300W Isolated DC-DC Converter (Upgraded)

Reference Guide

RD249-RGUIDE-01

Toshiba Electronic Devices & Storage Corporation

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1. Introduction

This reference guide documents the specifications, usage, and characteristics of the 300W isolated DC-DC converter (Upgraded) (hereafter referred to as “this design”). This design is based on the existing “300W Isolated DC-DC Converter Power Supply” released in August 2018, and achieves improved conversion efficiency through replacement of the secondary-side switching MOSFETs with the latest generation devices and circuit optimization.

As with the existing design, this design features a wide input voltage range of DC 36 to 75V, and can be applied to telecom equipment where 48V distribution lines are available, industrial equipment connected to 48V batteries, and various other applications. Provided as a reference design, this design offers comprehensive design information and helps reduce design effort when adapting to actual specifications.

This design adopts compact surface-mount power MOSFETs for both the primary-side and secondary-side switching devices of the DC-DC converter. By also using compact surface-mount components elsewhere, and while employing a general-purpose wound-structure transformer, this design achieves a compact footprint (82mm × 82mm) and high efficiency (94.6%). The use of a wound-structure transformer facilitates deployment in real-world applications and enables constructing the power circuit directly on the host equipment’s PCB instead of relying on external power modules.

2. Specifications

2.1. Specifications

Table 2.1 lists the characteristics of this design.

Table 2.1 Specifications

Parameters	Conditions	Min	Typ.	Max	Unit
Input Characteristics					
Input voltage		36	48	75	V
Input current	V_{in} = 48V, I_{out} = 25A			12	A
Output Characteristics					
Output voltage		11.4	12	12.6	V
Output current				25	A
Output power				300	W
Output ripple voltage				200	mV
Switching frequency			185		kHz
Other					
Protection	Input undervoltage protection, input/output overvoltage protection, output overcurrent protection, and overtemperature protection				
Substrate structure	FR-4, 6-layer (through-hole via), t = 1.6mm, Copper thickness: 105µm (outer layers), 35µm (inner layers).				

2.2. Block Diagram

Fig 2.1 shows a block diagram to understand the function.

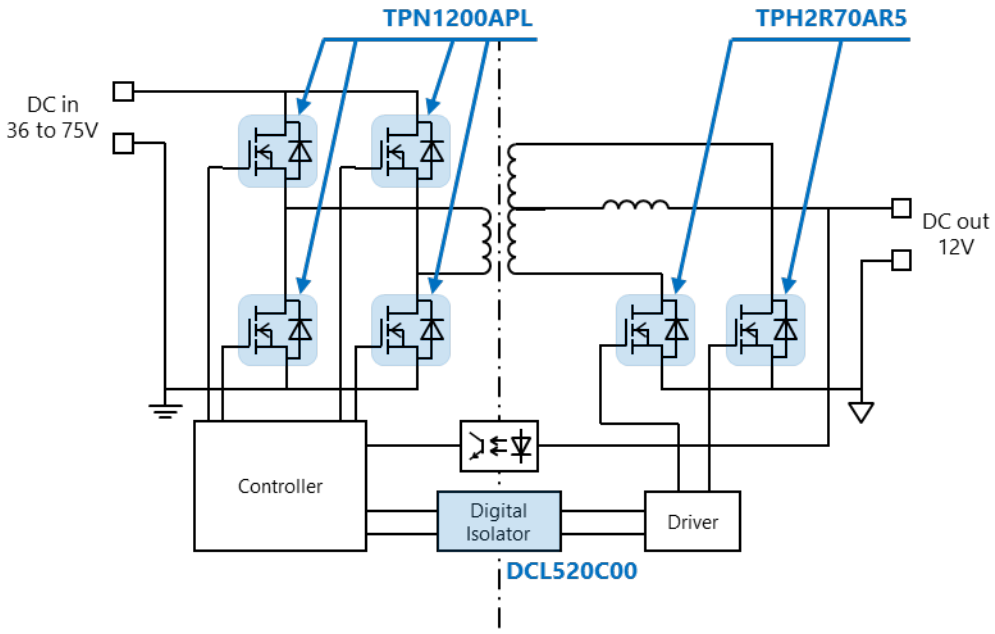


Fig 2.1 Block Diagram

2.3. Appearance

Fig 2.2 shows an external view of this design.

