GDQ54S12B-4
DC-DC Converter Technical Manual V1.0

Quarter-Brick DC-DC Converter	40 V - 60 V Input	12 V Output	54 A Current	Negative Logic

Description

The GDQ54S12B-4 is a new generation isolated DC-DC converter that uses an industry standard quarter-brick structure, and features high efficiency and power density, operates from an input voltage range of 40 V to 60 V, provides the rated output voltage of 12 V and the maximum output current of 54 A. The converter is applied only to Pre-Regulator system.

GDQ54S12B-4

Operational Features

- Input voltage: 40 V - 60 V
- Output current: 0 - 54 A
- Low output ripple and noise
- Efficiency: 96.3% (12 V, 54 A)

Mechanical Features

- Industry standard quarter-brick (L x W x H, with baseplate): 57.9 mm x 36.8 mm x 13.2 mm (2.28 in. x 1.45 in. x 0.52 in.)
- Weight: about 80 g

Control Features

- Remote on/off

Protection Features

- Input undervoltage protection
- Input overvoltage protection (shutdown)
- Output overcurrent protection (hiccup mode)
- Output short circuit protection (hiccup mode)
- Output overvoltage protection (hiccup mode)
- Overtemperature protection (self-recovery)

Safety Features

- UL60950-1 and CSA C22.2 No. 60950-1-07
- Meet UL94V-0 flammability requirements
- RoHS6 compliant

Designation Explanation

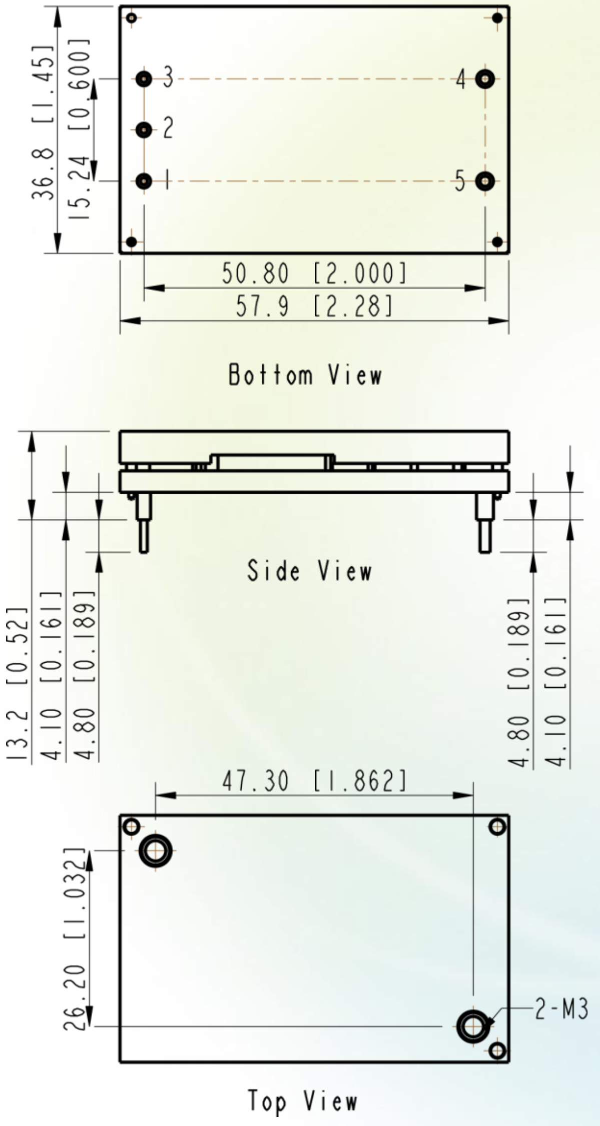
GDQ	54	S	12	B	-4
1	2	3	4	5	6

1 — 48Vin, high performance, digital control quarter-brick
2 — Output current: 54 A
3 — Single output
4 — Output voltage: 12 V
5 — With baseplate
6 — Pin length: 4.8 mm

NOTE

EN41QACI on the label of the module is the internal model used by the manufacturer.

