Technical Specification
NQ10W50PKA07

12Vin Input	0.7-5.0V Outputs	7 Amp Current	Non Isolated	SMT Surface Mount Package

The NiQor® module is a surface mount, DC/DC non-isolated buck regulator, with a single programmable output voltage. The converter employs a synchronous rectification and a discontinuous mode at light loads to achieve extremely fast transient response and 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. Typical applications include telecom/datacom, industrial, medical, transportation, data processing/storage and test equipment. RoHS Compliant (see page 12).

NiQor® Non-Isolated

NiQor NQ10W50PKA07

Operational Features

- Ultra high efficiency, up to 93% at full load current
- Delivers up to 7 Amps of output current with no derating up to 85C, 100LFM
- Input Voltage Range : 10.2 - 13.2V
- Fast transient response time
- Input voltage compensation gives excellent rejection of input voltage ripple and input voltage transients
- On-board input (capacitive) filtering
- No minimum load requirement means no preload resistors required
- High accuracy output voltage regulation
- Discontinuous mode option offers extremely low dissipation at light loads

Mechanical Features

- Surface mount package
- Package size: 0.9” x 0.4” x 0.232”
- Total weight: 0.18 oz. (5.0 g), lower mass greatly reduces vibration and shock problems
- Open frame construction maximizes air flow cooling

Protection Features

- Current limit foldback protects converter from excessive load current or short circuits

Control Features

- On/Off control positive logic
- Output voltage trim permits custom voltages and voltage margining
- Remote sense (+/-) for output voltage compensation due to output distribution drops
- External/Internal reference options
- Up/Down margining with digital input signals

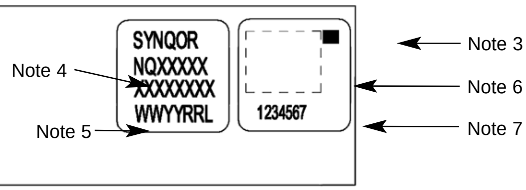
Safety Features

- UL/cUL 60950-1 recognized (US & Canada)
- 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

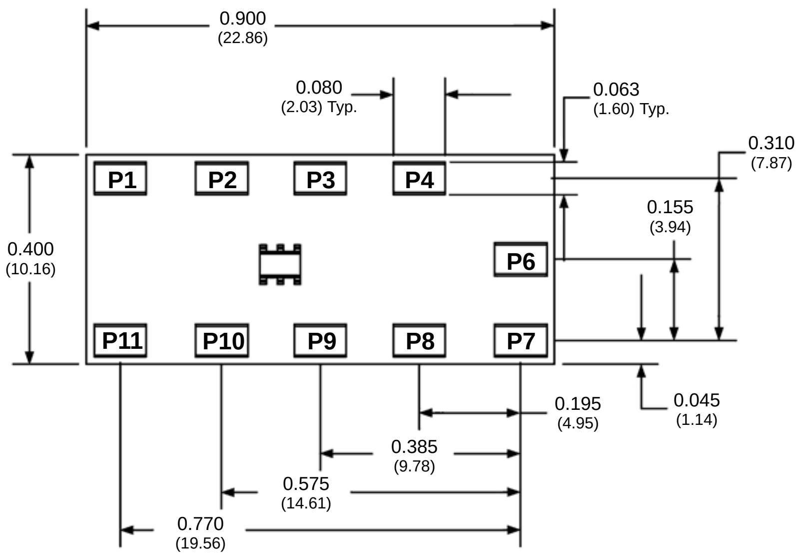
MECHANICAL DIAGRAM

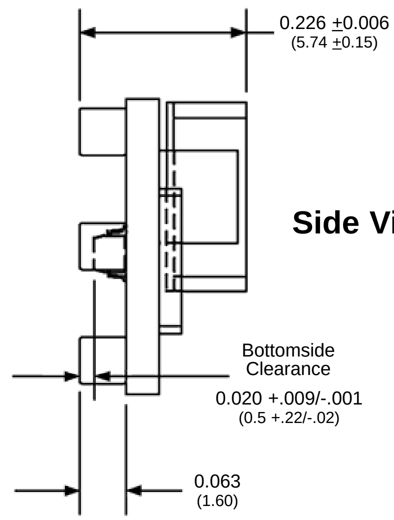
Surface Mount Package

Top View



Bottom View





Side View

NOTES

1) SMT Contacts: Material - Brass
   Finish - Gold over Nickel plate
2) Lead co-planarity Pins 1-10 = 0.004"max (0.10 mm)
3) Pin designator located on top side inductor label.
4) SynQor part number on two lines of text
5) Product Info: WWYY - Date code; RR - Revision; L - Manuf. code
6) Product serial number. Barcode format Datamatrix or Micro PDF417. Barcode includes "S" for serial number prefix.
7) Product serial number, human readable text.
8) Undimensioned components are shown for visual reference only.
9) All dimensions in inches (mm)
   Tolerances: x.xx +/-0.02 in. (x.x +/-0.5mm)
   x.xxx +/-0.010 in. (x.xx +/-0.25mm)
10) Weight: 0.18 oz. (5 g) typical
11) Workmanship: Meets or exceeds IPC-A-610C Class II

SMT CONTACT CONNECTIONS

Pin No.	Name	Function
1	CTRL GND	Low Current Ground
2	OE	Output Enable (active high)
3	PWRGD	Power Good (active high)
4	PWR GND	Power (Vin & Vout) Ground
6	TRIMN	Margin Control (trim down)
7	VSET	Setpoint Voltage
8	VIN	Input Voltage
9	TRIMP	Margin Control (trim up)
10	VOUT	Output Voltage
11	VADJ	Feedback Voltage

ELECTRICAL CHARACTERISTICS - NQ10W50PKA07 Series

T_A=25°C, airflow rate=300 LFM, V_{in}=12Vdc unless otherwise noted; full operating temperature range is -5°C to +85°C ambient temperature with appropriate power derating. Specifications subject to change without notice.

