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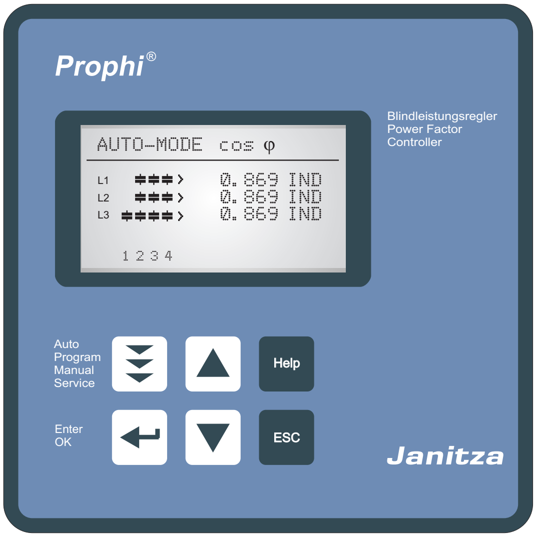
Power Factor Controller

Prophi® 15R-III

Manual



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CONTENTS

CAUTIONS:

1. High voltage !
2. Device 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 is the consequent follow-up development of the well proven series *Prophi*.
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.

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 are available for the *Prophi*; 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 mascing 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 device 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 controller, 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 mm^2 Cu.

Terminals may only be plugged when de-energized!

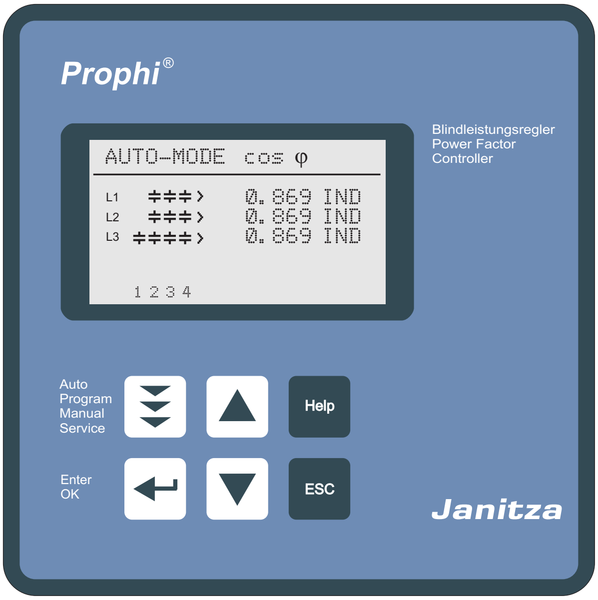
Attention!
During single-phase operation the coil voltage for the capacitor contactors must be drawn from the same phase as the measuring voltage as only the measuring voltage is monitored. (Protection against direct re-switching of contactors during a short-term single-phase voltage drop.)

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!

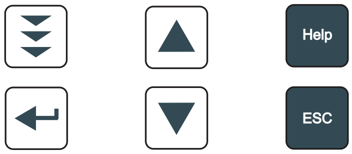
The controller is supplied for a standard operating voltage of 110...440VAC (+/-10%), a measuring voltage of 30...440 V~ (L-N) resp. 50...760V~ (L-L), 50/60Hz, and a measuring current of 5A or 1A (programmable). A voltage converter is required for different operating voltages.

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



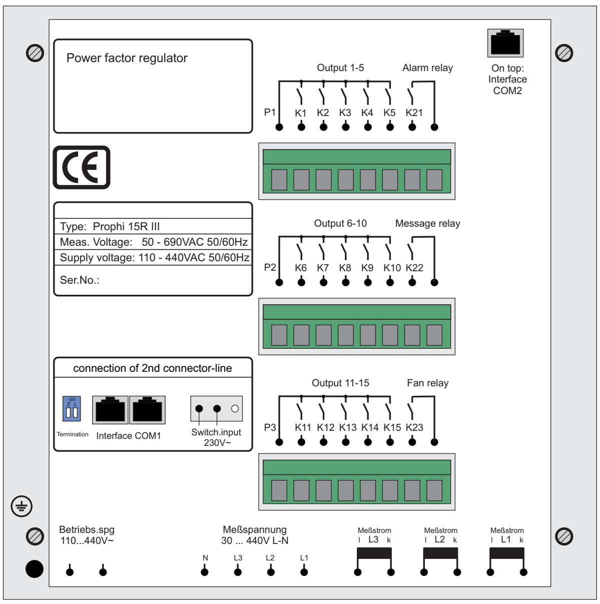
Front view

Operating mode:	Increase selected parameter	HELP opens Help pages
- Automatic - Program. - Manual oper. - Service - Expert Mode - Osci - Mode - Display Editor		



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!

