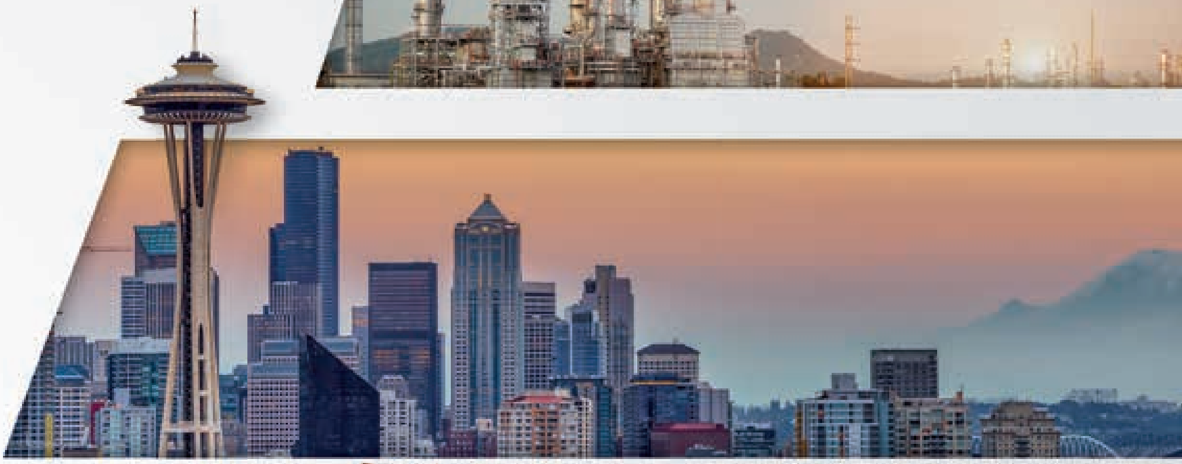
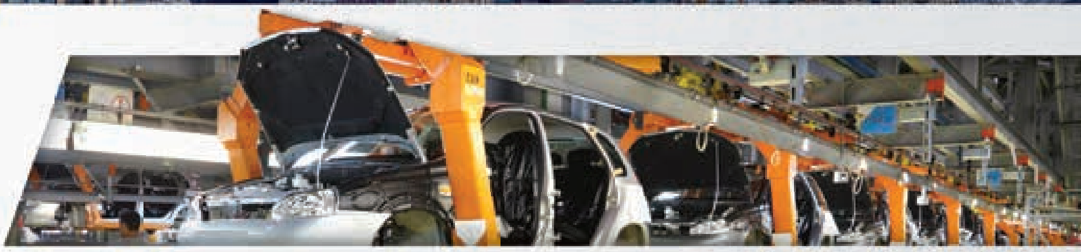
ICAR
technology looking ahead

2016





60Hz FREQUENCY

CATALOGUE

POWER FACTOR CORRECTION LV

Metallized paper capacitors
High gradient metallized polypropylene capacitors
Standard polypropylene capacitors

QUALITY MADE IN ITALY

Power Quality in your hands with new regulators RPC 8LGA and 5LGA

Power Quality functions:
THD calculation and display of current and voltage.

Powerful.
Regulators with poor and confusing displays are a thing of the past: The 8BGA will amaze you with its 128x80 pixel LCD matrix graphic display.
The sharp detail allows intuitive navigation of the menus represented by icons and text in the 10 available languages - these include Italian, English, French, German, Russian, Spanish, Portuguese.

Better readability
of the measures and messages on the screen, thanks to the graphic display, LED and icons.

Alarms descriptions
in six available languages, for better events understanding.

Alarm preventive maintenance,
to keep the system always efficient.

Optical port
for adjustment and quick reference by PC using USB cable or WIFI dongle.

RPC 5LGA is on MICROmatic and MINImatic, RPC 8LGA on MIDImatic.

Protection degree IP4X standard for Multimatic

The degree of protection IP4X is no longer an option for MULTImatic PFCS but it is a STANDARD feature, for better reliability and durability of the system. Furthermore, the new cabinet simplifies the maintenance operations, thanks to the easily removable panels.

FREE Warranty Extension

It's possible to extend free the warranty for additional 12 months. Applied to all Automatic Power Factor Correction Systems (MICROmatic, MINImatic, MIDImatic, MULTImatic) of the following ranges:

- FH: Power Factor Correction Systems with high energy density
- polypropylene capacitors and detuned reactors.
- FD: Power Factor Correction Systems with metallized paper capacitors and detuned reactors
- TC: Power Factor Correction Systems with metallized paper capacitors.

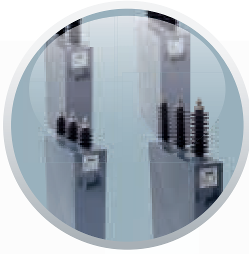
To have the extension simply register within 60 days from the delivery date on the web site:
www.warranty.icar.com

Icar: Products and solutions

ICAR is a leading manufacturer of capacitors and power factor correction systems in low and medium voltage; it controls with its own companies all production phases: the polypropylene/paper film manufacturing, metallization, winding,manufacturing of the finished product.

The ICAR Group has 6 plants, all located in Europe. The power factor correction range is made entirely in Italy.
For details on the individual families, download the full catalogs on the website, www.icar.com. Here are all equipment and the solutions ICAR proposes.

Custom components for power factor correction



MV Capacitors and banks for power factor correction

Power electronics capacitors

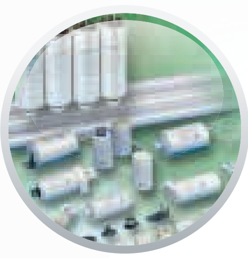
Active Harmonic Filters

LV voltage stabilizers

EMI RFI filters

Motor run capacitors

Capacitors for energy storage and discharge



Lighting capacitors

Isolation and LV/LV special transformers

Services

For many companies, the electricity is an important cost element, and a part of the amounts is due to the consumption of reactive energy. All companies that distribute electricity are collecting penalties in the bill of consumption, if the user consumes reactive power over the allowed limits.

So today is particularly convenient to install a power factor correction system effectively, correctly sized, which saves a lot of money: a power factor corrector is often pay for itself within a year.

But we must not forget the power factor correction installed for several years: we must monitor the proper functioning because if you do not keep them in perfect working order, they "lose power", and you are likely to pay penalties. With proper maintenance you can avoid wasting money and unnecessary power dissipation in the electric plant cables and transformers that undergoes premature aging.

It is also important a proper maintenance and use of original spare parts since capacitors, when worn or of poor quality, are likely to burst causing damage to electrical equipment, plant shutdowns due to protection tripping, or even real fire.

Our services:

- Interventions to verify existing power factor correction systems.
- Interventions on electrical systems analysis and LV verification to be corrected
- Interventions on the start-up and commissioning of new LV power factor correction banks
- Analysis on the energy quality in LV installations
- Scheduled maintenance on power factor correction systems
- Revamping solutions
- Original spare parts
- Analysis of the Energy Authority Penalties

Make your own measurement and let us know

Check-up of existing PFC systems

Local support

Tailor made capacitor banks

Power Quality Assessment

Quality

ICAR has always regarded product quality and effectiveness of internal processes as key factors of corporate strategy. In ICAR we believe that compliance with international standards is a basic requirement to offer equipment that can meet the needs of our customers.

Quality System

The ICAR Quality management system is certified according to ISO 9001 since 1994.
We participate actively in international standards committees that draft regulations applicable to our production equipment, and in particular to industrial capacitors: this guarantees to be always up with changes in legislation, or rather pre-empt it.

Since 2011 the ICAR quality management system is certified by IRIS (International Railway Industry Standard). Promoted by UNIFE (Association of European companies operating in the railway sector) and supported by operators, system integrators and equipment manufacturers, IRIS integrates the ISO 9001 quality standard introducing additional requirements, specific to the railway industry.

Certificato UNI EN Iso9001:2008

IRIS is modeled on quality standards similar to those already in use in the automotive and aerospace industries.

Independent certification bodies and approved by the promulgators of the standard ensure objectivity and transparency in the evaluation.
IRIS certification, while being oriented in the rail sector, has a positive effect on the whole ICAR quality system, with benefits for all types of produced devices.

The valid certificates can be downloaded from the website www.icar.com the section "Company - Quality"

Product quality

The equipment produced in ICAR are tested both in our laboratories and in the most important internationally recognized laboratories, in order to ensure compliance with the highest standards.

The convenience of power factor correction

No more penalties

The Electricity Authorities, force companies distributing electricity to apply financial penalties to utilities that have a substantial contractual power and energy cos phi with a lower average of 0,9 or tan phi lower than 0,484.
The correct power factor of the electric plant allows you to avoid those penalties, which often are not reflected in the bill, and then are paid by the final user without even realizing it.

The industrial electric plants are increasingly affected by harmonic currents caused by inverters, electronic drives, computers, filament free lamps, motors with variable speed drives, etc.

The harmonics cause more stress to the power factor correction capacitors: their performance decade by dropping progressively cos phi of the system to below the fateful value of 0,9.
You may pay significant penalties... as time goes on!
In an electric industrial plant, the installation of a photovoltaic in on-site exchange causes reduction of the power factor seen to the counter.
After connection of the photovoltaic electricity, bills may be burdened with significant penalties.

Increased system capacity

The thermal capacity of generators, transformers and cables limit the kVA that can be supplied by the system. Reducing the KVAR demand from existing load by installing capacitors, allows additional load to be added to the system.

Improved voltage

High demand of reactive power increases the voltage drops across transformers, cables and other system components. The result is a decreased utilization voltage.
The voltage drops can be limited by increasing the power factor.

Reduced circuit losses

Since current is reduced in direct proportion to the increase in power factor, the resistive losses, in the circuit, are inversely proportional to the power factor. The increase of power factor allows a losses reduction with substantial benefits for the system.

Glossary

Cos Phi. Simplifying, in an electrical system is appointed with phi (φ), the phase shift between the voltage and the electric current at the fundamental frequency of the system (50Hz). The cos phi is therefore a dimensionless number between 0 and 1, and varies from moment to moment. Typically, an industrial electrical system has an inductive cos phi, which value depends on the characteristics of the user plant.

Power factor. In an electrical system means, with power factor, the ratio between the active power and the apparent power. Also the power factor is a dimensionless quantity between 0 and 1, which varies from moment to moment. However, the cos phi and the power factor coincide only in systems devoid of sinusoidal harmonic currents. In a system with harmonic, the power factor is always less than the cos phi.

Monthly average power factor.
Electricity bills often show the monthly average power factor, obtained from the ratio between the active power consumed by the user and the apparent power transited the point of delivery. Typically, the average monthly power factor is calculated separately on different time slots.

Penalty for low power factor.
If the monthly average power factor is less than 0,9 lagging, are applied in the bill some financial penalties.

Isolation level. For a capacitor that complies with IEC 61921, the isolation level is indicative of the voltage pulse that can withstand.

Insulation voltage. For a power factor correction system that complies with the IEC 60439-1/2, the isolation voltage is indicative of the maximum voltage that can withstand the entire system.

Nominal voltage of the capacitor U_N.
It is the rated voltage of the capacitor, at which its output rated power is calculated.

Maximum operating voltage U_{MAX}.
It is the maximum voltage that the capacitor can withstand, for the time indicated by the IEC 60831-1/2. The following relation applies U_{MAX} = 1,2 U_N.

Rated operational voltage U_e.
It is the rated voltage of the power factor correction system, which guarantees proper use. A capacitor with a rated voltage can have on board capacitors with voltage U_N> U_E. It may never happen otherwise.

Short-circuit current Icc.
As indicated in the IEC 61439-1 Article 3.8.9.4, is the prospective short-circuit current that the cabinet can endure for a specified time. It's a value stated by the manufacturer of the cabinet on the basis of laboratory tests. The short-circuit current of the cabinet can be increased, in case of need, by installing fuses. In this case the declared data must be accompanied by the words "fuse conditioning short-circuit current."

Steps aboard an automatic power factor corrector. They are the physical units of power factor bank, each controlled by a dedicated switching device (static switch or contactor). A rack may be constituted by a single step (as typically occurs in detuned bank) or more steps. For example, the MULTIrack HP10 from 150kvar/400V consists of 6 steps: 2 from 15kvar and 4 from 30kvar. It 'is easily verified by counting the number of contactors present on the front of the drawer. More step can be merged to achieve larger power steps: in these cases they are controlled by the same controller contact.

Combinations. It is the internal configurations number which proposes a particular automatic power factor corrector, as a function of the steps (number and power) that has on board. For example, a power factor corrector of 280kvar with steps 40-80-160 offers 7 combinations: 40-80-120-160-200-240-280.
The greater the number of possible combinations, the better "accuracy" and the flexibility to use the power factor correction bank.

THD (Total Harmonic Distortion).
For a periodic non-sinusoidal wave, the THD is the ratio between the rms of all harmonic components value and the rms value of the fundamental at 50Hz.

$THDI_C$. It is the harmonic overload suggested in order to satisfy the technical requirements of the components. It is a characteristic value of each capacitor, indicative of its robustness: much higher is the THDIC, more robust is the capacitor. The THDIC is the most significant value to compare different capacitors, together with the maximum temperature of use.

$THDI_R$. It is the maximum THD present in the plant without any capacitor battery installed on the basis of which to select the type of the capacitor to be installed in the plant. It is an empirical fact, based on the construction technology used and the experience of the manufacturer. There is no theoretical link between THDIR and THDIC valid for all plants. The THDIR can also be very different, for capacitors with the same THDIC produced by different manufacturers, depending on the risk tolerance of the manufacturer.

THDV. It is the voltage THD bearable by a power factor correction bank with harmonic blocking reactors.

f_N: is the detuning frequency between inductance and capacitance of a detuned capacitor bank, that is a capacitor bank equipped with harmonic biocking reactors. The detuning frequency is the most objective parameter for detuned capacitor bank comparison; the lower the detuning frequency is the sounder the capacitor bank is.
In particular an 180Hz detuned capacitor bank is sounder and more reliable than another with 189Hz detuning frequancy f_N.
As of Ferranti effect, detuned capacitor bank capacitors are exposed to a voltage that is higher than the rated system voltage; for this reason these capacitors are rated for higher voltage according to the p% factor.

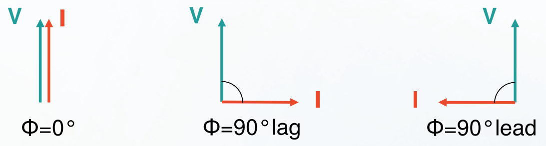
Summary

CHAPTER 1

Power Factor Correction Principles

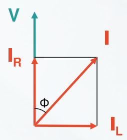
Power factor correction: why?

In electrical circuits the current is in phase with the voltage whenever are in presence of resistors, whereas the current is lagging if the load is inductive (motors, transformers with no load conditions), and leading if the load is capacitive (capacitors).



The total absorbed current, for example, by a motor is determined by vector addition of:

1. I_R resistive current;
2. I_L inductive reactive current;



$$\text{Cos } \varphi = \frac{I_R}{I}$$

These currents are related to the following powers:

1. active power linked to I_R;
2. reactive power linked to I_L;

The reactive power doesn't produce mechanical work and it is an additional load for the energy supplier.
The parameter that defines the consumption of reactive power is the power factor.

We define power factor the ratio between active power and apparent power:

$$FP = \frac{P}{A}$$

$$A = \sqrt{P^2 + Q^2}$$

As far as there are not harmonic currents power factor coincides to cosφ of the angle between current and voltage vectors. cosφ decreases as the reactive absorbed power increases.

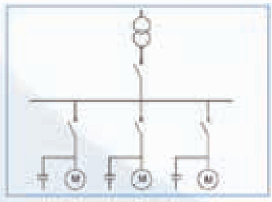
Low cosφ, has the following disadvantages:

1. High power losses in the electrical lines
2. High voltage drop in the electrical lines
3. Over sizing of generators, electric lines and transformers.

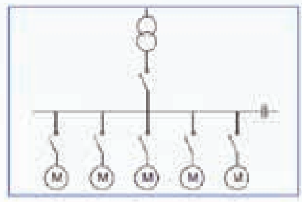
From this we understand the importance to improve (increase) the power factor. Capacitors need to obtain this result.

Power factor correction: how?

By installing a capacitor bank it is possible to reduce the reactive power absorbed by the inductive loads in the system and consequently to improve power factor.
It is suitable to have cosφ a little in excess of 0.9 to avoid paying the penalties provided for by the law. cosφ must not be too close to unity, to avoid the leading currents in of the electrical system.
The choice of the correct power factor correction equipment depends on the type of loads present and by their way of working.
The choice is between CENTRAL COMPENSATION and INDIVIDUAL COMPENSATION.
Individual compensation: power factor correction is wired at each single load (i.e. motor terminals)
Central compensation: there is only one bank of capacitors on the main power distribution switch board or substation.



Individual Compensation



Central Compensation

The individual compensation is a simple technical solution: the capacitor and the user equipment follow the same sorts during the daily work, so the regulation of the cosφ becomes systematic and closely linked to the load.
Another great advantage of this type of power factor correction is the simple installation with low costs.
The daily trend of the loads has a fundamental importance for the choice of most suitable power factor correction.
In many systems, not all the loads work in the same time and some of them work only a few hours per day.
It is clear that the solution of the individual compensation becomes too expensive for the high number of capacitors that have to be installed. Most of these capacitors will not be used for long period of time.
The individual compensation is more effective if the majority of the reactive power is concentrated on a few substatios loads that work long period of time.
Central compensation is best suited for systems where the load fluctuates throughout the day.
If the absorption of reactive power is very variable, it is advisable the use of automatic regulation in preference to fixed capacitors.

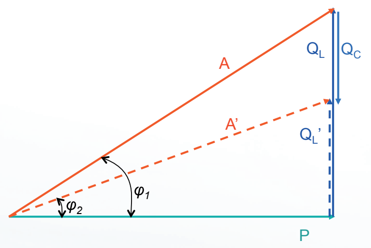
Power factor correction: How many capacitors?

The choice of capacitor bank to install in a system is closely depended from:

- $\cos\phi_2$ value that we would obtain
- $\cos\phi_1$ starting value
- installed active power.

By the following equation:

$Q_C = P * (\tan\varphi_1 - \tan\varphi_2)$



Can be also written $Q_c = k * P$

where the parameter k is easily calculable using table 1 below and

Q_C = Required Capacitors Reactive Output [kvar];
P = Active Power [kW];
Q_L, Q'_L = Inductive Reactive Output before and after the installation of the capacitor bank;
A, A'= apparent power before and after the power factor correction [kVA].

As example if we have installed a load that absorbs an active power of 300 kW having a power factor 0.7 and we want to increase it until 0.95.
From the table 1 we find: k = 0,692

Which means: $Q_c = 0{,}692 * 300 = 207{,}6$ kvar

Starting power factor	Final power factor					
	0,9	0,91	0,92	0,93	0,94	0,95
0,40	1,807	**1,836**	1,865	**1,896**	1,928	**1,963**
0,41	1,740	**1,769**	1,799	**1,829**	1,862	**1,896**
0,42	1,676	**1,705**	1,735	**1,766**	1,798	**1,832**
0,43	1,615	**1,644**	1,674	**1,704**	1,737	**1,771**
0,44	1,557	**1,585**	1,615	**1,646**	1,678	**1,712**
0,45	1,500	**1,529**	1,559	**1,589**	1,622	**1,656**
0,46	1,446	**1,475**	1,504	**1,535**	1,567	**1,602**
0,47	1,394	**1,422**	1,452	**1,483**	1,515	**1,549**
0,48	1,343	**1,372**	1,402	**1,432**	1,465	**1,499**
0,49	1,295	**1,323**	1,353	**1,384**	1,416	**1,450**
0,50	1,248	**1,276**	1,306	**1,337**	1,369	**1,403**
0,51	1,202	**1,231**	1,261	**1,291**	1,324	**1,358**
0,52	1,158	**1,187**	1,217	**1,247**	1,280	**1,314**
0,53	1,116	**1,144**	1,174	**1,205**	1,237	**1,271**
0,54	1,074	**1,103**	1,133	**1,163**	1,196	**1,230**
0,55	1,034	**1,063**	1,092	**1,123**	1,156	**1,190**
0,56	0,995	**1,024**	1,053	**1,084**	1,116	**1,151**
0,57	0,957	**0,986**	1,015	**1,046**	1,079	**1,113**
0,58	0,920	**0,949**	0,979	**1,009**	1,042	**1,076**
0,59	0,884	**0,913**	0,942	**0,973**	1,006	**1,040**
0,60	0,849	**0,878**	0,907	**0,938**	0,970	**1,005**
0,61	0,815	**0,843**	0,873	**0,904**	0,936	**0,970**
0,62	0,781	**0,810**	0,839	**0,870**	0,903	**0,937**
0,63	0,748	**0,777**	0,807	**0,837**	0,870	**0,904**
0,64	0,716	**0,745**	0,775	**0,805**	0,838	**0,872**
0,65	0,685	**0,714**	0,743	**0,774**	0,806	**0,840**
0,66	0,654	**0,683**	0,712	**0,743**	0,775	**0,810**
0,67	0,624	**0,652**	0,682	**0,713**	0,745	**0,779**
0,68	0,594	**0,623**	0,652	**0,683**	0,715	**0,750**
0,69	0,565	**0,593**	0,623	**0,654**	0,686	**0,720**
0,70	0,536	**0,565**	0,594	**0,625**	0,657	**0,692**
0,71	0,508	**0,536**	0,566	**0,597**	0,629	**0,663**
0,72	0,480	**0,508**	0,538	**0,569**	0,601	**0,635**
0,73	0,452	**0,481**	0,510	**0,541**	0,573	**0,608**
0,74	0,425	**0,453**	0,483	**0,514**	0,546	**0,580**
0,75	0,398	**0,426**	0,456	**0,487**	0,519	**0,553**
0,76	0,371	**0,400**	0,429	**0,460**	0,492	**0,526**
0,77	0,344	**0,373**	0,403	**0,433**	0,466	**0,500**
0,78	0,318	**0,347**	0,376	**0,407**	0,439	**0,474**
0,79	0,292	**0,320**	0,350	**0,381**	0,413	**0,447**
0,80	0,266	**0,294**	0,324	**0,355**	0,387	**0,421**
0,81	0,240	**0,268**	0,298	**0,329**	0,361	**0,395**
0,82	0,214	**0,242**	0,272	**0,303**	0,335	**0,369**
0,83	0,188	**0,216**	0,246	**0,277**	0,309	**0,343**
0,84	0,162	**0,190**	0,220	**0,251**	0,283	**0,317**
0,85	0,135	**0,164**	0,194	**0,225**	0,257	**0,291**
0,86	0,109	**0,138**	0,167	**0,198**	0,230	**0,265**
0,87	0,082	**0,111**	0,141	**0,172**	0,204	**0,238**

Table 1
See the full table in Appendix

A typical example of power factor correction, sometimes not much considered but surely important, concerns the power factor correction of transformers for the distribution of energy. It is essentially a fixed power factor correction that must compensate for the reactive power absorbed by the transformer in its no load condition (this happens often during the night). The calculation of the needed reactive output is very easy and it bases itself on this equation:

$$Q_c = I_0\% * \frac{A_N}{100}$$

where
I_0%= magnetising current of the transformer
A_N= Apparent rated power in kVA of the transformer

If we don't have these parameters, it is convenient to use the following table.

