SQT48T20120 DC-DC Converter Data Sheet
42-53 VDC Input; 12 VDC @ 20 A Output

Applications

- Intermediate Bus Architectures
- Telecommunications
- Data communications
- Distributed Power Architectures
- Servers, workstations

Benefits

- High efficiency – no heat sink required
- Extremely small footprint: 0.896” x 2.30” (2.06 in^2), 38% smaller than conventional quarter-bricks
- Reduces total solution board area

Features

- RoHS lead-free solder and lead-solder-exempted products are available
- Delivers up to 230 Watts at Vin = 48 V
- Ultra-high Efficiency 96.1% at Vin = 48 V, Io = 20 A
- Industry-standard IBC quarter-brick pinout
- On-board input differential LC-filter
- No minimum load required
- Weight: 0.88 oz [25.2 g]
- Operating ambient temperature: -40 °C to 85 °C
- Fixed-frequency operation
- Fully protected (OTP, OCP, OVP, UVLO)
- Latching short circuit and overcurrent protection
- Paralleling capability
- Positive or negative logic ON/OFF option
- High reliability: MTBF calculated per Telcordia TR-332, Method I Case 1
- Meets Basic Insulation requirements of EN60950
- UL60950 recognized in US and Canada and DEMKO certified per IEC/EN60950 (pending)
- 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 20 A SQT48 Intermediate Bus Converter (IBC) provides an ultra-high efficiency single output, in a physical package that is only 62% the size of the industry-standard quarter-brick IBC, while still preserving the same pinout and functionality. Inclusion of this converter in a new design can result in significant board space and cost savings.

The 20 A SQT48 IBC provides outstanding thermal performance in high temperature environments. This performance is accomplished through the use of patent-pending power electronics circuits, packaging, and processing techniques to achieve ultra-high efficiency, excellent thermal management, and a low-body profile.

Operating from a 42 V to 53 V input, the SQT48T20120 converters provide a loosely-regulated 12 volt output which tracks the input voltage. The converter has paralleling capability with accurate current sharing.

The designer can expect system reliability improvements over other available converters because of the 20 A SQT48 IBC’s optimized thermal efficiency which is due to the use of a multi-layer PWB and the extensive use of the heavy copper plating. The low-body profile minimizes airflow shadowing, thus enhancing cooling for both upstream and downstream devices. The use of 100% automation for assembly, coupled with advanced electronic circuits and thermal design, results in a product with extremely high reliability.

Electrical Specifications

Conditions: T_A = 25 ºC, Airflow = 300 LFM (1.5 m/s), Vi n = 48 VDC, unless otherwise specified.

Parameter	Notes	Min	Typ	Max	Units
Absolute Maximum Ratings					
Input Voltage	Continuous			60	VDC
Isolation Voltage (input to output)	Basic level, Pollution degree			2000	VDC
Operating Ambient Temperature		-40		85	°C
Storage Temperature		-55		125	°C
Voltage at ON/OFF Input Pin		-20		20	V
Isolation Characteristics					
I/O Isolation Voltage		2000			VDC
Isolation Resistance			30		MΩ
Isolation Capacitance				500	pF
Feature Characteristics					
Switching Frequency			155		kHz
Turn-On Delay Time [1]	Full resistive load				
With Vin = (Module Enabled, then Vin applied)	From Vin = Vin(min) to Vo = 0.1*Vo(nom)		0.7		ms
With Enable (Vin = Vin(nom) applied, then enabled)	From enable to Vo = 0.1*Vo(nom)		0.7		ms
Rise Time [1]	From 10% to 90%, full resistive load		2		ms
Output Overvoltage Protection	Non-latching		13.75		VDC
Overtemperature Shutdown			125		°C
ON/OFF Control (Positive Logic)					
Converter Off		-20		0.8	VDC
Converter On		2.4		20	VDC
ON/OFF Control (Negative Logic)					
Converter Off		2.4		20	VDC
Converter On		-20		0.8	VDC
Temperature Limits Curves	For Power Derating				
Semiconductor Junction Temperature	Package rated to150 °C		120		°C
Board Temperature	UL rated max. operating temperature 130°C		120		°C
Transformer Temperature			120		°C

Additional Notes:

[1] Note that startup time is the sum of turn-on delay time and rise time.

