SynQor®

MCOTS-C-28-270-FZ
Single Output
Full-brick

MILITARY COTS DC-DC CONVERTER

16-40 V Continuous Input	16-50 V Transient Input	270 V Output	3.7 A Output	96%@1.85 A / 95% @3.7 A 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

- 3000V dc, 100 MΩ input-to-output isolation - pending
- (see Standards and Qualifications page)

Mechanical Features

- Industry standard full-brick form factor
- Size: 4.686" x 2.486" x .512"
  119.0 x 63.1 x 13.0 mm
- Total weight: 9.9 oz (280 g)
- Flanged baseplate version available

Control Features

- Fully isolated On/Off control
- Fully isolated active current sharing

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, 95% at full rated load current
- Operating input voltage range: 16-40 V
- Fixed frequency switching provides predictable EMI
- No minimum load requirement

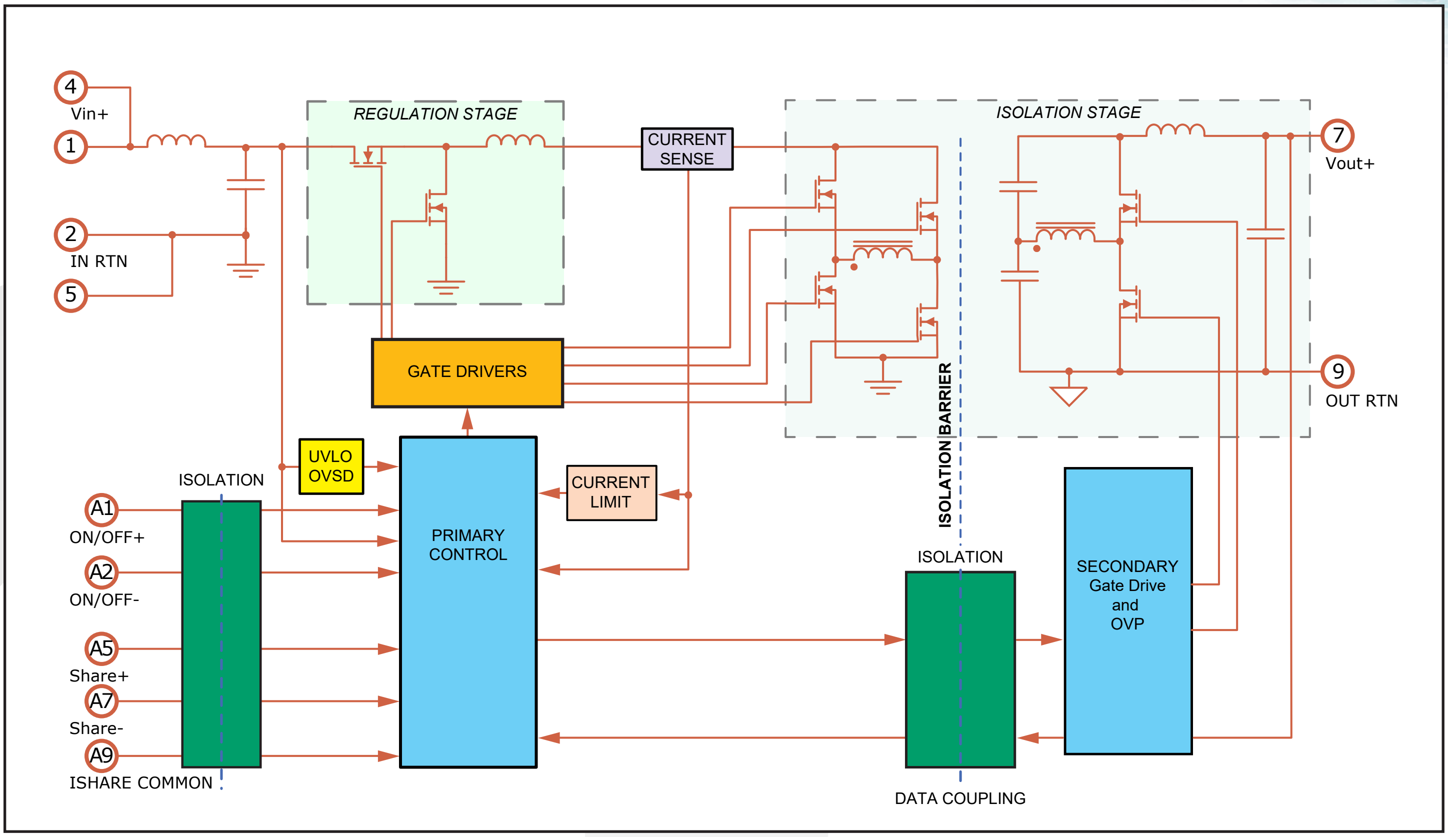
Protection Features

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

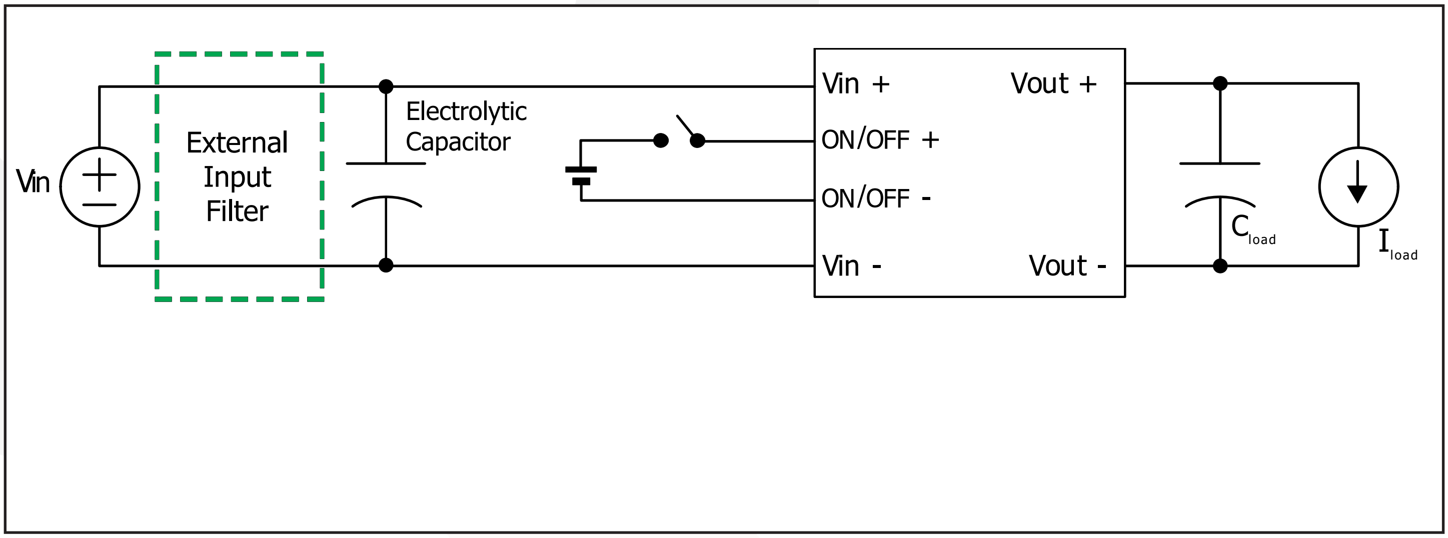
Screening/Qualification

- 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-28-270-FZ 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
ABSOLUTE MAXIMUM RATINGS					
Input Voltage					
Non-Operating	-0.5		60	V	Continuous
Operating			40	V	Continuous
Operating Transient Protection			50	V	1 s transient, square wave
Isolation Voltage					
Input to Output			3000	V dc	See Note 6
Input to Baseplate			750	V dc	See Note 6
Output to Baseplate			2300	V dc	See Note 6
Operating Temperature	-55		+100	°C	Baseplate temperature
Storage Temperature	-65		+135	°C	
Voltage at ON/OFF input pin	-2		18	V	
INPUT CHARACTERISTICS					
Operating Input Voltage Range	16	28	40	V	Vin = 50 V, 1 s transient, square wave; See Note 3
Input Under-Voltage Turn-On Threshold	14.9		15.9	V	
Input Under-Voltage Turn-Off Threshold	14.0		15.2	V	
Input Under-Voltage Hystersis	0.9	1.0	1.2	V	
Recommended External Input Capacitance		1800		μF	Typical ESR 0.1Ω-0.2Ω; See Note 2
Input Filter Component Values (C\L\C)		0.1\0.2\80		μF\μH\μF	Internal values; see Figure E
Maximum Input Current			70.0	A	Vin min; in current limit
No-Load Input Current		600	750	mA	
Disabled Input Current		10	20	mA	
Response to Input Transient		8		V	With a 100 μF output capacitor; See Figure 12
Input Terminal Ripple Current		500		mA	RMS; See Note 4
Recommended Input Fuse			80	A	Fast acting external fuse recommended
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	270.0	275.0	280.0	V	No load set point; see Figure 6
Output Voltage Regulation					
Over Line		±1.0	±1.5	%	
Over Load		-7.5%*Vout*Iout/Iomax		V	
Over Temperature	-1.0		1.0	V	
Total Output Voltage Range	246		283	V	Over sample, line, load, temperature & life
Output Voltage Ripple and Noise					20 MHz bandwidth; see Note 1
Peak-to-Peak		2	3	V	Full load (See Figure 10)
RMS		350	550	mV	Full load
Operating Output Current Range			3.7	A	Subject to thermal derating
Output DC Current-Limit Inception	4.0	4.4	4.8	A	Output voltage 10% Low
Output DC Current-Limit Shutdown Voltage		135		V	
