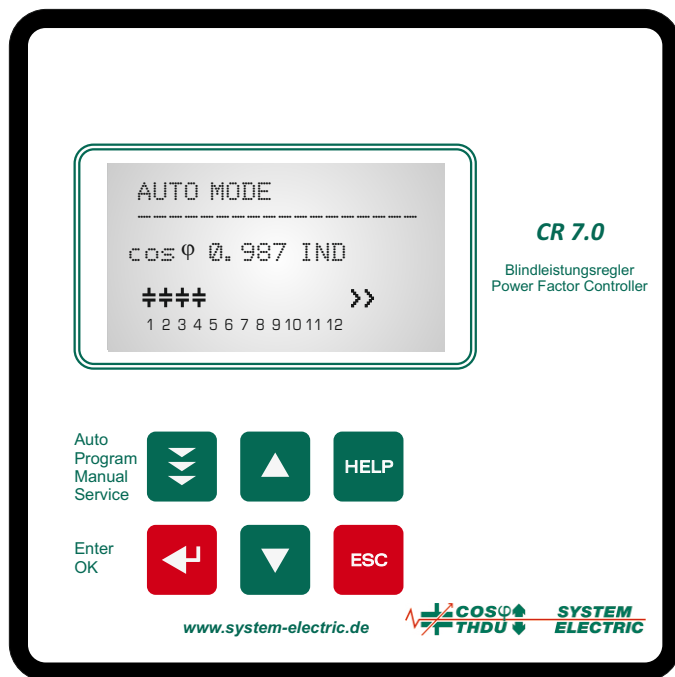
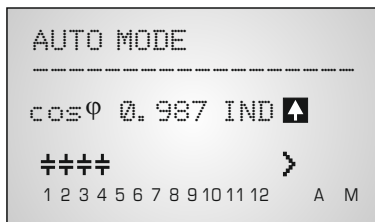


power factor controller

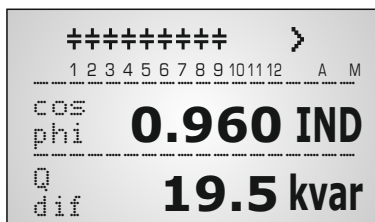
CR 7.0-1 (-S485)



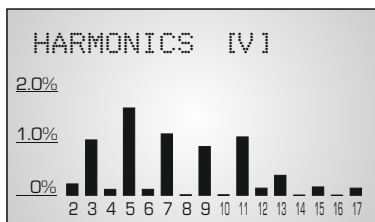
Manual
Version 4.0 - E
SupplyVoltage: 110-440V



AUTO-MODE



DISPLAY-MODE



BARGRAPH-MODE



ERROR MESSAGE

CAUTIONS:



1. High voltage !
2. The device may only be used indoor !
3. Make sure that the discharge time set in controller matches capacitor discharge time !

CONTENTS

Section 1	General / type series and accessories	3
Section 2	Installation of the controller / connection diagram	5
	2.1 Current measurement	6
	2.2 Programming of phase-correction	
	2.3 Error messages: Alarm- / Message relay	7
Section 3	Operating modes	7
Section 4	Automatic operation / display functions	8
Section 5	Programming	
	5.1 Automatic initialization	9
	5.2 Manual programming	10
	5.3 Programming lock	13
Section 6	Manual operation 1&2 / Programming of fixed stages	14
Section 7	Service menu, Test run	15
Section 8	Expert mode	16
	8.1 Expert mode 1	
	8.2 Expert mode 2	18
Section 9	Control principle	19
Section 10	Display editor	20
Section 11	Initial operation	20
Section 12	Maintenance and warranty	20
Section 13	Interface	21
Annex:	Annex 1 Troubleshooting	23
	Annex 2 Technical data	24
	Annex 3 Table of control series	25
	Description of control-series editor	
	Annex 4 Default settings	26
	Application Coupling of compensation systems	27
	Application Mixed dynamic compensation	28
	Cascading of controllers	
	Application Real current measurement	29
	Alarm and status notifications	30
	Handling-diagram / short reference	31

Section1 General

The power factor controller CR7.0-1 (single phase) enlarges the product range of power factor control devices by a useful combination of the features.

The big graphic display enables a user-friendly programming and gives further benefits such as larger display in the Display-mode and the display of various parameters in bargraph-mode.

With the additional "ESCAPE"-button a backward navigation in all menus is possible. The "HELP"-button allows an interactive help in the particular menu item (German/English).

The controller is characterized by its user friendly operating interface via menu driven plain text display. The display of several grid parameters, the storage of different values as well as the possibility of test run allow a simple error analysis and system monitoring. If required, an automatic initialization is possible which reduces the start-up operation to a minimum.

- ☑ 12 respectively 13 switching outputs
- ☑ Extended supply-voltage range 110...440V
- ☑ 20 pre-programmed control series with self optimized intelligent control behavior
- ☑ Control series editor for individual control series
- ☑ Operation and display completely menu-driven
- ☑ Illuminated graphic display 128 x 64 dots
- ☑ 4 quadrant operation
- ☑ Automatic initialization possible
- ☑ Display of several grid parameters also in large letters
- ☑ Display of harmonics of voltage and current, also as bar diagram
- ☑ Display and monitoring of temperature
- ☑ Monitoring of the particular capacitor output
- ☑ Storage of maximum values of grid parameters as well as switching operations and switch-in times of particular capacitor contactors
- ☑ Manual/automatic operation
- ☑ Programming of fixed steps or skipping of single outputs possible
- ☑ Zero voltage switch off
- ☑ Error display of different states and alarm output (relay)
- ☑ Error storage
- ☑ Test run of the system with error analysis
- ☑ Panel-mounted instrument 144 x 144 x 53 mm
- ☑ Firmware update possible

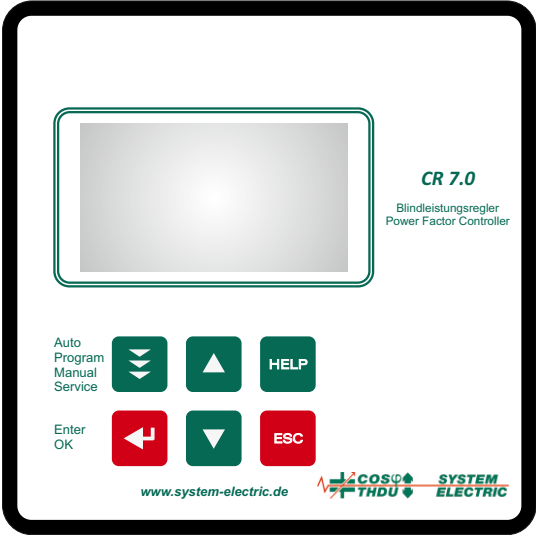
Version with interface only:

- ☑ additional external input (function programmable), e.g. for 2nd parameter set
- ☑ additional freely programmable alarm relay, e.g. for fan, status notification
- ☑ serial interface RS485, for controller coupling, integration into networks
- ☑ visualization, programming and data processing via PC by enclosed software
- ☑ Parameterization of the controller via PC
- ☑ Usage as system interface
- ☑ Usage with accessory MMI6000/MMI7000 for real current or remote measuring
- ☑ Connection of system accessory (e.g. datalogger)

The controller is supplied as standard for an operating voltage of 110...440 VAC (+/-10%), a measuring voltage of 30...440 V~ (L-N) resp. 50...760V~(L-L) and a measuring current of 5A or 1A. A voltage converter is required for different operating voltages.



Caution!
Voltages which exceed the specified voltage range can damage the device!



Front view

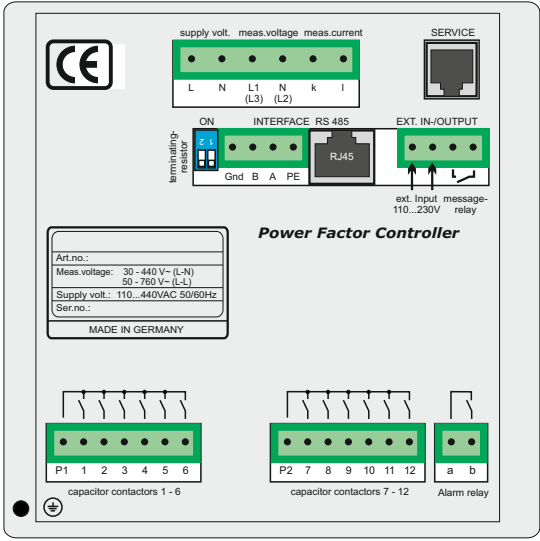
- Operating mode:
- Automatic
 - Program.
 - Manual oper.
 - Service
 - Expert Mode
 - Osci - Mode
 - Display Editor

Increase selected parameter
 HELP opens Help pages



ENTER/ OK Confirmation storage of values
 Reduce selected parameter
 Escape previous page/value in the display

Rear view



Section 2 Installation and connection of the controller

The device is designed to be incorporated into the front panel of a PFC-cabinet. It requires a switchboard section of 138 x 138 mm to DIN 43700/ IEC 61554. The controller is inserted from the front and is attached by means of the appended clamps. The controller may be inserted only by qualified technicians and must be operated in accordance with the specified safety regulations.

Before the device is connected up, all leads and cables must be checked to ensure that no current is flowing through them and the current converter must be short-circuited. Care should be taken to ensure that the measuring voltage and current are in the correct phase position. The measuring-current circuit must be wired with copper leads of 2.5mm². The connection should be set up as shown below. The specified safety regulations must be observed.

