KBR Energy Management

Operating instructions
Technical Parameters

multicomp

Power Factor Controller

2F144-NC-1V1C12RO

Your Partner for Reactive Current Compensation

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Dear Customer

We would like to thank you for choosing a KBR GmbH quality product.

In order to familiarize yourself with the operation and programming of the device and always be able to use the whole functionality of this high-quality product, we recommend that you read this manual thoroughly.
The individual chapters serve to explain the technical details of the device and show how to avoid damage by means of proper installation and commissioning.

The manual is included in the scope of delivery of the device and must be accessible for the user at all times (e.g. in the switchgear cabinet). Even when the device is resold to third parties, the manual remains part of the device.

Although we used the utmost care in assembling this manual, we would like to thank you in advance for notifying us about any errors or ambiguous descriptions that might be in it. You will find a form for corrections in the appendix.

Sincerely,

KBR GmbH Schwabach

2009-1 GB

Safety Precautions

This manual contains notes that must be observed for your personal safety and to avoid damage to equipment. Notes are identified by a warning sign or an info symbol according to the degree of hazard they represent.

Danger

means that death, major injuries or damage **will** occur in case the appropriate safety measures are not performed.

Warning

means that death, major injuries or damage **may** occur in case the appropriate safety measures are not performed.

Caution

means that minor injuries or damage may occur in case the appropriate safety measures are not performed.

Note

is an important information on the product, product handling or the respective part of the user manual to which special reference is made.

Disclaimer

The contents of this manual has been checked with the described hardware and software components. Certain deviations, however, cannot be excluded, so the manufacturer is not liable for complete conformity. The specifications made in this manual are checked on a regular basis, necessary corrections are included in the next revision.
We appreciate your corrections and comments.

2009-1 GB

General Safety Precautions

In order to prevent operating errors, handling of the device is kept as simple as possible. This way, you will be able to use the device very soon.

In your own interest, however, you should read the following safety precautions carefully.

Warning

During installation, the applicable DIN / VDE regulations must be observed!

Mains connection, setup and operation of the device must only be performed by qualified personnel. Qualified personnel as understood in the safety precautions of this manual are persons authorized to setup, ground and mark equipment, systems and wiring systems in accordance with applicable standards.

To avoid the hazard of fire and electrical shock, the device must not be subjected to rain or other humidity!

Before the device is connected to the mains, you will have to check whether the local mains conditions comply with the specifications on the manufacturer's label. A wrong connection may destroy the device!

When connecting the device, the connection chart must be observed (see chapter "Connection chart") and the connection lines must be powerless. Only use proper line material and watch the correct polarity when wiring!

In order to ensure proper and safe operation of the product, it must be transported, stored, installed and mounted in accordance with the specifications and operated and maintained carefully.

A device showing visible damage must by all means be considered as unfit for operation and must be disconnected from the mains!

Error detection, repairs and maintenance work may only be carried out in our facilities or after contacting our service team. Every warranty obligation of the manufacturer expires if the device is opened without written consent from our service team. Proper operation can no longer be guaranteed!

Opening the device may expose parts under voltage. Capacitors in the device may still be loaded even if the device was disconnected from all voltage sources. It is generally not allowed to operate the open device!

In facilities subject to hazard of lightning, lightning protection must be provided for all input and output lines (recommendations see chapter "Protective measures")!

Product Liability

With these product, you have acquired a quality product.

In its manufacture, only components of the highest reliability and quality were used. Each device is subject to long-term testing before it is delivered.

For information on product liability, please refer to our General Terms and Conditions for electronic devices**.**

The warranted properties of the device apply only if it is operated in accordance with its intended use!

Disposal

Please dispose of defective, outdated or no longer used devices properly.
At your request, we will be pleased to dispose of the devices for you.

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1 Controller functional principle

The controller's micro processor acquires the supply voltage and the current consumption of the downstream facility via measuring transformer inputs (A/D transformer) and calculates the active and reactive power ratios of the network. The controller operates based on a 4 quadrant operation.

- **Energy recovery in generator operation is recognized and displayed (the LCD shows a flashing „G"). During this time, compensation to CosPhi 1.00 (recovery CosPhi) will be performed. To avoid alternating switching operations when switching between recovery and consumption, compensation to the recovery CosPhi is performed for 15 minutes when recovery is detected. During this period of time, the set target-CosPhi is disabled.**

The compensation power required for the target CosPhi is calculated continuously. If the power difference corresponds to the set hysteresis (switch on and off hysteresis), the staged switching is performed in accordance with the compensation power required. Manually switched stages, however, are not included in the optimization. In case of identical stages with identical power, the stage disconnected for the longest time is connected.

With only a few switching operations an optimal adjustment is obtained. Even for large facilities, sensitive controls may be set up with only a few modules. No stage ratios need to be considered. After compensation, switching operations are interrupted for a programmable time. In order to avoid alternating switching operations, the stage switch off hysteresis can be increased to up to 150% of the lowest stage power.
For light load operation (secondary measurement current under the limit (< 20mA), the stages are switched off after 1 hour.

The programmed values are saved on an EEPROM and will thus not be lost after a network failure.

The measuring cycle of the controller for recording the necessary network parameters takes approx. 20 ms.

Note!

Limiting value for overvoltage switch-off = nominal voltage + 10% (taking into account the measurement voltage transformer ratio). The value of 10% is unchangeable and serves the safety of the compensation facility

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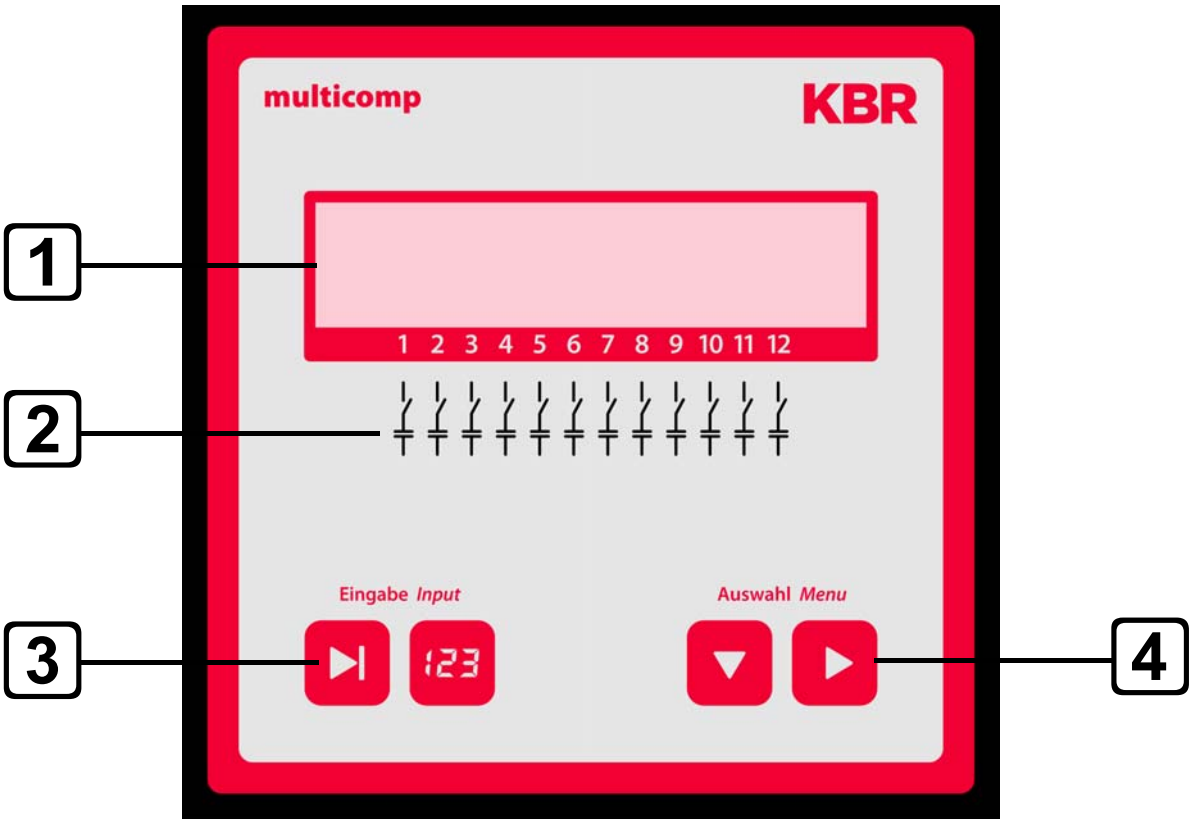
2 Operating and display panel