Back-Drive Current Limit while Enabled		1.1		A	Negative current drawn from output
Back-Drive Current Limit while Disabled		0.1		mA	Negative current drawn from output
Maximum Output Capacitance			5	mF	Vout nominal at full load (resistive load)
Output Voltage during Load Current Transient					
Step Change in Output Current (0.1 A/μs)		4		V	50% to 75% to 50% Iout max
Settling Time		300		μs	To within 0.1% Vout nom
Output Over-Voltage Protection	296	308	320	V	Over full temp range
EFFICIENCY					
100% Load		95		%	
50% Load		96		%	

Note 1: Output is terminated with 5x1 μF ceramic and 1x670 uF electrolytic capacitors. For applications requiring reduced output voltage ripple and noise, consult SynQor applications support (e-mail: mqnbofae@synqor.com)

Note 2: Or an equivalent network of capcitors

Note 3: Transient operation permitted outside of the thermal derating (figure 5) for 30 seconds, limited by maximum ratings: Tbp<100 °C, Vin<Vinmax and Io<Iomax

Note 4: Measured using a 0.47 μH input filter inductor and 2 x 1000 μF electrolytic input filter capacitor

MCOTS-C-28-270-FZ 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
DYNAMIC CHARACTERISTICS					
Turn-On Transient					
Turn-On Time - No Load		380		ms	Enable Transition to Vout = 90% nom.
Turn-On Time - Full Load		380		ms	Enable Transition to Vout = 90% nom.
Output Voltage Overshoot		0		%	Maximum Output Capacitance
ISOLATION CHARACTERISTICS					
Isolation Voltage (dielectric strength)			3000	V dc	See Absolute Maximum Ratings, Note 6.
Isolation Resistance	100			MΩ	
Isolation Capacitance (input to output)		500		pF	See Note 5
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	
FEATURE CHARACTERISTICS					
Switching Frequency	237	242	247	kHz	
Startup					
Startup Inhibit Time		100		ms	Enable Transition to Start of Vout Rise
ON/OFF Control					
Off-State Voltage	2.2		18	V	
On-State Voltage	-1.0		1.1	V	
ON/OFF Control					Application notes Figures A & B
Input Resistance		3		kΩ	
Over-Temperature Shutdown OTP Trip Point		120		°C	Average PCB Temperature
Over-Temperature Shutdown Restart Hysteresis		10		°C	
RELIABILITY CHARACTERISTICS					
Calculated MTBF per MIL-HDBK-217F		1.4		10^6 Hrs.	Ground Benign, 70 °C Tb
Calculated MTBF per MIL-HDBK-217F		239		10^3 Hrs.	Ground Mobile, 70 °C Tb

Note 5: Additional input to output isolation capacitance external to the module is recommended.

Note 6: 1 minute for qualification test, and less than 1 minute in production.

STANDARDS COMPLIANCE

Parameter	Notes & Conditions
STANDARDS COMPLIANCE	**Pending**
UL 60950-1	Reinforced Insulation
CAN/CSA C22.2 No. 60950-1	
EN 60950-1	
CE Marked	2006/95/EC Low Voltage Directive

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.

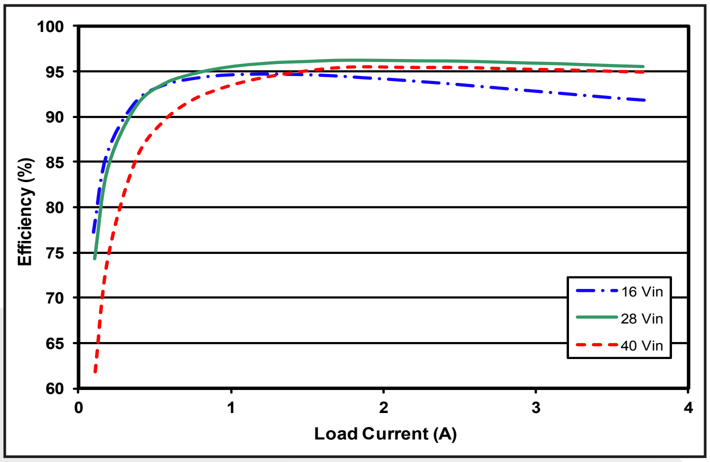


Figure 1: Efficiency at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at 25°C.

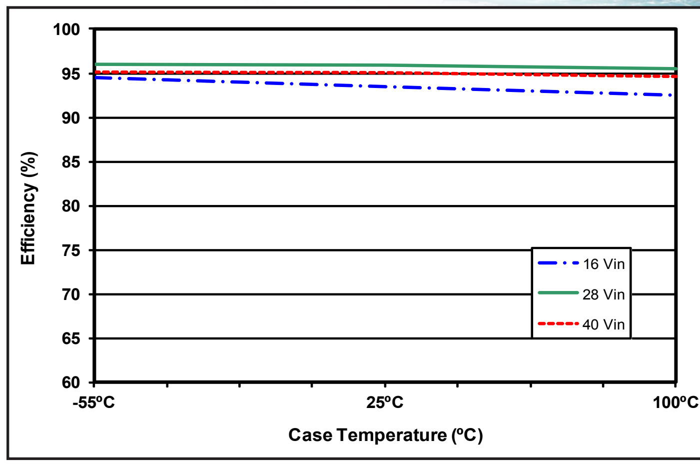


Figure 2: Efficiency at nominal output voltage and 60% rated power vs. case temperature for minimum, nominal, and maximum input voltage.

