Circuit proposal using Thermoflagger^{TM} (Over temperature detection IC) TCTH0 series and PTC thermistors

Description

Toshiba Thermoflagger™ Over-Temperature Detection ICs offer a new approach to detecting and protecting against abnormal heat generation. Thermoflagger™ is designed to be connected in series with PTC Thermistors placed near heat sources.

This document describes an applied circuit proposal using Thermoflagger^{TM} and PTC thermistors (POSISTOR) of Murata Manufacturing Co., Ltd. (hereinafter referred to as Murata Manufacturing) .

Note1: Thermoflagger^{TM} is a trademark of Toshiba Electronic Devices & Storage Corporation.
Note2: POSISTOR is a trademark of Murata Manufacturing Co., Ltd..

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1. Introduction

This document describes a circuit using Thermoflagger™ TCTH0 series and PTC thermistors. For more information on Thermoflagger™, please refer to our product page. For PTC Thermistor, please refer to Murata Manufacturing product page.

2. What is Thermoflagger™?

A Thermoflagger™ is an IC that can detect a rise in the temperature of electronic equipment when combined with a PTC thermistor. This solution is simple and easy to create. The resistance of PTC thermistors is almost constant near room temperature. However, the resistance rises rapidly when the temperature rises above the detected temperature, and it is used to protect against overheating. Thermoflagger™ detects changes in the resistance value of a PTC thermistor and outputs FLAG signal when a PTC thermistor is overheated. It is possible to detect the temperature at any location in the electronic circuit by several PTC thermistors in series. If you want to change the trigger temperature to detect in each location, you can easily achieve by changing the PTC thermistor.
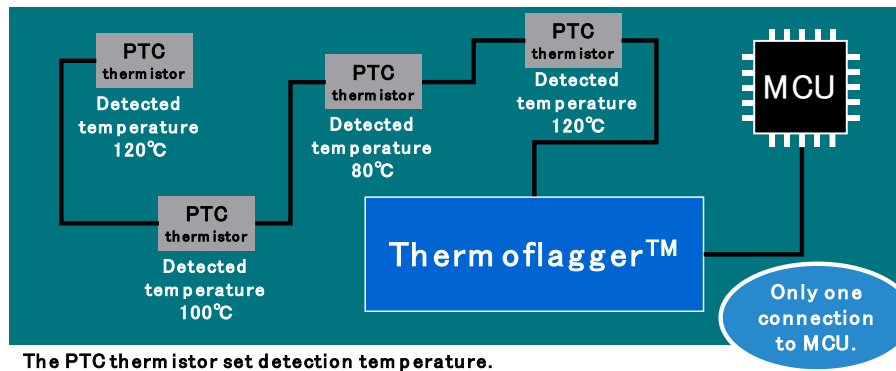

Figure 2-1   Over temperature protection solution using Thermoflagger™ with PTC thermistor

3. TCTH0 series Overview

The following figure shows a block diagram of Thermoflagger™ TCTH0 series. This IC has functions of constant-current, reference-voltage, and comparator. Connect the PTC thermistor(s) to PTCO terminal. This IC outputs a constant-current I_{PTCO} from PTCO terminal and converts to voltage with connected PTC thermistor resistor.

The PTC thermistor heats up, PTCO voltage (V_{PTCO}) rises. When V_{PTCO} exceeds the detection voltage (V_{DET}), "Low" is output from PTCGOOD by the internal comparator.

For more information about the product, refer to our product page or the "Thermoflagger™ (Over temperature detection IC) TCTH0 series Application Notes".
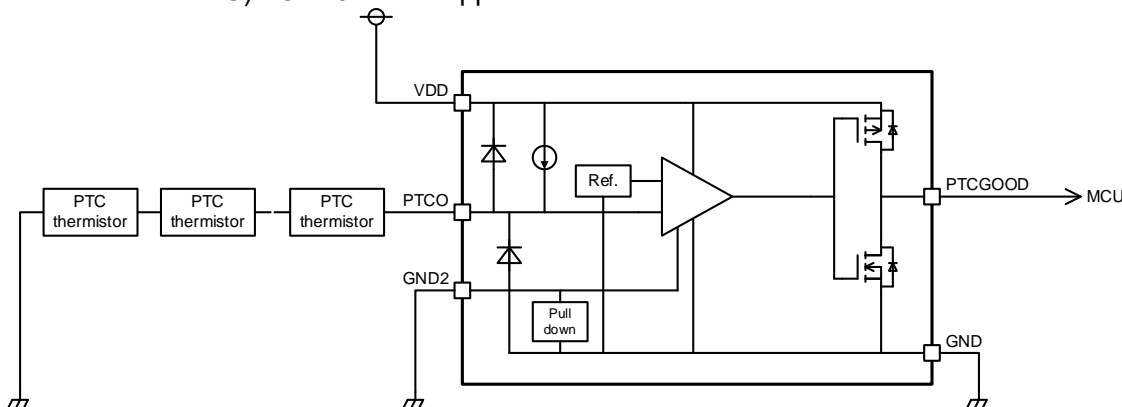

