Reference manual

REACTIVE POWER REGULATOR

CX plus

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1. Revision list

Date	Name	Revision	Comment
28.06.17	ChP	1.0	First edition
07.07.17	ARP	2.0	Revision of the schematic menu view
07.08.18	SO	3.0	Adaptation to software version 1.1
26.03.19	SMi	3.1	New revision numbering, content and structural adjustments, addition of transistor type
30.12.20	Le	3.2	Adaptation to the new THD-I and step detection settings
30.07.2024	AVS	4	Firmware update 01.04.0 Menu items 210, 406, 518, 524, 525, 901 - 904

2. Safety instructions

The **safety notes and instructions** must be read carefully and thoroughly. Familiarize yourself with the appliance before installing and operating it. The following symbols are used in the manual and on the back of the appliance to highlight hazards or provide special instructions.

! DANGER
DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

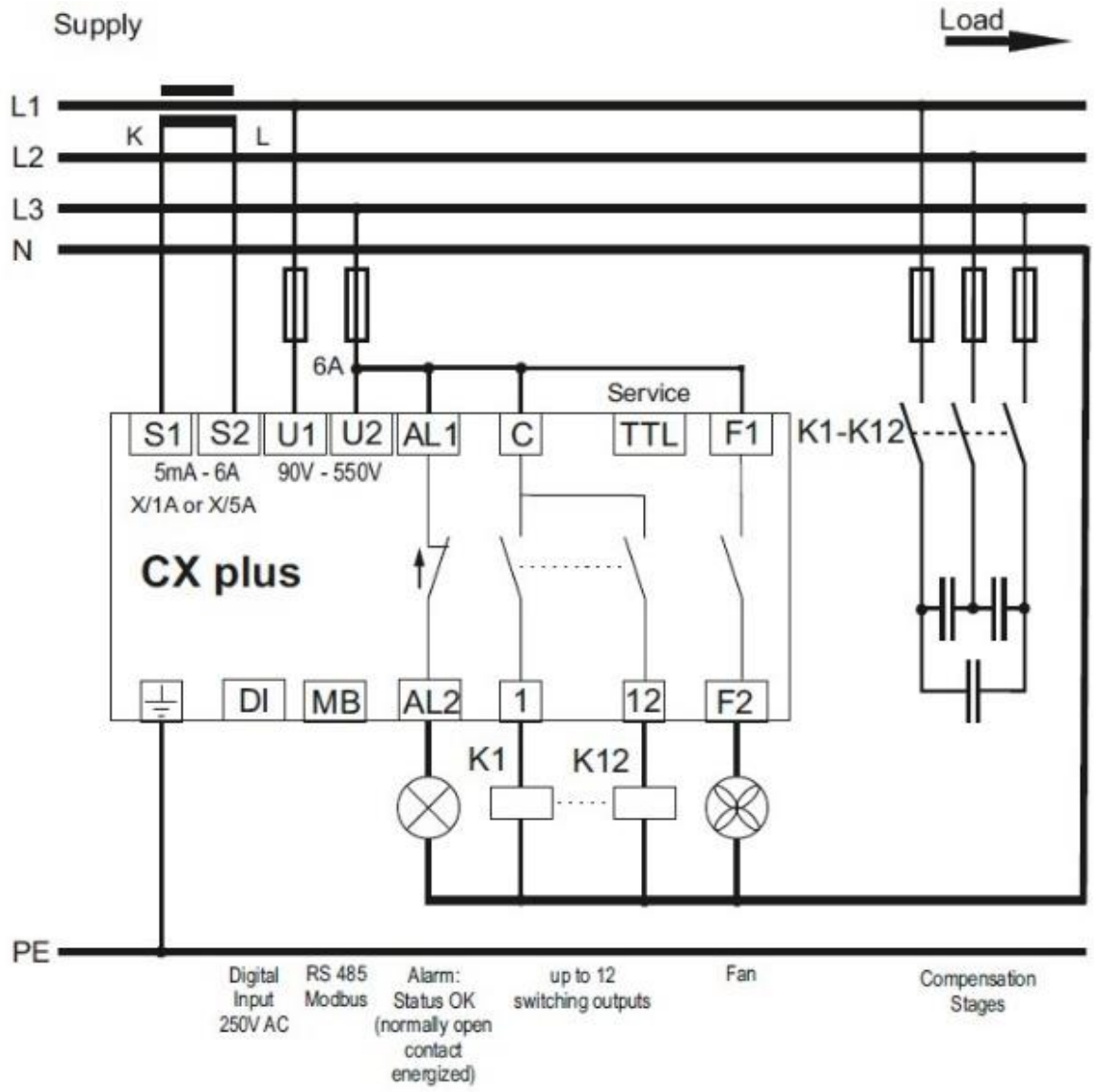
! WARNING
WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

! ATTENTION
CAUTION indicates circumstances which may damage or destroy the appliance if not observed, but which will not result in injury.

NOTE Fields contain information on certain functional features. They provide information on the correct operation of the device.

3. Connection

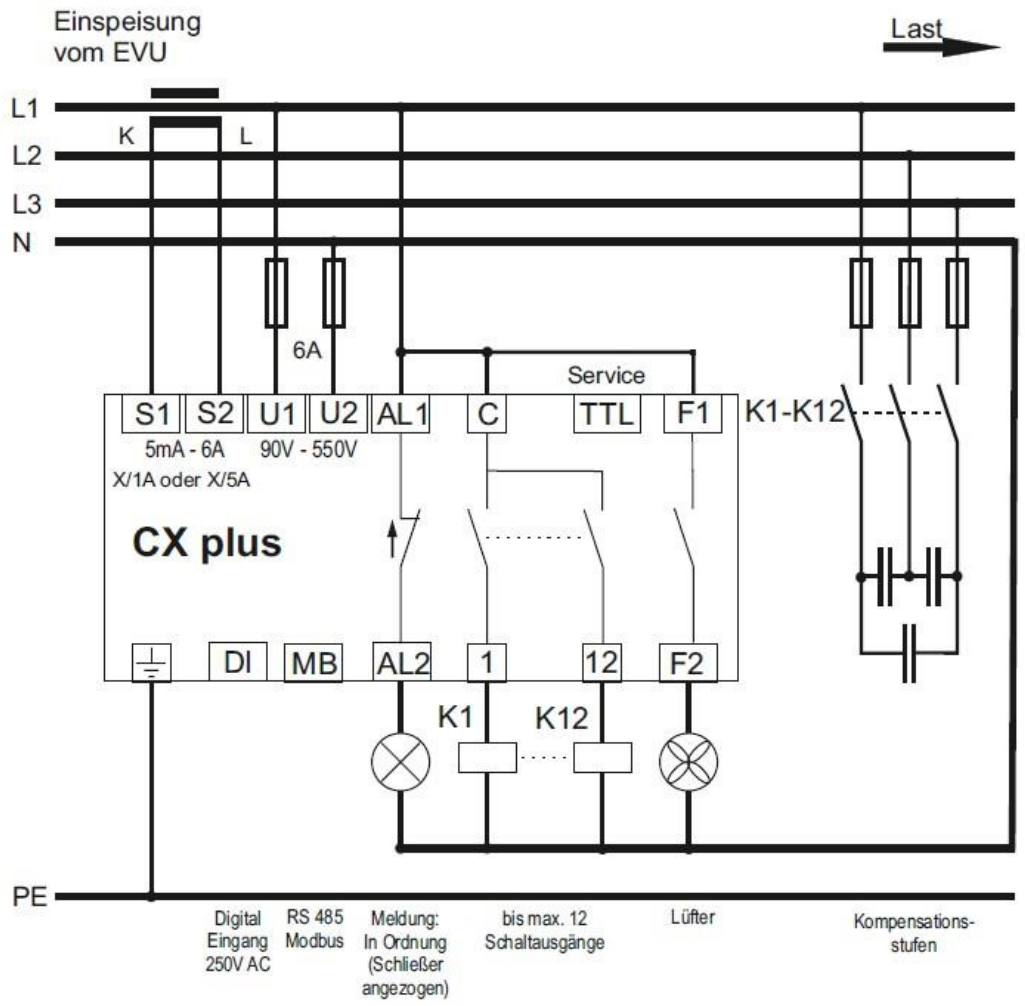
3.1 CX plus -12R



NOTE: The CX plus is designed for the operation of **capacitive or inductive** stages. A mixed connection of capacitive and inductive stages is not possible.

NOTE: The relay switching outputs are **not** suitable for controlling thyristor controllers.

3.2 CX plus -12T



NOTE: The CX plus is designed for the operation of **capacitive or inductive** stages. A mixed connection of capacitive and inductive stages is not possible.

3.3 Options list

Designation		Option
CX plus	-06R	6 stage outputs, type: relay
	-12R	12 stage outputs, type: relay
	-06T	6 stage outputs, type: transistor
	-12T	12 stage outputs, type: transistor
	-MB	Modbus RTU, RS485
	-nc	Signal or alarm relay, type: NC contact

3.4 Connections

Measuring / supply voltage	
	Combined voltage measurement and supply Terminals: U1 / U2 Conversion factor: 1.0 - 350.0
Current measurement	
	Current measurement Terminals: S1 (K) / S2 (L) Conversion factor: 1 - 9600 Use of x/1 and x/5 converters possible
Step outputs	
Option -xxR	Type: Relay, NO contact, potential-free Supply terminal: C Output terminal: 1 - 6 or 1 - 12
Option -xxT	Type: Transistor, normally open contact, open collector output Supply terminal: C Output terminal: 1 - 6 or 1 - 12
Fan output	
	Closes when the set temperature limit TEMP1 is exceeded or can alternatively be used as the 7th or 13th switching output for a stage Type: Relay, NO contact, potential-free Terminals: F1 / F2
Alarm output	
Standard	Closed in normal operating state, opens in the event of an alarm Type: Relay, NO contact, potential-free Terminals: AL1 / AL2
Option -nc	Open in normal operating state, closes in the event of an alarm Type: Relay, NC contact, potential-free Terminals: AL1 / AL2
Digital input	
	Switching between target cos φ 1 and target cos φ 2, suppression of the I-Low alarm or as external alarm input Logic: Adjustable, high or low active Terminals: I1 / I2

Modbus	
Standard	Not equipped
Option -MB	Serial communication Protocol: Modbus-RTU Interface: RS485 Terminals: + / GND / -
Service interface	
	For service purposes only

3.5 Installation

! DANGER

Installation, commissioning and maintenance may only be carried out by a qualified electrician with the necessary qualifications. A qualified electrician is a person who has the ability, experience and the necessary knowledge for the construction, installation and operation of electrical devices and systems, and who has been instructed in the recognition and avoidance of potential hazards.

During installation, the relevant regulations on the installation of switchgear and accident prevention must be observed. Devices with damaged or open housings or terminals must not be connected to the mains and must be disconnected immediately.

Before disconnecting the current measurement path from the device or the current transformer, the current transformer must be short-circuited. Failure to do so can lead to a life-threatening voltage at the connections of the current measurement path or the transformer. The transformer will be destroyed by a persistently high voltage.

1) Before installation, the connection data of the CX plus must be compared with the network data.

2) The working area must be de-energized and secured against unauthorized and unintentional reconnection. The absence of voltage must be determined using a standardized measuring device. The de-energized system must be grounded and short-circuited. Neighboring live parts must be covered and/or fenced off.

3) The current transformer must be short-circuited. A current transformer that is **not** short-circuited generates a very high voltage that endangers people and appliances. This can lead to the destruction of the current transformer.

4) Insert the CX plus into the control panel cut-out and secure it with the two fastening clips.

5) The protective earth conductor must be connected to the PE connection provided on the rear of the metal.

6) All connecting cables must be connected in accordance with chapter 3. must be connected. On the current transformer, the K connection must be connected to terminal S1 and the L connection to terminal S2.

7) The current transformer bridge must be removed.

8) The voltage can now be switched on.

9) If the connection is correct, the display lights up for one second and all symbols are shown as part of a display test.

10) Start the **First Setup** by confirming **YES**. The individual points must be configured according to the network. If you have any questions about operating the CX plus, please refer to chapter 6. . The individual points of the **First Setup** are described in chapter 9. in detail.

11) After a successful **First Setup**, **AUTO** appears on the display. Regulation starts after the discharge timeout has expired.

4. Commissioning

The standard settings in the CX plus are selected so that commissioning in the 400 V network (according to the circuit diagram) is as simple as possible. Only the current transformer factor must be entered for correct calculation of the measured values and for correct recognition of the step sizes (SETUP/Ct). The measured values for current and power are only displayed if a current transformer factor has been set.

If the measured voltage and the measured current are within the tolerance, **AUTO** and the currently measured cosφ are shown on the display. Normally, the cosφ should be inductive. This is symbolized in the display by a small **i** behind the first line. From this moment on, the discharge time block of the capacitors is active. Once the discharge time block has expired, the CX plus starts regulation. During control, the tap sizes are automatically recognized. Unused stage outputs are set to stage type **FOFF** if the first three switching operations were unsuccessful. This symbolizes that these stages will be ignored by the controller in future.

If the connection of the measured voltage and current results in a phase angle between voltage and current that is not equal to 0° (voltage measurement L-N) or 90° (voltage measurement L-L), the **auto initialization** must be carried out or the phase correction angle (SETUP/206) must be entered manually. To determine the phase correction angle manually, see chapter 19. Information is provided.

NOTE: Automatic initialization determines the phase position between the measured voltage and the measured current, as well as the assignment of the switching outputs. Automatic detection of the stage variables only takes place during normal control operation.

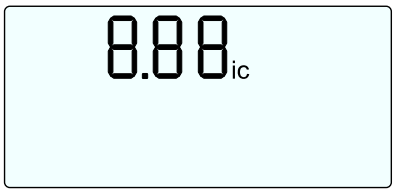
NOTE: Automatic initialization is only possible in conjunction with capacitive stages. The use of inductive stages requires manual input of the phase correction angle (SETUP/206) and manual input of the stage sizes (SETUP/402).

5. Indications in the display

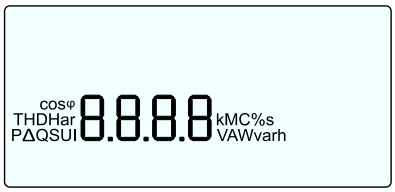
5.1 General

The currently selected main menu is shown on the right-hand side of the display.

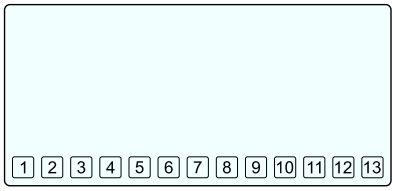
AUTO or No display	Measured values menu
INFO	Level database
AUTO	Automatic control is active (purely informative, no menu function)
MANUAL	Switch stages on and off manually
SETUP	Settings
ALARM	Alarm memory



The current cos φ is shown in the first line of the display in the main menu. The small **i** or **c** indicates whether the cos φ is **inductive** or **capacitive**. In the respective submenus, this line represents the individual sub-items.

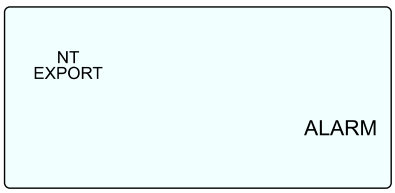


The second line of the display shows the setting and measured values (center) with the corresponding abbreviations (left) and the units (right). Messages are also displayed in this line.



The switching outputs can be found in the bottom line. The stage numbers displayed represent stages that are switched on. If a stage is detected as defective, the corresponding stage symbol flashes.

In the menu of the stage database and the stage settings, the stage symbol of the selected stage flashes here.



NT	The target cos φ 2 is active as a control target.
EXPORT	Regeneration of active power is present**.**

ALARM This symbol flashes when an alarm message is present.

5.2 Alarm messages

In the event of an alarm, the **ALARM** indicator on the CX plus also flashes an alarm message on the display. If several alarms are active, the alarm messages are alternated after flashing three times.

U ALARM	The measured voltage is outside the set tolerance.
I Lo ALARM	The measuring current is less than 5 mA.
I hi ALARM	The measuring current is greater than 6 A.
PFC ALARM	The controller cannot achieve the compensation target.
HArU ALARM	The set limit for the THD of the voltage has been exceeded.
HArI ALARM	The set limit for the THD of the current has been exceeded.
StEP **FltY** ALARM	One or more stages are defective. The stage symbols of the defective stages flash with the alarm message. The error codes **Step** and **FLty** flash alternately.
SPL **No** ALARM	The stage power of one or more stages has fallen below 75% of the initial power. The error code and stage number flash alternately. Only the smallest affected stage number is displayed.
thi ALARM	The second temperature limit was exceeded.
OPh ALARM	Set limit value for operating hours exceeded.
OPC **No** ALARM	The set limit for the maximum permissible switching cycles of one or more stages has been exceeded. The error code and stage number flash alternately. Only the smallest affected stage number is displayed.
OPh **No** ALARM	Set limit of maximum permissible operating hours of one or more stages exceeded. The error code and stage number flash alternately. Only the smallest affected stage number is displayed.
SYS **004F** ALARM	There is a system alarm. The message **SYS** appears on the display, alternating with a four-digit error code. The device is defective and must be returned to BELUK GmbH.

di ALARM	An external alarm signal is present at the digital input. The digital input alarm is active.

NOTE: Alarm messages are only displayed in the main window. The **INFO**, **MANUAL**, **SETUP** or **ALARM** menu items must not be selected for this.

NOTE: Depending on the configuration (SETUP/501), **alarms that are no longer pending** are automatically reset after 15 s or must be reset manually by pressing the◄ (ESC) button (3 s).

5.3 Error and status messages

Error messages:

Ai / Abrt	Automatic initialization was aborted due to an error. The control has been switched off.

NOTE: An error message can be reset by pressing (3 s) the◄ (ESC) button.

Status messages:

FAn	The temperature limit TEMP1 has been exceeded and the fan relay is switched on.
PFC / OFF	The control is switched off.
PFC / Hold	The regulation is stopped.

NOTE: Status messages **cannot** be reset by pressing the◄ (ESC) button.

NOTE: Error and status messages are only displayed in the main window. The **INFO**, **MANUAL**, **SETUP** or **ALARM** menu items must not be selected for this.

