GBS20S5V5-4E DC-DC Converter

Technical Manual

Issue 1.1

Date 2020-12-25

HUAWEI TECHNOLOGIES CO., LTD.

About This Document

Purpose

This document describes the GBS20S5V5-4E DC-DC Converter, including its electrical specifications, features, applications, and communication.

The figures provided in this document are for reference only.

Intended Audience

This document is intended for:

- Sales personnel
- Technical support engineers
- System engineers
- Software engineers
- Hardware engineers

Symbol Conventions

The symbols that may be found in this document are defined as follows.

Symbol	Description
DANGER	Indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.
WARNING	Indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
NOTICE	Indicates a potentially hazardous situation which, if not avoided, could result in equipment damage, data loss, performance deterioration, or unanticipated results. NOTICE is used to address practices not related to personal injury.
NOTE	Supplements the important information in the main text. NOTE is used to address information not related to personal injury, equipment damage, and environment deterioration.

Change History

Changes between document issues are cumulative. The latest document issue contains all the changes made in earlier issues.

Issue 1.1 (2020-12-25)

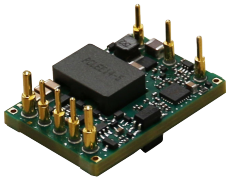
Updated "**2.6 Dynamic Characteristics**".

Issue 1.0 (2020-12-3)

This issue is the first release.

Contents

1 Product Overview



Product Description

The GBS20S5V5-4E is a new generation isolated DC-DC converter that uses an industry standard sixteenth-brick structure, featuring high efficiency and power density with low output ripple and noise. It operates from an input voltage range of 36 V to 75 V, and provides the rated output voltage of 5.5 V as well as the maximum output current of 18.2 A.

Features

- Efficiency: 91.5% (T_A = 25°C; V_{in} = 48 V, V_{out} = 5 V, 100% load)
- Length x Width x Height: 33.3 mm x 23.1 mm x 9.9 mm (1.31 in. x 0.91 in. x 0.39 in.)
- Weight: 16 g
- Input undervoltage protection, output overvoltage protection (hiccup mode), output overcurrent protection (hiccup mode), output short circuit protection (hiccup mode), and overtemperature protection (self-recovery)
- Remote on/off and output voltage trim communication
- UL certification
- UL 60950-1, UL 62368-1, C22.2 NO. 60950-1
- RoHS6 and IPC9592B compliant

Model Naming Convention

GBS	20	S	5V5	_	4	E
1	2	3	4		5	6

1 — 48 V input, analog control, sixteenth-brick

2 — Output current: 20 A

3 — Single output

4 — Output voltage: 5.5 V

5 — Pin length: 4.8 mm

6 — Extension code

Applications

- Servers
- Telecom and data communication applications
- Industrial equipment

2 Electrical Specifications

2.1 Absolute Maximum Ratings

Table 2-1 Absolute maximum ratings

Parameter	Minimum	Typical	Maximum	Unit	Notes & Conditions
Input voltage • Continuous • Transient (100 ms)	 - -	 - -	 80 100	 V V	When the input voltage is 75 V to 80 V, the converter must not be damaged. Not all the characteristic parameters should be conformed to the specification.
Operating ambient temperature (T_A)	–40	-	85	°C	-
Storage temperature	–55	-	125	°C	-
Operating humidity	5	-	95	% RH	Non-condensing
External voltage applied to ON/OFF	-	-	12	V	-
External voltage applied to Trim	-	-	3.5	V	-
Altitude	–60	-	5000	m	When the altitude above 1800 m, T_A derating applies decreases by 1°C for each additional 220 m.

2.2 Input

Table 2-2 Input specifications

Parameter	Minimum	Typical	Maximum	Unit	Notes & Conditions
Operating input voltage	36	48	75	V	-
Maximum input current	-	-	4	A	V_{in} = 36–75 V
No-load loss	-	-	5	W	V_{in} = 48 V; I_{out} = 0 A; T_A = 25°C
Input capacitance	100	150	-	µF	Aluminum eletrolytic capacitor
Input transient response	-	-	-	mV	0.25 V/µs input transient; 36 V to 48 V or 48 V to 75 V, at full load

