ENGINEERING:

A fast growing list of hazards and complexions caused by introduction of high tech equipment and devices makes it very difficult (if not impossible) for customers to find a most suitable and long live solutions to their power quality problems. Therefore, engineering is becoming a vital part of every power quality project.

More that one third of staff are engineers holding B.S. or higher degrees. With the use of very sophisticated analyzers, and software such as ETAP, Our engineering department is effectively capable of helping customers with diagnosis of their problems pertaining power quality.

Recognized, internally, as a separate field of service and product, "Engineering Services" have been presented and delivered to many industries including Oil, Gas, Petrochemical, Cement, Car and textile.

PROCUREMENT:

Regardless of wide variety of resources for raw material & components, our company is disciplined to provide its need from the best available who are. Majority (more than 90%) of our international resources are from Europe.

Trying to use most advanced guidelines for managing the economics of quality, we constantly search and identify factors affecting customer satisfaction and modify our company main processes accordingly. Among those processes, procurement is of our major organizational focus. From years of experience We have has acquired the knowledge of sanctity of product quality to its components and raw materials. Most stringent acceptance criteria applies to purchase of those materials who has bigger influence on final quality of product.

CONSTRUCTION:

Equipped with most advanced production line in region, we produce a wide range of capacitors, capacitor banks, harmonic filters and reactive power controllers to the latest international standard such as IEC, etc.

- Power capacitors and reactive power controllers are produced under the **PANIR** trademark.
- ***PANIR*** capacitors have been introduced and exported to different countries.
- Our products are designed and manufactured to satisfy different environment and service conditions.
- Design and construction of capacitor banks are carefully picked up to meet customer requirements aiming at best solution available for their problems with defects in power quality.

QUALITY IS OUR POWER

We are a registered firm by BSI and SGS, the quality system complies with ISO9001:2000 standard.

At our organization, great emphasis is laid upon quality and throughout the whole process of manufacturing, strict quality control is maintained. The quality assurance starts from selection and acceptance of raw material, (i.e., metallized polypropylene film, metal spray wire, encapsulating resin, solder wire, thermoplastic materials, wires and etc.)

To make sure that the production process is mistake free, During the production of capacitors, stringent quality checks are carried out at various stages which adds up to more than 20 measurement and test. The winding process takes place in controlled temperature and humidity environment, which is also completely dust free.

Finally, the most accurate and modern test equipment for routine tests are utilized to make sure that the quality is hundred percent achieved and nothing is left to probabilities. The type tests are carried out on randomly selected samples.

GUARANTEE

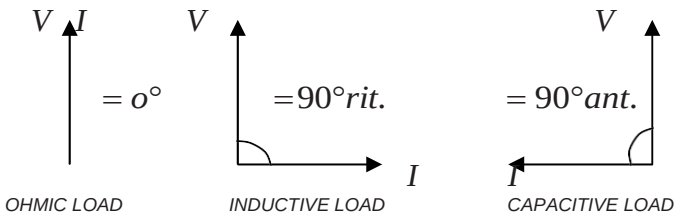
PANIR capacitors are given ***two years*** guarantee and ***ten years*** full coverage of after sales services.

TECHNOLOGY

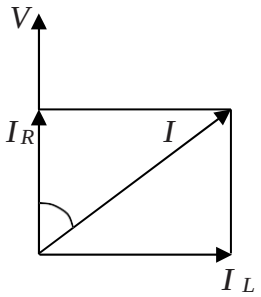
Power Factor Correction: Why & How?

POWER FACTOR CORRECTION: WHY?

In electrical circuits the current is in phase with the voltage when we 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:



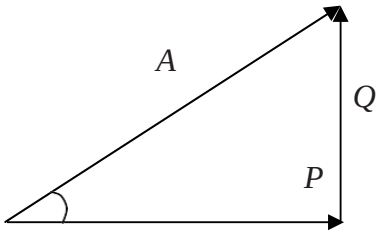
1. I_R resistive current
2. I_L inductive reactive current

These currents are linked 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 absorption of reactive power is the power factor.

As per definition power factor is the ratio between active power and apparent power:



$$\text{Cos} = \frac{P}{A}$$

Where

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

cos decreases as the absorbed reactive power increases. Low cos has the following disadvantages:

1. High power losses in the electrical lines
2. High voltage variation 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 are needed to achieve this goal.

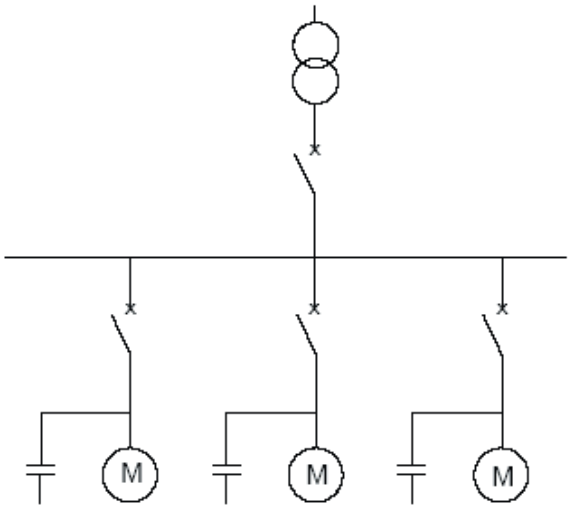
POWER FACTOR CORRECTION: HOW?

By installing a capacitor bank it is possible to reduce the reactive power absorbed by the inductive loads in the system and consequently the power factor improves.
It is suitable to have Cos a little in excess of 0.9 to avoid paying the penalties provided for by the law.
Cos must not be too close to unity, to avoid the capacitive working 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 sited at each single load
(i.e. motor terminals)

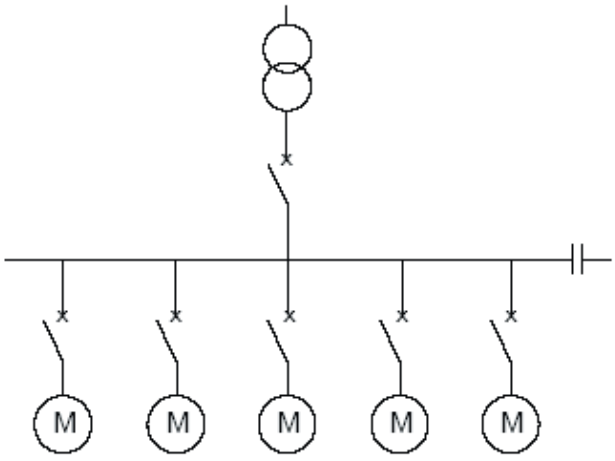
Central compensation: we install only one bank of capacitors to a main power distribution station or substation.

INDIVIDUAL 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 Cos becomes systematic and closely linked to the load.
Another grate advantage of this type of power factor correction is the simple installation with low costs.

CENTRAL COMPENSATION



The daily trend of the loads has a fundamental importance for the choice of power factor correction most suitable.
In lots of systems, not all the users work in the same and same of them work only a few hours per day. It is clear that the solution of the individual compensation becomes too expensive for 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 most effective if the majority of the reactive power is concentrated on a few loads that contribute the greatest power band 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 is very variable, it is advisable the use of automatic regulation in preference to fixed capacitors.

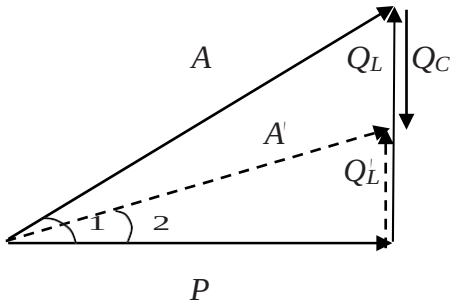
POWER FACTOR CORRECTION: *HOW MANY CAPACITORS?*

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

- Cos $_2$ value that we would obtain
- Cos $_1$ starting value
- Install active power

By the following equation

$$Q_c = P \bullet (\tan\ _1 - \tan\ _2)$$



Where

Q_c = Required capacitors reactive output (kvar)
P = Active power
Q_L, Q_L' = Inductive reactive output before and after the installation of the capacitor bank
A, A' = Apparent power before and after power factor correction

The equation

$$Q_c = P \bullet (\tan\ _1 - \tan\ _2)$$

Can be also written

$$Q_c = K \bullet P$$

Where the parameter ***K*** is easily calculable using table 1 bellow.

Ex: We have installed a load that absorb an active power of 300 kw whit a beginning power factor 0.7 and we want to increase it until 0.92,
From the table 1 we find:

$$K = 0.591$$

Cos	0.8	0.85	0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.98	0.99	1
0.40	1.557	1.668	1.805	1.832	1.861	1.895	1.924	1.959	1.998	2.037	2.085	2.146	2.288
0.41	1.474	1.605	1.742	1.769	1.798	1.831	1.860	1.896	1.935	1.973	2.021	2.082	2.225
0.42	1.413	1.544	1.681	1.769	1.738	1.771	1.800	1.836	1.874	1.913	1.961	2.022	2.164
0.43	1.356	1.487	1.624	1.709	1.680	1.713	1.742	1.778	1.816	1.855	1.903	1.964	2.107
0.44	1.290	1.421	1.558	1.651	1.614	1.647	1.677	1.712	1.751	1.790	1.837	1.899	2.041
0.45	1.230	1.360	1.501	1.585	1.561	1.592	1.626	1.659	1.695	1.737	1.784	1.846	1.988
0.46	1.179	1.309	1.446	1.532	1.502	1.533	1.567	1.600	1.636	1.677	1.725	1.786	1.929
0.47	1.130	1.260	1.397	1.473	1.454	1.485	1.519	1.532	1.588	1.629	1.677	1.758	1.881
0.48	1.076	1.206	1.343	1.425	1.400	1.430	1.464	1.497	1.534	1.575	1.623	1.684	1.826
0.49	1.030	1.160	1.297	1.370	1.355	1.386	1.420	1.453	1.489	1.530	1.578	1.639	1.782
0.50	0.982	1.112	1.248	1.326	1.303	1.337	1.369	1.403	1.441	1.481	1.529	1.590	1.732
0.51	0.936	1.066	1.202	1.276	1.257	1.291	1.323	1.357	1.395	1.435	1.483	1.544	1.686
0.52	0.894	1.024	1.160	1.230	1.215	1.249	1.281	1.315	1.353	1.393	1.441	1.502	1.644
0.53	0.850	0.980	1.116	1.188	1.171	1.205	1.237	1.271	1.309	1.349	1.397	1.458	1.600
0.54	0.809	0.939	1.075	1.144	1.130	1.164	1.196	1.230	1.268	1.308	1.356	1.417	1.559
0.55	0.769	0.899	1.035	1.103	1.090	1.124	1.156	1.190	1.228	1.268	1.316	1.377	1.519
0.56	0.730	0.865	0.996	1.063	1.051	1.085	1.117	1.151	1.189	1.229	1.277	1.338	1.480
0.57	0.692	0.822	0.958	0.986	1.013	1.047	1.079	1.113	1.151	1.191	1.239	1.300	1.442
0.58	0.665	0.785	0.921	0.949	0.976	1.010	1.042	1.076	1.114	1.154	1.202	1.263	1.405
0.59	0.618	0.748	0.884	0.912	0.939	0.973	1.005	1.039	1.077	1.117	1.165	1.226	1.368
0.60	0.584	0.714	0.849	0.878	0.905	0.939	0.971	1.005	1.043	1.083	1.131	1.192	1.334
0.61	0.549	0.679	0.815	0.843	0.870	0.904	0.936	0.970	1.008	1.048	1.096	1.157	1.299
0.62	0.515	0.645	0.781	0.809	0.836	0.870	0.902	0.936	0.974	1.014	1.062	1.123	1.265
0.63	0.483	0.613	0.749	0.777	0.804	0.838	0.870	0.904	0.942	0.982	1.030	1.091	1.233
0.64	0.450	0.580	0.716	0.744	0.771	0.805	0.837	0.871	0.909	0.949	0.997	1.058	1.200
0.65	0.419	0.549	0.685	0.713	0.740	0.774	0.806	0.840	0.878	0.918	0.966	1.007	1.169
0.66	0.388	0.518	0.654	0.682	0.709	0.743	0.775	0.809	0.847	0.887	0.935	0.996	1.138
0.67	0.358	0.488	0.624	0.652	0.679	0.713	0.745	0.779	0.817	0.857	0.905	0.966	1.108
0.68	0.329	0.459	0.595	0.623	0.650	0.684	0.716	0.750	0.788	0.828	0.876	0.937	1.079
0.69	0.299	0.429	0.565	0.593	0.620	0.654	0.686	0.720	0.758	0.798	0.840	0.907	1.049
0.70	0.270	0.400	0.536	0.564	0.591	0.625	0.657	0.691	0.729	0.769	0.811	0.878	1.020
0.71	0.242	0.372	0.508	0.536	0.563	0.597	0.629	0.663	0.701	0.741	0.783	0.850	0.992
0.72	0.213	0.343	0.479	0.507	0.534	0.568	0.600	0.634	0.672	0.712	0.754	0.821	0.963
0.73	0.186	0.316	0.452	0.400	0.507	0.541	0.573	0.607	0.645	0.685	0.727	0.794	0.936
0.74	0.159	0.289	0.425	0.453	0.480	0.514	0.546	0.580	0.618	0.658	0.700	0.767	0.909
0.75	0.132	0.262	0.389	0.426	0.453	0.487	0.519	0.553	0.591	0.631	0.673	0.740	0.882
0.76	0.105	0.235	0.371	0.399	0.426	0.460	0.492	0.526	0.564	0.604	0.652	0.713	0.855
0.77	0.079	0.209	0.345	0.373	0.400	0.434	0.466	0.500	0.538	0.578	0.620	0.687	0.829
0.78	0.053	0.183	0.319	0.347	0.374	0.408	0.440	0.474	0.512	0.552	0.594	0.661	0.803
0.79	0.026	0.156	0.292	0.320	0.347	0.381	0.413	0.447	0.485	0.525	0.567	0.634	0.776
0.80	-	0.130	0.266	0.294	0.321	0.355	0.387	0.421	0.459	0.499	0.541	0.608	0.750
0.81	-	0.104	0.240	0.268	0.295	0.329	0.361	0.395	0.433	0.473	0.515	0.582	0.724
0.82	-	0.078	0.214	0.242	0.269	0.303	0.335	0.369	0.407	0.447	0.489	0.556	0.698
0.83	-	0.052	0.188	0.216	0.243	0.277	0.309	0.343	0.381	0.421	0.463	0.530	0.672
0.84	-	0.026	0.162	0.190	0.217	0.251	0.283	0.317	0.355	0.395	0.437	0.504	0.645
0.85	-	-	0.136	0.164	0.191	0.225	0.257	0.291	0.329	0.369	0.417	0.478	0.620
0.86	-	-	0.109	0.140	0.167	0.198	0.230	0.264	0.301	0.343	0.390	0.450	0.593
0.87	-	-	0.083	0.114	0.141	0.172	0.204	0.238	0.275	0.317	0.364	0.424	0.567
0.88	-	-	0.054	0.085	0.112	0.143	0.175	0.209	0.246	0.288	0.335	0.395	0.538
0.89	-	-	0.028	0.059	0.086	0.117	0.148	0.183	0.230	0.262	0.309	0.369	0.512
0.90	-	-	-	0.031	0.058	0.089	0.121	0.155	0.192	0.234	0.281	0.341	0.484

