freemaq®
PASSIVE HARMONIC FILTER

Passive Filter

Hardware and installation Manual

POWER ELECTRONICS®

Low Harmonics Notch Filter

Hardware and Installation Manual

Edition: June 2016

FQPMTHW01BI Rev. B

SAFETY SYMBOLS

Always follow safety instructions to prevent accidents and potential hazards from occurring.

 **WARNING**	This symbol means improper operation may results in serious personal injury or death.
 **CAUTION**	Identifies shock hazards under certain conditions. Particular attention should be given because dangerous voltage may be present. Maintenance operation should be done by qualified personnel.
	Identifies potential hazards under certain conditions. Read the message and follow the instructions carefully.
	Identifies shock hazards under certain conditions. Particular attention should be given because dangerous voltage may be present.

ENGLISH

Edition of June 2016

This publication could present technical imprecision or misprints. The information here included will be periodically modified and updated, and all those modifications will be incorporated in later editions.
To consult the most updated information of this product you might access through our website www.power-electronics.com where the latest version of this manual can be downloaded.

Revisions

Date	Revision	Description
08 / 07 / 2015	A	First edition.
24 / 06 / 2016	B	Transport.

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SAFETY INSTRUCTIONS

IMPORTANT!

- Read this manual carefully to maximise the performance of this product and to ensure its safe use and installation.
- Power Electronics accepts no responsibility or liability for any damage resulting from inappropriate use of the equipment.
- In this manual, safety messages are classified as follows:

⚠ WARNING

Do not remove the metal cover while the power is applied or the unit is in operation.
Otherwise, electric shock could occur.

Do not run the equipment with the front cover removed.
Otherwise, you may get an electric shock due to the high voltage terminals or exposure of charged capacitors.

The filter does not remove the voltage from the input busbars. Before working on it, isolate the whole equipment from the supply.

Do not remove the cover except for periodic inspections or wiring, even if the input power is not applied.
Otherwise, you may access to the charged circuits and may get an electric shock.

Wiring and periodic inspections should be performed at least 10 minutes after disconnecting the input power. Otherwise, you may get an electric shock.

Operate the switches with dry hands.
Otherwise, you may get an electric shock.

Do not use cables with damaged insulation.
Otherwise, you may get an electric shock.

Do not subject the cables to abrasions, excessive stress, heavy loads or pinching.
Otherwise, you may get an electric shock.

Do not make any insulation or voltage withstand tests on the motor with the filter and drive connected.

CAUTION

Install the filter on a non-flammable surface. Do not place flammable material nearby.
Otherwise fire could occur.

Disconnect the input power if the filter is damaged.
Otherwise, it could result in a secondary accident or fire.

After stopping the filter and drive, it will remain hot for a couple of minutes. Touching hot parts may result in skin burns.

Do not apply power to a damaged filter or to a filter with parts missing even if the installation is complete. Otherwise, you may get an electric shock.

It is not permitted to weld the cabinet; this can damage the electronic sensitive equipment inside.

Do not allow lint, paper, wood chips, dust, metallic chips or other foreign matter into the filter. Otherwise fire or accident could occur.

WARNINGS

RECEPTION

- The Freemaq FQP filters are carefully tested and perfectly packed before delivering.
- In the event of transport damage, please ensure that you notify the transport agency and POWER ELECTRONICS: 902 40 20 70 (International +34 96 136 65 57) or your nearest agent, within 24hrs from receipt of the goods.

UNPACKING

- Make sure model and serial number of the filter are the same on the box, delivery note and unit.
- Each filter is delivered with a Hardware and Installation Manual.

RECYCLING

- Packing of the equipments should be recycled. For this, it is necessary to separate different materials included (plastic, paper, cardboard, wood ...) and deposit them on proper banks.
- Waste products of electric and electronic devices should be selectively collected for your correct recycling company.

SAFETY

- Before operating the equipment, read this manual thoroughly to gain an understanding of the unit. If any doubt exists then please contact POWER ELECTRONICS, (902 40 20 70 / +34 96 136 65 57) or your nearest agent.
- Wear safety glasses when operating the filter with power applied or the front cover is removed.
- Handle and transport the filter following the recommendations within this manual.
- Install the filter according to the instructions within this manual and the local regulations.
- Do not place heavy objects on the filter.
- Ensure that the filter is mounted vertically and keeping the minimum clearances distances.
- Do not drop the filter or subject it to impact.
- Avoid installing the filter in conditions that differ from those described in the *Environmental Ratings* section.

CONNECTION PRECAUTIONS

- To ensure correct operation of the filter, it is recommended to use a SCREENED CABLE for the control wiring.

TRIAL RUN

- Verify all parameters before operating the filter. Alteration of parameters may be required depending on application and load.
- Always apply voltage and current signals to each terminal that are within levels indicated within this manual.

OPERATION PRECAUTIONS

- Do not modify or alter internal wiring and spare parts without Power Electronics supervision.

EARTH CONNECTION

- Ground the filter to ensure a safety operation and to reduce electromagnetic emission.
- Connect the input PE terminal only to the dedicated PE terminal. Do not use the case or the chassis screw for grounding.
- Use appropriate conductors to comply with the local regulations. The ground conductor should be connected first and removed last.

1. INTRODUCTION

The Freemaq consist of a Notch Filter connected to the input of the SD700 drive in order to reduce the Harmonic Distortion. The Freemaq filter is not a common passive filter, the grid impedance modification, the connection of multiple systems or the grid expansion will not reduce the filtering features and will never cause resonance.

The Harmonic filter is the suitable complement to the exceptional features of the SD700 series. Its design is based in the parallel connection of unitary filter modules. Each module is smartly designed to optimize the space and the internal cooling system. All of them are managed and controlled without additional hardware by the SD700 drive. SD700 with Freemaq is a compact solution for installations willing to reduce the harmonic distortion. This robust design reduces the Harmonic Distortion below the 10% or the 5% as requested.

Figure 1.1. General View SD700 FL - Low Harmonics Notch Filter for SD700 Variable Speed Drive

2. CONFIGURATION TABLE

CODE EXAMPLE: FQP00905205

FQP	0090		5		2		05	
FREEMAQ Series	Current [1]		Input Voltage		Protection Degree		THDi	
	0090	90A	5	380-500VAC	2	IP20	05	5%
	0210	210A			5	IP42	10	10%
	...	...						

