User Manual CX plus

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⚠ DANGER ⚠ General safety notes

Failure to observe the following instructions may result in serious injury or death!

There is a risk of electric shock during installation! Therefore, electrical devices may only be installed, operated, serviced and maintained by qualified professionals. A professional is someone who has the ability, experience and knowledge required for the construction, installation and operation of electrical equipment and who has been instructed in identification and avoidance of possible hazards.
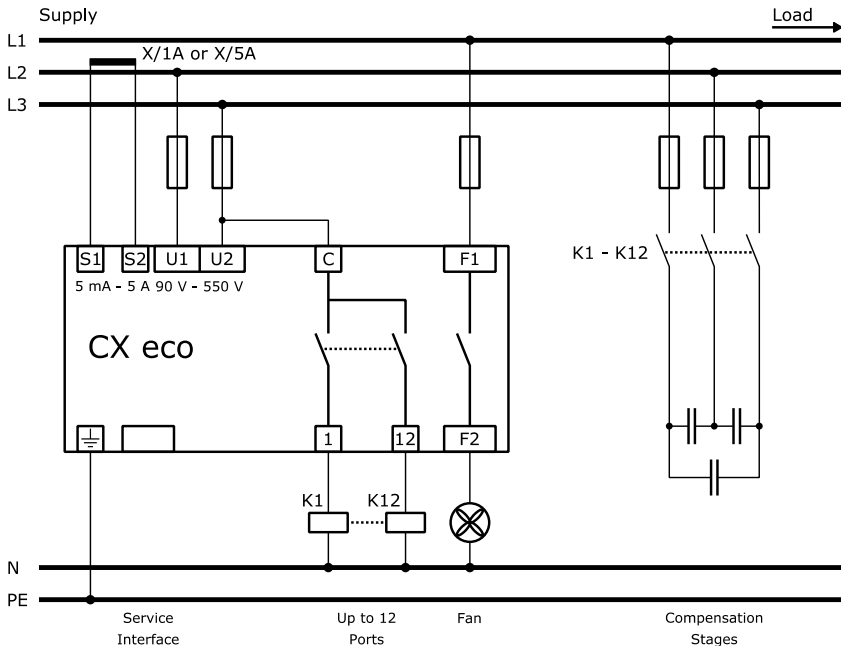
During installation and maintenance, the relevant regulations for the installation of switchgear and accident prevention must be observed and adhered to.

Devices with damaged or open housings or terminals must not be operated on the power grid and must be disconnected immediately.

After disconnecting the device, 10 minutes must be waited until the capacitors have been discharged. Subsequently, doors or covers may be removed. It must be checked whether the disconnected area is voltage-free using a standardized measuring instrument.

Ther BELUK GmbH assumes no responsibility or warranty for damage to persons and equipment caused by improper installation and use.

Connection diagram: CX plus -12R

Supply

Load

L1
L2
L3

X/1A or X/5A

| S1 | S2 | U1 | U2 | | C | | F1 |

5 mA – 5 A 90 V – 550 V

CX eco

K1 – K12

1   12   F2

K1   K12

Service
Interface

Up to 12
Ports

Fan

Compensation
Stages

N

PE

NOTE: The CX plus is designed to control **capacitive or inductive** stages. Operating both stage types simultaneously is not possible.

Connection diagram: CX plus -12T

Supply ... **Load**

L1
L2 — X/1A or X/5A
L3

Service Interface

DC Power Supply

| S1 | S2 | U1 | U2 | AL1 | C | TTL | F1 |
| 5mA - 5A | | 90V - 550V | | | | | |

CX plus

K1 - K12

| | DI | MB | AL2 | 1 | ... | 12 | F2 |

Digital Input — RS 485 Modbus

N
PE

Alarm Signal (NO)

Up to 12 Ports

Fan

Compensation Stages

NOTE: The CX plus is designed to control **capacitive or inductive** stages. Operating both stage types simultaneously is not possible.

