

180-425V Continuous Input	475V Transient Input	1.8-48V Outputs	156W Max Power	4250Vdc Reinforced Insulation	Quarter-brick DC-DC Converter
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The InQor quarter-brick converter series is composed of next-generation, board-mountable, REINFORCED INSULATION, fixed switching frequency dc-dc converters that use synchronous rectification to achieve extremely high power conversion efficiency. Each module is supplied completely encased to provide protection from the harsh environments seen in many industrial and transportation applications.

InQor®



Operational Features

- High efficiency, 81-89% at full rated load current
- Operating input voltage range: 180-425V
- Fixed frequency switching provides predictable EMI
- No minimum load requirement

Mechanical Features

- Industry standard Quarter-brick pin-out configuration
- Size: 2.386" x 1.536" x 0.500" (60.60 x 39.01 x 12.70 mm)
- Total weight: 3.0 oz (85 g)

Control Features

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

Safety Features

Reinforced Insulation

- Input-to-output isolation 4250Vdc
- UL 60950-1 2nd Ed. 2007
- CAN/CSA-C22.2 No. 60950-1-07
- EN60950-1 Ed. 2.0
- CE Marked
- RoHS compliant (see last page)

Protection Features

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

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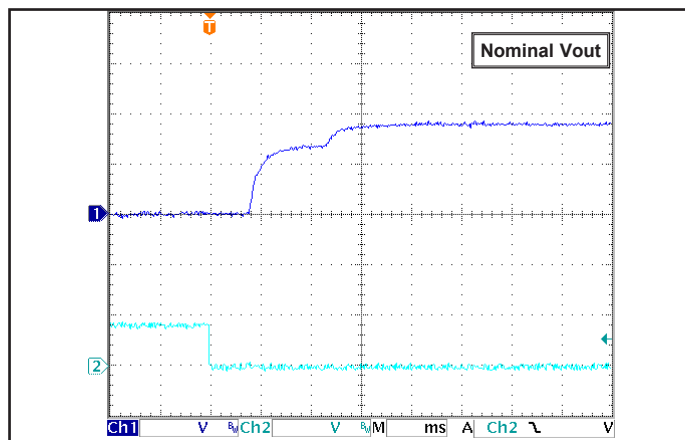
IQ4H Family Electrical Characteristics (all output voltages)

Ta = 25 °C, airflow rate = 300 LFM, Vin = 385V dc unless otherwise noted; full operating temperature range is -40 °C to +100 °C baseplate temperature with appropriate power derating. Specifications subject to change without notice.

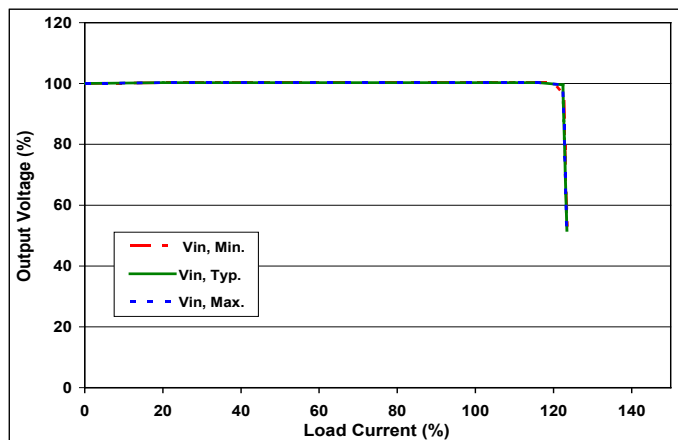
Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
ABSOLUTE MAXIMUM RATINGS					
Input Voltage					
Non-Operating			600	V	Continuous
Operating			425	V	Continuous
Operating Transient Protection			475	V	100 ms transient, square wave
Isolation Voltage					
Input to Output			4250	V dc	Reinforced Insulation
Input to Base-Plate			2300	V dc	Basic Insulation
Output to Base-Plate			2300	V dc	Basic Insulation
Operating Temperature	-40		100	°C	Baseplate temperature
Storage Temperature	-55		125	°C	
Voltage at ON/OFF input pin	-2		18	V	
INPUT CHARACTERISTICS					
Operating Input Voltage Range	180	385	425	V	475V transient for 100 ms; see Note 1
Input Under-Voltage Lockout					
Turn-On Voltage Threshold	171.0	174.0	177.0	V	
Turn-Off Voltage Threshold	159	162	165	V	
Lockout Voltage Hysteresis		12.0		V	
Input Over-Voltage Shutdown		500		V	
Recommended External Input Capacitance		3.3		µF	Typical ESR 8Ω
Input Filter Component Values (L\C)		56\0.272		µH\µF	Internal values; see Figure D
DYNAMIC CHARACTERISTICS					
Turn-On Transient					
Turn-On Time		42		ms	Full load, Vout=90% nom.
Start-Up Inhibit Time	180	200	220	ms	-40 °C to +85 °C; Figure E
Output Voltage Overshoot		0		%	Maximum Output Capacitance
ISOLATION CHARACTERISTICS					
Isolation Voltage (dielectric strength)			4250	V dc	See Absolute Maximum Ratings
Isolation Resistance		100		MΩ	Per EN 60255-5
Isolation Capacitance (input to output)		N/A		pF	
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					
ON/OFF Control					
Off-State Voltage	2.4		18	V	
On-State Voltage	-1		0.8		
ON/OFF Control					Application notes Figures A & B
Pull-Up Voltage		5		V	
Pull-Up Resistance		68.1		kΩ	
Over-Temperature Shutdown OTP Trip Point		125		°C	Average PCB Temperature
Over-Temperature Shutdown Restart Hysteresis		10		°C	
RELIABILITY CHARACTERISTICS					
Calculated MTBF (Telcordia) TR-NWT-000332		1.00		10 ⁶ Hrs.	Tb = 70°C
Calculated MTBF (MIL-217) MIL-HDBK-217F		1.10		10 ⁶ Hrs.	Tb = 70°C
Field Demonstrated MTBF				10 ⁶ Hrs.	See our website for details

Note 1: Input Voltage Transient dv/dt=1 V/ us

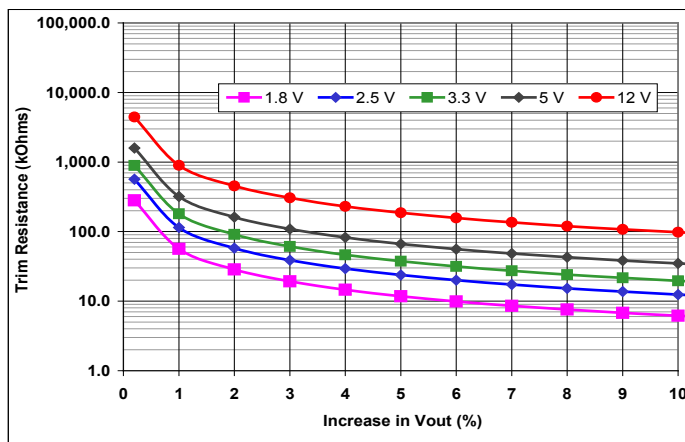
Family Figures (all output voltages)



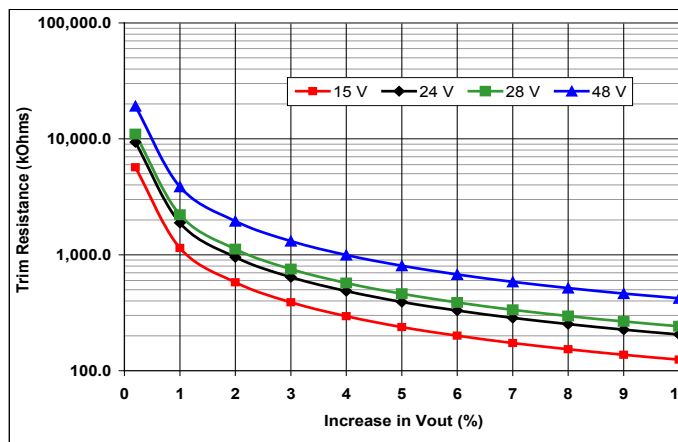
Common Figure 1: Typical startup waveform. Input voltage pre-applied, ON/OFF Pin on Ch 2.



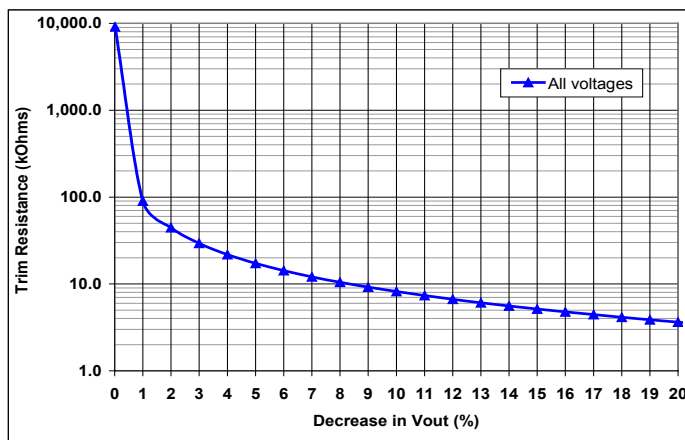
Common Figure 2: Output voltage vs. load current showing typical current limit curves and converter shutdown points.



Common Figure 3: Trim graph for trim-up 1.8 to 12V outputs.



Common Figure 4: Trim graph for trim-up 15 to 48V outputs.



Common Figure 5: Trim graph for trim down.



Technical Specification

Input: 180-425V
Output: 3.3V
Current: 30A
Part No.: IQ4H033QTx30

IQ4H033QTx30 Electrical Characteristics (3.3 Vout)

Ta = 25 °C, airflow rate = 300 LFM, Vin = 385V dc unless otherwise noted; full operating temperature range is -40 °C to +100 °C baseplate temperature with appropriate power derating. Specifications subject to change without notice.

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
INPUT CHARACTERISTICS					
Maximum Input Current			1.0	A	Vin min; trim up; in current limit
No-Load Input Current		20	30	mA	
Disabled Input Current		5	10	mA	
Response to Input Transient		0.13		V	See Figure 6
Input Terminal Ripple Current		20		mA	RMS
Recommended Input Fuse			3	A	Fast acting external fuse recommended
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	3.267	3.300	3.333	V	
Output Voltage Regulation					
Over Line		±0.1	±0.3	%	
Over Load		±0.1	±0.3	%	
Over Temperature	-50		50	mV	
Total Output Voltage Range	3.217		3.383	V	Over sample, line, load, temperature & life
Output Voltage Ripple and Noise					20 MHz bandwidth; see Note 1
Peak-to-Peak	0	35	70	mV	Full load
RMS		10	20	mV	Full load
Operating Output Current Range	0		30	A	Subject to thermal derating
Output DC Current-Limit Inception	32.0	37.5	43.0	A	Output voltage 10% Low
Output DC Current-Limit Shutdown Voltage		2.3		V	
Back-Drive Current Limit while Enabled		5.0		A	Negative current drawn from output
Back-Drive Current Limit while Disabled		5		mA	Negative current drawn from output
Maximum Output Capacitance			10,000	µF	Vout nominal at full load (resistive load)
Output Voltage during Load Current Transient					
Step Change in Output Current (0.1 A/µs)		50		mV	50% to 75% to 50% Iout max
Settling Time		100		µs	To within 1% Vout nom
Output Voltage Trim Range	-15		10	%	Across Pins 8&4; Common Figures 3-5; see Note 2
Output Voltage Remote Sense Range			10	%	Across Pins 8&4
Output Over-Voltage Protection	115	125	137	%	Over full temp range; % of nominal Vout
Switching Frequency	400	450	500	kHz	Isolation stage switching freq. is half this
EFFICIENCY					
100% Load		86		%	See Figure 1 for efficiency curve
50% Load		83		%	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: support@synqor.com)

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

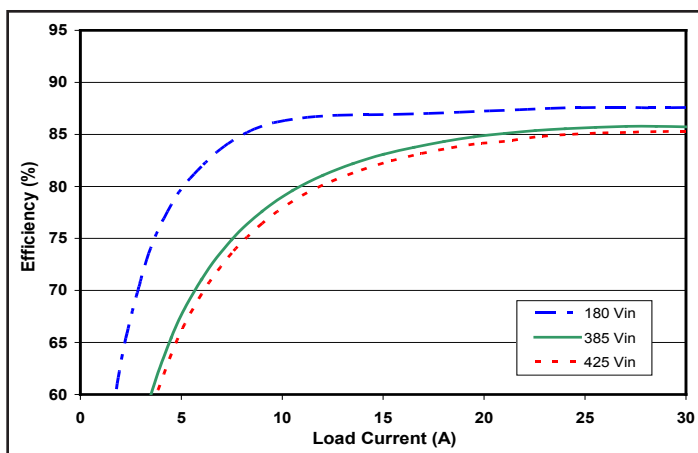


Figure 1: Efficiency at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at 25°C.

