eFuse Application Circuit (with Thermal Shutdown)

Reference Guide

RD241A-RGUIDE-01

Toshiba Electronic Devices & Storage Corporation

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1. Introduction

This reference guide document describes the specifications and operation procedure of the eFuse Application Circuit (with Thermal Shutdown).

In recent years, various protective functions have become important in various consumer devices such as notebook PCs, game machines, storage devices, servers, etc. This document describes the Protection Circuit (hereafter referred to as "this design"), which is ideal for these applications, it is built using the eFuse IC (electronic fuse) and the over temperature detection IC Thermoflagger™.

eFuse IC (electronic fuse) operates when excessive current flows and has a fast current interruption function compared to the conventional fuse. In addition, it can be used repeatedly because it doesn't get destroyed by a single event of overcurrent. Various other protection functions, such as overvoltage protection, are also built in.

Thermoflagger™ (Over temperature detection IC) detects abnormally high temperature in the electronic devices in conjunction with a PTC thermistor. By arranging several PTC thermistors and connecting them to the Thermoflagger™, a wide range of abnormal temperatures can be detected at a low-cost. Featuring low current consumption operation, this product contributes to power saving.

This Design consists of a module board and a base board.

The module board consists of an eFuse IC (TCKE905ANA) with overcurrent protection and an over temperature detection IC Thermoflagger™ (TCTH021BE). In case of overcurrent detection, the eFuse IC cuts off the current. If the temperature of the PTC thermistor connected to the over temperature detection IC Thermoflagger™ rises due to abnormal heating, the Thermoflagger™ will output an over temperature detection signal and then this signal is sent to the eFuse IC which cuts off the current. In addition to eFuse IC functions, this design can be used to create a compact circuit that cuts off the output current when over temperature is detected at several points on the BOARD.

The base board is used for evaluating the module board. It is equipped with the N-ch power MOSFETs TPHR8504PL1, the MOSFET gate driver ICs TCK402G, the transistors with bias resistors for signal-control, the one-gate logic ICs TC7PZ17FU, and the CMOS logic ICs 74HC123D.

The base board is also used in the reference design of the Power Multiplexer Circuit.

2. Specifications and Appearance

2.1. Specifications

Table 2.1 and Table 2.2 show the specifications of the module board and the base board.

Table 2.1 Module Board Specifications

Board Name	Input Voltage	Rated Output Current
eFuse Application Circuit (with Thermal Shutdown)	Min. 2.7V Typ. 5V Max. 6V	1.1A (Typ.), up to 4A with appropriate resistor setting

Table 2.2 Base Board Specifications

Input/Output	Description
Input	VINA input (VINA 2.7V to 6V) VINB input (not used) Drive power supply (VDD 5V to 12V)
Output	Output load A to D (LOAD-A to LOAD-D, each Load can have both resistive load and capacitive load, Max current is 4A for the module board of this design) FLAG output (H-level (approximately 5V) is output when VINA is input)

2.2. Block Diagrams

2.2.1. Module Board Block Diagram

Fig. 2.1 shows the block diagram of the module board (eFuse Application Circuit (with Thermal Shutdown)).