Operating elements:

1 LCD displaying current status and user prompts
2 Number of controller output lines possible
3 Two sensor buttons for parameter programming
4 Two sensor buttons for menu selection

General notes on operating the sensor buttons:

Button ▶|	Start input for configuration and reset.
Button 123	Value change during configuration
Button ▼	Navigation through submenus
Button ▶	Navigation through main menus and save button during configuration
Key combinations:	
Buttons ▶ and 123	Deletion of cumulated values Perform reset

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Basic controller settings (default settings):

- Consumption target CosPhi: 0.95 inductive
- Recovery target CosPhi: 1.00
- Alarm CosPhi: 0.92 inductive
- Main transformer current: Primary current 1000 A
- Secondary current 5 A
- Measurement voltage: Primary voltage 400 V Ph-Ph
- Secondary voltage 400 V Ph-Ph
- Rot.field U: L1-N
- Rot.field I: L1
- Attenuation coefficient for current: 2
- Attenuation coefficient for voltage: 2
- Attenuation coefficient Qmiss: 2
- Alarm delay: 20 minutes (1200 seconds)
- Idle time: 30 seconds
- Switching interval: 8 seconds
- Hysteresis connection: 100% of smallest stage power
- Hysteresis disconnection: 100% of smallest stage power
- Limit switching cycles: 80000
- Switching cycle count: Activated by programmed limit
- Stage switching mode: Automatic
- Scanning frequency: Automatic
- Harmonics monitoring: Activated by programmed limit
- THD limit: 8%
- Stage power: not programmed
- Stage power monitoring: disabled
- Discharge time: 60 seconds
- Password No password (9999, meaning all functions are accessible)
- Language display: English
- Contrast setting: 4

The controls in the assembled compensation units are preset.

The following needs to be checked or set:

- Target CosPhi according to energy supplier regulations
- (for kVA tariff CosPhi = 1)
- Primary current and secondary current in accordance with input current transformer.
- If required voltage transformer ratio

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3 Mounting and electrical connection of the device

3.1 General, very important!

- **Tighten all screws and connections as otherwise warranty will be void!**
- **The device needs to be installed and operated in accordance with valid VDE regulations (in particular VDE 0100) and energy supplier regulations.**

Connection cross-sections and fuse protection table: see attachment

3.2 Current transformer connection and measurement voltage:

If possible, mount the transformer in the phase that corresponds to L1 of the compensation facility (determine by means of voltage measurement). All capacitor and consumer currents need to be determined. In case of unbalanced phase load (small facilities), install the transformer in the phase with the highest load.

- **P1 (K)** to energy supply (indicated on the transformer).
- **P2 (L)** to load
- **S1 (k**) with terminal **k** (controller terminal 20) and
- **S2 (l)** with terminal **l** (controller terminal 21) needs to be connected in the compensation facility (use two-color cable!).

Line cross-section: up to 3 m = 1.5 mm², up to 6 m = 2.5 mm². For greater distances, we recommend using a 1 A transformer. The controller is designed for the connection of 5 A and 1 A transformers, switching is set in the configuration.
If using existing transformers, the current paths always need to be connected in series.
The secondary transformer current needs to be at least 12 mA. For smaller currents, no capacitors will be connected (display shows “missing current“).
Measurement voltage connection according to connection chart.

3.3 Current transformer dimensions

The current transformer is dimensioned based on the current consumption of the consumers and not the capacitor current. If other measuring devices are connected to a transformer in addition to the reactive power controller, the transformer power needs to be dimensioned accordingly. Also, losses occur in the current transformer line that need to be considered in case of large distances between the transformer and the controller.

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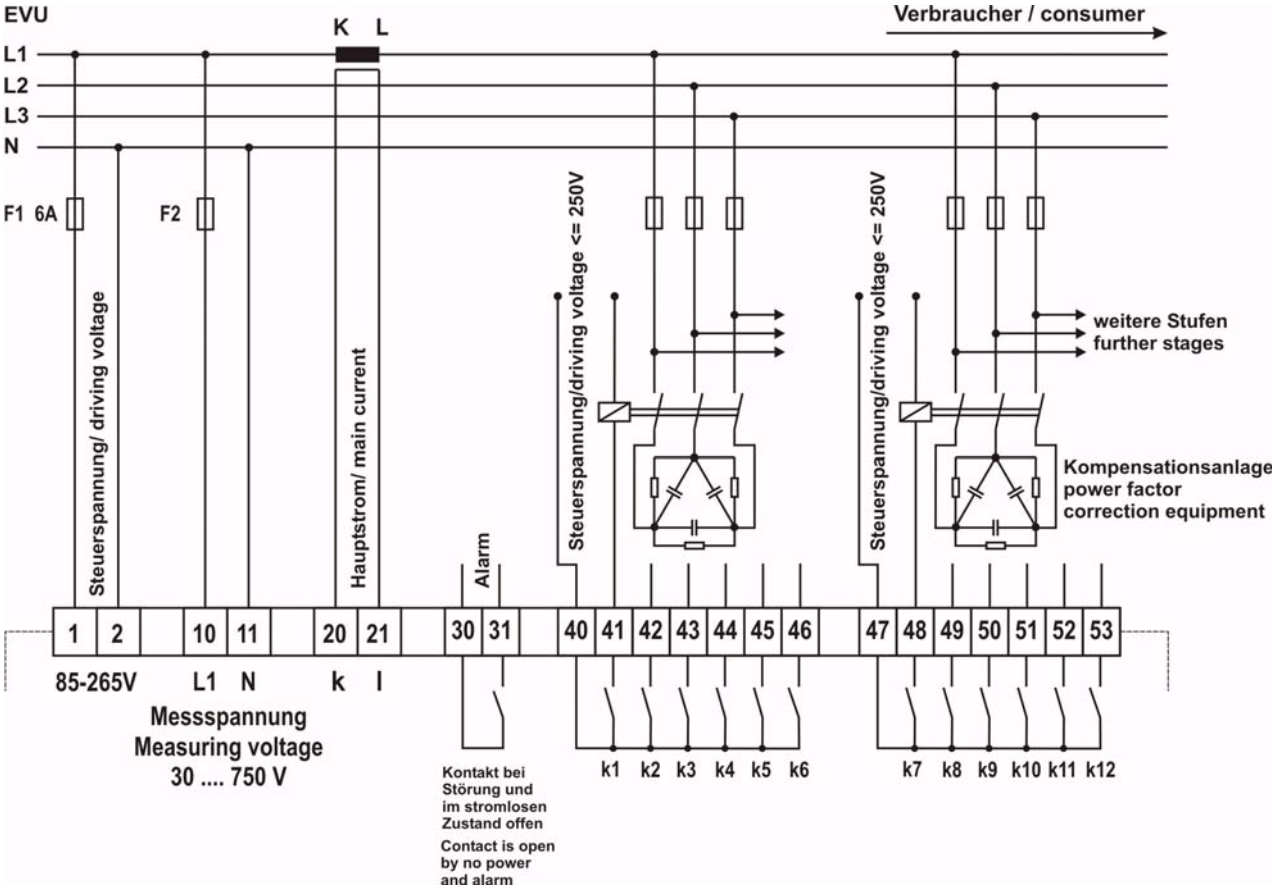
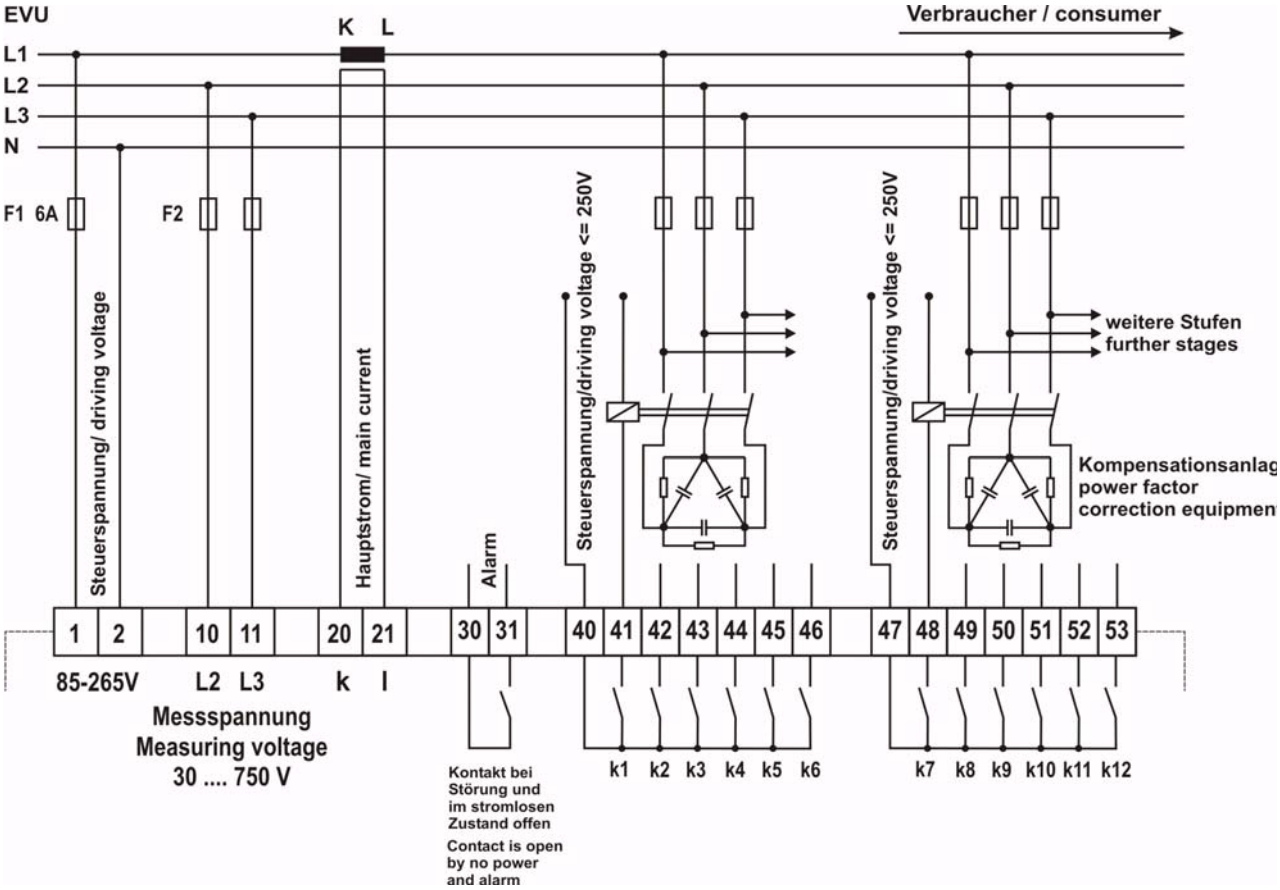
3.4 Standard connection chart measurement voltage Ph-N