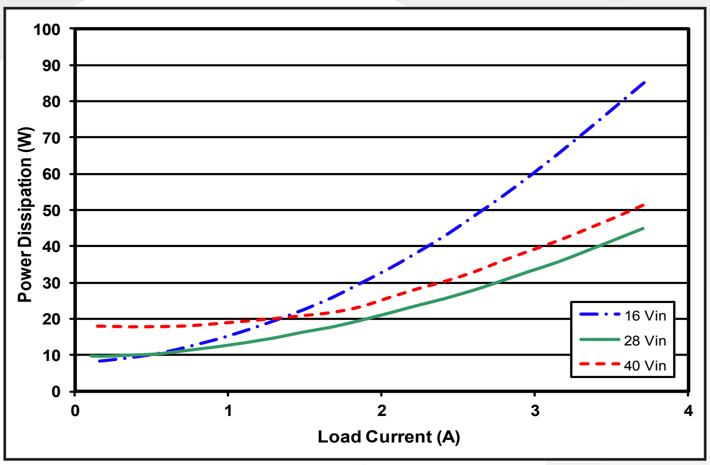


Figure 3: Power dissipation at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at TCASE=25°C.

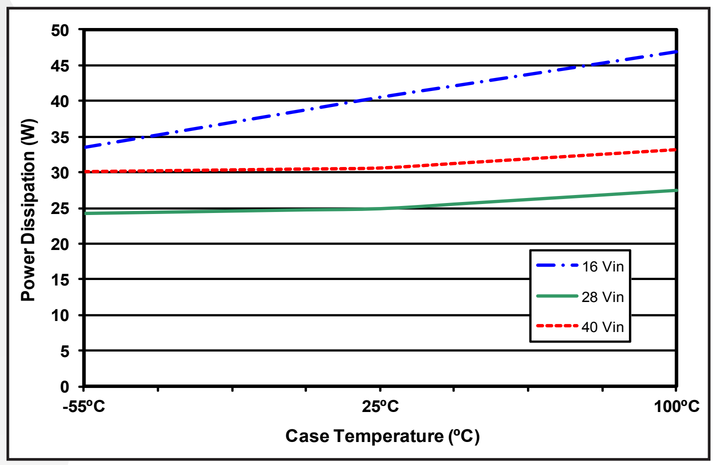


Figure 4: Power dissipation at nominal output voltage and 60% rated power vs. case temperature for minimum, nominal, and maximum input voltage.

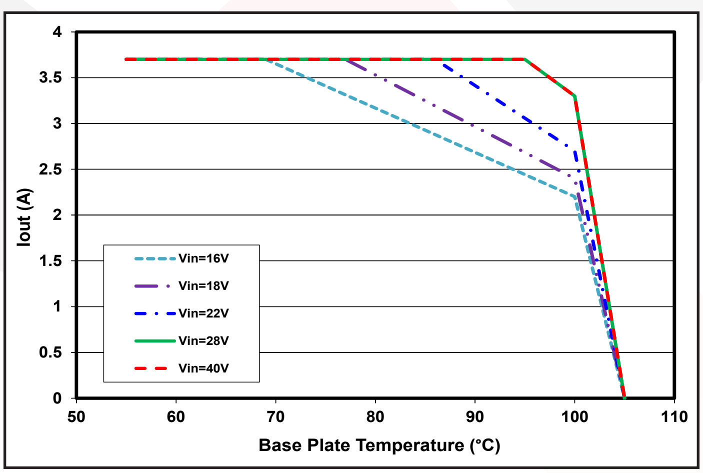


Figure 5: Maximum output current vs. base plate temperature (nominal input voltage).

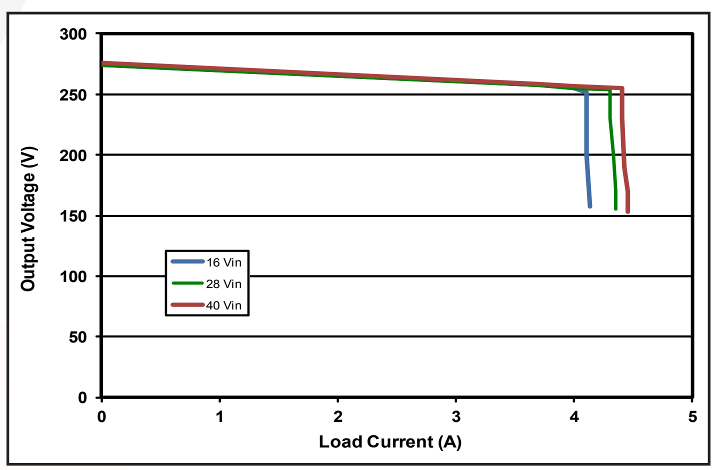


Figure 6: Output voltage vs. load current showing typical current limit curves. See Current Limit section in the Application Notes.

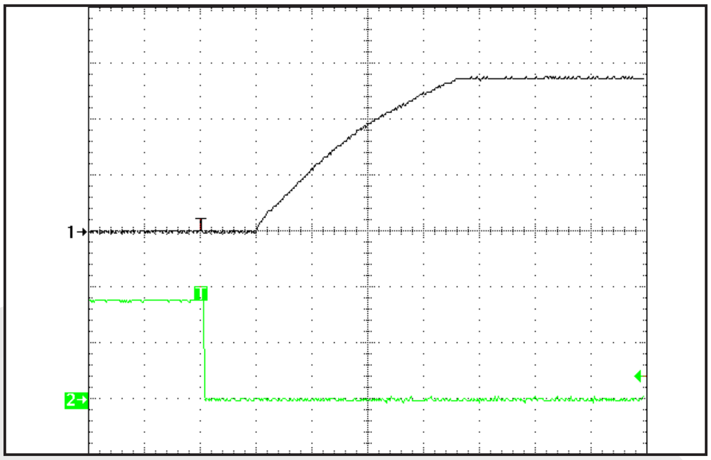


Figure 7: *Typical startup waveform with 0% load and 680µF output capacitance. Input voltage pre-applied. Ch 1: Vout (100V/div). Ch2: ON/OFF Pin (10V/div). Horizontal Scale: 100msec/div*

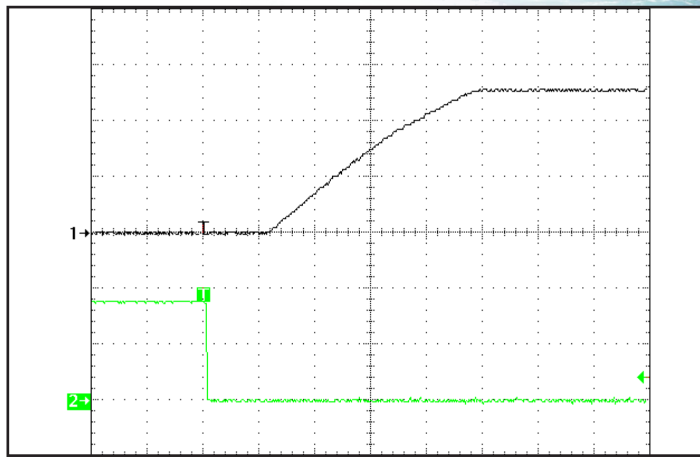


Figure 8: *Typical startup waverform with 100% load and 680µF output capacitance. Input voltage pre-applied. Ch 1: Vout (100V/div). Ch2: ON/OFF Pin(10V/div). Horizontal Scale: 100msec/div*