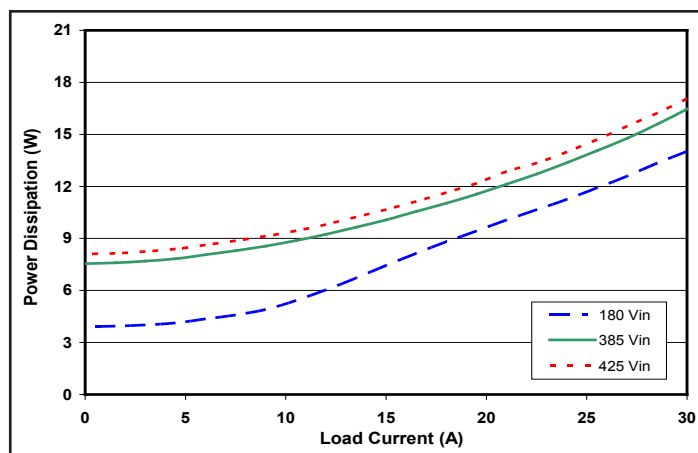


Figure 2: Power dissipation at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at 25°C.

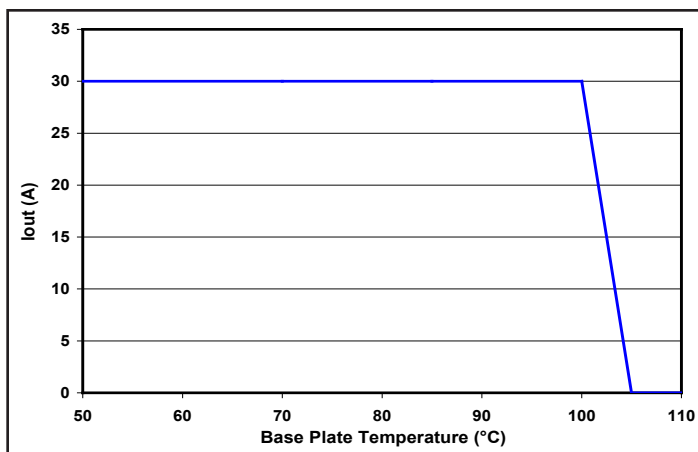


Figure 3: Encased converter max. output power derating vs. base plate temperature (nominal input voltage).

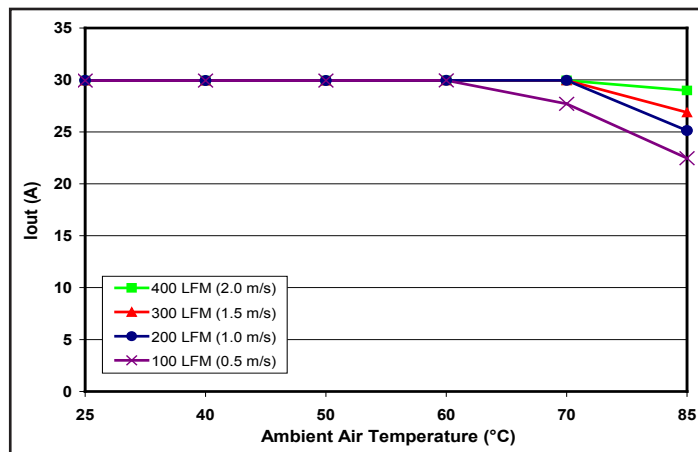


Figure 4: Encased converter (with 0.45" heatsink) max. output power derating vs. ambient air temperature for airflow rates of 100 LFM through 400 LFM. Air flows across the converter from input to output (nominal input voltage).

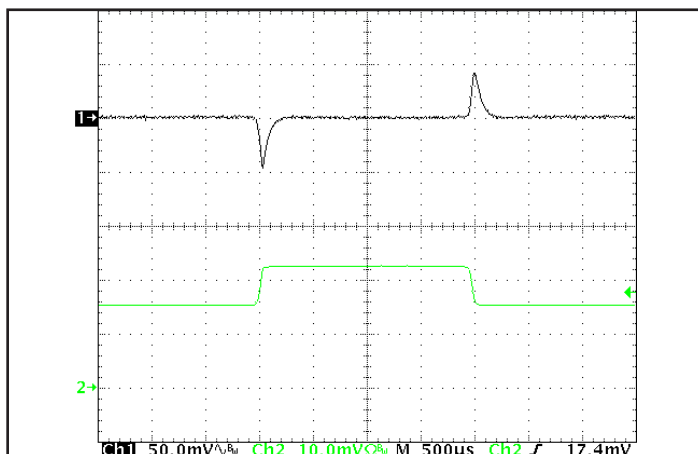


Figure 5: Output voltage response to step-change in load current (50%-75%-50% of Iout(max); dI/dt = 0.1A/μs). Load cap: 15μF, 100 mΩ ESR tantalum cap and 1μF ceramic cap. Ch 1: Vout (50mV/div), Ch 2: Iout (10A/div).

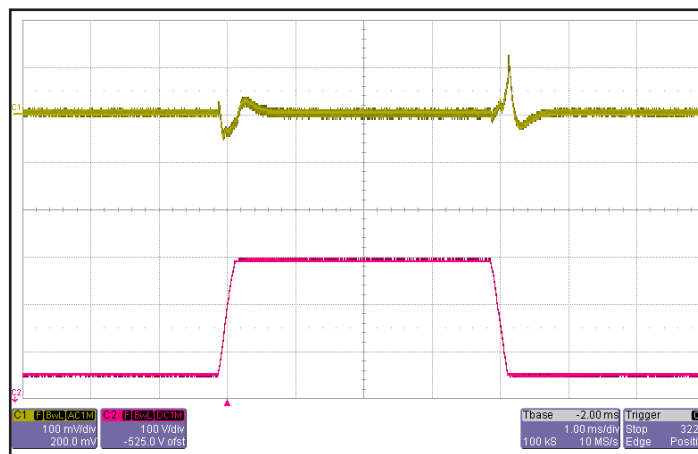


Figure 6: Output voltage response to step-change in input voltage (180 V - 425 V - 180 V) with 250 μs rise/fall time. Load cap: 15μF, 100 mΩ ESR tantalum cap and 1μF ceramic cap. Ch 1: Vout (100mV/div). Ch 2: Vin (100V/div).



Technical Specification

Input: 180-425V
Output: 5.0V
Current: 30A
Part No.: IQ4H050QTx30

IQ4H050QTx30 Electrical Characteristics (5.0 Vout)

Ta = 25 °C, airflow rate = 300 LFM, Vin = 385V dc unless otherwise noted; full operating temperature range is -40 °C to +100 °C baseplate temperature with appropriate power derating. Specifications subject to change without notice.

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
INPUT CHARACTERISTICS					
Maximum Input Current			1.5	A	Vin min; trim up; in current limit
No-Load Input Current		25	35	mA	
Disabled Input Current		5	10	mA	
Response to Input Transient		0.22		V	See Figure 6
Input Terminal Ripple Current		23		mA	RMS
Recommended Input Fuse			3	A	Fast acting external fuse recommended
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	4.950	5.000	5.050	V	
Output Voltage Regulation					
Over Line		±0.1	±0.3	%	
Over Load		±0.1	±0.3	%	
Over Temperature	-75		75	mV	
Total Output Voltage Range	4.875		5.125	V	Over sample, line, load, temperature & life
Output Voltage Ripple and Noise					20 MHz bandwidth; see Note 1
Peak-to-Peak	0	40	80	mV	Full load
RMS		5	10	mV	Full load
Operating Output Current Range	0		30	A	Subject to thermal derating
Output DC Current-Limit Inception	33.0	37.5	42.0	A	Output voltage 10% Low
Output DC Current-Limit Shutdown Voltage		3.0		V	
Back-Drive Current Limit while Enabled		5.3		A	Negative current drawn from output
Back-Drive Current Limit while Disabled		5		mA	Negative current drawn from output
Maximum Output Capacitance			10,000	µF	Vout nominal at full load (resistive load)
Output Voltage during Load Current Transient					
Step Change in Output Current (0.1 A/µs)		200		mV	50% to 75% to 50% Iout max
Settling Time		150		µs	To within 1% Vout nom
Output Voltage Trim Range	-20		10	%	Across Pins 8&4; Common Figures 3-5; see Note 2
Output Voltage Remote Sense Range			10	%	Across Pins 8&4
Output Over-Voltage Protection	115	125	137	%	Over full temp range
Switching Frequency	485	550	615	kHz	Isolation stage switching freq. is half this
EFFICIENCY					
100% Load		86		%	See Figure 1 for efficiency curve
50% Load		85		%	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: support@synqor.com)

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

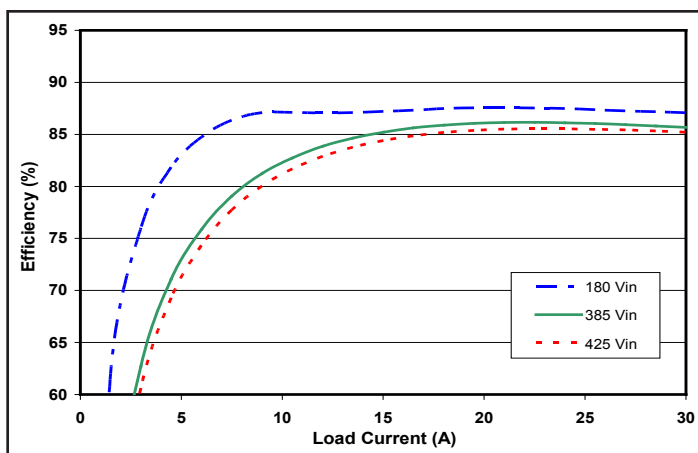


Figure 1: Efficiency at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at 25°C.

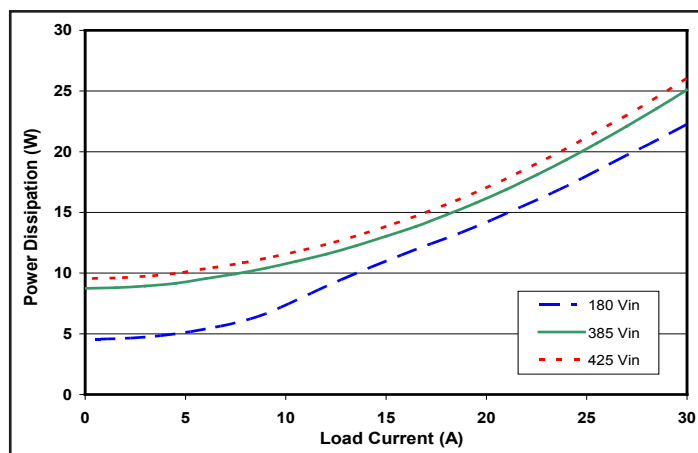


Figure 2: Power dissipation at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at 25°C.