Figure 3-1   Block diagram of TCTH0 series and Application circuit

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4. Murata Manufacturing PTC thermistor (POSISTOR)

This document describes the applications of Thermoflagger^{TM} and Murata Manufacturing PTC Thermistor (POSISTOR).

Murata Manufacturing has PRF series as the PTC thermistor for overheat sensing. A wide variety of PTC thermistors are available in accordance with their size/detection temperature.

Figure 4-1   PTC Thermistor for Overheat Detection (POSISTOR) at Murata Manufacturing Co., Ltd.

Click

The following table shows the selection table for Thermoflagger^{TM} and Murata Manufacturing PTC thermistors (POSISTOR). The detection temperature can be set by selecting the product number of the PTC thermistors (POSISTOR). The detection temperature depends on the using conditions, so please verify thoroughly before use.

Table 4-1   Selection table for Thermoflagger^{TM} and Murata Manufacturing PTC thermistors (POSISTOR)

Thermoflagger^{TM} Product name	Murata Manufacturing POSISTOR product name	Overheat detection temperature (Reference)
TCTH021AE TCTH022AE TCTH021BE TCTH022BE	PRF18AR471QB5RB	150 ºC
	PRF18BA471QB5RB	140 ºC
	PRF18BB471QB5RB	130 ºC
	PRF18BC471QB5RB	120 ºC
	PRF18BD471QB5RB	110 ºC
	PRF18BE471QB5RB	100 ºC
	PRF18BF471QB5RB	90 ºC
	PRF18BG471QB5RB	80 ºC
	PRF15BA102RB6RC	136 ºC
	PRF15BB102RB6RC	126 ºC
	PRF15BC102RB6RC	116 ºC
	PRF15BD102RB6RC	106 ºC
	PRF03BB541NB7RL	135 ºC
TCTH011AE TCTH012AE TCTH011BE TCTH012BE	PRF15BB103RB6RC	122 ºC

This document shows the simulation on over temperature detection using TCTH02xxE and Murata Manufacturing PTC thermistor: PRF18BC471QB5RB.

5. Simulation of TCTH02xxE and PRF18BC471QB5RB

5.1. Products used for simulation

The detection temperature varies depending on V_{DET}, I_{PTCO} variation of Thermoflagger™ and the resistance variation of PTC thermistor. The following shows the variations in detection when Thermoflagger™ and Murata Manufacturing PTC thermistor (POSISTOR) are combined.

5.1.1. PTC thermistor (POSISTOR): PRF18BC471QB5RB

The following figure shows PRF18BC471QB5RB characteristics.
Refer to Murata Manufacturing product page for detailed characteristics.
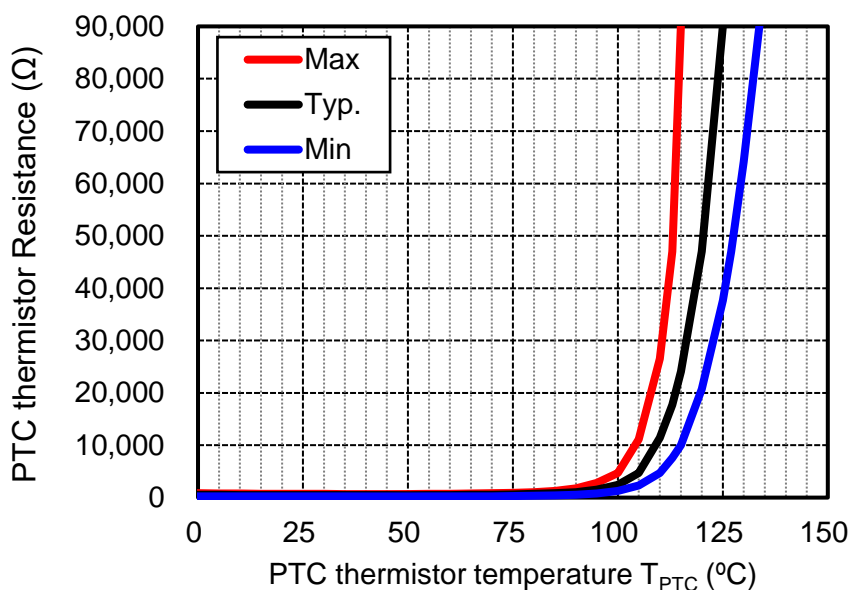
Figure 5-1   PRF18BC471QB5RB main characteristics