For voltage supply, see nameplate.

3.5 Standard connection chart measurement voltage Ph-Ph



For voltage supply, see nameplate.

4 Commissioning the facility

4.1 General commissioning notes

- Switch on a sufficient number of inductive consumers (e.g. motors) prior to switching on the compensation facility. A transformer current of at least 15 mA needs to flow in the secondary circuit for the controller to be activated. Below this limit the display will show **“missing transformer current”**.
- The transformer connection needs to be checked (transformer ratio too high?).
- Before switching on the controller, measurement voltage must be available.
  No error message is displayed, but the learning mode cannot be started.
- If stage power has been programmed, the power factor CosPhi should be displayed after initialization.
  Normally, when no capacitors are connected, CosPhi is in the range of 0.6 to 09. inductive,
  (e.g. CosPhi 0.80 ind).
- If a capacitive value is displayed, or if there is a flashing G symbol, the phase allocation of current and voltage measurement is incorrect. In the Commissioning programming menu, the phase allocation can be changed using the function **Rot.field U** and **Rot.field I** (provided that there is no generator operation at the time).
- The first switching operation may take up to 60 seconds. The stages are switched in a set 1 second interval until compensation. The CosPhi displayed has to converge target CosPhi.

Note!

The learning process is started in the Commissioning menu, in the Activate learning mode submenu.

4.2 Compensation facility with controller

The controller is preset as a component of a compensation facility (refer to connection diagram of compensation facility). The following need to be programmed or checked:

- Target CosPhi according to energy supplier regulations.
- Primary and secondary current in the main circuit according to the mounted transformer.
- If required, set measurement voltage transformer data.
- If no stage power has been programmed, the controller will switch into the **Commissioning** menu. Subsequently, stage power programming can be performed in the settings menu, or using the learning process.

The programmed values are saved on an EEPROM and will thus not be lost after a network failure.

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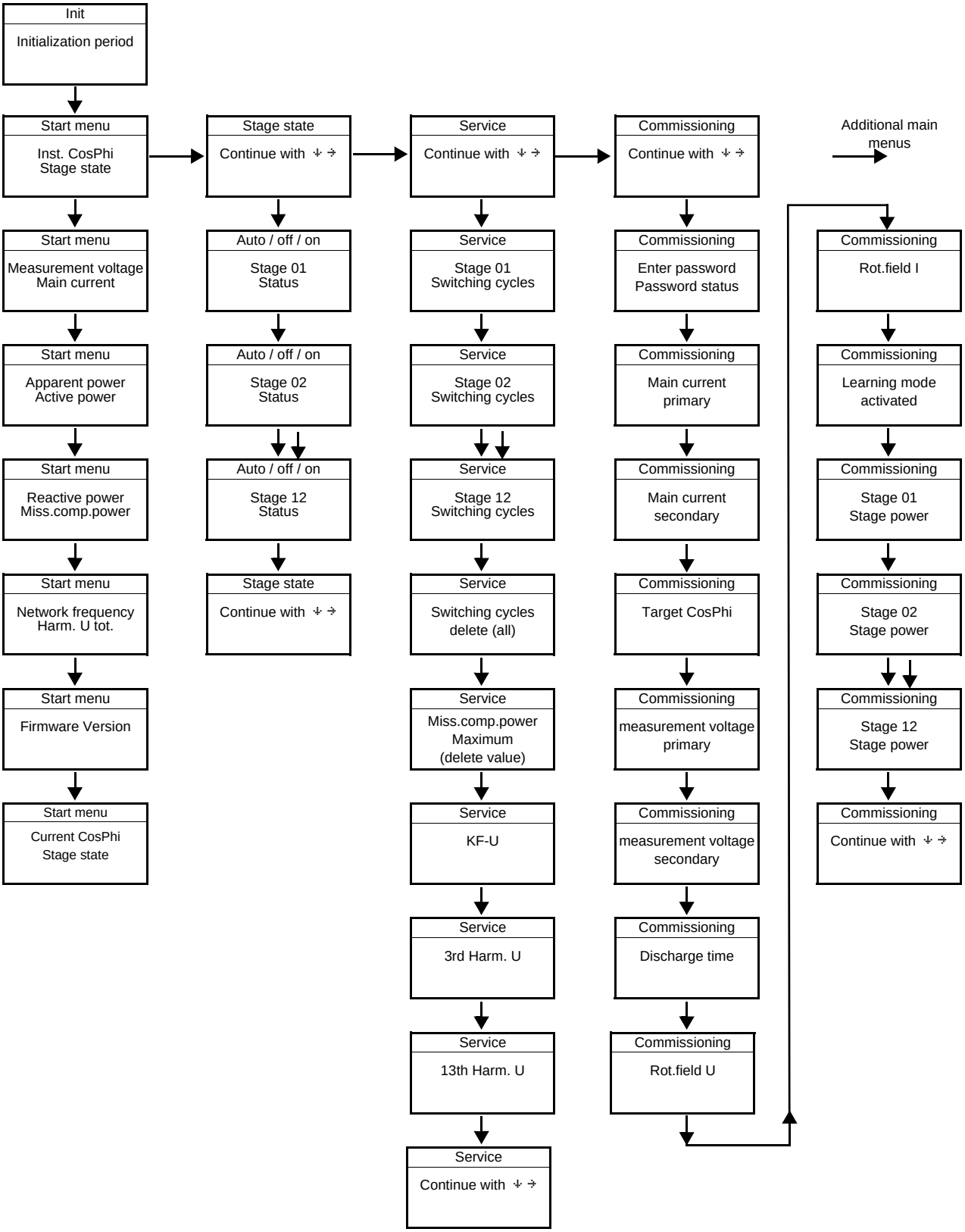
5 Navigation and device displays