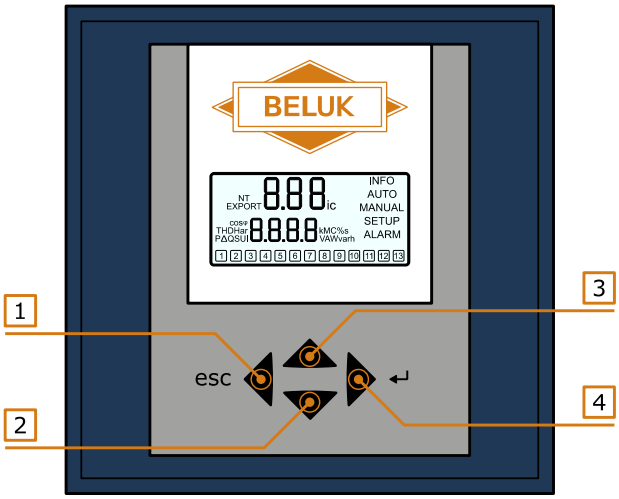
NOTE: The messages **Ai** / **Abrt**, **PFC** / **OFF**, **PFC** / **Hold** and **FAn** are only displayed in the main window if no alarm is signaled.

NOTE: Only **one** active error or status message is displayed. The error message **Ai** / **Abrt** has priority over the status messages **FAn**. This in turn has priority over **PFC** / **OFF** or **PFC** / **Hold**.

6. Operating the controller

6.1 Operating concept

The CX plus is operated using 4 buttons. If no button is pressed within 60 seconds, the backlighting switches off. If the backlighting is switched off, pressing one of the 4 buttons first switches the backlighting back on again. A reaction in the user menu only occurs when a button is pressed again. Depending on the respective menu item, the operating buttons have different functions.



1
- Exit menu item
- Move cursor to the left
- Reset alarm (press and hold for 3 seconds)

2
- Reduce values
- Select the next measured value, menu item or step number

3
- Increase values
- Select previous measured value, menu item or step number

4
- Open menu item
- Move cursor to the right
- Adopt value

6.2 Entering values

If a menu item has been selected, the first digit of the current value flashes. Digits can be increased or decreased by pressing the buttons ▲ and .

Press the ▶ button to switch to the next digit. Press the ◀ button to return to the previous position.

Once the last digit (right) has been selected and the ▶ button is pressed again, a multiplier **k** (kilo) or **M** (mega) can be set using the ▲ and ▼ buttons if required. To accept the value and complete the entry, press the ▶ button again.

If a set value is not accepted or a different value is displayed after entry, one possible cause is that the previously set value has exceeded or fallen below the limit of the setting range.

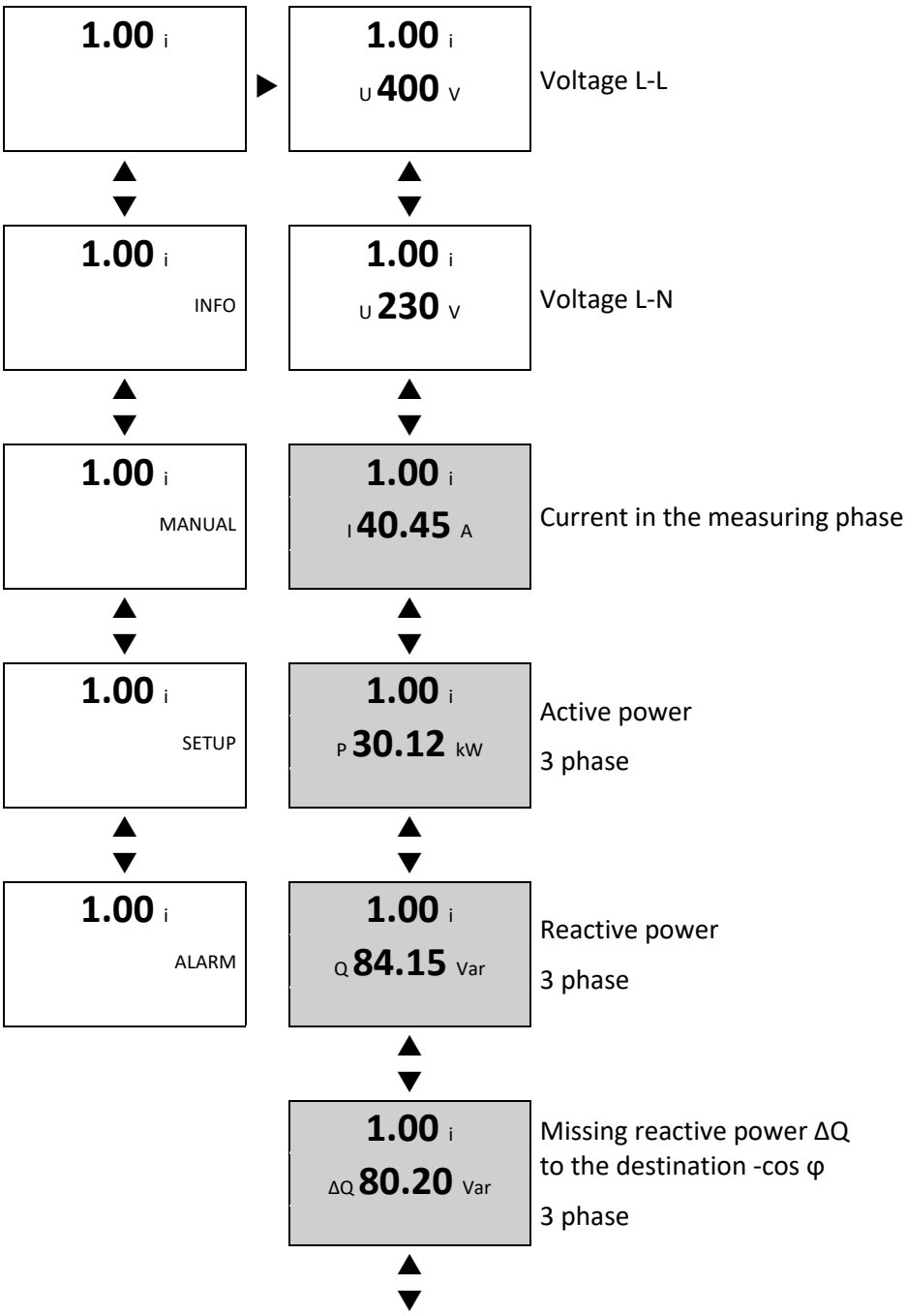
The entry of a value can be canceled at any time using the ◀ button. To do this, press the ◀ button repeatedly until the first digit (left) is selected. Pressing the ◀ button again cancels the entry without accepting the new value.

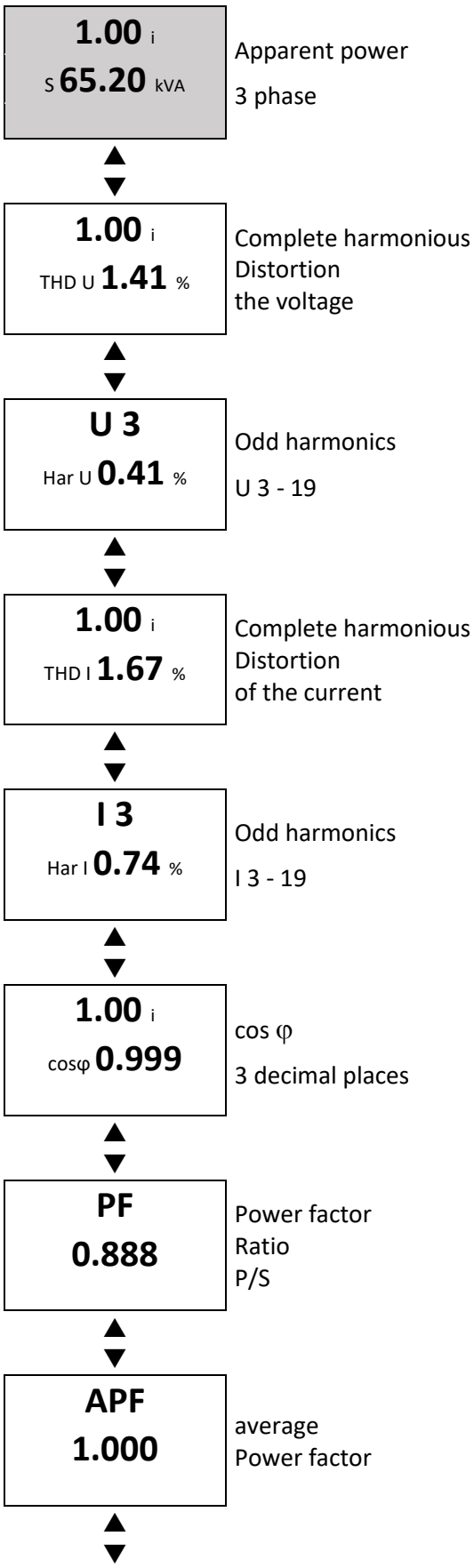
7. Menu navigation

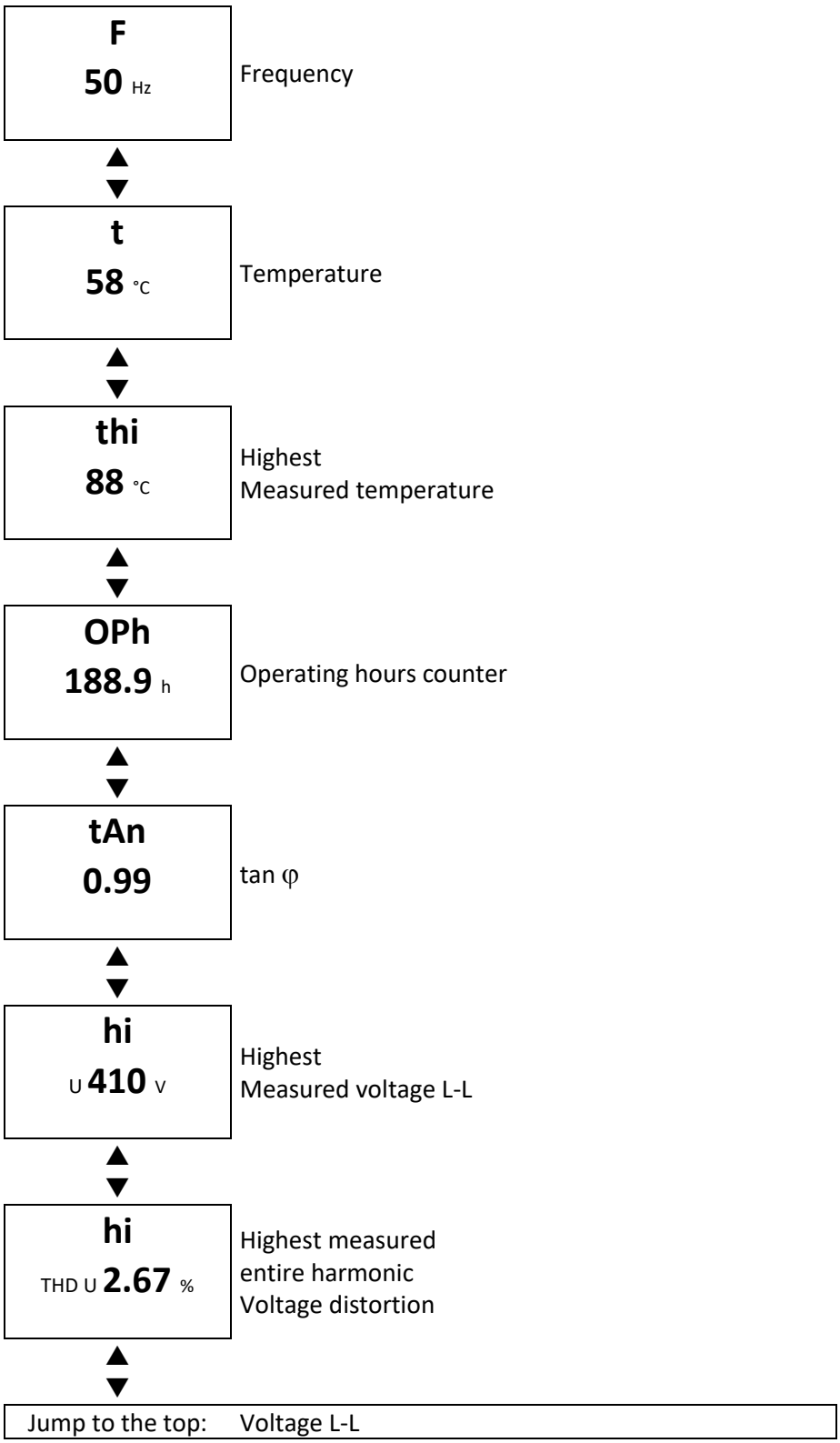
7.1 Measured values menu

All measured values with a gray background are hidden on delivery and are only displayed if the current transformer factor has been set (SETUP/100/Ct).

NOTE: If the device is reset to the factory settings (SETUP/602), the current transformer factor must be entered again so that all measured values are displayed again.




1.00 i
S 65.20 kVA
Apparent power
3 phase
1.00 i
THD U 1.41 %
Complete harmonious
Distortion
the voltage
U 3
Har U 0.41 %
Odd harmonics
U 3 - 19
1.00 i
THD I 1.67 %
Complete harmonious
Distortion
of the current
I 3
Har I 0.74 %
Odd harmonics
I 3 - 19
1.00 i
cosφ 0.999
cos φ
3 decimal places
PF
0.888
Power factor
Ratio
P/S
APF
1.000
average
Power factor

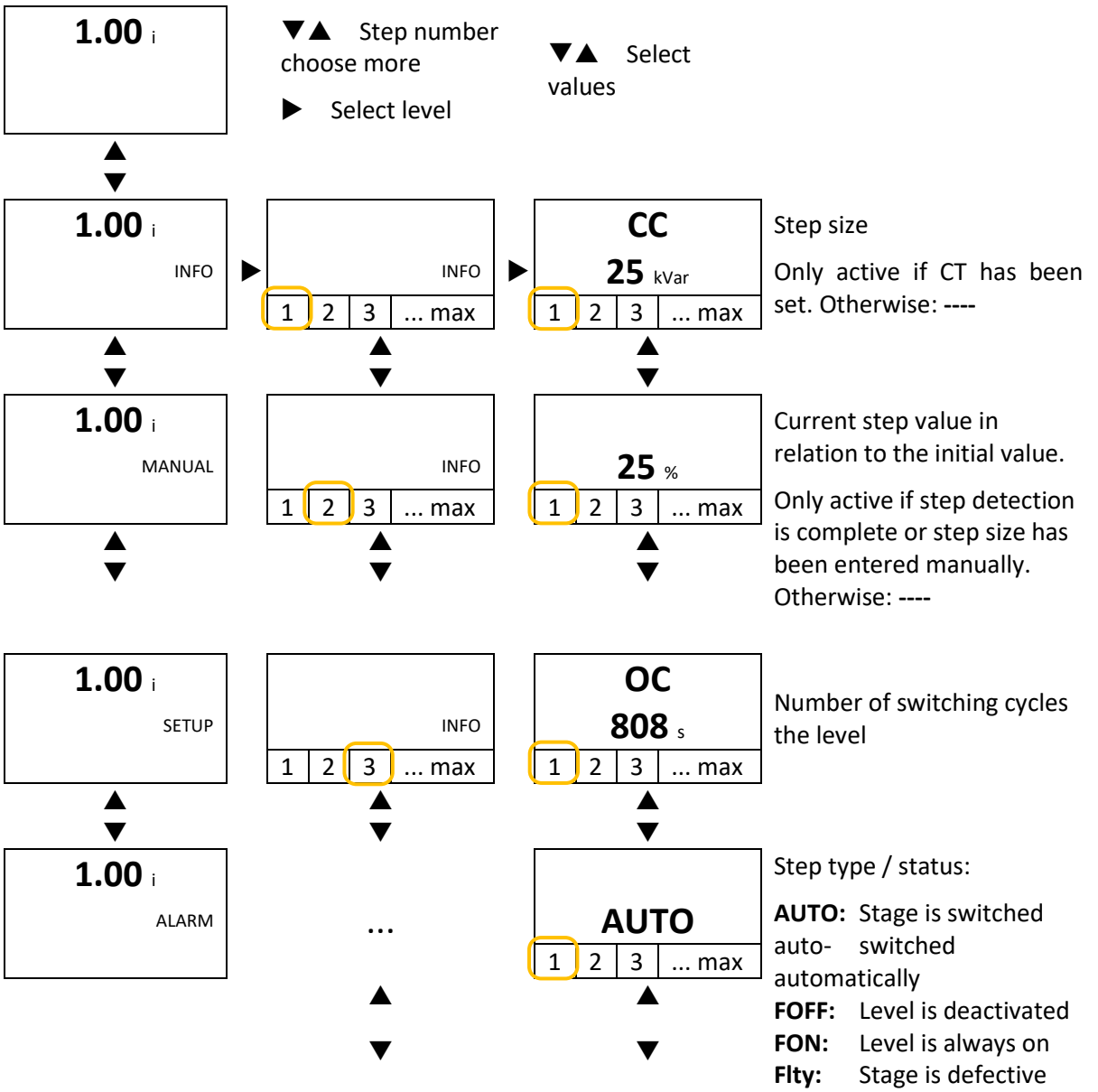

F
50 Hz
Frequency
t
58 °C
Temperature
thi
88 °C
Highest
Measured temperature
OPh
188.9 h
Operating hours counter
tAn
0.99
tan φ
hi
U 410 V
Highest
Measured voltage L-L
hi
THD U 2.67 %
Highest measured
entire harmonic
Voltage distortion
Jump to the top: Voltage L-L

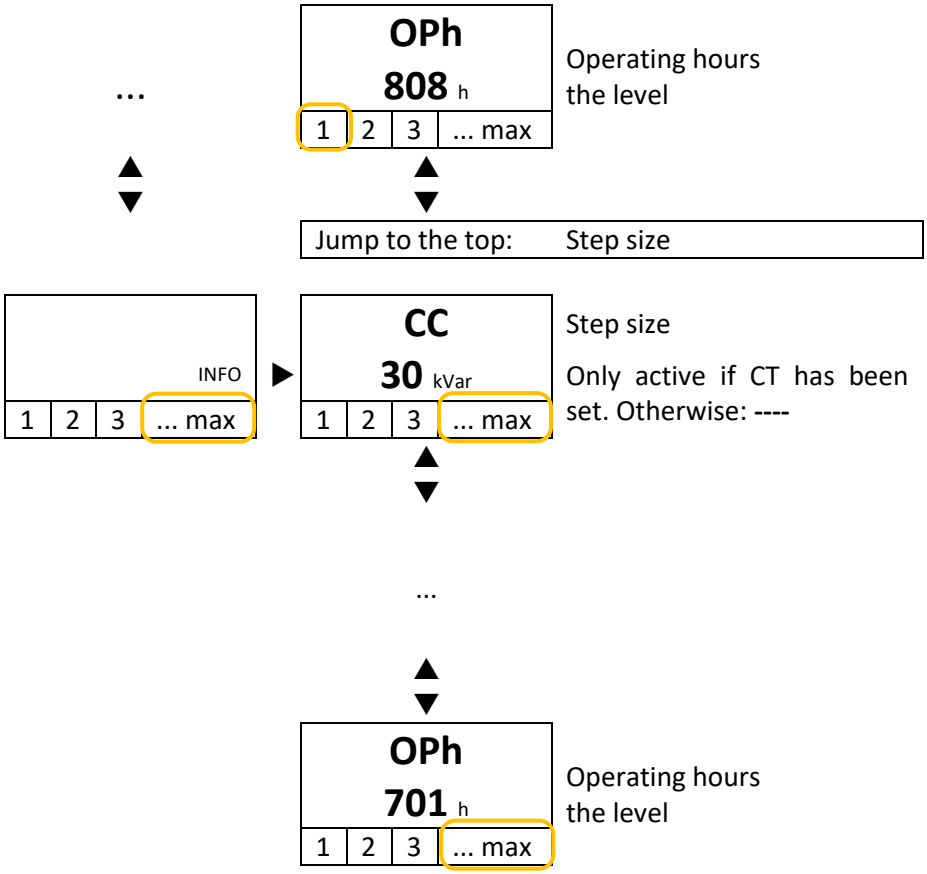
7.2 INFO - Level database

The INFO menu displays the switching cycles, the operating hours, the stage type and status, the current stage power and the stage power in relation to the initial power (as a percentage) for each stage. This data can be used to draw conclusions about the status of the system and the status of the individual stages.