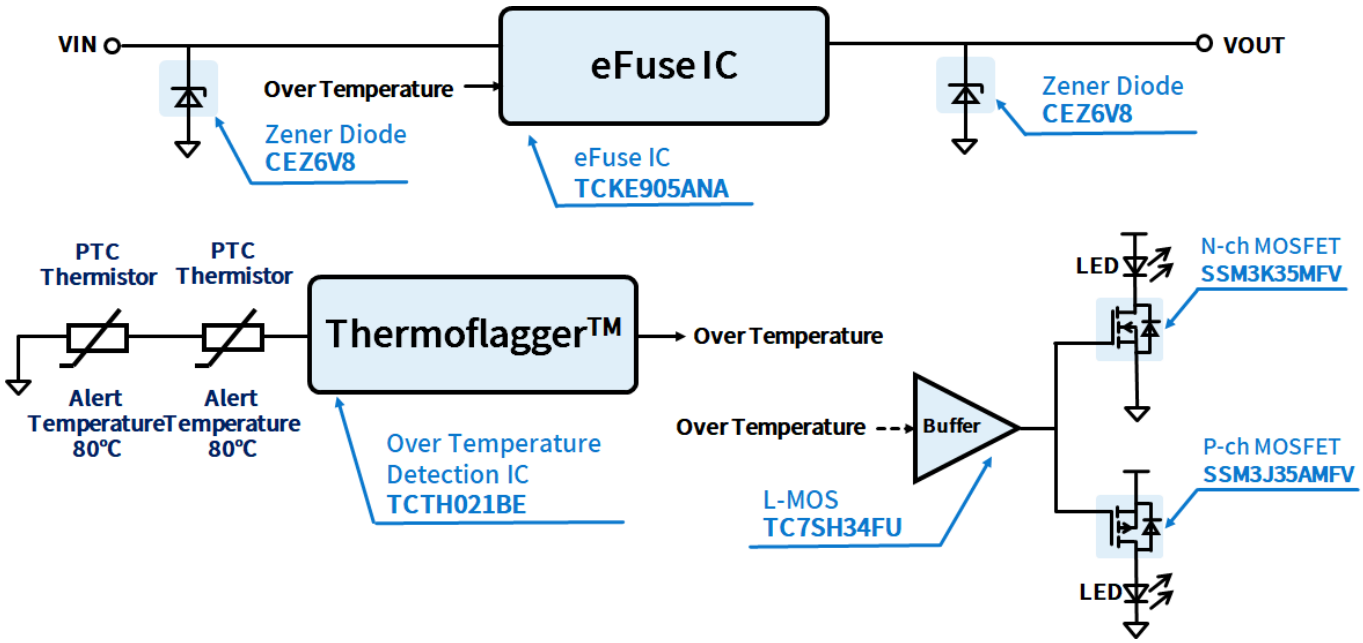


Fig. 2.1 Module Board Block Diagram

2.2.2. Base Board Block Diagram

Fig. 2.2 shows the block diagram of the base board.

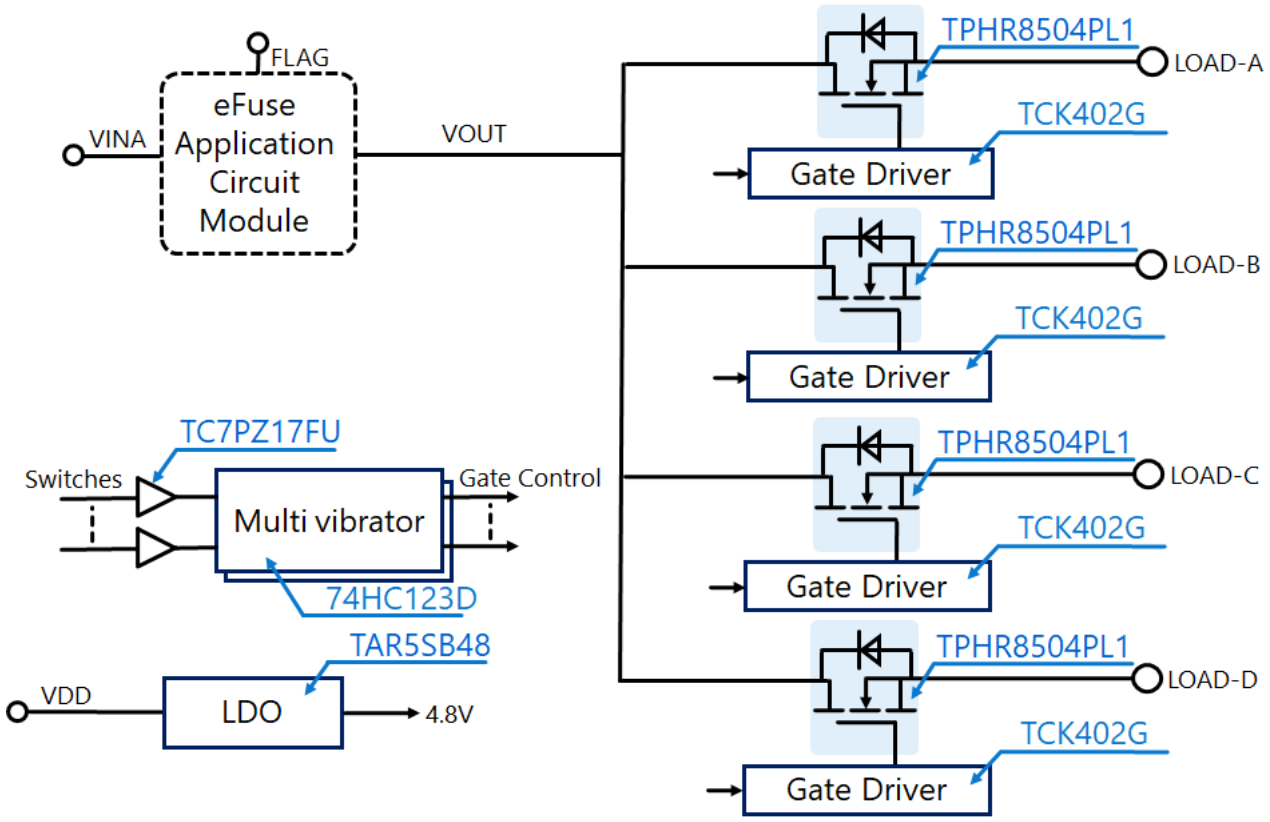


Fig. 2.2 Base Board Block Diagram

2.3. Appearance and Component Layout

The appearance and the component layout of the module board and the base board are shown below.

2.3.1. Module Board

Fig. 2.3 shows the appearance and Fig. 2.4 and 2.5 show the component layout of the module board.