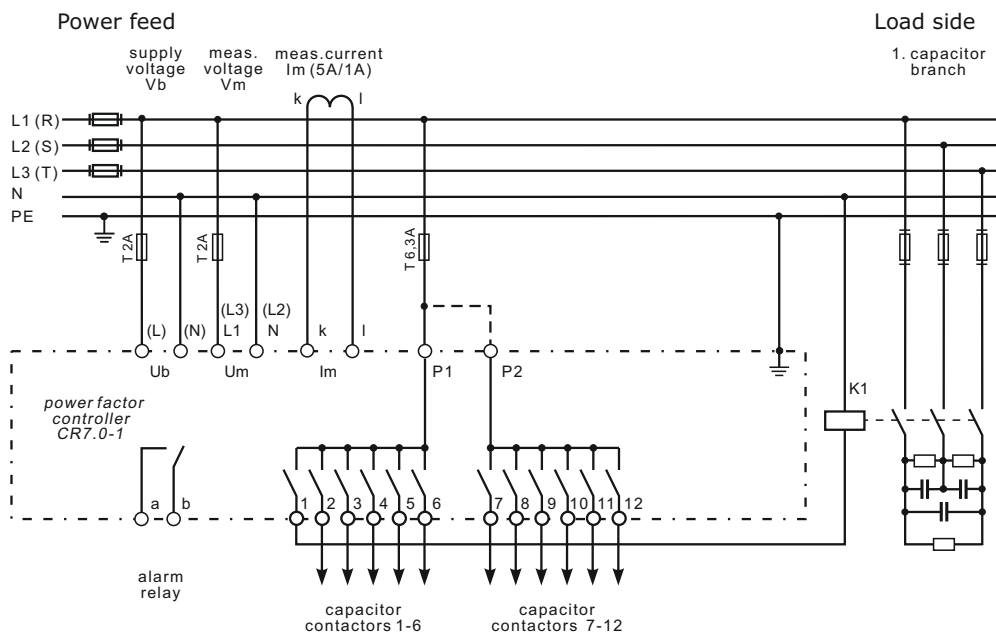
The measuring voltage may lie in the range from 30...440 V~ (L-N) resp. 50..760V~ (L-L) (programming of phase correction needed)

The operating voltage is 110...440 VAC +/- 10%.



The coil voltage for the capacitor contactors and the measuring voltage must be drawn from the same phase conductor, as only the measuring voltage is monitored. (Protection against direct reconnection of the capacitor contactors in the event of momentary single-phase power failure)

Connection plan



2.1 Current measurement

When installing the current converter, care should be taken to ensure that the load current and capacitor-current flows through it. The outputs of the compensation network must be installed behind the current converter (in the direction of current flow). If the device is connected up via sum-current converters, the overall conversion ratio is entered.

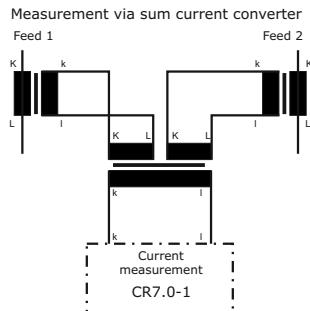
Example:

C.converter 1: 1000/5A

C.converter 2: 1000/5A

Sum-current converter: 5A+5A/5A

C.converter ratio is: 2000/5A



2.2 Programming of phase-correction - e.g. connection directly L-L (400V)

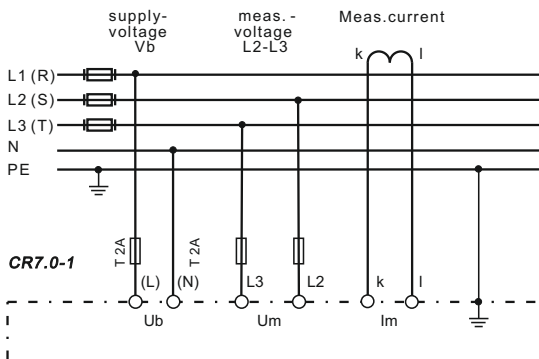
Adjustment of phase-correction between voltage and current in the meas. system is done in expert mode 1

Example :

Meas.current: L1

Meas. voltage: L3-L2

Phase U/I [90°]



using	meas. current	meas. voltage	phase-angle
Preset:	L1	L1 - N	0°
	L1	L1 - L2	30°
	L1 (k<->l)	L2 - N	60°
	L1	L3 - L2	90°
	L1	L3 - N	120°
	L1	L3 - L1	150°
	L1 (k<->l)	L1 - N	180°
	L1 (k<->l)	L1 - L2	210°
	L1	L2 - N	240°
	L1	L2 - L3	270°
	L1	L3 - N	300°
	L1 (k<->l)	L3 - L1	330°

2.3 Error-Messages: Alarmrelay / Message-relay*

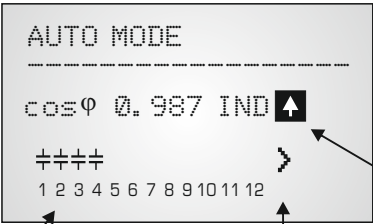
The CR7.0-1 is equipped with an alarm relay. Version /S485 features an additional message relay. The functions may be programmed as follows:

Alarm relay: Setting under Programming: 14 Alarm relay		Message relay: Setting under INTERFACE: 1 MESSAGE RELAY	Remark
0	13th step		Alarm relay= 13.th step
1	OFF	OFF	
2	ERROR	ERROR	ERROR-summary report List of errors: see page 12 ERROR:relay closed in case of error ERROR inverse (factory setting): contact open in case of error
3	ERROR inverse	ERROR inverse	
4	FAN	FAN	
5	Supply	Supply	
6	Undercurrent	Undercurrent	
7	Harmonics	Harmonics	
8	Overcompensated	Overcompensated	
9	Undercompensated	Undercompensated	
10	Warning switch. oper.	Warning switch. oper.	
11	Modbus-Error	Modbus-Error	
12	\ Modbus-Error	\ Modbus-Error	
13	MMI-Error	MMI-Error	
14	C-defect	C-defect	
15		Fixed step OUT	ext. input triggers fixed step

Adjustment and masking of all ERRORS is possible in the ExpertMode 2. The adjustment is valid for both relays.

Section 3: Operating modes

When the operating voltage is switched on, the controller briefly displays its designation and software version, then changes to its normal operating status (automatic operation).



further messages compare last cover page !

Supply display (for 4-quadrant operation)

- The control direction is symbolized by a closed arrow
 - ▶ Connecting-in
 - ◀ Connecting-out
- The connecting-in arrow is always located after the maximum possible number of stages (end stop)
- An open arrow indicates that the required blocking time (discharge time) is running before an impending switching step



By pressing the cursor buttons, the display of capacitor stages can be changed:

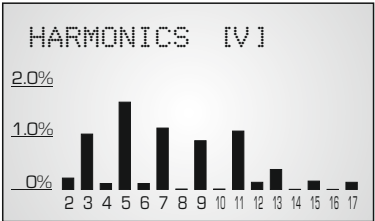


A double arrow symbolizes fast switching of several branches

Display-Mode

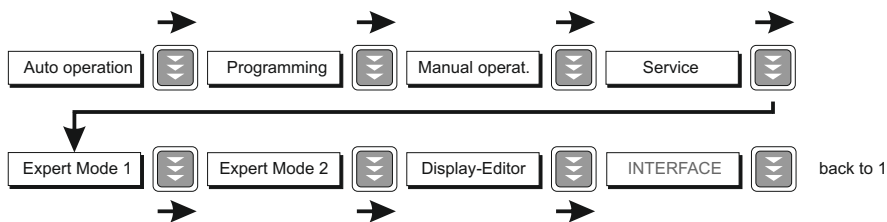


Harmonics as bar-diagram



By activating the ENTER-button the selected display can be stored as standard main display.

Repeated pressing of the "Operating Mode" key takes the user to the various menus:



Section 4 Automatic operation - display of network parameter

The controller is set to automatic operation as standard (not AUTO-INIT). Capacitor stages are then automatically connected in or out in order to reach the target power factor. This happens if the required reactive power is approx. 1/3 higher than the value of the smallest capacitor step.

In automatic operation, various network parameters can be displayed by repeatedly pressing the "ENTER" key:

Action	Display
ENTER	1 LINE VOLTAGE in V /%
ENTER	2 APPARENT CURRENT in A /%
ENTER	3 REACTIVE POWER in kvar /%
ENTER	4 ACTIVE POWER in kW /%
ENTER	5 APPARENT POWER in kVA /%
ENTER	6 DIFF. kVAR TO TARGET COS
ENTER	7 FREQUENCY in Hz / min/max
ENTER	8 TEMPERATURE in °C / °F
ENTER	9 HARMONICS V / %, I / % Selection via arrow-keys
ENTER	10 HARMONICS THD-V/%, THD-I/%
ENTER	11 Compensation power in kvar
ENTER	12 ENERGY (kWh, kvarh, consumption, delivery) reset in: service / max.value reset
ENTER	13 DATE - TIME
ENTER	Software version
ENTER	Return to: 1

```

AUTO-MODE
-----
3 REACTIVE POWER
118 kvar
  
```


```

AUTO-MODE
-----
10 HARMONICS THD rel.
V 1.7% I 0.8%
  
```



The power value specifies the total power (3-phase) assuming symmetrical load. If no key is pressed for 120 seconds, the display automatically returns to the operating status!


Under "13 Date-Time" the date format 12h/24h setting can be changed by the arrow buttons (only version /S).


Section 5: Programming


Pressing the  key once takes the user into the **PROGRAMMING** mode.

The display always shows the parameter and the set value. Values that can be edited are generally put into square brackets [].

The values are changed by pressing the keys:  

Subsequent pressing of the  key stores the value and takes the user to the next parameter.

 "ESCAPE" allows return to previous menu item.

To quit programming mode in any step, press the key: 

5.1. Automatic initialization

available only, if in ExpertMode 2: „2 Auto-Init = YES“

With the automatic initialization the device will automatically recognize the parameters of the PFC-system. It also serves as plausibility check and storage of these parameters - the user only has to make very little or even no adjustments.

Start of the initialization process is done from the menu point "PROGRAMMING" by pressing the button "↑"

AUTO-INIT [YES] to be confirmed with pressing the ENTER button.

