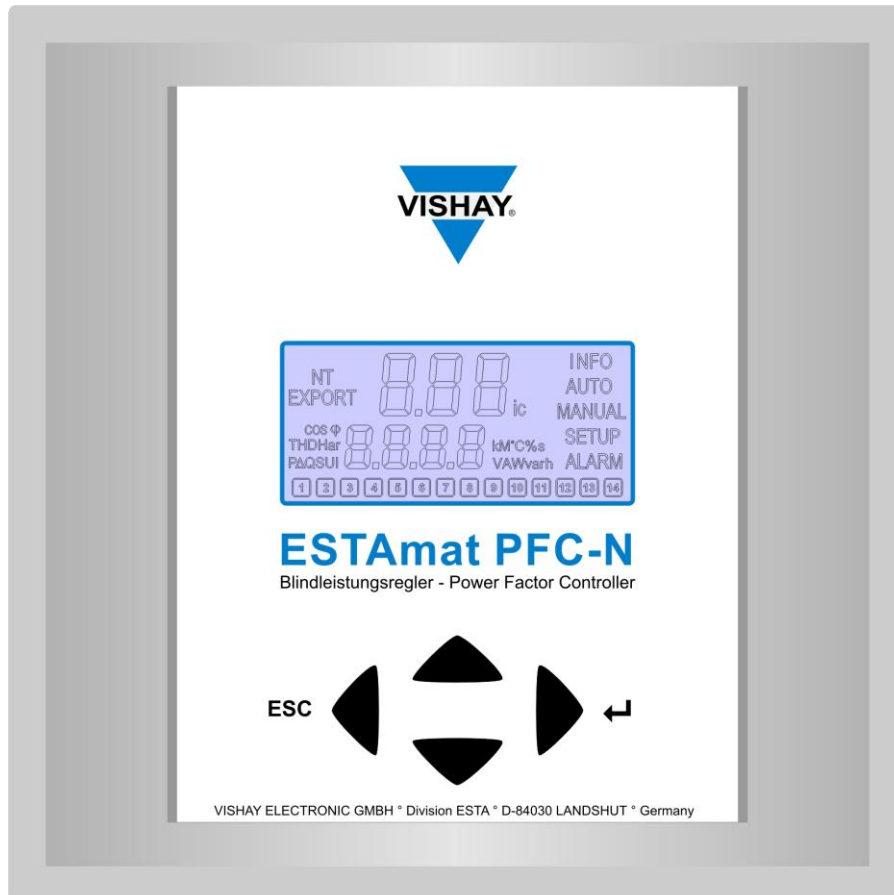


REFERENCE BOOK



POWER FACTOR REGULATOR

ESTAmat PFC-N



Power Factor Regulator ESTAmat PFC-N

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Document history

Date	Name	Revision	Comment
22.07.09	Le	01	initial document release
25.01.10	Le	02	Examples added, changes to software version 1.04
16.06.10	Le	03	Add features of software version 1.06
09.09.10	Le	04	Editorial changes

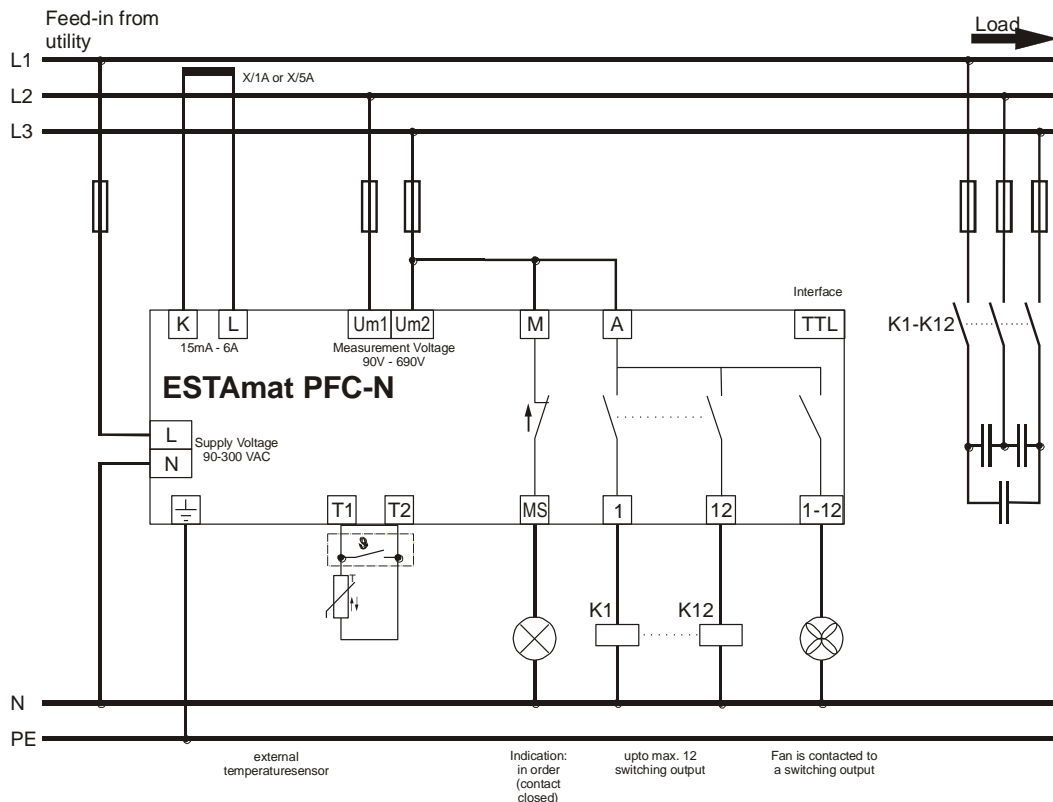
1 INSTALLATION AND CONNECTION



Only qualified staff is allowed to perform the installation. All legal rules have to be observed and technical standards have to be met. Before connecting the device check that all connecting leads are de-energized and that current transformers are bypassed.

- 1) Compare auxiliary-, measurement-, control voltage, frequency and the current path of the device (see type label) with the data of the electricity network.
- 2) Assemble the relay in the switch panel with the 2 mounting clips. If the device is not fitting in the cut out the small plastic bars on the side of the case can be removed with a knife.
- 3) Connect protective ground to the terminal link of the case.
- 4) Connect in accordance to the wiring diagram. Pay special attention to the cross section size of the CT connections! A combined power supply and measurement ensures a safe shutdown of capacitors at low voltage.
- 5) Remove short circuit links of the current transformer.

1.1 Wiring diagram



1.2 Connection data

Meas.- Supply voltage

Combined measurement and Power supply
Range 90-550V.
Terminals UM1 / UM2
With using of VT a ratio can be adjusted.
Range 1-350

Current measurement

Current measurement
Range 15mA – 6A,
Measurement transformer types x/1A or also x/5A can be used.
Terminals K (S1) / L (S2)
CT ratio is 1-9600
(Devices with Firmware before 1.04 had the adjustable range
from 1-4000)

Regulation exits

Assembly with 4, 6, 8, 10, 12, 14 Regulation exits possible.
Regulation exits volt free with common root.
Terminals A 1-14.
max. breaking capacity 5A/250VAC

Alarm contact

Opens in case of alarm and grid failure (Life Contact).
Terminals M / MS
max. breaking capacity 5A/250VAC

Temperature sensor / Digital Input

Temperature measurement or Digital Input to switch over to
second COS φ .
Terminals T1 / T2
Setting is explained in the Alarm menu.

