10kW 3-Phase AC 400V Input PFC Converter

Reference Guide

RD263-RGUIDE-01

Toshiba Electronic Devices & Storage Corporation

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1. Introduction

This reference guide describes the specifications, usage, and characteristics of the 10kW 3-Phase AC 400V Input PFC Power Supply (hereafter referred to as “this design”).

This design can provide 10kW at the output DC 750V. 3-phase AC power supply (312V to 528V) is input, and DC 750 V is output in a 3-phase totem pole configuration employing a 1200V SiC MOSFET. It can be applied to various industrial equipment with 3-phase AC power input, such as charging stations for electric vehicles.

The PFC stage uses our latest 1200V SiC MOSFET TW060N120C, which contributes to low power loss. The TLP5214A gate driver photocoupler is used for isolated gate driving of the MOSFETs, and the TLP7920 isolation amplifier is used for isolated sensing of the input and output voltages.

2. Appearance and Specifications

2.1. Specifications

Table 2.1 lists the input and output characteristics of this design.

Table 2.1 10kW 3-Phase AC 400V Input PFC Power Supply Specifications

Parameters	Conditions	Minimum	Typical	Maximum	Unit
Input Characteristics					
AC input voltage (line-to-line rms)		312		528	V
AC Input frequency		49.8		60.3	Hz
AC input current (rms)				19.3	A
Output Characteristics					
Output voltage		742	750	758	V
Output current				13.5	A
Output power				10000	W
Switching frequency			50		kHz

2.2. Block Diagram

Fig. 2.1 shows a block diagram to understand the function.

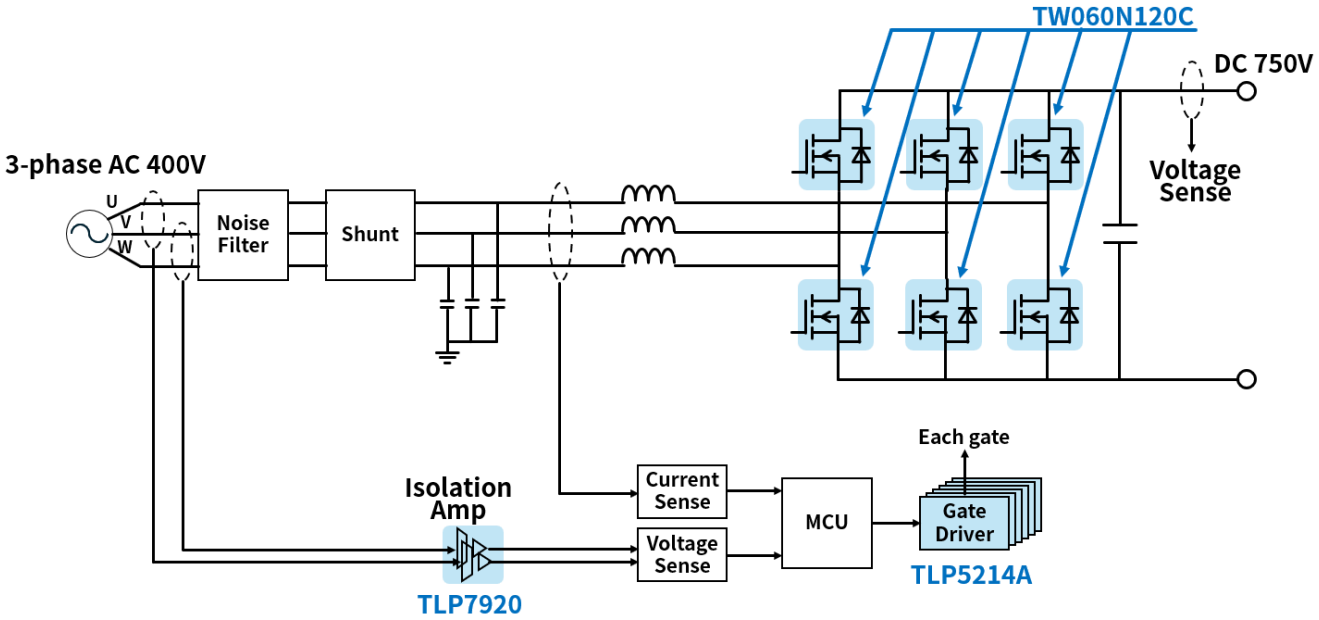


Fig. 2.1 Block Diagram

2.3. Appearance

Fig. 2.2 shows the appearance of this design.