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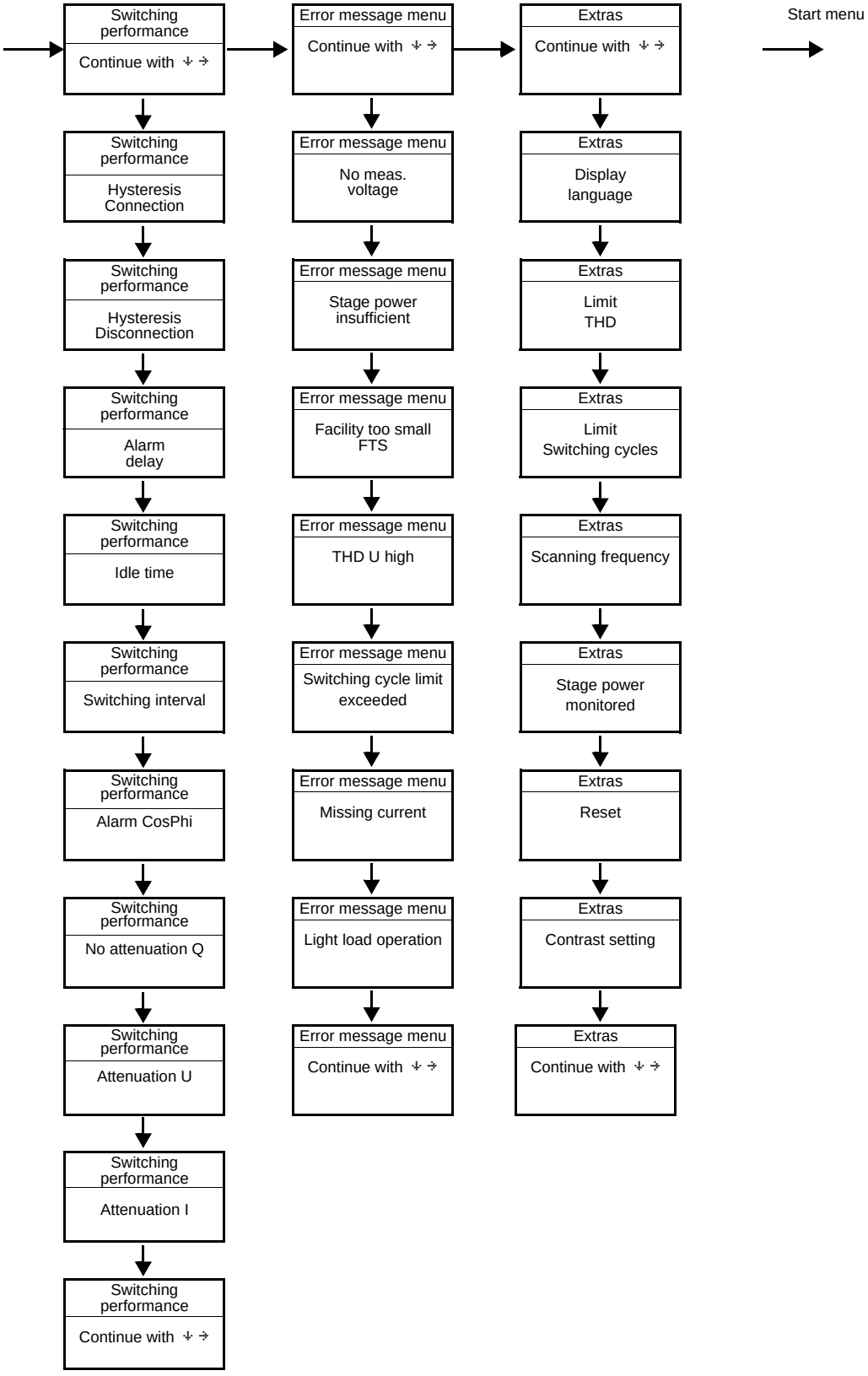

Switching performance
Continue with
Switching performance
Hysteresis Connection
Switching performance
Hysteresis Disconnection
Switching performance
Alarm delay
Switching performance
Idle time
Switching performance
Switching interval
Switching performance
Alarm CosPhi
Switching performance
No attenuation Q
Switching performance
Attenuation U
Switching performance
Attenuation I
Switching performance
Continue with
Error message menu
Continue with
Error message menu
No meas. voltage
Error message menu
Stage power insufficient
Error message menu
Facility too small FTS
Error message menu
THD U high
Error message menu
Switching cycle limit exceeded
Error message menu
Missing current
Error message menu
Light load operation
Error message menu
Continue with
Extras
Continue with
Extras
Display language
Extras
Limit THD
Extras
Limit Switching cycles
Extras
Scanning frequency
Extras
Stage power monitored
Extras
Reset
Extras
Contrast setting
Extras
Continue with
Start menu

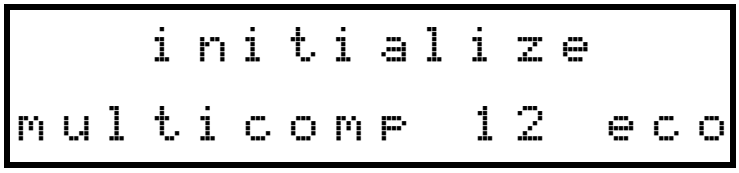
6 Main menu displays

For the current displays and the controller configuration, the following main menus with their submenus can be used: see item 5 Navigation and device displays:

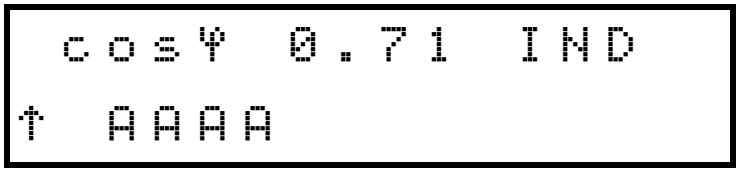
Note!

In the next chapter, the main menus and their submenus are described in detail.