Table 1

And then we find

$$Q_c = 0{,}591 \bullet 300 \div 177k \text{ var}$$

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 correction 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.

$$Q_c = I_O\% \bullet \frac{A_N}{100}$$

Where

$I_o\%$ = magnetizing current of the transformers(AS%)

A_N = apparent rated power in kva of the transformer

If we don't have these parameters, it is possible using 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. Needed reactive power for each motor rating show in table 3.

Required reactive power for electro motors

Motor 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

Note: the capacitor output must not be 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 over voltages (self-excitation phenomena).
To avoid the danger of self – excitation it is necessary to limit the power of the capacitor to 90% of the no load reactive power of the motor:

$$Q_c = \frac{0.9 \cdot I_0 \cdot U_N \cdot \sqrt{3}}{1000}$$

Where:

Q_c = Capacitor power (kvar)

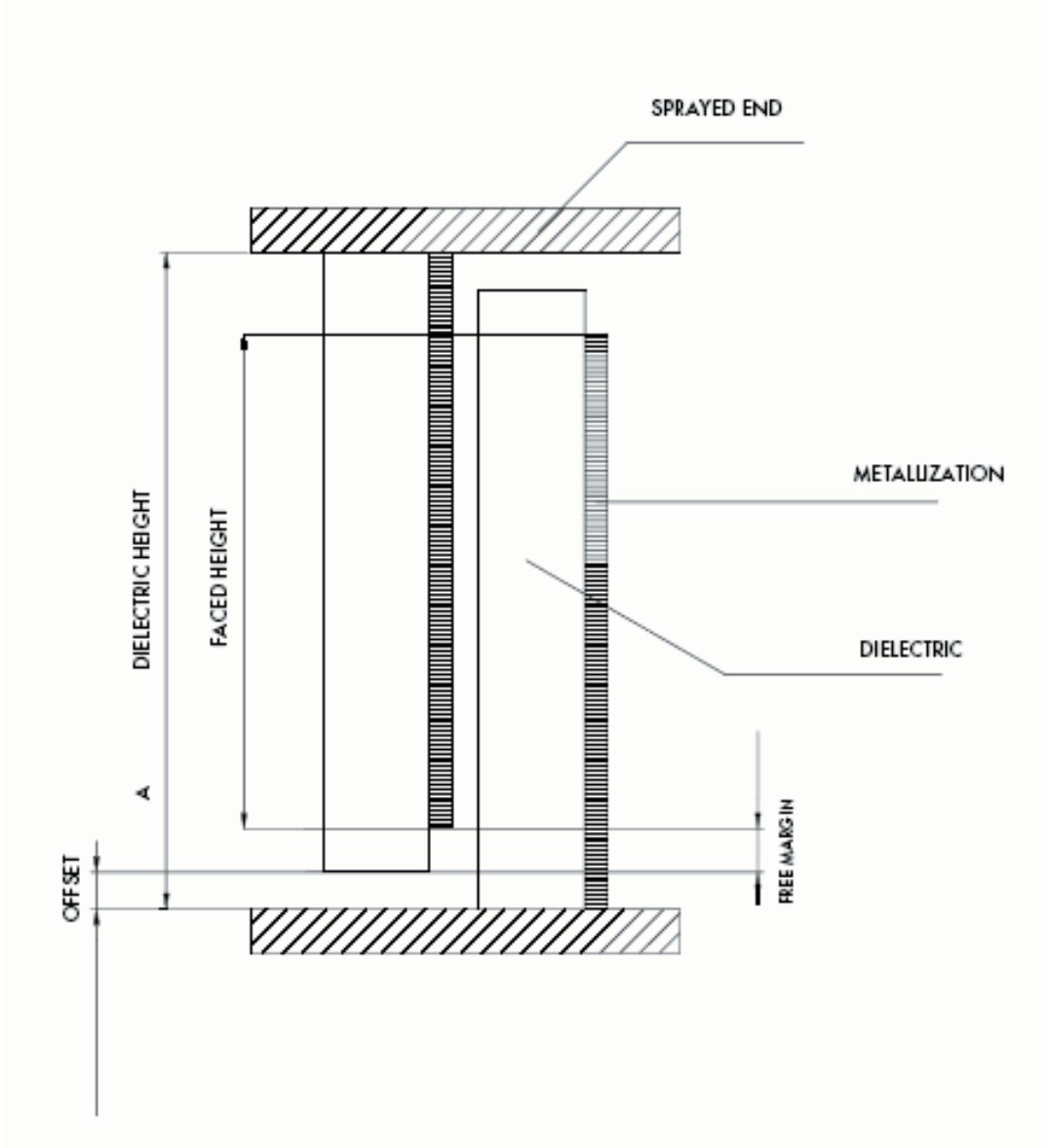
I_0 = No load current of the motor (A)

Un = Voltage between phases (V)

TYPE OF CAPACITORS USED

- Self-healing DRY type capacitors

All the capacitors are environmentally friendly and contain NO PCB's



These type of capacitors are characterized by:

- A polypropylene metallic self-healing film;
- All capacitors featured in this catalogue are fitted with a safety device such as overpressure disconnector or internal fuse. If several self healing breakdowns occur at the end of useful life or a result of thermal or electric overload, the formation of gas produces a fast rise in pressure inside the capacitor case. This causes a change in length of the case stretching of the expansion bellow. Expansion beyond a certain degree will disconnect the internal wires and from the line.

POWER FACTOR CORRECTION: HARMONICS IN THE NETWORK

At the presence of nonlinear loads (e.g., inverters, saturated transformers, rectifiers, etc.) non sinusoidal voltage and current will be generated and distributed. Consequently the following problems may occur:

- On the AC motors: mechanical vibration that can reduce the life. The increase of the losses creates overheating with consequent damping of the insulating materials;
- In transformers: increase the copper and iron losses with possible damaging of the windings. The eventual presence of continuous components of voltage or current could cause the saturation of the nucleus with consequent increasing of the magnetizing current;
- The capacitors suffer from the overheating and the increasing of the voltage that reduce their life time.

The wave form of the current (or voltage) generated from a non-linear load, being periodical, could be represented by the sum of more sinusoidal waves (a 50Hz component called fundamental and other components with multiple frequency of the fundamental components, called HARMONICS):

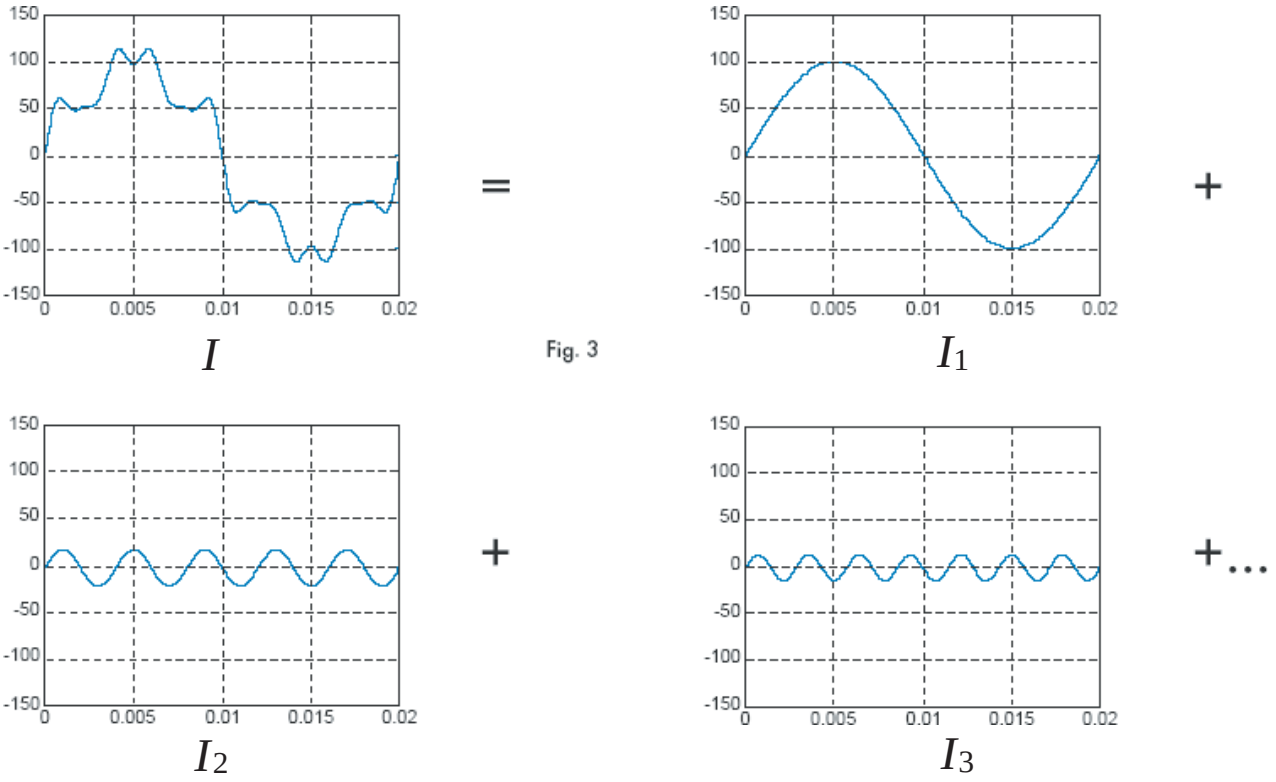


Fig. 3

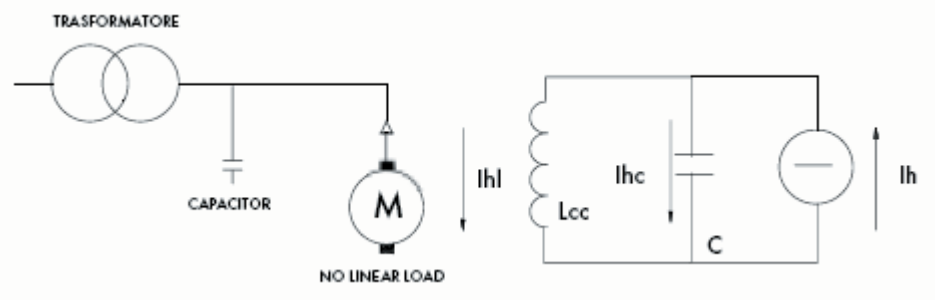
$$I = I_1 + I_2 + I_3 + \square I_n$$

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

$$\left\{ \xi_L = \frac{1}{\xi_C} \right.$$

The resonance is divided in two different typologies: ***series or parallel***.