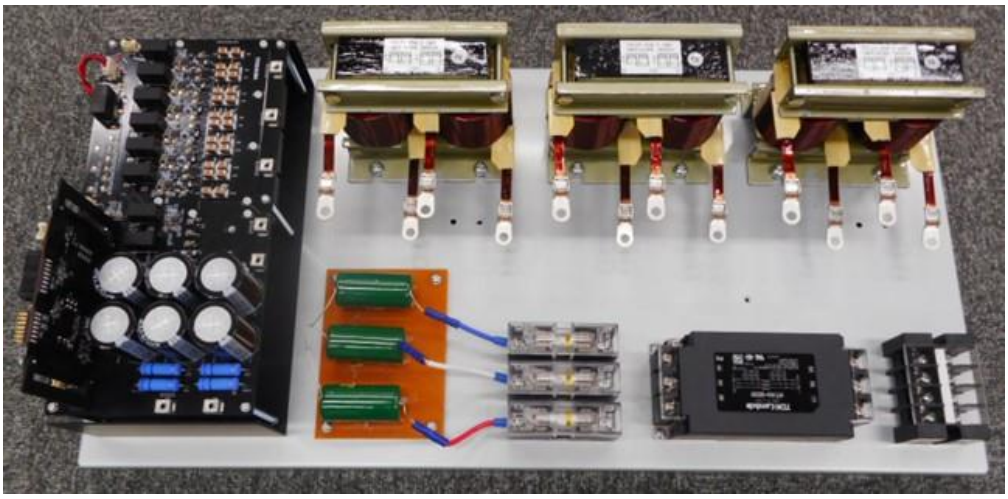
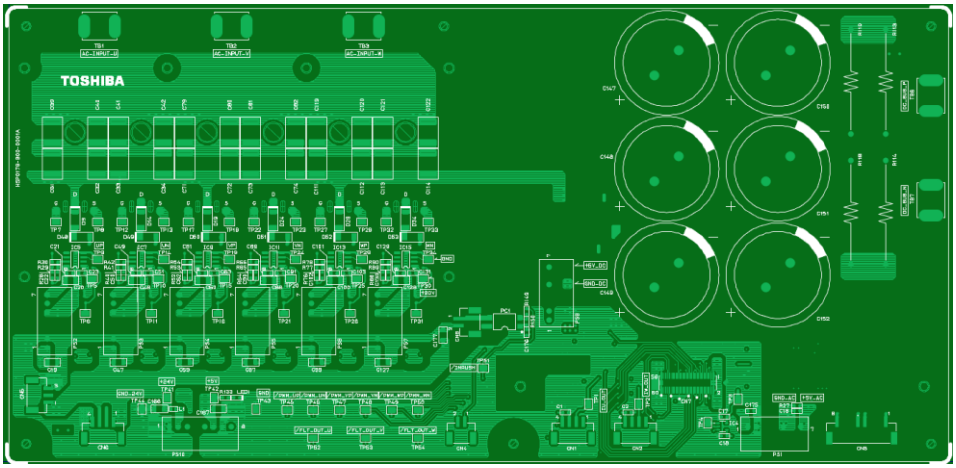


Fig. 2.2 External View of This Design

External Dimensions : 500mm x 320mm x 160mm

2.4. PCB Component Layout

Fig. 2.3 shows the component layout of the main circuit board, Fig. 2.4 shows the component layout of the control board.



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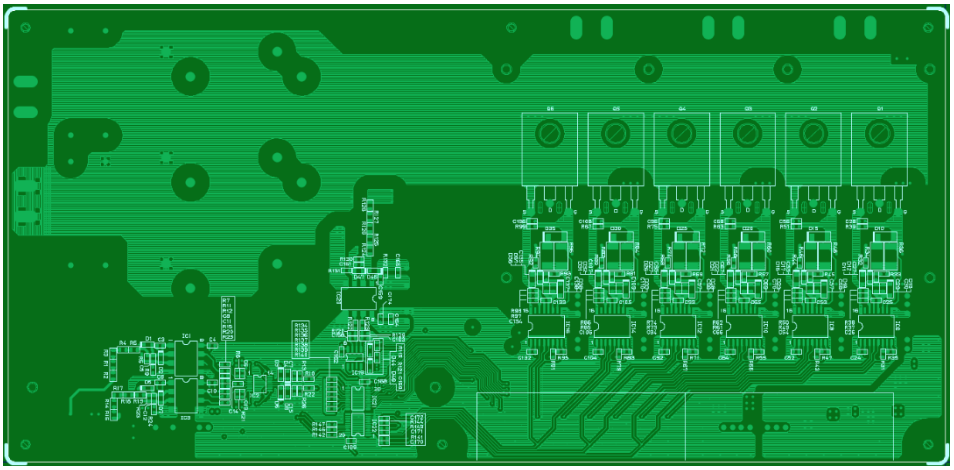

