

SynQor®

MQME-28E-T6 Transient Filter

HIGH RELIABILITY EMI FILTER

-40V to +70V
Continuous Input

20A
Output Current

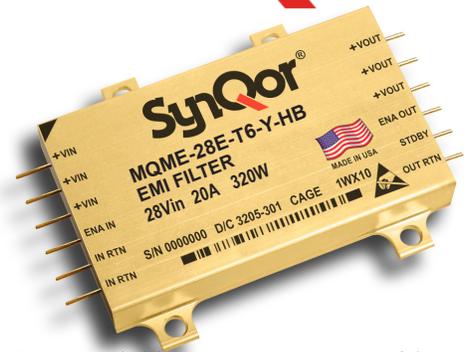
60mΩ @ 125°C
Max. DC Resistance

>80dB @ 500kHz
Differential Attenuation

FULL POWER OPERATION: -55°C to +125°C

The MilQor® series of high-reliability EMI filters brings SynQor's field proven technology and manufacturing expertise to the Military/Aerospace industry. SynQor's innovative QorSeal® 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 comply with a wide range of military standards.

MilQor®



DESIGNED & MANUFACTURED IN THE USA
FEATURING QORSEAL® HI-REL ASSEMBLY

Design Process

MQME series filters are:

- Designed for reliability per NAVSO-P3641-A guidelines
- Designed with components derated per:
 - MIL-HDBK-1547A
 - NAVSO P-3641A

Qualification Process

MQME series filters are qualified to:

- MIL-STD-810F
 - consistent with RTCA/DO-160E/F/G
- SynQor's First Article Qualification
 - consistent with MIL-STD-883F
- SynQor's Long-Term Storage Survivability Qualification
- SynQor's on-going life test

In-Line Manufacturing Process

- AS9100 and ISO 9001 certified facility
- Full component traceability
- Temperature cycling
- Constant acceleration
- 24, 96, 160 hour burn-in
- Three level temperature screening

Features

- Transient suppression circuitry to block voltage surges and spikes
- Soft-Start circuitry to limit in-rush charging currents
- Reverse polarity protection with a low loss synchronous rectifier
- Input over-voltage shutdown
- Output current limit for short-circuit protection
- Enable pass-through circuitry
- Standby circuitry to minimize quiescent power draw
- 20 Amp output current
- Very low DC resistance
- > 80 dB differential-mode attenuation at 500kHz
- > 60 dB common-mode attenuation at 500kHz
- Stabilizing bulk capacitor and damping resistor included
- All capacitors are X7R multi-layer ceramic
- Designed to meet all MIL-STD 461 EMI and most RTCA/DO-160E/F/G Section 22 lightning requirements

Specification Compliance

MQME filters (with MQFL converters) are designed to meet:

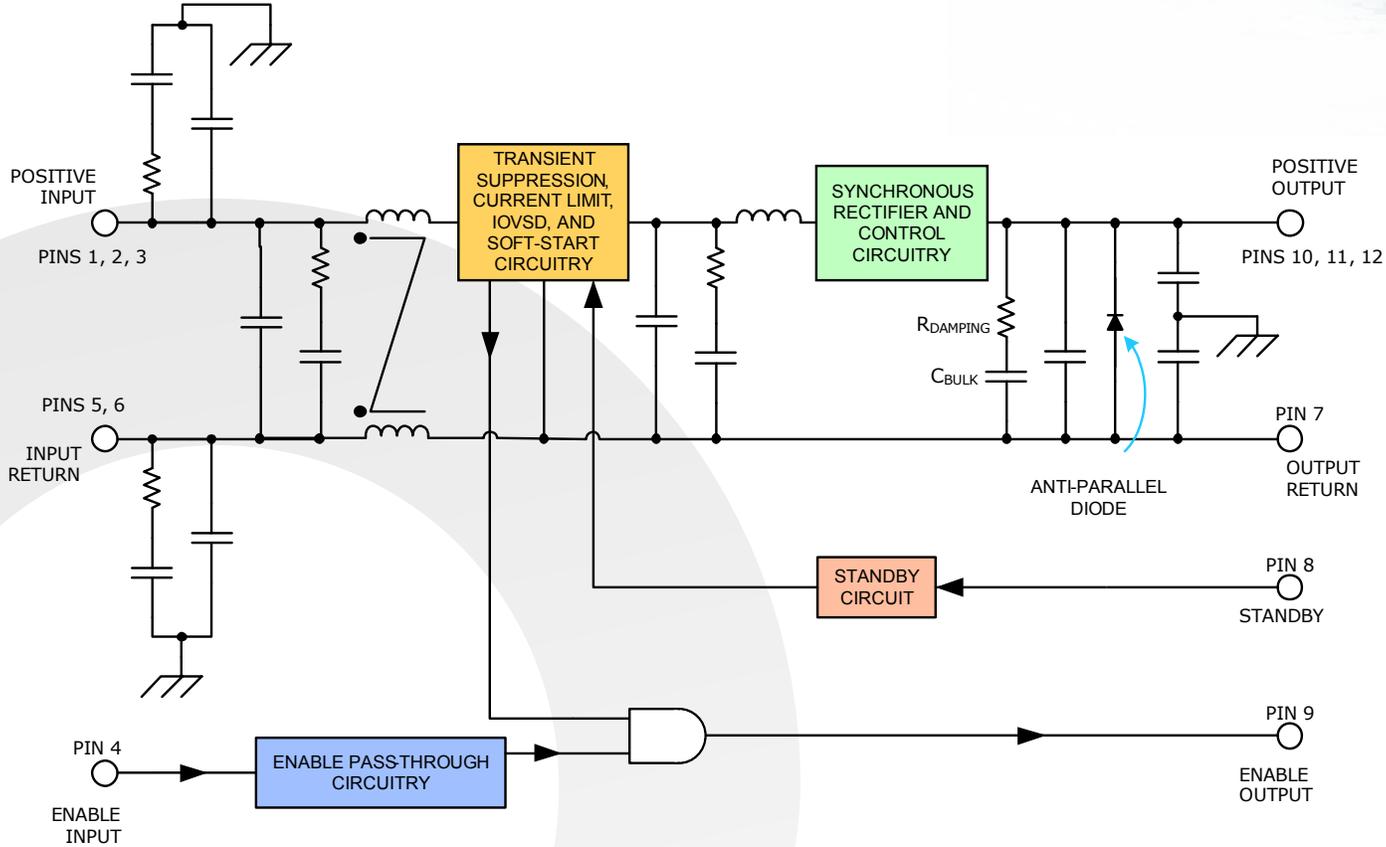
- MIL-HDBK-704-8 (A through F)
- RTCA/DO-160E/F/G Section 16
- MIL-STD-1275B/D
- DEF-STAN 61-5 (part 6)/6
- MIL-STD-461 (C, D, E, F)
- RTCA/DO-160E/F/G Section 22