The electric circuit could be represented with the equivalent circuit below:



The resonance is calculated in this way:

$$N = \sqrt{\frac{S_{CC}}{Q}} \div \sqrt{\frac{A \bullet 100}{Q \bullet V_{CC}\,\%}}$$

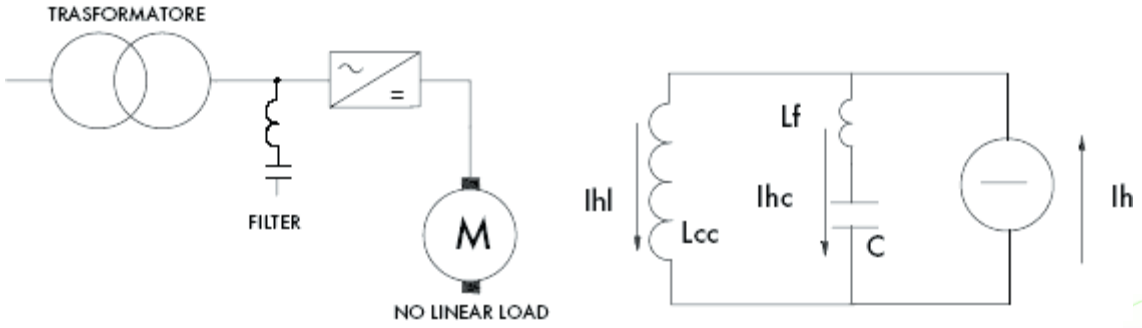
S_{CC} = Short-circuit power of the network (MVA)
Q = Output of power factor correction bank (kvar)
A = Transformer rated power (kva)
V_{CC} % = Short-circuit voltage
N = Harmonic order

In parallel resonance conditions, the current and the voltage of the circuit Lcc-C are hardly amplified like the harmonics. Hereinafter an example.

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

$$N = \sqrt{\frac{A \bullet 100}{Q \bullet V_{CC\,\%}}} = \sqrt{\frac{630 \bullet 100}{300 \bullet 6}} \div 6$$

The result shows that in this conditions the system transformer-capacitor bank has the parallel resonance frequency of 300Hz (N*50Hz). The most convenient solution is the detune filter, formed by 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.



It is easy verify that with this typology of solution the parallel resonance frequency is modified from

$$f_{P} = \frac{1}{2 \cdot \pi \cdot \sqrt{L_{CC} \cdot C}}$$

to

$$f_{P} = \frac{1}{2 \cdot \pi \cdot \sqrt{(L_{CC} + L_{f}) \cdot C}}$$

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

$$f_{S} = \frac{1}{2 \cdot \pi \cdot \sqrt{L_{f} \cdot C}}$$

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

$$THD = \frac{\sqrt{I^2 + I^2 + \ldots + I^2}}{I_1}$$

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 these equipments is linked to the circuit parameter:

- Impedance of the network (filterable effect decreases as the short-circuit power on the network increases: in same cases could be useful to add in series with the network a reactance to increase the filtering effect);
- Presence of possible and further loads that generate harmonics linked to other nodes on the network
- Capacitor types

The importance of capacitor type comes from the fact that the polypropylene metallic capacitors (standard capacitors) lose capacitance during time of operation; for example it could happen that after 2-3 years the capacitance decreases by 5% or more (this phenomena is caused typically by voltage and temperatures rise).

Decreasing the capacitance automatically varies the series resonance frequency $f_s = \frac{1}{2 \cdot \pi \cdot \sqrt{L_f \cdot C}}$ and this

Inconveniently could be very dangerous because the system could have parallel resonance. In this case, not only the filter does not absorb any more of the harmonics but also it amplifies them. To guarantee a constant capacitance during the time, it is necessary to use another type of capacitor in bi-metallic paper and with polypropylene totally impregnated (Reinforce type).
Besides the tuned filter made of capacitors and inductance (passive filter), it is possible to remove the harmonics in the network, using another type of construction of tuned filter: the ***Active Filter***. The working is based on the injection in the network of the same current harmonics created by the non-linear loads but with angle phase.

POWER FACTOR CORRECTION: QUALITY AND SAFETY

BASIC REQUIREMENT

We define "safety" as the absence of risks for people and equipment when in operation or in a warehouse. This involves the identification of all possible risks; eliminating or controlling them in order to reduce the risk factor to an acceptable level.
The capacitors and the banks MUST NOT be used other than power factor correction. If the capacitors are employed for purposes other than power factor correction, even filter components, their use with regard to safety conditions MUST be agreed with us.

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.
The user has to verify that the capacitor's and power factor correction equipment working voltage and frequency are 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 utilization.
Capacitors and power factor correction equipment MUST NOT be exposed to damping action of chemical substance or to attacks of flora and/or fauna. Capacitors and power factor correction equipment must be protected against risks of mechanical damaging due to which they could be exposed during normal working conditions or during the installation.
The storage or the installations are prohibited of capacitors and other power factor correction equipment that were mechanically or electrically damaged for any reason during the transport are prohibited.

ADDITIONAL INSTRUCTION ABOUT THE POWER FACTOR CORRECTION EQUIPMENT

Definition

Power factor correction equipment means:

- One or more groups of capacitors that can be connected and disconnectrd on the network automatically or by hand 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 the given instructions in the documentation attached considering the safe distance, the connection standard criteria, working standards and the instructions for the controls and the maintenance.

Compatibility
One must pay attention to the electromagnetic interferences with the nearby equipment.

Contactors
Contactors used must be suitable for use with capacitors (use category AC6-b) because, having ore-insertion resistance, are able to limit over currents that exist when we connect a capacitor bank.
($i = C \bullet \frac{d_v}{d_t}$)
The advance insertion, in respect of the main contactor eliminates the following hazards:

- Stops main contacts WELDING together
- Avoids capacitor damage

RECOMMENDATION FOR THE INSTALLATION

Fixing and connection
To fix the power factor correction equipment we advise using the following fixing accessories:

- Riphaso series with M10 screw
- FMN series with M10 screw
- wall-mounted with FISHER 8

The installation of the power factor correction equipment is for indoor application; for different installations call our 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 free from phenomena of re-strike free.
The active part of capacitors are made of polypropylene that is a flammable material. Even if a fire doesn't begin from the capacitors or inside the panel, they could 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" must be followed.

Danger for people
Installing power factor correction equipment one 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 if the tightening of the terminal and of all the bolts is correct.

PROTECTINS

Fuses
All the capacitors have an overpressure or internal fuse device which when operated, as in the case of breakdown, disconnects the element from use. This 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.

Voltages

Nominal voltage of a capacitor and of power factor correction equipment is the r.m.s. value of the alternating voltage for which the capacitor has been designed. Capacitor units shall be suitable for operation at voltage levels according to table below

Voltage	*Overvoltage Factor (times Urms)*	*Max, Duration*	*Observation*
Without harmonics	1,00	Continuous	Highest average value during any period of capacitor energized. For energized period less than 24h, exceptions apply as indicated below
Without harmonics	1,10	8h every 24h	System voltage regulation and fluctuation
Without harmonics	1,15	30 min. every 24h	System voltage regulation and fluctuation
Without harmonics	1,20	5 min	Voltage rise at light load
Without harmonics	1,30	1 min	

Table 4

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
- The voltage at the capacitor terminals increases when capacitors are in series with inductors for the harmonic control
- 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-excitation after that the equipment 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, one must be aware of the overvoltage when this device is working
- All the power factor correction equipment exposed to overvoltage caused by atmospheric discharge must be protected in correct way. If used the dischargers for overvoltages 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. Therefore, it is very important that heat generated dissipated correctly and the ventilation be in such a way that the heat loses in the capacitors do not exceed the ambient temperature limits. The highest working temperature in normal service conditions between two capacitors; Occurs at a point 2/3 of the capacitors height and at a distance of 0.1m from them. The capacitors temperature must not exceed the temperature limits hereinafter tabled.

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

Table 5

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 $\sqrt{2}V_N$ 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 one to short-circuit the capacitor terminals and earth each he needs to handle the capacitor.

Residual voltage
The residual voltage of a capacitor in service must not exceed 10% of the nominal voltage. This condition is generally satisfied in power factor correction equipment by setting reconnection time of the bank at 30 seconds, on the reactive power regulator or adding an extra discharging system.

Case connection
The cases of all metallic capacitors are fixed at earth. The case is earthed to the frame on which the capacitors are fixed.

Altitude
Power factor correction equipment must not be used above an altitude of 2000m. Otherwise, please call up our technical assistance.

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 call up our technical assistance of.

MAINTENANCE

After the disconnection of the bank, prior to accessing the terminals of the capacitors wait 5 minute and then short-circuit the terminals and earth.

Once a month

- Cleanliness by blast of air of the internal part of the power factor correction equipment and of the air filter if 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 it might be necessary to clean using blasts of air more frequently).

STORAGE AND HANDLING

Handling of the power factor correction equipment must be done with care avoiding mechanical stresses. Capacitors not installed must be stored with their packages in a dry and protected place.

PRODUCTION

Reactive Power Compensation SOLUTION

POWER FACTOR CORRECTION CAPACITORS

Cylindrical Single-Phase Dry Type Capacitor **CSC TYPE**

Construction

Dielectric: Polypropylene film

Non PCB, Resin or oil impregnated

Extruded round aluminium can with stud

Features

Single phase

Naturally air cooled or forced air cooling

Indoor mounting

Typical applications

PFC and detuned systems
(normal or filter type capacitor banks)

Terminals

Fast-on terminal

Mounting parts

Threated stud at bottom of can
Max. torque = 10 Nm for M12(Q 63.5mm)

POWER FACTOR CORRECTION CAPACITORS

Cylindrical Single-Phase Dry Type Capacitor **CSC TYPE**

Technical characteristics

Characteristics	
Rated voltage Ur	Ur=230~525 volt
Rated frequency Fr	Fr=50/60HZ
Capacitance tolerance	-5/+10%
Mean life expectancy	100 000 operating hours
Case/shape	Aluminum/cylindrical
Safety	Self-healing technology, overpressure disconnector,
Standard	CEI EN 60831-1/2
Maximum rating	
Max permissible overcurrent Imax	1.3*In
Max permissible overvoltage Umax	Ur+10% (up to 8h daily) Ur+15% (up to 30m daily) Ur+20% (up to 5m daily) Ur+30% (up to 1m daily)
Number of switching operations	Max. 5 000 switching per year according IEC 831
Transient inrush current (max) Is	100*Ir
Losses:	
Dielectric	< 0.2 W/kvar
Total	< 0.5 W/kvar
Insulating voltage	3/15 KV (Ur<660V)
Terminal voltage test	2.15*Ur, 10s
Temperature class	-25/D Max. temp. 55 ˚C Max. mean 24h = 45 ˚C Max. mean 1year = 35 ˚C
Enclosure	IP00
Permissible maximum humidity	95%
Maximum permissible altitude	2 000m above sea level
Mounting posirtion	Upright
Mounting and grounding	Threated M12

POWER FACTOR CORRECTION CAPACITORS

Cylindrical Single-Phase Dry Type Capacitor **CSC TYPE**

Rated voltage: 230 VAC, 50/60 Hz

Type	50 Hz		60 Hz		Cn	d*h	Weight	Drawing code
	Output kvar	Ir A	Output kvar	Ir A	µf	mm	Approx kg	see next page
CSC23	0.41	1.78	0.5	2.17	25	40*103	0.30	1
CSC23	0.83	3.61	1	4.34	50	45*128	0.30	2
CSC23	1.66	7.2	2	8.7	100	60*138	0.36	4

Rated voltage: 400 VAC, 50/60 Hz

Type	50 Hz		60 Hz		Cn	d*h	Weight	Drawing code
	Output kvar	Ir A	Output kvar	Ir A	µf	mm	Approx kg	see next page
CSC40	0.83	2.075	1	2.5	16.6	40*103	0.30	1
CSC40	1.66	4.15	2	5	33.3	55*128	0.32	3
CSC40	2.08	5.2	2.5	6.25	41.4	55*128	0.32	3
CSC40	3.33	8.3	4	10	66.6	60*138	0.36	4
CSC40	4.16	10.4	5	12.5	82.7	60*138	0.36	4

Rated voltage: 440 VAC, 50/60 Hz

Type	50 Hz		60 Hz		Cn	d*h	Weight	Drawing code
	Output kvar	Ir A	Output kvar	Ir A	µf	mm	Approx kg	see next page
CSC44	0.83	1088	1	2.27	13.6	40*103	0.30	1
CSC44	1.66	3.77	2	4.54	27.3	45*128	0.32	2
CSC44	3.33	7.57	4	9.1	54.7	60*138	0.36	4

Rated voltage: 460 VAC, 50/60 Hz

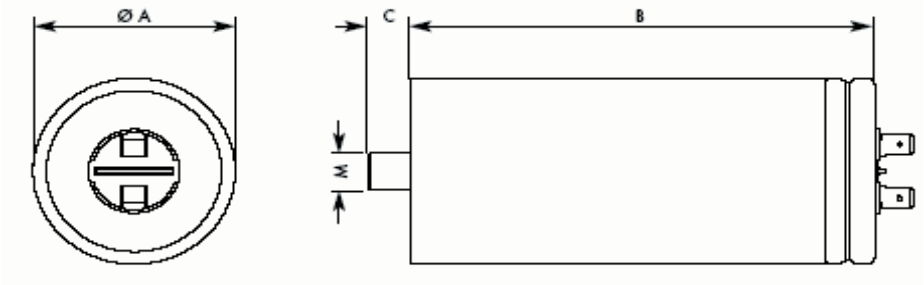
Type	50 Hz		60 Hz		Cn	d*h	Weight	Drawing code
	Output kvar	Ir A	Output kvar	Ir A	µf	mm	Approx kg	see next page
CSC46	0.83	1.8	1	2.17	12.5	45*128	0.32	2
CSC46	1.66	3.6	2	4.34	25	55*128	0.32	3
CSC46	3.33	7.24	4	8.7	50	60*138	0.36	4