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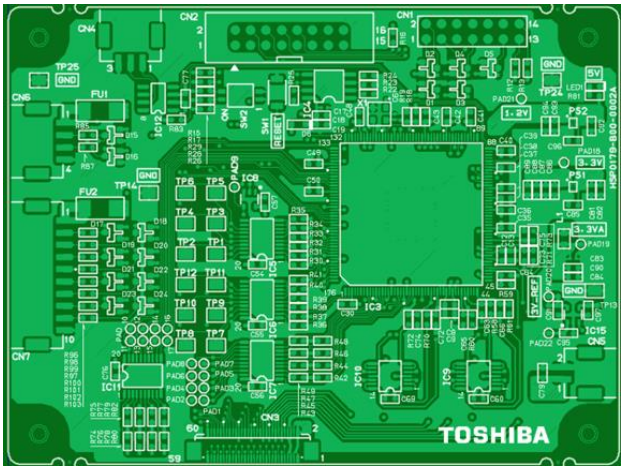
Fig. 2.3 Component Layout of Main Circuit Board



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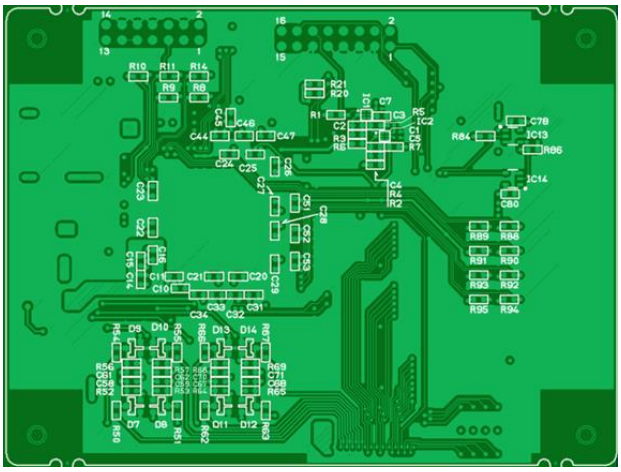

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Fig. 2.4 Component Layout of Control Board

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

3.1. Schematic

Refer to following files:
Main circuit board: RD263-SCHEMATIC1-xx.pdf
Control board: RD044-SCHEMATIC2-xx.pdf
(xx is the revision number.)

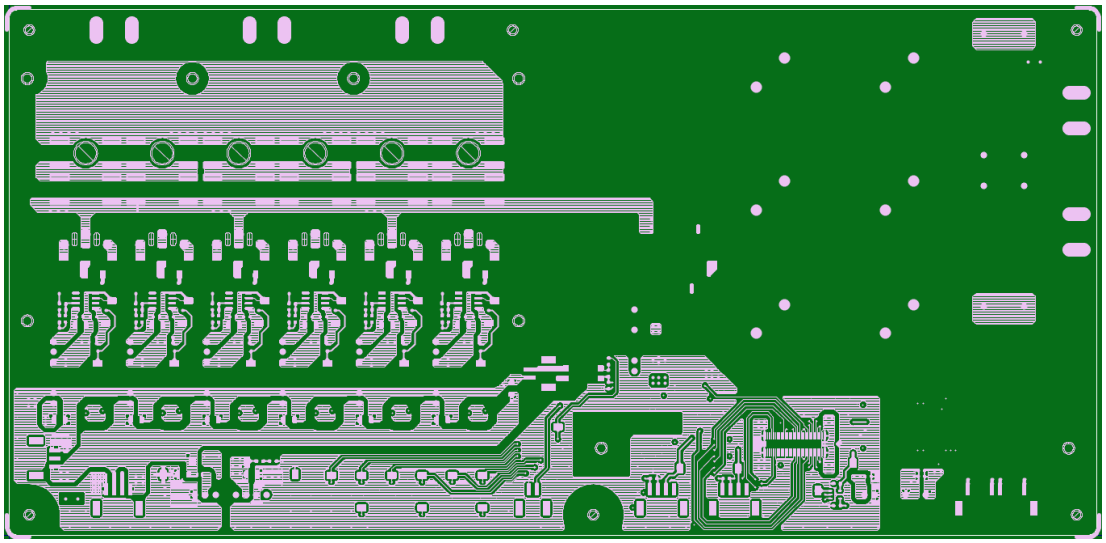
3.2. Bill of Materials

Refer to following files:
Main circuit board: RD263-BOM1-xx.pdf
Control board: RD044-BOM2-xx.pdf
(xx is the revision number.)

