APLIKACIJSKI ČLANEK
APPLICATION ARTICLE

Murata's PTC, NTC Thermistors Respond to Safety Requirements

Apart from the strong demand for electronic products that are small, thin and light, the markets for electronic devices and systems also require that these devices must adopt enhanced functions and faster speed. To meet this demand, electronic components are made smaller and in multi-layer on the board to fully utilize high density mounting technology. Furthermore, electronic parts that have shrunk in size must be able to perform at the upper limits of their rated values.

With these market needs, heat radiation from parts increases on the board so much so that it is very difficult to ensure sufficient heat radiation. In view of this, measures for heat radiation have become more important than ever. This article focuses on Murata Manufacturing Co., Ltd.'s PTC thermistors (Posistors) and its NTC thermistors, both of which are used as temperature-sensing devices.

Thermistor

The thermistor is a resistor that exhibits a very sharp change in resistance according to temperature change. Thermistors are classified into two types – the NTC (Negative Temperature Coefficient) thermistor whose resistance value decreases according to temperature rise, and the PTC (Positive Temperature Coefficient) thermistor whose resistance value rises sharply when the temperature rises above a certain limit (Fig. 1). Murata uses Posistor as trade name for its PTC thermistors. These two kinds of thermistors are used for different purposes, displaying their own characteristics, to detect the temperature of systems and equipment as a whole, the temperature of boards and also the temperature of parts, for instance, FETs.

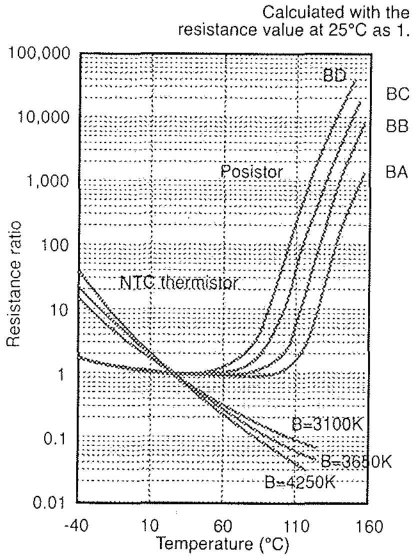

Fig. 1: Resistance ratio-temperature characteristics of thermistors

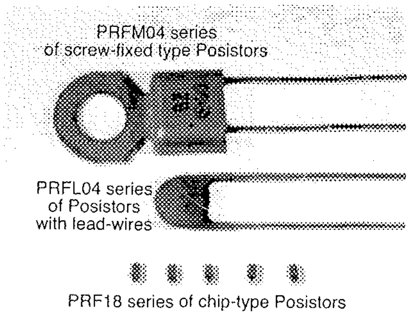

Photo 1: External view of overheating-sensing Posistors

The Posistor, whose change in resistance value is very sharp within a specified temperature range, is characterized by the fact that it can directly control power devices such as transistors and FETs. In contrast, characteristically, the NTC thermistor is excellent in temperature-sensing accuracy, although it requires a somewhat complex circuit, and is capable of temperature controls over a wide temperature range.

Posistor

The Posistor is a ceramic device made by sintering barium titanate with an addition of extremely small amounts of rare earth elements (Y, La, etc.). Characteristically, its resistance value rises sharply when it is heated above a certain temperature. This temperature characteristic can be set over a wide range by properly selecting the kinds and amounts of additives to this ceramic body. For the purpose of sensing the overheating of electronic equipment, Posistors whose detection temperatures are set at 60°C~120°C are extensively used.

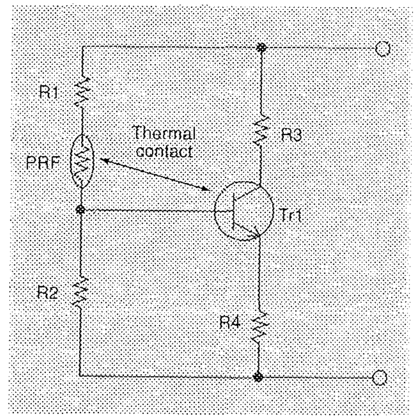

Fig. 2: Circuit pattern for a Posistor (Example 1)