GENERAL CONSIDERATIONS:

[1] The filters are designed according to the nominal motor input power. Verify nominal current and power of the motor nameplate to guarantee the compatibility with the selected filter. Be aware that the selection of an inadequate filter could reduce effectiveness.

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3. TECHNICAL CHARACTERISTICS

INPUT	Rated Operating Voltage	(3-Phase) 400VAC (±10%) (3-Phase) 690VAC (±10%)
	Operating Frequency [1]	50Hz, 60Hz
	Rated Current [2]	6A to 344A at 400V 52A to 213A at 690V
	Rated Motor Power	2,2kW to 200kW at 400V 45kW to 200kW at 690V
MAIN FEATURES	Total Harmonic Current Distortion (THDi) [3]	Model FQP___05: <5% at rated power Model FQP___10: <10% at rated power
	Efficiency	>97% at rated voltage and power
	Displacement Power Factor (DPF = cos Φ)	≥ 0.99
	Drive DC Link Voltage Behavior	No load: +10% Full load: - 5%
	Insulating Voltage	2500VAC (1min)
	Overload Capacity	120% during 60 sec at 40ºC Other under request.
	No-load Current	<0.3· I_{Rated} input at 400VAC (capacitive current) <0.37· I_{Rated} input at 500VAC (capacitive current) <0.3· I_{Rated} input at 690VAC (capacitive current)
ENVIRONMENT CONDITIONS	Ambient Temperature	-30ºC to +50ºC
	Altitude	1.000m
	Altitude de-rating	>1.000m, -1% per 100m; 3.000m max
	Protection Degree	IP20 and IP42
	Relative Humidity	<95%, non condensing
	Cooling	Internal forced cooling Frame1: 70 m^3/h fresh air Frame2: 135 m^3/h fresh air Frame3: 165 m^3/h fresh air Frame4: 300 m^3/h fresh air Frame5: 550 m^3/h fresh air
STANDARDS [4]	Certifications	CE
	Electromagnetic compatibility	EMC Directive (2004/108/CE) IEC/EN 61800-3 IEEE 519
	Design and construction	LVD Directive (2006/95/CE) IEC/EN 61800-2 General requirements IEC/EN 61800-5-1 Safety
PROTECTIONS	Free-potential contact on terminals with thermal protection function for user [5].	
ADDITIONAL FEATURES	Line Voltage Unbalance Sensitivity	Low
	Line Impedance Sensitivity	Low
	Built-in contactor for capacitive current reduction [6].	

NOTE: Frame 5 up, filters can be connected in parallel to rise 1750kW @400V and 2000kW @690V. For more information, consult the SD700FL installation manual.

[1] 60Hz under request
[2] Filter FQ05 reduces RMS input and peak current by reducing the harmonic currents and improving the power factor.
[3] General conditions:
-System requirements: THDv <2%, line voltage unbalance <1%.
-Harmonics are below the limits defined in IEEE519 for all I_{SC}/I_L.
[4] Corresponding to SD700+Freemaq.
[5] The connection of one digital input of the SD700 configured as 'External Fault' is recommended by Power Electronics.
[6] The control by means of one output relay from the SD700 is recommended by Power Electronics.

3.1. Functional diagram

The following figure shows the general connection of a single module filter.

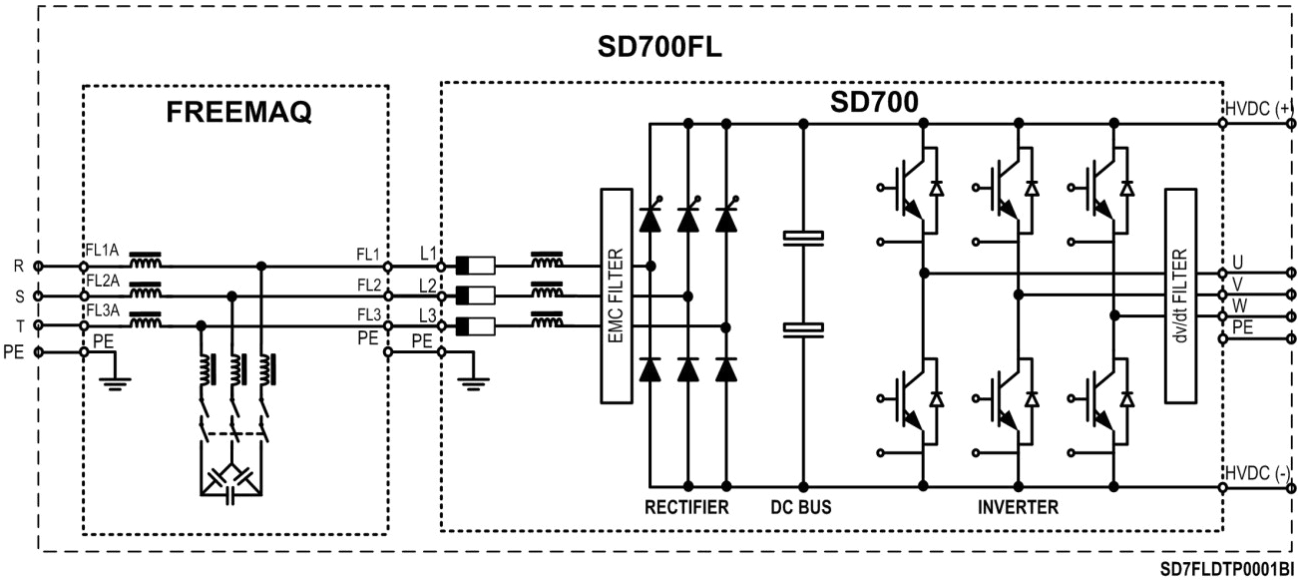

Figure 3.1 1 filtering module connection functional diagram

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4. RECEPTION, HANDLING AND TRANSPORTATION

CAUTION

Read carefully the following installation instructions for a correct mechanical installation.
Otherwise, the equipment can be damaged and lead to injury to people**.**

4.1. Reception and Storage

The Freemaq filters are carefully tested and perfectly packed before delivering. In the event of transport damage, please ensure that you notify the transport agency and Power Electronics: 902 40 20 70 (International +34 96 136 65 57) or your nearest agent, within 24hrs from receipt of the goods.

Make sure model and serial number of the Freemaq cabinets are the same on the box, delivery note and unit. Check that the following documentation is attached:

- Hardware and installation Manual Freemaq FQP.
- General documentation CD.

