THE DATASHEET OF

SSQE48S09120-NS0NG

Applications

- Telecommunications
- Data communications
- Wireless communications
- Servers, workstations

Benefits

- High efficiency – no heat sink required
- Cost effective, single board design
- Small size and low-profile

Features

- RoHS lead-free solder and lead-solder-exempted products are available
- Industry-standard DOSA SM and TH pin-out
- Output: 12 V at 106 W
- On-board input differential LC-filter
- Start-up into pre-biased load
- No minimum load required
- Weight: 0.44 oz [12.3 g] *(est.)*
- Fixed-frequency operation
- Hiccup overcurrent protection
- Fully protected (OTP, OCP, OVP, UV)
- Remote ON/OFF positive or negative logic option
- Industry standard 1/16th brick footprint: 0.9" by 1.3"
- High reliability: MTBF > 10 million hours, calculated per Telcordia TR-332, Method I Case 1
- Designed to meet UL/CSA60950-1 recognized in US and Canada and TUV certified per IEC/EN60950-1
- Designed to meet Class B conducted emissions per FCC and EN55022 when used with external filter
- All materials meet UL94, V-0 flammability rating

Description

The SSQE48S09120 DC-DC converter is an open frame one sixteenth-brick DC-DC converter. The converter operates over an input voltage range of 45 to 55 VDC, and provides a tightly regulated output voltage with an output power up to 100 W. The output is fully isolated from the input permitting a positive or negative output configuration.

The converter is constructed using a single-board approach with both planar and discrete magnetics. The standard feature set includes remote On/Off control (positive or negative logic), input undervoltage lockout, output overvoltage, overcurrent, and short circuit protections and overtemperature shutdown with hysteresis.

With standard pin-out and excellent thermal performance, the surface mountable SSQE48S09120 converters can replace in most cases existing eighth-brick converters. Inclusion of this converter in a new design can result in significant board space and cost savings.

Electrical Specifications

Conditions: T_A = 25 ºC, Airflow = 200 LFM (1.5 m/s), Vin = 50 VDC, Cin=47 µF, unless otherwise specified.

Parameter	Notes	Min	Typ	Max	Units
Absolute Maximum Ratings					
Input Voltage	Continuous	0		60	VDC
Operating Ambient Temperature		-20		70	°C
Storage Temperature		-55		125	°C
Isolation Characteristics					
I/O Isolation (Standard Version – **N**)		500			VDC
Isolation Capacitance (Standard Version - **N**)			1,150		pF
Isolation Resistance		10			MΩ
Feature Characteristics					
Switching Frequency			400		kHz
Output Over-voltage Protection	Non-latching	14.4	15.2	16	VDC
Over-temperature Shutdown	Non-latching		135		°C
Auto-Restart Period	Applies to all protection features		200	250	ms
Turn-On Time (from Enable to 90% Vout)	See Figures B, C, and D		7		ms
ON/OFF Control (Positive Logic)					
Converter Off (logic low)		-20		0.8	VDC
Converter On (logic high)		2.4		20	VDC
ON/OFF Control (Negative Logic)					
Converter Off (logic high)		2.4		20	VDC
Converter On (logic low)		-20		0.8	VDC
Mechanical					
Weight			12.3		g
Reliability					
MTBF	Telcordia SR-332, Method I Case 1 50% electrical stress, 40°C ambient		10		MHrs

Electrical Specifications (continued)

Conditions: T_A = 25 ºC, Airflow = 200 LFM (1.5 m/s), Vin = 50 VDC, Cin=47 µF, unless otherwise specified.

Parameter	Notes	Min	Typ	Max	Units
Input Characteristics					
Operating Input Voltage Range		45	50	55	VDC
Input Under-voltage Lockout					
Turn-on Threshold		41	43	45	VDC
Turn-off Threshold		39	41	43	VDC
Input Voltage Transient Hysteresis	100 ms			60	VDC
Maximum Input Current	V_{IN} = 45 VDC , P_{OUT} = 100 W			2.5	ADC
Input Stand-by Current	Vin = 50 V, converter disabled		8	12	mA
Input No Load Current (0 load on the output)	Vin = 50 V, converter enabled		48	60	mA
Input Reflected-Ripple Current, i_S	Vin = 50 V, 25 MHz bandwidth		100		mA_{PK-PK}
Output Characteristics					
External Load Capacitance	Plus full resistive load			1,250	µF
Output Current Range	12 VDC	0		9	ADC
Current Limit Inception	Non-latching, for 12 VDC	9.9	11.5	12.6	ADC
Peak Short-Circuit Current (< 200 us)	Non-latching, Short = 10 mΩ		18		A
RMS Short-Circuit Current	Non-latching		2.5		Arms
Output Voltage Set-point (no load) [2]		11.76	12.00	12.24	V
Output Regulation					
Over Line			±2	±5	mV
Over Load			±2	±20	mV
Overall Output Voltage Range	Over line, load and temperature	11.64		12.36	V
Output Ripple and Noise – 25 MHz bandwidth	Full load + 10 µF tantalum + 1 µF ceramic		70	150	mV_{PK-PK}
Dynamic Response [1]					
Load Change 50%-75%-50% of Iout Max, di/dt = 0.1 A/µs	Co = 1 µF ceramic + 10 µF tantalum Figure 13		120	150	mV
Load Change 50%-75%-50% of Iout Max , di/dt = 1 A/µs	Co = 47µF tantalum + 1 µF ceramic Figure 14		200	250	mV
Settling Time to 1% of Vout			50	75	µs
Efficiency					
100% Load	V_{OUT} = 12 VDC		94.4		%
50% Load	V_{OUT} = 12 VDC		93.7		%
Power Derating					
$P_{O\,MAX}$ (V_{IN} = 45V – 55V)	Component Derating				
55 °C Ambient / 200 LFM [2]	In accordance with IPC99592A guidelines			100	W
70 °C Ambient / 200 LFM [2]	Component temperatures do not exceed manufacturers' component ratings. OTP is not activated, reliability is not compromised			100	W

