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Operating Instructions

Power Factor Control Relay CXPLUS - Expert's Instruction Manual

Software Version 1.08 from relay serial number 1123596. Dated of issue Sep 05 2012

Contents

1.0 **<u>Connection</u>**

1.1 **Installation must only be carried out by suitably qualified personnel.** All local safety regulations must of course be followed including IEE wiring regulations 17th edition if installation is in the UK

The power supply to the relay is taken from the phase – phase 50 or 60hz voltage and connected via a fuse 6A max to Um1 and Um2. The relay power supply power convertor is switched mode so that the CXPLUS accepts any voltage across Um1-Um2 in the range 90-550V 50/60Hz. Voltage Transformers for different supply voltages are a thing of the past. Check that the supply voltage is within the limits of the relay rated voltage., and the CT has 1A or 5A output., at full load.

1.2 – **Current Transformer**

The current supply to the relay is taken from a current transformer, which can be split core or ring type Class 1., with 5VA rating. The current transformer (CT) must be kept short circuited until connections have been securely applied to terminals K-L. The CT is normally mounted on a different phase to L2-L3 for the voltage supply. Other connections are possible – see phase offset menu 206. It is essential to ensure:

a) That the CT is measuring the **total** load of the feeder to be corrected – **including** the PFC capacitor current
b) The ratio of the CT is such that full load current is about 75% of the CT ratio.
   e.g. .for a Max load of 500 amps, select a CT ratio of 800/5 – not 5000/5. This is because at the lower current ranges CT's are less accurate.
c) Do not use a CT with too low a ratio for the measured load. E.g. If the load is 750 Amps, and you use a 500/5 CT ., the CT will then be saturated and will give inaccurate results.

When mounting the CT, 'P' should be pointing in the direction of the incoming supply and 'L' towards the load. S1 on the CT Should be connected to 'K' on the relay and S2 to 'L' on the relay. The output from the CT can be 1A or 5A. The Max ratio of the CT must be such that the smallest step of switched capacitance will produce a current of not less than 15mA. Reactive – preferably 20mA.

Example : The smallest step size is 25 kvar., at 415v 3ph 50 Hz. What is the highest CT ratio permissible?.
25 kvar at 415v = 34.7 amps. Capacitor will switch at 60% of nominal kvar = 20.8 amps.
Minimum current = 20mA reactive ., so Max CT ratio = 20.8/.02=1040/1 or 5200/5 for a 25 kvar capacitor operating at 415v/3ph/50 hz. A 5000/5 would normally be selected as a max ratio

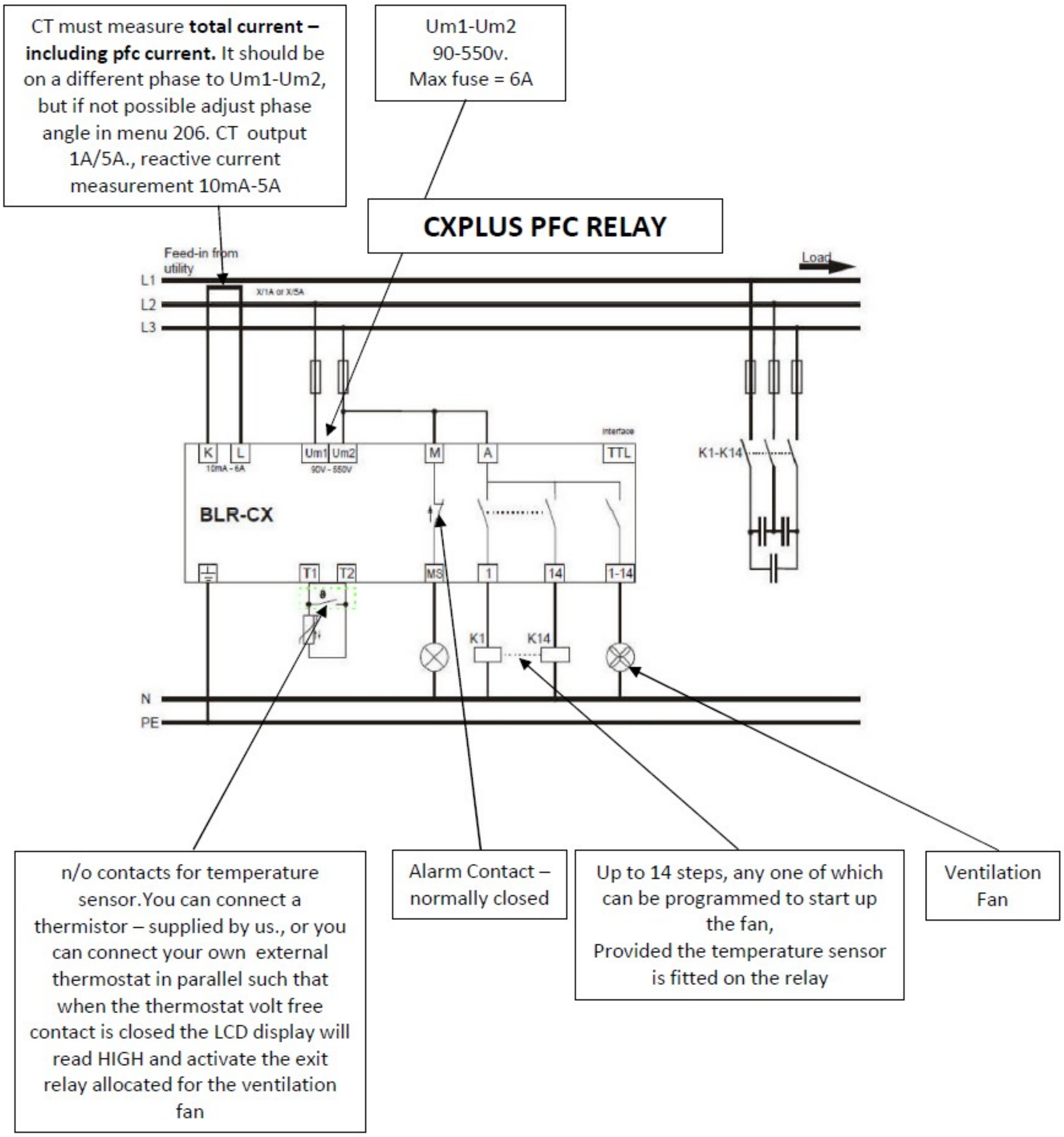
1.3 Connect the earth tag link on the instrument case to earth