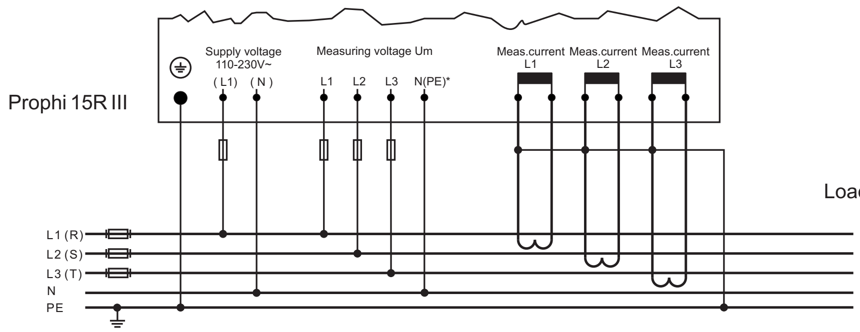
In the "HELP"-menu the device directly displays the actual correct allocation of outputs (AUTO-MODE: Help-page 7-9).

For examples also see page 20

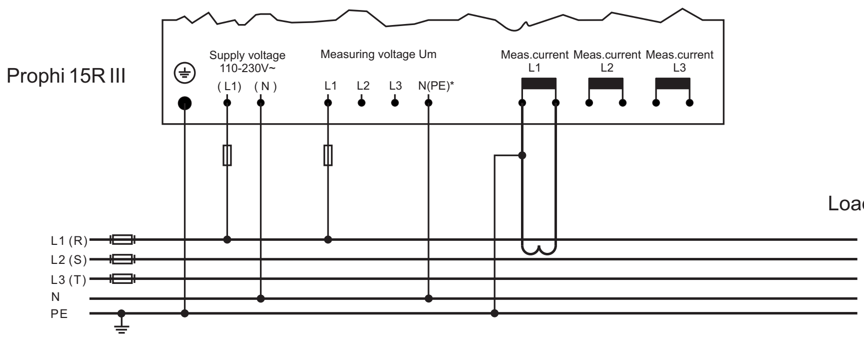
Section 3: CONNECTION ALTERNATIVES MEASURING VOLTAGE AND MEASURING CURRENT

According to the existing grid and the desired operating mode (CONTROL-MODE Programming) the device 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

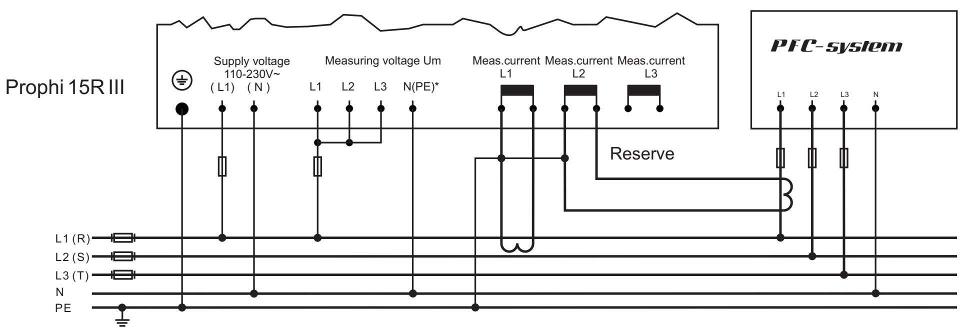
Alternative 1: measuring performed in each phase - 3 current transformers needed
Use: CONTROL-MODE: 1 - 4



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



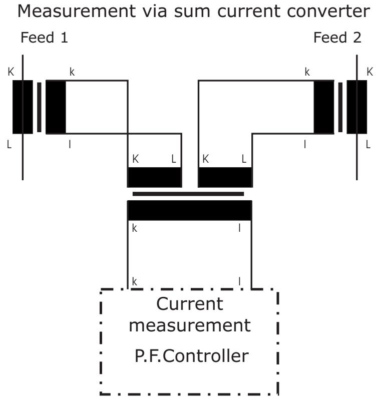
Connection of current transformer / sum current transformer

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 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