2.3 Output

Table 2-3 Output specifications

Parameter	Minimum	Typical	Maximum	Unit	Notes & Conditions
Output voltage setpoint	5.39	5.50	5.61	V	V_{in} = 48 V; I_{out} = 50% I_{onom}, T_A = 25°C
Output current	0	-	20	A	The maximum output current is 20 A when the output voltage is below 5 V, and the maximum output power is 100 W when the output voltage is above 5 V.
Output power	0	-	100	W	
Output line regulation	–0.3	-	0.3	%	V_{in} = 36–75 V; I_{out} = I_{onom}
Output load regulation	–0.3	-	0.3	%	V_{in} = 48 V; I_{out} = I_{omin} – I_{onom}
Regulated voltage precision	–3	-	3	%	V_{in} = 36–75 V; I_{out} = I_{omin} – I_{onom}

Parameter	Minimum	Typical	Maximum	Unit	Notes & Conditions
Temperature coefficient	–0.02	-	0.02	%/°C	T_A = –40°C to +85°C (–40°F to +185°F)
External capacitance	470	-	2000	µF	470 µF: solid aluminum capacitor, and the layout distance of minimum capacitor must be within 3 cm, T_A = –40°C to +85°C
Output voltage ripple and noise (peak-to-peak)	-	50	150	mV	Oscilloscope bandwidth: 20 MHz
Output voltage Trim range	5.0	-	5.5	V	-
Output voltage overshoot	-	-	5	%	Full range of V_{in}, I_{out} and T_A
Output voltage delay time	-	10	30	ms	From V_{in} connection to 10% V_{out}
Output voltage rise time	-	-	30	ms	From 10% V_{out} to 90% V_{out}, V_{out} = 5 V
Switching frequency	-	400	-	kHz	-

2.4 Efficiency

Table 2-4 Efficiency specifications

Parameter	Minimum	Typical	Maximum	Unit	Notes & Conditions
100% load	90.5	91.5	-	%	T_A = 25°C (77°F); V_{in} = 48 V; V_{out} = 5 V
50% load	89.5	90.5	-	%	
20% load	87.0	88.5	-	%	

2.5 Protection

Table 2-5 Input protection

Parameter	Minimum	Typical	Maximum	Unit	Notes & Conditions
Input undervoltage protection startup threshold	28	30	34	V	-
Input undervoltage protection shutdown threshold	26	28	30	V	-
Input undervoltage protection hysteresis	1	2	3	V	-

Table 2-6 Output protection

Parameter	Minimum	Typical	Maximum	Unit	Notes & Conditions
Output overvoltage protection	-	-	7	V	Hiccup mode, adjust by Trim.
Output short-circuit protection	-	-	-	-	Hiccup mode
Output overcurrent protection	110	-	160	% I_{omax}	
Overtemperature protection threshold	110	115	130	°C	Self-recovery The values are obtained by measuring the temperature of the PCB near the thermistor R_t.
Overtemperature protection hysteresis	5	-	-	°C	

2.6 Dynamic Characteristics

Table 2-7 Dynamic characteristics

Parameter	Minimum	Typical	Maximum	Unit	Notes & Conditions
Overshoot amplitude	-	100	250	mV	Current change rate: 0.1 A/μs; load: 25%–

Parameter	Minimum	Typical	Maximum	Unit	Notes & Conditions
Overshoot recovery time	-	-	400	µs	50%–25%, 50%–75%–50% Larger than 80% load step, there is no special standard. When the ambient temperature is below –5°C and the input voltage is 60–75 V, it is recommended that the output capacitor be at least 660 µF to meet the dynamic speci ications.
Overshoot amplitude	-	160	300	mV	Current change rate: 1 A/µs; load: 25%–50%–25%, 50%–75%–50% Larger than 80% load step, there is no special standard. When the ambient temperature is below –5°C and the input voltage is 60–75 V, it is recommended that the output capacitor be at least 660 µF to meet the dynamic specifications.
Overshoot recovery time	-	-	400	µs	
Overshoot amplitude	-	-	550	mV	Current change rate: 1 A/µs, with at least 1500 µF external output aluminum electrolytic capacitor; load: 10%–90%–10%
Overshoot recovery time	-	-	400	µs	