Parameter	Setpoint	Min.	Typ.	Max.	Units	Notes & Conditions
ABSOLUTE MAXIMUM RATINGS						
Non-Operating Input Voltage	All			15	V	Continuous
Operating Input Voltage	All	10.2	12.0	13.2	V	Continuous
Operating Temperature	All	-5		85	°C	Consult factory for lower operating temperatures
Storage Temperature	All	-40		85	°C	
TRIMP and TRIMN pins	All	-0.3		5.0	V	
VSET pin	All	-0.3		2.7	V	
Voltage at OE (output enable) input pin	All	-0.3		5	V	ON/OFF control pin
INPUT CHARACTERISTICS						
Operating Input Voltage Range	All	10.2	12	13.2	V	
Input Under-Voltage Lockout						
Turn-On Voltage Threshold	All		3.3	4.0	V	
Turn-Off Voltage Threshold	All		3.2	3.9	V	
Maximum Input Current (100% Load, 10.2Vin)	0.7V			0.7	A	
"	0.9V			0.9	A	
"	1.2V			1.1	A	
"	1.5V			1.3	A	
"	1.8V			1.5	A	
"	2.5V			2.0	A	
"	3.3V			2.6	A	
"	5.0V			3.8	A	
No-Load Input Current (DCM Versions QS1, QS2 [1])	All		4	6	mA	See note 1 in page 5
No-Load Input Current (CCM Versions QS3, QS4 [2])	0.7V		14	20	mA	At 25°C. See note 2 in page 5
"	0.9V		16	25	mA	
"	1.2V		19	30	mA	
"	1.5V		22	35	mA	
"	1.8V		25	40	mA	
"	2.5V		31	45	mA	
"	3.3V		37	55	mA	
"	5.0V		46	70	mA	
Disabled Input Current	All		0.5	2.0	mA	
Inrush Current Transient Rating	All		0.02		A^2s	Including 22uF external input capacitor
Input Ripple Voltage (RMS)	0.7V		0.027		V	With 22µF external cap; see Figures 14 & 17
"	0.9V		0.032		V	
"	1.2V		0.036		V	
"	1.5V		0.020		V	
"	1.8V		0.013		V	
"	2.5V		0.022		V	
"	3.3V		0.028		V	
"	5.0V		0.037		V	
Recommended Input Fuse for 0.9Vout	All		1.0		A	Use fuse with minimal additional current rating
Recommended Input Fuse for 3.3Vout	All		3.0		A	Use fuse with minimal additional current rating
Input Filter Capacitor Value	All		22		µF	Internal value
Recommended External Input Capacitance	All	22			µF	Ceramic
OUTPUT CHARACTERISTICS						
Output Voltage Set Point (QS1, QS4 versions)	All		±1.2		%	With 50% load, see trimming app note
Output Voltage Set Point (QS2, QS3 versions)	All		±0.7		%	With Vset=0.7V, 50% load, see trimming app note
Output Voltage Regulation [3]						See trimming and remote sensing app notes
Over Line	All		±0.1		%	
Over Load	All		±0.2		%	
Over Temperature	All		±0.3		%	
Total Output Voltage Range	All		±1.8		%	Over sample, line, load, temperature & life
Output Voltage Ripple and Noise						20MHz bandwidth, 110uF ceramic output cap.
Peak-to-Peak	All		10	25	mV	Full Load. See note 4 in page 5
Operating Output Current Range	All	0		7	A	See note 3 in page 5
Output DC Current-Limit Threshold	All		15		A	5% drop in Vout; see Figure 16
Recommended Output Capacitance	All	110	176	2000	µF	Nominal Vout at 7A resistive load

ELECTRICAL CHARACTERISTICS (continued) - NQ10W50PKA07 Series

Parameter	Setpoint	Min.	Typ.	Max.	Units	Notes & Conditions
OUTPUT CHARACTERISTICS (continued)						
Output Voltage Ripple and Noise						20MHz bandwidth, 110uF ceramic output cap.
Peak-to-Peak	All		10	25	mV	Full Load. See note 4 in page 5
DYNAMIC CHARACTERISTICS						
Input Voltage Ripple Rejection	5V		-60		dB	120 Hz, see Figure 15
"	0.7V, 1,8V		-80		dB	120 Hz, see Figure 15
"	All		-40		dB	Audio to 5 MHz; see Figure 15
Output Voltage during Load Current Transient					dB	See Figures 9 & 10
Step Change in Output Current	All		±100		mV	10% to 90% to 10% Iout max, 5A/uS or faster
Settling Time	All		20		μs	To within 1.5% Vout nom
Turn-On Transient						VSET=0.8V for QS2 or QS3
Turn-On Time	0.7V-2.5V	2.2	3.5	4.7	ms	Full load, Vout=97% steady state level
"	3.3V	2.7	3.9	5.0	ms	Full load, Vout=97% steady state level
"	5.0V	3.3	4.4	5.5	ms	Full load, Vout=97% steady state level
EFFICIENCY						
85% Load (6A)	0.7V		77		%	
"	0.9V		81		%	
"	1.2V		84		%	
"	1.5V		86		%	
"	1.8V		87		%	
"	2.5V		90		%	
"	3.3V		92		%	
"	5.0V		94		%	
28% Load (2A)	0.7V		81		%	
"	0.9V		83		%	
"	1.2V		84		%	
"	1.5V		86		%	
"	1.8V		87		%	
"	2.5V		89		%	
"	3.3V		91		%	
"	5.0V		93		%	
TEMP. LIMITS FOR POWER DERATING						
Semiconductor Junction Temperature	All			125	°C	Package rated to 150°C
Board Temperature	All			125	°C	UL rated max operating temp 130°C
FEATURE CHARACTERISTICS						
Switching Frequency	0.7V	340	395	450	kHz	See Figure 18 for other voltages
"	5.0V	660	740	830	kHz	See Figure 18 for other voltages
ON/OFF Control						
Off-State Voltage	All	0		1.0	V	Applied at OE pin
On-State Voltage	All	2.0		5.0	V	Applied at OE pin
Transition Voltage	All	1.1		1.9	V	
OE Pin Input Resistance	All		332		V	To ground only, no internal pull-up
Output Over-Voltage Protection	All	110		130	%	Over full temp range; % of nominal Vout
External Reference Input (Versions QS2, QS3)						
VSET Pin Voltage Range	All	0.7	0.8	1.0	V	
Input Filter	All		1.0/1.0		kΩ/μF	Internal filter
Margining (Versions QS1, QS4)						
Margin-Up Trimming	All	4.5	5.0	5.5	%	Vout increase when pulling up TRIMP pin
Margin-Down Trimming	All	-5.5	-5.0	-4.5	%	Vout decrease when pulling up TRIMN pin
TRIMN and TRIMP Pin Thresholds	All		1.4		V	
PowerGood						
Internal Pull-up Resistance	All		100		kΩ	
Internal Pull-up Voltage	All	4.7	5.0	5.3	V	
Upper Threshold	All	7	10	13	%	
Lower Threshold	All	-13	-10	-7	%	
Hysteresis	All		1.5	3	%	
Low Voltage	All		0.15	0.4	V	With 4mA sink current

ELECTRICAL CHARACTERISTICS (continued) - NQ10W50PKA07 Series

Parameter	Setpoint	Min.	Typ.	Max.	Units	Notes & Conditions
FEATURE CHARACTERISTICS (continued)						
Trimming and Remote Sense						
Output Voltage Trim Range	All	0.7		5.25	V	Measured across pins 10 & 4
Output Voltage Remote Sense Range	All			+5	%	Measured across pins 10 & 4, less setpoint voltage
Remote Sense Accuracy	5.0V		94		%	Percentage of voltage drop compensated
"	1.8V		98		%	Percentage of voltage drop compensated
Thevenin Resistance	All		990		Ω	At VADJ pin with no external resistance
Thevenin Voltage	All		Vout/101		V	At VADJ pin with no external resistance
RELIABILITY CHARACTERISTICS						
Calculated MTBF (Telcordia)	5.0Vout		21.5		10^6 Hrs.	TR-NWT-000332; 100% load, 300LFM, 40°C T_a
Calculated MTBF (MIL-217)	5.0Vout		12.4		10^6 Hrs.	MIL-HDBK-217F; 100% load, 300LFM, 40°C T_a
Demonstrated MTBF	5.0Vout	1.0			10^6 Hrs.	Field demonstrated MTBF

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
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.

