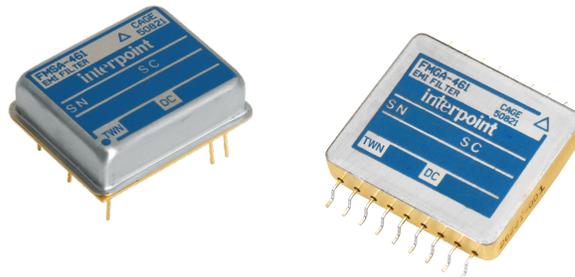


FMSA and FMGA EMI Input Filters

0 TO 50 VOLT INPUT - 0.8 AMP

FEATURES

- Attenuation
50 dB (FMSA-461) at 500 kHz
55 dB (FMGA-461) at 500 kHz
- Small footprint
FMSA-461 0.79 in² (5.1 cm²)
FMGA-461 0.89 in² (5.7 cm²)
- Operating temperature -55° to +125°C
- Nominal 28 volts input, 0 to 50 volts operation
- Up to 0.8 amps throughput current
- Compliant to MIL-STD-461C CE-03
- Compatible with MIL-STD-704 A-E 28 volt power bus



MODELS	
THROUGHPUT CURRENT (A)	
FMSA-461	0.8
FMGA-461	0.8

DESCRIPTION

[FMSA-461 PAGE 1 AND FMGA-461 PAGE 2]

FMSA-461 SERIES™ EMI FILTER

The Interpoint® FMSA-461 EMI filter modules have been designed as a companion for Interpoint MSA Series™ flyback DC-DC converters. Multiple MSA power converters can be operated from a single filter provided the total power line current does not exceed the maximum current rating of the filter. The FMSA-461 filter will reduce the MSA's power line reflected ripple current to within the limit of MIL-STD-461C, Method CE03, as shown in the example of Figure 7 on page 9.

The FMSA-461 is fabricated using thick film hybrid technology and is sealed in a metal package for military, aerospace and other applications requiring EMI suppression. See case A1, Figure 14 on page 11 for dimensions. The filter uses only ceramic capacitors for reliable high temperature operation.

OPERATION

The MSA power converter has an internal 2 µF capacitor across its input power terminals. See Figure 1 on page 3. When the MSA and FMSA-461 filters are used together, this capacitor becomes part of the filter and forms its final LC output section. When 2 or 3 MSAs are used with a single filter, this capacitor becomes 4 µF or 6 µF respectively, rather than 2 µF, improving the rejection vs. frequency.

The FMSA-461 filter can also be used with other types of Interpoint power converters (MHF Series™, MHF+ Series™ and MHE Series™) to comply with CE03. For MHF, MHF+ and MHE models, the converter has an LC type line filter such that an inductor is seen looking into its positive input terminal. For these converters, it is necessary to terminate the filter with a capacitor to insure unconditionally stable operation. A capacitor across the filter output terminals of greater than 4 µF or the optional damping circuit shown on the connection diagram will be adequate for stable operation. No capacitor is required for the MSA Series models.

OPTIONAL DAMPING CIRCUIT

The optional damping circuit (Figure 3 on page 4) can be used to prevent filter overshoot caused by MIL-STD-704A 80 volt, or other, transients having rise times of less than 200 microseconds. This damping can be alternately provided with a 1.50 Ω resistor in series with the filter's positive input where the additional line loss can be tolerated. For transients with rise times of greater than 200 microseconds, there is no overshoot and the damping circuit is not required.

LAYOUT REQUIREMENTS

The case of the filter must be connected to the case of the converter through a low impedance connection to minimize EMI.

FMSA and FMGA EMI Input Filters

0 TO 50 VOLT INPUT - 0.8 AMP

FMGA-461 SERIES™ EMI FILTER

The Interpoint surface mount FMGA-461 EMI filter has been designed to work with Interpoint surface mount MGA Series™ and MGH Series™ DC-DC converters. Multiple MGA or MGH converters can be operated from a single FMGA-461 filter provided the total power line current does not exceed the filter's maximum current rating. The FMGA-461 filter will reduce the converter's power line reflected ripple current to within the limit of MIL-STD-461C, Method CE03 as shown in Figure 9 through Figure 13 on page 10. The filter uses only ceramic capacitors for reliable high-temperature operation.

CONNECTION AND OPERATION

Where more than one pin has the same designation (e.g. pins 7, 8, and 9 are Positive Output), all of those pins must be connected for output performance to meet the specifications.

The MGA Series has an internal 2 μF capacitor on its input terminals and the MGH Series has an internal 0.47 μF capacitor across its input power terminals. See Figure 3 on page 4. When the MGA or MGH converters are used with the FMGA-461 filter, this capacitor becomes part of the filter and forms its final LC output section. When 2 or 3 MGA or MGH converters are used with a single filter, this capacitor becomes larger, improving the rejection versus frequency.

