SIEMENS

NTC Thermistors

Data Book 1980/81

SIEMENS AKTIENGESELLSCHAFT

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The German specifications (DIN and VDE) have been used for reference purposes in this data book.

The sign ∅ on drawings denotes diameter.
A comma in the outline drawings represents the decimal point.

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■ Not for new design!

Types for industrial and standard applications

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(alphanumerically arranged)

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General Technical Information

1. General information

NTC thermistos (negative temperature coefficient thermistors) are, in accordance with IEC Publ. 529 and DIN 44070, semiconductor resistors whose resistance values drop as their temperatures increase. Their negative temperature coefficients of the resistance value lie in the range between 3 and 6%/K, thus being approximately ten times greater than those of metals. NTC thermistors consist of polycrystalline mixed oxide ceramics. The conduction mechanism is complex, i.e. either extrinsic conduction or intrinsic conduction may occur. In many cases, the NTCs have a spinell structure and then show valence conduction effects.

1.1 Manufacture

The basic materials are various heavy metal oxides which are mixed in specific proportions. In some cases, oxides or salts of light elements are added in order to stabilize the electrical characteristics or to improve the sintering behavior.

NTC thermistor blanks are principally manufactured in three versions:

- Disc-shaped NTCs are pressed from a granulate of the oxide mixture onto automatic preforming presses.
- Stick-shaped NTCs are extruded: The oxide mixture is plasticized by adding a binder and pressed through a nozzle with high pressure.
- Bead-type NTCs are deposited as drops onto two parallelly strained wires made of a platinum alloy. For this purpose, the oxide mixture is suspended in an epoxy resin.

The blanks are now sintered at high temperatures (between 1000 and 1400°C). That process results in the formation of the crystalline NTC thermistor body.

Discs and sticks are mainly contacted by burning silver paste onto the surface. Contacts for beads are formed by the wires which the beads have been deposited on.

For final assembly, the NTCs are equipped with leads or plugs and, depending on the application, also installed in various types of cases.

This is followed by artificial aging: The use of special methods provides high stability of the electrical values. Before being delivered the electrical and, if necessary for the application, the mechanical and thermal characteristics of the NTCs are checked.

2. Electrical characteristics

2.1 Behavior of an NTC thermistor without load

2.1.1 Resistance value – temperature characteristic curve

The following equation is a good approximation for showing the dependence of the NTC resistance value on the temperature:

$$R_T = A \times e^{\frac{B}{T}} \quad (1)$$

or, after conversion

$$R_T = R_R \times e^{B\left(\frac{1}{T} - \frac{1}{T_R}\right)} \quad (2)$$

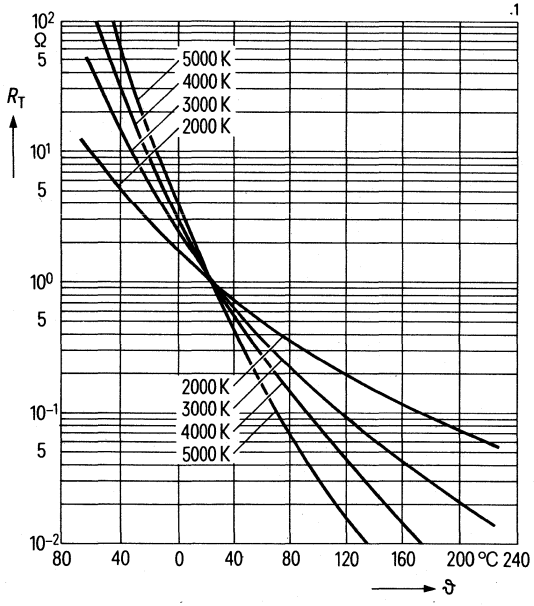


Figure 1
Resistance – temperature characteristics (parameter = B)

R_T NTC thermistor resistance value at temperature T in K
R_R NTC thermistor resistance value at temperature T_R in K
A Constant with the dimension Ω
B Material constant of the NTC thermistor with the dimension K, the "B value"
T Temperature in K

The temperature coefficient of an NTC thermistor results from the equations (1) or (2) as follows.

$$\alpha_R = \frac{1}{R_t} \times \frac{dR_T}{dT} = -\frac{B}{T^2} \quad (3)$$

For B values between 2500 K and 5000 K which occur in practical applications, the temperature coefficient at room temperature lies between −2.8 and −5.6%/K.

The approximation for the resistance value-temperature characteristic curve given in equations (1) and (2) will be sufficient for most applications.

Better approximations for precise measurements over a wide temperature range can be obtained by applying various correction formulae. Our experience has shown that the minimum calculation effort is required if only the B value is regarded as temperature-dependent, as in

$$R_T = R_{TO} \times e^{B(\vartheta)\left(\frac{1}{T}-\frac{1}{T_o}\right)} \qquad (4)$$

$B(\vartheta) = B[1+\beta(\vartheta - 100)]$

$\beta \quad = 2.5 \times 10^{-4}$ 1/K for $\vartheta > 100$°C

$\beta \quad = 5 \times 10^{-4}$ 1/K for $\vartheta < 100$°C

$To \quad = 298.15$ K ($\triangleq$25°C)

ϑ is the temperature in °C, i.e. $T = \vartheta + 273.15$ K.

The characteristic curve of the precision NTC thermistors is calculated with square-law correction elements which are determined empirically.

2.1.2 Tolerance

The resistance value R_R and the B value are subject to manufacturing tolerances. Due to the B tolerance, which describes the varying steepness of the resistance-temperature characteristic, an increase in deviation must be expected at temperatures which lie above or below the rated temperature T_R. The deviation of an NTC from its theoretical characteristic curve is calculated according to equation (5).

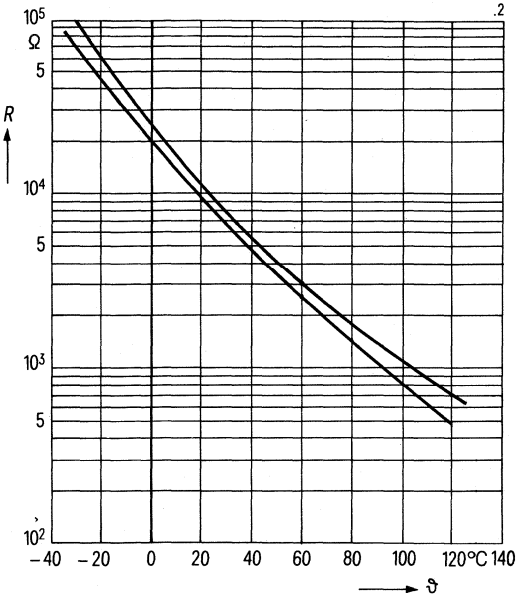


Figure 2
Deviation range of the resistance value (K11/5%/10 kΩ)

$$\left|\frac{\Delta R_T}{R_T}\right| = \left|\frac{\Delta R_R}{R_R}\right| + \left|\frac{\Delta B}{B}\, ln\, \frac{R_T}{R_R}\right| \qquad (5)$$

$\frac{\Delta R_T}{R_T}$ is the maximum deviation of the resistance value at temperature T.

$\frac{\Delta R_R}{R_R}$ is the tolerance at the rated temperature T_R.

$\frac{\Delta B}{B}$ is the permissible deviation of the B value.

The resistance deviation thus consists of the basic tolerance of the rated resistance, and a temperature-dependent component which includes the tolerance of the B value.

For example, the maximum resistance deviation expected in type K11/5%/10k is
at 20°C : 10kΩ±5%;
at 120°C : 0.6kΩ±19%.

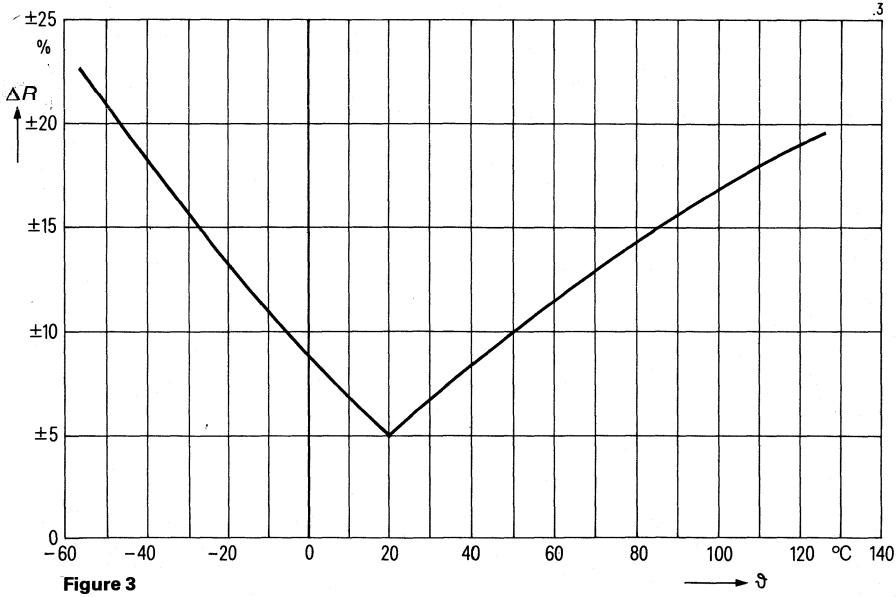


Figure 3
Deviation range of the resistance value
(K11/5%/10kΩ)

In the case of the precision NTC thermistors M841, M843, M846, M847, M867, an extremely close resistance tolerance over a wide temperature range is achieved by special selection of the NTC compound, by special production methods, and by individual adjustment.

2.1.3 Aging

Certain reactions causing a change in resistance value, occur within the polycrystalline NTC thermistor body even at low temperatures. As this variation decays with time, the NTCs are subjected to artificial aging. This considerably improves the long-term stability.

Typical values for the change in resistance value due to aging, are provided by the equation

$$\left(\frac{\Delta R_R}{R_R}\right)t = \left(\frac{\Delta R_R}{R_R}\right)_{10000} \times \left(\frac{t}{10000}\right)^K \quad (6)$$

$\left(\frac{\Delta R_R}{R_R}\right)_t$ Change in resistance value after time t in hours

$\left(\frac{\Delta R_R}{R_R}\right)_{10000}$ Change in resistance value after 10000 hours

K The value for the exponent K lies between 0.3 and 0.5.

With some types, the values specified for the change in resistance after 10000 hours are valid if the NTC thermistor is operated within the permissible temperature range. Should the maximum operating temperature be only 60°C, then the change is generally reduced a factor of 2 to 3.

2.2 Behavior of the NTC thermistor under electrical load

2.2.1 General information

The following formula applies in general to the heating of an NTC thermistor by electric load:

$$P = G_{th}\,(T - T_{amb}) + C_{th} \times \frac{dT}{dt} \quad (7)$$

P Electric power load

G_{th} Thermal conductance of the NTC

T Temperature of the NTC

T_{amb} Ambient temperature

C_{th} Thermal capacitance of the NTC

$\frac{dT}{dt}$ Change in temperature with time

2.2.2 Voltage-current characteristic curve

If a constant electric power is supplied to the NTC thermistor, then its temperature will first vary considerably, but the rate of change decreases with time. After a certain period, a steady state is reached in which the power applied is dissipated into the environment by thermal conduction or thermal radiation.

In this case, $\frac{dT}{dt}$ in equation (7) becomes 0; this results in

$$P = G_{th} \times (T - T_{amb}) \quad (8)$$

$$I^2 \times R_T = G_{th} \times (T - T_{amb})$$

$$\frac{V^2}{R_T} = G_{th} \times (T - T_{amb})$$

and with

$$R_T = A \times e^{\frac{B}{T}}$$

$$I = \sqrt{\frac{G_{th}\,(T - T_{amb})}{A \times e^{\frac{B}{T}}}} \quad (8a)$$

$$V = \sqrt{G_{th}\,(T - T_{amb}) \times A \times e^{\frac{B}{T}}} \quad (8b)$$

in the parameter description of the voltage-current characteristic curve, whereby R_T is the (temperature-dependent) resistance value of the NTC thermistor.

If the voltage values obtained at a constant temperature are plotted versus the current, then the result will be the voltage-current characteristic curve of the NTC thermistor. Equations (8a) and (8b) are the parameter description of that characteristic curve, with the aid of which it is possible to calculate the voltage-current characteristic curves of various ambient temperatures or to draw them graphically in a double logarithmic coordinate system. [In this case, the curves of equal power (P = const.) and the curves of equal resistance value (R = const.) become straight lines at an angle of 45°.]

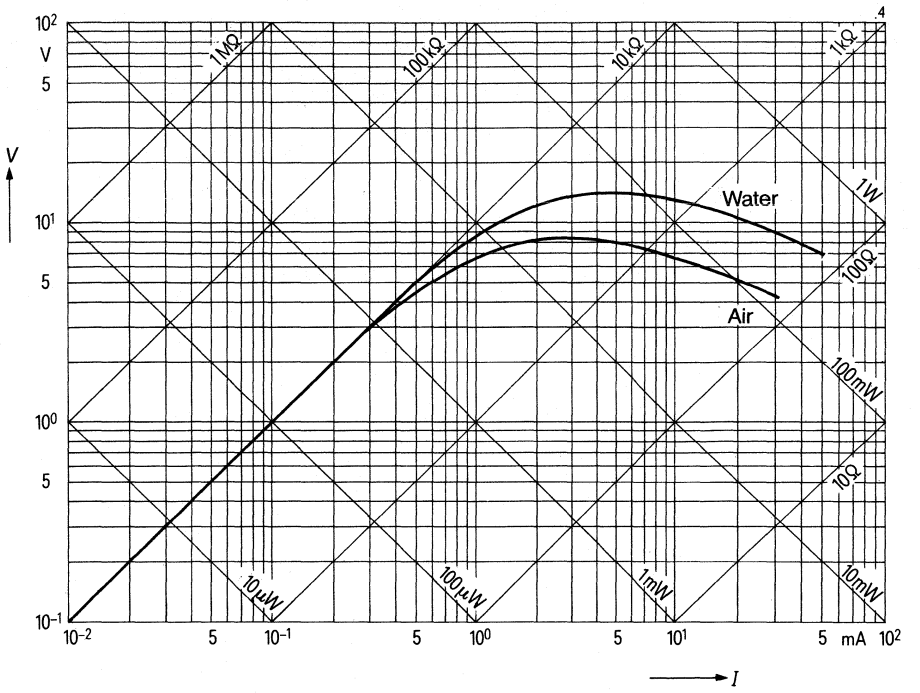


Figure 4
Voltage-current characteristic: M85/10 kΩ
(logarithmic scale)

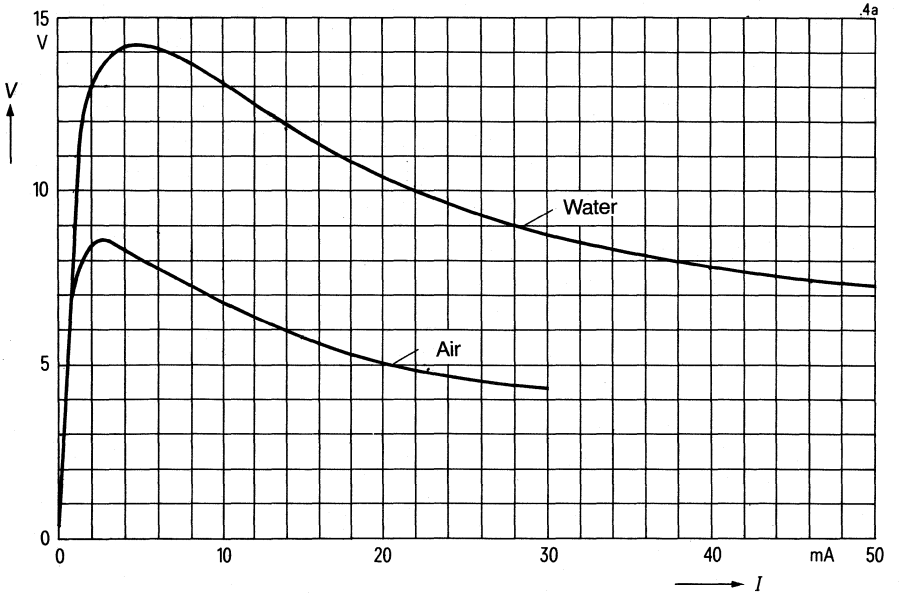


Figure 4a
Voltage-current characteristic: M85/10 kΩ
(linear scale)

The voltage-current characteristic curve of an NTC thermistor has three different sections:

1. The straight rise in which the power applied is so low that no noticeable intrinsic heating occurs. In this section, the resistance value of the NTC is only dependent on the ambient temperature.

2. The delayed rise up to the maximum voltage in which the resistance value of the NTC is already noticeably reduced. At the maximum voltage, the relative resistance reduction $\Delta R/R$ – due to heating – is equal to the relative current increase $\Delta I/I$.

3. The falling section, in which the relative resistance reduction is higher than the relative current increase.

The condition for the maximum voltage can be determined from equation (8b)

if $\frac{dV}{dT}$ is set equal to 0.

This results in the equation

$$T = \frac{B}{2}\left(1 - \sqrt{1 - \frac{4T_{amb}}{B}}\right) \qquad (8c)$$

The corresponding pair of values V_1 and I_1 can then be determined from equations (8a) and (8b).

In case where $B < 4T_{amb}$ (approximately $B < 1200\,K$), there will not be any maximum voltage as the value under the square root sign will become negative.

At an ambient temperature of 25°C and a typical practical B value between 2500 K and 5000 K the maximum voltage lies above the ambient temperature if the NTC temperature amounts to a value between 30 and 50 K.

As shown in equations (8a) and (8b), the NTC thermistor resistance R_T as well as the NTC thermal conductance G_{th} are part of the voltage-current characteristic behavior.
The thermal conductance is not only dependent on size and shape of the NTC and its leads, but also on the medium which surrounds the NTC.

The voltage-current characteristic curves shown in the data sheets are specified for stationary air as surrounding medium. In flowing air or in a liquid, the thermal conductance rises and the voltage-current characteristic curve is displaced towards higher voltage and current values. If the medium is a vacuum, the opposite applies.

The position of the voltage-current characteristic curve can thus indicate the surrounding medium. This results in the possibility of using NTC thermistors as sensors for flow rates of gases and liquids, for vacuum measurements, or for gas analysis.

2.2.3 Thermal time constant τ_{th}

If the electric load is disconnected from an NTC thermistor, then equation (7) changes to

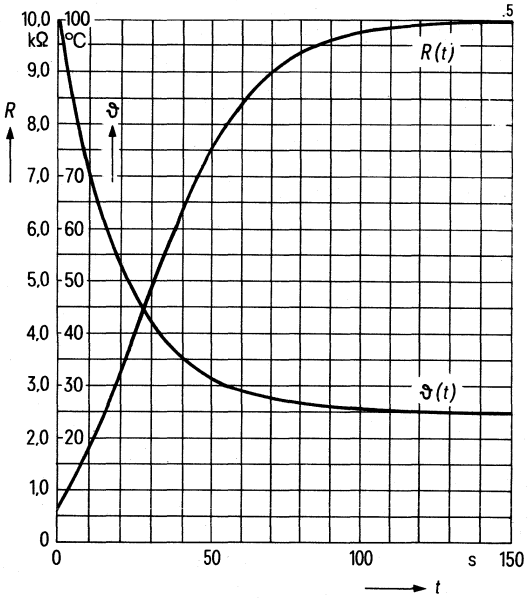


Figure 5
Resistance-time characteristic (K164/10 kΩ)

$$G_{th}\,(T - T_{amb}) + C_{th} \times \frac{dT}{dt} = 0$$

This equation can be integrated and results in

$$(T - T_{amb}) = (T_i - T_{amb}) \times e^{-\frac{t}{\tau_{th}}} \qquad (9)$$

T_i Initial temperature of the NTC
T_{amb} Ambient temperature

$\tau_{th} = \frac{C_{th}}{G_{th}}$, the thermal time constant of the NTC

With the aid of equation (4) for $R\,(\vartheta)$, the resistance-time characteristic curve can be calculated.
Example: K164 (figure 5)

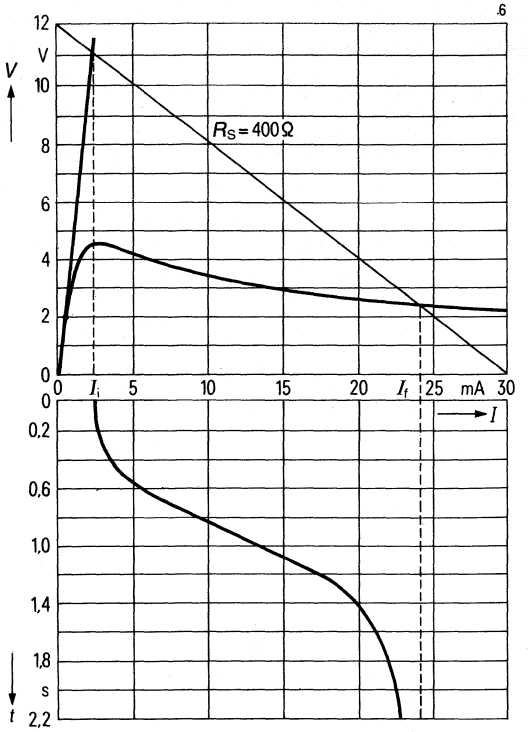


Figure 6
Current-time characteristic
(A34-2/30)

2.2.4. Current-time characteristic curve

If an NTC thermistor is connected via a series resistor to a voltage soure and the current is measured versus the time, the result will be the current-time characteristic curve of the NTC.

When the voltage is applied, the thermistor is cold, which means that it has a high resistance and only little current flows. This current heats the NTC and the power applied increases as the NTC thermistor resistance approaches the one of the series resistor. Thereby the rate of current rise becomes steeper and steeper until the NTC thermistor resistance is equal to the one of the series resistor. If the NTC thermistor resistance continues to decrease, the power applied is reduced due to the increasing mismatching, and the current tends to settle at a final value. In this state, the complete power applied is used to maintain the overtemperature.

The behavior of the current-time characteristic curve is of particular importance if the NTC is employed for delaying relay operation or for suppression of current surges.

In the data sheets, current-time characteristic curves are only provided for NTC types which are particularly manufactured for those applications.

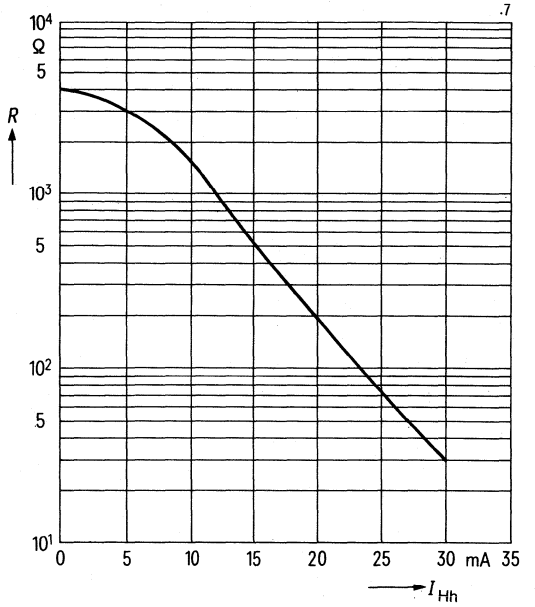


Figure 7
Resistance value-heater current characteristic (F75-34/14u)

2.3 Externally heated NTC thermistors

Externally heated NTCs consist of a bead-shaped NTC thermistor onto which the glass carrier of a heater helix is melted. With the help of that glass carrier, the heater is electrically isolated from the NTC, but it still has a good thermal contact with the latter. A current flowing through the heater helix controls the NTC thermistor resistance.

Externally heated NTC thermistors are mainly used for level regulation in carrier frequency systems and generally as current-dependent, controllable resistors in measuring and regulating systems.

3. Application notes

3.1 Application possibilities

Owing to the features and characteristic curves mentioned in section 2, the NTC thermistor has a wide range of possible applications

in chemistry
Calorimetry
Differential-thermometrical titration
Level regulation of liquids, e. g. liquid nitrogen
Measuring the thermal conductivity of gases

in physics
Vakuum measurement
Measuring the flow rates of gases and liquids
Radiometry

in medical science
Measuring the body and skin temperatures
Measuring the flow rates of blood

in temperature regulation of household appliances
Deep freezers
Washing machines
Electric stoves
Heating systems
Air conditioning systems

in vehicles
Measuring the coolant and oil temperatures
Monitoring of exhaust gas temperatures
Glaze warning units

in electric engineering
Delaying the relay operation
Compensation of undesirable temperature variation
Microwave power measurement

The various types of NTC thermistors are divided and designated corresponding to their main application fields. The first letter of the type designation indicates the application according to the following code:

H	High temperature sensors $> 200°C$
K; M	Temperature compensation and temperature measurement
A	Relay delay and current surge suppression
R	Regulation of voltages
F	Externally heated NTC thermistors

The two or three figures following the letter indicate the design. After a hyphen or slash follows the characteristic electrical data – in some cases in encoded form.

3.2 Installation notes

3.2.1 Soldering

In accordance with DIN 44070, the following maximum temperatures and times must be observed when soldering at the NTC thermistor leads.

Dip soldering
Bath temperature 260°C – soldering time 4 s

Iron soldering
Iron temperature 360°C – soldering time 2 s

Unless otherwise specified, soldering should not be carried out less than 6 mm away from the NTC body. If the soldering conditions are more severe, resistance changes must be expected. In the case of NTC thermistors without leads, soldering is only possible with certain restrictions. Due to the temperature shock when the hot solder is applied, fine cracks may occur in the ceramic body and result in resistance changes.

In order to prevent removal of the silver layer from the ceramic disc during soldering, solders with silver additives or solders with low tin contents should be used.

3.2.2 Mechanical stress on the leads

Twisting (torsion) of the leads by an angle of 180° is only permissible if the distance from the NTC body is at least 6 mm.

It is not permitted to bend the leads directly at the NTC body.

The wire may be bent at a minimum distance of twice the wire diameter +2 mm from the NTC body. The bending radius must at least be 0,75 mm. Bending of the solder tags or plug pins is not permissible.

3.2.3 Encapsulation and sealing

If NTC thermistors are to be encapsulated or sealed, care must be taken that no mechanical stresses are transferred to the NTC. A method which has proved successful is to encapsulate the NTC with a silicon rubber compound before sealing it with epoxy resins.

In order to prevent a corrosion of the NTC contacts, the sealing compound must be chemically neutral.

3.3 Dimensioning notes

3.3.1 Temperature measurement and regulation

Compared with other commercially available temperature sensors, NTC thermistors have considerable advantages in many applications:

a) Owing to the high resistance value, the resistive effects of leads can be neglected. Due to the wide spectrum of various resistance values, the most favorable resistance value can be selected for any application.

b) The high temperature coefficient enables a measuring of temperature differences of 10^{-4} K or less with little effort.

c) The small sizes which are possible for NTCs permit small time constants and thus a rapid response of the sensors. The smallest measuring NTC thermistor in this data book has a diameter of only 0.4 mm.

The tolerances (see also section 2.1.2) can, if necessary, be compensated by resistors connected in series and parallel with the NTC thermistor. This also permits linearization of the resistance-temperature characteristics in accordance with equation (2). The dimensioning of linearization resistors is specified in section 3.3.2. However, any connection of fixed resistors decreases the steepness of the characteristic curve.

NTC thermistors used for temperature measurement purposes should have such a low electrical load that no remarkable heating will occur and the NTC resistance value will be determined only by the ambient temperature.

If an overtemperature ΔT due to intrinsic heating is permitted, then

$$I = \sqrt{\frac{G_{th} \times \Delta T}{R_T}} \qquad (10a)$$

and

$$V = \sqrt{G_{th} \cdot \Delta T \cdot R_T} \qquad (10b)$$

A rule of thumb is the fact that the overtemperature ΔT should be lower than the required measuring accuracy. The thermal conductance G_{th} is normally specified in the NTC data sheets for the case where the NTC thermistor is surrounded by stationary air.

If the NTC is operated in a liquid or if it is installed in a case, the thermal conductance may be increased by a factor of 2 to 5, thus permitting a higher load.

3.3.2 Temperature compensation (linearization)

The electrical load should also in this case be so low that the NTC resistance value is determined only by the ambient temperature. In compensation applications, the distinct nonlinearity of the NTC thermistor characteristic curve is often a problem. However, that characteristic curve can be linearized by connecting a fixed resistor in parallel. The combination of NTC thermistor and parallel resistor has an S-shaped characteristic curve with an inflection point, depending on the temperature.

