

R.5/6

Automatic capacitor banks with detuned filters



Automatic capacitor banks with detuned filters

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Automatic capacitor banks with detuned filters

The **FR / FRE** capacitor banks with detuned filters have been designed for power compensation purposes in networks with a high content of harmonics and where there is a risk of resonance.

Nowadays, installations with a high content of harmonics are quite common, so that when we perform a study for the compensation of the power factor, we must not only take into account the standard parameters, such as the active power, $\cos \varphi$ initial, $\cos \varphi$ objective and simultaneity of loads, but we must also take into account the harmonic distortion present in the installation.

Capacitor banks do not generate harmonics but they are elements that are highly sensitive to the presence of harmonics. Capacitors are receivers that can cause harmonic resonance, amplifying the levels of harmonics in our installations. They are capable of causing the following effects:

- Premature deterioration of capacitors, with the risk of their destruction.
- Unwanted protection tripping.
- Conductor overheating
- Overheating of transformers, causing excessive temperature trips, as well as additional losses in copper and iron and saturation
- Increase of thermal losses
- Errors in control processes.

Said filters are equipped with filter reactances, with factor $p = 7\%$, avoiding the amplification of harmonics above 189 Hz, while dampening existing harmonics.

In order to avoid resonances in frequencies under 189 Hz (third-order harmonics), filters with $p=14\%$

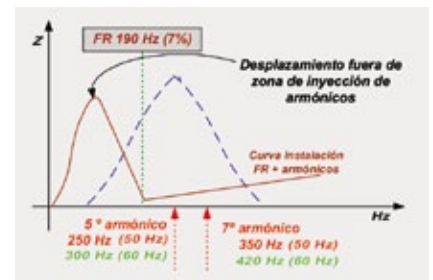
Functions of a rejection filter

- Protection of the network by shifting the resonance out of the frequencies injected in harmonics. This is done to avoid the amplification effects
- **Protection of capacitors** against the overloads generated by amplified voltages

The threshold values recommended by **CIRCUTOR** for the installation of capacitor banks of the **FR/FRE** type, equipped with detuned filters, are as follows:

$$\begin{aligned} \text{THD}(I) &\geq 15\% \\ \text{THD}(U) &\geq 2.5\% \end{aligned}$$

The set of values mentioned above must be analysed to determine the need to install a capacitor bank with filters. A high value of $\text{THD}(U)$ with a low value of $\text{THD}(I)$ might be an indicator of a weak short-circuit power in our system, so that the harmonic resonance can increase and important changes in the levels of harmonics can lead to the deformation of the wave shape under voltage.



In the case of project installations where the analysis of the values of $\text{THD}(I)$ and $\text{THD}(U)$ is not possible or is complicated, we will apply the following formula to determine whether it is necessary to install a capacitor bank with detuned filters or not.

Harmonic contamination index = $(\text{kW (harmonic loads)} / \text{kW (total load)}) \times 100$

A value above 15% indicates that our installation has a high content of harmonics, so that a capacitor bank with filters must be installed.

Selecting a FR / FRE capacitor bank

The following information is required before selecting a **FR / FRE** capacitor bank:

- ▶ Power factor (evolution in time)
- ▶ Measurement of the installation, in order to check the following:
 - Content of harmonics or potential resonance
 - Load variation speed. This will allow us to determine the type of regulation technology (contactors or electronic, with thyristors)



Connecting a FR / FRE capacitor bank

FR / FRE capacitor banks are usually connected to the general switchboard or secondary switchboards in the case of large-scale installations.

The FRF / FRM fixed capacitors act as single step filters. They are usually installed on the secondary power transformer of the installation.

Classification of detuned filters, in accordance with their compensation method

Detuned filters are as follows, as in the case of capacitor banks:

- **Fixed detuned filters.** For the compensation of transformers and motors (FRF /FRM).
- **Automatic detuned filters.** For the monitoring of variable loads.

The equipment will be (depending on the fluctuation speed of the load):

- **FR Series.** Equipped with electromechanical contactors and conventional power factor regulator
- **FRE Series.** Equipped with static contactors based on thyristors and quick power factor regulator. This solution offers a very fast switching operation and low maintenance as a result of the absence of mobile mechanical parts.

Comments about the data table

► (1) Switch

The switch gauge required by the capacitor bank is provided, but it is not included in the standard references. It is an optional element

► (2) Cable section (power connection cables)

The following tables show the cable sections recommended for the capacitor banks. The following have been taken into account to select the unit:

- Dimensioning criteria, 1.4 times the nominal current of the capacitor bank
- The section is provided by the phase
- The sections correspond to unipolar copper cables, with XLPE insulation, exposed (type F, perforated tray, ICT-BT-19), with a room temperature of 40 °C and no reducing coefficients by the grouping of various different lines
- Distance between the mains and capacitor bank of 15 m
- We recommend calculating the cable section in accordance with real data, as regards the length, type of channeling and cable used

FR 12 / FRE 12 type cabinets

The FR 12 / FRE 12 type cabinets are composed of two FR 6 / FRE6 cabinets. Therefore, they need two independent power cable connections.

When the capacitor banks are equipped with switches, one will be installed in each FR 6 / FRE 6 cabinet (total: two switches)

B - Alteration filtering solutions

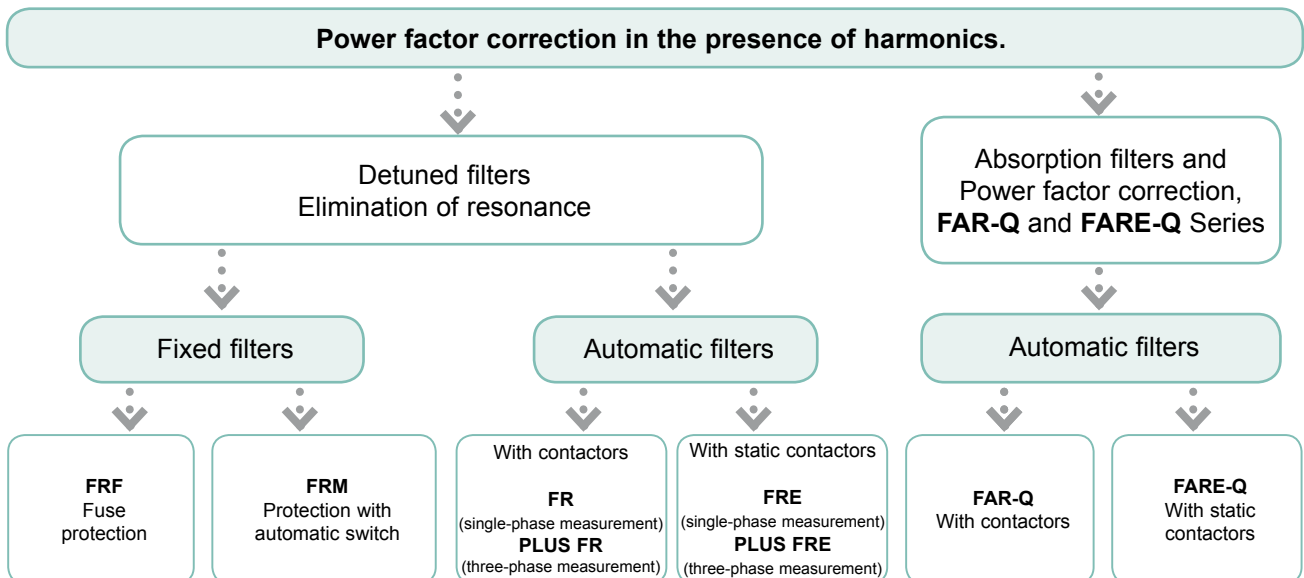
Different types of units are required to neutralise the different types of anomalies detected.