*Other voltage on request

POWER FACTOR CORRECTION CAPACITORS

Cylindrical Single-Phase Dry Type Capacitor **CSC TYPE**

Dimensional drawing



Drawing code	ØA	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

POWER FACTOR CORRECTION CAPACITORS

Cylindrical Three-Phase Dry Type Capacitor **CRT TYPE**

Construction

- Dielectric: Polypropylene film
- Resin impregnated / dry type
- Extruded round aluminium can with stud

Features

- Three phase, delta connected
- Self-healing technology
- Overpressure disconnector switch
- Filled with self extinguish resin
- Discharge resistor
- Protection cover (optional)
- Naturally air cooled or forced air cooling
- Indoor mounting

Typical applications

For Fix and Automatic Power Factor Correction Systems
(normal or filter type capacitor banks)

Terminals

Terminal board or Screw connections

Mounting parts

Threated stud at bottom of can
Max. torque = 10 Nm for M12(Q 63.5mm)

POWER FACTOR CORRECTION CAPACITORS

Cylindrical Three-Phase Dry Type Capacitor **CRT TYPE**

Technical data and specification

Characteristics	
Rated power	2.5 up to 30 kvar
Rated voltage Ur	Ur=230~440 volt
Rated frequency Fr	Fr=50/60HZ
Capacitance tolerance	-5/+10%
Case/shape	Aluminum/cylindrical
Safety	Self-healing technology, overpressure disconnector,
Installation	Indoor
Maximum rating	
Max permissible overcurrent Imax	1.3*In
Max permissible overvoltage Umax	Ur+10% (up to 8h daily) Ur+15% (up to 30m daily) Ur+20% (up to 5m daily) Ur+30% (up to 1m daily)
Transient inrush current (max) Is	100*Ir
Losses:	
Dielectric	< 0.2 W/kvar
Total	< 0.5 W/kvar
Test data	
Insulating voltage	3/15 KV (Ur<660V)
Terminal voltage test	2.15*Ur, 10s
tano (50Hz)	< 0.5 W/kvar
Climatic category / -25/D	
Temperature class	-25/D Min. temp. -25 ˚C Max. temp. +55˚C Max. mean 1year = 35 ˚C
Permissible maximum humidity	95%
Maximum permissible altitude	2 000m above sea level
Mean life expectancy	
Mean life expectancy	100 000 operating hours
Number of switching operations	Max. 5 000 switching per year according IEC 831

POWER FACTOR CORRECTION CAPACITORS

Cylindrical Three-Phase Dry Type Capacitor **CRT TYPE**

Design data	
Dimension	See dimensional drawing at page 5
Weight approx	1~2.5 Kg (see on selection guide tables at page 4)
Mounting posirtion	Any mounting position possible.
Mounting and grounding	Threated bolt M12
Enclosure	IP00, IP20(with cover)

Terminals	
Degree of protection	Isolated terminals, IP20
Max. torque	1.2 Nm
Terminal cross section	16 mm^2
Max. terminal current	50 A
Creepage distance	12.7 mm
Clearance	9.6 mm

Safety	
Mechanical safety	Overpressure disconnector
Discharge resistor time	< 3 minutes to 75 V

Reference Standards
IEC EN 60831-1
IEC EN 60831-2

POWER FACTOR CORRECTION CAPACITORS

Cylindrical Three-Phase Dry Type Capacitor **CRT TYPE**

Rated voltage: 400 VAC, 50 Hz

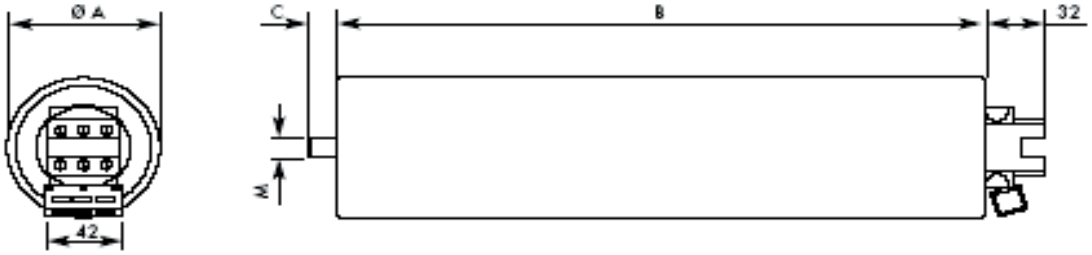
Type	50 Hz		Cn	Diameter	Height	Weight	Drawing code
	Output kvar	Ir A	µf	mm	mm	kg	see next page
CRT-78M-02-400	2.5	3.6	3*16.5	75	210	1	1
CRT-78M-05-400	5	7.2	3*33	75	210	1	1
CRT-78M-07-400	7.5	10.8	3*50	75	247	1.2	2
CRT-78M-10-400	10	14.4	3*66	85	247	1.8	3
CRT-78M-12-400	12.5	18	3*83	85	285	2	4
CRT-78M-15-400	15	21.7	3*100	85	360	2.3	5
CRT-78M-20-400	20	28.9	3*133	85	360	2.3	5
CRT-78M-25-400	25	36.1	3*166	100	295	2.8	6
CRT-78M-30-400	30	43.3	3*199	100	373	2.8	7

*Other voltage on request

POWER FACTOR CORRECTION CAPACITORS

Cylindrical Three-Phase Dry Type Capacitor **CRT TYPE**

Dimensional drawing



Drawing code	8A	B	C	M
1	75	210	16	12
2	75	247	16	12
3	85	247	16	12
4	85	285	16	12
5	85	360	16	12
6	100	295	16	12
7	100	373	16	12

POWER FACTOR CORRECTION CAPACITORS

Cylindrical Three-Phase Dry Type Capacitor **CTC TYPE**

Construction

- Dielectric: Polypropylene film
- Resin impregnated / dry type
- Extruded round aluminium can with stud

Features

- Three phase, delta connected
- Self-healing technology
- Overpressure disconnector switch
- Filled with self extinguish resin
- Discharge resistor
- Protection cover (optional)
- Naturally air cooled or forced air cooling
- Indoor mounting

Typical applications

For Fix and Automatic Power Factor Correction Systems
(normal or filter type capacitor banks)

Terminals

Terminal board

Mounting parts

Threated stud at bottom of can
Max. torque = 10 Nm for M12(Q 63.5mm)

POWER FACTOR CORRECTION CAPACITORS

Cylindrical Three-Phase Dry Type Capacitor **CTC TYPE**

Technical data and specification

Characteristics	
Rated power	2.5 up to 20 kvar
Rated voltage Ur	Ur=400 volt
Rated frequency Fr	Fr=50/60HZ
Capacitance tolerance	-5/+10%
Case/shape	Aluminum/cylindrical
Safety	Self-healing technology, overpressure disconnector,
Installation	Indoor
Maximum rating	
Max permissible overcurrent Imax	1.3*In
Max permissible overvoltage Umax	Ur+10% (up to 8h daily) Ur+15% (up to 30m daily) Ur+20% (up to 5m daily) Ur+30% (up to 1m daily)
Transient inrush current (max) Is	100*Ir
Losses:	
Dielectric	< 0.2 W/kvar
Total	< 0.5 W/kvar
Test data	
Insulating voltage	3/15 KV (Ur<660V)
Terminal voltage test	2.15*Ur, 10s
tano (50Hz)	< 0.5 W/kvar
Climatic category / -25/D	
Temperature class	-25/D Min. temp. -25 ˚C Max. temp. +55 ˚C Max. mean 1year = 35 ˚C
Permissible maximum humidity	95%
Maximum permissible altitude	2 000m above sea level
Mean life expectancy	
Mean life expectancy	100 000 operating hours
Number of switching operations	Max. 5 000 switching per year according IEC 831

POWER FACTOR CORRECTION CAPACITORS

Cylindrical Three-Phase Dry Type Capacitor **CTC TYPE**

Design data	
Dimension	See dimensional drawing at page 5
Weight approx	1~2.5 Kg (see on selection guide tables at page 4)
Mounting posirtion	Any mounting position possible.
Mounting and grounding	Threated bolt M12
Enclosure	IP00, IP20(with cover), IP54(for polemounted purpose)

Terminals	
Degree of protection	Isolated terminals, IP20
Max. torque	1.2 Nm
Terminal cross section	16 mm^2
Max. terminal current	50 A
Creepage distance	12.7 mm
Clearance	9.6 mm

Safety	
Mechanical safety	Overpressure disconnector
Discharge resistor time	< 3 minutes to 75 V

Reference Standards
IEC EN 60831-1
IEC EN 60831-2

POWER FACTOR CORRECTION CAPACITORS

Cylindrical Three-Phase Dry Type Capacitor **CTC TYPE**

Rated voltage: 400 VAC, 50 Hz

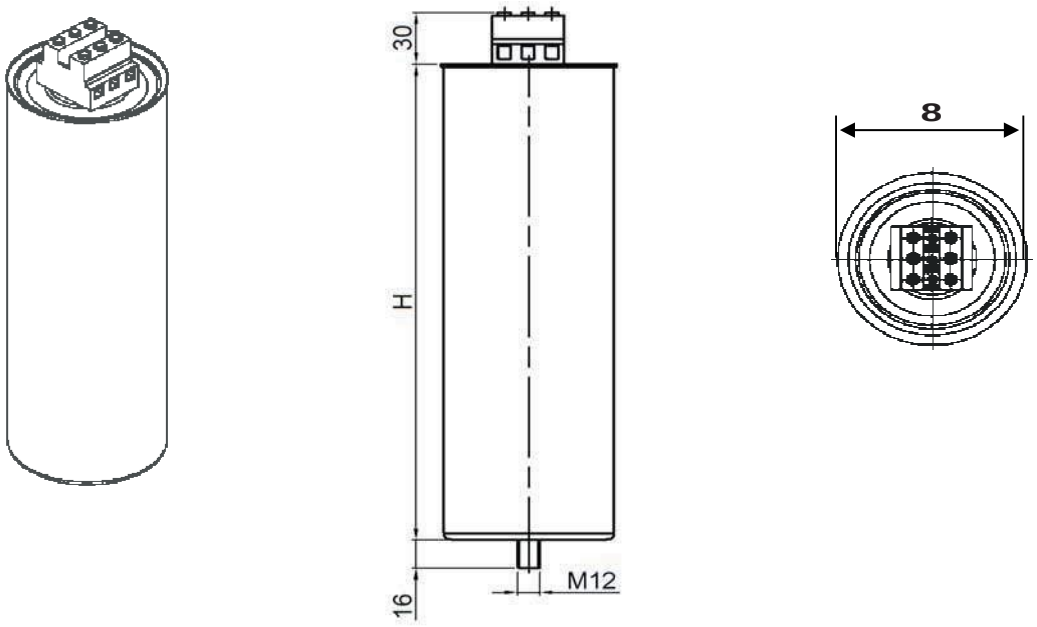
Type	50 Hz		Cn	Diameter	BOX Height	Drawing code
	Output kvar	Ir A	µf	mm	mm	see next page
CTC1-11A-02-400	2.5	3.6	3*16.5	70	173	1
CTC1-11A-05-400	5	7.2	3*33	70	173	1
CTC1-11A-07-400	7.5	10.8	3*50	90	173	2
CTC1-11A-10-400	10	14.4	3*66	90	173	2
CTC1-11A-12-400	12.5	18	3*83	70	286	3
CTC1-11A-15-400	15	21.7	3*100	90	286	4
CTC1-11A-17-400	17.5	25.3	3*116	90	286	4
CTC1-11A-20-400	20	28.9	3*133	90	286	4
CTC1-11A-25-400	25	36	3*166	90	286	4
CTC1-11A-30-400	30	43.3	3*199	90	286	4

*Other voltage on request

POWER FACTOR CORRECTION CAPACITORS

Cylindrical Three-Phase Dry Type Capacitor **CTC TYPE**

Dimensional drawing



Drawing code	ø	H
1	70	173
2	90	173
3	70	286
4	90	286

POWER FACTOR CORRECTION CAPACITORS

Rectangular Three-Phase Dry Type Capacitor **FMN TYPE**

Construction

- Dielectric: Polypropylene film
- Resin impregnated / dry type
- Fitted in Steel cubical container
  (with 60µm thickness painting)

Features

- Three phase, delta connected
- Self-healing technology
- Separate internal fuse for each element
- Void spaces are filled with an inert, non-flammable, humidity absorbant mineral material
- Discharge resistor
- Protection cover
- Naturally air cooled or forced air cooling
- Indoor mounting

Typical applications

For Fix and Automatic Power Factor Correction Systems
(normal type capacitor banks)