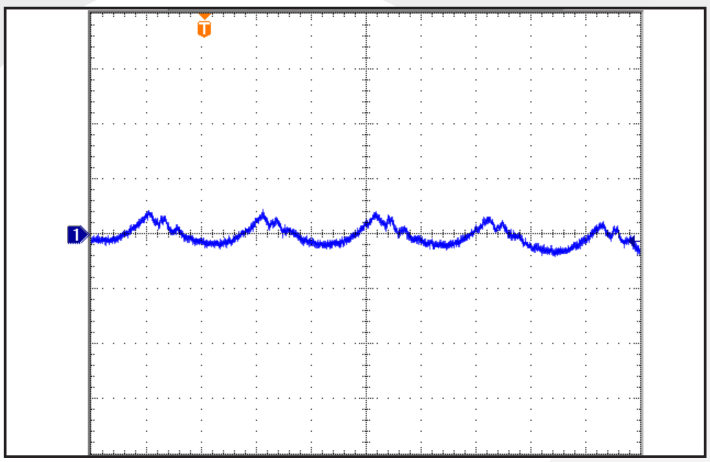


Figure 9: *Input terminal current ripple at full load and nominal input voltage. Output capacitance: 100µF electrolytic in parallel with 1µF ceramic. Ch 1: Input (1.0A/div, BW= 20MHz). Horizontal Scale: 2µsec/div.*

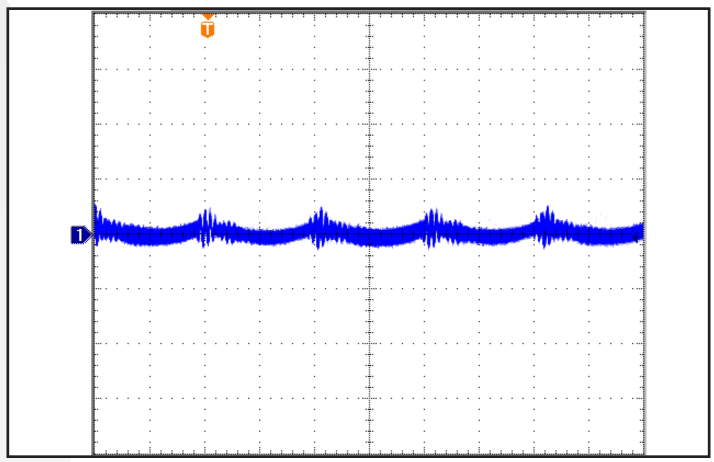


Figure 10: *Output voltage ripple at nominal input voltage and rated load current. Output capacitance: 100µF electrolytic in parallel with 1µF ceramic. Ch1: Vout (200 mV/div, BW= 20MHz). Horizontal Scale: 2µsec/div.*

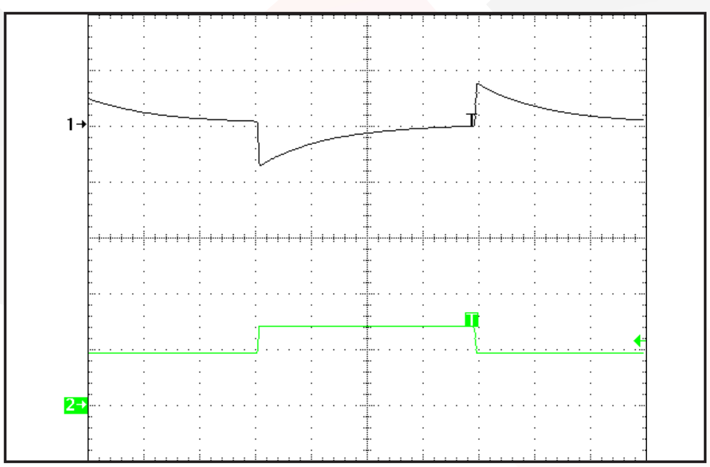


Figure 11: *Output voltage response to step-change in load current (50%-75%-50% of Iout(max); dI/dt = 0.1 A/µsec). Output capacitance: 100µF electrolytic in parallel with 1µF ceramic. Ch 1: Vout (5V/div), Ch 2: Iout (2A/div). Horizontal Scale: 100msec/div*

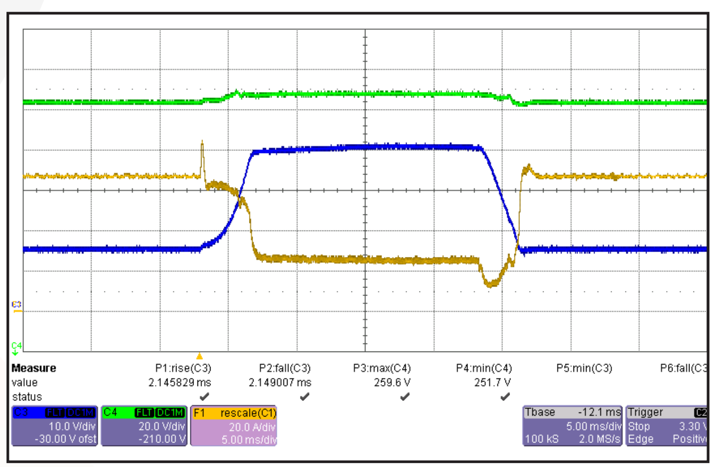


Figure 12: *Output voltage response to step-change in input voltage (16V-40V-16V; 10V/ms, 100 µF output capacitor). Ch 3: Vin (10V/div), Ch 4: Vout (20V/div), Ch F1: Iin (20A/div) .*

BASIC OPERATION AND FEATURES

This converter series uses a two-stage power conversion topology. The first stage 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-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 significantly less energy than Schottky diodes, enabling the converter to achieve high efficiency.

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. See Ordering Information page for available thermal design options.

SynQor FZ full-brick converter uses the industry standard full-brick footprint with a unique pin-out to accommodate high input current and high output voltage.

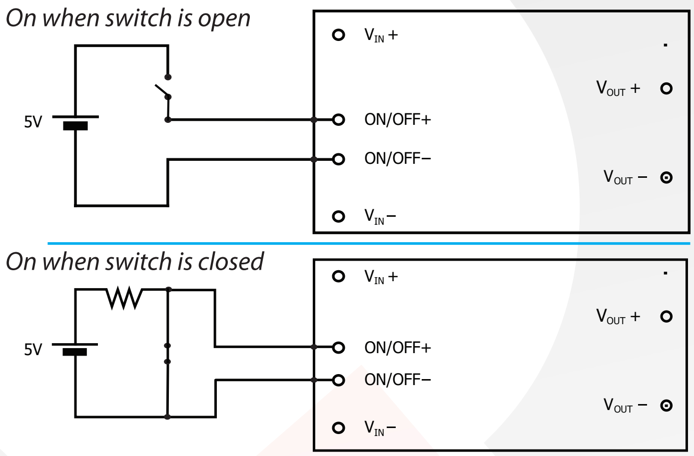


Figure A: Various Circuits for Driving the ON/OFF Pin

CONTROL FEATURES

ON/OFF+ and ON/OFF- (Pin A1 and A2) - Remote ON/OFF: The ON/OFF inputs, pins A1 and A2, permit the user to turn the converter on or off. These two inputs are fully isolated from both the input and the output side of the power converter, allowing the user the option to reference on/off control to either the input or the output potentials.