Additional Notes:
[1] Measured at output pins
[2] Transverse or longitudinal direction

Operations

Input and Output Impedance

These power converters have been designed to be stable with no external capacitors when used in low inductance input and output circuits.

However, in some applications, the inductance associated with the distribution from the power source to the input of the converter can affect the stability of the converter. A 47 µF electrolytic capacitor with adequate ESR based on input impedance is recommended to ensure stability of the converter over all operating conditions.

Depending on applications, the user should use decoupling capacitance at the load depending on operating conditions. The power converter will exhibit stable operation with external load capacitance up to 1,250 µF.

ON/OFF (Pin 2)

The ON/OFF pin is used to turn the power converter on or off remotely via a system signal. There are two remote control options available, positive and negative logic, both referenced to Vin(-). A typical connection is shown in Fig. A.

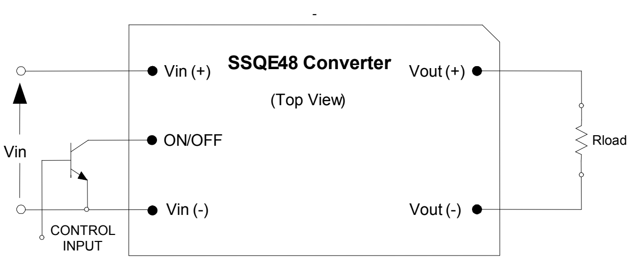


Fig. A: Circuit configuration for ON/OFF function.

The positive logic version turns on when the ON/OFF pin is at logic high or left open and turns off when the pin is at a logic low. See the Electrical Specifications for logic high/low definitions.

The negative logic version turns on when the pin is at a logic low and turns off when the pin is at a logic high. To enable automatic power up of the converter without the need of an external control signal the ON/OFF pin can be hard wired directly to Vin(-) for N and left open for P version..

The ON/OFF pin is internally pulled up to 5 V through a resistor. A properly de-bounced mechanical switch, open-collector transistor, or FET can be used to control the ON/OFF pin. The device must be capable of sinking up to 0.2 mA at a low level voltage of ≤ 0.8 V. An external voltage source (±20 V maximum) may be connected directly to the ON/OFF input, in which case it must be capable of sourcing or sinking up to 1 mA depending on the signal polarity. See the Startup Information section for system timing waveforms associated with use of the ON/OFF pin.

Protection Features

Input Undervoltage Lockout

Input undervoltage lockout is standard with this converter. The converter will shut down when the input voltage drops below a pre-determined voltage.

The input voltage should be typically 43 V for the converter to turn on. Once the converter has been turned on, it will shut off when the input voltage drops typically below 41 V. This feature is beneficial in preventing deep discharging of batteries used in telecom applications.

Output Overcurrent Protection (OC)

The converter is protected against overcurrent or short circuit conditions. Upon sensing an overcurrent condition, the converter will shut down after entering the constant current mode of operation, regardless of the value of the output voltage.

Once the converter has shut down, it will enter hiccup mode with attempt to restart every 200 ms until the overload or short circuit conditions are removed.

Output Overvoltage Protection (OVP)

The converter will shut down if the output voltage across Vout(+) (Pin 5) and Vout(-) (Pin 4) exceeds the OVP circuitry. The OVP circuitry contains its own reference, independent of the output voltage regulation loop. Once the converter has shut down, it will enter hiccup mode and attempt to restart every 200 ms until the OVP condition is removed.

Overtemperature Protection (OTP)

The converter will shut down under an overtemperature condition to protect itself from overheating caused by operation outside the thermal derating curves, or operation in abnormal conditions such as system fan failure. Converter will automatically restart after it has cooled to a safe operating temperature.

Safety Requirements

The converters are safely approved to UL/CSA60950-1, EN60950-1, and IEC60950-1. Functional isolation is provided between input and output.

The converters have no internal fuse. To comply with safety agencies requirements, an input line fuse must be used external to the converter. A 5 A fuse is recommended for use with this product.

The SSQE48S09129 converter is UL approved for a maximum fuse rating of 15A.

Electromagnetic Compatibility (EMC)

EMC requirements must be met at the end-product system level, as no specific standards dedicated to EMC characteristics of board mounted component DC-DC converters exist. However, Power-One tests its converters to several system level standards, primary of which is the more stringent EN55022, *Information technology equipment - Radio disturbance characteristics-Limits and methods of measurement.*

An effective internal LC differential filter reduces input reflected ripple current, and improves EMC.

With the addition of an external filter, all versions of the SSQE48S09120 converters will pass the requirements of Class B conducted emissions per EN55022 and FCC requirements.