OPTIONAL DAMPING CIRCUIT

The optional damping circuit shown in Figure 3 on page 4 will prevent filter overshoot caused by 80 volt transients with rise times of less than 200 microseconds. The damping circuit can be used with a 1.50 Ω resistor in series with the filter's positive input where the additional line loss can be tolerated. For transients with rise times of greater than 200 microseconds, there is no overshoot and the damping circuit is not required.

SURFACE MOUNT PACKAGE

The FMGA-461 EMI filter can be surface mounted with pick-and-place equipment or manually. It is recommended that the case be attached with flexible epoxy adhesive or silicone which is thermally conductive (>1 watt /meter/ $^{\circ}\text{K}$).

Internal components are soldered with SN96 (melting temperature 221 $^{\circ}\text{C}$) to prevent damage during reflow. Maximum reflow temperature for surface mounting the FMGA-461 filter is 220 $^{\circ}\text{C}$ for a maximum of 30 seconds. SN60, 62, or 63 are the recommended types of solder. Hand soldering should not exceed 300 $^{\circ}\text{C}$ for 10 seconds per pin.

The hermetically sealed metal cases are available in two different lead configurations. For case dimensions and options, see Case B, Figure 15 on page 12 and the solder pad layout of Figure 16 on page 12.

LAYOUT REQUIREMENTS

The case of the filter must be connected to the case of the converter through a low impedance connection to minimize EMI.

