SynQor®

PRELIMINARY

Technical Specification

BQ55090ETL16

35-55V Input	9.6V Output	150Watt Power	2000Vdc Isolation	Eighth-brick DC Bus Converter

The BusQor™ BQ55090ETL16 bus 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. The BusQor series provides an isolated step down voltage from 48V to a 9.6V intermediate bus with no regulation in a standard "eighth-brick" module. BusQor converters are ideal for creating the mid-bus voltage required to drive point-of-load (non-isolated) converters in intermediate bus architectures.

BusQor™ Bus Converter

BQ55090ETL16 Module

Operational Features

- Ultra-high efficiency, >95% at full rated load current
- Delivers up to 16 amps of output current (150W) with minimal derating - no heatsink required
- Input voltage range: 35V – 55V provides 6.3-11V bus for distributed power architectures
- Fixed frequency switching provides predictable EMI performance

Mechanical Features

- Industry standard eighth-brick bus converter pin-out
- Industry standard size: 0.90" x 2.3" (22.9x58.4mm)
- Total height only 0.327" (8.05mm), permits better airflow and smaller card pitch
- Total weight: 0.7 oz. (20 grams)
- Flanged pins designed to permit surface mount soldering (avoid wave solder) using FPiP technique

Control Features

- On/Off control referenced to input side (positive and negative logic options available)

Protection Features

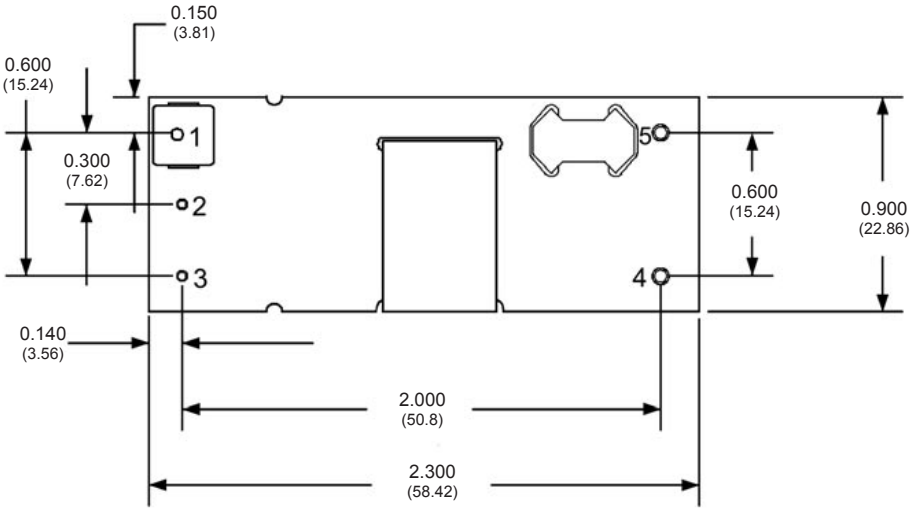
- Input under-voltage lockout and over-voltage shutdown protects against abnormal input voltages
- Output current limit and short circuit protection (auto recovery or latching options)
- Output over-voltage protection
- Thermal shutdown (auto recovery or latching options)

Safety Features

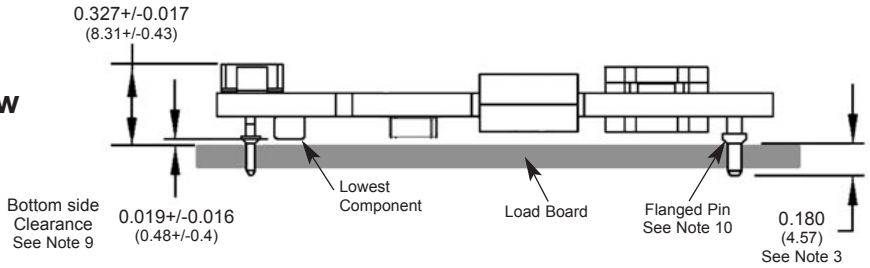
- 2000V, 30 MΩ input-to-output isolation
- UL/cUL 60950 recognized (US & Canada), basic insulation rating
- TUV certified to EN60950
- Meets 72/23/EEC and 93/68/EEC directives
- Meets UL94V-0 flammability requirements

MECHANICAL DIAGRAM

Top View



Side View



NOTES

1) Pins 1-3 are 0.040" (1.02mm) diameter with 0.080" (2.03 mm) diameter standoff shoulders.
2) Pins 4 and 5 are 0.062" (1.57 mm) diameter with 0.100" (2.54 mm) diameter standoff shoulders.
3) Other pin extension lengths available. Recommended pin length is 0.03" (0.76mm) greater than the PCB thickness.
4) All Pins: Material - Copper Alloy
   Finish - Tin/Lead over Nickel plate
5) Undimensioned components are shown for visual reference only.
6) All dimensions in inches (mm)
   Tolerances: x.xx +/-0.02 in. (x.x +/-0.5mm)
   x.xxx +/-0.010 in. (x.xx +/-0.25mm)
7) Weight: 0.7 oz. (20 g) typical
8) Workmanship: Meets or exceeds IPC-A-610C Class II
9) UL/TUV standards require a clearance of 0.04" (1.02mm) around primary areas of the module. Refer to section on Keep Out Areas under Application Considerations for details.
10) The flanged pins are designed to permit surface mount soldeing (avoiding the wave soldering process) through the use of the flanged pin-in-paste technique.

