Vishay Electronic GmbH
Hofmark-Aich-Str.36
D-84030 Landshut
Telefon +49 871 86-0
www.vishay.com

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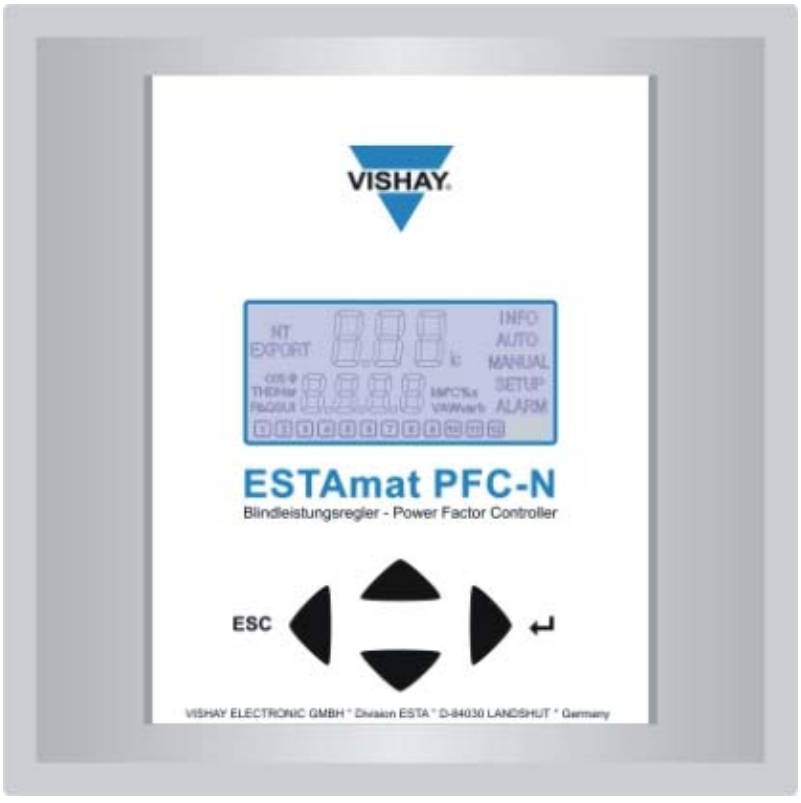
Power Factor Correction Controller

ESTAmat PFC-N



Operating Instruction MV1181

QUALITY MANAGEMENT

Certified by VDE according to
DIN EN ISO 9001
Reg. No. 2556/QM/03.94

Revision history

Date	Name	Revision	Change
19.04.11	rjo	00	initial document release
16.11.11	rjo	01	advise on HV operation

INSTALLATION AND CONNECTION

Only qualified staff is allowed to perform the installation. Also there have to be kept all valid rules from government! Before connecting the device check that all lines are without voltage and shorten current transformer.

1) Compare auxiliary-, measurement-, control voltage, frequency and the current path of the device (see type label) with the data of the electricity network.