NOTE: The current tap size is only displayed if the current transformer factor has been set in the SETUP menu.

The step power in relation to the initial power (as a percentage) is only displayed if step detection has been completed or the step size has been entered manually. Further information on this topic can be found in chapter 11.





7.3 MANUAL - Switch stages on and off manually

Stage outputs can be switched manually for test purposes. Automatic control is stopped in the MANUAL menu. To prevent unintentional stopping of the control, this menu item is provided with a key lock.

As soon as the menu is exited, the control system restarts automatically and switches off any stages that are not required.

To access this menu, press and hold the ▶ button for 3 seconds.

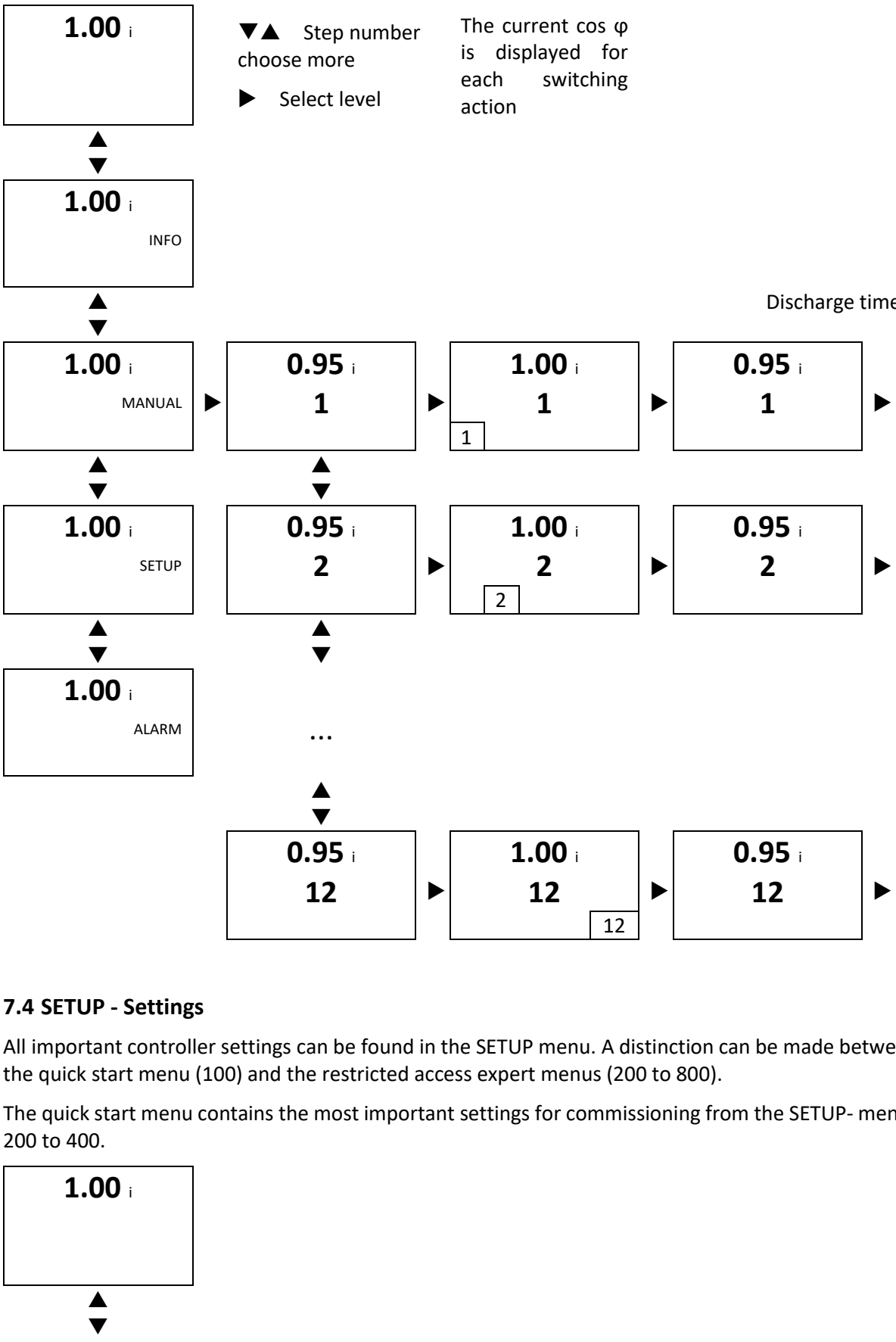
NOTE: The discharge time block is also taken into account when switching stages manually. After manually switching off a stage, the discharge time block is active for this stage. The affected stage can only be switched on again after the discharge time block has expired.

NOTE: Deactivated stages (**FOFF**), permanently connected stages (**FON**) and blocked stages (**Flty**, **FOFF** due to stage power loss alarm) cannot be switched manually.

NOTE: Manual operation is not possible

a) During automatic initialization.

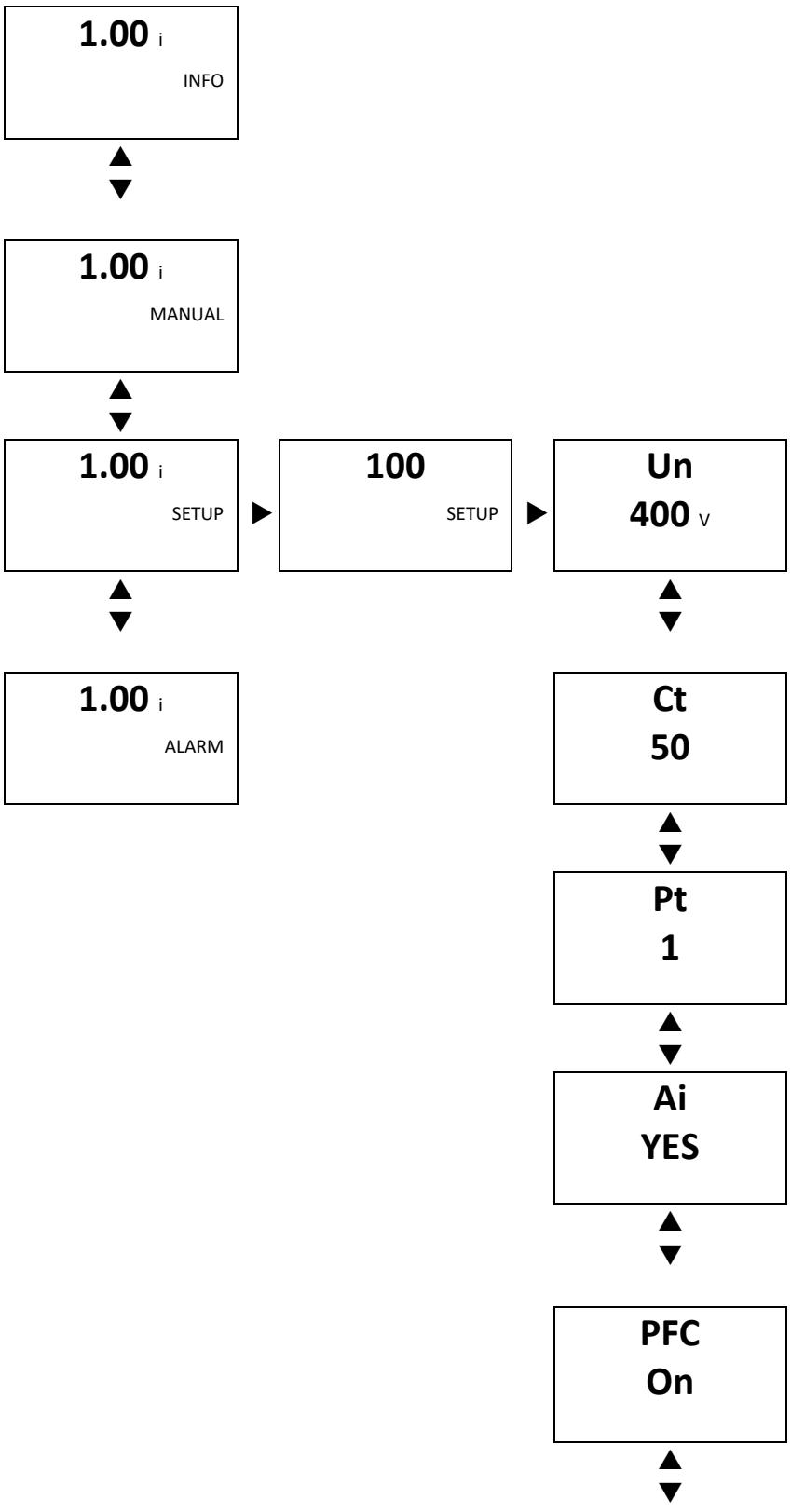
b) If **LIFO**, **FIFO** or **COMBI-FILTER** is selected as the control algorithm.

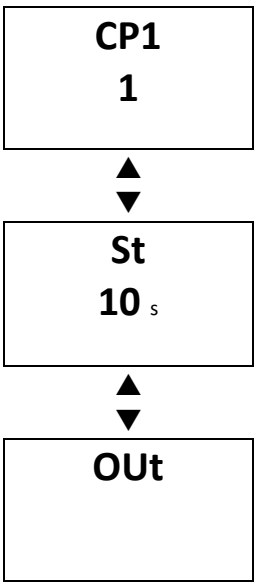


7.4 SETUP - Settings

All important controller settings can be found in the SETUP menu. A distinction can be made between the quick start menu (100) and the restricted access expert menus (200 to 800).

The quick start menu contains the most important settings for commissioning from the SETUP- menus 200 to 400.


1.00 i
INFO
1.00 i
MANUAL
1.00 i
SETUP
100
SETUP
Un
400 V
Nominal voltage **Un** (phase conductor voltage).
This value is required for monitoring the voltage tolerance.
1.00 i
ALARM
Ct
50
Current transformer factor
e.g. 250/5 = 50
Pt
1
Voltage transformer factor
If no converter is used:
Value = 1
Ai
YES
Yes: The controller detects the phase position (connection of measured voltage and current) and the assignment of the switching outputs
PFC
On
ON: Control ON
OFF: Control OFF
Hold: Regulation stopped



Target cos φ 1 of the regulation

Switching time that is waited between switching the individual stages on and off

▼▲ Step number choose more

▶ Select level

AUTO: Stage is switched auto- switched automatically
FOFF: Level is deactivated
FON: Level is always on
Flty: Stage is defective (cannot be set)

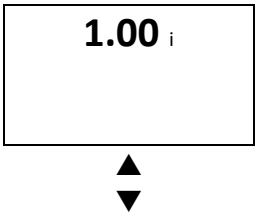
7.5 ALARM - Alarm memory

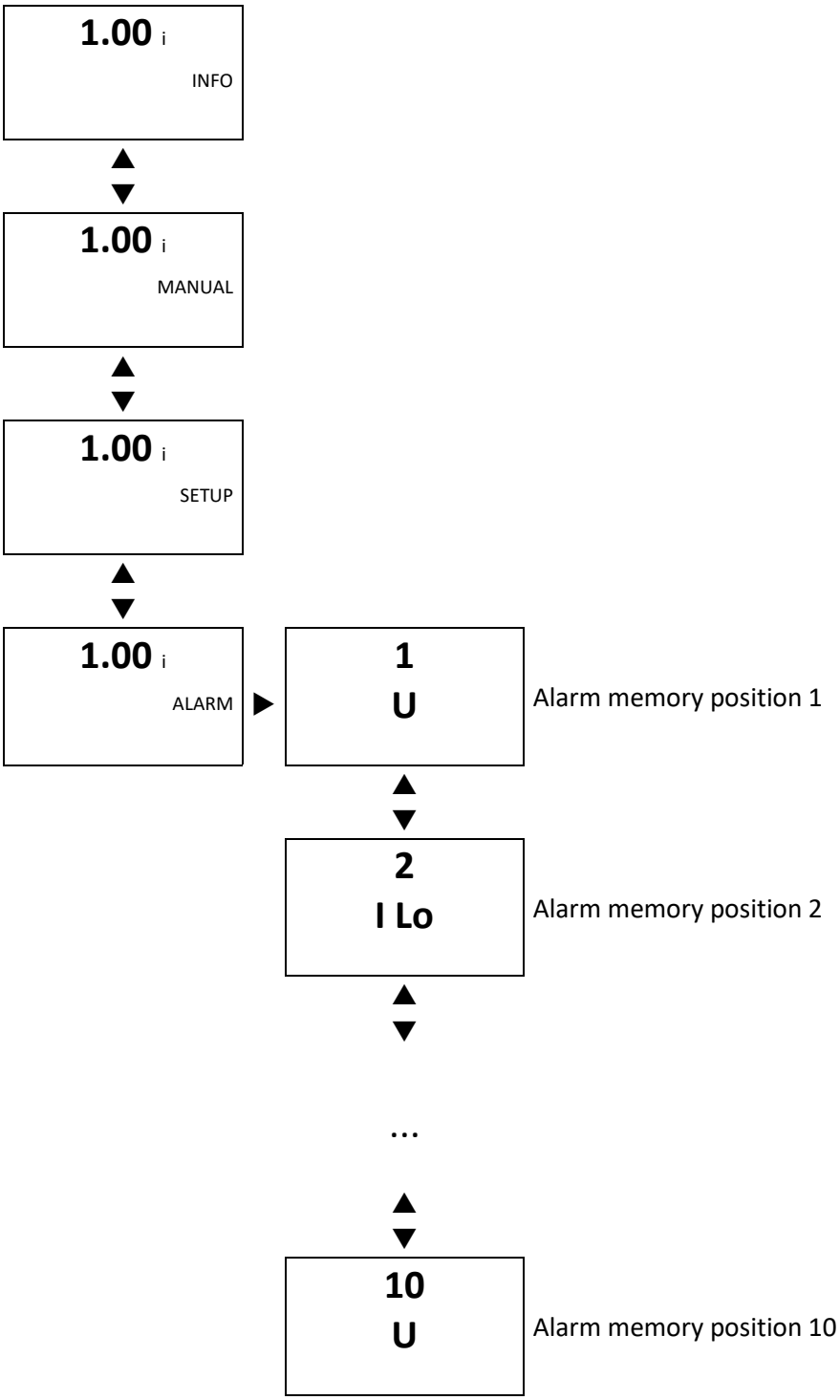
The last 10 alarms that occurred can be called up in the alarm memory. The chronological order is such that memory location 1 contains the most recent alarm and memory location 10 contains the oldest alarm.

The alarm memory works as a sliding buffer. If a new alarm is signaled, it is stored in the first position. All existing entries (1 - 10) from memory location 1 are moved forward by one memory location. The alarm previously stored in memory location 10 is deleted as a result.

The alarm memory is non-volatile and can be completely deleted by pressing the buttons ▲ and ▼ simultaneously (approx. 3 s) in the alarm memory menu. The alarm memory can also be deleted in the reset menu (SETUP/606).

NOTE: All alarms signaled in the display are also reset if there is no longer an alarm.




1.00 i
INFO
1.00 i
MANUAL
1.00 i
SETUP
1.00 i
ALARM
1
U
Alarm memory position 1
2
I Lo
Alarm memory position 2
...
10
U
Alarm memory position 10

8. Settings

The controller can be configured in the SETUP menu. The quick start menu contains all the important settings from menus 200 - 400.

To access the expert menus of the CX plus from the quick start menu, press the ▼ or ▲ button. You will then be asked to enter a PIN.

Entering the PIN and confirming with the ▶ button takes you to the previously hidden menus 200 to 800, which can now be selected using the ▼ and ▲ buttons.

To access the respective submenu, press the ▶ button.

NOTE: The PIN can be changed under SETUP/608. However, you can always access the expert menus with the master PIN **242**. If the PIN is set to **000**, the expert- menus are no longer protected by a PIN. All SETUP menus are unlocked.

8.1 Overview

100 Quick start

Contains all settings from the setup menus 200 to 400 that are important for commissioning. This menu is always visible.

200 Measurement

Contains settings to adapt the measurement of the CX Plus to the grid conditions.

300 Regulation

Contains settings to adapt and optimize the control to the system requirements.

400 Level database

The stage parameters are set in the stage database. If stage detection is switched off, the stage size must be entered manually for each individual stage.

500 Alarm

Alarms and monitoring functions can be activated and deactivated and limit values can be set in the alarm menu.

