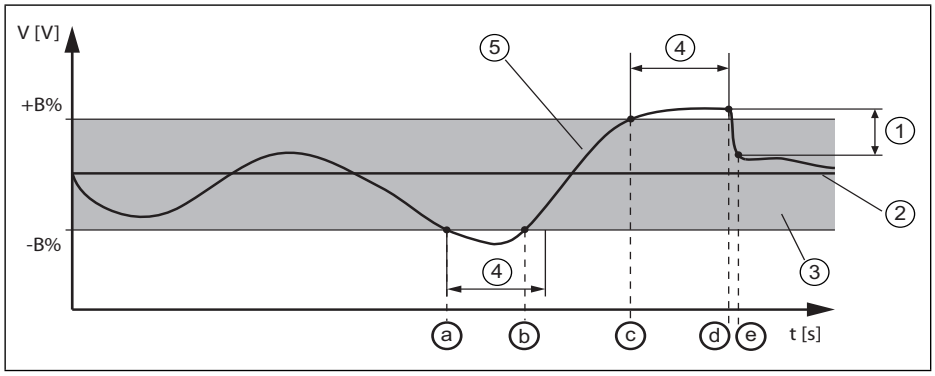


Figure 8 Measured voltage and bandwidth over time

1 ΔV_{step}: Step size

2 V_{target}: Voltage level in V

3 B%: Bandwidth range

4 T1: Specified delay time

5 V_{actual}: Measured voltage

a V_{actual} is outside the bandwidth, T1 starts

b V_{actual} within bandwidth before T1 lapses, no tap-change operation

c V_{actual} is outside the bandwidth, T1 starts

d V_{actual} outside B% before T1 lapses, tap-change operation initiated

e Tap-change operation complete, V_{actual} within the bandwidth

5.2.1.2.1 Visual display

The deviation from the set bandwidth is shown visually in the voltage regulator display (see **Figure 9**). The measured voltage mark shows whether the measured voltage is above, inside or below the set bandwidth.

Progress of delay time T1 is indicated by the time bar in the voltage regulator's display gradually filling. The seconds display above this indicates the remaining delay time T1.

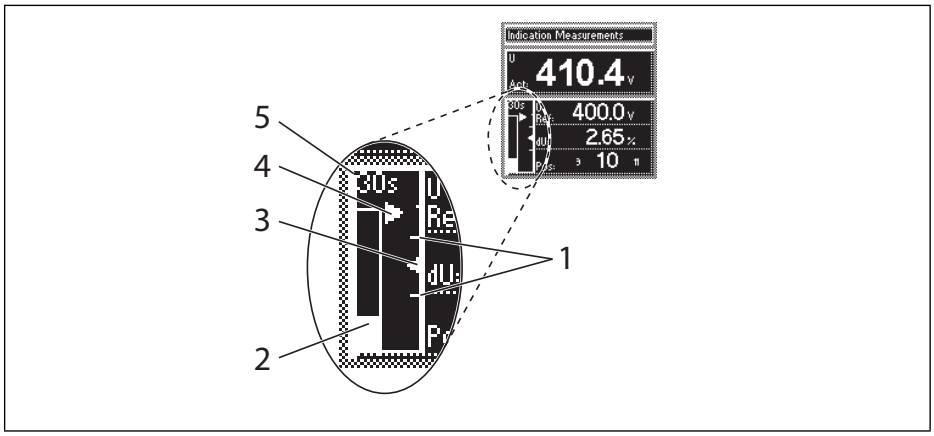


Figure 9 Visual display of deviation from voltage level

1 Bandwidth (upper and lower limit)
2 Time bar for delay time T1
3 Voltage level
4 Measured voltage
5 Remaining delay time T1

5.2.1.2.2 Determining bandwidth

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

The following value is recommended for the bandwidth "*B %*":

$$[\ \pm B\ \%\ ] \geq 0.6 \cdot \frac{V_{n-1} - V_n}{V_{nominal}} \cdot 100\ \%$$

where : V_{n-1}: step voltage of position n-1

Vn: step voltage of position n

$V_{nominal}$: nominal voltage

The bandwidth must be selected in such a way that the output voltage of the transformer (V_{actual}) returns within the specified tolerance range after the tap change

If too small a bandwidth is defined, the output voltage exceeds the bandwidth selected and the voltage regulator must immediately issue a tap-change command in the opposite direction.

If a very large bandwidth is selected, this results in a major control deviation.

Sample calculation

The following transformer parameters are used by way of example for determining the recommended bandwidth:

Nominal voltage:	$V_{nominal}$ = 11000 V
Step voltage of position 4:	V_{step4} = 11275 V
Step voltage of position 5:	V_{step5} = 11000 V

Following the recommendation for calculating bandwidth, our example results in:

$$[\ \pm B\ \%\ ] \geq 0.6 \cdot \frac{V_{step4} - V_{step5}}{V_{nominal}} \cdot 100\ \%$$

$$[\ \pm B\ \%\ ] \geq 0.6 \cdot \frac{11275\ V - 11000\ V}{11000\ V} \cdot 100\ \%$$

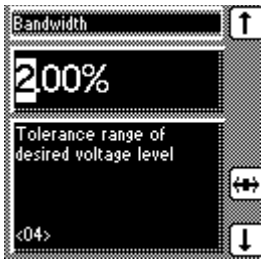
$$[\ \pm B\ \%\ ] \geq 1.5\ \%$$

5.2.1.2.3 Setting the bandwidth

Setting range	Step size	Factory setting
0.5 %...9 %	0.1 %	2 %

Table 12 Setting range for bandwith

The calculated bandwidth is entered as follows:



1. MENU key > Regulation Param. > Voltage Regulation > 4x NEXT
   ↳ <04> Bandwidth
2. Press F4 in order to highlight the decimal place.
   ↳ The required place is now highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ENTER.

The bandwidth is now set.

5.2.1.3 Setting delay time T1

Time delay T1 delays the issuing of a tap-change command for a defined period. This function prevents unnecessary tap-change operations if the tolerance range is exceeded for a short time.

If the current measured voltage leaves the bandwidth, delay time T1 starts. This is shown visually in the display by the time bar filling and the remaining time being indicated (see **Figure 9** on Page 50).

If the control deviation is still present after the delay time, a tap-change command is issued.

If during the delay time the measured voltage returns to within the bandwidth range, the delay time still running is counted down in seconds starting from the time already expired. The absolute time displayed is deleted. The time bar graph is shown hatched and shrinks steadily.

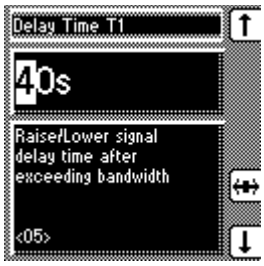
If the measured voltage exceeds the set bandwidth once more whilst the time is not displayed, then the time delay is restarted from the remaining time.

The minimum waiting time between two consecutive tap-change operations is 60 s.

Setting range	Step size	Factory setting
0 s...600 s	1 s	40 s

Table 13 Setting range for delay time T1

To set the delay time T1, proceed as follows:



1. MENU key > Regulation Param. > Voltage Regulation > 5x NEXT
   ↳<05> Delay Time T1
2. Press F4 in order to highlight the decimal place.
   ↳The required place is now highlighted and the value can be changed.
3. Press F1 to increase the time or F5 to reduce it.
4. Press ENTER.

The delay time T1 is now set.

5.2.1.4 Setting the control response T1 (linear/integral)

The delay time T1 can be set to linear or integral. With "Linear Time" the regulator responds with a constant delay time which is independent of the control deviation.

If "Integral Time" is set, the delay time decreases depending on the relationship of the current control deviation to the set bandwidth B, to a minimum of 1 second. The greater the control deviation (ΔV) the shorter the response time. This means that the voltage regulator reacts faster to unexpectedly large voltage changes in the grid. The regulation accuracy therefore increases at the expense of switching frequency (see **Figure 10** on Page 55).

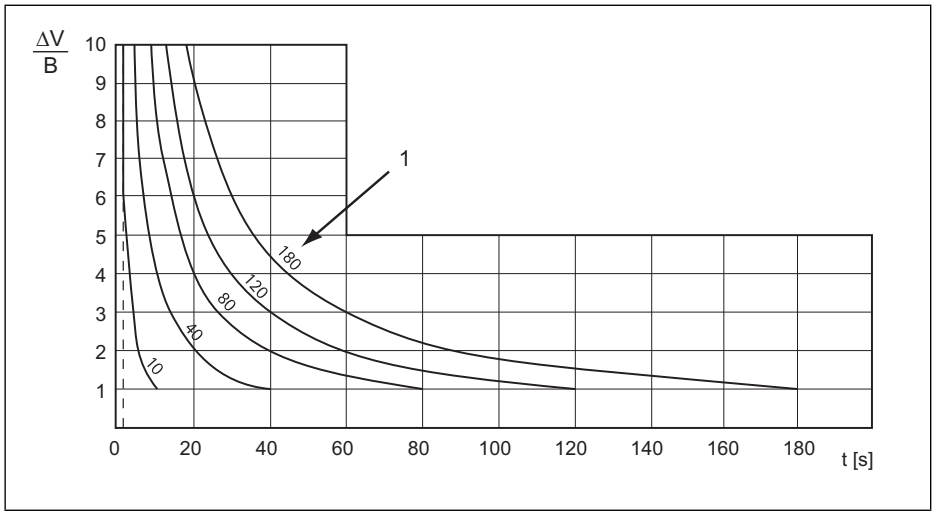
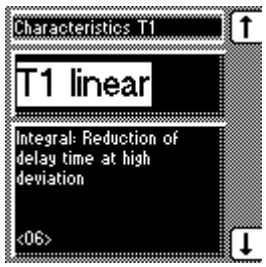


Figure 10 ΔV/B voltage change

1 "Delay time T1" parameter

ΔV/B: Control deviation "ΔV" as % of voltage level as ratio to the set bandwidth "B" as % of voltage level.

To set the control response T1, proceed as follows:



1. MENU key > Regulation Param. > Voltage Regulation> 6x NEXT
   ↳<06> Characteristics T1

2. Press F5 to select "linear" or F1 to select "integral".

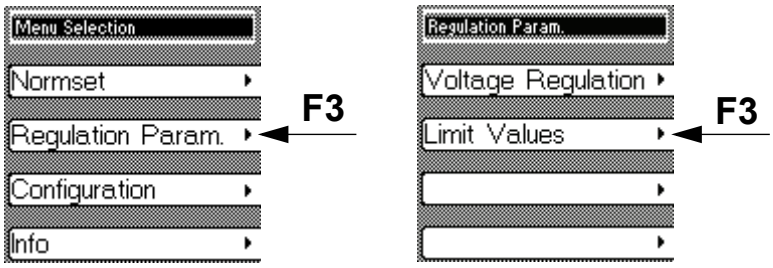
3. Press ENTER.

   The control response T1 is now set.

5.2.2 Limit values

This subgroup contains all the parameters required for monitoring the limit values. The limit values are set as percentage values.

MENU key > Regulation Param. > Limit Values



For the undervoltage and overvoltage parameters, the inputs are basically determined by the specified voltage level. For overcurrent and undercurrent, the values relate to the set current transformer nominal current or the selected current transformer connection.

5.2.2.1 Setting the limit value V< Undervoltage (%)

Undervoltage blocking prevents tap-change operations if there is a power cut. The voltage regulator output pulses are blocked and the red "V<" LED lights up as soon as the measured voltage falls below the set blocking value.

If the measured voltage falls below the set limit value, the signaling relay comes into operation after the set V< undervoltage delay (X4-1/3 contacts).

Setting range	Step size	Factory setting
100 %...140 % of voltage level	1 %	110 %

Table 14 Setting range for V< undervoltage blocking

To set the undervoltage blocking, proceed as follows:

1. MENU key > Regulation Param. > Limit Values
   ↳<00> Undervoltage V< [%]
2. Press F1 to increase the value or F5 to reduce it.
3. Press ENTER.

The undervoltage blocking V< is now set.

5.2.2.2 Setting the V< undervoltage delay

To prevent the undervoltage relay activating immediately a short-lived voltage dip occurs, a delay time can be set for this signal. The undervoltage LED will light up immediately in any case.

Setting range	Step size	Factory setting
0 s...20 s	0.1 s	10 s

Table 15 Setting range for V< undervoltage delay

To set this signal delay, proceed as follows:

1. MENU key > Regulation Param. > Limit Values > 1x NEXT
   ↳<01> Delay Time V<
2. Press F4 in order to highlight the decimal place.
   ↳The required place is now highlighted and the value can be changed.
3. Press F1 to increase the time or F5 to reduce it.
4. Press ENTER.

The undervoltage delay V< is now set.

5.2.2.3 Activating/deactivating V< undervoltage blocking

The undervoltage blocking can be activated or deactivated. If blocking is deactivated and the value falls below that specified, then only a signal appears via the relay and LED. Regulation is not however blocked.

To activate/deactivate the undervoltage blocking, proceed as follows:

1. MENU key > Regulation Param. > Limit Values > 2x NEXT
   ↳<02> Blocking Undervolt. V<
2. Press the F1 or F5 keys to activate/deactivate blocking.
3. Press ENTER.

   V< undervoltage blocking is now activated/ deactivated.

5.2.2.4 Disabling V< undervoltage signal <30 V

Disabling the "V< undervoltage" signal can be useful in order to avoid error signals when the transformer is switched off (Measured voltage V< 30 V at the regulator).

To disable the V< undervoltage signal, proceed as follows:

1. MENU key > Regulation Param. > Limit Values > 3x NEXT
   ↳<03> V< Below 30 V
2. Press the F1 key to disable the undervoltage signal.
3. Press ENTER.

   The V< undervoltage signal is now disabled.

5.2.2.5 Setting the V> overvoltage limit value

When the overvoltage detection responds, the on-load tap-changer is activated by periodical control of the motor-drive unit until the measured voltage is less than the set overvoltage limit value.motor-drive unit The control is carried out by the output relay for the "Lower" switching direction at the intervals dictated by the minimum time of 60 s between two tap-change operations without the set switching delay becoming active. At the same time, the "V>" LED is illuminated and a signaling relay is activated (MIO-X4-1/3) as long as there is overvoltage. The section on "Setting the RL switching pulse time" on Page 70 contains the intervals for switching lower.

Instead of the high-speed return control function, the control can also be blocked if the overvoltage value is exceeded.

The V> overvoltage limit is given as a percentage of the set voltage level.

Setting range	Step size	Factory setting
100 %...140 % of voltage level	1 %	110 %

Table 16 Setting range for V> overvoltage limit

To set overvoltage blocking, proceed as follows:

1. MENU key > Regulation Param. > Limit Values > 4x NEXT
   ↳<04> Overvoltage V> [%]
2. Press F1 to increase the V> value or F5 to decrease it.
3. Press ENTER.

The V> overvoltage limit is now set.

5.2.2.6 Activating/deactivating the V> overvoltage blocking

If overvoltage blocking is deactivated, then the rapid return mode is used if overvoltage occurs.