3.3. PCB Pattern Diagram

Fig. 3.1 shows PCB pattern diagram of the main circuit board, Fig. 3.2 shows PCB pattern diagram of the control board.

Refer to following files:
Main circuit board: RD263-LAYER1-xx.pdf
Control board: RD044-LAYER2-xx.pdf
(xx is the revision number.)



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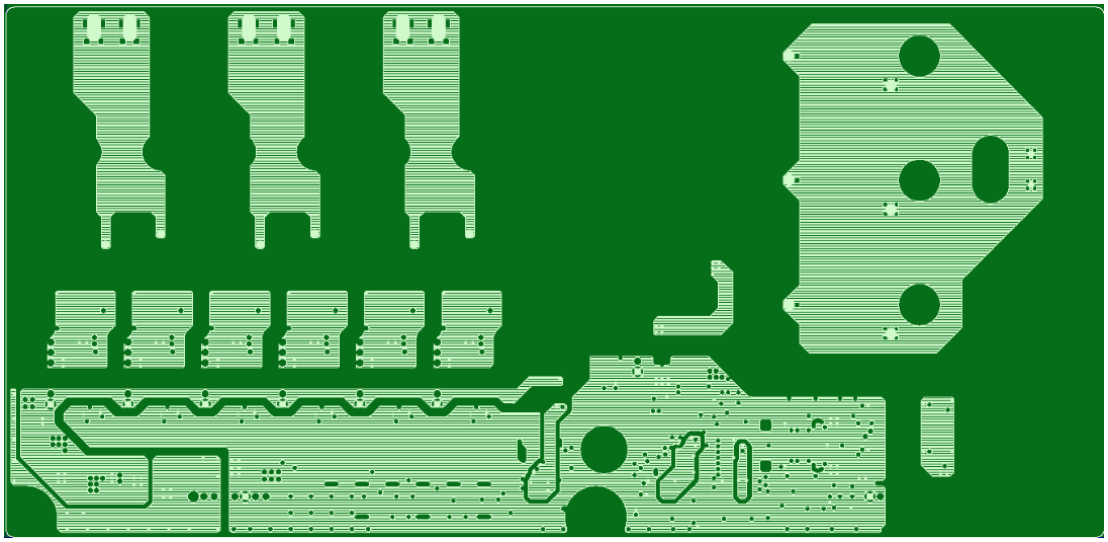

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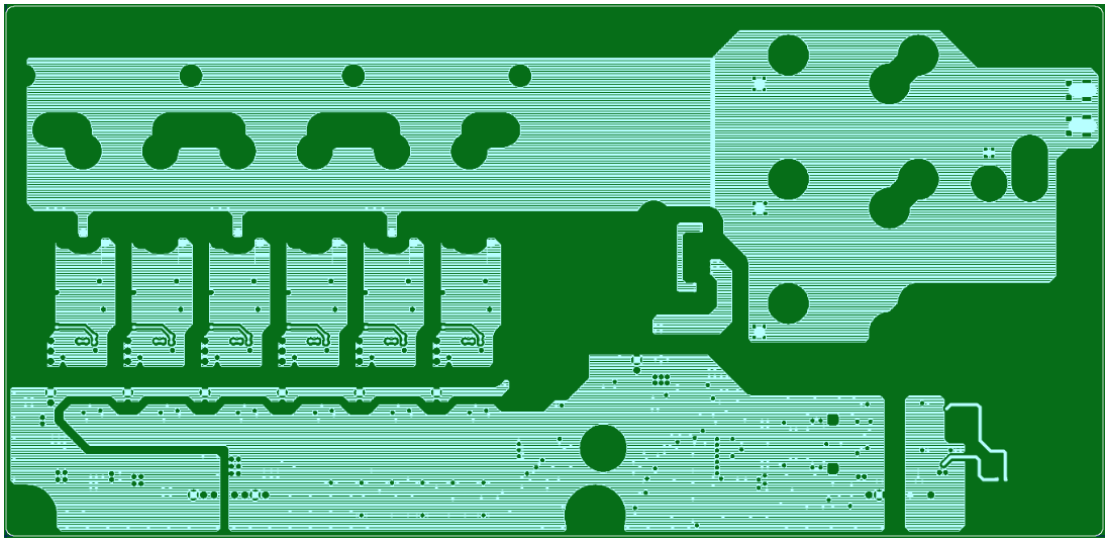