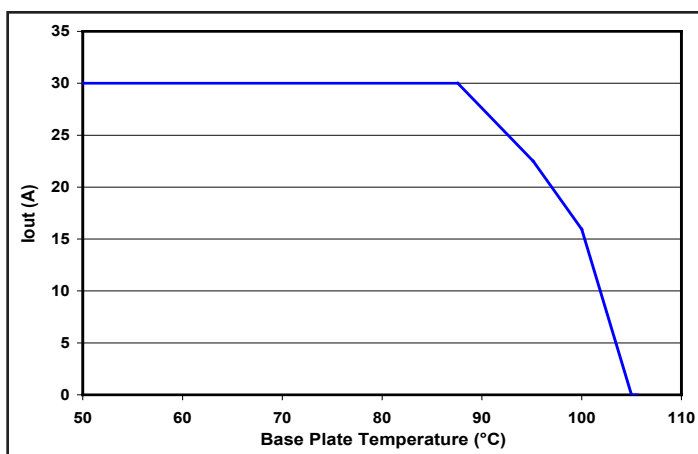


Figure 3: Encased converter max. output power derating vs. base plate temperature (nominal input voltage).

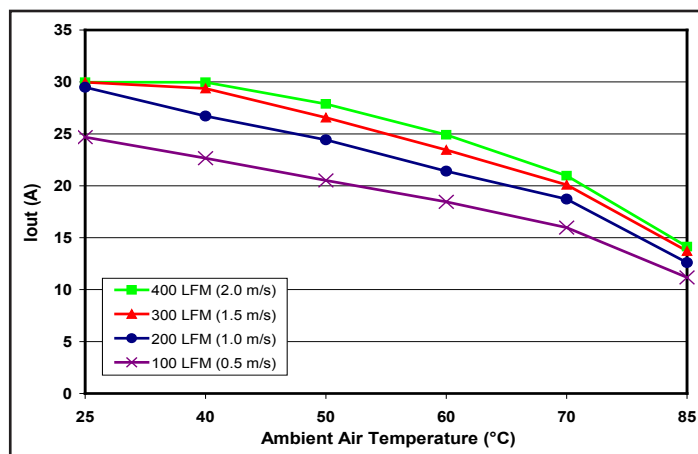


Figure 4: Encased converter (with 0.45" heatsink) max. output power derating vs. ambient air temperature for airflow rates of 100 LFM through 400 LFM. Air flows across the converter from input to output (nominal input voltage).

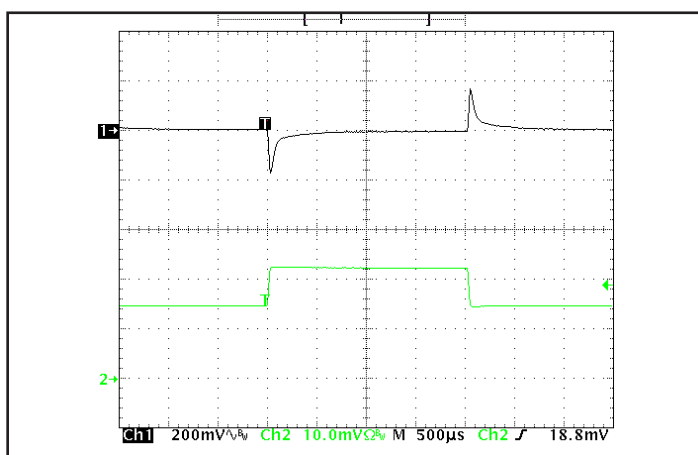


Figure 5: Output voltage response to step-change in load current (50%-75%-50% of I_{out}(max); dI/dt = 0.1A/μs). Load cap: 15μF, 100 mΩ ESR tantalum cap and 1μF ceramic cap. Ch 1: V_{out} (200mV/div), Ch 2: I_{out} (10A/div).

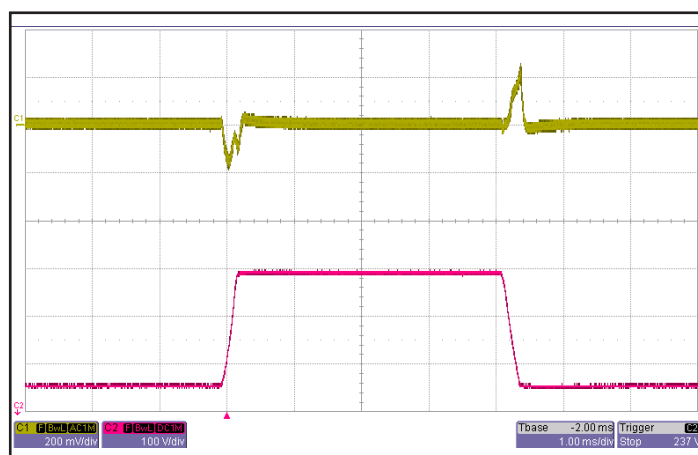


Figure 6: Output voltage response to step-change in input voltage (180 V - 425 V - 180 V) with 250 μs rise/fall time. Load cap: 15μF, 100 mΩ ESR tantalum cap and 1μF ceramic cap. Ch 1: V_{out} (200mV/div). Ch 2: V_{in} (100V/div).



Technical Specification

Input: 180-425V
Output: 12V
Current: 13A
Part No.: IQ4H120QTx13

IQ4H120QTx13 Electrical Characteristics (12.0 Vout)

Ta = 25 °C, airflow rate = 300 LFM, Vin = 385V dc unless otherwise noted; full operating temperature range is -40 °C to +100 °C baseplate temperature with appropriate power derating. Specifications subject to change without notice.

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
INPUT CHARACTERISTICS					
Maximum Input Current			1.6	A	Vin min; trim up; in current limit
No-Load Input Current		25	35	mA	
Disabled Input Current		5	10	mA	
Response to Input Transient		0.5		V	See Figure 6
Input Terminal Ripple Current		23		mA	RMS
Recommended Input Fuse			3	A	Fast acting external fuse recommended
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	11.88	12.00	12.12	V	
Output Voltage Regulation					
Over Line		±0.1	±0.3	%	
Over Load		±0.1	±0.3	%	
Over Temperature	-180		180	mV	
Total Output Voltage Range	11.70		12.30	V	Over sample, line, load, temperature & life
Output Voltage Ripple and Noise					20 MHz bandwidth; see Note 1
Peak-to-Peak	0	75	150	mV	Full load
RMS		15	30	mV	Full load
Operating Output Current Range	0		13	A	Subject to thermal derating
Output DC Current-Limit Inception	14.3	16.3	18.2	A	Output voltage 10% Low
Output DC Current-Limit Shutdown Voltage		7.2		V	
Back-Drive Current Limit while Enabled		2.1		A	Negative current drawn from output
Back-Drive Current Limit while Disabled		5		mA	Negative current drawn from output
Maximum Output Capacitance			3,000	µF	Vout nominal at full load (resistive load)
Output Voltage during Load Current Transient					
Step Change in Output Current (0.1 A/µs)		350		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; Common Figures 3-5; see Note 2
Output Voltage Remote Sense Range			10	%	Across Pins 8&4
Output Over-Voltage Protection	115	125	137	%	Over full temp range
Switching Frequency	485	550	615	kHz	Isolation stage switching freq. is half this
EFFICIENCY					
100% Load		86		%	See Figure 1 for efficiency curve
50% Load		86		%	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: support@synqor.com)

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

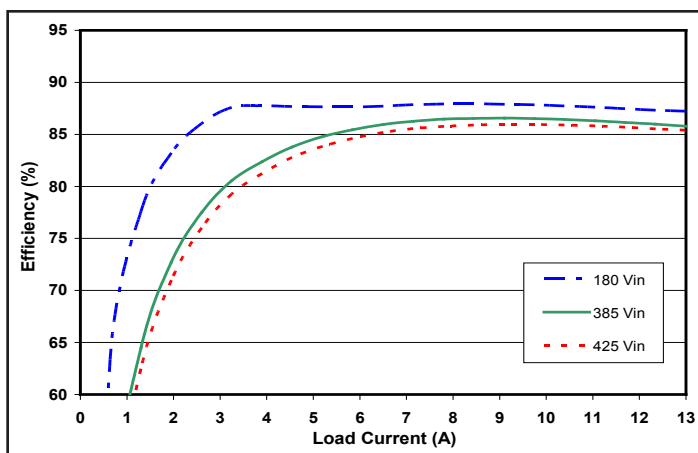


Figure 1: Efficiency at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at 25°C.

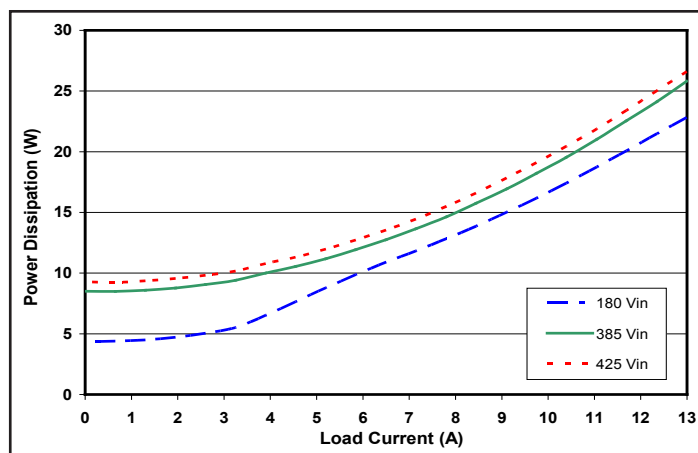


Figure 2: Power dissipation at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at 25°C.

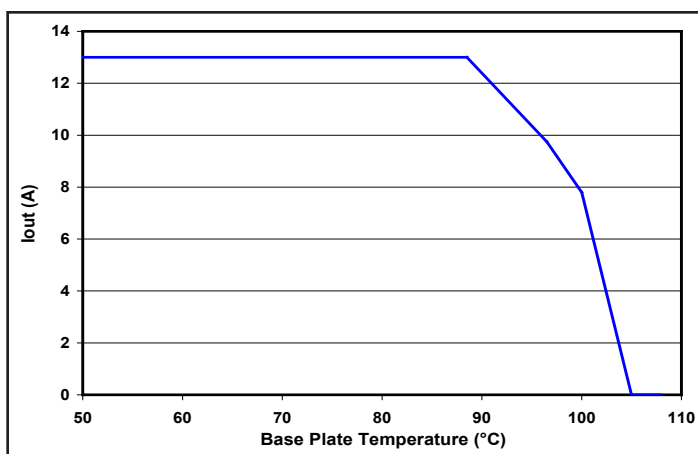


Figure 3: Encased converter max. output power derating vs. base plate temperature (nominal input voltage).

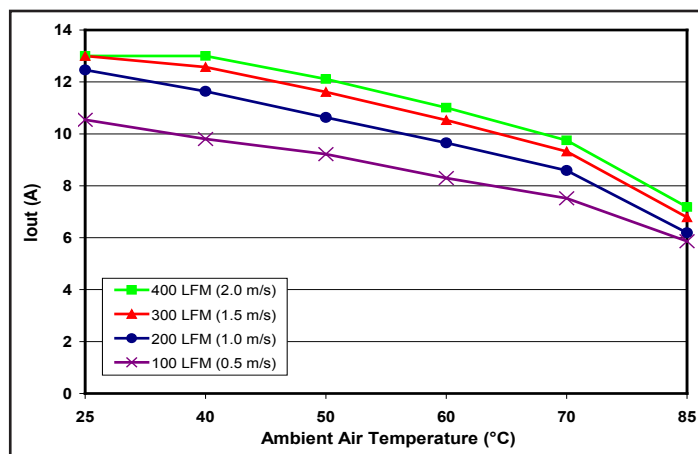


Figure 4: Encased converter (with 0.45" heatsink) max. output power derating vs. ambient air temperature for airflow rates of 100 LFM through 400 LFM. Air flows across the converter from input to output (nominal input voltage).

