

44-52V

Input

7.3V

Output

60A

Current

438W

Max Power

2250V dc

Isolation

Half-Brick

DC-DC Converter

The PQ50073HZB60 PowerQor® Zeta Half-Brick converter is a next-generation, board-mountable, isolated, fixed switching frequency DC/DC converter. The Zeta series offers industry leading power density for standard isolated DC/DC converters with both a wide input range and a tightly regulated output. Targeted for use in intermediate bus architectures, this module supplies an isolated step down voltage from 44-52V to 7.3V and provides 2,250Vdc isolation, tolerance of output current transients up to 85A, and more available power and higher efficiency than most competitive bus converters. RoHS compliant (see last page).

Protection Features

- Input under-voltage lockout
- Output current limit and short circuit protection
- Active back bias limit
- Output over-voltage protection
- Protection from permanent damage and hazardous conditions
- Thermal shutdown

Mechanical Features

- Industry standard half brick pin-out configuration
- Standard Size Baseplated: 2.40" x 2.30" (60.6 x 63.1mm)
- Total height only 0.495" (12.6mm)
- Baseplated Weight: 4.3oz (123g) typical
- Flanged pins designed to permit surface mount soldering (avoid wave solder) using FPIP technique

Control Features

- On/Off control referenced to input side

Safety Features

- CAN/CSA C22.2 No. 60950-1
- UL 60950-1
- EN 60950-1

PowerQor®



PQ50073HZB60 Model

Operational Features

- High efficiency, 93% at full rated load current
 - Delivers 438W of output power with minimal derating
 - Operating input voltage range: 44-52Vdc
 - Fixed frequency switching provides predictable EMI
- Output voltage trim range of -50%, +10%

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Technical Specifications

Input: 44-52V
Output: 7.3V
Current: 60A
Package: Half-Brick

PQ50073HZB60 Electrical Characteristics

Ta = 25 °C, airflow rate = 300 LFM, Vin = 48V dc unless otherwise noted; full operating temperature range is -40 °C to +100 °C baseplate temperature with appropriate power derating. Specifications subject to change without notice.

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
ABSOLUTE MAXIMUM RATINGS					
Input Voltage					
Non-Operating	-1		80	V	Continuous
Operating			60	V	Continuous
Isolation Voltage					
Input to Output			2250	V	
Operating Temperature	-40		100	°C	
Storage Temperature	-55		125	°C	
Voltage at ON/OFF input pin	-2		18	V	
INPUT CHARACTERISTICS					
Operating Input Voltage Range	44	48	52	V	
Input Under-Voltage Lockout					
Turn-On Voltage Threshold	34.0	35.5	37.0	V	
Turn-Off Voltage Threshold	32.5	34	35.5	V	
Lockout Voltage Hysteresis		1.5		V	
Maximum Input Current			20	A	100% Load, 44V Vin, trimmed up 10%
No-Load Input Current		210		mA	
Disabled Input Current		50	40	mA	
Input Reflected Ripple Current		225		mA	RMS thru 4.7µH inductor
Input Terminal Ripple Current		5		mA	RMS
Recommended Input Fuse			30	A	Fast acting external fuse recommended
Recommended External Input Capacitance		330		µF	Typical ESR 0.1-0.2Ω
Input Filter Component Values (L\C)		0.5\11.0		µH\µF	
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	7.230	7.300	7.360	V	
Output Voltage Regulation					
Over Line		±0.20\14		%\mV	
Over Load		±0.20\14		%\mV	
Over Temperature		60	90	mV	
Total Output Voltage Range	7.170		7.430	V	Over sample, line, load, temperature & life
Output Voltage Ripple and Noise					20MHz bandwidth; see Note 2
Peak-to-Peak		80		mV	Full load; 5mF Electrolytic capacitance
RMS		15		mV	Full load; 5mF Electrolytic capacitance
Operating Output Current Range			60	A	Subject to thermal derating
Output DC Current-Limit Inception	90	100	110	A	Output Voltage 10% Low
Output DC Current-Limit Shutdown Voltage		3.0		V	See Note 3
Back-Drive Current Limit while Enabled		24		A	Negative current drawn from output
Back-Drive Current Limit while Disabled		3	5	mA	Negative current drawn from output
Maximum Output Capacitance Electrolytic			12	mF	Nominal Vout at full load (resistive load)
EFFICIENCY					
100% Load		93		%	
50% Load		93		%	

Note 1: For applications requiring reduced output voltage ripple and noise, consult SynQor applications support (e-mail: support@synqor.com)

Note 2: Unit can withstand output current transients below the current limit threshold for up to 10ms. Subject to thermal derating.

Note 3: If the output voltage falls below the Output DC Current Limit Shutdown Voltage for more than 50ms, then the unit will enter into hiccup mode, with a 500ms off-time.

PQ50073HZB60 Electrical Characteristics (continued)

Ta = 25 °C, airflow rate = 300 LFM, Vin = 48V dc unless otherwise noted; full operating temperature range is -40 °C to +100 °C baseplate temperature with appropriate power derating. Specifications subject to change without notice.