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°C to 100°C, unit temp. ramp 15°C/min., 500 cycles
Power/Thermal Cycling	5	$T_{operating}$ = min to max, V_{in} = min to max, full load, 100 cycles
Design Marginality	5	T_{min}-10°C to T_{max}+10°C, 5°C steps, V_{in} = min to max, 0-105% load
Humidity	5	85°C, 85% RH, 1000 hours, 2 minutes on and 6 hours off
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 more information about Proof of Design and Proof of Manufacturing processes.

Note 1: DCM = Discontinuous Conduction Mode - see application notes.
Note 2: CCM = Continuous Conduction Mode - see application notes.
Note 3: QS1 and QS2 versions at no load (up to 50mA) may have a higher Vout error of up to +1.5% associated with deep discontinuous mode operation.
Note 4: The user will see higher output ripple at light loads (< 4A @ 5V, <1.5A @ 0.9V) on the discontinuous conduction mode versions. To reduce output ripple, increase output capacitance or use continuous conduction mode version.

OPTIONS

SynQor provides various options for Packaging, Mounting, Optional Functions and Current Sharing for this family of DC/DC converters. Please consult the last page of this specification sheet for information on available options.

PATENTS

SynQor is protected under various patents. Please consult the last page for further information.

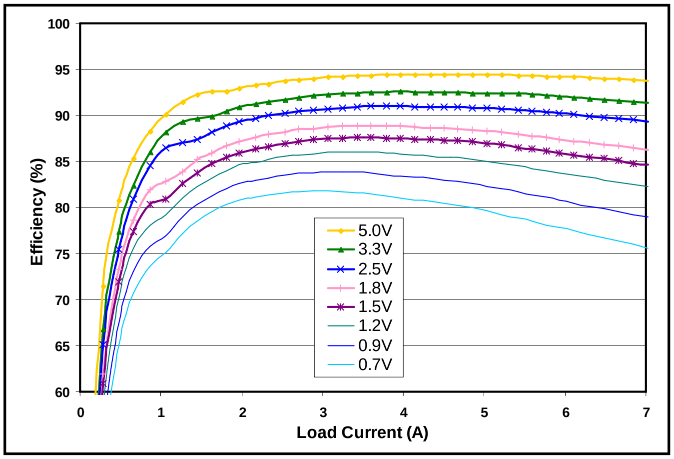


Figure 1: *Efficiency at* ***12Vin*** *and nominal output voltage vs. load current for CCM modules at 25°C (see Continuous vs Discontinuous Conduction app note).*

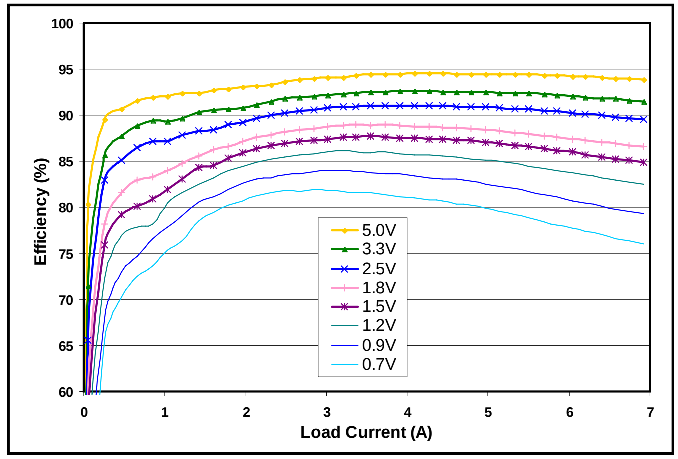


Figure 2: *Efficiency at* ***12Vin*** *and nominal output voltage vs. load current for DCM modules at 25°C (see Continuous vs Discontinuous Conduction app note).*

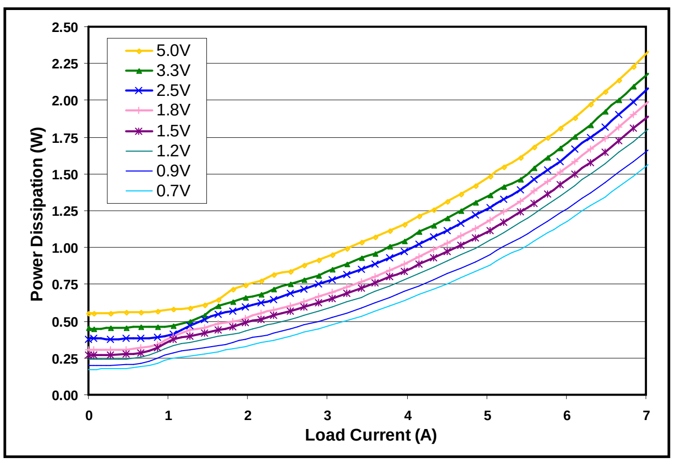


Figure 3: *Power dissipation at* ***12Vin*** *and nominal output voltage vs. load current for CCM modules at 25°C (see Continuous vs Discontinuous Conduction app note).*

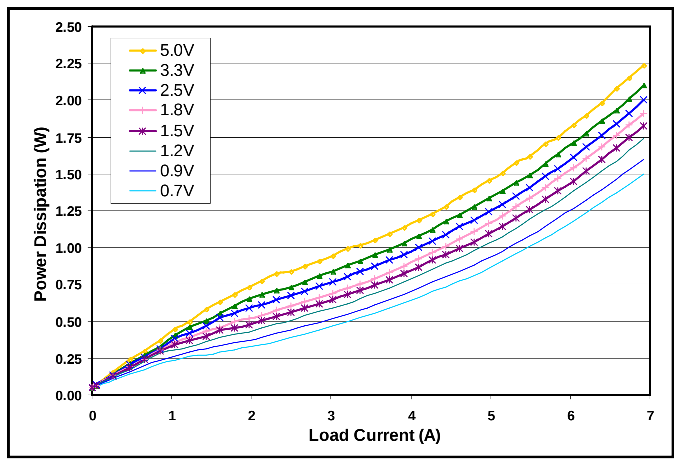


Figure 4: *Power dissipation at* ***12Vin*** *and nominal output voltage vs. load current for DCM modules at 25°C (see Continuous vs Discontinuous Conduction app note).*

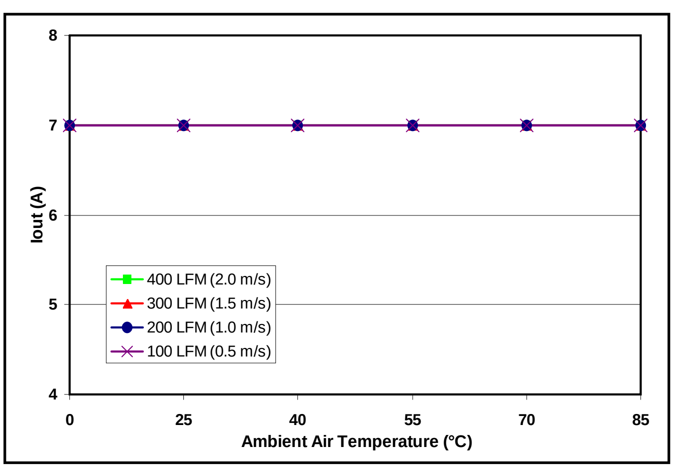


Figure 5: *Maximum output power derating curves vs. ambient air temp for all output voltages at* ***12Vin****. Airflow rates of 100 - 400 LFM with air flowing across the converter from pin 1 to 11..*

