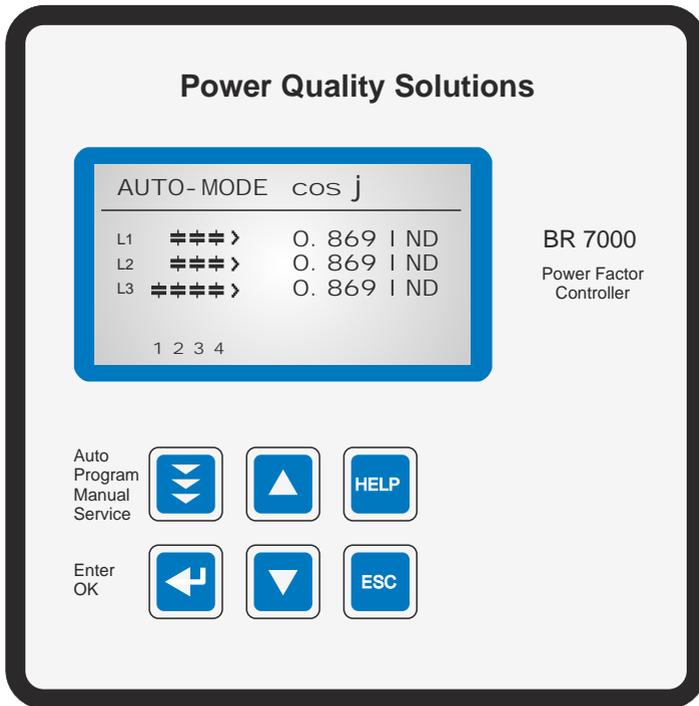


Power Factor Controller BR 7000



Manual

Version 4.0 E

PC-Software „BR7000-Soft“ (enclosed with delivery)

Windows-Software for programming of the PF-controller BR7000 and for visualization, storage and analysis of grid parameters.

- ☑ Connection to RS485-Bus
- ☑ Administration of several controllers possible
- ☑ Direct connection to USB-port of PC via accessory USB-adapter

It allows a comfortable visualization and analysis of grid parameters during online-operation. At the same time, the storage and graphical analysis of all recorded data incl. the export- and printing function can be performed. The spectrum of harmonics can promptly be displayed as bar chart.

The display and recording mode allows a convenient online-display of different grid parameters. 3 display arrangements with each up to 12 different parameters can be shown simultaneously. All values displayed can be recorded for a later processing.

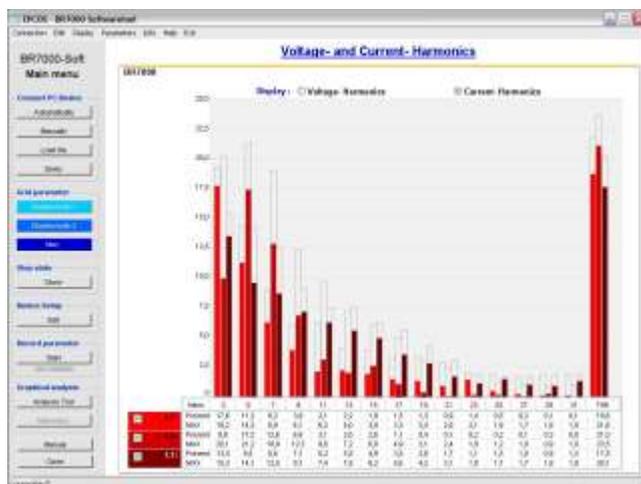
The step display delivers detailed information about the single switching steps.

With the configuration manager all parameters of the BR7000 can completely be read out, edited and stored and can be delivered back to the device. All values can be recorded in a configuration file.

The graphic mode allows the graphical display of recorded grid parameters for a congruent evaluation. All values can be freely configured. Copy and print function are possible.

A graphic bar diagram in the online-mode allows the display of voltage and current harmonics at one glance.

A detailed description of all software functions can be found in the online brochure resp. in the online-help-function of the software.



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CAUTIONS:



1. High voltage !
2. BR7000 may only be used indoor !
3. Make sure that the discharge time set in the controller matches the capacitor discharge time !

Section 1: GENERAL

The power factor controller BR7000 is the consequent follow-up development of the well proven series BR6000.

The main distinctive feature is the new 3-phases measuring system. Due to the 3-phases recording of voltage and current the device allows a convenient usage as grid measuring device and as power factor controller.

All measuring values can be edited and may be displayed in big letters for easier readability.

2 interfaces are standard. By means of the comfortable windows-software that is included in the delivery and by using one interface for a connection to a PC the execution and evaluation of grid measurements is possible. The second interface can be used for customer specific purposes.

Used as PF-controller various control modes are available. They allow not only to control according to the phase with the highest load or the average demand of the phases, but also to realize a real single-phase control (balancing) or a mix of balancing and conventional three-phases-control.

All well proven functions of the BR6000-series are available for the BR7000; for example the control series editor, the test-run etc. For an easy usage the concept of graphic menu navigation has mainly been adapted. New are amongst others an integrated help (HELP-button) and the possibility to jump back in the programming menu by an additional ESCape-button.

The usage of a fully graphic support display allows an additional Oscilloscope-Mode where the phases (half waves) of voltage and current can graphically be displayed.

- 3 x 5 free programmable switching outputs
- 1 alarm relay, 1 programmable message relay, 1 relay for the cabinet fan
- Operating voltage: 110 ... 440VAC (+/-10%)
- Measuring voltage: 3 x 30 ... 440 VAC (L-N) / 50...760 V (L-L)
- Measuring current: 3 x 5A / 1A
- Pre-programmed control series and control series editor
- Illuminated graphic display 128 x 64 dot, graphical menu navigation
- 4-quadrant-operation
- Automatic test-run possible
- Measuring of capacitor current possible
- Three-phase display of various grid parameters (U, I, F, Q, P, S Delta Q ...)
- Display up to 31st harmonic of voltage and current
- Simultaneous graphical display 1 period of voltage and current in Osci-mode
- Monitoring of temperature and particular capacitor output
- Storage of maximum grid parameters and switching operations/switch on times of capacitors with time stamp
- Manual/automatic operation
- Programming of fixed steps or masking of particular outputs possible
- Control possible as 3-phase, 1-phase or mixed-mode
- Display of different error messages, error storage
- Complete 2nd parameter set programmable
- 2 integrated separate interfaces
- Firmware update possible, controller coupling possible
- Integrated clock, several timers possible
- Integrated help-function/plain text
- Panel-mounted instrument 144 x 144 x 50 mm

Section 2: INSTALLATION AND INSTRUCTIONS FOR USAGE

The BR7000 is designed as panel mounting instrument in PFC-systems. This requires a cut out of 138 x 138 mm according to DIN 43700 / IEC 61554. The controller has to be inserted from the front and fixed with the clamps (included in delivery). The device may only be installed by qualified personnel and may only be operated according the given safety regulations. In addition the relevant legal and safety instructions have to be obeyed.

The measuring input is designed for 1- and 3-phase grids with or without neutral conductor. The maximum measuring voltage is 440V~ (L-N) / 760V~ (L-L).
The supply voltage is 110...440 V +/-10%.



Wiring connections must be suitable for the particular voltages. Input leads have to be protected by over-current-protection devices. The supply voltage must be protected by a fuse; it must be possible to switch off the supply voltage by a separator.

The device must not be operated without protective earth contactor connected!

Before connecting the BR7000, it has to be checked that all connections are at zero potential; current transformers have to be short circuited. Correct phasing of measuring voltage and measuring current have to be checked. The measuring current circuits must be wired with minimum 2.5 mm² Cu.

Terminals may only be plugged when de-energized!



Attention!

During single-phase operation the coil voltage for the capacitor contactors must be drawn from the same phase as the measuring voltage as only the measuring voltage is monitored. (Protection against direct re-switching of contactors during a short-term single-phase voltage drop.)

The controller may only be operated when installed. The complete programming of all application-specific parameters is done according chapter programming. Then the device is set to automatic operation by pushing the operation mode button. The controller is now ready for operation.



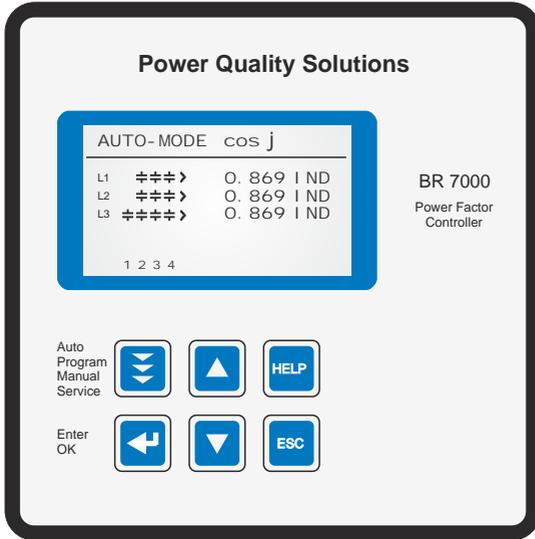
Operating the controller without following to these operating instructions may be harmful and dangerous!

The controller is supplied for a standard operating voltage of 110...440VAC (+/-10%), a measuring voltage of 30...440 V~ (L-N) resp. 50...760V~ (L-L), 50/60Hz, and a measuring current of 5A or 1A (programmable). A voltage converter is required for different operating voltages.



Caution!

Voltages which exceed the allowed voltage range can damage the device!



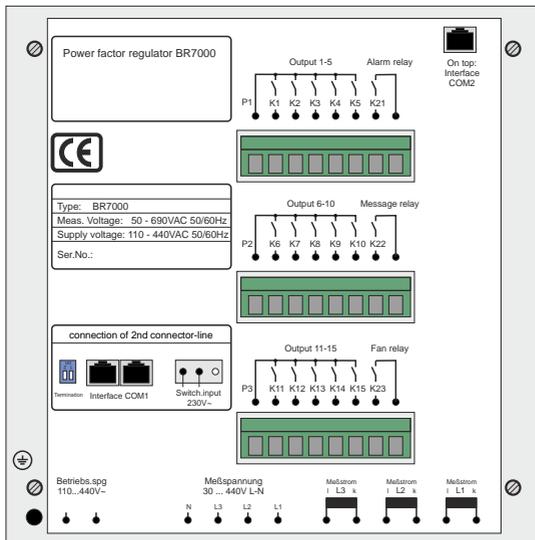
Front view

- 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



The allocation of switching outputs K1..K15 to the capacitors complies to the selected connection variant and the desired CONTROL-MODE (Programming/point 2)

Especially in "Mixed Mode" where some outputs are used for single phase capacitors, others for 3-phase-capacitors the proper connection must be assured!

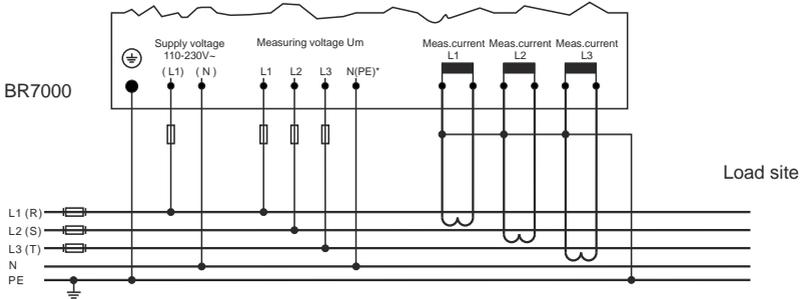
In the "HELP"-menu the BR7000 directly displays the actual correct allocation of outputs (AUTO-MODE: Help-page 7-9).