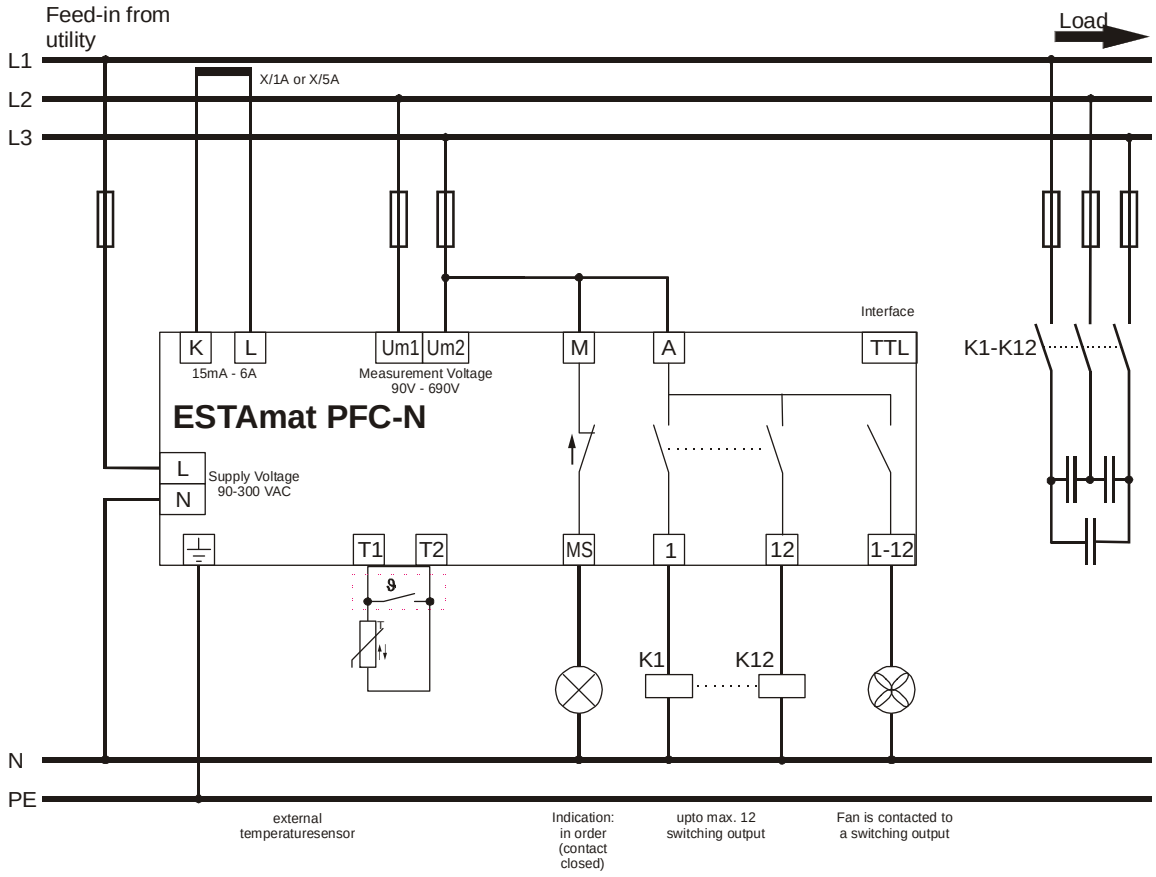
2) Assemble the relay in the switch panel with the 2 mounting clips. If the device is not fitting in the cut out the small plastic bars on the side of the case can be removed with a knife.

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



Operation of ESTAmat PFC-N in High Voltage compensation panels

The below list is showing the parameters of the ESTAmat PFC-N which need special attention for operation in High Voltage compensation panels.

Attention: When putting the ESTAmat PFC-N in operation, the countdown for “AI” has to be stopped by pushing the “esc” button.

Un = Adjust the nominal voltage to local conditions
Ct = Adjust the Ct ratio to local conditions
Pt = Adust the Pt ratio to local conditions
St = Adjust the switching time to local requirements
208 = Set item 208 to “No” and switch off the countdown for “AI”
308 = Set item 308 to “Yes” and switch off the automatic step size detection.
401 = Adjust discharging time to local conditions
402 = Adjust step sizes

Attention: When resetting the ESTAmat PFC-N by using menu item 601 or 602, all adjusted values are set to factory settings.

When using factory settings for High voltage compensation a proper and save operation is not possible!

1.2 Connection data

Supply voltage	
	Range 90-300VAC. Terminals L / N
Measurement voltage	
	Range 90-690V. Terminals UM1 / UM2 With using of VT's 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 Outputs	
	Assembly with 6 or 12 Regulation Outputs possible. Regulation Outputs volt free with common root. Terminals A 1-12 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 target Pf. Terminals T1 / T2 Setting are explained in the Alarm menu.

2 COMMISSIONING

2.1 ESTAmat PFC-N is parameterized:

After the supply voltage is applied, in ESTAmat PFC-N starts a countdown with 90 sec. Cancel the countdown by pressing the ◄(esc) button or expire the countdown. After expiring the countdown, starts the adjusted discharge time for the capacitors (default 75 sec.). Only then the regulations starts with preset parameters.

2.2 ESTAmat PFC-N is not parameterized:

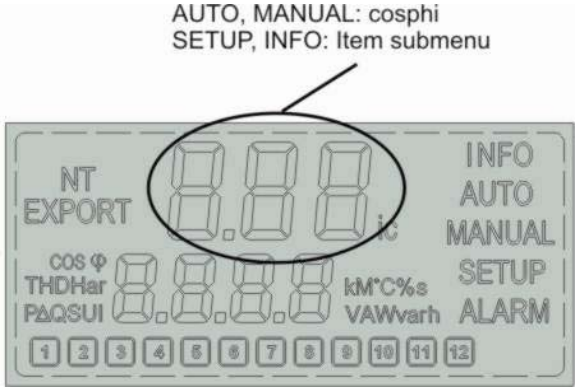
During the countdown, the auto-initialization can be start by pushing the ►(↵) button. The regulator determine which control outputs are not used and blocks them. A wrong connection of voltage and current will be determined and corrected. After expiration of the auto-initialization, the controller start the regulation and recognize automatically the step sizes of the capacitors. 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



INFO:	Capacitor database
AUTO:	automatic control is running
MANUAL:	manual mode
SETUP:	setup menu
ALARM:	blinking in case of alarm
NT:	Pf 2 active
EXPORT:	export of active energy
1 – 12:	control outputs

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.

