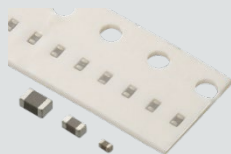


Application note

PTC Thermistor (POSISTOR) PRF series

Overheat detection by Thermoflagger™



PTC Thermistor
(POSISTOR)
PRF series



Toshiba Device & Storage
Thermoflagger™
TCTH0xxxE series

Mar. 2024 Doc.No:PSE-24THM-0080





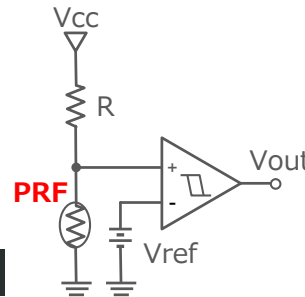
1	Features of temperature detection by PRF series Easier to change the detection temperature and detect multiple locations	p3
2	Temperature detection circuit and output by PRF series Output by constant voltage and constant current circuit of PRF series	p4-7
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1. Features of temperature detection by PRF series

Chip PTC thermistor (POSISTOR) PRF series has a characteristic that the resistance value rises rapidly from a certain temperature due to an increase in ambient temperature. Typical characteristics are shown in the right graph. In PRF series, the point at 10 times of the resistance value at normal temperature (25°C) and the point at 100 times of the resistance value are defined as the detection temperature.

■ Simple detection circuit

The detection circuit can be detected by setting the reference voltage to the output voltage of the detection temperature without a microcomputer as the example circuit on the right figure.

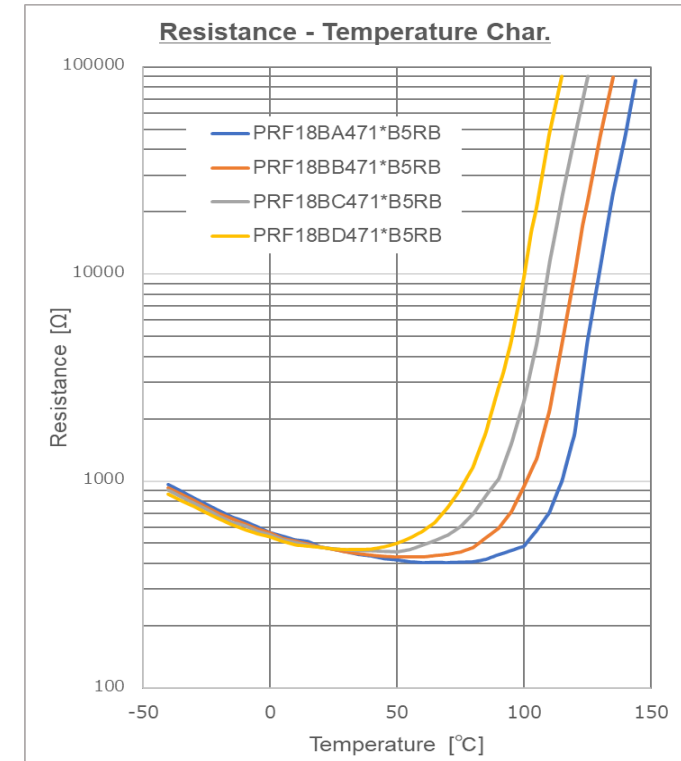


■ Easy to change detection temperature

For changing the detection temperature, the circuit design can be used without change by only replacing the PRF type. Because PRF series has characteristics of the same resistance value at normal temperature with the different detection temperatures.

■ Monitor multiple locations at once

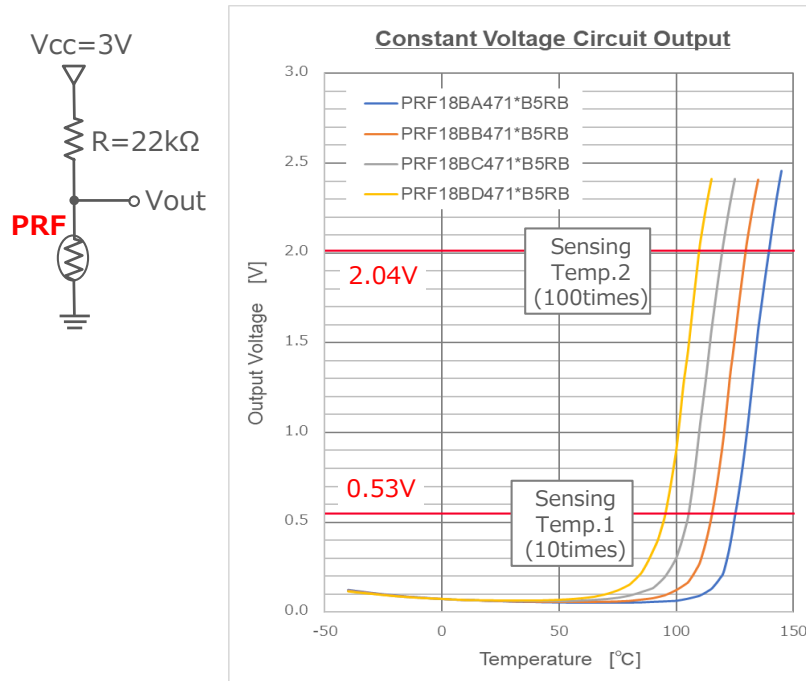
By using this detection circuit and connecting multiple PRF in series, it is possible to monitor temperature at multiple locations. See page 5 for details.



