Technical Specification
NQ04W33SMA16

2.4-6.0V Input	0.75-3.6V Outputs	16 Amp Current	Non Isolated	SMT Surface Mount

The NiQor® SMT DC/DC converter is a non-isolated buck regulator which employs synchronous rectification to achieve extremely high conversion efficiency. The NiQor family of converters is used predominately in DPA systems using a front end DC/DC high power brick (48Vin to low voltage bus). These non-isolated 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 13).

NiQor® Non-Isolated

NQ04W33SMA16 wide trim module

DOSA Distributed-power Open Standards Alliance

Operational Features

- Ultra high efficiency, up to 94% at full rated load
- Delivers up to 16 Amps of output current with minimal derating - no heatsink required
- Input Voltage Range : 2.4 - 6.0V
- Programmable output voltages from 0.75 - 3.6V
- On-board input and output filter capacitor
- No minimum load requirement means no preload resistors required

Mechanical Features

- DOSA standard SMT pin-out configuration
- Industry standard size: 1.3" x 0.53" x 0.29" (33 x 13.5 x 7.3 mm)
- Available in SIP configuration
- Total weight: 0.18 oz. (5 grams), lower mass greatly reduces vibration and shock problems
- Open frame construction maximizes air flow cooling

Control Features

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

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

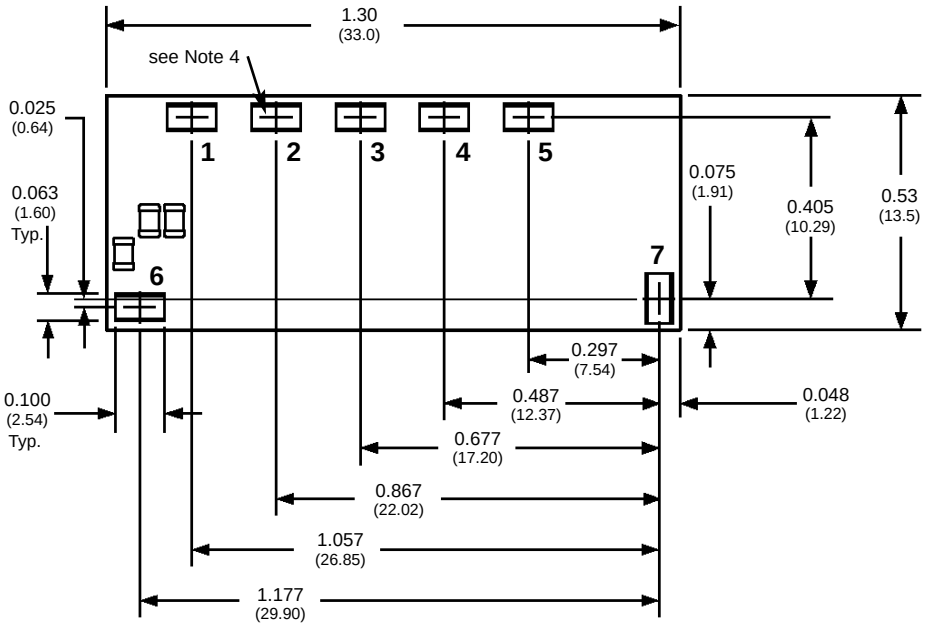
Safety Features

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

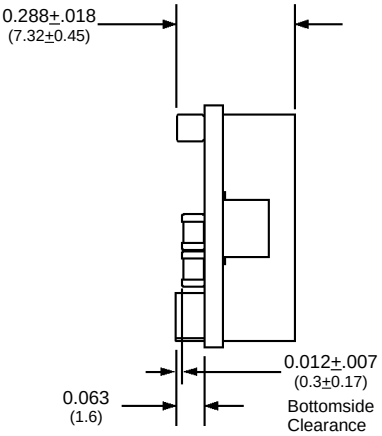
* Final datasheet pending ECO review and signature.

MECHANICAL DIAGRAM

Surface Mount Package



Bottom View



Side View

Recommended SMT Pad Size:
Minimum: 0.074" x 0.122" (1.88mm x 3.1mm)
Maximum: 0.095" x 0.140" (2.41mm x 3.56mm)

NOTES

1) SMT Contacts: Material - Brass
   Finish - Gold over Nickel plate
2) Undimensioned components are shown for visual reference only.
3) All dimensions in inches (mm)
   Tolerances: x.xx +/-0.02 in. (x.x +/-0.5mm)
   x.xxx +/-0.010 in. (x.xx +/-0.25mm)
4) Coplanarity for pins 1-7 is 0.004" max
5) Weight: 0.18 oz. (5 g) typical
6) Workmanship: Meets or exceeds IPC-A-610C Class II

SMT CONTACT DESIGNATIONS

Pin No.	Name	Function
1	*SEQ*	*Sequencing*
2	GND	Ground
3	Vout(+)	Positive output voltage
4	TRIM	Output Voltage Trim
5	*SENSE(+)*	*Positive remote sense*
6	Vin(+)	Positive input voltage
7	ON/OFF	Input to turn converter on/off

Pins in Italics Shaded text are Optional

ELECTRICAL CHARACTERISTICS - NQ04W33SMA16 Series

V_{in}=3.3Vdc and 5.0Vdc except 3.3V_{out} units where V_{in}=5.0V; T_A=25°C, airflow rate=300 LFM unless otherwise noted; full operating temperature range is -40°C to +105°C ambient temp with appropriate power derating. Specifications subject to change without notice.