1.4 Connect in accordance with the wiring diagram.

1.5 **Remove any short circuit links from the CT and relay**

1.6.1 Wiring diagram: Contactors

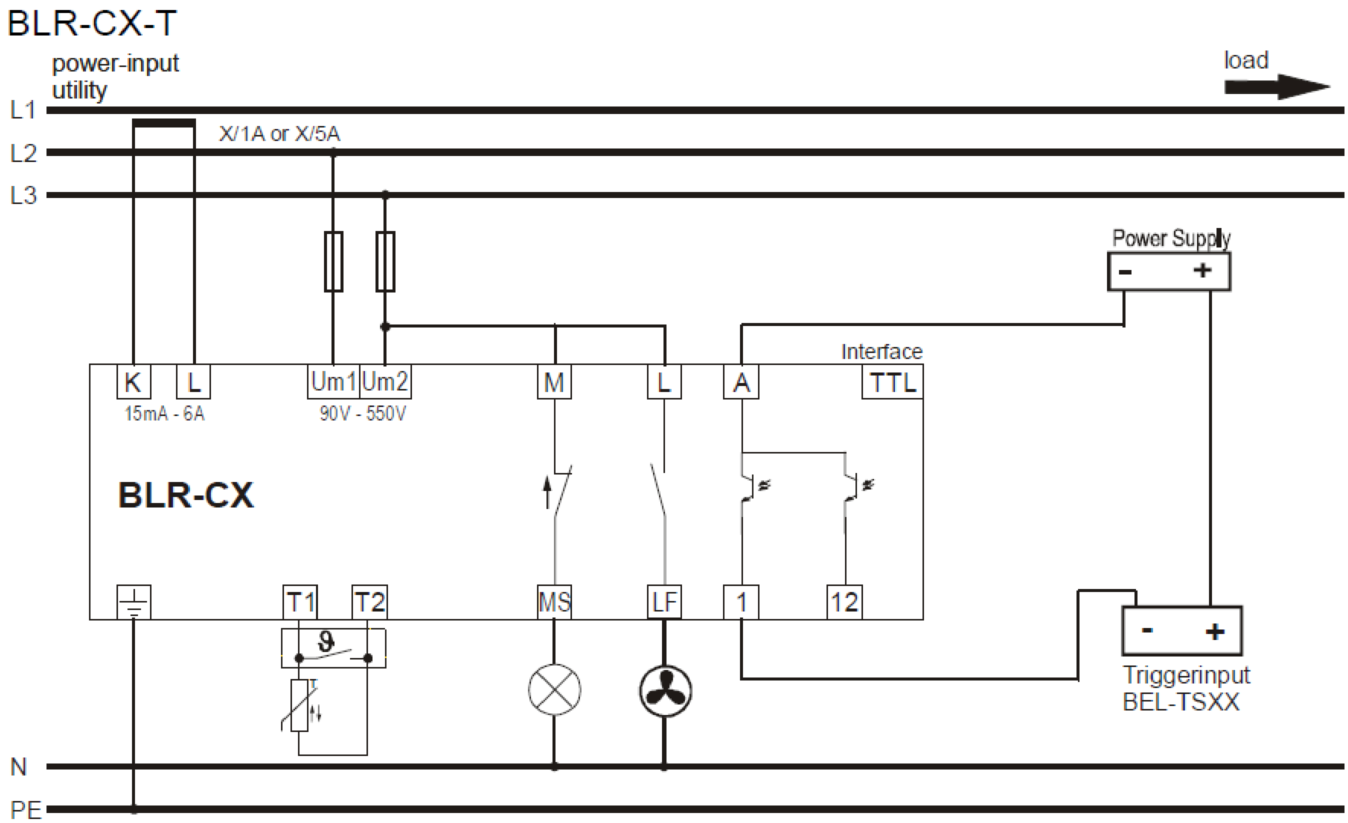
This dwg shows contactor coil switching phase - neutral but if phase-phase voltage contactor coils (415v in the uk) are used and no neutral is brought into the cubicle, the common side of the coils can be to one of the phases as long the common phase as not the same phase as Um2



1.6.2 Wiring Diagram – Thyristors

The CXPLUS can switch with a one second time delay per step. For faster 20 millisec switching per step – or all steps - you need the CM relay. To trigger the thyristors you need an aux power supply of 12v DC – see wiring diagram.

CXPLUS – T :



2.0 <u>Energising the relay</u>

2.1 **The lockout time of 90 seconds** will start counting down, after energising the CXPLUS . This to ensure that capacitors are not switched in immediately after an emergency generator start up - for example. To defeat lockout time press escape ◄. and you will now scroll through values pressing ▼▲to navigate the measured values.

2.2 **Measured Values in the Display**

The three larger digits at the top show system power factor.-
e.g. 0.91i = lagging p.f. 0.91., 0.98c = leading p.f 0.98
The scrolled values▲ ▼ have the following meanings . These are the readings the customer can readily access. Note that **if the CT ratio is left at the factory default of 1 ., then the values marked ** will not be displayed.**

2.2 **Continued**

The Scroll Through Menu – What do the Symbols mean?