Now either the values of the current transformer OR the value of the smallest step of the system have to be keyed in. The input of one of these values is absolutely mandatory. After input (confirm with ENTER) the automatic test run of the controller is executed.

```
AUTO-INIT
-----
1 CURRENT TRANSF.
  [ UNKNOWN ]
```

```
AUTO-INIT
-----
4 POWER 1. STAGE
  [251.00 kvar
```

```
AUTO-INIT
-----
START TEST
```

3 test-runs will be performed during which all stages are being switched on and off. All necessary parameters are collected, evaluated and stored. Under certain circumstances 3 additional test-runs may be required for a proper initialization.

After successful finalization of AUTO-INIT the controller will switch to normal operation.

In case of recognition of any discrepancies (plausibility) or of inaccurate connection, the detected error will be displayed in plain text after finalization of AUTO-INIT and can be eliminated. (see possible error messages at the end of the manual). AUTO-INIT may be repeated then.

5.2. Manual programming (program menu)

- 0 LANGUAGE:** This selects the language of the operating menu
(German, English, Spanish, Portuguese, French, RU, Cz, NL, PL, TR, IT)
- 1 I-CONVERTER PRIM:** [5...13000] A
This selects the primary current of the current converter.
Advice: In ExpertMode 1 / 28 an OFFSET value is available. Herewith each primary current is possible.
- 2 I-CONVERTER SEC:** [5 or 1] A
This sets the secondary current of the current converter
Selection via \uparrow / \downarrow . Save and continue with ENTER
- 3 END STOPP:** [12/13 resp.] switching to 13. stage in item 14 (alarm-relay)
By setting the end stopp, the number of active capacitor branches is matched to the respective capacitor bank. This is done via the \uparrow / \downarrow keys. The visible symbols of the capacitors correspond to the connected outputs. Preset = 12
Save and continue with ENTER
- 4 CONTROL SERIES:** [1...20 + E]
The ratio of the capacitor branch power determines the control series, the power of the first capacitor always being assigned the value 1. The control series required for the compensation network is again selected via the \uparrow / \downarrow keys. If the required control series should exceptionally not be present (Annex 3), the user may define a special one (control series "E"). More on this point in the control-series editor in Annex 3.
- 5 CONTROL PRINCIPLE:** The control preference may be selected here:
- SEQUENTIAL connection**
LOOP connection
INTELLIGENT loop connection (default setting)
COMBINED CHOKE
See Section 9 for an explanation of the various control modes.
Selection with \uparrow / \downarrow keys. Save and continue with ENTER
- 6 POWER 1. STAGE:** [0.01 ... 255.99] kvar
To determine the controller's response sensitivity, the dimensions of the network's smallest capacitor (stage 1) must be known. They are entered in two steps in kvar. The integral kvar values (before the comma) are initially selected via the \uparrow / \downarrow keys and saved with ENTER. The positions after the comma are then selected, again via the \uparrow / \downarrow keys. If the response sensitivity is being undercut, a warning will occur (indication of "!" in the display)
Save and continue with ENTER
- 7 TARGET COS PHI:** [0.1 ind ... 0.1 cap] or TAN PHI [9.0 ind ... 9.0 cap]
By setting the target cos phi, the power factor to be attained via the PF correction is defined. It is also set via the \uparrow / \downarrow keys.
Switch-over COS/TAN PHI in the ExpertMode 1: 21 DISPLAY

8 MEASURING VOLTAGE [30 ... 760]V~

Programming the measuring voltage of the system.

The values programmed here always refer to the voltage at the clamps of the device !

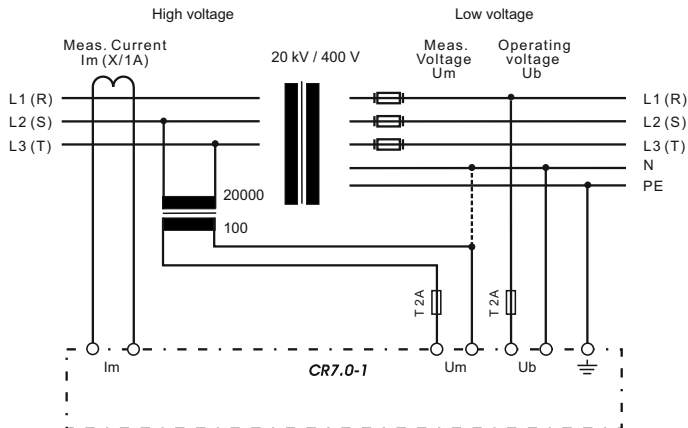
The voltage is selected via the \uparrow/\downarrow keys. Save and continue with ENTER.

9 V - CONVERTER RATIO [NO / 230V ... 380kV]

When a measuring-voltage converter (e.g. for HV-measurement) is used, its conversion ratio should be programmed here.

(Input of prim.voltage is here, sec. voltage is automatically from item 8)

Selection via the \uparrow/\downarrow keys. Save and continue with ENTER.



10 CONNECTING TIME

This refers to the time between connecting the capacitors to increase the momentary network capacitance. It should be noted that in practical operation the real connection time is affected by the discharge time (locking time).

Setting range: 1 sec. ... 137 min. (long time for HV- networks)

Default setting: 40 sec.

Selection is performed via the \uparrow/\downarrow keys. Continue with ENTER

11 DISCONNECTING TIME

This refers to the time between disconnecting the capacitors to reduce the momentary network capacitance.

Setting range: 1 sec. ... 137 min. (long time for HV- networks)

Default setting: 40 sec.

Selection is performed via the \uparrow/\downarrow keys. Continue with ENTER

12 DISCHARGE TIME

This is the time for which an individual output is blocked between connecting and disconnecting. This blocking time has priority over connecting and disconnecting times. It depends on the capacitor discharge rating and thus is specified by the compensation network. The discharge time of a conventional network without additional fast-discharge resistors or chokes should be set to no less than 40 seconds. For setting of a second discharge time compare 'Expert Mode1' point 12

Setting range: 1 sec ... 137 min. Default setting: 60 sec.

Selection is performed via the \uparrow/\downarrow keys. Continue with ENTER

13 ALARM TEMP

[40...85]°C

The alarm temperature programmed here is the temperature at which the capacitor stages are disconnected in steps. The controller's **alarm relay** responds after ten minutes. (Factory settings) At the same time the display shows the cause of the alarm (over-temperature). If the temperature drops again, the required branches are automatically re-connected in steps. (Hysteresis: 5 degrees) Factory setting: 55°C

The selection is performed with the **↑/↓** keys. Save and continue with ENTER.

14 ALARM RELAY

can be programmed here for one of the following functions:

ERROR = Summary report

0	13th step	Relay output = 13th capacitor step
1	OFF	
2	ERROR	Contact closed in case of error (except voltage sag)
3	ERROR inverse	Contact open in case of error (factory setting) ERROR resp. ERROR inverse is a collective report and includes the following errors: Overtemperature, Meas.voltage, Overvoltage, Undervoltage, Over- Undercompensated, Overcurrent, Harmonics
4	FAN	for external fan Parameterization under "15 FAN temperature"
5	SUPPLY	Message when real-power is supplied
6	UNDERCURRENT	Measuring current below minimum
7	HARMONICS	Exceeding of THD-V limit value (7%) Parameterization under "16 Harmonics"
8	OVERCOMPENSATED	
9	UNDERCOMPENSATED	
10	Warning switch. oper.	Exceeding of set switching operations value
11	MODBUS-ERROR	only version -/S485
12	\ MODBUS-ERROR	Modbus-Error inverse - only version -/S485
13	MMI-ERROR	only version -/S485
14	C-defect	only version -/S485

Section each is done with the **↑/↓** buttons. Save/continue with ENTER

15 FAN TEMP * [15...70]°C

Input of the switching threshold for the fan. *Only active if option 'Fan' is selected

16 HARMONICS THD-V (harmonic limit) [7] % (OFF or 0.1 - 25.5)%

A limit for the total harmonic distortion (in%) can be entered here. When this threshold is exceeded, a message is given. THD-V is the ratio of the geometric sum of the harmonics to the fundamental. -, - means OFF

16 HARMONICS THD-I (harmonic limit) [7] % (OFF or 0.1 - 25.5)%

see above, Preset is OFF (-, -)

17 HARMONICS

selection of harmonics for bar graph-display in Display-Mode

[3. 5. 7. - 19.] Odd up to 19th (factory setting)

[3. 5. 7. - 33.] Odd up to 33th

[2. 3. 4. - 17.] Even and odd up to 17th

18 CONTRAST

Adjustment of optimal contrast for the display possible

19 - 28 Programming of all values of the 2nd parameter set (version /S485 only)

*only active if under „INTERFACE: 3 EXT. INPUT“ the function



„2nd parameter set“ is activated

From factory side the values of the 2nd parameter are set equal to the ones of the normal parameters. By changing of particular parameters for example the target cos-phi can be changed here. Other cases of application are transformer switch over or change of switching times.

By applying a control voltage (110...230V) at the external input the 2nd parameter set is activated with following indicated values:

19. CT primary, 20. CT sec., 21. End-stopp, 22. Control series,
23. Control principle, 24. Output 1st st., 25. Target cos-phi, 26. Switch-on time,
27. Switch off time, 28. Discharge time.

29 Q-OFFSET [NO] (multiple of 1st stage)

Here an additional capacitive power is switched on independent from target cos-phi and controlling - e.g. transformer direct compensation.
(value programmable via arrow-keys).

BASIC SETTINGS: [NO] (YES / NO)

When the selection is made with YES and confirmed with ENTER, all parameters are reset to the basic setting made by the PFC-system manufacturer.

(Optimal network values when the controller was supplied with a complete PFC-system). If the controller is supplied from the works, this point corresponds to the default setting.

CAUTION: All user settings are lost!

5.3 Programming lock

The controller is equipped with a programming lock to ensure protection from unauthorized or inadvertent changes to the system parameters. The lock can be activated in Expert Mode1 - item9. If the lock is active, all parameters can be checked but not changed.

