

## MILITARY COTS DC-DC CONVERTER

|                                   |                                  |                      |                     |                                          |
|-----------------------------------|----------------------------------|----------------------|---------------------|------------------------------------------|
| <b>16-40V</b><br>Continuous Input | <b>16-50V</b><br>Transient Input | <b>28V</b><br>Output | <b>4A</b><br>Output | <b>92% @ 2A / 90% @ 4A</b><br>Efficiency |
|-----------------------------------|----------------------------------|----------------------|---------------------|------------------------------------------|

Operation: -55°C to +100°C

The MilQor® series of Mil-COTS DC-DC converters brings 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. Compatible with the industry standard format, 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.

# MilCOTS™



Designed and Manufactured in the USA

### Safety Features

- 2250 V, 30 MΩ input-to-output isolation
- Certified 60950-1 requirement for basic insulation (see Standards and Qualifications page)

### Mechanical Features

- Industry standard quarter-brick pin-out
- Size: 1.54" x 2.39" x 0.50"  
(39.0 x 60.6 x 12.7 mm)
- Total weight: 3.2 oz. (91 g)
- Flanged baseplate version available

### Protection Features

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

### Specification Compliance

MCOTS series converters (with an MCOTS filter) are designed to meet:

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

### Operational Features

- High efficiency, 90% at full rated load current
- Operating input voltage range: 16-40 V
- Fixed frequency switching provides predictable EMI
- No minimum load requirement

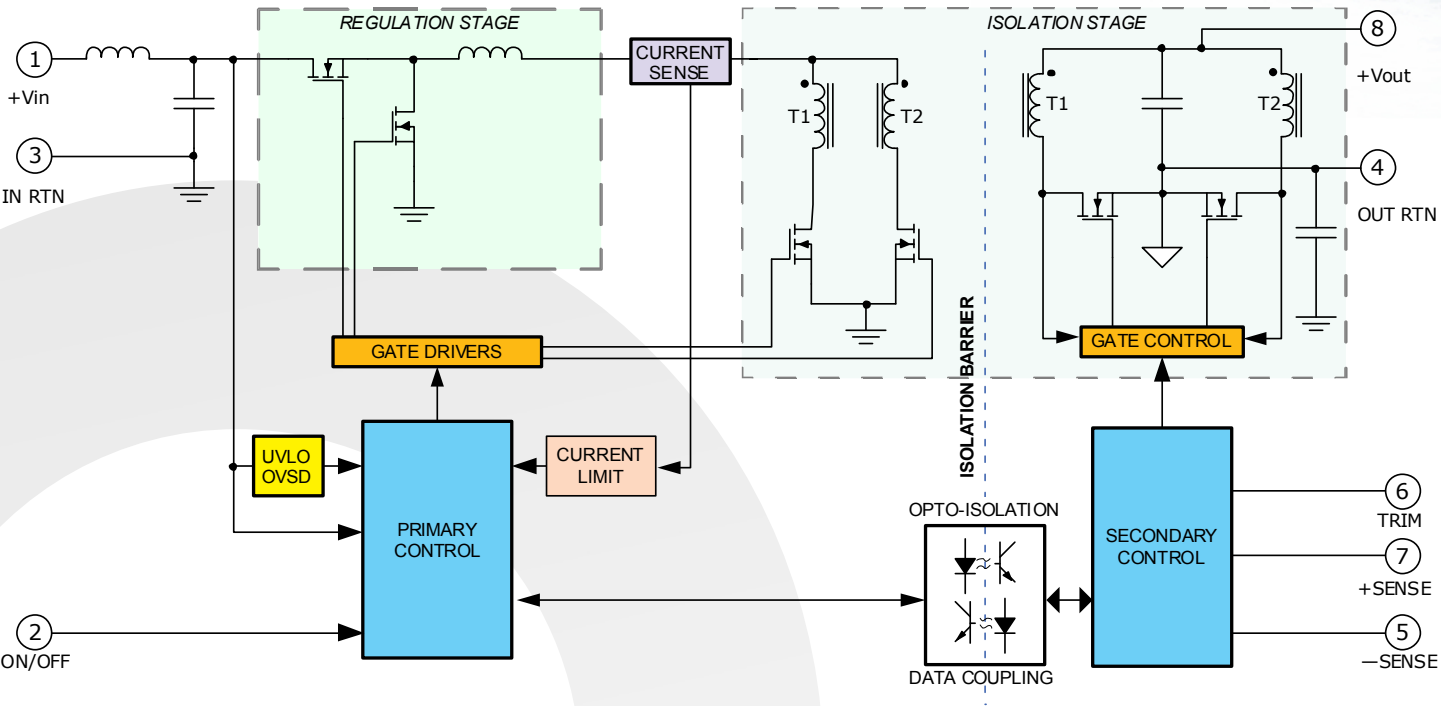
### Control Features

- On/Off control referenced to input return
- Remote sense for the output voltage
- Output voltage trim range of +10%, -20%

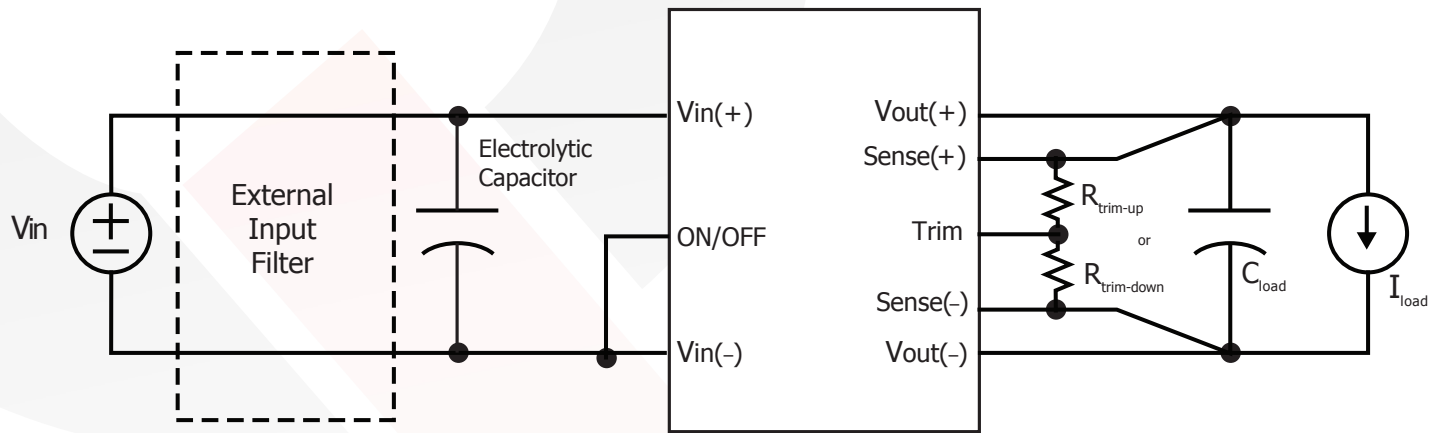
### Screening/Qualification

- AS9100 and ISO 9001 certified facility
- Qualified to MIL-STD-810
- Available with S-Grade or M-Grade screening
- Pre-cap inspection per IPC-A-610, Class III
- 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





