KBR Energy Management

Technical reference

multicomp

4-quadrant controller

F144-NC-1V1C6DO6RO-2

Your partner for network analysis

System | English

20801-EDEBDA0232-4716-1_EN

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Dear customer

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

To familiarize yourself with the device operation and configuration, we recommend you read this manual carefully. This will enable you to make use of the entire range of functions that this high-quality product offers.

The individual chapters serve to explain the technical details of the device and show how to properly install and start up the device to prevent damage.

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

Although the utmost care has been taken in putting together this user manual, errors may still occur. We would be very grateful if you could notify us of any errors or unclear descriptions you may notice. You will find a form for corrections in the appendix.

Yours sincerely,

KBR GmbH Schwabach

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These operating instructions contain notes that must be observed for your personal safety and to avoid damage to equipment. These instructions are identified by a warning sign or information symbol, depending on the degree of hazard they represent.

Warning

means that death, major injury or substantial damage may occur if the appropriate safety measures are not taken.

Caution

means that minor injury or damage may occur if the appropriate safety precautions are not taken.

Note

is an important piece of 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 have 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 will be included in the next revision.

We appreciate your corrections and comments.

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Safety notes

In order to prevent operating errors, handling of the device has been kept as simple as possible. This way, you will be able to use the device very quickly. In your own interest, however, the following safety notes should be read carefully.

Warning

The applicable DIN / VDE regulations must be observed for installation!

Power supply connection, setup and operation of the device must be performed by qualified personnel only. Qualified personnel as defined in the safety notes in this user manual are those authorized to set up, ground and mark devices, systems and circuits in accordance with the applicable standards and regulations.

To prevent fire and electric shocks, the device must not be exposed to rain or moisture!

Before connecting the device to the power supply, check whether the local power supply conditions comply with the specifications on the device nameplate.

A faulty connection can lead to the destruction of the device!

For device connection, the data given in the connection diagram must be complied with (see chapter "Connection diagram") and the connection lines must be voltage-free. When wiring, always ensure that all wiring material used is neither damaged nor defective

and that the polarity is correct!

In order to ensure proper and safe product operation, ensure the device is transported, stored, installed and assembled and carefully operated and maintained in accordance with the specifications.

A visibly damaged device must generally be considered unfit for use and disconnected from the power supply. Error detection, repair and maintenance work may only be carried out in our facilities or after contacting our service team.

Opening the device without authorization will render your warranty null and void. Correct operation can no longer be guaranteed!

Opening the device may expose live parts. Capacitors in the device may still be charged, even if the device has been disconnected from all voltage sources. Do not operate open devices under any circumstances!

Systems that are at risk from lightning strikes must feature lightning protection for all input and output lines (see chapter "Protective measures" for recommendations).

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Product liability

You have purchased a high-quality product.

Only components of the highest quality and maximum reliability are used.

Each device is subject to long-term testing before it is delivered.

For details on product liability, please refer to our

general terms and conditions for electronic equipment.

Warranty device properties only apply if
the device has been operated in accordance with its intended use!

Disposal

Defective, outdated or disused devices must be properly disposed of.

If required, we will dispose of the devices for you.

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1 Functional principle of the controller

The multicomp F144-1V1C6DO6RO-2 hybrid controller has 12 outputs to control capacitive compensation stages. Outputs 1 to 6 are designed to control thyristor modules (by optocoupler outputs) and outputs 7 to 12 to control capacitor contactors (by floating relay contacts).

To make optimal use of the thyristor modules' or capacitor contactor modules' switching performance, you can set the following parameters separately:

for thyristor stages

Switching interval	50 to 9999 milliseconds
Discharge time	20 to 9999 milliseconds
Idle time	20 to 9999 milliseconds

for contactor stages

Switching interval	0 to 10 seconds
Discharge time	0 to 900 seconds
Idle time	0 to 300 seconds

The controller's microprocessor records the mains voltage and current consumption of the downstream system via measuring transformer inputs (A/D converter) and calculates the active and reactive power ratio of the power supply. The controller operates in four quadrants.

- **Energy recovery in generator operation is detected and indicated by a "G" flashing on the LCD display. During this time, compensation to CosPhi 1.00 (output CosPhi) is performed. To prevent alternating switching operations when switching between recovery and consumption, compensation to the output CosPhi is performed for 15 minutes when recovery is detected.**

The set target CosPhi is not activated until this time has elapsed.

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 are, however, not included in the optimization. In case of identical stages with identical power, the stage that has been switched off for the longest time is switched on.

Having fewer switching operations results in an optimum adjustment. Even for large systems, sensitive controls may be set up with only a few modules. Stage ratios do not have to be considered. After compensation, switching operations are interrupted for a programmable time. In order to prevent alternating switching operations, the stage

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switch-off hysteresis can be increased to up to 150% of the lowest stage power.

After an adaption time of 60 seconds, the thyristor stages are switched by contactor stages of the same size. This guarantees that the fast control characteristics can be kept.

For low load operation (secondary measuring current under the limit (<15 mA)), the stages are switched off after 1 hour.