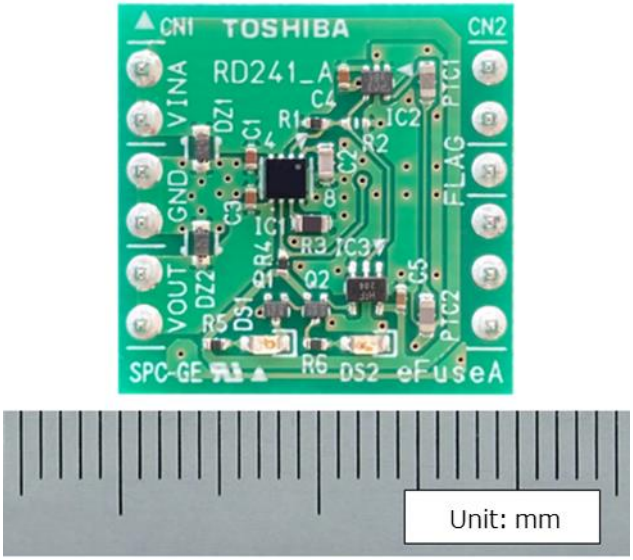


Fig. 2.3 Module Board (Top View)

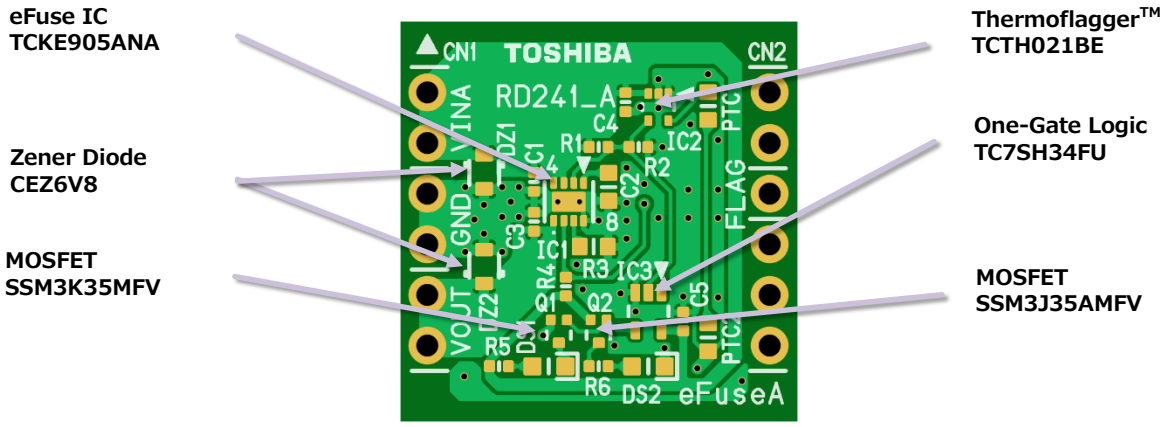


Fig. 2.4 Module Board Component Layout (Top View)

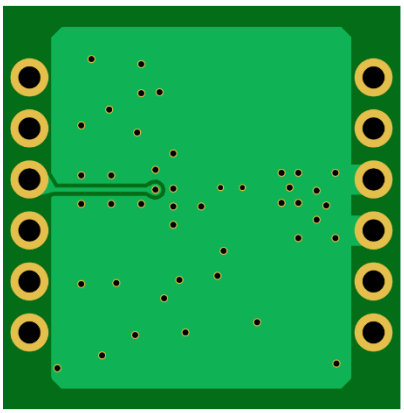


Fig. 2.5 Module Board Component Layout (Bottom View)

2.3.2. Base Board

Fig. 2.6 shows the appearance and Fig. 2.7 shows the component layout of the base board.