600 Reset menu

Allows you to reset settings as well as values and counters stored in the controller. In addition, the software version of the device can be queried and the PIN for the expert- menus can be set.

700 Modbus

The Modbus RTU interface can be configured in this menu.

NOTE: This menu is only available with the CX plus -MB option.

800 System

The duration of the backlighting at system start can be parameterized here.

900 DTC-OPTION

Here, the transformer load is also taken into account in the compensation.

100 Quick start

Contains all important settings for commissioning.

100 Quick start

MENU	FUNCTION	AREA
Un	Nominal voltage (phase conductor voltage)	100 ... 242000 V

The nominal voltage must be entered correctly as it is used to calculate the upper and lower limits of the voltage monitoring. The tap sizes stored in the tap database also refer to the set nominal voltage.

Ct	Current transformer factor	1 ... 9600

Enter the current transformer factor. The ratio must be entered as the value (e.g. 1000/5 = 200).

NOTE: If the current transformer factor is entered and

a) If automatic step detection is **deactivated**, the current step size of all steps is reset to the original value (entered value).

b) If automatic stage detection is **activated**, the current and original stage size of all stages is capacitively reset to the starting value of 3 VAr. The stage detection starts again.

Pt	Voltage transformer factor	1.0 ... 350.0

Enter the voltage transformer factor. The ratio must be entered as the value (e.g. 1000/100 = 10).

If the device is connected directly to the measuring voltage without a transformer, the value **1** should be used.

The voltage transformer factor can be entered with one decimal place. As only 3 characters are available for displaying the stored value, the value is rounded up or down for the display.

NOTE: If the voltage transformer factor is entered and

a) If automatic step detection is **deactivated**, the current step size of all steps is reset to the original value (entered value).

b) If automatic stage detection is **activated**, the current and original stage size of all stages is capacitively reset to the starting value of 3 VAr. The stage detection starts again.

Ai	Automatic initialization	Yes/No

YES: Starts automatic initialization (Ai).

Confirming **YES** starts the automatic initialization. The setting is immediately reset to **NO**. As long as the Ai has not been started (U-Alarm, I-Low-Alarm), the setting remains set to **YES**.

Automatic initialization switches through all outputs one after the other to determine the switching outputs used. In addition, the phase position (connection of measuring voltage and current) is detected. The phase angle is determined and automatically corrected by a phase correction angle if necessary.

Automatic initialization only starts if the current and voltage are within the set tolerances.

Outputs that are set to the **FON** or **Flty** stage type are not taken into account during automatic initialization.

NOTE: Automatic initialization can only detect the phase position if capacitors are connected to the switching outputs. If the CX plus compensates the reactive power with the help of choke coils, this function will lead to errors.

NOTE: The prevalence of constant load conditions favors a successful execution of the **Ai**.

PFC	Regulation	On/Off/Hold

Starting, stopping and switching off automatic control. The following settings are available:

ON: Control is on and operates in normal mode.

OFF: Control is off and active stages are switched off one after the other at 3-second intervals.

Hold: Control is stopped and active stages remain switched on.

If the control is set to **OFF**, **PFC** and **OFF** appear alternately in the display.

If the control is set to **Hold**, **PFC** and **Hold** appear alternately in the display.

NOTE: The control is **OFF** and the upper setting is blocked if

a) No current transformer factor has been entered yet.

b) Step detection is deactivated and at least one step size has not yet been entered manually.

CP1	Target cos φ 1	0.70 c ... 0.70 i

Setting the target cos φ 1 defines the active power factor that is to be achieved by the reactive power compensation (control target).

St	Switching time	1 ... 6500 s

The switching time is the time that is waited between the switching of individual stages in the normal control algorithm.

The switching time should be set with the following aspects in mind:

a) The switching time is intended to protect contactors from unnecessary switching operations and thus from excessive wear.

b) The reactive power requirement is averaged over the switching time. Rapid fluctuations in reactive power are compensated for.

OUt	Switching outputs (level 1 ... max)	AUTO/FON/FOFF/Flty

With the exception of the **Flty** stage type, the following stage types can be set for each individual stage.

AUTO: Level is switched automatically by the controller**.**

FON: Level is permanently switched on (level is nevertheless monitored and switched off in critical situations).

FOFF: Stage is permanently switched off or deactivated. Unused stages should be set to this stage type to avoid unnecessary switching operations and alarms .

Flty: Stage was switched three times without success and recognized as faulty. This is no longer used for control. Defective stages flash in the stage display.

8.2 200 Measurement

Contains settings to adapt the measurement of the CX plus to the grid conditions.

200 Measurement settings

MENU	FUNCTION	AREA
201	Rated voltage measurement (phase-to-phase voltage)	100 ... 242000 V

The nominal voltage must be entered correctly as it is used to calculate the upper and lower limits of the voltage monitoring. The tap sizes stored in the tap database also refer to the set nominal voltage.

202	Current transformer factor	1 ... 9600

Enter the current transformer factor. The ratio must be entered as the value (e.g. 1000/5 = 200).

NOTE: If the current transformer factor is entered and

a) If automatic step detection is **deactivated**, the current step size of all steps is reset to the original value (entered value).

b) If automatic stage detection is **activated**, the current and original stage size of all stages is capacitively reset to the starting value of 3 VAr. The stage detection starts again.

203	Voltage transformer factor	1 ... 350

Enter the voltage transformer factor. The ratio must be entered as the value (e.g. 1000/100 = 10).

If the device is connected directly to the measuring voltage without a transformer, the value **1** should be used.

The voltage transformer factor can be entered with one decimal place. As only 3 characters are available for displaying the stored value, the value is rounded up or down for the display.

NOTE: If the voltage transformer factor is entered and

a) If automatic step detection is **deactivated**, the current step size of all steps is reset to the original value (entered value).

b) If automatic stage detection is **activated**, the current and original stage size of all stages is capacitively reset to the starting value of 3 VAr. The stage detection starts again.

204	Tolerance range Nominal voltage	0 ... 100 %

This setting determines the tolerance range of the nominal voltage. If the measured voltage is outside the set tolerance, an alarm is triggered**.**

205	Connection type Voltage measurement	U-LL/U-LN

U-LL: Voltage measurement takes place between L-L

U-LN: Voltage measurement takes place between L-N

Based on the set nominal voltage, the controller calculates the voltages for both connection types (L-L and L-N) from the measured voltage. If these are within the set voltage tolerance (factory setting +/- 10 %), the controller automatically determines the connection type for the voltage measurement. This cannot be changed manually.

If the measured voltage is outside this tolerance, the voltage measurement connection type can be set manually.

206	Phase correction angle	0 ... 345°

If the connection of the measured voltage and current results in a phase angle between voltage and current that is not equal to 0° (voltage measurement L-N) or 90° (voltage measurement L- L), the phase correction angle must be set accordingly. An incorrect value has a negative effect on the calculation of the power, cos φ, power factor and stage sizes. The controller will then not work correctly or not at all.

The phase correction angle can be detected automatically by executing the automatic initialization or can be entered manually in **15° steps**.

If the phase correction angle for current and voltage measurement has been correctly recognized by the Ai, this value should not be changed.

In the event that automatic initialization fails due to unfavourable grid conditions, the phase correction angle can be entered manually or an incorrectly detected phase angle can be corrected.

To determine the phase correction angle manually, refer to chapter 19. Information is provided.

NOTE: It is recommended to switch off the control during manual input (SETUP/100/PFC or SETUP/310).

207	Automatic initialization	Yes/No

YES: Starts automatic initialization (Ai).

Confirming **YES** starts the automatic initialization. The setting is immediately reset to **NO**. As long as the Ai has not been started (U-Alarm, I-Low-Alarm), the setting remains set to **YES**.

Automatic initialization switches through all outputs one after the other to determine the switching outputs used. In addition, the phase position (connection of measuring voltage and current) is detected. The phase angle is determined and automatically corrected by a phase correction angle if necessary.

Automatic initialization only starts if the current and voltage are within the set tolerances.

Outputs that are set to the **FON** or **Flty** stage type are not taken into account during automatic initialization.

NOTE: Automatic initialization can only detect the phase position if capacitors are connected to the switching outputs. If the CX plus compensates the reactive power with the help of choke coils, this function will lead to errors.

NOTE: The prevalence of constant load conditions favors a successful execution of the **Ai**.

208	Synchronization frequency	Auto/50/60

To achieve the highest accuracy in current and voltage measurement, the sampling rate must be synchronized to the mains frequency. Despite internal filtering, strong commutation dips in the mains voltage can lead to automatic synchronization being disrupted. Disturbed synchronization in turn leads to measurement errors. For this reason, the following settings can be made.

AUTO: Automatic synchronization for maximum measuring accuracy at mains voltage without commutation dips

50: For safe operation in 50 Hz mains with extremely poor mains quality.

60: For safe operation in 60 Hz mains with extremely poor mains quality.

209	Temperature offset	-10 ... 10 °C

A temperature offset for the temperature measurement can be set here to correct any component-dependent deviations.

210	CO2 counter	0...9999.9 g/kvarh

This "Emission factor reactive" parameter is used to determine the amount of CO2 required for
the provision of 1 kvarh is entered [g/kvarh].
-> Default value is 8.5g/kvarh

Measured value display CO2 -> CO2 saved in kg.
(Calculation via stage sizes/running time/reactive emission factor)
The value is updated every hour and saved every 24 hours.
The counter can be reset via menu item 610 "Reset CO2 counter".

NOTE: The value is only approximate, as the reactive emission factor for the provision of 1 kvarh cannot be determined exactly. The factor depends on many factors and the location and also changes repeatedly over time.
It is therefore the customer's responsibility to ensure that the parameters 210 to enter the appropriate value.

The current default value of 8.5g/karh
corresponds approximately to the European level of 2022.

8.3 300 Regulation

Contains settings to adapt and optimize the control to the system requirements.

300 Control settings

MENU	FUNCTION	AREA
301	Control sensitivity	55 ... 100 %

The control sensitivity defines the switching threshold for switching the stages on and off (hysteresis). A lower value enables a more precise compensation result, but increases the number of switching cycles.

A value of 60 % is set here at the factory. If the missing reactive power to the control target is greater than 60 % of the stage power of a stage, the stage may be switched on or off. In this case, 40 % overcompensation is permitted after switching on and 40 % undercompensation after switching off.

302	Target cos φ 1	0.70 c ... 0.70 i

Setting the target cos φ 1 defines the active power factor that is to be achieved by the reactive power compensation (control target).

303	Target cos φ 2	0.70 c ... 0.70 i

The setting of the target cos φ 2 defines the active power factor that is to be achieved by the reactive power compensation (control target).

The target cos φ 2 can be used as a control target for P export (SETUP/304 = **YES**) or when switching to the low tariff via the digital input.

304	Target cos φ 2 for P Export	Yes/No

YES: If active power is being fed back, control is based on the set -target cos φ 2.

NO: The target cos φ 1 remains the control target even if active power is fed back.

305	Switching time	1 ... 6500 s

The switching time is the time that is waited between the switching of individual stages in the normal control algorithm.

This time should be adjusted according to the following aspects:

a) The switching time is intended to protect contactors from unnecessary switching operations and thus from excessive wear.

b) The reactive power requirement is averaged over the switching time. Rapid fluctuations in reactive power are compensated for.

306 Switching time step change 1 ... 6500 s

This is the waiting time between switching off an active stage and switching on another stage that fits the calculated reactive power requirement more precisely. The normal switching time is not observed when switching stages.

307 Step exchange Yes/No

YES: The controller attempts to achieve the control target more effectively by changing stages.

NO: The function is deactivated**.**

NOTE: To avoid unnecessary switching cycles, this function should be deactivated when using steps of the same size.

NOTE: If **KOMBI-FILTER**, **LIFO**, **FIFO** or **PROGRESSIVE** has been selected as the control algorithm, the stage exchange function is always deactivated.

308 Step detection Yes/No

YES: Step detection is activated. Stage sizes are automatically determined during operation and continuously updated. Faulty stages and the power loss of the individual stages are detected. Manually entered stage sizes are overwritten by the automatic tracking of the stage size. Once stage detection is complete for a stage (50 switching operations), its original stage size is set to the value of the current stage size.

Step detection can also be completed prematurely by manually entering the step size.

NO1: Step detection is deactivated**.** The tap sizes must therefore be entered manually. However, the tracking of the stage sizes, the detection of defective stages and the detection of power losses are **active**. By entering the stage size, the value of the original stage size is set to the value of the current stage size (entered stage size).

NO2: Stage detection including stage tracking/defect stage detection/power loss detection is deactivated
-> "Defect stage detection" menu 316 and "Alarm: Power loss stages" menu 516 can then no longer be activated either

Manual entry may be necessary:

a) If there are strong load fluctuations and the tap size is incorrectly recognized.

b) If the switching devices have a delay of more than 200 ms.

NOTE: If stage detection has been completed for a stage or the stage size has been entered manually, the current stage size in relation to the original stage size is displayed as a percentage for this stage in the stage database (**INFO**).

NOTE: By switching off the tap detection, the control is switched off and set to **OFF** and is blocked. This setting is blocked until the current transformer factor has been entered once and at least one tap size has been entered manually. The control can then be switched on again.

309 Locking faulty steps Yes/No

YES: Stages that have already been detected or manually configured are classified as faulty by the controller after three consecutive switching operations without a mains response and blocked for 24 hours.

Stages recognized as defective flash in the stage display and have the stage type **Flty** (SETUP/100/Out or SETUP/403).

NO: Incorrectly detected stages are not blocked and continue to be used by the controller. This results in unnecessary switching cycles.

NOTE: Incorrectly detected stages are set to the **AUTO** stage type and checked again every 24 hours or after a restart of the controller.

NOTE: If defect level detection is deactivated (SETUP/316 = **NO**), this function has no effect.

310 Regulation ON/OFF/Hold

Start, stop and switch off automatic control. The following settings are available:

ON: Control is on and operates in normal mode.

OFF: Control is off and active stages are switched off one after the other at 3-second intervals

Hold: Control is stopped and active stages remain switched on.

If the control is set to **OFF**, **PFC** and **OFF** appear alternately in the display.

If the control is set to **Hold**, **PFC** and **Hold** appear alternately in the display.

NOTE: The control is **OFF** and the upper setting is blocked if

a) No current transformer factor has been entered yet.

b) Step detection is deactivated and at least one step size has not yet been entered manually.

311 Control algorithm 1

1 **BEST-FIT:** The controller operates according to the BEST-FIT principle in order to achieve the best compensation result. Before each switching operation, the controller compares all the stage sizes stored in the stage database with the calculated reactive power requirement and always selects the stage that comes closest to the set control target. If stages of the same size are connected to the controller, the number of switching operations is automatically distributed to the affected stages either via the switching cycles or the operating hours (SETUP/315).

2 **LIFO (Last In - First Out):** The controller starts with level 1 and always switches to the level of the next higher number if required. The stages are switched off in reverse order. A check is carried out for each stage to determine whether a switching action is appropriate.

The best compensation result is achieved by using steps of the same size.

To ensure control stability, faulty stages are always blocked and skipped by the control algorithm. The corresponding setting can therefore not be modified (SETUP/309).

NOTE: The settings in the step change (SETUP/307) and switching distribution (SETUP/315) menus are ignored.

3 **KOMBI-FILTER:** Suitable for combined filter systems with two different degrees of restriction. The control is based on the BEST-FIT principle and ensures that more or the same amount of compensation power is always switched on at the odd-numbered switching outputs as is available at the even-numbered outputs.
This prevents overloading of the lower choked compensation stages. The higher choked stages must be connected to the odd-numbered stage outputs for this purpose.

The control algorithm also takes into account permanently switched on stages (**FON**). However, it is not recommended to switch stages on permanently to avoid an imbalance.

To ensure control stability, faulty stages are always blocked and skipped by the control algorithm. The corresponding setting can therefore not be modified (SETUP/309).

NOTE: The settings in the step change (SETUP/307) and switching distribution (SETUP/315) menus are ignored.

NOTE: The combi-filter algorithm only works with **capacitive** stages.

NOTE: If stage detection is carried out for the first time, more stage power may be connected to the even switching outputs than to the odd ones. To prevent this, the tap sizes must be entered manually (SETUP/402).

4 **PROGRESSIVE:** The control is based on the BEST-FIT principle and switches several stages on and off one after the other with a shorter switching time if required. The set switching time is ignored. This results in faster switching behavior and a shorter response time.

The tap sizes must be entered manually, as tap detection is deactivated in this control algorithm. This has the disadvantage that it is not possible for the control system to detect defective stages and power loss.

NOTE: The settings in the step change (SETUP/307) and switching distribution (SETUP/315) menus are ignored.

5 **FIFO (First In - First Out):** The controller starts with level 1 and always switches to the level of the next higher number if required. When switching off, the controller starts with level 1 and always switches off the level of the next higher number if required.

If, for example, levels 3 to 7 are still switched on, the control starts with level 8 when switching on. If level 12 has been switched on and level 1 is not yet switched on, the next step is to start with level 1 again. When switching off, the control starts with level 3. If level 12 has been switched off and level 1 is still switched on, level 1 is started next. A separate check is carried out for each stage to determine whether a switching action is appropriate.

The best compensation result is achieved by using steps of the same size.

To ensure control stability, faulty stages are always blocked and skipped by the control algorithm. The corresponding setting can therefore not be modified (SETUP/309).

NOTE: The settings in the step change (SETUP/307) and switching distribution (SETUP/315) menus are ignored.

312 Offset reactive power (Q-offset) -9.9 MVAr ... 9.9 MVAr

An offset that is added to the measured reactive power. This function allows compensation for a permanent reactive load that is present and cannot be measured (e.g. inductance of the upstream supply transformer).

NOTE: The offset of the reactive power also influences the following measured values: current, reactive power, control deviation, apparent power, power factor, cosφ and tanφ .

313 Asymmetry factor -127 ... 127

Describes the relationship between the switch-on and switch-off time. The switching time for the stage change is not affected. In the following description, **X** is the asymmetry factor.

X = 1: Switch-on and switch-off times are the same

X = +2 to +127: Switch-off delay = switching time multiplied by X
Switch-on delay = switching time

X = -2 to -127: Switch-on delay = switching time multiplied by X
Switch-off delay = switching time

314 Switch off for capacitive Q stages Yes/No

YES: Capacitive actual value of cos φ is **NOT** permitted. If a capacitive cos φ is measured, the controller switches off the necessary tap power **without** observing the switching time in order to prevent capacitive grid conditions.