PIN DESIGNATIONS

Pin No.	Name	Function
1	Vin(+)	Input Positive (35V - 55V)
2	ON/OFF	Logic control input to turn converter on and off.
3	Vin(-)	Input Negative
4	Vout(-)	Output Negative
5	Vout(+)	Output Positive

BQ55090ETL16 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 ambient 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			60	V	continuous
Operating			56	V	continuous
Isolation Voltage (input to output)			2000	V	Basic insulation, Pollution Degree 2
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	35	48	55	V	
Input Under-Voltage Lockout					
Turn-On Voltage Threshold		32.0		V	
Turn-Off Voltage Threshold		30.5		V	
Lockout Voltage Hysteresis		1.5		V	
Input Over-Voltage Shutdown					
Turn-Off Voltage Threshold		58.0		V	
Turn-On Voltage Threshold		56.5		V	
Maximum Input Current			4.7	A	100% Load, 35 Vin
No-Load Input Current			0.12	A	
Disabled Input Current		15	30	mA	
Inrush Current Transient Rating			0.1	A^2s	
Input Reflected Ripple Current		5		mA	RMS through 10µH inductor; Figures 12 & 14
Input Terminal Ripple Current		50	100	mA	RMS, full load; Figures 12 & 13
Recommended Input Fuse			12	A	fast blow external fuse recommended
Input Filter Component Values (L\C)		3.3\2.2		µH\µF	internal values
Recommended External Input Capacitance		47		µF	Typical ESR 0.1-0.2Ω, see Figure 12
OUTPUT CHARACTERISTICS					
Output Voltage Set Point		9.60		V	48Vin, no load
Output Voltage Regulation					
Over Line		±20 \ 2.4		%\V	Figure 4
Over Load		±4.1 \ 500		%\mV	Figure 4
Over Temperature		±1.7 \ 200		%\mV	Figure 4
Total Output Voltage Range	6.3		11.0	V	over sample, line, load, temperature & life
Output Voltage Ripple and Noise[1]					20MHz bandwidth; Fig. 12 & 15
Peak-to-Peak		100	120	mV	Full Load, see Figures 12 & 15
RMS		20	40	mV	Full Load, see Figures 12 & 15
Operating Output Current Range	0		16	A	Subject to thermal derating; Figures 5-8
Output DC Current-Limit Inception		20		A	Output Voltage 10% Low; Figure 16
Output DC Current-Limit Shutdown Voltage		0		V	
Current Share Accuracy (2 units paralleled)		±10		%	% of rated output current
Back-Drive Current Limit while Disabled		10		mA	Negative current drawn from output
Maximum Output Capacitance			2,500	µF	9.6Vout at 16A Resistive Load
DYNAMIC CHARACTERISTICS					
Output Voltage during Load Current Transient					
For a Step Change in Output Current (0.1A/µs)		150		mV	50% to 75% to 50% Iout max; Figure 11
Settling Time		200		µs	to within 1% Vout nom
Turn-On Transient					
Turn-On Time		1		ms	Full load, Vout=90% nom.; Figures 9 & 10
Start-Up Inhibit Time		40		ms	-40°C to +125°C
Output Voltage Overshoot		0		%	2,500 µF load capacitance, Iout = 0A
EFFICIENCY					
100% Load		95.5		%	Figures 1-3
50% Load		95.0		%	Figures 1-3
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	See Figures 5 - 8 for derating curves
ISOLATION CHARACTERISTICS					
Isolation Voltage (dielectric strength)		2000		V	
Isolation Resistance		30		MΩ	
Isolation Capacitance[2]			470	pF	

Note 1: For applications requiring reduced output voltage ripple and noise, consult SynQor applications support (e-mail: support@synqor.com)
Note 2: Higher values of isolation capacitance can be added external to the module.