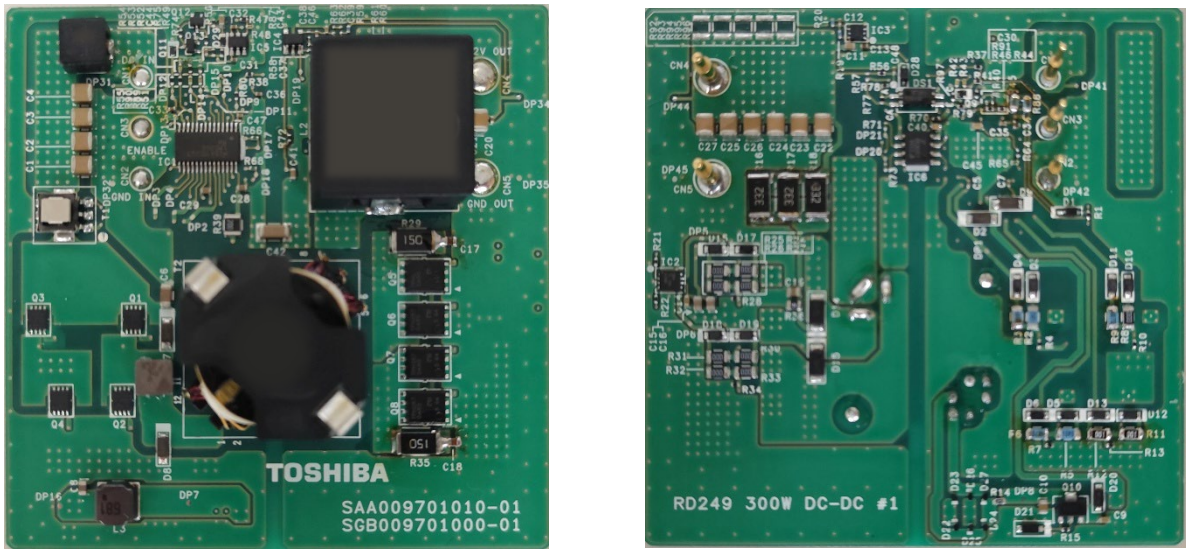
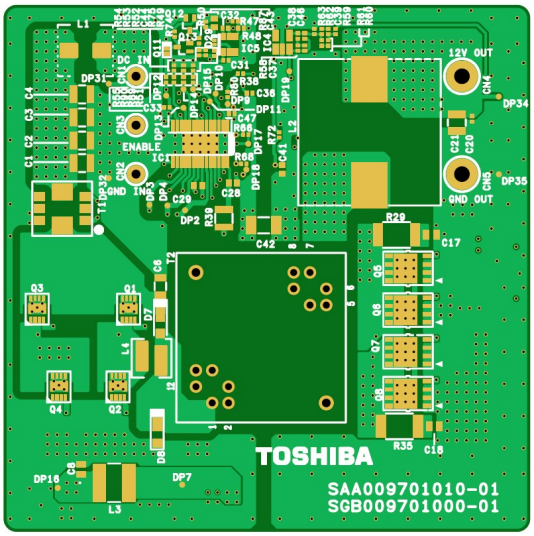


Fig 2.2 External View of This Design

External Dimensions : 82mm x 82mm x 24mm

2.4. PCB Component Layout

Fig 2.3 shows the component layout of the board.