For examples also see page 20

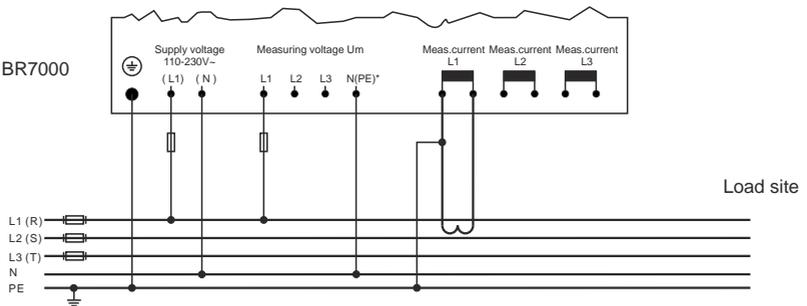
Section 3: CONNECTION ALTERNATIVES MEASURING VOLTAGE AND MEASURING CURRENT

According to the existing grid and the desired operating mode (CONTROL-MODE Programming) the BR7000 has to be connected accord. one of the following alternatives. In grids without neutral conductor the connector N from meas.voltage at the controller has to be open.
 Program the ExpertMode 1 as: 13 U-connection: -- L1 - L2 - L3

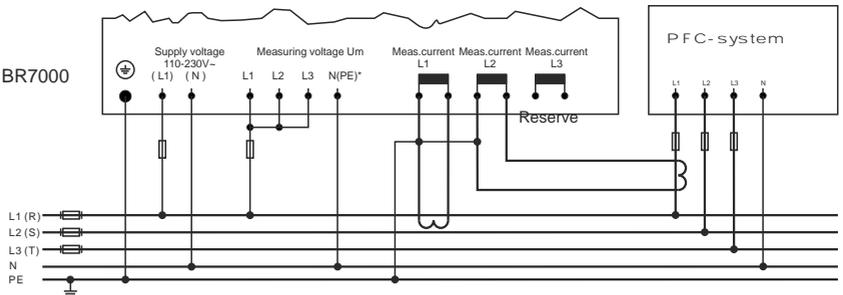
Alternative 1: measuring performed in each phase - 3 current transformers needed
 Use: CONTROL-MODE: 1 - 4



Alternative 2: single-phase measuring via current transformer in L1 Values extrapolated (balance assumed).
 Measuring complies with conventional measuring for switching of three-phase capacitors.
 Use: CONTROL-MODE 5



Alternative 3: single-phase measuring as alternative 2, but with capacitor current measuring in the compensation system for collection of real capacitor currents.
 Use: CONTROL-MODE 6

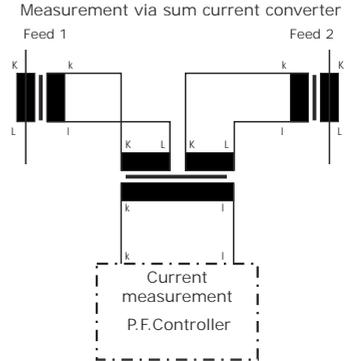


Connection of current transformer / sum current transformer

When installing the current converter, care should be taken to ensure that the load 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 BR7000 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

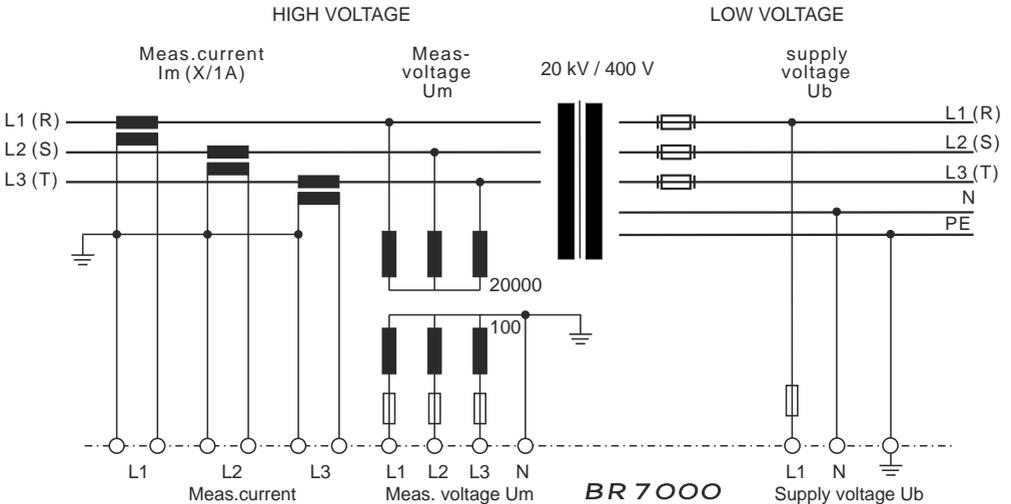


Caution!
The secondary clamps of the CT have to be short circuited before current leads are interrupted !

BR7000 in High Voltage Application

The example shows the connection of BR7000 in HV-application. The measuring current is taken off primary via X/1A transformer. Measuring voltage produced via transformer 20000/100 V. In this case, the BR7000 has to be programmed as follows:

- 4 I-CONVERTER sek: X / 1A
- 14 MEASUR.VOLTAGE (L-N): 100 V: 1,73 = 58V
- 15 V-CONVERTER: 20kV / 100 V



Section 4: DISPLAY - FUNCTIONS

After the operating voltage has been switched on, the BR7000 briefly indicates with description and software-version before changing to automatic operation.

Actual values and symbols of the particular operation state are shown in the display. In the automatic operation (standard) capacitor steps are automatically switched on or off to reach the pre-set target cos-phi. This happens when the required reactive power is higher than the value of the smallest capacitor step.

Example 1: Automatic operation
L1...L3: Individual compensation by single-phase capacitors

AUTO-MODE		cos j
L1	===>	0. 869 I ND
L2	===>	0. 869 I ND
L3	====>	0. 869 I ND
1 2 3 4		

Example 2: Automatic operation (Mixed Mode)
L1...L3: phase wise compensation by single phase capacitors
S: Three-phase capacitors activated

AUTO-MODE		cos j
L1	====>>	
L2	===>>	control direction
L3	==>>	(here: connected-in)
S	===	active capacitor branches
1 2 3 4		

Example 3: Automatic operation
Measuring in one phase
Controlling of 15 three-phase-capacitors

AUTO-MODE		cos j
S	0. 917 CAP	
S	=====>	
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15		

Number of switching outputs until end stop.
Here: 15 three-phase capacitors, end-stop: 15

Control direction is symbolized by a compact 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

▶▶ A double arrow symbolizes switching of several branches

Σ The sigma-sign indicates the three-phase-value (mean-value) resp. activated three-phase-capacitors

A Alarm relay activated (declines in case of error)

S Message relay activated: "SUPPLY"

U Message relay activated: "Undercurrent"

H Message relay activated: "Harmonics"

F FAN-relay: ON

⊞ The particular capacitor outputs are permanently monitored. Inverse display = capacitor out of range

2 Display of 2nd parameter-set

↑ Supply display (i.e.generator operation)

T 2nd Target-cos phi activated by timer

↑ 2nd Target-cos phi activated by supply

L 2nd Target-cos phi activated by supply and low load operation

E ERROR COM

Section 5: DISPLAY OF GRID PARAMETERS

5.1 Display of 3 selected grid parameters

In Auto-Mode, button \uparrow leads to display mode 1. Here 3 (free selectable) grid parameters are displayed in large letters. The selection and storage of these values is done in the Display- Editor.

Example: Display mode 1:

Desired values selected in the Display Editor (see section 13)

QΣ	14	kvar
PΣ	137	kW
SΣ	140	kVA

5.2 Display of particular grid parameters (from AUTO-MODE by pressing ENTER)

By repeated activation of the "ENTER"-button (in automatic operation) several grid parameters can be displayed (s. table below):

Action	Display	Unit	in%	Bargraph possible	3-phase
ENTER	1 LINE VOLTAGE	V			x
ENTER	2 CURRENT	A	(apparent-, active-, reactive)		x
ENTER	3 REACTIVE POWER	kvar			x
ENTER	4 ACTIVE POWER	kW			x
ENTER	5 APPARENT POWER	kVA			x
ENTER	6 DIFF. kvar to target	kvar			x
ENTER	7 FREQUENCY	Hz			
ENTER	8 TEMPERATURE	°C / °F			
ENTER	9 3.-31. HARMONICS	V/ I	x	x	x
ENTER	10 HARMONICS THD-V/I		x	x	x
ENTER	11 Comp.- power	(only at real capacitor current measurement)			
ENTER	12 ENERGY	kvarh / kWh (+), (-)			
ENTER	13 TIME / DATE	\uparrow / \downarrow change the date format			
ENTER	14 Software version	\uparrow / \downarrow more information			
ENTER	return to: 1				

Buttons \uparrow / \downarrow change the display format:

The values can be displayed in their unit, in % or as bar chart.
Examples, see next page.

=== DISPLAY ===

Examples of different displays:

DI SPLAY	
1 LINE VOLTAGE	
L1-N	233 V
L2-N	233 V
L3-N	233 V

VOLTAGE 3-phas.

DI SPLAY [1]	
2 CURRENT	
L1	235 A
L2	133 A
L3	133 A

CURRENT: 3-phas.

DI SPLAY	
3 REACTIVE POWER	
L1	71 kvar
L2	23 kvar
L3	22 kvar
Σ	116 kvar

REACTIVE PWR 3-phas.

DI SPLAY [7]			
9 HARMONICS [3]			
L1 V	0.4%	I	0.5%
L2 V	1.4%	I	0.8%
L3 V	1.4%	I	0.7%

HARMONICS in %

DI SPLAY [1]	
8 TEMPERATURE	
29° C	

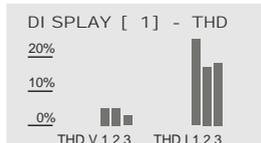
TEMPERATURE °C

DI SPLAY	
6 DIFF-REACTIVE POWER	
L1	52 kvar
L2	50 kvar
L3	46 kvar

DIFF. REACTIVE PWR in %



HARMONICS diagram



THD V/I as bar diagram

DI SPLAY	
12 ENERGY	
40.4 kWh	(+)
0.4 kWh	(-)
20.4 kvarh	(+)
0.0 kvarh	(-)

ENERGY

Repeated pressing of the "Operating Mode" key activates the various menus in sequence:

- Automatic operation
- Programming
- Manual Mode
- Service
- Expert-Mode 1 and 2
- Osci-Mode
- Display-Editor
- INTERFACE Mode
- C-TEST MODE

and back to Auto.

Section 6: PROGRAM-MODE (manual programming)

Pressing the button "Operation Mode" one time switches from automatic operation to the program mode.

The upper part of the display always shows the parameter, the adjustable values are shown in the lower part. Editable values are generally given in square brackets. Changes of these values can be done by the buttons \uparrow / \downarrow . By pressing the "ENTER-button" the value is stored. Pressing the "ESC"-button allows to go one step back (without storing).

