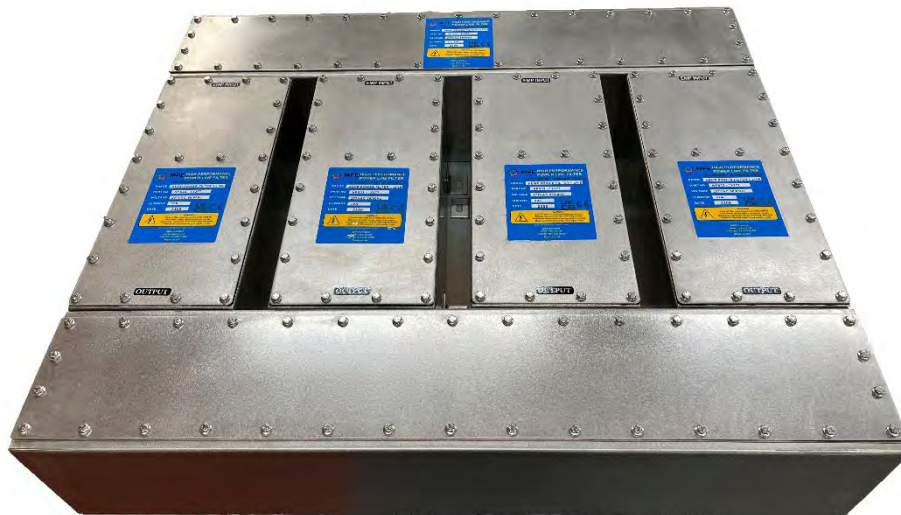




HEMP & IEMI PROTECTION FILTERS FOR MAINS POWER LINES COMPLIANT TO REQUIREMENTS OF MIL-STD-188-125-1A



**CONFORMING TO THE ELECTRICAL
POINT-OF-ENTRY REQUIREMENTS FOR
SHORT (E1) AND INTERMEDIATE (E2)
RESIDUAL PULSE CURRENT
AND SHIELDING EFFECTIVENESS**



MPE Limited
Hammond Road,
Knowsley Industrial Park,
Liverpool
L33 7UL
UK

Overview

This range of filters is the latest in high-altitude electromagnetic protection (HEMP) for power lines. MPE have designed these filter circuits from the ground up in order to be compliant with the stringent E1 and E2 pulse current injection and shielding effectiveness requirements of the latest MIL-STD-188-125-1A protection standard. These high performance filters also protect equipment from the effects of intentional electromagnetic interference (IEMI).

All lines are individually filtered and feature inductive input to offer both good continuous wave electromagnetic compatibility (EMC) performance and superior transient handling performance even on supplies with low source impedance. All lines are fitted with high-energy transient suppressors.

Typical Applications

- Fixed ground-based C⁴I military facilities
- New build & upgrade facilities requiring HEMP protection to MIL-STD-188-125-1A

Features

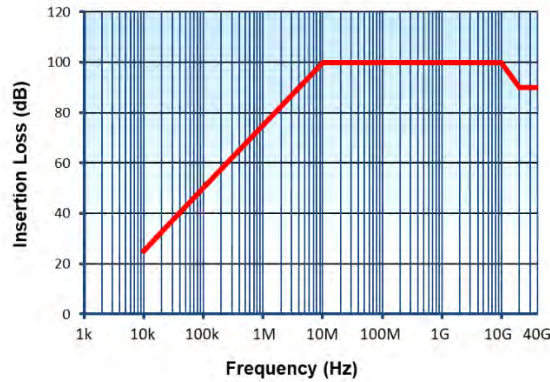
- Single line “modular” construction for quick and easy installation
- Supplied in either 2, 3 or 4 line configurations with termination enclosures
- Very low residual pulse current – high safety margin on E1 pulse residual norm limits
- High-energy transient suppressors for reliability against E2 pulse
- High performance feedthrough capacitors
- Utilises self-healing metallised plastic film technology – excellent reliability and long service life
- UL94-V0 insulating materials used
- UL1283 compliant design and materials used
- UKCA & CE marked
- Compliant to latest versions of RoHS & LVD directives
- Practical to keep spare modules for critical facilities – reducing any potential downtime