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

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

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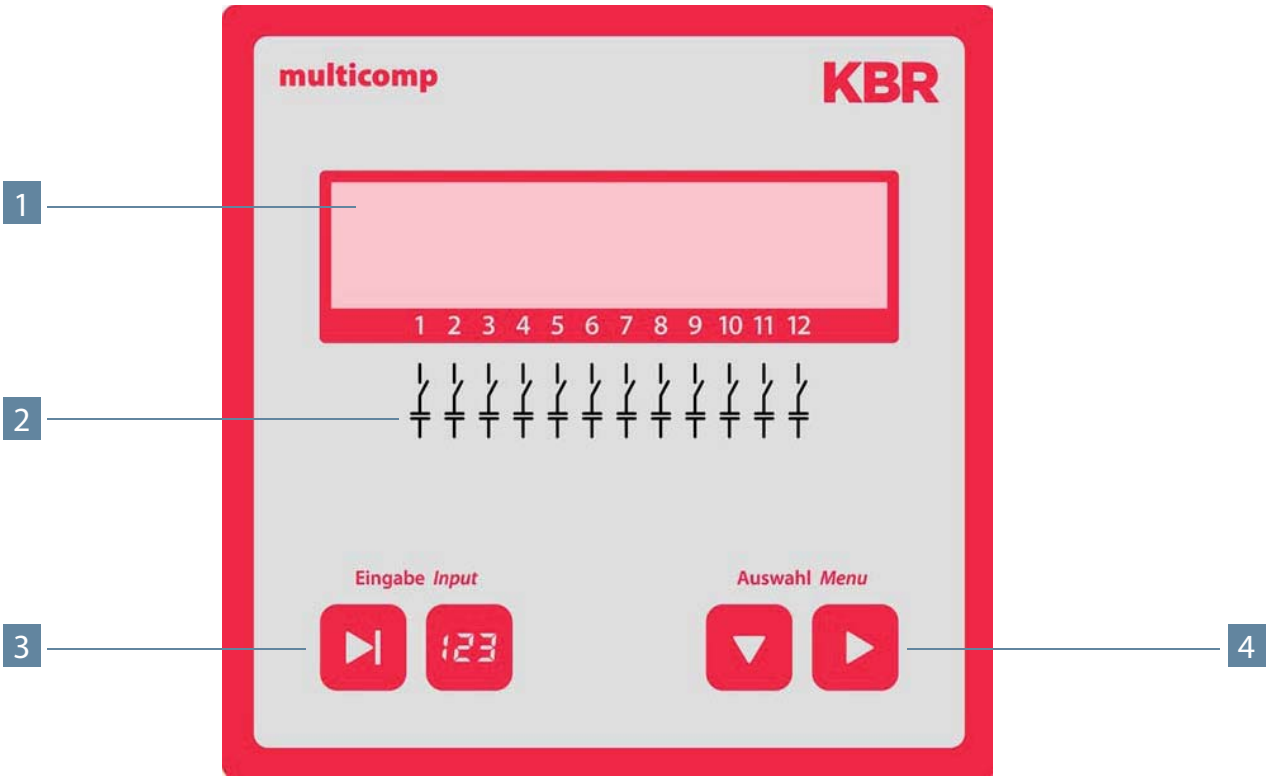
Note

Limit for overvoltage switch-off = rated voltage + 10% (taking into account the measuring voltage ratio). The value of 10% cannot be changed and serves to protect the compensation system. The reset hysteresis is 1 % of the rated voltage.

In the event of an error, the compensation stages are switched off and "overvoltage" is displayed.

2 Control and display panel

multicomp F144-1V1C6DO6RO



Operating elements:

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

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General notes on operating the sensor buttons:

Button	Start input for configuration and reset
Button	Change values during configuration
Button	Navigation though submenus
Button	Navigation through main menus and save button during configuration

Button combinations:

Button and	Delete accumulated values and perform reset

Default controller settings after reset:

Commissioning menu

▪ Password:	no password (9999, meaning all functions are accessible)
▪ Main transformer current:	Primary current 1000 A Secondary current 5 A
▪ Target CosPhi consumption:	0.95 inductive
▪ Measuring voltage:	Primary voltage 400 V Ph-Ph Secondary voltage 400 V Ph-Ph
▪ Thyristor discharge time:	20 milliseconds
▪ Contactor discharge time:	180 seconds
▪ Max. stage power per switching operation	0 kvar
▪ Rotary field U:	L1-N
▪ Rotary field I:	L1
▪ Stage power:	not set

Switching performance menu

▪ Hysteresis connection:	100% of lowest stage power
▪ Hysteresis disconnection:	100% of lowest stage power
▪ Alarm delay:	20 minutes (1200 seconds)
▪ Thyristor idle time:	20 milliseconds
▪ Contactor idle time:	30 seconds
▪ Thyristor switching interval:	50 milliseconds
▪ Contactor switching interval:	8 seconds
▪ Alarm CosPhi:	0.92 inductive
▪ Attenuation coefficient Q_{miss}:	0
▪ Attenuation coefficient for voltage:	0
▪ Attenuation coefficient for current:	0

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Extras menu

- THD limit: 8 %
- Harmonics monitoring: Activated by set limit
- Contactor stage operating cycle limit: 80000
- Operating cycle count: Activated by set limit
- Scanning frequency: Automatic
- Stage power monitoring: Deactivated
- Contrast setting: 4
- Low-load limit: 15 mA
- Low-load delay: 60 minutes

Other

- Recovery target CosPhi: 1.00, cannot be changed
- Stage switching mode: Automatic

The controls in the compensation systems are preset.

The following need to be checked or set:

- target CosPhi in accordance with the 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 Installation and electrical connection of the system

3.1 General, highly important information

- Tighten all screws and connections as otherwise the warranty will be rendered void.
- The device must be installed and operated in accordance with the applicable VDE regulations (in particular VDE 0100) and the energy supplier regulations.
- Connection cross-sections and fuse protection table: see attachment

3.2 Current transformer connection and measuring voltage

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

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

Line cross section: up to 3 m =1.5 mm^2, up to 6 m =2.5 mm^2. 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 15 mA.
For lower currents, no capacitors will be connected (display shows “missing current”). Measuring voltage connection according to the connection diagram.