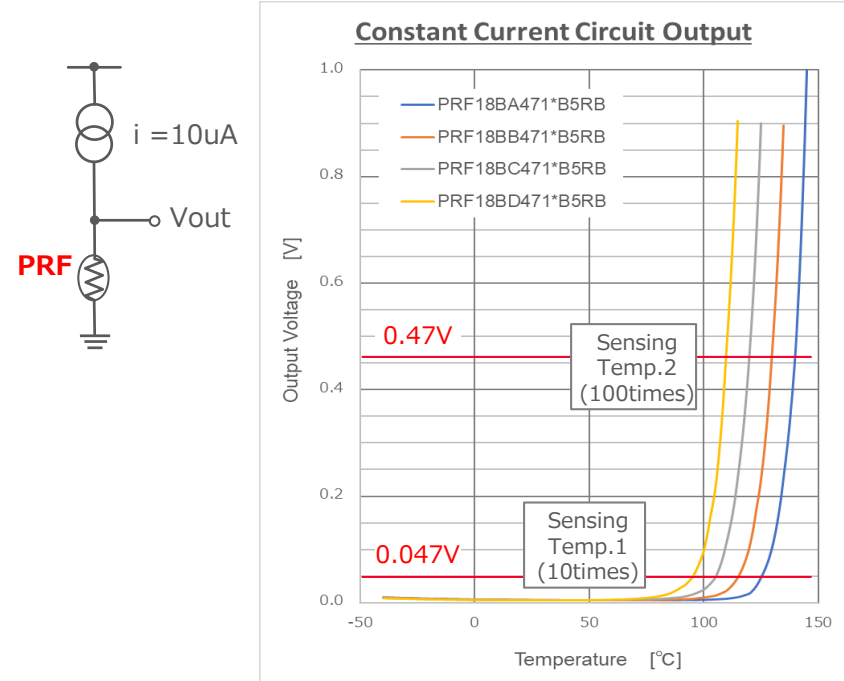
POSISTOR, PRF series [Site link](#)

2. Temperature detection circuit and output by PRF series

■ Constant Voltage circuit



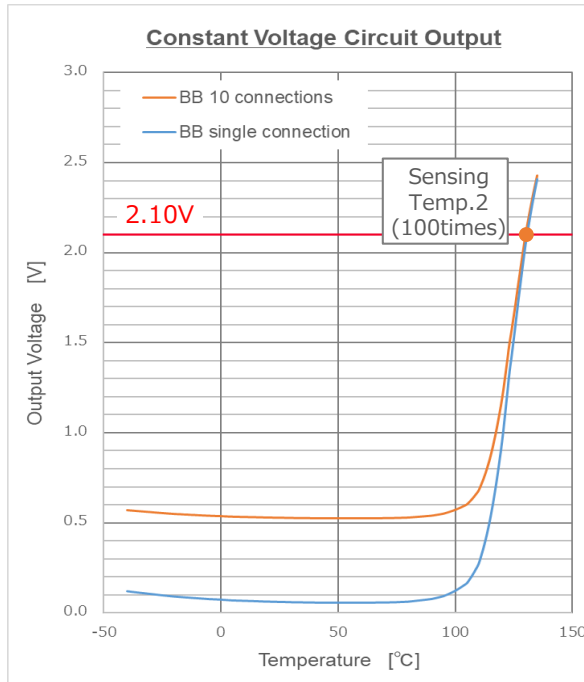
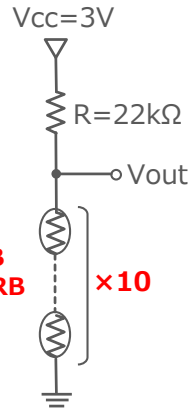
■ Constant Current circuit



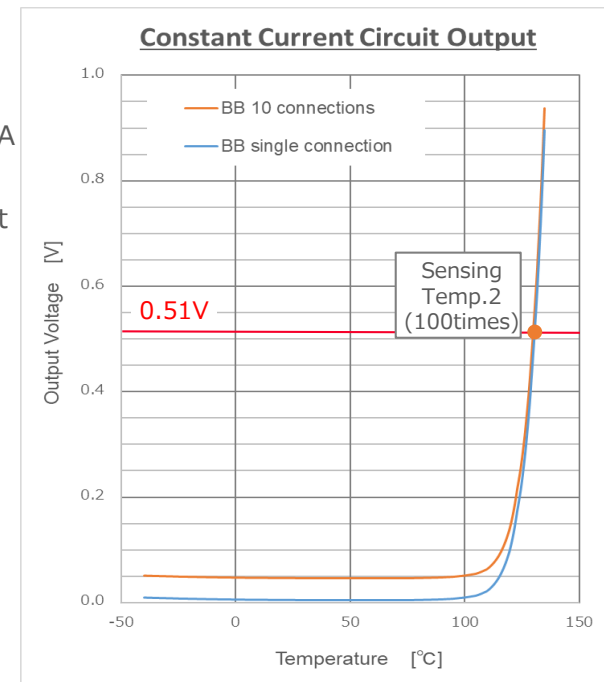
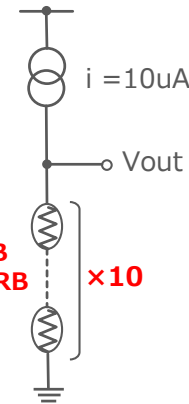
The same output can be obtained with a constant voltage circuit or a constant current circuit.

