KBR Energy Management

Technical reference

multicomp

4-quadrant controller

F144-MS-1V1C1TI6RO-3
F144-MS-1V1C1TI12RO-3

Your partner for network analysis

System | English

21719_EDEBDA0235-3517-2_EN

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Dear customer

Thank you for choosing a KBR product.

To familiarize yourself with operation and configuration of the device, we recommend that 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. The form included in the appendix to this manual can be used to send us corrections or suggested improvements.

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.

DANGEROUS VOLTAGE

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

CAUTION

means that minor injuries or property 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. However, deviations may occur so that no guarantee can be made for complete agreement with the documentation. The specifications given 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 will enable to use the device very quickly. In your own interest, however, the following safety notes should be read carefully.

DANGEROUS VOLTAGE

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

Power supply connection, setup and operation of the device may only be performed by qualified personnel. Qualified personnel as defined in the safety notes in this user manual are personnel with electrical engineering qualifications, knowledge of the national accident prevention regulations and safety engineering standards as well as of the installation, commissioning and operation of the device.

To reduce the risk of fire or shock hazard, the device must not be exposed to rain or humidity!

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 may result in the destruction of the device!

When connecting the device, ensure that the data given in the connection chart is complied with (see "Connection diagram") and that the connection cables are not live. 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 that 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. Troubleshooting, repairs and maintenance work may only be carried out in our facilities or after contacting our service team.

Unauthorized opening of the the device 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 sources of electricity. Do not operate open devices under any circumstances!

Systems that are at risk from lightning strikes must be fitted with lightning protection for all input and output cables (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.

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

Disposal

Devices that are faulty, now obsolete or no longer used 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 controller's microprocessor records the mains voltage and current consumption of the entire company 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 cos phi 1.00 (output cos phi) is performed. To prevent alternating switching operations, this target cos phi is maintained for 15 minutes after generator operation.

The compensated power required for the target cos phi is calculated continuously. If the power difference corresponds to the set hysteresis (switch-on and switch-off hysteresis), the stages are switched depending on the required compensation power. 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. To prevent alternating switching operations, you can increase the stage switch-off delay by up to 150% of the smallest stage's power.

In low load operation (secondary measuring current under the limit), the stages are switched off after the sett delay time.

The integrated temperature measurement input monitors the temperature in the reactive power compensation system and triggers the fan to be switched on if a predefined limit temperature is exceeded and switched off again when the temperature drops below the reset temperature.

To prevent unnecessarily frequent switching of the fan, it has a run-on time of 30 minutes. You can switch the fan (relay output 6 or 12 depending on the device version) on or off permanently using the "Stage status" menu. If you select "Auto", the fan output is controlled by the temperature measuring input.

Furthermore, you can protect the system by defining a switch-off temperature. This makes it possible to switch off stages in time if there is a risk of damage due to overtemperature. If the reset temperature is exceeded, the stages are switched on again one after the other.

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The settings are saved on an EEPROM so that they are not lost in the event of a power failure.

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

NOTE

Limit for overvoltage switch-off = measuring voltage + 10% (taking the measuring voltage ratio into account). This value cannot be changed and serves to protect the compensation system. In the event of an error, the compensation stages are switched off and "Overvoltage" is displayed.

CAUTION

The discharge times are automatically predefined for the following programmed stage powers. However, these must be checked and corrected if they differ from the capacitor specifications.

Capacitor power	Discharge resistance	Discharge time
0.1 kvar – 9.9 kvar	300 kOhm	60 seconds
10 kvar – 19.9 kvar	300 kOhm	120 seconds
20 kvar and above	300 kOhm	180 seconds

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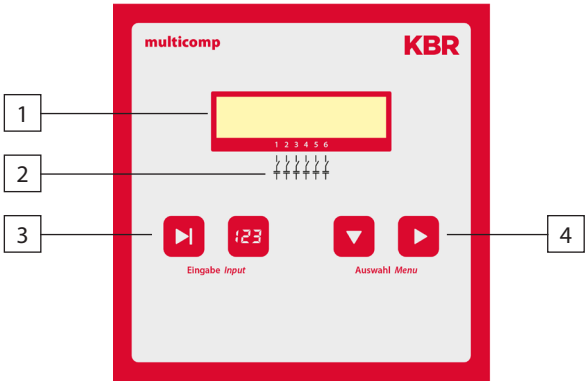
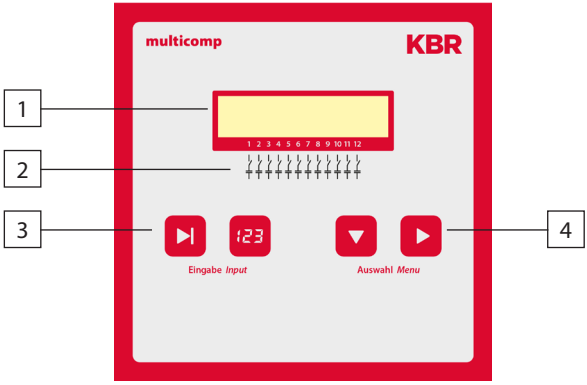
2 Control and display panel

multicomp F144-MS-1V1C1TI6RO-3



multicomp F144-MS-1V1C1TI12RO-3



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

Button combinations:

and buttons	Delete accumulated values and perform reset

Default controller settings after reset:

Commissioning menu

▪ Consumption target cos phi:	0.95 inductive
▪ Recovery target cos phi:	1.00 (cannot be changed)
▪ Alarm cos phi:	0.92 inductive
▪ Main transformer current:	Primary current 1000 A
	Secondary current 5 A
▪ Measuring voltage:	Primary voltage 400 V Ph-Ph (corresponds to 230V Ph-N)
	Secondary voltage 400 V Ph-Ph (corresponds to 230V Ph-N)
▪ Rot. field U:	L1-N
▪ Rot. field I:	L1
▪ Current attenuation coefficient:	2
▪ Voltage attenuation coefficient:	2
▪ Attenuation coefficient Qmiss:	2
▪ Alarm delay:	20 minutes (1200 seconds)
▪ Idle time:	30 seconds
▪ Switching interval:	8 seconds
▪ Hysteresis connection:	100% of lowest stage power
▪ Hysteresis switch-off:	100% of lowest stage power
▪ Operating cycle limit:	80000
▪ Operating cycle count:	Activated by set limit
▪ Stage switching mode:	Automatic

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▪ Sampling rate:	Automatic
▪ Harmonics monitoring:	Activated by set limit
▪ THD limit:	8%
▪ Stage power:	Not set
▪ Stage power monitoring:	Deactivated
▪ Discharge time:	180 seconds
▪ Password:	No password (9999, meaning all functions are accessible)
▪ Language display:	English
▪ Contrast setting:	5
▪ Brightness setting:	5
▪ Dimmer brightness:	0
▪ Low-load limit:	15 mA
▪ Low-load delay:	60 minutes
▪ Temperature measurement:	On
▪ Relay 6/12 as stage or fan:	Fan relay
▪ Fan switch-on temperature:	> 28 °C
▪ Fan switch-off temperature:	< 23 °C
▪ System switch-off temperature:	> 48 °C
▪ System switch-on temperature:	< 43 °C
▪ Learning mode menu display:	Off
▪ Key sounds:	On

Error message dialog after reset:

No measuring voltage:	Message and alarm relay
No stage power:	Message and alarm relay
PFC too small:	Message and alarm relay
THD too high:	Message and alarm relay
Operating cycle limit exceeded:	Message and alarm relay
No measuring current:	Message and alarm relay
Low load operation:	Message and alarm relay
Temperature switch-off:	Message and alarm relay

The controls in the compensation systems are preset.

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The following need to be checked or set:

- Target cos phi in accordance with the electricity supplier regulations (for kVA tariff cos phi = 1)
- Primary current and secondary current in accordance with input current transformer.
- Voltage transformer ratio, if required

NOTE

Upon delivery, the bus protocol is set to: Modbus RTU, baud rate 38400, parity even. This setting can only be changed manually on the device. However, performing a "Reset to default settings" has no effect on a changed setting.