U	phase – phase voltage
U	phase – neutral voltage
I **	phase Amps on phase CT is connected
P**	3 phase kW assuming balanced load
Q**	3 phase kvar total assuming balanced load
∆Q**	3 phase kvar required to reach target Cosphi assuming balanced load
S**	3 phase KVA assuming balanced load
THD U	Total Harmonic voltage distortion of L2 – L3 (if this figure is above 5% check the current taken by the capacitors since high THDU can result in harmonic overload of the capacitor steps. Harmonic Blocking reactors must then be fitted to limit harmonic overload current)
3-5-9-7-9-11-13-15-17-19	harmonic voltages as % of fundamental
0.--i cos	Top figure = Fundamental 50/60hz Cosphi to 2 decimal places Bottom Figure = Fundamental Cosphi to 3 decimal places as required in certain countries
PF	True rms power factor including all harmonic currents and voltages
APF	Average rms power factor (kW/kVA) since relay commissioned
F	Supply frequency
t	Real Time Ambient temperature
thi	Max Ambient temp. To date
0ph	Counter for number of hours relay has been in service, since last reset
tAn	Tangent of phase angle phi

NOTE: The CXPLUS measures in 4 quadrants and will detect import and export of kw/kvar. If you see EXPORT, when you know for certain you are importing load the reasons could be:

- CT total current is below 15mA
- CT is reversed (you will see the letter ‘c’ after the power factor when you know it should be ‘i’)
- Phase angle (menu 206) is incorrect

3.0 The 100 Quick Start Menu – for Commissioning Engineers and Contractors etc.

3.1 **The 100 Menu allows you to set the CT ratio- voltage measurement values, target power factor setting., and switching time per step. This is the menu the Commissioning Engineer can use on site.**
Values of kW/kVA/kvar will not be correct unless the correct setting is made for voltage and current .
In order to make these settings we have to go into the commissioning menu 100.

3.2 How to get into menu 100:

press ◄ repeatedly to get back to the value 0....i
Now press ▼ and you see 'INFO' in the top right corner
Press ▼ again and you see 'MANUAL'
Press ▼ again and you see 'SETUP'
Press ► and release .'100' shows in the display
Press ► again – you are now in the commissioning menu 100. The 100 menu allows you to make the essential settings are marked in **bold**

3.3 Un - Voltage Setting

The first value you see is the Un – which you may think is phase Volts Phase – Neutral . **It is not ! It is the phase – phase system nominal voltage**
The default setting for UK customers is 415v.,but if you need to change this press ► and the first digit starts flashing – using ▲▼adjust as needed and key ► to adjust the second figure and so on. Press ► to confirm and the digits stop flashing.
If the relay is working at 11kV via a voltage transformer, then set 11.0 and by using ▲▼ keys select kV ., then ►., to get 11.0kV in the display

▼

3.4 C.T Setting

To set the CT ratio key ► and the first digit starts flashing.
Assume the CT ratio is 1000/5., which is 200/1. Always set the CT ratio as a multiplication factor to 1 so for the CT ratio 1000/5 we set Ct to 200. The same sequence with ▼ and ► is used for all the other settings.
If you set the Ct=1 ., then you will not get any readout values for KW-KVA-KVAR – I as marked ** in the scroll through menu above.

▼

3.5 Pt - Voltage Transformer ratio setting.

This is only used when the relay is used on MV/HV systems. The default setting is 1., but if the relay is working on an 11kv system with 110v voltage input ., the setting for Pt is 100, for example.

▼

3.6 Ai – Automatic step start up switching to record kvar per step in the memory

This is a 'YES' 'NO' setting for automatic initialisation. The default setting is NO and we recommend you leave it there.
If set to 'YES' – when the relay is first commissioned it will switch each step one by one.. As it switches each step and out so the kvar outputs per step are recorded in the CXPLUS memory. If there is a wiring error of incorrect CT polarity the CXPLUS <u>will only in the Ai </u>mode correct this error internally. Ai will only start switching after pressing enter ►and the discharge time has expired (401- default 75 secs).If you have 4 steps on a 6 step relay then the last 2 steps will come up as FOFF and will remain out of service. If the load is fluctuating very heavily then it is best not to use Ai, i.e. make sure the Ai setting is on NO
If Ai is set to 'NO' then no automatic switching on initial energising will take place, and the steps will be switched in for the first time when they are required. Each time they switch in their kvar value is recorded in the relay memory.
Power factor control is then achieved by the best fit principle – automatically selecting the most suitable kvar size to fulfill ΔQ (kvar needed to reach target p.f.)
Our recommendation is not to use Ai but to commission the relay to your requirements and leave Ai on NO.

▼

3.7 PFC – Step switching Control

This control allows you to decide how you want the steps to be switched The possible selections are :

ON - Normal switching of steps on/off as the reactive demand changes . This is the same as normal AUTO control

OFF – Reactive control de-activated and all steps in circuit will be switched off

HOLD – The steps switched in will remain on. The reactive control is de-activated

The default setting is 'ON'- automatic switching of steps.

3.8 CPI – or Target Power factor setting.

Set to the required target PF. Note if you press ▲ when the CPI is 1 you will go into a leading pf setting. You can target up to 0,70 lead., which is an unlikely setting but when the PFC is on the LV side of a transformer and the customer is paying for energy on the HV side and the CT is on the lv side of the transformer it may be useful to target to about 0.99 lead so as to compensate for transformer reactive current which is creating I^2R losses in the windings on no load..

3.9 St- Switching time per step

Adjustable from 1 second –6500 seconds.

If the switch time is set to 1 second per step, for a rapidly changing load, of course it cannot switch back in again after a delay of only 3 seconds, due to the charge held on the capacitor. In this case the relay will wait until the programmed discharge time set in menu 401. Default setting on menu 401 is 75 secs.

3.10 OUt – Setting of Output for each Step

This setting allows you to select each step setting either as:

AUTO – normal automatic relay controlled step switching

AL – This step operates the temperature alarm contact. When the temperature is above the target setting – this contact can be used to start up the ventilation fan. See ventilation fan setting 513 in the expert menu.. This is only active if the relay is fitted with the temperature sensor option. All pfc relays manufactured in the UK have this temperature sensor fitted.

