SynQor®

# Technical Specification
# BQ60120HEA30

| 35-75V Input | 12V Output | 360Watt Power | 2250Vdc Isolation | Half-brick DC/DC Converter |
|---|---|---|---|---|

*The BQ60120HEA30 BusQor™ Exa series converter is a next-generation, board-mountable, isolated, wide input, regulated, fixed switching frequency DC/DC converter that uses synchronous rectification to achieve extremely high conversion efficiency. The BusQor Exa series provides an isolated step down voltage from 35-75V to 12V with tight output voltage regulation in a standard "half-brick" module and is available in open-frame and baseplated version. BusQor converters are ideal for customers who need multiple outputs and wish to use point of load converters to work with a 12V rail. The BusQor Exa series converters offer industry-leading useable output current for powering intermediate bus architecture systems. RoHS 5/6 compliant (see page 12).*

BusQor® Bus Converter

*BQ60120HEA30 Module*

## Operational Features

- Ultra-high efficiency, 95% at full rated load current
- Delivers up to 360 Watts of output power, subject to derating over temperature and airflow
- Wide input voltage range: 35V – 75V, with 100V 100ms input voltage transient withstand capability
- Fixed frequency switching provides predictable EMI performance

## Mechanical Features

- Industry standard half-brick pin-out configuration
- Industry standard size: 2.3" x 2.4" (58.4 x 61mm)
- Total height 0.45" (11.5mm), permits better airflow and smaller card pitch (0.54" baseplated module)
- Total weight: 2.6 oz. (75 grams) for open-frame

## Safety Features

- 2250V, 30 MΩ input-to-output isolation
- UL/cUL 60950-1 recognized (US & Canada), basic insulation rating
- TUV certified to EN60950-1
- Meets 72/23/EEC and 93/68/EEC directives
- Meets UL94V-0 flammability requirements

## Protection Features

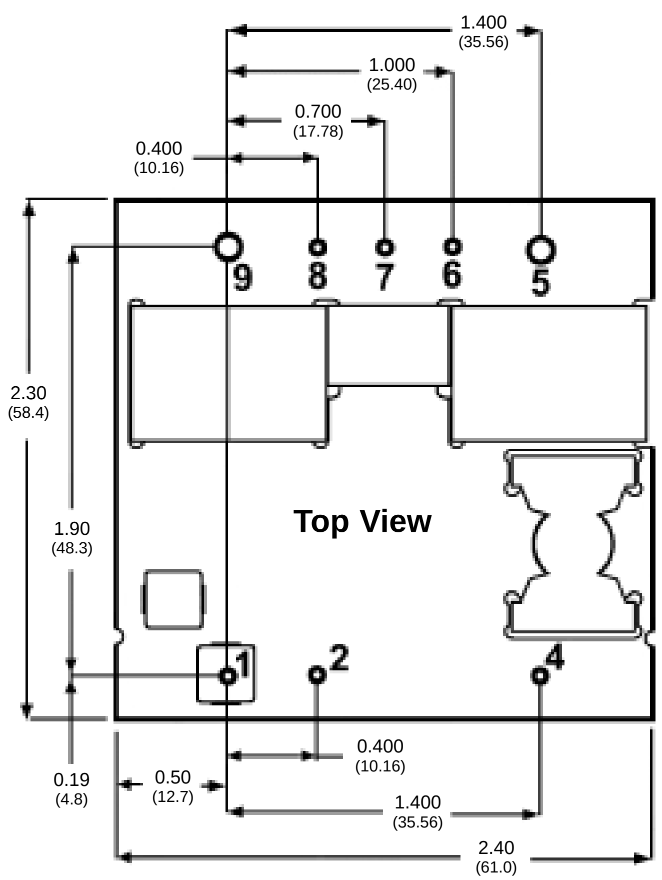
- Input under-voltage lockout
- Output current limit and short circuit protection
- Output over-voltage protection
- Thermal shutdown
- Backdrive protection prevents excessive negative current flow

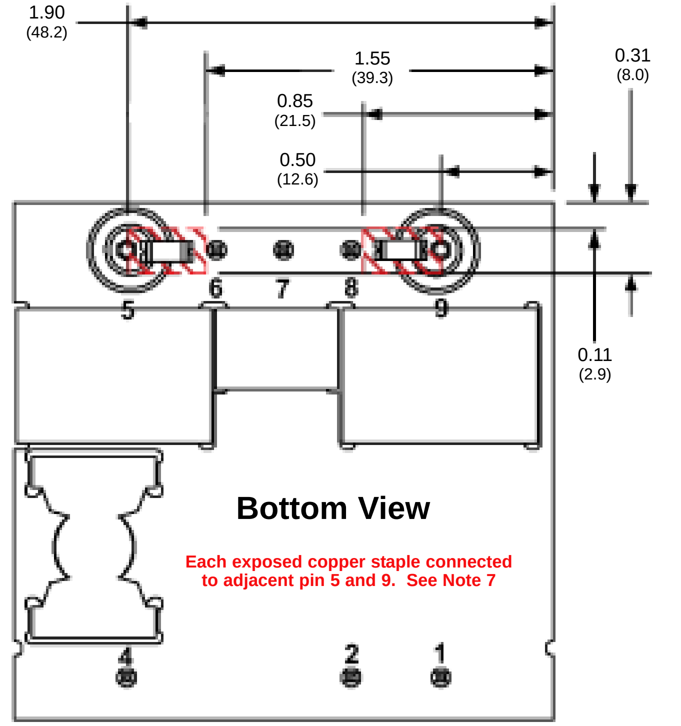
## Control Features

- On/Off control referenced to input side (positive and negative logic options are available)
- Remote sense for the output voltage compensates for output distribution drops
- Output voltage trim down to 6.0V permits custom voltages and voltage margining (+5%/-50%)
- Short startup inhibit time