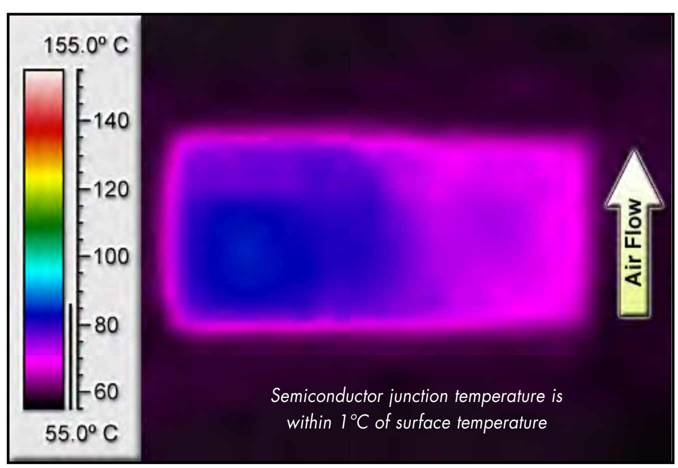


Figure 6: *Thermal plot of* ***0.9Vo*** *converter at* ***12.0Vin*** *with 7 amp load current and 55°C. Air is flowing across the converter from pin 1 to 11 at 200 LFM.*

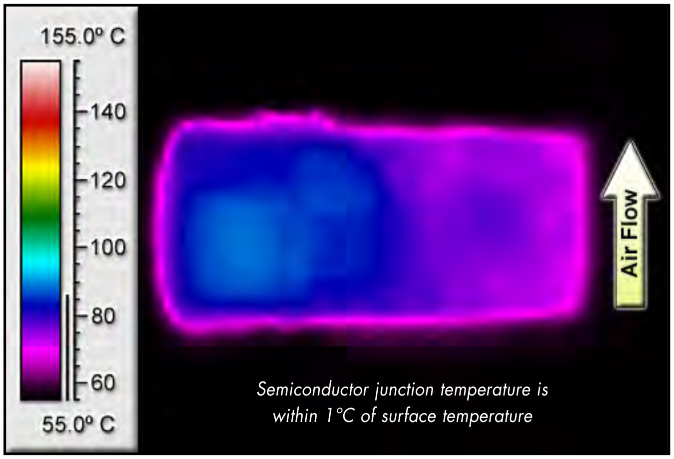


***Figure 7:** Thermal plot of **2.5Vo** converter at **12.0Vin** with 7 amp load current and 55°C. Air is flowing across the converter from pin 1 to 11 at 200 LFM.*

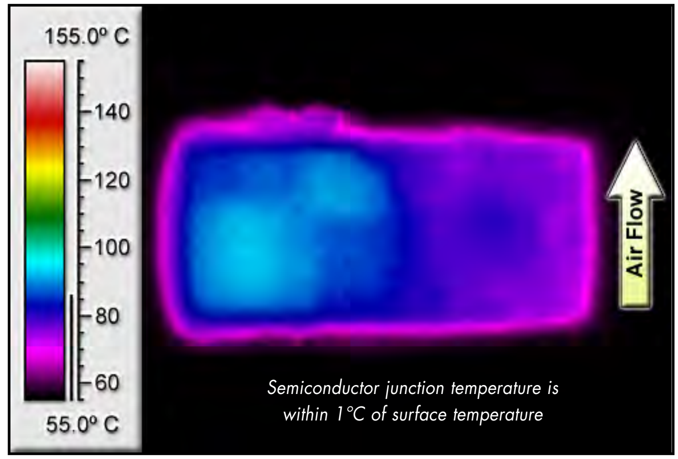


***Figure 8:** Thermal plot of **5.0Vo** converter at **12.0Vin** with 7 amp load current and 55°C. Air is flowing across the converter from pin 1 to 11 at 200 LFM.*

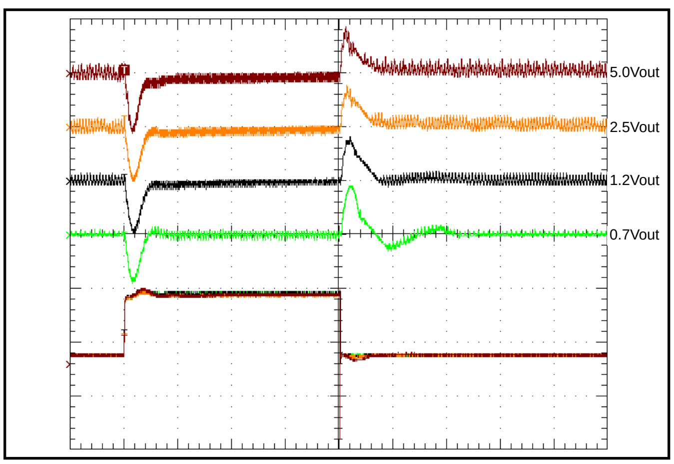


***Figure 9:** DCM (QS1 & QS2) output voltage response at **12.0Vin** to step-change in load current (10% to 90% of Iout max; di/dt=**20A/μs**; 50μs/div). Load cap: 376μF ceramic. Top: Vout (100mV/div), Bottom: Iout (5A/div).*

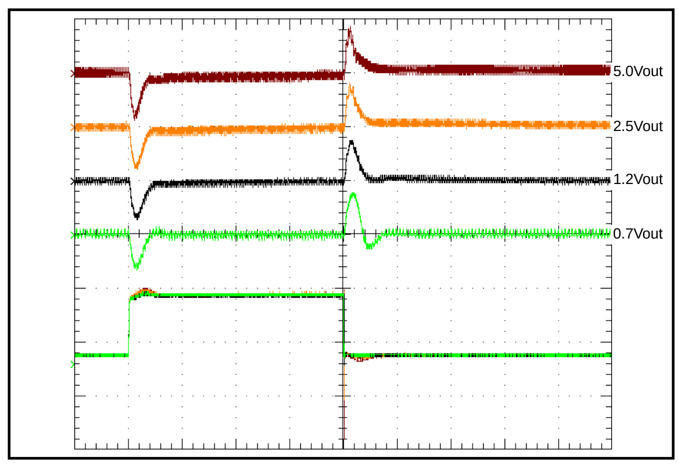


***Figure 10:** CCM (QS3 & QS4) output voltage response at **12.0Vin** to step-change in load current (10% to 90% of Iout max; di/dt=**20A/μs**; 50μs/div). Load cap: 376μF ceramic. Top: Vout (100mV/div), Bottom: Iout (5A/div).*