Power transformer KVA	Oil transformer kvar	Resin transformer kvar
10	**1**	1,5
20	**2**	1,7
50	**4**	2
75	**5**	2,5
100	**5**	2,5
160	**7**	4
200	**7,5**	5
250	**8**	7,5
315	**10**	7,5
400	**12,5**	8
500	**15**	10
630	**17,5**	12,5
800	**20**	15
1000	**25**	17,5
1250	**30**	20
1600	**35**	22
2000	**40**	25
2500	**50**	35
3150	**60**	50

Table 2

Another very important example of power factor correction concerns asynchronous three-phase motors that are individually corrected. The reactive power likely needed is reported on table 3:

Motor power		Required Reactive Power (kvar)				
HP	kW	3000 rpm	1500 rpm	1000 rpm	750 rpm	500 rpm
0,4	0,55	-	-	0,5	0,5	-
1	0,73	0,5	0,5	0,6	0,6	-
2	1,47	0,8	0,8	1	1	-
3	2,21	1	1	1,2	1,6	-
5	3,68	1,6	1,6	2	2,5	-
7	5,15	2	2	2,5	3	-
10	7,36	3	3	4	4	5
15	11	4	5	5	6	6
30	22,1	10	10	10	12	15
50	36,8	15	20	20	25	25
100	73,6	25	30	30	30	40
150	110	30	40	40	50	60
200	147	40	50	50	60	70
250	184	50	60	60	70	80

Table 3

Be careful: the capacitor output must not be dimensioned too high for individual compensated machines where the capacitor is directly connected with the motor terminals. The capacitor placed in parallel may act as a generator for the motor which will cause serious overvoltages (self-excitation phenomena). In case of wound rotor motor the reactive power of the capacitor bank must be increased by 5%.

Power factor correction: technical reasons

Recent energy market deregulation, along with new potential energy supplier rising, had lead to many and different type of invoicing which are not very clear in showing Power Factor up.
However as energy final price is steady growing, to correct power factor is becoming more and more convenient.
In most of the cases power factor improvement device prime cost is paid back in few months.
Technical-economical advantages of the installation of a capacitor bank are the following:

- decrease of the losses in the network and on the transformers caused by the lower absorbed current
- decrease of voltage drops on lines
- optimisation of the system sizing.

The current I, that flows in the system, is calculated by:

$$I = \frac{P}{\sqrt{3} * V * \cos\varphi}$$

where
P= Active power
V= Nominal Voltage
While cosφ increases, with the same absorbed power we can obtain a reduction in the value of the current and as a consequence the losses in the network and on the transformers are reduced. Therefore we have an important saving on the size of electrical equipment used on a system. The best system sizing has some consequence on the line voltage drop. We can easily see that looking at the following formula:

$$\Delta V = R * \frac{P}{V} + X * \frac{Q}{V}$$

where
P= active power on the network (kW)
Q= reactive power on the network (kvar)
while R is the cable resistance and X its reactance (R<<X).
The capacitor bank installation reduces Q so we have a lower voltage drop. If, for a wrong calculation of the installed capacitor bank value, the reactive part of the above equation becomes negative, instead of a reduction of the voltage drop we have an increasing of the voltage at the end of the line (Ferranti Effect) with dangerous consequence for the installed loads.
Some examples clarify the concepts set out above:

1. Power loss (kW), in function of cosφ, from a copper cable 3 x 25mm² 100m long carrying 40kW at 400Vac.
2. Supplied active power (kW) by a transformer 100kVA, in function of cosφ

cos ϕ	1)	2)
0,5	3,2	50
0,6	2,3	60
0,7	1,6	70
0,8	1,3	80
0,9	1	90
1		100

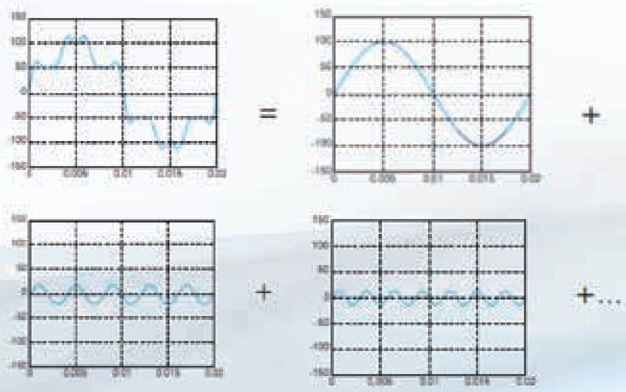
As we can see as the power factor increases we have fewer losses in the network and more active power from the same KVA.
This allows us to optimise on the system sizing.

Power factor correction: Harmonics in the network

The distortions of the voltage and current waveforms are generated by non-linear loads (inverter, saturated transformers, rectifier, etc.) and produce the following problems:

- On the A.C. motors we find mechanical vibration that can reduce expected life. The increase of the losses creates overheating with consequent damaging of the insulating materials;
- In transformers they increase the copper and iron losses with possible damaging of the windings. The presence of direct voltage or current could cause the saturation of the cores with consequent increasing of the magnetising current;
- The capacitors suffer from the overheating and the increasing of the voltage that reduce their life.

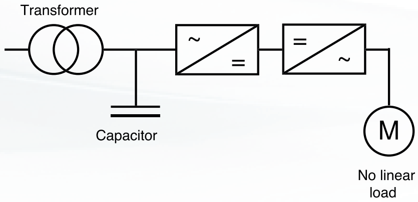
The waveform of the current (or voltage) generated by a non-linear load (fig. 1), being periodical, could be represented by the sum of many sinusoidal waves (a 50Hz component called fundamental and other components with multiple frequency of the fundamental component so called HARMONICS).

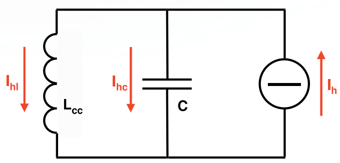


$$I = I_1 + I_2 + I_3 + I_4 + \dots I_n$$

It is not advisable to install the power factor correction without considering the harmonic content of a system.
This is because, even if we could manufacture capacitors that can withstand high overloads, capacitors produce an increase of harmonic content, with the negative effects just seen. We speak about resonance phenomena when an inductive reactance is equal to the capacitive one:

$$2\pi f\, L = \frac{1}{2\pi f\, C}$$





Ideal current generator represents motor as harmonic current components generator, these are independent from circuit inductance, while L_{CC} is obtainable by capacitor upstream short circuit power (in general it is equal to transformer short-circuit inductance) the resonance frequency is obtained as follows:

$$N = \sqrt{\frac{S_{cc}}{Q}} \cong \sqrt{\frac{A * 100}{Q * v_{cc}\%}}$$

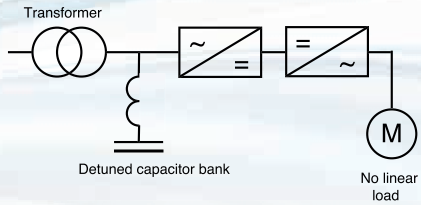
S_{cc} = Short-circuit power of the network (MVA)	
Q = Output of power factor correction bank (kvar)	
A = Rated power transformer (kVA)	
$v_{cc}\%$ = Short-circuit voltage %	
N = Resonance harmonic order	

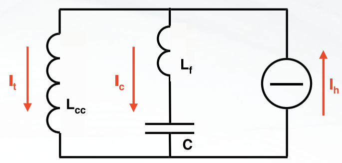
In parallel resonance conditions the current and the voltage of the circuit L_{CC} - C are heavily amplified as well as the nearby harmonic currents. Hereinafter an example:

A = 630kVA (rated power transformer)	
$V_{cc}\%$ = 6 (shot-circuit voltage %)	
Q = 300kvar (output of power factor correction bank)	

$$N = \sqrt{\frac{A * 100}{Q * v_{cc}\%}} = \sqrt{\frac{630 * 100}{300 * 6}} \cong 6$$

The result shows that in these conditions the system transformer-capacitor bank has the parallel resonance frequency of 300Hz (Nx50Hz). This means likely amplification of 5^{h} and 7th harmonic current.
The most convenient solution to avoid this is the detuned filter, formed introducing a filter reactor in series with the capacitors, making this a more complex resonant circuit but with the desired feature of having a resonance frequency below the first existing harmonic.





With this type of solution, the parallel resonance frequency is modified from

$$f_{rp} = \frac{1}{2 * \pi * \sqrt{L_{cc} * C}}$$

to

$$f_{rp} = \frac{1}{2 * \pi * \sqrt{(L_{cc} + L_f) * C}}$$

Normally the resonance frequency between the capacitor and the series reactance is shifted lower than 250Hz and it is generally between 135Hz and 210Hz. The lower frequencies correspond to higher harmonic loads.
The installation of a reactance in series with the capacitor bank produces a series resonance frequency:

$$f_{rs} = \frac{1}{2 * \pi * \sqrt{L_f * C}}$$

If a harmonic current I_h with the same frequency of the resonance in series exists, this one will be totally absorbed by the system capacitors - reactors without any effect on the network. The realisation of a **tuned passive filter** is based on this simple principle. This application is required when we want the reduction of the total distortion in current (THD) on the system:

$$THD = \frac{\sqrt{I_3^2 + I_5^2 + I_7^2 + ...I_n^2}}{I_1}$$

I_1 = Component at the fundamental frequency (50Hz) of the total harmonic current	
I_3 , I_5... = Harmonic components at the multiple frequency of the fundamental (150Hz, 250Hz, 350Hz, ...)	

The dimensioning of tuned/passive filters is linked to the circuit parameter:

- impedance of the network (attenuation effect less as the short-circuit power on the network increases: in some cases could be useful to add in series with the network a reactance to increase the filtering effect);
- presence of further loads that generate harmonics linked to other nodes on the network
- capacitor types;

On this last point we have to make some considerations.
It is known that the capacitors tend to decrease capacity over time: varying the capacity inevitably varies the resonance series frequency

$$f_{rs} = \frac{1}{2 * \pi * \sqrt{L_f * C}}$$

and this drawback can be very dangerous because the system could lead in parallel resonance conditions. In this case, the filter does not absorb more harmonics but even amplifies them. In order to have a constant capacity guarantee over time we need to use another type of capacitors made in bimetallized paper and oil impregnated polypropylene. In addition to the passive absorption filter realized with capacitors and inductances is possible to eliminate the network harmonics, with another type of absorption filter: the Active Filter. The operation principle is based on the in-line injection of the same current harmonics produced by non-linear loads, but out of phase.

Power factor correction in presence of distorted voltage

In many industrial electrical systems or in the tertiary sector, the presence of non-linear loads (inverter, welding, filament free lamps, computers, drives, etc..) causes a distortion of the current, which is synthesized by the THDI% numeric parameter: if the current is sinusoidal his THDI% is zero, more the current is deformed so much higher is its THDI%. In electrical currents with very deformed currents, the power factor correction equipment are carried out in a "filter banks" (or "block" or "blocked" or "detuned" if you prefer), or rather with inductors that prevent harmonic current to reach and damage the capacitor.
Usually the supply voltage remains sinusoidal even if a very deformed current flows in the plant; however, if the MV/LV transformer impedance is high, the voltage may also be affected by deformation: this impedance, crossed by a distorted current, will create a voltage drop equally distorted, causing on LV users a non-sinusoidal supply voltage (or with a certain THDV%). It is rare that the THDV% reaches 8% (limit of IEC EN 50160), this happens for example when the MV/LV transformer is characterized by a high series impedance and/or is overloaded (saturation).
In a plant with distorted voltage there will be problems of various types, depending on the utilities (breakage or malfunction of electronic parts such as relays, plc, controller, computers; production beyond the acceptable tolerances, etc.). Regarding the power factor correction, a high THDV% creates problems for the blocking reactors used in power factor correction banks.
These can saturate and overheat for overload up to be damaged, causing the out of service of the power factor correction bank and/or problems to the capacitors. This will result in an economic loss (payment of penalties for low cos phi) and technical, because the plant will run through by a higher current, resulting in conductors additional overhead (cables, bars) and the transformer. For this problem, ICAR has developed a dedicated solution: the MULTImatic FD25V (for 400V network) and FD70V (for 690V network) power factor correction ranges. They are made with sound heavy duty-bimetallized paper capacitors with high performance electronic instrumentation for the electrical parameters control; high linearity reactance allow them to bear up to 8% THDV continuously.

Power factor correction in the presence of a photovoltaic system in spot trading

If on electrical plant of an industrial user is added a photovoltaic system, the active power drawn from the supply is reduced because of the power supplied by the photovoltaic system and consumed by the plant (consumption).
Therefore, it changes the relationship between reactive power and active energy drawn from the network and, consequently, the power factor is lower than the same system without photovoltaic. We must therefore pay particular attention to the power factor correction not to have any penalties for low cos phi that could seriously erode the economic benefits of the photovoltaic system.
The power factor correction will be reviewed both for installed capacity, both for construction type. In fact, increasing the power factor corrector power, you will modify the resonance conditions with the MV/LV transformer which supply the system. When the photovoltaic system has more power than the users one, or if it is possible that power is introduced to the network, the power factor corrector must also be able to run on the four quadrants. The two "standard" quadrants are related to the plant operation as a user that absorbs from the network both active and inductive reactive power, while the two quadrants related on the plant functioning as a generator, it provides the network active power, but it absorbs the inductive reactive power (quadrants of generation).

All ICAR range of cos phi electronic controllers are able to operate in four quadrants, running two different cos phi targets to optimize the system economic performance. To manage the cogeneration quadrants you can alter some parameters settings. It is advisable to enter a value equal to 1, to optimize the yield of the PFC Bank. Refer to the manuals of the controllers for more details. To get the maximum benefit in the time allowed by the PFC Bank, we recommend to use bimetallized paper capacitors, the only ones that guarantee a useful life comparable to the photovoltaic system one.

Power factor correction: quality and safety

Basic requirement

We define safety the absence of dangers for people and things while the good is in use or stored in a warehouse. This means to identify stresses, risks and potential damages and the relevant elimination and to keep them under control so that to reduce the risk to a reasonable level.
Power capacitors and capacitor banks shall not be used:

- For uses other than Power Factor Correction and for AC or DC plants.
- As tuned or detuned filters unless specifically approved in written by ICAR

General requirement

The capacitors are constructed in accordance with IEC – CEI EN methods, parameters and tests. The low voltage capacitors are assembled with the required protection devices and assembled into banks to give a QUALITY product which will operate SAFELY. They are not considered as the indication that the capacitors and the power factor correction equipments are suitable for a use in the same conditions of the tests. The user has to verify that the capacitor and power factor correction equipment are of the correct voltage and frequency suitable for values of the network on which they are installed. The user has to verify that the installation of the capacitors and/or the power factor correction equipment is in accordance with the catalogue and the instructions of use. Capacitors and power factor correction equipment MUST NOT be exposed to damaging action of chemical substance or to attacks of flora and/or fauna. Capacitors and power factor correction equipments must be protected against risks of mechanical damaging to which could be exposed during normal working conditions or during the installation. Capacitors and power factor correction equipments that were mechanically or electrically damaged for any reason during the transport, the storage or the installation must not be used and these that breakdown during use must be immediately removed.

Additional instructions about power factor correction equipments

Definition

Power factor correction equipment means:

- one or more groups of capacitors that can be connected and disconnected on the network automatically or manually using suitable operating devices (contactors, circuit breakers, load-break switch, ...)
- operating devices
- control, protection and measure systems
- connections

The equipment could be open or closed inside a metal enclosure.

General requirement

Follow ICAR instructions in the documentation attached to equipments considering the safe distance, the connection standard criteria, working standards and the instructions for the controls and the maintenance.

Compatibility

It must be paid attention to the electromagnetic interferences with the near by equipments.

Contactors

It is advisable to adopt capacitor duty contactors (category AC6-b) because they are equipped with pre charge resistors that substantially reduce the inrush currents while capacitors are switched on. The early switching on of these resistors in respect to the closing or the contactor contacts, allows:

- To avoid main contacts melting.
- To avoid capacitor damage.

Recommendations for installation

Fixing and connection

To fix the power factor correction equipments it is advised to use these types of screws:

- Riphaso series with M10 screw
- MICROmatic and MICROfix series wall-mounted with FISHER 8
- MINImatic wall-mounted and floor-mounted with M8 screw
- MULTImatic and MULTImatic HLP floor-mounted with M12 screw.

The installation of the power factor correction equipment is for indoor application; for different use call ICAR technical department.

Protection devices

Operating devices (load-break switch) or operation and protection (circuit-breakers if the cables are longer than 3m) must be dimensioned to withstand capacitive currents (about 1.3 times nominal current), the inrush currents, the number of operations and they must be re-strike free.
The capacitors are made of polypropylene that is a flammable material. Even if a fire doesn't begin from capacitors or inside the panel, they could however spread it creating dangerous gasses. If a danger exists from the presence of an explosive or flammable atmosphere, the IEC standard; "Electric equipment with explosion and fire danger", shall be strictly followed.

Danger for people

When we install power factor correction equipment we must pay attention that the parts which could be exposed to voltage are correctly protected from accidental contacts in accordance with IEC standards. Before the commissioning verify the tightening of the terminal and of all the bolts is correct.

Protections

Fuses and overpressure disconnector

All the capacitors have an overpressure device which when operated, as in the case of breakdown, disconnects the element from use. This device is not a substitution for the fuses or external circuit-breakers that are specified in our power factor correction equipment.

Limit conditions

The influence of each factor below has not to be considered individually, but in combination and with the influence of other factors.

Voltage

Capacitor and capacitor bank nominal voltage is intended as the design and testing voltage.
The safe and proper use of power factor correction capacitors and capacitor banks, implies that the working voltage is not higher than the nominal voltage.
In special conditions, excluding the installation phases, higher over voltage are allowed as per below table (ref. IEC 60831).

Overvoltage factor (x U_N eff)	Max. duration	Observations
1	Continous	Highest average value during any period of capacitor energization. For energization period less than 24h, exceptions apply as indicated below
1,10	8h every 24h	System voltage regulation and fluctuation
1,15	30 min. every 24h	System voltage regulation and fluctuation
1,20	5 min	Voltage rise at light load
1,30	1 min	

Note: for voltage without harmonics

The life expectancy of capacitors and power factor correction equipment is greatly reduced when operating in overload conditions. The choice of the nominal voltage is determined by the following considerations:

- On some networks working voltage could be very different from nominal voltage
- Power factor correction equipment in parallel could cause an increase of the voltage at the connection point
- The voltage increases with the presence of harmonics on the network and/or cosφ of in advance
- The voltage at the capacitor terminals increases when capacitors are in series with reactors for harmonic blocking.
- If the power factor correction equipment is connected to a motor and not sized correctly, when we disconnect it from the network we may have a phenomena caused by the inertia that makes the motor to work as a self-excited generator consequently increasing of the voltage level at the terminals of the equipment
- The remaining voltage caused by the self-excited after that the equip- ment has been disconnected from the network is dangerous for the generators
- If the power factor correction equipment is connected to a motor with a star-delta starting device we have to pay attention to not cause the overvoltage when this device is working
- All the power factor correction equipments exposed to overvoltage caused by atmospheric lightning must be protected in correct way. If surge arrestors are use they have to be placed as near as possible to the equipment.

Working temperature

Working temperature of power factor correction equipment is a fundamental parameter for safe operation. As a consequence it is very important that heat generated is dissipated correctly and that the ventilation is such that the heat losses in the capacitors do not exceed the ambient temperature limits. The highest workings temperature in normal service conditions between two capacitors is measured at a point 2/3 of the capacitors height and at a distance of 0.1m from them. The capacitor temperature must not exceed the temperature limits hereinafter tabled.

	Ambient temperatures (°C)		
		Highest mean over any period of:	
Symbol	Maximum	24h	1 year
A	40	30	20
B	45	35	25
C	50	40	30
D	55	45	35

Mechanical Limits

The user has not to expose the equipment to exaggerated mechanical limits of operation. The user has to pay attention to the electrical and geometrical dimensioning of the connections to avoid exceeding the mechanical limits which may be reached by temperature variation.

Other considerations for the working safety

Discharge device

Every capacitor must have a discharge device that can discharge it within 3 minutes. The discharge time is calculated from the starting peak of voltage equal to $\sqrt{V_N}$ until 75V. Between the capacitor and the discharge system there shall not be a circuit-breaker, fuses or other sectioning devices.

This doesn't relief to short-circuit the capacitor terminals and earth every time it is required to handle the capacitor.

Residual voltage

When the capacitor is placed under tension its residual voltage must not exceed 10% of the rated voltage. This condition is generally satisfied when the power factor correction equipment is calibrated properly, the reactive power controller, reconnection time shall be appropriate to the discharge time.

Case connection

To keep capacitors case at fix voltage and to discharge fault current toward the case itself, they are grounded by connecting to earth the capacitors supporting frame.

Altitude

Power factor correction equipment must not be used above an altitude of 2000m. On the contrary please contact technical assistance of ICAR S.p.A.

Particular ambient conditions

Power factor correction equipment are not suitable for the applications in places where there are conditions as follows:

- Fast generation of mould
- Caustic and saline atmosphere
- Presence of explosive materials or very flammable
- Vibrations

For environments with these characteristics: high relative humidity, high concentration of dust and atmospheric pollution, please contact technical assistance of ICAR S.p.A.