Terminals

Connection terminals M10
Max. torque = 15 Nm for M10

POWER FACTOR CORRECTION CAPACITORS

Rectangular Three-Phase Dry Type Capacitor **FMN TYPE**

Technical data and specification

Characteristics	
Rated power	5 up to 100 kvar
Rated voltage Ur	Ur=230~690 volt
Rated frequency Fr	Fr=50/60HZ
Capacitance tolerance	-5/+10%
Case/shape	Steel container (with 60µm thickness painting)
Safety	Self-healing technology, Internal fuse,
Installation	Indoor
Maximum rating	
Max permissible overcurrent Imax	1.3*In
Max permissible overvoltage Umax	Ur+10% (up to 8h daily) Ur+15% (up to 30m daily) Ur+20% (up to 5m daily) Ur+30% (up to 1m daily)
Transient inrush current (max) Is	100*Ir
Losses:	
Dielectric	< 0.2 W/kvar
Total	< 0.5 W/kvar
Test data	
Insulating voltage	3/15 KV (Ur<660V)
Terminal voltage test	2.15*Ur, 10s
tano (50Hz)	< 0.5 W/kvar
Climatic category / -40/D	
Temperature class	-40/D Min. temp. -40 ˚C Max. temp. +55 ˚C
Permissible maximum humidity	95%
Maximum permissible altitude	2 000m above sea level
Mean life expectancy	
Mean life expectancy	160 000 operating hours
Number of switching operations	Max. 5 000 switching per year according IEC 831

POWER FACTOR CORRECTION CAPACITORS

Rectangular Three-Phase Dry Type Capacitor **FMN TYPE**

Design data	
Dimension	See dimensional drawing at page 5
Weight approx	4~17 Kg (see on selection guide tables at page 4)
Mounting posirtion	Upright
grounding	bolt M6
Enclosure	IP2X(with cover)

Terminals	
Degree of protection	Isolated terminals, IP20
Max. torque	15 Nm
Max. terminal current	150 A

Safety	
Mechanical safety	Internal fuse
Discharge resistor time	< 5 minutes to 75 V

Reference Standards
IEC EN 60831-1
IEC EN 60831-2
IEC 70/70A
BS 1650

POWER FACTOR CORRECTION CAPACITORS

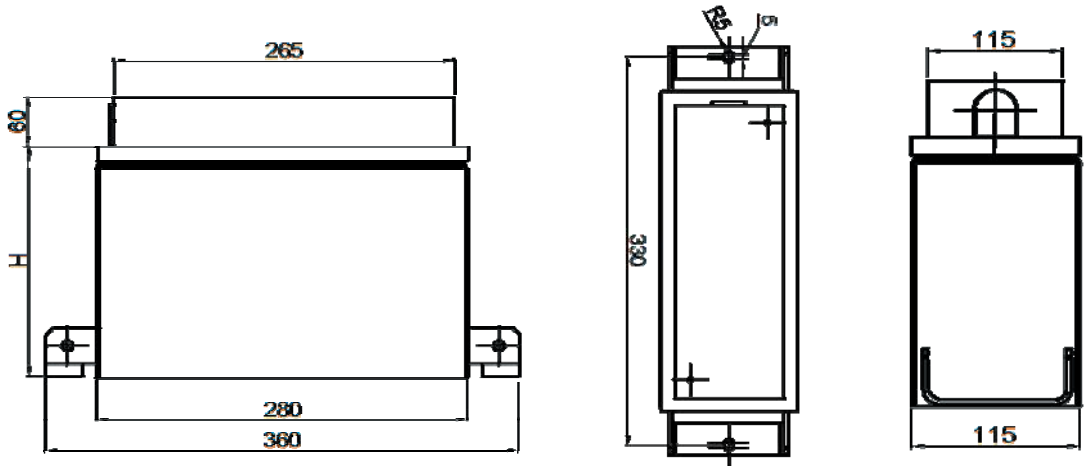
Rectangular Three-Phase Dry Type Capacitor **FMN TYPE**

Rated voltage: 400 VAC, 50 Hz

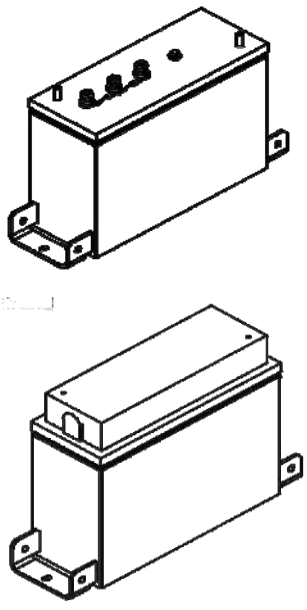
Type	50 Hz Output kvar	Ir A	Wide W mm	Length D mm	Height H mm	Weight kg	Drawing code see next page
FMN 4005	5	7.2	117	360	180	3	1
FMN 4010	10	14.4	117	360	180	4	1
FMN 4012	12.5	18	117	360	180	4	1
FMN 4015	15	21.6	117	360	180	5	1
FMN 4020	20	28.9	117	360	180	5	1
FMN 4025	25	36.1	117	360	230	6	2
FMN 4030	30	43.3	117	360	230	6	2
FMN 4040	40	57.8	117	360	270	8	3
FMN 4050	50	72.2	117	360	330	9	4
FMN 4060	60	86.7	117	360	460	11	5
FMN 4075	75	108.3	117	360	460	14	5
FMN 4080	80	115.6	117	360	460	14	5
FMN 4099	100	144.5	117	360	550	17	6

*Other voltage on request

Dimensional drawing



Drawing code	D	W	H
1	360	117	180
2	360	117	230
3	360	117	270
4	360	117	330
5	360	117	460
6	360	117	550



POWER FACTOR CORRECTION CAPACITORS

Rectangular Three-Phase Dry Type Capacitor **PCD TYPE**

Construction

- Dielectric: Polypropylene film
- Oil impregnated / dry type
- Fitted in Steel cubical container
  (with 70µm thickness painting - RAL5024)

Features

- Three phase, delta connected
- Self-healing technology
- Separate overpressure switch for each element
- Discharge resistor
- Equipped with epoxy resin insulator
- Naturally air cooled or forced air cooling
- Indoor mounting
- Equipped with earth terminal

Typical applications

For Fix and Automatic Power Factor Correction Systems
(normal type capacitor banks)

Terminals

Connection terminals M10
Max. torque = 15 Nm for M10

Technical data and specification

Characteristics	
Rated power	5 up to 60 kvar
Rated voltage Un	Un=230~690 volt
Rated frequency Fn	Fn=50/60HZ
Capacitance tolerance	-5/+10%
Case/shape	Steel container (with 70μm thickness painting)
Safety	Self-healing technology, overpressure disconnector
Installation	Indoor
Maximum rating	
Max permissible overcurrent Imax	1.3*In
Max permissible overvoltage Umax	Un+10% (up to 8h daily) Un+15% (up to 30m daily) Un+20% (up to 5m daily) Un+30% (up to 1m daily)
Transient inrush current (max) Is	100*Ir
Losses:	
Dielectric	< 0.2 W/kvar
Total	< 0.5 W/kvar
Test data	
Insulating voltage	3/15 KV (Un<660V)
Terminal voltage test	2.15*Un, 10s
tano (50Hz)	< 0.5 W/kvar
Climatic category / -40/D	
Temperature class	-25/D Min. temp. -25 ˚C Max. temp. +55 ˚C
Permissible maximum humidity	95%
Maximum permissible altitude	2 000m above sea level
Mean life expectancy	
Mean life expectancy	100 000 operating hours
Number of switching operations	Max. 5 000 switching per year according IEC 831

POWER FACTOR CORRECTION CAPACITORS

Rectangular Three-Phase Dry Type Capacitor **PCD TYPE**

Design data	
Dimension	See dimensional drawing at page 5
Weight approx	4~17 Kg (see on selection guide tables at page 4)
Mounting posirtion	Upright
grounding	bolt M6
Enclosure	IP 00

Terminals	
Degree of protection	Isolated terminals, IP20
Max. torque	15 Nm
Max. terminal current	150 A

Safety	
Mechanical safety	Over pressure switch
Discharge resistor time	< 5 minutes to 75 V

Reference Standards
IEC EN 60831-1
IEC EN 60831-2
IEC 70/70A
BS 1650

POWER FACTOR CORRECTION CAPACITORS

Rectangular Three-Phase Dry Type Capacitor **PCD TYPE**

Rated voltage: 400 VAC, 50 Hz

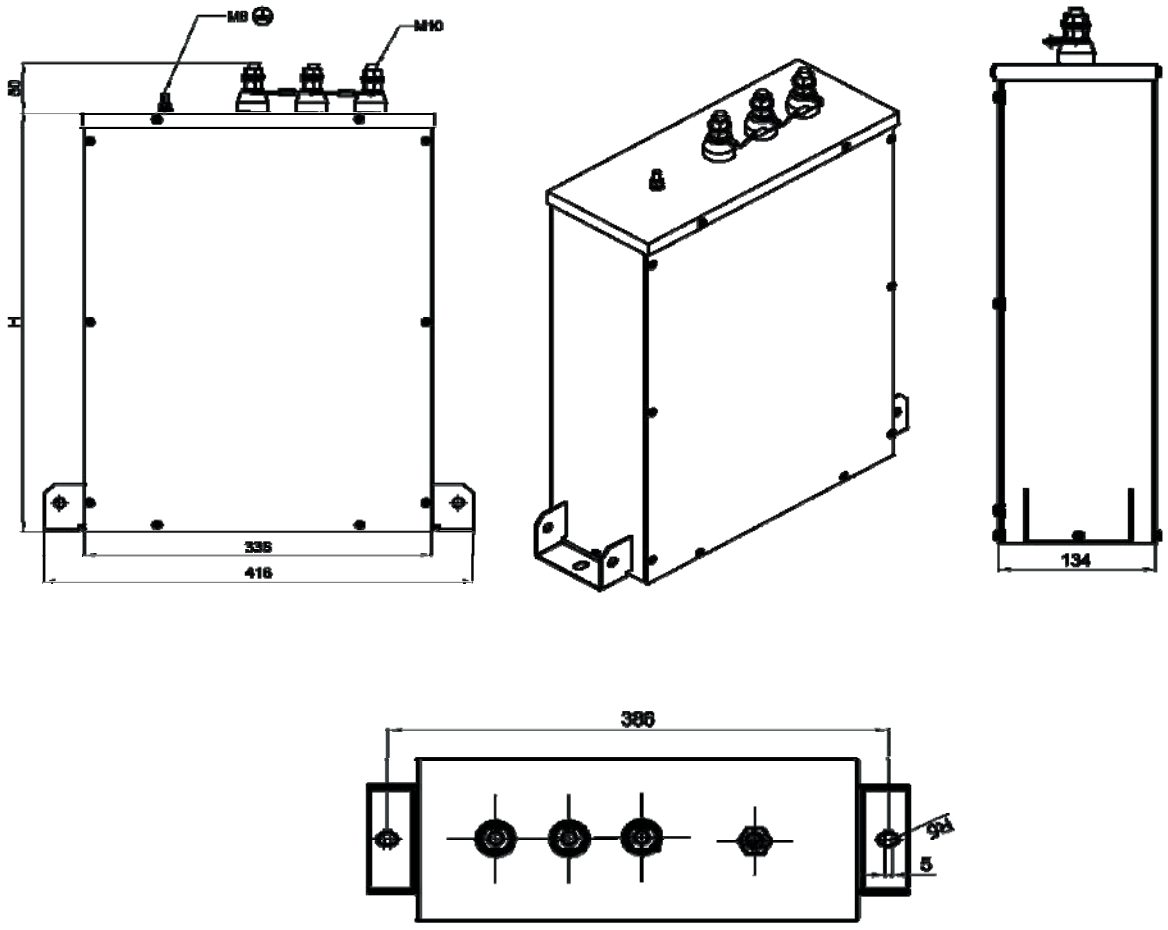
Type	50 Hz Output kvar	In A	Wide W mm	Length D mm	Height H mm	Weight kg	Drawing code see next page
PCD 4005	5	7.2	134	336	220		1
PCD 4010	10	14.4	134	336	220		1
PCD 4012	12.5	18	134	336	220		1
PCD 4015	15	21.6	134	336	220		1
PCD 4020	20	28.9	134	336	220		1
PCD 4025	25	36.1	134	336	220		1
PCD 4030	30	43.3	134	336	220		1
PCD 4040	40	57.8	134	336	440		2
PCD 4050	50	72.2	134	336	440		2
PCD 4060	60	86.7	134	336	440		2

*Other voltage on request

POWER FACTOR CORRECTION CAPACITORS

Rectangular Three-Phase Dry Type Capacitor **PCD TYPE**

Dimensional drawing



Drawing code	D	W	H
1	360	117	220
2	360	117	440

POWER FACTOR CORRECTION CAPACITORS

Rectangular Three-Phase Dry Type Capacitor **Riphaso TYPE**

Construction

- Dielectric: Polypropylene film
- Non PCB, Oil impregnated internal elements
- impregnated with biodegradable ambient compatible PCB free dielectric fluid
- Metalic enclosure painted with epossidic dust paint, colour RAL7032

Features

- Three phase, delta connected
- Self-healing technology
- Overpressure disconnector switch
- Discharge resistor
- Protection cover
- Naturally air cooled or forced air cooling
- Indoor mounting

Typical applications

For Fix and Automatic Power Factor Correction Systems (normal or filter type capacitor banks)