NOTE: The control algorithm checks whether capacitive reactive power behavior would occur at the affected measuring point before an additional capacitor stage is switched on. If this is the case, the capacitor stage is not connected in order to prevent unstable control behavior in the form of oscillation. At this point, the control sensitivity setting (SETUP/301) is not taken into account by the control algorithm, which can affect the control accuracy.

NO: Capacitive actual value of the cos φ is permitted.

NOTE: The target cos □□1 is internally limited to 0.98 i, provided that the set parameter value is in the range of 0.98 i ... 1.0 i ... 0.70 c.

NOTE: When using **inductive** stages, this option must be set to **NO.**

315 Distribute switching operations Yes/No

YES: The switching operations of stages with the same stage size are distributed over the **operating hours** of the affected stages.

NO: The switching operations of stages with the same stage size are distributed via the **switching cycles** of the affected stages.

316 Defect stage detection Yes/No

YES: Defective stages are detected by the control algorithm**.**

A stage detected as defective when switching on is immediately switched off again. If the option is activated (SETUP/309 = **YES**), the stage in question is set to **Flty** after three consecutive unsuccessful switching operations and is no longer taken into account by the control algorithm.

NOTE: During the first 3 switching cycles, the stage type of the affected stage is set to **FOFF** instead of **Flty**. This prevents unassigned stage outputs from being treated as faulty.

NO: The defective stage detection option is deactivated and defective stages are not detected by the control algorithm during switching operations. Activated stages remain active until the deviation of the control value from the setpoint allows a switching operation. This renders option SETUP/309 ineffective.

8.4 400 Level database

All stage parameters are set in the stage database.

400 Settings level database

MENU	FUNCTION	AREA

401 Discharge time lock 1 ... 1200 s

The set discharge time applies to all stages and is a blocking time that elapses after a stage is switched off. It is used to completely discharge capacitors before they are switched on again.

As long as this blocking time has not expired, the corresponding stage of the control is not available. The discharge time block must be adapted to the discharge time of the capacitors.

402 Nominal stage value (stage 1 ... max) -9.9 MVAr ... 9.9 MVAr

If automatic tap detection is deactivated, the tap size (nominal tap value) must be entered manually for each tap. The nominal tap value entered refers to the set nominal voltage.

NOTE: If stage detection has been completed for a stage or the stage size has been entered manually, the current stage size in relation to the original stage size (as a percentage) appears for this stage in the stage database (**INFO**).

403 Stage type (stage 1 ... max) AUTO/FON/FOFF/Flty

With the exception of the **Flty** stage type, the following stage types can be set for each individual stage.

AUTO: Level is switched automatically by the controller.

FON: Level is permanently switched on (level is nevertheless monitored and switched off in critical situations).

FOFF: Stage is permanently switched off or deactivated. Unused stages should be set to this stage type to avoid unnecessary switching operations and alarms.

Flty: Stage was switched three times without success and recognized as faulty. This is no longer used for control. Defective stages flash in the stage display.

404 Switching cycle counter (level 1 ... max) 0 ... 500000 cycles

For each complete switching operation (switching on and off) of a stage, the switching cycle counter of the affected stage is increased by 1. The number of switching cycles of a stage provides information on the status of the capacitor contactors.

If the service alarm is activated (Setup/506 = **YES**) and the switching cycle counter of a stage exceeds the set limit (Setup/507), the **OPC alarm** (max. switching cycles) is triggered and signaled. The alarm relay switches.

If, for example, the power contactor of a stage has been replaced, the switching cycle counter for the affected stage can be reset to **0** in this menu. This resets a pending **OPC alarm** and restarts monitoring.

If several stages of the same size are connected and the switching cycle distribution is carried out via the number of switching operations (SETUP/315 = **NO**), the controller automatically carries out a distribution for these stages based on the switching cycle counters. The stages concerned have the same number of switching operations (+/- 1).

405 Operating hours counter levels (level 1 ... max) 0 ... 65500 h

When switched on, an operating hours counter runs for each stage and provides information on the running time and condition of a capacitor.

If the service alarm is activated (Setup/506 = **YES**) and the operating hours counter of a stage exceeds the set limit (Setup/509) by 1 hour, the **OPh stages**- alarm (max. operating hours stages) is triggered and signaled. The alarm relay switches.

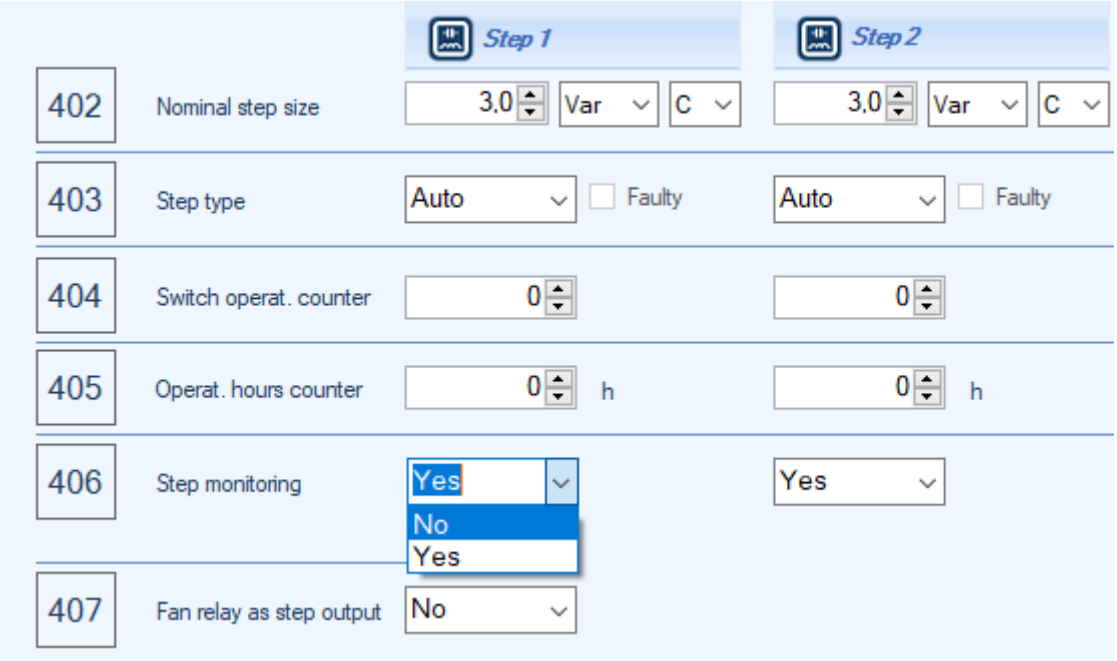
If, for example, a capacitor has been replaced, the operating hours counter for the affected stage can be reset to **0** hours in this menu. This resets a pending **OPh stage** -alarm and restarts monitoring.

NOTE: Operating hours must be entered as whole hours**.**

If several stages of the same size are connected and the switching cycle distribution is based on the number of operating hours (SETUP/315 = **YES**), the controller automatically carries out a distribution for these stages based on the operating hours counter.

406 Stage monitoring Yes/No

Stage monitoring can be deactivated for each individual stage.
Small stages are not recognized correctly (e.g. if the current transformer is selected too large, etc.) and lead to errors in stage recognition/stage tracking/defective stage recognition.
This can be used to switch off stage monitoring for these.



407	Fan relay as an additional stage output	Yes/No

YES: The fan relay is available as a 7th or 13th stage output. It is controlled by the controller.

NO: The fan relay is used normally. It is activated by the alarm system.

NOTE: In the event of a modification, all active stages are first switched off one after the other and the control system restarts. **FON stages** are not affected by this.

8.5 500 Alarm

Alarms and monitoring functions can be activated and deactivated and limit values can be set in the alarm menu.

NOTE: The following alarms cannot be deactivated: **U-Alarm**, **I-High-Alarm**, **-THDUAlarm**, **THD-I-Alarm** and **TEMP2-Alarm**

NOTE: Limit values for the **U-alarm** are defined by the settings nominal voltage (SETUP/100/Un or SETUP/201), voltage tolerance band (SETUP/204) and voltage transformer factor (SETUP/100/Pt or SETUP/203).

500 Alarm settings

MENU	FUNCTION	AREA
501	Reset alarm manually	Yes/No

YES: Alarm messages (display and alarm relay) must be reset manually.

To reset an alarm, **press and hold** the button◄ **(esc)** for **approx. 3 seconds.**

NOTE: An alarm can only be reset manually if it is no longer present.

NO: As soon as the alarm condition is no longer present, alarm messages are automatically reset after 15 seconds.

502	THD-U limit value	3 ... 20 %

If the set limit value is exceeded, the alarm is signaled after the set delay time (SETUP/504) has elapsed. The message **HarU** and **ALARM** appear on the display and the alarm relay is switched.

503	Switch off active stages for THD-U / THD-I / TEMP2 alarm	Yes/No

YES: If the set THD-U, THD-I or TEMP2 limit value is exceeded, all active stages (**AUTO** & **FON**) are switched off one after the other at the set switch-off interval (SETUP/523).

NOTE: The control is stopped as long as the alarm is active. The stages switched off by the alarm system are blocked for 30 minutes.

Manually activated stages are **not** switched off. If a stage is switched off manually, it is only blocked for the duration of the discharge time.

NOTE: In manual mode, the alarm system does not switch off the stages. The tap-change cut-off sequence only starts after exiting the MANUAL menu.

NO: Active stages are not switched off in the event of an alarm**.**

504	THD-U delay time, THD-I alarm	1 ... 255 s

Delay time until a THD-U or THD-I alarm is signaled.

505	Stop control when current is zero	Yes/No

YES: If the actual current in the secondary circuit is less than 5 mA, the control is stopped. All active stages remain switched on.

NO: If the actual current in the secondary circuit is less than 5 mA, the I- Low- alarm is signaled. The controller switches off all active stages one after the other at intervals of 60 s.

If the measured current is greater than or equal to 5 mA again, the control is switched on again and the controller can switch stages on and off again. An active stage switch-off sequence is canceled in this case.

NOTE: Active **FON stages** and manually activated stages are **not** switched off.

506	Service alarm	Yes/No

YES: A service alarm is signaled and the alarm relay is switched if one of the following limit values is exceeded.

a) The operating hours of the controller.

b) The operating hours of at least one stage.

c) The maximum switching cycles of a stage.

NO: The service alarm is not signaled

507	Max. Switching cycles of one stage	1 ... 500000

If the service alarm is activated (SETUP/506 = **YES**) and the switching cycle limit value for a stage is exceeded, the service alarm is signaled immediately. The display shows **OPC** and **ALARM** alternating with the stage number. Only the smallest affected stage is displayed. The alarm relay is also switched.

Before resetting the alarm, the affected contactors may need to be replaced as part of a maintenance measure. The switching cycle counters of the affected stages must then be manually set to **0** (SETUP/404).

508	Max. Operating hours of the controller	1 ... 65500 h

If the service alarm is activated (SETUP/506 = **YES**) and the limit value is exceeded by 1 hour, the service alarm is signaled immediately. **OPh** and **ALARM** are shown on the display and the alarm relay is switched.

Before resetting the alarm, maintenance work must be carried out on the system if necessary. Then reset the operating hours counter of the controller to **0** hours (SETUP/603).

NOTE: The limit value can only be entered as whole hours.

509	Max. Operating hours of one stage	1 ... 65500 h

Limit value for the service alarm. If the service alarm is activated (SETUP/506 = **YES**) and the operating hours limit for a stage is exceeded by 1 hour, the service alarm is signaled immediately. The display shows **OPh** and **ALARM** alternating with the stage number. Only the smallest affected stage is displayed. The alarm relay is also switched.

Before resetting the alarm, maintenance measures may need to be carried out on the affected stages. The operating hours counters of the affected stages must then be manually set to **0** hours (SETUP/405).

NOTE: The limit value can only be entered as whole hours.

510	THD-I limit value	0(OFF) ... 999 %

Limit value for THD-I monitoring. If the set THD-I limit value is exceeded, the alarm is signaled after the set delay time (SETUP/504) has elapsed. The message **HArI** and **ALARM** appear on the display and the alarm relay is switched. If the limit value is set to "0", the THD-I alarm is switched off.

511	Logic of the digital input	Yes/No

YES: High active: The digital input is active when **a** signal is present

NO: Low active: The digital input is active when **no** signal is present

512	Fan temperature limit TEMP1	3 °C ... (TEMP2 - 5 K)

If the temperature limit TEMP1 is exceeded, the controller switches the fan on. The switched output is indicated by a flashing **FAn** symbol in the bottom line of the main window. If the temperature falls below the temperature limit TEMP1 by 5 K, the controller switches the switching output for the fan off again after 10 seconds.

NOTE: If the switching output is used as an additional stage output (SETUP/406 = **YES**), the fan control is deactivated by the alarm system.

513	Alarm temperature limit TEMP2	(TEMP1 + 5 K) ... 60 °C

If the temperature limit TEMP2 is exceeded, the alarm is signaled after a delay time of 10 seconds. **The** display shows **thi** and **ALARM** and the alarm relay is switched

514	Rule alarm: Target cos φ cannot be reached	Yes/No

YES: Control alarm is activated. If the controller cannot reach the target cos φ after 75 times the switching time because no suitable stage is available for switching on or off, the control alarm is signaled. **PFC** and **ALARM** appear on the display and the alarm relay is switched.

NO: Control alarm is deactivated**.**

515	Step alarm: Faulty steps	Yes/No

YES: Alarm for faulty stages is activated. If the SETUP/309 function is activated and a step is detected as faulty after 3 unsuccessful switching operations, the step alarm for faulty steps is signaled. **Step**, **ALARM** and **Flty** are shown alternately on the display. Stages that are recognized as defective and blocked flash in the stage display. The alarm relay is also switched.

NO: Alarm for faulty stages is deactivated**.**

516	Step alarm: Power loss steps	Yes/No

YES: If the current tap size falls below 75 % of the original tap size, the tap alarm for loss of tap power is signaled.

The display shows **SPl** and **ALARM** alternating with the stage number. Only the smallest stage number of the affected stages is displayed. The alarm relay is also switched.

The stage type of the affected stages is set to **FOFF** and cannot be changed. The affected stage is blocked for control.

To reset the alarm and activate the affected stages, they must first be swapped. Then enter the stage sizes of the affected stages manually (SETUP/402) so that the current stage size is equal to the initial size again (100 %). The stage type can now be set again.

NO: Stage alarm power loss stages is deactivated**.**

517	Display flashes when alarm is signaled	Yes/No

YES: The display flashes when an alarm is signaled.

NOTE: Only works when the backlight of the device is switched off. If you press a button, the backlight is switched on again. The display no longer flashes. If no further button is pressed, the backlighting is switched off after 60 seconds. The display flashes again.

NO: Display does not flash when an alarm is signaled.

518	Function of the digital input	CP2/I Lo/di

CP2: The digital input is used to switch to the target cos φ 2 (low tariff).

I Lo: The digital input is used to suppress the I-Low alarm.

di: The digital input is used as an input for external alarm signals.

Ofst: Furnace Switch-off Q Offset at off-peak times

519	I-Low alarm suppression	---

This menu provides information about the I-Low alarm suppression.

YES: The I-Low alarm **is currently** suppressed.

NO: The I-Low alarm **is currently not** suppressed.

> **NOTE:** This menu item is only visible if the function of the digital input has been set to **I Lo** (SETUP/518).

520	Switch off active stages for digital input alarm	Yes/No

YES: If the digital input is used as an input for external alarm signals (SETUP/518 = **di**), all active stages (**AUTO** & **FON**) are switched off one after the other with the set switch-off interval (SETUP/523) if a digital input alarm is present.

> **NOTE:** The control is stopped as long as the alarm is active. The stages switched off by the alarm system are blocked for 30 minutes.
>
> Manually activated stages are **not** switched off. If a stage is switched off manually, it is only blocked for the duration of the discharge time.

> **NOTE:** In manual mode, the alarm system does not switch off the stages. The tap-change cut-off sequence only starts after exiting the MANUAL menu.

NO: Active stages are not switched off in the event of an alarm**.**

521	I-Low alarm	Yes/No

YES: The I-Low alarm is activated. If the measured current is less than 5 mA, the I-Low alarm is signaled after the delay time of 60 s has elapsed. **I Lo** and **ALARM** are shown alternately on the display and the alarm relay is switched.

NO: The I-Low alarm is permanently deactivated and is not signaled.

522	Delay time I-High alarm	10 s ... 30 s

Adjustable delay time until the I-High alarm is signaled.

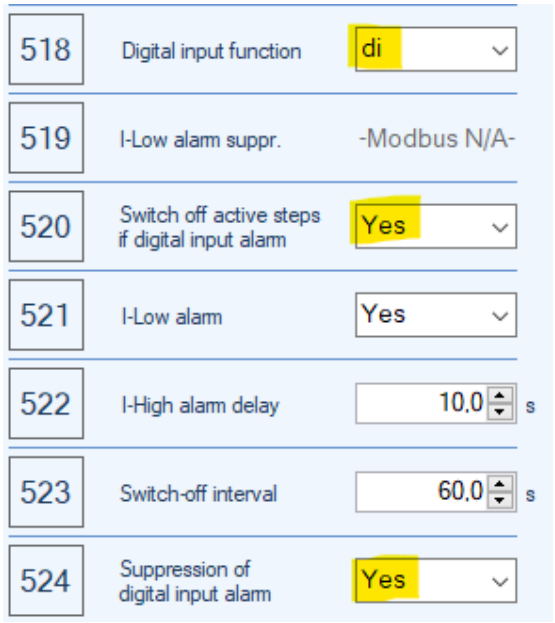
523	Switch-off interval for THD-U, THD-I, TEMP2, digital input alarm	1 ... 255 s

The set time corresponds to the switch-off interval of the stages in the event of an alarm, provided the setting for the THD-U, THD-I and TEMP2 alarm is activated (SETUP/503 = **YES**) or the setting for the digital input alarm is activated (SETUP/520 = **YES**).