Installation and commissioning

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

2) Disconnect the power supply and secured the working area against unauthorized and unintentional reconnection. Check if the disconnected area is voltage-free using a standardized measuring instrument. The voltage-free system must be earthed and short-circuited. Neighboring live parts must be covered and/or bypassed.

3) The current transformer must be short-circuited. A current transformer which has not been short-circuited generates a life-threatening voltage. This can lead to a destruction of the current transformer.

4) Insert the CX plus into the panel cut-out and fix it by using both fixing clamps.

5) Connect the grounding cable to the intended terminal on the backside of the device.

6) All cables must be connected as it is depicted in the connection diagram. The terminal K of the current transformer must be connected to terminal S1 and the terminal L to terminal S2.

7) Remove the short-circuit bridge at the current transformer.

8) The voltage can now be switched on.

9) If the device is connected correctly, the display will light up for one second and all symbols will be displayed during a display test.

10) Now the **First Setup** can be started by confirming **YES**. The different settings must be adjusted according to the power grid.

11) After a successful **First Setup**, the display shows **AUTO**. The control starts after the set discharge time has been expired.

Frequently asked questions during commissioning

1) **AUTO is not shown** → control is switched off
   Possible reasons: Manual operation activated; control is switched off; temperature is too high; current is less than 5 mA; voltage or THD of the voltage are inadmissible

2) **U ALARM is shown** → voltage is out of tolerance
   Possible reasons: Nominal voltage (SETUP/Un) or voltage transformer factor is set incorrectly (SETUP/Pt)

3) **I Lo ALARM is shown** → measuring current is smaller than 5 mA
   Possible reasons: Connection from the current transformer to the controller is incorrect; the current transformer jumper was not removed; current transformer ratio is too large; no current flow

4) **EXPORT is shown** → reverse current flow
   Possible reasons: If there is no real reverse current flow, the voltage or current measurement is incorrect (phase, polarity)

5) **Wrong cos φ is shown** → incorrect connection
   Possible reasons: Voltage or current measurement is incorrect (phase, polarity)

6) **Outputs are immediately switched off**
   Possible reasons: Stage sizes in the stage database are incorrect

7) **Frequent switching operations**
   Possible reasons: Capacitor capacity have not been recognized yet

Display
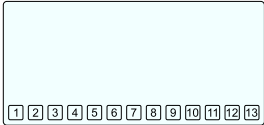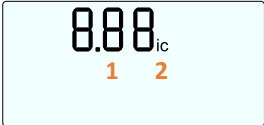
	AUTO or
no display:	Measurement menu
INFO:	Stage database
AUTO:	Control is active (no menu item)
MANUAL:	Manual mode
SETUP:	Controller settings
ALARM:	Alarm memory
NT:	Target-cos φ 2 active
EXPORT:	Reverse current flow
ALARM:	Flashes if an alarm is pending

First line

1: Power factor cos φ / Menu item

2: Inductive **i** / capacitive **c**

Second line

1: Abbreviations

2: Measurement values / alarm codes

3: Units

Stage outputs

Stage status:	On, off, faulty (flashing)
Stage data base:	Selected stage flashes

Operation concept
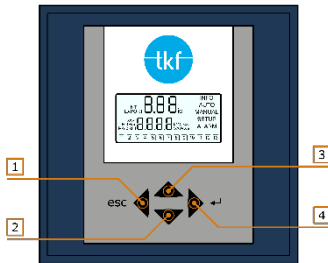
1		
	▪	Exit menu
	▪	Move cursor to the left
	▪	Reset alarm (push for 3 s)

2		
	▪	Decrease value
	▪	Select next value, menu or stage number

3		
	▪	Increase value
	▪	Select previous value, menu item or stage number

4		
	▪	Open menu
	▪	Move cursor to the right
	▪	Accept value

Entering values

If a menu item has been entered, the first digit of the current value flashes. Numbers can be increased or decreased by pushing the ▲ and ▼ keys.

The next digit can be selected by pushing the ▶ key. In order to select the previous digit, the ◀ key must be pushed.