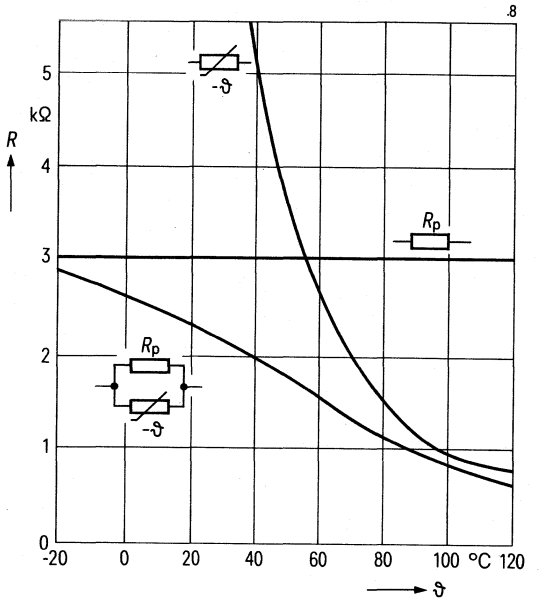


Figure 8
Linearization of the characteristic curve by a parallel resistor; $R_p = 3\,k\Omega$ (K11/10 kΩ)

The best linearization is obtained by placing that inflection point in the center of the operation temperature range. The resistance value of the parallel resistor is then

$$R_p = R_{Tctr} \times \frac{B - T_{ctr}}{B + 2T_{ctr}} \qquad (11)$$

R_{Tctr} NTC thermistor resistance at the center temperature T_{ctr}

B B value of the NTC thermistor

The steepness of the characteristic curve of this combination is independent of the temperature

$$\frac{dR}{dT} = -\frac{B}{T_{ctr}^2} \times R_{Tctr} \times \frac{1}{\left(1 + \frac{R_{Tctr}}{R_p}\right)^2} \qquad (12)$$

If the value R_{Tctr}/R_p obtained from equation (11) is put into equation (12), then the suitable NTC thermistor resistance for a given $\frac{dR}{dT}$ can be calculated.

The circuit shown in figure 9 can be used for temperature compensation of voltages which are linearly dependent on the temperature.

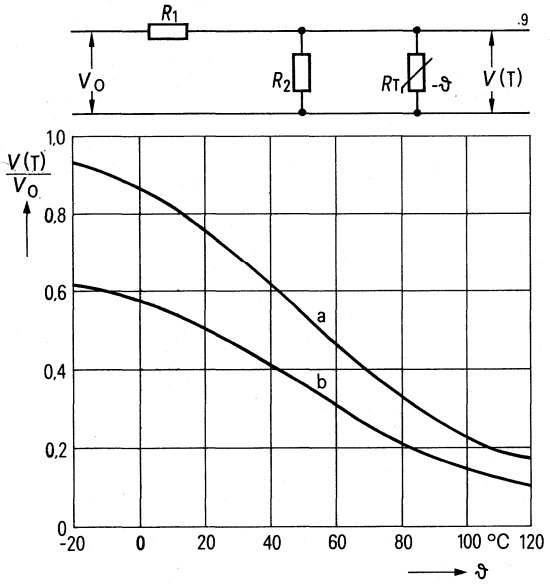


Figure 9
Temperature-dependent voltage divider
a: $R_1 = 3\ k\Omega$; $R_2 \rightarrow \infty$
b: $R_1 = 4.5\ k\Omega$; $R_2 = 9\ k\Omega$
R_T = K11–10 kΩ

In this case, the voltage $V(T)$ has an S-shaped behavior and the following applies at the inflection point:

$$R = R_{Tctr} \times \frac{B - 2T}{B + 2T}$$

where $R = \frac{R_1 \times R_2}{R_1 + R_2}$

The voltage variation with temperature is in this case

$$\frac{dV}{dT} = \frac{R_2}{R_1 + R_2} \times V_0 \times -\frac{B}{T^2} \times \frac{R_{Tctr}}{R} \times \frac{1}{\left(1 + \frac{R_T}{R}\right)^2} \qquad (13)$$

Any required voltage variations can be adjusted by means of the division ratio $\frac{R_2}{R + R_2}$, but a possible loading of the voltage divider must be taken into account. The resistance of the load takes effect as reduction of R_2.

3.3.3 Relay delay

Type series A34 has been predominantly developed for delaying relay operation. Those NTC thermistors permit relay starting and delay times in the range between 0.1 s and several seconds. However, the delay time t_d depends considerably on the supply voltage V_{op}, approximately

$$t_d \sim \frac{1}{V_{op}^2} \text{ to } \frac{1}{V_{op}^3},$$

and in addition, it is temperature-dependent. Its temperature coefficient is approximately half that of the NTC thermistor if the following dimensioning rules are observed.

As shown in figure 10, a series connection of NTC thermistor and relay coil is used for delaying the relay start.

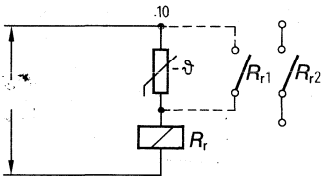


Figure 10
Delay of relay start

When the voltage V_{op} is connected, the current through the relay coil will be limited to a fraction of the relay response current by the high resistance of the cold NTC thermistor. The NTC intrinsic heating causes the NTC resistance value to drop, and the current rises until response current I_{resp} of the relay is reached. The following rules should be observed when dimensioning delay circuits with NTC thermistors (see figure 6).

- The supply voltage V_{op} should be at least 1.5 times and at most 6 times the maximum voltage V_1 of the NTC voltage-current characteristic curve.
- The supply voltage V_{op} should be at least 1.5 times, but if possible, be twice the average relay starting voltage.
- The maximum response current I_{resp} of the relay must not exceed 0.8 times the resulting final current value I_f.
- The stationary final current I_f must not be greater than the continuous operating current I_R specified in the data sheets. Should the NTC thermistor be short-circuited or disconnected after the relay has been started, both, I_{resp} and I_f, may be greater than I_R provided that the maximum current $I_{NTC\,M}$ will not be exceeded.

A parallel connection of relay coil and NTC thermistor is used for delaying the relay release.

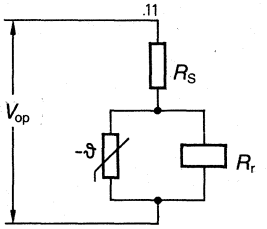


Figure 11
Delay of relay release

In this case, the following dimensioning rules apply:

- With a cold NTC thermistor, the voltage across the coil must be at least 1.5 times the maximum voltage V_1.
- The voltage at which the relay is released should not be less than 1.5 times the rated voltage of the NTC thermistor V_R.

The switching sequence of a relay delayed by means of an NTC thermistor depends on the NTC recovery time. The NTC has to cool down before it can cause a new delay. If it is unloaded for a period of $t = 3 \times \tau_{th}$ (3 times the thermal time constant) between two load operations, then the delay of the second operation is approximately 80 to 90% of the first delay time. It is therefore advisable to short-circuit or disconnect the NTC thermistor by means of additional relay contacts in order to provide the maximum possible time for cooling the NTC (shown as a dashed line in figure 10).

3.3.4 Voltage regulation

NTC thermistors can be used in a manner similar to Z diodes for stabilizing voltages. If a fixed resistor with a value of approximately 1% of the NTC cold resistance is connected in series with the NTC thermistor, an about 10% constant voltage can be picked off across NTC thermistor and series resistor over a current range of 1:10.

Compared with Z diodes, voltage regulation with NTC thermistors has the advantage of no harmonic vibration being generated, and in this way regulation of wide frequency bands is made possible. A distortion factor, which rises with decreasing frequency, does not occur unless frequency values amount to about only 20 Hz, and is caused by the fact that the NTC resistance value is already changed during one half wave.

Version R51 with which voltages of approximately 4 V (R51-4/1/20) and 8 V (R51-8/0.5/10) can be regulated, is especially suitable for that application purpose.

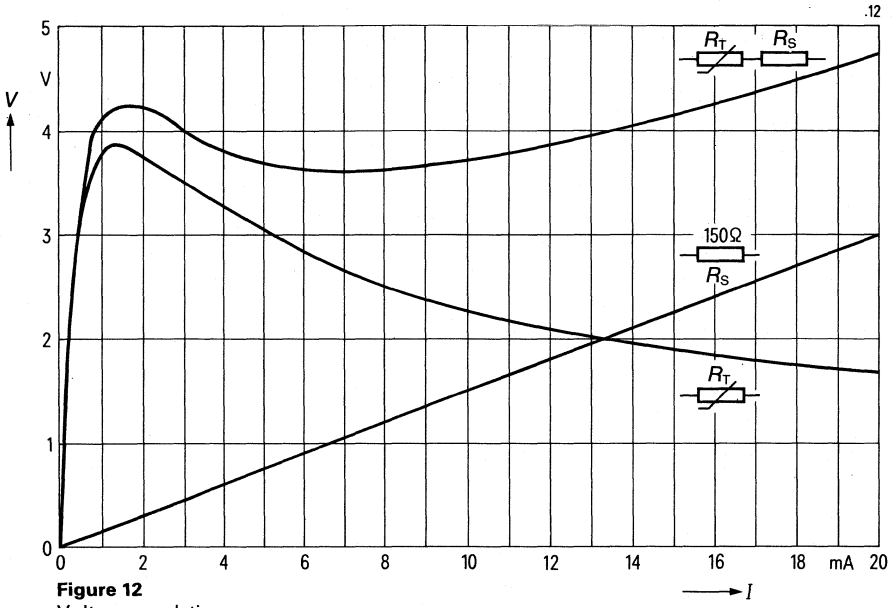


Figure 12
Voltage regulation
(R51-4/1/20)

3.3.5. Parallel connection of NTC thermistors

Parallel connection of two or more NTC thermistors is only possible as long as the heating due to electrical loading is negligible. As soon as the NTC thermistors are driven into the negative section of the voltage-current characteristic curve, the NTC with the lowest resistance value will carry most of the current, is thus heated even more, and will finally carry the complete current amount.

4. Explanation of technical data

4.1. Rated or reference temperature

The terms used in the following technical data for NTC thermistors largely comply with DIN 44070 "Thermistors, NTC Technical Terms and Tests".

The temperature at which the rated resistance value is specified, is for historical reasons mostly 20°C. Conversion to 25°C would result in unusual resistance values if interchangeability with the original types is to be ensured.

As nowadays the reference temperature of 25°C is also used, this technical data introduces a rated temperature at which the rated resistance value is specified; this being a deviation from the standard. The rated resistance values specified in the technical data are no-load resistance values, i.e. the resistance value is measured with such little electrical load that a further reduction of the load would result in not more than a 0.1% change of the resistance value.

4.2 Quality specifications

In order to characterize the quality of NTC thermistors, the following is indicated:

- Limit values, as well as the deviation of the characteristic data (tolerances)
- Maximum proportions of defective components, so-called AQL values (acceptable quality level), for the values specified in the table below. The principles of statistics must be taken into account when judging the delivery quality.
- A defect exists if a component characteristic does not correspond to the data sheet specifications. The defects are distinguished either according to their type or to their extent.

  Distinction according to the defect types:
  - Defects at cases and terminals
  - Defects in the electrical features

  Distinction according to the defect extent:
  - Total defects: Defects which exclude any functional application
  - Gradual defects: Defects which permit a functional application subject to restrictions
- AQL values:
  The AQL values which apply to the various defects are listed in the table below.

  Defects with respect to deviation values are counted separately.

Defects	AQL value	Remarks
Defects at cases and terminals		
Total defects	0.25%	Total of all defects
Gradual defects	2.5 %	
Defects in the electrical characteristics		
Total defects	0.25%	Total of all defects
Gradual defects		
for characteristics with AQL specification	0.65%	For each defect
	2.5 %	Total of all defects
for characteristics without AQL specification	The deviation of these characteristics are specified such that approximately 2.5% of the product may lie above or below the limits.	

- Incoming inspection

  The examinations carried out by the manufacturer are intended to make an incoming inspection by the user unnecessary. However, should the user nevertheless wish to carry out an incoming inspection, then the application of a random sampling test plan in accordance with the following regulations is recommended:

  VG 95082 and 95083, as well as ABC STD 105
  ASQ random sampling test tables for attribute examination ASQ/AWF1
  (available from Beuth-Vertrieb GmbH, Berlin W15 and Cologne).

4.3 Matching pairs

Matching pairs of some NTC thermistor types are supplied upon request.

The two NTCs which are packed together, deviate in their rated resistances and B values only by a specified amount from the common average value.

Two pairing conditions are offered:

Matching pair P1

$$\frac{R_R - R_{av}}{R_{av}} \leqslant \pm 2.5\%$$

$$\frac{B - B_{av}}{B_{av}} \leqslant \pm 2\%$$

Matching pair P2

$$\frac{R_R - R_{av}}{R_{av}} \leqslant \pm 1.5\%$$

$$\frac{B - B_{av}}{B_{av}} \leqslant \pm 1\%$$

Thereby, $R_{av} = \frac{R_{R1} + R_{R2}}{2}$ $B_{av} = \frac{B_1 + B_2}{2}$

R_{R1} and B_1 are rated resistance and B value of the one NTC thermistor, R_{R2} and B_2 rated resistance and the B value of the other NTC thermistor.

5. Climatic categories in accordance with DIN 40040

In this data book, the climatic category is specified for each version concerned. The upper and lower category temperatures can be found in table I. Table II provides information on the humdity category.

Climatic categories are formed in accordance with DIN 40040, 2.73.
In compliance with this standard, the coding of climatic categories comprises three letters:

1. Code letter for lower category temperature
2. Code letter for upper category temperature
3. Code letter for permissible humidity category

Example for the formation of climatic categories with code letters: **F** **K** **F**

Lower category temperature	− 55°C
Upper category temperature	+125°C
Humidity category	
Annual average	75%
Max. values for 30 days per year	95%
No dew precipitation is permissible	

5.1 Lower category temperature ϑ_{min}

is defined as the lowest permissible component temperature during operation (without the effects of intrinsic and extrinsic heating, at the moment of turning on).

5.2 Upper category temperature ϑ_{max}

is defined as the maximum permissible temperature which may occur at the hottest point on the component surface (including the effects of intrinsic and extrinsic heating).

5.3 Code letters for category temperatures (in accordance with DIN 40040, 2.73)

The permissible temperature ranges depend on the component version.
The following category temperatures occur:

1st code letter	Lower category temperature
E	− 65°C
F	− 55°C
G	− 40°C
H	− 25°C
J	− 10°C
K	0

2nd code letter	Upper category temperature
A	+400°C
B	+350°C
C	+300°C
D	+250°C
E	+200°C
F	+180°C
G	+170°C
H	+155°C
J	+140°C
K	+125°C
L	+110°C
M	+100°C
N	+ 90°C
P	+ 85°C
Q	+ 80°C
R	+ 75°C
S	+ 70°C
T	+ 65°C
U	+ 60°C
V	+ 55°C
W	+ 50°C
Y	+ 40°C
Z	+ 1000°C

5.4 Code letters for humidity categories (in accordance with DIN 40040, 2.73)

3rd code letter	Limits of the relative humidity[1]			e.g. suitable for the following environmental component climates
	Relative humidity		Dew precipitation	
	Annual average	Maximum value		
R[3]	≤90%	100%	yes	Equipment installed outside or in outdoor rooms; in cold, moderate, or subtropical climatic areas; also in unheated rooms which are not too damp.
D[3]	≤80%	100% for 30 days[2] per year	yes	Equipment in outdoor rooms and in medium moist rooms; in unheated rooms without major additional moisture sources, in moderate and cold climatic areas. Equipment installed outside in warm-dry climatic areas, if $\overline{U_{mon}}$ = 75%[5] in the month with the most moisture.
E[4]	≤75%	95% for 30 days[2] per year	seldom and slight	Equipment installed in warm-dry climatic areas in outdoor and indoor rooms, if $\overline{U_{mon}}$ = 70%[5] in the month with the most moisture. Operated equipment in rooms endangered by moisture, e.g. workshops, in cold, moderate, and warm-dry climatic areas. Non-operated equipment in moderate rooms endangered by moisture, in moderate and cold climatic areas; seldom and slight short-term dew precipitation is permissible.
F[4]	≤75%	95% for 30 days[2] per year	no	Like category E, but dew precipitation is not permitted.

[1] Specifications refer to the environmental component climate.
[2] Those days should be distributed throughout the year in a natural way.
[3] The values specified apply to all temperatures within the upper and lower category temperatures (permissible temperature range). Particularly for climatic areas with additional moisture sources.
[4] The values specified for the relative humidity refer to components in ambient temperature. In case of higher temperatures, the relative humidity decreases in accordance with DIN 40040, supplement I.
[5] $\overline{U_{mon}}$ is the monthly average value of the relative humidity, which has been ascertained over a period of many years.

6. Symbols and terms

A	NTC thermistor constant
α_R	Temperature coefficient of the specific resistance
B	B value, material constant for determination of the temperature dependence of NTC thermistors
ΔB	Tolerance (of B value)
B_{av}	Average B value
β	Temperature coefficient of the B value
$C_{NTC\text{-}Hh}$	Capacitance between NTC thermistor and heater helix of externally heated NTC thermistors
C_p	Parallel capacitance
C_{th}	Thermal capacitance
d	Diameter
G_{th}	Thermal conductance
G_{thA}	Thermal conductance in air
G_{thC}	Thermal conductance in case of chassis mounting
G_{thW}	Thermal conductance in water
I	Current through the NTC
I_1	Current at the maximum voltage V_1 of the stationary voltage-current characteristic curve
I_f	Final value of current
I_{Hh}	Heater helix current of externally heated NTC thermistors
I_{htM}	Maximum heater current
I_i	Initial current
I_{meas}	Measuring current
$I_{NTC\,M}$	NTC peak current (permissible current for short periods, providing the NTC resistance R_T does not drop below a specific minimum value)
I_R	Rated current
I_{resp}	Response current
$k_{3\,kHz}$	Distortion factor at 3 kHz
$k_{30\,Hz}$	Distortion factor at 30 Hz
L_{ht}	Heater inductance
L_s	Series inductance

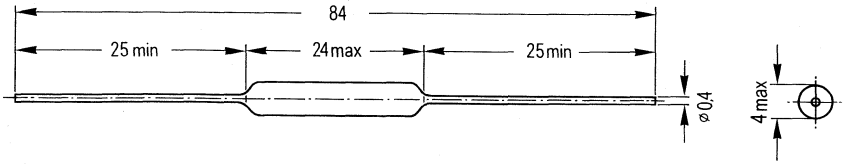
NTC	Abbreviation for negative temperature coefficient thermistor
P	Power
P_{25}	Power rating at 25°C
P_{60}	Power rating at 60°C
P_{100}	Power rating at 100°C
P_{max}	Peak NTC power rating (permissible power dissipation for short periods, providing the NTC thermistor resistance R_T does not drop below a specific value)
R	Resistance
R_{20}	Resistance at 20°C
R_{25}	Resistance at 25°C
R_{80}	Resistance at 80°C
R_{130}	Resistance at 130°C
R_{-30}	Resistance at −30°C
R_{av}	Average resistance
R_{ba}	Series of basic resistance values
ΔR_{ba}	Permissible deviation of the basic resistance values
R_{Hh}	Resistance of the heater helix of externally heated NTC thermistors
ΔR_{Hh}	Tolerance of the resistance of heater helix
R_{hot}	Resistance of the hot NTC thermistor
R_{is}	Insulation resistance
R_{min}	Hot resistance (minimum value for continuous operation)
R_p	Value of parallel resistance
R_r	Relay resistance
R_R	Rated resistance
ΔR_R	Tolerance of the rated resistance
$\Delta R_{10.}$	Maximum change of the rated resistance after 10 000 hours
R_S	Series resistance
R_T	NTC thermistor resistance at temperature T
R_{Tctr}	NTC thermistor resistance at temperature T_{ctr}
ΔR_T	Deviation of the resistance value from the ideal characteristic curve
$(\Delta R_T)_t$	Expected resistance change after time t

t	Time
t_d	Rated value of delay time
Δt_d	Tolerance of delay time
$t_{sold\,M}$	Maximum soldering time
t_t	Test duration
th	Thickness
T	Absolute temperature
ΔT	Temperature difference
T_{amb}	Ambient temperature
T_{ctr}	Temperature at the center of a temperature range
T_i	Initial temperature
T_R	Rated temperature
T_{stg}	Storage temperature
V	Voltage
V_1	Maximum voltage of current-voltage characteristic curve
V_{op}	Operating voltage
V_R	Rated voltage
ΔV_R	Tolerance of the rated voltage
V_{test}	Test voltage
τ	Time constant
τ_{th}	Thermal time constant
τ_{thA}	Thermal time constant in air
τ_{thC}	Thermal time constant in case of chassis mounting
τ_{thW}	Thermal time constant in water
ϑ	Temperature
ϑ_{min}	Lower category temperature
ϑ_{max}	Upper category temperature
ϑ_R	Rated temperature
$\vartheta_{sold\,M}$	Maximum soldering temperature
$\vartheta_{stg\,min}$	Minimum storage temperature
$\vartheta_{stg\,max}$	Maximum storage temperature

Types for Industrial and Standard Applications

NTC thermistors with 5 kΩ to 200 kΩ

Application	Starting and release delay of relays
Version	Glass case, hermetically sealed
Terminals	Leads, tinned
Marking	Type designation is stamped on the component
Quality characteristic	High reliability due to special production and aging methods



Weight: approx. 0.6 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**FKR**
Lower category temperature	**F** − 55°C
Upper category temperature	**K** +125°C
Humidity category	**R** Average relative humidity ≤ 90% 100% continuously on 30 days per year 95% occasionally on the remaining days Dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

Type	Rated resistance	Tolerance	*B* value	Ordering code
A 34−2/30a	5 kΩ	±30%	3440 K	Q63034−A1−J
A 34−2/30b	5 kΩ	±30%	3440 K	Q63034−A1−M
A 34−4/20	15 kΩ	±30%	3440 K	Q63034−A2
A 34−5/15	40 kΩ	±30%	3450 K	Q63034−A3
A 34−6/40	6 kΩ	±20%	2920 K	Q63034−A4
A 34−7/10	100 kΩ	±30%	3950 K	Q63034−A5
A 34−10/25	40 kΩ	±20%	3440 K	Q63034−A6
A 34−14/30	40 kΩ	±20%	3440 K	Q63034−A7
A 34−25/18	200 kΩ	±20%	3900 K	Q63034−A8

Characteristic data

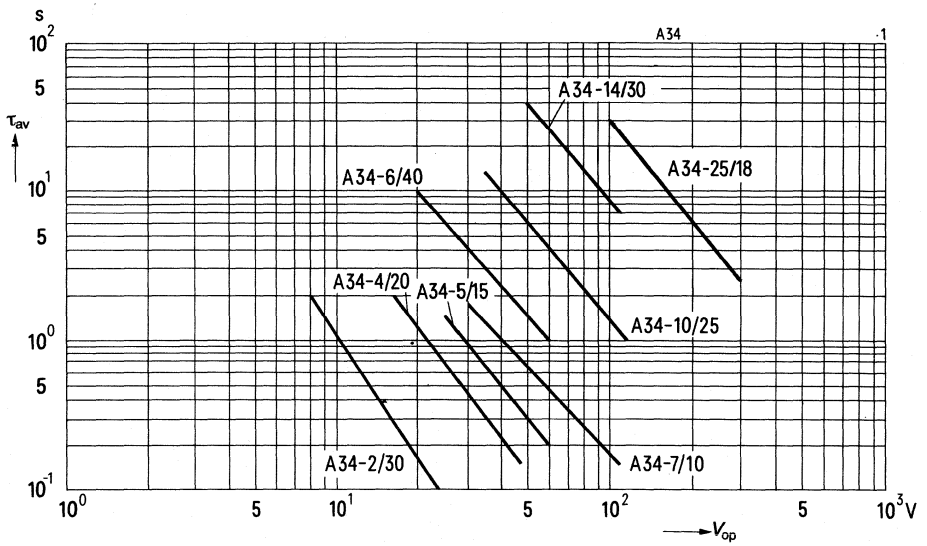
Type	A 34	2/30a	2/30b	4/20	5/15	6/40	7/10	10/25	14/30	25/18	Unit
Power rating at 25°C	P_{25}	60	60	80	75	240	70	250	420	450	mW
at 60°C	P_{60}	46	46	66	61	190	56	210	340	360	mW
Rated temperature	ϑ_R	20	20	20	20	20	20	20	20	20	°C
Rated resistance	R_R	5	5	15	40	6	100	40	40	200	kΩ
Tolerance [1])	ΔR_R	±30	±30	±30	±30	±20	±30	±20	±20	±20	%
B value	B	3440	3440	3440	3450	2920	3950	3440	3440	3900	K
Thermal conductance in air	G_{thA}	0.4	0.4	0.4	0.4	1.5	0.4	1.2	2.3	2.5	mW/K
Thermal time constant	τ_{th}	1.2	1.2	1.2	1.2	7.0	1.2	6.0	14	12	s
Thermal capacitance	C_{th}	0.5	0.5	0.5	0.5	10.0	0.5	7.0	32	30	mJ/K
Rated voltage	V_R	2	2	4	5	6	7	10	14	25	V
Rated current	I_R	30	30	20	15	40	10	25	30	18	mA
Maximum voltage	V_1	4	4	8	13	9	18	21	28	60	V
Power rating, intermittent [2])	P_{max}	600	600	600	600	1200	600	1200	2000	2000	mW
Max. permissible current, intermittent [2])	I_1	60	60	30	25	60	20	40	60	25	mA
Min. permissible hot resistance	R_{min}	40	40	150	300	120	500	350	350	1000	Ω
Operating voltage	V_{op}	12	12	24	36	24	60	60	60	220	V
Series resistance	R_S	0.2	0.2	0.6	1.2	0.4	3	1.5	1.5	10	kΩ
Response current	I_{resp}	30	30	20	15	30	10	20	20	11	mA
Delay time	t_d	0.7	0.7	0.7	0.6	7	0.5	3.5	24	25	s
Tolerance [1])	Δt_d	$^{-40}_{+20}$	$^{-20}_{+40}$	±30	±30	±25	±30	±25	±25	±25	%

Delay times
at various operating voltages V_{op}
(typical values)

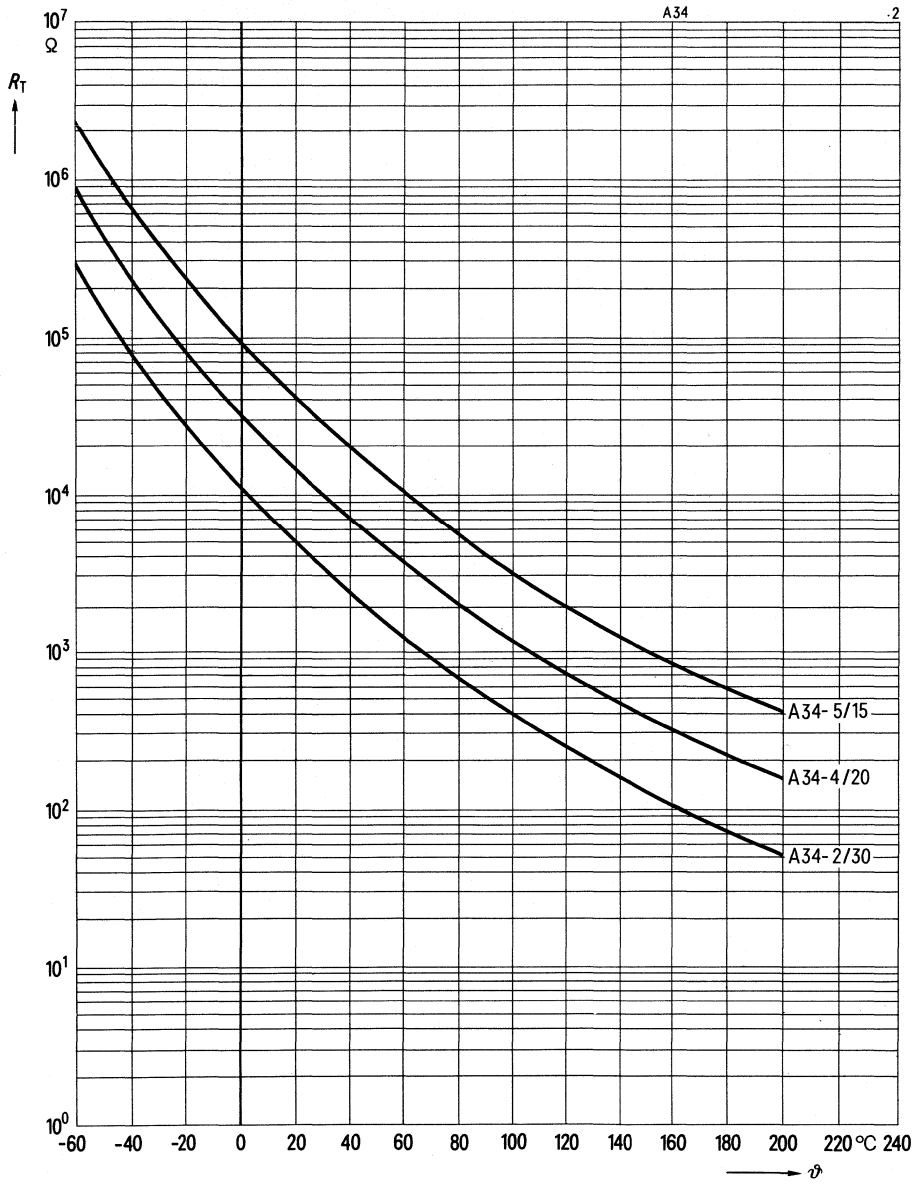
Operating voltage V_{op}	8 V	12 V	16 V	24 V	36 V	48 V	60 V	110 V	220 V	Unit
Type										
A 34– 2/30	2	0.7	0.4	0.1	–	–	–	–	–	s
A 34– 4/20	–	–	1.7	0.7	0.2	0.1	–	–	–	s
A 34– 5/15	–	–	–	1.5	0.6	0.3	0.2	–	–	s
A 34– 6/40	–	–	17	7	2.5	1.5	–	–	–	s
A 34– 7/10	–	–	–	–	2	0.8	0.5	–	–	s
A 34–10/25	–	–	–	–	10	6	3.5	1	–	s
A 34–14/30	–	–	–	–	–	40	24	6	(1)	s
A 34–25/18	–	–	–	–	–	–	–	20	5	s