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3 Setting range of the configurable parameters:

Stage status:	
Stage switching mode	Automatic, Manual off, Manual on
Commissioning:	
Password	4 digits, numerical, no password = 9999 (meaning all functions are accessible)
Primary current	1 A to 999999 A
Secondary current	1 and 5 A
Consumption target cosφ	ind. 0.80 to cap. 0.80
Recovery target cosφ	ind. 1.0 (cannot be configured)
Primary voltage	1 V to 99999 V Ph-Ph
Secondary voltage	1 V to 999 V Ph-Ph
Rot. field U	L1N, L2N, L3N, L12, L23, L31
Rot. field I	L1, L2, L3, -L1, -L2, -L3
Stage power learning mode	Yes, No
Stage power	0 to 999.9 kvar
Discharge time	0 to 999 sec.
Switching performance:	
Hysteresis connection	70 to 150%
Hysteresis switch-off	70 to 150%
Alarm relay time	3 to 3000 sec.
Idle time	0 to 300 sec.
Switching interval	0 to 10 sec.
FTS alarm cosφ	ind. 0.70 to 1.0
Attenuation coefficient Q_{miss}	0 to 9
Voltage attenuation coefficient	0 to 9
Current attenuation coefficient	0 to 9

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Error message dialog:

No measuring voltage	The settings **Message** or
No stage power	**Alarm relay** or **Message** and
PFC too small	**Error message relay** or **Off**
THD too high	is identical for all errors**!**
Operating cycle limit exceeded	
No measuring current	
Low load	
Temperature switch-off	

Extras:

Display language	German, English, French, Spanish
THD limit	0 to 10%, harmonics monitoring can be disabled (0%)
Operating cycle limit	0 to 999999 (0 = deactivated)
Scanning frequency	Automatic, fixed 50 Hz, fixed 60 Hz
Stage power monitoring	Yes, No
Reset	Run
Contrast setting	0 to 10
Brightness setting	0 to 9
Dimming brightness	0 to 9
Low-load limit	15 mA, 50 mA
Low-load delay	1 minute to 60 minutes
Temperature measurement	On, Off
Relay 6 or 12 (depending on the controller version)	Compensation stage, fan relay
Fan switch-on temperature	> 0 °C to 70 °C
Fan switch-off temperature	0 °C to 70 °C
System switch-off temperature	> 0 °C to 70 °C
System switch-on temperature	0 °C to 70 °C
Bus mode	Modbus (eBus for production)
Learning mode menu display	On / Off
Key sounds	On / Off

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4 Installation and electrical connection of the system

4.1 General, very important information

- Tighten all screws and connections. Failure to do so will void the warranty.
- Install and operate the device in accordance with the applicable VDE regulations (in particular VDE 0100) and the electricity supplier regulations.
- Connection cross-sections and fuse protection table: see annex.

CAUTION

Failure to observe the connection conditions or exceeding the permissible voltage range may result in damage or destruction of the device.

Before connecting the power supply to the device, please note:

- The voltage and frequency must comply with the specifications on the nameplate. Observe the limits specified in this manual!
- A disconnector or circuit-breaker must be provided for the power supply voltage in the building installation, in accordance with the applicable local regulations.
- Install an isolating switch that is easily accessible to the user and close to the device. It must be marked as an isolating switch for this device.
- Install a suitable, correspondingly marked fuse and isolating switch for the voltage measurement inputs nearby (alternative: circuit breaker). These voltages are dangerous to touch!
- Voltages that exceed the permissible rated voltages must be connected using a voltage transformer.
- Measuring voltages and measuring currents must be taken from the same power supply.

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4.2 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 companies), 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) have to be connected in the compensation system (use a two-color cable!).

Wire cross section: up to 3 m =1.5 mm^2, up to 6 m =2.5 mm^2. For longer distances, we recommend using a 1 A transformer. The controller is designed for connection to 5 A and 1 A transformers; switching is done by firmware.

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 are connected (display shows "Missing current"). Measuring voltage connection according to the connection diagram.

4.3 Current transformer dimensions

The current transformer is designed on the basis of the current consumption of the consumers, not the capacitor current. If, in addition to the reactive power controller, other measuring devices are connected to the same transformer, the transformer power needs to be chosen accordingly. Losses also occur in the current transformer cable that need to be considered if there are long distances between the transformer and the controller.

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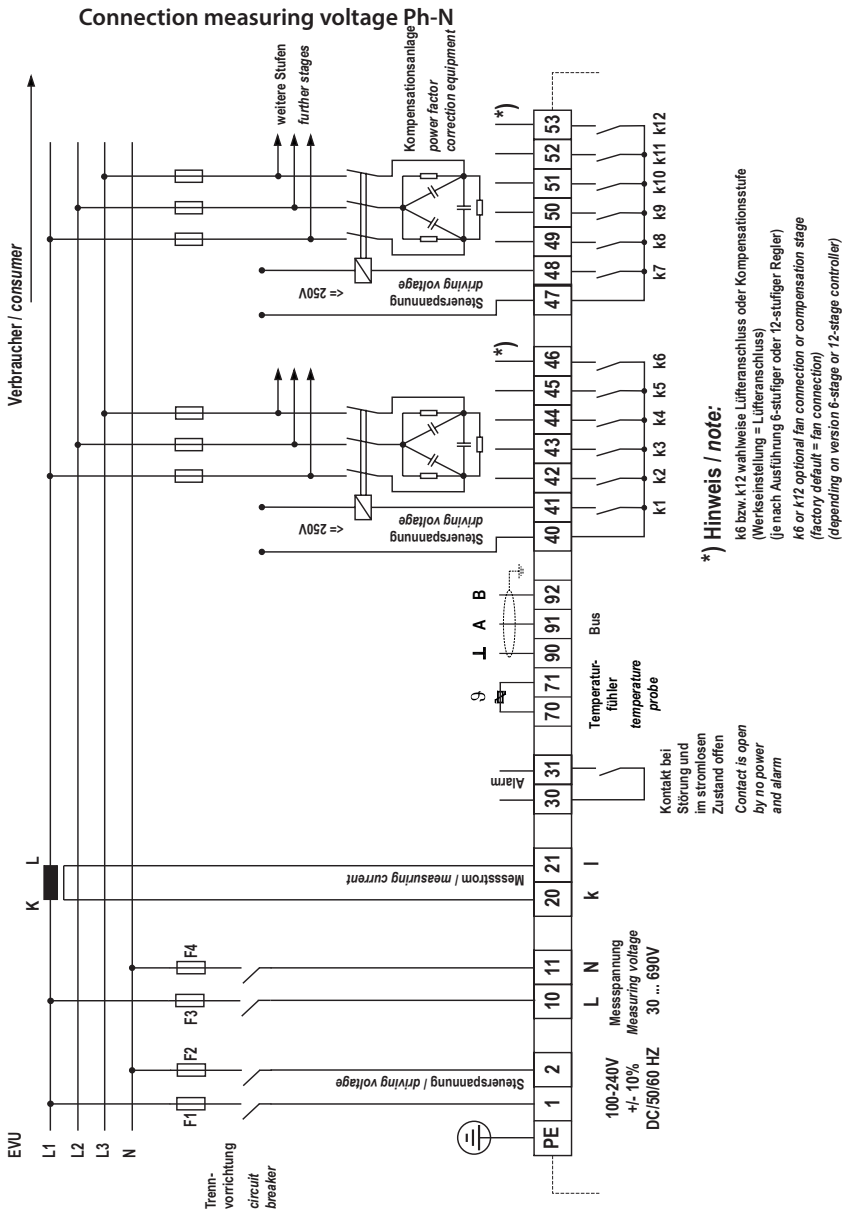
4.4 Standard connection diagram:



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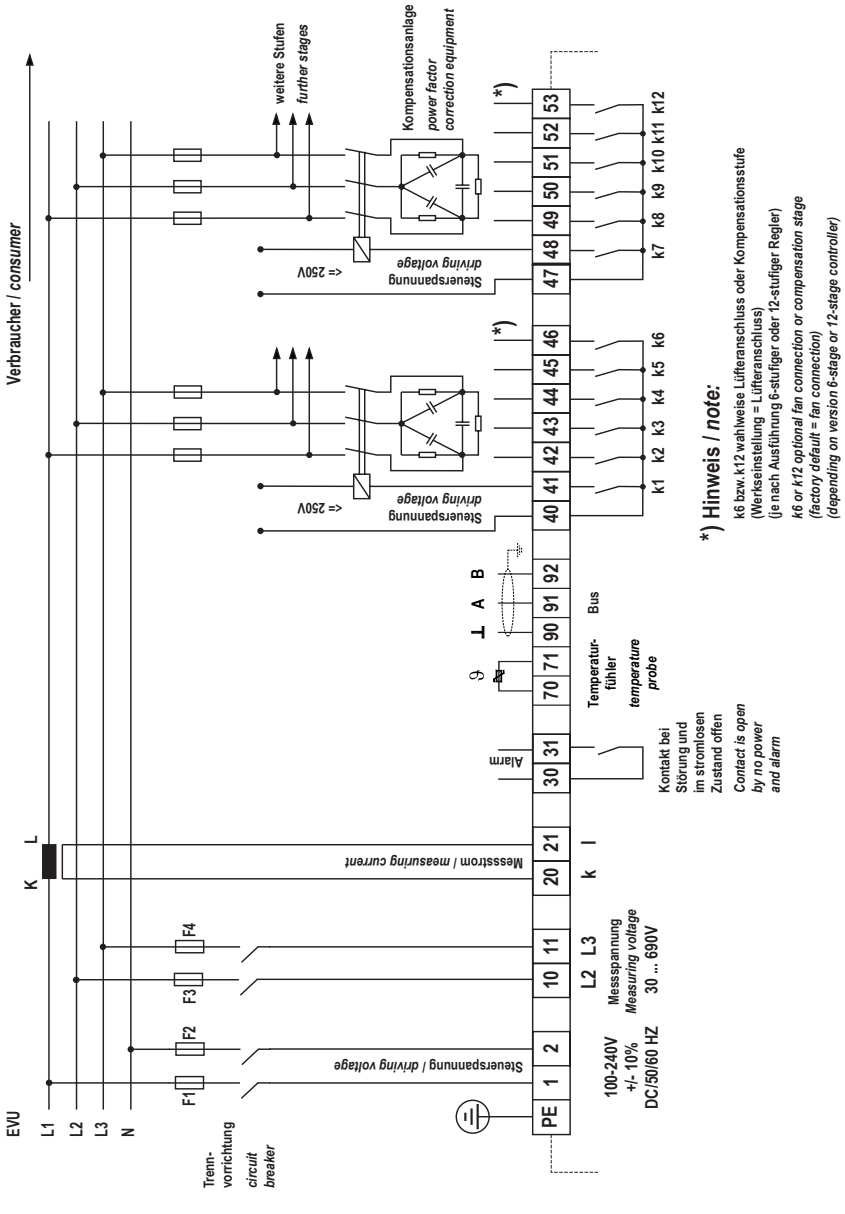
Connection measuring voltage Ph-Ph



5 Commissioning the system

5.1 General notes on commissioning

The controller is preset as a compensation system component (see connection diagram). The following need to be configured or checked:

- Target cos phi according to electricity supplier specifications.
- Primary and secondary current in the main circuit according to the transformer fitted.
- Set the measuring voltage transformer data, if necessary.
- If no stage powers have been programmed, the controller will switch to the Commissioning menu after initialization. Next, stage power programming can be performed in the settings menu, or using the learning process.

NOTE

You can start the learning process from the **Activate learning mode?** submenu in the **Commissioning** menu, using the Enter/Input buttons. If the "Learning mode" window is not displayed, please check the following:
- is **Menu on** set for "Learning mode" in the "Extras" menu?

The settings are saved on an EEPROM so that they are not lost in the event of a power failure.

- 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 "No transformer current". Check the transformer connection (transformer ratio too high?).
- If all connection conditions are OK, the instantaneous power factor cos phi should appear on the display after initialization, e.g. Normally, when no capacitors are connected, cos phi lies in the range of 0.6 to 0.9 inductive, (e.g. cos phi 0.80 ind).
- If a capacitive value is displayed, or if the "G" symbol is flashing, the phase allocation of the current and voltage measurement is incorrect. In the Commissioning programming menu, the phase allocation can be changed using the functions Rot. field U and Rot. field I (provided that there is no generator operation at the time).

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- The first switching operation may take up to 180 seconds. The stages are switched in a set intervals until compensation occurs. The displayed cos phi must increase to at least the set target cos phi.

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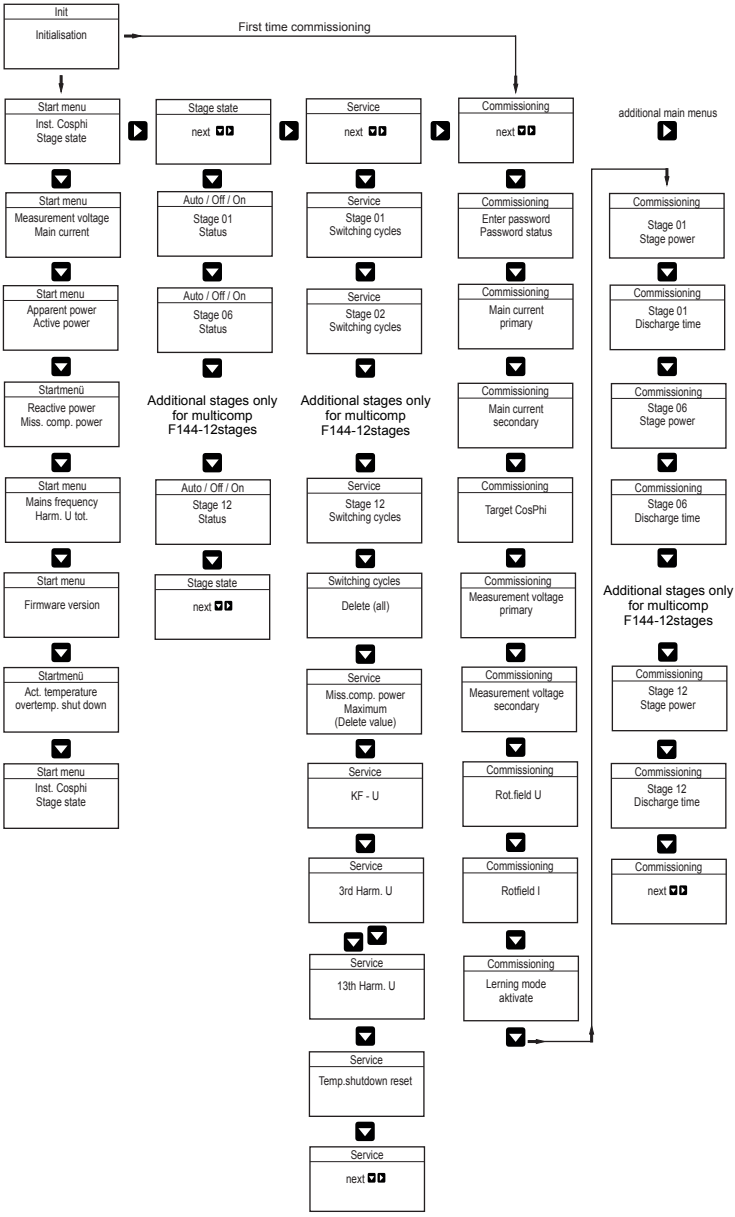
6 Navigation and device displays