1 LANGUAGE

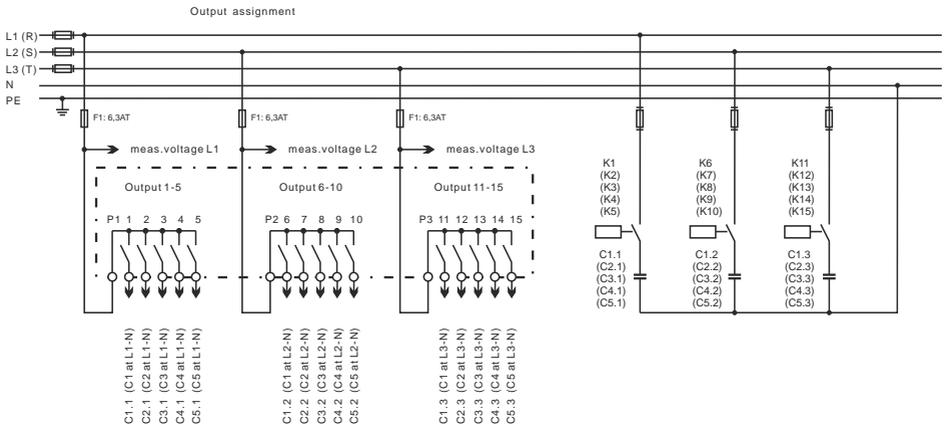
This selects the language of the operating menu
[GERMAN, ENGLISH, SPANISH, RUSSIAN, TURKISH]

2 CONTROL-MODE [1...12]

CONTROL-MODE [1]:

3-phase measuring / max. 3x5 single phase capacitors L-N
(3 current transformers needed), values displayed and calculated per phase.
Connection of measuring current and measuring voltage (refer to page 6).
Controlling is done with max. 5 outputs per phase in case of switching of single-phase capacitors L-N.

Example :
3x 5 single-phase capacitors (L-N)



Allocation of switching outputs K1...K15 to the capacitors according to the selected connection variant and the desired CONTROL-MODE.

Especially in "Mixed Mode" where some outputs are used for single phase capacitors, and others for 3-phase-capacitors the proper connection must be assured!

In the HELP-function the BR7000 directly displays the correct allocation of outputs (AUTO-MODE: Help-page 7-9).

=== PROGRAM-MODE ===

CONTROL-MODE [2]: MIXED-MODE 3-phase measuring

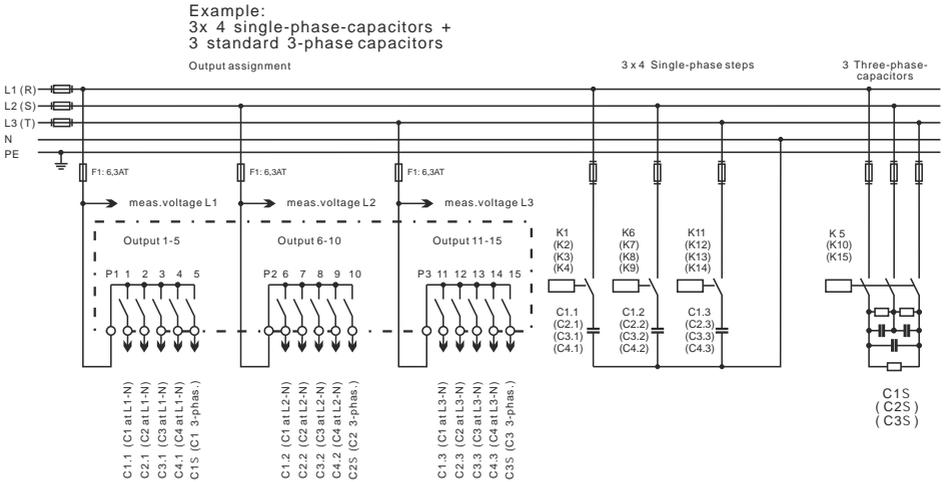
3 current transformers required. Values displayed and calculated per phase. Connection of measuring current and measuring voltage see page 6.

Controlling done with max. 4 outputs per phase for switching of single phase capacitors L-N. The rest of the outputs (min. 3, max. 12) are used for switching of three-phase capacitors to control the base load.

Partitioning into single-phase / three-phase capacitors is done at

Programming: 4 ENDSTOP!

The allocation of the switching outputs to the particular capacitors can be retrieved in AUTO-MODE on HELP-pages 7...9.

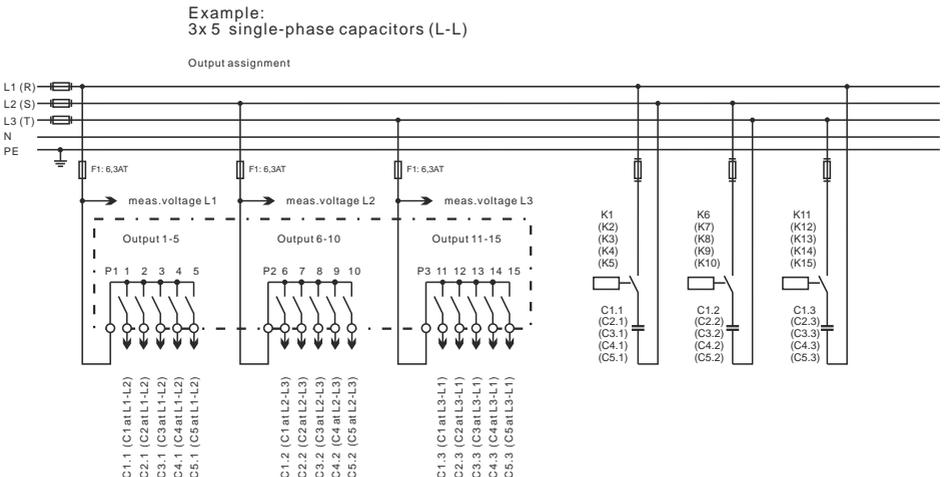


CONTROL-MODE [3]:

3-phase measuring / max. 3x5 single-phase capacitors L-L

3 current transformers required. Values displayed and calculated per phase.

Controlling done with max. 5 outputs per phase, switching of single phase capacitors L-L



=== PROGRAM-MODE ===

CONTROL-MODE [4]: 3-phase measuring / max. 15 three-phase capacitors

Connection of measuring current and measuring voltage refer to page 6.

Values displayed and calculated per phase. Controlling done with max. 15 outputs according to maximum or mean-value of the reactive power

CONTROL-MODE [5]: 1-phase measuring / max. 15 three-phase capacitors

Only current transformer in L1 required

Connection of measuring current and measuring voltage see page 6

Values extrapolated to all phases (balance assumed)

Measuring complies with conventional measuring for switching of three-phase capacitors.

*CONTROL-MODE [6]: 1-phase measuring / max. 15 three-phase capacitors
with internal capacitor current measurement*

According variant 5, but the free current inputs (L2 or L3) are used for internal capacitor current measurement for real monitoring of capacitors.

Connection of measuring current and measuring voltage see page 6 - pict. 3!

CONTROL-MODE [7]: 3-phase measuring / max. 15 three-phase capacitors

External measurement for *real monitoring of capacitors* via 1...6 pcs. devices „MMI6000“

Programming of numbers of MMI in C-TEST MODE

Can be used for 1...6 cabinet-parts

Connection of MMI6000 via LAN-cables (COM2 at BR7000)

Connection of BR7000: compare *Control-Mode 4*

CONTROL-MODE [8]: 1-phase measuring / max. 15 three-phase capacitors

External measurement for *real monitoring of capacitors* via 1...6 pcs. devices „MMI6000“

Programming of numbers of MMI in C-TEST MODE

Can be used for 1...6 cabinet-parts

Connection of MMI6000 via LAN-cables (COM2 at BR7000)

Connection of BR7000: compare *Control-Mode 5*

CONTROL-MODE [9]: 3-phase measuring / max. 3x5 single phase capacitors L-N

correspond to Control-Mode 1, but *remote measurement* via „MMI 7000“

Can be used if CT is far away from the controller or MMI 7000 already exists in the system

Connection of MMI 7000 is done via LAN-cable to COM2 at BR7000

Connection of MMI 7000: compare connection of BR7000 at page 6 / pict. 1

Connection of BR7000: 3-phase voltage only, no connection of CTs needed.

CONTROL-MODE [10]: 3-phase measuring / max. 15 three-phase capacitors

correspond to Control-Mode 4, but *remote measurement* via „MMI 7000“

Connection of MMI 7000 is done via LAN-cable to COM2 at BR7000

Connection of MMI 7000: compare connection of BR7000 at page 6 / pict. 1

Connection of BR7000: 3-phase voltage only, no connection of CTs needed.

CONTROL-MODE [11]: 3-phase measuring / max. 15 three-phase capacitors

Remote measurement and internal real monitoring of capacitors (L1...L3) correspond to Control-Mode 6, but *remote measurement* via „MMI 7000“

internal real monitoring of capacitors via current inputs L1...L3

e.g. Monitoring for 1...3 cabinets

Connection of MMI 7000 is done via LAN-cable to COM2 at BR7000

Connection of MMI 7000: compare connection of BR7000 at page 6 / pict. 1

CONTROL-MODE [12]: 3-phase measuring / max. 15 three-phase capacitors

Remote measurement and internal real monitoring of capacitors (L1...L3) correspond to Control-Mode 6, but *remote measurement* via „MMI 7000“

internal real monitoring of capacitors via current inputs L1...L3

--> Single-phase monitoring for 1 cabinet

Connection of MMI 7000 is done via LAN-cable to COM2 at BR7000

Connection of MMI 7000: compare connection of BR7000 at page 6 / pict. 1

=== PROGRAM-MODE ===

3 I-CONVERTER PRIM [1000] A / X (5 ... 13000) A
 Selects the primary current of the current converter.
 Sequential adjustment of L1...L3.
 via the \uparrow / \downarrow keys. Save and continue with ENTER

PROGRAM-MODE	
3	I-CONVERTER PRIM
L1	[1000] A / 5 A
L2	1000] A / 5 A
L3	1000] A / 5 A

4 I-CONVERTER SEC 1000 A / [5] A (1 / 5 A)
 This sets the secondary current of the current converter.
 Selection via \uparrow / \downarrow . Save and continue with ENTER

5 END STOPP
 Programming of the maximum number of active capacitor branches.
 Depending on the selected operation mode the maximum number of connected capacitors at the output groups L1...L3 and (if available) for the output groups S (three-phase capacitors) are set.
 The visible symbols of the capacitors correspond to the connected outputs.
 Input via \uparrow / \downarrow . Save and continue with ENTER

PROGRAMM-MODE [5]	
5	END STOP L1-N
L1-N	***** [5]
L2-N	***** 5
L3-N	***** 5
	1 2 3 4 5

6 CONTROL SERIES [1] (1...20 + ED)
 The ratio of the capacitor branch powers determines the control series, the power of the first capacitor always being assigned the value 1.
 Selection of desired control series consecutively for L1...L3 and for S (three-phase outputs).
 If the required control series should not be present, the user may define a special one in control series "ED" (see Annex 4: Control-series editor)