Section 6

Manual operation (initial operation, maintenance, service) Programming of fixed stages

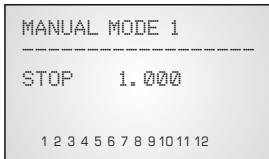
In manual operation, capacitor branches can be connected/disconnected **in the set control series and switching time** - irrespective of prevailing power-line conditions.

Manual operation 1: The starting condition is STOPP (no stages connected). Connections are made by pressing the \uparrow key (CAP ON).

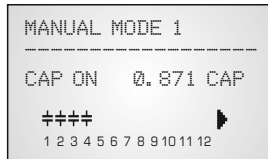
Pressing \downarrow initially leads back to STOPP mode.

Repeated pressing of \downarrow leads to the disconnection of stages (CAP OFF).

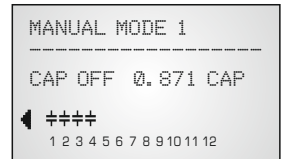
The active operating status and active power factor are always shown on the display.



device-Stop



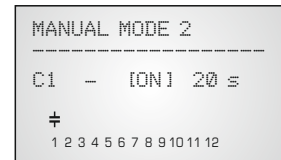
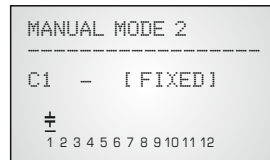
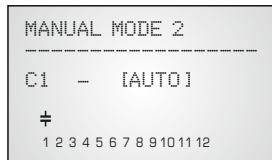
connection of steps



disconnection of steps

Pressing ENTER takes the user to the **Manual operation 2**.

Normally, all stages are programmed for automatic operation (default setting).



Here all controller outputs (C1 - C12) may be permanently defined in succession (continued switching via ENTER) for the following statuses:

FIXED: The output is continuously connected, e.g. for fixed PFC. The output is marked by an underlined capacitor symbol.

AUTO: Automatic (normal) operation

The relevant output is marked by a capacitor symbol.

OFF: The output is continuously disconnected - e.g. for temporarily disconnecting a defective capacitor. The capacitor symbol for this output is faded out. Minus (-) appears.

ON: The selected stage will be switched ON (maybe putting into operation)- in case a discharge-time is active - it will be shown at the display

The active stage is blinking. The required status is set via \uparrow / \downarrow . By pressing ENTER, the user saves this step and moves to the next stage.

The programmed statuses for the outputs also remain visible on the display in automatic operation.

After the required settings have been made, pressing the "Operating Mode" key takes the user to the next menu ("Service") or further to "Automatic Operation".

Section 7 Service menu



The service menu is reached by the operating-mode key.

The stored maximum values of the network parameters can be displayed here as well as the number of switching operations of the individual capacitors and their operating time. The desired stages [in square brackets] can be selected via the arrow keys.

* In Version /S485 the max.values are stored including time-stamp!

In addition, a fault memory is available, in which the last 50 fault states of the system are stored with fault code and in plain text. (This allows, for example, capturing short lived events of overtemperature or overvoltage)

Action	Display
ENTER	1 min/max. VOLTAGE in V
ENTER	2 max. REACTIVE POWER in kvar
ENTER	3 max. ACTIVE POWER in kW
ENTER	4 max. APPARENT POWER in kVA
ENTER	5 max. TEMPERATURE in °C / °F
ENTER	6 max. THD - V / THD - I in %
ENTER	7 RESET the maximum and energy values
ENTER	8 SWITCHING OPERATIONS C [1] - ...
+/-	to C [12]
ENTER	9 OPERATING TIME C [1] - ... in h
+/-	to C [12]
ENTER	10 ERROR MEMORY E [1] - in plaintext
ENTER	11 ERROR MEMORY RESET
ENTER	12 TEST RUN
ENTER	13 C-POWER (only after a test-run or AUTO-INIT)
ENTER	14 SERVICE INTERVALL (--/2...100 month) after this time a service notice appears
ENTER	15 - 27 creating of a service telefon number (max. 13 numbers)
ENTER	Back to 1

TEST-RUN

This menu point allows the user to check the settings of the PFC controller. After activation of the test run, the controller switches each stage ON and OFF successively and calculates the output of the capacitors connected (this procedure is done three times to eliminate possible errors). The values calculated are stored and can be retrieved in the following menu item (C-POWER). At the same time, a plausibility check is conducted with the values programmed.

Discrepancies are displayed in plain text afterwards. The following errors can be displayed:

- No measuring voltage present
- Measuring voltage too high - check programming
- Measuring voltage too low - check programming
- No measuring current? - Short circuit link in current transformer?
- Phase angle current transformer? k/I or phase transposed ?
- Current transformer ratio / 1. step power wrong ?
- Control series? - check programming
- End stop? - check programming
- Capacitor defect or wrong power input

Note: The results displayed are messages intended to help the user trace the cause of the error. Final evaluation remains the responsibility of the user. Under complicated (high load fluctuations) grid conditions, 100% error recognition cannot be guaranteed.

Section 8.1 Expert mode 1

The expert mode is meant for the adjustment of values which normally should not be changed. As a protection against mal-operation this level has an access code.

Factory setting: "6343" The password can be changed in point 22 of expert mode 1.

- 1 PASSWORD ????** (Factory setting: 6343)
- 2 BASIC SETTING NEW** [NO] (available: NO/YES)
Storage of active programming as a new basic setting (usually performed by the PFC-system manufacturer).
Caution: The original values are overwritten in the process!
- 3 SWITCHING OPERATIONS RESET** [NO] (available: NO/YES)
The stored switching operations of all capacitor stages are reset to zero. Caution: No information is then available about the switching frequency of the stages and thus the status of the network. (Reset of individual stages in Expert-mode 2)
- 4 OPERATING TIME RESET** [NO] (available: NO/YES)
The stored operating times of all outputs are set to zero.
(Reset of individual stages in Expert-mode 2)
- 5 INTEGRATION TIME** [1] s (1...255 sec.)
The integration time (the time required to form the mean values of a measurement) can be changed for special applications.
- 6 SWITCHING POWER max** [100] kvar (multiples of the smallest stage)
This factor specifies the maximum power which may be switched in one switching step. It can be used to control the intelligent control system, which switches several stages as a function of the power-factor requirement.
(Factory setting: 4 times the power of the first stage)
- 7 SWITCH.TRIGGER IND** [66]% (30...100%)
Threshold for switching ON of next stage. (α -value)
Should not be changed in the normal case!
- 8 SWITCH.TRIGGER CAP** [66]% (30...100%)
Threshold for switching OFF next stage. (β -value)
It should not be changed in the normal case!
- 9 OPERATING LOCK** [NO] (NO / YES)
- 10 SWITCHING OPERATIONS WARNING** [50,000] (1000 ... 255,000)
After an output has performed this number of switching operations, a warning message is displayed. (Abrasion of capacitor contactors and capacitors)
- 11 FAST DISCHARGE** [NO] (NO or X for the desired stages)
If only some stages of a network are equipped with fast discharge equipment, those stages can here be indicated with X. In this case, the desired discharge time for these stages can be specified in the next menu point.
- 12 DISCHARGE TIME** [1] s (1s ..programmed normal discharge time)
Only available when fast discharge is programmed. The specified discharge time is then also included in the normal display.

- 13 PHASE I** [L1] Adjustment of current phase position
Selection of phase of current transformer
- 14 PHASE V** [L1-N] Adjustment of voltage phase position:
Between which conductors has the measuring voltage of the controller been connected:
L-L resp. L-N of all phases possible.
- Phase correction between voltage and current in the measuring system. (refer p.6)
- 15 C-TEST** [YES] (YES / NO)
The power of the particular capacitor stage is calculated during each switching operation and compared with the stage output of the capacitor. If the result varies from the nominal value, an error message is generated. This test can be stopped here. **In coupling-mode C-TEST is inactive!**
- 16 C-FAULT** (+) [150]%
(-) [50]%
The deviation from the rated value of the capacitor, for which a fault message is generated, can be specified here (see point 15)
- 17 TEST ATTEMPTS** [6] (2...9)
When at least this number of successive measurements has resulted in a fault in the capacitor power, a C-fault message is output.
- 18 OUTPUT 1. STEP** [0...255] (0...2550; 0...25500)
The range for entering the stage output can be increased to [0...25500] here (e.g. for high-voltage measurement)
- 19 CONTROL** [3] PHASE [CAP]
The measuring system of the controller is based on a single phase measurement.
3-phase CAP (factory setting): The measurement is converted and all outputs are displayed 3-phase (presuming symmetry in the grid).
1-phase CAP: Display and control is only performed for the measured 1-phase value (for example 1-phase compensation in non-symmetric grids)
3-phase IND: set-up of an inductive compensation with reactors possible (3- phase)
1-phase IND: set-up of an inductive compensation 1-phase
3-phase C/I : Mixed compensation possible (CAP/IND)
1-phase C/I : (Realization according separate application solution)
- 20 SUPPLY** Setting of the controller in case supply of electric power takes place
[1] --- (no reaction) factory setting
[2] switch-off stepwise
[3] total switch off
[4] 2.cos-Phi
- 21 DISPLAY [cos φ]** (cos φ / tan φ)
Switch over between cosinus or tangens φ in the display (all menus)
- 22 PASSWORD CHANGE?** (YES/NO)
The password for ExpertMode can be changed here. All combinations of letters and figures are possible
- 27 ERROR - DISPLAY BACKLIGHT**
If an error or warning message appears in the display -the backlight can change to red light for better attention. Edit here: (OFF/ white/ red/ pink)
- 28 CT Offset** [0] (-4 ...1000)
This value will be added to the value programmed in „PROG / 1 I-CV-PRIM“
Thus all CT ratios are possible .

Section 8.2. Expert mode 2

The additional 2nd expert mode includes all messages for operation, warning and error which are displayed by the controller. Here they may be deactivated separately. When deactivated, the indication of the message in the display as well as possible activation of the relay or effects on the control behavior are suppressed. Additionally, switching operations and operation times of the capacitors can be reset.