Electrical Ratings and Characteristics

Rated Voltages/Frequencies Available	120VAC 50/60Hz 250VAC 50/60Hz 277VAC 50/60Hz
Test Voltage	2250VDC (5 seconds) each line to case
Rated Currents Available, I _R @ 50°C	16A 32A 63A 100A 200A 250A 400A 800A 1200A
Overload Current	1.5 x I _R for 10 minutes
Insulation Resistance	>100MΩ (prior to fitting discharge resistors)
Discharge Resistors	Fitted internally from each line to case
Discharge Time to below 34V	<30s
Peak Surge Current	70kA (8/20μs)

Insertion Loss Performance

Asymmetric attenuation shown as measured in 50Ω system with or without load, in accordance with MIL-STD-220C, CISPR-17 and BS EN 55017.



Frequency	10kHz	100kHz	1MHz	10MHz	100MHz	1GHz
Minimum Insertion Loss to help meet MIL-STD-188-125-1A Shielding Effectiveness	20dB	40dB	60dB	80dB	80dB	80dB
Typical Filter Insertion Loss	25dB	50dB	75dB	100dB	100dB	100dB

Shielding Effectiveness

The filter enclosures are constructed in stainless steel and all seams are fully welded. Access lids are supplied with high frequency RFI gaskets to ensure the shielding effectiveness at the point-of-entry (POE) does not compromise that of the EMP shield.

Frequency	10kHz	100kHz	1MHz	10MHz	100MHz	1GHz
Minimum Shielding Effectiveness to meet MIL-STD-188-125-1A	20dB	40dB	60dB	80dB	80dB	80dB
Typical Filter Shielding Effectiveness	30dB	50dB	75dB	100dB	100dB	100dB

Transient Suppression Performance

All the filters in this catalogue have passed acceptance PCI tests for both 2.5kA wire-to-ground (WTG) and 5kA common-mode (CM) E1 pulses, and 250A WTG E2 pulses by a leading independent EMP test authority. The below table shows the typical WTG E1 pulse handling performance of the filters at increasing pulse current injections in accordance with MIL-STD-188-125-1A.

PCI acceptance test, short pulse current injection (E1) wire-to-ground, wave shape 20/500ns					
Input pulse amplitude	250A	500A	1000A	1750A	2500A
Typical filter residual current*	<2A	<2.5A	<3A	<4A	<6A

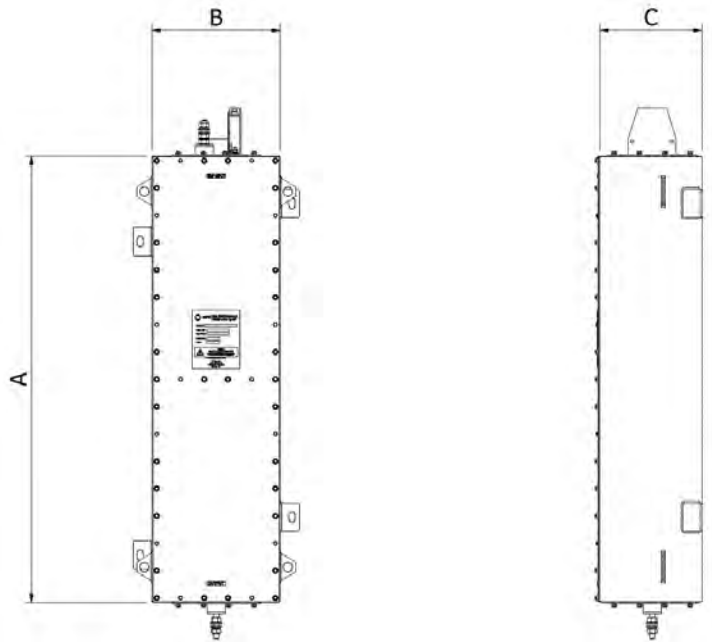
Acceptance test, intermediate pulse current injection (E2) wire-to-ground, wave shape 1.5/3000µs	
Input pulse amplitude	250A
Minimum requirement	No filter damage or performance degradation
Typical filter response	No filter damage or performance degradation

*See table on page 5 for the 2.5kA pulse residual currents for each product in the range.