FOFF – This step is permanently off (Fixed off)

FON – this step is permanently on (Fixed on)

Default setting is **AUTO**

3.11 How to cancel Alarms quickly

To cancel all alarms quickly , hold the escape key ◄ for 5 seconds. To cancel particular alarms see menu 500 – Alarms.

3.12 ALARMS – What do they mean ?

In the case of Alarm , the display will flash alternately ALARM .

.... /
ALARM

TO CANCEL ALL ALARMS – EXCEPT THE SPL/... ALARM HOLD THE ESCAPE KEY◄ FOR ABOUT 3 SECS. THE ALARM SHOULD THEN CLEAR To cancel SPL/... see the table below

The display will also show one of the following :

Alarms:

U	Measured voltage outside % tolerance set in menu 204	**thi**	The second ambient temp set in menu 514 has been exceeded. Sequential switching off of steps to bring ambient temp down will commence
I Lo	Measured current below 15mA. Check for open circuit or short circuited CT, or insufficient load	**OPH**	The limit set for operating hours between servicing has been reached. Call the service engr.
I Hi	Measured current too high. CT saturated and inaccurate	**OPC/--**	The limit set in menu 508 for number of switching operations for contactor indicated has been reached. Default=80,000
HAr	5% harmonic voltage distortion exceeded.., or setting put in menu 503. If reactors fitted this %setting can be increased	**PFC**	Target Cosphi not reached. More capacitors needed or need replacing,.
StP /--	The step indicated is faulty. Check fuses contactor, capacitor on that step	**Ai/Abrt**	Automatic Start Up (self commissioning) aborted.
SPL /--	The step indicated has lost more than 30% of its initial kvar value when first commissioned		
SPL /--	**SPL /-- alarm cannot be cancelled using the ◄ esc. button. If you have the SPL alarm, the step indicated has lost 30% or more than 30% of its initial kvar value. Call your supplier if SPL /-- alarm activates for advice.**		

4.0 - Manual Switching

4.1 Sometimes there is no load on the system when the relay is commissioned.
In order to test everything is working correctly, the best way is to switch steps in manually until a leading power factor is achieved, and then to return the relay to automatic mode to make sure the relay switches out to reach the target power factor.
Press ◄ repeatedly to get back to **Cosphi –i** in the display
▼- INFO
▼- MANUAL
Now enter MANUAL mode ►, **by holding down the ►key for 3 secs** , Scroll up ▲ and the figure 1 is in the display. This is step 1 – to switch step 1 on key ►. Now move through the steps using ▲ to get to the next step and ► to switch it on. To switch off press ► again. Under low loads on the system this will create a leading power factor. To switch back to Automatic control, so as to check the relay is working correctly, press ◄ repeatedly until MANUAL-INFO-SETUP disappear from the right hand side of the display, so the relay is now in its normal AUTO` automatic switching function , and if the Cos phi is leading it should switch steps out to achieve the target Cosphi
(as set in 3.8)
Remember , if you have switched on and then off., you have to wait for the discharge time (default 75 secs) before this same step can be switched on again.
The kvar values of each step are not recorded in the MANUAL mode

5.0 The INFO Menu

To get into the INFO menu press escape ◄ a few times and then ▼., and you see INFO in the top right corner of the display. Enter the INFO programme with ►.
Now you see the steps in the bottom section of the display.1-6., to 1-12., or 1-14 depending on the number of steps on this relay.
The INFO programme is extremely useful since it tells you exactly how each step has been performing since installation. You can move to interrogate each step by using the ▼▲ keys.
To examine the behaviour of any one step enter that step with ► and as you scroll down you see the following symbols:

CC: This is the latest recorded kvar output of this step. The value is calculated over the last 10 switchings – average value
but remember this kvar value is only correct if the CT has been set to the correct ratio

% : This shows the % loss in kvar per step since that step was first energised (very useful to check capacitor quality and possible over stress due to harmonics)

OC: number of switchings of that contactor. The display goes up to 999., and after 999 it changes to 1.00k , so you show each ten switchings after 1000 operation. The default setting for an Alarm to show is set to 80,000 switchings for each contactor. The display would then show 80.0k You can change this default setting in menu 508.

AUTO-FOFF-FON-AL – to indicate how that step has been allocated in the Quick Start Menu

6.0 How to enter the Professional or Expert Menus 200- 300- 400- 500- 600

The professional menus 200-600 enable the qualified user to set the relay in any particular way needed. Because the settings can affect the satisfactory operation of the relay they must only be changed by professionally knowledgeable personnel. The object of this password protected entry mode is to dissuade unauthorised persons from adjusting important settings.

To enter these professional menus :
Press ◄ repeatedly until you get to the **Cosphi…i** in the display
Now press ▼ - INFO in top right hand corner
Press ▼ again to – MANUAL - ▼ again to SETUP enter SETUP with ►
You see 100 press ▼ you see **Pin** and below this the three digits **000**

Enter the password : 242

You can change this password if you want to – see menu 608
Now using ▲▼ you can enter all the expert menus 200……600

Menu 200

To set the values once you have 200 in the display press ►., then ▼

6.1 **201** – set the nominal phase – phase voltage because this is used to calculate kW/kVA/kvar.Default setting is 415v for the UK. This is in fact already done if you have set it in the 100 menu under Un

6.2 **202 – set the CT ratio. See notes in the 100 menu**. This has probably already been done in the 100 menu under Ct

6.3 **203 – set the VT ratio. See notes in the 100 menu**. This has probably already been done in the 100 menu under Pt

6.4 **204 – set the tolerance of nominal voltage setting** . This is a very important setting. The default setting is +-10%. If the voltage falls outside the pre-set tolerance, the capacitors will be switched out. Low voltages can cause contactors not to close properly, and consequently over heat and fail. High voltages will overload the capacitors and other equipment

6.5 **205 – Select the voltage used on the measurement circuit.** YES = L-L volts (default setting). NO= L-N voltage measurement. Provided the measured voltage is within the specified tolerance levels no setting is necessary since the relay will recognise which voltage is being used., and adjust itself automatically.

