NOTE

Changes may have been made to a product after going to press with this documentation.
We expressly reserve the right to make changes to a product’s technical data and design as well as changes to the scope of delivery.
In all cases, the information submitted and agreements concluded during processing of the quotation and order in question shall be binding.
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1 General

1.1 Foreword
The TAPCON® 260 D voltage regulator is part of a new device generation from MR Reinhausen. The simple user interface enables the user to quickly master the individual functions.

Please read these instructions before commissioning the TAPCON® 260 D. The operator is responsible for ensuring that users of the device have fully understood the operating and safety instructions.

1.2 Manufacturer
The voltage regulator TAPCON® 260 D is manufactured by:
Maschinenfabrik Reinhausen GmbH
Falkensteinstrasse 8
93059 Regensburg, Germany
Tel.: (+49) 9 41/40 90-0
Fax: (+49) 9 41/40 90-6 00
E-Mail: sales@reinhausen.com

Further copies of these operating instructions are available from the above address, if required.
2 Safety

2.1 Safety instructions

Safety instructions for operating the TAPCON® 260 D voltage regulator are presented in three different forms in this manual. **These instructions must always be followed!**

Failure to follow the safety instructions may lead to accidents and severe personal injury.

What you should always do!

Read the operating instructions!

Please read these instructions before switching on the TAPCON® 260 D. As the operator, you are responsible for ensuring that users of the device have fully understood the operating and safety instructions.

Only let skilled personnel work with the TAPCON® 260 D!

The TAPCON® 260 D voltage regulator is designed exclusively for application in electrical or energy systems and facilities operated by appropriately trained staff, i.e. staff who are familiar with the installation, assembly, commissioning and operation of such products.

Train your staff!

Before asking staff to work with the TAPCON® 260 D, provide training about:
- the general and special safety instructions
- the accident prevention regulations
- the specified use of TAPCON® 260 D
2.2 Safety instructions for TAPCON® 260 D

**WARNING**

**Transformer test!** If the 19-inch electronics sub-rack is installed in the ED motor-drive unit, ensure that the supply and control lines leading to the motor-drive are disconnected directly at the motor-drive before carrying out lightning and max. admissible voltage tests for the transformer.

**WARNING**

**Fire hazard!** All relevant fire protection regulations must be strictly observed.

**WARNING**

**Risk of electric shock!** Ensure that the TAPCON® 260 D is connected and its housing earthed with due care. Otherwise there is an increased risk of electric shock when working on live parts.

**CAUTION**

**Risk of injury!** For safety reasons, no unauthorized and improperly executed work, i.e. installation, modification, alteration of the equipment, electrical connection, or commissioning of the equipment, is permitted without first consulting MR.

2.3 Warranty and liability

Warranty and liability claims for personal injury or damage to property are excluded, if they were caused by one or more of the following:

- Inappropriate use of the TAPCON® 260 D.
- Improper commissioning and operation of the TAPCON® 260 D.
- Operation of TAPCON® 260 D with safety equipment that is faulty, or with safety or protection equipment that is installed incorrectly or non-functioning.
- Non-adherence to the notes in the operating instructions with regard to installation, commissioning and operation of the TAPCON® 260 D.
- Unauthorized modification of the TAPCON® 260 D.

2.4 Specified application

The TAPCON® 260 D is used for automatic control of transformers with motor-driven on-load tap-changer. The motor-drive mechanism receives the corresponding control signals from the voltage regulator. With these signals, the on-load tap-changer moves to the next position and the transformer's voltage value is adapted to the preset desired voltage level.

To allow individual adaptation of the control system to the various field service conditions encountered, influencing variables such as:

- Time delay
- Bandwidth
- line or load-dependent parameters for compensating voltage drops
- voltage or current-dependent limits can be programmed.

As a special feature, the TAPCON® 260 D is also capable of controlling parallel transformer operation.
3  Description of the device

The individual components are mounted in a standardized 19-inch rack. The front plates of the components are fixed to the rack at the top and at the bottom. Electrical connection is provided by plug connectors according to DIN 41612. The components are connected to each other via data bus and separate DC supply, making it very easy to retrofit the system with additional plug-in modules or extension modules at any later date, if required.

The front panel of TAPCON® 260 D contains an LCD graphic display, several LED lamps and several function keys and menu keys.

The device is controlled by a microcontroller (see Appendix, block/connection diagram). Besides a voltage transformer and a current transformer it contains opto-coupler inputs with potential separation as well as potential-free output relay contacts.

The parameters of the TAPCON® 260 D can be set via a PC and an integrated serial interface (COM 1 or RS232) installed at the front panel; the associated software is included in the scope of supply. The functions of the TAPCON® 260 D voltage regulator are largely compatible with those of the earlier voltage regulator generations.

3.1 Technical Data

Tolerances

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply (VT secondary side)</td>
<td>± 0.5 V</td>
</tr>
<tr>
<td>Voltage regulation</td>
<td>± 1.0 V</td>
</tr>
<tr>
<td>Undervoltage (pick-up)</td>
<td>± 1.0 V</td>
</tr>
<tr>
<td>Overvoltage (pick-up)</td>
<td>± 1.0 V</td>
</tr>
<tr>
<td>Overcurrent (pick-up)</td>
<td>± 2.5 % of measured current</td>
</tr>
<tr>
<td>Transducers</td>
<td>± 0.4 mA</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>± 0.15 % concerning setting value</td>
</tr>
<tr>
<td>Pulse duration time</td>
<td>± 0.2 s</td>
</tr>
<tr>
<td>Delay time T1</td>
<td>± 2.0 s</td>
</tr>
<tr>
<td>Delay time T2</td>
<td>± 0.5 s</td>
</tr>
<tr>
<td>Message delay time for undervoltage</td>
<td>± 1.0 s</td>
</tr>
</tbody>
</table>
### Setting ranges

<table>
<thead>
<tr>
<th>Setting ranges</th>
<th>Step width</th>
<th>Standard factory settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desired voltage level 1</td>
<td>0.1 V</td>
<td>100 V</td>
</tr>
<tr>
<td>Desired voltage level 2</td>
<td>0.1 V</td>
<td>100 V</td>
</tr>
<tr>
<td>Desired voltage level 3</td>
<td>0.1 V</td>
<td>100 V</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>0.01 %</td>
<td>1 %</td>
</tr>
<tr>
<td>Delay time 1</td>
<td>1 s</td>
<td>40 s</td>
</tr>
<tr>
<td>Delay time 2</td>
<td>1 s</td>
<td>10 s</td>
</tr>
<tr>
<td>Switching pulse duration</td>
<td>1.5 s</td>
<td>1.5 s</td>
</tr>
<tr>
<td>LDC</td>
<td>0.1 V</td>
<td>0 V</td>
</tr>
<tr>
<td>With optional Z-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compensation selection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage rise 0 to 15 % of desired</td>
<td>0.1 %</td>
<td>0 %</td>
</tr>
<tr>
<td>voltage level</td>
<td>0.1 %</td>
<td>0 %</td>
</tr>
<tr>
<td>limitation 0 to 15 % of desired</td>
<td>0.1 %</td>
<td>0 %</td>
</tr>
<tr>
<td>voltage level</td>
<td>0.1 %</td>
<td>0 %</td>
</tr>
<tr>
<td>Undervoltage blocking</td>
<td>60 to 100 %</td>
<td>1 %</td>
</tr>
<tr>
<td>of desired voltage level</td>
<td>90 %</td>
<td></td>
</tr>
<tr>
<td>Overvoltage detection</td>
<td>100 to 140%</td>
<td>1 %</td>
</tr>
<tr>
<td>of desired voltage level</td>
<td>110 %</td>
<td></td>
</tr>
<tr>
<td>with high-speed return control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pulse signal 1.5 / 1.5 s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(interruptible)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overcurrent blocking</td>
<td>50 to 210 %</td>
<td>1 %</td>
</tr>
<tr>
<td>Voltage transformer</td>
<td>0 to 999,0 kV/100 V to 110 V</td>
<td>0 kV/100 V</td>
</tr>
<tr>
<td>Current transformer</td>
<td>100 to 10,000 A/5/1/0,2 A</td>
<td>no presetting</td>
</tr>
<tr>
<td>Measuring circuit</td>
<td>phase angle adjustable between U and I for 1-phase and 3-phase system according to CT/VT connection</td>
<td></td>
</tr>
<tr>
<td>Function monitoring</td>
<td>15 min.</td>
<td>On</td>
</tr>
</tbody>
</table>

\(^1\) including max. possible limit values
3 Description of the device

Control elements, display

Function keys
- Manual / automatic control mode
- Raise / lower
- Menu keys
- Remote / supervisory

Display
- Monochromatic 128 x 128 dot display with graphics capacity
  - 1 LED lamp (green) operation display
  - 1 LED lamp (red) each for signalling U<, U>, I>
  - 1 LED (yellow) for signalling parallel operation active
  - 1 LED lamp (green) for signalling "Normset active" status
  - 3 LED lamps (yellow) for master, follower and independent
  - 1 LED lamp (green/red) for MDU local

Inputs and outputs

<table>
<thead>
<tr>
<th>Input relays</th>
<th>Output relays:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1x raise</td>
<td>1x raise</td>
</tr>
<tr>
<td>1x lower</td>
<td>1x lower</td>
</tr>
<tr>
<td>1x manual control mode</td>
<td>1x manual control mode</td>
</tr>
<tr>
<td>1x automatic control mode</td>
<td>1x automatic control mode</td>
</tr>
<tr>
<td>1 x master</td>
<td>1x status</td>
</tr>
<tr>
<td>1 x follower</td>
<td>1x group alarm U&lt;, U&gt;, I&gt;</td>
</tr>
<tr>
<td>tap-change incomplete</td>
<td>1x function monitoring</td>
</tr>
<tr>
<td>AVR-VT supply absent</td>
<td>1x parallel operation active</td>
</tr>
<tr>
<td>TC motor supply faulty</td>
<td>1x parallel operation disturbed</td>
</tr>
<tr>
<td>TC control supply faulty</td>
<td>1x master</td>
</tr>
<tr>
<td>tap position</td>
<td>1x out of step</td>
</tr>
<tr>
<td>topology</td>
<td>MR signalling red</td>
</tr>
<tr>
<td>MDU remote</td>
<td>MR signalling yellow</td>
</tr>
<tr>
<td>motor drive in progress</td>
<td>user signalling red</td>
</tr>
<tr>
<td></td>
<td>user signalling yellow</td>
</tr>
<tr>
<td></td>
<td>extreme tap</td>
</tr>
<tr>
<td></td>
<td>tap-change incomplete</td>
</tr>
<tr>
<td></td>
<td>MDU L/R to SCS</td>
</tr>
<tr>
<td></td>
<td>TC motor supply faulty</td>
</tr>
<tr>
<td></td>
<td>TC control supply faulty</td>
</tr>
</tbody>
</table>

AD card Input parameters:
- 0 ... +20 mA
- 4 ... +20 mA
- 0 ... +10 V

- potentiometer contact series, 50 Ω ... 2 kΩ

- Input "V" → input resistance = 2 MΩ
- Input "mA" → input resistance = 250 Ω
- Input "Ω" → input resistance = 2 MΩ
3 Description of the device

AN card
Output parameters: 0 ... ±20 mA
0 ... ±10 mA
0 ... ±1 mA
0 ... ±10 V
Max. admissible working resistance at ±20 mA: 500 Ω (short-circuit-proof)
Max. admissible working resistance at ±10 mA: 1 kΩ (short-circuit-proof)
Max. admissible working resistance at ±1 mA: 10 kΩ (short-circuit-proof)
Max. admissible working resistance at ±10 V: 10 kΩ (not short-circuit-proof)

AC card
This auxiliary card is used for converting the 230 V AC supply into an auxiliary voltage of approximately 60 V DC, which is used for the digital inputs of the UC and IO card, for example.

UC card
Inputs: 48 ... 250 V DC
Outputs: 30 V, 5 A DC
110 V, 0.4 A DC
220 V, 0.3 A DC
250 V, 5 A AC

IO card
Inputs: 48 ... 250 V DC
Outputs: 30 V, 5 A DC
110 V, 0.4 A DC
220 V, 0.3 A DC
250 V, 5 A AC

Voltage transformer
85 to 140 V, measuring range 60 ... 185 V,
r.m.s. value 40 to 60 Hz, intrinsic consumption < 1 VA

Current transformer
0.2 / 1 / 5 A, 40 ... 60 Hz, r.m.s. value
intrinsic consumption < 1 VA,
overload capacity 2 x In continuously, 40 x In/1 s

Measuring error
Voltage measuring: < 0.3 % ± 40 ppm/°C
Current measuring: < 0.5 % ± 40 ppm/°C

Serial interfaces
1x serial interface RS232 (COM1 on the front plate) for parametering via PC
1x CAN bus for parallel operation optional terminating impedance at both ends: 120 Ω
RJ45 for connection to SCADA

Clutches
MI-card, CT-connection 4 mm²
MI-card, VT-connection 2.5 mm²
SU-card 2.5 mm²
IO-card 2.5 mm²
AC-card 2.5 mm²
UC-card 2.5 mm²
AN-card 2.5 mm²
AD-card 2.5 mm²
3 Description of the device

Power supply
- DC 18 to 72 V
- AC, DC 93 to 265 V
Consumption: approx. 45 VA ± 2 VA dependent on active relays and functions (measurable one minute after start of device)

Protective housing
- 19-inch module frame according to DIN 41 494 Part 5
- Dimensions: 483 x 133 x 178 mm (W x H x D)
- Degree of protection: IP 00 according to IEC 60529
- Weight: approx. 5 kgs

Temperature limits
- Admissible ambient temperature for operation: -25 °C to + 70 °C
- Admissible ambient temperature for storage and transport: -30 °C to +85 °C

Tests

Electrical safety
- Protection class 1 in accordance with IEC 60536
- Protection rating IP00 in accordance with IEC 60529
- Degree of soiling 2 in accordance with IEC report 664-1
- Overvoltage category III in accordance with IEC report 664-1
- Fulfills IEC 60688
- EN 61010-1 Safety provisions governing electrical measurement, control, regulation and laboratory equipment.
- Dielectric test with operating frequency of 2.5 kV/1 min
- IEC 60255 Dielectric test with surge voltage, 5 kV, 1.2/50 μs

Electromagnetic compatibility
- IEC 61000-4-2 Interference immunity against electrostatic discharge with 6/8 kV
- IEC 61000-4-3 Interference immunity against HF fields with 10 V/m, 80 to 1000 MHz
- IEC 61000-4-4 Interference immunity against bursts with 2 kV
- IEC 61000-4-5 Interference immunity against surges with 2 kV
- IEC 61000-4-6 Interference immunity against HF on lines with 10 V, 150 kHz to 80 MHz
- IEC 61000-4-8 Interference immunity against magnetic fields with 30 mA/m, 50 Hz, continuous
- IEC 61000-4-11 Interference immunity against voltage drops with AC supply: 30 % / 0.5 period 60 % / 5 periods; with DC supply 100 % / 10 ms and 60 % / 100 ms
- EN 61000-6-2 CE conformity
- EN 61000-6-4 CE conformity

Temperature and climate resistance
- IEC 60068-2-1 Dry cold, -25 °C / 20 hours
- IEC 60068-2-2 Dry heat, +70 °C / 16 hours
- IEC 60068-2-3 Moist heat, constant, +40 °C / 93 % / 2 days, no moisture condensation
- IEC 60068-2-30 Moist heat, cyclic (12 + 12 hours) + 55 °C / 93 % / 6 cycles
3 Description of the device

Installation drawing, 19-inch mounting rack
3.2 Description of the front panel

The TAPCON® 260 D is equipped with a key lock to protect against unintentional operation. For activation/deactivation, simultaneously press the keys ESC (fig. 1) and F5 (fig. 1). More details of the function keys will be given further on.