1 PASSWORD ???? (Factory setting: 6343)
Changing of code is possible in ExpertMode1 / item 22

2 Activation / Deactivation / Setting if delay time of particular operation, warning and error messages - s. above:

Meas.-voltage; Overvoltage; Overcompensated; Undercompensated; Harmonics!;
Overtemperature; Overcurrent; Undervoltage; Switch.Operations!; Undercurrent;
Modbus-Error; MMI-Error; Remote-disconnect; Remote-stop; Remote-connect;
MODBUS-remote; Current<; BusError extern; C-defect; Current>; Overload equip.;
External Error; C-Error Off; Service-interval; Auto-Init

3 ERROR ME.RELAY [10] min. (1...255min.)
Time after which the alarm relay will respond

4 UNDERVOLTAGE [50] % (20 ...100 %)
meas. voltage below this threshold will switch OFF all
stages at the same time

5 OVERVOLTAGE [130] % (105 ...140 %)
meas. voltage above this threshold will switch OFF
the stages step by step

If the measure voltage returns to the permissible range,
the stages will switch ON again.

6 FREQUENCY [42...80 Hz] (50Hz / 60Hz / 42...170Hz / 16.7Hz)
Measurement by the controller is done automatically in grids of 40 ... 80 Hz.
In grids with extremely poor voltage quality it is recommend to select a fix
frequency (50 or 60 Hz) to avoid measuring errors due to voltage sags.

7 OVERCOMPENSATED [QDIF] (0.1 ... 0.99 CAP)
QDIFF = factory setting; the threshold for alarm-message
"overcompensated" can be changed here

8 UNDERCOMPENSATED [QDIF] (0.1 ... 0.99 IND)
QDIFF = factory setting; the threshold for alarm-message
"undercompensated" can be changed here

9 SWITCH. OPERATIONS **C1** RESET [NO] (YES/NO) to
C12 RESET [NO] (YES/NO)
Reset of switching operations of particular capacitors possible

10 OPERATION TIME **C1** RESET [NO] (YES/NO) to
C12 RESET [NO] (YES/NO)
Reset of operation time of particular capacitors possible

Section 9 Control principle

The control response of the controller can be selected in programming mode.
The controller has four different control modes:

1. Sequential connection

In sequential connection, the required capacitor stages are successively connected and disconnected in stages (last in - first out). The ranking of each step always corresponds to the power of the smallest stage.

Advantage: Exact definition of the next capacitor to be connected in each case

Disadvantage: Long settling time, high switching frequency of the small stages

In order to shorten the settling time, the controller switches several stages simultaneously for a large power-factor requirement. This applies to all control types. The maximum dimensions of the simultaneously switching branches can be changed in expert mode. If the value of the smallest stage is pre-selected, the conventional sequential connection is obtained.

2. Loop connection

In this variant, the controller operates in loop mode (first in - first out) which minimizes the wear on the capacitor bank, i.e. where stages are of equivalent dimensions, the stage which was disconnected for the longest period of time is always connected next.

Advantage: Balanced utilization of equivalent stages and thus an increased operating life of the capacitor bank.

Disadvantage: This mode can only be used in control series with groups of the same stage power and long settling time, as every switching step corresponds to the value of the smallest stage.

3. Intelligent loop connection (default setting)

The intelligent control principle combines the advantages of the network-sparing loop connection (first in - first out) with a much faster settling time, even for large load skips, and reaches this goal with the fewest possible switching operations of the capacitor stages. The optimized time response is achieved by the simultaneous switching of several or larger capacitor groups as a function of the missing power factor in the power line. Both the number of real switching frequencies of the capacitors as well as the turn-on times of the branches are considered.

Advantage: Reaches the target $\cos \phi$ in a fast-optimized settling time with a low switching frequency of the capacitors.

4. Combined de-tuning (special case for combined de-tuned banks)

Within a combined de-tuned application, 2 adjoining equal steps are switched with just one joint choke. This pairwise de-tuning requires an appropriate closed control series (i.e. 1:1:1:1..., 1:1:2:2..., 1:1:2:2:4:4... or similar)

The condition for the switching behavior is defined in such a way that the number of activated odd steps is always greater than or equal to the number of activated even steps. The controller complies with the requirements of the control regime while largely conforming to the intelligent switching behavior.

The particular capacitor steps are permanently monitored. **In case of a defect capacitor or higher deviation from the nominal output the capacitor will be displayed inverted.**

Section 10 Display-Editor

The Display-editor is reached by activation the operation button.

In the Display-editor a selection of measuring values can be performed which shall be displayed in the Display-mode.

Out of the available measuring values shown below 3 values can be selected sequently which then are available in the Display-mode as large letters. Selection is done by the arrow-buttons, confirmation with ENTER:

- 1 Grid voltage
- 2 Apparent current
- 3 Reactive power
- 4 Active power
- 5 Apparent power
- 6 Difference reactive power
- 7 Frequency
- 8 Temperature
- 9 THD-V
- 10 THD-I
- 11 Cos Phi
- 12 Tan Phi
- 13 System Clock
- 14 Relays / Error
- 15 --- (no display)

```
DISPLAY-EDITOR
-----
1.DISPLAY [ 1 ]
[ DISPLAYS / ERROR ]
```

Example: Display in DISPLAY-MODE

Selected parameters:

1. Relay / Error
2. Cos Phi
3. Diff. reactive power

```
+++++++>
 1 2 3 4 5 6 7 8 9 10 11 12 A M
-----
cos 0.960 IND
phi
-----
Q
dif 19.5 kvar
```

Note:

Even in Display-Mode the device will continue to operate as P.F.controller in the background with all functions programmed!

Section 11 Initial operation

The controller must have been installed before being set up and operated.

All network-specific parameters are fully programmed as described in section 5 (Programming) by being entered in sequence and stored. The controller is then set to automatic operation with the operating mode key. It is now ready for operation.

Section 12 Maintenance and warranty

The controller should need no maintenance if the operating conditions are observed. However, it is recommended that a functional check of the controller be performed in conjunction with the regular checking of the capacitor bank. In the event of any interventions in the controller during the warranty period, all warranty claims lapse.

Section 13: Menu INTERFACE

The device is optionally equipped with a RS485-interface, an internal clock, a potential free external input (110 ... 230 V) and an additional message relay. Therefore the following functions are only available for version /S485:

1 MESSAGE RELAY [1]

Functions and settings see section 2.3 Error messages (p.7)

2 FAN TEMPERATURE

Input of switching threshold, when message relay = FAN has been selected.

3 EXTERNAL INPUT

The function of the external input (110..230 V) can be selected here

[0] - OFF

[1] - 2nd parameter set

Activation of the input in this operation mode releases the 2nd parameter set featuring the following settings: 19/20 I-transformer; 21 End stop; 22 Control series; 23 Control principle; 24 Output 1st step; 25 Target cos-phi; 26-28 Switching times

[2] - EXTERNAL ERROR

In this operation mode the activation of the input causes a controlled switch off of all steps (remote switch off)

[3] - Q-OFFSET By activating of the input in this operation mode an additional capacitive output is switched on independent from target cos-phi and controlling (value in offset-power programmable).

[4] - Coupling operation parallel – Coupling operation of two systems, the input receives a signal of the coupling switch between the systems, the systems symmetrically (parallel) switch on the steps.

[5] - Coupling operation serial – Coupling operation of two systems, the input receives the signal of the coupling switch between the systems, the systems sequentially switch in the steps (first system 1, then system 2)

[6] [INPUT FIXED STEP]

4 OFFSET POWER (Fixed power step) – only if external input on Q-OFFSET!

Input of reactive power value that is added when activating the input to the required reactive power.

5 ... 9 Adjusting of internal CLOCK (HOUR, MINUTE, DATE)

10 PROTOCOL COM1

MODBUS KTR

MODBUS RTU

ASCII OUT

Modbus-protocol for individual usage
Transmitting of grid-values as ASCII-Data,
permanent sequential output of:
U, I, Q, P, S, switched steps
(display "XXX-----" = 3 active steps)

MASTER MMI

Adjustment in case of real current measurement with MMI6000/7000 (s. application p. 29)

EXTERNAL

Usage of an external measuring device (MMI6000/MMI7000).
The values of this device are used for display and controlling.

SLAVE MODE

Coupling of several controllers via interface (s. page 28)

MASTER MODE

see above

Depending on the selected protocol the following settings may be partially deactivated:

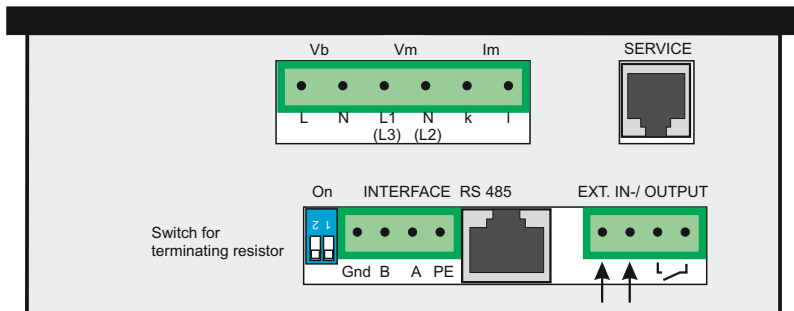
11 BAUDRATE COM1		Baudrate 9600...256000 adjustable Parity NONE, ODD, EVEN selectable
12 ADRESS COM1	[1]	(1...255)
13 Number MMI	[1]	(1...9) Number of connected MMI
14 Type of measuring device	(MMI6000 / MMI7000 / UCM-5)	
15 Number of BR7000-1	(1...4)	Connected devices during cascading
16 ASCII transmit. interval	[10] sec.	(1-255) Repeat. time ASCII transmission
17 Separator	(for ASCII Protocol) Selection HT; LF/CR; SP; CR/LF; Minus; CSV	
18 PROTOCOL COM2	----	OFF
	MODBUS KTR	Modbus monitoring
	MODBUS RTU	Modbus standard protocol
	SYNC-MODE	compare separate application
	EXTERN	
	TI8004	Temp. interface