Parameter	Module	Min.	Typ.	Max.	Units	Notes & Conditions
ABSOLUTE MAXIMUM RATINGS						
Input Voltage						
Non-Operating	All	0		7	V	Continuous
Operating	All			6	V	Continuous
Operating Temperature	All	-40		105	°C	
Storage Temperature	All	-55		125	°C	
Voltage at ON/OFF input pin	All	-3		6	V	
RECOMMENDED OPERATING CONDITIONS						
Input Voltage Range	All	2.4		6	V	
Input Fuse Rating	All			20	A	Fast blow external fuse recommended
External Input Capacitance	All	100			µF	ESR<1.5Ω
Output Voltage	All	0.75		3.6	V	
Output Current	All	0		16	A	
INPUT CHARACTERISTICS						
Input Under-Voltage Lockout						
Turn-On Voltage Threshold	All	2.07	2.21	2.35	V	
Turn-Off Voltage Threshold	All	1.92	2.01	2.10	V	
Lockout Hysteresis	All		0.2		V	
Maximum Input Current	0.75V			6.28	A	2.4Vin; 100% load
"	2.5V			11.16	A	3.6Vin; 100% load
"	3.3V			15.33	A	3.6Vin; 100% load
No-Load Input Current	0.75V		106		mA	5Vin; 16A load
"	2.5V		119		mA	"
"	3.3V		124		mA	"
Disabled Input Current	All		10		mA	
Inrush Current Transient Rating	All			0.1	A^2s	With min. output capacitance
Input Filter Capacitor Value	All		30		µF	
Input Reflected-Ripple Current (pk-pk\RMS)	0.75V		37\11		mA	5Vin; 100% load
"	2.5V		70\21		mA	
"	3.3V		60\18		mA	
OUTPUT CHARACTERISTICS						
Output Voltage Set Point	0.75V	0.745	0.750	0.755	V	5Vin 50% load
Output Voltage Range	All	0.75		3.60	V	
Operating Output Current Range	All	0		16	A	
Output Voltage Regulation						
Over Line	All			0.5	%	With sense pin
Over Load	All			0.5	%	"
Over Temperature	All			1	%	"
Total Output Voltage Range	All			3	%	With sense pin, over sample, line, load, temp. & life
Output Voltage Ripple and Noise (pk-pk\RMS)	0.75V		22.4\6.0		mV	Full load; 20MHz bandwidth; Figures 13 & 16
"	2.5V		33.2\10.3		mV	"
"	3.3V		30.8\8.5		mV	"
Output DC Over Current Shutdown	All	20	24	28	A	
External Output Capacitance	All	100		5000	µF	>0.5mohm
DYNAMIC CHARACTERISTICS						
Input Voltage Ripple Rejection	All		45		dB	120Hz; Figure 18
Output Voltage during Current Transient						
For a Step Change in Output Current (0.1A/µs)	All		100		mV	50%-75%-50% Iout max; 100uF; Figure 11
For a Step Change in Output Current (3A/µs)	All		100		mV	50%-75%-50% Iout max; 470uF; Figure 11
Settling Time	All		100		µs	To within 1.5% Vout nom.; Figures 11 & 12
Turn on Transient						Figures 9 & 10
Inhibit Time	All	2		6	ms	Resistive load
Rise Time	All	2		6	ms	"
Output Voltage Overshoot	All			0	V	"

ELECTRICAL CHARACTERISTICS (continued) - NQ04W33SMA16 Series

Parameter	Module	Min.	Typ.	Max.	Units	Notes & Conditions
EFFICIENCY						
100% Load	0.75V		80.0		%	Figures 1 & 2
"	2.5V		91.5		%	"
"	3.3V		94.0		%	"
50% Load	0.75V		84.0		%	"
"	2.5V		93.5		%	"
"	3.3V		95.0		%	"
TEMP LIMITS FOR POWER DERATING						
Semiconductor Junction Temperature	All			125	°C	Package rated to 150°C; Figures 3 - 8
Board Temperature	All			125	°C	UL rated max operating temp 130°C
FEATURE CHARACTERISTICS						
Switching Frequency	All	275	300	325	kHz	
ON/OFF Control						See Applications Information
Pull-Up Voltage	All	4.7	5	5.3	V	
Pull-Up Resistance	All		100		kΩ	
Output Voltage Trim Range	All	0.75		3.6	V	Measured Vout+ to common pins; Table 1
Output Over-Voltage Protection	All	3.9	4.2	4.6	V	Over full temp range
Over-Temperature Shutdown	All		128		°C	Average PCB Temperature
Over-Temperature Shutdown Restart Hysteresis	All		10		°C	
RELIABILITY CHARACTERISTICS						
Calculated MTBF (Telcordia)	All		TBD		10^6 Hrs.	TR-NWT-000332; 100% load, 200LFM, 40°C T_a
Calculated MTBF (MIL-217)	All		TBD		10^6 Hrs.	MIL-HDBK-217F; 100% load, 200LFM, 40°C T_a
Field Demonstrated MTBF	All				10^6 Hrs.	See our website for details

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. Contact SynQor for official safety certificates on new releases or download from the SynQor website.

QUALIFICATION TESTING

Parameter	# Units	Test Conditions
QUALIFICATION TESTING		
Life Test	32	95% rated V_{in} 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, 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 qualification documents.

OPTIONS

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

PATENTS

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

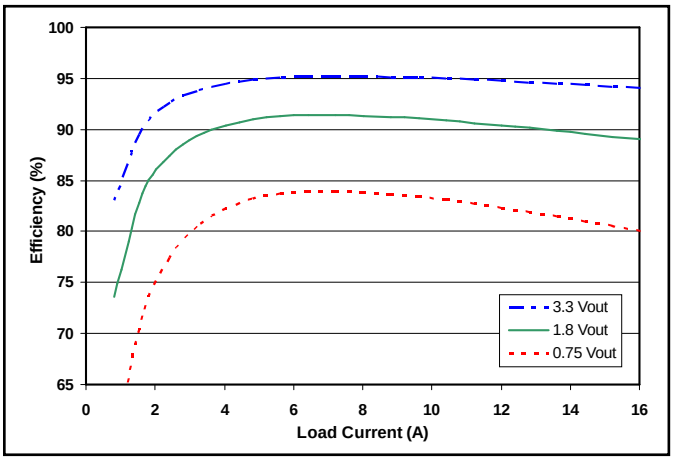


Figure 1: *Efficiency at nominal output voltage vs. load current for nominal input voltage at 25°C.*

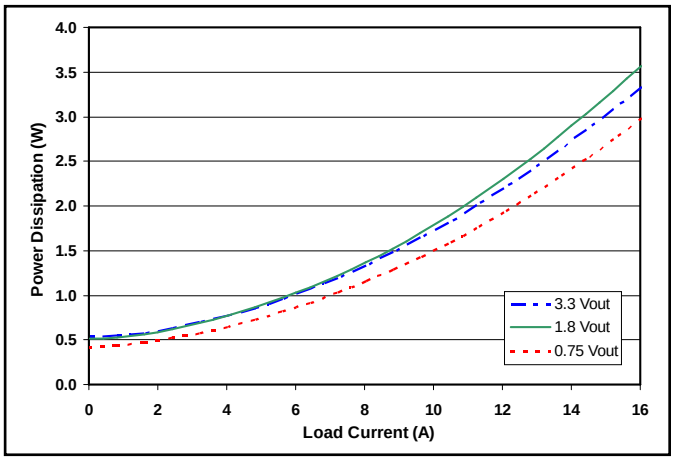


Figure 2: *Power dissipation at nominal output voltage vs. load current for nominal input voltage at 25°C.*

