FMC-461 EMI Input Filters

0 TO 50 VOLT INPUT – 2.7 AMP

NOT RECOMMENDED FOR NEW DESIGN

FEATURES

- 60 dB attenuation typical at 500 kHz
- Compliant to MIL-STD-461C CE03
- Compatible with MIL-STD-704 A-E 28 volt power bus [1]
- Fully qualified to Class H
- -55°C to +125°C operation
- Nominal 28 volt input
- 0 to 50 volts operation [1]
- 2.7 amps throughput current

MODELS	INPUT (V)	CURRENT (A)
FMC-461NT [1]	0 - 50	2.7
FMC-461 [1]	0 - 40	2.7

DESCRIPTION

The Interpoint® FMC-461 Series™ of EMI filters offers up to 2.7 amps of throughput current in a low profile package. The FMC-461 filters are manufactured in our fully certified and qualified MIL-PRF-38534 Class H production facility and packaged in hermetically sealed steel cases. They are ideal for use in programs requiring high reliability and small size. They have been specifically designed to reduce the input line reflected ripple current of Interpoint MFK, MFX, MWR, MHV and MHF+ Series of DC-DC converters including their space counterparts. The filter can be used to filter combinations of the lower power converters up to the rated current of the filter. They are intended for use in applications which have high frequency switch-mode DC-DC converters and which must meet MIL-STD-461C levels of conducted noise.

The FMC-461 filters are built using thick-film hybrid technology and are hermetically sealed in metal packages for military, aerospace, and other high-reliability applications. The filters use only ceramic capacitors for reliable high temperature operation.

The filters are offered with standard screening, “ES” screening, or fully compliant to “883” MIL-PRF-38534 Class H screening. A DLA Drawing is available, see Table 3.

MIL-STD Noise Management

When used in conjunction with Interpoint converters, the FMC-461 and FMC-461NT filters reduce input ripple current giving the filter/converter combination a performance which exceeds the CE03 test of MIL-STD-461C. CE03 performance of a typical converter with the FMC-461 filter connected is shown in Figure 6 on page 6. Typical FMC-461 filter frequency response and output impedance behavior are shown in Figure 7 and Figure 8 on page 6.

Transient Suppression - FMC-461 only

The FMC-461 [1] filter also features an optional fast-reacting (1 pico second) transient suppressor (transorb SMCG40A) which begins clamping the input voltage at approximately 47 volts, protecting the DC-DC converter from damage from induced line transients.

The FMC-461NT [1] does not have a transorb option.

Operating Temperature

The filters are rated to operate, with no degradation of performance, over the temperature range of -55°C to +125°C (as measured at the baseplate). Above +125°C, current must be derated as specified in Table 5.

Insertion Loss

Low dc resistance design results in a maximum power loss of less than 2% with typical input voltage.

Layout Requirement

The case pin, and ideally the case, should be tied to the case of the converter through a low-inductance connection.

Note 1.
a) The FMC-461 has a transorb and will not protect against transients as defined in MIL-STD-704A Figures 8 and 9, curves 1 and 2. It will begin clamping the voltage at approximately 47 volts. Operation beyond the defined specifications may damage the transorb.

b) The FMC-461NT does not have a transorb and does not clamp the input voltage. Transients of higher than 40 volts will not harm the filter but will be passed to the converter.

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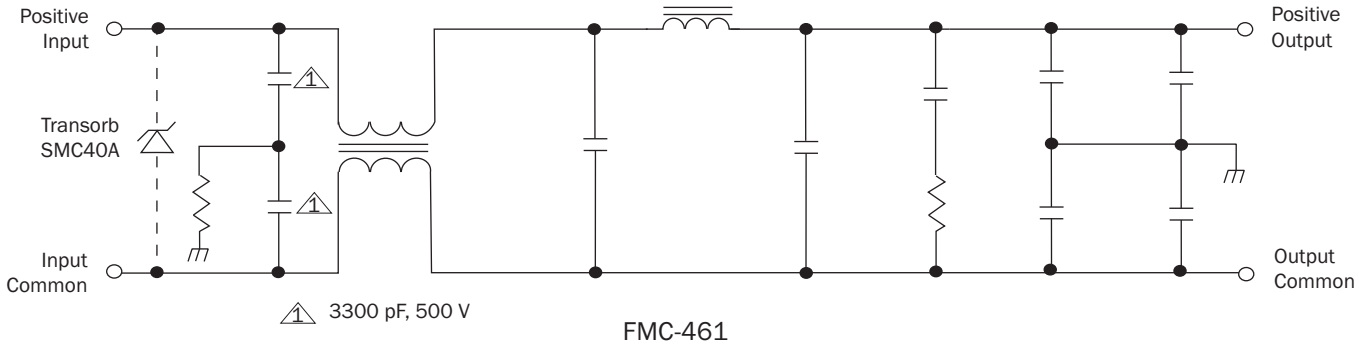