5.1.2. Thermoflagger™: TCTH02xxE

The following table shows TCTH02xxE characteristics.
Please refer to our product page for detailed characteristics.

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Table 5-1   TCTH02xxE main characteristics

Characteristics	symbol	Test condition	T_j = 25 °C			T_j = -40 to 125 °C		Unit
			Min	Typ.	Max	Min	Max	
PTCO output current	I_{PTCO}	TCTH02xxE, V_{DD} = 1.7 V to 5.5 V	8.0	10.0	12.2	7.2	13.2	µA
Detect Voltage	V_{DET}	V_{DD} = 3.3 V	0.42	0.50	0.58	0.36	0.64	V

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5.2. Combining TCTH02xxE and 1 pc PRF18BC471QB5RB

The following figure shows a circuit diagram in which single PRF18BC471QB5RB is connected to PTCO terminal of TCTH02xxE, and V_{PTCO} voltage vs PTC thermistor temperature.

The combined overheat detection temperature is 121 ºC ± 10 ºC.
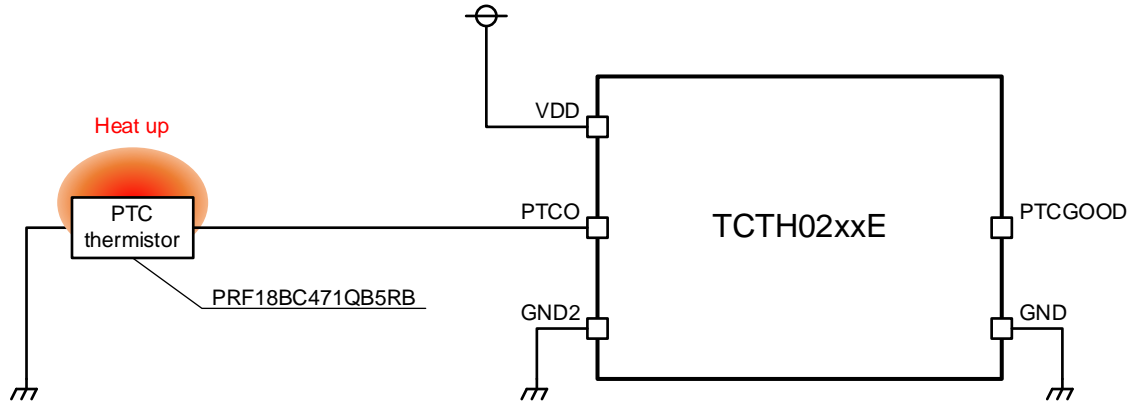
Figure 5-2   Application circuit diagram
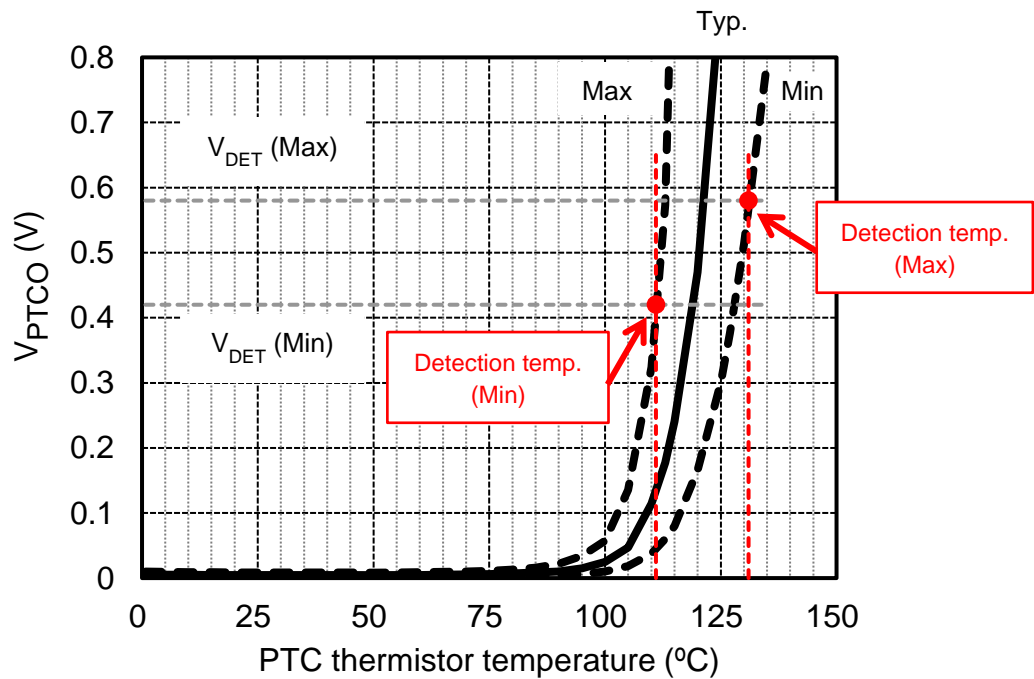
Figure 5-3   Simulation result

