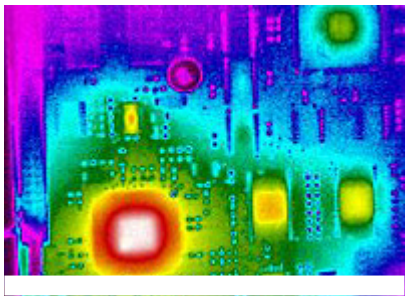
Applications & Cases



Thermal management with PTC thermistors December 2006

Keeping an eye on hot spots

Thermal management is becoming increasingly important as a result of miniaturization, rising power consumption and tougher requirements on reliability. At the same time the number of hot spots on boards and equipment is also growing. These are points where critical temperature rises must be expected.

Among the typical applications that require the monitoring of several hot spots are computers such as servers and notebooks, industrial equipment such as large power supplies, UPS systems, frequency converters, lighting controllers as well as automotive electronics systems. The hot spots at which excess temperatures can occur as a result of power dissipation are often found on power semiconductors such as MOSFETs or IGBTs. Other possible locations include inductors, transformers, capacitors and motors.

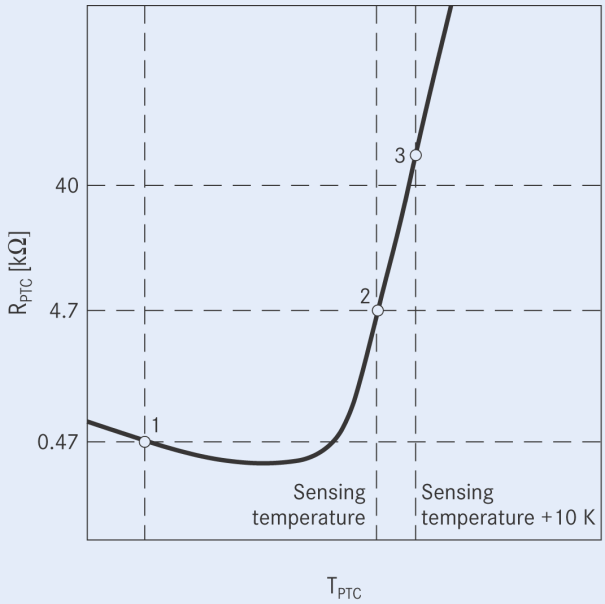
Most techniques used to measure temperature operate on the same principle. They use a sensor, such as a PT100 or an NTC thermistor, whose resistance changes with temperature as a relatively linear function. A specific resistance always corresponds to a predetermined temperature. Such a resistor is often integrated into a voltage divider for simple recording of excess temperature. The latter can then be linked directly to a specific output voltage V_{out}. As a rule, this voltage, which is applied to a controller IC or an operational amplifier connected to it as a comparator, triggers a specific action such as shutting the system down or turning on an active cooling process. This concept comes up against its limits when several points need to be simultaneously monitored for excess temperature. A separate sensor electronics would then be required for each single hot spot. The drawback is obvious: apart from higher development effort, costs increase and valuable space is taken up on the circuit board.

Unique product family

EPCOS offers an elegant concept for the simultaneous monitoring of several hot spots with size 0603 PTC thermistors from the B59601 series. The resistance of a PTC thermistor changes with temperature according to the curve shown in Fig. 1. In the lower temperature range, the component has a low resistance (R_{25} = 470 Ω ±50 %). At its specified sensor temperature, however, this rises to a value of 4.7 kΩ. This specified temperature can be set to an accuracy of ±3 K. PTCs from EPCOS are available with sensor temperatures of between 75 °C and 135 °C in steps of 10 K.

Applications & Cases

FIGURE 1: RESISTANCE CHARACTERISTIC OF PTC THERMISTORS



Product family
B59601A0*X5B062

1 Resistance at
25 ˚C:
470 Ω ±50%

2 Sensing temperature
(R_{PTC} = 4.7 kΩ):
75 ˚C - 135 ˚C in steps of 10 K
Tolerance: ±3 K

3 Resistance at
sensing temperature +10 K:
> 40 kΩ

At a temperature rise of 10 K above the defined sensor temperature, the resistance changes from 4.7 kΩ to more than 40 kΩ. This effect is used for the simple recording of excess temperatures.

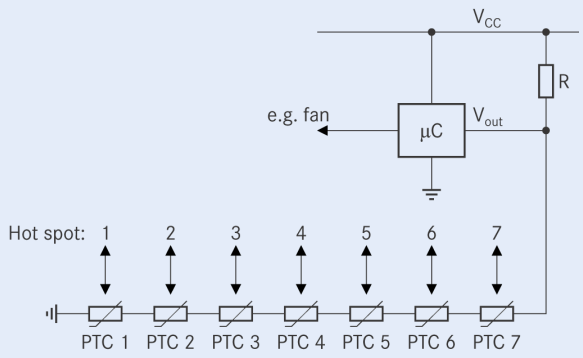
Thanks to the impressively steep R/T curve of this product family, the resistance is already considerably higher at a temperature of about 10 K above the specified value. Thus the PTC (ordering code B59601A0095B062) with a specified sensor temperature of 95 °C ±3 K (4.7 kΩ) has a resistance of over 40 kΩ at 105 °C, for example. This steep R/T curve is a unique feature of PTC sensors from EPCOS.

Seven at a time

The exceptionally steep and rapid change in resistance with temperature allows several hot spots to be monitored with one simple circuit. Therefore, if seven different points on a circuit board or equipment need to be simultaneously monitored to detect excess temperature at about 100 °C, irrespective of which hot spot reaches this value, then the circuit shown in Fig. 2 is suitable for this purpose. A single PTC of the B59601 series in an SMT version is placed at each point to be monitored. Thanks to their typically steep characteristic, all these PTCs can be connected in series and nevertheless assure reliable monitoring of each hot spot.

Applications & Cases

FIGURE 2: TEMPERATURE MEASUREMENT AT SEVERAL HOT SPOTS



Despite the series circuit, excess temperatures can be reliably recorded at each hot spot. This circuit topology allows cost-effective, space-saving and reliable temperature management.

As long as all seven PTCs remain below the specified value for the sensor temperature of 95 °C ±3 K, their overall resistance will stay below 7 x 4.7 kΩ = 32.9 kΩ.

Even if only a single series-connected PTC reaches a temperature of 105 °C, the resistance of the resistor chain will rise to a value considerably higher than 40 kΩ. Depending on how or where the higher temperatures occur on the circuit board, an overall resistance of 40 kΩ is reached as soon as the hottest hot spot has risen to about 100 °C.

This behavior also allows a voltage divider to be used to detect the excess temperature in this case with seven PTCs on one side and a fixed-value resistance on the other. The output voltage then provides information as to whether one or even several points have become too hot.

Apart from the SMT types already mentioned, EPCOS also offers a series of leaded variants for temperature measurement. Application specific versions of these components may also be supplied. They include strap or screw types that can be mounted directly onto the heat sinks of power electronics components.

PRODUCT PROFILE OF PTC LIMIT-TEMPERATURE SENSOR

PTC thermistors of the B59601 series are well suited as limit-temperature sensors in power supplies, domestic appliances and in many sectors of industrial and automotive electronics.

Size: 0603

R_{25}: 470 Ω

Limit temperature (4.7 kΩ): 75 °C to 135 °C in steps of 10 K

Tolerance: ±3 K

Author: Dr. Stefan Benkhof