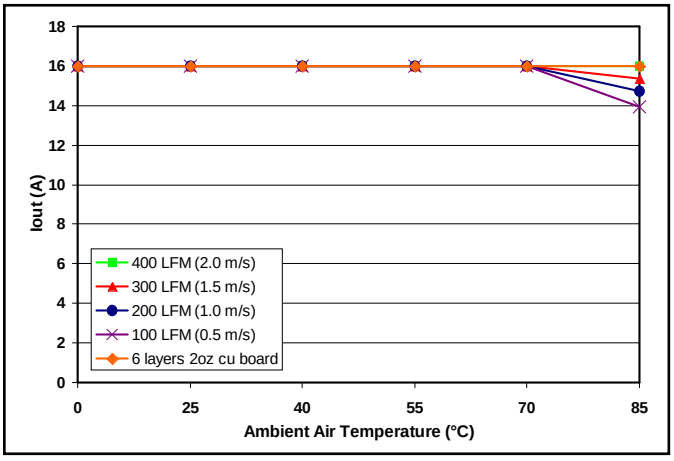


Figure 3: *Maximum output power derating curves for **0.75Vo, 1.2Vo** units under various thermal conditions and nominal input voltage. See Thermal Considerations section for more details.*

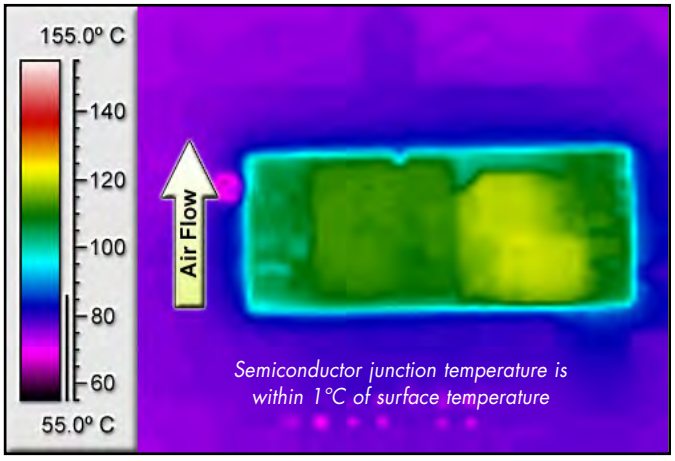


Figure 4: *Thermal plot of **0.75Vo, 1.2Vo** converters at nominal Vin and 16 amp load current mounted on a 85°C, 6-Layer, 2 oz. copper board (typical installation).*

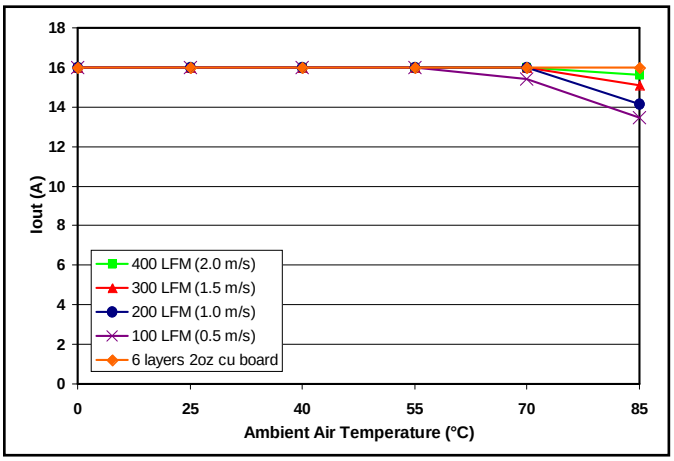


Figure 5: *Maximum output power derating curves for **1.5Vo, 1.8Vo** units under various thermal conditions and nominal input voltage. See Thermal Considerations section for more details.*

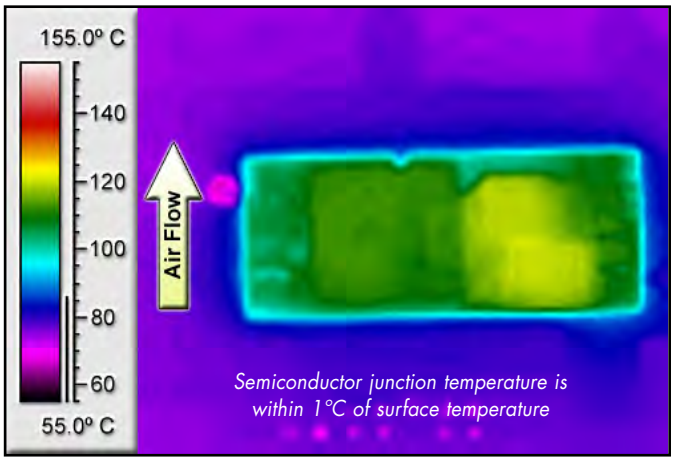


Figure 6: *Thermal plot of **1.5Vo, 1.8Vo** converters at nominal Vin and 16 amp load current mounted on a 85°C, 6-Layer, 2 oz. copper board (typical installation).*

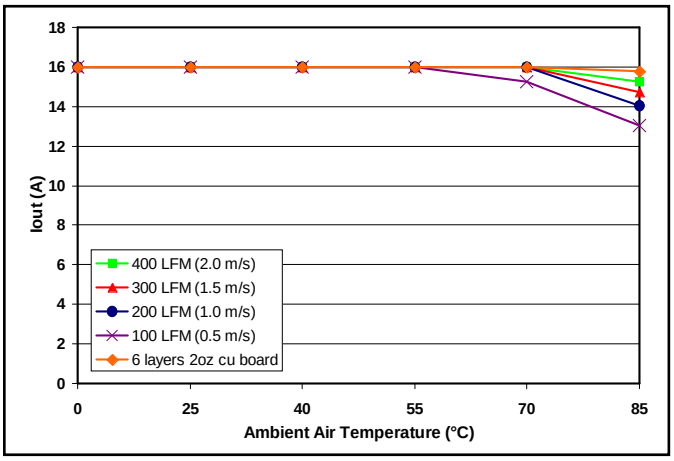


Figure 7: *Maximum output power derating curves for* ***2.5Vo, 3.3Vo*** *units under various thermal conditions and nominal input voltage. See Thermal Considerations section for more details.*