2. Temperature detection circuit and output by PRF series

■ Constant Voltage circuit (10 connections)



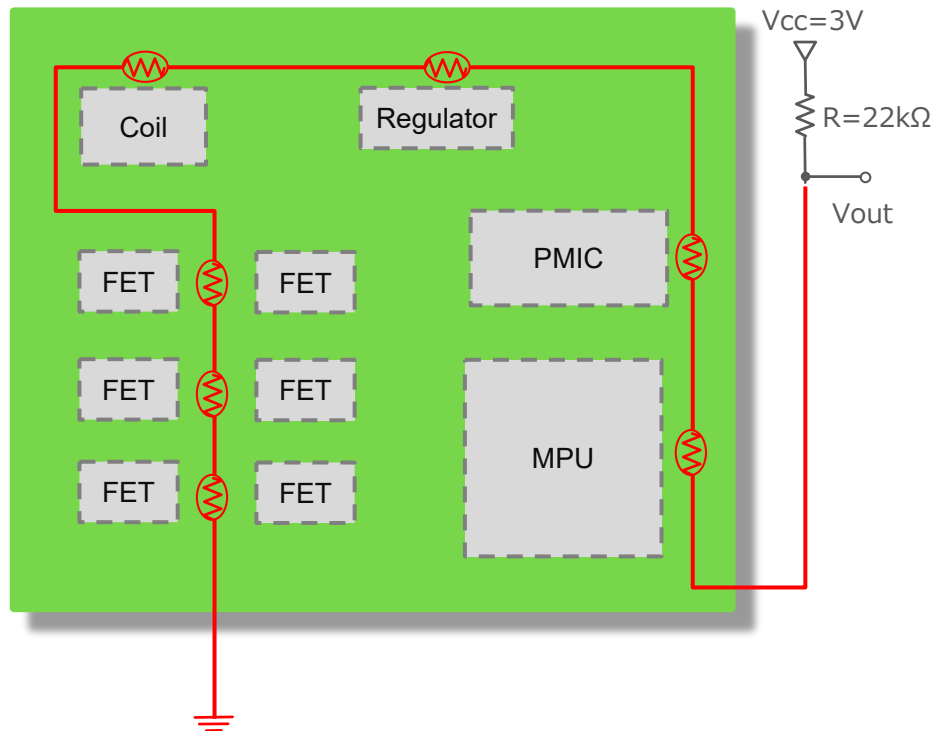
■ Constant Current circuit (10 connections)



When the detection temperature is reached at any one of 10 connected PTCs, the output will change significantly.

2. Temperature detection circuit and output by PRF series

■ How to use PRF temperature detection in multiple places



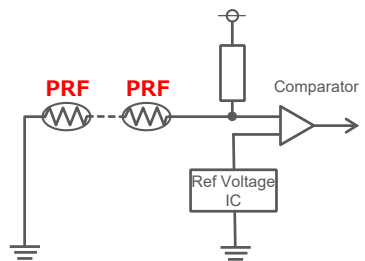
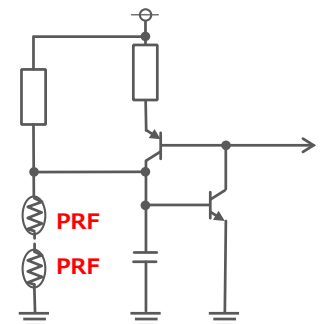
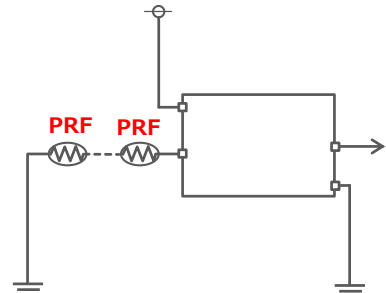
As shown on the left figure, place the PRF near the heat generating part on the board and connect them in series. A single detection circuit can monitor the temperature at multiple points.

Even if the detection temperature is different at each point, (For example, 100°C detection, 90°C detection, 120°C detection, etc.) PRF can also be used.

After patterned the circuit design, the detection temperature can be changed simply by selecting PRF type. In addition, even if a short circuit resistor is replaced in a place where temperature detection is no longer necessary, the circuit output at the detection temperature will hardly change, so it can be used without changing the circuit of the board.

2. Temperature detection circuit and output by PRF series

■ Example of detection circuit

Composition	Discrete Configuration1 Individual IC base	Discrete Configuration2 Transistor base	Toshiba Thermoflagger™ Monolithic IC base
Circuit example			

When designing an overheat detection circuit in the PRF series, it is necessary to set the threshold of the comparator circuit.