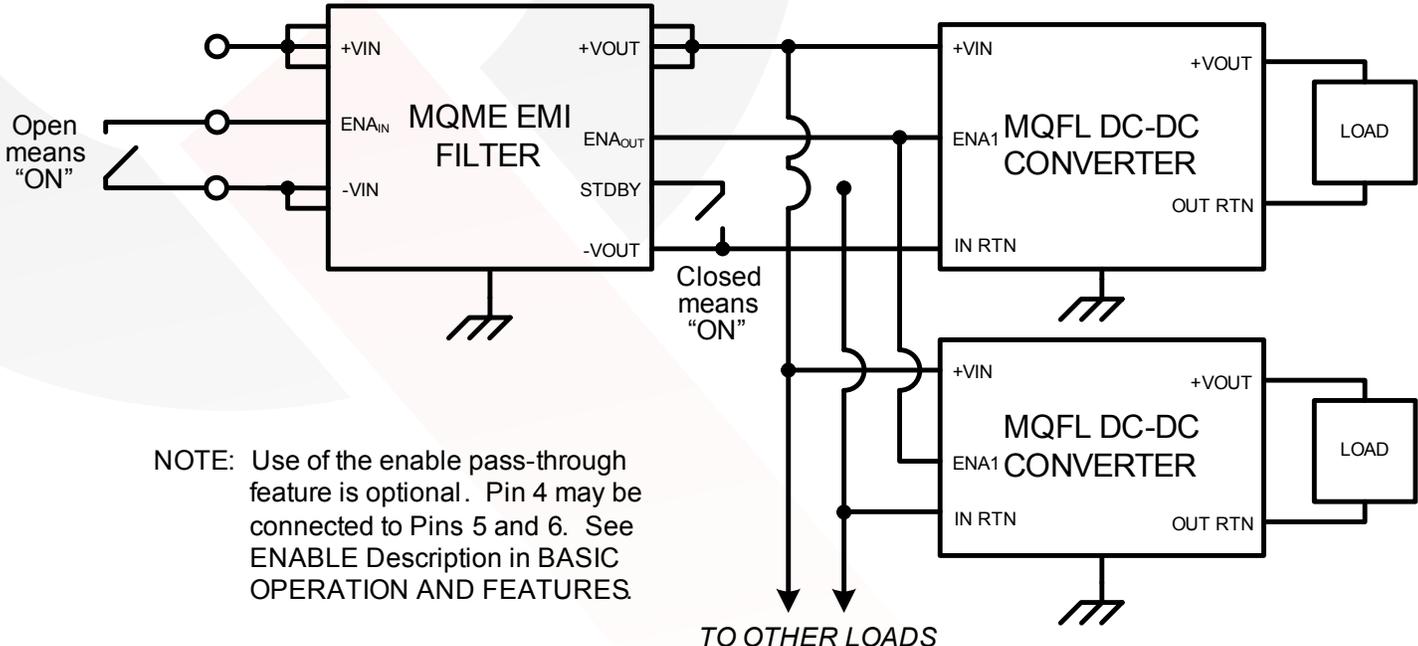
MQME-28E-T6
Current: 20A

Technical Specification

BLOCK DIAGRAM



TYPICAL CONNECTION DIAGRAM



NOTE: Use of the enable pass-through feature is optional. Pin 4 may be connected to Pins 5 and 6. See ENABLE Description in BASIC OPERATION AND FEATURES.



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MQME-28E-T6 ELECTRICAL CHARACTERISTICS

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions	Group A Subgroup (See Note 3)
Specifications subject to change without notice						
					Vin=28V DC ±5%, Pout= 320W unless otherwise specified	
ABSOLUTE MAXIMUM RATINGS						
Input Voltage					See Note 1	
Continuous	-70		100	V		
Transient (≤ 1 s)	-70		210	V		
Isolation Voltage (input/output to case)						
Continuous	-500		500	V		
Transient (≤ 1 s)	-1000		1000	V		
Output Current			25	A		
Operating Case Temperature	-55		125	°C	HB Grade Products, See Note 7	
Storage Case Temperature	-65		135	°C		
Lead Temperature (20 s)			300	°C		
Voltage at ENA IN, ENA OUT	-0.5		50	V		
Voltage at STDBY	0.0		5.0	V		
ELECTRICAL CHARACTERISTICS						
Input Voltage					See INPUT OVER VOLTAGE SHUTDOWN Application Section	
Continuous	-40		70	V	See Note 6	1, 2, 3
Transient (1 s, Rs* = 0 Ω)	-50		80	V	See Note 6	
Transient (≤ 100 ms, Rs* = 0 Ω)	-50		100	V	See Note 6 and Figure E	4
Transient (≤ 1 s, Rs* = 0 Ω)	-50		210	V	See Note 6 and Figure E	
Zero Load Input Current		9.5		mA		
Standby Mode Input Current		4.0		mA		
Output Voltage (continuous)	Vout = Vin - (Iin x Rdc) - Vsr			V		1, 2, 3
Output Current (continuous)			20	A		1, 2, 3
Output Power (continuous)			320	W		1, 2, 3
DC Resistance Rdc						
Tcase = 25°C			45	mΩ		1
Tcase = 125°C			60	mΩ		3
Synchronous Rectifier Drop (Vsr)		40		mV		
Power Dissipation (20A output current)					Vin = 16V	
Tcase = 25°C			18	W		1
Tcase = 125°C			24	W		3
Maximum Output Capacitance			1	mF		
Soft-Start Circuitry						
Output current During Soft-Start		1.6		A	See Note 4	1, 2, 3
Soft-Start Duration Period			110	ms		
Soft-Start Recycle Period		600		ms		
Anti-Parallel Diode						
Forward Current						
Continuous			2	A		1, 2, 3
Transient (≤ 8 ms)			50	A		
Forward Voltage (@ 1 A)		0.6	1.00	V		1, 2, 3
Total Differential-Mode Capacitance		78		μF	Measured across input and output pins	
Total Common-Mode Capacitance		0.27		μF	Measured between any pin to case	
Bulk Capacitor		65		μF		
Damping Resistor		0.2		Ω		
Noise Attenuation					See Figure 1	
INPUT VOLTAGE SPIKE SUPPRESSION						
Output Voltage Deviation due to a Spike					See Note 2	
Input Voltage Spike (Centered on Vin)						
±250 V, 100 μs, Emax = 15 mJ	-10		16	ΔV	MIL-STD-1275B/D	
±200 V, 10 μs, Rs* ≤ 0.5 Ω	-10		16	ΔV	MIL-STD-461C (CS06); DEF-STAN 61-5	
±400 V, 5 μs, Rs* ≤ 0.5 Ω	-10		16	ΔV	MIL-STD-461C (CS06)	
±600 V, 10 μs, Rs* ≤ 0.5 Ω	-10		16	ΔV	RTCA/DO-160E	

* Rs = Source Impedance



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Technical Specification

MQME-28E-T6 ELECTRICAL CHARACTERISTICS (Continued)