Mechanical Diagram



Pin Description

Pin No.	Function
1	V_{in} (+)
2	On/Off
3	V_{in} (-)
4	V_{out} (-)
5	V_{out} (+)

NOTE

1. All dimensions in mm [in.]
   Tolerances: x.x ± 0.5 mm [x.xx± 0.02 in.]
   x.xx ± 0.25 mm [x.xxx ± 0.010 in.]
2. Pin 1-3 are 1.00 ± 0.05 mm [0.040 ± 0.002 in.] diameter with 2.00 ± 0.10 mm [0.080 ± 0.004 in.] diameter standoff shoulders. Pin 4 and pin 5 are 1.50 ± 0.05 mm [0.060 ± 0.002 in.] diameter with 2.50 ± 0.10 mm [0.098 ± 0.004 in.] diameter standoff shoulders.
3. M3 screw used to bolt unit's baseplate to other surfacees (such as heat sink) must not exceed 4.00 mm [0.157 in.] depth below the surface of baseplate.

Electrical Specifications

Conditions: T_A = 25°C (77°F), Airflow = 1 m/s (200 LFM), V_{in} = 48 V, unless otherwise notes.

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
Absolute maximum ratings					
Input voltage Continuous Transient (100 ms)	 - -	 - -	 62 70	 V V	 - -
Operating ambient temperature	-40	-	85	ºC	See the thermal derating curve
Storage temperature	-55	-	125	ºC	-
Operating humidity	10	-	95	% RH	Non-condensing
External voltage applied to On/Off	-	-	12	V	-
Input characteristics					
Operating input voltage	40	48	60	V	-
Maximum input current	-	-	20	A	V_{in} = 0 - 60 V; I_{out} = 54 A
No-load loss	-	6	9	W	V_{in} = 48 V; I_{out} = 0 A
Input capacitance	470	680	-	µF	Aluminum electrolytic capacitor
Inrush transient	-	-	2	A²s	-
Input reflected ripple current (peak to peak)	-	-	100	mA	Oscilloscope bandwidth: 20 MHz
Output characteristics					
Output voltage set point	11.82	12.00	12.18	V	V_{in} = 48 V; I_{out} = 27 A
Output power	0	-	650	W	-
Output line regulation	-	-	±0.3	%	V_{in} = 40 V - 60 V; I_{out} = 54 A
Output load regulation	-	-	±5	%	V_{in} = 48 V; I_{out} = 0 - 54 A
Regulated voltage precision	-	-	±5	%	V_{in} = 40 V - 60 V; I_{out} = 0 - 54 A
Temperature coefficient	-	-	±0.02	%/°C	T_A = -40°C to +85°C (-40°F to +185°F)
External capacitance	470	-	5000	µF	SMD aluminum solid capacitor or chip aluminum capacitor, see ***note 1***
Output current	0	-	54	A	-
Output ripple and noise (peak to peak)	-	200	500	mV	Oscilloscope bandwidth: 20 MHz
Output voltage overshoot	-	-	5	%	The whole range of V_{in} , I_{out} and T_A
Output voltage delay time	-	-	100	ms	From V_{in} connection to 10%V_{out}
Output voltage rise time	-	50	100	ms	From 10%V_{out} to 90%V_{out}
Switching frequency	-	160	-	kHz	-

Note 1: If T_A < -5 ℃, the type of the external capacitor should be SMD aluminum solid capacitor, and the capacitance value at least 1000 µF.

Electrical Specifications

Conditions: T_A = 25°C (77°F), Airflow = 1 m/s (200 LFM), V_{in} = 48 V, unless otherwise notes.

