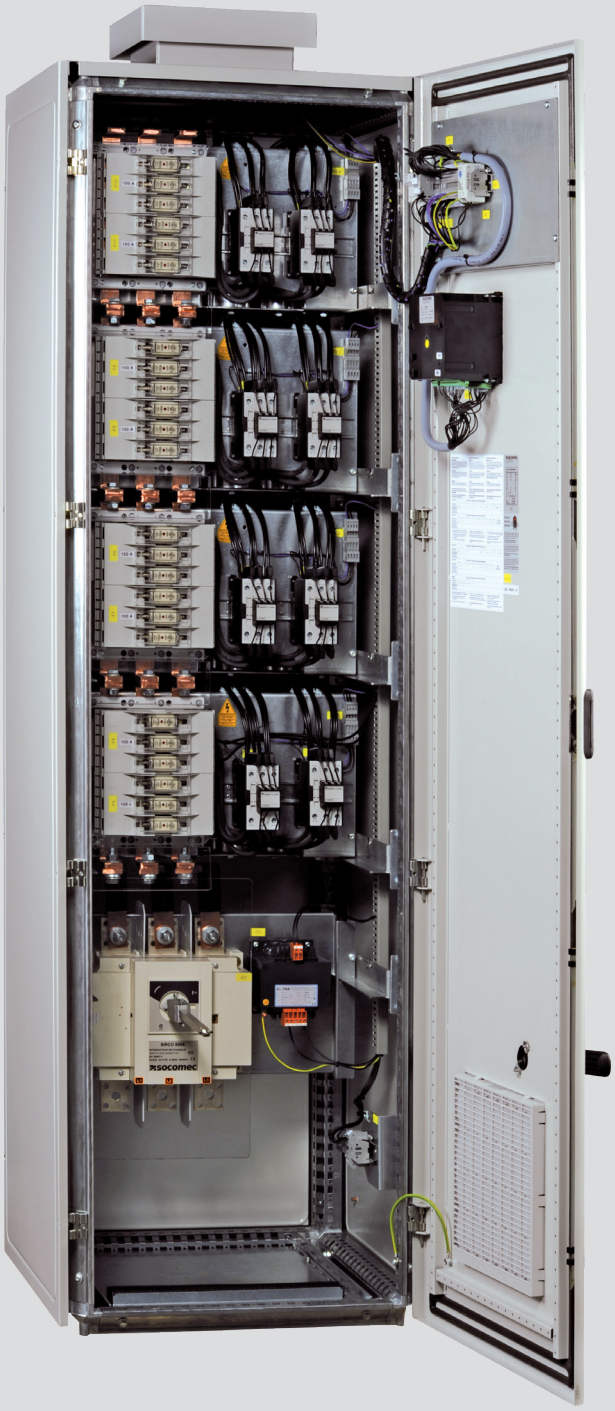
INSTALLATION AND OPERATING MANUAL

EN

Automatic power factor correction system

COSYS PFC



socomec
Innovative Power Solutions

EN CONTENTS

1. CONDITIONS OF WARRANTY

- The warranty conditions are stipulated in the sales contract. In all other cases, the following conditions apply.
- The manufacturer guarantees its product exclusively against constructional or operational defects due to errors in the design, choice of materials or workmanship, in accordance with the conditions defined below.
- The manufacturer may – without prior notice – modify its product to comply with the warranty conditions or replace defective parts.
- The producer's warranty does not apply in the following cases:
    - Faults caused by the designs or parts prescribed or supplied by the customer.
    - Replacements or repairs resulting from normal wear and tear of the parts or equipment
    - Damage or injury caused by user negligence
    - Insufficient maintenance or improper use of products
    - Battery unsuitable for the power network
- The warranty is valid for the 12 months following installation of the equipment, but cannot exceed 18 months after delivery.
- Replacements, repairs or modifications of parts made during the warranty period by the manufacturer can in no way extend the duration of the warranty.
- To benefit from this warranty, the buyer is obliged – within a maximum period of 8 days beyond which the warranty expires – to expressly inform the manufacturer of any defects in the design, materials or workmanship, justifying the reason for the claim in detail.
- Defective parts replaced free of charge by the manufacturer must be made available to the manufacturer as sole owner.
- The warranty is not applicable if the buyer on their own initiative carries out modifications or repairs on the manufacturer's products, without the prior consent of the latter.
- The liability of the manufacturer is limited to the aforementioned obligations (repairs or replacements). All other damages are formally excluded.

2. HAZARDS AND WARNINGS

The assembly, use, servicing (including cleaning) and maintenance of this equipment must only be carried out by trained, qualified professionals (in case of failure, please contact our Customer Services).
SOCOMEC is not responsible for any failure to follow the procedures given in these instructions.