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions	Group A Subgroup ³
Specifications subject to change without notice						
Vin=28V DC ±5%, Pout=320W, unless otherwise specified						
INPUT VOLTAGE SURGE SUPPRESSION						
Output Voltage During a Surge						
Input Surge Voltage and Duration						
60 V, 550 ms, Rs* = 0 Ω		60		V	Output not clamped, within continuous operation	
80 V, 100 ms, Rs* = 0 Ω	70		78	V	MIL-HDBK-704A; RTCA/DO-160E	
100 V, 80 ms, Rs* = 0 Ω	70		78	V	MIL-STD-1275B/D; DEF-STAN 61-5	
110 V, 5 ms, Rs* = 0 Ω	70		78	V	DEF-STAN 61-5	
202 V, 350 ms, Rs* = 0 Ω	0		78	V	MIL-STD-1275B/D; DEF-STAN 61-5 (Part 6)/6, see Note 5	
ISOLATION CHARACTERISTICS						
Input Voltage (any pin to case)						
Continuous	-500		500	V		1
Transient (≤ 100 μs)	-800		800	V		
Isolation Resistance (any pin to case)	100			MΩ		1
FEATURE CHARACTERISTICS						
Enable Input						
Off-State Voltage	-0.5		0.8	V		1
Off-State Voltage Pulldown Current	80			μA	Current drain required to ensure logic low	
On-State Voltage	2.0		50	V		1
On-State Pine Leakage Current			20	μA	Imax drawn from pin allowed, module on	
Pull-Up Voltage	3.2	4	4.5	V	See Figure A	1
Enable Output						
Off-State Resistance			17	Ω		1
Off-State Voltage	-100			mV		
On-State Voltage	2		35	V		
On-State Leakage Current			20	μA		1
Standby Input						
Normal-State Voltage	0		3.5	V		
Standby-State Voltage	4		5	V		
Pull-Up Voltage		5		V		
Pull-Up Resistance		50		kΩ		
Under Voltage Lockout						
Turn-On Input Voltage Threshold	15.0	15.5	16.0	V		1
Turn-Off Output Voltage Threshold	2.0	3.0	4.0	V		1
Output Power Limit (continuous)		450		W		1
RELIABILITY CHARACTERISTICS						
Calculated MTBF (MIL-STD-217F2)						
GB @ Tcase = 70°C		14.8		10 ⁶ Hrs.		
AIF @ Tcase = 70°C		0.69		10 ⁶ Hrs.		
WEIGHT CHARACTERISTICS						
Device Weight		79		g		

Electrical Characteristics Notes

1. While the filter will survive these input voltage limits, the filter's output voltage will be outside the limits for an MQFL converter input voltage range.
2. Verified by qualification testing and analysis.
3. Only the ES and HB grade products are tested at three temperatures. The C grade products are tested at one temperature. Please refer to the Construction and Environmental Stress Screening Options table for details.
4. Soft start is engaged only when the output voltage starts from zero or dips below the Turn-Off Output Voltage Threshold (4V max).
5. Module will shut down per Figure E.
6. Shutdown and Restart if the input voltage goes below the UVLO value or above 84V.
7. The specified operating case temperature for ES grade products is -45°C to 100°C. The specified operating case temperature for C grade products is 0°C to 70°C.

* R_S = Source Impedance



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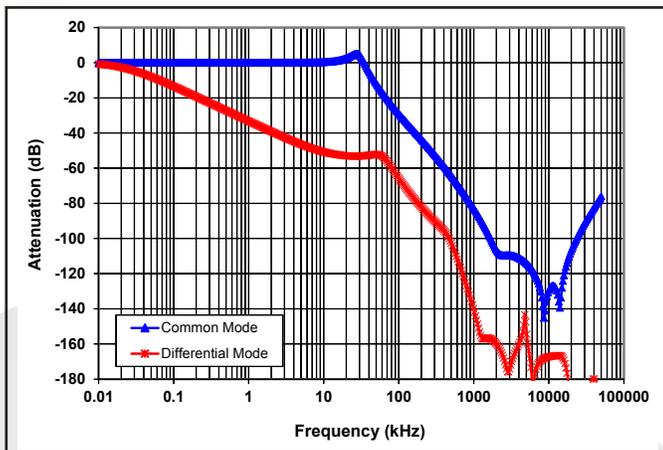


Figure 1: Typical Common Mode and Differential Mode Attenuation provided by the filter as a function of frequency. Both input lines are connected to chassis ground through 50Ω resistors. The filter case is also connected to chassis ground.

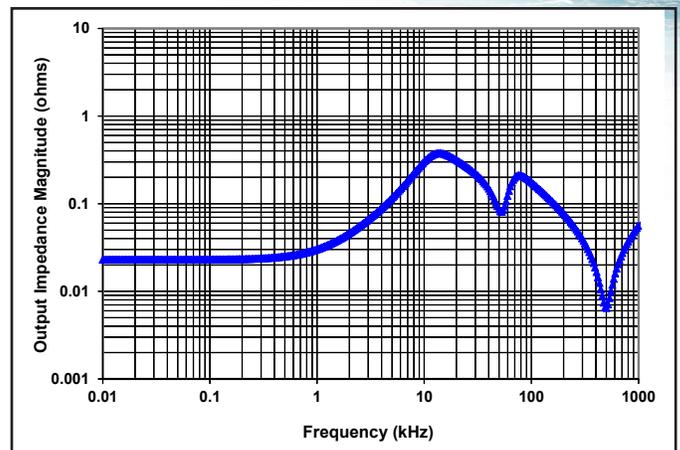


Figure 2: Typical Output Impedance (magnitude) of the filter looking back into its output pins with the input pins connected to a source with zero source impedance.

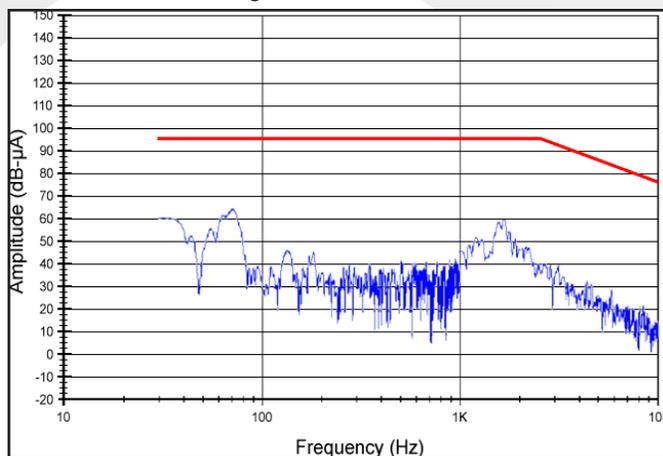


Figure 3: MIL-STD-461E Method CE101 Low Frequency Conducted Emissions. Limit line (in red) is the 'Submarine Applications DC Curve'. See MIL-STD-461 Compliance Matrix Table for test setup.

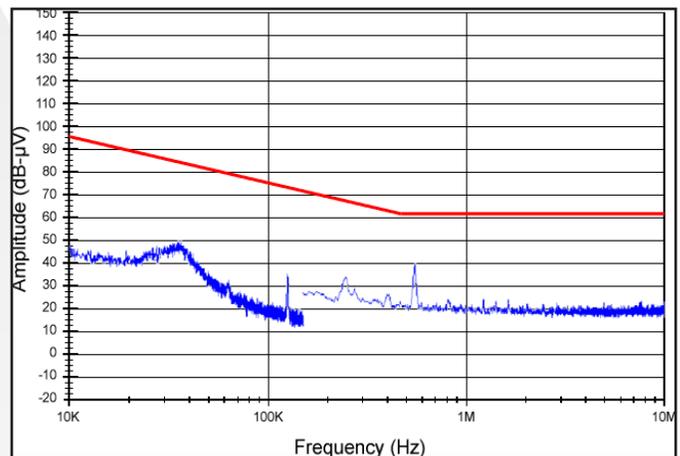


Figure 4: MIL-STD-461E Method CE102 High Frequency Conducted Emissions. Limit line (in red) is the 'Basic Curve'. See MIL-STD-461 Compliance Matrix Table for test setup.