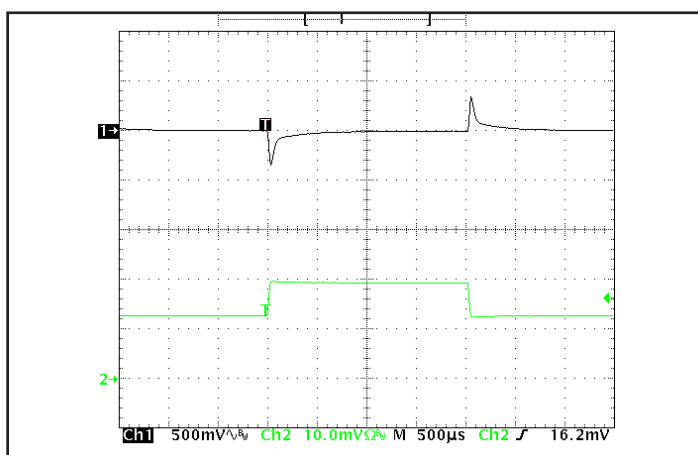


Figure 5: Output voltage response to step-change in load current (50%-75%-50% of I_{out}(max); dI/dt = 0.1A/μs). Load cap: 15μF, 100 mΩ ESR tantalum cap and 1μF ceramic cap. Ch 1: V_{out} (500mV/div), Ch 2: I_{out} (5A/div).

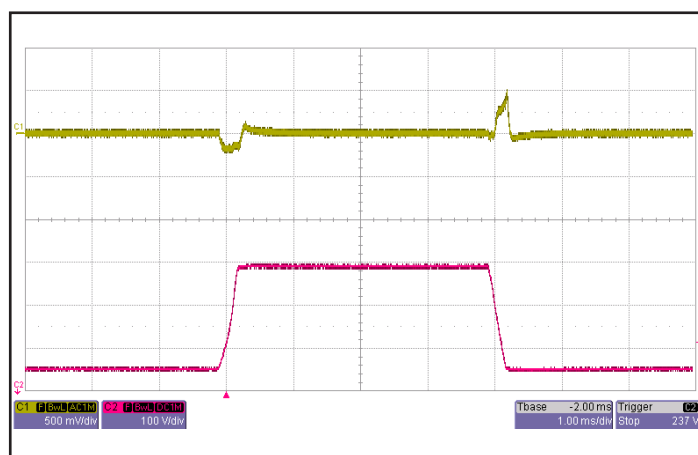


Figure 6: Output voltage response to step-change in input voltage (180 V - 425 V - 180 V) with 250 μs rise/fall time. Load cap: 15μF, 100 mΩ ESR tantalum cap and 1μF ceramic cap. Ch 1: V_{out} (500mV/div). Ch 2: V_{in} (100V/div).



Technical Specification

Input: 180-425V
Output: 15V
Current: 10A
Part No.: IQ4H150QTx10

IQ4H150QTx10 Electrical Characteristics (15.0 Vout)

Ta = 25 °C, airflow rate = 300 LFM, Vin = 385V dc unless otherwise noted; full operating temperature range is -40 °C to +100 °C baseplate temperature with appropriate power derating. Specifications subject to change without notice.

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
INPUT CHARACTERISTICS					
Maximum Input Current			1.5	A	Vin min; trim up; in current limit
No-Load Input Current		25	35	mA	
Disabled Input Current		5	10	mA	
Response to Input Transient		0.7		V	See Figure 6
Input Terminal Ripple Current		23		mA	RMS
Recommended Input Fuse			3	A	Fast acting external fuse recommended
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	14.85	15.00	15.15	V	
Output Voltage Regulation					
Over Line		±0.1	±0.3	%	
Over Load		±0.1	±0.3	%	
Over Temperature	-225		225	mV	
Total Output Voltage Range	14.62		15.38	V	Over sample, line, load, temperature & life
Output Voltage Ripple and Noise					20 MHz bandwidth; see Note 1
Peak-to-Peak	0	60	120	mV	Full load
RMS		10	20	mV	Full load
Operating Output Current Range	0		10	A	Subject to thermal derating
Output DC Current-Limit Inception	11.0	12.5	14.0	A	Output voltage 10% Low
Output DC Current-Limit Shutdown Voltage		9		V	
Back-Drive Current Limit while Enabled		2.3		A	Negative current drawn from output
Back-Drive Current Limit while Disabled		5		mA	Negative current drawn from output
Maximum Output Capacitance			2,000	µF	Vout nominal at full load (resistive load)
Output Voltage during Load Current Transient					
Step Change in Output Current (0.1 A/µs)		400		mV	50% to 75% to 50% Iout max
Settling Time		150		µs	To within 1% Vout nom
Output Voltage Trim Range	-20		10	%	Across Pins 8&4; Common Figures 3-5; see Note 2
Output Voltage Remote Sense Range			10	%	Across Pins 8&4
Output Over-Voltage Protection	115	125	137	%	Over full temp range
Switching Frequency	485	550	615	kHz	Isolation stage switching freq. is half this
EFFICIENCY					
100% Load		86		%	See Figure 1 for efficiency curve
50% Load		86		%	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: support@synqor.com)

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

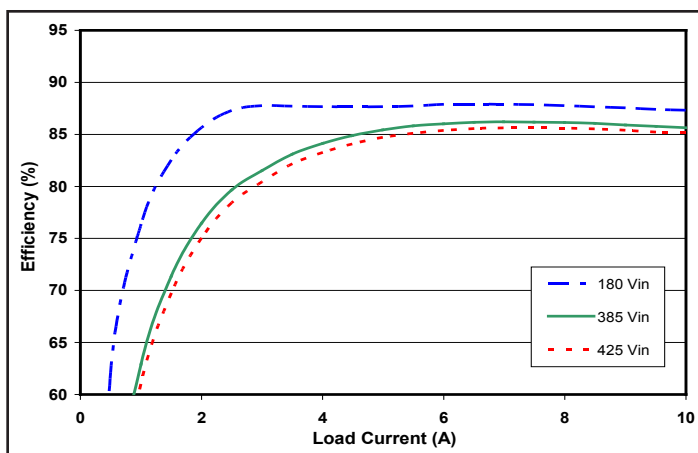


Figure 1: Efficiency at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at 25°C.

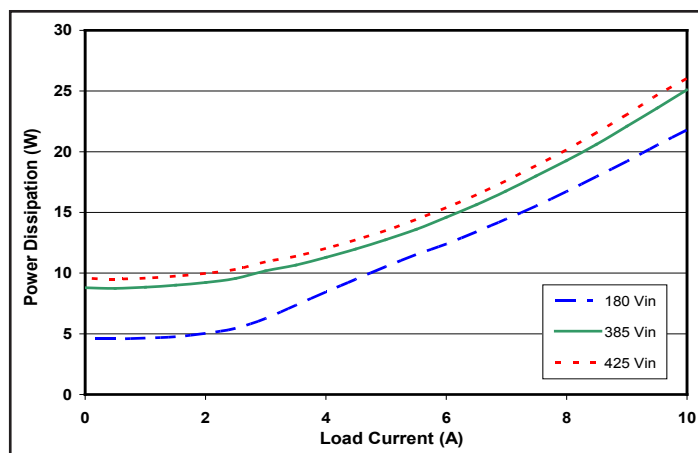


Figure 2: Power dissipation at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at 25°C.

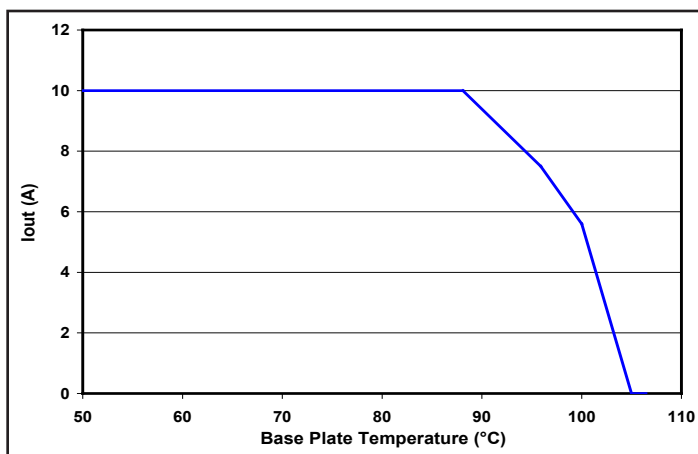


Figure 3: Encased converter max. output power derating vs. base plate temperature (nominal input voltage).

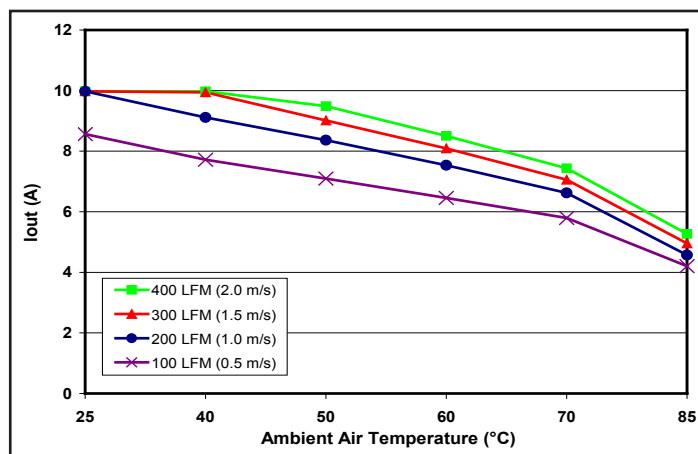


Figure 4: Encased converter (with 0.45" heatsink) max. output power derating vs. ambient air temperature for airflow rates of 100 LFM through 400 LFM. Air flows across the converter from input to output (nominal input voltage).

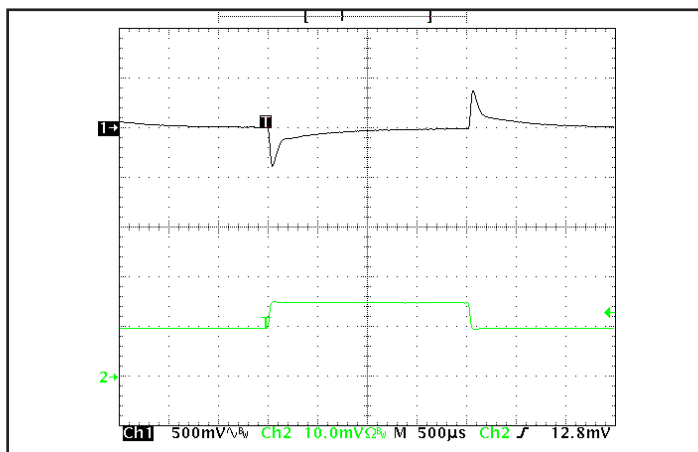


Figure 5: Output voltage response to step-change in load current (50%-75%-50% of I_{out}(max); dI/dt = 0.1A/μs). Load cap: 15μF, 100 mΩ ESR tantalum cap and 1μF ceramic cap. Ch 1: V_{out} (500mV/div), Ch 2: I_{out} (5A/div).