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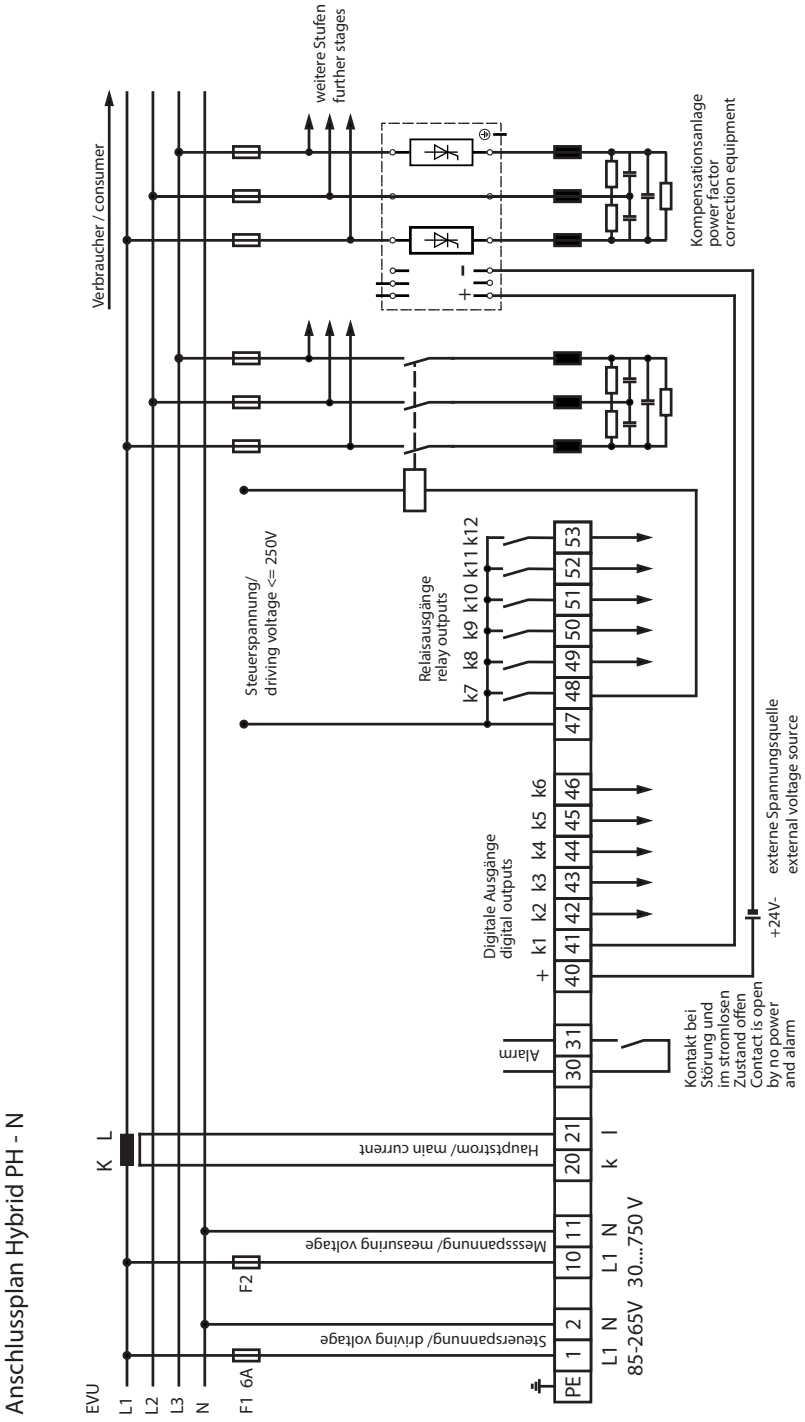
3.3 Current transformer dimensions

The current transformer is designed 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. Losses also occur in the current transformer line that need to be considered if there are large distances between the transformer and the controller.

3.4 Standard connection diagram measuring voltage Ph-N



For voltage supply, see nameplate.

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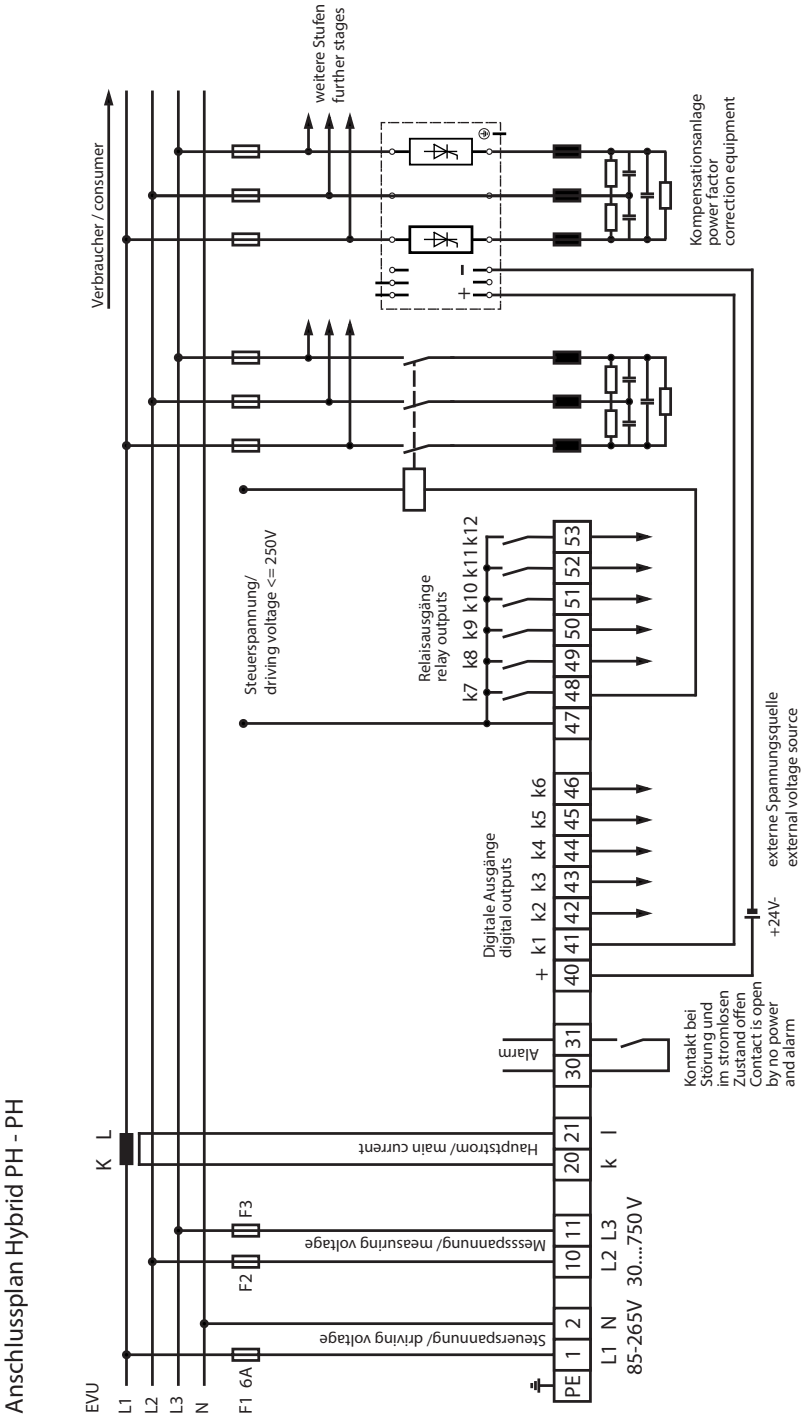
3.5 Standard connection diagram measuring voltage Ph-Ph



For voltage supply, see nameplate.