**MCOTS-C-28-28-QT**

**Output: 28V**

**Current: 4.0A**

## Technical Specification

### MCOTS-C-28-28-QT ELECTRICAL CHARACTERISTICS

Tb = 25 °C, Vin = 28 Vdc 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                          |
|----------------------------------------------|-------|---------|-------|-------|---------------------------------------------|
| <b>ABSOLUTE MAXIMUM RATINGS</b>              |       |         |       |       |                                             |
| Input Voltage                                |       |         |       |       |                                             |
| Non-Operating                                | -1    |         | 60    | V     | Continuous                                  |
| Operating                                    |       |         | 40    | V     | Continuous                                  |
| Operating Transient Protection               |       |         | 50    | V     | 1 s transient, square wave                  |
| Isolation Voltage                            |       |         |       |       |                                             |
| Input to Output                              |       |         | 2250  | V dc  |                                             |
| Input to Base-Plate                          |       |         | 2250  | V dc  |                                             |
| Output to Base-Plate                         |       |         | 2250  | V dc  |                                             |
| Operating Temperature                        | -55   |         | 100   | °C    | Baseplate temperature                       |
| Storage Temperature                          | -65   |         | 135   | °C    |                                             |
| Voltage at ON/OFF input pin                  | -2    |         | 18    | V     |                                             |
| <b>INPUT CHARACTERISTICS</b>                 |       |         |       |       |                                             |
| Operating Input Voltage Range                | 16    | 28      | 40    | V     | 50V transient for 1 s                       |
| Input Under-Voltage Lockout                  |       |         |       |       |                                             |
| Turn-On Voltage Threshold                    | 14.8  | 15.3    | 15.9  | V     |                                             |
| Turn-Off Voltage Threshold                   | 13.8  | 14.3    | 15.1  | V     |                                             |
| Lockout Voltage Hysteresis                   |       | 1.0     |       | V     |                                             |
| Recommended External Input Capacitance       |       | 100     |       | µF    | Typical ESR 0.1-0.2 Ω                       |
| Input Filter Component Values (L/C)          |       | 1.0\6.6 |       | µH\µF | Internal values; see Figure E               |
| Maximum Input Current                        |       |         | 10.3  | A     | Vin min; trim up; in current limit          |
| No-Load Input Current                        |       | 100     | 120   | mA    | Vin is set to the nominal voltage           |
| Disabled Input Current                       |       | 2       | 4     | mA    |                                             |
| Response to Input Transient                  |       | 0.7     |       | V     | See Figure 12                               |
| Input Terminal Ripple Current                |       | 340     |       | mA    | RMS                                         |
| Recommended Input Fuse                       |       |         | 20    | A     | Fast acting external fuse recommended       |
| <b>OUTPUT CHARACTERISTICS</b>                |       |         |       |       |                                             |
| Output Voltage Set Point                     | 27.72 | 28.00   | 28.28 | V     |                                             |
| Output Voltage Regulation                    |       |         |       |       |                                             |
| Over Line                                    |       | ±0.1    | ±0.3  | %     |                                             |
| Over Load                                    |       | ±0.1    | ±0.3  | %     |                                             |
| Over Temperature                             | -420  |         | 420   | mV    |                                             |
| Total Output Voltage Range                   | 27.3  |         | 28.7  | V     | Over sample, line, load, temperature & life |
| Output Voltage Ripple and Noise              |       |         |       |       | 20 MHz bandwidth; see Note 1                |
| Peak-to-Peak                                 | 0     | 65      | 130   | mV    | Full load                                   |
| RMS                                          |       | 15      | 30    | mV    | Full load                                   |
| Operating Output Current Range               | 0     |         | 4     | A     | Subject to thermal derating                 |
| Output DC Current-Limit Inception            | 4.4   | 4.8     | 5.2   | A     | Output voltage 10% Low                      |
| Output DC Current-Limit Shutdown Voltage     |       | 15      |       | V     |                                             |
| Back-Drive Current Limit while Enabled       |       | 0.08    |       | A     | Negative current drawn from output          |
| Back-Drive Current Limit while Disabled      |       | 5       |       | mA    | Negative current drawn from output          |
| Maximum Output Capacitance                   |       |         | 250   | µF    | Vout nominal at full load (resistive load)  |
| Output Voltage during Load Current Transient |       |         |       |       |                                             |
| Step Change in Output Current (0.1 A/µs)     |       | 1400    |       | mV    | 50% to 75% to 50% Iout max                  |
| Settling Time                                |       | 100     |       | µs    | To within 1% Vout nom                       |
| Output Voltage Trim Range                    | -20   |         | 10    | %     | Across Pins 8&4; Figure C; see Note 2       |
| Output Voltage Remote Sense Range            |       |         | 10    | %     | Across Pins 8&4                             |
| Output Over-Voltage Protection               | 32.76 | 34.16   | 35.56 | V     | Over full temp range                        |
| <b>EFFICIENCY</b>                            |       |         |       |       |                                             |
| 100% Load                                    |       | 90      |       | %     | See Figure 1 for efficiency curve           |
| 50% Load                                     |       | 92      |       | %     | See Figure 1 for efficiency curve           |

Note 1: Output is terminated with 1 µF ceramic and 15 µF low-ESR tantalum capacitors. For applications requiring reduced output voltage ripple and noise, consult SynQor applications support (e-mail: mqnbfae@synqor.com)

Note 2: Trim-up range is limited below 10% at low line and full load.





**MCOTS-C-28-28-QT**

**Output: 28V**

**Current: 4.0A**

## Technical Specification

### MCOTS-C-28-28-QT ELECTRICAL CHARACTERISTICS

Tb = 25 °C, Vin = 28 Vdc 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.

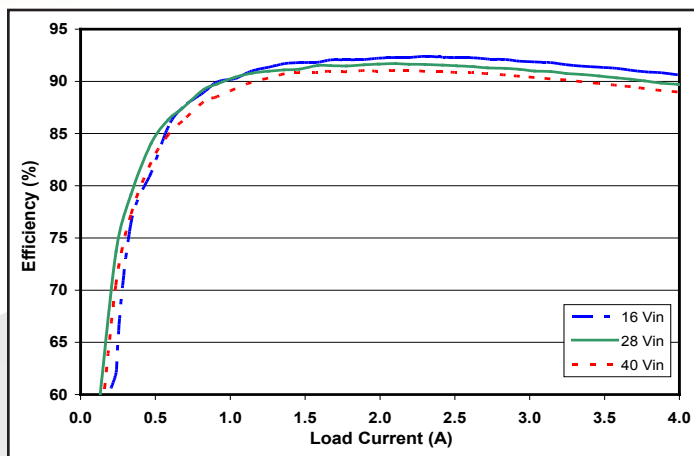
| Parameter                                           | Min. | Typ. | Max. | Units                | Notes & Conditions                 |
|-----------------------------------------------------|------|------|------|----------------------|------------------------------------|
| <b>DYNAMIC CHARACTERISTICS</b>                      |      |      |      |                      |                                    |
| Turn-On Transient                                   |      |      |      |                      |                                    |
| Turn-On Time                                        |      | 9    |      | ms                   | Full load, Vout=90% nom.           |
| Start-Up Inhibit Time                               | 180  | 200  | 220  | ms                   | See Figure F                       |
| Output Voltage Overshoot                            |      | 0    |      | %                    | Maximum Output Capacitance         |
| <b>ISOLATION CHARACTERISTICS</b>                    |      |      |      |                      |                                    |
| Isolation Voltage (dielectric strength)             |      |      |      |                      | See Absolute Maximum Ratings       |
| Isolation Resistance                                | 30   |      |      | MΩ                   |                                    |
| Isolation Capacitance (input to output)             |      | 1000 |      | pF                   | See Note 1                         |
| <b>TEMPERATURE LIMITS FOR POWER DERATING CURVES</b> |      |      |      |                      |                                    |
| 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                   |                                    |
| <b>FEATURE CHARACTERISTICS</b>                      |      |      |      |                      |                                    |
| Switching Frequency                                 | 230  | 250  | 270  | kHz                  | For both input and isolation stage |
| ON/OFF Control                                      |      |      |      |                      |                                    |
| Off-State Voltage                                   | 2.4  |      | 18   | V                    |                                    |
| On-State Voltage                                    | -2.0 |      | 0.8  |                      |                                    |
| ON/OFF Control                                      |      |      |      |                      | Application notes Figures A & B    |
| Pull-Up Voltage                                     |      | 5    |      | V                    |                                    |
| Pull-Up Resistance                                  |      | 50   |      | kΩ                   |                                    |
| Over-Temperature Shutdown OTP Trip Point            |      | 125  |      | °C                   | Average PCB Temperature            |
| Over-Temperature Shutdown Restart Hysteresis        |      | 10   |      | °C                   |                                    |
| <b>RELIABILITY CHARACTERISTICS</b>                  |      |      |      |                      |                                    |
| Calculated MTBF per MIL-HDBK-217F                   |      | 3.4  |      | 10 <sup>6</sup> Hrs. | Ground Benign, 70°C Tb             |
| Calculated MTBF per MIL-HDBK-217F                   |      | 0.58 |      | 10 <sup>6</sup> Hrs. | Ground Mobile, 70°C Tb             |

Note 1: Higher values of isolation capacitance can be added external to the module.

