SynQor®

MCOTS-F-270-P-DM
Passive Filter
Demi-Brick

MILITARY COTS EMI FILTER

-500V to +500V	.7A	392mΩ @ 100°C	>70dB @ 250kHz
Continuous Input	Output Current	Max. DC Resistance	Differential Attenuation

FULL POWER OPERATION: -55ºC to +100ºC

The Mil-COTS series of EMI filters brings SynQor's field proven technology and manufacturing expertise to the military and aerospace industry. SynQor's innovative packaging approach ensures survivability in the most hostile environments. Compatible with the industry standard format, these filters have high differential-mode and common-mode attenuation, low DC resistance, and a stabilizing bulk capacitor resistor. They follow conservative component derating guidelines and they are designed and manufactured to the highest standards.

MilCOTS™

Designed and Manufactured in the USA

Operational Features

- 0.7 amps output current
- Very low DC resistance
- > 70 dB differential-mode attenuation at 250kHz
- > 40 dB common-mode attenuation at 250kHz
- Stabilizing bulk capacitor and damping resistor included
- All capacitors are X7R or X7T multi-layer ceramic

Mechanical Features

- Size: 1.55" x 1.52" x 0.50" (39.4 x 38.6 x12.7 mm)
- Total weight: 1.97 oz (56g)
- Flanged baseplate version available

Safety Features

- 2250V input/output to common-mode pins
- Certified 62368-1 requirement for basic insulation (see Standards and Qualifications page)