To activate the V> undervoltage blocking, proceed as follows:

1. MENU key > Regulation Param. > Limit Values > 5x NEXT
   ↳<05> Blocking Overvolt. V>
2. Press the F1 or F5 keys to activate/deactivate overvoltage blocking.
3. Press ENTER.

V> overvoltage blocking is now activated/ deactivated.

5.2.2.7 Setting limit value I> overcurrent

The I> overcurrent blocking prevents tap-change operations during load currents which are higher than the selected limit value (e.g. overload).

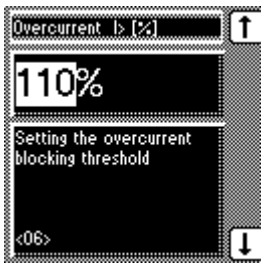
As soon as the measured current exceeds the set blocking value, control is blocked. The "I>" LED lights up and the relevant signaling relay is activated (MIO-X4-1/3 contacts).

The set limit value is entered in % and only becomes active when overcurrent blocking is activated.

Setting range	Step size	Factory setting
50 %...210 %	1 %	110 %

Table 17 Setting range for I> overcurrent blocking

To set the limit value I> overcurrent for overcurrent blocking, proceed as follows:



1. MENU key > Regulation Param. > Limit Values > 6x NEXT
   ↳<06> Overcurrent I> [%]
2. Press F1 to increase the value or F5 to reduce it.
3. Press ENTER.

The limit value I> overcurrent is now set

The I> overcurrent blocking can now be activated (see **Section 5.2.2.8**).

5.2.2.8 Activating/deactivating the I> overcurrent blocking

After setting the limit value for the I> overcurrent blocking (see **Section 5.2.2.7**), the I> overcurrent blocking can be set. When the overcurrent blocking is deactivated, only the I> LED lights up and the relevant signaling relay is activated. Regulation continues.

To activate the I> overcurrent blocking, proceed as follows:

1. MENU key > Regulation Param. > Limit Values > 7x NEXT
   ↳<07> Blocking Overcurrent I>

2. Press the F1 or F5 keys to activate/deactivate overvoltage blocking.

3. Press ENTER.

   The I> overcurrent blocking is activated/ deactivated.

5.2.2.9 Setting the limit value I< undercurrent

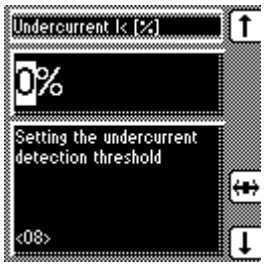
As soon as the measured current falls below the set blocking value, control is blocked.

The set limit value is entered in % and only becomes active when the undercurrent blocking is activated (see **Section 5.2.2.10**).

Setting range	Step size	Factory setting
0 %...210 %	1 %	0 %

Table 18 Setting range for I< undercurrent blocking

To set the limit value for the I< undercurrent blocking, proceed as follows:



1. MENU key > Regulation Param. > Limit Values > 8x NEXT
   ↳<08> Undercurrent I< [%]
2. Press F1 to increase the value or F5 to reduce it.
3. Press ENTER.

   The limit value for I< undercurrent blocking is now set.

   I< undercurrent blocking can now be activated.

5.2.2.10 Activating/deactivating I< undercurrent blocking

After setting the limit value for the I< undercurrent blocking (see **Section 5.2.2.9**), the I< undercurrent blocking can be set. When the undercurrent blocking is deactivated, only the I< LED lights up and the relevant signaling relay is activated. Regulation continues.

To activate the I< undercurrent blocking, proceed as follows:

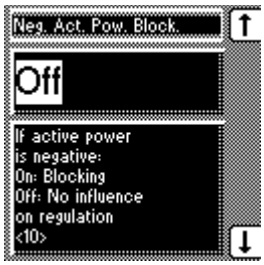
1. MENU key > Regulation Param. > Limit Values > 9x NEXT
   ↳<09> Blocking Undercurr. I<
2. Press the F1 or F5 keys to activate (On) / deactivate (Off) the blocking.
3. Press ENTER.

   The I< undercurrent blocking is activated/ deactivated.

5.2.2.11 Activating/deactivating the regulator blocking with negative active power

When the regulator blocking is activated, the control is blocked if a negative active power flow is detected. However, this is only possible if the current transformer connection is connected and correctly set. When the regulator blocking is deactivated, then the sign of the active power does not affect the regulation.

To activate/deactivate the regulator blocking, proceed as follows:



1. MENU key > Regulation Param. > Limit Values > 10x NEXT
   ↳<10> Neg. Active Power Block.
2. Press the F1 or F5 keys to activate (ON) / deactivate (OFF) the blocking.
3. Press ENTER.

   Blocking the regulator with negative active power is now activated/deactivated.

5.3 Configuration

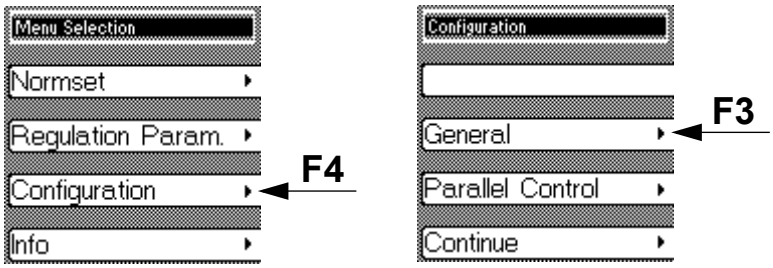
This section describes how to carry out all the settings for configuring system-specific data. To make it easier to find specific parameters, the description refers to subgroups of functionally related individual parameters.

5.3.1 General

This submenu enables general settings to be made on the device. Some settings, such as language, have already been specified during commissioning. The following settings can be changed:

- Language
- Regulator ID
- Baud rate
- R/L Pulse duration
- Switching operation counter
- Display dimming
- Key lock
- Function Monitoring
- Motor runtime
- Manual and automatic mode
- Local und Remote

MENU key > Configuration > General



Each of the settings is described in more detail in the following sections.

5.3.1.1 Setting the language

The required display language can be set or changed. The following languages are available:

- English
- German

To set the required language, proceed as follows:

1. MENU key > Configuration > General
   ↳<00> Language
2. Press the F1 key or F5 key to select the required language.
3. Press ENTER.

The required display language is now set.

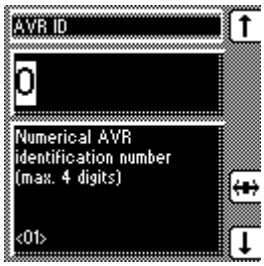
5.3.1.2 Setting the regulator ID

The regulator ID consists of a four-digit sequence of digits and is used as additional identification for a TAPCON® 230 AVT voltage regulator. Identification is only used for the visualization (TAPCONtrol software). If you do not want to set the regulator ID, the serial number and firmware version are the only features.

The regulator ID can be used to ensure that the connection takes place between the visualization software and a specific voltage regulator.

During online communication the software running on the PC queries this ID and compares it with the regulator data available. This enables accurate allocation of data or parameters.

To set the regulator ID, proceed as follows:



1. MENU key > Configuration > General >
   1x NEXT
   ↳<01> AVR ID

2. Press F1 to change the first digit.

If you wish to enter a multidigit sequence, continue to step 3. If you do not wish to enter additional digits, proceed to step 7:

3. Press the F1 key repeatedly (> 9) until a further digit position appears.

4. Press F4 in order to highlight a digit position to be changed.
   ↳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 ENTER.

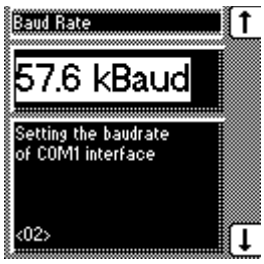
The regulator ID is now set.

5.3.1.3 Setting the baud rate

This submenu can be used to specify the baud rate for the COM1 interface (communication to TAPCON-trol® software). The following values can be set:

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

To set the baud rate, proceed as follows:



1. MENU key > Configuration > General > 2x NEXT
   ↳<02> Baud Rate
2. Press the F1 key or F5 key to select the required baud rate.
3. Press ENTER.

   The baud rate is now set.

5.3.1.4 Setting the Raise/Lower switching pulse time

This submenu can be used to set the duration of the switching pulse for the motor-drive unit.

If you are setting the R/L switching pulse time to 1.5 seconds for example, after the waiting time there will be a switching pulse lasting 1.5 seconds (see **Figure 11**).

The waiting time between two consecutive switching pulses corresponds to the set delay time T1, but is at least 60 s. In quick switching mode, the next tap-change operation always takes place after 60 s.

If the "Motor running" signal is still present on the voltage regulator after the waiting time, this time is extended until the signal is no longer present.

If the motor-drive unit does not start using the default setting (1.5 seconds), then increase the pulse time.

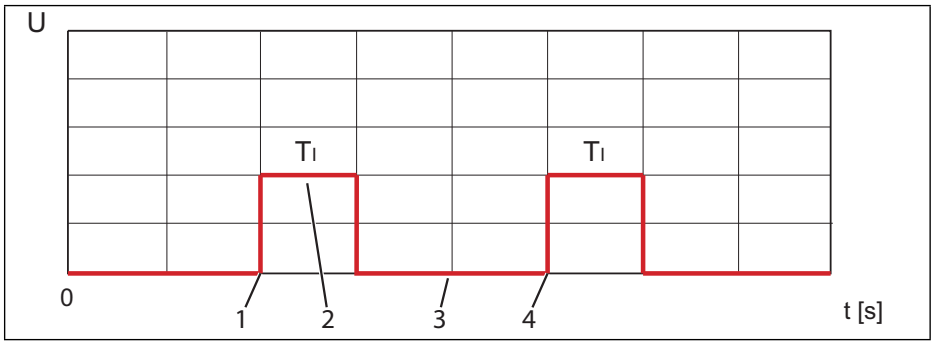


Figure 11 Switching pulse in standard operating mode

1 Start of first R/L switching pulse

2 T_1 = Switching pulse duration (1.5 seconds)

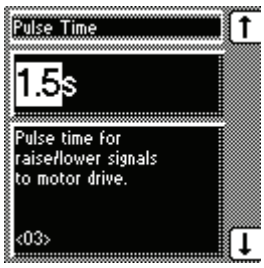
3 Waiting time between two consecutive switching pulses

4 Start of second R/L switching pulse

Setting range	Step size	Factory setting
0.1 s...10 s	0.1 s	1.5 s

Table 19 Setting range for R/L switching pulse time

To set the pulse time, proceed as follows:



1. MENU key > Configuration > General > 3x NEXT
   ↳<03> R/L Pulse Time
2. Press the F1 key or F5 key to select the required pulse time.
3. Press ENTER.

The R/L pulse time is now set.

5.3.1.5 Switching operation counter

As soon as a switching operation is initiated by the voltage regulator, the voltage regulator receives feedback via the "Motor running" signal". This detects whe-ther the motor is active. The switching operation counter counts the number of pulses of the motor-drive unit if a GPI has been parameterized to "Motor running".

Setting range	Step size	Factory setting
0...99,999,999	1	0

Table 20 Switching operation counter setting range

To activate this display, proceed as follows:

1. MENU key > Configuration > General > 4x NEXT
   ↳<04> Switching Operation Counter
2. Press the F1 key to increase the value or F5 to lower it.
3. Press ENTER.

The switching operation counter is now set.

5.3.1.6 Switching the background illumination for the display on/off

If this function is activated, the display is automatically dimmed if no key is pressed within a period of 15 minutes. However, the display can still be read. Activating this function increases the lifespan of the display. The display returns to full brightness by pressing any key.

1. MENU key > Configuration > General > 5x NEXT
   ↳<05> Display Dimming
2. Press the F1 key or F5 key to switch on (ON) / switch off (OFF) display dimming.
3. Press ENTER.

The background illumination on the display is now activated/deactivated.

5.3.1.7 Activating/deactivating the automatic key lock

If the automatic key lock is activated, then the device locks automatically after 15 minutes if no key has been pressed. This function can be activated or deactivated as required.

To activate/deactivate the key lock, proceed as follows:

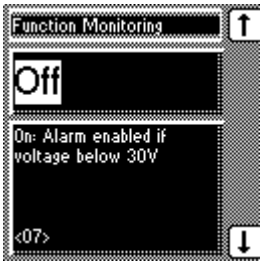
1. MENU key > Configuration > General > 6x NEXT
   ↳<06> Key Lock
2. Press the F1 or F5 keys to activate (ON)/ deactivate (OFF) the automatic key lock.
3. Press ENTER.

The key lock is now activated/deactivated

5.3.1.8 Disabling function monitoring

If the measured value leaves the set bandwidth (voltage level +/- bandwidth) for more than 15 minutes, the function monitoring relay is activated. This results in a message alert on the display which is only reset when the measured value returns within the current bandwidth.

If there is no measured voltage (i.e. < 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 key > Configuration > General > 7x NEXT
   ↳<07> Function Monitoring

2. Press the F1 key or F5 key to switch on (on) / switch off (off) the function monitoring.

3. Press ENTER.

   The function monitoring is now activated/ deactivated for voltages <30 V.

5.3.1.9 Monitoring motor runtime

The motor-drive unit's runtime can also be monitored by the voltage regulator. This function is used to identify motor-drive unit malfunctions during the tap-change operation and to trigger any actions needed.

The corresponding GPI must be correctly wired and parameterized to "Motor running" in order to use runtime monitoring. The motor runtime must also be set.

5.3.1.9.1 Function

The motor-drive unit supplies the "Motor-drive unit running" signal during the tap-change operation. This signal is present until the tap-change operation is complete.

The voltage regulator compares the duration of this signal with the motor runtime set. If the set motor runtime is exceeded, the voltage regulator triggers various actions:

1. "Motor runtime monitoring" message
2. Continuous signal via GPO "Motor-drive unit runtime exceeded" (optional)
3. Impulse signal via GPO "Trigger motor protective switch" (optional)

5.3.1.9.2 Wiring and parameterizing GPI/GPO

If you want to monitor the motor runtime, the voltage regulator and motor-drive unit must be connected and parameterized as follows. The procedure for parameterizing the GPIs and GPOs is given in **Section 5.5.1** and **Section 5.5.2**.