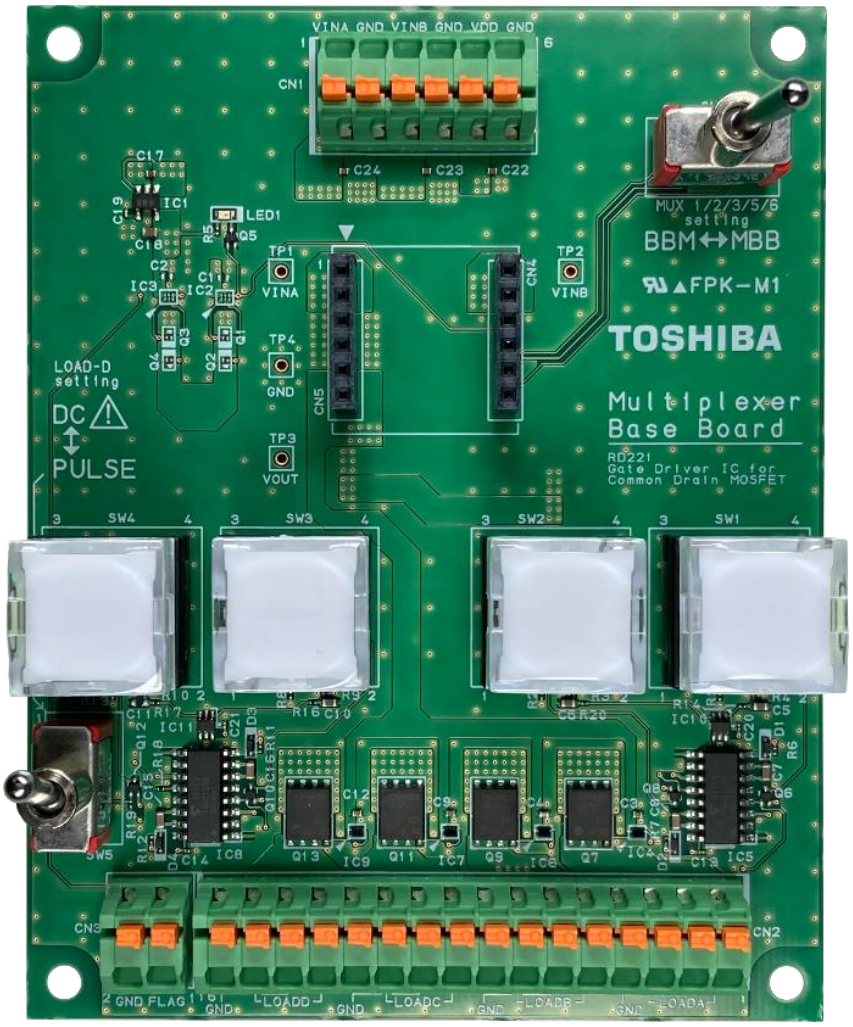


Fig. 2.6 Base Board (Top View)