2.7 Insulation Characteristics

Table 2-8 Insulation characteristics

Parameter	Minimum	Typical	Maximum	Unit	Notes & Conditions
Input-output insulation voltage	-	-	1500	V	Basic insulation (1-minute test); altitude: 3000 m (70 kPa); leakage current < 1 mA; without arc or breakdown
Input-output insulation voltage	-	-	1500	V	Functional insulation (1-minute test); altitude: 5000 m (54 kPa); leakage current < 1 mA; without arc or breakdown

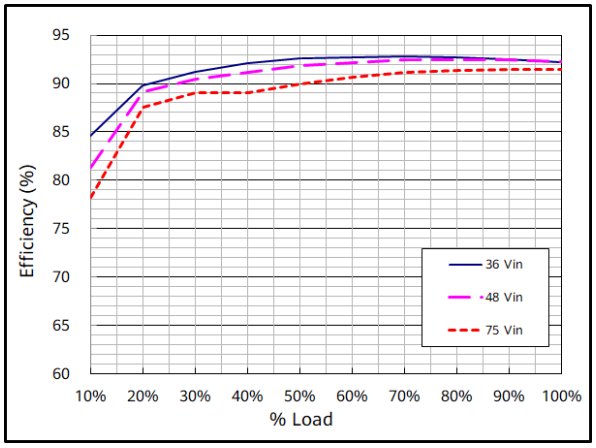
2.8 Other Characteristics

Table 2-9 Other characteristics

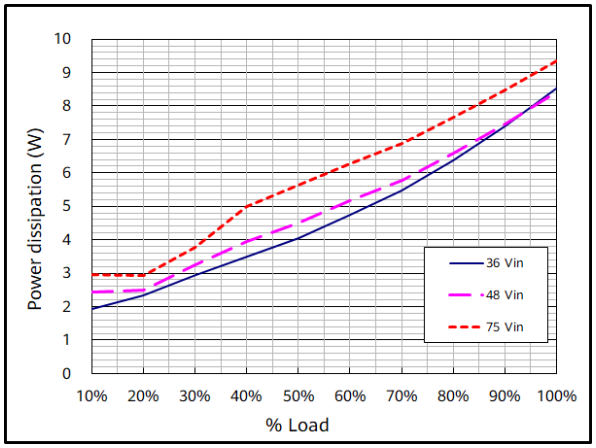
Parameter	Minimum	Typical	Maximum	Unit	Notes & Conditions
Remote On/Off voltage low level	–0.7	-	1.2	V	Negative logic
Remote On/Off voltage high level	3.5	-	12.0	V	
On/Off current low level	-	-	1.0	mA	-
On/Off current high level	-	-	-	μA	
Remote on delay time	180	240	300	ms	From remote on enable to 10% V_{out}. The CNT pin must be dangling more than 200 μs after remote off (controller stops switching).

Parameter	Minimum	Typical	Maximum	Unit	Notes & Conditions
+SENSE	-	-	-	% V_o	1. This function is not recommended. 2. The Sense pin and the V_{out} pin need to be short-circuited nearby, if the sense compensation function is not used.
-SENSE	-	-	-	% V_o	
Mean time between failures (MTBF)	-	2.5	-	Million hours	Telcordia, SR332 Method 1 Case 3; 80% load, normal input/rated output; T_A = 40°C; 300 LFM

3 Characteristic Curves



Efficiency curve
(T_A = 25°C; V_{in} = 36 V, 48 V, or 75 V)



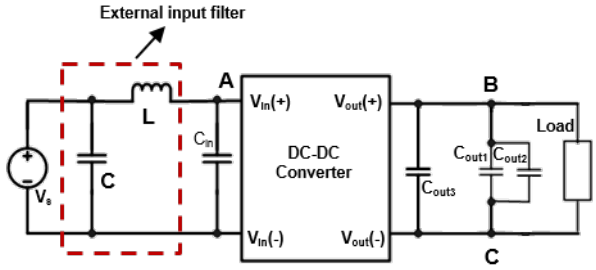
Power dissipation curve
(T_A = 25°C; V_{in} = 36 V, 48 V, or 75 V)

4 Typical Waveforms

NOTE

- During the test of input re lected ripple current, the input terminal must be connected to the external input filter (include a 12 μH inductor and a 220 μF electrolytic capacitor), which is not required in other tests.
- Point B and C, which are for testing the output voltage ripple, must be 25 mm (0.98 in.) away from the V_{out} (+) pin and the V_{out} (–) pin.