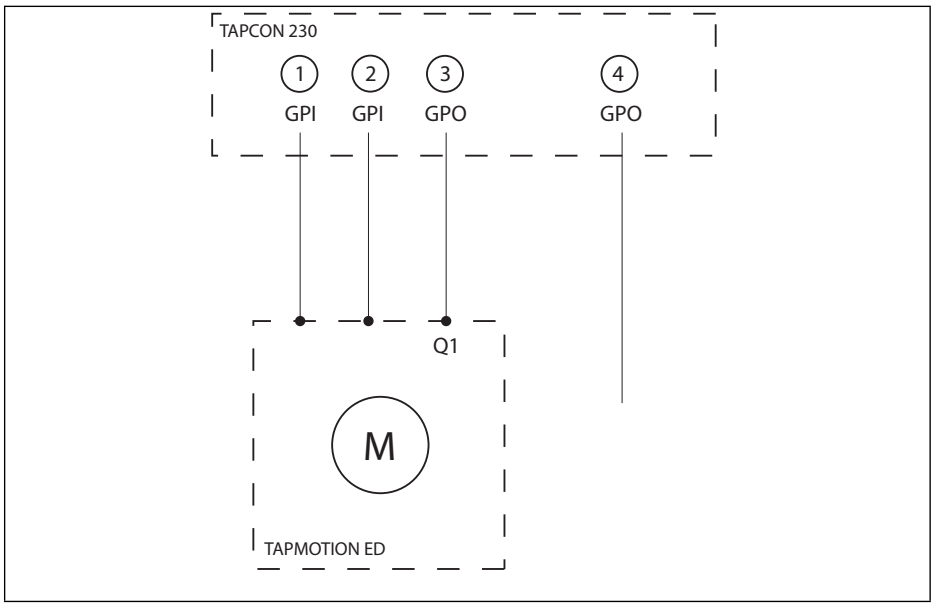


Figure 12 Wiring for motor runtime monitoring

1 GPI "Motor running"
2 GPI "Motor protective switch triggered" (optional)
3 GPO "Trigger motor protective switch" (optional)
4 GPO "Motor-drive unit runtime exceeded" (optional)

If you want to use the GPOs, the feedback from the motor-drive unit "Motor protective switch triggered" must also be wired to a GPI and parameterized. This message resets the GPO "Motor runtime exceeded" when the motor protective switch is switched back on and activates the "Motor protection" message.

5.3.1.9.3 Setting the motor runtime

Setting range	Step size	Factory setting
0 s...30 s	0.1 s	0 s

Table 21 Setting range for motor runtime

To set the motor runtime, proceed as follows:

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

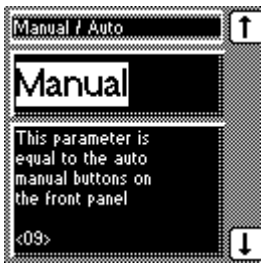
1. MENU key > Configuration > General > 8x NEXT
   ↳<08> Motor Runtime
2. Press F4 in order to highlight the decimal place.
   ↳The required place is now highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ENTER.

The motor runtime is now set.

5.3.1.10 Activating manual/automatic mode

This parameter has the same functions as the MANUAL key for manual mode and the AUTO key for automatic mode on the front panel of the device. Manual or automatic mode can be set using the keys or via the display.

To activate manual or automatic mode, proceed as follows:



1. MENU key > Configuration > General > 9x NEXT
   ↳<09> Manual / Auto
2. Press the F1 key or F5 key to activate the manual (Manual) or automatic (Auto) modes.
3. Press ENTER.

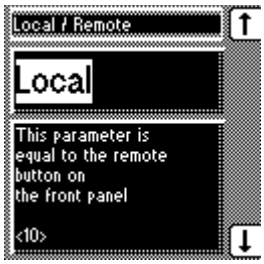
Manual or automatic mode is not set.

5.3.1.11 Activating Local/Remote

This parameter has the same function as the REMOTE key on the front panel of the device. The REMOTE function can be set with the relevant key or in the display.

If *"Local"* is activated, then the device can be operated directly using the front panel, while *"Remote"* only allows remote control via the inputs or the control system. If a TAPCON® 230 AVT voltage regulator is available, then the communication interface can also be used for remote control.

To activate "*Local*" or "*Remote*", proceed as follows:

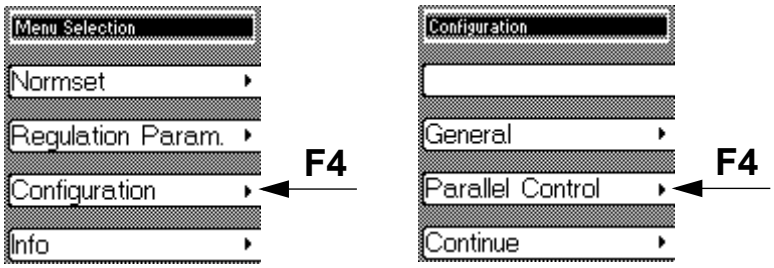


1. MENU key > Configuration > General > 10x NEXT
   ↳<10> Local / Remote
2. Press the F1 key or F5 key to activate "Local" or "Remote".
3. Press ENTER.

Local/ Remote is now set.

5.4 Parallel operation

MENU key > Configuration > Parallel Operation



Mains power supply sometimes requires an increase in the short circuit capacity or the throughput capacity at a site. For this reason, step transformers are connected in parallel.

A safer and more cost effective parallel operating mode is achieved if the joint capacity of the transformers connected in parallel is utilized without overloading individual transformers.

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

- Identical rated voltage
- Ratio of transformer power ratings (< 3:1)
- Maximum deviation of short-circuit voltages (V_K) for transformers connected in parallel ≤10 %
- Identical vector group specification

The voltage regulator enables control of up to 6 transformers connected in parallel in one or 2 groups. Information exchange is carried out using the CAN bus. Parallel operation is activated using one of 2 status inputs or the control system.

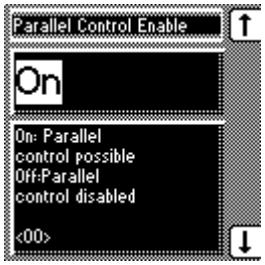
There are 2 reasons for setting up parallel operating mode:

1. To increase the short circuit capacity
2. To increase the throughput capacity

5.4.1 Activating parallel operation

Before activating parallel operation, additional requirements must be met:

- ✓ Correct individual CAN bus addresses must be set (not equal to 0) (see **Section 5.4.5**)
- ✓ The parallel operation group 1 or 2 must be selected or activated using a predefined GPI (see **Section 5.5.1**).



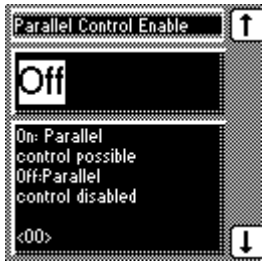
1. MENU key > Configuration > Parallel Operation
   ↳<00> Parallel Operation Enable
2. Press the F1 or F5 key to activate parallel operation.
3. Press ENTER.

Parallel operation is now activated.

Further settings for parallel operation can be car-- ried out.

5.4.2 Disabling parallel operation

To disable parallel operation proceed as follows:



1. MENU key > Configuration > Parallel Operation
   ↳<00> Parallel Operation Enable
2. Press the F1 or F5 key to disable parallel operation.
3. Press ENTER.

Parallel operation is now disabled.

5.4.3 Parallel operation method

The parallel operation methods which can be selected and set are described in the following sections. Four different methods can be assigned to the voltage regulators:

Circulating reactive current

- Recommended transformer data
- No tap position input required

Tap synchronization (master/follower/auto)

- Transformers with identical ratings
- Tap position input required

5.4.3.1 Selecting "Circulating reactive current" parallel operation method

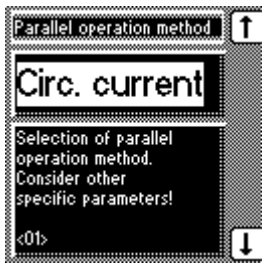
When circulating reactive current is selected, then parallel operation is carried out using the circulating reactive current minimization method.

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.

This method is suitable for transformers with similar nominal output, nominal voltage Vk and a vector group with equal and unequal step voltage. This does not require any information about the tap position.

When setting the "circulating reactive current" method, the values for blocking and circulating reactive current sensitivity must first be set (see **Section 5.4.6** “Activating/deactivating stand-alone blocking” on page 84 and **Section 5.4.7** “Setting circulating reactive current sensitivity” on page 85).

To select the "circulating reactive current" parallel operation method, proceed as follows:



1. MENU key > Configuration > Parallel Operation > 1x NEXT
   ↳<01> Parallel operation method
2. Press the F1 key or F5 key repeatedly until "Circ. current" appears in the display.
3. Press ENTER.

The parallel operation method "Circulating reactive current" is now selected.

5.4.3.2 Defining "Tap synchronization master" parallel operation method

In this method the voltage regulator is designated as the master. This regulator takes over control while all other follower regulators comply with the control commands of the master.

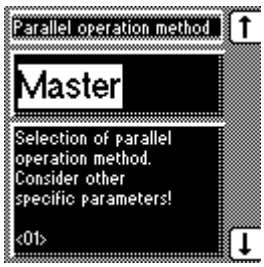
The master compares the tap positions of the followers with its own tap position using the CAN bus. If there is a tap position deviation, the master directs the followers to be adjusted to the same tap position.

If the specified master fails, then the error message "Parallel operation error: no master available" appears. In addition, depending on the configuration of the "Simplex mode blocking" parameter (see **Section 5.4.9**), those regulators which are set accordingly are blocked or continue in simplex mode.

Please note that each voltage regulator must be assigned an address using the "CAN Address" submenu. Each address may only be used once.

Only when all voltage regulators have been registered can they communicate with one another using the CAN bus and use the "master/follower" method.

To specify the "master" parallel operation method, proceed as follows:



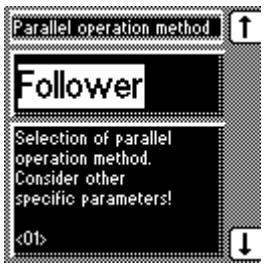
1. MENU key > Configuration > Parallel Operation > 1x NEXT
   ↳<01> Parallel operation method
2. Press the F1 key or F5 key repeatedly until "Master" appears in the display.
3. Press ENTER.

The "master" parallel operation method is now specified.

5.4.3.3 Defining "Tap synchronization follower" parallel operation method

In this method the voltage regulator is designated as the follower. This regulator receives the control commands from the master and has to comply with these (see **Section 5.4.3.2**).

To define the "Follower" parallel operation method, proceed as follows:



1. MENU key > Configuration > Parallel Operation > 1x NEXT
   ↳<01> Parallel operation method
2. Press the F1 key or F5 key repeatedly until "Follower" appears in the display.
3. Press ENTER.

   The "Follower" parallel operation method is now defined.

5.4.3.4 Selecting "Automatic tap synchronization" parallel operation method

In this master/follower method, the voltage regulator with the lowest CAN address - of all the voltage regulators on the CAN bus within the same parallel operation group - is automatically selected as master. This regulator undertakes the measurement and adjusts the on-load tap-changer in order to correct the voltage if a deviation occurs.

As with the Master method, the voltage regulator compares the tap positions of the followers with its own tap position using the CAN bus. If there is a tap position deviation, the voltage regulator directs the followers to be adjusted to the same tap position.

If there is a tap position deviation between the master and follower which is larger than the maximum set tap position deviation (**Section 5.4.12**), then the "Parallel operation error" signal is issued and automatic regulation is blocked.

Please note that each voltage regulator must be assigned an address using the "CAN Address" submenu. Each address may only be used once.

Only when all voltage regulators have been registered can they communicate with one another using the CAN bus and use the "master/follower" method.

To select the "Automatic tap synchronization" parallel operation method, pro-- ceed as follows:

1. MENU key > Configuration > Parallel Operation > 1x NEXT
   ↳<01> Parallel operation method
2. Press the F1 key or F5 key repeatedly until "Auto tap sync." appears in the display.
3. Press ENTER.

   The automatic synchronization parallel operation method is now selected.

5.4.4 Assigning parallel operation group

A transformer group can be assigned to the voltage regulator using the "Parallel Operation Group" display. The "Group 1 and group 2" setting enables the voltage regulator to be assigned to 2 groups simultaneously. The following groupings are possible:

Setting	Function
None	Voltage regulator not assigned to any group
Group 1	Voltage regulator assigned to group 1
Group 2	Voltage regulator assigned to group 2
Group 1 and group 2	Voltage regulator assigned to group 1 and group 2

Table 22 Assigning parallel operation group

The parallel operation group can only be selected using the menu if no allocation has been carried out using a GPI.

To assign the paralleling group, proceed as follows:

1. MENU key > Configuration > Parallel Operation > 2x NEXT
   ↳<02> Parallel Operation Group
2. Press the F1 key or F5 key repeatedly until the required function appears in the display.
3. Press ENTER.

The parallel operation group is now set.

5.4.5 Entering the CAN Address

So that all voltage regulators can communicate using the CAN bus, each voltage regulator requires a unique identifier. Addresses can be set from 1 to 16. If the value is set to 0, then no communication takes place.

To enter the CAN address, proceed as follows:

1. MENU key > Configuration > Parallel Operation > 3x NEXT
   ↳<03> CAN Address
2. Press F1 to increase the CAN address number or F5 to decrease it.
3. Press ENTER.

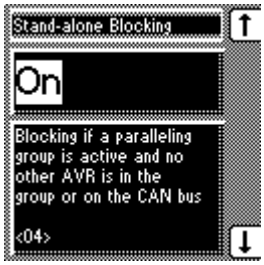
The CAN address has now been entered.

5.4.6 Activating/deactivating stand-alone blocking

If a parallel group with several voltage regulators has been defined, then the blocking function is available. This function is activated on the voltage regulator if no other voltage regulator in the group is recognized using the CAN bus.

"Stand-alone blocking" can be activated if single regulation of the voltage regulator needs to be avoided. In systems with two transformers running in parallel, this prevents the regulators undertaking single regulation if the CAN connection is interrupted despite them still being connected in parallel.

To activate/deactivate blocking, proceed as follows:



1. MENU key > Configuration > Parallel Operation > 4x NEXT
   ↳<04> Stand-alone Blocking
2. Press the F1 or F5 keys to activate (On) or deactivate (Off) blocking.
3. Press ENTER.

The blocking is now activated/deactivated

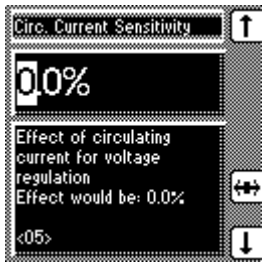
5.4.7 Setting circulating reactive current sensitivity

The sensitivity of the circulating reactive current is a measure of its effect on the behavior of the voltage regulator. A setting of 0% has no effect. A setting of 10%, for example, would cause the voltage in the voltage regulator to be corrected by 10% if the circulating reactive current were as high as the nominal current on the current converter. This correction to the voltage can be increased or decreased with this setting.

Setting range	Step size	Factory setting
0 %...100 %	0.1 %	0 %

Table 23 Setting range for circulating reactive current sensitivity.

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



1. MENU key > Configuration > Parallel Operation > 5x NEXT
   ↳<05> Circ. Current Sensitivity
2. Press F1 to increase the value or F5 to reduce it.
3. Press the F4 key to select the decimal place.
   ↳The decimal place is now highlighted and the value can be changed.
4. Press ENTER.

   The circulating reactive current sensitivity is now set.