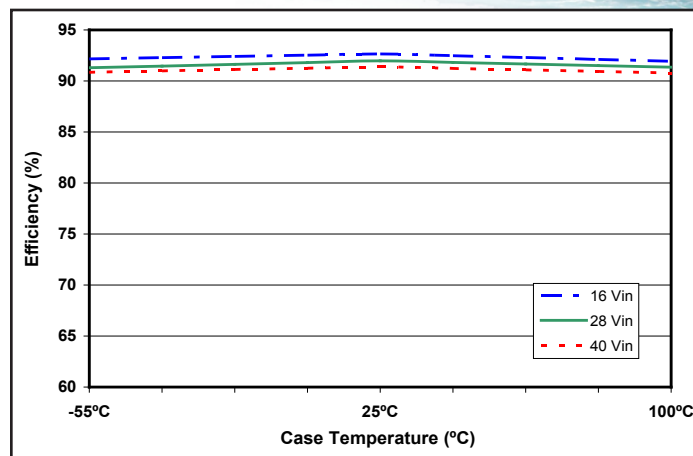
### STANDARDS COMPLIANCE

| Parameter                   | Notes & Conditions |
|-----------------------------|--------------------|
| <b>STANDARDS COMPLIANCE</b> |                    |
| UL 60950-1                  | Basic Insulation   |
| CAN/CSA C22.2 No. 60950-1   |                    |
| EN 60950-1                  |                    |

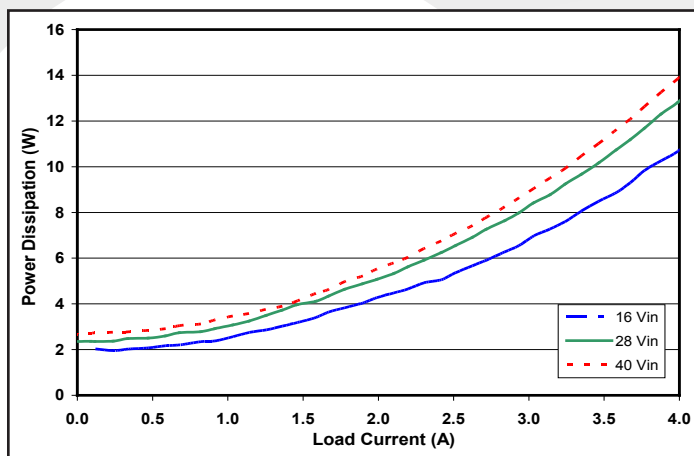
Note: An external input fuse must always be used to meet these safety requirements.



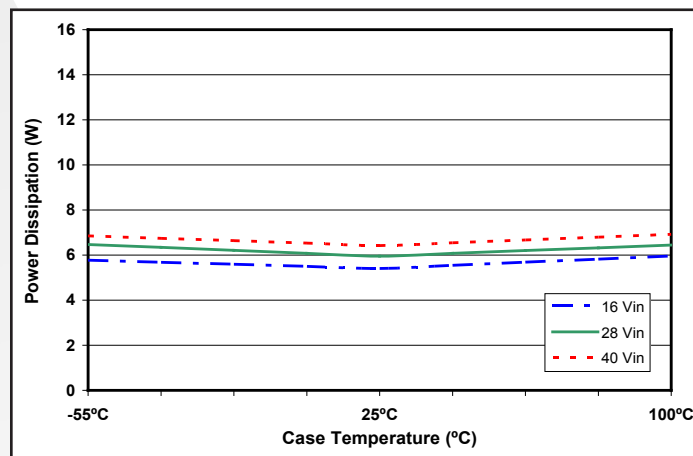
**Figure 1:** Efficiency at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at 25°C.



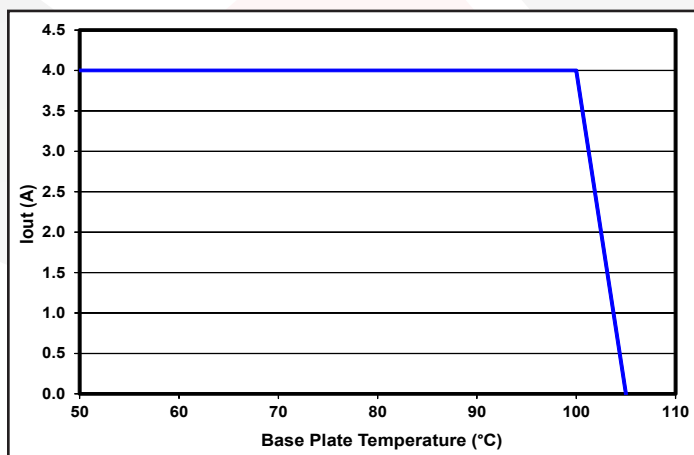
**Figure 2:** Efficiency at nominal output voltage and 60% rated power vs. case temperature for minimum, nominal, and maximum input voltage.



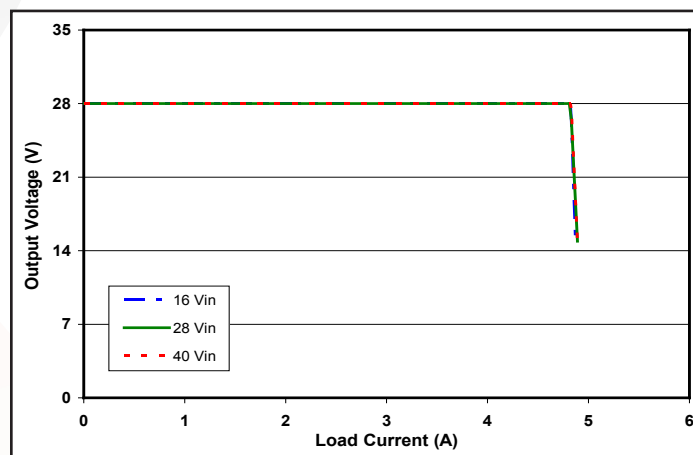
**Figure 3:** Power dissipation at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at TCASE=25°C.



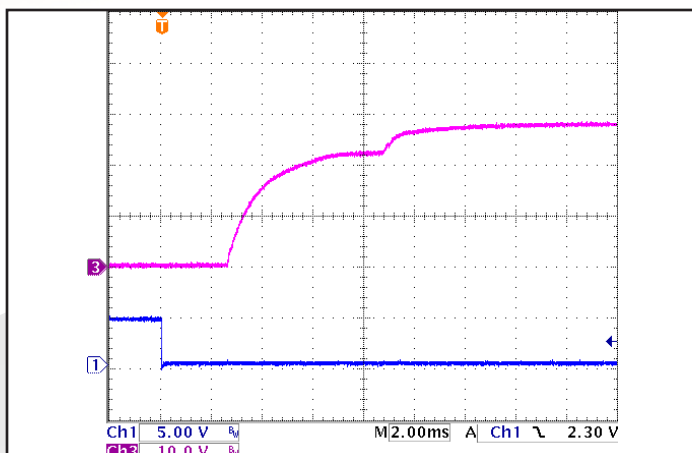
**Figure 4:** Power dissipation at nominal output voltage and 60% rated power vs. case temperature for minimum, nominal, and maximum input voltage.



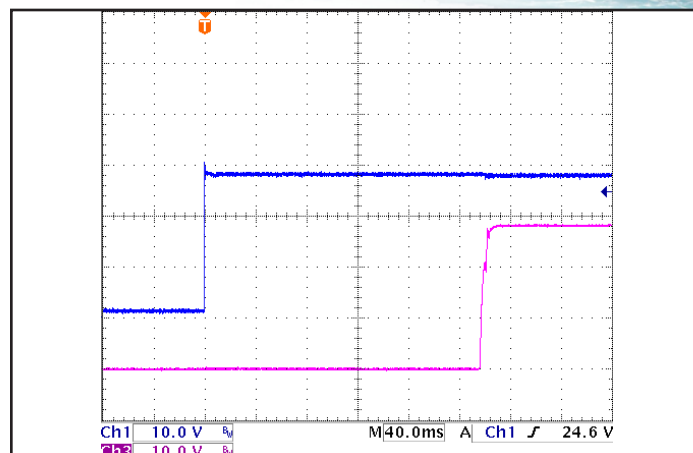
**Figure 5:** Maximum output current vs. base plate temperature (nominal input voltage).



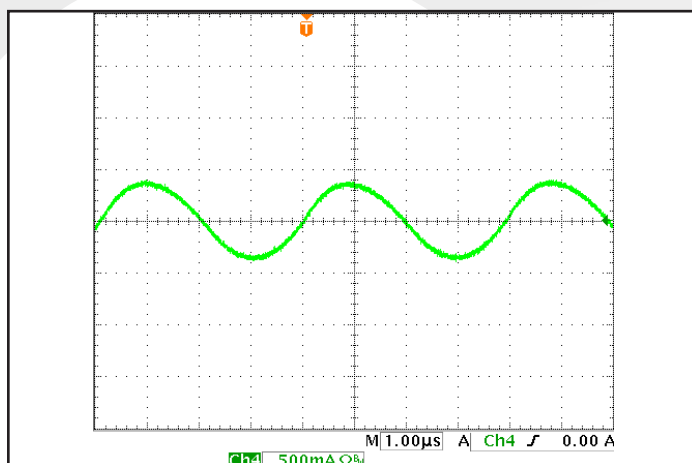
**Figure 6:** Output voltage vs. load current showing typical current limit curves. See Current Limit section in the Application Notes.



