

Current

Isolated

The NiQor[™] SIP DC/DC converter is a non-isolated buck regulator, which employs synchronous rectification to achieve extremely high conversion efficiency. The NiQor family of converters are used predominately in DPA systems using a front end DC/DC high power brick (48Vin to low voltage bus). The non-isolated NiQor converters are then used at the point of load to create the low voltage outputs required by the design. The wide trim module can be programmed to a variety of output voltages through the use of a single external resistor. RoHS Compliant (see page <u>13</u>).

Outputs

Operational Features

Input

- Ultra high efficiency, up to 95% at full and half rated load
- Delivers up to 10A of output current with no derating up to 85°C ambient with 100LFM - no heatsink required
- Input Voltage Range : 9.6V 14.4V
- Programmable output voltages from 0.9V 5.0V
- On-board input and output filter capacitor
- No minimum load requirement means no preload resistors required

Mechanical Features

- Industry standard SIP pin-out configuration
- Industry standard size: 2.0" x 0.55" x 0.29" (50.8 x 14 x 7.3mm)
- Total weight: 0.30 oz. (9.4 g)
- Open frame construction maximizes air flow cooling
- Available in both vertical and horizontal mounting

Control Features

- On/Off control
- Output voltage trim (industry standard) permits custom voltages and voltage margining



Single In-Line Package

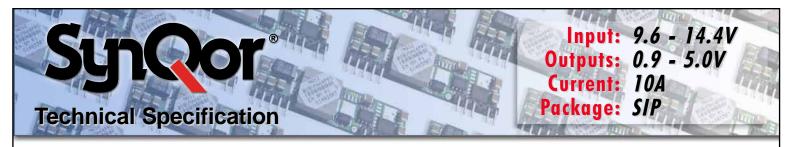
NQ12T50VKA10 wide trim module

Protection Features

- Input under-voltage lockout disables converter at low input voltage conditions
- Temperature compensated over-current shutdown protects converter from excessive load current or short circuits
- Output over-voltage protection protects load from damaging voltages
- Thermal shutdown protects converter from abnormal environmental conditions

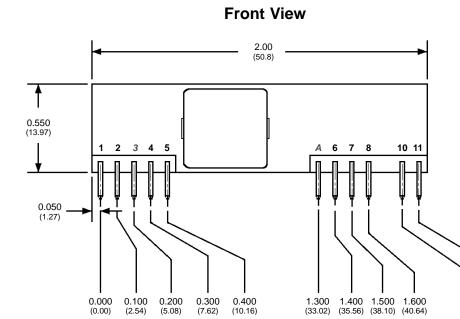
Safety Features

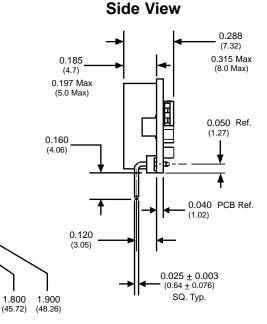
- UL/cUL 60950-1 recognized (US & Canada), basic insulation rating
- TUV certified to EN60950-1
- Meets 72/23/EEC and 93/68/EEC directives which facilitates CE Marking in user's end product
- Board and plastic components meet UL94V-0 flammability requirements



MECHANICAL DIAGRAM

Vertical Mount





NOTES

- 1) All pins are 0.025" (0.64mm) +/- 0.003 (0.076mm) square.
- 2) All Pins: Material Copper Alloy Finish - Matte Tin over Nickel plate
- 3) Vertical, horizontal, vertical with reverse pins and surface mount options (future) available.
- 4) Undimensioned components are shown for visual reference only.
- 6) All dimensions in inches (mm) Tolerances: x.xx +/-0.02 in. (x.x +/-0.5mm) x.xxx +/-0.010 in. (x.xx +/-0.25mm)
- 7) Weight: 0.30 oz. (9.4 g) typical
- 7) Weight: 0.30 oz. (9.4 g) typical
- 8) Workmanship: Meets or exceeds IPC-A-610C Class II

Pin Connection Notes:

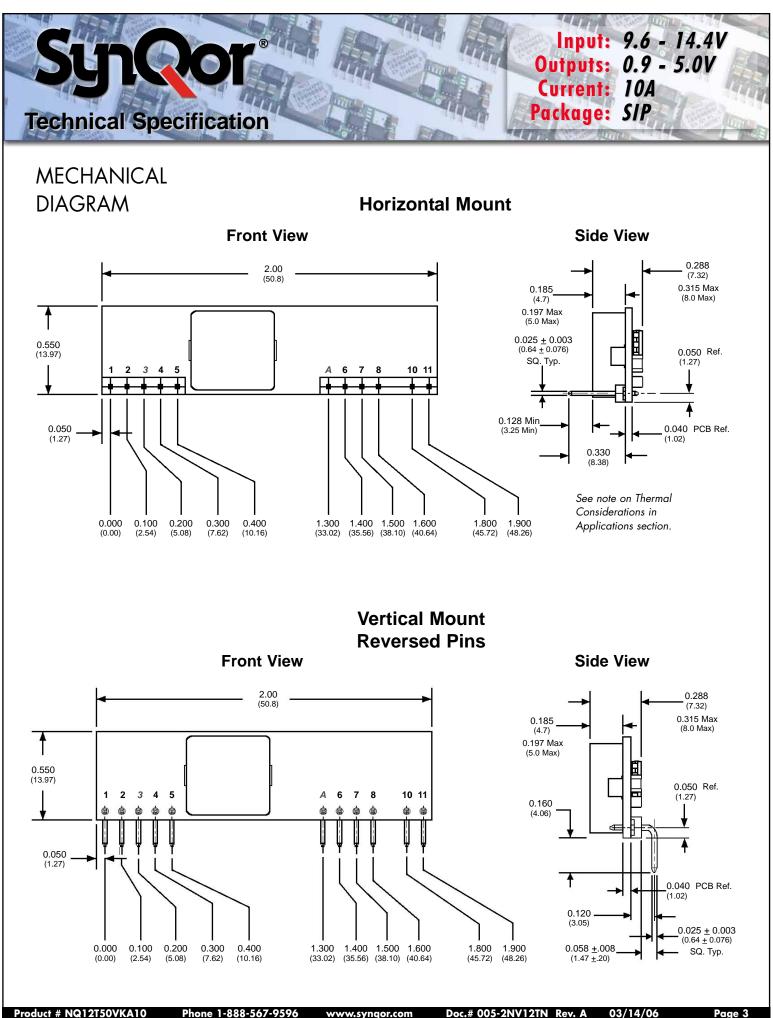
- Pin 10 for fixed resistors, connect between Trim and Vout(+) to trim down or between Trim and Common (Ground) to trim up.
- 2. Pin 11 see section on Remote ON/OFF pin for description of enable logic options.

