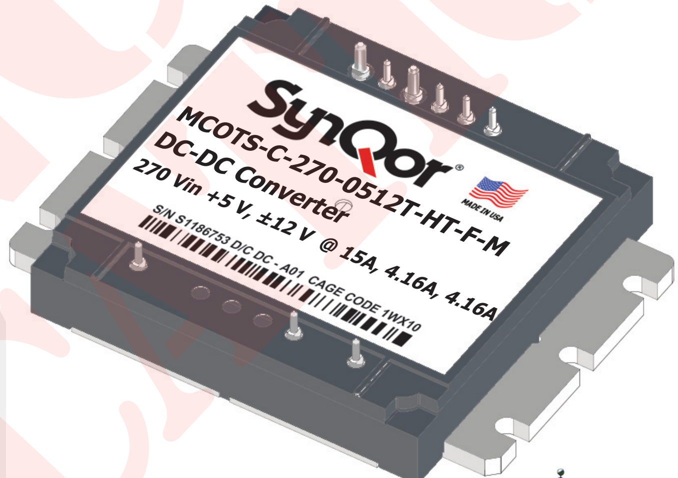
MCOTS-C-270-0512T-HT
Triple Output

Military COTS DC-DC Converter

155-425 V	155-475 V	+5 V, ±12 V	15A, 4.16A, 4.16A	89% @ Full Load / 86% @ Half Load
Continuous Input	Transient Input	Output	Output	Efficiency

The Mil-COTS DC-DC Converters bring SynQor's field proven high-efficiency synchronous rectification technology to the Military/Aerospace industry. SynQor's ruggedized encased packaging approach ensures survivability in demanding environments. These converters operate at a fixed frequency and follow conservative component derating guidelines. They are designed and manufactured to comply with a wide range of military standards.



Safety Features

- 4250 V, 100 MΩ input-to-output isolation
- Certified 62368-1 requirement pending (see Standards and Qualifications page)

Mechanical Features

- Size: 1.55" x 1.52" x 0.50" (39.4 x 38.6 x 12.7 mm)
- Total weight: 1.97 oz. (56 g)
- Flanged baseplate version available

Control Features

- On/Off control referenced to input return
- Output voltage trim range of +10%, -10%

Compliance Features

MilCOTS series converters (With an MCOTS filter) are designed to meet:
- MIL-HDBK-704-8 (A-F)
- MIL-STD-461 (C, D, E, F)

Operational Features

- High efficiency, 90% at full rated load current
- Operating input voltage range: 155-425 V
- Fixed frequency switching to provide predictable EMI
- No minimum load requirement

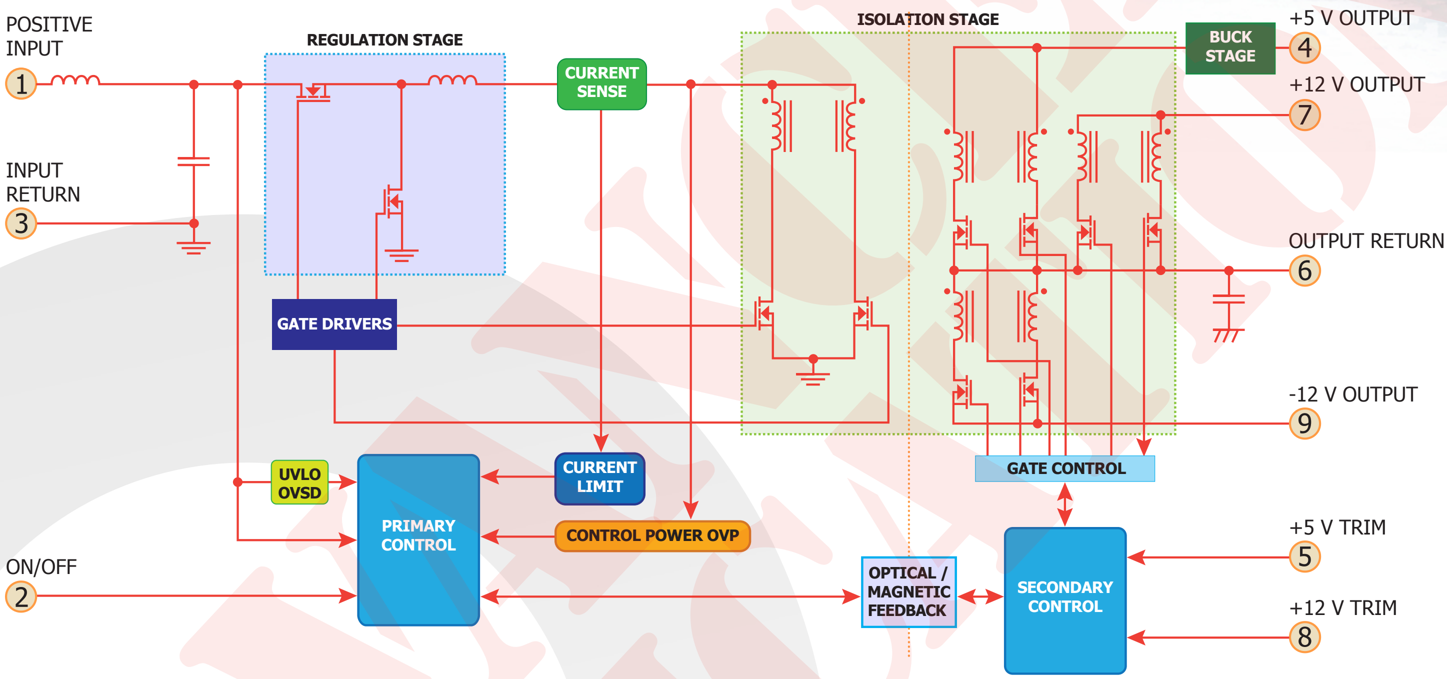
Protection Features

- Input under-voltage and over-voltage lockout
- Output current limit and short circuit protection
- Active back bias limit
- Output over-voltage protection
- Thermal shutdown

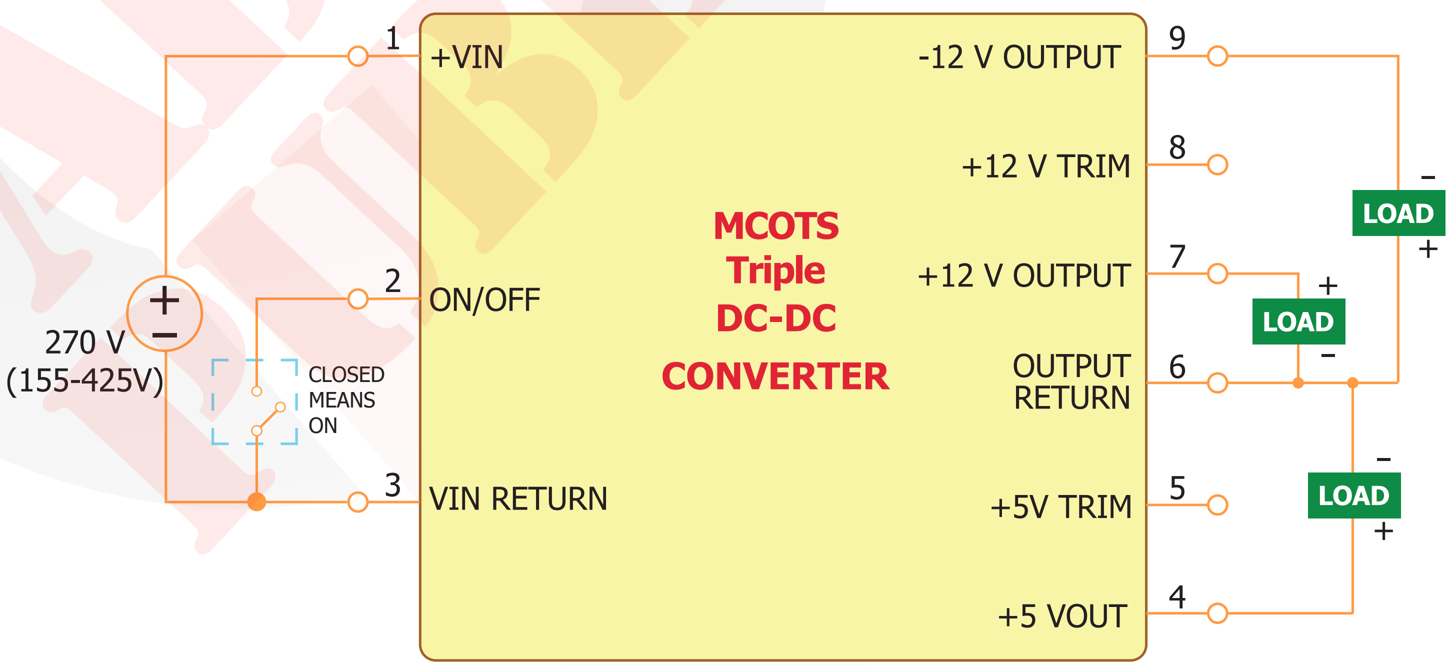
Screening/Qualification

- AS9100 & ISO 9001 certified facility
- Qualified to MIL-STD-810
- Available with S-Grade or M-Grade screening
- Temperature cycling per MIL-STD-883, Method 1010, Condition B, 10 cycles
- Burn-In at 100 °C baseplate temperature
- Final visual inspection per MIL-STD-883, Method 2009
- Full component traceability

Block Diagram



Typical Connection Diagram



Electrical Characteristics

MCOTS-C-270-0512T-HT ELECTRICAL CHARACTERISTICS

Tb = 25 °C, Vin = 270 Vdc, full load unless otherwise noted; full operating temperature range is -55 °C to +100 °C baseplate temperature with appropriate power derating. Specifications subject to change without notice.