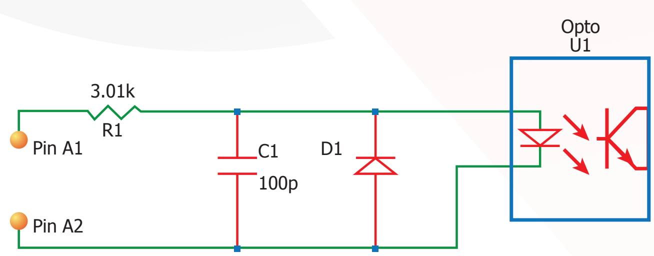


Figure B: Internal ON/OFF Pin Circuitry

The user's on/off control signal is applied between the ON/OFF+ pin and the ON/OFF- pins. Figure A details two possible circuits for driving the ON/OFF pin. Figure B shows the cirucit internal to the module that connects to the ON/OFF pins.

OUTPUT OVERVOLTAGE PROTECTION: The Output Over-Voltage Protection circuit senses the voltage across the output (Pins 7 and 9) to determine when it should trigger.

Protection Features

Input Under-Voltage Lockout (UVLO): The converter is designed to turn off when the input voltage is too low, helping to avoid an input system instability problem, which is described in more detail in the application note titled "Input System Instability" on the SynQor 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* 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-Current Protection (OCP): If the output current exceeds the "Output DC Current Limit Inception" value*, then a fast linear current limit controller will reduce the output voltage to maintain a constant output current. If as a result, the output voltage falls below the "Output DC Current Limit Shutdown Voltage"* for more than 50 ms, then the unit will enter into an auto-restart mode. In this mode the unit will be off for 500 ms and will then automatically attempt to restart.

Back-Drive Current Limit: If there is negative output current of a magnitude larger than the "Back-Drive Current Limit while Enabled" specification*, then a fast back-drive limit controller will increase the output voltage to maintain a constant output current. If this results in the output voltage exceeding the "Output Over-Voltage Protection" threshold*, then the unit will shut down.

Output Over-Voltage Protection (OVP): 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) a release of a short-circuit condition, or 2) a release of a current limit condition. Load capacitance determines exactly how high the output voltage will rise in response to these conditions. After 500 ms the converter will automatically restart.

Over-Temperature Protection (OTP): 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*.

Startup Inhibit Period: The Startup Inhibit Period ensures that the converter will remain off for approximately 500 ms when it is shut down due to a fault. This generates a 2 Hz auto-restart mode, which prevents the converter from overheating. In all, there are three ways that the converter can be shut down, initiating a Startup Inhibit Period:

- Output Over-Voltage Protection
- Output Over-Current Protection
- Short Circuit Protection

* See Electrical Characteristics section.

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: A typical circuit diagram, Figure D below details the input filtering.

Input Filtering and External Input Capacitance: Figure E below shows the internal input filter components. This filter dramatically reduces input terminal ripple current, which otherwise could exceed the rating of an external electrolytic input capacitor. The recommended external input capacitance is specified in the Input Characteristics section of the Electrical Specifications. More detailed information is available in the application note titled "EMI Characteristics" on the SynQor website.

Output Filtering and External Output Capacitance: The internal output filter dramatically reduces output voltage ripple. Some minimum external output capacitance is required, as specified in the Output Characteristics area of the Electrical Characteristics section. No damage will occur without this capacitor connected, but peak output voltage ripple will be higher.

Thermal Considerations: The max operating baseplate temperature, T_B, is 100ºC. Refer to the Thermal Derating Curves in the Technical Figures section to see the available output current at baseplate temperatures below 100ºC.

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_{THBA}, of the chosen heatsink between the baseplate 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 if its base-plate is to be no higher than 100ºC.

$$P_{diss}^{max} = \frac{100^{\circ}C - T_A}{R_{THBA}}$$

This value of maximum power dissipation can then be used in conjunction with the data shown in the Power Dissipation Curves in the Technical Figures section to determine the maximum load current (and power) that the converter can deliver in the given thermal condition.

For convenience, Thermal Derating Curves are provided in the Technical Figures section.

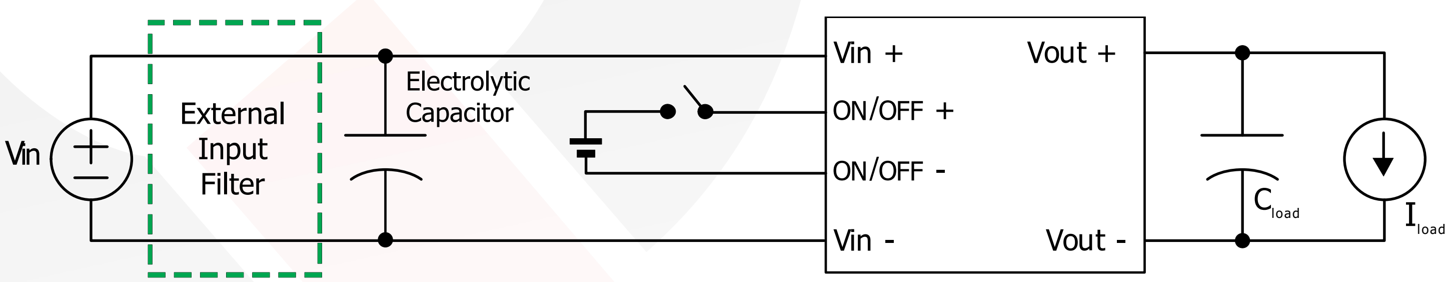


Figure D: Typical Application Circuit (negative logic unit, permanently enabled)

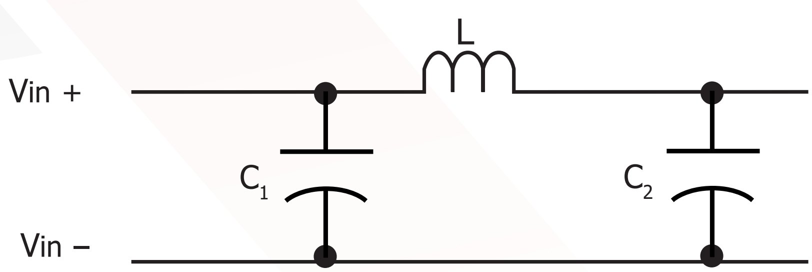


Figure E: Internal Input Filter Diagram (component values listed in Electrical Characteristics section)

Active Current Share Application Section

Overview: The FZ supports active current sharing. This feature can be utilized by connecting two pins, SHARE+ and SHARE-, between modules that are in parallel.

Connection of Paralleled Units: Up to 100 units can be placed in parallel. In this current share architecture, one unit is dynamically chosen to act as a master, controlling all other units. It cannot be predicted which unit will become the master at any given time, so units should be wired symmetrically (see Figures F & G).

- Input power pins and output power pins should be tied together between units, preferably with wide overlapping copper plans, after any input common-mode chokes.
- The SHARE+ and SHARE- pins should be routed between all paralleled units as a differential pair.
- The ON/OFF pins should be connected in parallel, and rise/fall times should be kept below 2ms.