2 COMMISSIONING

2.1 Commissioning manual:

After the supply voltage is applied, in ESTAmat PFC-N starts a countdown with 90 sec. Cancel the countdown by pressing the ◀(esc) button. Enter the “SETUP” menu and control respectively adjust the parameters. To enter the “SETUP” menu, please follow the arrows (▼ ▲▶) as shown at menu 4.4. All parameters of the “SETUP” menu are explained in the corresponding chapter.

2.2 Commissioning automatically:

During the countdown, the auto-initialization can be start by pushing the ▶(↵) button. Automatic initialization is switching all exits. During this test it can get information, which exits are working and it can correct the connection of the measuring channels for voltage and current by internal settings.

Automatic initialization can be started only when the voltage and current are ok. Settings of c/K value and the switching sequence is not required.

When mains conditions are not suitable for auto-initialization, it will be interrupted. The controller shows the message

„Ai Abrt“. If multiple repetition do not lead to any result, the following chapters shall be considered.

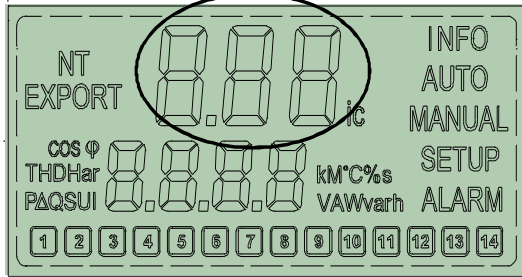
Display „Auto“: Indication „Auto“ shows that the control is working. If „Auto“ is not displayed then control function is stopped. This can happen for the following Reasons: manual mode is active, control function is switched off, temperature is to high, measured current is less than 15mA, voltage or the harmonic content is outside the admissible range.

Over-and undervoltage monitoring: The ESTAmat PFC-N is equipped with an over and undervoltage monitoring. The admissible voltage range refers to the adjusted nominal voltage. If the measured voltage is outside of the admissible range the message **U Alarm** appears. Then the setting of nominal voltage has to be adapt to local ratings. The nominal voltage is independent of the connection always the line voltage.

Activation of the measured value display: see chapter 4.1

3 DISPLAY

AUTO, MANUAL: cosphi
 SETUP, INFO: Nummer Untermenü



- INFO:** Capacitor database
- AUTO:** automatic control is running
- MANUAL:** manual mode
- SETUP:** setup menu
- ALARM:** blinking in case of alarm
- NT:** COS φ 2 active
- EXPORT:** export of active energy
- 1 – 14:** control exits

In case of an alarm will flash alternately at ESTAmat PFC-N with "ALARM" an error code in the display. The table below gives an overview of all possible error codes.

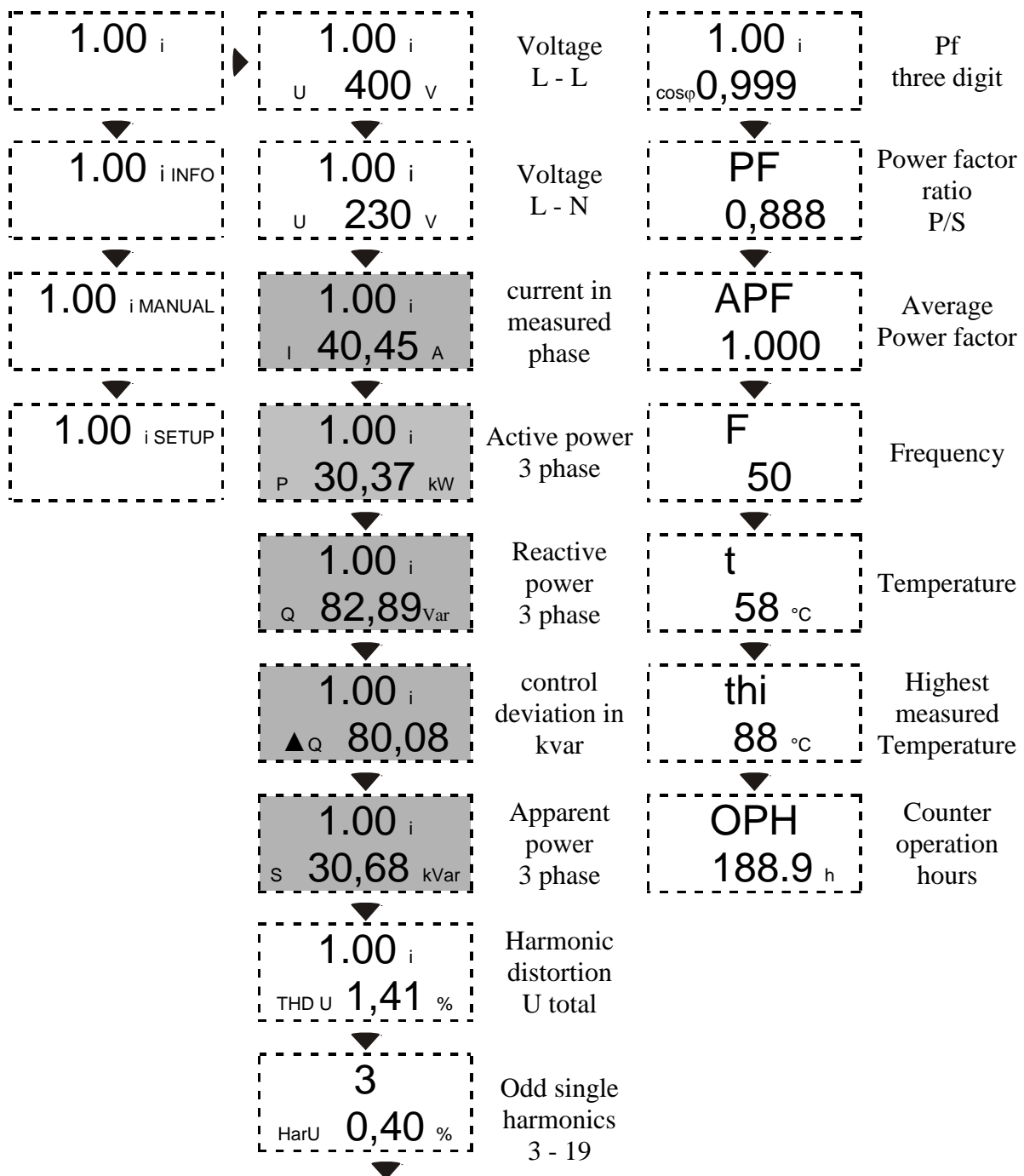
To reset pending alarms hold the ◀(esc) button pressed for 5 seconds.

