SynQor

Technical Specification

Half Brick $48V_{in}$ $1.5V_{out}$ $40A_{out}$

40 Amp, No Heatsink, Isolated DC/DC Converter

The PQ48015HNA40 PowerQor™ converter is a next-generation, board-mountable, isolated, fixed switching frequency dc/dc converter that uses synchronous rectification to achieve extremely high conversion efficiency. The power dissipated by the converter is so low that a heatsink is not required, which saves cost, weight, height, and application effort. All of the power and control components are mounted to the multi-layer PCB substrate with high-yield surface mount technology. Since the PowerQor converter has no explicit thermal connections, the PowerQor converter is very reliable.

PowerQor™

PQ48015HNA40 Module

Features

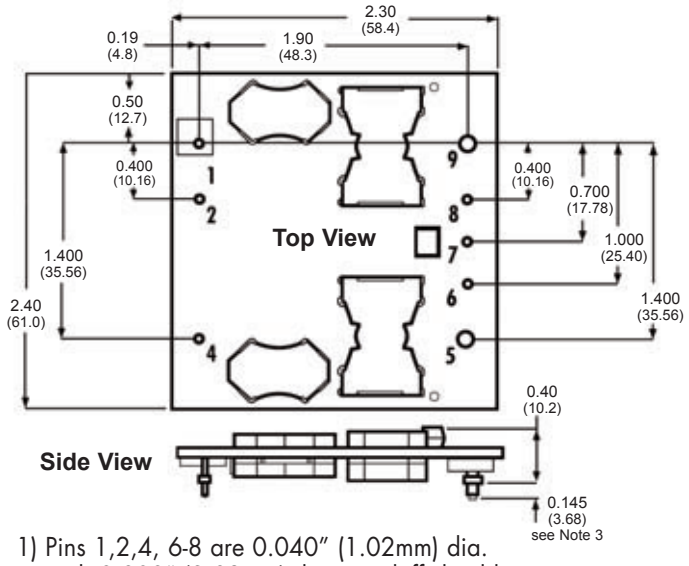
- Ultra-high efficiency, over 82% at 40 amps
- Industry standard pin-out configuration (pin for pin compatible with Lucent JW150 series)
- Industry standard size: 2.3″ x 2.4″
- Total height only 0.40″
- Total weight: 58 grams (2.0 oz.)
- Wide input voltage range: 36V – 75V
- On/Off control referenced to input side (positive and negative logic options are available)
- Remote sense for the output voltage
- Output voltage trim: +20%/-10%
- Input under-voltage lockout and over-voltage shutdown
- Output current limit and short ciruit protection
- Output over-voltage protection
- Thermal shutdown
- 2000V, 10 MΩ input-to-output isolation
- UL 1950 recognized (US & Canada) basic insulation rating, TUV certified to EN60950
- Meets 72/23/EEC and 93/68/EEC directives

Benefits

- Reduces dissipated heat; saves energy, more current
- Pin and feature compatible with older dc/dc converters
- Small footprint saves board space
- Extremely low profile permits better airflow and smaller card pitch in the rack
- Greatly reduces vibration and shock problems
- Meets or exceeds all 48V bus standards
- Converter turn-on/off can be sequenced
- Compensates for output distribution drops
- Permits custom voltages and voltage margining
- Protects against input system instability and input system induced failure
- Protects the converter against excessive load current or a short circuit condition
- Protects the load from a damaging voltage
- Protects the converter against abnormal environmental conditions
- Provides input/output ground separation
- Provides a Safety Extra Low Voltage output and non-flammability
- Facilitates CE Marking in user's end product

Technical Specification

Half Brick $48V_{in}$ $1.5V_{out}$ $40A_{out}$



1) Pins 1,2,4, 6-8 are 0.040″ (1.02mm) dia. with 0.080″ (2.03mm) dia. standoff shoulders.
2) Pins 5 and 9 are 0.080″ (2.03 mm) dia. with 0.125″ (3.18mm) dia. standoff shoulders.
3) Other pin extension lengths available. All pins are Brass with Tin/Lead plating over Nickel
4) Undimensioned components for visual reference only.
5) Weight: 2.0 oz. (58 g)
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) Workmanship: Meets or exceeds IPC-A-610B Class II

ABSOLUTE MAXIMUM RATINGS

Input Voltage:
- Non-Operating: 100V continuous
- Operating: 80V continuous

Input/Output Isolation Voltage: 2000V
Storage Temperature: -55°C to +125°C
Operating Temperature: -40°C to +115°C
Voltage at ON/OFF input pin: +18V / -4V

Shown Actual Size

Pin No.	Name	Function
1	Vin(+)	Positive terminal for the +48V input bus
2	ON/OFF	Logic signal to turn converter on and off, referenced to Vin(-). Positive and negative logic versions available.
4	Vin(-)	Return terminal for the +48V input bus
5	Vout(-)	Return terminal for the 1.5V output voltage
6	SENSE(-)	Return remote sense
7	TRIM	Output voltage trim
8	SENSE(+)	Positive remote sense
9	Vout(+)	Positive terminal for the 1.5V output voltage

OPTIONS

The PQ48015HNA40 comes in two versions that differ by the sense of the logic used for the ON/OFF control signal. The PQ48015HNA40P version uses positive logic; meaning that the converter is on when the ON/OFF signal (Pin 2) is high. The PQ48015HNA40N version uses negative logic; the converter is on when the ON/OFF signal is low.

Patents: SynQor is protected under various patents, including but not limited to U.S. Patent # 5,999,417.

SAFETY

The PQ48015HNA40 series of converters are UL 1950 recognized (US & Canada) with basic insulation rating and TUV certified to EN60950 requirements.

The converters also meet 72/23/EEC and 93/68/EEC directives as well as 94V-0 flammability requirements for board and plastic components.

An external input fuse must always be used to meet these safety requirements.

PQ48015HNA40 ELECTRICAL CHARACTERISTICS

(T_A=25°C, airflow rate=300 LFM, V_{in}=48Vdc unless otherwise noted; full operating temperature range is -40°C to +100°C with appropriate power derating.)

PARAMETER	NOTES and CONDITIONS	PQ48015HNA40			
		Min.	Typ.	Max.	Units
INPUT CHARACTERISTICS					
Operating Input Voltage Range		36	48	75	V
Input Under-Voltage Lockout					
Turn-On Voltage Threshold		33.2	34.5	35.5	V
Turn-Off Voltage Threshold		30.2	31.5	33	V
Lockout Hysteresis Voltage		2.9	3	3.1	V
Input Over-Voltage Shutdown					
Turn-Off Voltage Threshold		77	78.5	79.5	V
Turn-On Voltage Threshold		76	77	78	V
Shutdown Hysteresis Voltage		1.4	1.5	1.6	V
Maximum Input Current	100% Load			1.8	A
No-Load Input Current			70	80	mA
Off Converter Input Current			1.6	3	mA
Inrush Current Transient Rating			.01		A^2s
Input Reflected-Ripple Current	RMS, thru 10µH with 47µF electrolytic on input		3		mA
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	50% load	1.48	1.50	1.52	V
Output Voltage Regulation					
Over Load			±4	±8	mV
Over Line			±4	±8	mV
Over Temperature			±15	±30	mV
Total Output Voltage Range			TBD		V
Output Voltage Ripple and Noise	20MHz bandwidth				
Peak-to-Peak			15	30	mV
RMS			5	10	mV
Operating Output Current Range		0		40	A
Output DC Current-Limit Inception	Output Voltage 10% Low	41	43	49	A
Output DC Current-Limit Shutdown Voltage			1.05		V
Output Short-Term Shutdown Current-Limit			100		A
Short-Circuit Surge Current Transient Rating			0.25		A^2s
DYNAMIC CHARACTERISTICS					
Input Voltage Ripple Rejection	120 Hz		60		dB
Output Voltage Current Transient					
Positive Step Change in Output Current	50% Io to 75% Io		350		mV
Negative Step Change in Output Current	75% Io to 50% Io		350		mV
Settling Time to 1%			300		µs
Turn-On Transient					
Turn-On Time			4		ms
Output Voltage Overshoot	10mF load capacitance, Iout = 0A			0	%
EFFICIENCY					
100% Load	Figure 1		82.2		%
80% Load			84.4		%
60% Load			85.6		%
40% Load			85.4		%
TEMPERATURE LIMITS FOR POWER DERATING CURVE					
Semiconductor Junction Temperature	Package rated to 150°C			125	°C
Board Temperature	Board rated to 165°C			125	°C
Transformer Temperature	Figures 3 & 4			125	°C
ISOLATION CHARACTERISTICS					
Isolation Voltage		2000			V
Isolation Resistance		10			MΩ
Isolation Capacitance			3300		pF
FEATURE CHARACTERISTICS					
Switching Frequency		207	230	253	kHz
ON/OFF Control (Option P)					
Off-State Voltage		0		0.8	V
On-State Voltage		2.7		15	V
ON/OFF Control (Option N)					
Off-State Voltage		2.7		15	V
On-State Voltage		0		0.8	V
ON/OFF Control (Either Option)					
Pull-Up Voltage			Vin/6	15	V
Pull-Up Resistance			20		kΩ
Output Voltage Trim Range	Across Pins 9 & 5; Figures A & B	-10		+20	%
Output Voltage Remote Sense Range	Across Pins 9 & 5			+10	%
Output Over-Voltage Protection			125		%
Over-Temperature Shutdown	Average PCB Temperature		115		°C

Specifications subject to change without notice.

Performance Curves

Half Brick $48V_{in}$ $1.5V_{out}$ $40A_{out}$

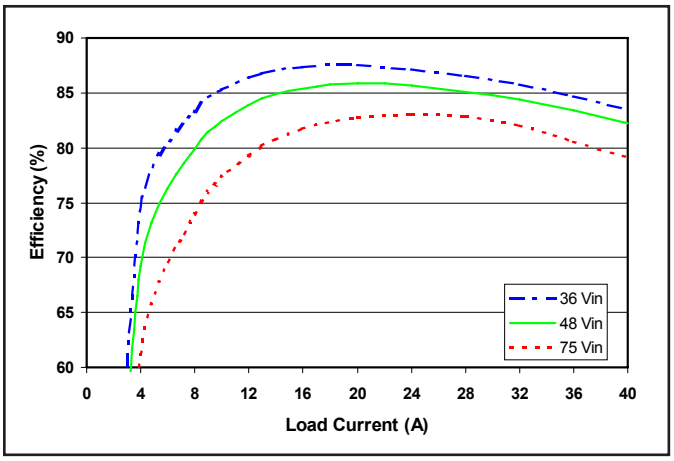


Figure 1: *Efficiency vs. load current for minimum, nominal, and maximum input voltage at 25°C.*

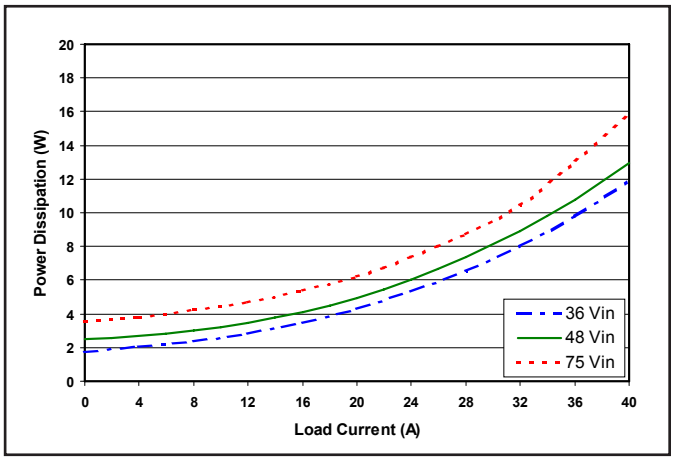


Figure 2: *Power dissipation vs. load current for minimum, nominal, and maximum input voltage at 25°C.*

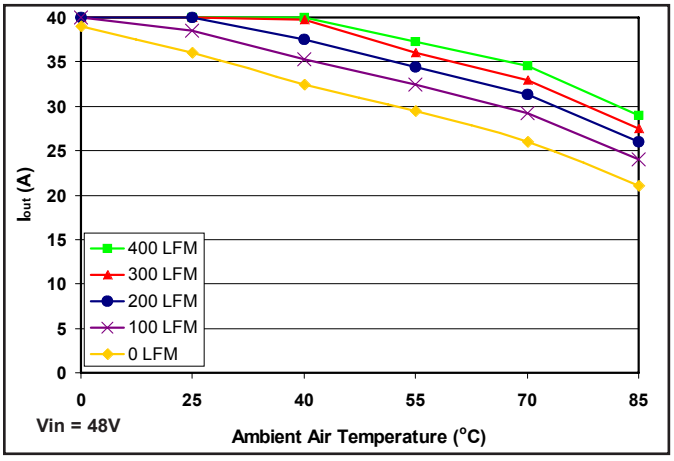


Figure 3: *Maximum output power-derating curves vs. ambient air temperature for airflow rates of 0 LFM through 400 LFM with air flowing from output to input (nominal input voltage).*

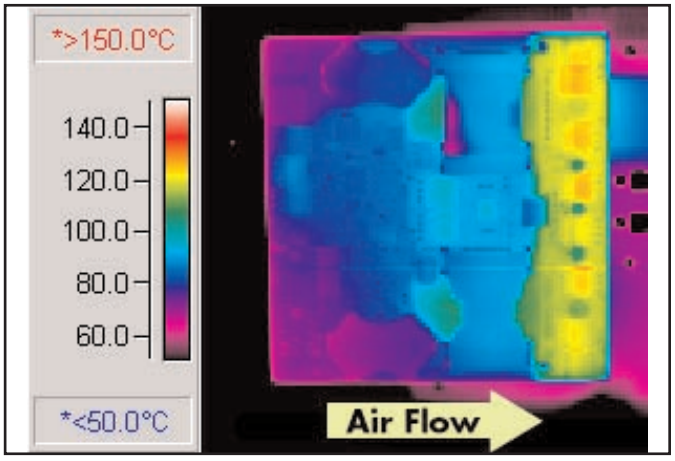


Figure 4: *Thermal plot of converter at 40 amp load current with 40°C air flowing at the rate of 300 LFM. Air is flowing across the converter from input to output (nominal input voltage).*

BASIC OPERATION AND FEATURES

The *Power*Qor series converter uses a two-stage power circuit topology. The first stage is a buck-converter that keeps the output voltage constant over variations in line, load, and temperature. The second stage uses a transformer to provide the functions of input/output isolation and voltage step-down to achieve the low output voltage required.

Both the first stage and the second stage switch at a fixed frequency for predictable EMI performance. Rectification of the transformer's output is accomplished with synchronous rectifiers. These devices, which are MOSFETs with a very low on-state resistance, dissipate far less energy than Schottky diodes used in conventional dc/dc converters. This is the primary reason that the *Power*Qor converter has such high efficiency—even at very low output voltages and very high output currents.

Dissipation throughout the converter is so low that the ***Power*Qor converter requires no heatsink** to deliver a greater level of power than can be delivered by a conventional, Schottky-diode-based dc/dc converter with a 0.5" high heatsink. At equivalent ambient air temperature, airflow rate, and output power level, the hottest semiconductor junction temperature and the hottest PCB temperature within the *Power*Qor converter are cooler than those found in conventional dc/dc converters with a 0.5" high heatsink attached.

Since a heatsink is not required, the *Power*Qor converter does not need a metal baseplate or potting material to help conduct the dissipated energy to the heatsink. The *Power*Qor converter can thus be built more simply using high yield surface mount techniques on a PCB substrate.

Unlike conventional dc/dc converters, which have critical thermal connections between the power components and the baseplate, and between the baseplate and the heatsink, the *Power*Qor converter has no explicit, failure-prone thermal connections.

Compared to a conventional Schottky-diode-based dc/dc converter with a 0.5" high heatsink, the *Power*Qor converter is more efficient and therefore it dissipates less than half the energy. Additionally, because the *Power*Qor converter is thinner (0.4" vs. 1.0"), the board-to-board pitch in a rack can be much smaller, and cooling airflow is less impeded by the converter. Because the *Power*Qor converter is much lighter, vibration and shock-induced problems are greatly reduced. Moreover, due to the lack of failure-prone explicit thermal connections and the lack of potting material the *Power*Qor converter is more reliable than conventional dc/dc converters.

The *Power*Qor series converter uses the industry standard pin-out configuration used by other vendors of comparably sized and rated dc/dc converters. The unit is pin for pin compatible with the Lucent JW series.

The *Power*Qor converter has many standard control and protection features:

- An **ON/OFF** input permits the user to control when the converter is *on* and *off* in order to properly sequence different power supplies and to reduce power consumption during a standby condition.
- **Remote sense** inputs permit the user to maintain an accurate voltage at the load despite distribution voltage drops between the converter's output and the load.
- An **output voltage trim** input permits the user to trim the output voltage up or down to achieve a custom voltage level or to do voltage margining.
- An **input under-voltage lockout** avoids input system instability problems while the input voltage is rising. An**input over-voltage shutdown** protects the converter from damage if the input voltage is too high.
- The **output current limit** protects both the converter and the board on which it is mounted against a short circuit condition.
- An **output over-voltage limit** circuit shuts the unit down if the output voltage at the output pins gets too high.
- A sensor located in a central spot of the PCB provides a **PCB temperature limit**. If, due to an abnormal condition, this spot gets too hot, the converter will turn off. Once the converter has cooled, it will automatically turn on again without the need to recycle the input power.

CONTROL PIN DESCRIPTIONS

Pin 2 (ON/OFF): The ON/OFF input, Pin 2, permits the user to control when the converter is *on* or *off*. This input is

referenced to the return terminal of the 48V input bus. There are two versions of the *Power*Qor series converter that differ by the sense of the logic used for the ON/OFF input. In the PQxxyyyHNA40Pzz version, the ON/OFF input is active high (meaning that a high turns the converter *on*). In the PQxxyyyQNA40Nzz version, the ON/OFF signal is active low (meaning that a low turns the converter *on*).

Pins 8 and 6 (SENSE(±)): The SENSE(±) inputs correct for voltage drops along the conductors that connect the converter's output pins to the load.

Pin 8 should be connected to Vout(+) and Pin 6 should be connected to Vout(-) at the point on the board where regulation is desired. That is,

$$[\text{Vout(+)} - \text{Vout(-)}] - [\text{SENSE(+)} - \text{SENSE (-)}] \leq 10\%\text{Vout}$$

Pins 8 and 6 must be connected for proper regulation of the output voltage. However, if these connections are not made, nothing catastrophic will happen to the converter under normal operating conditions—the converter will simply deliver an output voltage that is slightly higher than its specified value.

Note: the output over-voltage protection circuit senses the voltage across the sense leads (pins 8 and 6) to determine when it should trigger, not the voltage across the converter's output pins (pins 9 and 5).

Pin 7 (TRIM): The TRIM input permits the user to adjust the output voltage across the sense leads up or down. To lower the output voltage, the user should connect a resistor between Pin 7 and Pin 6, which is the SENSE(-) input. To raise the output voltage, the user should connect a resistor between Pin 7 and Pin 8, which is the SENSE(+) input.

A resistor connected between Pin 7 and Pin 6 will decrease the output voltage. For a desired decrease of Δ percent of the nominal output voltage, the value of this resistor should be

$$R_{trim\text{-}down} = \left(\frac{100\%}{\Delta}\right) - 2 \quad (\text{in k}\Omega)$$

where

$$\Delta = \left(\frac{V_{NOM} - V_{DES}}{V_{NOM}}\right) \times 100\%$$

and

V_{NOM} = Nominal Voltage
V_{DES} = Desired Voltage

Figure A graphs this relationship between $R_{trim\text{-}down}$ and Δ. The output voltage can be trimmed down as much as 10%.

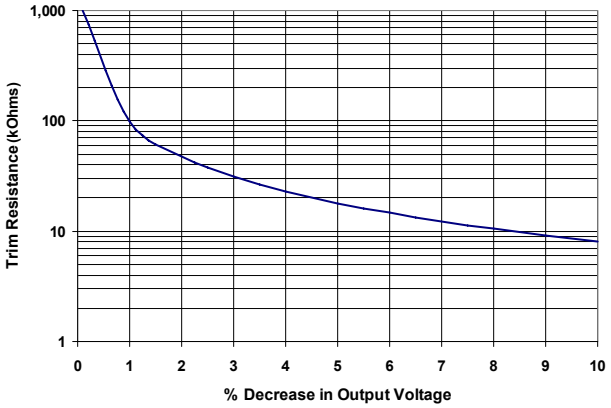


Figure A: Trim Down Graph for 1.5Vout

A resistor connected between Pin 7 and Pin 8 will increase the output voltage. For a desired increase of Δ percent of the nominal output voltage, the value of this resistor should be

$$R_{trim\text{-}up} = \frac{\left(\frac{V_{NOM}}{V_{REF}} - 2\right) \bullet V_{DES} + V_{NOM}}{V_{DES} - V_{NOM}} \quad (\text{in k}\Omega)$$

where

V_{NOM} = Nominal Voltage
V_{DES} = Desired Voltage
V_{REF} = 1.225 Volts

Figure B graphs this relationship between Rtrim-up and Δ. The output voltage can be trimmed up as much as 20%.

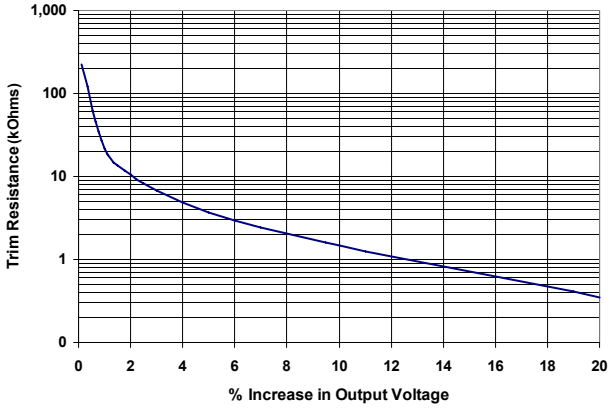


Figure B: Trim Up Graph for 1.5Vout

Note: the TRIM feature does not affect the voltage at which the output over-voltage protection circuit is triggered. Trimming the output voltage too high may cause the over-voltage protection circuit to engage, particularly during transients.

TOTAL DC VARIATION OF Vout: For the converter to meet its full specifications, the maximum variation of the dc value of Vout, due to both trimming and remote load voltage drops, should not be greater than +20%/-10%

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. The lockout circuitry is a comparator with dc hysteresis. When the input voltage is rising, it must exceed a typical value of 34.5V before the converter will turn on. Once the converter is on, the input voltage must fall below a typical value of 31.5V before the converter will turn off.

Input Over-Voltage Shutdown: The converter also turns off when the input voltage is too high. This protection feature allows the converter to withstand an input voltage as high as 100V without destruction. The shutdown circuitry is a comparator with dc hysteresis. When the input voltage exceeds a typical value of 78.5V, the converter will turn off. Once the converter is off, it will turn back on when the input voltage falls below a typical value of 77V.

Output Current Limit: The current limit does not change appreciably as the output voltage drops. However, once the impedance of the short across the output is small enough to make the output voltage drop below approximately 60% of its nominal value, the converter turns off.

The converter then enters a mode where it repeatedly turns on and off at a 5 Hz (nominal) frequency with a 5% duty cycle until the short circuit condition is removed. This prevents excessive heating of the converter or the load board.

Output Over-Voltage Limit: If the voltage across the output pins exceeds the O.V. threshold, the converter will immediately stop switching. This prevents damage to the load circuit due to 1) a sudden unloading of the converter, 2) a release of a short-circuit condition, or 3) a release of a current limit condition. Load capacitance determines exactly how high the output voltage will rise in response to these conditions.

Thermal Shutdown: The *Power*Qor series has a temperature sensor located such that it senses the average temperature of the converter. The thermal shutdown circuit is designed to turn the converter off when the temperature at the sensed location reaches 115°C. It will allow the converter to turn on again when the temperature of the sensed location falls below 110°C.

APPLICATION CONSIDERATIONS

Input System Instability: This condition can occur because a dc/dc converter appears incrementally as a negative resistance load. A detailed application note titled "Input System Instability" is available on the SynQor web site (www.synqor.com) which provides an understanding of why this instability arises, and shows the preferred solution for correcting it.

Multiple Converters: When using multiple converters for the same load board, consult SynQor factory for additional application notes.

Other application notes can be found on the SynQor web site or consult a technical support engineer at SynQor.

PART NUMBERING SYSTEM

The part numbering system for SynQor's *Power*Qor DC/DC converters has the following format:

PQxxyyyHNAzzPKS

The PQ denotes the *Power*Qor product line. The two digits labeled xx designate the nominal input voltage of the converter. The three digits labeled yyy designate the output voltage (00.0). The H designates Half-Brick package size, the N for standard output current, the A indicates open frame design. The two digits labeled zz designate the maximum rated current. The P position indicates ON/OFF logic, P for Positive and N for Negative. The K position indicates pin length (default is 0.110"). For instance, a 48 Vin, 3.3 Vout half-brick converter capable of delivering 40 amps to its output with Positive logic, standard pin length and standard features has the following part number:

PQ48033HNA40PKS

40Amp Half-Brick Product Family and Part Numbering Scheme

Product Family	Input Voltage	Output Voltage	Package Size	Performance Series	Thermal Design	"Rated" Output Current	Pos./Neg. Logic	Pin Length	Features
PQ	**48**	**033**	**H**	**N**	**A**	**40**	**P**	**K**	**S**
PQ - PowerQor	48 - 35V-75V	015 - 1.5V 018 - 1.8V 020 - 2.0V 025 - 2.5V 033 - 3.3V	H - Half Brick	N - Normal	A - Open Frame	40 - 40 Amps	P - Positive N - Negative	K - 0.110" N - 0.145" R - 0.180" Y - 0.250"	S - Standard F - Full Feature
This is the base part number							*Added to indicate options*		

Contact SynQor for further information:

Phone: 978-567-9596
Toll Free: 888-567-9596
Fax: 978-567-9599
E-mail: sales@synqor.com
Web: www.synqor.com
Address: 188 Central Street
Hudson, MA 01749

Warranty

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