ELECTRICAL CHARACTERISTICS (Continued)

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
FEATURE CHARACTERISTICS					
Switching Frequency	180	200	230	kHz	
ON/OFF Control (Option P)					
Off-State Voltage	-1.0		0.8	V	
On-State Voltage	2.4		18	V	
ON/OFF Control (Option N)					
Off-State Voltage	2.4		18	V	
On-State Voltage	-1.0		0.8	V	
ON/OFF Control (Either Option)					Figures A, B
Pull-Up Voltage		10		V	
Pull-Up Resistance		30		kΩ	
Output Over-Voltage Protection		11.6		V	Over full temp range; no load
Over-Temperature Shutdown	140		150	°C	Average PCB Temperature
Over-Temperature Shutdown Restart Hysteresis		10		°C	
Load Current Scale Factor		1000			See App Note: Output Load Current Calc.
RELIABILITY CHARACTERISTICS					
Calculated MTBF (Telcordia)		TBD		10^6 Hrs.	TR-NWT-000332; 100% load,300LFM, 40°C T_a
Calculated MTBF (MIL-217)		TBD		10^6 Hrs.	MIL-HDBK-217F; 100% load, 300LFM, 40°C T_a
Field Demonstrated MTBF				10^6 Hrs.	See website for latest values

STANDARDS COMPLIANCE

Parameter	Notes
STANDARDS COMPLIANCE	
UL/cUL 60950	File # E194341, Basic insulation & pollution degree 2
EN60950	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

- 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, 2 minutes on and 6 hours off
Solderability	3	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 factory for official product family qualification document.

OPTIONS

SynQor provides various options for Logic Sense, Pin Length and Feature Set for this family of DC/DC converters. Please consult the SynQor website (www.synqor.com) for information on available options.

PATENTS

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

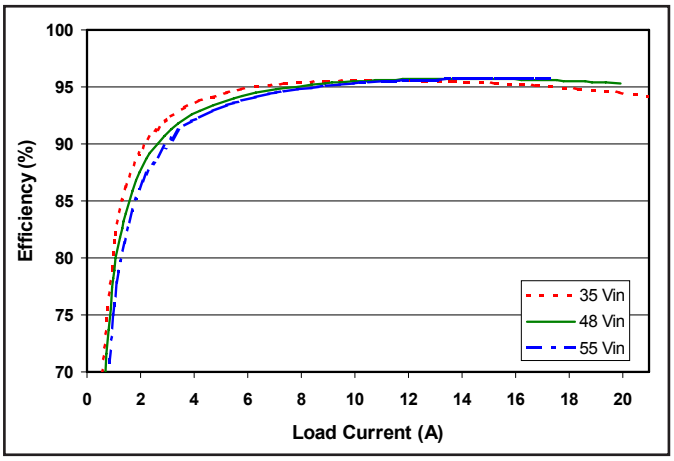


Figure 1: *Efficiency at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at 25°C.*

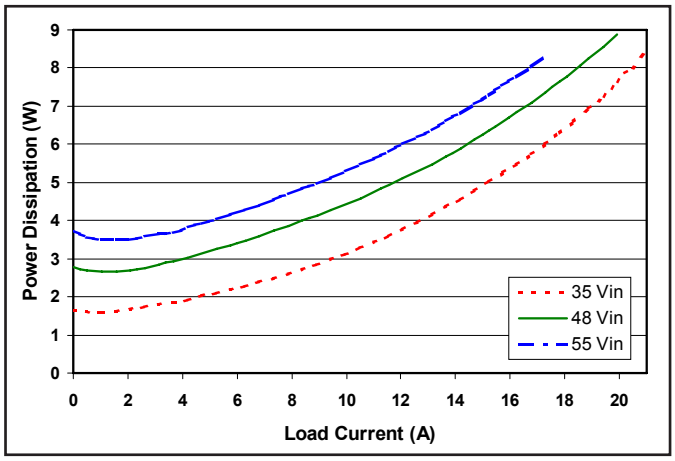


Figure 2: *Power dissipation at nominal output voltage vs. load current for minimum, nominal, and maximum input voltage at 25°C.*

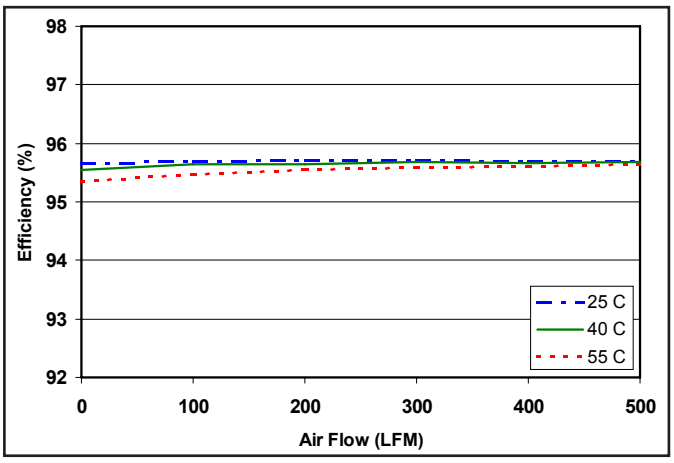


Figure 3: *Efficiency at nominal output voltage and 60% rated power vs. airflow rate for ambient air temperatures of 25°C, 40°C, and 55°C (nominal input voltage).*