$\frac{0.0}{0.0}$ ALARM	measured voltage is outside the set tolerance
$\frac{0}{0.00}$ ALARM	measured current is less than 15mA (check the short circuit bridge K and L and the entire current path)
$\frac{0}{000}$ ALARM	measured current is to high
$\frac{0.0}{0.0}$ ALARM	The controller cannot achieve the target COS φ
$\frac{0000}{0}$ ALARM	The set limit for the THD of the voltage is exceeded
$\frac{0.0}{0.0} / \frac{0.0}{0.0}$ ALARM	One or more steps are broken. The defective step is blinking with the alarm message.
$\frac{0.0}{0.0} / \frac{0}{0}$ ALARM	One or more step's have fallen below 70% of initial power. step number and error code will flash alternately. For devices with software version before 1.04 the alarm is triggered at 50% of initial power.
$\frac{0}{000}$ ALARM	The second temperature limit is exceeded. Stage were switched off successively.
$\frac{0000}{0000}$ ALARM	Set limit of operation hours has been exceeded
$\frac{0000}{0.0}$ ALARM	Set limit of the max. allowable operation cycles, for one or more steps, has been exceeded.
$\frac{00}{00}$ / $\frac{00}{00}$	Abort of auto-initialization.

4 MENU ESTAmat PFC-N

4.1 Measurement menu

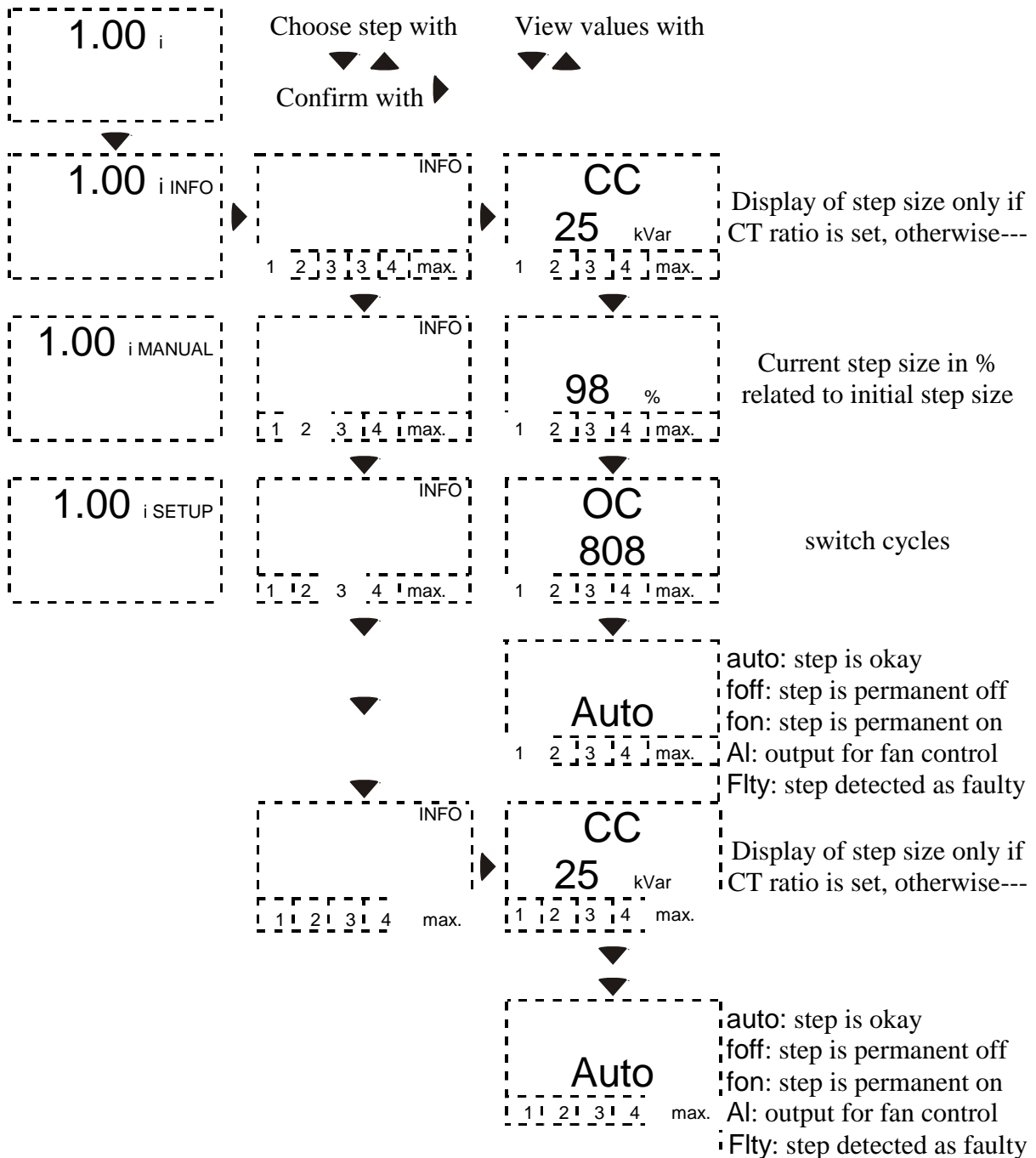
All grey fields are hidden in the factory settings and will only appear if the CT ratio is set in the "SETUP" menu. For devices with software version before 1.04 the complete measurement menu is hidden and must be activated by adjusting the CT ratio.



4.2 Info (Step database)

In the "INFO" menu for each connected step the number of switching cycles, the current step size and the step size in relation to the initial step size is stored.

Using these data, conclusions can be drawn on the condition of the site and the condition of single step's. **Step sizes are shown in kVar only when in the CT ratio is set in "Setup" menu.**