Figure 4-1 Test set-up diagram



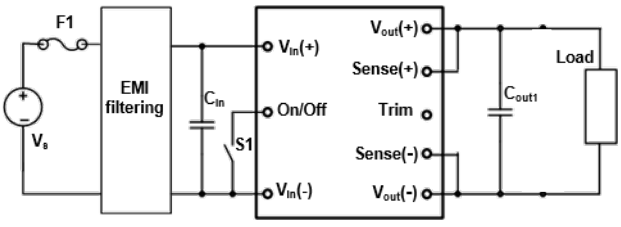
C_{in}: The 100 μF aluminum electrolytic capacitor is recommended.

C_{out1}: The 0.1 μF ceramic capacitor is recommended.

C_{out2}: The 10 μF electrolytic capacitor is recommended.

C_{out3}: The 470 μF solid aluminum capacitor is recommended.

Figure 4-2 Typical circuit applications

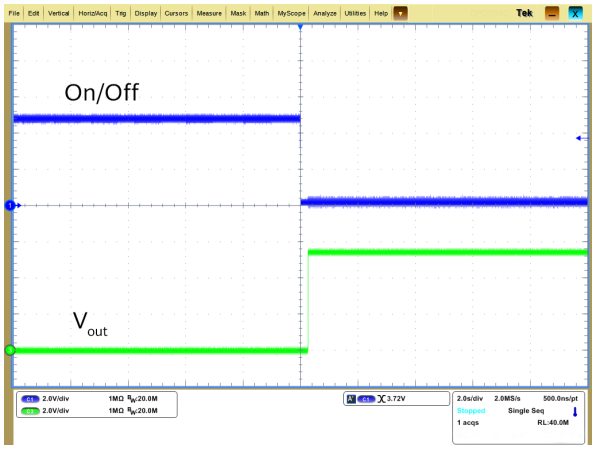


F_1: 7 A fuse (fast blowing).

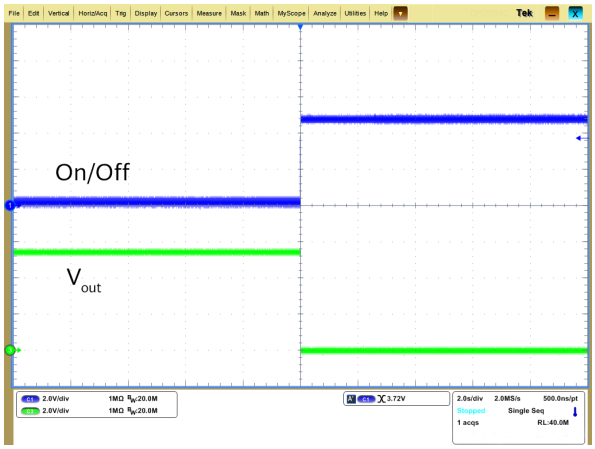
C_{in}: The 100 μF aluminum electrolytic capacitor is recommended.

C_{out}: The 470 μF solid aluminum capacitor is recommended.