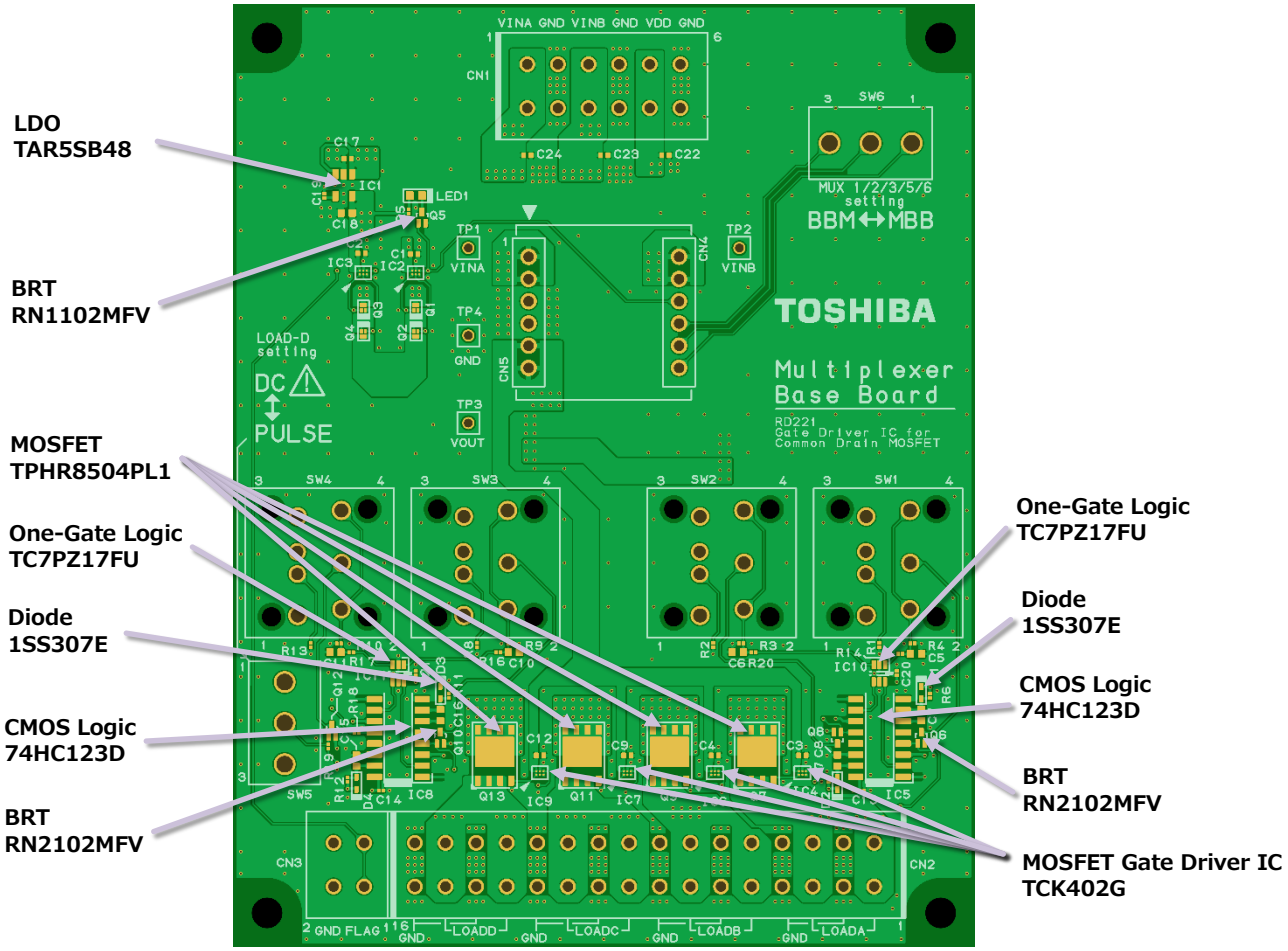


Fig. 2.7 Base Board Component Layout (Top View)

3. Schematic, Bill of Materials, and PCB Pattern

3.1. Schematic

Refer to the following files:

Module board RD241-SCHEMATIC1-xx.pdf

Base board RD221-SCHEMATIC7-xx.pdf

(xx is the revision number.)

3.2. Bill of Materials

Refer to the following files:

Module board RD241A-BOM1-xx.pdf

Base board RD221-BOM7-xx.pdf

(xx is the revision number.)

3.3. PCB Pattern

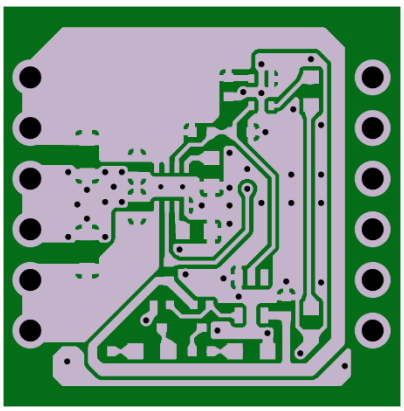
Fig. 3.1 shows the PCB pattern diagram of the module board, and Fig. 3.2 shows the pattern diagram of the base board.

For more details, refer to the following files:

Module board RD241-LAYER1-xx.pdf

Base board RD221-LAYER7-xx.pdf

(xx is the revision number.)



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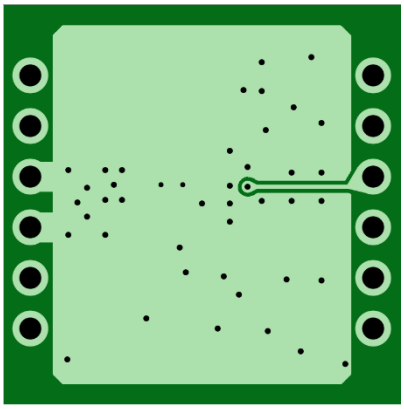
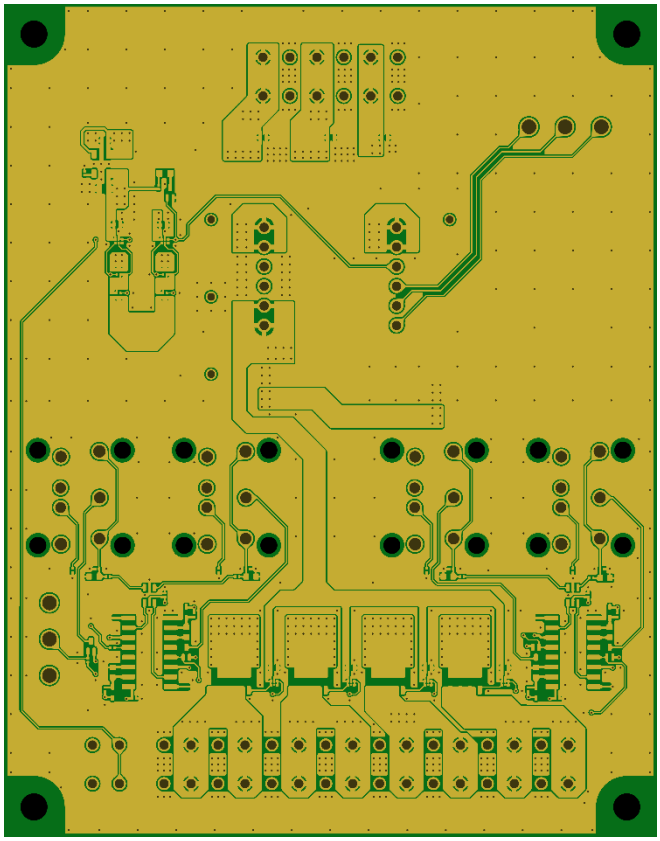


<Layer 2 Bottom>

Fig. 3.1 Module Board PCB Pattern Diagram (Top View)