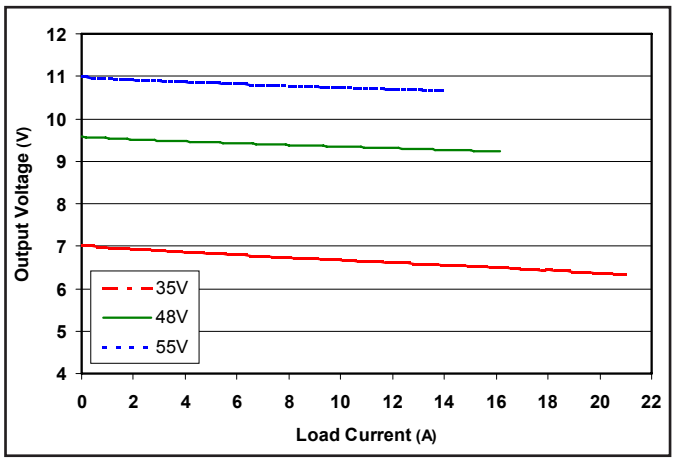


Figure 4: *Output voltage regulation vs. load current for minimum, nominal, and maximum input voltage at 25°C.*

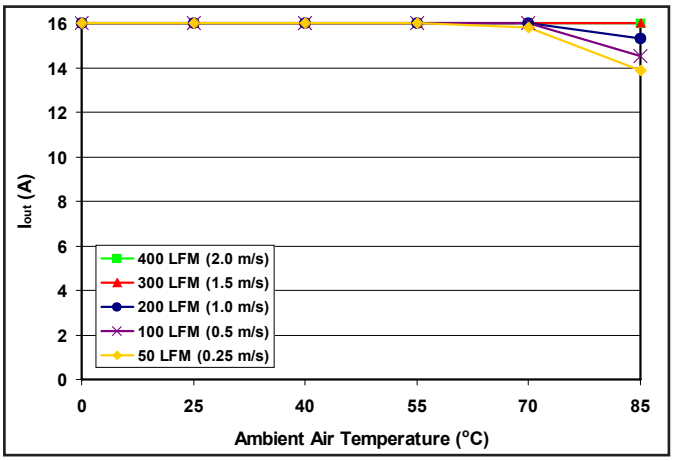


Figure 5: *Maximum output power derating curves vs. ambient air temperature for airflow rates of 50 LFM through 400 LFM with air flowing from pin 3 to pin 1 (nominal input voltage).*

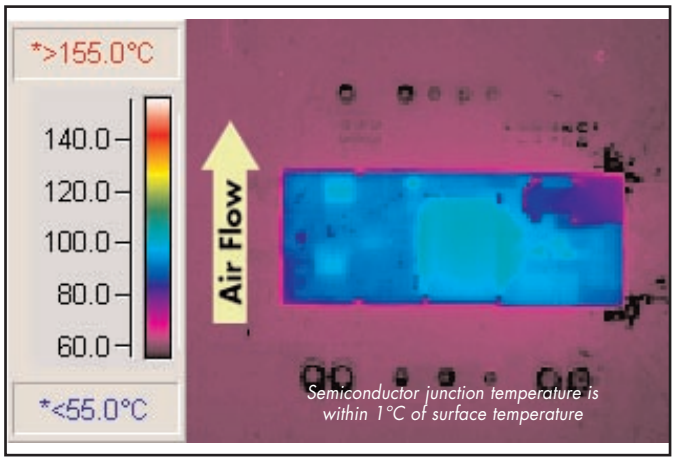


Figure 6: *Thermal plot of converter at 16 amp load current (150W) with 55°C air flowing at the rate of 200 LFM. Air is flowing across the converter from pin 3 to pin 1 (nominal input voltage).*

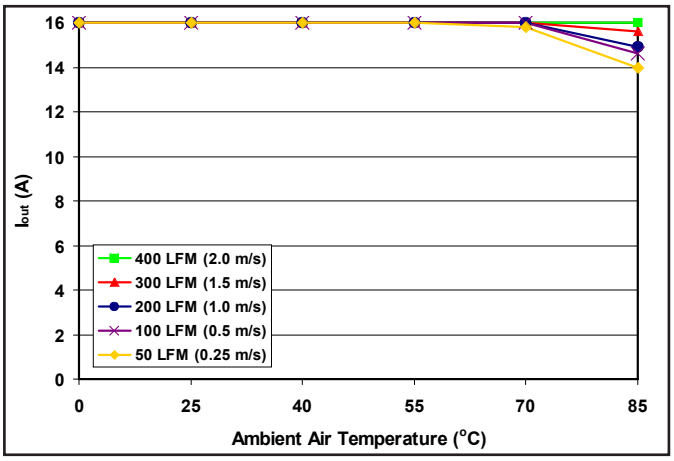


Figure 7: *Maximum output power derating curves vs. ambient air temperature for airflow rates of 50 LFM through 400 LFM with air flowing from output to input (nominal input voltage).*