Terminals

Connection terminals M8*20 screw
Max. torque = 10 Nm for M8

POWER FACTOR CORRECTION CAPACITORS

Rectangular Three-Phase Dry Type Capacitor **Riphaso TYPE**

Technical data and specification

Characteristics	
Rated power	5 up to 50 kvar
Rated voltage Ur	Ur=230~690 volt
Rated frequency Fr	Fr=50/60HZ
Capacitance tolerance	-5/+10%
Case/shape	Metalic enclosure painted with epossidic dust paint,
Safety	Self-healing technology, Overpressure disconnector,
Installation	Indoor
Maximum rating	
Max permissible overcurrent Imax	1.3*In
Max permissible overvoltage Umax	Ur+10% (up to 8h daily) Ur+15% (up to 30m daily) Ur+20% (up to 5m daily) Ur+30% (up to 1m daily)
Transient inrush current (max) Is	100*Ir
Losses:	
Dielectric	< 0.2 W/kvar
Total	< 0.5 W/kvar
Test data	
Insulating voltage	3/15 KV (Ur<660V)
Terminal voltage test	2.15*Ur, 10s
tano (50Hz)	< 0.5 W/kvar
Climatic category	
Temperature class	 Min. temp. -25 ˚C Max. temp. +60 ˚C
Permissible maximum humidity	95%
Maximum permissible altitude	2 000m above sea level
Mean life expectancy	
Mean life expectancy	100 000 operating hours
Number of switching operations	Max. 5 000 switching per year according IEC 831

Design data	
Dimension	See dimensional drawing at page 5
Weight approx	4~11 Kg (see on selection guide tables at page 4)
Mounting posirtion	Upright
Enclosure	IP21

Terminals	
Degree of protection	Isolated terminals, IP3X
Max. torque	10 Nm
Max. terminal current	80 A

Safety	
Mechanical safety	Overpressure disconnector
Discharge resistor time	< 5 minutes to 75 V

Reference Standards
IEC EN 60831-1
IEC EN 60831-2

POWER FACTOR CORRECTION CAPACITORS

Rectangular Three-Phase Dry Type Capacitor **Riphaso TYPE**

Rated voltage: 400 VAC, 50 Hz

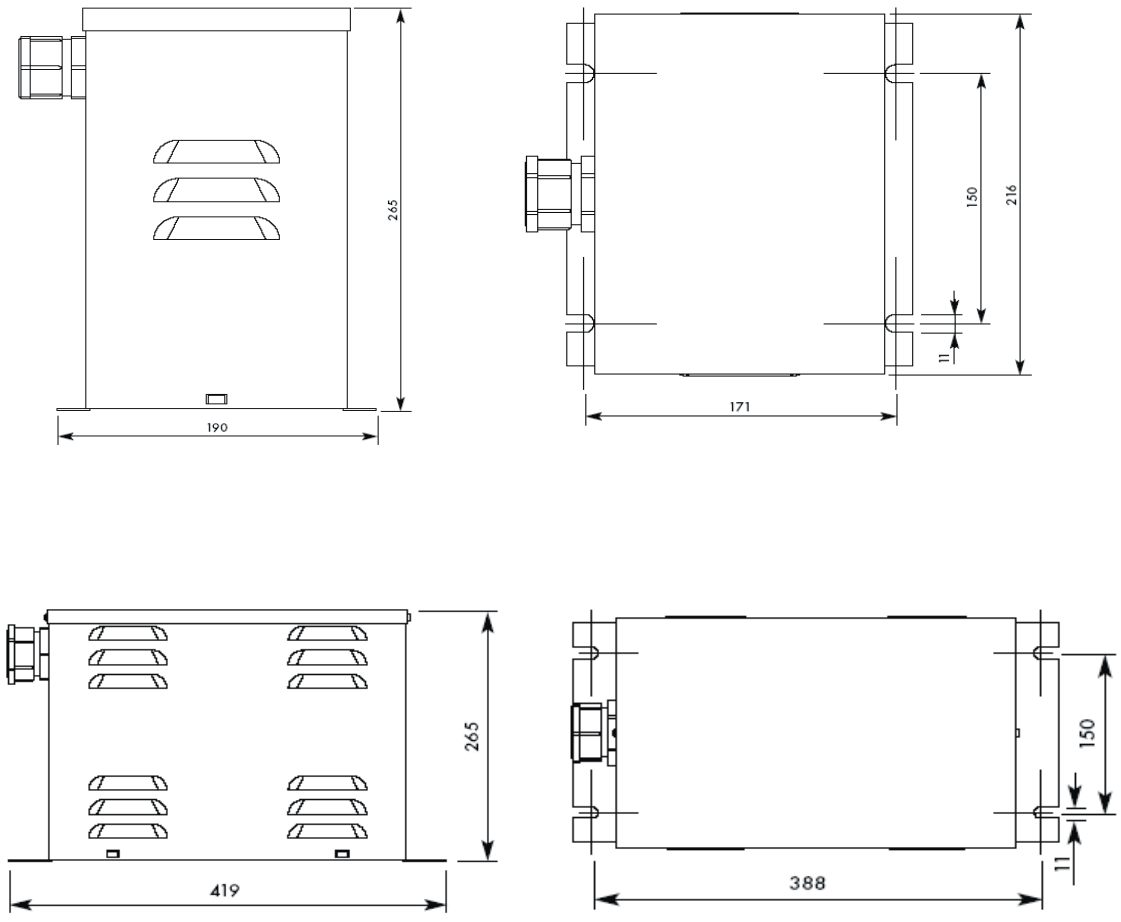
Type	50 Hz		Wide	Length	Height	Weight
	Output kvar	Ir A	mm	mm	mm	kg
RPH 4005	5	7.2	117	190	265	4.5
RPH 4010	10	14.4	117	190	265	5
RPH 4012	12.5	18	117	190	265	5.5
RPH 4015	15	21.6	117	190	265	6
RPH 4020	20	28.9	117	190	265	6.5
RPH 4025	25	36.1	117	419	265	7.5
RPH 4030	30	43.3	117	419	265	8
RPH 4040	40	57.8	117	419	265	9.5
RPH 4050	50	72.2	117	419	265	11

*Other voltage on request

POWER FACTOR CORRECTION CAPACITORS

Rectangular Three-Phase Dry Type Capacitor **Riphaso TYPE**

Dimensional drawing



POWER FACTOR CONTROLLER

Reactive Power Regulator **CBR3006&3012 SERIES**

Construction

- Intelligent controller to maximize availability
- Advanced harmonic calculation
- Self identification capability
- Up to 30 parameters setting
- User friendly

Features

- 6 & 12 output stages
- One output alarm relay
- Advanced alarm system
- Temperature measurement
- Detection of defective stage (e.g. fuse failure or contactor welded)
- Target power factor change over input
- Capacitor harmonic over current calculation (di%)
- Measuring & display of V, A, P, Q, Qc, temperature, di%
- Monitoring & recording of switching No & using time of each step

Typical applications

automatic power factor controller
(normal or filter type capacitor banks)

Terminals

Plug in terminals

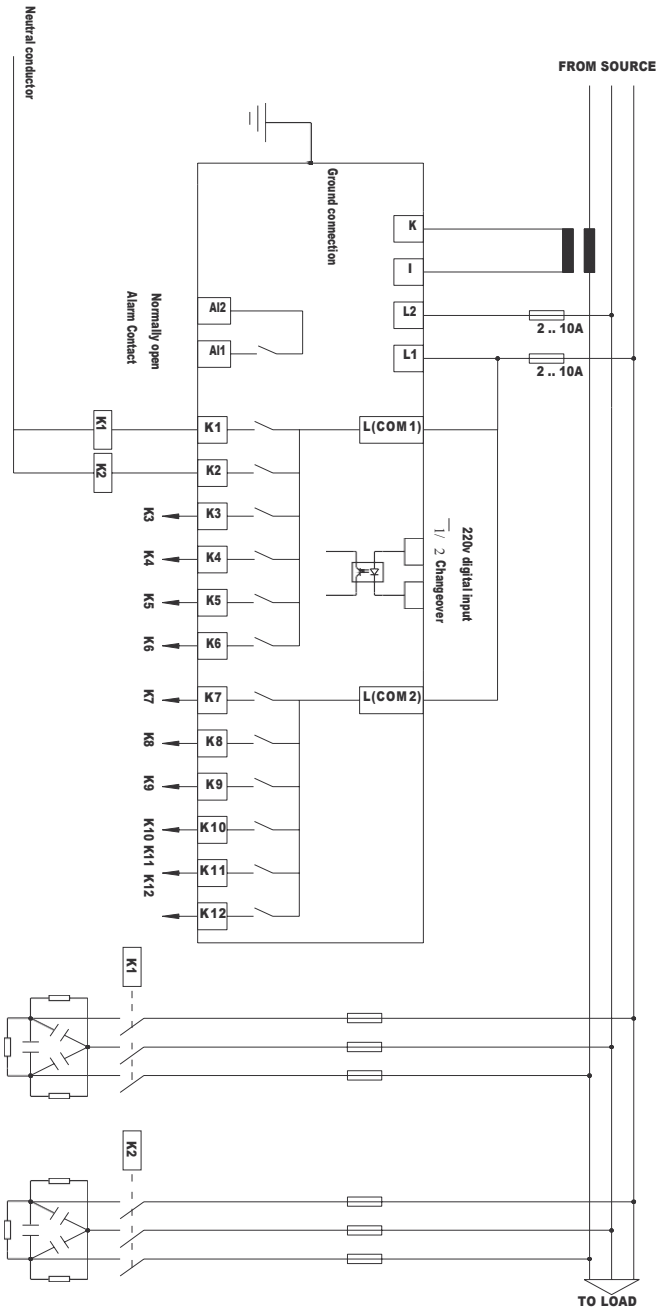
POWER FACTOR CONTROLLER

Reactive Power Regulator **CBR3006&3012 SERIES**

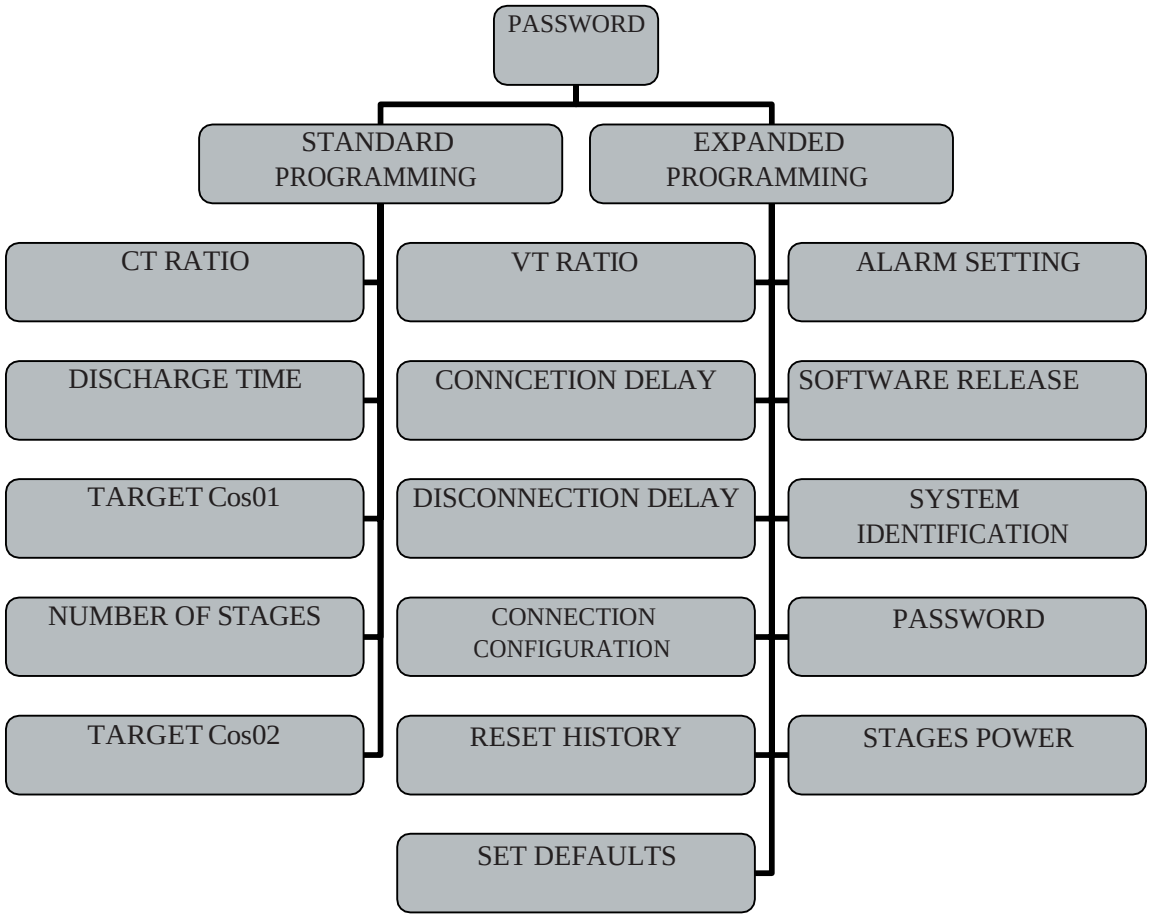
Technical characteristics

Characteristics	
Rated voltage Ur	Ur=400 volt
Rated frequency Fr	Fr=50 & 60HZ
Number of stage	1~12
Alarm relay	Included
Interface	RS232 (optional)
Tariff cos0 changeover	Included
Output data	
Number of relay	6 or 12
Switching voltage	250 VAC
Switching power	2000 VA
Measurement data	
Measurement voltage range	Phase to Phase 380V
Measurment current	1 & 5 A (self configurable)
Min. current measuring	20 mA
Max. current	5.5 A
Fundamental frequency	50 & 60 Hz available
Operation data	
Supply voltage	400 VAC ±10%
Frequency	50 & 60 Hz
Power consumption	7VA
Ambient data	
Operation temperature	Min. temp. -10 ˚C Max. temp. +65 ˚C
Over voltage class	3
Pollution degree	2
Mounting position	138*138 mm
Operation height	Max. 2 000m over NN
Humidity class	15% to 95% with out dew
Protection class	Front plate IP65 (IEC529) Rear side IP20 (IEC529)
Mechanical data	
Weight	1.1 Kg
Dimension	140*140*71mm