PIN DESIGNATIONS

Pin No.	Name	Function
1	Vout(+)	Positive output voltage
2	Vout(+)	Positive output voltage
3	SENSE(+)	Positive remote sense
4	Vout(+)	Positive output voltage
5	Common	
А	l share	Current share*
6	Common	
7	Vin(+)	Positive input voltage
8	Vin(+)	Positive input voltage ¹
10	TRIM	Output voltage trim ²
11	ON/OFF	LOGIC input to turn the converter on and off.

Pins in Italics Shaded text are Optional

* Contact the factory for availability of current share modules.



 $\label{eq:theta} \underbrace{\mbox{ELECTRICAL CHARACTERISTICS - NQ12T50VKA10 Series}}_{T_A=25^\circ\text{C}, \mbox{ airflow rate=300 LFM, } V_{in}=12.0Vdc \ unless \ otherwise \ noted; \ full \ operating \ temperature \ range \ is \ -40^\circ\text{C} \ to \ +105^\circ\text{C} \ ambient \ temperature \ with \ appropriate \ power \ derating.} \ Specifications \ subject \ to \ change \ without \ notice.}$

Input: 9.6 - 14.4V Outputs: 0.9 - 5.0V Current: 10A

Package: SIP

Parameter	Vo trim set	Min.	Тур.	Max.	Units	Notes & Conditions
ABSOLUTE MAXIMUM RATINGS						
Input Voltage						
Non-Operating	All	0		16	V	Continuous
Operating	All			14.4	V	Continuous
Operating Temperature	All	-40		105	°C	
Storage Temperature	All	-55		125	°C	
Voltage at ON/OFF input pin	All	-3		15	V	
INPUT CHARACTERISTICS		<i></i>				
Operating Input Voltage Range	All	9.6	12	14.4	V	
Input Under-Voltage Lockout						
Turn-On Voltage Threshold	All	8.25	8.75	9.2	V	
Turn-Off Voltage Threshold	All	7.25	7.75	8.1	V	
Lockout Hysteresis	All		1.0		V	
Maximum Input Current	0.9V			1.40	A	100% Load, 9.6Vin, 0.9Vout, 10% trim up
	1.2V			1.87	A	100% Load, 9.6Vin, 1.2Vout, 10% trim up
	1.5V			2.18	A	100% Load, 9.6Vin, 1.5Vout, 10% trim up
	1.8V			2.50	A	100% Load, 9.6Vin, 1.8Vout, 10% trim up
	2.5V			3.43	A	100% Load, 9.6Vin, 2.5Vout, 10% trim up
	3.3V			4.37	A	100% Load, 9.6Vin, 3.3Vout, 10% trim up
	5.0V			6.56	A	100% Load, 9.6Vin, 5.0Vout, 10% trim up
No-Load Input Current	0.9V		0.026	0.031	A	
	1.2V		0.031	0.037	A	
	1.5V		0.037	0.045	A	
	1.8V		0.043	0.052	A	
	2.5V		0.062	0.075	A	
	3.3V		0.084	0.101	A	
	5.0V		0.116	0.140	A	
Disabled Input Current	All		7.5	10	mA	
Inrush Current Transient Rating	All			0.1	A ² s	With min. output capacitance
Response to Input Transient	0.9-2.5V		5		mV/V	80V/ms input transient (all)
	3.3V		7.5		mV/V	
	5.0V		12.5		mV/V	
Input Reflected-Ripple Current	0.9V		25	49	mA	Pk-pk thru 1µH inductor; Figures <u>15</u> & <u>16</u> (all
	1.2V		35	63	mA	
	1.5V		45	76	mA	
	1.8V		50	89	mA	
	2.5V		65	112	mA	
	3.3V		80	131	mA	
	5.0V		100	147	mA	
Recommended Input Fuse	All			10	A	Fast blow external fuse recommended
Input Filter Capacitor Value	All		30		μF	Internal ceramic
Input Ripple Voltage	0.9V		34		mV	RMS, full load; Figures <u>15</u> & <u>17</u> (all)
	1.2V		44		mV	
	1.5V		53		mV	
	1.8V		61		mV	
	2.5V		77		mV	
	3.3V		91		mV	
	5.0V		107		mV	