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Electrical Specifications (continued)

Conditions: T_A = 25 °C, Airflow = 300 LFM (1.5 m/s), Vin = 48 VDC, unless otherwise specified.

Parameter	Notes	Min	Typ	Max	Units
Input Characteristics					
Operating Input Voltage Range		42	48	53	VDC
Input Undervoltage Lockout					
Turn-on Threshold			41		VDC
Turn-off Threshold			39.2		VDC
Hysteresis Voltage			1.8		VDC
Input Overvoltage Lockout					
Shutdown Threshold	Vin when unit will shutdown		54.5		VDC
Restart Threshold	Vin when unit turns on after shutdown event		53.8		VDC
Maximum Input Current	Full load @ 42 VDC In			5.2	ADC
Input No Load Current			40		mADC
Disabled Input Current			5		mADC
Input Reflected-Ripple Current	RMS through 10 µH inductor; Fig. 13		3		mADC
Input Terminal-Ripple Current	RMS, full load; Fig. 13		110	150	mADC
Recommended Input Fuse	Fast blow external fuse recommended		10	15	A
Input Filter Component Values (C\L\C)			1\1.5\3.2		µF\µH\µF
Recommended external Input Capacitance		33	47		µF
Output Characteristics					
Output Voltage Set Point	48 Vin, no load		12.00		VDC
Output Regulation					
Over Line			±15\1.8		%\V
Over Load			±4.1\500		%\mV
Total Output Voltage Range	Over line, load and temperature	9.7		13.3	VDC
Output Ripple and Noise	20 MHz bandwidth				
Peak-to-Peak			45	65	mV
RMS			15	20	mV
Back-Drive Current Limit Disabled (Vout =12 V)	Max negative current drawn from output		10		mA
Maximum Output Load Capacitance				3,000	µF
Output Current Range		0		20	ADC
Output DC Current Limit Inception	Latching		26	32	ADC
Output Short Circuit Protection	Latching				
Current Share Accuracy (2 units in parallel)	% of rated output current		±8		%
Efficiency					
100% Load			96.1		%
50% Load			96.5		%

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.

In many applications, the inductance associated with the distribution from the power source to the input of the converter can affect the stability of the converter. The addition of a 47 µF electrolytic capacitor with an ESR < 1 Ω across the input helps to ensure stability of the converter. In many applications, the user has to use decoupling capacitance at the load. The power converter will exhibit stable operation with external load capacitance up to 3,000 µF on 12 V output.

Additionally, see the EMC section of this data sheet for discussion of other external components which may be required for control of conducted emissions.

Parallel Option

The converter is capable paralleling of several units with current sharing guaranteed by design (See Fig. A). A typical circuit for two converters in parallel is shown on Fig. B. The maximum load current for N converters in parallel is $I_{MAX} = (18 * N) + 2$ [ADC]. The input capacitors should be placed close to the input pins of the converters. Inductors L1 and L2 (1.0 µH to 4.7 µH) are not required but they are recommended to reduce the input ripple current and EMI performance.

