QTR54T48108 DC-DC Converter
51 – 55.5 VDC Input, 480W output

Preliminary Data Sheet

RoHS Compliant

Features

- Lead-free/RoHS 6/6 compliant design
- Delivers up to 480W of regulated output voltage
- Ultra-high efficiency up to 97%
- Industry standard quarter-brick pinout
- Start-up into pre-biased output
- No minimum load required
- Input-to-output isolation 500Vdc
- Fixed frequency operation
- Fully protected (OTP, OCP, OVP, UVLO) with automatic recovery
- Parallel operation with current sharing (3 Units)
- 0.480” height profile (12.20mm)
- Fixed frequency operation
- High reliability, MTBF = 7.4 Million Hours
- Approved to the following Safety Standards: ULCSA60950-EN60950-1 and IEC 60950-1. (pending)
- Low conducted and radiated EMI
- All materials meet UL94, V-0 flammability rating

Applications

- Intermediate Bus Architectures
- Data communications/processing
- LAN/WAN
- Servers, Workstations

Benefits

- High efficiency– standard baseplate

Description

The QTR54T48108 converter provides regulated, isolated, step-down voltage over entire input voltage range. The converter provides ultra-high efficiency up to 97% with standard base plate for maximum output power.

The QTR54T48108 is an excellent choice as a front end DC/DC converter for intermediate bus applications. Non-isolated Point of Load converters can be used with the QTR54T48108 to convert its output into multiple regulated, low voltage outputs.

Electrical Specifications

Conditions: T_A = -5 ÷ 55 ºC, Airflow = 200 LFM (1.0 m/s), Vin = 51 ÷ 55.5 V, unless otherwise specified

Parameters	Notes	Min	Typ	Max	Units
Absolute Maximum Ratings					
Input Voltage	Continuous	0	-	60	VDC
Operating Ambient Temperature, Long-Term		- 5	-	55	°C
Operating Ambient Temperature, Short-Term	96 hrs max.	- 20	-	70	°C
Operating Temperature	Components Temperature	-20	-	125	°C
Required Airflow		200	-	-	LFM
Storage Temperature		-55	-	125	°C
Altitude – Operating	Feet Above Sea Level (not to exceed maximum component temperatures per Thermal Derating section)	-500	-	13000	Feet
Relative Humidity	Operating, Non-Condensing	10	-	90	%
Isolation Characteristics					
Input to Output Isolation (Functional)		500	-	-	VDC
Isolation Resistance		10	-	-	MΩ
Feature Characteristics					
Switching Frequency			250		kHz
Overtemperature Shutdown	Non-Latching, Tc1 in Fig. B (case Q401)	-	-	150	°C
ON/OFF Control Signal	(Signal referenced to - Vin)				
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 low)		2.4	-	20	VDC
Converter On (logic high)		- 20	-	0.8	VDC
Enable Pin Current, Source, On	Out of the pin, On	-	-	200	µA
Enable Pin Current, Source, Off	Out of the pin, Off	-	-	10	µA
Enable Pin Current, Sink from 15V Pull-Up	Into pin, external pull-up to 15V	-	-	0.5	mA
Enable Pin Current, Sink from 10V Pull-Up	Into pin, external pull-up to 10V	-	-	0.3	mA
Resistance from ON/OFF pin to –Vin	With or w/out +Vin shorted to -Vin	-	125	-	kΩ
Input Characteristics					
Operating Input Voltage Range		51	54	55.5	VDC
Input Undervoltage Lockout	Non-latching				
Turn-on Threshold		34	36	38	VDC
Turn-off Threshold		32	34	36	VDC
Maximum Input Current	480W Output @ 51 VDC Input	-	-	10	ADC
Input Inrush Current		-	-	150	% of Iin
Input Stand-by Current		-	3	15	mADC
Input No Load Current		-	150	-	mADC
Input Ripple Current – (i_{cin})	Max. input capacitance, per Fig. C	-	-	480	mArms
Input Capacitance	Nichicon UPM1J470MPH or equivalent	0.2	-	1.0	µF/W

Electrical Specifications (continued)

Conditions: T_A = -5 ÷ 55 ºC, Airflow = 200 LFM (1.0 m/s), Vin = 51 ÷ 55.5 V, unless otherwise specified.