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
DYNAMIC CHARACTERISTICS					
Output Voltage during Load Current Transient					
Step Change in Output Current (0.1A/μs)		150		mV	50% to 75% to 50% Iout max, 470 μF load cap
Step Change in Output Current (5A/μs)		775		mV	
Settling time		3		ms	To within 1% Vout nom
Turn-On Transient					
Turn-On Time	43	47	51	ms	Full load, Vout=90% nom
First Startup Delay		2		ms	
Output Voltage Overshoot		0		%	Max output capacitance and full load
ISOLATION CHARACTERISTICS					
Isolation Voltage (dielectric strength)		2250		V	
Isolation Resistance		30		MΩ	
Isolation Capacitance (input to output)		1000		pF	See Note 1
TEMPERATURE LIMITS FOR POWER DERATING CURVES					
Semiconductor Junction Temperature			125	°C	Package rated to 150°C
Board Temperature			125	°C	UL rated max operating temp 130°C
Transformer Temperature			125	°C	
Baseplate Temperature			100	°C	See Figure 3 for derating curve
FEATURE CHARACTERISTICS					
Switching Frequency (Isolation Stage)		125		kHz	
Switching Frequency (Regulation Stage)		500		kHz	
ON/OFF Control (Option P)					
On-State Voltage	2.4		18	V	
Off-State Voltage	-2.0		0.8		
ON/OFF Control (Option N)					
OnState Voltage	-2.0		0.8	V	
Off-State Voltage	2.4		18		
ON/OFF Control (Either Option)					Application notes; Figures A & B
Pull-Up Voltage	4.5	5.0	5.5	V	
Pull-Up Resistance		10		kΩ	
Output Voltage Trim Range	-50		+10	%	Measured across Pins 8 & 4; Figure B
Output Voltage Remote Sense Range			10	%	Measured across Pins 8 & 4
Output Over-Voltage Protection	8.1	8.4	8.7	V	Over Full Temperature Range
Over-Temperature Shutdown OTP Trip Point		125		°C	Average PCB Temperature; Auto Recovery
Over-Temperature Shutdown Restart Hysteresis		10		°C	
RELIABILITY CHARACTERISTICS					
Calculated MTBF (Telcordia)		2.1		10 ⁶ Hrs.	TR-NWT-000332; 80% load, 300LFM, 40°C Ta
Calculated MTBF (MIL-217)		1.9		10 ⁶ Hrs.	MIL-HDBK-217F; 80% load, 300LFM, 40°C Ta
Field Demonstrated MTBF				10 ⁶ Hrs.	See our website for details

Note 1: Higher values of isolation capacitance can be added external to the module.



Technical Specifications

Input: 44-52V
Output: 7.3V
Current: 60A
Package: Half-Brick

Standards Compliance & Qualification Testing

Parameter	Notes & Conditions
STANDARDS COMPLIANCE	
CAN/CSA C22.2 No. 60950-1	
UL 60950-1	
EN 60950-1	
Note: An external input fuse must always be used to meet these safety requirements. Contact SynQor for official safety certificates on new releases or download from the SynQor website.	

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

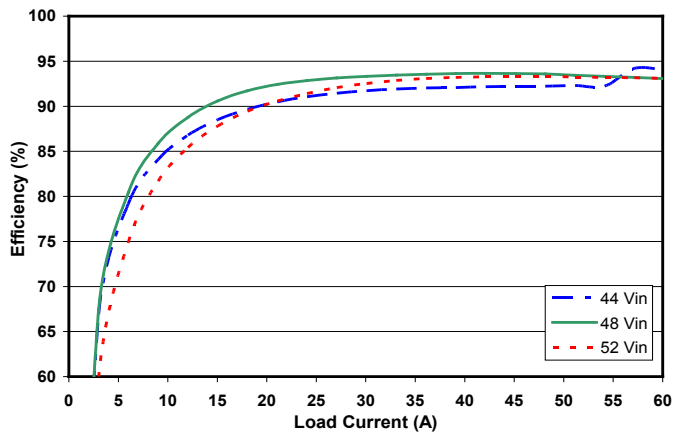


Figure 1: Efficiency at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at 25°C.

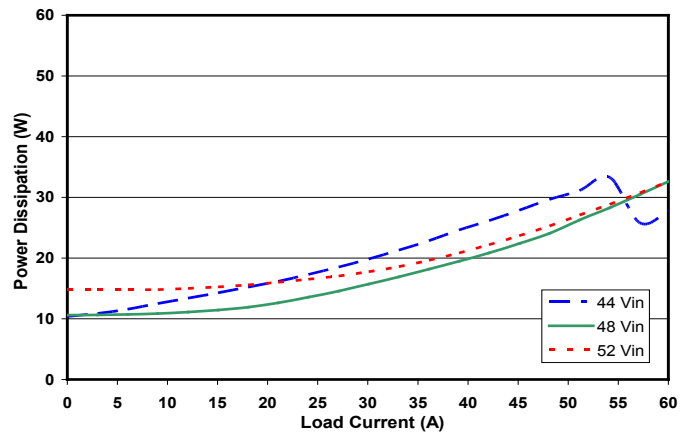


Figure 2: Power dissipation at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at 25°C.