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5.3. Combining TCTH02xxE and 10 pc PRF18BC471QB5RB

5.3.1. Ex. 1) Ambient temperature Ta = 25 °C

The following figure shows a circuit diagram in which ten PRF18BC471QB5RB are connected to PTCO terminals of TCTH02xxE. In this circuit, when one of the ten PTC thermistors is overheated at IC and PTC thermistor ambient temperature Ta = 25 °C, V_{PTCO} voltage vs PTC thermistor temperature change is shown in Fig. 5-5.

The combined overheat detection temperature is 120 ºC +11 ºC/-10 ºC.
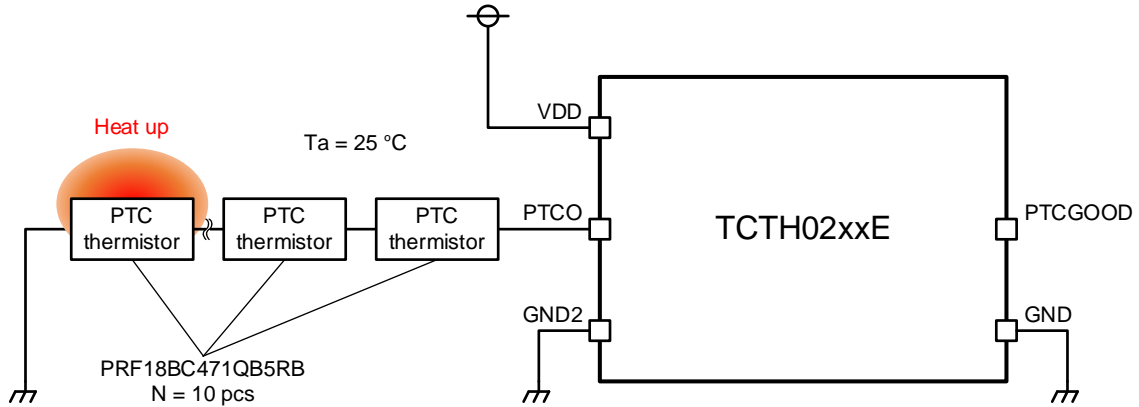
Figure 5-4   Application circuit diagram
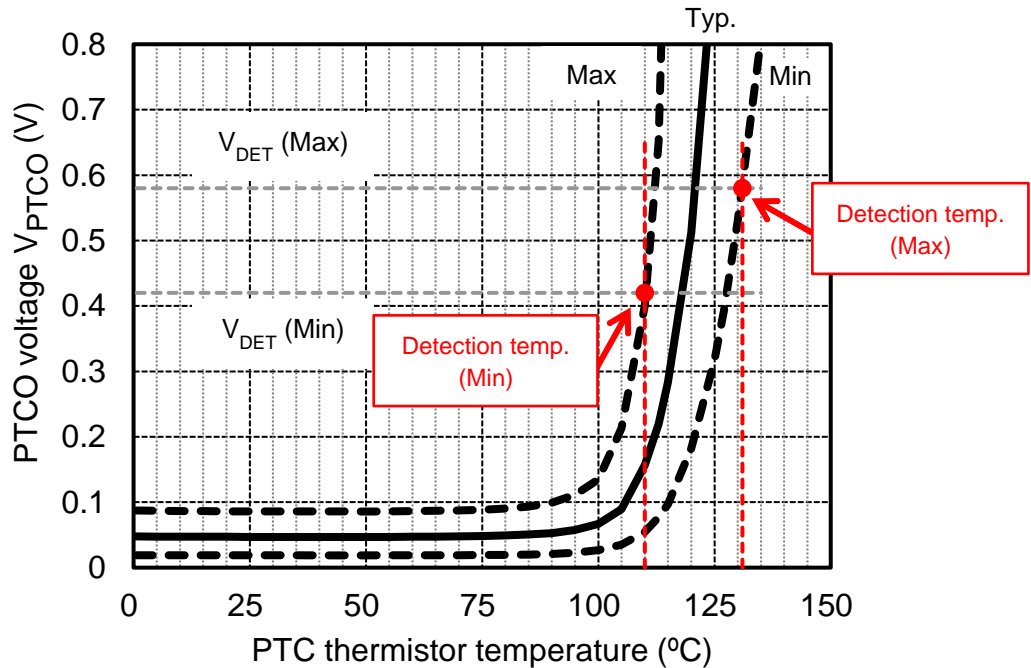
Figure 5-5   Simulation result