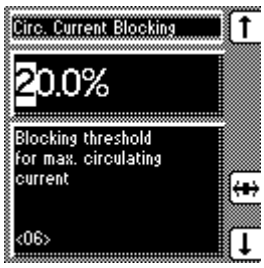
5.4.8 Setting the blocking threshold for the maximum permitted circulating reactive current

This sets the limit value for the maximum permitted circulating current in relation to the current transformer nominal current. If, during parallel operation, the circulating current exceeds the set limit value, then the "Parallel operation error" event is activated. As a result, all voltage regulators operating in parallel are blocked. Depending on the set delay time, the "Parallel operation fault" signaling relay is activated (GPO4 by default). To set the delay time for the parallel ope-ration error message, see **Section 5.4.10** “Setting the delay time for the parallel operation error message” on page 88.

Setting range	Step size	Factory setting
0.5 %...40 %	0.1 %	20 %

Table 24 Setting range for circulating current blocking

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



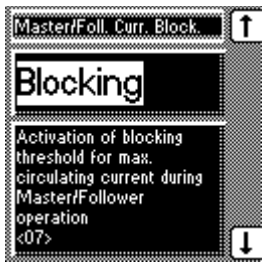
1. MENU key > Configuration > Parallel Operation > 6x NEXT
   ↳<06> Circ. Blocking
2. Press F1 to increase the value or F5 to decrease it.
3. Press F4 in order to highlight the decimal place.
   ↳The required position is now highlighted and the value can be changed.
4. Press ENTER.

The blocking threshold for the maximum permitted circulating current is now set.

5.4.9 Activating/deactivating master/follower current blocking

This monitoring function is available with the parallel operation method "Master/follower synchronized tap-change operation" along with a current measurement. If the circulating current reaches the limit set in **Section 5.4.8**, then the voltage regulator is blocked.

To activate/deactivate the current blocking, proceed as follows:



1. MENU key > Configuration > Parallel Operation > 7x NEXT
   ↳<07> Master/Foll. Curr. Block.

2. Press the F1 or F5 key to activate (On)/ deactivate (Off) the blocking.

3. Press ENTER.

   The master/follower current blocking is activated/ deactivated.

5.4.10 Setting the delay time for the parallel operation error message

If the voltage regulator detects an error during parallel operation, then the message "Parallel operation error" is issued.

If a parallel operation error occurs, then the relevant LED immediately lights up. The signal is only issued at the GPO4 after the set delay time.

Setting range	Step size	Factory setting
1 s – 99 s	1 s	30 s

Table 25 Setting range for parallel operation error message delay time

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

1. MENU key > Configuration > Parallel Operation > 8x NEXT
   ↳<08>Delay Parallel Failure
2. Press F1 to increase the value or F5 to decrease it.
3. Press ENTER.

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

5.4.11 Selecting the follower tapping direction

As in parallel mode the tap positions of the transformers which are running in parallel with one another are compared according to the "master/follower" method, it is absolutely essential that these transformers have the same position designation and that the "Raise" or "Lower" signals produce the same voltage change in all transformers.

If it should happen that the follower regulator(s) switch(es) the master regulator step change in the opposite direction, then this parameter setting must be changed from "Default" to "Swapped".

To select the tapping direction, proceed as follows:

Please note whether the voltage regulator has been designated as master or follower when setting the tapping direction. Setting the tapping direction to "Swapped" only affects how the follower behaves because only this has the tap position as its desired parameter for regulation. The master continues to regulate according to measured voltage.

1. MENU key > Configuration > Parallel Operation > 9x NEXT
   ↳<09> Follower Tapping Direction
2. Press the F1 key or F5 key to select the required tapping direction.
3. Press ENTER.

The follower tapping direction is now selected.

5.4.12 Setting the maximum tap position deviation

The aim of the tap synchronization method is to set the same tap position for all transformers connected in parallel. The follower therefore always follows the position commands from the master.

You can use the "Max. tap deviation" function to define the maximum permissible tap position deviation. If this limit is exceeded during operation, the follower emits the signal "Parallel operation error" and blocks.

A deviation of up to 4 tap positions can be set.

Setting range	Step size	Factory setting
0...4	1	0

Table 26 Setting range for permitted tap position deviation

To set the maximum tap position deviation, proceed as follows:

1. MENU key > Configuration > Parallel Operation > 10x NEXT
   ↳<10> Max. Tap Deviation
2. Press F1 to increase the value or F5 to reduce it.
3. Press ENTER.

The maximum tap position deviation is now set.

5.4.13 Activating/deactivating follower tapping without measuring voltage

If the follower does not have a measuring voltage or an existing voltage measurement has no function, this function can be used to define whether the voltage regulator should block in this situation or should continue to carry out the master's control commands.

To activate/deactivate this function, proceed as follows:

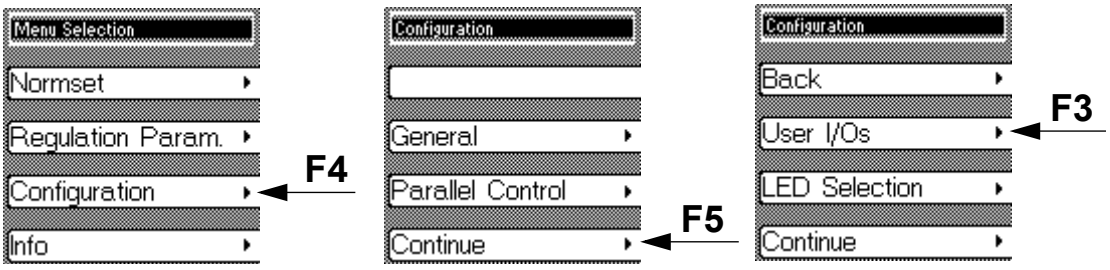
1. MENU key > Configuration > Parallel Operation > 11x NEXT
   ↳<11> Foll. Tapping w/o Vmeas
2. Press the F1 or F5 keys to activate (On) or deactivate (Off) the Function.
3. Press ENTER.

The function is now activated/deactivated

5.5 Assigning freely configurable inputs/outputs

This section describes the user inputs and outputs. Functions can be assigned to the GPIs and GPOs in accordance with the **Table 27** on Page 92 if required.

MENU key > Configuration > Continue > User I/Os



5.5.1 Assigning inputs (GPIs)

The following functions are available for the GPIs:

	Function options	Description of functions
1	Off	No function selected
2	Master/Foll.	Master mode active when signal on; Follower mode active when signal off
3	Remote/Loc.	"Remote" mode active when signal on; "Local" mode active when signal off
4	Blocking	Automatic regulation blocked
5	Quick Tap	T1 deactivated. Raise/lower pulse if value falls below or exceeds bandwidth immediately after the waiting time of 60 s.
6	MPS tripped	Signal: Motor protection switch was triggered
7	Motor running	Message: Motor running
8	Voltage level 2	Voltage level 2 activated
9	Voltage level 3	Voltage level 3 activated
10	Remote VL	Remote setting of voltage level activated
11	ParGroup1	Regulator in group 1 during parallel operation
12	ParGroup2	Regulator in group 2 during parallel operation
13	Blk U raise	Raise pulse blocked
14	Blk U low	Lower pulse blocked

Table 27 Function options for GPIs

The procedure for assigning the functions is described in the following sections.

To assign functions to the GPIs, proceed as follows (example GPI 1 - X4:13):

1. MENU key > Configuration > Continue
   User I/Os
   ↳<00> GPI 1 - X4:13
2. Press the F1 key or F5 key repeatedly until the required function appears in the display.
3. Press ENTER.

   The function is now assigned.

All additional GPIs can be assigned as described on Page 93. The following GPIs are available:

GPI	Press NEXT key	Page number in the display
GPI 1 - X4:13	-	<00>
GPI 2 - X4:14	1x	<01>
GPI 3 - X4:15	2x	<02>
GPI 4 - X4:16	3x	<03>
GPI 5 - X4:17	4x	<04>
GPI 6 - X4:18	5x	<05>
GPI 7 - X6:1	6x	<06>
GPI 8 - X6:2	7x	<07>

Table 28 Freely-configurable GPIs

5.5.2 Assigning outputs (GPOs)

A relay can be assigned a function using the GPOs. Should the assigned event occur, then the relevant message will appear on the screen. These messages are only for information. The following functions are available for the GPOs:

	Function options	Description of functions
1	Off	No function selected
2	Master	Assign master
3	Follower	Assign follower
4	ParState	Assign parallel operation status
5	ParError	Assign parallel operation error
6	Local/Rem.	Message: Local control / remote control
7	Undervoltage	Message: Undervoltage blocking
8	Overvoltage	Message: Overvoltage blocking
9	Undercurrent	Message: Undercurrent blocking
10	Overcurrent	Message: Overcurrent blocking
11	DVL1	Message: Voltage Level 1
12	DVL2	Message: Voltage Level 2
13	DVL3	Message: Voltage Level 3
14	Trip MPS	Signal: Motor protection switch was triggered
15	Motor runtime>	Message: Motor runtime exceeded
16	Motor running	Message: Motor running
17	Bandwidth <	Message: Lower tolerance band exceeded
18	Bandwidth >	Message: Upper tolerance band exceeded
19	GPI 1	Message: GPI 1 active
20	GPI 2	Message: GPI 2 active
21	GPI 3	Message: GPI 3 active
22	GPI 4	Message: GPI 4 active
23	GPI 5	Message: GPI 5 active
24	GPI 6	Message: GPI 6 active
25	GPI 7	Message: GPI 7 active
26	GPI 8	Message: GPI 8 active
27	Event	Message: Event active

Table 29 Function options for GPOs

The procedure for assigning the functions is described in the following sections.

To assign functions to the GPOs, proceed as follows

(Example GPO 1 - X4:9):

1. MENU key > Configuration > Continue
   User I/Os > 8x NEXT
   ↳<08> GP0 1 - X4:9

2. Press the F1 key or F5 key repeatedly until the required function appears in the display.

3. Press ENTER.

   The function is now assigned.

All additional GPOs can be assigned as described above. The following GPOs are available:

GPO	Press NEXT key	Page number in the display
GPO 1 - X4:9	8x	<08>
GPO 2 - X4:12	9x	<09>
GPO 3 - X5:9	10x	<10>
GPO 4 - X5:12	11x	<11>
GPO 5 - X5:18	12x	<12>
GPO 6 - X5:21	13x	<13>
GPO 7 - X5:24	14x	<14>

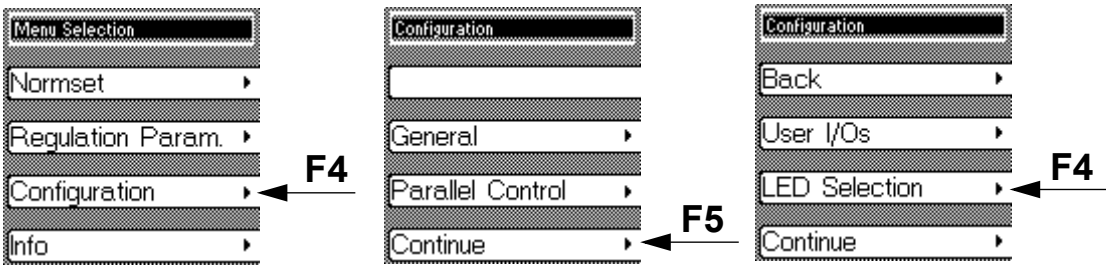
Table 30 Freely-configurable GPOs

5.5.3 Setting LEDs

The settings in this subgroup can be used to assign an input or function to the free LEDs. If an event occurs, the LED lights up, providing that the relevant function has been set.

To label the LED, the label strip underneath can be removed and labeled individually (e.g. using transferable lettering).

MENU key > Configuration > Continue > LED Selection



An overview of the functions which can be assigned is given below. If the corresponding event occurs, then the assigned LED lights up.

The following functions are available for the LEDs:

	Function	Description of functions
1	Off	LED deactivated
2	GPI 1	Signal issued at GPI 1 input
3	GPI 2	Signal issued at GPI 2 input
4	GPI 3	Signal issued at GPI 3 input
5	GPI 4	Signal issued at GPI 4 input
6	GPI 5	Signal issued at GPI 5 input
7	GPI 6	Signal issued at GPI 6 input
8	GPI 7	Signal issued at GPI 7 input
9	GPI 8	Signal issued at GPI 8 input
10	GPO 1	Relay output GPO1 operative
11	GPO 2	Relay output GPO2 operative
12	GPO 3	Relay output GPO3 operative
13	GPO 4	Relay output GPO4 operative
14	GPO 5	Relay output GPO5 operative
15	GPO 6	Relay output GPO6 operative
16	GPO 7	Relay output GPO7 operative
17	FailParCtr.	Parallel operation error detected

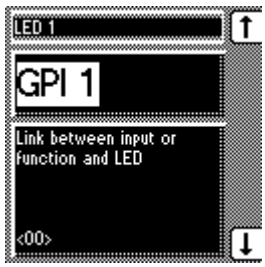
Table 31 Function options for LEDs

	Function	Description of functions
18	Undercurrent	Undercurrent detected
19	Trip MPS	Motor protection switch tripped
20	Blocking	Control blocked
21	Circulating reactive current	Parallel operation selected using circulating reactive current method
22	Master	Voltage regulator in parallel operation activated as follower
23	Follower	Voltage regulator in parallel operation activated as master
24	Bandwidth <	Lower tolerance band exceeded
25	Bandwidth >	Upper tolerance band exceeded
26	Voltage level 1	Voltage level 1 active
27	Voltage level 2	Voltage level 2 active
28	Voltage level 3	Voltage level 3 active
29	Function monitoring	Message "Function Monitoring" active
30	Remote	REMOTE operating mode active
31	Local	LOCAL operating mode active
32	Auto	Automatic mode active
33	Manual	Manual mode active
34	Event	Event active

Table 31 Function options for LEDs

A function can be assigned to an LED if desired. As soon as the assigned event occurs, the selected LED lights up. There is a total of 4 LEDs available which can each be assigned an input or a function. LED 3 and LED 4 are dichromatic and can each be assigned two different functions.

To assign a function to an LED, proceed as follows (Example: "LED 1"):



1. MENU key > Configuration > Continue > LED selection
   ↳<00> LED 1
2. Press the F1 key or F5 key repeatedly until the required function appears in the display.
3. Press ENTER.

   The function is now assigned.

All additional LEDs can be assigned as described above. The following LEDs are available:

LED	Characteristics	Press NEXT key	Page number in the display
LED 1	Monochromatic	-	<00>
LED 2	Monochromatic	1x	<01>
LED 3 yellow	Dichromatic	2x	<02>
LED 3 green	Dichromatic	3x	<03>
LED 4 red	Dichromatic	4x	<04>
LED 4 yellow	Dichromatic	5x	<05>

Table 32 Freely-configurable LEDs

5.6 Tap position display

If the tap position is captured using an analog signal, then the analog input (terminal strip X7) must be adapted to the signal of the tap position transmitter.

