

SynQor®

MQHL-28-3R3S
Single Output

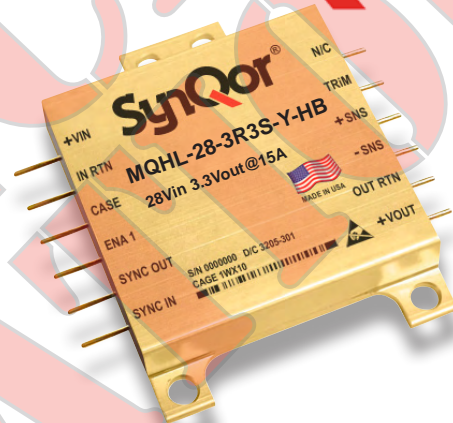
HIGH RELIABILITY DC-DC CONVERTER

16-40 V Continuous Input	16-50 V Transient Input	3.3 V Output	15.0 A Output	86% @ 7.5A / 86% @ 15A Efficiency
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FULL POWER OPERATION: -55°C TO +125°C

The MilQor series of high-reliability DC-DC converters brings SynQor's field proven high-efficiency synchronous rectifier technology 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 converters operate at a fixed frequency, have no opto-isolators, and follow conservative component derating guidelines. 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

MQHL series converters are:

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

Qualification Process

MQHL series converters are qualified to:

- MIL-STD-810F
 - consistent with RTCA/DO-160E
- 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 9001:2000 certified facility
- Full component traceability
- Temperature cycling
- Constant acceleration
- 24, 96, 160 hour burn-in
- Three level temperature screening

Features

- Fixed switching frequency
- No opto-isolators
- Remote sense
- Clock synchronization
- Primary referenced enable
- Continuous short circuit and overload protection
- Input under-voltage lockout/over-voltage shutdown
- Output under voltage and over voltage protection

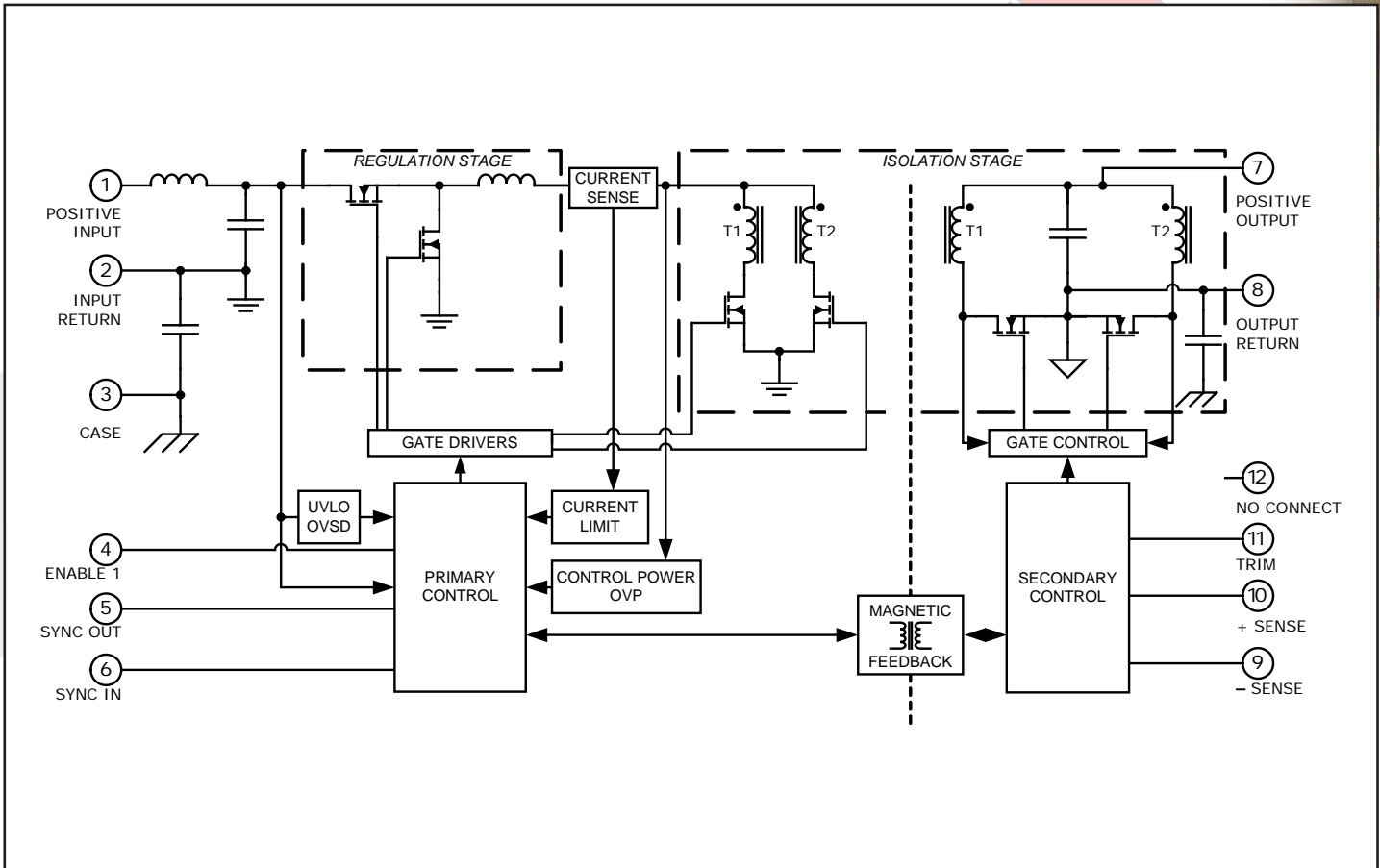
Specification Compliance

MQHL series converters (with MQHE filter) are designed to meet:

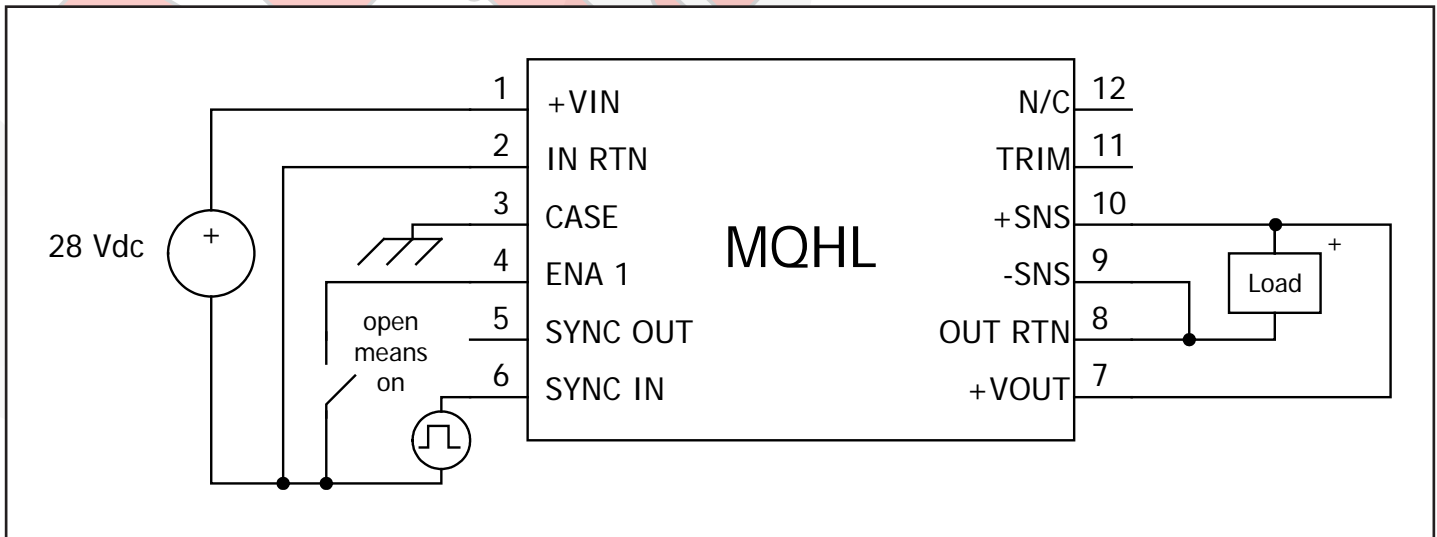
- MIL-HDBK-704-8 (A through F)
- RTCA/DO-160E Section 16
- MIL-STD-1275B
- DEF-STAN 61-5 (part 6)/5
- MIL-STD-461 (C, D, E)
- RTCA/DO-160E Section 22