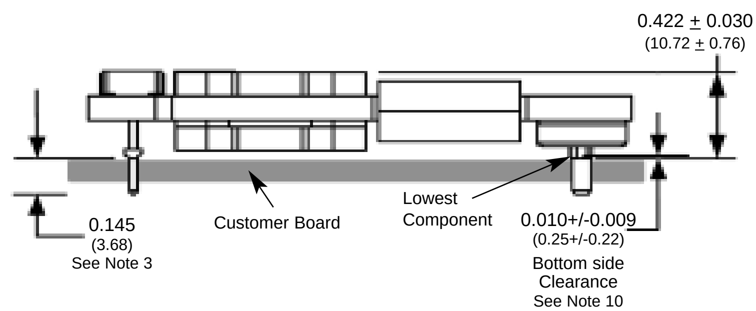
# MECHANICAL DIAGRAM

## Open-Frame Version




Side View




## NOTES

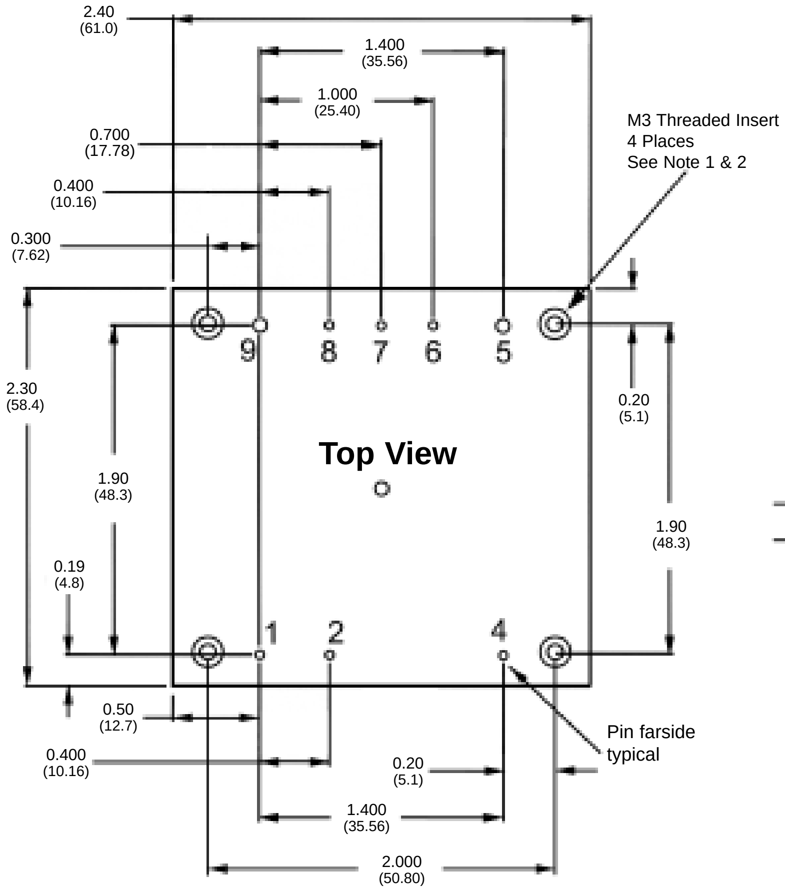
1) Pins 1, 2, 4, 6-8 are 0.040” (1.02mm) diameter with 0.080” (2.03mm) diameter standoff shoulders.
2) Pins 5 and 9 are 0.080” (2.03 mm) diameter shoulderless pins.
3) Other pin extension lengths available. Recommended pin length is 0.03” (0.76mm) greater than the PCB thickness.
4) All Pins: Material - 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) Same net copper planes recommended on customer board in designated areas adjacent to pins 5 and 9, as worst case bottom side clearance could cause exposed copper staple to touch customer board surface.
8) Weight: 2.6 oz. (75g) typical
9) Workmanship: Meets or exceeds IPC-A-610C Class II
10) UL/TUV standards require a clearance greater than 0.04” (1.02mm) between input and output for Basic insulation. This issue should be considered if any copper traces are on the top side of the user’s board. Note that the ferrite cores are considered part of the input/primary circuit.

## PIN DESIGNATIONS

| Pin No. | Name | Function |
|---|---|---|
| 1 | Vin(+) | Positive input voltage |
| 2 | ON/OFF | TTL input to turn converter on and off, referenced to Vin(-), with internal pull up. |
| 4 | Vin(-) | Negative input voltage |
| 5 | Vout(-) | Negative output voltage |
| 6 | SENSE(-) | Return remote sense |
| 7 | TRIM | Output voltage trim |
| 8 | SENSE(+) | Positive remote sense |
| 9 | Vout(+) | Positive output voltage |

# MECHANICAL DIAGRAM

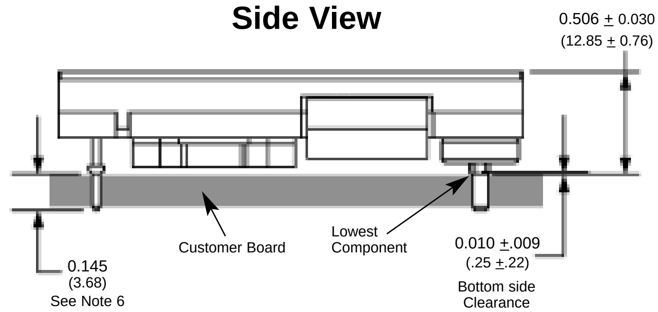
## Baseplated Version




### Bottom View

Bottom view is identical to open-frame version shown on Page 2.

### Side View




## NOTES

1) M3 screws used to bolt unit's baseplate to other surfaces (such as heatsink) must not exceed 0.100" (2.54 mm) depth below the surface of the baseplate.
2) Applied torque per screw should not exceed 6in-lb. (0.7 Nm)
3) Baseplate flatness tolerance is 0.004" (.10mm) TIR for surface
4) Pins 1, 2, 4, 6-8, are 0.040" (1.02mm) diameter with 0.080" (2.03mm) diameter standoff shoulders
5) Pins 5, 9 are 0.080" (2.03mm) diameter shoulderless pins.
6) Other pin extension lengths available
7) All Pins: Material - Copper Alloy
Finish - Tin/Lead over Nickel plate
8) Undimensioned components are shown for visual reference only.
9) Weight: 4.3 oz. (123 g) typical
10) All dimensions in inches (mm)
Tolerances: x.xx +/-0.02 in. (x.x +/-0.5mm)
x.xxx +/-0.010 in. (x.xx +/-0.25mm)
11) Workmanship: Meets or exceeds IPC-A-610C Class II

## PIN DESIGNATIONS

Pin connections are identical to open-frame version shown on Page 2. Use "B" as 10th letter in part number for baseplated version (see ordering page).

# BQ60120HEA30 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 | | | 100 | V | Continuous |
| Operating | | | 80 | V | Continuous |
| Operating Transient Protection | | | 100 | V | 100ms transient, square wave |
| Isolation Voltage (input to output) | | | 2250 | V | Basic insulation level, Pollution degree 2 |
| Operating Temperature | -40 | | 100 | °C | See Figures 7 - 10 for derating |
| Storage Temperature | -55 | | 125 | °C | |
| **INPUT CHARACTERISTICS** | | | | | |
| Operating Input Voltage Range | 35 | 48 | 75 | V | |
| Input Under-Voltage Lockout | | | | | |
| Turn-On Voltage Threshold | 31.5 | 33.5 | 34.4 | V | |
| Turn-Off Voltage Threshold | 29.5 | 30.5 | 32.4 | V | |
| Lockout Voltage Hysteresis | | 3.0 | | V | |
| Maximum Input Current | | | 11.6 | A | 100% Load, 35 Vin, trimmed up 5% |
| No-Load Input Current | | 140 | 180 | mA | |
| Disabled Input Current | | 30 | 50 | mA | |
| Input Reflected Ripple Current | | 20 | 40 | mA | RMS thru inductor; Figures 15 & 17 |
| Input Terminal Ripple Current | | 130 | | mA | RMS; Figures 15 & 16 |
| Recommended Input Fuse | | | 20 | A | Fast blow external fuse recommended |
| Input Filter Component Values ($C_1$\L\$C_2$) | | 0\1.0\5.0 | | µF\µH\µF | Internal values; see Figure D |
| Output Filter Component Values ($L_{out}$\$C_{out}$) | | 100\90 | | nH\µF | Internal values; see Figure D |
| Recommended External Input Capacitance | 100 | 100 | | µF | Typical ESR 0.2Ω; see Figure 15 |
| Recommended External Input Capacitor ESR[1] | 0.04 | 0.2 | 1.5 | Ω | 100kHz, -40°C to 100°C |
| **OUTPUT CHARACTERISTICS** | | | | | |
| Output Voltage Set Point | 11.88 | 12.00 | 12.12 | V | |
| Output Voltage Regulation | | | | | |
| Over Line | | ±0.05 \ 6 | ±0.1 \ 12 | %\mV | |
| Over Load | | ±0.1 \ 12 | ±0.2 \ 24 | %\mV | |
| Over Temperature | | ±45 | ±90 | mV | |
| Total Output Voltage Range | 11.75 | | 12.33 | V | Over sample, line, load, temperature & life |
| Output Voltage Ripple and Noise | | | | | 44µF local ceramic, Figures 15 & 18 |
| Peak-to-Peak | | 60 | 120 | mV | Full Load; Figures 15 & 18 |
| RMS | | 20 | 40 | mV | Full Load; Figures 15 & 18 |
| Operating Output Current Range | 0 | | 30 | A | Subject to thermal derating; Figures 7 - 10 |
| Output DC Current-Limit Inception | 34 | 37 | 40 | A | Output Voltage 10% Low; Figure 19 |
| Back-Drive Current Limit while Enabled | 0.8 | 1.8 | 3.2 | A | Negative current drawn from output |
| Back-Drive Current Limit while Disabled | | 0.3 | 0.6 | A | Negative current drawn from output |
| Maximum Output Capacitance | | | >10,000 | µF | 12Vout at 30A resistive load |
| Start-up Output Voltage Overshoot (with max. cap.) | | 0 | | % | 10,000µF, Iout=30A resistive load |
| Recommended External Output Capacitance | 44 | | | µF | Local ceramic |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| Input Voltage Ripple Rejection | | 80 | | dB | 120 Hz; Figure 22 |
| Output Voltage during Load Current Transient | | | | | |
| For a Step Change in Output Current (0.1A/µs) | | 300 | | mV | 50% to 75% to 50% Iout max; Figure 13 |
| For a Step Change in Output Current (5A/µs) | | 500 | | mV | 50% to 75% to 50% Iout max; Figure 14 |
| Settling Time | | 100 | | µs | To within 1% Vout nom |
| Turn-On Transient | | | | | |
| Turn-On Time | 8 | 14 | 20 | ms | Full load, Vout=90% nom.; Figures 11 & 12 |
| Start-Up Inhibit Period | 2 | 3 | 4 | ms | |
| **EFFICIENCY** | | | | | |
| 100% Load | | 95 | | % | Figures 1 - 6 |
| 50% Load | | 95 | | % | Figures 1 - 6 |
| **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 7 - 10 for derating curves |
| Maximum Baseplate Temperature Limit | | | 100 | °C | Applies to BQ60120HEB30 only |
| **ISOLATION CHARACTERISTICS** | | | | | |
| Isolation Voltage (dielectric strength) | | 2250 | | V | |
| Isolation Resistance | | 30 | | MΩ | |
| Isolation Capacitance | | 1000 | | pF | |