Startup Information (using negative ON/OFF)

Scenario #1: Initial Startup From Bulk Supply
ON/OFF function enabled, converter started via application of V_{IN}. See Figure B.

Time	Comments
t_0	ON/OFF pin is ON; system front-end power is toggled on, V_{IN} to converter begins to rise.
t_1	V_{IN} crosses undervoltage Lockout protection circuit threshold; converter enabled.
t_2	Converter begins to respond to turn-on command (converter turn-on delay).
t_3	Converter V_{OUT} reaches 100% of nominal value.

For this example, the total converter startup time (t_3- t_1) is typically 7 ms.

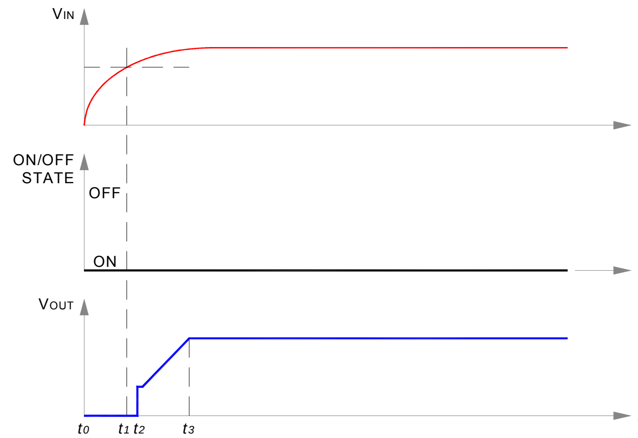


Fig. B: Startup scenario #1.

Scenario #2: Initial Startup Using ON/OFF Pin
With V_{IN} previously powered, converter started via ON/OFF pin. See Figure C.

Time	Comments
t_0	V_{INPUT} at nominal value.
t_1	Arbitrary time when ON/OFF pin is enabled (converter enabled).
t_2	End of converter turn-on delay.
t_3	Converter V_{OUT} reaches 100% of nominal value.

For this example, the total converter startup time (t_3- t_1) is typically 7 ms.

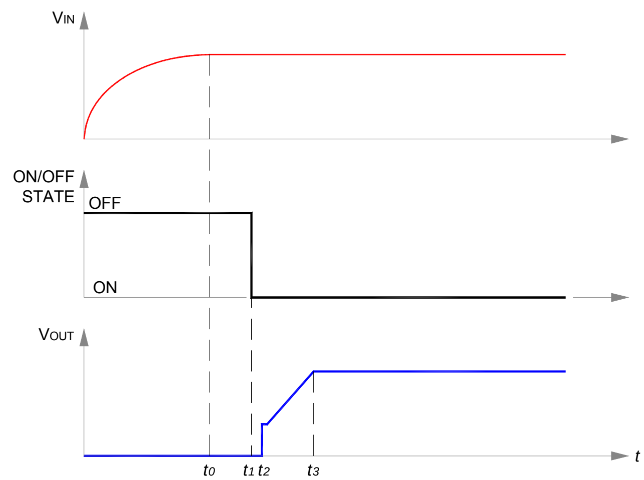


Fig. C: Startup scenario #2.

Scenario #3: Turn-off and Restart Using ON/OFF Pin
With V_{IN} previously powered, converter is disabled and then enabled via ON/OFF pin. See Figure D.

Time	Comments
t_0	V_{IN} and V_{OUT} are at nominal values; ON/OFF pin ON.
t_1	ON/OFF pin arbitrarily disabled; converter output falls to zero; turn-on inhibit delay period (200 ms typical) is initiated, and ON/OFF pin action is internally inhibited.
t_2	ON/OFF pin is externally re-enabled. **If (t_2- t_1) ≤ 200 ms**, external action of ON/OFF pin is locked out by startup inhibit timer. **If (t_2- t_1) > 200 ms**, ON/OFF pin action is internally enabled.
t_3	Turn-on inhibit delay period ends. If ON/OFF pin is ON, converter begins turn-on; if off, converter awaits ON/OFF pin ON signal; see Figure F.
t_4	End of converter turn-on delay.
t_5	Converter V_{OUT} reaches 100% of nominal value.

For the condition, **(t_2- t_1) ≤ 200 ms**, the total converter startup time (t_5- t_2) is typically 207 ms. For **(t_2- t_1) > 200 ms**, startup will be typically 7 ms after release of ON/OFF pin.

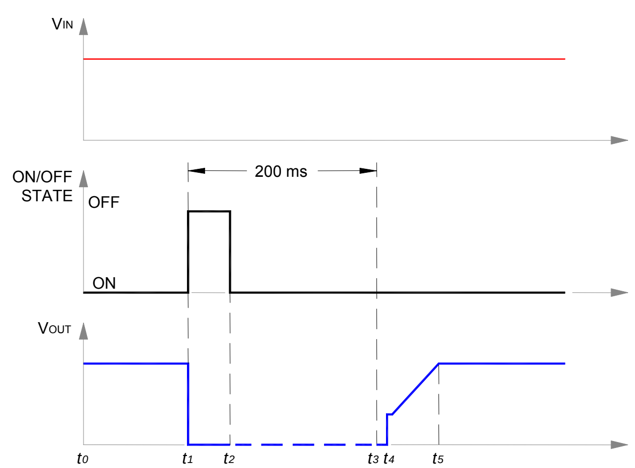


Fig. D: Startup scenario #3.