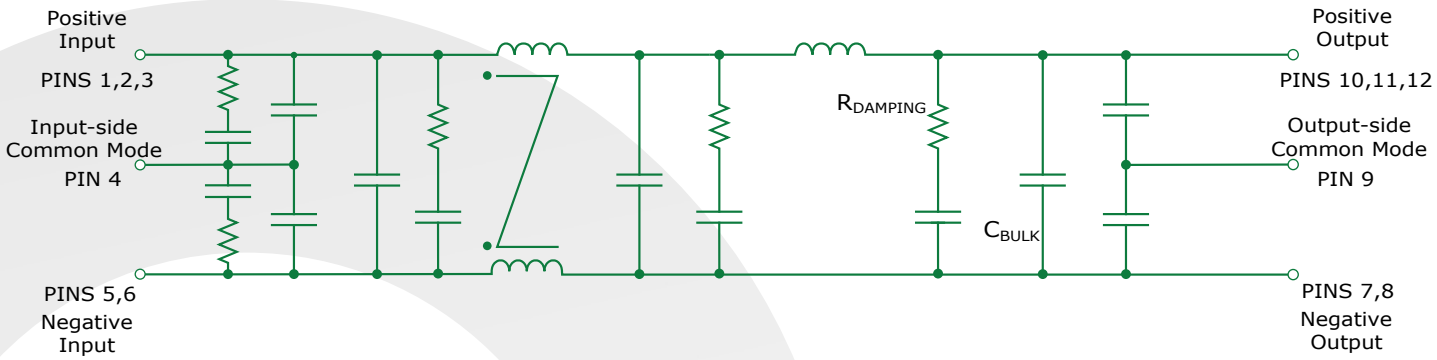
In-Line Manufacturing Process

- AS9100 and ISO 9001 Certified Facility
- Full component traceability

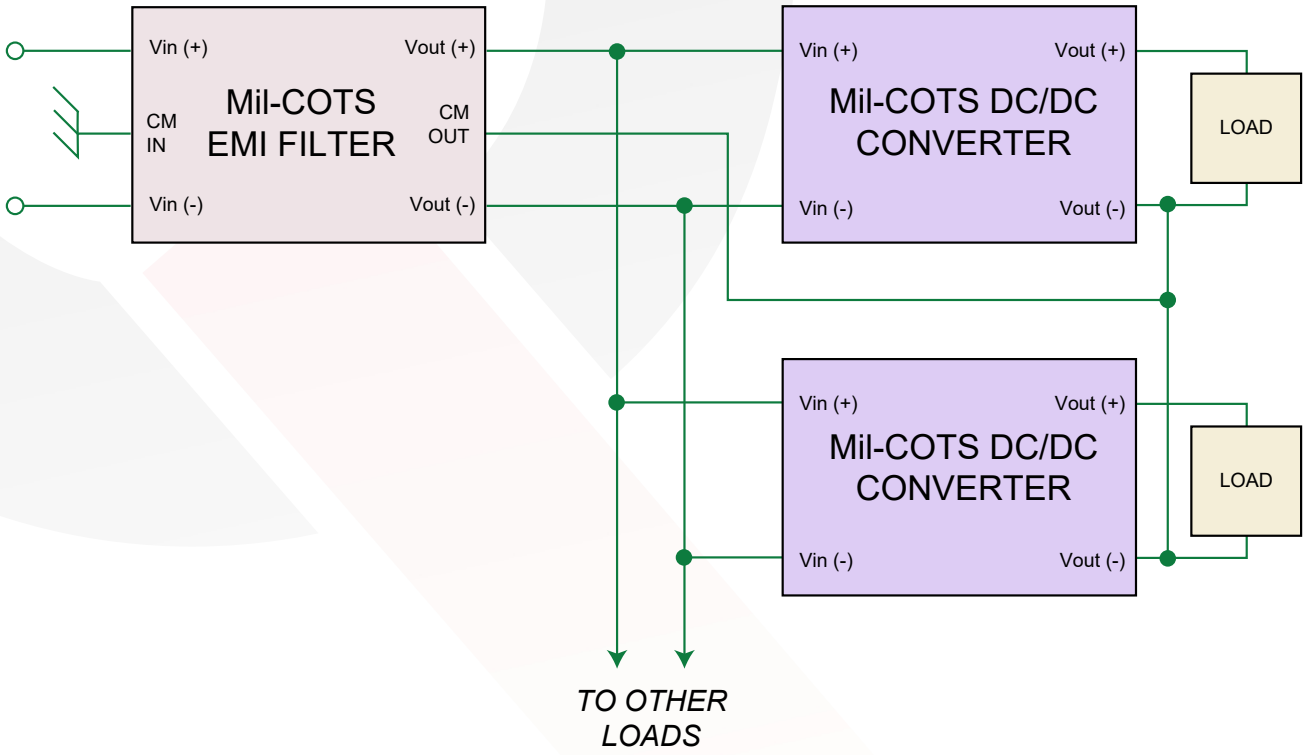
Screening Qualifications

- Qualified to MIL-STD-810
- Available with S-Grade or M-Grade screening
- Pre-cap inspection per IPC-610, Class III
- Temperature cycling per MIL-STD-883, Method 1010, Condition B, 10 cycles
- Burn-In at 100°C baseplate temperature
- Final visual inspection per MIL-STD-883, Method 2009

Fundamental Circuit Diagram



Typical Connection Diagram



MCOTS-F-270-P-DM ELECTRICAL CHARACTERISTICS

Tb = 25 °C, Vin=270V DC ±5%, Iout=0.7A unless otherwise noted; full operating temperature range is -55 °C to +100 °C baseplate temperature.
Specifications subject to change without notice.