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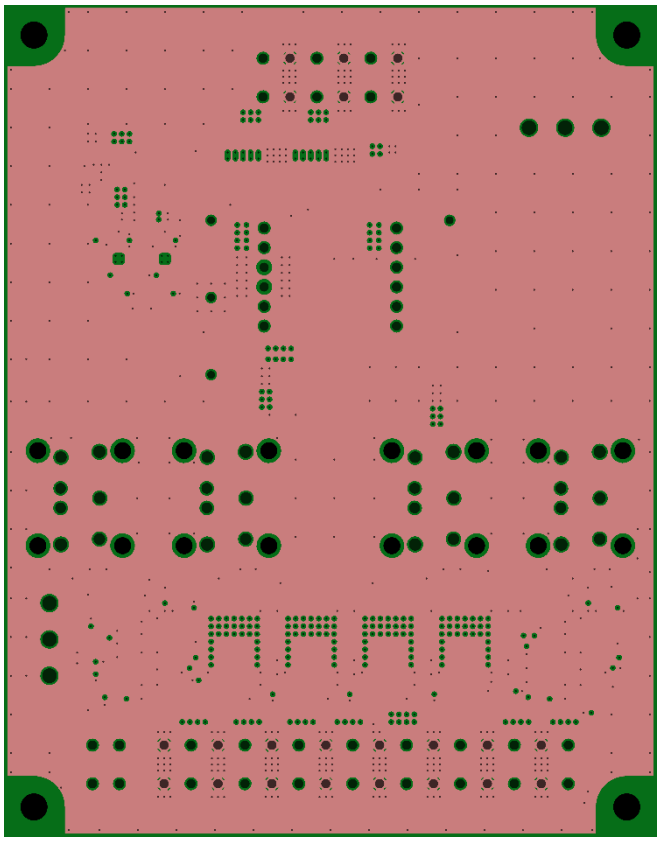
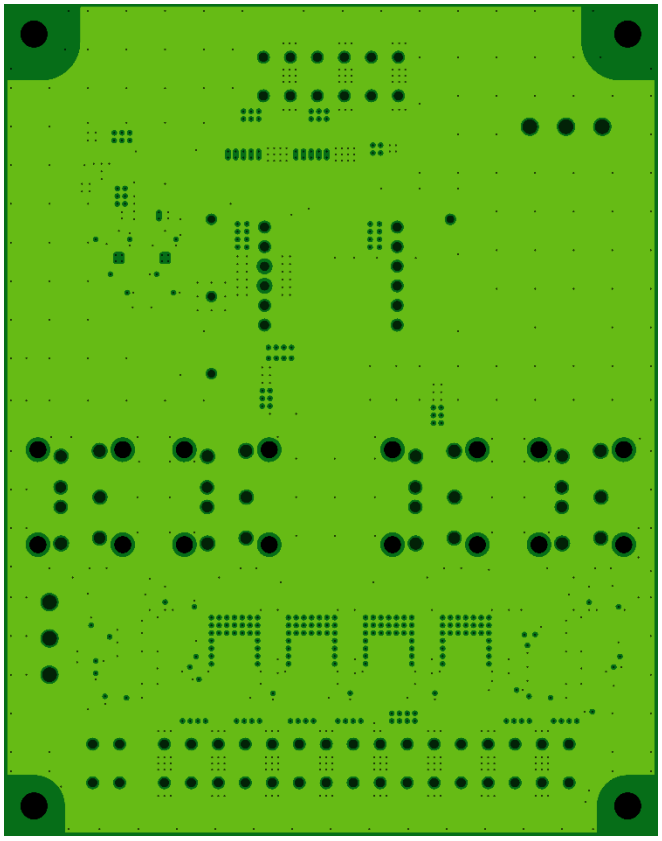


<LAYER2>

Fig. 3.2 (a) Base Board PCB Pattern Diagram (Top View)



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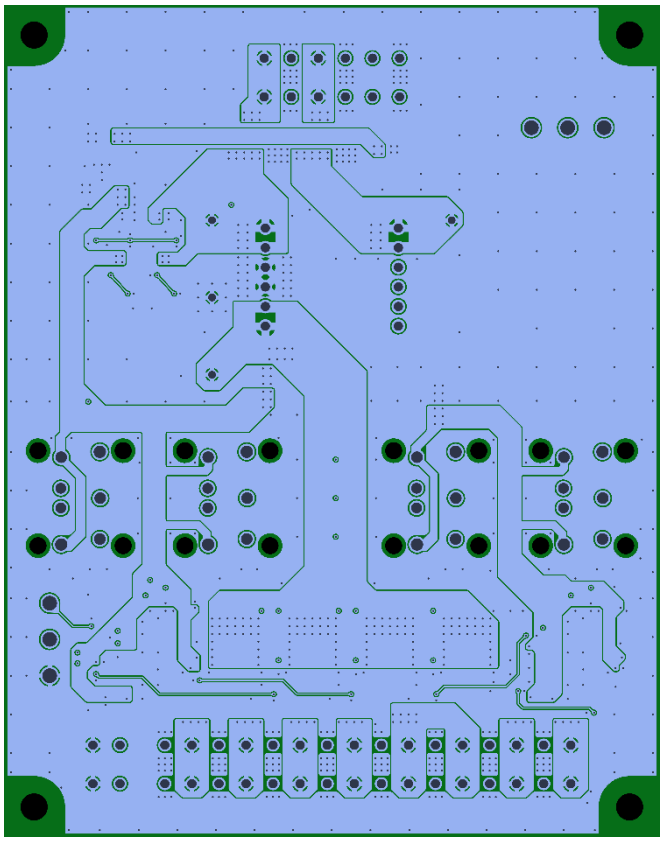