ELECTRICAL CHARACTERISTICS (continued) - NQ12T50VKA10 Series

Parameter	Vo trim set	Min.	Тур.	Max.	Units	Notes & Conditions
OUTPUT CHARACTERISTICS Output Voltage Set Point	0.9V	0.888	0.900	0.912	V	12Vin; 50% load (all)
Oupur voliage ser Folili	1.2V	1.184	1.200	1.216	V	
	1.2V 1.5V	1.481	1.200	1.520	V	
	1.3V	1.401	1.800	1.823	V	
	2.5V	2.468	2.500	2.533	V	
	3.3V	3.257	3.300	3.343	V	
	5.0V	4.935	5.000	5.065	V	
Output Voltage Regulation	5.01	4.700	5.000	5.005	, v	
Over Line	All		3	6	mV	
Over Load	All		7	12	mV	With sense pin
Over Temperature	All		±0.50	±1.50	%	
Total Output Voltage Range	0.9V	0.882	_0.00	0.918	V	With sense pin, over sample, line, load,
	1.2V	1.176		1.224	V	Temperature & life (all)
	1.5V	1.470		1.530	V	
	1.8V	1.764		1.836	V	
	2.5V	2.450		2.550	V	
	3.3V	3.234		3.366	V	
	5.0V	4.900		5.100	V	
Output Voltage Ripple and Noise (pk-pk\RMS)	0.9-2.5V		40\10	60\20	mV	Full load; 20MHz bandwidth; Figures <u>15</u> & <u>18</u>
3 1	3.3V		40\10	70\20	mV	, , , , , , , , , , , , , , , , , , ,
	5.0V		40\10	70\20	mV	
Operating Output Current Range	All	0		10	A	
Output DC Current Limit Threshold	All	11	16	21	А	Figure 4
Output Capacitance Range	All	0		5,000	μF	>2.5 m Ω ESR
DYNAMIC CHARACTERISTICS				.,		
nput Voltage Ripple Rejection	0.9V		75		dB	120 Hz
	5.0V		65		dB	
Output Voltage during Load Current Transient						
For a Step Change in Output Current (0.1A/µs)	All		40	75	mV	50%-75%-50% lout max, 10µF; Figure <u>13</u>
For a Step Change in Output Current (3A/µs)	All		100		mV	50%-75%-50% lout max, 470µF; Figure <u>14</u>
Settling Time	All		50		μs	To within 1.5% Vout nom.; Figures 13 & 1
Turn-On Transient						Figures <u>11</u> & <u>12</u>
Turn-On Time	0.9-1.5V	0.75	1.5	2.5	ms	Full resistive load, Vout=100% nom. (all)
	1.8-5.0V	1	2	3	ms	
Output Voltage Overshoot	All		0	1	%	Resistive load
EFFICIENCY						
100% Load	0.9V		86		%	Figures <u>1 - 3</u>
	1.2V		88		%	
	1.5V		90		%	
	1.8V		92		%	
	2.5V		93		%	
	3.3V		94		%	
	5.0V		95		%	
50% Load	0.9V		87		%	Figures <u>1 - 3</u>
	1.2V		89		%	
	1.5V		91		%	
	1.8V		92		%	
	2.5V		93		%	
	3.3V		93		%	
	5.0V		95		%	
TEMP. LIMITS FOR POWER DERATING						
с. I. I. I. Т	All			125	°C	Package rated to 150°C; Figures <u>5 - 10</u>
Semiconductor Junction Temperature	All			125	°C	UL rated max operating temp 130°C

Input: 9.6 - 14.4V Outputs: 0.9 - 5.0V

Current: 10A Package: SIP

ELECTRICAL CHARACTERISTICS (continued) - NQ12T50VKA10 Series

Parameter	Vo trim set	Min.	Тур.	Max.	Units	Notes & Conditions
FEATURE CHARACTERISTICS						
Switching Frequency	All	300	325	350	kHz	May drop by 10% at light load
ON/OFF Control						See Applications Information
Off-State Voltage	All			2.3	V	
On-State Voltage	All	2.65			V	
Pull-Up Voltage	All		Vin/2		V	
Pull-Up Resistance All	All		10		kΩ	
Output Voltage Trim Range	All	0.85		5.5	V	Measured Vout+ to common pins
Output Voltage Remote Sense Range	All			+10	%	Measured Vout+ to common pins
Output Over-Voltage Protection	All	118	127	140	%	Over full temp range; % of nominal Vout
Over-Temperature Shutdown	All		133		°C	Average PCB Temperature
Over-Temperature Shutdown Restart Hysteresis	All		12		°C	
RELIABILITY CHARACTERISTICS						
Calculated MTBF (Telcordia)	All		8.34		10° Hrs.	TR+NWT-000332; 100% load, 200LFM, 40°C T _a
Calculated MTBF (MIL-217)	All		6.66		10 ⁶ Hrs.	MILHDBK-217F; 100% load, 200LFM, 40°C Ta
Field Demonstrated MTBF	All				10 ⁶ Hrs.	See our <u>website</u> for latest values

STANDARDS COMPLIANCE

Parameter	Notes
STANDARDS COMPLIANCE	
UL/cUL 60950-1	File # E194341
EN60950-1	Certified by TUV
72/23/EEC	,
93/68/EEC	
Needle Flame Test (IEC 695-2-2)	Test on entire assembly; board & plastic components UL94V-0 compliant ESD test, 8kV - NP, 15kV air - NP (Normal Performance) Section 7 - electrical safety, Section 9 - bonding/grounding
IEC 61000-4-2	ESD test, 8kV - NP, 15kV air - NP' (Normal Performance)
GR-1089-CORE	Section 7 - electrical safety, Section 9 - bonding/grounding
Telcordia (Bellcore) GR-513	

• 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 <u>SynQor website</u>.