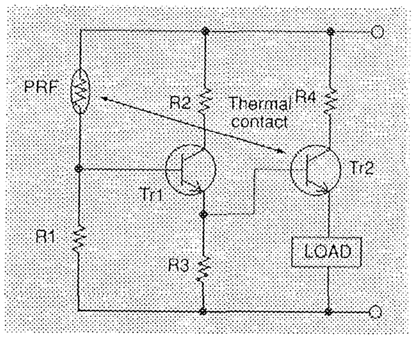

Fig. 3: Circuit pattern for a Posistor (Example 2)

By utilizing this characteristic, an overheating prevention circuit can be easily devised by which the speed of a fan is increased or the output power is suppressed when the temperature of a circuit board or others reaches a specified level. The typical cases in which transistors are used as switching devices are shown (Fig. 2, Fig

3). In case abnormal heat is generated in a power transistor due to various causes such as increased output current or heat radiation trouble, the resistance value of the thermally coupled Posistor rises sharply before the power transistor reaches the limit of its tolerable temperature, to lower its current, and thus the collector current of Tr1 and Tr2 is suppressed, as shown in Figs. 2 and 3, respectively. This way, serious trouble, fuming and firing can be prevented. Various kinds of power supplies, DC/DC converters and other electronic devices are provided with this function.

The Posistor is resettable and returns to its original low resistance value when the temperature goes down, so that it can be used repeatedly, and unlike a temperature fuse, it does not need to be exchanged for a new one. Furthermore, without a contact point, there is no possibility of it causing contact failures or generating noise, a trouble that is liable to occur in a bimetal.

Posistors for temperature sensing are offered in two types, a lead-wire type and a surface-mountable type. Shown in Photo 1 are the external views of a disc type, which can detect the temperature of the surrounding environment, a type with a screw fixing terminal, which can be screwed on to a heat sink or others, and a surface-mountable type that senses the temperature of the board. These types can be selected according to the mounting forms adopted for electronic equipment.

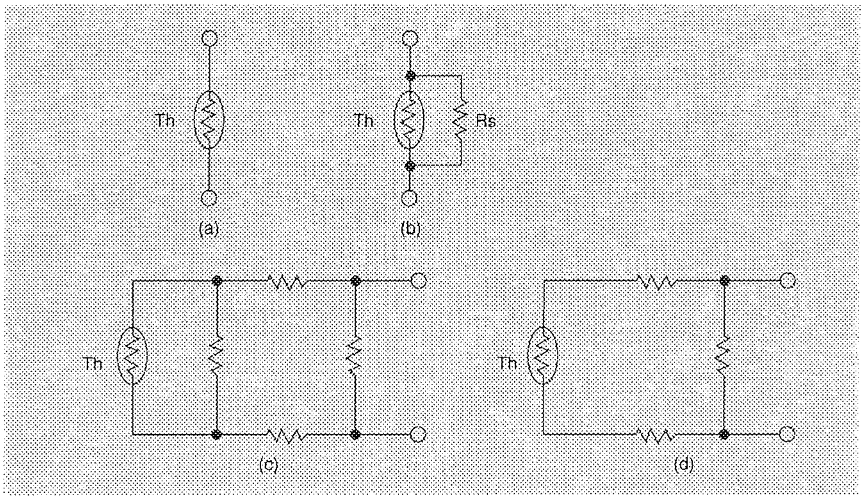

Fig. 4: Connection methods of NTC thermistors

The temperature-sensing accuracy of these types is set at ±5°C of a sensed temperature, while the temperature-sensing range is set at 55°C~105°C for the lead-wire type and at a step of 10°C between 85°C and 145°C for the surface-mountable type. As an example, the ratings of a surface-mountable type Posistor are listed in Table 1. These types are being supplied with lead-free external terminals for the purpose of reducing substances harmful to the environment.

At present, the company is making efforts to develop narrow-deviation and small-sized Posistors and will continue to endeavor too, in the future, to diversify the assortment of Posistors.

