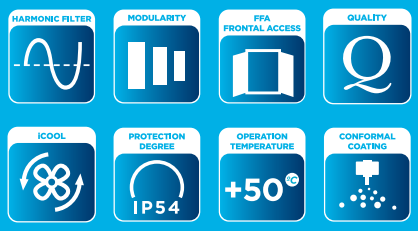
Freemaq
Active Harmonic Filter

POWER ELECTRONICS®

At a growing rate, Industries and Commercial facilities are embracing new LED-based lighting, motor control devices, power sources and other non-linear loads that introduce harmonic pollution into the electrical distribution system. This harmonic current content leads to a poor power quality causing electrical equipment overload, wear and tear.

Freemaq active harmonic filter (AHF) injects reactive and harmonic current to improve displacement power factor (cos φ), harmonic distortion (THDi) and voltage stabilization in your electrical distribution system. The 3-wire Freemaq AHF monitors the load current or the line current at the point of interconnection, and injects the inverse current wave that cancels the harmonic distortion. Freemaq AHF includes the most accurate dynamic harmonic cancellation algorithms offering a high performance at any load condition to comply with IEEE519.

Freemaq AHF is designed to last under the most demanding environments by integrating a modular design, unique iCOOL system for 50°C operation, an easy front access for servicing, and totally sealed and conformally coated electronics.



Rugged design and accurate harmonic cancellation suitable for IEEE519 compliance

freemaq®
ACTIVE HARMONIC FILTER

- **Ranging from 230Vac to 525Vac**
- **Modular units from 100A to 630A**
- **Accurate and dynamic harmonic cancellation (THDi)**
- **Power factor control (cos φ)**
- **Active Voltage regulation system to support grid stabilization**
- **Temperature controlled cooling and 50°C operation – iCOOL**
- **Totally sealed electronics IP54 without dust filters**
- **Easy front access to the main components (FFA)**

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INTRODUCTION TO POWER FACTOR

• **Active Power (P):** Is the power used by a device to produce useful work. It is expressed in Watt or KiloWatt (kW).

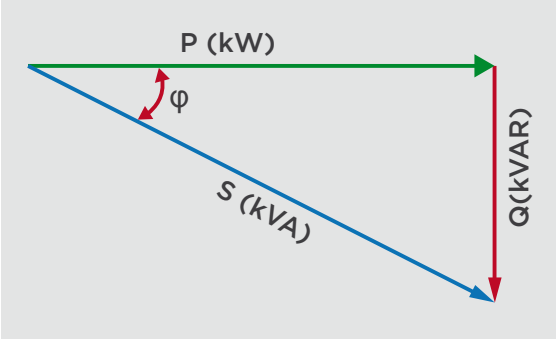
• **Reactive Power (Q):** Is the power that does not produce work but is needed in an alternating-current transmission system to support the transfer of active power over the network by temporarily storing energy in inductive and capacitive elements. It is expressed in var or Kilovar (kVAr).

• **Apparent Power (S):** is the power resulting by the vector sum of both the active and reactive power. It is expressed in Volt Amperes or KiloVolt Amperes (kVA).

$$S\ (kVA) = \sqrt{P(kW)^2 + Q(kVAr)^2}$$

• **Displacement Power Factor (cos φ):** Is the cosine of angle between active and apparent power. When the DPF reaches unity, it means that all the fundamental current that flows through the electrical equipment produces work. This factor does not consider harmonic currents.

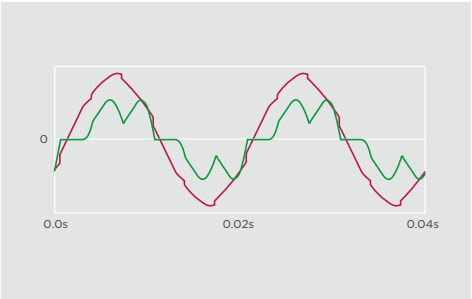
$$\cos\varphi = \frac{P(kW)}{S(kVA)}$$

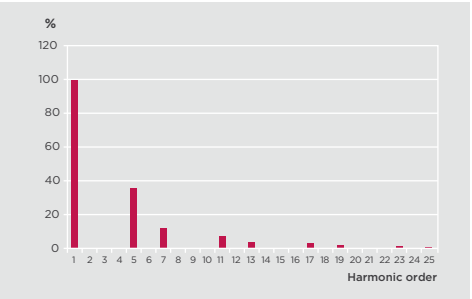


Current harmonics are multiple of the fundamental frequency (50Hz or 60Hz) current. This perturbation is caused by non-linear loads such as power supplies, LED-lamps, computers, televisions, variable speed drives, rectifiers and others.