QUALIFICATION TESTING

Parameter	# Units	Test Conditions
QUALIFICATION TESTING		
Life Test	32	95% rated Vin and load, units at derating point, 1000 hours
Vibration	5	10-55Hz sweep, 0.060" total excursion, 1 min./sweep, 120 sweeps for 3 axis
Mechanical Shock	5	100g minimum, 2 drops in x and y axis, 1 drop in z axis
Temperature Cycling	10	-40°Č to 100°Ć, unit temp. ramp 15°C/min., 500 cycles
Power/Thermal Cycling Design Marginality	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	1 85°C, 85% RH, 1000 hours, continuous Vin applied except 5min./day
Solderability	15 pins	MIL-STD-883, method 2003

• Extensive characterization testing of all SynQor products and manufacturing processes is performed to ensure that we supply robust, reliable product. Contact the factory for official product family gualification documents.

OPTIONS

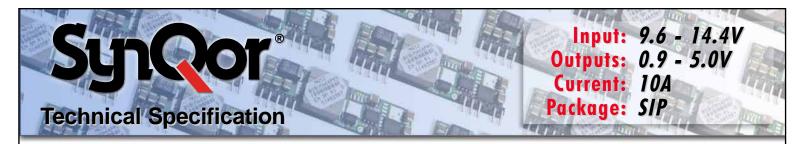
SynQor provides various options for Packaging, Enable Logic, Pin Style and Feature Set for this family of DC/DC converters. Please consult the <u>last page</u> for information on available options.

PATENTS

SynQor is protected under various patents, including but not limited to U.S. Patent numbers: 5,999,417; 6,222,742 B1; 6,594,159 B2; 6,545,890 B2.

Input: 9.6 - 14.4V Outputs: 0.9 - 5.0V

Current: 10A Package: SIP



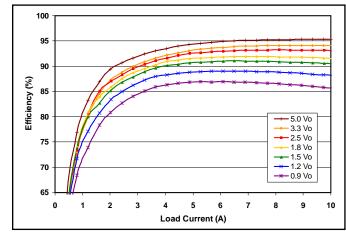


Figure 1: Efficiency at nominal output voltage vs. load current for all modules at 25°C and nominal input voltage.

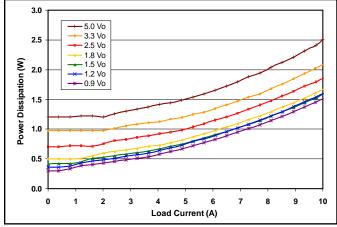


Figure 3: Power dissipation at nominal output voltage vs. load current for all modules at 25°C and nominal input voltage.

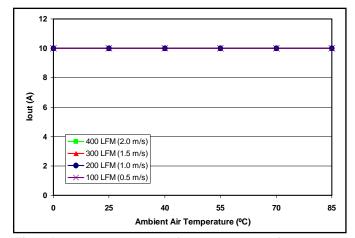


Figure 5: Maximum output power derating curves vs. ambient air temp for 0.9Vo, 1.2Vo, 1.5Vo units. Airflow rates of 100 - 400 LFM with air flowing across the converter from pin 11 to pin 1 (Vin nom, vert mount).

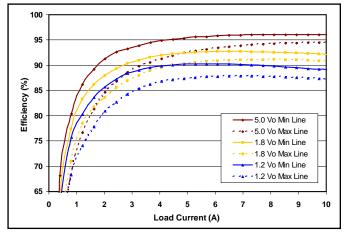


Figure 2: Efficiency at min and max line vs. load current for 1.2Vo, 1.8Vo and 5.0Vo units at 25°C.

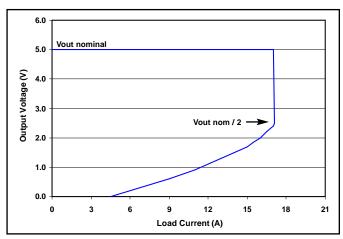


Figure 4: Output voltage vs. load current showing current limit inception point and fold-back current limit behavior.

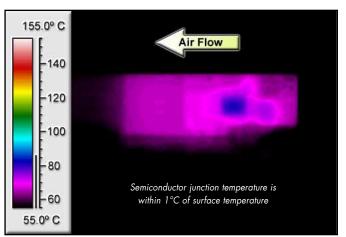
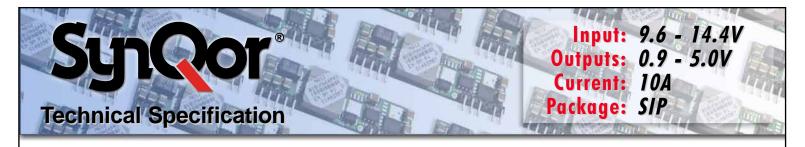


Figure 6: Thermal plot of 0.9Vo, 1.2Vo, 1.5Vo converters at 10 amp load current with 55°C air flowing at the rate of 200 LFM. Air is flowing across converter from pin 11 to pin 1 (Vin nom, vert mount).



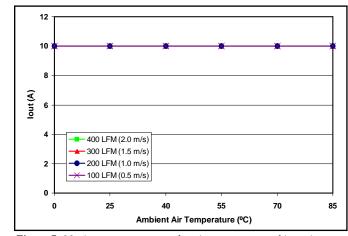


Figure 7: Maximum output power derating curves vs. ambient air temp for 1.8Vo, 2.5Vo units. Airflow rates of 100 - 400 LFM with air flowing across the converter from pin 11 to pin 1 (Vin nom, vert mount).