Combined with the over temperature detection IC "Thermoflagger™," it is easy to design a detection circuit for multiple connections of PRF (POSISTOR).

3. PRF Series Overview

■ Spec.

For Consumer

- General type
- Full Lineup



Size	Part Number	Sensing Temp. (at 4.7kΩ) [°C]	Sensing Temp. (at 47kΩ) [°C]	Max. Voltage [V]	Resistance (25°C) [Ω]
1608mm (0603inch)	PRF18AS471QB5RB	145±5°C	—	32	470±50%
	PRF18AR471QB5RB	135±5°C	150±7°C		
	PRF18BA471QB5RB	125±5°C	140±7°C		
	PRF18BB471QB5RB	115±5°C	130±7°C		
	PRF18BC471QB5RB	105±5°C	120±7°C		
	PRF18BD471QB5RB	95±5°C	110±7°C		
	PRF18BE471QB5RB	85±5°C	100±7°C		
	PRF18BF471QB5RB	75±5°C	90±7°C		
	PRF18BG471QB5RB	65±5°C	80±7°C		

- Narrow tolerance
(±3°C)



サイズ	Part Number	Sensing Temp. (at 4.7kΩ) [°C]	Sensing Temp. (at 47kΩ) [°C]	Max. Voltage [V]	Resistance (25°C) [Ω]
1608mm (0603inch)	PRF18BB471RB5RB	115±3°C	130±7°C	32	470±50%
	PRF18BC471RB5RB	105±3°C	120±7°C		
	PRF18BD471RB5RB	95±3°C	110±7°C		
	PRF18BE471RB5RB	85±3°C	100±7°C		
	PRF18BF471RB5RB	75±3°C	90±7°C		
	PRF18BG471RB5RB	65±3°C	80±7°C		

- General type
- 0402 size



サイズ	Part Number	Sensing Temp. (at 10kΩ) [°C]	Sensing Temp. (at 100kΩ) [°C]	Max. Voltage [V]	Resistance (25°C) [Ω]
1005mm (0402inch)	PRF15BA102RB6RC	125±5°C	140±3°C	32	1k±50%
	PRF15BB102RB6RC	115±5°C	130±3°C		
	PRF15BC102RB6RC	105±5°C	120±3°C		
	PRF15BD102RB6RC	95±5°C	110±3°C		

- High resistance
- 0402 size



サイズ	Part Number	Sensing Temp. (at 4.7MΩ) [°C]	Max. Voltage [V]	Resistance (25°C) [Ω]
1005mm (0402inch)	PRF15BB103RB6RC	-	32	10k±50%

- 0201 size

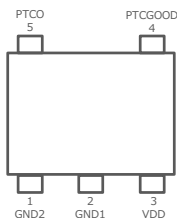


サイズ	Part Number	Sensing Temp. (at 4.7kΩ) [°C]	Sensing Temp. (at 47kΩ) [°C]	Max. Voltage [V]	Resistance (25°C) [Ω]
0603mm (0201inch)	PRF03BB541NB7RL	115±5°C	135±7°C	32	540±30%

4. Toshiba Thermoflagger™ Overview

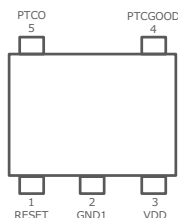
A CMOS process IC that detects changes in the resistance value of an external PTC thermistor and outputs an abnormal signal to the outside.

■ Pin Assignment(Top View)



TCTH0x1xE

Without FLAG signal
latch function



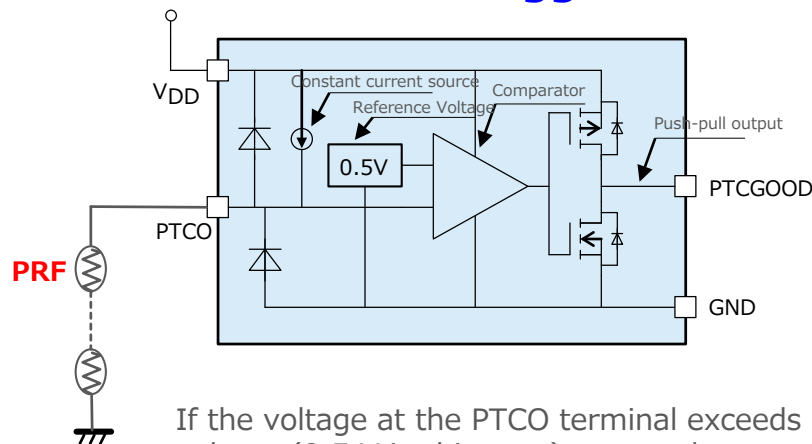
TCTH0x2xE

With FLAG signal
latch function

PIN	Pin Description
VDD	Power supply
GND	Ground
RESET	Reset for FLAG signal
PTCO	Constant current out
PTCGOOD	FLAG signal output