[1]) AQL = 0.65%
[2]) Only permissible as long as $R > R_{min}$

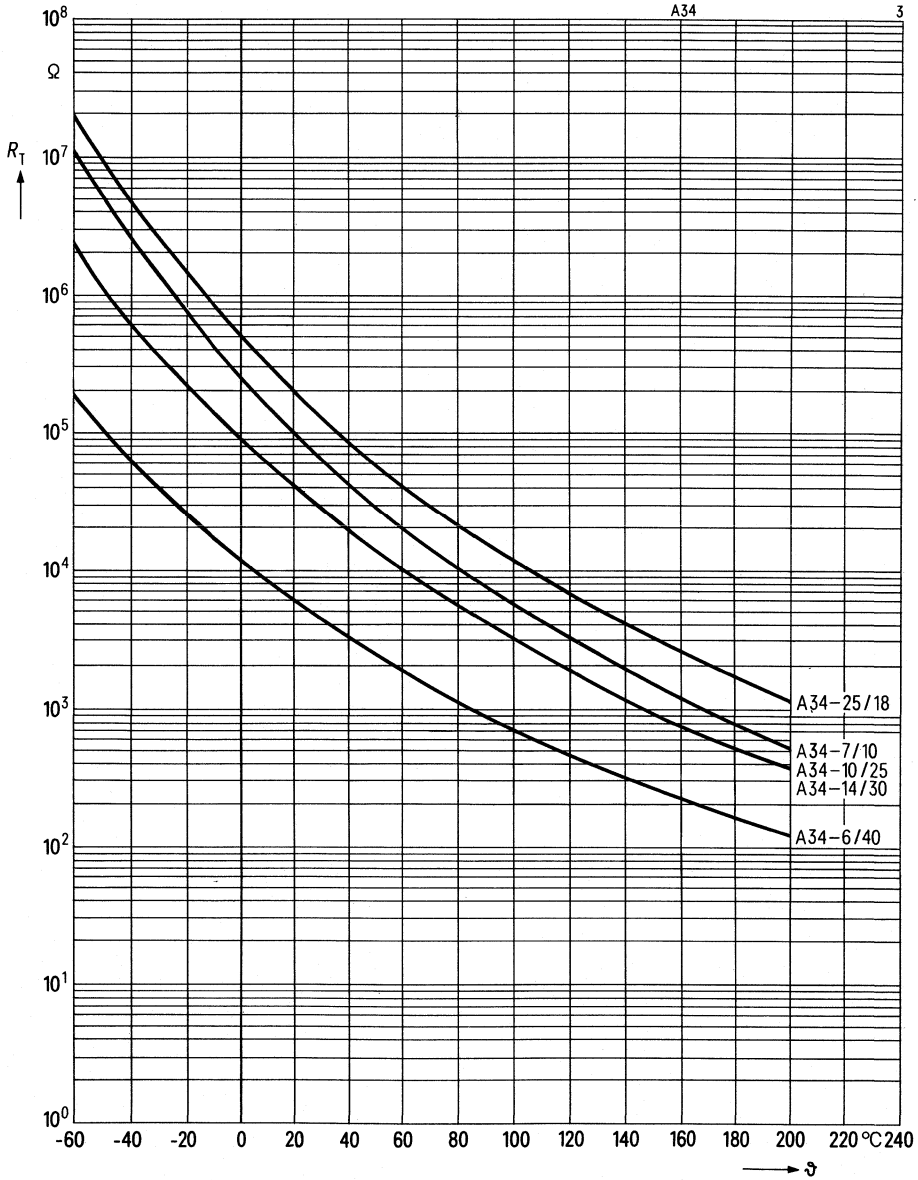
Delay time $\tau_{av} = f(V_{op})$
versus operating voltage (typical values)



NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature

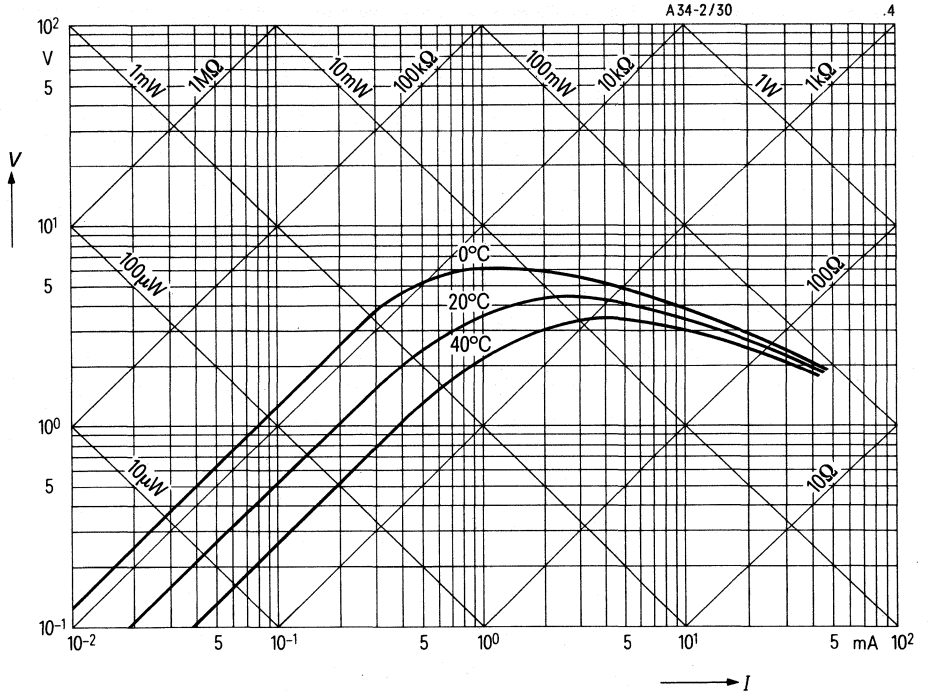


NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



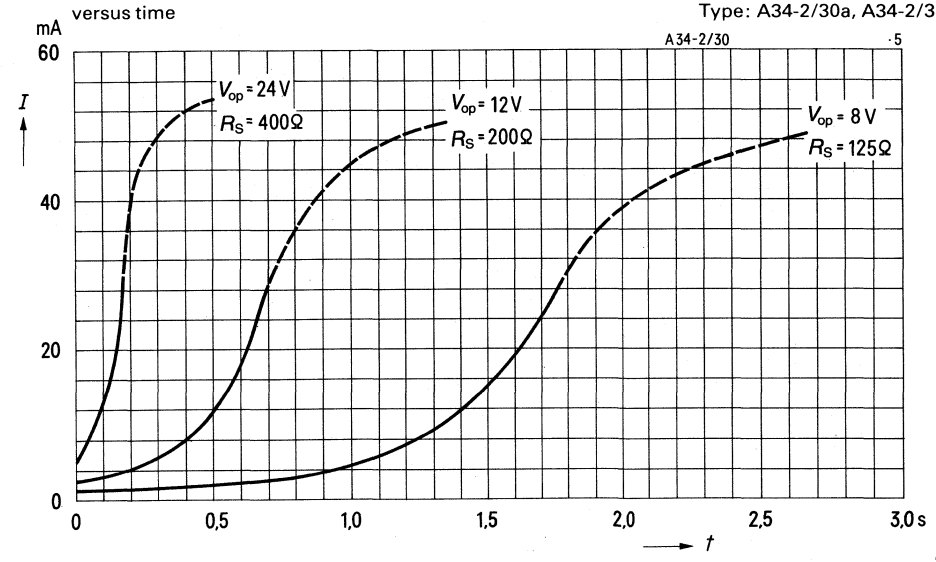
Voltage-current characteristics $V = f(I)$

Type: A34-2/30a, A34-2/30b



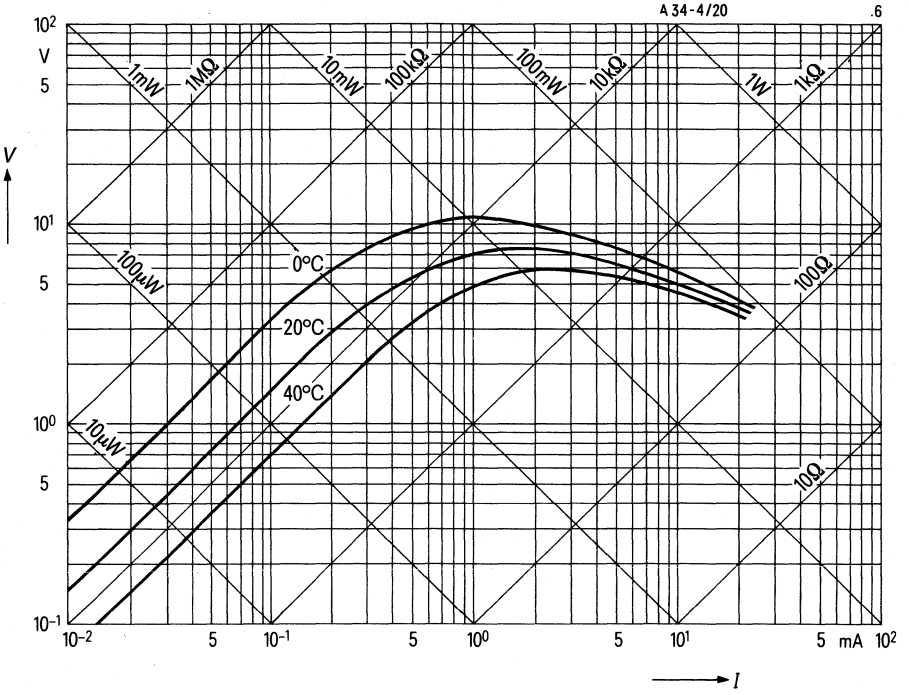
NTC thermistor current $I = f(t)$
versus time

Type: A34-2/30a, A34-2/30b



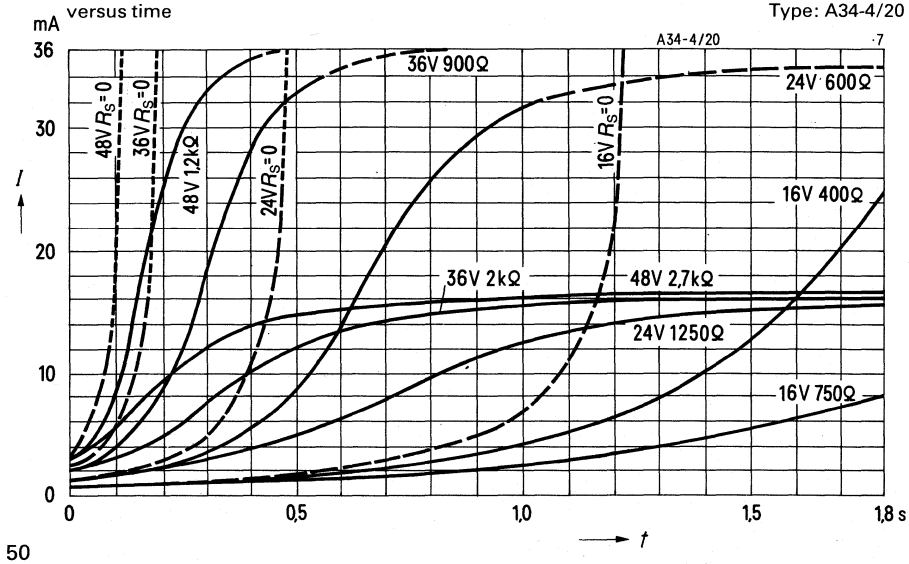
Voltage-current characteristics $V = f(I)$

Type: A34-4/20



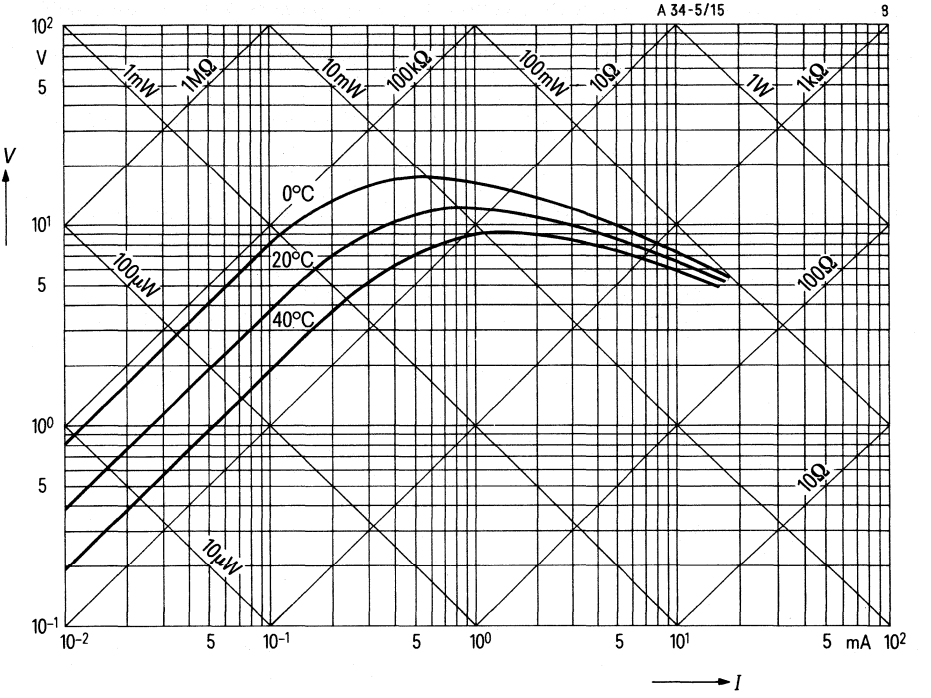
NTC thermistor current $I = f(t)$
versus time

Type: A34-4/20



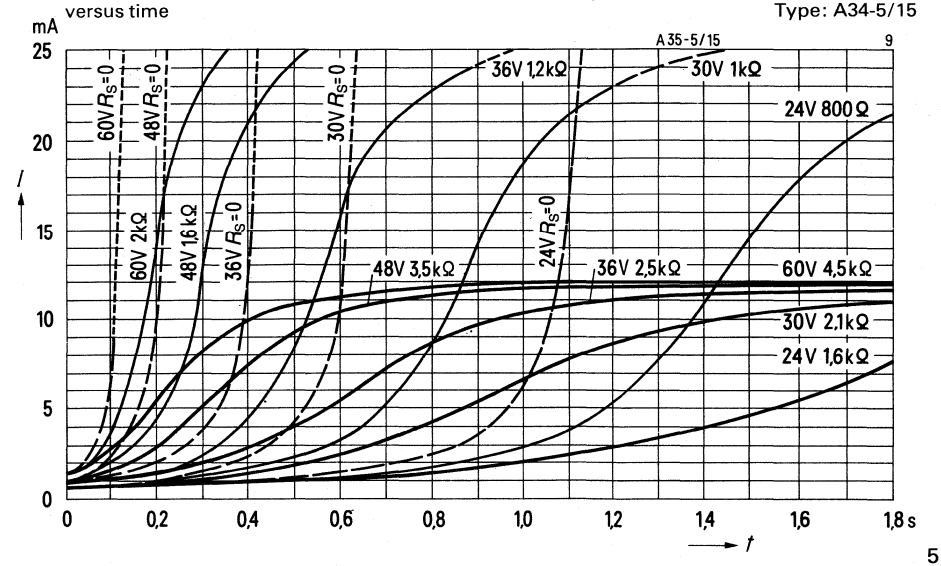
Voltage-current characteristics $V = f(I)$

Type: A34-5/15



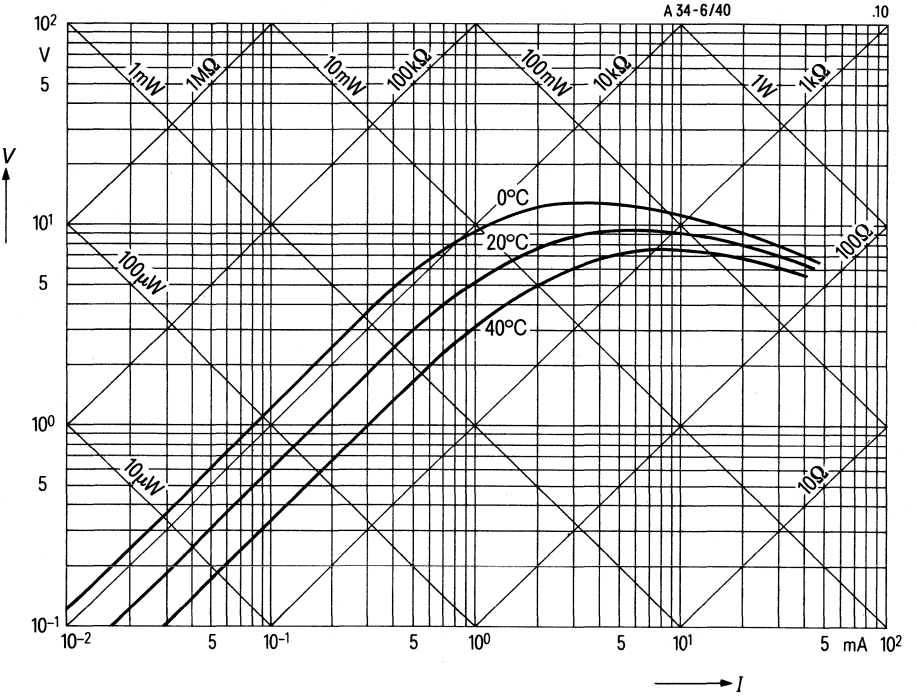
NTC thermistor current $I = f(t)$
versus time

Type: A34-5/15



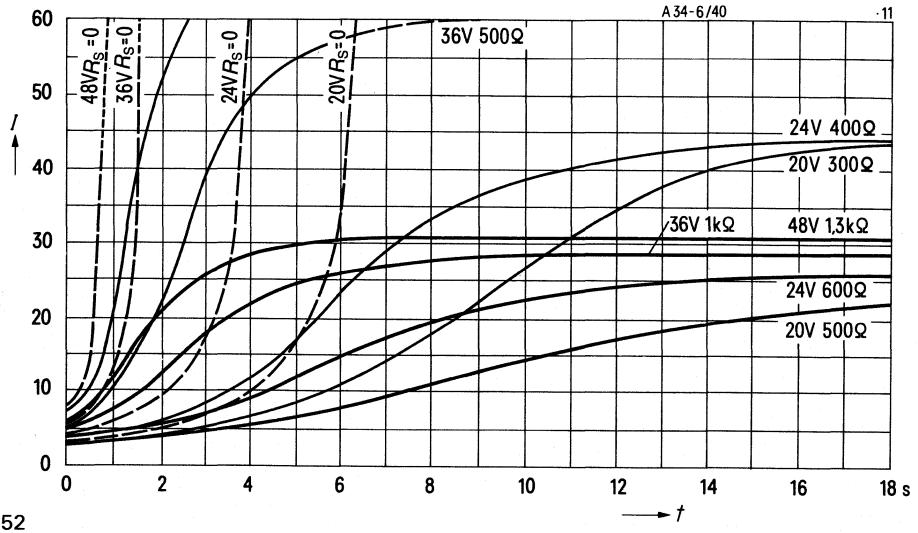
Voltage-current characteristics $V = f(I)$

Type: A34-6/40



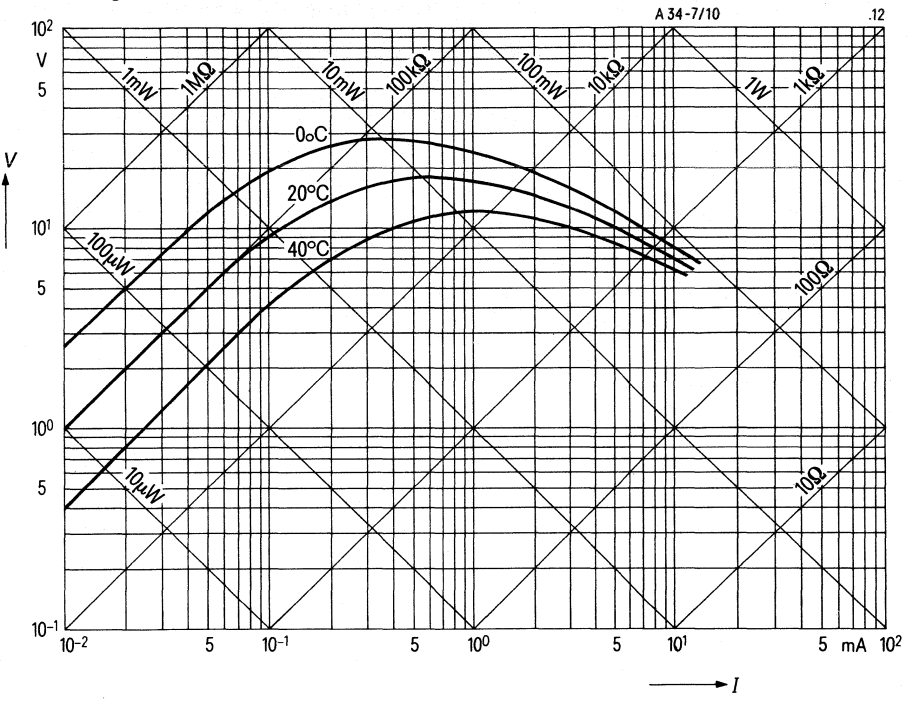
NTC thermistor current $I = f(t)$
versus time

Type: A34-6/40



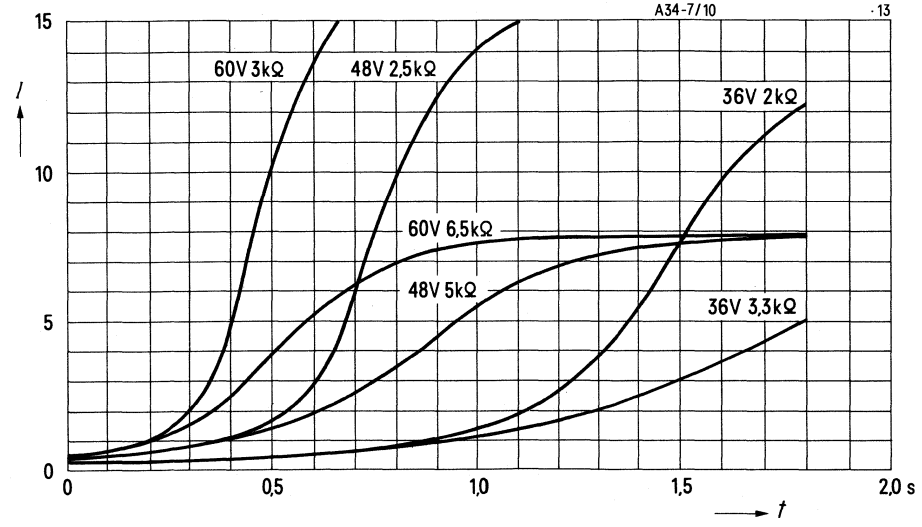
Voltage-current characteristics $V = f(I)$

Type: A34-7/10



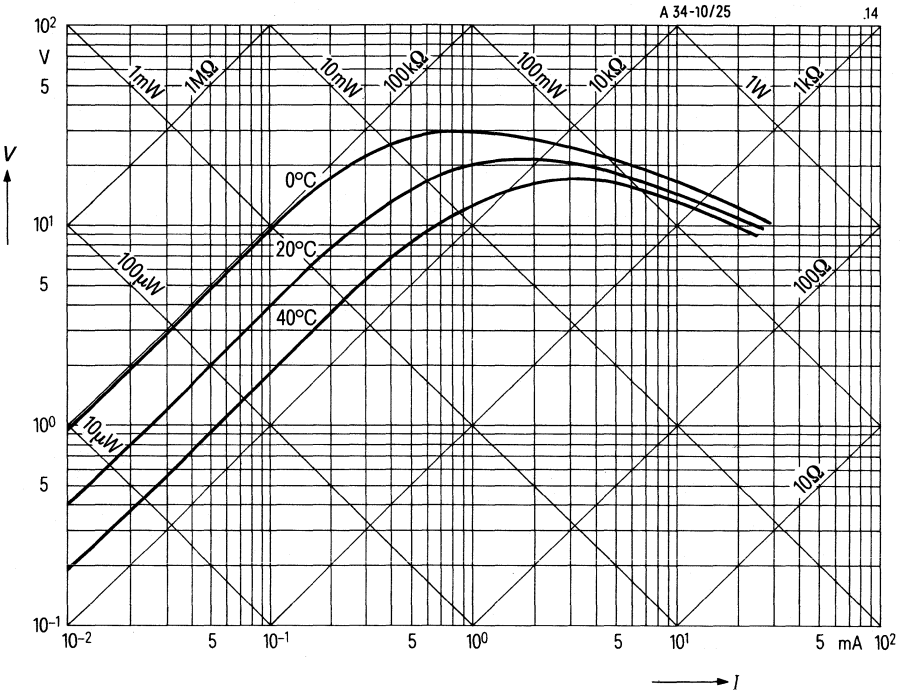
NTC thermistor current $I = f(t)$ versus time

Type: A34-7/10



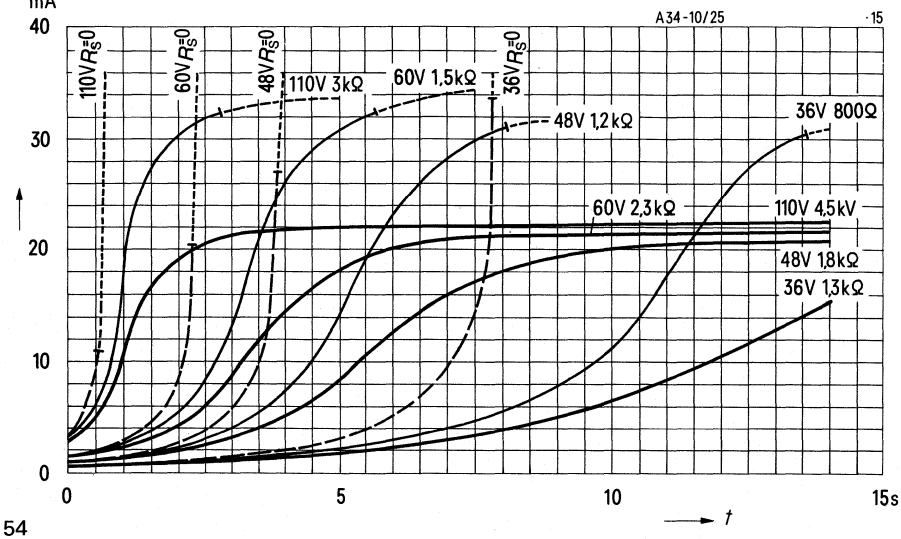
Voltage-current characteristics $V = f(I)$