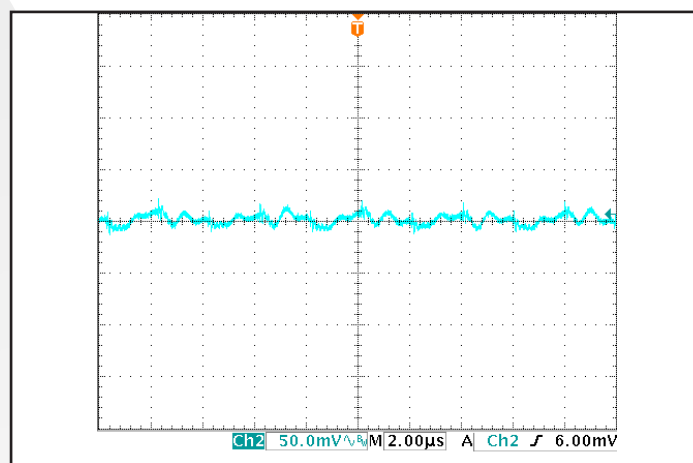
**Figure 7:** Typical startup waveform. Input voltage pre-applied, ON/OFF Pin. on Ch 1



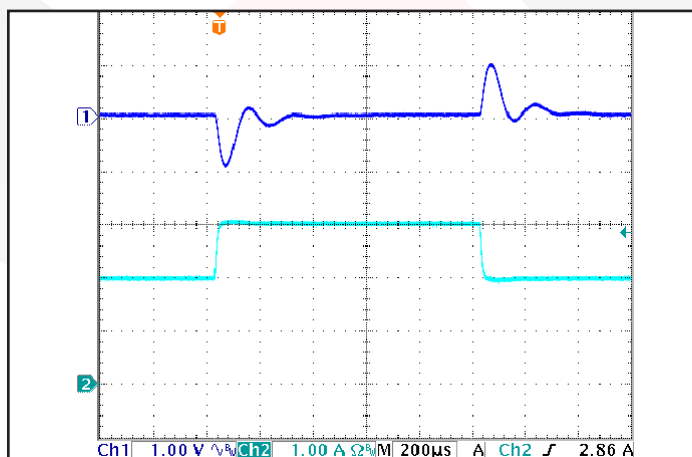
**Figure 8:** Turn-on transient at full resistive load and zero output capacitance initiated by Vin. ON/OFF Pin previously low. Ch 1: Vin (20V/div). Ch 3: Vout (10V/div).



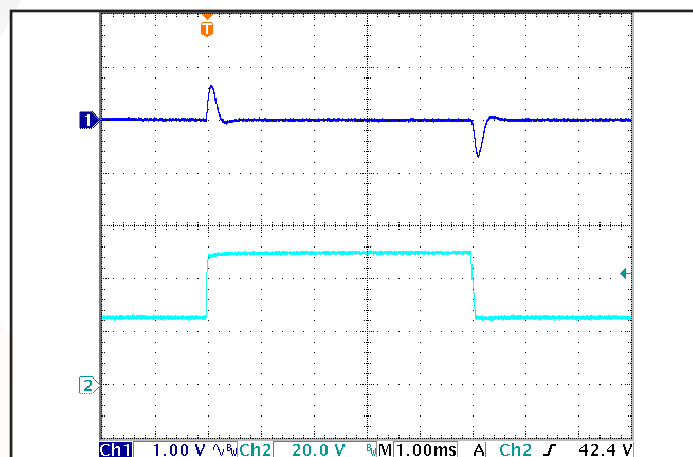
**Figure 9:** Input terminal current ripple,  $i_C$ , at full rated output current and nominal input voltage with SynQor MCOTS filter module (500 mA/div). Bandwidth: 20MHz. See Figure 17.



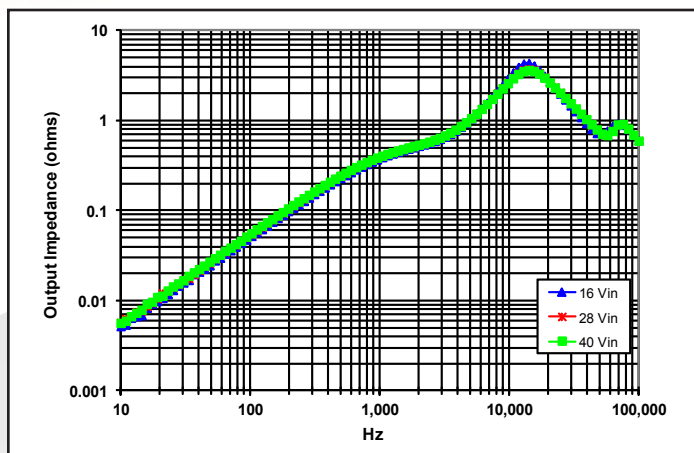
**Figure 10:** Output voltage ripple,  $V_{out}$ , at nominal input voltage and rated load current (50 mV/div). Load capacitance: 1μF ceramic capacitor and 15μF tantalum capacitor. Bandwidth: 10 MHz. See Figure 17.



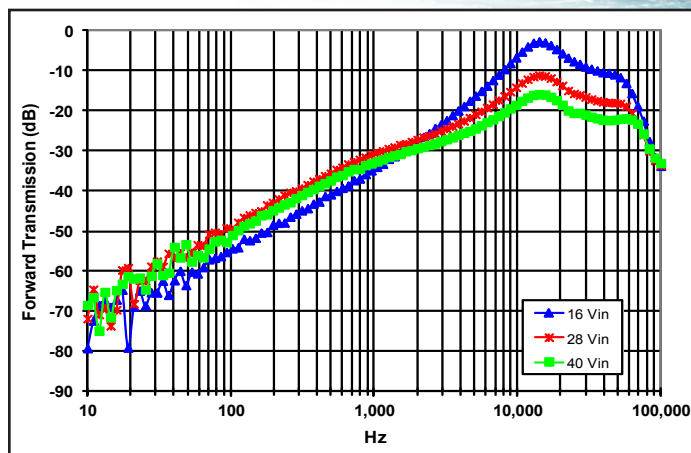
**Figure 11:** Output voltage response to step-change in load current (50%-75%-50% of  $I_{out(max)}$ ;  $dI/dt = 0.1 \text{ A}/\mu\text{s}$ ). Load cap: 1 μF ceramic and 15 μF tantalum capacitors. Ch 1:  $V_{out}$  (1V/div), Ch 2:  $I_{out}$  (1A/div).



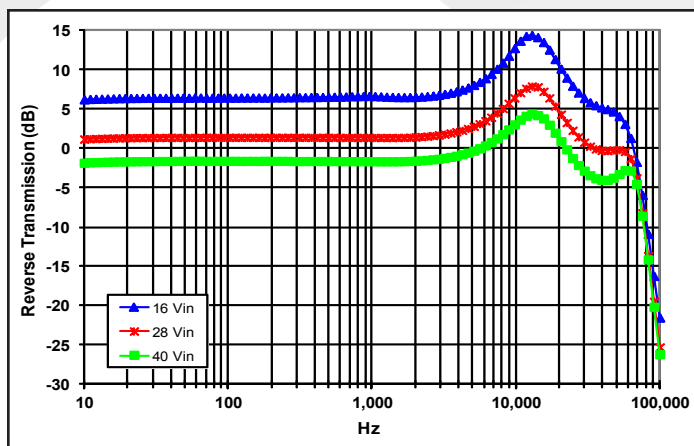
**Figure 12:** Output voltage response to step-change in input voltage (250V/ms). Load cap: 100 μF electrolytic output capacitance. Ch 1:  $V_{out}$  (1V/div), Ch 2:  $V_{in}$  (20V/div).