■ Block diagram

Thermoflagger™



1.6 x 1.6 x 0.55 mm

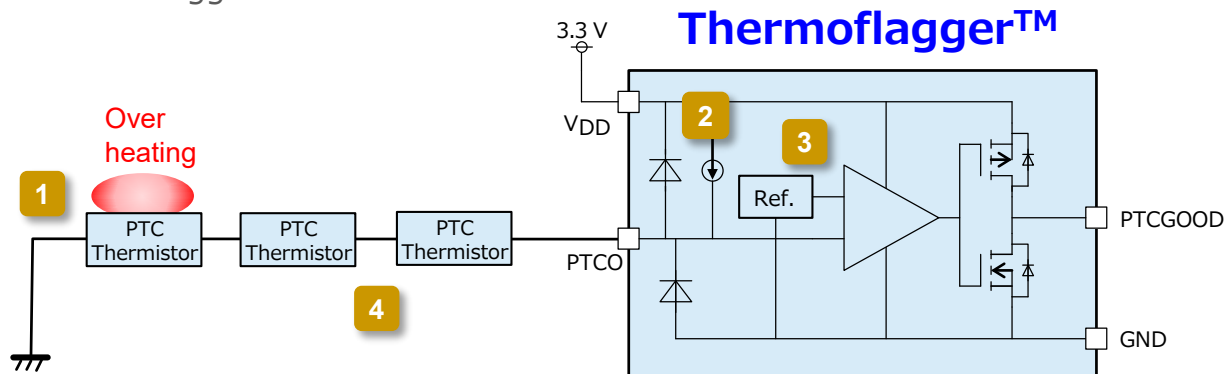
If the voltage at the PTCO terminal exceeds the reference voltage (0.5 V in this case), an overhear condition will be detected and the output of PTCGOOD will be "LOW."

For more information on Thermoflagger™, please refer to Toshiba Electronic Devices & Storage's product page. [Site link](#)

* Thermoflagger™ is a trademark of Toshiba Electronic Devices & Storage Corporation.

5. Detection temperature error by PRF series and Thermoflagger™ muRata INNOVATOR IN ELECTRONICS

The following points are the causes of temperature errors in temperature detection circuits using PRF series and Thermoflagger™.



1 PRF series variation

ex)
PRF18BC471QB5RB
Sensing Temp. (@47kΩ): 120°C
± 7°C

2 PTCO output current variation

ex)
TCTH021AE
PTCO Output current: 10uA
25°C : **9.2~10.8uA**
60/85°C : **7.6~12.7uA**

3 Detection voltage variation

ex)
TCTH021AE
Reference Voltage: 0.5V
25°C : **0.42~0.58V**
60/85°C : **0.36~0.64V**

4 Environmental temperature of the undetected PTC

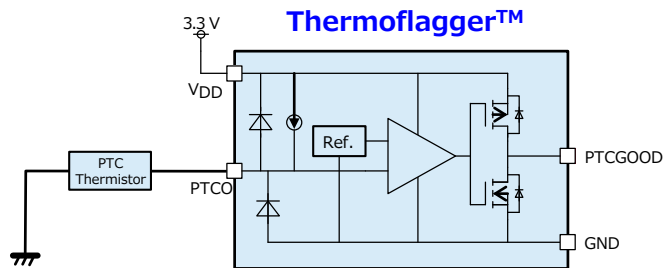
ex)
Environmental temperature to which a PTC other than a PTC that is temperature-sensing at 120°C is exposed (Multiple connections)

Using these conditions, the following pages show examples of simulations using PTC thermistor (POSISTOR) by single connection and multiple connections.

Chip PTC Thermistor (POSISTOR)

5-1. Detection temperature error by single PRF connection (one location)

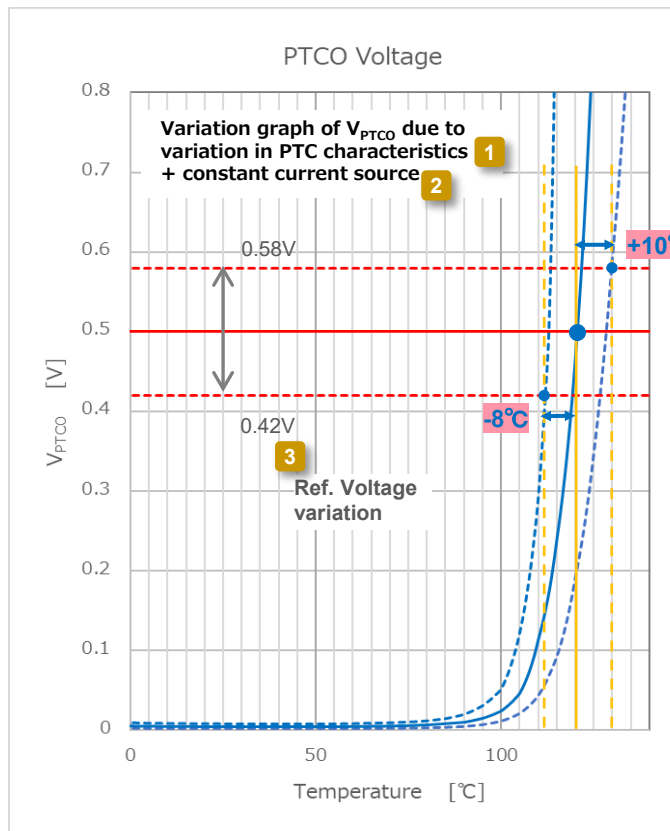
■ PRF series Single Connection



● Simulation condition

- 1 PRF18BC471QB5RB**
Sensing Temp. (@47 kΩ): 120°C ± 7°C
- 2 TCTH021AE**
PTCO Output current: 10uA (9.2~10.8uA @25°C)
- 3 TCTH021AE**
Reference Voltage: 0.5V (0.42 ~ 0.58V @25°C)

● Simulation results



In combination,
PRF18BC471QB5RB and
TCTH021AE

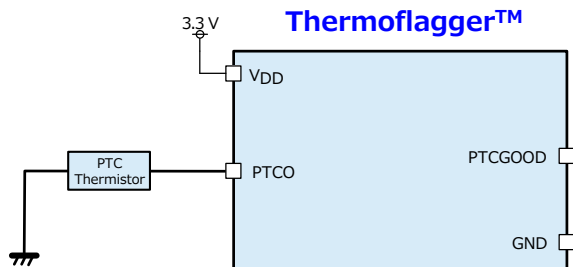
120°C + 10°C / -8°C

Overheat temperature
detection is possible.

Chip PTC Thermistor (POSISTOR)

5-1. Detection temperature error by single PRF connection (one location)

■ PRF series Single Connection



The detection temperature and error by combination of PRF series and Thermoflagger™ are shown in the right table.

● Simulation results

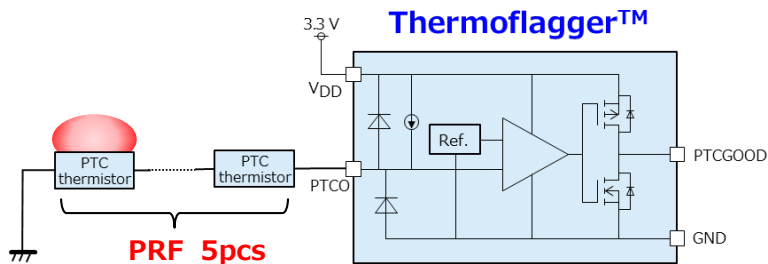
POSISTOR P/N	Toshiba Thermoflagger™	Detection temp.& Error
PRF18AR471QB5RB	TCTH02xxE	150 +10/-8 degC
PRF18BA471QB5RB		140 +10/-8 degC
PRF18BB471Q(R)B5RB		130 +10/-8 degC
PRF18BC471Q(R)B5RB		120 +10/-8 degC
PRF18BD471Q(R)B5RB		110 +10/-8 degC
PRF18BE471Q(R)B5RB		100 +10/-8 degC
PRF18BF471Q(R)B5RB		90 +10/-8 degC
PRF18BG471Q(R)B5RB		80 +10/-8 degC
PRF15BA102RB6RC	TCTH02xxE	136 +4/-4 degC
PRF15BB102RB6RC		126 +4/-4 degC
PRF15BC102RB6RC		116 +4/-4 degC
PRF15BD102RB6RC		106 +4/-4 degC
PRF03BB541NB7RL	TCTH02xxE	135 +10/-8 degC

POSISTOR P/N	Toshiba Thermoflagger™	Detection temp.& Error
PRF15BB103RB6RC	TCTH01xxE	122 +5/-5 degC

Chip PTC Thermistor (POSISTOR)

5-2. Detection temperature error by multiple PRF connections (multiple locations)

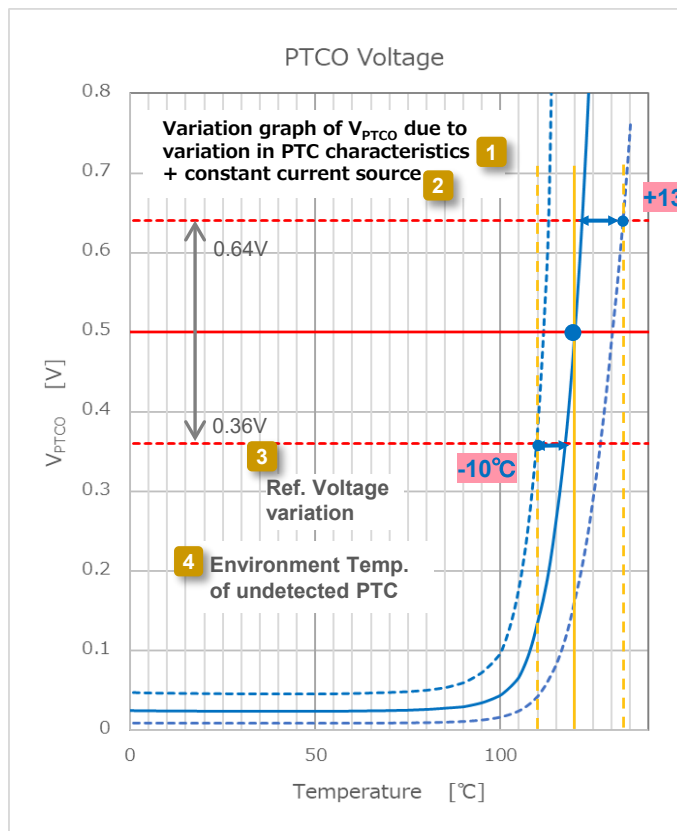
■ PRF series Multi. Connections(5pcs)