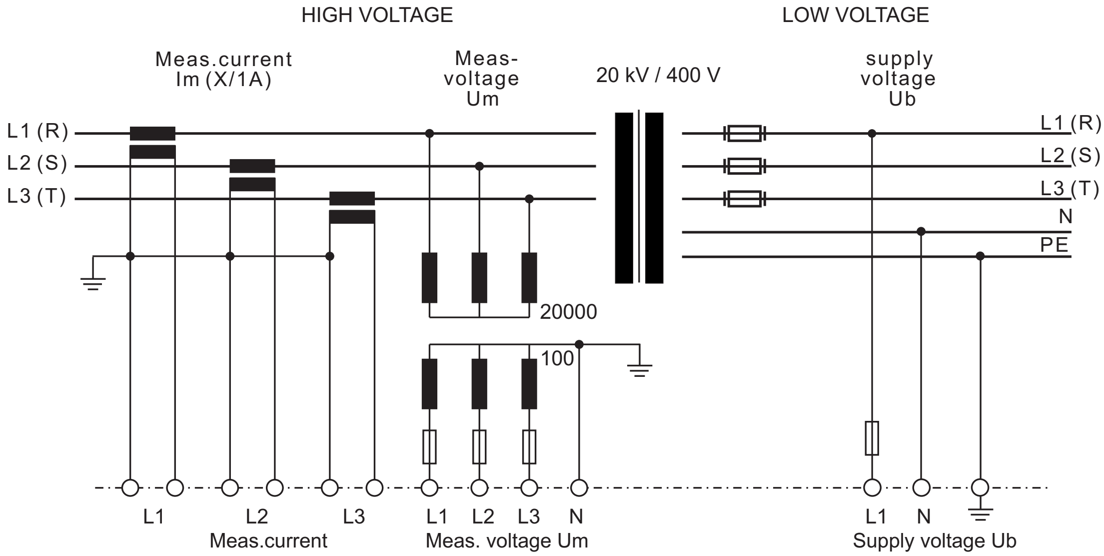


Caution!
The secondary clamps of the CT have to be short circuited before current leads are iterrupted !

High Voltage Application

The example shows the connection 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 controller has to be programmed as follows:

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

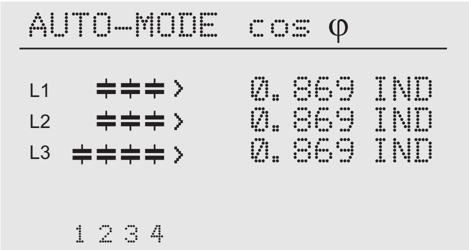


Section 4: DISPLAY - FUNCTIONS

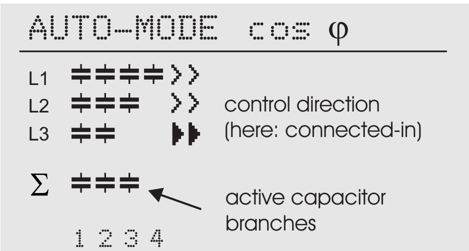
After the operating voltage has been switched on, the controller briefly indicates with description and software-version before changing to automatic operation.

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.

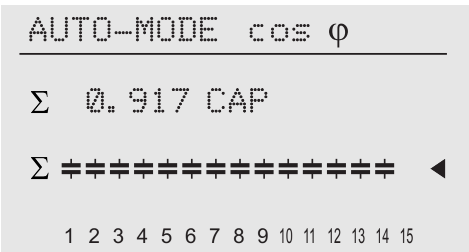
Example 1: Automatic operation
L1...L3: Individual compensation by single-phase capacitors



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



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



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 aktivated: “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 ↑ 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)

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):

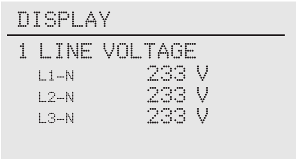
Action	Display	Unit	in%	Bargraph possible	3-phase
ENTER	1 LINE VOLTAGE	V			x
ENTER	2 CURRENT	A	(apparent-, active-, reactive)		x
ENTER	3 REACTIVE POWER	kvar			x
ENTER	4 ACTIVE POWER	kW			x
ENTER	5 APPARENT POWER	kVA			x
ENTER	6 DIFF. kvar to target	kvar			x
ENTER	7 FREQUENCY	Hz			
ENTER	8 TEMPERATURE	°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	↑ / ↓ change the date format			
ENTER	14 Software version	↑ / ↓ more information			
ENTER	return to: 1				

Buttons ↑ / ↓ change the display format:

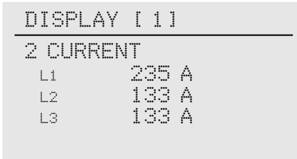
The values can be displayed in their unit, in % or as bar chart.
Examples, see next page.

=== DISPLAY ===

Examples of different displays:

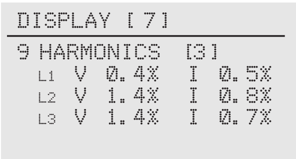


VOLTAGE 3-phas.



CURRENT: 3-phas.

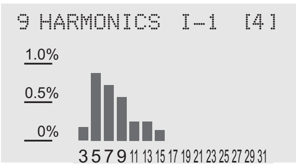
REACTIVE PWR 3-phas.



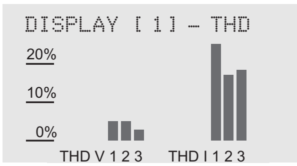
HARMONICS in %

TEMPERATURE °C

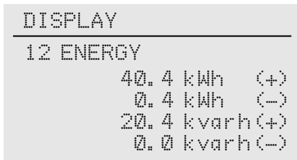
DIFF. REACTIVE PWR in %



HARMONICS diagram



THD V/I as bar diagram



ENERGY

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

- **Auto**matic 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 ↑ / ↓. By pressing the "ENTER-button" the value is stored. Pressing the "ESC"-button allows to go one step back (without storing).