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
ABSOLUTE MAXIMUM RATINGS					
Input Voltage					
Continuous	-500		500	V	
Transient (≤ 1 s)	-630		630	V	
Isolation Voltage	-2500		2500	V	Input/Output to Common-mode pins
Output Current			1	A	Vin = 155V
Operating Case Temperature	-55		100	°C	Baseplate Temperature
Storage Case Temperature	-65		135	°C	
RECOMMENDED OPERATING CONDITIONS					
Input Voltage					
Continuous	-500		500	V	Operating
Transient (1 s, Rs* = 0 Ω)	-630		630	V	* Rs = Source Impedance
Output Current (continuous)	-0.7		0.7	A	
ELECTRICAL CHARACTERISTICS					
Output Voltage (continuous)	Vout = Vin - (Iin x Rdc)			V	
DC Resistance (Rdc)					
Tcase = 25°C			306	mΩ	
Tcase = 100°C			392	mΩ	
Power Dissipation (0.7 A output current)					
Tcase = 25°C			150	mW	
Tcase = 100°C			195	mW	
Total Differential-Mode Capacitance		0.41		µF	Measured across output pins
Total Common-Mode Capacitance		0.04		µF	Measured between any pin to case
Bulk Capacitor		4.5		µF	Measured without a DC bias
Damping Resistor		3		Ω	
Noise Attenuation					See Figure A
Isolation Resistance (any pin to case)	30			MΩ	
Input Voltage dV/dt			1	V/µsec	Measured across the input pins
RELIABILITY CHARACTERISTICS					
Calculated MTBF (MIL-STD-217F2)					
GB @ Tcase = 70ºC		240		10^6 Hrs.	
GM @ Tcase = 70ºC		15		10^6 Hrs.	
WEIGHT CHARACTERISTICS					
Device Weight		56		g	

Electrical Characteristics Notes

1. Only the M grade products are tested at three temperatures. The S grade products are tested at one temperature. Please refer to the Mil-COTS Screening table for details.

* Rs = Source Impedance

Basic Operation and Features

This module is a multi-stage differential-mode and common-mode passive EMI filter designed to interface a power source with one or more Mil-COTS DC-DC converters (or other loads that create EMI). Each stage of this filter is well damped to avoid resonances and oscillations, and only X7R and X7T multi-layer ceramic capacitors are used. This Mil-COTS EMI filter includes a large bulk capacitor with a series damping resistor to correct for the unstabilizing effect of a converter's negative input resistance. A white paper discussing this negative input resistance and the need for corrective damping can be found on the SynQor website (see Input System Instability application note).

A typical application would place the Mil-COTS filter close to the input of the DC-DC converter. The input-side common-mode pin would be connected to the chassis ground that is common with the system input line filter or other earthed point used for EMI measurement. The output-side common-mode pin would be connected to the output ground or plane of the power converters with as low inductance a path as possible. There are no connections to the metal baseplate, which may also be connected to the chassis ground if desired.

Do not connect the outputs of multiple Mil-COTS filters in parallel. Connecting filters in this manner may result in slightly unequal currents to flow in the positive and return paths of each filter. These unequal currents may cause the internal common-mode chokes to saturate and thus cause degraded common-mode rejection performance.

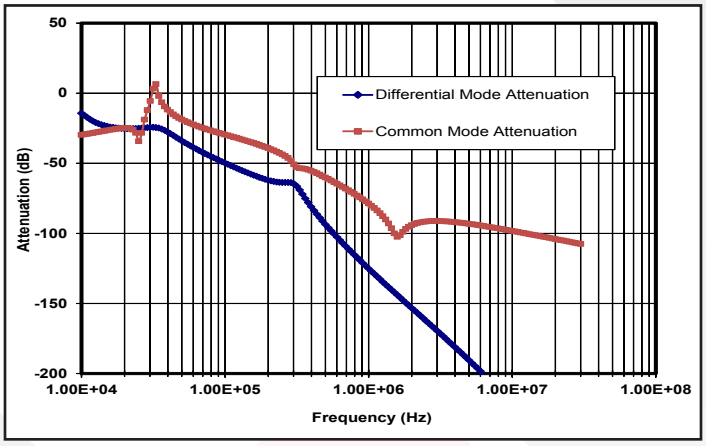


Figure A: *Calculated Common Mode and Differential Mode Attenuation provided by the filter as a function of frequency. Both input lines are connected to chassis ground through 50Ω resistors. The filter case is also connected to chassis ground.*

Simulation

A simulation of the filter was used to evaluate common mode and differential mode attenuation, the output impedance of the filter and the response of the filter to fast transient spikes defined in MIL-STD-461C CS06, MIL-STD-461F CS101 and RTCA DO160G, Section 17. The model includes parasitic resistance associated with both capacitive and magnetic devices, and the self-resonant and saturation characteristics of magnetic components.