Technical Specification

BLOCK DIAGRAM



TYPICAL CONNECTION DIAGRAM





MQHL-28-3R3S
Output: 3.3 V
Current: 15 A

Technical Specification

MQHL-28-3R3S ELECTRICAL CHARACTERISTICS

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions	Group A Subgroup (see Note 12)
ABSOLUTE MAXIMUM RATINGS						
Input Voltage						
Non-Operating			60	V		
Operating			50	V	See Note 1	
Reverse Bias (Tcase = 125°C)			-0.8	V		
Reverse Bias (Tcase = -55°C)			-1.2	V		
Isolation Voltage (I/O to case, I to O)						
Continuous	-500		500	V		
Transient ($\leq 100 \mu s$)	-800		800	V		
Operating Case Temperature	-55		125	°C	See Note 2	
Storage Case Temperature	-65		135	°C		
Lead Temperature (20 s)			300	°C		
Voltage at ENA1, ENA2	-1.2		50	V		
INPUT CHARACTERISTICS						
Operating Input Voltage Range	16	28	40	V	Continuous	1, 2, 3
"	16	28	50	V	Transient, 1 s	4, 5, 6
Input Under-Voltage Lockout					See Note 3	
Turn-On Voltage Threshold	14.75	15.50	16.00	V		1, 2, 3
Turn-Off Voltage Threshold	14.00	14.75	15.50	V		1, 2, 3
Lockout Voltage Hysteresis	0.65	0.75	0.85	V		1, 2, 3
Input Over-Voltage Shutdown					See Note 3	
Turn-Off Voltage Threshold	52.0	55.0	58.0	V		1, 2, 3
Turn-On Voltage Threshold	50.5	53.5	56.5	V		1, 2, 3
Shutdown Voltage Hysteresis	1.0	1.5	2.5	V		1, 2, 3
Maximum Input Current			3.9	A	Vin = 16 V; Iout = 15 A	1, 2, 3
No Load Input Current (operating)		75	100	mA		1, 2, 3
Disabled Input Current (ENA)		10	15	mA	Vin = 16 V, 28 V, 50 V	1, 2, 3
Input Terminal Current Ripple (pk-pk)		40	60	mA	Bandwidth = 100 kHz – 10 MHz; see Figure 14	1, 2, 3
OUTPUT CHARACTERISTICS						
Output Voltage Set Point (Tcase = 25°C)	3.267	3.30	3.333	V	Vout at sense leads	1
Output Voltage Set Point Over Temperature	3.247	3.30	3.353	V	"	2, 3
Output Voltage Line Regulation	-20	0	20	mV	" ; Vin = 16 V, 28 V, 40 V; Iout=15 A	1, 2, 3
Output Voltage Load Regulation	-10	0	10	mV	" ; Vout @ (Iout=0 A) - Vout @ (Iout=15 A)	1, 2, 3
Total Output Voltage Range	3.23	3.30	3.37	V	"	1, 2, 3
Output Voltage Ripple and Noise Peak to Peak		15	45	mV	Bandwidth = 10 MHz; CL=11µF	1, 2, 3
Operating Output Current Range	0		15	A		1, 2, 3
Operating Output Power Range	0		50	W		1, 2, 3
Output DC Current-Limit Inception	16	18	21	A	See Note 4	1, 2, 3
Back-Drive Current Limit while Enabled		4		A		1, 2, 3
Back-Drive Current Limit while Disabled		10	30	mA		1, 2, 3
Maximum Output Capacitance			5,000	µF		See Note 5
DYNAMIC CHARACTERISTICS						
Output Voltage Deviation Load Transient					See Note 6	
For a Pos. Step Change in Load Current	-550	-350		mV	Total Iout step = 7.5A->15A, 1.5A->7.5A; CL=11µF	4, 5, 6
For a Neg. Step Change in Load Current		350	550	mV	"	4, 5, 6
Output Voltage Deviation Line Transient					Vin step = 16V->50V; CL=11 µF; see Note 8	
For a Pos. Step Change in Line Voltage	-100		100	mV	"	4, 5, 6
For a Neg. Step Change in Line Voltage	-100		100	mV	"	4, 5, 6
Turn-On Transient						
Output Voltage Rise Time		6	10	ms	Vout = 0.5V->4.5V; Full Resistive Load	4, 5, 6
Output Voltage Overshoot		0	2	%	Resistive load	See Note 5
Turn-On Delay, Rising Vin		5.5	8.0	ms	ENA = 5 V; see Notes 9 & 11	4, 5, 6
Turn-On Delay, Rising ENA		3.0	6.0	ms	See Note 9	4, 5, 6
Restart Inhibit Time		180	250	ms	See Note 11	4, 5, 6
Short Circuit Start Time	15.0	20	25	ms		4, 5, 6
EFFICIENCY						
Iout = 15 A (16 Vin)	TBD	87		%		1, 2, 3
Iout = 7.5 A (16 Vin)	TBD	88		%		1, 2, 3
Iout = 15 A (28 Vin)	TBD	86		%		1, 2, 3
Iout = 7.5 A (28 Vin)	TBD	86		%		1, 2, 3
Iout = 15 A (40 Vin)	TBD	84		%		1, 2, 3
Iout = 7.5 A (40 Vin)	TBD	83		%		1, 2, 3
Load Fault Power Dissipation	11	TBD		W	Iout at current limit inception point, see Note 4	1, 2, 3
Short Circuit Power Dissipation	11	TBD		W	Vout ≤ 1.2 V	1, 2, 3



MQHL-28-3R3S
Output: 3.3 V
Current: 15 A

Technical Specification

MQHL-28-3R3S ELECTRICAL CHARACTERISTICS (Continued)

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions	Group A Subgroup (see Note 12)
ISOLATION CHARACTERISTICS						
Isolation Voltage					Dielectric strength	
Input RTN to Output RTN	500			V		1
Any Input Pin to Case	500			V		1
Any Output Pin to Case	500			V		1
Isolation Resistance (in rtn to out rtn)	100			MΩ		1
Isolation Resistance (any pin to case)	100			MΩ		1
Isolation Capacitance (in rtn to out rtn)		22		nF		1
FEATURE CHARACTERISTICS						
Switching Frequency (free running)	500	550	600	kHz		1, 2, 3
Synchronization Input						
Frequency Range	500		700	kHz		1, 2, 3
Logic Level High	2.0		5.5	V		1, 2, 3
Logic Level Low	-0.5		0.8	V		1, 2, 3
Duty Cycle	20		80	%		See Note 5
Synchronization Output						
Pull Down Current	20			mA	VSYNC OUT = 0.8 V	See Note 5
Duty Cycle	40		60	%	Output connected to SYNC IN of other MQFL unit	See Note 5
Enable Control (ENA)						
Off-State Voltage			0.8	V		1, 2, 3
Module Off Pulldown Current	80			μA	Current drain required to ensure module is off	See Note 5
On-State Voltage	2			V		1, 2, 3
Module On Pin Leakage Current			20	μA	I _{max} draw from pin allowed with module still on	See Note 5
Pull-Up Voltage	3.2	4.0	4.8	V	See Figure A	1, 2, 3
RELIABILITY CHARACTERISTICS						
Calculated MTBF (MIL-STD-217F2)						
GB @ T _{case} = 70°C		2800		10 ³ Hrs.		
AIF @ T _{case} = 70°C		440		10 ³ Hrs.		
Demonstrated MTBF		TBD		10 ³ Hrs.		
WEIGHT CHARACTERISTICS						
Device Weight		50		g		

Electrical Characteristics Notes

- Converter will undergo input over-voltage shutdown.
- Derate output power to 50% of rated power at T_{case} = 135° C.
- High or low state of input voltage must persist for about 200μs to be acted on by the lockout or shutdown circuitry.
- Current limit inception is defined as the point where the output voltage has dropped to 90% of its nominal value.
- Parameter not tested but guaranteed to the limit specified.
- Load current transition time ≥ 10 μs.
- Line voltage transition time ≥ 100 μs.
- Input voltage rise time ≤ 250 μs.
- Operating the converter at a synchronization frequency above the free running frequency will slightly reduce the converter's efficiency and may also cause a slight reduction in the maximum output current/power available. For more information consult the factory.
- After a disable or fault event, module is inhibited from restarting for 180 ms. See Shut Down section.
- The module will attempt to start into an overload for 20ms before shutting down and waiting to Auto Retry.
- 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 ESS table for details.
- These derating curves apply for the ES- and HB- grade products. The C- grade product has a maximum case temperature of 100° C and a maximum junction temperature rise of 20° C above T_{case}.