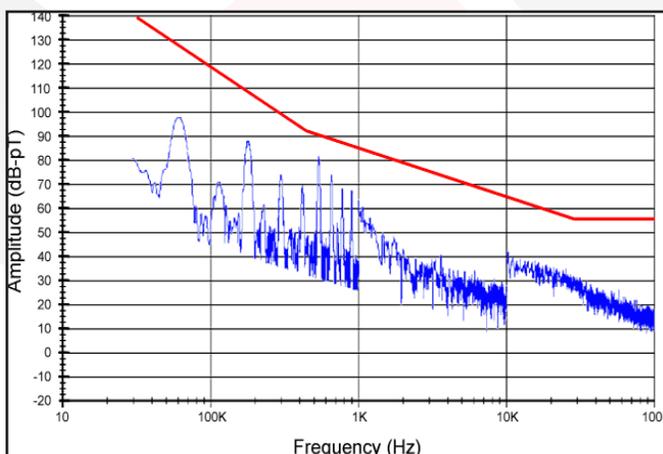


Figure 5: MIL-STD-461E Method RE101 Low Frequency Radiated Emissions. Limit line (in red) is the 'Standard Curve' from MIL-STD-461C Method RE01, which is more strict than all RE101 limits. See MIL-STD-461 Compliance Matrix Table for test setup.

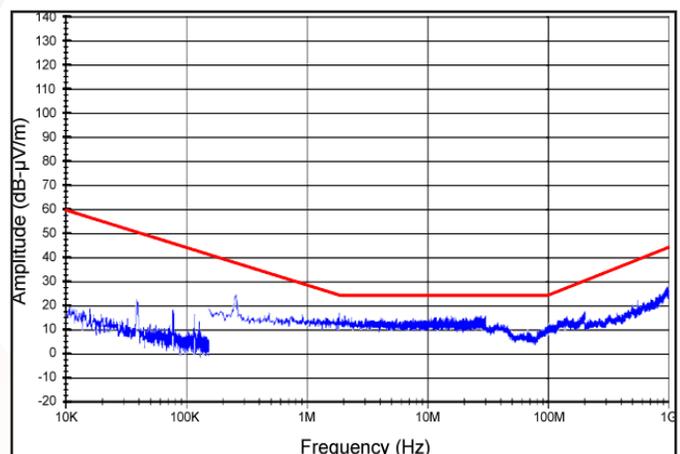


Figure 6: MIL-STD-461E Method RE102 High Frequency Radiated Emissions. Limit line (in red) is the 'Submarine External to Pressure Hull Curve'. See MIL-STD-461 Compliance Matrix Table for test setup.



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BASIC OPERATION AND FEATURES

The MQME-28E-T6 is a multi-stage differential-mode and common-mode passive EMI filter designed to interface a power source with one or more SynQor 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 multi-layer ceramic capacitors are used. Figure 1 shows the typical differential and common-mode attenuation provided by this filter when the source impedance is 50Ω to chassis ground on each input line.

The MQME-28E-T6 EMI filter includes a large bulk capacitor (also X7R) 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). Figure 2 shows the magnitude of the filter's output impedance when the filter input is connected to a stiff voltage source.

When used with SynQor's DC/DC converters, the MQME-28E-T6 EMI filter is designed to pass all the relevant MIL-STD-461C/D/E/F requirements to their most stringent limits. The MIL-STD-461 Compliance Matrix Table lists these requirements and describes the setup used to pass them. Figures 3 - 6 show results from selected conductive and radiated emissions tests.

TRANSIENT SUPPRESSION: The input voltage surge and spike compliance matrix displays the worst case requirements listed in various 28V Military (Vehicle and Aircraft) and Civil Aircraft standards. The MQME-28E-T6 EMI filter is designed to handle all of the short duration voltage spike requirements of these standards (with certain assumptions regarding DEF-STAN 61-5). Some of the long duration voltage surge requirements remain within the 50V maximum transient rating of a SynQor MQFL-28 DC/DC converter. The others require the transient suppression circuitry of the MQME-28E-T6 EMI filter to protect the converter from an over-voltage condition. If MQFL-28E or MQFL-28VE converters are used, voltage surges as high as 80V can be tolerated without the need for this transient suppression circuitry.

The MQME-28E-T6 EMI filter is also designed to pass the waveform types and applications specified in RTCA/DO-160E Section 22 (Lightning Induced Transient Susceptibility) to Level 4. The Section 22 Compliance Matrix Table lists these waveforms and applications and describes the setup used to pass them.

REVERSE POLARITY PROTECTION: The MQME-28E-T6 EMI filter has a series-connected MOSFET that is controlled to function as a diode, but with a very small forward voltage drop ($\leq 4 \text{ m}\Omega \times I_{out}$). This "Synchronous Rectifier" blocks reverse current flow if the filter's input voltage is mistakenly connected with the wrong polarity. The anti-parallel diode, working with the synchronous rectifier, ensures that the filter's output voltage goes only slightly negative during this time, and therefore satisfying the minimum input voltage specifications of SynQor's MQFL converters.

The synchronous rectifier also performs a useful function during negative polarity spikes and surges, and during brief power interrupts. Since it stops current from flowing negatively through the EMI filter back toward the source, the synchronous rectifier allows the total bulk capacitor (located both within and external to the filter) to better hold up the output voltage during these transients.

ENABLE: The MQME-28E-T6 filter has enable pass-through circuitry that bridges an enable signal across the filter's common-mode impedance. The ENABLE INPUT pin (pin 4) is referenced with respect to the filter's INPUT RETURN (pins 5 and 6). The ENABLE OUTPUT pin (pin 9) is referenced with respect to the filter's OUTPUT RETURN (pin 7). The INPUT RETURN and OUTPUT RETURN may have a different voltage due to common-mode noise and transients.

NOTE: During the time that the MQME-28E-T6 filter is in its Soft-Start mode the ENABLE OUTPUT will be held at a logic low. This is done so that all of the filter's loads can be disabled by this signal during the Soft-Start period. Once the Soft-Start is completed, ENABLE OUTPUT will follow ENABLE INPUT.

Figure A shows the equivalent circuit looking into ENABLE INPUT. The ENABLE INPUT pin must be pulled low to turn an MQFL converter off. It may be left open-circuit to turn the converter on.

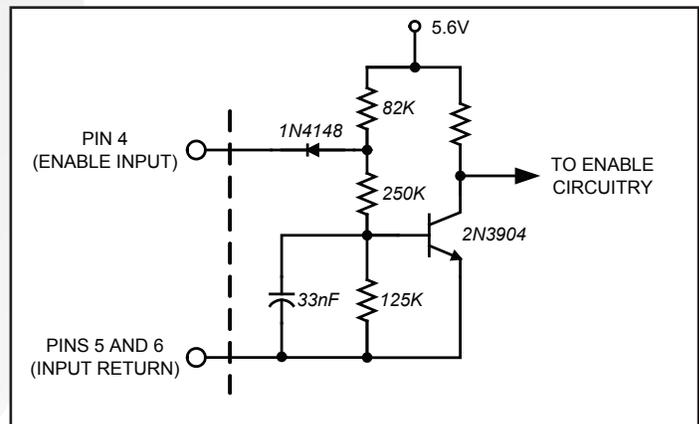


Figure A: Equivalent circuit looking into the ENABLE INPUT pin with respect to the INPUT RETURN pin.

Figure B shows the equivalent circuit looking into ENABLE OUTPUT. The n-channel MOSFET in this circuit turns on when power is applied to the filter and ENABLE INPUT is low. Otherwise, the MOSFET is off. ENABLE OUTPUT is capable of driving the ENABLE INPUTs of up to 15 MQFL converters.

If the enable pass-through circuit is not being used, the ENABLE INPUT pin may be left open or connected to the INPUT RETURN pins. The ENABLE OUTPUT pin may be left open or connected to the OUTPUT RETURN pins.

SOFT-START: The MQME-28E-T6 filter incorporates Soft-Start circuitry to limit the amount of current drawn from the power source by the charging of large bulk capacitors at the filter's output.