FMSA and FMGA EMI Input Filters

0 TO 50 VOLT INPUT - 0.8 AMP

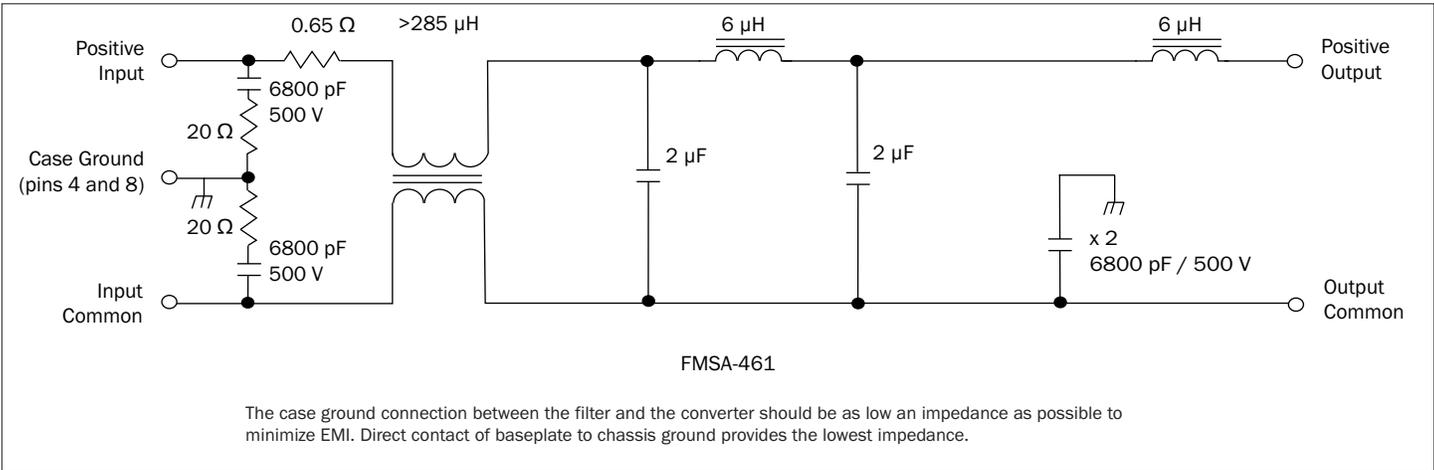


FIGURE 1: FMSA-461 SCHEMATIC – TYPICAL VALUES

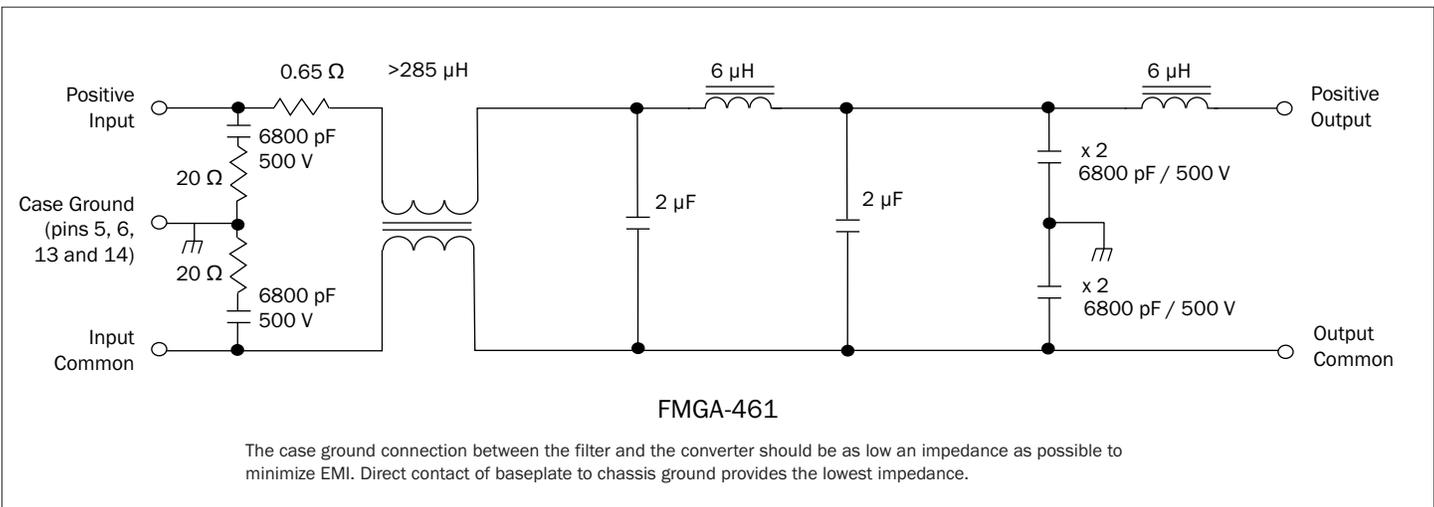


FIGURE 2: FMGA-461 SCHEMATIC – TYPICAL VALUES

FMSA and FMGA EMI Input Filters

0 TO 50 VOLT INPUT - 0.8 AMP

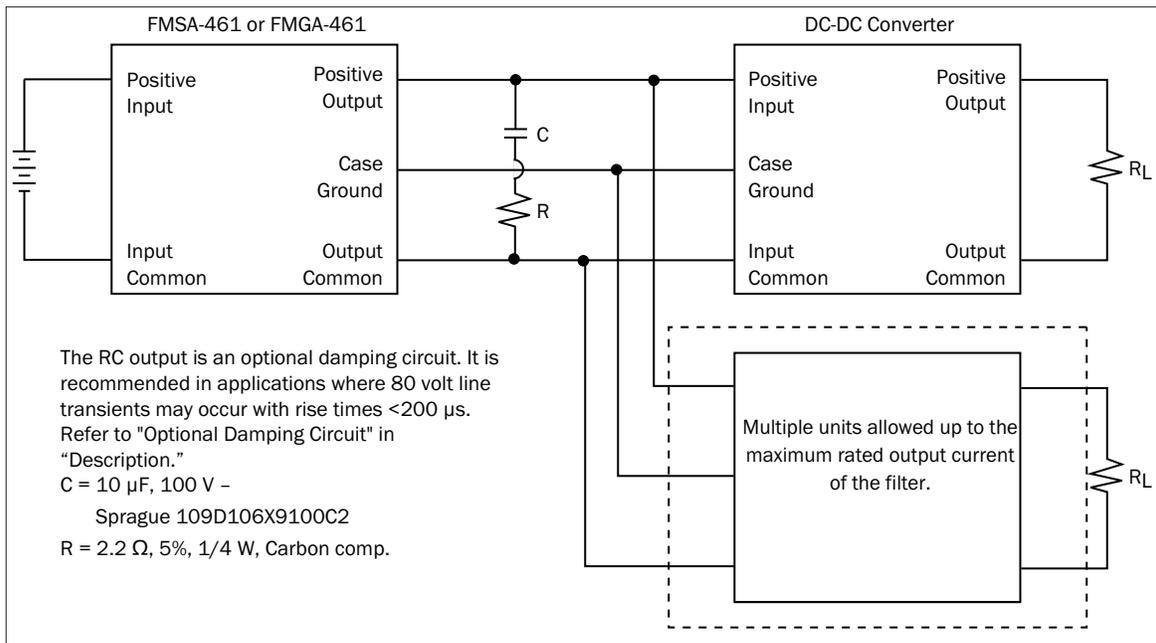


FIGURE 3: FMSA-461 AND FMGA-461 DAMPING CIRCUIT

FMSA and FMGA EMI Input Filters

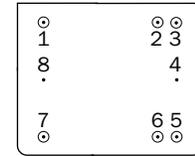
0 TO 50 VOLT INPUT - 0.8 AMP

PIN OUT FMSA-461	
Pin	Designation
1	Positive Input
2, 3	Positive Output
4	Case Ground ¹
5, 6	Output Common
7	Input Common
8	Case Ground ¹

1. Case ground pins need to be connected to the case ground of the downstream DC-DC converter in order to realize Common mode filtering.

TABLE 1: FMSA-461 PIN OUT

Squared corner and dot on top of cover indicate pin one.



Bottom View FMSA-461

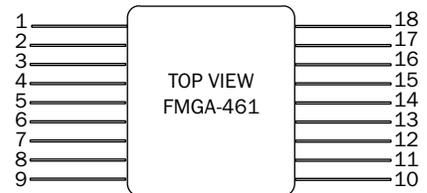
For dimensions, see case A1, Figure 14 on page 11.

FIGURE 4: FMSA-461 PIN OUT

PIN OUT FMGA-461	
Pin	Designation
1, 2	Positive Input
3, 4	No connection
5, 6	Case Ground ¹
7, 8, 9	Positive Output
10, 11, 12	Output common
13, 14	Case Ground ¹
15, 16	No connection
17, 18	Input Common

1. Case ground pins need to be connected to the case ground of the downstream DC-DC converter in order to realize Common mode filtering.