There are five categories that classify the unit in accordance with the objective desired:








- **B.1:** Power factor correction in networks with harmonic currents
- **B.2:** Harmonic filtering
- **B.3:** Neutral discharges
- **B.4:** HF filtering
- Unbalance between phases (see NETACTIVE MULTIFUNCTION)

Power factor correction in networks with harmonic currents B.1

The Power factor correction in networks with a high content of harmonics can be carried out under two different objectives, as shown on the following diagram:

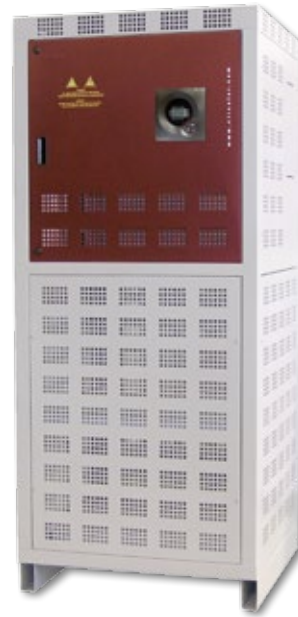


Product selection table

	Equipment	Detuned filters	Protection	Connection	Scope	Page
FRF		Fixed filters	By fuses	Contactora	25 to 100 kvar	11
FRM		Fixed filters	By automatic switch	Contactora	25 to 100 kvar	11
FR		Automatic	-	Contactora	Up to 75 kvar: FRS Up to 400 kvar: FR4 Up to 600 kvar: FR6 Up to 800 kvar: FR8 Up to 1200 kvar: FR12	7
PLUS FR		Automatic	-	Contactora	Up to 75 kvar: PLUS FRS Up to 400 kvar: PLUS FR4 Up to 600 kvar: PLUS FR6 Up to 800 kvar: PLUS FR8 Up to 1200 kvar: PLUS FR12	9
FRE		Automatic filters	-	Thyristors	Up to 75 kvar: FRES Up to 400 kvar: FRE4 Up to 600 kvar: FRE6 Up to 800 kvar: FRE8 Up to 1200 kvar: FRE12	13
PLUS FRE		Automatic filters	-	Thyristors	Up to 75 kvar: PLUS FRES Up to 400 kvar: PLUS FRE4 Up to 600 kvar: PLUS FRE6 Up to 800 kvar: PLUS FRE8 Up to 1200 kvar: PLUS FRE12	15
PLUS FRE f-f		Automatic filters	-	Thyristors	Up to 300 kvar: PLUS FREF4 Up to 400 kvar: PLUS FREF6 Up to 600 kvar: PLUS FREF8 Up to 800 kvar: PLUS FREF12	17

FR

Capacitor banks with detuned filters



Description

The **FR** Series capacitor banks with detuned filters have been designed for power compensation purposes in networks with fluctuating load levels, a high content of harmonics and where there is a risk of resonance. Power variations are relatively slow (in seconds) so that the switching operations are carried out with contactors.

Application

Its application is mainly focused on the compensation of installations with different loads, which require a regulated compensation, as a result of the power factor variations and where there is a high content of harmonics in the network.

• **Fixed detuned filters.** For the compensation of transformers and motors (**FRF/FRM**)

• **Automatic detuned filters.** For the monitoring of variable loads (**FR**).

Features

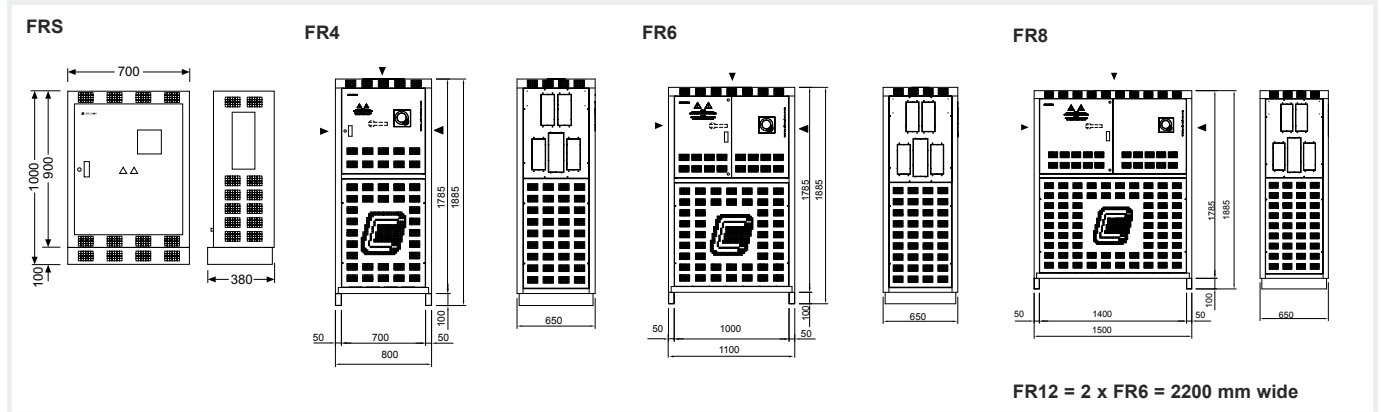
Features		
Operating voltage		230, 400 V (for other voltages, please ask)
Support voltage (400 V)		440 V
Capacity tolerance		± 10%
Unit composed of		<ul style="list-style-type: none"> • CFB capacitor • Contactors with pre-insertion block and quick discharge resistor • Individual protection of each step with fuses with high rupture power (HRP). NH-00 Series. • Two-pole protection circuit-breaker for capacitor bank and regulator operations. • Power factor regulator of the computer Max series. • Detuned filters tuned at 189 Hz for the protection against harmonics present in the network and to avoid the problems of resonance with fifth or higher order harmonics. Built-in thermostat for the disconnection of the step in case of excessive temperatures (90 °C).
Add-ons		<ul style="list-style-type: none"> • Manual capacitor bank header switch • Automatic capacitor bank header switch • Automatic switch + Earth leakage protection at the capacitor bank's header • Forced ventilation unit + thermostat • Polycarbonate plate to protect against direct contacts • Auto-transformer 400/230 V
Insulation level		3 / 15 kV
Discharge resistance		75 V / 3 minutes
Overload		1.3 times the rated current permanently
Overvoltage		<ul style="list-style-type: none"> • 10 % 8 over 24 hours • 15 % up to 15 minutes over 24 hours • 20 % up to 5 minutes over 24 hours • 30 % up to 1 minutes over 24 hours
Contactor operating voltage		230 V
Ambient conditions		
Class D temperature	Daily mean	45 °C
	Annual mean	35 °C
	Maximum	50 °C
	Minimum	-25 °C
Humidity		80% RH
Altitude		2,000 m
Construction features		
Degree of protection		IP 21
Colour		RAL 7035 Grey RAL 3005 Maroon
Assembly conditions		
Type of assembly		Vertical
Ventilation		Natural or forced, depending on the option
Distance between capacitors		Minimum, 2 cm
Standards		
CEI 60831-1, CEI 70/7, UNE 20827, UNE 20010, BS 1650, VDE 560		