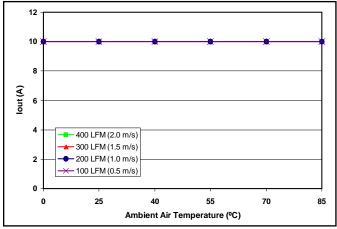
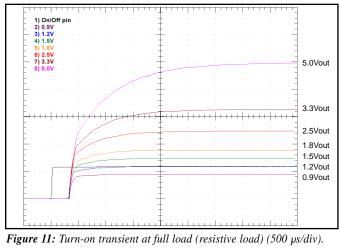


Figure 9: Maximum output power derating curves vs. ambient air temp for 3.3Vo, 5.0Vo units. Airflow rates of 100 - 400 LFM with air flowing across the converter from pin 11 to pin 1 (Vin nom, vert mount).



Ch 1: ON/OFF input (5V/div) Ch 2-8: Vout (1V/div)

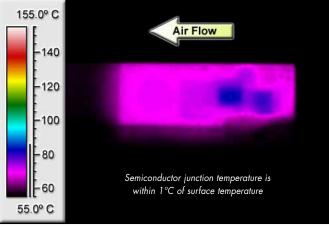


Figure 8: Thermal plot of *1.8Vo*, *2.5Vo* converters at 10 amp load current with 55°C air flowing at the rate of 200 LFM. Air is flowing across converter from pin 11 to pin 1 (Vin nom, vert mount).

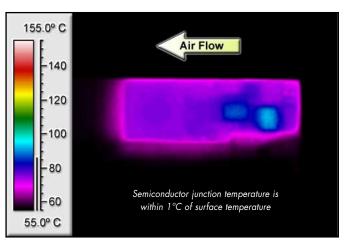


Figure 10: Thermal plot of 3.3Vo, 5.0Vo converters at 10 amp load current with $55^{\circ}C$ air flowing at the rate of 200 LFM. Air is flowing across converter from pin 11 to pin 1 (Vin nom, vert mount).

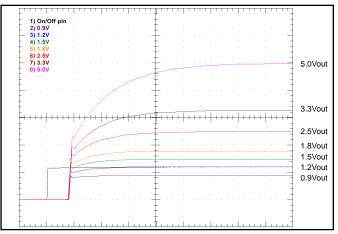


Figure 12: Turn-on transient at zero load (500 µs/div). Ch 1: ON/OFF input (5V/div) Ch 2-8: Vout (1V/div)

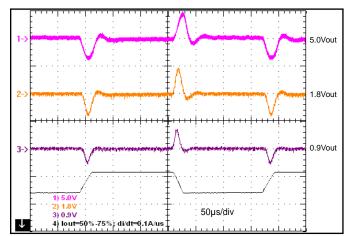
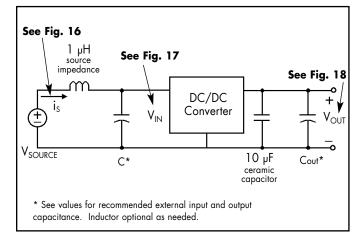
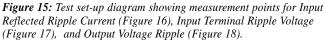


Figure 13: Output voltage response for 0.9V, 1.8V, 5.0V units to step-change in load current (50-75-50% of Iout max; di/dt=0.1A/ μ s). Load cap: 15 μ F, 100m Ω ESR tant, 10 μ F cer. Ch 1: Iout (5A/div), Ch 2-4: Vout (100mV/div).





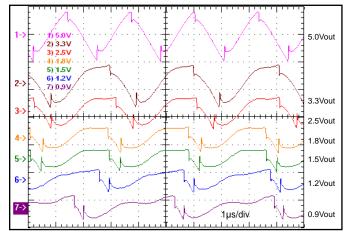
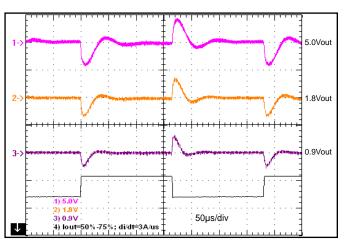


Figure 17: Input Terminal Ripple Voltage at nominal input voltage and rated load current (200 mV/div). Load capacitance: $10\mu F$ ceramic cap. Bandwidth: 20 MHz. See Figure 15.



Input: 9.6 - 14.4V Outputs: 0.9 - 5.0V

Current: 10A Package: SIP

Figure 14: Output voltage response for 0.9V, 1.8V, 5.0V units to step-change in load current (50-75-50% of Iout max; di/dt=3A/ μ s). Load cap: 470 μ F, 25m Ω ESR tant, 10 μ F cer. Ch 1: Iout (5A/div), Ch 2-4: Vout (100mV/div).

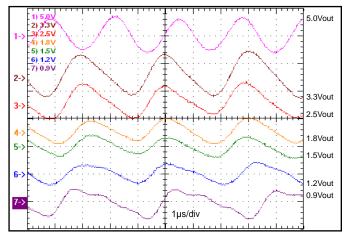


Figure 16: Input Reflected Ripple Current, i_{S} through a 1 μ H source inductor at nominal input voltage and rated load current (50 mA/div). See Figure 15.