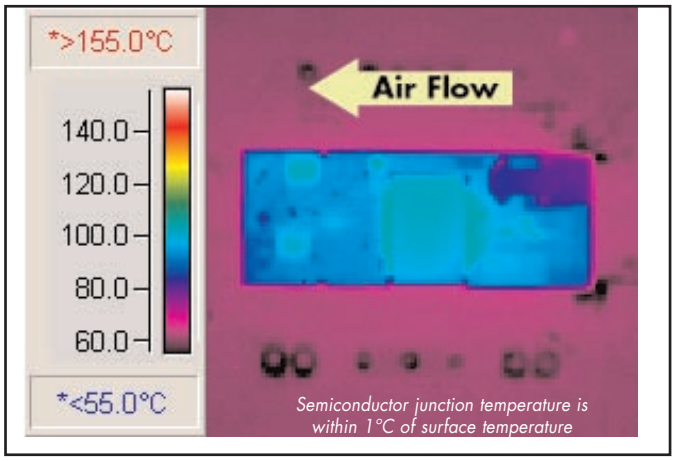


Figure 8: *Thermal plot of converter at 16 amp load current (150W) with 55°C air flowing at the rate of 200 LFM. Air is flowing across the converter from output to input (nominal input voltage).*

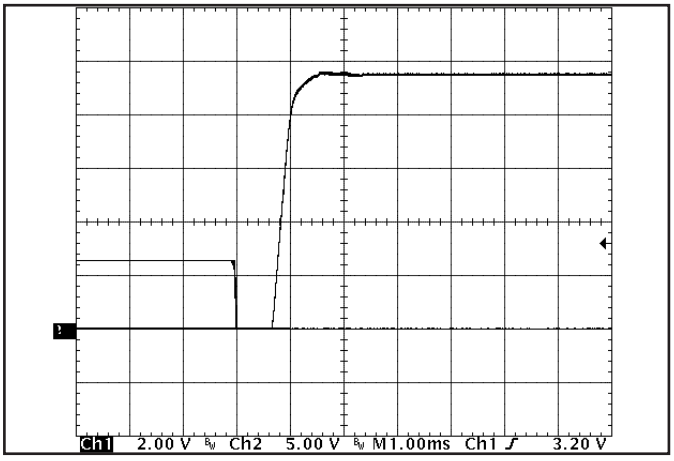


Figure 9: *Turn-on transient at full load (resistive load) (1.0 ms/div). Input voltage pre-applied. Top Trace: Vout (2V/div). Bottom Trace: ON/OFF input (5V/div).*

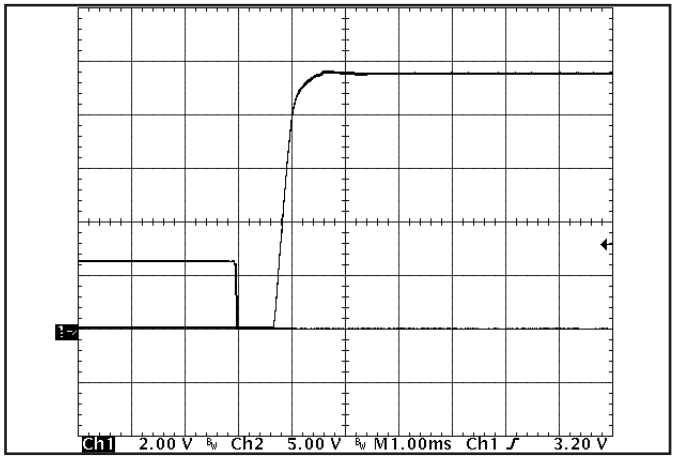


Figure 10: *Turn-on transient at zero load (1.0 ms/div). Top Trace: Vout (2V/div). Bottom Trace: ON/OFF input (5V/div).*

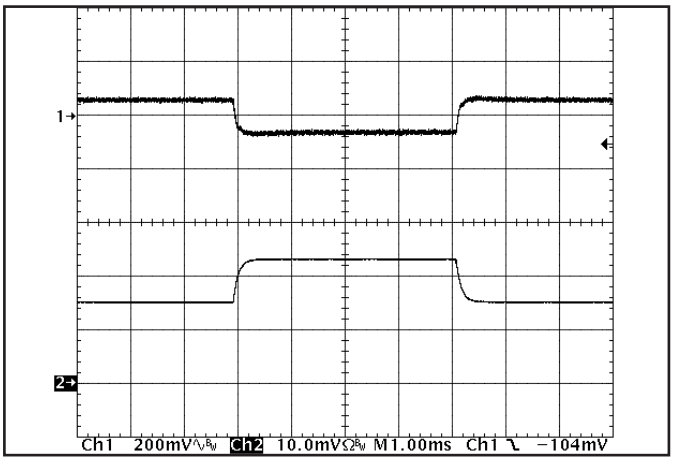


Figure 11: *Output voltage response to step-change in load current (50%-75%-50% of Iout(max); dI/dt = 0.1A/µs). Load cap: 15µF, 100 mΩ ESR tantalum cap and 1µF ceramic cap. Top trace: Vout (200mV/div), Bottom trace: Iout (5A/div).*