MQHL-28-3R3S
Output: 3.3 V
Current: 15 A

Technical Specification

To be provided in future revisions.

To be provided in future revisions.

Figure 1: Efficiency at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at Tcase=25°C.

Figure 2: Efficiency at nominal output voltage and 60% rated power vs. case temperature for input voltage of 16V, 28V, and 40V.

To be provided in future revisions.

To be provided in future revisions.

Figure 3: Power dissipation at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at Tcase=25°C.

Figure 4: Power dissipation at nominal output voltage and 60% rated power vs. case temperature for input voltage of 16V, 28V, and 40V.

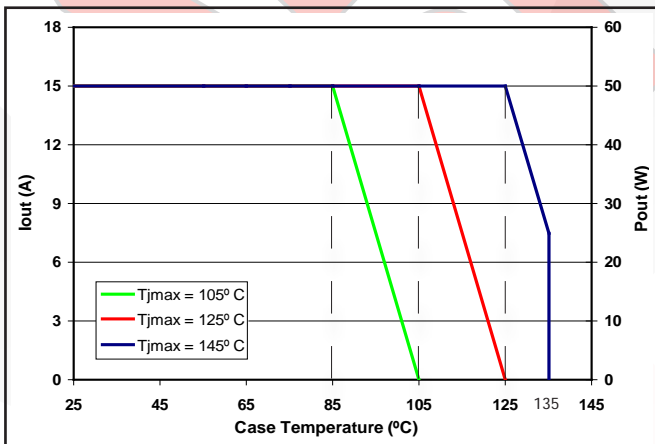


Figure 5: Output Current / Output Power derating curve as a function of Tcase and the Maximum desired power MOSFET junction temperature at Vin = 28V (see Note 13).

To be provided in future revisions.

Figure 6: Output voltage vs. load current showing typical current limit curves.



MQHL-28-3R3S
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Current: 15 A

Technical Specification

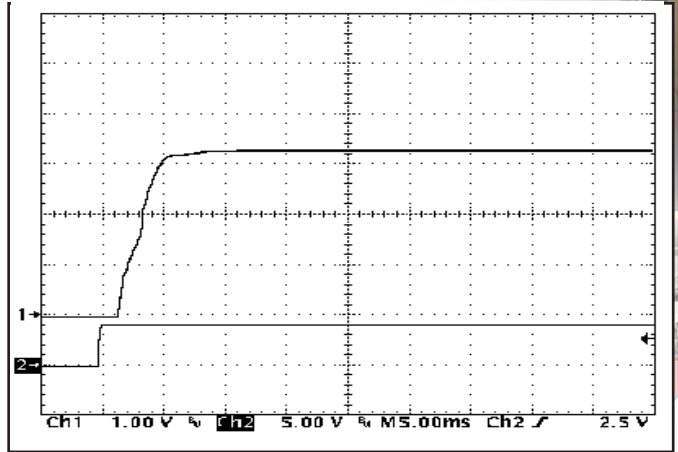
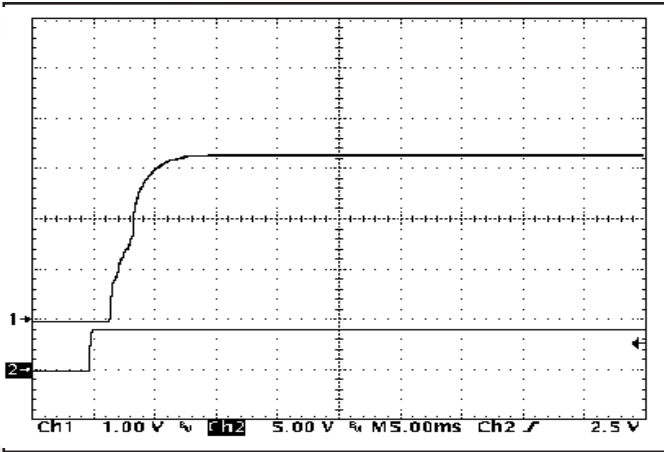


Figure 7: Turn-on transient at full resistive load and zero output capacitance initiated by ENAI. Input voltage re-applied. Ch 1: Vout (1V/div). Ch 2: ENAI (5V/div).

Figure 8: Turn-on transient at 10A resistive load and 5mF output capacitance initiated by ENAI. Input voltage pre-applied. Ch 1: Vout (1V/div). Ch 2: ENAI (5V/div).

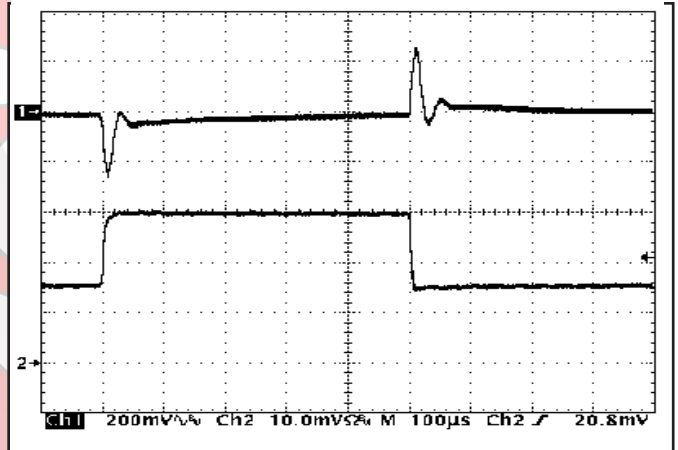
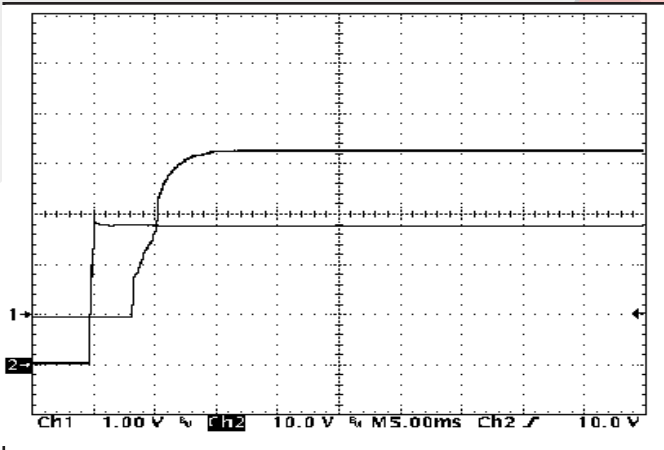


Figure 9: Turn-on transient at full resistive load and zero output capacitance initiated by Vin. ENAI previously high. Ch 1: Vout (1V/div). Ch 2: Vin (10V/div).

Figure 10: Output voltage response to step-change in load current 50%-100%-50% of Iout (max). Load cap: 1µF ceramic cap and 10µF, 100mΩ ESR tantalum cap. Ch 1: Vout (200mV/div). Ch 2: Iout (5A/div).