4 Starting up the system

4.1 General notes on starting up

- Switch on a sufficient number of inductive consumers (e.g. motors) before switching the compensation system on. A transformer current of at least 15 mA needs to be flowing in the secondary circuit for the controller to be activated. Below this limit, the display will show "missing transformer current".
- Check the transformer connection (transformer ratio too high?).
- The measuring voltage has to be correct before switching on the controller. No error message is displayed, but the learning mode cannot be started.
- If stage power has been programmed, the power factor CosPhi has to be displayed after initialization. Normally, when no capacitors are connected, CosPhi lies in the range of 0.6 to 0.9 inductive, (e.g. CosPhi 0.80 ind).
- If a capacitive value is displayed or if the "G" symbol is flashing, the phase allocation of current and voltage measurement is incorrect (provided that there is no generator operation at the time). In the Commissioning programming menu, the phase allocation can be changed using the rotary field U and rotary field I functions.
- The first switching operation may take up to 10 seconds. The thyristor stages are switched in a set milliseconds interval until compensation. If the existing thyristor stages are not sufficient, additional contactor stages are switched on. The CosPhi displayed has to approximately reach the target CosPhi.

Note

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

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4.2 Compensation system with controller

The controller is preset as a component of a compensation system (refer to the connection diagram of the compensation system). 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 the measuring voltage transformer data.
- If no stage powers have been programmed, the controller will switch to the

Commissioning menu. Subsequently, the stage power can be programmed 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 mains failure.

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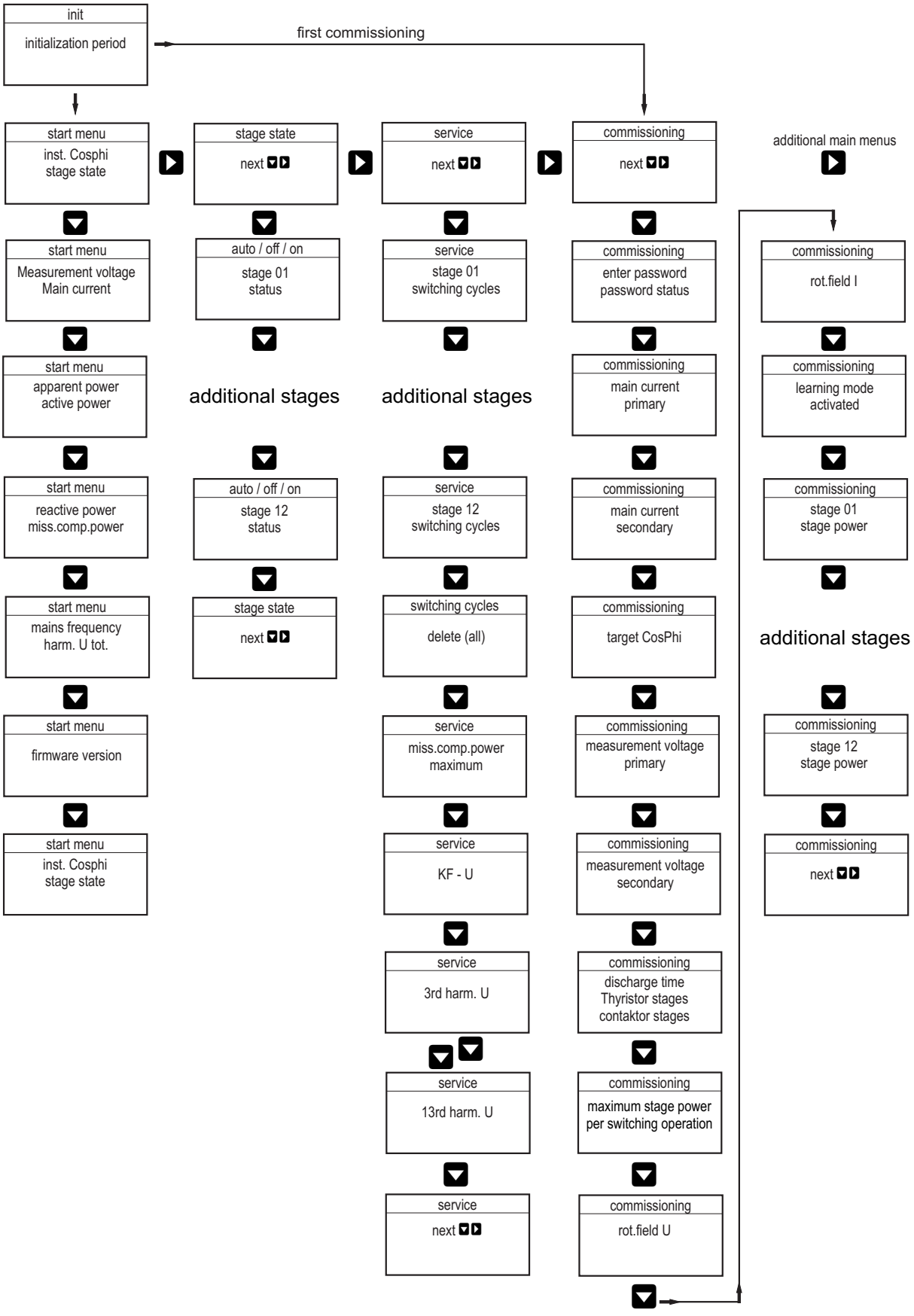
5 Navigation and device displays