524	Suppression of the DI alarm	Yes/No

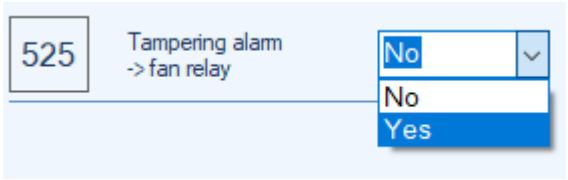
Option to suppress the di alarm (524) with active DI (518)
There should be NO alarm message
This means that the DI can be used to monitor the switching of the
AUTO /MANUAL operating state can be used.

NOTE: If this option is activated, the stages are not blocked for 30 minutes with 520 YES if the stages are to be switched off, as with switch-off with alarm, but only the set discharge time block is active.



525	Triggering of the fan relay	Yes/No

Serves the purpose of detecting tampering attempts. When activated, the fan relay triggers as soon as the user is in manual mode or in the setup menu.



8.6 600 Reset menu

Allows you to reset settings, saved values and counters. The software version of the device can also be queried and the PIN changed.

600 Reset menu

MENU	FUNCTION	AREA
601	Reset settings	Yes/No

YES: Resets all settings made to the factory setting. The control is temporarily switched off and all active stages (**AUTO)** are switched off one after the other. **FON stages** are not switched off. The initial commissioning (**First Setup**) is also restarted.

NOTE: The **SETUP/402, 403, 404** and **405** settings are not affected by the reset.

NOTE: The nominal voltage, the current and voltage transformer factor and the phase correction angle must be entered again after a reset. As an alternative to entering the phase correction angle, automatic initialization can also be carried out.

602 Reset stage database Yes/No

YES: Resets the stage database to its factory settings. All active stages, including **FON stages**, are switched off immediately.

The stage sizes, the recorded power loss and the switching cycles and operating hours counters of the individual stages are reset. A pending service alarm (max. switching cycles or operating hours of stages) is also reset.

NOTE: The settings not affected by the reset are the discharge time of the stages (**SETUP/401**) and the configuration of the fan relay (**SETUP/406**).

NOTE: If stage detection is deactivated (SETUP/308 = **NO**), the control is switched off and blocked. The stage sizes must be entered manually again (SETUP/402).

The control is blocked until the current transformer factor and at least one step size have been entered manually. The control can then be switched on again (SETUP/100/PFC or SETUP/310).

603 Reset operating hours counter Yes/No

YES: Resets the operating hours counter of the controller. After confirmation, the setting automatically returns to **NO**.

604 Reset Average power factor (APF) Yes/No

YES: Resets the average power factor (APF). After confirmation, the setting automatically returns to **NO**.

605 Reset maximum measured temperature Yes/No

YES: Resets the value of the highest measured temperature. After confirmation, the setting automatically returns to **NO**.

606 Reset alarm messages and alarm memory Yes/No

YES: Resets all displayed alarm messages and the alarm memory (ALARM menu). After confirmation, the setting automatically returns to **NO**.

NOTE: The alarm messages on the display are only reset if the alarms concerned are no longer present.

607 Display software version status of the device ---

Displays the software version of the device. The display is shown as a ticker: **xx.xx.xx**

608 Expert password (PIN) 0 ... 999

Set an expert password (PIN) for the SETUP menus 200, 300, 400, 500, 600, 700 and 800**.**

> **NOTE:** You can always access the expert menus with the master PIN **242**-.
>
> If the PIN is set to **000**, the expert menus are no longer protected by a PIN. All SETUP menus are unlocked.

609	Restart First Setup	Yes/No

YES: Initial commissioning is restarted and the control is switched off. All active AUTO **stages** are switched off one after the other. **FON**- stages are not switched off. If the initial setup is completed or canceled, the control starts again.

> **NOTE:** Settings and the level database are not reset**.**

8.7 700 Modbus

The Modbus RTU interface can be configured in this menu.

700 Modbus

MENU	FUNCTION	AREA
701	Baud rate	1.2 k ... 115.2 k

The baud rate determines the transmission speed of the communication interface.

702	Parity and stop bits	EVEN/ODD/NONE

EVEN: Parity: **Even** Stop bit: **1**
ODD: Parity: **Odd** Stop bit: **1**
NONE: Parity: **None** Stop bit: **2**

703	Slave address	1 ... 247

Defines the bus address of the device.

> **NOTE:** This address may only be assigned once within the bus**.**

8.8 800 System

This menu item contains various system settings.

800 System settings

MENU	FUNCTION	AREA
801	Backlighting Commissioning mode	Yes/No

YES: Activates the backlight for start-up mode.

NO: Cancels the backlighting start-up mode. The setting automatically reverts to **NO** after the delay time (SETUP/802) has elapsed.

802	Backlight delay time	0.25/0.50/1.00 h

For configuring the duration of commissioning mode. During commissioning mode, the remaining time is displayed here.

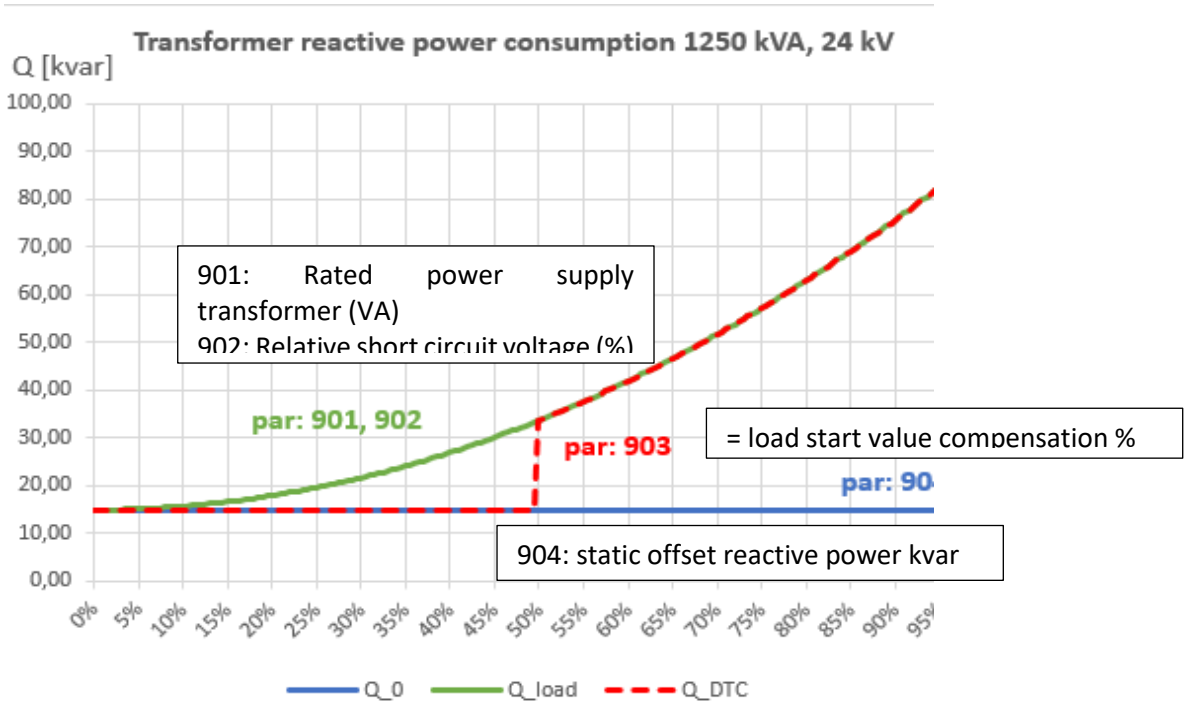
8.9 900 DTC dynamic transformer compensation - OPTION

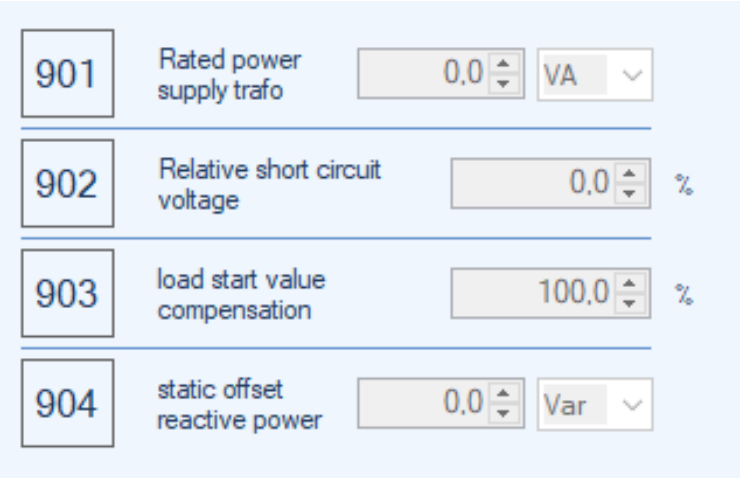
The menu items below provide an overview of the
Controller setting parameters that must be set for dynamic transformer compensation when operating the BLR-CXplus.

NOTE: Dynamic reactive current compensation is switched off when active power is exported.

900	Transformer Rated power	0-200MVA
	This value can be found on the rating plate	
902	relative short-circuit voltage in % Setting range	0-100%
	This value can be found on the rating plate	
903	Start value after transformer utilization in % Setting range	0-100%
	Recommended from a capacity utilization of 50%	
	NOTE: Dependent on the dynamic reactive power component of the transformer and the available tap size.	

904	Offset for dynamic transformer compensation	c 999.9...i 999.9 Mvar
	The (cap.) transformer base load must be set here.	

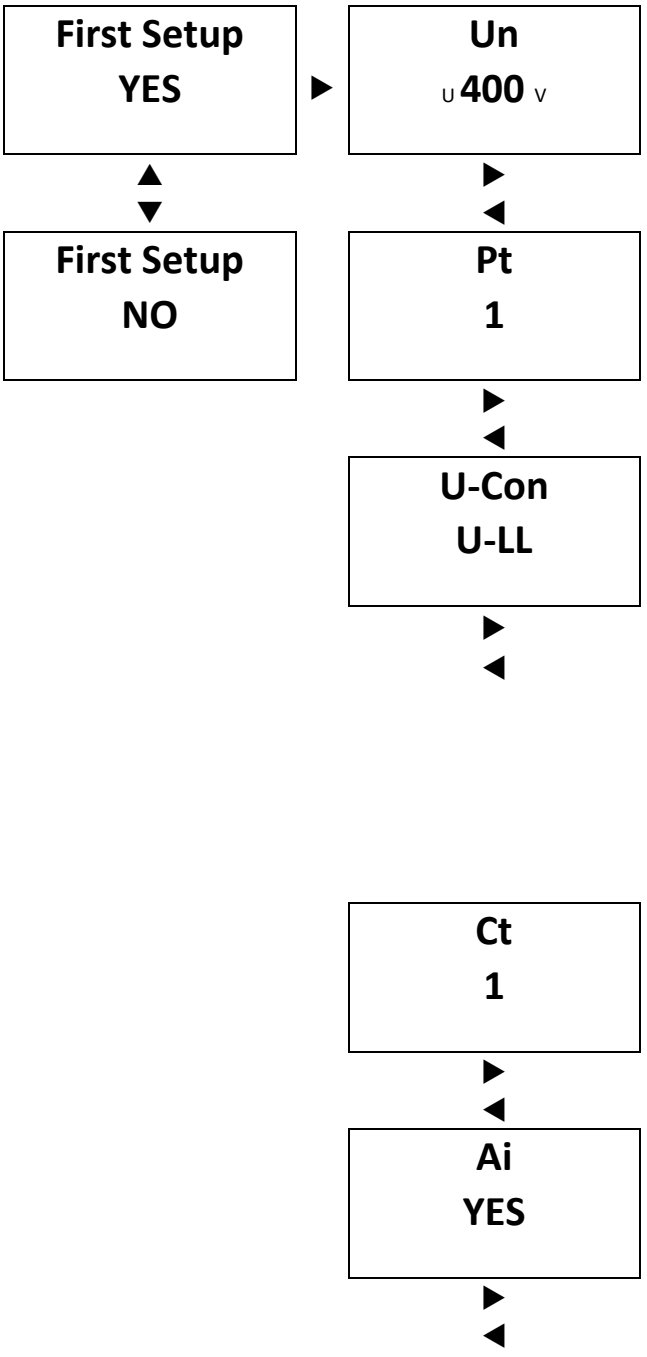

Transformer reactive power consumption 1250 kVA, 24 kV
Q [kvar]
100,00
90,00
80,00
70,00
60,00
50,00
40,00
30,00
20,00
10,00
0,00
0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
75%
80%
85%
90%
95%
901: Rated power supply transformer (VA)
902: Relative short circuit voltage (%)
par: 901, 902
par: 903
= load start value compensation %
par: 90
904: static offset reactive power kvar
Q_0
Q_load
Q_DTC


901
Rated power supply trafo
0,0
VA
902
Relative short circuit voltage
0,0
%
903
load start value compensation
100,0
%
904
static offset reactive power
0,0
Var

9. First Setup

The user-guided initial commissioning serves to prevent errors when commissioning the reactive power controller for the first time. The user is guided through the most important settings of the controller.

The initial setup can be carried out during initial commissioning. The initial commissioning can also be restarted at any time (SETUP/609 = **YES**).



Voltage L-L

Voltage transformer factor

If no converter is used: Value = 1

Type of voltage measurement

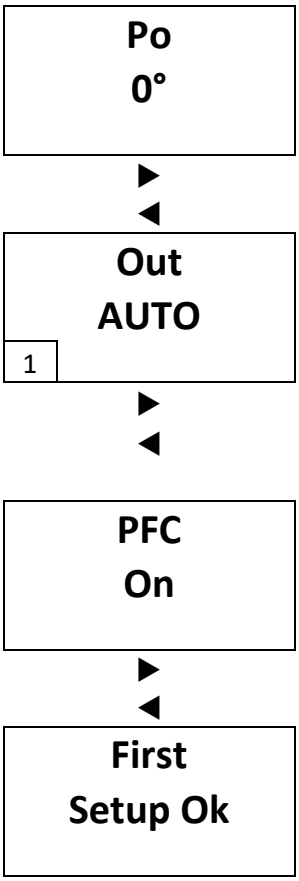
U-LN: Between conductor and neutral conductor
U-LL: Between ladder and ladder

If Un and Pt have been set correctly, the CX plus recognizes the connection automatically. The detected voltage connection appears for 1 second.

The determined U-LL voltage is also displayed for 3 seconds.

Current transformer factor

YES: The controller detects the phase position (connection of measured voltage and current) and the assignment of the switching outputs.



Phase angle

Only appears if the Ai was skipped. The calculated cos φ is shown on the display during input

Step type / status:

AUTO: Level is switched automatically
FOFF: Level is deactivated
FON: Level is always on
Flty: Stage is defective

ON: Control ON
OFF: Control OFF
Hold: Control stopped

User-guided initial commissioning has been completed

10. Control algorithms

10.1 BEST-FIT (CAR)

The controller operates according to the BEST-FIT principle in order to achieve the best compensation result. Before each switching operation, the controller compares all the stage sizes stored in the stage database with the calculated reactive power requirement and always selects the stage that comes closest to the set control target. If stages of the same size are connected to the controller, the number of switching operations is automatically distributed to the affected stages either via the switching cycles or the operating hours (SETUP/315).

Blocked defective stages (**Flty**) and stages of type **FON** and **FOFF** are skipped by the control. If a stage is detected as defective and blocked (**Flty**) after being switched on 3 times, it is no longer used for control. Stages that have been switched off by the alarm system using the stage switch-off sequence and blocked for a maximum of 30 minutes are also skipped.

10.2 LIFO (Last In - First Out)

The controller starts with level 1 and always switches to the level of the next higher number if required. The stages are switched off in reverse order. A check is carried out for each stage to determine whether a switching action is appropriate.

The best compensation result is achieved by using steps of the same size.

To ensure control stability, faulty stages are always blocked and skipped by the control algorithm. The corresponding setting can therefore not be modified (SETUP/309).

NOTE: The settings in the step change (SETUP/307) and switching distribution (SETUP/315) menus are ignored.

10.3 COMBI FILTER

Suitable for combined filter systems with two different degrees of choking. The control is based on the BEST-FIT principle and ensures that more or the same amount of compensation power is always switched on at the odd-numbered switching outputs as is available at the even-numbered outputs.

This prevents overloading of the lower choked compensation stages. The higher choked stages must be connected to the odd-numbered stage outputs for this purpose.

The control algorithm also takes into account permanently switched on stages (**FON**). However, it is not recommended to switch stages on permanently to avoid an imbalance.

To ensure control stability, faulty stages are always blocked and skipped by the control algorithm. The corresponding setting can therefore not be modified (SETUP/309).

NOTE: The settings in the step change (SETUP/307) and switching distribution (SETUP/315) menus are ignored.

NOTE: The combi-filter algorithm only works with **capacitive** stages.

NOTE: If stage detection is carried out for the first time, more stage power may be connected to the even switching outputs than to the odd ones. To prevent this, the tap sizes must be entered manually (SETUP/402).

10.4 PROGRESSIVE

The control is based on the BEST-FIT principle and switches several stages on and off one after the other with a shorter switching time if required. The set switching time is ignored. This results in faster switching behavior and a shorter response time.

The tap sizes must be entered manually, as tap detection is deactivated in this control algorithm. This has the disadvantage that it is not possible for the control system to detect defective stages and power loss.

NOTE: The settings in the step change (SETUP/307) and switching distribution (SETUP/315) menus are ignored.

10.5 FIFO (First In - First Out)

The controller starts at level 1 and always switches to the level of the next higher number if required. When switching off, the controller starts at level 1 and always switches off the level of the next higher number if required.

If, for example, levels 3 to 7 are still switched on, the control starts with level 8 when switching on. If level 12 has been switched on and level 1 is not yet switched on, the next step is to start with level 1 again. When switching off, the control starts with level 3. If level 12 has been switched off and level 1 is still switched on, level 1 is started next. A separate check is carried out for each stage to determine whether a switching action is appropriate.

The best compensation result is achieved by using steps of the same size.

NOTE: To ensure control stability, faulty stages are always blocked and skipped by the control algorithm. The corresponding setting can therefore not be modified (SETUP/309).

NOTE: The settings in the step change (SETUP/307) and switching distribution (SETUP/315) menus are ignored.

11. Automatic initialization

11.1 Executing the Ai

Automatic initialization determines the phase position between the measured voltage and the measured current, as well as the assignment of the switching outputs.