Electrical drawing



Regulator menu



REACTOR FOR FILTERING

Detune Harmonic Filter Reactors **R & RB TYPE**

Construction

- Built with oriented grain iron sheet and cooper windings
- Anti saturation characteristics and very low losses
- Vacuum impregnated with a varnish having high insulation properties

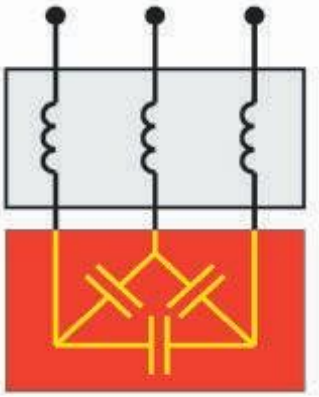
Features

- Internal insulation class F
- Protaction thermostat
- Vacuum varnish impregnation
- Indoor installation
- For Banks with electro-mechanical contactors

Typical applications

Correct the following problems:
Resonance in L.V. supply, caused by the power factor correction equipment
Detune of harmonics incertain parts of the distribution

REACTOR WIRING



R or RB Reactor

Capacitor
with special characteristics

Banks with electro-mechanical contactors

REACTOR FOR FILTERING

Detune Harmonic Filter Reactors **R & RB TYPE**

Technical data and specification

Characteristics	
Rated power	5 up to 120 kvar
Rated voltage Ur	Ur=400 volt
Rated frequency Fr	Fr=50/60HZ
Safety	Thernostat with trip temperature 90˚C
Tolerance	3%
Insulation voltage	4 KV
Linearity	1.8 In
Core material	Oriented grain coating (with multiple scatters in RB type)
Conductor material	Copper wire / Aluminium band (RB type)
Protection grade	IP00
Maximum rating	
Overcurrent:	
Permanent	1.7 In
Transient(1min)	2 In
Temperature category / Class F	
Temperature class	F(155 ˚C)
Permissible maximum humidity	95%
Maximum permissible altitude	1 000m above sea level
Assembly conditions	
Installation	Indoor
Mounting	Vertical
Connection	Terminal block (R type) / Aluminuim busbar (RB type)
Minimum distance between reactors	4 cm
Reference Standards	
IEC 289	
IEC 076	

REACTOR FOR FILTERING

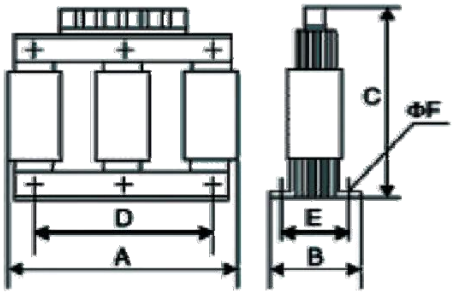
Detune Harmonic Filter Reactors **R & RB TYPE**

Rated voltage: 400 VAC, 50 Hz

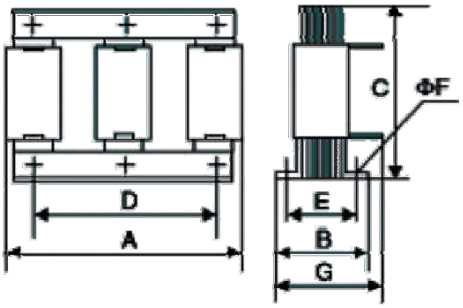
Type	50 Hz Output kvar	P	In A	Losses W	Weight kg
R-5-400	5	7%	7.5	25	6
R-10-400	10	7%	15	50	8
R-15-400	12.5	7%	22	57	9.2
RB-20-400	15	7%	30	76	9.4
RB-25-400	20	7%	37	90	14
RB-30-400	30	7%	45	120	19
RB-40-400	40	7%	60	145	20
RB-50-400	50	7%	75	185	27
RB-60-400	60	7%	90	205	31
RB-80-400	80	7%	120	235	38
RB-100-400	100	7%	145	250	50
RB-120-400	120	7%	175	295	58

*Other voltage on request

Dimensional drawing



R TYPE



RB TYPE

Type	A mm	B mm	C mm	D* mm	E* mm	F mm	G mm
R-5-400	155	112	165	75	85	7	-
R-10-400	180	102	190	90	75	7	-
R-15-400	180	112	190	90	85	7	-
RB-20-400	260	124	174	150	90	7	150
RB-25-400	260	124	174	150	90	7	150
RB-30-400	290	124	231	160	90	9	150
RB-40-400	293	124	231	160	90	9	150
RB-50-400	310	144	233	160	110	9	175
RB-60-400	305	146	260	160	110	11	180
RB-80-400	335	155	280	180	120	11	185
RB-100-400	338	170	300	180	135	11	215
RB-120-400	355	170	350	200	135	13	220

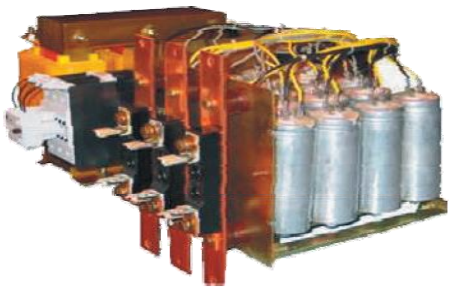
*Distance between fixing screw

POWER FACTOR CORRECTION CAPACITOR BANKS

Multi Rack Capacitor Bank **NORMAL and DETUNE TYPE**

Construction

- Fix and Extendable modules in depth and width
- Easy inatallation in different cubicle
- Easy substation of single element
- Less volume and weight in comparison with the same classic banks



Features

- Up to 100 kvar normal module(non-filter)
- Up to 50 kvar De-tuned (7%) for each module
- Up to 600 kvar for each cubicle at normal module(non-filter)
- Up to 300 kvar for each cubicle at De-tuned
- Individual test of each module according to IEC439
- Protection againts direct contact
- Safe busbar connection
- Optional fuse failure alarm for each module
- Discharge devices

Typical applications

For Fix and Automatic Power Factor Correction Systems
(normal or Detune type capacitor banks)

Technical data and specification

Characteristics	
Rated power	up to 100 kvar (Normal type) up to 50 kvar (De-Tune type)
Rated voltage Un	Un=230~690 volt (Normal type) Un=440~460 volt (De-Tune type)
Rated frequency Fn	Fn=50/60HZ
Capacitance tolerance	-5/+10%
Capacitor case/shape	Aluminum/cylindrical
Safety	Self-healing technology, overpressure disconnector,
Installation	Indoor
Maximum rating	
Max permissible overcurrent Imax	1.3*In
Max permissible overvoltage Umax	Un+10% (up to 8h daily) Un+15% (up to 30m daily) Un+20% (up to 5m daily) Un+30% (up to 1m daily)
Transient inrush current (max) Is	100*In
Losses:	
Dielectric	< 0.2 W/kvar
Total	< 0.5 W/kvar
Test data	
Insulating voltage	3/15 KV (Un<660V)
Terminal voltage test	2.15*Un, 10s
tano (50Hz)	< 0.5 W/kvar
Climatic category / -40/D	
Temperature class	-25/D Max. temp. 55 ˚C Max. mean 24h = 45 ˚C Max. mean 1year = 35 ˚C
Permissible maximum humidity	95%
Maximum permissible altitude	2 000m above sea level
Mean life expectancy	
Mean life expectancy	100 000 operating hours
Number of switching operations	Max. 5 000 switching per year according IEC 831

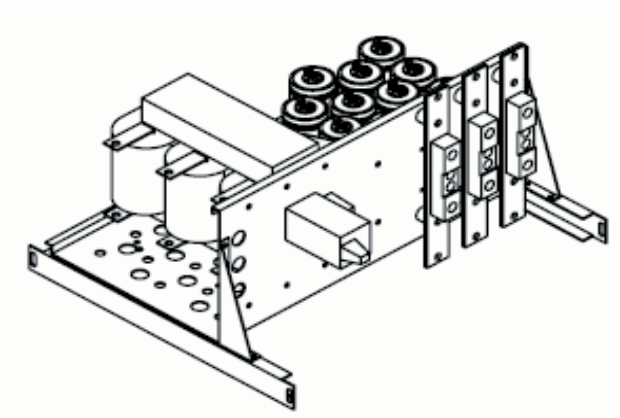
POWER FACTOR CORRECTION CAPACITOR BANKS

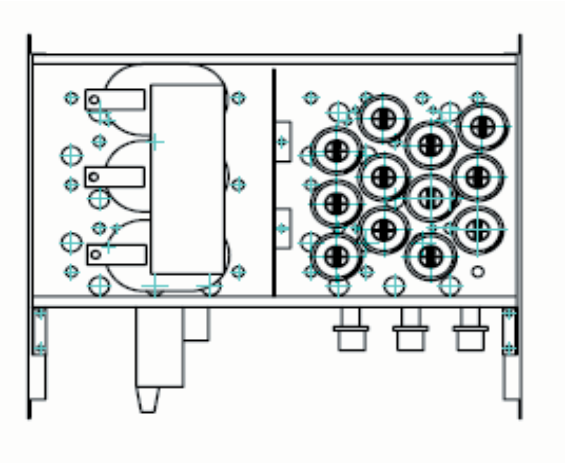
Multi Rack Capacitor Bank **NORMAL and DETUNE TYPE**

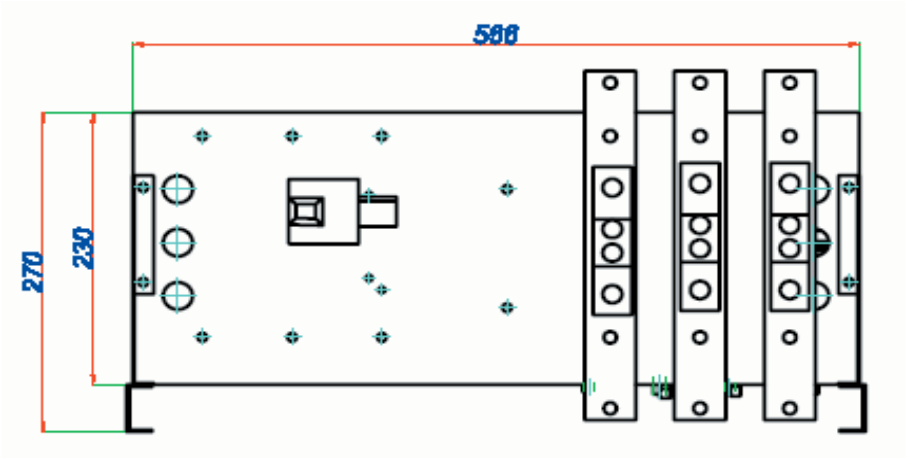
Accessories	
HRC fuse	Included (Optional)
Capacitor contctor	Included (Optional)
Detune Reactor (7%)	Included (on Detune Type)
Design data	
Dimension	See dimensional drawing at page 5
Mounting posirtion	Upright
Enclosure	IP00
Safety	
Mechanical safety	Overpressure disconnector
Discharge resistor time	< 5 minutes to 75 V
Reference Standards	
IEC EN 60831-1	
IEC EN 60831-2	
IEC 70/70A	
BS 1650	

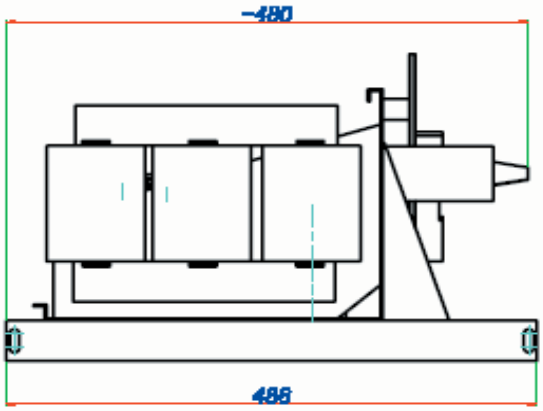
Dimensional drawing

DeTune Rack (Type D)