Characterization

General Information

The converters have been characterized for many operational aspects, to include thermal derating (maximum load current as a function of ambient temperature and airflow) for vertical and horizontal mounting, efficiency, startup and shutdown parameters, output ripple and noise, transient response to load step-change, overload, and short circuit.

Test Conditions

All data presented were taken with the converter soldered to a test board, specifically a 0.060" thick printed wiring board (PWB) with four layers. The top and bottom layers were not metalized. The two inner layers, comprised of two-ounce copper, were used to provide traces for connectivity to the converter.

The lack of metallization on the outer layers as well as the limited thermal connection ensured that heat transfer from the converter to the PWB was minimized. This provides a worst-case but consistent scenario for thermal derating purposes.

All measurements requiring airflow were made in the vertical and horizontal wind tunnel using Infrared (IR) thermography and thermocouples for thermometry.

If one anticipates operating the converter at or close to the maximum loads specified in the derating curves, it is prudent to check actual operating temperatures in the application. Thermographic imaging is preferable; if this capability is not available, then thermocouples may be used. The use of AWG #40 gauge thermocouples is recommended to ensure measurement accuracy. Careful routing of the thermocouple leads will further minimize measurement error. Refer to Fig. E for the recommended measuring thermocouple location.

Thermal Derating

Load current vs. ambient temperature and airflow rates are given in Figure 1, Figure 3, and Figure 5. Ambient temperature was varied between 25 °C and 85 °C, with airflow rates from 30 to 500 LFM (0.15 to 2.5 m/s).

For each set of conditions, the maximum load current was defined such that components are not exceeding IPC-9592 derating guidelines

During normal operation, derating curves should not be exceeded. Thermocouple locations shown in Fig. E should be T_{C1} < 100 °C and T_{C2} < 120 °C.

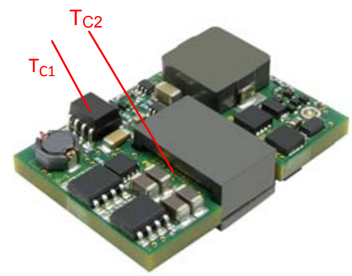


Fig. E: Locations of the thermocouple for thermal testing.

Efficiency

Efficiency vs. load current is shown in Figure 7 for ambient temperature (T_A) of 25ºC, airflow rate of 200LFM (1.5m/s) with vertical mounting and input voltages of 45V, 50V, and 55V. Also, a plot of efficiency vs. load current, as a function of ambient temperature with Vin = 50V, airflow rate of 200 LFM (1 m/s) with vertical mounting is shown in Figure. 8.

Power Dissipation

Power dissipation vs. load current is shown in Figure. 9 for T_A=25ºC, airflow rate of 200LFM (1.5m/s) with vertical mounting and input voltages of 45V, 50V, and 55V. Also, a plot of power dissipation vs. load current, as a function of ambient temperature with Vin = 50V, airflow rate of 200 LFM (1m/s) with vertical mounting is shown in Figure. 10.

Startup

Output voltage waveforms during the turn-on transient using the ON/OFF pin for full rated load currents (resistive load) are shown without and with external load capacitance in Figure 11 and Figure 12 respectively.

Ripple and Noise

Figure 15 shows the output voltage ripple waveform, measured at full rated load current with a 10 μF tantalum and 1 μF ceramic capacitor across the output. Note that all output voltage waveforms are measured across a 1 μF ceramic capacitor.

The input reflected-ripple current waveforms are obtained using the test setup shown in Figure. 16.

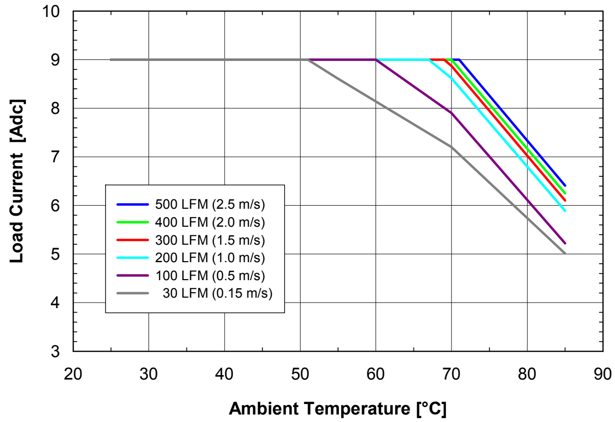


Fig. 1: Available output current vs. ambient air temperature and airflow rates for converter mounted vertically with air flowing from pin 1 to pin 3. Vin = 45V.

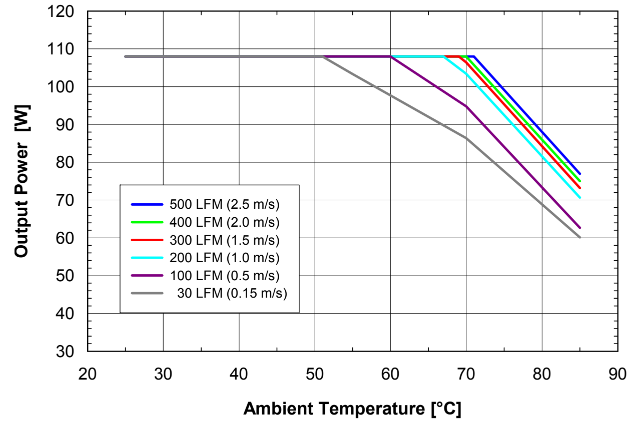


Fig. 2: Available output power vs. ambient air temperature and airflow rates for converter mounted vertically with air flowing from pin 1 to pin 3. Vin = 45V.