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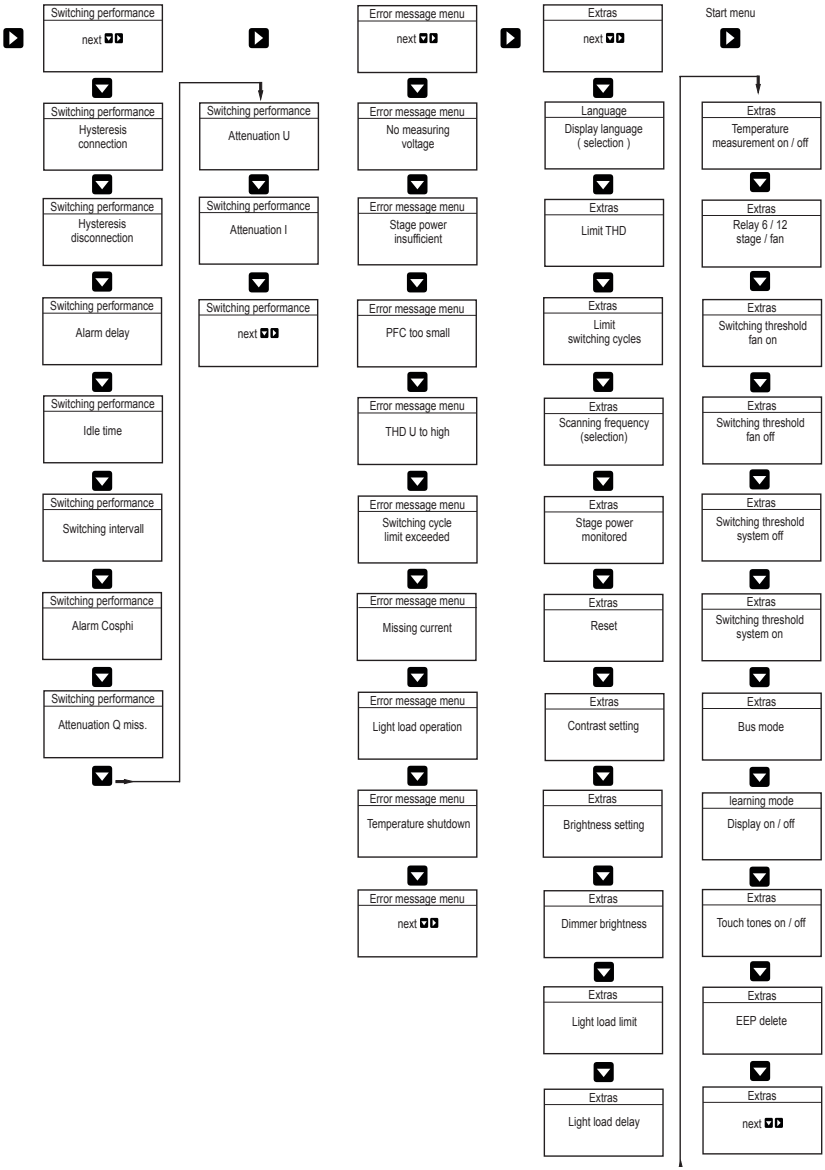

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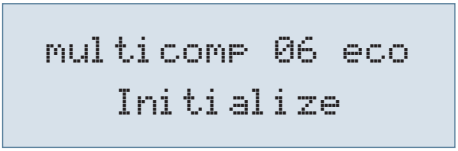
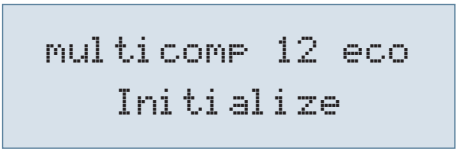
7 Device displays of the main menus

Different main menus and submenus can be used for current displays and controller configuration.

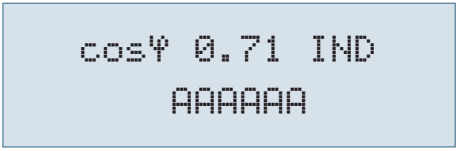
Initialization menu – no input possible

multicomp F144-3 6-stage or 12-stage

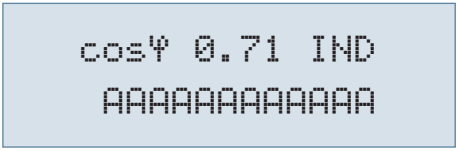




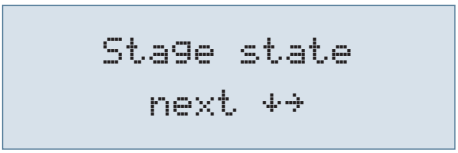
Start menu window – display of the current values multicomp F144-3 6-stage



multicomp F144-3 12-stage



Stage state window – stage status can be changed



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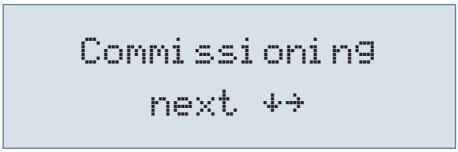
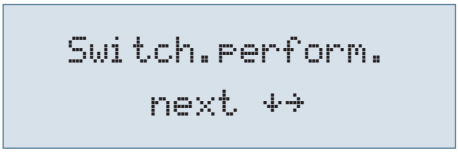
Service window – display and deletion options

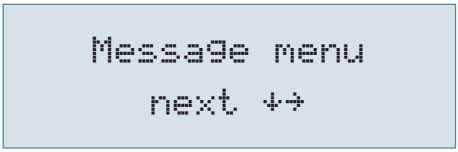
Commissioning window – entry of operating parameters



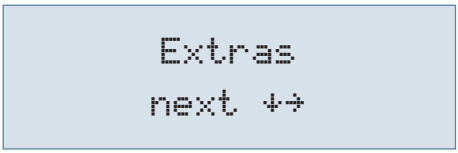
Switching performance window – influencing switching performance



Error message menu – editing the error message dialog



Extras window – setting special parameters



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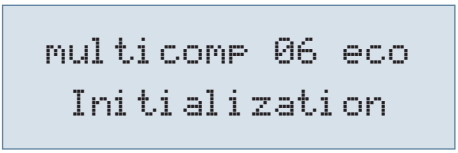
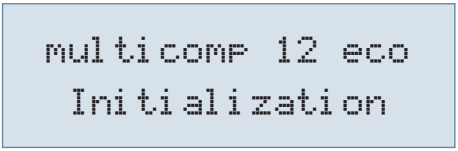
8 Description of the individual display windows

8.1 Initialization window:

multicomp F144-3 6-stage or 12-stage



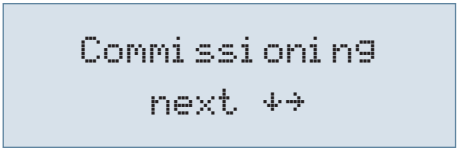


This is displayed after connecting the power supply to the controller.

NOTE

Please do not press any sensor buttons during initialization; they are adjusted automatically to ensure correct operation.

8.2 Commissioning window if no stage power is programmed:



During **initial startup** of the **multicomp F144-3**, the Commissioning menu is displayed as the F144-3 start screen (after the initialization phase) once you have connected the power supply.

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

If you wish to use a controller that is already integrated into a KBR compensation system by default, only the parameters of the current transformer need to be configured.

Press ▼ to select submenus.

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Password protection:

A password can be entered (4-digit number code, e.g. 4321) to protect a system against unauthorized access of the configured parameters.

If the password is lost, the controller can be unlocked using the **master password 1976**. To unlock a controller completely, enter the password 9999 (no password = 9999, all functions are accessible).

When unlocking a password-protected controller, it is possible to press a button for up to 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 need to be set correctly. The primary and secondary current of the transformer need 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 needs 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 cos phi:

You can ask your electricity supplier for the target cos, which should be set up at this point. By default, the target cos is 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 mains network (voltage Ph-Ph: 400 V primary, 400 V secondary). If you use a voltage transformer, configure the parameters indicated on the voltage transformer, e.g. 690 V / 100 V, as well as the measuring mode, e.g. L12 for measuring voltage connection between 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. You can set the discharge time from 0 to 999 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 auto configuration mode.

NOTE

The Auto configuration mode menu will not appear
- if the "Learning mode" is switched off in the "Extras" menu

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 enter the power value for each stage individually.

If you want to activate the learning mode, ensure that all previous submenu parameters have been set correctly.

The learning mode is activated by pressing . Change to Yes by pressing and confirm by pressing . The auto configuration mode then automatically sets the stage powers and discharge times. However, these values need to be checked after the learning process has been completed.

NOTE

If an error occurs in the auto configuration mode (harmonics exceeding the limit, measuring voltage too high, missing measuring voltage), the process is interrupted and "Auto configuration mode – Error" is displayed. The auto configuration mode can be restarted once the cause of the error has been rectified.

System function test:

A function test should be performed after all values have been programmed step by step. To do so, the controller has to be disconnected from the power supply for a few seconds.

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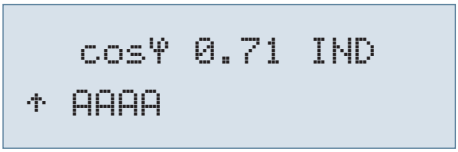
After it is reconnected to the power supply, the controller should start automatically. If the cosφ voltage is read in the start menu immediately after switching it on, the value for cosφ should be low and inductive. After approx. 60 seconds, the controller starts to switch on the individual capacitor stages.

The cosφ, which can be read in the start menu, should have risen in comparison to its previous value, or it should rise when switching on additional stages. If the compensation system is designed correctly, the controller should compensate to the set target cos phi after a while.