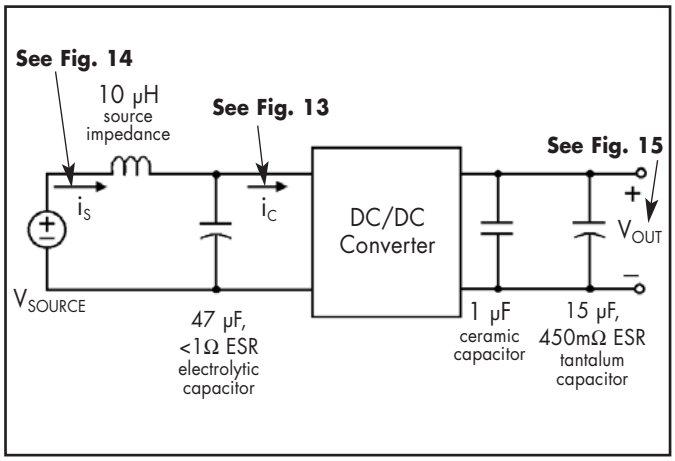


Figure 12: *Test set-up diagram showing measurement points for Input Terminal Ripple Current (Figure 13), Input Reflected Ripple Current (Figure 14) and Output Voltage Ripple (Figure 15).*

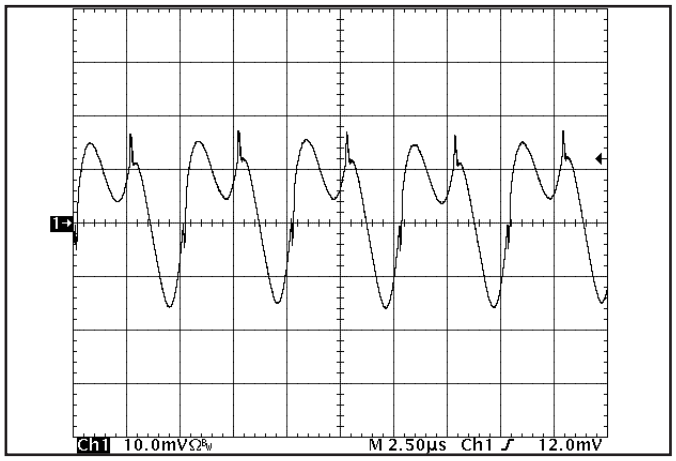


Figure 13: *Input Terminal Ripple Current, i_C, at full rated output current and nominal input voltage with 10µH source impedance and 47µF electrolytic capacitor (20 mA/div). See Figure 12.*

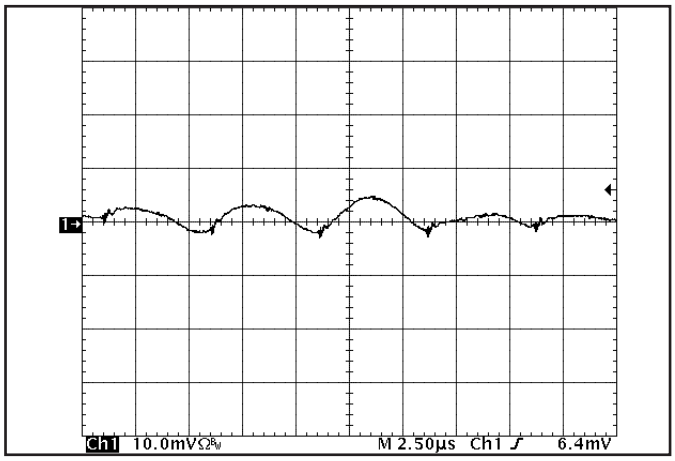


Figure 14: *Input reflected ripple current, i_S, through a 10 µH source inductor at nominal input voltage and rated load current (5mA/div). See Figure 12.*

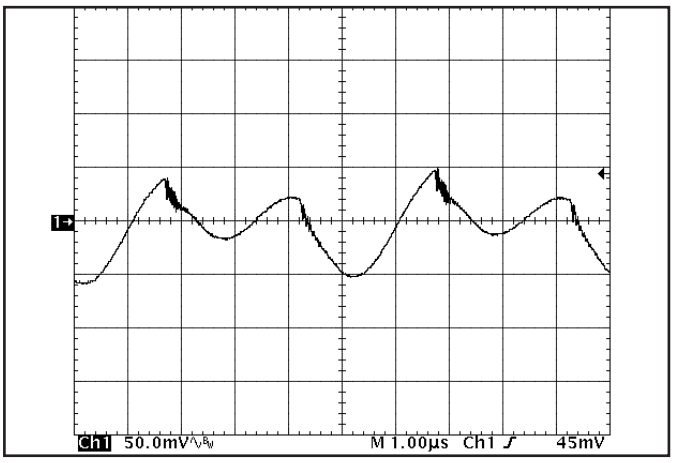


Figure 15: *Output voltage ripple at nominal input voltage and rated load current (50 mV/div). Load capacitance: 1µF ceramic capacitor and 15µF tantalum capacitor. Bandwidth: 20 MHz. See Figure 12.*