PROGRAM-MODE [1]	
6	CONTR. SERIES L1-N
L1-N	12333 [3]
L2-N	12333 3
L3-N	12333 3
	1 2 3 4 5

7 CONTROL PRINCIPLE
 The control preference may be selected here:
 SEQUENTIAL connection
 LOOP connection
 INTELLIGENT loop connection (default setting)
 COMBINED CHOKE
 See Section 13 for an explanation of the control modes.
 Selection with \uparrow / \downarrow keys.
 Save and continue with ENTER

PROGRAM-MODE [3]	
7	CONTR. PRINCIPLE
	[INTELLIGENT]

8 POWER 1st STAGE [0.01 ... 255.99] / [10...2550] kvar
 To determine the controller's response sensitivity, the dimensions of the 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 capacitor value is below the response sensitivity, a warning will occur (indication of "!" in the display)

PROGRAM-MODE	
8	POWER 1. STAGE
L1-N	[25] . 00 kvar
L2-N	25 . 00 kvar
L3-N	25 . 00 kvar

=== PROGRAM-MODE ===

- 9 TARGET COS PHI [0.98 ind] (0.1 ind ... 0.1 cap)
 By setting the target cos phi, the power factor to be attained via the PF correction is defined.
 Sequential setting of L1 ... L3 via \uparrow / \downarrow ,
 Save and continue with ENTER.

```
PROGRAM-MODE
9 TARGET cos j
[ 0.980 I ND]
```

- 10 TARGET 2nd cosPhi [NO] (1...4)
 1: NO (no 2nd target cosPhi, continue with 14)
 2: Timer (2nd cos Phi - activated by timer, scheduler with 12,13)
 3: Energy supply (2nd target cos-phi - activated by Energy-supply)
 4: Low load (2nd target cos Phi - activated by low load (smaller than 3x 1st stage))

```
PROGRAM-MODE [ 3 ]
10 TARGET 2nd cos j
[ SUPPLY ]
```

- 11 TARGET 2nd cosPhi [0.9 IND] (0.1 ind ... 0.1 cap)
 Set point for the 2nd target cosPhi
 (only available if selected under 10)

- 12 SWITCH ON TIME j 2 [HH:MM:SS]
 Switch-on time of the timer for the 2nd target-cos phi
 (only available if selected under 10)

- 13 SWITCH OFF TIME j 2 [HH:MM:SS]
 Switch-off time of the timer for the 2nd target-cos phi
 (only available if selected under 10)

```
PROGRAM-MODE
12 SWI TCH ON TI ME j 2
ON [ 16]: 00 MO-FR
OFF 07 : 00 MO-FR
```

- 14 MEASURING VOLTAGE L-L [400]V (50...760)V
 Programming of measuring voltage.
 The values programmed here always refer to the voltage at the clamps of the controller!
 Selection via \uparrow / \downarrow . Save / continue with ENTER

- 15 V-CONVERTER [NO] (300V-380kV / 440V)
 When a measuring-voltage converter (e.g. for HV-measurement) is used, its conversion ratio is to be programmed here.
 Selection via \uparrow / \downarrow . Save / continue with ENTER

```
PROGRAM-MODE
15 V- CONVERTER
[ NO]
```

- 16 FREQUENCY [40...90] Hz (50Hz, 60Hz, 16,7Hz)
 Use fix-frequency in grids with difficult voltage form (harmonics)

- 17 CONNECTING TIME: [40] sec. (1 sec. ... 130min.)
 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).
 Selection via \uparrow / \downarrow . Save / continue with ENTER

=== PROGRAM-MODE ===

18 DISCONNECT TIME: [40] sec. (1 sec. ... 130min.)
The time between disconnecting the capacitors to reduce the momentary network capacitance.
Selection via **↑** / **↓**. Save / continue with ENTER

19 DISCHARGE TIME: [60] sec. (1 sec. ... 130min.)

This is the time for which an individual output is blocked between disconnecting and connecting. It depends on the discharge device of the capacitor. The discharge time of a conventional system without fast discharge resistors or reactors should not be adjusted to less than the data sheet value of the used capacitor.
Selection with buttons **↑** / **↓**. Save / Continue with ENTER

20 ALARM TEMPERATURE [55] °C (20...80) °C

The alarm temperature programmed here is the temperature at which a stepwise disconnection of the capacitors is performed. After 10 min. the standard alarm relay of the controller (K21) will respond. At the same time, the display shows the cause of the alarm (over temperature).
When the temperature drops again, the required branches are automatically re-connected in steps.
Selection with **↑** / **↓**. Save / Continue with ENTER

21 FAN TEMPERATURE [30] °C (15...70) °C
Threshold for the fan relay (K23) for control of a cabinet fan.

22 MESSAGE RELAY [OFF] (1...9)

The message relay (K22) can be programmed for one of the following options as required:

- 1 - OFF
- 2 - Supply: Message when active power is supplied.
- 3- Under current: Display: **S**
Message when the measuring current is not met.
- Signal is generated when the current value Display: **U**
drops below the response sensitivity of the controller.
- 4 - Harmonics: Display: **H**
Message when the limiting value of the total harmonic distortion factor (THD-V) is exceeded. This value can be parameterized under "38 Harmonics" (in %).
- 5 - ERROR - System current measuring
- 6 - ERROR - Com1 (interface error) Display: **E**
- 7 - ERROR - Com2 (interface error)
- 8 - ERROR - Com1/2 (interface error) Display: **E**
- 9 - C-DEFECT

=== PROGRAM-MODE ===

- 23 EXTERNAL INPUT [NO] (1...8)
Setting of the desired action upon applying a control voltage of 110...230V~ at the external input.
- 1 - NO (no action)
 - 2- 2nd parameter set (switch over to 2nd parameter set).
This selection simultaneously activates the following points 24...37 for programming of the values of the 2nd parameter set.
 - 3 - External error (Display of an error message)
 - 4 - Remote - Switch ON
 - 5 - Remote - Switch OFF
 - 6 - Remote - Stopp
 - 7 - Coupling operation parallel COM2
(Input for signal of coupling switch)
 - 8 - Coupling operation Master/Slave COM2
(Input for signal of coupling switch)
- Description of coupling operation s.page 31

2 Programming of 2nd parameter set
(only active if 23 EXTERNAL INPUT is set to 2nd parameter set)

As a standard, the values of the 2nd parameter set equal the values of the normal parameter set. Possible applications are for example: changing of target cos-phi, switch-over of current transformer or switch-over the switching times.

By triggering a 110...230V~ signal at the external input, the 2nd parameter set is activated with following values:

- 2** 24. I-converter prim
- 2** 25. I-converter sec
- 2** 26. End stop
- 2** 27. Control serie
- 2** 28. Control principle
- 2** 29. Power 1st stage
- 2** 30. Target cos-Phi nominal value
- 2** 31. 2nd target cos-Phi NO/supply/Timer
- 2** 32. 2nd target cos-Phi nominal value
- 2** 33. Switch on time target cos-Phi-2
- 2** 34. Switch off time target cos-Phi-2
- 2** 35. Connecting time
- 2** 36. Disconnecting time
- 2** 37. Discharge time

The programming of the 2nd parameter set is performed equivalent to the programming of the 1st set parameters (3-19)

- 38 HARMONICS [7]% (--- ... 25.5)%
Threshold value THD-V (in%). In case this value is exceeded a message will be displayed. THD-V ist the ratio of the geometric sum of unequal harmonics to the 1st harmonic. In any case, a warning will be displayed. Warning via message relay will only be executed if selected in 22.

=== PROGRAM-MODE ===

- 39 HARMONICS [--,--]% (--- ... 25.5)%
Threshold value THD-I (in%). In case this value is exceeded a message will be displayed.
- 40 CLOCK [HH:MM], DATE [DD.MM.YY]
Set system-time and date
(Due to an internal battery the time will be kept even in case of power loss)
Selection with **↑** / **↓**. Save/continue with ENTER
- 41 Q-OFFSET (L1-L3) [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).
- 42 CONTRAST [4] (0..10)
Adjustment of display contrast for best readability
- 40 BASIC SETTINGS [NO] (YES/NO)
When selecting YES and confirmed with ENTER, all parameters are set back to the basic settings of the panel builder (optimum values for the system if the controller has been delivered together with the PFC-system).
If the controller has been delivered ex works, this point corresponds to the default settings.

ATTENTION: All user settings get lost !

Section 6.1: PROGRAMMING LOCK

As a protection against unauthorized changes of the system parameters, the device is equipped with a programming lock. This can be activated in the EXPERT MODE. When the lock is active, all parameters can be checked but not changed.

Alternatives:

Lock active / Not active / Automatic activation after 24 h

Section 7: HELP-Functions / actual output assignment

The BR7000 features a context related help function.

For each menu item one or more help pages are available which can be accessed directly with the HELP-button. Scrolling is done with "UP/DOWN" buttons, back retrace with ESCape.

In automatic operation (= = =AUTO-MODE= = =) 9 help pages are available. The first pages explain the general meaning of used symbols.

On the help pages 7..9 the actual assignment of the internal relay outputs K01...K15 to the phases and to the capacitors are shown directly.



This table depends on the CONTROL-MODE that is set and will change automatically.

The assignment shown here is not trivial, especially in CONTROL-MODE 2 (MIXED MODE) and must be obeyed without exception!

s. example next page

Section 8: ALARM RELAY / ERROR MESSAGES

The contact of the alarm relay (K21) is closed during normal operation and opens in case of failure. At the same time, the respective error is indicated in plain text in the display:

UNDER COMPENSATED missing reactive power	- display and relay
OVER COMPENSATED	- display and relay
OVER CURRENT	- display and relay
MEASURING VOLTAGE ???	- display and relay
OVER TEMPERATURE	- display and relay
OVER VOLTAGE	- display and relay
UNDER VOLTAGE	- display and relay
HARMONICS	- display and relay

Additionally, several messages for different operation states are generated. An individual adjustment resp. masking of single messages is possible in EXPERT-MODE 2.

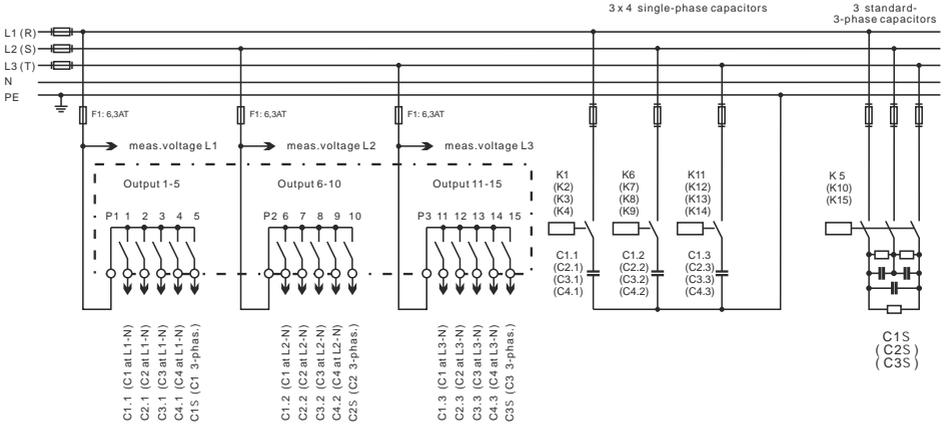
During masking, the display of message, the eventual output via alarm relay and possible influences on the control process are suppressed.