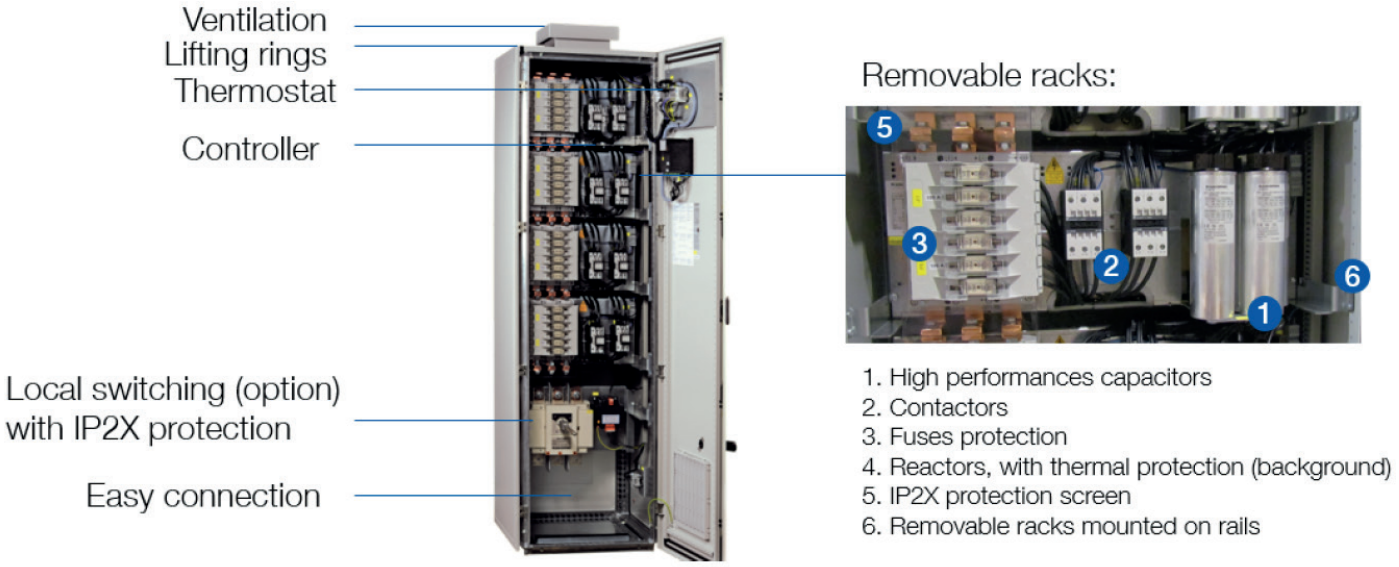
Please consult our general safety notice available on our website: www.socomec.com

Failure to follow these precautions could result in serious injury or death.

If there is a problem, please contact:
SOCOMEC,1 rue de Westhouse, 67235 BENFELD, FRANCE
Tel. +33 3 88 57 41 41

3. DESCRIPTION OF THE PRODUCT

Automatic COSYS PFC systems are designed to automatically offset variable reactive energy by switching on / engaging capacitor racks.



1. High performances capacitors
2. Contactors
3. Fuses protection
4. Reactors, with thermal protection (background)
5. IP2X protection screen
6. Removable racks mounted on rails

3.1. Environment

- Ambient storage temperature: -20°C / +60°C
- Ambient operating temperature: -5°C / +40°C
- Humidity: max. 90%, non-condensing
- Altitude: max. 2000m
- Do not cover top or front vents (clearance: min. 50cm above cabinet)
- The enclosure or cabinet must be level
- Our standard system is intended for indoor use. To install it outdoors, please consult us to adapt the system.

3.2. Selecting your cables and protection devices

The power cable width (3 phases + earth) is defined according to the rated current of the system, increased by a coefficient of 1.43 x In, pursuant to IEC 60831.

As regards the protection rating, standards governing the capacitors (IEC 60831-1) and PFC cabinet (IEC 61921) stipulate the following coefficients:

- 1.43.In (1.3 x 1.1 x In) for PFC unit <100kvar
- 1.365.In (1.3 x 1.05 x In) for PFC unit >100kvar

Ensure compliance with installation regulations, including NF C 15-100 for France.

The table below gives an indication of the typical values:

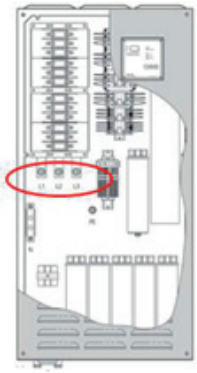
Power (kvar)	400 V/50 Hz			525 V/50 Hz			690 V/50 Hz		
	Current (A)	Fuse rating (A)	Cable width (mm^2)	Current (A)	Fuse rating (A)	Cable width (mm^2)	Current (A)	Fuse rating (A)	Cable width (mm^2)
2.5	3.6	10	4 × 1.5	2.7	10	4 × 1.5	2.1	10	4 × 1.5
5	7.2	10	4 × 1.5	5.5	10	4 × 1.5	4.2	10	4 × 1.5
6.25	9.0	16	4 × 2.5	6.9	10	4 × 1.5	5.2	10	4 × 1.5
7.5	10.8	16	4 × 2.5	8.2	16	4 × 2.5	6.3	10	4 × 1.5
10	14.4	20	4 × 2.5	11.0	16	4 × 2.5	8.4	16	4 × 2.5
12.5	18.0	25	4 × 4	13.7	20	4 × 2.5	10.5	16	4 × 2.5
15	21.7	35	4 × 6	16.5	25	4 × 4	12.6	20	4 × 2.5
17.5	25.3	35	4 × 6	19.2	35	4 × 6	14.6	25	4 × 4
20	28.9	50	4 × 10	22.0	35	4 × 6	16.7	25	4 × 4
25	36.1	50	4 × 10	27.5	50	4 × 10	20.9	35	4 × 6
27.5	39.7	63	4 × 16	30.2	50	4 × 10	23.0	35	4 × 6
30	43.3	63	4 × 16	33.0	50	4 × 10	25.1	35	4 × 6
31.5	45.1	63	4 × 16	34.4	50	4 × 10	26.1	50	4 × 10
37.5	54.1	80	3 × 25 / 16	41.2	63	4 × 16	31.4	50	4 × 10
40	57.7	80	3 × 25 / 16	44.0	63	4 × 16	33.5	50	4 × 10
43.75	63.1	100	3 × 35 / 16	48.1	80	3 × 25 / 16	36.6	63	4 × 16
45	65.0	100	3 × 35 / 16	49.5	80	3 × 25 / 16	37.7	63	4 × 16
50	72.2	100	3 × 35 / 16	55.0	80	3 × 25 / 16	41.8	63	4 × 16
52.5	75.8	125	3 × 50 / 25	57.7	80	3 × 25 / 16	43.9	63	4 × 16
60	86.6	125	3 × 50 / 25	66.0	100	3 × 35 / 16	50.2	80	3 × 25 / 16
62.5	90.2	125	3 × 50 / 25	68.7	100	3 × 35 / 16	52.3	80	3 × 25 / 16
67.5	97.4	160	3 × 70 / 35	74.2	125	3 × 50 / 25	56.5	80	3 × 25 / 16
68.75	99.2	160	3 × 70 / 35	75.6	125	3 × 50 / 25	57.5	80	3 × 25 / 16
75	108.3	160	3 × 70 / 35	82.5	125	3 × 50 / 25	62.8	100	3 × 35 / 16
87.5	126.3	200	3 × 95 / 50	96.2	160	3 × 70 / 35	73.2	125	3 × 50 / 25
93.75	135.3	200	3 × 95 / 50	103.1	160	3 × 70 / 35	78.4	125	3 × 50 / 25
100	144.3	200	3 × 95 / 50	110.0	160	3 × 70 / 35	83.7	125	3 × 50 / 25
112.5	162.4	250	3 × 120 / 70	123.7	200	3 × 95 / 50	94.1	160	3 × 70 / 35
125	180.4	250	3 × 120 / 70	137.5	200	3 × 95 / 50	104.6	160	3 × 70 / 35
150	216.5	315	3 × 185 / 95	165.0	250	3 × 120 / 70	125.5	200	3 × 95 / 50
175	252.6	400	2 × 3 × 95 / 50	192.5	315	3 × 185 / 95	146.4	250	3 × 120 / 70
200	288.7	400	2 × 3 × 95 / 50	219.9	315	3 × 185 / 95	167.3	250	3 × 120 / 70
225	324.8	500	2 × 3 × 120 / 70	247.4	400	2 × 3 × 95 / 50	188.3	315	3 × 185 / 95
250	360.8	500	2 × 3 × 120 / 70	274.9	400	2 × 3 × 95 / 50	209.2	315	3 × 185 / 95
275	396.9	630	2 × 3 × 185 / 95	302.4	500	2 × 3 × 120 / 70	230.1	400	2 × 3 × 95 / 50
300	433.0	630	2 × 3 × 185 / 95	329.9	500	2 × 3 × 120 / 70	251.0	400	2 × 3 × 95 / 50
350	505.2	800	2 × 3 × 240 / 120	384.9	630	2 × 3 × 185 / 95	292.9	500	2 × 3 × 120 / 70
375	541.3	800	2 × 3 × 240 / 120	412.4	630	2 × 3 × 185 / 95	313.8	500	2 × 3 × 120 / 70
400	577.4	800	2 × 3 × 240 / 120	439.9	630	2 × 3 × 185 / 95	334.7	500	2 × 3 × 120 / 70
500	721.7	1000	3 × 3 × 185 / 95	549.9	800	2 × 3 × 240 / 120	418.4	630	2 × 3 × 185 / 95

3.3. Connections

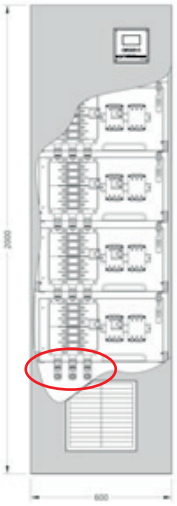
3.3.1. Connecting power cables

- Our standard systems have the cable input at the bottom (can be the top if required, please contact us).
- Cable glands are supplied with our enclosed systems. Cabinets have a cable bushing plate already fitted inside.
- The cabinet must be earthed. Use the dedicated pin, marked by the earth symbol.
- The power cables of each phase must be connected to the corresponding copper terminals.