The optional hardware-adapter „IF8000“ extend the device with a 2nd interface COM2:

19 BAUDRATE COM2	compare COM1
20 ADRESS COM2	compare COM1
21 Type of measuring device	compare COM1
22 Function TI8004	(monitoring of system, group or step)
23 Numbers of meas. sensors	[4] (1...12)
24 - 36 Correlation cap.steps --> temp.sensors	

Instructions for bus wiring when using the interface

- ☒ For bus wiring screened cable has to be used!
- ☒ The bus wirings (incoming and outgoing leads) always have to be applied directly to the device (no branch boxes)!
- ☒ In the devices at the end of the busses the terminating resistors integrated in the device have to be activated (DIP-switch ON).



ext. input 110...230V
message-relay

Annex 1: Troubleshooting

Fault	Check / Solution
At target $\cos \phi = 1$ and inductive load, switch-off or connection of capacitor in the corrected line Supply / Drawing mismatched Wrong line $\cos \phi$ is displayed	Check terminals of the measuring voltage and current (l and k)! Check phase position See above
Display: "UNDER CURRENT"	Current in measuring range? Line interruption? Wrong current-converter factor? Current transformer short-circuited?
Display: "OVERCURRENT" Alarm relay: after 10 min.	Check current-converter ratio Go through measuring current range
Display: "UNDERCOMPENSATED" Alarm relay: after 10 min.	Check connection and phase position! All stages connected - target $\cos \phi$ not reached: compensation network sufficiently dimensioned?
Display: "OVERCOMPENSATED" Alarm relay: after 10 min.	Check connection and phase position! Capacitive grid, although all stages disconnected
Display: "MEASUREMENT VOLTAGE ???" Alarm relay: after 10 min.	No measurement voltage!
Display: "OVERTEMPERATURE" Alarm relay: after 10 min.	Cabinet temperature too high: Outputs are switched off in stages irrespective of power-line conditions
Stages are disconnected for an inductive line or connected for a capacitive line	If a target $\cos \phi$ is set which deviates from 1 despite an inductive line load, the display < (disconnect stages) may light up. The arrows indicate the control direction and not the line conditions.
The controller does not connect all stages, or $\cos \phi$ does not change at the last stages In automatic operation, individual stages are not connected or disconnected	Check END STOPP ! Check whether individual stages are programmed as fixed stages or OFF in the "Manual operation / Fixed stages" menu!
In strongly asymmetrically loaded lines, differences may occur between control response and power-factor measurement, as the power factor is measured in single phase.	Line measurements allow the most favorable phase for measuring the power factor to be determined. The current converter is set accordingly for the measuring current.
No operating voltage	Note: No display

Annex 2: Technical data

Type series	CR7.0-1
Outputs	12 (13)
Languages	D / E / ES / RU / NL / CZ / PL / F / PT / TR / IT
Switching power of relay outputs	250 VAC, 1000 W
Number of active outputs	Programmable
Operation and display	Illuminated graphic display, 128x64dot
Number of control series	20
User-defined control series	1
Control principle	Sequential connection, loop connection or self-optimized switching response Four-quadrant operation
Auto-Init	YES
Operating voltage	110...440 VAC +/-10%, 50 / 60Hz
Measuring voltage	30...440V~ (L-N) resp. 50...760V~ (L-L)
Measuring current	X : 5 / 1A selectable
Power drawn	< 5 VA
Sensitivity	20 mA
Target cos phi	0.1 inductive to 0.1 capacitive adjustable
Connecting time	Selectable from 1 sec ... 137 min.
Disconnecting time	Selectable from 1 sec ... 137 min.
Discharge time	Selectable from 1 sec ... 137 min.
Fixed stages/ skipped stages	Programmable
Alarm relay	Standard
No-voltage triggering	Standard
Display of power-line parameters	cos Phi, voltage, reactive & apparent current, frequency, reactive-, active-, apparent power, missing kvar, harmonics, energy, temperature
Storage of maximum values	Voltage, reactive power, active power, apparent power, temperature, THD-V, THD-I
Storage of switching number	Yes, each output, individual reset possible
Storage of operating time	Yes, each capacitor, individual reset possible
Temperature measurement range	-30°C ... 100°C
Error memory	Last 50 error states are stored
Accuracy	Current, voltage: 1% Reactive-, active-, apparent power: 2%
Housing	Switchboard-integrated housing DIN 43 700, 144 x 144 x 53 mm
Weight	1 kg
Operating ambient temperature	-20 to +60°C
Protection type to DIN 40 050	Front: IP 54, Rear: IP 20
Safety guidelines	IEC 61010-1:2010, EN 61010-1:2010
Sensitivity to interference (industrial areas)	IEC62053-23:2017; IEC61326-1:2013 EN50082-1:1997 IEC 61000-4-2: 8kV; IEC 61000-4-4: 4kV

Annex 3: Table of control series

No.	Control series	Loop connection
1	1 : 1 : 1 : 1 : 1 : 1 : 1 : 1 : 1 : 1 : 1 : 1	Possible
2	1 : 2 : 2 : 2 : 2 : 2 : 2 : 2 : 2 : 2 : 2 : 2	Possible
3	1 : 2 : 3 : 3 : 3 : 3 : 3 : 3 : 3 : 3 : 3 : 3	Possible
4	1 : 2 : 3 : 4 : 4 : 4 : 4 : 4 : 4 : 4 : 4 : 4	Possible
5	1 : 2 : 4 : 4 : 4 : 4 : 4 : 4 : 4 : 4 : 4 : 4	Possible
6	1 : 2 : 3 : 6 : 6 : 6 : 6 : 6 : 6 : 6 : 6 : 6	Possible
7	1 : 2 : 4 : 8 : 8 : 8 : 8 : 8 : 8 : 8 : 8 : 8	Possible
8	1 : 1 : 1 : 1 : 2 : 2 : 2 : 2 : 2 : 2 : 2 : 2	Possible
9	1 : 1 : 1 : 1 : 1 : 6 : 6 : 6 : 6 : 6 : 6 : 6	Possible
10	1 : 1 : 2 : 2 : 2 : 2 : 2 : 2 : 2 : 2 : 2 : 2	Possible
11	1 : 1 : 2 : 2 : 2 : 4 : 4 : 4 : 4 : 4 : 4 : 4	Possible
12	1 : 1 : 2 : 2 : 4 : 4 : 4 : 4 : 4 : 4 : 4 : 4	Possible
13	1 : 1 : 1 : 2 : 2 : 2 : 2 : 2 : 2 : 2 : 2 : 2	Possible
14	1 : 1 : 2 : 3 : 3 : 3 : 3 : 3 : 3 : 3 : 3 : 3	Possible
15	1 : 1 : 2 : 4 : 4 : 4 : 4 : 4 : 4 : 4 : 4 : 4	Possible
16	1 : 1 : 2 : 4 : 8 : 8 : 8 : 8 : 8 : 8 : 8 : 8	Possible
17	1 : 2 : 3 : 3 : 3 : 3 : 3 : 3 : 3 : 3 : 3 : 3	Possible
18	1 : 2 : 3 : 4 : 4 : 8 : 8 : 8 : 8 : 8 : 8 : 8	Possible
19	1 : 2 : 2 : 4 : 4 : 4 : 4 : 4 : 4 : 4 : 4 : 4	Possible
20	1 : 2 : 2 : 2 : 4 : 4 : 4 : 4 : 4 : 4 : 4 : 4	Possible
"E"	Control-series editor	Possible

Control-series editor (programming up to a rating of 30)

The control-series editor allows the user to simply define his/her own control series if the required control series is not available for any reason.

The last control series - Control Series E - is selected by pressing the "Programming" key (point 4: Control series) and confirmed with ENTER. This leads to the insertion of an additional menu point in the main menu -> the control-series editor. It may be reached via the "Operating Mode" key.



In the control-series editor, all stages can be set in succession to the desired value with the selection keys \uparrow / \downarrow . The next stage in each case is reached by pressing ENTER.

In the control series editor, the various steps may be programmed up to a rating of 30 (!). The rating >9 is indicated in the display as follows:

10=A, 11=B, 12=C, 13=D, 14=E, 15=F, 16=G 30=U

ALL control series can be generated (even downwards). The customer will decide whether the generated control series is of sense.

The maximum number of stages can be limited by a programmed END STOPP < 12.

Annex 4: Default settings

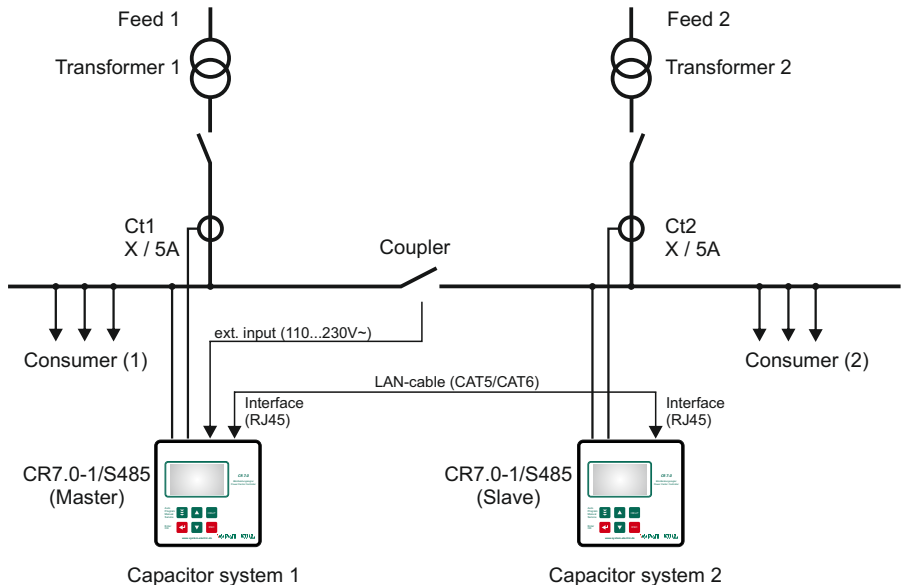
Note: The following values for the default settings apply only if the controller is supplied directly from the manufacturer. Otherwise, these values may have been replaced by settings made by the manufacturer of the compensation network (optimal values for the relevant network).