Parameter	Notes	Min	Typ	Max	Units
Output Characteristics					
Output Voltage Set Point (No Load)		11.40	11.45	11.495	VDC
Output Regulation					
Over Line	Full resistive load	-	-	12	mV
Over Load	From no load to full load	-	0.4	-	V
Output Voltage Range	Over line, load and temperature	10.90	11.10	11.50	VDC
Output Ripple and Noise – 20 MHz bandwidth	Cout=750uF, 25% cer., 75% OSCON or POSCAP	-	-	150	mV_{PK-PK}
External Load Capacitance	Typically 25% ceramic, 75% OSCON or POSCAP	0	-	12.5	µF/W
Output Current		0		44	A
Over-Current Protection	Non-latching	110	120	140	%
Over-Voltage Protection	Non-latching	12	-	14	VDC
Hiccup Restart Time		200	250	300	ms
Current Share Operation					
Current Share Accuracy (3 units in parallel)	At rated power			10	%
Maximum Output Power					
Max Output Power @ 55 °C, 200LFM	Component derating per IPC9592			480	W
Max Output Power @ 70 °C, 200LFM	Max component temperature ≤ 135 °C			475	W
Dynamic Response					
Load Change 50%-75%-50%, di/dt = 1 A/µs	Co = 0.4uF/W			350	mV
Efficiency					
100% Load	Vin = 54 VDC	-	96.5	-	%
50% Load		-	96	-	%
Start-Up Inhibit Time (Enable ON)	From UVLO to Vo = 10% Vonom	9	10	15	ms
Turn-On Delay Time (Vin > UVLO)	From Enable to Vo = 10% Vonom	-	2.5	5	ms
Output Voltage Rise Time	From Vo = 10% to 90% Vonom	-	10	15	ms
Pre-Bias Voltage		0	-	Vout	V
Turn-On Overshoot		-	-	3	%
Turn-Off Undershoot		-	-	3	%

Notes:

General Specifications

Parameter	Notes	Min	Typ	Max	Units
Calculated MTBF	50% Stress, Ta=40°C	-	7.4	-	Million Hours
Weight	With base plate	-	73 (2.6)	-	g (oz)

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.

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

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. A.

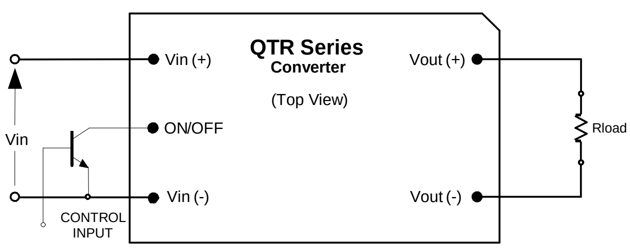

Fig. A: Circuit configuration for ON/OFF function.

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 5V through a resistor. A properly de-bounced 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 0.2mA at a low level voltage of ≤ 0.8V. An external voltage source (±20V maximum) may be connected directly to the ON/OFF input, in which case it must be capable of sourcing or sinking up to 1mA depending on the signal polarity.

Resistance across ENABLE 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 must be typically 36V for the converter to turn on. Once the converter has been turned on, it will shut off when the input voltage drops typically below 34V. This feature is beneficial in preventing deep discharging of batteries used in telecom applications.

Output Overcurrent Protection (OCP)

The converter is protected against overcurrent or short circuit conditions. Upon sensing an overcurrent condition, the converter will enter hiccup mode.