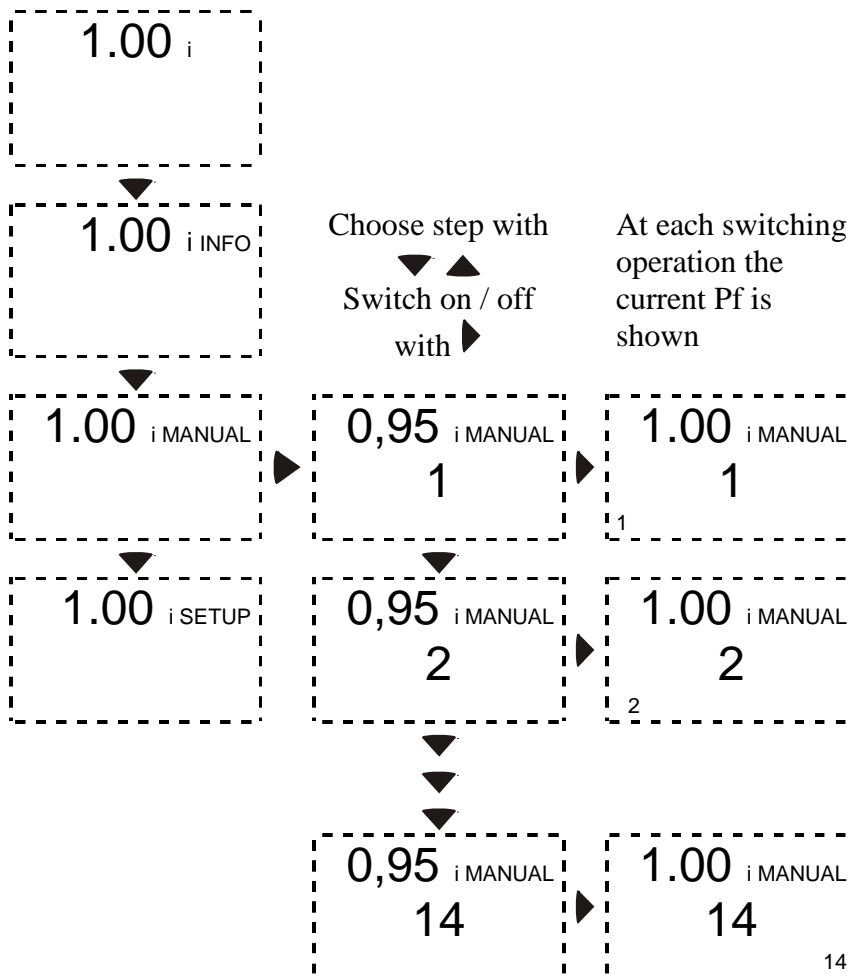


4.3 Manual (step switching manual)

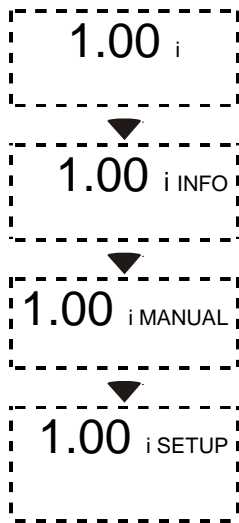
To enter in manual mode, please select “manual” in main menu and push ► for 3 seconds. By entering this submenu the manual mode for the regulator is active. The automatic control is stopped and the exits can be switched manually. By the means of the ▼▲ -keys the referring step can be selected. Changing the switching state is possible by pushing the ►-key.



Manual switching is only possible when measurement voltage is in allowed range. Otherwise over- and undervoltage protection will block this function. After switching off an active step the discharge time is active. Only after this time is over the step can be switched on manually again.



4.4 Setup (Quick start menu)

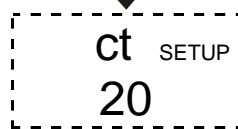


To start the control, it's only necessary that the nominal voltage is correct.

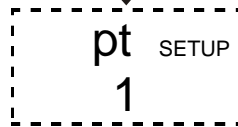
All other settings are only for optimal adaptation to the conditions in the system and display system data. To change a setting, enter the setting by pushing the **▶** button. Change the value with **▼ ▲** and confirm with **▶**. When you start the auto-initialization the ESTAmat PFC-N checks the connection of the measurement and the exits. With these data, the regulation starts automatically.

Un = nominal voltage

Setting of nominal voltage. From this value the upper and lower limits for voltage monitoring is calculated



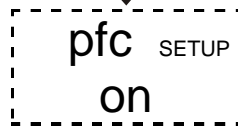
Input current transformer ratio
e.g. 250/5 = 50



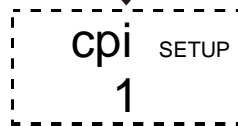
Input voltage transformer ratio
when no VT is used the value is 1



"Yes" the controller performs the auto-initialization again



"ON" automatic control
"OFF" control off
"HOLD" control freeze



Target COS φ of control



Interval between switching the steps



Possible types of output:
auto: step is used for regulation
foff: step is permanent off
fon: step is permanent on
Al: output for fan control
 Valid from Version 1.06.

5 EXPERT MENU ESTAmat PFC-N

To open the expert menu of ESTAmat PFC-N, choose menu item "SETUP" and hold ►(←) button until "100" appears. By using the ▼ ▲ buttons the submenus can be selected. The expert menu of ESTAmat PFC-N is divided into six groups, where the menu items are logically grouped together. The following groups exist:

100 Quick start menu

Contains all important points for commission.

200 Measurement settings

Contains settings to adapt the measurement of the ESTAmat PFC-N to the surrounding network conditions.

300 Setup Control System

The items in the menu "control system" allow an optimization of the control or an adaptation to specific site requirements.

400 Setup Step Database

In the step database, all settings and data are combined which are required to adjust and adapt the steps.

500 Setup Alarm

The alarm menu of ESTAmat PFC-N. Here, all the alarms and monitoring functions can be activated and the limits configured.

600 Resetmenu

Allows you to reset all settings made by the controller and stored data. Additionally, it contains the software version of the device (displayed from 1.04).



5.1 100 Quick start menu

Contains all important points for commission:

100 Quick start menu

<u>MENU</u>	<u>FUNCTION</u>	<u>RANGE</u>
Un	NOMINAL VOLTAGE = PHASE - PHASE Function of the setting of nominal voltage is to make a definition about the nominal voltage of the system. The threshold levels for under- and overvoltage are based on this as well as the ratings of the capacitor sizes in step database, which are used for control and monitoring. The capacitor sizes, which are stored in step database, are also rated to the nominal voltage.	100...241500 V
Ct	CT-FACTOR The CT FACTOR is the ratio of current transformer. (e. g. 1000/5 = ratio 200). At devices with software version 1.04 is the adjustment range from 1-4000.	1...9600
Pt	VT-FACTOR VT FACTOR is the ratio of the voltage transformer. If the regulator is connected directly to the measurement voltage without VT the value 1 has to be used.	1...350
Ai	AUTO-INITIALIZING START "YES" starts auto-initializing Automatic initialization is switching all exits. During this test it can get information, which exits are working and it can correct the connection of the measuring channels for voltage and current by internal settings. Automatic initialization can be started only when the voltage and current are ok. Steps with step type "FON" or "AL" will be not considered in case of new auto-initialization. AUTOMATIC INITIALIZATION is only able to work, when capacitors are used for compensation. If ESTAmat PFC-N has to switch reactors for compensation of capacitive load, this feature will cause failures. AI is working at best, when there are stable load conditions!	Yes/No
PFC	START / STOP / HOLD PF-CONTROL At devices with software revision before 1.04, stages which are set to "FOFF" were not retested.	On/Off/Hold

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Stopping the automatic control. The following options are available:

On: Control in automatic mode

Off: Control stops and active steps were disconnected successive

Hold: Control Stops and active step's remain switched on.

If "OFF" or "HOLD" is selected, will appear in the display "PFC" alternating with "OFF" or "HOLD". To start the control, select "ON".

CP1	COS φ 1	0.70 c ...0.70 i
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This is the setting for target COS φ 1. It will be valid during normal operation.

St	SWITCH INTERVAL	1...6500 s
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The switch interval is the time delay between switching steps in regulation.

The switch interval has two different functions:

1. Protecting the contactors by reducing the number of switching cycles.
2. Building of the average of the reactive power in the time of the switch interval.

Out	TYPE OF OUTPUT	
------------	-----------------------	--

With the exception of step type "flty" the following step types can be selected:

- Auto = Step is used for normal regulation algorithm.
- Alarm = If the set temperature limit 1 is exceeded this step is switched as fan output.
- Fon = Step is permanently switched on (Step is still monitored and shut down in critical situations).
- Foff = Step is permanently switched off. Not used steps should be adjusted to this type to avoid unnecessary alarm.
- Flty = Step was switched three time without success and is not longer used for automatic control.

As "flty" stored steps can be set to desired step type in this menu.



5.2 200 Measurement settings

Contains settings to adapt the measurement of the ESTAmat PFC-N to the surrounding network conditions.