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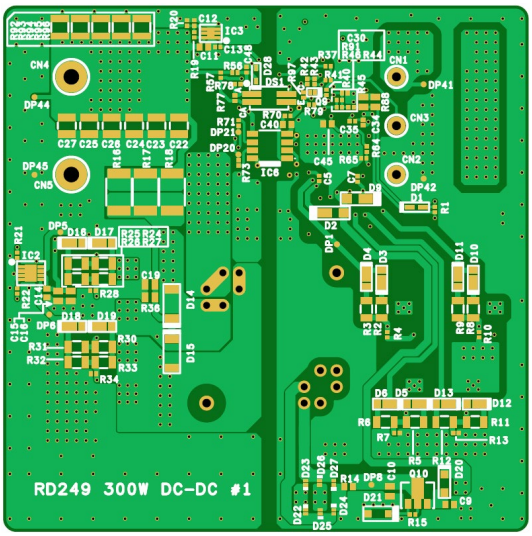


<Back Side>

Fig 2.3 PCB Component Layout

3. Schematic, Bill of Materials, and PCB Pattern Diagram

3.1. Schematic

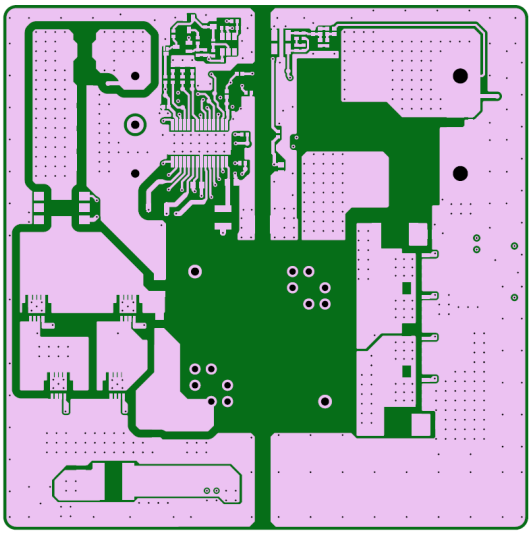
Refer to following files:
RD249-SCHEMATIC-xx.pdf
(xx is the revision number.)

3.2. Bill of Materials

Refer to following files:
RD249-BOM-xx.pdf
(xx is the revision number.)

3.3. PCB Pattern Diagram

Fig. 3.1 shows PCB pattern diagram of the board.
Refer to following files:
RD249-LAYER-xx.pdf
(xx is the revision number.)



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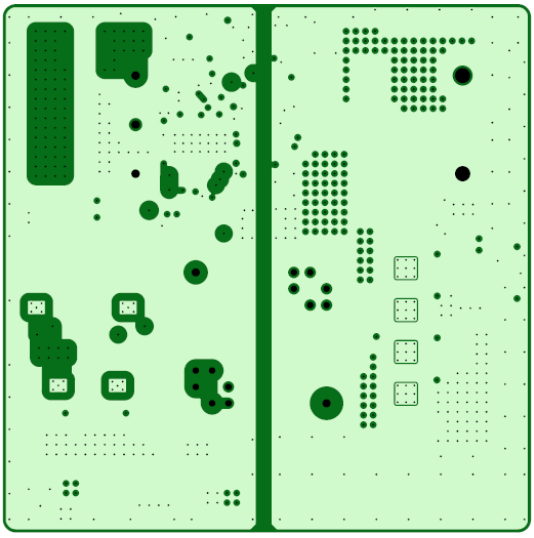

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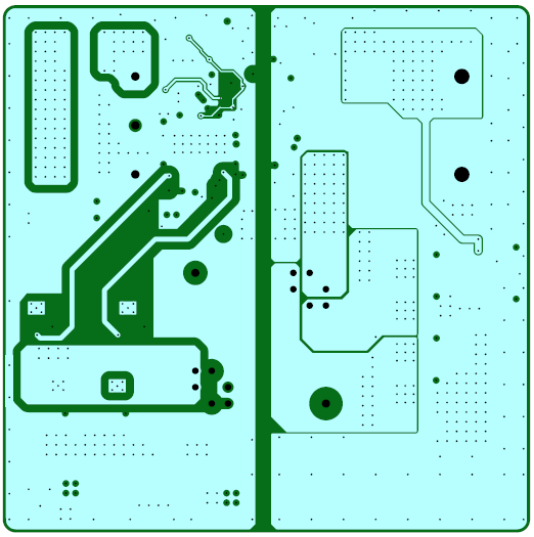