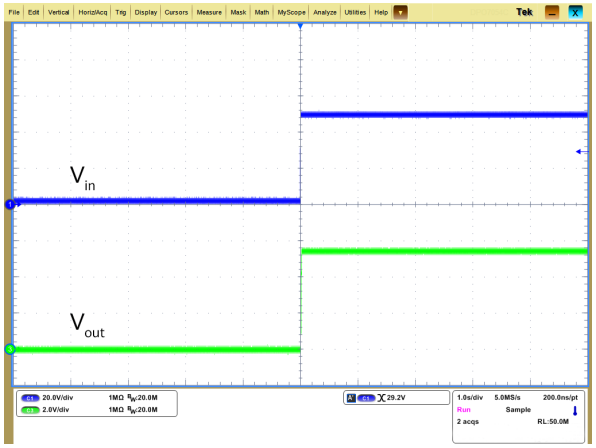
4.1 Turn-on/Turn-off



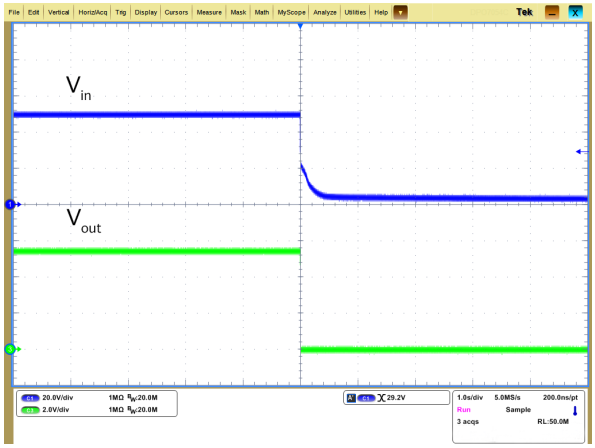
Startup from On/Off



Shutdown from On/Off

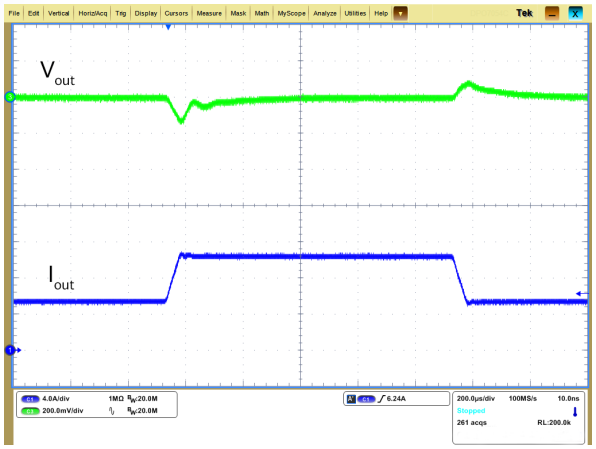


Startup by power-on

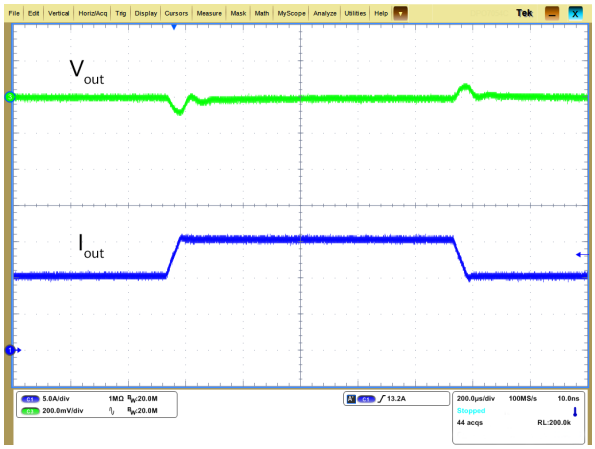


Shutdown by power-off

4.2 Output Voltage Dynamic Response

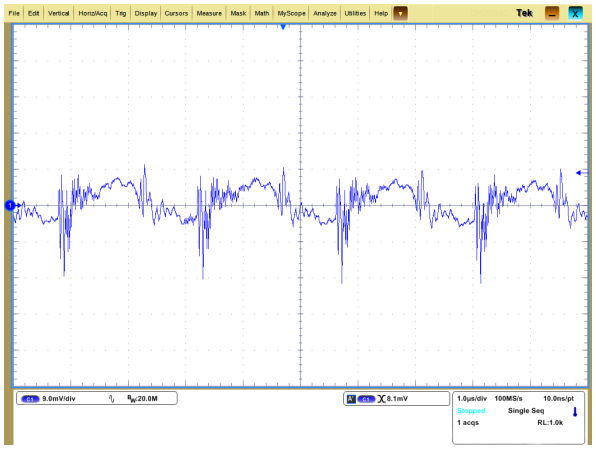


Output voltage dynamic response
(Load: 25%–50%–25%, di/dt = 0.1 A/μs)



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

4.3 Output Voltage Ripple



Output voltage ripple (V_{in} = 48 V, V_{out} = 5.5 V, I_{out} = 18.2 A)

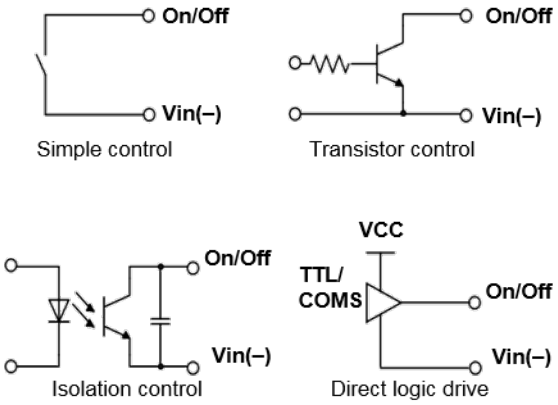
5 Control Characteristic

5.1 Remote On/Off

The main output of module can be turned on or turned off by On/Off signal.

