Military COTS 3-Phase AC Line Filter

85 to 140 Vrms (L-N) Input Voltage	6 Arms Output Current	2.0 kW @ 115 Vrms (L-N) Output Power	200 mΩ @ 100°C Max Resistance per Phase	45 dB @ 200 kHz Noise Attenuation with 4.5 Arms per Phase

Full Power Operation: -55 °C to +100 °C

The MilCOTS 3-phase AC EMI Line Filter is an essential building block of an AC-DC power supply. Used in conjunction with SynQor's MPFC-115-3PH-270-FP 3-phase PFC module, this filter will allow compliance with key MIL-STD-461 EMI requirements, assuming proper system-level design. Compatible with the industry standard format, these filters have high differential-mode and common-mode attenuation and low series resistance. Designed and manufactured to comply with a wide range of military standards, SynQor's innovative packaging approach ensures survivability in the most hostile environments.

MilCOTS™

MACF-115-3PH-UNV-HT-N-M Module

Operational Features

- -55 °C to +100 °C baseplate temperature
- 6 Arms output current
- Very low series resistance
- 45 dB @ 200 kHz noise attenuation with 4.5 Arms per phase
- Meets common EMC standards in properly designed system with SynQor's MPFC module and MCOTS 270 converters

Mechanical Features

- Standard Size: 2.49" x 2.39" x 0.51" (63.1 x 60.6 x 13.0 mm)
- Total weight: 4.8 oz (136 g)
- Flanged baseplate version available

In-Line Manufacturing Process

- AS9100 and ISO 9001:2008 certified facility
- Full component traceability

Compliance Features

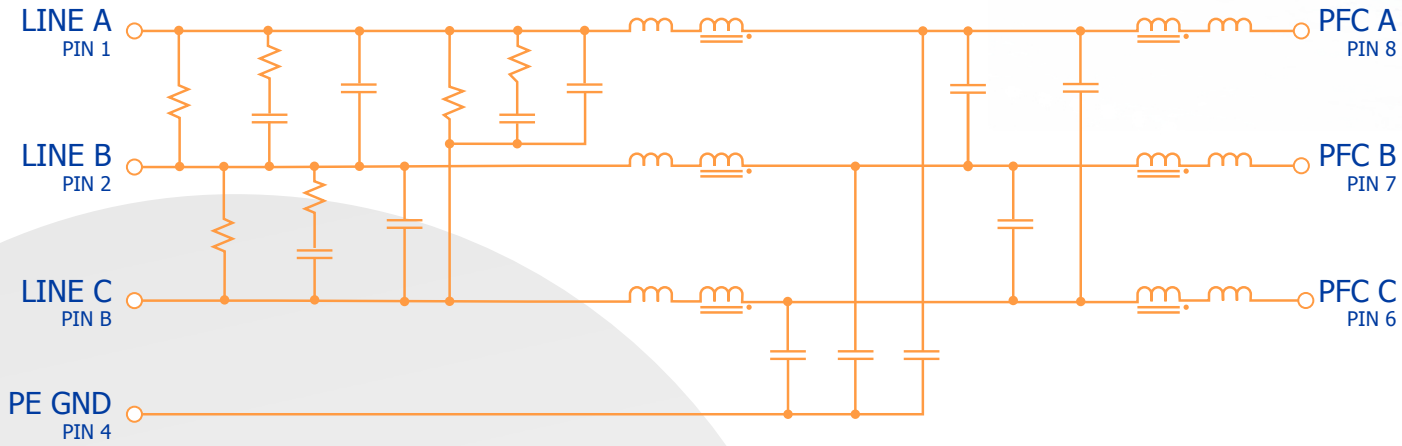
MACF Series filters (with MPFC & MCOTS converters) are designed to meet:

- MIL-STD-704 (A-F) w/ leading power factor
- MIL-STD-461 (C, D, E, F)
- MIL-STD-1399
- MIL-STD-810G