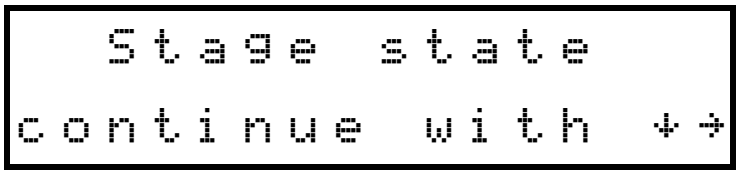
Initialization menu – no input possible



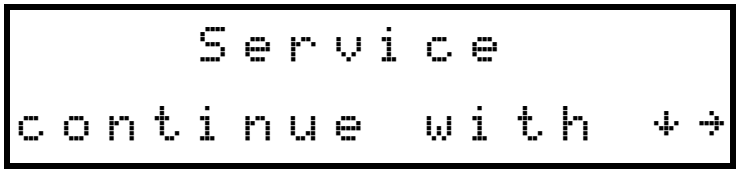
Start menu window - display of current values



Stage state window – stage state can be changed



Service window – display and deletion options



Commissioning window – entry of operating parameters

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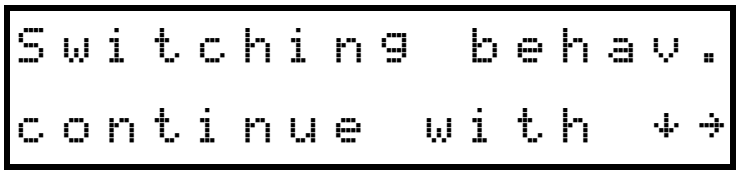
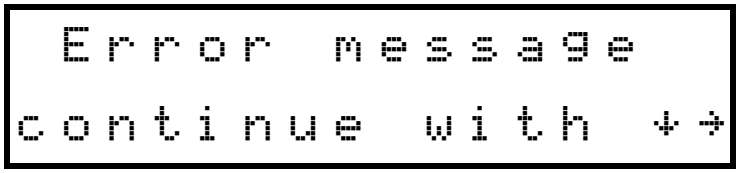
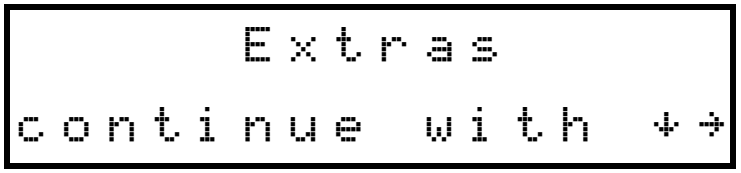
Switching behavior window – influencing switching behavior



Error message menu – editing the error message dialog

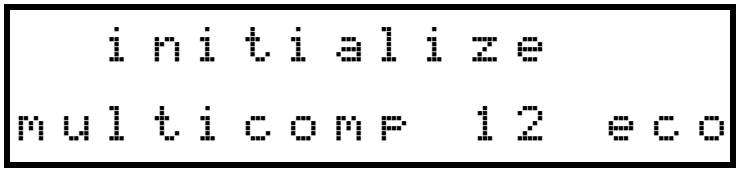


Extras window – setting special parameters



7 Description of the individual display windows

7.1 Initialization window:

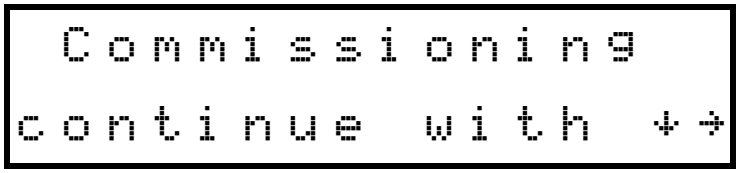


This is displayed after connecting the supply voltage to the controller.

Caution!

During the initialization period, please do not press any sensor buttons; they are adjusted automatically to ensure correct operation.

7.2 Commissioning window if no stage power is programmed:



If the multicomp **2F144-NC-1V1C12RO** is being commissioned for the first time, after connecting the supply voltage, the initializing window is displayed, followed by the Commissioning window.

This menu is used for the **initial commissioning** of the controller, where all the necessary settings can be made.

If a controller already integrated into a KBR compensation facility by default should be used, only the parameters of the current transformer have to be configured.

Selection of submenus with button ▼.

Password protection:

To protect a facility against unauthorized access of the configured parameters, a password can be entered (4-digit number code, e.g. 4321).
In case the password gets lost somehow, the controller can be unlocked with the **master password 1976**.
When unlocking a password protected controller, it is possible to press a button within 300 seconds.
If no button is pressed during this period, the controller is locked again.

The password can be configured by pressing the button ▶| to start entering and changing the entry position, 123 to change or set the value and ▶ to save the entry.

Configuring current transformer values:

For the compensation controller to function properly, all parameters concerning the current transformer have to be set correctly. Primary and secondary current of the transformer have to be set (**submenu Iprim. / Isec.**). These parameters can be read on the nameplate of the current transformer. In addition, the phase allocation of the transformer has to be set correctly. In the controller, the phase (L1, L2, L3) in which the current transformer is integrated has to be set (**submenu Rot.field I**). If the transformer connections are mixed up (k and l interchanged), this can be corrected with the setting -L1, -L2 and -L3.

Setting target CosPhi:

You can ask your energy supply company for the target CosPhi, which should be set up at this point.
The target CosPhi is by default set to 0.95 inductive (see chapter Default settings).

Setting the voltage transformer parameters:

Specify the primary voltage in the **U primary** submenu, the secondary voltage under **U secondary** and the phase allocation of the measurement voltage under **Rot.field U**. These settings apply to a standard network (voltage Ph-Ph: 400V primary, 400V secondary). With measurement voltages of over 500V, the parameters specified on the voltage transformer have to be configured, e.g. 690V / 100V, as well as the measuring mode, e.g. L12 for the measurement voltage connection between the phases L1 and L2.

Setting the discharge time:

Checking or, if required, changing the discharge time of the capacitor stages is a very important menu item. Possible discharge times are 0, 3, 30, 60, 300, 600, 900 sec. Please make sure that the correct value is set, otherwise the capacitors could be damaged.

Configuring the capacitor stages:

There are two ways of configuring the capacitor stages: The stages can be configured manually or using the learning mode.

Caution!

If there is no measurement voltage, the learning mode menu does not appear.

It is important to set the stage power correctly. The stage power can be looked up on the nameplate of the stage or the circuit diagram and then programmed manually. In this case, skip the menu item **Activate learning mode** and individually enter the power value vor each stage.

If you want to **Activate the learning mode**, you have to make sure that all previous submenu parameters have been set correctly.

The learning mode is activated by pressing the button . Change to Yes with the button and confirm with button .

The learning mode automatically sets the stage power. However, this value has to be checked after each time the learning process is performed.

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Function test:

After all values have been programmed, a function test should be performed. To do so, the controller has to be taken off the voltage supply for a few seconds.

After connecting it to the voltage supply, the controller has to start automatically. When reading out the CosPhi voltage in the start menu immediately after switching on, CosPhi should be inductive. After approx. 60 seconds, the controller starts to switch on the individual capacitor stages, until the facility is compensated.
The CosPhi, which can be read out in the start menu, should have risen in comparison with former values, or it should rise when switching on additional stages. If the compensation facility is set up correctly, the controller should compensate the set target CosPhi after a certain period of time.

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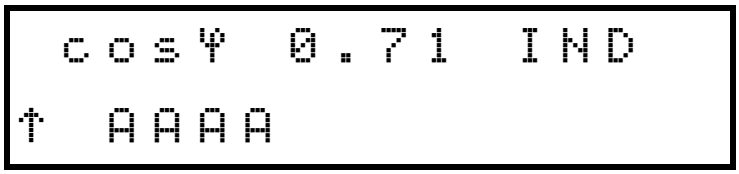
7.3 Start menu window:



This is displayed after the initialization window when the stage power has already been programmed. Here, the current total controller state and the currently measured CosPhi are measured.

Example:

Line 1: Currently measured CosPhi 0.71 inductive

Line 2: Controller connects stages, stage 1 to 4 are already connected in automatic operation, whereby for example the following applies:

- ↑ stages are connected when compensation power is required.
- ↓ stages are disconnected due to overcompensation.
- A the stage has been connected in automatic operation.
- H the stage has been connected manually.
- 0 the stage has been disconnected manually.
- X the stage has been recognized as being defect (stage monitoring activated, cf. main menu Extras, submenu Stage monitoring).

Selection of submenus with button ▼ .

The currently measured values are displayed in the submenus:

measurement voltage in Volt, depending on type of connection chosen
(menu Commissioning, submenu Rot.field U) in Ph-N (⅄) or Ph-Ph (△) .

Apparent current series transformer in Ampere (1-phase value measured).

Apparent power in kVA, extrapolated as 3-phase value (provided that the network load is symmetric).

Active power in kW, extrapolated as 3-phase value (provided that the network load is symmetric).