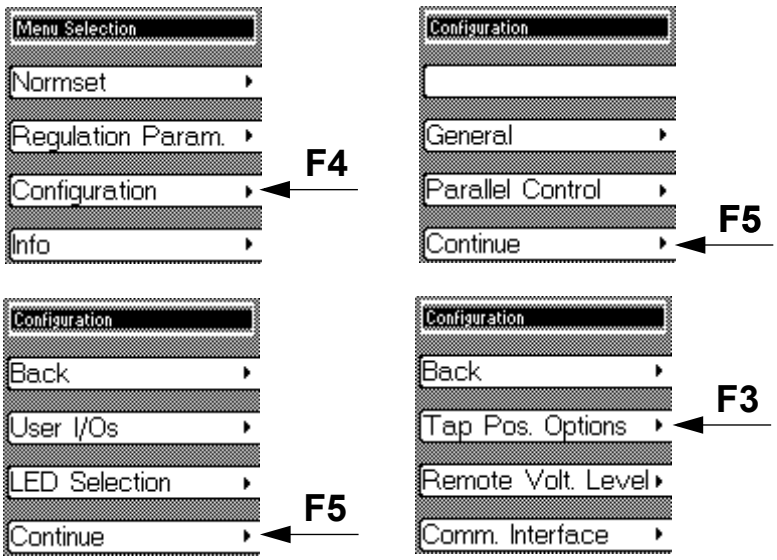
The analog input (terminal strip X7) can be used either for the input of the tap position or for setting the voltage level remotely.

The following tap position transmitters can be used:

- Tap change potentiometer (100...2000 Ohm)
- Injected current 0/4-20 mA

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

MENU key > Configuration > Continue > Continue > Tap Pos. Options



5.6.1 Tap position input options

Six options are available for setting the tap position input:

- Off (no tap position input)
- Current 0/4...20 mA
- Resistor contact series
- BCD (see **Table 33**)
- Gray (see **Table 33**)
- Binary (see **Table 33**)

Operating position	BCD						Gray						Binary					
	20	10	8	4	2	1							32	16	8	4	2	1
1						X						X						X
2					X						X	X					X	
3					X	X					X						X	X
4				X						X	X					X		
5				X		X				X	X	X				X		X
6				X	X					X		X				X	X	
7				X	X	X				X						X	X	X
8			X						X	X					X			
9			X			X			X	X		X			X			X
10		X							X	X	X	X			X		X	
11		X				X			X		X				X		X	X
12		X			X				X		X				X	X		
13		X			X	X			X		X	X			X	X		X
14		X		X					X			X			X	X	X	
15		X		X		X			X						X	X	X	X
16		X		X	X			X	X					X				
17		X		X	X	X		X	X			X		X				X
18		X	X					X	X		X	X		X			X	
19		X	X			X		X	X		X			X			X	X
20	X							X	X	X	X			X		X		
...																		

Table 33 Tap position coding

To select the tap position input option, proceed as follows:

1. MENU key > Configuration > Continue > Continue > Tap Pos. Options
   ↳<00> Tap pos. indication
2. Press the F1 key or F5 key to select the required option.
3. Press ENTER.

   The required option for the tap position input is now selected.

5.6.2 Assigning the analog value for the minimum tap position

To configure the analog input, the lower value of the input signal must be specified.

With injected current as the transmitter signal, the values to enter are 0 % in the case of 0 mA and 20 % in the case of 4 mA (see Example in **Table 34**).

Tap position	Current	Value
Minimum tap position 1	4 mA	20% (of analog input signal range)

Table 34 Example for configuring the analog input (min.)

If the transmitter for capturing the tap position is a resistor contact series (potentiometer), then 0 % must be always be used.

Setting range	Step size	Factory setting
0 %...100 %	0.1 %	0 %

Table 35 Setting range for analog value for minimum tap position

To assign the minimum tap position to the analog value, proceed as described on the next page:

1. MENU key > Configuration > Continue > Continue > Tap position > 1x NEXT
   ↳<01> Analog Val. Tap Pos. Min

2. Press F4 in order to highlight the decimal place.
   ↳The required place is now highlighted and the value can be changed.

3. Press F1 to increase the value or F5 to reduce it.

4. Press ENTER.

   The analog value for the minimum tap position is now assigned.

5.6.3 Setting the analog value for the maximum tap position

To configure the analog input, the upper value of the input signal must be specified.

With injected current as the transmitter signal, the values to enter are 100 % in the case of 20 mA (see example in **Table 36**).

Tap position	Current	Value
Maximum tap position 19	20 mA	100% (of analog input signal range)

Table 36 Example for configuring the analog input (max.)

If the transmitter for capturing the tap position is a resistor contact series (potentiometer), then 100 % must be always be used.

Setting range	Step size	Factory setting
0 %...100 %	0.1 %	100 %

Table 37 Setting range for analog value for maximum tap position

To set the maximum tap position for the analog value, proceed as described on the next page:

1. MENU key > Configuration > Continue > Continue > Tap position > 2x NEXT
   ↳<02> Analog Val. Tap Pos. Max
2. Press F4 in order to highlight the decimal place.
   ↳The required place is now highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ENTER.

   The analog value for the maximum tap position is now set.

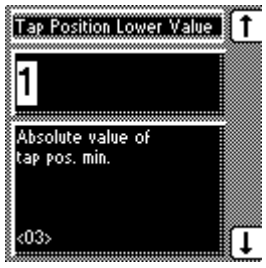
5.6.4 Setting minimum tap position

To configure the analog input, an absolute value must be allocated to the lower value of the applied signal (e.g. the value "1" for the lowest tap position).

Setting range	Step size	Factory setting
-40...40	1	1

Table 38 Setting range for lowest tap position

To set the lowest tap position, proceed as follows:



1. MENU key > Configuration > Continue > Continue > Tap position > 3x NEXT
   ↳<03> Tap Position Lower Value
2. Press F1 to increase the value or F5 to reduce it.
3. Press ENTER.

   The lowest tap position is now set.

5.6.5 Setting the highest tap position

To configure the analog input, an absolute value must be allocated to the upper value of the applied signal (e.g. the value "25" for the highest tap position).

Setting range	Step size	Factory setting
-40...40	1	9

Table 39 Setting range for highest tap position

To set the highest tap position, proceed as follows:

1. MENU key > Configuration > Continue > Continue > Tap position > 4x NEXT
   ↳<04> Tap Position Upper Value

2. Press F1 to increase the value or F5 to reduce it.

3. Press ENTER.

The highest tap position is now set.

5.6.6 Setting the lower tap position blocking limit

If it is necessary to limit the number of tap positions available during operation, a lower tap position blocking limit can be defined. When the minimum defined tap position is reached then tap position blocking is activated. This prevents any further tap change downwards..

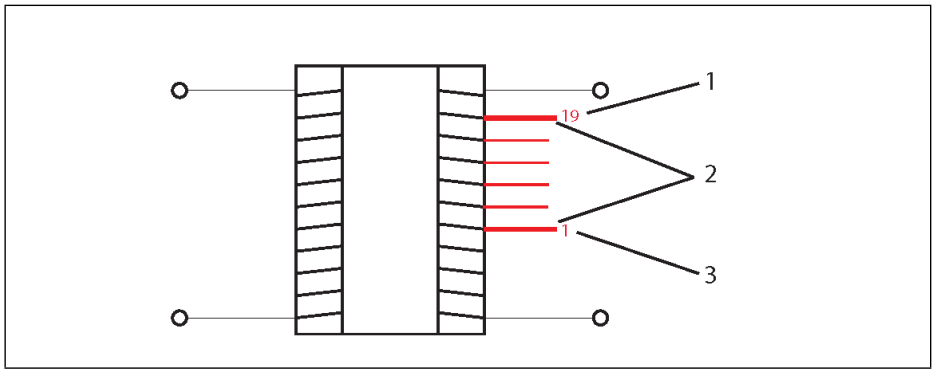


Figure 13 Range of tap positions

1 Highest tap position

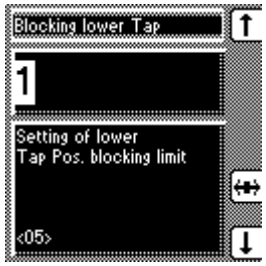
2 Limited range of tap positions

3 Lowest tap position

Setting range	Step size	Factory setting
-128...128	1	1

Table 40 Setting range for lower tap position blocking limit

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



1. MENU key > Configuration > Continue > Continue > Tap position > 5x NEXT
   ↳<05> Blocking lower Tap

2. Press F1 to increase the value or F5 to reduce it.

3. Press F4 to highlight a decimal place (for values >10).
   ↳The required place is now highlighted and the value can be changed.

4. Press ENTER.

The lower tap position blocking limit is now set.

5.6.7 Setting the upper tap position blocking limit

If it is necessary to limit the number of tap positions available during operation, an upper tap position blocking limit can be defined. When the maximum defined tap position is reached then tap position blocking is activated. This prevents any further tap change upwards (see **Figure 13**).

Setting range	Step size	Factory setting
-128...128	1	9

Table 41 Upper tap position blocking limit setting

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

1. MENU key > Configuration > Continue > Continue > Tap position > 6x NEXT
   ↳ <06> Blocking upper Tap
2. Press F1 to increase the value or F5 to reduce it.
3. Press F4 to highlight a decimal place (for values >10).
   ↳ The required place is now highlighted and the value can be changed.
4. Press ENTER.

The upper tap position blocking limit is now set.

5.6.8 Setting the tap position blocking mode

The tap position blocking mode can be set in relation to the upper and lower tap position blocking limits. The following options are available:

- Off
- Directional
- Non-directional

With a directional tap position blocking mode, the voltage regulator blocks as soon as the specified maximum or minimum tap position limit is reached. The voltage regulator then only switches in the direction of valid tap positions.

With a non-directional tap position blocking mode, the voltage regulator blocks as soon as the specified maximum or minimum tap position limit is reached. This means that the voltage regulator does not go any higher or lower.

To change the voltage regulator back into the defined range, proceed as follows:

- Switch to manual.
- Change back manually into the defined tap position limits.

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

1. MENU key > Configuration > Continue > Continue > Tap position > 7x NEXT
   ↳<07> Blocking Mode Tap position limits
2. Press the F1 key or F5 key to select the required option.
3. Press ENTER.

The tap position blocking mode is now set.

5.7 Remote setting of voltage level

If you want to change the voltage level by remote control, a GPI must be wired and the "Remote voltage level" function must be programmed (see **Section 5.5.1**). Remote setting of voltage level is only active when there is a signal at this GPI.

The analog input can be used to specify the voltage level. This requires the analog input (terminal strip X7) to be adapted to the voltage level transmitter signal.

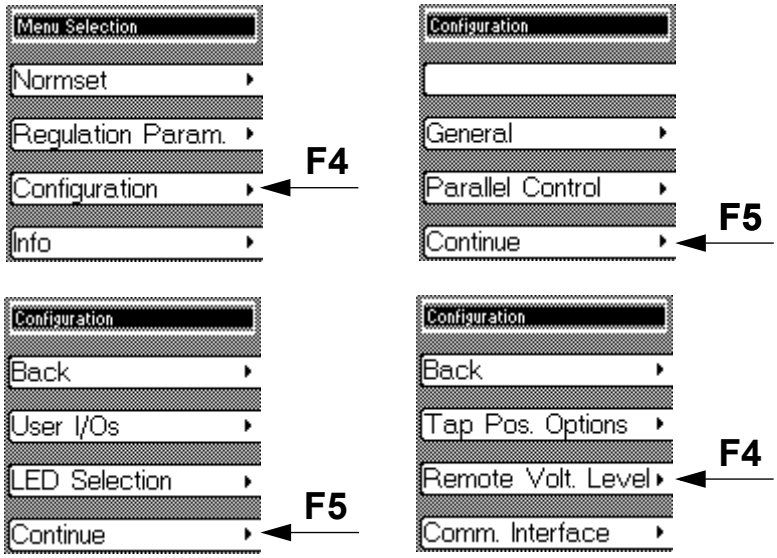
The analog input (terminal strip X7) can be used either for the input of the tap position or for setting the voltage level remotely.

The following transmitters can be used:

- Tap change potentiometer (150...2000 Ohm)
- Injected current 0/4...20 mA

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

MENU key > Configuration > Continue > Continue > Remote Volt. Level Setting



5.7.1 Remote voltage level setting options

There are 3 options for setting the voltage level remotely:

- Off (no remote setting of voltage level)
- Current of 0/4...20 mA
- Resistor contact series

Proceed as follows:

1. MENU key > Configuration > Continue > Continue > Remote Volt. Level Setting
   ↳<00> Remote Volt. Level Setting
2. Press the F1 key or F5 key to select the required option.
3. Press ENTER.

   The method of setting the remote voltage level is now selected.

The range between 265 V and 380 V is not intended for entering the voltage level and will result in the error message: "Voltage level not in permitted range of measurements".

5.7.2 Setting the analog value for the minimum voltage level

To configure the analog input, the lower value of the input signal must be specified.

With injected current as the transmitter signal, the values to enter are 0 % in the case of 0 mA and 20 % n the case of 4 mA (see example in**Table 42**).

Voltage level	Current	Value
Min. voltage level 230 V	4 mA	20% (of analog input signal range)

Table 42 Example for configuring the analog input (min.)

If the transmitter for capturing the tap position is a resistor contact series (poten--tiometer), then 0 % must be always be used.

Setting range	Step size	Factory setting
0 %....100 %	0.1 %	0 %

Table 43 Setting range for analog value for minimum voltage level

To set the minimum analog voltage level, proceed as follows:

1. MENU key > Configuration > Continue > Continue > Remote Volt. Level Setting > 1x NEXT
   ↳<01> Analog Value % Volt. Level Min
2. Press F4 in order to highlight the decimal place.
   ↳The required place is now highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ENTER.

The minimum analog voltage level is now set.

5.7.3 Setting the analog value for the maximum voltage level

To configure the analog input, the maximum value of the input signal must be specified.

With injected current as the transmitter signal, the values to enter are 100 % n the case of 20 mA.

If the transmitter for the remote voltage level setting is a resistor contact series (potentiometer), then 100 % must be always be used (see **Table 44**).

Voltage level	Current	Value
Max. voltage level 250 V	20 mA	100% (of analog input signal range)

Table 44 Example for configuring the analog input (max.)

Setting range	Step size	Factory setting
0 %....100 %	0.1 %	100 %

Table 45 Setting range for analog value for maximum voltage level

To set the maximum analog voltage level, proceed as follows:

1. MENU key > Configuration > Continue > Continue > Remote Volt. Level Setting > 2x NEXT
   ↳<02> Analog Value % Volt. Level Max

2. Press F4 in order to highlight the decimal place.
   ↳The required place is now highlighted and the value can be changed.

3. Press F1 to increase the value or F5 to reduce it.

4. Press ENTER.

The maximum analog voltage level is now set.

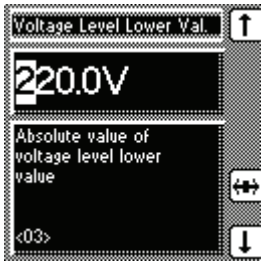
5.7.4 Setting minimum voltage level

To configure the analog input, an absolute value must be allocated to the lower value of the applied signal (e.g. 230 V for the minimum voltage level).