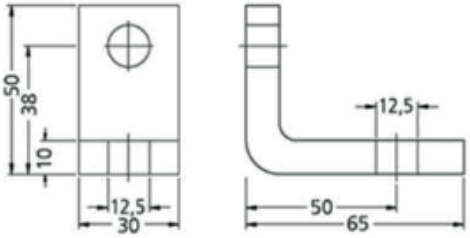
Example of enclosure



Example of cabinet



Power cable copper terminal:



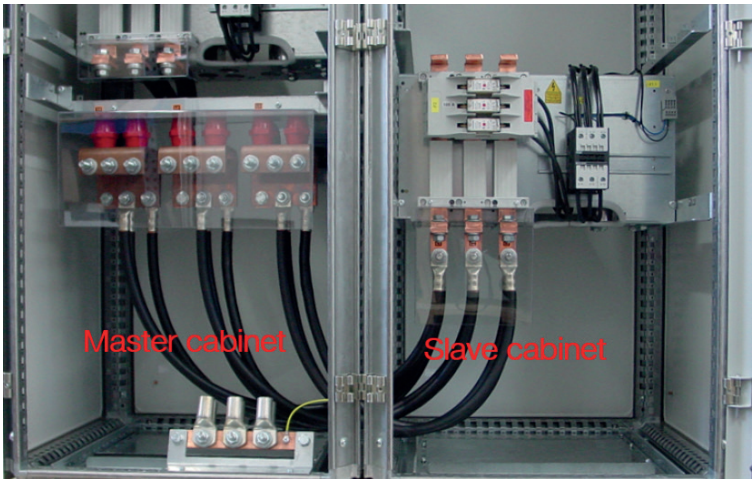
Diameter of connecting screws: M12

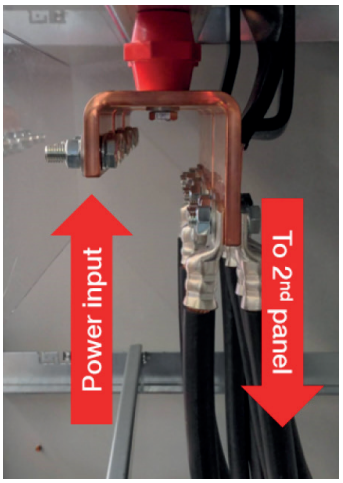
Type of terminal	Max. tightening torque (Nm)
Fuse base terminal	13
Copper terminal	45

For multiple cable connections per phase, we recommend using adapter parts. The following accessory can be ordered separately (please contact us):

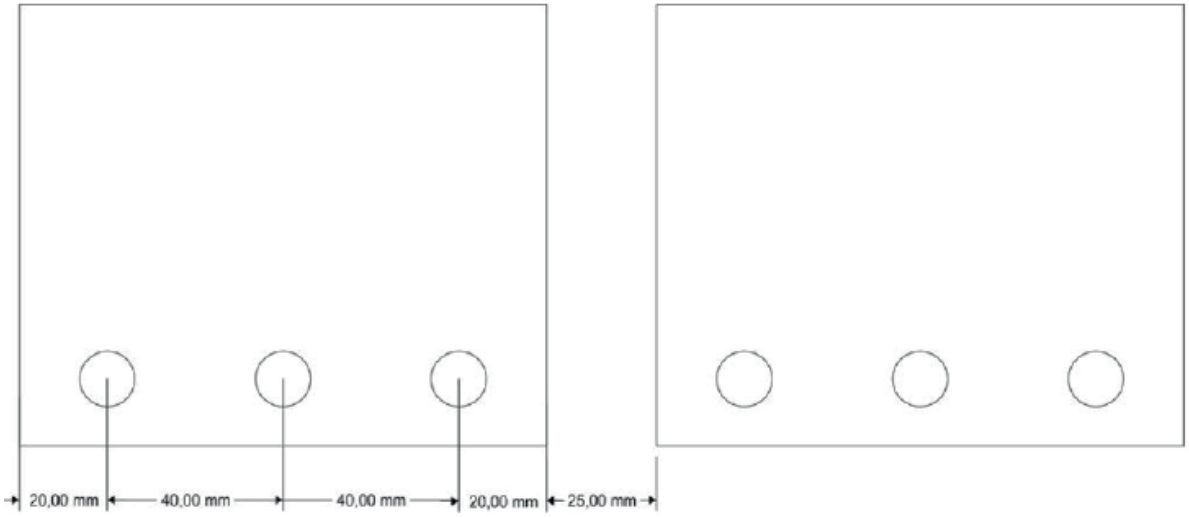
It is not possible to connect an aluminium cable directly to the copper terminal.
Bi-metal terminals would be required, so as to meet electrochemical torque values.

Systems used for high power rates are composed of several cabinets (please refer to our general catalogue or our commercial offer). Connect the power between these two cabinets using the cables (supplied but not attached).





The cable opening between the cabinets is already provided for on delivery.



For models with load-break switch:

Type of switch	Switch rating (A)	Screw size	Tightening torque (Nm)
Fuse combination switch	63	Pozidrive	2.5 - 3
Fuse combination switch	160	M8	8.3 - 13
Load-break switch	160	M8	8.3 - 13
Load-break switch	250	M10	20 - 26
Load-break switch	400	M10	20 - 26
Load-break switch	630	M12	40 - 45
Load-break switch	800	4 x M8 1 x M16	8.3 - 13 145
Load-break switch	CD 1000	4 x M8 1 x M16	8.3 - 13 145
Load-break switch	1250	M12	40 - 45
Load-break switch	1600	M12	40 - 45
Load-break switch	2000	M12	40 - 45

3.3.2. Connecting the current transformer (CT)

Select the CT according to the following criteria (to be ordered separately):

- Primary CT: according to the facility loads
- Secondary CT: 5A (recommended) or 1A
- Min. 5VA, min. class 3

Ensure that the transformer's secondary unit is short-circuited in the event of it being disconnected when the primary is powered. We recommend using a CTP to enable automatic short-circuiting of the secondary (to be ordered separately).