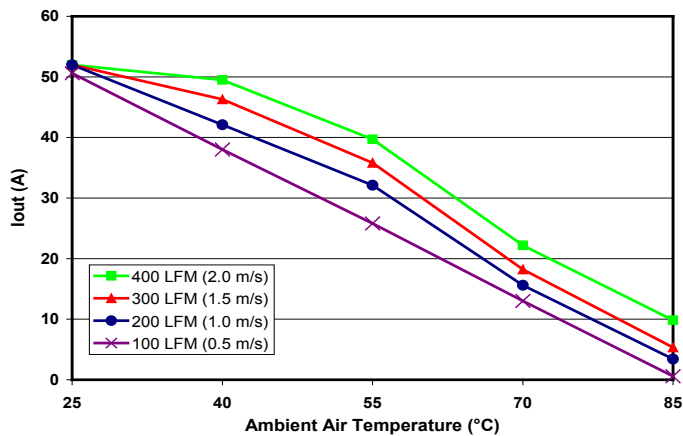


Figure 3: Maximum output power derating curves vs. ambient air temperature for airflow rates of 100 LFM through 400 LFM with air flowing from pin 4 to pin 1 (nominal input voltage).

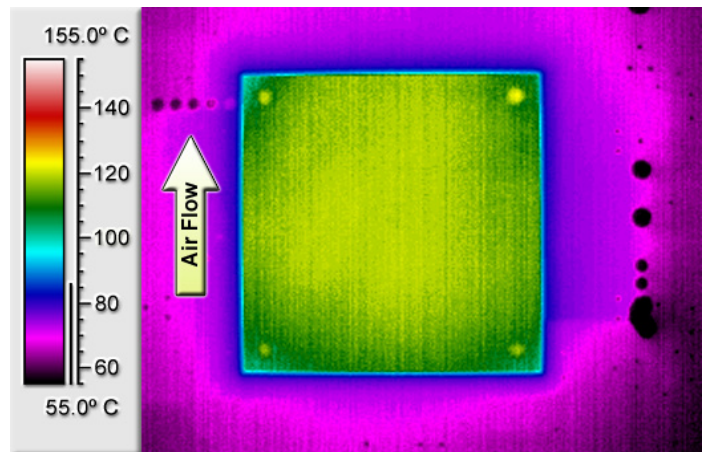


Figure 4: Thermal plot of converter at 32.1 amp load current (234W) with 55°C air flowing at the rate of 200 LFM. Air is flowing from pin 4 to pin 1 (nominal input voltage).

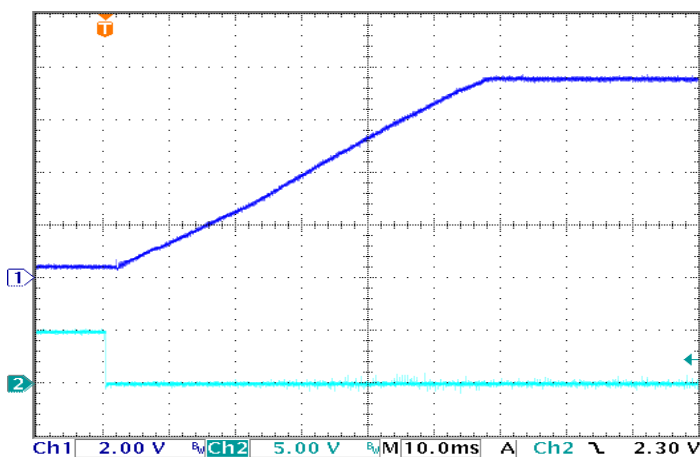


Figure 5: Turn-on transient at full load (resistive load) (10 ms/div). Input voltage pre-applied. Top Trace: V_{out} (2V/div). Bottom Trace: ON/OFF input (5V/div)

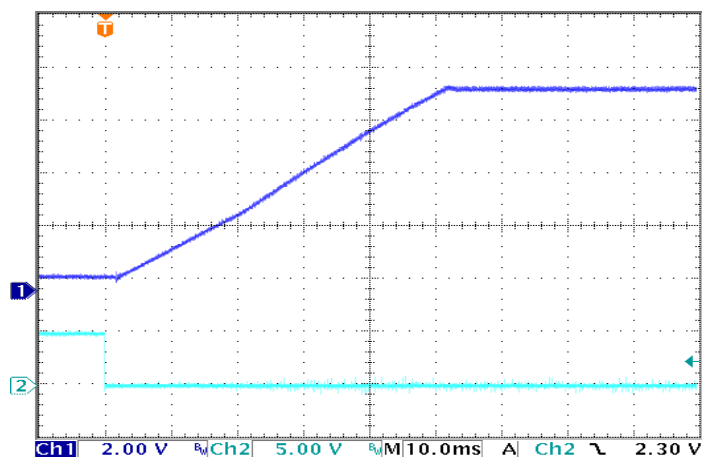


Figure 6: Turn-on transient at zero load (10 ms/div). Top Trace: V_{out} (2V/div). Bottom Trace: ON/OFF input (5V/div)

