MACF-U-230-QT Technical Specification

Military COTS AC Line Filter

85 to 264Vrms	5Arms	575W @ 115Vrms 1.1kW @ 230Vrms	330mΩ @ 100°C	>40dB @ 250kHz
Input Voltage	Output Current	Output Power	Max Series Resistance	Differential & Common-mode Attenuation

Full Power Operation: -55°C to +100°C

MilCOTS™

MCOTS series of EMI AC Line 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 and low series resistance. They follow conservative component derating guidelines and they are designed and manufactured to the highest standards.

MACF-U-230-QT-N-M Module

Operational Features

- -55°C to +100°C Operation
- 5Arms output current
- Very low series resistance
- High Differential & Common-mode Attenuation
- All capacitors are safety-rated X7R multi-layer ceramic
- Meets common EMC standards in properly designed system with SynQor's MPFIC module
- 45 - 800 Hz input frequency

Mechanical Features

- Standard Size: 1.54" x 2.39" x 0.50" (39.0 x 60.6 x 12.7 mm)
- Total weight: 2.9 oz (82 g)
- Flanged baseplate version available

Compliance Features

MACF Series filters (with MPFIC converters) are designed to meet:

- MIL-STD-461 for EMC
- MIL-STD-1399
- MIL-STD-704

In-Line Manufacturing Process

- AS9100 and ISO 9001 certified facility
- Full component traceability

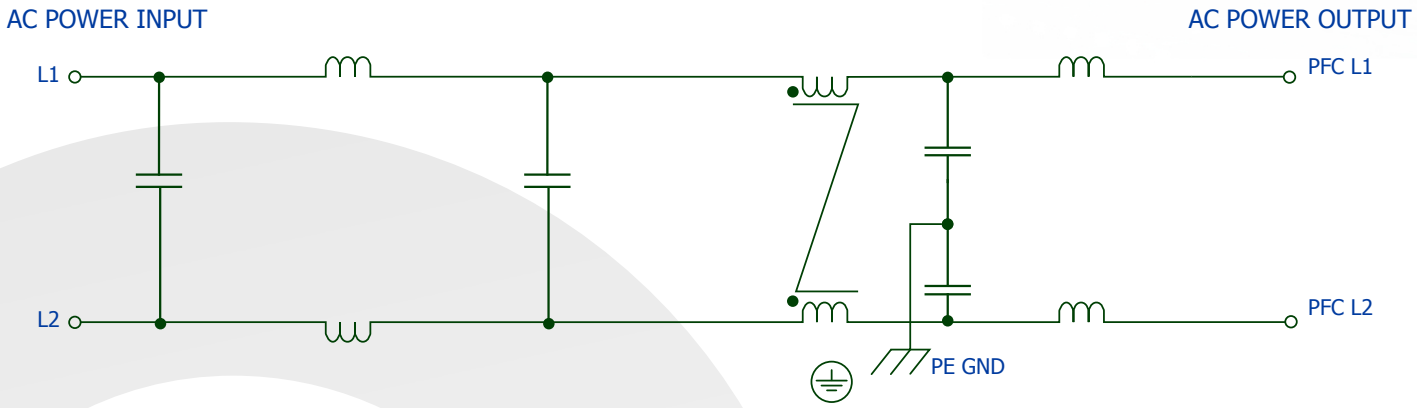
Safety Features

- 2500Vdc input-to-case & input-to-gnd-pin high-potential test
- Safety rated class X2 line-to-line & class Y2 line-to-gnd capacitors
- Certified 62368-1 requirement for basic insulation (pending, see Standards and Qualifications page)