Automatic initialization can be activated in the SETUP menu (SETUP/100/Ai or SETUP/207 = **YES**) and starts as soon as the voltage is within the tolerance and the measured current is greater than 5 mA. **Ai run** and the **number** of the run are shown on the display.

When the Ai is executed, the set switching and discharging time is taken into account. Stages of stage type **FON** and **Flty** are ignored by the Ai. If stages have been switched on by the control system before the start, they are switched off one after the other before the Ai can begin. If the measured power change during a run is too small, the Ai first switches all stages on one after the other in the next run and then switches them off again one after the other.

If the automatic initialization was successful within **a maximum of four runs**, the determined phase correction angle is set automatically and unused stage outputs are set to stage type **FOFF**. **AUTO** appears on the display and after the discharge time has elapsed, the control system starts switching the stages on and off. The set switching time is taken into account.

The duration of the automatic initialization depends on the number of passes, the number of stage outputs, the set switching time and the discharge time of the stages.

NOTE: Automatic initialization only works with capacitor stages**.**

NOTE: Automatic initialization does not detect the stage sizes. The stage sizes are only detected by the control system during normal control operation.

NOTE: Due to load fluctuations, the Ai may not correctly recognize occupied stage outputs. It is therefore necessary to check whether all connected stages have the **AUTO** stage type.

11.2 Termination of the Ai

The Ai can be canceled manually at any time (SETUP/100/Ai or SETUP/207 =). To do this, answer the subsequent control query with **YES**. The phase correction angle and the assignment of the stage outputs have therefore not been determined. The control is also off.

Ai is automatically aborted if the phase angle is not detected within **four runs**. **Ai** and **Abrt** are shown alternately on the display and control is stopped.

If the Ai is not successful after several attempts, the phase correction angle **must** be set manually (SETUP/206). Furthermore, the stage types must be configured manually (SETUP/100/Out or SETUP/403) and the control must be restarted (SETUP/100/PFC or SETUP/310 = **ON**).

12. Levels Functions

12.1 Automatically detect step size

If stage detection is activated (SETUP/308 = **YES**), the CX plus automatically determines the size of the switched stage for each switching operation. After 50 switching operations (switch on 25x, switch off 25x), stage detection for a stage is complete. From now on, stage power loss monitoring is active for the respective stage.

NOTE: Step detection can be completed prematurely at any time and for each step by manually entering the step size.

If the controller cannot detect a mains response during the first 3 switching operations (switch on 3x, switch off 3x), the stage type of the affected stage is set to **FOFF**. It is assumed that no stage is connected.

NOTE: If the current transformer or voltage transformer factor is entered, all tap sizes (current and original tap size) are reset to the initial value of 3 VAr capacitive. The tap detection starts from the beginning.

NOTE: Automatic detection of the step size is only possible with capacitive steps. For inductive stages, the stage size must be entered manually (SETUP/402).

12.2 Enter step size manually

If stage detection is switched off (SETUP/308 = **NO**), the stage size (nominal stage value) must be entered manually (SETUP/402). Otherwise, the controller will switch stages on and off again immediately, as the start value in the stage database (3 VAr capacitive) differs greatly from the actual stage size. Once the tap size has been entered, monitoring of the tap power losses is active.

NOTE: Tracking and adjusting the step size is also active when step detection is switched off.

NOTE: If the current transformer or voltage transformer factor is entered, the current stage size of each individual stage is reset to the last manually entered value.

NOTE: Switching off tap detection switches off the control and blocks it. This setting is blocked until the current transformer factor and at least one tap size have been entered manually. Only then can the control be switched on again.

12.3 Adding additional levels

If one or more stages are added to an existing system, these can simply be added to the stage database.

To do this, simply set the stage type of the additionally assigned switching outputs to **AUTO** (SETUP/100/OUt or SETUP/403).

If stage detection is switched off (SETUP/308 = **NO**), the stage sizes must also be entered manually (SETUP/402).

12.4 Power loss detection

The CX plus continuously determines the current step size when switching a step.

$$\text{Stufengröße } [\%] = \frac{Q_{\text{aktuell}}}{Q_{\text{original}}} * 100$$

If the current stage size falls below 75 % of the original stage size, the alarm system can trigger an alarm and switch off and permanently block the affected stages. **SPL** and **ALARM** as well as the stage number of the affected stage are then shown alternately on the display. The alarm relay is also activated. If several stages are affected, only the smallest stage number of the affected stages is displayed.

To activate this option, the function **Stage alarm: Power loss stages** must be activated (SETUP/516 = **YES)**. Affected stages are then always switched off immediately and set to stage type **FOFF**. The stage is then disabled for control and in manual mode. The stage type of the affected stage is blocked and cannot be changed.

The **stage alarm: power loss stages** is used to protect choked capacitor stages. Due to the ageing of capacitors, the resonant frequency of choked systems increases. Harmonic currents are consequently less attenuated and can lead to overloading of the chokes or capacitors.

To reset the alarm and activate the affected stages, the affected stages must first be replaced. The stage size must then be entered manually for each new stage (SETUP/402) and the stage type must be set to **AUTO** again (SETUP/403). The stages can now be switched again by the controller or in manual mode.

NOTE: The monitoring of a step only becomes active once the step detection has been completed or the step size has been entered manually.

12.5 Detecting and resetting defective stages

Stages that have already been detected or manually configured are classified as faulty by the controller after three consecutive switching operations without a mains response.

If the **Block faulty stages** function is activated (SETUP/309 = **YES**), the affected stage is set to stage type **Flty** and is blocked for control for 24 hours. Manual switching of this stage is also not possible. The stage symbol of the faulty stage flashes in the lower part of the display.

After 24 hours, the controller sets the stage type of the affected stage back to **AUTO** and tests it again. If no mains response is detected again after three consecutive switching cycles, this stage is blocked again by the controller for 24 hours (stage type = **Flty**).

If the defective stage has been replaced, the stage type can be manually switched back to **AUTO** (SETUP/100/OUt or SETUP/403). The stage is then available to the control system again and can also be switched again in manual mode. When replacing stages, make sure that the new nominal stage value is entered manually in the stage database (SETUP/402).

If a defective contactor was responsible for the faulty stage, the switching cycle counter of the affected stage (SETUP/404) must be manually reset to **0** after replacing the contactor in order to restart the switching cycle monitoring for the contactor.

12.6 Automatic switching distribution

The CX plus automatically performs a switching distribution across all connected stages **of the same size**. This distribution is carried out either via the number of switching cycles or via the operating hours of the individual stages.

Distribution over the switching cycles

If several stages of the same size are connected and the **Distribute switching operations** option is deactivated (SETUP/315 = **NO**), the controller automatically carries out a switching cycle distribution for stages of the same size based on the switching cycle counters. Accordingly, the stages concerned have the same number of switching operations (+/- 1).

Distribution over the number of switching operations is recommended if contactors are used to switch the capacitor stages. This ensures an even load on the contactors and prevents excessive wear on individual contactors.

Distribution over the operating hours

If several stages of the same size are connected and the **Distribute switching operations** option is activated (SETUP/315 = **YES**), the controller automatically carries out a switching distribution for stages of the same size based on the operating hours counter. Accordingly, the operating hours are distributed evenly across the affected stages.

A distribution over the number of operating hours must be selected if uniform ageing of the installed capacitors is to be achieved.

12.7 Add 7th / 13th step output

The CX plus is equipped with 6 or 12 switching outputs as standard. If an additional step output is required, the fan relay can be used for this purpose.

NOTE: The regular function of the fan relay is then no longer available.

To use the fan relay as the 7th or 13th stage, the **fan relay** function must be activated **as an additional stage output** (SETUP/406 = **YES**). All stage functions are now available for this output.

NOTE: In the event of a modification, all active stages are first switched off one after the other and the control system restarts. **FON stages** are not affected by this.

NOTE: The fan relay is **not** suitable for controlling thyristor controllers.

The stage type (SETUP/100/OUt and SETUP/403) must be set for the additional switching output. If stage detection is switched off (SETUP/308 = **NO**), the stage size must still be entered manually.

If the stage type is set to **AUTO**, the controller uses the fan relay as a fully-fledged 7th or 13th stage. If the controller switches the relay on, this is indicated in the display by the stage symbol **7** or **13**. If the stage type is set to **FON**, the stage is permanently switched on.

12.8 Protection against overtemperature

The CX plus is equipped with an integrated temperature sensor that can be used to monitor the stage temperature.

For this purpose, a temperature limit value TEMP2 must be set in the alarm system (SETUP/513), from which all active stages are to be switched off one after the other. For this setting, the temperature limit TEMP1 may also need to be adjusted due to the following condition (SETUP/512).

$$\mathrm{TEMP2_{min}} = \mathrm{TEMP1} + 5\ \mathrm{K}$$

The protective shutdown of the stages must be activated in the SETUP menu (SETUP/503 = **YES).** To minimize mains feedback, the time sequence of the switch-off sequence can also be configured (SETUP/523).

If the temperature limit TEMP2 is exceeded, **thi** and **ALARM** appear on the display after a delay time (SETUP/504) and the alarm relay is activated. After the set switch-off interval has elapsed, the stage switch-off sequence begins. The last stage switched on is switched off first. All active stages are switched off one after the other in time with the switch-off interval as long as the temperature alarm is still present. All stages switched off by the alarm system are blocked for 30 minutes. If all active stages have been switched off, the control is stopped.

If the temperature in the control cabinet falls below the temperature limit TEMP2 by 5 K, a stage switch-off sequence that is still active is aborted. The control system restarts and can switch stages on and off. However, the stages switched off by the alarm system remain blocked for the duration of the blocking time and are therefore not available to the control system.

12.9 THD-U / THD-I protection

To protect capacitor stages, the CX plus can switch off all active stages one after the other if there is a high level of harmonic distortion (THD). This is possible for both the THD of the voltage (THD-U) and the THD of the current (THD-I).

For this purpose, limit values for THD-U (SETUP/502) and THD-I (SETUP/510) can be configured in the alarm system.

The protective shutdown of the stages must be activated in the SETUP menu (SETUP/503 = **YES).** To minimize mains feedback, the time sequence of the switch-off sequence can also be configured (SETUP/523).

If the THD-U or THD-I limit value is exceeded, **HArU** and **ALARM** (THD-U alarm) or **HArI** and **ALARM** (THD-I alarm) appear on the display after a delay time (SETUP/504) and the alarm relay is activated.

Once the set switch-off interval has elapsed, the stage switch-off sequence begins. The last stage to be switched on is switched off first. All active stages are switched off one after the other in time with the switch-off interval as long as the THD-U or THD-I alarm is still present. All stages switched off by the alarm system are blocked for 30 minutes. Once all active stages have been switched off, control is stopped.

If the THD-U or THD-I falls below the set limit value, an active stage switch-off sequence is canceled. The control starts again and can switch stages on and off. However, the stages switched off by the alarm system remain blocked for the duration of the blocking time and are therefore not available to the control system.

NOTE: In order to measure harmonic current values accurately, the current in the secondary circuit of the current transformer (measured current) must be greater than 50 mA.

13. Digital input

13.1 Switch to target cos φ 2

The digital input of the CX plus can be used to differentiate between high and low tariffs for the target cos φ.

To do this, the digital input must be configured accordingly (SETUP/518 = **CP2**). The logic of the digital input can also be defined (SETUP/511).

The digital input can then be used to switch back and forth between target cos φ 1 (SETUP/100/CP1 or SETUP/302) and target cos φ 2 (SETUP/303). An active target cos φ 2 is indicated on the display by an **NT** symbol.

13.2 Suppression of the I-Low alarm

An I-Low state can be a normal operating state during the off-peak period. It may therefore not be desirable for an I-Low alarm to be signaled during this time. For this reason, a pending I-Low alarm can be suppressed via the digital input.

To do this, the digital input must be configured accordingly (SETUP/518 = **I Lo**). The logic of the digital input can also be defined (SETUP/511).

The I-Low alarm can then be suppressed via the digital input. The current status is displayed under SETUP/519.

NOTE: If a pending I-Low alarm is signaled and the digital input is activated for suppression, the alarm message is only reset after 15 seconds. The **AUTO** symbol is only displayed again after the set switching time has elapsed if the control is not switched off.

NOTE: If a pending I-Low alarm is suppressed and the digital input is no longer activated, the alarm is only signaled after the delay time of 60 s has elapsed.

NOTE: If the delay time has not yet expired and the digital input is activated again, a pending I-Low alarm is immediately suppressed again. If the digital input is no longer activated, the delay time is restarted (60 s). The I-Low alarm is not signaled until the delay time has elapsed.

13.3 Input for external alarm signals

The digital input can be used as a logical input for external alarm signals, e.g. overtemperature via thermostat.

To do this, the digital input must be configured accordingly (SETUP/518 = **di**). The logic of the digital input can also be defined (SETUP/511).

It is also possible to configure that active stages are switched off when an alarm is triggered (SETUP/520 = **YES**). The switch-off interval (SETUP/523) is taken into account here. The message **di** and **ALARM** appear on the display and the alarm relay is switched.

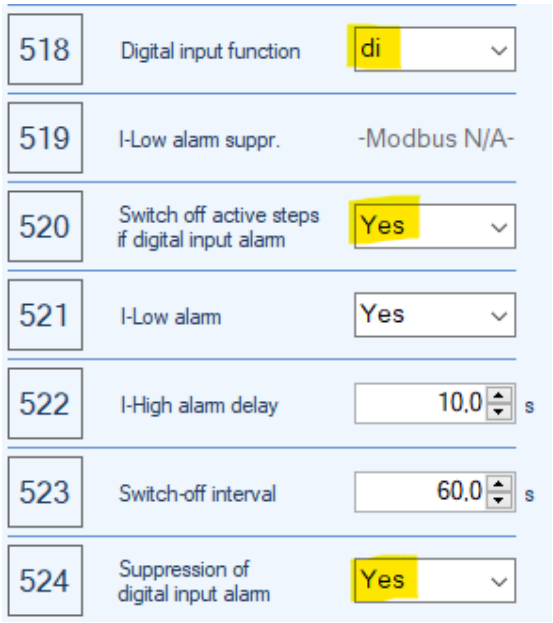
Once the set switch-off interval has elapsed, the stage switch-off sequence begins. The last stage to be switched on is switched off first. All active stages are switched off one after the other in time with the switch-off interval as long as the alarm signal is still present. All stages switched off by the alarm system are blocked for 30 minutes. Once all active stages have been switched off, the control is stopped.

If the switch-off condition is no longer fulfilled, a stage switch-off sequence that is still active is canceled. The control system restarts and can switch stages on and off. However, the stages switched off by the alarm system remain blocked for the duration of the blocking time and are therefore not available to the control system.

13.4 Option to suppress the alarm

Option to suppress the di alarm (524) with active DI (518)
There should be NO alarm message
This means that the DI can be used to monitor the switching of the
AUTO /MANUAL operating state can be used.

NOTE: If this option is activated, the stages are not blocked for 30 minutes with 520 YES if the stages are to be switched off, as with switch-off with alarm, but only the set discharge time block is active.



14. Fan control

If the controller is installed in a control cabinet with a fan, the CX plus can control the fan. The temperature is determined by a temperature sensor integrated in the housing.

The fan relay is controlled by the alarm system. For this, the **fan relay** function must be deactivated **as an additional stage output** (SETUP/406 = **NO**).

NOTE: In the event of a modification, all active stages are first switched off one after the other and the control system restarts. **FON stages** are not affected by this.

The temperature limit TEMP1 must also be set (SETUP/512). For this setting, the temperature limit TEMP2 may also need to be adjusted due to the following condition (SETUP/513).

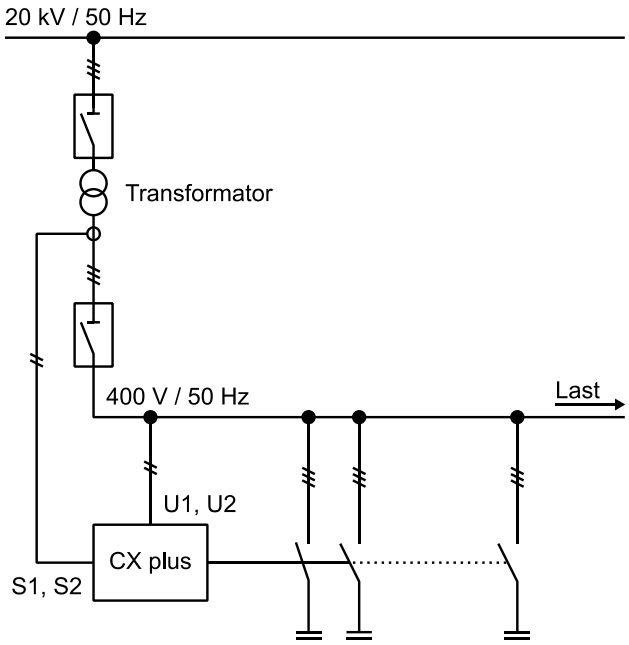
$$\mathrm{TEMP1}_{\max} = \mathrm{TEMP2} - 5\ \mathrm{K}$$

The fan relay is now switched on when the temperature limit TEMP1 is exceeded. Fan operation is indicated by a flashing **FAn** symbol in the bottom line of the display (main window). If the temperature in the control cabinet falls 5 K below the temperature limit TEMP1, the fan relay is switched off again after 10 seconds.

NOTE: The error message **Ai / Abrt** is suppressed by the status message **FAn**. If necessary, reset the error message **Ai / Abrt** by pressing the◄ (ESC) button (3 s).

15. Transformer compensation

15.1 Offset reactive power



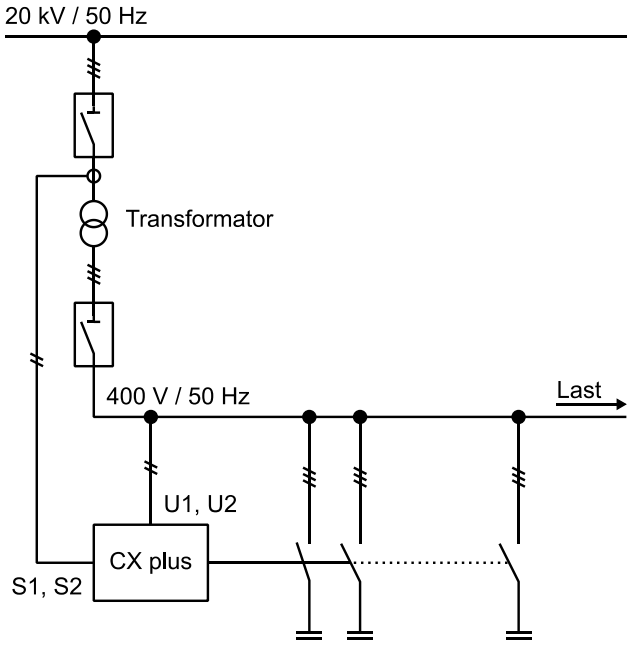
measurement

If no fixed stages are available to compensate for an upstream transformer, this can be taken over by the CX plus controller.