FR

Capacitor banks with detuned filters



Dimensions

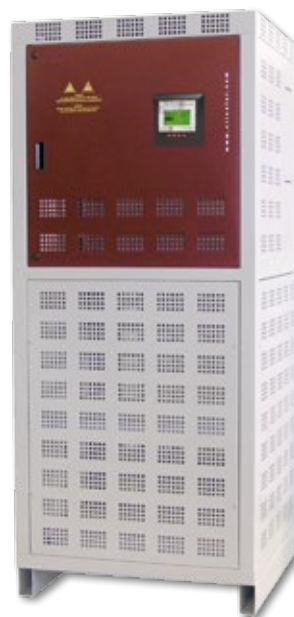


References

kvar	Composition	Switch (A)	Cable section (mm ²)	Weight (kg)	Dimensions (mm) width x height x depth	Type	Code
440	400						
17,5	14 (2,5 + 5 + 10)	63 - Included	6	105	700 x 1000 x 380	FRS-17,5-440	R5H450
25	21 (5 + (2 X 10))	63 - Included	10	120	700 x 1000 x 380	FRS-25-440	R5H455
27,5	23 (2,5 + 5 + (2 x 10))	125 - Included	16	130	700 x 1000 x 380	FRS-27,5-440	R5H460
35	29 (5 + (3 X 10))	125 - Included	16	140	700 x 1000 x 380	FRS-35-440	R5H465
37,5	31 (7,5 + (2 X 15))	125 - Included	25	150	700 x 1000 x 380	FRS-37,5-440	R5H470
45	37 (3 x 15)	125 - Included	25	175	700 x 1000 x 380	FRS-45-440	R5H475
60	50 (4 x 15)	200 - Included	35	200	700 x 1000 x 380	FRS-60-440	R5H480
75	62 (4 x 18,75)	200 - Included	50	215	700 x 1000 x 380	FRS-75-440	R5H485
87,5	72 (12,5 + 25 + 50)	200	50	300	800 x 1900 x 650	FR4-87,5-440	R5E416
100	83 (25 + 25 + 50)	250	95	325	800 x 1900 x 650	FR4-100-440	R5E420
125	103 (25 + 50 + 50)	400	95	345	800 x 1900 x 650	FR4-125-440	R5E422
150	125 (25 + 25 + 50 + 50)	400	95	355	800 x 1900 x 650	FR4-150-440	R5E423
175	145 (25 + 50 + 100)	400	120	365	800 x 1900 x 650	FR4-175-440	R5E425
200	165 (50 + 50 + 100)	400	150	380	800 x 1900 x 650	FR4-200-440	R5E428
250	207 (50 + (2 x 100))	630	185	390	800 x 1900 x 650	FR4-250-440	R5E429
300	248 (50 + 50 + (2 x 100))	630	240	410	800 x 1900 x 650	FR4-300-440	R5E430
350	289 (50 + (3 x 100))	800	2x150	430	800 x 1900 x 650	FR4-350-440	R5E432
400	331 (4 x 100)	800	2x150	460	800 x 1900 x 650	FR4-400-440	R5E434
400	331 (50 + 50 + (3 x 100))	800	2x185	550	1100 x 1900 x 650	FR6-400-440	R5J425
450	372 (50 + (4 x 100))	1000	2x185	587	1100 x 1900 x 650	FR6-450-440	R5J430
500	413 (5 x 100)	1000	2x240	621	1100 x 1900 x 650	FR6-500-440	R5J435
550	455 (50 + (5 x 100))	1250	2x240	658	1100 x 1900 x 650	FR6-550-440	R5J440
600	496 (6 x 100)	1250	2x240	685	1100 x 1900 x 650	FR6-600-440	R5J445
600	496 (50 + 50 + (5 x 100))	1250	2x240	820	1500 x 1900 x 650	FR8-600-440	R5K436
650	537 (50 + (6 x 100))	1250	3x150	865	1500 x 1900 x 650	FR8-650-440	R5K438
700	579 (7 x 100)	1250	3x150	910	1500 x 1900 x 650	FR8-700-440	R5K440
750	620 (50 + (7 x 100))	1600	3x185	955	1500 x 1900 x 650	FR8-750-440	R5K442
800	661 (8 x 100)	1600	3x185	1000	1500 x 1900 x 650	FR8-800-440	R5K442
800	661 (50 + 50 + (7 x 100))	1250 / 400	2x240/ 240	1100	2200 x 1900 x 650	FR12-800-440	R5L425
850	702 (50 + (8 x 100))	1000 / 630	2x240/ 240	1137	2200 x 1900 x 650	FR12-850-440	R5L430
900	744 (9 x 100)	1250 / 630	2x240/ 240	1174	2200 x 1900 x 650	FR12-900-440	R5L435
950	785 (50 + (9 x 100))	1000 / 800	2x240/ 2x185	1211	2200 x 1900 x 650	FR12-950-440	R5L440
1000	826 (10 x 100)	1250 / 800	2x240/ 2x185	1248	2200 x 1900 x 650	FR12-1000-440	R5L445
1050	868 (50 + (10 x 100))	1250 / 800	2x240/ 2x240	1285	2200 x 1900 x 650	FR12-1050-440	R5L450
1100	909 (11 x 100)	1250 / 1000	2x240/ 2x240	1322	2200 x 1900 x 650	FR12-1100-440	R5L455
1150	950 (50 + (11 x 100))	2 X 1250	2x240/ 2x240	1359	2200 x 1900 x 650	FR12-1150-440	R5L460
1200	992 (12 x 100)	2 X 1250	2x240/ 2x240	1389	2200 x 1900 x 650	FR12-1200-440	R5L465

PLUS FR

Intelligent capacitor banks with detuned filters



Description

Intelligent state-of-the-art capacitor banks, capable of measuring the three installation phases and compensating the total power factor consumption accurately.

The **PLUS FR** series includes detuned filters tuned at 189 Hz to avoid the resonance phenomena in 5th or higher order harmonics. Units for other harmonics orders are manufactured on demand.

Including **CIRCUTOR's** measurement technology, effectively creating a compensation + measurement unit. As a power quality analyzer, it displays any electrical parameter of the network in real time and records it in its memory, with maximum and minimum values, date and hour.

Application

Its application is mainly focused on the compensation of installations with different loads, which require a regulated compensation, as a result of the power factor variations and where there is a high content of harmonics in the network.

- **Fixed detuned filters.** For the compensation of transformers and motors (**FRF /FRM**).
- **Automatic detuned filters.** For the monitoring of variable loads (**PLUS FR**).

Features

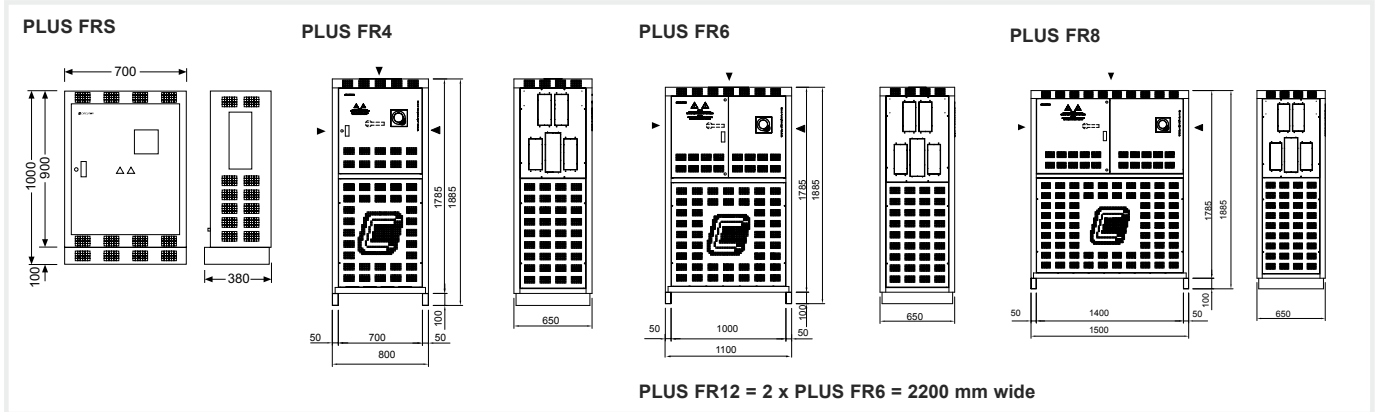
Features		
Operating voltage	230, 400 V (for other voltages, please ask)	
Support voltage (400 V)	440 V	
Capacity tolerance	± 10%	
Unit composed of	<ul style="list-style-type: none"> • CFB capacitor • Contactors with pre-insertion block and quick discharge resistor • Individual protection of each step with fuses with high rupture power (HRP), NH-00 Series. • Two-pole protection circuit-breaker for capacitor bank and regulator operations. • Power factor regulator of the computer Plus series, three-phase measurement and power analyzer functions • Detuned filters tuned at 189 Hz for the protection against harmonics present in the network and to avoid the problems of resonance with fifth or higher order harmonics. Built-in thermostat for the disconnection of the step in case of excessive temperatures (90 °C) 	
Add-ons	<ul style="list-style-type: none"> • Manual capacitor bank header switch • Automatic capacitor bank header switch • Automatic switch + Earth leakage protection at the capacitor bank's header • Forced ventilation unit + thermostat • Polycarbonate plate to protect against direct contacts • Auto-transformer 400/230 V 	
Insulation level	3 / 15 kV	
Discharge resistance	75 V / 3 minutes	
Overload	1.3 times the rated current permanently	
Overvoltage	<ul style="list-style-type: none"> • 10 % 8 over 24 hours • 15 % up to 15 minutes over 24 hours • 20 % up to 5 minutes over 24 hours • 30 % up to 1 minutes over 24 hours 	
Contacting operating voltage	230 V	
Ambient conditions		
Class D temperature	Daily mean	45 °C
	Annual mean	35 °C
	Maximum	50 °C
	Minimum	-25 °C
Humidity		80% RH
Altitude		2,000 m
Construction features		
Degree of protection		IP 21
Colour		RAL 7035 Grey RAL 3005 Maroon
Assembly conditions		
Type of assembly		Vertical
Ventilation		Natural or forced, depending on the option
Distance between capacitors		Minimum, 2 cm
Standards		
		CEI 60831-1, CEI 70/7, UNE 20827, UNE 20010, BS 1650, VDE 560