=== Actual assignment of outputs ===

Example: CONTROL-MODE 2 (MIXED-MODE)

set in END STOP to:

4 stages with 3 single- phase capacitors each and
3 stages with 1 three-phase capacitor each



In case of the setting the BR7000 will automatically assign the capacitors according to the wiring diagram.

This output assignment can always be called up in help-mode AUTO-MODE/ HELP/ page 7...9 and is displayed in the example as follows:

HELP-MODE p. 7/9
OUTPUT ASSIGNMENT
REL K01 -> L1 -> C1.1
REL K02 -> L1 -> C2.1
REL K03 -> L1 -> C3.1
REL K04 -> L1 -> C4.1
REL K05 -> S -> C1S

HELP-MODE p. 8/9
OUTPUT ASSIGNMENT
REL K06 -> L2 -> C1.2
REL K07 -> L2 -> C2.2
REL K08 -> L2 -> C3.2
REL K09 -> L2 -> C4.2
REL K10 -> S -> C2S

HELP-MODE p. 9/9
OUTPUT ASSIGNMENT
REL K11 -> L3 -> C1.3
REL K12 -> L3 -> C2.3
REL K13 -> L3 -> C3.3
REL K14 -> L3 -> C4.3
REL K15 -> S -> C3S

Section 9: MANUAL OPERATION

Manual operation is designed for maintenance and service purpose. Menu "MANUAL-MODE" consists of the following sub-windows:

1 MANUAL CONTROL [STOP] L1 (L1...L3)

In manual operation, capacitor steps can be connected /disconnected according to the control series and switching time irrespective of the prevailing power-line-conditions.

Starting position is STOP (no stages connected).



CONNECTION or DISCONNECTION is done by pressing the buttons resp. .

This manual operation is executed consecutively for particular phases L1-L3 resp. S.

The operation status and the power power factor of the actual phase are permanently shown in the display.



2 STEP STATE [AUTO] (FIXED/ AUTO/ OFF / ON)

In special cases, all controller outputs (C1- C15) may be permanently defined (continued switching via ENTER) for the following states:

AUTO: Automatic (normal) operation

The relevant output is marked by a capacitor symbol.



AUTO

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

FIX

OFF: The output is continuously disconnected, e.g. for temporarily disconnecting of a defective capacitor. The capacitor symbol for this output is faded out. "MINUS" sign appears.

OFF

ON: switches the output temporarily ON

(e.g. putting into operation) - a possible discharge time of the stage will be displayed

ON

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

The programmed status for the outputs also remains visible on the display in automatic operation.

Section 10: SERVICE MENU / Fault memory

This service menu can be reached by the operating-mode key.

The stored maximum values of the grid parameters can be displayed here as well as the number of switching operations of the individual capacitor steps and their operation time. The desired stage (in square brackets) is selected via the arrow keys.

In addition, a fault memory is available where the last fault events of the system are stored in plain text (e.g. short-term over temperature or over voltage).

Action	Display	Unit	3-phase
ENTER	1 max. VOLTAGE	in V	L1 ... L3
ENTER	2 max. CURRENT	in A	L1 ... L3
ENTER	3 max. REACTIVE POWER	in kvar	L1 ... L3
ENTER	4 max. ACTIVE POWER	in kW	L1 ... L3
ENTER	5 max. APPARENT POWER	in kVA	L1 ... L3
ENTER	6 max. TEMPERATURE	in °C /°F	
ENTER	7 max. THD - V / THD-I	in % / bargraph	L1 ... L3
ENTER	8 MAX. VALUE RESET		
ENTER	9 ENERGY RESET		
ENTER	10 Switch.OPERATIONS C [1] -		
↑/↓	to C [15]		
ENTER	11 OPERATING TIME C [1]-	in h	
↑/↓	to C [15]	in h	
ENTER	12 ERROR MEMORY	in plaintext with time-stamp	
ENTER	13 ERROR MEMORY RESET		
ENTER	Back to 1		

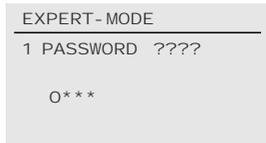
The Time-stamp can be selected via arrow-keys.

Example ERROR display:
overcompensated in phase L3
with date / time stamp

```
SERVI CE
-----
12 ERROR MEMORY
capacitive Load
too high
overcompensated L3
01.03.16 - 15:58:00
```

Section 11: EXPERT-MODE 1 and 2

The expert modes are meant for the adjustment of values which normally should not be changed. As a protection these levels have access codes:



11.1 EXPERT-MODE 1 (Code: 6 3 4 3)

- 1 PASSWORD ? " 6 3 4 3"
- 2 BASIC SETTINGS NEW [NO] (NO/YES)
Storage of the present programming as a new basic setting (usually performed by the PFC-system manufacturer).
Caution: All original values will be overwritten!
- 3 SWITCHING OPERATIONS RESET [NO] (NO/YES)
The stored switching operations of all capacitor stages are reset to zero. (reset of particular stages in Expert-mode 2)
- 4 OPERATION TIME RESET [NO] (NO/YES)
The stored operating times of all outputs are set to zero. (reset of particular stages in Expert-mode 2)
- 4 INTEGRATION TIME [1] s (1...60 sec.)
The integration time (the time required to calculate the mean values of a measurement) can be changed for special applications.
- 6 SWITCHING POWER max [100] kvar (multiple of smallest step)
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.
- 7 SWITCHING TRIGGER [66]% IND (20...200%)
- 8 SWITCHING TRIGGER [66]% CAP (20...100%)
Threshold for switching on of the next stage. (IND and CAP direction separately)
It should not be changed in the normal case !
- 9 OPERATING LOCK [NO] (NO / YES / 24H)
24 H means, that the lock will be automatically after 24 hours.
- 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)
- 11 CONTROL [MEAN VALUE] (Mean /Maximum value)
Only at single-phase measuring!
Selection whether the control during single-phase measuring should be done according to the mean or the maximum value of the missing reactive power (of the 3 phases)

=== EXPERT-MODE 1 ===

12 DISPLAY [cos j -0.10 ... +0.10]
(tan j -9.95 ... +9.95)
(cos j -0.910 ... +0.910)
(tan j -0.456 ... +0.456)

Display of the power factor (cos oder tan)

13 U-Selection [N - L1 - L2 - L3]
(- L1 - L2 - L3)

! Connection of the voltage (with or without Neutral) has to be programmed here in every case!

14 POWER 1 . STAGE [0...255] (0...2550; 0...25500) kvar
The range of the power for the 1st stage can be changed here.
(e.g. High voltage application)

15 CHANGE PASSWORD [NO] (NO / YES)

16 - 19 PASSWORD [6] 3 4 3 Changing

20 ERROR-BACKLIGHT [PINK] (OFF / RED / WHITE)
Changes the colour of the backlight at an ERROR

11.2 EXPERT-MODE 2 (Code: 6 3 4 3)

The 2nd expert mode defines all operation-, warning- and fault messages which can be displayed by the controller. They can be activated/de-activated separately.

Also a setting of a delay-time (0...255sec.) is possible.

When de-activated, the display of the message as well as the possible activation of the alarm-relay or consequent effects on the control behavior are suppressed.

1 PASSWORD ? "6 3 4 3"

2 NOTIFICATIONS / ALARM [YES] =activ (YES / NO)

Activation/De-activation of the particular operation,- warning- and default messages:

Measuring voltage, over voltage, over-/under compensated, harmonics, over-temperature, over-current, under-voltage, switching operations, measuring current, error COM1, error COM2, Modbus-error, switch off, stop, switch on, system current <, Bus-error external, C-defect, System current >0, overload system, external error, relay-error

3 ALARM RELAY

Delay time [10] min. (1...255 min.)

4 UNDER VOLTAGE [50] % (20...95%)

If the measuring voltage falls below this value, all steps are simultaneously switched off.

5 OVER VOLTAGE [115] % (105...140%)

If the measuring voltage exceeds this value, the stages are switched off step by step. If the measuring voltage is again in the defined range, stepwise re-connection of steps is done.

6 OVERCOMPENSATED [Q-DIFF] (0,99...0,10 CAP)

QDIFF = factory setting; the threshold for alarm-message "overcompensated" can be changed here (independent of the target-cos Phi)

7 UNDERCOMPENSATED [Q-DIFF] (0,99 - 0,10 IND)

QDIFF = factory setting; the threshold for alarm-message "undercompensated" can be changed here (independent of the target-cos Phi)

8 SWITCHING OPERATIONS C1 RESET [NO] (YES/NO)

to

C15 RESET [NO] (YES/NO)

Reset of switching operations of particular capacitor steps, e.g. after exchange of capacitors or capacitor contactors.

9 OPERATION TIME C1 RESET [NO] (YES/NO)

to

C15 RESET [NO] (YES/NO)

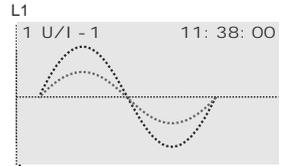
Reset of operation time of particular capacitor steps, e.g. after exchange of capacitors or capacitor contactors.

Section 12: OSCI-MODE



To be reached via button operation menu in the main menu.

In Osci-mode the actual form of a period of voltage and current is graphically displayed. This provides information about phase shift and curve form. Display possible consecutively for L1...L3



Section 13: DI SPLAY EDITOR



To be reached via button operation mode in the main menu.

In Display editor the values that will be permanently shown in the display mode 1.

Out of all 50 measuring values that are available for each line (three lines in total) the desired value can be selected.

```
DI SPLAY EDITOR [ 10 ]
1 DI SPLAY LI NE 1
1 [ REACTI VE POWER L1 ]
2 REACTI VE POWER L2
3 REACTI VE POWER L3
```

Section 14: MAI NTENANCE AND WARRANTY

No maintenance of the BR7000 is required when operation conditions are obeyed. Nevertheless a functional check of the controller together with the rotational check of the compensation system is recommended.

The typical life expectancy of the internal Li-battery is min. 8...10 years. It should only be exchanged by the manufacturer.

In the event of any interventions in the controller during the warranty period, all warranty claims lapse.

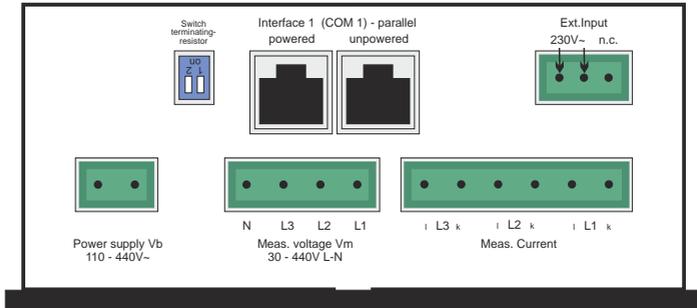
Section 15: INTERFACES

As a standard, the BR7000 is equipped with two RS485 interfaces.

COM 1 is located at the bottom of the device as double- RJ 45 jack.
(for standard-patch-cable)

The „powered“ jack has an additional internal power supply for external accessories.
(e.g. datalog)

View from
bottom:



COM 2 is located at the top of the controller.
This interface has a fix terminating resistor inside.