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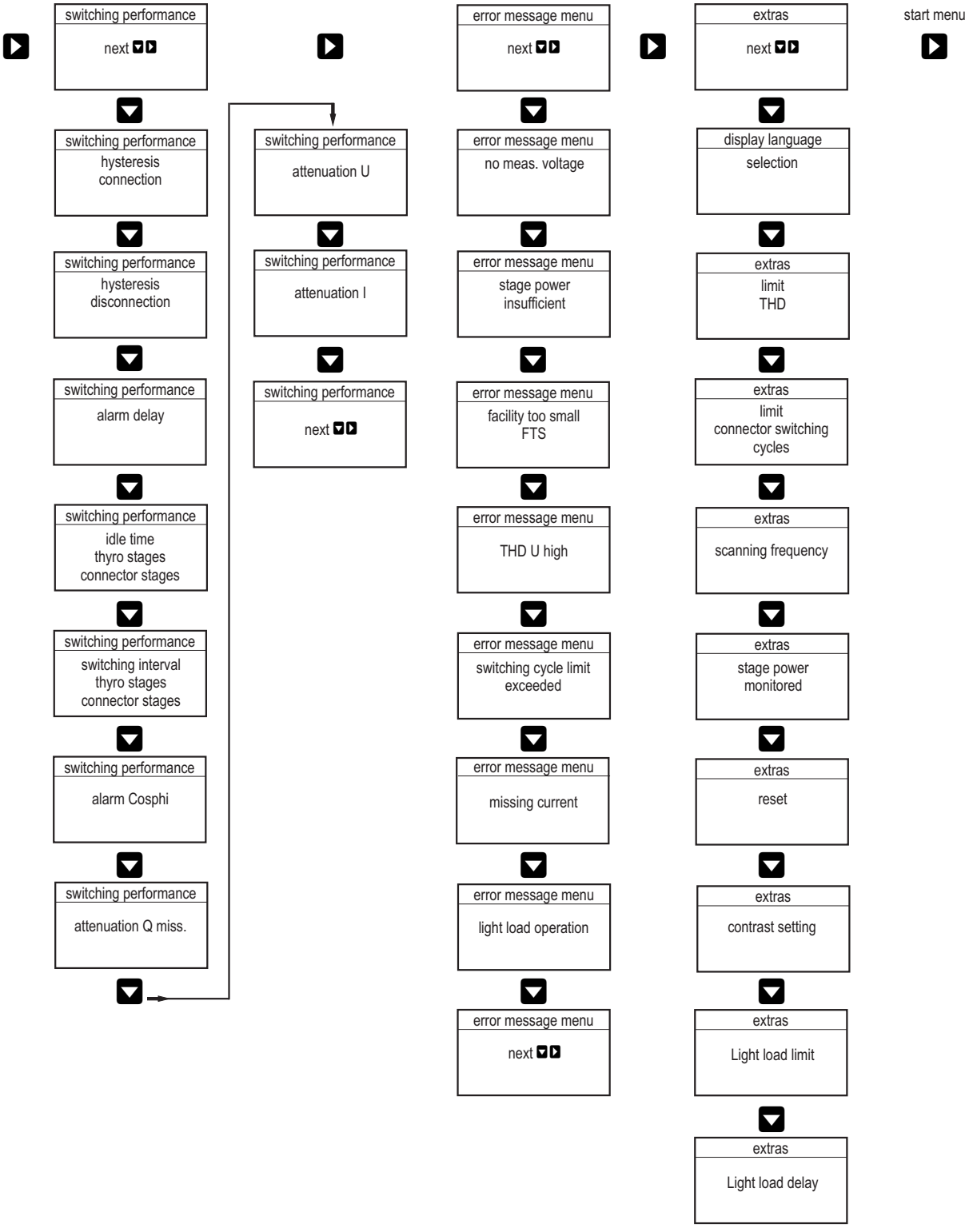

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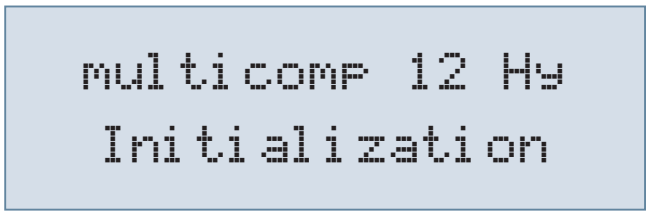
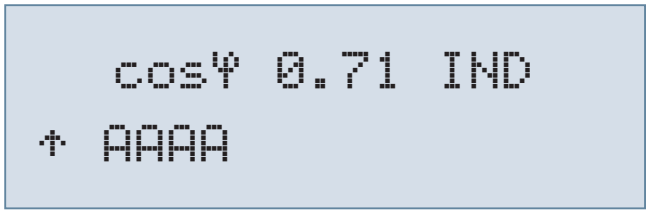
6 Device displays of the main menus

For current displays and controller configuration, different main menus and their submenus can be used.

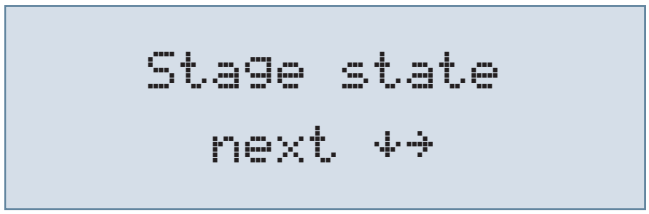
Initialization menu – no input possible



Start menu window - display of current values



Stage state window – stage state can be changed



Service window – display and deletion options

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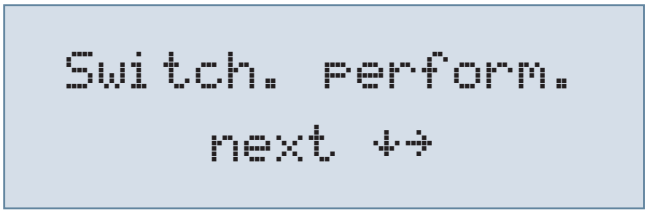
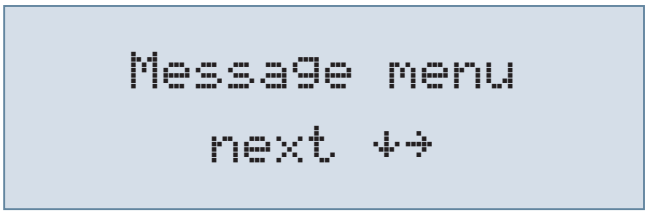
Commissioning window – entry of operating parameters