Input: 44-52V
Output: 7.3V
Current: 60A
Package: Half-Brick

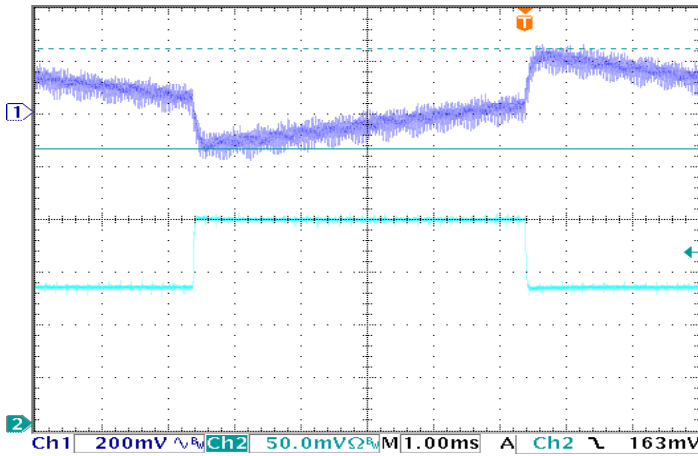


Figure 7: Output voltage response to step-change in load current (50%-75%-50% of $I_{out(max)}$); $dI/dt = 0.1A/\mu s$. Load cap: $5000\mu F$, ceramic output capacitance. Top trace: V_{out} (200mV/div). Bottom trace: I_{out} (10A/div).

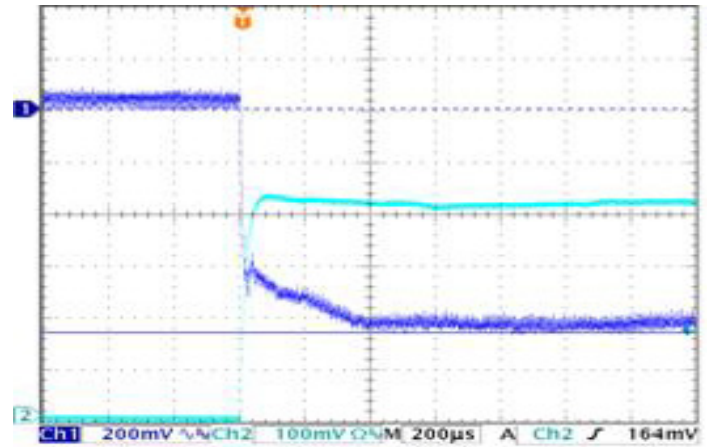


Figure 8: Output voltage response to step-change in load current (0% - 100% of $I_{out(max)}$); $dI/dt = 5A/\mu s$. Load cap: $5000\mu F$, electrolytic output capacitance. Top trace: V_{out} (200mV/div). Bottom trace: I_{out} (20A/div).

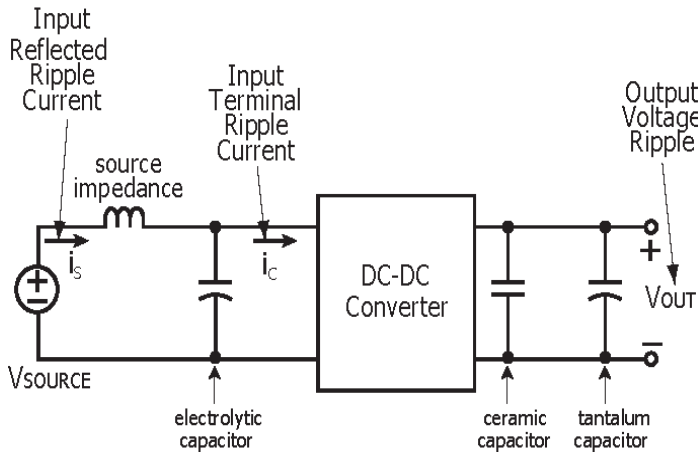


Figure 9: Test set-up diagram showing measurement points for Input Terminal Ripple Current (Figure 10), Input Reflected Ripple Current (Figure 11) and Output Voltage Ripple (Figure 12).

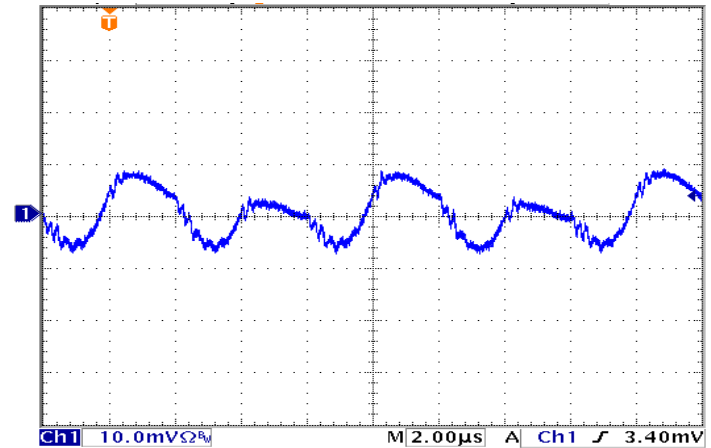


Figure 10: Input Terminal Ripple Current, i_c , at full rated output current and 55V input voltage with $4.7\mu H$ source impedance and $330\mu F$ electrolytic capacitor (Ch1 500mA/div). (See Figure 9).

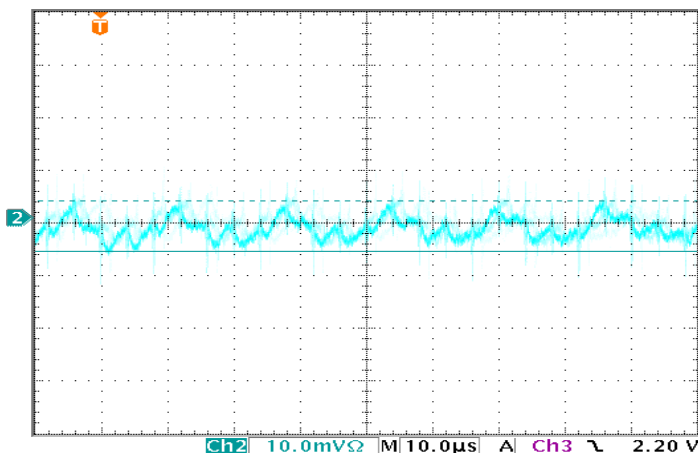


Figure 11: Input reflected ripple current, i_s , through a $4.7\mu H$ source inductor at 55V input voltage and rated load current (20 mA/div). (See Figure 9).

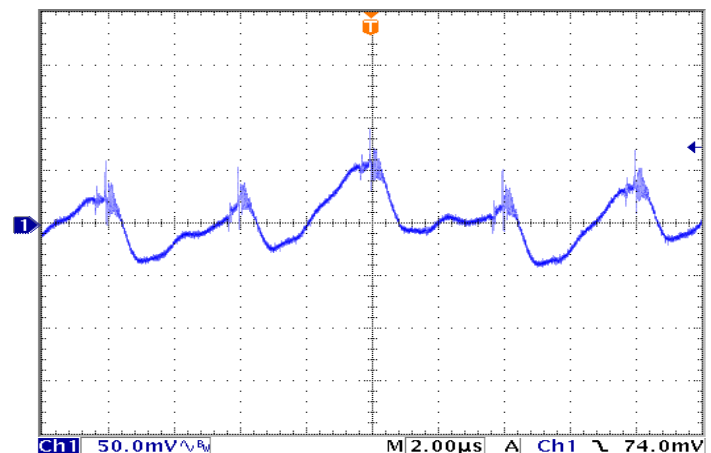


Figure 12: Output voltage ripple at nominal input voltage and rated load current (200 mV/div). Load capacitance: two $1.0\mu F$ ceramic capacitors and $5000\mu F$ electrolytic capacitor. Bandwidth: 20 MHz. (See Figure 9).

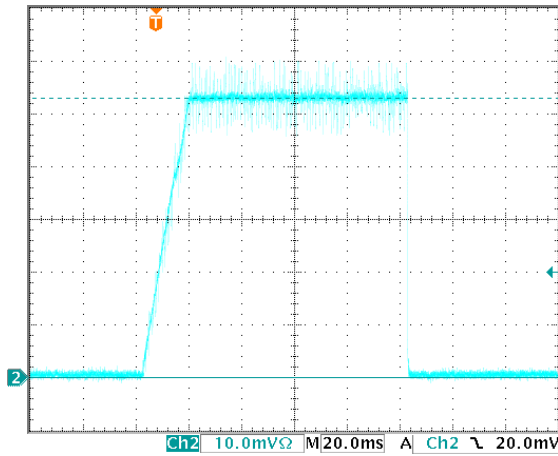


Figure 13: Load current (20A/div) as a function of time when the converter attempts to turn on into a 1 mΩ short circuit.

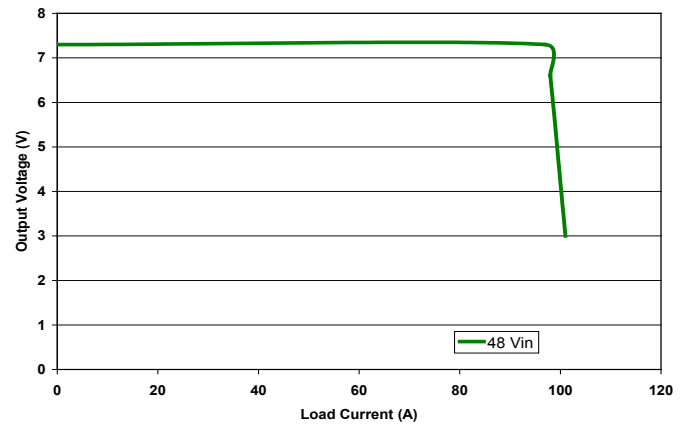


Figure 14: Output voltage vs. load current showing typical current limit curve and converter shutdown point.