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5.3.2. Ex. 2) Ambient temperature Ta = 50 °C

The following figure shows a circuit diagram in which ten PRF18BC471QB5RB are connected to PTCO terminals of TCTH02xxE. In this circuit, when one of the ten PTC thermistors is overheated at the ambient temperature Ta = 85 ºC of IC and PTC thermistor, V_{PTCO} voltage vs PTC thermistor temperature change is shown in Fig. 5-7.

The combined temperature is 119 ºC +14 ºC/-12 ºC.
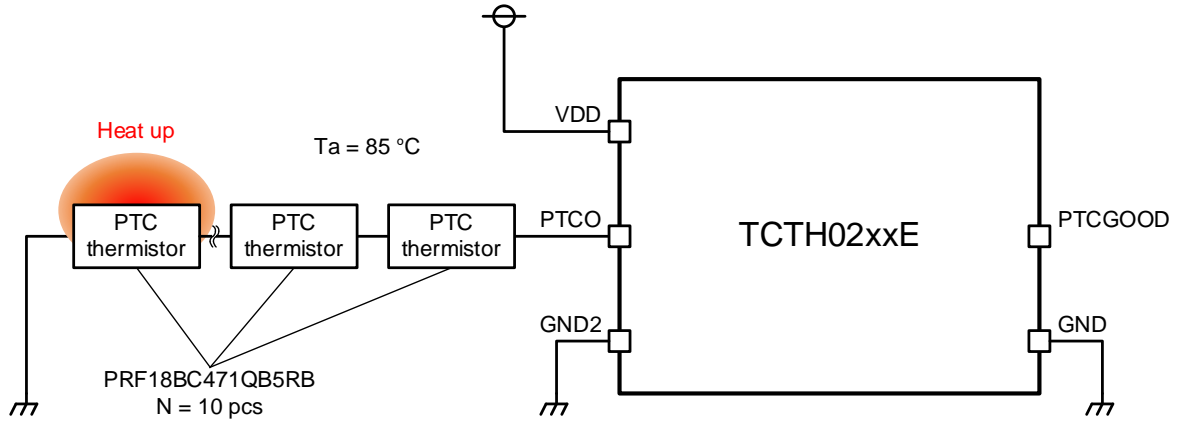
Figure 5-6   Application circuit diagram
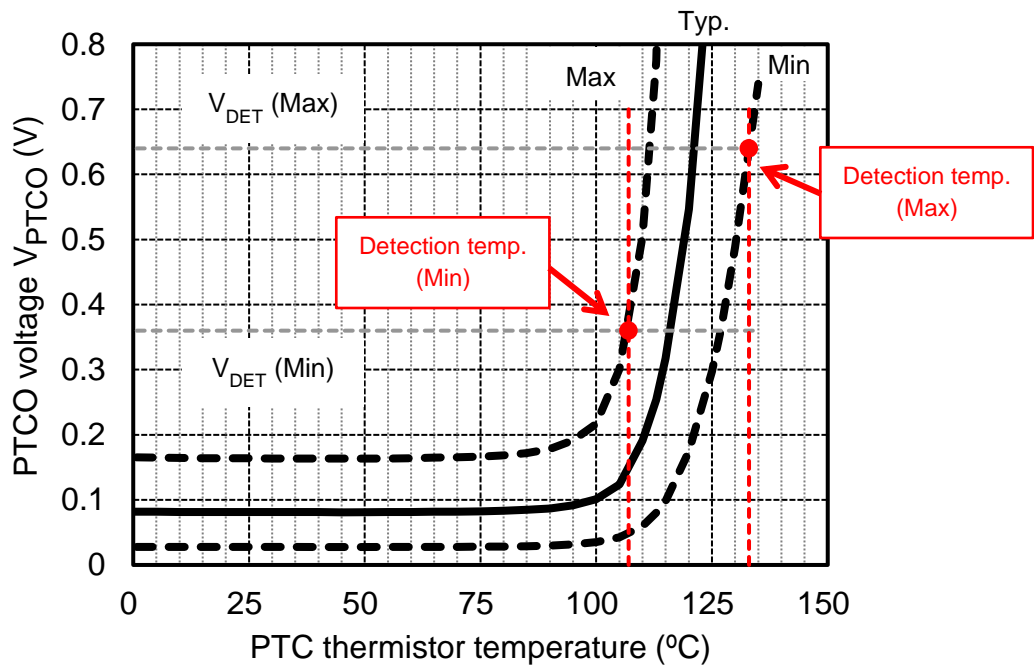
Figure 5-7   Simulation result