1 - Manual setting of display contrast
2 - LEDs
3 - Function keys
4 - Menu
5 - Cancel
6 - Enter
7 - Changing screens within the same level (arrow keys)
8 - Automatic voltage regulation
9 - Manual
10 - Remote / Supervisory
11 - Raise / Lower control

Fig. 1 TAPCON® 260 D control panel
3.3 Description of the display

Status line
In case of a special occurrence or in case of a setting, the corresponding occurrences will be displayed blinking in the status line.

The following status or occurrences will cause information to be displayed in the status line (please refer also to chapter 9):
- Undervoltage
- Overvoltage
- Overcurrent
- Failure Par. Contr.
- No OLTC-position
- Tap changer in extreme pos.
- Tap change incomplete
- Out of Step
- TC motor supply faulty
- TC control supply faulty
- AVR VT supply absent
- Tap change recognition
- Master
- Follower
- Independent

3.4 Description of the function keys (see fig. 1)

Keys F1 ... F5
are used to navigate the sub-groups or input screens

Auto mode
is used for automatic voltage regulation

Manual mode
For parameterization of the TAPCON® 260 D and for manual control of the on-load tap-changer.

REMOTE / SUPRY
If SUPERVISORY is displayed:
Control via the IEC 61850 operations control system protocol
If REMOTE is displayed:
1. Control via TAPCON® inputs (DCS)
2. Control via TAPCON®
   No display: Control only via motor-drive unit

ESC
The ESC key takes you back to a higher level.

MENU
This key takes you back to the initial screen.

Arrow keys
In Auto and Manual mode, the arrow keys can be used for changing the "Measured value display" (see display) and for navigating between the sub-groups.

Raise/Lower keys
In manual mode (diagram), the on-load tap-changer can be operated directly via the Raise/Lower keys (changing the step voltage).

Enter key
For confirming / entering a modified parameter in the setup menu (see chapter "Parametering").

Serial interface COM 1
For connecting the TAPCON® 260 D voltage regulator with a PC. The associated parameterization software is included in the scope of supply.
3.5 Basic screen display showing current measuring values

The basic screen display on the monitor shows the desired and actual voltage rates in V or kV, the system deviation rate, and the current tap-change position. You can set the unit to V or kV.

TAPCON® 260 D offers several options for setting the display unit to kV or V. You can convert all values via the "kV/V Display" submenu or specify the unit via the individual input screens for the desired values.

![NOTE](image)

Please note that the correct display of the primary voltage depends on the correct entry of the potential transformer data (see chapter CT/VT data).

3.6 Raise/Lower control

The tap position can only be changed in "Manual" mode. In "Manual" mode, the motor-drives can be set higher or lower by pressing the "Raise" or "Lower" key.

3.7 Special operating reliability for TAPCON® 260 D

The TAPCON® 260 D control panel is sub-divided into two levels (so-called security levels). We refer to them as operation control level and protected level for parameterization. The operation control keys are clearly separated from those for parameterization. In addition, all requests for user action are indicated via LEDs (visual feedback).

The LEDs integrated in the "Raise"-"Lower"-keys are illuminated over the complete duration of the on-load tap-changer operation. This visual monitoring facility makes operation of the TAPCON® 260 D easier.

Digital protection and control devices such as TAPCON® 260 D are normally password-protected. Due to the significant number of digital devices found in transformer stations, our developers deliberately avoided the allocation of a password in the interest of clarity.

TAPCON® 260 D parameters can only be changed in manual mode. Switching to manual mode represents an operation control action and is associated with feedback to the control room. Operation / parameterization of the TAPCON® 260 D can thus be monitored seamlessly without password.
4 Voltage regulation of transformers with TAPCON® 260 D

Voltage regulation for transformers with on-load tap-changers is an important issue for energy supply companies. According to DIN-IEC 38, the 230 V/400 V voltage in the public low-voltage grid has to be kept constant with an accuracy of at least ± 10 %. TAPCON® 260 D makes this control task simple and straightforward. The TAPCON® 260 D voltage regulator continuously compares the actual value $U_{\text{actual}}$ (output voltage at the transformer) with a fixed or load-depending desired voltage level $U_{\text{desired}}$ that you can specify.

Depending on the difference between actual and desired value, TAPCON® 260 D provides the actuating pulse for the on-load tap-changer of the transformer. The on-load tap-changer switches if the actual value falls outside the preset bandwidth ($U_{\text{desired}}$ $\pm$ B%). 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 behaviour, so that a balanced control response with minimum number of on-load tap-changer operations is achieved.

All you have to do is enter the desired voltage level and the potential transformer ratio via the standard NORMset function. TAPCON® 260 D automatically deals with the rest.

Separate transformer signal converters are no longer required. These included, for example, programmable multi-signal converters or analog signal converters for transmission of measured current, voltage, active power and reactive load values. All these functions can now be integrated in the TAPCON® 260 D digital voltage regulator.

The additional “measuring value recorder” module (8 MB capacity) can be used to store and display valuable measuring values.

All measured data can also be displayed and analysed on your PC via the software included:

- Measured values:
  - on-load tap-changer positions
  - voltage
  - active current
  - reactive current

- Calculated values:
  - active power
  - reactive load
  - apparent power
  - power factor

The TAPCON® 260 D enables you to set and monitor the on-load tap-changer positions directly in manual mode. Separate tap position displays directly at the transformer are therefore no longer required.

4.1 Parallel operation of tapped transformers

Transformer control is relatively clear and easy to handle. The situation is less clear if transformers are operated in parallel. Safe and economic parallel operation of transformers can only be ensured if their performance capability, i.e. their rated power, can be utilized fully and without overloading an individual transformer.

NOTE

On the primary side, the transformers must be connected to the same voltage, and the voltages on the secondary side must have the same magnitude and angle. The transformers should therefore meet the following criteria:

- comparable output
- same vector group
- same rated voltage and comparable voltage ratios
- comparable relative short-circuit impedance

There are several good reasons for operating transformers in parallel. TAPCON® 260 D was therefore developed further and optimized for this mode of operation.

Reasons include:
1. Higher short circuit capacity
2. Higher throughput

However, parallel operation requires special control measures for minimizing equalizing currents (circulating reactive currents) between the transformers.

The formation of circulating currents is described in the following chapter. Under adverse conditions, circulating currents $I_{kr}$ may lead to overload or uneconomic operation of transformers.
4.1.1 Formation of circulating currents

With unequal no-load voltages \( U_1 \neq U_x \), the differential voltage \( \Delta U = U_1 - U_x \) as an EMF (electro-motive force) causes a current to flow through the windings of the transformers operated in parallel. This current is independent of the load current.

Unequal no-load voltages occur if the angle and/or magnitude of the voltages differ.

The magnitude and angle of the circulating current is determined by the short-circuit impedances \( Z_K \) (in series) of the transformers operated in parallel, including the impedance of the connecting lead between the transformers. The impedance of the load is negligible, because this circulating current flows through the transformers even in the absence of a load.

The circulating currents \( I_{Kr} \) depend on the short-circuit impedances \( Z_{K1} ... Z_{Kx} \) and the differences between the no-load voltages \( U_1 - U_x \).

\[
I_{Kr} = \frac{U_1 - U_x}{Z_{K1} + Z_{K2}}
\]

**Definition:**

- \( U_1 ... U_x \): no-load voltages
- \( I_{Kr1} ... I_{Krx} \): circulating currents
- \( Z_{K1} ... Z_{Kx} \): short-circuit impedance

The formation of circulating currents is represented in the following figure.

The short-circuit impedances \( Z_{K1} ... Z_{Kx} \) of the transformers are usually very low. This results in considerable circulating currents \( I_{Kr} \).

In this example we assume that the driving voltage \( U_1 \) is greater than \( U_2 \) to \( U_x \).

\( U_1 > U_2, U_x \)

![Parallel operation of transformers - equivalent circuit diagram](Fig. 5)
4 Voltage regulation of transformers with TAPCON® 260 D

4.1.2 Parallel operation with TAPCON® 260 D

TAPCON® 260 D enables control of sixteen transformers operated in parallel in one or two groups. Parallel operation is managed via the CAN bus. Parallel operation is activated via one of two status inputs or via a control system. This ensures that the TAPCON® 260 D knows in which group the associated parallel-operated transformer is located.

For safe and economic parallel operation of transformers, TAPCON® 260 D has to ensure the following operating conditions of the transformers:

1. Avoidance or minimization of circulating currents
2. Avoidance of an unequal transformer load

Different control techniques are used for meeting these requirements. These techniques are described below:

4.1.2.1 Master/Follower principle
(synchronism control of tap-changer)

With this technique, one controller takes on a master function. This regulator is assigned overall control (master), while the other regulators (followers) execute its control commands. Via the CAN bus the master compares the tap position of the followers with its own tap position. If a tap position deviation is detected, the master ensures that the followers are brought to the same tap position.

4.1.2.2 Master/Follower principle
(automatic synchronism)

This technique is a special form of the master/follower technique. Even in the event of the specified master regulator failing, the power supply of the customer is not interrupted. The TAPCON® 260 D automatically assigns the regulator with the lowest CAN bus address as master.

4.1.2.3 Circulating reactive current principle

This technique is suitable for transformers with comparable power and voltage rating, impedance voltage and vector group with identical or different step voltage. The tap position of the transformer is irrelevant.

The circulating reactive current is calculated via the transformer currents and their phase angles at the supply and minimized through specific adjustment of the on-load tap-changer.

4.2 Description of the main variables and functions for voltage regulation

In order to be able to fully utilize the benefits offered by TAPCON® 260 D right from the start, this chapter describes the main voltage regulation parameters and functions.

4.2.1 Desired voltage level \( U_{\text{desired}} \)

The desired voltage level is specified as a fixed value. The desired voltage level can be specified via the TAPCON® 260 D user interface in the NORMset mode sub-group or in the parameter mode sub-group.

The TAPCON® 260 D keeps the voltage at the transformer constant. You can set the desired voltage level to be displayed in kV or V. Accordingly, the TAPCON® 260 D compares the desired voltage level with the primary voltage (kV) or the secondary voltage (V) of the potential transformer.

The TAPCON® 260 D offers various further options for changing the desired voltage level during operation.

4.2.1.1 Voltage level change via analog input

Via the analog input, you can change or adjust the desired voltage levels as follows:

- potentiometer: 50 Ohm ... 2k Ohm
- small signal current: -20 mA ... +20 mA
- small signal voltage: 0 V ... 10 V

**NOTE**

Please ensure that each regulator has an address number assigned via the “CAN address submenu”. Only once all controllers have been picked up can they communicate with each other via the CAN bus and use the “automatic synchronism” technique.
4.2.1.2 Binary inputs (standard)

Up to three desired voltage levels (only possible in parameter mode) may be entered – desired voltage level 1 (2/3).
Desired voltage level 1 is usually used as reference value.
Desired voltage levels 2 or 3 are activated in the presence of a continuous signal at the IO-X1/17 or IO-X1/16 input. If a signal is present at both inputs, desired voltage level 2 will be active.

4.2.1.3 BCD-coded voltage level change

Optionally, the desired voltage level may be specified via binary inputs. Further information is available on request.

4.2.2 Bandwidth "B %"

If the measuring voltage, i.e. the measured actual value, falls outside the specified bandwidth (deviation \( \Delta U \)), after the set delay time \( T_1 \) an output pulse is issued, and the on-load tap-changer switches up or down accordingly.

The bandwidth, i.e. the positive and negative percentage deviation from the desired voltage level \( (U_{\text{desired}} \pm B \%) \) should be chosen such that the output voltage of the transformer \( (U_{\text{actual}}) \) does not exceed the specified bandwidth limits after the tap-change operation. Violation of the bandwidth would immediately cause a reversed tap-change operation in order for the system to return to the tolerance range of the defined bandwidth. This procedure would be repeated continuously, i.e. the result would be frequent tap-change operations and undesirable fluctuations of the line voltage.

Guide value for the bandwidth:

Normally, the following value is recommended for the bandwidth \( B \% \):

\[ \left[ \pm B \% \right] \geq 0.6 \times \Delta U_{\text{step}} \]

Example for determining the permissible bandwidth:

Voltage rating: \( U_{\text{nom}} = 100 \text{kV} \)
Number of tap positions: ±15 (= 30 steps)
Setting range: 85 kV ... 115 kV
Step voltage: \( (115 \text{kV} - 85 \text{kV}) / 30 \text{ steps} = 1 \text{kV} / \text{step} \)

Thus 1 kV/step corresponds to value 1% of \( U_{\text{nom}} \).

**NOTE**

You may set the bandwidth "B %" at the TAPCON® 260 D from 0.5 % to 9 % in steps of 0.01 %. The transformer's step voltage must be known to ensure proper setting of this value (see example).

For increased regulating sensitivity it is also possible to set lower values, although it is highly unadvisable to go below 60 % \( \left[ \pm B \% \right] \geq 0.6 \times \Delta U_{\text{step}} \) of the computed value.
4.2.3 Control delay: T1 and T2

Delay time T1:
A violation of the specified bandwidth is referred to as deviation $\Delta U$, in which case the regulator starts to respond. In order to avoid unnecessary switching operations caused by short-term violation of the bandwidth, the TAPCON® 260 D features a delay time option. The duration of this delay is specified via the delay time parameter T1. A gradually filling time bar indicates the time left until the start of the control operation.

If the deviation is still present after the delay time has elapsed, an output pulse is issued, and the on-load tap-changer initiates a switching operation.

If the deviation returns to within bandwidth limits during the delay time T1, the delay time is decremented. The bar in the time diagram is shown hatched and becomes gradually smaller. No tap-change operation occurs. The benefit of decrementing is that the regulator does not keep counting from 0 sec. if the bandwidth is exceeded regularly. Instead, the time already elapsed is used as a measure for the start of the subsequent delay time. The TAPCON® 260 D meets the requirements of fast and optimized control response.

Via the submenu "T1 control response", the delay time T1 can be set with linear or integral response.

Linear time:
The regulator responds with a constant delay time, independent of the deviation.

Integral time:
Depending on the deviation, the response time of the regulator is reduced to a minimum of 1 sec. i. e. the greater the deviation ($U_{actual}$ from $U_{desired}$ +/- B %), the shorter the response time. The TAPCON® 260 D can thus respond more quickly to unexpectedly large voltage changes in the grid. Control accuracy is increased.

Delay time T2:
In rare cases, more than one tap-change operation is required for returning the transformer output voltage to within the specified bandwidth "B %". However, particularly with integral control response this would mean that the time until an output pulse is issued would increase with each tap-change operation. This behaviour can be counteracted by using delay time T2. The first output pulse is issued after the specified delay time T1. Further pulses required for stabilization are issued after the specified delay time T2, usually between 10 and 15 sec.

$\Delta U / E$ - voltage change $\Delta U$ in % of the desired value, in relation to the set bandwidth in % of the desired voltage level.
4.2.4 Line compensation: LDC and Z compensation

The energy supply quality at the customer not only depends on the busbar voltage of the supply transformer (measured value $U$), but even more on the voltage directly at the customer equipment.

In selected cases, voltage regulation has to take account of the feeder impedance (in the cables or overhead lines to the customers). These feeder lines may be subject to a significant (load-dependent!) voltage drop.

This voltage drop depends on the impedance of the line, the current and the phase angle $\varphi$ at the consumer.