Type: A34-10/25



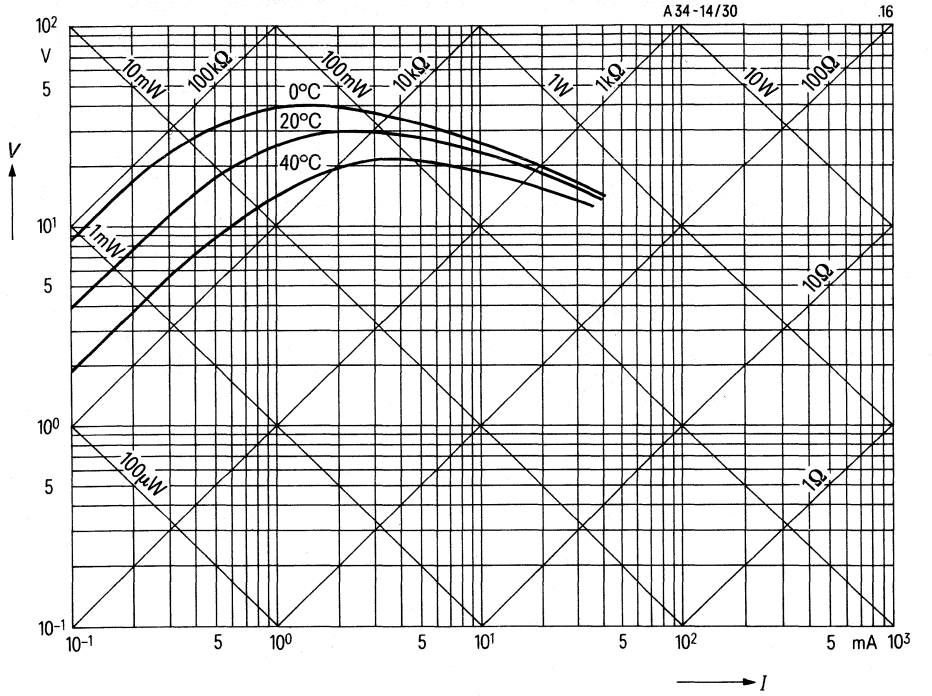
NTC thermistor current $I = f(t)$
versus time

Type: A34-10/25



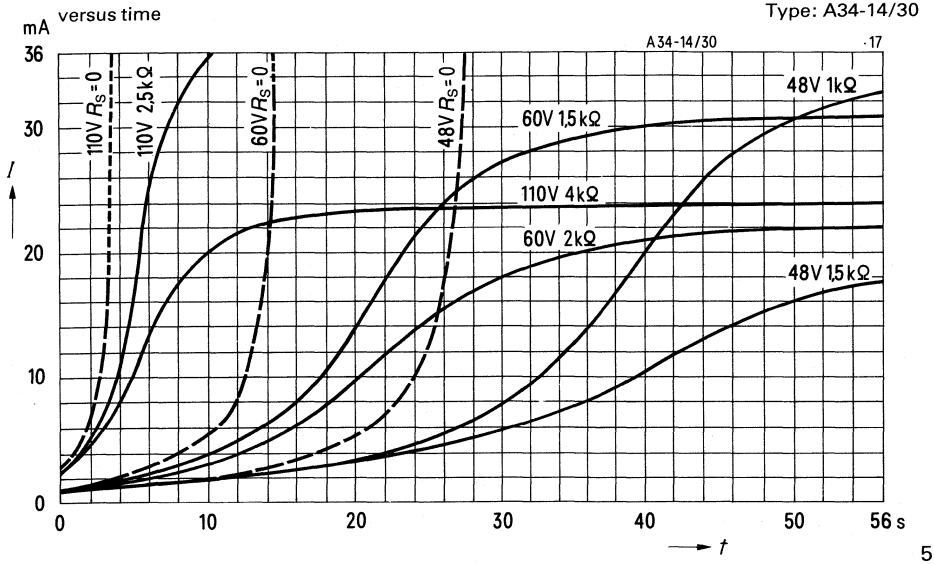
Voltage-current characteristics $V = f(I)$

Type: A34-14/30



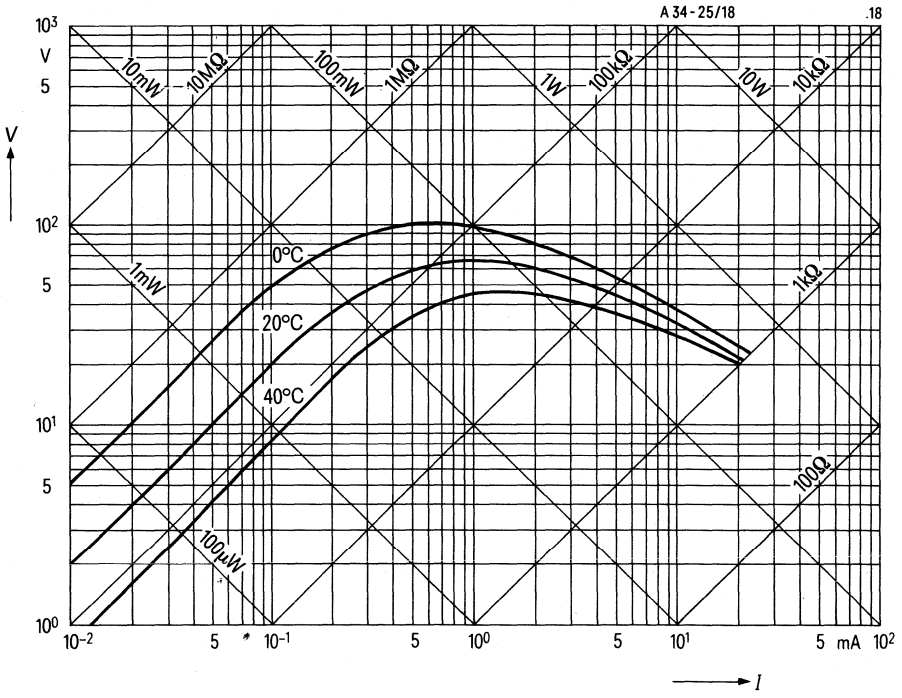
NTC thermistor current $I = f(t)$ versus time

Type: A34-14/30



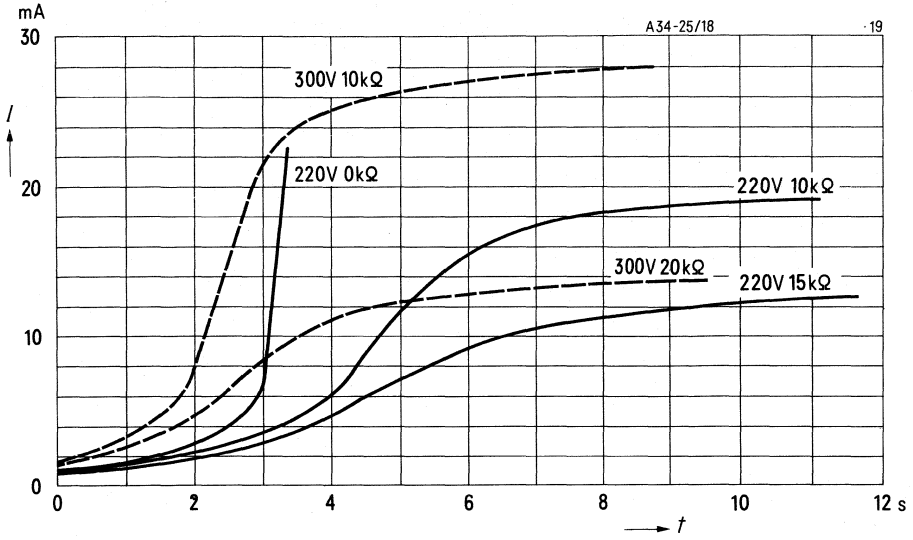
Voltage-current characteristics $V = f(I)$

Type: A34-25/18



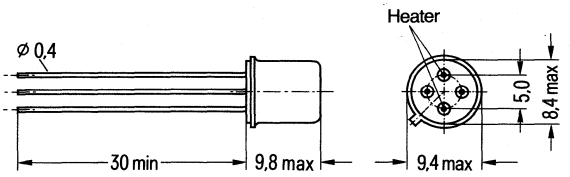
NTC thermistor current $I = f(t)$
versus time

Type: A34-25/18



NTC thermistors with 4 kΩ to 400 kΩ

Application	Solution of regulating tasks in electronic equipment, for level regulation, and as a replacement for mechanical regulating elements
Version	Metal case, hermetically sealed, similar to T05
Terminals	Leads, tinned, insulated
Marking	Type designation is stamped on the component



Weight: approx. 3 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**FKF**
Lower category temperature	**F** − 55°C
Upper category temperature	**K** +125°C
Humidity category	**F** Average relative humity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

Type	Rated resistance	Tolerance	*B* value	Ordering code
F 75–34/14u[1]	4 kΩ	±20%	3440 K	Q63075–F9
F 75–34/14x[2]	4 kΩ	±20%	3440 K	Q63075–F1
F 75–41/21u[1]	10 kΩ	±20%	3440 K	Q63075–F2
F 75–41/21x[2]	10 kΩ	±20%	3440 K	Q63075–F3
F 75–46/23u[1]	60 kΩ	±20%	3950 K	Q63075–F4
F 75–46/23x[2]	60 kΩ	±20%	3950 K	Q63075–F5
F 75–54/32u[1]	400 kΩ	±20%	4300 K	Q63075–F6
F 75–54/32x[2]	400 kΩ	±20%	4300 K	Q63075–F7

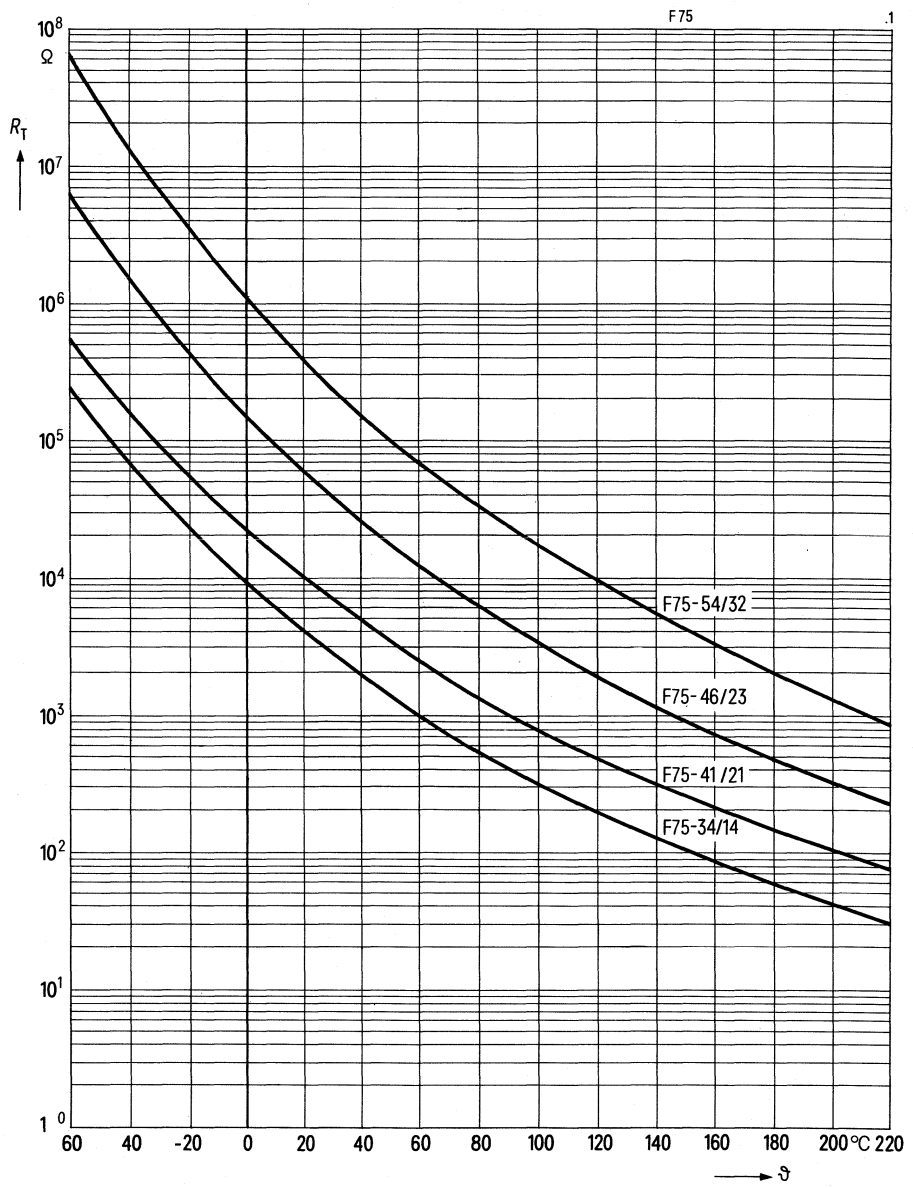
[1] Heater helix resistance = 100Ω
[2] Heater helix resistance = 400Ω

Characteristic data

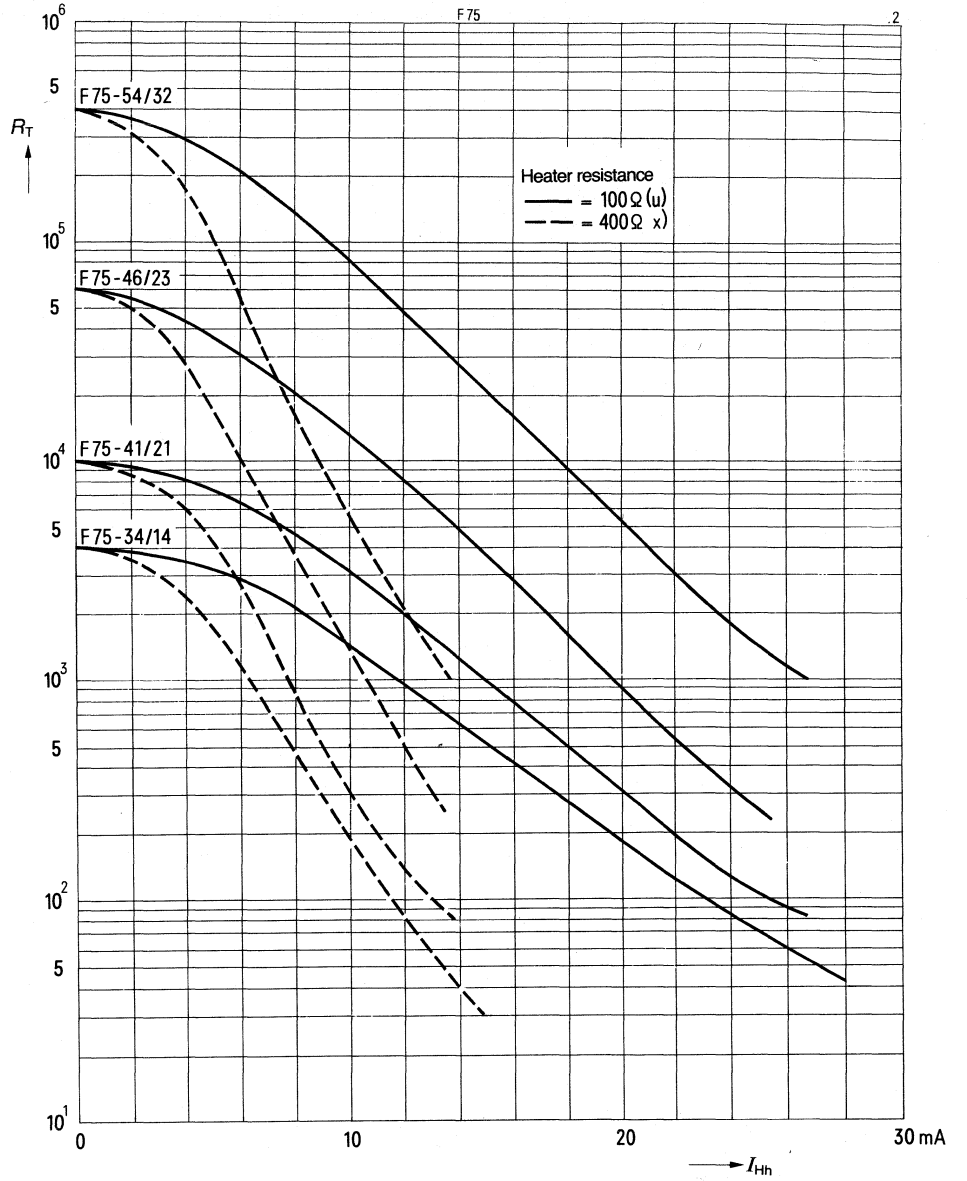
Type	F 75	34/14u	34/14x	41/21u	41/21x	46/23u	46/23x	54/32u	54/32x	Unit
Rated temperature	ϑ_R	20	20	20	20	20	20	20	20	°C
Rated resistance	R_R	4	4	10	10	60	60	400	400	kΩ
Tolerance [1]	ΔR_R	±20	±20	±20	±20	±20	±20	±20	±20	%
B value	B	3440	3440	3440	3440	3950	3950	4300	4300	K
Tolerance[1]	ΔB	± 5	± 5	± 5	± 5	± 5	± 5	± 5	± 5	%
Thermal conductance heater-NTC thermistor	G_{thA}	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	mW/K
Thermal time constant	τ_{th}	3	3	3	3	3	3	3	3	s
Min. permissible hot resistance	R_{min}	35	35	80	80	250	250	1500	1500	Ω
Resistance of heater helix	R_{Hh}	100	400	100	400	100	400	100	400	Ω
Tolerance	ΔR_{Hh}	±10	±10	±10	±10	±10	±10	±10	±10	%
Maximum permissible heater current	$I_{Ht\,M}$	32	16	32	16	32	16	32	16	mA
NTC thermistor resistance at $I_{Ht\,M}$	R_{hot}	≤40	≤40	≤100	≤100	≤300	≤300	≤2000	≤2000	Ω
Capacitance NTC thermistor-heater helix	$C_{NTC\text{-}Hh}$	2	2	2	2	2	2	2	2	pF
Parallel capacitance	C_p	1	1	1	1	1	1	1	1	pF
Insulation resistance	R_{is}	100	100	100	100	100	100	100	100	MΩ
Test voltage	V_{test}	250	250	250	250	250	250	250	250	V

[1]) AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature

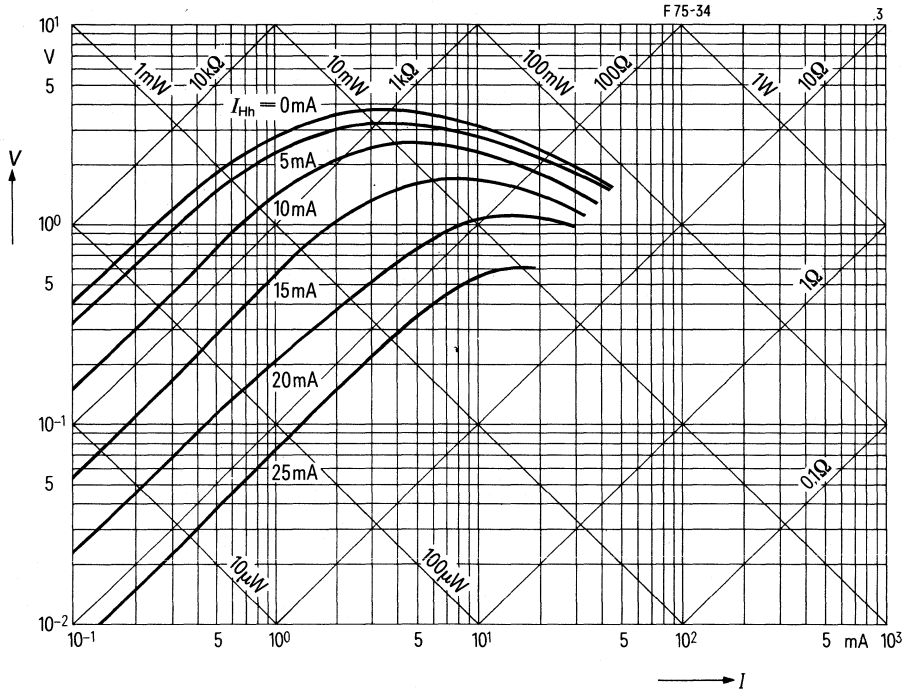


NTC thermistor resistance $R_T = f(I_{Hh})$
versus heater helix current



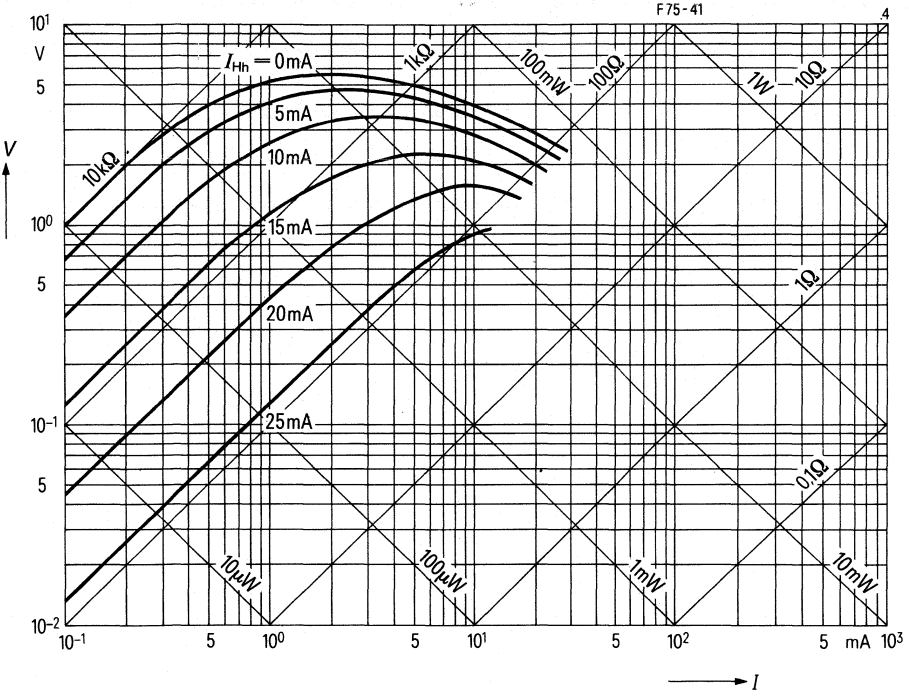
Voltage-current characteristics $V = f(I)$

Type: F75-34/14u



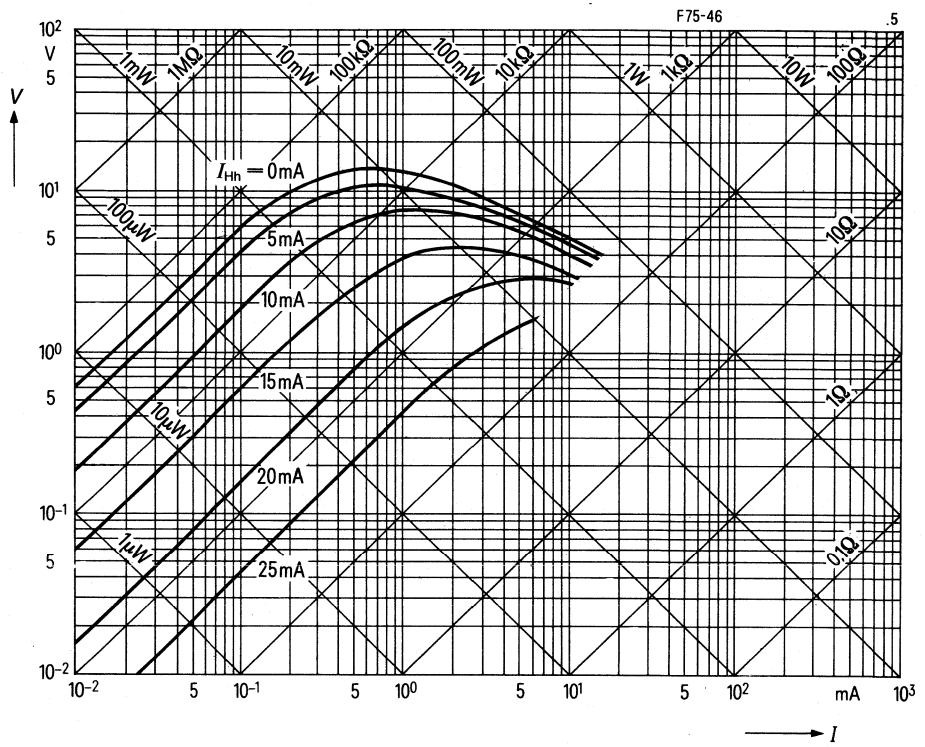
Voltage-current characteristics $V = f(I)$

Type: F75-41/21u



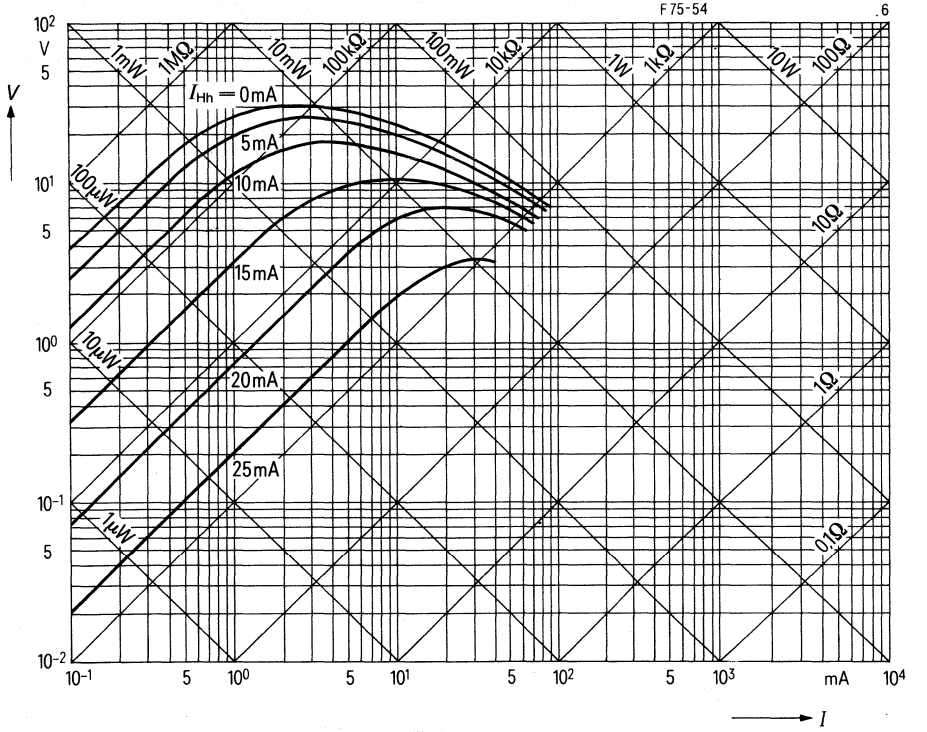
Voltage-current characteristics $V = f(I)$

Type: F75-46/23u



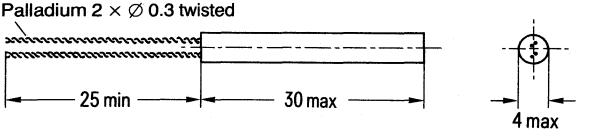
Voltage-current characteristics $V = f(I)$

Type: F75-54/32u



NTC thermistor with 30 kΩ

Application	Temperature measurement in the range between 300°C and 1000°C
Version	Ceramic case
Terminals	Leads made of palladium
Marking	None
Quality characteristic	No current or polarity dependence of the resistance value at a measuring voltage of <250 mV



Weight: approx. 1.6 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**FZF**
Lower category temperature	**F** − 55°C
Upper category temperature	**Z** +1000°C
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperature

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

Characteristic data

Rated temperature	ϑ_R	600 °C
Rated resistance	R_R	30 kΩ
Tolerance [1]	ΔR_R	±30 %
B value	*B*	6500 K
Tolerance [1]	ΔB	±10 %
Measuring voltage	V_{meas}	<250 mV
Time constant [2]	τ	10 s

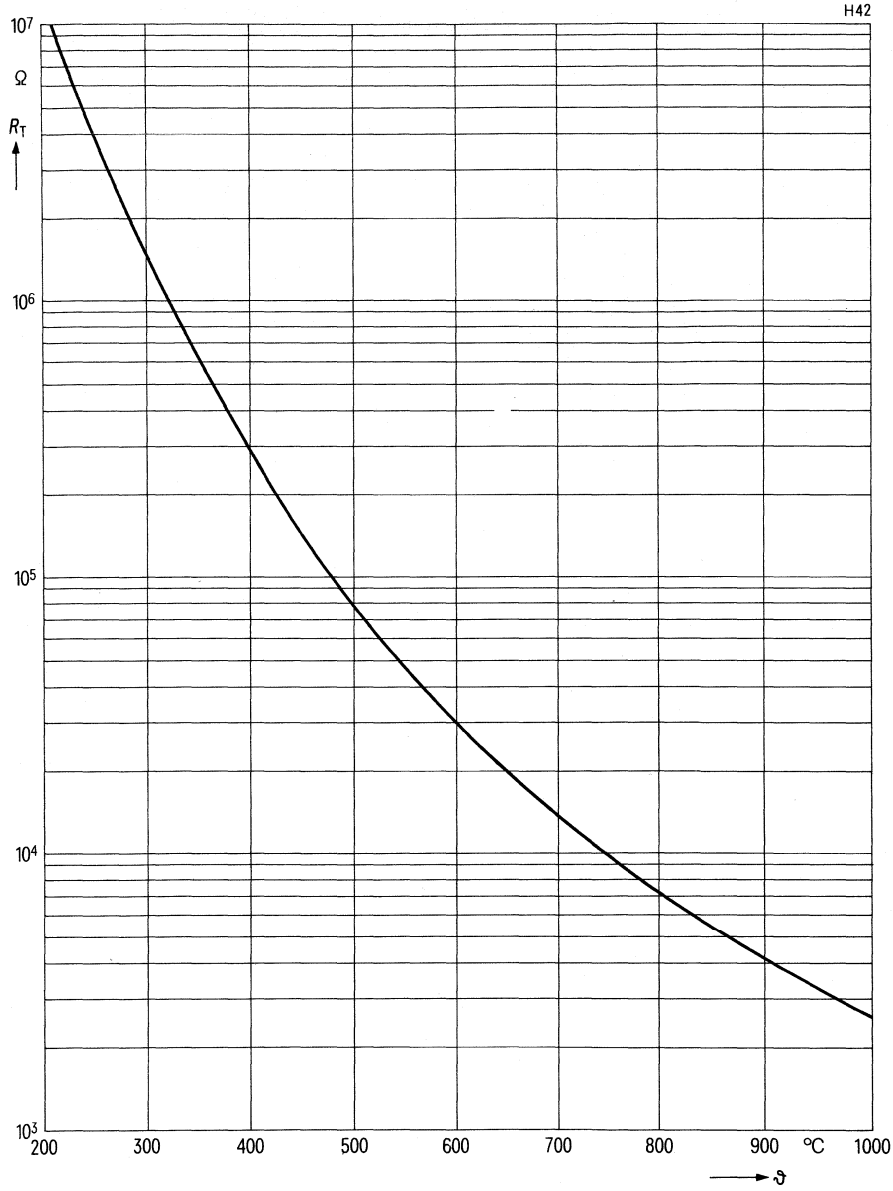
The NTC thermistor can be disturbed when operated with a voltage of >250 mV

Type	Rated resistance	Tolerance	*B* value	Ordering code
H 42/30%/30kΩ/600	30 kΩ	±30%	6500 K	Q63042−H303−N600

[1]) AQL = 0.65%

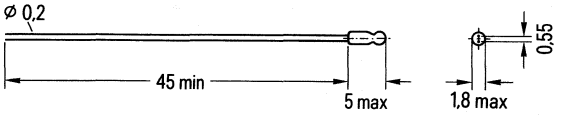
[2]) The time constant is the time required for the thermistor to follow a temperature jump from 900°C to 1000°C to an extent of 50%.