FMC-461
(Transorb is not present in FMC-461NT)

FIGURE 1: FMC-461 SCHEMATIC

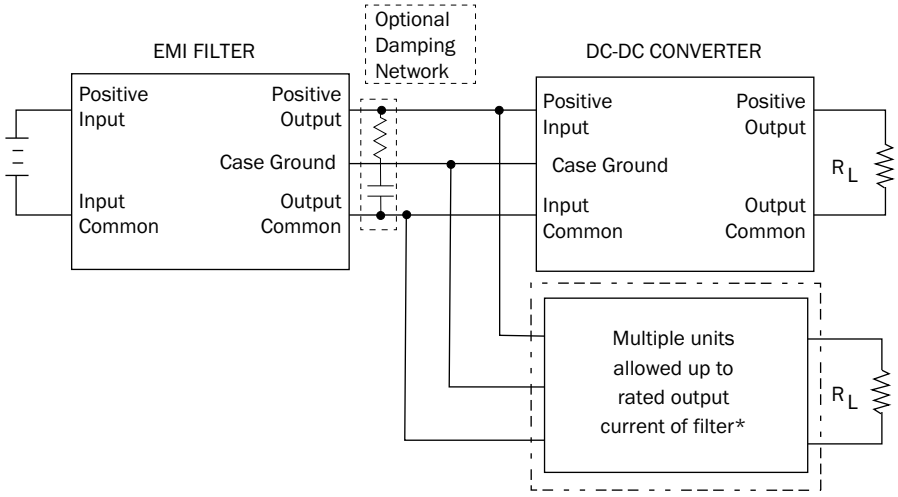

FIGURE 2: CONNECTION DIAGRAM

The case ground connection between the filter and the converter should be as low an impedance as possible to minimize EMI. Direct contact of baseplate to chassis ground provides the lowest impedance.

An external RC damping network may need to be added across the output of the FMC-461 to lower it's impedance in comparison to the impedance of the converters it will be paired with. See our EMI Conducted Interference application note or contact our Application Engineers at powerapps@craneae.com or call +1 425.882.3100.

FMC-461 EMI Input Filters

0 TO 50 VOLT INPUT – 2.7 AMP

PIN OUT	
Pin	**Single Output**
1	Positive Input
2	Positive Output
3	Case Ground
4	Output Common
5	Input Common

TABLE 1: PIN OUT

PINS NOT IN USE	
Case Ground Pin 3	Connect case ground for optimum filtering

TABLE 2: PINS NOT IN USE

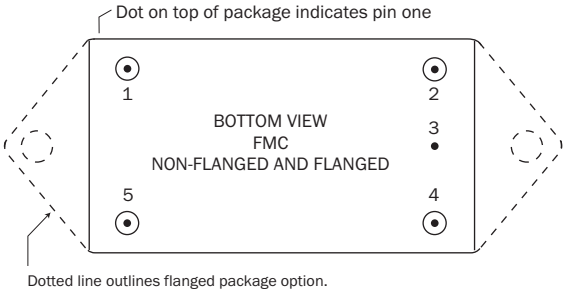

FIGURE 3: PIN OUT

See Figure 10 and Figure 11 for dimensions.

FMC-461 EMI Input Filters

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MODEL NUMBERING KEY

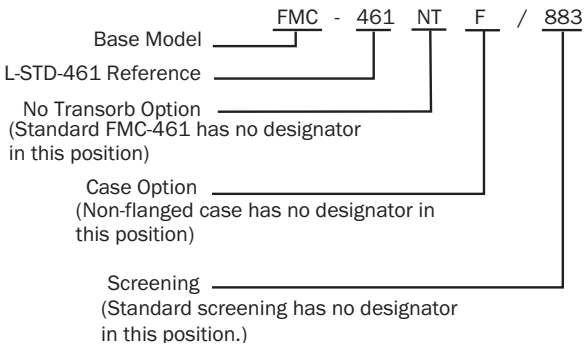

FIGURE 4: MODEL NUMBERING KEY

DLA NUMBERS	
DLA DRAWING (5915)	**FMC-461 SIMILAR PART**
94010-01HXC	FMC-461/883
94010-01HZC	FMC-461F/883
94010-02HXC [1]	FMC-461NT/883 [1]
94010-02HZC [1]	FMC-461NTF/883 [1]

1. Models with "NT" have no transorb (-02 in the DLA numbers).
For exact specifications for a DLA product, refer to the DLA drawing. DLA drawings can be downloaded from: https://landandmaritimeapps.dla.mil/programs/smcr

TABLE 3: DLA CROSS REFERENCE

MODEL NUMBER OPTIONS [1]

TO DETERMINE THE MODEL NUMBER ENTER ONE OPTION FROM EACH CATEGORY IN THE FORM BELOW.