Table 1: Ratings of chip-type PRF18 series

Product no.	Characteristic	Resistance value (at +25°C)	Sensing temperature at 4.7kΩ	Max. voltage	Operating temperature range
PRF18AS471QB1RB	AS		145± 5°C		-20~ + 160°C
PRF18AR471QB1RB	AR		135± 5°C		-20~ + 150°C
PRF18BA471QB1RB	BA		125± 5°C		-20~ + 140°C
PRF18BB471QB1RB	BB		115± 5°C		-20~ + 130°C
PRF18BC471QB1RB	BC	470Ω± 50%	105± 5°C	DC32V	-20~ + 120°C
PRF18BD471QB1RB	BD		95± 5°C		-20~ + 110°C
PRF18BE471QB1RB	BE		85± 5°C		-20~ + 100°C
PRF18BF471QB1RB	BF		75± 5°C		-20~ + 90°C
PRF18BG471QB1RB	BG		65± 5°C		-20~ + 80°C

AS~BE-characteristic thermistors are UL1434-certified products.

Table 2: Ratings of chip-type NCP15 series (excerpts)

Product no.	Resistance value (at +25°C)	B-constant (25/50°C)	Max. operating current (25°C,mA)	Operating temperature range
NCP15XF101□03RC	100Ω	3,250K ± 3%	3.10	
NCP15XQ471□03RC	470Ω	3,650K ± 3%	1.40	
NCP15XQ102□03RC	1,000Ω	3,650K ± 3%	1.00	
NCP15XM472□03RC	4,700Ω	3,500K ± 3%	0.46	
NCP15XH103□03RC	10,000Ω	3,380K ± 3%	0.31	-40 ~ +125°C
NCP15WB473□03RC	47,000Ω	4,050K ± 3%	0.17	
NCP15WF104□03RC	100,000Ω	4,250K ± 3%	0.10	
NCP15WM474□03RC	470,000Ω	4,500K ± 3%	0.04	

Note: The blanks are to be filled by resistance value deviation marks (J: ±5%, K: ±10%). Products with a resistance value deviation of ±1% (F) are also offered. When a maximum allowable current is impressed, the thermistor radiates 1°C of heat.

NTC Thermistors

The NTC thermistor is a ceramic-type temperature-sensing resistor made of the sintered oxides of transition metals (Mn, Ni, Fe, Cu, etc.). It has a negative temperature coefficient, that is, its resistance value decreases as the temperature rises. NTC thermistors have a wide range of se-