The TAPCON® 260 D offers two different options for compensating load-dependent voltage drop between transformer and consumer.

a) Line Drop Compensation (LDC) requires knowledge of the exact line data. LDC offers accurate compensation of line voltage drops.

Correct setting of the LDC requires calculation of the resistive and inductive line voltage drop in relation to the secondary side of the voltage transformer in V and the correct setting of the existing measuring transformer configuration.

b) Z compensation can be used in case of minor shifts of the phase angle $\varphi$, also in meshed network applications.

Correct setting of the Z compensation requires calculation of the voltage increase $\Delta U$ taking account of the magnitude of the current.

5 Additional performance characteristics of TAPCON® 260 D

5.1 NORMset

The NORMset function is an automatic mechanism that considerably simplifies configuration of a TAPCON® 260 D. For starting the device, you simply have to enter the desired voltage level, the primary and secondary voltage and, if necessary, the potential transformer data. Depending on whether kV or V has been specified as the unit, the desired voltage level is compared with the primary or secondary voltage of the potential transformer. The correct application depends on the correct entry of the potential transformer data. If the desired voltage level is entered while the NORMset function is active (LED illuminates green), the TAPCON® 260 D will examine the given line/network conditions and proceed to perform an automatic adaptation of all further inputs (comprised in part of the pre-parametering and standard reference values) which used to be required for conventional regulators.

5.2 Protection functions

Trouble-free operation is ensured by the regulator’s inherent undervoltage blocking or overcurrent blocking (“$<U$” and “$>I$”) and overvoltage monitoring (“$>U$”).

Entering the limit values:

For undervoltage and overvoltage, the limit values in percent % refers to the desired voltage level $U_{\text{desired}}$. For undervoltage and overvoltage, the limit value in kV or V refers to the primary or secondary voltage of the potential transformer.

For overcurrent, the limit value in percent % or A refers to the set rated current of the current transformer.

The undervoltage threshold is superposed by a hysteresis function as outlined in the diagram below:

Explanation:

1. Activation if the signalling threshold is reached, i.e. if a value falls short of the defined ranges
2. Deactivation if the defined limit value is exceeded
5 Additional performance characteristics of TAPCON® 260 D

Taking a "U< %" setting of 90 % and a hysteresis value of 3 % as hypothetic examples, the following behaviour would ensue:

- Emission of a "U<" signal as soon as the voltage falls below 90 %
- Continuation of the "U<" signal which will disappear only after the voltage has again risen above 93 %

The same mechanism applies to hysteresis functions with values indicated in "Volt". Therefore, taking "U<" settings of 90 V and a hysteresis value of 3 V as a hypothetic example, the following behaviour would ensue:

- Emission of a "U<" signal as soon as the voltage falls below 90 V
- Continuation of the "U<" signal which will disappear only after the voltage has again risen above 93 V.

Important note:
The setting of the hysteresis value in percent is defined in the firmware at the time of order receipt.

5.2.1 Undervoltage blocking

Undervoltage blocking prevents tap-change operations in the event of a network breakdown.

The TAPCON® 260 D output pulses are blocked and the red LED "<U" illuminates as soon as the output voltage of the transformer falls below the set blocking value. After delay time of approx. 10 s, the associated signalling relay (contacts IO-X1/18; IO-X1/19; IO-X1/20) is energized and remains that way. The signalling relay will not respond in case of a failure of the transformer output voltage or supply voltage (< 30 V) (this standard setting can be deactivated - see Parameters Limit values also below 30 V).

5.2.2 Overcurrent blocking

Overcurrent blocking prevents tap-change operations in the presence of overload.

The voltage regulator output pulses are blocked and the red LED ">I" illuminates as soon as the load current falls below the set blocking value. The associated signalling relay (contacts IO-X1/18; IO-X1/19; IO-X1/20) is energized and remains that way.

5.2.3 Overvoltage detection

Overvoltage detection causes the on-load tap-changer to select an appropriate value for returning to the required operating state. The message "function monitoring" will be emitted if a regulating deviation lasting 15 min. is detected by the regulator which is not eventually compensated.

In the event of an overvoltage detection response, the on-load tap-changer keeps getting activated by periodic pulses to the motor-drive mechanism until the overvoltage falls below the response threshold.

The motor-drive mechanism is activated by periodic pulses of 1.5 s through the "Lower" output relay (can be set in the menu - see Configuration General Raise/Lower pulse length).

In this case, "Delay time T1" is not active. The red LED ">U" illuminates as long as overvoltage is present.

If the voltage regulator regulates towards a higher voltage than the set limit "U>" due to unfavourable parametering (e. g. LDC settings too high), it is prevented from exceeding the limit. The signalling relays (contacts IO-X1/18; IO-X1/19; IO-X1/20) are only activated as long as an overvoltage is present.

5.2.4 Detection of the off-status of the transformer

The TAPCON® 260 D is able to detect the off state of the transformer and to prevent regulating operations independently. The user can set the voltage threshold.

5.3 TAPCON® 260 D without "long-term memory"

The TAPCON® 260 D voltage regulator is equipped with a short-term memory allowing a limited number of voltage and tap positions to be stored.

With a high-resolution scanning rate, it is possible to record the history of the voltage positions and on-load tap-changer positions for the last eight minutes.

The voltage curve and the change in tap positions can be visualised via the visual display software included in the delivery.

Without the long-term memory module (8 MB), the display has a memory capacity for up to 1,000 values. The data are read into this memory at a maximum resolution. This has the effect that whenever the subdivision is changed, the recorded graph no longer goes all the way to the left edge of the graph chart recorder. For settings where more values are available than can be displayed, it is possible to „shift“ the screen into the past. However, this is admissible only to the extent that the graph is still visible across the entire screen. After being shifted, the display stalls at the desired value and stops moving altogether. It is “frozen”. Press the "F1" or "F2" function keys to switch back and forth between one entire page at a time.
6 Commissioning

6.1 Installation
The standardized module frame of the TAPCON® 260 D (see appendix) is intended for installation in a 19-inch control cabinet. The swing frame design is recommended as it offers easier access to the terminal at the back.

6.2 Connection
Connect the TAPCON® 260 D in accordance with the wiring diagram (see appendix).

![Diagram of TAPCON® 260 D]

**WARNING**
Ensure that the TAPCON® 260 D is connected and the housing earthed with due care. Otherwise there is a risk of electric shock.

**NOTE**
Pay attention to the correct phase angle of the secondary terminals of current transformer and voltage transformer.

![Diagram of Earthing connection for the interface cable screen]

**NOTE**
Ensure correct connection of the output relays to the motor-drive unit.

By default, the X8 interface has no function. Instructions for using it are available on request. A PC can be connected via the visualisation software and the RS232 interface at the front panel.

In general, the TAPCON® 260 D is fed by an auxiliary voltage of 93 – 265 V AC, DC. The TAPCON® 260 D is optionally available with a supply input of 18 – 72 V DC.

The TAPCON® 260 D was developed in compliance with the relevant EMC standards. The following instructions must be observed to ensure preservation of the EMC properties:

- Ensure correct connection to ground of the TAPCON® 260 D by means of the ground screw attached to the housing
- Be sure to use only shielded cables for the data links from the TAPCON® 260 D to other equipment
- The screenings must be connected to ground via the cable clamps at the housing included in the delivery (see fig. 8: section of CPU card, bilateral grounding).

6.3 Easy setting of operating modes with NORMset
Prior to commissioning/initiation, be sure to check the entire switch configuration and the measuring and operating voltage. To assess the working mode of the TAPCON® 260 D, the use of a registering device to record the regulator voltage (actual value) is highly recommended. The related transformer should be subject to normal load.

a) Select the "Manual" operating mode at TAPCON® 260 D
b) Select the NORMset function as indicated
c) Set the desired voltage level 1.

default, you do not require the primary voltage to be displayed in kV, you may now proceed to initiate the regulator by operating the "Auto" function key. If you do require the voltage to be displayed in kV, please proceed as follows:
d) Set the rated transformer voltage and the rated current (see chapter "CT/VT data").
e) Change the display to kV.
Start the regulator via the “Auto” function key.
6 Commissioning

6.4 Function checks, operational settings for individual operation

Prior to commissioning/initiation, be sure to check the entire switch configuration and the measuring and operating voltage. To assess the working mode of the TAPCON® 260 D, the use of a registering device to record the CT/VT voltage (actual value) is highly recommended. The related transformer should be subject to normal load.

a) Select the "Manual" operating mode at TAPCON® 260 D.
b) Set the transformation ratios of the CT/VT, as well as the measuring circuit.
c) Let the measured actual voltage (= voltage from the voltage transformer) be indicated on the display of the TAPCON® 260 D.
d) Let the current, power, and phase angle values be indicated on the display and compare these values with those from possibly existing service measuring instruments. If wrong signs are indicated, reverse the polarity of the current or voltage transformer.

Please note that the factory presetting for the current transformer is 0 Ampere! To ensure proper display of the correct operating values, please be sure to enter the primary rated transformer current in the menu "Configuration → CT/VT data → primary current".
e) Set the desired voltage level. By manual control of the motor-drive, bring the tap-changer to the service position so that the desired voltage level is obtained.
f) Set the desired voltage level to this value.
g) Set the bandwidth to 1.0 %. In most cases the TAPCON® 260 D is now in a balanced state (no presignal). Otherwise change the desired voltage level in steps of 0.1 V until a balanced state is reached.
h) Set the bandwidth in dependence of the step voltage.
i) Set the delay time T1 to 20 s linear; by manual control, move the tap-changer towards "Raise" by one step.

Set the mode of operation to "Auto". The time bar fills up from bottom to top while the time is simultaneously displayed above the time bar until activation of the on-load tap-changer. After a period of 20 s the TAPCON® 260 D must control the on-load tap-changer back to its previous service position.
At that point the bar graph display moves back into the normal position.

Set the mode of operation to "Manual". Repeat the control procedure towards "Lower".

Set the operating delay time T2 to 10 s. Set the mode of operation to "Manual". By manual control, move the tap-changer towards "Raise" by two steps.

Set the mode of operation to "Auto". After a period of 20 s the TAPCON® 260 D must automatically control the on-load tap-changer back to its previous service position by one step and after further 10 s by another step.

Set the delay times T1 and T2 to the desired value. If T2 is not utilized, the "Off" setting will be required.

When putting the transformer into service, it is recommended to set the delay time T1 provisionally to 100 s. Depending on the existing operating conditions, you may want to determine the definitive setting only after some time of observation. For this purpose it is recommended to register the variation of the actual voltage and the number of tap change operations on a day-to-day basis. If an inverse response of the TAPCON® 260 D is desired, set an integral time response for the delay time 1.

If an inverse response of the TAPCON® 260 D is desired, set an integral time response for the delay time 1. In this case the delay time is automatically shortened inversely proportional to the deviation.

k) Set the response threshold for undervoltage blocking U< to 85 %. Set the mode of operation to "Manual" and set the existing voltage level, e.g. 110 V to 110 V / 0.85 ≈ 95 V so that the actual voltage now corresponds to the set percentage of the response threshold for the blocking value. Set the mode of operation switch to "Auto". The output relay "Raise" must not issue a control command. After approx. 10 s the signalling relay "U <" must be energized; the signalling contact (IO-X1/18 and IO-X1/19) will open. LED "U<" will now respond. Upon completion of this function test you may now set the desired response threshold for undervoltage blocking.

l) Set the response threshold for overvoltage detection "U>" to 115 %. Set the mode of operation to "Manual", e.g. 110 V to 110 V / 1.15 = 95 V so that the actual voltage now corresponds to the set percentage of the response threshold for overvoltage detection. The signalling contact (IO-X1/18 and IO-X1/19) opens. LED "U>" will now respond.

Set the mode of operation to "Auto". The output relay "Lower" must issue periodic control commands at 1.5 s intervals.

Now set the desired response threshold for overvoltage detection to the initially desired voltage level.
m) Set the response threshold for overcurrent blocking "I>". A function check is not necessary.
n) Setting the load drop LDC (the basic display with the deviation from the desired voltage level is required for this setting).

Set the mode of operation to "Manual".
Settings for $U_x = U_r = 0$ (deviation from desired voltage level $\rightarrow 0$).
Setting of $U_r = 20$ V, $U_x = 0$ V (deviation from desired voltage level $\rightarrow -$).
Setting of $U_r = -20$ V, $U_x = 0$ V (deviation from desired voltage level $\rightarrow +$) (during this function check the minimum load current of 10% of the rated current of the CT/VT must flow).

If the bar graph display moves in the opposite direction, change the polarity of the current transformer.

The actually desired load drop can be set upon completion of the above settings.

Set the mode of operation to "Auto".

Check if the setting is correct by observing the voltage at the line end during service and with different loads. When the setting is correct the voltage at the line end will remain constant.

o) Setting of Z-Compensation as an alternative to LDC.

Set the mode of operation to "Manual".

Set the voltage rise to 0, the TAPCON® 260 D is in a balanced state.

Setting Z-compensation limit = 15%.

Setting voltage increase = 15% (deviation from desired voltage level $\rightarrow -$ during this function check the minimum load current of 10% of the rated current of the CT/VT must flow).

The desired values for Z-compensation can be set upon completion of the above settings.

Set the mode of operation to "Auto". Check if the setting is correct by observing the stability of a certain point in the network with different loads. When the setting is correct the voltage at this point will remain constant.

p) Set the desired voltage level 2 to the desired value.

Set the mode of operation to "Manual" and connect L+ to IO-X1/16. The bar graph display must move in the direction of "Lower" or "Raise" according to the set value for desired voltage level 2, and the signal relay for desired voltage level 2 will respond (contact IO-X1/25 and IO-X1/26).

Please proceed in the same manner for desired voltage level 3 by connecting L+ to the IO-X1/17 signaling relay for desired voltage level 3 (contact IO-X1/23 and IO-X1/24). Set mode of operation to "Auto".

6.5 Function checks, operational settings during parallel operation
(see chapter Parallel operation settings)

NOTE

The prerequisite for the proper functioning of parallel operation is the commissioning of TAPCON® 260 D for individual operation.

The current transformer inputs must be connected and the CT/VT configuration must be parameterised correctly.

The TAPCON® 260 D must be set to identical operating parameters for the desired voltage, bandwidth, time delay $T_1$, and line compensation, if applicable (LDC or Z-Compensation, respectively).

In all cases, set stability to "0 %" and "Bandwidth Threshold" to "20 %".

During parallel operation, time delay 2 must never be set below 8 s!
All settings must be performed in the "Manual" operating mode.
Each regulator must be assigned an address of its own on the CAN bus (Menu "CAN address").

6.5.1 Parallel operation according to the principle of "circulating reactive current"

Setting the interference variable (Stability)

Individually set both transformers to identical voltage with the tap-changers so that both TAPCON® 260 D are in a balanced state (bar graph display in normal position, the indication of "dU %" must be as low as possible, i.e. lower than the preset bandwidth "dU max").

Now switch the transformers to parallel operation and enable parallel control. The TAPCON® 260 D must continue to remain in a balanced state, the LED lamp "parallel operation" on the front panel is lighting up.

Raise one of the two transformers by one voltage step and lower the other of the two transformers by one voltage step. Both regulators must continue to remain in a balanced state.

Upon modification of the setting value "Stability", the value of the efficiency will change in the last line of the help text. Now keep adjusting the stability until the display of the efficiency exceeds the preset value for the bandwidth by approx. 0.2 to 0.3 %. Now set this value at all TAPCON® 260 D engaged in parallel operation.
6 Commissioning

Select the "Auto" operating mode for both TAPCON® 260 D. Both voltage regulators must control the tap-changers back into their previous service positions.