Common Mode and Differential Mode Attenuation

Figures B and C show the circuit configuration used to simulate common mode and differential mode attenuation. The results are shown in Figure A. The low frequency damped resonances shown in Figure A are artifacts primarily of the interaction of the filter with the LISN impedances (accentuated by the assumption of an input voltage source with zero output impedance).

Voltage Spikes:

Our analysis shows that a properly designed system using the MCOTS-F-270-P-DM filter and the 270F DM or SK DC to DC converters can meet the spike requirements of RTCA DO-160 (Section 17), MIL-STD-461C (CS06) and MIL-STD-461F (CS106). We recommend additional damping networks across the output of the filters to meet CS06 and CS106 requirements. The component values must be determined empirically for each application. As a starting point, we recommend the following:

- The MIL-STD-461C, CS06 200V spike requirement:
  1 ohms in series with 3.3 µF X7R or X7T ceramic capacitor.
- The MIL-STD-461F, CS106 400V spike requirement:
  0.5 ohm in series with 6.8 µF X7R or X7T ceramic capacitor.

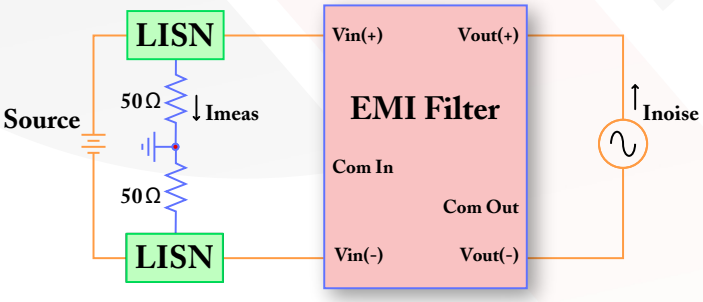


Figure B: *Differential-Mode Current Attenuation, Imeas / Inoise*

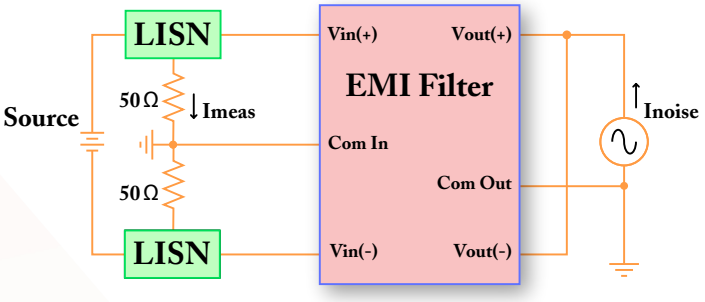
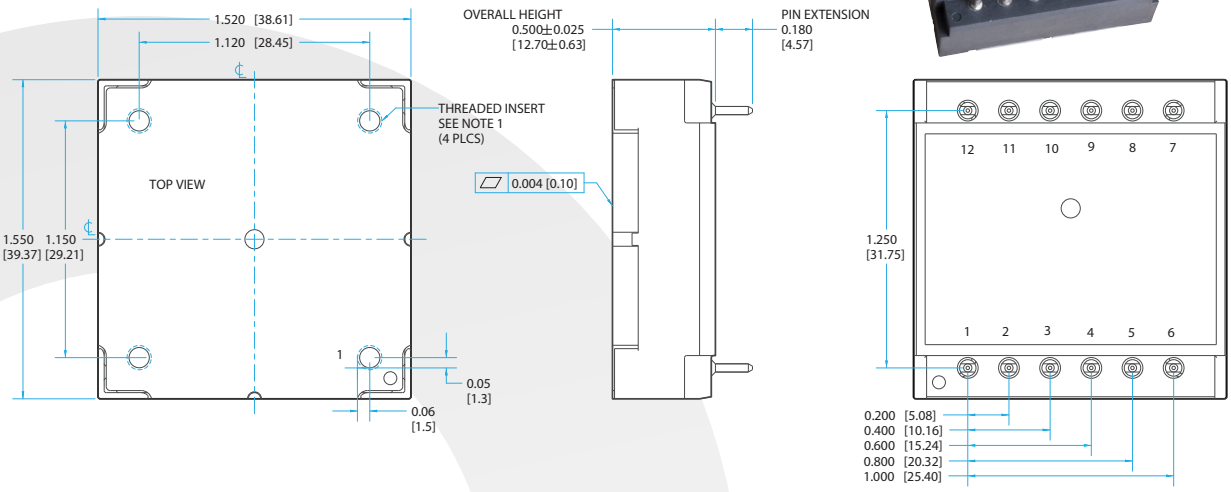