Setting range	Step size	Factory setting
220 V...440 V	0.1 V	220 V

Table 46 Setting range for minimum voltage level

To set the minimum voltage level, proceed as follows:



1. MENU key > Configuration > Continue > Continue > Remote Volt. Level Setting > 3x NEXT
   ↳ <03> Voltage level lower value
2. Press F4 in order to highlight the decimal place.
   ↳ The required place is now highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ENTER.

The minimum voltage level has now been set.

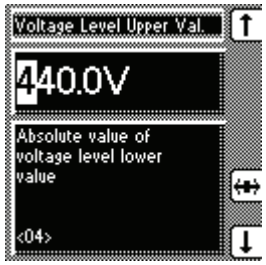
5.7.5 Setting maximum voltage level

To configure the analog input, an absolute value must be allocated to the upper value of the applied signal (e.g. 265 V for the maximum voltage level).

Setting range	Step size	Factory setting
220 V...440 V	0.1 V	440 V

Table 47 Setting range for maximum voltage level

To set the maximum voltage level, proceed as follows:



1. MENU key > Configuration > Continue > Continue > Remote Volt. Level Setting > 4x NEXT
   ↳<04> Voltage level upper value

2. Press F4 in order to highlight the decimal place.
   ↳The required place is now highlighted and the value can be changed.

3. Press F1 to increase the value or F5 to reduce it.

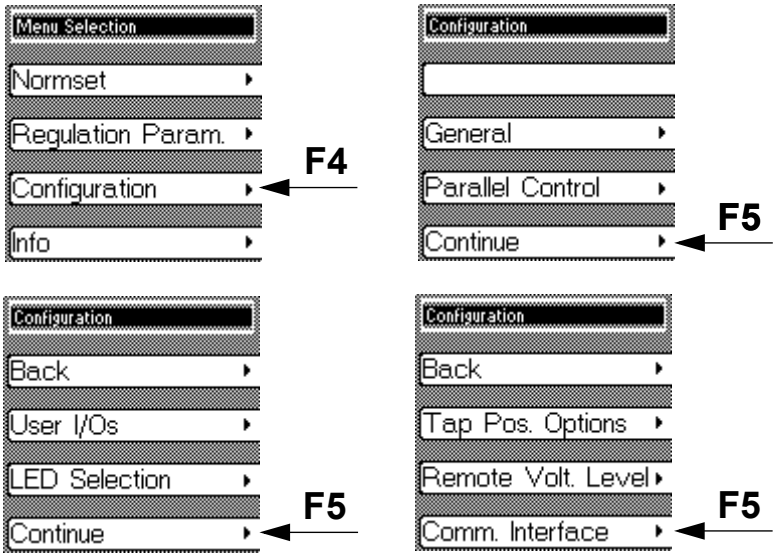
4. Press ENTER.

The voltage level upper value is now set.

5.8 Communication interface

The TAPCON® 230 AVT voltage regulator has additional communication interfaces.

MENU key > Configuration > Continue > Continue > Comm. Interface



The TAPCON® 230 AVT has various PCB connections to guarantee communication with the voltage regulator. The voltage regulator is equipped with the following interfaces:

- Serial interface RS232
- RS485
- Ethernet

Setting the PCB connections and each of their functions is described in more detail in the following sections:

5.8.1 Selecting the communication protocol

This enables the required communication protocol to be activated. The fol-lowing options are available:

- TAPCON-trol® (visualization software)
- Modbus ASCII
- Modbus RTU

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

1. MENU key > Configuration > Continue > Continue > Comm. Interface.
   ↳<00> Communication Protocol
2. Press the F1 key or F5 key to select the required option.
3. Press ENTER.

The communication protocol is now set.

5.8.2 Selecting the communication port

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

- RS232
- RS485
- Ethernet

Only one communication port can be selected. All remaining ports remain disabled. Simultaneous use of several communication ports is not possible.

To set the communication port, proceed as follows:

1. MENU key > Configuration > Continue > Continue > Comm. Interface. > 1x NEXT
   ↳<01> Communication Port
2. Press the F1 key or F5 key to select the required option.
3. Press ENTER.

The communication port is now set.

5.8.3 Selecting the communication baud rate

This enables selection of the required transfer speed for the communication interface. The following transfer speeds are available:

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

The baud rate of 57.6 kBd is only active for communication interfaces RS232 and RS485.

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

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

1. MENU key > Configuration > Continue > Continue > Comm. Interface. > 2x NEXT
   ↳<02> Baud Rate Communication
2. Press the F1 key or F5 key to select the required baud rate.
3. Press ENTER.

The baud rate is now set.

5.8.4 Setting network address

If the voltage regulator is equipped with an Ethernet module, then the TAPCON® 230 AVT must be assigned a valid network address (IPv4).

Setting range	Step size	Factory setting
0...255	1	0.0.0.0

Table 48 Setting range for network address

To assign the network address, proceed as follows:

1. MENU key > Configuration > Continue > Continue > Comm. Interface. > 3x NEXT
   ↳ <03> IP address
2. Press F4 in order to highlight the position.
   ↳ The required place is now highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ENTER.

The network address for the TAPCON® 230 AVT is now assigned.

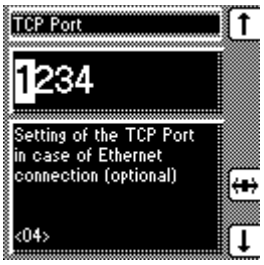
5.8.5 Assigning the TCP port

If the voltage regulator is equipped with an Ethernet module, then the TAPCON® 230 AVT must be assigned a valid TCP port.

Setting range	Step size	Factory setting
0...32767	1	1234

Table 49 Setting range for TCP port

To set the TCP port, proceed as follows:



1. MENU key > Configuration > Continue > Continue > Comm. Interface. > 4x NEXT
   ↳<04> TCP Port
2. Press F4 in order to highlight the position.
   ↳The required place is now highlighted and the value can be changed.
3. Press F1 to increase the value or F5 to reduce it.
4. Press ENTER.

The TCP port is now set.

5.8.6 Setting the SCADA address

This enables a valid SCADA address to be set for the chosen control system protocol. The voltage regulator communication address must be specified when connecting to the control system.

Setting range	Step size	Factory setting
0...9999	1	0

Table 50 Setting range for SCADA address

To enter the SCADA address, proceed as follows:

1. MENU key > Configuration > Continue > Continue > Comm. Interface. > 6x NEXT
   ↳<06> Local SCADA Address

2. Press F1 to change the first digit.

If you wish to enter a multidigit sequence, continue to step 3. If you do not wish to enter additional digits, proceed to step 7:

3. Press the F1 key repeatedly (> 9) until a further digit position appears.

4. 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 ENTER.

The SCADA address is now set.

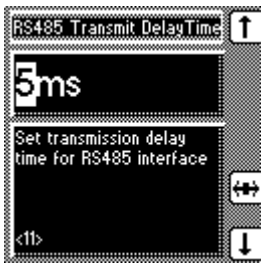
5.8.7 Setting the transmission delay time for the RS485 interface

If the physical interface RS485 has been selected, then the transmission delay time can be set as desired.

Setting range	Step size	Factory setting
0 ms...254 ms	1 ms	5 ms

Table 51 Setting range for RS485 transmission delay time

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



1. MENU key > Configuration > Continue > Continue > Comm. Interface. > 11x NEXT
   ↳<11> RS485 Transmit Delay Time
2. Press F1 to increase the value or F5 to reduce it.
3. Press ENTER.

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

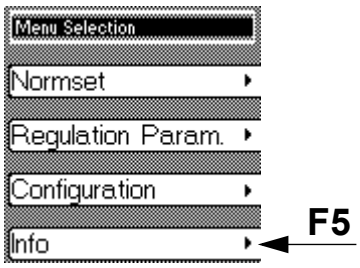
5.9 Info

This menu item displays general information on the voltage regulator. In addition, calibration of the resistor contact series can be carried out on the analog input (terminal strip X7) (see **Section 5.10**):

- Measured values
- Calculated values
- Functional reliability of the LEDs (LED test)
- MIO card digital inputs (terminals X4:13 - X4:24)
- MIO card digital outputs (terminals X3:3 - X4:12)
- PIO card digital inputs (terminals X6:1 - X6:15)
- PIO card digital outputs (terminals X5:3 - X5:24)
- Parallel mode
- Data on CAN bus
- Peak memory
- CI card information
- Default Parameter
- Memory overview
- Event overview

To make things easier to find, subgroups are formed from related information.

MENU key > Info



Each of the information displays is described in the following sections.

5.9.1 Displaying the Info Screen

Information on the device can be viewed here. The following information is dis--played:

- Device model
- Firmware version number
- Serial number
- RAM - working memory
- Additional cards

To view the information on the device, proceed as described below:

▸ MENU key > Info
↳<00> Info

5.9.2 Displaying measurement values

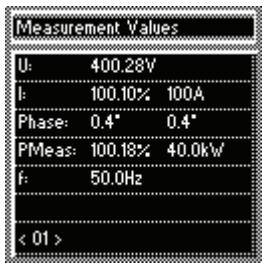
The current measurement values can be viewed here. The following measurement values can be displayed:

- Voltage V in V
- Current I in % and A
- Phase
- Pmeas
- f (frequency)

The values to the right (see figure below) of the voltage, current and power are only displayed if the transformer data have been entered previously.

For "Phase" measurement, the actual measured phase is given on the left. The phase converted by the measured transformer circuit is shown on the right.

To display the measurement values, proceed as follows:



▸ MENU key > Info > 1x NEXT
↳<01> Measured values

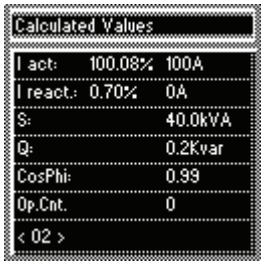
5.9.3 Display calculated values

The calculated values can be viewed here. Values displayed:

- I active power in A
- I reactive power in A
- S in kVA
- Q in kVAr
- CosPhi
- Op. Cnt. (Switching operation counter)

The values on the right (see Figure below) are only displayed if the transformer data have been entered previously.

To display the calculated values, proceed as follows:



▸ MENU key > Info > 2x NEXT
↳<02> Calculated values

5.9.4 Carry out LED test

An LED function test can be carried out based on the information displayed. This checks whether all the LEDs are functioning

To carry out the LED test, proceed as follows:

1. MENU key > Info > 3x NEXT
   ↳<03> LED test

2. To carry out the function test, press any F key for the required LED (see **Table 52**).

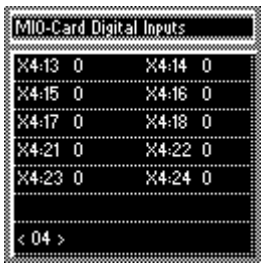
Key	LED no.	LED
F1	LED 1	AUTO
F2	LED 2	MANUAL
F3	LED 3	LOWER
F4	LED 4	RAISE
F5	LED 5	> I
ENTER	All LEDs	All LEDs

Table 52 Selecting the LEDs for tests

5.9.5 Display MIO card digital inputs

The "MIO card digital inputs" displays the status of each of the optocoupler inputs. As soon as a continuous signal is present at the input, it is shown in the display with a "1". "0" indicates no signal at the input.

To display "MIO Inputs", proceed as follows:

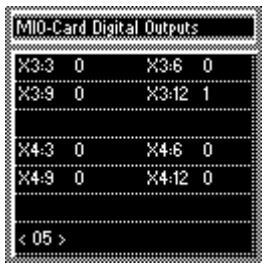


- MENU key > Info > 4x NEXT
  ↳<04> MIO Card Digital Inputs

5.9.6 Display MIO card digital outputs

The "MIO card digital outputs" displays the status of each of the relays. As soon as a relay is activated, it is shown as a "1" in the display. With "0", the relay is not activated.

To display "MIO Outputs", proceed as follows:

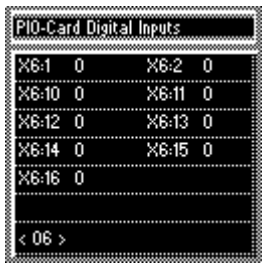


- MENU key > Info > 5x NEXT
  ↳<05> MIO Card Digital Outputs

5.9.7 Display PIO card digital inputs

The "PIO card digital inputs" displays the status of each of the optocoupler inputs. As soon as a continuous signal is present at the input, it is shown in the display with a "1". "0" indicates no signal at the input.

To display "PIO card digital inputs", proceed as follows:

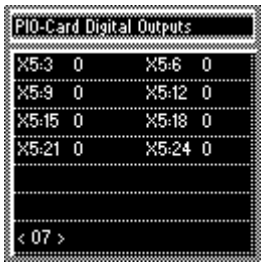


- MENU key > Info > 6x NEXT
  ↳<06> PIO Card Digital Inputs

5.9.8 Display PIO card digital outputs

The "PIO card digital outputs" displays the status of each of the relays. As soon as a relay is activated, it is shown as a "1" in the display. With "0", the relay is not activated.

To display "PIO card digital inputs", proceed as follows:

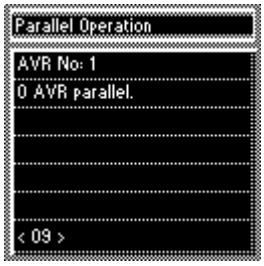


- MENU key > Info > 7x NEXT
  ↳<07> PIO Card Digital Outputs

5.9.9 Displaying parallel operation

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

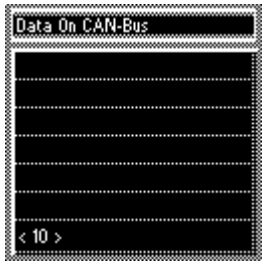
To display "Parallel operation", proceed as follows:



- MENU key > Info > 9x NEXT
  ↳<09> Parallel Operation

5.9.10 Displaying data on CAN bus

To display the "CAN bus", proceed as follows:

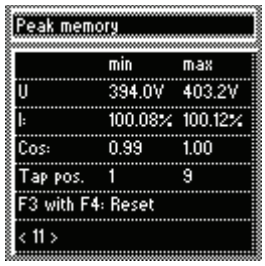


- MENU key > Info > 10x NEXT
  ↳<10> CAN Bus

5.9.11 Displaying peak memory

This screen indicates whether the parameter settings are all correctly stored after restarting the voltage regulator or after transferring a parameter setting.

To display "Peak memory", proceed as follows:



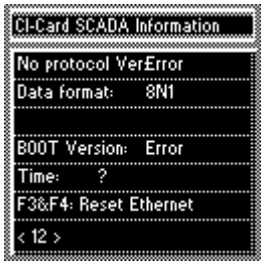
- MENU key > Info > 11x NEXT
  ↳<11> Peak memory

This information can be reset if required:

- Press the F3 and F4 keys simultaneously for about 1 second.
  ↳ All values are now set to default.