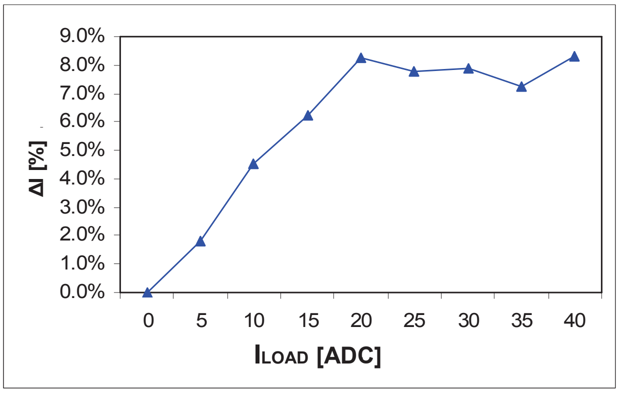


Fig. A: Current sharing accuracy for two paralleled converters, calculated as $\Delta I = \frac{(I_{LOAD}/2) - I}{I_R}$ **X 100%**

where, I = Converter's current [ADC]

I_R = Converter's rated current (20 A)

I_{LOAD} = Total load current [ADC]

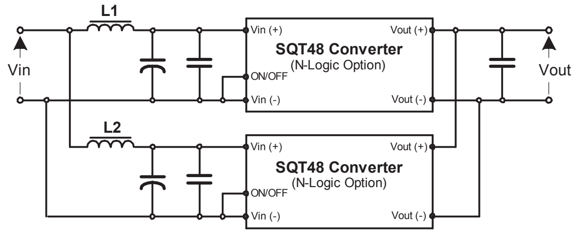


Fig. B: Paralleling for increased current output.

The following precautions must be observed when operating several SQT48T20120's in parallel:

1. The inputs of the converters must be attached to the same voltage source.
2. The PCB trace resistance from each unit to the load (Vout+ and Vout- traces) should be equalized as much as is practical. The same should be done with the input trace resistances (Vin+ and Vin-) to ensure better current sharing accuracy.
3. The ON/OFF pins of the converters must be tied together.
4. The undervoltage lockout startup point will slightly vary from unit to unit, therefore the dv/dt of the input source as it rises from 0 V to its final value will affect the ability of the parallel units to turn on into a load equal to more than the maximum rated load of 1 unit. The dv/dt of the rising edge of the input voltage must be greater than 2 V/ms.

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, with both referenced to Vin(-). A typical connection is shown in Fig. C.

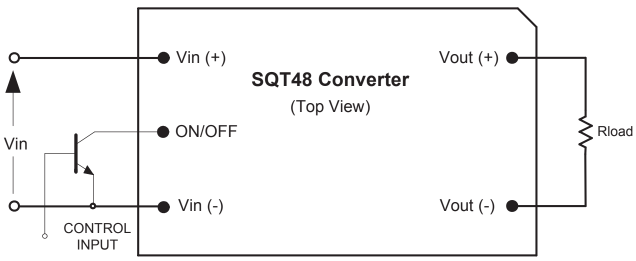


Fig. C: Circuit configuration for ON/OFF function.

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

The ON/OFF pin is internally pulled up to 5 V through a resistor. A properly debounced mechanical switch, open-collector transistor, or FET can be used to drive the input of 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.

Protection Features

Input Undervoltage and Overvoltage 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 must be typically 41 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 39.2 V. This feature is beneficial in preventing deep discharging of batteries used in telecom applications.

The converter will shut down when the input voltage exceeds typically 54.5 V, thus automatically providing output overvoltage protection. The converter will restart when the input voltage drops below typically 53.8 V. The limiting of Vin is automatically correspond to the limiting of Vout. Because the transformer's ratio is 4:1, the output voltage will be typically limited to 13.5 V.

Output Overcurrent Protection (OCP)

The converter is protected against overcurrent or short circuit conditions. Upon sensing an overcurrent condition, the converter will shut down. In order to restart converter either ON/OFF pin or input voltage need to be recycled.

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. After the converter has cooled to a safe operating temperature, it will automatically restart.

Safety Requirements

The converters meet North American and International safety regulatory requirements per UL60950 and EN60950 (pending). Basic Insulation is provided between input and output.

To comply with safety agencies' requirements, an input line fuse must be used external to the converter. A 10 A fuse is recommended for use with a standalone SQT48T20120 converter.