CATEGORY	Base Model and Input Voltage	Transorb [2]	Case Option [3]	Screening [4]
OPTIONS	FMC-461	(with transorb, leave blank) NT (no transorb)	(standard, leave blank) F (Flanged)	(standard, leave blank) ES 883
FILL IN FOR MODEL # [5]	FMC-461	_____	_____	/ _____

Notes
1. See Figure 4, above, for an example of a model number.
2. The FMC-461 has a transorb for transient suppression (see page 1). The FMC-461NT does not have a transorb.
3. Case Options: For the standard case, Figure 10, leave the case option blank. For the flanged case option, Figure 11, insert the letter F in the Case Option position.
4. Screening: For standard screening leave the screening option blank. For other screening options, insert the desired screening level. For more information see Table 8.
5. If ordering by model number add a "-Q" to request solder dipped leads (FMC-461/883-Q).

TABLE 4: MODEL NUMBER OPTIONS

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TABLE 5: OPERATING CONDITIONS: 28 VIN, UNLESS OTHERWISE SPECIFIED.

MODEL		FMC-461			
PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
LEAD SOLDERING TEMPERATURE [1]	10 seconds max.	—	—	300	°C
STORAGE TEMPERATURE [1]		-65	—	+150	°C
CASE OPERATING TEMPERATURE [1]	FULL POWER	-55	—	+125	°C
	ABSOLUTE	-55	—	+135	
DERATE [2] (R_{DC}) [1]	LINEARLY	From 100% at 125°C to 0% at 135°C			
ISOLATION, [2]	500 VDC AT 25°C	100	—	—	Megohms

Notes
1. Guaranteed by characterization test and /or analysis. Not a production test.
2. Tested with all pins, except case pin, tied together. When testing isolation, discharge the pins before and after testing.

TABLE 6: ELECTRICAL CHARACTERISTICS: -55°C TO +125°C CASE, 28 VIN, UNLESS OTHERWISE SPECIFIED.

MODEL		FMC-461			FMC-461NT			
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	UNITS
INPUT VOLTAGE [1, 2]	CONTINUOUS	0	28	40	0	28	50	V
	TRANSIENT 50 MS	—	47	—	—	—	80	
INPUT CLAMPING VOLTAGE [2]	T_C = -55°C	40.8	45.1	49.4	—	—	—	V
	T_C = 25°C	44.7	47.0	49.4	—	—	—	
	T_C = 125°C	44.7	49.5	54.2	—	—	—	
NOISE REJECTION	500 KHZ	55	—	—	55	—	—	
DIFFERENTIAL NOISE	1 MHZ	60	—	—	60	—	—	dB
NOISE REJECTION	2 MHZ	40	—	—	40	—	—	dB
COMMON MODE [1]	50 MHZ	50	—	—	50	—	—	
DC RESISTANCE (R_{DC})	T_C = 25°C	—	—	0.2	—	—	0.2	Ω
CAPACITANCE 25°C,[3]	ANY PIN TO CASE EXCEPT CASE PIN	—	—	48,000	—	—	48,000	pF
OUTPUT VOLTAGE [1, 4]	STEADY STATE	$V_{OUT} = V_{IN} - I_{IN} (R_{DC})$			$V_{OUT} = V_{IN} - I_{IN} (R_{DC})$			V
OUTPUT CURRENT [1,]	RIPPLE	—	—	1.0	—	—	1.0	A rms
	STEADY STATE	—	—	2.7	—	—	2.7	A
POWER DISSIPATION [1,]	MAXIMUM CURRENT	—	—	1.5	—	—	1.5	W

Notes Table 5 and Table 6
1. Guaranteed by characterization test and/or analysis. Not a production test.
2. Transients:
   a) The FMC-461 has a transorb and will not protect against transients as defined in MIL-STD-704A Figures 8 and 9, curves 1 and 2. Operation beyond the defined specifications may damage the transorb. It will begin to clamp the voltage at approximately 47 volts.
   b) The FMC-461NT does not have a transorb and does not clamp the input voltage. Transients of higher than 40 volts will not harm the filter but will be passed to the converter.
3. Tested with all pins tied together except case pin.
4. Typical applications result in V_{OUT} within 2% of V_{IN}.