1. Electrolytic capacitor ESR tends to increase dramatically at low temperature.

## ELECTRICAL CHARACTERISTICS (Continued)

| Parameter | Min. | Typ. | Max. | Units | Notes & Conditions |
|---|---|---|---|---|---|
| **FEATURE CHARACTERISTICS** | | | | | |
| Switching Frequency Regulation Stage | 270 | 300 | 330 | kHz | |
| Switching Frequency Isolation Stage | 135 | 150 | 165 | kHz | Synchronous to regulation stage |
| ON/OFF Control (Option P) | | | | | |
| Off-State Voltage | -2 | | 0.8 | V | |
| On-State Voltage | 3.5 | | 18 | V | |
| ON/OFF Control (Option N) | | | | | |
| Off-State Voltage | 2.7 | | 18 | V | |
| On-State Voltage | -2 | | 0.8 | V | |
| ON/OFF Control (Either Option) | | | | | Figure A |
| Pull-Up Voltage | 4.5 | 5 | 6 | V | |
| Pull-Up Resistance | | 10 | | kΩ | |
| Output Voltage Trim Range | -50 | | +5 | % | Measured across Pins 9 & 5; Figure B |
| Output Over-Voltage Protection | 113 | 118 | 123 | % | Over full temp range; % of nominal Vout |
| Over-Temperature Shutdown | | 120 | | °C | Average PCB Temperature |
| Over-Temperature Shutdown Restart Hysteresis | | 10 | | °C | |
| Load Current Scale Factor | | 600 | | | See App Note: Output Load Current Calc. |
| **RELIABILITY CHARACTERISTICS** | | | | | |
| Calculated MTBF (Telcordia) | | 1.9 | | $10^6$ Hrs. | TR-NWT-000332; 80% load,300LFM, 40°C $T_a$ |
| Calculated MTBF (MIL-217) | | 1.4 | | $10^6$ Hrs. | MIL-HDBK-217F; 80% load, 300LFM, 40°C $T_a$ |
| Field Demonstrated MTBF | | | | $10^6$ Hrs. | See our website for details |

## STANDARDS COMPLIANCE

| Parameter | Notes |
|---|---|
| **STANDARDS COMPLIANCE** | |
| UL/cUL 60950-1 | File # E194341, Basic insulation & pollution degree 2 |
| 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, 2 minutes on and 6 hours off |
| Solderability | 15 pins | MIL-STD-883, method 2003 |

- Extensive characterization testing of all SynQor products and manufacturing processes is performed to ensure that we supply robust, reliable product. Contact factory for official product family qualification document.

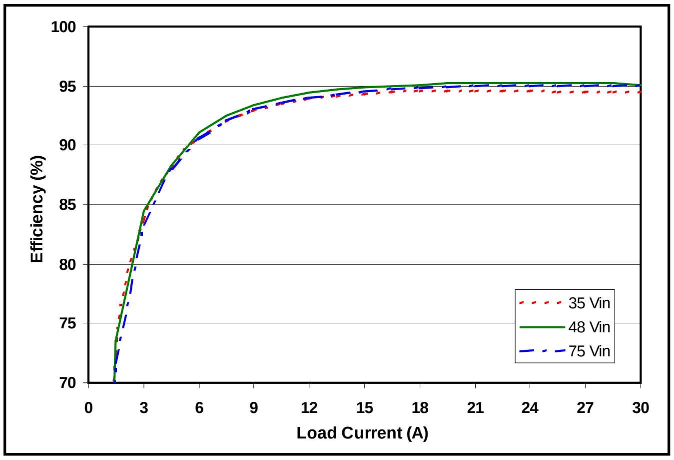



***Figure 1:*** *Efficiency at nominal **12V** output vs. load current for minimum, nominal, and maximum input voltage at 25°C.*

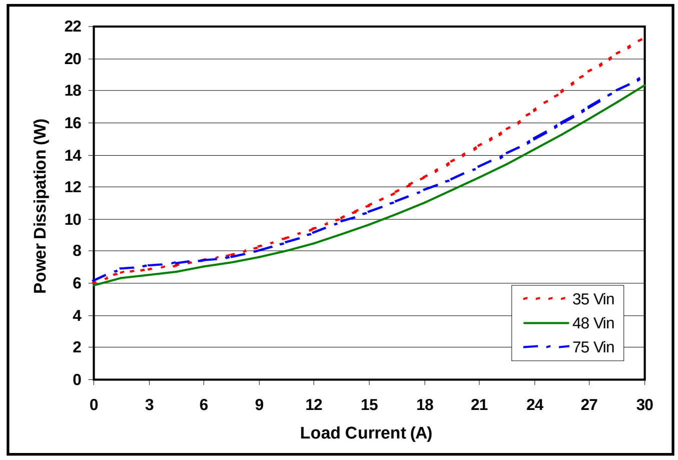



***Figure 2:*** *Power dissipation at nominal **12V** output vs. load current for minimum, nominal, and maximum input voltage at 25°C.*