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 significantly reduces input reflected-ripple current, and improves EMC.

With the addition of a simple external filter, all versions of the SQT-Series of converters pass the requirements of Class B conducted emissions per EN55022 and FCC requirements. Please contact Power-One Applications Engineering for details of this testing.

Characterization

General Information

The converter has 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 mountings, efficiency, startup and shutdown parameters, output ripple and noise, transient response to load step-change, overload, and short circuit.

The following pages contain specific plots or waveforms associated with the converter. Additional comments for specific data are provided below.

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 metalization 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 tunnels using Infrared (IR) thermography and thermocouples for thermometry.

Ensuring components on the converter do not exceed their ratings is important to maintaining high reliability. 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. D for the optimum measuring thermocouple locations.

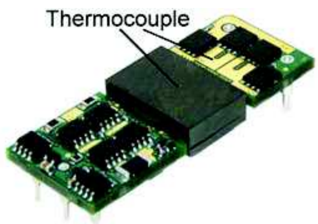


Fig. D: Locations of the thermocouple for thermal testing.

Thermal Derating

Load current vs. ambient temperature and airflow rates are given in Fig. 1 and Fig. 2 for vertical and horizontal converter mountings. 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 as the lowest of:

(i) The output current at which any FET junction temperature does not exceed a maximum specified temperature of 120 °C as indicated by the thermographic image, or

(ii) The temperature of the transformer does not exceed 120 °C, or

(iii) The nominal rating of the converter (20 A).

During normal operation, derating curves with maximum FET temperature less or equal to 120 °C should not be exceeded. Temperature at the both thermocouple locations shown in Fig. D should not exceed 120 °C in order to operate inside the derating curves.

Efficiency

Fig. 3 shows the efficiency vs. load current plot for ambient temperature of 25 ºC, airflow rate of 300 LFM (1.5 m/s) with vertical mounting and input voltages of 42 V, 48 V and 53 V. Also, a plot of efficiency vs. load current, as a function of ambient temperature with Vin = 48 V, airflow rate of 200 LFM (1 m/s) with vertical mounting is shown in Fig. 4.

Power Dissipation

Fig. 5 shows the power dissipation vs. load current plot for Ta = 25 ºC, airflow rate of 300 LFM (1.5 m/s) with vertical mounting and input voltages of 42 V, 48 V and 53 V. Also, a plot of power dissipation vs. load current, as a function of ambient temperature with Vin = 48 V, airflow rate of 200 LFM (1 m/s) with vertical mounting is shown in Fig. 6.

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 Fig. 7 and Fig. 8, respectively.

Ripple and Noise

Fig. 11 show the output voltage ripple waveform, measured at full rated load current with a 15 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 Fig 12. The corresponding waveforms are shown in Fig. 13 and Fig. 14.

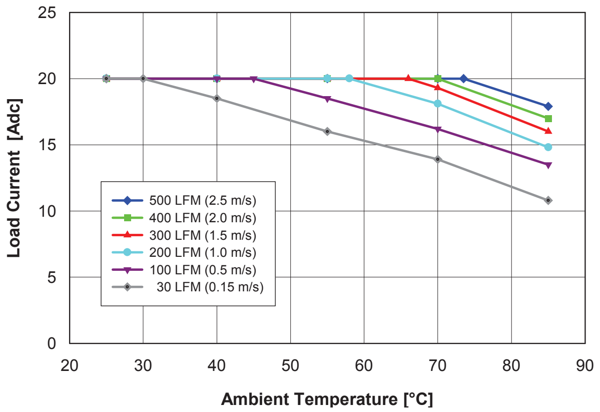


Fig. 1: Available load current vs. ambient air temperature and airflow rates for converter with D height pins mounted vertically with Vin = 48 V, air flowing from pin 3 to pin 1, and maximum FET temperature ≤ 120 °C.