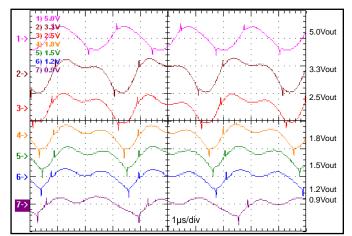
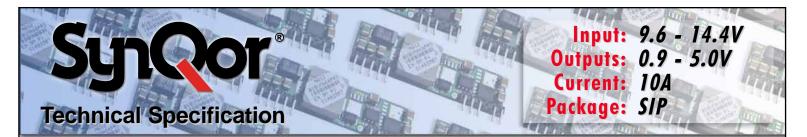


Figure 18: Output Voltage Ripple at nominal input voltage and rated load current (20 mV/div). Load capacitance: 10µF ceramic cap. Bandwidth: 20 MHz. See Figure 15.



BASIC OPERATION AND FEATURES

The NiQor series non-isolated converter uses a buck-converter that keeps the output voltage constant over variations in line, load, and temperature. The NiQor modules employ synchronous rectification for very high efficiency.

Dissipation throughout the converter is so low that it does not require a heatsink or metal baseplate for operation. The *Ni*Qor converter can thus be built more simply and reliably using high yield surface mount techniques on a single PCB substrate.

The *Ni*Qor series of SIPs and SMT converters uses the established industry standard footprint and pin-out configurations.

CONTROL FEATURES

REMOTE ON/OFF: The ON/OFF input permits the user to control when the converter is on or off. There is currently a single option available for the ON/OFF input described in the table below. Others may become available if demand exists.

Option	Description	Pin-Open Float Voltage	Pin-Open Converter State	Pin Action
P Logic	Positive/Open	Vin / 2	On	Pull Low = Off
O Logic	Negative/Open	0	On	Pull High = Off

OUTPUT VOLTAGE TRIM: The TRIM input permits the user to adjust the output voltage according to the trim range specifications by using an external resistor. If the TRIM feature is not being used, leave the TRIM pin disconnected.

TRIM-UP: To increase the output voltage from the nominal setpoint of 0.7525V using an external resistor, connect the resistor $R_{trim-up}$ between the TRIM and the Ground pin according to Figure A below.

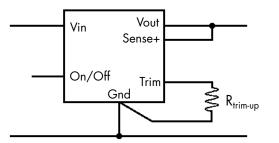


Figure A: Trim Up connection

For a desired increase of the nominal output voltage, the value of the resistor should be:

$$R_{\text{trim-up}} = \frac{10500}{V_{\text{DES}} - 0.7525} - 1000 \quad (\Omega)$$

or
$$V_{\text{OUT}} = 0.7525 + \frac{10500}{R_{\text{trim-up}} + 1000} \quad (\Omega)$$

where V_{DES} = Desired Output Voltage

To maintain the accuracy of the output voltage over load current, it is vital that any trim-up resistor be terminated directly to the converter's ground foot, not at the connection to the load. A separate Kelvin connection to the PCB pad for the ground foot is optimal. Trim-down resistors should be terminated at the converter's Sense+ pin.

We do <u>not</u> recommend bypassing the trim pin directly to ground with a capacitor. The voltage gain from the trim pin to output is rather large, 15:1. Ground bounce through a bypass capacitor could introduce significant noise into the converter's control circuit.

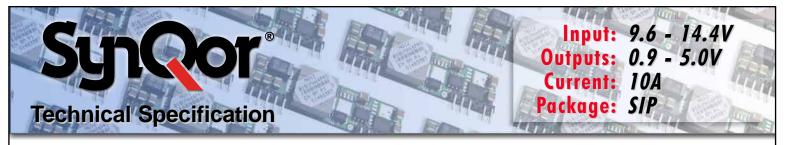
PROTECTION FEATURES

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". 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 Limiting: The NQ12 family of converters employs foldback current limiting. A typical output voltage-current curve is shown in Figure 23 in the Performance Curves section. Current limit is reached at about 135% of rated current. Loads in excess of that limit will cause the output to droop. If the load is sufficient to pull the output down to roughly 1/2 of its nominal setpoint, foldback will ensue. From there, as the load is further increased, the output current will decrease linearly to about 1/3 of rated current at zero Vout. Thus, operating into a dead short, the unit will deliver 1/3 rated current indefinitely. This reduces stress on the converter and ensures that prolonged short-circuits will not overheat the converter.

Since there is no "hiccup mode" to the current-limit operation, there is also no concern with operation or startup into large

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capacitive loads. The voltage may rise slowly while charging the output capacitance, but it will rise.

There are also no problems starting into a load that has a resistive V-I curve. As long as the load draws less than the current limit value at 1/2 of the unit's setpoint voltage, proper startup is ensured.

Internal Over-Voltage Protection: To fully protect from excessive output voltage, the NQ12 series contains two levels of Output Over-Voltage Shutdown circuitry.

The first type monitors the output at the load via the Sense+ pin (or the output if Sense+ is left open). If the sensed voltage exceeds the (optionally trimmed) setpoint by ~10%, this protective circuit asserts the converter's low-side switch until the output returns to normal. This circuit tracks the trimmed setpoint; the +10% threshold is maintained over the wide trim range of the T50 model. This circuit can also be benignly activated during the response to a large, fast drop in load current. In this instance the converter's normal transient response is momentarily overridden by this OVP. The result is a slight asymmetry in the converter's observed transient response.

It should be noted that there is no limit on this OVP; if a powerful external source attempts to raise the output of an NQ12 converter beyond 110% of its setpoint, the converter will sacrifice itself trying to draw down that external source and protect its load from the overvoltage.

The second Output Over-Voltage Shutdown circuit independently compares the voltage at the converter's output pin with that of a redundant reference. If the output ever exceeds ~125% of nominal setpoint, both converter switches are disabled. After the output voltage returns to normal, a softstart cycle is initiated.