It should be handled with care and be strictly protected of the rain and the sunlight. The impacts during transport should be avoided. During transport and handling, avoid the equipment exposure to humidity, Sharp turns, vibrations and impacts. It is important to carefully inspect the shipping container and contents prior to installation. For any damaged or missing item, please consult Power Electronics.

4.2. Handling and Transportation

Only the transport methods described in this document or in the delivery notes are permissible. Any other transport method or system could damage the unit.

Freemaq FQP is delivered horizontally, fastened to a wooden pallet and covered with a wooden box. Depending on the transport method, the drive could be moisture protected with a vacuum plastic bag. Move the complete pallet as close as possible to its final installation place before unpacking, to avoid any damage during transportation.

It is mandatory to transport it with a pallet truck, forklift or crane fork, taking care about the load distribution and center of gravity. Check the size and weight of the filter components to choose proper lifting equipment with a capacity greater than the filter's weight.

Unpack the filter carefully. Do not use an edge tool to protect the product from damage. After open the package, please check the goods contained. Verify the item numbers contained within the package with the packing inventory list. Please set aside and reserve, if contained, the case of spare parts shipped with the product. There should be no evident damage caused by vibration, dropping or moisture.

CAUTION

If the maximum tonnage of cranes cannot meet the requirement, it could cause damage to the equipment and lead to injury to people.

To unpack, if necessary, unscrew the bolts that fix the wooden box with the pallet. Then, the drive is fixed to the pallet through the L shapes place in its four corners, unscrew all the fixation screws.

To rise to an upright position use only a crane or forklift equipped with belts or slings. Lift it carefully pulling from the four M8 top eyebolts.

Once it is upright positioned, remove the red transport fixing brackets of the equipment. The filter integrates six fixing brackets in the rear part and two in the bottom front part.

CAUTION

Remove the red transport fixing brackets before commissioning. Otherwise, the equipment could be damaged.

Lift the filter pulling from the top part. Avoid brusque movements and shocks during transportation. At the time of placing the filter on the floor, stop lowering it just before reaching the floor and then slowly lower it on the floor to avoid any shock.

The next figure shows how to lift the equipment:

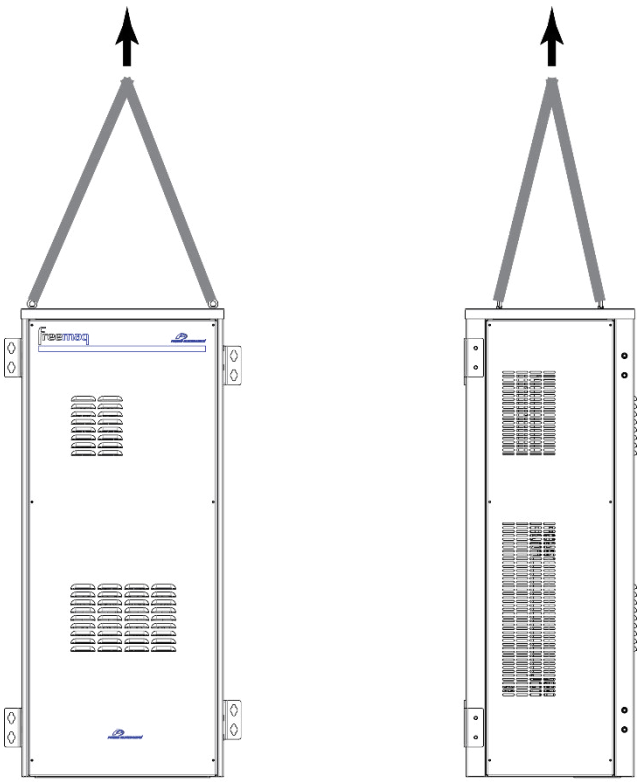

Figure 4.1 Freemaq FQP transportation

During handling and transportation, the goods should not be exposed to moisture, overturned, inverted, tilted or impacted. The tilting angle should be no more than 30º.

5. MECHANICAL INSTALLATION

CAUTION

The installation must be done by qualified personal.
Otherwise, the equipment can be damaged and lead to injury to people.

5.1. Environmental ratings

It is recommended to follow the instructions of this manual to ensure the correct operation of the filter. The installer has the responsibility of a properly indoor installation to ensure the ambient conditions of the filter. Additionally, the installer is ultimate responsible of the local regulation fulfilment. The environmental ratings are the following ones:

- Environmental category: Indoor
- Wet locations: No
- Ingress protection rating: IP20
- Operation Ambient temperature: -30ºC to 50ºC
- Storage Ambient temperature: -20ºC to 65ºC
- Humidity: <90 % (non condensing)
- Maximum altitude and power derating: 1000m 1% PN(kW) per 100m; 4000m maximum

5.2. Filter mounting

This section provides guidelines to select the best mounting location to ensure the optimum performance, cautions and warnings that you should follow to avoid injury and/or equipment damage.

The Freemaq FQP filters for frames 1 to 4 are wall-mounting devices and for frame 1 is designed to be placed over a technical floor.

The installation method and mounting location must be suitable for the weight and dimensions of the cabinet. Power electronics recommend hanging the Freemaq cabinet on a solid wall or structure through the anchorages placed on the sides of the filter, which supports the cabinet weight and the possible forces generated by the wiring.

5.3. Clearances

The Freemaq FQP frames 1 to 4 must be installed in vertical position, and firmly fastened through the dedicated anchorages placed in the sides of the cabinet that avoid any movement. Frame 5 has been designed to be placed over a technical floor. In order to make easy the power connection, the Freemaq is installed over a plinth that increases the total height to 2000mm. The floor must guarantee a non-flammable, solid, plain and levelled surface to the drive, a minimum clearance around it and a smoothly cable access. The maximum allowed slope is 1cm in every 6 meters. Fix the Freemaq cabinets to the wall or floor by using the L brackets placed in both sides of the filter. These brackets have an Ø11 hole and can be used either in the legs or in the rear part of the drive.

If the equipment is installed inside a cabinet, ensure that the hot air expelled from the filter is evacuated outside. This hot air can be aspirated again so the filter may suffer from overheating. To ensure a suitable cooling avoid the recirculation of air and keep the minimum clearance distances indicated below.