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 100 kΩ and 1 MΩ

Application	Temperature measurement up to 450°C
Version	Glass case, hermetically sealed
Terminals	Leads made of nickel-iron alloy
Marking	None



Weight: approx. 40 mg
Dimensions in mm

Climatic category in accordance with DIN 40040	**FAF**
Lower category temperature	**F** − 55°C
Upper category temperature	**A** +450°C
Humidity category	**F** Average relative humidity ⩽ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

Minimum storage temperature $\vartheta_{stg\ min}$ −25°C
Maximum storage temperature $\vartheta_{stg\ max}$ +65°C

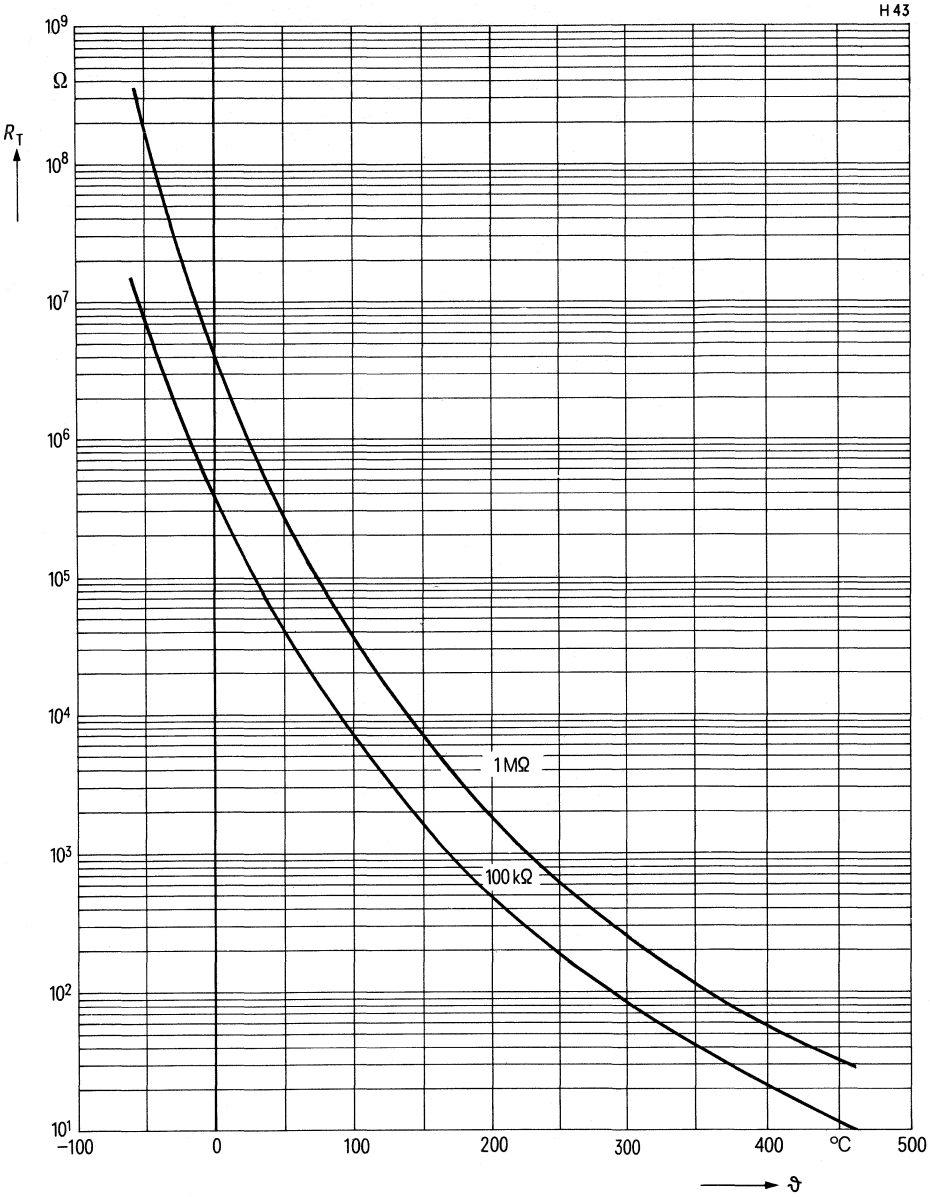
Characteristic data

Type H 43/20%		100k	1MΩ	Unit
Power rating at 25°C	P_{25}	290	290	mW
at 60°C	P_{60}	270	270	mW
Rated temperature	ϑ_R	25	25	°C
Rated resistance	R_R	0.1	1	MΩ
Tolerance[1]	ΔR_R	±20	±20	%
B value	*B*	4200	4800	K
Tolerance[1]	ΔB	± 5	± 5	%
Thermal conductance in air	G_{thA}	0.7	0.7	mW/K
Thermal time constant	τ_{th}	5	5	s
Thermal capacitance	C_{th}	3.5	3.5	mJ/K

Type	Rated resistance	Tolerance	*B* value	Ordering code
H 43/20%/100 kΩ	100 kΩ	±20%	4200 K	Q63043−H104−M
H 43/20%/1MΩ	1 MΩ	±20%	4800 K	Q63043−H105−M

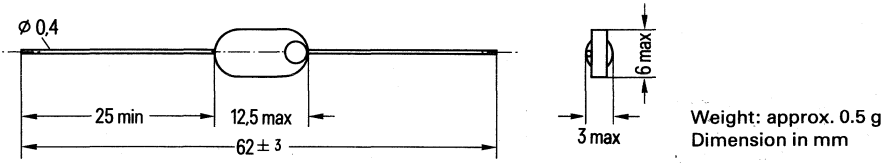
[1] AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 10 Ω to 500 kΩ

Application	For compensation and measuring tasks with low electrical loads
Version	NTC thermistor body painted blue
Terminals	Leads made of silver
Marking	The rated resistance value is stamped on the component.
	The tolerance is indicated either by a stamp or by a color dot.[1]
Quality characteristic	High reliability due to special production and aging methods.



Weight: approx. 0.5 g
Dimension in mm

Climatic category in accordance with DIN 40040	**FKF**
Lower category temperature	**F** – 55°C
Upper category temperature	**K** +125°C
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

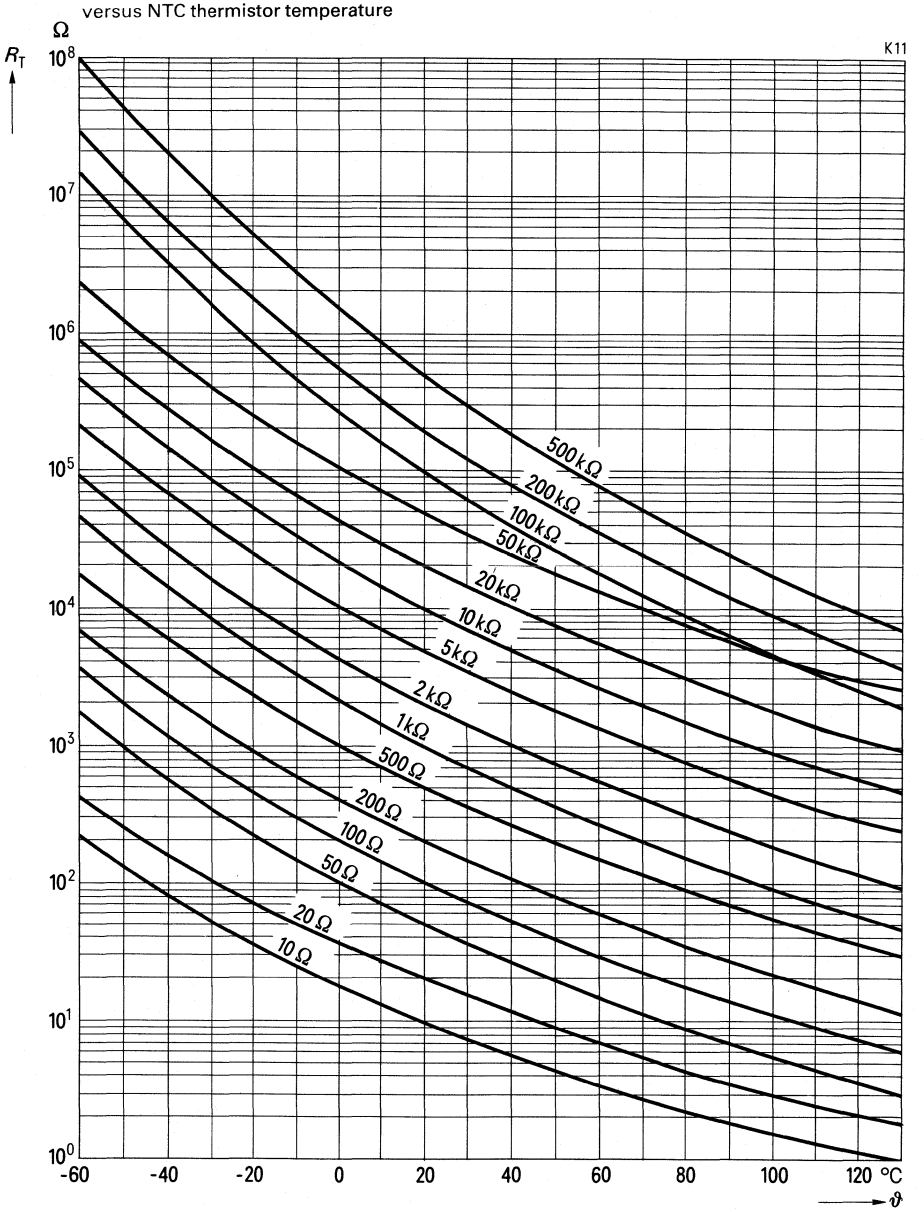
Characteristic data

Power rating at 25°C	P_{25}	100 mW
at 100°C	P_{100}	100 mW
Rated temperature	ϑ_R	20 °C
Rated resistance	R_R	See table
Tolerance[2]	ΔR_R	See table
Expected resistance change after 10000 hours	$\Delta R_{10.}$	≤3 %
B value	*B*	See table
Tolerance[2]	ΔB	± 5 %
Thermal conductance in air	G_{thA}	8(>6.5) mW/K
Thermal time constant	τ_{th}	approx. 30 s
Thermal capacitance	C_{th}	350 mJ/K

[1] Silver ≙ ±10%; gold ≙ ±5%
[2] AQL = 0.65%

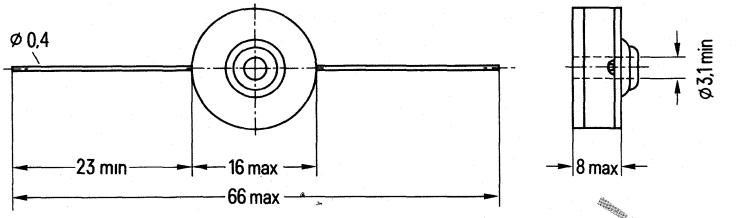
Type	Rated resistance	Tolerance	*B* value	Ordering code
K 11/20%/10 Ω	10 Ω	±20%	2580K	Q63011–K100–M
K 11/10%/20 Ω	20 Ω	±10%	2580K	Q63011–K200–K
K 11/20%/20 Ω	20 Ω	±20%	2580K	Q63011–K200–M
K 11/ 5%/50 Ω	50 Ω	± 5%	3000K	Q63011–K500–J
K 11/10%/50 Ω	50 Ω	±10%	3000K	Q63011–K500–K
K 11/20%/50 Ω	50 Ω	±20%	3000K	Q63011–K500–M
K 11/ 5%/100Ω	100 Ω	± 5%	3000K	Q63011–K101–J
K 11/10%/100Ω	100 Ω	±10%	3000K	Q63011–K101–K
K 11/20%/100Ω	100 Ω	±20%	3000K	Q63011–K101–M
K 11/ 5%/200Ω	200 Ω	± 5%	3000K	Q63011–K201–J
K 11/10%/200Ω	200 Ω	±10%	3000K	Q63011–K201–K
K 11/20%/200Ω	200 Ω	±20%	3000K	Q63011–K201–M
K 11/ 5%/500Ω	500 Ω	± 5%	3000K	Q63011–K501–J
K 11/10%/500Ω	500 Ω	±10%	3000K	Q63011–K501–K
K 11/20%/500Ω	500 Ω	±20%	3000K	Q63011–K501–M
K 11/ 5%/1 kΩ	1 kΩ	± 5%	3240K	Q63011–K102–J
K 11/10%/1 kΩ	1 kΩ	±10%	3240K	Q63011–K102–K
K 11/20%/1 kΩ	1 kΩ	±20%	3240K	Q63011–K102–M
K 11/ 5%/2 kΩ	2 kΩ	± 5%	3240K	Q63011–K202–J
K 11/10%/2 kΩ	2 kΩ	±10%	3240K	Q63011–K202–K
K 11/20%/2 kΩ	2 kΩ	±20%	3240K	Q63011–K202–M
K 11/ 5%/5 kΩ	5 kΩ	± 5%	3250K	Q63011–K502–J
K 11/10%/5 kΩ	5 kΩ	±10%	3250K	Q63011–K502–K
K 11/20%/5 kΩ	5 kΩ	±20%	3250K	Q63011–K502–M
K 11/ 5%/10 kΩ	10 kΩ	± 5%	3250K	Q63011–K103–J
K 11/10%/10 kΩ	10 kΩ	±10%	3250K	Q63011–K103–K
K 11/20%/10 kΩ	10 kΩ	±20%	3250K	Q63011–K103–M
K 11/ 5%/20 kΩ	20 kΩ	± 5%	3250K	Q63011–K203–J
K 11/10%/20 kΩ	20 kΩ	±10%	3250K	Q63011–K203–K
K 11/20%/20 kΩ	20 kΩ	±20%	3250K	Q63011–K203–M
K 11/ 5%/50 kΩ	50 kΩ	± 5%	3250K	Q63011–K503–J
K 11/10%/50 kΩ	50 kΩ	±10%	3250K	Q63011–K503–K
K 11/20%/50 kΩ	50 kΩ	±20%	3250K	Q63011–K503–M
K 11/ 5%/100kΩ	100 kΩ	± 5%	4250K	Q63011–K104–J
K 11/10%/100kΩ	100 kΩ	±10%	4250K	Q63011–K104–K
K 11/20%/100kΩ	100 kΩ	±20%	4250K	Q63011–K104–M
K 11/ 5%/200kΩ	200 kΩ	± 5%	4250K	Q63011–K204–J
K 11/10%/200kΩ	200 kΩ	±10%	4250K	Q63011–K204–K
K 11/20%/200kΩ	200 kΩ	±20%	4250K	Q63011–K204–M
K 11/ 5%/500kΩ	500 kΩ	± 5%	4550K	Q63011–K504–J
K 11/10%/500kΩ	500 kΩ	±10%	4550K	Q63011–K504–K
K 11/20%/500kΩ	500 kΩ	±20%	4550K	Q63011–K504–M

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 50 Ω to 50 kΩ

Application	For temperature compensation and temperature measurement at high electrical load, especially for surface measurements
Version	Metal case, NTC thermistor electrically insulated
Terminals	Leads made of silver
Marking	Resistance value is stamped on the component
Quality characteristic	High reliability due to special production and aging methods



Weight: approx. 5.0 g
Dimensions in mm

Climatic category **FKF**
in accordance with DIN 40040

Lower category temperature	**F** − 55°C
Upper category temperature	**K** +125°C
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures
Minimum storage temperature $\vartheta_{stg\ min}$ −25°C
Maximum storage temperature $\vartheta_{stg\ max}$ +65°C

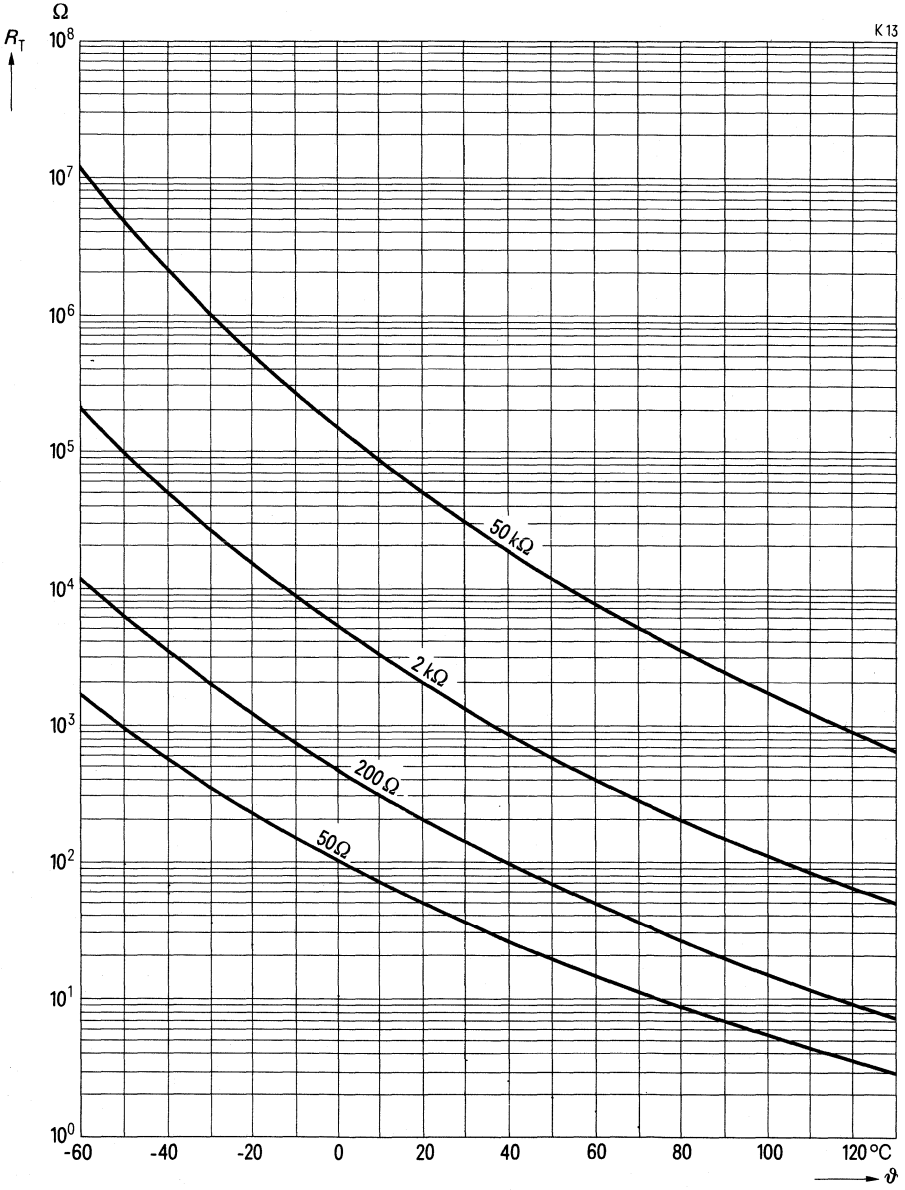
Characteristic data

Power rating at 25°C	P_{25}	600 mW
at 60°C	P_{60}	600 mW
Rated temperature	ϑ_R	20 °C
Rated resistance	R_R	See table
Tolerance[1)]	ΔR_R	±10 %
B value	B	See table
Tolerance[1)]	ΔB	± 5 %
Thermal conductance in case of chassis mounting	G_{thC}	60(>50) mW/K
Thermal time constant	τ_{th}	approx. 50 s
Insulation resistance	R_{is}	>100 MΩ
Test voltage	V_{test}	250 V
Test duration	t_t	1 s

Type	Rated resistance	Tolerance	*B* value	Ordering code
K 13/10%/ 50 Ω	50 Ω	±10%	3000 K	Q63013−K500−K
K 13/10%/200 Ω	200 Ω	±10%	3530 K	Q63013−K201−K
K 13/10%/ 2 kΩ	2 kΩ	±10%	3950 K	Q33013−K202−K
K 13/10%/ 50 kΩ	50 kΩ	±10%	4600 K	Q63013−K503−K

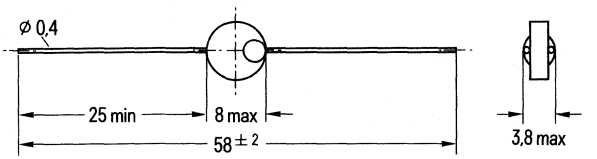
[1)] AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 4 Ω bis 5 kΩ

Application	For compensation tasks at high temperatures
Version	NTC thermistors body not painted
Terminals	Leads made of silver
Marking	Resistance value is stamped on the component



Weight: approx. 0.5 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**FHF**
Lower category temperature	**F** − 55°C
Upper category temperature	**H** +155°C
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperature

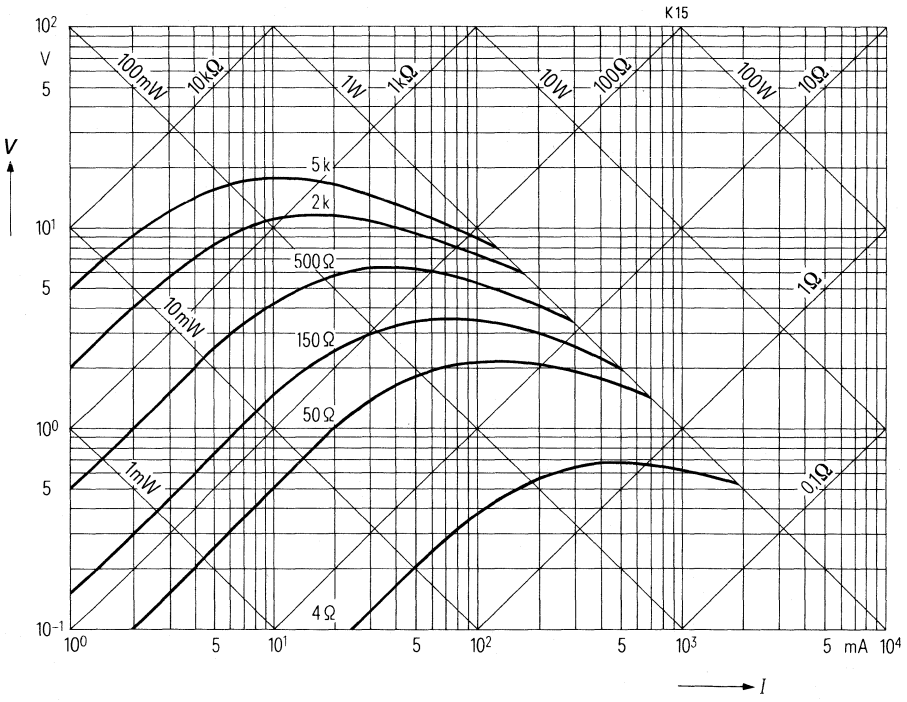
Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

Type	Rated resistance	Tolerance	*B* value	Ordering code
K 15/20%/ 4 Ω	4 Ω	±20%	2580 K	Q63015−K 40−M
K 15/20%/ 50 Ω	50 Ω	±20%	3000 K	Q63015−K500−M
K 15/20%/150 Ω	150 Ω	±20%	3530 K	Q63015−K151−M
K 15/20%/500 Ω	500 Ω	±20%	3610 K	Q63015−K501−M
K 15/20%/ 2 kΩ	2 kΩ	±20%	3950 K	Q63015−K202−M
K 15/20%/ 5 kΩ	5 kΩ	±20%	4250 K	Q63015−K502−M