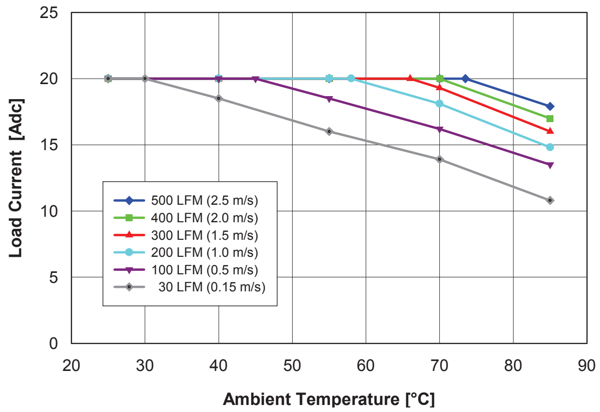


Fig. 2: Available load current vs. ambient air temperature and airflow rates for converter with D height pins mounted horizontally with Vin = 48 V, air flowing from pin 3 to pin 1, and maximum FET temperature ≤ 120 °C.

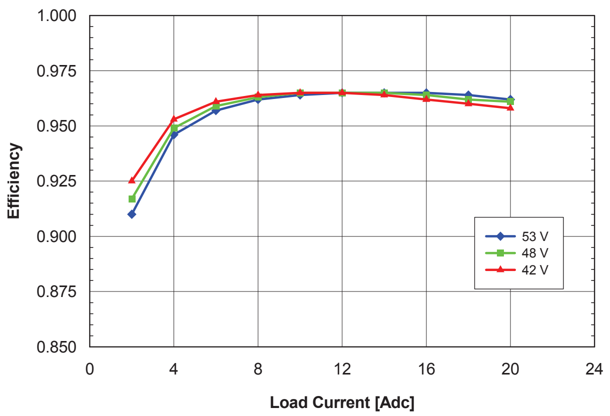


Fig. 3: Efficiency vs. load current and input voltage for converter mounted vertically with air flowing from pin 3 to pin 1 at a rate of 300 LFM (1.5 m/s) and Ta = 25 °C.

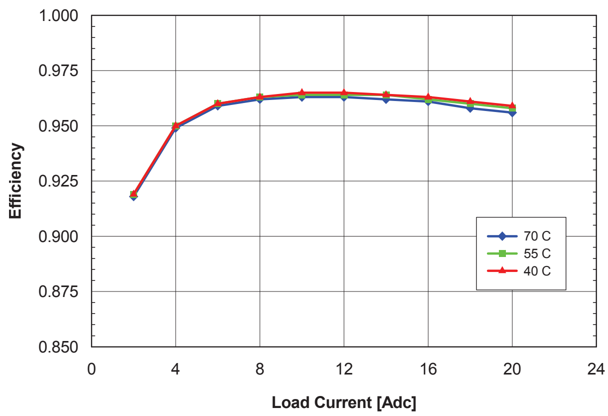


Fig. 4: Efficiency vs. load current and ambient temperature for converter mounted vertically with Vin = 48 V and air flowing from pin 3 to pin 1 at a rate of 200 LFM (1.0 m/s).

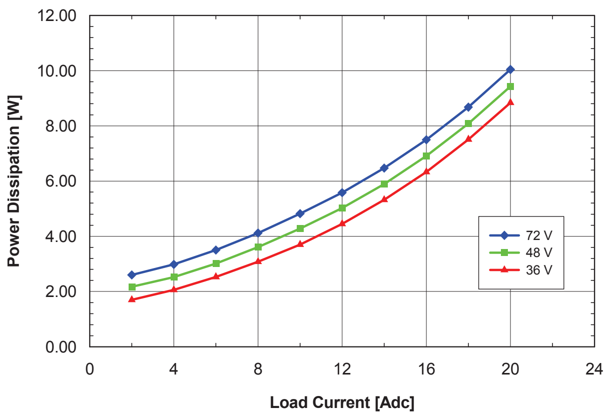


Fig. 5: Power dissipation vs. load current and input voltage for converter mounted vertically with air flowing from pin 3 to pin 1 at a rate of 300 LFM (1.5 m/s) and Ta = 25 °C.