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5.4. TCTH02xxE and PRF18BC471QB5RB Combinatorial Simulation-Results List

For TCTH02xxE and PRF18BC471QB5RB applications, the sensed temperatures are listed in Table 5-2. The overheat detection temperature varies depending on how many PTC thermistors are connected and the ambient temperature of IC and PTC thermistor(s).

Table 5-2 Overheat detection temperature-simulation for TCTH02xxE and PRF18BC471QB5RB

		Ambient temperature (Ta)								
		25 ºC			50 ºC			85 ºC		
		Min	Typ.	Max	Min	Typ.	Max	Min	Typ.	Max
Conected PTC thermistor quantity (pcs)	1	111 ºC	120 ºC	131 ºC	110 ºC	120 ºC	134 ºC	110 ºC	120 ºC	134 ºC
	5	111 ºC	120 ºC	131 ºC	110 ºC	120 ºC	133 ºC	109 ºC	120 ºC	134 ºC
	10	110 ºC	120 ºC	131 ºC	109 ºC	120 ºC	133 ºC	107 ºC	119 ºC	133 ºC
	15	110ºC	119 ºC	131 ºC	108 ºC	119 ºC	133 ºC	104 ºC	118 ºC	133 ºC

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6. Thermoflagger^{TM} Applications

The following are application examples.

Thermal protection solutions using Thermoflagger^{TM}, and PTC thermistors are suitable around power supply circuitry in consumer and industrial equipment. Place PTC thermistors near MOSFETs or other heat sources.

(1) Notebook PC, etc.
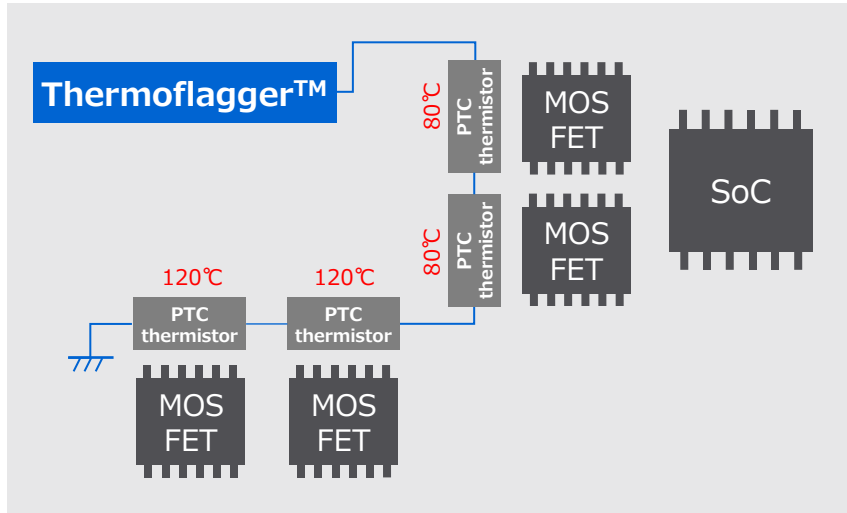
Figure 6-1   Notebook PC Application example