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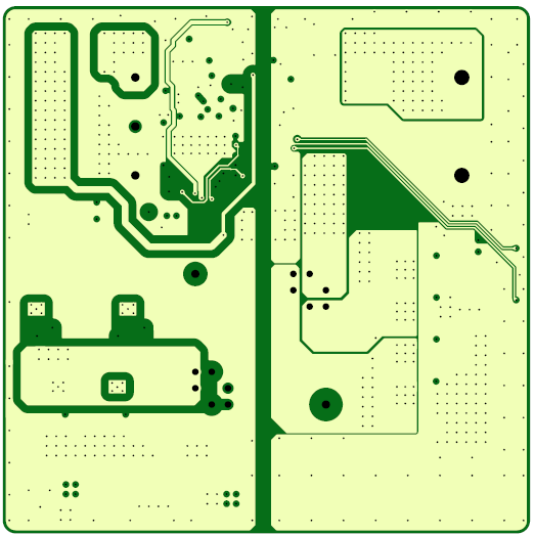

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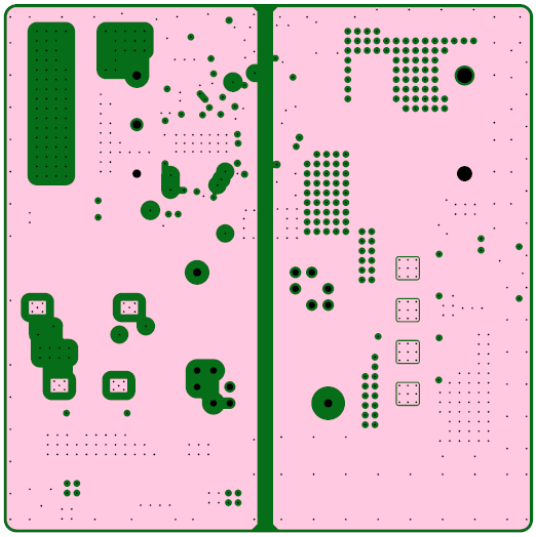

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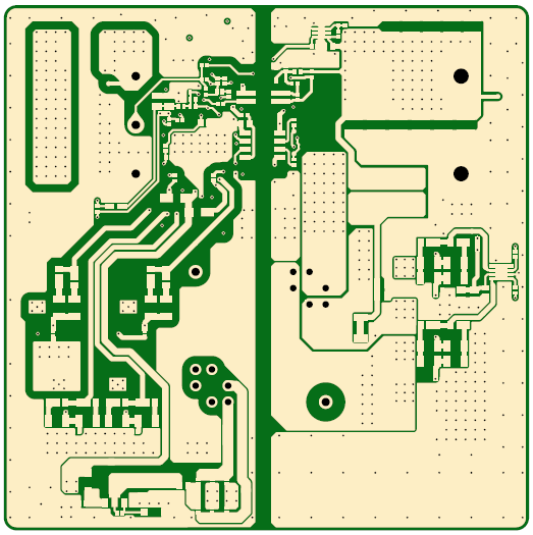

<L6 (Bottom Layer)>

Fig 3.1 PCB Pattern Diagram (Top View)

4. Operating Procedure

This section describes the operating procedure of this design.

4.1. Connections to External Equipment

Fig 4.1 shows the external connection terminals.

The areas enclosed in red indicate the input terminals. Connect a regulated DC power supply to the Input (+) and Input (−) terminals. The connected power supply, cables, leads, and connectors must meet Table 2.1 (Design specifications). The Enable terminal determines the operating state of this design. To stop, leave the Enable terminal open. To start, short the Enable terminal to Input (−) (GND).

The areas enclosed in blue indicate the output terminals. Connect a load device to the Output (+) and Output (−) terminals. The connected load device, cables, and connectors must meet Table 2.1 Specifications (Design specifications).

