KBR Energy Management

User manual
Technical Parameters

4-quadrant controller

multicomp
F144-MS-1V1C1TI6RO6DO-3

System | English

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You can find the instructions for your KBR device at our download center.

https://www.kbr.de/de/dienstleistungen/download-center

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1 Introduction

Thank you for choosing this KBR quality product.

To become familiar with the operation and programming of the device and to use the full range of functions of this high-quality product at all times, you should read this user manual carefully.

The individual chapters explain the technical details of the device and show how damage can be avoided through proper installation and commissioning.

1.1 User manual

This user manual describes the device version multicomp F144-3. This user manual 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 writing this user manual, errors may still occur. We would be very grateful if you would notify us of any errors or unclear descriptions you may notice.

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1.2 Safety keys

This manual contains instructions that you must follow for your personal safety and to avoid material damage. These instructions are identified by a warning sign or information symbol, depending on the degree of hazard they warn about.

DANGEROUS VOLTAGE

„Warning“ means that death, major injuries or damage may occur if suitable safety precautions are not taken.

CAUTION

„Caution“ means that minor injuries or damage may occur if the appropriate safety precautions are not taken.

NOTE

„Note“ is an important piece of information on the product, its operation or the respective part of the operating instructions to which special reference is being made.

Disclaimer

The contents of these operating instructions have been carefully reviewed in terms of the hardware and software described. Nonetheless, deviations cannot be ruled out, and the manufacturer cannot guarantee 100% conformity. The specifications made in these operating instructions are reviewed on a regular basis; any corrections required will be included in the next revision.

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1.3 Safety notes

In order to prevent operating errors, device operation is kept as simple as possible. This will enable you to start your device up quickly.

It is in your own interest to read the following safety instructions carefully. 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 applicable standards and regulations.

To prevent fire and electric shock, do not expose the device 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.

CAUTION

Incorrectly connecting the device can damage it.

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!

Proper and safe operation of the product requires correct transport, storage, installation and assembly as well as careful operation and maintenance.

If the device has any visible damage it is considered unfit for use and must be disconnected from the power supply!

Troubleshooting, repairs and maintenance work may only be carried out at our plant or after contacting our customer service team. If the device is opened without authorization, any warranty or guarantee claim is forfeited. Correct functioning 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 power 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.

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1.4 Product liability

You have purchased a high-quality product. Only top-quality components with exceptional reliability are used.

Each device undergoes a long-term test before delivery.

With regard to product liability, please see our general terms and conditions for electronic devices, which you can read at www.kbr.de.

The warranty on device characteristics only applies if the device is operated in accordance with its intended use!

1.5 Disposal

Please dispose of defective, out-of-date or no longer used devices properly.

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

1.6 Overvoltage and lightning protection

To protect your purchased high-quality devices from damage, we strongly recommend that you take overvoltage protection measures. Protect control voltage inputs, pulse and bus lines.

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2 Functional Principle of the Controller

The multicomp F144-1V1C6DO6RO- 3 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 entire plant by measuring transformer inputs (A/D converter) and, on the basis of this, calculates the active and reactive power ratio of the mains. 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 optimum adjustment. Even for large systems, sensitive controls can be set up with just a few modules. Stage ratios do not need to be considered. After compensation, switching operations are interrupted for a configurable time. To prevent alternating switching operations, you can increase the stage switch-off delay by up to 150% of the smallest stage's 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.

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

The integrated temperature measurement input monitors the temperature in the reac-

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tive power compensation system and causes the fan to be switched on if a predefined temperature threshold is exceeded and switched off again when the temperature drops below the reset temperature.

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

You can also protect the system by defining a switch-off temperature. This makes it possible to switch stages off in time if there is a risk of damage due to overheating. Once the temperature drops below the reset temperature, the stages are switched on again one after the other.

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 used to record 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. The alarm relay switches and "Overvoltage" is displayed.

CAUTION

The discharge times are automatically predefined, **in the capacitor contactor stage**, 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

A discharge time changed later on is retained however, as long as the stage power is not changed.

In the thyristor stages, irrespective of the stage power, the discharge time is always entered as 20 milliseconds, both when reprogramming and when changing the stage power.

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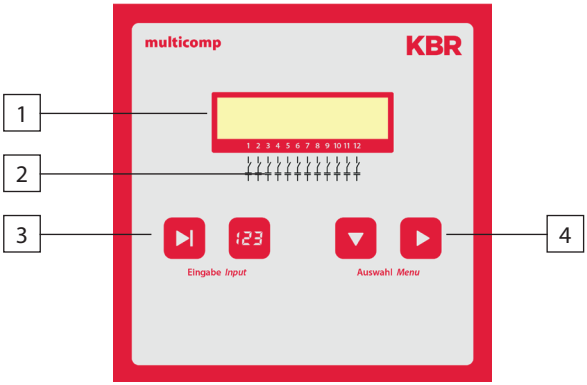
3 Control and Display Panel

multicomp F144-3 hybrid 6RO-6DO



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	Navigate through submenus
	Navigate through main menus and save button during configuration

Button combinations:

and buttons	Delete accumulated values and reset the system

Default controller settings after reset:

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 230 V Ph-N) Secondary voltage 400 V Ph-Ph (corresponds to 230 V Ph-N)
Rot. field U:	L1-N
Rot. field I:	L1
Current attenuation coefficient:	0
Voltage attenuation coefficient:	0
Attenuation coefficient Qmiss:	0
Alarm delay:	20 minutes (1200 s)
Thyristor idle time	30 msec.
Contactor idle time	30 sec.
Thyristor switching interval:	50 ms
Contactor switching interval	8 sec.
Hysteresis connection:	100% of lowest stage power
Hysteresis switch-off:	100% of lowest stage power
Switching performance Priority	Operation cycles, 24hours Switching off
Operating cycle limit:	80000
Operating cycle count:	Activated by set limit

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■ Stage switching mode:	Automatic
■ Sampling rate:	Automatic
■ Harmonics monitoring:	Activated by set limit
■ Limit THD:	8%
■ Stage power:	Not set
■ Max. stage pow. per switch. cycle	0 kVar
■ Thyristor discharge time:	20 ms
■ Contactor discharge time:	180 sec.
■ Password:	No password (9999, meaning all functions are accessible)
■ Language display:	English
■ Contrast setting:	4
■ Brightness setting:	5
■ Dimmer brightness:	0
■ Low load limit:	15 mA
■ Low load delay:	60 minutes
■ Temperature measurement:	On
■ Output 12 as stage or fan:	Fan
■ Alarm relay as error message or fan:	Error message
■ 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
Facility 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

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The controls in the compensation systems are preset.

- The following parameters 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.
Performing a "Reset to default settings" has no effect on changed settings.

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4 Setting Range of the Configurable Parameters:

Stage state:

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 changed)
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
Thyristor stage discharge time	0 to 9999 ms
Contactor stage discharge time	0 to 900 seconds

Switching performance:

Hysteresis connection	70 to 150 %
Hysteresis switch-off	70 to 150 %
Switching performance Priority	Operation cycles, runtime
Alarm relay time	3 to 3000 sec.
Thyristor stage idle time	20 to 9999 ms
Contactor stage idle time	0 to 300 seconds
Thyristor stage switching interval	50 to 9999 ms
Contactor stage switching interval	0 to 10 seconds
FTS alarm cosφ	ind. 0.70 to 1.0
Attenuation coefficient Q_{miss}	0 to 9
Attenuation coefficient voltage	0 to 9
Attenuation coefficient current	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
Facility too small	Alarm relay or Off
THD too high	is identical for all errors!
Operating cycle limit exceeded	
No measuring current	
Light load	
Temperature switch-off	

Extras:

Display language	German, English, French, Spanish
THD limit	0 to 10%, harmonics monitoring can be disabled (0%)
Sampling rate	Automatic, fixed 50 Hz, fixed 60 Hz
Reset	Run
Contrast setting	0 to 10
Brightness setting	0 to 9
Dimmer brightness	0 to 9
Low-load limit	15 mA, 50 mA
Light load delay	1 minute to 60 minutes
Temperature measurement	On / Off
Output 12	Compensation stage, fan relay
Alarm relay Error message, fan relay	
Fan switch on temperature	> 0 °C to 60 °C
Fan switch off temperature	< 0 °C to 60 °C
Switching threshold system off	> 0 °C to 60 °C
System switch on temperature	< 0 °C to 60 °C
Bus mode	Modbus (eBus for production)
Learning mode menu display	On / Off
Key sounds	On / Off

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5 Installation and Electrical Connection of the System

5.1 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's regulations.
- Connection cross-sections and fuse protection table: see attachment

5.2 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 unbalanced phase load (small systems), 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
- Connect S2 (l) to terminal l (controller terminal 21) 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 you use existing transformers, the current paths must always be connected in series.

The secondary transformer current needs to be at least 15 mA. For lower currents, no capacitors are connected ("No measuring current" is displayed).

Connect the measuring voltage in accordance with the connection diagram.

5.3 Current transformer dimensions

The current transformer is designed on the basis of the current consumption of the consumers, 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 cable that need to be considered if there are long distances between the transformer and the controller.

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5.4 Standard connection diagram

NOTE

The stage outputs 1 to 6 are optocoupler outputs. External voltage supply Terminal input 40 max. 30 VDC
(rated voltage 24 VDC), max. 35 mA.

When connecting the phase (L1) to terminal 1 and the neutral conductor (N) to terminal 2 (Ph-N 100V – 240V+//10 % 50Hz/ 60 Hz/DC) the safety device and the disconnector in the supply line to terminal 2 (N) are not required.

The safety device and the disconnector to terminal 2 (N) are only required for the following connection variants:

Alternating voltage:

Terminal 1 (L1) and terminal 2 (L2):

US1 Phase-Phase 100V - 240V +/-10% 50Hz/60 Hz

Direct voltage:

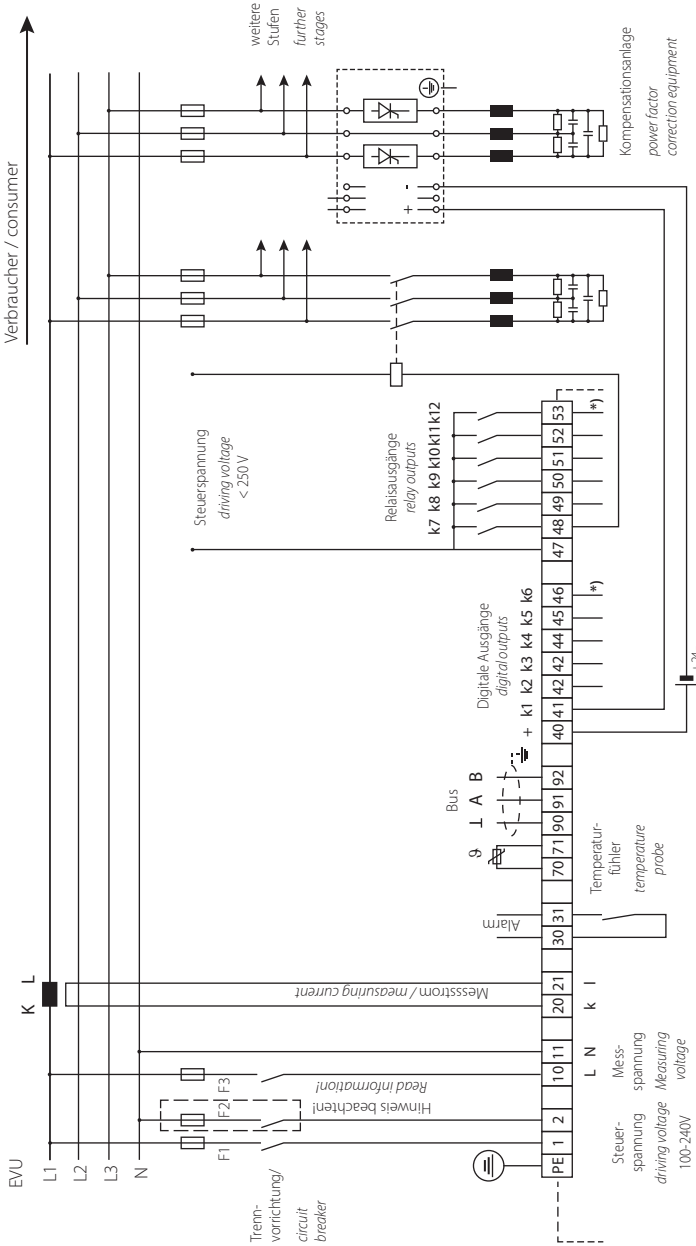
Terminal 1 (+) and terminal 2 (-):

US1 100V - 240V +/-10% DC

Connection variants of the power supply

Terminal 1	Terminal 2	Voltage Power supply unit US1	Safety device and disconnector to Terminal 2 required
Phase L	Neutral conductor N	100V - 240V +/-10% AC 50/60 Hz	No
Phase L1	Phase L2	100V - 240V +/-10% AC 50/60 Hz	yes
+	-	100V - 240V +/-10% DC	yes

5.5 Measuring voltage connection Ph-N



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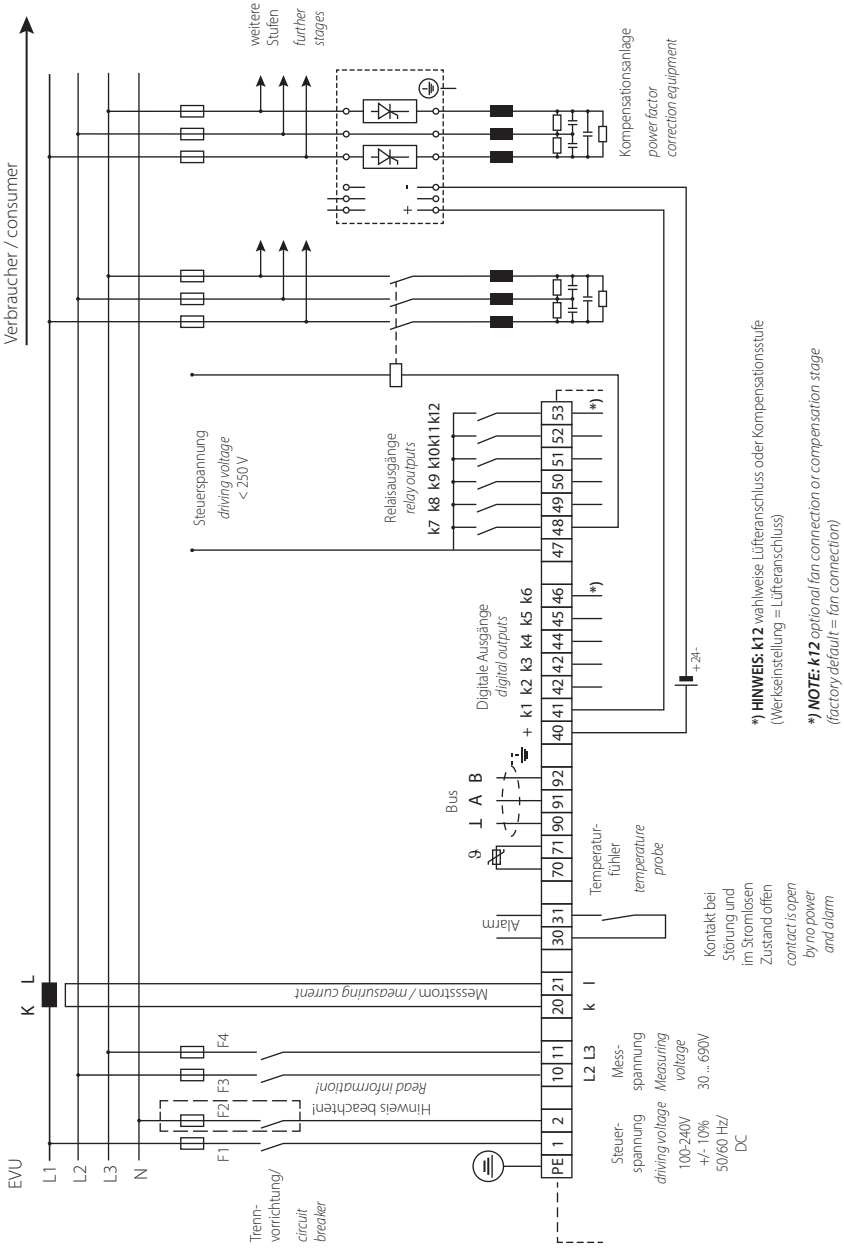
5.6 Measuring voltage connection Ph-Ph



6 Commissioning the System

6.1 General Notes on Commissioning

Compensation unit with controller

The controller is configured as a compensation system component (see connection diagram) by default. The following settings 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.
- If required, set the measuring voltage transformer data.
- 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 "Learning mode activate" 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 error message "No transformer current" will be displayed.