This OVP is independent of the trimmed setpoint. As such, the converter's load is protected from faults in the external trim circuitry (such as a trim pin shorted to ground). Since the setpoint of this OVP does not track trim, it is set at 125% of 5.0V, or 6.2V, in the wide-trim T50 model.

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 Filtering/Capacitance/Damping: The filter circuit of Figure C is often added to the converter's input to prevent switching noise from reaching the input voltage bus.

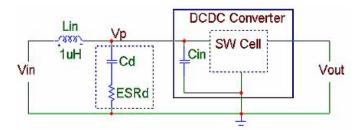


Figure C: NQ12 converter with Input Filter

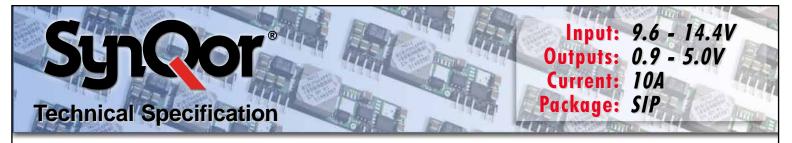
In the VKA10 (SIP) converters Cin = 45μ F of high quality ceramic capacitors. With Lin of 1μ H, Cd should be $100-200\mu$ F and Rd should be $0.1-0.2\Omega$, in most applications. For more information on designing the input filter and choosing proper values, contact SynQor technical support.

Adding significant external pure ceramic capacitance directly across the converter's input pins is not recommended. Parasitic inductance associated with the input pin geometry and PCB traces can create a high-Q CLC circuit with any external capacitors. Just a few nano-Henries of parasitic inductance can create a resonance (or an overtone) near the converter's switching frequency. Cin has a reactance of $10-20m\Omega$ at the 330kHz switching frequency. To avoid this high-frequency resonance, any external input filter should exhibit a net source impedance of at least $20m\Omega$ resistive through this frequency range. This requirement is easily met with the damping elements discussed above. Adding a small amount (a few μ F) of high-frequency external ceramic will not violate it.

If using converters at higher powers, do consider the ripple current rating of Cd. Contact SynQor technical support for more information.

Output Capacitance: The VKA10 series does not require any external output capacitance. In many applications, however, additional external output capacitance is required to reduce the response to load transients to an allowable level.

The output impedance of these converters can be quite accurately modeled from DC to about 100kHz as shown in Figure D. A further simplified version of it, valid below 40Hz and above 1kHz, is shown in Figure E. In diagram, Ct represents the minimum recommended output capacitance, and its resistance Rt. However, in the VKA10 family, that capacitor is again included in the converter.



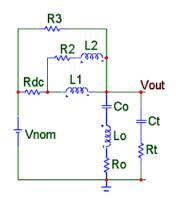


Figure D: NQ12 Passive Output Model

If the dynamic characteristics of the load are known, any standard simulator can use these models to predict the in-circuit transient response.

If the transients are current steps then Table 2 provides values for

ESRd and Cd for different allowable responses. The allowable step response is normalized to a 1A step, and the maximum allowable value of ESRd can be read from the table.

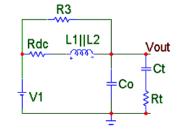


Figure E: Simplified NQ12 Output Model

Vnom	0.9	1.0	1.2	1.5	1.8	2.5	3.3	5.0
Rdc	360μΩ		490μΩ	$450\mu\Omega$	365μΩ	$300 \mu \Omega$	330μΩ	$510 \mu \Omega$
L1	650nH		920nH	1.08µH	590nH	775nH	675nH	650nH
R2	4mΩ		4mΩ	4mΩ	2.0mΩ	3mΩ	2mΩ	$1.5 m\Omega$
L2	1.56µH		1.4μH	1.4μH	850nH	1.03µH	706nH	840nH
R3	29mΩ		31mΩ	$32m\Omega$	$35m\Omega$	30mΩ	29mΩ	35mΩ
Co	60µF		50µF	60µF	50µF	30µF	30µF	20µF
Lo	30nH		30nH	30nH	50nH	75nH	75nH	145nH
Ro	15mΩ		20mΩ	$15 \text{m}\Omega$	$20 \text{m}\Omega$	$23 \text{m}\Omega$	23mΩ	33mΩ

Table 1: Component Values for Passive Output Models

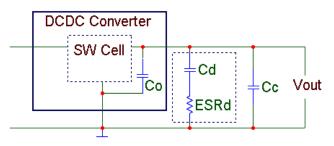


Figure F: Converter with Additional Output Capacitance

For minimal overshoot upon recovery, Cd should be related to the minimum in-circuit net ESR.

$$Cd > \frac{parallel (L1, L2)}{ESRd_{min^2}}$$

The third column in Table 2 gives Cdmin for a 40% reduction in ESR and the highest L1 ||L2 value in Table 1. Cc represents external ceramic capacitance that may be added. It has no appreciable ESR and provides no damping to the output. For more detailed derivations of these values, contact SynQor technical support.