Output Overvoltage Protection (OVP)

The converter will shut down if the output voltage exceeds the threshold of the OVP circuitry, and the converter will automatically enter hiccup mode.

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). Operational 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 20 Amp fuse is recommended for use with this product.

The QTR54T48108 converter is UL approved (pending) for a maximum fuse rating of 20 Amps. To protect a group of converters with a single fuse, the rating can be increased from the recommended value above.

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, the QTR54T48108 converter will pass the requirements of Class B conducted emissions per EN55022 and FCC requirements. Please contact Power-One Applications Engineering for details of this testing.

Parallel Operation

The following precautions must be observed when operating two QTR54T48108 units in parallel:

1. The inputs of all units must be attached to the same voltage source.
2. The PCB trace resistance into each unit should be equalized as much as is practical.
3. The accuracy of the current sharing will be affected by the series impedance between each unit at the load. Balancing these impedances will enhance the current share accuracy.

When operating in a parallel configuration, not all units have to be on.

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 Figure B for the optimum measuring thermocouple location.

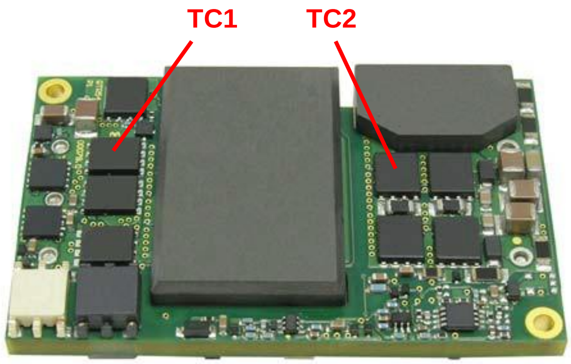

Figure B: Location of the thermocouples for thermal testing.

Thermal Derating

Output power vs. ambient temperature and airflow rates are given in Figures 5 and 7 with components derating per IPC9592. Ambient temperature was varied between 25 °C and 70 °C, with airflow rates from 30 to 500 LFM (0.15 m/s to 2.5 m/s), and vertical converter mountings. The airflow during the testing is parallel to the long axis of the converter.

During normal operation, derating curves with maximum FET temperature less than or equal to 120°C should not be exceeded. Temperature on the MOSFETs at the locations TC1 and TC2 shown in Figure B should not exceed 120°C in order to operate inside the derating curves continuously.

Ripple and Noise

The output voltage ripple waveform is measured at full rated load current. Note that all output voltage waveforms are measured across a 180 μF ceramic capacitor and 570 uF OSCON or POSCAP, and input waveforms are measured with 470uF electrolytic capacitor (Nichicon UPM1J470MPH or equivalent).

The output voltage ripple and input ripple current waveforms are obtained using the test setup shown in Figure C.

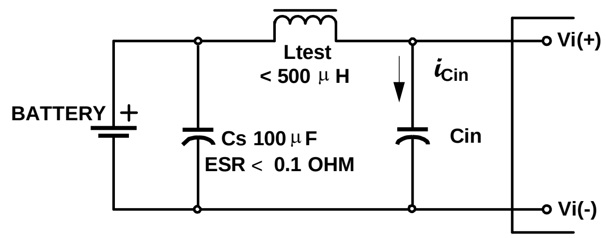

Figure C: Test set-up diagram showing the measurement of the input ripple current (i_{cin}) at the pins of the UUT.

NOTE: The input ripple current must be measured with a simulated source inductance (Ltest) of < 500uH.