Characteristic data

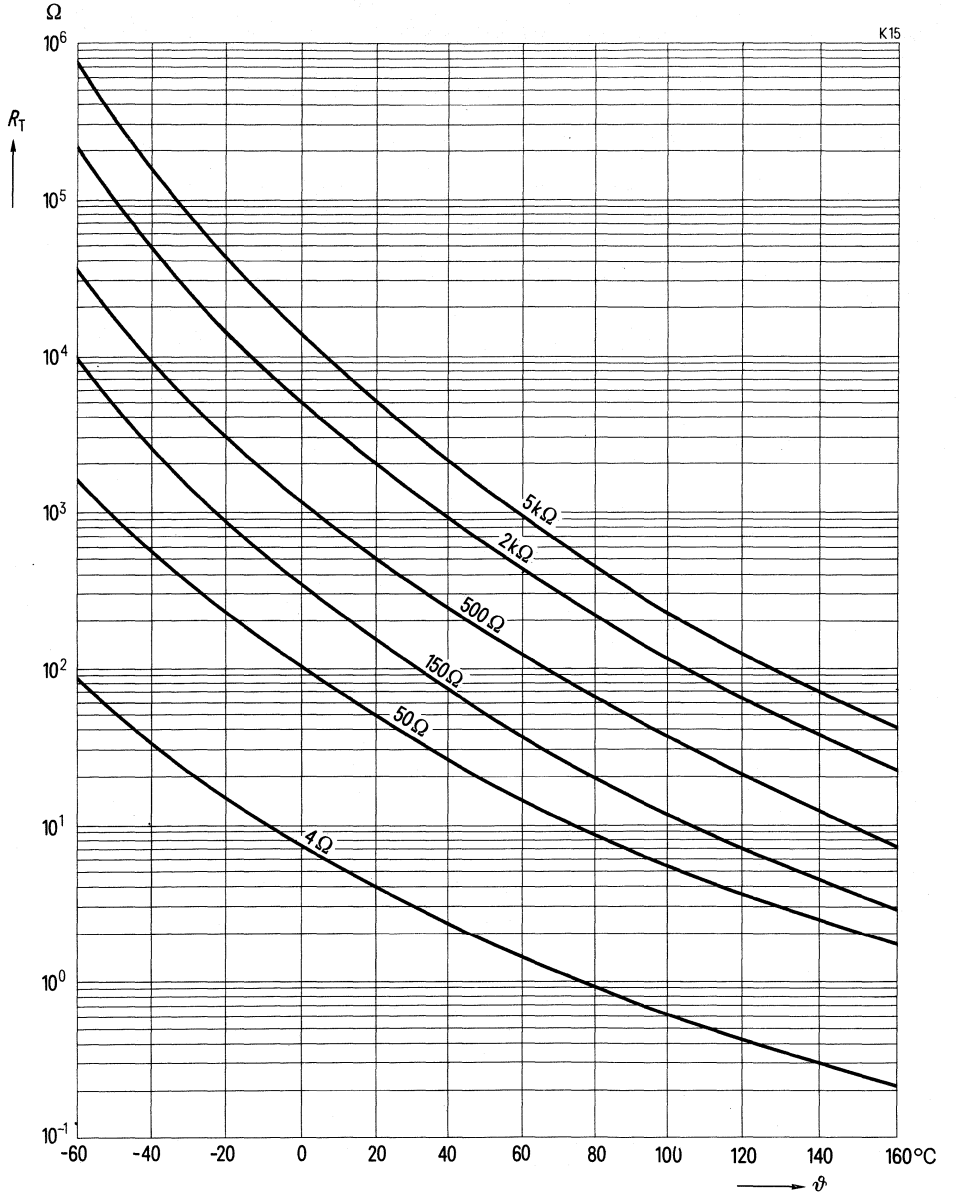
Power rating at 25°C	P_{25}	1000 mW
at 60°C	P_{60}	700 mW
Rated temperature	ϑ_R	20 °C
Rated resistance	R_R	See table
Tolerance[1)]	ΔR_R	±20 %
B value	B	See table
Tolerance[1)]	ΔB	± 5 %
Thermal conductance in air	G_{thA}	8 mW/K
Thermal time constant	τ_{th}	approx. 30 s
Thermal capacitance	C_{th}	approx. 240 mJ/K

Voltage-current characteristics $V = f(I)$



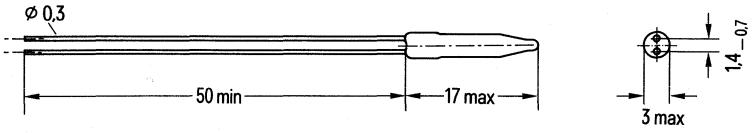
[1)] AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 2.5 kΩ to 100 kΩ

Application	As temperature sensor with low thermal inertia
Version	Glass body, hermetically sealed
Terminals	Leads, tinned
Marking	Type designation is stamped on the component
Quality characteristic	High reliability due to special production and aging methods



Weight: approx. 0.3 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**FDE**
Lower category temperature	**F** – 55°C
Upper category temperature	**D** +250°C
Humidity category	**E** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days Seldom or slight dew precipitation is permissible[1)]

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

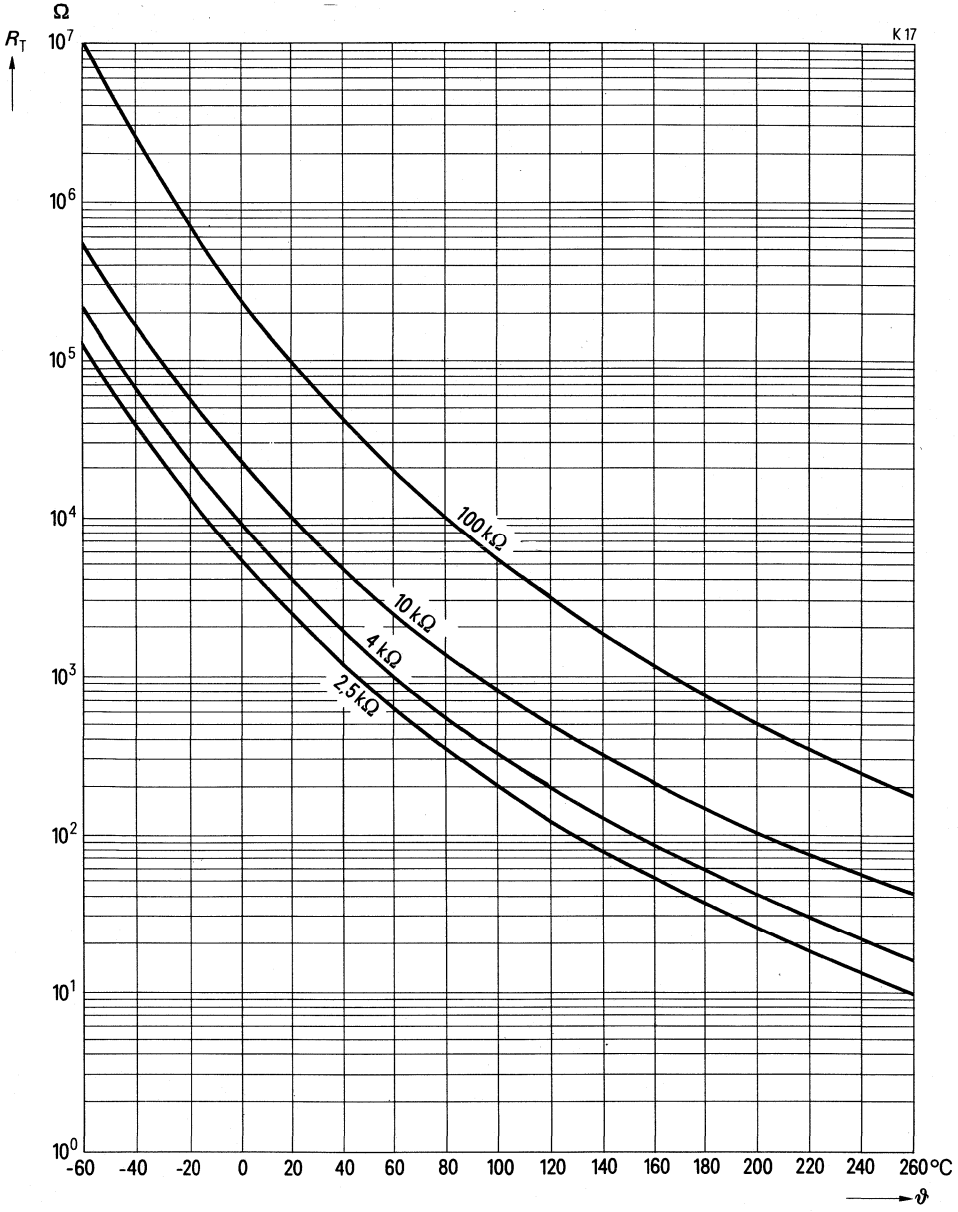
Characteristic data

Power rating	at 25°C	P_{25}	160 mW
	at 60°C	P_{60}	140 mW
Rated temperature		ϑ_R	20 °C
Rated resistance		R_R	See table
Tolerance [2)]		ΔR_R	See table
B value		B	See table
Tolerance[2)]		ΔB	±5 %
Thermal conductance			
in air		G_{thA}	0.8 mW/K
in water		G_{thW}	1.5 mW/K
Thermal time constant		τ_{th}	approx. 3 s

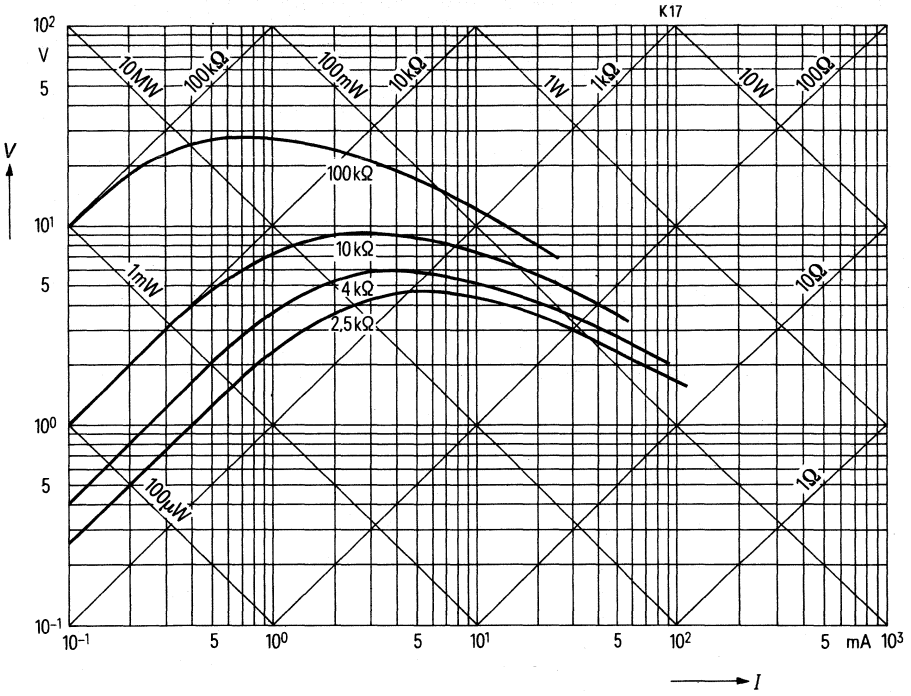
[1)] Dew precipitation may cause a temporary short-circuit at the lead outlets.
[2)] AQL = 0.65%

Type	Rated resistance	Tolerance	*B* value	Matching pairs	Ordering code
K 17/10%/ 2.5 kΩ	2.5kΩ	±10%	3420K	–	Q63017–K252–K
K 17/10%/ 4 kΩ	4 kΩ	±10%	3420K	–	Q63017–K402–K
K 17/10%/ 4 kΩ/P1	4 kΩ	±10%	3420K	P1	Q63017–K402–K1
K 17/10%/ 4 kΩ/P2	4 kΩ	±10%	3420K	P2	Q63017–K402–K2
K 17/10%/ 10 kΩ	10 kΩ	±10%	3420K	–	Q63017–K103–K
K 17/10%/ 10 kΩ/P1	10 kΩ	±10%	3420K	P1	Q63017–K103–K1
K 17/10%/ 10 kΩ/P2	10 kΩ	±10%	3420K	P2	Q63017–K103–K2
K 17/10%/100 kΩ	100 kΩ	±10%	3950K	–	Q63017–K104–K
K 17/10%/100 kΩ/P1	100 kΩ	±10%	3950K	P1	Q63017–K104–K1
K 17/10%/100 kΩ/P2	100 kΩ	±10%	3950K	P2	Q63017–K104–K2
K 17/20%/ 2.5 kΩ	2.5kΩ	±20%	3420K	–	Q63017–K252–M
K 17/20%/ 4 kΩ	4 kΩ	±20%	3420K	–	Q63017–K402–M
K 17/20%/ 4 kΩ/P1	4 kΩ	±20%	3420K	P1	Q63017–K402–M1
K 17/20%/ 4 kΩ/P2	4 kΩ	±20%	3420K	P2	Q63017–K402–M2
K 17/20%/ 10 kΩ	10 kΩ	±20%	3420K	–	Q63017–K103–M
K 17/20%/ 10 kΩ/P1	10 kΩ	±20%	3420K	P1	Q63017–K103–M1
K 17/20%/ 10 kΩ/P2	10 kΩ	±20%	3420K	P2	Q63017–K103–M2
K 17/20%/100 kΩ	100 kΩ	±20%	3950K	–	Q63017–K104–M
K 17/20%/100 kΩ/P1	100 kΩ	±20%	3950K	P1	Q63017–K104–M1
K 17/20%/100 kΩ/P2	100 kΩ	±20%	3950K	P2	Q63017–K104–M2

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature

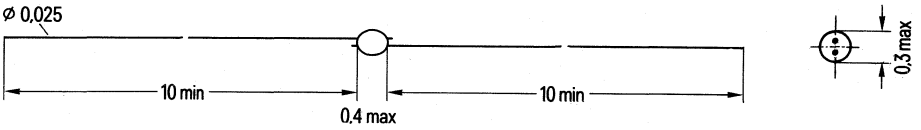


Voltage-current characteristics $V = f(I)$



NTC thermistors with 12 kΩ

Application	For temperature measurements at small measuring points and with rapid temperature change, flow rates measurements for gases, thermal radiation and vacuum measurements
Version	NTC thermistor body with enamel coating
Terminals	Leads made of platinum
Marking	None



Weight: approx. 0.3 mg
Dimensions in mm

Climatic category in accordance with DIN 40040	**FEF**
Lower category temperature	**F** – 55°C
Upper category temperature	**E** +200°C
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

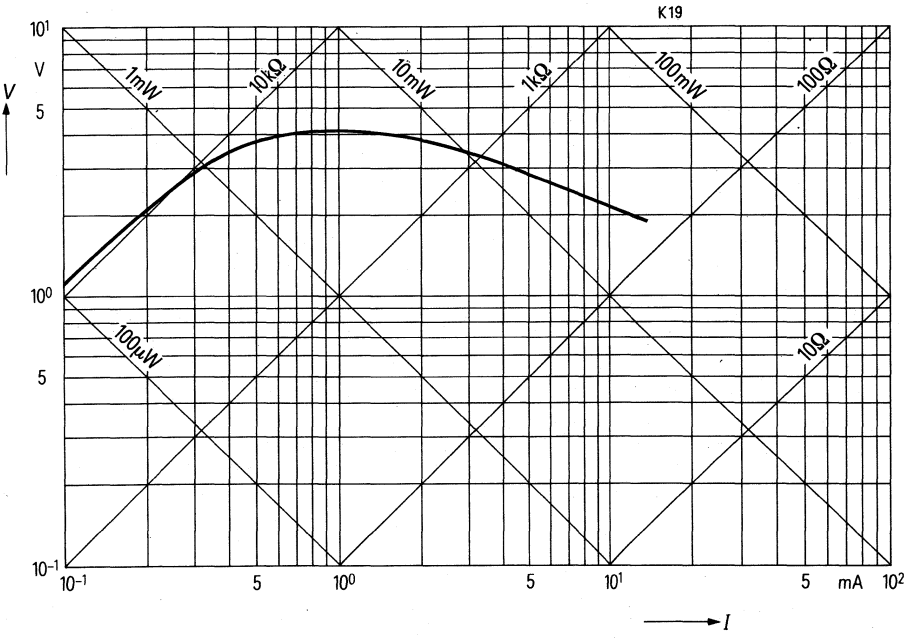
Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

Type	Rated resistance	Tolerance	*B* value	Matching pairs	Ordering code
K 19/10%/12 kΩ	12 kΩ	±10%	3440 K	–	Q63019–K123–K
K 19/20%/12 kΩ	12 kΩ	±20%	3440 K	–	Q63019–K123–M
K 19/20%/12 kΩ/P1	12 kΩ	±20%	3440 K	P1	Q63019–K123–M1
K 19/20%/12 kΩ/P2	12 kΩ	±20%	3440 K	P2	Q63019–K123–M2

Characteristic data

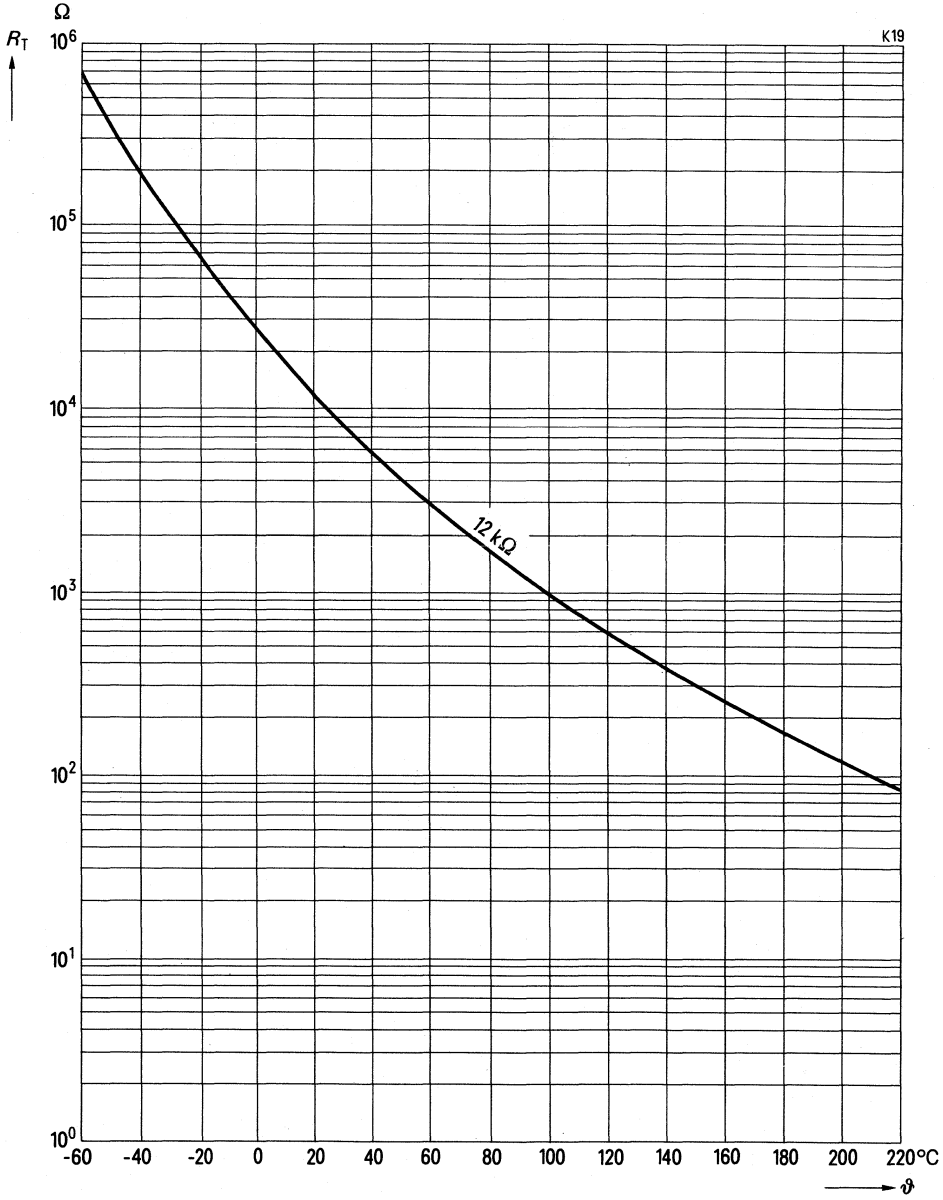
Power rating	at 25°C	P_{25}	25 mW
	at 60°C	P_{60}	20 mW
Rated temperature		ϑ_R	20 °C
Rated resistance		R_R	12 kΩ
Tolerance [1]		ΔR_R	See table
B value		B	3440 K
Tolerance[1]		ΔB	±5 %
Thermal conductance in air		G_{thA}	0.14 mW/K
Thermal time constant		τ_{th}	0.4 s
Thermal capacitance		C_{th}	56 µJ/K

Voltage-current characteristic $V = f(I)$



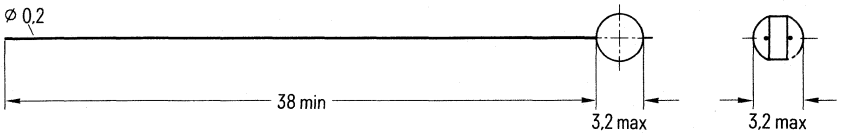
[1]) AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 1 kΩ to 250 kΩ

Application	For compensation and measuring tasks at high temperatures, protection of motor windings
Version	NTC thermistor body, unpainted
Terminals	Silver-coated leads (material with bad thermal conductivity)
Marking	Color dot, see table



Weight: approx. 0.1 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**FEF**
Lower category temperature	**F** – 55°C
Upper category temperature	**E** +200°C
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

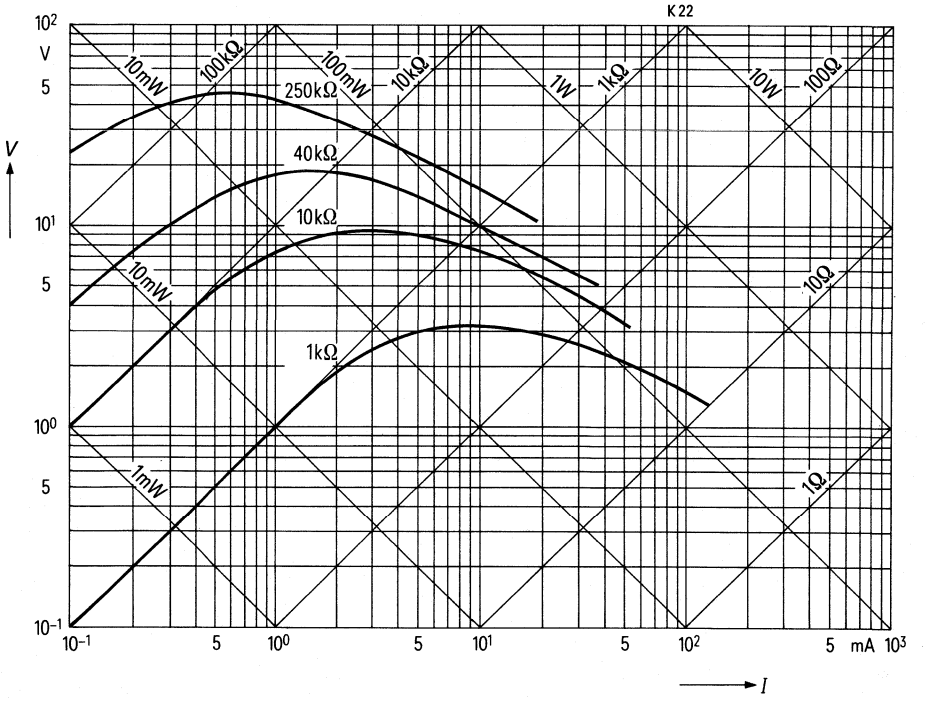
Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

Type	Rated resistance	*B* value	Color dot	Ordering code
K 22/20%/ 1 kΩ	1 kΩ	3530 K	orange	Q63022–K102–M
K 22/20%/ 10 kΩ	10 kΩ	3950 K	brown	Q63022–K103–M
K 22/20%/ 40 kΩ	40 kΩ	4300 K	yellow	Q63022–K403–M
K 22/20%/250 kΩ	250 kΩ	4560 K	–	Q63022–K254–M

Characteristic data

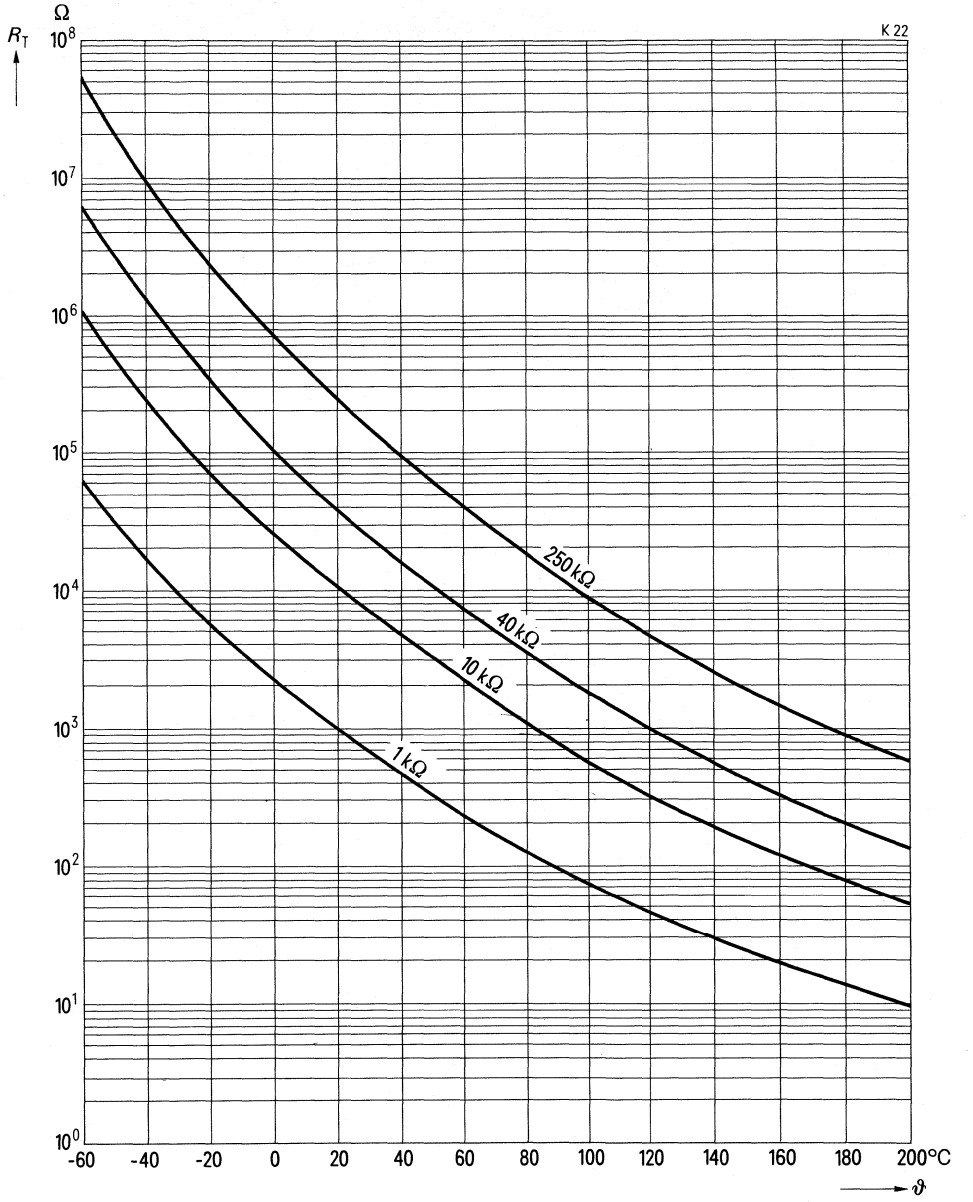
Power rating at 25°C	P_{25}	150 mW
at 60°C	P_{60}	125 mW
Rated temperature	ϑ_R	20 °C
Rated resistance	R_R	See table
Tolerance[1)]	ΔR_R	±20 %
B value	B	See table
Tolerance[1)]	ΔB	± 5 %
Thermal conductance in air	G_{thA}	1 mW/K
Thermal time constant	τ_{th}	approx. 30 s
Thermal capacitance	C_{th}	30 mJ/K

Voltage-current characteristics $V = f(I)$



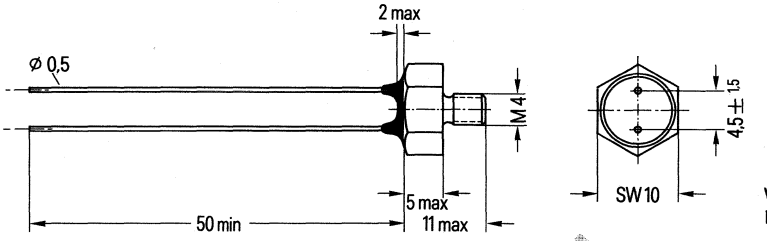
[1)] AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 10 Ω to 40 kΩ

Application	Temperature compensation of transistor output stages
Version	Metal case, NTC thermistor electrically insulated
Terminals	Leads, tinned
Marking	Color code (color of sealing compound), see table



Weight: approx. 1.0 g
Dimensions in mm

Climatic category **HMF**
in accordance with DIN 40040

Lower category temperature	**H** – 25°C
Upper category temperature	**M** +100°C
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\,min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\,max}$ +65°C