Maintenance

After the disconnection of the bank, prior to accessing the terminals of the capacitors wait 5 minutes and then short-circuit the terminals and earth. Make these procedures:

Once a month:

- Cleanliness by blast of air of the internal part of the power factor correction equipment and of the air filter anytime there is a cooling system
- Visual control
- Control of the ambient temperature.

Once every 6 months:

- Control of the surfaces condition: painting or other treatments
- Control of the correct tightening of the screw (this operation must be done before the commissioning).

If there are concerns about any environmental conditions an appropriate maintenance program must be established (for example in a dusty environment could be necessary to clean using blasts of air more frequently).

Once a year

- Checking the contactors status
- Checking the capacitors status

Storage and handling

The power factor correction equipment handling must be made carefully avoiding the mechanical stresses and shocks.

The equipment in highest cabinet may be hard to handle, because the center of gravity may be very high and decentralized.

Upon receipt of new equipment, make sure that the packaging is not damaged, although mild. Always make sure that the equipment has not been damaged by transportation: take away the packaging and make a visual inspection with open door. If you discover some damage, write it on the delivery note (carrier copy) the reason for refusal or reserve.

The capacitors and power factor correction awaiting installation storage must be done leaving them in their original packaging, in a covered and dry place.

For more detail refer to specific product user's Manual.

Selection criteria

Capacitors used in power factor correction solutions

In our power factor correction systems we only use our capacitors production, made entirely from ICAR: in this way, we can offer to our customers the highest guarantee of the equipment reliability. The capacitors used are divided into three different types, which lead to electrical and thermal performance completely different:

Polypropylene standard capacitors

They are made by wrapping a metallized polypropylene film.
In function of the film thickness, the layer of metal deposited on the surface and the number of windings made, you get the desired characteristics of capacity, rated voltage, withstand overcurrents etc.
According to the characteristics, the polypropylene standard capacitors are used in power factor correctors SP20, RP10, RP20 families.

High gradient metallized polypropylene capacitors

The substantial difference with the standard polypropylene capacitors is the mode with which the dielectric film is metallized: if in the standard capacitors the metal layer thickness deposited on the surface of the film is constant, for those "high gradient" the metal layer has a suitably modulated thickness.
The metallization thickness modulation allows to greatly improve the capacitors (and therefore of the power factor correction systems which are the fundamental component) in terms of:

- Increase in power density (kvar/dm^3) with a consequent power size reduction of the power factor correction systems;
- Robustness improvement against voltage surges, for greater reliability even in systems with the presence of voltage fluctuations due to the network or maneuvers on the system;
- Improved behavior of the internal short circuit withstand.

According to the characteristics, the metallized polypropylene capacitors are used in high gradient power factor correctors HP10, HP20, HP30, FH20 and FH30 families.

Bimetallized paper capacitors

The bimetallized and impregnated paper capacitors are now the most robust solution for industrial power factor correction.
They are made by wrapping a thin sheet of special paper on the surfaces of which is deposited by evaporation process, a infinitesimal layer of metal alloy with function of electrode; between the sheets of paper is placed a polypropylene film with only the dielectric role between electrode. The bimetallized paper capacitors robustness is due to the already excellent mechanical paper characteristics, to which are added the impregnation in oil benefits. This technology, among the most tested for the capacitors production, was also adopted to realize capacitors used in power electronics, since solicited with high frequencies and designed to work with high temperatures.
The ICAR bimetallized paper capacitors are particularly suitable for applications in plants with high harmonic content currents and/or high operating temperatures; they are used for the detuned filters realization for "troubled" installations because, thanks to the steady capacitance throughout the useful life, these capacitors are able to keep in time the tuning of the filter frequency, even in high operating temperatures presence.
In function of the characteristics, the bimetallized paper capacitors are used in TC10,TC20, FD25, FD35, etc. families.

Our paper bimetallized capacitors are, today, the most imitated... but just look at the construction characteristics detail of what is proposed as "3In" or "4In" to realize that they are simple polypropylene capacitors, maybe just a little '"strengthened".

By their nature, they cannot even come close to the technology "bimetallized paper" performance, especially as regards the maximum operating temperature.
Summing up, the main different types of capacitors features are shown in the table below.

Capacitor technology	Life expectancy	Loss of capacitance	Voltage withstand	Allowed current overload	Peak current withstand	Overall reliability	Maximum working temperature
Standard polypropylene	very good	low	good	good	good	good	55°C
High voltage polypropylene	very good	low	excellent	very good	very good	very good	55°C
Metallized paper	excellent	negligible	very good	excellent	excellent	excellent	70°C

Maximum working temperature is meant capacitor sorrounding air temperature.

FIX POWER FACTOR CORRECTION SYSTEMS

CRTE

The simplest and most efficient fixed power factor correction is three-phase capacitor.
Available from 1kvar to 50kvar at 400V or higher voltages (up to 800V). See dedicated catalog.

MICROfix

Power factor correction for fixed three-phase systems, in metal enclosure with IP3X protection degree.
MICROfix is equipped with a integrated door lock isolating switch, signal lamps and fuses. For power up to 60kvar at 400V.

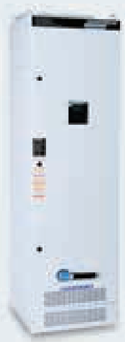
AUTOMATIC POWER FACTOR CORRECTION SYSTEMS

MICROmatic

It is the smaller size of automatic power factor correction bank, suitable for small users power factor correction. It is made with modular concept (MICROrack) to simplify the management of spare parts and maintenance. For reactive power up to 64kvar at 400V in very small dimensions. Allows you to have up to 19 steps for optimal power factor correction in the presence of highly variable loads or characterized by long periods of "no load" operation.
The HP10 family is also available in FAST version for small loads fast power factor correction (lifts, elevators, car washes, etc.).

MINImatic

For small/medium powers automatic power factor correction, can deliver up to 225kvar 400V, depending on the version. Is made with completely removable rack (MINIRack) to simplify management and maintenance. Very flexible Framework, allows the realization of many variations as shown in the available options table. MINImatic is also available in a version with harmonic blocking reactors and cable entry from bottom.



MULTImatic

Power factor correction automatic for large users, allows systems of up to several Mvar, with master-slave logic. MULTImatic is made rack (MULTIrack) for easy replacement and maintenance. It is available in SPEED series (for fast loads), detuned or tuned, in the degrees of protection, IP 4X, IP55, with cable entry from top or bottom. The distribution of power is with robust copper bars.
Frameworks of standard equipments made from multiple columns side by side are equipped with a disconnector and a cable entry in each column. ICAR can make framework on multiple columns with one single cable entry.

Automatic Capacitor Banks Standard features

These are the common features to all automatic banks: PFC regulator with temperature control, IP3X degree of protection (IP4X for MULTImatic), RAL 7035 cabinet paint color, Working voltage Ue of 400V*.

	MICRO matic	MINI matic	MULTImatic
Cable incoming	top/bottom	top	bottom
Ventilation	forced	forced	forced
PFC controller	RPC 5LGA	RPC 5LGA	RPC 8BGA

* For Ue working voltage other than 400V please consult us.

Optional for automatic PFC banks

	MICRO matic	MINI matic	MULTImatic
Cable incoming top/ bottom	yes	yes (4)	yes (4)
IP55 Degree of protection cabinet (cable incoming)	yes (Top)	yes (Bottom)	yes (Bottom)
Remote Communication (1)	yes	yes	yes
Control and protection module MCP (2)	no	yes	yes
Other paint color (upon request)	yes	yes	yes
Automatic Circuit Breaker	no	yes	yes

	MICRO matic	MINI matic	MULTImatic
Fuse melting signaling	no	yes	yes
Other Short Circuit fault withstand level	yes	yes	yes
Thyristor Switched bank (3)	no	no	yes
Controller Remote Software	yes	yes	yes
Modem for Remote Control	no	no	yes
Fused Main Switch	no	yes	yes

Notes

The RPC 8BGA regulator mounted on MULTImatic can be equipped with additional modules to communicate: RS 485 ModBus or Profinet, Ethernet, modem GSM/GPRS network.
(2): For better protection of power factor correction system against max THD, Max Temp, MULTImatic of FH20, FH30, FD25, FD25V, FD35 "detuned" families are equipped in standard with integrated MCP5 in the RPC 8BGA controller.
(3): The static switches replace the normal electromechanical contactors and allow the cos φ quick adjustment even in the presence of loads with sudden changes in absorption (welding machines, mixers, ovens, etc.).
(4): To be specified in the order.

Thyristor Switched Capacitor Banks

The MIDImatic and MULTImatic ranges can be made with thyristor switches. Compared to traditional power factor correction systems, enables obtaining interesting performances thank to the reaction speed of thyristors, (SCR) that control capacitors banks/steps.
By this solution the following performances are available:

- Switching speed: all the reactive power of the bank can be switched in about 60 ms. This is particularly suitable for plants characterized by fast changing loads (mixers, robots, welders) that could create problems to traditional electromechanic contactors used in standard power factor correction banks.
- Capacitor switching with minimization of the transient current peak.
- Particularly suitable for plants which power factor correction banks has to perform a great numbers of manoeuvres and in presence of devices sensitive to transient over voltage/currents.
- Silence: with no mechanical components on the move, the real time capacitor banks are really suitable for applications where the installation of the power factor correction switchboard occurs near places which require minimum noises (banks, data elaboration centres, theatres, cinemas, libraries, schools).
- Reduced maintenance: the lack of mechanical parts reduces the stress on the switchboard which therefore needs a little periodical maintenance compare to systems with traditional electromechanical contactors. This characteristic is really useful in rooms with conducting powder that could through the conductors into crises.

Power Factor Correction Tuned Filters

MINImatic and MULTImatic can be used for perform harmonic filtering. They are banks with reactance connected in series to the capacitors. The LC circuit made in this way, has a network resonant frequency that is different from the network frequency (50Hz) and depending on the electric values of the components used (resistance, capacity, inductance) are obtained "detuned" filters or "absorption" filters. These are preferable solutions for those plants characterized by the presence of harmonics due to distorting loads (lighting, power electronics, induction ovens, welders etc), for the reasons described below.

Blocking (detuned) filters

The detuned filters are designed to power factor correction of a system characterized by the presence of harmonics, "protecting" the capacitors that would be damaged. The addition of the filter does not change the system harmonic content: the harmonics will continue to flow without "enter" into power factor corrector. The blocking filters have a tuning frequency lower than that of the harmonic current that circulates in the system with lower order. Typically, the tuning frequency (f_N) is 180-190Hz, and the blocking filter is much more robust the lower the f_N. In systems with particularly high harmonic content, we realize blocking filters tuned to 135Hz and therefore particularly sound.

Absorption passive filters

Absorption filters are meant for plant power factor correction capacitors and, at the same time, totally or partially solve the problem of plant harmonics. The filter is tuned near the harmonic frequency to be eliminated, (for example 250Hz to eliminate the 5th harmonic) and, consequently, that current will almost completely flow in the filter, leaving the electric circuit "clean".
Usually the absorption filter is realized after a careful analysis of the circuit and a measurement campaign of the harmonics in order to come up with a solution really "ad hoc".

Power factor correction for high voltages systems (≥ 550V)

The power factor correction systems for applications in nominal voltages of 600/660/690V (eg. voltages used for mining, highway tunnels and rail cargoes on board ship, port cranes, steel mills, paper mills and other "heavy" applications) can be realized in different ways as follows.

Capacitors star connection

A widely used mode embodiment, but risky, provides a capacitors star connection (fig 1): in this way capacitors are subjected to a voltage equal to the nominal plant divided by $\sqrt{3}$.

- Advantages: you can then use capacitors smaller and cheaper, getting more compact and lightweight frameworks.
- Disadvantages: in case the capacity of the capacitors degradations, a phenomenon that is intended, however, to take place, the voltage across the capacitors of the star will no longer be balanced but will increase on the side with greater capacity degrades up to reach values higher than the rated voltage of the capacitors themselves. In this situation, the risk of overvoltage with possible consequent capacitors explosion/fire increases dramatically.

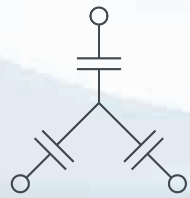


Fig 1: Capacitors star connection

Using capacitors at full rated voltage, delta-connected

This solution calls for the use of capacitors with a voltage rating at least equal to that of the network, as can be seen in Figure 2.

- Advantages: equipment electrically robust. Even in case of loss of capacity of a capacitor, the other does not suffer any consequences: you reset the malfunctions risks and capacitors damage.
- Disadvantages: cabinet bulkier and heavier, with higher costs.

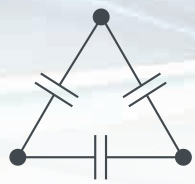


Fig 2: Capacitors delta connection

The ICAR way

ICAR APFC banks for working voltages higher than 550V are made with delta connected capacitors, and so they have a nominal voltage higher than the system network working voltage; this is the most sound and reliable solution. To improve power factor of 690V plants, ICAR uses 900V polypropylene or metallized paper capacitors.

Selection criteria depending on the type of plant

The choice of power factor correction equipment must be made by evaluating the design data of the system or, better yet, your electricity bills. The choice of the power factor correction type must be carried out according to the following table, which shows on the ordinate the rate of harmonic distortion of the plant current ($THDI_R$%) and in abscissa the ratio between the reactive power Q_C (in kvar) of the PFC bank and LV/MV transformer apparent power (kVA).

In light of these data, it identifies the box with proposed families, starting from the family that ensures the proper functioning with the best quality/price ratio.
So you choose the automatic power factor corrector series.
The fixed power factor correction must have the same electrical characteristics of the automatic.

The table was made starting from the following assumptions:

- Network voltage 400V
- Initial power factor of the plant 0.7 inductive
- Power factor target 0.95 inductive
- Non linear load with 5°-7° -11° -13° harmonics current

The hypotheses used are general and valid in the most of cases. In particular situations (harmonics coming from other branch of network, presence of rank equal to or a multiple of 3 harmonics) previous considerations may be invalid.
In these cases, the guarantee of a correct choice of the equipment occurs only as a result of a measurement campaign of harmonic analysis of the network and/or the appropriate calculations. ICAR disclaims any responsibility for incorrect choice of the product.

Automatic power factor correction systems 230vac rated voltage

THDI%> 27	HP10	FH20	FH20	FH20	FH20	FH20	FH20
20 <THDI%≤ 27	HP10	FH20	FH20	FH20	FH20	FH20	FH20
12 <THDI%≤ 20	HP10	FH20	FH20	HP10	HP10	FH20	FH20
THDI%≤ 12	HP10	HP10	HP10/FH20	HP10	HP10	FH20	FH20
	QC/AT≤0,05	**0,05<QC/AT≤0,1**	**0,1<QC/AT≤0,15**	**0,15<QC/AT≤0,2**	**0,2<QC/AT≤0,25**	**0,25<QC/AT≤0,3**	**QC/AT>0,3**
	QC/AT						

Automatic power factor correction systems 400vac rated voltage

THDI%> 27	HP30	FH20/FH30	FH20/FH30	FH20/FH30	FH20/FH30	FH20/FH30	FH20/FH30
20 <THDI%≤ 27	HP30	FH20/FH30	FH20/FH30	HP30	HP30/FH20	FH20/FH30	FH20/FH30
12 <THDI%≤ 20	HP30	FH20/FH30	FH20/FH30	HP30	HP30	FH20/FH30	FH20/FH30
THDI%≤ 12	HP30	HP30	HP30/FH20	HP30	HP30	HP30/H20	FH20/FH30
	QC/AT≤0,05	**0,05<QC/AT≤0,1**	**0,1<QC/AT≤0,15**	**0,15<QC/AT≤0,2**	**0,2<QC/AT≤0,25**	**0,25<QC/AT≤0,3**	**QC/AT>0,3**
	QC/AT						

Automatic power factor correction systems 440vac rated voltage

THDI%> 27	HP30	FH20	FH20	FH20	FH20	FH20	FH20
20 <THDI%≤ 27	HP30	FH20	FH20	HP30	HP30/FH20	FH20	FH20
12 <THDI%≤ 20	HP30	FH20	FH20	HP30	HP30	FH20	FH20
THDI%≤ 12	HP30	HP30	HP30/FH20	HP30	HP30	HP30/FH20	FH20
	QC/AT≤0,05	**0,05<QC/AT≤0,1**	**0,1<QC/AT≤0,15**	**0,15<QC/AT≤0,2**	**0,2<QC/AT≤0,25**	**0,25<QC/AT≤0,3**	**QC/AT>0,3**
	QC/AT						

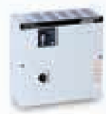
Automatic power factor correction systems 480vac rated voltage

THDI%> 27	HP30	FD00	FD00	FD00	FD00	FD00	FD00
20 <THDI%≤ 27	HP30	FD00	FD00	FD00	FD00	FD00	FD00
12 <THDI%≤ 20	HP30	FD00	FD00	FD00	FD00	FD00	FD00
THDI%≤ 12	HP30	HP30/FD00	FD00	HP30	HP30/FD00	FD00	FD00
	QC/AT≤0,05	**0,05<QC/AT≤0,1**	**0,1<QC/AT≤0,15**	**0,15<QC/AT≤0,2**	**0,2<QC/AT≤0,25**	**0,25<QC/AT≤0,3**	**QC/AT>0,3**
	QC/AT						

Standard power factor correction

The standard power factor correction is used in those plants where there are no current heavily deformed (verify the THD% data of the system current, which must be less than $THDI_R$% of the selected power factor correction family) or resonance problems (see the table selection criteria).

If the harmonics presence in the plant is not negligible, are preferred solutions with reinforced capacitors (i.e. with an higher nominal voltage than that of the network). In case of use in systems with heavy duty cycle, or in the case of installation in cabinets with high temperature, solutions with bimetallized papercapacitors are preferred.

			FIX	AUTOMATIC		
Capacitor construction techno-logy	**Range and Nominal values**		**MICRO fix 5÷50kvar**	**MICRO matic 10÷65kvar**	**MINI matic 70÷225kvar**	**MULTI matic from 130kvar**
Polypropylene standard	**SP20**	$THDI_R$%=7% $THDI_C$%=40% U_N=400V	✓			
Polypropylene standard	**RP20**	$THDI_R$%=20% $THDI_C$%=70% U_N=550V	✓			
High Energy Density Polypropylene	**HP10**	$THDI_R$%=20% $THDI_C$%=70% U_N=415V		✓	✓	✓
High Energy Density Polypropylene	**HP30**	$THDI_R$%=20% $THDI_C$%=70% U_N=550V			✓	✓
Metallized Paper	**TC40**	$THDI_R$%=15% $THDI_C$%=60% U_N=550V	✓		✓	✓

Power factor correction with blocking reactors

The power factor correction with blocking reactors (this solution is called in different ways in the technical literature such as “blocking filters", or "detuned filters", or "detuned power factor correctors", etc.) is a solution used when a current flows in the electric system with a high harmonic content (THD) and / or with the resonance risk with the MV/LV transformer. In these cases, the installation of a "normal" power factor corrector, devoid of blocking reactors, can cause the rapid degradation of the capacitors and cause dangerous electrical and mechanical stresses in the components of power plant (cables, busbars, switches, transformers).
Chokes protect the capacitors by harmonics and at the same time exclude the resonances risk; leave without sacrificing the harmonic content of the current system *.

* If you want to reduce the system harmonic content, you must install active or passive filters. Consult us.

This type of power factor correction is therefore to be preferred for systems with important non-linear loads (lighting not luminescent, power electronics, VSD, soft starters, induction furnaces, welding machines...).

ICAR offers two types of solutions with power factor correction with blocking reactors: one with 180Hz blocking frequency (detuned to 3.6 times the line frequency) and another one with 135Hz (2.7). It’s correct noting that the lower the tuning frequency is the more robust is the cabinet, because the reactor should have a larger iron core. ICAR power factor correction with blocking reactor, solutions are made with capacitors and inductors produced in the group; also are used only capacitors with rated voltage higher than that of the network, to ensure strength and durability counteracting the Ferranti effect (permanent overvoltage on the capacitor due to the blocking inductance).

AUTOMATIC

Capacitor construction technology	Range and Nominal values		MULTI matic from 75kvar
High Energy Density Polypropylene	**FH20**	$THDI_R\%<60\%$ $THDV\%<6\%$ $U_N=550V$ $f_N=216Hz$	✓
High Energy Density Polypropylene	**FH30**	$THDI_R\%>60\%$ $THDV\%<6\%$ $U_N=550V$ $f_N=162Hz$	✓
Metallized Paper	**FD40**	$THDI_R\%<60\%$ $THDV\%<6\%$ $U_N=660V$ $f_N=216Hz$	✓

Legend

On board capacitors technology:
- standard polypropylene
- high gradient polypropylene
- bimetallized paper

Equipment type

Capacitors type

Common technical specifications

Available solutions

Short description

Part numbers and detailed technical features, divided by family device size and cutting in kvar

Other available versions with the same type of capacitor. Refer to the general catalog, or contact your Regional Sales Office

AUTOMATIC POWER FACTOR CORRECTION SYSTEMS

HP10

Ue	U_N	U_{MAX}[1]	f	$THDI_R$%	$THDI_C$%[2]
230V	415V	455V	60 Hz	≤20%	≤70%

TECHNICAL CHARACTERISTICS:

Rated operational voltage	Ue=230V
Rated frequency	60Hz
Max current overload In (capacitors)	1,3xIn (continous)
Max voltage overload Vn (capacitors)	3 x UN (for 1 min.)
Max current overload In (bank)	1.3xIn
Max voltage overload Vn (bank)	1.1xUe
Insulating voltage (bank)	690V
Temperature range (capacitors)	-25/+55°C
Temperature range (bank)	-5/+40°C
Discharge device	on each bank
Use	indoor
Service	continous
Capacitors connection	delta
Operation devices	capacitors contactors (AC6b)
Total losses	~ 2W/kvar
Inner surface finish	zinc passivation
Standards (capacitors)	IEC 60831-1/2
Standards (bank)	IEC 61439-1/2, IEC 61921

GENERALITIES:
- Zink-passivated metallic enclosure painted with epossidic dust paint, colour RAL 7035.
- Auxiliary transformer to separate power and auxiliary circuit parts (110V).
- Load-break switch with door interlock designed at 1,495* I_n as per IEC 60831-1 art.34.
- Contactors with damping resistors to limit capacitors inrush current.
- N07V-K self-extinguish cable according to IEC 50267-2--1 standards.
- Microprocessor Power Factor Correction relay
- Single phase self-healing metallized polypropylene capacitor with U_N=415V rated voltage.