6.6 **206 - Select the phase angle.** The table below gives the settings between measured resistive current and voltage. The common settings for lv systems are :

Voltage	L1-N	L2-N	L3-N	L1-N	L2-N	L3-N	L1-N	L2-N	L3-N
C.T in phase	L1	L2	L3	L2	L3	L1	L3	L1	L2
Correction angle-degrees	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
C.T in phase	L1	L2	L3	L2	L3	L1	L3	L1	L2
Correction angle-degrees	90	90	90	330	330	330	210	210	210

Note that all relays are defaulted in menu 206 as follows :
When the relay recognises that the Um1-Um2 voltage is the L-L volts as Un – the default is 90
When the relay recognises that the Um1-Um2 voltage phase-neutral voltage – the default is 0

6.7 **207 – Start Automatic Initialisation**
YES – Automatic switching of the steps will take place on first energising of the relay, and kvar values per step will be recorded in the memory
NO - No steps will be automatically switched in.
If YES is selected , switching will start and the display will return to NO. Ai is fully described in the 100 set up menu. Default setting is NO and we recommend it is kept there.

6.8 **208 Activate Automatic Initialisation on relay start up**
Default setting is NO.

6.9 **209 Setting the Supply Frequency on networks with bad power quality**
The selections on this setting are : AUTO-50-60.
If the network quality is good , the highest accuracies will be obtained on the AUTO setting However, if the power quality is very bad with violent voltage fluctuations, sags and surges, transients and/or high harmonic content , the CXPLUS will show incorrect readings in the display for the measured values In this case change over to settings 50 or 60 according to the stated system supply frequency. (50Hz or 60 Hz)

6.10 **210 - Temperature Setting adjustment**
This setting allows you to adjust the temperature readings obtained from the temp. sensor in the CXPLUS. If you find , for example the temp sensor is reading 2° too low., then put in an offset on this setting of + 2°

7.0 MENU 300 - Control Settings

7.1 **301 – Switching Step Threshold Setting**

This determines the % level of kvar at which the step will switch according to its measured reactive value. Settings can be made in the range 55-100%. If the setting is made to 50% or less then hunting can take place. The factory setting is 60% , so that in the case of a 100 kvar capacitor, there must be 60 kvar of lag or lead before switching starts.

7.2 **302 – Target Power factor Setting Cosphi**

This will probably have already been set in the Start Up Menu under the setting CPI

If not , set the target power factor No. 1 which is the main target to be achieved under normal operating conditions. This often means that there will be times when the target will not be achieved and for this reason the default setting for the low pf alarm (515) is

NO ALARM

7.3 **303 – Target Power factor Setting Cosphi 2 (**For Emergency Generators- etc)

If there is an emergency generator on the system – for example - a second lower power factor is often desirable since emergency generators can become unstable at leading power factors. This menu allows you to set a different Cosphi 2. In order to activate Cosphi 2 externally – see menu 510

7.4 **304 – Target Power Factor Setting for Export**

If the generator is exporting power you have two choices of target power factor:

YES – Cosphi 2 is selected for power export

NO - Cosphi 1 is selected for power export

7.5 **305 – Switching Time per Step**

This will probably have been set up in the 100 start up Menu , but if not you can set it or change it here. The following points must be observed when setting the switch time :

1. Too rapid a switch time will result in excessive wear on the contactors
2. The relay is calculating the kvar demand after each switching operation has taken place, and too rapid a switch cycle will result in incorrect evaluations being made., in the recorded kvar per step.

7.6 **306 – Step Switching Swap Over time**

This is the time taken to switch over from an active step to a new step that has been selected – see menu 307. The default setting setting is 2 seconds.

7.7 **307** – **Activation of Step Swap Over**

This function is useful if there are large steps mixed in with small steps on the installation. 'YES' – causes the relay – for example - switch out 2x 25 kvar and switch in 1 x 50 kvar. 'NO' de-activates this function. Menu 307 has no purpose if all steps are the same value

7.8 **308 – Stop Automatic Capacitor Size Detection.**

YES – The kvar outputs of each step must be manually entered. Automatic step kvar value is de-activated. This is used when :

a) The relay is working on a very rapidly changing load – for example with cranes or elevators – so that the relay does not have time to recognise the effective kvar value of each step, then 'YES' should be selected., and the kvar value of each step entered manually.
b) If faulty step recognition is not required.
c) If the switching time of the capacitor step circuit breaker has a time delay of more than 200msecs.(this can occur on MV/HV capacitor banks)

If YES is selected then set the values per step manually – see 402

'NO' – Step kvar recognition is functioning automatically each time switching takes place. This is the preferred setting since he relay will report an failures. **Note that on 'MANUAL' setting there will be no step kvar recognition.**
Default setting 'NO'
This means that if you want to check the operation of contactors in the workshop, with the capacitor fuses pulled you can switch each step manually and its 0 kvar value will not be recorded in the memory.

7.9 **309 – Blocking Defective Capacitor Steps**

'YES' - Any capacitor steps that are recognised as faulty will be permanently switched off until replaced or repaired.
'NO' - Capacitors reported as faulty will continue to be switched
Default setting 'YES'

7.10 **310 – Stop – Start – Hold PF Control**

This setting allows you to stop automatic switching , when setting up the relay for example, so that unwanted rapid switching does not take place These are the possible settings :
ON - Relay works normally in Auto
OFF - Regulation will be stopped and all active steps switched out
HOLD -Regulation will be stopped and all active steps will remain switched in.
Default setting ON
This has probably already been set in 3.10

7.11 **311 – Selection of Switching Sequences**

1. **Automatic** – The relay is working on the 'Best Fit' Principle. i.e. The relay is using its intelligence stored in the data bank to select the capacitor step value most suited to the real time kvar requirement

2. **LIFO** – Last in – First out Switching is made sequentially 1.......14 in and 14.....1 out (or number of steps available)

3. **Kombifilter** – The relay works on the Best Fit principle , but this programme has been modified so that it always switches the same or more capacitance on the odd numbered exits to that switched in on the even exits.