Type	Rated resistance	Tolerance	*B* value	Color code	Ordering code
K 25/20%/ 10 Ω	10 Ω	±20%	2580 K	brown	Q63025–K100–M
K 25/20%/ 25 Ω	25 Ω	±20%	2800 K	black	Q63025–K250–M
K 25/20%/ 60 Ω	60 Ω	±20%	2800 K	gray	Q63025–K600–M
K 25/20%/150 Ω	150 Ω	±20%	3090 K	yellow[1)]	Q63025–K151–M
K 25/20%/240 Ω	240 Ω	±20%	3260 K	green	Q63025–K241–M
K 25/20%/ 1 kΩ	1 kΩ	±20%	3530 K	violet	Q63025–K102–M
K 25/20%/ 6 kΩ	6 kΩ	±20%	3950 K	blue	Q63025–K602–M
K 25/20%/ 40 kΩ	40 kΩ	±20%	4250 K	white	Q63025–K403–M

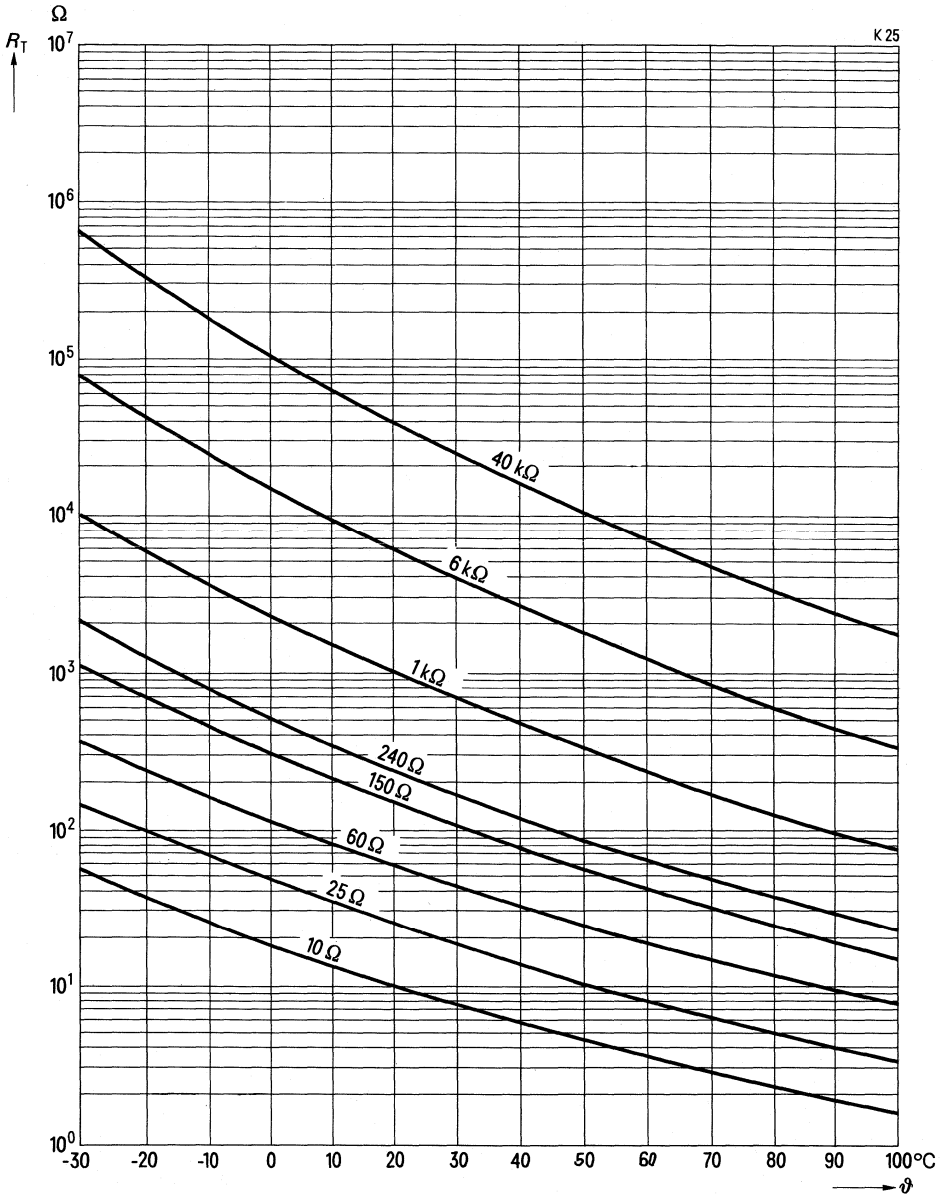
[1)] With a white color dot.

Characteristic data

Power rating	at 25°C	P_{25} 400 mW
	at 60°C	P_{60} 400 mW
Rated temperature		ϑ_R 20 °C
Rated resistance		R_R See table
Tolerance [1]		ΔR_R ±20 %
B value		B See table
Tolerance[1]		ΔB ±7 %
Thermal conductance in case of chassis mounting		G_{thC} ≥30 mW/K
Thermal time constant		τ_{th} approx. 20 s

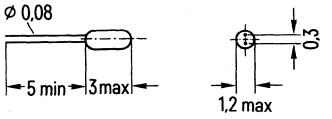
[1]) AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 12 kΩ

Application	Temperature measurement and regulation at small measuring points, measurement of thermal radiation and flow rates
Version	Glass case, hermetically sealed
Terminals	Leads made of a platinum alloy
Marking	None
Quality characteristic	High reliability due to special aging method



Weight: approx. 6 mg
Dimensions in mm

Climatic category in accordance with DIN 40040	**FDE**
Lower category temperature	**F** – 55°C
Upper category temperature	**D** +250°C
Humidity category	**E** Average relative humidity ⩽ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days Seldom and slight dew precipitation is permissible[1)]

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

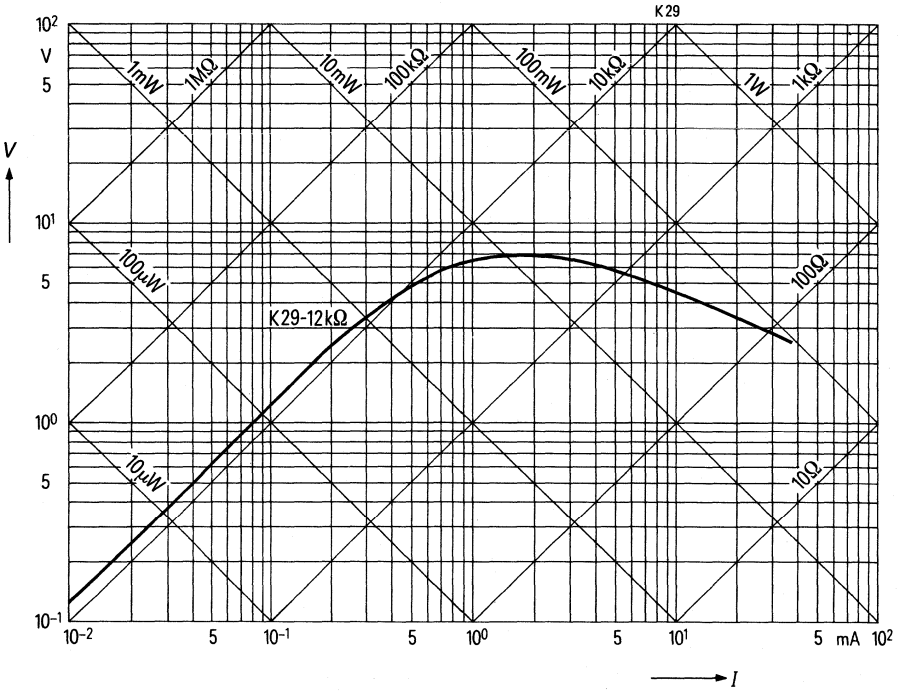
Type	Rated resistance	Tolerance	*B* value	Matching pairs	Ordering code
K 29/10%/12 kΩ	12 kΩ	±10%	3430 K	–	Q63029–K123–K
K 29/10%/12 kΩ/P1	12 kΩ	±10%	3430 K	P1	Q63029–K123–K1
K 29/10%/12 kΩ/P2	12 kΩ	±10%	3430 K	P2	Q63029–K123–K2
K 29/20%/12 kΩ	12 kΩ	±20%	3430 K	–	Q63029–K123–M
K 29/20%/12 kΩ/P1	12 kΩ	±20%	3430 K	P1	Q63029–K123–M1
K 29/20%/12 kΩ/P2	12 kΩ	±20%	3430 K	P2	Q63029–K123–M2

[1)] Dew precipitation may cause a temporary short-circuit at the lead outlets.

Characteristic data

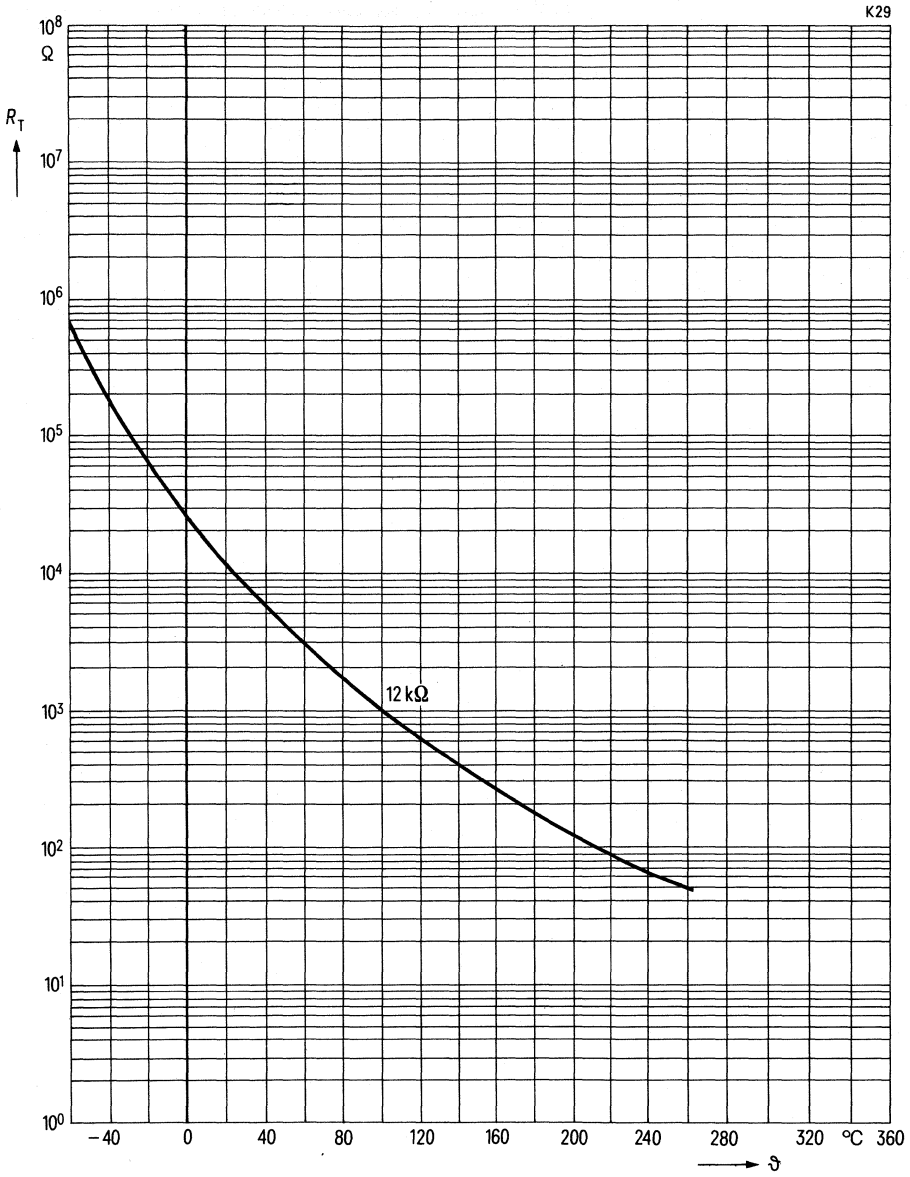
Power rating	at 25°C	P_{25}	70 mW
	at 60°C	P_{60}	55 mW
Rated temperature		ϑ_R	20 °C
Rated resistance		R_R	12 kΩ
Tolerance [1]		ΔR_R	See table
B value		B	3430 K
Tolerance[1]		ΔB	±5 %
Thermal conductance in air		G_{thA}	0.4 mW/K
Thermal time constant		τ_{th}	approx. 5 s
Thermal capacitance		C_{th}	2 mJ/K

Voltage-current characteristic $V = f(I)$



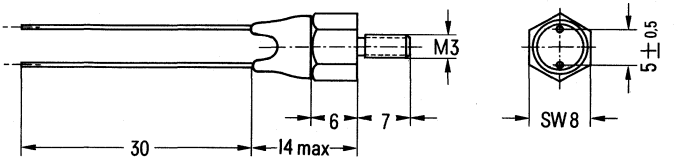
[1]) AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistor with 2.2 kΩ*)

Application	Temperature compensation and measurement
Version	Metal case, NTC thermistor body electrically insulated
Terminals	Leads, tinned
Marking	None



Weight: approx. 1.0 g
Dimensions in mm

Climatic category in accordance with DIN 40040 — **FKF**

Lower category temperature	**F** − 55°C
Upper category temperature	**K** +125°C
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

Minimum storage temperature $\vartheta_{stg\ min}$ −25°C
Maximum storage temperature $\vartheta_{stg\ max}$ +65°C

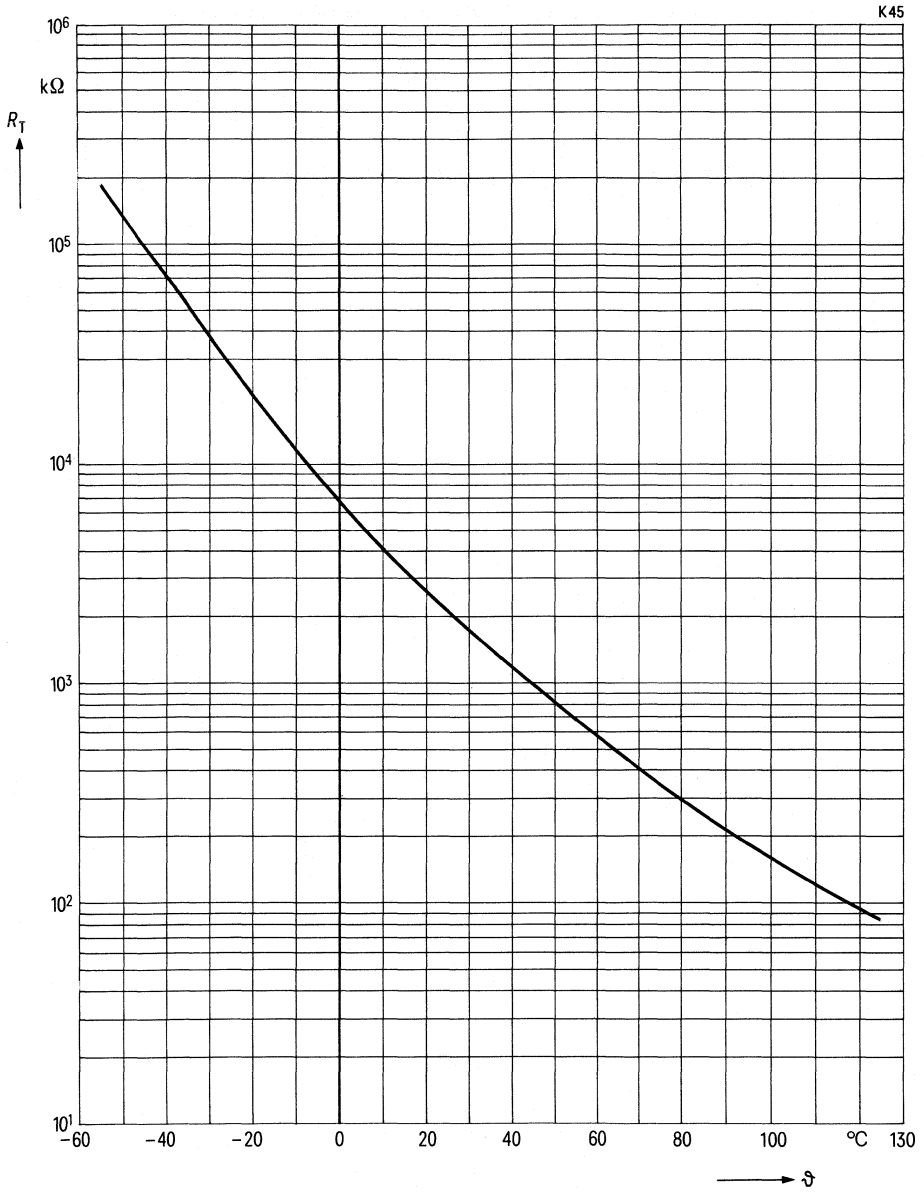
Characteristic data

Power rating at 25°C	P_{25}	750 mW
at 60°C	P_{60}	500 mW
Rated temperature	ϑ_R	25 °C
Rated resistance	R_R	2.2 kΩ
Tolerance[1)]	ΔR_R	±10 %
B value	B	3850 K
Tolerance[1)]	ΔB	±5 %
Thermal conductance in case of chassis mounting	G_{thC}	>15 mW/K
Thermal time constant	τ_{th}	approx. 30 s
Insulation resistance	R_{is}	>100 MΩ
Test voltage	V_{test}	2500 V
Test duration	t_t	1 s

Type	Rated resistance	Tolerance	*B* value	Ordering code
K 45/10%/2.2 kΩ	2.2 kΩ	±10%	3850 K	Q63045−K222−K

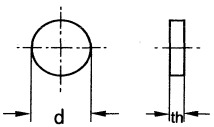
*) Other resistance values or tolerances upon request.
1) AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 12.5 Ω to 144 Ω

Application	Temperature measurement, e.g. automotive cooling water temperature, oil temperature
Version	NTC thermistor disc, lapped in a coplanar way
Terminals	Front surfaces, silver-plated
Marking	None
Quality characteristic	Resistance drift: $< \pm 2\%$ after 20000 temperature changes between room temperature and upper category temperature



Weight: approx. 0.3 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**FHF**
Lower category temperature	**F** − 55°C
Upper category temperature	**H** +155°C
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

Type	Rated resistance	Dimensions d [mm]	th [mm]	Ordering code
K 150/S1/12.5 Ω	12.5 Ω	7.7 −1.0	2.0 ± 0.5	Q63015−K9120−S1
K 150/S1/82.5 Ω	82.5 Ω	7.3 − 1.0	2.0 − 1.0	Q63015−K9820−S1
K 150/S1/100 Ω	100 Ω	7.3 − 1.0	2.0 − 1.0	Q63015−K9101−S1
K 150/S1/144 Ω	144 Ω	6.9 ± 0.4	1.4 ± 0.3	Q63015−K9141−S1

Characteristic data

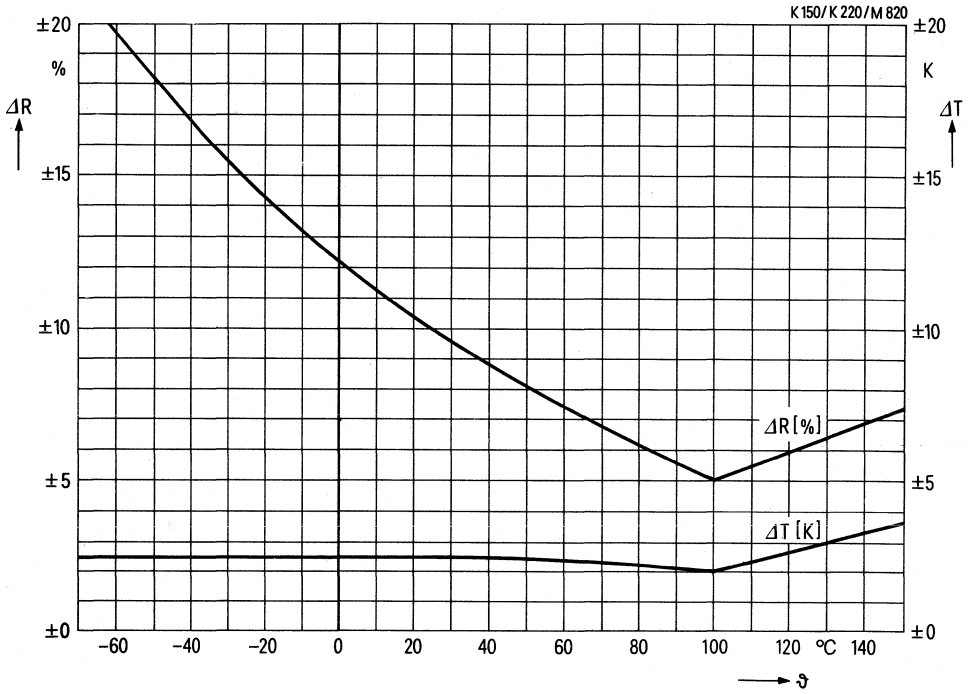
Power rating at 25°C	P_{25}	650 mW
at 60°C	P_{60}	470 mW
Rated temperature	ϑ_R	100 °C
Rated resistance	R_R	See resistance-temperature characteristic
Tolerance [1]	ΔR_R	See diagram
B value	B	See resistance-temperature characteristic
Thermal conductance in air	G_{thA}	5 mW/K
Thermal conductance in case of chassis mounting	G_{thC}	30 mW/K
Thermal time constant	τ_{th}	7 s
Thermal capacitance	C_{th}	200 mJ/K

Resistance-temperature characteristic

Type	**K 150/S1/12.5 Ω**	**K 150/S1/82.5 Ω**	**K 150/S1/100Ω**	**K 150/S1/144 Ω**
Temperature °C	Resistance Ω	Resistance Ω	Resistance Ω	Resistance Ω
−60	8360	14120	9670	235000
−50	4400	8500	6160	113000
−40	2440	5330	4070	57800
−30	1410	3460	2770	31000
−20	848	2310	1940	17400
−10	528	1590	1390	10100
± 0	338	1120	1015	6130
10	223	805	758	3820
20	151	591	575	2440
30	104	441	444	1600
40	73	334	347	1080
50	52.7	257	275	739
60	38.4	200	220	516
70	28.5	158	178	367
80	21.4	126	146	265
90	16.3	102	120	194
100	12.5	82.5	100	144
110	9.8	68.0	84.2	109
120	7.7	56.5	71.4	83.5
130	6.2	47.3	61.0	64.7
140	5.0	39.9	52.5	50.7
150	4.1	33.9	45.4	40.1

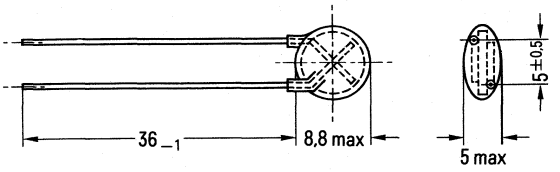
[1]) AQL = 0.65%

Permissible deviation of the resistance-temperature measurement error



NTC thermistors with 1.5 Ω to 15 Ω

Application	Temperature compensation in transistor circuits, e. g. in radio sets, TV sets, and tape recorders
Version	NTC thermistor disc, painted
Terminals	Leads, tinned
Marking	The resistance value is stamped on the component[1]



Weight: approx. 0.6 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**HMF**
Lower category temperature	**H** − 25°C
Upper category temperature	**M** +100°C
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

Type	Rated resistance	Tolerance	*B* value	Ordering code
K 153/25%/1.5 Ω[2]	1.5 Ω	±25%	2580 K	Q63015−K3159−N
K 153/20%/2.2 Ω	2.2 Ω	±20%	2580 K	Q63015−K3229−M
K 153/20%/8 Ω	8 Ω	±20%	2800 K	Q63015−K3809−M
K 153/10%/15 Ω	15 Ω	±10%	3000 K	Q63015−K3150−K

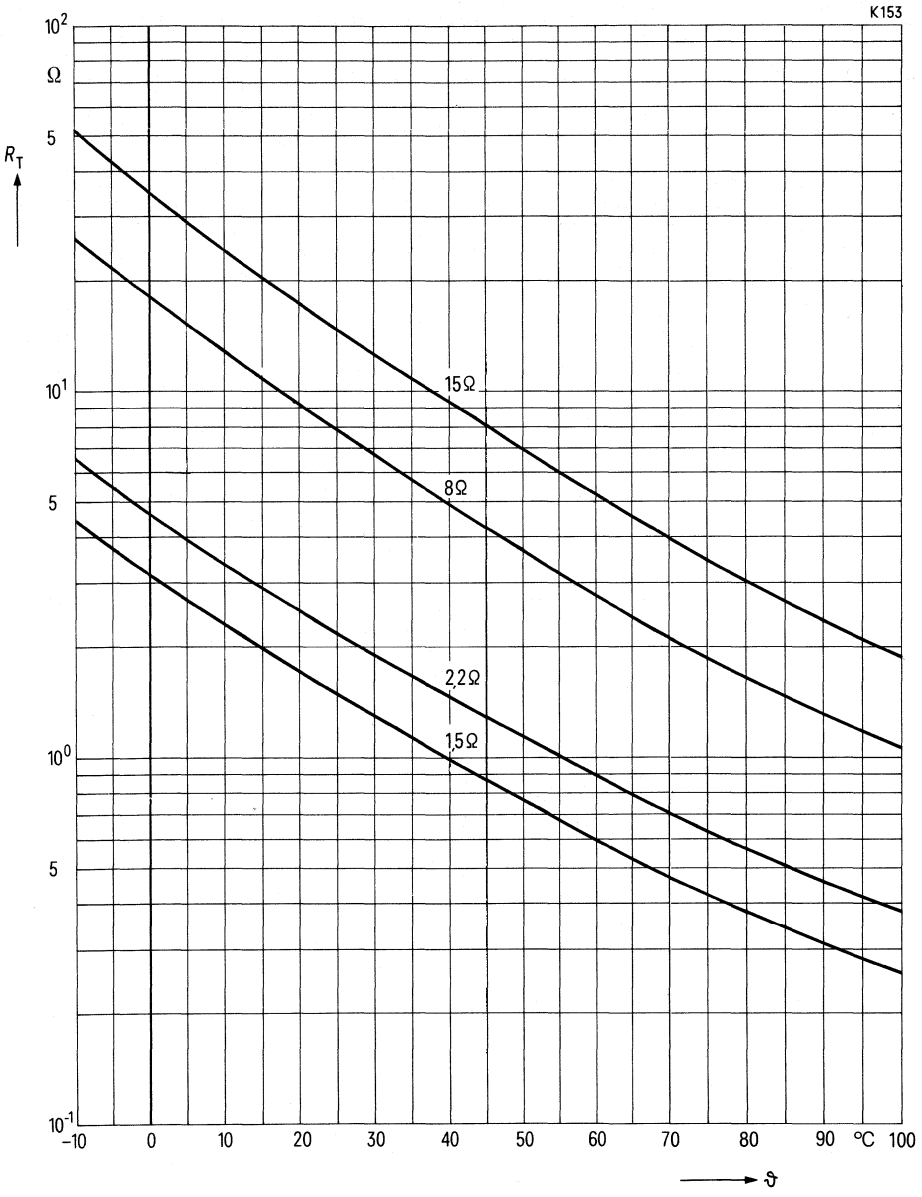
[1]) The tolerance ±10% is encoded by a line placed below the resistance value.
[2]) Diameter of wire is 0.8 mm

Characteristic data

Type	**K 153**	**25%** **1.5 Ω**	**20%** 2.2 Ω	**20%** 8 Ω	**10%** 15 Ω	Unit
Power rating at 25°C	P_{25}	600	600	600	600	mW
at 60°C	P_{60}	300	300	300	300	mW
Rated temperature	ϑ_R	25	25	25	25	°C
Rated resistance	R_R	1.5	2.2	8.0	15	Ω
Tolerance [1]	ΔR_R	±25	±20	±20	±10	%
B value	*B*	2580	2580	2900	3000	K
Tolerance[1]	ΔB	±5	±5	±5	±5	%
Thermal conductance in air	G_{thA}	8	8	8	8	mW/K
Thermal time constant	τ_{th}	30	30	30	30	s
Thermal capacitance	C_{th}	240	240	240	240	mJ/K