All components inside this products are compliant with EU Safety.

	CODE IP3X	POWER U_e=230V 60Hz (kvar)	STEP1 kvar U_e=230V 60Hz	STEP2 kvar	STEP3 kvar	STEP4 kvar	STEP5 kvar	STEP6 kvar	Regulator Type	L.B. SWITCH (A)	I_{cc} (kA)	Weight Kg	Dim. WxHxD (mm) IP3X
MICROmatic	IC0ABB150060652	5	0,75	1,5	3,0				RPC 5LGA	63	50	12	51
	IC0ABB175060652	7,5	1,5	3,0	3,0				RPC 5LGA	63	50	13	51
	IC0ABB180060652	8	0,75	1,5	3,0	3,0			RPC 5LGA	80	50	16	52
	IC0ABB210060652	10	1,5	3,0	6,0				RPC 5LGA	80	50	14	51
	IC0ABB211060652	11	0,75	1,5	3,0	6,0			RPC 5LGA	80	50	17	52
	IC0ABB213060652	13	1,5	3,0	3,0	6,0			RPC 5LGA	100	50	18	52
	IC0ABB214060652	14	0,75	1,5	3,0	3,0	6,0		RPC 5LGA	100	50	22	52
	IC0ABB217060652	17	1,5	3,0	6,0	6,0			RPC 5LGA	100	50	23	52
	IC0ABB220060652	20	1,5	3,0	6,0	9,0			RPC 5LGA	125	50	25	52
	IC0ABB223060652	23	1,5	3,0	6,0	12,0			RPC 5LGA	125	50	27	52
	IC0ABB227060652	27	3,0	6,0	6,0	12,0			RPC 5LGA	160	50	29	52

	CODE IP3X	POWER Ue=230V 60Hz (kvar)	STEP1 kvar	STEP2 kvar	STEP3 kvar	STEP4 kvar	STEP5 kvar	STEP6 kvar	Regulator Type	L.B. SWITCH (A)	I_{cc} (kA)	Weight Kg	Dim. IP3X
MINImatic	IF0ABB230060652	30	3	6	9	12			RPC 5LGA	250	9	41	55
	IF0ABB242060652	42	3	6	9	12	12		RPC 5LGA	250	9	47	56
	IF0ABB251060652	51	3	6	9	12	21		RPC 5LGA	400	9	51	56
	IF0ABB262060652	62	6	12	18	24			RPC 5LGA	400	9	54	56
	IF0ABB272060652	72	6	12	24	30			RPC 5LGA	400	9	60	57
	IF0ABB278060652	78	6	12	24	36			RPC 5LGA	500	9	65	57
	IF0ABB290060652	90	6	12	24	48			RPC 5LGA	500	9	69	57
	IF0ABB310260652	102	12	24	24	42			RPC 5LGA	400	9	74	58

	CODE IP4X	POWER U_e=230V 60Hz (kvar)	STEP1 kvar	STEP2 kvar	STEP3 kvar	STEP4 kvar	STEP5 kvar	STEP6 kvar	Regulator Type	L.B. SWITCH (A)	I_{cc} (kA)	Weight Kg	Dim. IP4X
MULTImatic	IN0ABB312060700	120	12	12	24	24	24	24	RPC 8BGA	800	50	300	72
	IN0ABB315060700	150	15	15	30	30	30	30	RPC 8BGA	1250	50	340	72
	IN0ABB318060700	180	18	18	36	36	36	36	RPC 8BGA	1250	50	360	72
	IN0ABB321060700	210	21	21	42	42	42	42	RPC 8BGA	1250	50	400	74
	IN0ABB324060700	240	24	24	48	48	48	48	RPC 8BGA	2x800	50	560	92
	IN0ABB327060700	270	27	27	54	54	54	54	RPC 8BGA	2x800	50	640	92
	IN0ABB330060700	300	30	30	60	60	60	60	RPC 8BGA	2x1250	50	660	92
	IN0ABB333060700	330	33	33	66	66	66	66	RPC 8BGA	2x1250	50	700	92
	IN0ABB336060700	360	36	36	72	72	72	72	RPC 8BGA	2x1250	50	720	92
	IN0ABB339060700	390	39	39	78	78	78	78	RPC 8BGA	2x1250	50	760	94
	IN0ABB342060700	420	42	42	84	84	84	84	RPC 8BGA	2x1250	50	800	94

Power factor correction solutions with standard or high gradient metallized polypropylene capacitors

	SP20	Fix Power Factor Correction Systems with standard polypropylene film and 400V nominal voltage capacitors
	RP20	Fix Power Factor Correction Systems with standard polypropylene film and 460V nominal voltage capacitors
	HP10	Automatic Power Factor Correction Systems with high energy density polypropylene film and 415V nominal voltage capacitors
	HP30	Automatic Power Factor Correction Systems with high energy density polypropylene film and 550V nominal voltage capacitors
	FH20	Automatic and fix detuned Power Factor Correction Systems with 180Hz detuned reactors and high energy density polypropylene film and 550V nominal voltage capacitors .
	FH30	Automatic detuned Power Factor Correction Systems with 135Hz detuned reactors and high energy density polypropylene film and 550V nominal voltage capacitors.

NB: see page 10 for standard and optional features.

CRM25

TECHNICAL CHARACTERISTICS:

Rated operational voltage	Ue=400-460-550V
Rated frequency	50Hz
Max current overload In	1,3 In
Max voltage overload Vn	1.1x
Insulating voltage	3/15kV - Ue≤660Vac
Temperature range	-25/+55°C
Capacitance tolerance	-5÷+10%
Terminal voltage test	2.15xU_N 10 sec.
Service	continous
Capacitors connection	polypropylene
Standards	IEC 60831-1/2

GENERALITIES:

- Metallic case with protection degree IP00 (other on request)
- Internal overpressure protection system
- Resin or oil impregnation

All parts inside these products are compliant with Safety Regulations.

Capacitors at frequency 50Hz used in PFC systems at 60Hz take account of the increase in frequency.

Range	Part number	Model	Rated Voltage U_N (V)	MAX Voltage U_{MAX} (V)	Power (kvar)	Capaci-tance (µF)	DIM (mm)	Weight (kg)	Pcs/box
SP20	CRMT166163400C0	**CRM25-11C-1.66-400**	400	**440**	1,66	**33,3**	55x128	**0,4**	36
	CRMT208163400B0	**CRM25-11B-2.08-400**	400	**440**	2,08	**41,3**	55x128	**0,4**	36
	CRMT333163400A0	**CRM25-11A-3.33-400**	400	**440**	3,33	**66,6**	60x138	**0,5**	36
	CRMT416163400A0	**CRM25-11A-4.16-400**	400	**440**	4,16	**82,7**	60x138	**0,5**	36
RP10	CRMM166163400B0	**CRM25-11B-1.66-460**	460	**500**	1,66	**25**	55x128	**0,4**	36
	CRMM333163400B0	**CRM25-11B-3.33-460**	460	**500**	3,33	**50**	60x138	**0,5**	36
	CRMM372163400B0	**CRM25-11B-3.72-460**	460	**500**	3,72	**56**	60x138	**0,5**	36
RP20	CRMR166163300A0	**CRM25-11A-1.66-550**	550	**600**	1,66	**17,5**	45x128	**0,3**	50
	CRMR333163400A0	**CRM25-11A-3.33-550**	550	**600**	3,33	**35**	60x138	**0,5**	36

CRM25

TECHNICAL CHARACTERISTICS:

Rated operational voltage	Ue=415-550V
Rated frequency	50Hz
Max current overload In	1,3 In (continous) 2 In (x 380s) 3 In (x150s) 4 In (x70s) 5 In (x45s)
Max voltage overload Vn	1.1x
Insulating voltage	3/15kV - Ue≤660Vac
Temperature range	-25/+55°C
Capacitance tolerance	-5÷+10%
Terminal voltage test	2.15xU_N 10 sec.
Service	continous
Capacitors connection	high gradient metallized polypropylene
Standards	IEC 60831-1/2

GENERALITIES:

- Metallic case with protection degree IP00
- Internal overpressure protection system
- Oil impregnation vacuum packed

All parts inside these products are compliant with Safety Regulations.

Capacitors at frequency 50Hz used in PFC systems at 60Hz take account of the increase in frequency.

Range	Part number	Model	Rated Voltage U_N (V)	MAX Voltage U_{MAX} (V)	Power (kvar)	Capaci-tance (µF)	DIM (mm)	Weight (kg)	Pcs/box
HP10	CRMK69006320SB0	**CRM-25-11A-0.69-415**	415	**456**	0,69	**12,2**	55x78	**0,25**	36
	CRMK13816320SB0	**CRM-25-11A-1.38-415**	415	**456**	1,38	**25,4**	55x78	**0,25**	36
	CRMK275163400A0	**CRM25-11A-2.75-415**	415	**456**	2,75	**50,8**	60x138	**0,5**	36
	CRMK550163400A0	**CRM25-11A-5.50-415**	415	**456**	5,5	**101,7**	60x138	**0,5**	36
HP30 FH20	CRMR13816320SB0	**CRM25-11A-1.38-550**	550	**600**	1,38	**14,5**	55x78	**0,25**	36
	CRMR275163400A0	**CRM25-11A-2.75-550**	550	**600**	2,75	**28,9**	60x138	**0,5**	36
	CRMR550163400A0	**CRM25-11A-5.50-550**	550	**600**	5,5	**57,9**	60x138	**0,5**	36

RP-SP

Ue	U_N	U_{MAX}[1]	f	$THDI_R\%$	$THDI_C\%$[2]
240V-400V-440V	400-550V	440-600V	60 Hz	≤7%	≤40%

MICROfix

TECHNICAL CHARACTERISTICS:

Rated operational voltage	Ue=240V-400V-440V
Rated frequency	60Hz
Max current overload In	1.3xIn
Max voltage overload Vn	1,1xUe
Insulating voltage (SUPERriphaso, Riphaso)	3/15kV - Ue≤660Vac
Insulating voltage (MICROfix)	690V
Temperature range (capacitor bank)	-5/+40°C
Temperature range (capacitors)	-25/+55°C
Discharge device	on each bank
Use	indoor
Service	continous
Capacitors connection	delta
Total losses	~ 2W/kvar
Inner surface finish (MICROfix)	zinc passivation
Applicable standards	IEC 61439-1/2, IEC 61921
Capacitors standards	IEC 60831-1/2

SP20

CODE IPX3	Power U_e=240V (kvar)	Seleziona-tore L.B. Switch (A)	I_{cc}[3]	Weight Kg	DIM IP3X	DIM IP55[4]
IB1AYY120060003	**2**	40	**80**	8	**41**	43
IB1AYY140060003	**4**	40	**80**	9	**41**	43
IB1AYY160060003	**6**	40	**80**	10	**41**	43
IB1AYY180060003	**8**	63	**80**	12	**41**	43
IB1AYY211060003	**11**	63	**80**	13	**41**	43
IB1AYY213060003	**13**	80	**80**	15	**41**	43
IB1AYY217060003	**17**	125	**80**	18	**42**	43
IB1AYY221060003	**21**	125	**80**	20	**42**	43
IB1AYY226060003	**26**	200	**80**	22	**42**	43

RP20

CODE IPX3	Power U_e=440V (kvar)	Seleziona-tore L.B. Switch (A)	I_{cc}[3]	Weight Kg	DIM IP3X	DIM IP55[4]
IB1NEE140060003	**4**	40	**80**	8	**41**	43
IB1NEE170060003	**7**	40	**80**	9	**41**	43
IB1NEE211060003	**11**	40	**80**	10	**41**	43
IB1NEE215060003	**15**	40	**80**	12	**41**	43
IB1NEE219060003	**19**	40	**80**	13	**41**	43
IB1NEE223060003	**23**	63	**80**	15	**41**	43
IB1NEE231060003	**31**	125	**80**	18	**42**	43
IB1NEE238060003	**38**	125	**80**	20	**42**	43
IB1NEE246060003	**46**	125	**80**	22	**42**	43

RP20

CODE IPX3	Power U_e=400V (kvar)	Seleziona-tore L.B. Switch (A)	I_{cc}[3]	Weight Kg	DIM IP3X	DIM IP55[4]
IB1NFF130060003	**3**	40	**80**	8	**41**	43
IB1NFF160060003	**6**	40	**80**	9	**41**	43
IB1NFF190060003	**9**	40	**80**	10	**41**	43
IB1NFF212060003	**12**	40	**80**	12	**41**	43
IB1NFF216060003	**16**	40	**80**	13	**41**	43
IB1NFF219060003	**19**	63	**80**	15	**41**	43
IB1NFF226060003	**26**	125	**80**	18	**42**	43
IB1NFF231060003	**31**	125	**80**	20	**42**	43
IB1NFF238060003	**38**	125	**80**	22	**42**	43

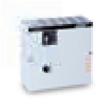
MICROfix: GENERALITIES

- Metallic enclosure internally and externally painted with epossidic dust paint, color RAL 7035.
- Load-break switch with door interlock, designed at 1,495 In according to IEC 60831-1 art.34.
- N07V-K self-extinguish cable according to IEC 50267-2-1 standards.
- IP 3X degree of protection
- Single phase self-healing metallized polypropylene capacitors with UN=400-550V rated voltage, capacitors equipped with discharge resistors
- Signal lamps power on

All components inside this products are compliant with EU Safety Regulations.

HP10

Ue	U_N	U_{MAX}[1]	f	$THDI_R$%	$THDI_C$%[2]
230V	415V	455V	60 Hz	≤20%	≤70%



MICRO matic

MINI matic

MULTI matic

GENERALITIES:

- Zink-passivated metallic enclosure painted with epossidic dust paint, colour RAL 7035.
- Auxiliary transformer to separate power and auxiliary circuit parts (110V).
- Load-break switch with door interlock designed at 1,495* I_n as per IEC 60831-1 art.34.
- Contactors with damping resistors to limit capacitors inrush current.
- N07V-K self-extinguish cable according to IEC 50267-2--1 standards.
- Microprocessor Power Factor Correction relay
- Single phase self-healing metallized polypropylene capacitor with U_N=415V rated voltage.

TECHNICAL CHARACTERISTICS:

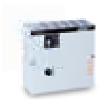
Rated operational voltage	Ue=230V
Rated frequency	60Hz
Max current overload In (capacitors)	1,3xIn (continous)
Max voltage overload Vn (capacitors)	3 x UN (for 1 min.)
Max current overload In (bank)	1.3xIn
Max voltage overload Vn (bank)	1.1xUe
Insulating voltage (bank)	690V
Temperature range (capacitors)	-25/+55°C
Temperature range (bank)	-5/+40°C
Discharge device	on each bank
Use	indoor
Service	continous
Capacitors connection	delta
Operation devices	capacitors contactors (AC6b)
Total losses	~ 2W/kvar
Inner surface finish	zinc passivation
Standards (capacitors)	IEC 60831-1/2
Standards (bank)	IEC 61439-1/2, IEC 61921

All components inside this products are compliant with EU Safety.

	CODE IP3X	POWER U_e=230V 60Hz (kvar)	STEP1 kvar U_e=230V 60Hz	STEP2 kvar	STEP3 kvar	STEP4 kvar	STEP5 kvar	STEP6 kvar	Regulator Type	L.B. SWITCH (A)	I_{cc} (kA)	Weight Kg	Dim. WxHxD (mm) IP3X
MICROmatic	IC0ABB150060652	5	0,75	1,5	3,0				RPC 5LGA	63	50	12	51
	IC0ABB175060652	7,5	1,5	3,0	3,0				RPC 5LGA	63	50	13	51
	IC0ABB180060652	8	0,75	1,5	3,0	3,0			RPC 5LGA	80	50	16	52
	IC0ABB210060652	10	1,5	3,0	6,0				RPC 5LGA	80	50	14	51
	IC0ABB211060652	11	0,75	1,5	3,0	6,0			RPC 5LGA	80	50	17	52
	IC0ABB213060652	13	1,5	3,0	3,0	6,0			RPC 5LGA	100	50	18	52
	IC0ABB214060652	14	0,75	1,5	3,0	3,0	6,0		RPC 5LGA	100	50	22	52
	IC0ABB217060652	17	1,5	3,0	6,0	6,0			RPC 5LGA	100	50	23	52
	IC0ABB220060652	20	1,5	3,0	6,0	9,0			RPC 5LGA	125	50	25	52
	IC0ABB223060652	23	1,5	3,0	6,0	12,0			RPC 5LGA	125	50	27	52
	IC0ABB227060652	27	3,0	6,0	6,0	12,0			RPC 5LGA	160	50	29	52
	CODE IP3X	**POWER Ue=230V 60Hz (kvar)**	**STEP1 kvar**	**STEP2 kvar**	**STEP3 kvar**	**STEP4 kvar**	**STEP5 kvar**	**STEP6 kvar**	**Regulator Type**	**L.B. SWITCH (A)**	**I_{cc} (kA)**	**Weight Kg**	**Dim. IP3X**
MINImatic	IF0ABB230060652	30	3	6	9	12			RPC 5LGA	250	9	41	55
	IF0ABB242060652	42	3	6	9	12	12		RPC 5LGA	250	9	47	56
	IF0ABB251060652	51	3	6	9	12	21		RPC 5LGA	400	9	51	56
	IF0ABB262060652	62	6	12	18	24			RPC 5LGA	400	9	54	56
	IF0ABB272060652	72	6	12	24	30			RPC 5LGA	400	9	60	57
	IF0ABB278060652	78	6	12	24	36			RPC 5LGA	500	9	65	57
	IF0ABB290060652	90	6	12	24	48			RPC 5LGA	500	9	69	57
	IF0ABB310260652	102	12	24	24	42			RPC 5LGA	400	9	74	58
	CODE IP4X	**POWER U_e=230V 60Hz (kvar)**	**STEP1 kvar**	**STEP2 kvar**	**STEP3 kvar**	**STEP4 kvar**	**STEP5 kvar**	**STEP6 kvar**	**Regulator Type**	**L.B. SWITCH (A)**	**I_{cc} (kA)**	**Weight Kg**	**Dim. IP4X**
MULTImatic	IN0ABB312060700	120	12	12	24	24	24	24	RPC 8BGA	800	50	300	72
	IN0ABB315060700	150	15	15	30	30	30	30	RPC 8BGA	1250	50	340	72
	IN0ABB318060700	180	18	18	36	36	36	36	RPC 8BGA	1250	50	360	72
	IN0ABB321060700	210	21	21	42	42	42	42	RPC 8BGA	1250	50	400	74
	IN0ABB324060700	240	24	24	48	48	48	48	RPC 8BGA	2x800	50	560	92
	IN0ABB327060700	270	27	27	54	54	54	54	RPC 8BGA	2x800	50	640	92
	IN0ABB330060700	300	30	30	60	60	60	60	RPC 8BGA	2x1250	50	660	92
	IN0ABB333060700	330	33	33	66	66	66	66	RPC 8BGA	2x1250	50	700	92
	IN0ABB336060700	360	36	36	72	72	72	72	RPC 8BGA	2x1250	50	720	92
	IN0ABB339060700	390	39	39	78	78	78	78	RPC 8BGA	2x1250	50	760	94
	IN0ABB342060700	420	42	42	84	84	84	84	RPC 8BGA	2x1250	50	800	94

HP30

Ue	U_N	U_{MAX}[1]	f	$THDI_R$%	THD_C%
400V	550V	600V	60 Hz	20%	70%



MICRO matic

MINI matic

MULTI matic

GENERALITIES:

- Zink-passivated metallic enclosure painted with epossidic dust paint, colour RAL 7035.
- Auxiliary transformer to separate power and auxiliary circuit parts (110V).
- Load-break switch with door interlock designed at 1,495* In as per IEC 60831-1 art.34.
- Contactors with damping resistors to limit capacitors' inrush current.
- N07V-K self-extinguish cable according to IEC 50267-2-1 standards.
- Microprocessor Power Factor Correction relay
- Single phase self-healing metallized polypropylene capacitor with UN=550V rated voltage.

All components inside this products are compliant with EU Safety Regulations.