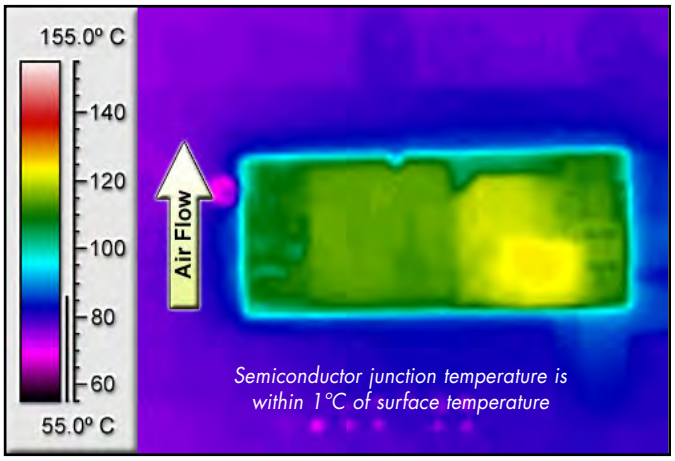


Figure 8: *Thermal plot of* ***2.5Vo, 3.3Vo*** *converters at nominal Vin and 16 amp load current mounted on a 85°C, 6-Layer, 2 oz. copper board (typical installation).*

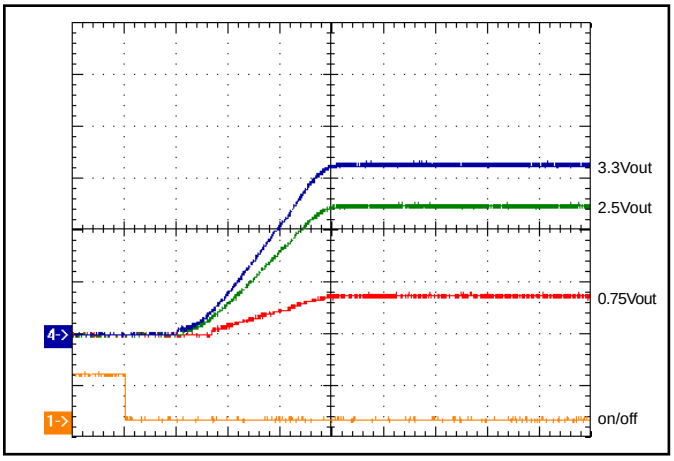


Figure 9: *Turn-on transient at full load (resistive load) (400 µs/div).*
Ch 1: ON/OFF input (5V/div)
Ch 2-4: Vout (1V/div)

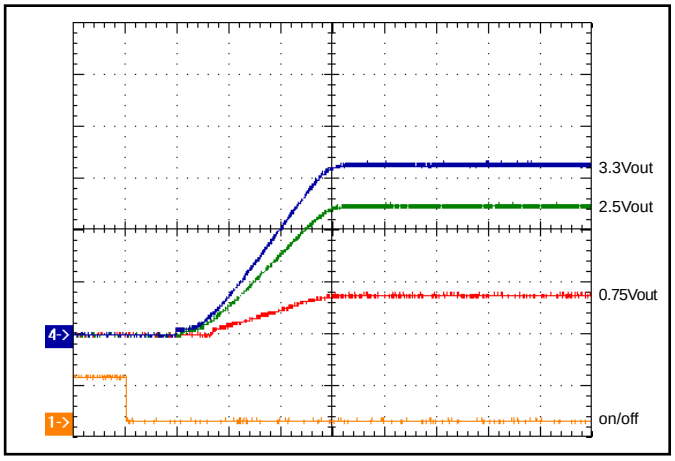


Figure 10: *Turn-on transient at zero load (400 µs/div).*
Ch 1: ON/OFF input (5V/div)
Ch 2-4: Vout (1V/div)

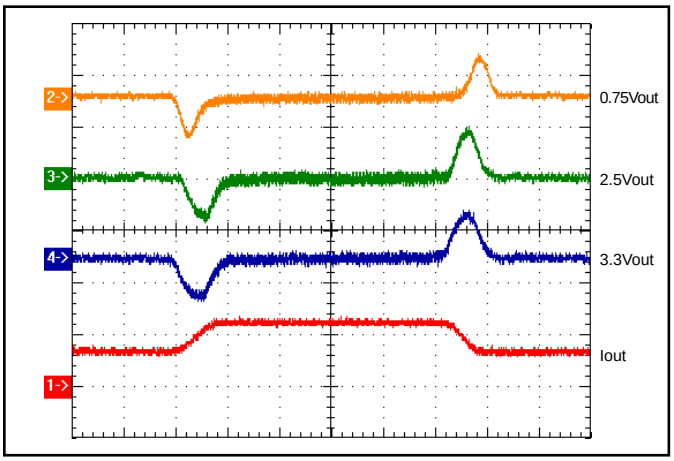


Figure 11: *Output voltage response for* ***0.75V, 2.5V, 3.3V units*** *to step-change in load current (50-75-50% of Iout max; di/dt=0.1A/µs). Load cap: 100µF, 100mΩ ESR tant, 10µF cer. Ch 1: Iout (10A/div), Ch 2-4: Vout (100mV/div).*

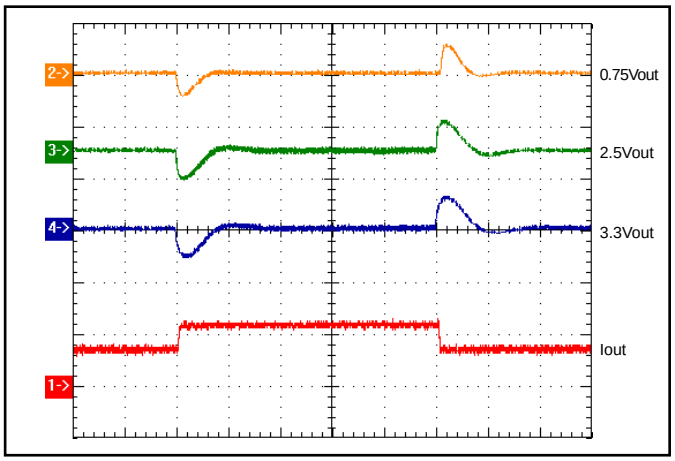


Figure 12: *Output voltage response for* ***0.75V, 2.5V, 3.3V units*** *to step-change in load current (50-75-50% of Iout max; di/dt=3A/µs). Load cap: 470µF, 100mΩ ESR tant, 10µF cer. Ch 1: Iout (10A/div), Ch 2-4: Vout (200mV/div).*