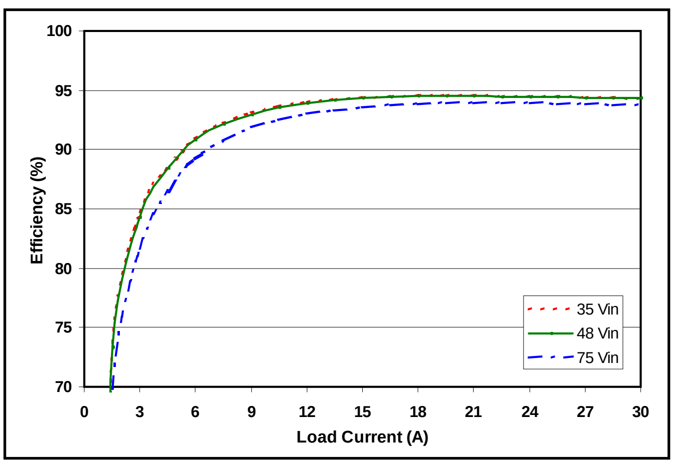



***Figure 3:*** *Efficiency at trimmed-down **9.0V** output vs. load current for minimum, nominal, and maximum input voltage at 25°C.*

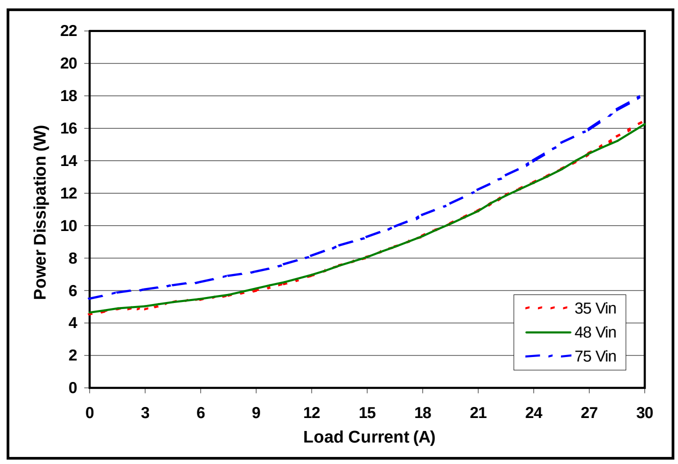



***Figure 4:*** *Power dissipation at trimmed-down **9.0V** output vs. load current for minimum, nominal, and maximum input voltage at 25°C.*

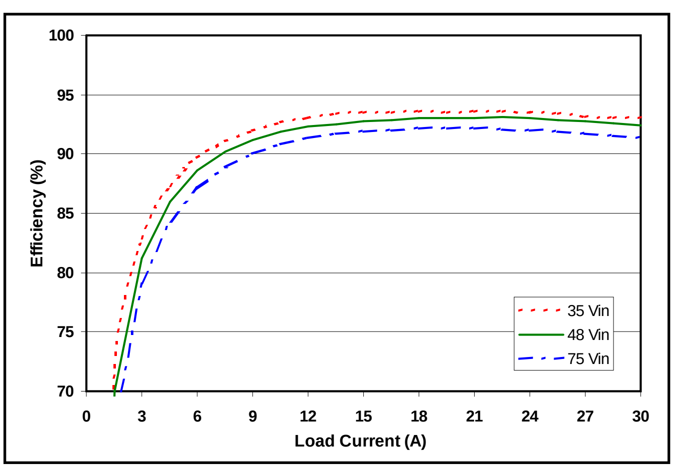



***Figure 5:*** *Efficiency at trimmed-down **6.0V** output vs. load current for minimum, nominal, and maximum input voltage at 25°C.*

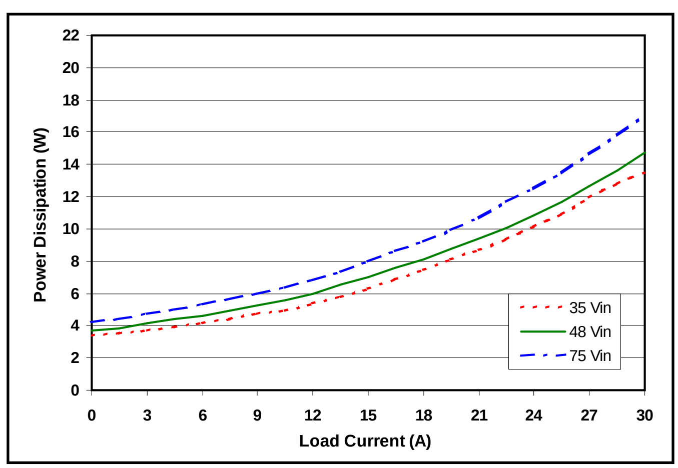



***Figure 6:*** *Power dissipation at trimmed-down **6.0V** output vs. load current for minimum, nominal, and maximum input voltage at 25°C.*

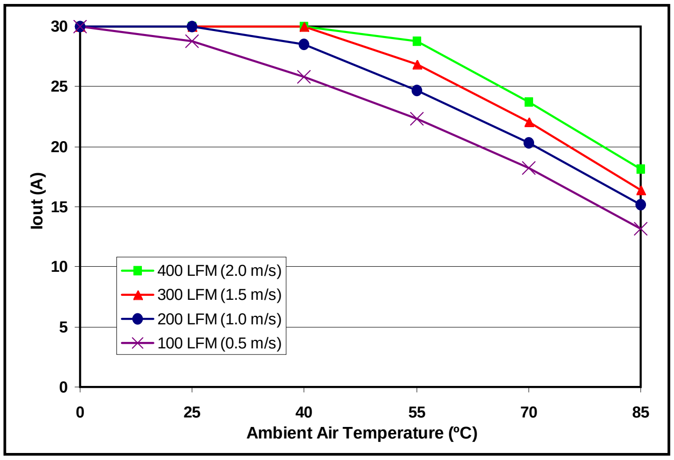



***Figure 7:*** *Maximum output power derating curves vs. ambient air temperature for airflow rates of 100 LFM through 400 LFM with air flowing from input to output (nominal input voltage).*

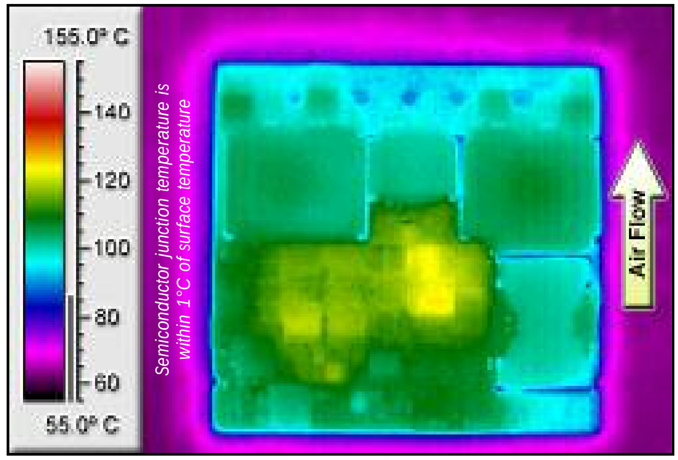



***Figure 8:*** *Thermal plot of converter at 25 amp load current (300W) with 55°C air flowing at the rate of 200 LFM. Air is flowing across the converter from input to output (nominal input voltage).*