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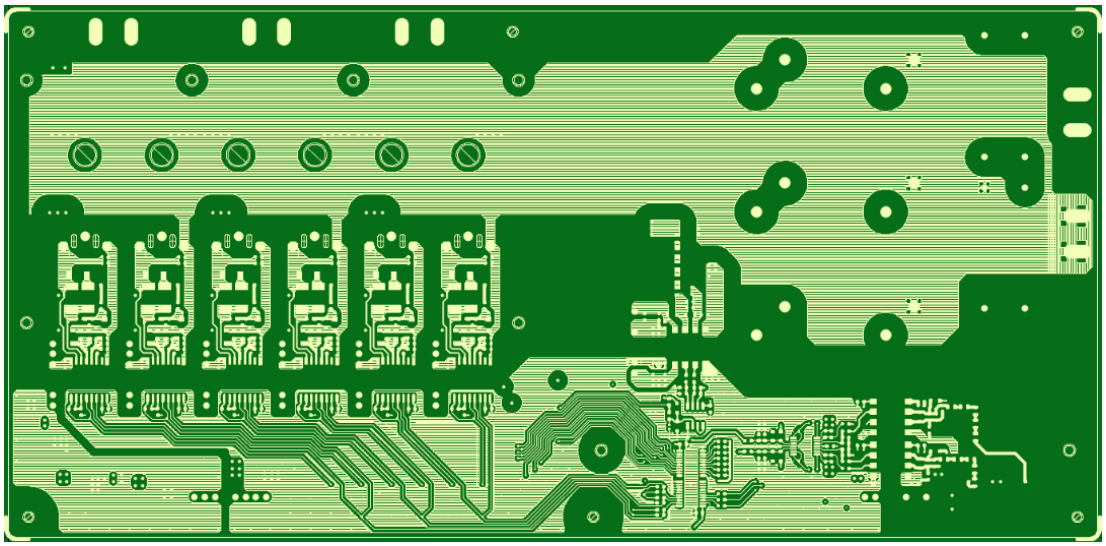

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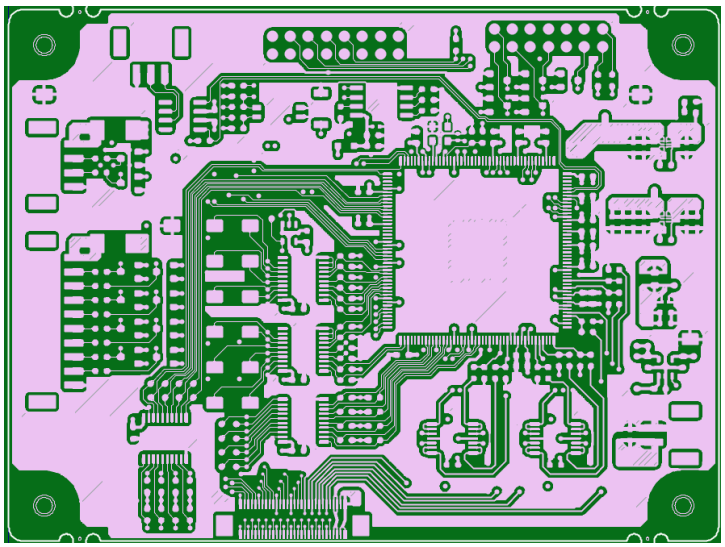
Fig. 3.1 Main Circuit Board Pattern Diagram



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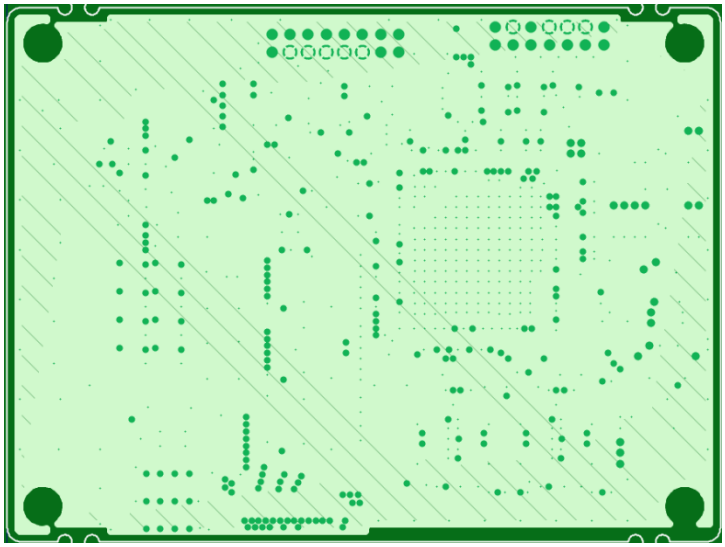