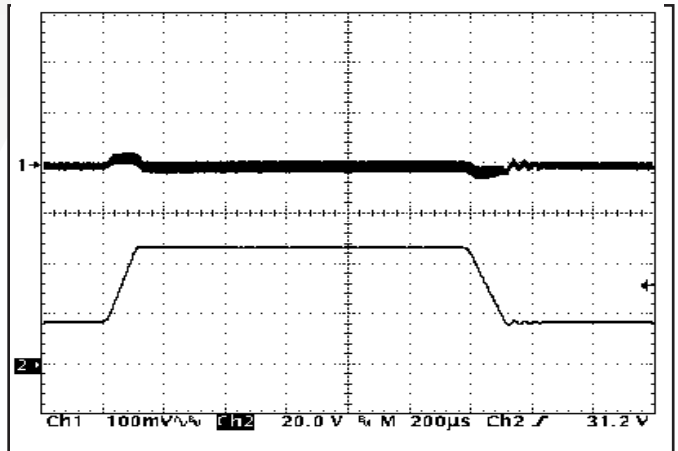
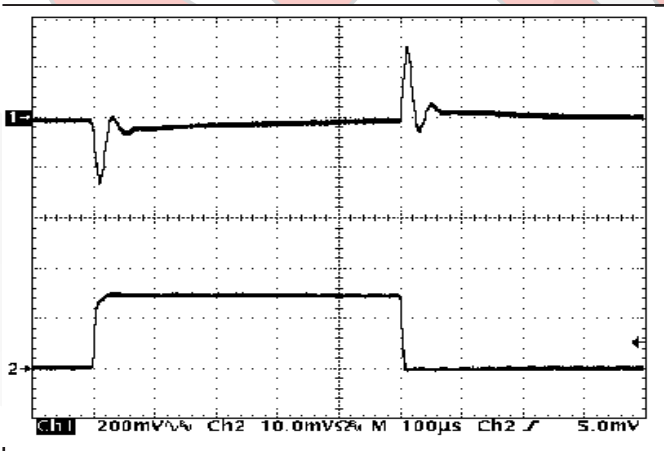


Figure 11: Output voltage response to step-change in load current 0%-50%-0% of Iout (max). Load cap: 1µF ceramic cap and 10µF, 100mΩ ESR tantalum cap. Ch 1: Vout (200mV/div). Ch 2: Iout (5A/div).

Figure 12: Output voltage response to step-change in input voltage (16V - 50V - 16V) in 250µS. Ch 1: Vout (100mV/div). Ch 2: Vin (20V/div).

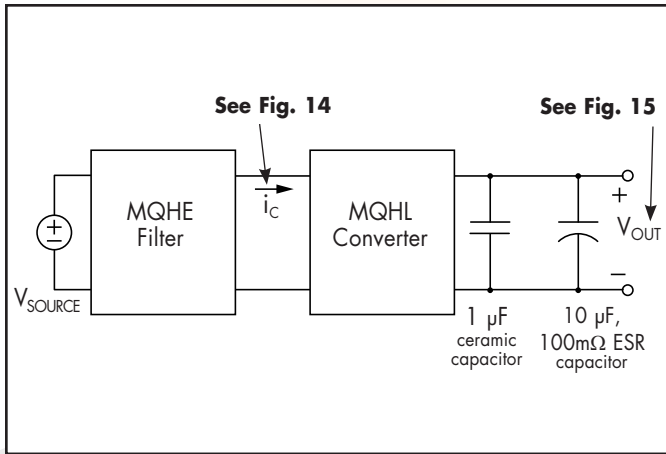


Figure 13: Test set-up diagram showing measurement points for Input Terminal Ripple Current (Figure 14) and Output Voltage Ripple (Figure 15).

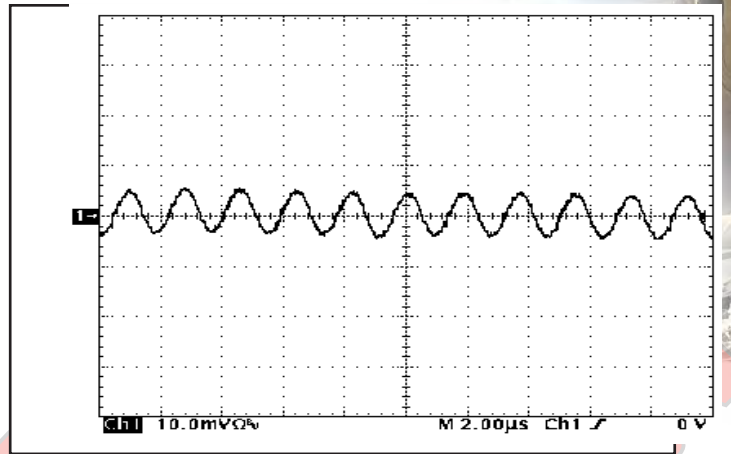


Figure 14: Input terminal current ripple, i_c , at full rated output current and nominal input voltage with SynQor MQ filter module (50mA/div). Bandwidth: 20MHz. See Figure 13.

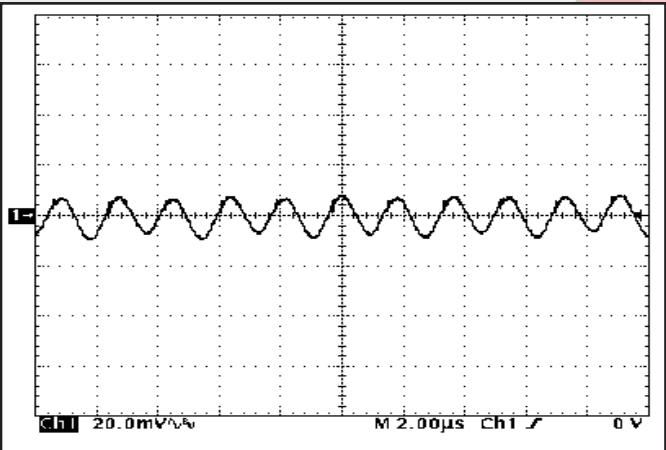


Figure 15: Output voltage ripple, V_{out} , at nominal input voltage and rated load current (20mV/div). Load capacitance: 1 μF ceramic capacitor and 10 μF tantalum capacitor. Bandwidth: 10MHz. See Figure 13.

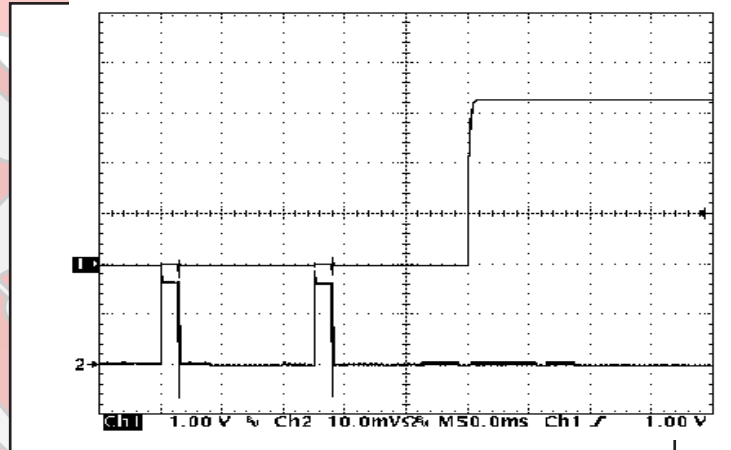


Figure 16: Rise of output voltage after the removal of a short circuit across the output terminals. Ch 1: V_{out} (1V/div). Ch 2: I_{out} (10A/div).

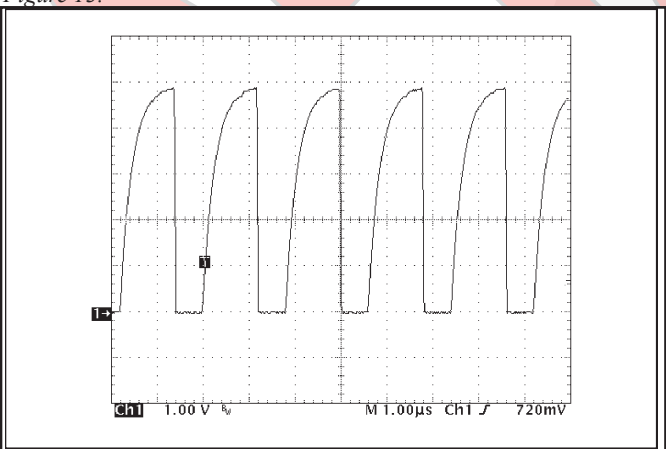


Figure 17: SYNC OUT vs. time, driving SYNC IN of a second SynQor MQHL converter. Ch1: SYNC OUT: (1V/div).