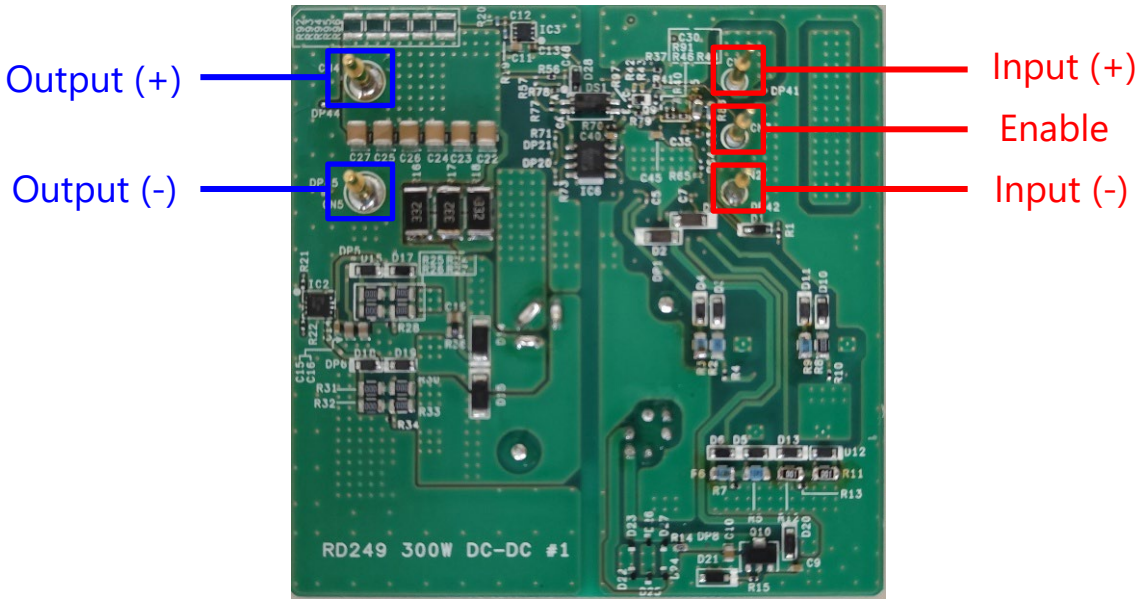

Fig 4.1External Connection Terminals

4.2. Start and Stop Procedures

Before starting, confirm that the voltages at all the following terminals are 0V:

- Input (+), Input (−), Output (+), Output (−)

[Start Procedure] Maintain an interval of 500ms or longer between each step.

1. Apply the output of the external regulated DC power supply.
2. Connect the Enable terminal to the GND terminal.

[Stop Procedure] Maintain an interval of 500ms or longer between each step.

1. Leave the Enable terminal open.
2. Turn off the output of the external regulated DC power supply.

Table 4.1 Enable Terminal Connection

Enable terminal connection	Power supply operation
Input (-)	Operation enabled
Open	Operation stopped

5. Common Precautions for Evaluation

Please read and follow the precautions below to ensure safe evaluation work.

- **Precautions for Electric Shock Prevention**
  - Before applying power, **confirm that the polarity of connectors, terminals, and wiring is correct**.
  - Some parts of the board may be exposed to high voltage. **Do not touch the board or components while power is applied**.
  - Even after the power is turned off, capacitors may retain residual charge. **Ensure that all capacitors are fully discharged before touching the board**.
  - When measuring voltage or current waveforms, **take sufficient precautions to avoid electric shock and maintain a safe distance**.
- **Precautions for Burn Prevention (High-Temperature Components)**
  - MOSFETs, diodes, inductors, coils, and semiconductor devices may become **very hot during operation**. Handle them carefully to avoid burns.
  - Under high load conditions, heat generation increases. **Use appropriate cooling (such as fans)**.
  - Component temperatures may remain high immediately after power-off. **Allow sufficient cooling time before touching**.
- **Precautions for the Evaluation Environment**
  - During operation checks, implement safety measures such as **covering the board with a non-conductive enclosure** if necessary **(e.g., acrylic case)**.
  - When using motors or other moving parts, **take measures to prevent contact during operation**.
  - For designs with shunt or jumper settings, **verify that the settings are correct before operation**.
- **Other Precautions**
  - Loads connected to output terminals may generate heat. **Pay attention to load temperature rise**.
  - Keep flammable and conductive materials away during evaluation to **avoid short circuits and accidents**.

6. Power Supply Characteristics

This chapter describes the results of efficiency measurements for this design.

6.1. Efficiency

Fig 6.1 shows the efficiency measurement results, and Fig 6.2 presents an efficiency comparison with the existing design.