TABLE 2: FMGA PIN OUT



Differently colored glass bead around pin one or dimple in header (bottom or side of case) indicates pin one. Cover marking is oriented with pin one at the upper right corner.

For dimensions and the gull-wing lead option, see case B Figure 15 on page 12. For solder pad layout, see case B, Figure 16 on page 12

FIGURE 5: FMGA-461 PIN OUT

PINS NOT IN USE FMGA	
No connection (3, 4, 15, 16)	Connect pins to case for optimum filtering.

TABLE 3: FMGA PINS NOT IN USE

FMSA and FMGA EMI Input Filters

0 TO 50 VOLT INPUT - 0.8 AMP

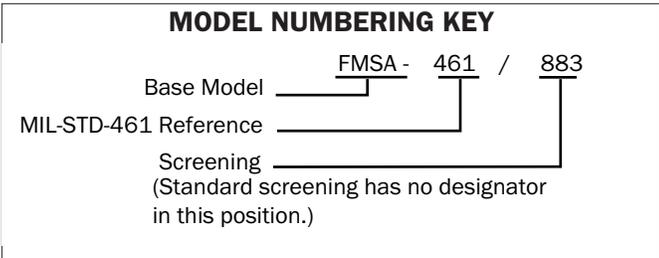


TABLE 4: MODEL NUMBERING KEY

DLA DRAWING NUMBERS	
DLA DRAWING (5915)	FMSA-461 SIMILAR PART
96003-01HXX	FMSA-461/883
For exact specifications for a DLA Drawing product, refer to the DLA Drawing. DLA Drawings can be downloaded from: https://landandmaritimeapps.dla.mil/programs/smcr	

TABLE 5: DLA DRAWING NUMBER CROSS REFERENCE

MODEL NUMBER OPTIONS		
TO DETERMINE THE MODEL NUMBER ENTER ONE OPTION FROM EACH CATEGORY IN THE FORM BELOW.		
CATEGORY	Base Model	Screening ¹
OPTIONS	FMSA-461	(standard, leave blank) ES 883
FILL IN FOR MODEL # ²	FMSA-461	/ _____
Notes 1. Screening: For standard screening leave the screening option blank. For other screening options, insert the desired screening level. For more information see Table 13 on page 13 and Table 14 on page 14. 2. If ordering by model number add suffix "-Q" to request solder dipped leads (FMSA-461/883-Q).		

TABLE 6: MODEL NUMBER OPTIONS

FMSA and FMGA EMI Input Filters

0 TO 50 VOLT INPUT - 0.8 AMP

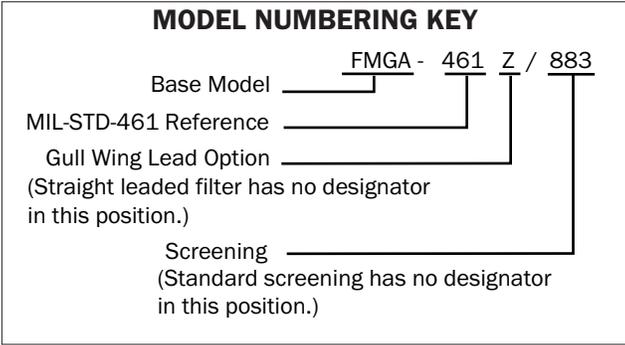


TABLE 7: MODEL NUMBERING KEY

DLA DRAWING NUMBERS	
DLA DRAWING (5915)	FMGA-461 SIMILAR PART
96003-01HYX	FMGA-461/883
96003-01HZA	FMGA-461Z/883
For exact specifications for a DLA Drawing product, refer to the DLA Drawing. DLA Drawings can be downloaded from: https://landandmaritimeapps.dla.mil/programs/smcr	

TABLE 8: DLA DRAWING NUMBER CROSS REFERENCE

MODEL NUMBER OPTIONS			
TO DETERMINE THE MODEL NUMBER ENTER ONE OPTION FROM EACH CATEGORY IN THE FORM BELOW.			
CATEGORY	Base Model	Surface Mountable Lead Configuration ¹	Screening ²
OPTIONS	FMGA-461	(standard "flat" case B, leave blank) Z (solder-dipped gull wings)	(standard, leave blank) ES 883
FILL IN FOR MODEL # ³	FMGA-461	/	/
Notes 1. Case B, standard "flat" case, does not require a case designator in the model number. Case B with solder-dipped gull wings requires "Z" in the case designator position of the model number. 2. Screening: For standard screening leave the screening option blank. For other screening options, insert the desired screening level. For more information see Table 13 on page 13 and Table 14 on page 14. 3. If ordering by model number add suffix "-Q" to request solder dipped leads (FMGA-461/883-Q).			

TABLE 9: MODEL NUMBER OPTIONS

FMSA and FMGA EMI Input Filters

0 TO 50 VOLT INPUT - 0.8 AMP

TABLE 10: OPERATING CONDITIONS, 25 °C CASE.