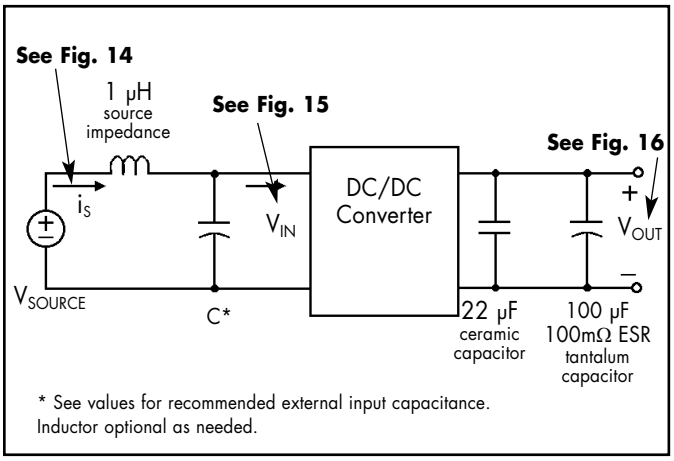


Figure 13: *Test set-up diagram showing measurement points for Input Reflected Ripple Current (Figure 14), Input Terminal Ripple Voltage (Figure 15), and Output Voltage Ripple (Figure 16).*

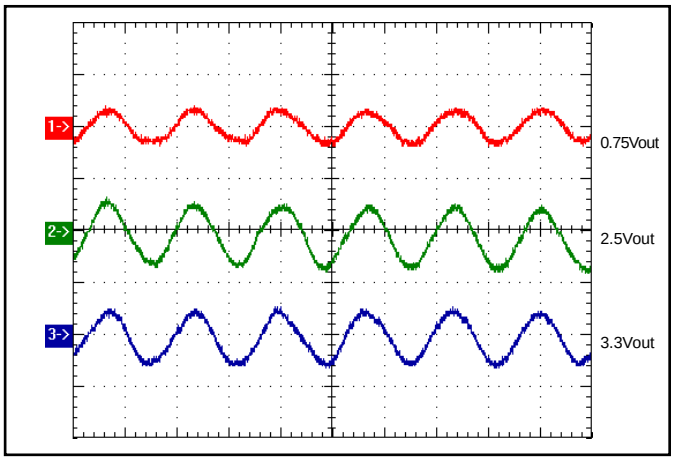


Figure 14: *Input Reflected Ripple Current, i_S, through a 1 µH source inductor at nominal input voltage and rated load current (10 mA/div). See Figure 13.*

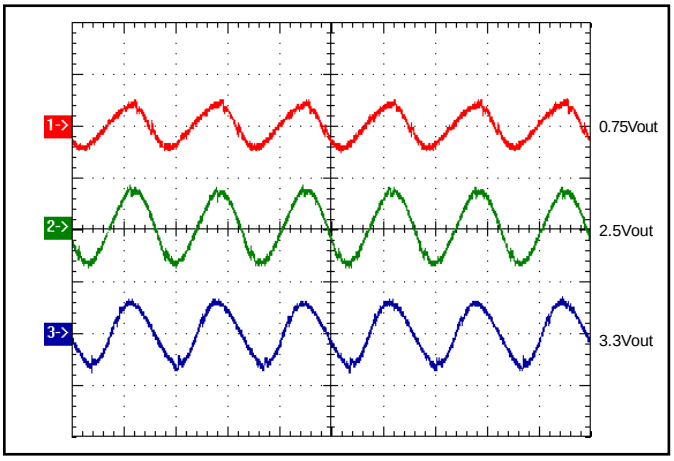


Figure 15: *Input Terminal Ripple Voltage at nominal input voltage and rated load current (200 mV/div). Load capacitance: 22µF ceramic cap and 100µF tantalum cap. Bandwidth: 20 MHz. See Figure 13.*

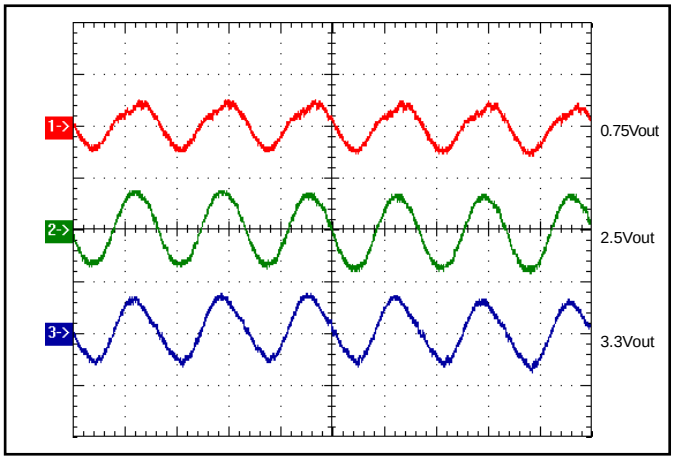


Figure 16: *Output Voltage Ripple at nominal input voltage and rated load current (20 mV/div). Load capacitance: 22µF ceramic cap and 100µF tantalum cap.. Bandwidth: 20 MHz. See Figure 13.*

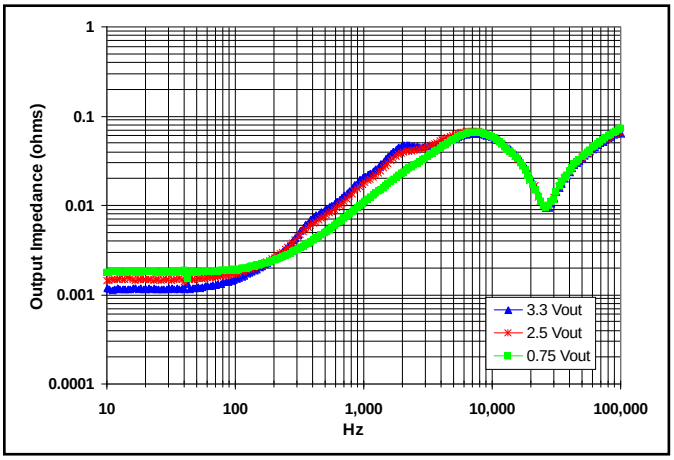


Figure 17: *Magnitude of incremental output impedance (Z_{out} = v_{out}/i_{out}) for nominal input voltage at full rated power with 100µF tantalum output capacitor.*

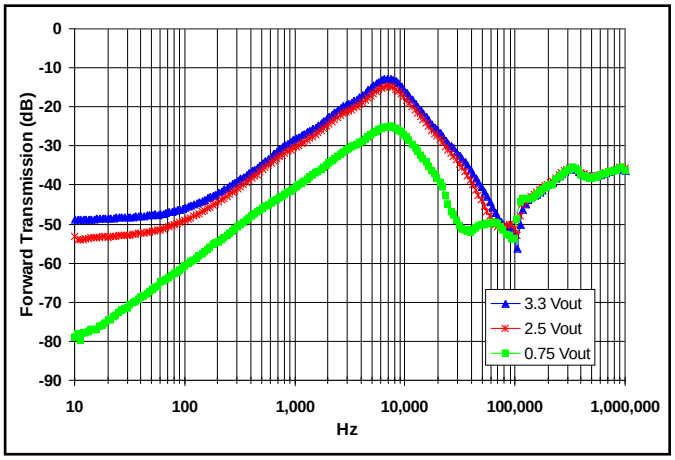


Figure 18: *Magnitude of incremental forward transmission (FT = v_{out}/v_{in}) for nominal input voltage at full rated power with 100µF tantalum output capacitor.*