No.	Parameter	Default setting	Programmed values of this system (to be entered by manufacturer or operator)	
0	LANGUAGE	ENGLISH		
1	I CONVERTER prim.	1000 A		
2	I CONVERTER sec.	5 A		
3	END STOPP	12		
4	CONTROL SERIES	1		
5	CONTROL PRINCIPLE	INTELLIGENT		
6	POWER 1. STAGE	25.00 kvar		
7	TARGET COS-PHI	0.98 IND		
8	MEASURING VOLTAGE	230 V L-N		
9	V- CONVERTER RATIO	- NO -		
10	SWITCH- IN TIME	40 sec.		
11	SWITCH- OFF TIME	40 sec.		
12	DISCHARGE TIME	60 sec.		
13	ALARM TEMP.	55 °C		
14	ALARM RELAY	ERROR INVERSE		
15	TEMP. FAN ON	30 °C		
16	HARMONICS THD-V/THD-I	7,0 % / -:-		
17	HARMONICS bar diagram	3. 5. 7. - 33.		
18	CONTRAST	4		
	Capacitor stages	AUTO	* version with interface only	
	Password Expert-mode1/2	6343		
	Integration time	1 sec.		
	Trigger value	66%		
	Max.simult.switch.power	4 x smallest stage		
	Operating lock	- NO -		
	Switch.operations warning	50,000		
	Fast discharge	- NO -		
	Phase shift U/I	0 °		
	C - Test	- YES -		
	C - Fail (max./min.)	150% / 50 %		
	Test Attempts	6		
	Power 1. stage	0...255 kvar		
	Control	3 - phase		
	Display power-factor	Cos Phi		
	Protocol*	Modbus-RTU		
	Baudrate*	9600/None		
	Adress*	1		
	Device-type*	MMI7000		
	Number of BR7000-I*	1		
	ASCII interval*	10 sec.		

Application: Coupling of two PFC-systems using 2 PF-controllers

The coupling of two compensation systems via the interface of PF-controllers CR7.0-1/S485 offers following advantages:

- no sum current transformer and no current transformer switching required
- easy installation, real dynamic compensation of both compensation systems



Application example:

Two separate systems operate at two transformers; a coupling via a coupling switch exists between both systems

- 1) Coupling is open: Both systems work completely independent.
- 2) Coupling is closed: Due to controller coupling, the two PFC systems are operated in PARALLEL (symmetrically) or in SERIES (as extension).
Undesired interactions of the compensation system are avoided during operation at a common bus bar (oscillation).

Description:

During controller coupling each controller measures its respective current. The measuring values of reactive power difference are transmitted via interface to the „Master“. The „Master“ controls and synchronizes the switching of both controllers. No additional installation required.

Installation:

The coupling of the 2 PF-controllers CR7.0-1/S485 is done via interface (RJ45 plug) using a standard LAN-cable CAT5 . The 110...230~ signal "Coupling switch closed" has to be conducted to the potential free external input of a controller ("Master").

Programming:

1. "Master": Menu INTERFACE/
3 EXTERNAL INPUT: COUPLING PAR. (systems will switching symmetrically) **OR**
 COUPLING SER. (systems will switching one after another)
11 BAUDRATE: free (but the same at each device)
2. Controller of 2nd system: Menu INTERFACE/
10 PROTOCOL COM1: MODBUS RTU
11 BAUDRATE COM1: equal to Master-controller
12 ADDRESS: 1

No additional settings are required.

NOTE: In coupling mode C-TEST is inactive!

Application: Mixed dynamical compensation system and cascading controllers

A mixed dynamical compensation system implements economically the advantages of a dynamic fast network. (Fast changing loads are compensated dynamically and basic loads / slowly changing loads are compensated conventionally)

For designing a mixed-dynamical compensation system a special controller is available:

The CR7.0-1-TH supports up to 12 transistor-outputs (for triggering thyristor modules) and additional 12 relay-outputs for standard capacitor contactors. It supports also triggering of up to 32 thyristor-switches TSM-LC-S in a network for bigger dynamical systems.

Please compare the separate manual.

In case more than 12 dynamical and 12 conventional stages or more than 12 standard-stages are required, the following applications are supported.

Variant 1:

Hybrid-system with one dynamical and 1...2 standard PF-controllers up to 36 outputs

CR7.0-3-T (3-phase)
(for dynamical steps)

Menu: PROGRAMMING

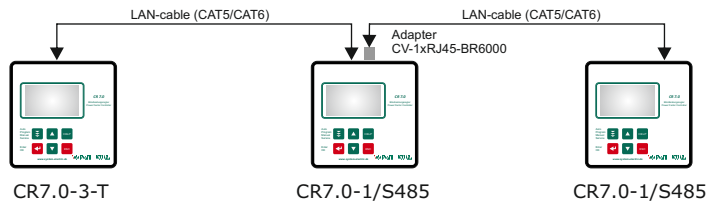
2 CONTROL-MODE: 7...14

up to 2 **CR7.0-1/S485**
(for conventional steps)

Menu: INTERFACE

Protocol: [Slave Hybrid]
Baudrate: [38400/NONE]

Address:[1] Address:[2]



Variant 2:

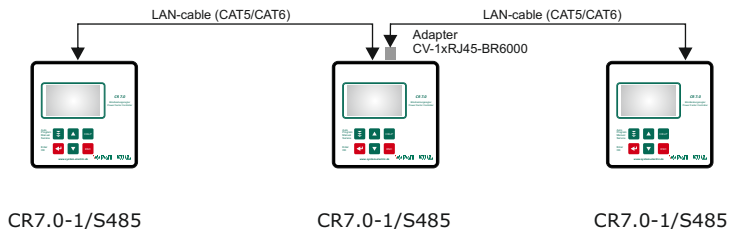
Extended systems with up to 60 outputs by cascading of 5 pcs. CR7.0-1/S485 (all controllers will switch symmetrically); 1 master and max. 4 slaves

Programming in menu "INTERFACE"

10 PROTOCOL com1:[Master Mode]
11 BAUDRATE com1:[38400/NONE]
12 ADDRESS com1:
15 NUMBER(of slaves):[2] (1...4)

[Slave Mode]
[38400/NONE]
[1]

[Slave Mode]
[38400/NONE]
[2]



Application: Capacitor current monitoring using MMI6000

Application

For permanent current monitoring inside the compensation system the MMI6000 is recommended as an accessory for the CR7.0-1/S485. This measuring device is able to determine the sum current of the complete PFC system as well as the current of single capacitor branches.

By monitoring the current of the installed capacitors, extraordinary grid conditions (e.g. harmonic currents which may cause an overload of capacitors) can be identified. In such a case, the power factor controller switches off the relevant compensation stages as long as the extraordinary situation continues. Monitoring of the capacitor current also means monitoring of the capacitor condition (damages, aging ...) and thus gives the opportunity to avoid consequential damages.

The MMI6000 will improve the reliability and safety of a PFC-system.

Method of operation:

The MMI6000 measures the sum current inside the PFC system. For this a current transformer has to be installed at the power input of the compensation system. During each switching operation, the actual current change is measured and compared to the rated current of the switched capacitor(s). In between the switching operations the current of the complete system is monitored.

In case the current of a step is too high (default +50%), this step is switched off. The controllers display shows **an inverted capacitor symbol**. The current is further on checked periodically. If the rated current reached again, the step is reactivated.

If the sum current of the complete PFC system too high, stages are switched off one after another and alarm relay is set. Periodical measurements are performed to check whether the current reaches the nominal value again. If so, the step is reactivated.

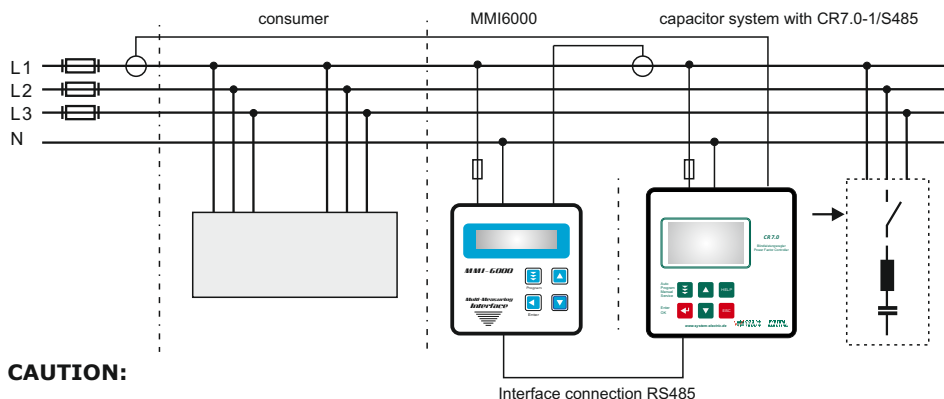
Settings MMI6000:

- Operation mode: Coupling MMI-BR6000
- Grid: 3-phase

Settings CR7.0-1:

- Menu: INTERFACE
- 10 Protocol: MASTER-MMI
- 11 Baudrate
- 13 Numbers of MMI
- Expert-mode 1:
- 15 C-Test: YES
- 16 C-Error (+150% /-50%)
(setting of switching threshold)

Principle circuit diagram:



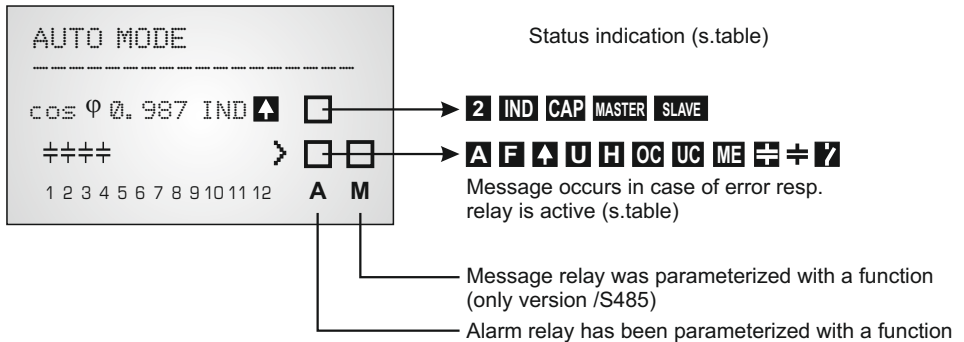
CAUTION:

For the bus-connection a shielded cable has to be used!