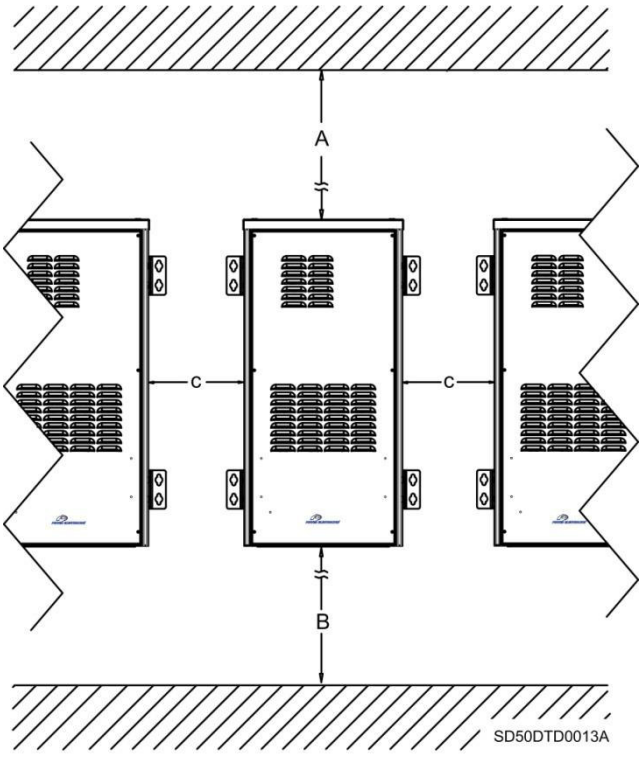

Figure 5.1 Minimum clearances

FRAME	DISTANCE (mm)			FRONT CLEARANCE
	A	B	C	
1	200	200	5	700
2	200	200	5	800
3	200	200	35	800
4	300	300	35	820
5	400	-	80	930

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5.4. Cooling system for the Freemaq filter

The Freemaq filters are individual cabinets. Inside the cabinets, the inductances and capacitors generate heat, so each cabinet presents an independent cooling system.

In frame 1 filters, an axial fan installed in the bottom part of the cabinet blows the fresh air through the hottest components. The air circulates inside the module to the top part and a grating evacuates it.

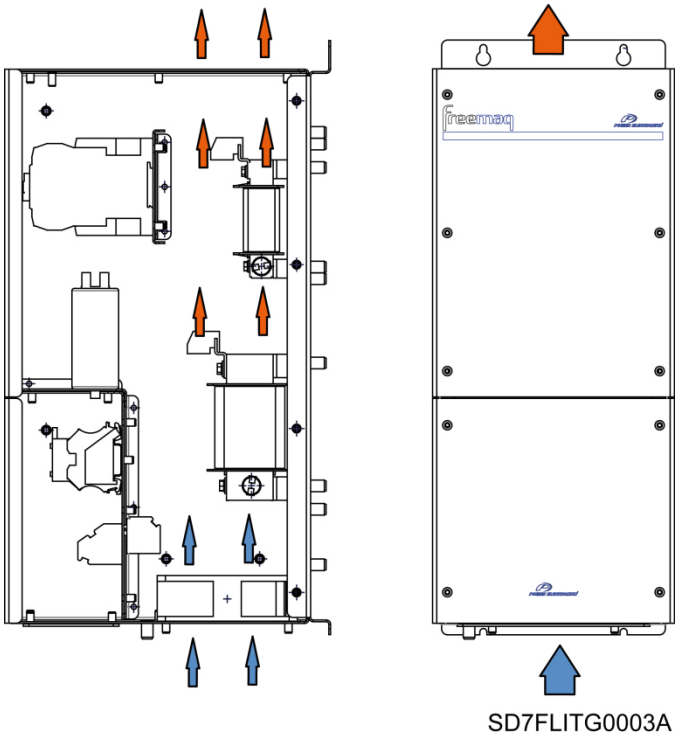

Figure 5.2 Cooling airflow for SD700FL. Frame 1 (Filter's cooling)

In frame 2 to 4 filters, the cabinets integrate air inlet gratings in the front part. Behind them are placed axial fans that allow blowing the fresh air to the hottest components. The air circulates inside the module to both sides, where some gratings evacuate it. In frames 2 and 3, there are 3 fans and in frame 4 there are 6 fans.

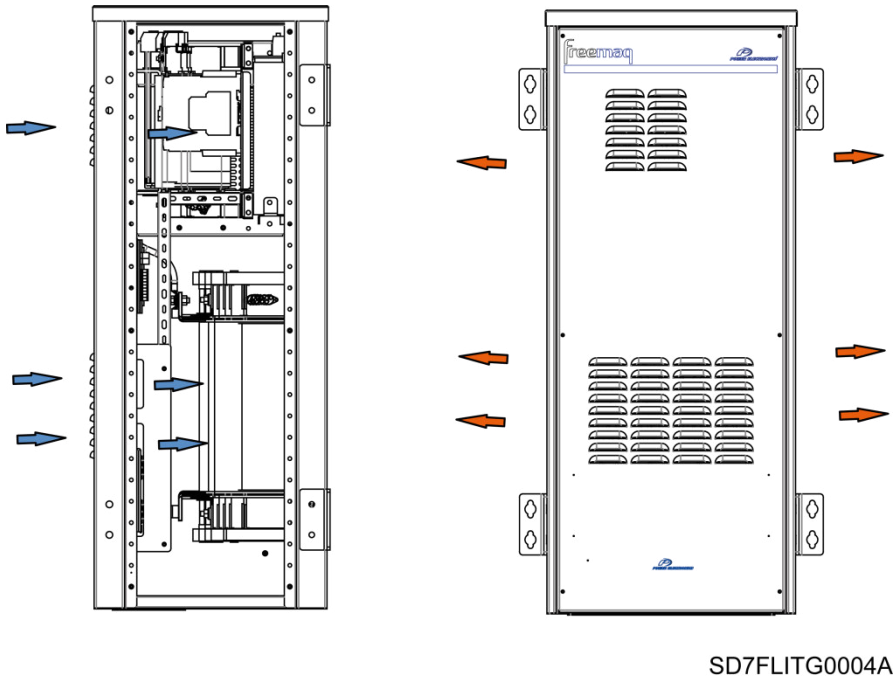

Figure 5.3 Cooling airflow for SD700FL. Frames 2 to 4 (Filter's cooling)

The filters frame 5 on have been designed in a modular way. Inside the modules, the inductances generate heat, so each module presents an independent cooling system.

The modules integrate air inlet gratings in their front part. Behind them are placed axial fans that allow blowing the fresh air to the hottest components (inductances and capacitors). The air circulates inside the module to the top part, where a centrifugal fan extracts the hot air.