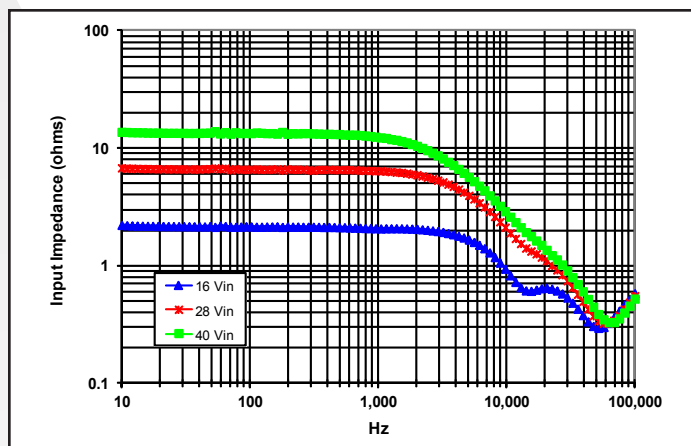
**Figure 13:** Magnitude of incremental output impedance ( $Z_{out} = v_{out}/i_{out}$ ) for minimum, nominal, and maximum input voltage at full rated power.



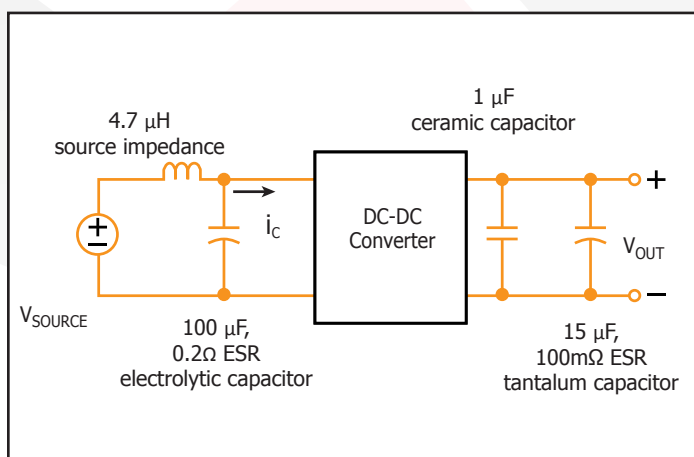
**Figure 14:** Magnitude of incremental forward transmission ( $FT = v_{out}/v_{in}$ ) for minimum, nominal, and maximum input voltage at full rated power.



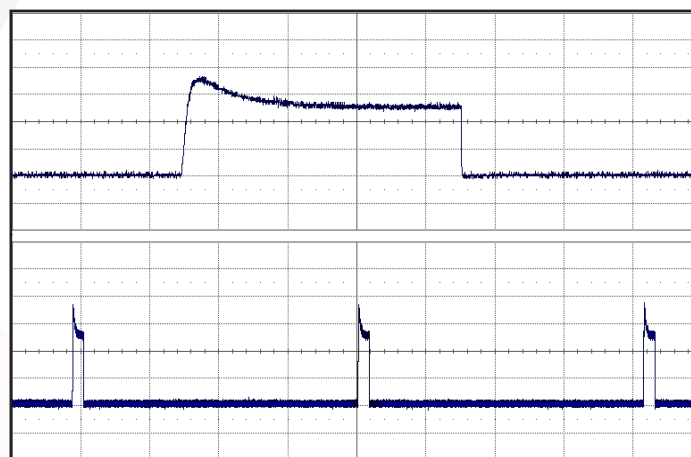
**Figure 15:** Magnitude of incremental reverse transmission ( $RT = i_{in}/i_{out}$ ) for minimum, nominal, and maximum input voltage at full rated power.



**Figure 16:** Magnitude of incremental input impedance ( $Z_{in} = v_{in}/i_{in}$ ) for minimum, nominal, and maximum input voltage at full rated power.



**Figure 17:** Test set-up diagram showing measurement points for Input Terminal Ripple Current (Figure 9) and Output Voltage Ripple (Figure 10).



**Figure 18:** Load current (2A/div) as a function of time (2ms/div and 50ms/div) when the converter attempts to turn on into a 10 mΩ short circuit.





## BASIC OPERATION AND FEATURES

This Mil-COTS converter series uses a two-stage power conversion topology. The first stage is a buck-converter that keeps the output voltage constant over variations in line, load, and temperature. The second stage uses a transformer to provide the functions of input/output isolation and voltage step-up or step-down to achieve the output voltage required.

Both the first stage and the second stage switch at a fixed frequency for predictable EMI performance. Rectification of the transformer's output is accomplished with synchronous rectifiers. These devices, which are MOSFETs with a very low on-state resistance, dissipate far less energy than Schottky diodes. This is the primary reason that the converter has such high efficiency, even at very low output voltages and very high output currents.

These converter are offered totally encased to withstand harsh environments and thermally demanding applications. Dissipation throughout the converter is so low that it does not require a heatsink for operation in many applications; however, adding a heatsink provides improved thermal derating performance in extreme situations.

This series of converters use the industry standard footprint and pin-out configuration.

## CONTROL FEATURES

**REMOTE ON/OFF (Pin 2):** 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(-). The ON/OFF signal is active low (meaning that a low turns the converter on). Figure A details four possible circuits for driving the ON/OFF pin. Figure B is a detailed look of the internal ON/OFF circuitry.

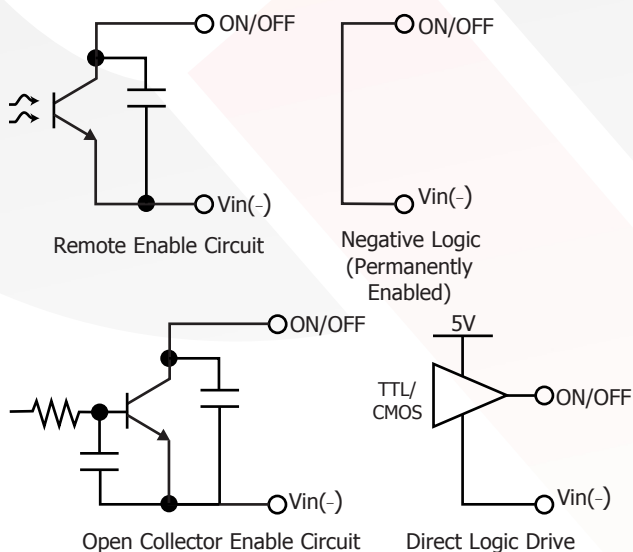
**REMOTE SENSE(±) (Pins 7 and 5):** The SENSE(±) inputs correct for voltage drops along the conductors that connect the converter's output pins to the load.

Pin 7 should be connected to Vout(+) and Pin 5 should be connected to Vout(-) at the point on the board where regulation is desired. A remote connection at the load can adjust for a voltage drop only as large as that specified in this datasheet, that is

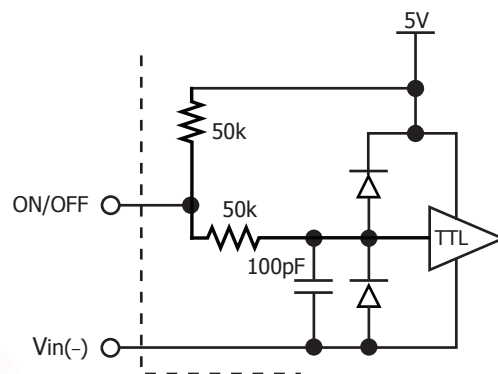
$$[V_{out(+)} - V_{out(-)}] - [V_{sense(+)} - V_{sense(-)}] \leq \text{Sense Range \%} \times V_{out}$$

Pins 7 and 5 must be connected for proper regulation of the output voltage. If these connections are not made, the converter will deliver an output voltage that is slightly higher than its specified value.

**Note:** the output over-voltage protection circuit senses the voltage across the output (pins 8 and 4) to determine when it should trigger, not the voltage across the converter's sense leads (pins 7 and 5). Therefore, the resistive drop on the board should be small enough so that output OVP does not trigger, even during load transients.



**Figure A:** Various circuits for driving the ON/OFF pin.



**Figure B:** Internal ON/OFF pin circuitry





**MCOTS-C-28-28-QT**

**Output: 28V**

**Current: 4.0A**

## Application Section

**OUTPUT VOLTAGE TRIM (Pin 6):** The TRIM input permits the user to adjust the output voltage across the sense leads up or down according to the trim range specifications.

To decrease the output voltage, the user should connect a resistor between Pin 6 and Pin 5 (SENSE(-) input). For a desired decrease of the nominal output voltage, the value of the resistor should be

$$R_{\text{trim-down}} = \left( \frac{511}{\Delta\%} \right) - 10.22 \text{ (k}\Omega\text{)}$$

where

$$\Delta\% = \left| \frac{V_{\text{nominal}} - V_{\text{desired}}}{V_{\text{nominal}}} \right| \times 100\%$$

To increase the output voltage, the user should connect a resistor between Pin 6 and Pin 7 (SENSE(+) input). For a desired increase of the nominal output voltage, the value of the resistor should be

$$R_{\text{trim-up}} = \left( \frac{5.11V_{\text{out}} \times (100 + \Delta\%)}{1.225\Delta\%} - \frac{511}{\Delta\%} - 10.22 \right) \text{ (k}\Omega\text{)}$$

where  $V_{\text{out}}$  = Nominal Output Voltage

Trim graphs show the relationship between the trim resistor value and  $R_{\text{trim-up}}$  and  $R_{\text{trim-down}}$ , showing the total range the output voltage can be trimmed up or down.