4. **Progressive –** When the relay recognises that the reactive demand is very high it will switch in steps rapidly to reach the required compensation with a minimum delay . Default setting 1

7.12 **312 – Reactive Power Offset**

This setting you to add on a value of kvar to the measured value. For example there may be an additional inductive load that is not being measured by the CT. The additional inductive kvar can be programmed to compensate for this amount. Default setting 0 (kvar)

7.13 **313 - Asymmetrical switching time delay** – possible selections +127 to -127

This setting allows unequal switch times in the inductive and capacitive directions. If the setting is put to +10 for example, the capacitor steps will switch out 10 times faster than they switch in . Default setting 1 (equal time for switch in/out of steps)

7.14 **314 – Switch off Capacitors in Leading Condition**

YES - As soon as the reactive load swings into lead all necessary excessive steps will be switched out immediately, disregarding the programmed step switch time.
NO – The relay switches steps out on a leading power factor according to the programmed switching time
Default setting NO. Generators do not generally like a leading pf so if you have a chp plant or stand by generator on the system it may be wise to set this setting to NO

<u>8.0 MENU 400 – Capacitor Database</u>

8.1 **401- Discharging Time**

The same discharge time is set for all steps. By setting this value (which must not be less than the stated discharge time given by the capacitor manufacturer) the relay will not re-energise a step that has just been switched out until the programmed discharge time has expired. See comments in 3.9
Default setting : 75 secs

8.2 **402 – Capacitor Size Step value – manual setting. 1.......14 (Max)**

If the automatic step kvar recognition is deactivated (if YES has been selected in 308) then the value of each step must be entered manually, for each step.
Scroll through each step using the ▲▼ keys., adjust the value and enter ►
The kvar load values will then be calculated from the settings of Voltage and Current and suitable steps selected.
Default setting : 5var

8.3 **403 – Type of Step Exit 1........14 (Max)**

This setting is identical to the Out setting in the 100 Quick start menu.

8.4 **404 – Capacitor Contactor Switching Counter**

Each time a contactor switches it will be shown on the display. By scrolling through the steps 1.......14 you can see the number of switching operations of each contactor. The number of operations recorded can be deleted in menu 602. A very useful record for the service engineer. This information can also be ascertained in the INFO menu.

<u>9.0 MENU 500 – ALARMS</u>

9.1 **501 Alarm Storage**

YES – Alarm display must be reset by hand
NO - Alarm display will disappear once the problem has gone away
Default setting : NO

9.2 **502 – THDU Alarm**

YES – open the alarm contacts when the pre-set THDU (total harmonic distortion-voltage) threshold is exceeded (see 503) The display will show : HAr ALARM
NO- Exceeded values of the THD setting will not be reported as an alarm
Default setting : YES. If you have fitted reactors to each capacitor step then this alarm can be set to NO

9.3 **503 – Threshold THD**

The threshold setting value for THD- Voltage – can be set
Default setting 5%

9.4 **504 – Disconnect capacitors when THD above threshold limit**

YES – If the THD is above the threshold the capacitor steps will be switched out one after the other
NO - No action will be taken if the THD is above the threshold
Default setting NO

9.5 **505 – Delay time of THD Alarm**

Delay of the alarm in the event of a short time excess of THD
Default setting : 60 secs.

9.6 **506 – Freeze Exit Relays when I==0**

YES – If the CT current falls below 15mA., all active steps will remain in circuit
NO - If the CT current falls below 15 mA.,all active steps will be switched off.
Default setting : NO

9.7 **507 – Service Alarm**

YES – The alarm **contact opens** when the Max number of programmed switching operations has been reached on any contactor or when the Max number of hours since the last service has been reached
NO – The alarm **remains closed** when the Max number of programmed switching operations has been reached on any contactor or when the Max number of hours since the last service has been reached
Settings – see 508
Default setting : NO

9.8 **508 – Alarm setting threshold for number of switching operations of any one contactor**

The same threshold setting applies to all steps
Default setting : 80,000 operations. Alarm Display : ***OPC*** **ALARM**

9.9 **509 – Max Operating Hours of the CXPLUS**

This allows an alarm to be given when the installation has not been serviced after the pre-set time.
Default Setting for relays made in the UK : 9000 hours (1.02 years).
Alarm Display: ***OPH*** **ALARM**

9.10 **510 – Temperature Sensor as Digital Input.**

YES – The the temperature sensor CONTACT (T1-T2) is used to switch over the target pf from Cosphi 1 to Cosphi 2 for example for high tariff and low tariff requirements – see 302-3.
This is not applicable generally in the UK. On the continent some power companies do not charge for reactive energy after midnight and in this case it

makes sense to have a night time p.f. Target lower than the day time pf so as to prolong the life of the capacitors and reduce capacitor watt losses
NO- The temperature sensor operates with an externally plugged in sensor to monitor the temperature threshold set in **512/3.** If a thermostat is connected ., then the display will show.
HIGH (alarm contact open) or LOW (alarm contact closed.)
Default Setting: NO. All relays supplied by Boddingtons after serial number 1123596 have the temperature measuring thermostat control fitted.
Note this menu is locked against 512. If 512 is set to YES this point will jump to NO and cannot be altered.