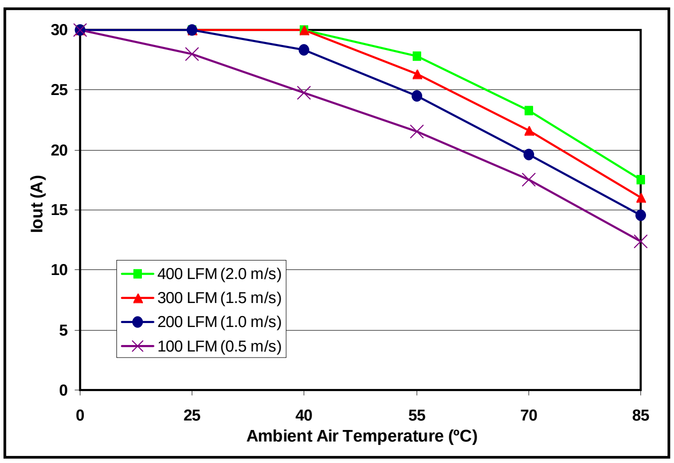



***Figure 9:*** *Maximum output power derating curves vs. ambient air temperature for airflow rates of 100 LFM through 400 LFM with air flowing from pin 1 to pin 4 (nominal input voltage).*

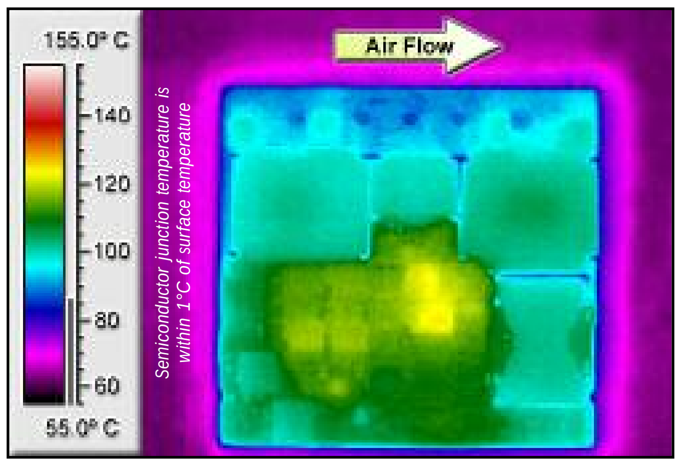



***Figure 10:*** *Thermal plot of converter at 24.5 amp load current (294W) with 55°C air flowing at the rate of 200 LFM. Air is flowing across the converter from pin 1 to pin 4 (nominal input voltage).*

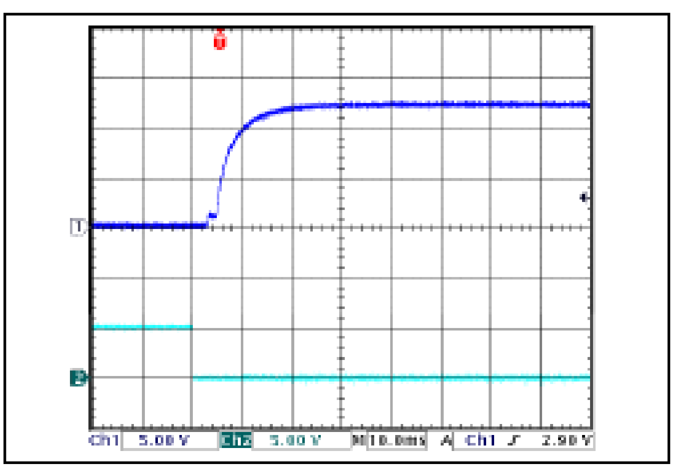


***Figure 11:*** *Turn-on transient at full load (resistive load) (10 ms/div). Input voltage pre-applied. Top Trace: Vout (5V/div). Bottom Trace: ON/OFF input (5V/div)*

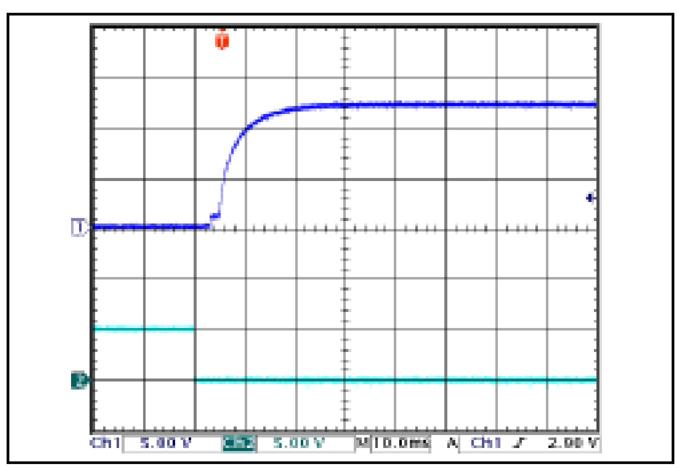


***Figure 12:*** *Turn-on transient at zero load (10 ms/div). Top Trace: Vout (5V/div). Bottom Trace: ON/OFF input (5V/div).*

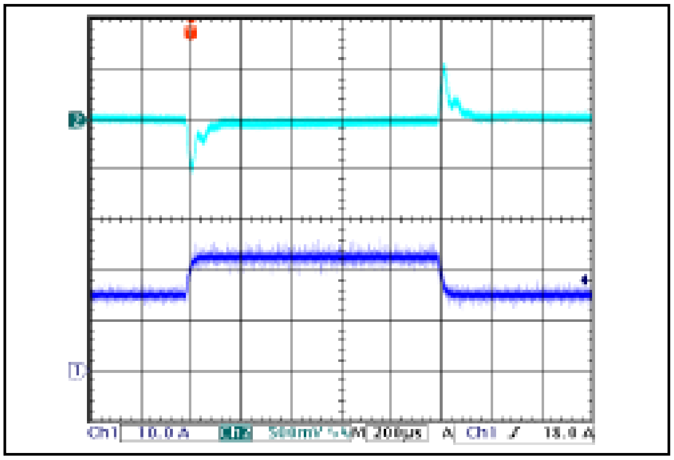


**Figure 13:** *Output voltage response to step-change in load current (50%-75%-50% of Iout(max); dI/dt = 0.1A/µs). Load cap: 47µF ceramic cap. Top trace: Vout (500mV/div), Bottom trace: Iout (10A/div).*

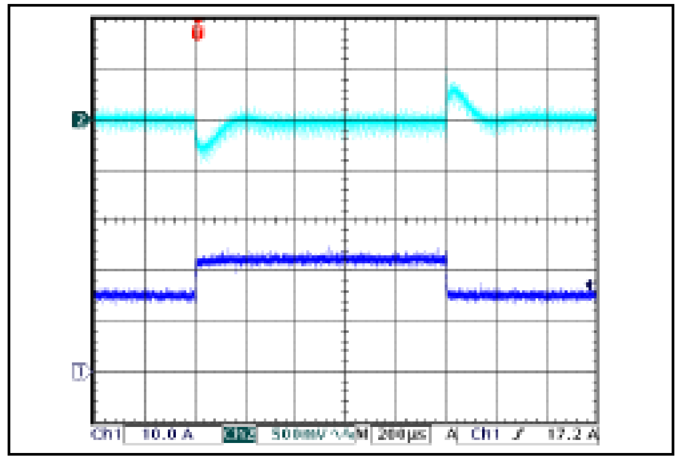


**Figure 14:** *Output voltage response to step-change in load current (50%-75%-50% of Iout(max): dI/dt = 5A/µs). Load cap: 470µF, 15 mΩ ESR tantalum cap and 47µF ceramic cap. Top trace: Vout (500mV/div), Bottom trace: Iout (10A/div).*