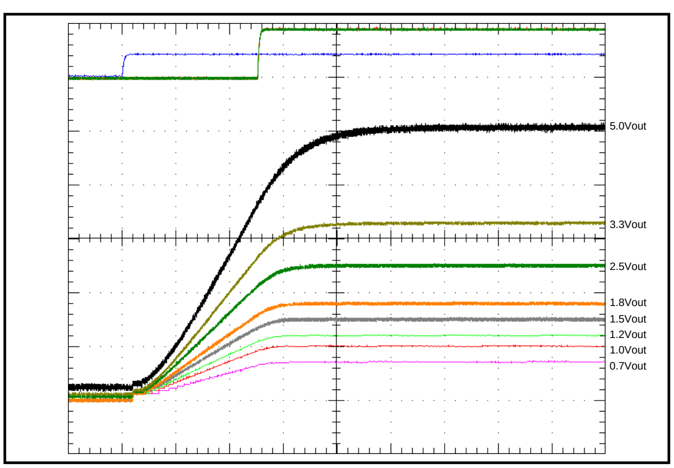


***Figure 11:** DCM (QS1 & QS2) turn-on transient at **12Vin** and full load (resistive load) with 370uF of output cap (1V/div, 1mS/div), top traces are OE pin (first to rise) and PWRGOOD (rising later), both at 5V div.*

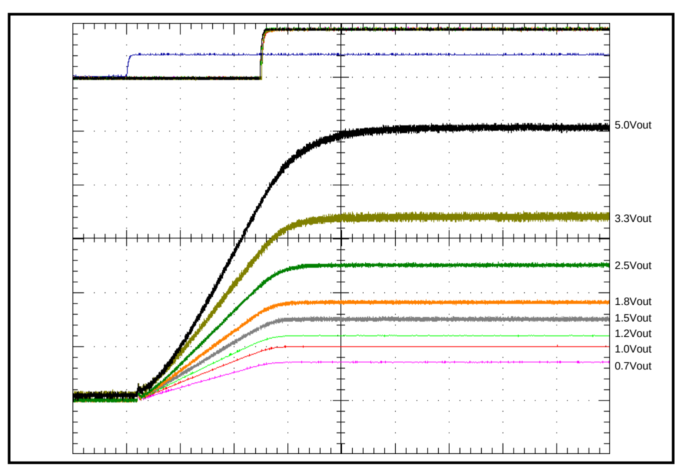


***Figure 12:** CCM (QS3 & QS4) turn-on transient at **12Vin** and full load (resistive load) with 370uF of output cap (1V/div, 1mS/div), top traces are OE pin (first to rise) and PWRGOOD (rising later), both at 5V div.*

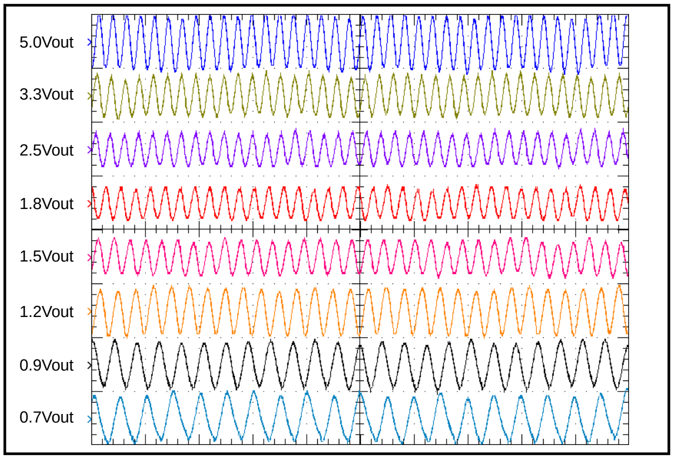


Figure 13: *Output Voltage Ripple at **12V** input voltage and rated load current (10 mV/div). Load capacitance: 5 ceramic 22µF capacitors. Bandwidth: 20 MHz. See Figure 17.*

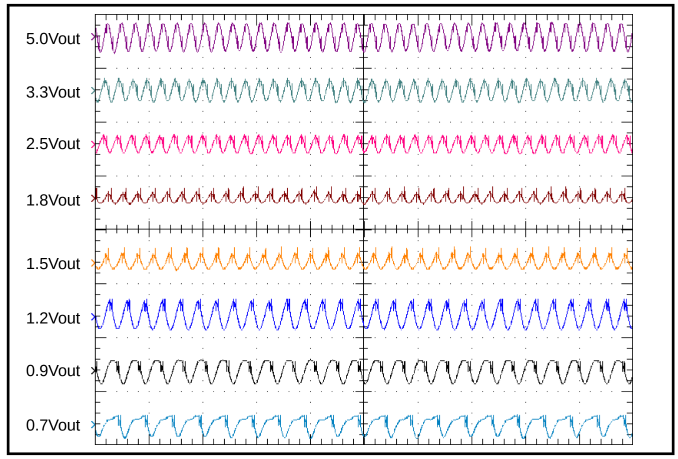


Figure 14: *Input Voltage Ripple across 22uF external input capacitor at **12V** input voltage and rated load current (200 mV/div). Load capacitance: 5 ceramic 22µF capacitors. Bandwidth: 20 MHz. See Figure 17.*

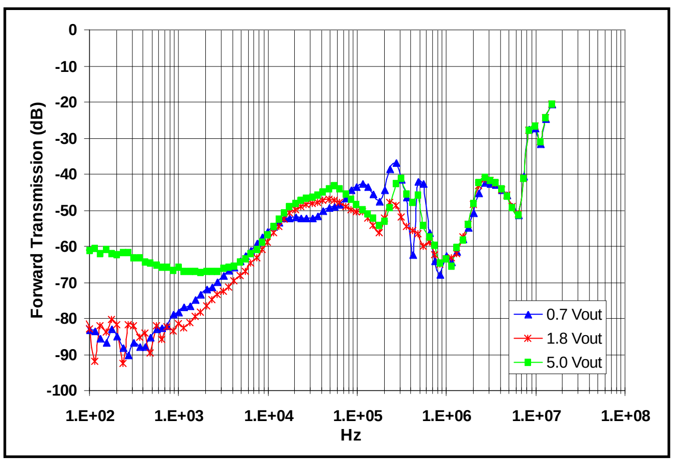


Figure 15: *Magnitude of incremental forward transmission (FT = v_{out}/v_{in}) for minimum, nominal, and maximum input voltage at full rated power.*

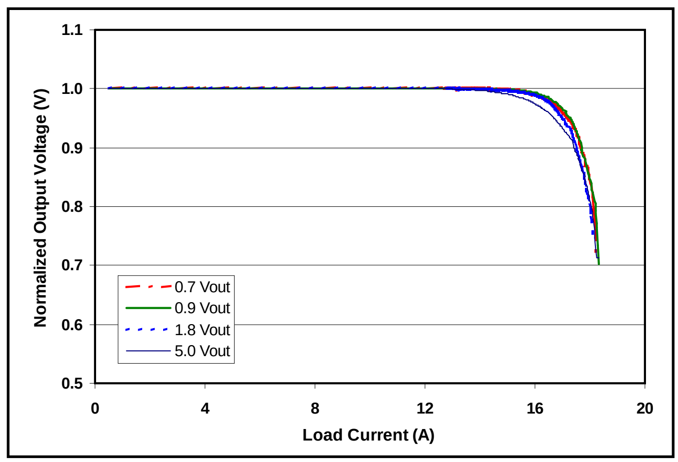


Figure 16: *Output voltage vs. load current showing typical current limit curves and converter shutdown points.*