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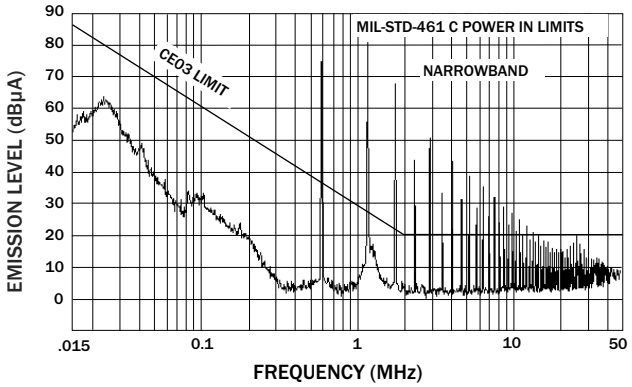
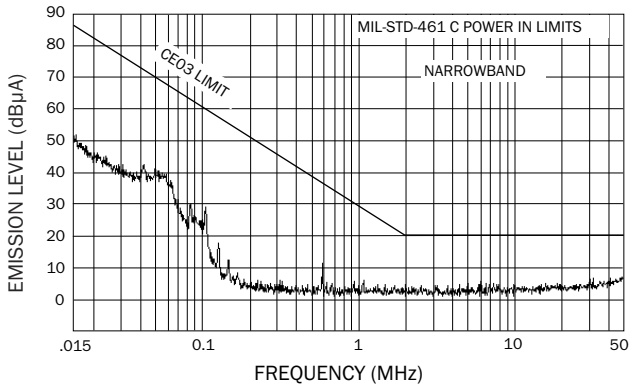
TYPICAL PERFORMANCE PLOTS: 25°C CASE, UNLESS OTHERWISE SPECIFIED.

FOR REFERENCE ONLY, NOT GUARANTEED SPECIFICATIONS.



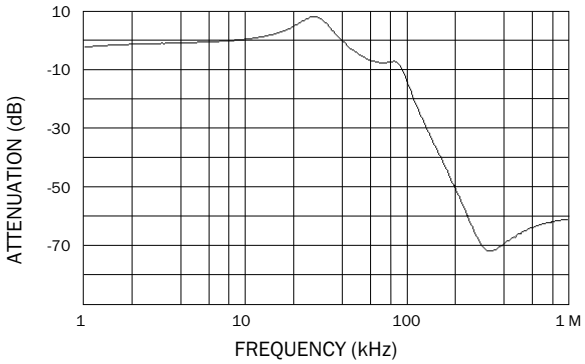
DC-DC CONVERTER AT FULL LOAD TYPICAL
UNFILTERED, WITH CE03 LIMIT LINE

FIGURE 5



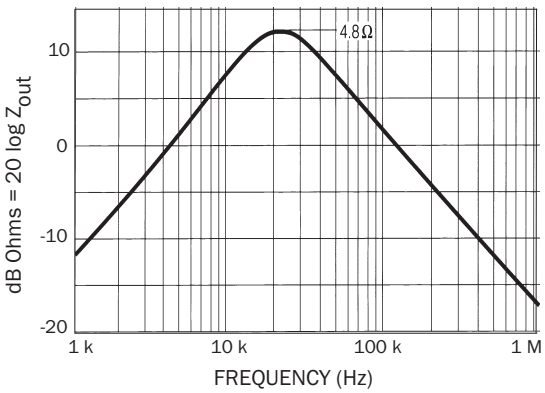
DC-DC CONVERTER AT FULL LOAD TYPICAL
WITH FMC-461 FILTER, CE03

FIGURE 6



FMC-461 TYPICAL AMPLITUDE RESPONSE VS. FREQUENCY

FIGURE 7



TYPICAL OUTPUT IMPEDANCE (Z) WITH INPUT SHORTED

FIGURE 8

FMC-461 EMI Input Filters

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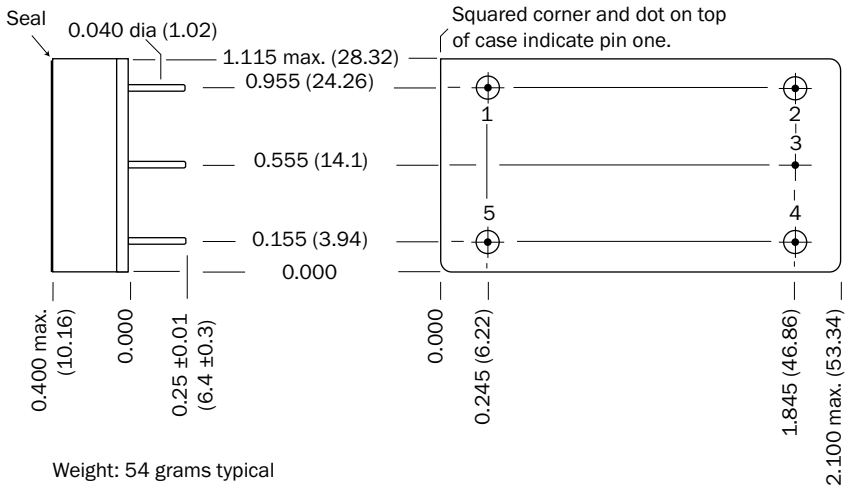
BOTTOM VIEW CASE H1