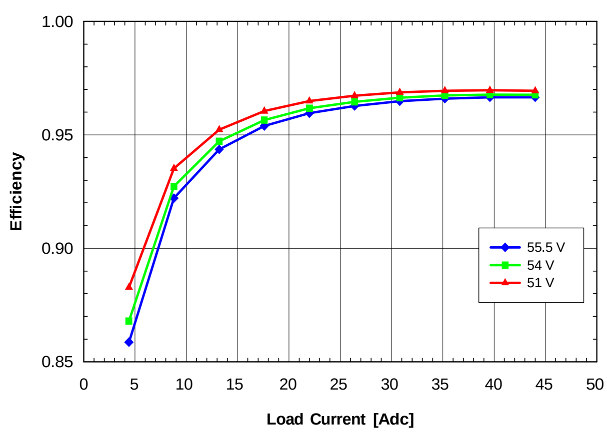

Fig. 1: Efficiency Curve vs. Input Voltage @ 25°C.

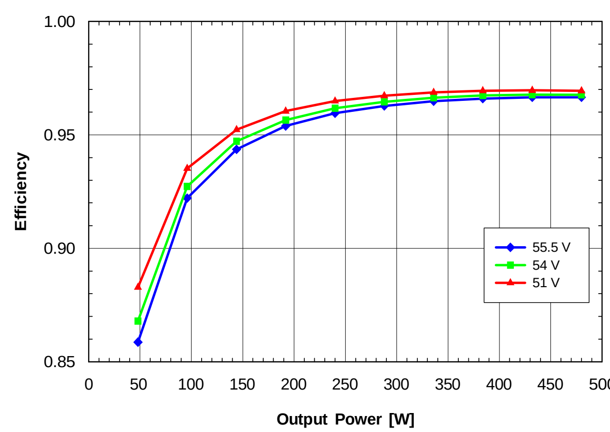

Fig. 2: Efficiency vs. Output Power @ 25°C.

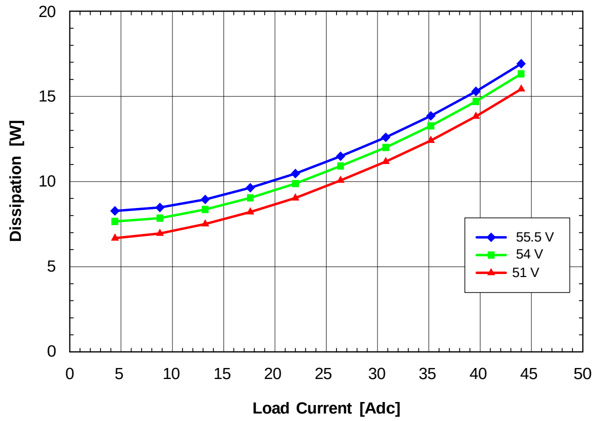

Fig. 3: Power Dissipation vs. Load Current and Input Voltage @ 25 °C.

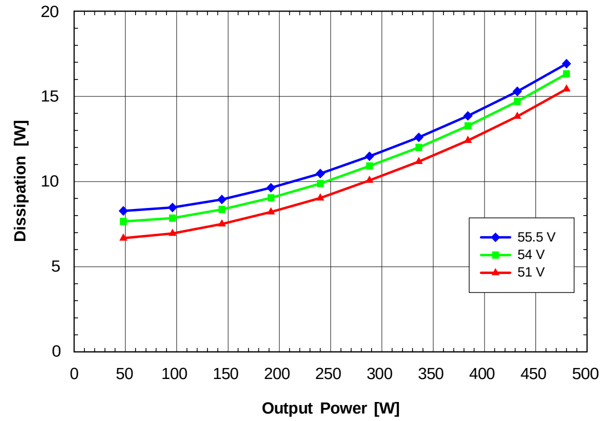

Fig. 4: Power Dissipation vs. Output Power and Input Voltage @ 25 °C.