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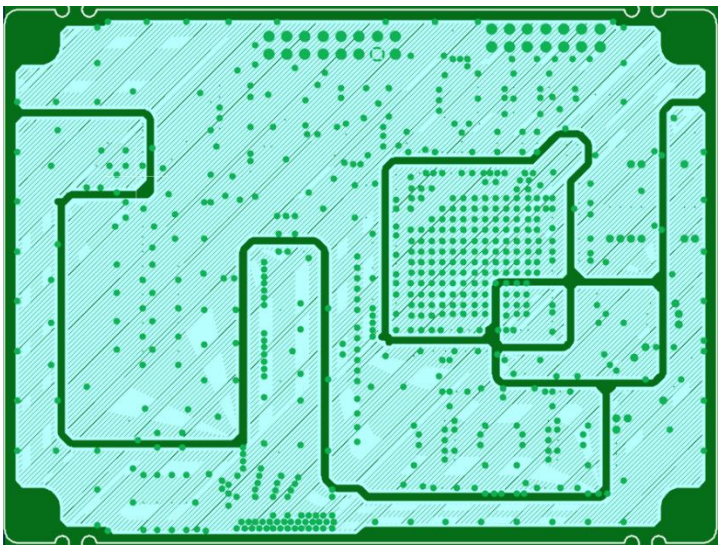

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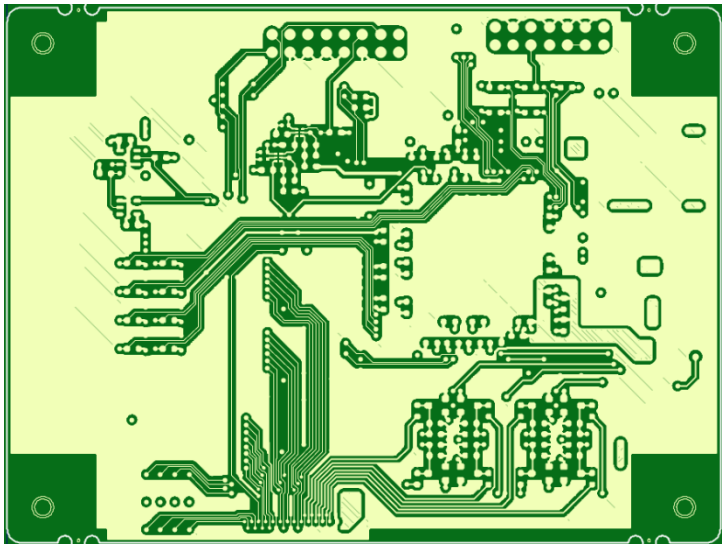

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Fig. 3.2 Control Board Pattern Diagram

4. Operating Procedure

4.1. Wiring Connection

Prepare the wiring connections for each part of the power supply according to the connection diagram shown in Fig. 4.1.