• **Total Harmonic Current Distortion THD (%):** This ratio quantifies the harmonic content in a specific current waveform. The ratio expresses the relation between the RMS value of each harmonic and the fundamental current in percentage. IEEE519 defines THD as below:

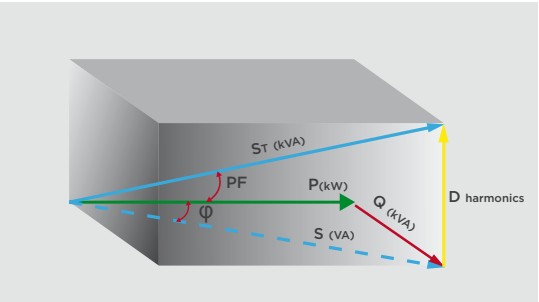
$$THD = \sqrt{\frac{\sum_{n=2}^{n=\infty} I_n^2}{I_1^2}}$$



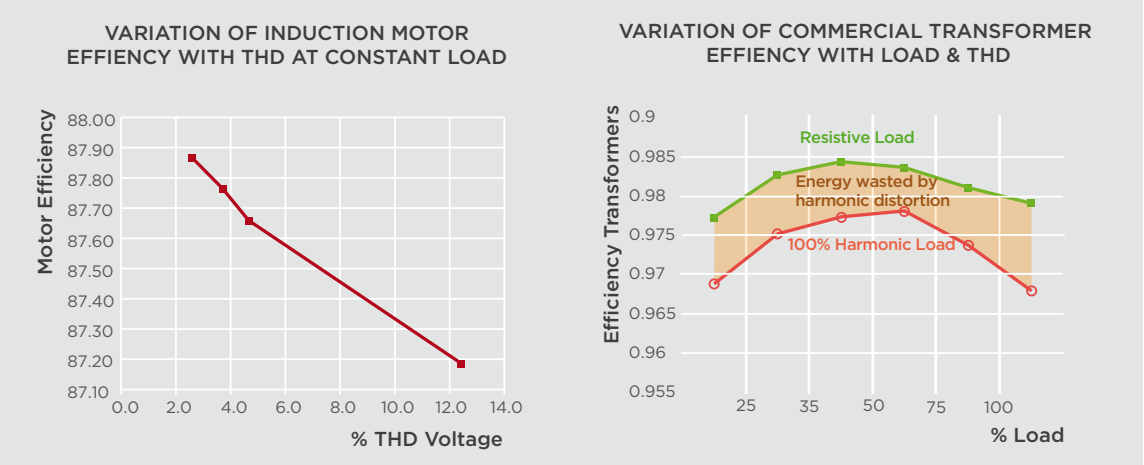


• **Power factor (PF):** Is the ratio that measures the efficiency of the electrical system considering the harmonic disturbance. As DPF, when the PF reaches unity it means that all the current that flows through the electrical equipment produces work.

$$PF = \frac{1}{\sqrt{1+THDi^2}} \cdot \cos\varphi = \frac{I_{50Hz}}{I_{rms}} \cdot \cos\varphi$$

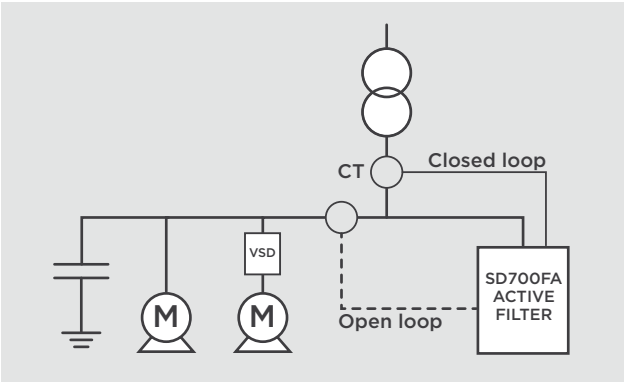


Poor power quality has many inconveniences leading amongst others to wear and tear, equipment failure, transformer and wiring overheating and losses, and motor efficiency decreasing.