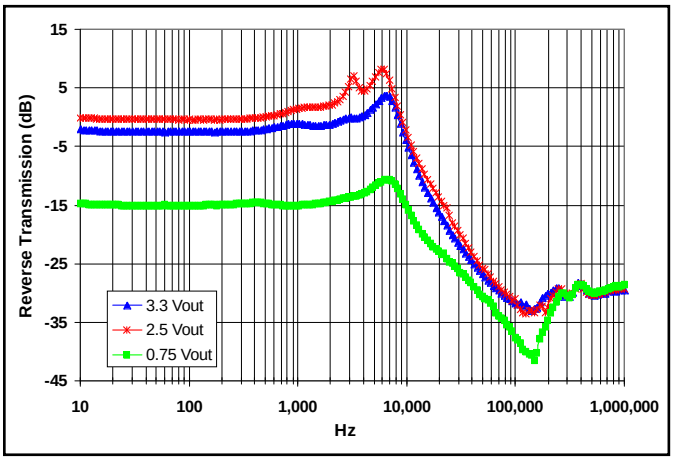


Figure 19: *Magnitude of incremental reverse transmission (RT = i_{in}/i_{out}) for nominal input voltage at full rated power with 100µF tantalum output capacitor.*

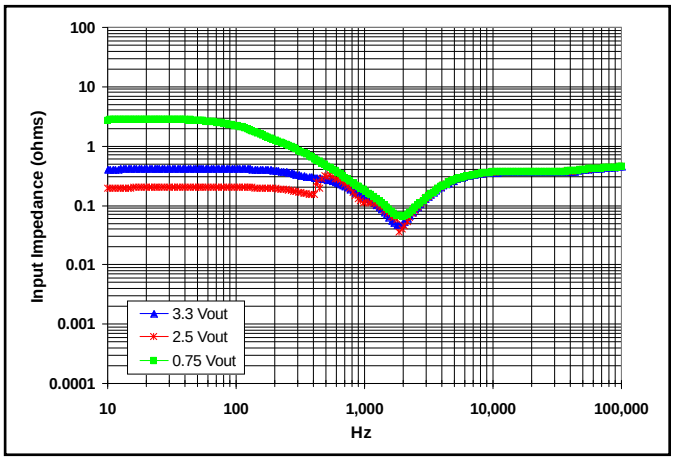


Figure 20: *Magnitude of incremental input impedance ($Z_{in} = v_{in}/i_{in}$) for nominal input voltage at full rated power with 100µF tantalum output capacitor.*

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.

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

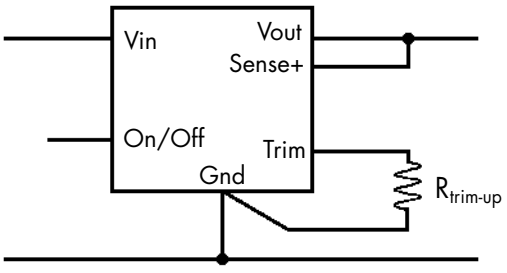
CONTROL FEATURES

REMOTE ON/OFF: The ON/OFF input permits the user to control when the converter is on or off. There are currently two options 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	5	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 set-point of 0.7525V using an external resistor, connect the resistor $R_{trim\text{-}up}$ between the TRIM and the Ground pin according to the diagram below.



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

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

or

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

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 not 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 to the converter's control circuit.

VOLTAGE SEQUENCING: This module includes a sequencing feature that enables users to implement various types of output voltage sequencing in their applications. This is done via an additional sequencing pin. When not using the sequencing feature, either tie the SEQ pin to VIN or leave it unconnected.

When an analog voltage is applied to the SEQ pin, the output voltage tracks this voltage until the output reaches the set-point voltage. The output follows the voltage on the SEQ pin on a one-to-one volt basis.

For proper voltage sequencing, input voltage is first applied to the module. The ON/OFF pin of the module is left unconnected (or tied to GND for negative logic modules or tied to VIN for positive logic modules) so that the module is ON by default. After applying an input voltage to the module, a minimum of 10msec delay is required before applying a voltage on the SEQ pin. During this time, a potential of 50mV (± 10 mV) is maintained on the SEQ pin. After a 10msec delay, an analog voltage is applied to the SEQ pin and the output of the module will track this voltage on a one-to-one volt basis until the output reaches the set-point voltage.

To initiate simultaneous shutdown of the modules, the SEQ pin voltage is lowered in a controlled manner. The output voltage of the modules tracks the voltages below their set-point voltages on a one-to-one basis. A valid input voltage must be maintained until the tracking and output voltages reach ground potential to

ensure a controlled shutdown of the modules.

By connecting multiple modules together, customers can get the units to track their output voltages to the voltage applied on the SEQ pin. This module has both simultaneous and ratio metric options for the TRACK function.

Simultaneous Startup: The circuit configuration is shown in Figure A. The circuit works by providing the same control voltage to the SEQ pins of multiple modules (two in this case).

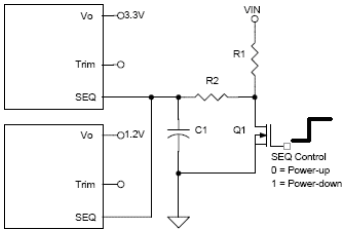


Figure A: *Circuit configuration for simultaneous start-up.*

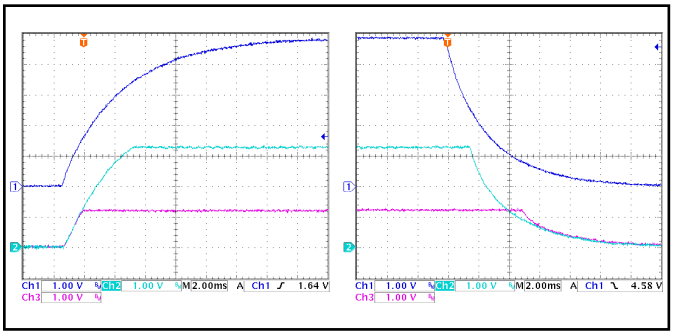


Figure B: *Ch1: Appling voltage on SEQ pin; Ch2: output of Unit #1; Ch3: output of unit #2. Simultaneous power up and power down.*

Ratiometric Startup: This is achieved by applying control voltages proportional to the respective nominal output voltages to the SEQ pins of the two modules. These proportional voltages on the SEQ pins will result in two different output slew-rates, with each module reaching its set-point voltage at approximately the same time instant. Figure C shows the circuit configuration with proportional control voltages applied to each of the two modules. Figure D shows the ratiometric power-up and power down sequence with control voltages on the SEQ pins and the resulting output voltages.