The cable width is recommended by the CT manufacturer.

Losses due to the distance between the CT and the regulator should be taken into account.

VA losses in copper cables for a secondary 5A CT:

	L (m)	1	5	10	20	50
S (mm^2)	2.5	0.36	1.79	3.57	7.14	17.9
	4	0.22	1.12	2.23	4.46	11.2
	6	0.15	0.74	1.49	2.98	7.44
	10	0.09	0.45	0.89	1.79	4.46

The regulator's current input consumption is 1.8VA.

Our regulators have insulated current inputs, which means you can connect a current transformer in series with another monitoring device.

Take into account the positioning of the CT in your facility when measuring the load currents and the capacitor currents:

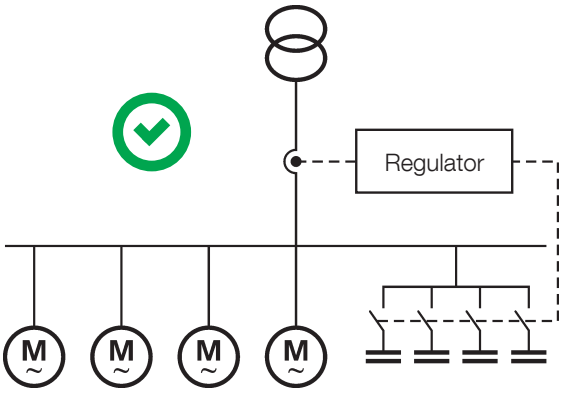


Fig. 1: Correct. The transformer measures the current of the facility loads and capacitors

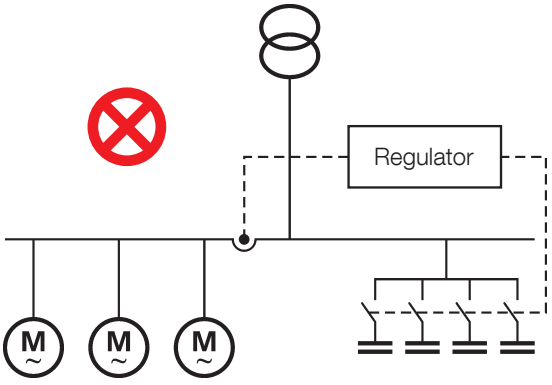


Fig. 2: Incorrect. The transformer measures only the current of the facility loads. Neither regulating nor automatic setup will work.

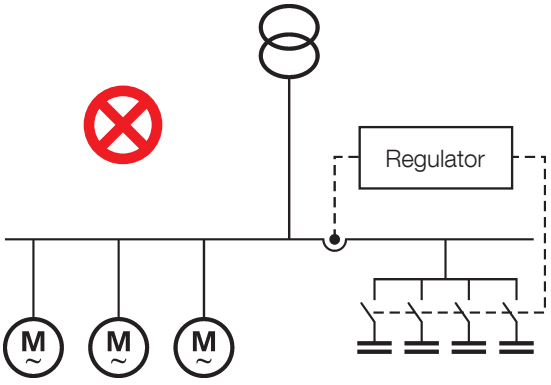


Fig. 3: Incorrect. The transformer measures only the current of the capacitors, which will initially be zero, preventing the system from being operated. "Under-current" alarm

We recommend installing the CT on the busiest phase or on the phase with the smallest phase shift factor, but it is possible to connect it to another phase thanks to the regulator's automatic detection function.

Connect the current sensor's secondary unit to the terminals marked "S1 / S2" on the terminal block located in the COSYS cabinet or enclosure.

3.3.3. Connecting control cables

To avoid over-heating, check the tightening torques of the contacts, especially after transport: min. 0.8 / max. 1.4 Nm.

Note: each terminal can have up to 5 cables connected, in compliance with and as validated by IEC 61439 standard testing and by electrical installation standards.

The spring-cage terminal system protects the capacitors from loosening.

3.3.3.1. Alarm contact

The control terminal block has a NO contact (can be set to NC), marked by terminals a & b.