If the last digit (right) has been selected and the ▶ key is pushed again, a multiplier **k** (kilo) or **M** (mega) can be set using the ▲ and ▼ keys. To accept the value and complete the entry, the ▶ key must be pushed again.

If an entered value has not been accepted, or if another value is displayed after an input, the entered value has exceeded or fallen below the threshold of the setting range.

An entry can be canceled at any time by pushing the ◀ key. Depending on the actual position, the ◀ key must be repeatedly pushed until the first digit (left) is selected. Pushing the ◀ key again exits the menu item without accepting changes.

Main menu

A menu can be selected by pushing ▲▼; Submenus are entered with ▶

|	
0.98 i AUTO	**Measurement menu** (Using ▲▼) Retrieve measured values
0.98 i INFO AUTO	**INFO – Stage database** Contains the reactive power, power losses, amount of switching cycles and operating hours, stage type of each stage
0.98 i AUTO MANUAL	**MANUAL – Switching stages manually** Switching stage outputs manually
0.98 i AUTO SETUP	**SETUP – Controller setup** Show and adjust all controller settings
0.98 i AUTO ALARM	**ALARM – Alarm memory** Show the last 10 alarm messages. The newest alarm message is saved in location 1.

INFO – Stage database
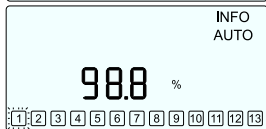
Stages can be selected by ▲▼ and entered by pushing ▶. The selected stage flashes. Using ▲▼, the following information can be shown.
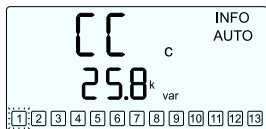
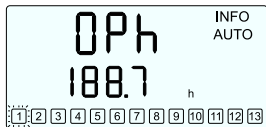|	
CC c **25.8** k var	**Current capacitor size** The reactive power value refers to the nominal voltage
98.8 %	**Capacitor size in percent** Current reactive power to nominal reactive power ratio
OC **307**	**Amount of switching cycles** Amount of completed switching operations
AUTO	**Stage type** **AUTO:** Stage is controlled automatically **FON:** Stage is always on **FOFF:** Stage is always off **Flty:** Stage has been detected as faulty
OPh **188.7** h	**Operating hours** Amount of operating hours

MANUAL – Switching stage outputs manually

In order to enter the MANUAL menu, the ▶ key must be pushed for 3 seconds.
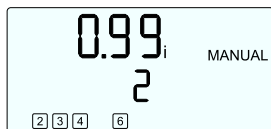
```0.99ᵢ``` MANUAL ```2``` ②③④ ⑥	▲▼ to select a stage. The selected stage is shown in the lower part of the display. A stage is switched on or off by pushing the ▶ button. The MANUAL menu can be exit by pushing the ◀ key.

Important information:

- Only stages of the type **AUTO** can be manually switched.

- The discharge time is considerd in manual mode as well. After switching a stage off, it is locked until the discharge time has been expired.

- The measured voltage must be within the set tolerance. If the voltage is out of tolerance, every stage is switched off and cannot be switched on again.

- As soon as the MANUAL menu is left, the control automatically starts again.

SETUP – Controller setup

The Quick Start menu (100) and the Expert menus (200 – 800) can be entered by pushing the ▶ button. The latter one requires the input of a PIN code.

Un   **Nominal voltage**

Ct   **Current transformer factor**

Pt   **Voltage transformer factor**

Ai   **Automatic initialization**
The phase angle between voltage and current is determined and which stage outputs are used.

PFC   **Control ON, OFF, Hold**
Switching on, off or suspend the control

CP1   **Target-cosφ 1**
Compensation target

St   **Switching time**
Delay between switching different stages

Out   **Stage type AUTO, FON, FOFF, Flty**
Stages are controlled automatically, are peramanetly on, permanently off or detected as faulty. **AUTO**, **FON** and **FOFF** can be adjusted and **Flty** stages can be reset.

Automatic initialization (Ai)

The Automatic initialization determines the phase angle between voltage and current and detects which stage outputs are used.

The 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. The display shows **Ai run** and the **number** of the active run. At the end of the Ai, the function of the controller must be checked.

NOTE: The Automatic initialization is only possible in conjunction with capacitive stages.

Due to load fluctuations, it may happens that the Ai does not correctly recognize used stage outputs or is aborted. The latter one is displayed by the error message **Ai** / **Abrt**. In this case, the control is stopped.

If the Automatic initialization is not successful after several attempts, the correct phase correction angle must be set manually (SETUP/206). Moreover, the stage types must be adjusted manually (SETUP/100/Out or SETUP/403) and the control must be started again (SETUP/100/PFC or SETUP/310 = **ON**).

Automatic stage size detection

If stage detection is activated (SETUP/308 = **YES**), the CX plus determines the size of the stages automatically during each switching operation. The detected sizes are stored in the stage database. There, a stage power loss can be monitored.

If the controller cannot detect a power grid reaction during the first three switching operations, the stage type of the affected stage is set to **FOFF** and it is not taken into account by the control.

NOTE: The automatic stage detection is only possible in conjunction with capacitive stages. The use of inductive stages requires a manual input of the stage sizes (SETUP/402).

Detect faulty stages

Stages whose size has already been adopted are classified as faulty by the control system after three successive switching operations without a power grid reaction. A new check is performed after 24 hours.

Faulty stages have the stage type **Flty** and are indicated by a flashing stage symbol.

The cause of a faulty stage could possibly be a defective fuse, a defective power contactor, a defective thyristor switch or a defective capacitor stage.

Most important Alarm and Error messages

U	ALARM	The measured voltage is out of the set tolerance.
I Lo	ALARM	The measured current is smaller than 5 mA.
I hi	ALARM	The measured current is higher than 6 A.
PFC	ALARM	The compensation target cannot be reached.
HArU	ALARM	The set THD voltage threshold has been exceeded.
HArI	ALARM	The set THD current threshold has been exceeded.
StEP/FltY	ALARM	At least one stage is faulty.
SPL/Nr	ALARM	The reactive power of at least one stage has fallen below 75 % of the initial power value.
thi	ALARM	The second temperature threshold has been exceeded.
OPh	ALARM	The set operating hours of the controller have been exceeded.
OPC/Nr	ALARM	The maximum switching cycles threshold of at least one stage has been exceeded.