PLUS FR

Intelligent capacitor banks with detuned filters



Dimensions



References

kvar	Composition	Switch (A)	Cable section (mm ²)	Weight (kg)	Dimensions (mm) width x height x depth	Type	Code
440	400						
17,5	14 (2,5 + 5 + 10)	63 - Included	6	105	700 x 1000 x 380	PLUS FRS-17,5-440	R5G450
25	21 (5 + (2 X 10))	63 - Included	10	120	700 x 1000 x 380	PLUS FRS-25-440	R5G455
27,5	23 (2,5 + 5 + (2 X 10))	125 - Included	16	130	700 x 1000 x 380	PLUS FRS-27,5-440	R5G460
35	29 (5 + (3 X 10))	125 - Included	16	140	700 x 1000 x 380	PLUS FRS-35-440	R5G465
37,5	31 (7,5 + (2 X 15))	125 - Included	25	150	700 x 1000 x 380	PLUS FRS-37,5-440	R5G470
45	37 (3 x 15)	125 - Included	25	175	700 x 1000 x 380	PLUS FRS-45-440	R5G475
60	50 (4 x 15)	200 - Included	35	200	700 x 1000 x 380	PLUS FRS-60-440	R5G480
75	62 (4 x 18,75)	200 - Included	50	215	700 x 1000 x 380	PLUS FRS-75-440	R5G485
87,5	72 (12,5 + 25 + 50)	200	50	300	800 x 1900 x 650	PLUS FR4-87,5-440	R5D416
100	83 (25 + 25 + 50)	200	95	325	800 x 1900 x 650	PLUS FR4-100-440	R5D420
125	103 (25 + 50 + 50)	250	95	345	800 x 1900 x 650	PLUS FR4-125-440	R5D422
150	125 (25 + 25 + 50 + 50)	400	95	355	800 x 1900 x 650	PLUS FR4-150-440	R5D423
175	145 (25 + 50 + 100)	400	120	365	800 x 1900 x 650	PLUS FR4-175-440	R5D425
200	165 (50 + 50 + 100)	400	150	380	800 x 1900 x 650	PLUS FR4-200-440	R5D428
250	207 (50 + (2 x 100))	630	185	390	800 x 1900 x 650	PLUS FR4-250-440	R5D429
300	248 (50 + 50 + (2 x 100))	630	240	410	800 x 1900 x 650	PLUS FR4-300-440	R5D430
350	289 (50 + (3 x 100))	630	2x150	430	800 x 1900 x 650	PLUS FR4-350-440	R5D432
400	331 (4 x 100)	800	2x150	460	800 x 1900 x 650	PLUS FR4-400-440	R5D434
400	331 (50 + 50 + (3 x 100))	800	2x185	550	1100 x 1900 x 650	PLUS FR6-400-440	R5M425
450	372 (50 + (4 x 100))	800	2x185	587	1100 x 1900 x 650	PLUS FR6-450-440	R5M430
500	413 (5 x 100)	1000	2x240	621	1100 x 1900 x 650	PLUS FR6-500-440	R5M435
550	455 (50 + (5 x 100))	1000	2x240	658	1100 x 1900 x 650	PLUS FR6-550-440	R5M440
600	496 (6 x 100)	1250	2x240	685	1100 x 1900 x 650	PLUS FR6-600-440	R5M445
600	496 (50 + 50 + (5 x 100))	1250	2x240	820	1500 x 1900 x 650	PLUS FR8-600-440	R57436
650	537 (50 + (6 x 100))	1600	3x150	865	1500 x 1900 x 650	PLUS FR8-650-440	R57438
700	579 (7 x 100)	1600	3x150	910	1500 x 1900 x 650	PLUS FR8-700-440	R57440
750	620 (50 + (7 x 100))	1600	3x185	955	1500 x 1900 x 650	PLUS FR8-750-440	R57442
800	661 (8 x 100)	1600	3x185	1000	1500 x 1900 x 650	PLUS FR8-800-440	R57444
800	661 (50 + 50 + (7 x 100))	1250 / 400	2x240/ 240	1100	2200 x 1900 x 650	PLUS FR12-800-440	R55425
850	702 (50 + (8 x 100))	1000 / 630	2x240/ 240	1137	2200 x 1900 x 650	PLUS FR12-850-440	R55430
900	744 (9 x 100)	1250 / 630	2x240/ 240	1174	2200 x 1900 x 650	PLUS FR12-900-440	R55435
950	785 (50 + (9 x 100))	1000 / 800	2x240/ 2x185	1211	2200 x 1900 x 650	PLUS FR12-950-440	R55440
1000	826 (10 x 100)	1250 / 800	2x240/ 2x185	1248	2200 x 1900 x 650	PLUS FR12-1000-440	R55445
1050	868 (50 + (10 x 100))	1250 / 800	2x240/ 2x240	1285	2200 x 1900 x 650	PLUS FR12-1050-440	R55450
1100	909 (11 x 100)	1250 / 1000	2x240/ 2x240	1322	2200 x 1900 x 650	PLUS FR12-1100-440	R55455
1150	950 (50 + (11 x 100))	2 X 1250	2x240/ 2x240	1359	2200 x 1900 x 650	PLUS FR12-1150-440	R55460
1200	992 (12 x 100)	2 X 1250	2x240/ 2x240	1389	2200 x 1900 x 650	PLUS FR12-1200-440	R55465

FRF / FRM

Fixed capacitor with rejection reactance $p = 7\%$



Description

The **FRF / FRM** Series capacitor banks with detuned filters have been designed for power compensation purposes in motors and transformers with a constant load level, a high content of harmonics and where there is a risk of resonance. Including:

- **FRF**: general protection with NH-00 fuses with a high rupture power (HRP) for the capacitor.
- **FRM**: general circuit breaker protection for the capacitor.

Application

Its application is mainly based on the compensation of transformers and motors. In general, it is used for the compensation of installations under constant loads and where there is a high content of harmonics in the network.