BASIC OPERATION AND FEATURES

This converter series uses a two-stage power conversion topology. The first stage 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 significantly less energy than Schottky diodes, enabling the converter to achieve high efficiency.

Dissipation throughout the converter is so low that it does not require a heatsink or even a baseplate for operation in many applications; however, adding a heatsink provides improved thermal derating performance in extreme situations. To further withstand harsh environments and thermally demanding applications, certain models are available totally encased. See Ordering Information page for available thermal design options.

SynQor half-brick converters use the industry standard footprint and pin-out.

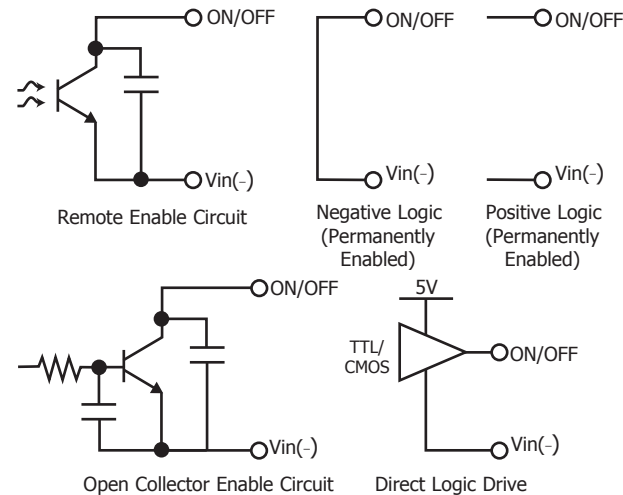


Figure A: Various Circuits for Driving the ON/OFF Pin

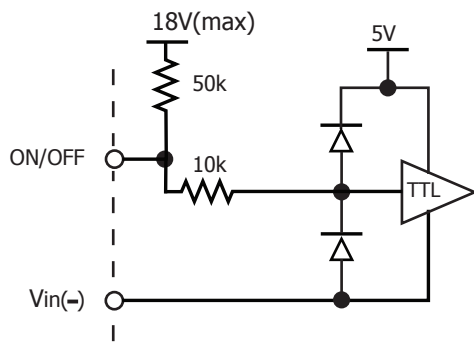


Figure B: Internal ON/OFF Pin Circuitry

CONTROL FEATURES

REMOTE ON/OFF (Pin 2): The ON/OFF input, Pin 2, permits the user to control when the converter is on or off. This input is referenced to the return terminal of the input bus, Vin(-).

In negative logic versions, the ON/OFF signal is active low (meaning that a low voltage turns the converter on). In positive logic versions, the ON/OFF input is active high (meaning that a high voltage turns the converter on). Figure A details possible circuits for driving the ON/OFF pin. Figure B is a detailed look of the internal ON/OFF circuitry. See Ordering Information page for available enable logics.

REMOTE SENSE Pins 8(+) and 6(-): The SENSE(+) and 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. If these connections are not made, the converter will deliver an output voltage that is slightly higher than its specified value.

Note: The Output Over-Voltage Protection circuit senses the voltage across the output (Pins 9 and 5) to determine when it should trigger, not the voltage across the converter's sense leads (Pins 8 and 6). Therefore, the resistive drop on the board should be small enough so that output OVP does not trigger, even during load transients.

OUTPUT VOLTAGE TRIM (Pin 7): The TRIM input permits the user to adjust the output voltage across the sense leads up or down according to the trim range specifications. SynQor uses industry standard trim equations.

To decrease the output voltage, the user should connect a resistor between Pin 7 (TRIM) and Pin 6 (SENSE(-) input). For a desired decrease of the nominal output voltage, the value of the resistor should be:

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

where

$$\Delta\% = \left| \frac{V_{\text{nominal}} - V_{\text{desired}}}{V_{\text{nominal}}} \right| \times 100\%$$

To increase the output voltage, the user should connect a resistor between Pin 7 (TRIM) and Pin 8 (SENSE(+) input). For a desired increase of the nominal output voltage, the value of the resistor should be:

$$R_{\text{trim-up}} = \frac{\left(\frac{V_{\text{nominal}}}{1.225} - 2 \right) \times V_{\text{desired}} + V_{\text{nominal}}}{V_{\text{desired}} - V_{\text{nominal}}} \text{ k}\Omega$$

The Trim Graph in Figure C shows the relationship between the trim resistor value and Rtrim-up and Rtrim-down, showing the total range the output voltage can be trimmed up or down.

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

It is not necessary for the user to add capacitance at the TRIM pin. The node is internally filtered to eliminate noise.

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

Active Trimming: Active trimming of the output voltage is supported, but dynamic active trimming with feedback is discouraged due to the potential for limit-cycling. If such trimming is necessary, control loop bandwidth should be limited to <1 Hz. A deadband which is at least as large as the line/load regulation specification is also recommended, but not required.