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
ABSOLUTE MAXIMUM RATINGS					
Input Voltage					
Non-Operating	-1		500	V	Continuous
Operating	155	270	425	V	Continuous
Operating Transient Protection	155		475	V	100 ms transient, square wave
Isolation Voltage					
Input to Output			4250	V	Reinforced Insulation
Input to Baseplate			2300	V	Basic Insulation
Output to Baseplate			2300	V	Basic Insulation
Operating Case Temperature	-55		100	°C	Baseplate temperature
Storage Case Temperature	-65		135	°C	
Voltage at ON/OFF input pin	-1.2		18	V	
INPUT CHARACTERISTICS					
Operating Input Voltage Range	155	270	425	V	475 V transient for 100 ms; see Notes 1, 5 & 8
Input Under-Voltage Turn-On Threshold	144	147	150	V	See Note 3
Input Under-Voltage Turn-Off Threshold	138	141	143	V	See Note 3
Input Under-Voltage Shutdown Hysteresis		6		V	
Input Over-Voltage Turn-Off Threshold	441	445	452	V	See Note 3
Input Over-Voltage Turn-On Threshold	430	440	444	V	See Note 3
Input Over-Voltage Shutdown Hysteresis		5		V	
Recommended External Input Capacitance		3000.0		μF	
Input Filter Component Values (L\C)		4.7\0.45		μH\μF	Internal values
Maximum Input Current			1.30	A	Vin = 155 V; Iout = 15A, 4.16A, 4.16A A
No Load Input Current	35	43	62	mA	
Disabled Input Current	616	737	900	uA	
Input Terminal Current Ripple (rms)		150		mA	Bandwidth = 100 kHz – 10 MHz
Recommended Input Fuse			10	A	Fast acting external fuse recommended
FEATURE CHARACTERISTICS					
Switching Frequency	540	550	560	kHz	Isolation stage switching freq. is half of this
ON/OFF Control					
Off-State Voltage	1		18	V	
Module Off Pulldown Current	80			μA	Current drain required to ensure module is off
On-State Voltage	-1		0.6	V	
Module On Pin Leakage Current			30	μA	Imax draw from pin allowed with module still on
Pull-Up Voltage	4.5	5.0	5.5	V	See Figure A
±12V DYNAMIC CHARACTERISTICS					
Turn-On Transient					
Output Voltage Rise Time		45	50	ms	Vout = 1.2 V to 10.8 V; Full Resistive Load
Output Voltage Overshoot		0	2	%	Resistive load
Turn-On Delay, Rising Vin		35	50	ms	On/Off = 5 V;
Turn-On Delay, Falling ON/OFF		40	50	ms	See Note 2
Restart Inhibit Time		400		ms	See Note 2
+5V DYNAMIC CHARACTERISTICS					
Turn-On Transient					
Output Voltage Rise Time		60	75	ms	Vout = 0.5 V to 4.5 V; Full Resistive Load
Output Voltage Overshoot		0	2	%	Resistive load
Turn-On Delay, Rising Vin		35	50	ms	On/Off = 5 V;
Turn-On Delay, Falling ON/OFF		40	50	ms	See Note 2
Restart Inhibit Time		400		ms	See Note 2

Electrical Characteristics

MCOTS-C-270-0512T-HT ELECTRICAL CHARACTERISTICS

Tb = 25 °C, Vin = 270 Vdc, full load unless otherwise noted; full operating temperature range is -55 °C to +100 °C baseplate temperature with appropriate power derating. Specifications subject to change without notice.

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
+5V OUTPUT CHARACTERISTICS					
Output Voltage Set Point	4.95	5	5.05	V	Io = 0 A; Vin = 270 V
Output Voltage Regulation					
Over Line	-0.3		0.3	%	
Over Load	-0.3		0.3	%	
Over Temperature	-10		10	mV	
Total Positive Output Voltage Range	4.90	5	5.10	V	Over sample, line, load, temperature & life
Output Voltage Ripple and Noise (Peak to Peak)		117	200	mV	Bandwidth = 20 MHz; CL=11 µF
Output Voltage Ripple and Noise (rms)		20	50	mV	Bandwidth = 20 MHz; CL=11 µF
Operating Output Current Range	0		15	A	
Operating Output Power Range	0		75	W	
Output DC Current-Limit Inception	16.5	18	20	A	
Back-Drive Current Limit		1.7	3.1	A	
Maximum Output Capacitance			5000	µF	
Output Voltage Deviation Load Transient					See Note 4
For a Pos. Step Change in Load Current		250		mV	50% to 75% to 50% Iout max
Settling Time		500		µs	To within 1% Vout nom
Response to Input Transient		TBD		mV	See Figure 21, see Note 5
Output Voltage Trim Range	-10		10	%	See Figure B
Output Over-Voltage Shutdown	5.8	6.2	6.6	V	
±12V OUTPUT CHARACTERISTICS					
Output Voltage Set Point					
Positive Output	11.88	12	12.12	V	Io = 0 A; Vin = 270 V
Negative Output	-12.12	-12	-11.88	V	Io = 0 A; Vin = 270 V
Output Voltage Regulation					
Over Line	-0.3		0.3	%	
Over Load	-0.3		0.3	%	
Over Temperature	-100		100	mV	
Total Positive Output Voltage Range	11.83	12	12.17	V	Over sample, line, load, temperature & life
Output Voltage Ripple and Noise (Peak to Peak)		140	200	mV	Bandwidth = 20 MHz; CL=11 µF
Output Voltage Ripple and Noise (rms)		22	50	mV	Bandwidth = 20 MHz; CL=11 µF
Operating Output Current Range	0		4.16	A	
Operating Output Power Range	0		50	W	
Total Output Power Limit			205	W	See Note 9
Back-Drive Current Limit while Enabled		0.9	1.2	A	
Maximum Output Capacitance			3000	µF	
Output Voltage Deviation Load Transient					See Note 4
For a Pos. Step Change in Load Current		350		mV	50% to 75% to 50% Iout max
Settling Time		500		µs	To within 1% Vout nom
Response to Input Transient		TBD		mV	See Figure 21, see Note 5
Output Voltage Trim Range	-10		10	%	See Figure A
Output Over-Voltage Shutdown	13.8	15	15.8	V	

Electrical Characteristics

MCOTS-C-270-0512T-HT ELECTRICAL CHARACTERISTICS

Tb = 25 °C, Vin = 270 Vdc, full load unless otherwise noted; full operating temperature range is -55 °C to +100 °C baseplate temperature with appropriate power derating. Specifications subject to change without notice.

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
ISOLATION CHARACTERISTICS					
Isolation Voltage (dielectric strength)			4250	V dc	See Absolute Maximum Ratings
Isolation Resistance		100		MΩ	
Isolation Capacitance (input to output)			750	pF	See Note 7
TEMPERATURE LIMITS FOR POWER DERATING CURVES					
Semiconductor Junction Temperature			125	°C	Package rated to 150 °C
Board Temperature			125	°C	UL rated max operating temp 130 °C
Transformer Temperature			125	°C	
Maximum Baseplate Temperature, Tb			100	°C	
EFFICIENCY					
Iout = 15A, 4.16A, 4.16A (270 Vin)		89		%	
Iout = 7.5 A (270 V in)		86		%	
RELIABILITY CHARACTERISTICS					
Calculated MTBF per MIL-HDBK-217F		TBD		10^6 Hrs.	Ground Benign, 70 ºC Tb
Calculated MTBF per MIL-HDBK-217F		TBD		10^6 Hrs.	Ground Mobile, 70 ºC Tb

Electrical Characteristics Notes

1. Converter will undergo input over-voltage shutdown.
2. After a disable or fault event, module is inhibited from restarting for 400 ms. See Shut Down section of the Control Features description.
3. High or low state of input voltage must persist for about 200 μs to be acted on by the shutdown circuitry.
4. Load current transition time ≥ 10 μs.
5. Line voltage transition time ≥ 100 μs.
6. Input voltage rise time ≥ 250 μs.
7. Isolation capacitance can be added external to the module.
8. An input capacitor with series resistance is necessary to provide system stability.
9. This value includes the 5V output power.

MCOTS-C-270-0512T-HT
Input: 155-425 V
Output: +5 V, ±12 V
Current: 15A, 4.16A, 4.16A

Technical Charts

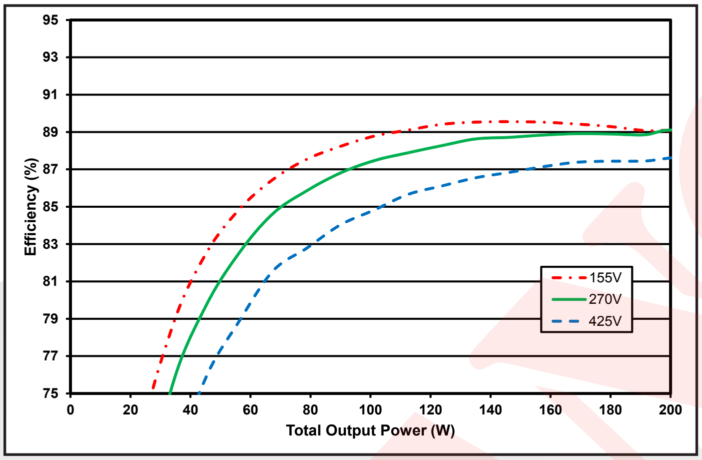


Figure 1: *Efficiency vs. output power, from zero load to full load on the ±12 V output and the +5 V output at minimum, nominal, and maximum input voltage at 25 °C.*