200 Measurement settings

<u>MENU</u>	<u>FUNCTION</u>	<u>RANGE</u>
201	NOMINAL VOLTAGE = PHASE – PHASE Function of the setting of nominal voltage is to make a definition about the nominal voltage of the system. The threshold levels for under- and overvoltage are based on this as well as the ratings of the capacitor sizes in step database, which are used for control and monitoring. The capacitor sizes, which are stored in step database, are also rated to the nominal voltage.	100...241500 V
202	CT-FACTOR The CT FACTOR is the ratio of current transformer. (e. g. 1000/5 = ratio 200). At devices with software version 1.04 is the adjustment range from 1-4000.	1...9600
203	VT-FACTOR VT FACTOR is the ratio of the voltage transformer. If the regulator is connected directly to the measurement voltage without VT the value 1 has to be used.	1...350
204	V-TOLERANCE The setting of this value is in percent related to the nominal voltage. By means of the set value, the upper and lower limits of the permissible voltage range are calculated. e.g. 10% at 400V nominal voltage is a permissible range from 360V to 440V.	0...100 %
205	CONNECTION MEASUREMENT "YES" voltage measurement L-L "NO" voltage measurement L-N CONNECTION MEASUREMENT the setting if measuring of voltage is connected between two phases or between phase and neutral phase. It is normally detected automatically at every start of BLR-CM. This is done by comparing the setting NOMINAL VOLTAGE and the real measured voltage. This cannot be changed by hand. If the measured voltage is outside this tolerance, the measurement can be adjusted by hand.	Yes/No
206	PHASE COMPENSATION	0...345



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The phase compensation enables the user to connect the current- and voltage measurement channels in any way. This compensation angle complies with the phase angle between connected active current and voltage. **This setting has to be made correct, because otherwise correct regulation is not possible! If the current transformer is connected inverted, additionally a phase compensation of 180° has to be respected.**

Is auto-initialization failed due to adverse network conditions, by hand a correction angle can be set or the incorrectly recognized can be corrected. Table 11.1 gives an overview of the connection options with corresponding phase angles.

207 START AUTO-INITIALIZING Yes/No

"YES" starts auto-initializing

Automatic initialization is switching all exits. During this test it can get information, which exits are working and it can correct the connection of the measuring channels for voltage and current by internal settings.

Automatic initialization can be started only when the voltage and current are ok.

AUTOMATIC INITIALIZATION is only able to work, when capacitors are used for compensation. If ESTAmat PFC-N has to switch reactors for compensation of capacitive load, this feature will cause failures. AI is working at best, when there are stable load conditions!

Steps with step type "FON" or "AL" will be not considered in case of new auto-initialization.

At devices with software revision before 1.04, stages which are set to "FOFF" were not retested.

208 AUTO-INITIALIZING BY REGULATOR RESTART Yes/No

YES = after starting the ESTAmat PFC-N, a countdown is running. During this countdown it is possible to start auto-initializing by pushing ►(←).

"NO" the countdown is not shown. To start AI, you have to choose Quickstart SETUP.

209 SYNCHRONISATION FREQUENCY Auto/Fix50/Fix60



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For a high precision of the measurement, the sampling rate has to be synchronized to the frequency of the grid. Caused by commutation notches of mainsvoltage it is possible that the automatic synchronizing will not work reliable. This creates failures in measurement. To avoid these problems, the following settings can be done:

Automatic synchronizing:

For best measurement results, when mains voltage is without commutation notches.

FIX-50HZ: For a safe operation at 50Hz grid with bad mains quality.

FIX-60HZ: For a safe operation at 60Hz grid with bad mains quality.

210	TEMPERATURE OFFSET (from software revision 1.04)	-10-10°C
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The temperature offset allows correction of temperature reading in a range -10°C to +10°C.

5.3 300 Setup Control System

The items in the menu "control system" allow an optimization of the control or an adaptation to specific site requirements.

300 Setup Control System

<u>MENU</u>	<u>FUNCTION</u>	<u>RANGE</u>
301	CONTROL SENSITIVITY Sensitivity is the switching threshold for switching-on or switching-off the capacitors in percent (%). The range of the sensitivity can be between 55% and 100% (factory setting is 60%. Due to this, the in following explanation 60% is used.). Sensitivity is used for two checks: <ol style="list-style-type: none"> 1. The controller is using sensitivity to check, if a switching operation is necessary or if it's possible. If the demand for compensation is bigger as 60% of the smallest for regulation available step, BLR-CM is selecting from step database, if there are suitable steps to switch. 2. To avoid hunting, the controller is only using steps, which will not overshoot more than 40% (100%-60%) of its size. 	55...100 %
302	COS φ 1 This is the setting for target cosφ 1. It will be valid during normal operation.	0.70 c ...0.70 i
303	COS φ 2	0.70 c ...0.70 i



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This is the setting for target $\cos\phi 2$. It will be valid when a switch over is caused by the digital input or another programmable action.

304	<p>COS $\phi 2$ FOR P EXPORT</p> <p>"YES" the controller operates in P-export with the COS $\phi 2$ as control target. "NO" the controller operates in P-export with the COS $\phi 1$.</p>	Yes/No
305	<p>SWITCH INTERVAL</p> <p>The switch interval is the time delay between switching steps in regulation.</p> <p>The switch interval has two different functions:</p> <ol style="list-style-type: none"> 1. Protecting the contactors by reducing the number of switching cycles. 2. Building of the average of the reactive power in the time of the switch interval. 	1...6500 s
306	<p>SWITCH INTERVAL STEP EXCHANGE</p> <p>For step exchange a separate switch interval is used. This is the delay-time between switching-off an active step and switching-in the next step to get a better power-factor.</p>	1...6500 s
307	<p>ACTIVATE STEP EXCHANGE</p> <p>"YES" = Step exchange is active. "NO" = Step exchange is disabled.</p> <p>Step exchange is supporting automatic control and combined filter control algorithm to reach an optimum result. If the controller detects that target-pf is not reached it starts searching for a step which gives better results. If step exchange is active, the controller can replace a switched-in step against a step which matches better, to reach the target.</p> <p>This function helps to reach target COS ϕ more exactly, when capacitors have different sizes. If all capacitor banks have the same size, this function makes no sense.</p>	Yes/No
308	<p>STEP RECOGNITION "OFF"</p>	Yes/No



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"YES": Step sizes have to be programmed by hand. The step sizes have to be programmed by hand if:

1. When fast-oscillating load influences automatic stepsize recognition.
2. When recognition of defective steps is not wished
3. When capacitor contactors are switching with a delay of more than 200msec.

"NO" Stepsizes are detected and corrected automatically during normal operation. "Step recognition ON" is the factory setting. It allows monitoring of capacitor sizes and gives alarms when they are faulty. Stepsizes which are programmed manually will be overwritten by step recognition.

309 **BLOCKING OF DEFECTIVE CAPACITORS** Yes/No

"YES" If a step is switched in three times without measurable network reaction, the controller is blocking the step and doesn't use it for the control.

Is a Step recognized to be defective, blinks in the display the corresponding output and in the step database and menu "403" it's displayed as step type "flty".

"NO" Steps are connected even if no network reaction is measurable. This results unnecessary switching cycles. Steps that are stored as defective will be tested every 24 hours or after the controller is restarted.

310 **START / STOP / HOLD PF-CONTROL** On/Off/Hold

Stopping the automatic control. The following options are available:

- On: Control in automatic mode
- Off: Control stops and active steps were disconnected successive
- Hold: Control Stops and active step's remain switched on.

If "OFF" or "HOLD" is selected, will appear in the display "PFC" alternating with "OFF" or "HOLD". To start the control, select "ON".