The maximum heat loses per module are 1% of the motor power.

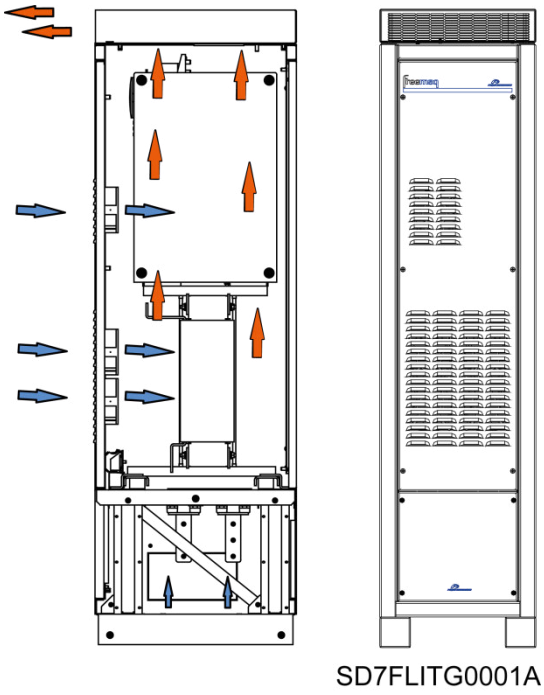

Figure 5.4 Cooling airflow. Frames 5 to 11 (Filter's cooling)

	Frame 1	Frame 2	Frame 3	Frame 4	Frame 5
INLET GRATING NET SECTION (m^2)	0.00668	0.01375	0.01375	0.0264	0.02475
OUTLET GRATING NET SECTION (m^2)	0.00743	0.0405	0.0513	0.0804	0.01925
MAXIMUM IN/OUT FLOW (m^3/h)	70	135	165	300	550

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6. POWER AND CONTROL CONNECTION

CAUTION

Read carefully the following installation instructions for a correct electrical installation.
Otherwise, it could cause damage to the equipment and lead to injury to people.

6.1. Power and control connection

The following scheme describes the general connection of the Freemaq filter.

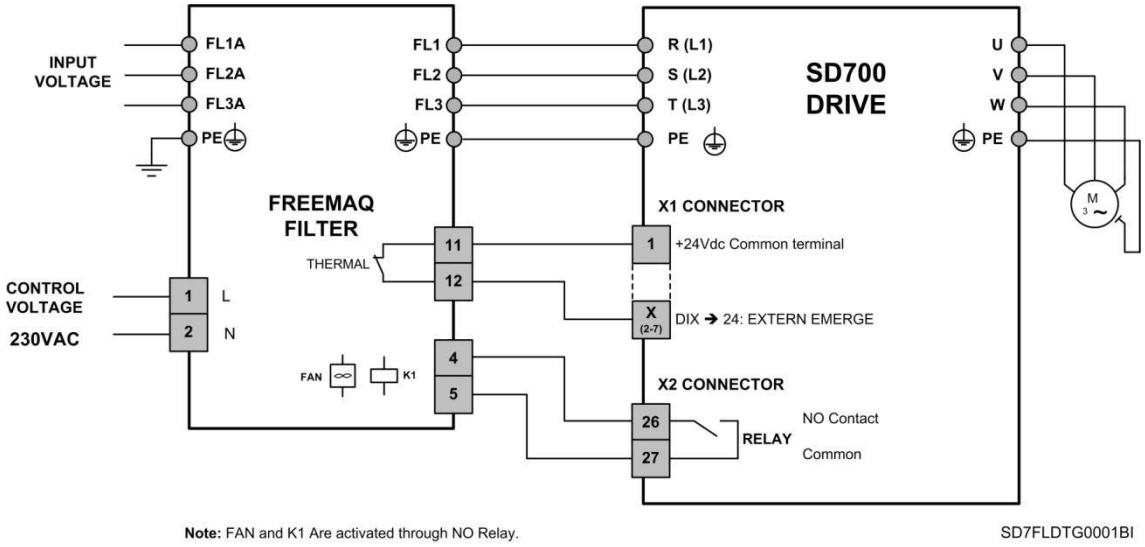

Figure 6.1: General control and Power interconnection

The Freemaq filter performance is managed by the SD700; specifically the SD700 activates the cooling fans and the contactor of the capacitors bank. On the other hand, the filters through thermal sensors placed in the primary inductances and connected in series report to the SD700 if one of them is overheated.

To implement the system it is necessary to connect and configure one output relay and one digital input. Check the Software and Programming manual to ensure the correct understanding of the described steps.

OUTPUT RELAY: COOLING SYSTEM AND CAPACITORS BANK CONTACTOR

- Select one of the free output relays of the SD700 control board and connect it as shown in the electric schemes attached. For the following description it is selected the first output relay.
- Configure the output relay as comparator (G8.1.1 option '17 COMPARATOR 1').
- Configure the motor power as the comparison value (G9.1.1 option '04 POWER MOTOR').
- Configure 35% as the limit of the activation value (G9.1.3 option '+35').
- Configure 15% as the limit of the deactivation value (G9.1.7 option '+15').
- Configure a delay time of 2s to the deactivation (G9.1.8 option '2.0').

DIGITAL INPUT: THERMAL FAULT

- Select one of the free digital inputs of the SD700 control board and connect it as shown in the electric schemes attached. For the following description it is selected the first digital input.
- Configure the digital input as an external fault (G4.1.5 option '24: EXTERNAL EMERGENCY').

6.2. Power Wiring

The input terminals FL1A, FL2A, FL3A and PE (filter supply), and output terminals FL1, FL2, FL3 and PE (drive supply) must be connected to the terminals situated in the front part of the cabinet. Do not drill or mechanize the gratings. Otherwise, the drive could reduce its cooling capacity.

These filters have all the power connection from below. The filter is connected in series with the SD700 drive as shown in the previous diagram. Remove the front panel and the plastic protector located in front of the power terminals. Remove then the metallic bedplate located in the lower part and connect the PE, input, and output terminals. If needed drill the metal bedplate and install a suitable cable grommet to prevent dust or moisture penetration.

As standard, the input and output terminals are made of alluminium. If they are oxidized prior to its installation, the connections will be poorly executed and will cause overheating. To avoid this effect is recommended to follow the next steps.