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
Protection characteristics					
Input undervoltage protection Startup threshold Shutdown threshold Hysteresis	 35 33 1	 37 35 2	 39 37 3	 V V V	 - - -
Input overvoltage protection	64	66	68	V	Shut down; the overvoltage will be maintained for a period of 120 ms before the converter shut down.
Output overcurrent protection	59.4	-	75.6	A	Hiccup mode
Output short circuit protection	-	-	-	-	Hiccup mode
Output overvoltage protection	13.8	-	16.8	V	Hiccup mode
Overtemperature protection Threshold Hysteresis	 105 5	 115 -	 130 -	 °C °C	Self-recovery The values are obtained by measuring the temperature of the PCB near the temperature sensor.
Dynamic characteristics					
Overshoot amplitude Recovery time	- -	- -	600 400	mV µs	Current change rate: 0.1 A/µs load : 25% - 50% - 25%; 50% - 75% - 50%
Overshoot amplitude Recovery time	- -	- -	1200 500	mV µs	Current change rate: 1 A/µs load : 25% - 50% - 25%; 50% - 75% - 50%; with 1000 µF load capacitor at output terminal
Efficiency					
100% load	95.3	96.3	-	%	V_{in} = 48 V; I_{out} = 54 A
50% load	95.5	96.5	-	%	V_{in} = 48 V; I_{out} = 27 A
20% load	85.5	87.5	-	%	V_{in} = 48 V; I_{out} = 10.8 A
Isolation characteristics					
Input-to-output Isolation voltage	-	-	1500	V DC	Function Isolation
Other characteristics					
Remote on/off voltage Low level High level	 -0.7 3.5	 - -	 1.2 12	 V V	 - -
On/Off current Low level High level	 - -	 - -	 1.0 -	 mA µA	 - -
Reliability characteristics					
Mean time between failures (MTBF)	-	2.5	-	Million hours	Telcordia SR332; 80% load; Airflow = 1.5m/s (300LFM); T_A = 40°C (104°F)

Characteristic Curves

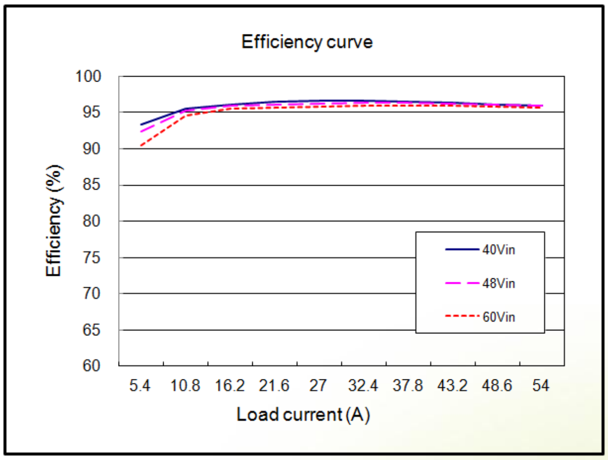


Figure 1: Efficiency (T_A = 25°C or 77°F)

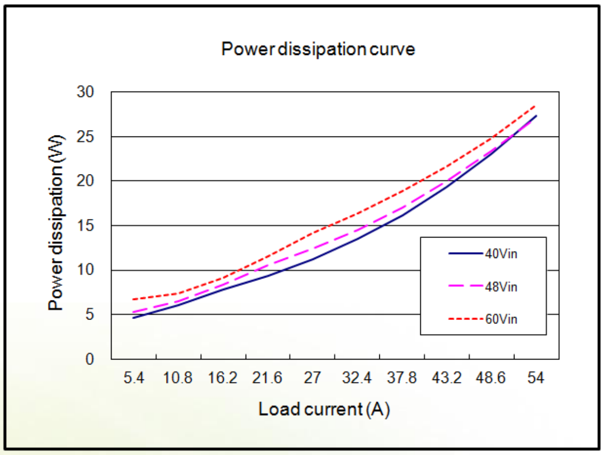


Figure 2: Power dissipation (T_A = 25°C or 77°F)

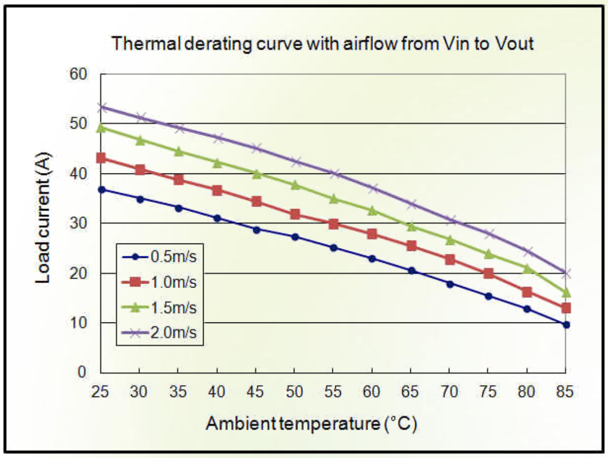


Figure 3: Thermal derating with airflow from V_{in} to V_{out} (V_{in} = 48 V; V_{out} = 12 V)