Values of R3 and R4 for desired output voltages can be determined by the following equation:

$$\frac{V2}{V1} = \frac{R4}{R3 + R4}$$

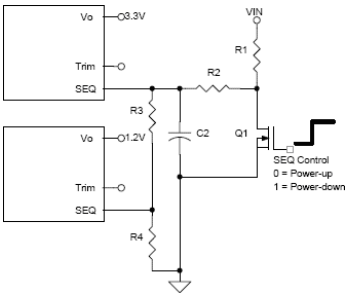


Figure C: *Circuit configuration for ratiometric startup.*

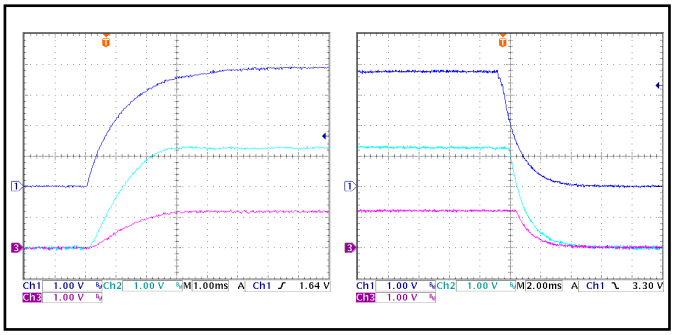


Figure D: *Ch1: Appling voltage on SEQ pin; Ch2: output of Unit #1; Ch3: output of unit #2. Ratiometric power up and power down.*

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 NQ04 family of converters employs foldback current limiting. Current limit is reached at about 125% 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 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 NQ04 series contains an Output Over-Voltage Shutdown circuitry.

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 4.2V, in the wide-trim W33 model.

The shutdown point is fixed on standard option. SMA also offers adjustable OVP set point. For more detailed information contact SynQor technical support.

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 E is often added to the converter's input to prevent switching noise from reaching the input voltage bus.

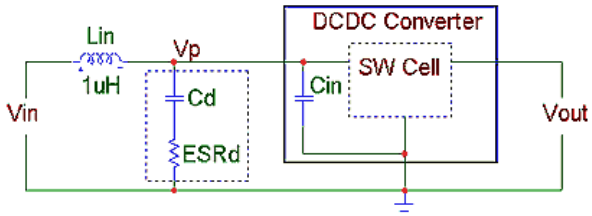


Figure E: *NQ04 converter with Input Filter*

In the SMA16 (surface mount) converters Cin = 30µF of high quality ceramic capacitors. With Lin of 1µH, Cd should be 100-200µF and Rd should be 0.1-0.2Ω, 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 10-20mΩ at the 300kHz switching frequency. To avoid this high-frequency resonance, any external input filter should exhibit a net source impedance of at least 20mΩ resistive through this frequency range. This requirement is easily met with the damping elements discussed above. Adding a small amount (a few µF) 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: It is recommended to add at least 100µF of capacitance, with an ESR in the 0.1Ω range, to the output of the SMA16 series of converters. The VMA16 series has this capacitance included internally. In many applications, however, additional external output capacitance is required to reduce the response to load transients to an allowable level.

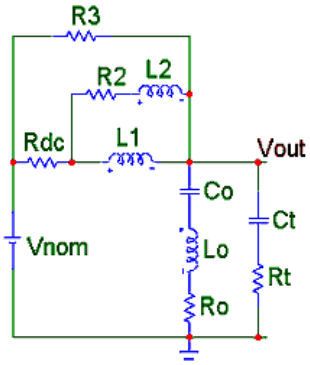


Figure F: *NQ04 Passive Output Model*

The output impedance of these converters can be quite accurately modeled from DC to about 100kHz as shown in Figure F. A further simplified version of it, valid below 40Hz and above 1kHz, is shown in Figure G. In the SMA16 case, the models depict the minimum recommended output capacitance, Ct with its resistance Rt. In the VMA16 family, that capacitor is again included in the converter.

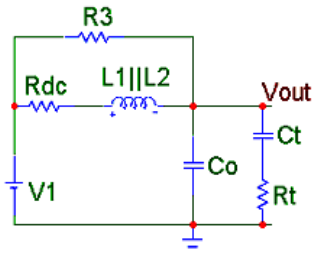


Figure G: *Simplified NQ04 Output Model*

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

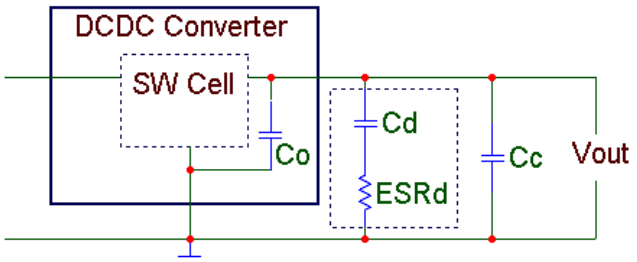


Figure H: *Converter with Additional Output Capacitance*

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

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

For more detailed derivations of these values contact SynQor technical support.

Thermal Performance (SMA16): While impossible to be exact, a simplified thermal model for the mounted converter is detailed below.

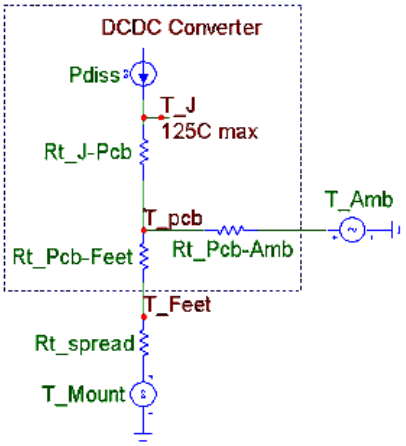


Figure I: *Thermal Model for NQ04 Surface Mount*

- Rt_J-Pcb models the conduction of heat from the converter's hottest junction to the converter's PCB at large. It is about 3°C/W for converters running at higher output voltage, and about 4°C/W for lower voltage converters.
- Rt_Pcb-Amb models the power dissipation from converter PCB to the air stream. It ranges from about 15°C/W at 400LFM to about 25°C/W 100LFM.
- Rt_Pcb-Feet expresses the thermal path from the converter's PCB though its mounting feet; it is about 3°C/W.
- Rt_spread models the heat spreading on the PCB to which the converter is mounted and is largely dependent upon the construction and layout of that PCB.
- T_mount is the temperature of that PCB in the greater vicinity of the converter.