If the previous service position cannot be achieved that way, the stability setting needs to be increased.

If the on-load tap-changers are regulating out of sync ("pumping"), this setting needs to be reduced.

**Setting the circulating reactive current monitoring (Bandwidth Threshold)**

Switch over one of the two TAPCON® 260 D to the "Manual" operating mode. Using the manual control, the associated motor-drive must now be reset to "Raise" by the maximum admissible difference of the service positions between the parallel operating transformers (e.g. by 1 ... 2 steps).

Starting with the preset value of "20 %", reset the bandwidth threshold towards a lower value in small steps until message "parallel operation disturbed" appears (please wait 2 - 3 s between the individual steps).

The bandwidth threshold of the circulating reactive current monitoring is reached as soon as the LED lamp lights up. All TAPCON® 260 D will block all further regulating actions and after 30 s (time can be adjusted) the signalling relay will respond (connection UC-X1/1 and UC-X1/2).

Now reset the bandwidth threshold again towards a higher value until the message “Parallel operation disturbed” disappears.

Again switch the TAPCON® 260 D back to the "Auto" operating mode. The motor-drive will be automatically controlled back to the original service position.

Use the value established for the bandwidth threshold to set it for all of the other regulators.

**Disturbances during parallel operation**

If one or all of the regulators signal "Parallel operation disturbed" even though the control inputs are properly connected for all regulators, the following causes may be present:

- Interruption of the data communication between the regulators. Check the data lead in that respect
- The second regulator is not functional
- Different methods of parallel operation were selected
- The bandwidth threshold of the circulating reactive current was exceeded
- Incorrect regulator addressing

The regulators will block under any of the above conditions.

6.5.2 Parallel operation in accordance with the principle of "Master/Follower tap synchronisation"

Select the corresponding method and determine which one of the regulators will assume master function and which of the regulators will assume follower function (see chapter Parallel operation settings).

6.5.3 Setting the time delay for the message "Parallel operation disturbed" (see chapter Parallel operation settings)

6.5.4 "Tap direction turned" setting (see chapter Parallel operation settings)

Since a comparison of the tap positions of the transformers jointly engaged in parallel operation is performed during parallel operation in accordance with the principle of "Master/Follower tap synchronisation", it is imperative to maintain identical position titles for all these transformers, and to ensure that the "Higher" and "Lower" signals will effect identical voltage changes in all the transformers.

If this is not the case, i.e. if the phenomenon appears that the follower regulator(s) switch(es) in the opposite direction of the master regulator's tapping direction, proceed by changing the setting of this parameter from "standard" to "turned".
The parameterization is password-protected (four-digit number code). It is activated via a screen setting under Configuration/General. The parameterization software also enables parameterization without the correct number code. Via the control system the voltage level, for example, can also be changed also without valid code.

The activation code to be entered can be set in the following screen:

If an invalid code is entered the parameters can be displayed but cannot be modified. In this case a message appears as shown in the following example (message text to the right of the display number):

From the main screen (showing the current measurement readings) the menu can be accessed as follows:
Measurement screen → Press "MENU" key → Menu screen → Press "F5"

Press "MENU" key

Display of measured values

Press "F5" key

Display of pre-selection

Press "F5" key

Display of main menu

The parameterization is password-protected (four-digit number code). It is activated via a screen setting under Configuration/General. The parameterization software also enables parameterization without the correct number code. Via the control system the voltage level, for example, can also be changed also without valid code.
7 Parametering

7.1 NORMset

Activating the NORMset function

Menu → NORMset → NORMset Activation

The term "NORMset" function stands for an automatism which considerably simplifies the parametering of a TAPCON® 260 D. The only thing left to do for the operator when commissioning during the NORMset mode is to enter the desired voltage level and, if required, the CT/VT values and subsequently take the device into operation.

All other parameters required for simple voltage regulation will be preassigned at the factory (e.g. bandwidth of 1%). Should the actual value exit the set bandwidth, an appropriate switching operation will be initiated at the on-load tap-changer.

The voltage change ensuing from the switching operation corresponds to the transformer's tap voltage and is checked for plausibility by the regulator, using the preset bandwidth. The bandwidth value is then corrected and optimised in accordance with the results gleaned from this check.

If the next system deviation occurs, the new bandwidth will be used as basis, which will be rechecked and readjusted, if necessary.

Should the marginal conditions change, the regulator will again optimise itself automatically.

It goes without saying that mains-specific and/or customer-specific settings such as LDC, parallel operation or position display can still be done in the standard mode and will be taken into consideration during determination of the optimum parameters.

NOTE

The parameters for undervoltage/overvoltage and overcurrent are not set by the NORMset function. If required, these parameters have to be entered manually during commissioning/initiation.

The NORMset function is deactivated during parallel operation.

Setting the desired voltage level

Menu → NORMset → Desired voltage level

The setting of the desired voltage level refers either to the secondary or to the primary voltage side of the voltage transformer connected to the TAPCON® 260 D.

The secondary voltage is displayed in Volt (V), the primary voltage in kilovolt (kV).

This display requires the correct input of the CT/VT data in the following two menu windows.

Setting range: 49 ... 140 V* / 0.1 ... 999.9 kV

Setting the primary voltage

Menu → NORMset → Primary voltage

Setting range: 0 ... 999.9 kV

Setting the secondary voltage

Menu → NORMset → Secondary voltage

Setting range: 100 ... 110 V

* including max. possible limit values
7.2 Setting the parameters

This chapter describes all settings required in regulating functions and monitoring tasks. To make specific parameters easier to find, sub-groups were created which contain functionally related individual parameters.

7.2.1 Regulating parameters

This sub-group comprises all parameters required for the regulating function.

Setting the desired voltage level 1 / 2 / 3

Menu → Parameter → Regulating parameter

Desired voltage level 1 / 2 / 3

The setting of the desired voltage level refers either to the secondary or to the primary voltage side of the voltage transformer connected to the TAPCON® 260 D. The secondary voltage is displayed in Volt (V), the primary voltage in kilovolt (kV).

Correct input of the voltage transformer data is a prerequisite for proper display of the desired voltage level 1, 2 or 3 or of the actual voltage level in kV.

The desired voltage levels 2 or 3 will be activated in the presence of a continuous signal at the I0-X1/17 or I0-X1/16 input. If a signal is present at both inputs, desired voltage level 2 will be active.

Setting range:  49 ... 140 V*)

Setting the bandwidth

Menu → Parameter → Regulating parameter

Bandwidth

You may set the bandwidth "B%" from 0.5 % to 9 % in steps of 0.01 %. The transformer's step voltage must be known to ensure proper setting of this value.

For increased regulating sensitivity it is also possible to set lower values, although it is highly unadvisable to go beneath 60% of the computed value. If the measuring-circuit voltage is altered far enough during operation to exceed the set bandwidth, an output pulse will be generated according to the set delay time.

This is shown by a consecutive filling-in of the time bar in the display. Simultaneously, the time left over until emission of the output pulse is displayed.

If no compensation occurs for more than 15 min, the "function monitoring" relay will respond (see connection diagram). The relay will not be reset until the deviation falls short of the set limit.

Setting range:  0.5 ... 9 %

*) including max. possible limit values
Setting the delay time T1 or T2 (delay time 1/delay time 2)
Menu → Parameter → Regulating parameter

**Delay time T1**

The delay time starts as soon as the regulating deviation exceeds the set bandwidth limits above or below. At the same time the time bar graph fills in from bottom to top and the time left until emission of the control pulse is displayed. If the regulating deviation is still present after the delay time has elapsed, an output pulse is emitted. If the deviation returns to within bandwidth limits within the delay time, then the current delay time will, starting from the time already elapsed, be deleted against zero. While this is going on, the absolute time display will be disappearing from the display. At the same time, the time bar graph is displayed as a slashed line permanently decreasing in size.

If the regulating deviation again exceeds the set bandwidth limits during deletion, the time delay will, starting from the remaining time, be started anew.

Setting range: 1 ... 600 s

Menu → Parameter → Regulating parameter

**T1 Regulating behavior**

The delay time T1 can be set with linear or integral response. If a delay time with integral response "Integral" is set, the delay time is automatically shortened according to the relation of actual system deviation to set bandwidth (B), down to a minimum of 1 s.

Menu → Parameter → Regulating parameter

**T2 Activation**

The delay time T2 will become effective only if more than one tap change is required for reduction of the control deviation below the bandwidth limit. The first output pulse is emitted after the set delay time T1, whereas the other pulses required for compensation will be emitted after the set delay time T2.

Menu → Parameter → Regulating parameter

**T2 Delay time**

Setting range: 1 ... 10 s

**NOTE**

During parallel operation, the delay time T2 must not be set lower than 8 s!
Parametering

$\frac{\Delta U (\%)}{E (\%)}$

Regulating deviation

Parameter T1 integral

$\Delta U / E$ - voltage change $\Delta U$ in % of the desired value, in relation to the set bandwidth in % of the desired voltage level.
7 Parametering

7.2.2 Limit values

This sub-group comprises all parameters required for the monitoring of limiting values.

The limiting values can be set both as percentage values and as absolute values.

If percentage values are entered, these values generally refer to the set desired voltage level for undervoltage and over-voltage parameters, whereas for overcurrent both values refer to the set rated current of the current transformer.

Menu → Parameter → Limit values

Absolute limit values

Off: Percentage values
On: Absolute values

Setting the undervoltage blocking ("U<")

Undervoltage blocking prevents tap-change operations in the event of a network breakdown. The voltage regulator output pulses are blocked and the red LED lamp "U<" responds when the measuring voltage falls below the set blocking value.

After a delay time of approx. 10 s, the associated signalling relay (contacts I0-X1/18, I0-X1/19, I0-X1/20) is energized and remains that way. The signalling relay will not respond in case of a failure of either the measuring voltage and/or the supply voltage (< 30 V) (this standard setting can be cancelled: see parameter "U< also under 30 V" at the foot of the limit values menu).

Setting of the limiting values for undervoltage blocking as percentage value of the set desired voltage level.

Menu → Parameter → Limit values

U< Undervoltage (%)

Setting range: 60 ... 100%
Setting the limiting values for undervoltage blocking as absolute value.

When converting the display to kV (F3 key), this value can be set in reference to the primary CT/VT voltage, whereas if the display is set to V this value will be in reference to the secondary voltage.

Menu → Parameter → Limit values

**U< Undervoltage (V)**

Setting range: 60 V ... 160 V

... kV

Setting the overvoltage detection (U>) with automatic return control

In the event of an overvoltage detection response, the tap-changer is operated by periodic pulses to the motor-drive until the overvoltage falls below the response threshold. The motor-drive is controlled by periodic pulses of 1.5 s through the “Lower” output relay (can be set in the Configuration menu) while the set delay time remains inactive during this operation. At the same time the “U>” LED lamp responds and a signalling relay is energized (contacts I0-X1/18, I0-X1/19, I0-X1/20), as long as overvoltage is present.

If the voltage regulator regulates towards a higher voltage than the set limit U> due to an unfavourable parametering (e.g. too high LDC settings), it is prevented from exceeding the limit. An unadjustable operating state is signalled by the signalling relay for “function monitoring”, after 15 minutes.

Menu → Parameter → Limit values

**U> Overvoltage (%)**

Setting of the limiting value for overvoltage blocking as percentage value of the set desired voltage level.

Setting range: 100 ... 140%

Setting the limiting value for overvoltage blocking as absolute value.

When converting the display to kV (F3 key), this value can be set in reference to the primary CT/VT voltage, whereas if the display is set to V this value will be in reference to the secondary voltage.

Menu → Parameter → Limit values

**U> Overvoltage (V)**

Setting range: 100 V ... 160 V

... kV

Setting the overcurrent blocking (I>)

Overcurrent blocking prevents tap-change operations in the presence of excessive overcurrent.

The TAPCON® 260 D output pulses are blocked and the “I>” LED lamp responds when the measured current exceeds the set blocking value. At the same time the corresponding signalling relay is energized and remains energized (contacts I0-X1/18, I0-X1/19, I0-X1/20).

Menu → Parameter → Limit values

**Overcurrent I>**

Press the F3 key to set the input of percentage values to absolute values. The values will in both cases refer to the rated current of the current transformer.
Function monitoring

The message “function monitoring” will be emitted if a regulating deviation lasting 15 min is detected by the regulator which is not eventually compensated. Use this parameter to suppress the message (= Off) to avoid the generation of an error message while the transformer is switched off and while at the same time the message has not been suppressed at U< also below 30 V (see the following paragraph).

Menu → Parameter → Limit values

Function monitoring

Delaying the response of the message undervoltage U<

Set a delayed response time for this message to avoid the immediate generation of a message in the event of short-term voltage drops.

Menu → Parameter → Limit values

U< Delay

Setting range: 0 ... 20 s

Deactivating the undervoltage blocking

It is possible to deactivate the blocking of “Lower” output pulses in the event of a shortfall of the undervoltage threshold. In that case, only a message will be emitted.

Menu → Parameter → Limit values

U< Blocking

Suppressing the undervoltage message

Suppress the message Undervoltage U< to avoid the generation of an error message while the transformer is switched off (= measuring voltage U< 30 V).

Menu → Parameter → Limit values

U< even under 30 V

7.2.3 Line compensation

Comparison between LDC and Z-Compensation

Application of the vectorial compensation (LDC):
- requires knowledge of the exact line data
- permits an accurate compensation of the line voltage drops

Application of the Z-Compensation:
- can be used in the case of minor shifts of the phase angle \( \phi \)
- can be also used in meshed network applications.

NOTE

For the correct setting of the LDC it is necessary to calculate the resistive and inductive line voltage drop in relation to the secondary side of the voltage transformer in V and the correct setting of the existing measuring configuration.
7.2.3.1 Line-Drop Compensation (LDC)

Calculation of the required setting values:

\[
U_r = I_N \cdot \frac{R_{CT}}{R_{VT}} \cdot r \cdot L \quad (V)
\]

\[
U_x = I_N \cdot \frac{R_{CT}}{R_{VT}} \cdot x \cdot L \quad (V)
\]

Where

- \( U_r \): LDC setting for resistive line voltage drop in V
- \( U_x \): LDC setting for inductive line voltage drop in V
- \( I_N \): Rated current in A of the selected current transformer connection to the voltage regulator, e.g. 0.2 A or 1 A or 5 A
- \( R_{CT} \): Current transformer ratio, e.g. 200 A/5 A
- \( R_{VT} \): Voltage transformer ratio, e.g. \( \frac{30000 \, V}{\sqrt{3}} \)
- \( r \): Ohmic resistance of line in \( \Omega/ \) km per phase
- \( x \): Inductive reactance of line in \( \Omega/ \) km per phase
- \( L \): Length of line in km

If the active voltage drops \( U_r \) and reactive voltage drops \( U_x \) are set correctly, then the line end voltage will remain constant regardless of load.

**Setting the resistive voltage drop \( U_r \)**

Menu → Parameter → Compensation

\( U_r \) - Line Drop Compensation

Set the calculated resistive voltage drop in the \( U_r \) display. The effect of the compensation can be reversed by 180° (minus sign preceding the setting). If no compensation is desired, then the value “0” is to be set.

Setting range: 0 ... 25 V

**Setting the inductive voltage drop \( U_x \)**

Menu → Parameter → Compensation

\( U_x \) - Line Compensation

Set the calculated inductive voltage drop in the \( U_x \) display. The effect of the compensation can be reversed by 180° (minus sign preceding the setting). If no compensation is desired, then the value “0” is to be set.

Setting range: 0 ... 25 V

**NOTE**

LDC and Z-Compensation can be operated simultaneously. Set the parameters of the compensation method not in use to “0”.