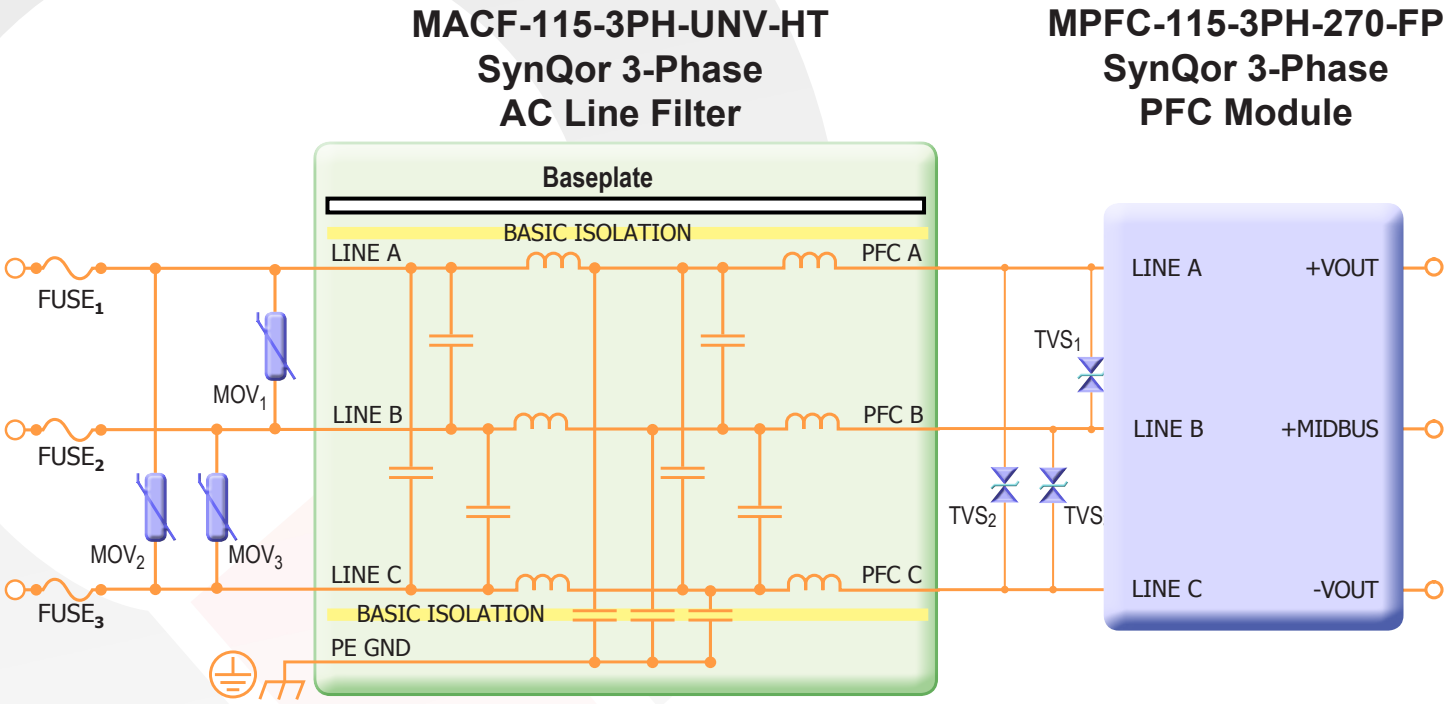
Contents

Technical Diagrams

Fundamental Circuit Diagram



Typical Application Diagram



Suggested Parts:
MOV 1-3 : 300 Vrms, 60 J ; EPCOS S10K300E2
TVS 1-3 : 430 Vpk, 20 J; Micro Commercial AK3-430C
Fuse 1-3 : 250 Vrms, 10 A; Littelfuse 0216010.XEP

MACF-115-3PH-UNV-HT Electrical Characteristics

Operating Conditions: Vin = 115 Vrms L-N (199 Vrms L-L) @ 400 Hz; 4.5 Arms per phase; baseplate temperature 25 °C unless otherwise noted.
Full operating baseplate temperature is -55 °C to 100 °C. Specifications subject to change without notice.