Protection Features

Input Under-Voltage Lockout (UVLO): The converter is designed to turn off when the input voltage is too low, helping to avoid an input system instability problem, which is described in more detail in the application note titled "Input System Instability" on the SynQor website. When the input is rising, it must exceed the typical "Turn-On Voltage Threshold"* before the converter will turn on. Once the converter is on, the input must fall below the typical "Turn-Off Voltage Threshold"* before the converter will turn off.

Output Current Limit (OCP): If the output current exceeds the "Output DC Current Limit Inception" value*, then a fast linear current limit controller will reduce the output voltage to maintain a constant output current. If as a result, the output voltage falls below the "Output DC Current Limit Shutdown Voltage"* for more than 50 ms, then the unit will enter into hiccup mode, with a 500 ms off-time. The unit will then automatically attempt to restart.

Back-Drive Current Limit: If there is negative output current of a magnitude larger than the "Back-Drive Current Limit while Enabled" specification*, then a fast back-drive limit controller will increase the output voltage to maintain a constant output current. If this results in the output voltage exceeding the "Output Over-Voltage Protection" threshold*, then the unit will shut down.

Output Over-Voltage Limit (OVP): If the voltage across the output pins exceeds the "Output Over-Voltage Protection" threshold*, the converter will immediately stop switching. This prevents damage to the load circuit due to 1) excessive series resistance in output current path from converter output pins to sense point, 2) a release of a short-circuit condition, or 3) a release of a current limit condition. Load capacitance determines exactly how high the output voltage will rise in response to these conditions. After 500 ms the converter will automatically restart for all but the S Feature Set option, which is latching and will not restart until input power is cycled or the ON/OFF input is toggled.

During an output over-voltage condition, the converter's LED will illuminate. For units with latching OVP (S Feature Set), once the over-voltage condition has been removed the LED will flash steadily until the input power or the ON/OFF input is toggled.

Over-Temperature Shutdown (OTP): A thermister 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"*.

Startup Inhibit Period: The Startup Inhibit Period ensures that the converter will remain off for approximately 500 ms when it is shut down due to a fault. This generates a 2 Hz "hiccup mode," preventing the converter from overheating. There are multiple ways the converter can be shut down, initiating a Startup Inhibit Period:

- Output Over-Voltage Protection
- Current Limit
- Short Circuit Protection

* See Electrical Characteristics section.

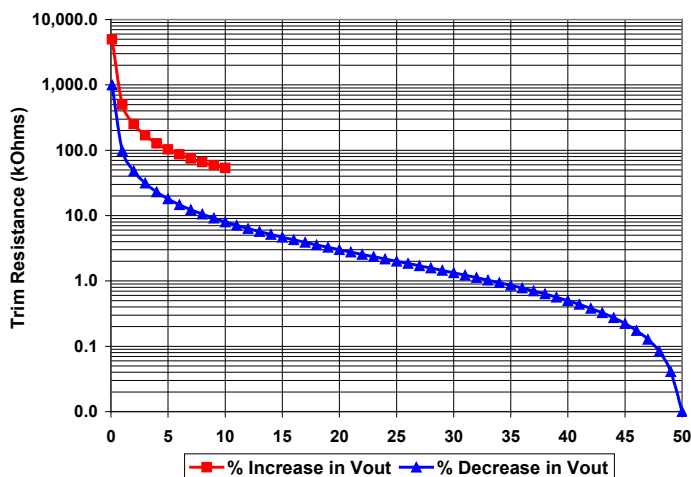


Figure C: Trim Graph

APPLICATION CONSIDERATIONS

Input System Instability: This condition can occur because any DC-DC converter appears incrementally as a negative resistance load. A detailed application note titled "Input System Instability" is available on the SynQor website which provides an understanding of why this instability arises, and shows the preferred solution for correcting it.

Application Circuits: A typical circuit diagram, Figure D below details the input filtering and voltage trimming.

Input Filtering and External Input Capacitance: Figure E below shows the internal input filter components. This filter dramatically reduces input terminal ripple current, which otherwise could exceed the rating of an external electrolytic input capacitor. The recommended external input capacitance is specified in the Input Characteristics section of the Electrical Specifications. More detailed information is available in the application note titled "EMI Characteristics" on the SynQor website.

Output Filtering and External Output Capacitance: The internal output filter components are shown in Figure E below. This filter dramatically reduces output voltage ripple. Some minimum external output capacitance is required, as specified in the Output Characteristics area of the Electrical Characteristics section. No damage will occur without this capacitor connected, but peak output voltage ripple will be much higher.

Thermal Considerations: For baseplated and encased versions, the max operating baseplate temperature, T_B , is 100°C. Refer to the Thermal Derating Curves in the Technical Figures section to see the available output current at baseplate temperatures below 100°C.