- It is recommended to use Ø9 alluminium terminal lugs.
- Use M8 zinc bolts and nuts and apply a torque of 25.5Nm. Check after the first week of operation that the torque applied is maintained.
- Before connecting the cables, clean the contact surfaces with a clean cloth and ethanol cleaner.
- Use a spring washer and a fender washer between the nuts or bolts head and the busbar or terminal lug.
- Use copper or aluminium 600Vac conductors for up to 500Vac rated voltage.

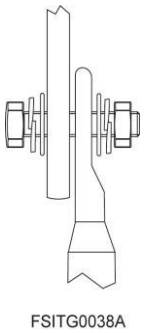

Figure 6.2 Terminal lug connection

Note: apply a torque of 25.5 Nm to the frame 1 filter terminals.

For more information, consult SD700 Hardware and installation manual.

6.3. Ground connection

Before connecting the power conductors, be sure that the filter's cabinet is connected to ground through the dedicated (PE) terminal. It is situated beside input and output power terminals. The dedicated PE terminal of the filter must be connected to the SD700 VFD's PE terminal and to earth. For more information check the SD700 hardware and installation manual.

When connecting the earth, ensure that all connected terminal lugs are securely tight and protected from mechanical forces. The tightening torque in case of M6 PE terminals is 10.30Nm.

CAUTION

For safety reasons it is determinant to measure the grounding resistance of the plant itself. This must be established before the first start up of the plant and with the drive disconnected.

It is responsibility of the installer to provide the adequate number, type and cross section grounding conductor alongside with the characteristics of the filter used and of the Plant in order to minimize the grounding resistance, that comply with the local and national regulation.

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6.4. Power Terminals for Frames 1 to 5

6.4.1. Connections for Frame 1

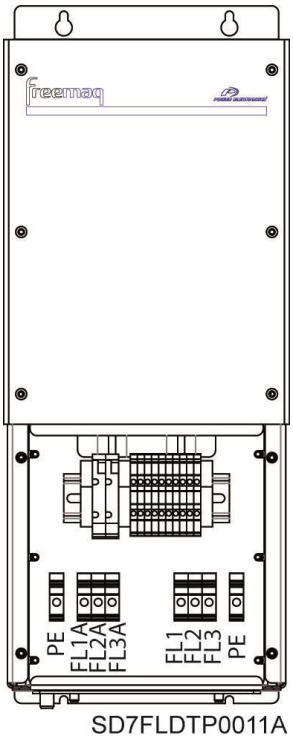

Figure 6.3 Location of power connections for equipments of Frame 1

6.4.2. Connections for Frames 2, 3 and 4

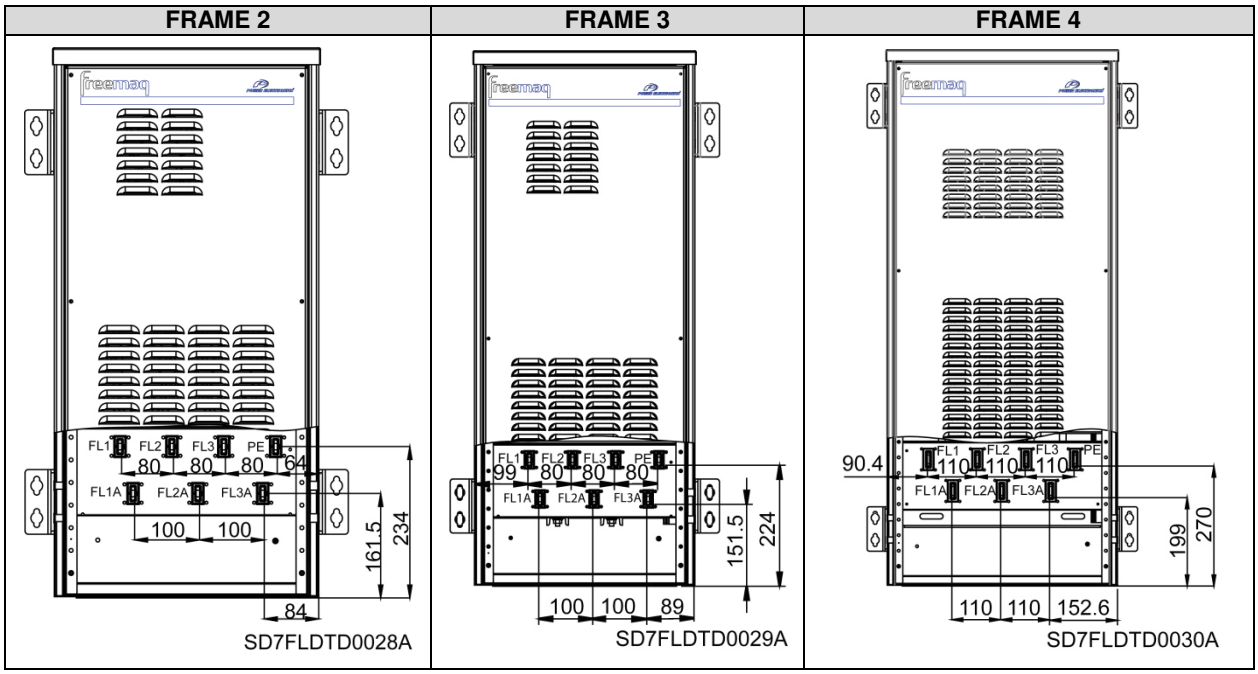

Figure 6.4 Location of power connections for filters Frames 2, 3 and 4 [mm]

