Boddingtons Power Controls
UNIT 1, ZONE D CHELMSFORD ROAD INDUSTRIAL ESTATE, GREAT DUNMOW, ESSEX CM6 1XG, UK
Tel: +44 (0) 1371 876543 Fax: +44 (0) 1371 875460
Website: www.boddingtonspowercontrols.co.uk Email: info@boddingtonspowercontrols.co.uk

Operating Instructions – General Instructions inserted in each relay box
Power Factor Control Relay
CXPLUSR (CONTACTOR SWITCHING)
CXPLUST (THYRISTOR SWITCHING)

These instructions apply from Ser. No. 1136054 Software 2.00 – Rev 6 issue date 29.6.2012

Contents

1.0 CONNECTION TO SUPPLY

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 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 C T'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

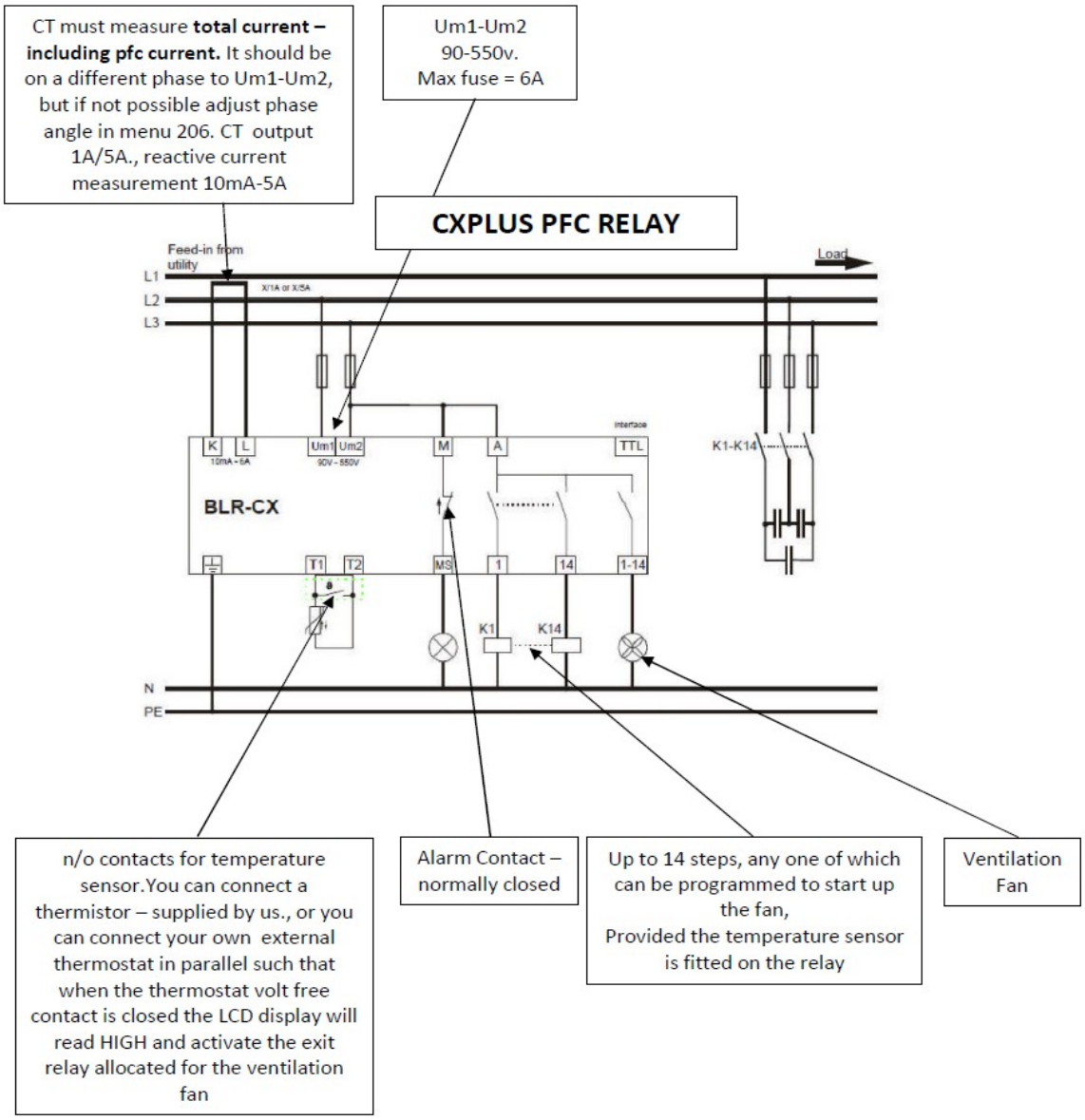
1.4 Connect in accordance with the wiring diagram for contactors or thyristors