<LAYER4 Bottom>

Fig. 3.2 (b) Base Board PCB Pattern Diagram (Top View)

4. Operation

4.1. Operation Procedure

The standard procedure to start up this design is as follows:

1. Connect the module board to the module board connector (CN4, CN5) on the base board as shown in Fig. 4.2.
2. At CN1 terminal block of the baseboard, first apply VDD power supply (5V), and then apply VINA power supply (5V).
3. To stop the operation, first turn off VINA power supply, and then turn off VDD power supply. *Be careful not to get burned from the overheated load resistance.

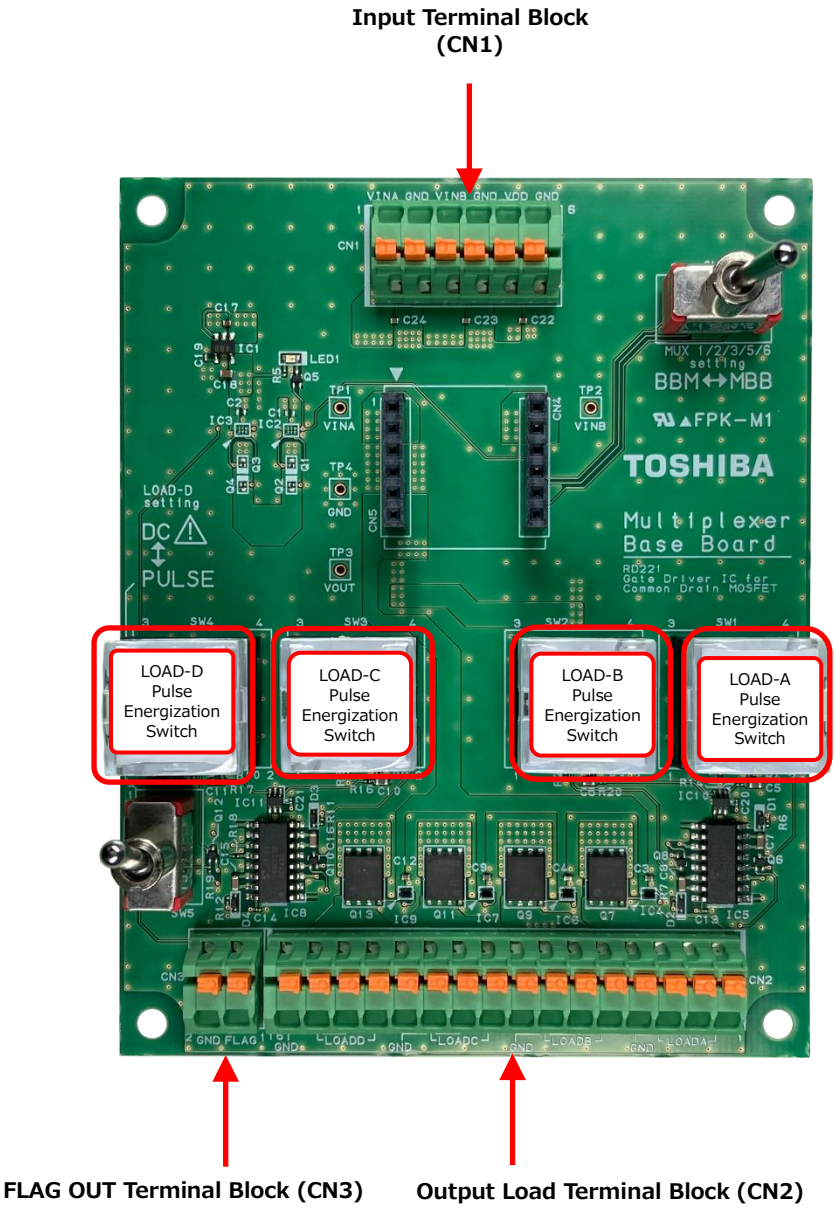

Fig. 4.1 Connectors and Switches on the Base Board

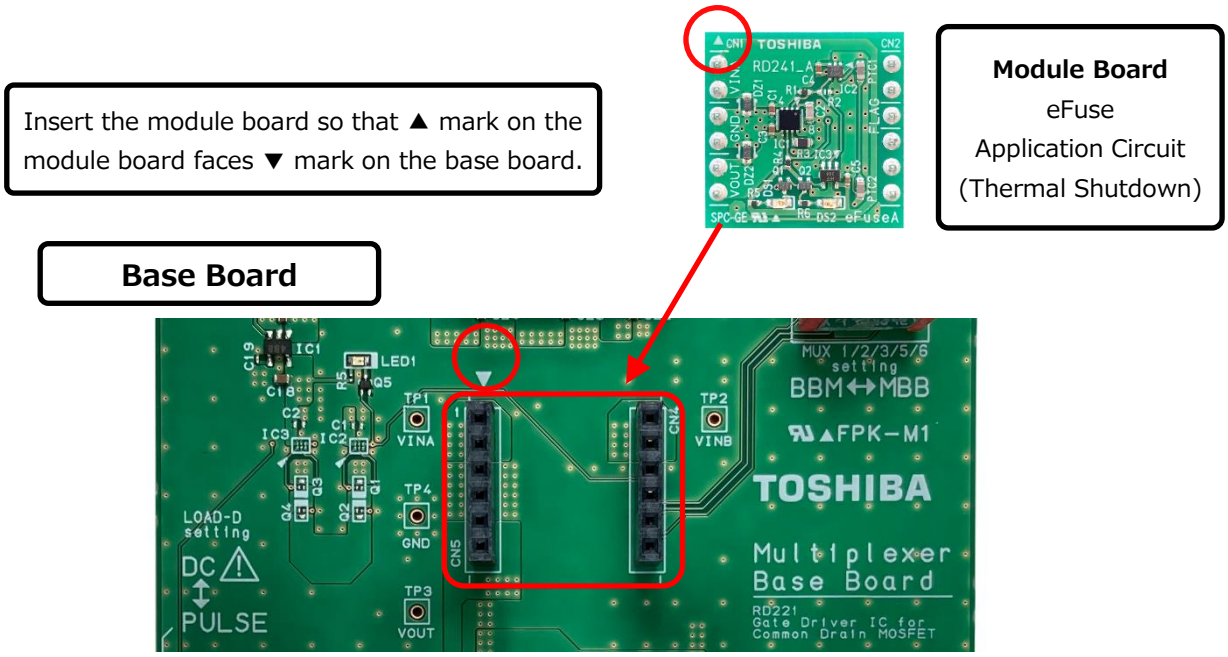

Fig. 4.2 Connection Between Base Board and Module Board

4.2. Base Board External Connector Specifications

The external connector specifications of the base board are as follows.

Table 4.1 Input Terminal Block (CN1) Specifications

Terminal No.	Input Terminal Name	Description	Voltage Range	Current Rating
1	VINA	eFuse Application Circuit (with Thermal Shutdown) VINA input terminal	Max. 6V	Max. 4A*
2	GND	(GND of the above terminal)		
3	VINB	(not used)	-	-
4	GND	(not used)		
5	VDD	Power supply terminal for driving the base board	5V to 12V	-
6	GND	(GND of the above terminal)		

* Individual component specifications allow a current flow greater than this value. However, the current on this board should not exceed this value because of the heat dissipation limitation.

Table 4.2 Output Load Terminal Block (CN2) Specifications

Terminal No.	Output Load Name	Description
1	LOAD-A	For resistive load connection
2		(GND of the above terminal)
3		For capacitive load connection
4		(GND of the above terminal)
5	LOAD-B	For resistive load connection