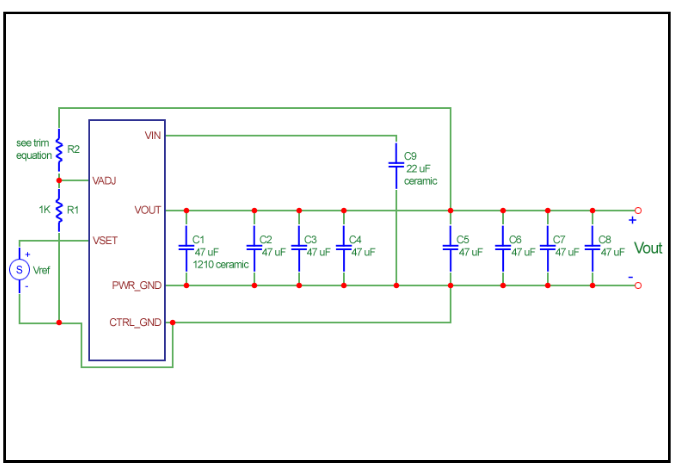


Figure 17: *External cap shown for transient response measurements. Not shown are PWRGOOD output and digital inputs OE, TRIMN and TRIMP. I/O pin arrangement not intended to match positions on the converter.*

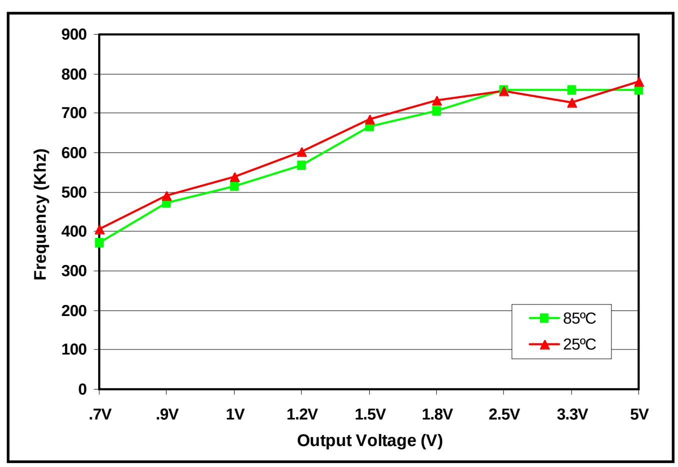


Figure 18: *Typical Switching Frequency vs Output Voltage, 12Vin, Full Rated Load Current.*

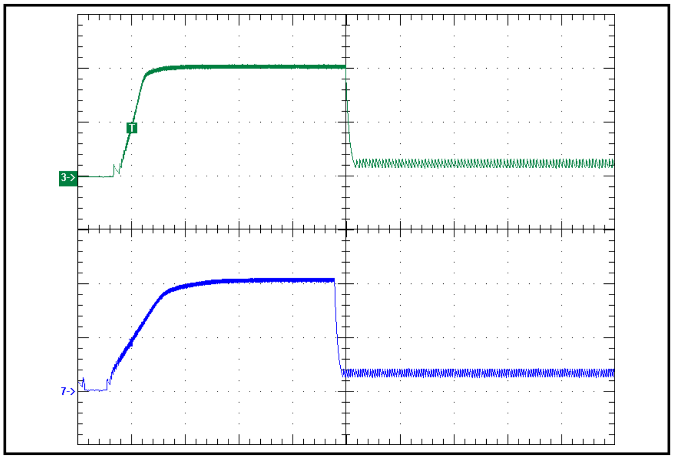


Figure 19: *Load current (10A/div) as a function of time (500uS/div) when attempting to turn on into a 10 mΩ short circuit. *-Output voltage setpoint is trimmed to 5.25V for the top trace and 0.7V for the bottom trace.*

BASIC OPERATION AND FEATURES

The *Ni*Qor series non-isolated converter uses a buck converter that keeps the output voltage constant over variations in line, load, and temperature. The *Ni*Qor 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.

CONTROL FEATURES

Remote ON/OFF (OE, pin 2): The OE (output enable) input, pin 2, permits the user to control when the converter is on or off. The OE pin connects directly to the enable pin of the PWM chip and must be pulled high to turn the converter on (see the specification pages for on/off logic thresholds). The converter has an internal 332K resistor from this pin to CTRL GND (pin 1).

PROTECTION FEATURES

Input Under-Voltage Lockout: The converter is designed to turn off when the input voltage is too low. When the input voltage is rising, it must exceed the typical Turn-On Voltage Threshold value (listed on the specification pages) 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: This converter employs foldback current limiting. A typical output voltage-current curve is shown in Figure 16 in the Performance Curves section. At room temperature current limit is reached at about 170% 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 approximately 50% of its nominal setpoint, the output current will begin to foldback. If the load continues to increase, the output current will decrease linearly to about 30% of the rated current at zero Vout. While operating into this dead short condition the unit will deliver 2-3A indefinitely reducing stress and ensuring 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 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.

Because the current limit tolerance is rather large, a fuse is recommended in series with the input source of each unit. The rating of the fuse should be above but as close as possible to the maximum input current specified on the specification pages. These maximum input currents account for full load conditions, maximum ambient temperature, and minimum input voltage. The curves for power dissipation vs load current may be used to estimate the reduction of input current at lighter load conditions.

APPLICATION CONSIDERATIONS

Input Over-Voltage Prevention: The power system designer must take precautions to prevent damaging the *Ni*Qor converters by input overvoltage. This is another reason to be careful about damping the input filter so that no ringing occurs from an underdamped filter. The voltage must be prevented from exceeding the absolute maximum voltage indicated in the Electrical Specifications section of the data sheet under all conditions of turn-on, turn-off and load transients and fault conditions. The power source should have an over voltage shutdown threshold as close as reasonably possible to the operating point.

External Output Capacitance: This converter is designed to operate with all-ceramic output capacitance. Although additional bulk output capacitance of other types may be found to improve performance, the output capacitance recommendations are generally based on low-ESR ceramic capacitors. A minimum of 110uF of ceramic capacitance should be placed as close as possible to the converter and preferably mounted directly under the converter on the opposite side of the converter with VOUT and PWR GND planes used to minimize the inductance of this connection. In order to maintain the desired capacitance up to higher output voltages, 5 22uF/1210 capacitors are recommended. To achieve the transient response specifications, 376uF is recommended. When operating the QS1 or QS2 version at light loads (see CCM vs DCM section), even more capacitance may be desired to reduce the output ripple voltage. Due to the low-frequency content of the discontinuous mode output voltage ripple, tantalum or polymer type capacitors may also be useful in reducing this ripple. In general, more capacitance is needed, particularly at high voltages, when using 100uF 1210 6.3V capacitors or other low voltage X5R capacitors which can similarly drop to 1/3 of their nominal value at a bias voltage of 5V.

Continuous vs Discontinuous Conduction Modes: Table 1 summarizes the difference among the converter versions. Referring to the last 3 digits of the part number, the QS1 and QS2 versions are configured to enable discontinuous conduction mode (DCM) operation at light loads, whereas the QS3 and QS4 versions force continuous conduction mode (CCM) operation. Table 2 shows the typical load current corresponding to the boundary for light-load discontinuous operation.