Apparent power in kvar, extrapolated as 3-phase value (provided that the network load is symmetric).

Missing compensation power to achieve the set target CosPhi.
The missing compensation power is displayed up to a maximum value of 9999.9 kVar.
If the value exceeds this limit, ----.- kvar is displayed

Power frequency in Hertz

THD (Harm. U total) in %, decisive for setting the THD limit (menu Extras, sub menu THD limit)

The firmware version of the controller, e.g. V 1.00R001, is important for support cases, as it can be used to deduce possible changes made to the device firmware.

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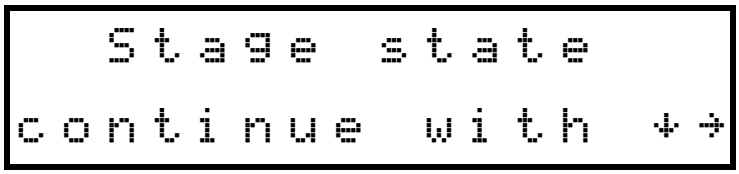
7.4 Stage state window:



Selection of submenus with button ▼.

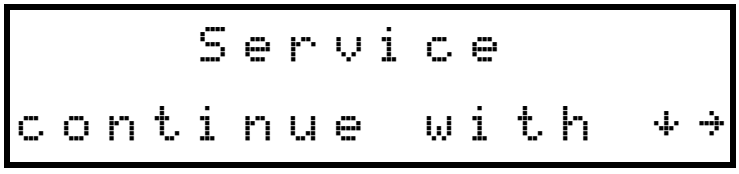
In the submenus of this window, it is displayed whether or not the capacitor stages connected are working in automatic operation, or if they are switched on or off permanently. The individual capacitor stages can be selected by pressing button ▼.

By pressing the buttons ▶| to start entering values, 123 to change and |▶ to save them, you can change the stage state from Auto (Automatic) to Off (switched off permanently) or On (switched on permanently).

Note!

Capacitor stages permanently switched on or off are <u>not</u> available to calculate the optimizing automatic operation.

7.5 Service window:



Selection of submenus with button ▼.

In the submenus of this window, the number of connections of each individual capacitor stage is displayed. In the Delete switching cycles menu item, the cumulated switching cycles can be deleted **for all stages**. This is done by simultaneously pressing the buttons ▶| and 123.
If the number of switches equals or exceeds the value set in the menu item **Extras / Switching cycle limit**, a message is displayed, depending on the settings in the **Error message** menu **/ Switching cycle limit** exceeded.

In addition, the value in the menu item **Missing Comp. power maximum** can be deleted by simultaneously pressing the buttons ▶| and 123, resetting the message **Facility too small**. In case the set target CosPhi is not reached despite all available stages switched on, this message is displayed after the set alarm delay time has elapsed. The alarm delay can be set in the menu **Switching performance / Alarm delay**.

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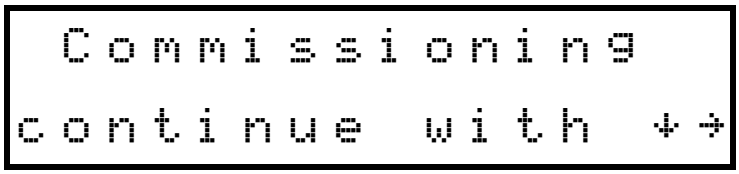
7.6 Commissioning window:



Selection of submenus with button ▼.

In the submenus of this window, a step-by-step description of the commissioning process is given. For facilities already in operation, the parameters set during commissioning can be read out here.

Password protection:

To protect a facility against unauthorized access of the configured parameters, a password can be entered (4-digit number code, e.g. 4321).
In case the password gets lost somehow, the controller can be unlocked with the **master password 1976**.
When unlocking a password protected controller, it is possible to press a button within 300 seconds. If no button is pressed during this period, the controller is locked again.

The password can be configured by pressing the button ▶| to start entering and changing the entry position, 23 to change or set the value and ▶ to save the entry.

Configuring current transformer values:

For the compensation controller to function properly, all parameters concerning the current transformer have to be set correctly. Primary and secondary current of the transformer have to be set (**submenu Iprim. / Isec.**). These parameters can be read on the nameplate of the current transformer. In addition, the phase allocation of the transformer has to be set correctly. In the controller, the phase (L1, L2, L3) in which the current transformer is integrated has to be set (**submenu Rot.field I**). If the transformer connections are mixed up (k and l interchanged), this can be corrected with the setting -L1, -L2 and -L3.

Caution!

Subsequently changing the main transformer parameters can directly influence the capacitor stages, for which the stage power was determined using the learning mode. This way it is ensured that the stage power is adequately adjusted in case of a subsequent correction of the transformer parameters.
Manually configured stages are not taken into account here.

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Setting target CosPhi:

You can ask your energy supply company for the target CosPhi, which should be set up at this point. The target CosPhi is by default set to 0.95 inductive (see chapter Default settings).

Setting the voltage transformer parameters:

Specify the primary voltage in the **U primary** submenu, the secondary voltage under **U secondary** and the phase allocation of the measurement voltage under **Rot.field U**. These settings apply to a standard network (voltage Ph-Ph: 400V primary, 400V secondary). With measurement voltages of over 500V, the parameters specified on the voltage transformer have to be configured, e.g. 690V / 100V, as well as the measuring mode, e.g. L12 for the measurement voltage connection between the phases L1 and L2.

Setting the discharge time:

Checking or, if required, changing the discharge time of the capacitor stages is a very important menu item. Possible discharge times are 0, 3, 30, 60, 300, 600, 900 sec. Please make sure that the correct value is set, otherwise the capacitors could be damaged.

Configuring the capacitor stages:

There are two ways of configuring the capacitor stages: The stages can be configured manually or using the learning mode.

It is important to set the stage power correctly. The stage power can be looked up on the nameplate of the stage or the circuit diagram and then programmed manually. In this case, skip the menu item **Activate learning mode** and individually enter the power value vor each stage.

Note!

If the menu item Activate learning mode cannot be selected, you have to verify that there is measurement voltage available at the controller. If this is not the case, the menu item is automatically disabled.

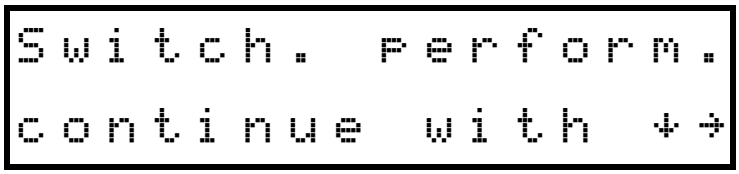
If you want to **Activate the learning mode**, you have to make sure that **all previous submenu parameters** have been set correctly.

The learning mode is activated by pressing the button . Change to Yes with the button and confirm with the button .
After starting the learning mode, "active" is flashing, and the remaining time until the end of the learning mode is displayed.

Note!

The learning mode then automatically sets the stage power. However, this value has to be checked after each time the learning process is performed.

7.7 Switching performance window:



Selection of submenus with button ▼.

In the submenus of this window, the settings made for the switching performance by default are displayed (default settings). These settings apply to most of the compensation facilities.

Caution!

However, you have to check all parameters to make sure that there are no deviations from the requirements the facility has to fulfill.

The following submenus are available to influence the switching performance.

Hysteresis connection (default setting 100%, setting range 70 to 150 %):
This value defines the switch-on criterion of the controller. This means the controller would switch on at 100% missing compensation power in relation to the smallest automatic capacitor stage of the facility.

Hysteresis disconnection (default setting 100%, setting range 70 to 150 %):
This value defines the switch-off criterion of the controller. This means the controller would switch off at 100% overcompensation power in relation to the smallest automatic capacitor stage of the facility.

Alarm delay (default setting 1200 seconds, setting range 0 to 3000 seconds):
This value defines the time until the message **Facility too small** is displayed. In case the set target CosPhi is not reached despite all available stages switched on, this message is displayed after the set alarm delay time has elapsed.