Figure C: *Common-Mode Current Attenuation, Imeas / Inoise*

Encased Mechanical Diagram



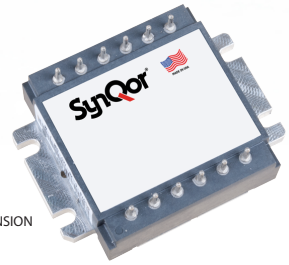
NOTES

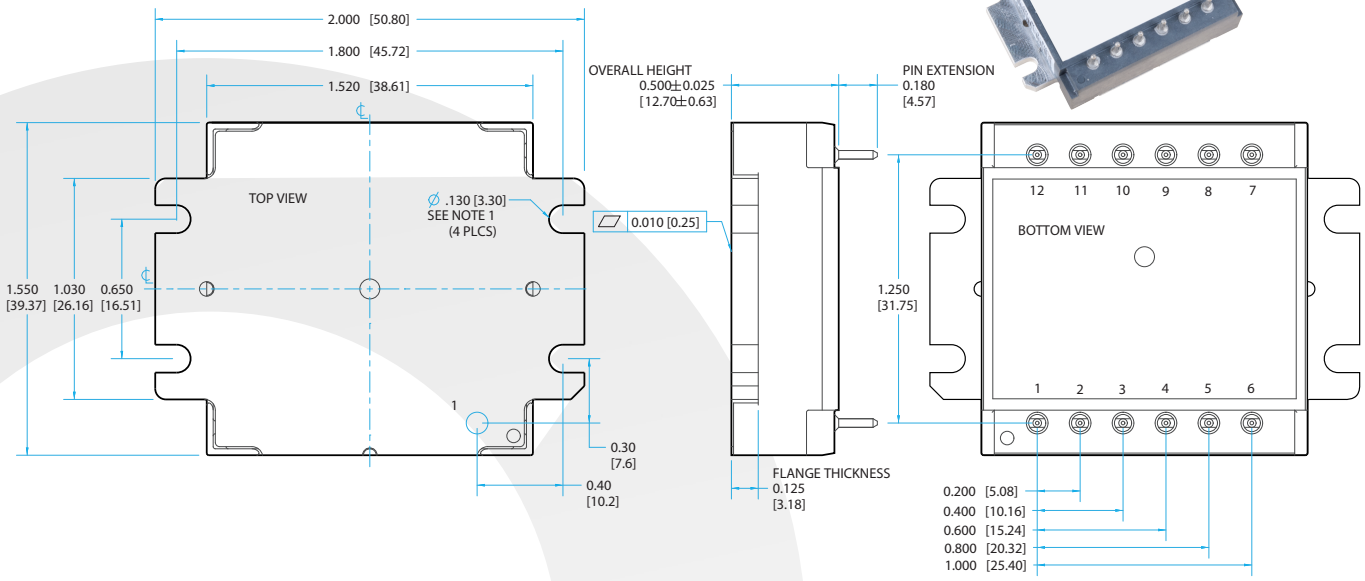
1. APPLIED TORQUE PER M3 SCREW 6in-lb RECOMMENDED
   SCREW SHOULD NOT EXCEED 0.100" (2.54mm)
   DEPTH BELOW THE SURFACE OF THE BASEPLATE.
2. BASEPLATE FLATNESS TOLERANCE IS 0.004" (.10mm) TIR FOR
3. PINS 1-12 ARE 0.040" (1.02mm) DIA. WITH 0.080"
   (2.03mm) DIA. STANDOFFS.
4. WORKMANSHIP: MEETS OF EXCEEDS IPC-A610
5. ALL PINS: MATERIAL: COPPER ALLOY
   FINISH: MATTE TIN OVER NICKEL PLATE
6. WEIGHT:1.97 oz (56g)
7. ALL DIMENSIONS IN INCHES(mm)
   TOLERANCES: X.XXIN +/-0.02 (X.Xmm +/-0.5mm)
   X.XXXIN +/-0.010 (X.XXmm +/-0.25mm)