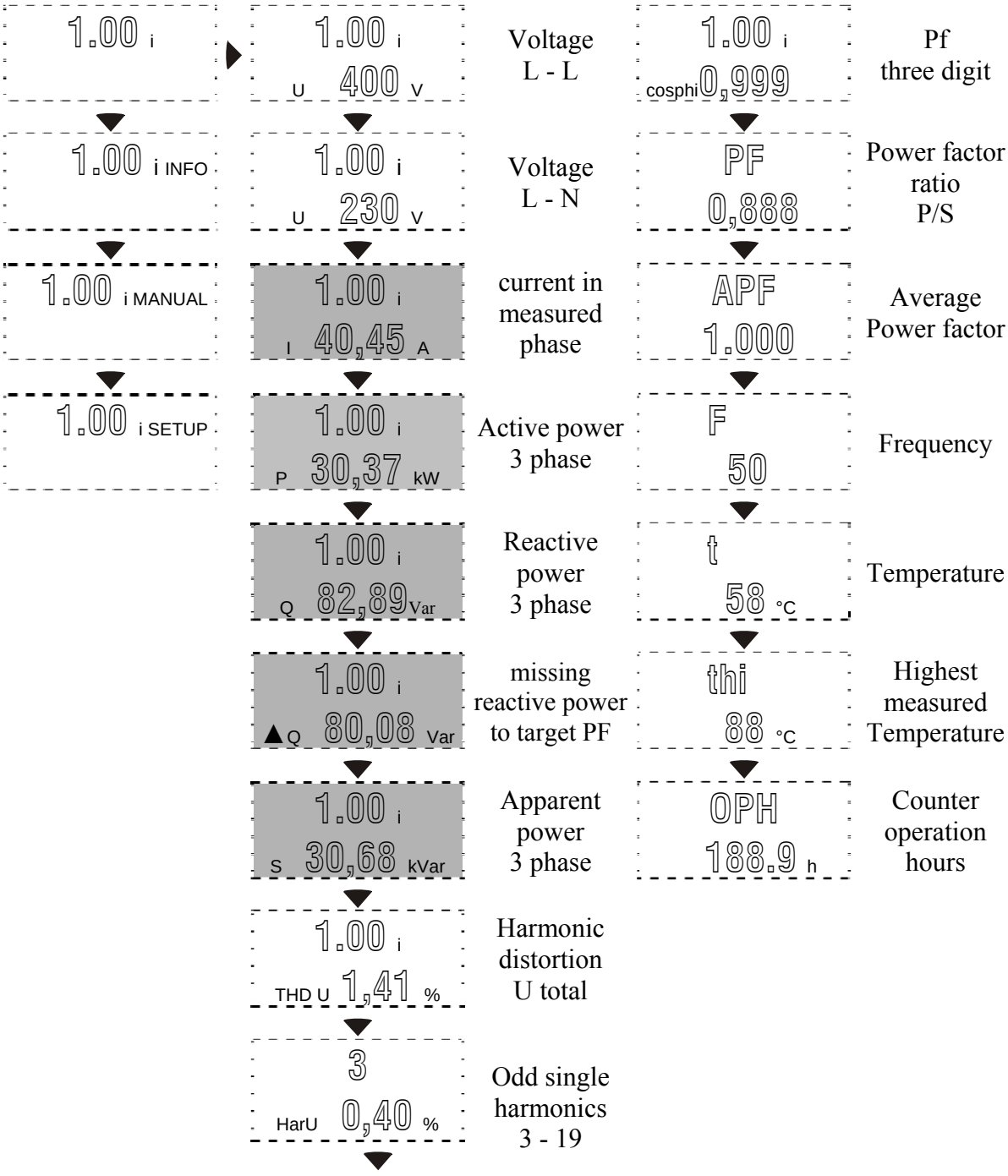
To reset pending alarms hold the ◄(esc) button pressed for 5 seconds.

U ALARM	measured voltage is outside the set tolerance
I Lo ALARM	measured current is less than 15mA (check the short circuit bridge K and L and the entire current path
I Hi ALARM	measured current is to high
PFC ALARM	The controller cannot achieve the target PF
HAr ALARM	The set limit for the THD of the voltage is exceeded
StEP ALARM / FLty ALARM	One or more steps are broken. The defective step is blinking with the alarm message.
SPL ALARM / 1 1 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.
tHi ALARM	The second temperature limit is exceeded. Stage were switched off successively.
OPH ALARM	Set limit of operation hours has been exceeded
OPC ALARM / 1 1 ALARM	Set limit of the max. allowable operation cycles, for one or more steps, has been exceeded.
Ai / Abrt	Abort of auto-initialization.