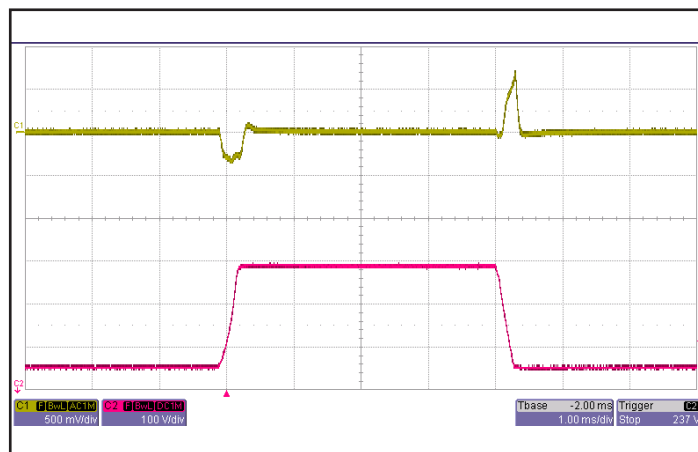


Figure 6: Output voltage response to step-change in input voltage (180 V - 425 V - 180 V) with 250 μs rise/fall time. Load cap: 15μF, 100 mΩ ESR tantalum cap and 1μF ceramic cap. Ch 1: V_{out} (500mV/div). Ch 2: V_{in} (100V/div).



Technical Specification

Input: 180-425V
Output: 24V
Current: 6.2A
Part No.: IQ4H240QTx06

IQ4H240QTx06 Electrical Characteristics (24.0 Vout)

Ta = 25 °C, airflow rate = 300 LFM, Vin = 385V dc unless otherwise noted; full operating temperature range is -40 °C to +100 °C baseplate temperature with appropriate power derating. Specifications subject to change without notice.

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
INPUT CHARACTERISTICS					
Maximum Input Current			1.5	A	Vin min; trim up; in current limit
No-Load Input Current		25	35	mA	
Disabled Input Current		5	10	mA	
Response to Input Transient		0.9		V	See Figure 6
Input Terminal Ripple Current		23		mA	RMS
Recommended Input Fuse			3	A	Fast acting external fuse recommended
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	23.76	24.00	24.24	V	
Output Voltage Regulation					
Over Line		±0.1	±0.3	%	
Over Load		±0.1	±0.3	%	
Over Temperature	-360		360	mV	
Total Output Voltage Range	23.40		24.60	V	Over sample, line, load, temperature & life
Output Voltage Ripple and Noise					20 MHz bandwidth; see Note 1
Peak-to-Peak	0	90	180	mV	Full load
RMS		20	40	mV	Full load
Operating Output Current Range	0		6.25	A	Subject to thermal derating
Output DC Current-Limit Inception	6.9	7.8	8.8	A	Output voltage 10% Low
Output DC Current-Limit Shutdown Voltage		14.5		V	
Back-Drive Current Limit while Enabled		1		A	Negative current drawn from output
Back-Drive Current Limit while Disabled		5		mA	Negative current drawn from output
Maximum Output Capacitance			1,000	µF	Vout nominal at full load (resistive load)
Output Voltage during Load Current Transient					
Step Change in Output Current (0.1 A/µs)		550		mV	50% to 75% to 50% Iout max
Settling Time		150		µs	To within 1% Vout nom
Output Voltage Trim Range	-20		10	%	Across Pins 8&4; Common Figures 3-5; see Note 2
Output Voltage Remote Sense Range			10	%	Across Pins 8&4
Output Over-Voltage Protection	115	125	137	%	Over full temp range
Switching Frequency	485	550	615	kHz	Isolation stage switching freq. is half this
EFFICIENCY					
100% Load		86		%	See Figure 1 for efficiency curve
50% Load		86		%	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: support@synqor.com)

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

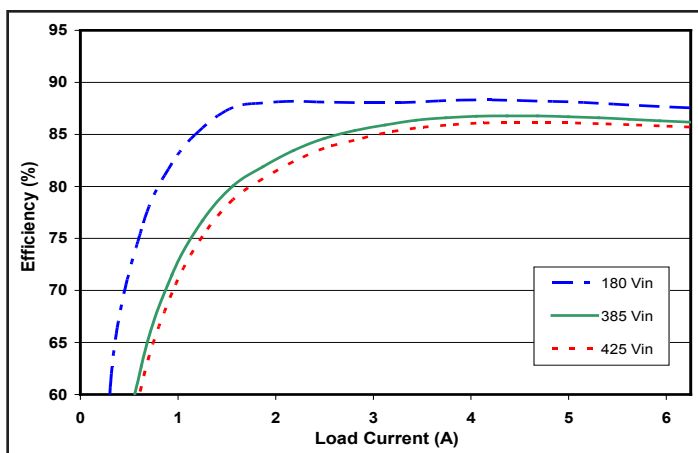


Figure 1: Efficiency at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at 25°C.

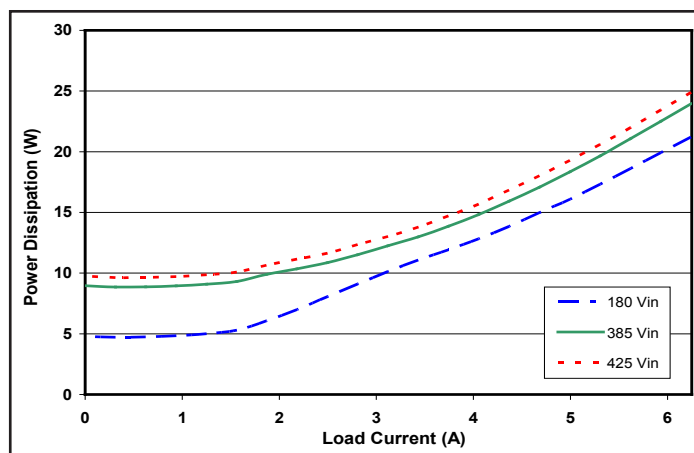


Figure 2: Power dissipation at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at 25°C.

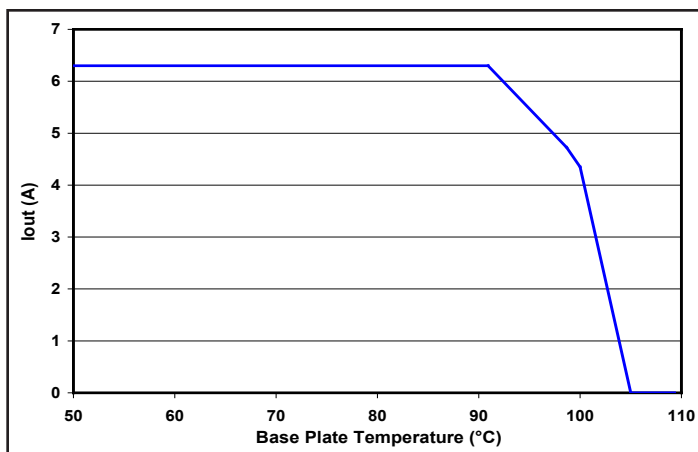


Figure 3: Encased converter max. output power derating vs. base plate temperature (nominal input voltage).

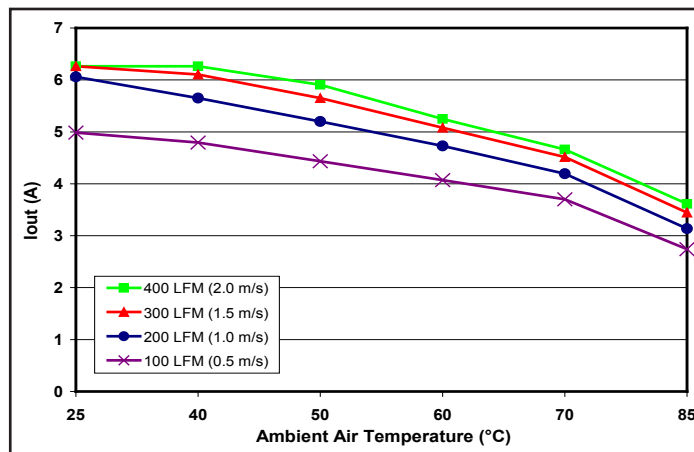


Figure 4: Encased converter (with 0.45" heatsink) max. output power derating vs. ambient air temperature for airflow rates of 100 LFM through 400 LFM. Air flows across the converter from input to output (nominal input voltage).

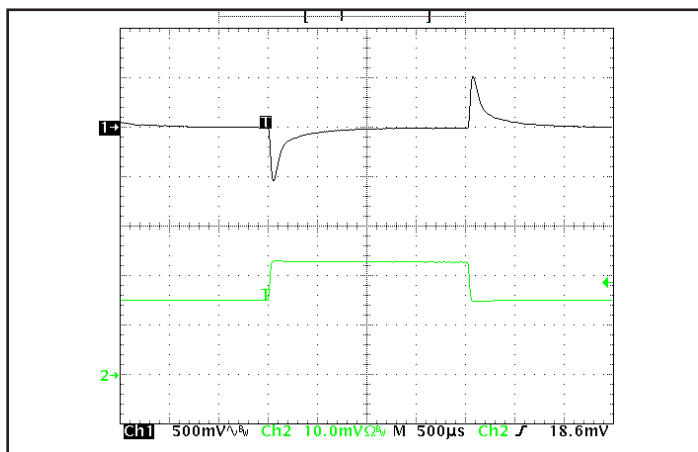


Figure 5: Output voltage response to step-change in load current (50%-75%-50% of I_{out}(max); dI/dt = 0.1A/μs). Load cap: 15μF, 100 mΩ ESR tantalum cap and 1μF ceramic cap. Ch 1: V_{out} (500mV/div), Ch 2: I_{out} (2A/div).

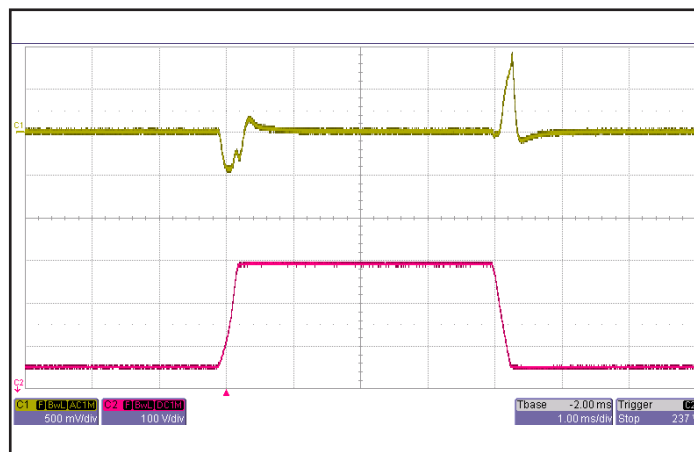


Figure 6: Output voltage response to step-change in input voltage (180 V - 425 V - 180 V) with 250 μs rise/fall time. Load cap: 15μF, 100 mΩ ESR tantalum cap and 1μF ceramic cap. Ch 1: V_{out} (500mV/div). Ch 2: V_{in} (100V/div).



Technical Specification

Input: 180-425V
Output: 28V
Current: 5.3A
Part No.: IQ4H280QTx05

IQ4H280QTx05 Electrical Characteristics (28.0 Vout)

Ta = 25 °C, airflow rate = 300 LFM, Vin = 385V dc unless otherwise noted; full operating temperature range is -40 °C to +100 °C baseplate temperature with appropriate power derating. Specifications subject to change without notice.