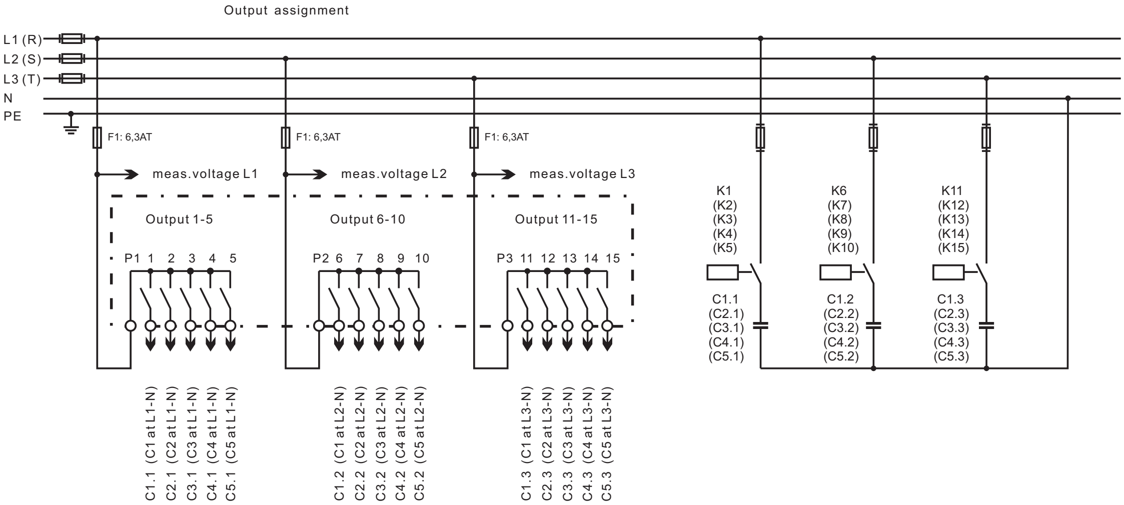
1 LANGUAGE

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!

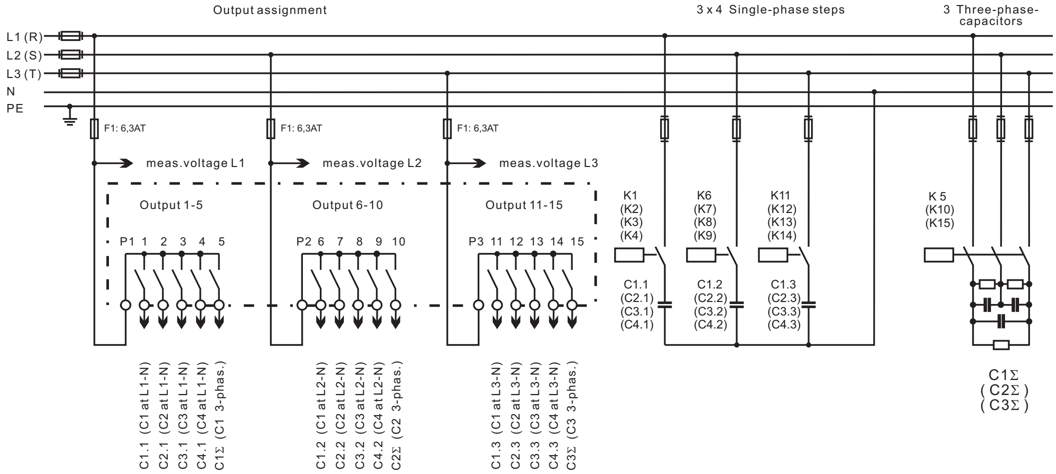
In the HELP-function the controller directly displays the correct allocation of outputs (AUTO-MODE: Help-page 7-9).

=== PROGRAM-MODE ===

CONTROL-MODE [2]: <u>MIXED-MODE</u> 3-phasige 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.

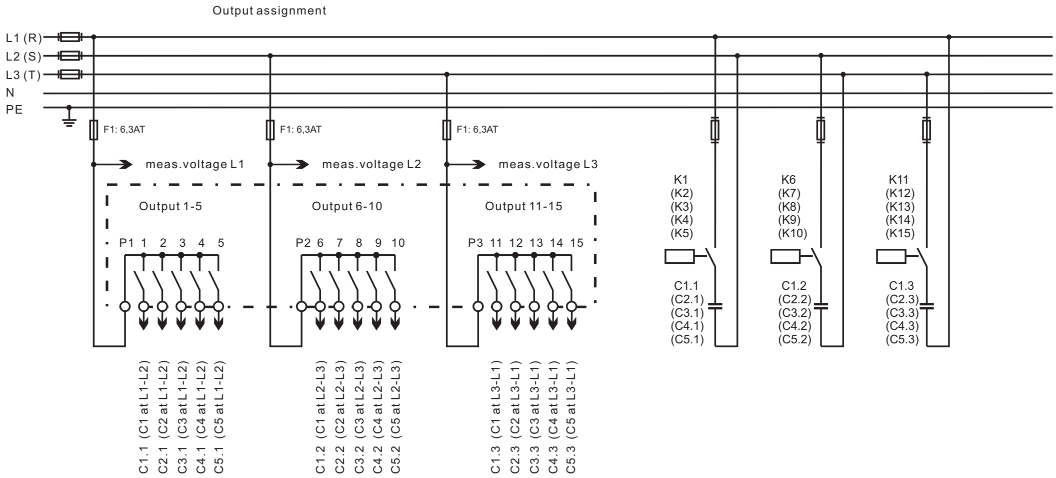
Example:
3x 4 single-phase-capacitors +
3 standard 3-phase capacitors