Version	Vref	Light-Load Operating Mode
QS1	0.7V	Discontinuous (DCM) Enabled
QS2	VSET pin	Discontinuous (DCM) Enabled
QS3	VSET pin	Forced Continuous (CCM)
QS4	0.6V	Forced Continuous (CCM)

Table 1: *Version differences*

Following are the main performance differences between the two versions:

1) Current-sinking: A DCM version (QS1, QS2) will not sink current if its output is backdriven, whereas a CCM version will sink current as needed to regulate its output voltage, though such negative current might be limited to a few amps but may exceed 10Amps. Since this is not a normal operating condition, the negative current limit is not specified.

2) Light-load input power: The main advantage of DCM operation is lower input current at light loads, down to only about 4 milliamps with no-load (for all input/output voltage conditions). The efficiency improvement of the DCM version only becomes evident as the load is reduced below 1.5A for a 5.0V output. This threshold gradually falls to about 1 Amp at 2.5V and 0.75A at 0.7V, as shown in Table 2 below.

3) Light-load output ripple: The output ripple of the DCM version has a higher amplitude, as well as a significant amount of low-frequency content at light loads (as low as 200Hz for 0.7Vout at no-load). With the same output capacitance, peak-to-peak output voltage ripple at light-loads may be 3 to 10 times as large for DCM as for the CCM version. At heavier loads, all versions operate in continuous conduction and have very low output voltage ripple.

4) Transient response: The CCM version has a better response to dynamic loads. The output voltage deviation, while excellent on both versions, is about 20% lower on the CCM version. With a falling load step, a longer settling time may also be noticeable, especially when stepping into very light loads, as there is no current sinking capability to quickly reduce the output voltage from its peak deviation.

5) No-Load Regulation: When operating in discontinuous mode with extremely light loads (<50mA), the output voltage may rise by 1 to 2% beyond the specified tolerance.

Output Voltage Setpoint	Boundary Current for Output Ripple	Efficiency Advantage Boundary Current
0.7V - 1.8V	2.0 Amps	0.75Amps
2.5V	2.2 Amps	1.0 Amps
3.3V	2.4 Amps	1.2 Amps
5.0V	2.6 Amps	1.5 Amps

Table 2: *Boundary currents below which DCM operation increases ripple and improves efficiency*

Setting Output Voltage (VADJ, pin 11): This converter is a wide-output module and requires external resistors R_1 and R_2 (see Figure 17) to set the output voltage. The output voltage is set by the ratio between R_1 and R_2 in parallel with an internal 100K resistor as follows:

$$V_{out} = V_{ref} * [1 + (R_2 \,||\, 100K) / R_1]$$

where Vref is given in Table 1 above. In terms of the top resistor R_2, the trim equation is:

$$R_2 = \frac{(V_{out} - V_{ref}) * R_1 * 100K}{V_{ref} * (R_1 + 100K) - V_{out} * R_1}$$

The recommended value for bottom resistor R_1 is 1.0K. Significantly larger values of R_1 will degrade the DC accuracy of the remote sensing, particularly with high output voltages where the trim resistor R_2 becomes comparable to the internal 100K parallel resistor. If remote sensing is not used, larger values of R_1 up to 5.0K may be used.

$$\text{With } R_1\text{=1K} \qquad R_2 \text{ (in kohm)} = \frac{(V_{out} - V_{ref}) * 100}{101 * V_{ref} - V_{out}}$$

Total DC Variation of Vout: For the converter to meet its specifications, the maximum variation of the DC value of the converter output voltage, due to voltage adjustment, margining, and remote load voltage drops, should not be greater than that specified for the output voltage trim range.

Differential Remote Sense: Using the differential remote sense feature, the converter can be configured to adjust its output voltage up to compensate for resistive drops between the converter and the load. Differential remote sensing is achieved by a Kelvin connection of the top trim resistor R_2 (see Figure 17) and the CTRL GND pin respectively to the Vout and common rails at the desired remote location. The other end of R_2 connects to the VADJ pin, and the bottom trim resistor R_1 connects between the

VADJ and CTRL GND pins. The R_1 connection should be between the pin and the point where the CTRL GND and PWR GND nodes meet. In cases where the output voltage is not trimmed above the reference voltage (R_2 < 50 Ω), it should be noted that the trim connection would be substantially used for high-frequency feedback as well as DC sensing, so the feedback loop would see any filtering network including parasitic inductance between the output pins and the remote sense point.

When using the remote sensing to compensate for a substantial voltage drop on the VOUT rail between converter and load (i.e., more than 1% of output voltage), the load voltage accuracy can be impacted by the internal 100K resistor between the VOUT and VADJ pins, especially at higher output voltage trim settings, where the trimming resistor R_2 connected to the remote sense load starts to become a significant fraction of the 100K resistor. The following equation for the load voltage adjusts for this effect:

$$V_{load} = V_{ref} * [1 + (R_2 \,||\, 100K) / R_1] - V_{drop} * [R_2 / (R_2 + 100K)]$$

Where Vdrop is the difference between the output voltage at the converter pin and the load voltage (both measured with respect to the CTRL GND pin.)

Internal vs External Reference: The QS1 version uses an internal reference to maintain 0.7V at the VADJ pin during normal steady-state operating conditions. The QS4 also uses an internal reference, but maintains 0.6V at the VADJ pin. The QS2 and the QS3 are configured to use an external reference voltage applied at the VSET pin. The converter will maintain this voltage, which may be between 0.7V and 1.0V, at the VADJ pin during normal steady-state operating conditions. Under no conditions should the VSET pin be driven above the absolute maximum voltage of 2.7V.

Margining: With the QS1 and QS4 versions, the converter output voltage can be margined up or down by 5% by applying a logic-high voltage to the TRIMP and TRIMN pins. The table below summarizes the margining operation. There is an internal 50K resistor to ground at each of these pins. The logic threshold is about 1.4V, and the pins should be driven no higher than 5V. When using the QS2 or QS3 versions, the TRIMP and TRIMN pins should be connected to the CTRL GND pin.

TRIMP pin	TRIMN pin	Mode
Low/Open	Low/Open	No Margining
High	Low/Open	+5%
Low/Open	High	-5%
High	High	No Margining

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 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.

SURFACE MOUNT INFORMATION

PCB Layout Considerations: SynQor recommends that the customer use a non-solder mask defined pad design. The minimum recommended pad size is 0.074" x 0.122" (1.88mm x 3.1mm) and the maximum pad size is 0.095" x 0.140" (2.41mm x 3.56mm), see the mechanical diagram on page 2. Interconnection to internal power planes is typically required. This can be accomplished by placing a number of vias between the SMT pad and the relevant plane. The number and location of the vias should be determined based on electrical resistance, current and thermal requirements. "Via-in-pad" design should be avoided in the SMT pads. Solder mask should be used to eliminate solder wicking into the vias.