Check the transformer connection (is the transformer ratio too high?).

- If all connection conditions are OK, the instantaneous power factor cos phi should be displayed 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).

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

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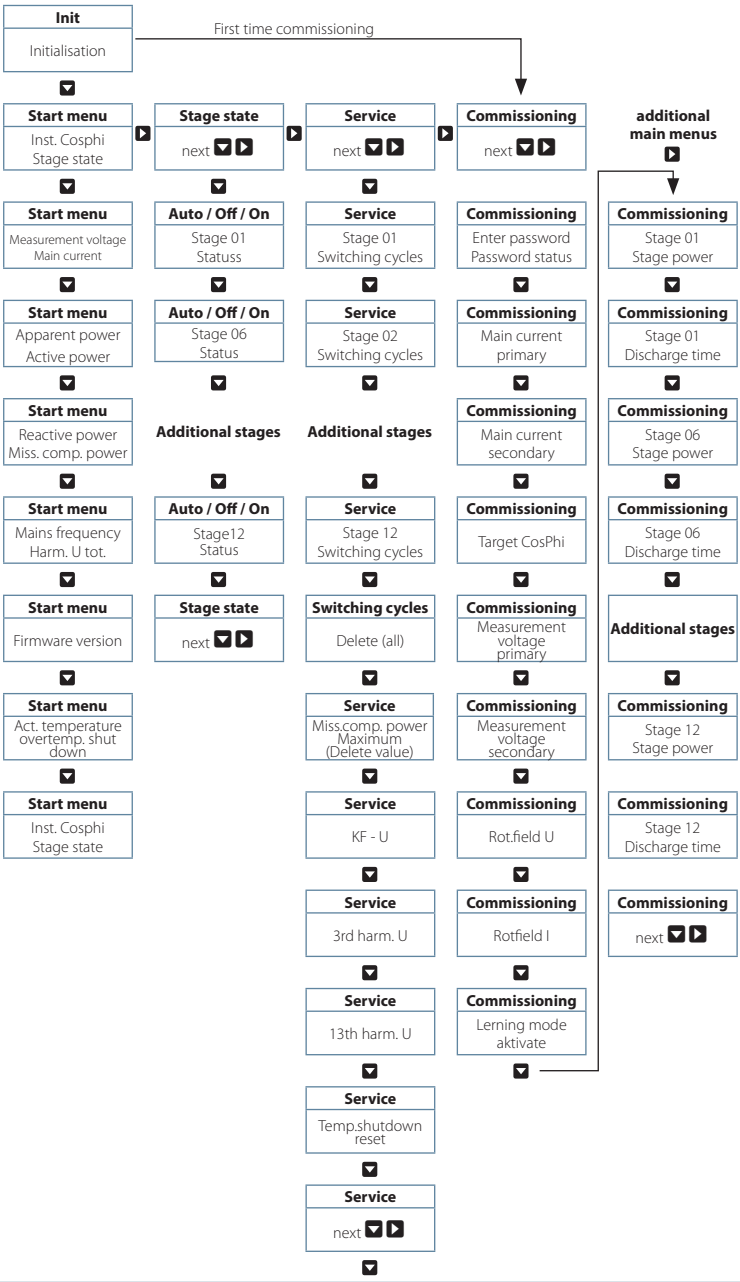
7 Navigation and Device Displays



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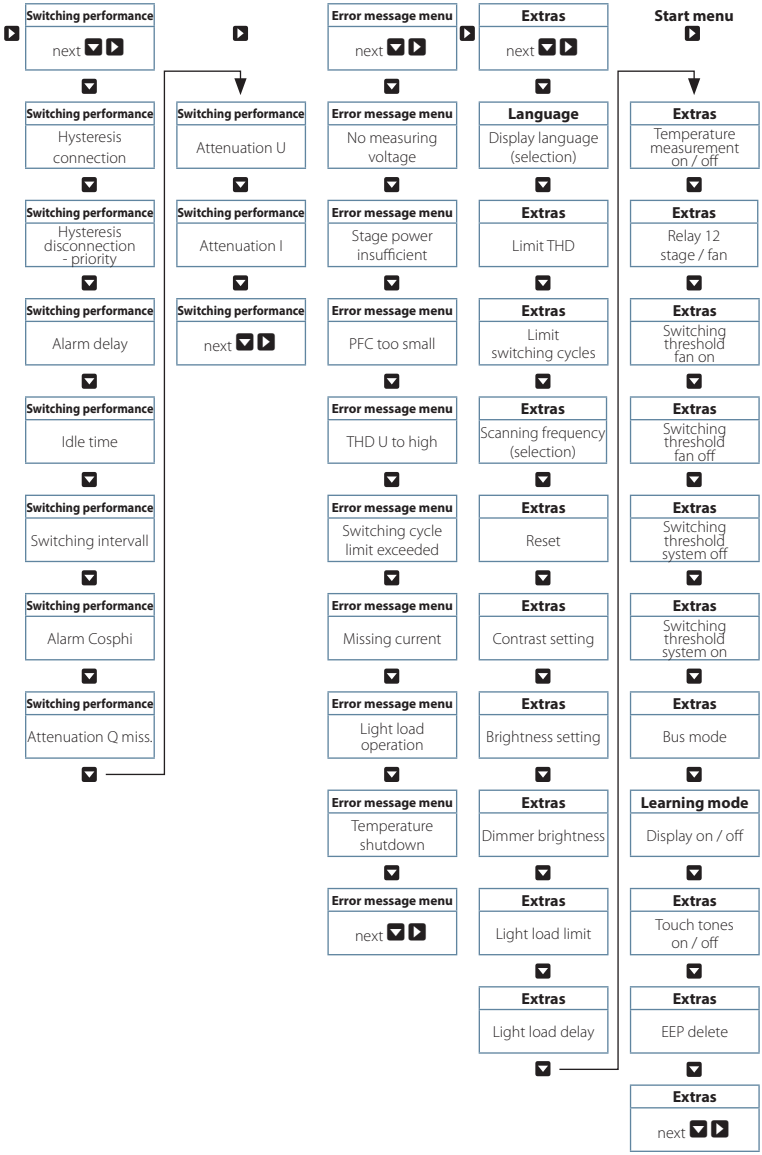

