PFC EQUIPMENTS

and

ACTIVE HARMONIC FILTERS

TECNOLOGIC

TRENDFIN S.r.l.

HOW TO CALCULATE THE REACTIVE POWER

The Reactive Power, Qc, is obtained by the multiplication of the Active Power, P, and the coefficient K.

Starting Values		Target Cos φ															
kvarh / kWh	Actual cos φ	0,85	0,86	0,87	0,88	0,89	0,90	0,91	0,92	0,93	0,94	0,95	0,96	0,97	0,98	0,99	1,00
2,96	**0,32**	2,341	2,367	2,394	2,421	2,448	2,476	2,505	2,535	2,565	2,598	2,632	2,669	2,710	2,758	2,818	2,961
2,77	**0,34**	2,146	2,173	2,199	2,226	2,254	2,282	2,310	2,340	2,371	2,403	2,437	2,474	2,515	2,563	2,623	2,766
2,16	**0,42**	1,541	1,567	1,594	1,621	1,648	1,676	1,705	1,735	1,766	1,798	1,832	1,869	1,910	1,958	2,018	2,161
2,04	**0,44**	1,421	1,448	1,474	1,501	1,529	1,557	1,585	1,615	1,646	1,678	1,712	1,749	1,790	1,838	1,898	2,041
1,93	**0,46**	1,311	1,337	1,364	1,391	1,418	1,446	1,475	1,504	1,535	1,576	1,602	1,639	1,680	1,727	1,788	1,930
1,83	**0,48**	1,208	1,234	1,261	1,288	1,315	1,343	1,372	1,402	1,432	1,465	1,499	1,536	1,577	1,625	1,685	1,828
1,73	**0,50**	1,112	1,139	1,165	1,192	1,220	1,248	1,276	1,306	1,337	1,369	1,403	1,440	1,481	1,529	1,590	1,732
1,64	**0,52**	1,023	1,049	1,076	1,103	1,130	1,158	1,187	1,217	1,247	1,280	1,314	1,351	1,392	1,440	1,500	1,643
1,56	**0,54**	0,939	0,965	0,992	1,019	1,046	1,074	1,103	1,133	1,163	1,196	1,230	1,267	1,308	1,356	1,416	1,559
1,48	**0,56**	0,860	0,886	0,913	0,904	0,967	0,995	1,024	1,053	1,084	1,116	1,151	1,188	1,229	1,276	1,337	1,479
1,40	**0,58**	0,785	0,811	0,838	0,865	0,892	0,920	0,949	0,979	1,009	1,042	1,076	1,113	1,154	1,201	1,262	1,405
1,33	**0,60**	0,714	0,740	0,767	0,794	0,821	0,849	0,878	0,907	0,938	0,970	1,005	1,042	1,083	1,130	1,191	1,333
1,27	**0,62**	0,646	0,672	0,669	0,726	0,753	0,781	0,810	0,839	0,870	0,903	0,937	0,974	1,015	1,062	1,123	1,265
1,20	**0,64**	0,581	0,607	0,634	0,661	0,688	0,716	0,745	0,775	0,805	0,838	0,872	0,909	0,950	0,998	1,058	1,201
1,14	**0,66**	0,519	0,545	0,572	0,599	0,626	0,654	0,683	0,712	0,743	0,775	0,810	0,847	0,888	0,935	0,996	1,138
1,08	**0,68**	0,459	0,485	0,512	0,539	0,566	0,594	0,623	0,652	0,683	0,715	0,750	0,787	0,828	0,875	0.936	1,078
1,02	**0,70**	0,400	0,427	0,453	0,480	0,508	0,536	0,565	0,594	0,625	0,657	0,692	0,729	0,770	0,817	0,878	1,020
0,96	**0,72**	0,344	0,370	0,397	0,424	0,452	0,480	0,508	0,538	0,569	0,601	0,635	0,672	0,713	0,761	0,821	0,964
0,91	**0,74**	0,289	0,316	0,342	0,369	0,397	0,425	0,453	0,483	0,514	0,546	0,580	0,617	0,658	0,706	0,766	0,909
0,86	**0,76**	0,235	0,262	0,288	0,315	0,343	0,371	0,400	0,429	0,460	0,492	0,526	0,563	0,605	0,652	0,713	0,855
0,80	**0,78**	0,183	0,209	0,236	0,263	0,290	0,328	0,347	0,376	0,407	0,439	0,474	0,511	0,552	0,559	0,660	0,802
0,75	**0,80**	0,130	0,157	0,183	0,210	0,238	0,266	0,294	0,324	0,355	0,387	0,421	0,458	0,499	0,547	0,608	0,750
0,70	**0,82**	0,078	0,105	0,131	0,158	0,186	0,214	0,242	0,272	0,303	0,335	0,369	0,406	0,447	0,495	0,556	0,698
0,65	**0,84**	0,026	0,053	0,079	0,106	0,134	0,162	0,190	0,220	0,251	0,283	0,317	0,354	0,395	0,443	0,503	0,645
0,59	**0,86**			0,027	0,054	0,081	0,109	0,138	0,167	0,198	0,230	0,265	0,302	0,343	0,390	0,451	0,593
0,54	**0,88**					0,027	0,055	0,084	0,114	0,145	0,177	0,211	0,248	0,289	0,337	0,397	0,540
0.48	**0,90**							0,029	0,058	0,089	0,121	0,156	0,193	0,234	0,281	0,342	0,484
0,43	**0,92**									0,031	0,063	0,097	0,134	0,175	0,223	0,284	0,426
0,36	**0,94**											0,034	0,071	0,112	0,160	0,220	0,363

PFC SYSTEMS FOR MOTORS			
Power of the motor	Rotation speed (rpm)		
	1500	1000	750
kW	kvar		
1 ... 1.9	0,5	0,5	0,6
2 ... 2,9	1	1,1	1,2
3 ... 3,9	1,5	1,6	1,7
4 ... 4,9	2	2,1	2,3
5 ... 5,9	2,5	2,6	2,9
6 ... 7,9	3	3,2	3,5
8 ... 10,9	4	4,2	4,6
11 ... 13,9	5	5,3	5,8
14 ... 17,9	6	6,3	6,9
18 ... 21,9	7,5	8,0	8,6
22 ... 29,9	10	10,5	11,5
30 ... 39,9	Almost 40% of Motor Power		
≥40	Almost 35% of Motor Power		

PFC SYSTEMS FOR TRANSFORMER		
Power of the Transformers	Oil-filled transformers	Resin-filled transformers
kVA	kvar	kvar
100	5,0	2,5
160	7,0	4,0
200	7,5	5,0
250	8,0	7,5
315	10,0	8,0
400	12,5	8,5
500	15,0	10,0
630	17,5	12,5
800	20,0	15,0
1000	25,0	16,7
1250	30,0	20,0
1600	35,0	22,0
2000	40,0	25,0

INDEX 2021-2022

The PF Correction solution in the electrical systems

VARACTOR PF controllers

Automatic PFC systems

Automatic PFC systems with detuned inductors for harmonics

Capacitors racks

Capacitors racks with detuned inductors for harmonics

Fixed PFC systems

Semi-automatic PFC systems

1-phase and 3-phase cylindrical capacitors

THE PF CORRECTION SOLUTION IN THE ELECTRICAL SYSTEMS

Energy suppliers apply penalties in the electrical bills for low Power Factor, therefore it is necessary to install a PFC system due to this main problem and some other ones. The PF compensation lets the final customer manage the energy consumption in a rational way, realizing a good economical saving and improving the energy efficiency. The economical advantages are as bigger as the electrical consumption is.

THE LOW POWER FACTOR

The Power Factor involves two important powers: the active and the reactive one. In the electrical systems most of the loads are inductive; each inductive load needs an EM field to start working, that means absorbing the following powers:

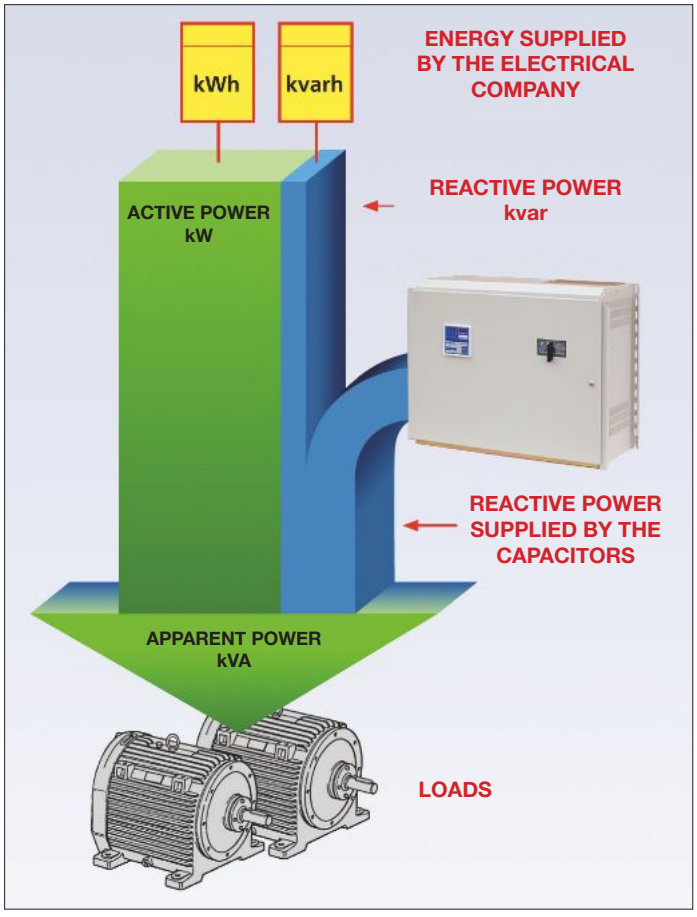
- **The Active Power** that produces the mechanical work, the heat, the movement, etc.
- **the Reactive Power** that produces the EM field.

The Active Power is measured in **kW** while the Reactive Power is measured in **kvar**. Apparent Power is the combination of both the Active and the Reactive powers and it is measured in **kVA**.

The Power Factor, that can be named cos(phi) if there is no presence of harmonics, is the ratio between the Active Power and the Apparent Power with a range between 0 and 1.

$$\cos\varphi = \frac{\textit{Active Power (kW)}}{\textit{Apparent Power (kVA)}}$$

The following image shows the partition of the two powers.



As regards the inductive loads, a phase shifting occurs between the voltage and the current: in particular the current is in **delay** on the voltage, reaching its maximum and zero point later than the voltage.

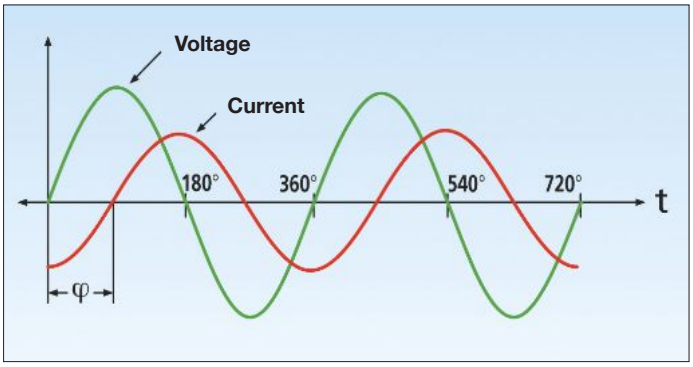


Fig. A - Inductive load: the current is in delay on the voltage

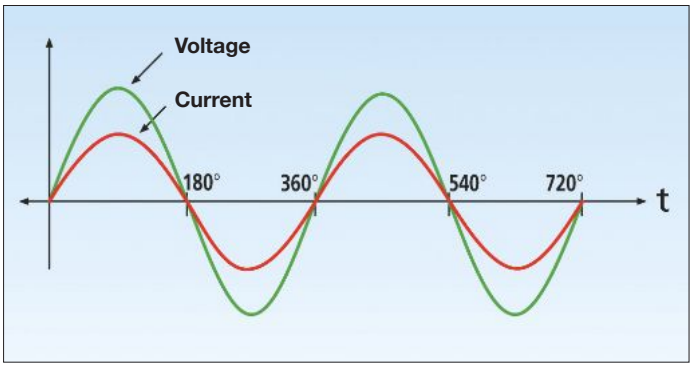


Fig. B - Resistive load: the current is in phase with the voltage

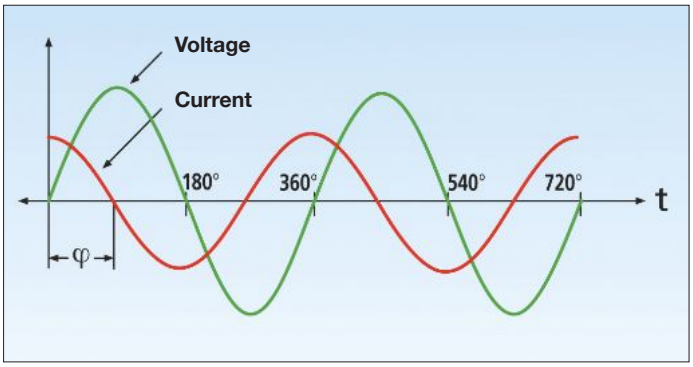
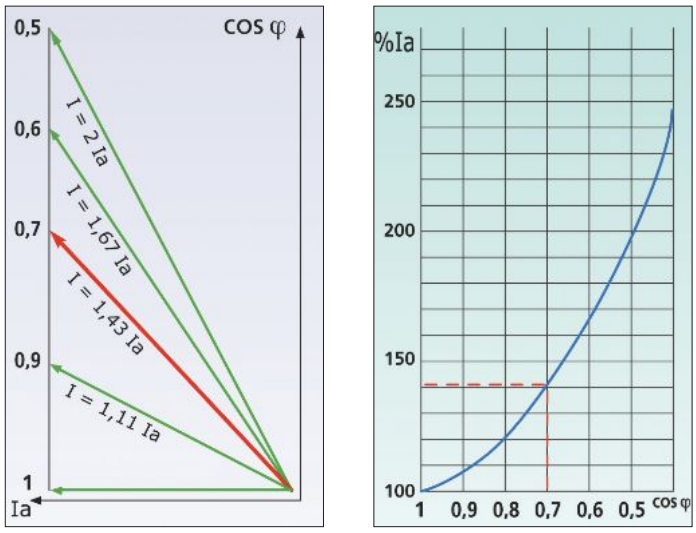


Fig. C - Capacitive load: the current ahead of the voltage

This phenomenon is shown in Fig. **A** while the Fig. **B** shows the sinusoidal waveforms of voltage and current related to a resistive load. The Fig. **C** displays a capacitive load where the current is ahead of the voltage. In Italy, for example, if the average Power Factor is lower than 0,95 (inductive) and the contractual power is higher than 15 kW, the energy supplier will charge the penalty for low Power Factor in the electrical bills.

THE PF CORRECTION SYSTEM

The easiest and the cheapest way to compensate the low Power Factor is connecting a capacitor bank in parallel with the loads. The capacitors may be represented as Reactive Power generators and they provide the electrical load with the reactive energy necessary to create the EM field.
The capacitor absorbs a current that is 90° ahead of the voltage and it behaves like a generator of reactive energy that is in opposition to the load one.
The Reactive Power supplied by the capacitors is not taken from the electrical network anymore so both the circulating average current and the phase shifting between the voltage and the current will be reduced. Therefore the penalty on the electrical bills will be deleted.
Taking a look at the following diagrams, it becomes easy to understand that the current absorbed by a motor working at cos φ = 0,7 is 43% bigger than the one absorbed by motor working at cos φ 1.



Behaviour of the current depending on the cos φ variation (considering a fixed active power)

ADVANTAGES OF THE PF CORRECTION

When an electrical system is correctly compensated, the end user only pays for the energy he uses. For example: if an electrical system works at an inductive cos φ of 0,7, only the 50% of the supplied power produces mechanical work, the other 50% is reactive power required by the load.
When the load is completely compensated by the reactive current produced by the capacitors, the MV/LV power transformer can provide the 98% of its total power. The installation of capacitor banks gives some other benefits:

- **The electrical bills may gain a remarkable reduction so that, in most of the cases, the PFC equipment can be amortized in about one year;**
- **There is an important reduction of the losses given by the heat of the electrical cables;**
- **The potential of the electrical system will increase;**
- **The available power will be higher and the heat of the power transformer will decrease;**
- **The main circuit breaker will be less stressed.**

HOW TO CORRECT AN ELECTRICAL SYSTEM

The capacitors may be installed everywhere in the electrical system only if the loads have a low Power Factor, but this solution is hardly never convenient despite it is the most correct. In fact, in an electrical system there might be several loads and each one might require a capacitor bank of adequate power, with its related cable line, protection devices and switches. On the other hand the safety standards don't allow to install a fixed capacitor bank that is directly connected to the electrical net, except for the fixed capacitor banks that compensate the no-load losses of the MV/LV transformer.
The capacitor banks can be connected to the electrical net only if the loads need to be compensated and they must not be compensated over cos φ = 1, otherwise an overcompensation might occur; this situation would create an unbalancing in the electrical system, a dangerous overvoltage, an increasing of the circulating current and an overload of electrical lines.
The above problems may be avoided by installing an AUTOMATIC PFC EQUIPMENT that is a single unit for the whole electrical system and it is installed upstream of the loads and dowstream of the LV main circuit breaker.
These equipments that are controlled by microprocessor PCB supply the Reactive Power on multiple steps, following the trend of the loads in order to create the best compensation of the Power Factor, in every condition. When the loads stop working, the Automatic PFC equipment is inhibited and its banks are disconnected.