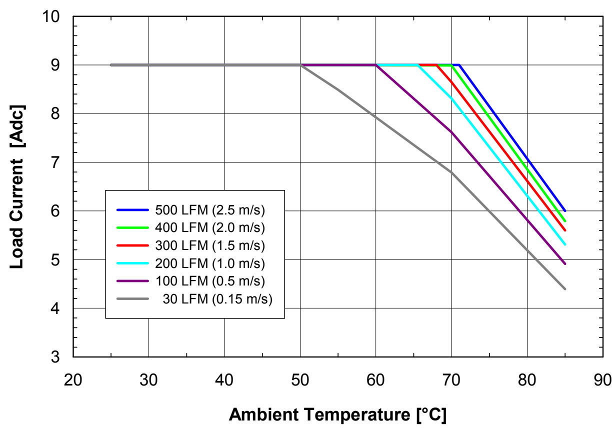


Fig. 3: Available output current vs. ambient air temperature and airflow rates for converter mounted vertically with air flowing from pin 1 to pin 3. Vin = 50V.

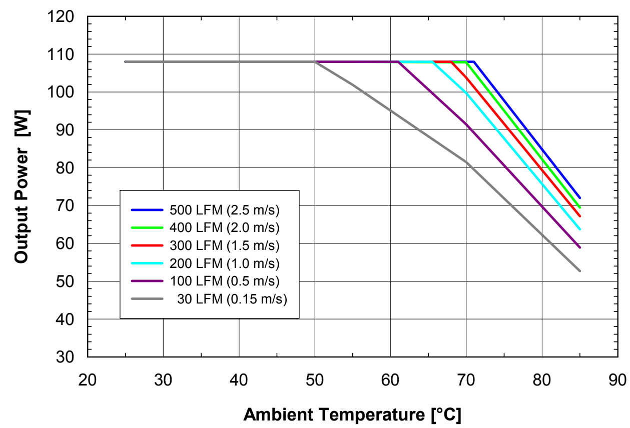


Fig. 4: Available output power vs. ambient air temperature and airflow rates for converter mounted vertically with air flowing from pin 1 to pin 3. Vin = 50V.

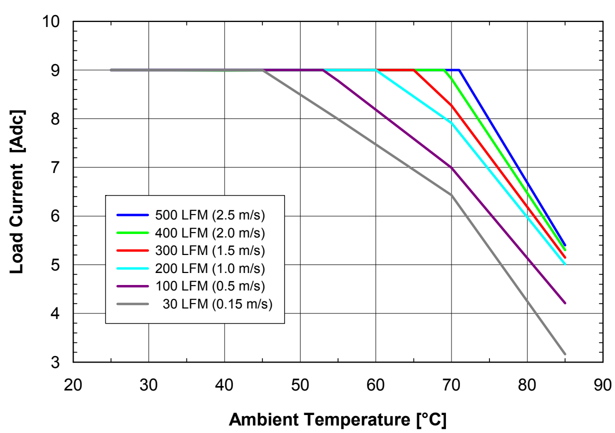


Fig. 5: Available output current vs. ambient air temperature and airflow rates for converter mounted vertically with air flowing from pin 1 to pin 3. Vin = 55V.

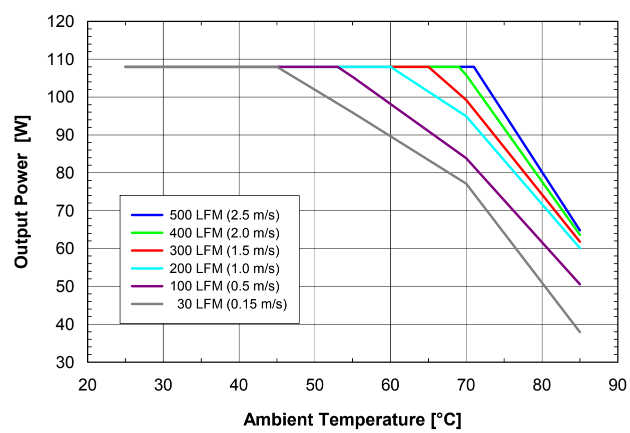


Fig. 6: Available output power vs. ambient air temperature and airflow rates for converter mounted vertically with air flowing from pin 1 to pin 3. Vin = 55V.

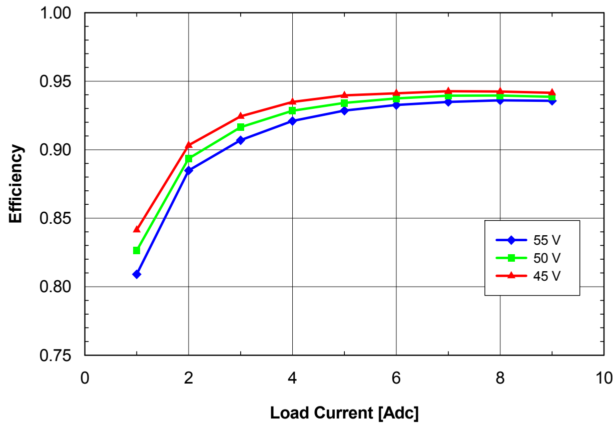


Fig. 7: Efficiency vs. load current and input voltage for converter mounted vertically with air flowing from pin 3 to pin 1 at a rate of 200 LFM (1.5 m/s) and Ta = 25 °C.