311 **CONTROL ALGORITHM** 1/2/3/4



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1. **Automatic:** The controller is working with the principle of „Best Fit“. Before a switching operation, all capacitor-sizes in step database are compared with control deviation. The available step which gives the best results will be switched.
2. **LIFO:** “Last In, First Out” The controller starts with regulation with step 1 and is switching further exits step-by-step. Switching-off is done vice versa.
3. **Combined Filter:** Special algorithm for combined filter banks with two different detuned ratings. The controller is working like in automatic mode with the principle “Best Fit”. From odd numbered steps, there is at least or more of the capacitance connected as from even numbered steps. Threshold level of each step is checked separately. If steps different sizes, this can cause inaccuracy. Step recognition is working in this mode. If steps are detected as defective, they are skipped in this mode. If this is not accepted, the step recognition has to be deactivated and capacitor sizes have to be programmed manually.
4. **Progressive:** The controller switches if required, several steps in sequence with a shorter switching time. From software 1.04, the controller uses independently of the set switching time always 1 sec. as switching time. Furthermore, the automatic step size detection is disabled and the step sizes need to enter by hand. The input of the step sizes should be as accurate as possible, because the regulator would otherwise tend to oscillate. Leaving the "Progressive" algorithm and use a different algorithm, the set switching time is used the step size detection is re-enabled.

312 OFFSET REACTIVE POWER Ct*Pt*7000

OFFSET of reactive power in kvar. This feature allows compensating a permanent reactive load, which cannot be measured (e.g. a transformer).

The offset of reactive power affects the readings of the following measuring values:

current, reactive power, control deviation, apparent power, power factor PF and cosφ.

313 ASYMMETRY FACTOR -127...127

ASYMMETRY FACTOR of switch interval. The factor is the ratio between switch interval for switching on and switching off. Switch interval for step exchange is not affected by this setting.

X= 1 = equal

X = +2 to +127: delay switching off = switch interval multiplied by X

X = -2 to -127: delay switching on = switch interval multiplied by X

314 Q CAPACITIVE STEPS TURN OFF Yes/No



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"YES" As soon as a capacitive condition is recognized, the controller switches off without keeping the switching time, the necessary step power in order to prevent leading network conditions.

"NO" The controller works only with the set target COS φ.

5.4 400 Setup Step Database

In the step database, all settings and data are combined which are required to adjust and adapt the steps.

400 Setup Step Database

<u>MENU</u>	<u>FUNCTION</u>	<u>RANGE</u>
401	DISCHARGE TIME	5...1200 s
	The discharge time is defined once and is valid for all steps. The discharging time is a blocking time, becoming active after switching off a step. As long as this time is running this step is not available for the regulation. Discharging time should be adapted to the capacitor discharging unit.	
402	STEP NOMINAL VALUE	Ct*Pt*7000
	If STEP RECOGNITION is not active, it is required to do this setting, to get proper function of the relay. The size of the capacitors can be programmed manually in kvar. Before this programming, CT FACTOR and NOMINAL VOLTAGE must be programmed correctly. A change of CT FACTOR or NOMINAL VOLTAGE is automatically changing the value of the capacitor size. The programming can be done for each step individually in kvar. So there is no special sequence necessary. A step can be programmed as a capacitor (c) or as an inductor (i).	
403	STEP TYPE	Auto/Al/FOn/FOff
	With the exception of step type "flty" the following step types can be selected: <ul style="list-style-type: none"> • Auto = Step is used for normal regulation algorithm. • Alarm = If the set temperature limit 1 is exceeded this step is switched as fan output. • Fon = Step is permanently switched on (Step is still monitored and shut down in critical situations). • Foff = Step is permanently switched off. Not used steps should be adjusted to this type to avoid unnecessary alarm. • Flty = Step was switched three time without success and is not longer used for automatic control. As "flty" stored steps can be set to desired step type in this menu. If defective steps should not be locked, you must disable this function under the menu item "309". Steps which are identified as defective will be tested again by the controller every 24 hours or after a restart.	
404	SWITCH CYCLES	0...262000



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The ESTAmat PFC-N is counting and showing the switching cycles of each step in the "Info" menu. After a contactor has been exchanged, the switching cycles can be set to "0" in this menu.

5.5 500 Setup Alarm

The alarm menu of ESTAmat PFC-N. Here, all the alarms and monitoring functions can be activated and the limits configured.

500 Setup Alarm

<u>MENU</u>	<u>FUNCTION</u>	<u>RANGE</u>
501	Reset Alarm manually	Yes/No
	"YES" Alarms (display and alarm relays) must be reset manually. To reset upcoming alarms, hold the ◀(esc) button pressed for 5 seconds. "NO" As soon as the alarm condition is no longer valid, the alarms drop out.	
502	THD U Alarm	Yes/No
	"YES" The set THD threshold under menu "503" is monitored. Exceeding the set threshold will open the alarm contact and the display will show the message "000000 N/A/NM". "NO" THD is not monitored.	
503	THD U Threshold	1...200 %
	Input of the threshold for THD monitoring.	
504	THD U > Threshold = disconnect steps	Yes/No
	"YES" Exceeding the set threshold for THD will switch off all active steps successive. Warning: Steps are only switched off when it is set at point 502 to "YES". "NO" Exceeding the set threshold follows no action.	
505	Interval time before triggers THD U and Temperature threshold 2	1...255 s
	Interval time after exceeding the threshold for THD U or temperature threshold 2.	
506	Freeze control if I == 0	Yes/No
	"YES" The measuring current drops below 15mA freezes the control. All active steps remains switched on. "NO" Measuring current falls below 15mA, the controller shuts down all active steps successive.	
507	Service Alarm	Yes/No
	"YES" the alarm contact opens when the max set switching cycles	

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	for one or more steps have been exceeded or if the set threshold for operation hours are reached. "NO" no alarm when exceeding the max. switching cycles or operation hours.	
508	Max. switching cycles per step Threshold switching cycles for service alarm. Display indication $\overline{00000}$ <small>ALARM</small>	1...262000
509	Max. operation hours Threshold switching cycles for service alarm. Display indication $\overline{000000}$ <small>ALARM</small>	1...65535 h
510	Use temp. input as digital input "YES" Temperature sensor is activated via a switch and causes a switchover to COS φ 2 (HT / NT) Note: This menu item is locked against menu item "512". If the temperature alarm is set to "Yes", this point will automatically jump to "NO" and can not be altered. "NO" the temperature input works with plug-in temperature sensors and monitors the in menu 513 and 514 adjustable temperature thresholds. Parallel to the temperature sensor, a thermostat can be connected. In this case, the controller displays "HIGH" for closed state and "LOW" for open state.	Yes/No
511	DI active at HIGH signal "YES" digital input is activated with closed terminals T1 & T2. "NO" digital input is activated with open terminals T1 & T2.	Yes/No
512	Temperature alarm "YES" the controller monitors the temperature threshold 1 and 2 and responses accordingly. "NO" alarm disabled.	Yes/No
513	Temperature threshold 1 By exceeding the temperature threshold 1 switches the controller as "AL" declared step (fan on).	3-74 °C
514	Temperature threshold 2 When the temperature exceeds temperature threshold 2, the controller switches all active steps ("AUTO" & "FON") from compliance with the under menu item 505 adjusted time in succession off. In addition, in the display appears $\overline{00000}$ <small>ALARM</small> and the alarm contact is opened.	4-75 °C
515	Control alarm (target cos φ can not be archived) "YES" alarm is triggered after 75 time switching time with $\blacktriangle Q >$ smallest step (Over / under compensation). Controller opens the	Yes/No



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	alarm contact and indicates ALARM in the Display. "NO" no monitoring for over / under compensation.	
516	Defective step alarm	Yes/No
	"YES" After 3 unsuccessful switching actions alarm is triggered. The controller opens the alarm contact and indicates ALARM / ALARM in the display. Steps recognized as defective flashing in the step indication. "NO" alarm disabled.	
517	Step power loss alarm	Yes/No
	"YES" If the current step size is less than 70% of the initial size, the controller opens the alarm contact and indicates the error with output number ALARM / ALARM in the display. "NO" Power loss of the capacitors is not monitored.	