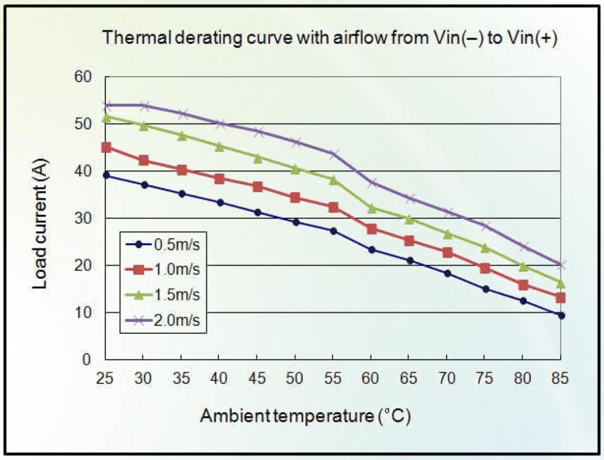


Figure 4: Thermal derating with airflow from V_{in}(-) to V_{in}(+) (V_{in} = 48 V; V_{out} = 12 V)

Typical Waveforms

NOTE

1. During the test of input reflected ripple current, the input terminal must be connected to a 12 µH inductor and a 220 µF electrolytic capacitor.
2. Point B, which is for testing the output voltage ripple, is 25 mm (0.98 in.) away from the V_{out}(+) pin.

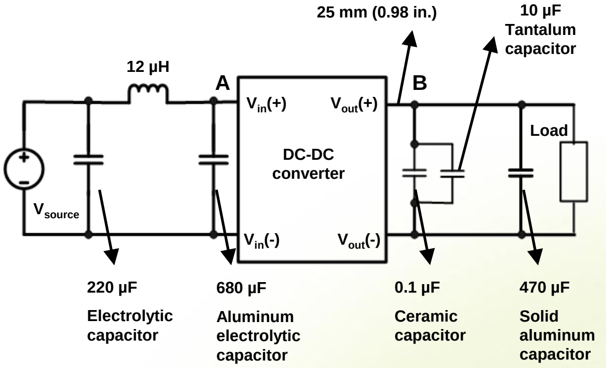


Figure 5: Test set-up diagram

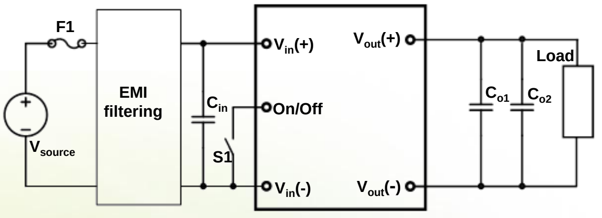


Figure 6: Typical circuit applications

F1: 30 A fuse (fast blowing)
C_{in}: The 680 µF aluminum electrolytic capacitor is recommended.
C_{o1}: The 1 µF ceramic capacitor is recommended.
C_{o2}: The 470 µF solid aluminum capacitor is recommended.

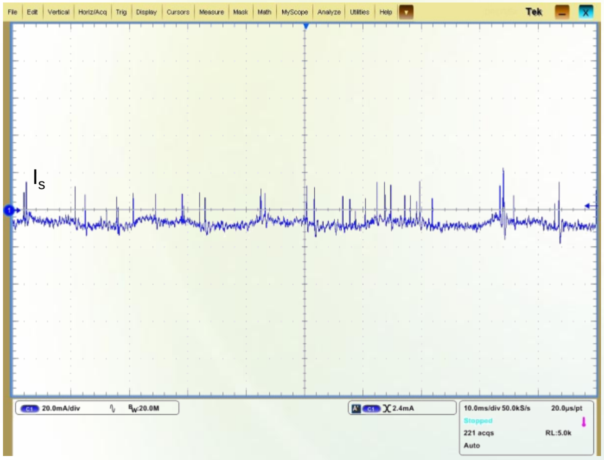


Figure 7: Input reflected ripple current
(for point A in the test set-up diagram, V_{in} = 48 V, V_{out} = 12 V, I_{out} = 54 A)

