Resistors - Wide Resistance Range

PTC and NTC Thermistors, Through-Hole Varistors

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RESOURCES

- For technical questions contact resistors@vishay.com

Using PTC – Positive Temperature Coefficient Thermistors

The electrical resistance of ceramic PTC (positive temperature coefficient) thermistors increases exponentially at the so called switching temperature or Ts. This typical characteristic makes PTC thermistors very useful components for several application areas such as voltage and current overload protection, over-temperature protection, inrush current generation, time delay, energy discharge, and as a ceramic self-limiting heating element. As an overload protective element, PTC thermistors are used in a wide range of circuits, including line cards, set-top boxes, and private automated branch exchanges in telecom applications; airbag and temperature control devices in automobiles; power supplies, transformers, DC motors and small domestic appliances; and in other consumer products.

PTC Overload Protection Principles

Features

- Different voltages in function of the application: 30 V to 60 V, 145 V, 265 V, 600 V
- Several mechanical executions: pellets, through hole leaded, SMD
- Wide range of trip and hold currents: from 10 mA to 4.5 A minimum trip currents
- Wide range of resistance: from 0.3 Ω to 5 kΩ
- Small ratio between trip and hold currents (I_{trip}/I_{hold} = 1.5 at 25 °C)
- High maximum inrush current: up to 30 A
- UL approved series

Part Numbers

General overload protection:

- 30 V to 60 V series: PTCCL..H....BE series (UL approved)
- 145 V series: PTCCL..H...FBE (UL approved)
- 265 V series: PTCCL..H...HBE (UL approved)
- 600 V series: PTCCL..H...SBE
- SMD series: PTCTZ

Over-temperature:

- Tn 70 °C to 140 °C: PTCSS Series (SMD, UL approved)
- Tn 70 °C to 150 °C: PTCSL Series

Telecom protection:

- General leaded: PTCTL
- SMD: PTCTZ and PTCTT

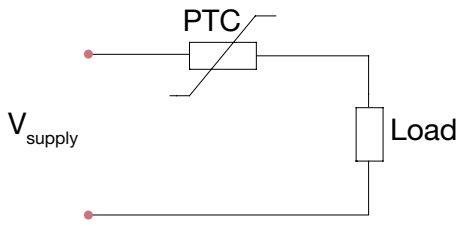


Figure 1

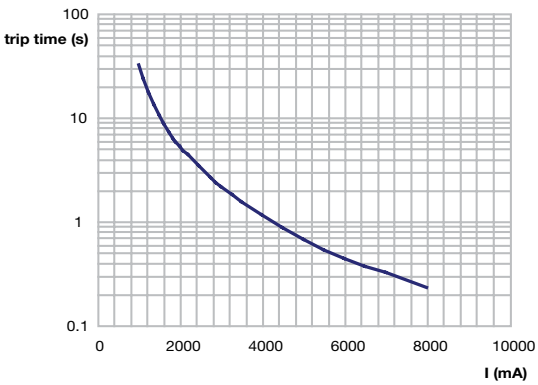


Figure 3

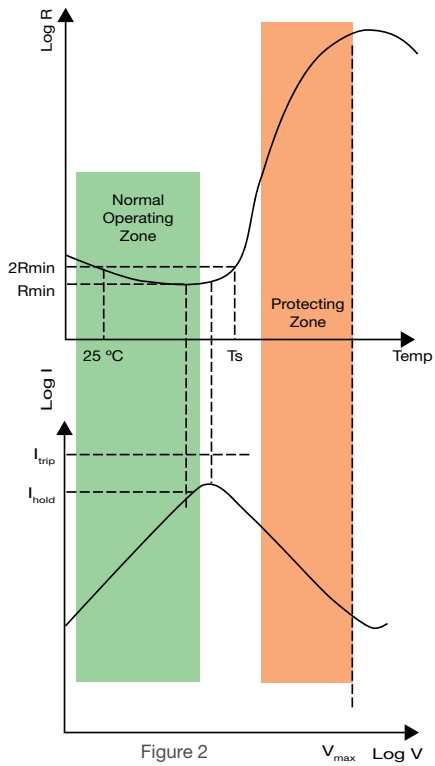


Figure 2

When connected in series with the input of an electrical or electronic circuit load (see Figure 1), such as a small motor or power supply, the PTC thermistor acts as a self-resettable fuse, protecting the circuit against current, voltage and temperature overload conditions.

In normal operating conditions the PTC resistance is low (see Figure 2), and the current is below its hold value (I_{hold}). However, an overload will quickly heat up the PTC thermistor until, at around the switching temperature (T_s), its resistance increases rapidly, limiting the current to far below its trip value (I_{trip}), and so protecting the circuit. The trip time until protection will depend on the level of overload (see Figure 3).