CONTROL-MODE [3]:
3-phase measuring / max. 3x5 single-phase capacitores 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

Example:
3x 5 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**)
Connection of controller: 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**)
Connection of controller: 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 „MMI7000"
Can be used if CT is far away from the controller or MMI7000 already exists in the system
Connection of MMI7000 is done via LAN-cable to **COM2** at the controller
Connection of MMI7000: compare connection at page 6 / pict.1
Connection of controller: 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 „MMI7000"
Connection of MMI7000 is done via LAN-cable to **COM2** at the controller
Connection of MMI7000: compare connection at page 6 / pict.1
Connection of controller: 3-phase voltage only, no connection of CTs needed.

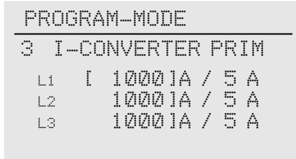
CONTROL-MODE [11]: 3-phase measuring / max. 15 three-phase capacitors Remote measurement and internal real monitoring of capacitors (L1...L3)
correspond to Control-Mode 6, but *remote measurement* via „MMI7000"
internal real monitoring of capacitors via current inputs L1...L3
e.g. Monitoring for 1...3 cabinets
Connection of MMI7000 is done via LAN-cable to **COM2** at the controller
Connection of MMI7000: compare connection 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 „MMI7000"
internal real monitoring of capacitors via current inputs L1...L3
--> Single-phase monitoring for 1 cabinet
Connection of MMI7000 is done via LAN-cable to **COM2** at the controller
Connection of MMI7000: compare connection at page 6 / pict.1

=== PROGRAM-MODE ===

3 I-CONVERTER PRIM [1000] A / X (5 … 13000) A

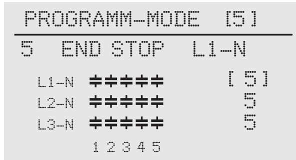
Selects the primary current of the current converter.
Sequential adjustment of L1…L3.
via the ↑ / ↓ keys. Save and continue with ENTER



4 I-CONVERTER SEC 1000 A /[5]A (1 / 5 A)

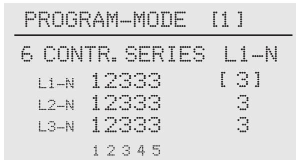
This sets the secondary current of the current converter.
Selection via ↑ / ↓. Save and continue with ENTER

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 Σ (three-phase capacitors) are set.
The visible symbols of the capacitors correspond to the connected outputs.
Input via ↑ / ↓. Save and continue with ENTER

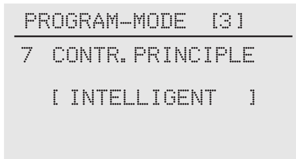
6 CONTROL SERIES [1] (1…20 + ED)



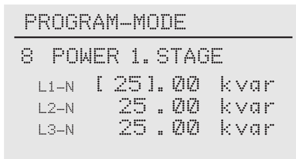
The ratio of the capacitor branch powers determines the control series, the power of the first capacitor always being assigned the value 1.
Selection of desired control series consecutively for L1…L3 and for Σ (three-phase outputs).
If the required control series should not be present, the user may define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

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 ↑ / ↓ keys.
Save and continue with ENTER



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 ↑ / ↓ keys and saved with ENTER.
The positions after the comma are then selected, again via the ↑ / ↓ keys.
If the capacitor value is below the response sensitivity, a warning will occur (indication of **"!"** in the display)

=== 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 ↑ / ↓,
Save and continue with ENTER.

```
PROGRAM-MODE
9   TARGET cos φ
  [ 0.980 IND ]
```

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 φ
  [ 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 φ2 [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 φ2 [HH:MM:SS]