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
INPUT CHARACTERISTICS					
Maximum Input Current			1.5	A	Vin min; trim up; in current limit
No-Load Input Current		25	35	mA	
Disabled Input Current		5	10	mA	
Response to Input Transient		1.3		V	See Figure 6
Input Terminal Ripple Current		23		mA	RMS
Recommended Input Fuse			3	A	Fast acting external fuse recommended
OUTPUT CHARACTERISTICS					
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	27.30		28.70	V	Over sample, line, load, temperature & life
Output Voltage Ripple and Noise					20 MHz bandwidth; see Note 1
Peak-to-Peak	0	110	220	mV	Full load
RMS		25	50	mV	Full load
Operating Output Current Range	0		5.35	A	Subject to thermal derating
Output DC Current-Limit Inception	5.9	6.7	7.5	A	Output voltage 10% Low
Output DC Current-Limit Shutdown Voltage		17		V	
Back-Drive Current Limit while Enabled		0.9		A	Negative current drawn from output
Back-Drive Current Limit while Disabled		5		mA	Negative current drawn from output
Maximum Output Capacitance			1,000	µF	Vout nominal at full load (resistive load)
Output Voltage during Load Current Transient					
Step Change in Output Current (0.1 A/µs)		500		mV	50% to 75% to 50% Iout max
Settling Time		150		µs	To within 1% Vout nom
Output Voltage Trim Range	-20		10	%	Across Pins 8&4; Common Figures 3-5; see Note 2
Output Voltage Remote Sense Range			10	%	Across Pins 8&4
Output Over-Voltage Protection	115	125	137	%	Over full temp range
Switching Frequency	485	550	615	kHz	Isolation stage switching freq. is half this
EFFICIENCY					
100% Load		88		%	See Figure 1 for efficiency curve
50% Load		86		%	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: support@synqor.com)

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

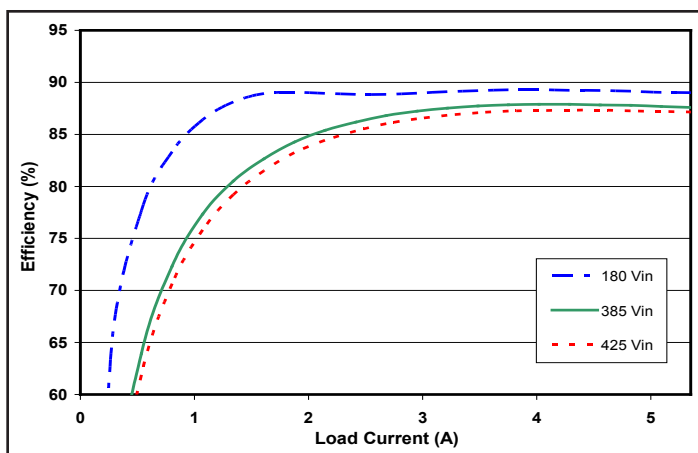


Figure 1: Efficiency at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at 25°C.

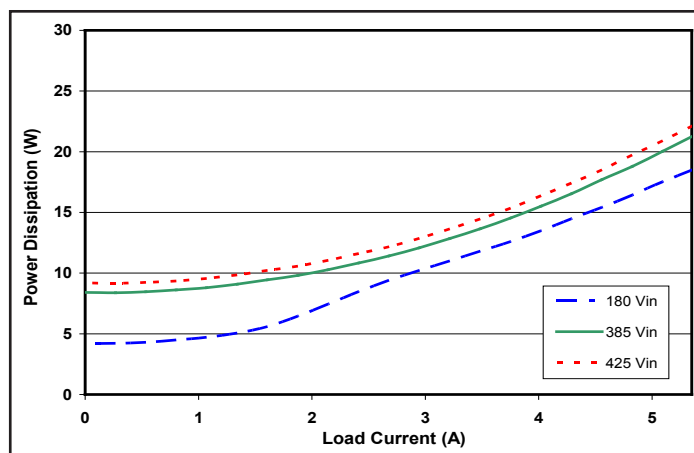


Figure 2: Power dissipation at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at 25°C.

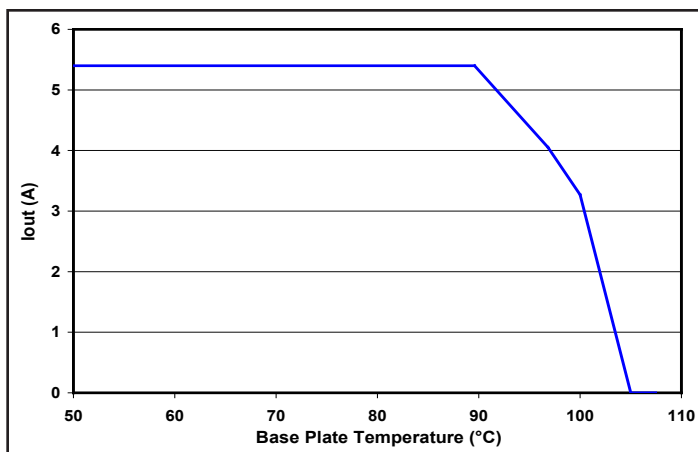


Figure 3: Encased converter max. output power derating vs. base plate temperature (nominal input voltage).

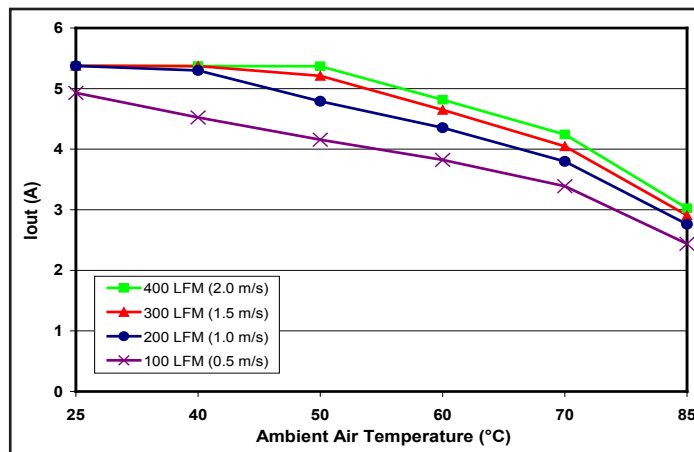


Figure 4: Encased converter (with 0.45" heatsink) max. output power derating vs. ambient air temperature for airflow rates of 100 LFM through 400 LFM. Air flows across the converter from input to output (nominal input voltage).

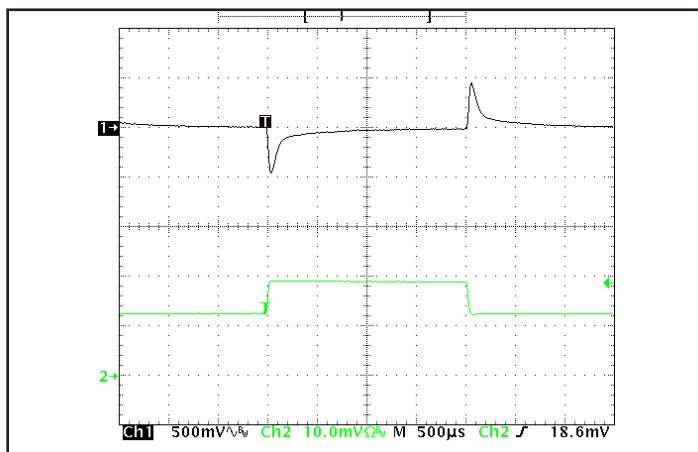


Figure 5: Output voltage response to step-change in load current (50%-75%-50% of I_{out}(max); dI/dt = 0.1A/μs). Load cap: 15μF, 100 mΩ ESR tantalum cap and 1μF ceramic cap. Ch 1: V_{out} (500mV/div), Ch 2: I_{out} (1A/div).

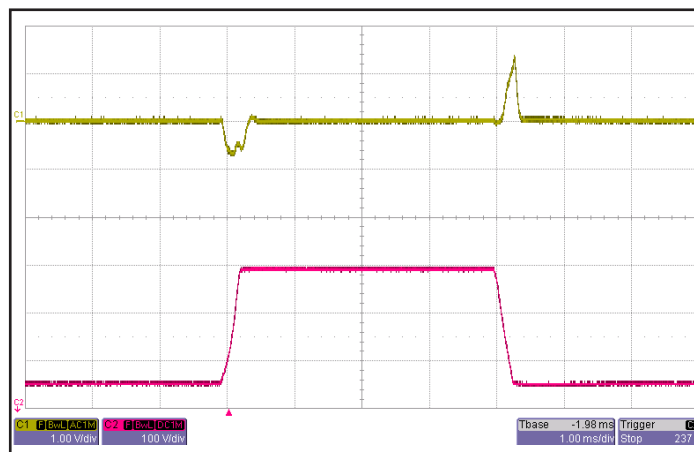


Figure 6: Output voltage response to step-change in input voltage (180 V - 425 V - 180 V) with 250 μs rise/fall time. Load cap: 15μF, 100 mΩ ESR tantalum cap and 1μF ceramic cap. Ch 1: V_{out} (1V/div). Ch 2: V_{in} (100V/div).



Technical Specification

Input: 180-425V
Output: 48V
Current: 3.1A
Part No.: IQ4H480QTx03

IQ4H480QTx03 Electrical Characteristics (48.0 Vout)

Ta = 25 °C, airflow rate = 300 LFM, Vin = 385V dc unless otherwise noted; full operating temperature range is -40 °C to +100 °C baseplate temperature with appropriate power derating. Specifications subject to change without notice.

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
INPUT CHARACTERISTICS					
Maximum Input Current			1.5	A	Vin min; trim up; in current limit
No-Load Input Current		25	35	mA	
Disabled Input Current		5	10	mA	
Response to Input Transient		1.9		V	See Figure 6
Input Terminal Ripple Current		23		mA	RMS
Recommended Input Fuse			3	A	Fast acting external fuse recommended
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	47.52	48.00	48.48	V	
Output Voltage Regulation					
Over Line		±0.1	±0.3	%	
Over Load		±0.1	±0.3	%	
Over Temperature	-720		720	mV	
Total Output Voltage Range	46.80		49.20	V	Over sample, line, load, temperature & life
Output Voltage Ripple and Noise					20 MHz bandwidth; see Note 1
Peak-to-Peak	0	105	210	mV	Full load
RMS		35	70	mV	Full load
Operating Output Current Range	0		3.125	A	Subject to thermal derating
Output DC Current-Limit Inception	3.4	3.9	4.4	A	Output voltage 10% Low
Output DC Current-Limit Shutdown Voltage		29		V	
Back-Drive Current Limit while Enabled		0.8		A	Negative current drawn from output
Back-Drive Current Limit while Disabled		5		mA	Negative current drawn from output
Maximum Output Capacitance			500	µF	Vout nominal at full load (resistive load)
Output Voltage during Load Current Transient					
Step Change in Output Current (0.1 A/µs)		800		mV	50% to 75% to 50% Iout max
Settling Time		150		µs	To within 1% Vout nom
Output Voltage Trim Range	-20		10	%	Across Pins 8&4; Common Figures 3-5; see Note 2
Output Voltage Remote Sense Range			10	%	Across Pins 8&4
Output Over-Voltage Protection	115	125	137	%	Over full temp range
Switching Frequency	485	550	615	kHz	Isolation stage switching freq. is half this
EFFICIENCY					
100% Load		88		%	See Figure 1 for efficiency curve
50% Load		87		%	See Figure 1 for efficiency curve

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

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

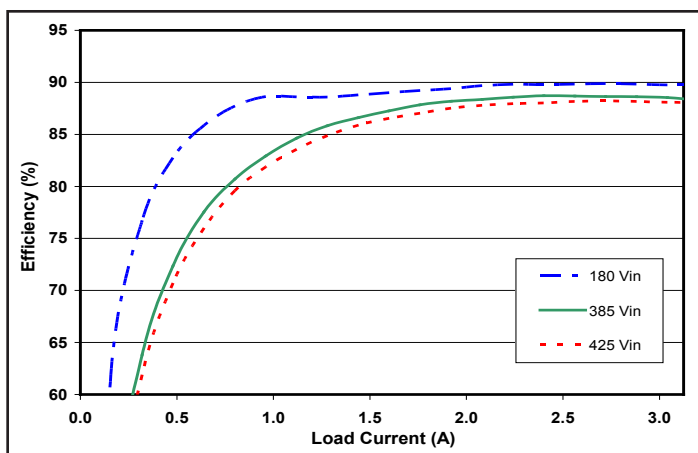


Figure 1: Efficiency at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at 25°C.