Load Current Step Response	External	Capacitor
Pk mV/Amp	ESRd max	Cd min (uF)
23	0.1*	100*
19	0.05	400
14	0.025	1,600
9	0.0125	6,400
5	0.00625	25,600
* Included in \/MA	min rocomm	anded for CMA

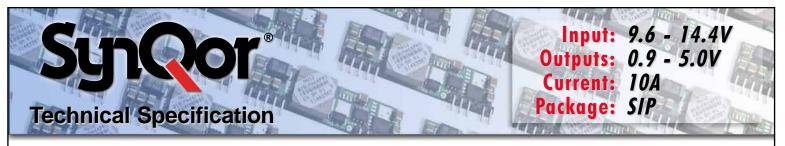
* Included in VMA, min recommended for SMA

Table 2: External Capacitor Values for Different Step Responses

Thermal Considerations: For vertical mount applications at elevated temperatures that call for forced air cooling (see thermal derating curves), the preferred airflow direction is from pin 11 to pin 1, as indicated in the thermal images provided. If airflow is in the opposite direction (pin 1 to pin 11) the power devices will run hotter by about 5 °C (corresponding to an additional 1 ampere of load derating at conditions where derating occurs).

For horizontal mount applications (NQ12xxxHMA parts), where the inductor and power devices are facing down, the preferred airflow direction is into the leading edge opposite the pin header edge, such that air flowing under the *Ni*Qor PCB flows out between the pins and the inductor. With this airflow direction, and with the inductor firmly contacting the application board, the user can apply the thermal derating curves provided herein for vertical mount with airflow from pin 11 to pin 1. Air flows in other directions across the horizontally mounted *Ni*Qor will result in temperatures that are higher by about 5 °C with pin 11 to pin 1 airflow and about 10 °C with pin 1 to pin 11 airflow. Also, temperature increases of up to 10 °C (2 Amp lower derating) can be expected if the inductor thermal interface does not make good contact to the customer's circuit board.

Layout Suggestion: When using a fixed output *Ni*Qor converter, the designer may chose to use the trim function and would thus be required to reserve board space for a trim resistor. It is suggested that even if the designer does not plan to use the trim function, additional space should be reserved on the board for a trim resistor. This will allow the flexibility to use the wide output



voltage trim range *Ni*Qor module at a later date. This module is especially useful if output voltages need trimming or are subject to change over the life of the design.

OPTIONAL FEATURES

REMOTE SENSE(+) (Pin 3 - Optional): The optional SENSE(+) input corrects for voltage drops along the conductors that connect the converter's output pins to the load.

Pin 3 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

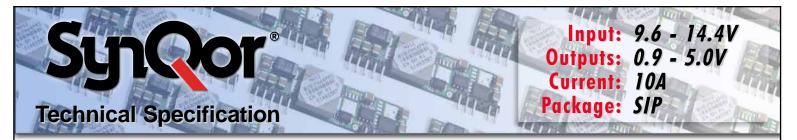
 $Vout(+) - Vsense(+) \leq Sense Range % x Vout$

Pin 3 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.

<u>Note</u>: the output over-voltage protection circuit senses the voltage across the output (pins 1, 2 and 4) to determine when it should trigger, not the voltage across the converter's sense lead (pin 3).

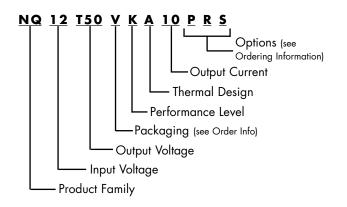
CURRENT SHARE (Pin A - Optional): Additional information on the current share feature will be provided in a future revision of this technical specification. Please contact SynQor engineering support for further details. **RoHS Compliance:** The EU led RoHS (Restriction of Hazardous Substances) Directive 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 available as 5/6 RoHS compliant (product with lead) or 6/6 RoHS compliant. For more information please refer to SynQor's RoHS addendum available at our <u>RoHS Compliance / Lead Free Initiative</u> web page or e-mail us at <u>rohs@synqor.com</u>.

03/14/06



PART NUMBERING SYSTEM

The part numbering system for SynQor's *Ni*Qor 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. Although there are no default values for packaging, enable logic, pin length and feature set, the most common options are vertical mount SIP (V), Positive/Open logic (P), 0.160" pins (R) and Sense feature set (S). These part numbers are more likely to be readily available in stock for evaluation and prototype quantities. A "-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 <u>website</u>.

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 3 characters for options. To order 6/6 RoHS compliant product please add a "-G" suffix.

Model Number	Input Voltage	Output Voltage	Max Output Current
NQ12009pKA10xyz	9.6 - 14.4 V	0.9 V	10 A
NQ12012pKA10xyz	9.6 - 14.4 V	1.2 V	10 A
NQ12015pKA10xyz	9.6 - 14.4 V	1.5 V	10 A
NQ12018pKA10xyz	9.6 - 14.4 V	1.8 V	10 A
NQ12020pKA10xyz	9.6 - 14.4 V	2.0 V	10 A
NQ12025pKA10xyz	9.6 - 14.4 V	2.5 V	10 A
NQ12033pKA10xyz	9.6 - 14.4 V	3.3 V	10 A
NQ12050pKA10xyz	9.6 - 14.4 V	5.0 V	10 A
NQ12T50pKA10xyz*	9.6 - 14.4 V	0.9-5.0 V	10 A

* Represents the wide trim unit. Detailed specifications for fixed output voltage modules are located in a separate datasheet located on the SynQor website.

The following option choices must be included in place of the *p x y z* spaces in the model numbers listed above.

Packaging: p	Options Description: x y z				
Packaging	Enable Logic	Pin Style	Feature Set		
V - Vert. Mount SIP H - Horz. Mount SIP	P - Positive/Open	R - 0.160" (Standard) V - 0.160" (Vert Reversed)	S - Sense (Std.) N - None		

Contact SynQor for further information:

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	USA

Warranty

SynQor offers a three (3) year limited warranty. Complete warranty information is listed on our <u>website</u> or is available upon request from SynQor.

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