In Fig 6.1 Efficiency measurement results, efficiency measurements were conducted with the input voltage set to 36V, 48V, and 75V. A high efficiency of 95.2% is achieved at 50% load under a 48V input condition.

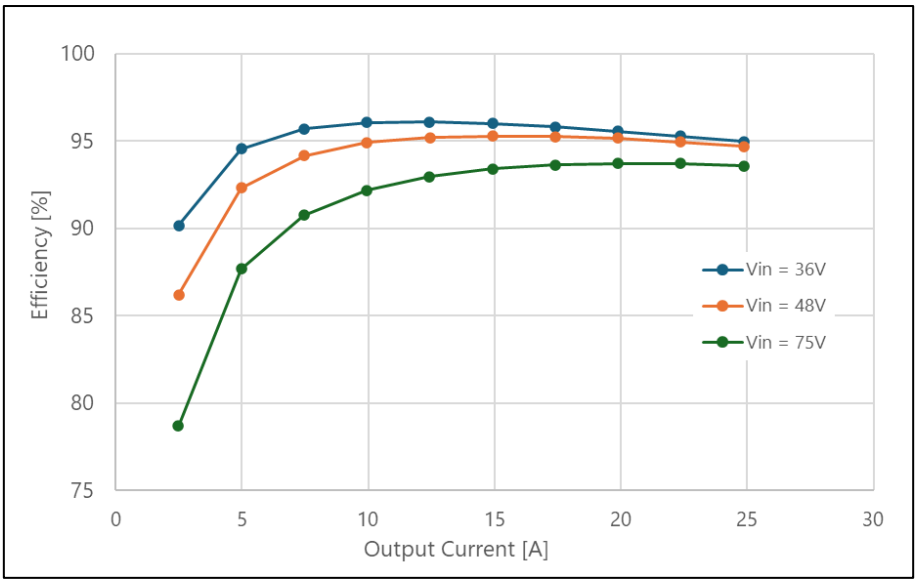

Fig 6.1 Efficiency Measurement Results

Fig 6.2 Efficiency comparison with the existing design , the efficiency at a 48V input is compared, showing an efficiency improvement of 1.4% at 20% load.
(Efficiency at 20% load: 90.9% for the existing design and 92.3% for the this Upgraded design.)

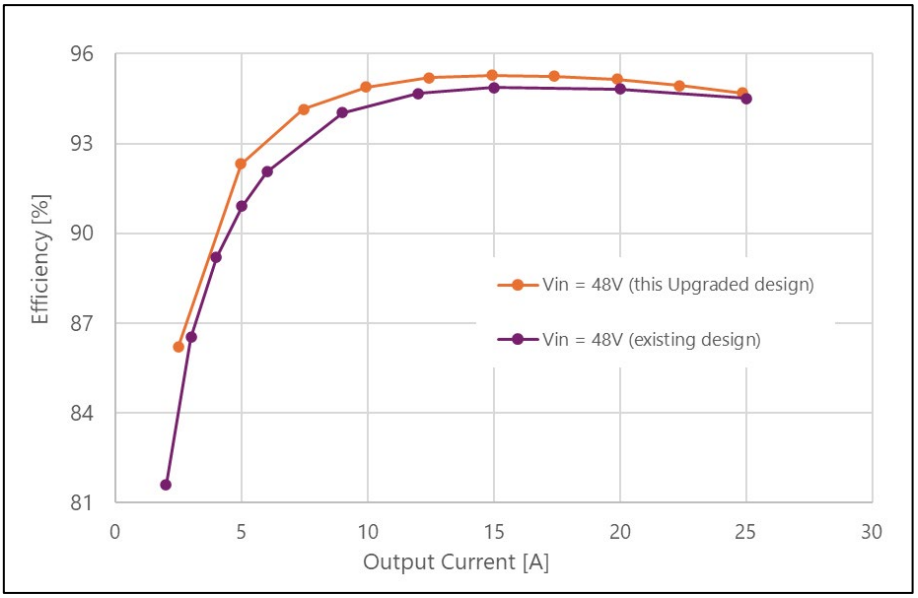

Fig 6.2 Efficiency Comparison With the Existing Design

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