4 MENU ESTAmat PFC-N

4.1 Measurement menu

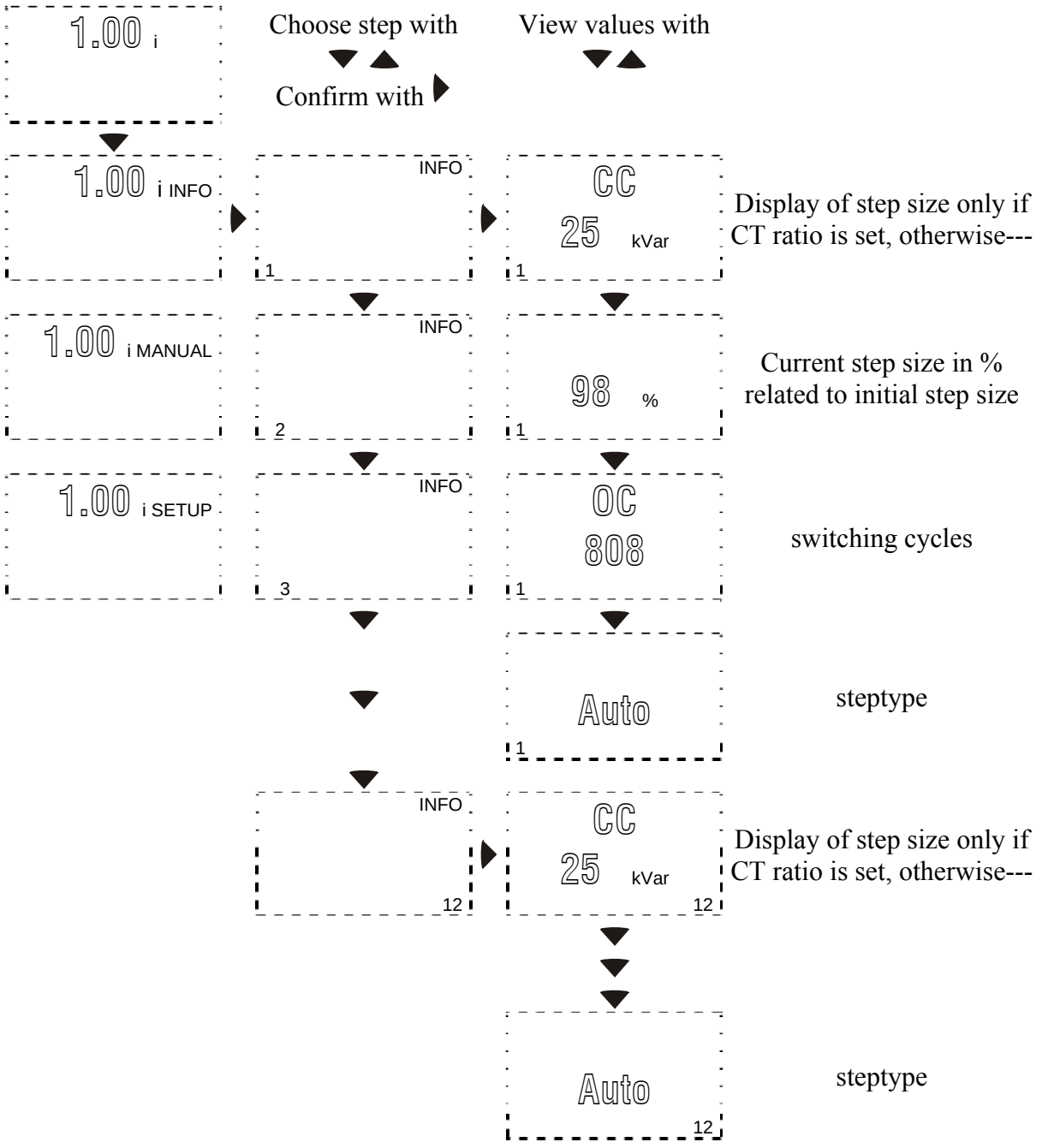
All grey fields are hidden in the factory settings and will only appear if the CT ratio is set in the "SETUP" menu. For devices with software version before 1.04 the complete measurement menu is hidden and must be activated by adjusting the CT ratio.