A power derating curve can be calculated for any heatsink that is attached to the base-plate of the converter. It is only necessary to determine the thermal resistance, R_{THBA} , of the chosen heatsink between the baseplate and the ambient air for a given airflow rate. This information is usually available from the heatsink vendor. The following formula can be used to determine the maximum power the converter can dissipate for a given thermal condition if its base-plate is to be no higher than 100°C.

$$P_{diss}^{max} = \frac{100^{\circ}C - T_A}{R_{THBA}}$$

This value of maximum power dissipation can then be used in conjunction with the data shown in the Power Dissipation Curves in the Technical Figures section to determine the maximum load current (and power) that the converter can deliver in the given thermal condition.

For convenience, Thermal Derating Curves are provided in the Technical Figures section.

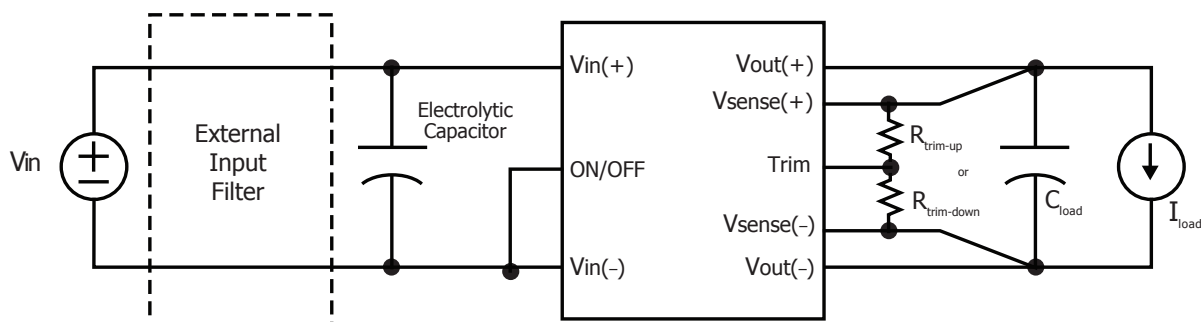


Figure D: Typical Application Circuit (negative logic unit, permanently enabled).

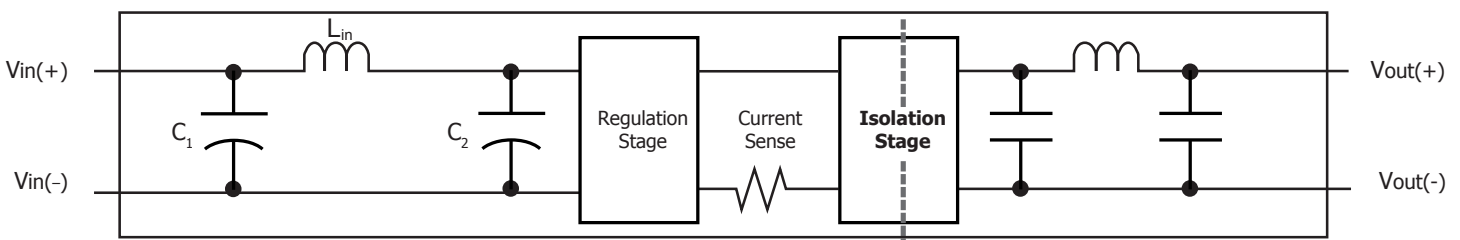


Figure E: Internal Input and Output Filter Diagram (component values listed in Electrical Characteristics section)

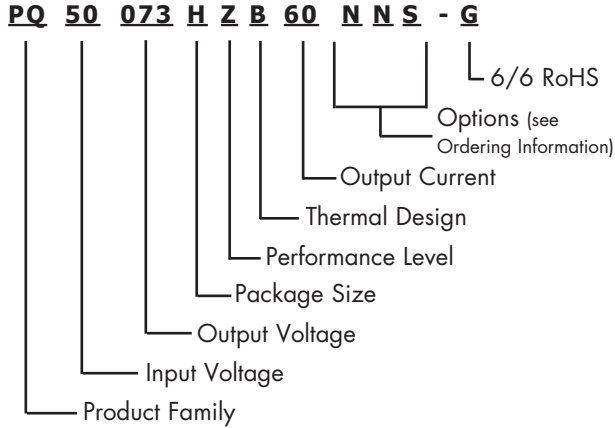


Ordering Information

Technical Specification PQ50073HZB60

Part Numbering System

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



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

Application Notes

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

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

Contact SynQor for further information and to order:

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

Ordering Information

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

Model Number	Input Voltage	Output Voltage	Max Output Current
PQ50073HZB60NNS-G	44-52V	7.3V	60A

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

Options Description: wxyz			
Thermal Design	Enable Logic	Pin Style	Feature Set
B - Threaded Baseplated	N - Negative	N - 0.145"	S - Standard

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

PATENTS

SynQor holds numerous U.S. patents, one or more of which apply to most of its power conversion products. Any that apply to the product(s) listed in this document are identified by markings on the product(s) or on internal components of the product(s) in accordance with U.S. patent laws. SynQor's patents include the following:

6,545,890	6,894,468	6,896,526	6,927,987	7,050,309	7,085,146
7,119,524	7,765,687	7,787,261	8,149,597	8,644,027	

WARRANTY

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