Features

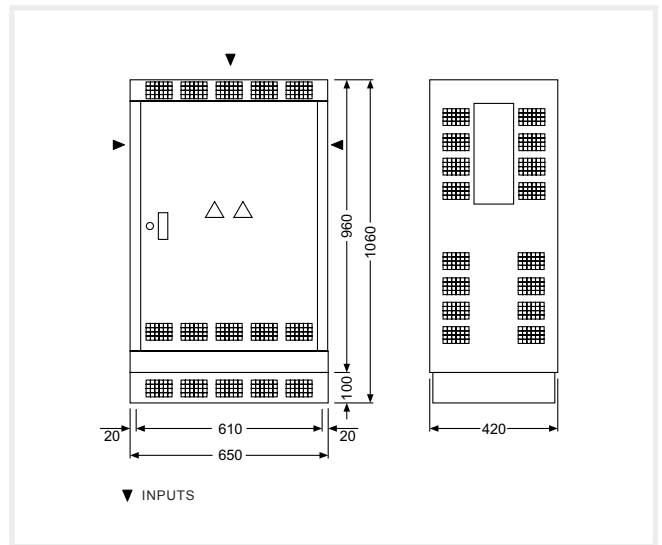
Features		
Operating voltage		230, 400 (for other voltages, please ask)
Support voltage (400 V)		440 V
Capacity tolerance		±10%
Unit composed of		<ul style="list-style-type: none"> • CFB capacitor • FRF: General protection fuse, type NH-00 with a high rupture power (HRP) • FRM: General three-pole protection circuit breaker • Detuned filters tuned at 189 Hz for the protection against harmonics present in the network and to avoid the problems of resonance with fifth or higher order harmonics. Built-in thermostat for the disconnection of the step in case of excessive temperatures (90 °C)
Insulation level		3 / 15 kV
Discharge resistance		75 V / 3 minutes
Overload		1.3 times the rated current permanently
Overvoltage		<ul style="list-style-type: none"> • 10 % 8 over 24 hours • 15 % up to 15 minutes over 24 hours • 20 % up to 5 minutes over 24 hours • 30 % up to 1 minute over 24 hours
Frequency		50 or 60 Hz
Losses:	<ul style="list-style-type: none"> • Dielectric • Total 	< 0.2 W / kvar < 0.5 W / kvar
Protections		<ul style="list-style-type: none"> • Dielectric regeneration • Internal fuse • Overpressure system • Vermiculite
Construction features		
Terminals:	<ul style="list-style-type: none"> • Power rating • Earth 	<ul style="list-style-type: none"> • M6 for CV, M10 para CQ, CSB, CSB-6B, CFB, CFB-6B • M6
Torque value		<ul style="list-style-type: none"> • CV 5 Nm • CQ, CSB, CSB-6B, CFB, CFB-6B: 15 Nm
Ambient conditions		
Class D temperature:	Daily mean	45 °C
	Annual mean	35 °C
	Maximum	50 °C
	Minimum	-25 °C
Humidity		80% RH
Altitude		2,000 m
Assembly conditions		
Degree of protection		IP 21
Type of assembly		Vertical
Ventilation		Natural or forced, depending on the option
Colour		RAL 7035 Grey RAL 3005 Maroon
Standards		
CEI 60831-1, CEI 70/7, UNE 20827, UNE 20010, BS 1650, VDE 560		

FRF / FRM

Fixed capacitor with rejection reactance $p = 7\%$



Dimensions



References

440 V / 50 Hz

FRF: APR Fuse protection

kvar		(A)	Weight (kg)	Cable section (mm ²)	Dimensions (mm) width x height x depth	Type	Code
440 V	400 V						
25	21	33	78	10	650 x 1060 x 420	FRF-25-440	R55350
37,5	31	47	82	16	650 x 1060 x 420	FRF-37.5-440	R55370
50	42	66	85	25	650 x 1060 x 420	FRF-50-440	R55380
60	50	79	90	35	650 x 1060 x 420	FRF-60-440	R55390
75	62	99	96	50	650 x 1060 x 420	FRF-75-440	R553A0
100	83	131	110	70	650 x 1060 x 420	FRF-100-440	R553B0

440 V / 50 Hz

FRM: Three-pole automatic protection

kvar		(A)	Weight (kg)	Cable section (mm ²)	Dimensions (mm) width x height x depth	Type	Code
440 V	400 V						
25	21	33	78	10	650 x 1060 x 420	FRM-25-440	R57350
37,5	31	47	82	16	650 x 1060 x 420	FRM-37.5-440	R57370
50	42	66	85	25	650 x 1060 x 420	FRM-50-440	R57380
60	50	79	90	35	650 x 1060 x 420	FRM-60-440	R57390
75	62	99	96	50	650 x 1060 x 420	FRM-75-440	R573A0
100	83	131	110	70	650 x 1060 x 420	FRM-100-440	R573B0

FRE

Capacitor banks with detuned filters with thyristors



Description

The **FRE** Series capacitor banks with detuned filters have been designed for power compensation purposes in networks with fluctuating load levels, a high content of harmonics and where there is a risk of resonance.

Power variations are relatively quick (in milliseconds) so that the switching operations can be carried out by thyristors, which are connected to a voltage control plate; the capacitor is connected and disconnected with a zero voltage difference. This system avoids transients in the connection and disconnection of steps, with an immediate response to load fluctuations.

Application

The most common application is with individual loads or in installations where a quick compensation response is needed (for ex., welding units, motors for lifting units, lifts, etc.) and where there is a high content of harmonics in the network.

Features

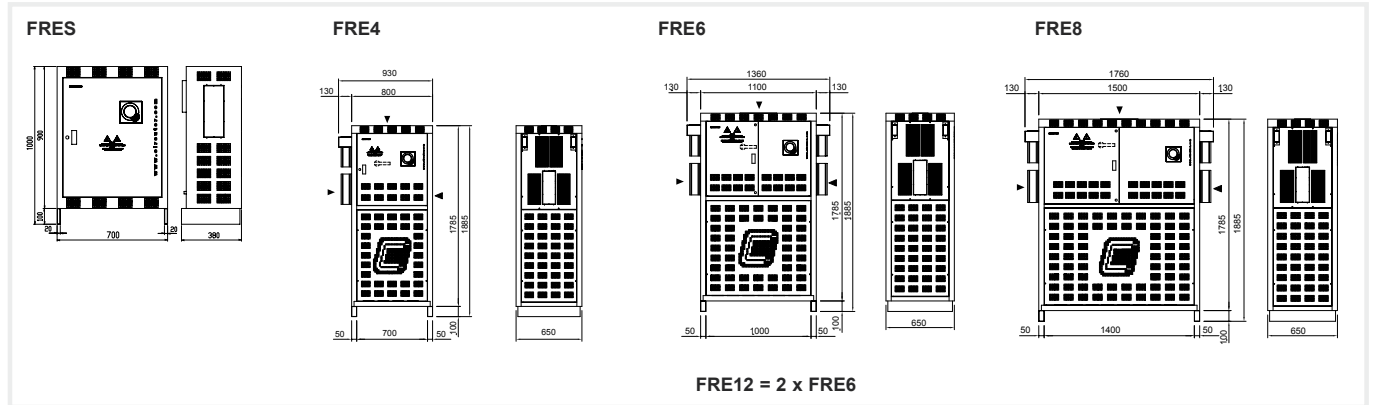
Features		
Operating voltage		230, 400 V (for other voltages, please ask)
Support voltage (400 V)		440 V
Capacity tolerance		± 10%
Unit composed of		<ul style="list-style-type: none"> • CFB capacitor • Static switching unit on each step, composed of static contactors (thyristors) • Individual protection of each step with fuses with high rupture power (HRP). NH-00 Series. • Two-pole protection circuit-breaker for capacitor bank and regulator operations. • Power factor regulator computer 8df / computer Smart-F series. • Heat removal radiators • Built-in thermostat on the radiator for the disconnection of each step in case of high temperatures (90 °C) • Detuned filters tuned at 189 Hz for the protection against harmonics present in the network and to avoid the problems of resonance with fifth or higher order harmonics.
Add-ons		<ul style="list-style-type: none"> • Manual capacitor bank header switch • Automatic capacitor bank header switch • Automatic switch + Earth leakage protection at the capacitor bank's header • Forced ventilation unit + thermostat • Polycarbonate plate to protect against direct contacts • Auto-transformer 400/230 V
Insulation level		3 / 15 kV
Discharge resistance		75 V / 3 minutes
Overload		1.3 times the rated current permanently
Overvoltage		<ul style="list-style-type: none"> • 10 % 8 over 24 hours • 15 % up to 15 minutes over 24 hours • 20 % up to 5 minutes over 24 hours • 30 % up to 1 minutes over 24 hours
Contacting operating voltage		230 V
Ambient conditions		
Class D temperature	Daily mean	45 °C
	Annual mean	35 °C
	Maximum	50 °C
	Minimum	-25 °C
Humidity		80% RH
Altitude		2,000 m
Construction features		
Degree of protection		IP 21
Colour		RAL 7035: Grey / RAL 3005: Maroon
Assembly conditions		
Type of assembly		Vertical
Ventilation		Natural or forced, depending on the option
Distance between capacitors		Minimum, 2 cm
Standards		
CEI 60831-1, CEI 70/7, UNE 20827, UNE 20010, BS 1650, VDE 560		