FMSA-461 SERIES / FMGA-461 SERIES		ALL MODELS			UNITS
PARAMETER	CONDITIONS	MIN	TYP	MAX	
LEAD SOLDERING TEMPERATURE ¹	10 seconds max.	–	–	300	°C
STORAGE TEMPERATURE ¹		-65	–	+150	°C
CASE OPERATING TEMPERATURE ^{1, 2}		-55	–	+125	°C
ISOLATION, ANY PIN TO CASE	@ 500 VDC AT 25 °C	100	–	–	Megohms

Notes

1. Guaranteed by characterization test and/or analysis. Not a production test.
2. Derate linearly from 100% at 100 °C to 0.60 amps at 125 °C. Above 125 °C derate to 0%.

TABLE 11: ELECTRICAL CHARACTERISTICS: -55 TO +125 °C CASE, UNLESS OTHERWISE SPECIFIED.

PARAMETER	CONDITIONS	FMSA-461			FMGA-461			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
INPUT VOLTAGE ¹	CONTINUOUS	0	28	50	0	28	50	V
	TRANSIENT 100 ms ¹	–	–	80	–	–	80	V
INPUT CURRENT ^{1, 2}	STEADY STATE	–	–	0.80	–	–	0.80	A
NOISE REJECTION	500 kHz	50	70	–	50	70	–	dB
	1 MHz	50	70	–	50	70	–	
COMMON MODE NOISE REJECTION ¹	2 to 50 MHz, T _C = 25 °C	40	–	–	40	–	–	
DC RESISTANCE (R _{DC})	T _C = 25 °C	–	–	1.2	–	–	1.2	Ω
CAPACITANCE	ANY PIN TO CASE T _C = 25 °C	22	–	31	36	–	45	nF
OUTPUT VOLTAGE ¹	STEADY STATE	$V_{OUT} = V_{IN} - I_{IN}(R_{DC})$			$V_{OUT} = V_{IN} - I_{IN}(R_{DC})$			V
INTERNAL POWER DISSIPATION ¹	MAXIMUM CURRENT T _C = 25 °C	–	–	0.77	–	–	0.77	W

Notes

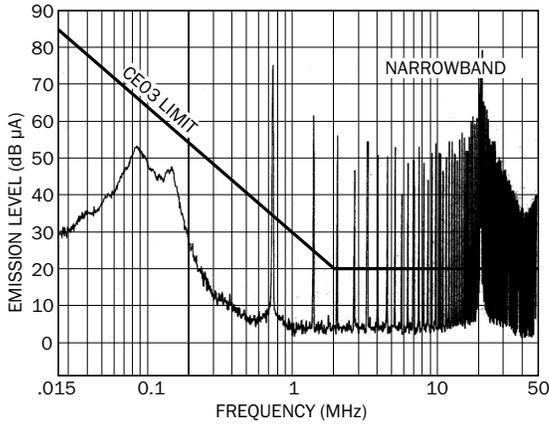
1. Guaranteed by characterization test and/or analysis. Not a production test.
2. Derate linearly from 100% at 100 °C to 0.60 amps at 125 °C. Above 125 °C derate to 0%.

FMSA and FMGA EMI Input Filters

0 TO 50 VOLT INPUT - 0.8 AMP

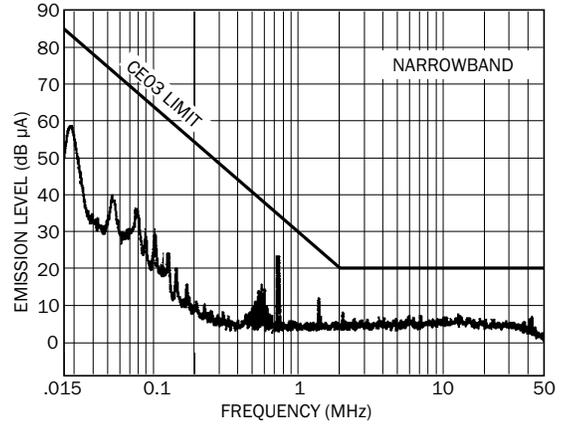
TYPICAL PERFORMANCE PLOTS: 25 °C CASE, 28 VIN, UNLESS OTHERWISE SPECIFIED.
FOR REFERENCE ONLY, NOT GUARANTEED SPECIFICATIONS.

FMSA-461 EMI FILTERS



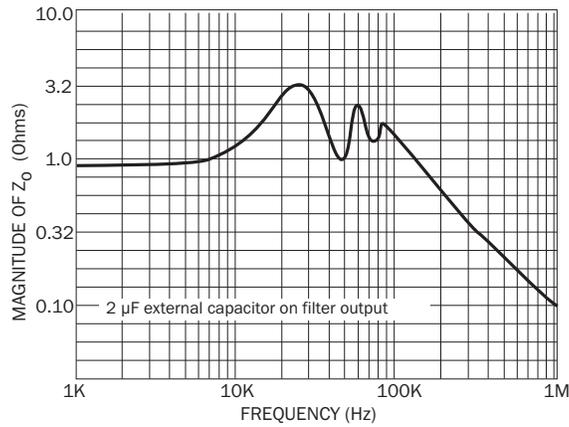
MSA2805S converter without a filter.