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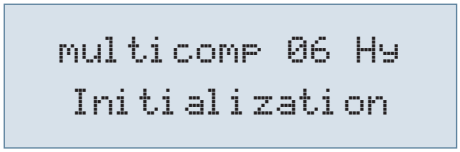
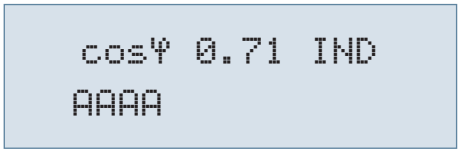
8 Device Displays of the Main Menus

The following main menus and submenus can be used for current displays and controller configuration:

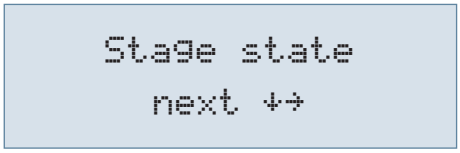
Initialization window – no input possible



Start menu window - display of current values



Stage state window– stage state can be changed



Service window– display and deletion options

Commissioning window – entry of operating parameters

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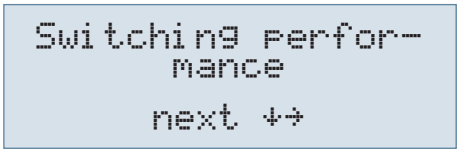
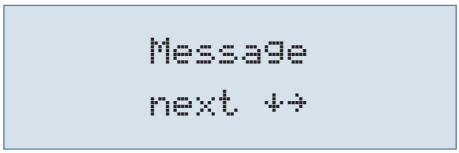
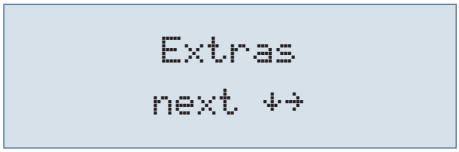
Switching performance window – influencing switching performance



Error message menu – editing the error message dialog



Extras window – setting special parameters



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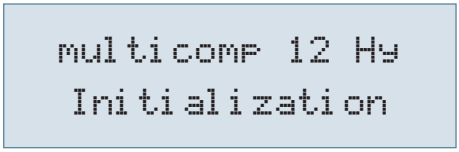
9 Description of the Individual Display Windows

9.1. Initialization window:

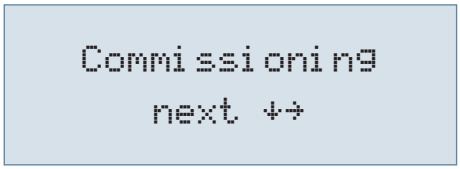


This is displayed after connecting the power supply to the controller.

NOTE

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

9.2 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 made.

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

Press ▼ to select submenus.

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Password protection (parameter protection):

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

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

Password protection is not active until a waiting time of 300 seconds has elapsed without pressing any buttons.

After unlocking a password protected controller, it is possible to press a button for up to 300 seconds. If no buttons are pressed during this time, the controller is then locked again.

The password can be set or changed by pressing to start entering or to change the entry position, to change or set the password and to save the entry.

Configuring current transformer values:

All current transformer parameters need to be configured correctly for the compensation controller to function properly. The primary and secondary current of the transformer need to be set (submenu Iprim. / Isec.). These parameters can be found on the nameplate of the current transformer. In addition, the phase allocation of the transformer needs to be configured correctly. This means that the phase (L1, L2, L3) which the current transformer is integrated in has to be set (submenu Rot. field I) in the controller. If the transformer connections are mixed up (k and l interchanged), this can be corrected with the setting -L1, -L2 and -L3.

Setting target cosine:

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 the "Default settings" chapter).

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: 400 V primary, 400 V secondary). If you use a voltage transformer, configure the parameters indicated on the voltage transformer, e.g. 690V / 100V, as well as the measuring mode, e.g. L12 for measuring voltage connection between phases L1 and L2.

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NOTE

A voltage transformer must be used here with no phase shift between current and voltage, as the device is not able to compensate this.