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
ABSOLUTE MAXIMUM RATINGS					
Input Voltage					
Operating			200	Vrms L-N	Continuous (= 346vrms L-L)
Operating Transient Protection			900	Vpk L-L	100 ms transient
Isolation Voltage			2150	Vdc	Input/Output to PE GND pin & baseplate
Operating Case Temperature	-55		100	°C	Baseplate temperature
Storage Case Temperature	-65		135	°C	
RECOMMENDED OPERATING CONDITIONS					
Input Voltage (Continuous)	85	115	140	Vrms L-N	= 147 to 242 Vrms L-L
Input Frequency	45		800	Hz	
Output Current Range			6.0	Arms	Per phase
ELECTRICAL CHARACTERISTICS					
Series Resistance Rs					Per phase
Tcase = 25 ºC		125		mΩ	
Tcase = 100 ºC			200	mΩ	
Total Power Dissipation					
Zero Load, 400 Hz		2.2		W	
Zero Load, 60 Hz		0.5		W	
6 Arms (per phase) @ 400 Hz, Tcase = 25 ºC		16		W	
6 Arms (per phase) @ 400 Hz, Tcase = 100 ºC			24	W	Guaranteed by design
Differential-Mode Line-Line Capacitance		0.35		µF	Three such capacitors form Δ line network
Internal Resistance (line-line)		1.5		MΩ	Discharges capacitors for safe handling
Reactive Power (per phase)		35		VAR	At 400 Hz; scales with line frequency
Common-Mode Capacitance (per phase)		9.4		nF	Three such capacitors connect each line to PE GND
Differential-Mode Attenuation, 200 kHz		45		dB	At 4.5 Arms per phase, See Figure A
Common-Mode Attenuation, 200 kHz		55		dB	At 4.5 Arms per phase, See Figure A
Isolation Resistance	100			MΩ	Any pin to PE GND
RELIABILITY CHARACTERISTICS					
Calculated MTBF (MIL-217) MIL-HDBK-217F		560		10^6 Hrs.	Ground Benign, Tb = 70 °C
Calculated MTBF (MIL-217) MIL-HDBK-217F		39		10^6 Hrs.	Ground Mobile, Tb = 70 °C
Field Demonstrated MTBF				10^6 Hrs.	See our website for details

BASIC OPERATION AND FEATURES

This module is a multi-stage differential-mode and common-mode passive EMI filter designed to interface a 3-Phase AC power source with a SynQor MCOTS 3-Phase PFC module and one or more SynQor converters (or other loads that create EMI).

A typical application would place the MCOTS AC line filter close to the AC input power entry point. The AC line filter's PE GND pin would be connected to the chassis ground that is common with AC input power protective earth 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 inputs & outputs of multiple MCOTS 3-Phase AC line filters in parallel. Connecting filters in this manner may result in slightly imbalanced currents to flow in the three paths of each filter. These imbalanced currents will cause the internal common-mode chokes to saturate and thus degrade common-mode attenuation.

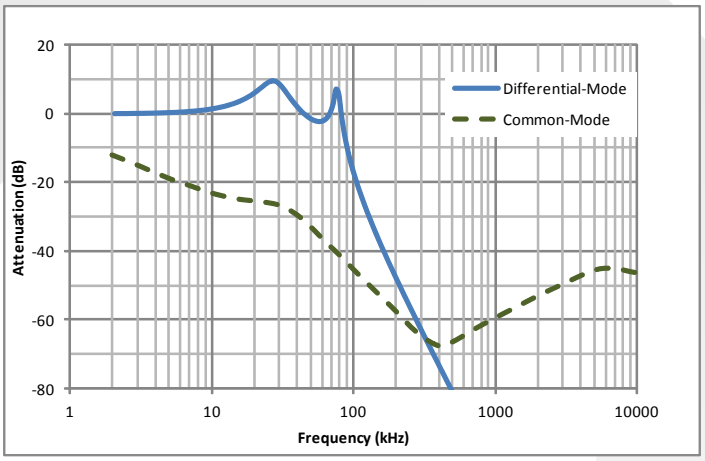


Figure A: *Typical Common Mode and Differential Mode Attenuation as a function of frequency. 115 Vrms, 4.5 Arms. Source and load resistance are 50Ω.*