5.6 600 Resetmenu

Allows you to reset all settings made by the controller and stored data. Additionally, it contains the software version of the device (displayed from 1.04).

600 Resetmenu

<u>MENU</u>	<u>FUNCTION</u>	<u>RANGE</u>
601	Reset Settings Sets all settings made back to factory settings.	Yes/No
602	Reset Step database Sets all step data back to factory settings.	Yes/No
603	Reset operation hours Sets the counter for operation hours to "0"	Yes/No
604	Reset average PF Reset the average PF.	Yes/No
605	Reset max. Temperature Reset the highest measured Temperature.	Yes/No
606	Reset alarms Reset all upcoming alarm.	Yes/No
607	Display software version contains the software version of the device (display from 1.04)	

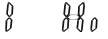
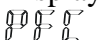
6 TECHNIAL DATA

Measuring- and supply voltage:	90 – 550V AC, single phase, 45-65HZ, 5VA, max. fuse 6A VT ratio from 1.-350.0
Current measurement	15mA – 6A, single phase, burden 20mOhm, CT-ratio from 1-9600 Before software version 1.04 the adjustable range is 1-4000
control exits	Up to 14 relays, n/o, with common point, max. fuse 6A breaking capacity: 250V AC / 5A
Temperature measuring:	By NTC
Alarm contact:	Relay, volt free, life contact, max. fuse 2A, breaking capacity: 250V AC / 5A
Fan control	By using one switching exit defined as "Alarm"
Interface:	TTL, rear
Ambient temperature:	Operation: -20°C – 70°C, storage: -40°C – 85°C
Humidity:	0% - 95%, without moisture condensation
Voltage class:	II, dirt class 3 (DIN VDE 0110, part 1 / IEC60664-1)
Standards:	DIN VDE 0110 part 1 (IEC 60664-1:1992) VDE 0411 part 1 (DIN EN 61010-1 / IEC 61010-1:2001) VDE 0843 part 20 (DIN EN 61326 / IEC 61326: 1997 + A1:1998 +A2: 2000)
Conformity and listing:	CE
Connection:	Pluggable terminal block, screw type max. 4qmm
Case:	Front: instrument case PC/ABS (UL94-VO), Rear: metal
Protection class:	Front: IP50, (IP54 by using a gasket), Rear: IP20
Weight:	ca. 0,6kg
Dimension:	144x144x58mm h x w x d, cut out 138 (+0,5) x 138 (+0,5)mm

7 TROUBLESHOOTING

Fault	possible cause	Remedy
No indication in display	<ul style="list-style-type: none"> aux. voltage missing 	<ul style="list-style-type: none"> Check the correct connection of power supply and correct if necessary.
Display "0.0 ALARM"	<ul style="list-style-type: none"> Voltage outside tolerance 	<ul style="list-style-type: none"> Check measurement voltage Check nominal voltage and adjusted tolerance and correct if necessary.
Display "0.0 0.0 ALARM"	<ul style="list-style-type: none"> Measured current is too small 	<ul style="list-style-type: none"> check connection of CT, probably there is a break in the line remove short circuit link of the CT
wrong display of current or voltage	<ul style="list-style-type: none"> wrong transformer ratio 	<ul style="list-style-type: none"> Check settings of transformer ratios in the "SETUP" (100) menu and correct if necessary.
The power factor is displayed incorrectly.	<ul style="list-style-type: none"> The connection detection was not performed. The phase angle was adjusted manually false. Offset reactive power is adjusted. 	<ul style="list-style-type: none"> Start "Ai" in "SETUP" menu. Check point 206 in the "EXPERTMENU" and correct the phase angle if necessary. With the compensation system, a transformer is compensated. The displayed Pf is in front of the transformer. The displayed Pf is in front of the transformer.
The power factor does not change after the switching of a step.	<ul style="list-style-type: none"> CT incorrectly positioned. 	<ul style="list-style-type: none"> Check installation position of the current transformer according to wiring diagram (current of the load and the capacitors must be measured!).
Steps are switched off again.	<ul style="list-style-type: none"> Capacitor defect 	<ul style="list-style-type: none"> Check capacitor, possible fuse, capacitor, or contactor defective.

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<p>Display  "ALARM"</p>	<ul style="list-style-type: none"> • Current is higher than allowed. 	<ul style="list-style-type: none"> • Check the current transformer secondary current and possibly replace it with matching current transformer.
<p>Display  "ALARM"</p>	<ul style="list-style-type: none"> • permanent over compensation • permanent under compensation 	<ul style="list-style-type: none"> • Check settings (possibly step with step type "FON") • Check contactors, contactor contact may bonded. • Check capacitors and fuses. • Dimensioning of the system examined.
<p>Opposite regulation behaviour</p>	<ul style="list-style-type: none"> • Current or voltage connections swapped. 	<ul style="list-style-type: none"> • correct connection or adapt phase compensation.
<p>Individual steps are not switched on or off.</p>	<ul style="list-style-type: none"> • wrong setting 	<ul style="list-style-type: none"> • Verify whether the steps were defined as Step type "FON" or "FOFF" (permanently on or off).
<p>Steps are detected as defective. Steps are switched off again.</p>	<ul style="list-style-type: none"> • Step defective 	<ul style="list-style-type: none"> • Check capacitor, possibly fuse, capacitor or contactor defective.
<p>Steps are not switched.</p>	<ul style="list-style-type: none"> • The steps are too large. 	<ul style="list-style-type: none"> • The required reactive power is below the switching threshold. Switching threshold is 60% of the smallest available step.

8 APPLICATIONS

8.1 Fan Control

The fan control is to be regulated through the ESTAmat PFC-N.

Solution:

If the ESTAmat PFC-N is equipped with a temperature sensor (option –L), can be via one of the switching exits, a fan to be controlled.

Procedure:

- Enable temperature alarm

In the expert menu item 512 set to "YES" (temperature alarm on).

- Set temperature thresholds

Set the following items 513 (temperature threshold 1) and 514 (temperature threshold 2) the temperature thresholds. By exceeding the temperature threshold 1 is witted the fan output. When you exceed the temperature threshold 2, all steps are switched off to prevent overheating.

- Select fan output

Select item 403 in expert menu and adjust for the step which shall work as the fan output step type "AL".

Features:

In order to prevent hunting of the fan relay, the fan is turned off only at a temperature below the set limit by at least 3°C. If the ESTAmat PFC-N is equipped with a temperature sensor, the current cabinet temperature is displayed and the highest measured temperature is stored in thi. Parallel to the temperature sensor can be connected a thermostat. By close of the thermostat , the temperature limit 2 is activated.