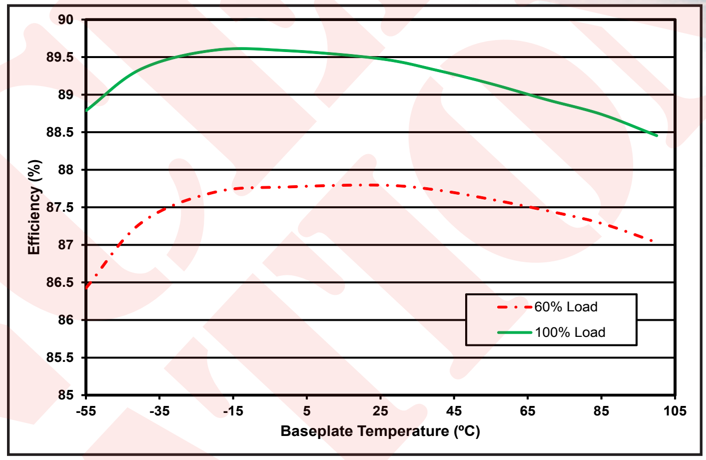


Figure 2: *Efficiency at 60% load and 100% load versus base plate temperature at nominal input voltage.*

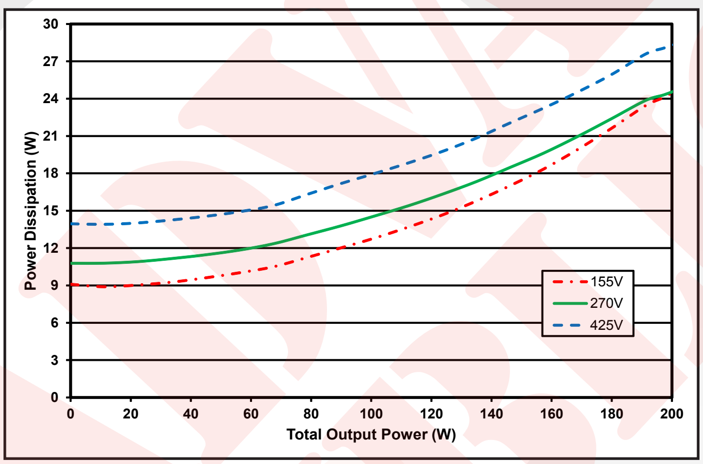


Figure 3: *Power dissipationr vs. output power, from zero load to full load on the ±12 V output and the +5 V output at minimum, nominal, and maximum input voltage at 25 °C.*

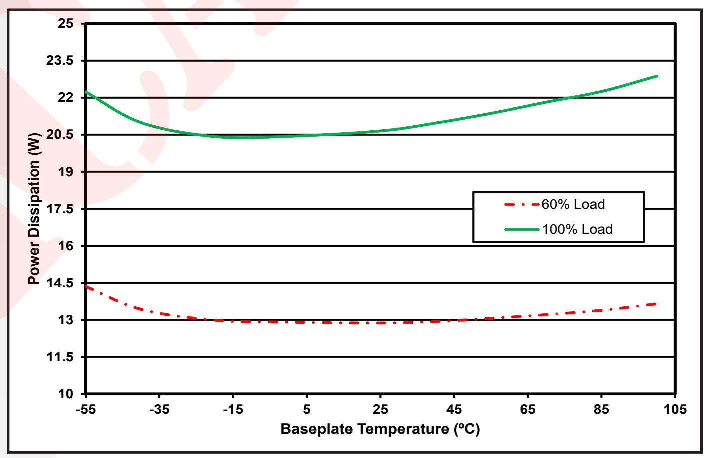


Figure 4: *Power dissipation at 60% load and 100% load versus base plate temperature at nominal input voltage.*

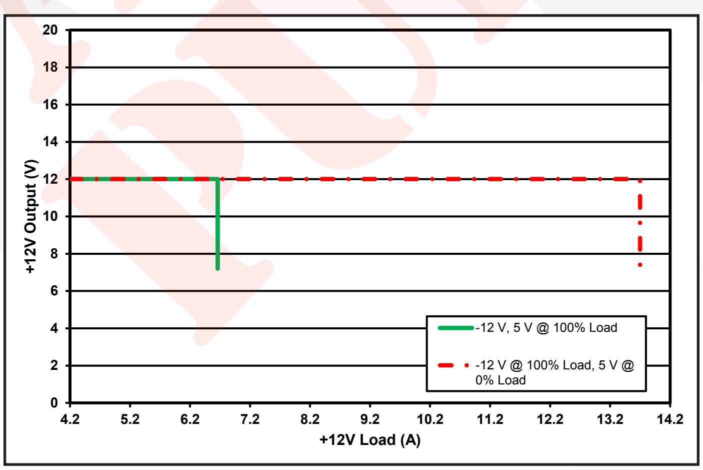


Figure 5: *Output voltage vs. load current for +12 V output showing typical current limit curves at nominal input voltage.*

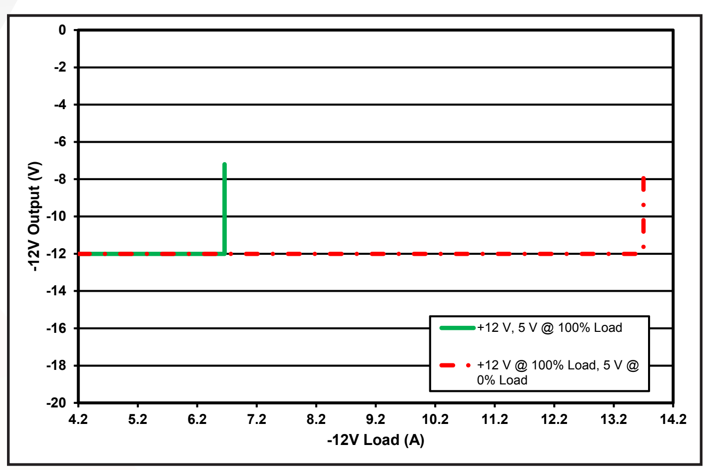


Figure 6: *Output voltage vs. load current for -12 V output showing typical current limit curves at nominal input voltage.*

Technical Charts

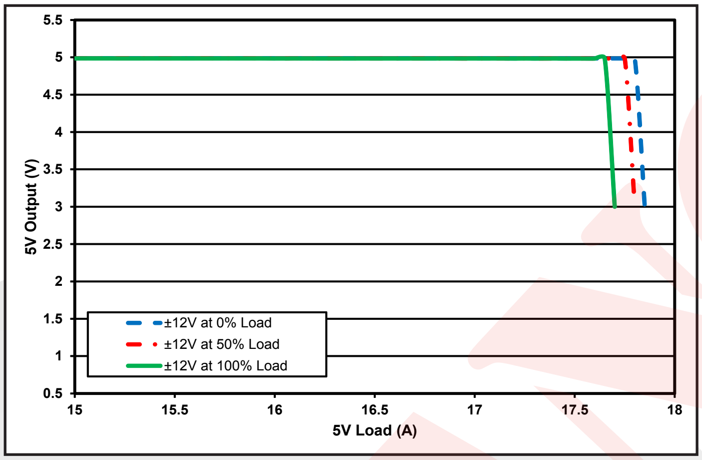


Figure 7: Output voltage vs. load current for +5 V output showing typical current limit curve for no load, half load and full load on +12 V output and -12 V output.

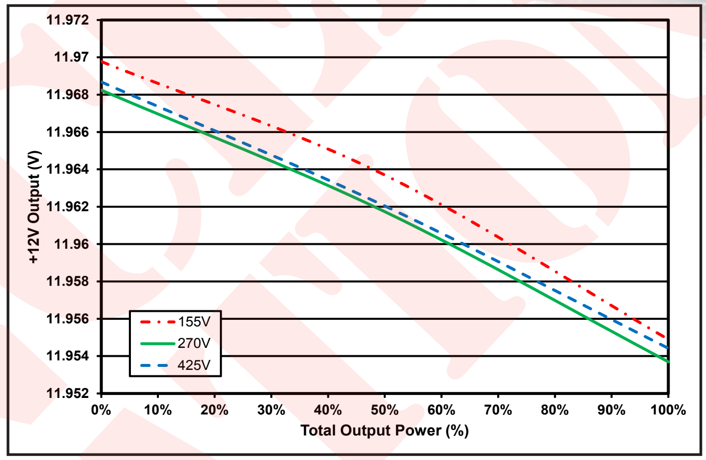


Figure 8: Output volatage vs. total load current showing load regulation on +12 V output, at minimum, nominal and maximum input voltage and at 25 °C.

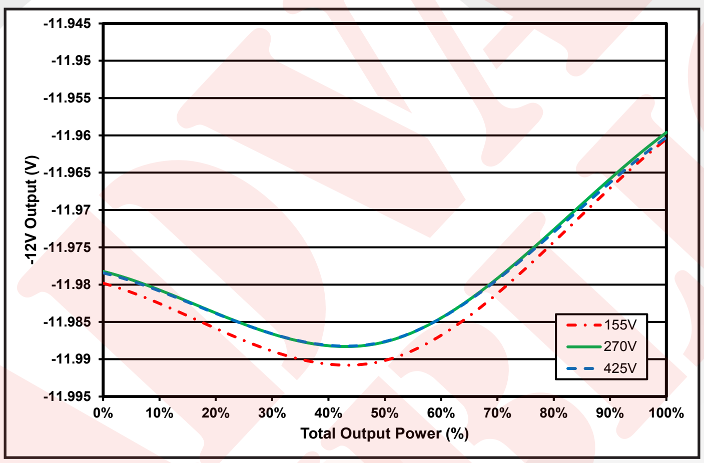


Figure 9: Output volatage vs. total load current showing load regulation on -12 V output, at minimum, nominal and maximum input voltage and at 25 °C.