Single Line Filter Modules

All the filters in this range are supplied as single line modules. The filters contain feedthrough capacitors wound in house from metallised high-grade polypropylene film, which provides low power losses and a dielectric self-healing capacity. They provide very high levels of interference attenuation up to 10GHz and beyond. The filters also incorporate non-saturating power chokes, achieving low losses and maintaining full frequency performance under all load conditions.

The filter components are housed in a rugged enclosure, supplied complete with access lids, screws and radio frequency interference (RFI) and environmental gaskets. Transient suppressors are mounted externally on the EMP input side of the enclosure in the form of high-energy absorbing SIOV metal oxide block varistors.



Rated Current (A)	Part Number	DC Resistance (mΩ)	Max. Earth Leakage* (A)	Residual Current [2.5kA] (A)	Major Dimensions			Terminal Size
					Length A (mm)	Width B (mm)	Height C (mm)	
16	HPS16-1	35	1.8	3.5	430	180	165	M5
32	HPS32-1	10	1.8	5.3	430	180	165	M8
63	HPS63-1	5	1.8	4.6	680	270	215	M8
100	HPS100-1	2	6.3	5.9	680	270	215	M8
200	HPS200-1	1	12.5	6.2	940	270	215	M12
250	HPS250-1	0.5	15	5.6	1250	270	215	M16
400	HPS400-1	0.5	15	4.4	1250	270	215	M20
800	HPS800-1	0.1	26	4.4	1600	310	320	50x8 busbar
1200	HPS1200-1	0.1	26	4.4	1600	310	320	80x10 busbar

*Maximum earth leakage calculated at worst-case voltage condition of 277VAC 60Hz.

Important note all filters in this range cannot be protected by a standard 30mA residual current circuit breaker. However, an RCCB protection device can be placed down line (load side) of the filter.

Mechanical Details

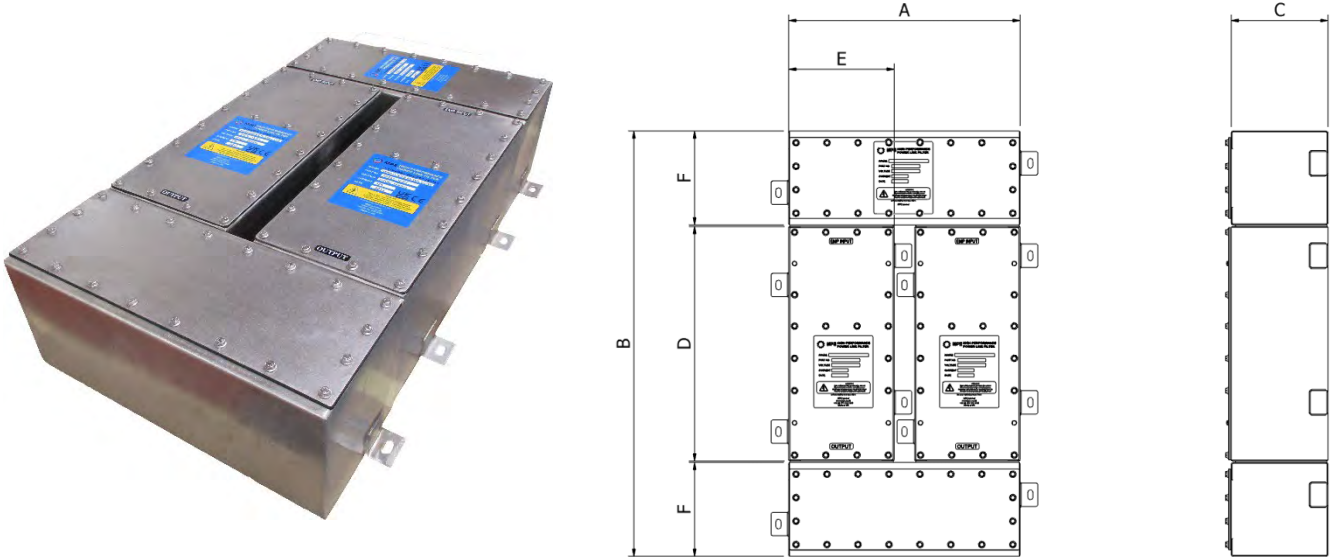
Enclosure		304 grade stainless steel
Terminals	≤ 400A	Nickel-plated brass
	≥ 800A	Copper bus-bar
Earth Terminals		Stainless steel stud
Mounting		Slots provided in external mounting feet
Mounting Hardware		None supplied
Finish		Natural, dressed

Environmental Details

Potting Compound Flammability Rating	UL 94 V-0
Full Load Operating Temperature Range	-40°C to +50°C
Storage Temperature Range	-40°C to +85°C

2-Line Installation Details

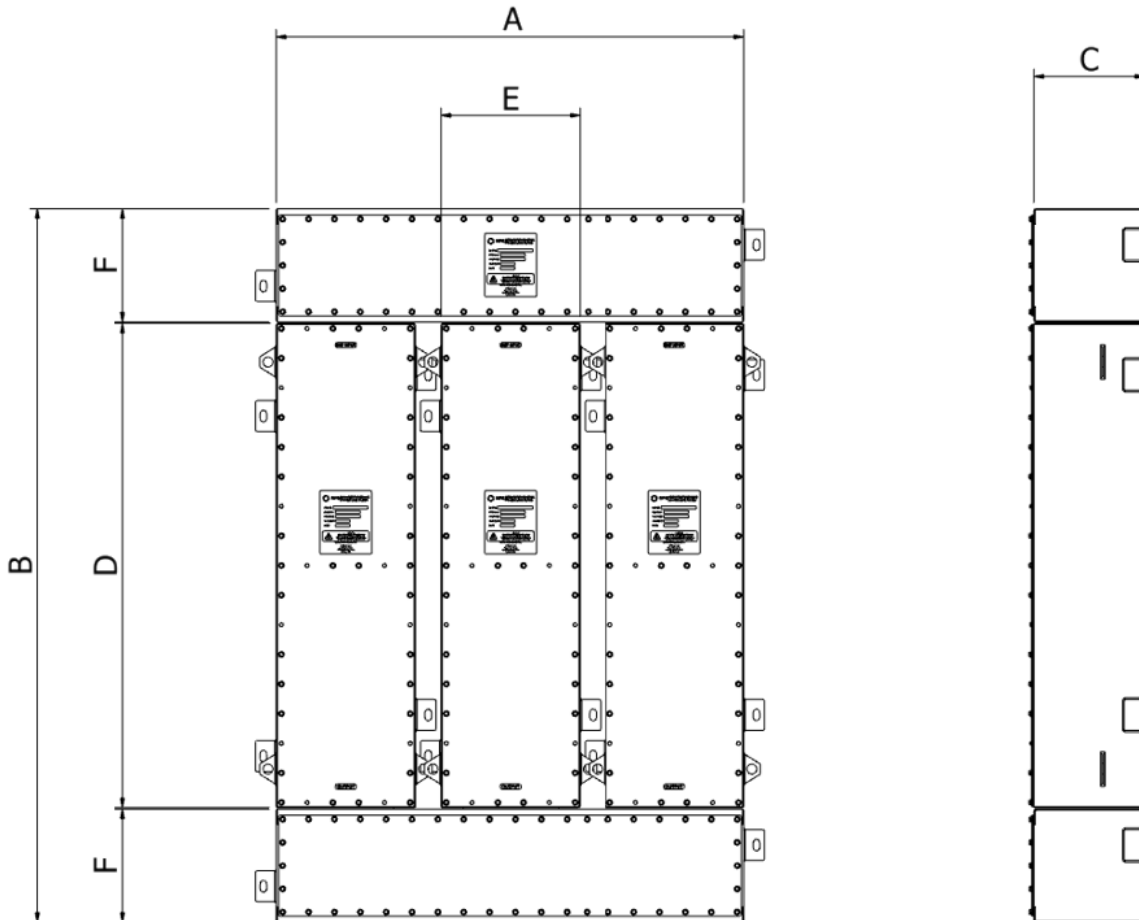
The 2-line installation package consists of two single line modules and separate wiring termination enclosures for the input and output wiring connections to be made. In order to maintain high frequency attenuation and shielding effectiveness of the installation, RFI knitmesh gaskets are supplied and should be fitted between each filter enclosure and wiring termination enclosure.



Rated Current (A)	Part No.	A	B	C	D	E	F
16	HPS16-2	395	755	165	430	180	160
32	HPS32-2	395	755	165	430	180	160
63	HPS63-2	590	1125	215	680	270	220
100	HPS100-2	590	1125	215	680	270	220
200	HPS200-2	590	1385	215	940	270	220
250	HPS250-2	590	1855	215	1250	270	300
400	HPS400-2	590	1855	215	1250	270	300
800	HPS800-2	680	2805	320	1600	310	600
1200	HPS1200-2	680	2805	320	1600	310	600

3-Line Installation Details

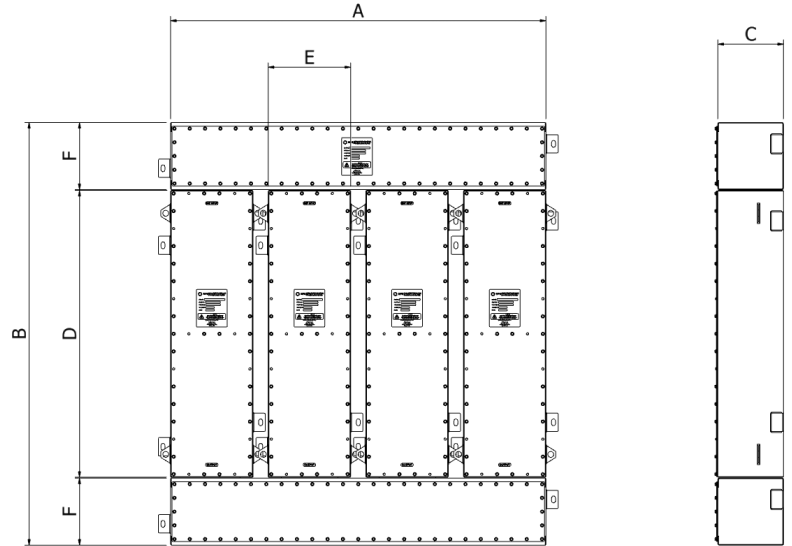
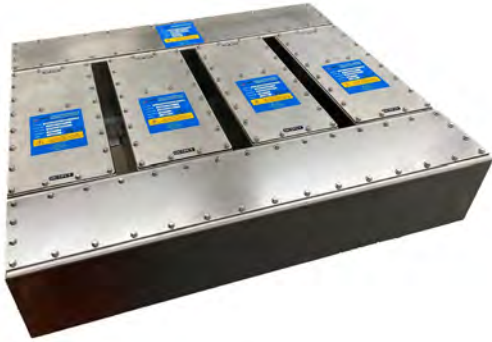
The 3-line installation package consists of three single line modules and separate wiring termination enclosures for the input and output wiring connections to be made. In order to maintain high frequency attenuation and shielding effectiveness of the installation, RFI knitmesh gaskets are supplied and should be fitted between each filter enclosure and wiring termination enclosure.



Rated Current (A)	Part No.	A	B	C	D	E	F
16	HPS16-3	610	755	165	430	180	160
32	HPS32-3	610	755	165	430	180	160
63	HPS63-3	810	1125	215	680	270	220
100	HPS100-3	810	1125	215	680	270	220
200	HPS200-3	810	1385	215	940	270	220
250	HPS250-3	810	1855	215	1250	270	300
400	HPS400-3	810	1855	215	1250	270	300
800	HPS800-3	1050	2805	320	1600	310	600
1200	HPS1200-3	1050	2805	320	1600	310	600

4-Line Installation Details

The 4-line installation package consists of four single line modules and separate wiring termination enclosures for the input and output wiring connections to be made. In order to maintain high frequency attenuation and shielding effectiveness of the installation, RFI knitmesh gaskets are supplied and should be fitted between each filter enclosure and wiring termination enclosure.