4.2 Info (Step database)

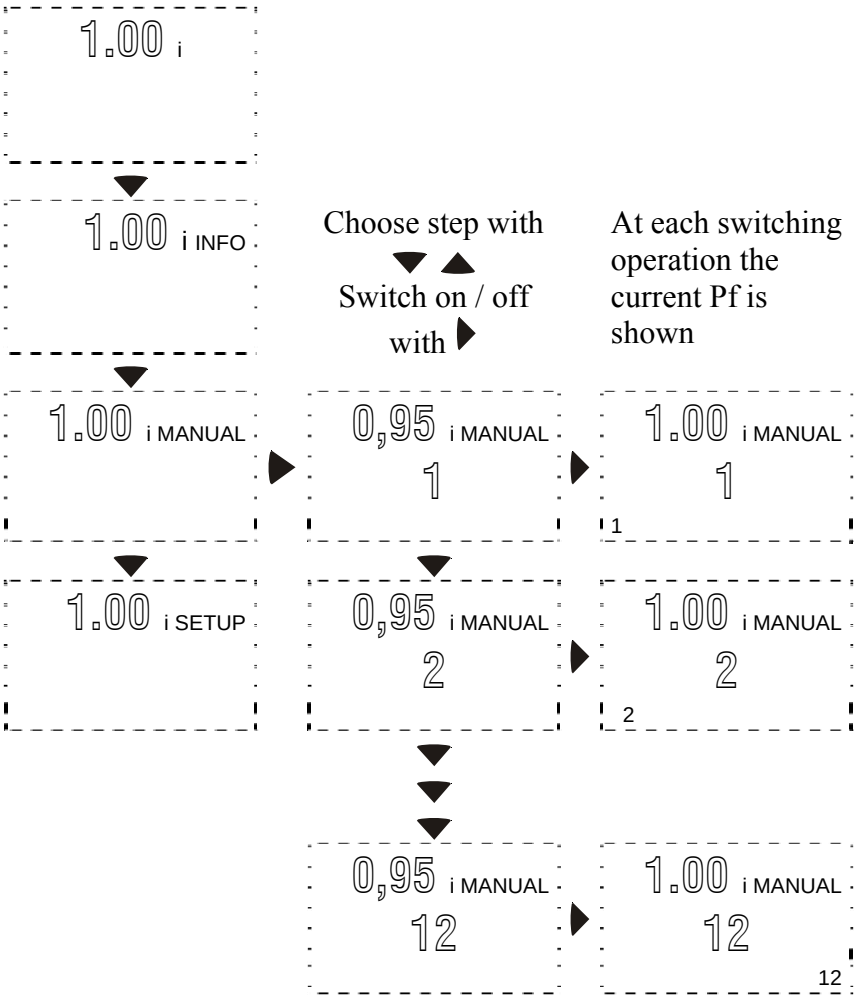
In the "INFO" menu for each connected step the number of switching cycles, the current step size and the step size in relation to the initial step size is stored.

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



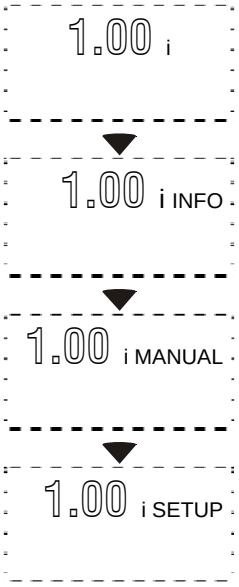
4.3 Manual (step switching manual)

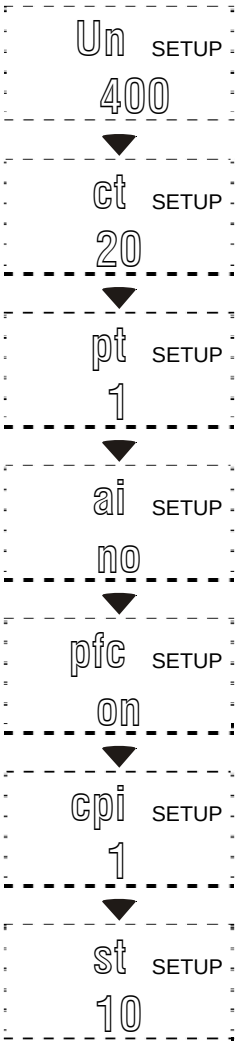
For testing purposes, it's possible at ESTAmat PFC-N that the outputs are switched by hand. In the "MANUAL" menu, the automatic control stopped. In order to avoid that control stop accidentally this menu item is protected by key lock. Hold ▶ button pressed for 3 sec. to enter this menu. As soon as you leave the menu, the system start automatically and switches off unnecessary step's. Also observed during the manual switching of the outputs is set discharge time. This applies for re-energizing of step's as well as for the blocking time after the start countdown is expired



4.4 Setup (Quick start menu)

To commission the control settings are not needed. When you start the auto-initialization the ESTAmat PFC-N checks the connection of the measurement and the outputs. With these data, the control starts automatically. However, the ESTAmat PFC-N offers some option's for optimal adaptation to the conditions in the system and display system data.