BASIC OPERATION AND FEATURES

The MQHL DC/DC converter uses a two-stage power conversion topology. The first, or regulation, stage is a buck-converter that keeps the output voltage constant over variations in line, load, and temperature. The second, or isolation, stage uses transformers to provide the functions of input/output isolation and voltage transformation to achieve the output voltage required.

Both the regulation and the isolation stages switch at a fixed frequency for predictable EMI performance. The isolation stage switches at one half the frequency of the regulation stage, but due to the push-pull nature of this stage it creates a ripple at double its switching frequency. As a result, both the input and the output of the converter have a fundamental ripple frequency of about 550 kHz in the free-running mode.

Rectification of the isolation stage's output is accomplished with synchronous rectifiers. These devices, which are MOSFETs with a very low resistance, dissipate far less energy than would Schottky diodes. This is the primary reason why the MQHL converters have such high efficiency, particularly at low output voltages.

Besides improving efficiency, the synchronous rectifiers permit operation down to zero load current. There is no longer a need for a minimum load, as is typical for converters that use diodes for rectification. The synchronous rectifiers actually permit a negative load current to flow back into the converter's output terminals if the load is a source of short or long term energy. The MQHL converters employ a "back-drive current limit" to keep this negative output terminal current small.

There is a control circuit in the MQHL converter that determines the conduction state of the power switches. It communicates across the isolation barrier through a magnetically coupled device. No opto-isolators are used.

An input under-voltage lockout feature with hysteresis is provided, as well as an input over-voltage shutdown and an output over-voltage limit. There is also an output current limit that is nearly constant as the load impedance decreases (i.e., there is not fold-back or fold-forward characteristic to the output current under this condition). When a load fault is removed, the output voltage rises exponentially to its nominal value without an overshoot. If a load fault pulls the output voltage below about 60% of nominal, the converter will shut down to attempt to clear the load fault. After a short delay it will try to auto-restart.

The MQHL converter's control circuit does not implement an over-temperature shutdown.

The following sections describe the use and operation of additional control features provided by the MQHL converter.

CONTROL FEATURES

ENABLE: The MQFL converter has one enable pin, ENA1 (pin 4), which is referenced with respect to the converter's input return (pin 2). It must have a logic high level for the converter to be enabled; a logic low inhibits the converter.

The enable pin is internally pulled high so that an open connection will enable the converter. Figure A shows the equivalent circuit looking into the enable pin. It is TTL compatible and has hysteresis.

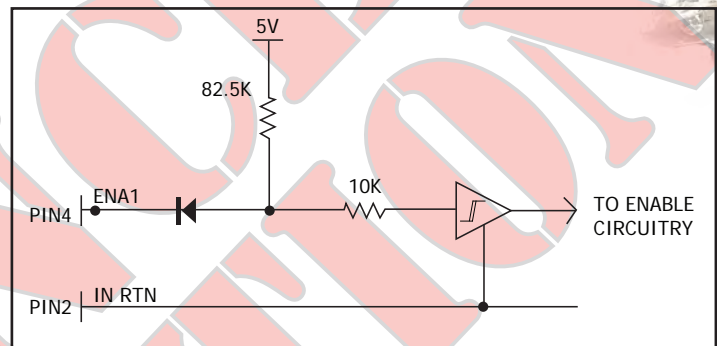


Figure A: Equivalent circuit looking into the ENA1 pin.

SHUT DOWN: The MQHL converter will shut down in response to only five conditions: ENA input low, VIN input below under-voltage lockout threshold, VIN input above over-voltage shutdown threshold, output voltage below the output under-voltage threshold, and output voltage above the output over-voltage threshold. Following any shutdown event, there is a startup inhibit delay which will prevent the converter from restarting for approximately 100ms. After the 100ms delay elapses, if the enable inputs are high and the input voltage is within the operating range, the converter will restart. If the VIN input is brought down to nearly 0V and back into the operating range, there is no startup inhibit, and the output voltage will rise according to the "Turn-On Delay, Rising Vin" specification.

REMOTE SENSE: The purpose of the remote sense pins is to correct for the voltage drop along the conductors that connect the converter's output to the load. To achieve this goal, a separate conductor should be used to connect the +SENSE pin (pin 10) directly to the positive terminal of the load, as shown in the connection diagram on Page 2. Similarly, the -SENSE pin (pin 9) should be connected through a separate conductor to the return terminal of the load.

NOTE: Even if remote sensing of the load voltage is not desired, the +SENSE and the -SENSE pins must be connected to +Vout (pin 7) and OUTPUT RETURN (pin 8), respectively, to get proper regulation of the converter's output. If they are left open, the converter will have an output voltage that is approximately 200mV higher than its specified value.

Technical Specification

Inside the converter, +SENSE is connected to +Vout with a 100Ω resistor and –SENSE is connected to OUTPUT RETURN with a 10Ω resistor.

It is also important to note that when remote sense is used, the voltage across the converter's output terminals (pins 7 and 8) will be higher than the converter's nominal output voltage due to resistive drops along the connecting wires. This higher voltage at the terminals produces a greater voltage stress on the converter's internal components and may cause the converter to fail to deliver the desired output voltage at the low end of the input voltage range at the higher end of the load current and temperature range. Please consult the factory for details.

SYNCHRONIZATION: The MQHL converter's switching frequency can be synchronized to an external frequency source that is in the 500 kHz to 700 kHz range. A pulse train at the desired frequency should be applied to the SYNC IN pin (pin 6) with respect to the INPUT RETURN (pin 2). This pulse train should have a duty cycle in the 20% to 80% range. Its low value should be below 0.8V to be guaranteed to be interpreted as a logic low, and its high value should be above 2.0V to be guaranteed to be interpreted as a logic high. The transition time between the two states should be less than 300ns.

If the MQHL converter is not to be synchronized, the SYNC IN pin should be left open circuit. The converter will then operate in its free-running mode at a frequency of approximately 550 kHz.

If, due to a fault, the SYNC IN pin is held in either a logic low or logic high state continuously, or the SYNC IN frequency is outside the 500-700 kHz range, the MQHL converter will revert to its free-running frequency.

The MQHL converter also has a SYNC OUT pin (pin 5). This output can be used to drive the SYNC IN pins of as many as ten (10) other MQHL converters. The pulse train coming out of SYNC OUT has a duty cycle of 50% and a frequency that matches the switching frequency of the converter with which it is associated. This frequency is either the free-running frequency if there is no valid synchronization signal at the SYNC IN pin, or the synchronization frequency if there is.

The synchronization feature is entirely compatible with that of SynQor's MQFL family of converters.

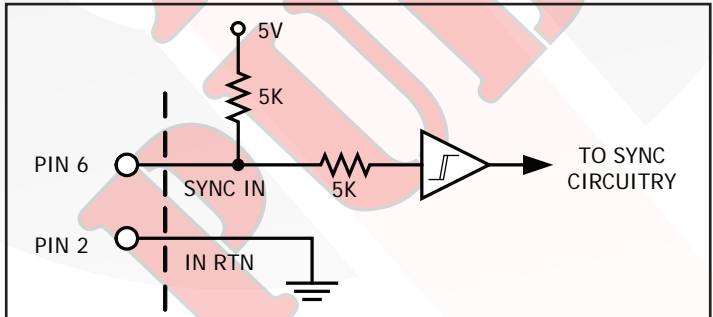


Figure B: Equivalent circuit looking into the SYNC IN pin with respect to the IN RTN (input return) pin.

Figure B shows the equivalent circuit looking into the SYNC IN pin and Figure C shows the equivalent circuit looking into the SYNC OUT pin.

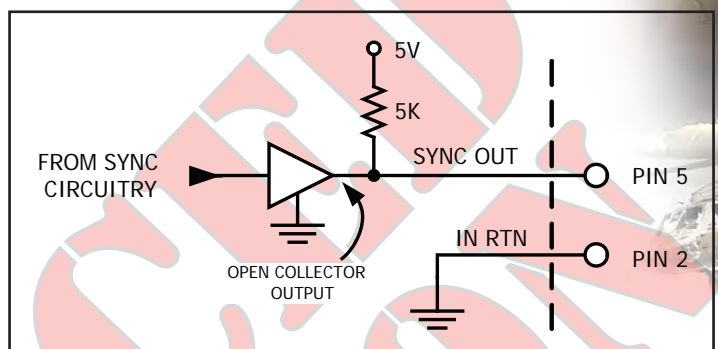


Figure C: Equivalent circuit looking into SYNC OUT pin with respect to the IN RTN (input return) pin.