NO contact: 250VAC / 3A

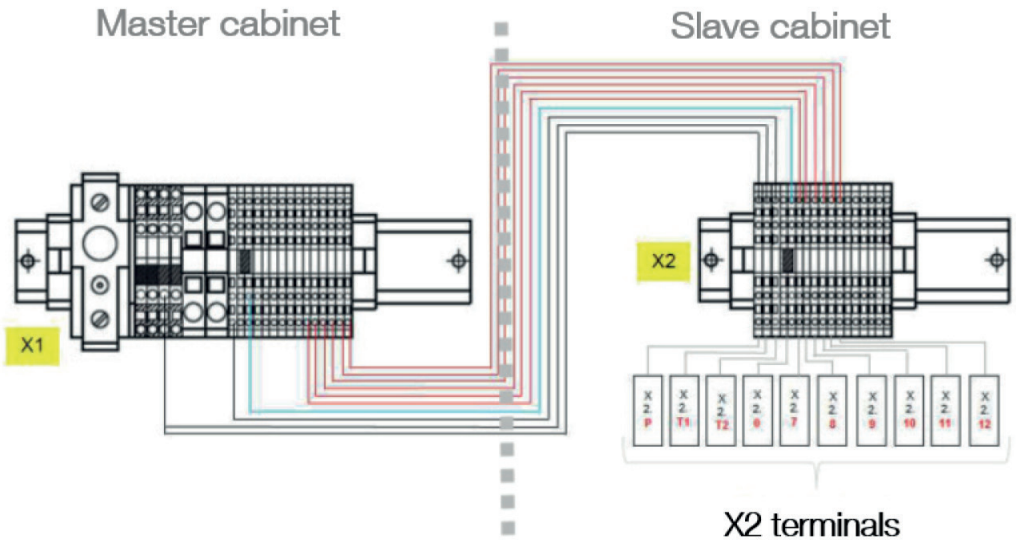
When you set up the regulator, you need to select the activation conditions for this contact: refer to the section SETTINGS ➜ ALARMS

3.3.3.2. Master/slave regulator

For capacitors composed of 2 cabinets, you need to connect the control circuit between the 2 batteries when the system is delivered. Make this connection between terminal block X1 (in the master cabinet) and terminal block X2 (in the slave cabinet).

The control circuit connection cable is supplied with the system.

Main diagram:



Refer to the electrical diagram supplied with the battery for details.

3.3.3.3. Connecting to a genset

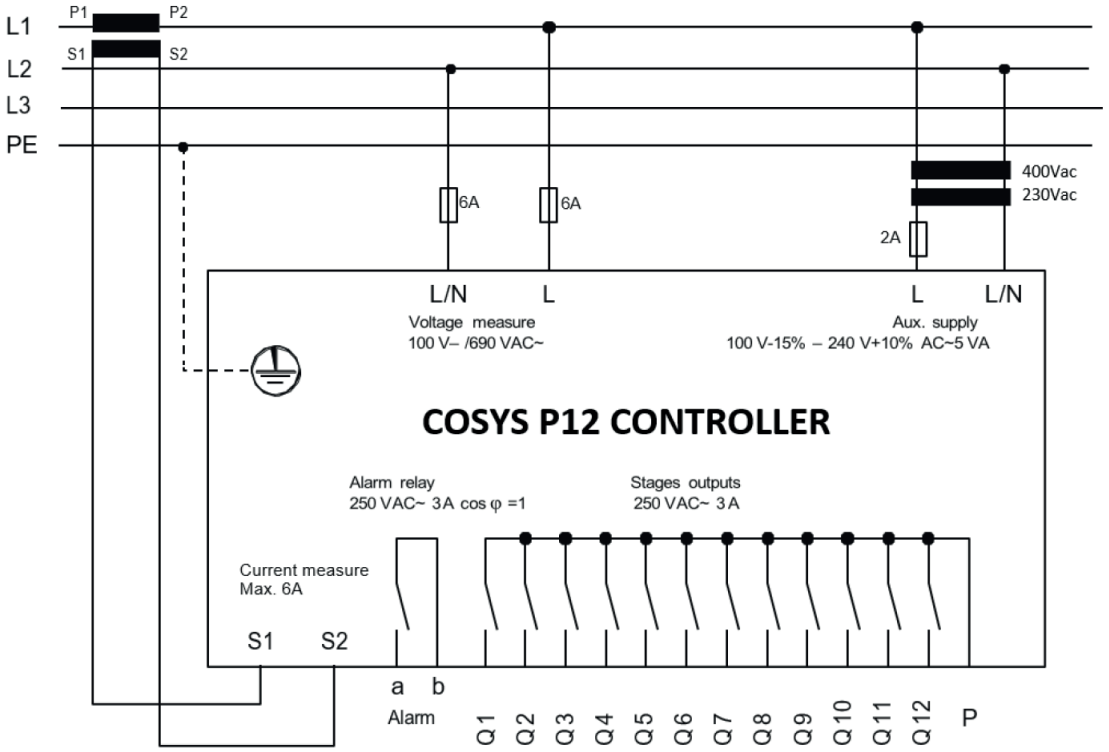
If your facility includes a genset, it is best to connect a genset-compatible opening contact (NC) to terminal T1/T2.

When starting up the unit after a drop or interruption in the distribution network, the contact's new state will in effect disconnect the PFC system and relieve your facility's capacitor.

Operating mode:

1. Remove the bridging located on terminal T1/T2 of terminal block –X1.
2. Downstream of terminal block T1/T2, connect the wires coming from the genset's operating contact.