FRE

Capacitor banks with detuned filters with thyristors



Dimensions



References

kvar		Composition	Switch (A)	Cable section (mm ²)	Weight (kg)	Dimensions (mm) width x height x depth	Type	Code
440	400							
17,5	14	(2,5 + 5 + 10)	Included	6	105	700 x 1000 x 380	FRES-17,5-440	R6H450
25	21	(5 + (2 X 10))	Included	10	120	700 x 1000 x 380	FRES-25-440	R6H455
27,5	23	(2,5 + 5 + (2 x 10))	Included	16	130	700 x 1000 x 380	FRES-27,5-440	R6H460
35	29	(5 + (3 X 10))	Included	16	140	700 x 1000 x 380	FRES-35-440	R6H465
37,5	31	(7,5 + (2 X 15))	Included	25	150	700 x 1000 x 380	FRES-37,5-440	R6H470
45	37	(3 x 15)	Included	25	175	700 x 1000 x 380	FRES-45-440	R6H475
60	50	(4 x 15)	Included	35	200	700 x 1000 x 380	FRES-60-440	R6H480
75	62	(4 x 18,75)	Included	50	215	700 x 1000 x 380	FRES-75-440	R6H485
87,5	72	(12,5 + 25 + 50)	200	70	300	930 x 1900 x 650	FRE4-87,5-440	R6E416
100	83	(25 + 25 + 50)	200	70	325	930 x 1900 x 650	FRE4-100-440	R6E420
125	103	(25 + 50 + 50)	250	95	345	930 x 1900 x 650	FRE4-125-440	R6E422
150	125	(25 + 25 + 50 + 50)	400	120	355	930 x 1900 x 650	FRE4-150-440	R6E423
175	145	(25 + 50 + 100)	400	120	365	930 x 1900 x 650	FRE4-175-440	R6E425
200	165	(50 + 50 + 100)	400	150	380	930 x 1900 x 650	FRE4-200-440	R6E428
250	207	(50 + (2 x 100))	630	185	390	930 x 1900 x 650	FRE4-250-440	R6E429
300	248	(50 + 50 + (2 x 100))	630	240	410	930 x 1900 x 650	FRE4-300-440	R6E430
350	289	(50 + (3 x 100))	630	2x150	430	930 x 1900 x 650	FRE4-350-440	R6E432
400	331	(4 x 100)	800	2x185	460	930 x 1900 x 650	FRE4-400-440	R6E434
400	331	(50 + 50 + (3 x 100))	800	2x185	550	1360 x 1900 x 650	FRE6-400-440	R6J425
450	372	(50 + (4 x 100))	800	2x185	587	1360 x 1900 x 650	FRE6-450-440	R6J430
500	413	(5 x 100)	1000	2x240	621	1360 x 1900 x 650	FRE6-500-440	R6J435
550	455	(50 + (5 x 100))	1000	2x240	658	1360 x 1900 x 650	FRE6-550-440	R6J440
600	496	(6 x 100)	1250	2x240	685	1360 x 1900 x 650	FRE6-600-440	R6J445
600	496	(50 + 50 + (5 x 100))	1250	2x240	820	1760 x 1900 x 650	FRE8-600-440	R6K436
650	537	(50 + (6 x 100))	1250	3x150	865	1760 x 1900 x 650	FRE8-650-440	R6K438
700	579	(7 x 100)	1250	3x150	910	1760 x 1900 x 650	FRE8-700-440	R6K440
750	620	(50 + (7 x 100))	1600	3x185	955	1760 x 1900 x 650	FRE8-750-440	R6K442
800	661	(8 x 100)	1600	3x185	1000	1760 x 1900 x 650	FRE8-800-440	R6K444
800	661	(50 + 50 + (7 x 100))	1250 / 400	2x240/ 240	1100	2720 x 1900 x 650	FRE12-800-440	R6L425
850	702	(50 + (8 x 100))	1000 / 630	2x240/ 240	1137	2720 x 1900 x 650	FRE12-850-440	R6L430
900	744	(9 x 100)	1250 / 630	2x240/ 240	1174	2720 x 1900 x 650	FRE12-900-440	R6L435
950	785	(50 + (9 x 100))	1000 / 800	2x240/ 2x185	1211	2720 x 1900 x 650	FRE12-950-440	R6L440
1000	826	(10 x 100)	1250 / 800	2x240/ 2x185	1248	2720 x 1900 x 650	FRE12-1000-440	R6L445
1050	868	(50 + (10 x 100))	1250 / 800	2x240/ 2x240	1285	2720 x 1900 x 650	FRE12-1050-440	R6L450
1100	909	(11 x 100)	1250 / 1000	2x240/ 2x240	1322	2720 x 1900 x 650	FRE12-1100-440	R6L455
1150	950	(50 + (11 x 100))	2 X 1250	2x240/ 2x240	1359	2720 x 1900 x 650	FRE12-1150-440	R6L460
1200	992	(12 x 100)	2 X 1250	2x240/ 2x240	1389	2720 x 1900 x 650	FRE12-1200-440	R6L465

PLUS FRE

Capacitor banks with detuned filters with thyristors



Description

Intelligent state-of-the-art capacitor banks, capable of measuring the three installation phases and compensating the total power factor consumption accurately and in real time.

The **PLUS FRE** series includes detuned filters tuned at 189 Hz to avoid the resonance phenomena in 5th or higher order harmonics. Units for other harmonics orders are manufactured on demand.

Including **CIRCUTOR's** measurement technology, effectively creating a compensation + measurement unit. As a power quality analyzer, it displays any electrical parameter of the network in real time and records it in its memory, with maximum and minimum values, date and hour.

Application

The most common application is with individual loads or in installations where a quick compensation response is needed (for ex., welding units, motors for lifting units, lifts, etc.) and where there is a high content of harmonics in the network.