● Simulation condition

- 1 **PRF18BC471QB5RB**
Sensing Temp.(@47 kΩ):120°C ± 7°C
- 2 **TCTH021AE**
PTCO Output current:10uA (7.6~12.7uA @60°C)
- 3 **TCTH021AE**
Reference Voltage: 0.5V (0.36~0.64V @60°C)
- 4 **Temperature of undetected PRF(4pcs)**
@60°C

● Simulation results



In combination,
PRF18BC471Q(Multiple)
and
TCTH021AE

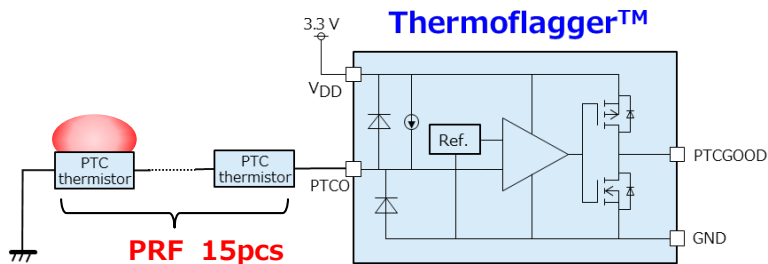
120°C + 13°C / -10°C

Overheat temperature
detection is possible.

Chip PTC Thermistor (POSISTOR)

5-2. Detection temperature error by multiple PRF connections (multiple locations)

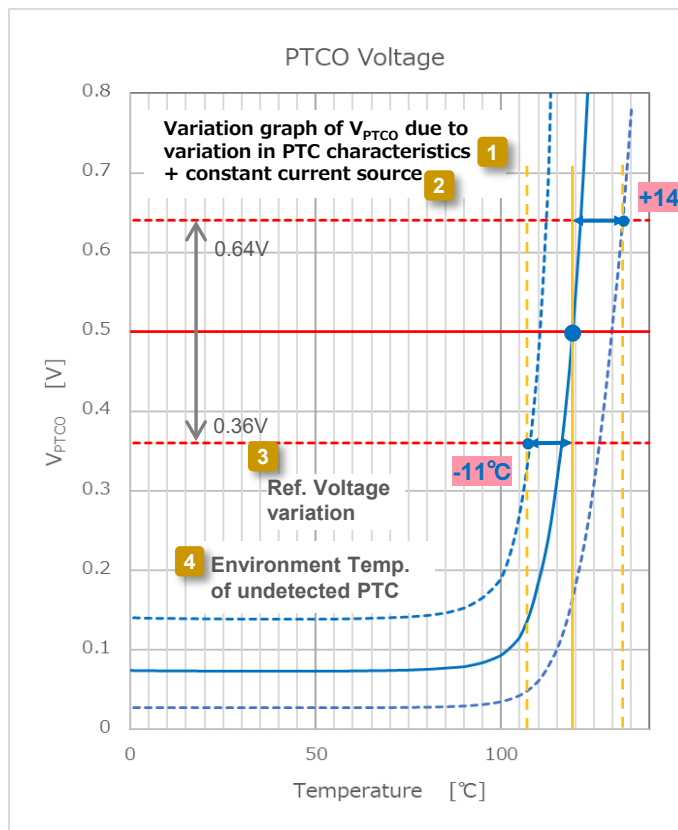
■ PRF series Multi. Connections(15pcs)



● Simulation condition

- 1 **PRF18BC471QB5RB**
Sensing Temp.(@47 kΩ):120°C ± 7°C
- 2 **TCTH021AE**
PTCO Output current:10uA (7.6~12.7uA @60°C)
- 3 **TCTH021AE**
Reference Voltage: 0.5V (0.36~0.64V @60°C)
- 4 **Temperature of undetected PRF(14pcs)**
@60°C

● Simulation results



In combination,
PRF18BC471Q(Multiple)
and
TCTH021AE

119°C+14°C/-11°C

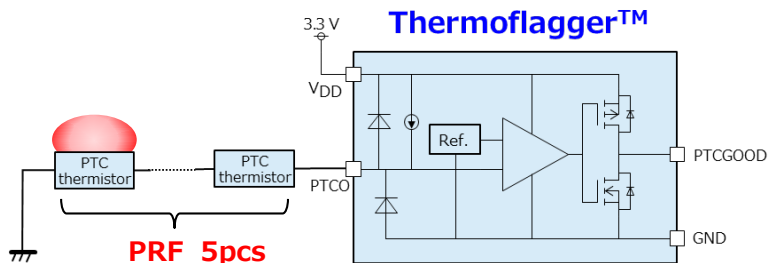
Overheat temperature
detection is possible.