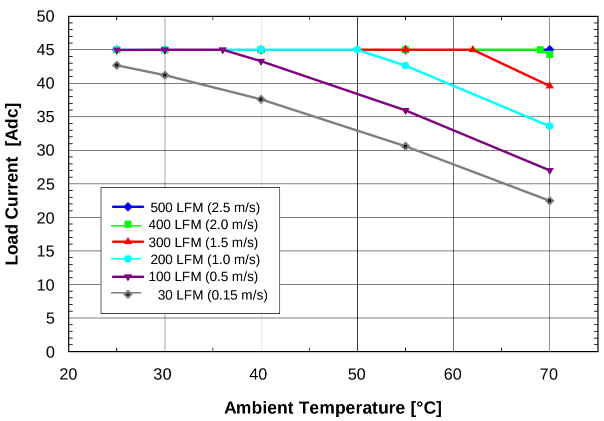

Fig. 5: Available Output Current vs. Ambient Temperature and Airflow Rates with Vin = 55 Vdc and Vertical Orientation (airflow direction from Vin - pin to Vin + pin.)

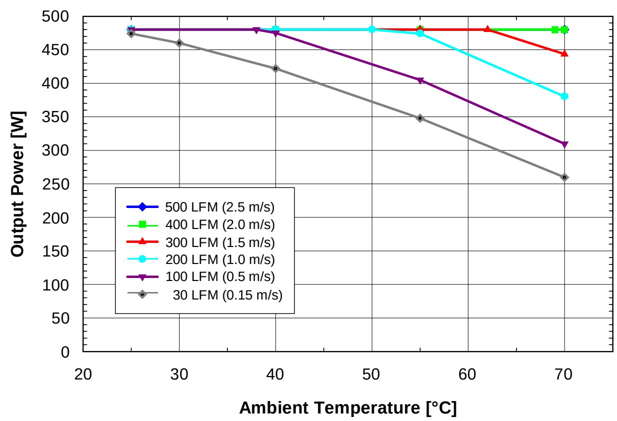

Fig. 6: Available Output Power vs. Ambient Temperature and Airflow Rates with Vin = 55 Vdc and Vertical Orientation (airflow direction from Vin - pin to Vin + pin.)

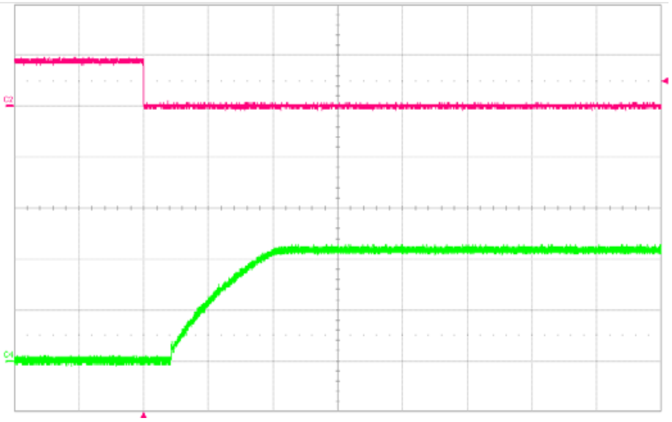

Fig. 9 Turn-on transient at full rated load current (resistive) with no output capacitor at Vin = 54Vdc, triggered via ON/OFF pin. Top Trace: ON/OFF Signal (5V/div). Bottom Trace: Output Voltage (5V/div). Time Scale: 5mS/div.

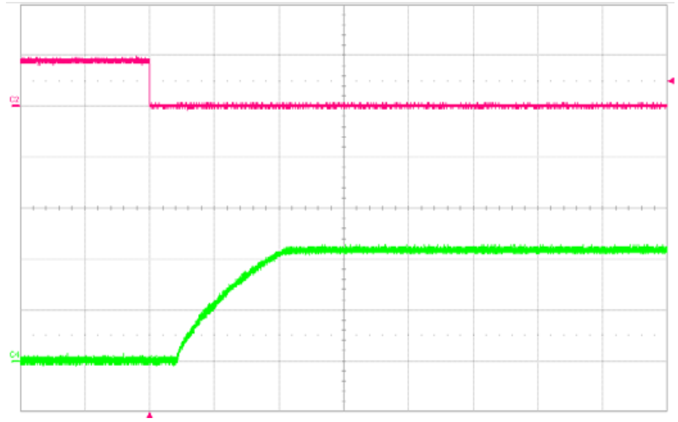

Fig. 10: Turn-on transient at full rated load current (resistive) plus 6,000uF output capacitor at Vin = 54 Vdc, triggered via ON/OFF pin. Top Trace: ON/OFF Signal (5V/div). Bottom Trace: Output Voltage (5V/div). Time Scale: 5ms/div.