The following functions can be realized via the interfaces:

- | | | |
|-------------------------------------|--|---------|
| <input checked="" type="checkbox"/> | Parameterization of the controller via PC with enclosed software | COM2 |
| <input checked="" type="checkbox"/> | Software-update | COM2 |
| <input checked="" type="checkbox"/> | Remote read out of grid parameters, storage, display, grid analysis with enclosed PC- software BR7000-SOFT during online-operation | COM1, 2 |
| <input checked="" type="checkbox"/> | Usage for external capacitor-current measurement with MMI or for coupling of two controllers | COM2 |
| <input checked="" type="checkbox"/> | Coupling of several controllers via Touch-Panel TP607LC | COM1 |
| <input checked="" type="checkbox"/> | Usage for customer specific applications (facility master control system, SPC etc.) | COM1 |
| <input checked="" type="checkbox"/> | MODBUS-protocol | COM1, 2 |
| <input checked="" type="checkbox"/> | ASCII-protocol | COM1 |

Coupling with a PC for the usage of Windows-Software can be done from both interfaces with accessory "USB-adapter".

RS485- Bus structure

All devices are connected to one line in parallel. (Example connection of several BR7000 to a PC). This can be done via standard patch-cables (LAN-cable)

NOTE: This is not a LAN-network

Max. cable length in the bus is 1,200 m (depending on cable and baud rate).

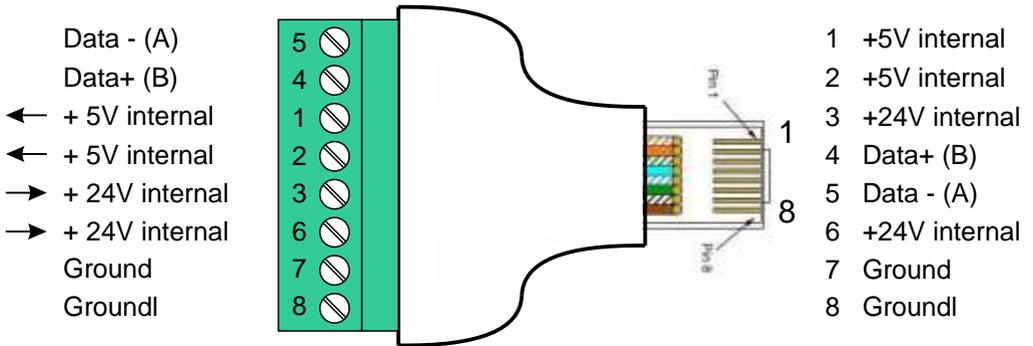
At the first and at the last device of the bus the cable has to be terminated with resistors. Activation (termination) on the controller side is done with the switch "Termination" next to the clamp "COM1" (both white switches on "ON").

COM2 has a fix terminating resistor inside.

INTERFACE Parameter:

1	PROTOCOL	COM1	[MODBUS RTU]	(ASCII, MODBUS, ----)
2	BAUDRATE	COM1	[9600/None]	(9600...256000 / None, Odd, Even)
3	BUS ADRESS	COM1	[1]	(1...255)
4	ASCII-Transm.interval		[10] sec.	(5...255)
5	PROTOCOL	COM2	[MODBUS-RTU]	(----, MODBUS, MASTER)
6	BAUDRATE	COM2	[38400/None]	(9600...256000 / None, Odd, Even)
7	BUS ADRESS	COM2	[1]	(1...255)

RJ45 Pin configuration



The adapter is available for standard-wiring as accessory.

Section 16: C-TEST-MODE and TEST-RUN

C-TEST: During each switching operation in AUTO-MODE the power of the particular capacitor stage is calculated and compared to the step power of the capacitor stage in the background. An error message will be displayed in case of discrepancies!

A calculated faulty capacitor will be shown in the display as inverse capacitor-symbol

- | | | | |
|----|---|---|--------------|
| 1 | C-TEST | [YES] | (YES/NO) |
| | The C-TEST can be suppressed here. | | |
| 2 | MMI -TYPE | [MMI8003] | |
| 3 | NUMBER OF MMI | [1] | (1...6) |
| 4 | FAULT C: OFF | [NO] | (NO / YES) |
| 5 | C-FAULT(+) | [140]% | (105...200%) |
| | Here the upwards deviation from the capacitor's nominal value can be determined. In case this value is reached, an error message is displayed. | | |
| 6 | C-FAULT (-) | [60]% | (10...90 %) |
| | Here the downwards deviation from the capacitor's nominal value can be determined. In case this value is reached, an error message is displayed. | | |
| 7 | TEST ATTEMPTS | [6] | (3...25) |
| | A C-error message is displayed only after these given numbers of consecutive measurements have indicated an error of the capacitor output. | | |
| 8 | FAULTY-C BLINKING | [NO] | (NO / YES) |
| | YES: defective capacitor will indicate blinking as inverse capacitor symbol, even when switched off. | | |
| 9 | TEST-RUN | [NO] | (NO / YES) |
| | YES: starting of 3 Test-runs. Here all stages will switched-on and -off one by one. The difference-current (before and after switching) are captured, rated and stored. All values are transferred to the table in item 13. | | |
| 10 | START | | |
| 11 | TEST-RUN | | |
| 12 | BREAK UP | | |
| 13 | C-TEST / TEST-RUN | Listing of the results of C-Test and TEST-RUN
[C01] -> (C-Test) kvar (Test-Run) kvar
[C02] -> (C-Test) kvar (Test-Run) kvar | |
| 14 | TIME STAMP- TEST | Info about last Test-Run | |
| 15 | MEMORY RESET | [NO] | (NO /YES) |
| | Reset of C-Test values and inverse capacitors | | |

CONTROL PRINCIPLE

The control behavior can be selected in the programming mode. Generally, the BR7000 offers different possibilities of controlling:

- **SEQUENTIAL CONNECTION**

In sequential connection, the required capacitor stages are successively connected or disconnected step by step (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 reaction time, high switching frequency of small stages, uneven strain on the capacitors.

In order to shorten the setting times nevertheless, the BR7000 simultaneously switches several steps in case a higher power factor correction is required.

This applies to all control modes.

The maximum size of the simultaneously switched branches can be changed in EXPERT-MODE 1. If the value of the smallest stage is pre-selected, the conventional sequential connection is obtained.

- **LOOP CONNECTION**

In this variant, the controller operates in loop connection (first in - first out) which minimizes the wear off of the system. E.g. in case of stages of same value always the stage that has been disconnected for the longest time is connected next.

Advantage: even utilization of stages, increase of life time of system.

Disadvantage: only effective for control series with groups of same stage power, long reaction times.

- **INTELLIGENT (Factory setting)**

The intelligent control principle combines the advantages of the system-saving loop connection (first in first out) with a significantly higher setting time even in case of high load skips, and reaches this target with the fewest possible switching operations of capacitor steps. The optimized time behavior is reached by simultaneous switching of several or larger capacitor groups depending on the missing reactive power in the grid. Additionally, the number of real switchings of the capacitors as well as switch-in times of the branches are considered.

Advantage: Reaching of target cos-phi in fast, optimized setting times in combination with a low switching frequency of the capacitor.

- **COMBINED DE-TUNING** (Special case for combined de-tuned systems)

Pair wise de-tuning requires an appropriate control series (e.g. 1:1:1:1..., 1:1:2:2:..., 1:1:2:2:4:4...). The condition for the switching behavior is defined in a way that the number of connected odd steps always is higher or equal to the number of connected even steps. The controller fulfills the requirements in the control regime whilst largely conforming to the switching behavior.

Design of ASCII -transmission protocol

The following data are send one after the other:

U1= 223 V	U2= 222 V	U3= 220 V	
I1= 100 A	I2= 100 A	I3= 100 A	
PF1= +0.949	PF2= -1.000	PF3= +1.000	
Q1= 100 kvar	Q2= 100 kvar	Q3= 100 kvar	
P1= 100 kW	P2= 100 kW	P3= 100 kW	
S1= 100 kVA	S2= 100 kVA	S3= 100 kVA	
OUT1= -----	OUT2= -----	OUT3= -----	(active stages)

Application: Controller coupling

Application example:

Two separate systems operate at two transformer feed ins; it exists one coupling with coupling switch between both systems.

- a) Coupler opened; both systems operate self-governed;
- b) Coupler closed; with the controller coupling both systems are operated symmetrically in *parallel operation* (same number of steps in each system) or both systems are operated in *master/slave mode*. (First all stages of the first system, then all steps of the second system)

Coupling of 2 power factor controllers BR7000 is done via their interface COM2:



The operation mode coupling operation (parallel operation resp. master-slave-operation) is selected in the program-mode under 23 EXTERNAL INPUT.

The 110...230V~ signal "coupling switch closed" has to be directed to the external input of a controller (master). The programming has to be performed only on this controller. No more settings required !

Annex 1: Table of control series

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

Control series editor: Programming of step values up to 30

The control series editor enables easy creation of own control series in case the required control series is not available.

In "PROGRAM-MODE" the last control series - control series ED - has to be selected and confirmed by ENTER. This adds an additional menu point to the main menu -> control series editor. It can be accessed via button „operation mode“.

In the control series editor all stages can be set consecutively to the desired value with the selection buttons \uparrow/\downarrow . Pressing ENTER leads to the next stage.

In the control series editor the particular stages can be programmed up to a value of 30 (!). The values >9 are displayed as follows:

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

Attention: All control series can be edited (even downwards). Whether an edited control series "makes sense" is the decision of the customer.

Maximum number of stages can be limited by a programmed ENDSTOP.

By pressing button "Operation mode" the editor is left.

Annex 2: Troubleshooting

Fault	Reasons / Solution
For target $\cos \text{PHI}=1$ and inductive load steps are switched out / for the already compensated grid steps are switched in Supply and consumption exchanged.	Check terminals of measuring voltage and measuring current (l and k)! Check phase position! Check phase allocation (voltage/current in same phase)
Wrong $\cos \text{Phi}$ is displayed	See above
Display "Measuring current <??>" (UNDERCURRENT)	Current in measuring range ? Line interruption ? Wrong current-converter factor ? Current transformer short-circuited ?
Display: "OVERCURRENT" Alarm relay: after 10 min.	Check ratio of current transformer (1/5A) Go through measuring current range
Display: "UNDERCOMPENSATED" Alarm relay: after 10 min.	Check connections and phase position ! All stages connected, target PF not reached: - system sufficient dimensioned ?
Display: "OVERCOMPENSATED" Alarm relay: after 10 min.	Check connections and phase-position ! Capacitive grid although all stages are disconnected
Display: "MEASURING VOLTAGE ??" Alarm relay: after 10 min.	Measuring voltage missing !
Display: "UNDERVOLTAGE" Alarm relay: after 10 min.	Measuring voltage (in programming) must be in line with real terminal voltage Check programming over-/under voltage range in EXPERT-MODE 2!
Display: "OVER-TEMPERATURE" Alarm relay: after 10 min.	System temperature too high ! Outputs are switched off in stages irrespective of power line conditions.
Display: "HARMONICS" Alarm relay: after 10 min.	Stages switch off consecutively according to the programmed time and control series. Check grid conditions! If permissible: increase threshold TDH-V (7 %)
Display: "WARN. SWITCH.OPERATIONS" Notification for user only! No influence on the control behavior.	Number of switching operations of a capacitor branch has reached the pre-set limiting value of 50,000. Reset possible in EXPERT-MODE.