5.9.12 CI card SCADA Information

To display the "CI card SCADA information", proceed as follows:



- MENU key > Info > 12x NEXT
  ↳<12> CI Card SCADA Information

This information can be reset if required:

- Press the F3 and F4 keys simultaneously for about 1 second.
  ↳ All values are now set to default.

5.9.13 Displaying memory overview

Memory overview can be used to display various inputs with the relevant number of records. They are only used for service checks and are not relevant for operation. The following entries can be displayed:

- File parameter
- Event data bits
- Flash file
- Events
- Operation counter (OpCnt)

To display the entries, proceed as follows:

1. MENU key > Info > 14x NEXT
   ↳<14> Memory overview

2. Press the F1 key or F5 key for the required entry.
   ↳The relevant number of records is displayed.

5.9.14 Event overview

The event overview can be used to display the number of current red and yellow events. To view the event overview, proceed as follows:

- MENU key > Info > 15x NEXT
  ↳Event overview

You will find an overview of all event messages in **Section 6.2** on Page 138.

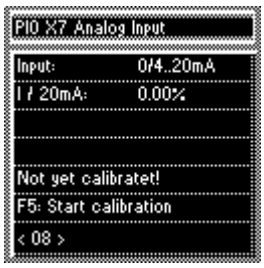
5.10 Miscellaneous settings

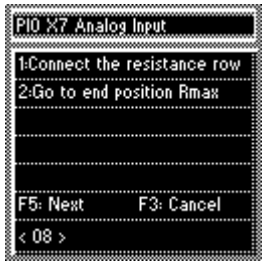
5.10.1 Calibrating the resistor contact series

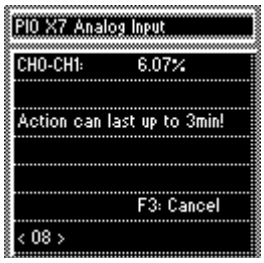
The menu item "Info" can be used for calibrating the resistor contact series. If the analog input is used, this must be calibrated during commissioning. This is used to adjust the external measuring circuit.

The F3 key can be used to cancel the calibration at any point.

To carry out the calibration, proceed as follows:







1. MENU key > Info > 8x NEXT
   ↳<08> PIO X7 Analog Input
2. Press the F5 key
   ↳The display with action prompts appears.
3. Connect potentiometer.
4. Turn potentiometer into end position Rmax.
5. Press the F5 key to start the calibration.
   ↳The calibration is started.

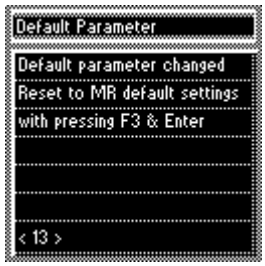
The procedure can last up to 3 minutes. If this time is exceeded, the error message "Check sliding contact" appears. In this case, make sure that the potentiometer is correctly connected and is not faulty.

5.10.2 Resetting default parameters

"Default Parameter" resets the settings to the factory settings.

To reset the parameters, proceed as follows:

Resetting the parameters to the factory settings permanently deletes your parameters. The language is reset to the original (English).



1. MENU key > Info > 13x NEXT
   ↳<13> Default Parameters

2. Press the F3 key and ENTER simultaneously.
   ↳"Default parameter active" is displayed.

All parameters have now been reset to the factory settings.

5.11 Summary of setting ranges

	Setting range	Step size	Factory setting
Voltage level 1/2/3	220 V...440 V	0.1 V	400 V
Bandwidth	0.5 %...9 %	0.01 %	2 %
Delay time Z1	0 s...600 s	1 s	40 s
V< undervoltage blocking	60 %...100 % of voltage level	1 %	90 %
V< undervoltage delay	0 s...20 s	0.1 s	10 s
V> overvoltage blocking	100 %...140 % of voltage level	1 %	110 %
I> overcurrent blocking	50 %...210 %	1 %	110 %
I< undercurrent blocking	0 %...210 %	1 %	0 %
R/L switching pulse time	0.1 s...10 s	0.1 s	1.5 s
Switching operation counter	0...99,999,999	1	0
Motor runtime	0 s...30 s	0.1 s	0 s
Circulating reactive current sensitivity	0 %...100 %	1 %	0 %
Circulating reactive current blocking	0.5 %...40 %	1 %	20 %
Delay time for parallel mode signal	1 s... 99 s	1 s	30 s
Max. tap position deviation	0...4	1	1
Analog value of minimum tap position	0 %...100 %	0.1 %	0 %
Analog value for maximum tap position	0 %...100 %	0.1 %	100 %
Tap position (lowest)	-40...40	1	1
Tap position (highest)	-40...40	1	9
Tap position blocking limit (lowest)	-128...128	1	1
Tap position blocking limit (highest)	-128...128	1	9
Analog value for minimum voltage level	0 %...100 %	0.1 %	0 %
Analog value for maximum voltage level	0 %...100 %	0.1 %	100 %
Minimum voltage level	220 V...440 V	0.1 V	220 V
Maximum voltage level	220 V...440 V	0.1 V	440 V
Network address	0...255 (depending on number)	1	0.0.0.0
TCP Port	0...9999	1	1234
SCADA address	0...99,999,999	1	0
RS485 send delay time	0 ms...254 ms	1 ms	5 ms

Table 53 Summary of all setting ranges TAPCON® 230 AVT

6 Fault elimination

The following chapter describes how to eliminate simple operating faults and the meaning of potential event messages.

6.1 Operating faults

If faults occur in the voltage regulator during operation, these can usually be remedied by the user. The following table is intended to provide assistance in recognizing and remedying faults.

Fault description	Characteristics	Detail	Cause	Remedy
No control in AUTO operating mode	Regulator control commands have no effect	R/L LEDs light up periodically	Local/Remote switch in motor drive switched to LOCAL	Check operating mode and correct if necessary
			Connection missing	Check wiring as per circuit diagram
	Blocking	LED V< illuminated	Undervoltage blocking active	Check parameter
		LED V> illuminated	Overvoltage blocking active	Check parameter
		-	Undercurrent blocking active	Check parameter
		LED I> illuminated	Overcurrent blocking active	Check parameter
		-	Negative power lock active	Check parameter
		-	Negative power flow	Check current transformer polarity
		-	User inputs parameterized twice	Check parameterization of user inputs
		-	One of the GPIs is parameterized with "Blocking" and has an appropriate input signal	Check parameter and status of inputs on information screen (PIO card)
		-	NORMset active	Carry out manual tap-change operation
	Bandwidth set too high	-	-	Calculate sensitivity: Step voltage x 100 / nominal voltage
MMI	Keys	Does not switch between MANUAL/ AUTO	REMOTE selected	Select LOCAL mode
		MANUAL and AUTO do not light up	Parameter error	Reset to factory settings (see **Section 5.10.2**)

Table 54 Fault elimination

Fault description	Characteristics	Detail	Cause	Remedy
MMI	Display	No display	Contrast incorrectly set	Set contrast using potentiometer in front panel
			Power supply interrupted	Check voltage supply
			Fuse faulty	Change fuse
		Different brightness on several voltage regulators	Activate/deactivate screen saver	Check "Screen saver" setting
	LEDs	Freely programmable LED is illuminated	User-specific LED parameterization	Check parameterization
		LED flashes irregularly	Input signal not constant	Check input signal
	COM 1	Cannot be connected to PC using TAPCON-trol	Different baud rates set	Check baud rate and correct if necessary (voltage regulator and TAPCON-trol)
	Terminals	Plug terminal cannot be installed	Plug terminal and socket are not the same	Check code and plug terminal
Measured values	Measured voltage	No measured value	Connection has no contact to the terminal	Check wiring and terminal
			Insulation trapped	
			Wire not inserted far enough	
			Circuit breaker tripped	Check fuse
		Measured value too low	Voltage drop on measuring lead	Check measured voltage at terminal X2:1/X2:2
		Measured value fluctuates	Possible sources of fault: • Leads laid in parallel • Switching operations	Check measured voltage at terminal X2:1/X2:2
				Increase distance from source of fault
				Install filter if necessary
	Measured current	No measured value	Current transformer interrupted	Check wiring
			Short-circuiting jumper in current transformer not removed	Remove short-circuiting jumper
		Measured value too high	Ratio not correctly parameterized	Correct parameterization
			Incorrect input connected	Check wiring of terminal strip X1
		Measured value too low	Ratio not correctly parameterized	Correct parameterization
			Incorrect input connected	Check wiring of terminal strip X1

Table 54 Fault elimination

Fault description	Characteristics	Detail	Cause	Remedy
Measured values	Phase angle	V/I	Fault in external measurement transformer circuit	Check measurement transformer circuit
			Measurement transformer circuit incorrectly parameterized	Compare with system connection diagram and correct parameter if necessary
			Transformer incorrectly connected	Compare measured values in info screen
				Exchange current transformer connection
				Check polarity of measurement transformer circuit and correct if necessary
				Check tap-change operation and correct if necessary
				Check measuring points and correct if necessary
General fault	No function	No supply voltage	Fuse tripped	Check all fuses and replace if necessary
	Relays chatter	-	Supply voltage too low	Check supply voltage
User-specific IOs	Function expected from factory setting does not take place	-	Parameterization has been overwritten manually or via TAPCOn-trol	Check active parameter
				Reset to factory settings
Digital inputs	Signal discontinuous	-	Intermittent DC voltage	???
	No signal	Info screen shows 0	Signal lead or wire for control voltage interrupted	Check wiring
		Info screen switches between 0 and 1	Intermittent DC voltage	Check DC voltage
No solution	Contact Maschinenfabrik Reinhausen. Please have the following data to hand: • Serial number You will find this: - Outer right side when viewed from the front - Name plate (inner right side panel when viewed from the front) - Info screen (MENU key > Info) • Firmware version (MENU key > 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?			

Table 54 Fault elimination

6.2 Event messages

When particular events occur, the voltage regulator issues an event message.

The following events can occur:

No.	Event message	Remark
1	-	not available
2	-	not available
3	Undervoltage	Message is displayed in the event of undervoltage. Limit value set according to **Chapter 5.2.2.1**.
4	Overvoltage	Message is displayed in the event of overvoltage. Limit value set according to **Chapter 5.2.2.5**.
5	Overcurrent	Message is displayed in the event of overcurrent. Limit value set according to **Chapter 5.2.2.7**.
6	Parallel error: Different parallel operation methods	Message is displayed if different parallel operation methods are set for 2 or more regulators in the same parallel operation group. Parallel operation method set according to **Chapter 5.4.3**.
7	Motor protection	Is triggered by the motor protective switch input
8	-	not available
9	Undercurrent	Message is displayed in the event of undercurrent. Limit value set according to **Chapter 5.2.2.9**.
10	-	not available
11	Error when setting user inputs (duplicate assignment)	At least 2 user inputs are parameterized to the same function. Message appears after the 2nd parameter has been confirmed with ENTER.
12	Function monitoring (voltage not adjusted within 15 min)	Message is displayed if the voltage has not been adjusted within 15 min.
13	Motor-drive unit runtime monitoring	Message is displayed if the set motor runtime is exceeded. Motor runtime set according to **Chapter 5.3.1.9**.
14	Analog input value too high Check your connection to terminal X7!	Message is displayed when the maximum permissible current of 20 mA is exceeded for connection X7.
15	Analog input value negative Check your connection to terminal X7!	Message is displayed in the event of reverse polarity or if X7 connection is incorrectly connected.
16	Parameter reloaded! Confirm with F3 & Enter	Message is displayed if the current set of parameters is flawed and the system has therefore switched to the standard set of parameters.
17	Check sliding contact.	Message is displayed if the tap position potentiometer is incorrectly connected or if a contact on this potentiometer is loose.

Table 55 Possible TAPCON® 230 AVT events

No.	Event message	Remark
18	No other CAN bus participants present	Message is displayed if parallel operation has been set but there is no regulator in the same parallel operation group or the CAN bus is actually interrupted.
19	Parallel error: Circulating reactive current blocking limit exceeded	Message is displayed if the parallel operation method is using circulating reactive current or Master/Follower and the blocking limit is activated. The circulating reactive current limit must also be exceeded.
20	Parallel error: Invalid tap position present on parallel regulators	Message is displayed if a tap position on a parallel regulator is invalid.
21	Parallel error: Tap position deviation to Follower	Message is displayed on Master if a Follower still has the same tap position as the Master after the set delay time. Limit values set according to **Chapter 5.4.10** and **Chapter 5.4.12**
22	Parallel error: Permitted tap position deviation to Master exceeded	Message is displayed on Follower if a Follower is still not within the permitted tap position deviation to the Master's tap position after the set delay time. Limit values set according to **Chapter 5.4.10** and **Chapter 5.4.12**
23	Parallel error: Number of Masters on CAN bus >1	Message is displayed if several regulators in a parallel operation group have been set as the Master.
24	Parallel error: No Master present or Master tap position invalid	Message is displayed if no regulator has been set as the Master or the Master is reporting an invalid tap position.
25	Parallel error: CAN address selected already in use	Message is displayed if the set CAN address is already in use.
26	Parallel error: Circulating reactive current invalid	Message is displayed if the current measurement for at least one controller is invalid and the circulating reactive current to be calculated is therefore invalid when the circulating reactive current parallel operation method is active.
27	Parallel error: Blocking initiated by other regulator	Message is displayed if blocking is initiated by another regulator.
28	Parallel error: No other regulators in parallel operation group	Message is displayed if there are no more regulators in the parallel operation group.
29	-	not available
30	Blocking: Signal at blocking user input	Message is displayed if there is a signal at the set 'Automatic regulation blocked' (blocking) user input.
31	Blocking: Negative active power	Message is displayed if the active power is negative and blocking is activated for negative active power.
32	Blocking: Signal at block lower user input	Message is displayed if there is a signal at the set 'Raise pulse blocked' (Blk U raise) user input.
33	Blocking: Signal at block raise user input	Message is displayed if there is a signal at the set 'Lower pulse blocked' (Blk U low) user input.

Table 55 Possible TAPCON® 230 AVT events

No.	Event message	Remark
34	Blocking: Lower blocked because tap position limit reached or exceeded	Message is displayed if lower is blocked because the corresponding tap position limit has been reached or exceeded.
35	Blocking: Raise blocked because tap position limit reached or exceeded	Message is displayed if raise is blocked because the corresponding tap position limit has been reached or exceeded.
36	Tap position limit reached or exceeded	Message is displayed if the set tap position limit has been reached or exceeded.
37	Negative active power	Message is displayed if the active power is negative
38	Desired value 1 not in permitted range of measurements	Message is displayed if desired value 1 is not in the permitted range of measurements.
39	Desired value 2 not in permitted range of measurements	Message is displayed if desired value 2 is not in the permitted range of measurements.
40	Desired value 3 not in permitted range of measurements	Message is displayed if desired value 3 is not in the permitted range of measurements.
41	Remote desired value not in permitted range of measurements	Message is displayed if the desired remotely set value is not in the permitted range of measurements.
42	Wait 60 seconds for cooling.	Message is displayed if a tap-change operation is to be performed before the 60 s minimum waiting time is over.