Features

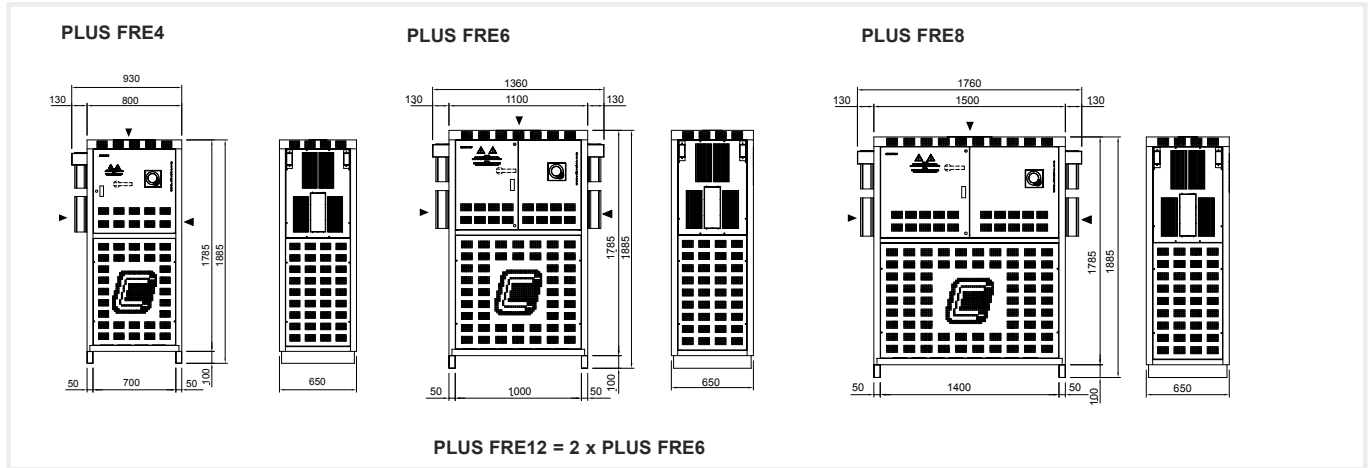
Features		
Operating voltage		230, 400 V (for other voltages, please ask)
Support voltage (400 V)		440 V
Capacity tolerance		± 10%
Unit composed of		<ul style="list-style-type: none"> • CFB capacitor • Static switching unit on each step, composed of static contactors (thyristors) • Individual protection of each step with fuses with high rupture power (HRP). NH-00 Series. • Two-pole protection circuit-breaker for capacitor bank and regulator operations. • Power factor regulator of the computer Plus-TF series, three-phase measurement and power analyzer functions • Heat removal radiators • Built-in thermostat on the radiator for the disconnection of each step in case of high temperatures (90 °C) • Detuned filters tuned at 189 Hz for the protection against harmonics present in the network and to avoid the problems of resonance with fifth or higher order harmonics.
Add-ons		<ul style="list-style-type: none"> • Manual capacitor bank header switch • Automatic capacitor bank header switch • Automatic switch + Earth leakage protection at the capacitor bank's header • Forced ventilation unit + thermostat • Polycarbonate plate to protect against direct contacts • Auto-transformer 400/230 V
Insulation level		3 / 15 kV
Discharge resistance		75 V / 3 minutes
Overload		1.3 times the rated current permanently
Overvoltage		<ul style="list-style-type: none"> • 10 % 8 over 24 hours • 15 % up to 15 minutes over 24 hours • 20 % up to 5 minutes over 24 hours • 30 % up to 1 minutes over 24 hours
Contacting operating voltage		230 V
Ambient conditions		
Class D temperature	Daily mean	45 °C
	Annual mean	35 °C
	Maximum	50 °C
	Minimum	-25 °C
Humidity		80% RH
Altitude		2,000 m
Construction features		
Degree of protection		IP 21
Colour		RAL 7035 Grey RAL 3005 Maroon
Assembly conditions		
Type of assembly		Vertical
Ventilation		Natural or forced, depending on the option
Distance between capacitors		Minimum, 2 cm
Standards		
CEI 60831-1, CEI 70/7, UNE 20827, UNE 20010, BS 1650, VDE 560		

PLUS FRE

Capacitor banks with detuned filters with thyristors



Dimensions



References

kvar	Composition	Switch (A)	Cable section (mm ²)	Weight (kg)	Dimensions (mm) width x height x depth	Type	Code
440	400						
87,5	72 (12,5 + 25 + 50)	200	70	300	930 x 1900 x 650	PLUS FRE4-87,5-440	R6B416
100	83 (25 + 25 + 50)	200	70	325	930 x 1900 x 650	PLUS FRE4-100-440	R6B420
125	103 (25 + 50 + 50)	250	95	345	930 x 1900 x 650	PLUS FRE4-125-440	R6B422
150	125 (25 + 25 + 50 + 50)	400	95	355	930 x 1900 x 650	PLUS FRE4-150-440	R6B423
175	145 (25 + 50 + 100)	400	120	365	930 x 1900 x 650	PLUS FRE4-175-440	R6B425
200	165 (50 + 50 + 100)	400	150	380	930 x 1900 x 650	PLUS FRE4-200-440	R6B428
250	207 (50 + (2 x 100))	630	185	390	930 x 1900 x 650	PLUS FRE4-250-440	R6B429
300	248 (50 + 50 + (2 x 100))	630	240	410	930 x 1900 x 650	PLUS FRE4-300-440	R6B430
350	289 (50 + (3 x 100))	630	2x150	430	930 x 1900 x 650	PLUS FRE4-350-440	R6B432
400	331 (4 x 100)	800	2x185	460	930 x 1900 x 650	PLUS FRE4-400-440	R6B434
400	331 (50 + 50 + (3 x 100))	800	2x185	550	1360 x 1900 x 650	PLUS FRE6-400-440	R68425
450	372 (50 + (4 x 100))	800	2x185	587	1360 x 1900 x 650	PLUS FRE6-450-440	R68430
500	413 (5 x 100)	1000	2x240	621	1360 x 1900 x 650	PLUS FRE6-500-440	R68435
550	455 (50 + (5 x 100))	1000	2x240	658	1360 x 1900 x 650	PLUS FRE6-550-440	R68440
600	496 (6 x 100)	1250	2x240	685	1360 x 1900 x 650	PLUS FRE6-600-440	R68445
600	496 (50 + 50 + (5 x 100))	1250	2x240	820	1760 x 1900 x 650	PLUS FRE8-600-440	R66436
650	537 (50 + (6 x 100))	1250	3x150	865	1760 x 1900 x 650	PLUS FRE8-650-440	R66438
700	579 (7 x 100)	1250	3x150	910	1760 x 1900 x 650	PLUS FRE8-700-440	R66440
750	620 (50 + (7 x 100))	1600	3x185	955	1760 x 1900 x 650	PLUS FRE8-750-440	R66442
800	661 (8 x 100)	1600	3x185	1000	1760 x 1900 x 650	PLUS FRE8-800-440	R66444
800	661 (50 + 50 + (7 x 100))	1250 / 400	2x240/ 240	1100	2720 x 1900 x 650	PLUS FRE12-800-440	R67425
850	702 (50 + (8 x 100))	1000 / 630	2x240/ 240	1137	2720 x 1900 x 650	PLUS FRE12-850-440	R67430
900	744 (9 x 100)	1250 / 630	2x240/ 240	1174	2720 x 1900 x 650	PLUS FRE12-900-440	R67435
950	785 (50 + (9 x 100))	1000 / 800	2x240/ 2x185	1211	2720 x 1900 x 650	PLUS FRE12-950-440	R67440
1000	826 (10 x 100)	1250 / 800	2x240/ 2x185	1248	2720 x 1900 x 650	PLUS FRE12-1000-440	R67445
1050	868 (50 + (10 x 100))	1250 / 800	2x240/ 2x240	1285	2720 x 1900 x 650	PLUS FRE12-1050-440	R67450
1100	909 (11 x 100)	1250 / 1000	2x240/ 2x240	1322	2720 x 1900 x 650	PLUS FRE12-1100-440	R67455
1150	950 (50 + (11 x 100))	2 X 1250	2x240/ 2x240	1359	2720 x 1900 x 650	PLUS FRE12-1150-440	R67460
1200	992 (12 x 100)	2 X 1250	2x240/ 2x240	1389	2720 x 1900 x 650	PLUS FRE12-1200-440	R67465

PLUS FRE f-f

Capacitor banks with detuned filters with thyristors



Description

State-of-the-art intelligent capacitor banks that are capable of measuring the three installation phases and compensating the total power factor consumption of each phase in real time.