Switch-off time of the timer for the 2nd target-cos phi
(only available if selected under 10)

```
PROGRAM-MODE
12  SWITCH ON TIME φ2
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 ↑ / ↓. 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 ↑ / ↓. 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 ↑ / ↓. 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. Display: **S**
3- Under current:
Message when the measuring current is not met. Display: **U**
Signal is generated when the current value
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 Display: **E**
6 - ERROR - Com1 (interface error)
7 - ERROR - Com2 (interface error) Display: **E**
8 - ERROR - Com1/2 (interface error)
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

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

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:

24. I-converter prim
25. I-converter sec
26. End stop
27. Control serie
28. Control principle
29. Power 1st stage
30. Target cos-Phi nominal value
31. 2nd target cos-Phi NO/supply/Timer
32. 2nd target cos-Phi nominal value
33. Switch on time target cos-Phi-2
34. Switch off time target cos-Phi-2
35. Connecting time
36. Disconnecting time
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 confirmated 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 *Prophi* 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 *Prophi-15R-III* 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 exeption!

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:

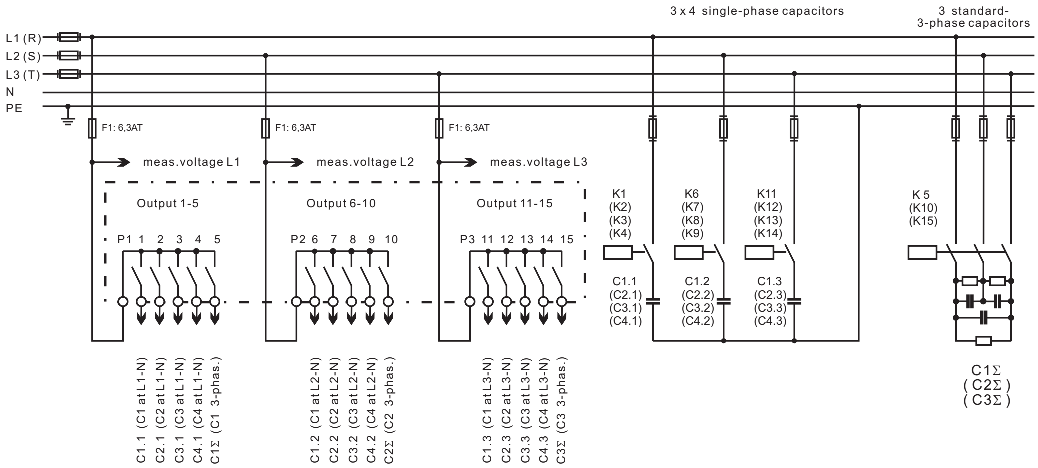
UNDER COMPENSATED missing reactive power	- display and relay
OVER COMPENSATED	- display and relay
OVER CURRENT	- display and relay
MEASURING VOLTAGE ???	- display and relay
OVER TEMPERATURE	- display and relay
OVER VOLTAGE	- display and relay
UNDER VOLTAGE	- display and relay
HARMONICS	- display and 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 influcences 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 controller 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 -> Σ -> C1Σ

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 -> Σ -> C2Σ

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 -> Σ -> C3Σ

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).

```
MANUAL-MODE 1
1 [ STOPP ]
L1     40 kvar
L1 
   1 2 3 4 5
```

CONNECTION or DISCONNECTION is done by pressing the buttons ↑ resp. ↓
This manual operation is executed consecutevely for particular phases L1-L3 resp. Σ.
The operation status and the power power factor of the actual phase are permanently shown in the display.

```
MANUAL-MODE 1
1 [ Switch-OFF ]
L1     40 kvar
L1 
   1 2 3 4 5
```

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:

```
MANUAL-MODE 2
2 STEP STATE L1
OUTPUT C1 [AUTO]
L1 
   1 2 3 4 5
```

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 temporarely 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]- to C [15]	in h 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

```
SERVICE
12 ERROR MEMORY
capacitive Load
too high
overcompensated L3
01.03.19 - 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:

```
EXPERT-MODE
1 PASSWORD  ????

   0***
```

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)

5 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 φ -0.10 ... +0.10]
(tan φ -9.95 ... +9.95)
(cos φ -0.910 ... +0.910)
(tan φ -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)

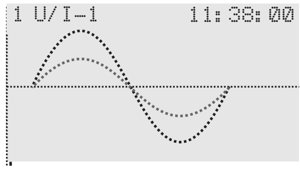
8 SWITCHING OPERATIONS **C1** RESET [NO] (YES/NO)
to
C15 RESET [NO] (YES/NO)
Reset of switching operations of particular capacitor steps,
e.g. after exchange of capacitors or capacitor contactors.

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

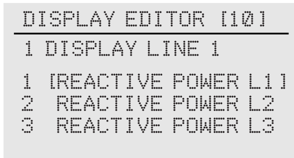
To be reached via button operation menu in the main menu.
In Osci-mode the actual form of a period of voltage and current is graphically displayed. This provides information about phase shift and curve form. Display possible consecutively for L1...L3

L1



Section 13: DISPLAY 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.



Section 14: MAINTENANCE AND WARRANTY

No maintenance of the device 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.

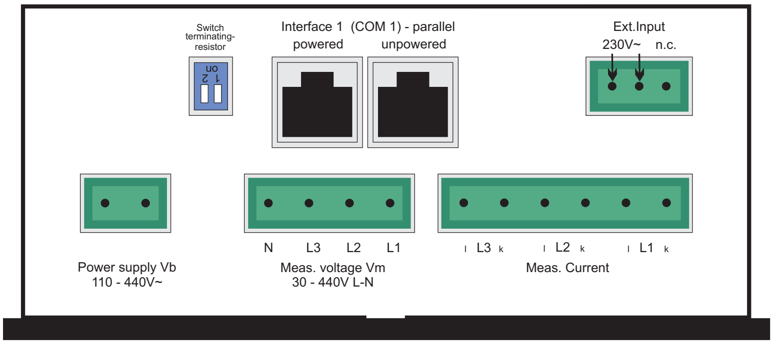
In the event of any interventions in the controller during the warranty period, all warranty claims lapse.