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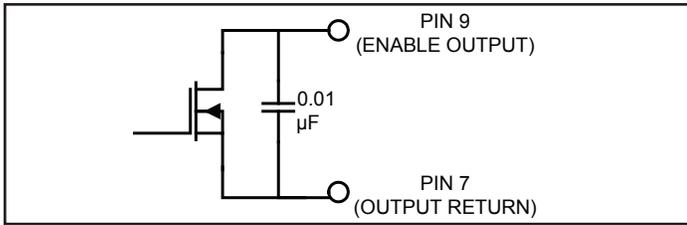


Figure B: Equivalent circuit looking into the ENABLE OUTPUT pin with respect to the OUTPUT RETURN pin.

Once the input voltage exceeds the turn-on threshold value, the Soft-Start circuitry controls the filter’s output current to be approximately 1.6A. This mode of operation continues until the filter’s output voltage reaches the input voltage, at which time the filter is able to deliver its rated output current. If after the Soft-Start duration period the filter’s output has not risen to the input voltage, then the filter will disconnect the output from the input, wait for a time equal to the Soft-Start recycle period, and initiate a new Soft-Start.

Since, during Soft-Start, the filter will deliver only 1.6A to its output, it is important to limit the load current so that the total bulk capacitance can be fully charged before the Soft-Start duration period is over. To facilitate this, the filter’s ENABLE OUTPUT pin is held low during the Soft-Start mode. This signal can therefore be used to disable the filter’s loads during this time. Once the Soft-Start mode is completed, ENABLE OUTPUT will follow ENABLE INPUT.

OUTPUT POWER LIMIT: The MQME-28E-T6 filter has an output power limit feature to protect against a short circuit at its output pins. This limit is disabled whenever the output voltage is rising so that it will not be encountered when charging output capacitance. When the output power exceeds ~450W and its output voltage is decreasing however, this feature will turn the filter off and reinstitute a soft-start cycle in 500ms. Figure C shows the output power limit threshold as a function of output voltage.

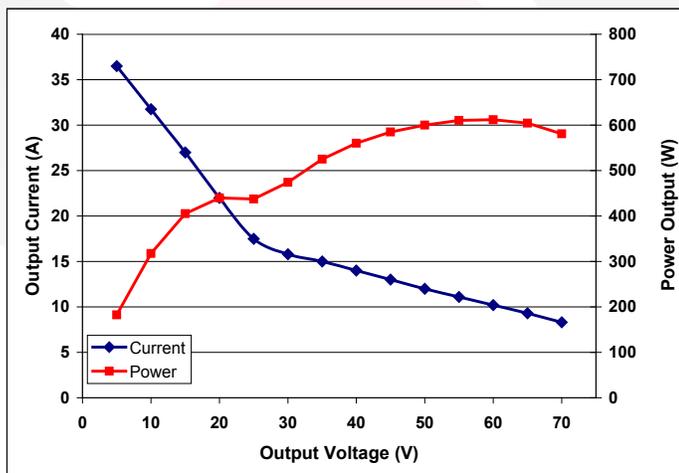


Figure C: Output Power Limit.

STANDBY: The MQME-28E-T6 filter has standby circuitry that minimizes the power drawn from the filter’s input power source when the standby feature is activated.

It does this in two ways. First, the output of the filter is disconnected from the input so that there will be no power drawn by downstream converters or other loads. Second, the active circuitry within the filter is placed into a reduced power consumption mode. The net result is a current draw of only about 2mA from a 28V input power source.

Figure D shows the equivalent circuit looking into the STANDBY pin (pin 8).

This pin is referenced with respect to the filter’s OUTPUT RETURN pin (pin 7). It should be pulled low to have the filter operate in its normal mode. If the pin is instead left open-circuit and pulled high by its internal circuitry, the standby feature will be activated.

Application Note: A typical application would place the MQME filter close to the input of the DC/DC converter, with the cases of the filter and the converter connected together through a ground plane. Both cases are electrically conductive, so connection to the cases can be made with the fasteners used to secure the device.

Do not connect the outputs of multiple MQME-28E-T6 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.

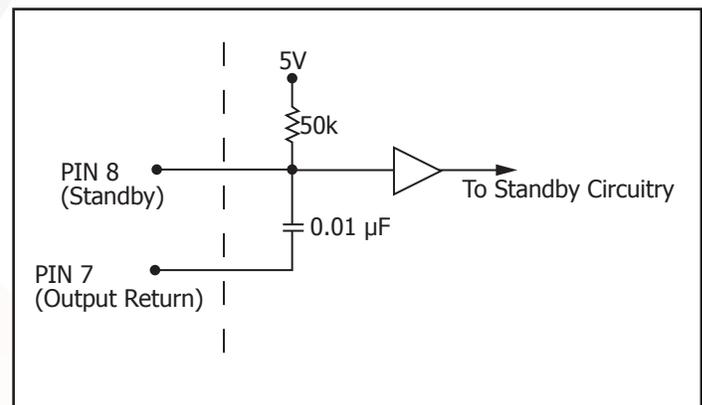


Figure D: Equivalent circuit looking into the STANDBY pin with respect to the OUTPUT RETURN pin.



Technical Specification

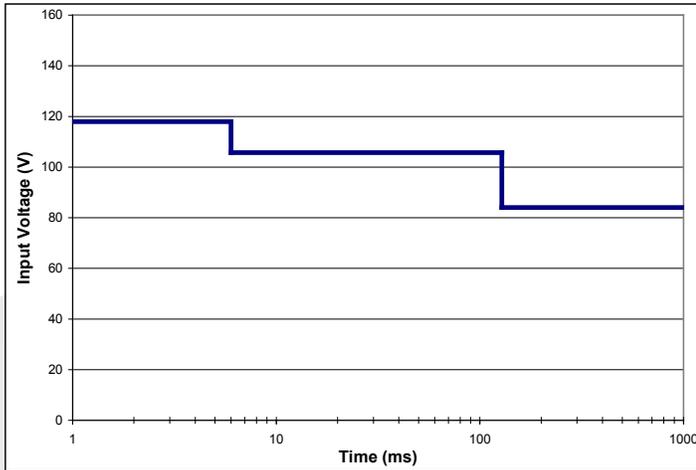


Figure E: Input over voltage shutdown envelope.

INPUT OVER VOLTAGE SHUTDOWN: To protect itself from damage due to sustained excessive power dissipation, the filter will shut down if the input voltage versus time exceeds the envelope in Figure E.

During this shutdown, power flow to the load is interrupted and the filter's ENABLE OUTPUT pin is pulled LOW. When the input voltage returns to normal limits (and a Soft-Start Recycle Period has elapsed), the filter automatically begins a Soft-Start cycle.

All of the surges listed in the VOLTAGE SURGE AND SPIKE COMPLIANCE MATRIX on page 11 fall below the Figure E envelope. Only the DEF STAN 61-5 (Part 6)/6 DIT08.B surge exceeds this envelope. During a DIT08.B surge the filter will shutdown and then automatically restart once the surge passes. This meets the requirements of DEF STAN 61-5 (Part 6)/6 at Performance Criterion C while the DIT08.B test requires only Performance Criterion D.