Setting the discharge time:

Checking or, if necessary, changing the discharge time of the capacitor stages is a very important menu item. Please make sure that the correct value is set, otherwise the system could be damaged!

The discharge times can be set:

- for thyristor stages 20 to 9999 milliseconds
- for contactor stages 0 to 900 seconds

The discharge times are automatically predefined, **in the capacitor contactor stage**, 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

In the thyristor stages, irrespective of the stage power, the discharge time is always entered as 20 milliseconds, both when reprogramming and when changing the stage power. A discharge time changed later on is retained however, as long as the stage power is not changed.

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 deactivated in the "Extras" **menu**

It is important to set the stage power correctly. You can find the stage power on the nameplate of the stage or the circuit diagram and then program it manually. In this case, skip the menu item "Learning mode activate" and enter the power value individually for each stage.

If you want to activate the learning mode, you have to make sure that all previous sub-

menu parameters have been set correctly.

To activate learning mode, press , change the setting to Yes by pressing , then press to confirm.

The auto configuration then automatically sets the stage powers and discharge times, but these values need to be checked once the learning process has been completed to ensure that they are correct.

NOTE

If an error occurs in 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. Auto configuration mode can be restarted once the cause of the error has been rectified.

System function test:

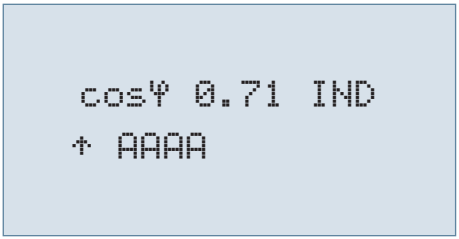
A function test should be performed after all values have been programmed step by step, by disconnecting the controller from the power supply for a few seconds.

The controller should start automatically after it is reconnected to the power supply. If the cosφ voltage is read in the start menu immediately after switching it on, the value for cosφ should be low and inductive. The controller then 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 additional stages are switched on. If the compensation system is designed correctly, the controller should compensate to the set target cos phi after a while.

9.3. Start menu window:

Example: F144-3 hybrid



This is displayed after the initialization window if the stage power has already been programmed. The current total controller state and the currently measured CosPhi are measured here.

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 mode.
a	the stage has been switched off in automatic mode
M	the stage has been switched on manually.
m	the stage has been switched off manually.

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NOTE

It is similar for the alarm relay or fan relay status display. Explanation:

E	the error message is active, the relay is open (there is an error)
e	the error message is not active, the relay is closed (there is no error)
V	the fan relay is active (the relay is closed, the fan turn-on threshold was or is exceeded or the run-ontime has not elapsed yet)
v	the fan relay is not active (the relay is open, the fan turn-on threshold is not exceeded or the run-ontime has elapsed)

Press ▼ to select submenus.

The current readings 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 (H) 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; --- °C is displayed if measurement is deactivated)

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

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

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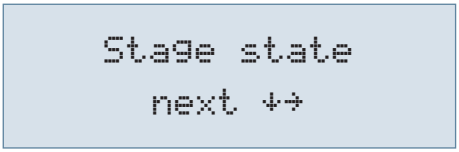
9.4 Stage state window:



Press ▼ to select submenus.

The submenus in 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.

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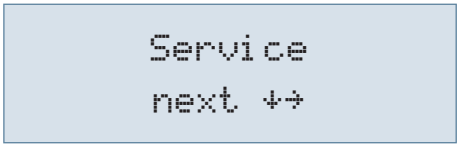
9.5 Service window:



Press ▼ to select submenus.

The number of connections of each individual capacitor stage is displayed in the submenus of this window. This value can be erased individually for each level by pressing ▶| and 123 together. You can delete the accumulated operating cycles **for all stages** by selecting **"Delete operating cycles"**. and pressing ▶| and 123 simultaneously.

If the number of operating cycles of a contactor 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, resetting the Facility 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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9.6 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 configured during setup can be read out here.

Password protection:

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

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

After unlocking a password protected controller, it is possible to press a button for up to 300 seconds. If no buttons are pressed during this time, the controller is then locked again.

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

Configuring current transformer values:

All current transformer parameters need to be configured correctly for the compensation controller to function properly. The primary and secondary current of the transformer have to be set (**submenu Iprim. / Isec**.). These parameters can be found on the nameplate of the current transformer. In addition, the phase allocation of the transformer needs to be configured 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.

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.

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Setting target cosine:

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 the "Default settings" chapter).

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: 400 V primary, 400 V secondary). If you use a voltage transformer, configure the parameters indicated on the voltage transformer, e.g. 690V / 100V, 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 necessary, changing the discharge time of the capacitor stages is a very important menu item. Please make sure that the correct value is set, otherwise the system could be damaged!

Setting the maximum stage power per switching cycle (switching operation):

To quickly compensate missing compensation power or overcompensation, it is possible to switch identical or different stage powers simultaneously. The number of stages to be switched simultaneously is determined by the value “Max. stage power per switching cycle”.

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 2x20 kvar and 1x10 kvar, for example.

The same applies for deactivation in case of overcompensation.

If the stage power limit is set lower than the value of the largest existing stage, the controller automatically uses the largest capacitor stage available. If the maximum stage power is set to "0", this function is deactivated and the controller switches each capacitor stage individually.

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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. You can find the stage power on the nameplate of the stage or the circuit diagram and then program it manually. In this case, skip the menu item "Learning mode activate" and enter the power value individually for each stage.

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 submenu 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.