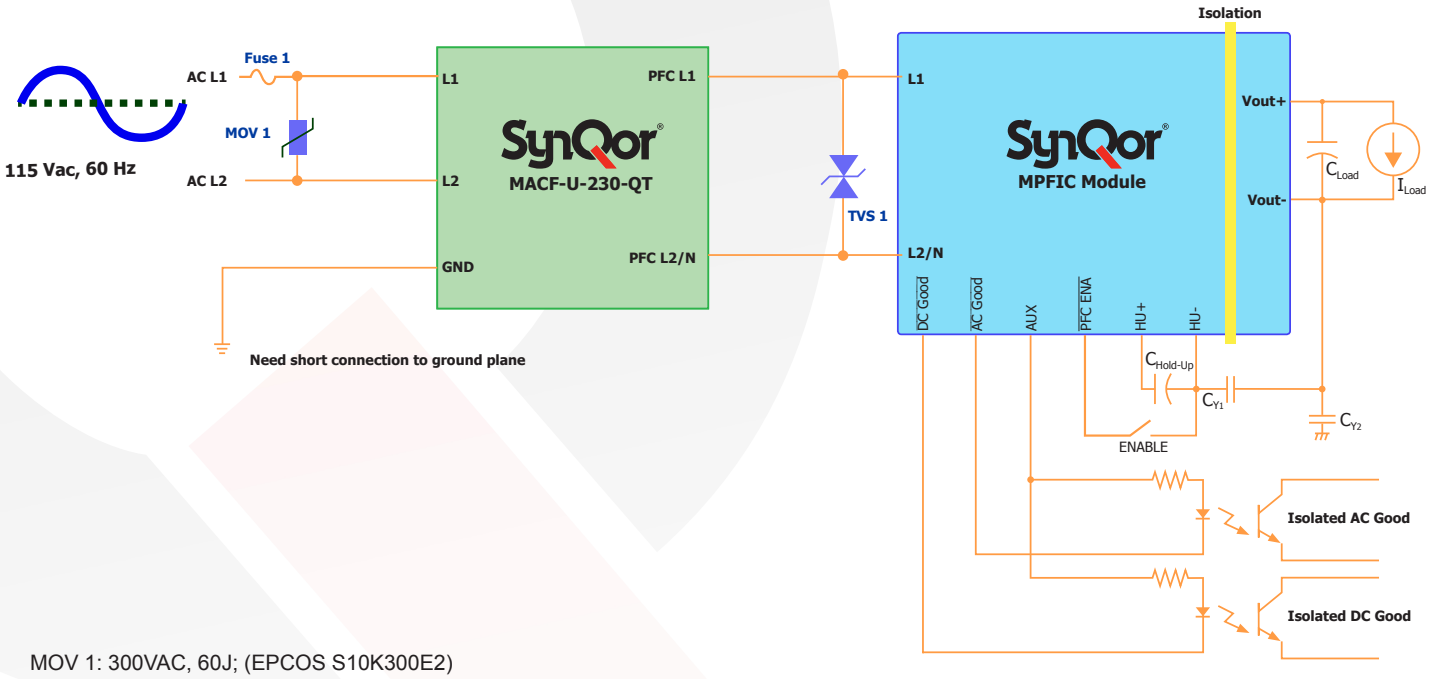
Contents

Technical Diagrams

Fundamental Circuit Diagram



Typical Connection Diagram



MOV 1: 300VAC, 60J; (EPCOS S10K300E2)
TVS 1: 400V, 3J; (Two VISHAY 1.5KE200CA devices connected in series)
C Hold-up: One 450V, 330µF; EPCOS B43508B5337M (-40°C)
Two 250V, 560µF; Cornell Dubilier MLS561M250EB0C in series
with balancing resistors (-55°C)
Fuse 1: 250VAC, 6.3A; (Littelfuse 021606.3MXEP)
C Y1: 3.3nF, 500VAC; Vishay VY1332M59Y5UQ6TV0
C Y2: 10nF, 300VAC; Vishay VY2103M63Y5US63V7

MACF-U-230-QT Electrical Characteristics

Vin <= 264Vrms, Iout <= 5Arms unless otherwise specified. Specifications subject to change without notice.

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
ABSOLUTE MAXIMUM RATINGS					
Input Voltage (Continuous)			264	Vrms	
Isolation Voltage			2500	Vdc	Input/output to PE GND pin & baseplate
Output Current (Continuous)			5	Arms	
Output Current (Surge)			150	A^2S	
Operating Case Temperature	-55		100	°C	Baseplate temperature
Storage Case Temperature	-65		135	°C	
RECOMMENDED OPERATING CONDITIONS					
Input Voltage (Continuous)			250	Vrms	
Output Current (Continuous)			5	Arms	
Input Frequency	45		800	Hz	
ELECTRICAL CHARACTERISTICS					
Output Voltage (Continuous)		Vout = Vin - (Iin x Rs)		V	
Series Resistance Rs					Total
Tcase = 25ºC		230		mΩ	
Tcase = 100ºC			330	mΩ	
Power Dissipation					
Zero Load, 115 Vrms 60 Hz		0.1		W	
Zero Load, 115 Vrms 400 Hz		0.6		W	
5 Arms @ 115 Vrms 400 Hz, Tcase = 25ºC		6.5		W	
5 Arms @ 115 Vrms 400 Hz, Tcase = 100ºC			9	W	Guaranteed by design
Total Differential-Mode Capacitance		336		nF	Measured across input or output pins
Total Common-Mode Capacitance		2 x 9.4		nF	Measured between PE GND and any other pin
Leakage current in PE GND Pin			0.9	mArms	250 Vrms L-N 50 Hz, See Note 1
Leakage current in PE GND Pin			3.3	mArms	115 Vrms L-N 400 Hz, See Note 1
Noise Attenuation					See Fig 1
Isolation Resistance	100			MΩ	Any pin to PE GND pin
RELIABILITY CHARACTERISTICS					
Calculated MTBF per Telcordia SR-332, Issue 2		238		10^6 Hrs.	Ground Benigh, Tb = 70 °C
Calculated MTBF per MIL-HDBK-217F		201		10^6 Hrs.	Ground Benign, Tb = 70 °C
Calculated MTBF per MIL-HDBK-217F		27		10^6 Hrs.	Airborne Inhabited Cargo, Tb = 70 °C
Field Demonstrated MTBF				10^6 Hrs.	See our website for details