Using NTC – Negative Temperature Coefficient Thermistors

The electrical resistance of NTC (negative temperature coefficient) thermistors increases as the ambient temperature decreases, and decreases when temperature increases. NTC thermistors are used for overtemperature protection in PCs, power supplies, and motherboards; Li-ion battery protection in fast chargers; and in digital scan cameras, fire and smoke detectors, TCXOs, and other automotive, consumer, and industrial applications. They are generally included in a voltage divider or Wheatstone bridges and can provide a measuring voltage to analog-digital converters. They also allow to control the temperature compensation of displays and regulation of temperature with opamps or more complex ICs.

Features for Circuit Protection:

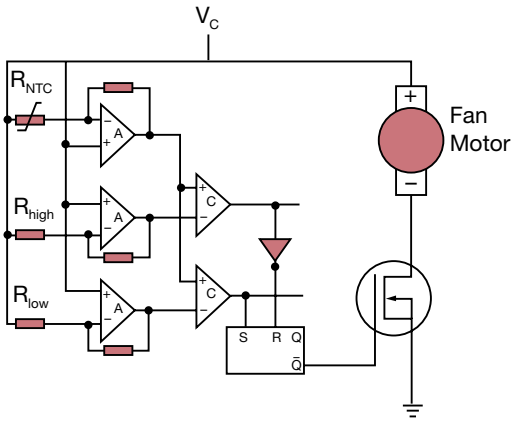
- Leaded and SMD versions in case sizes from 0402 to 1206
- Large resistance range: from 3.3 Ω to 470 kΩ
- Temperature range: - 55 °C to + 155 °C
- SMD termination: 100 % Sn over Nickel
- Customized types available upon request

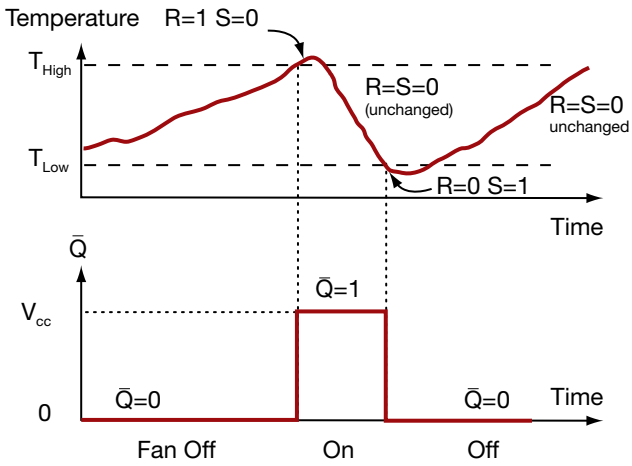
Examples of NTC Circuit Protection

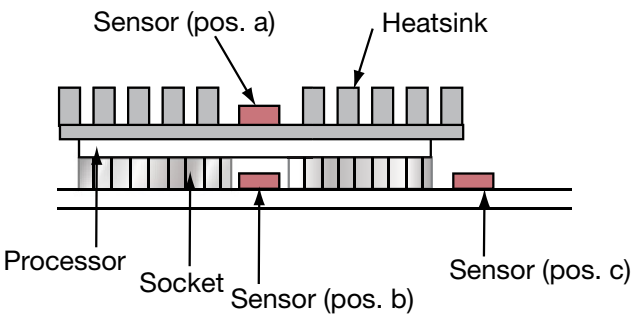
PC Cooling Fan

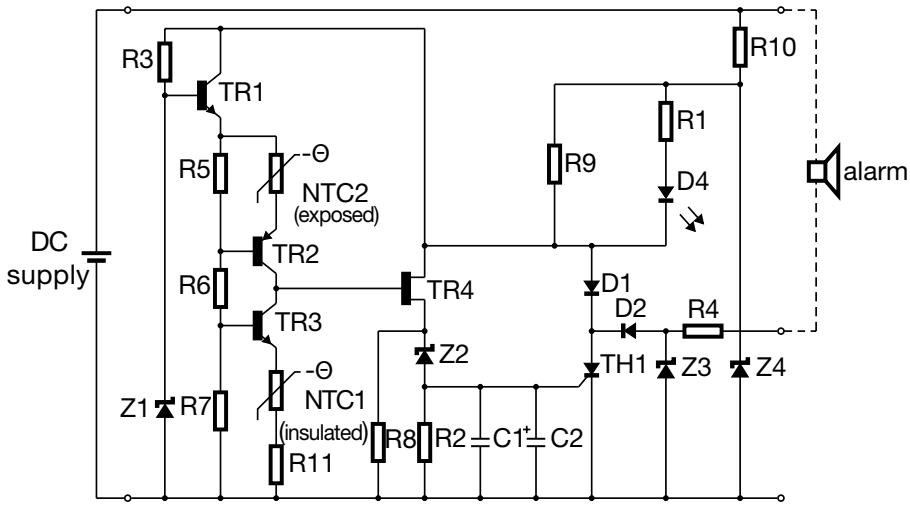
The output $\bar{Q}$ of a bistable RS drives the gate of a MOSFET transistor switching a cooling fan on and off.