Regulator connection setup (detailed diagram supplied with the capacitor):



4. POWERING ON

Before powering on:

- Clear the area of any items (e.g. tools) and make sure it is clean.
- Make sure you follow the tightening torques mentioned in the section CONNECTION, especially for contacts:
    - K3-10 to K3-22: min. 0.8Nm / max. 1.4Nm
    - K3-24 to K3-40: min 2.5Nm / max. 3Nm
    - K3-50 to K3-74: min. 3.5Nm / max. 4.5Nm

To power on:

- Close the cabinet or enclosure door.
- Turn off the upstream protective device.
- Turn off the system's optional load-break switch (if applicable).

The first time the unit is powered on, the heated varnish of the inductances can give off a chemical odour. This will dissipate after a few hours of use.

5. SETTINGS

5.1. Automatic setup

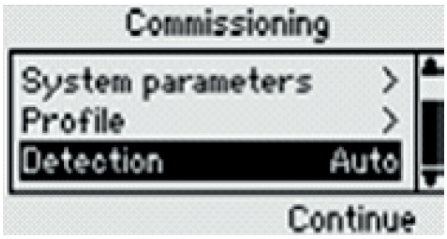
The regulator is configured by default according to the power and battery type.

The first time it is powered on, the regulator automatically detects the connection (phase direction), the racks' switching sequence and the base current.

User settings under the Network Settings menu: primary/secondary transformation ratio of the current transformer, nominal voltage and frequency of the equipment, and the filtering factor.

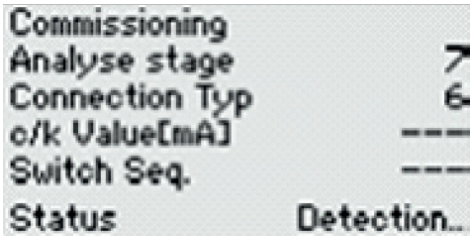
Select Auto Detect

Press Continue



Automatic setup takes place

The next screen shows you the progress



5.2. Manual setup

In cases of rapid load variations or a low-load facility, start operation in manual mode at setup.

1. Go to the Settings menu

The password is the last 4 digits of the serial number (see SN in About PQC)

2. Go to the Setup menu > Network settings

- Enter the CT transformation ratio (e.g. 600A primary / 5A secondary ➜ 120)
- For the voltage transformer, keep the ratio at 1
- Enter the nominal voltage shown on the nameplate of the capacitor (see also the product description)
- Set the frequency to between 50Hz and 60Hz
- The filtering factor depends on the inductance: (0% for PFC41, 7% for PFC42, 14% for PFC43, 5.67% for PFC44)

3. Go to the Setup menu > Profile

- Profile 1 The ideal control curve for all consumer networks where an inductive cos ϕ is required. (standard)
- Profile 2 Suitable for consumer networks where an average cos ϕ factor = 1 must be obtained.
- Profile 3 Suitable for consumer networks where an average cos ϕ factor is close to 1 or over-correction must be avoided.
- Profile 4 Suitable for consumer networks (see Profile 1), but also generator networks (e.g. co-generation)
- Profile 5 Suitable for generating networks, such as hydroelectric power plants or wind turbines, where a cos ϕ factor is required.

4. Go to the Setup menu > Detection

- Enable Manual Detection
- Select Continue to confirm your settings

5. Go to the Configuration menu

- Select the connection or cable type. The phase shift angle of the current and voltage follows the type of connection. This is shown in the table below:

Connection type	Connecting to the voltage path		
	L/N – L	L/N – L	L/N – L
0	L1 – N	L2 – N	L3 – N
1	L1 – L3	L2 – L1	L3 – L2
2	N – L3	N – L1	N – L2
3	L2 – L3	L3 – L1	L1 – L2
4	L2 – N	L3 – N	L1 – N
5	L2 – L1	L3 – L2	L1 – L3
6	N – L1	N – L2	N – L3
7	L3 – L1	L1 – L2	L2 – L3
8	L3 – N	L1 – N	L2 – N
9	L3 – L2	L1 – L3	L2 – L1
10	N – L2	N – L3	N – L1
11	L1 – L2	L2 – L3	L3 – L1
Current transformer in:	↑ L1	↑ L2	↑ L3

Example: The current transformer is installed on phase L1, while the voltage is measured between phase L2 and L1. So, this is a Type 5 connection.

- Enter the c/k value. For a network of 400 / 50 Hz, refer to the value of the c/k setting in the table below:

c/k setting for a 400 V 50 Hz AC ~ network															
Current		Power of the smallest rack (not total power) of the PFC system in kvar													
	k	2.5	5	6.25	7.5	10	12.5	15	20	25	30	40	50	60	100
30/5	6	400	800	980	1200	1600									
40/5	8	300	600	740	900	1200	1500								
50/5	10	240	480	590	720	960	1200	1440							
60/5	12	200	400	490	600	800	1000	1200	1600						
75/5	15	160	320	390	480	640	800	960	1280	1600	1920				
100/5	20	120	240	300	360	480	600	720	960	1200	1440	1920			
150/5	30	80	160	200	240	320	400	480	640	800	960	1280	1600	1920	
200/5	40	60	120	150	180	240	300	360	480	600	720	960	1200	1440	
250/5	50	50	100	120	140	190	240	290	380	480	580	770	960	1150	1920
300/5	60	40	80	100	120	160	200	240	320	400	480	640	800	960	1600
400/5	80	30	60	80	90	120	150	180	240	300	360	480	600	720	1200
500/5	100	20	50	60	70	100	120	140	190	240	290	380	480	580	960
600/5	120		40	50	60	80	100	120	160	200	240	320	400	480	800
750/5	150		30	40	50	60	80	100	130	160	190	260	320	380	640
1000/5	200		20	30	40	50	60	70	100	120	140	190	240	290	480
1500/5	300			20	20	30	40	50	60	80	100	130	160	190	320
2000/5	400					20	30	40	50	60	70	100	120	140	240
2500/5	500						20	30	40	50	60	80	100	120	190
3000/5	600							20	30	40	50	60	80	100	160
4000/5	800								20	30	40	50	60	70	120
5000/5	1000									20	30	40	50	60	100
6000/5	1200										20	30	40	50	80
7000/5	1400											20	30	40	70