Weight: 54 grams typical

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	Cold Rolled Steel/Nickel/Gold
Cover	Kovar/Nickel
Pins	#52 alloy/Gold, ceramic seal
	Seal hole 0.120 ±0.002 (3.05 ± 0.05)

Please refer to the numerical dimensions for accuracy.

FIGURE 9: FMC-461 CASE H1

FMC-461 EMI Input Filters

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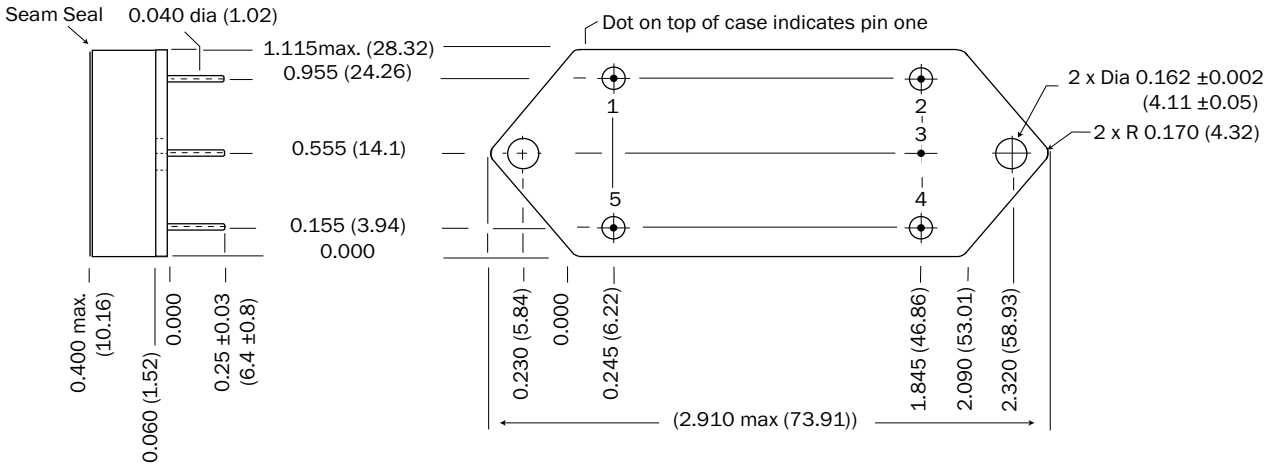
BOTTOM VIEW CASE K2

Flanged cases: Designator “F” required in Case Option position of model number.



Weight: 54 grams typical

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 Cold Rolled Steel/Nickel/Gold
Cover Kovar/Nickel
Pins #52 alloy/Gold, ceramic seal.
Seal Hole: 0.120 ±0.002 (3.05 ±0.05)

Please refer to the numerical dimensions for accuracy.

FIGURE 10: FMC-461 FLANGED CASE K2

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ELEMENT EVALUATION TABLES FOR QML PRODUCTS ARE IN "APP-009 QUALITY AND CERTIFICATION", APPENDIX A, IN COMPLIANCE WITH MIL-PRF-38534 REVISION L. (LINK HTTPS://WWW.CRANEAE.COM/QUALITY-ASSURANCE-MODULAR-POWER)

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

	NON-QML [1]			CLASS H QML [2, 3]
TEST PERFORMED	**STANDARD**	**/ES**	**/SX [4]**	**/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			■ [5]	■ [5]
Burn-in Method 1015, +125°C case, typical [6]				
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. A QML products which has an SMD number is marked "QML". A QML product which does not have an SMD number is marked per MIL-PRF-38534 table III.
4. "SX" screening is performed per MIL-PRF-38534, MIL-STD-883, Class H for non-QML devices.
5. Not required by DLA but performed to assure product quality.
6. Burn-in temperature designed to bring the case temperature to +125°C minimum. Burn-in is a powered test.

Table 8: Environmental Screening High Reliability DC-DC Converters and EMI Filters Standard, /ES, /SX and /883 (Class H)