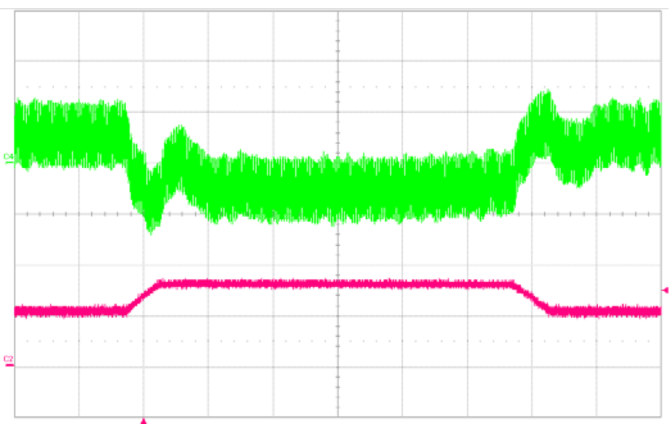

Fig. 11: Output voltage response to load current step change (22A – 33A – 22A) at Vin = 54Vdc. (Current Slew Rate: 0.1A/us. Co = 10uF tantalum + 1uF ceramic). Top Trace: Output Voltage (100mV/div). Bottom Trace: Load Current (20A/div). Time Scale: 0.2 ms/div.

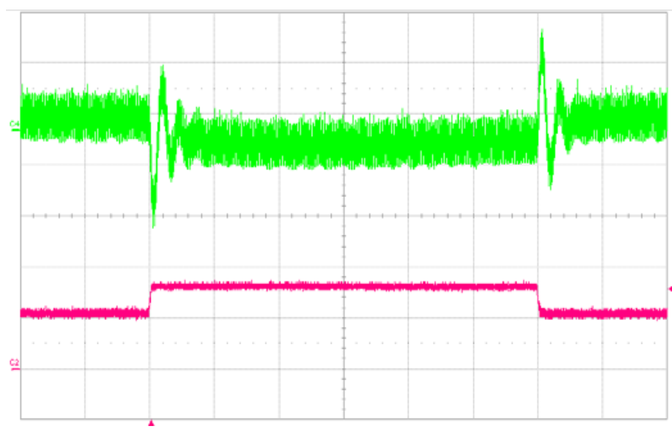

Fig. 12: Output voltage response to load current step change (22A – 33A – 22A) at Vin = 54 Vdc. (Current Slew Rate: 1A/us. Co = 192uF). Top Trace: Output Voltage (200mV/div). Bottom Trace: Load Current (20A/div). Time Scale: 0.2 ms/div.

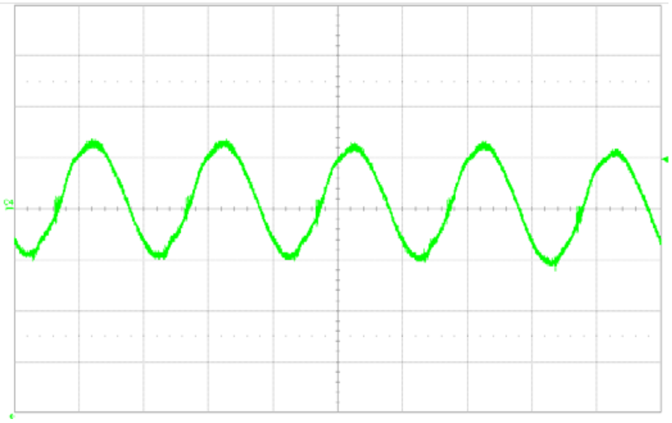

Fig. 13: Output voltage ripple (20 mV/div) at full rated load current into a resistive load with Co = 750 uF, 25% ceramic, 75% OSCON or POSCAP and Vin = 54 Vdc. Time Scale: 2 µs/div.