OUTPUT VOLTAGE TRIM: the TRIM pin (pin 11) can adjust the MQHL converter's output voltage ±10% around its nominal value.

To trim the output voltage above its nominal value, connect an external resistor from the TRIM pin to the –SENSE pin as shown in Figure D. The value of this trim up resistor should be chosen according to the following equation or from Figure E:

$$R_{trim\ up}(\Omega) = \frac{6000\Omega * V_{nom}}{V_{out} - V_{nom}} - 30000\Omega$$

where:

- Vnom = the converter's nominal output voltage,
- Vout = the desired output voltage (greater than Vnom), and
- Rtrim up is in Ohms.

As the output voltage is trimmed up, it produces a greater voltage stress on the converter's internal components and may cause the converter to fail to deliver the desired output voltage at the low end of the input voltage range at the higher end of the load current and temperature range. Please consult the factory for details.

To trim the output voltage below its nominal value, connect an external resistor between the TRIM pin and the +SENSE pin. The value of this trim down resistor should be chosen according to the following equation or from Figure E:

$$R_{trim\ down}(\Omega) = \frac{15000\Omega * V_{out} - 6000\Omega * V_{nom}}{V_{nom} - V_{out}} - 30000\Omega$$

where:

- Vnom = the converter's nominal output voltage,
- Vout = the desired output voltage (less than Vnom), and

Rtrim down is in Ohms.

Factory trimmed converters are available by request.

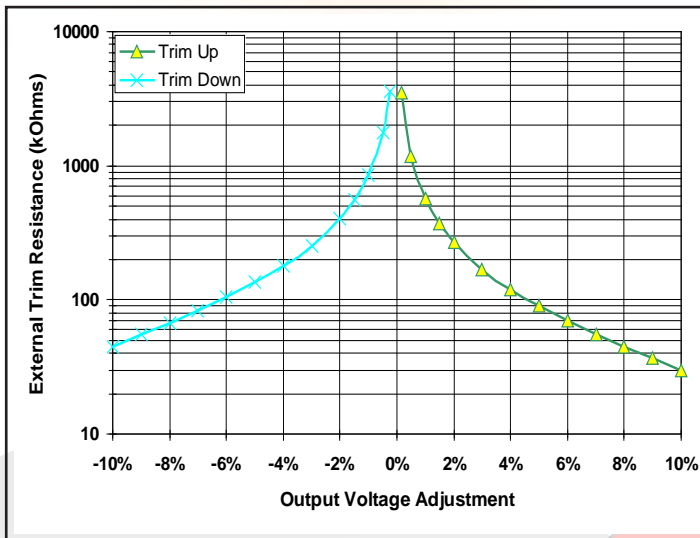


Figure D: Trim up and Trim down as a function of external trim resistance.

INPUT UNDER-VOLTAGE LOCKOUT: The MQHL converter has an under-voltage lockout feature that ensures the converter will be off if the input voltage is too low. The input voltage turn-on threshold is higher than the turn-off threshold. In addition, the MQHL converter will not respond to a state of the input voltage unless it has remained in that state for more than about 200 μ s. This hysteresis and the delay ensure proper operation when the source impedance is high or in a noisy environment.

INPUT OVER-VOLTAGE SHUTDOWN: The MQHL converter also has an over-voltage feature that ensures the converter will be off if the input voltage is too high. It also has a hysteresis and time delay to ensure proper operation.

OUTPUT OVER-VOLTAGE SHUTDOWN: The MQHL converter will shut down if the voltage at its power output pins ever exceeds about 130% of the nominal value. The

shutdown threshold does not change with output trim or sense drops; excessive trim-up or output wiring drops may cause an output over-voltage shutdown event. After a startup inhibit delay, the converter will attempt to restart.

OUTPUT UNDER-VOLTAGE SHUTDOWN: The MQHL converter will also shut down if the voltage at its power output pins ever dips below 60% of the nominal value for more than a few milliseconds. Output voltage reduction due to output current overload (current limit) is the most common trigger for this shutdown. The shutdown threshold does not change with output trim but at only 10%, trim-down should not trigger this event. After a startup inhibit delay, the converter will attempt to restart. This shutdown is disabled during startup.

BACK-DRIVE CURRENT LIMIT: Converters that use MOSFETs as synchronous rectifiers are capable of drawing a negative current from the load if the load is a source of short- or long-term energy. This negative current is referred to as a "back-drive current".

Conditions where back-drive current might occur include paralleled converters that do not employ current sharing. It can also occur when converters having different output voltages are connected together through either explicit or parasitic diodes that, while normally off, become conductive during startup or shutdown. Finally, some loads, such as motors, can return energy to their power rail. Even a load capacitor is a source of back-drive energy for some period of time during a shutdown transient.

To avoid any problems that might arise due to back-drive current, the MQHL converters limit the negative current that the converter can draw from its output terminals. The threshold for this back-drive current limit is placed sufficiently below zero so that the converter may operate properly down to zero load, but its absolute value (see the Electrical Characteristics page) is small compared to the converter's rated output current.

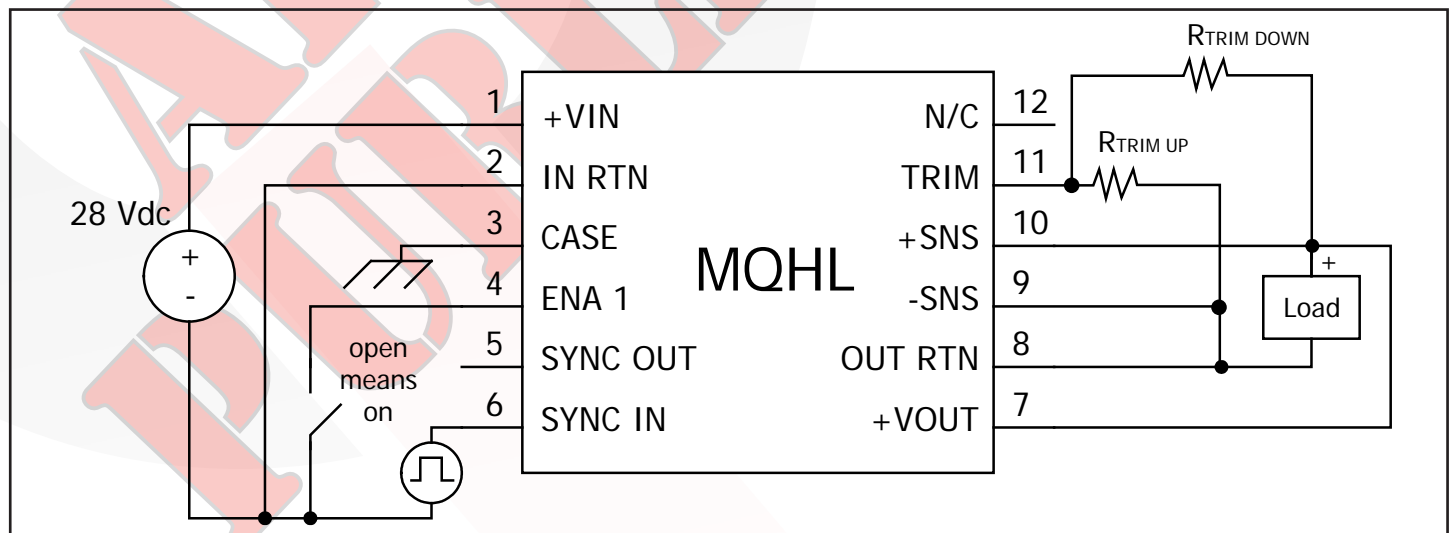


Figure E: Typical connection for output voltage trimming.



MQHL-28-3R3S
Output: 3.3 V
Current: 15 A

Technical Specification

THERMAL CONSIDERATIONS: Figure 5 shows the suggested Power Derating Curves for this converter as a function of the case temperature and the maximum desired power MOSFET junction temperature. All other components within the converter are cooler than its hottest MOSFET, which at full power is no more than 20°C higher than the case temperature directly below this MOSFET.