Standards & Qualification Testing

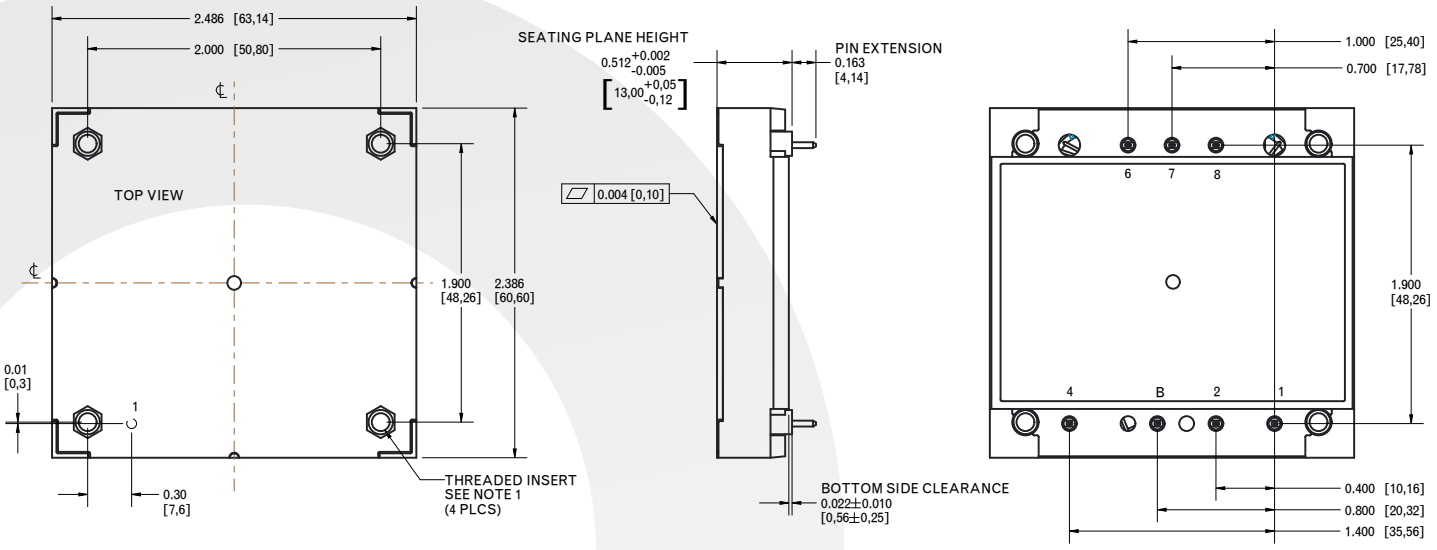
Mil-COTS MIL-STD-810G Qualification Testing