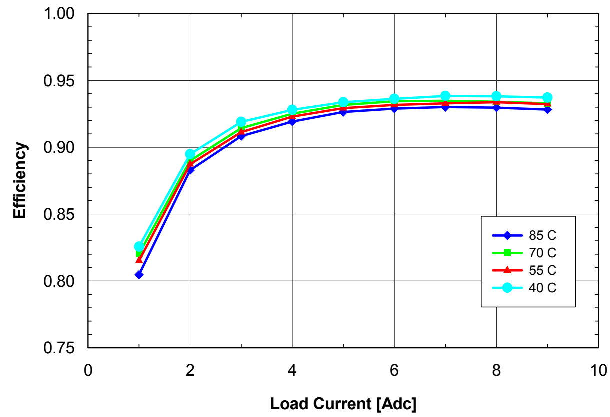


Fig. 8: Efficiency vs. load current and ambient temperature for converter mounted vertically with Vin = 50V and air flowing from pin 3 to pin 1 at a rate of 200 LFM (1.0 m/s).

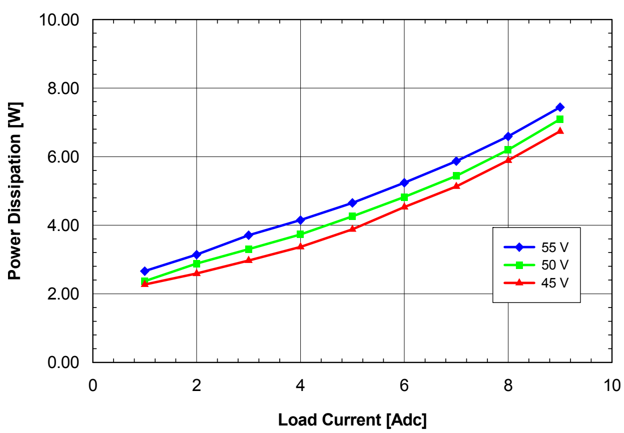


Fig. 9: Power dissipation vs. load current and input voltage for converter mounted vertically with air flowing from pin 3 to pin 1 at a rate of 200 LFM (1.5 m/s) and Ta = 25 °C.

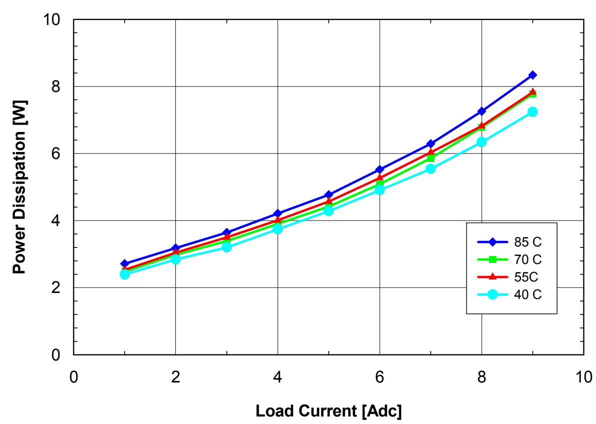


Fig. 10: Power dissipation vs. load current and ambient temperature for converter mounted vertically with Vin = 50 V and air flowing from pin 3 to pin 1 at a rate of 200 LFM (1.0 m/s).

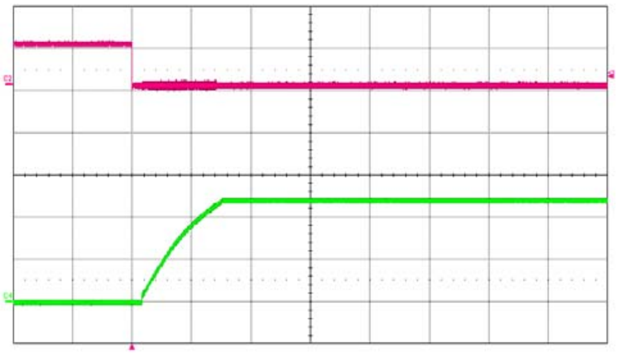


Fig. 11: Turn-on transient at full rated load current (resistive) with Cout 10 μF tantalum + 1 μF ceramic at Vin = 50 V, triggered via ON/OFF pin. Top trace: ON/OFF signal (5 V/div.). Bottom trace: output voltage (5 V/div.). Time scale: 5 ms/div.

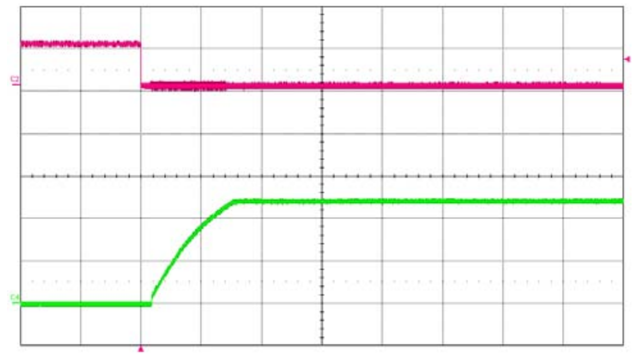


Fig. 12: Turn-on transient at full rated load current (resistive) plus 1,500 μF at Vin = 50 V, triggered via ON/OFF pin. Top trace: ON/OFF signal (5 V/div.). Bottom trace: output voltage (5 V/div.). Time scale: 5 ms/div.