TECHNICAL CHARACTERISTICS:

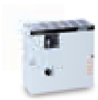
Rated operational voltage	Ue=400V
Rated frequency	60Hz
Max current overload In (capacitors)	1,3xIn (continous)
Max voltage overload Vn (capacitors)	3xUN (for 1 min.)
Max current overload In (bank)	1.3xIn
Max voltage overload Vn (bank)	1.1xUe
Insulating voltage (bank)	690V
Temperature range (capacitors)	-25/+55°C
Temperature range (bank)	-5/+40°C
Discharge device	on each bank
Use	indoor
Service	continous
Capacitors connection	delta
Operation devices	capacitors
Total losses	~ 2W/kvar
Inner surface finish	zinc passivation
Standards (capacitors)	IEC 60831-1/2
Standards (bank)	IEC 61439-1/2, IEC 61921

	CODE IP3X	POWER U_e=400V 60Hz (kvar)	STEP1 kvar	STEP2 kvar	STEP3 kvar	STEP4 kvar	STEP5 kvar	STEP6 kvar	Regulator Type	L.B. SWITCH (A)	I_{cc} (kA)	Weight Kg	Dim. IP3X
MICROmatic	IC0TFF190060652	9	1,3	2,5	5				RPC 5LGA	63	9	12	55
	IC0TFF213060652	13	2,5	5	5				RPC 5LGA	63	9	13	56
	IC0TFF214060652	14	1,3	2,5	5	5			RPC 5LGA	80	9	16	56
	IC0TFF218060652	18	2,5	5	10				RPC 5LGA	80	9	14	56
	IC0TFF219060652	19	1,3	2,5	5	10			RPC 5LGA	80	9	17	57
	IC0TFF223060652	23	2,5	5	5	10			RPC 5LGA	100	9	18	57
	IC0TFF224060652	24	1,3	2,5	5	5	10		RPC 5LGA	100	9	22	57
	IC0TFF228060652	28	2,5	5	10	10			RPC 5LGA	100	9	23	58
	IC0TFF233060652	33	2,5	5	10	15			RPC 5LGA	125	9	25	58
	IC0TFF238060652	38	2,5	5	10	20			RPC 5LGA	125	10	27	58
	IC0TFF245060652	45	5	10	10	20			RPC 5LGA	160	11	29	58
MINImatic	IF0TFF250060652	50	5	10	15	20			RPC 5LGA	125	9	41	55
	IF0TFF270060652	70	5	10	15	20	20		RPC 5LGA	125	9	47	56
	IF0TFF285060652	85	5	10	15	20	35		RPC 5LGA	250	9	51	56
	IF0TFF310060652	100	10	20	30	40			RPC 5LGA	250	9	54	56
	IF0TFF312060652	120	10	20	40	50			RPC 5LGA	250	9	60	57
	IF0TFF313560652	135	10	20	40	65			RPC 5LGA	400	9	65	57
	IF0TFF315060652	150	10	20	40	80			RPC 5LGA	400	9	69	57
	IF0TFF317060652	170	20	40	40	70			RPC 5LGA	400	9	78	58
	IF0TFF320060652	200	20	40	60	80			RPC 5LGA	400	9	88	58

	CODE IP4X	POWER U_e=400V 60Hz (kvar)	STEP1 kvar	STEP2 kvar	STEP3 kvar	STEP4 kvar	STEP5 kvar	STEP6 kvar	Regulator Type	L.B. SWITCH (A)	I_{cc} (kA)	Weight Kg	Dim. IP4X
MULTImatic	IN2DFF315060700	150	15	15	30	30	30	30	RPC 8BGA	400	25	178	72
	IN2DFF320060700	200	20	20	40	40	40	40	RPC 8BGA	400	25	190	72
	IN2DFF325060700	250	25	25	50	50	50	50	RPC 8BGA	630	25	212	72
	IN2DFF330060700	300	30	30	60	60	60	60	RPC 8BGA	800	50	252	72
	IN2DFF335060700	350	35	35	70	70	70	70	RPC 8BGA	800	50	274	74
	IN2DFF340060700	400	40	40	80	80	80	80	RPC 8BGA	1250	50	300	74
	IN2DFF345060700	450	45	45	90	90	90	90	RPC 8BGA	1250	50	320	70
	IN2DFF350060700	500	50	50	100	100	100	100	RPC 8BGA	1250	50	340	70
	IN2DFF355060700	550	55	55	110	110	110	110	RPC 8BGA	2x630	25	360	92
	IN2DFF360060700	600	60	60	120	120	120	120	RPC 8BGA	2x800	50	400	92
	IN2DFF365060700	650	65	65	130	130	130	130	RPC 8BGA	2x800	50	440	94
	IN2DFF370060700	700	70	70	140	140	140	140	RPC 8BGA	2x800	50	480	94
	IN2DFF375060700	750	75	75	150	150	150	150	RPC 8BGA	2x800	50	620	94
	IN2DFF380060700	800	80	80	160	160	160	160	RPC 8BGA	2x1250	50	640	94
	IN2DFF385060700	850	85	85	170	170	170	170	RPC 8BGA	2x1250	50	660	90
	IN2DFF390060700	900	90	90	180	180	180	180	RPC 8BGA	2x1250	50	680	90
	IN2DFF395060700	950	95	95	190	190	190	190	RPC 8BGA	2x1250	50	705	90
	IN2DFF410060700	1000	100	100	200	200	200	200	RPC 8BGA	2x1250	50	730	90
	IN2DFF410560700	1050	105	105	210	210	210	210	RPC 8BGA	2x1250	50	755	91
	IN2DFF411060700	1100	110	110	220	220	220	220	RPC 8BGA	2x1250	50	780	91

HP30

Ue	U_N	U_{MAX}[1]	f	$THDI_R$%	THD_C%
440V	550V	600V	60 Hz	20%	70%



MICRO matic

MINI matic

MULTI matic

GENERALITIES:

- Zink-passivated metallic enclosure painted with epossidic dust paint, colour RAL 7035.
- Auxiliary transformer to separate power and auxiliary circuit parts (110V).
- Load-break switch with door interlock designed at 1,495* In as per IEC 60831-1 art.34.
- Contactors with damping resistors to limit capacitors' inrush current.
- N07V-K self-extinguish cable according to IEC 50267-2-1 standards.
- Microprocessor Power Factor Correction relay
- Single phase self-healing metallized polypropylene capacitor with UN=550V rated voltage.

All components inside this products are compliant with EU Safety Regulations.

TECHNICAL CHARACTERISTICS:

Rated operational voltage	Ue=440V
Rated frequency	60Hz
Max current overload In (capacitors)	1,3xIn (continous)
Max voltage overload Vn (capacitors)	3xUN (for 1 min.)
Max current overload In (bank)	1.3xIn
Max voltage overload Vn (bank)	1.1xUe
Insulating voltage (bank)	690V
Temperature range (capacitors)	-25/+55°C
Temperature range (bank)	-5/+40°C
Discharge device	on each bank
Use	indoor
Service	continous
Capacitors connection	delta
Operation devices	capacitors
Total losses	~ 2W/kvar
Inner surface finish	zinc passivation
Standards (capacitors)	IEC 60831-1/2
Standards (bank)	IEC 61439-1/2, IEC 61921

	CODE IP3X	POWER U_e=440V 60Hz (kvar)	STEP1 kvar	STEP2 kvar	STEP3 kvar	STEP4 kvar	STEP5 kvar	STEP6 kvar	Regulator Type	L.B. SWITCH (A)	I_{cc} (kA)	Weight Kg	Dim. IP3X
MICROmatic	IC0TEE211060652	**11**	1,5	**3**	6				RPC 5LGA	**63**	9	**12**	51
	IC0TEE215060652	**15**	3	**6**	6				RPC 5LGA	**63**	9	**13**	51
	IC0TEE217060652	**17**	1,5	**3**	6	**6**			RPC 5LGA	**80**	9	**16**	52
	IC0TEE221060652	**21**	3	**6**	12				RPC 5LGA	**80**	9	**14**	51
	IC0TEE223060652	**23**	1,5	**3**	6	**12**			RPC 5LGA	**80**	9	**17**	52
	IC0TEE227060652	**27**	3	**6**	6	**12**			RPC 5LGA	**100**	9	**18**	52
	IC0TEE229060652	**29**	1,5	**3**	6	**6**	12		RPC 5LGA	**100**	9	**22**	52
	IC0TEE233060652	**33**	3	**6**	12	**12**			RPC 5LGA	**100**	9	**23**	52
	IC0TEE239060652	**39**	3	**6**	12	**18**			RPC 5LGA	**125**	9	**25**	52
	IC0TEE245060652	**45**	3	**6**	12	**24**			RPC 5LGA	**125**	10	**27**	52
	IC0TEE254060652	**54**	6	**12**	12	**24**			RPC 5LGA	**160**	11	29	52
MINImatic	IF0TEE265060652	**65**	6,5	**13**	19,5	**26**			RPC 5LGA	**125**	9	**41**	55
	IF0TEE291060652	**91**	6,5	**13**	19,5	**26**	26		RPC 5LGA	**125**	9	**47**	56
	IF0TEE311160652	**111**	6,5	**13**	19,5	**26**	46		RPC 5LGA	**250**	9	**51**	56
	IF0TEE313060652	**130**	13	**26**	39	**52**			RPC 5LGA	**250**	9	**54**	56
	IF0TEE315660652	**156**	13	**26**	52	**65**			RPC 5LGA	**250**	9	**60**	57
	IF0TEE317660652	**176**	13	**26**	52	**85**			RPC 5LGA	**400**	9	**65**	57
	IF0TEE319560652	**195**	13	**26**	52	**104**			RPC 5LGA	**400**	9	**69**	57
	IF0TEE321160652	**221**	26	**52**	52	**91**			RPC 5LGA	**500**	9	**78**	58

	CODE IP4X	POWER U_e=440V 60Hz (kvar)	STEP1 kvar	STEP2 kvar	STEP3 kvar	STEP4 kvar	STEP5 kvar	STEP6 kvar	Regulator Type	L.B. SWITCH (A)	I_{cc} (kA)	Weight Kg	Dim. IP4X
MULTImatic	IN2DEE312560700	**125**	13	**13**	25	**25**	25	**25**	RPC 8BGA	**250**	17	**178**	72
	IN2DEE318860700	**188**	19	**19**	38	**38**	38	**38**	RPC 8BGA	**400**	25	**190**	72
	IN2DEE325060700	**250**	25	**25**	50	**50**	50	**50**	RPC 8BGA	**630**	25	**212**	72
	IN2DEE331360700	**313**	31	**31**	62	**62**	62	**62**	RPC 8BGA	**630**	25	**252**	72
	IN2DEE337560700	**375**	38	**38**	75	**75**	75	**75**	RPC 8BGA	**800**	50	**274**	72
	IN2DEE343860700	**438**	44	**44**	88	**88**	88	**88**	RPC 8BGA	**1250**	50	**300**	74
	IN2DEE350060700	**500**	50	**50**	100	**100**	100	**100**	RPC 8BGA	**1250**	50	**320**	74
	IN2DEE356360700	**563**	56	**56**	112	**112**	112	**112**	RPC 8BGA	**1250**	50	**340**	70
	IN2DEE362560700	**625**	63	**63**	125	**125**	125	**125**	RPC 8BGA	**1250**	50	**360**	70
	IN2DEE368860700	**688**	69	**69**	138	**138**	138	**138**	RPC 8BGA	**2x630**	25	**400**	92
	IN2DEE375060700	**750**	75	**75**	150	**150**	150	**150**	RPC 8BGA	**2x800**	50	**440**	92
	IN2DEE381360700	**813**	81	**81**	162	**162**	162	**162**	RPC 8BGA	**2x800**	50	**480**	94

HP30

U_e	U_N	U_{MAX}[1]	f	$THDI_R$%	THD_C%
480V	550V	600V	60 Hz	10%	50%

MULTI
matic

TECHNICAL CHARACTERISTICS:

Rated operational voltage	Ue=480V
Rated frequency	60Hz
Max current overload In (capacitors)	1,3xIn (continous)
Max voltage overload Vn (capacitors)	3xUN (for 1 min.)
Max current overload In (bank)	1.3xIn
Max voltage overload Vn (bank)	1.1xUe
Insulating voltage (bank)	690V
Temperature range (capacitors)	-25/+55°C
Temperature range (bank)	-5/+40°C
Discharge device	on each bank
Use	indoor
Service	continous
Capacitors connection	delta
Operation devices	capacitors
Total losses	~ 2W/kvar
Inner surface finish	zinc passivation
Standards (capacitors)	IEC 60831-1/2
Standards (bank)	IEC 61439-1/2, IEC 61921

GENERALITIES:

- Zink-passivated metallic enclosure painted with epossidic dust paint, colour RAL 7035.
- Auxiliary transformer to separate power and auxiliary circuit parts (110V).
- Load-break switch with door interlock designed at 1,495* In as per IEC 60831-1 art.34.
- Contactors with damping resistors to limit capacitors' inrush current.
- N07V-K self-extinguish cable according to IEC 50267-2-1 standards.
- Microprocessor Power Factor Correction relay
- Single phase self-healing metallized polypropylene capacitor with UN=550V rated voltage.

All components inside this products are compliant with EU Safety Regulations.

MULTImatic

CODE IP4X	POWER U_e=480V 60Hz (kvar)	STEP1 kvar U_e=480V 60Hz (kvar)	STEP2 kvar U_e=480V 60Hz (kvar)	STEP3 kvar U_e=480V 60Hz (kvar)	STEP4 kvar U_e=480V 60Hz (kvar)	STEP5 kvar U_e=480V 60Hz (kvar)	STEP6 kvar U_e=480V 60Hz (kvar)	Regulator Type	L.B. SWITCH (A)	I_{cc} (kA)	Weight Kg	Dim. IP4X
IN2DGG275060700	**75**	7,5	**7,5**	15	**15**	15	**15**	RPC 8BGA	**250**	17	**187**	72
IN2DGG315060700	**150**	15	**15**	30	**30**	30	**30**	RPC 8BGA	**400**	25	**222**	72
IN2DGG322560700	**225**	23	**23**	45	**45**	45	**45**	RPC 8BGA	**400**	25	**252**	72
IN2DGG330060700	**300**	30	**30**	60	**60**	60	**60**	RPC 8BGA	**630**	25	**274**	72
IN2DGG337560700	**375**	38	**38**	76	**76**	76	**76**	RPC 8BGA	**800**	50	**300**	72
IN2DGG345060700	**450**	45	**45**	90	**90**	90	**90**	RPC 8BGA	**800**	50	**320**	72
IN2DGG352560700	**525**	53	**53**	105	**105**	105	**105**	RPC 8BGA	**1250**	50	**340**	74
IN2DGG360060700	**600**	60	**60**	120	**120**	120	**120**	RPC 8BGA	**2x630**	25	**360**	92
IN2DGG367560700	**675**	68	**68**	135	**135**	135	**135**	RPC 8BGA	**2x630**	25	**400**	92
IN2DGG375060700	**750**	75	**75**	150	**150**	150	**150**	RPC 8BGA	**2x800**	50	**440**	92
IN2DGG382560700	**825**	83	**83**	165	**165**	165	**165**	RPC 8BGA	**2x800**	50	**480**	92
IN2DGG390060700	**900**	90	**90**	180	**180**	180	**180**	RPC 8BGA	**2x800**	50	**620**	92
IN2DGG397560700	**975**	98	**98**	195	**195**	195	**195**	RPC 8BGA	**2x1250**	50	**640**	94

FH20

Ue	U_N	U_{MAX}[1]	f	$THDI_R$%	f_N	THD_V%
230V	415V	455V	60 Hz	≤60%	216 Hz	≤6%

100% NON LINEAR LOAD IN NETWORK

MULTI
matic

GENERALITIES:

- Zink-passivated metallic enclosure painted with epossidic dust paint, colour RAL 7035.
- Auxiliary transformer to separate power and auxiliary circuit parts (110V).
- Load-break switch with door interlock designed at 1,495* In as per IEC 60831-1 art.34.
- Contactors.
- N07V-K self-extinguish cable according to IEC 50267-2-1 standards.
- Microprocessor Power Factor Correction relay
- Single phase self-healing metallized polypropylene capacitor with UN=415V rated voltage

All components inside this products are compliant with EU Safety Regulations.

TECHNICAL CHARACTERISTICS:

Rated operational voltage	Ue=230V
Rated frequency	60Hz
Max current overload In (capacitors)	1,3xIn (continous)
Max voltage overload Vn (capacitors)	3xUN (for 1 min.)
Max current overload In (bank)	1.3xIn
Max voltage overload Vn (bank)	1.1xUe
Insulating voltage (bank)	690V
Temperature range (capacitors)	-25/+55°C
Temperature range (bank)	-5/+40°C
Discharge device	on each bank
Use	indoor
Service	continous
Capacitors connection	delta
Operation devices	capacitors
Total Joule losses	~ 6W/kvar
Inner surface finish	zinc passivation
Standards (capacitors)	IEC 60831-1/2
Standards (bank)	IEC 61439-1/2, IEC 61921

MULTImatic

CODE IP4X	POWER U_e=230V 60Hz (kvar)	STEP1 kvar	STEP2 kvar	STEP3 kvar	STEP4 kvar	STEP5 kvar	STEP6 kvar	Regulator Type	L.B. SWITCH (A)	I_{cc} (kA)	Weight Kg	Dim. IP4X
IN7ABB288060701	88	12,5	25	50				RPC 8BGA	400	25	250	72
IN7ABB313860701	138	12,5	25	50	50			RPC 8BGA	630	25	315	72
IN7ABB318860701	188	12,5	25	50	50	50		RPC 8BGA	800	50	380	74
IN7ABB323860701	238	12,5	25	50	50	50	50	RPC 8BGA	1250	50	460	70
IN7ABB328860701	288	12,5	25	50	50	50	100	RPC 8BGA	1250	50	520	71
IN7ABB335060701	350	25	25	50	50	100	100	RPC 8BGA	2x800	50	740	94
IN7ABB340060701	400	50	50	100	100	100		RPC 8BGA	2x800	50	800	94
IN7ABB345060701	450	50	100	100	100	100		RPC 8BGA	2x1250	50	860	90
IN7ABB350060701	500	50	50	100	100	100	100	RPC 8BGA	2x1250	50	920	90
IN7ABB355060701	550	50	100	100	100	100	100	RPC 8BGA	2x1250	50	980	91
IN7ABB360060701	600	50	50	100	100	100	200	RPC 8BGA	2x1250	50	1040	91

FH20

Ue	U_N	U_{MAX}[1]	f	$THDI_R$%	f_N	THD_V%
400V	550V	600V	60 Hz	≤60%	216 Hz	≤6%

100% NON LINEAR LOAD IN NETWORK

MULTI
matic

TECHNICAL CHARACTERISTICS:

Rated operational voltage	Ue=400V
Rated frequency	60Hz
Max current overload In (capacitors)	1,3xIn (continous)
Max voltage overload Vn (capacitors)	3xUN (for 1 min.)
Max current overload In (bank)	1.3xIn
Max voltage overload Vn (bank)	1.1xUe
Insulating voltage (bank)	690V
Temperature range (capacitors)	-25/+55°C
Temperature range (bank)	-5/+40°C
Discharge device	on each bank
Use	indoor
Service	continous
Capacitors connection	delta
Operation devices	capacitors
Total losses	~ 6W/kvar
Inner surface finish	zinc passivation
Standards (capacitors)	IEC 60831-1/2
Standards (bank)	IEC 61439-1/2, IEC 61921

GENERALITIES:

- Zink-passivated metallic enclosure painted with epossidic dust paint, colour RAL 7035.
- Auxiliary transformer to separate power and auxiliary circuit parts (110V).
- Load-break switch with door interlock designed at 1,495* In as per IEC 60831-1 art.34.
- Contactors.
- N07V-K self-extinguish cable according to Il standards.
- Microprocessor Power Factor Correction relay
- Single phase self-healing metallized polypropylene capacitor with UN=550V rated voltage.

All components inside this products are compliant with EU Safety Regulations.

MULTImatic

CODE IP4X	POWER U_e=400V 60Hz (kvar)	STEP1 kvar	STEP2 kvar	STEP3 kvar	STEP4 kvar	STEP5 kvar	STEP6 kvar	Regulator Type	L.B. SWITCH (A)	I_{cc} (kA)	Weight Kg	Dim. IP4X
IN7AFF275060701	**75**	15	**30**	30				RPC 8BGA	**250**	17	**220**	72
IN7AFF310560701	**105**	15	**30**	60				RPC 8BGA	**250**	17	**260**	72
IN7AFF313560701	**135**	15	**30**	30	**60**			RPC 8BGA	**400**	25	**300**	72
IN7AFF316560701	**165**	15	**30**	60	**60**			RPC 8BGA	**400**	25	**325**	72
IN7AFF319560701	**195**	15	**30**	30	**60**	60		RPC 8BGA	**400**	25	**365**	74
IN7AFF322560701	**225**	15	**30**	60	**60**	60		RPC 8BGA	**630**	25	**385**	74
IN7AFF325560701	**255**	15	**30**	30	**60**	60	**60**	RPC 8BGA	**630**	25	**415**	70
IN7AFF328560701	**285**	15	**30**	60	**60**	60	**60**	RPC 8BGA	**630**	25	**445**	70
IN7AFF331560701	**315**	15	**30**	30	**60**	60	**120**	RPC 8BGA	**800**	50	**475**	71
IN7AFF334560701	**345**	15	**30**	60	**60**	60	**120**	RPC 8BGA	**800**	50	**505**	71
IN7AFF337560701	**375**	15	**30**	30	**60**	120	**120**	RPC 8BGA	**2x400**	25	**775**	94
IN7AFF342060701	**420**	60	**120**	120	**120**			RPC 8BGA	**2x630**	25	**800**	94
IN7AFF348060701	**480**	60	**60**	120	**120**	120		RPC 8BGA	**2x630**	25	**860**	94
IN7AFF354060701	**540**	60	**120**	120	**120**	120		RPC 8BGA	**2x800**	50	**920**	90
IN7AFF360060701	**600**	60	**60**	120	**120**	120	**120**	RPC 8BGA	**2x800**	50	**980**	90
IN7AFF366060701	**660**	60	**120**	120	**120**	120	**120**	RPC 8BGA	**2x800**	50	**1040**	91
IN7AFF372060701	**720**	60	**60**	120	**120**	120	**240**	RPC 8BGA	**2x800**	50	**1100**	91

FH20

Ue	U_N	U_{MAX}[1]	f	$THDI_R$%	f_N	THD_V%
440V	550V	600V	60 Hz	≤60%	216 Hz	≤6%

100% NON LINEAR LOAD IN NETWORK

MULTI
matic

GENERALITIES:

- Zink-passivated metallic enclosure painted with epossidic dust paint, colour RAL 7035.
- Auxiliary transformer to separate power and auxiliary circuit parts (110V).
- Load-break switch with door interlock designed at 1,495* In as per IEC 60831-1 art.34.
- Contactors.
- N07V-K self-extinguish cable according to IEC 50267-2-1 standards.
- Microprocessor Power Factor Correction relay
- Single phase self-healing metallized polypropylene capacitor with UN=550V rated voltage

All components inside this products are compliant with EU Safety Regulations.