The Mil-HDBK-1547A component derating guideline calls for a maximum component temperature of 105°C. Figure 5 therefore has one power derating curve that ensures this limit is maintained. It has been SynQor's extensive experience that reliable long-term converter operation can be achieved with a maximum component temperature of 125°C. In extreme cases, a maximum temperature of 145°C is permissible, but not recommended for long-term operation where high reliability is required. Derating curves for these higher temperature limits are also included in Figure 5. The maximum case temperature at which the converter should be operated is 135°C.

When the converter is mounted on a metal plate, the plate will help to make the converter's case bottom a uniform temperature. How well it does so depends on the thickness of the plate and on the thermal conductance of the interface layer (e.g. thermal grease, thermal pad, etc.) between the case and the plate. Unless this is done very well, it is important not to mistake the plate's temperature for the maximum case temperature. It is easy for them to be as much as 5-10°C different at full power and at high temperatures. It is suggested that a thermocouple be attached directly to the converter's case through a small hole in the plate when investigating how hot the converter is getting. Care must also be made to ensure that there is not a large thermal resistance between the thermocouple and the case due to whatever adhesive might be used to hold the thermocouple in place.

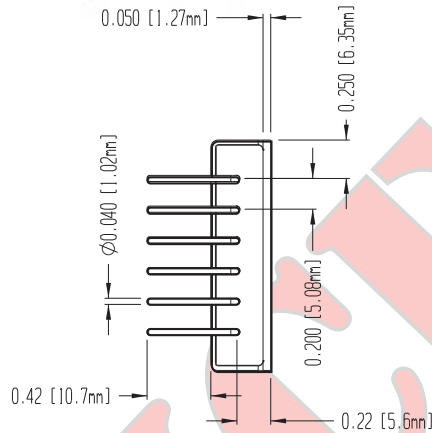
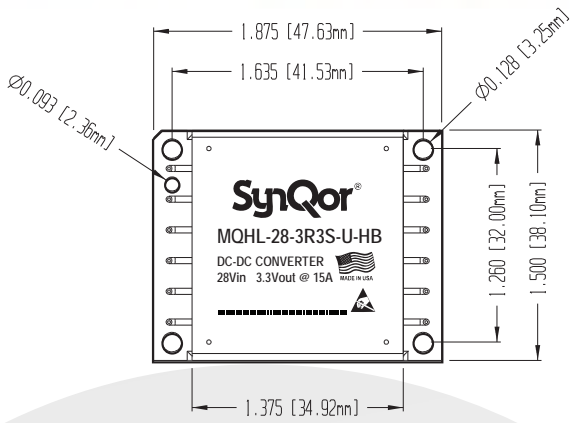
INPUT SYSTEM INSTABILITY: This condition can occur because any dc-dc converter appears incrementally as a negative resistance load. A detailed application note titled "Input System Instability" is available on the SynQor website which provides an understanding of why this instability arises, and shows the preferred solution for correcting it.



CONSTRUCTION AND ENVIRONMENTAL STRESS SCREENING OPTIONS

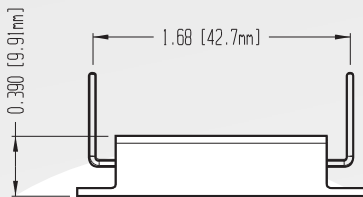
Screening	Consistent with MIL-STD-883F	C-Grade (-40 °C to +100 °C)	ES-Grade (-55 °C to +125 °C) (Element Evaluation)	HB-Grade (-55 °C to +125 °C) (Element Evaluation)
Internal Visual	*	Yes	Yes	Yes
Temperature Cycle	Method 1010	No	Condition B (-55 °C to +125 °C)	Condition C (-65 °C to +150 °C)
Constant Acceleration	Method 2001 (Y1 Direction)	No	500g	Condition A (5000g)
Burn-in	Method 1015 Load Cycled • 10s period • 2s @ 100% Load • 8s @ 0% Load	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	Full QorSeal
External Visual	2009	*	Yes	Yes
Construction Process		QorSeal	QorSeal	QorSeal
* Per IPC-A-610 (Rev. D) Class 3				

MilQor converters and filters are offered in four variations of construction technique and environmental stress screening options. The three highest grades, C, ES, and HB, all 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.

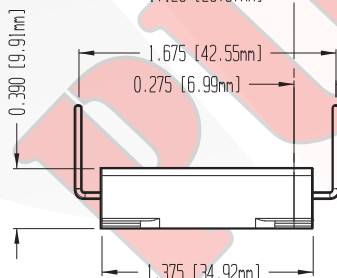
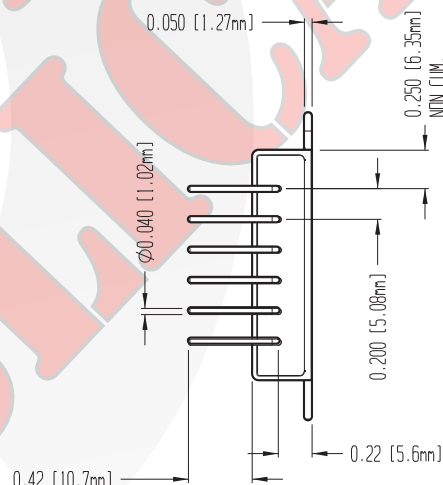
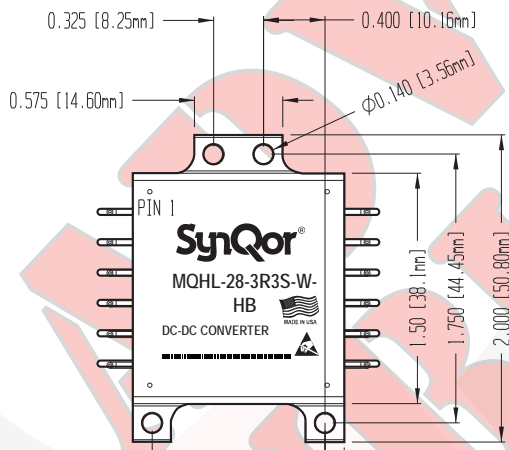


PACKAGE PINOUTS

Pin #	Function
1	POSITIVE INPUT
2	INPUT RETURN
3	CASE
4	ENABLE 1
5	SYNC OUTPUT
6	SYNC INPUT
7	POSITIVE OUTPUT
8	OUTPUT RETURN
9	- SENSE
10	+ SENSE
11	TRIM
12	No Connection



Case U



Case W

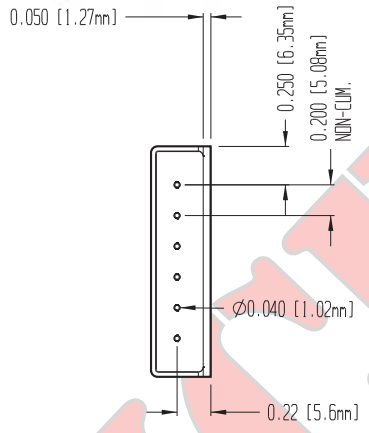
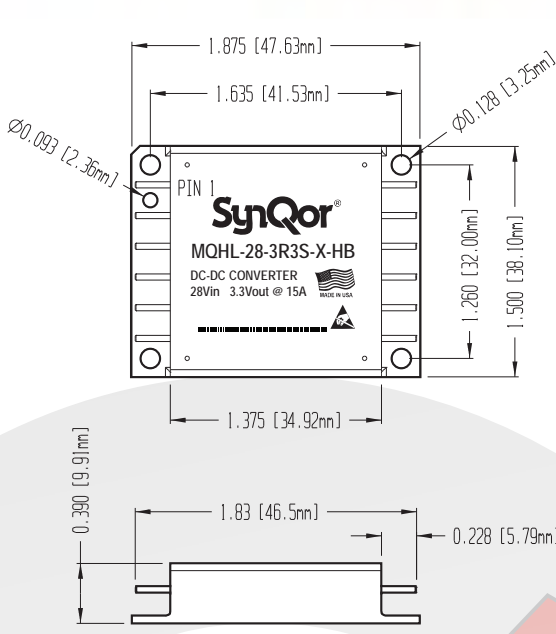
NOTES