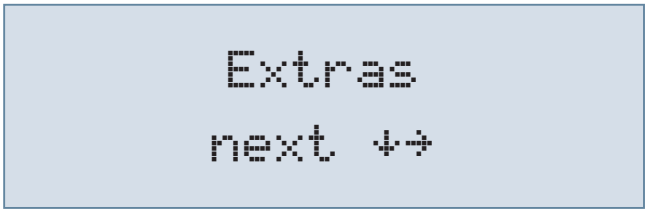
Switching performance window – influencing switching performance



Error message menu – editing the error message dialog



Extras window – setting special parameters



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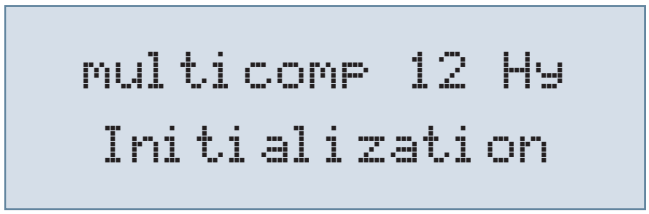
7 Description of the individual display windows

7.1 Initialization window:



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

Note

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:

At the **initial startup** of the **multicomp F144-1V1C6DO6RO-2**, the Commissioning menu is displayed as the start screen (after the initialization phase) once you have set up the supply voltage.

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

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

Select submenus by pressing ▼.

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Password protection:

To protect a system 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 to start entering and changing the entry position, to change or set the value and to save the entry.

Configuring current transformer values:

For the compensation controller to function properly, all current transformer parameters affecting 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 measuring voltage under **Rot.field U**. These settings apply to a standard network (voltage Ph-Ph: 400V primary, 400V secondary). With measuring 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 measuring voltage connection between the phases L1 and L2.

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Setting the discharge time:

Checking or, if required, changing the discharge time of the capacitor stages is a very important menu item. The discharge time can be set between 20 and 9999 milliseconds for thyristor stages and 0 to 900 seconds for contactor stages. Please make sure that the correct value is set, otherwise the system 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 auto configuration mode.

Note

If there is no measuring voltage, the auto configuration mode menu will 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 for 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 . Change to Yes with and confirm by pressing . The auto configuration mode then automatically sets the stage power. However, this value has to be checked after each time the learning process is performed.

Function test:

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

After re-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. The controller starts to switch on the individual capacitor stages after a maximum of 10 seconds (the maximum discharge time of the thyristor stages) until the system is compensated.

The CosPhi, which can be read in the start menu, should have risen in comparison with former values, or it should rise when switching on additional stages. If the compensation unit is designed correctly, the controller should compensate the set target CosPhi after a while.

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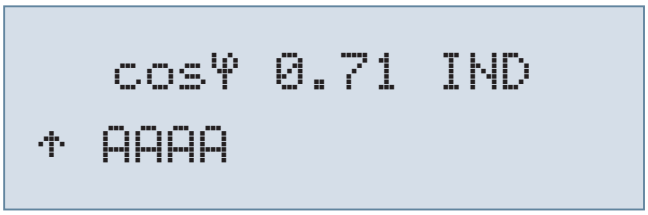
7.3 Start menu window:



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: the controller switches on stages; stages 1 to 4 are already switched to automatic operation, whereby:

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

Select submenus by pressing ▼.

The current measured values are displayed in the submenus:

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

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

Apparent power in kVA, projected as three-phase value (provided that the network load is symmetrical).

Active power in kW, projected as three-phase value (provided that the network load is symmetrical).

Apparent power in kvar, projected as three-phase value (provided that the network load is symmetrical).

Missing compensation power to achieve the set target CosPhi.

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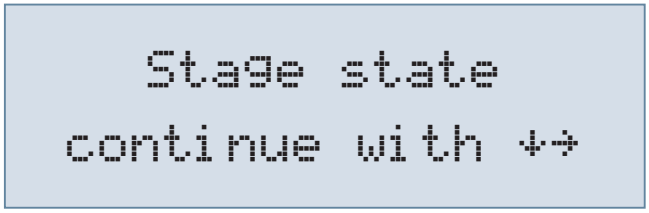
The missing compensation power is displayed up to a maximum value of 9999.9 kvar.
If the value exceeds this limit, ----.- kvar is displayed

Power frequency in Hertz

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

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.

7.4 Stage state window:



Select submenus by pressing .

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 .

By pressing to start entering values, to make changes 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 not available to calculate the optimizing automatic operation.

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7.5 Service window:

Select submenus by pressing ▼.

In the submenus of this window, the number of connections of each individual capacitor stage is displayed. In the **delete operating cycles** menu item, you can delete the accumulated operating cycles **for all stages**. To do so, simultaneously press ▶| and 123.

If the number of operating cycles of a **contactor stage** equals or exceeds the value set in the menu item **Extras / Limit**, a message is displayed, depending on the settings in the **Error message menu / Operating cycle limit exceeded**.

For **thyristor stages**, however, only the number of operating cycles is counted.

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

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7.6 Commissioning window:

Select submenus by pressing .

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

Password protection:

To protect a system 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 to start entering and changing the entry position, to change or set the value and to save the entry.

Configuring current transformer values:

For the compensation controller to function properly, all current transformer parameters have to be set correctly. The 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 **(Rot.field I submenu)**. If the transformer connections are mixed up (k and l interchanged), this can be corrected with the setting -L1, -L2 and -L3.

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Note

Changing the series transformer parameters later on can directly influence the capacitor stages for which the stage power was determined using the auto configuration 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.**

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 measuring voltage under Rot.field U. These settings apply to a standard network (voltage Ph-Ph: 400V primary, 400V secondary). With measuring 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 measuring 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. The discharge time can be set between 20 and 9999 milliseconds for thyristor stages and 0 to 900 seconds for contactor stages. Please make sure that the correct value is set, otherwise the system could be damaged!

Setting the maximum stage power per switching operation:

To quickly compensate missing compensation power or overcompensation, it is possible to switch identical or different stage powers at the same time.
The number of stages to be switched simultaneously is determined by the value **"Maximum stage power per switching operation"**.