TECHNICAL CHARACTERISTICS:

Rated operational voltage	Ue=440V
Rated frequency	60Hz
Max current overload In (capacitors)	1,3xIn (continous)
Max voltage overload Vn (capacitors)	3xUN (for 1 min.)
Max current overload In (bank)	1.3xIn
Max voltage overload Vn (bank)	1.1xUe
Insulating voltage (bank)	690V
Temperature range (capacitors)	-25/+55°C
Temperature range (bank)	-5/+40°C
Discharge device	on each bank
Use	indoor
Service	continous
Capacitors connection	delta
Operation devices	capacitors
Total losses	~ 6W/kvar
Inner surface finish	zinc passivation
Standards (capacitors)	IEC 60831-1/2
Standards (bank)	IEC 61439-1/2, IEC 61921

MULTImatic

CODE IP4X	POWER U_e=440V 60Hz (kvar)	STEP1 kvar	STEP2 kvar	STEP3 kvar	STEP4 kvar	STEP5 kvar	STEP6 kvar	Regulator Type	L.B. SWITCH (A)	I_{cc} (kA)	Weight Kg	Dim. IP4X
IN7AEE312660701	**90**	18	**36**	36				RPC 8BGA	**250**	17	**220**	72
IN7AEE312660701	**126**	18	**36**	72				RPC 8BGA	**250**	17	**260**	72
IN7AEE316260701	**162**	18	**36**	36	**72**			RPC 8BGA	**400**	25	**300**	72
IN7AEE319860701	**198**	18	**36**	72	**72**			RPC 8BGA	**400**	25	**325**	72
IN7AEE323460701	**234**	18	**36**	36	**72**	72		RPC 8BGA	**400**	25	**365**	74
IN7AEE327060701	**270**	18	**36**	72	**72**	72		RPC 8BGA	**630**	25	**385**	74
IN7AEE330660701	**306**	18	**36**	36	**72**	72	**72**	RPC 8BGA	**630**	25	**415**	70
IN7AEE334260701	**342**	18	**36**	72	**72**	72	**72**	RPC 8BGA	**630**	25	**445**	70
IN7AEE337860701	**378**	18	**36**	36	**72**	72	**144**	RPC 8BGA	**800**	50	**475**	71
IN7AEE341460701	**414**	18	**36**	72	**72**	72	**144**	RPC 8BGA	**800**	50	**505**	71
IN7AEE345060701	**450**	18	**36**	36	**72**	144	**144**	RPC 8BGA	**2x400**	25	**775**	94
IN7AEE350460701	**504**	72	**144**	144	**144**			RPC 8BGA	**2x630**	25	**800**	94
IN7AEE357660701	**576**	72	**72**	144	**144**	144		RPC 8BGA	**2x630**	25	**860**	94
IN7AEE364860701	**648**	72	**144**	144	**144**	144		RPC 8BGA	**2x800**	50	**920**	90
IN7AEE372060701	**720**	72	**72**	144	**144**	144	**144**	RPC 8BGA	**2x800**	50	**980**	90
IN7AEE379260701	**792**	72	**144**	144	**144**	144	**144**	RPC 8BGA	**2x800**	50	**1040**	91
IN7AEE386460701	**864**	72	**72**	144	**144**	144	**288**	RPC 8BGA	**2x800**	50	**1100**	91

1. Maximum allowed value according to CEI EN 60831-1 art. 20.1

FH30

Ue	U_N	U_{MAX}[1]	f	$THDI_R$%	f_N	THD_V%
400V	550V	600V	60 Hz	>60%	162 Hz	≤6%

100% NON LINEAR LOAD IN NETWORK

MULTI
matic

TECHNICAL CHARACTERISTICS:

Rated operational voltage	Ue=400V
Rated frequency	60Hz
Max current overload In (capacitors)	1,3xIn (continous)
Max voltage overload Vn (capacitors)	3xUN (for 1 min.)
Max current overload In (bank)	1.3xIn
Max voltage overload Vn (bank)	1.1xUe
Insulating voltage (bank)	690V
Temperature range (capacitors)	-25/+55°C
Temperature range (bank)	-5/+40°C
Discharge device	on each bank
Use	indoor
Service	continous
Capacitors connection	delta
Operation devices	capacitors
Total Joule losses	~ 8W/kvar
Inner surface finish	zinc passivation
Standards (capacitors)	IEC 60831-1/2
Standards (bank)	IEC 61439-1/2, IEC 61921

GENERALITIES:

- Zink-passivated metallic enclosure painted with epossidic dust paint, colour RAL 7035.
- Auxiliary transformer to separate power and auxiliary circuit parts (110V).
- Load-break switch with door interlock designed at 1,495* In as per IEC 60831-1 art.34.
- Contactors.
- N07V-K self-extinguish cable according to IEC 50267-2-1standards.
- Microprocessor Power Factor Correction relay
- Single phase self-healing metallized polypropylene capacitor with UN=550V rated voltage

All components inside this products are compliant with EU Safety Regulations.

MULTImatic FH30

CODE IP4X	POWER U_e=400V 60Hz (kvar)	STEP1 kvar	STEP2 kvar	STEP3 kvar	STEP4 kvar	STEP5 kvar	STEP6 kvar	Regulator Type	L.B. SWITCH (A)	I_{cc} (kA)	Weight Kg	Dim. IP4X
IN7JFF281060702	**81**	16	**32,5**	32,5				RPC 8BGA	**250**	17	**220**	72
IN7JFF311460702	**114**	16	**32,5**	65				RPC 8BGA	**250**	17	**260**	72
IN7JFF314660702	**146**	16	**32,5**	32,5	**65**			RPC 8BGA	**400**	25	**300**	72
IN7JFF317960702	**179**	16	**32,5**	65	**65**			RPC 8BGA	**400**	25	**325**	72
IN7JFF321160702	**211**	16	**32,5**	32,5	**65**	65		RPC 8BGA	**630**	25	**365**	74
IN7JFF324460702	**244**	16	**32,5**	65	**65**	65		RPC 8BGA	**630**	25	**385**	74
IN7JFF327660702	**276**	16	**32,5**	32,5	**65**	65	**65**	RPC 8BGA	**630**	25	**415**	70
IN7JFF330960702	**309**	16	**32,5**	65	**65**	65	**65**	RPC 8BGA	**800**	50	**445**	70
IN7JFF334160702	**341**	16	**32,5**	32,5	**65**	65	**130**	RPC 8BGA	**800**	50	**475**	71
IN7JFF337460702	**374**	16	**32,5**	65	**65**	65	**130**	RPC 8BGA	**800**	50	**505**	71
IN7JFF340660702	**406**	16	**32,5**	32,5	**65**	130	**130**	RPC 8BGA	**2x630**	25	**775**	94
IN7JFF345560702	**455**	65	**130**	130	**130**			RPC 8BGA	**2x630**	25	**800**	94
IN7JFF352060702	**520**	65	**65**	130	**130**	130		RPC 8BGA	**2x630**	25	**860**	94
IN7JFF358560702	**585**	65	**130**	130	**130**	130		RPC 8BGA	**2x800**	50	**920**	90
IN7JFF365060702	**650**	65	**65**	130	**130**	130	**130**	RPC 8BGA	**2x800**	50	**980**	90
IN7JFF371560702	**715**	65	**130**	130	**130**	130	**130**	RPC 8BGA	**2x800**	50	**1040**	91
IN7JFF378060702	**780**	65	**65**	130	**130**	130	**260**	RPC 8BGA	**2x800**	50	**1100**	91

1. Maximum allowed value according to CEI EN 60831-1 art. 20.1

CHAPTER 4

Power factor correction solutions with metallized paper capacitors

In this chapter you will find the following ranges

	TC40	Fix Power Factor Correction Systems with metallized paper and 480V nominal voltage capacitors
	FD40	Automatic Power Factor Correction Systems with detuning chokes and bimetallized paper capacitors.

CRM25

TECHNICAL CHARACTERISTICS:

Rated operational voltage	Ue=400-460-550V
Rated frequency	50Hz
Max current overload In	3xIn (continous)
Max voltage overload Vn	1.1xUN
Insulating voltage	3/15kV - Ue≤660Vac
Temperature range	-25/+85°C
Capacitance tolerance	-5÷+10%
Terminal voltage test	2.15xU_N 10 sec
Service	continous
Capacitors connection	metallized paper
Standards	IEC 60831-1/2

GENERALITIES:

- Metallic case with protection degree IP00
- Internal overpressure protection system
- Oil impregnation vacuum packed.

All components inside this products are compliant with EU Safety Regulations.

Range	Part number	Model	Rated Voltage U_N (V)	Max. Voltage U_{MAX} (V)	Power (kvar)	Capacitance (µF)	Dim (cap7)	Weight (kg)	Pcs/ box
TC10	CRMT250163400A0	**CRM25-11A-2.50-400**	400	**440**	2,5	**50**	60x138	**0,5**	36
TC20 - FD25	CRMM250163400A0	**CRM25-11A-2.50-460**	460	**500**	2,5	**37**	60x138	**0,5**	36
FD35	CRMR250163400A0	**CRM25-11A-2.50-550**	550	**605**	2,5	**26**	60x138	**0,5**	36

TC40

Ue	U_N	U_{MAX}[1]	f	$THDI_R$%	$THDI_C$%[2]
480V	550V	600V	60 Hz	≤15%	≤60%

MICROfix

TECHNICAL CHARACTERISTICS:

Rated operational voltage	Ue=480V
Rated frequency	60Hz
Max current overload In (capacitors)	3xIn (continous)
Max current overload In (bank)	1.3xIn
Max voltage overload Vn	1.1xUe
Insulating voltage (bank)	690V
Temperature range (bank)	-5/+40°C
Temperature range (capacitors)	-25/+70°C
Discharge device	on each bank
Use	indoor
Service	continous
Capacitors connection	delta
Total Joule losses	~ 3W/kvar
Inner surface fi nish (MICROfi x)	zinc passivation
Standards (bank)	IEC 60831-1/2
Standards (capacitors)	IEC 61439-1/2, IEC 61921

TC40

CODE IPX3	Power (kvar) U_e=480V (kvar)	Seleziona-tore L.B. Switch (A)	I_{cc}[3] (kA)	Weight Kg	DIM IP3X	DIM IP55[4]
IB2PGG155060003	**5,5**	40	**80**	9	**41**	43
IB2PGG211060003	**11**	40	**80**	12	**41**	43
IB2PGG216560003	**16,5**	100	**80**	15	**41**	43
IB2PGG222060003	**22**	125	**80**	18	**42**	43
IB2PGG227560003	**27,5**	125	**80**	20	**42**	43
IB2PGG233060003	**33**	125	**80**	22	**42**	43

MICROfix: GENERALITIES

- Metallic enclosure internally and externally painted with epossidic dust paint, color RAL 7035.
- Load-break switch with door interlock, designed at 1,495 In according to IEC 60831-1 art.34.
- N07V-K self-extinguish cable according to IEC 50267-2-1 standards.
- IP 3X degree of protection
- Single phase self-healing metallized polypropylene capacitors with UN=550V rated voltage, capacitors equipped with discharge resistors
- Signal lamps power on

All components inside this products are compliant with EU Safety Regulations.

FD40

Ue	U_N	U_{MAX}[1]	f	$THDI_R$%	f_N	THDV%
480V	660V	725V	60 Hz	≤60%	216 Hz	≤6%

100% NON LINEAR LOAD IN NETWORK

TECHNICAL CHARACTERISTICS:

Rated operational voltage	Ue=480V
Rated frequency	60Hz
Max current overload In (capacitors)	3xIn (continous)
Max current overload In (bank)	1.3xIn
Max voltage overload Vn (bank)	1.1xUe
Insulating voltage (bank)	690V
Temperature range (capacitors)	-25/+70°C
Temperature range (bank)	-5/+40°C
Discharge device	on each bank
Use	indoor
Service	continous
Capacitors connection	delta
Operation devices	capacitors
Total Joule losses	~ 6W/kvar
Inner surface finish	zinc passivation
Standards (capacitors)	IEC 60831-1/2
Standards (bank)	IEC 61439-1/2, IEC 61921

Generalities:

- Zink-passivated metallic enclosure painted with epossidic dust paint, colour RAL 7035.
- Auxiliary transformer to separate power and auxiliary circuit parts (110V).
- Load-break switch with door interlock, designed at 1,495* I_n as per IEC 60831-1 art.34
- Contactors.
- N07V-K self-extinguish cable according to IEC 50267-2-1 standards.
- Microprocessor Power Factor Correction relay
- Control and protection multimeter MCP5, integrated in RPC8BGA controller.
- Single phase self-healing bimetallized paper capacitors with UN=660V rated voltage.
- Three phase detuning choke with tuning frequency 216Hz (p=7,7%).

All components inside this products are compliant with EU Safety Regulations.

MULTImatic FD40 (N=3.6 - 216Hz)

CODE IP4X	POWER U_e=480V 60Hz (kvar)	STEP1 kvar	STEP2 kvar	STEP3 kvar	STEP4 kvar	STEP5 kvar	STEP6 kvar	Regulator Type	L.B. SWITCH (A)	I_{cc} (kA)	Weight Kg	Dim. IP4X
IN8PGG311060701	**110**	22	**44**	44				RPC 8BGA	**250**	17	**250**	72
IN8PGG315460701	**154**	22	**44**	44	**44**			RPC 8BGA	**400**	25	**315**	74
IN8PGG319860701	**198**	22	**44**	44	**44**	44		RPC 8BGA	**400**	25	**380**	70
IN8PGG324260701	**242**	22	**44**	44	**44**	44	**44**	RPC 8BGA	**630**	25	**460**	71
IN8PGG326460701	**264**	44	**44**	44	**44**	44	**44**	RPC 8BGA	**630**	25	**520**	71
IN8PGG330860701	**308**	22	**22**	44	**44**	88	**88**	RPC 8BGA	**2x400**	25	**740**	94
IN8PGG333060701	**330**	22	**44**	44	**44**	88	**88**	RPC 8BGA	**2x400**	25	**800**	94
IN8PGG335260701	**352**	44	**44**	88	**88**	88		RPC 8BGA	**2x400**	25	**860**	94
IN8PGG339660701	**396**	44	**88**	88	**88**	88		RPC 8BGA	**2x630**	25	**920**	90
IN8PGG344060701	**440**	44	**44**	88	**88**	88	**88**	RPC 8BGA	**2x630**	25	**980**	90
IN8PGG348460701	**484**	44	**88**	88	**88**	88	**88**	RPC 8BGA	**2x630**	25	**1040**	91
IN8PGG352860701	**528**	44	**44**	88	**88**	88	**176**	RPC 8BGA	**2x630**	25	**1100**	91

1. Maximum allowed value according to IEC 60831-1 art. 20.1

Reactive power regulators and protections

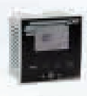
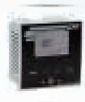
The reactive power regulator is, together with the capacitors and reactors (in detuned filter cabinets), the key component of the automatic power factor correction system. It is in fact the "intelligent" element, responsible for the verification of the power factor of the load, in function of which controls the switching on and off of the capacitors batteries in order to maintain the power factor of the system beyond the target.

The reactive power regulators RPC used in automatic ICAR power factor correction systems are designed to provide the desired power factor while minimizing the wearing on the banks of capacitors, accurate and reliable in measuring and control functions are simple and intuitive in installation and consultation.
By purchasing a ICAR automatic power factor correction system you receive it ready for commissioning. In fact he controller is already set, you just need to connect it to the line CT and set the value of the primary current.
The controller automatically recognizes the current direction of the CT secondary, to correct any wiring errors.
The flexibility of ICAR regulators allows you to modify all the parameters to customize its operation to fit the actual characteristics of the system to be corrected (threshold power factor, sensitivity of step switching, reconnecting time of the steps, presence of photovoltaics, etc.).

As described below, the ICAR regulators offer important features as for the maintenance and management of the power factor correction bank, aimed at identifying and solving problems, which could lead to its damage with consequent life expectancy reduction.

RPC 5LGA

RPC 8BGA

	System Range	PFC Controller	
	MICROmatic	RPC 5LGA	 
	MINImatic	RPC 5LGA + MCP4 optional	
	MINImatic filter	RPC 5LGA + MCP4 optional	
	MULTImatic	RPC 8BGA +MCP5 optional	 
	MULTImatic filter	RPC 8BGA +MCP5 in standard	 

RPC 8BGA reactive power regulator

The RPC 8BGA reactive power regulator equips MULTImatic automatic power factor correction systems.
It is a very innovative controller, with exclusive features:

- High electrical performance
- Extended Capabilities
- Graphic display
- Advanced communication
- Upgradability, even after installation
- Powerful supervision software

More details below, referring to the following page tables and manuals for further information.

High electrical performance: The 8BGA controller is equipped with powerful hardware, which allows a considerable electrical performances: it can be connected to the CT secondary 5A or 1A, it can work on networks with voltages from 100 to 600Vac with a measuring range from 75VAC to 760VAC, it can be connected to a single CT (typical configuration of the power factor correction) or three-CTs (for a more accurate measurement of the power factor, and this fact makes the 8BGA controller to refocus and to be a multimeter as well).

Extended Capabilities: The 8BGA reactive power regulator is controlled by a powerful microprocessor that allows a set of new functions to solve problems even in complex plant. 8BGA can work master-slave functions, handles up to 10 languages simultaneously, can be used in MV systems managing the transformation ratio of the VT, it can support multiple inputs and outputs via optional modules, it can handle target cos phi from 0.5 inductive to 0.5 capacitive. 8BGA can build a network of 4 wired units (one master three slaves) to be able to handle up to 32 steps of power factor correction in a consistent and uniform way.

Graphical display with high readability: forget the regulators with small displays and difficult to read: 8BGA will amaze you with its display matrix graphic LCD 128x80 pixels. The detail and sharpness allow intuitive navigation between the different menus, represented with text and icons.

Advanced communication: 8BGA born to be a regulator able to communicate in a manner in line with the latest technology: Ethernet, RS485, GSM / GPRS modem, USB, WIFI. Now you can see the information of the company cos phi, without having to go in front of the regulator. It will be the controller to inform you by posting, if you wish, SMS or email. Or you can consult a tablet, a smartphone, or PC. The information about the cos phi is important, because it impacts heavily on the company's income statement.

Evolutivity: the "basic" 8BGA regulator can be enhanched with up to four additional modules "plug and play" which greatly expands its performance.
And 'possible to add additional control relays (up to a total of 16), even for a static control (thyristors), digital and analog inputs, analog outputs, communication modules.
Your controller can become a small PLC, and the PFC system can become a point of data aggregation, for remote communication.

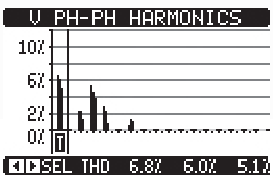
Measurement functions and help to maintain

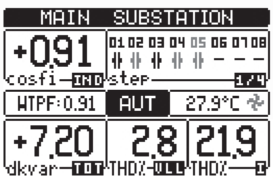
8BGA is a real evolved multimeter, thanks also to the graphic display of excellent readability and to the powerful microprocessor .
The measured parameters are the basic ones (cos phi, FP, V, I, P, Q, A, Ea, Er) with the addition of the distortion of the voltage and current (THD, histogram of the value of each harmonic, waveform graphic visualization).
If 8BGA is connected to three CT, the harmonic analysis is detailed for each phase, in order to identify any anomalies of single phase loads.
8BGA measure and count values that can help in ruling the PFC (temperature, number of switching of each step). 8BGA also suggests the maintenance to be carried out by means of simple messages on the display. Keep efficient capacitor becomes much easier.

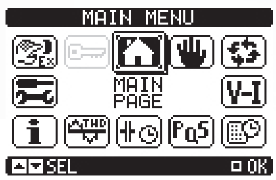
8BGA stores the maximum values of current, voltage, temperature, each associated with the date and time of the event for a better analysis of what happened.

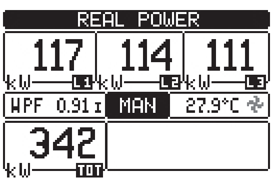
Alarms

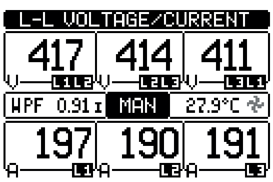
The set of alarms (maximum and minimum voltage, maximum and minimum current, over and under-compensation, overload of the capacitors, maximum temperature, microinterruption) associated with the readability of the messages on the display allows a better understanding of what happened. Even alarm programming (enable / disable, delay, relapse etc.) is easier and faster.

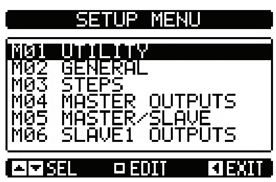










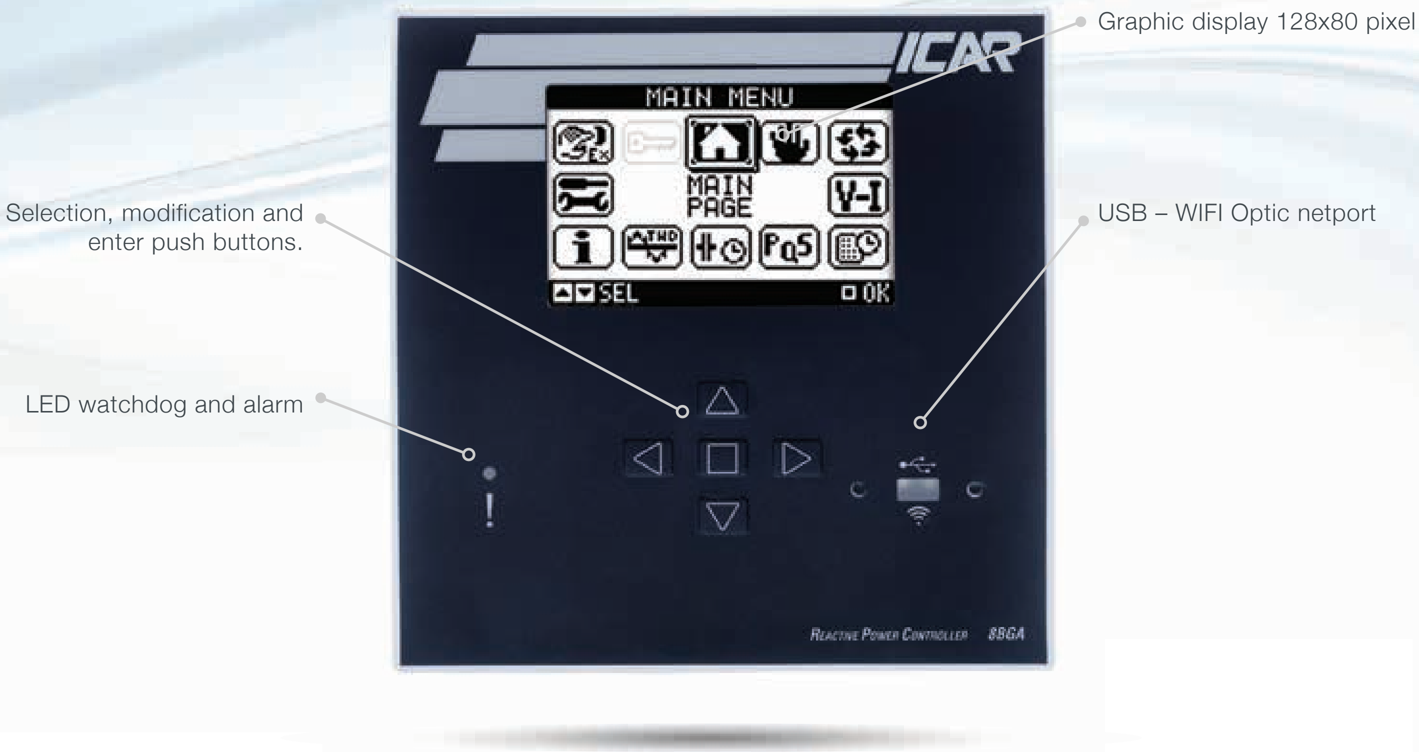


8BGA Power Factor Correction Controller: technical parameters

CHARACTERISTICS

- Supply Voltage: 100÷440Vac
- Frequency: 50Hz/60Hz
- Voltage Measuring range: 100÷690V (-15% / +10%)
- Current Measuring range: 5A (1A selectable)
- Current incoming range: from 25mA to 6A (from 10mA to 1,2A)
- Automatic phase sequence reading: yes
- Compensation in cogeneration: yes
- Burden: 12 VA (10,5W)
- Output relay current: 5A – 250Vac
- Cos ϕ range: from 0,5 ind to 0,5 cap
- Tan ϕ range: from -1,732 to + 1,732
- Step switching time: 1s÷1000s (20ms in case of STR4NO)
- Alarm relay: yes
- Degree of protection: IP55
- Working temperature range: from -30°C to +70°C
- Storage temperature range: from -30°C to + 80°C
- USB optic communication port (with COMUSB)
- Temperature Control: from -30°C to +85°C
- Standards compliance: IEC EN 61010-1; IEC/EN 61000-6-2; IEC/EN 61000-6-3; UL508; CSA C22-2 n°14
- Step output relays: 8 (expandable till 16, see expandability table)
- Dimensions: 144x144mm
- Weight: 0,98kg
- Part number: A25060046411000

RPC 8BGA

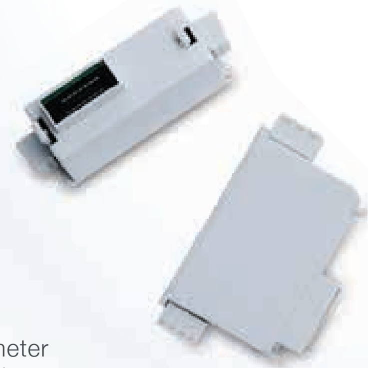


RPC 8BGA Power Factor Correction Controller: additional modules

The RPC 8BGA controller accommodates up to 4 additional modules "plug & play".
Once you have added an additional module, the controller recognizes and activates the menu for its programming.
Additional modules can also be installed in the rear.