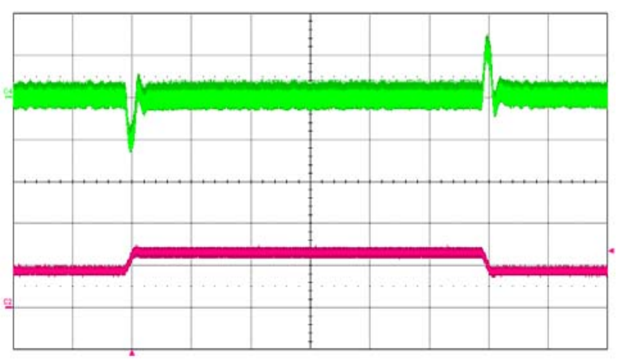


Fig. 13: Output voltage response to load current step-change (4.5 A – 6.25 A – 4.5 A) at Vin = 50 V. Top trace: output voltage (100 mV/div.). Bottom trace: load current (10 A/div.). Current slew rate: 0.1 A/μs. Co = 1 μF ceramic + 10 μF tantalum. Time scale: 200 μs/div.

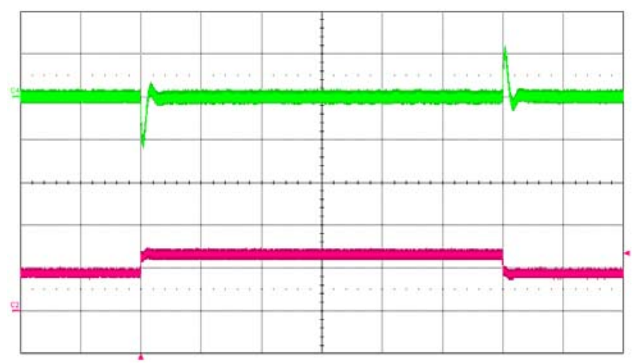


Fig. 14: Output voltage response to load current step-change (4.5 A – 6.25 A – 4.5 A) at Vin = 50 V. Top trace: output voltage (200 mV/div.). Bottom trace: load current (5 A/div.). Current slew rate: 1 A/μs. Co = 1 μF ceramic + 47 μF tantalum. Time scale: 200 μs/div.

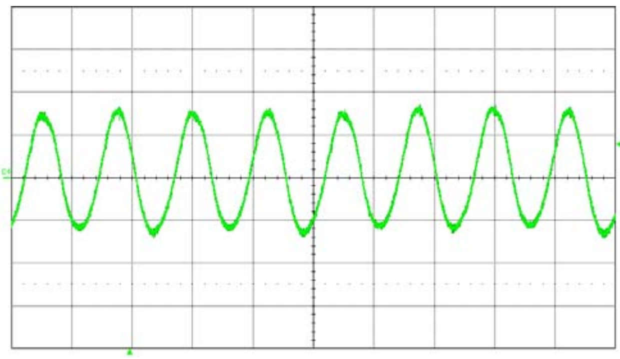


Fig. 15: Output voltage ripple (20 mV/div.) at full rated load current into a resistive load with Co = 10 µF tantalum + 1 µF ceramic and Vin = 50 V. Time scale: 2 µs/div.

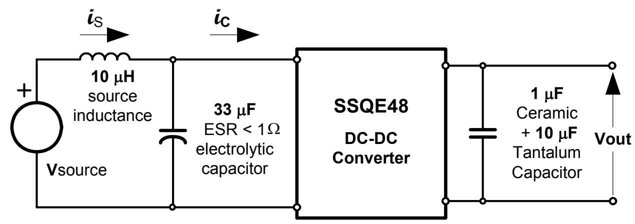


Fig. 16: Test setup for measuring input reflected ripple currents, i_c and i_s.

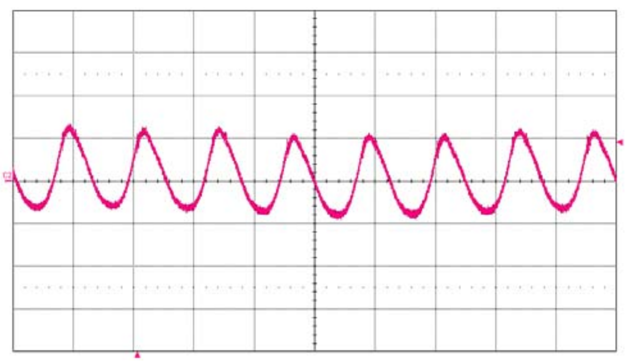


Fig. 17: Input reflected ripple current, i_c (50 mA/div.), measured at input terminals at full rated load current and Vin = 50 V. Refer to Fig. 16 for test setup. Time scale: 2 µs/div.