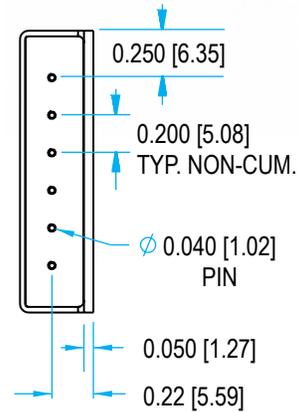
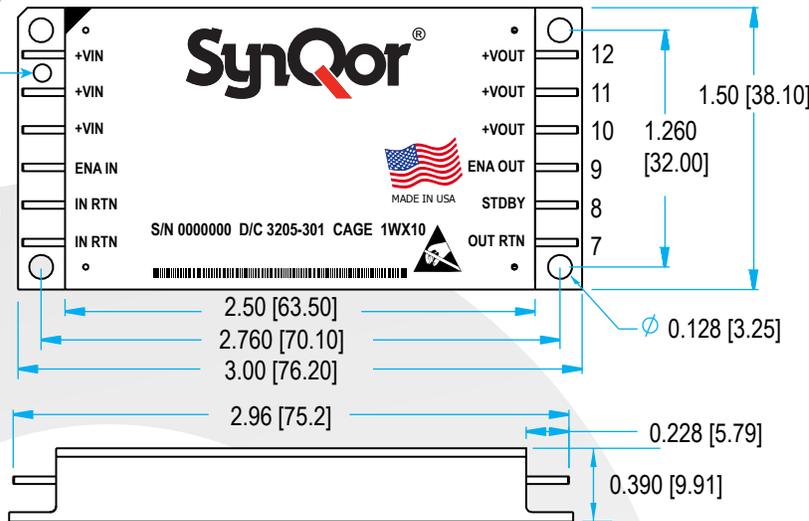


SynQor®

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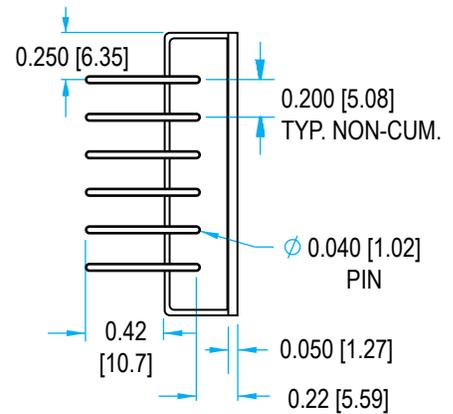
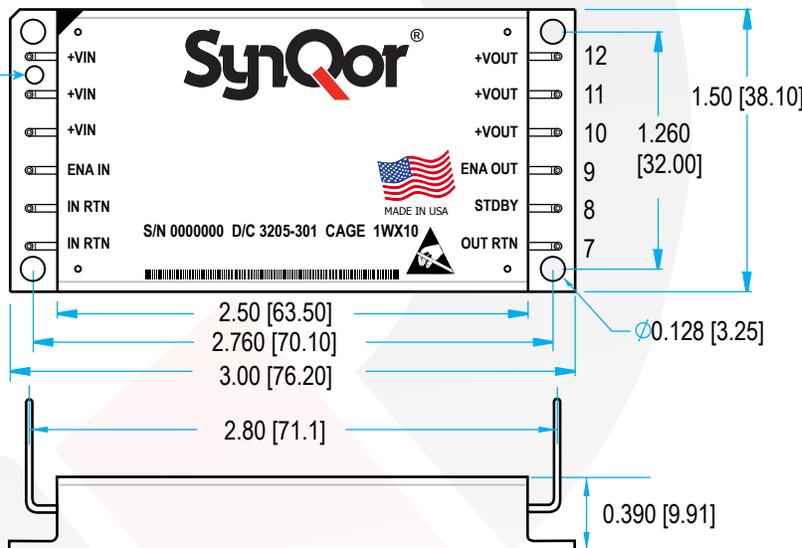
MQME-28E-T6
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SEE NOTE 7



Case X

SEE NOTE 7



Case U

NOTES

- 1) Pins 0.040" (1.02 mm) diameter
- 2) Pins Material: Copper Alloy
Finish: Gold over Nickel plating, followed by Sn/Pb solder dip
- 3) 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)
- 4) Weight: 2.8 oz (78.5 g) typical
- 5) Workmanship: Meets or exceeds IPC-A-610C Class III
- 6) Print Labeling on Top Surface per Product Label Format Drawing
- 7) Pin 1 identification hole, not intended for mounting (case X and U)

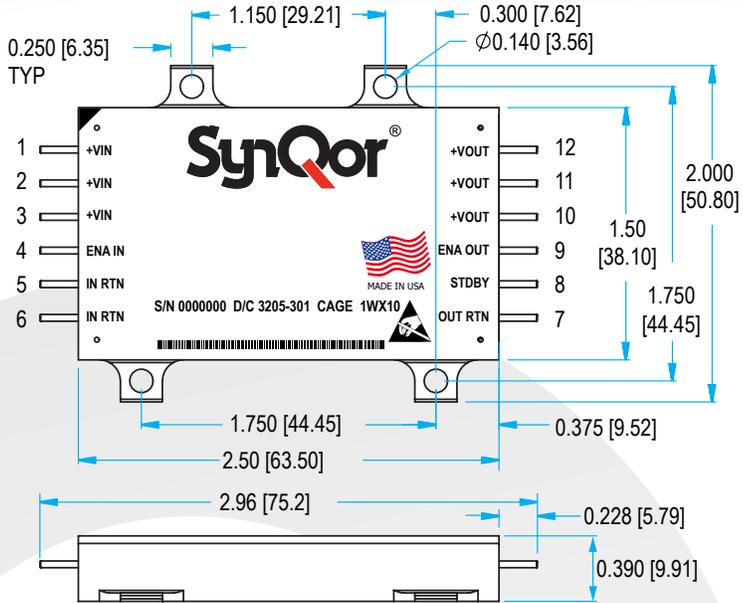
PIN DESIGNATIONS

Pin #	Function	Pin #	Function
1	Positive input	7	Output Return
2	Positive input	8	Standby
3	Positive input	9	Enable output
4	Enable input	10	Positive output
5	Input return	11	Positive output
6	Input return	12	Positive output