1.5 Remove any short circuit links from the CT and relay

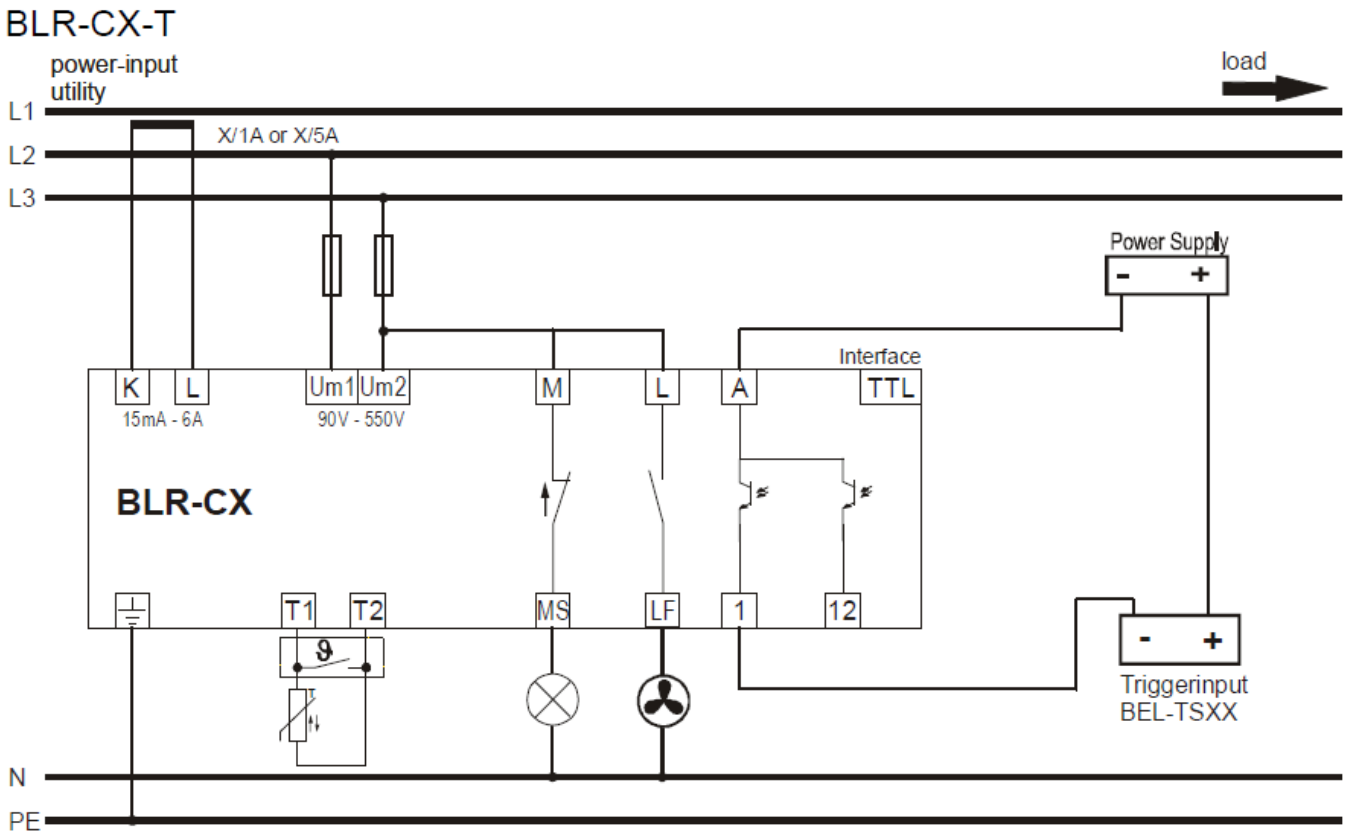
1.6 Wiring diagram

1.6.1 (CXPLUS..R – Contactor switching)

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 (CXPLUS..T – Thyristor switching)



2.0 ENERGISING THE RELAY

2.1 The CXPLUS has a default lockout time of 75 seconds and will start counting down, after energising. This to ensure that capacitors are not switched in immediately after power loss and an emergency generator start up - for example. Also, this 75 second default time operates when any one step has been switched. This is to ensure that it cannot be switched in again until that step has discharged. This enables the short step switching time of 10 secs to be set – but you can adjust step switch time in the quick start menu.