Fault	Reasons / Solution
<p>In inductive grid stages are switched off resp. in capacitive grid conditions stages are switched on</p>	<p>In case a value other than 1 for target- cos-phi is pre-set, the display "<" may be illuminated despite an inductive grid load. Arrows indicate the control direction, not the grid conditions!</p>
<p>The controller does not connect all stages or cos-phi does not change at the last stages</p>	<p>Check END STOP! Check CONTROL-MODE!</p>
	<p>Check whether in the menu "Manual operation/fixed steps" particular steps have been programmed as fixed steps or as OUT</p>
<p>Connected capacitor contactors are not in line with the expected capacitor stages.</p>	<p>Check allocation of outputs to capacitors: In program mode HELP-button call page 7-9 > table of allocations is displayed. Check control-mode and END STOP!</p>
<p>The system permanently switches capacitors on and off although the number of consumers does not change (system oscillating).</p>	<p>Check programming and the capacitance of the smallest stage. Check programming and the values of the current converters. Check programming of the control series and the capacitance of the capacitors.</p>
<p>Operation voltage missing</p>	<p>Note: no display, alarm relay open</p>

Annex 3: Technical Data

Type series	BR 7000...
Operating voltage	110...440 V~, +/-10%, 50 / 60Hz
Measuring voltage (3-phase)	3 · 30... 440 V~ (L-N) / 50...760V~ (L-L)
Measuring current (3-phase)	3 · X : 5 / 1A selectable
Power consumption	< 5 W
Sensitivity	50 mA / 10mA
Switching power	
Relay outputs for capacitor branches	15 relays: freely programmable for switching of single- and three-phase capacitors
Alarm relay	1
Message relay	1, programmable
Relay for panel fan	1
Switching power of relay outputs	250VAC, 1000W
Number of active outputs	programmable
Operation and display	illuminated full graphic display 128x64 dot
Menu Languages	Ger / E / ES / RU / TR
Number of control series	20
User-defined control series	1 via editor
Controlling	true controlling of each phase (L-N) und (L-L)
Modes of operation (1- and 3-phase)	1- phase: up to 3 · 5 single phase capacitors 3- phase: up to 15 three-phase capacitors mixed Mode: for balancing and compensation
Control principle	series switching, circular switching, self-optimized intelligent switching, 4-quadrant operation
Automatic initialization	possible
Meas. of individual capacitor step current	possible
Target- cos j	0.1 ind. ... 0.1 cap adjustable
2 nd target cos j (time- or result controlled)	0.1 ind. ... 0.1 cap adjustable
Switch on time	selectable from 1 sec. to 130 min
Switch off time	selectable from 1 sec. to 130 min
Discharge time	selectable from 1 sec. to 130 min
Internal clock / several timers	yes
Manual operation	yes
Fixed steps / skip steps	programmable
Zero voltage release	standard

Display / Display functions	
Display of grid parameters As real value/in %/as bar graph	3-phase cos-Phi, voltage, current, frequency, reactive-, active-, apparent power, missing kvar, temperature, THD-V / THD-I
Large display of 3 grid parameters	selection via display-editor
Harmonics	3. - 31. harmonics of U and I display also in % or as bar graph
Osci-mode	graphical display of 1 period U/I in oscilloscope mode
Precision	current / voltage: 1% active, reactive, apparent power: 2%
Integrated auxiliary function	context depending, plain text
Storage function	
Storage of maximum values with time stamp	voltage, current, reactive-, active-, apparent power, temperature, THD-V, THD-I
Storage of switching operations	each output, separately re-settable
Storage of operation time	each capacitor step, separately re-settable
Temperature measuring range	-30 ... 100°C
Temperature monitoring	automatic switching-off of steps
Error storage	error register in plain text with time stamp
Interface	2 independent interfaces RS485 (MODBUS RTU)
Software for device settings, visualization, display and recording of grid parameters	enclosed in delivery
External Input	
Complete 2nd parameter set	110...230V~ isolated via external input or event driven
Casing	panel-mounted instrument DIN 43 700, 144 x 144 x 50 mm
Weight	1 kg
Operating ambient temperature	-20 ... +60°C
Protection class accord. EN60529:2014	front: IP 54, rear: IP 20
Safety standards	IEC 61010-1: 2011-07
Interference resistance	IEC 61000-6-2: 2006-03
EMV-resistance	IEC 61000-4-2: 2009-12
	IEC 61000-4-4: 2013-04
	EN 61326

Annex 4: Factory 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 system (optimal values for the relevant network)

No.	Parameter	Default setting	Programmed values of this system (to be entered by manufacturer or operator)
1	LANGUAGE	ENGLISH	
2	CONTROL-MODE	[1] 3x5 single-phase capacitors L-N	
3	I CONVERTER PRIM.	1000 A	
4	I CONVERTER SEC.	5 A	
5	END STOP	3 x 5	
6	CONTROL SERIE	1	
7	CONTROL PRINCIPLE	INTELLIGENT	
8	POWER 1st STAGE	25.00 kvar	
9	TARGET COS-PHI	0.98 IND	
10	TARGET 2nd COS-PHI	- SUPPLY -	
14	MEASURING VOLTAGE	L-L 400 V (L-N 230V)	
15	V-CONVERTER	- NO -	
16	FREQUENCY	40...90 Hz	
17	CONNECTING TIME	40 sec.	
18	DISCONNECT. TIME	40 sec.	
19	DISCHARGE TIME	60 sec.	
20	ALARM TEMPERATURE	55°C	
21	FAN TEMPERATURE	30°C	
22	MESSAGE RELAY	- OFF -	
23	EXT. INPUT	- NO -	
24-37	Values 2nd parameter set		Default values are the same as in the 1st parameter set.
38	HARMONICS THD-V	7 %	
39	HARMONICS THD-I	--,--	
40	CLOCK / DATE		
41	Q-OFFSET	- NO -	
42	CONTRAST	4	
43	BASIC SETTINGS	- NO -	

No.	Parameter 2nd parameter set / EXPERT-MODE	Default setting	programmed values of this system (to be entered by manufacturer or operator)
	EXPERT-MODE:		
1	PASSWORD Expert-Mode 1	6 3 4 3	
2	BASIC SETTINGS	- NO -	
3	SWITCH.OPERATION Reset	- NO -	
4	OPERATING TIME Reset	- NO -	
5	INTEGRATION TIME	1 sec.	
6	SWITCH.POWER	4 x smallest stage	
7	SWITCH.TRIGGER IND	66 %	
8	SWITCH.TRIGGER CAP	66%	
9	OPERATING LOCK	- NO -	
10	SWITCH.OPER.WARNING	50,000	
11	CONTROL *	MEAN VALUE	
12	DISPLAY	cosj -0.10...+0.10	
13	V - connection	N - L1 - L2 - L3	
14	OUTPUT 1st STEP	0 ... 255 kvar	
15	CHANGE PASSWORD	- NO -	
20	Error Backlight	Pink	
1	PASSWORD Expert-Mode2	6 3 4 3	
2	Error messages	all „YES“	
3	Delay alarm-relay	10 min.	
4	C-FAULT (+)	50%	
5	C-FAULT (-)	115%	
6	OVERCOMPENSATED	Q-Diff.	
7	UNDERCOMPENSATED	Q-Diff.	
8	Switch.operation RESET	- NO -	
9	Operating time - RESET	- NO -	
	INTERFACE:		
1	Protocol COM1	Modbus RTU	
2	Baudrate COM1	9600 / None	
3	Bus-adress COM1	1	
4	ASCII transm. interval	10 sec.	
5	Protocol COM2	Modbus RTU	
6	Baudrate COM2	38000 / None	
7	Bus-adress COM2	1	
	C TEST MODE		
1	C-TEST	YES	
2	MMI-TYPE	MMI8003	
3	Number MMI	1	
4	FAULTY C OFF	NO	
5	C-FAULT (+)	140 %	
6	C-FAULT (-)	60 %	
7	TEST ATTEMPTS	6	
8	DEFECTIVE C BLINKING	NO	

AUTO-MODE 1/2
 L1 cos ϕ 0.869 IND
 L2 cos ϕ 0.869 IND
 L3 cos ϕ 0.869 IND
 L1 *****
 L2 *****
 L3 *****
 1 2 3 4

===== PROGRAM-MODE =====

1 LINE VOLTAGE
 L1-N 230 V
 L2-N 230 V
 L3-N 230 V
 PE-N 0 V

1 LANGUAGE [1]
 [ENGLISH]

2 CURRENT [1]
 L1 123 A
 L2 239 A
 L3 167 A

2 CONTROL-MODE [1]
 [3] PHASE MEASURING
 max. [3x5 single phas.]
 capacitors Ph - N

3 REACTIVE POWER
 L1 88 kvar
 L2 88 kvar
 L3 88 kvar
 S 264 kvar

3 I-CONVERTER PRIM.
 L1 [1000] A / 5 A
 L2 1000 A / 5 A
 L3 1000 A / 5 A

4 ACTIVE POWER
 L1 88 kW
 L2 88 kW
 L3 88 kW
 S 264 kW

4 I-CONVERTER SEC.
 L1 1000 A / [5] A
 L2 1000 A / [5] A
 L3 1000 A / [5] A

5 APPARENT POWER
 L1 88 kVA
 L2 88 kVA
 L3 88 kVA
 S 264 kVA

5 ENDSTOP L...-N
 L1-N ***** [5]
 L2-N ***** 5
 L3-N ***** 5

6 DIFF. TO PF
 L1 12 kvar
 L2 24 kvar
 L3 16 kvar
 N 52 kvar

6 CONTR.SERIES
 L1-N 11111 [1]
 L2-N 11111 1
 L3-N 11111 1

7 FREQUENCY
 50 Hz

7 CONTR. PRINC. [3]
 [INTELLIGENT]

8 TEMPERATURE
 25 °C

8 POWER 1st STAGE
 L1 [25] 00 kvar
 L2 25 00 kvar
 L3 25 00 kvar

9 HARMONICS [3]
 L1 V 0.5% I 1.0%
 L2 V 0.8% I 1.0%
 L3 V 0.5% I 1.0%

9 TARGET cos ϕ
 [0.98 IND]

10 HARMONICS THD
 L1 V 0.3% I 0.2%
 L2 V 0.3% I 0.2%
 L3 V 0.3% I 0.2%

10 TARGET 2nd cos ϕ
 [SUPPLY]

11 COMP-POWER
 100 kvar / 7%

11 TARGET 2nd cos ϕ
 [1.00 IND]

12 ENERGY
 xxx kvarh (+)
 xxx kvarh (-)
 xxx kWh (+)
 xxx kWh

12 SWITCH-ON TIME j 2
 ON [16] : 00 MO-FR
 OFF 07 : 00 MO-FR

13 TIME / DATE
 11:55:00
 THURSDAY
 05.05.2016

13 SWITCH-OFF TIME j 2
 ON 16 : 00 MO-FR
 OFF [07] : 00 MO-FR

14 MEASUR.VOLTAGE
 L - L [400] V
 L - N 230 V

15 V - CONVERTER
 [NO]

16 FREQUENCY
 [40...90Hz]

17 SWITCH-ON TIME
 C-ON [40] s
 C-OFF 40 s
 C-DIS 60 s

18 SWITCH-OFF TIME
 C-ON 40 s
 C-OFF [40] s
 C-DIS 60 s

19 DISCHARGE TIME
 C-ON 40 s
 C-OFF 40 s
 C-DIS [60] s

20 ALARM TEMPERATURE
 [55 °C]

21 FAN TEMPERATURE
 [30 °C]

22 MESSAGE RELAY [1]
 [OFF]

23 EXT.INPUT [1]
 [NO]

24 - 37 values 2nd parameter set correspond to item 3 ... 18 of standard programming