Example:

If there is a missing compensation power of at least 50 kvar and a limit of 50 kvar for this function, the controller simultaneously switches e.g. 2x20 kvar and 1x10 kvar.

The same applies to switch-off in case of overcompensation.

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If the stage power limit is set lower than the value of the largest existing stage, but larger than or equal to “0”, the controller automatically uses the largest capacitor stage available.

Configuring the capacitor stages:

There are two ways of configuring the capacitor stages. The stages can be configured manually or using the auto configuration 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 for each stage.

Note

If the menu item "Activate learning mode" cannot be selected, you have to verify that there is measuring voltage 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 . Change to Yes by pressing and confirm with .

After starting the learning mode, active flashes and the remaining time until the end of the learning mode is displayed.

Note

The auto configuration mode then automatically sets the stage power. You have to ensure that the current flow though the main current transformer is not influenced by switching consumers on or off. Check the stage power determined after each time the learning process is performed.

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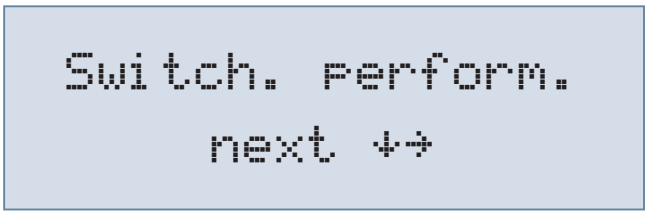
7.7 Switching performance window:



Select submenus by pressing ▼.

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 systems.

Caution

However, you have to check all parameters to make sure that there are no deviations from the requirements the system 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 system.
- Hysteresis switch-off (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 system.
- 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 alarm CosPhi is not reached even if all available stages are switched on, this message is displayed after the set alarm delay time has elapsed.

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- Idle time (default setting for thyristor stages 20 msec, setting range 20 to 9999 msec, for contactor stages 10 sec, setting range 0 to 300 sec):
  This value defines the time the controller is idle after compensation before another switching operation is performed (connection or disconnection).

- Switching interval (default setting for thyristor stages 50 msec, setting range 50 to 9999 msec, for contactor stages 8 sec, setting range 0 to 10 sec):
  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 **PFC too small**. If this value is not reached after the alarm delay has elapsed despite all stages being switched on, the message **PFC too small** is displayed.

- Attenuation Qmiss (default settings 0, setting range 0 to 9):
  This value defines the attenuation to prevent fast parameter changes of the missing compensation power.

- Attenuation U (default settings 0, setting range 0 to 9):
  This value defines the attenuation to prevent fast parameter changes of the measuring voltage.

- Attenuation I (default settings 0, setting range 0 to 9):
  This value defines the attenuation to prevent fast parameter changes of the measuring current.

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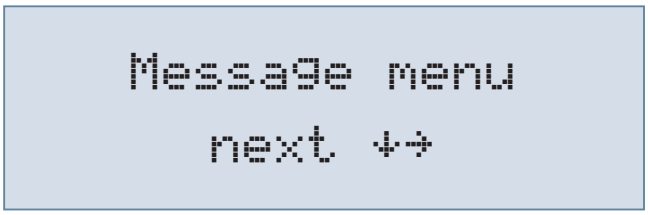
7.8 Error message window:



Select submenus by pressing ▼.

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

The following error messages can be configured:

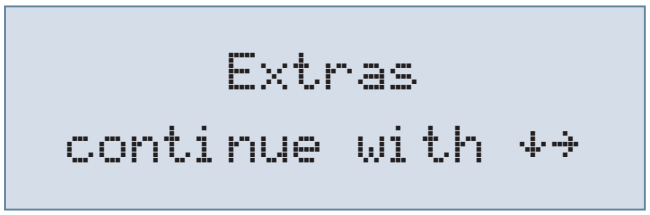
Alarm submenu	Possible actions			
	Off	Message	Alarm relay	Message and relay
Missing measuring voltage	✓	✓	✓	✓
Missing stage power	✓	✓	✓	✓
PFC too small	✓	✓	✓	✓
THD (voltage harmonics) too high	✓	✓	✓	✓
Operating cycle limit exceeded (contactor stages)	✓	✓	✓	✓
Missing measuring current	✓	✓	✓	✓
Low load operation	✓	✓	✓	✓

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

Caution

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

7.9 Extras window:



Select submenus by pressing .

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

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

The following submenus are available:

- User language:
  In this submenu, you can choose the LCD display user language. You can choose between German, English, French and Spanish.
- THD limit:
  The limit of the harmonic switch-off refers to the total of all measuring voltage harmonics. The programming range lies between 0 and 10 %. The setting is done in increments 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 switch-off is performed.
- Operating cycle limit:
  The limit of the capacitor contactor operating cycles is used as an indication for customers that the capacitor contactor could be worn out due to the number of switching operations accumulated. This message in no way influences the function of the compensation system. It is used merely as a "maintenance instruction". Manual switching operations are not counted.

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- Sampling rate:
  In this submenu, the power frequency tracing settings are displayed. The setting "Auto" causes the sampling rate to be traced automatically, within a range of 40 to 70 Hertz. Alternatively, a fixed sampling rate of 50 Hz or 60 Hz can be set.
- Monitoring stage power:
  In this submenu, the monitoring of the stage power can be activated or deactivated. However, only stages being operated automatically 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.
- Functional principle:
  Each time a capacitor stage is switched on, it is checked whether or not a change of current takes place in the main current transformer. If this is not the case, the stage is marked with ⁙ in the start menu window. The following reasons are possible and have to be checked:
  - Capacitor defective
  - Contactor defective
  - Fuse defective
- Reset:
  The **Reset** item offers you various methods of resetting the programmed controller parameters. The programmable parameters are reset to default settings. A list of the settings can be found in the section **Control and display panel**.

  This has the advantage that all configured parameters are deleted at the same time and the controller restarts with the default settings.
- Perform reset:
  Extras menu, Reset menu item

  Press ▶| = Reset flashes

  Press ▶| and 123 simultaneously = "done" is displayed

  After about 2 seconds, the display switches back to Reset

Note

The resetting process can be interrupted by pressing ▶.