Section 15: INTERFACES

As a standard, the *Prophi-15R-III* 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:

☑	Parameterization of the controller	COM2
☑	Software-update	COM2
☑	Remote read out of grid parameters, storage, display, grid analysis during online-operation	COM1, 2
☑	Usage for external capacitor-current measurement with MMI or for coupling of two controllers	COM2
☑	Coupling of several controllers via Touch-Panel TP607LC	COM1
☑	Usage for customer specific applications (facility master control system, SPC etc.)	COM1
☑	MODBUS-protocol	COM1, 2
☑	ASCII-protocol	COM1

RS485- Bus structure

All devices are connected to one line in parallel. This can be done via standard patch-cables (LAN-cable)

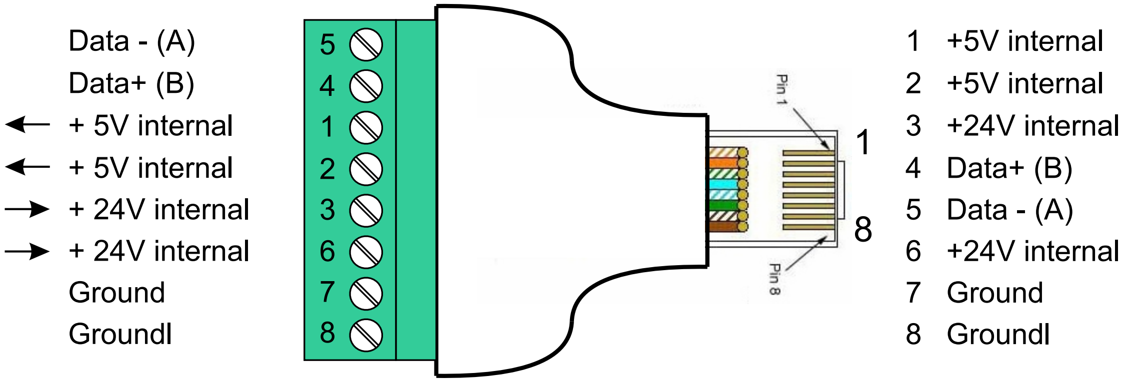
NOTE: This is not a LAN-network

.
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 transfered 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 controller 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 device 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)

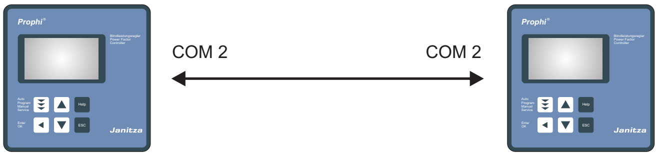
Application: Controller coupling

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 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 ↑ /↓. 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 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 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
In inductive grid stages are switched off resp. in capacitive grid conditions stages are switched on	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!
The controller does not connect all stages or cos-phi does not change at the last stages	Check END STOP! Check CONTROL-MODE!
	Check whether in the menu ”Manual operation/fixed steps‟ particular steps have been programmed as fixed steps or as OUT
Connected capacitor contactors are not in line with the expected capacitor stages.	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!
The system permanently switches capacitors on and off although the number of consumers does not change (system oscillating).	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.
Operation voltage missing	Note: no display, alarm relay open

Annex 3: Technical Data

Type series	*Prophi-15R-III*
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 φ	0.1 ind. ... 0.1 cap adjustable
2nd target cos φ (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

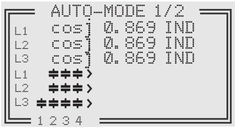
Display / Display functions	
Display of grid parameters As real value/in %/as bar graph	3-phase cos-Phi, voltage, current, frequency, reactive-, active-, apparent power, missing kvar, temperature, THD-V / THD-I
Large display of 3 grid parameters	selection via display-editor
Harmonics	3. - 31. harmonics 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)
External Input	110...230V~ isolated
Complete 2nd parameter set	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 62053-23:2017; IEC 61326-1:2013
EMV-resistance	IEC 61000-6-2: 2006-03 IEC 61000-4-2: 2009-12 IEC 61000-4-4: 2013-04

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	cosφ -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	



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

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

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

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

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

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

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

7 FREQUENCY
50 Hz

8 TEMPERATURE
25 °C

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

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

11 COMP-POWER
100 kvar / 7%

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

13 TIME / DATE
11:55:00
THURSDAY
05.05.2019

14 SOFTWAREVERSION

BACK to 1

1 LANGUAGE [1]
[ENGLISH]

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

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

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

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

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

7 CONTR. PRINC. [3]
[INTELLIGENT]

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

9 TARGET cos φ
[0.98 IND]

10 TARGET 2nd cos φ
[SUPPLY]

11 TARGET 2nd cos φ
[1.00 IND]

12 SWITCH-ON TIME φ2
ON [16] : 00 MO-FR
OFF 07 : 00 MO-FR

13 SWITCH-OFF TIME φ2
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 ALARMTEMPERATURE
[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 : JJJJ