**Note:** the TRIM feature does not affect the voltage at which the output over-voltage protection circuit is triggered. Trimming the output voltage too high may cause the over-voltage protection circuit to engage, particularly during transients.

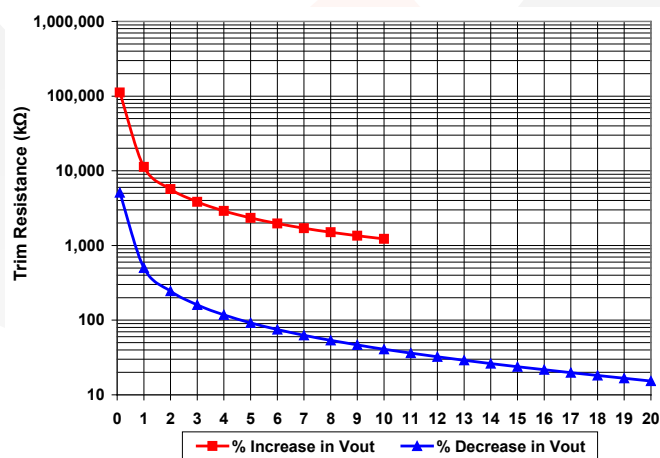


Figure C: Trim graph for trim-up, trim down.

It is not necessary for the user to add capacitance at the Trim pin. The node is internally bypassed to eliminate noise.

**Total DC Variation of  $V_{\text{out}}$ :** For the converter to meet its full specifications, the maximum variation of the dc value of  $V_{\text{out}}$ , due to both trimming and remote load voltage drops, should not be greater than that specified for the output voltage trim range.

## PROTECTION FEATURES

**Input Under-Voltage Lockout:** The converter is designed to turn off when the input voltage is too low, helping avoid an input system instability problem, described in more detail in the application note titled "Input System Instability" on our website. The lockout circuitry is a comparator with dc hysteresis. When the input voltage is rising, it must exceed the typical Turn-On Voltage Threshold value (listed on the specifications page) before the converter will turn on. Once the converter is on, the input voltage must fall below the typical Turn-Off Voltage Threshold value before the converter will turn off.

**Output Over-Voltage Limit:** If the voltage across the output pins exceeds the Output Over-Voltage Protection threshold, the converter will immediately stop switching. This prevents damage to the load circuit due to 1) excessive series resistance in output current path from converter output pins to sense point, 2) a release of a short-circuit condition, or 3) a release of a current limit condition. Load capacitance determines exactly how high the output voltage will rise in response to these conditions. After 200 ms the converter will automatically restart.

**Over-Temperature Shutdown:** 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.

**Output Current Limit:** The maximum current limit remains constant as the output voltage drops. However, once the impedance of the load across the output is small enough to make the output voltage drop below the specified Output DC Current-Limit Shutdown Voltage, the converter turns off.

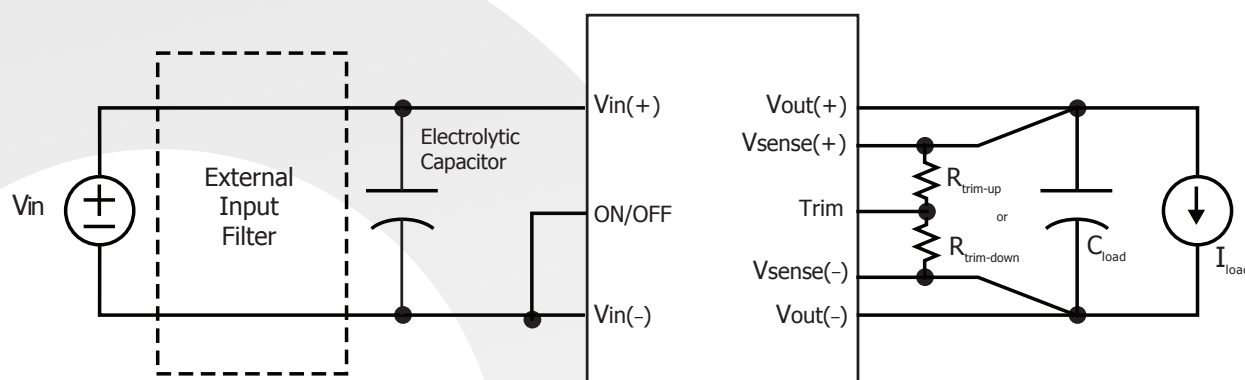
The converter then enters a "hiccup" mode where it repeatedly turns on and off at a 5 Hz (nominal) frequency with 5% duty cycle until the short circuit condition is removed. This prevents excessive heating of the converter or the load board.



## APPLICATION CONSIDERATIONS

**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.

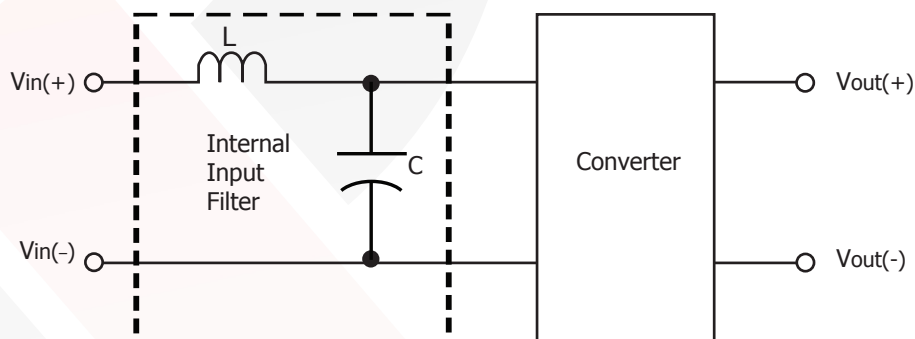
**Application Circuits:** Figure D provides a typical circuit diagram which details the input filtering and voltage trimming.



**Figure D:** Typical application circuit (negative logic unit, permanently enabled).

**Input Filtering and External Capacitance:** Figure E provides a diagram showing the internal input filter components. This filter dramatically reduces input terminal ripple current, which otherwise could exceed the rating of the converter's external electrolytic input capacitor. The recommended external input capacitance

is specified in the Input Characteristics section on the Electrical Characteristics page. More detailed information is available in the application note titled "EMI Characteristics" on the SynQor website.



**Figure E:** Internal Input Filter Diagram



**Startup Inhibit Period:** The Startup Inhibit Period ensures that the converter will remain off for approximately 200 ms when it is shut down for any reason. When an output short is present, this generates a 5 Hz “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
- Over Temperature Shutdown
- Current Limit
- Short Circuit Protection
- Turned off by the ON/OFF input

Figure F 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.

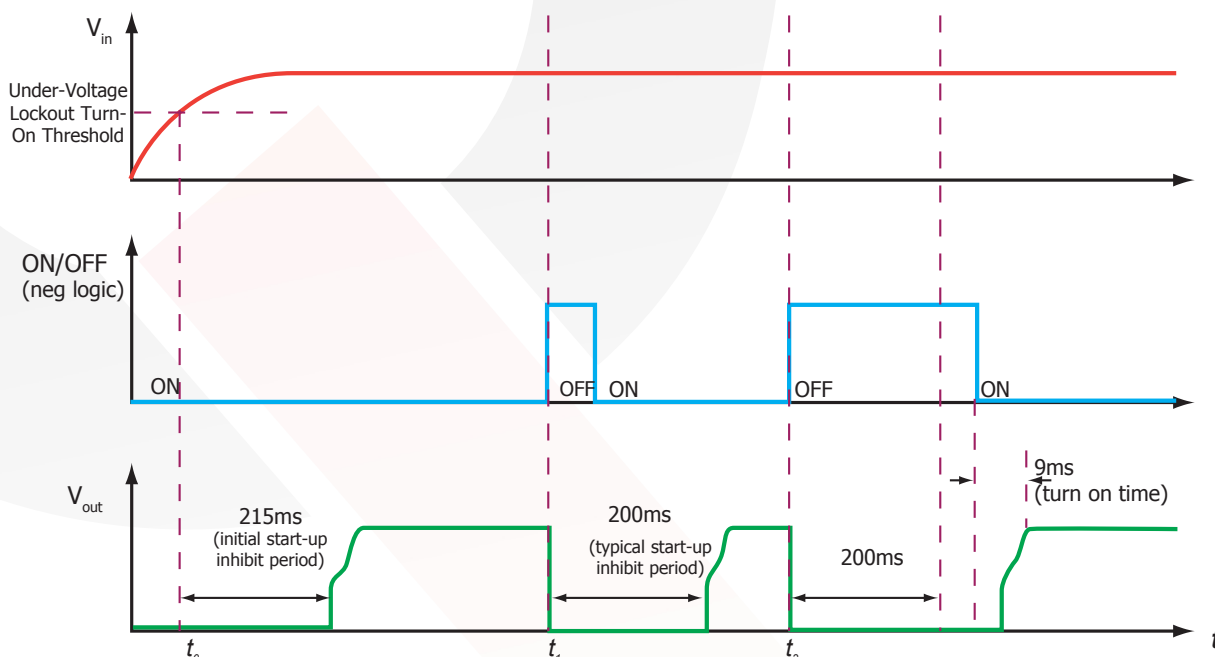
When the ON/OFF pin goes high after  $t_2$ , the Startup Inhibit Period has elapsed, and the output turns on within the typical Turn-On Time.