(2) Hand drills, Robotic vacuum cleaners, Printers, etc.
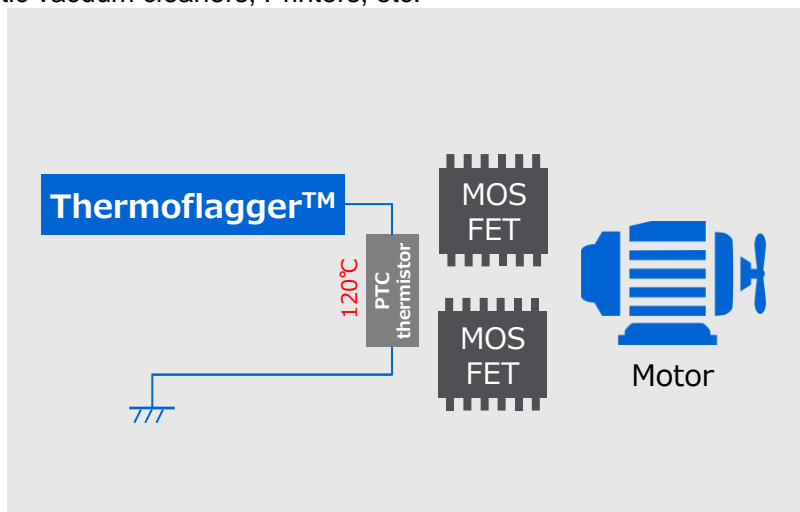
Figure 6-2   Hand drills, Robotic vacuum cleaner, and Printers Application example

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7. Notes on Contents

7.1. PTC thermistor (POSISTOR)

Contact Murata Manufacturing for any inquiries regarding PTC Thermistor (POSISTOR) in this document.

7.2. Simulation details

The contents described in this document are simulation results. It is recommended that this device be fully verified before use.

7.3. Capacitor for power supply terminal

For stable Thermoflagger™ operation, connect a capacitor between VDD and GND as close to the IC.

7.4. GND pin

All GND pins must be connected to the system GND.

7.5. PTCO pin

Do not apply a voltage exceeding 1 V from outside.

7.6. Design Considerations

If the system noise is very high, the internal comparator inside the IC may detect false positives. Before using the product, design it with sufficient consideration.

7.7. Precautions for layout

We recommend designing the board that PTC thermistor and Thermoflagger™ are sufficiently far from each other to prevent heat generation from being transmitted to Thermoflagger™.

7.8. Others

When using this device, please read through and understand the concepts described and follow absolute maximum ratings from the information datasheet or from our 'Semiconductor Reliability Handbook'. Please operate these products below absolute maximum ratings in all instances. Furthermore, Toshiba highly recommends inserting failsafe systems into the design.

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8. Summary

 So far, Thermoflagger^{TM} and Murata's PTC Thermistor (POSISTOR) have been used to explain the applications.

 If the temperature of electronic equipment becomes higher than expected, it may be a major issue in terms of reliability and safety. Thermoflagger^{TM} with a PTC thermistor can be combined to easily build an overheating monitoring solution. We use Murata's technical data to propose an overheat monitoring solution that combines Murata's POSISTOR with Thermoflagger^{TM}.

 We are pleased to refer to this document and use Thermoflagger^{TM} to realize the overheat detection function easily. We intend to expand our lineup to include a wider range of selections to match the specifications of the equipment you are using, so we would like you to hear the loyalty of our Thermoflagger^{TM}.

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➢ Application Notes	**Click**
➢ Murata Manufacturing's PTC Thermistor (POSISTOR)	**Click**

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