

High Performance Equipment Filters



For General Purpose and Switched Mode
Power Supply Applications



High Performance Equipment Filters

Introduction

MPE's reputation as one of Europe's leading filter specialists is based on over 65 years experience in the design, development, and production of high performance radio frequency interference filters and custom capacitors. Our commitment to a policy of continuous product development and innovation has resulted in one of the most comprehensive ranges of filter products available from a single manufacturer.

The latest filter technology has been developed and adapted to new requirements by maintaining continuous close liaison with Defence Contractors and commercial organisations both in the UK and abroad. Our unrivalled capability and experience enables us to design and build filters to suit almost any application.

In addition to the equipment filters covered by this catalogue, standard ranges of filter products manufactured by MPE cover designs with current ratings up to 2400A, voltages up to 440V, and modular precision filters for telephone, data, and control lines.

Capacitor products range from close tolerance, miniature, designs for military telecommunications equipment to very high voltage X-Ray capacitors tested to 200,000 volts.

Non-standard requirements can be fulfilled by a custom designed filter or capacitor from a very diverse range and capability also offered by MPE.

Apart from many individual vendor approvals by customers, MPE holds the following major factory accreditations:

- * NATO AQAP-1
- * BS5750 Part 1 / ISO9001 / EN29001
- * BS9000 approval
- * CECC approval
- * Member of Industrial TEMPEST Scheme



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General Purpose Filters

These ranges of equipment filters are intended for general purpose applications where high performance over a wide range of frequencies is required. Separate ranges are offered for a.c. and d.c. applications.

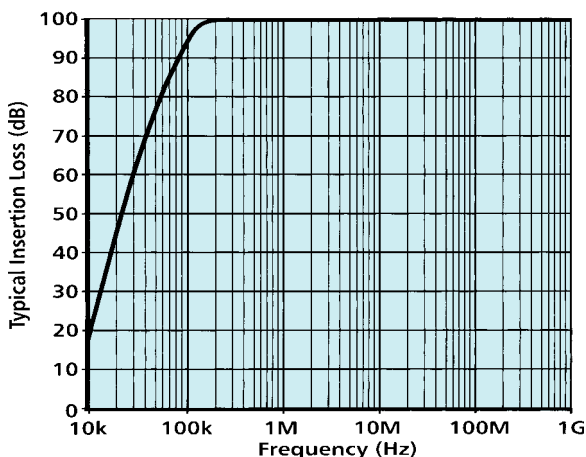
High performance is achieved through the use of MPE's proprietary feedthrough capacitors and bulkhead mounting design, which enable good filtering performance to be achieved to 1GHz and beyond. The feedthrough capacitors will also provide greater immunity of the equipment to high frequency transients than is usually provided by general purpose filters.

Most general purpose equipment filters do not use feedthrough capacitors and are not designed for bulkhead mounting, which limits their useful performance above about 1MHz. Above this frequency, the performance will drop off rapidly due

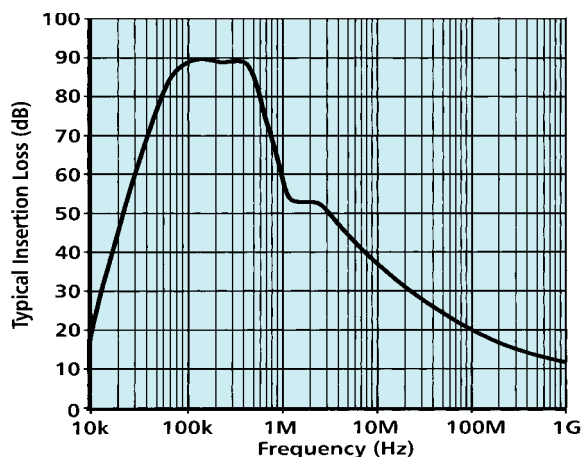
to the capacitors going into self resonance. This can be a severe disadvantage as the European EMC directive will require equipment to be fully suppressed to at least 30MHz and filters not using feedthrough capacitors may not offer sufficient performance. Some existing specifications already require suppression up to 1GHz and this is likely to be the increasing trend.

The graphs below show the measured performance of two typical d.c. filter circuits. The circuits are identical apart from the fact that one uses feedthrough capacitors, so is representative of filters in this catalogue, and the other uses two-terminal capacitors of the same value, so is representative of many other general purpose filters.

The graphs clearly show the dramatic difference in performance offered by the two circuits above 1MHz.



Performance of MPE filter with feedthrough capacitors



Performance of similar filter not using feedthrough capacitors

Summary of Features of MPE General Purpose Filters

- * Excellent high frequency performance
- * Improves equipment immunity
- * Symmetric and asymmetric filtering modes
- * Full performance with/without load
- * High reliability design
- * Tested to BS613 proof voltages for safety
- * Mains versions conform to BS613 capacitance limitations for use on portable equipment

High Performance Equipment Filters

General Purpose - DC



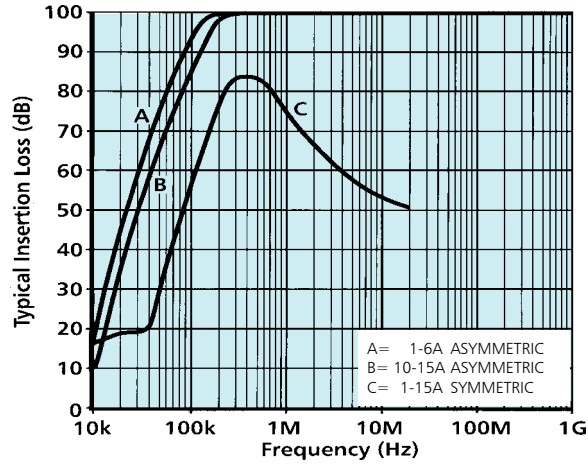
General Specification

Rated Voltage	: 100V d.c.
Test Voltage	: 200V d.c.
Rated Current	: As tabulated below
Insertion Loss	: See graph opposite
Maximum Temperature Rise on Full Load	: 25°C
Operating Temperature Range	: -25°C to + 55°C
Maximum Full Load Heat Dissipation	: As tabulated below
Maximum Volt Drop per line at Full Load d.c. Current	: 250mV
Discharge Time to below 34V	: 2s maximum

Range Available

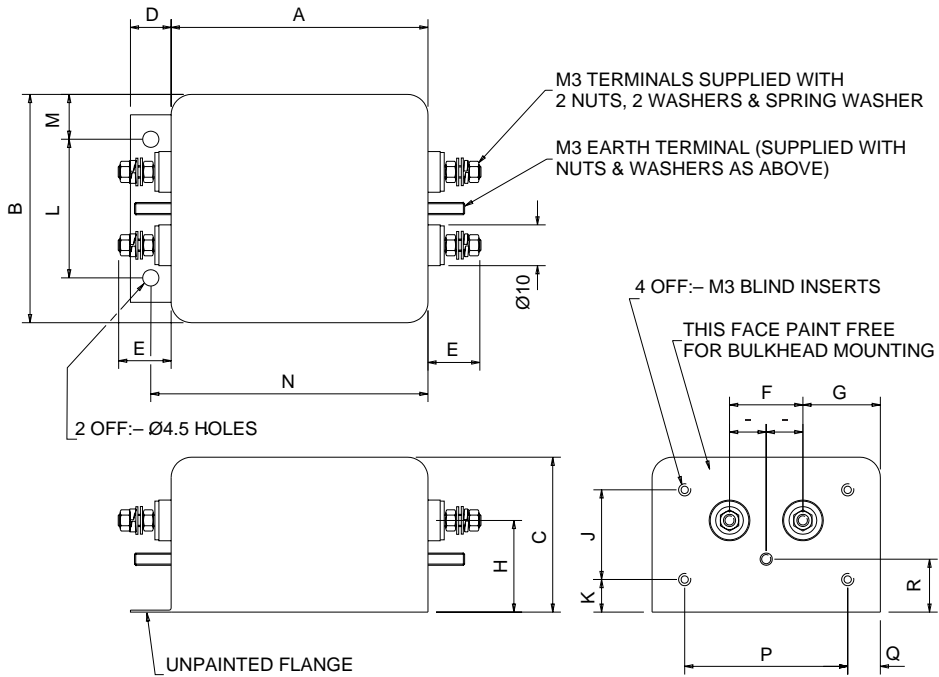
Current Rating (A)	MPE Part Number	Maximum Heat Dissipation (W)	Major Dimensions (mm)			Weight (g)
			Length A	Width B	Depth C	
1	DS26780	0.15	51	51	32	170
3	DS26781	1.5	51	51	32	170
6	DS26782	3.5	64	56	38	260
10	DS26783	2.0	88	60	38	440
15	DS26784	4,5	88	60	38	440

Performance Graph



Insertion Loss in 50 ohm system
with or without load

Dimensions



MPE Part Number	Dimensions (mm)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
DS26780	51	51	32	-	13	16	17.5	21.5	18	7	-	-	-	37	7	10.5
DS26781	51	51	32	-	13	16	17.5	21.5	18	7	-	-	-	37	7	10.5
DS26782	64	56	38	-	13	18	19	25	22	7	-	-	-	40	8	12.5
DS26783	88	60	38	11	13	20	20	25	20	9	35	12.5	94	44	8	12.5
DS26784	88	60	38	11	13	20	20	25	20	9	35	12.5	94	44	8	12.5

High Performance Equipment Filters

General Purpose - AC



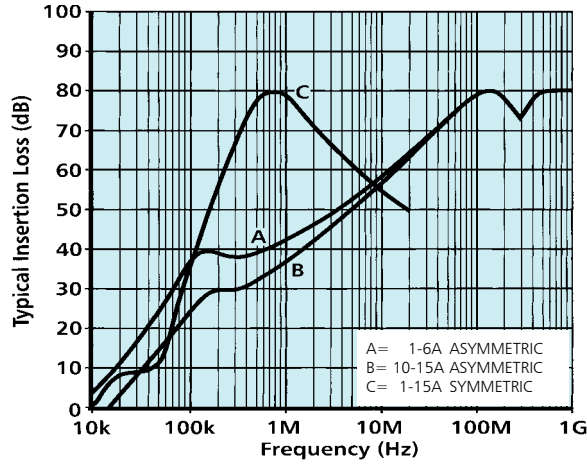
General Specification

Rated Voltage	: 250V a.c. 50/60Hz
Test Voltage (line - earth)	: 2250V d.c.
(line - line)	: 1250V d.c.
Rated Current	: As tabulated below
Insertion Loss	: See graph opposite
Maximum Temperature Rise on Full Load	: 25°C
Operating Temperature Range	: -25°C to + 55°C
Maximum Full Load Heat Dissipation	: As tabulated below
Maximum Volt Drop per line at Full Load d.c. Current	: 250mV
Discharge Time to below 34V	: 2s maximum
Maximum Leakage Current (at 50Hz)	: 0.4mA

Range Available

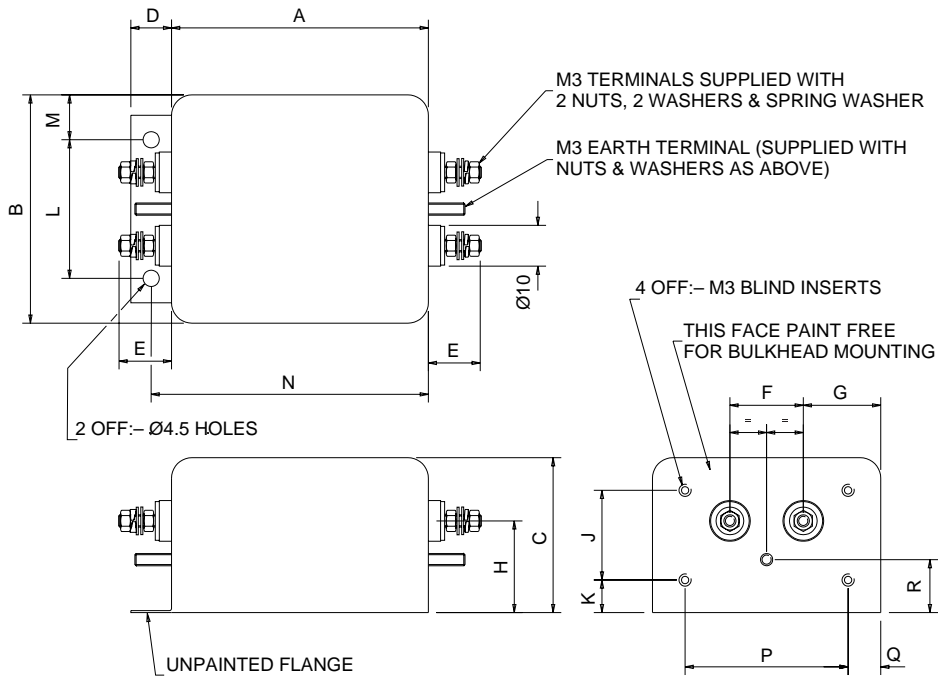
Current Rating (A)	MPE Part Number	Maximum Heat Dissipation (W)	Major Dimensions (mm)			Weight (g)
			Length A	Width B	Depth C	
1	DS26770	0.15	51	51	32	170
3	DS26771	1.5	51	51	32	170
6	DS26772	3.5	64	56	38	260
10	DS26773	2.0	88	60	38	440
15	DS26774	4.5	88	60	38	440

Performance Graph



Insertion Loss in 50 ohm system
with or without load

Dimensions



MPE Part Number	Dimensions (mm)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
DS26770	51	51	32	-	13	16	17.5	21.5	18	7	-	-	-	37	7	10.5
DS26771	51	51	32	-	13	16	17.5	21.5	18	7	-	-	-	37	7	10.5
DS26772	64	56	38	-	13	18	19	25	22	7	-	-	-	40	8	12.5
DS26773	88	60	38	11	13	20	20	25	20	9	35	12.5	94	44	8	12.5
DS26774	88	60	38	11	13	20	20	25	20	9	35	12.5	94	44	8	12.5

Mains Input Filters for Switched Mode Power Supplies

Why have Special Filters for Switched Mode Power Supplies?

When considering published performance figures for filters, the insertion loss will invariably be quoted in a 50 ohm system. This is because, historically, 50 ohms was considered to be representative of most practical situations, and measurement specifications were written around this impedance.

In practice, many systems have an impedance different from 50 ohms. Switched mode power supplies are a common application requiring filtering where the impedance is not 50 ohms. In fact, a switched mode power supply (SMPS) will usually present a very low impedance to the filter.

For such applications, a filter performance measured in a 50 ohm system can be very misleading as it is unlikely to represent the attenuation which will be achieved when the filter is connected in circuit.

Many simple general purpose filter designs, although offering reasonable performance in a 50 ohm system, will offer little or no insertion loss when presented with a low impedance interference source such as a SMPS. A more specialised filter circuit therefore needs to be considered.

The problem arises due to the operating principles of the SMPS. The SMPS circuit will normally operate at a switching frequency of between 20kHz and 200kHz. This will generate unwanted RFI at the switching frequency and its numerous harmonics often up to several hundred MHz.

RFI noise is generated by the SMPS both in the asymmetric mode (each line to earth) and symmetric mode (live to neutral), the symmetric mode noise being predominant at the lower frequencies, up to a few hundred kHz, and the asymmetric mode noise being predominant at higher frequencies above about 1MHz.

Because the switching operation of the SMPS applies almost a short circuit across the line, the source impedance of the RFI generated by the SMPS is very low, typically 0.1 ohm, and this is the impedance presented to the filter. The other end of the filter will be facing the mains supply which is likely to have an impedance in the order of 50 - 100 ohms over the range of frequencies of interest.

In order to obtain good filter performance, it is necessary to achieve as great as possible an impedance mismatch between each end of the filter and the system in which it operates.

Part of the solution is to use a filter which has been specifically designed to operate in the practical system impedance. Such a filter design will have an inductive input to face the low impedance of the SMPS and a capacitive output to face the higher impedance of the mains supply.

A second requirement for a filter designed specially for use with switched mode power supplies is good symmetric mode performance which must, of course, be provided in the special impedance system.

Finally, if the noise generated by the SMPS extends into frequencies beyond a few MHz, then the two-terminal capacitors normally used in most types of general purpose filter may not be adequate as they will go into resonance and lose performance above a few MHz. For EMC specifications which specify noise levels up to 30MHz, this can be a problem, especially if the SMPS is particularly noisy.

A filter design incorporating feedthrough capacitors then needs to be used. This is even more important if the specification requirement extends beyond 30MHz which is the increasing tendency. The filters should be bulkhead mounted to ensure maximum filter performance is obtained.

MPE Filters for Switched Mode Power Supplies

Based on experience gained from testing and providing filtering solutions for numerous types of switched mode power supplies over a number of years, MPE has developed a range of mains input filters specifically for switched mode power supplies.

These filters feature all of the benefits of the general purpose filters described on previous pages but also incorporate the circuitry required to provide effective suppression under the special impedance conditions presented by the switched mode power supply for both modes of interference.

The standard range of filters detailed on the following pages has a mains input rating of 240V 50/60Hz with current ratings of 1, 3, 6, 10, and 15 amps.

Insertion loss performance is quoted both in the usual 50 ohm system and also in a 0.1/100 ohm system to provide a more realistic indication of the likely performance which will be achieved with the filter connected in circuit. The 0.1/100 ohm test is derived from BS 6299 / CISPR 17 as a worst case test method for power line filters, but is equally appropriate for SMPS filters.

High quality feedthrough capacitors are used in the filters which are designed for bulkhead mounting to permit high filtering performance to be achieved up to frequencies of 1GHz and beyond.

The filters will also provide improved immunity of the switched mode power supply against mains borne interference, and comply with BS613 capacitance limitations for use on portable equipment.

The bulkhead mounting design of the filters facilitates interfacing with shielding of the switched mode power supply to help prevent radiated interference.

These filters are also suitable for other applications which may have a low source or load impedance. To offer the best performance, the filters should be connected so that their inductive end faces the lower impedance. (N.B. The inductive end of the filter is marked "To SMPS")

It should be remembered that these filters have been designed to operate with a low source impedance. They will offer the performance quoted where the practical impedance is the same as the measurement system impedance.

Because no two SMPS circuits will have the same characteristics in terms of impedance and noise emissions, any filter must be expected to perform differently in different applications. Some applications may therefore require custom designed filter solutions to provide full specification compliance - see page 12 for more details.

MPE also design and manufacture other components suitable for use with switched mode power supplies. These include general purpose capacitors and suppression components, output filters, and high performance, low ESR capacitors.

Summary of Features of MPE Filters for Switched Mode Power Supplies

- * Prevents SMPS generated noise from contaminating mains supply
- * Excellent performance under SMPS low impedance conditions
- * Improves immunity of SMPS against mains-borne interference
- * Excellent high frequency performance
- * Symmetric and asymmetric filtering modes
- * Application tested design
- * Meets BS613 requirements for proof voltage and capacitance limitation

Mains Input Filters for Switched Mode Power Supplies



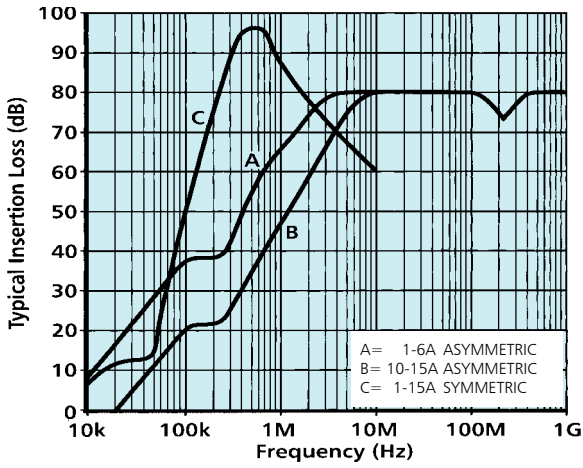
General Specification

Rated Voltage	: 250V a.c. 50/60Hz
Test Voltage (line - earth) (line - line)	: 2250V d.c. : 1250V d.c.
Rated Current	: As tabulated below
Insertion Loss	: See graphs opposite
Maximum Temperature Rise on Full Load	: 25°C
Operating Temperature Range	: -25°C to + 55°C
Maximum Full Load Heat Dissipation	: As tabulated below
Maximum Volt Drop per line at Full Load d.c. Current	: 300mV
Discharge Time to below 34V	: 2s maximum
Maximum Leakage Current (at 50Hz)	: 0.4mA

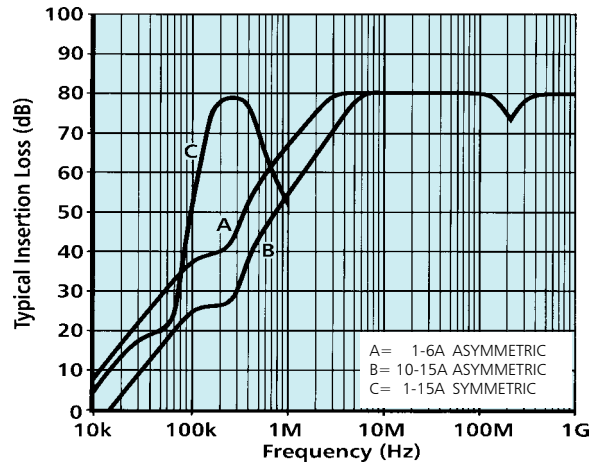
Range Available

Current Rating (A)	MPE Part Number	Maximum Heat Dissipation (W)	Major Dimensions (mm)			Weight (g)
			Length A	Width B	Depth C	
1	DS26760	0.3	64	56	38	275
3	DS26761	2.5	64	56	38	275
6	DS26762	3.5	88	60	38	455
10	DS26763	3.0	112	76	38	750
15	DS26764	6.5	112	76	38	750

Performance Graphs

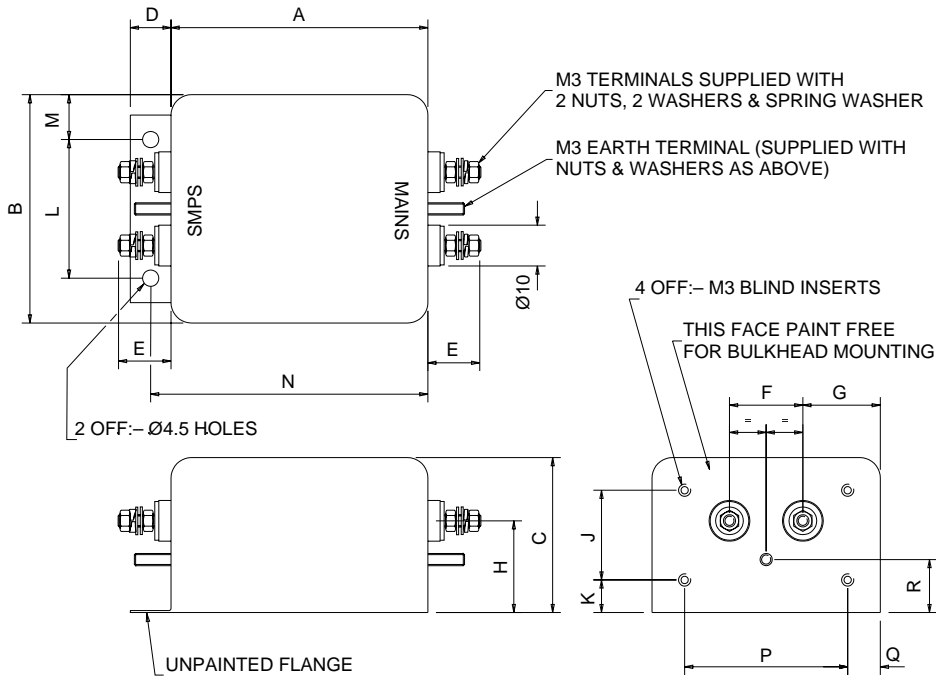


Insertion Loss in 50 ohm system
with or without load



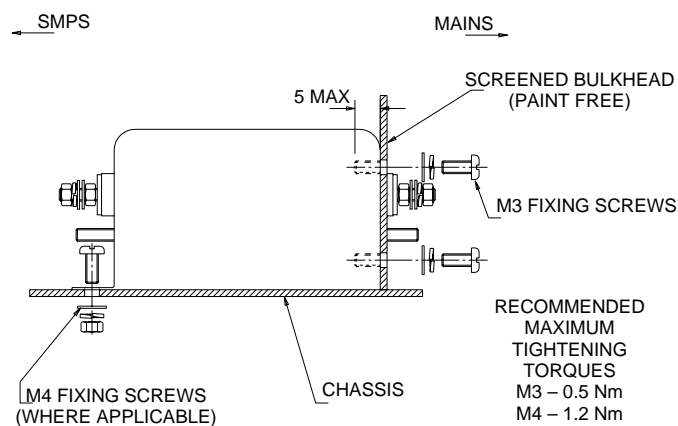
Insertion Loss in 0.1/100 ohm system
with or without load
(0.1 ohm at SMPS end)

Dimensions



MPE Part Number	Dimensions (mm)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
DS26760	64	56	38	-	13	18	19	25	22	7	-	-	-	40	8	12.5
DS26761	64	56	38	-	13	18	19	25	22	7	-	-	-	40	8	12.5
DS26762	88	60	38	11	13	20	20	25	20	9	35	12.5	94	44	8	12.5
DS26763	112	76	38	11	13	25	25.5	25	17	9	51	12.5	118	56	10	12.5
DS26764	112	76	38	11	13	25	25.5	25	17	9	51	12.5	118	56	10	12.5

Installation Details



Typical installation details are shown above.

These filters should ideally be mounted through a conductive metal bulkhead (unpainted but electroplated to prevent corrosion, if applicable). They should be fixed using 4 M3 screws of an appropriate length to suit the bulkhead thickness. This method of mounting will provide optimum high frequency filter performance. Larger filters are also provided with a mounting flange at the other end of the filter which should be secured with M4 screws. It is important that a good low impedance earth connection is obtained between the end of the filter and the bulkhead.

If bulkhead mounting is not used, the filter may be mounted using suitable brackets from the filter inserts, again ensuring that a good earth connection is made to the filter either via the mounting bracket or via the earth stud connection. Without bulkhead mounting, to maintain the high frequency performance of the filter, it is important to minimise by-pass coupling of the filter by using screened leads and by careful consideration of cable routing.

Safety

All high performance filters contain capacitors which will store charge even after the power has been removed from the filter. All filters listed in this catalogue are fitted with internal discharge resistor networks. These are intended to discharge the capacitors to a safe level within two seconds of

Bulkhead mounting is recommended to ensure the best high frequency performance is obtained.

The quoted torque figures should be observed for the mounting inserts and the filter terminals. When making connections to the filter terminals, two spanners should be used to avoid applying excessive torque to the filter terminal studs.

In the case of SMPS filters, the end marked "To SMPS" is the inductive end of the filter and should face the SMPS or low impedance. The other end (bulkhead mounting end) should face the higher impedance, (normally the mains). General purpose filters may be connected either way round.

It must always be ensured that a good low impedance earth connection is made to the filter

Terminals should be enclosed by the user, if required, for safety.

switching off the power. As an added precaution, after removing the power, filter terminals should always be shorted to earth (filter case) and to each other, before touching.

A good low impedance earth connection must be made to the filter.

Custom Design Service



Because every application is different, standard products can never be ideal for every application.

By utilising standard enclosures, terminals and components, we can offer a very cost-effective custom design service. This may involve a tailored electrical circuit and/or mechanical package to provide an optimum solution to a specific filtering problem.

If it is possible to provide details of source and load impedance, mode of interference, problem frequency range, equipment noise, specification requirement, and details of equipment circuitry, we can advise the most suitable filter design.

We can employ computer simulation and circuit analysis techniques to accurately predict the actual performance a given filter will provide in specific practical circuits.

We also have a screened room test facility where we can measure the conducted noise emitted by equipment and can rapidly provide a suppression solution by a combination of computer modelling and practical testing with breadboard filters.

Because we design and manufacture all of our own capacitors and inductors, we can easily accommodate requirements for special component values or alternative packaging details.

MPE also offer a custom design service for other SMPS components including output filters and low ESR capacitors.

For free impartial technical advice, please call our technical helpline number below:

MPE TECHNICAL HELPLINE +44(0) 151 632 9199

STANDARD TERMS AND CONDITIONS

Except where the buyer is dealing as a consumer (as defined in section 12 of the Unfair Contract Terms Act 1977) all other warranties, conditions or terms relating to the quality and/or fitness for purpose, merchantability or condition of the goods and/or supply of the services and whether implied by statute or common law or made expressly whether by us or our servants or agents or otherwise are excluded to the fullest extent permitted by law.

Except in relation to death or personal injury caused by our negligence, we shall not be liable by reason of any representation or any implied warranty, condition or other term, or any duty at common law, or under any express terms, for any indirect or consequential loss or damage (including loss of profits), costs, expenses or other claims for consequential loss whatsoever (and whether caused by the negligence by us, our employees or agents or otherwise) which arise out of or in connection with the supply of the goods and/or services or the use or resale of the goods by the buyer or arising from any breach or failure, direct or indirect, on the buyer's part under the terms of the contract.