8.3 Start menu window:

Example: F144-3 12-stage



This is displayed after the initialization window if 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, where:

↑	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's measured stage power does not correspond to the configured value (stage monitoring activated, see the Stage monitoring submenu of the Extras menu)

Press ▼ to select submenus.

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The current readings are displayed in the submenus:

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

Main series transformer apparent current in amps (single-phase value).

Apparent power in kVA, projected as a 3-phase value (provided the network load is symmetrical).

Active power in kW, projected as a 3-phase value (provided the network load is symmetrical).

Reactive power in kvar, projected as a 3-phase value (provided the network load is symmetrical).

Compensation power to achieve the set target cos phi missing.

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

Power frequency in Hz

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

Current temperature reading (if temperature measurement is activated; if measurement is deactivated, --- °C is displayed)

Number of overtemperature switch-offs (if temperature measurement is activated; if measurement is deactivated, --- °C is displayed)

The firmware version of the controller, e.g. V 2.00R001, is important for support requests, as it can be used to deduce possible changes made to the device firmware.

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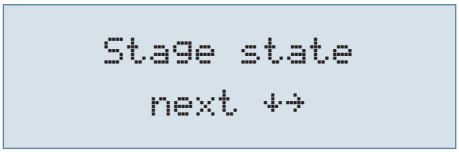
8.4 Stage state window:



Press ▼ to select submenus.

The submenus of this window display whether or not the capacitor stages connected are working in automatic mode, or if they are switched on or off permanently. The individual capacitor stages can be selected by pressing ▼.

You can change the stage state from Auto (Automatic) to Off (switched off permanently) or On (switched on permanently) by pressing ▶| to start entering values, 123 to make changes or ▶ to save them.

NOTE

Capacitor stages that are permanently switched on or off are not available to calculate the optimizing automatic operation.

8.5 Service window:

Press ▼ to select submenus.

The number of connections of each individual capacitor stage are displayed in the submenus of this window,. You can delete the accumulated operating cycles for all stages by selecting the Delete operating cycles menu item and pressing ▶| and 123 simultaneously.

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

In addition, the value in the menu item Missing comp. power maximum can be deleted by pressing ▶| and 123 simultaneously, which resetCompensation units the too small message. If the set target cos phi 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 .

You can also delete the number of overtemperature switch-offs here (this menu item is only displayed if temperature measurement is activated and accumulated switch-offs are displayed).

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8.6 Commissioning window:

Press ▼ to select submenus.

A step-by-step description of the setup process is given in the submenus of this window. For systems which are already running, the parameters set during setup can be read out here.

Password protection:

To protect a system against unauthorized access to the configured parameters, a password (a 4-digit number code, e.g. 4321) can be set.

If the password is lost, the controller can be unlocked using the **master password 1976**.

When unlocking a password protected controller, it is possible to press a button for up to 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, 123 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 need 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 needs 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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CAUTION

Changing the main current transformer parameters or voltage transformer values subsequently can directly influence the capacitor stages for which the stage power was determined using the auto configuration mode. This is ensures 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 cos phi:

You can ask your electricity supplier for the target cos phi, which should be set up at this point. By default, the target cos phi is set to 0.95 inductive (see chapter "Default settings").

Setting the voltage transformer parameters:

Set 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: 400 V primary, 400 V secondary). If you use a voltage transformer, configure the parameters indicated on the voltage transformer, e.g. 690 V / 100 V, as well as the measuring mode, e.g. L12 for measuring voltage connection between 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. You can set the discharge time from 0 to 999 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 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 enter the power value individually for each stage.

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NOTE

If you cannot select the Learning mode menu item, check whether menu "On" is selected for "Learning mode" in the "Extras" menu.

If you want to **activate the learning mode**, make sure that **all previous sub-menu parameters** have been set correctly.

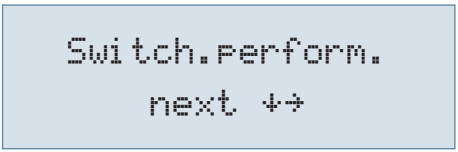
The learning mode is activated by pressing . Change to Yes by pressing and then to confirm.

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 sets the stage power automatically. However, this value has to be checked each time the learning process is completed.

8.7 Switching performance window:



Press ▼ to select submenus.

The settings for the switching performance by default (default settings) are displayed in the submenus of this window. These settings apply to most of the compensation systems.

NOTE

Check all parameters to ensure that there are no deviations from the specifications made for this system.

The following submenus are available to affect the switching performance:

- Hysteresis switch-on (default setting 100%, setting range 70 to 150%): This value defines the controller switch-on criterion. This means the controller would switch on at 100% missing compensation power relative to the smallest capacitor stage of the system.
- Hysteresis switch-off (default setting 100%, setting range 70 to 150%): This value defines the controller switch-off criterion. This means the controller would switch off at 100% overcompensation power relative to the smallest 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 **PFC too small** is displayed. If the set target cos phi is not reached, despite all available stages being 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).

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- 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 cos phi (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 Q_{miss} (default settings 2, setting range 0 to 9): This value defines the attenuation of the display and control behavior to prevent rapid parameter changes if there is no compensation power.
- Attenuation U (default settings 2, setting range 0 to 9): This value defines the display attenuation to prevent rapid parameter changes of the measuring voltage.
- Attenuation I (default settings 2, setting range 0 to 9): This value defines the display attenuation to prevent rapid parameter changes of the measuring current.

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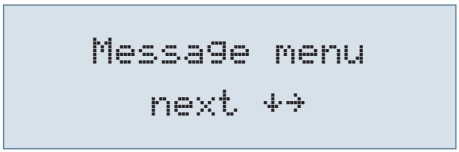
8.8 Error message window:



Press ▼ to select submenus.

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

The following error messages can be configured:

Alarm submenu	Possible actions			
	Off	Message	Alarm relay	Message and relay
No measuring voltage	✓	✓	✓	✓
No stage power	✓	✓	✓	✓
PFC too small	✓	✓	✓	✓
THD (voltage harmonics) too high	✓	✓	✓	✓
Operating cycle limit exceeded (contactor stages)	✓	✓	✓	✓
No measuring current	✓	✓	✓	✓
Low load operation	✓	✓	✓	✓
Temperature switch-off	✓	✓	✓	✓

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.

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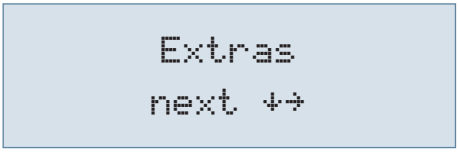
NOTE

The stage monitoring function (see **Extras** menu, **Monitor stage power** submenu) does not issue any messages, but marks the stages with an ⁜ (in the start menu window).

8.9 Extras window:



Press ▼ to select submenus.

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

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

The following submenus are available:

- User language:
  In this submenu, you can select the language for the LCD display (German, English, French or Spanish).
- THD limit:
  The harmonic switch-off limit refers to the total of all measuring voltage harmonics (Lim THD). The programming range lies between 0 and 10%. The setting can be adjusted in increments of 1 %. In addition, harmonics monitoring can also be disabled here (if the setting is Lim = 0%, limit monitoring is deactivated). If voltage harmonics exceed the limit, an error message is displayed and a stage switch-off is performed.
- Operating cycle limit:
  The limit of the capacitor contactor operating cycles is used as an indication to 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 merely used as a "maintenance instruction". If the setting is Lim = 0%, limit monitoring is deactivated but the operating cycle count is still activated.

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- Sampling rate:
  The power frequency tracing settings are displayed in this submenu. If the setting is "Auto", the sampling rate is traced automatically, within a range of 40 to 70 Hz. Alternatively, a fixed sampling rate of 50 Hz or 60 Hz can be set.
- Monitoring stage power:
  The monitoring of the stage power can be activated or deactivated in this submenu. Only stages the stage power of which has been recorded in the learning mode are monitored. The manually configured stage power 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, a check is performed to determine whether a change of current takes place in the main current transformer. If this is not the case, the stage is marked with an x in the start menu window. This may be for one of the following reasons and needs to be checked:
  - Capacitor faulty
  - Contactor faulty
  - Fuse faulty
- Reset:
  The Reset menu item offers various methods of resetting the programmed controller parameters. The programmable parameters are reset to the default settings. 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 shows **Reset** again

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.

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- Brightness setting:
  The LCD brightness can be changed in this submenu. Setting range: 0 to 9.