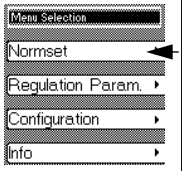
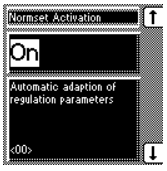
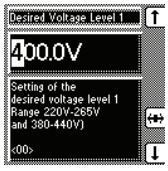
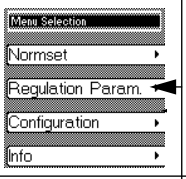
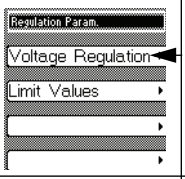
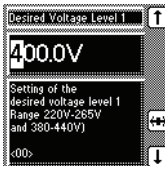
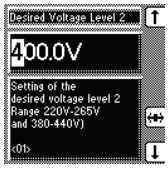
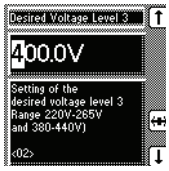
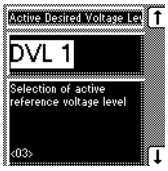
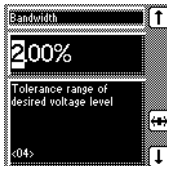
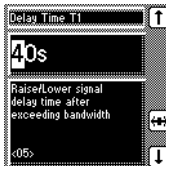
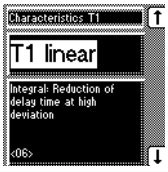
Table 55 Possible TAPCON® 230 AVT events

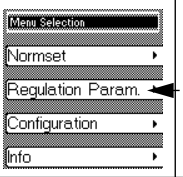
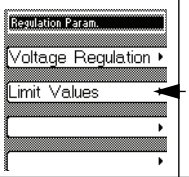
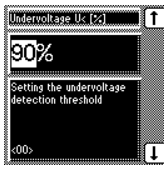
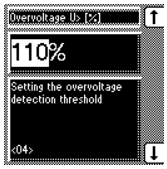
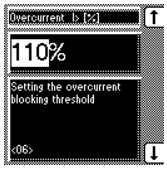
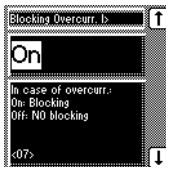
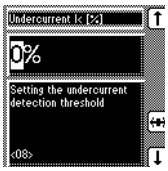
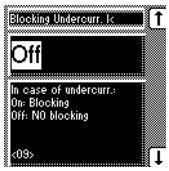
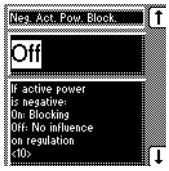
7 Technical data

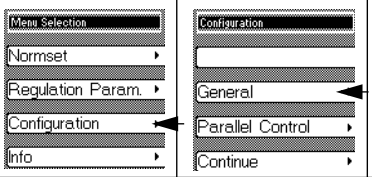
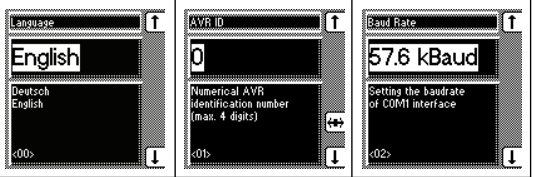
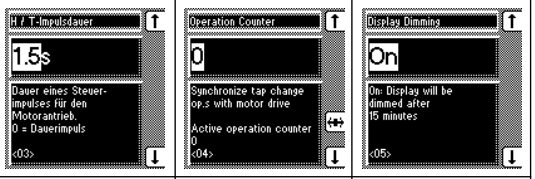
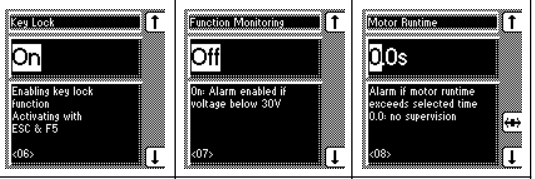
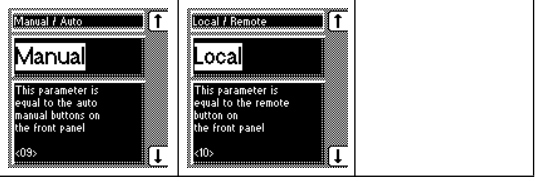
Electrical safety	
EN 61010-1	Safety requirements for electrical measurement and control equipment and laboratory instruments
IEC 61131-2	Dielectric test with operating frequency 350 V AC – 5870 V AC (depending on the operating voltage of the power circuit)
IEC 60255	Dielectric test with impulse voltage 5 kV, 1.2 / 50 µs
VDE 0435	Short-time current and long-term load capacity of current transformer inputs • 100 x I_n / 1 s • 2 x I_n / continuous
EMC tests	
IEC 61000-4-2	Electrostatic discharges (ESD) 8 kV /15 kV
IEC 61000-4-3	Electromagnetic fields (HF) 10 V/m 80...3000 MHz
IEC 61000-4-4	Fast transients (burst) 6.5 kV
IEC 61000-4-5	Surge transient immunity 2 kV (line/line), 4 kV (line/earth)
IEC 61000-4-6	HF interference immunity (lines) 10 V, 150 kHz...80 MHz
IEC 61000-4-8	Power frequency magnetic field immunity 1000 A/m
IEC 61000-6-2	Immunity requirements for industrial environments
IEC 61000-6-4	Emission standard for industrial environments
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 - 25 °C / 16 hours
IEC 60068-2-2	Dry heat + 70 °C
IEC 60068-2-3	Constant moist heat + 40 °C / 93% / 21 days
IEC 60068-2-30	Cyclic moist heat (12 + 12 hours) + 55 °C / 93 % and + 25 °C / 95 % / 6 cycles
Mechanical stability	
IEC 60068-2-31	Drop and topple, unpacked 100 mm fall height
IEC 60068-2-32	Free fall, unpacked 250 mm fall height
IEC 255-21-1 Class 1	Bounce test
IEC 255-21-2 Class 1	Shock and bump test
IEC 255-21-3 Class 1	Seismic test

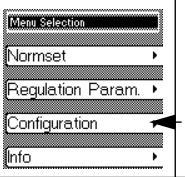
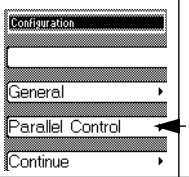
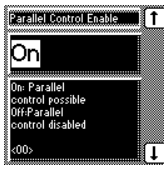
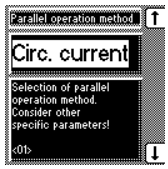
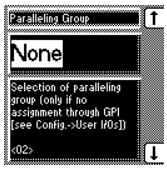
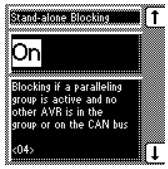
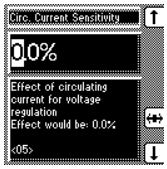
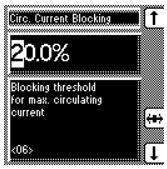
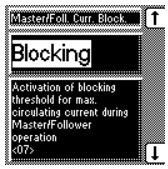
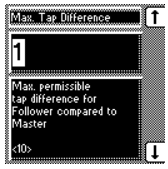
Table 56 Technical data for the TAPCON® 230 AVT

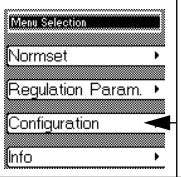
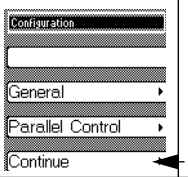
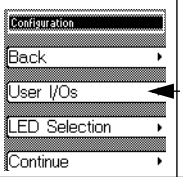
8 Menu overview

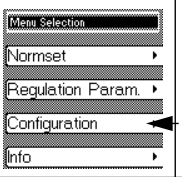
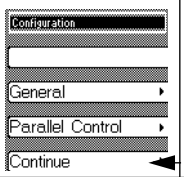
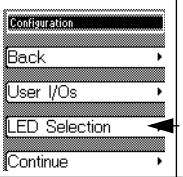
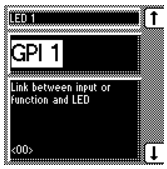
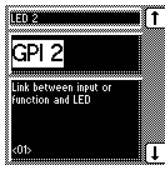
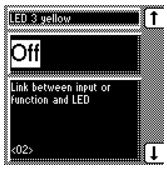
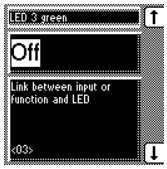
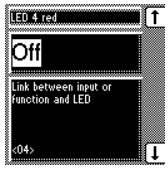
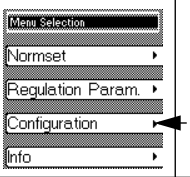
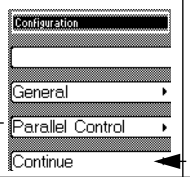
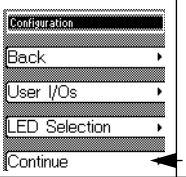
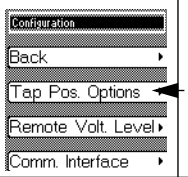
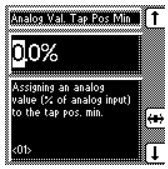
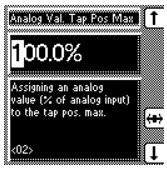
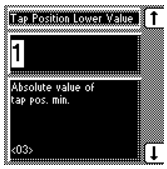
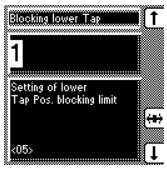
Main group: MENU key	1. Sub group: F2 - F5 key	2. Sub group: F2 - F5 key	3. Sub group: F2 - F5 key	Parameter in direction 1: key Parameter in direction n: key		
NORMset						
						
Regulation Parameter - Voltage Regulation						
						
						
						

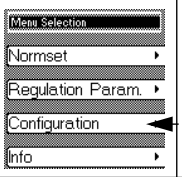
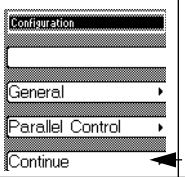
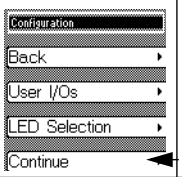
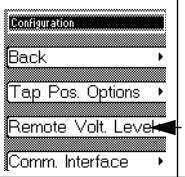
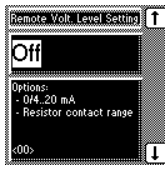
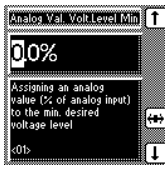
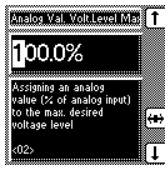
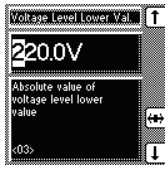
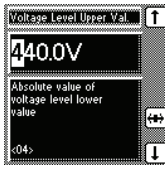
Main group: MENU key	1. Sub group: F2 - F5 key	2. Sub group: F2 - F5 key	3. Sub group: F2 - F5 key	Parameter in direction 1: key  Parameter in direction n: key 		
Regulation Parameter - Limit Values						
						
						
						
						

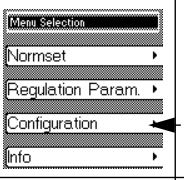
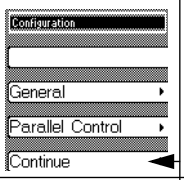
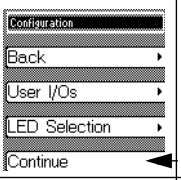
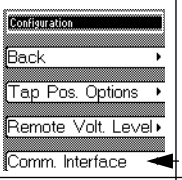
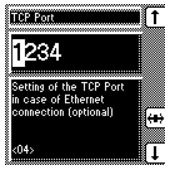
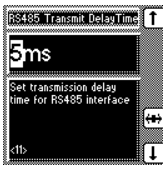
Main group: MENU key	1. Sub group: F2 - F5 key	2. Sub group: F2 - F5 key	3. Sub group: F2 - F5 key	Parameter in direction 1: key Parameter in direction n: key
Configuration - General				
				
				
				
				

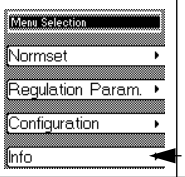
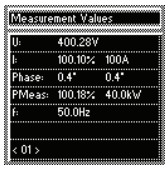
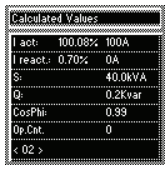
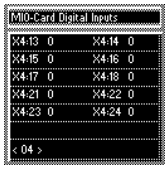
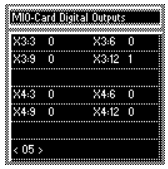
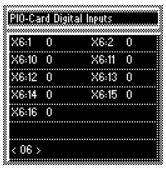
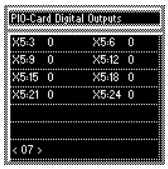
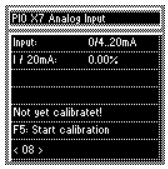
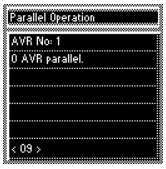
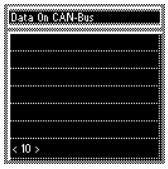
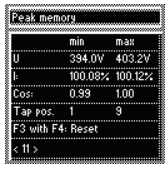
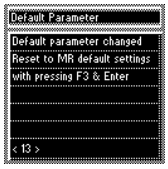
Main group: MENU key	1. Sub group: F2 - F5 key	2. Sub group: F2 - F5 key	3. Sub group: F2 - F5 key	Parameter in direction 1: key  Parameter in direction n: key 		
Configuration - Parallel Control						
 						
						
						
						

Main group: MENU key	1. Sub group: F2 - F5 key	2. Sub group: F2 - F5 key	3. Sub group: F2 - F5 key	Parameter in direction 1: key  Parameter in direction n: key 		
Configuration - User I/Os						
						
						
						
						
						

Main group: MENU key	1. Sub group: F2 - F5 key	2. Sub group: F2 - F5 key	3. Sub group: F2 - F5 key	Parameter in direction 1: key  Parameter in direction n: key 		
Configuration - LED Selection						
						
						
Configuration - Tap Position Options						
						
						
						

Main group: MENU key	1. Sub group: F2 - F5 key	2. Sub group: F2 - F5 key	3. Sub group: F2 - F5 key	Parameter in direction 1: key  Parameter in direction n: key 		
Configuration - Remote Voltage Level						
						
						

Main group: MENU key	1. Sub group: F2 - F5 key	2. Sub group: F2 - F5 key	3. Sub group: F2 - F5 key	Parameter in direction 1: key  Parameter in direction n: key 		
Configuration - Communication Interface						
						
						
						

Main group: MENU key	1. Sub group: F2 - F5 key	2. Sub group: F2 - F5 key	3. Sub group: F2 - F5 key	Parameter in direction 1: key Parameter in direction n: key		
Info						
						
						
						
						
						
						

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