38 HARMONICS
 THD-V [7.0] %

39 HARMONICS
 THD-I [---] %

40 TIME / DATE
 [HH] : [MM]
 WEEKDAY
 TT : [MM] : [JJJ]

41 Q-OFFSET L1
 [NO]

42 CONTRAST
 ***** [4] *****

43 BASIC SETTINGS
 [NO]

BACK TO 1

Changing of values by buttons:



only available if control serie „ED“ is selected

CONTROL SERIES EDITOR



VALENCY C01 [1]
 ①1111111111111111

select with button ENTER up to (max) C15

VALENCY C15 [1]
 111111111111111①

BACK TO 1



MANUAL-MODE



MANUAL-MODE 1
 [STOPP]
 L1 Q-diff kvar

MANUAL-MODE 1
 [STOPP]
 L2 Q-diff kvar

MANUAL-MODE 1
 [STOPP]
 L3 Q-diff kvar

MANUAL-MODE 2
 2 STEP STATUS L1
 OUTPUT C1 [AUTO]

BIS

MANUAL-MODE 2
 2 STEP STATUS L3
 OUTPUT C15 [AUTO]



== SERVICE ==



1_max VOLTAGE
 L1-N 230 / 235 V
 L2-N 230 / 235 V
 L3-N 230 / 235 V

2_max CURRENT
 L1 123 A
 L2 239 A
 L3 167 A

3_max REACT.POWER
 L1 88 kvar
 L2 88 kvar
 L3 88 kvar

4_max ACTIVE POWER
 L1 88 kW
 L2 88 kW
 L3 88 kW

5_max APPARENT POWER
 L1 88 kVA
 L2 88 kVA
 L3 88 kVA

6_max TEMPERATURE
 35 °C

7_max THD: V-I
 L1 V 1.0% I 2.0%
 L2 V 1.0% I 2.0%
 L3 V 1.0% I 2.0%

8_MAX VALUES
 RESET [NO]

9_ENERGY
 RESET [NO]

10_SWITCH.OPERATIONS
 [C01] -> 257
 [C02] -> 137
 [C03] -> 121

11_OPERATING TIME
 [C01] -> 50:30 h
 [C02] -> 37:20 h
 [C03] -> 15:34 h

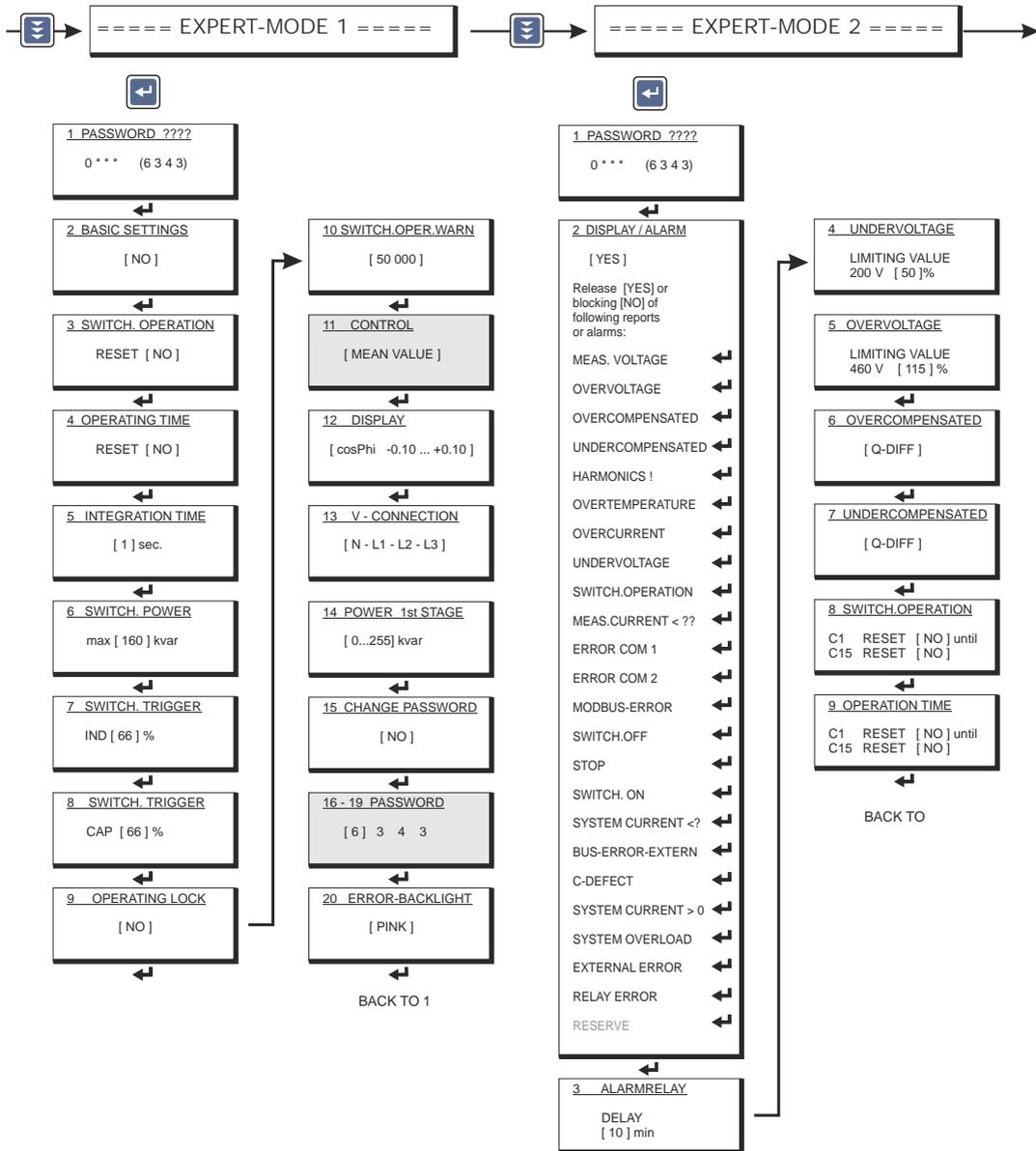
12_ERROR MEMORY
PLAIN TEXT....
DATE / TIME

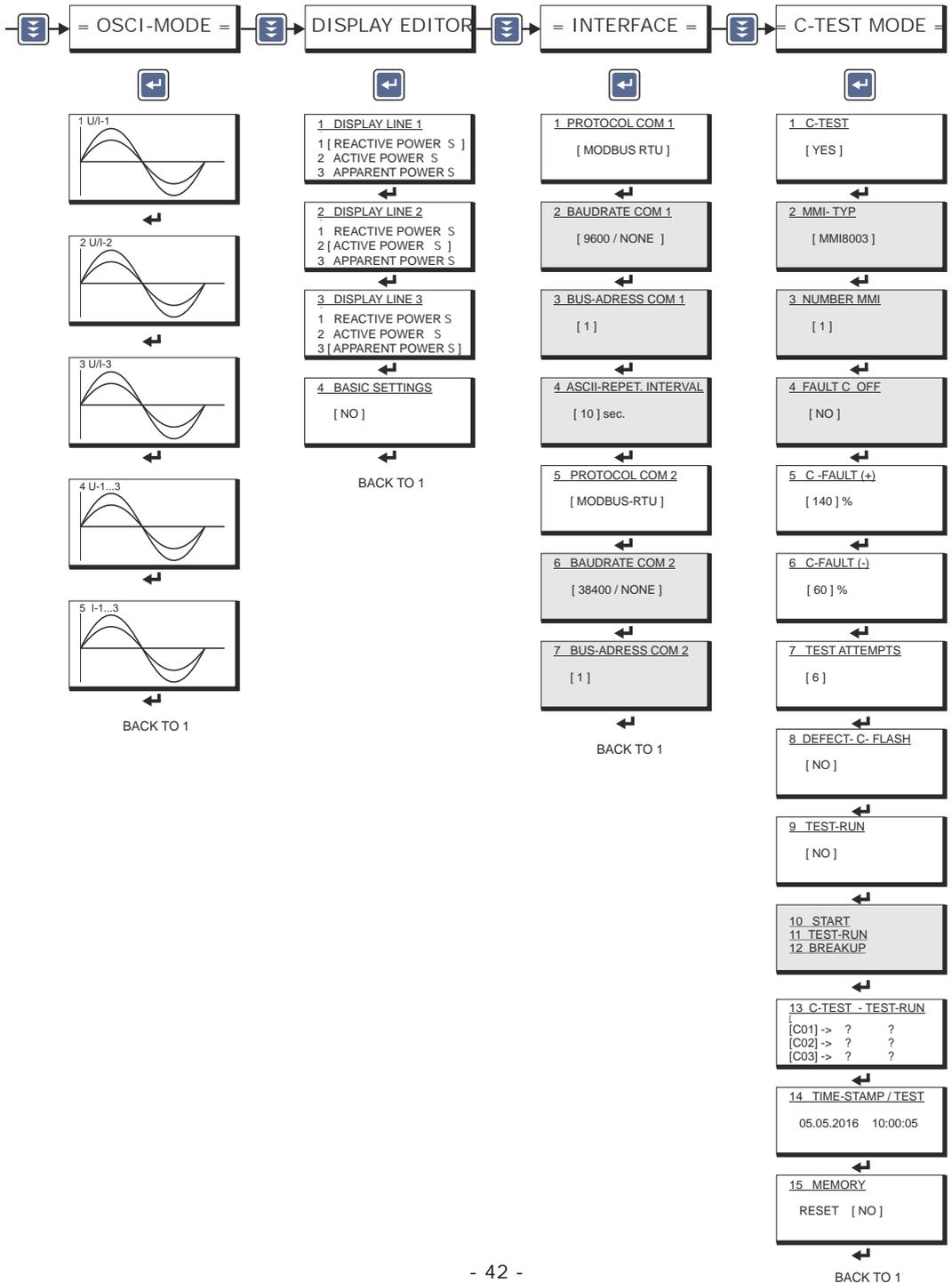
13_ERROR MEMORY
 RESET [NEIN]

After 4 min. without pressing any button, automatic change to auto-mode

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 BR 7000





Accessories

Multi Measuring Devices
MMI6000 and MMI7000



Data-Logger "DataLog SD"
for BR6000 and BR7000
Recording of all grid- and
system parameters on a
SD memory card



RJ45 adapter connectors for
PF controllers and MMIs.
Terminal to RJ45 converter to
connect the devices via RJ45-
standard cable.



USB to RS485 converter to connect
the PF controllers or other devices
with Interface RS485 to a PC with
USB-interface.

Thyristor-switches
different types: TSM-LC / TSM-HV
10 ... 200kvar / 400 ... 690V