7.2.3.2 Z-Compensation

For correct setting of the parameters the voltage rise (\( \Delta U \)) has to be calculated in consideration of the current.

Calculation of the required setting values:

\[
\Delta U (\%) = 100 \cdot \frac{U_{Tr} - U_{Load}}{U_{Load}} \cdot \frac{I_N \cdot R_{CT}}{I}
\]

- \( \Delta U \): Setting of Z-Compensation in %
- \( U_{Tr} \): Transformer voltage at current \( I \)
- \( U_{Load} \): Line end voltage at current \( I \) and with the same service position of the tap-changer
- \( I \): Load current in A
- \( I_N \): Rated current in A of the selected current transformer connection to the TAPCON® 260 D, i.e. 0.2 A or 1 A or 5 A
- \( R_{CT} \): Current transformer ratio, e.g. 200 A/5 A

**Setting the voltage rise**

Menu → Parameter → Compensation

\( \text{Z-Compensation} \)

Set the calculated percentage of the voltage rise, referred to the desired voltage level. If no compensation is desired, the value “0” is to be set.

Setting range: 0 ... 15 %
7 Parametering

Setting the limiting value for ΔU (LIMIT)
Menu → Parameter → Compensation

Z-Comp Limit
If a certain compensation is desired while excessive transformer voltage rises (e.g. in case of an unusually high load) shall be avoided the max. permissible voltage rise referred to the desired voltage level can be set.
Setting range: 0 ... 15 %

7.3 Setting of configuration

This chapter treats all settings relevant in the configuration of system-specific data. To make specific parameters easier to find, sub-groups were created which contain functionally related individual parameters.

7.3.1 CT/VT data

The transformation ratios and measuring set-ups of the voltage and current transformers used can be set in the corresponding displays by pressing the F1, F4 and F5 function keys.

ATTENTION
The standard value preset at the factory is 0 ampere, i.e. 0 ampere will be displayed even in the presence of a current flow.
Setting of the current transformer connection in use
Menu → Configuration → CT/VT data

**Current transformer connection**

These data are required for the computation and display of the absolute current value.
If the setting “unknown” is selected, the current will be displayed as a percentage value in reference to the terminal used (0.2 A, 1 A or 5 A).

Setting the phase angle of current/voltage transformer

Settings of the conventional measuring circuits in accordance with fig. 10.

Menu → Configuration → CT/VT data

**CT/VT connection**

This factor can be entered locally. It defines the transformer ratio for calculating the on-load tap changer current.

Can be set in menu Configuration/Transformer data.
7.3.2 General

Regulator identification serves as the identification characteristic of a TAPCON® 260 D voltage regulator. Its task is to ensure that a connection is established between the visual display software and a specifically defined TAPCON® 260 D. During online communication, this regulator identification is inquired by the software running on the PC and subsequently compared with the existing regulator data. This allows an accurate classification of the data and/or parameters.

Setting the desired display language
Menu → Configuration → General Language

Regulator identification
Regulator identification is comprised of a four-digit string.

Setting the transmission speed
Menu → Configuration → General COM1 setting
Setting the Baud rate for data transmission to the visual display software at the voltage regulator.

Conversion of the voltage displays from kV to V
Conversion of the voltage displays causes the desired voltage level and the actual voltage level in the basic display to be converted to either kV or V.

Setting the pulse duration during tapping operations
Menu → Configuration → General R/L pulse time
The Raise/Lower pulse duration can be changed within a range of 0 ... 10 s.

ATTENTION
If the pulse duration is set to 0 s, a continuous pulse will be emitted.
Parametering

Illumination of the display
Menu → Configuration → General
Display dimmed

In case of activating this function, 15 min after the last pushing a button the display will be dimmed but is still readable. By pushing any button the display lights up again.

Selection of motor running time
Menu → Configuration → General
Motor running time

The running time of the motor-drive unit is monitored by the TAPCON® 260 D via the input "Motor running". When a signal is queued longer than specified on this input, the TAPCON® 260 D generates an impulse on a so-called customer relay to be defined.

Two freely definable relays are always available to the user who can use them for this function.

The maximum permissible running time of the motor-drive unit can be set between 0 and 20 seconds via the "Motor run time" (see adjacent figure) in the menu Configuration → General.

When "0 s" is set, run time monitoring is disabled.

Simultaneously with the impulse for triggering the motor protective switch, the "run time exceeded" relay (relay must be assigned by the customer) is turned on. This relay is then automatically turned off again when no signal is queued on the "malfunction - motor-drive unit" input (input must be assigned by the customer).

The status on the input "malfunction - motor protective switch" (input must be assigned by the customer) is reported on the "malfunction - motor-drive unit" relay (relay must be assigned by the customer).

Similarly, the status on the input "motor-drive unit functioning" triggers a signal on the "motor-drive unit functioning" relay.

The functions described above are summarised in a functional diagram.
In this example the motor run time was set to "10 s."

7 Parametering

NOTE

The message "tap change incomplete" appears if the tap position remains unchanged after the controller has issued an instruction for changing the tap position.

The device is monitored for a change in tap position within the set time window after a switch operation (adjustable up to approx. 30 s), or if the motor drive has issued an associated signal. The time window corresponds to the "motor run time" parameter (special case: 15 s is used if "motor run time" = 0 s).

The message remains active until the tap position changes after a further tap position change request.
7.3.3 Parallel operation settings

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Data of meas.Trf.</th>
<th>General</th>
<th>Parallel control</th>
<th>Continue</th>
</tr>
</thead>
</table>

Parallel operation

Parallel operation of 16 transformers max. without system topology recognition. In this context, parallel operation of all 16 transformers is possible either in a busbar arrangement or in two groups.

Parallel operation management is achieved via the CAN bus. Activation of parallel operation is achieved via one of two status inputs. This way the TAPCON® 260 D can determine in which group the associated transformer engaged in parallel operation is contained.

Parallel control is possible in two different ways:
- Parallel operation according to the principle of "minimum circulating reactive current" or
- Parallel operation according to the principle of tap-change synchronism (Master-Follower).

Selection of the desired parallel operation principle is effected via a menu window.

Setting of parallel operation principle

Parallel mode is set by pressing the "Menu" key on the front panel of the controller. The display shows the following menu, from which the parallel mode submenu can be accessed by pressing the "F3" key.

<table>
<thead>
<tr>
<th>Menu Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select menu</td>
</tr>
<tr>
<td>Bus Bar Status</td>
</tr>
<tr>
<td>Parallel mode</td>
</tr>
<tr>
<td>Main menu</td>
</tr>
</tbody>
</table>

The respective method is activated by pressing one of the "F..." keys - the selected element is indicated by highlighting of the text field.

The following selection options are available:
1. Parallel Auto
2. Parallel Manual
   - 2.1 Master
   - 2.2 Follower
   - 2.3 Individual
3. Circulating current

Activated mode "Parallel Auto":

<table>
<thead>
<tr>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set parallel mode</td>
</tr>
<tr>
<td>Parallel Auto</td>
</tr>
<tr>
<td>Parallel Manual</td>
</tr>
<tr>
<td>Circulating current</td>
</tr>
</tbody>
</table>

Activated mode "Master" under menu item "Parallel Manual":

<table>
<thead>
<tr>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parallel Manual</td>
</tr>
<tr>
<td>Master</td>
</tr>
<tr>
<td>Follower</td>
</tr>
<tr>
<td>Individual</td>
</tr>
</tbody>
</table>

Activated mode "Follower" under menu item "Parallel Manual":

<table>
<thead>
<tr>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parallel Manual</td>
</tr>
<tr>
<td>Master</td>
</tr>
<tr>
<td>Follower</td>
</tr>
<tr>
<td>Individual</td>
</tr>
</tbody>
</table>

Activated mode "Individual" under menu item "Parallel Manual":

<table>
<thead>
<tr>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parallel Manual</td>
</tr>
<tr>
<td>Master</td>
</tr>
<tr>
<td>Follower</td>
</tr>
<tr>
<td>Individual</td>
</tr>
</tbody>
</table>
7 Parametering

Alternative setting of parallel operation principle

Menu → Configuration → Parallel operation

Parallel operation principle

Set the desired parallel operation principle by pressing the F1 and F5 function keys.

Setting options:

- Independent: no parallel operation
- Circulating current: parallel operation following the principle of minimum circulating reactive current
- Master: Master/Follower principle: the regulator assumes Master function
- Follower: Master/Follower principle: the regulator assumes Follower function
- Parallel Auto: Master/Follower principle: with this setting, the regulator with lowest CAN address of all other regulators is automatically selected as Master.

Parallel control according to the Master/Follower principle requires no further settings other than the setting of the delay time and "out of step delay".

In each case, the voltage regulators engaged in parallel operation have to be connected via the CAN bus interface (see appendix).

NOTE

Please bear in mind that the CAN bus must be connected with a resistor of 120 Ω at both ends (at the first and last regulator).

The resistor is included in the scope of delivery.

If parallel mode is active, the permissible deviation in the tap positions of parallel voltage regulators has to be specified. This can be set via an adjustable time delay between 10 and 30 s. If a difference in tap position remains after this period, an "out of step" alarm is issued.

Can be set in Configuration/General
Range 0.0 ... 30.0 s

If the value is set to 0.0 s, no "out of step" alarm is generated.
Parallel operation according to the principle of "Master/Follower" (synchronism control)
The type of parallel operation at TAPCON® 260 D can be set via the parameter "parallel operation" (see above).
According to the settings made, one of the regulators is then elected as Master. This regulator assumes the measuring tasks and adjusts the on-load tap-changer for voltage compensation in the presence of deviations. Following a tap-change operation, the Master proceeds to compare the Followers' tap-change positions with its own via CAN bus and, if a discrepancy is noted, likewise initiates readjustment of the Followers to an identical tap-change position.
If a difference of two or more tap-change positions is noted, the message „Parallel operation disturbed” will be emitted and automatic regulation will be blocked.
This method is suitable for transformers featuring identical electrical characteristics.

Parallel operation according to the principle of “minimum circulating reactive current”
The circulating reactive current is computed from the transformer currents and their respective phase angles. For correction of the measuring circuit voltage, a voltage proportional to the circulating reactive current is applied to self-sufficiently operating regulators. This correction voltage can be either decreased or increased through adjustment of the „stability” setting.
If an inadmissibly high circulating reactive current is detected, all tap-changers involved will be reset after only 10 s, regardless of the delay time preset at the regulator.
This method is suitable for transformers of comparable rated power, rated voltage, uk and vector group whether with uniform or with non-uniform step voltage. No information on tap position is required.

System configuration, settings
Feed the additional connections/terminals to the regulators (see appendix).
To do this use "parallel group 1" or "parallel group 2".

Setting the interference variable (stability)
Menu → Configuration → Parallel operation 
Stability
To set a stability value between 0 and 100 %, press the function keys F1, F4 and F5. The stability value is a measure used for determining the efficiency of the circulating reactive current on the TAPCON® 260 D.
If it is set to “0 %”, no efficiency will be present.
For a circulating reactive current equal to the rated current of the current transformer, a setting value of 10 % would effect a voltage correction of 10 % for the TAPCON® 260 D.
Changing the stability value automatically changes the efficiency value in the help text.

Setting the admissible circulating reactive current (blocking threshold)
Menu → Configuration → Parallel operation 
Blocking
Set the bandwidth from 0.5 to 20 % (in relation to the rated current of the current transformer) by pressing the function keys F1 and F5. If the circulating reactive current exceeds the preset threshold value during parallel operation, the signalling LED lamp “Parallel operation disturbed” will come on and all TAPCON® 260 D engaged in parallel operation will be blocked. After the adjustable delay period, the signalling relay contact (UC-X1/1 and UC-X1/2) will respond.
7 Parametering

Delay of error message
Menu → Configuration → Parallel operation

Alarm
A delay (1-30 s) can be set for emission of the message „Parallel operation disturbed“ to avoid the generation of short-term error messages in the event of run-time differences between the motor-drive mechanisms engaged in parallel operation.

Appearance of this error message will cause blocking of the automatic regulation, i.e., at this point tap-changer adjustment is no longer possible except in the manual mode.

Setting range: 1 ... 30 s

Setting the tap direction
During parallel operation in accordance with the Master/Follower principle, the tap direction has to be turned if an adjustment of the transformer towards a higher voltage causes a change in tap position towards the position "1."

In the standard setting, a switch operation in the direction of a higher voltage will automatically cause a tap increase (in the direction of "n").

Menu → Configuration → Parallel operation

Tapping direction turned

7.3.4 Configuration of analog input on the input card (option)
The analog input on the AD card is used for computation of the tap position information received from an analog encoder (stepping potentiometer or proportional current). Adaptation to the existing encoder will be done during commissioning.

Lower limiting value of the analog input 1
To configure the analog input, the lower value of the input signal must be specified.
With proportional current, the value 0 % must be entered here for 0mA and the value 20 % for 4mA.
If the input is used to acquire the tap position by a potentiometer as the encoder, the value 20 % must always be set.

Menu → Configuration → Continue → Analog inputs

Lower limit in %

Upper limiting value of the analog input 1
To configure the analog input, the upper value of the input signal has to be specified. With proportional current, the value 100 % must be entered here, if the whole range of the pending signal is to be used.
If the input is used to acquire the tap position by a potentiometer as the encoder, the value 100 % must always be set.

Menu → Configuration → Continue → Analog inputs

Upper limit in %
7 Parametering

Lower value of analog input 1
To configure the analog input, the lower value of the pending signal has to be assigned an absolute value (e.g. the value „1” for the lowest tap position).
Menu → Configuration → Continue → Analog inputs

Upper limiting value of the analog input 2
To configure the analog input, the upper value of the pending signal must be specified.
With proportional current, the value 100 % must be entered here if the entire range of the pending signal is to be used. If the input is used to acquire the tap position by a potentiometer as the encoder, the value 100 % must always be set here.
Menu → Configuration → Continue → Analog inputs

Lower value of the analog input 2
To configure the analog input, an absolute value must be assigned to the lower value of the pending signal (e.g., the value “1” for the lowest tap position).

Upper value of the analog input 1
To configure the analog input, an absolute value must be assigned to the upper value of the pending signal (e.g., for the highest tap position the value „27”).
Menu → Configuration → Continue → Analog inputs

Lower limiting value of the analog input 2
To configure the analog input, the lower value of the input signal must be specified.
With proportional current, the value 0 % must be entered here for 0 mA and the value 20 % for 4 mA.
If the input is used to acquire the tap position by a potentiometer as the encoder, the value 20 % must always be set.
Menu → Configuration → Continue → Analog inputs

Lower limit in %

Upper value of the analog input 2
To configure the analog input, an absolute value must be assigned to the upper value of the pending signal (e.g., the value „27” for the highest tap position).
Menu → Configuration → Continue → Analog inputs

Upper value

Upper limiting value in %

Lower value

Lower value in %

Actual value: 0.0 %
7 Parametering

7.3.5 LED selection

Use the settings of this sub-group to assign inputs or functions to the four unoccupied LEDs.

Menu → Configuration → Continue → LED selection

LED1 ... LED3

Upon activation, the LEDs will light up in „red“. For marking the LEDs, pull out the underlying inscription strips and mark them as desired (e.g. with rub-off letters).

LED4 may light up either in „red“ or in „green“, depending on the type of activation. If both inputs are activated simultaneously, the mixed shade „yellow“ will be created. In case of setting both red and green LED4 to „off“, the LED4 will show automatically the status of the TAPGUARD®.

NOTE

The number and the assignment of the analog inputs may differ depending on how the hardware is configured. Usually the first analog input is located on the first analog input card AD and the second on the expansion plug-in card AD1. A third analog input may be placed on an additional AD card.