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

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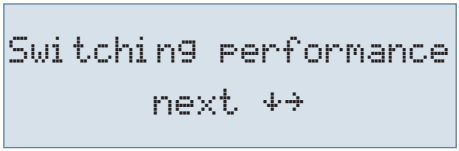
9.7 Switching performance window:



Press ▼ to select submenus.

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

NOTE

Check all parameters to ensure that they do not deviate from the specifications for this system.

The following submenus are available to affect switching performance:

- Hysteresis connection (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.
- Priority allows the switching criteria for the compensation stages to be changed.
  This setting indicates that the compensation stages should be used as evenly as possible. It allows the compensation stages to be selected according to the fewest operating hours (turn-on duration) or the fewest switching cycles.
  With the setting for the fewest operating hours, an exchange of the connected compensation stages with equivalent stages after 24 hours of run-time can also be activated/deactivated with the parameter ⸢24h⸣.
  However, this function is only available for the capacitor contactor stages.
- Alarm delay (default setting 1200 seconds, setting range 0 to 3000 seconds): This value defines the time until the message **Compensation unit 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 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).

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- Switching interval (default setting for thyristor stages 50 msec, setting range 50 to 9999 ms, for contactor stages 8 sec, setting range 0 to 10 sec):
  This value defines the time the controller is 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 setting 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.

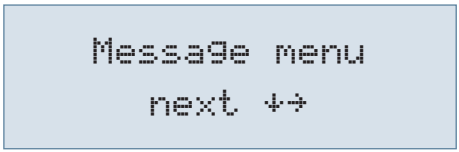
- Attenuation U (default setting 0, setting range 0 to 9):
  This value defines the display attenuation to prevent rapid parameter changes of the measuring voltage.

- Attenuation I (default setting 2, setting range 0 to 9):
  This value defines the display attenuation to prevent rapid parameter changes of the measuring current.

NOTE

Due to the default settings on the discharge time (20 ms) and switching switched (50 ms) for thyristor stages, an attenuation set later on (default setting 0) does not have any effect. The attenuation value set is only applied if the capacitor discharge time and the switching interval of the stages is greater than 100 ms.

9.8 Error message window:



Press ▼ to select submenus.

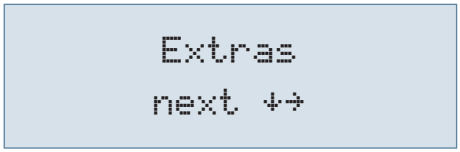
The possible messages and the display configuration are displayed in the submenus of this window.

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	✓	✓	✓	✓
Light 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.

9.9 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).
- Limit THD:
  The harmonic switch-off limit refers to the total of all measuring voltage harmonics (Lim THD). The programming range is between 0 and 10%. The setting can be adjusted in increments of 1 %.
  In addition, harmonics monitoring can also be disabled here (limit monitoring is deactivated if the setting is Lim = 0%).
  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".
  However, the operating cycles of the thyristor stages are not taken into consideration for this.
  If the setting is Lim = 0%, limit monitoring is deactivated but the operating cycle count is still activated.
- Sampling rate:
  The power frequency tracing settings are displayed in this submenu. 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.

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- 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 ⊞ simultaneously = **done** is displayed

  After about 2 seconds, **Reset** is displayed again

NOTE

The reset 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.

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

- Dimmer brightness:
  The LCD dimming 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 light load detection limit can be changed to either 15 mA or 50 mA.

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

- Temperature measurement:
  In this submenu, the temperature measurement can be activated of deactivated.

- Fan relay:
  In this submenu, the fan relay can set the last stage relay (stage 12) or assign the alarm relay.

- Switching threshold fan on:
  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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10 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 being 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 can be found 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 defective contactors.

Undercompensation, all stages are switched on:

The existing system is insufficiently dimensioned (e.g. due to new inductive consumers). Please contact your local representative (enlarge your system). The number of the service hotline is given on the cover of these operating instructions.

Overcompensation, too many stages are switched on:

Check the controller settings (target cos φ capacitive?).
Is the transformer installed in the wrong position?

Controller switches too often, in particular during light load times (at the weekend, at night):

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

NOTE

Please call your local representative if you are unable to find the cause of the error.

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11 System and Safety Device Maintenance

In order to ensure that your system functions properly and has a long service life, perform the following checks after commissioning 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.
- Check the control performance in automatic mode.
- Check the cooling air setting (fans, temperature monitoring function):
- Check that the controller temperature relay switches the fans on at 28 °C.
- Check that 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 on the basis of the electricity bill.

NOTE

The current consumption and the temperature of these systems must be checked regularly so that overloading 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.

12 Technical Data

12.1 Measuring and display values

Voltage	RMS value of a measuring interval	Phase - 0 or phase - phase, depending on configuration
	Units	V, kV;] display switches 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	Instantaneous value of the measuring 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. and cap.	Q_{total}; Q_{miss}; distinction between ind./cap.
	Units	kvar
	Display range	0.0 var to 9999.9 kvar
Power factor	Calculation —> ind. and 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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12.2 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

12.3 Measuring principle

Sampling	128 readings per period
A/D converter	12 bit
Measurement of U and I	Simultaneous recording of U and I readings;
Update speed (complete 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

12.4 Device memory

Memory	16 kB RAM (volatile)
Program and parameter memory	128 kB flash
Extreme values (max.)	No compensation power Q_{max}
Operating cycles	Memory cycles every 15 minutes
Temperature	max. measured value

12.5 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)