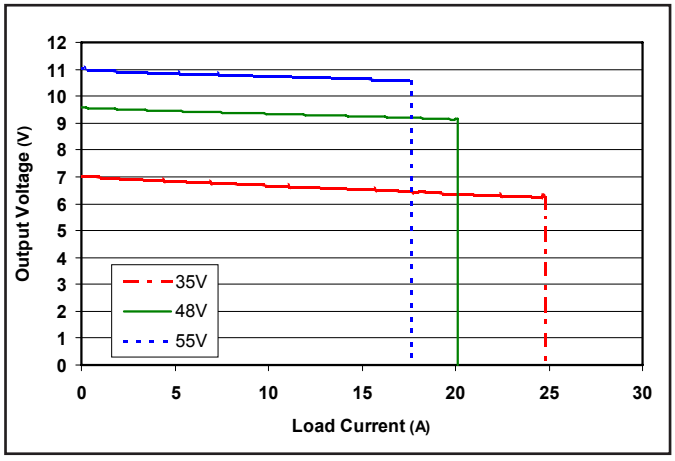


Figure 16: *Output voltage vs. load current showing typical current limit curves and converter shutdown points.*

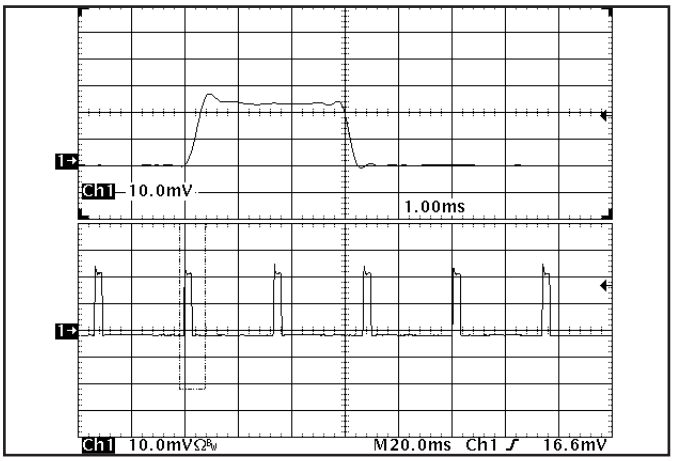


Figure 17: *Load current (20A/div) as a function of time when the converter attempts to turn on into a 1 mΩ short circuit. Top trace (1.0ms/div) is an expansion of the on-time portion of the bottom trace.*

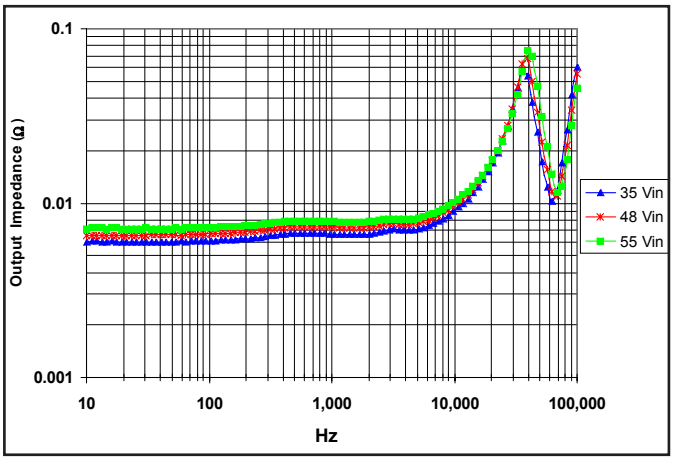


Figure 19: *Magnitude of incremental output impedance (Z_{out} = v_{out}/i_{out}) for minimum, nominal, and maximum input voltage at full rated power.*

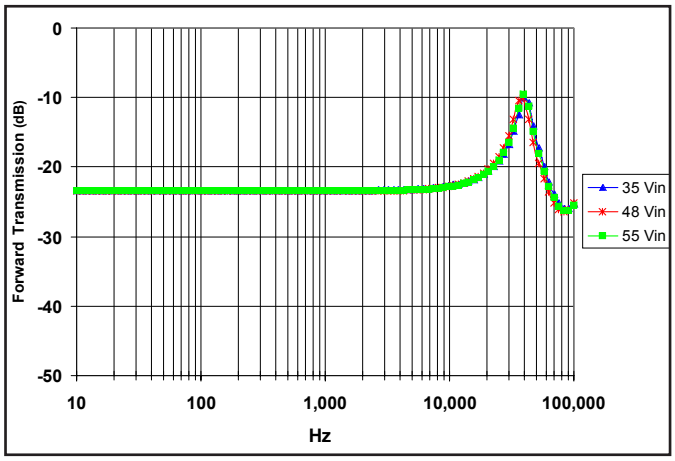


Figure 20: *Magnitude of incremental forward transmission (FT = v_{out}/v_{in}) for minimum, nominal, and maximum input voltage at full rated power.*