Note 1: If the neutral line is interrupted, leakage current may reach twice this level.

BASIC OPERATION AND FEATURES

This module is a multi-stage differential-mode and common-mode passive EMI filter designed to interface an AC power source with a SynQor MCOTS PFC module and one or more SynQor converters (or other loads that create EMI). Each stage of this filter is well damped to avoid resonances and oscillations, and only X7R multi-layer ceramic safety rated capacitors are used.

A typical application would place the MCOTS AC line filter close to the AC input power entry point. The AC Line Filter GND pin would be connected to the chassis ground that is common with AC input power protective earth (PE GND) or other earthed point used for EMI measurement. 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 MCOTS AC line 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 will cause the internal common-mode chokes to saturate and thus cause degraded common-mode rejection performance.

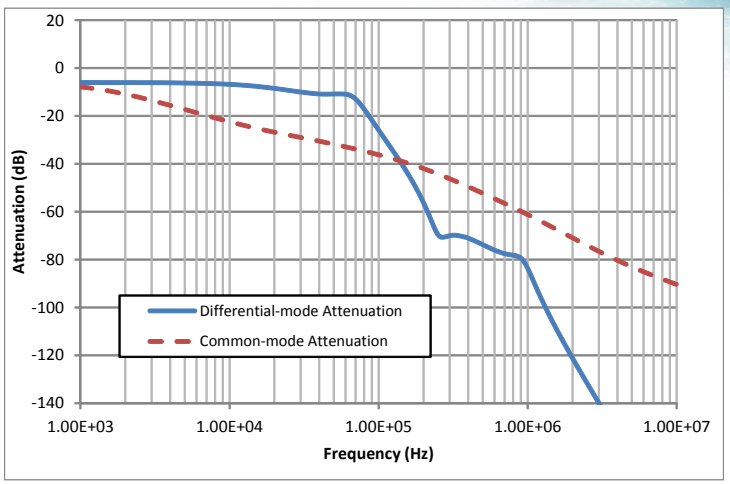


Figure 1: *Typical Common Mode and Differential Mode Attenuation provied by the filter as a function of frequency. Source and load resistance are 50Ω.*