Pin	Name	Function
1	Vin (+)	Positive input voltage
2	Vin (+)	Positive input voltage
3	Vin (+)	Positive input voltage
4	COM IN	Input-side Common-mode
5	Vin (-)	Negative input voltage
6	Vin (-)	Negative input voltage
7	Vout (-)	Negative output voltage
8	Vout (-)	Negative output voltage
9	COM OUT	Output-side Common-mode
10	Vout (+)	Positive output voltage
11	Vout (+)	Positive output voltage
12	Vout (+)	Positive output voltage

Pin Designation Notes:
1: Pin out differs from other
Mil-COTS products.

Flanged Encased Mechanical Diagram





NOTES

1. APPLIED TORQUE PER M3 OR 4-40 SCREW 6in-lb RECOMMENDED
2. BASEPLATE FLATNESS TOLERANCE IS 0.010" (.25mm) TIR FOR SURFACE.
3. PINS 1-12 ARE 0.040" (1.02mm) DIA. WITH 0.080" (2.03mm) DIA. STANDOFFS.
4. ALL PINS: MATERIAL: COPPER ALLOY
   FINISH: MATTE TIN OVER NICKEL PLATE
5. ALTERNATIVE PIN LENGTH MAYBE AVAILABLE. CHECK WITH
6. WEIGHT: 2.08 oz (59g)
7. ALL DIMENSIONS IN INCHES(mm)
   TOLERANCES: X.XXIN +/-0.02 (X.Xmm +/-0.5mm)
   X.XXXIN +/-0.010 (X.XXmm +/-0.25mm)

Pin	Name	Function
1	Vin (+)	Positive input voltage
2	Vin (+)	Positive input voltage
3	Vin (+)	Positive input voltage
4	COM IN	Input-side Common-mode
5	Vin (-)	Negative input voltage
6	Vin (-)	Negative input voltage
7	Vout (-)	Negative output voltage
8	Vout (-)	Negative output voltage
9	COM OUT	Output-side Common-mode
10	Vout (+)	Positive output voltage
11	Vout (+)	Positive output voltage
12	Vout (+)	Positive output voltage

Pin Designation Notes:
1: Pin out differs from other Mil-COTS products.

Mil-COTS Qualification

Test Name	Details	# Tested (# Failed)	Consistent with MIL-STD-883F Method
Life Testing	Visual, mechanical and electrical testing before, during and after 1000 hour burn-in @ full load	15 (0)	Method 1005.8
Shock-Vibration	Visual, mechanical and electrical testing before, during and after shock and vibration tests	5 (0)	MIL-STD-202, Methods 201A & 213B
Humidity	+85 °C, 95% RH, 1000 hours, 2 minutes on / 6 hours off	8 (0)	Method 1004.7
Temperature Cycling	500 cycles of -55 °C to +100 °C (30 minute dwell at each temperature)	10 (0)	Method 1010.8, Condition A
Solderability	15 pins	15 (0)	Method 2003
DMT	-65 °C to +110 °C across full line and load specifications in 5 °C steps	7 (0)	
Altitude	70,000 feet (21 km), see Note	2 (0)	

Note: A conductive cooling design is generally needed for high altitude applications because of naturally poor convective cooling at rare atmospheres.