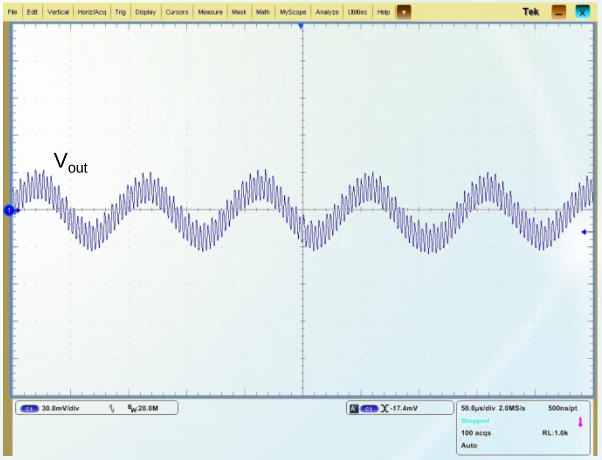


Figure 8: Output voltage ripple
(for point B in the test set-up diagram, V_{in} = 48 V, V_{out} = 12 V, I_{out} = 54 A)

Typical Waveforms

Conditions: T_A = 25°C (77°F), V_{in} = 48 V.

Figure 9: Startup from On/Off

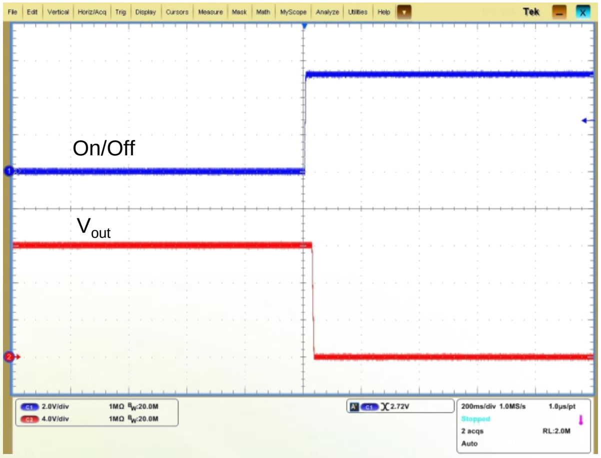


Figure 10: Shutdown from On/Off

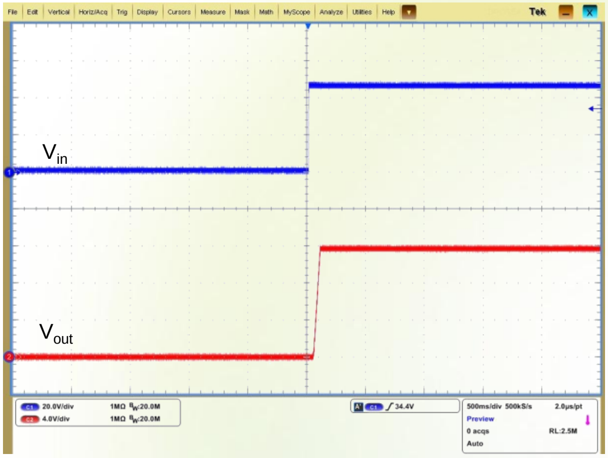


Figure 11: Startup by power on

Figure 12: Shutdown by power off

Figure 13: Output voltage dynamic response
(Load: 25% - 50% - 25%, di/dt = 0.1 A/µs)

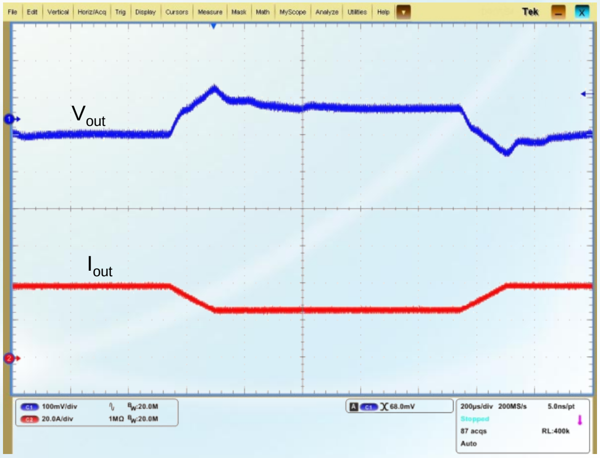


Figure 14: Output voltage dynamic response
(Load: 50% - 75% - 50%, di/dt = 0.1 A/µs)