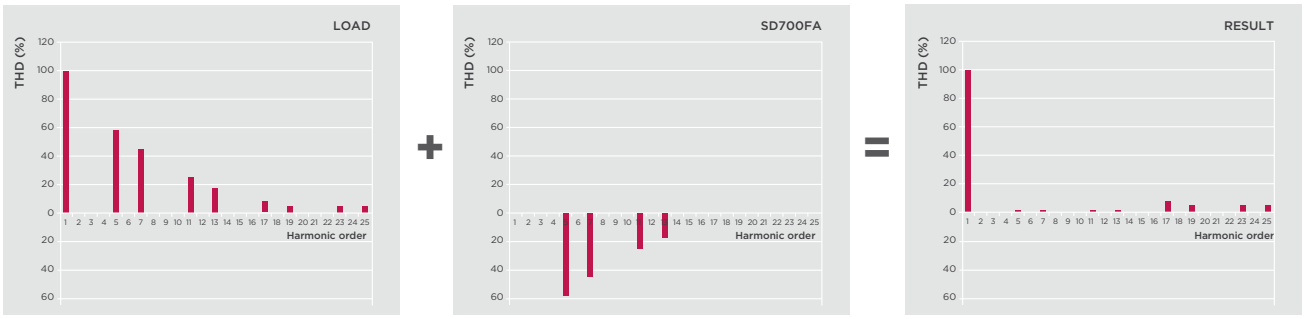
HARMONIC CANCELLATION

Freemaq AHF can run in open loop or closed loop configuration, increasing the installation possibilities in retrofit projects. An open loop configuration measures the load current and injects the inverse current harmonic wave form that cancels the harmonic distortion. On the contrary, a closed loop configuration measures the line current at the point of interconnection and injects inverse current harmonic to reach the target established by the user.

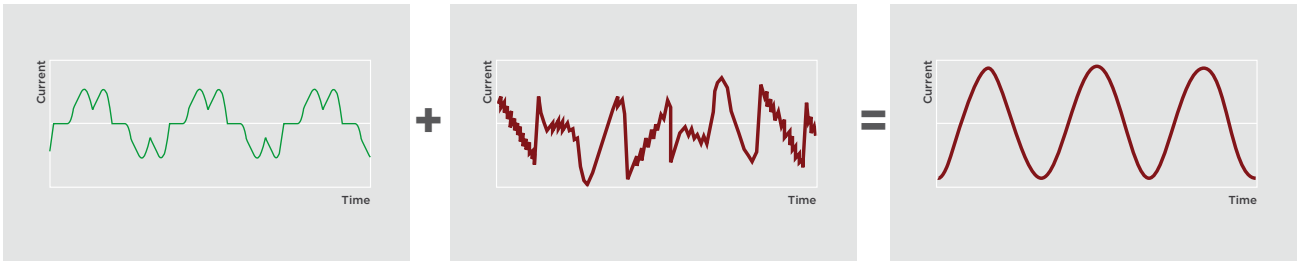


The Freemaq AHF can work with two harmonic cancellation algorithms: selective and full spectrum.

By setting the **selective harmonic cancellation** you will be able to compensate in perfect opposite phase up to 6 individual harmonics simultaneously. Freemaq AHF working at a 4kHz switching frequency allow the user to cancel up to the 13th harmonic. Be aware that the higher the harmonic order the higher the required switching frequency thus leading to a less efficient unit due to an increase of the switching losses. Power Electronics will support you to select and adjust the unit to get the most from your facilities.

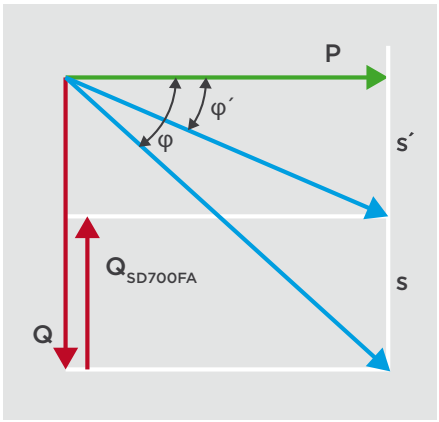


By setting the **full spectrum harmonic cancellation** the unit will not be focused on a specific harmonic number. Any harmonic content will be cancelled by injecting an opposite phase current wave form that results from subtracting the fundamental (50Hz) current wave.



POWER FACTOR CORRECTION

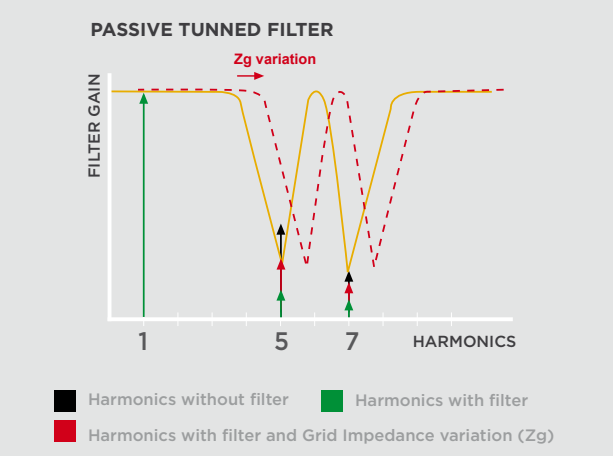
Freemaq AHF implements a dynamic algorithm that controls the reactive current injection to keep a specific displacement power factor (cos φ) at any load condition.