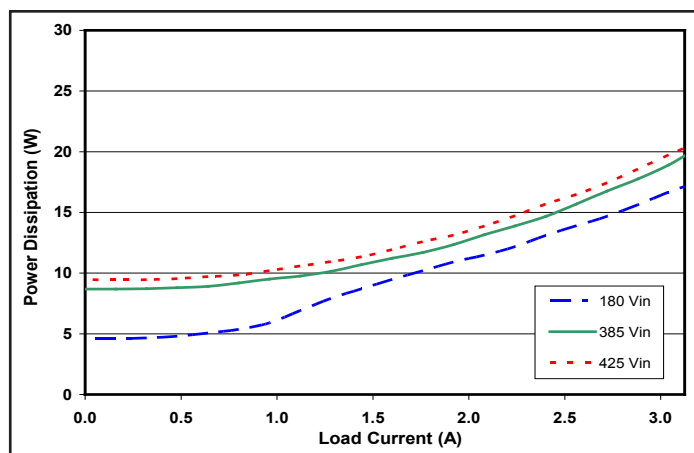


Figure 2: Power dissipation at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at 25°C.

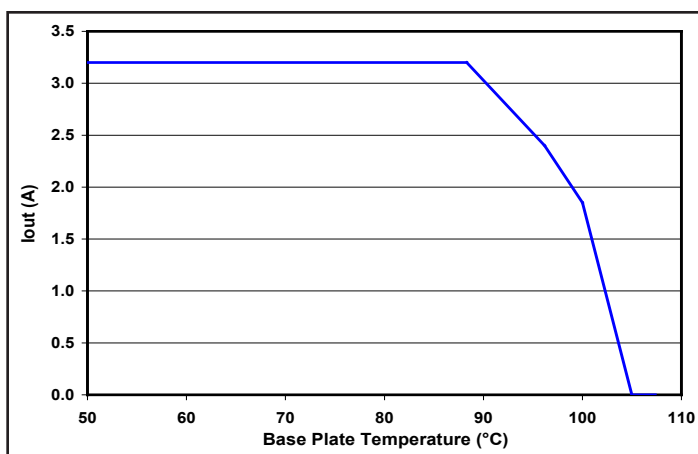


Figure 3: Encased converter max. output power derating vs. base plate temperature (nominal input voltage).

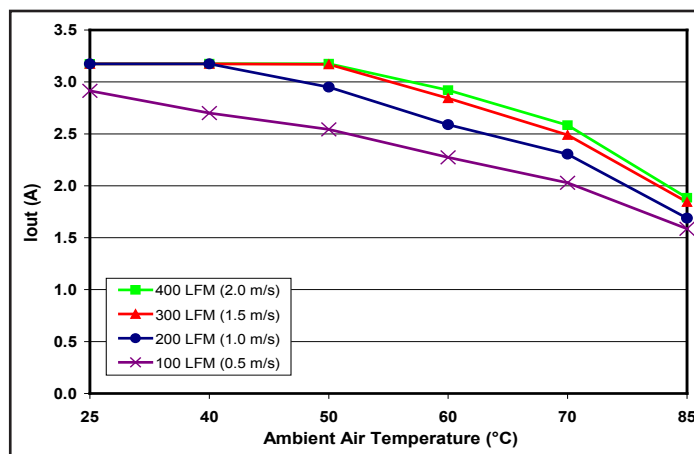


Figure 4: Encased converter (with 0.45" heatsink) max. output power derating vs. ambient air temperature for airflow rates of 100 LFM through 400 LFM. Air flows across the converter from input to output (nominal input voltage).

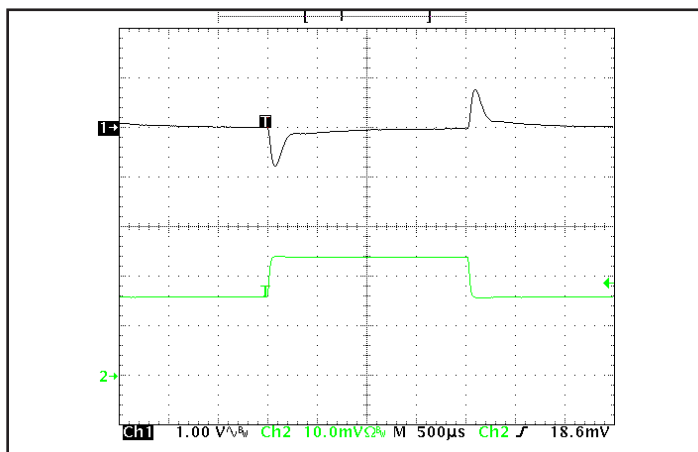


Figure 5: Output voltage response to step-change in load current (50%-75%-50% of Iout(max); dI/dt = 0.1A/μs). Load cap: 15μF, 100 mΩ ESR tantalum cap and 1μF ceramic cap. Ch 1: Vout (1V/div), Ch 2: Iout (1A/div).

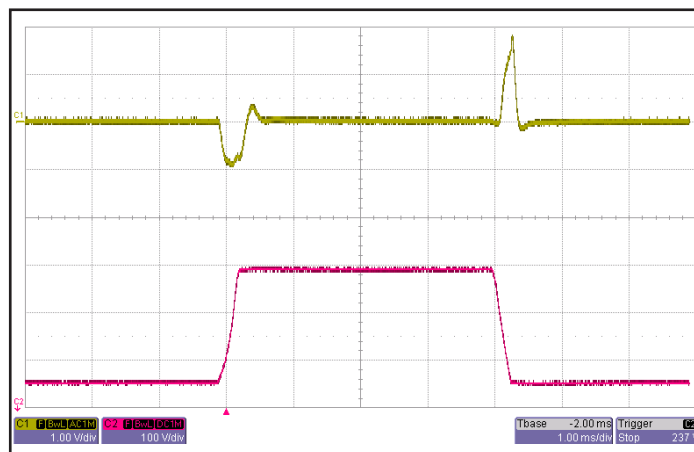


Figure 6: Output voltage response to step-change in input voltage (180 V - 425 V - 180 V) with 250 μs rise/fall time. Load cap: 15μF, 100 mΩ ESR tantalum cap and 1μF ceramic cap. Ch 1: Vout (1V/div). Ch 2: Vin (100V/div).

BASIC OPERATION AND FEATURES

This 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 converters 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 uses 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.

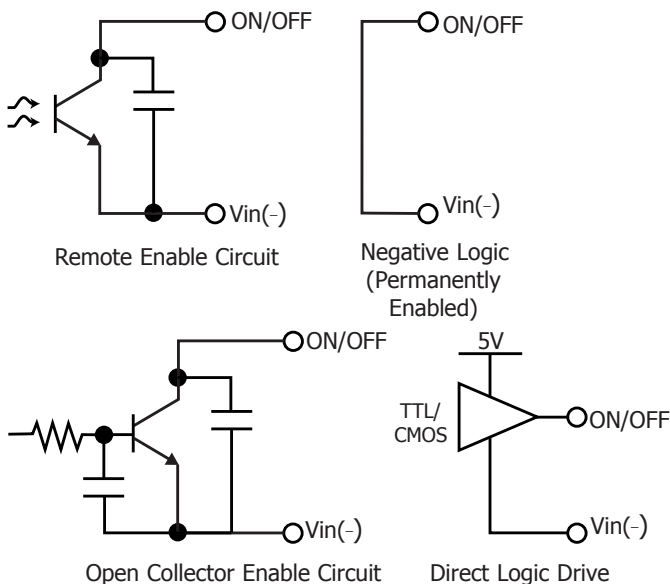


Figure A: Various circuits for driving the ON/OFF pin.

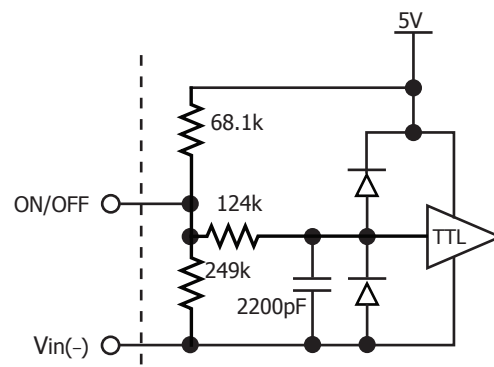


Figure B: Internal ON/OFF pin circuitry

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

$$R_{\text{trim-down}} = \left(\frac{90.9}{\Delta\%} - 0.909 \right) (\text{k}\Omega)$$

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:

$$R_{\text{trim-up}} = \left(\frac{100 + \Delta\%}{\Delta\%} \right) \left(\frac{V_{\text{nom}}}{1.225} - 0.909 \right) (\text{k}\Omega)$$

where:

V_{nom} = Nominal Output Voltage

Graphs show the relationship between the trim resistor value, $R_{\text{trim-up}}$ and $R_{\text{trim-down}}$. This shows 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.

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 Vout: For the converter to meet its full specifications, the maximum variation of the dc value of VOUT, 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" available 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 (listed on the specification 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 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 4 Hz (nominal) frequency with a 20% duty cycle until the short circuit condition is removed. This prevents excessive heating of the converter or the load board.

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.

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 C provides a typical circuit diagram which details the input filtering and voltage trimming.

Input Filtering and External Capacitance: Figure D provides a diagram showing 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 on the Electrical Characteristics page. More detailed information is available in the application note titled "EMI Characteristics" on the SynQor website.

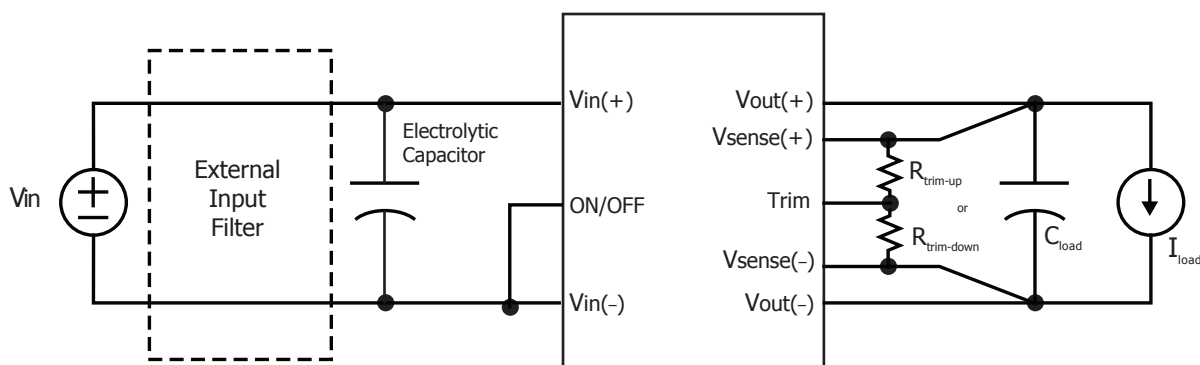


Figure C: Typical application circuit (negative logic unit, permanently enabled).

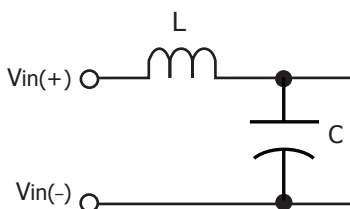


Figure D: Internal Input Filter Diagram (component values listed on the specifications page).