Idle time (default setting 30 seconds, setting range 0 to 300 seconds):
This value defines the time the controller is idle **after compensation** before another switching operation is performed (connection or disconnection).

Switching interval (default setting 8 seconds, setting range 0 to 10 seconds):
This value defines the time the controller is **always** idle between two switching operations.

Alarm CosPhi (default setting ind. 0.92, setting range ind. 0.70 to 1.0):
This value is connected to the message **Facility too small**. If this value is not reached after the alarm delay has elapsed despite all stages switched on, the message **Facility too small** is displayed

Attenuation Qmiss (default settings 2, setting range 0 to 9):
This value defines how much the display is attenuated to prevent fast parameter changes of the missing compensation power.

Attenuation U (default settings 2, setting range 0 to 9):
This value defines how much the display is attenuated to prevent fast parameter changes of the measurement voltage.

Attenuation I (default settings 2, setting range 0 to 9):
This value defines how much the display is attenuated to prevent fast parameter changes of the measurement current.

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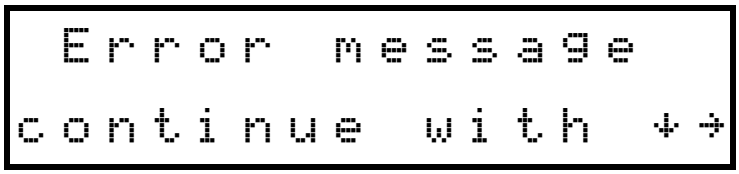
7.8 Error message menu:



Selection of submenus with button ▼.

In the submenus of this window, the possible messages are displayed, as well as the display configuration.

The following error messages can be configured:

Alarm submenu	Possible actions			
	Off	Message	Alarm relay	Message and relay
Missing measurement voltage	✓	✓	✓	✓
Missing stage power	✓	✓	✓	✓
Facility too small	✓	✓	✓	✓
THD (voltage harmonics) too high	✓	✓	✓	✓
Switching cycle limit exceeded	✓	✓	✓	✓
Missing current	✓	✓	✓	✓
Light load operation	✓	✓	✓	✓

If a submenu is selected (using the button ▼), the error message dialog can be changed by pressing the buttons ▶| to start entering values, 123 to change the settings and ▶ to save them.

Caution!

If there is a Stage monitoring error (cf. menu Extras (7.9), submenu Monitoring stage power), no message is displayed, and only the stages in the start menu window are marked with an X.

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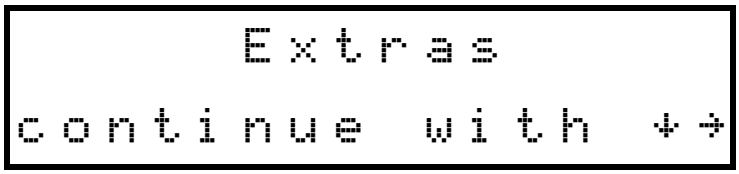
7.9 Window Extras:



Selection of submenus with button ▼.

In the submenus of this window, the additional settings possible are displayed.

If a submenu is selected (using the button ▼), the settings can be changed by pressing the button ▶| to start entering values, 123 to change the setting and ▶ to save it.

The following submenus are available:

Language:

In this submenu, you can choose the language of the LCD (German or English).

THD limit:

The limiting value of the harmonic switch-off refers on one hand to the total of all measurement voltage harmonics. The programming range lies between 0 and 10%. The setting is done in steps of 1%.
In addition, harmonics monitoring can be disabled here (for configuration limit = 0).
For voltage harmonics exceeding the limit, error messages are displayed and a stage disconnect is performed.

Limit switching cycles:

The limiting value of the capacitor contactor switching cycles is used as an indication for customers that due to the number of switching actions accumulated, the capacitor contactor could be worn out. This message in no way influences the function of the compensation facility. It is used merely as a "maintenance note".
Manual switching operations are not counted.

Scanning frequency:

In this submenu, the power frequency tracing settings are displayed. The setting **Auto** causes the scanning frequency to be traced automatically, within a range of 40 to 70 Hertz. Alternatively, a fixed scanning frequency of **50** Hz or **60** Hz can be set.

Monitoring stage power:

In this submenu, the monitoring of the stage power can be enabled or disabled. However, only stages in automatic operation can be monitored.
The stage power configured manually is not taken into account, as it is assumed that the stage power has been configured in accordance with the nameplate of the compensation stage.
Operating mode: Each time a capacitor stage is switched on, it is checked whether or not a change of current takes place in the series transformer. If this is not the case, the stage is marked with an **X** in the start menu window. The following reasons are possible and have to be checked:

- Capacitor defective
- Contactor defective
- Fuse defective

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Reset:

With the item **Reset**, it is possible to reset the programmed parameters of the controller. Here, the programmable parameters are reset to default settings. A listing of the settings can be found in the appendix **Technical Data**.

This has the advantage of all configured parameters to be deleted at once and the controller restarting with the default settings stored.

Perform reset: Menu Extras, menu item Reset
Press button = **Reset** flashes
Press buttons and simultaneously = **done** is displayed
After about 2 seconds, the display switches back to **Reset**

Note!

The resetting process can be interrupted by pressing the button .

Contrast setting:

The contrast settings of the LCD can be changed in this submenu. Setting range: 0 to 10.

8 Notes on detecting errors

Undercompensation, not enough stages are connected:

Check controller for error displays (refer to section 7.8). If the target CosPhi is set to 0.8 capacitive, the capacitors need to connected one after another. If the facility is not over-dimensioned, almost all stages need to be connected.

Undercompensation, all stages are connected:

The existing facility is not sufficient (e.g. due to new inductive consumers).
Please contact your local representative (extend your facility).
See the cover sheet of these operating instructions for the service telephone number.

Check the main fuse and group fuses of the facility. Checking the controller parameters.
The group fuses must display at least 1.7 times the value of the capacitor power.
If the fuses do not hold, despite their being correctly selected, the groups must be checked individually for excessive current input and for defective contactors.

Overcompensation, too many stages are connected:

Check controller settings (target CosPhi capacitive?).
Transformer connected in the wrong position?

Controller switches a lot, in particular during low load (at the weekend, during the night):

Check programming of the transformer ratio.
Switch on a small stage permanently (manually), if required.

Note!

If no cause of error is found, please call your local representative. Please see the cover sheet of this manual for the phone number.

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9 Facility and safety devices maintenance

In order to ensure proper function and a long service life of your facility, the following checks have to be performed after commissioning and then once a year!

- Check and retighten all connections. Screwed connections may become loose at the beginning due to thermal stress.
- Check fuses, safety devices and switching equipment. Contactors are wearing parts. If the contactor is intact, switching must take place without excessive formation of sparks.
- Check the controller performance in automatic mode.
- Examine the cool air proportions (ventilators, temperature monitoring function):
- Clean filter mats, depending on how dirty they are.
- Visual inspection of capacitors.
- Examine the current input and capacitor terminal voltage.

Note!