When installing capacitor banks in a network polluted with harmonics it magnifies the effects by:

• Reducing the network impedance and therefore increasing the THDv.
• Creates a low impedance path to harmonics that overloads and overheats the bank. This inconvenience can lead to reduced life of the capacitors.

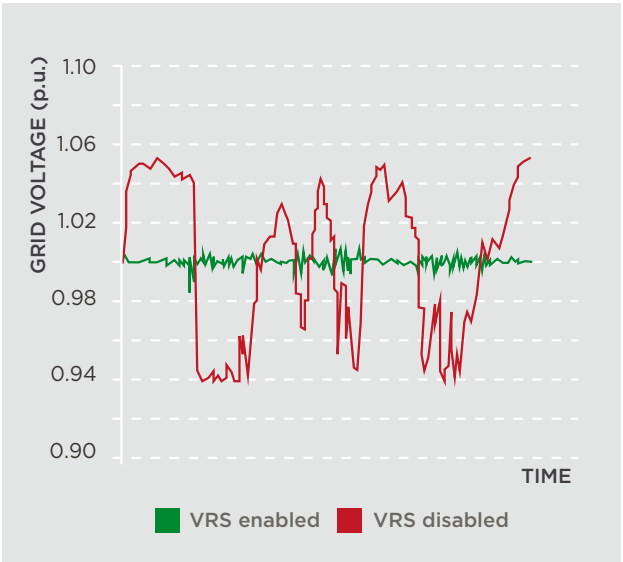
One of the most extended alternatives is the installation of heavy, costly and inefficient tuned passive filters that can only inject leading reactive current (kVAr) and can only mitigate a single harmonic number.



FREEMAQ AHF IS YOUR SAFEST AND MOST RELIABLE SOLUTION THAT CAN AT THE SAME TIME CONTROL THE HARMONIC CONTENT AND THE DISPLACEMENT POWER FACTOR, WITH NONE OF THE INCONVENIENCE THAT TRADITIONAL SOLUTIONS HAVE.

VOLTAGE REGULATION SYSTEM (STATCOM)

The Freemaq AHF can perform reactive power control to stabilize the grid voltage. By enabling the full reactive current injection from pure lagging to pure leading, it is able to support grid operators under transitory low voltage or high voltage conditions.



TECHNICAL CHARACTERISTICS

INPUT	Nominal voltage [1]	380-440Vac, 480-525Vac (±10%); (3 phase – 3 wires)
	Compensation capacity per phase (Arms)	100A – 800A
	Frequency	50Hz (±5%), 60Hz (±6%)
	Power switching devices	IGBT 4kHz Configurable
	Efficiency	≥ 97%
	Current transformers	Any ratio from 250 to 10,000A primary with 5A secondary
	No. transformers / configuration	3 required / Open loop or Close loop
FEATURES	Harmonic filtering algorithms	• Selective harmonic cancellation: 6 simultaneous harmonics up to 13th harmonic
	Reactive power control	Static and Dynamic Adjustable Displacement Power Factor (DPF)
	Dynamic grid support	Low Voltage Ride Through (Optional) – UPS supply required
ENVIRONMENTAL CONDITIONS	Degree of protection	IP20 (IP54 electronics)
	Cooling	Temperature controlled axial fans
	Operation/ storage temperature [2]	-10°C to 40°C continuous @50°C 10% Current derating / -20°C to 70°C
	Altitude	1000m; >1000m 1%Pn per 100m, Max.3000m
	Relative humidity	<95% non condensing
	EMC	C3 Second environment (Industrial), C2 optional
HARDWARE	Digital inputs	4 programmable, Active high (24Vdc), Isolated power supply
	Analogue input	2 programmable differential inputs. 0 – 20mA, 4 – 20mA, 0 – 10Vdc and ±10Vdc (Optically isolated) (Optional)
	Analogue outputs	2 isolated programmable outputs: 0 – 20mA, 4 – 20mA, 0 – 10Vdc and ±10Vdc (Optional)
	User power supply	+24Vdc user power supply (Max 180mA) regulated and short-circuit protected +10Vdc user power supply (Max 2 potentiometers R= 1 kΩ) regulated and short-circuit protected
COMMUNICATION INTERFACE	Standard hardware	RS485 port
	Standard protocol	Modbus-RTU
	Optional protocol	Profibus-DP, DeviceNet, Ethernet (Modbus TCP), Ethernet IP, CAN Open, N2 Metasys Gateway,
	Interface	Alphanumeric Display, PowerComms desktop SW tool available
REGULATION	Certification	CE
	Safety	IEC / EN 50178; IEC / EN 60146
	Electromagnetic compatibility	EMC Immunity: EN/IEC 61000-6-2 Industrial level EMC Emissions: EN/IEC 61000-6-4 class A, IEC 61000-3-4, IEEE 519-1992