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 4 Hz "hiccup mode," which prevents the converter from overheating. In all, there are six ways that the converter can be shut down, initiating a Startup Inhibit Period:

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

The Startup Inhibit Period graph 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 85 °C. As long as the user's thermal system keeps $T_B \leq 85$ °C, the converter can deliver its full rated power.

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 if its base-plate is to be no higher than 85 °C.

$$P_{diss}^{max} = \frac{85\text{ °C} - T_A}{R_{TH_{BA}}}$$

This value of power dissipation can then be used in conjunction with the data shown in Figure 2 to determine the maximum load current (and power) that the converter can deliver in the given thermal condition.

For convenience, Figures 3 and 4 provide Power derating curves for an encased converter.

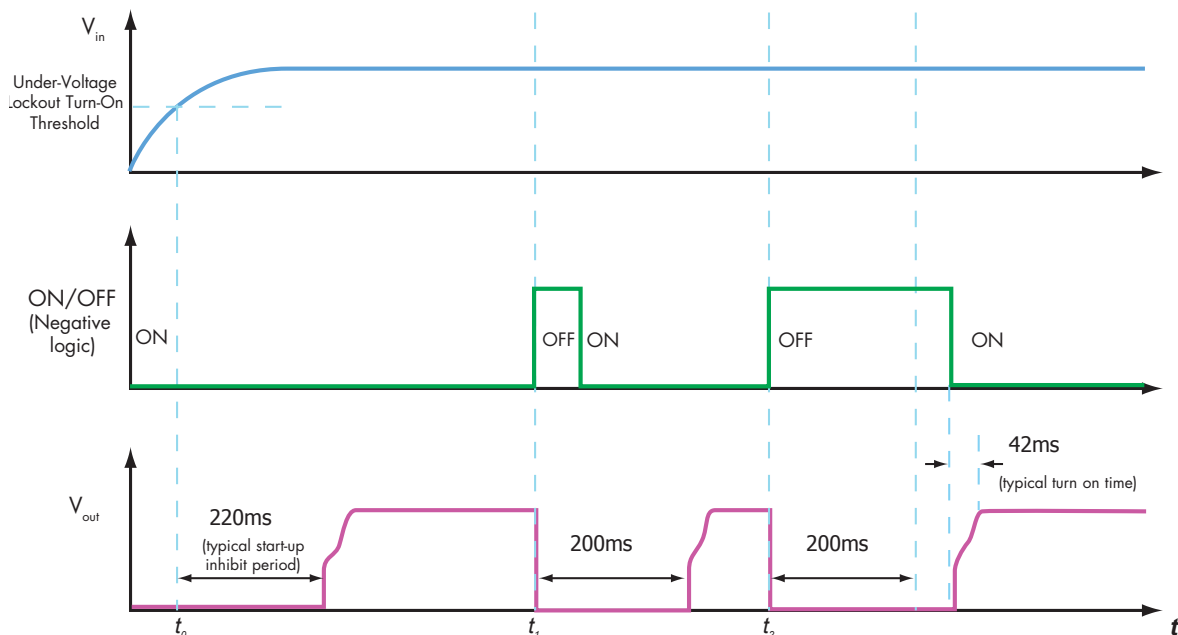


Figure E: Startup Inhibit Period (turn-on time not to scale)

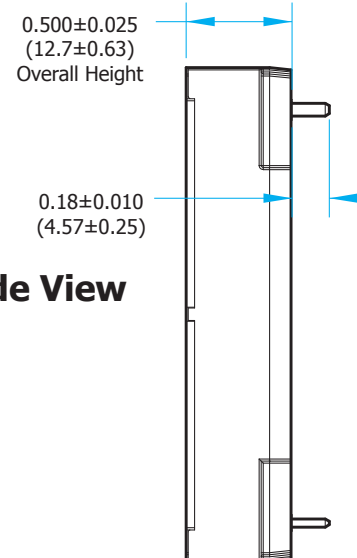
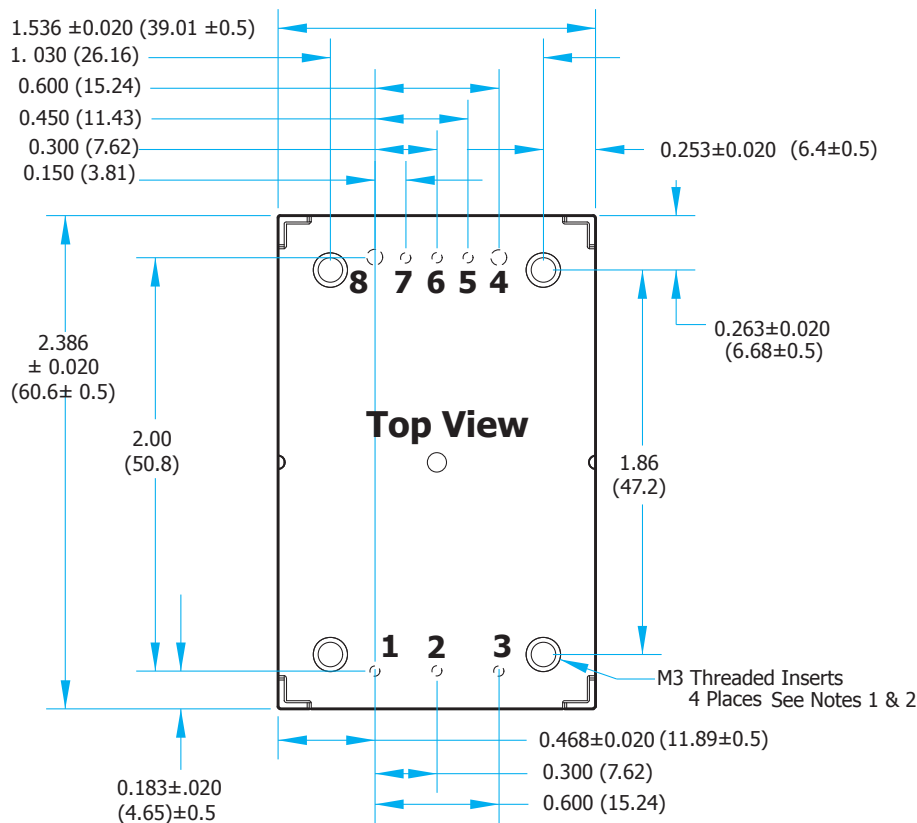
Standards & Qualification Testing

Parameter	Notes & Conditions
STANDARDS COMPLIANCE	
UL 60950-1 2nd Ed. 2007	Reinforced Insulation
CAN/CSA-C22.2 No. 60950-1-07	
EN60950-1 Ed. 2.0	
CE Marked	2006/95/EC Low Voltage Directive
IEC 61000-4-2	ESD test, 8 kV - NP, 15 kV air - NP (Normal Performance)

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.

Parameter	# Units	Test Conditions
QUALIFICATION TESTING		
Life Test	32	95% rated Vin and load, units at derating point, 1000 hours
Vibration	5	10-55 Hz sweep, 0.060" total excursion, 1 min./sweep, 120 sweeps for 3 axis
Mechanical Shock	5	100g minimum, 2 drops in x, y, and z axis
Temperature Cycling	10	-40 °C to 100 °C, unit temp. ramp 15 °C/min., 500 cycles
Power/Thermal Cycling	5	Toperating = min to max, Vin = min to max, full load, 100 cycles
Design Marginality	5	Tmin-10 °C to Tmax+10 °C, 5 °C steps, Vin = min to max, 0-105% load
Humidity	5	85 °C, 85% RH, 1000 hours, continuous Vin applied except 5 min/day
Solderability	15 pins	MIL-STD-883, method 2003
Altitude	2	70,000 feet (21 km), see Note

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



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 (RoHS 6/6) - Matte Tin over Nickel plate
- 7) Weight: 3.02 oz. (85.7 g) typical
- 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-A-610 Class II
- 10) Recommended pin length is 0.03" (0.76mm) greater than the PCB thickness.

PIN DESIGNATIONS

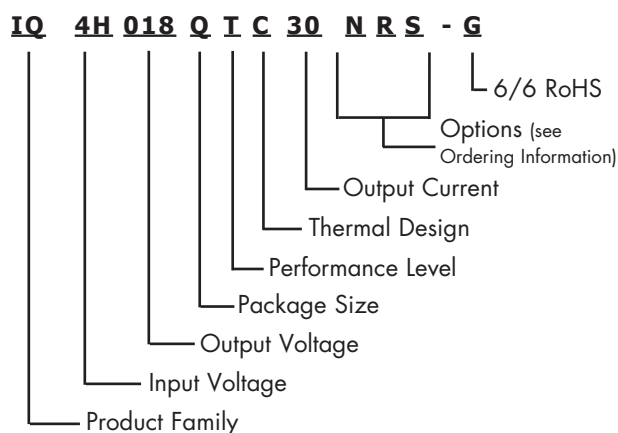
Pin	Name	Function
1	Vin(+)	Positive input voltage
2	ON/OFF	TTL input to turn converter on and off, referenced to Vin(-), with internal pull up.
3	Vin(-)	Negative input voltage
4	Vout(-)	Negative output voltage
5	SENSE(-)	Negative remote sense ¹
6	TRIM	Output voltage trim ²
7	SENSE(+)	Positive remote sense ³
8	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.

PART NUMBERING SYSTEM

The part numbering system for SynQor's dc-dc converters follows the format shown in the example below.



The first 12 characters comprise the base part number and the last 3 characters indicate available options. The "-G" suffix indicates 6/6 RoHS compliance.

Application Notes

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

RoHS Compliance: The EU led RoHS (Restriction of Hazardous Substances) Directive bans the use of Lead, Cadmium, Hexavalent Chromium, Mercury, Polybrominated Biphenyls (PBB), and Polybrominated Diphenyl Ether (PBDE) in Electrical and Electronic Equipment. This SynQor product is 6/6 RoHS compliant. For more information please refer to SynQor's RoHS addendum available at our [RoHS Compliance / Lead Free Initiative web page](#) or e-mail us at rohs@synqor.com.

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 Boxborough, MA 01719
 USA

ORDERING INFORMATION

The tables below show the valid model numbers and ordering options for converters in this product family. When ordering SynQor converters, please ensure that you use the complete 15 character part number consisting of the 12 character base part number and the additional characters for options. Add "-G" to the model number for 6/6 RoHS compliance.

Model Number	Continuous Input Voltage	Output Voltage	Maximum Output Current
IQ4H018QTW30xyz	180-425V	1.8	30
IQ4H025QTW30xyz	180-425V	2.5	30
IQ4H033QTW30xyz	180-425V	3.3	30
IQ4H050QTW30xyz	180-425V	5.0	30
IQ4H120QTW13xyz	180-425V	12	13.0
IQ4H150QTW10xyz	180-425V	15	10.0
IQ4H240QTW06xyz	180-425V	24	6.25
IQ4H280QTW05xyz	180-425V	28	5.35
IQ4H480QTW03xyz	180-425V	48	3.12

The following options must be included in place of the **wxyz** spaces in the model numbers listed above.

Options Description			
Thermal Design	Enable Logic	Pin Style	Feature Set
C - Encased V - Encased with Flanged Baseplate	N - Negative	R - 0.180"	S - Standard

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

PATENTS

SynQor holds the following U.S. patents, one or more of which apply to each product listed in this document. Additional patent applications may be pending or filed in the future.

5,999,417	6,222,742	6,545,890	6,577,109	6,594,159
6,731,520	6,894,468	6,896,526	6,927,987	7,050,309
7,072,190	7,085,146	7,119,524	7,269,034	7,272,021
7,272,023	7,558,083	7,564,702	7,765,687	7,787,261

Warranty

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

Information furnished by SynQor is believed to be accurate and reliable. However, no responsibility is assumed by SynQor for its use, nor for any infringements of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of SynQor.