Pick and Place: The NiQor surface mount modules are designed for automated assembly using standard SMT pick and place equipment. The modules have a centrally located inductor component with a flat surface area to be used for component pick-up. The units use open frame construction and have a low mass that is within the capability of standard pick and place equipment. Those modules however have a larger mass than most conventional SMT components and so variables such as nozzle size, tip style, handling speed, and placement pressure should be optimized for best results. A conformal tipped placement nozzle design is recommended. Coplanarity of better than 0.004" (0.1mm) is achieved through the SMT NiQor's terminal design.

Reflow Soldering Guidelines: Figure J shows a typical reflow profile for a eutectic solder process. Due to variations in customer applications, materials and processes, it is not feasible for SynQor to recommend a specific reflow profile. The customer should use this profile as a guideline only. Since the *NiQor* surface mount modules have a larger thermal mass and lower thermal resistance than standard SMT components, it may be necessary to optimize the solder reflow profile based on limitations of the other components on the customer board. Sufficient reflow time must be allowed to fuse the plating on the connection to ensure a reliable solder joint. The solder reflow profile should be confirmed by accurately measuring the SMT interconnect leads. The guidelines illustrated in Figure J must be observed to ensure the maximum case temperature of 260°C (exposure for 5 seconds or less) is not exceeded for the *NiQor* units.

Lead-Free Soldering: These *NiQor* surface mount modules are manufactured with lead free solder and PCB finish and meet the conditions for Lead-Free Class 3 status. Users who wish to assemble the modules in a Lead-Free solder process may require peak reflow temperatures exceeding 240°C. The maximum allowable case temperature of the surface mount *NiQor* modules is 260°C for no greater than 5 seconds.

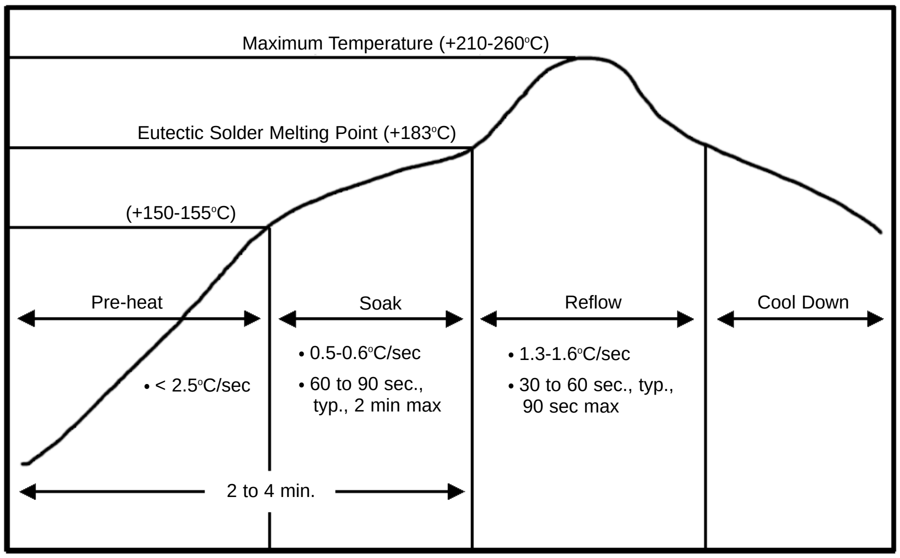
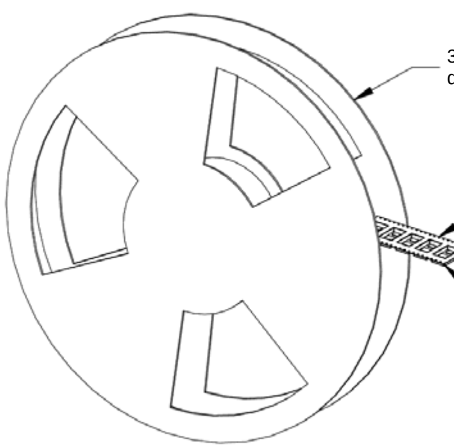


Figure J: *Typical Eutectic (96.5Sn/3.0Ag/0.5Cu) Solder Profile*

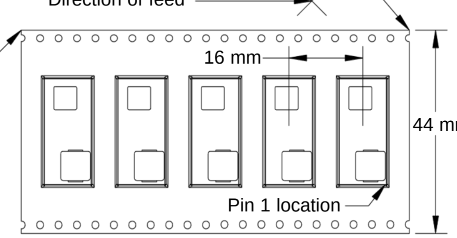
Moisture Sensitivity: These NiQor surface mount modules have an MSL rating 1 per IPC/JEDEC J-STD-033A.

Cleaning and Drying: When possible, a no-clean solder paste system should be used to solder the NiQor SMT units to their application board. The modules are suitable for aqueous washing, however, the user must ensure sufficient drying to remove all water from the converter before powering up. Inadequate cleaning and drying can affect the reliability of the converter and the testing of the final assembly.

Tape & Reel Packaging: The *NiQor* SMT modules are supplied in tape and reel packaging in quantities of 300 units per reel. Packaging conforms to EIA-481 standards. Tape and reel dimensions are shown in the diagram below.



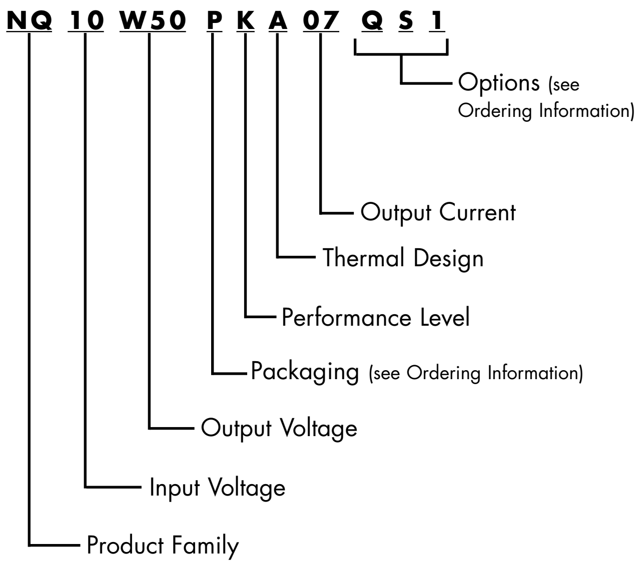
Reel View



Tape View

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 next 3 characters indicate available options. A "-G" suffix indicates the product is 6/6 RoHS compliant.

Application Notes

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

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, the next 3 characters for options. A "-G" suffix indicates the product is 6/6 RoHS compliant.

Model Number	Input Voltage	Output Voltage	Max Output Current
NQ10W50*p* KA07*xyz* -G	10.2 - 13.2V	0.7-5.0V	7.0 A

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

Packaging: *p*	**Options Description: *x y z***		
Packaging	**Enable Logic**	**Pin Style**	**Feature Set**
P - 0.4"x0.9" Surface Mount	Q - Positive	S - SMT	1 - Internal 0.7V Reference & Margining (DCM version) 2 - External Reference & Variable Margining (DCM version) 3 - External Reference & Variable Margining (CCM version) 4 - Internal 0.6V Reference & Variable Margining (CCM version)

PATENTS (additional patent applications may be filed)

SynQor holds the following patents, one or more of which might apply to this product:

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

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

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