9.11 **511 – Digital Input active with High Signal**
YES – Temperature sensor digital input T1-T2 n/o contact
NO - Temperature sensor digital input T1-T2 n/c contact
Default setting : NO

9.12 **512 – Temperature Alarm**
YES – The relay monitors temperature alarm 1+2
NO - Alarm disabled
Default setting : NO

9.13 **513 – Temperature Threshold 1 – Fan Start Up Contact**
Default setting 30°C – when this temperature is reached the exit relay nominated as alarm will close, in order to start up the cubicle ventilation.

9.14 **514 – Temperature Threshold 2 –coming into circuit Switch off Capacitors**
Default setting 55°C – When this temperature is reached the relay will switch all steps off one after the other. Alarm Display : ***thi*** **ALARM**

9.15 **515- Failure to reach Target Cosphi**
YES - If the relay fails to reach the target power factor after 75 x step switch time ('St' in start up menu) the designated alarm contact will close and the failure will be reported in the display. The display will show : *PFC ALARM / FLTY ALARM* (IN STEP DISPLAY)
NO - Under compensation alarm switched off
Default setting –NO. We set this to NO because many customers target to unity pf (CPI=1.0) and this may not be reached at the higher loads so the alarm is going off unnecessarily.

9.16 **516 – Defective switching step Alarm**
YES – After three attempts if the relay does not sense sufficient reactive kvar coming into circuit , the alarm contact is opened and the failure is shown in the display. All defective steps will be shown in the display. The display will show : St EP ALARM
NO - Alarm disabled
Default setting: NO

9.17 **517 – Step Power Loss Alarm**
YES – If the output of any step fall to less than 70% of its initially recorded value, the alarm contact opens and an indication is shown in the display. The display will be : *SPL ALARM* in the display for each step you will see , for Step 11 for example *11 ALARM*
NO - The alarm contact is disabled

Default setting : NO

<u>10.0 600 – The Reset Menu</u>

10.1 **601 - Reset All Settings to factory Default Setting**

YES – Resets all settings to the factory default setting – including discharge time (401) – see default settings in 13.0

10.2 **602 - Reset Step Data Memory**

YES – Resets all recorded data (number of switchings of each contactor.(404) , kvar size of each step (402)

10.3 **603 – Reset Operating Hours Memory**

ES -Resets Oph to zero as shown in the main display.

10.4 **604 – Reset Average PF**

YES – Resets average PF recorded to date

10.5 **605 – Reset Max Temperature**

YES – Resets the highest recorded temperature back to current ambient temperature

10.6 **606 – Reset Alarm**

YES – Cancels all current alarm indications.

10.7 **607 – Software Version**

Displays software version on this relay

10.8 **608 – Password**

The default password is 242., but you can change this if you wish. If you do change 242 is always active

11.0 SUMMARY OF MENUS OF CXPLUS:

	Default			Default	
Un	415	Set L-L system volts	PFC	ON	Selects whether steps are on AUTO-HOLD-ON-OFF
t	1	Set CT ratio :1	CPI	1	Target Cosphi
Pt	1	Set VT ratio :1	St	10S	Switching Time
Ai	NO	Automatic Initialisation?YES/NO	OUt	AUTO	Selects what each output does. AUTO-Fon-Foff—AL(starts up ventilation fan)
		Expert Menus 200 – 600 To get into these please call your supplier			
200		**MEASURING**	**400**		**CAPACITOR DATABASE**
201	415	Sets system Voltage Level Un (repeat of Un in Menu 100)	401	75 secs	Set discharge time to prevent re-energisation on quick switching sequence
202	1	Sets CT ratio:1 (repeat of Menu 100)	402	5 var (1.max)	Manual entry of kvar values per step
203	1	Set VT ratio:1 (repeat of Menu 100)	403	AUTO All steps	Select what each output does Same as Out setting in 100 menu
204	10%	Tolerance % of Un Voltage Setting	404	0	Step switch counter Initial value 0 increases with each switching
205	YES	Select L-L or L-N as measurement voltage	**500**		**ALARMS**
206	90º	Select Phase Angle U - I	501	YES	Select if alarm display is cancelled when fault cleared or not
207	NO	Ai (Automatic Initialisation) start	502	YES	THD Alarm setting YES = on NO =off
208	NO	Activate Step kvar Recognition	503	5%	% setting for THD alarm if on
209	AUTO	Frequency setting for low quality networks	504	NO	Select if steps are switched off if THDU above target level
210	0°C	Temp setting offset	505	60 secs	Select time delay of THDU alarm
			506	NO	Freeze exits if no CT current
300		**CONTROL**	507	YES	YES=Service alarm operates when max operating hours or switchings on any step is reached.
301	60%	% value of kvar for step switching.	508	80,000	Set No. of contactor operations for Alarm
302	1.00	Target PF 1	509	9,000	Set No. of operating Hours for Alarm
303	0.95i	Target PF 2	510	NO	Temperature sensor is set to monitor temp and show it in the LCD Display.
304	NO	Target PF when exporting	511	NO	Select if Digital input is n/c or n/o
305	10 S	Switch Time per step in seconds	512	NO	Temp. Alarms 513/514 ON/OFF
306	2S	Step switch swap over time	513	30°C	Temp Setting for exit relay nominated as fan control
307	YES	Activation of Step swap over	514	55°C	Emergency switch off of steps one by one if temp exceeds target setting – default = 55°C
308	NO	Stop Automatic kvar step detection	515	NO	Target Cosphi setting
309	YES	Blocking defective Capacitor Steps	516	YES	YES= Alarm for defective step if no step kvar output after 3 attempts
310	ON	AUTO-OFF-HOLD setting	517	YES	Step power loss alarm
311	1	Selection of switching sequence. 1=Auto.,2=Last in first out,3=Kombifilter ,4=Progressive	**600**		**ALARM RESETS**
312	0	Reactive kvar offset	601	NO	All alarms back to factory default
313	1	Assymetrical Switching fast in slow out etc.	602	NO	Resets all recorded data of kvar per step+kvar output of each step
314	NO	Switch off steps if cosphi is leading. Used for aux.generators	603	NO	Resets Operating Hours to zero
			604	NO	Resets Average PF
			605	NO	Rests Highest Ambient Temp
			606	NO	Reset all alarms
			607	NO	Displays software version
			608	NO	Gives password