Remote On/Off

Logic Enable	On/Off Pin Level	Status
Negative logic	Low level	On
	High level or left open	Off

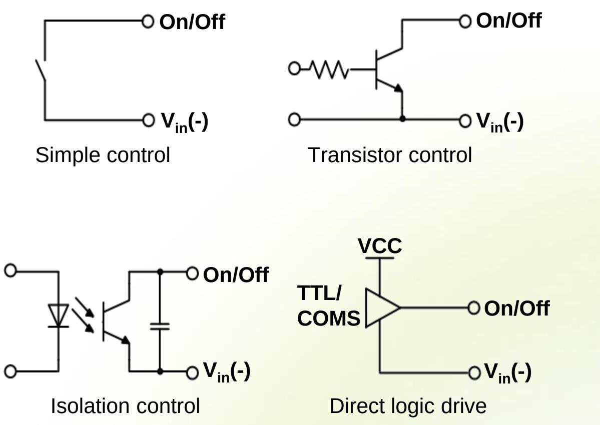


Figure 15: Various circuits for driving the On/Off pin

Input Undervoltage Protection

The converter will shut down after the input voltage drops below the undervoltage protection threshold for shutdown. The converter will start to work again after the input voltage reaches the input undervoltage protection threshold for startup. For the Hysteresis, see the Protection characteristics.

Input Overvoltage Protection

The converter will shut down after the input voltage exceed the overvoltage protection threshold. The overvoltage will be maintained for a period of 120 ms before the converter shut down. The converter will start to work again after the input voltage drops below 62 V.

Output Overvoltage Protection

When the voltage directly across the output pins exceeds the output overvoltage protection threshold, the converter will enter hiccup mode. When the fault condition is removed, the converter will automatically restart.

Output Overcurrent Protection

The converter equipped with current limiting circuitry can provide protection from an output overload or short circuit condition. If the output current exceeds the output overcurrent protection threshold, the converter enters hiccup mode. When the fault condition is removed, the converter will automatically restart.

Overtemperature Protection

A temperature sensor on the converter senses the average temperature of the module. It protects the converter from being damaged at high temperatures. When the temperature exceeds the overtemperature protection threshold, the output will shut down. It will allow the converter to turn on again when the temperature of the sensed location falls by the value of Overtemperature Protection Hysteresis.

MTBF

The MTBF is calculated according to the Telcordia, SR332 Method 1 Case3.

Recommend Reverse Polarity Protection Circuit

Reverse polarity protection is recommended under installation and cabling conditions where reverse polarity across the input may occur.

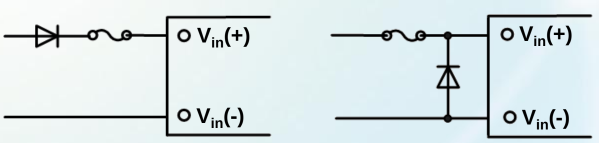


Figure 16: Recommend reverse polarity protection circuits

Recommended Fuse

The converter has no internal fuse. To meet safety and regulatory requirements, a 30 A fuse is recommended.

NOTE

The fuse current should be 1.5 to 2 times the maximum operating current in actual use.