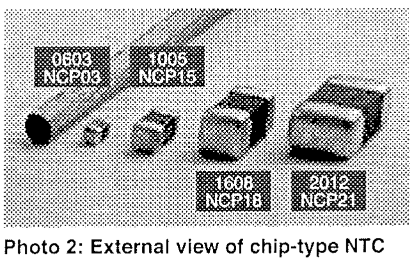

Photo 2: External view of chip-type NTC thermistors

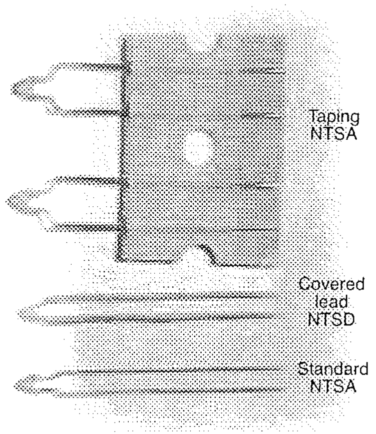

Photo 3: External view of lead-wire type NTC thermistors

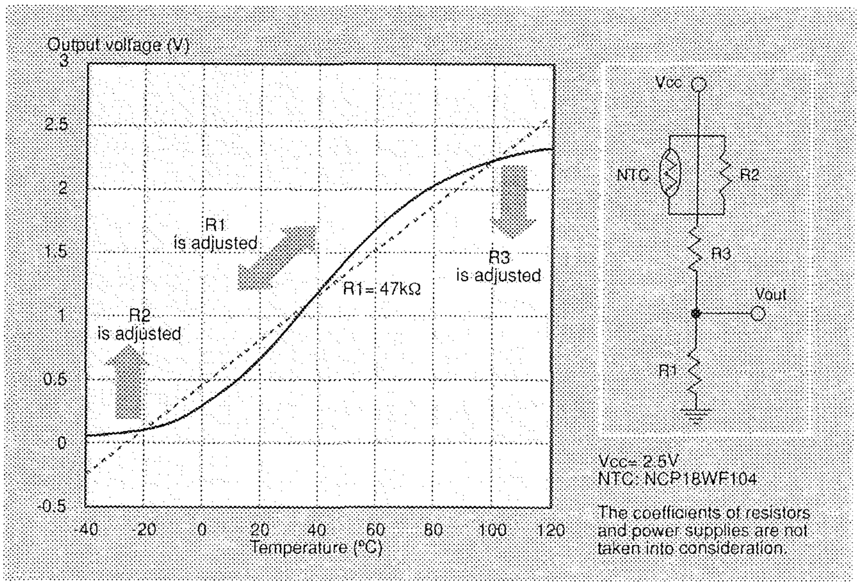

Fig. 6: Output voltage-temperature characteristics

lectable resistance values so that they can be designed with relative ease, and the change of their resistance values relative to temperature change is as large as 3.0~5.3 percent/°C. Because of these characteristics, they are extensively used for electronic equipment as general-purpose temperature sensors. These characteristics are explained below.

Fig. 4(a): The resistance value-temperature characteristics of a thermistor can be used without alteration, with large gain secured.

Fig. 4 (b): The resistance value-temperature characteristics can be easily linearized (Refer to Fig. 5).

Fig. 4 (c) (d): The resistance value-temperature characteristics can be linearized over a wide temperature range.

It is possible to upgrade the temperature-sensing accuracy of NTC thermistors to ±1°C within a range of -40°C~+75°C. In actual circuits, they are designed so as to ensure a sensing accuracy of ±3°C within a temperature range of 0°C~+70°C, even when the scattering of characteristics of power supply voltage regulators and other devices is taken into consideration.

Fig. 6 illustrates the examples of simple connections of NTC thermistors and the adjustment of output voltage-temperature curves.

It is possible to improve the sensitivity of a NTC thermistor within an operating temperature range and obtain a necessary voltage by properly combining resistors in parallel and series arrangement, and thereby to enable it to exhibit performance comparable to a general-purpose sensor IC in temperature-sensing accuracy and dynamic range.

As for their product types, the company supplies a lead-wire type (NTSA series, 3.0 x 1.6mm) and a chip-type. The chip-type has already been made lead-free (Photos 2 and 3). The company plans to expand the series of small-sized products (0.6 x 0.3mm) and add a B-constant variation to its product line.

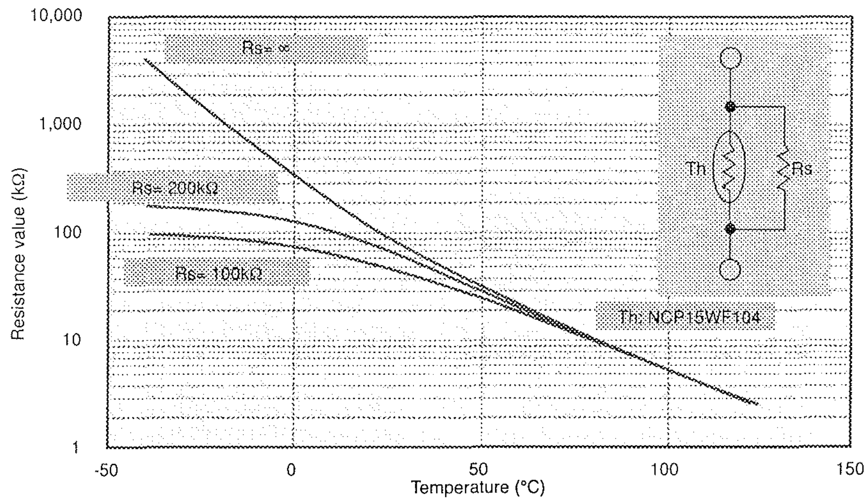

Fig. 5: The linearization of the resistance-temperature characteristic of thermistors by means of resistors in parallel arrangement

Future Development

Electronic equipment that meet market needs for comfortable and convenient use will be required in the future to respond to more challenging market needs, apart from safety requirements. In further developing its Posistors and NTC thermistors as temperature-sensing devices, an important factor for product safety, Murata Manufacturing will endeavor to expand its lineup by confirming and meeting the required specifications of a variety of equipment, and expand the possible applications of its thermistors.

About This Article

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