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	•	•

Encased Mechanical Diagram



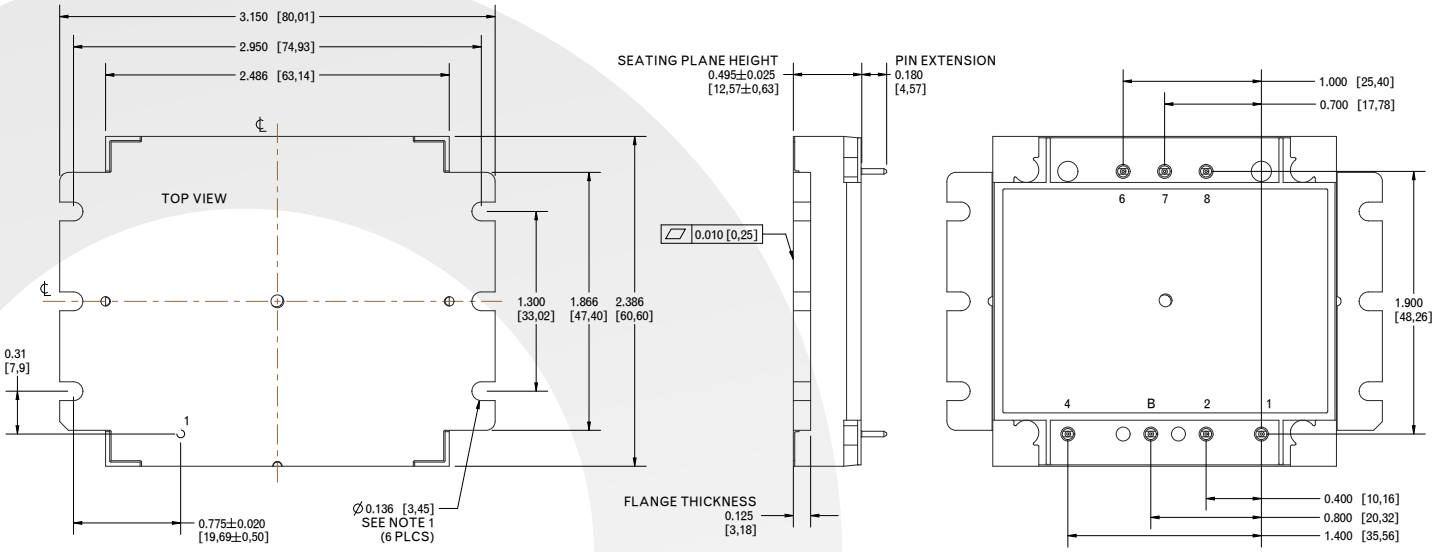
NOTES

1) Applied torque per M3 screw is not to exceed 6 in-lb
   Non-Threaded: Dia 0.125" (3.18 mm)
2) Baseplate flatness tolerance is 0.004" (.10 mm) TIR for surface.
3) Pins are 0.040" (1.02 mm) dia. with 0.080" (2.03 mm) dia. standoffs.
4) All Pins: Material - Copper Alloy
   Finish: Matte Tin over Nickel plate
5) Total weight: 4.8 oz (136 g)
6) Tolerances: x.xx +/-0.02 in. (x.x +/-0.5 mm)
   x.xxx +/-0.010 in. (x.xx +/-0.25 mm)

PIN DESIGNATIONS

Pin	Name	Function
1	LINE A	AC Line Input A
2	LINE B	AC Line Input B
B	LINE C	AC Line Input C
4	PE GND	Protective Earth
6	PFC C	Filter Output C
7	PFC B	Filter Output B
8	PFC A	Filter Output A

Flanged Mechanical Diagram



NOTES

1) Applied torque per M3 or 4-40 screw is not to exceed 6 in-lb
2) Baseplate flatness tolerance is 0.010" (.25 mm) TIR for surface.
3) Pins are 0.040" (1.02 mm) dia. with 0.080" (2.03 mm) diameter standoffs.
4) All Pins: Material - Copper Alloy
   Finish: Matte Tin over Nickel plate
5) Weight: 5.0 oz (142 g)
6) All dimensions in inches (mm)
   Tolerances: x.xx +/-0.02 in. (x.x +/-0.5 mm)
   x.xxx +/-0.010 in. (x.xx +/-0.25 mm)

PIN DESIGNATIONS

Pin	Name	Function
1	LINE A	AC Line Input A
2	LINE B	AC Line Input B
B	LINE C	AC Line Input C
4	PE GND	Protective Earth
6	PFC C	Filter Output C
7	PFC B	Filter Output B
8	PFC A	Filter Output A

Ordering Specifications

Family	Input Voltage	Phase	Input Frequency	Package	Thermal Design	Screening Level
MACF	115	3PH	UNV	HT	N	S
MACF: AC Line Filter	**115:** 85 to 140 Vrms (L-N)	**3PH:** 3-Phase	**UNV:** 45 - 800 Hz	**HT:** Half-Brick Tera	**N:** Encased Threaded **D:** Non-Threaded **F:** Flanged	**S:** S-Grade **M:** M-Grade

Part Number Example: **MACF-115-3PH-UNV-HT-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 6,594,159 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
9,143,042

WARRANTY

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