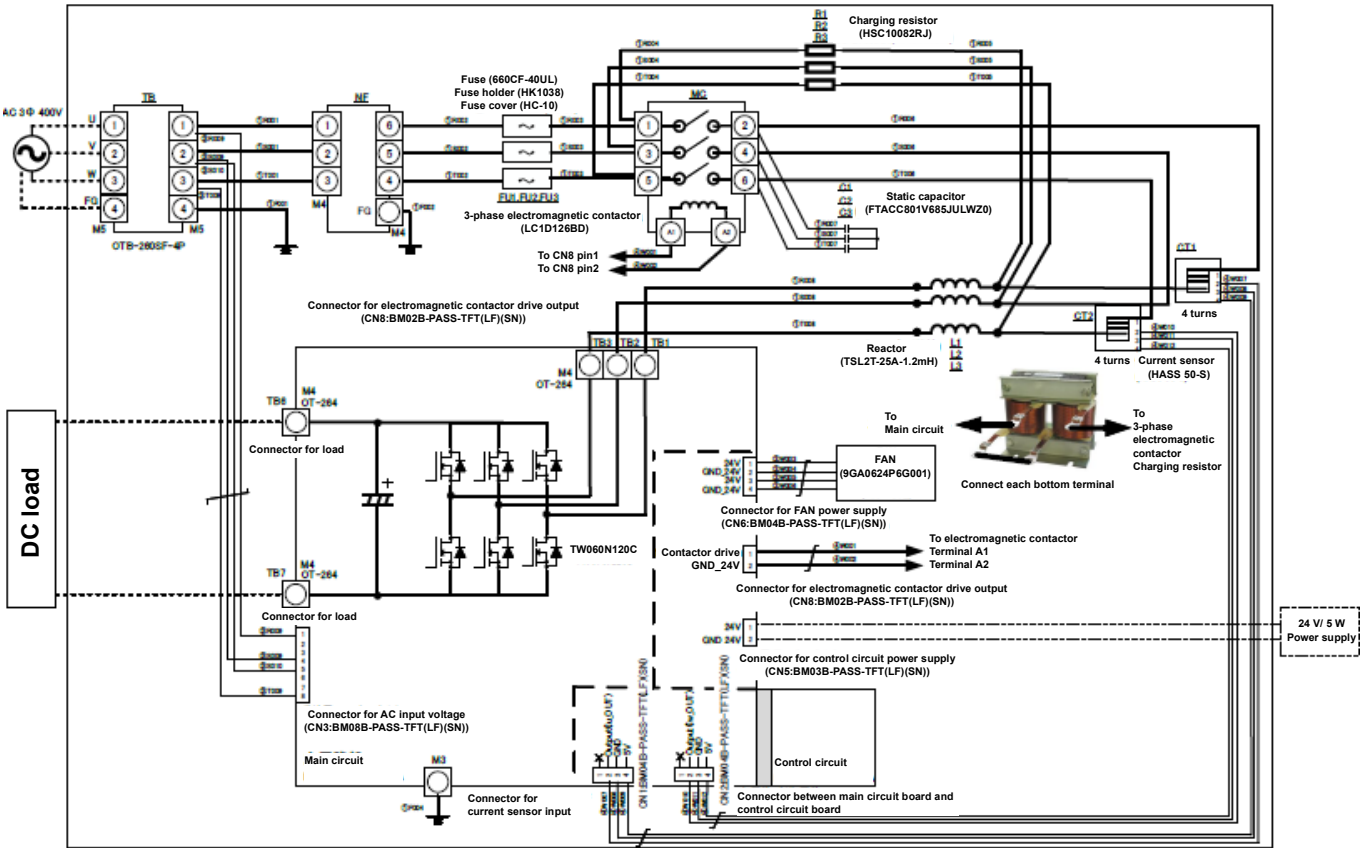

Fig. 4.1 Wiring Connection Diagram

4.2. Connecting to an External Device

Connect a stabilized power supply that outputs 3-phase AC to the input terminal of this design and a load unit to the output terminal. Also, connect the 24V power supply for the control circuit to the control board.

4.3. Start and Stop Procedures

Before starting the power supply, check that the input and output pin voltages are all 0V.

[Power-up Procedure]

1. Turn on the 24V power supply for the control circuit.
2. Turn on the stabilized power supply.

[Power-off Procedure]

1. Shut down the stabilized power supply.
2. Stop the 24V power supply for the control circuit.

4.4. Evaluation Precautions (Electric Shock, Burn Injury, etc.)

Be careful of electric shock when connecting a stabilized power supply. Do not touch each part of the power supply directly while the power is on. Be very careful when observing the waveform. Even after this power supply is stopped, there is a risk of electric shock due to the remained charge of various capacitors. Confirm that the voltage of each part has decreased sufficiently before touching the board.

In addition, the semiconductor or inductor of this power supply generates heat according to the load current. Do not touch each part of the power supply while the power supply is in operation, as there is a risk of burns.

5. Power Characteristics

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

5.1. Efficiency

Showing this power supply efficiency evaluation result with stabilized power supply output of 400V / 440V / 480V.

Fig. 5.1 shows the power supply efficiency measurement results of this design.
The output voltage of the AC stabilized power supply is set to 400V and measured. The efficiency is as high as 97.9% when the load power is 100%.