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

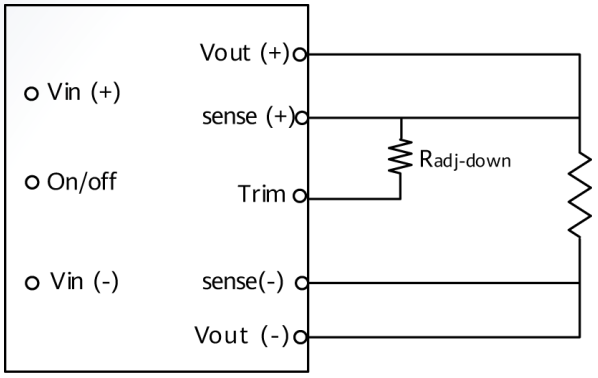
Figure 5-1 Various circuits for driving the On/Off pin



5.2 Output Voltage Trim

The output voltage can be decreased by installing an external resistor between the Trim pin and the Sense (+) pin.

Figure 5-2 Configuration diagram for Trim down



The relationship between $R_{adj\text{-}down}$ and V_{out}:

$$R_{adj\text{-}down} = \frac{35.93}{5.49 - V_{out}} - 17.11\ (k\Omega)$$

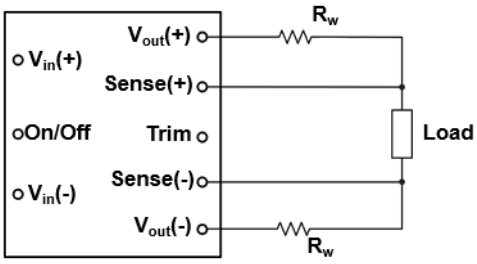
5.3 Remote Sense

This function is used to compensate for voltage drops on R_w. The Sense (+), Sense (–), V_{out} (+), and V_{out} (–) terminals should meet the following requirements:

$[V_{out}\ (+) - V_{out}\ (-)] - [\text{Sense}\ (+) - \text{Sense}\ (-)] \leq 10\% \times V_{nom}$

(V_{nom} is the rated output voltage.)

Figure 5-3 Configuration diagram for remote sense



NOTE

1. R_w indicates the line impedance between the output terminal and the load.
2. If the remote sense function is disabled, the Sense (+) terminal directly connects to the V_{out} (+) terminal and the Sense (–) terminal directly connects to the V_{out} (–) terminal.
3. The module does not support the remote sense function.

6 Protection Characteristic

- **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 **Table 2-5**.

- **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, see **Table 2-6**.

- **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.

- **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.

7 Mechanical Overview

Figure 7-1 Mechanical overview

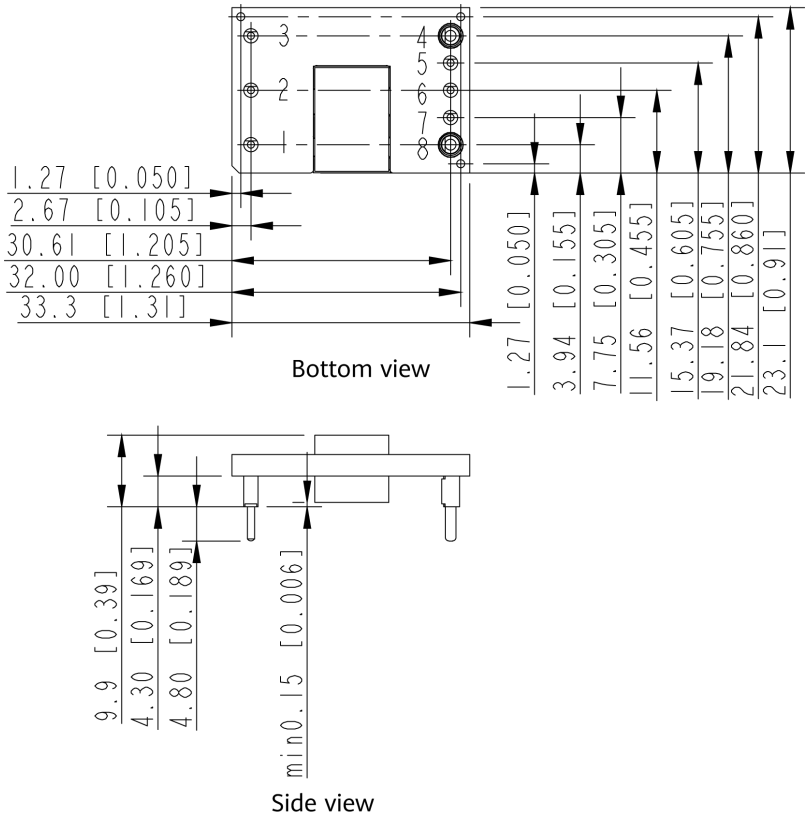


Table 7-1 Pin description

Pin No.	Function	Pin No.	Function	Pin No.	Function
1	V_{in} (+)	4	V_{out} (–)	7	Sense (+)
2	CNT	5	Sense (–)	8	V_{out} (+)
3	V_{in} (–)	6	Trim	-	-

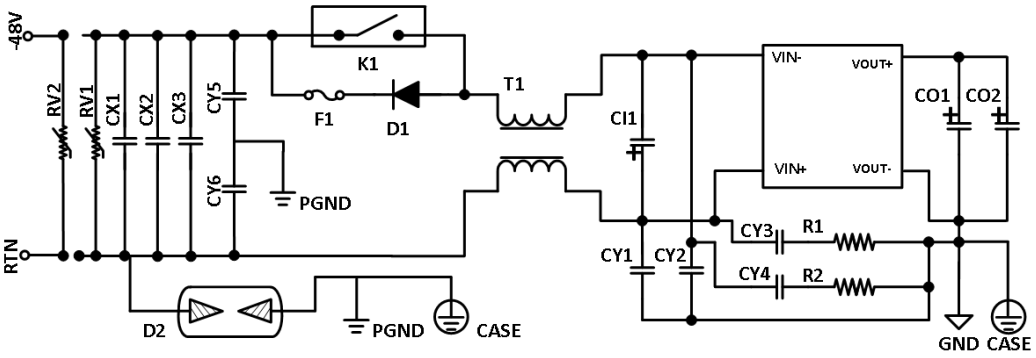
NOTE

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. Pins 1-3, 5-7 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 8 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.

8 Safety

8.1 EMC Specifications

Figure 8-1 EMC test set-up diagram



D1	Schottky diode, 400 V, 16 A
D2	Gas discharge tube, 90 V, 10 kA
RV1, RV2	Varistor, 100 V, 4500 A
CX1–CX3	Metalized film capacitor, 275 V, 1 µF
F1	125 V, 3 A fuse (slow blowing)
K1	30 A
T1	EMI common-mode inductor, 400 µH
CI1	Aluminum electrolytic capacitor, 100 µF
CY1, CY2, CY5, CY6	Metalized film capacitor, 275 V, 0.1 µF
CY3, CY4	Chip multilayer ceramic capacitor, 1000 V, 22 nF
R1, R2	Chip thick film resistor, 1 W, 1 Ω
CO1, CO2	Non-solid radial lead aluminum electrolytic capacitor, 220 µF

NOTE

This is a class A product. In residential areas, this product may cause radio interference. Therefore, users may be required to take appropriate measures.

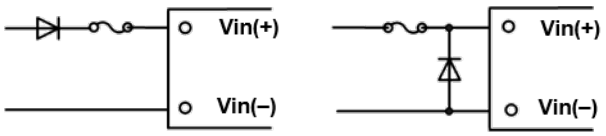
8.2 Recommended Fuse

The converter has no internal fuse. To meet safety and regulatory requirements, a 7 A fuse is recommended.