EMC

For the acceptance standard, see the *DC-DC Converter EMC Acceptance Manual.*

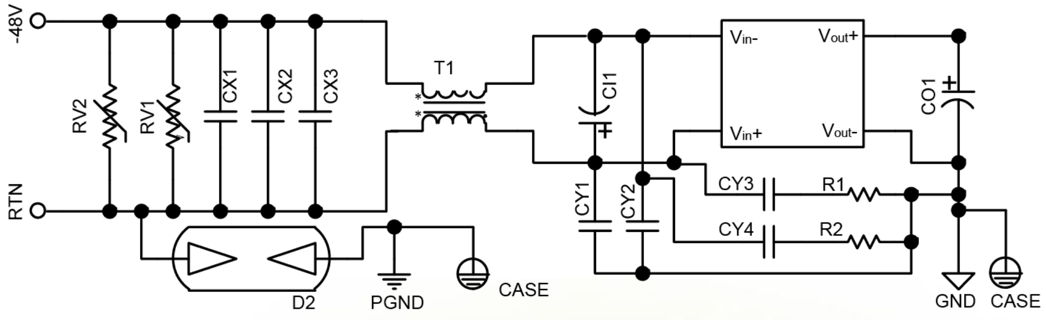


Figure 17: EMC test set-up diagram

RV1,RV2: Varistor, 100 V, 4500 A
D2: Gas discharge tube, 90 V, 10 kA

CI1: Aluminum electrolytic capacitor, 650 µF
CO1: Non-solid radial lead aluminum electrolytic capacitor, 2 x 470 µF

CX1,CX2,CX3: Metalized film capacitor, 1 µF, 275 V
CY1,CY2: Metalized film capacitor, 0.1 µF, 275 V
CY3,CY4: Chip multilayer ceramic capacitor, 1000 V, 22 nF

R1, R2: Chip thick film resistor, 1 W, 1Ω
T1: Common mode inductor, single phase, 400 µH

Qualification Testing

Parameter	Units	Condition
High Accelerated Life Test (HALT)	3	Low temperature limit : -60°C (-76°F); high temperature limit: 110°C (230°F); vibration limit: 40 G
Temperature Humidity Bias (THB)	8	Maximum input voltage; 85°C (185°F); 85% RH; 1000 operating hours under lowest load power
High Temperature Operation Bias (HTOB)	8	Rating input voltage; air flow:0.5 m/s (100 FLM) to 5 m/s (1000 FLM); ambient temperature between +45°C (+113°F) and +55°C (+131°F); 1000 operating hours; 50% to 80% load
Power and Temperature Cycling Test (PTC)	8	Rating input voltage; air flow:0.5 m/s (100 FLM) to 5 m/s (1000 FLM); ambient temperature between -40°C (-40°F) and +85°C (+185°F); 1000 operating hours ; 50% load; temperature slope: 15°C (59°F) per minute; dwell time: 22 minutes

Thermal Consideration

Thermal Test Point

Decide proper airflow to be provided by measuring the temperature of the temperature sensor as shown in Figure 18 to protect the converter against overtemperature. The overtemperature protection threshold is also obtained based on thermal test point.

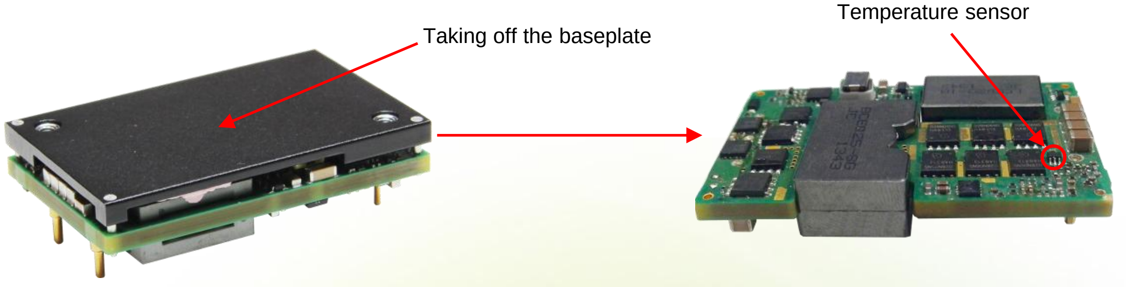


Figure 18: Thermal test point

Power Dissipation

The converter power dissipation is calculated based on efficiency. The following formula reflects the relationship between the consumed power (P_d), efficiency (η), and output power (P_o): $P_d = P_o(1-\eta)/\eta$

Mechanical Consideration

Installation

Although the converter can be mounted in any direction, free airflow must be taken.

Soldering

The converter is compatible with standard wave soldering techniques. For wave soldering, the converter pins should be preheated for 20 to 30 seconds at 110°C (230°F), and wave soldered at 260°C (500°F) for less than 7 seconds.
For hand soldering, the iron temperature should be maintained at 350°C (662°F) to 420°C (788°F) and applied to the converter pins for less than 10 seconds.
The converter can be rinsed using the isopropyl alcohol (IPA) solvent or other proper solvents.

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