Rated Current (A)	Part No.	A	B	C	D	E	F
16	HPS16-4	825	755	165	430	180	160
32	HPS32-4	825	755	165	430	180	160
63	HPS63-4	1230	1125	215	680	270	220
100	HPS100-4	1230	1125	215	680	270	220
200	HPS200-4	1230	1385	215	940	270	220
250	HPS250-4	1230	1855	215	1250	270	300
400	HPS400-4	1230	1855	215	1250	270	300
800	HPS800-4	1420	2805	320	1600	310	600
1200	HPS1200-4	1420	2805	320	1600	310	600

Cable Entry Options

The termination enclosures are supplied as standard without any cable entry holes so that the installer can make appropriate provisions for the best size and position of the holes for their particular installation. It is common for sizes and positions of holes in the termination enclosures to differ depending on the choice of cable, conductor material and termination glands. In some cases the most suitable hole configuration may not be decided until install work commences on-site.

Configuration	Description
X	No holes provided. Suitable for the end user to make alternative hole arrangements.

The installer should ensure to take good care when piercing the enclosures and follow good electrical wiring, EMP and EMC practises to ensure a full continuation of the EMP shield at the point-of-entry.

The termination enclosures can be supplied with pre-punched cable entry hole positions during manufacture at the factory. For more information on cable entry options, please contact sales@mpe.co.uk

Voltage Ratings

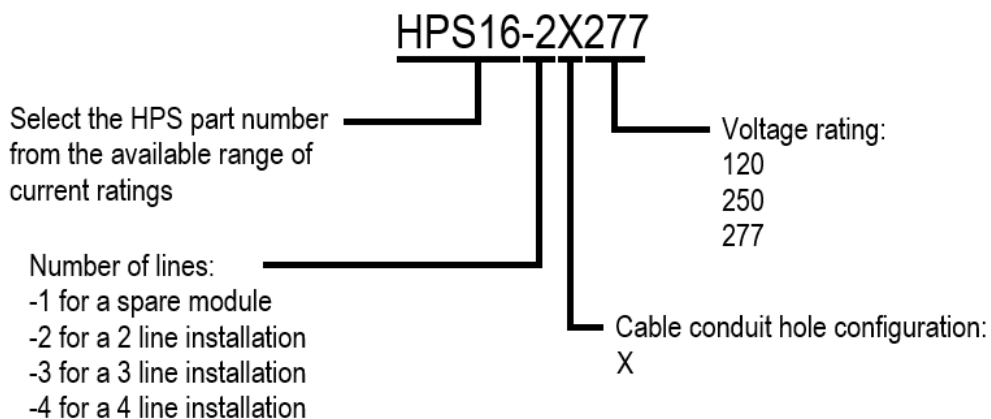
The filters are available with the following phase-ground voltage ratings:

Phase to Ground Voltage Rating	Application
120VAC 50/60Hz	Suitable for low voltage US and Canadian power supplies, Typically RCLI (Residential, Commercial, Light Industrial) 2 lines - single phase and neutral 277VAC 50/60Hz or 300VDC 3 lines - three phase (no neutral) 480/277VAC 50/60Hz 4 lines - three phase and neutral 480/277VAC 50/60Hz
250VAC 50/60Hz	Suitable for UK and European power supplies, 2 lines - single phase and neutral 250VAC 50/60Hz or 300VDC 3 lines - three phase (no neutral) 440/250VAC 50/60Hz 4 lines - three phase and neutral 440/250VAC 50/60Hz
277VAC 50/60Hz	Suitable for US and Canadian power supplies, Typically industrial and higher power requirements 2 lines - single phase and neutral 277VAC 50/60Hz or 300VDC 3 lines - three phase (no neutral) 480/277VAC 50/60Hz 4 lines - three phase and neutral 480/277VAC 50/60Hz

Ordering Codes

To order one of the installations packages or a single line module, select the order code using the following instructions:

1. Select the rated current
2. Add the number of lines
3. Add the cable conduit hole configuration preferred for your installation
4. Add the voltage rating