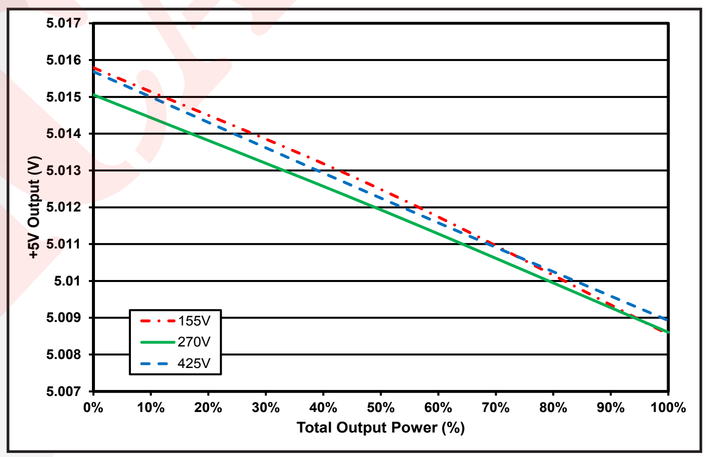


Figure 10: Output volatage vs. total load current showing load regulation on +5 V output, at minimum, nominal and maximum input voltage and at 25 °C.

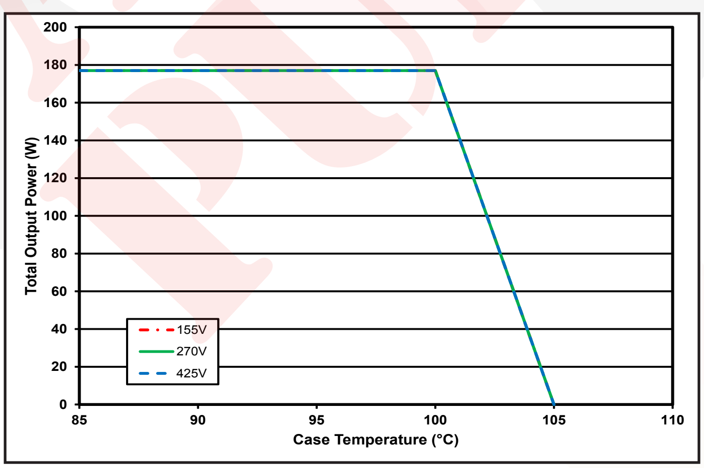


Figure 11: Total output power vs. case temperature for minimum, nominal and maximum input voltage.

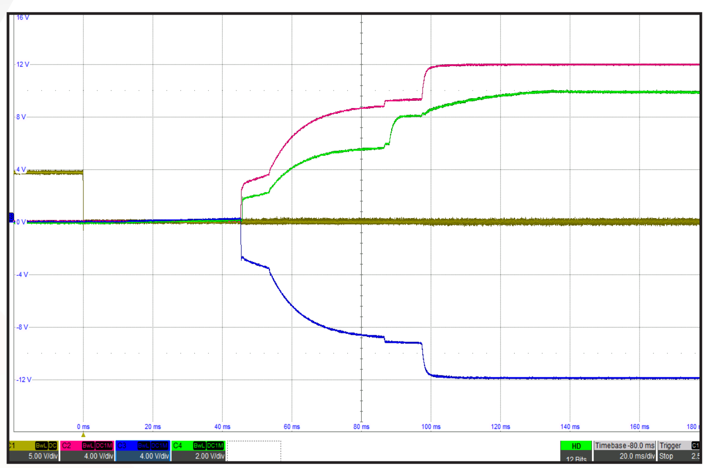


Figure 12: Turn-on transient at no load (±12 V and +5 V) and zero output capacitance initiated by On/Off. Nominal input voltage pre-applied. C1: On/Off (5 V/div); C2: +12 Vout (4 V/div); C3: -12 Vout (4 V/div); C4: +5 Vout (2 V/div); Timescale: 20 ms/div;

Technical Charts

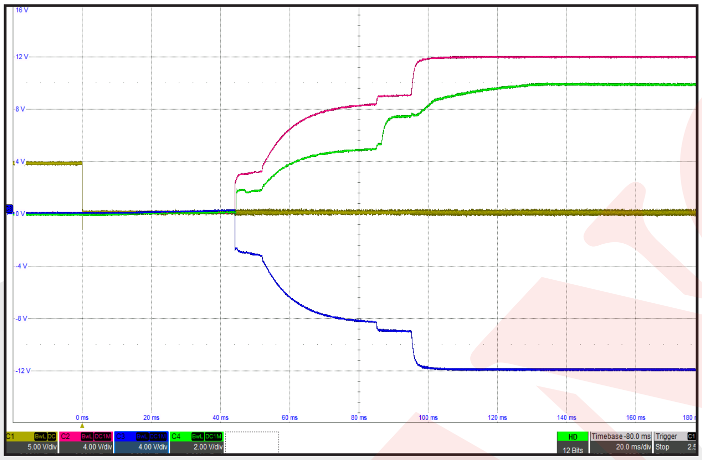


Figure 13: *Turn-on transient at full load (±12 V and +5 V) and zero output capacitance initiated by On/Off. Nominal input voltage pre-applied. C1: On/Off (5 V/div); C2: +12 Vout (4 V/div); C3: -12 Vout (4 V/div); C4: +5 Vout (2 V/div); Timescale: 20 ms/div;*

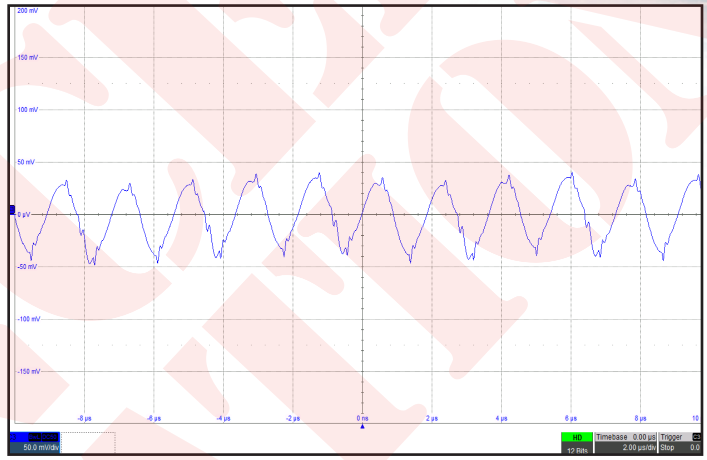


Figure 14: *Input terminal current ripple, at full rated output current and nominal input voltage. C3: Vin (50 mV/div, 20 MHz Bandwidth); Timescale: 2 µs/div.*

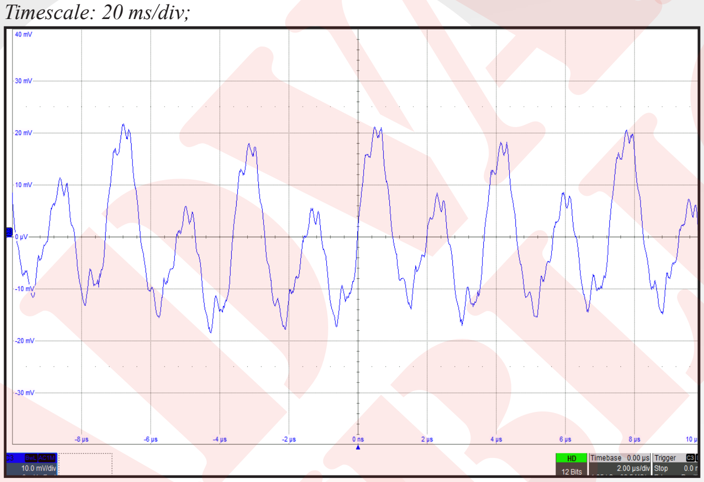


Figure 15: *Output voltage ripple, +12 Vout, at nominal input voltage and full rated load current. C3: +12 Vout (10 mV/div, 20 MHz Bandwidth); Timescale: 2 µs/div.*

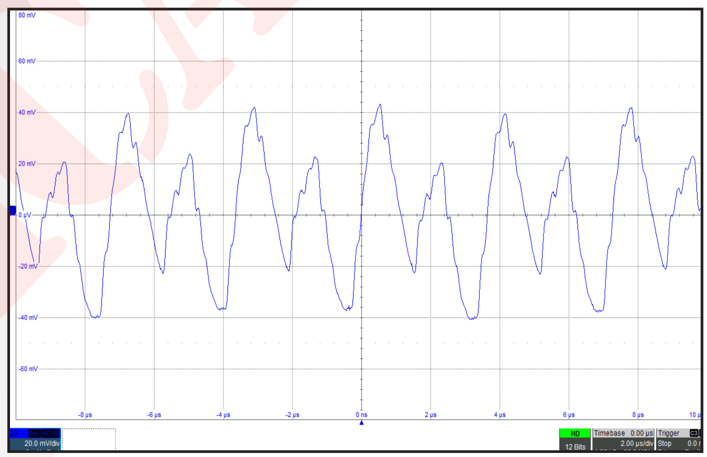


Figure 16: *Output voltage ripple, -12 Vout, at nominal input voltage and full rated load current. C3: -12 Vout (20 mV/div, 20 MHz Bandwidth); Timescale: 2 µs/div.*