Digital inputs and outputs

These modules allow you to increase the contacts funding for control of the steps contactors (OUT2NO module) or thyristors (STR4NO module) switched banks, or to add inputs and / or digital / analog acquisition of parameters and implementing simple logic.



- OUT2NO module 2 digital outputs to control additional steps (two relays 5A 250 Vac)
- STR4NO module 4 static outputs for thyristor control steps (range SPEED)
- INP4OC module 4 digital inputs
- 2IN2SO module 2 digital inputs and 2 static outputs
- INP2AN module 2 analog inputs
- OUT2AN module 2 analog outputs

Protection functions (MCP5) and data logging (DATLOG)

The control and protection module MCP5 allows a more detailed inspection of the electrical parameter that can damage the capacitors, thanks to algorithms particularly suitable for equipment consisting of capacitors and reactors (detuned filters MULTImatic FH20, FH30, FD25, FD25V, FD35, FH70, FD70).
The data logging module adds the ability to orodatare events, for a better understanding and diagnosis of troubled plants.

- MCP5 module for protection and control for additional safety of capacitors, especially suitable in the detuned banks
- DATLOG data logger module with real time clock and battery backup for data retention

Communication functions

RPC 8BGA regulator is very powerful in terms of communication.
The modules dedicated to these functions allow multiple solutions to remotely control the power factor system and all other variables measured, calculated or obtained from the instrument.

- COM232 isolated RS232 interface
- COM485 RS485 opto-isolated
- WEBETH Ethernet interface with webserver function
- COMPRO isolated Profibus-DP interface
- COMGSM GPRS / GSM modem
- CX01 cable connection from the RPC 8BGA optical port to the USB port of the computer for programming, downloading / uploading data, diagnostics etc..
- CX02 device to connect the optical port in the PRC 8BGA via WIFI: for programming, downloading / uploading data, diagnostics etc..
- CX03 antenna quad band GSM (800/900/1800

App[1]

App available for WIFI interfacing with the RPC 8BGA controller via tablet or smartphone. For iOS and Android.
You have the following functions:

- Set of up regulator
- Sending commands
- Reading information
- Download information and data residing on board
- Calculation of the economic benefit brought by the capacitor in terms of less penalties in the bill

1: contact Icar sales

RPC 5LGA reactive power regulator

The RPC 5LGA reactive power regulator equips MICROmatic and MINImatic, automatic power factor correction systems. It is a very innovative controller, with exclusive features:

- High electrical performance
- Extended Capabilities
- Graphic display
- RS232-RS485 communication
- Powerful supervision software

More details below, referring to the following page tables and manuals for further information.

High electrical performance: The 5LGA controller is equipped with powerful hardware, which allows a considerable electrical performances: it can be connected to the CT secondary 5A or 1A, it can work on networks with voltages from 100 to 600Vac with a measuring range from 50Vac to 720Vac.

Extended Capabilities: The 5LGA reactive power regulator is controlled by a powerful microprocessor, handles up to 6 languages simultaneously, can be used in MV systems managing the transformation ratio of the VT, it can handle target cos phi from 0.5 inductive to 0.5 capacitive.

Advanced communication: 5LGA born to be a regulator able to communicate in a manner in line with the latest technology: RS485.
Now you can see the information of the company cos phi, without having to go in front of the regulator.
The information about the cos phi is important, because it impacts heavily on the company's income statement.

Measurement functions and help to maintain

5LGA is a multimeter, thanks also to the graphic display of excellent readability and to the powerful microprocessor.
The measured parameters are the basic ones (cos phi, FP, V, I) with the addition of the distortion of the voltage and current.
5LGA measure and count values that can help in ruling the PFC (temperature, number of switching of each step).
5LGA also suggests the maintenance to be carried out by means of simple messages on the display.
Keep efficient capacitor becomes much easier. 5LGA stores the maximum values of current, voltage, temperature.

Alarms

The set of alarms (maximum and minimum voltage, maximum and minimum current, over and under-compensation, overload of the capacitors, maximum temperature, microinterruption) associated with the readability of the messages on the display allows a better understanding of what happened.
Even alarm programming (enable / disable, delay, relapse etc.) is easier and faster.

5LGA Power Factor Correction Controller: Technical parameters

TECHNICAL CHARACTERISTICS

- Microprocessor control
- Auxiliary supply voltage: 100 to 440 V AC
- Frequency: 50Hz / 60Hz
- Voltage measuring input : 100 to 600V
- Current measuring input : 5A (1A pr ogrammable)
- Current reading range: from 25mA to 6A (from 25mA to 1.2A)
- Automatic current way sensing: yes
- Operation in systems with cogeneration: yes
- Power consumption: 9.5 VA
- Output relay : 5A - 250Vac
- Cos φ adjustment: from 0.5 ind to 0.5 cap
- Step Switching Time: 15s ÷ 1000s
- Alarm relay: yes
- Degree of protection: IP54 on front and IP20 at
- terminals
- Operating temperature: -20 ° C to + 60 ° C
- Storage temperature: -30 ° C to + 80 ° C
- Optical port Front: for communication USB or WIFI
- with dedicated accessories
- Compliance with the standards: IEC EN 61010-1;
- IEC / EN 61000-6-2; IEC / EN 61000-6-4; UL508;
- CSA C22-2 n ° 14

RPC 5LGA Power Factor Correction Controller: additional modules

The RPC 8BGA controller accommodates 1 additional module "plug & play".
Once you have added an additional module, the controller recognizes and activates the menu for its programming. Additional modules can also be installed in the rear.

Digital inputs and outputs
This module allow you to increase the contacts funding for control of the steps to contactors (OUT2NO form).

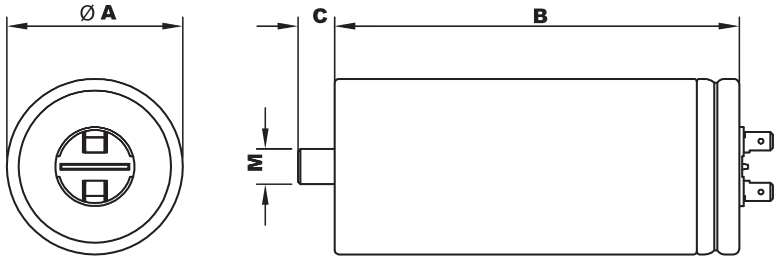
- OUT2NO module 2 digital outputs to control additional steps (two relays 5A 250 Vac)

Communication functions
RPC 5LGA regulator is very powerful in terms of communication.
The modules dedicated to these functions allow multiple solutions to remotely control the power factor of the system and all other variables measured, calculated or obtained from the instrument.

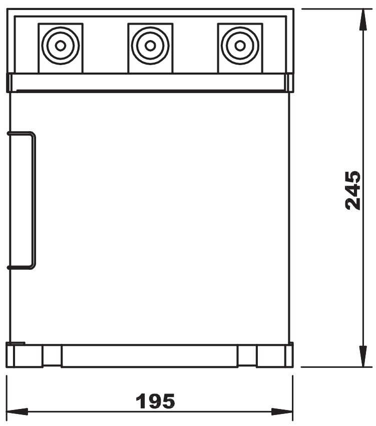
- COM232 isolated RS232 interface
- COM485 RS485 opto-isolated
- CX01 cable connection from the RPC 5LGA optical port to the USB port of the computer for programming, downloading / uploading data, diagnostics etc..
- CX02 device to connect the optical port in the PRC 5LGA via WIFI: for programming, downloading / uploading data, diagnostics etc..

CHAPTER 6

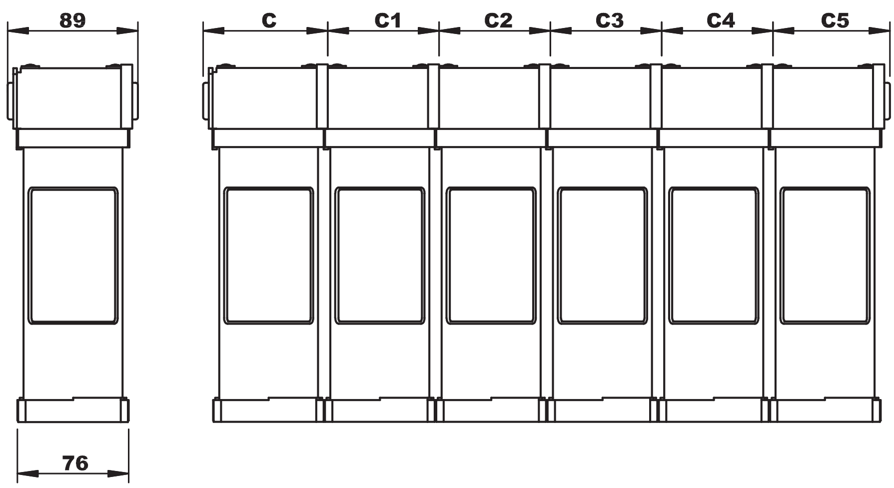
Dimensions

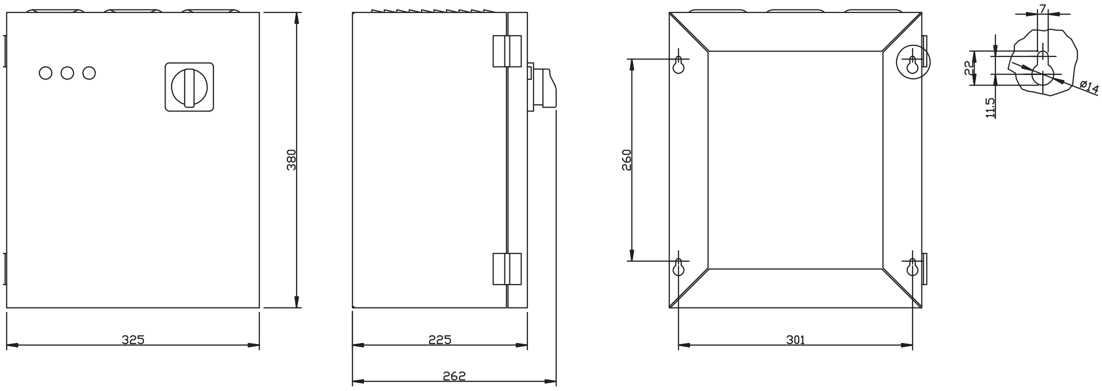


Drawing	Ø A	B	C	M
1	40	103	10	8
2	45	128	10	8
3	55	128	12,5	12
4	60	138	12,5	12

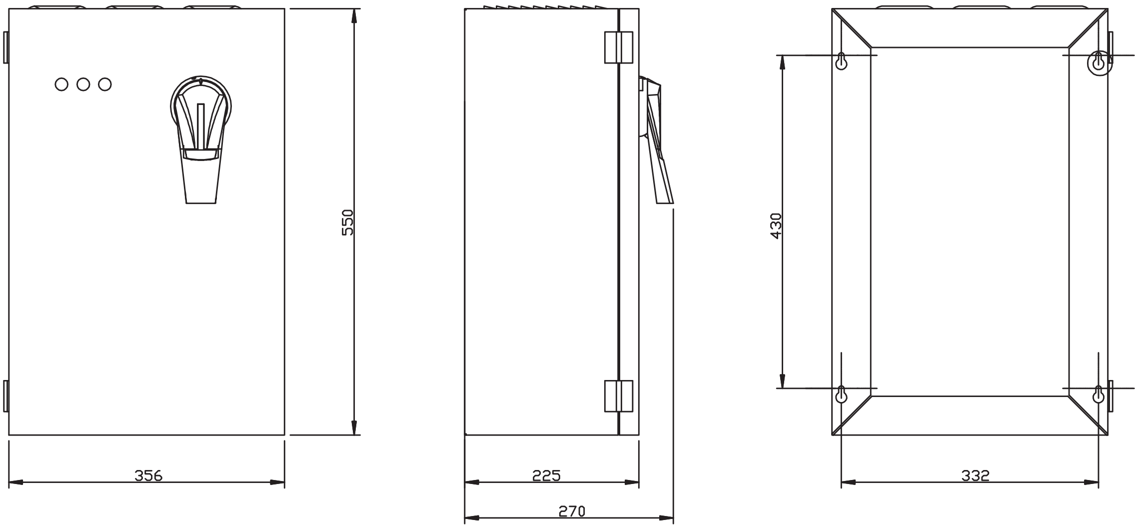


Drawing	C	C1	C2	C3	C4	C5
21	89					
22		165				
23			241			
24				317		
25					393	
26						469

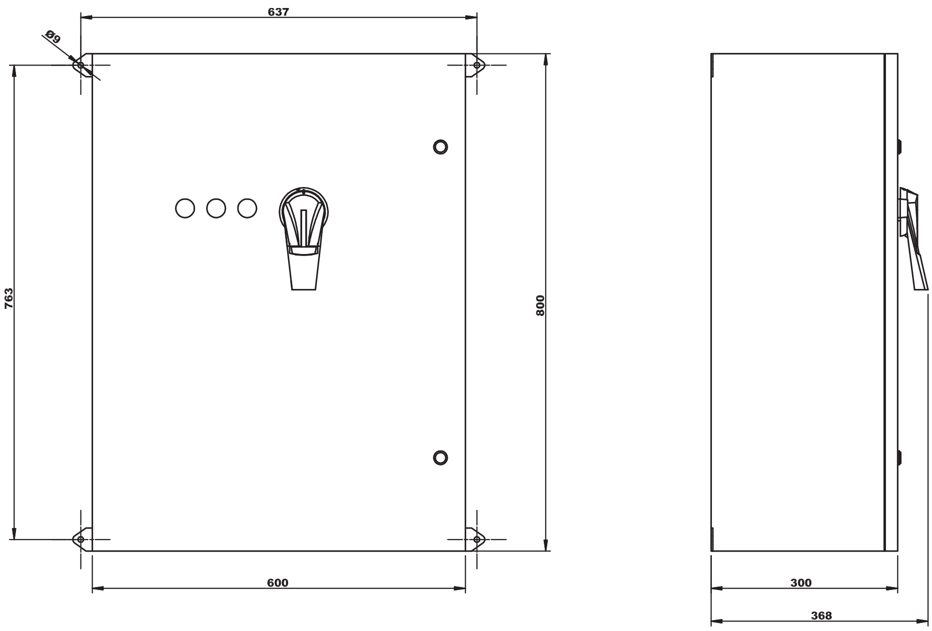



380
325
225
262
260
301
7
22
11.5
Ø14

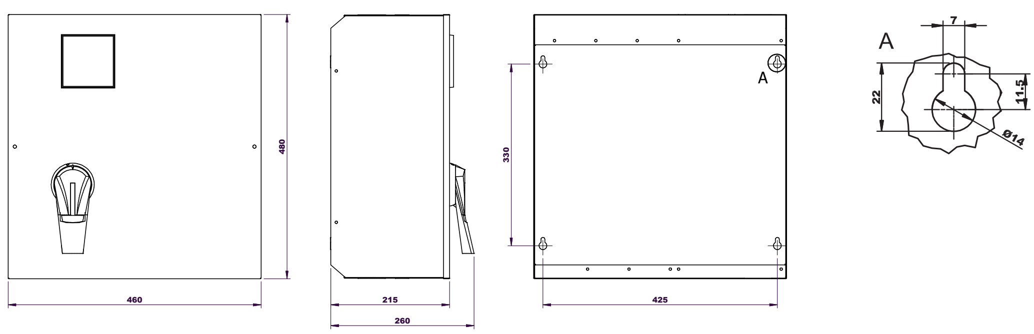
41


550
356
225
270
430
332

42

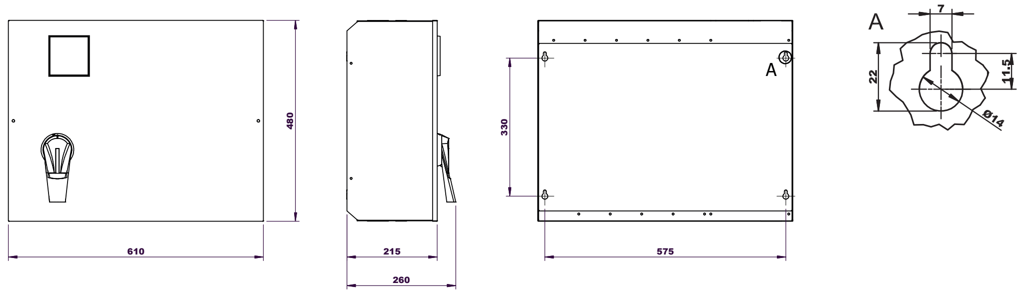

637
Ø9
763
800
600
300
368

43

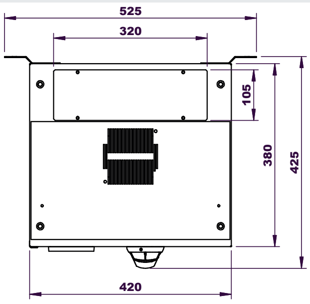

480
460
215
260
330
425
A
A
7
22
11.5
Ø14

51

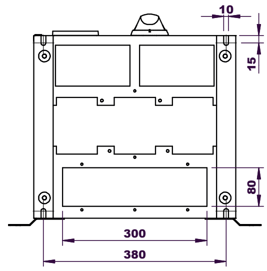
52



Applicable to drawings
55, 56, 57, 58

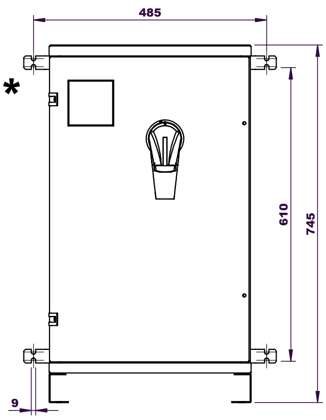


Top view with cable
incoming inlet

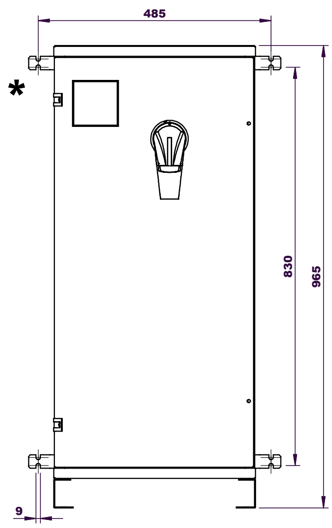


Bottom view with cable
incoming inlet

55



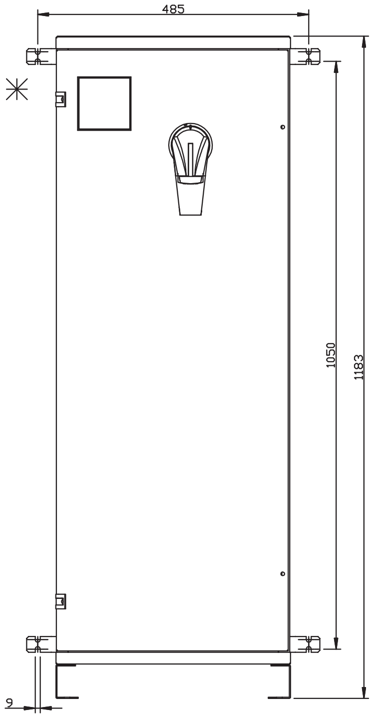
* Fixing pads are removable



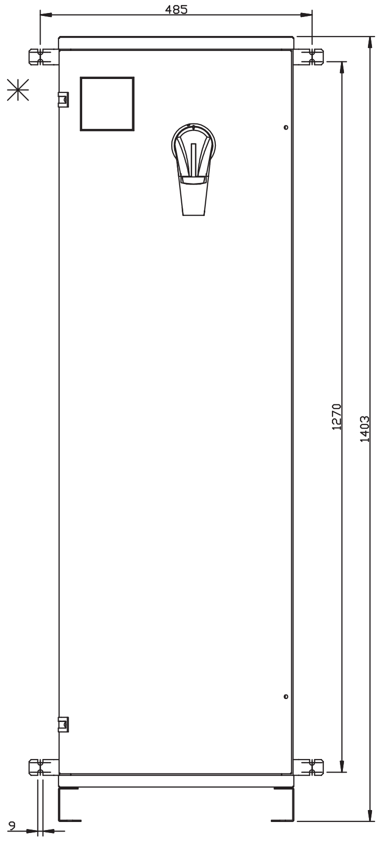
56

✳ Fixing pads are removable

57

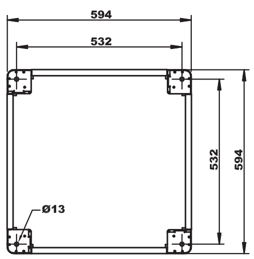


58

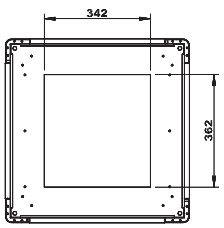


70

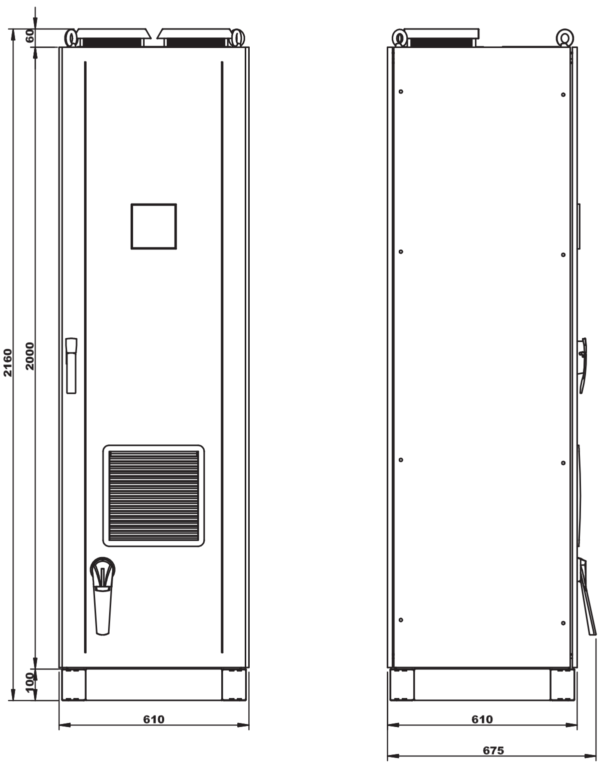
Applicable to drawings
70, 71, 73, 76, 77, 78