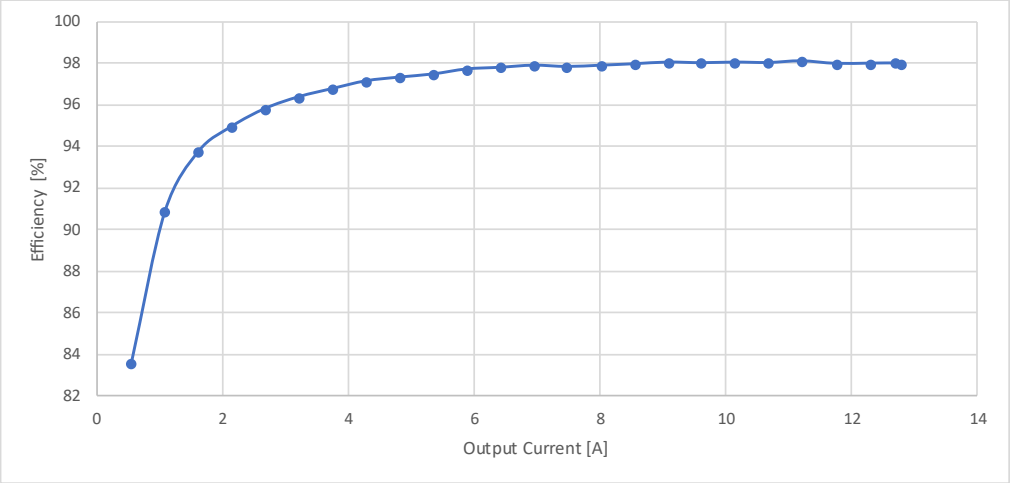

Fig. 5.1 Efficiency Measurement Results (V_{in} = 400V)

Fig. 5.2 shows the output voltage of the AC stabilized power supply is set to 440V and measured. The efficiency is as high as 98.3% when the load power is 100%.

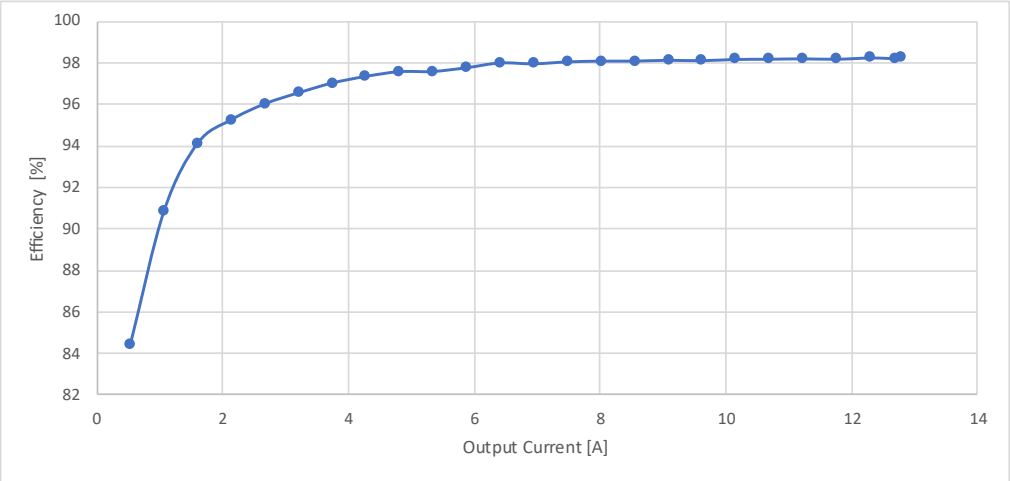

Fig. 5.2 Efficiency Measurement Results (V_{in} = 440V)

Fig. 5.3 shows the output voltage of the AC stabilized power supply is set to 480V and measured. The efficiency is as high as 98.4% when the load power is 100%.

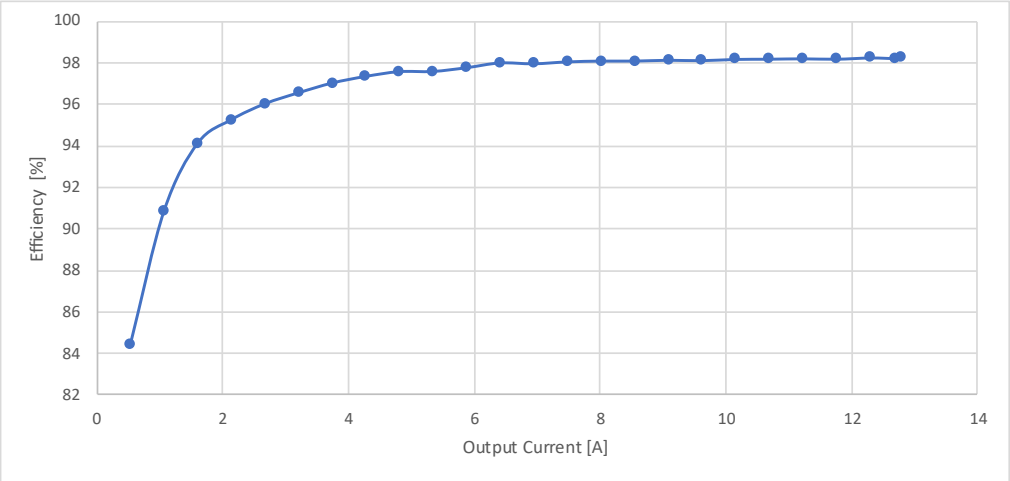

Fig. 5.3 Efficiency Measurement Results (V_{in} = 480V)

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