12.6 Power supply

Power supply	100V - 240V +/-10% DC/50/60 Hz 12VA, 6W

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12.7 Hardware inputs and outputs

12.7.1 Hardware inputs

Voltage measuring input	U_{PH-N} or U_{PH-PH}	30 - 690 VAC (max. permissible value: 790 VAC)
	Input impedance	1500 kOhm
	Measuring range	1 measuring range, measuring voltage transformer can be programmed
Current measuring input	I_{L1} or IL2 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 programmed
Analog input	PT 1000 measurement sensor	Temperature measurement -10 °C to 60 °C, +/- 2 °C max. cable length < 3 meters

12.7.2 Hardware outputs

Alarm relay	Switching capacity	250 V (AC) / 2 A floating
Optocoupler Stages 1 to 6	Switching capacity	approx. 5 to 30 VDC, max. 35 mA, external supply
Capacitor stages relay stages 7 to 12	Switching capacity	250V (AC) / 2A floating
Serial interface	BUS	RS485 for connection to the Modbus
	Protocol, baud rate	Modbus RTU, bud rate 4800, 9600, 19200, 38400 Parity none, even, odd
	Address assignment	Modbus: manual setting on the device, address 1 to 247

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12.8 Electrical connection

Connection elements		Plug-in terminals
Permissible cross-section of the connection lines		2.5 mm^2
Measurement voltage inputs	Fuse	max. 1 A slow blow or max. C2 - automatic in addition isolating switch UL/IEC-approved
Measuring current input	Fuse	NONE!!! Always short-circuit current transformer terminals k and l before opening the circuit!
Input control voltage	Fuse	max. 1 A slow blow or max. C2 - automatic in addition isolating switch UL/IEC-approved
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	max 2 A medium time-lag
Transformer connection	Connections	See connection diagram
Interface connection	Pins for BUS connection via RS-485	Terminal 90 ⊥ Terminal 91 A Terminal 92 B

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12.9 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	K55/ -5 °C …. +55°C
	Air humidity	K55 / 5% …. 95% non-condensing
	Storage temperature	-25°C ….+70°C
	Operating height	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	voltage measurement CAT III: 400 V current measurement CAT III: 300V power supply CAT III: 300V
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
	Rated surge voltage	4 kV

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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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14 Data point description for the Modbus protocol

multicomp F144-3-1Ph

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14.1 Modbus commands supported

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.

14.2 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	Complies with 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 relative 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!

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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 over the bus as the first byte.

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 is represented 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 results in 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

➢ 0110101011010100111111

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.

14.3 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 present. The interface parameters can only be configured on the device (not via bus).

14.4 Device settings

The settings are read with the 0x04 command (read input registers) as shown in 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
0xD00A	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 "Compensation unit 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			
		General		

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 the threshold is exceeded	0-700	unsigned long
0xD02c	2	Temperature [0.1 °C] that causes the fan to switch off when the value falls below the threshold	0-700	unsigned long
0xD02e	2	Temperature [0.1 °C] that triggers the stages when the value falls below the threshold	0-700	unsigned long
0xD030	2	Temperature [0.1 °C] that causes the stages to switch off when the threshold is exceeded	0-700	unsigned long
0xD032	2			
0xD034	2			
0xD036	2			
0xD038	2			
0xD03A	2			
0xD03C	2			
0xD03E	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 "Compensation unit too small" is displayed [s]	3-3000	unsigned long
0xD048	2	Idle time after compensation [sec.]	0-30	unsigned long
0xD04A	2	Thyristor idle time after compensation [ms]	20-9999	unsigned long
0xD04C	2	Contactor switching interval [sec.]	0-10	unsigned long

Address	Words	Description	Value	Format
0xD04E	2	Thyristor switching interval [ms]	50-9999	unsigned long
0xD050	2	max. switching capacity per pulse(kvar)	0-9999	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			
		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 light 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
		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	Relay stage discharge time [s] Thyristor stage discharge time [ms]	0-999 20-9999	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

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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

Example Modbus RTU

Request:
01 04 D0 01 00 02 18 CB
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
18 CB	CRC code

Response:
01 04 04 44 54 80 00 CF 64
in which

01	Device address	
04	Command	
04	4 data bytes	
44 54 80 00	Primary transformer measuring voltage	850V
CF 64	CRC code	

14.5 Data points

Data points can be read via the command 0x04 (read input registers) in accordance with table 1.

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	No 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 7rd harmonic	%	float
0x001e	2	Voltage 9rd harmonic	%	float
0x0020	2	Voltage 11rd harmonic	%	float
0x0022	2	Voltage 13rd 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:	Light 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:	Light 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 01 00 06 21 C8
in which

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 06	Read 6 registers, i.e. read 3 data points
21 C8	CRC code

Response:

01 04 0C 43 6B 5A B4 42 DC 67 20 42 48 0C 63 AF 7C

in which

01	Device address	
04	Command	
0C	12 data bytes	
43 6B 5A B4	Voltage	235.35 V
42 DC 67 20	Current	110.20 A
42 48 0C 63	Network frequency	50.012 Hz
AF 7C	CRC code	

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15 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 6D 75 6C 74 69 63 6F 6D 70 20 46 31 34 34
2D 33 20 20 02 09 20 32 2E 30 30 72 30 31 36 CD DB

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	Text length of ID 00
4B 42 52 20 47 6D 62 48	“KBR GmbH”
01	Object ID 01
12	Text length 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	Text length of ID 02
20 32 2E 30 30 72 30 31 36	„2.00r016“
CD DB	CRC code

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