FIGURE 6



MSA2805S converters at full load with an FMSA-461 EMI filter

FIGURE 7



Typical output impedance (Z) with input shorted FMSA-461 EMI filter

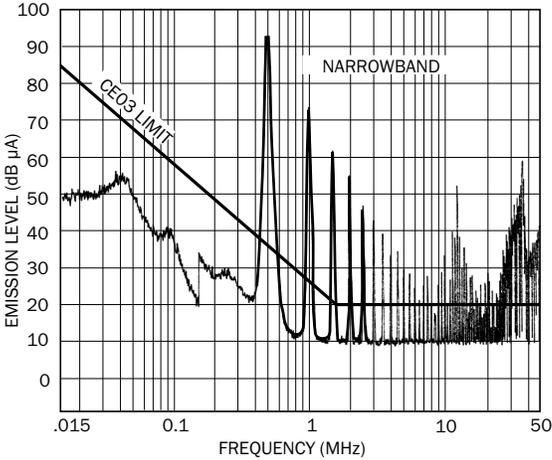
FIGURE 8

FMSA and FMGA EMI Input Filters

0 TO 50 VOLT INPUT - 0.8 AMP

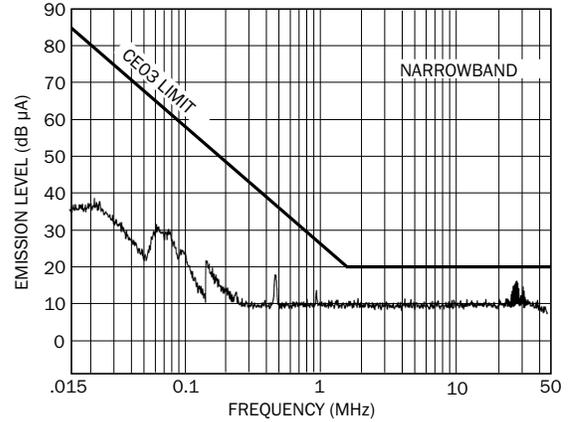
TYPICAL PERFORMANCE PLOTS: 25 °C CASE, 28 VIN, UNLESS OTHERWISE SPECIFIED.
FOR REFERENCE ONLY, NOT GUARANTEED SPECIFICATIONS.

FMGA-461 EMI FILTERS



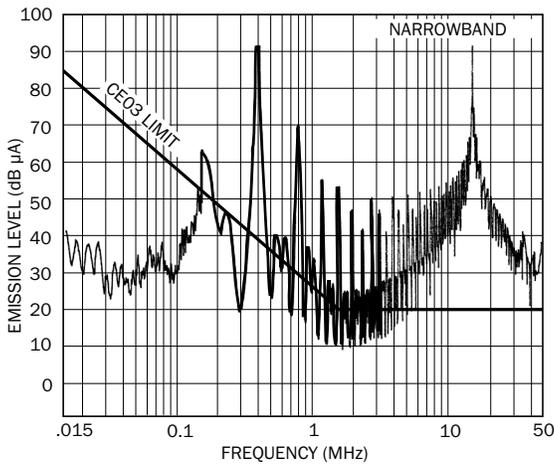
Two MGA2805S converters at full load, no filtering.
Typical power line spectral noise current.

FIGURE 9



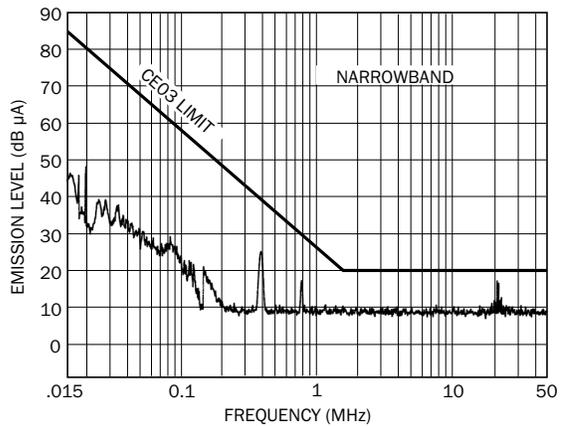
Two MGA2805S converters at full load with FMGA-461 filtering.
Typical power line spectral noise current.

FIGURE 10



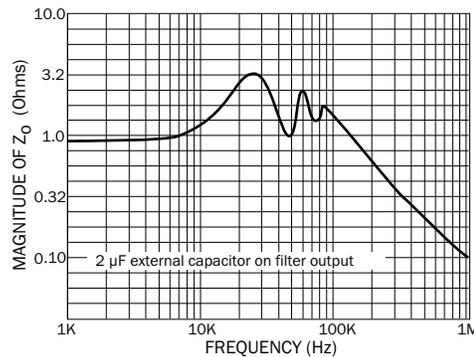
Two MGH2805S converters at full load, no filtering.
Typical power line spectral noise current.