12.0 **TROUBLE SHOOTING**

FAULT	POSSIBLE CAUSE	SUGGESTED REMEDY
No indication in the display	No power supply to terminals UM1-UM2	Check for voltage in the range 90-550v 50/60hz on these terminals
Display shows ***U* ALARM**	Power supply is outside voltage tolerance setting.	Check the setting entered on menu 201 and 204
Display shows ***I* LO**	Measured Current is below 15mA	Check CT circuit. Are summated CT's in opposition? Has short circuit link been removed? Is CT circuit broken?
Display shows wrong value of Voltage or Current	Incorrect CT or VT ratio has been submitted.	Check settings of VT and CT. Remember the settings are :1 so a 1000/5 CT = setting of 200
Display shows wrong value of Power Factor	Capacitor Step Size has not been recognised, or phase angle setting has been wrongly entered in 206	Start Ai in the set up menu, Check the setting of phase angle in 206 and rectify if necessary.
Power factor does not improve after stepping steps in. Steps won't switch out	CT in wrong position – see notes 1.2 of these operating instructions.	Check position of CT ensure it is measuring total current including capacitor current and if split core make sure the gap is fully closed up.
Display shows ***I Hi* ALARM**	Output from CT is too high – above 5 amps.	Check the CT ratio selected. Change if necessary.
Display shows ***PFC* ALARM**	Continuous over compensation or continuous under compensation	Check the capacitors and contactors. Contactor could be welded in. Check that steps are not in the FON setting (PFC /Out in menu 100) Is the kvar supplied sufficient for the reactive demand? If not under compensation will be reported.
Display Shows Leading Cosphi....c When you know there is lagging load	Voltage or current connections wrong way around. Phase angle incorrectly entered (206)	Switch off and swap over Um1 and Um2 (This is better than swapping over the CT connections since voltage surges form open circuit CT are avoided) If necessary check settings of 206
Certain steps don't switch in or out.	Wrong selection on the Out menu.	Check to see if some steps have been set as FON or FOFF (permanently on or off) instead of AUTO.
Steps are shown as defect ***FLTY*.**	Capacitor step faulty or fuse or contactor has failed.	Check capacitor current with clamp on power meter, and compare with rated current are fuses and contactor operating correctly? Replace as required.
Steps won't ever switch in, but there is nothing wrong with them	Capacitor step sizes are too big.	Provide more steps of lower kvar per step.
EXPORT shows in the display but there is no export.	CT reversed.	Swap over Um1/Um2 to correct. EXPORT may be shown if the CT Current is below 15mA, check to see the CT ratio is not too high. Check you have correct phase angle setting in 206.

13.0 **TECHNICAL DATA**

Measurement and Supply Voltage	90 – 550V 45- 65hz 5VA max. Fused to Max. 6A VT multiplication factor adjustable 1......350
Current Measurement	15mA ..... 6A single phase. Internal CT with Current Sensor 20 milliohm. CT multiplication factor adjustable 1.......4500
Exit relay Ratings	Max rating at 240v 50/60 hz phase-neutral Contactor coils 6A inrush Max rating 415v 50/60 hz phase-phase Contactor Coils 2.5A inrush
Temperature measurement	By varistor or thermocouple
Alarm Contact	Volt free relay normally closed (N/C). Max fuse rating 2A., Switch contact 250V 2.5A
Air Ventilation Control	Achieved by designating one of the exit relays as ventilation fan contact
Data Output	BSTO software by TTL on back of relay
Operating Temperature	-20+70ºC. Storage -40+85ºC
Humidity	0-95% - Dew droplets not permitted.
Over Voltage Category	II Pollution Degree 3 (DIN VDE 0110 Part 1 / IEC 60664-1)
Standards Complied with	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 Listings	CE - UL - cUL
Connections	Screw Terminals with plug in connectors to facilitate easy swap overs
Casing	Front Plastic Facia (UL94-VO)., Rear - Metal case.
IP Ratings	Front : IP50 – IP54 if transparent over cover fitted Rear: IP20
Weight	0.60g Approx
Dimensions	144 x 144 x 58mm – Cut Out 138 (+0.5) x 138 (+0.5) mm

14.0 **SETTINGS ON PFC RELAY INSTALLED:**

Relay Serial Number …..(marked on back of the CXPLUS)

Menu	Factory default setting	This relay setting if different	Menu	Factory default setting	This relay setting if different
100			**400**		
Un	415v		401	75 SECS	
Ct	1		402	5 var (1…max)	
Pt	1		403	AUTO for all steps	
Ai	NO		404	0 for all steps	
PFC	ON		**500**		
CPI	1		501	NO	
St	10 SECS.		502	NO	
OUt	AUTO for all steps.		503	20%	
200			504	NO	
201	415v		505	60 SECS	
202	1		506	NO	
203	1		507	NO	
204	10%		508	80,000 contactor operations.	
205	NO		509	9,000 operating hours for service alarm	
206	Automatic change over When Um1-Um 2 is same as Un. Default =90 When Um1-Um 2 is phase – neutral voltage Default =0		510	NO	
207	NO		511	NO	
208	YES		512	NO	
209	AUTO		513	30°C	
210	0		514	70°C	
300			515	NO	
301	60%		516	YES	
302	1		517	YES	
303	0.95i		**600**		
304	NO		601	NO	
305	10 SECS		602	NO	
306	2 SECS		603	NO	
307	NO		604	NO	
308	NO		605	NO	
309	YES		606	NO	
310	ON				
311	1				
312	0				
313	1				
314	NO				