- Case: Aluminum with gold over nickel plate finish for the C-, ES-, and HB-Grade products.
- Pins: Diameter: 0.040" (1.02mm)
Material: Copper
Finish: Gold over Nickel plate
- All dimensions as inches (mm)
- Tolerances: a) x.xx ±0.02"
(x.x ±0.5mm)
b) x.xxx ±0.010"
(x.xx ±0.25mm)
- Weight: 1.6 oz. (45.4 g) typical
- Workmanship: Meets or exceeds IPC-A-610C Class III



Technical Specification

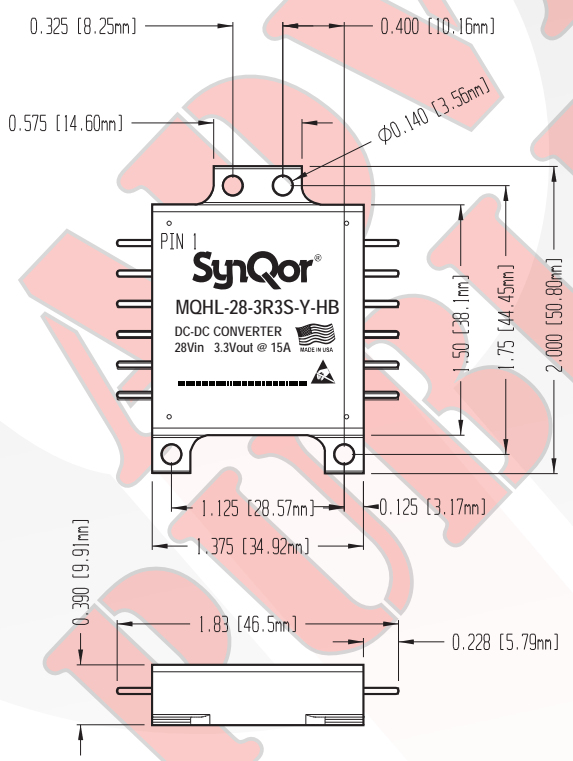
MQHL-28-3R3S
Output: 3.3 V
Current: 15 A



Case X

PACKAGE PINOUTS

Pin #	Function
1	POSITIVE INPUT
2	INPUT RETURN
3	CASE
4	ENABLE 1
5	SYNC OUTPUT
6	SYNC INPUT
7	POSITIVE OUTPUT
8	OUTPUT RETURN
9	- SENSE
10	+ SENSE
11	TRIM
12	No Connection



Case Y

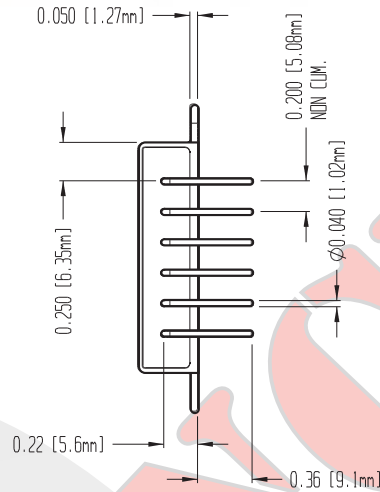
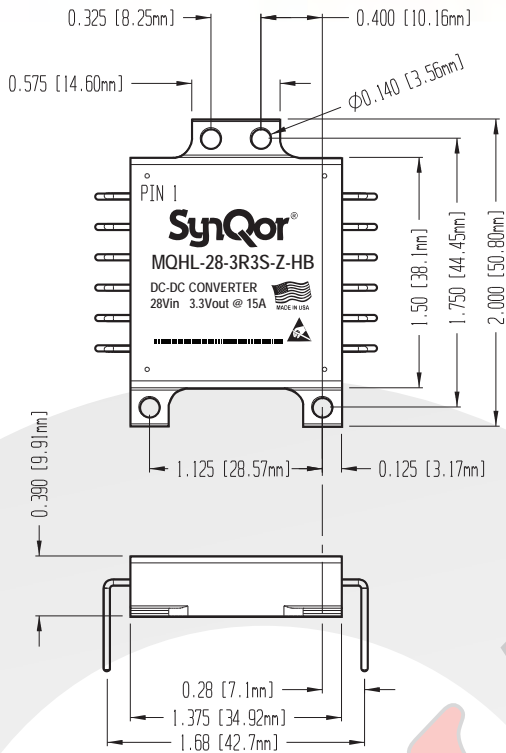
NOTES

- Case: Aluminum with gold over nickel plate finish for the C-, ES-, and HB-Grade products.
- Pins: Diameter: 0.040" (1.02mm)
Material: Copper
Finish: Gold over Nickel plate
- All dimensions as inches (mm)
- Tolerances: a) x.xx ±0.02"
(x.x ±0.5mm)
b) x.xxx ±0.010"
(x.xx ±0.25mm)
- Weight: 1.6 oz. (45.4 g) typical
- Workmanship: Meets or exceeds IPC-A-610C Class III



Technical Specification

MQHL-28-3R3S
Output: 3.3 V
Current: 15 A



Case Z

PACKAGE PINOUTS

Pin #	Function
1	POSITIVE INPUT
2	INPUT RETURN
3	CASE
4	ENABLE 1
5	SYNC OUTPUT
6	SYNC INPUT
7	POSITIVE OUTPUT
8	OUTPUT RETURN
9	- SENSE
10	+ SENSE
11	TRIM
12	No Connection

NOTES

- 1) Case: Aluminum with gold over nickel plate finish for the C-, ES-, and HB-Grade products.
- 2) Pins: Diameter: 0.040" (1.02mm)
Material: Copper
Finish: Gold over Nickel plate
- 3) All dimensions as inches (mm)
- 4) Tolerances: a) x.xx ±0.02"
(x.x ±0.5mm)
b) x.xxx ±0.010"
(x.xx ±0.25mm)
- 5) Weight: 1.6 oz. (45.4 g) typical
- 6) Workmanship: Meets or exceeds IPC-A-610C Class III



MQHL-28-3R3S
Output: 3.3 V
Current: 15 A

Technical Specification

MilQor MQHL FAMILY MATRIX

The tables below show the array of MQHL converters 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.

Single Output	1.5V (1R5S)	1.8V (1R8S)	2.5V (2R5S)	3.3V (3R3S)	5V (05S)	6V (06S)	7.5V (7R5S)	9V (09S)	12V (12S)	15V (15S)	28V (28S)
MQHL-28 16-40Vin Cont. 16-50Vin 1s Trans.* Absolute Max Vin = 60V	20A	20A	20A	15A	10A	8.3A	6.6A	5.5A	4.2A	3.3A	1.8A
MQHL-28E 16-70Vin Cont. 16-80Vin 1s Trans.* Absolute Max Vin =100V	20A	20A	20A	15A	10A	8.3A	6.6A	5.5A	4.2A	3.3A	1.8A

Dual Output	5V (05D)	12V (12D)	15V (15D)
MQHL-28 16-40Vin Cont. 16-50Vin 1s Trans.* Absolute Max Vin = 60V	10A Total	8.3A Total	6.6A Total
MQHL-28E 16-70Vin Cont. 16-80Vin 1s Trans.* Absolute Max Vin =100V	10A Total	8.3A Total	6.6A Total

*Converters may be operated continuously at the highest transient input voltage, but some component electrical and thermal stresses would be beyond MIL-HDBK-1547A guidelines.

†80% of total output current available on any one output.



MQHL-28-3R3S
Output: 3.3 V
Current: 15 A

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	Output Voltage(s)		Package Outline/ Pin Configuration	Screening Grade
		Single Output	Dual Output		
MQHL	28 28E	1R5S	05D 12D 15D	U X Y W Z	C ES HB
		1R8S			
		2R5S			
		3R3S			
		05S			
		06S			
		7R5S			
		09S			
		12S			
		15S			
		28S			

APPLICATION NOTES

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

Example: MQHL - 28 - 3R3S - Y - ES

PATENTS

SynQor holds the following patents, one or more of which might apply to this product:

5,999,417 6,222,742 6,545,890 6,577,109 6,594,159 6,731,520 6,894,468 6,896,526
6,927,987 7,050,309 7,072,190 7,085,146 7,119,524 7,269,034 7,272,021 7,272,023

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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.

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