8.2 Switching on COS ϕ 2 via digital input

By using a switch, the ESTAmat PFC-N will be switched to COS ϕ 2.

Solution:

Using the temperature input as digital input.

Procedure:

- Enable digital input
Set item 510 in expert menu to "YES".
- Using digital input as n/o or n/c

"YES" digital input is activated with closed terminals T1 & T2.

"NO" digital input is activated with open terminals T1 & T2.

Features:

The temperature input is used as a digital input, shows the controller at active input "high" and with not active input "low" instead of the temperature. The controller uses with active digital input the COS ϕ 2 and will show "NT" in the display.

8.3 Problems with the Step recognition.

The controller is used in a system with rapid changes in load conditions and has problems with the automatic step recognition

Solution:

To solve this problem, the step sizes must be entered by hand, and the step recognition must be turned off.

Procedure:

- Stop control.

Set item PFC to "OFF" in menu 100 (quick start menu).

- switch off Step detection.

Set item 308 to "Yes" (step recognition off) in the expert menu.

- enter step sizes.

Setting the nominal value of the capacitors connected at point 402 in the expert menu.

- Check step type

For problems with the step detection, it may happen that the connected steps will be stored by the controller incorrectly as "FIX-OFF". Therefore, the step type of each step should be controlled under the menu item "403". All steps of the automatic control used, must be use the step type "AUTO".

Features:

By switching off the automatic step recognition, a step failure or power loss is not reported. To monitor the system anyway, it is appropriate to enable the control alarm to be alerted in case of failure timely. (See alarm menu)

8.4 Transformer compensation

The compensation of a transformer can be solved with the ESTAmat PFC-N in two ways:

8.4.1 Setting a reactive power offset

Setting reactive power offset. This is added to the required compensation power within the system.

Procedure:

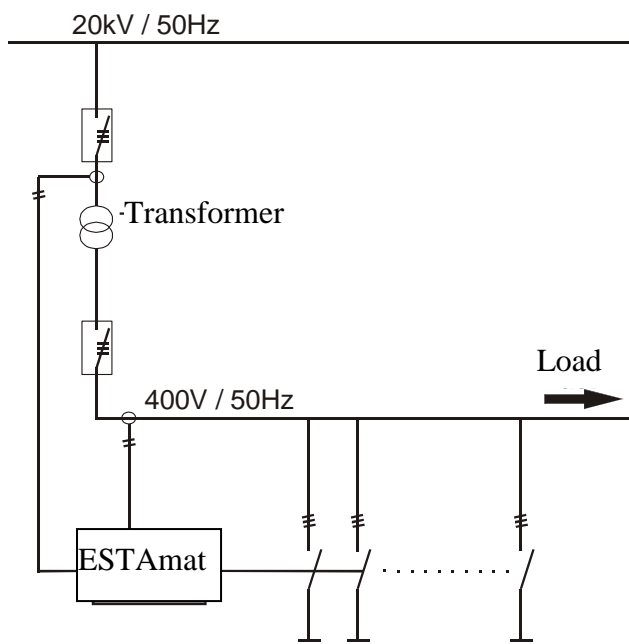
Determine the required capacitive reactive power to compensate the transformer. Enter the calculated value in the menu item "312". Control will start immediately with the additional required reactive power.

Features:

The set here reactive power offset is always added to the measured reactive power. Therefore, it's always the Pf appears before the transformer. This means that the system can capacitive, but the measurement of the utility the required Pf recoded.

8.4.2 Mixed measurement:

By the current measurement on medium voltage side, is the from the transformer caused reactive power measured and regulated by the connected compensation system.



Procedure:

Connect the measurement of the controller as shown in the diagram adjacent. Then start the automatic initialization. The vector group of the transformer is automatically considered.

Connection:

When auto-initialization will be aborted, under item 11.2, the most common transformer vector groups are listed.

8.5 Reset defective steps respectively add additional steps

If the controller has a step recognized as defective (3 switching operations without result), it will be excluded for 24 hours from the regulation. After this period, the step is tested again from the controller. If the controller can detect the step it will again be included in the control. If not the step is blocked again for 24 hours after 3 unsuccessful switching cycles. Defect steps are in the "INFO" menu with the step type "flty" marked and flashing in the step indication. When a compensation system need additional capacitors to be added, proceed as described below:

Procedure:

Select item "403" in expert menu and use the ▼ ▲ buttons to select the corresponding step. Confirm with ►(↵) button and use the ▼ ▲ buttons to adjust step type "AUTO".

Feature:

If a step because of power loss greater than 30% is exchanged, it's appropriate for the step, to program the nominal step size by hand. Select the affected step in menu "402" and program the nominal step size.

If the alarm was triggered by a defective contactor should, upon the exchange took place, the accumulated switching operation under item "404" set to "0".

9 CUSTOMER SETTINGS

Menu	Factory setting	Customer setting	Menu	Factory setting	Customer setting
100			400		
Un	400 V		401	75 s	
Ct	1		402	5 var (1-max.)	
Pt	1		403	AUTO (1-max.)	
Ai	NO		404	0 (1-max.)	
PFC	ON		500		
CP1	1		501	NO	
St	10 s		502	NO	
200			503	20 %	
201	400 V		504	NO	
202	1		505	60 s	
203	1		506	NO	
204	10%		507	NO	
205	NO		508	262 k	
206	0		509	65.5 k h	
207	NO		510	NO	
208	YES		511	NO	
209	AUTO		512	NO	
300			513	30 °C	
301	60%		514	55 °C	
302	1		515	0 °C	
303	0,95 i		516	NO	
304	NO		517	NO	
305	10 s		518	NO	
306	2 s		600		
307	YES		601	NO	
308	NO		602	NO	
309	YES		603	NO	
310	ON		604	NO	
311	1		605	NO	
312	0		606	NO	
313	1		607	1.xx	
314	NO				

10 APPENDIX

10.1 Settings Phase-angle

Voltage	L1-N	L2-N	L3-N	L1-N	L2-N	L3-N	L1-N	L2-N	L3-N
CT	L1	L2	L3	L2	L3	L1	L3	L1	L2
Phase-angle	0°	0°	0°	240°	240°	240°	120°	120°	120°
Voltage	L2-L3	L3-L1	L1-L2	L2-L3	L3-L1	L1-L2	L2-L3	L3-L1	L1-L2
CT	L1	L2	L3	L2	L3	L1	L3	L1	L2
Phase-angle	90°	90°	90°	330°	330°	330°	210°	210°	210°

10.2 Connections for mixed measurement

Transformer vector group	CT	Voltage
Dy5	L1	L2-N
Dy5	L2	N-L3
Dy5	L3	N-L1
Yz5	L1	L2-N
Yz5	L2	N-L3
Yz5	L3	N-L1
Dx6	L1	L3-L2
Dx6	L2	L2-L1
Dx6	L3	L1-L3
Yy6	L1	L3-L2
Yy6	L2	L2-L1
Yy6	L3	L1-L3
Dy11	L1	N-L2
Dy11	L2	L3-N
Dy11	L3	L1-N
Yz11	L1	N-L2
Yz11	L2	L3-N
Yz11	L3	L1-N