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

Input current transformer CT 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

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

Target PF of control

Latency between switching the steps

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:

5.1 100 Quick start menu

Contains all important points for commission:

100 Quick start menu

MENU	FUNCTION	RANGE
Un	Nominal voltage measurement = phase voltage	100...241500 V
	Setting the correct nominal voltage is needed because from this value the upper and lower limits for voltage monitoring is calculated (See. tolerance Nominal voltage). The Step sizes stored in Step database relate to the adjusted nominal voltage.	
Ct	Current transformer ratio	1...9600
	Setting the CT factor. Value must be entered as the ratio (eg 1000 / 5 = 200) At devices with software version 1.04 is the adjustment range from 1-4000.	
Pt	Voltage transformer ratio	1...350
	Stetting the VT factor. Value must be entered as the ratio. If the device is directly connected to the measurement the value 1 has to be used.	
Ai	Auto-Initializing Start	Yes/No
	"YES" starts auto-initializing "NO" nothing happen If the auto-initializing starts, the controller is testing all step's with step type "AUTO" and "FOFF" again and the step type is newly stored in the step database. Steps that are programmed to "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.	

PFC	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".

CP1	Target Pf 1	0.70 c ...0.70 i

With the setting of the target Pf 1, the power factor is set to be achieved by power factor correction.

St	Switching time latency	1...6500 s

The switching time is the time what is waited between the switching of individual steps in the normal control algorithm. This value should be adapt to the site.
When setting the switching time, the following points should be considered:

1. The switching time is to protect the relays from unnecessary switching operation and to rapid wear.
2. During the switching time the need of reactive power is averaged. This function compensates fast load changes.

5.2 200 Measurement settings

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

200 Measurement settings

MENU	FUNCTION	RANGE
201	Nominal voltage measurement = phase voltage Setting the correct nominal voltage is needed because from this value the upper and lower limits for voltage monitoring is calculated (See. Nominal voltage tolerance range). The Step sizes stored in Step database relate to the adjusted nominal voltage.	100...241500 V
202	Current transformer ratio Setting the CT factor. Value must be entered as the ratio (e.g. 1000 / 5 = 200) At devices with software version 1.04 is the adjustment range from 1-4000.	1...9600
203	Voltage transformer ratio Stetting the VT factor. Value must be entered as the ratio. If the device is directly connected to the measurement the value 1 has to be used.	1...350
204	Nominal voltage tolerance range 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 voltage measurement "YES" voltage measurement L-L "NO" voltage measurement L-N Based on the set voltage, the controller automatically detects the voltage for both types of connection (LL and LN). If these are within the set tolerance (factory setting +/- 10%) the controller shall determine the voltage measurement. 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-offset	0...345

This menu contains the correction angle for current and voltage measurement determined during the auto-initialization. This value should not be changed, because then the control not longer works correctly.

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
"NO" nothing happen
If the auto-initializing starts, the controller is testing all step's with step type "AUTO" and "FOFF" again and the step type is newly stored in the step database. Steps that are programmed to "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" The controller starts after every restart the countdown to the auto-initialization.
"NO" The control starts after restart with the saved values.

209	Frequency synchronization	Auto/Fix50/Fix60

For the highest accuracy of measurement, the samples need to be synchronized to the grid frequency.
Strong voltage commutation notches can, in spite of the internal filtering, result that automatic synchronization is disturbed.
This could result in large measurement errors. For this reason the following settings can made.
Automatic synchronization:
For maximum accuracy at mains voltage without commutation notches.
FIX-50HZ: For safe operation in the 50Hz grid with extremely poor power quality.
FIX-60HZ. For safe operation in the 60Hz grid with extremely poor power quality.

210	Temperature offset (from software revision 1.04)	-10-10°C

This menu allows the setting of an additional temperature offset to correct temperature dependent deviations of the components.