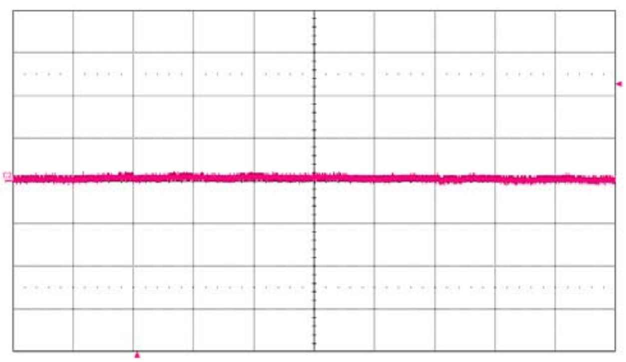


Fig. 18: Input reflected ripple current, i_s (20 mA/div.), measured through 10 µH at the source at full rated load current and Vin = 50 V. Refer to Fig. 16 for test setup. Time scale: 2 µs/div.

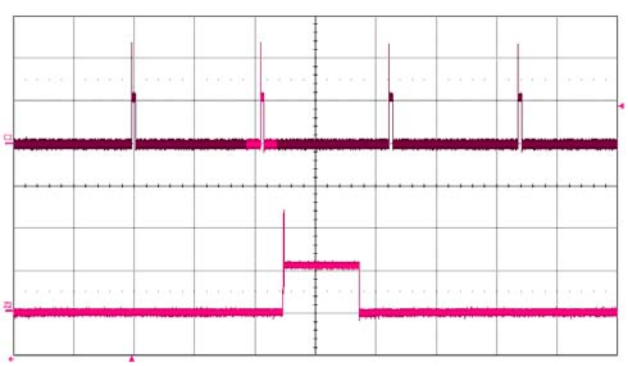
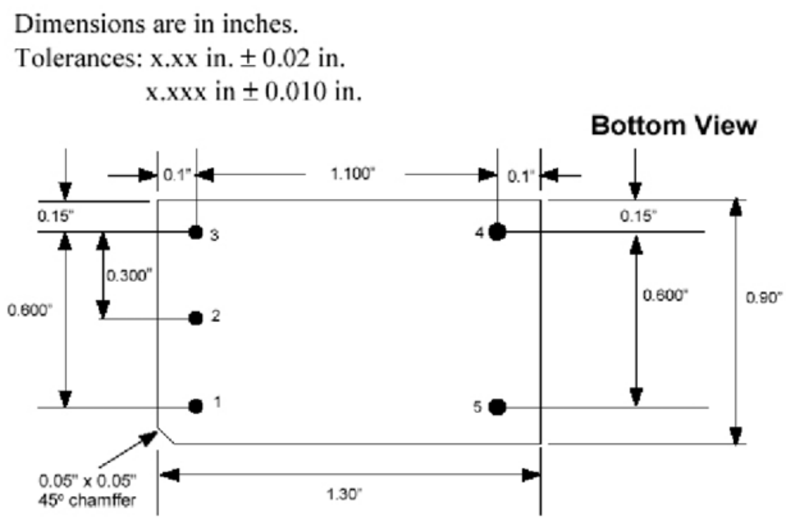
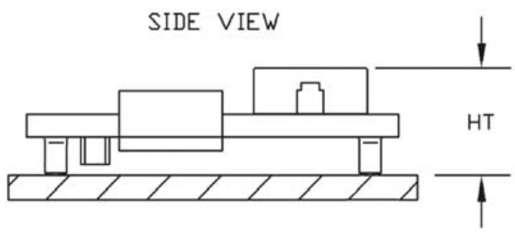


Fig. 19: Load current (top trace, 10 A/div., 100 ms/div.) into a 10 mΩ short circuit during restart, at Vin = 50 V. Bottom trace (10 A/div., 5 ms/div.) is an expansion of the on-time portion of the top trace.

Physical Information





Clearance from module to host board: ≥ 20 mils

HTmax = 0.400"

SSQE48S Pin-out (Surface Mount)

Pad/Pin Connections	
Pad/Pin #	**Function**
1	Vin (+)
2	ON/OFF
3	Vin (-)
4	Vout (-)
5	Vout (+)

SSQE48S Platform Notes

- All dimensions are in inches [mm]
- Pin material: Brass Alloy
- Pin Finish: Gold over Nickel
- Converter Weight: 0.44 oz [12.3 g] ***(est.)***
- Pins 1 – 5: 0.062" dia.+/- 0.002"
- Suggested land pad: 0.110" dia.

Converter Part Numbering/Ordering Information

Product Series	Input Voltage	Mounting Scheme	Rated Load Current	Output Voltage		ON/OFF Logic	Module Height [HT]	Pin Length [PL]	Special Features	RoHS
SSQE	**48**	**S**	**09**	**120**	**-**	**N**	**S**	**0**	**N**	**G**
Sixteenth Brick Format	45-55 V	S ⇒ Surface Mount	09 ⇒ 9 ADC	120 ⇒ 12 V		N ⇒ Negative P ⇒ Positive	S ⇒ SMT @ 0.400"$_{MAX}$	0 ⇒ n/a	N ⇒ Standard	No Suffix ⇒ RoHS lead-solder-exemption compliant G ⇒ RoHS compliant for all six substances

The example above describes P/N SSQE48S09120-NS0NG: 45-55 V input, surface mounting, 9 A @ 12 V output, negative ON/OFF logic, module height of 0.400" $_{MAX}$, standard feature set, and RoHS compliant for all 6 substances. Consult factory for availability of other options.

Notes:

1. NUCLEAR AND MEDICAL APPLICATIONS - Power-One products are not designed, intended for use in, or authorized for use as critical components in life support systems, equipment used in hazardous environments, or nuclear control systems without the express written consent of the respective divisional president of Power-One, Inc.
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