- Dimmer brightness:
  The LCD brightness reduction can be changed in this submenu. Setting range: 0 to 9. The brightness is reduced after a set time of 15 minutes.

- Low-load limit:
  In this submenu, the low-load detection limit can be changed to either 15 mA or 50 mA.

- Low-load delay:
  The low-load detection delay time can be changed in this submenu. It can be varied between 1 and 60 minutes.

- Fan relay:
  In this submenu, you can set the last stage relay (stage 6 or 12, depending on the device version) as a compensation stage relay or fan relay.

- Switching threshold for switching on fan:
  In this submenu, the switching threshold for switching on the fan relay can be changed to between 0°C and 70 °C.

- Switching threshold for switching off fan:
  In this submenu, the switching threshold for switching the fan relay off can be changed to between 0°C and 70 °C. To prevent unnecessary fan switching, a run-on time of 30 minutes is set.

- Switching threshold for system switch-off:
  In this submenu, the switching threshold for switching off the system can be changed to between 0°C and 70 °C.

- Switching threshold for system switch-on:
  In this submenu, the switching threshold for switching on the system can be changed to between 0°C and 70 °C.

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- Bus mode:
  In this submenu, the bus protocol of the device can be set to KBR eBus or Modbus RTU. If Modbus RTU is selected, you can set the transmission parameters now. The supported transmission parameters are:

Baud rate (Baud)	4800, 9600, 19200, 38400
Parity	even, odd, none
Data bits	8
Stop bits	1 for even and odd, 2 for Parity none
	The KBR eBus setting is used for testing purposes.

- Learning mode:
  In this submenu, you can show or hide the submenu item "Activate learning mode" (in the Commissioning menu).

- Key sounds:
  In this submenu, you can turn the key sounds (which sound if a sensor button is pushed) on or off.

- Delete EEP:
  For production purposes only.

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9 Notes on troubleshooting

Undercompensation, not enough stages are switched on:

Check controller for error messages If the target cos φ 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.

Check the system's main fuse and group fuses. All values are entered in the enclosed documents.

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.

Undercompensation, all stages are switched on:

The existing system is not sufficient (e.g. due to new inductive consumers). Please contact your local representative (enlarge your system). The service telephone number is given on the cover of these operating instructions.

Overcompensation, too many stages are switched on:

Check controller settings (target cos φ capacitive?).
Is the 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 a small stage on permanently.

NOTE

If the cause of the error cannot be found, please call your local representative. The phone number is given on the cover of this manual.

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10 System and safety device maintenance

In order to ensure proper functioning and a long service life of your system, perform the following checks after commissioning the system and then on an annual basis.

- 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 sparking.
- Check the control performance in automatic mode.
- Check the cooling air setting (fans, temperature monitoring function):
- Check if the controller temperature relay switches the fans on at 28 °C.
- Check if the temperature monitoring switches the system off via controller at 48 °C.
- Clean the filter mats if necessary, depending on how dirty they are.
- Perform a visual inspection of the capacitors.
- Examine the current input and capacitor terminal voltage once every three months.
- Check the reactive energy consumption by looking at the electricity bill.

NOTE

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

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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 configuration
	Units	[V; kV;] display is switched automatically
	Display range	0.00 kV to 99.9 kV
	Measuring range	30 - 690 VAC (max. permissible value: 790 VAC)
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 A (max. permissible value: 6 A)
Frequency	Network frequency measurement	$f_{Network}$
	Units	[Hz]
	Measuring range	41 - 70 Hz
Apparent power	Calculation	S_{tot}, 3-phase
	Units	kVA
	Display range	0.0 VA to 9999.9 kVA
Active power	Calculation	P_{total}; 3-phase
	Units	kW
	Display 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.
Temperature	Measuring range	-10 °C to +60 °C
Harmonics	Distortion factor (THD) for voltage	Voltage: THD-U
	Partial distortion factors	3^{rd}; 5^{th}; 7^{th}; 9^{th}; 11^{th}; 13^{th}; voltage harmonic
	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
Temperature	± 2 °C / ± 1 digit

11.3 Measuring principle

Sampling	128 readings per period
A/D converter	12 bit
Measurement of V and I	Simultaneous recording of U and I readings
Measuring cycle	20 ms
Harmonics calculation	FFT with 128 points over one period
Frequency measurement	Consumption: Voltage measurement between phase Lx - N / Ly)
Temperature sensor	Analog measurement with PT 1000

11.4 Device memory

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

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	100-240V +/- 10% DC/50/60 HZ

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11.7 Hardware inputs and outputs

11.7.1 Hardware inputs

Voltage measuring input	U_{PH-N} or U_{PH-PH}	30 - 690 VAC (max. permissible value: 790 VAC)
	Input impedance	750 kOhm
	Measuring range	1 measuring range, measuring voltage transformer can be configured
Current measuring input	I_{L1} or I_{L2} or I_{L3}	0.015 - 5 A (max. permissible value: 6 A)
	Power consumption	0.3 VA at 6 A, 0.05 VA at 1.2 A
	Measuring range	1 measuring range, current transformer can be configured
Analog input	PT 1000 measurement sensor	Temperature measurement -10 °C to 60 °C, +/- 2 °C max. length of connecting cables < 3 meters

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
Serial interface	BUS	RS485 for connection to the Modbus
	Protocol, baud rate	Modbus RTU; baud rate 4800, 9600, 19200; 38400 Parity none, even, odd
	Addressing	Modbus: manual on the device, address 1 to 247

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11.8 Electrical connection

Connection elements		Plug terminals
Permissible cross section of the connection lines		2.5 mm²
Measuring 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 supply voltage	Fuse protection	max. 6 A
BUS connection	Connection material	To ensure proper operation, only use shielded twisted-pair cables; e.g. I-Y(St)Y EIB 2x2x0.8
Relay output	Fuse protection	max 2 A medium time-lag
Transformer connection	Connections	See wiring diagram
Interface connection	Pins for BUS connection via RS-485	Terminal 90 ⊥ Terminal 91 A Terminal 92 B

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11.9 Mechanical data

Switchboard installation	Housing dimensions	144 x 144 x 60 mm (H x W x D),
	Installation cut-out	138 x 138 mm
	Weight	Approx. 650g

11.10 Standards and miscellaneous

Ambient conditions	Standards	DIN EN 60721-3-3:1995-09 + DIN EN 60721-3-3/A2:1997-07; 3K5+3Z11; (IEC721-3-3;3K5+3Z11)
	Operating temperature	-5 °C -.+55 °C
	Humidity	5% - 95% non-condensing
	Storage temperature	-25°C -.+70°C
	Operating altitude	up to max. 2000 m above sea level
Electrical safety	Standards	DIN EN 61010-1:2011-07; DIN EN 61010-2-030:2011-07
	Protection class	I
	Overvoltage category, measurement category	III
Protection type	Standards	DIN EN 60529:2014-09
	Front	IP 51 (with optional front door max. IP 54)
	Terminals	IP 20
EMC	Standards	DIN EN 61000-6-2:2006-03 + amendment 1:2011-06 DIN EN 61000-6-3:2011-09 + amendment 1:2012-11

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12 Selection of cables and fuses

C power (400 V) Q (kvar)	Current consumption I (A) per phase	Supply cable 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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13 Data point description for the Modbus protocol

multicomp F144-3

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13.1 Supported Modbus commands

0x04	Read input registers
0x2B	Read device identification

The multicomp F144-3 does not support broadcast commands. All Modbus commands described are device-specific commands.

13.2 Data formats

(unsigned) short: 0x1234

Address	+0	+1		
Contents	0x12	0x34		

Rule for byte sequence: MSB before LSB

(unsigned) long: 0x12345678

Address	+0	+1	+2	+3
Contents	0x12	0x34	0x56	0x78

Rule for byte sequence: MSB before LSB

float:

Format	corresponds to the IEEE 754 standard
Representation	4 bytes
Accuracy	24 bits (➢ represent >7 decimal points)
Composition	24-bit mantissa; 8-bit exponent
Mantissa	24 bits (M) + 1 bit (S)
Exponent	The MSB of the mantissa is always 1 => it is not saved separately! S = sign of the mantissa: S = 1 ➢ negative number; S = 0 ➢ positive number
Exponent	8 bits (0-255); is saved relatively to 127, i.e. the current value of the exponent is calculated by subtracting the number 127 from the saved value. Curr. exp. = saved exp value. – 127 => range from 128 to -127!