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]
①1 1 1 1 1 1 1 1 1 1 1 1 1 1

select with button ENTER up to (max) C15

VALENCY C15 [1]
1 1 1 1 1 1 1 1 1 1 1 1 1 1①

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]

TO

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 Prophi-15R-III

===== EXPERT-MODE 1 =====

1 PASSWORD ????
0 * * * (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
max [160] kvar

7 SWITCH. TRIGGER
IND [66] %

8 SWITCH. TRIGGER
CAP [66] %

9 OPERATING LOCK
[NO]

10 SWITCH.OPER.WARN
[50 000]

11 CONTROL
[MEAN VALUE]

12 DISPLAY
[cosPhi -0.10 ... +0.10]

13 V - CONNECTION
[N - L1 - L2 - L3]

14 POWER 1st STAGE
[0...255] kvar

15 CHANGE PASSWORD
[NO]

16 - 19 PASSWORD
[6] 3 4 3

20 ERROR-BACKLIGHT
[PINK]

BACK TO 1

===== EXPERT-MODE 2 =====

1 PASSWORD ????
0 * * * (6 3 4 3)

2 DISPLAY / ALARM
[YES]

Release [YES] or blocking [NO] of following reports or alarms:

- MEAS. VOLTAGE
- OVERVOLTAGE
- OVERCOMPENSATED
- UNDERCOMPENSATED
- HARMONICS !
- OVERTEMPERATURE
- OVERCURRENT
- UNDERVOLTAGE
- SWITCH.OPERATION
- MEAS.CURRENT < ??
- ERROR COM 1
- ERROR COM 2
- MODBUS-ERROR
- SWITCH.OFF
- STOP
- SWITCH. ON
- SYSTEM CURRENT <?
- BUS-ERROR-EXTERN
- C-DEFECT
- SYSTEM CURRENT > 0
- SYSTEM OVERLOAD
- EXTERNAL ERROR
- RELAY ERROR
- RESERVE

3 ALARMRELAY
DELAY
[10] min

4 UNDERVOLTAGE
LIMITING VALUE
200 V [50]%

5 OVERVOLTAGE
LIMITING VALUE
460 V [115] %

6 OVERCOMPENSATED
[Q-DIFF]

7 UNDERCOMPENSATED
[Q-DIFF]

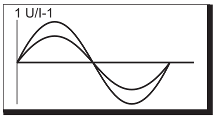
8 SWITCH.OPERATION
C1 RESET [NO] until
C15 RESET [NO]

9 OPERATION TIME
C1 RESET [NO] until
C15 RESET [NO]

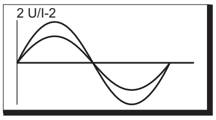
BACK TO 2

= OSCI-MODE =

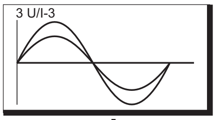
1 U/I-1



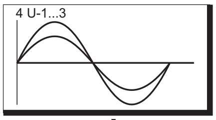
2 U/I-2



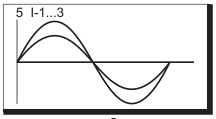
3 U/I-3



4 U/I-1...3



5 I-1...3



BACK TO 1

DISPLAY EDITOR

1 DISPLAY LINE 1
1 [REACTIVE POWER Σ]
2 ACTIVE POWER Σ
3 APPARENT POWER Σ

2 DISPLAY LINE 2
1 REACTIVE POWER Σ
2 [ACTIVE POWER Σ]
3 APPARENT POWER Σ

3 DISPLAY LINE 3
1 REACTIVE POWER Σ
2 ACTIVE POWER Σ
3 [APPARENT POWER Σ]

4 BASIC SETTINGS
[NO]

BACK TO 1

= INTERFACE =

1 PROTOCOL COM 1
[MODBUS RTU]

2 BAUDRATE COM 1
[9600 / NONE]

3 BUS-ADRESS COM 1
[1]

4 ASCII-REPET. INTERVAL
[10] sec.

5 PROTOCOL COM 2
[MODBUS-RTU]

6 BAUDRATE COM 2
[38400 / NONE]

7 BUS-ADRESS COM 2
[1]

BACK TO 1

= C-TEST MODE =

1 C-TEST
[YES]

2 MMI- TYP
[MMI8003]

3 NUMBER MMI
[1]

4 FAULT C OFF
[NO]

5 C -FAULT (+)
[140] %

6 C-FAULT (-)
[60] %

7 TEST ATTEMPTS
[6]

8 DEFECT- C- FLASH
[NO]

9 TEST-RUN
[NO]

10 START
11 TEST-RUN
12 BREAKUP

13 C-TEST - TEST-RUN
[C01] -> ? ?
[C02] -> ? ?
[C03] -> ? ?

14 TIME-STAMP / TEST
05.05.2016 10:00:05

15 MEMORY
RESET [NO]

BACK TO 1

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