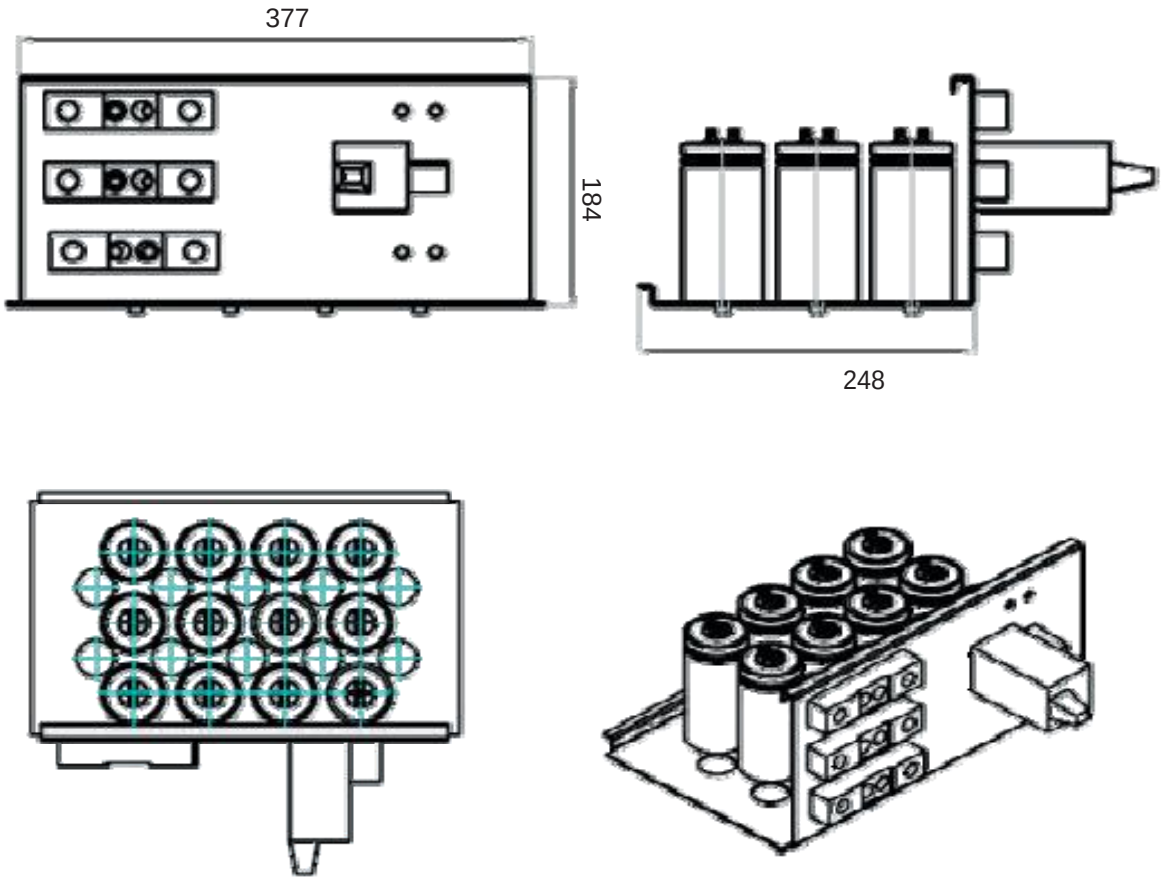






Dimensional drawing

Normal Rack (Type N)



POWER FACTOR CORRECTION CAPACITOR BANKS

Low Voltage Capacitor Banks **GENERAL**

PANIR automatic and fix capacitor banks are used for centralized and individual compensation of power factor in low voltage installation.
These equipment are supplied completely assembled and ready for use: it is only necessary to connect it to the mains with cables of adequate cross section, and to supply the operation signal from a suitable current transformer(in autamatic type).

PANIR automatic capacitor banks are composed of the following elements:

Construction

- High rupturing capacity (HRC) fuses connected to a busbar system that includes the terminals for the for the connection of the capacitor banks to the mains
- Contactors specially adapted to the work with capacitors wich is equipped with pre-insertion block
- Inrush current limiting inductances wich is appliance on contactor
- Fast discharge resistor (optional)
- Low losses power capacitors
- CBR3006, CBR3012 or CBR2012 reactive power controllers
- Terminals for neutral and protection conductors
- Metal cabinet containing all the switchgear

Features

- Equipments wired and tested at works, full finished and supplied with all control and safety devices
- Easy transportation and installation due to their light weigh
- Easy selection of the most appropriate cosφ to avoid penalty charges on tariffs
- Long life and high reliability, derived from the use of self-healing and low losses capacitors
- Wide range of power (from 5 to 900 kvar, 400V) with standard equipments for immediate delivery
- Option of including various accessories

Technical data and specification

Characteristics	
Rated power	5 up to 900 kvar
Rated voltage Un	Un=440 volt
Rated frequency Fn	Fn=50/60HZ
Control voltage	220V (110V on request)
Installation	Indoor/outdoor (optional)
Fast discharge resistor	included (optional)
Controller	CBR3006/CBR30012
Working program	Unlimited
Indication of steps connection	Digital display on the controller
Manual & Automatic selector switch	Incuded (on regolator or by H-O-A selector)
External current transformer	/1A or /5A (not supplied)
Main switch	On request (Fuse switch or MCCB)
Maximum rating	
Max permissible overcurrent Imax	1.3*In
Max permissible overvoltage Umax	Ur+10% (up to 8h daily) Ur+15% (up to 30m daily) Ur+20% (up to 5m daily) Ur+30% (up to 1m daily)
Transient inrush current (max) Is	100*In
Losses:	
Dielectric	< 0.2 W/kvar
Total	< 0.5 W/kvar
Climatic category	
Temperature range	Min. temp. -25 ˚C Max. temp. +55˚C Max. mean 1year = 35 ˚C
Permissible maximum humidity	95%
Maximum permissible altitude	2 000m above sea level

Design data	
Mounting posirtion	Flour mounting/Wall mounting
Constraction	Metal cabinet (1.5 mm thickness)
Cables entry	From bottom
Arrangement	Front access
Gland plate	Incuded
Lifting angle	Incuded
Anti condensation heater	Optional (with termostat)
Enclosure	IP3X
Colour	RAL 7032

Reference Standards
IEC EN 60831-1
IEC EN 60831-2
IEC EN 60439
IEC EN 70/70A

Special equipment

On request, automatic capacitor banks can be produced to customers special requirments among the different possibilities are the following:

- Other voltage and frequencies
- Capacitor banks with different degrees of protection
- Capacitor banks for outdoor installation
- Fixed step (for transformer compensation)
- Higher powers than the above stated

Installation

Automatic capacitor banks are supplied with all the necessary technical information for their installation and connection and maintenance.

Service

The TECHNICAL ASSISTANCE SERVICE is at your disposal to cooprate at differents stage, from project to commissioning of automatic capacitor banks.

Important note

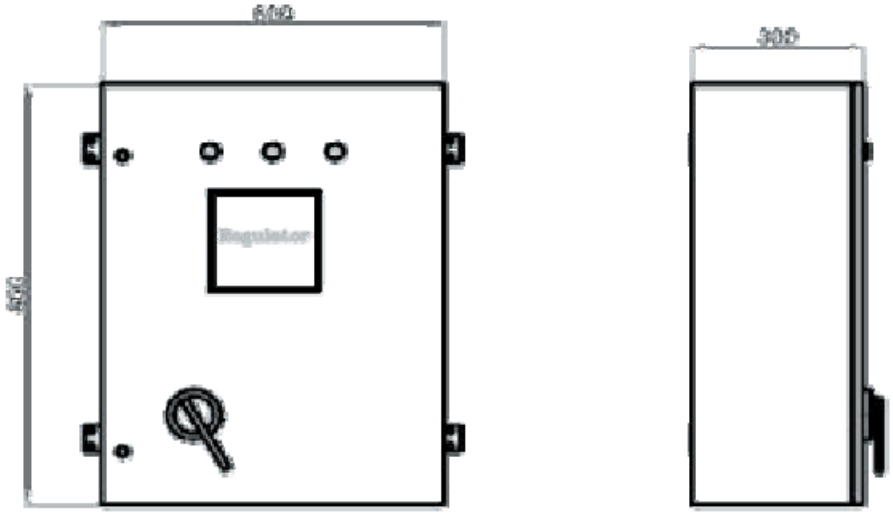
It is necessary to take special care where there is harmonic distortion in the network.

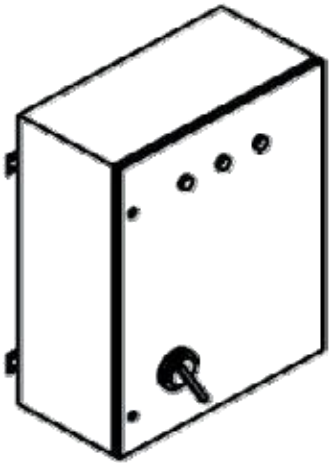
POWER FACTOR CORRECTION CAPACITOR BANKS

Low Voltage Capacitor Banks **WALLMOUNTING**

Features

- Up to 80 KVAR
  Up to 30kvar at 1 cell and from 35 up to 80 kvar at 2 closing cell
- Fix or Automatic type
- 3 up to 6 step (on automatic type)
- Suitable for power factor correction of small industrial workroom & residential or joinery buildings



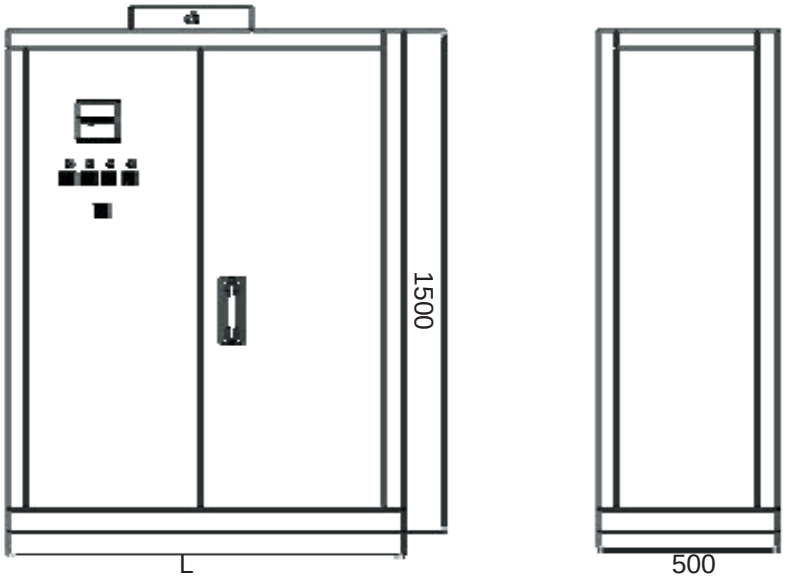


POWER FACTOR CORRECTION CAPACITOR BANKS

Low Voltage Capacitor Banks **STADARD FLOURMOUNTING**

Features

- Up to 600 KVAR
- Type A up to 4 step (Dimension: 500*500*1500 W*D*H)
- Type B up to 6 step (Dimension: 750*500*1500 W*D*H)
- Type C up to 12 step
  (Dimension: from 1100*500*1500 to 2200*500*1500 W*D*H)

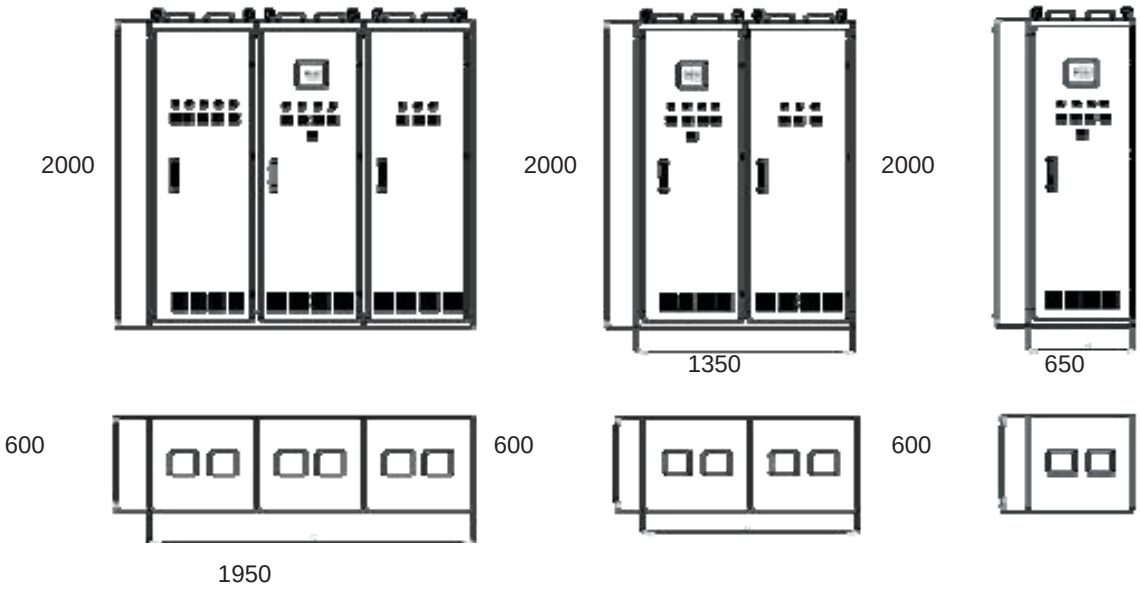


Drawing code	L (cm)
LV110	110
LV75	75
LV50	50

Features

Up to 250 KVAR in each compartment (Normal Type) Up to 500 KVAR in each compartment (Detune Type) Max. 3 compartment

Compact design and easy maintenance



Equipped with modern, sophisticate and automated manufacturing and testing machines, wide range of capacitors, capacitor banks, and reactive power regulators can be produced according to the latest international standards such as IEC, etc.

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