HOW TO SIZE A PFC SYSTEM

The electrical system medium cos φ is an important parameter for sizing the correct PFC system. The easiest way is checking it on the last 5 electrical bills and making and average among them. If this data is not available, the following formula will be sufficient to get the cos φ if the Active Power (kWh) and the Reactive Power (kvar) of the system are known.
These values are always indicated on the electrical bills but it is possible to check them on the energy meter after a long period.

$$\cos\varphi = \frac{\textit{Active Energy}}{\sqrt{(\textit{active energy})^2 + (\textit{reactive energy})^2}}$$

Example:
Active Energy = 12500 kWh **Reactive Energy** = 11024 kvarh

$$\cos\varphi = \frac{12.500}{\sqrt{(12.500)^2 + (11.024)^2}} = 0{,}75$$

PFC SYSTEM IN PRESENCE OF HARMONICS

Before deciding the correct size of the PFC equipment it is highly recommended to check the presence of harmonics, in order to avoid any possible overload on the capacitors. Therefore it is helpful to make some instrumental measurements with a power analyzer to be aware of presence of distorting loads such as converters, U.P.S., arc furnaces, variable speed motors, rectifiers, saturated transformers, etc.
If the PFC system is not well sized and it is installed in these particular conditions, it might be damaged or quickly put out of service or even completely destroyed.

VARACTOR PF CONTROLLERS

CE **CERTIFICATION - STANDARDS: EN50081-2, EN55011, EN55014, EN50082-2, ENV50140, ENV50204, EN61000-4-8, EN61000-4-2, EN61000-4-4**

Model		N. output relays	S/N
VARACTOR	V 450/4	4	PA450104
VARACTOR	V 450/6	6	PA450106

TECHNICAL FEATURES

Dimensions:	96x96x50mm
Supply Voltage:	110-220-400* V
Minimum Secondary Current:	0,100 A
Voltage Signal:	100 - 690 Vrms
Frequency:	50/60 Hz
Display:	LED
Serial Port:	no
Required C.T. :	1

*on request

Model		N. output relays	S/N
VARACTOR	V 650/6	6	PA650106
VARACTOR	V 650/12	12	PA650112

Dimensions:	144x144x50mm
Supply Voltage:	110-220-400* V
Minimum Secondary Current:	0,100 A
Voltage Signal:	100 - 690 Vrms
Frequency:	50/60 Hz
Display:	LED
Serial Port:	no
Required C.T. :	1

*on request

Model		N. output relays	S/N
VARACTOR	V 850/12	12	PA850112

Dimensions:	148x148x62mm
Supply Voltage:	220 V - 400 V
Minimum Secondary Current:	0,125 A
Voltage Signal:	180 - 485 Vrms
Frequency:	50/60 Hz
Display:	LED
Serial Port:	RS485 (Modbus - RTU)
Required C.T. :	1

Model		N. output relays	S/N
VARACTOR	V 950/13	13	PA950113

Dimensions:	148x148x62mm
Supply Voltage:	220 V - 400 V
Minimum Secondary Current:	0,125 A
Voltage Signal:	180 - 485 Vrms
Frequency:	50/60 Hz
Display:	1280x64 dots LCD COG
Serial Port:	RS485 (Modbus - RTU) ETHERNET (TCP/IP)
Required C.T. :	1

Model		N. output transistors	S/N
BR7000-I-TH/12	BR7000/12	12	BR700112

Dimensions:	144x144x55mm
Supply Voltage:	110 V - 400 V
Minimum Secondary Current:	0,020 A
Voltage Signal:	50 - 760 Vrms
Frequency:	50/60 Hz
Display:	1280x64 dots LCD
Serial Port:	RS485 (Modbus - RTU)
Required C.T. :	1

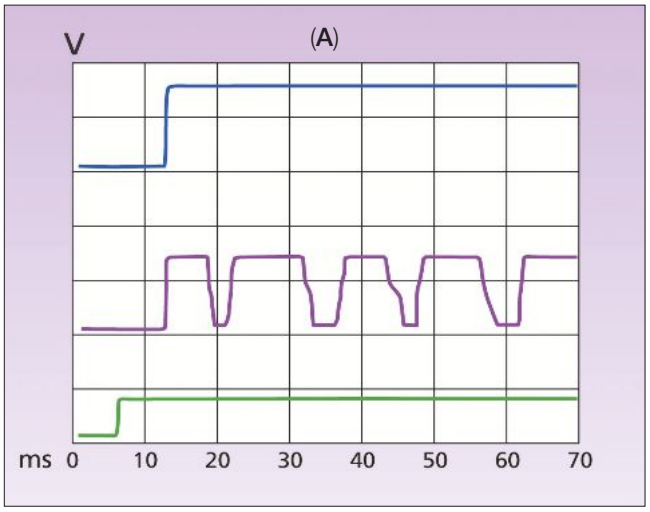
RAM SUPERTEC

PRINCIPLE OF OPERATION

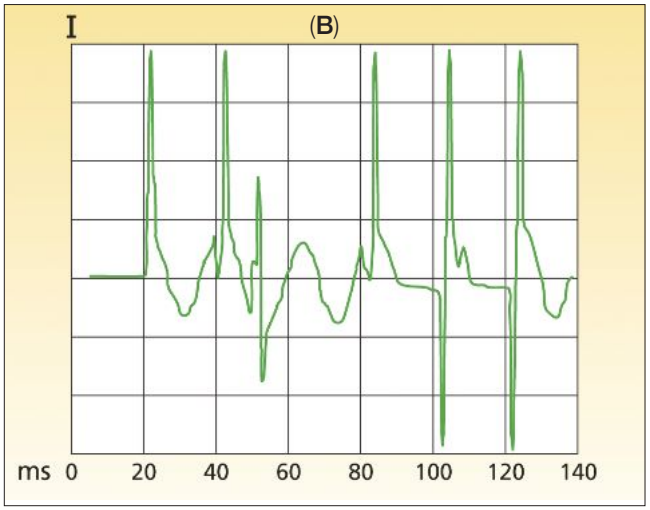
One of the main problem to face with the contactors for the capacitors insertion is the supplied voltage of the contactors coil, which must be sufficiently high for allowing a proper closure of the contacts. However it cannot be too high in order to avoid damages. Thanks to the electronic system **SUPERTEC** that is applied to the new **HD** contactors, developed for this application, a technological standard is eventually reached and it offers remarkable performances in the worst working conditions as well. (**A**)

It is important to consider that the magnet of the contactors might strike with high power, mostly due to the variation of the magnetic circuit when the cores get closer. Considering the high variability of the voltage in the different kind of installations and the randomness of the voltage comand, the contact working parameters are continuously changeable and this condition puts some limits on the standard contactors.
When a capacitor bank is connected to the electrical line these limits are remarkably amplified because, if an electric arc between the contacts occurs due to the electrical rebounds, the connection of the capacitors with the net is restored and this might cause dangerous overvoltages for the PFC system. (**B**)

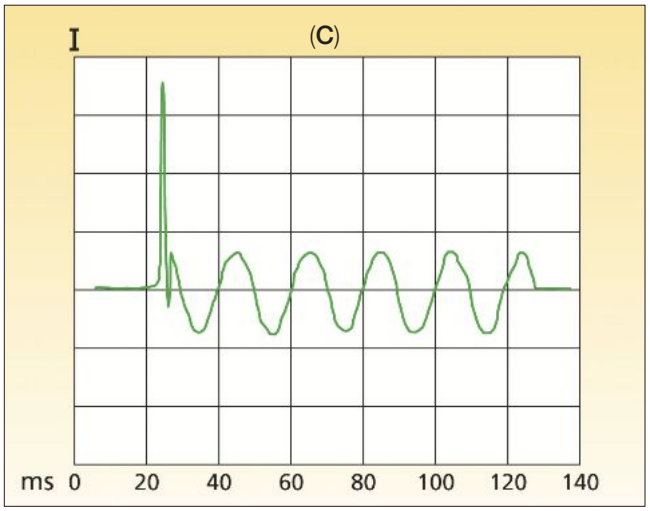
These inrush overcurrents might cause thermal stresses on the capacitors plates that might be damaged and put out of service: in this situation the capacitor dissipation factor (tg δ) increases.
The limitation of the inrush overcurrents and the elimination of the electrical rebounds of the contats is really important. The SUPERTEC system realizes a perfect match between standard technology and the most recent innovation. The standard and widely spread system deals with the insertion of the capacitor using a contactor whose contact are parallel-connected. The first group of contacts is early-closing type and connects the capacitor to the network by a group of resistences able to undo the peak of current: after some milliseconds the power contacts shortcircuit the resistences while the early-closing contacts become an open circuit. The precharge resistences must be inserted for an adequate time allowed by the electronic system.
The system that leads the contactors cannot be a simple relay contact but it becomes a microprocessor electronic system that ensures the optimization, the synchronism and the repeatability of the insertions. (**C**)



Command impulse (green) – Contact of a standard contactor with rebounds (purple) – SUPERTEC contact without rebounds (blue).



Capacitor insertion and its related overcurrents caused by the contactors rebounds.



Capacitor insertion and its related overcurrents thanks to SUPERTEC system.

PF CONTROLLER VARACTOR 180 WITH SUPERTEC SYSTEM

Model		N. output transistors	S/N
VARACTOR	V 180/4	4	PS180204

PF CONTROLLER VARACTOR 650 S WITH SUPERTEC SYSTEM

Model		N. output transistors	S/N
VARACTOR	V 650 S	6	PS650Z06

AUTOMATIC PFC SYSTEMS

for 400 V supply

RAM 2650

- **DIMENSIONS** (mm): **W** = 280 **H** = 550 **D** = 235

RAM 2750

- **DIMENSIONS** (mm): **W** = 280 **H** = 615 **D** = 235

TECHNICAL FEATURES

- Indoor installation
- IP30 protection degree with locked door
- RAL 7035 color
- 3P/3W supply
- Top cable entry
- Protection switch
- PF controller **VARACTOR 180**
- **EPCOS** resin-filled capacitors
- **HD** 3-phase contactors with pre-charge resistors, powered by **SUPERTEC**

EXPANDABILITY

The powers between the brackets are the maximum powers that can be reached with the expandabilty. The ✓ flag means that the system can be expanded.

ON REQUEST:

- **IP 54 Solution**: S/N: A ☐ ☐ ☐ ☐ ☐ 5 ☐
  Dimensions (mm): **W** = 400 **H** = 600 **D** = 250
- **Expandability Kit 2,5kvar** - 400 V
  Kap 2,5 - 400 V
  S/N: EX0022PZ
- **Expandability Kit 5kvar** - 400 V
  Kap 5 - 400 V
  S/N: EX0052PZ
- **Expandability Kit 2,5kvar** - 440 V
  Kap 2,5 - 440 V
  S/N: EX0024PZ
- **Expandability Kit 5kvar** - 440 V
  Kap 5 - 440 V
  S/N: EX0054PZ

CE **CERTIFICATION - Standards:**
CEI EN 61439 - 1/2, CEI EN 61921 - 1, CEI EN 60831 - 1/2

RAM 2650			Nominal Power	Nominal Current	BANKS POWER kvar				Steps Number	Weight kg	S/N
			kvar	A	I	II	III	IV			
RAM 2650	- 7,5	- 415 V	7,5	10	2,5	5			3	12,5	AP007330
RAM 2650	- 10	- 415 V	10	13	2,5	2,5	5		4	12,8	AP010330
RAM 2650	- 12,5	- 415 V	12,5	16	2,5	5	5		5	13	AP012330
RAM 2650	- 15	- 415 V	15	20	2,5	5	7,5		6	13	AP015330
RAM 2650	- 17,5	- 415 V	17,5	23	2,5	5	10		7	13,5	AP017330
RAM 2650	- 20	- 415 V	20	26	5	5	10		4	13,5	AP020330
RAM 2650	- 25	- 415 V	25	33	5	10	10		5	14	AP025330
RAM 2650	- 30	- 415 V	30	40	5	10	15		6	14,5	AP030330

RAM 2750			Nominal Power	Nominal Current	BANKS POWER kvar				Steps Number	Weight kg	S/N
			kvar	A	I	II	III	IV			
✓ RAM 2750	- 7,5	- 400 V	7,5 (15)	11	2,5 (2,5)	5(+5)			3	12,5	AQ007231
✓ RAM 2750	- 12,5	- 400 V	12,5 (25)	18	2,5(+2,5)	5(+5)	5 (+5)		5	13	AQ012231
✓ RAM 2750	- 17,5	- 400 V	17,5 (35)	25	2,5(+2,5)	5(+5)	10(+5+5)		7	13,5	AQ017231
✓ RAM 2750	- 20	- 400 V	20 (35)	29	5	5(+5)	10(+5+5)		4	13,5	AQ020231
✓ RAM 2750	- 22,5	- 400 V	22,5 (35)	32	2,5(+2,5)	5(+5)	5(+5)	10	9	14	AQ022231
✓ RAM 2750	- 25	- 400 V	25 (35)	36	5	10	10(+5+5)		5	14	AQ025231
✓ RAM 2750	- 27,5	- 400 V	27,5 (35)	40	2,5(+2,5)	5(+5)	10	10	11	14,5	AQ027231
✓ RAM 2750	- 30	- 400 V	30 (35)	43	5	10	15(+5)		6	14,5	AQ030231
RAM 2750	- 35	- 400 V	35	50	5	10	20		7	14,8	AQ035230
✓ RAM 2750	- 7,5	- 440 V	7,5 (15)	9	2,5 (2,5)	5(+5)			3	12,5	AQ007431
✓ RAM 2750	- 12,5	- 440 V	12,5 (25)	15	2,5(+2,5)	5(+5)	5 (+5)		5	13	AQ012431
✓ RAM 2750	- 17,5	- 440 V	17,5 (35)	21	2,5(+2,5)	5(+5)	10(+5+5)		7	13,5	AQ017431
✓ RAM 2750	- 20	- 440 V	20 (35)	24	5	5(+5)	10(+5+5)		4	13,5	AQ020431
✓ RAM 2750	- 22,5	- 440 V	22,5 (35)	27	2,5(+2,5)	5(+5)	5(+5)	10	9	14	AQ022431
✓ RAM 2750	- 25	- 440 V	25 (35)	30	5	10	10(+5+5)		5	14	AQ025431
✓ RAM 2750	- 27,5	- 440 V	27,5 (35)	33	2,5(+2,5)	5(+5)	10	10	11	14,5	AQ027431
✓ RAM 2750	- 30	- 440 V	30 (35)	36	5	10	15(+5)		6	14,5	AQ030431
✓ RAM 2750	- 35	- 440 V	35 (40)	42	5(+5)	10	20		7	14,8	AQ035431
✓ RAM 2750	- 37,5	- 440 V	37,5 (40)	45	2,5(+2,5)	5	10	20	15	15,5	AQ037431
RAM 2750	- 40	- 440 V	40	48	10	10	20		4	15,3	AQ040430

EXPANDABILITY KIT

AUTOMATIC PFC SYSTEMS

for 400 V supply

RAM 2850

- **DIMENSIONS** (mm): **W** = 430 **H** = 650 **D** = 280

RAM 2950

- **DIMENSIONS** (mm): **W** = 510 **H** = 775 **D** = 280

TECHNICAL FEATURES

- Indoor installation
- IP30 protection degree with locked door
- RAL 7035 color
- 3P/3W supply
- Top cable entry
- Protection switch
- Protection with NH00 fuses
- PF controller **VARACTOR 180**
- **EPCOS** resin-filled capacitors
- **EPCOS** N_2-filled capacitors for **HG** series
- **HD** 3-phase contactors with pre-charge resistors, powered by **SUPERTEC**

EXPANDABILITY

The powers between the brackets are the maximum powers that can be reached with the expandabilty. The ✓ flag means that the system can be expanded.

ON REQUEST:

- **IP 54 Solution**: S/N: A ☐ ☐ ☐ ☐ ☐ 5 ☐
  RAM 2850 - Dimensions (mm): **W** = 600 **H** = 800 **D** = 250
  RAM 2950 - Dimensions (mm): **W** = 600 **H** = 1000 **D** = 250
- **Expandability Kit 5kvar** - 400 V
  Kap 5 - 400 V
  S/N: EX0052PZ
- **Expandability Kit 6,25kvar** - 400 V
  Kap 6,25 - 400 V
  S/N: EX0062PZ
- **Expandability Kit 12,5kvar** - 400 V
  Kap 12,5 - 400 V
  S/N: EX0122PZ
- **Expandability Kit 7,5kvar** - 440 V
  Kap 7,5 - 440 V
  S/N: EX0074PZ
- **Expandability Kit 15kvar** - 440 V
  Kap 15 - 440 V
  S/N: EX0154PZ

CE **CERTIFICATION - Standards:**
CEI EN 61439 - 1/2, CEI EN 61921 - 1, CEI EN 60831 - 1/2

RAM 2850	Nominal Power	Nominal Current	BANKS POWER kvar				Steps Number	Weight kg	S/N
	kvar	A	I	II	III	IV			
✓ RAM 2850 - 30 - 400 V	30 (60)	43	5(+5+5+5)	10(+5+5)	15(+5)		6	20,2	AR030231
✓ RAM 2850 - 35 - 400 V	35 (60)	50	5(+5+5+5)	10(+5+5)	20		7	20,6	AR035231
✓ RAM 2850 - 37,5 - 400 V	37,5 (55)	54	2,5(+2,5)	5(+5)	10(+5+5)	20	15	21	AR037231
✓ RAM 2850 - 40 - 400 V	40 (60)	58	10(+5+5)	10(+5+5)	20		4	21	AR040231
✓ RAM 2850 - 45 - 400 V	45 (60)	65	5(+5)	10	10(+5+5)	20	9	22,2	AR045231
✓ RAM 2850 - 50 - 400 V	50 (60)	72	10(+5+5)	20	20		5	22,8	AR050231
✓ RAM 2850 - 55 - 400 V	55 (60)	79	5(+5)	10	20	20	11	23	AR055231
RAM 2850 - 60 - 400 V	60	86	10	10	20	20	6	23,4	AR060230
RAM 2850 - 37,5 - 415 V	37,5	50	7,5	15	15		5	23,5	AR037330
RAM 2850 - 50 - 415 V	50	67	12,5	12,5	25		4	24,5	AR050330
RAM 2850 - 65 - 415 V	65	87	13	26	26		5	26	AR065330
✓ RAM 2850 - 45 - 440 V	45 (52,5)	54	7,5	15	22,5(7,5)		6	21,5	AR045431
✓ RAM 2850 - 52,5 - 440 V	52,5 (60)	62	7,5(+7,5)	15	30		7	22,3	AR052431
✓ RAM 2850 - 60 - 440 V	60 (75)	71	15	15(+15)	30		4	22,5	AR060431
RAM 2850 - 75 - 440 V	75	89	15	30	30		5	23	AR075430
RAM 2850 HG	**N_2 - FILLED CAPACITORS**								
RAM 2850 HG - 12,5 - 400 V	12,5	18	3,125	3,125	6,25		4	21,6	AS012230
RAM 2850 HG - 15 - 400 V	15,6	22	3,125	6,25	6,25		5	21,8	AS015230
RAM 2850 HG - 20 - 400 V	21,8	31	3,125	6,25	12,5		7	22	AS020230
RAM 2850 HG - 28 - 400 V	28	40	3,125	6,25	6,25	12,5	9	24,6	AS028230
RAM 2850 HG - 35 - 400 V	34,3	49	3,125	6,25	12,5	12,5	11	24,8	AS035230
RAM 2850 HG - 47 - 400 V	47	67	3,125	6,25	12,5	25	15	25,4	AS047230
RAM 2850 HG - 50 - 400 V	50	72	6,25	6,25	12,5	25	8	26	AS050230
RAM 2850 HG - 56 - 400 V	56	80	6,25	12,5	12,5	25	9	26,2	AS056230
RAM 2850 HG - 62,5 - 400 V	62,5	90	12,5	25	25		5	24,4	AS062230

RAM 2950	Nominal Power	Nominal Current	BANKS POWER kvar				Steps Number	Weight kg	S/N
	kvar	A	I	II	III	IV			
✓ RAM 2950 - 68,5 - 400 V	68,5 (87,5)	99	6,25 (+6,25)	12,5 (+12,5)	25	25	11	33,5	AT068231
✓ RAM 2950 - 75 - 400 V	75 (87,5)	108	12,5	12,5 (+12,5)	25	25	6	35	AT075231
✓ RAM 2950 - 87,5 - 400 V	87,5 (100)	126	12,5	25	25	25 (+12,5)	7	40	AT087231
RAM 2950 - 100 - 400 V	100	144	12,5	25	25	37,5	8	42	AT100230
RAM 2950 - 75 - 415 V	75	104	15	30	30		5	36,2	AT075330
RAM 2950 - 90 - 415 V	90	125	15	15	30	30	6	38	AT090330
RAM 2950 - 105 - 415 V	105	146	15	30	30	30	7	40	AT105330
RAM 2950 - 120 - 415 V	120	167	15	30	30	45	8	41,8	AT120330
✓ RAM 2950 - 67,5 - 440 V	67,5 (90)	80	7,5 (+7,5)	15 (+15)	15	30	9	36,2	AT067431
✓ RAM 2950 - 82,5 - 440 V	82,5 (105)	98	7,5 (+7,5)	15 (+15)	30	30	11	37	AT082431
✓ RAM 2950 - 90 - 440 V	90 (105)	107	15	15 (+15)	30	30	6	38	AT090431
✓ RAM 2950 - 105 - 440 V	105 (120)	125	15	30	30	30 (+15)	7	40	AT105431
RAM 2950 - 120 - 440 V	120	142	15	30	30	45	8	41	AT120430
RAM 2950 HG	**N_2 - FILLED CAPACITORS**								
RAM 2950 HG - 68,5 - 400 V	68,5	99	6,25	12,5	25	25	11	35,5	AV068230
RAM 2950 HG - 75 - 400 V	75	108	12,5	12,5	25	25	6	35,6	AV075230
RAM 2950 HG - 87,5 - 400 V	87,5	126	12,5	25	25	25	7	36,5	AV087230
RAM 2950 HG - 100 - 400 V	100	144	25	25	25	25	4	37,5	AV100230

AUTOMATIC PFC SYSTEMS

for 400 V ÷ 440 V supply

RAM 4100

- **DIMENSIONS** (mm): **W** = 745 **H** = 640 **D** = 600

RAM 4200

- **DIMENSIONS** (mm): **W** = 745 **H** = 1300 **D** = 600

TECHNICAL FEATURES

- Indoor installation
- IP30 protection degree with locked door
- RAL 7035 color
- 3P/3W supply
- Top cable entry
- Protection switch
- Removable racks
- Protection with NH00 fuses
- **EPCOS** resin-filled capacitors
- **EPCOS** N_2-filled capacitors for **HG** series
- **HD** 3-phase contactors with pre-charge resistors, powered by **SUPERTEC**
- Forced ventilation
- PF controller **VARACTOR 650 S**:
  - **Alarms:** Overvoltage - High Temperature - High THD% - Undercompensation
  - **Measurements of:** Voltage - THD in current - Missing Reactive Power - Cos φ - Temperature
  - Two manual modes for switching the capacitors banks
  - **Alarm contact for remote reporting**

EXPANDABILITY

The ✓ flag means that the system can be expanded.
For RAM 4100 Series the powers between the brackets are the maximum powers that can be reached with the expandabilty.
For RAM 4200 Series the system can be expanded by adding a rack: the system is already provided with auxiliary and power cables, sliding guides and the switch is rated for the added power.

ON REQUEST:

- **IP 54 Solution**: S/N: C ☐ ☐ ☐ ☐ ☐ 5 ☐
  Dimensions (mm): **W** = 800 **H** = 1500 **D** = 600
- **Bottom cable entry solution**:
  S/N: C ☐ ☐ ☐ ☐ ☐ D ☐
- **Expandability Kit 25kvar - 400 V for RAM 4100 - 4100 HG:**
  Kap 25 - 400V — S/N: EX0252PZ
  Kap HG 25 - 400V — S/N: EX0252GZ
- **IP 54 Solution with bottom cable entry:**
  S/N: C ☐ ☐ ☐ ☐ ☐ F ☐

CE **CERTIFICATION - Standards:**
CEI EN 61439 - 1/2, CEI EN 61921 - 1, CEI EN 60831 - 1/2

RAM 4100	Nominal Power	Nominal Current	BANKS POWER kvar						Steps Number	Weight kg	S/N
	kvar	A	I	II	III	IV	V	VI			
✓ RAM 4100 - 68,5 - 400 V	68,5 (118,5)	99	6,25	12,5	25	25	(+25)	(+25)	11	53,5	CA068231
✓ RAM 4100 - 75 - 400 V	75 (125)	108	12,5	12,5	25	25	(+25)	(+25)	6	54	CA075231
✓ RAM 4100 - 87,5 - 400 V	87,5 (137,5)	126	12,5	25	25	25	(+25)	(+25)	7	54,5	CA087231
✓ RAM 4100 - 100 - 400 V	100 (125)	144	12,5	12,5	25	25	25	(+25)	8	55	CA100231
✓ RAM 4100 - 112,5 - 400 V	112,5 (137,5)	162	12,5	25	25	25	25	(+25)	9	56	CA112231
RAM 4100 - 125 - 400 V	125	180	12,5	12,5	25	25	25	25	10	57	CA125230
RAM 4100 - 137,5 - 400 V	137,5	198	12,5	25	25	25	25	25	11	57,5	CA137230
RAM 4100 - 150 - 400 V	150	216	25	25	25	25	25	25	6	58	CA150230
RAM 4100 HG	**N_2 - FILLED CAPACITORS**										
✓ RAM 4100 HG - 68,5 - 400 V	68,5 (118,5)	99	6,25	12,5	25	25	(+25)	(+25)	11	52	CB068231
✓ RAM 4100 HG - 75 - 400 V	75 (125)	108	12,5	12,5	25	25	(+25)	(+25)	6	52,5	CB075231
✓ RAM 4100 HG - 87,5 - 400 V	87,5 (137,5)	126	12,5	25	25	25	(+25)	(+25)	7	53	CB087231
✓ RAM 4100 HG - 100 - 400 V	100 (125)	144	12,5	12,5	25	25	25	(+25)	8	53,7	CB100231
✓ RAM 4100 HG - 112,5 - 400 V	112,5 (137,5)	162	12,5	25	25	25	25	(+25)	9	54,7	CB112231
RAM 4100 HG - 125 - 400 V	125	180	12,5	12,5	25	25	25	25	10	56	CB125230
RAM 4100 HG - 137,5 - 400 V	137,5	198	12,5	25	25	25	25	25	11	57	CB137230
RAM 4100 HG - 150 - 400 V	150	216	25	25	25	25	25	25	6	58	CB150230

RAM 4200	Nominal Power	Nominal Current	BANKS POWER kvar						Steps Number	Weight kg	S/N
	kvar	A	I	II	III	IV	V	VI			
✓ RAM 4200 - 125 - 400 V	125	180	12,5	12,5	25	25	25	25	10	85	CC125231
✓ RAM 4200 - 137,5 - 400 V	137,5	198	12,5	25	25	25	25	25	11	87	CC137231
✓ RAM 4200 - 150 - 400 V	150	216	25	25	25	25	25	25	6	88	CC150231
RAM 4200 - 162,5 - 400 V	162,5	234	12,5	25	25	25	25	50	13	92,5	CC162230
RAM 4200 - 175 - 400 V	175	252	25	25	25	25	25	50	7	94	CC175230
RAM 4200 - 187,5 - 400 V	187,5	270	12,5	25	25	25	50	50	15	95,5	CC187230
RAM 4200 - 200 - 400 V	200	288	25	25	25	25	50	50	8	97	CC200230
RAM 4200 - 225 - 400 V	225	324	25	25	25	50	50	50	9	100	CC225230
RAM 4200 - 250 - 400 V	250	360	25	25	50	50	50	50	10	103	CC250230
RAM 4200 - 275 - 400 V	275	396	25	50	50	50	50	50	11	107	CC275230
RAM 4200 - 300 - 400 V	300	432	25	50	50	50	50	75	12	110	CC300230
RAM 4200 HG	**N_2 - FILLED CAPACITORS**										
✓ RAM 4200 HG - 125 - 400 V	125	180	12,5	12,5	25	25	25	25	10	82	CD125231
✓ RAM 4200 HG - 137,5 - 400 V	137,5	198	12,5	25	25	25	25	25	11	83	CD137231
✓ RAM 4200 HG - 150 - 400 V	150	216	25	25	25	25	25	25	6	84	CD150231
RAM 4200 HG - 162,5 - 400 V	162,5	234	12,5	25	25	25	25	50	13	88	CD162230
RAM 4200 HG - 175 - 400 V	175	252	25	25	25	25	25	50	7	89	CD175230
RAM 4200 HG - 187,5 - 400 V	187,5	270	12,5	25	25	25	50	50	15	90	CD187230
RAM 4200 HG - 200 - 400 V	200	288	25	25	25	25	50	50	8	92	CD200230
RAM 4200 HG - 225 - 400 V	225	324	25	25	25	50	50	50	9	95	CD225230
RAM 4200 HG - 250 - 400 V	250	360	25	25	50	50	50	50	10	98	CD250230
RAM 4200 HG - 275 - 400 V	275	396	25	50	50	50	50	50	11	101	CD275230
RAM 4200 HG - 300 - 400 V	300	432	25	50	50	50	50	75	12	104	CD300230

EXPANDABILITY KIT

AUTOMATIC PFC SYSTEMS

for 400 V ÷ 440 V supply

RAM 4400

- **DIMENSIONS** (mm): **W** = 745 **H** = 1700 **D** = 600

RAM 4500

- **DIMENSIONS** (mm): **W** = 745 **H** = 2100 **D** = 600

TECHNICAL FEATURES

- Indoor installation
- IP30 protection degree with locked door
- RAL 7035 color
- 3P/3W supply
- Top cable entry
- Protection switch
- Removable racks
- Protection with NH00 fuses
- **EPCOS** resin-filled capacitors
- **EPCOS** N_2-filled capacitors for **HG** series
- **HD** 3-phase contactors with pre-charge resistors, powered by **SUPERTEC**
- Forced ventilation
- PF controller **VARACTOR 650 S**:
  - **Alarms:** Overvoltage - High Temperature - High THD% - Undercompensation
  - **Measurements of:** Voltage - THD in current - Missing Reactive Power - Cos φ - Temperature
  - Two manual modes for switching the capacitors banks
  - **Alarm contact for remote reporting**

EXPANDABILITY

The ✓ flag means that the system can be expanded.
The system can be expanded by adding a rack: the system is already provided with auxiliary and power cables, sliding guides and the switch is rated for the added power.

ON REQUEST:

- **IP 54 Solution**: S/N: C ☐ ☐ ☐ ☐ ☐ 5 ☐
  RAM 4400 - Dimensions (mm): **W** = 800 **H** = 1700 **D** = 600
  RAM 4500 - Dimensions (mm): **W** = 800 **H** = 2100 **D** = 600

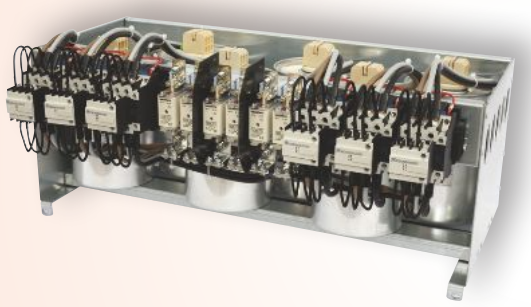
- **Bottom cable entry solution**:
  S/N: C ☐ ☐ ☐ ☐ ☐ D ☐

- **IP 54 Solution with bottom cable entry:**
  S/N: C ☐ ☐ ☐ ☐ ☐ F ☐

CE **CERTIFICATION - Standards:**
CEI EN 61439 - 1/2, CEI EN 61921 - 1, CEI EN 60831 - 1/2

RAM 4400	Nominal Power	Nominal Current	BANKS POWER kvar						Steps Number	Weight kg	S/N
	kvar	A	I	II	III	IV	V	VI			
✓ RAM 4400 - 250 - 400 V	250	360	25	25	50	50	50	50	10	157	CH250231
✓ RAM 4400 - 275 - 400 V	275	396	25	50	50	50	50	50	11	160	CH275231
✓ RAM 4400 - 300 - 400 V	300	432	25	50	50	50	50	75	12	163	CH300231
RAM 4400 - 325 - 400 V	325	468	25	50	50	50	50	100	13	169	CH325230
RAM 4400 - 350 - 400 V	350	504	25	50	50	50	75	100	14	172	CH350230
RAM 4400 - 375 - 400 V	375	540	25	50	50	50	100	100	15	174	CH375230
RAM 4400 - 400 - 400 V	400	576	50	50	50	50	100	100	8	177	CH400230
RAM 4400 - 450 - 400 V	450	648	50	50	50	100	100	100	9	180	CH450230
RAM 4400 HG	**N_2 - FILLED CAPACITORS**										
✓ RAM 4400 HG - 250 - 400 V	250	360	25	25	50	50	50	50	10	143	CJ250231
✓ RAM 4400 HG - 275 - 400 V	275	396	25	50	50	50	50	50	11	146	CJ275231
✓ RAM 4400 HG - 300 - 400 V	300	432	25	50	50	50	50	75	12	157	CJ300231
RAM 4400 HG - 325 - 400 V	325	468	25	50	50	50	50	100	13	162	CJ325230
RAM 4400 HG - 350 - 400 V	350	504	25	50	50	50	75	100	14	164	CJ350230
RAM 4400 HG - 375 - 400 V	375	540	25	50	50	50	100	100	15	166	CJ375230
RAM 4400 HG - 400 - 400 V	400	576	50	50	50	50	100	100	8	169	CJ400230
RAM 4400 HG - 450 - 400 V	450	648	50	50	50	100	100	100	9	171	CJ450230

RAM 4500	Nominal Power	Nominal Current	BANKS POWER kvar						Steps Number	Weight kg	S/N
	kvar	A	I	II	III	IV	V	VI			
✓ RAM 4500 - 350 - 400 V	350	504	25	50	50	50	75	100	14	187	CK350231
✓ RAM 4500 - 375 - 400 V	375	540	25	50	50	50	100	100	15	189	CK375231
✓ RAM 4500 - 400 - 400 V	400	576	25	50	50	75	100	100	16	192	CK400231
✓ RAM 4500 - 450 - 400 V	450	648	25	50	75	100	100	100	18	195	CK450231
RAM 4500 - 475 - 400 V	475	684	25	50	100	100	100	100	19	225	CK475230
RAM 4500 - 500 - 400 V	500	720	50	50	100	100	100	100	10	228	CK500230
RAM 4500 - 550 - 400 V	550	792	50	100	100	100	100	100	11	231	CK550230
RAM 4500 - 575 - 400 V	575	828	25	50	100	100	150	150	23	234	CK575230
RAM 4500 - 600 - 400 V	600	864	50	100	100	100	100	150	12	237	CK600230
RAM 4500 HG	**N_2 - FILLED CAPACITORS**										
✓ RAM 4500 HG - 350 - 400 V	350	504	25	50	50	50	75	100	14	182	CL350231
✓ RAM 4500 HG - 375 - 400 V	375	540	25	50	50	50	100	100	15	184	CL375231
✓ RAM 4500 HG - 400 - 400 V	400	576	25	50	50	75	100	100	16	187	CL400231
✓ RAM 4500 HG - 450 - 400 V	450	648	25	50	75	100	100	100	18	190	CL450231
RAM 4500 HG - 475 - 400 V	475	684	25	50	100	100	100	100	19	215	CL475230
RAM 4500 HG - 500 - 400 V	500	720	50	50	100	100	100	100	10	218	CL500230
RAM 4500 HG - 550 - 400 V	550	792	50	100	100	100	100	100	11	221	CL550230
RAM 4500 HG - 575 - 400 V	575	828	25	50	100	100	150	150	23	224	CL575230
RAM 4500 HG - 600 - 400 V	600	864	50	100	100	100	100	150	12	227	CL600230



EXPANDABILITY RACK

AUTOMATIC PFC SYSTEMS

for 400 V ÷ 440 V supply

RAM 7700

TECHNICAL FEATURES

- Indoor installation
- IP30 protection degree with locked door
- Dimensions (mm): **W** = 800 **H** = 2100 **D** = 800
- RAL 7035 color
- 3P/3W supply
- Top cable entry
- Protection switch
- Removable racks
- Protection with NH00 fuses
- **EPCOS** resin-filled capacitors
- **EPCOS** N_2-filled capacitors for **HG** series
- **HD** 3-phase contactors with pre-charge resistors, powered by **SUPERTEC**
- Forced ventilation
- PF controller **VARACTOR 650 S**
- **Alarm contact for remote reporting**

EXPANDABILITY

The ✓ flag means that the system can be expanded.
The system can be expanded by adding a rack: the system is already provided with auxiliary and power cables, sliding guides and the switch is rated for the added power.

ON REQUEST:

- **IP 54 Solution**: S/N: F ☐ ☐ ☐ ☐ ☐ 5 ☐
- **Expandability: (with a rack of 225 kvar max):**
  S/N: F ☐ ☐ ☐ ☐ ☐ ☐ 1

CE **CERTIFICATION - Standards:**
CEI EN 61439 - 1/2, CEI EN 61921 - 1, CEI EN 60831 - 1/2

RAM 7700	Nominal Power	Nominal Current	BANKS POWER kvar						Steps Number	Weight kg	S/N
	kvar	A	I	II	III	IV	V	VI			
✓ RAM 7700 - 525 - 400 V	525	756	75	75	75	75	75	150	7	300	FA525230
✓ RAM 7700 - 600 - 400 V	600	864	75	75	75	75	150	150	8	310	FA600230
✓ RAM 7700 - 675 - 400 V	675	972	75	75	75	150	150	150	9	320	FA675230
RAM 7700 - 750 - 400 V	750	1080	75	75	150	150	150	150	10	350	FA750230
RAM 7700 - 825 - 400 V	825	1188	75	150	150	150	150	150	11	360	FA825230
RAM 7700 - 900 - 400 V	900	1296	75	75	150	150	150	300	12	370	FA900230
RAM 7700 HG	**N_2 - FILLED CAPACITORS**										
✓ RAM 7700 HG - 525 - 400 V	525	756	75	75	75	75	75	150	7	270	FC525230
✓ RAM 7700 HG - 600 - 400 V	600	864	75	75	75	75	150	150	8	280	FC600230
✓ RAM 7700 HG - 675 - 400 V	675	972	75	75	75	150	150	150	9	290	FC675230
RAM 7700 HG - 750 - 400 V	750	1080	75	75	150	150	150	150	10	330	FC750230
RAM 7700 HG - 825 - 400 V	825	1188	75	150	150	150	150	150	11	340	FC825230
RAM 7700 HG - 900 - 400 V	900	1296	75	75	150	150	150	300	12	350	FC900230

AUTOMATIC PFC SYSTEMS

for 400 V ÷ 440 V supply

RAM 7700 HG DYNAMIC

TECHNICAL FEATURES

- Indoor installation
- IP30 protection degree with locked door
- Dimensions (mm): **W** = 800 **H** = 2100 **D** = 800
- RAL 7035 color
- 3P/3W supply
- Top cable entry
- Protection switch
- Removable racks
- Protection with NH00 fuses
- **EPCOS** N_2-filled capacitors for **HG** series
- Thyristor modules for capacitors switching
- Forced ventilation
- PF controller **BR7000-I-TH**:
  - LCD display with integrated power analyzer
  - Measurements of:
    - Voltage
    - Current
    - Frequency
    - Reactive Power
    - Active Power
    - Cos φ
    - Harmonic Currents
  - Capacitors real current
  - Total switchings for each bank
  - Temperature sensor for the fan control
  - Maximum switching frequency: 10 Hz

ON REQUEST:

- **IP 54 Solution**: S/N: F F ☐ ☐ ☐ ☐ 5 ☐

CE **CERTIFICATION - Standards:**
CEI EN 61439 - 1/2, CEI EN 61921 - 1, CEI EN 60831 - 1/2

RAM 7700 HG DYNAMIC	N_2 - FILLED CAPACITORS										
	Nominal Power	Nominal Current	BANKS POWER kvar						Steps Number	Weight kg	S/N
	kvar	A	I	II	III	IV	V	VI			
RAM 7700 HG Dy - 175 - 400 V	175	252	25	50	50	50			7	270	FF175230
RAM 7700 HG Dy - 200 - 400 V	200	288	25	25	50	50	50		8	300	FF200230
RAM 7700 HG Dy - 225 - 400 V	225	324	25	50	50	50	50		9	330	FF225230
RAM 7700 HG Dy - 250 - 400 V	250	360	50	50	50	50	50		5	360	FF250230
RAM 7700 HG Dy - 300 - 400 V	300	432	50	50	50	50	50	50	6	390	FF300230
RAM 7700 HG Dy - 350 - 400 V	350	504	50	50	50	50	50	100	7	420	FF350230
RAM 7700 HG Dy - 400 - 400 V	400	576	50	50	50	50	100	100	8	450	FF400230

PFC SYSTEMS IN PRESENCE OF HARMONIC CURRENTS

In the industrial systems the presence of motors with speed variation, U.P.S., frequency converters is very widespread. These types of electrical machines are powered by AC/DC converters that absorbe a non-linear current: this means that its trend is non-sinusoidal but it is made by ripples. The following pictures in Fig. A show their typical waveforms.

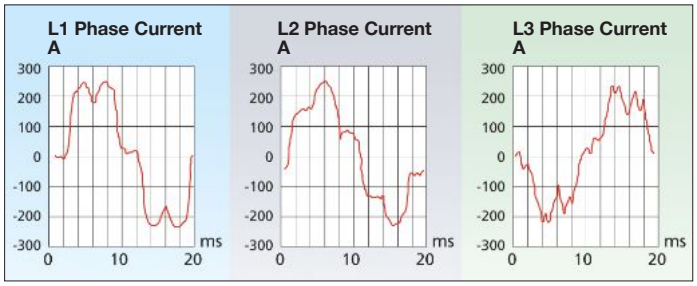


Fig. A

A periodic non-sinusoidal waveform can be decomposed in some frequencies divided into the fundamental one and its multiples: double, triple, etc., that are named second harmonic, third harmonic, etc.

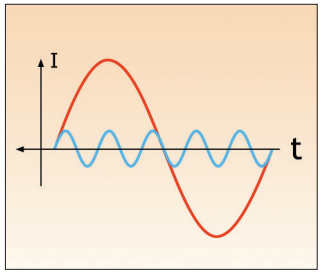


Fig. B

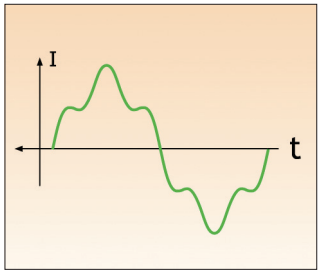


Fig. C

The Fig. B shows the fundamental sinusoidal wave at 50 Hz that is overlapped to a wave at 250 Hz related to the fifth harmonic order wave.
The Fig. C shows the harmonic distorsion created by the overlap between the two above waveforms.

The TOTAL HARMONIC DISTORSION (THD) is defined as the per cent ratio the tota harmonic value and the fundamental one:

$$THD\ \% = \frac{\sqrt{\sum_n I_{an}^2}}{I_f}\ x\ 100 = \frac{I_{aT}}{I_f}\ x\ 100$$

where: n = harmonic order
I_{an} = harmonic current value
I_f = fundamental current value
I_{aT} = total armonic value

In presence of harmonic currents (in general the voltage harmonics are negligible) the installation of capacitors might create some problems that must be carefully evaluated.

The capacitors must withstand currents above their nominal values since they amplify the harmonic currents and that is why some resonance phenomena might occur: this situation is very dangerous both for the capacitors and the electrical system.

The worst condition that might occur is the Parallel Resonance which is a destructive swing between the inductance of the system and the reactance of the capacitors.

For example, let's consider an inverter that could be represented as a harmonic generator and the Power Transformer and the Net could be considered as the total shortcircuit impedance, as shown in Fig. D.

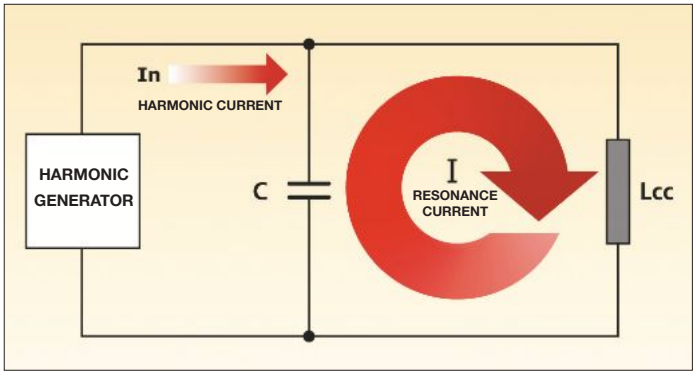


Fig. D

The resonance frequency is given by:

$$f_0 = \frac{1}{2 \cdot \pi \sqrt{L_{cc} \cdot C}}$$

When the resonance occurs the voltages and the currents related to the parallel Lcc-C are amplified; this condition also includes the other harmonics.

When the harmonic current frequency overlaps the frequency of the system Capacitor-Net, the impedance reaches its minimum value while the current gets its maximum, although the voltage keeps remaining a constant.

In order to avoid these inconveniences the capacitors are matched with the inductors, realizing a LC series filter that is tuned on a frequency value than the harmonic orders of the electrical system: thanks to this solution the capacitors are not hit by harmonic currents.

The main purpose of the detuned inductors is to avoid the resonance between the power transformer and the capacitors and their dangerous overload.

The detuned inductor is series-connected with the capacitors supply, as shown in Fig. E. The resonance frequency between the inductors and the capacitors is 189 Hz and the typical frequency response is always figured in Fig. E.

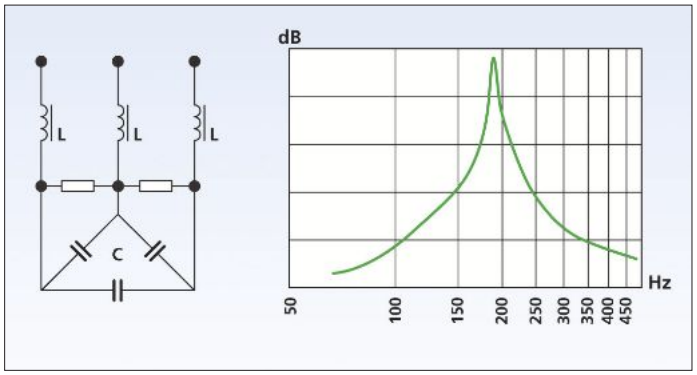


Fig. E

The series chokes make the capacitors voltage increasing and its value increases the higher is the inductor value, reaching an overvoltage of 10% of V_n: hence the capacitors must be properly rated.

SIMULVAR: HOW TO SOLVE PFC PROBLEMS

Trendfin S.r.l. developed SIMULVAR software in order to supply a helpful device for checking the electrical systems and for sizing the PFC equipments. After some complex calculations, SIMULVAR software provides the customer with the correct solution within a few minutes, avoiding any waste of time.

The software gives proper solutions very quickly by only adding the parameters of the electrical system, such as:

- Reactive power required by the electrical system;
- Features of the capacitors;
- Presence of dangerous harmonic currents for the capacitors;
- Any resonance detection;
- PFC equipments provided with antiresonance inductors.

Possible power variations of the electrical systems and expandabilities for the PFC equipments can be easily simulated.

SIMULVAR also automatically provides the user with the correct automatic PFC equipment that is proposed in the **TRENDFIN** catalogue.

DESCRIPTION

The program is divided into two parts:

- In the first part the data of the electrical system and the information about the distorting loads must be added; the info about the harmonics may be filled in with four different methods:
  1) The power of the distorting load related to the total load, expressed in %.
  2) The value of each harmonic current that is present in the system.
  3) The Total Harmonic Distorsion (THD) that is expressed in %.
  4) The true RMS value of the THD in current.

- In the second part the user is provided with the following information:

- The required capacitive power.
- The effects produced by the harmonics.
- The PFC equipment choice.
- The simulation of the current overloads.

EXAMPLE

Let's simulate the analysis of the following system:

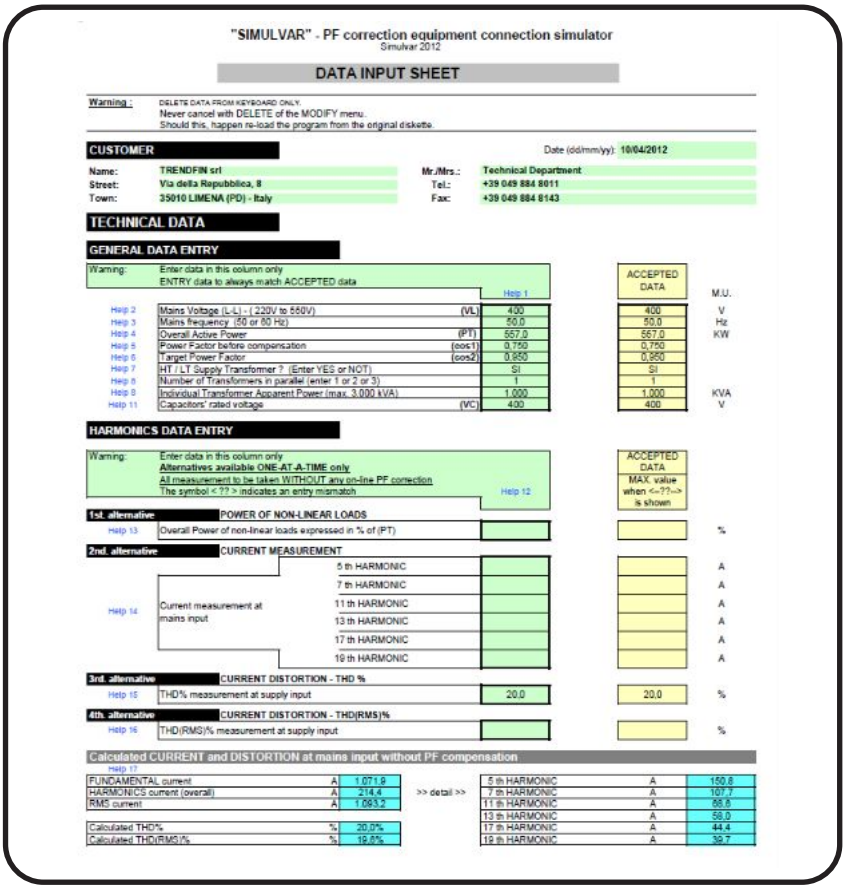
- Supply voltage: 400V
- Supply frequency: 50 Hz
- Total Power of the load: 557 kW
- Power Factor of the non-compesated load: cos φ 0,75
- Target Power Factor: cos φ 0,95
- Apparent Power of the transformer: 1000KVA
- Nominal Voltage of the capacitors: 400V
- Measured THD% on the general busbar: 20

This simulation leads to:

- The required Reactive Power is 308,2 kvar
- The PFC equipment must be protected by antiresonance inductors due to harmonic currents.

Hence the needed PFC system will be::

RAM 9400 HG - 360 - 400V


"SIMULVAR" - PF correction equipment connection simulator
Simulvar 2012

DATA INPUT SHEET

Warning : DELETE DATA FROM KEYBOARD ONLY.
Never cancel with DELETE of the MODIFY menu.
Should this, happen re-load the program from the original diskette.

CUSTOMER — Date (dd/mm/yy): 10/04/2012

Name: TRENDFIN srl — Mr./Mrs.: Technical Department
Street: Via della Repubblica, 8 — Tel.: +39 049 884 8011
Town: 35010 LIMENA (PD) - Italy — Fax: +39 049 884 8143

TECHNICAL DATA

GENERAL DATA ENTRY

Warning: Enter data in this column only; ENTRY data to always match ACCEPTED data

		Help 1	ACCEPTED DATA	M.U.
Help 2	Mains Voltage (L-L) - (220V to 550V) (VL)	400	400	V
Help 3	Mains frequency (50 or 60 Hz)	50,0	50,0	Hz
Help 4	Overall Active Power (PT)	557,0	557,0	KW
Help 5	Power Factor before compensation (cos1)	0,750	0,750	
Help 6	Target Power Factor (cos2)	0,950	0,950	
Help 7	HT / LT Supply Transformer ? (Enter YES or NOT)	SI	SI	
Help 8	Number of Transformers in parallel (enter 1 or 2 or 3)	1	1	
Help 9	Individual Transformer Apparent Power (max. 3.000 kVA)	1.000	1.000	KVA
Help 11	Capacitors' rated voltage (VC)	400	400	V

HARMONICS DATA ENTRY

Warning: Enter data in this column only; Alternatives available ONE-AT-A-TIME only; All measurement to be taken WITHOUT any on-line PF correction; The symbol < ?? > indicates an entry mismatch — Help 12

ACCEPTED DATA: MAX. value when <-??-> is shown

1st. alternative — POWER OF NON-LINEAR LOADS
Help 13: Overall Power of non-linear loads expressed in % of (PT) — %

2nd. alternative — CURRENT MEASUREMENT
Help 14: Current measurement at mains input

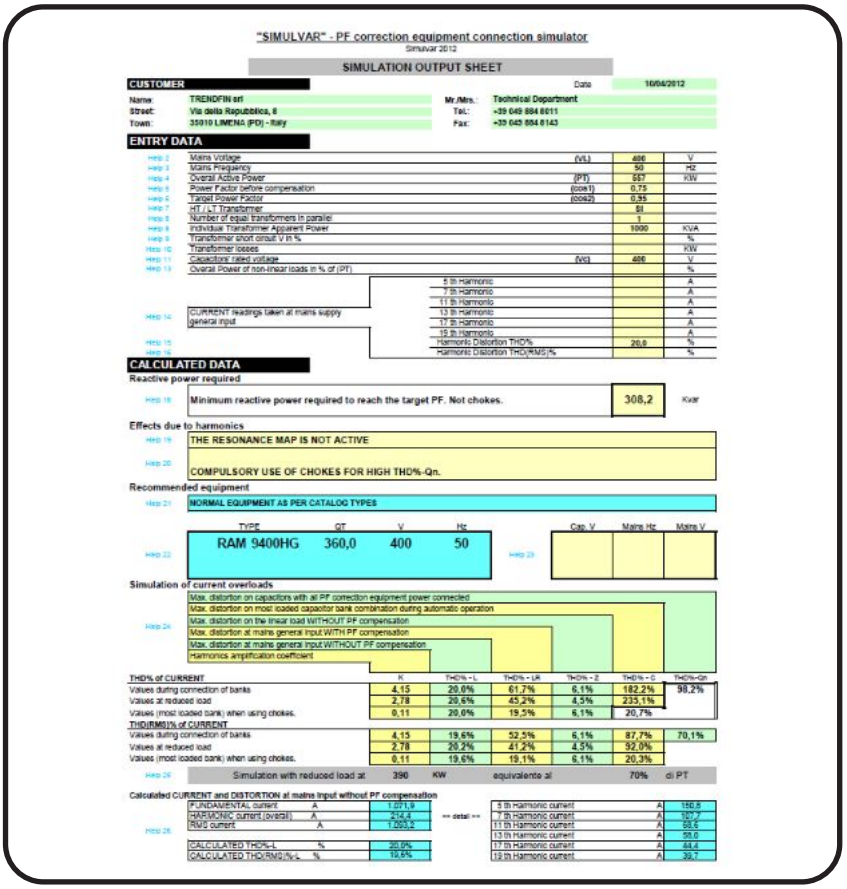
		ACCEPTED DATA	
5 th HARMONIC			A
7 th HARMONIC			A
11 th HARMONIC			A
13 th HARMONIC			A
17 th HARMONIC			A
19 th HARMONIC			A

3rd. alternative — CURRENT DISTORTION - THD %
Help 15: THD% measurement at supply input — 20,0 — 20,0 %

4th. alternative — CURRENT DISTORTION - THD(RMS)%
Help 16: THD(RMS)% measurement at supply input — %

Calculated CURRENT and DISTORTION at mains input without PF compensation
Help 17

FUNDAMENTAL current	A	1.071,9	>> detail >>	5 th HARMONIC	A 150,8
HARMONICS current (overall)	A	214,4		7 th HARMONIC	A 107,7
RMS current	A	1.093,2		11 th HARMONIC	A 58,8
				13 th HARMONIC	A 58,0
Calculated THD%	%	20,0%		17 th HARMONIC	A 44,4
Calculated THD(RMS)%	%	19,6%		19 th HARMONIC	A 39,7


"SIMULVAR" - PF correction equipment connection simulator
Simulvar 2012

SIMULATION OUTPUT SHEET

CUSTOMER — Date 10/04/2012

Name: TRENDFIN srl — Mr./Mrs. Technical Department
Street: Via della Repubblica, 8 — Tel.: +39 049 884 8011
Town: 35010 LIMENA (PD) - Italy — Fax: +39 049 884 8143

ENTRY DATA

Help 2	Mains Voltage (VL)		400	V
Help 3	Mains Frequency		50	Hz
Help 4	Overall Active Power (PT)		557	KW
Help 5	Power Factor before compensation (cos1)		0,75	
Help 6	Target Power Factor (cos2)		0,95	
Help 7	HT / LT Transformer		SI	
Help 8	Number of equal transformers in parallel		1	
Help 9	Individual Transformer Apparent Power		1000	KVA
Help 9	Transformer short circuit V in %			%
Help 10	Transformer losses			KW
Help 11	Capacitors rated voltage (Vc)		400	V
Help 13	Overall Power of non-linear loads in % of (PT)			%
Help 14	CURRENT readings taken at mains supply general input	5 th Harmonic		A
		7 th Harmonic		A
		11 th Harmonic		A
		13 th Harmonic		A
		17 th Harmonic		A
		19 th Harmonic		A
Help 15		Harmonic Distortion THD%	20,0	%
Help 16		Harmonic Distortion THD(RMS)%		%

CALCULATED DATA

Reactive power required
Help 18: Minimum reactive power required to reach the target PF. Not chokes. — 308,2 Kvar

Effects due to harmonics
Help 19: THE RESONANCE MAP IS NOT ACTIVE
Help 20: COMPULSORY USE OF CHOKES FOR HIGH THD%-Qn.

Recommended equipment
Help 21: NORMAL EQUIPMENT AS PER CATALOG TYPES

TYPE	QT.	V	Hz	Cap. V	Mains Hz	Mains V
RAM 9400HG	360,0	400	50			

Help 22 — Help 23

Simulation of current overloads
Help 24

	K	THD% - L	THD% - LR	THD% - Z	THD% - C	THD%-Qn
Max. distortion on capacitors with all PF correction equipment power connected						
Max. distortion on most loaded capacitor bank combination during automatic operation						
Max. distortion on the linear load WITHOUT PF compensation						
Max. distortion at mains general input WITH PF compensation						
Max. distortion at mains general input WITHOUT PF compensation						
Harmonics amplification coefficient						
THD% of CURRENT						
Values during connection of banks	4,15	20,0%	61,7%	6,1%	182,2%	98,2%
Values at reduced load	2,78	20,6%	45,2%	4,5%	235,1%	
Values (most loaded bank) when using chokes.	0,11	20,0%	19,5%	6,1%	20,7%	
THD(RMS)% of CURRENT						
Values during connection of banks	4,15	19,6%	52,5%	6,1%	87,7%	70,1%
Values at reduced load	2,78	20,2%	41,2%	4,5%	92,0%	
Values (most loaded bank) when using chokes.	0,11	19,6%	19,1%	6,1%	20,3%	

Help 25: Simulation with reduced load at 390 KW equivalente al 70% di PT

Calculated CURRENT and DISTORTION at mains input without PF compensation
Help 26

FUNDAMENTAL current	A	1.071,9	>> detail >>	5 th Harmonic current	A 150,8
HARMONIC current (overall)	A	214,4		7 th Harmonic current	A 107,7
RMS current	A	1.093,2		11 th Harmonic current	A 58,8
				13 th Harmonic current	A 58,0
CALCULATED THD%-L	%	20,0%		17 th Harmonic current	A 44,4
CALCULATED THD(RMS)%-L	%	19,6%		19 th Harmonic current	A 39,7

AUTOMATIC PFC SYSTEMS

for 400 V supply

RAM 9100

- **DIMENSIONS** (mm): **W** = 745 **H** = 640 **D** = 600

RAM 9200

- **DIMENSIONS** (mm): **W** = 745 **H** = 1300 **D** = 600

TECHNICAL FEATURES

- Indoor installation
- IP30 protection degree with locked door
- RAL 7035 color
- 3P/3W supply
- Top cable entry
- Protection switch
- Removable racks
- Protection with NH00 fuses
- **EPCOS** resin-filled capacitors
- **EPCOS** N_2-filled capacitors for **HG** series
- **HD** 3-phase contactors with pre-charge resistors, powered by **SUPERTEC**
- **High-linearity inductors with a detuning frequency of 189 Hz (p=7%)**
- Forced ventilation
- PF controller **VARACTOR 650 S**:
  - **Alarms:** Overvoltage - High Temperature - High THD% - Undercompensation
  - **Measurements of:** Voltage - THD in current - Missing Reactive Power - Cos φ - Temperature
  - Two manual modes for switching the capacitors banks
  - **Alarm contact for remote reporting**

ON REQUEST:

- **IP 54 Solution**: S/N: G ☐ ☐ ☐ ☐ ☐ 5 ☐
  Dimensions (mm): **W** = 800 **H** = 1500 **D** = 600

- **Bottom cable entry solution**:
  S/N: G ☐ ☐ ☐ ☐ ☐ D ☐

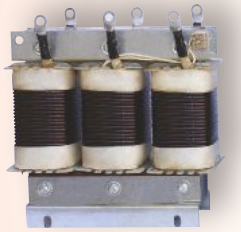
- **IP 54 Solution with bottom cable entry:**
  S/N: G ☐ ☐ ☐ ☐ ☐ F ☐

CE **CERTIFICATION - Standards:**
CEI EN 61439 - 1/2, CEI EN 61921 - 1, CEI EN 60831 - 1/2

RAM 9100	Nominal Power	Nominal Current	BANKS POWER kvar				Steps Number	Weight kg	S/N
	kvar	A	I	II	III				
✓ RAM 9100 - 30 - 400 V	30	43	7,5	7,5	15		4	84	GA030230
✓ RAM 9100 - 52,5 - 400 V	52,5	75	7,5	15	30		5	90	GA052230
✓ RAM 9100 - 60 - 400 V	60	86	15	15	30		4	96	GA060230
RAM 9100 HG	**N_2 - FILLED CAPACITORS**								
✓ RAM 9100 HG - 30 - 400 V	30	43	7,5	7,5	15		4	83	GB030230
✓ RAM 9100 HG - 52,5 - 400 V	52,5	75	7,5	15	30		5	89	GB052230
✓ RAM 9100 HG - 60 - 400 V	60	86	15	15	30		4	95	GB060230

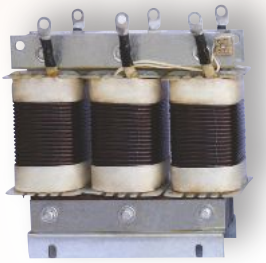
RAM 9200	Nominal Power	Nominal Current	BANKS POWER kvar				Steps Number	Weight kg	S/N
	kvar	A	I	II	III	IV			
RAM 9200 - 67,5 - 400 V	67,5	97	7,5	15	15	30	9	120	GC067230
RAM 9200 - 82,5 - 400 V	82,5	118	7,5	15	30	30	11	135	GC082230
RAM 9200 - 90 - 400 V	90	129	15	15	30	30	6	138	GC090230
RAM 9200 - 105 - 400 V	105	151	15	30	60		7	140	GC105230
RAM 9200 - 120 - 400 V	120	172	30	30	60		4	145	GC120230
RAM 9200 - 135 - 400 V	135	194	15	30	30	60	9	150	GC135230
RAM 9200 - 150 - 400 V	150	216	30	60	60		5	155	GC150230
RAM 9200 - 165 - 400 V	165	237	15	30	60	60	11	165	GC165230
RAM 9200 - 180 - 400 V	180	259	30	30	60	60	6	175	GC180230
RAM 9200 - 210 - 400 V	210	302	30	60	60	60	7	185	GC210230
RAM 9200 - 240 - 400 V	240	345	60	60	60	60	4	195	GC240230
RAM 9200 HG	**N_2 - FILLED CAPACITORS**								
RAM 9200 HG - 67,5 - 400 V	67,5	97	7,5	15	15	30	9	116	GD067230
RAM 9200 HG - 82,5 - 400 V	82,5	118	7,5	15	30	30	11	131	GD082230
RAM 9200 HG - 90 - 400 V	90	129	15	15	30	30	6	134	GD090230
RAM 9200 HG - 105 - 400 V	105	151	15	30	60		7	136	GD105230
RAM 9200 HG - 120 - 400 V	120	172	30	30	60		4	140	GD120230
RAM 9200 HG - 135 - 400 V	135	194	15	30	30	60	9	146	GD135230
RAM 9200 HG - 150 - 400 V	150	216	30	60	60		5	152	GD150230
RAM 9200 HG - 165 - 400 V	165	237	15	30	60	60	11	160	GD165230
RAM 9200 HG - 180 - 400 V	180	259	30	30	60	60	6	170	GD180230
RAM 9200 HG - 210 - 400 V	210	302	30	60	60	60	7	180	GD210230
RAM 9200 HG - 240 - 400 V	240	345	60	60	60	60	4	190	GD240230

HIGH-LINEARITY INDUCTORS FOR HARMONICS



LH 15

S/N: RR015ZZ1



LH 30

S/N: RR030ZZ1

LH 60

S/N: RR060ZZ1

AUTOMATIC PFC SYSTEMS

for 400 V supply

RAM 9400

- **DIMENSIONS** (mm): **W** = 745 **H** = 1700 **D** = 600

RAM 9500

- **DIMENSIONS** (mm): **W** = 745 **H** = 2100 **D** = 600

TECHNICAL FEATURES

- Indoor installation
- IP30 protection degree with locked door
- RAL 7035 color
- 3P/3W supply
- Top cable entry
- Protection switch
- Removable racks
- Protection with NH00 fuses
- **EPCOS** resin-filled capacitors
- **EPCOS** N_2-filled capacitors for **HG** series
- **HD** 3-phase contactors with pre-charge resistors, powered by **SUPERTEC**
- **High-linearity inductors with a detuning frequency of 189 Hz (p=7%)**
- Forced ventilation
- PF controller **VARACTOR 650 S**:
  - **Alarms:** Overvoltage - High Temperature - High THD% - Undercompensation
  - **Measurements of:** Voltage - THD in current - Missing Reactive Power - Cos φ - Temperature
  - Two manual modes for switching the capacitors banks
  - **Alarm contact for remote reporting**

ON REQUEST:

- **IP 54 Solution**: S/N: G ☐ ☐ ☐ ☐ ☐ 5 ☐
  RAM 9400 - Dimensions (mm): **W** = 800 **H** = 1700 **D** = 600
  RAM 9500 - Dimensions (mm): **W** = 800 **H** = 2100 **D** = 600

- **Bottom cable entry solution**:
  S/N: G ☐ ☐ ☐ ☐ ☐ D ☐

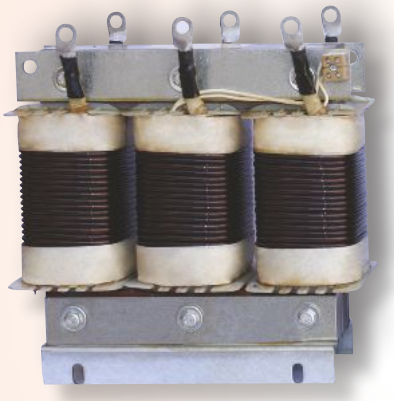
- **IP 54 Solution with bottom cable entry:**
  S/N: G ☐ ☐ ☐ ☐ ☐ F ☐

CE **CERTIFICATION - Standards:**
CEI EN 61439 - 1/2, CEI EN 61921 - 1, CEI EN 60831 - 1/2

RAM 9400	Nominal Power	Nominal Current	BANKS POWER kvar						Steps Number	Weight kg	S/N
	kvar	A	I	II	III	IV	V	VI			
RAM 9400 - 240 - 400 V	240	345	30	30	60	60	60		8	296	GH240230
RAM 9400 - 270 - 400 V	270	388	30	60	60	60	60		9	310	GH270230
RAM 9400 - 300 - 400 V	300	432	30	30	60	60	60	60	10	316	GH300230
RAM 9400 - 330 - 400 V	330	475	30	60	60	60	60	60	11	360	GH330230
RAM 9400 - 360 - 400 V	360	518	60	60	60	60	60	60	6	375	GH360230
RAM 9400 HG	**N_2 - FILLED CAPACITORS**										
RAM 9400 HG - 240 - 400 V	240	345	30	30	60	60	60		8	292	GJ240230
RAM 9400 HG - 270 - 400 V	270	388	30	60	60	60	60		9	306	GJ270230
RAM 9400 HG - 300 - 400 V	300	432	30	30	60	60	60	60	10	310	GJ300230
RAM 9400 HG - 330 - 400 V	330	475	30	60	60	60	60	60	11	352	GJ330230
RAM 9400 HG - 360 - 400 V	360	518	60	60	60	60	60	60	6	366	GJ360230

RAM 9500	Nominal Power	Nominal Current	BANKS POWER kvar						Steps Number	Weight kg	S/N
	kvar	A	I	II	III	IV	V	VI			
RAM 9500 - 360 - 400 V	360	518	30	60	60	60	60	90	12	356	GK360230
RAM 9500 - 390 - 400 V	390	561	30	60	60	60	60	120	13	370	GK390230
RAM 9500 - 420 - 400 V	420	604	30	60	60	60	90	120	14	376	GK420230
RAM 9500 - 450 - 400 V	450	648	30	60	60	60	120	120	15	420	GK450230
RAM 9500 - 480 - 400 V	480	691	60	60	60	60	120	120	8	435	GK480230
RAM 9500 HG	**N_2 - FILLED CAPACITORS**										
RAM 9500 HG - 360 - 400 V	360	518	30	60	60	60	60	90	12	352	GL360230
RAM 9500 HG - 390 - 400 V	390	561	30	60	60	60	60	120	13	366	GL390230
RAM 9500 HG - 420 - 400 V	420	604	30	60	60	60	90	120	14	370	GL420230
RAM 9500 HG - 450 - 400 V	450	648	30	60	60	60	120	120	15	412	GL450230
RAM 9500 HG - 480 - 400 V	480	691	60	60	60	60	120	120	8	426	GL480230

HIGH-LINEARITY INDUCTORS FOR HARMONICS



LH 30

S/N: RR030ZZ1

LH 60

S/N: RR060ZZ1

AUTOMATIC PFC SYSTEMS

for 400 V supply

RAM 9800 HG

TECHNICAL FEATURES

- Indoor installation
- IP30 protection degree with locked door
- Dimensions (mm): **W** = 800 **H** = 2100 **D** = 1000
- RAL 7035 color
- 3P/3W supply
- Top cable entry
- Protection switch
- Removable racks
- Protection with NH00 fuses
- **EPCOS** N_2-filled capacitors for **HG** series
- **HD** 3-phase contactors with pre-charge resistors, powered by **SUPERTEC**
- Forced ventilation
- **High-linearity inductors with a detuning frequency of 189 Hz (p=7%)**
- PF controller **VARACTOR 650 S**
- **Alarm contact for remote reporting**

EXPANDABILITY

The ✓ flag means that the system can be expanded.
The system can be expanded by adding a rack: the system is already provided with auxiliary and power cables, sliding guides and the switch is rated for the added power.

ON REQUEST:

- **IP 54 Solution**: S/N: G S ☐ ☐ ☐ ☐ 5 ☐

- **Expandability: (with a rack of 200 kvar max):**
  S/N: G S ☐ ☐ ☐ ☐ ☐ 1

CE **CERTIFICATION - Standards:**
CEI EN 61439 - 1/2, CEI EN 61921 - 1, CEI EN 60831 - 1/2

RAM 9800 HG	N_2 - FILLED CAPACITORS										
	Nominal Power	Nominal Current	BANKS POWER kvar						Steps Number	Weight kg	S/N
	kvar	A	I	II	III	IV	V	VI			
✓ RAM 9800 - 300 - 400 V	300	432	50	50	100	100			6	486	GS300230
✓ RAM 9800 - 350 - 400 V	350	504	50	100	100	100			7	507	GS350230
✓ RAM 9800 - 400 - 400 V	400	576	33,3	66,6	100	100	100		12	554	GS400230
✓ RAM 9800 - 450 - 400 V	450	648	50	100	100	100	100		9	575	GS450230
✓ RAM 9800 - 500 - 400 V	500	720	33,3	66,6	100	100	100	100	15	601	GS500230
✓ RAM 9800 - 550 - 400 V	550	792	50	100	100	100	100	100	11	622	GS550230
✓ RAM 9800 - 600 - 400 V	600	864	33,3	66,6	100	100	100	200	18	642	GS600230
RAM 9800 - 650 - 400 V	650	936	50	100	100	100	100	200	13	692	GS650230
RAM 9800 - 700 - 400 V	700	1008	33,3	66,6	100	100	200	200	21	718	GS700230
RAM 9800 - 750 - 400 V	750	1080	50	100	100	100	200	200	15	739	GS750230
RAM 9800 - 800 - 400 V	800	1152	33,3	66,6	100	200	200	200	24	760	GS800230

AUTOMATIC PFC SYSTEMS

for 400 V supply

RAM 9800 HG DYNAMIC

TECHNICAL FEATURES

- Indoor installation
- IP30 protection degree with locked door
- Dimensions (mm): **W** = 800 **H** = 2100 **D** = 1000
- RAL 7035 color
- 3P/3W supply
- Top cable entry
- Protection switch
- Removable racks
- Protection with NH00 fuses
- **EPCOS N_2**-filled capacitors for **HG** series
- Thyristor modules for capacitors switching
- Forced ventilation
- **High-linearity inductors with a detuning frequency of 189 Hz (p=7%)**
- PF controller **BR7000-I-TH**:
  - LCD display with integrated power analyzer
  - Measurements of:
    - Voltage
    - Current
    - Frequency
    - Reactive Power
    - Active Power
    - Cos φ
    - Harmonic Currents
  - Capacitors real current
  - Total switchings for each bank
  - Temperature sensor for the fan control
  - Maximum switching frequency: 10 Hz

ON REQUEST:

- **IP 54 Solution**: S/N: G T ☐ ☐ ☐ ☐ 5 ☐

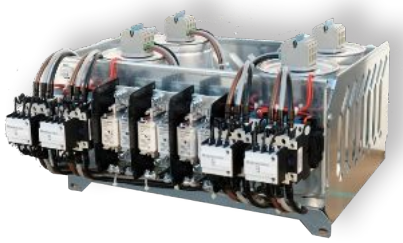
CE **CERTIFICATION - Standards:**
CEI EN 61439 - 1/2, CEI EN 61921 - 1, CEI EN 60831 - 1/2

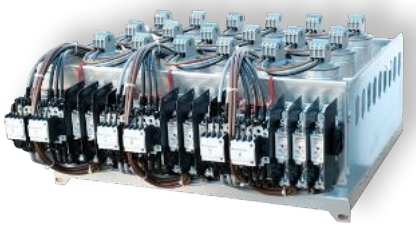
RAM 9800 HG DYNAMIC	N_2 - FILLED CAPACITORS										
	Nominal Power	Nominal Current	BANKS POWER kvar						Steps Number	Weight kg	S/N
	kvar	A	I	II	III	IV	V	VI			
RAM 9800 HG Dy - 175 - 400 V	175	252	25	50	50	50			7	390	GT175230
RAM 9800 HG Dy - 200 - 400 V	200	288	25	25	50	50	50		8	450	GT200230
RAM 9800 HG Dy - 225 - 400 V	225	324	25	50	50	50	50		9	510	GT225230
RAM 9800 HG Dy - 250 - 400 V	250	360	50	50	50	50	50		5	570	GT250230
RAM 9800 HG Dy - 300 - 400 V	300	432	50	50	50	50	50	50	6	630	GT300230
RAM 9800 HG Dy - 350 - 400 V	350	504	50	50	50	50	50	100	7	730	GT350230
RAM 9800 HG Dy - 400 - 400 V	400	576	50	50	50	50	100	100	8	750	GT400230

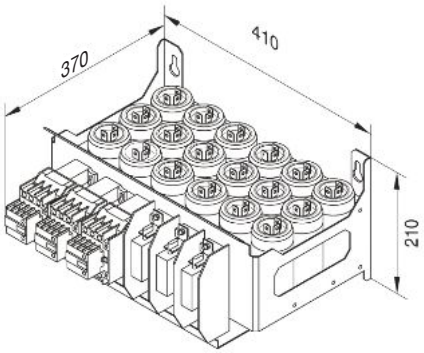
CAPACITORS RACKS

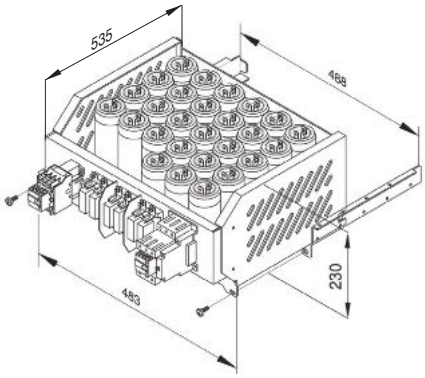
for 400 V ÷ 440 V supply

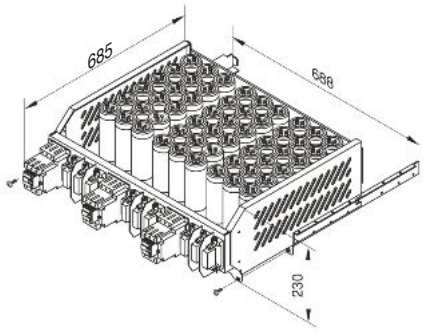
CAR 5500 | CAR 6700 | CAR 7700

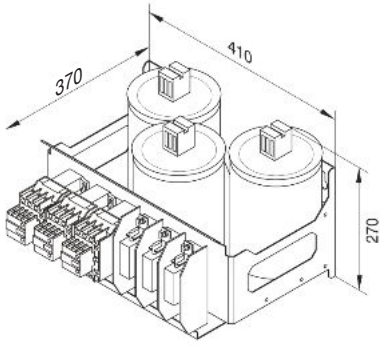


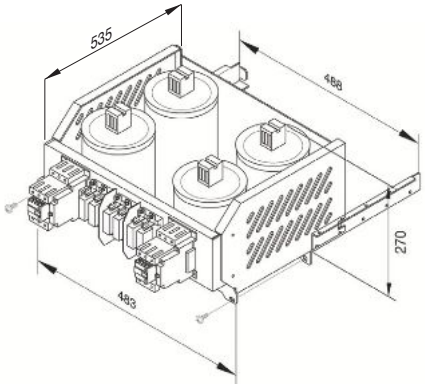


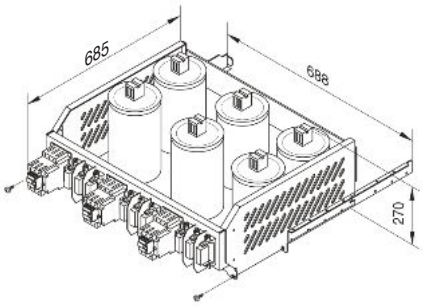












TECHNICAL FEATURES

- Indoor installation
- IP00 protection degree with locked door
- RAL 7035 color
- 3P/3W supply
- Maximum ambient temperature: 40°C
- Protection made with NH00 fuses
- **EPCOS** resin-filled capacitors
- **EPCOS** N_2-filled capacitors for **HG** series
- **HD** 3-phase contactors with pre-charge resistors
- Voltage of auxiliary circuits: 110 V, 50 Hz
- Total losses: 1,5 W/kvar

MOUNTING

The racks are supplied with special sliding guides, in order to ensure a good robustness. The guides may be fixed to the transoms inside the electrical panel.

These racks are suitable for panel having the following dimensions:

Width: mm 600 - Depth: mm 400: **CAR 5500**
Width: mm 600 - Depth: mm 600: **CAR 6700**
Width: mm 800 - Depth: mm 800: **CAR 7700**

CE **CERTIFICATION - Standards:**

CEI EN 61439 - 1/2, CEI EN 61921 - 1, CEI EN 60831 - 1/2

CAR 5500	Nominal Power	Nominal Current	BANKS POWER kvar			Weight kg	S/N
	kvar	A	I	II	III		
CAR 5500 - 37,5/2 - 400 V	37,5	54	12,5	25		9	LE030202
CAR 5500 - 50/2 - 400 V	50	72	25	25		10	LE050202
CAR 5500 - 50/3 - 400 V	50	72	12,5	12,5	25	10	LE050203
CAR 5500 - 62,5/3 - 400 V	62,5	90	12,5	25	25	11	LE062203
CAR 5500 - 75/3 - 400 V	75	108	25	25	25	12	LE075203
CAR 5500 HG	**N_2 - FILLED CAPACITORS**						
CAR 5500 HG - 37,5/2 - 400 V	37,5	54	12,5	25		7	LF037202
CAR 5500 HG - 50/2 - 400 V	50	72	25	25		8	LF050202
CAR 5500 HG - 50/3 - 400 V	50	72	12,5	12,5	25	8	LF050203
CAR 5500 HG - 62,5/3 - 400 V	62,5	90	12,5	25	25	9	LF062203
CAR 5500 HG - 75/3 - 400 V	75	108	25	25	25	10	LF075203

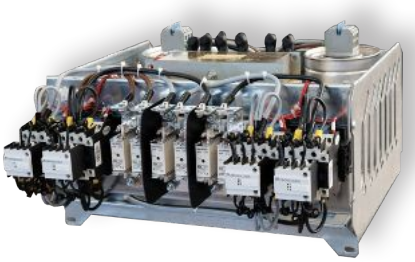
CAR 6700	Nominal Power	Nominal Current	BANKS POWER kvar			Weight kg	S/N
	kvar	A	I	II	III		
CAR 6700 - 50/1 - 400 V	50	72	50			18	LH050201
CAR 6700 - 50/2 - 400 V	50	72	25	25		19	LH050202
CAR 6700 - 50/3 - 400 V	50	72	12,5	12,5	25	21	LH050203
CAR 6700 - 75/2 - 400 V	75	108	25	50		22	LH075202
CAR 6700 - 75/3 - 400 V	75	108	25	25	25	24	LH075203
CAR 6700 - 100/2 - 400 V	100	144	50	50		26	LH100202
CAR 6700 - 100/3 - 400 V	100	144	25	25	50	28	LH100203
CAR 6700 - 125/3 - 400 V	125	180	25	50	50	30	LH125203
CAR 6700 - 150/2 - 400 V	150	216	75	75		32	LH150202
CAR 6700 HG	**N_2 - FILLED CAPACITORS**						
CAR 6700 HG - 50/1 - 400 V	50	72	50			16	LJ050201
CAR 6700 HG - 50/2 - 400 V	50	72	25	25		17	LJ050202
CAR 6700 HG - 75/2 - 400 V	75	108	25	50		19	LJ075202
CAR 6700 HG - 75/3 - 400 V	75	108	25	25	25	19	LJ075203
CAR 6700 HG - 100/2 - 400 V	100	144	50	50		21	LJ100202
CAR 6700 HG - 100/3 - 400 V	100	144	25	25	50	23	LJ100203
CAR 6700 HG - 125/3 - 400 V	125	180	25	50	50	25	LJ125203

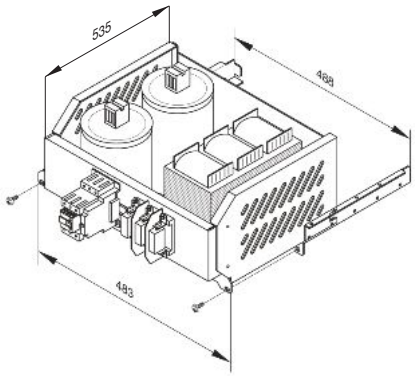
CAR 7700	Nominal Power	Nominal Current	BANKS POWER kvar			Weight kg	S/N
	kvar	A	I	II	III		
CAR 7700 - 125/3 - 400 V	125	180	25	50	50	36	LK125203
CAR 7700 - 150/3 - 400 V	150	216	50	50	50	38	LK150203
CAR 7700 - 175/3 - 400 V	175	253	50	50	75	40	LK175203
CAR 7700 - 200/3 - 400 V	200	288	50	75	75	45	LK200203
CAR 7700 - 225/3 - 400 V	225	325	75	75	75	48	LK225203
CAR 7700 HG	**N_2 - FILLED CAPACITORS**						
CAR 7700 HG - 125/3 - 400 V	125	180	25	50	50	34	LL125203
CAR 7700 HG - 150/3 - 400 V	150	216	50	50	50	36	LL150203
CAR 7700 HG - 175/3 - 400 V	175	253	50	50	75	38	LL175203
CAR 7700 HG - 200/3 - 400 V	200	288	50	75	75	43	LL200203

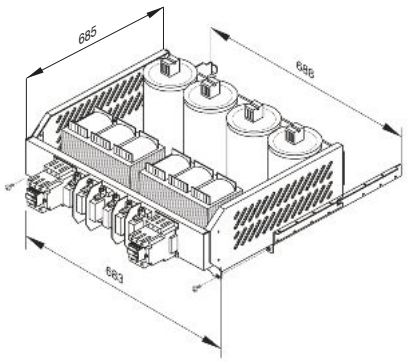
CAPACITORS RACKS

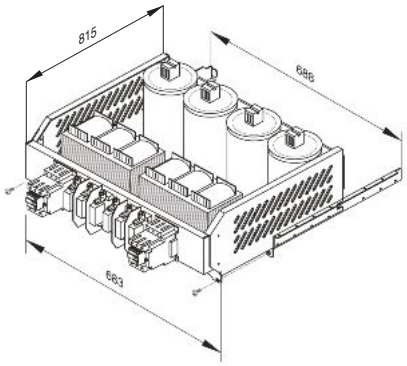
for 400 V supply

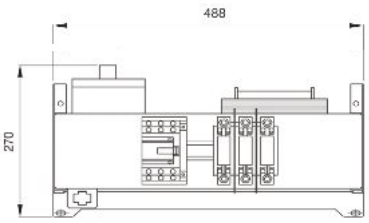
CAR 9670	CAR 9770	CAR 9800

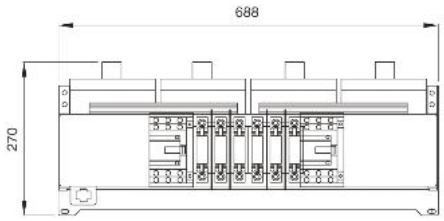


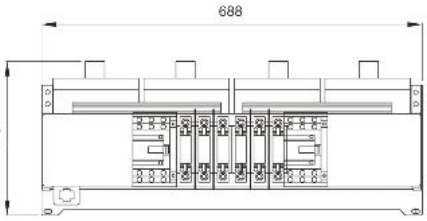












TECHNICAL FEATURES

- Indoor installation
- IP00 protection degree with locked door
- RAL 7035 color
- 3P/3W supply
- Maximum ambient temperature: 40°C
- Protection made with NH00 fuses
- **EPCOS** resin-filled capacitors
- **EPCOS** N_2-filled capacitors for **HG** series
- **HD** 3-phase contactors with pre-charge resistors
- Voltage of auxiliary circuits: 110 V, 50 Hz
- **High-linearity inductors with a detuning frequency of 189 Hz (p=7%)**
- Total losses: 5 W/kvar

MOUNTING

The racks are supplied with special sliding guides, in order to ensure a good robustness. The guides may be fixed to the transoms inside the electrical panel.

These racks are suitable for panel having the following dimensions:

Width: mm 600 - Depth: mm 600: **CAR 9670**
Width: mm 800 - Depth: mm 800: **CAR 9760**
Width: mm 800 - Depth: mm 1000: **CAR 9800**

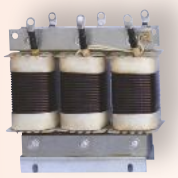
CE **CERTIFICATION - Standards:**
CEI EN 61439 - 1/2, CEI EN 61921 - 1, CEI EN 60831 - 1/2

CAR 9670	Nominal Power	Nominal Current	BANKS POWER kvar			Weight kg	S/N
	kvar	A	I	II	III		
CAR 9670 - 25/1 - 400 V	25	36	25			36	MX025201
CAR 9670 - 50/1 - 400 V	50	72	50			42	MX050201
CAR 9670 - 50/2 - 400 V	50	72	25	25		46	MX050202
CAR 9670 - 100/1 - 400 V	100	144	100			62	MX100201
CAR 9670 - 100/2 - 400 V	100	144	33,3	66,6		65	MX100202
CAR 9670 HG	**N_2 - FILLED CAPACITORS**						
CAR 9670 HG - 25/1 - 400 V	25	36	25			36	MH025201
CAR 9670 HG - 50/1 - 400 V	50	72	50			42	MH050201
CAR 9670 HG - 50/2 - 400 V	50	72	25	25		46	MH050202
CAR 9670 HG - 100/1 - 400 V	100	144	100			62	MH100201
CAR 9670 HG - 100/2 - 400 V	100	144	33,3	66,6		65	MH100202

CAR 9770	Nominal Power	Nominal Current	BANKS POWER kvar			Weight kg	S/N
	kvar	A	I	II	III		
CAR 9770 - 100/1 - 400 V	100	144	100			70	MY100201
CAR 9770 - 150/2 - 400 V	150	216	50	100		96	MY150202
CAR 9770 - 200/2 - 400 V	200	288	100	100		117	MY200202
CAR 9770 - 200/3 - 400 V	200	288	33,3	66,6	100	125	MY200203
CAR 9770 HG	**N_2 - FILLED CAPACITORS**						
CAR 9770 HG - 100/1 - 400 V	100	144	100			70	MJ100201
CAR 9770 HG - 150/2 - 400 V	150	216	50	100		96	MJ150202
CAR 9770 HG - 200/2 - 400 V	200	288	100	100		117	MJ200202
CAR 9770 HG - 200/3 - 400 V	200	288	33,3	66,6	100	125	MJ200203

CAR 9800	Nominal Power	Nominal Current	BANKS POWER kvar			Weight kg	S/N
	kvar	A	I	II	III		
CAR 9800 - 100/1 - 400 V	100	144	100			70	MT100201
CAR 9800 - 150/2 - 400 V	150	216	50	100		96	MT150202
CAR 9800 - 200/2 - 400 V	200	288	100	100		117	MT200202
CAR 9800 - 200/3 - 400 V	200	288	33,3	66,6	100	125	MT200203
CAR 9800 HG	**N_2 - FILLED CAPACITORS**						
CAR 9800 HG - 100/1 - 400 V	100	144	100			70	MV100201
CAR 9800 HG - 150/2 - 400 V	150	216	50	100		96	MV150202
CAR 9800 HG - 200/2 - 400 V	200	288	100	100		117	MV200202
CAR 9800 HG - 200/3 - 400 V	200	288	33,3	66,6	100	125	MV200203

HIGH-LINEARITY INDUCTORS FOR HARMONICS



LH 25

S/N: RR025ZZ1

LH 50

S/N: RR050ZZ1

LH 100

S/N: RR100ZZ1

LH 100/2

S/N: RR100ZZ2

FIXED PFC SYSTEMS RFT
SEMI-AUTOMATIC PFC SYSTEMS RFM

for 400 V ÷ 440 V supply

The RFT series is directly connected to the load that needs to be compensated.
The RFM series is also made by contactors that may be switched on and off through an auxiliary N.O. contact.
In both the solutions three leds show the following features: the presence of the supply voltage, the failure of the capacitors and the issue on the fuses.

TECHNICAL FEATURES

- Indoor installation
- IP30 protection degree with locked door
- RAL 7035 color
- 3P/3W supply
- Top cable entry
- Protection switch
- Protection with NH00 fuses
- 3 leds on the front door
- **EPCOS** resin-filled capacitors
- **EPCOS** N_2-filled capacitors for **HG** series
- **HD** 3-phase contactors with pre-charge resistors (only for RFM series)

DIMENSIONS (mm)

RFT1 - **RFM1**: **W** = 280 **H** = 615 **D** = 235
RFT2 - **RFM2**: **W** = 430 **H** = 650 **D** = 280
RFT3 - **RFM3**: **W** = 510 **H** = 775 **D** = 280

ON REQUEST

- **IP 54 Solution**: S/N: K ☐ ☐ ☐ ☐ ☐ 5 ☐
  Dimensions (mm):
  RFT1 - **RFM1**: **W** = 400 **H** = 600 **D** = 250
  RFT2 - **RFM2**: **W** = 600 **H** = 800 **D** = 250
  RFT3 - **RFM3**: **W** = 600 **H** = 1000 **D** = 250

CE **CERTIFICATION - Standards:**

CEI EN 61439 - 1/2, CEI EN 61921 - 1, CEI EN 60831 - 1/2

RFT			Nominal Power	Nominal Current	Weight kg	S/N
			kvar	A		
RFT 1	- 5	- 440 V	5	6	11,2	JK005430
RFT 1	- 7,5	- 440 V	7,5	9	11,5	JK007430
RFT 1	- 10	- 440 V	10	12	11,7	JK010430
RFT 1	- 12,5	- 440 V	12,5	15	12,2	JK012430
RFT 1	- 15	- 440 V	15	18	12,5	JK015430
RFT 1	- 20	- 440 V	20	24	13,0	JK020430
RFT 1	- 25	- 440 V	25	30	13,0	JK025430
RFT 1	- 30	- 440 V	30	36	13,8	JK030430
RFT 2	- 40	- 440 V	40	48	22,0	JM040430
RFT 2	- 50	- 440 V	50	60	23,0	JM050430
RFT 2	- 60	- 440 V	60	72	24,3	JM060430
RFT 3	- 75	- 440 V	75	90	34,7	JP075430
RFT 3	- 90	- 440 V	90	108	36,5	JP090430
RFT 3	- 105	- 440 V	105	126	37,5	JP105430
RFT 3	- 120	- 440 V	120	144	39,0	JP120430

RFM			Weight kg	S/N
RFM 1	- 5	- 440 V	11,7	KK005430
RFM 1	- 7,5	- 440 V	12	KK007430
RFM 1	- 10	- 440 V	12,2	KK010430
RFM 1	- 12,5	- 440 V	12,7	KK012430
RFM 1	- 15	- 440 V	13,0	KK015430
RFM 1	- 20	- 440 V	13,5	KK020430
RFM 1	- 25	- 440 V	13,5	KK025430
RFM 1	- 30	- 440 V	13,8	KK030430
RFM 2	- 40	- 440 V	22,5	KM040430
RFM 2	- 50	- 440 V	24,0	KM050430
RFM 2	- 60	- 440 V	25,3	KM060430
RFM 3	- 75	- 440 V	36,2	KP075430
RFM 3	- 90	- 440 V	38,0	KP090430
RFM 3	- 105	- 440 V	40,0	KP105430
RFM 3	- 120	- 440 V	41,8	KP120430

RFT HG			N_2 - FILLED CAPACITORS			
			Nominal Power	Nominal Current	Weight kg	S/N
RFT 1 HG	- 5	- 440 V	5	6	12,0	JL005430
RFT 1 HG	- 7,5	- 440 V	7,5	9	12,2	JL007430
RFT 1 HG	- 12,5	- 440 V	12,5	15	12,2	JL012430
RFT 1 HG	- 15	- 440 V	15	18	12,4	JL015430
RFT 1 HG	- 25	- 440 V	25	30	13,3	JL025430
RFT 1 HG	- 30	- 440 V	30	36	13,3	JL030430
RFT 2 HG	- 40	- 440 V	40	48	24,2	JN040430
RFT 2 HG	- 50	- 440 V	50	60	25,0	JN050430
RFT 2 HG	- 60	- 440 V	60	72	26,3	JN060430
RFT 3 HG	- 75	- 440 V	75	90	31,8	JQ075430
RFT 3 HG	- 90	- 440 V	90	108	32,7	JQ090430
RFT 3 HG	- 105	- 440 V	105	126	34,2	JQ105430
RFT 3 HG	- 120	- 440 V	120	144	35,0	JQ120430

N_2 - FILLED CAPACITORS				
RFM HG			Weight kg	S/N
RFM 1 HG	- 5	- 440 V	12,4	KL005430
RFM 1 HG	- 7,5	- 440 V	12,6	KL007430
RFM 1 HG	- 12,5	- 440 V	12,6	KL012430
RFM 1 HG	- 15	- 440 V	12,8	KL015430
RFM 1 HG	- 25	- 440 V	13,7	KL025430
RFM 1 HG	- 30	- 440 V	13,7	KL030430
RFM 2 HG	- 40	- 440 V	25,2	KN040430
RFM 2 HG	- 50	- 440 V	26,0	KN050430
RFM 2 HG	- 60	- 440 V	27,3	KN060430
RFM 3 HG	- 75	- 440 V	33,8	KQ075430
RFM 3 HG	- 90	- 440 V	34,7	KQ090430
RFM 3 HG	- 105	- 440 V	36,5	KQ105430
RFM 3 HG	- 120	- 440 V	37,4	KQ120430

LONGLIFE N_2-FILLED CAPACITORS

MKK ENERGY

MKK ENERGY capacitors are made by self-healing metallized polypropylene film with very low losses and their can is made by aluminum. The protection from any issue is given by the overpressure disconnector. Three inner overlying capacitances are connected in delta configuration or star configuration in order to reach a high reliabilty during the working cycle. Their construction and tests comply with EN 60831-1/2 (DIN VDE 0560/46).

OPERATING LIFE: 220.000 HOURS

The reduction of the capacitance may occur in different situations, e.g. the presence of high temperature and high voltage or the corrosion on the plates of the capacitors caused by the humidity. Thanks to the innovative process for the metallization of the PP it is possible to eliminate the corrosion, in order to maintain the same capacitance for the entire working life of the capacitor. Since the filling solution with resin may not give a complete impregnation of the PP film, the N_2-filling solution has been chosen. The nominal operating life is referred to the standard working conditions, in terms of voltage, temperature, etc. If the nominal voltage of the capacitor is increased by a 10%, the nominal operating life will raise to a 50%.

SAFETY

This new kind of technology ensures an other type of safety thanks to its N_2 impregnation. In fact, the main difference between the resin and the N_2 gas is that the first one might burn and the second one cannot. In addition, their overpressure disconnector can break the internal fuses in order to completely disconnect the capacitor from the main.

SELF-HEALING

The voltage paeaks reaching 3 times the nominal voltage might occur due to the frequent switchings in the LV grid. In this case if the PP film is penetrated, the self-healing system starts woking and regenerates it. After that the capacitor keeps working with a negligible reduction of the capacitance.

TECHNICAL FEATURES

- Maximum overvoltage 1,1 V_n (8h/d)
- Mamimum overcurrent 2 I_n
- Maximum peak of current ≤ 500 I_n
- Frequency 50/60 Hz
- Losses (dielectric) < 0,2 W/kvar
- Capacitance tolerance -5% / 10%
- Operating life 220.000 h
- Temperature range -40/+60 °C (Hot Spot = 85°C)
- Impregnation Inert Gas N_2 (Nitrogen)
- Certification cUL File No. E238746; GOST
- Standards IEC 831-1/2, UL 810 - 5th edition

PhaseCap Energy Capacitor	Power kvar	V_n V	d x h mm	Weight kg	S/N
MKK - 5 - 440 V	5	440	121 x 204	1,2	**NC0054ZZ**
MKK - 7,5 - 440 V	7,5	440	75 x 250	1,1	**NC0074ZZ**
MKK - 15 - 440 V	15	440	85 x 265	1,5	**NC0154ZZ**
MKK - 30 - 440 V	30	440	125 x 245	2,8	**NC0304ZZ**
MKK - 33 - 440 V	33	440	116 x 275	2,8	**NC0334ZZ**
MKK - 15 - 480 V	15	480	100 x 255	1,9	**NC0157ZZ**
MKK - 30 - 480 V	30	480	125 x 240	2,8	**NC0307ZZ**
MKK - 12,5 - 525 V	12,5	525	121 x 209	1,5	**NC0129ZZ**
MKK - 25 - 525 V	25	525	142 x 245	2,5	**NC0259ZZ**

1-PHASE AND 3-PHASE RESIN-FILLED CAPACITORS

1-PHASE MKP

3-PHASE MKP

VAR-PAK

1-PHASE MKP	Power kvar	V_n V	Cap. µF	d x h mm	S/N
MKP - 66 - 415V	3,5	415	66	53 x 142	**ND0663ZZ**
MKP - 77 - 415V	4,2	415	77	63,5 x 142	**ND0773ZZ**
MKP - 91 - 415V	5	415	91,5	63,5 x 142	**ND0913ZZ**
MKP - 55 - 440V	3,3	440	55	53 x 142	**ND0554ZZ**
MKP - 68 - 440V	4,2	440	68,5	63,5 x 142	**ND0684ZZ**
MKP - 82 - 440V	5	440	82	63,5 x 142	**ND0824ZZ**

3-PHASE MKP	Power kvar	V_n V	Cap. µF	d x h mm	S/N
MKP - 2,5 - 415V	2,5	415	3 x 15,5	63,5 x 129	**NE0023ZZ**
MKP - 5 - 415V	5	415	3 x 31	63,5 x 129	**NE0053ZZ**
MKP - 2,5 - 440V	2,5	440	3 x 13,5	63,5 x 129	**NE0024ZZ**
MKP - 5 - 440V	5	440	3 x 13,5	63,5 x 129	**NE0054ZZ**
MKP - 15 - 440V	15	440	3 x 82	85 x 280	**NE0154ZZ**
MKP - 30 - 440V	30	440	3 x 164	90 x 355	**NE0304ZZ**

VAR-PAK	Q_n kvar	I_n A	W mm	H mm	D mm	S/N
VP - 2,5 - 400V	2,5	3,6	76	290	200	**NF0022ZZ**
VP - 5 - 400V	5	7,2	76	290	200	**NF0052ZZ**
VP - 7,5 - 400V	7,5	10,8	76	290	200	**NF0072ZZ**
VP - 10 - 400V	10	14,4	76	290	200	**NF0102ZZ**
VP - 12,5 - 400V	12,5	18	76	290	200	**NF0122ZZ**
VP - 15 - 400V	15	21,6	76	290	200	**NF0152ZZ**
VP - 20 - 400V	20	28,9	142	290	200	**NF0202ZZ**
VP - 25 - 400V	25	36,1	142	290	200	**NF0252ZZ**
VP - 30 - 400V	30	43,3	142	290	200	**NF0302ZZ**
VP - 40 - 400V	40	57,7	208	290	200	**NF0402ZZ**
VP - 50 - 400V	50	72,2	274	290	200	**NF0502ZZ**

GENERAL FEATURES

MKP capacitors are self-healing type and their plates are made of two thin films of metallized polypropylene that are wrapped in order to create a cylinder. The external case is an aluminium can. If any voltage transient occurs, the dielectric may be penetrated giving birth to a heat dissipation that causes the sublimation of the metal sheet close to the penetration point, without damaging the PP film and avoiding any relevant reduction of the capacitance. When the capacitor fails due to high temperature, high voltage and so on, it produces a big quantity of gas that, thanks to its overpressure, pushes the top side of the can in order to disconnect the capacitor from the main.

TECHNICAL FEATURES

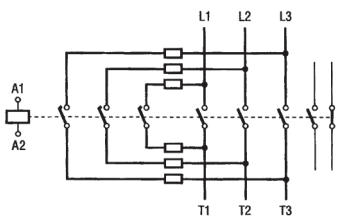
- Maximum overvoltage 1,1 V_n (8h/d)
- Mamimum overcurrent 1,5 I_n
- Frequency 50/60 Hz
- Losses (dielectric) < 0,2 W/kvar
- Capacitance tolerance - 5% / + 10%
- Test voltage between the terminals 2,15 V_n - 10 sec.
- Operating life > 150.000 ore
- Temperature range -40/D
- Impregnation Fluido biodegradabile
- Certification cUL
- Standards IEC 831-1/2, UL 810 - 5th edition

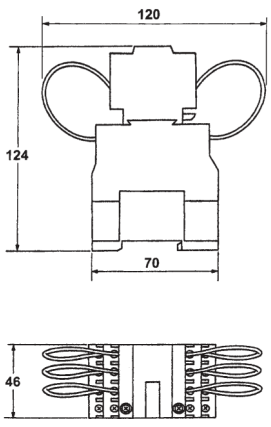
HD CONTACTORS FOR CAPACITORS (IEC-EN 60947-4-1)

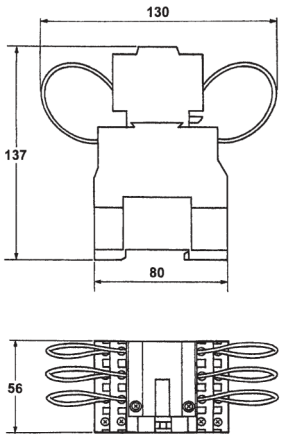
Special contactors for the connection of 3-phase capacitors The inrush overcurrent value is reduced by the early closure contacts and by the limitation resistors.	HD 15	HD 30	HD 60
			

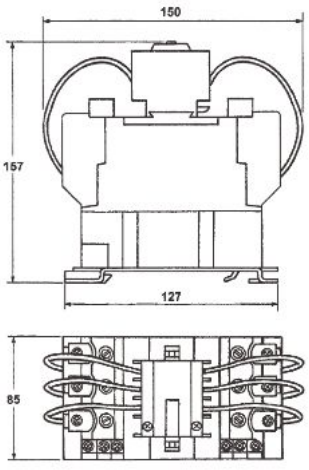
HD CONTACTORS FOR CAPACITORS (IEC-EN 60947-4-1)				
Maximum working voltage	(V)	690	690	690
Nominal isolation voltage IEC 947	(V)	1.000	1.000	1.000
Nominal thermal current	I_{th} (A)	32	60	110
Working power at 55°C and 400 V	kvar	12,5	25	50
Total number of insertions	N.	280.000	250.000	85.000
Maximum frequency of rotations	(RPM)	5,83	4	2,5
Power of the leading circuit	VA	10	10	20
Weight	kg	0,415	0,640	1,570

When the contactor coil is energized, the early closure contacts are closed and they supply the capacitor through the precharge resistors; then the power contacts are closed and after that the early closure contacts are opened.