Standards & Qualification Testing

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

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	•	•

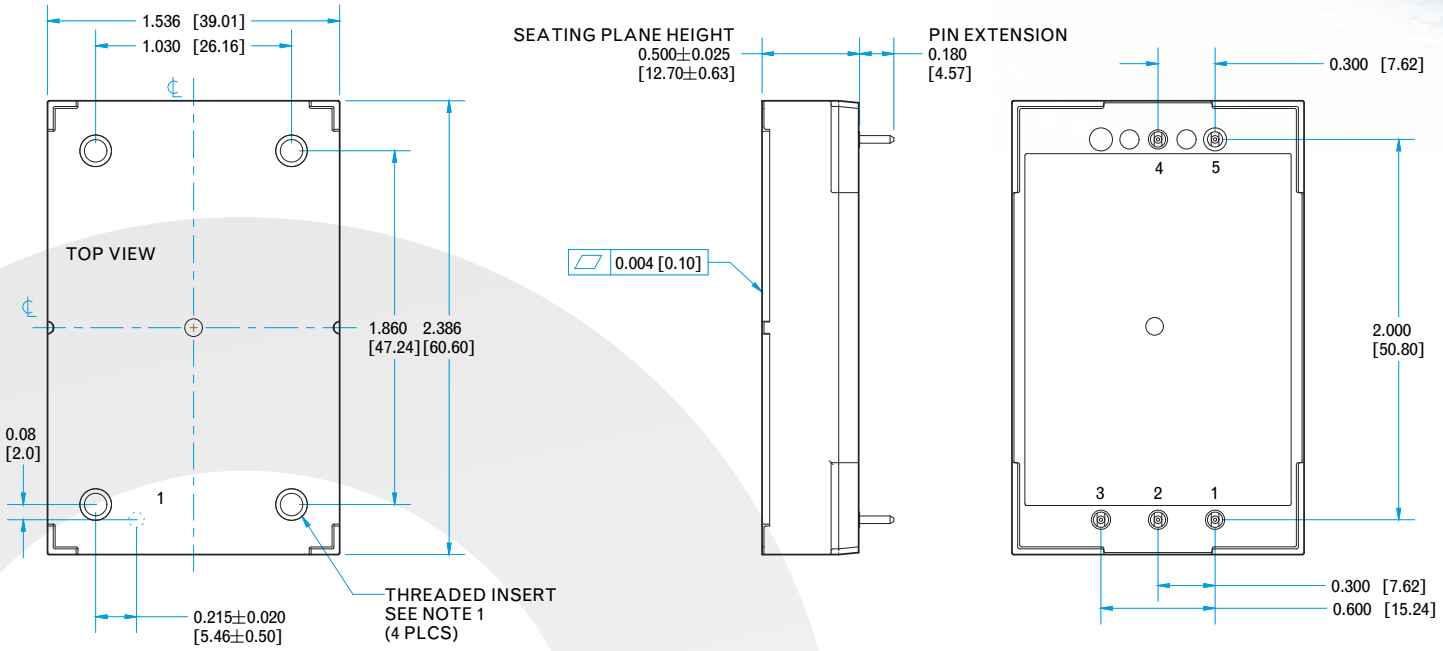
Parameter	Notes & Conditions
STANDARDS COMPLIANCE (Pending)	
UL 62368-1	Basic Insulation
CAN/CSA-C22.2 No. 60950-1	
EN62368-1	Certified by TUV

Note: An external input fuse must always be used to meet these safety requirements, see Typical Connection Diagram. Proper protective earthing procedure must be observed for system design. Contact SynQor for official safety certificates on new releases or download from SynQor website.

Parameter	# Units	Test Conditions
QUALIFICATION TESTING		
Life Test	32	95% rated Vin and load, units at derating point, 1000 hours
Vibration	5	10-55 Hz sweep, 0.060" total excursion, 1 min./sweep, 120 sweeps for 3 axis
Mechanical Shock	5	100g minimum, 2 drops in x, y, and z axis
Temperature Cycling	10	-55 °C to 100 °C, unit temp. ramp 15 °C/min., 500 cycles
Power/Thermal Cycling	5	Toperating = min to max, Vin = min to max, full load, 100 cycles
Design Marginality	5	Tmin-10 °C to Tmax+10 °C, 5 °C steps, Vin = min to max, 0-105% load
Humidity	5	85 °C, 95% RH, 1000 hours, continuous Vin applied except 5 min/day
Solderability	15 pins	MIL-STD-883, method 2003
Altitude	2	70,000 feet (21 km), see Note