The **PLUS FRE f-f** series includes detuned filters tuned at 189 Hz to avoid the resonance phenomena in 5th or higher order harmonics. Units for other harmonics orders are manufactured on demand.

Including **CIRCUTOR's** measurement technology, effectively creating a compensation + measurement unit. As a power quality analyzer, it displays any electrical parameter of the network in real time and records it in its memory, with maximum and minimum values, date and hour.

Application

The most common application is with individual loads or in installations where a quick compensation response is needed (for ex., welding units, motors for lifting units, lifts, etc.) and where there is a high content of harmonics in the network.

Features

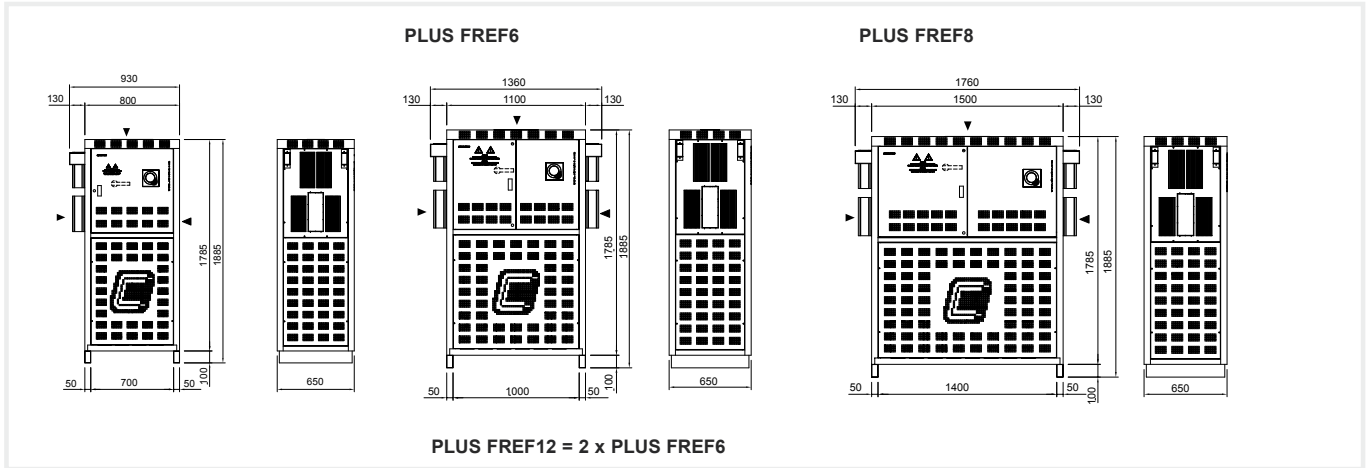
Features		
Operating voltage	230, 400 V (for other voltages, please ask)	
Support voltage	440 V	
Capacity tolerance	± 10%	
Unit composed of	<ul style="list-style-type: none"> • CFB capacitor • Static switching unit on each step, composed of static contactors (thyristors) • Individual protection of each step with fuses with high rupture power (HRP). NH-00 Series. • Two-pole protection circuit-breaker for capacitor bank and regulator operations. • Power factor regulator of the computer Plus-TF series, three-phase measurement and power analyzer functions • Heat removal radiators • Built-in thermostat on the radiator for the disconnection of each step in case of high temperatures (90 °C) • Detuned filters tuned at 189 Hz for the protection against harmonics present in the network and to avoid the problems of resonance with fifth or higher order harmonics. 	
Add-ons	<ul style="list-style-type: none"> • Manual capacitor bank header switch • Automatic capacitor bank header switch • Automatic switch + Earth leakage protection at the capacitor bank's header • Forced ventilation unit + thermostat • Polycarbonate plate to protect against direct contacts • Auto-transformer 400/230 V 	
Insulation level	3 / 15 kV	
Discharge resistance	75 V / 3 minutes	
Overload	1.3 times the rated current permanently	
Overvoltage	<ul style="list-style-type: none"> • 10 % 8 over 24 hours • 15 % up to 15 minutes over 24 hours • 20 % up to 5 minutes over 24 hours • 30 % up to 1 minutes over 24 hours 	
Contacting operating voltage	230 V	
Ambient conditions		
Class D temperature	Daily mean	45 °C
	Annual mean	35 °C
	Maximum	50 °C
	Minimum	-25 °C
Humidity		80% RH
Altitude		2,000 m
Construction features		
Degree of protection		IP 21
Colour		RAL 7035 Grey
		RAL 3005 Maroon
Assembly conditions		
Type of assembly		Vertical
Ventilation		Natural or forced, depending on the option
Distance between capacitors		Minimum, 2 cm
Standards		
		CEI 60831-1, CEI 70/7, UNE 20827, UNE 20010, BS 1650, VDE 560

PLUS FRE f-f

Capacitor banks with detuned filters with thyristors



Dimensions



References

kvar	Composition	Switch (A)	Cable section (mm ²)	Weight (kg)	Dimensions (mm) width x height x depth	Type	Code
440	400						
87,5	72 (12,5 + 25 + 50)	200	50	300	930 x 1900 x 650	PLUS FREF4-87,5-440	R69000
100	83 (25 + 25 + 50)	200	95	325	930 x 1900 x 650	PLUS FREF4-100-440	R69001
125	103 (25 + 50 + 50)	250	95	345	930 x 1900 x 650	PLUS FREF4-125-440	R69002
150	125 (3 x 50)	400	95	355	930 x 1900 x 650	PLUS FREF4-150-440	R69003
175	145 (25 + 50 + 100)	400	120	365	930 x 1900 x 650	PLUS FREF4-175-440	R69004
200	165 (50 + 50 + 100)	400	150	380	930 x 1900 x 650	PLUS FREF4-200-440	R69005
250	207 (50 + 100 + 100)	630	185	390	930 x 1900 x 650	PLUS FREF4-250-440	R69006
300	248 (3 x 100)	630	240	410	930 x 1900 x 650	PLUS FREF4-300-440	R69007
300	248 (50 + 50 + (2 x 100))	630	240	430	1360 x 1900 x 650	PLUS FREF6-300-440	R69008
350	289 (50 + (3 x 100))	630	2x150	445	1360 x 1900 x 650	PLUS FREF6-350-440	R69009
400	331 (4 x 100)	800	2x185	460	1360 x 1900 x 650	PLUS FREF6-400-440	R69010
400	331 (50 + 50 + (3 x 100))	800	2x185	550	1760 x 1900 x 650	PLUS FREF8-400-440	R69011
450	372 (50 + (4 x 100))	800	2x185	587	1760 x 1900 x 650	PLUS FREF8-450-440	R69012
500	413 (5 x 100)	1000	2x240	621	1760 x 1900 x 650	PLUS FREF8-500-440	R69013
500	413 (50 + 50 + (4 x 100))	1000	2x240	638	1760 x 1900 x 650	PLUS FREF8-500-440	R69014
550	455 (50 + (5 x 100))	1000	2x240	658	1760 x 1900 x 650	PLUS FREF8-550-440	R69015
600	496 (6 x 100)	1250	2x240	685	1760 x 1900 x 650	PLUS FREF8-600-440	R69016
600	496 (50 + 50 + (5 x 100))	800 / 400	240/95	870	2720 x 1900 x 650	PLUS FREF12-600-440	R69017
650	537 (50 + (6 x 100))	630 / 630	2x150/95	907	2720 x 1900 x 650	PLUS FREF12-650-440	R69018
700	579 (7 x 100)	800 / 630	2x185/240	944	2720 x 1900 x 650	PLUS FREF12-700-440	R69019
750	620 (50 + (7 x 100))	800 / 630	2x185/2x150	981	2720 x 1900 x 650	PLUS FREF12-750-440	R69020
800	661 (8 x 100)	2 x 650	2x185/2x185	1016	2720 x 1900 x 650	PLUS FREF12-800-440	R69021

R.5/6

Automatic capacitor banks with detuned filters

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