2.2 Measured Values in the Display

The three larger digits at the top show system 50 hz power factor.
e.g. 0.91i = lagging p.f. 0.91., 0.98c = leading p.f 0.98
If you have a known lagging power – inductive load – then 'i' should be displayed in the LCD. If you see 'c' and you are certain the load is lagging., switch off and swap over Um1 and Um2. This is better than swapping over a load carrying CT – which may produce excessive voltages on open circuit. To access the scroll down values press ►
The scrolled values ▲ ▼ have the following meanings. These are the readings the end user can readily access.
NB If you do not set the CT ratio, and leave it at the factory setting of 1 ., then the items marked ** will not be shown. You set the CT ratio in section C.T of the 100 Menu, below.

The Scroll through Menu – What do the Symbols mean?

To see these readings, when you are in the main display and the Cosphi power factor is displayed ., press enter ► and you see U ., now press ▼ to scroll through the other readings

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
ΔQ**	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)
3-5-7-9-11-13-15-17-19	harmonic voltages as % of fundamental
0.--i cos	Top figure = Fundamental 50/60hz Cosphi to 2 decimal places. Bottom figure =Fundamental Cosphi to three 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
OPh	Counter for number of hours relay has been in service, since last reset
tAn	Tangent of phase angle phi

3.0 THE QUICK START MENU 100 TO SET CT AND VT RATIOS

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. Other settings in the expert menus can be made with the help of a qualified Engineer or Technician.

Values of kW/kVA/kvar will not be correct unless the correct setting is made for voltage (Un) and current. (Ct)
In order to make these settings we have to go into the commissioning menu 100.

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**

Un – Voltage Setting

The first value you see is the Un. This is the **phase – phase voltage., not Phase-Neutral.** So for the UK for example the setting for Un is 415v. This is the factory default setting for relays made in the UK after serial number 1123596
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.
It is important to have the correct voltage setting Un because the alarm thresholds are defaulted to operate when the voltage is +-10% from nominal Un setting.

▼

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.

▼

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

▼

Ai – Automatic Initialisation

This is defaulted to NO and we recommend it is left on NO
If set to 'YES' – when the relay is first commissioned it will switch each step one by one. It will correct any mistaken wiring of the CT.., and store the kavar values per step in its menu. We do not recommend use of this Ai feature unless you do not know which phase the CT is on.
If Ai is '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 their kvar value is recorded in the micro-processor memory.

▼

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 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.

▼

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 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.

▼

St – Switching time per step

Adjustable from 1 second – 999 seconds. For longer times there is also the possibility to have 'k' (x 1000) and 'M' x 1 Million if needed. 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 2 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.

▼

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 an alarm contact. When the temperature is above the target setting – this contact can be used to start up the ventilation fan. If you select AL for one of the exit relays, the default switching temperature is 30ºC, when this contact will close.

FOFF – This step is permanently off (Fixed off)

FON – this step is permanently on (Fixed on)

Default setting is **AUTO**

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 and watch the increase in the Cos Phi display until a leading power factor is achieved, and then to return the relay to AUTO to make sure the relay switches out to reach the target power factor.

Press ◄ repeatedly to get back to Cosphi 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 ►., to switch off ► again. Now move through the steps using ▲ to get to the next step and ► to switch it on. 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 switching function , and if the Cos phi is leading it should switch steps out to achieve the target Cosphi

(as set in 3.8)

5.0 THE INFO MENU

To get into the INFO 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 ., or 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:
C: This is the real time kvar output of this step –
but remember this 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

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

6.0 ALARMS – What do they mean?

In the case of Alarm, the display will flash alternately

..... /
ALARM

The display will show one of the following alarms:

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

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.**		

7.0 DEFAULT SETTINGS – AND WHAT EACH MENU DOES

	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	0ºC	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	30ºC	Temp Setting for exit relay nominated as fan control
307	YES	Activation of Step swap over	514	70ºC	Emergency switch off of steps one by one if temp exceeds target setting – default = 70ºC
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

8.0 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. Alt the Ai feature has caused this to show. Defeat Ai by setting 208=NO

9.0 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

YOUR SUPPLIER FOR SERVICING and FURTHER INFORMATION PFC / RE-ORDERING: