1 kW Full-Bridge DC-DC Converter Reference Guide

RD170-RGUIDE-01

TOSHIBA ELECTRONIC DEVICES & STORAGE CORPORATION
Contents

1. Introduction .................................................................3

2. Specification ...............................................................3
   2.1. Specification ..........................................................3
   2.2. Outline .................................................................4
   2.3. Block Diagram ..........................................................5
   2.4. Component Placement ...............................................6
   2.5. PCB Pattern ...........................................................8

3. Operating Procedure ......................................................12
   3.1. Connection with External Equipment ............................12
   3.2. Start and Stop Procedures ..........................................13
   3.3. Precautions for Evaluation (Electric Shock, Burn Injury, etc.) .... 13

4. Power Characteristics ......................................................15
   4.1. Efficiency ..............................................................15
1. Introduction

This reference guide describes the specifications, usage, and efficiency properties of 1 kW full-bridge DC-DC converter (this power supply). This power supply is capable of supplying 1 kW power at the DC 54 V output. The input-voltage range is from DC -36 V to -60 V, and it can be used in applications including communication-related equipment, industrial equipment, and various other applications. This reference guide provides various design information including reference design, and contributes to reduction of effort required in designing according to actual specifications.

2. Specification

2.1. Specification

Table 2.1 lists the I/O characteristics of this power supply.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC input voltage (rms)</td>
<td></td>
<td>90</td>
<td>264</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>AC input current (rms)</td>
<td>VinAC = 90 V, Iout = 16.67 A</td>
<td>10</td>
<td></td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>AC Input frequency</td>
<td></td>
<td>47</td>
<td>63</td>
<td>Hz</td>
<td></td>
</tr>
<tr>
<td><strong>Semi-Bridgeless PFC Circuit Output Characteristics (Internal Characteristics)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output voltage</td>
<td></td>
<td>390</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Output current</td>
<td>VinAC = 230 V</td>
<td>4.5</td>
<td></td>
<td>A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>VinAC = 115 V</td>
<td>2.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switching frequency</td>
<td></td>
<td>60</td>
<td></td>
<td>kHz</td>
<td></td>
</tr>
<tr>
<td><strong>Output Characteristics (PSFB Circuit)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output voltage</td>
<td></td>
<td>45.6</td>
<td>48.0</td>
<td>50.4</td>
<td>V</td>
</tr>
<tr>
<td>Output current</td>
<td>VinAC = 230 V</td>
<td>33.33</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>VinAC = 115 V</td>
<td>16.67</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output power</td>
<td>VinAC = 230 V</td>
<td>1.6</td>
<td>kW</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>VinAC = 115 V</td>
<td>0.8</td>
<td>kW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output ripple voltage</td>
<td>Ta = 25 °C</td>
<td>480</td>
<td>mV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switching frequency</td>
<td></td>
<td>97.05</td>
<td></td>
<td>kHz</td>
<td></td>
</tr>
</tbody>
</table>
2.2. Outline

Fig. 2.1 shows an overview of this power supply.

Fig. 2.1  External View of 1 kW Full-Bridge DC-DC Converter

Outline size
207 mm x 120 mm x 45 mm
2.3. Block Diagram

Fig. 2.2 shows a block diagram to describe the function operation. Refer to RD170-SCHEMATIC-01 for the actual schematic and to RD170-BOM-01 for the bill of materials.

![Block Diagram](image_url)
2.4. Component Placement

Fig. 2.3 and Fig. 2.4 show the layout of parts on the PCB of this power supply.

Fig. 2.3  PCB Component Placement (Front Side)
Fig. 2.4  PCB Component Placement (Back Side)
2.5. PCB Pattern

PCB design data of this power supply is compatible with various EDA (Electronic Design Automation) tools. Please refer to webpage for more information.

Fig. 2.5 shows Layer1 of the PCB
Fig. 2.6 shows Layer2 of the PCB

Fig. 2.6  Layer2
Fig. 2.7 shows Layer3 of the PCB
Fig. 2.8 shows Layer4 of the PCB
3. Operating Procedure

This section describes the operating procedure of this power supply.

3.1. Connection with External Equipment

Fig. 3.1 shows the external connection pins. The parts enclosed in red are the input terminals. Connect a stabilized DC power supply to the Input (+) and Input (-) terminals. The power supply, cables, leads, and connectors to be connected must satisfy 2.1 Power Supply Specifications. The parts enclosed in blue are the output terminals. Connect the load unit to the Output (+) and Output (-) terminals. Load units, cables, and connectors to be connected must satisfy 2.1 Power Supply Specifications.

![Fig. 3.1 External Connection Terminals](image_url)
3.2. Start and Stop Procedures

Before starting the power supply, check that all of the following pin voltages are 0V.
Input (+) terminal, Input (-) terminal, Output (+) terminal, and Output (-) terminal.

[Startup Procedure]
Turn On the output of external stabilized DC power supply.

[Stop Procedure]
Turn Off the output of external stabilized DC power supply.

3.3. Precautions for Evaluation (Electric Shock, Burn Injury, etc.)

Fig. 3.2 shows the input and output side areas of this power supply. After this power supply is stopped, there is a risk of electric shock due to the residual charge present in various capacitors. Before touching the board, check that the voltage of each component has decreased sufficiently.

In addition, semiconductors, transformers, etc. of this power supply generate heat according to the load current. Fig. 3.3 shows the parts with high heat generation with red broken line frames. This power supply is designed to work with forced air-cooling. Use an air-cooling device that ensures that the temperature of these component remain within the rated temperature range at high loads. Also, do not touch these parts while the power supply is running, as there is a risk of burns.

Fig. 3.2  Input and Output Side Areas
Fig. 3.3  Parts with High Heat Generation
4. Power Characteristics

The power supply efficiency measurement results of this power supply are described below.

4.1. Efficiency

Fig. 4.1 shows the power supply efficiency measurement results of this power supply. The input voltage is set to -48 V, -54 V and -60 V for measurement.

![Efficiency Measurement Results](image)

**Fig. 4.1** Efficiency Measurement Results (Vin = -36 V, Vin = -54 V, Vin = -60 V)
Terms of Use

This terms of use is made between Toshiba Electronic Devices and Storage Corporation ("We") and customers who use documents and data that are consulted to design electronics applications on which our semiconductor devices are mounted ("this Reference Design"). Customers shall comply with this terms of use. Please note that it is assumed that customers agree to any and all the terms of use if customers download this Reference Design. We may, at its sole and exclusive discretion, change, alter, modify, add, and/or remove any part of this terms of use at any time without any prior notice. We may terminate this terms of use at any time and for any reason. Upon termination of this terms of use, customers shall destroy this Reference Design. In the event of any breach thereof by customers, customers shall destroy this Reference Design, and furnish us a written confirmation to prove such destruction.

1. Restrictions on usage
   1. This Reference Design is provided solely as reference data for designing electronics applications. Customers shall not use this Reference Design for any other purpose, including without limitation, verification of reliability.
   2. This Reference Design is for customer's own use and not for sale, lease or other transfer.
   3. Customers shall not use this Reference Design for evaluation in high or low temperature, high humidity, or high electromagnetic environments.
   4. This Reference Design shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable laws or regulations.

2. Limitations
   1. We reserve the right to make changes to this Reference Design without notice.
   2. This Reference Design should be treated as a reference only. We are not responsible for any incorrect or incomplete data and information.
   3. Semiconductor devices can malfunction or fail. When designing electronics applications by referring to this Reference Design, customers are responsible for complying with safety standards and for providing adequate designs and safeguards for their hardware, software and systems which minimize risk and avoid situations in which a malfunction or failure of semiconductor devices could cause loss of human life, bodily injury or damage to property, including data loss or corruption. Customers must also refer to and comply with the latest versions of all relevant our information, including without limitation, specifications, data sheets and application notes for semiconductor devices, as well as the precautions and conditions set forth in the "Semiconductor Reliability Handbook".
   4. When designing electronics applications by referring to this Reference Design, customers must evaluate the whole system adequately. Customers are solely responsible for all aspects of their own product design or applications. WE ASSUME NO LIABILITY FOR CUSTOMERS' PRODUCT DESIGN OR APPLICATIONS.
   5. No responsibility is assumed by us for any infringement of patents or any other intellectual property rights of third parties that may result from the use of this Reference Design. No license to any intellectual property right is granted by this terms of use, whether express or implied, by estoppel or otherwise.
   6. THIS REFERENCE DESIGN IS PROVIDED "AS IS". WE (a) ASSUME NO LIABILITY WHATSOEVER, INCLUDING WITHOUT LIMITATION, INDIRECT, CONSEQUENTIAL, SPECIAL, OR INCIDENTAL DAMAGES OR LOSS, INCLUDING WITHOUT LIMITATION, LOSS OF PROFITS, LOSS OF OPPORTUNITIES, BUSINESS INTERRUPTION AND LOSS OF DATA, AND (b) DISCLAIM ANY AND ALL EXPRESS OR IMPLIED WARRANTIES AND CONDITIONS RELATED TO THIS REFERENCE DESIGN, INCLUDING WARRANTIES OR CONDITIONS OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, ACCURACY OF INFORMATION, OR NONINFRINGEMENT.

3. Export Control
   Customers shall not use or otherwise make available this Reference Design for any military purposes, including without limitation, for the design, development, use, stockpiling or manufacturing of nuclear, chemical, or biological weapons or missile technology products (mass destruction weapons). This Reference Design may be controlled under the applicable export laws and regulations including, without limitation, the Japanese Foreign Exchange and Foreign Trade Law and the U.S. Export Administration Regulations. Export and re-export of this Reference Design are strictly prohibited except in compliance with all applicable export laws and regulations.

4. Governing Laws
   This terms of use shall be governed and construed by laws of Japan.