6.4.3. Connections for Frame 5

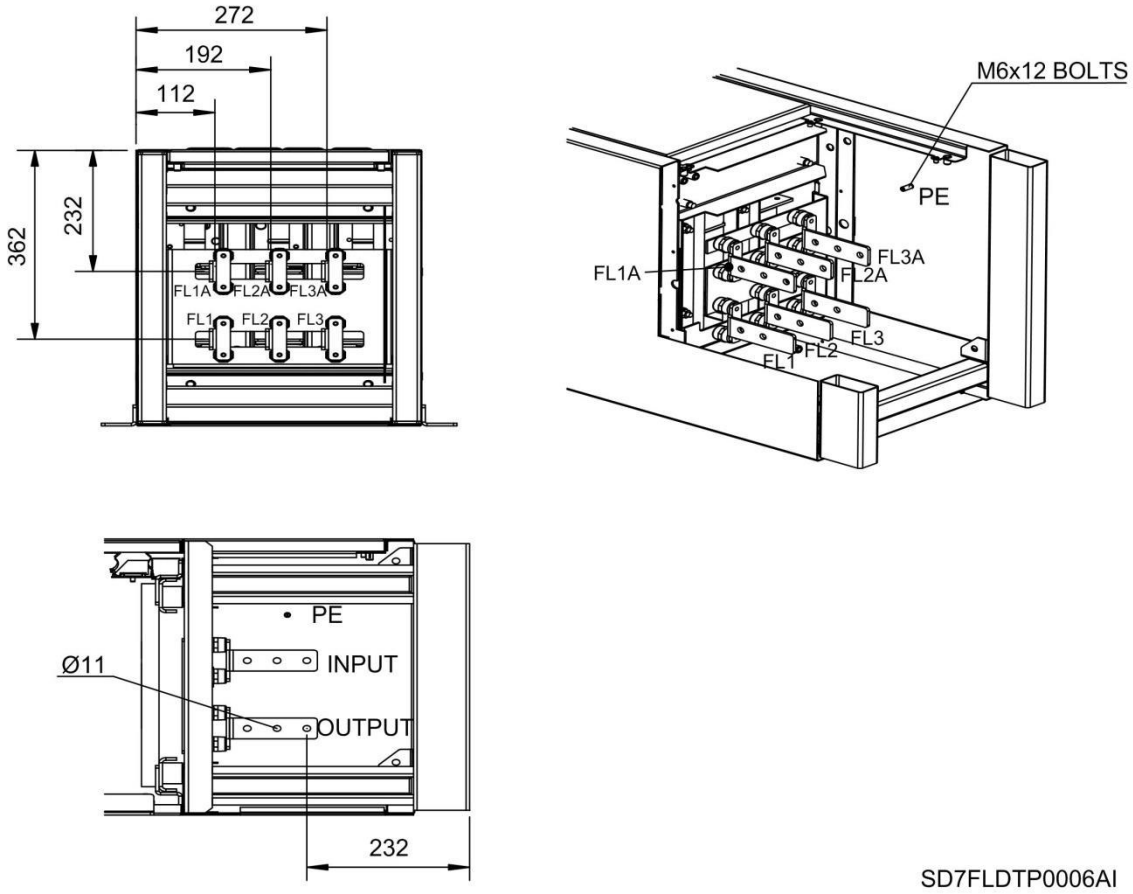

Figure 6.5 Location of power connections for filters Frame 5 [mm]

6.5. Control wiring recommendations

Before planning the installation, follow the next recommendations. The parallel cable routing should be minimized and the distance between the control wiring and the power wiring should be maximized. It is recommended to route control cables with different voltages in separately cable racks, trays or ducts.

It is recommended to use shielded twisted cable for all the data, signal or control cables that came out from the filter, with the properly shield bonding to ground. To ensure an effective shield bonding, it is recommended to include in the SD700 front metal panel of the control board, EMC shield clamps that ensure a 360º effective shield bonding.

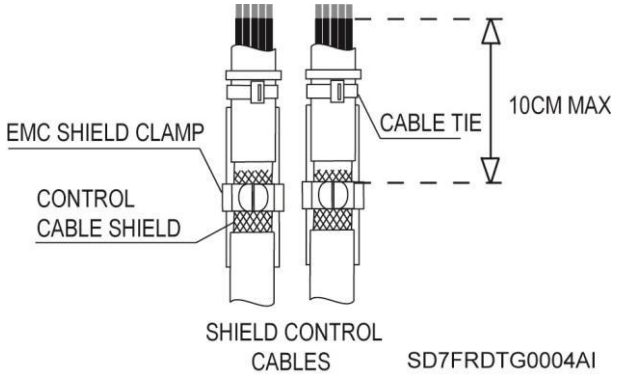

Figure 6.6 Shield bonding

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Digital signal cables must be grounded at both ends of the cable. It is recommended to use independent shielded cables for digital and analogue signals. When using multiple analogue signals do not use common return for them. If a low-interference is experienced (hum loops) using analogue signals disconnect the shield grounding from one of the ends. The maximum section for the control cables is 2.5mm² and the recommended tightening torque is 0.4Nm.

Although the control board is insulated galvanically, for safety reasons it is recommended not to modify the wiring while the equipment is connected to the input power supply.

CAUTION

Changes of control wiring or bridges should be performed following the safety instructions indicated before. Otherwise, it could cause damage to the equipment and lead to injury to people.

7. DIMENSIONS

7.1. Dimensions of Frames 1 and 2

FRAME	DIMENSIONS (mm)								WEIGHT (kg)
	H1	H2	H3	W1	W2	W3	D1	Y1	
1	507.6	498.4	6.8	207	120	35.7	279	-	50
2	851	556	111	500	463	18	394	50	75