110 V coil: S/N 220 V coil: S/N 380 V coil: S/N	**RA0150ZZ** **RA0151ZZ** **RA0152ZZ**	**RA0300ZZ** **RA0301ZZ** **RA0302ZZ**	**RA0600ZZ** **RA0601ZZ** **RA0602ZZ**

CURRENT TRANSFORMERS FOR AUTOMATIC PFC SYSTEMS

HOW TO SIZE THE CURRENT TRANSFORMER

The Current Transformer (C.T.) is not supplied with the APFC equipment, but it must be requested separately. The Controller needs a current signal that must be related to the current absorbed by the load that needs to be compensated; the correct device is a C.T. with an adequate ratio and a secondary coil current of 5 A. The primary coil current must be chosen on the maximum current of the electrical system that must be compensated, without considering the inrush current of the loads. This value can be obtained by the maximum power absorbed by the load that is expressed in kW; it can be also found on the electrical bills, on the energy meters or by using the following formula:

$$A = \frac{kW}{1{,}73 \times V \times Cos\,\varphi} \times 1000$$

Example – data: V = 400 kW = 50 Cosφ = 0,90

$$\text{Current in A} = \frac{50}{1{,}73 \times 400 \times 0{,}90} \times 1000 = 80\ A$$

Once the current value is found, the correct size of the C.T. is the one available on the market that is close to this value; the C.T. size found on the market must be always higher than the first one. In the above example the required C.T. must have a primary coil current of 100/150 A. The C.T. must not be oversized than required so that the PFC controller does not lose its sensitivity.

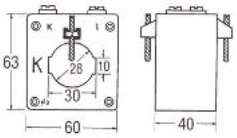
CLASS, PERFORMANCE, CONNECTIONS OF THE C.T.

The C.T. must be properly chosen and sized, otherwise some distorsions on the current signal and some remarkable errors on the measurements might occur.
As regards the precision of the C.T., it must be of 1 Class as already mentioned; if this kind of C.T. is difficult to be found, a 3 Class C.T. may be used with a performance reduction of 50%.
For example: a 3 Class C.T. with a performance of 10 VA must be used as a 1 Class C.T. with a performance of 5 VA.
The C.T. performance, that is its apparent power which is expressed in VA, and the secondary cables section are linked as it is easily shown in the below table:

Cable section in mm2	C.T. performance in VA			
	3	5	10	15
	Maximum length of the connection			
1,5	2,8	5	10	16
2,5	4,6	9	18	27
4	7,2	13	28	43
6	11	20	42	64
10	18	33	71	108

Example: a 5 VA performance C.T. may be connected up to 5 m far from the APFC equipment if the connection is realized with cables of 1,5 mm² and up to 9 m using 2,5 mm² cables.

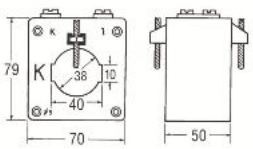
TAC1 - Secondary current 5 A – Performance 3 VA – 1 Class – Working voltage 750 V – Test voltage 3 Kv – The hole is suitable for busbars up to 30x10 mm and for cables up to a diameter of 28 mm.



Available transformation ratios:

TAC1	50 /5A	**(SA050ZZ5)**	**TAC1**	100/5A	**(SA100ZZ5)**
TAC1	150/5A	**(SA150ZZ5)**	**TAC1**	200/5A	**(SA200ZZ5)**
TAC1	300/5A	**(SA300ZZ5)**	**TAC1**	400/5A	**(SA400ZZ5)**

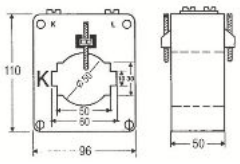
TAC2 - Secondary current 5 A – Performance 5 VA – 1 Class – Working voltage 750 V – Test voltage 3 Kv – The hole is suitable for busbars up to 40x10 mm and for cables up to a diameter of 38 mm.



Available transformation ratios:

TAC2	150/5A	**(SB150ZZ5)**	**TAC2**	200/5A	**(SB200ZZ5)**
TAC2	300/5A	**(SB300ZZ5)**	**TAC2**	400/5A	**(SB400ZZ5)**
TAC2	600/5A	**(SB600ZZ5)**	**TAC2**	800/5A	**(SB800ZZ5)**

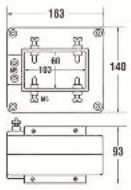
TAC3 - Secondary current 5 A – Performance 10 VA – 1 Class – Working voltage 750 V – Test voltage 3 Kv – The hole is suitable for busbars up to 60x10 mm and for cables up to a diameter of 50 mm.



Available transformation ratios:

TAC3	400/5A	**(SC400ZZ5)**	**TAC3**	600 /5A	**(SC600ZZ5)**
TAC3	800/5A	**(SC800ZZ5)**	**TAC3**	1000/5A	**(SCA00ZZ5)**

TAC4 - Secondary current 5 A – Performance 15 VA – 1 Class – Working voltage 750 V – Test voltage 3 Kv – The hole has 103x60 mm dimensions and it is suitable for busbars and cables.



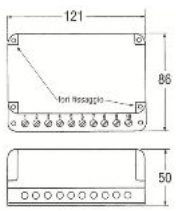
Available transformation ratios:

TAC4	1500/5A	**(SDA50ZZ5)**	**TAC4**	2000/5A	**(SDB00ZZ5)**
TAC4	3000/5A	**(SDC00ZZ5)**	**TAC4**	4000/5A	**(SDD00ZZ5)**

TSW - **SUMMATION CURRENT TRANSFORMERS**

This kind of C.T.s is used for catching the signal coming from different main C.T.s connected in parallel on different busbars of the same electrical system. The main C.T.s must have the same transformation ratio of the other ones (for different applications please contact our Technical Department). The summation C.T. is provided with as many primary windings as main C.T.s and with one secondary winding that is connected to the APFC equipment. The self-consumption of the TSW is 5 VA that must be divided into the number of main C.T.s.

Secondary current 5 A – Performance 10 VA – 1 Class



TSW 2X5/5A	Two inputs of 5 A	**(SEA25ZZZ)**
TSW 3X5/5A	Three inputs of 5 A	**(SFB35ZZZ)**
TSW 4X5/5A	Four inputs of 5 A	**(SHC45ZZZ)**
TSW 5X5/5A	Five inputs of 5 A	**(SJD55ZZZ)**

ACTIVE HARMONIC FILTERS

The main purpose of the PQSine Active Harmonic Filter (AHF) series is to reduce the harmonic currents generated by the several distorting loads that are connected to the electrical system. The AHF is able to check every single current phasor, up to the 50th order, that is coming from the load and to inject as many in phase opposition, in order to get a remarkable reduction of unwanted harmonics. The AHF behaviour does not depend on the number of loads connected to system and its response time is very short, lower than 5 ms. In this way it is possible to gain a reduction of the Total Harmonic Distortion in Current expressed in %, THDC%, higher than 97%. Moreover the 3-phase/4 wires (3P/4W) model allows to delete the neutral current that may be created by a third harmonic current or by the 1-phase loads that are connected to the system. Another important feature is the compensation of the Power Factor; in this case the AHF injects a current phasor that leads the voltage in order to reach the target Power Factor. These three features can quickly come to operation thanks to 3-level-topology inverter that belongs to the AHF. The NPC 3-level-topology ensures three values of voltage output (positive, 0 and negative) for deleting the ripple of the waveform and for reducing the transistors internal losses.

AHF working principle:

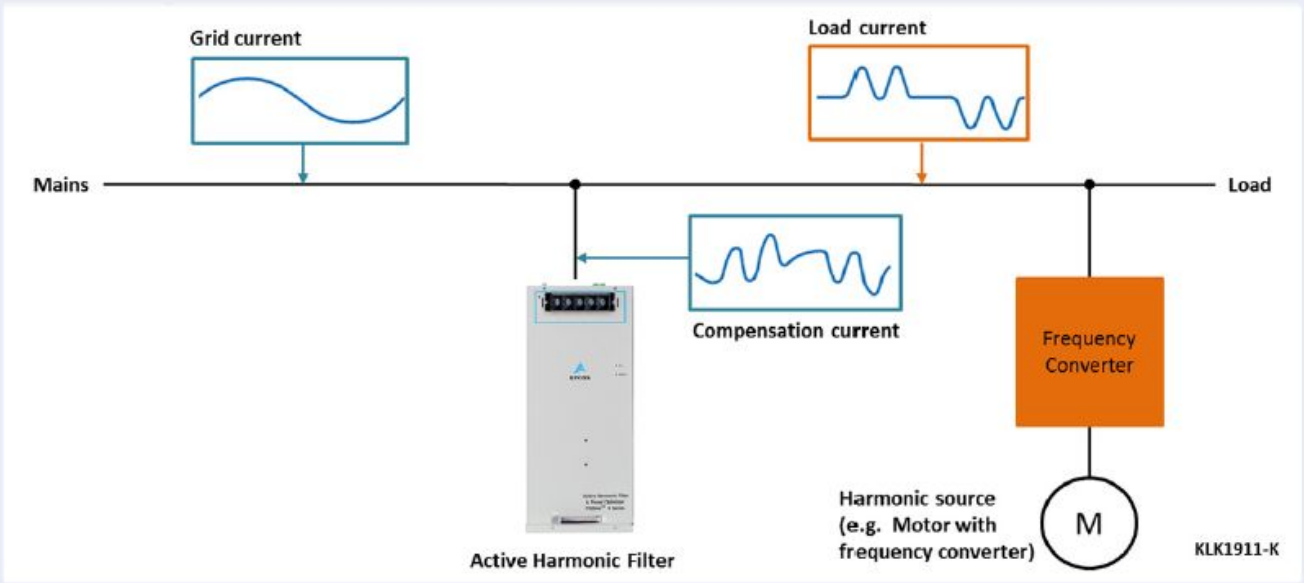


Figure 2: Total harmonic current distortion without active filter

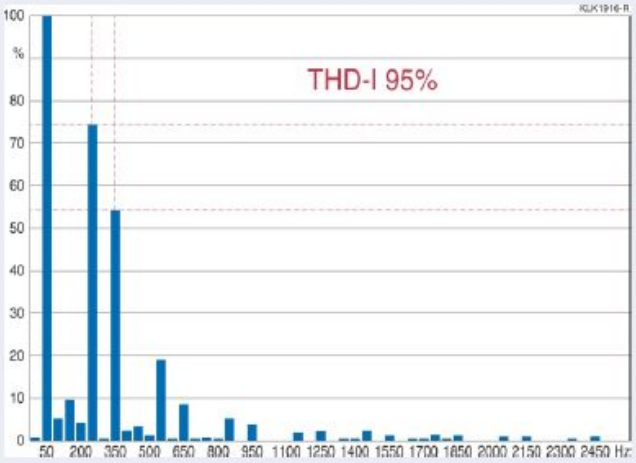
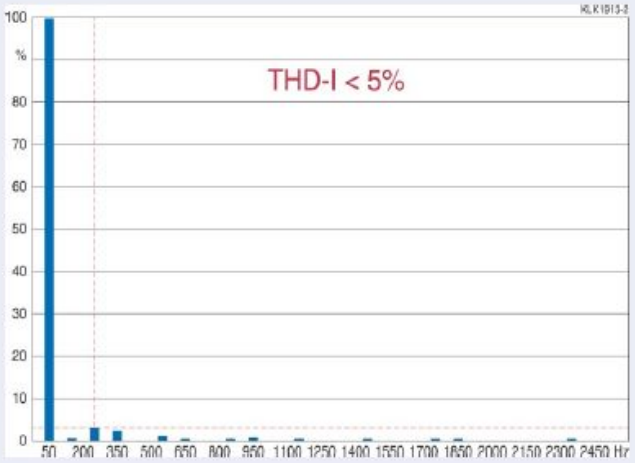


Figure 3: Total harmonic current distortion with active filter



AHF - WM	Nominal Current A	Weight kg	Dimensions (wxhxd) mm	S/N 3P/3W
AHF - WM - 25 - 400 V	25	18	440x470x150	AFW0252303W
AHF - WM - 35 - 400 V	35	18	440x470x150	AFW0352303W
AHF - WM - 50 - 400 V	50	35	440x610x190	AFW0502303W
AHF - WM - 60 - 400 V	60	35	440x610x190	AFW0602303W
AHF - WM - 100 - 400 V	100	46	440x625x232	AFW1002303W
AHF - WM - 150 - 400 V	150	48	500x585x270	AFW1502303W

AHF - FM	Nominal Current A	Weight and Dimensions	S/N 3P/3W
AHF - FM - 200 - 400 V	200	According to the required configuration	AFF2002303W
AHF - FM - 250 - 400 V	250		AFF2502303W
AHF - FM - 300 - 400 V	300		AFF3002303W
AHF - FM - 400 - 400 V	400		AFF4002303W
AHF - FM - 500 - 400 V	500		AFF5002303W
AHF - FM - 600 - 400 V	600		AFF6002303W

- **3-phase/4 wires (3P/4W) solution:**
  S/N: A F ☐ ☐ ☐ ☐ ☐ ☐ ☐ 4 ☐
- **IP54 Solution:**
  S/N: A F ☐ ☐ ☐ ☐ ☐ 5 ☐ ☐ ☐

TECHNICAL FEATURES

• Supply voltage	228 V - 456 V*
• Frequency	43 Hz - 62 Hz
• Reaction time	50 us
• Response time	< 5ms
• Switching frequency	20 kHz
• Harmonics compensation	100% odd and even
• Reactive power compensation	inductive and capacitive
• Efficiency	> 97%
• Ventilation	Forced

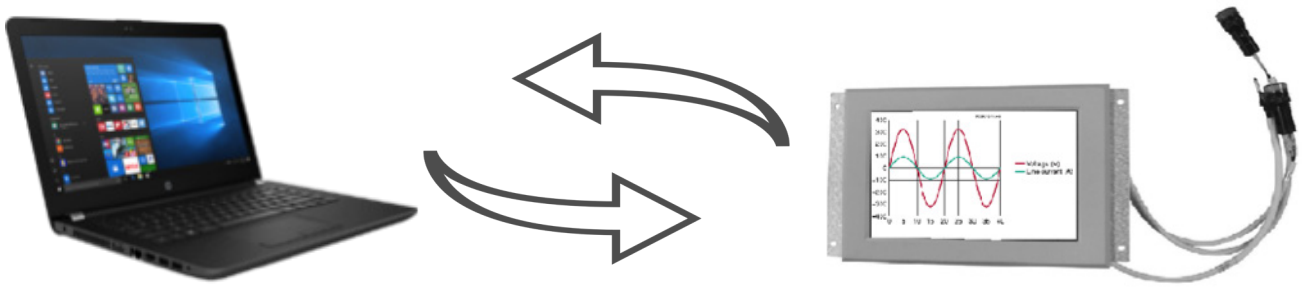
CE Certifiction and ETL Certification (UL 508, CSA C22.2#2014)**
Standards: IEEE 61000, IEEE 519, ER G5/4

* other supply voltages on request
** only for AHF-WM models

AHF - FM

AHF - WM

Remote connection through the RS485 or ETHERNET ports



Request the software for a remote monitoring of the AHF!

MICROVAR

1 - PHASE POWER FACTOR CORRECTION SYSTEM WITH THYRISTORS CONTROL FOR LOADS UP TO 6 kW

DESCRIPTION:

MICROVAR is a 1-phase PFC unit that does not need to be set up. It is controlled by a microprocessor electronic board able to mantain Power Factor between 0,9 and 1. It silently and quickly switches capacitor banks using thyristors control. Therefore it ensures a total reduction of reactive power demand from the grid.

TECHNICAL DATA:

• Operating Voltage	230-240 Vrms + 15%;
• Frequency	50/60 Hz;
• Insulation Voltage	2000 Vrms for 1 min;
• Working Temperature	-10 +55°C;
• IP Degree	IP 30;
• Dimensions (l x h x d)	228 x 278 x 140 mm;
• Weight	4,5 kg;
• Standards	CEI EN 61439-1/2, CEI EN 61921-1, CEI EN 60831-1/2.

TYPE	NOMINAL POWER [kvar]	STEPS [kvar]			CODE
		I	II	III	
MICROVAR - 2,50 - 230 V	2,50	0,50	1,00	1,00	TC002130

CONNECTION DIAGRAM

INSTALLATION STEPS

- **Set Main panel switch to OFF;**
- **disconnect the two cables from the Main circuit breaker;**
- **connect those cables to the PFC "OUT" terminals;**
- **take two new cables and connect them to the PFC "IN" terminals;**
- **connect those cables to the Main panel terminals;**
- **set Main panel switch back to ON;**
- **switch MICROVAR's circuit breaker on.**

ADVANTAGES

- **no Current Transformer required;**
- **easy installation and maintenance;**
- **Epcos self-healing capacitors.**

MV PFC SYSTEMS

MV PFC Systems may be supplied on request.

TRENDFIN S.r.l.

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