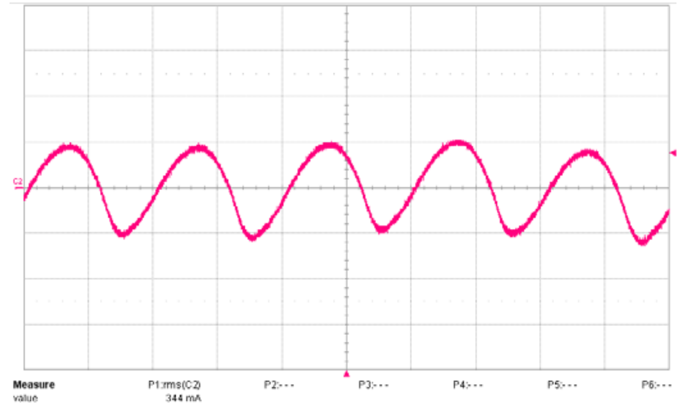

Fig. 14: Input ripple current (i_{cin}) measured at the input terminals at full rated load current and Vin = 54Vdc. Vertical Axis: 500mA/div. Time Scale: 2us/div.

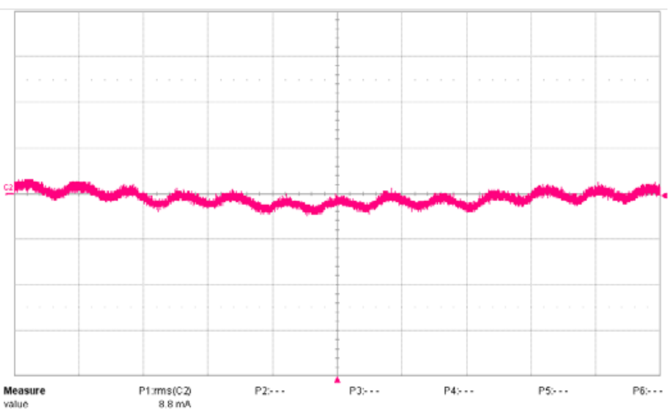

Fig. 15: Input reflected ripple current (is) measured through a 5uH inductor / 470uF capacitor filter at the source at full rated load current and Vin = 54Vdc. Vertical Axis: 50mA/div. Time Scale: 5 µs/div.

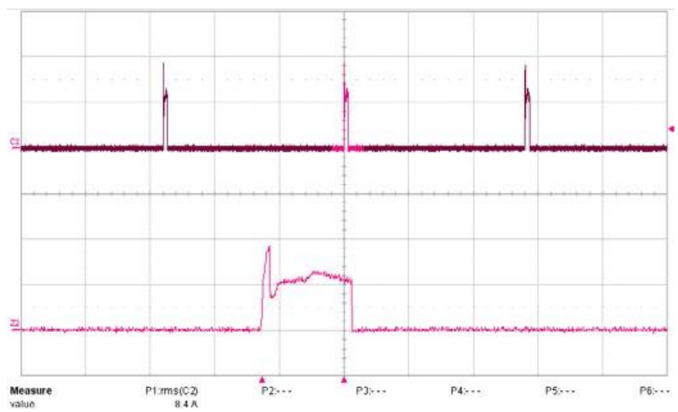

Fig. 16: Load Current into 10mOhm load during short circuit test at Vin = 54Vdc. Top Trace: Load Current (50A/div, 100ms/div). Bottom trace (50A/div, 5ms/div) is an expansion of the on-time portion of the top trace.