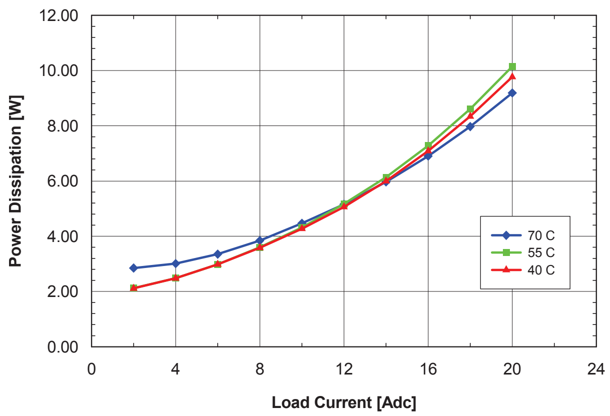


Fig. 6: Power dissipation vs. load current and ambient temperature for converter mounted vertically with Vin = 48 V and air flowing from pin 3 to pin 1 at a rate of 200 LFM (1.0 m/s).

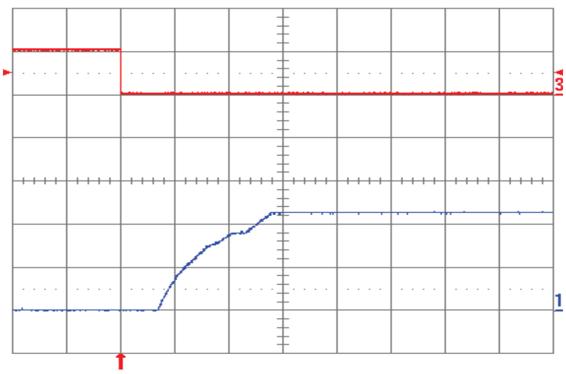


Fig. 7: Turn-on transient at full rated load current (resistive) with no output capacitor at Vin = 48 V, triggered via ON/OFF pin. Top trace: ON/OFF signal (5 V/div.). Bottom trace: output voltage (5 V/div.). Time scale: 1 ms/div.

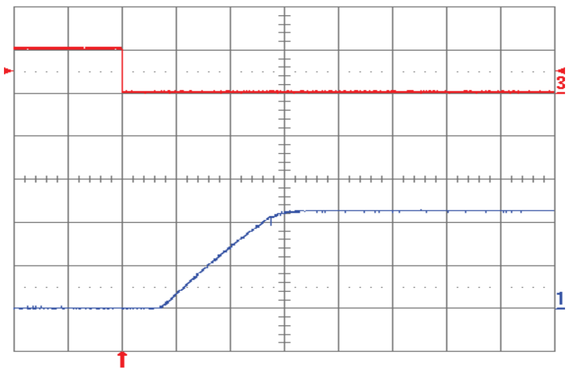


Fig. 8: Turn-on transient at full rated load current (resistive) plus 2,200 μF at Vin = 48 V, triggered via ON/OFF pin. Top trace: ON/OFF signal (5 V/div.). Bottom trace: output voltage (5 V/div.). Time scale: 1 ms/div.

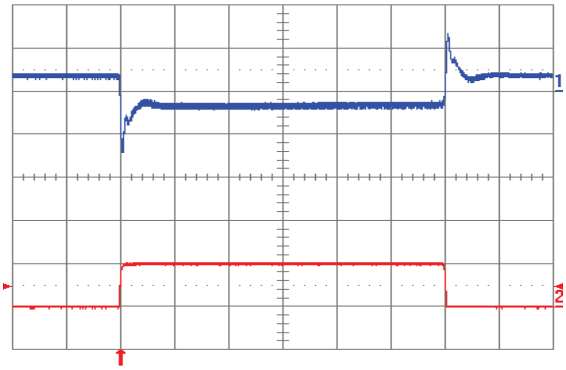


Fig. 9: Step load response to 0% – 50% – 0%) with 20 µF external capacitor and di/dt = 10 A/µs. Top trace: output voltage (500 mV/div.). Bottom trace: load current (10 A/div.). Time scale: 0.2 ms/div.