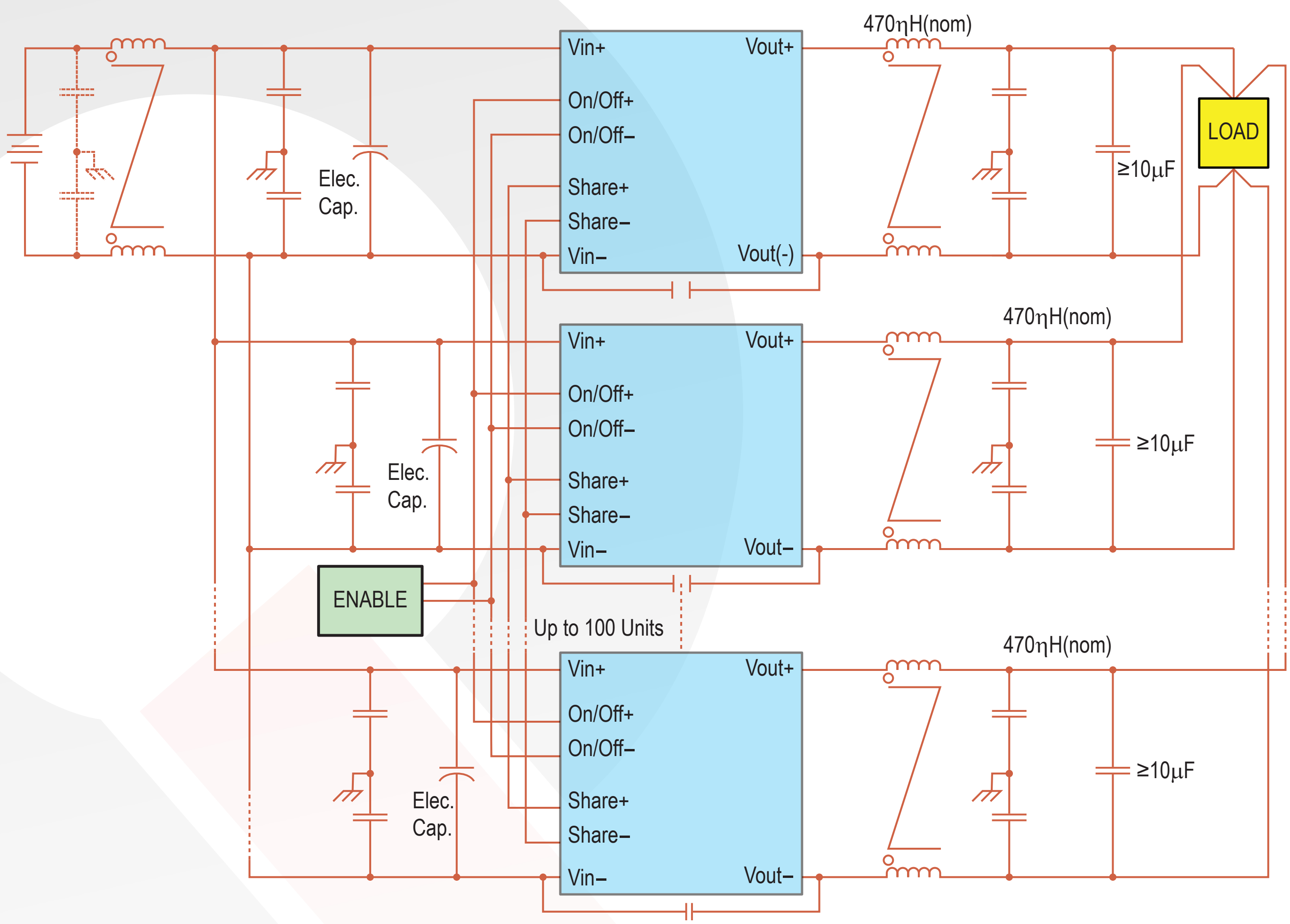


Figure F: Typical Application Circuit for Paralleling of Full-Featured Units with an Input Common-Mode Choke. If an input common-mode choke is used, Vin(-) may be tied together either before or after the choke for each unit. 470 nH (nominal) inductor or an output common-mode choke is required. See Figure G for output common-mode choke configuration.

Automatic Configuration: The micro-controller inside each power converter unit is programmed at the factory with a unique chip number. In every other respect, each shared unit is identical and has the same orderable part number.

On initial startup (or after the master is disabled or shuts down), each unit determines the chip number of every other unit currently connected to the shared serial bus formed by the SHARE+ and SHARE- pins. The unit with the highest chip number dynamically reconfigures itself from slave to master. The rest of the units (that do not have the highest chip number) become slaves.

The master unit then broadcasts its control state over the shared serial bus on a cycle-by-cycle basis. The slave units interpret and implement the control commands sent by the master, mirroring every action of the master unit.

If the master is disabled or encounters a fault condition, all units will immediately shut down, and if the master unit is unable to restart, then the unit with the next highest chip number will become master. If a slave unit is disabled or encounters a fault condition, all other units continue to run, and the slave unit can restart seamlessly.

Automatic Interleaving: The slave units automatically lock frequency with the master, and interleave the phase of their switching transitions for improved EMI performance. To obtain the phase angle relative to the master, each slave divides 360 degrees by the total number of connected units, and multiples the result by its rank among chip numbers of connected units.

ORing Diodes placed in series with the converter outputs must also have a resistor smaller than 500 Ω placed in parallel. This resistor keeps the output voltage of a temporarily disabled slave unit consistent with the active master unit. If the output voltage of the slave unit were allowed to totally discharge, and the slave unit tried to restart, it would fail because the slave reproduces the duty cycle of the master unit, which is running in steady state and cannot repeat an output voltage soft-start.

Common-Mode Filtering can be used on either the primary or secondary side of the converter. Adding a common-mode choke at the output eliminates the need for the 470 nH indcutor at the output of shared units.

Resonance Between Output Capacitors is Possible: When multiple higher-voltage modules are paralleled, it is possible to excite a series resonance between the output capacitors internal to the module and the parasitic inductance of the module output pins. This is especially likely at higher output voltages where the module internal capacitance is relatively small. This problem is independent of external output capacitance. For the FZ (whose output voltage is 270V), it is important to ensure that this resonant frequency is below the switching frequency. A 470 nH inductor should be added to the output located close to the module, in series with each converter output to damp this resonance. There must be at least 10 µF of capacitance per converter, located on the load-side of that inductor. The inductance could be from the leakage inductance of a secondary-side common-mode choke; in which case the output capacitor should be appropriately sized for the chosen choke (see Figure G).

RS-485 Physical Layer: The internal RS-485 transceiver includes many advanced protection features for enhanced reliability:

- Current Limiting and Thermal Shutdown for Driver Overload Protection
- IEC61000 ESD Protection to +/- 16.5 kV
- Hot Plug Circuitry – SHARE+ and SHARE- Outputs Remain Tri-State During Power-up/Power-down

Internal Schottky Diode Termination: Despite signaling at high speed with fast edges, external termination resistors are not necessary. Each receiver has four Schottky diodes built in, two for each line in the differential pair. These diodes clamp any ringing caused by transmission line reflections, preventing the voltage from going above about 5.5 V or below about -0.5 V. Any subsequent ringing then inherently takes place between 4.5 and 5.5 V or between -0.5 and 0.5 V. Since each receiver on the bus contains a set of clamping diodes to clamp any possible transmission line reflection, the bus does not necessarily need to be routed as a daisy-chain.

Pins SHARE+ and SHARE- are galvanically isolated internally to the module. Thus the SHARE+ and SHARE- pins may be connected to other modules whose input and/or output returns are ac isolated from each other. It is recommended that these signals should be rounted as a differential pair near the Vin- or Vout- planes for optimal signal integrity.

Share Accuracy: Inside each converter micro-controller, the duty cycle is generated digitally, making for excellent duty cycle matching between connected units. Some small duty cycle mismatch is caused by (well controlled) process variations in the MOSFET gate drivers. However, the voltage difference induced by this duty cycle mismatch appears across the impedance of the entire power converter, from input to output, multiplied by two, since the differential current flows out of one converter and into another. So, a small duty cycle mismatch yields very small differential currents, which remain small even when 100 units are placed in parallel.