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

MENU	FUNCTION	RANGE
301	Control sensitivity	55...100 %
	The control sensitivity indicates the switching threshold for switching of the steps. A low values allows a more accurate compensation result. However, this increases the likelihood the controller tends to oscillate. The adjustment range is between 55% and 100%. The factory setting is 60% of the available steps.	
302	Target Pf 1	0.70 c ...0.70 i
	With the setting of the target Pf 1, the power factor is set to be achieved by power factor correction.	
303	Target Pf 2	0.70 c ...0.70 i
	With the setting of the target Pf 2, the power factor is set to be used when P-export is detected or switch over to NT.	
304	Target Pf 2 for P Export	Yes/No
	"YES" the controller operates in P-export with the target Pf 2 as control target. "NO" the controller operates in P-export with the target Pf 1.	
305	Switching time latency	1...6500 s
	The switching time is the time what is waited between the switching of individual steps in the normal control algorithm. This value should be adapt to the site. When setting the switching time, the following points should be considered: 1. The switching time is to protect the relays from unnecessary switching operation and to rapid wear. 2. During the switching time the need of reactive power is averaged. This function compensates fast load changes.	
306	Switching time Step exchange	1...6500 s
	This is the time between the disconnection of an active step and the switch on of a better in the identified need for reactive power matching step. When step exchange, normal switching time is not respected.	

307	Activate Step exchange	Yes/No

"YES" for an optimal compensation result, the controller can switch off active steps and replace them with more suitable steps.
"NO" This function is deactivated.
This function is useful when different step sizes are available. If all available step have the same step size, then this feature should be disabled otherwise is may lead to unnecessary switching cycles.

308	Step recognition "OFF"	Yes/No

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

a) there is in the system quickly changing loads and problems with the automatic step size detection occurs.
b) the automatic detection of defective steps is not desired.
c) the contactors have a delay of more than 200msec.

"NO" Step sizes are automatically determined during operation and losses of step sizes were tracked and considered at the control.

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

1. **Automatic:** The controller operates on the "Best Fit" principle. This means the controller compares before each switching operation, all in the step database stored step sizes with the identified need for reactive power and choose always the step which is the closest to the control target. If the controller has several equal steps available, the number of switching cycles automatically distributed to these steps.
2. **LIFO:** „Last In, First Out“ Switch on the outputs is always done in the switching sequence 1-2-3-4-max. The switch off is in the switching sequence been turned upside max-4-3-2-1.
3. **Kombifilter:** Special algorithm for combined filter banks. The controller operates on the "best fit" principle as in automatic mode. Unlike to automatic mode the controller is connecting always at least the same or more capacitance which is connected to the odd numbered outputs with the even numbered outputs. If the controller has several equal steps available, the number of switching cycles automatically distributed to these steps.
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

The set here offset reactive power is always added to the measured reactive power. This means that the system can be capacitive, but measurement of the utility records the required Pf. The set offset reactive power also goes into the calculation of ▲Q, Pf, apparent power, current and active power. The max. offset reactive power that can be entered is calculated from the set current and voltage transformer ratios.

313 Switching time asymmetrical -127...127

The set factor multiplies the selected switching time in the capacitive direction (fast switch on of steps and slow switch off). If this factor is set with – as sign the function works vice versa. Factory setting "1" (means symmetrical switching times for both directions)

314	Switch-off in leading condition	Yes/No

"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 Pf.

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

MENU	FUNCTION	RANGE
401	Discharge time	0,5...1200 s
	The discharge time is defined once and is valid for all steps. The discharge time is a lockout time, which expires after switching off a step. Until this time has not expired, the corresponding step for the regulation is not available. The discharge time should be adapted to the discharge unit of the capacitor.	
402	Capacitor size	Ct*Pt*7000
	If the automatic size-detection is disabled, then it is necessary to enter the nominal step size. The input is done in var and is related to nominal voltage. The adjustment must be done separately for each output. **Warning:** Before the step size is set, must be set the correct current and voltage transformer ratio since the max. possible steps size is limited by these ratios. After an step size has been entered, should the current and voltage transformers ratio will not changed because these changes affect the set step size. Hand-programmed "normal" steps will be overwritten by the automatic step size detection	
403	Type of output	Auto/Al/FOn/FOff
	For each step the function can be set separately. The following functions can be selected: • Auto = Step is used in the normal control 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 • flty = Step was switched three times without success and is not longer used for the control. Defective steps flashing in the step indication. 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	Switching cycles	0...262000
	The ESTAmat PFC-N is counting the operations of the switching outputs and displays them 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

MENU	FUNCTION	RANGE
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 "ALARM". "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	Latency time before triggers THD U and Temperature threshold 2	1...255 s
	Latency 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 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	1...262000

Threshold switching cycles for service alarm.
Display indication 0PC ALARM

509	Max. operation hours	1...65535 h

Threshold switching cycles for service alarm.
Display indication 0PH ALARM

510	Use temp. sensor as digital input	Yes/No

"YES" Temperature sensor is activated via a switch and causes a switchover to target Pf 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.

511	DI active at HIGH signal	Yes/No

"YES" digital input is used as n/o contact
"NO" digital input is used as n/c contact.