Example 1: -12.5 decimal = 0xC1480000 hex
M: 24 bit-mantissa
E: Exponent with offset of 127
S: Sign for mantissa (S=1 neg.; S=0 pos.)

Address	+0	+1	+2	+3
Format	SEEEEEEE	EMMMMMMM	MMMMMMMM	MMMMMMMM
Binary	1 1 0 0 0 0 0 1	0 1 0 0 1 0 0 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0
Hex	C1	48	00	00

The byte sequence is defined as follows:
The byte with the "S sign bit" is transmitted as the first byte over the bus.
The sequence of the float bytes of the bus can be reversed, if necessary, using the device parameter 0xD02C (see table 1).
The register value 0xD02C in this case means:

- with 1 -> sign bit S in 1st byte (sequence as defined)
- with 0 -> sign bit S in 4th byte (sequence reversed)

The following information can be derived from this:
The sign bit is 1 => negative mantissa
The value of the exponent amounts to 10000010 bin or 130 dec.
This results in an exponent value of: 130 - 127 = 3
The mantissa has the following value: 10010000000000000000000
The decimal point can be found at the left end of the mantissa, preceded by a 1. This position does not appear in the hexadecimal numeric notation. If you add 1 and set the decimal point at the beginning of the mantissa, the following value is obtained:
1.10010000000000000000000
Now, the mantissa needs to be adjusted to the exponent. A negative exponent shifts the decimal point to the left, a positive exponent shifts it to the right. Since the exponent is 3, this appears in our representation as:
1100.10000000000000000000
The number obtained corresponds to the binary floating-point number.
Binary digits to the left of the decimal point result in values > 1. In this example, 1100 bin yields the number 12 dec. {(1x23)+ (1x22)+ (0x21)+ (0x20)}
Binary digits to the right of the decimal point result in values < 1. In this example, .100..... bin results in the number 0.5 dec. {(1x2-1)+ (0x2-2)+ (0x2-3)+ (0x2-4)}
By adding the individual values, 12.5 is obtained. As the sign bit was set, it is a negative value, -12.5. The hexadecimal number 0xC1480000 thus corresponds to -12.5.

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Example 2: -12.55155 decimal = 0xC148D325 hex

Address	+0	+1	+2	+3
Format	SEEEEEEE	EMMMMMMM	MMMMMMMM	MMMMMMMM
Binary	1 1 0 0 0 0 0 1	0 1 0 0 1 0 0 0	1 1 0 1 0 0 1 1	0 0 1 0 0 1 0 1
Hex	C1	48	D3	25

Example 3: 45.354 decimal = 0x42356A7F hex

Address	+0	+1	+2	+3
Format	SEEEEEEE	EMMMMMMM	MMMMMMMM	MMMMMMMM
Binary	0 1 0 0 0 0 1 0	0 0 1 1 0 1 0 1	0 1 1 0 1 0 1 0	0 1 1 1 1 1 1 1
Hex	42	35	6A	7F

Exponent: 10000100 bin = 132 dec.

- Exp.= 132-127=5

Mantissa: S=0

- Sign=positive

01101010110101001111111 bin

Decimal point added to the first position of the mantissa

- 01101010110101001111111

Leading 1 in front of the decimal point

- 1. 01101010110101001111111

Taking the exponent into account (=5)

- 101101. 010110101001111111

to the left of the decimal point: 101101 bin = 25+ 23+ 22+20 = 45 dec.

To the right of the decimal point: 010110101001111111 bin =

2-2 + 2-4 + 2-5 + 2-7 + 2-9 + 2-12 + 2-13 + 2-14 + 2-15 + 2-16 + 2-17 + 2-18 = 0.3540001 dec

Final result: +45.03540001 dec.

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13.3 Interface parameters

Baud rate (Baud)	Parity	Data bits	Stop bits
4800,9600,19200, 38400	even, odd, none	8	2 for parity none, otherwise 1

The maximum data length of a Modbus transmission is 256 bytes. This results in a user data length of 253 bytes.

The number of data bits and stop bits is defined in the Modbus definition. Baud rates of less than 4800 baud are possible by definition, but not implemented at the moment. The interface parameters can only be configured on the device (not via bus).

13.4 Device settings

The settings are read with the 0x04 command (read input registers) in accordance with table 1. Writing is not possible at present.

Address	Words	Description	Value	Format
0xD002	2	Primary transformer measuring voltage	0 - 999999 V	float
0xD004	2	Secondary transformer measuring voltage	0 - 999 V	float
0xD006	2	Primary transformer measuring current	0 - 999999 A	float
0xD008	2	Secondary transformer measuring current	1 A / 5 A	float
0xD00 A	2	Target CosPhi 1	-1.0 - +1.0	float
0xD00C	2			float
0xD00E	2	Target CosPhi for energy recovery (fixed setting)	-1.0 - +1.0	float
0xD010	2	Target CosPhi for message “PFC too small”	-1.0 - +1.0	float
0xD012	2	Connected phase voltage measurement	0=L1N // 1=L2N // 2=L3N // 4=L12 // 5=L23 // 6=L31	unsigned long
0xD014	2	Connected phase current measurement	0=L1 // 1=L2 // 2=L3 // 3=-L1 // 4=-L2 // 5=-L3	unsigned long
0xD016	2			
0xD018	2			
0xD01a	2			
0xD01c	2			
0xD01e	2	General		

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Address	Words	Description	Value	Format
0xD020	2	Byte sequence for float on the Modbus (1=as defined // 0=reversed)	0-1	unsigned long
0xD022	2	Frequency correction (0=Auto // 1=50 Hz // 2=60 Hz)	0-2	unsigned long
0xD024	2	Stage monitoring (0=No, 1=Yes)	0/1	unsigned long
0xD026	2	Temperature measurement (1=Yes // 0=No)	0/1	unsigned long
0xD028	2	Fan relay (1=available // 0=not available)	0/1	unsigned long
0xD02a	2	Temperature [0.1 °C] that triggers the fan when exceeded	0-700	unsigned long
0xD02c	2	Temperature [0.1 °C] that causes the fan to switch off when the value falls below the limit	0-700	unsigned long
0xD02e	2	Temperature [0.1 °C] that triggers the stages when the value falls below the limit	0-700	unsigned long
0xD030	2	Temperature [0.1 °C] that causes the stages to switch off when exceeded	0-700	unsigned long
0xD032	2			
0xD034	2			
0xD036	2			
0xD038	2			
0xD03A	2			
0xD03C	2			
0xD03E	2			
0xD040	2	Switching performance		
0xD042	2	Percentage of smallest available stage before activation	70-150	unsigned long
0xD044	2	Percentage of smallest available stage before stages can be switched off	70-150	unsigned long
0xD046	2	Time before message "PFC too small" is displayed [s]	3-3000	unsigned long
0xD048	2	Idle time after compensation [s]	0-300	unsigned long
0xD04A	2			unsigned long
0xD04C	2	Switching interval [s]	0-10	unsigned long

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Address	Words	Description	Value	Format
0xD04E	2			unsigned long
0xD050	2			unsigned long
0xD052	2	Attenuation coefficient for voltage	0-9	unsigned long
0xD054	2	Attenuation coefficient for current	0-9	unsigned long
0xD056	2	Attenuation coefficient Q_{miss}	0-9	unsigned long
0xD058	2			
0xd05A	2			
0xD05C	2			
0xD05E	2			
0xD060	2	Extras		
0xD062	2	Limit for operating cycle message	0-999999	unsigned long
0xD064	2	Low-load limit [A]	0.015 or 0.05	float
0xD066	2	Time until low-load switch-off in minutes	1-60	unsigned long
0xD068	2			unsigned long
0xD06A	2	Voltage harmonic limit [%]	0-10	unsigned long
0xD06C	2			unsigned long
0xD06E	2	Modbus address	1-247	unsigned long
0xD070	2	Modbus parameters (0=e4800 // 1=o4800 // 2=n4800 // 3=e9600 // 4=o9600 // 5=n9600 // 6=e19200 // 7=o19200 // 8=n19200 // 9=e38400 // 10=o38400 // 11=n38400)	0-11	unsigned long
0xD072	2			
0xD074	2			
0xD076	2			
0xD078	2			
0xD07A	2			
0xD07C	2			