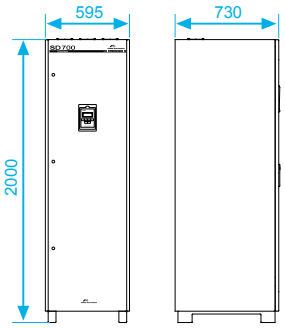
NOTES [1] Other configurations consult Power Electronics.
[2] Switching frequency 4kHz.

ORDERING INFO

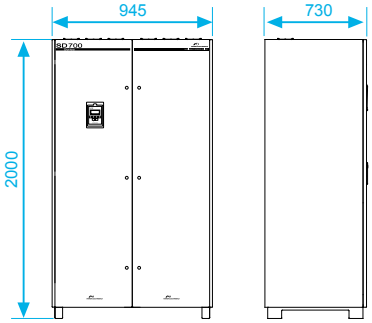
Freemaq Series	Model		Output Current[1]		Input Voltage		Degree of protection	
FQ	A	ACTIVE HARMONIC FILTER	0100	100A	5	380-440Vac	5	IP54
			...	...	7	480-525Vac		

NOTE [1] Consult Power Electronics to guarantee the compatibility of the selected filter.

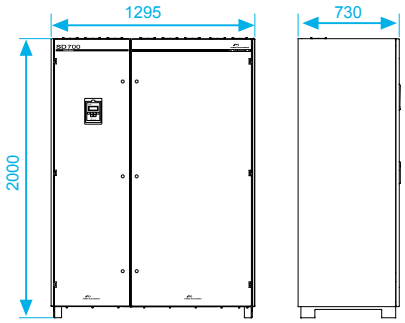
DIMENSIONS AND WEIGHTS



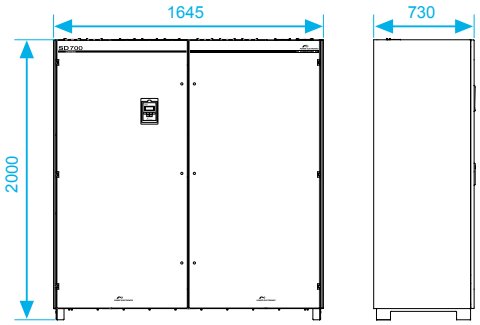
FRAME 5



FRAME 6



FRAME 7



FRAME 8

STANDARD RATINGS

380-440Vac							
FRAME	REFERENCE	Total RMS Current Limit [A] (400V)		Max. Individual Harmonic Compensation [A]			
		Total RMS Current [A] 40°C	Total RMS Current [A] 50°C	I5 (80%)	I7 (50%)	I11 (30%)	I13 (15%)
5	FQA0100 5	100	90	80	50	30	15
	FQA0150 5	150	135	120	75	45	23
	FQA0200 5	200	180	160	100	60	30
6	FQA0250 5	250	225	200	125	75	38
	FQA0315 5	315	284	252	158	95	47
	FQA0400 5	400	360	320	200	120	60
7	FQA0450 5	450	405	360	225	135	68
	FQA0500 5	500	450	400	250	150	75
	FQA0600 5	600	540	480	300	180	90
8	FQA0700 5	700	630	560	350	210	105
	FQA0800 5	800	720	640	400	240	120

480-525Vac							
FRAME	REFERENCE	Total RMS Current Limit [A] (500V)		Max. Individual Harmonic Compensation [A]			
		Total RMS Current [A] 40°C	Total RMS Current [A] 50°C	I5 (80%)	I7 (50%)	I11 (30%)	I13 (15%)
5	FQA0100 7	100	90	80	50	30	15
	FQA0165 7	165	149	132	83	50	25
6	FQA0200 7	200	180	160	100	60	30
	FQA0250 7	250	225	200	125	75	38
	FQA0330 7	330	297	264	165	99	50
7	FQA0400 7	400	360	320	200	120	60
	FQA0450 7	450	405	360	225	135	68
	FQA0495 7	495	446	396	248	149	74
8	FQA0600 7	600	540	480	300	180	90
	FQA0660 7	660	594	528	330	198	99

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