In other current-sharing schemes, it is common to have a current-sharing control loop in each unit. However, due to the limited bandwidth of this loop, units do not necessarily share current on startup or during transients before this loop has a chance to respond. In contrast, the current-sharing scheme used in this product has no control dynamics: control signals are transmitted fast enough that the slave units can mirror the control state of the master unit on a cycle-by-cycle basis, and the current simply shares properly, from the first switching cycle to the last.

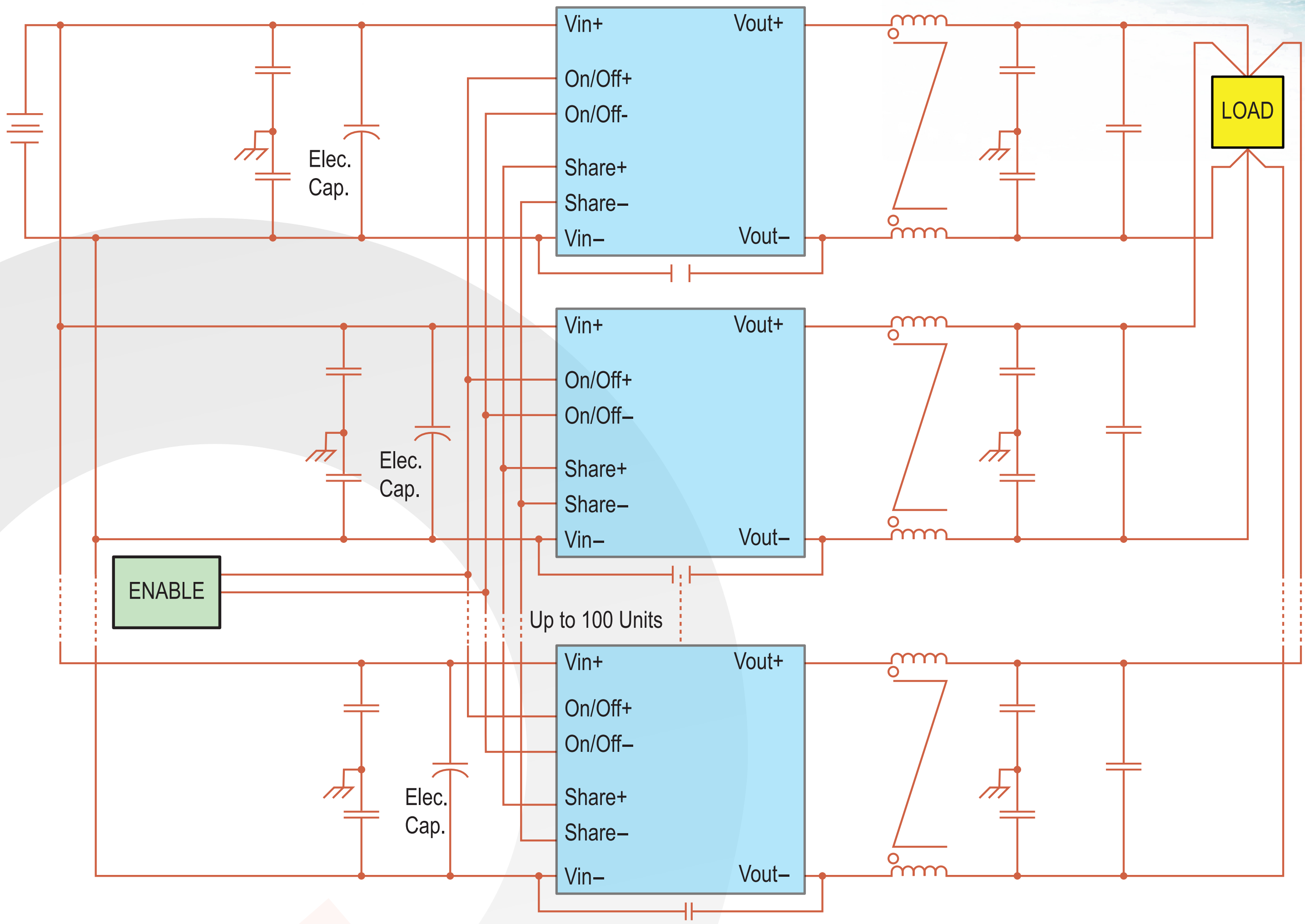
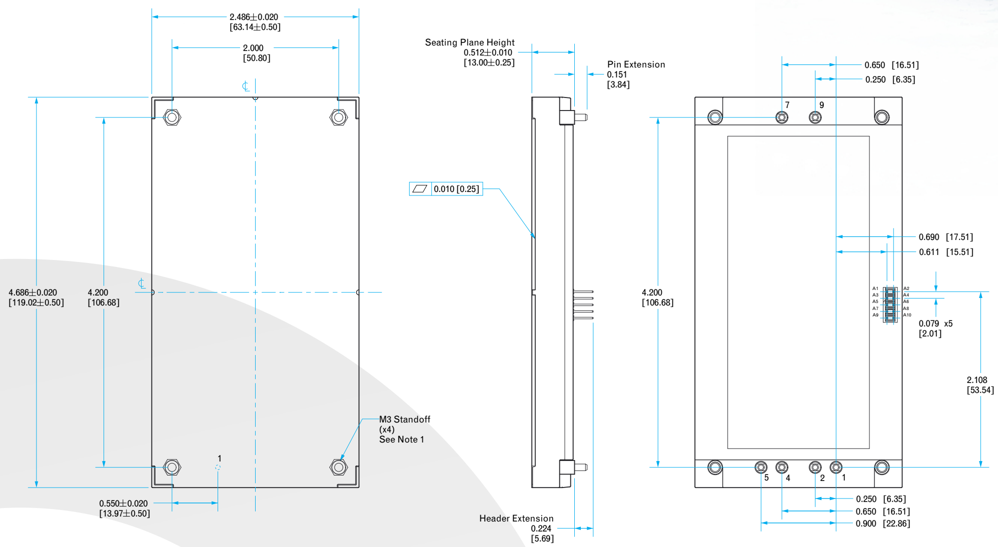


Figure G: Typical Application Circuit for Paralleling of Full-Featured Units with an Output Common-Mode Choke. *See Figure F for configuration with an input common-mode choke.*