Mil-COTS Converter and Filter Screening

Screening	Process Description	S-Grade	M-Grade
Baseplate Operating Temperature		-55 °C to +100 °C	-55 °C to +100 °C
Storage Temperature		-65 °C to +135 °C	-65 °C to +135 °C
Pre-Cap Inspection	IPC-A-610, Class III	•	•
Temperature Cycling	MIL-STD-883F, Method 1010, Condition B, 10 Cycles		•
Burn-In	100 °C Baseplate	12 Hours	96 Hours
Final Electrical Test	100%	25 °C	-55 °C, +25 °C, +100 °C
Final Visual Inspection	MIL-STD-883F, Method 2009	•	•

STANDARDS COMPLIANCE

Parameter	Notes & Conditions
STANDARDS COMPLIANCE	
UL 62368-1	Basic Insulation
CAN/CSA C22.2 No.62368-1	
EN 62368-1	

Note: An external input fuse must always be used to meet these safety requirements. Contact SynQor for official safety certificates on new releases or download from the SynQor website.

Mil-COTS MIL-STD-810G Qualification Testing

MIL-STD-810G Test	Method	Description
Fungus	508.6	Table 508.6-I
Altitude	500.5 - Procedure I	Storage: 70,000 ft / 2 hr duration
	500.5 - Procedure II	Operating: 70,000 ft / 2 hr duration; Ambient Temperature
Rapid Decompression	500.5 - Procedure III	Storage: 8,000 ft to 40,000 ft
Acceleration	513.6 - Procedure II	Operating: 15 g
Salt Fog	509.5	Storage
High Temperature	501.5 - Procedure I	Storage: 135 °C / 3 hrs
	501.5 - Procedure II	Operating: 100 °C / 3 hrs
Low Temperature	502.5 - Procedure I	Storage: -65 °C / 4 hrs
	502.5 - Procedure II	Operating: -55 °C / 3 hrs
Temperature Shock	503.5 - Procedure I - C	Storage: -65 °C to 135 °C; 12 cycles
Rain	506.5 - Procedure I	Wind Blown Rain
Immersion	512.5 - Procedure I	Non-Operating
Humidity	507.5 - Procedure II	Aggravated cycle @ 95% RH (Figure 507.5-7 aggravated temp - humidity cycle, 15 cycles)
Random Vibration	514.6 - Procedure I	10 - 2000 Hz, PSD level of 1.5 g^2/Hz (54.6 g_{rms}), duration = 1 hr/axis
Shock	516.6 - Procedure I	20 g peak, 11 ms, Functional Shock (Operating no load) (saw tooth)
	516.6 - Procedure VI	Bench Handling Shock
Sinusoidal vibration	514.6 - Category 14	Rotary wing aircraft - helicopter, 4 hrs/axis, 20 g (sine sweep from 10 - 500 Hz)
Sand and Dust	510.5 - Procedure I	Blowing Dust
	510.5 - Procedure II	Blowing Sand

Ordering Information

Example MCOTS-F-270-P-DM-N-S

Family	Product	Input Voltage	Filter Type	Package	Thermal Design	Screening Level
MCOTS	**F:** Filter	**28:** -40V to +40V **28E:** -70V to +70V **270:** -500V to +500V	**P:** Passive	**DM:** Demi-Brick	**N:** Normal Threaded **F:** Flanged	**S:** S-Grade **M:** M-Grade

Not all combinations make valid part numbers, please contact SynQor for availability. See the Product Summary web page for more options.

Application Notes

A variety of application notes and technical white papers can be downloaded in pdf format from our website.

Contact SynQor for further information and to order:

Phone: 978-849-0600 **Fax:** 978-849-0602
E-mail: power@synqor.com **Web:** www.synqor.com
Address: 155 Swanson Road, Boxborough, MA 01719 USA

Warranty

SynQor offers a two (2) year limited warranty. Complete warranty information is listed on our website or is available upon request from SynQor.

PATENTS

SynQor holds numerous U.S. patents, one or more of which apply to most of its power conversion products. Any that apply to the product(s) listed in this document are identified by markings on the product(s) or on internal components of the product(s) in accordance with U.S. patent laws. SynQor's patents include the following:

7,765,687 7,787,261
8,149,597 8,644,027