With the previous hardware versions the analog inputs were located on the UC card(s).

7.3.6 Configuration of measuring transducer function (option)

Using the signal converter module, it is possible to obtain two or four measured values as analog values in the ranges ±20 mA, ±10 mA, ±10 V, ±1 mA, depending on the configuration and model of the signal transformer module.

The following values are available:
- U1
- U2 (optional, via a second measuring input)
- I1
- active current
- reactive current
- active power
- reactive power
- apparent power
- tap position
- voltage level

Since the configuration is performed at the plant, please be sure to specify in your order the desired measured values and type of analog output!

If the analog outputs desired by the customer have not already been set at the factory, this can be done with the aid of the following description of measuring transducer 1.
Follow the same principle for the settings for measuring transducers 2 to 4.

**Measuring transducer, value of output 1**
This parameter is used for assigning the measuring quantity to be transmitted to the output of measuring transducer 1.
Menu \(\rightarrow\) Configuration \(\rightarrow\) 2x Continue \(\rightarrow\) Measuring transducer 1/2

*Output 1 measured value*

Possible settings:
- Off
- U1, U2, voltage level
- I1, active current, reactive current
- step
- apparent power, active power, reactive power

**Lower output value for measuring transducer 1**
Assignment of a measurable physical quantity
Menu \(\rightarrow\) Configuration \(\rightarrow\) 2x Continue \(\rightarrow\) Measuring transducer 1/2

*Output 1 low*

Possible settings:
- 0 mA, -1 mA, -4 mA, -10 mA, -20 mA
- 0 V, -10 V

**Upper output value for measuring transducer 1**
Assignment of a measurable physical quantity
Menu \(\rightarrow\) Configuration \(\rightarrow\) 2x Continue \(\rightarrow\) Measuring transducer 1/2

*Output 1 top*

Possible settings:
- 1 mA, 10 mA, 20 mA
- 10 V

**Measuring transducer, lower value of output 1**
This parameter is used for assigning an absolute value to the lower limit of measuring transducer 1.
Menu \(\rightarrow\) Configuration \(\rightarrow\) 2x Continue \(\rightarrow\) Measuring transducer 1/2

*Output 1 lower value*

**Measuring transducer, upper value of output 1**
This parameter is used for assigning an absolute value to the upper limit of measuring transducer 1.
Menu \(\rightarrow\) Configuration \(\rightarrow\) 2x Continue \(\rightarrow\) Measuring transducer 1/2

*Output 1 upper value*
7 Parametering

7.3.7 Parallel mode with plant topology

- The existing topology function presents six transformers.
- Up to three groups can be visualized.
- The transformers are displayed in a maximum of three groups on two screens, each showing three transformers.

Menu ➔ Info

The three symbolically presented transformers and group numbers are always shown on the two topology screens. The user can issue his own transformer designations (refer to 3.2 Setting the switches and nodes).

The horizontal lines correspond to the group designations (on the left side of fig. 1).

If a transformer belongs to a group that is no longer presented on the same screen, the connecting line ends as a broken line at the edge of the screen (refer to fig. 1, Topology screen).

Topology screen

Menu ➔ Configuration ➔ Forward ➔ Forward ➔ Forward ➔ Topology

Buttons F1 and F5 can be used to edit the designation of the transformer in the range from 0 to 999. Use button F4 to select the designation you want to edit. The transformer numbering in the top line is identical with the CAN address.

The numbers entered here will be used as the transformer designations in the graphic topology displays in INFO screens 15 and 16.

Menu ➔ Configuration ➔ Forward ➔ Forward ➔ Forward ➔ Topology

For up to 24 switches you can set the two nodes to which the switch is connected.

Node number 0 means that this point is not connected. The node numbers 1..16 are reserved for the nodes of the secondary sides of the transformers. Node numbers 17..48 are freely available. Node numbers 49 ... 64 are reserved for the nodes on the primary sides of the transformers. Node numbers 65 ... 80 are available again.

Menu ➔ Configuration ➔ Forward ➔ Forward ➔ Forward ➔ Topology

Whether transformers are considered as operating in parallel depends additionally on the setting of the parameter „topology prim/sec“.

There are three possible settings:

Secondary: Normal mode. The transformers are considered as operating in parallel if their secondary sides are connected in parallel. There is no information on the switch required from the primary side.

Both sides: The transformers are considered as operating in parallel if they are connected in parallel both on the secondary and the primary side.

One side: The transformers are considered as operating in parallel if they are connected in parallel on at least one side.

Information on displaying the parallel configuration in the information display:

The lines indicating which transformers are connected in parallel (previous page in this specification) are only shown on the secondary side. These lines shall only indicate which transformers are connected in parallel. No information is given whether the primary or the secondary side or both were used for identification of the parallel operation.
7 Parametering

Configuration of the topology is illustrated by the following simple example:

Fig. 2 Configuration example

Following settings can be made from fig. 2:

<table>
<thead>
<tr>
<th>Parameter nodes</th>
<th>Nodes/K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter 1 nodes a</td>
<td>1</td>
</tr>
<tr>
<td>Parameter 1 nodes b</td>
<td>17</td>
</tr>
<tr>
<td>Parameter 2 nodes a</td>
<td>1</td>
</tr>
<tr>
<td>Parameter 2 nodes b</td>
<td>18</td>
</tr>
<tr>
<td>Parameter 3 nodes a</td>
<td>2</td>
</tr>
<tr>
<td>Parameter 3 nodes b</td>
<td>19</td>
</tr>
<tr>
<td>Parameter 4 nodes a</td>
<td>2</td>
</tr>
<tr>
<td>Parameter 4 nodes b</td>
<td>20</td>
</tr>
<tr>
<td>Parameter 5 nodes a</td>
<td>17</td>
</tr>
<tr>
<td>Parameter 5 nodes b</td>
<td>18</td>
</tr>
<tr>
<td>Parameter 6 nodes a</td>
<td>19</td>
</tr>
<tr>
<td>Parameter 6 nodes b</td>
<td>20</td>
</tr>
<tr>
<td>Parameter 7 nodes a</td>
<td>17</td>
</tr>
<tr>
<td>Parameter 7 nodes b</td>
<td>19</td>
</tr>
<tr>
<td>Parameter 8 nodes a</td>
<td>18</td>
</tr>
<tr>
<td>Parameter 8 nodes b</td>
<td>20</td>
</tr>
<tr>
<td>Parameter 9 nodes a</td>
<td>0</td>
</tr>
<tr>
<td>Parameter 9 nodes b</td>
<td>0</td>
</tr>
<tr>
<td>...</td>
<td></td>
</tr>
<tr>
<td>Parameter 24 nodes a</td>
<td>0</td>
</tr>
<tr>
<td>Parameter 24 nodes b</td>
<td>0</td>
</tr>
</tbody>
</table>

7.4 Information menu/measuring values

Consult this menu point to find information on the TAPCON® 260 D and the measuring values.
Sub-groups with related information were assembled to facilitate the search.

7.4.1 Information

Consult this sub-group to retrieve information on the TAPCON® 260 D.

| INFO | |
| Line 1 : Type designation | |
| Line 2 and 3: Software version and its date of issue | |
| Line 4 to the left: EEPROM size | |
| Line 4 to the right: Internal regulator ID number | |
| Line 5 and 6: Size of the built-in RAM and flash memory | |

An LED function test can be performed in accordance with the data indicated.

NOTE

This test involves only the LED itself, not the function behind it!
7 Parametering

7.4.2 Status

Display of the regulator number for parallel operation (= CAN address) and of the number of the TAPCON® 260 D currently engaged in parallel operation.

<table>
<thead>
<tr>
<th>Parallel control</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVR No 1</td>
</tr>
<tr>
<td>0 AvR parallel</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>&lt; 00 &gt;</td>
</tr>
</tbody>
</table>

Status display of the inputs at the UC1 module
0 = no presence of signal at input
1 = presence of signal at input

<table>
<thead>
<tr>
<th>UC1 MODULE STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 0 11 0</td>
</tr>
<tr>
<td>33 0 32 0</td>
</tr>
<tr>
<td>31 0 30 0</td>
</tr>
<tr>
<td>17 0 16 0</td>
</tr>
<tr>
<td>15 0 14 0</td>
</tr>
<tr>
<td>&lt; 04 &gt;</td>
</tr>
</tbody>
</table>

Status display of the inputs at the UC2 module
0 = no presence of signal at input
1 = presence of signal at input

<table>
<thead>
<tr>
<th>UC2 MODULE STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 0 11 0</td>
</tr>
<tr>
<td>33 0 32 0</td>
</tr>
<tr>
<td>31 0 30 0</td>
</tr>
<tr>
<td>17 0 16 0</td>
</tr>
<tr>
<td>15 0 14 0</td>
</tr>
<tr>
<td>&lt; 05 &gt;</td>
</tr>
</tbody>
</table>

NOTE

This operation will cause all values to be reset to standard level, including any values already adapted and individually set earlier!

Display indicating whether the parameter sets were properly stored following a regulator restart and/or whether all parameters were properly stored following the recording of a parameter set. If a parameter was not properly stored, it will be indicated as incorrectly stored and can be reset to a standard factory setting by pressing the F1 key. To reset all parameters to standard settings, press the F3 and F4 keys.

Display of pending messages, e.g. overvoltage/undervoltage or parallel operation disturbance.

<table>
<thead>
<tr>
<th>PARAMETER</th>
</tr>
</thead>
<tbody>
<tr>
<td>All params stored correctly</td>
</tr>
<tr>
<td>F3 and F4: set all on standard</td>
</tr>
<tr>
<td>&lt; 06 &gt;</td>
</tr>
</tbody>
</table>

Status display of the inputs at the I/O module
0 = no presence of signal at input
1 = presence of signal at input

<table>
<thead>
<tr>
<th>INPUT / OUTPUT STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>33 6 31 6</td>
</tr>
<tr>
<td>29 6 29 6</td>
</tr>
<tr>
<td>17 6 16 6</td>
</tr>
<tr>
<td>14 6 13 6</td>
</tr>
<tr>
<td>11 6 12 6</td>
</tr>
<tr>
<td>&lt; 03 &gt;</td>
</tr>
</tbody>
</table>
7.4.3 CAN Bus

RTC = Real Time Clock
When the TAPCON® 260 D is started up for the first time a counter is set in motion which continues to run even while the regulator is inactive. For the visual display of measuring values, all of the counter's times will be overwritten by the PC's times.

Data on the CAN Bus
Line configuration:
No. AAA: BBB CCC DDD EEE
meanings:
AAA: CAN Address of the regulator
BBB: Voltage in V
CCC: Active current in %
DDD: Reactive current in %
EEE: Tap position

Press F1 key to call up the other information.
F: Group input 1
G: Group input 2
H: Circulating reactive current parallel operation selected
I: Tap synchronisation Master selected
J: Tap synchronisation Follower selected
K: Tap synchronisation Auto selected
L: Regulator intends to block the group due to a disturbance in parallel operation.

7.4.4 Measuring values

Indication of measured values
Line 1: Voltage at the first measuring input
Line 2: Current on first measuring input
Line 3: Phase position U1 to I1
Line 4: Voltage on the second measuring input
Lines 5 and 6: Active and reactive current on the first measuring input

Storage of peak value
Display of the minimum and maximum voltages occurred since the last reset (drag hand function for voltage and tap position)

Storage of measuring values
The TAPCON® 260 D is not equipped with a long-term storage module.

Memory of statistical values
The TAPCON® 260-D saves the historic data of tap changes. In the display with the number "20" the total counter is visualized in the first line. Underneath the number of tap changes per tap number are presented.
7 Parametering

7.4.5 Position of the circuit breakers

The screen for the circuit breaker positions can be called up in two ways. Starting from the measured value display these are:

1. "MENU" key → "F2" key (Bus Bar Status)
2. "MENU" key → "F5" key (Main Menu) → "F5" key (About) → Screen <21>

An additional screen is displayed in the "Info" area/special menu as described above. It indicates the current position of the circuit breakers, as shown in below illustration for the three transformers.

The information whether there is ...

- always a closed switch
- always an open switch or
- the signal from one of the regulator’s topology entries with CAN – address 1 as an open or closed switch

... indicated for a certain position, is defined in the firmware at the time of order receipt, as is the assignment of the respective circuit breaker to an input.

For more detailed information, please refer to chapter 7.3.7.
Digital remote position indication

The TAPCON® 260 D voltage regulator is equipped with a digital remote position indication. The display can be selected/activated either with a BCD signal (standard) or optionally with an analog signal (option).

### 8.1 Digital remote position indication through activation with BCD signal (standard version)

Prerequisite for a digital position indication is the conversion and transmission of the position indicating signal into BCD code. For this purpose an N/O contact range connected to a diode matrix and the corresponding transmission lines between motor-drive unit and TAPCON® 260 D are required (see next fig.).

![Diagram of contact series, diode matrix, and transmission line](image)

Transmission of the BCD signal between motor-drive unit and TAPCON® 260 D for 1...19 operating positions (example)

The linking function of the diode matrix assigns the related parallel BCD signal to each on-load tap-changer operating position which is simulated by the N/O contact range of the motor drive unit (see table on operating positions).

#### Operating position table

Conversion of the numerical operating positions 1 to 19 into the equivalent BCD signal (example)

<table>
<thead>
<tr>
<th>Operating-position</th>
<th>BCD signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td></td>
</tr>
</tbody>
</table>
8 Digital remote position indication

8.2 Digital remote position indication through activation with analog signal (option)

Upon request, the TAPCON® 260 D voltage regulator is available with an analog control/activation of the remote position indication. This option requires an analog AD input card.

The following analog values can be processed:

- 0 ... 10 V
- 0 ... 2 kOhm
- 0(4) ... 20 mA

If all of the following data are indicated in the order, the voltage regulator will be delivered in fully and appropriately configured condition.

Information pertaining to position indication (examples):

- 0(4) mA $\triangleleft$ Pos. 1  $\triangleright$ 20 mA $\triangleleft$ Pos.19
- 0 Ohm $\triangleleft$ Pos. 1  $\triangleright$ 180 Ohm $\triangleleft$ Pos. 19
- 0 V $\triangleleft$ Pos. 1  $\triangleright$ 10 V $\triangleleft$ Pos. 19

Should it become necessary to change the values previously preset in the factory in accordance with customer specifications, this can be effected via the displays "analog input 1", lower/upper limiting value and "analog input 1", lower/upper value.

Upon customer request, the analog input of the AD card is preset in the factory to 0-20 mA, 0-10 mA, 0-1 mA or 0-10 V. It should be mentioned that the above indicated current and voltage ranges can be in the positive or in the negative range.

If e. g. the position of an on-load tap-changer is signalled via a 4-20 mA signal, it will be necessary to define the lower limit of 4 mA with 20 % (of 20 mA).

This assignment allows a fine-tuning of the position indication (see chapter Configuration of analog input on the analog AD input card).

8.3 Remote indication of tap position

Optionally, the tap position of the TAPCON® 260 D can be indicated either by way of BCD signal via potentialfree contacts or as analog signal (e. g. 0(4) – 20 mA, 0 – 10 V, - 5 ... 5 mA).
9 Status messages and error messages on the display

The monitor screen of the TAPCON® 260 D may display the following status and error messages whose causes are listed in the table.