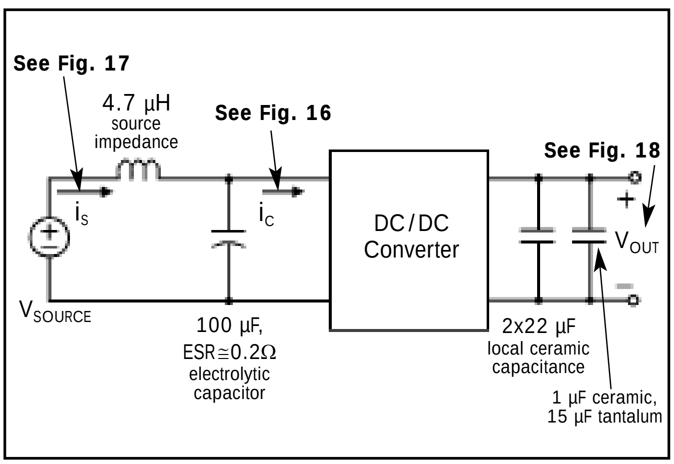



**Figure 15:** *Test set-up diagram showing measurement points for Input Terminal Ripple Current (Figure 16), Input Reflected Ripple Current (Figure 17) and Output Voltage Ripple (Figure 18).*

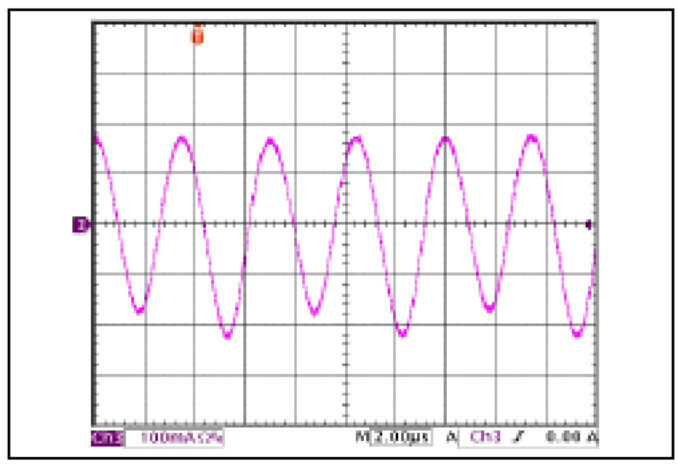


**Figure 16:** *Input Terminal Ripple Current, $i_C$, at full rated output current and nominal input voltage with 4.7µH source impedance and 100µF electrolytic capacitor (100 mA/div). (See Figure 15)*

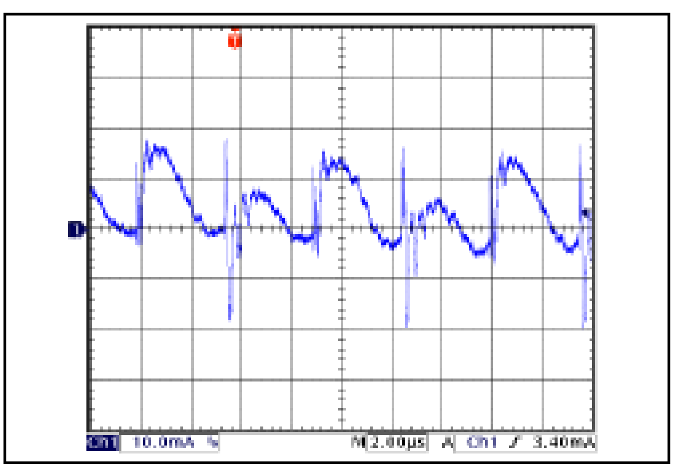


**Figure 17:** *Input reflected ripple current, $i_S$, through a 4.7 µH source inductor at nominal input voltage and rated load current (10 mA/div). (See Figure 15)*

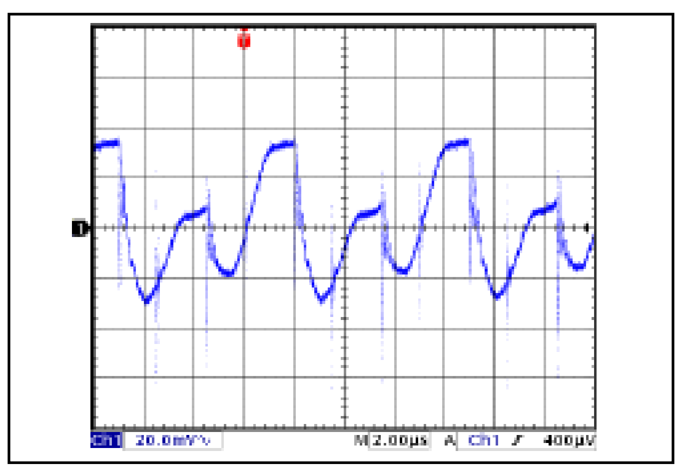


**Figure 18:** *Output voltage ripple at nominal input voltage and rated load current (20 mV/div). Load capacitance: 2x22µF ceramic capacitor. Bandwidth: 500 MHz. (See Figure 15)*

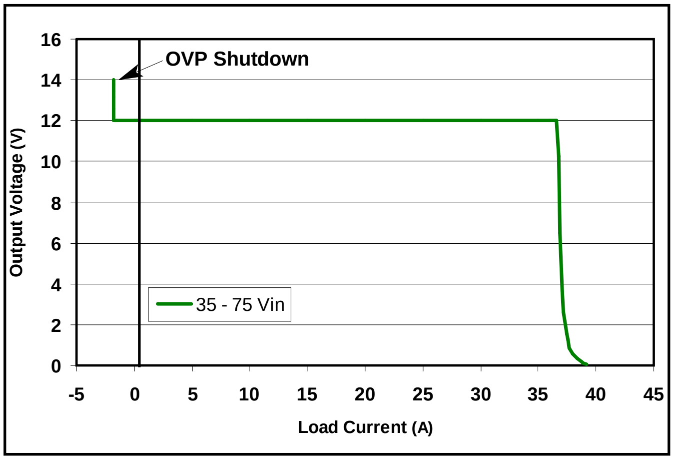



***Figure 19:*** *Output voltage vs. load current showing typical current limit curves and OVP shutdown point.*

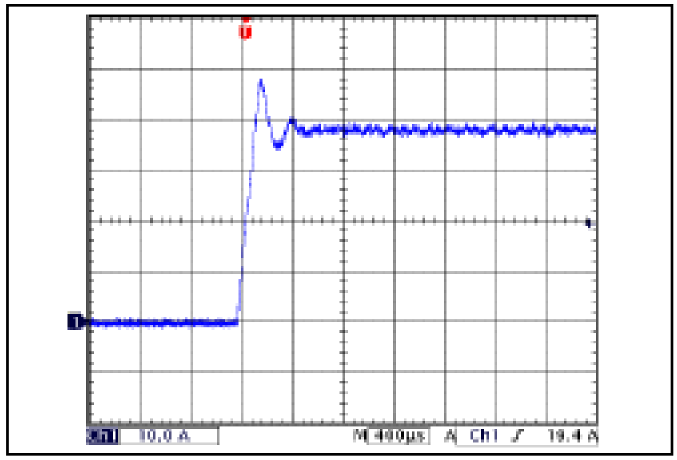



***Figure 20:*** *Load current (10A/div) as a function of time when the converter attempts to turn on into a 1 mΩ short circuit.*