The cooling principle is based on a limit cycle regulation between a chosen low temperature T_{low} (the NTC value at temperature T_{low} is equal to R_{low}) and a high temperature Thigh (the NTC value at T_{high} is equal to R_{high}). The NTC value is compared to fixed resistors of values R_{low} and R_{high}. Input R and S depend directly upon this comparison. The cooler fan will work between the moment when R or S go from 0 to 1 .









Rate of Rise Heat Detecting Fire Alarm

Rate of rise heat detecting fire alarms operate on the principle of monitoring for a sudden rise in temperature associated with an outbreak of fire, rather than waiting for the temperature to increase to a predetermined fixed limit before activating. They therefore provide a faster response to a fire incident. The detector employs two matched NTC thermistors (NTC_1 and NTC_2), one of which is semi-protected in the body of the fire-alarm unit, while the other is exposed to the surrounding atmosphere.

With a gradual rise and fall in ambient temperature, both sensors track each other fairly closely. With the outbreak of fire however, the exposed thermistor will react to the temperature increase faster than the shielded sensor. This causes an imbalance between the two sensors which in turn triggers the detector output. These detectors also feature an upper temperature limit at which point the detector will respond regardless of rise time.

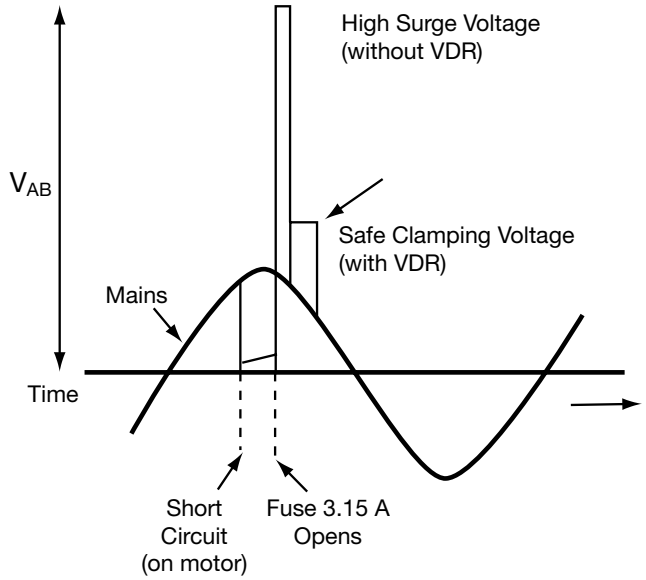
Using Through-Hole Varistors

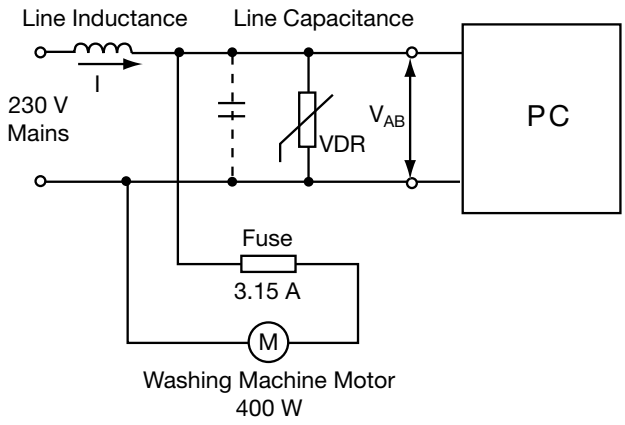
VDRs (voltage dependent resistors), or Metal Oxide Varistors (MOV), are used for transient surge suppression. Surge suppression circuits are commonly used in computers, automobiles, telecom and industrial equipment, domestic appliances, and other consumer products.

Specifications Table

Standard Series: VDRS05 to VDRS20		
Sizes from 5 mm to 20 mm	V_{rms} from 14 V to 680 V V_{dc} from 18 V to 895 V	Can absorb surges up to 6,500 A UL recognized according UL1449 edition 3
High-Surge Series: VDRH05 to VDRH20		
Sizes from 5 mm to 20 mm	V_{rms} from 11 V to 680 V V_{dc} from 14 V to 895 V	Can absorb surges up to 10,000 A UL recognized according UL1449 edition 3

Example of VDR Circuit Protection in PC





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