As is evident, the values for Rt_spread and T_mount will have great effect upon the thermal operation of the converter. With Rt_Pcb-Amb being 5 to 8 times as large as Rt_Pcb-Feet, in most applications these converters will be predominantly cooled via thermal conduction through their feet. Airflow and T_Amb will have only a minimal cooling effect.

- Rt_spread should be minimized. Attach the converter to large copper planes, on multiple layers, with multiple vias near the mounting feet.
- T_mount should also be minimized. Place the converter far enough away from other sources of heat on the PCB so that it is as cool as practical.
- If operation near derating limits is even suspected, thermal performance should be verified with the unit mounted in its intended manner and powered in circuit with all neighboring circuitry active. Attach a thermocouple to the converter's hotspot as shown in Figures 4, 6, and 8 in the Performance Curves section.

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.

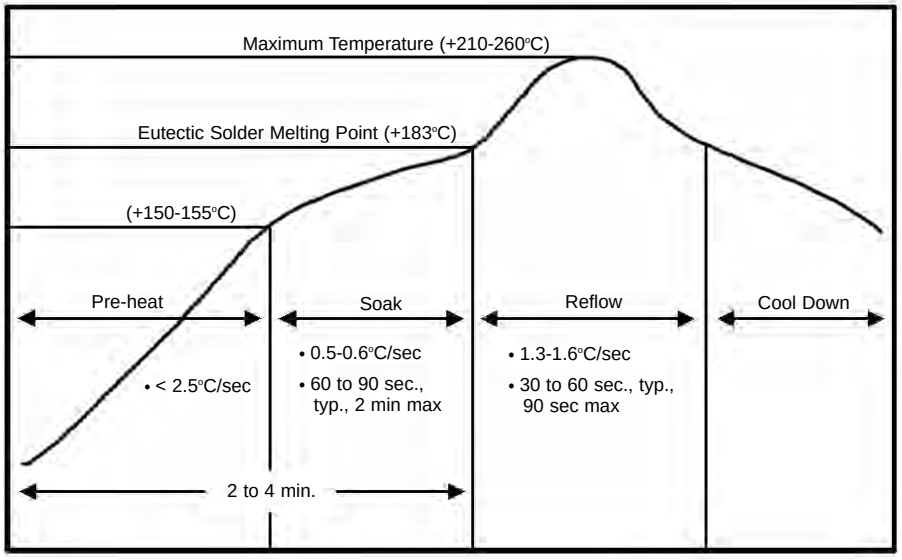


Figure J: *Typical Eutectic (96.5Sn/3.0Ag/0.5Cu) Solder Profile*

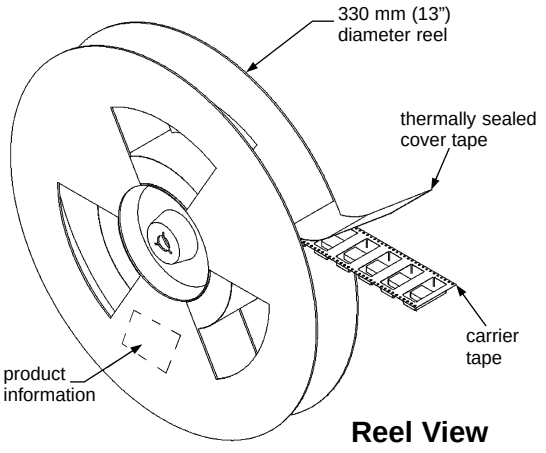
Lead-Free Soldering: The *NiQor* surface mount modules are manufactured with lead free solder and PCB finish and meet the conditions for Lead-Free Class 3 status. Users who wish to assemble the modules in a Lead-Free solder process may require peak reflow temperatures exceeding 240°C. The maximum allowable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

Moisture Sensitivity: The 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.

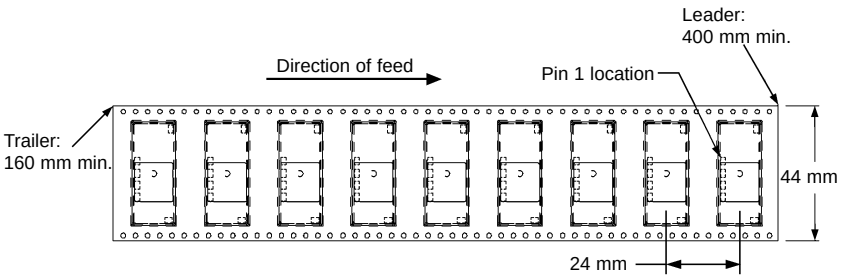
Tape & Reel Packaging: The *NiQor* SMT modules are supplied in tape and reel packaging in quantities of 320 units per reel. Packaging conforms to EIA-481 standards. Tape and reel dimensions are shown in the diagram below.

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.



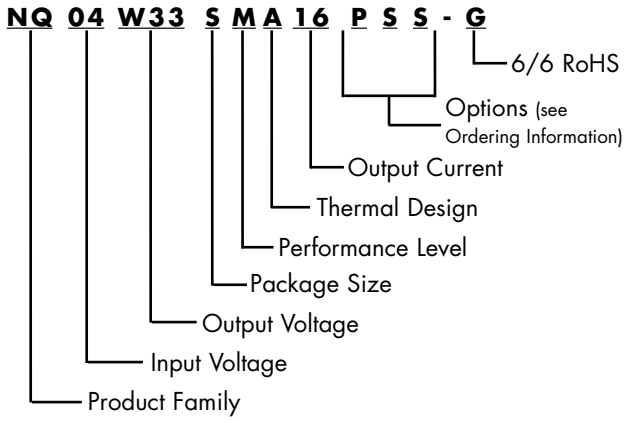
Reel View

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 last 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.

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

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. A "-G" suffix indicates the product is 6/6 RoHS compliant.

Model Number	Input Voltage	Voltage	Current
NQ04W33*p* MA16*xyz* -G	2.4 - 6.0 V	0.75-3.6V	16 A

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

Packaging: *p*	**Options Description: *x y z***		
Packaging	**Enable Logic**	**Pin Style**	**Feature Set**
S - SMT V - SIP	P - Pos./Open O - Neg./Open	S - Standard	S - Sense Z - Sequencing R - Sense & Seq. N - None

Contact SynQor for further information:

Phone: 978-849-0600
Toll Free: 888-567-9596
Fax: 978-849-0602
E-mail: power@synqor.com
Web: www.synqor.com
Address: 155 Swanson Road
Boxborough, MA 01719
USA

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