**Thermal Considerations:** The maximum operating base-plate temperature,  $T_B$ , is 100 °C. Refer to the thermal derating curve, Figure 5, to see the available output current at baseplate temperatures below 100 °C.

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 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:

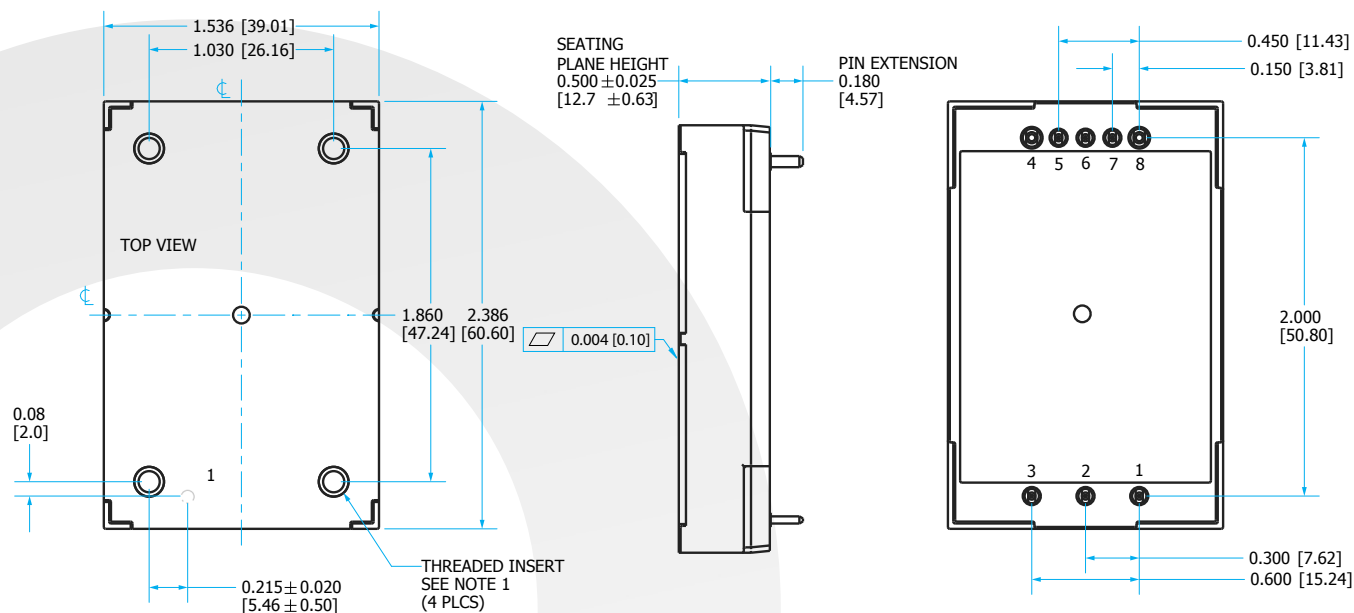
$$P_{diss}^{max} = \frac{T_B - T_A}{R_{TH_{BA}}}$$

This value of power dissipation can then be used in conjunction with the data shown in Figure 3 to determine the maximum load current (and power) that the converter can deliver in the given thermal condition.



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





### NOTES

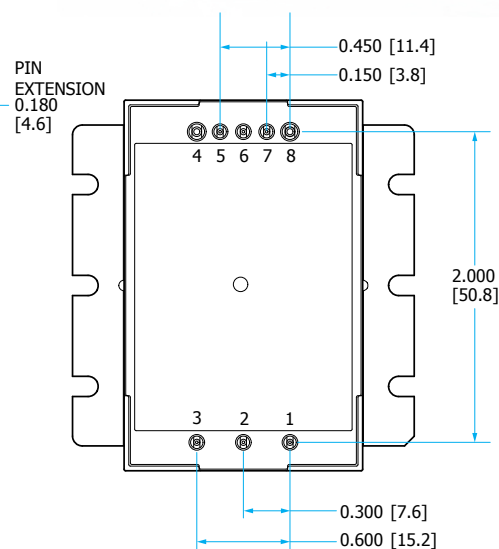
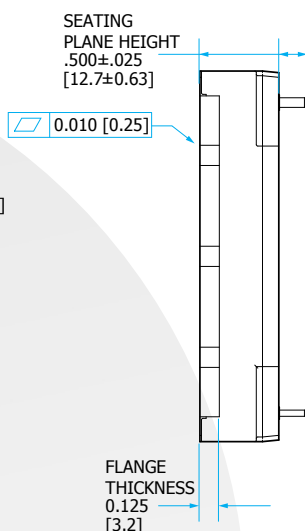
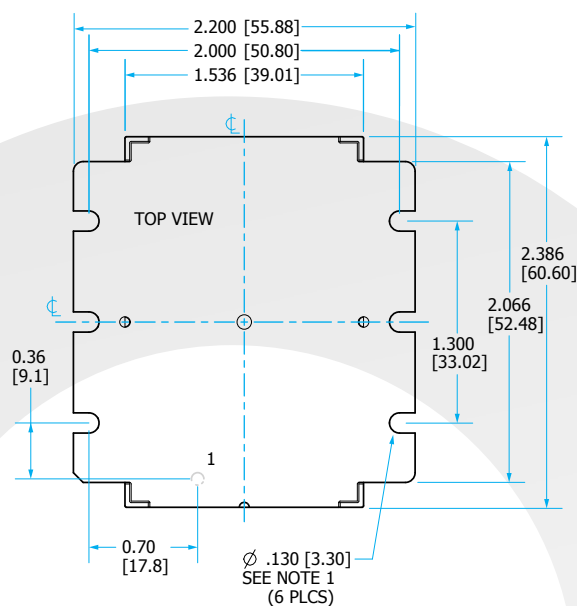
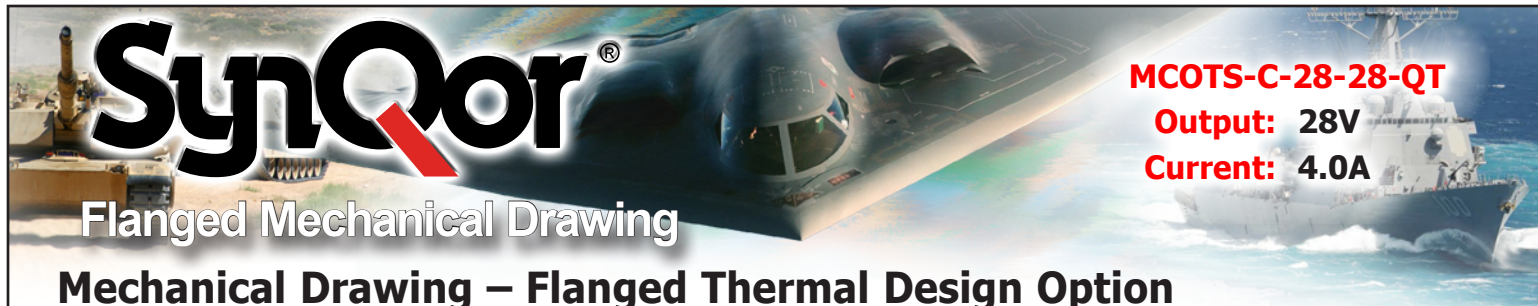
- 1) M3 screws used to bolt unit's baseplate to other surfaces (such as a heatsink) must not exceed 0.100" (2.54 mm) depth below the surface of the baseplate.
- 2) Applied torque per screw should not exceed 6in-lb (0.7 Nm).
- 3) Baseplate flatness tolerance is 0.004" (.10mm) TIR for surface.
- 4) Pins 1-3, 5-7 are 0.040" (1.02mm) diameter, with 0.080" (2.03mm) diameter standoff shoulders.
- 5) Pins 4 and 8 are 0.062" (1.57 mm) diameter with 0.100" (2.54 mm) diameter standoff shoulders.
- 6) All Pins: Material – Copper Alloy; Finish – Matte Tin over Nickel plate
- 7) Undimensioned components are shown for visual reference only.
- 8) Weight: 3.2 oz. (91 g) typical
- 9) All dimensions in inches (mm)  
Tolerances: x.xx +/-0.02 in. (x.x +/-0.5mm)  
x.xxx +/-0.010 in. (x.xx +/-0.25mm)
- 10) Workmanship: Meets or exceeds IPC-A610 Class II