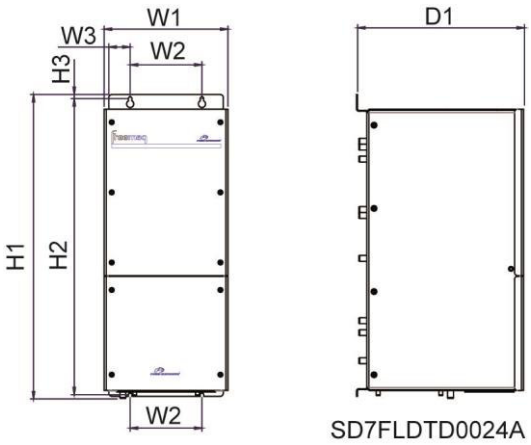

Figura 7.1 Dimensions of Frame 1

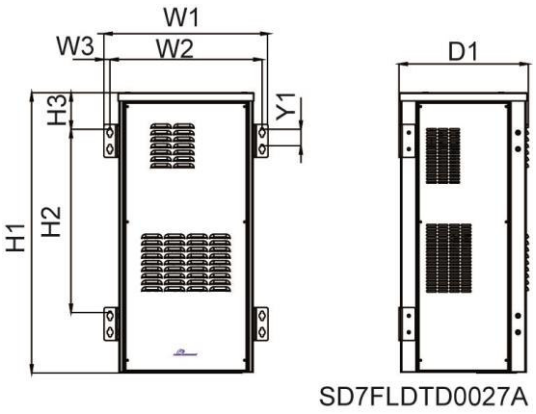

Figura 7.2 Dimensions of Frame 2

7.2. Dimensions of Frames 3 and 4

FRAME	DIMENSIONS (mm)						WEIGHT (kg)
	H1	H2	H3	H4	W1	D1	
3	990	696	113	50	500	390	107
4	1206	952	91	50	608	440	183.5

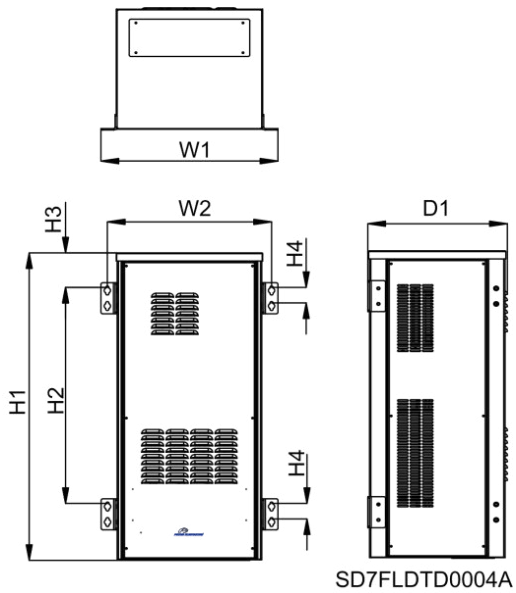

Figura 7.3 Dimensions of Frame 3

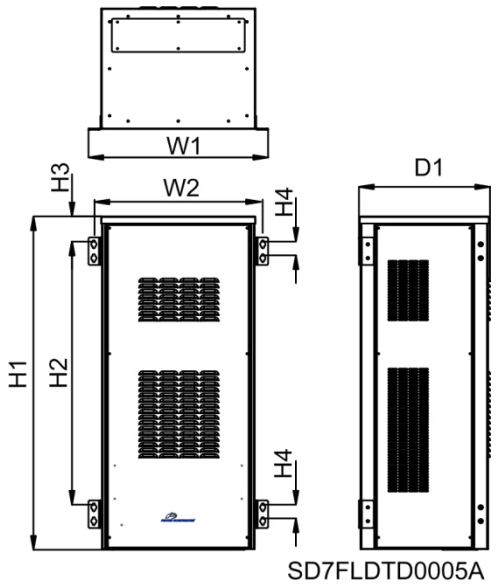

Figura 7.4 Dimensions of Frame 4

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7.3. Dimension of Frame 5

FRAME	DIMENSIONS (mm)					WEIGHT (kg)
	H1	W1	W2	W3	D1	
5	2000	407	431	838	529	584

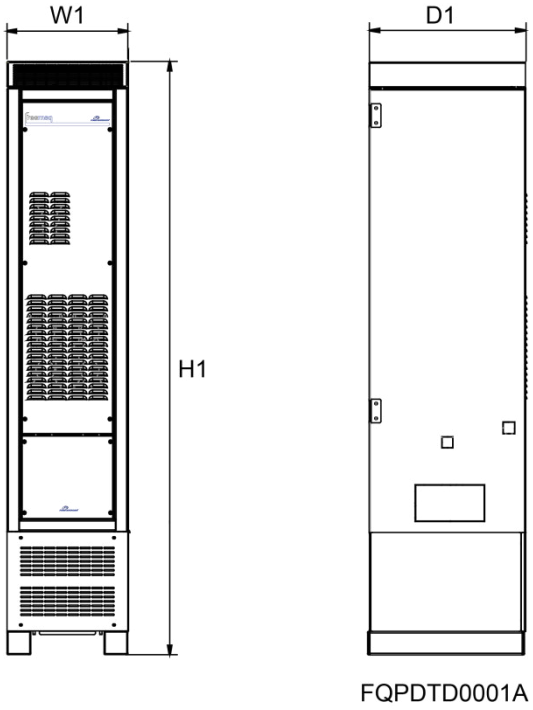

Figura 7.5 Dimensions of Frame 5

8. MAINTENANCE

Temperature, humidity, vibration and deteriorated components can reduce the filter's efficiency. To avoid any possible irregularity we recommend making periodic inspections.

8.1. Warnings

- Be sure to remove the input power while performing maintenance.

8.2. Routine Inspection

Be sure to check the following points before handling the filter:

- Installation site conditions.
- Filter cooling system conditions.
- Excessive overheating.

Inspection site	Inspection element	Inspection	Period			Inspection method	Criterion	Instrument of Measurement
			Monthly	3 months	2 years			
All	Ambient conditions	Are there dust particles? Are the ambient temperature and the humidity within specification?	o			Visual check	Temperature: -30 to +50 (or 40ºC) Humidity: below 95% non-condensing.	Thermometer, Hygrometer, Recorder.
	Module	Are there any abnormal noises or oscillations?	o			Visual and audible.	There are no anomalies.	
	Input power	Is the input power to the main circuit correct?	o			Measure the voltage between terminals L1, L2, L3 and PE.		Digital multimeter. Tester.
	Power connections	Are the Power terminals correctly fastened?		o		Measure the temperature and torque of the power connections	Fasten the bolts again one week after its start-up. Check that the temperature is homogeneous and below 70ºC	Infrared thermometer , Torque key
Main circuit	Conductor/ Cable	Is the conductor corroded? Is the sheathing of the cable damaged?		o o		Visual check.	No anomaly.	
	Terminal	Is any damage visible?		o		Visual check.	No anomaly.	
	Correct capacitor	Have fluid leakages been observed? Is the capacitor well fastened? Is any dilation or retraction sign observed? Measure the capacitance	o o	o		Visual check. Measure the capacitance with a proper instrument.	No anomaly Capacitance higher than 85% of rated capacitance.	Instrument for measuring capacity.
	Inductances	Is there any liquid leak? Is there any overheated point?		o o		Visual check. Measure the surface and connectors' temperature.	No anomaly. Check that the temperature is homogeneous and below 70ºC	Infrared thermometer.
	Circuit breaker	Is the circuit breaker of the filter damaged?		o		Disconnect the power supply. Reset de circuit breaker with the test button.	No anomaly.	
Cooling system	Cooling fans	Are there any abnormal noises or oscillations? Is the cooling fan disconnected?	o	o		Disconnect the power supply (OFF) and rotate the fan manually. Check the connections.	Fan should rotate effortlessly. No anomaly.	

Note: Long life of the main components above indicated are based on a continuous operation for the stipulated load. These conditions can change according to the environment conditions.

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