FIGURE 11



Two MGH2805S converters at full load with FMGA-461 filtering.
Typical power line spectral noise current.

FIGURE 12



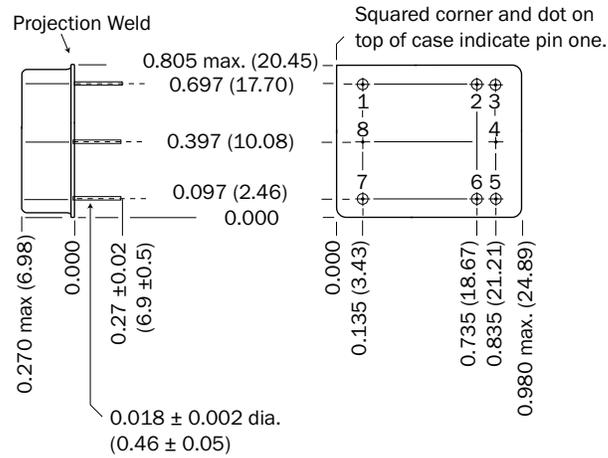
Typical Output Impedance (Z)
With Input Shorted - FMGA-461

FIGURE 13

FMSA and FMGA EMI Input Filters

0 TO 50 VOLT INPUT - 0.8 AMP

BOTTOM VIEW CASE A1 FMSA



Weight: 11.5 grams maximum

Case dimensions in inches (mm)

Tolerance ±0.005 (0.13) for three decimal places
 ±0.01 (0.3) for two decimal places
 unless otherwise specified

CAUTION

Heat from reflow or wave soldering may damage the device. Solder pins individually with heat application not exceeding 300°C for 10 seconds per pin.

Materials

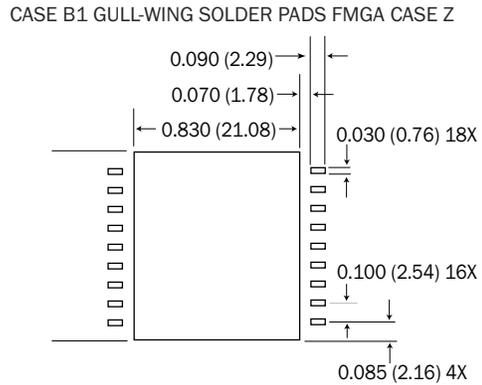
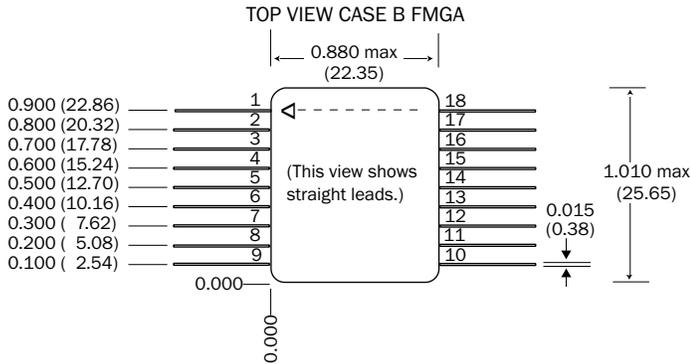
Header Kovar/Nickel/Gold
 Cover Kovar/Nickel
 Pins Kovar/Nickel/Gold matched glass seal
 Gold plating of 50 microinches minimum
 Seal hole: 0.056 ±0.002 (1.42 ±0.05)

Please refer to the numerical dimensions for accuracy.

FIGURE 14: CASE A1

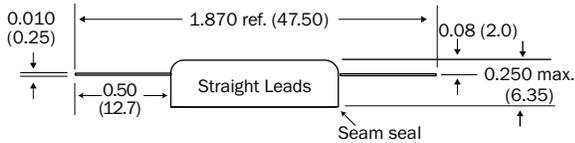
FMSA and FMGA EMI Input Filters

0 TO 50 VOLT INPUT - 0.8 AMP

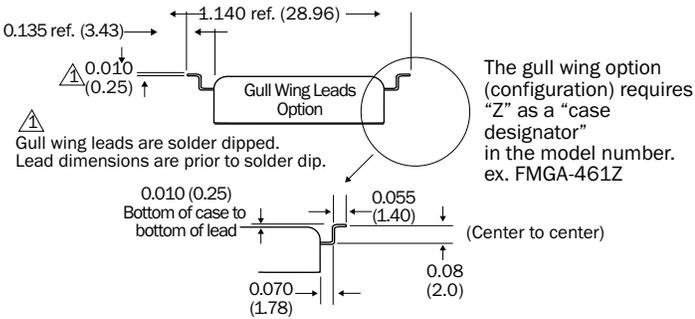


The triangle (ESD) marking on the cover indicates pin one. Cover marking is oriented with pin one at the upper right corner. The straight lead configuration does not require a "case designator" in the model number. ex. FMGA-461

Dimensions in inches (mm)
Tolerance ± 0.005 (0.13) for three decimal places ± 0.01 (0.3) for two decimal places, unless otherwise specified.
Please refer to the numerical dimensions for accuracy.