The input current and the temperature of these facilities must be checked regularly so that an overload on the capacitors can be detected at an early stage.
A higher input current can be caused by an increasing proportion of harmonics or by defective capacitors

10 Setting range of the parameters configurable:

Primary voltage	1 V to 39999 V Ph-Ph
Secondary voltage	1 V to 999 V Ph-Ph
Primary current	1 A to 39999 A
Secondary current	1 and 5 A
Rot.field U	L1N, L2N, L3N, L12, L23, L31
Rot.field I	L1, L2, L3, -L1, -L2, -L3
Consumption target CosPhi	ind. 0.80 to cap. 0.80
Recovery target CosPhi	ind. 1.0 (cannot be set)
FTS Alarm CosPhi	ind. 0.70 to 1.0
Attenuation coefficient current	0 to 9
Attenuation coefficient voltage	0 to 9
Attenuation coefficient Qmiss	0 to 9
Idle time	0 to 300 sec.
Alarm relay time	0 to 3000 sec.
Hysteresis connection	70 to 150 %
Hysteresis disconnection	70 to 150 %
Switching interval	0 to 10 sec.
Limit switching cycles	0 to 999999
Stage power	0 to 999.9 kvar
Discharge time	0, 3, 30, 60, 90, 300, 600, 900 sec.
Stage switching mode	= Automatic, manual off, manual on
Stage power monitoring	Deactivatable
Harmonics monitoring	Deactivatable (0%)
THD limit	0 to 10%
Scanning frequency	Automatic, fixed 50 Hz, fixed 60 Hz
Password	No password (9999, meaning all functions are accessible)
Display language	German, English
Contrast settings	0 to 10

Error message dialog:

Missing measurement voltage	The settings **Message** or **alarm relay** /
Missing measurement current	**Message and error relay** / **Off**
Missing stage power	is identical for all errors!
Facility too small	
THD too high	
Switching cycle limit exceeded	
Light load operation	

Error message dialog after reset:

Missing measurement voltage	Alarm relay
Missing current	Message
Missing stage power	Alarm relay
FTS (**F**acility **T**oo **S**mall)	Message and alarm relay
THD too high	Alarm relay
Switching cycle limit exceeded	Alarm relay
Light load operation	Off

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11 Technical Data

11.1 Measuring and display values

Voltage	Actual value of a measuring interval	Phase - 0 or phase - phase, depending on programming
	Units	[V, kV;] display is switched automatically
	Display range	0.00 kV to 99.9 kV
	Measuring range	30 ... 690 ... 790 V
Current (apparent	Actual value of a measuring interval	Instantaneous value per phase
	Units	[A;kA] display is switched automatically
	Display range	0.00 A to 999 kA
	Measuring range	0.015 ... 5 ... 6 A
Frequency	Power frequency measurement	$f_{Network}$
	Units	[Hz]
	Measuring range	40.....70Hz
Apparent power	Calculation	S_{total}, three-phase
	Units	kVA
	Measuring range	0.0 VA to 9999.9 kVA
Active power	Calculation	$P_{total;}$ three-phase
	Units	kW
	Measuring range	0.0 W to 9999.9 kW
Reactive power	Calculation —> ind. & cap.	$Q_{total;}$ $Q_{miss;}$ distinction between ind./cap.
	Units	kvar
	Display range	0.0 var to 9999.9 kvar
Power factor	Calculation —> ind. & cap.	CosPhi; distinction between ind./cap. CosPhi in display
	Display range	CosPhi 0.10 ind. <—1 —> 0.10 cap.
Harmonics	Distortion factor (THD) of voltage	Voltage: KF-U
	Partial distortion factors	3rd; 5th; 7th; 9th; 11th; 13th; Voltage harmonics
	Units	[%]
	Measuring range	0.00% to 100%

11.2 Measuring accuracy

Current	± 2% / ± 1digit
Voltage	± 2% / ± 1digit
Power	± 4% / ± 1digit
Power factor	± 2% / ± 1digit
Frequency	± 0.1% / ± 1digit

11.3 Measuring principle

Reading	128 values per period
A/D converter	12 Bit
Measuring U and I	Acquiring measuring values for U and I simultaneously;
Measuring cycle	20 ms
Calculation of harmonics	DFT with 128 points over one period
Frequency measurement	Mode: Voltage measurement between phase Lx - N / Ly);

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11.4 Device memory

Data storage	16 kB RAM volatile
Program and parameter memory	128 kB flash
Extreme values (Max.)	Missing compensation power Q_{max}

11.5 Other limits:

Limit violations: harmonics	acquisition time	approx. 100 ms
Overvoltage disconnect:	acquisition time	approx. 40 ms
No voltage disconnect:	acquisition time	approx. 40 ms (for measurement voltage)

11.6 Power supply

Power supply	85 to 265V AC/DC; max. 12 VA, 6 W

11.7 Hardware inputs and outputs

11.7.1 Hardware inputs

Measuring input for voltage	U_{PH-N} or U_{PH-PH}	30V ... 690V ... 790V AC
	Direct impedance	750 kOhm
	Measuring range	1 measuring range, measurement voltage transformer programmable
Measuring input for current	I_{L1} or I_{L2} or I_{L3}	0.015A ... 5A ... 6A AC
	Power consumption	≤ 2VA at 6A
	Measuring range	1 measuring range, current transformer programmable

11.7.2 Hardware outputs

Alarm relay	Switching capacity	250 V (AC) / 2 A potential-free
Capacitor stage relay	Switching capacity	250 V (AC) / 2 A potential-free

11.8 Electrical connection

Connection elements		Plug-in terminals
Permissible cross section of the connection lines		2.5 mm^2
Measurementmeasurement current voltage inputs	Fuse protection	max. 6 A
measurement current input	Fuse protection	NONE!!! Always short-circuit current transformer terminals k and l prior to opening the circuit!
Input Control voltage	Fuse protection	max. 6 A
Relay output	Fuse protection	max 2 A medium time-lag
Transformer connection	Connections	See connection chart

11.9 Mechanical data

Flush-mounted device	Housing measures	144 x 144 x 2.36 in (H x W x D),
	Mounting cutout	138 x 138 mm
	Mode of protection	Front IP51 (with optionally available front door max. IP54), terminals IP20
	Weight	approx. 650g

11.10 Standards and Miscellaneous

Environmental conditions	Standards	DIN EN 60721-3-3/A2: 1997-07; 3K5+3Z11; (IEC721-3-3; 3K5+3Z11)
	Operating temperature	- 5°C ….+55°C
	Humidity	5% ……..95%
	Storage temperature	-25°C ….+70°C
Electrical safety	Standards	DIN EN 61010-1/A2: Aug. 2002; (IEC1010-1/A2)
	Protection class	II, in accordance with DIN EN 61010-/A2: Aug. 2002
	Overvoltage category	CAT III: U_{PH-PH} up to 400V
	Mode of protection	IP20 in accordance with DIN EN 40050 Part 9: 1993-05
	Electromagnetic compatibility	DIN EN 61000-6-3: 2005-6; (IEC 61000-6-3) DIN EN 61000-6-2: 2005; (IEC 61000-6-2)
Password protection	4-digit	Deleting and programming parameters on the device is not enabled if password protection is active.

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12 Selection of lines and fuses

C power (400 V) Q (kvar)	**Current input per phase I (A)**	**Supply line Cu (mm²)**	**Fuse protection slow-blowing 3 x I (A)**
0.5	0.72	4 x 1.5	10
1	1.44	4 x 1.5	10
1.5	2.16	4 x 1.5	10
2	2.88	4 x 1.5	10
2.5	3.60	4 x 1.5	10
3	4.32	4 x 1.5	10
4	5.76	4 x 1.5	10
5	7.20	4 x 2.5	16
6	8.64	4 x 2.5	16
7.5	10.80	4 x 2.5	16
10	14.40	4 x 2.5	25
12.5	18.00	4 x 6	35
15	21.60	4 x 10	35
16.7	24.00	4 x 10	35
20	28.80	4 x 10	50
25	36.00	4 x 16	63
30	43.20	4 x 16	80
33.3	48.00	4 x 16	80
35	50.40	4 x 25	80
40	57.60	4 x 25	100
45	64.80	3 x 35/ 16	100
50	72.00	3 x 50/ 25	125
60	86.40	3 x 50/ 25	125
70	100.80	3 x 70/ 35	160
75	108.00	3 x 70/ 35	160
80	115.10	3 x 95/ 50	200
90	129.60	3 x 95/ 50	200
100	144.00	3 x 95/ 50	250
120	172.80	3 x 120/ 70	250
125	180.00	3 x 120/ 70	250
150	216.00	3 x 150/ 70	315
180	259.20	3 x 240/120	400
200	288.00	3 x 240/120	400
250	360.00	2 x 3 x 150/ 70	500
300	432.00	2 x 3 x 185/ 95	630
350	504.00	2 x 3 x 240/ 120	2 x 400
400	576.00	2 x 3 x 240/ 120	2 x 400
450	648.00	4 x 3 x 120/ 70	2 x 500
500	720.00	4 x 3 x 150/ 70	2 x 500

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