### PIN DESIGNATIONS

| Pin | Label   | Name     | Function                                                                             |
|-----|---------|----------|--------------------------------------------------------------------------------------|
| 1   | +VIN    | Vin(+)   | Positive input voltage                                                               |
| 2   | ON/OFF  | ON/OFF   | TTL input to turn converter on and off, referenced to Vin(-), with internal pull up. |
| 3   | IN RTN  | Vin(-)   | Input return                                                                         |
| 4   | OUT RTN | Vout(-)  | Output return                                                                        |
| 5   | -SNS    | SENSE(-) | Negative remote sense <sup>1</sup>                                                   |
| 6   | TRIM    | TRIM     | Output voltage trim <sup>2</sup>                                                     |
| 7   | +SNS    | SENSE(+) | Positive remote sense <sup>3</sup>                                                   |
| 8   | +VOUT   | Vout(+)  | Positive output voltage                                                              |

#### Notes:

- 1) SENSE(-) should be connected to Vout(-) either remotely or at the converter.
- 2) Leave TRIM pin open for nominal output voltage.
- 3) SENSE(+) should be connected to Vout(+) either remotely or at the converter.



## NOTES

- 1) Applied torque per screw should not exceed 6in-lb (0.7 Nm).
- 2) Baseplate flatness tolerance is 0.010" (.25mm) TIR for surface.
- 3) Pins 1-3, 5-7 are 0.040" (1.02mm) diameter, with 0.080" (2.03mm) diameter standoff shoulders.
- 4) Pins 4 and 8 are 0.062" (1.57mm) diameter with 0.100" (2.54mm) diameter standoff shoulders.
- 5) All Pins: Material - Copper Alloy; Finish - Matte Tin over Nickel plate
- 6) Weight: 3.5 oz. (98 g) typical
- 7) Undimensioned components are shown for visual reference only.
- 8) All dimensions in inches (mm)  
Tolerances: x.xx +/-0.02 in. (x.x +/-0.5mm)  
x.xxx +/-0.010 in. (x.xx +/-0.25mm)
- 9) Workmanship: Meets or exceeds IPC-A610 Class II

## PIN DESIGNATIONS - CONVERTER

| Pin | Label   | Name     | Function                                                                             |
|-----|---------|----------|--------------------------------------------------------------------------------------|
| 1   | +VIN    | Vin(+)   | Positive input voltage                                                               |
| 2   | ON/OFF  | ON/OFF   | TTL input to turn converter on and off, referenced to Vin(-), with internal pull up. |
| 3   | IN RTN  | Vin(-)   | Input return                                                                         |
| 4   | OUT RTN | Vout(-)  | Output return                                                                        |
| 5   | -SNS    | SENSE(-) | Negative remote sense <sup>1</sup>                                                   |
| 6   | TRIM    | TRIM     | Output voltage trim <sup>2</sup>                                                     |
| 7   | +SNS    | SENSE(+) | Positive remote sense <sup>3</sup>                                                   |
| 8   | +VOUT   | Vout(+)  | Positive output voltage                                                              |

### Notes:

- 1) SENSE(-) should be connected to Vout(-) either remotely or at the converter.
- 2) Leave TRIM pin open for nominal output voltage.
- 3) SENSE(+) should be connected to Vout(+) either remotely or at the converter.



**MCOTS-C-28-28-QT**

**Output: 28V**

**Current: 4.0A**

## Qualifications & Screening

### Mil-COTS Qualification

| Test Name                  | Details                                                                                          | # Tested<br>(# Failed) | Consistent with<br>MIL-STD-883F Method |
|----------------------------|--------------------------------------------------------------------------------------------------|------------------------|----------------------------------------|
| <b>Life Testing</b>        | Visual, mechanical and electrical testing before, during and after 1000 hour burn-in @ full load | 15<br>(0)              | Method 1005.8                          |
| <b>Shock-Vibration</b>     | Visual, mechanical and electrical testing before, during and after shock and vibration tests     | 5<br>(0)               | MIL-STD-202,<br>Methods 201A & 213B    |
| <b>Humidity</b>            | +85 °C, 95% RH, 1000 hours, 2 minutes on / 6 hours off                                           | 8<br>(0)               | Method 1004.7                          |
| <b>Temperature Cycling</b> | 500 cycles of -55 °C to +100 °C<br>(30 minute dwell at each temperature)                         | 10<br>(0)              | Method 1010.8, Condition A             |
| <b>Solderability</b>       | 15 pins                                                                                          | 15<br>(0)              | Method 2003                            |
| <b>DMT</b>                 | -65 °C to +110 °C across full line and load specifications in 5 °C steps                         | 7<br>(0)               |                                        |
| <b>Altitude</b>            | 70,000 feet (21 km), see Note                                                                    | 2<br>(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                 |
|----------------------------------------|---------------------------------------------------|-------------------|-------------------------|
| <b>Baseplate Operating Temperature</b> |                                                   | -55 °C to +100 °C | -55 °C to +100 °C       |
| <b>Storage Temperature</b>             |                                                   | -65 °C to +135 °C | -65 °C to +135 °C       |
| <b>Pre-Cap Inspection</b>              | IPC-A-610, Class III                              | •                 | •                       |
| <b>Temperature Cycling</b>             | MIL-STD-883F, Method 1010, Condition B, 10 Cycles |                   | •                       |
| <b>Burn-In</b>                         | 100 °C Baseplate                                  | 12 Hours          | 96 Hours                |
| <b>Final Electrical Test</b>           | 100%                                              | 25 °C             | -55 °C, +25 °C, +100 °C |
| <b>Final Visual Inspection</b>         | MIL-STD-883F, Method 2009                         | •                 | •                       |

### Mil-COTS MIL-STD-810G Qualification Testing

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





**MCOTS-C-28-28-QT**

**Output: 28V**

**Current: 4.0A**

## Ordering Information

### Ordering Information/ Part Numbering

Example MCOTS-C-28-28-QT-N-S

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

| Family       | Product             | Input Voltage                                                                                             | Output Voltage                                                                                                                                                       | Package                  | Thermal Design                                 | Screening Level                        | Options                      |
|--------------|---------------------|-----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|------------------------------------------------|----------------------------------------|------------------------------|
| <b>MCOTS</b> | <b>C:</b> Converter | <b>28:</b> 16-40V<br><b>28V:</b> 9-40V<br><b>28VE:</b> 9-70V<br><b>48:</b> 34-75V<br><b>270:</b> 155-425V | <b>1R8:</b> 1.8V<br><b>3R3:</b> 3.3V<br><b>05:</b> 5.0V<br><b>07:</b> 7.0V<br><b>12:</b> 12V<br><b>15:</b> 15V<br><b>24:</b> 24V<br><b>28:</b> 28V<br><b>48:</b> 48V | <b>QT:</b> Quarter Brick | <b>N:</b> Normal Threaded<br><b>F:</b> Flanged | <b>S:</b> S-Grade<br><b>M:</b> M-Grade | <b>[ ]:</b> Standard Feature |

### APPLICATION NOTES

A variety of application notes and technical white papers can be downloaded in PDF format from our [website](#).

#### Contact SynQor for further information and to order:

**Phone:** 1 (603) 541-4141

**Web:** [www.synqor.com](http://www.synqor.com)

**E-mail:** [power@synqor.com](mailto:power@synqor.com)

**Address:** 9 Northeastern Blvd., Suite 200, Salem, NH 03079 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