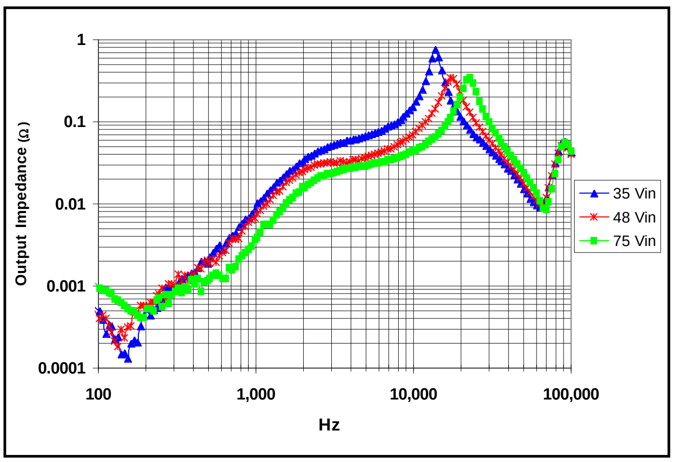



***Figure 21:*** *Magnitude of incremental output impedance ($Z_{out}$ = $v_{out}/i_{out}$) for minimum, nominal, and maximum input voltage at full rated power.*

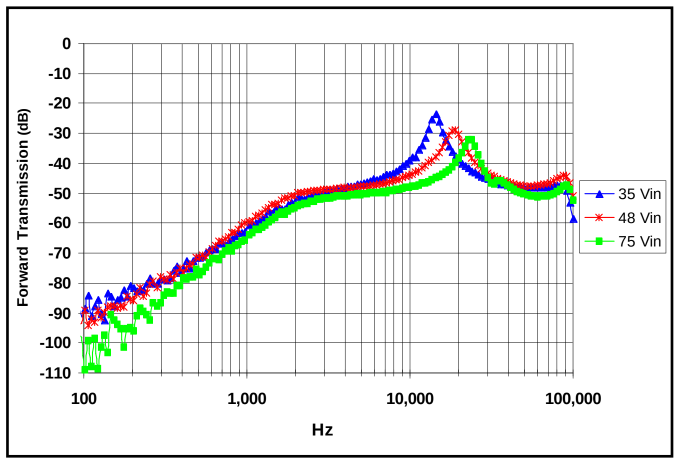



***Figure 22:*** *Magnitude of incremental forward transmission (FT = $v_{out}/v_{in}$) for minimum, nominal, and maximum input voltage at full rated power.*

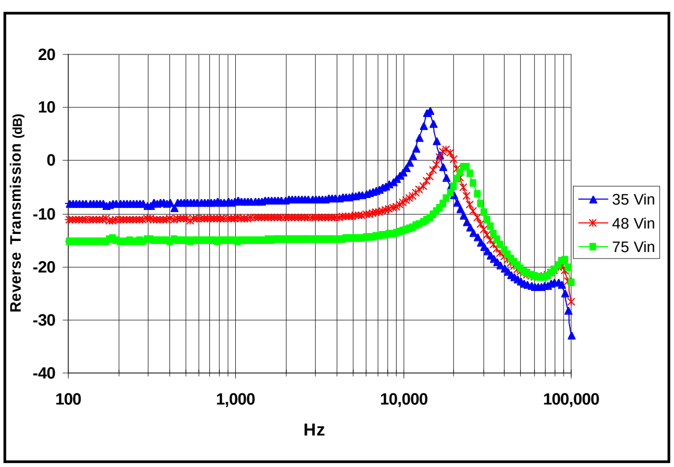



***Figure 23:*** *Magnitude of incremental reverse transmission (RT = $i_{in}/i_{out}$) for minimum, nominal, and maximum input voltage at full rated power.*

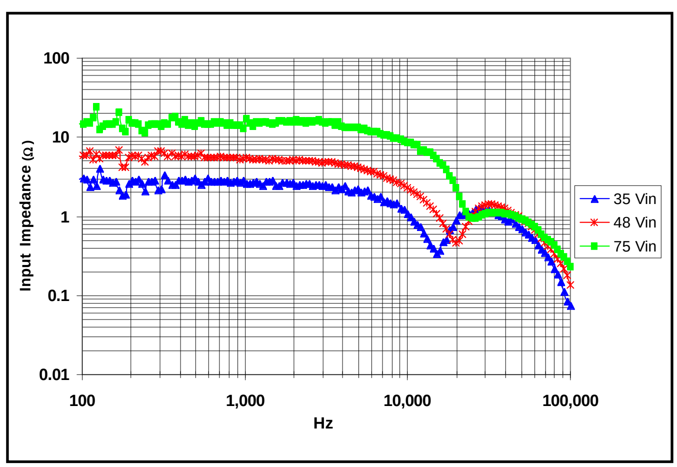



***Figure 24:*** *Magnitude of incremental input impedance ($Z_{in}$ = $v_{in}/i_{in}$) for minimum, nominal, and maximum input voltage at full rated power.*

## BASIC OPERATION AND FEATURES

The *Bus*Qor Exa series converter 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 far less energy than Schottky diodes. This is the primary reason that the *Bus*Qor converter has such high efficiency.

Dissipation throughout the converter is so low that it does not require a heatsink for operation. Since a heatsink is not required, the *Bus*Qor converter does not need a metal baseplate or potting material to help conduct the dissipated energy to the heatsink. The *Bus*Qor converter can thus be built more simply and reliably using high yield surface mount techniques on a PCB substrate.

The *Bus*Qor series of half-brick, quarter-brick and eighth-brick converters uses the industry standard footprint and pin-out configuration.

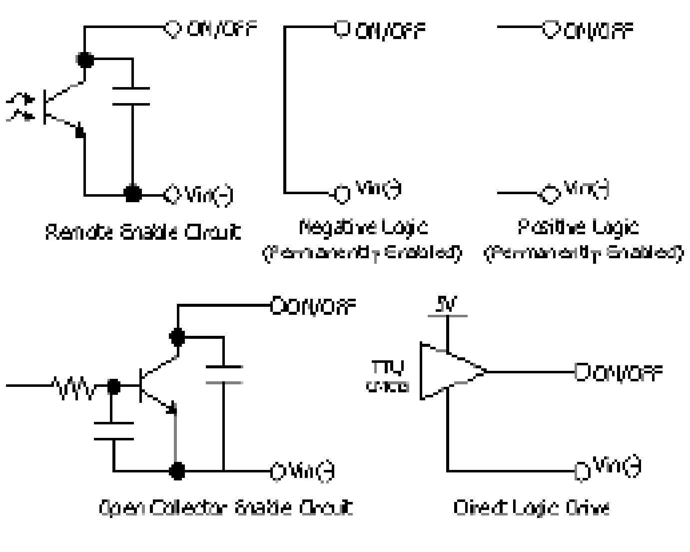



***Figure A:*** *Various circuits for driving the ON/OFF pin.*

## 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(-). There are two versions of the converter that differ by the sense of the logic used for the ON/OFF input.

In the positive logic version, the ON/OFF input is active high (meaning that a high turns the converter *on*). In the negative logic version, the ON/OFF signal is active low (meaning that a low turns the converter *on*). Figure A details five possible circuits for driving the ON/OFF pin.

**REMOTE SENSE(±) (Pins 8 and 6)**: 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. If these connections are not made, the converter will deliver an output voltage that is slightly lower 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).

**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 and Pin 6 (SENSE(-) input). For a desired decrease of the nominal output voltage, the value of the resistor should be

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

where

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

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

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

Figure B graphs 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.