Bus-connections (in and out) have always to be made directly to the relevant device!

The terminating resistors inside the connected devices have to be activated (DIP-switch ON).

Alarm- and status messages in the display



Display of status:

2 2. parameter set active

IND Display of present controller status in case a mixed compensation CAP/IND
(Switching of capacitive or inductive steps)
CAP See ExpertMode 1: 19 CONTROL

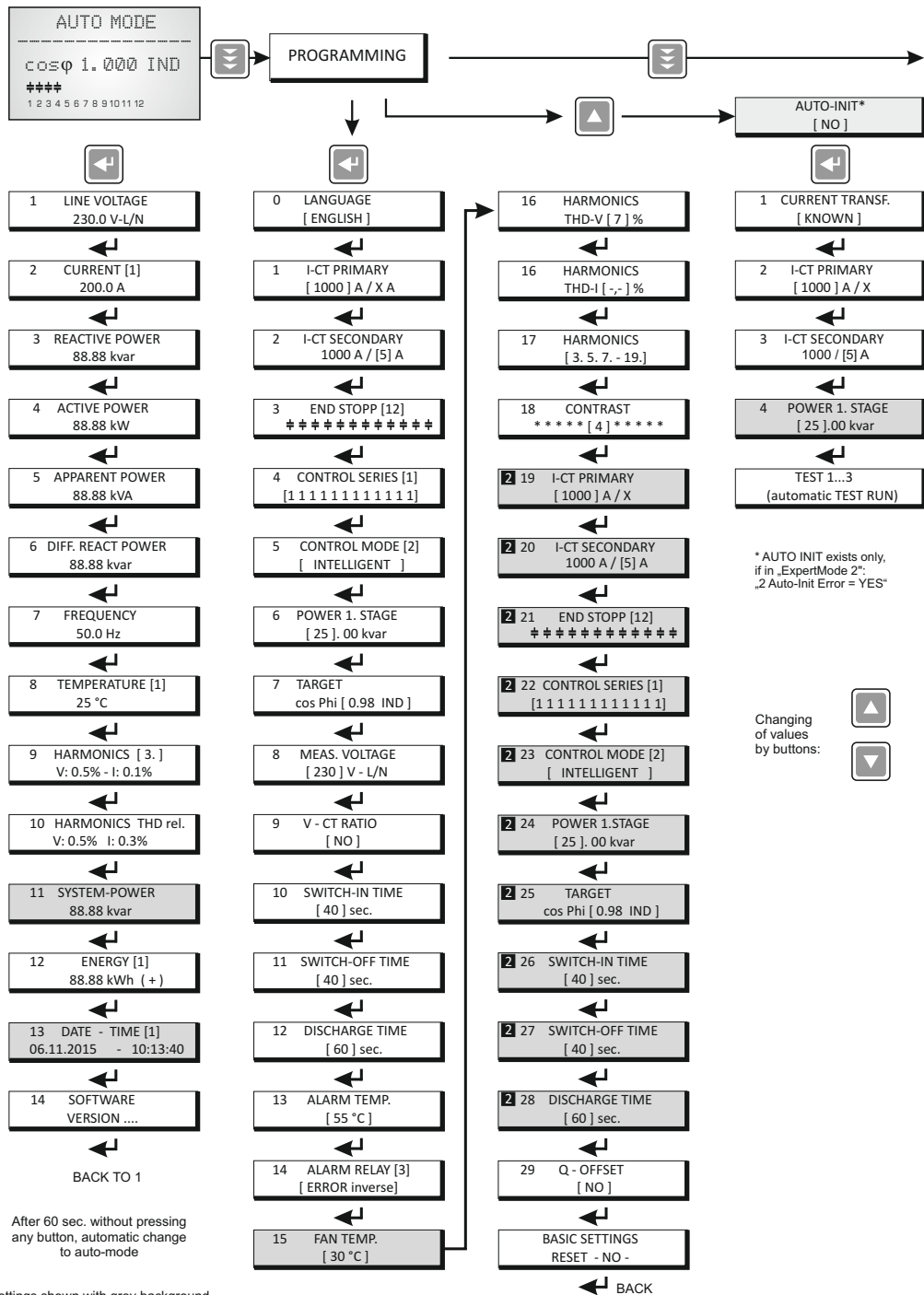
MASTER In case of controller coupling or extension of systems (several controllers)
SLAVE according to the applications shown in applications page 27/28 the respective message is displayed (Master/Slave) as soon as the connection has successfully been established and the communication works without fault.

Display of alarm and message relay functions

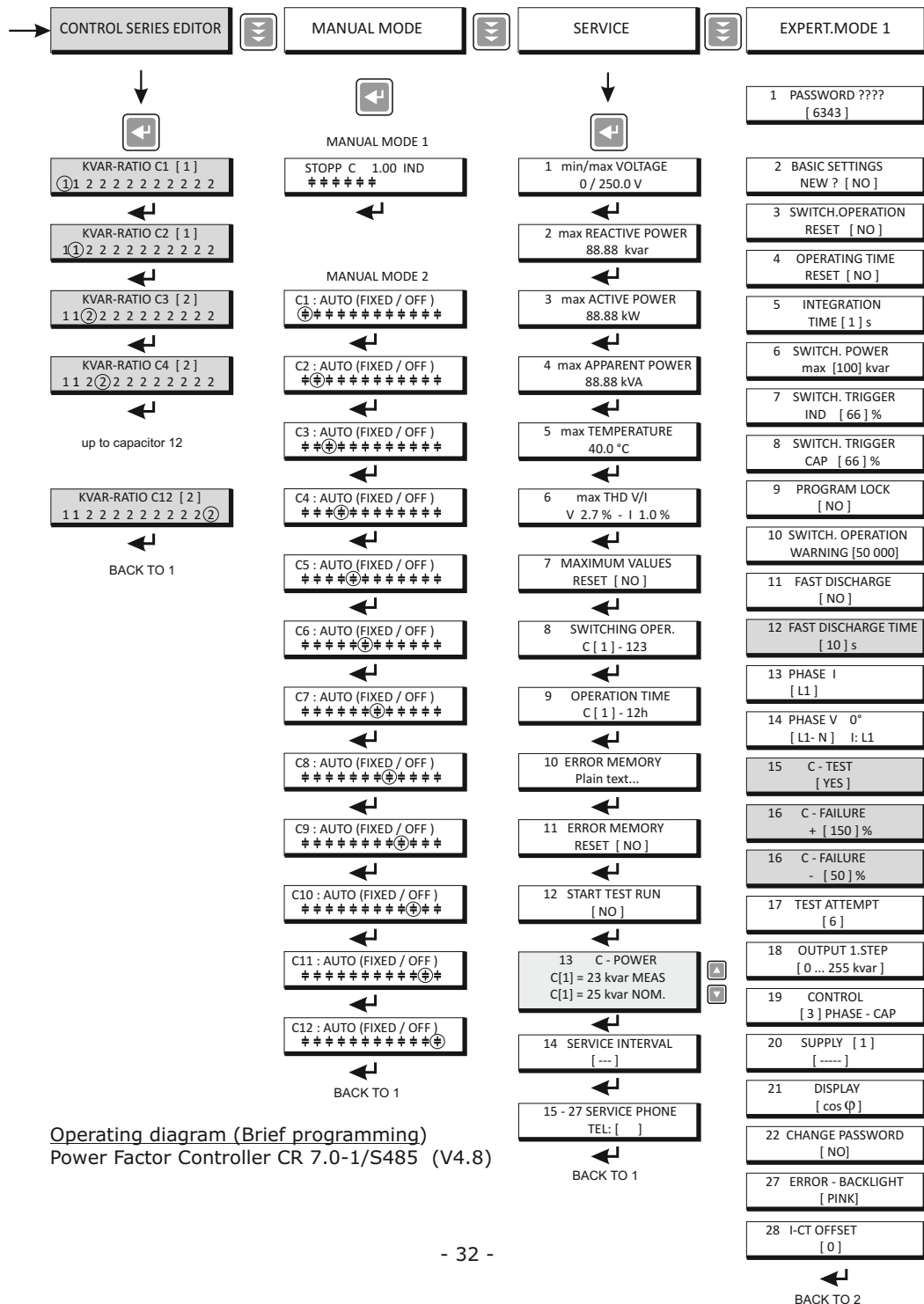
Programming of alarm relay in: PROGRAMMING: 14 ALARM RELAY
Programming of message relay in: INTERFACE: 1 MESSAGE RELAY

- A** Display of error summary report
(relay programmed as ERROR resp. ERROR inverse)
- F** Display FAN-ON (relay programmed : „FAN“)
- ↑** Display SUPPLY real power (relay programmed: „SUPPLY“)
- U** Display UNDERCURRENT
- H** HARMONICS
- OC** OVERCOMPENSATED
- UC** UNDERCOMPENSATED
- ?** SWITCHING OPERATIONS (number of programmed switch. oper. exceeded)
- ME** MODBUS-ERROR or MMI-ERROR
- ÷** C-DEFECT
- ÷** 13. step (programming only possible for the alarm-relay)

By pressing the cursor buttons (up / down) the stage display mode can be changed



Settings shown with grey background colour are active only in case of certain other settings. If not needed they are not displayed.



Operating diagram (Brief programming)
Power Factor Controller CR 7.0-1/S485 (V4.8)