- 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 switched on:

Check the controller for detected errors (refer to section 7.8). If the target Cos-Phi is set to 0.8 capacitive, the capacitors need to start to be switched on. If the system is not over-dimensioned, almost all stages need to be switched on.

Undercompensation, all stages are switched on:

The existing system is not sufficient (e.g. due to new inductive consumers). Please contact the KBR service (for system expansion).

Check the main fuse and group fuses of the system. Checking the controller parameters. The group fuses must display at least 1.7 times the value of the capacitor power. If the fuses blow despite being correctly selected, the groups must be checked individually for excessive current input and for defective contactors.

Overcompensation, too many stages are switched on:

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

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

Check the transformer ratio configuration. If required, (manually) switch on a small stage permanently.

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9 System and safety devices maintenance

In order to ensure proper function and a long service life of your system, perform the following checks after startup and subsequently once a year.

- Check and re-tighten all connections. Screw 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 control performance in automatic mode.
- Examine the cooling air setting (fans, temperature monitoring function):
- Clean the filter mats, depending on how dirty they are.
- Visually inspect the capacitors.
- Examine the current consumption and capacitor terminal voltage.

Note

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

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10 Setting range of the configurable parameters:

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 configured)
PFC too small 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
Thyristor stage idle time	20 to 9999 milliseconds
Contactor stage idle time	0 to 300 seconds
Alarm relay time	0 to 3000 seconds
Hysteresis connection	70 to 150 %
Hysteresis disconnection	70 to 150 %
Thyristor stage switching interval	50 to 9999 milliseconds
Contactor stage switching interval	0 to 10 seconds
Contactor operating cycle limit	0 to 999999
Stage power	0 to 999.9 kvar
Thyristor stage discharge time	20 to 9999 milliseconds
Contactor stage discharge time	0 to 900 seconds
Stage switching mode	automatic, manual off, manual on
Stage power monitoring	can be deactivated
Harmonics monitoring	can be deactivated (0%)

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THD limit	0 to 10%
Sampling rate	automatic, fixed 50 Hz, fixed 60 Hz
Password	1111 to 9998, no password 9999, meaning all functions are accessible
Display language	German, English, French, Spanish
Contrast setting	0 to 10

Error message dialog:

Missing measuring voltage	The settings **Message** or **Alarm relay** / **Message**
Missing measuring current	**and alarm relay** or **Off**
Missing stage power	identical for all errors.
PFC too small	
THD too high	
Operating cycle limit exceeded	
Low load operation	

Error message dialog after reset:

Missing measuring voltage	alarm relay
Missing stage power	alarm relay
PFC too small	message and alarm relay
THD too high	alarm relay
Operating cycle limit exceeded	alarm relay
Missing current	message
Low load operation	off

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11 Technical data

11.1 Measuring and display values

Voltage	RMS 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 current)	RMS value of a measuring interval	Actual 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.....70 Hz
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) for voltage	Voltage: THD-U
	Partial distortion factors	3.; 5.; 7.; 9.; 11.; 13.; Voltage harmonics
	Units	[%]
	Measuring range	0.00% to 100%

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11.2 Measuring accuracy

Current	± 0.5% / ± 1 digit (for 0.1 to 5 A)
Voltage	± 0.5% / ± 1 digit
Power	± 1% / ± 1 digit
Power factor	± 1% / ± 1 digit
Frequency	± 0.1% / ± 1 digit

11.3 Measuring principle

Sampling	128 measured values per period
A/D converter	12 bit
Measurement of U and I	simultaneous recording of measured values for U and I
Measuring cycle	20 ms
Harmonics calculation	FFT with 128 points over one period
Frequency measurement	Mode: Voltage measurement between phase Lx - N / Ly)

11.4 Device memory

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

11.5 Other limits:

Limit violations:	
Harmonics	Acquisition time approx. 100 ms
Overvoltage switch-off:	Acquisition time approx. 40 ms
Zero-voltage switch-off:	Acquisition time approx. 40 ms (for measuring voltage)

11.6 Power supply

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

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11.7 Hardware inputs and outputs

11.7.1 Hardware inputs

Voltage measuring input	UPH-N or UPH-PH	30 V... 690 V... 790 V AC
	Input impedance	750 kOhm
	Measuring range	1 measuring range, measuring voltage transformer can be programmed
Current measuring input	IL1, IL2 or IL3	0.015 A ... 5 A ... 6 A AC
	Power consumption	approx. 2 VA at 6 A
	Measuring range	1 measuring range, current transformer can be programmed

11.7.2 Hardware outputs

Alarm relay	Switching capacity	250 V (AC) / 2 A floating
Capacitor stage relay	Switching capacity	250 V (AC) / 2 A floating
Optocoupler output	Switching capacity	max. 35 VDC, max. 35 mA, external supply

11.8 Electrical connection

Connection elements		Plug terminals
Permissible cross-section of the connection lines		2.5 mm^2
Measurement voltage inputs	Fuse protection	max. 6 A
Measuring current input	Fuse protection	NONE!!! Always short-circuit current transformer terminals k and l before 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 diagram

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11.9 Mechanical data

Switchboard installation	Housing dimensions	144 x 144 x 60 mm (H x W x D),
	Assembly cut-out	138 x 138 mm
	Protection type	Front IP51 (with optionally available front door max. IP54), terminals IP20
	Weight	Approx. 650g

11.10 Standards and miscellaneous

Ambient 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
	Operating altitude	up to max. 2000 m above sea level
Electrical safety	Standards	DIN EN 61010-1/A2: Aug. 2002; (IEC1010-1/A2)
	Protection class	I, in accordance with DIN EN 61010-/A2: Aug. 2002
	Overvoltage category	CAT III: UPH-PH up to 400 V
	Protection type	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 code	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 consumption I (A) per phase	Supply line Cu (mm^2)	Fuse (slow-blow) 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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Notes

KBR Kompensationsanlagenbau GmbH

Am Kiefernschlag 7
D-91126 Schwabach,
Germany

T +49 (0) 9122 6373 - 0
F +49 (0) 9122 6373 - 83
E info@kbr.de

www.kbr.de

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