512	Temperature alarm	Yes/No

"YES" the controller monitors the temperature threshold 1 and 2 and responses accordingly.
"NO" alarm disabled.

513	Temperature threshold 1	3-74 °C

By exceeding the temperature threshold 1 switches the controller as "AL" declared step (fan on).

514	Temperature threshold 2	4-75 °C

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 "ALARM" and the alarm contact is opened.

515	Control alarm (target Pf can not be archived)	Yes/No

"YES" alarm is triggered after 75 time switching time with ▲Q> smallest step (Over / under compensation). Controller opens the alarm contact and indicates PFC 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 STEP ALARM /FLAY 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 SPL ALARM /1 1 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 (display from 1.04).

600 Resetmenu

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

6 TECHNIAL DATA

Supply voltage:	90 – 300V AC, 45-65HZ, 5VA, power consumption 5VA, max. fuse 6A
Measurement voltage	90 – 690V AC +-10%, 45-65HZ, power consumption <1VA, 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 outputs	Up to 12 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	• aux. voltage missing	• Check the correct connection of power supply and correct if necessary.
Display "ALARM"	• Voltage outside tolerance	• Check measurement voltage • Check nominal voltage and adjusted tolerance and correct if necessary.
Display "ALARM"	• Measured current is to small	• 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	• wrong transformer ratio	• Check settings of transformer ratios in the "SETUP" (100) menu and correct if necessary.
The power factor is displayed incorrectly.	• The connection detection was not performed. • The phase angle was adjusted manually false. • Offset reactive power is adjusted.	• 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.	• CT incorrectly positioned.	• 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.	• Steps defective	• Check capacitor, possible fuse, capacitor, or contactor defective.

Display "ALARM"	• Current is greater than allowed.	• Check the current transformer secondary current and possibly replace it with matching current transformer.
Display PFC "ALARM"	• permanent over compensation	• Check settings (possibly step with step type "FON") • Check contactors, contactor contact may bonded.
	• permanent under compensation	• Check capacitors and fuses. • Dimensioning of the system examined.
Opposite regulation behaviour	• Current or voltage connections swapped.	• correct connection or adapt phase compensation.
Individual steps are not switched on or off.	• wrong setting	• Verify whether the steps were defined as Step type "FON" or "FOFF" (permanently on or off).
Steps are detected as defective. Steps are switched off again.	• Step defective	• Check capacitor, possibly fuse, capacitor or contactor defective.
Steps are not switched.	• The steps are to large.	• 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 ESTAmat PFC-N is equipped by default with a temperature sensor. The fan is controlled via one of the switching outputs.

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 2the temperature thresholds. By exceeding the temperature threshold 1 is witched 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 target Pf 2 via digital input

By using a switch, the ESTAmat PFC-N will be switched to target Pf 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

  In the menu item 511 can be determined whether the digital inputs as n/c (NO) or n/o (YES) is used.

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 target Pf 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:

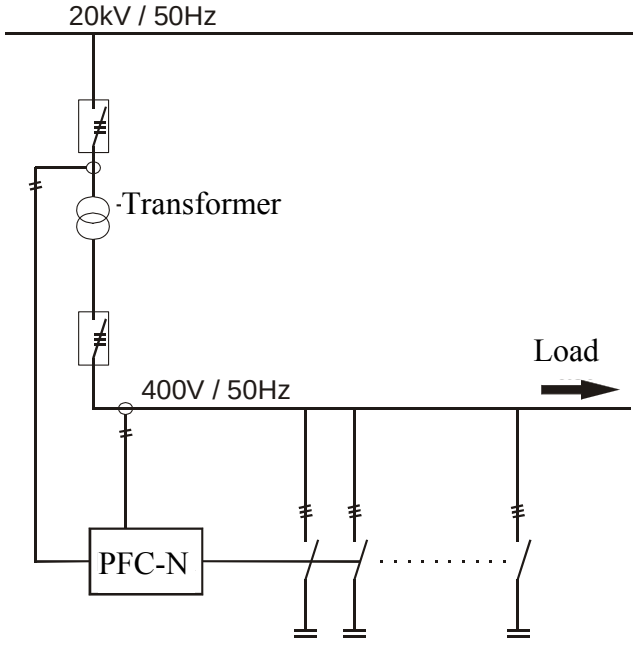
Determine the required capacitive reactive power to compensate the transformer. Enter the calculated value in the menu item "312". Control will start immediately with the additional required reactive power.

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 ot 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 aditional 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 24hours 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 in menu "402" the affected step 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 INDEX

11 APPENDIX

11.1 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°

11.2 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