<table>
<thead>
<tr>
<th>Error message</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undervoltage</td>
<td>The measuring voltage is lower than the preset &quot;U&lt;&quot; limit. If the parameter &quot;U&lt; also under 30 V&quot; is set to OFF, messages will be suppressed for measuring voltages under 30 V.</td>
</tr>
<tr>
<td>Overvoltage</td>
<td>The measuring voltage is higher than the preset &quot;U&gt;&quot; limit.</td>
</tr>
<tr>
<td>Overcurrent</td>
<td>The current is higher than the preset &quot;I&gt;&quot; limit.</td>
</tr>
<tr>
<td>Failure Par. Contr.</td>
<td>For synchronism:</td>
</tr>
<tr>
<td></td>
<td>- The tap positions of the regulators engaged in parallel operation were longer than the preset parallel control signalling delay was unequal.</td>
</tr>
<tr>
<td></td>
<td>- One of the regulators engaged in parallel operation is not signalling a valid tap position.</td>
</tr>
<tr>
<td></td>
<td>- None of the regulators engaged in parallel operation is Master.</td>
</tr>
<tr>
<td></td>
<td>- More than one of the regulators engaged in parallel operation is Master.</td>
</tr>
<tr>
<td></td>
<td>- One of the regulators engaged in parallel operation is operating in accordance with the circulating reactive current principle.</td>
</tr>
<tr>
<td></td>
<td>For the circulating reactive current principle:</td>
</tr>
<tr>
<td></td>
<td>- The circulating reactive current of the regulator was longer than the preset parallel control signalling delay was greater than the preset limit value.</td>
</tr>
<tr>
<td></td>
<td>- One of the regulators engaged in parallel operation is operating in accordance with the tap synchronism principle.</td>
</tr>
<tr>
<td></td>
<td>- The plant topology information is missing.</td>
</tr>
<tr>
<td></td>
<td>- Presence of a signal at one of the group inputs minimum, but no other regulator was found in the same group.</td>
</tr>
<tr>
<td>Motor protective switch</td>
<td>Presence of a signal at the input for the motor protective switch signal.</td>
</tr>
<tr>
<td>Function monitoring</td>
<td>A signal is emitted if a regulating deviation lasting 15 min is detected by the regulator which is not eventually compensated.</td>
</tr>
<tr>
<td>No OLTC-position</td>
<td>Recognition of tap position is faulty; this may be caused by defect wiring, modules or not yet finished movement of the OLTC; the message disappears when a tap position is displayed at the device</td>
</tr>
<tr>
<td>Tap-changer in extreme position</td>
<td>Message will just appear if the highest or lowest tap position is in use</td>
</tr>
<tr>
<td>Tap change incomplete</td>
<td>Message will be resetted automatically if the next tap position is detected correctly</td>
</tr>
<tr>
<td>Out of Step</td>
<td>Valid if the parallel-operation is in use: this message becomes active, if there is a tap difference of one or more tap positions between master and follower</td>
</tr>
<tr>
<td>TC motor supply faulty</td>
<td>This message depends on the digital inputs of the device; it is getting activated, if there is a voltage connected to the input (refer to the wiring scheme)</td>
</tr>
<tr>
<td>TC control supply faulty</td>
<td>This message depends on the digital inputs of the device; it is getting activated, if there is a voltage connected to the input (refer to the wiring scheme)</td>
</tr>
<tr>
<td>Tap change recognition</td>
<td>This message depends on the digital inputs of the device; it is getting activated, if there is a voltage connected to the input (refer to the wiring scheme)</td>
</tr>
</tbody>
</table>
9 Status messages and error messages on the display

<table>
<thead>
<tr>
<th>Status message</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circulating reactive current</td>
<td>In parallel operation the regulator is operating in accordance with the circulating reactive current principle.</td>
</tr>
<tr>
<td>Master</td>
<td>The regulator is engaged in parallel operation as Master in accordance with the synchronism principle.</td>
</tr>
<tr>
<td>Follower</td>
<td>The regulator is engaged in parallel operation as Follower in accordance with the synchronism principle.</td>
</tr>
<tr>
<td>Independent</td>
<td>The regulator is engaged in parallel operation as Independent in accordance with the synchronism principle.</td>
</tr>
<tr>
<td>Blocking</td>
<td>Presence of a signal at the &quot;Regulation Block&quot; customer input (IO-X1:31 or IO-X1:33)</td>
</tr>
<tr>
<td>Status</td>
<td>Is present at the binary output in the event of</td>
</tr>
<tr>
<td></td>
<td>- missing operating voltage</td>
</tr>
<tr>
<td></td>
<td>- a controller failure</td>
</tr>
<tr>
<td></td>
<td>- a program crash</td>
</tr>
</tbody>
</table>
## IEC 61850 interface description

### 10.1 Component overview
- **TAPCON® 260 D**
- **SID card**
- **Network cable with RJ45 connector**

### 10.2 Device-specific data points for the TAPCON® 260 D

<table>
<thead>
<tr>
<th>Declaration</th>
<th>Description</th>
<th>read/writeable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health</td>
<td>health</td>
<td>R</td>
</tr>
<tr>
<td>NamPlt</td>
<td>name plate</td>
<td>R</td>
</tr>
<tr>
<td>PhyNam</td>
<td>name plate</td>
<td>R</td>
</tr>
<tr>
<td>PhyHealth</td>
<td>health</td>
<td>R</td>
</tr>
<tr>
<td>Proxy</td>
<td>indicates if proxy</td>
<td>R</td>
</tr>
<tr>
<td>Health</td>
<td>Health</td>
<td>R</td>
</tr>
<tr>
<td>NamPlt</td>
<td>Name plate</td>
<td>R</td>
</tr>
<tr>
<td>Loc</td>
<td>Local operation</td>
<td>R</td>
</tr>
<tr>
<td>TapChg</td>
<td>Change Tap Position</td>
<td>R&amp;W</td>
</tr>
<tr>
<td>ParOp</td>
<td>Parallel/Independent</td>
<td>R&amp;W</td>
</tr>
<tr>
<td>LTCBllk</td>
<td>Block Automatic Control</td>
<td>R&amp;W</td>
</tr>
<tr>
<td>Auto</td>
<td>Automatic/Manual operation</td>
<td>R</td>
</tr>
<tr>
<td>CiLV</td>
<td>Control Voltage</td>
<td>R</td>
</tr>
<tr>
<td>LodA</td>
<td>Load Current (percentage of nominal load current)</td>
<td>R</td>
</tr>
<tr>
<td>BndCtr</td>
<td>Band center voltage</td>
<td>R&amp;W</td>
</tr>
<tr>
<td>BndWid</td>
<td>Band width voltage (as percent of nominal voltage, FPF presumed)</td>
<td>R&amp;W</td>
</tr>
<tr>
<td>ClTDITmms</td>
<td>Control intentional time delay (FPF presumed, in seconds)</td>
<td>R&amp;W</td>
</tr>
<tr>
<td>LDCR</td>
<td>Line drop voltage due to line resistance component (voltage)</td>
<td>R&amp;W</td>
</tr>
<tr>
<td>LDCX</td>
<td>Line drop voltage due to line reactance component (voltage)</td>
<td>R&amp;W</td>
</tr>
<tr>
<td>BkLV</td>
<td>Control voltage below which auto Lower commands blocked (voltage)</td>
<td>R&amp;W</td>
</tr>
<tr>
<td>LimLodA</td>
<td>Limit Load Current (LTC Block Load Current, percentage)</td>
<td>R&amp;W</td>
</tr>
<tr>
<td>LDC</td>
<td>Line Drop Compensation is R and X or Z model (0=R and X, 1=Z compensation)</td>
<td>R&amp;W</td>
</tr>
<tr>
<td>TmDiChr</td>
<td>Time delay linear or inverse characteristic (0=lin., 1=inv.)</td>
<td>R&amp;W</td>
</tr>
<tr>
<td>LDCZ</td>
<td>Line drop voltage due to line total impedance (percentage of nominal voltage)</td>
<td>R&amp;W</td>
</tr>
<tr>
<td>ParAuto</td>
<td>Definition of status ‘parallel automatic’</td>
<td>R</td>
</tr>
<tr>
<td>Master</td>
<td>Master mode (parallel control)</td>
<td>R&amp;W</td>
</tr>
<tr>
<td>Follower</td>
<td>Follower mode (parallel control)</td>
<td>R&amp;W</td>
</tr>
<tr>
<td>Health</td>
<td>health</td>
<td>R</td>
</tr>
<tr>
<td>NamPlt</td>
<td>name plate</td>
<td>R</td>
</tr>
<tr>
<td>OpCnt</td>
<td>operation counter</td>
<td>R</td>
</tr>
<tr>
<td>TapChg</td>
<td>change tap-position</td>
<td>R</td>
</tr>
<tr>
<td>EndPosR</td>
<td>end-position raise reached</td>
<td>R</td>
</tr>
<tr>
<td>EndPosL</td>
<td>end-position lower reached</td>
<td>R</td>
</tr>
<tr>
<td>ExTrTap</td>
<td>extreme tap</td>
<td>R</td>
</tr>
<tr>
<td>OcStep</td>
<td>out-of-step</td>
<td>R</td>
</tr>
<tr>
<td>MotDrvRem</td>
<td>motordrive in ‘remote’</td>
<td>R</td>
</tr>
<tr>
<td>TCIncomp</td>
<td>tap-change incomplete</td>
<td>R</td>
</tr>
<tr>
<td>MotSupFault</td>
<td>OLTC motor supply faulty</td>
<td>R</td>
</tr>
<tr>
<td>ContSupFault</td>
<td>OLTC control supply fault</td>
<td>R</td>
</tr>
<tr>
<td>SupAbsent</td>
<td>AVR-VT supply absent</td>
<td>R</td>
</tr>
<tr>
<td>MotDrv</td>
<td>motordrive-unit lowering/raising tap-position</td>
<td>R</td>
</tr>
<tr>
<td>AbrPrts</td>
<td>percentage level of abrasion parts</td>
<td>R</td>
</tr>
<tr>
<td>OilExCl</td>
<td>percentage level of oil exchange and cleaning</td>
<td>R</td>
</tr>
<tr>
<td>AbsWPt</td>
<td>percentage level of absolute wear point</td>
<td>R</td>
</tr>
<tr>
<td>OilSamp</td>
<td>percentage level of taking oil sampling</td>
<td>R</td>
</tr>
<tr>
<td>OnSTMntv</td>
<td>percentage level of on-site time-interval</td>
<td>R</td>
</tr>
</tbody>
</table>
## Declaration

<table>
<thead>
<tr>
<th>Declaration</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mod</td>
<td>mode</td>
</tr>
<tr>
<td>Beh</td>
<td>behaviour</td>
</tr>
<tr>
<td>Health</td>
<td>health</td>
</tr>
<tr>
<td>Loc</td>
<td>local operation</td>
</tr>
<tr>
<td>TapChg</td>
<td>change tap-position</td>
</tr>
<tr>
<td>ParOp</td>
<td>parallel/independent</td>
</tr>
<tr>
<td>LTCBlk</td>
<td>block automatic control; control-point for automatic/manual mode</td>
</tr>
<tr>
<td>Auto</td>
<td>automatic/manual operation; status information about automatic/manual operation-mode</td>
</tr>
</tbody>
</table>

## DataSet01, report

<table>
<thead>
<tr>
<th>Declaration</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CtlV</td>
<td>control voltage</td>
</tr>
<tr>
<td>LodA</td>
<td>load current (percentage of nominal load current)</td>
</tr>
</tbody>
</table>

## DataSet02, report

<table>
<thead>
<tr>
<th>Declaration</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mod</td>
<td>mode</td>
</tr>
<tr>
<td>Beh</td>
<td>behaviour</td>
</tr>
<tr>
<td>Health</td>
<td>health</td>
</tr>
<tr>
<td>OpCnt</td>
<td>operation counter</td>
</tr>
<tr>
<td>TapChg</td>
<td>change tap-position</td>
</tr>
<tr>
<td>EndPosR</td>
<td>end-position raise reached</td>
</tr>
<tr>
<td>EndPosL</td>
<td>end-position lower reached</td>
</tr>
<tr>
<td>ExtrTap</td>
<td>extreme tap</td>
</tr>
<tr>
<td>OoStep</td>
<td>out-of-step</td>
</tr>
<tr>
<td>MotDrvRem</td>
<td>motordrive in ’remote’</td>
</tr>
<tr>
<td>TCIncomp</td>
<td>tap-change incomplete</td>
</tr>
<tr>
<td>MotSupFault</td>
<td>OLTC motor supply faulty</td>
</tr>
<tr>
<td>ContSupFault</td>
<td>OLTC control supply fault</td>
</tr>
<tr>
<td>SupAbsent</td>
<td>AVR-VI supply absent</td>
</tr>
<tr>
<td>MotDrv</td>
<td>motordrive-unit lowering/raising tap-position</td>
</tr>
</tbody>
</table>

## DataSet03, report

<table>
<thead>
<tr>
<th>Declaration</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AbrPrts</td>
<td>percentage level of abrasion parts</td>
</tr>
<tr>
<td>OilExCl</td>
<td>percentage level of oil exchange and cleaning</td>
</tr>
<tr>
<td>AbsWPt</td>
<td>percentage level of absolute wear point</td>
</tr>
<tr>
<td>OilSamp</td>
<td>percentage level of taking oil sampling</td>
</tr>
<tr>
<td>OnSTmIntv</td>
<td>percentage level of on-site time-interval</td>
</tr>
</tbody>
</table>
### Declaration

<table>
<thead>
<tr>
<th>Mod</th>
<th>mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beh</td>
<td>behaviour</td>
</tr>
<tr>
<td>Health</td>
<td>health</td>
</tr>
<tr>
<td>OpCnt</td>
<td>operation counter</td>
</tr>
<tr>
<td>TapChg</td>
<td>change tap-position</td>
</tr>
<tr>
<td>EndPosR</td>
<td>end-position raise reached</td>
</tr>
<tr>
<td>EndPosL</td>
<td>end-position lower reached</td>
</tr>
<tr>
<td>ExtrTap</td>
<td>extreme tap</td>
</tr>
<tr>
<td>OoStep</td>
<td>out-of-step</td>
</tr>
<tr>
<td>MotDrvRem</td>
<td>motordrive in 'remote'</td>
</tr>
<tr>
<td>TCIncomp</td>
<td>tap-change incomplete</td>
</tr>
<tr>
<td>MotSupFault</td>
<td>OLTC motor supply faulty</td>
</tr>
<tr>
<td>ContSupFault</td>
<td>OLTC control supply fault</td>
</tr>
<tr>
<td>SupAbsent</td>
<td>AVR-VT supply absent</td>
</tr>
<tr>
<td>MotDrv</td>
<td>motordrive-unit lowering/raising tap-position</td>
</tr>
</tbody>
</table>

### DataSet01, report

Data with FC='ST' (YLTC1)

| AbrPrts | percentage level of abrasion parts |
| OilExCl | percentage level of oil exchange and cleaning |
| AbsWPT | percentage level of absolute wear point |
| OilSamp | percentage level of taking oil sampling |
| OnSTmlntv | percentage level of on-site time-interval |
10.3 Physical connection

Connection to the system plane must be established by means of a network cable via the RJ45 interface on the rear of the TAPCON® 260 D. The speed is then automatically managed in a range between 10 and 100 Mbit per second.

Calibration of the configuration data between the customer or system developer and MR is required before the TAPCON® 260 D is first put into operation. In this process MR transmits the ICD file (Intelligent electronic device Configuration Description) to the customer or system developer on request and obtains in return the calibrated configuration details via CID file (Configured Intelligent electronic Device).

Parameterizing of the TCP/IP address, subnet mask and time server address can also be performed subsequently. This can be done either directly on the TAPCON® 260 D via the corresponding screens or on a PC or laptop using the "TAPCON-trol System" visualization software. The system time for the SID card is consequently set via the SNTP (Simple Network Time Protocol) time server.