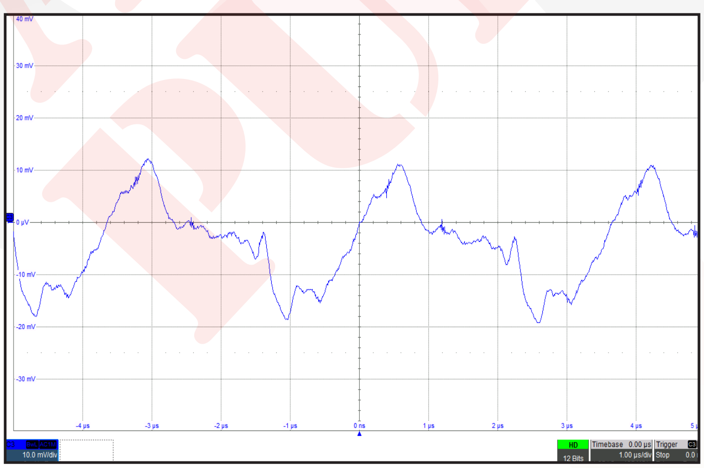


Figure 17: *Output voltage ripple, +5 Vout, at nominal input voltage and full rated load current. C3: +5 Vout (10 mV/div, 20 MHz Bandwidth); Timescale: 1 µs/div.*

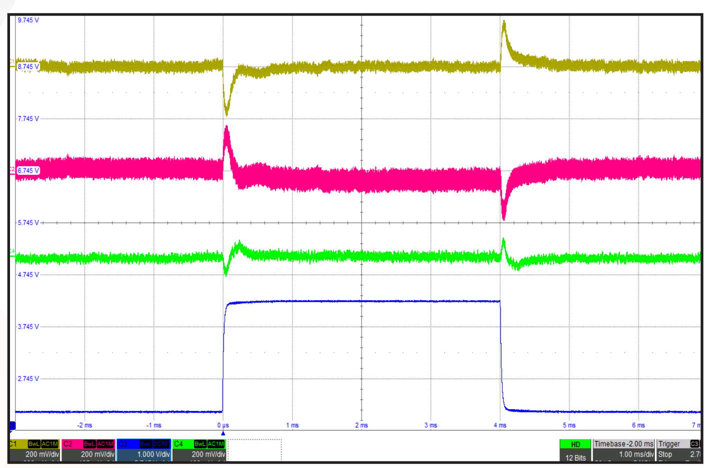


Figure 18: *Output voltage vs. load current, response to step-change in load current 50%-100%-50% of +12 V output. -12 V and 5 V output at full load.No external load capacitance. C1: +12 Vout (500 mV/div); C2: -12 Vout (500 mV/div); C3: +12 Iout (1 V = 1 A); C4: +5 Vout (500 mV/div); Timescale: 1 ms/div;*

Technical Charts

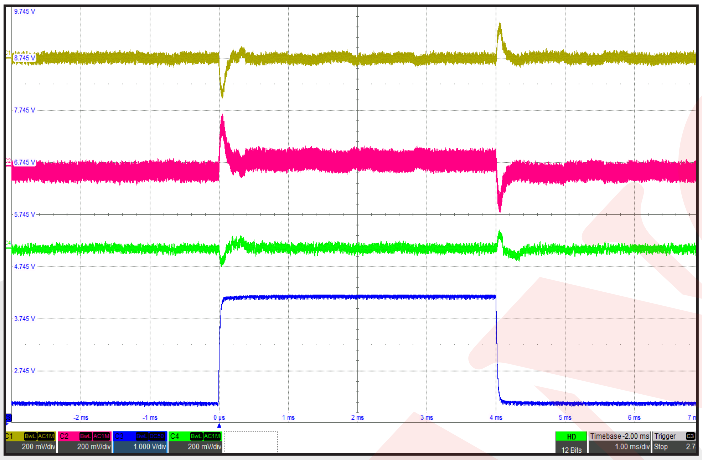


Figure 19: *Output voltage vs. load current, response to step-change in load current 50%-100%-50% of -12 V output. +12 V and 5 V output at full load.No external load capacitance. C1: +12 Vout (200 mV/div); C2: -12 Vout (200 mV/div); C3: -12 Iout (1 A/div); C4: +5 Vout (200 mV/div); Timescale: 1 ms/div;*

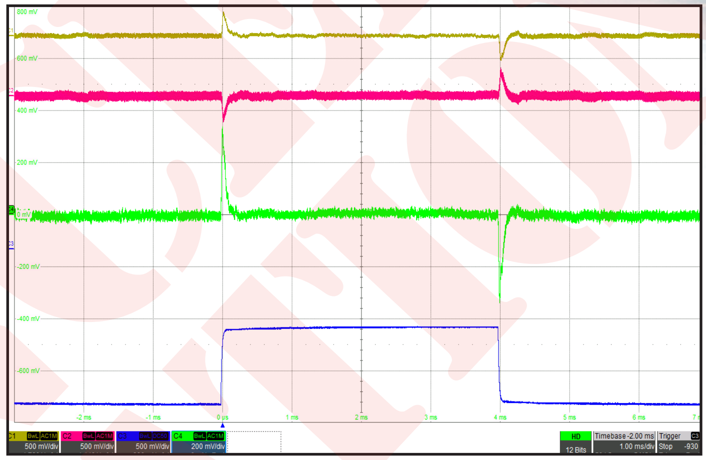


Figure 20: *Output voltage vs. load current, response to step-change in load current 50%-100%-50% of 5V output. +12 V and -12 V output at full load.No external load capacitance. C1: +12 Vout (500 mV/div); C2: -12 Vout (500 mV/div); C3: +5 Iout (1 A = 10 A); C4: +5 Vout (200 mV/div); Timescale: 1 ms/div;*

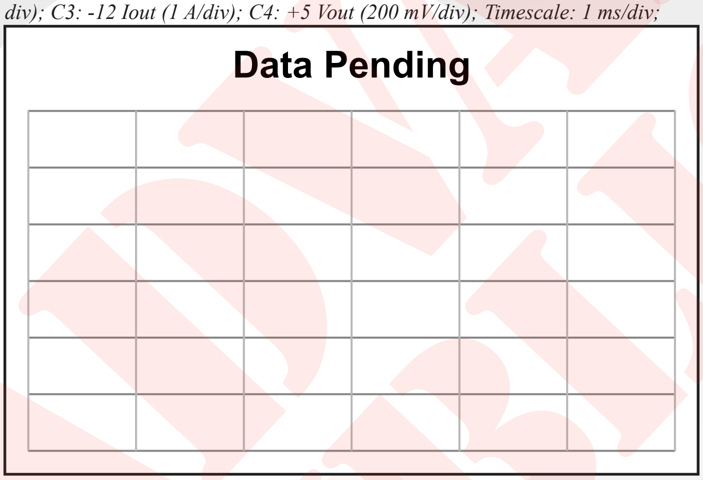


Figure 21: *Output voltage (±12 V and 5 V) vs. input voltge, response to step-change in input voltage (270V - 425V - 270V).*

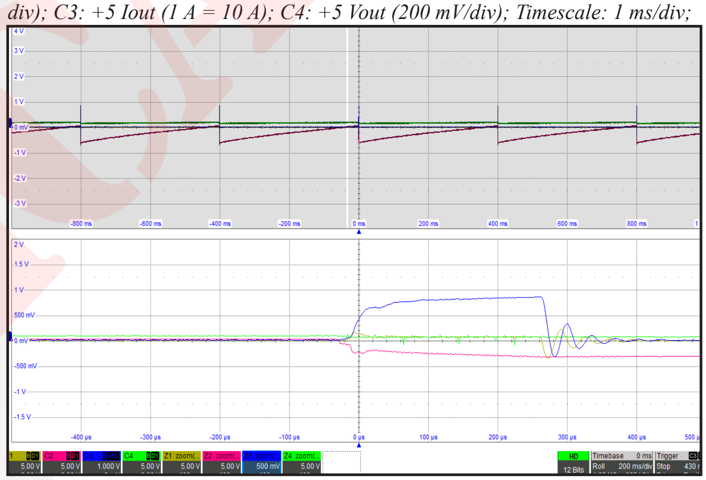


Figure 22: *Load current vs. time with short circuit across +12 Vout terminals. Nominal input voltage applied. C1: +12 Vout (5 V/div); C2: -12 Vout (5 V/div); C3: +5 Iout (1 V = 50 A); C4: +5 Vout (5 V/div); Timescale: 200 ms/div;*

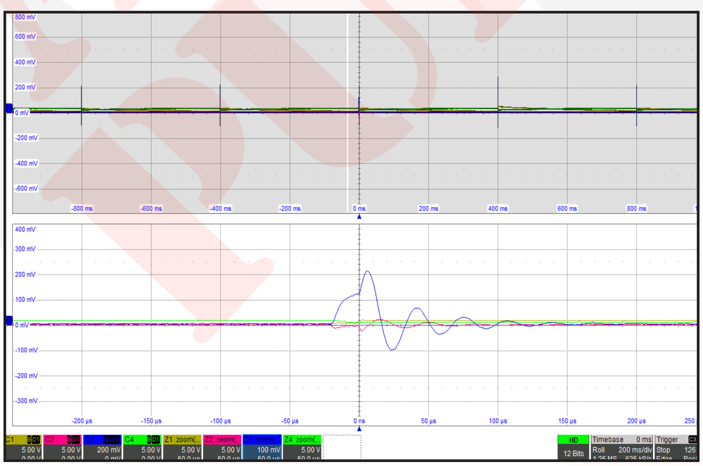


Figure 23: *Load current vs. time with short circuit across -12 Vout terminals. Nominal input voltage applied. C1: +12 Vout (5 V/div); C2: -12 Vout (5 V/div); C3: +5 Iout (1 V = 50 A); C4: +5 Vout (5 V/div); Timescale: 200 ms/div;*

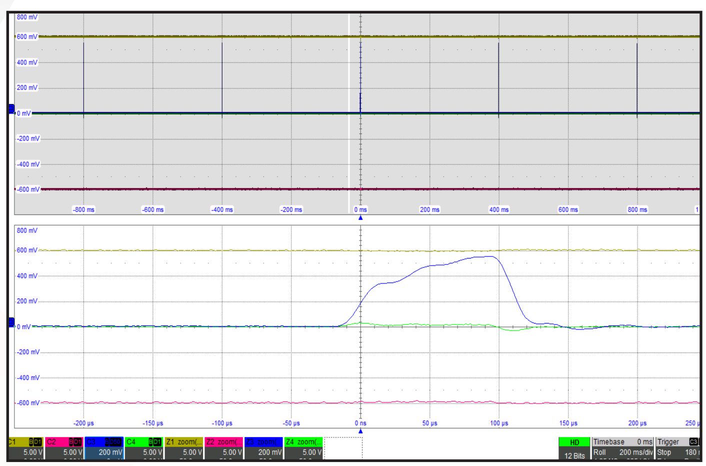


Figure 24: *Load current vs. time with short circuit across +5 Vout terminals. Nominal input voltage applied. C1: +12 Vout (5 V/div); C2: -12 Vout (5 V/div); C3: +5 Iout (1 V = 50 A); C4: +5 Vout (5 V/div); Timescale: 200 ms/div;*

Application Section

Basic Operation and Features

The Mil-COTS DC/DC converter uses a two / three-stage power conversion solution. 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 required output voltage for the ±12V outputs. A third stage provides the required step-down function to generate the 5V output from the voltage output bus.