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Address	Words	Description	Value	Format
0xD07E	2	Stage parameters		
0xD080	2	Base index for the following stage parameters (addresses 0xD080 to 0xD08E)	0 (= stage 1)	unsigned long
0xD082	2	Mode	0 = Off // 1 = Auto 2 = On	unsigned long
0xD084	2	Stage power [0.1 kvar]	0-9999	unsigned long
0xD086	2	Discharge time [s]	0-999	unsigned long
0xD088	2	Operating cycles	0-999999	unsigned long
0xD08A	2		0	unsigned long
0xD08C	2		0	unsigned long
0xD08E	2		0	unsigned long
0xD090	2	Base index for the following stage parameters (addresses 0xD090 to 0xD09E)	1 (= stage 2)	unsigned long
0xD09E	2		0	unsigned long
0xD0A0	2	Base index for the following stage parameters (addresses 0xD0A0 to 0xD0AE)	2 (= stage 3)	unsigned long
0xD0AE	2		0	unsigned long
0xD0B0	2	Base index for the following stage parameters (addresses 0xD0B0 to 0xD0BE)	3 (= stage 4)	unsigned long
0xD0BE	2		0	unsigned long

Address	Words	Description	Value	Format
0xD0C0	2	Base index for the following stage parameters (addresses 0xD0C0 to 0xD0CE)	4 (= stage 5)	unsigned long
0xD0CE	2		0	unsigned long
0xD0D0	2	Base index for the following stage parameters (addresses 0xD0D0 to 0xD0DE)	5 (= stage 6)	unsigned long
0xD0DE	2		0	unsigned long
0xD0E0	2	Base index for the following stage parameters (addresses 0xD0E0 to 0xD0EE)	6 (= stage 7)	unsigned long
0xD0EE	2		0	unsigned long
0xD0F0	2	Base index for the following stage parameters (addresses 0xD0F0 to 0xD0FE)	7 (= stage 8)	unsigned long
0xD0FE	2		0	unsigned long
0xD100	2	Base index for the following stage parameters (addresses 0xD100 to 0xD10E)	8 (= stage 9)	unsigned long
0xD10E	2		0	unsigned long
0xD110	2	Base index for the following stage parameters (addresses 0xD110 to 0xD11E)	9 (= stage 10)	unsigned long

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Address	Words	Description	Value	Format
0xD11E	2		0	unsigned long
0xD120	2	Base index for the following stage parameters (addresses 0xD120 to 0xD12E)	10 (= stage 11)	unsigned long
0xD12E	2		0	unsigned long
0xD130	2	Base index for the following stage parameters (addresses 0xD130 to 0xD13E)	11 (= stage 12)	unsigned long
0xD13E	2		0	unsigned long

Request:
01 04 D0 01 00 02 xx xx
in which

01	Device address
04	Command
D0 01	Read from register 0xD002 "Measuring voltage primary transformer" (in accordance with the Modbus definition, the required address must be set to -1 in the request telex)
00 02	Read 2 registers, i.e. read 1 data point
xx xx	CRC code

Response:
01 04 04 xx xx xx xx yy yy
in which

01	Device address	
04	Command	
04	4 data bytes	
xx xx xx xx	Measuring voltage primary transformer	400V
yy yy	CRC code	

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13.5 Data points

Address	Words	Description	Unit	Format
0x0002	2	Voltage	V	float
0x0004	2	Current	A	float
0x0006	2	Network frequency	Hz	float
0x0008	2	Current CosPhi		float
0x000a	2	Active power	W	float
0x000c	2	Fundamental reactive power	var	float
0x000e	2	Missing compensation power	var	float
0x0010	2	Apparent power	VA	float
0x0012	2	THD	%	float
0x0014	2	Temperature	°C	float
0x0016	2	Overtemperature switch-off		float
0x0018	2	Voltage 3rd harmonic	%	float
0x001a	2	Voltage 5th harmonic	%	float
0x001c	2	Voltage 7th harmonic	%	float
0x001e	2	Voltage 9th harmonic	%	float
0x0020	2	Voltage 11th harmonic	%	float
0x0022	2	Voltage 13th harmonic	%	float
0x0024	2	Maximum missing compensation power	var	float
0x0026	2	Relay states (12 bit: bit 0 = stage 1 - bit 11 = stage 12 // bit 13 = error message)	bitwise	unsigned long
0x0028	2	Messages (bit coded)		unsigned long
0x002a	2	Error messages (bit coded)		unsigned long

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Messages:	**Bit 00 set:**	**No stage power**
(display)	Bit 01 set:	System temperature switch-off
	Bit 02 set:	No measuring current
	Bit 03 set:	No measuring voltage
	Bit 04 set:	Low load operation
	Bit 05 set:	Voltage harmonics limit reached
	Bit 06 set:	Operating cycle limit reached
	Bit 07 set:	PFC too small

Error messages:	**Bit 00 set:**	**No stage power**
(relay set)	Bit 01 set:	System temperature switch-off
	Bit 02 set:	No measuring current
	Bit 03 set:	No measuring voltage
	Bit 04 set:	Low load operation
	Bit 05 set:	Voltage harmonics limit reached
	Bit 06 set:	Operating cycle limit reached
	Bit 07 set:	PFC too small

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Example Modbus RTU
Request:
01 04 00 1F 00 32 40 19
where

01	Device address
04	Command
00 01	Read voltage from register 0x0002 (in accordance with Modbus definition, the required address must be set to -1 in the request telex)
00 26	Read 38 registers, i.e. read 19 data points
40 19	CRC code

Response:

01 04 64 xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx
xx xx xx xx xx xx xx
xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx
xx xx xx xx xx xx xx
xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx
xx xx xx yy yy
where

01	Device address	
04	Command	
4C	76 data bytes	
xx xx xx xx	Voltage	xx V
xx xx xx xx	Current	xx A
xx xx xx xx	Network frequency	xx Hz
xx xx xx xx	Current CosPhi	xx
xx xx xx xx	Active power	xx W
xx xx xx xx	Fundamental reactive power	xx var
xx xx xx xx	Missing compensation power	xx var
xx xx xx xx	Apparent power	xx VA
xx xx xx xx	THD	xx %
xx xx xx xx	Temperature	xx °C
xx xx xx xx	Overtemperature switch-off	xx
xx xx xx xx	Voltage 3rd harmonic	xx %
xx xx xx xx	Voltage 5rd harmonic	xx %
xx xx xx xx	Voltage 7rd harmonic	xx %
xx xx xx xx	Voltage 9rd harmonic	xx %
xx xx xx xx	Voltage 11rd harmonic	xx %

xx xx xx xx	Voltage 13rd harmonic	xx %
xx xx xx xx	Maximum missing compensation power	xx var
xx xx xx xx	Relay states (12 bit: bit 0 = stage 1 - bit 11 = stage 12 // bit 13 = error message)	xx
yy yy	CRC code	

13.6 Device information

The device information is read via the command 0x2B (Read Device Identification)

Information about the manufacturer, device code and device version is read in the process. The device supplies the "Basic Device Identification". "Regular" and "Extended Device Identification" are optional according to the Modbus definition.

Example Modbus RTU
Request:
01 2B 0E 01 00 70 77
in which

01	Device address
2B	Command
0E	MEI type according to the Modbus definition always 0x0E
01	Device ID Code for "Basic Device Identification" (see Modbus definition)
00	Object ID -> in our example manufacturer name, product name and version
70 77	CRC code

Response:

01 2B 0E 01 01 00 00 03 00 08 4B 42 52 20 47 6D 62 48 01 12 4D 75 6C 74 69 6D 65 73 73 20 43 6F 6D 66
6F 72 74 02 09 20 32 2E 30 30 72 31 30 30 yy yy

01	Device address
2B	Command
0E	MEI type (see Modbus definition)
01	"Basic identification" (see Modbus definition)
01	"Conformity level" (see Modbus definition)
00	No further information follows (no additional telex required)
00	Next object ID
03	Number of objects
00	Object ID 00
08	Length of the text of ID 00
4B 42 52 20 47 6D 62 48	"KBR GmbH"
01	Object ID 01
12	Length of the text of ID 01
6D 75 6C 74 69 63 6F 6D 70 20 46 31 34 34 1D 33 20 20	"multicomp F144-3"
02	Object ID 02
09	Length of the text of ID 02
20 32 2E 30 30 72 31 30 30	"2.00r100"
yy yy	CRC code

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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

21719_EDEBDA0235-3517-2_EN