To do this, the reactive power of the transformer must be made known to the controller as offset reactive power (SETUP/312). This value is then added to the measured reactive power value and taken into account in the control deviation.

NOTE: The cos φ is always displayed **before** the transformer. This means that the cos ⍰⍰innerhalb of the system can be capacitive.

15.2 Medium-voltage side current



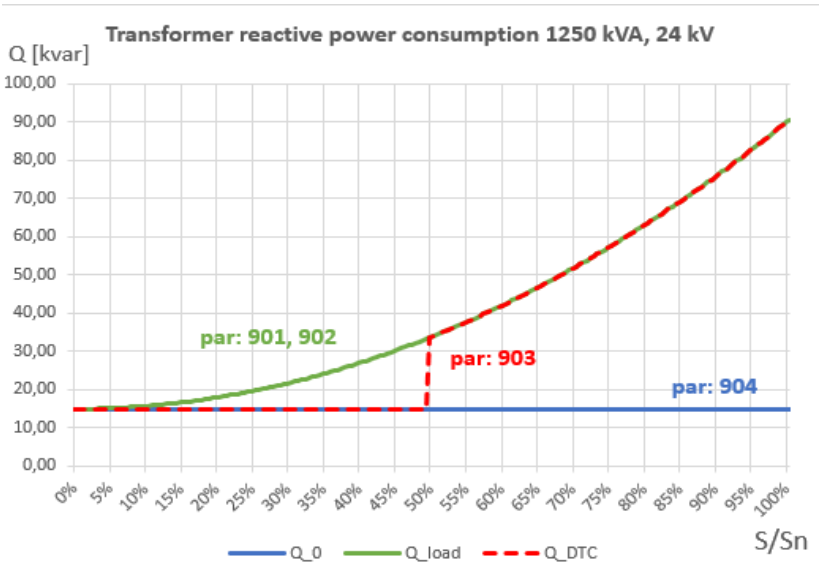
The reactive power caused by the transformer is recorded by a medium-voltage current measurement and compensated for by the connected compensation system.

In addition to the structure shown, the phase correction angle must also be taken into account. This depends on the wiring of the transformer.

Automatic initialization can be used to determine the phase correction angle (SETUP/100/Ai or SETUP/207 = **YES**).

For manual input of the phase correction angle (SETUP/206), the example calculation from chapter 19.3. can be used.

15.3 Dynamic transformer compensation



The reactive power required for transformers changes depending on the transformer utilization.

To avoid overcompensation in the low load range or undercompensation in the full load range

the CXplus-DTC has a dynamic adjustment in addition to the fixed offset reactive power.

The controller continuously calculates the required reactive power of the transformer and switches it on or off as required during compensation

<u>Only 3 settings are required for this:</u>

Rated power transformer [VA]-> setting range 0 - 200MVA

Relative short-circuit voltage transformer [%] -> setting range 0 - 100%

Start from transformer load [%] -> setting range 0 - 100 %

The calculated reactive power is automatically added to the calculated reactive power required to achieve the target cos phi.

16. Assistance

16.1 General

1) No indication on the display

Possible causes:
Supply or measuring voltage is missing.

Solution:
Check whether the connected measuring voltage is within the range of 90 ... 550 V AC.

Solution:
Check/adjust the correct connection of the measuring voltage.

2) **AUTO** is **not** displayed on the right

Possible causes:
Manual mode selected or the control has been stopped or switched off.

Solution:
Restart control (SETUP/100/PFC or SETUP/310 = **ON**).

Possible causes:
Current is less than 5 mA, voltage or THD-I/U are outside the valid range, temperature is too high, automatic initialization (Ai) was aborted with an error.

Solution:
The points mentioned above should be checked/adjusted.

3) Display **EXPORT**

Possible causes:

If there is no real regenerative power supply, the set phase correction angle does not match the connection of the measured voltage and current.

Solution:
Perform automatic initialization (SETUP/100/Ai or SETUP/207) or set the phase correction angle correctly manually (SETUP/206).

Solution:

Check the connection polarity. If the connection sense is rotated by 180°, add or subtract 180° from the manually set phase correction angle (see chapter 19.2) and set (SETUP/206).

4) Display **Ai** Abrt

Possible causes:
Automatic initialization was aborted due to strong load fluctuations.

Solution:
Start automatic initialization again when the network is quieter.

Possible causes:
The measured current is too low. The current transformer ratio may be too high.

Solution: The selected current transformer may not be suitable for the system and must be replaced. Automatic initialization must then be carried out again.

Possible causes:
The step sizes are too small.

Solution:
If automatic initialization is not successful after several attempts, the correct phase correction angle can alternatively be set manually (SETUP/206). The unused stage outputs can be set manually (SETUP/100/OUt) to stage type **FOFF**.

The control must be switched on again manually (SETUP/100/PFC or SETUP/310).

5) Incorrect **cos φ** is displayed

Possible causes/solution:
See 3).

Possible causes:
The phase correction angle has been set incorrectly. The set offset reactive power is not correct.

Solution:
Start automatic initialization (SETUP/100/Ai or SETUP/207) or set the phase correction angle manually (SETUP/206).

Solution:
Check/adjust the reactive power offset (SETUP/312).

6) **NT** is not displayed although digital input is activated

Possible causes:
Digital input function has not been configured. Logic set incorrectly.

Solution:
Configure digital input (SETUP/518 = **CP2**) and adjust logic (SETUP/511).

7) Current and power values are not displayed

Possible causes:
The current transformer factor has not been set.

Solution:
Enter the current transformer factor correctly (SETUP/100/Ct or SETUP/202).

8) Measured voltage is not correct

Possible causes:
Incorrect voltage transformer ratio or incorrect voltage connection detection.

Solution:
Check/adjust voltage transformer ratio (SETUP/100/Pt or SETUP/203).

Solution:
Check/adjust connection type (SETUP/205).

9) Measured current is not correct

Possible causes:
Incorrect current transformer ratio set.

Solution:
Check/adjust current transformer ratio (SETUP/100/Ct or SETUP/202).

16.2 Alarms

1) Display **U ALARM**

Possible causes:
The entered values for nominal voltage, voltage transformer factor or tolerance band do not match the system.

Solution:
Check/adjust nominal voltage (SETUP/100/Un), voltage transformer (SETUP/100/Pt) and tolerance band (SETUP/204).

2) Display **I Lo ALARM**

Possible causes:
Measuring current less than 5 mA. The connection from the current transformer to the controller is not correct. The current transformer bridge has not been removed or the transformation ratio of the transformer is too high.

Solution:
Check the connections and the current transformer factor. The current in the transformer secondary circuit must be at least 5 mA.

Solution:
Adapt the transducer type to the system.

3) Display **I hi ALARM**

Possible causes:
Measured current on the secondary side greater than 6 A.

Solution:
Use a transformer type with a higher current transformer ratio.

4) **PFC ALARM** display

Possible causes:
Over- or undercompensation is present and the control target cannot be achieved.

Solution:
Check target cos φ settings.

Solution:
Check/replace power contactors or thyristor controllers.

Solution:
Check/adjust step setting.

Solution:

Check/adapt the dimensions of the system.

5) **SPL** ALARM display

Possible causes:
The current step size has fallen below 75% of the original size.

Solution: Check/adjust step sizes. It may be necessary to replace steps.

6) No **I Lo ALARM** although measuring current is less than 5 mA

Possible causes:
I-Low alarm is suppressed by digital input. The logic of the digital input is set incorrectly.

Solution:
Check/adjust the SETUP/519 setting and, if necessary, the SETUP/518 and SETUP/511 settings.

16.3 Steps

1) Stages are not switched on

Possible causes:
The available levels are too large.

Solution:
Check the dimensions of the system. Fine-tune the stage sizes.

Possible causes:
The discharge times of the stages have not yet expired. A THD-U, THD-I or TEMP2 alarm has blocked the stages for 30 minutes.

Solution:
Wait for unloading time or locking time.

2) Individual stages are not switched on or off

Possible causes:
The step type has been set to **FON** or **FOFF**.

Solution:
Check/adapt step types.

3) Step outputs are switched off again immediately

Possible causes:
The stored nominal value of at least one stage no longer matches the stage database or no stage power was detected when the stage was switched.

Solution: Check/replace stages, fuses, contactors or thyristor controllers.

Solution:
If stages have been replaced, the new stage values must be entered manually in the stage database.

4) One or more stages were recognized as faulty

Possible causes/solution:
See 3).

5) Frequent switching of the outputs

Possible causes:
The start values (3 VAr) of the individual stages are still stored in the stage database.

Solution:
It takes several switching operations for the exact tap power of the capacitive tap-changers to be saved in the tap database.

6) Power factor does not change after switching stages

Possible causes:
Current transformer incorrectly positioned. Stages defective.

Solution:
Check/adjust the installation position of the current transformer.

Solution:
Check/replace stage, power contactor or thyristor controller.

7) Power factor when connecting stages does not match

Possible causes:
Connection of measuring voltage or current rotated by 180°. The phase correction angle is not correct.

Solution:
Check/adjust connection of current and voltage.

Solution:
Phase correction angle according to the connection type (see chapter 19.).

8) Steps cannot be switched manually

Possible causes:
The discharge times of the stages have not yet expired. A THD-U, THD-I or TEMP2 alarm has blocked the stages for 30 minutes.

Solution:
Wait for unloading time or locking time.

16.4 Fan

1) Fan does not switch on

Possible causes:
TEMP1 limit value is set too high. The fan relay is used as a step output.

Solution:
Check/adjust temperature limit value (SETUP/512).

Solution:
Assign fan relay to fan function (SETUP/406 = **NO**)

17. Default settings

The following table contains all the default settings stored in the controller. The fields with a gray background either cannot be changed (status displays) or are automatically reset to **NO** when switching from **NO** to **YES** (reset menu).

NOTE: Settings from SETUP menus 200, 300 and 400 that are important for commissioning are summarized again in quick start menu 100. The relevant settings only need to be made in one place.

Menu	Default setting	Customer attitude
100	**Quickstart**	
Un	400 V	
Ct	1	
Pt	1	
Ai	NO	
PFC	ON	
CP1	1	
St	10 s	
OUt	AUTO (level 1 ... max.)	
200	**Measurement**	
201	400 V	
202	1	
203	1	
204	10 %	
205	U-LN/U-LL (Automatically determined)	
206	Connection voltage L-N = 0° L-L = 90°	
207	NO	
208	AUTO	
209	0 °C	
210	OPTION- CO2 counter	
300	**Control**	
301	60 %	
302	1	
303	0,95 i	
304	NO	
305	10 s	
306	2 s	

307	YES	
308	YES	
309	YES	
310	ON	
311	1	
312	0	
313	1	
314	NO	
315	NO	
316	YES	

400	**Step database**	
401	75 s	
402	3 VAr c (level 1 ... max.)	
403	AUTO (level 1 ... max.)	
404	0 (level 1 ... max.)	
405	0 h (level 1 ... max.)	
406	Yes / No	
407	Yes / No	

500	**Alarm**	
501	NO	
502	20 %	
503	NO	
504	60 s	
505	NO	
506	NO	
507	500 k	
508	65.5 kh	
509	65.5 kh	
510	50 %	
511	YES	
512	30 °C	
513	55 °C	
514	NO	
515	NO	
516	NO	
517	NO	
518	CP2	
519	YES/NO (Automatic)	
520	NO	
521	YES	

522	10 s	
523	60 s	
524	Yes/No	

600	**Reset menu**	
601	NO	
602	NO	
603	NO	
604	NO	
605	NO	
606	NO	
607	xx.xx.xx	
608	242	
609	NO	

700	**Modbus**	
701	19.2 k	
702	EVEN	
703	1	

800	**System**	
801	NO	
802	0.25 h	

900	**DTC- OPTION**	
901	0.0 VA	
902	0.0 %	
903	0.0 %	
904	0.0 Var C	

18. Technical data

Measuring / supply voltage	
	Connection: Single-phase Range: 90 - 550 V AC, 45 - 65 Hz Fuse protection: Max. 6 A Power consumption: 6 VA Conversion factor: Adjustable 1.0 ... 350.0
Current measurement	
	Connection: Single-phase Range: 5 mA - 5 A Conversion factor: Adjustable 1 ... 9600
Step outputs	
	6 or 12 switching outputs
Option -xxR	Type: Relay, NO contact, potential-free Power supply: Common, max. 10 A Switching capacity per relay: 250 V AC / 5 A 400 V AC / 1 A 48 V DC / 1 A 110 V DC / 0.2 A
Option -xxT	Type: Transistors, normally open contact, open collector output Power supply: Common, max. 1.2 A Switching capacity per transistor: 100 mA / 8 - 48 V DC
Temperature measurement	
	Type: NTC under the housing cover Accuracy: +- 5 °C
Alarm output	
Standard	Type: Relay, NO contact, potential-free Switching capacity: 5 A / 250 V AC
Option -nc	Type: Relay, NC contact, potential-free Switching capacity: 5 A / 250 V AC
Fan output	
	Type: Relay, NO contact, potential-free Switching capacity: 250 V AC / 5 A 400 V AC / 1 A 48 V DC / 1 A 110 V DC / 0.2 A
Digital input	
	Logic: Adjustable, high or low active Input signal: 90 - 250 V AC

Service interface	
	For service purposes only
Modbus	
Standard	Not equipped
Option -MB	Protocol: Modbus-RTU Interface: RS485 Common mode input voltage: -7 - 12 V Differential input voltage: -12 - 12 V Output current: -60 - 60 mA
Ambient temperature	
	Operation: -20 °C - 70 °C Storage: -40 °C - 85 °C
Air humidity	
	Range: 0 % - 95 % Condensation: Not permitted
Overvoltage category	
	300 V_{LN} / 519 V_{LL} → CAT III 519 V - 550 V → CAT II Degree of soiling → 2
Standards	
	IEC 61010-1, IEC 61000 6-2, IEC 61000 6-4: Level B, IEC 61326-1, UL 61010
Conformity and listing	
	CE, NRTL (C TÜV Süd), EAC
Connections	
	Type: Screw terminals, pluggable Cross section: Max. 4 mm^2
Housing	
	Front: Plastic housing (UL94 V-0) Back: metal lid
Protection class	
	Front side: IP41 Rear: IP20
Weight	
	approx. 0.6 kg
Dimensions	

Device: H x W x D: 144 x 144 x 58 mm,
Cut-out: H x W: 138 (+0.5) x 138 (+0.5) mm

19. Appendix

19.1 Phase correction angle after connection

Depending on the connection of the measuring voltage and the measuring current, a certain phase angle results. For correct measurement, this must be compensated for accordingly via the phase correction angle (SETUP/206).

Tension	L1-N	L2-N	L3-N	L1-N	L2-N	L3-N	L1-N	L2-N	L3-N
Current transformer	L1	L2	L3	L2	L3	L1	L3	L1	L2
Correction angle	0°	0°	0°	240°	240°	240°	120°	120°	120°

Tension	L2-L3	L3-L1	L1-L2	L2-L3	L3-L1	L1-L2	L2-L3	L3-L1	L1-L2
Current transformer	L1	L2	L3	L2	L3	L1	L3	L1	L2
Correction angle	90°	90°	90°	330°	330°	330°	210°	210°	210°

19.2 Phase correction angle Connection twisted

If the current transformer connection is inverted, a phase correction of 180° must also be taken into account (SETUP/206). The same applies to the reversed connection of the measuring voltage.

NOTE: If adding an **angle x** results in a **phase angle equal to or greater than 360°**, this **angle x** must be subtracted instead.

Example:

Previously set phase correction angle = 270°

270° + 180° = 450° (**≥ 360°!)**

The actual phase correction angle to be set is: 270° - 180° = **90°**

19.3 Phase correction angle Medium-voltage side current measurement

If the current transformer is positioned in front of the transformer, the phase correction angle to be set (SETUP/206) is calculated by the wiring of the transformer. The following examples are intended to illustrate the calculation method to be used.

1) Switching group: Dz6, measuring voltage U: L3-N, current measurement I: L1

Phase shift through switching group **Dz6**:

$$\mathbf{6} * 30° = 180°$$

Phase offset through connection **U: L3-N** and **I: L1** according to table:

$$240°$$

Resulting phase correction angle:

$$180° + 240° = 420° \ (\geq 360!)$$

$$240° - 180° = \mathbf{60}°$$

2) Switching group: Yd5, measuring voltage U: L3-L1, current measurement I: L2

Phase shift through switching group **Yd5**:

$$\mathbf{5} * 30° = 150°$$

Phase offset through connection **U: L3-L1** and **I: L2** according to table:

$$90°$$

Resulting phase correction angle:

$$90° + 150° = \mathbf{240}° \ (\leq 360!)$$

3) Switching group: Yy6, measuring voltage U: L1-L2, current measurement I: L2

Phase shift through switching group **Yy6**:

$$\mathbf{6} * 30° = 180°$$

Phase offset through connection **U: L1-L2** and **I: L2** according to table:

$$210°$$

Resulting phase correction angle:

$$210° + 180° = 390° \ (\geq 360!)$$

$$210° - 180° = \mathbf{30}°$$

4) Switching group: Yz5, measuring voltage U: L1-N, current measurement I: L3

Phase shift through switching group **Yz5**:

$$\mathbf{5} * 30° = 150°$$

Phase offset through connection **U: L1-N** and **I: L3** according to table:

$$120°$$

Resulting phase correction angle:

$$120° + 150° = \mathbf{270}° \ (\leq 360!)$$

NOTE: If adding an **angle x** results in a **phase angle equal to or greater than 360°**, this **angle x** must be subtracted instead.

Example:

Previously set phase correction angle = 270°

270° + 180° = 450° (≥ **360°!)**

The actual phase correction angle to be set is: 270° - 180° = **90°**