In the triple output converter, there are three secondary windings in the transformer of the isolation stage, one for each output. However, only the positive outputs are regulated. The negative output therefore displays "Cross-Regulation", meaning that its output voltage depends on how much current is drawn from each output.

All the positive and the negative outputs share a common OUTPUT RETURN pin.

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 approximately 550 kHz.

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 Mil-COTS 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 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 Mil-COTS converters employ a "back-drive current limit" to keep this negative output terminal current small.

An input under-voltage shutdown feature is provided, as well as an input over-voltage shutdown and an output over-voltage shutdown, an over temperature shutdown, and an output current limit. 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 following sections provide a more in-depth description of the different control features.

Control Features

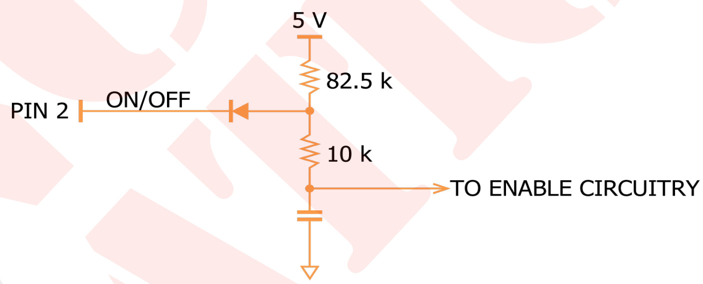


Figure A: *Circuit diagram shown for reference only, actual circuit components may differ from values shown for equivalent circuit.*

ON/OFF: The ON/OFF input, Pin 2, permits the user to control when the converter is on or off. This input is referenced to the return terminal of the input bus, VIN RETURN (pin 3). The ON/OFF signal is active low (meaning that a low signal turns the converter on). Figure A is a detailed look of the internal ON/ OFF circuitry.

SHUT DOWN: The Mil-COTS converter will shut down in response to six different faults: ON/OFF pin input high or open, VIN input below under-voltage shutdown threshold, VIN input above over-voltage shutdown threshold, over current / short circuit condition, output voltage above the output over-voltage threshold, and an overtemperature condition. Following any shutdown event, there is a startup inhibit delay which will prevent the converter from restarting for approximately 400ms after the fault clears. After a current limit fault, if the ON/OFF input pin is low and the input voltage is within the operating range, the converter will restart 400ms after the fault was triggered. 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.

OVER TEMPERATURE SHUT DOWN: A temperature sensor on the converter senses the average temperature of the module. The thermal shutdown circuit is designed to turn the converter off when the temperature at the sensed location reaches the Over-Temperature Shutdown value. It will allow the converter to turn on again when the temperature of the sensed location falls by the amount of the Over-Temperature Shutdown Restart Hysteresis value.

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OUTPUT VOLTAGE TRIM: If desired, it is possible to increase or decrease the Mil-COTS triple converter's output voltages from its nominal value. The +12V and -12V outputs are coupled together and change in unison. To increase the output voltage, a resistor ($R_{trim-up}$) should be connected between TRIM pins (pin 5 for 5V output and pin 8 for ±12V output) and the OUTPUT RETURN pin (pin 6), as shown in Figure C. The value of this resistor should be determined according to the following equation or from Figure B (±12V output) and Figure D (5V output):

$$R_{trim-up}(\Omega) = \frac{A\Omega * V_{nom}}{V_{out} - V_{nom}} - 1000\Omega$$

where:
V_{nom} = the converter's nominal output voltage,
V_{out} = the desired output voltage (greater than V_{nom}), and
$R_{trim-up}$ is in Ohms.

Output	Value of A
12V	673.36
5V	566.18

.

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.

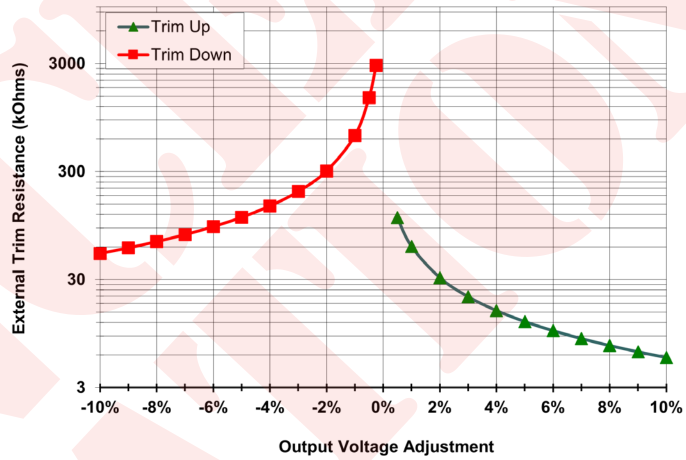

Figure B: *Trim up and Trim down for 12V output as a function of external trim resistance.*

To trim the output voltage below its nominal value, connect an external resistor ($R_{trim-down}$) between the TRIM pins (pin 5 for 5V output and pin 8 for ±12V output) and the POSITIVE OUTPUT pins (pin 4 for 5V output and pin 7 for ±12V output). The values of these trim down resistors should be chosen according to the following equation or from Figure B (±12V output) and Figure D (5V output):

$$R_{trim-down}(\Omega) = \frac{A\Omega * (B * V_{nom} - V_{out})}{V_{out} - V_{nom}} - 1000\Omega$$

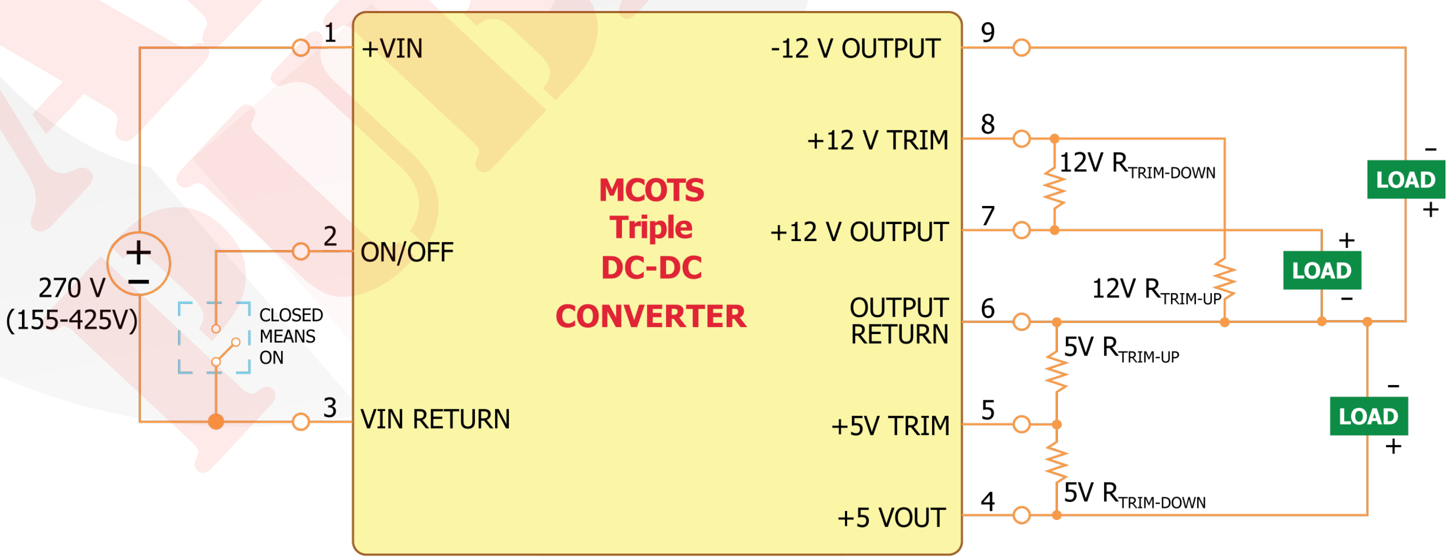

Figure C: *Typical connection for output voltage trimming.*

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where:

V_{nom} = the converter's nominal output voltage,

V_{out} = the desired output voltage (less than V_{nom}), and

$R_{trim-down}$ is in Ohms.

Output	Value of A	Value of B
12V	6590	0.1022
5V	2310	0.2451

Protection Features

INPUT UNDER-VOLTAGE SHUTDOWN: The Mil-COTS converter has an under-voltage shutdown 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 Mil-COTS converter will not respond to a state of the input voltage unless it has remained in that state for more than about 20µs. This delay ensures proper operation when the source impedance is high or in a noisy environment.