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

Encased Mechanical Diagram



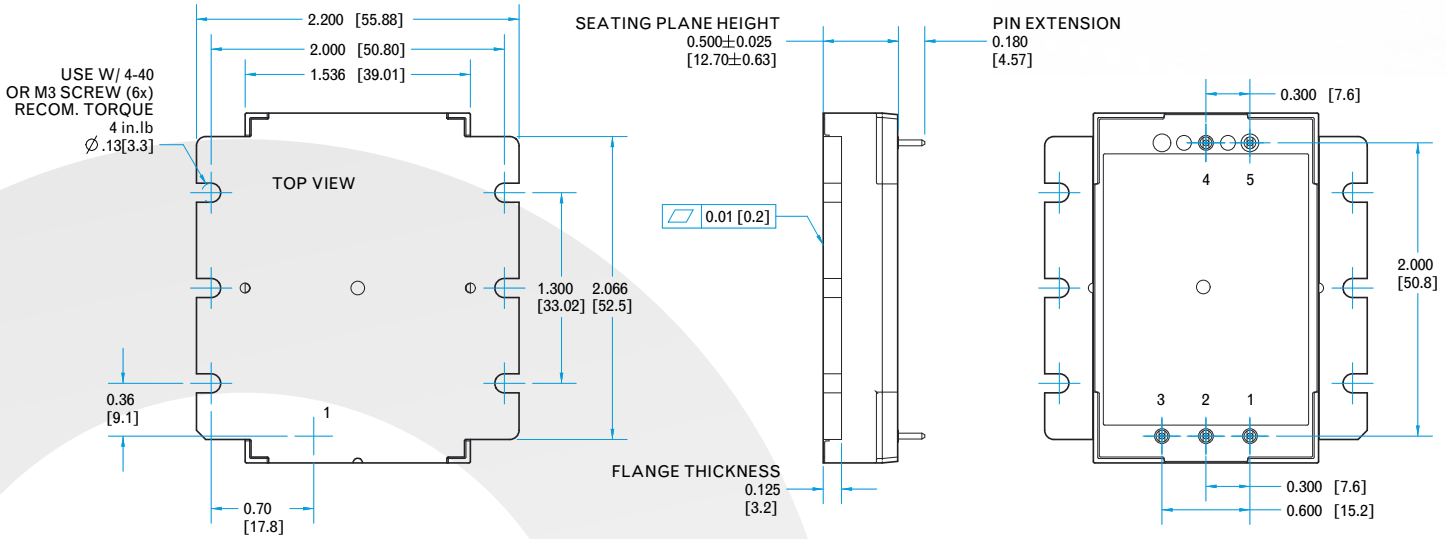
NOTES

1) Applied torque per M3 screw is not to exceed 6in-lb (0.7 Nm). Screw should not exceed 0.100" (2.54mm) below the surface of the baseplate.
2) Baseplate flatness tolerance is 0.010" (0.25 mm) TIR for surface.
3) Pins are 0.040" (1.02mm) diameter, with 0.080" (2.03mm) diameter standoff shoulders.
4) All Pins: Material - Copper Alloy
   Finish: Matte Tin over Nickel plate
5) Undimensioned components only for visual reference.
6) Total weight: 2.9 oz (82 g)
7) All dimensions in inches (mm)
   Tolerances: x.xx +/-0.02 in. (x.x +/-0.5mm)
   x.xxx +/-0.010 in. (x.xx +/-0.25mm)
   - unless otherwise noted.
8) Workmanship: Meets or exceeds current IPC-A-610 Class II

PIN DESIGNATIONS

Pin	Label	Name	Function
1	L1	L1	AC Line 1
2	L2/N	L2/N	AC Line 2 / Neutral
3	PE GND	PE GND	Protective Earth
4	PFC L2/N	PFC L2/N	PFC Input Line 2 / Neutral
5	PFC L1	PFC L1	PFC Input Line 1

Flanged Mechanical Diagram



NOTES

1) Applied torque per M3 or 4-40 screw is not to exceed 6 in-lb (0.7 Nm)
2) Baseplate flatness tolerance is 0.010" (.25 mm) TIR for surface.
3) Pins are 0.040" (1.02mm) diameter, with 0.080" (2.03mm) diameter standoff shoulders.
4) All Pins: Material - Copper Alloy
   Finish: Matte Tin over Nickel plate
5) Undimensioned components only for visual reference.
6) Total weight: 3.1 oz (88 g)
7) All dimensions in inches (mm)
   Tolerances: x.xx +/-0.02 in. (x.x +/-0.5mm)
   x.xxx +/-0.010 in. (x.xx +/-0.25mm)
   - unless otherwise noted.
8) Workmanship: Meets or exceeds current IPC-A-610 Class II

PIN DESIGNATIONS

Pin	Label	Name	Function
1	L1	L1	AC Line 1
2	L2/N	L2/N	AC Line 2 / Neutral
3	PE GND	PE GND	Protective Earth
4	PFC L2/N	PFC L2/N	PFC Input Line 2 / Neutral
5	PFC L1	PFC L1	PFC Input Line 1

Ordering Specifications

Family	Input Frequency	Input Voltage	Package	Thermal Design	Screening Level
MACF	U	230	Q	N	S
MACF: AC Line Filter	**U:** 45 - 800 Hz	**230:** 85 to 264Vrms	**QT:** Quarter-Brick Tera	**N:** Encased Threaded **F:** Flanged	**S:** S-Grade **M:** M-Grade

Part Number Example: **MACF-U-230-QT-N-M**

APPLICATION NOTES

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

ORDERING INFORMATION

Not all combinations make valid part numbers, please contact SynQor for availability.

Contact SynQor for further information and to order:

Phone:	978-849-0600
Toll Free:	888-567-9596
Fax:	978-849-0602
E-mail:	power@synqor.com
Web:	www.synqor.com
Address:	155 Swanson Road Boxborough, MA 01719 USA

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:

6,545,890 6,894,468 6,896,526 6,927,987 7,050,309 7,085,146
7,119,524 7,765,687 7,787,261 8,149,597 8,644,027

Warranty

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