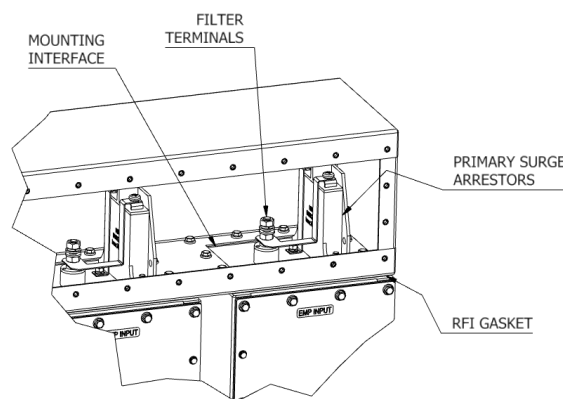


Installation Details

Two, three and four line installations include suitable termination enclosures and RFI gaskets. The RFI gaskets should be fitted between each filter module and the incoming and outgoing termination enclosures. RFI gaskets are supplied for both sides of the filter module as the filters may be installed on either the outside or the inside wall of the EMP shield. If the filter is positioned inside the EMP shield (and therefore inside the “clean” area) then both sets of gaskets will be required.

Single line modules can be supplied as spares. They are not supplied with termination enclosures but do come with RFI gaskets and transient suppressor for straight-forward replacement of an in situ module.

The filters can be mounted vertically as shown in the drawing details, or alternatively they can be mounted horizontally. All filters are labelled as if mounted as shown in the drawings.



Two spanners should always be used when tightening terminal fasteners. The recommended tightening torque figure for the terminal fixings are:

Fixing Type	Size	Recommended Tightening Torque (N-m)
Access Lid Screws	M5	1
Terminals, Earth Studs & Mounting Screws	M5	2
	M6	2.5
	M8	5
	M10	8
	M12	11
	M16	20
	M20	32

Earth Bonding for Performance

It is important to ensure a low impedance earth bond to the unpainted base of the filter enclosure as possible. It is recommended that filters be mounted on a steel surface, which has been electroplated with tin or zinc. This should be unpainted, clean and must be flat and smooth. This type of large area connection to the box ensures that at high frequencies, inductive and capacitive values are minimal, allowing a clear path to ground potential. This is necessary to obtain the best possible pulse protection and insertion loss performance from the filter.

Safety

Relevant safety standards have been adhered to in the design and manufacture of these products, however the User should ensure they are familiar with restrictions on capacitance value, earth leakage current, test voltage, and safety labelling requirements, which may be applicable to their particular installation.

Earth Bonding for Safety

The installer must ensure the filter is solidly and permanently grounded to the EMP shield or fixed ground reference, both for safe operation and to achieve optimum EMP performance. This is essential for filters with direct capacitance between phases and the enclosure. Poor earth bonding will result in reduced performance and could compromise safety. In the event of the earth connection to the enclosure becoming disconnected, the enclosure will rise in voltage to an unsafe level.

Discharging after Isolation

All filters in this catalogue contain large values of capacitance. These capacitors can store a hazardous electrical charge long after the power has been removed. Therefore as a safety measure, all filters are fitted with internal bleeder resistors intended to discharge the capacitors, lowering the stored voltage to a safe level after the removal of power. Even though bleeder resistors are fitted to this range of filters, it is important to follow a safe disconnection procedure when working on cables and filters. Terminals should always be shorted to case prior to touching to ensure the capacitors are fully discharged. Always ensure the voltage between phases, between phase and neutral, and between phase and ground are safe before working on any part of the cabling connected to a filter.

Approvals

All filters within this range have been designed to comply with the safety requirements to UL1283, LVD 2014/35/EU and UK Electrical Equipment (Safety) Regulations 2016.

All filters within this catalogue have been pulse current injection (PCI) acceptance tested by an independent test authority, specialising in EMP hardening and survivability, including PCI testing. All filters have been tested and shown to conform to the WTG and CM point-of-entry requirements of MIL-STD-188-125-1A as detailed on page 5. Product specific PCI test certificates for these products are available from our website.

All filters in this catalogue are compliant with the latest EU and UK RoHS Regulations.

Reliability & Service Life

MPE's power and EMP filters have been in service in strategic installations for over 30 years and have been demonstrated to be very reliable. They have been found not to exhibit any signs of safety or performance degradation, endorsing the claims of high reliability. Some EMP filters have been removed after 20 years continuous service for site upgrades to new HEMP filters, and when tested were found to still conform to their original electrical specification. Customer returns of filters due to electrical problems have been less than 0.1% over a 15 year period.

Transient suppressors must be considered as consumable devices that could potentially degrade over time. Transient suppressors should be regularly inspected for overheating and degradation as part of an equipment maintenance schedule.