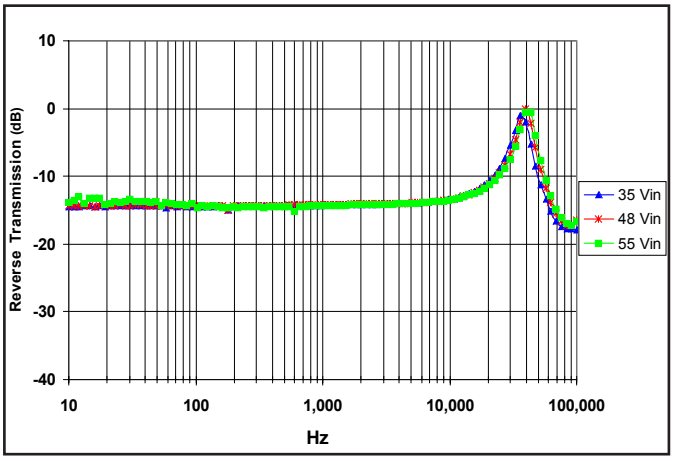


Figure 21: *Magnitude of incremental reverse transmission (RT = i_{in}/i_{out}) for minimum, nominal, and maximum input voltage at full rated power.*

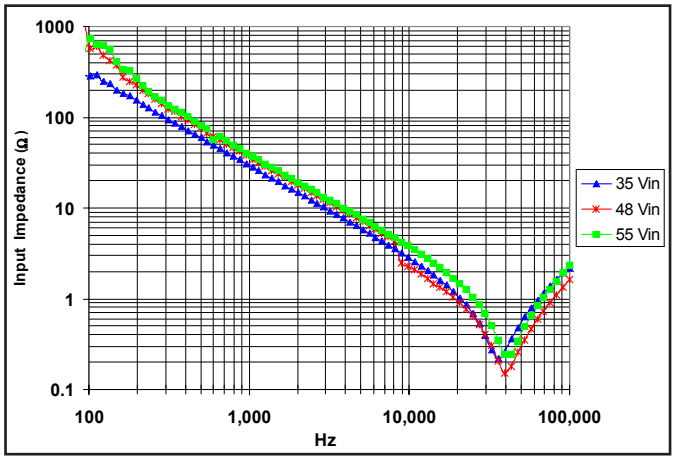
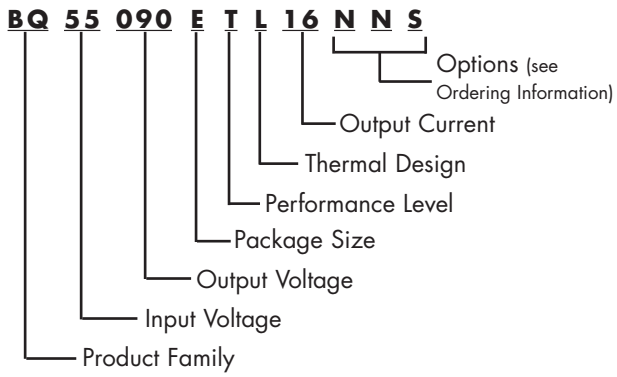


Figure 22: *Magnitude of incremental input impedance (Z_{in} = v_{in}/i_{in}) for minimum, nominal, and maximum input voltage at full rated power.*

PART NUMBERING SYSTEM

The part numbering system for SynQor's *Bus*Qor DC bus converters follows the format shown in the example below.



The first 12 characters comprise the base part number and the last 3 characters indicate available options. Although there are no default values for enable logic and pin length, the most common options are negative logic and 0.145" pins. These part numbers are more likely to be readily available in stock for evaluation and prototype quantities.

Application Notes

A variety of application notes and technical white papers can be downloaded in pdf format at www.synqor.com.

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.

Model Number	Input Voltage	Output Voltage	Max Output Current
BQ55090ETL16*xyz*	35 - 55 V	9.6 V	16 A
BQ55120ETL13*xyz*	35 - 55 V	12 V	13 A
BQ50120ETL13*xyz*	43 - 52 V	12 V	13 A

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

Options Description: *x y z*		
Enable Logic	**Pin Length**	**Feature Set**
P - Positive N - Negative	K - 0.110" N - 0.145" R - 0.180" Y - 0.250"	S - Auto Recovery K - Latching

Contact SynQor for further information:

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