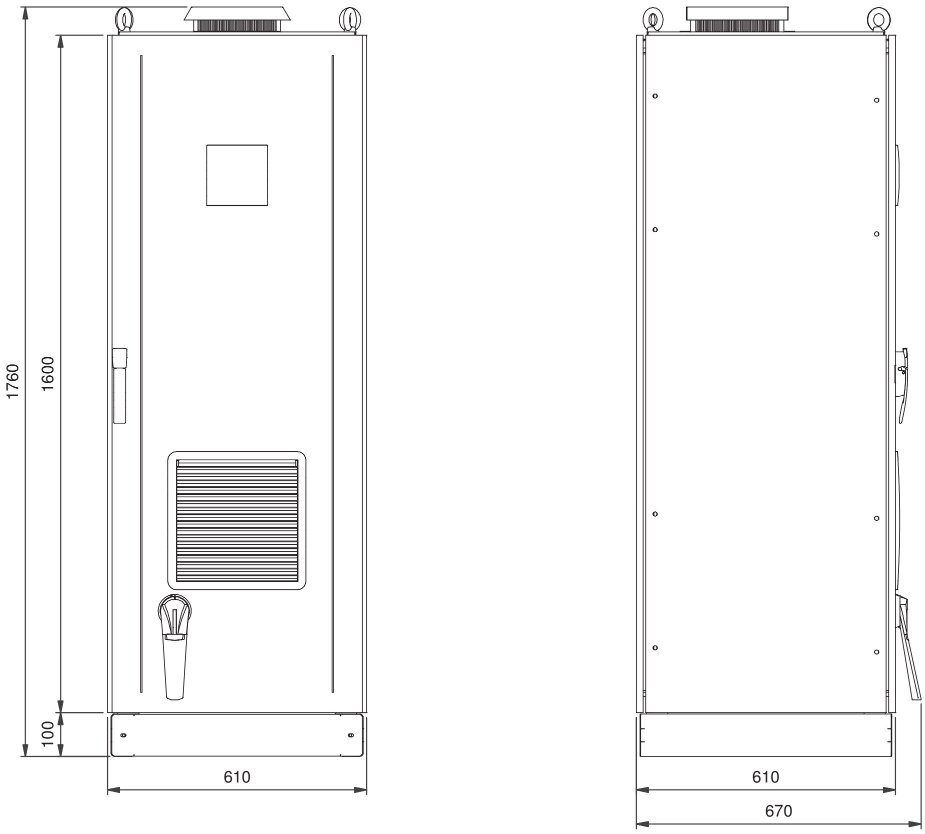
Floor fixing



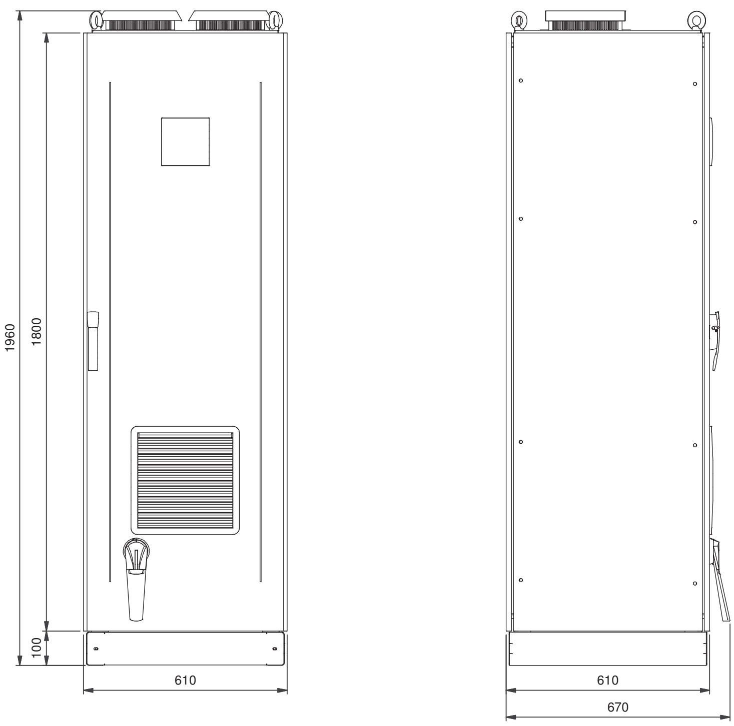
Bottom view with cable incoming inlet



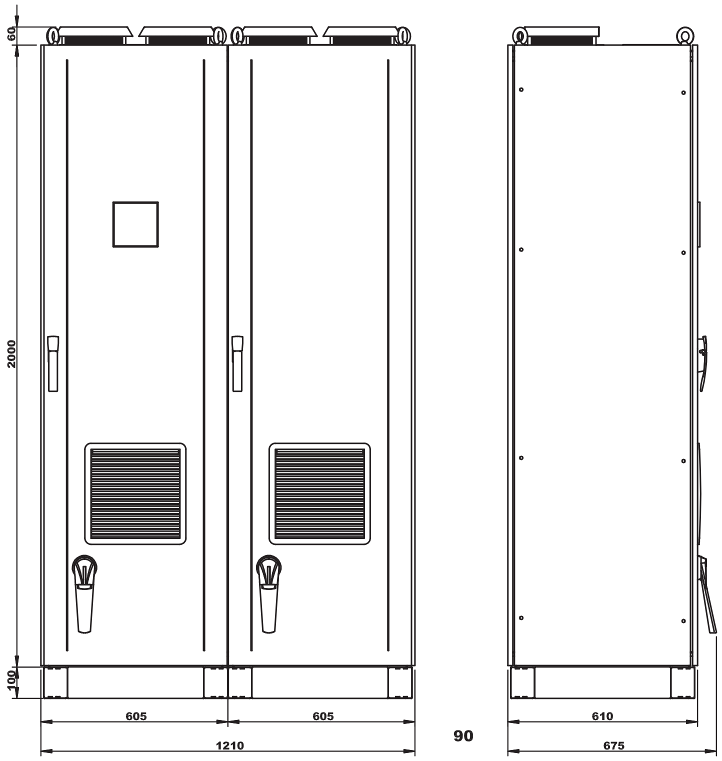
72

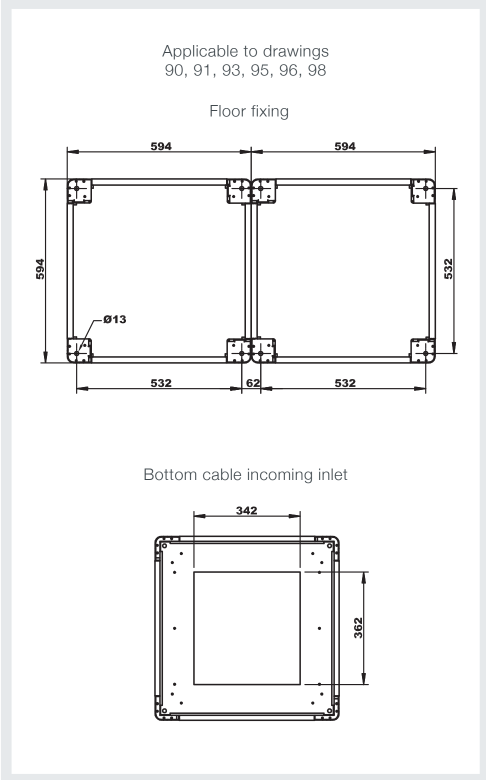


74

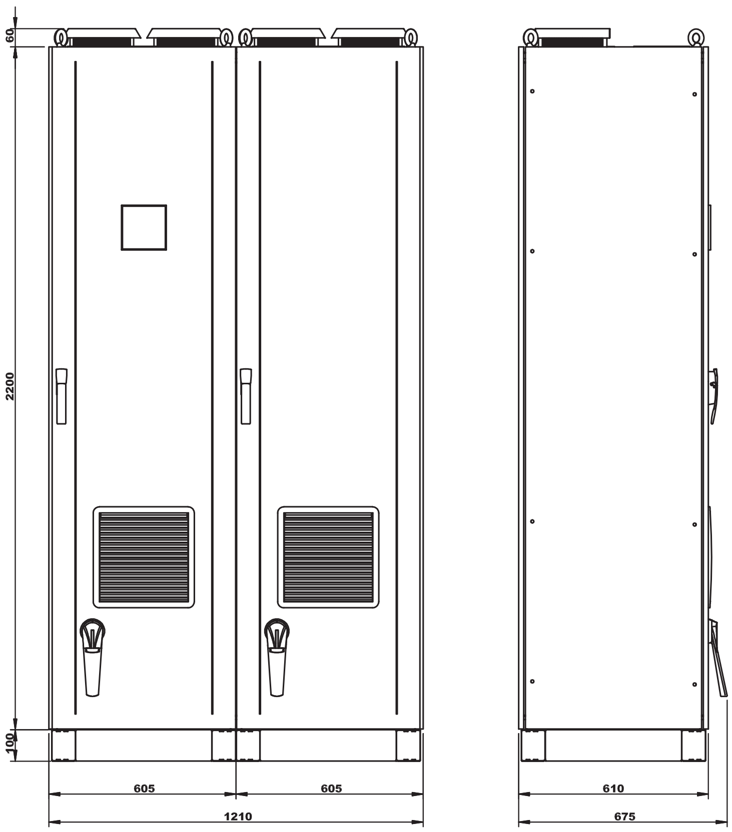


90


60
2000
100
605
605
1210
90
610
675


Applicable to drawings
90, 91, 93, 95, 96, 98
Floor fixing
594
594
594
532
Ø13
532
62
532
Bottom cable incoming inlet
342
362

91


60
2200
100
605
605
1210
610
675

92


60
1760
1600
100
610
610
1220


610
670

94


60
1960
1800
100
610
610
1220


610
670

K factor for turning active power into reactive power to achieve target power factor.

Existing Power Factor	Target Power Factor									
	0,9	0,91	0,92	0,93	0,94	0,95	0,96	0,97	0,98	0,99
0,30	2,695	2,724	2,754	2,785	2,817	2,851	2,888	2,929	2,977	3,037
0,31	2,583	2,611	2,641	2,672	2,704	2,738	2,775	2,816	2,864	2,924
0,32	2,476	2,505	2,535	2,565	2,598	2,632	2,669	2,710	2,758	2,818
0,33	2,376	2,405	2,435	2,465	2,498	2,532	2,569	2,610	2,657	2,718
0,34	2,282	2,310	2,340	2,371	2,403	2,437	2,474	2,515	2,563	2,623
0,35	2,192	2,221	2,250	2,281	2,313	2,348	2,385	2,426	2,473	2,534
0,36	2,107	2,136	2,166	2,196	2,229	2,263	2,300	2,341	2,388	2,449
0,37	2,027	2,055	2,085	2,116	2,148	2,182	2,219	2,260	2,308	2,368
0,38	1,950	1,979	2,008	2,039	2,071	2,105	2,143	2,184	2,231	2,292
0,39	1,877	1,905	1,935	1,966	1,998	2,032	2,069	2,110	2,158	2,219
0,40	1,807	1,836	1,865	1,896	1,928	1,963	2,000	2,041	2,088	2,149
0,41	1,740	1,769	1,799	1,829	1,862	1,896	1,933	1,974	2,022	2,082
0,42	1,676	1,705	1,735	1,766	1,798	1,832	1,869	1,910	1,958	2,018
0,43	1,615	1,644	1,674	1,704	1,737	1,771	1,808	1,849	1,897	1,957
0,44	1,557	1,585	1,615	1,646	1,678	1,712	1,749	1,790	1,838	1,898
0,45	1,500	1,529	1,559	1,589	1,622	1,656	1,693	1,734	1,781	1,842
0,46	1,446	1,475	1,504	1,535	1,567	1,602	1,639	1,680	1,727	1,788
0,47	1,394	1,422	1,452	1,483	1,515	1,549	1,586	1,627	1,675	1,736
0,48	1,343	1,372	1,402	1,432	1,465	1,499	1,536	1,577	1,625	1,685
0,49	1,295	1,323	1,353	1,384	1,416	1,450	1,487	1,528	1,576	1,637
0,50	1,248	1,276	1,306	1,337	1,369	1,403	1,440	1,481	1,529	1,590
0,51	1,202	1,231	1,261	1,291	1,324	1,358	1,395	1,436	1,484	1,544
0,52	1,158	1,187	1,217	1,247	1,280	1,314	1,351	1,392	1,440	1,500
0,53	1,116	1,144	1,174	1,205	1,237	1,271	1,308	1,349	1,397	1,458
0,54	1,074	1,103	1,133	1,163	1,196	1,230	1,267	1,308	1,356	1,416
0,55	1,034	1,063	1,092	1,123	1,156	1,190	1,227	1,268	1,315	1,376
0,56	0,995	1,024	1,053	1,084	1,116	1,151	1,188	1,229	1,276	1,337
0,57	0,957	0,986	1,015	1,046	1,079	1,113	1,150	1,191	1,238	1,299
0,58	0,920	0,949	0,979	1,009	1,042	1,076	1,113	1,154	1,201	1,262
0,59	0,884	0,913	0,942	0,973	1,006	1,040	1,077	1,118	1,165	1,226
0,60	0,849	0,878	0,907	0,938	0,970	1,005	1,042	1,083	1,130	1,191
0,61	0,815	0,843	0,873	0,904	0,936	0,970	1,007	1,048	1,096	1,157
0,62	0,781	0,810	0,839	0,870	0,903	0,937	0,974	1,015	1,062	1,123
0,63	0,748	0,777	0,807	0,837	0,870	0,904	0,941	0,982	1,030	1,090
0,64	0,716	0,745	0,775	0,805	0,838	0,872	0,909	0,950	0,998	1,058
0,65	0,685	0,714	0,743	0,774	0,806	0,840	0,877	0,919	0,966	1,027
0,66	0,654	0,683	0,712	0,743	0,775	0,810	0,847	0,888	0,935	0,996
0,67	0,624	0,652	0,682	0,713	0,745	0,779	0,816	0,857	0,905	0,966
0,68	0,594	0,623	0,652	0,683	0,715	0,750	0,787	0,828	0,875	0,936
0,69	0,565	0,593	0,623	0,654	0,686	0,720	0,757	0,798	0,846	0,907
0,70	0,536	0,565	0,594	0,625	0,657	0,692	0,729	0,770	0,817	0,878
0,71	0,508	0,536	0,566	0,597	0,629	0,663	0,700	0,741	0,789	0,849
0,72	0,480	0,508	0,538	0,569	0,601	0,635	0,672	0,713	0,761	0,821
0,73	0,452	0,481	0,510	0,541	0,573	0,608	0,645	0,686	0,733	0,794
0,74	0,425	0,453	0,483	0,514	0,546	0,580	0,617	0,658	0,706	0,766
0,75	0,398	0,426	0,456	0,487	0,519	0,553	0,590	0,631	0,679	0,739
0,76	0,371	0,400	0,429	0,460	0,492	0,526	0,563	0,605	0,652	0,713
0,77	0,344	0,373	0,403	0,433	0,466	0,500	0,537	0,578	0,626	0,686
0,78	0,318	0,347	0,376	0,407	0,439	0,474	0,511	0,552	0,599	0,660
0,79	0,292	0,320	0,350	0,381	0,413	0,447	0,484	0,525	0,573	0,634
0,80	0,266	0,294	0,324	0,355	0,387	0,421	0,458	0,499	0,547	0,608
0,81	0,240	0,268	0,298	0,329	0,361	0,395	0,432	0,473	0,521	0,581
0,82	0,214	0,242	0,272	0,303	0,335	0,369	0,406	0,447	0,495	0,556
0,83	0,188	0,216	0,246	0,277	0,309	0,343	0,380	0,421	0,469	0,530
0,84	0,162	0,190	0,220	0,251	0,283	0,317	0,354	0,395	0,443	0,503
0,85	0,135	0,164	0,194	0,225	0,257	0,291	0,328	0,369	0,417	0,477
0,86	0,109	0,138	0,167	0,198	0,230	0,265	0,302	0,343	0,390	0,451
0,87	0,082	0,111	0,141	0,172	0,204	0,238	0,275	0,316	0,364	0,424
0,88	0,055	0,084	0,114	0,145	0,177	0,211	0,248	0,289	0,337	0,397
0,89	0,028	0,057	0,086	0,117	0,149	0,184	0,221	0,262	0,309	0,370
0,90	-	0,029	0,058	0,089	0,121	0,156	0,193	0,234	0,281	0,342
0,91	-	-	0,030	0,060	0,093	0,127	0,164	0,205	0,253	0,313
0,92	-	-	-	0,031	0,063	0,097	0,134	0,175	0,223	0,284
0,93	-	-	-	-	0,032	0,067	0,104	0,145	0,192	0,253
0,94	-	-	-	-	-	0,034	0,071	0,112	0,160	0,220
0,95	-	-	-	-	-	-	0,037	0,078	0,126	0,186

MV/LV transformer No Load Power Factor.

Transformer Power kVA	Oil Transformer kvar	Cast Resin Transformer kvar
10	1	**1,5**
20	2	**1,7**
50	4	**2**
75	5	**2,5**
100	5	**2,5**
160	7	**4**
200	7,5	**5**
250	8	**7,5**
315	10	**7,5**
400	12,5	**8**
500	15	**10**
630	17,5	**12,5**
800	20	**15**
1000	25	**17,5**
1250	30	**20**
1600	35	**22**
2000	40	**25**
2500	50	**35**
3150	60	**50**

Three Phase Asynchronous Motors. Special care to self-excitation.

Motor Power		Reactive Power (kvar)				
HP	kW	3000 rpm	1500 rpm	1000 rpm	750 rpm	500 rpm
0,4	0,55	**-**	-	**0,5**	0,5	**-**
1	0,73	**0,5**	0,5	**0,6**	0,6	**-**
2	1,47	**0,8**	0,8	**1**	1	**-**
3	2,21	**1**	1	**1,2**	1,6	**-**
5	3,68	**1,6**	1,6	**2**	2,5	**-**
7	5,15	**2**	2	**2,5**	3	**-**
10	7,36	**3**	3	**4**	4	**5**
15	11	**4**	5	**5**	6	**6**
30	22,1	**10**	10	**10**	12	**15**
50	36,8	**15**	20	**20**	25	**25**
100	73,6	**25**	30	**30**	30	**40**
150	110	**30**	40	**40**	50	**60**
200	147	**40**	50	**50**	60	**70**
250	184	**50**	60	**60**	70	**80**

Typical Power Factor of few common loads.

		cos phi
Office appliances (computers, printers, etc)		**0,7**
Fridges		**0,8**
Commercial mall		**0,85**
Office block		**0,8**
Extruders		**0,4÷0,7**
Resistor furnaces		**1**
Arc furnaces		**0,8**
Induction furnaces		**0,85**
Incandescent lamps		**1**
Discharge lamps		**0,4÷0,6**
Fluorescent lamps without integrated PFC		**0,5**
Fluorescent lamps with integrated PFC		**0,9÷0,93**
LED lamps without integrated PFC		**0,3÷0,6**
LED lamps with integrated PFC		**0,9÷0,95**
Asynchronous motor		
Load Factor	**0**	**0,2**
	25%	**0,55**
	50%	**0,72**
	75%	**0,8**
	100%	**0,85**
Mechanical workshop		**0,6÷0,7**
Carpentry		**0,7÷0,8**
Hospital		**0,8**
Glassworks		**0,8**
Food appliances with VSD		**0,99**
Photovoltaic plants with site exchange		**0,1÷0,9**

www.icar.com

On internet ICAR web you'll find, more information about PFC:

- **ANY NEWS**
- **REFERENCES**
- **ICAR SERVICES**
- **ALL DOCUMENTS FOR DOWNLOAD**
  - **manuals**
  - **catalogues and brochures**
  - **technical newsletters for**
    - quick installation guidelines
    - CT selection and positioning
    - Selection of PFC in case of photovoltaic plants
    - Selection and tuning of PFC upstream protections
    - Selection table for heavily polluted and resonance risk plants
    - Selection table for replacement of old controllers
    - Meaning of error messages and problem solvinge

Similar information is available for MV Power Factor Correction

COLTADV.IT

ICCA01A0715E

technology looking ahead

ICAR S.p.A.
Via Isonzo, 10
20900 Monza (MB) - Italy
tel. +39 039 83.951
fax +39 039 83.32.27
www.icar.com
sales@icar.com