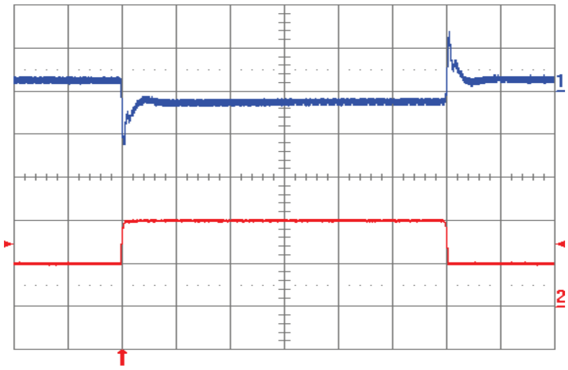


Fig. 10: Step Load response to 50% – 100% – 50% with 20 µF external ceramic capacitor and di/dt = 10A/µs. Top trace: output voltage (500 mV/div.). Bottom trace: load current (10 A/div). Time scale: 0.2 ms/div .

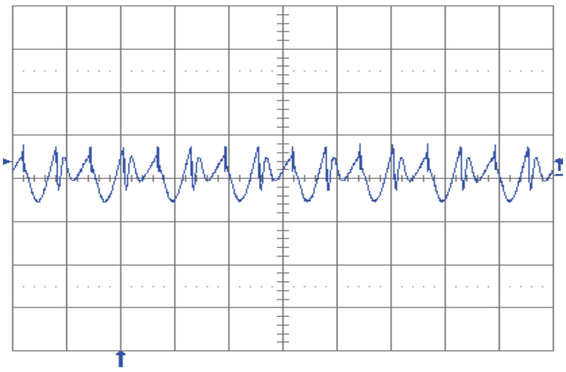


Fig. 11: Output voltage ripple (50 mV/div.) at full rated load current into a resistive load with Co = 15 µF tantalum + 1 µF ceramic and Vin = 48 V. Time scale: 5 µs/div.

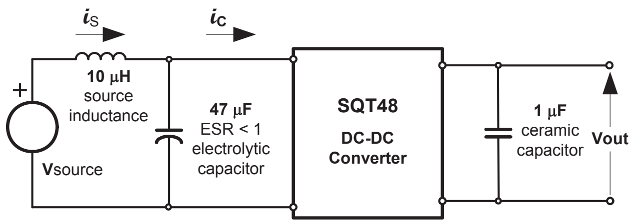


Fig. 12: Test setup for measuring input reflected-ripple currents, i_c and i_s.

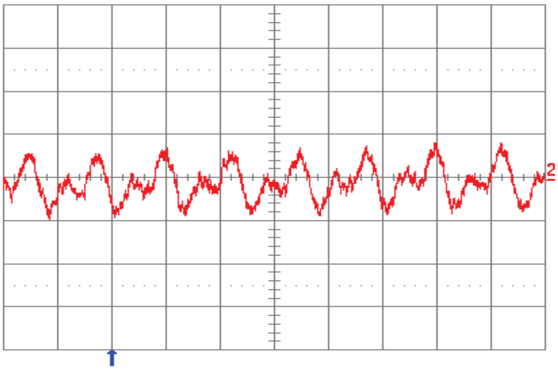


Fig. 13: I Input reflected-ripple current, i_s (10 mA/div), measured through 10 μH at the source at full rated load current and Vin = 48 V. Refer to Fig. 12 for test setup. Time scale: 5 μs/div .