6		(GND of the above terminal)
7		For capacitive load connection
8		(GND of the above terminal)
9	LOAD-C	For resistive load connection
10		(GND of the above terminal)
11		For capacitive load connection
12		(GND of the above terminal)
13	LOAD-D	For resistive load connection
14		(GND of the above terminal)
15		For capacitive load connection
16		(GND of the above terminal)

Table. 4.3 FLAG Out Terminal Block (CN3) Specifications

Terminal No.	Output Terminal Name	Description
1	FLAG	FLAG output H-level (approximately 3.3V) when VINA is input
2	GND	(GND of the above terminal)

4.3. Module Board Operation Summary

4.4. Over Temperature Detection

In this design the temperature above 80°C is considered abnormal temperature. If the temperature of either of the two PTC thermistors (PTC1, PTC2) connected to PTCO terminal of TCTH021BE (IC2) exceeds approximately 80 °C (abnormal temperature), the PTCGOOD terminal changes from High level to Low level. This signal is connected to EN/UVLO terminal of TCKE905ANA (IC1) and the input terminal of TC7SH34FU (IC3), which cuts off the output VOUT of TCKE905ANA (IC1), turns off SSM3K35MFV (Q1) and turns on SSM3J35AMFV (Q2), this turns off the blue LED (DS1) and turns on the red LED (DS2).

4.5. Output Overcurrent Detection

TCKE905ANA (IC1) has an overcurrent protection function. If a current of approximately 1.1A or more flows from the terminal VOUT, the overcurrent protection function activates to cut off VOUT and FLAG terminal changes from High level to Low level.

5. Precautions

・Be careful of the electric shock as the applied voltage is high.
・Be careful not to get burned from the heat generated at the load.

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