Note: To avoid possible difficulties with regard to EMC, it is important to use a shielded cable for the Ethernet connection. The shielding of the cable must be connected to earth (e. g. via a clip on the CPU card of the TAPCON® 260 D; cf. the chapter "Commissioning" → "Connection").
The optional MC1-card is used to convert the electrical signal of the SID-card into an fibre-optical connection of type FH-ST connectors. The wavelength of the fibre optical connection is 1300 nm.

To connect the power supply via clamps 1 and 2, please refer to the wiring scheme of the device.

The following table defines the setting of the buttons, located as shown in the figure.

<table>
<thead>
<tr>
<th>Button description</th>
<th>Configuration state</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDI</td>
<td>for crossed or patch cable configuration between SID-card and MC1-card</td>
</tr>
<tr>
<td>MDI-X</td>
<td>button pressed</td>
</tr>
<tr>
<td>A/N ON</td>
<td>100 MBit with TX and RX in full or half duplex mode (auto negotiate)</td>
</tr>
<tr>
<td>A/N OFF</td>
<td>button released</td>
</tr>
<tr>
<td>M/L ON</td>
<td>In 'M/L' (missing link) the communication via copper is permanently disturbed if the link via fibre optic is disturbed.</td>
</tr>
<tr>
<td>LNK TST</td>
<td></td>
</tr>
</tbody>
</table>

10.4 Setting the network mask

The network mask and the IP address must be entered for linking the TAPCON® 260 D to the IEC61850 control system. These values are defined by the available network and can be obtained from your Intranet or Internet provider.

Each of the addresses consists of four single blocks of three digits each. Use the key to switch between all twelve digits together. Use the arrow keys to select the digits.

The address of the time server can be set with this parameter. This is necessary for the time offset of the polling to and from the control system.

The network mask and the IP address must be entered for linking the TAPCON® 260 D to the IEC61850 control system. These values are defined by the available network and can be obtained from your Intranet or Internet provider.

Each of the addresses consists of four single blocks of three digits each. Use the key to switch between all twelve digits together. Use the arrow keys to select the digits.
11 Implementation of TAPGUARD® 240 in the TAPCON® 260 D

11.1 Features of the TAPGUARD® 240 Basic Unit

The front panel of TAPGUARD® 240 contains an LCD graphic display, several LEDs and various function and menu keys.

The device is controlled by a microcontroller (see appendix, block circuit/connection diagram) and contains potential-separated optocoupler inputs and potential-free relay output contacts, in addition to voltage and current transformers.

A serial interface (RS232) integrated in the front panel of TAPGUARD® 240 can be used to parameterize TAPGUARD® 240 with the aid of a PC. The necessary software is included.

The standard model of TAPGUARD® 240 is equipped with a measured value recorder in which data (e.g., run through operating positions of the on-load tap-changer, the switched currents and the wear on the contacts) are automatically stored. These data can be downloaded with the visualization software of TAPGUARD® 240 and then edited on a PC and viewed.

**NOTE**

Each TAPGUARD® 240 is configured for a defined on-load tap-changer. These parameters cannot be used for other on-load tap-changers without first consulting MR since the parameters are based on the type of on-load tap-changer, on the one hand, and on the tap-changer’s particular operating state, on the other hand.

The included visualization software can be used to notify the technical service department of MR so that changes in these configuration data can be made. A change in the general configuration must always be accompanied by an update of the firmware. The only exceptions are the parameters of the visualization software.
11 Implementation of TAPGUARD® 240 in the TAPCON® 260 D

11.2 Technical Data

Operator control elements, indicators

<table>
<thead>
<tr>
<th>Function keys</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote/supry</td>
<td>Graphic, monochrome display, 128 x 128 pixels</td>
</tr>
<tr>
<td>Manual/automatic</td>
<td>1 LED (green)</td>
</tr>
<tr>
<td>Raise/lower</td>
<td>1 LED each (red)</td>
</tr>
<tr>
<td>Menu keys</td>
<td>1 LED (yellow)</td>
</tr>
<tr>
<td></td>
<td>1 LED (green)</td>
</tr>
<tr>
<td></td>
<td>3 LEDs (yellow)</td>
</tr>
<tr>
<td></td>
<td>1 LED (green/yellow/red)</td>
</tr>
</tbody>
</table>

Only in combination with functions of the TAPCON®

Preset for the functions of the TAPCON® voltage regulator

11.3 Configuring the Settings

This chapter describes all the settings for configuration of system-specific data of the TAPGUARD® 240 in addition to the chapters before.

To make it easier to find certain parameters, subgroups were created with functionally related individual parameters.

11.3.1 Memory

Specification of the time and the date is used to organize the measured results by the time at which they occurred.

NOTE

With the optional combination of TAPGUARD® and TAPCON®, additional menus, subdirectories and parameters appear which are described separately in the operating instructions of TAPCON® and in related supplement sheets.
11 Implementation of TAPGUARD® 240 in the TAPCON® 260 D

11.3.2 Maintenance

Announcement of abrasion parts replacement
This value is specified as a percentage.
Menu → Configuration → Maintenance

Announcement of diverter switch insert replacement
This value is specified as a percentage.
Menu → Configuration → Maintenance

Announcement that maximum contact wear has been reached
This value is specified as a percentage.
Menu → Configuration → Maintenance

Announcement of oil sample test
This value is specified as a percentage.
Menu → Configuration → Maintenance

Announcement of tap selector inspection
This value is specified as a percentage.
Menu → Configuration → Maintenance
11.3.3 OLTC

On-load tap-changer type
Specification of the on-load tap-changer basic type which will be used for the configuration of the system.
Menu → Configuration → OLTC

Fabrication number of the on-load tap-changer
The on-load tap-changer can be internally assigned a fabrication number for better identification during archivation.
Menu → Configuration → OLTC

Lower operating position
Specification of the lowest operating position of the on-load tap-changer. This defines the lower limit for the indication of the on-load tap-changer positions within the software.
Menu → Configuration → OLTC

The status line alternately shows "Messages" and "Extreme Tap" for approx. 10 s, if switching to "Lower" at the lowest tap position or "Higher" at the highest tap position is required. The switching pulses themselves are suppressed.

Upper operating position
Specification of the uppermost operating position of the on-load tap-changer. This defines the upper limit for the indication of the on-load tap-changer positions within the software.
Menu → Configuration → OLTC

The status line alternately shows "Messages" and "Extreme Tap" for approx. 10 s, if switching to "Lower" at the lowest tap position or "Higher" at the highest tap position is required. The switching pulses themselves are suppressed.

Medium tap voltage of the on-load tap-changer
Menu → Configuration → OLTC
11 Implementation of TAPGUARD® 240 in the TAPCON® 260 D

Transition resistor R1 of the on-load tap-changer
Menu → Configuration → OLTC

Transition resistor R2 of the on-load tap-changer
Menu → Configuration → OLTC

Factor of internal current division
Menu → Configuration → OLTC

Number of parallel sectors
Menu → Configuration → OLTC

NOTE
The parameters marked with *) are individually set at the factory for each on-load tap-changer. They cannot be changed by the user.
11.3.4 Contacts

Wear on transition contacts WKA or WK1A in mm (depending on the type of on-load tap-changer)
This value can only be changed by a service representative.
Note:
The movable and fixed contact parts were combined for this value.
Menu → Configuration → Contacts

Wear on transition contacts WKB or WK1B in mm (depending on the type of on-load tap-changer)
This value can only be changed by a service representative.
Note:
The movable and fixed contact parts were combined for this value.
Menu → Configuration → Contacts

Wear on main contact SKA in mm
This value can only be changed by a service representative.
Note:
The movable and fixed contact parts were combined for this value.
Menu → Configuration → Contacts

Wear on main contact SKB in mm
This value can only be changed by a service representative.
Comment: It is not necessary to enter this parameter for the OLTC's of the type OILTAP® V.
Note:
The movable and fixed contact parts were combined for this value.
Menu → Configuration → Contacts
11 Implementation of TAPGUARD® 240 in the TAPCON® 260 D

Wear on transition contact WK2A in mm
This value can only be changed by a service representative. Comment: This parameter is just in use for specific OLTC's. It is not necessary to enter this parameter for the OLTC's of the type OILTAP® V.

Note:
The movable and fixed contact parts were combined for this value. Certain types of on-load tap-changers do not have these contacts. In this case, the remaining thickness is specified as "0." Menu → Configuration → Contacts

Wear on transition contact WK2B in mm
This value can only be changed by a service representative. Comment: This parameter is just in use for specific OLTC's. It is not necessary to enter this parameter for the OLTC's of the type OILTAP® V.

Note:
The movable and fixed contact parts were combined for this value. Certain types of on-load tap-changers do not have these contacts. In this case, the remaining thickness is specified as "0." Menu → Configuration → Contacts

NOTE
If wear parameters are wrongly entered internal miscalculations can result. If contacts are interchanged during service work on the on-load tap-changer it is imperative to start by entering the wear values of the six indicated contacts as "0" and save them. Then the current wear values can be entered and saved. This procedure ensures that all essential internal date of the adaptive wear determination are correctly initialized.

11.3.5 User
Interval of number of operations of the user
This number is specified in 1000 s. This means that an entry of "100" stands for a number-of-operations interval of "100,000".

Note:
- Event or message based on the number of operations
  - The user can set a number-of-operations interval.
  - When the user number-of-operations message is reset, the start and end of the interval is saved.
  - The current operations counter is taken as the starting value after the reset.
  - The percentage for the display is determined from the starting value, the end value and the current operations counter.
  - The operations performed after the reset are output as the "operations counter of the user" (screen below "Info").
Menu → Configuration → User
Announcement that the user number of operations has been reached

**Note:**
Event or message based on the number of operations
- The user can set a number-of-operations interval.
- When the user number-of-operations message is reset, the start and end of the interval is saved.
- The current operations counter is taken as the starting value after the reset.
- The percentage for the display is determined from the starting value, the end value and the current operations counter.
- The operations performed after a reset are output as the "operations counter of the user" (screen below "Info").

Menu → Configuration → User

---

Time interval of the user

This value is specified in "years" and is used in combination with the "date of user interval" as the basis for calculation of the status bar in the indication of the current measured values.

**Note:**
Event or message based on the time
- The user can set a time interval.
- When the user time message is reset, only the due date (user interval date) is saved.
- The percentage for the display is determined from the user time interval and the current date.
- When the time interval changes, the percentage which is shown as a bar is automatically changed.

Menu → Configuration → User

---

**Note**

The internal operations counter of the TAPGUARD® works independently from the motor-drive and is used for internal calculations only.
11 Implementation of TAPGUARD® 240 in the TAPCON® 260

Date limit of the user
The date is always automatically set when the "time interval, user" is reset. However, the user can manually adjust both the date and the time. The date limit is used in combination with "time interval, user" as the basis for calculation of the status bar for indication of the current measured values.

Note:
Event or message based on the time
- The user can set a time interval.
- When the user time message is reset, only the due date (user interval date) is saved.
- The percentage for the display is determined from the due date (user time interval date) user time interval and the current date.
- When the time interval changes, the percentage which is shown as a bar is automatically changed.

Menu → Configuration → User

11.3.6 Service

Password within the TAPGUARD® for service personnel
After entry of the password, additional standard parameters can be adjusted.
Not until the valid password is entered do the following additional parameter displays appear under the "Service" submenu.
Menu → Configuration → Service

Announcement of the user time interval as percentage

Note:
Event or message based on the time
- The user can set a time interval.
- When the user time message is reset, only the due date (user interval date) is saved.
- The percentage for the display is determined from the user time interval date and the current date.
- When the time interval changes, the percentage which is shown as a bar is automatically changed.

Menu → Configuration → User

Reset the parts replacement criterion
Entering "YES" confirms that maintenance was performed correctly in accordance with the on-load tap-changer maintenance guidelines.
Menu → Configuration → Service
Reset the oil change and cleaning criterion
Entering “YES” confirms that maintenance was performed correctly (oil change and cleaning) in accordance with the on-load tap-changer maintenance guidelines.
Menu → Configuration → Service

Reset the diverter switch insert criterion
Entering “YES” confirms that maintenance was performed correctly in accordance with the on-load tap-changer inspection guidelines.
Menu → Configuration → Service

Reset the tap selector inspection criterion
Entering “YES” confirms that maintenance was performed correctly in accordance with the on-load tap-changer maintenance guidelines.
Menu → Configuration → Service

Reset the oil sample criterion
Entering „YES“ confirms that maintenance was performed correctly in accordance with the on-load tap-changer maintenance guidelines.
Menu → Configuration → Service

Reset the number-of-operations limit specified by the user
Selecting “YES” confirms that maintenance was performed correctly.

**Note:**
Event or message based on the number of operations
- The user can set a number-of-operations interval.
- When the “user number of operations” message is reset, the start and the end of the interval are saved.
- The current number-of-operations counter is taken as the start value after the reset.
- The percentage for the display is determined from the start value, end value and current number-of-operations counter.
- The operations performed after a reset are output as the number-of-operations counter of the user, (screen below “Info”).
Menu → Configuration → Service
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Reset the time interval specified by the user
Selecting "YES" confirms that maintenance was performed correctly.

**Note:**
Event or message based on the time
- The user can set a time interval.
- When the user time message is reset, only the due date (user interval date) is saved.
- The percentage for the display is determined from the user time interval date and the current date.
- When the time interval changes, the percentage which is shown as a bar is automatically changed.
Menu → Configuration → Service

Reset of the oil filter cartridge
Selecting "YES" confirms that maintenance of the oil filter system and the replacement of the insert were performed correctly.
Menu → Configuration → Service

11.4 Info/Measured Values Menu
This menu item gives you information on TAPGUARD® as well as measured values and the folder on equipment management.

Subgroups of related information were created to make it easier for you to find the information you are looking for.

Indication of whether all parameters are stored correctly after a new start of TAPGUARD® or after a parameter record has been transferred.
If a parameter was not stored correctly, this is shown and can then be set to a standard default value with F1.
All values are set to standard values with F3 and F4.

**NOTE**
Values which were already individually adjusted and set are also set to the standard values.
11.4.1 Status

Indication of queued messages
Queued messages are shown in the regular monitor screens. The three text lines (illustrated here as an example) give the user information on which events or maintenance jobs are queued.

The display can be turned off by pressing the "ENTER" key below the display. However, as long as service has not been performed and the necessary reset has not been initiated, the warning will continue to appear after every operation.

11.4.2 Pending Maintenance Jobs

The following display gives you information on the current status of the maintenance jobs. Five so-called fill bars indicate how far along the service criteria of the equipment have progressed.

Press and hold down the keys F1, F2, F3, F4 or F5 (see text inside the fill bar) which are located to the right of the display to obtain additional information on the selected criterion (e.g., the projected value of expected date of service) in another display. As soon as you release the F1, F2, F3, F4 or F5 key, the display with the five bars appears again.

NOTE
The display indicates that no maintenance jobs are queued at this time.

NOTE
Three of the bars in the display indicate the progression of the maintenance criteria. The criteria for the oil change have progressed the furthest.
11.4.3 Info "LOG File"

The LOG file contains the confirmations of performed maintenance jobs. Both the designation and the date and time are listed.

After service is performed and the reset is activated (cf. chapter on Parameter assignment → Service → Password), the designation and the time of reset are automatically entered in the LOG file.

![LOG File Image]

**NOTE**

The LOG file cannot be edited on the TAPGUARD® itself. Desired texts can only be created manually with the included visualization software and then transferred to TAPGUARD®.