WARNING! The c/k value should always be >20, to ensure the correct calculation of reactive power per rack.

- Define the switching sequence (see product label or method below): Define the switching sequence according to the relative values of individual racks in relation to each other.
  Example: 1:1:1:1:1 for racks of the same power, or 1:1:1:2:2 for three 25kvar racks and two 50kvar racks.
- Enter the number of levels, also called racks (see product label or our offer)
- Select Continue

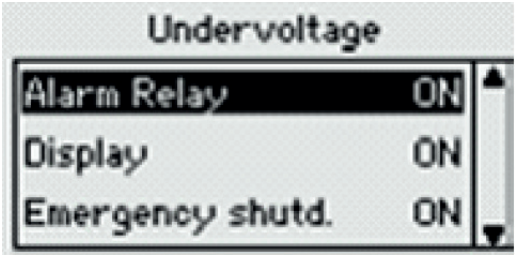
The racks' switching sequence is applied to reach the default setpoint (cos phi = 0.96).

QR code for tutorial video on manual setup:

5.3. Alarms

Each alarm can have up to three different effects on the system. The options are:

- Enable relay output (contact a/b)
- Show alarm on the regulator screen
- Emergency stop, interrupt regulation process and turn off all the racks. Shutdown continues until the alarm is acknowledged and for an additional 240 seconds, after which the COSYS system automatically initiates the system control to reach the targeted cos phi again



The following alarms are available:

- **Cos phi alarm:** alarm for when the battery can no longer regulate an over-inductive cos phi (all the racks are already on) or an over-capacitive cos phi (all the racks are already triggered)
- **Operating cycle counter:** each power-on of the racks is counted separately to estimate functional wear (by default, alarm emitted at 80,000 operations before a contact should be replaced)
- **Under-voltage:** alarm warns when the measured voltage drops below 10% of the nominal voltage of the supply network (non-configurable).
- **Over-voltage:** alarm warns when the measured voltage exceeds 10% of the nominal voltage of the supply network (non-configurable).
- **Low current:** alarm warns when the measured secondary current falls below 10 mA (non-configurable).
- **Overcurrent:** alarm warns when the ratio between the instantaneous effective current and the earth current in the capacitor exceeds the set limit. This alarm shows the proportion of harmonic currents in relation to the base current. (This calculation also takes into account the filtering factor p of the reactive power factor correction system)
- **Zero load detected:** alarm warns when a rack's reactive power drop relative to its calibration value exceeds the set limit. If this alarm is triggered, the rack is excluded from any power factor correction.
- **THDI:** THDI threshold alarm
- **U harmonics:** alarm triggered by the voltage harmonics threshold, configurable by rank
- **I harmonics:** alarm triggered by the current harmonics threshold, configurable by rank
- **Voltage interruption:** alarm triggered by brief drops in voltage, depending on the nominal voltage. The default setting is at 85% of the rated voltage to protect capacitors and contacts from switching on / triggering unexpectedly.
- **Temperature (optional):** temperature limit alarm (°C)
- **Inputs/outputs (optional):** alarm for when an input signal is received. (E.g. emergency stop on input signal 2, control profile toggled on input signal 5). Module with max. 5 inputs.

Note: for more information, please refer to the COSYS P6 / P12 regulator manual (reference: **547052**).

6. MAINTENANCE

Routine maintenance of this equipment requires periodic checks (at least once a year) of the following:

- Proper functioning of the regulator
- Visual checks of capacitors by replacing any that are deformed on the top part of the outer housing.
- Contact function (max. 80,000 operations or 8 years) and tightening of their terminals
- Tightening of power connections (see section Connections and tightening torques)
- Auxiliary circuit and capacitor protection fuses
- Ventilation function (replace every 4 years)
- Cleanliness of the ventilation grid and filter to ensure the housing is well ventilated

Note: The cabinet houses a temperature relay that cuts off the external power supply to the regulator (60°C, non-adjustable).

Socomec is here to help you maintain and upscale your system.

7. SHUTDOWN

Powering down the system may be necessary as part of maintenance operations or with the aim of preserving components outside of reactive energy penalty periods.

To perform system shutdown:

- Switch off all the racks manually, via the MANUAL ADJUSTMENT menu of the regulator (if necessary, see regulator manual 547052, chapter 6.3.7.2).
- Cut off the system power supply, either by the switch-disconnector of the cabinet, or by opening the upstream protection, in order to ensure electrical isolation.

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