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

OUTPUT OVER-VOLTAGE SHUTDOWN: The Mil-COTS 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; excessive trim-up or output wiring voltage drops may cause an output over-voltage shutdown event. After a startup inhibit delay, the converter will attempt to restart as long as the fault has cleared.

OUTPUT UNDER-VOLTAGE SHUTDOWN: The Mil-COTS 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 behaves as 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 that are connected together through either explicit or parasitic diodes that, while normally off, become conductive during startup or shutdown events. Finally, some loads, such as motors, can return energy to their input power rail. Even a load capacitor is a source of back-drive energy for some period of time during a start-up / shutdown transient.

To avoid any problems that might arise due to back-drive current, the Mil-COTS 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 currents.

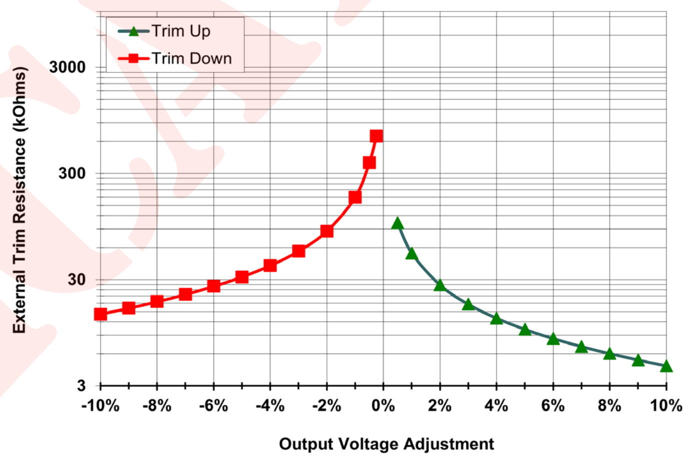

Figure D: Trim up and Trim down for 5V output as a function of external trim resistance.

CURRENT LIMIT: In the event of excess load, the Mil-COTS converter will quickly reduce its output voltage to keep the load current within safe limits (see Figure 6 and Figure 7). If the overload persists for more than 40 milliseconds, the converter will shut down, wait a restart delay, and then automatically attempt to re-start. The timeout is internally implemented with a timer, in this way a series of short-duration overloads will not cause the converter to shut down, while it will shut down in response to sustained overloads.

Application Considerations

THERMAL CONSIDERATIONS: The maximum operating base-plate temperature, T_B, is 100 ºC. Refer to the thermal derating curve, Figure 11, to see the available output current at baseplate temperatures at or below 100 ºC. A power derating curve can be calculated for any heatsink that is attached to the base-plate of the converter. It is only necessary to determine the thermal

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resistance, $R_{TH_{BA}}$, of the chosen heatsink between the base-plate and the ambient air for a given airflow rate. This information is usually available from the heatsink vendor. The following formula can then be used to determine the maximum power the converter can dissipate for a given thermal condition:

$$P_{diss}^{max} = \frac{T_B - T_A}{R_{TH_{BA}}}$$

This value of power dissipation can then be used in conjunction with the data shown in Figure 5 to determine the maximum load current (and power) that the converter can deliver in the given thermal condition.

It has been SynQor's extensive experience that reliable long-term converter operation can be achieved with a maximum component temperature of 125 ºC.

INPUT SYSTEM INSTABILITY: This condition can occur because any dc-dc converter appears incrementally as a negative resistance load to the input source. 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.

STARTUP INHIBIT PERIOD: The Startup Inhibit Period ensures that the converter will remain off for approximately 400ms when it is shut down for any reason. When an output short is present, this generates a "hiccup" mode, which prevents the converter from overheating. In all, there are seven ways that the converter can be shut down, initiating a Startup Inhibit Period:

- Input Under-Voltage Lockout
- Input Over-Voltage Lockout
- Output Over-Voltage Protection
- Current Limit
- Short Circuit Protection
- Turned off by the ON/OFF input
- Over Temperature fault

Figure E shows three turn-on scenarios, where a Startup Inhibit Period is initiated at t_0 , t_1 and t_2 : Before time t_0 , when the input voltage is below the UVL threshold, the unit is disabled by the Input Under-Voltage Lockout feature. When the input voltage rises above the UVL threshold, the Input Under-Voltage lockout is released, and a Startup Inhibit Period is initiated. At the end of this delay, the ON/OFF pin is evaluated, and since it is active, the unit turns on. At time t_1 , the unit is disabled by the ON/OFF pin, and it cannot be enabled again until the Startup Inhibit Period has elapsed. When the ON/OFF pin goes high after t_2 , the Startup Inhibit Period has elapsed, and the output turns on within the typical Turn-On Time.

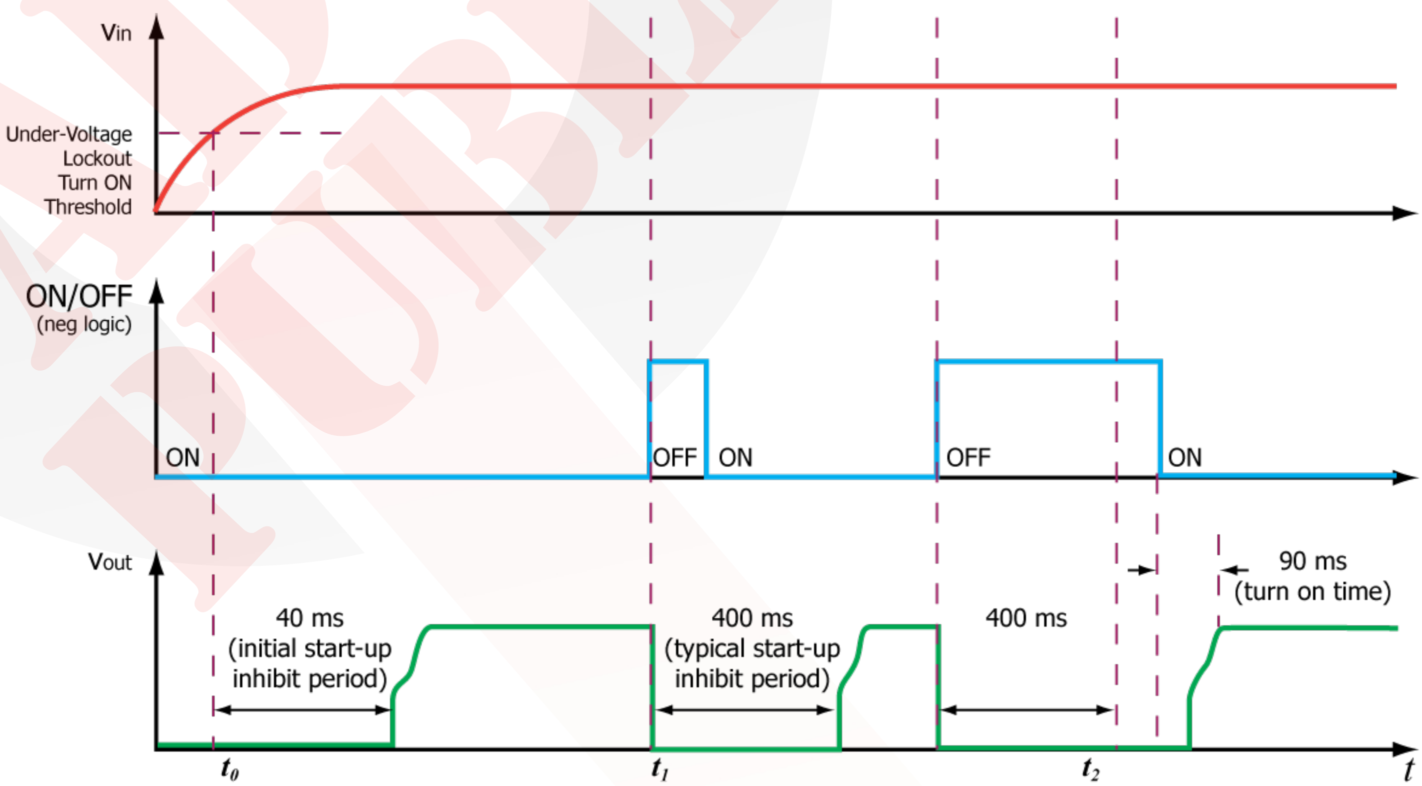
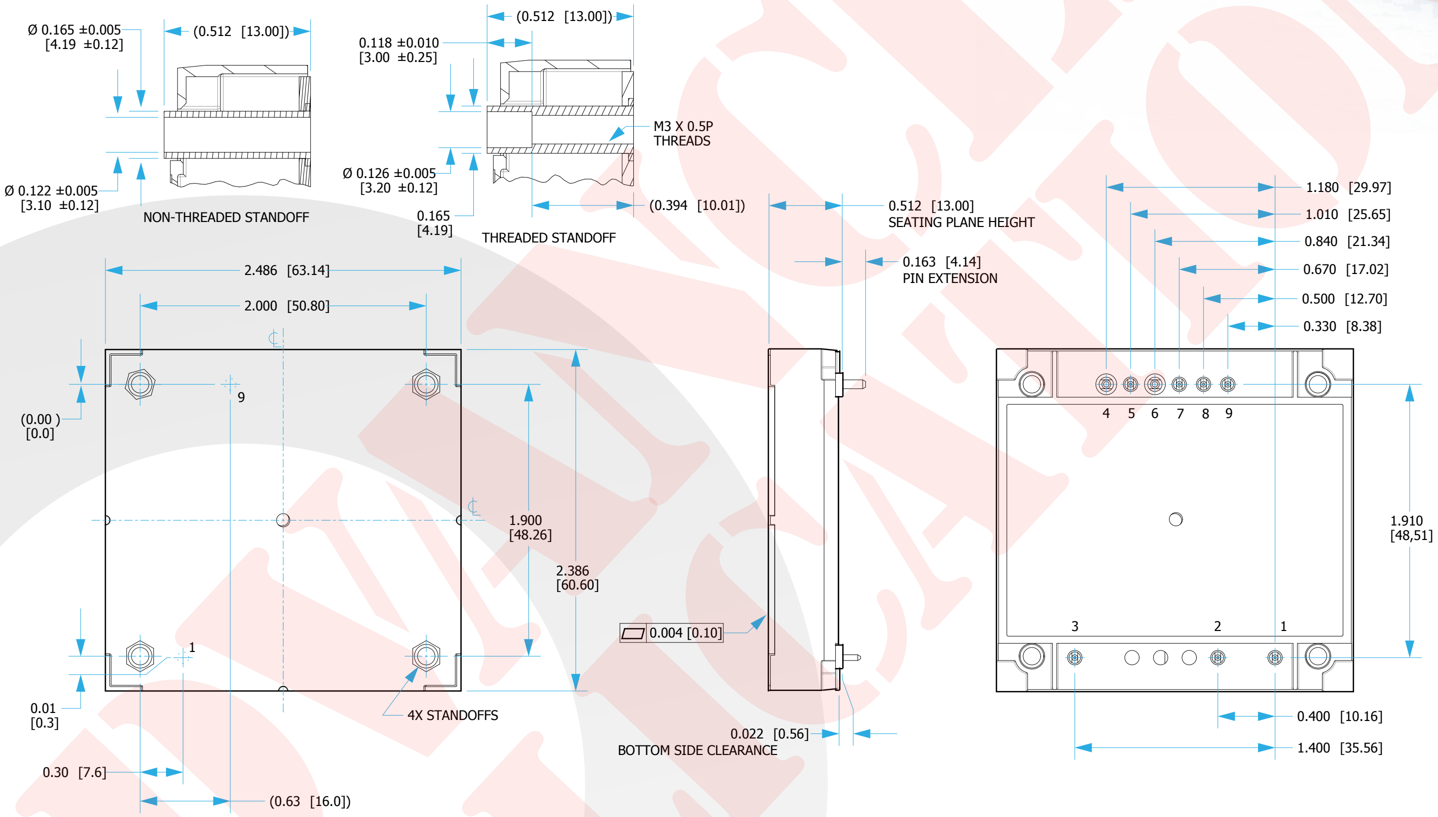