NOTES

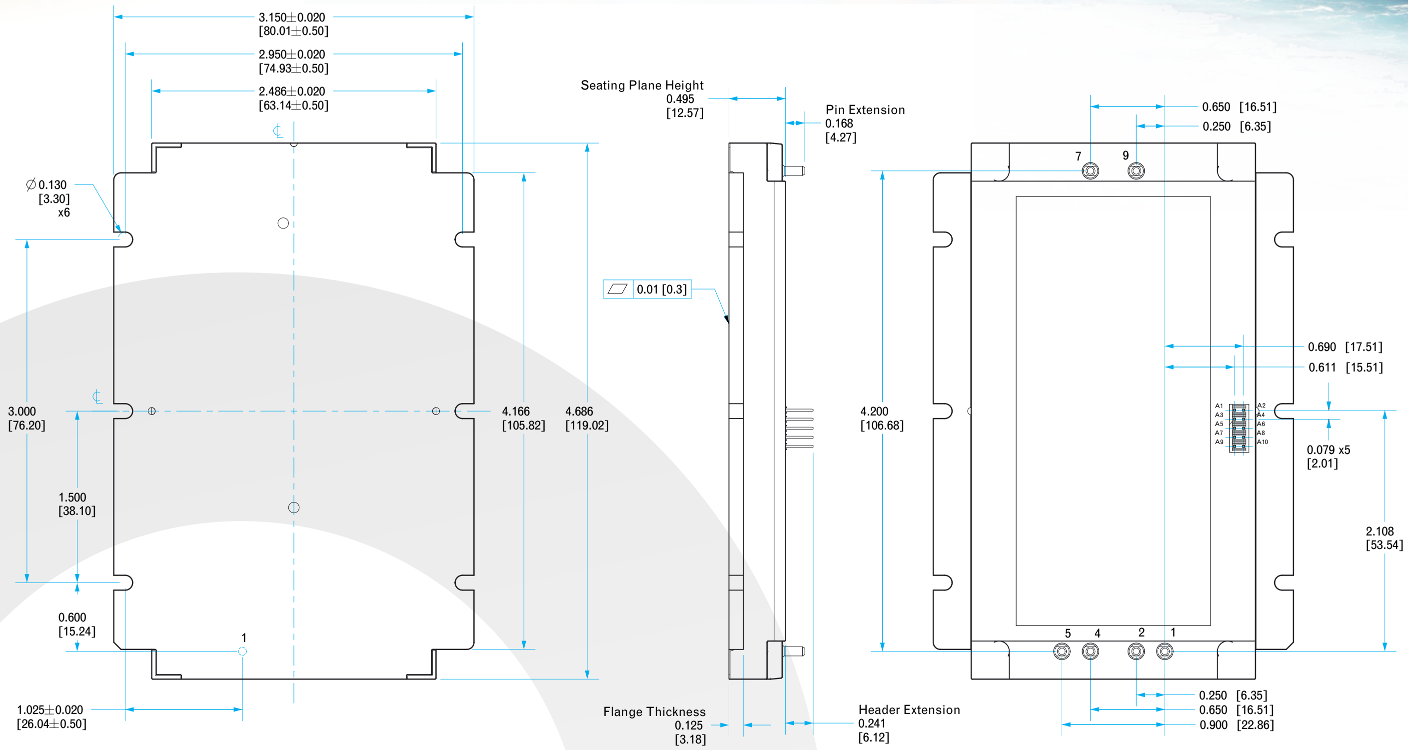
1) APPLIED TORQUE PER M3 SCREW SHOULD NOT EXCEED 6in-lb (0.7Nm)
2) BASEPLATE FLATNESS TOLERANCE IS 0.010"(.25mm) TIR FOR SURFACE.
3) PINS 1-9 ARE 0.080" (2.03mm) DIA. WITH 0.125" (3.18mm) DIA. STANDOFFS.
4) PINS A1-A10 ARE SQUARE 0.020" (0.5mm) x 0.020" (0.5mm)
5) PINS 1-9: MATERIAL: COPPER ALLOY
FINISH: MATTE TIN OVER NICKEL PLATE
6) PINS A1-A10: MATERIAL: COPPER ALLOY
FINISH: GOLD FLASH OVER PALLADIUM NICKEL
7) THREADED AND NON-THREADED OPTIONS AVAILABLE
8) WEIGHT: 9.9 oz (280 g)
9) ALL DIMENSIONS IN INCHES (mm)
TOLERANCES: X.XXIN +/-0.02 (X.Xmm +/-0.5mm)
X.XXXIN +/-0.010 (X.XXmm +/-0.25mm)

PIN DESIGNATIONS

Pin	Label	Name	Function
1	+VIN	Vin(+)	Positive Input Voltage
2	–VIN	IN RTN	Input Voltage Return
4	+VIN	Vin(+)	Positive Input Voltage
5	–VIN	IN RTN	Input Voltage Return
7	+VOUT	+VOUT	Positive Output Voltage
9	–VOUT	OUT RTN	Negative Return for +VOUT
A1	ON/OFF+	ON/OFF(+)	Turn converter on and off, referenced to ON/OFF(-)
A2	ON/OFF–	ON/OFF(–)	Fully isolated ground return for ON/OFF(+)
A3	DNC	Reserved	Reserved - Do Not Connect
A4	DNC	Reserved	Reserved - Do Not Connect
A5	SHARE+	SHARE(+)	Active current share differential pair (Note 1)
A6	DNC	Reserved	Reserved - Do Not Connect
A7	SHARE–	SHARE(-)	Active current share differential pair (Note 1)
A8	DNC	Reserved	Reserved - Do Not Connect
A9	GND ISHR	GND ISHR	Isolated Ground Reference for Pins A5 and A7
A10	DNC	Reserved	Reserved - Do Not Connect

Pin Designations Notes:
1 See Full-Feature Application Notes

Flanged Mechanical Diagram



NOTES

1) APPLIED TORQUE PER M3 OR 4-40 SCREW SHOULD NOT EXCEED 6in-
2) BASEPLATE FLATNESS TOLERANCE IS 0.010"(.25mm) TIR FOR SURFACE.
3) PINS 1-9 ARE 0.080" (2.03mm) DIA. WITH 0.125" (3.18mm) DIA. STANDOFFS.
4) PINS A1-A10 ARE SQUARE 0.020" (0.5mm) x 0.020" (0.5mm)
5) PINS 1-9: MATERIAL: COPPER ALLOY
FINISH: MATTE TIN OVER NICKEL PLATE
6) PINS A1-A10: MATERIAL: COPPER ALLOY
FINISH: GOLD FLASH OVER PALLADIUM NICKEL
7) WEIGHT: 10.3 oz (293 g)
8) ALL DIMENSIONS IN INCHES (mm)
TOLERANCES: X.XXIN +/-0.02 (X.Xmm +/-0.5mm)
X.XXXIN +/-0.010 (X.XXmm +/-0.25mm)

PIN DESIGNATIONS

Pin	Label	Name	Function
1	+VIN	Vin(+)	Positive Input Voltage
2	–VIN	IN RTN	Input Voltage Return
4	+VIN	Vin(+)	Positive Input Voltage
5	–VIN	IN RTN	Input Voltage Return
7	+VOUT	+VOUT	Positive Output Voltage
9	–VOUT	OUT RTN	Negative Return for +VOUT
A1	ON/OFF+	ON/OFF(+)	Turn converter on and off, referenced to ON/OFF(-)
A2	ON/OFF–	ON/OFF(–)	Fully isolated ground return for ON/OFF(+)
A3	DNC	Reserved	Reserved - Do Not Connect
A4	DNC	Reserved	Reserved - Do Not Connect
A5	SHARE+	SHARE(+)	Active current share differential pair (Note 1)
A6	DNC	Reserved	Reserved - Do Not Connect
A7	SHARE–	SHARE(-)	Active current share differential pair (Note 1)
A8	DNC	Reserved	Reserved - Do Not Connect
A9	GND ISHR	GND ISHR	Isolated Ground Reference for Pins A5 and A7
A10	DNC	Reserved	Reserved - Do Not Connect

Pin Designations Notes:
1 See Full-Feature Application Notes

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

Example MCOTS-C-28-270-FZ-N-M-F

Not all combinations make valid part numbers, please contact SynQor for availability. See the website for details.

Family	Product	Input Voltage	Output Voltage	Package	Heatsink Option	Screening Level	Feature
MCOTS	**C:** Converter	**28:** 16-40V	**270:** 270V	**FZ:** Full Brick Zeta	**N:** Normal Threaded **F:** Flanged **D:** Normal Non-Threaded	**S:** S-Grade **M:** M-Grade	**F:** Full Feature (Active current share)

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: 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