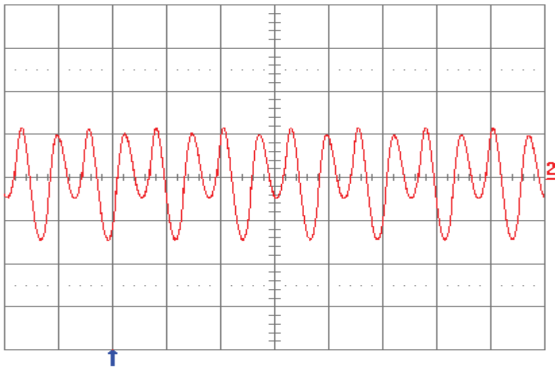
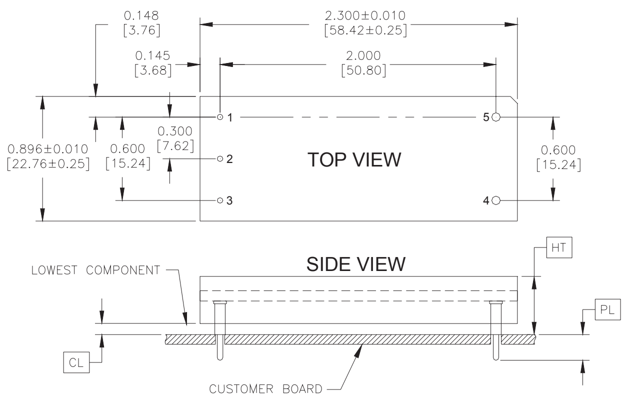


Fig. 14: Input reflected-ripple current, i_c (200 mA/div.), measured at input terminals at full rated load current and Vin = 48 V. Refer to Fig. 12 for test setup. Time scale: 5 μs/div.

Physical Information



SQT48 Pinout (Through-hole)

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

SQT48 Platform Notes

- All dimensions are in inches [mm]
- Pins 1-3 are Ø 0.040" ± 0.002 [1.02 ± 0.05] with Ø 0.078" ± 0.002 [1.98 ± 0.05] shoulder
- Pins 4 and 5 are Ø 0.062" ± 0.002 [1.57 ± 0.05] with Ø 0.096"± 0.002 [2.43 ± 0.05] shoulder
- Pin Material & Finish: Brass Alloy 360 with Matte Tin over Nickel
- Converter Weight: 0.88 oz [25.2 g]

Height Option	HT (Max. Height) +0.000 [+0.00] -0.038 [- 0.97]	CL (Min. Clearance) +0.016 [+0.41] -0.000 [- 0.00]
D	0.393 [9.98]	0.040 [1.02]

Pin Option	PL Pin Length ±0.005 [±0.13]
A	0.188 [4.78]
B	0.145 [3.68]

Converter Part Numbering Ordering Information

Product Series	Input Voltage	Mounting Scheme	Rated Load Current	Output Voltage		ON/OFF Logic	Maximum Height [HT]	Pin Length [PL]	Special Features	Environmental
SQT	**48**	**T**	**20**	**120**	**-**	**N**	**D**	**A**	**L**	
One-Eighth Brick Format	42-53 V	T⇒ Through-hole	20 A	120 ⇒ 12 V		N ⇒ Negative P ⇒ Positive	Through hole D ⇒ 0.393"	Through hole A ⇒ 0.188" B ⇒ 0.145"	L ⇒ Latching Option	No Suffix ⇒ RoHS lead-solder-exemption compliant G ⇒ RoHS compliant for all six substances

The example above describes P/N SQT48T20120-NDAL: 42-53 V input, through-hole mounting, 20 A @ 12 V output, negative ON/OFF logic, a maximum height of 0.393", a through the board pin length of 0.188", latching option, and Eutectic Tin/Lead solder[1]. Please consult factory for the complete list of available options.

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