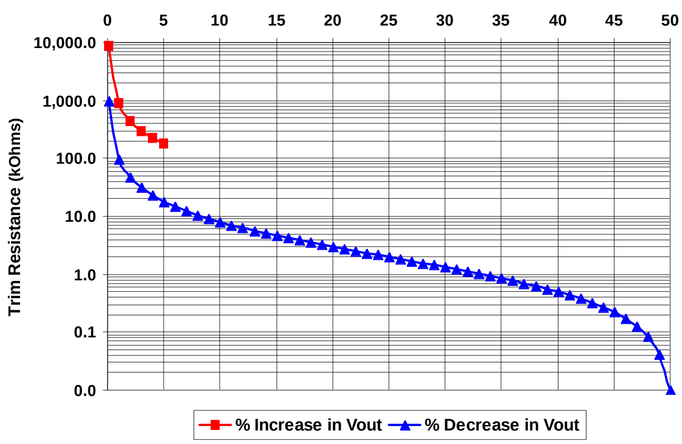



***Figure B:*** *Trim Graph for 12Vout module*

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.

## 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” available on the SynQor website. 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* 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 Limit**: If the output current exceeds the "Output DC Current Limit Inception" point*, then a fast linear current limit controller will reduce the output voltage to maintain a constant output current. There is no minimum operating output voltage. The converter will run with low on-board power dissipation down to zero output voltage. A redundant circuit will shutdown the converter if the primary current limit fails.

**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. The full I-V output characteristic can be seen in Figure 19.

**Output Over-Voltage Limit**: 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.

**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.

**Start-up Inhibit Period**: If any protection feature causes the converter to shut down, the converter will attempt to restart after 2ms (typical), the "Startup Inhibit Period".* On initial application of input voltage, with the on/off pin set to enable the converter, the "Turn-On Time"* will increase by only 2ms.

***** See specification page.

## 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 (www.synqor.com) which provides an understanding of why this instability arises, and shows the preferred solution for correcting it.

**Application Circuits**: Figure C below provides a typical circuit diagram which details the input filtering and voltage trimming.

**Input Filtering and External Input Capacitance**: Figure D 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. More detailed information is available in the application note titled "EMI Characteristics" on the SynQor website.

**Output Filtering and External Output Capacitance**: Figure D below shows the internal output filter components. This filter dramatically reduces output voltage ripple. However, some minimum external output capacitance is required, as specified in the Output Characteristics section on the Electrical Specifications page. No damage will occur without this capacitor connected, but peak output voltage ripple will be much higher.

**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. SynQor products are currently 5/6 RoHS compliant with lead being the exception. For more information please visit our RoHS Compliance / Lead Free Initiative web or e-mail us at rohs@synqor.com.

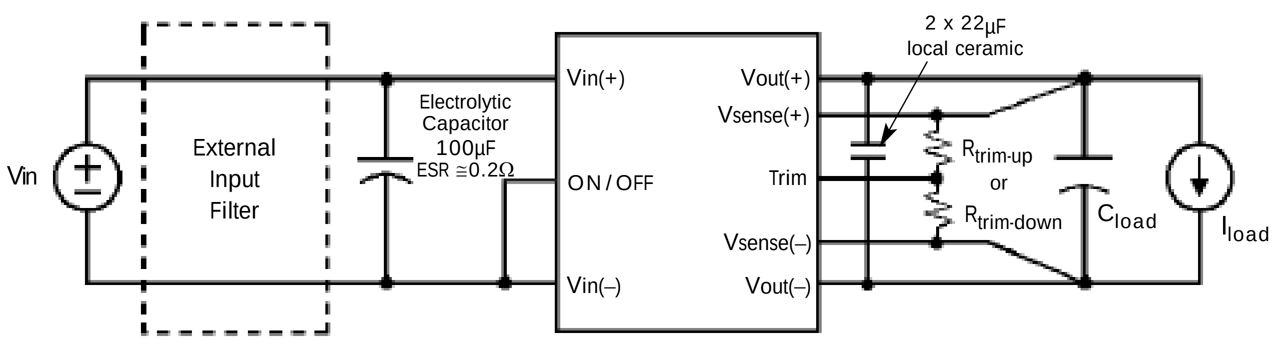



***Figure C:*** *Typical application circuit (negative logic unit, permanently enabled).*

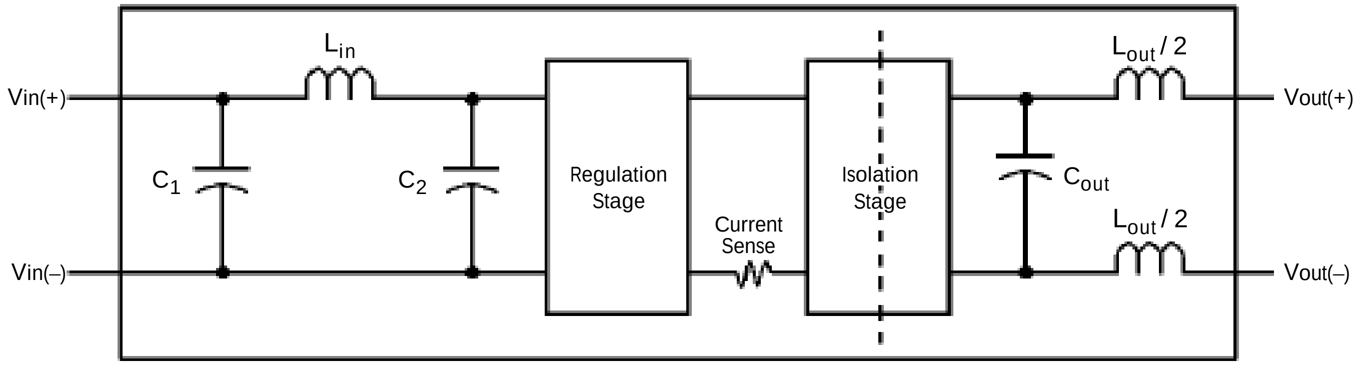



***Figure D:*** *Internal Input and Output Filter Diagram* (component values listed on the specifications page).

## PART NUMBERING SYSTEM

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

**BQ 60 120 H E A 30 N N S**

- BQ — Product Family
- 60 — Input Voltage
- 120 — Output Voltage
- H — Package Size
- E — Performance Level
- A — Thermal Design
- 30 — Output Current
- N N S — Options (see Ordering Information)

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, pin length, and feature set, the most common options are negative logic, 0.145" pins and standard feature set. 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 from our website.

## ORDERING INFORMATION

The tables below show the valid model numbers and ordering options for converters in this product family. When ordering SynQor converters, please ensure that you use the complete 15 character part number consisting of the 12 character base part number and the additional 3 characters for options.

| Model Number | Input Voltage | Output Voltage | Max Output Current |
|---|---|---|---|
| **BQ60120HEw25xyz** | 35 - 75 V | 12 V | 25 A |
| **BQ60120HEw30xyz** | 35 - 75 V | 12 V | 30 A |

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

| Options Description: *w x y z* | | | |
|---|---|---|---|
| **Thermal Design** | **Enable Logic** | **Pin Length** | **Feature Set** |
| A - Open Frame<br>B - Baseplated | P - Positive<br>N - Negative | K - 0.110"<br>N - 0.145"<br>R - 0.180"<br>Y - 0.250" | S - Standard |

## PATENTS

SynQor holds the following U.S. patents, one or more of which apply to each product listed in this document. Additional patent applications may be pending or filed in the future.

| | | | | |
|---|---|---|---|---|
| 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 | 7,119,524 | 7,269,034 | 7,272,021 |
| 7,272,023 | 7,558,083 | 7,564,702 | | |

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Warranty

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