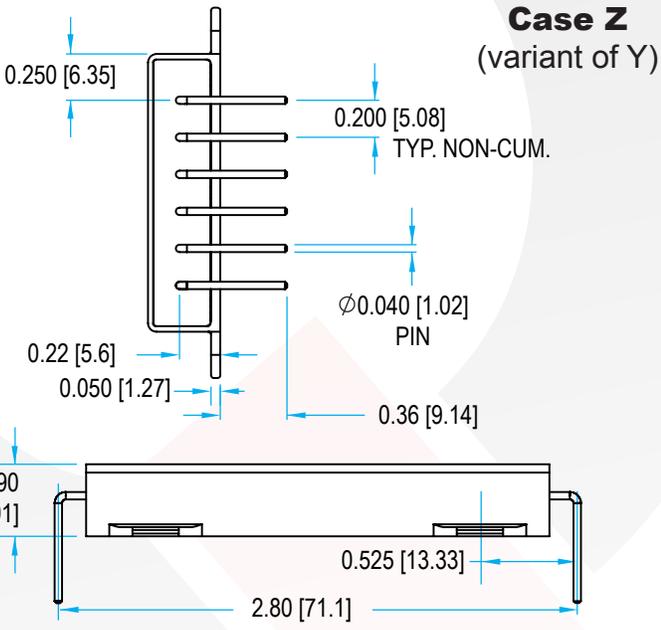


MQME-28E-T6
Current: 20A

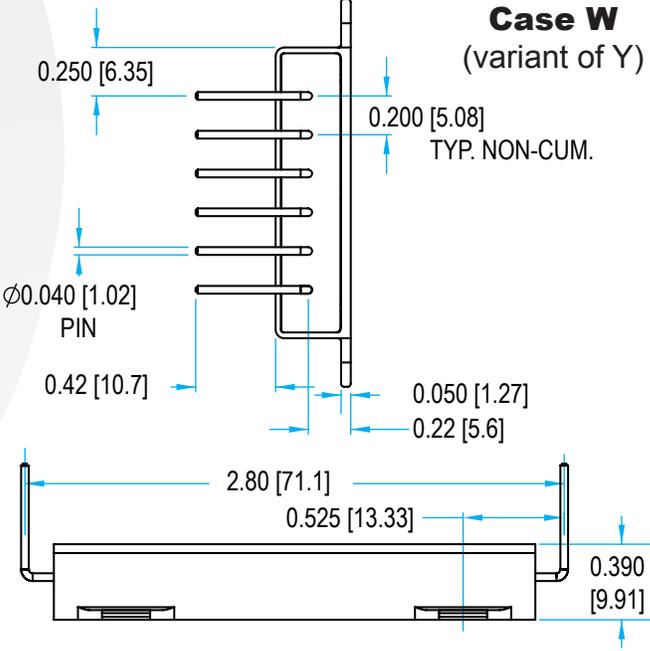
Technical Specification



Case Y



Case Z
(variant of Y)



Case W
(variant of Y)

NOTES

- 1) Pins 0.040" (1.02 mm) diameter
- 2) Pins Material: Copper Alloy
Finish: Gold over Nickel plating, followed by Sn/Pb solder dip
- 3) 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)
- 4) Weight: 2.8 oz (78.5 g) typical
- 5) Workmanship: Meets or exceeds IPC-A-610C Class III
- 6) Print Labeling on Top Surface per Product Label Format Drawing
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PIN DESIGNATIONS

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4	Enable input	10	Positive output
5	Input return	11	Positive output
6	Input return	12	Positive output



MQME-28E-T6

Current: 20A

Technical Specification

VOLTAGE SURGE AND SPIKE COMPLIANCE MATRIX

These tables show the Voltage Surge and Spike requirements/limits that have been met* by a stand-alone setup comprised of:

- MQME-28-P (or -T) Filter
- MQFL-28-05S DC/DC Converter
- 120W Resistive Load
- Metal Chassis Plane

Vehicle 28Vin	Part	Worst Case Over-Voltage Surge (Voltage/Duration)	Short Duration Spikes (Voltage/Duration/Impedance)
MIL-STD-1275D	(Gen. + Bat.)	40V / 50ms	±250V / 15mJ / 0.5Ω
	(Bat. only)	100V / 50ms	
	(Gen. only)	100V / 50ms	
DEF STAN 61-5 (PART 6)/5†	(Gen. + Bat.)	40V / 50ms	+130V to -100V max§ +90V to -60V / 10µs§
	(Bat. Only)	+70V to -40V / 5ms§	
	(Bat. Only, Non-Regen. Ld. Sw.)	+70V to -40V / 5ms§	
	(Bat. Only, Regen. Ld. Sw.)	80V / 80ms§	
	(Gen. only)	80V / 80ms§ 100V / 50ms +110V to -50V / 5ms§	
DEF STAN 61-5 (PART 6)/6†	DIT08.B, DIT07.B	+174V / 350ms	±200V / 200ns / 50Ω +90V to -60V / 10µs§
	DET03.A	40V / 50ms§	
	DET04.A	+70V to -40V / 1ms§	
	DIT04.A	+110V / 300ms§	

Aircraft 28Vin	Part	Worst Case Over-Voltage Surge (Voltage/Duration)	Short Duration Spikes (Voltage/Duration/Impedance)
MIL-HDBK-704-8	(704A)	80V / 50ms	N/A
		60V / 550ms	
	(704B, C, D, E, F)	50V / 50ms	
RTCA/DO-160E	(Cat A)	47V / 100ms	±600V / 10µs / 50Ω
		38V / 1s	
	(Cat B)	60V / 100ms	±200V / 10µs / 50Ω
		40V / 1s	
	(Cat C)	80V / 100ms	N/A
48V / 1s			

Met by any Hi-Rel Filter	Met by an MQME-28-T Filter having the Transient Suppression and Reverse Polarity Protection Features	Met by MQME-28E-T6 Filter Only: Performance Criteria C
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* Surge/spike requirements/limits are deemed to have been met as long as transient deviations in the converter's output voltage remain within ±10% of its initial value.

§ These are defined as the maximum disturbances that equipment can inflict upon the power system, not as disturbances imposed upon utilization equipment. To ensure compatibility, however, these are within the designed stress envelope of the indicated filters & converters.

† For the DEF STAN 61-5 specification:

- 1) Negative surges require reverse voltage protection circuitry to protect the converter (but not the filter) from a negative input. This circuitry is included in the MQME-28-T but not the MQME-28-P and MQHE-28-P filters.
- 2) The negative surges may cause the converter to shut down unless additional holdup capacitance is included.
- 3) Maximum spike voltages are assumed to last <1µs



MIL-STD-461 COMPLIANCE MATRIX

This table shows the MIL-STD-461 requirements/limits that have been met* by a stand-alone setup comprised of:

- MQME-28-P (or -T) Filter
- MQFL-28-05S DC/DC Converter
- 120W Resistive Load
- Metal Chassis Plane

	-461C		-461D/E/F	
	Requirement	Most Stringent Limit Listed	Requirement	Most Stringent Limit Listed
Conducted Emissions	CE01 CE03 CE07	Class A5 (Submarine) Class A5 (Submarine) Class A1 (Aircraft)	CE101 CE102	Submarine Basic Curve
Conducted Susceptibility	CS01 CS02	Class A5 (Submarine) Class A5 (Submarine)	CS101	Curve #2
	CS06	Class A1/A5 (Aircraft/Sub)	CS106	(461F Only)
	CS10 CS11	Class A5 (Submarine) Class A5 (Submarine)	CS114 CS115 CS116	Curve #5 Basic Waveform $I_{MAX} = 10A$
Radiated Emissions	RE01 RE02†	Class A5 (Submarine) Class A5 (Submarine)	RE101 RE102†	Navy Submarine
Radiated Susceptibility	RS01 RS02 RS03	Class A5 (Submarine) Class A1/A5 (Aircraft/Sub) Class A4 (Surface Ship)	RS101 RS103	Army Aircraft External

Met by any MQME/MQHE Filter	Met by an MQME Filter having the Transient Suppression and Reverse Polarity Protection Features
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* Susceptibility requirements/limits are deemed to have been met as long as transient deviations in the converter's output voltage remain within $\pm 10\%$ of its initial value.

† Met with metal screen shield covering the filter, converter, and resistive load.



MQME-28E-T6

Current: 20A

Technical Specification

**RTCA/DO-160E SECTION 22 COMPLIANCE MATRIX
(LIGHTNING INDUCED TRANSIENT SUSCEPTIBILITY)**

The following table shows the RTCA/DO-160 Section 22 requirements that have been met* by a stand-alone setup comprised of:

- MQME-28-P (or -T) Filter
- MQFL-28-05S DC/DC Converter
- Resistive Load
- Metal Chassis Plane
- Unshielded Power Cable Bundle

	Waveform	Maximum Level Passed	Test Conditions
Pin Injection	3	4	Signal applied to +Vin pin. Input Return pin connected to system ground
	4	4†	
	5a	4†	
Single- and Multiple-Stroke Cable Induction	2	4**	Signal applied to unshielded power cable bundle
	3	4	
Single- and Multiple-Stroke Ground Injection	4	4	Signal applied between metal ground plane and system ground
	5a	4	
Multiple-Burst Cable Induction	3	4	Signal applied to unshielded power cable bundle

Met by any MQME/MQHE Filter	Met by an MQME Filter having the Transient Suppression and Reverse Polarity Protection Features
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* Requirement is deemed to have been met as long as transient deviations in the converter’s output voltage remain within ±10% of its initial value.