Chip PTC Thermistor (POSISTOR)

5-3. Detection temperature error by multiple PRF connections (environmental temperature change)

■ PRF series Multi. Connections(5pcs)

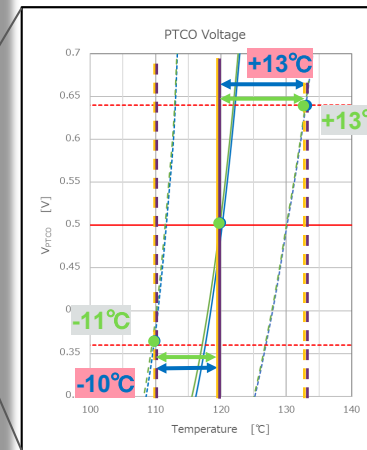
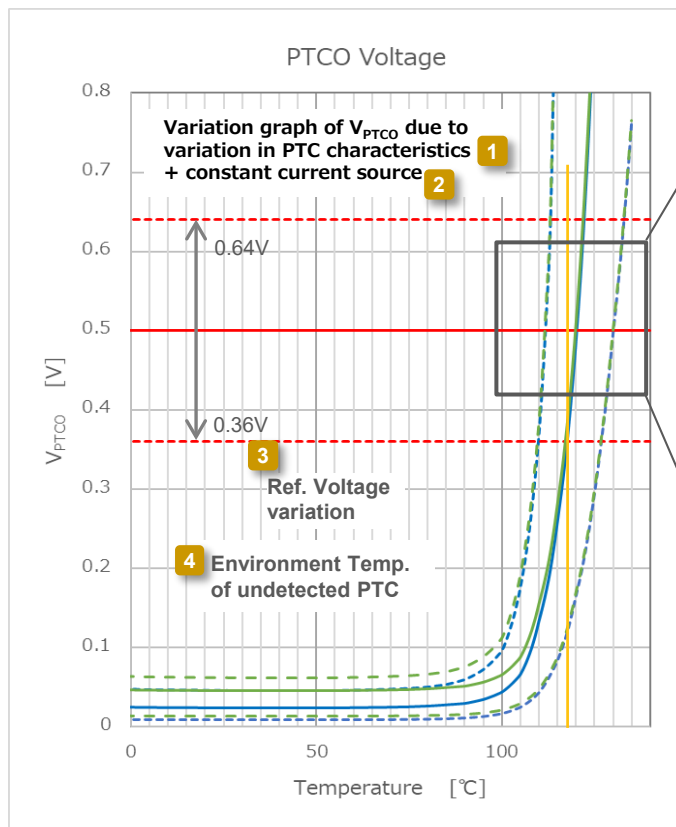
Influence of environmental temperature



● Simulation condition

- 1 **PRF18BC471QB5RB**
Sensing Temp.(@47 kΩ):120°C ± 7°C
- 2 **TCTH021AE**
PTCO Output current:10uA (7.6~12.7uA)
- 3 **TCTH021AE**
Reference Voltage: 0.5V (0.36~0.64V)
- 4 **Environment Temp. of the undetected PRF(4pcs)**
@60°C ————
@85°C ————

● Simulation results

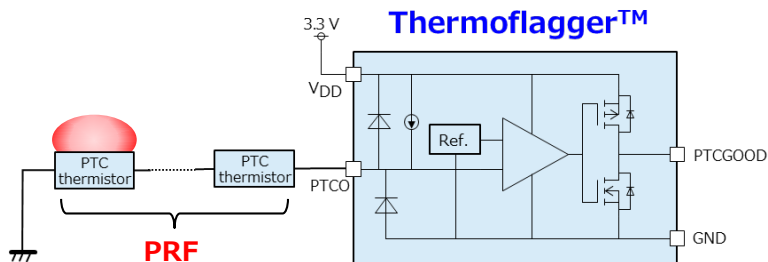


● **Environment temperature 60°C**
Detection error : 120+13°C/ -10°C

● **Environment temperature 85°C**
Detection error : 120+13°C/ -11°C


5-4. Detection Temperature error by PRF series and Thermoflagger™

■ PRF series Multi. Connections



The detection temperature and error by combination of PRF series and Thermoflagger™ are shown in the right table.

In case of multiple PRF connections, when the environmental temperature of undetected PRF is considered, the detection temperature and temperature error change. Also, undetectable combinations occur.

Please contact Murata for further temperature error simulation. [Contact us](#) 

● Simulation results

POSISTOR P/N	Toshiba Thermoflagger™	PRF Number	Undetected PRF Temp.	Detection temp. & Error
PRF18BC471Q(R)B5RB	TCTH021AE	5	60℃	120 +13/-10 ℃
		10		120 +13/-11 ℃
		15		119 +14/-11 ℃
		5	85℃	120 +13/-11 ℃
		10		119 +14/-12℃
		15		118 +14/-14℃
PRF15BC102RB6RC	TCTH021AE	5	60℃	116 +6/-9 ℃
		10		115 +7/-11 ℃
		15		114 +7/-17 ℃
		5	85℃	116 +6/-10 ℃
		10		114 +8/-21 ℃
		15		Undetectable