CAUTION:
Internal components are soldered with SN96 (melting temperature 221 °C) to prevent damage during reflow. Maximum reflow temperature for surface mounting the FMGA filter is 220 °C for a maximum of 30 seconds. SN60, 62, or 63 are the recommended types of solder.
Hand soldering should not exceed 300 °C for 10 seconds per pin.



- SOLDER MASK NOTES**
1. Pad dimensions are for the solder mask. Leads common to each other can be connected to each other as desired.
 2. Ground (case) pins should be connected to the center pad for improved grounding.
 3. Connect "no connection" pins to case ground to reduce EMI.
 4. Center pad should not have a solder mask.
 5. Adhesive attach is intended to be a surface for soldering the hybrid to the circuit board.
 6. Pre-tin base of converter prior to soldering.
 7. If less rotation of case is desired, reduce the width of the large case pad by 0.020 inches (0.51 mm). Pad length can be extended 0.010 inches (0.25 mm) towards the case body and an as-desired dimension away from the case body.
 8. Do not exceed 220 °C as measured on the body of the converter (top or bottom).
 9. Attach the body of the case to the board with a thermally conductive adhesive or SN60, 62, or 63 solder. The adhesive can be electrically conductive as well. It can be applied as an underfill post solder or dispensed and cured prior or during solder.
 10. In the presence of vibration, to ensure reliable mechanical attachment, the body of the case should be attached with adhesive or solder as noted above (note 7). The leads alone do not provide sufficient mechanical attachment.

Weight: 12 grams maximum

Case dimensions in inches (mm)
Tolerance ± 0.005 (0.13) for three decimal places, ± 0.01 (0.3) for two decimal places unless otherwise specified. Please refer to the numerical dimensions for accuracy.

CAUTION
Maximum reflow temperature is 220 °C for a maximum of 30 seconds. SN60, SN62, or SN63 are the recommended types of solder. See MGH gull-wing solder pad layout. Hand soldering should not exceed 300 °C for 10 seconds per pin.

Materials
Header Kovar/Nickel/Gold
Cover Kovar/Nickel
Pins Kovar/Nickel/Gold matched glass seal
Gold plating of 50 - 150 microinches is included in pin diameter
Seal hole: 0.040 \pm 0.002 (1.02 \pm 0.05)

Please refer to the numerical dimensions for accuracy.

FIGURE 15: CASE B

FIGURE 16: CASE B SOLDER PAD

FMSA and FMGA EMI Input Filters

0 TO 50 VOLT INPUT - 0.8 AMP

ELEMENT EVALUATION ¹ HIGH RELIABILITY DC-DC CONVERTERS AND EMI FILTERS /883 (CLASS H)

COMPONENT-LEVEL TEST PERFORMED	QML	
	CLASS H /883	
	M/S ²	P ³
Element Electrical	■	■
Visual	■	■
Internal Visual	■	
Final Electrical	■	■
Wire Bond Evaluation	■	■

Notes

1. Element evaluation does not apply to standard and /ES product.
2. M/S = Active components (microcircuit and semiconductor die).
3. P = Passive components, Class H element evaluation. Not applicable to standard and /ES element evaluation.

TABLE 12: ELEMENT EVALUATION

FMSA and FMGA EMI Input Filters

0 TO 50 VOLT INPUT - 0.8 AMP

ENVIRONMENTAL SCREENING HIGH RELIABILITY STANDARD, /ES AND /883 (CLASS H)

TEST PERFORMED	NON-QML ¹		CLASS H QML ²
	STANDARD	/ES	/883
Pre-cap Inspection, Method 2017, 2032	■	■	■
Temperature Cycle (10 times)			
Method 1010, Cond. C, -65 °C to +150 °C, ambient			■
Method 1010, Cond. B, -55 °C to +125 °C, ambient		■	
Constant Acceleration			
Method 2001, 3000 g			■
Method 2001, 500 g		■	
PIND, Test Method 2020, Cond. A			■ ³
Burn-in Method 1015, +125 °C case, typical ⁴			
96 hours		■	
160 hours			■
Final Electrical Test, MIL-PRF-38534, Group A,			
Subgroups 1 through 6, -55 °C, +25 °C, +125 °C case			■
Subgroups 1 and 4, +25 °C case	■	■	
Hermeticity Test, Method 1014			
Gross Leak, Cond. C ₁ , fluorocarbon		■	■
Fine Leak, Cond. A ₂ , helium		■	■
Gross Leak, Dip	■		
Final visual inspection, Method 2009	■	■	■

Test methods are referenced to MIL-STD-883 as determined by MIL-PRF-38534.

Notes

1. Non-QML products may not meet all of the requirements of MIL-PRF-38534.
2. All processes are QML qualified and performed by certified operators.
3. Not required by DLA but performed to assure product quality.
4. Burn-in temperature designed to bring the case temperature to +125 °C minimum.
Burn-in is a powered test.

TABLE 13: ENVIRONMENTAL SCREENING