Figure E: *Startup Inhibit Period (turn-on time not to scale)*

Encased Mechanical Diagram



PIN DESIGNATIONS

Pin #	Function
1	Positive input
2	On/Off
3	Input return
4	+5V Output
5	Trim 5V
6	Output return
7	+12V Output
8	Trim 12V
9	-12V Output

NOTES:

1: THREADED: APPLIED TORQUE PER M3 SCREW SHOULD NOT EXCEED 6 in-lb (0.7 Nm). NONTHREADED: DIA 0.122” (3.10 mm)

2: BASEPLATE FLATNESS TOLERANCE IS 0.004” (0.10 mm) TIR FOR SURFACE.

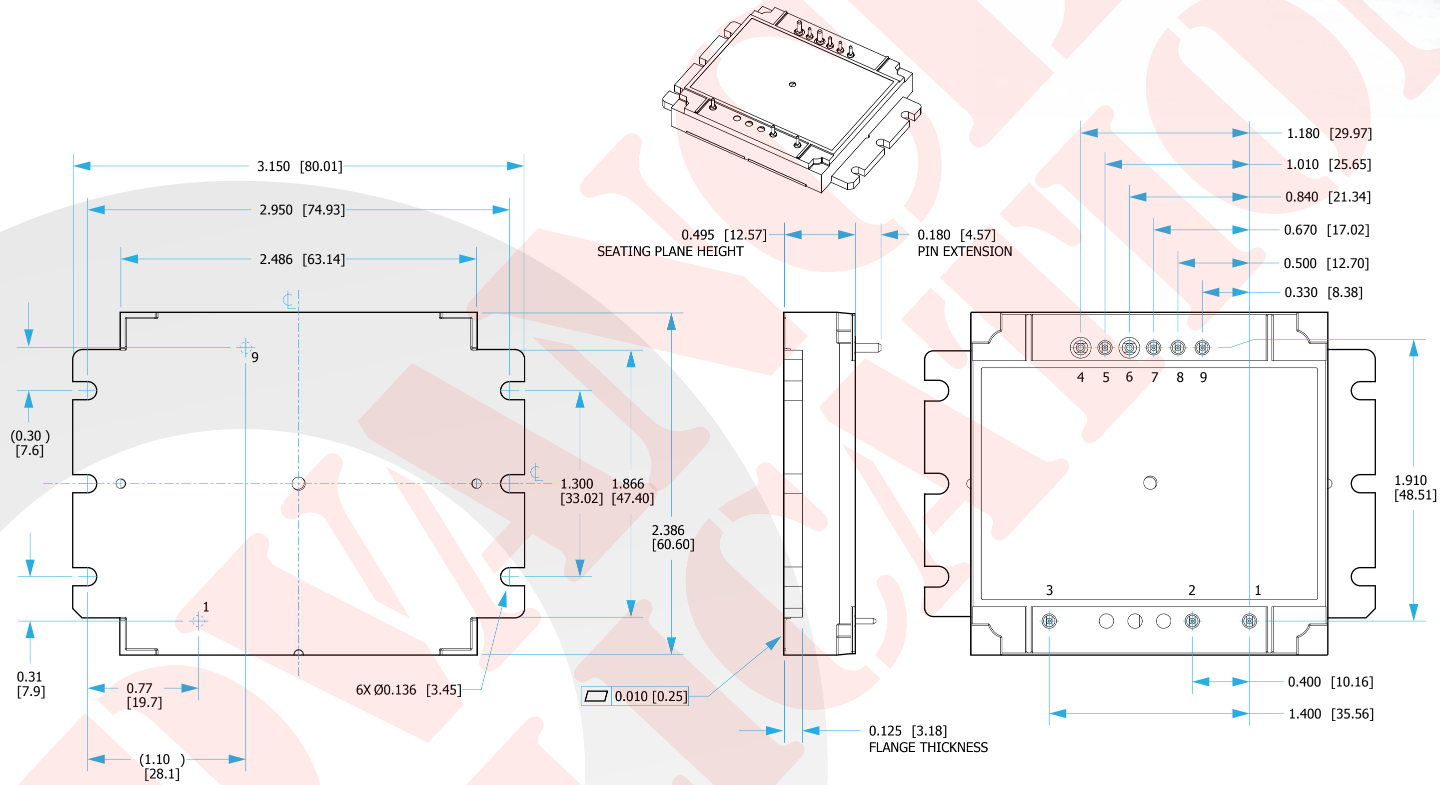
3: PINS 1-3, 5, 7-9 ARE 0.040” (1.02 mm) DIA, WITH 0.080” (2.03 mm) DIA. STANDOFF. PINS 4 AND 6 ARE 0.062” (1.57 mm) DIA, WITH 0.100” (2.54 mm) DIA. STANDOFF.

4: ALL PINS: MATERIAL: COPPER ALLOY FINISH: MATTE TIN OVER NICKEL PLATE

5: WEIGHT: 5.8 oz. (164 g)

6: ALL DIMENSIONS IN INCHES (mm) TOLERANCES: X.XXIN +/-0.02 (X.X mm +/-0.5 mm) X.XXXIN +/-0.010 (X.XX mm +/-0.25 mm)

Flanged Encased Mechanical Diagram



PIN DESIGNATIONS

Pin #	Function
1	Positive input
2	On/Off
3	Input return
4	+5V Output
5	Trim 5V
6	Output return
7	+12V Output
8	Trim 12V
9	-12V Output

NOTES:

1: APPLIED TORQUE PER M3 OR 4-40 SCREW SHOULD NOT EXCEED 6 in-lb (0.7 Nm)

2: BASEPLATE FLATNESS TOLERANCE IS 0.010” (0.25 mm) TIR FOR SURFACE.

3: PINS 1-3, 5, 7-9 ARE 0.040” (1.02 mm) DIA, WITH 0.080” (2.03 mm) DIA. STANDOFF
PINS 4 AND 6 ARE 0.062” (1.57 mm) DIA, WITH 0.100” (2.54 mm) DIA. STANDOFF.

4: ALL PINS: MATERIAL: COPPER ALLOY
FINISH: MATTE TIN OVER NICKEL PLATE

5: WEIGHT: 6.0 oz. (169 g)
ALL DIMENSIONS IN INCHES (mm)

6: TOLERANCES: X.XXIN +/-0.02 (X.X mm +/-0.5 mm)
X.XXXIN +/-0.010 (X.XX mm +/-0.25 mm)

Qualifications & Screening

Mil-COTS Qualification

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

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

Mil-COTS Converter and Filter Screening

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

Mil-COTS MIL-STD-810G Qualification Testing

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

Ordering Information

Part Numbering Scheme							
Family	**Product**	**Input Voltage**	**Output Voltage**	**Package Size**	**Heatsink Option**	**Screening Level**	**Options**
MCOTS	**C:** Converter	**270:** 155-425 V	**0512T:** ±12V,+5V **0515T:** ±15V,+5V	**HT:** Half-brick Tera	**N:** Normal Threaded **F:** Flanged **D:** Non Threaded	**S:** S-Grade **M:** M-Grade	**[ ]:** Standard Feature

Ordering Information / Part Numbering

Example: MCOTS-C-270-0512T-HT-F-M

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

Application Notes

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

STANDARDS COMPLIANCE

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

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

Contact SynQor for further information and to order:

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

WARRANTY

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

PATENTS

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

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