† For these waveforms at Level 3 and above, an external transient suppressor of sufficient energy rating must be placed across the filter’s input pins to keep the differential transient input voltage below +200V/-50V. Negative polarity waveforms may cause power flow to the converter to be interrupted long enough to cause a graceful shutdown and restart of the converter. Also, the reverse voltage protection feature of the -T filter is required to protect the converter (but not the filter) from negative polarity waveform.

** For this waveform at a Level 4 and above, external transient suppressors of sufficient energy rating must be added between the filter’s input power pins and its case to keep the common-mode transient input voltage below ±800V.



MQME-28E-T6

Current: 20A

Technical Specification

CONSTRUCTION AND ENVIRONMENTAL STRESS SCREENING OPTIONS

Screening	Consistent with MIL-STD-883F	C-Grade (specified from 0 °C to +70 °C)	ES-Grade (specified from -45 °C to +100 °C)	HB-Grade (specified from -55 °C to +125 °C)
Element Evaluation		No	Yes	Yes
Internal Visual	IPC-A-610 Class 3	Yes	Yes	Yes
Temperature Cycle	Method 1010	No	Condition B (-55 °C to +125 °C)	Condition C (-65 °C to +150 °C)
Constant Acceleration	Method 2001 (Y1 Direction)	No	500 g	Condition A (5000 g)
Burn-in	Method 1015	24 Hrs @ +125 °C	96 Hrs @ +125 °C	160 Hrs @ +125 °C
Final Electrical Test	Method 5005 (Group A)	+25 °C	-45, +25, +100 °C	-55, +25, +125 °C
Mechanical Seal, Thermal, and Coating Process			Full QorSeal	Full QorSeal
External Visual	Method 2009	Yes	Yes	Yes
Construction Process			QorSeal	QorSeal

MilQor® Hi-Rel converters and filters are offered in three variations of environmental stress screening options. All ES-Grade and HB-Grade MilQor Hi-Rel converters use SynQor’s proprietary QorSeal® Hi-Rel assembly process that includes a Parylene-C coating of the circuit, a high performance thermal compound filler, and a nickel barrier gold plated aluminum case. Each successively higher grade has more stringent mechanical and electrical testing, as well as a longer burn-in cycle. The ES- and HB-Grades are also constructed of components that have been procured through an element evaluation process that pre-qualifies each new batch of devices.



SynQor®

Technical Specification

MQME-28E-T6

Current: 20A

MIL-STD-810F Qualification Testing

MIL-STD-810F Test	Method	Description
Fungus	508.5	Table 508.5-I
Altitude	500.4 - Procedure I	Storage: 70,000 ft / 2 hr duration
	500.4 - Procedure II	Operating: 70,000 ft / 2 hr duration; Ambient Temperature
Rapid Decompression	500.4 - Procedure III	Storage: 8,000 ft to 40,000 ft
Acceleration	513.5 - Procedure II	Operating: 15 g
Salt Fog	509.4	Storage
High Temperature	501.4 - Procedure I	Storage: 135 °C / 3 hrs
	501.4 - Procedure II	Operating: 100 °C / 3 hrs
Low Temperature	502.4 - Procedure I	Storage: -65 °C / 4 hrs
	502.4 - Procedure II	Operating: -55 °C / 3 hrs
Temperature Shock	503.4 - Procedure I - C	Storage: -65 °C to 135 °C; 12 cycles
Rain	506.4 - Procedure I	Wind Blown Rain
Immersion	512.4 - Procedure I	Non-Operating
Humidity	507.4 - Procedure II	Aggravated cycle @ 95% RH (Figure 507.5-7 aggravated temp - humidity cycle, 15 cycles)
Random Vibration	514.5 - Procedure I	10 - 2000 Hz, PSD level of 1.5 g ² /Hz (54.6 g _{rms}), duration = 1 hr/axis
Shock	516.5 - Procedure I	20 g peak, 11 ms, Functional Shock (Operating no load) (saw tooth)
	516.5 - Procedure VI	Bench Handling Shock
Sinusoidal vibration	514.5 - Category 14	Rotary wing aircraft - helicopter, 4 hrs/axis, 20 g (sine sweep from 10 - 500 Hz)
Sand and Dust	510.4 - Procedure I	Blowing Dust
	510.4 - Procedure II	Blowing Sand



SynQor[®]

Technical Specification

MQME-28E-T6
Current: 20A

First Article Testing consistent with MIL-STD-883F

MIL-STD-883F Test	Method	Description
Electrical Tests	5005	
Physical Dimensions test	2016	
Resistance to Solvents test	2015.13	
Solderability test	2003.8	
Lead Integrity test	2004.5	
Salt Atmosphere test	1009.8	Condition "A"
Adhesion of Lead Finish test	2025.4	
Altitude Operation test	1001	Condition "C"
ESD Sensitivity	3015.7	Class 2
Stabilization Bake test	1008.2	Condition "C"
Vibration Fatigue test	2005.2	Condition "A"
Random Vibration test	2026	Condition "II K"
Sequential Test Group #1		
Life Test – Steady State test	1005.8	
Life Test – Intermittent Duty test	1006	
Sequential Test Group #2		
Temperature Cycle test	1010.8	Condition "C"
Constant Acceleration test	2001.2	Condition "A"
Sequential Test Group #3		
Thermal Shock test	1011.9	Condition "B"
Temperature Cycle test	1010.8	Condition "C"
Moisture Resistance test	1004.7	With Sub cycle
Sequential Test Group #4		
Mechanical Shock test	2002.4	Condition "B"
Variable Frequency Vibration test	2007.3	Condition "A"



Technical Specification

MilQor Filter FAMILY MATRIX

The tables below show the array of MilQor filters available. When ordering SynQor converters, please ensure that you use the complete part number according to the table in the last page. Contact the factory for other requirements.

Product Family Designator	Continuous Input Voltage	Power (Amperage) Rating	Version (see table below)	Features Available (In Addition to Passive Filter Components)			
				Enable Pass-Through Circuitry	Transient Suppression Circuitry	Soft-Start Circuitry	Reverse Polarity Protection Circuitry
MQME-28	40V	320W (20A)	P				
MQME-28E	70V		T	•	•	•	•
			T6	•	•	•	•
MQHE-28	40V	160W (10A)	P				
MQHE-28E	70V						
MQHE-270	400V	160W (1A)	P				
MQME-270	400V	320W (2A)	P				
			R				•
MQME-270L	400V	200W (3A)	P				
			R				•



MQME-28E-T6
Current: 20A

Technical Specification

PART NUMBERING SYSTEM

The part numbering system for SynQor's *MilQor* DC-DC converters follows the format shown in the table below.

Model Name	Input Voltage Range	Version	Package Outline/Pin Configuration	Screening Grade
MQME MQHE	28 28E	P T T6	U X Y W Z	C ES HB
	270 270L	P R		

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

Example: MQME-28E-T6-Y-ES

APPLICATION NOTES

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

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

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:
 6,927,987 7,050,309 7,765,687
 7,787,261 8,149,597 8,644,027