OPh/Nr	ALARM	The set operating hours of at least one stage have been exceeded.
Ai/Abrt	ALARM	The Automatic initialization has been aborted due to an error. The control is switched off.

Factory settings

SETUP/100 Quick Start		**open**
Un/ Nominal voltage		400 V
Ct/ Current transformer factor		1
Pt/ Voltage transformer factor		1
Ai/ Start Ai		NO
PFC/ Control		ON
CP1/ Target-cosφ 1		1
St/ Switching time		10 s
Out/ Stage type		AUTO

SETUP/200 Measurement	**locked**
201/ Nominal voltage	400 V
202/ Current transformer factor	1
203/ Voltage transformer factor	1
204/ Voltage tolerance	10 %
205/ Meas. connection	U-LN
206/ Phase correction angle	0
207/ Start Ai	NO
208/ Sync. frequency	AUTO
209/ Temperature offset	0 °C

SETUP/300 Control	**locked**
301/ Control sensitivity	60 %
302/ Target-cosφ 1	1.00
303/ Target-cosφ 2	0.95 i

304/ Target-cosφ 2 if P export	NO
305/ Switching time	10 s
306/ Sw. time stage exchange	2 s
307/ Stage exchange	YES
308/ Stage detection	YES
309/ Block faulty stages	YES
310/ Control	ON
311/ Control algorithm	1
312/ Reactive power offset	0 var
313/ Asymmetry factor	1
314/ Switch off if Q is cap	NO
315/ Distribute sw. operations	NO
316/ Detect faulty stages	YES

SETUP/400 Stage database	**locked**
401/ Discharge time	75 s
402/ Nominal stage size	c 3 var
403/ Stage type	AUTO
404/ Switch operat. counter	0
405/ Operat. hours counter	0 h
406/ Fan relay as stage output	NO

SETUP/500 Alarm	locked		SETUP/600 Reset menu	locked
501/ Reset alarms manually	NO		**601**/ Factory reset	NO
502/ THD-U threshold	20 %		**602**/ Stage database	NO
503/ Switch off stages	NO		**603**/ Operating hours	NO
504/ THD alarm delay	60 s		**604**/ Average power factor	NO
505/ Stop control if I=0	NO		**605**/ Max. temperature	NO
506/ Service alarm	NO		**606**/ Alarm memory	NO
507/ Max. OPc stages	500 k		**607**/ Info firmware	---
508/ Max. OPh controller	65.5 kh		**608**/ Change password	242
509/ Max. OPh stages	65.5 kh		**609**/ Restart First Setup	NO
510/ THD-I threshold	50 %			
511/ Digital input logic	YES		SETUP/700 Modbus	---
512/ TEMP1 threshold	30 °C		Baud rate	19.2 k
513/ TEMP2 threshold	55 °C		Parity and stop bits	EVEN
514/ Control alarm	NO		Slave address	1
515/ Faulty stages alarm	NO			
516/ Stage power loss alarm	NO		SETUP/800 System	locked
517/ Flashing display	NO		**801**/ Backlight during Commissioning mode	NO
518/ Digital input function	CP2		**802**/ Backlight delay time	0.25 h
519/ I-Low alarm suppr.	YES/NO			
520/ Switch off active stages if digital input alarm	NO			
521/ I-Low alarm	YES			
522/ I-High alarm delay	10 s			
523/ Switch-off interval	60 s			

Specifications

Voltage measurement / supply:	Connection: Single phase Range: 90 – 550 V AC, 45 – 65 Hz Protection: Max. 6 A Power consumption: 6 VA Transformer factor: Adjustable 1.0 … 350.0
Current measurement:	Connection: Single phase Range: 5 mA – 5 A Transformer factor: Adjustable 1 … 9600

Stage outputs:
 	
Option -xxR
	6 or 12 Stage ouputs
	
	Type: Relay, normally-open, potential-free
	Supply: Common, max. 10 A
	Swit. capacity per relay: 250 V AC / 5 A
	                                   400 V AC / 1 A
	                                 48 V DC / 1 A
	                                110 V DC / 0.2 A
	
	Type: Transistor, normally-open, open collector output
	Supply: Common, max. 1,2 A
	Switching capacity per transistor: 100 mA / 8 – 48 V DC

Temperature measurement:	NTC: Under the housing cover Accuracy: +- 5 °C

Alarm output:	
Default	Type: Relay, normally-open, potential-free Switching capacity: 5 A / 250 V AC
Option -nc	Type: Relay, normally-closed, potential-free Switching capacity: 5 A / 250 V AC
Fan output:	Type: Relay, normally-open, 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 purpose only
Modbus:	
Default	Unassembled
Option -MB	Protocol: Modbus-RTU Interface: RS485 Common-mode range: -7 – 12 V Differential-mode range: -12 – 12 V Output current: -60 – 60 mA
Ambient temperature:	Operating: -20 °C – 70 °C Storing: -40 °C – 85 °C

Humitdity:	Range: 0 % – 95 %
	Condensation: Not allowed
Overvoltage category:	300 V_{LN} / 519 V_{LL} → CAT III
	519 V – 550 V → CAT II
	Degree of contamination → 2
Standards:	IEC 61010-1, IEC 61000 6-2,
	IEC 61000 6-4: Level B, IEC 61326-1, UL 61010
Compliance and Listing:	CE, c NRTL us (c UL us), EAC
Connections:	Type: Screw terminals, pluggable
	Cross section: Max. 4 mm^2
Housing:	Front: Plastic housing (UL94 V-0)
	Back: Metal cover
Protection class:	Front: IP41
	Back: IP20
Weight:	Approx. 0,6 kg
Dimensions:	Device: H x B x T: 144 x 144 x 58 mm
	Cut-out: H x B: 138 (+0,5) x 138 (+0,5) mm

Notes