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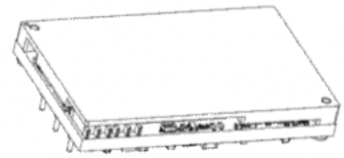
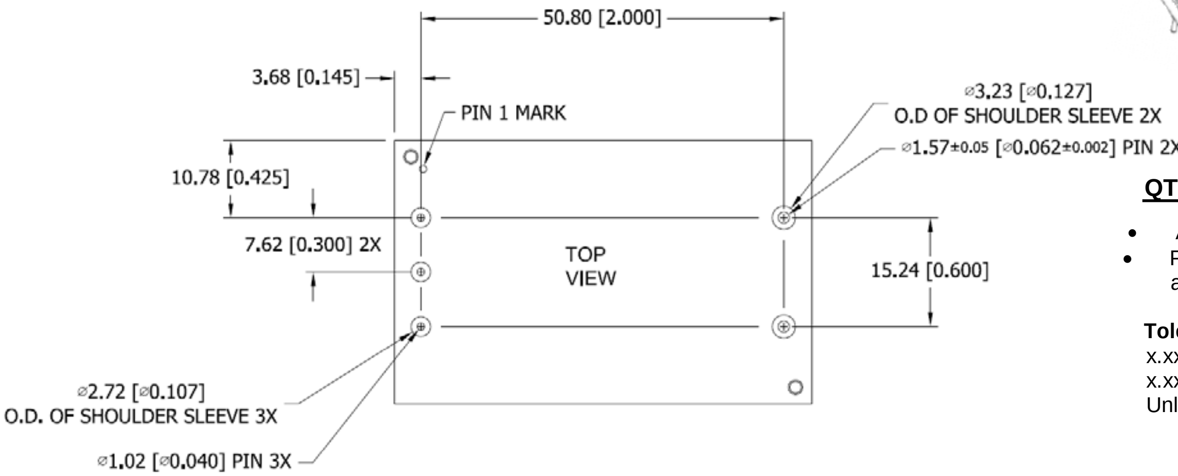
Physical Information

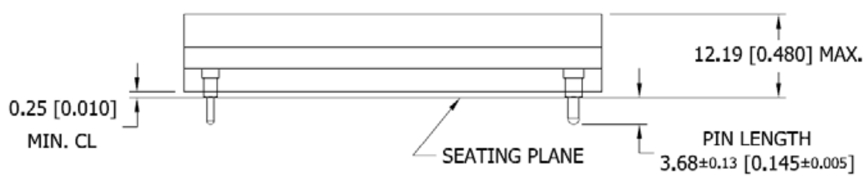




QTR54T48108 Platform Notes

- All dimensions are in mm [in]
- Pin material & finish: Te-Cu alloy, gold plated

Tolerances:
x.xxx in. +/- .010 [x.xx mm +/- 0.25]
x.xx in. +/- .020 [x.x mm +/- 0.5]
Unless otherwise indicated



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

Converter Part Numbering Scheme/Ordering Information

Product Series	Input Voltage	Mounting Scheme	Rated Load Current	Output Voltage		ON/OFF Logic	Maximum Height	Pin Length	Special Features	Environmental
QTR	**54**	**T**	**48**	**108**						
1/4th Brick Format	51 - 55.5 VDC	T⇒ Through-hole	48 ⇒ 44 A @11.1V	108 ⇒ 10.9–11.5 VDC		No Suffix ⇒ Negative	No Suffix ⇒ Through-hole w/ baseplate 0.48”	No Suffix ⇒ Through-hole 0.145”	No Suffix ⇒ Baseplate	No Suffix ⇒ RoHS compliant for all six substances

The example above describes P/N QTR54T48108: 51-55.5 VDC input, 480W output, through-hole mounting, 44A @ 11.1VDC output, negative ON/OFF logic, a maximum height of 0.48”, a through the board pin length of 0.145”, and RoHS 6/6 compliant.

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