8.3 Recommended Reverse Polarity Protection Circuit

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

Figure 8-2 Recommended reverse polarity protection circuit



8.4 Qualification Testing

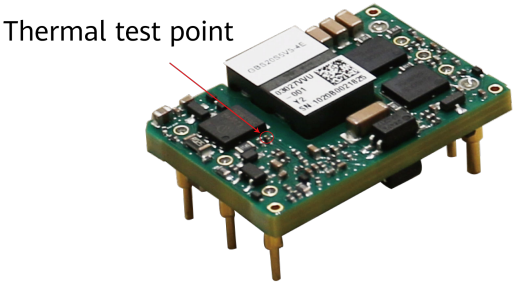
Parameter	Units	Condition
Highly accelerated life test (HALT)	6	Low temperature limit: –60°C; high temperature limit: 110°C; vibration limit: 40 G; temp change rate: 40 °C/min; vibration freq range: 10 Hz to 10000 Hz; axes of vibration: X/Y/Z
Thermal humidity bias (THB)	16	Maximum input voltage; 85°C; 85% RH; 1000 operating hours under lowest load power
High temperature operation bias (HTOB)	16	Rated input voltage; air flow: 0.5 m/s (100 LFM) to 5 m/s (1000 LFM); ambient temperature between +45°C and +55°C; 1000 operating hours; 50% to 80% load
Power and temperature cycling test (PTC)	32	Rated input voltage; air flow: 0.5 m/s (100 LFM) to 5 m/s (1000 LFM); ambient temperature between –40°C and +85°C; 1000 cycles; 50% load

8.5 Thermal Consideration

Thermal Test Point

Decide proper airflow to be provided by measuring the temperature of the PCB near the thermal resistor shown in **Figure Thermal test point** to protect the converter against overtemperature. The overtemperature protection threshold is also obtained based on this thermal test point.

Figure 8-3 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): $P_d = P_o(1-\eta)/\eta$.

8.6 MSL Rating

Store and transport the converter as required by the moisture sensitivity level (MSL) rating 3 specified in the J-STD-020/033C. The surface of a soldered converter must be clean and dry. Otherwise, the assembly, test, or even reliability of the converter will be negatively affected.

8.7 Mechanical Consideration

Installation

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

Soldering

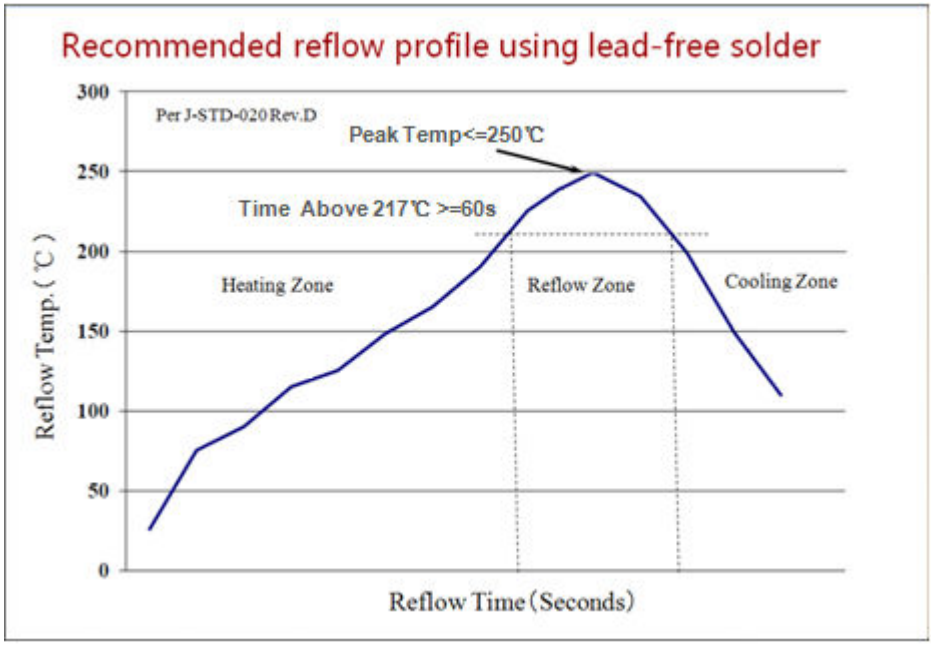
The converter is compatible with standard wave soldering, reflow soldering and hand soldering.

1. For wave soldering, the converter pins can be soldered at 260°C for less than 7 seconds.
2. For reflow soldering, the temperature on body is specified to maximum 250°C for maximum 10s.

3. For hand soldering, the iron temperature should be maintained at 350°C to 420°C and applied to the converter pins for less than 10 seconds.

The converter can be rinsed using the isopropyl alcohol (IPA) solvent or other suitable solvents.

Figure 8-4 Recommended reflow profile using lead-free solder



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