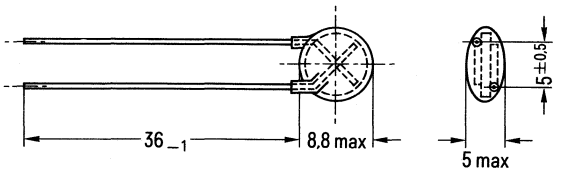
[1]) AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 4 Ω to 60 kΩ

Application	Temperature compensation in radio sets, TV sets, and tape recorders
Version	NTC thermistor disc, painted
Terminals	Leads, tinned
Marking	The resistance value is stamped on the component[1]



Weight: approx. 0.6 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**HMF**
Lower category temperature	**H** − 10°C
Upper category temperature	**M** +100°C
Humidity category	**F** Average relative humidity ⩽ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

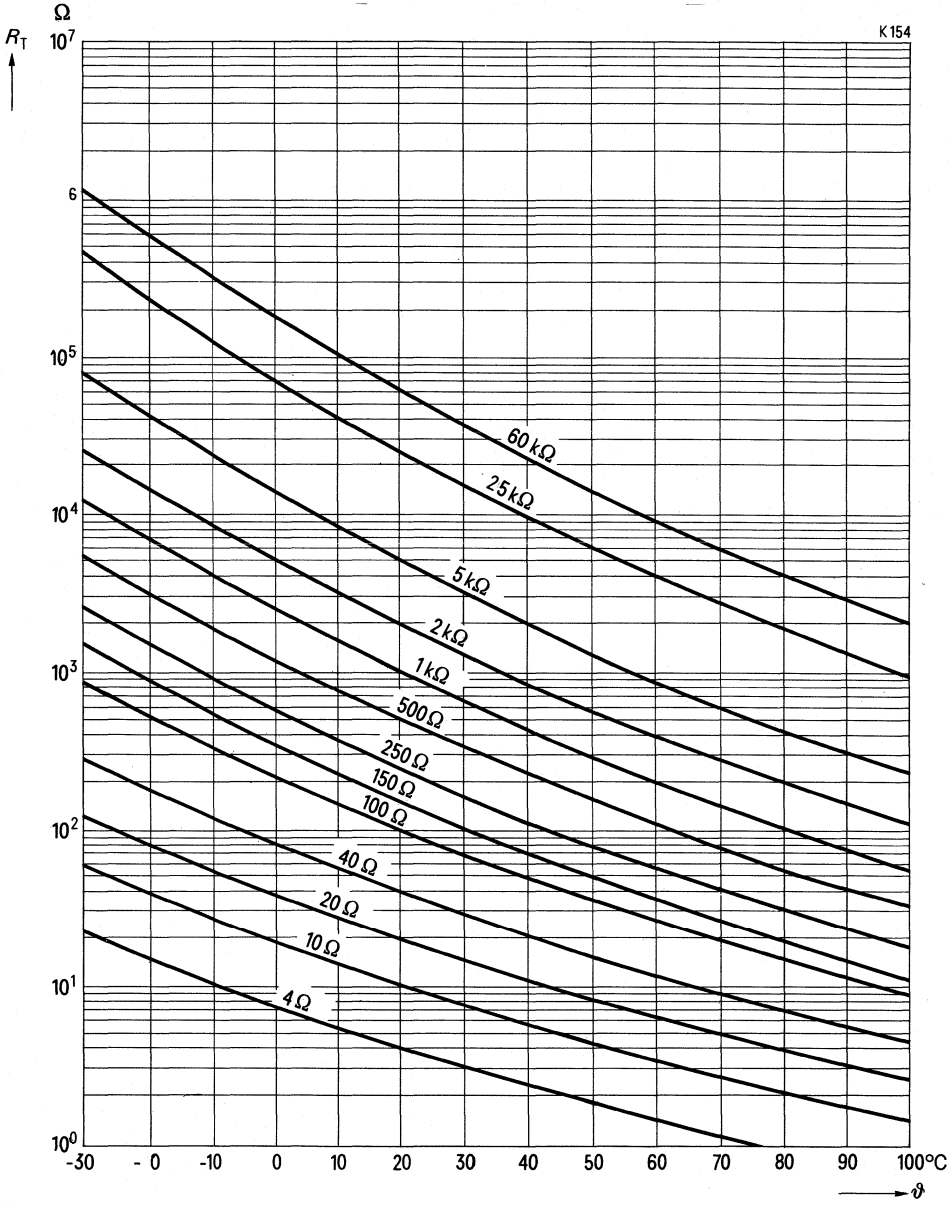
Characteristic data

Power rating	at 25°C	P_{25}	600 mW
	at 60°C	P_{60}	300 mW
Rated temperature		ϑ_R	20 °C
Rated resistance		R_R	See table
Tolerance [2]		ΔR_R	±20 %
B value		*B*	See table
Tolerance[2]		ΔB	±7 %
Thermal conductance in air		G_{thA}	8 mW/K
Thermal time constant		τ_{th}	approx. 30 s

[1]) The tolerance ±10% is encoded by a line placed below the resistance value.
[2]) AQL = 0.65%

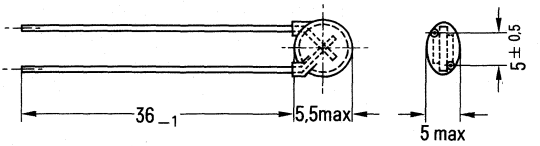
Type	Rated resistance	Tolerance	*B* value	Ordering code
K 154/20%/ 4 Ω	4 Ω	±20%	2580 K	Q63015–K4040–M
K 154/20%/ 10 Ω	10 Ω	±20%	2800 K	Q63015–K4100–M
K 154/20%/ 20 Ω	20 Ω	±20%	2810 K	Q63015–K4200–M
K 154/20%/ 40 Ω	40 Ω	±20%	3000 K	Q63015–K4400–M
K 154/20%/100 Ω	100 Ω	±20%	3260 K	Q63015–K4101–M
K 154/20%/150 Ω	150 Ω	±20%	3530 K	Q63015–K4151–M
K 154/20%/250 Ω	250 Ω	±20%	3600 K	Q63015–K4251–M
K 154/20%/500 Ω	500 Ω	±20%	3600 K	Q63015–K4501–M
K 154/20%/ 1 kΩ	1 kΩ	±20%	3950 K	Q63015–K4102–M
K 154/20%/ 2 kΩ	2 kΩ	±20%	3950 K	Q63015–K4202–M
K 154/20%/ 5 kΩ	5 kΩ	±20%	4250 K	Q63015–K4502–M
K 154/20%/10 kΩ	10 kΩ	±20%	4250 K	Q63015–K4103–M
K 154/20%/25 kΩ	25 kΩ	±20%	4450 K	Q63015–K4253–M
K 154/20%/60 kΩ	60 kΩ	±20%	4600 K	Q63015–K4603–M
K 154/10%/ 4 Ω	4 Ω	±10%	2580 K	Q63015–K4040–K
K 154/10%/ 10 Ω	10 Ω	±10%	2800 K	Q63015–K4100–K
K 154/10%/ 20 Ω	20 Ω	±10%	2810 K	Q63015–K4200–K
K 154/10%/ 40 Ω	40Ω	±10%	3000 K	Q63015–K4400–K
K 154/10%/100 Ω	100 Ω	±10%	3260 K	Q63015–K4101–K
K 154/10%/150 Ω	150 Ω	±10%	3530 K	Q63015–K4151–K
K 154/10%/250 Ω	250 Ω	±10%	3600 K	Q63015–K4251–K
K 154/10%/500 Ω	500 Ω	±10%	3600 K	Q63015–K4501–K
K 154/10%/ 1 kΩ	1 kΩ	±10%	3950 K	Q63015–K4102–K
K 154/10%/ 2 kΩ	2 kΩ	±10%	3950 K	Q63015–K4202–K
K 154/10%/ 5 kΩ	5 kΩ	±10%	4250 K	Q63015–K4502–K
K 154/10%/10 kΩ	10 kΩ	±10%	4250 K	Q63015–K4103–K
K 154/10%/25 kΩ	25 kΩ	±10%	4450 K	Q63015–K4253–K
K 154/10%/60 kΩ	60 kΩ	±10%	4600 K	Q63015–K4603–K

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 6.8 Ω to 470 kΩ

Application	Temperature compensation in radio sets, TV sets, and tape recorders
Version	NTC thermistor disc, painted
Terminals	Leads, tinned
Marking	The resistance value is stamped on the component



Weight: approx. 0.6 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**FKF**
Lower category temperature	**F** – 55°C
Upper category temperature	**K** +125°C
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

Type	Rated resistance	Tolerance	*B* value	Ordering code
K 164/20%/ 6.8 Ω	6.8 Ω	±20%	2600 K	Q63016–K4006–M8
K 164/20%/ 10 Ω	10 Ω	±20%	2600 K	Q63016–K4010–M
K 164/20%/ 15 Ω	15 Ω	±20%	2900 K	Q63016–K4015–M
K 164/20%/ 22 Ω	22 Ω	±20%	2900 K	Q63016–K4022–M
K 164/20%/ 33 Ω	33 Ω	±20%	2900 K	Q63016–K4033–M
K 164/20%/ 47 Ω	47 Ω	±20%	3050 K	Q63016–K4047–M
K 164/20%/ 68 Ω	68 Ω	±20%	3050 K	Q63016–K4068–M
K 164/20%/100 Ω	100 Ω	±20%	3250 K	Q63016–K4100–M
K 164/20%/150 Ω	150 Ω	±20%	3250 K	Q63016–K4150–M
K 164/20%/220 Ω	220 Ω	±20%	3250 K	Q63016–K4220–M
K 164/20%/330 Ω	330 Ω	±20%	3480 K	Q63016–K4330–M
K 164/20%/470 Ω	470 Ω	±20%	3480 K	Q63016–K4470–M
K 164/20%/680 Ω	680 Ω	±20%	3560 K	Q63016–K4680–M

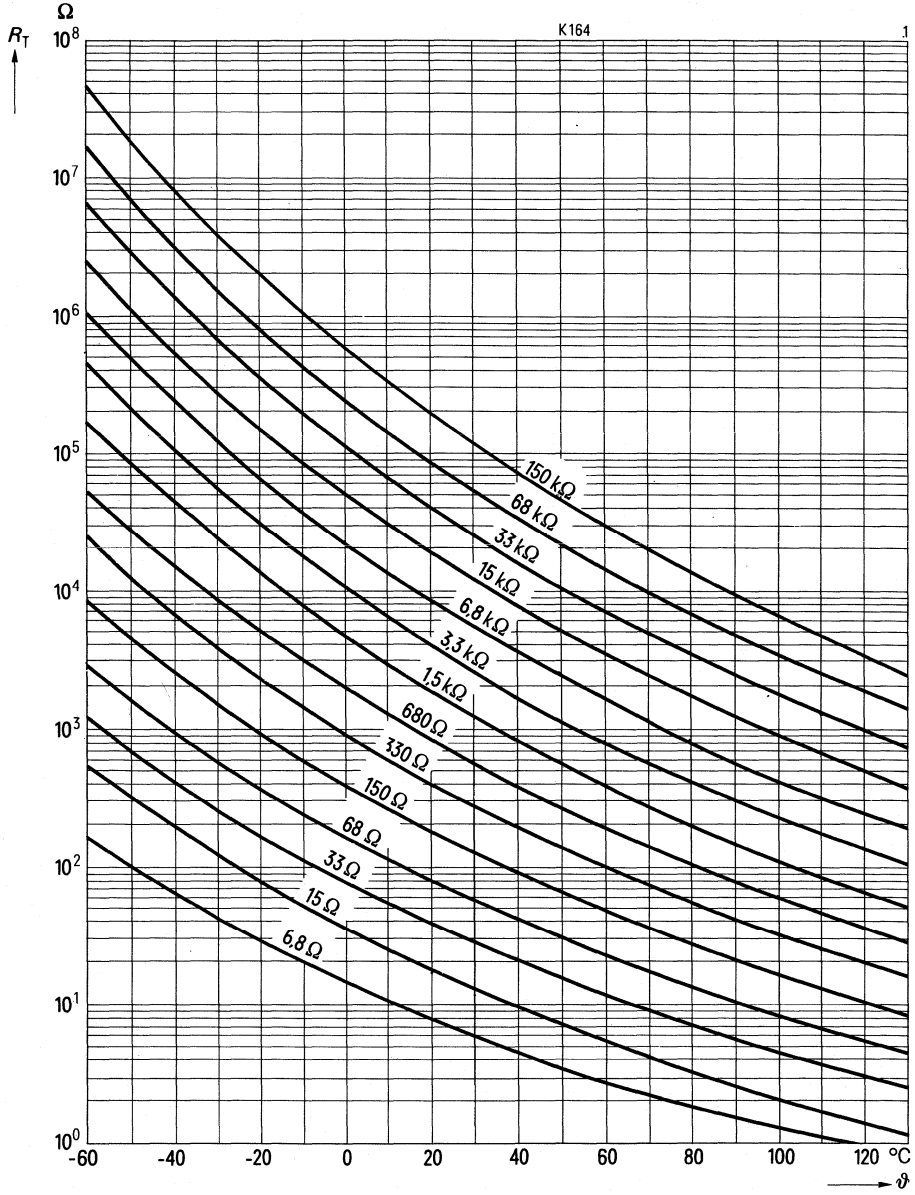
Type	Rated resistance	Tolerance	*B* value	Ordering code
K 164/20%/ 1 kΩ	1 kΩ	±20%	3700 K	Q63016–K4001–M40
K 164/20%/ 1.5 kΩ	1.5 kΩ	±20%	3850 K	Q63016–K4001–M45
K 164/20%/ 2.2 kΩ	2.2 kΩ	±20%	3850 K	Q63016–K4002–M42
K 164/20%/ 3.3 kΩ	3.3 kΩ	±20%	3950 K	Q63016–K4003–M43
K 164/20%/ 4.7 kΩ	4.7 kΩ	±20%	3950 K	Q63016–K4004–M47
K 164/20%/ 6.8 kΩ	6.8 kΩ	±20%	4100 K	Q63016–K4006–M48
K 164/20%/ 10 kΩ	10 kΩ	±20%	4100 K	Q63016–K4010–M40
K 164/20%/ 15 kΩ	15 kΩ	±20%	4150 K	Q63016–K4015–M40
K 164/20%/ 22 kΩ	22 kΩ	±20%	4300 K	Q63016–K4022–M40
K 164/20%/ 33 kΩ	33 kΩ	±20%	4300 K	Q63016–K4033–M40
K 164/20%/ 47 kΩ	47 kΩ	±20%	4450 K	Q63016–K4047–M40
K 164/20%/ 68 kΩ	68 kΩ	±20%	4450 K	Q63016–K4068–M40
K 164/20%/100 kΩ	100 kΩ	±20%	4450 K	Q63016–K4100–M40
K 164/20%/150 kΩ	150 kΩ	±20%	4650 K	Q63016–K4150–M40
K 164/20%/220 kΩ	220 kΩ	±20%	4850 K	Q63016–K4220–M40
K 164/20%/470 kΩ	470 kΩ	±20%	4850 K	Q63016–K4470–M40
K 164/10%/ 6.8 Ω	6.8 Ω	±10%	2600 K	Q63016–K4006–K8
K 164/10%/ 10 Ω	10 Ω	±10%	2600 K	Q63016–K4010–K
K 164/10%/ 15 Ω	15 Ω	±10%	2900 K	Q63016–K4015–K
K 164/10%/ 22 Ω	22 Ω	±10%	2900 K	Q63016–K4022–K
K 164/10%/ 33 Ω	33 kΩ	±10%	2900 K	Q63016–K4033–K
K 164/10%/ 47 Ω	47 Ω	±10%	3050 K	Q63016–K4047–K
K 164/10%/ 68 Ω	68 Ω	±10%	3050 K	Q63016–K4068–K
K 164/10%/100 Ω	100 Ω	±10%	3250 K	Q63016–K4100–K
K 164/10%/150 Ω	150 Ω	±10%	3250 K	Q63016–K4150–K
K 164/10%/220 Ω	220 Ω	±10%	3250 K	Q63016–K4220–K
K 164/10%/330 Ω	330 Ω	±10%	3480 K	Q63016–K4330–K
K 164/10%/470 Ω	470 Ω	±10%	3480 K	Q63016–K4470–K
K 164/10%/680 Ω	680 Ω	±10%	3560 K	Q63016–K4680–K
K 164/10%/ 1 kΩ	1 kΩ	±10%	3700 K	Q63016–K4001–K40
K 164/10%/ 1.5 kΩ	1.5 kΩ	±10%	3850 K	Q63016–K4001–K45
K 164/10%/ 2.2 kΩ	2.2 kΩ	±10%	3850 K	Q63016–K4002–K42
K 164/10%/ 3.3 kΩ	3.3 kΩ	±10%	3950 K	Q63016–K4003–K43
K 164/10%/ 4.7 kΩ	4.7 kΩ	±10%	3950 K	Q63016–K4004–K47
K 164/10%/ 6.8 kΩ	6.8 kΩ	±10%	4100 K	Q63016–K4006–K48
K 164/10%/ 10 kΩ	10 kΩ	±10%	4100 K	Q63016–K4010–K40
K 164/10%/ 15 kΩ	15 kΩ	±10%	4150 K	Q63016–K4015–K40
K 164/10%/ 22 kΩ	22 kΩ	±10%	4300 K	Q63016–K4022–K40
K 164/10%/ 33 kΩ	33 kΩ	±10%	4300 K	Q63016–K4033–K40
K 164/10%/ 47 kΩ	47 kΩ	±10%	4450 K	Q63016–K4047–K40
K 164/10%/ 68 kΩ	68 kΩ	±10%	4450 K	Q63016–K4068–K40
K 164/10%/100 kΩ	100 kΩ	±10%	4450 K	Q63016–K4100–K40
K 164/10%/150 kΩ	150 kΩ	±10%	4650 K	Q63016–K4150–K40
K 164/10%/220 kΩ	220 kΩ	±10%	4850 K	Q63016–K4220–K40
K 164/10%/470 kΩ	470 kΩ	±10%	4850 K	Q63016–K4470–K40

Characteristic data

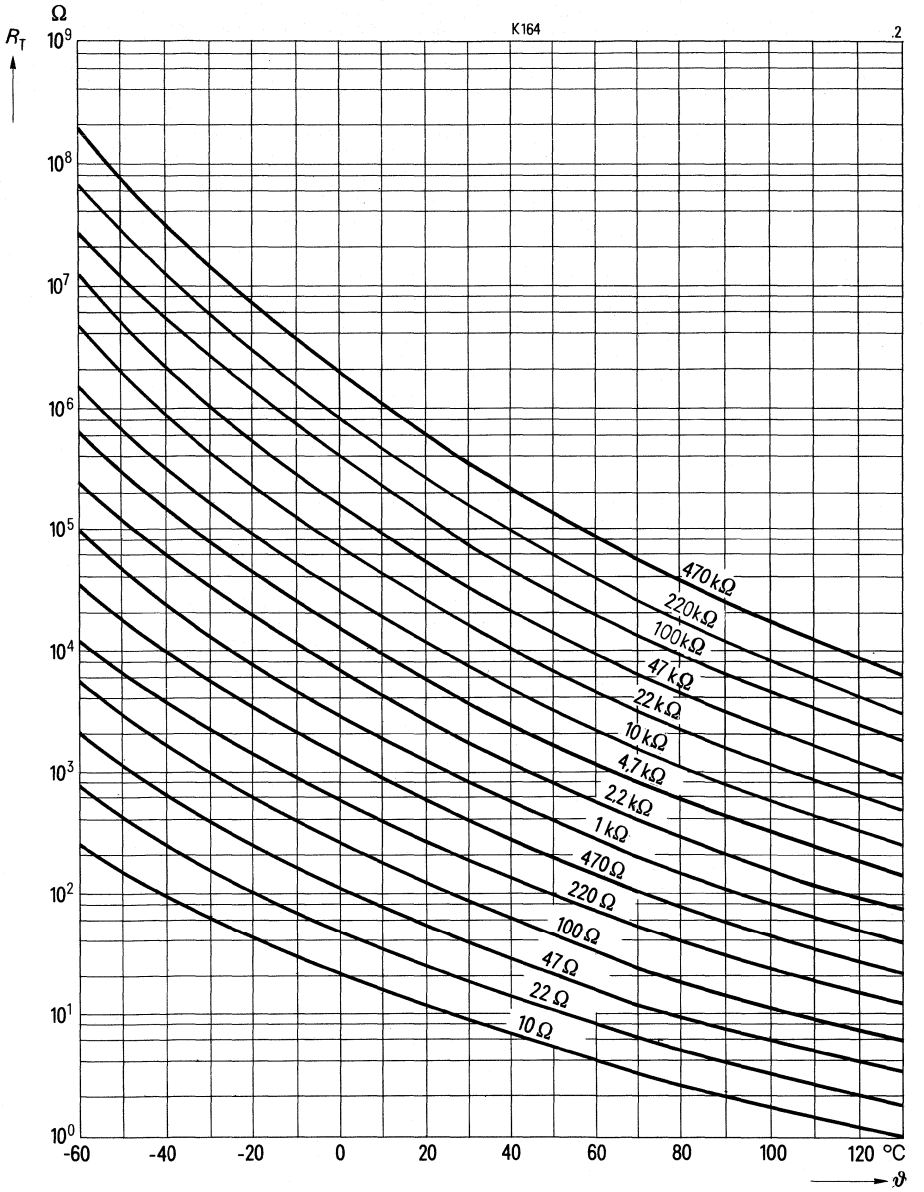
Power rating	at 25°C	P_{25}	750 mW
	at 60°C	P_{60}	500 mW
Rated temperature		ϑ_R	25 °C
Rated resistance		R_R	See table
Tolerance [1]		ΔR_R	See table
Resistance change to be expected after 10 000 hours		$\Delta R_{10.}$	±15 %
B value		B	See table
Tolerance[1]		ΔB	±5 %
Thermal conductance in air		G_{thA}	≥6 mW/K
Thermal time constant		τ_{th}	(20±5) s

[1]) AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature

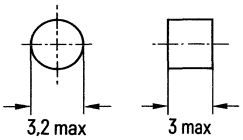


NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 1.6 kΩ and 2.5 kΩ*)

Application	Temperature measurement with low electrical load
Version	NTC thermistor disc, lapped in a coplanar way
Terminals	Front surface, silver-plated
Marking	None
Quality characteristic	Resistance drift $< \pm 2\%$ after 20000 temperature changes between room temperature and upper category temperature



Weight: approx. 0.2 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**FDF**
Lower category temperature	**F** − 55°C
Upper category temperature	**D** +250°C
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

Type	Rated resistance	Tolerance	*B* value	Ordering code
K 220/S1/1.6 kΩ	1.6 kΩ	±10%	3560 K	Q63022−K162−S1
K 220/S1/2.5 kΩ	2.5 kΩ	±10%	3560 K	Q63022−K252−S1

*) Other resistance values upon request.

Characteristic data

Type	K 220/S1	1.6 kΩ	2.5 kΩ	Unit
Power rating at 25°C	P_{25}	220	220	mW
at 60°C	P_{60}	180	180	mW
Rated temperature	ϑ_R	20	20	°C
Rated resistance	R_R	1.6	2.5 k	Ω
Tolerance [1]	ΔR_R	±10	±10	%
Resistance at 130°C	R_{130}	58	90	%
Tolerance of R_{130} [1]	ΔR_{130}	±10	±10	Ω
B value	B	3560	3560	K
Tolerance [1]	ΔB	See resistance-temperature characteristic		
Thermal conductance in air	G_{thA}	1	1	mW/K
in case of chassis mounting	G_{thC}	approx. 6	approx. 6	mW/K
Thermal time constant	τ_{th}	approx. 5	approx. 5	s
Thermal capacitance	C_{th}	30	30	mJ/K

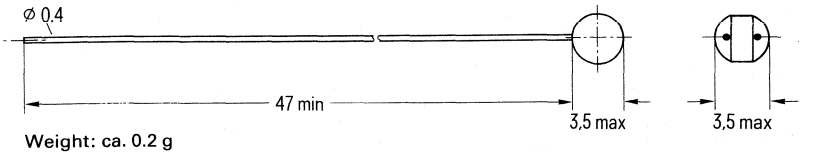
[1]) AQL = 0.65%

Resistance-temperature characteristic

Type	**K 220/S1/1.6 kΩ**	**K 220/S1/2.5 kΩ**	**K 220/S1/1.6 kΩ** **K 220/S1/2.5 kΩ**
Temperature	Resistance	Resistance	Tolerance
−60°C	104.5 kΩ	163.3 kΩ	±30.9%
−50°C	53.6 kΩ	83.8 kΩ	±27.6%
−40°C	29.0 kΩ	45.3 kΩ	±24.5%
−30°C	16.4 kΩ	25.6 kΩ	±21.6%
−20°C	9.65 kΩ	15.08 kΩ	±19.0%
−10°C	5.89 kΩ	9.20 kΩ	±16.5%
± 0°C	3.71 kΩ	5.80 kΩ	±14.2%
10°C	2.41 kΩ	3.76 kΩ	±12.0%
20°C	1.60 kΩ	2.50 kΩ	±10.0%
30°C	1.09 kΩ	1.70 kΩ	±10.0%
40°C	755 Ω	1.18 kΩ	±10.0%
50°C	535 Ω	837 Ω	±10.0%
60°C	386 Ω	603 Ω	±10.0%
70°C	282 Ω	441 Ω	±10.0%
80°C	209 Ω	327 Ω	±10.0%
90°C	157 Ω	246 Ω	±10.0%
100°C	120 Ω	187 Ω	±10.0%
110°C	92.8 Ω	145 Ω	±10.0%
120°C	73.0 Ω	114 Ω	±10.0%
130°C	57.6 Ω	90 Ω	±10.0%
140°C	46.1 Ω	72 Ω	±11.1%
150°C	37.1 Ω	58 Ω	±12.2%
160°C	30.2 Ω	47.3 Ω	±13.2%
180°C	20.5 Ω	32.1 Ω	±15.2%
200°C	14.3 Ω	22.3 Ω	±17.0%
220°C	10.2 Ω	16.0 Ω	±18.6%
240°C	7.5 Ω	11.7 Ω	±20.2%
260°C	5.6 Ω	8.7 Ω	±21.7%

NTC thermistor with 2.5 kΩ *)

Application	Measuring and compensation tasks with low electrical load
Version	NTC thermistor disc, unpainted
Terminals	Leads made of silver
Marking	None



Weight: ca. 0.2 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**FHF**
Lower category temperature	**F** − 55°C
Upper category temperature	**H** +150°C
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

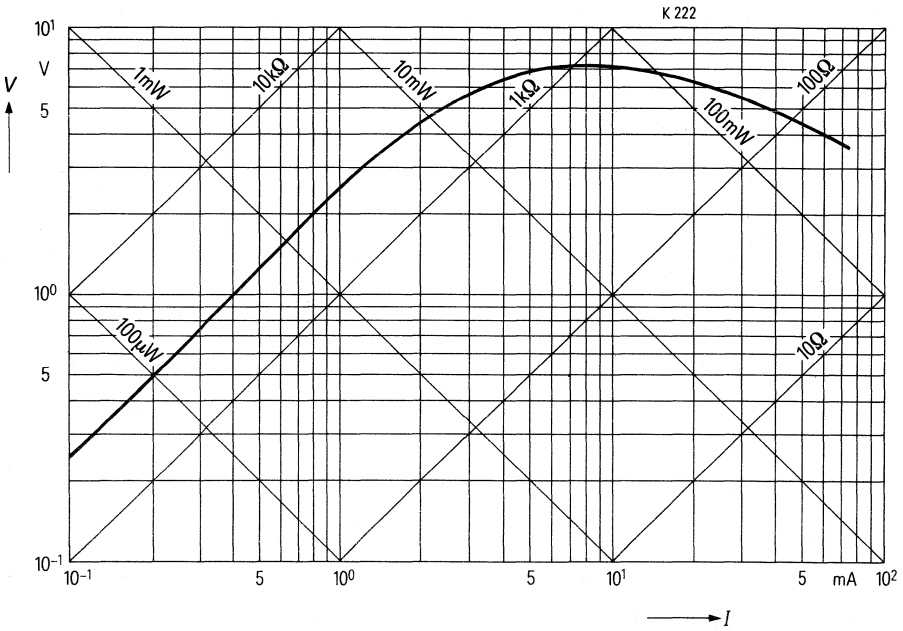
Type	Rated resistance	*B* value	Ordering code
K 222/S1/2.5 kΩ	2.5 kΩ	3560 K	Q63022−K2252−S1

*) Other resistance values upon request.

Characteristic data

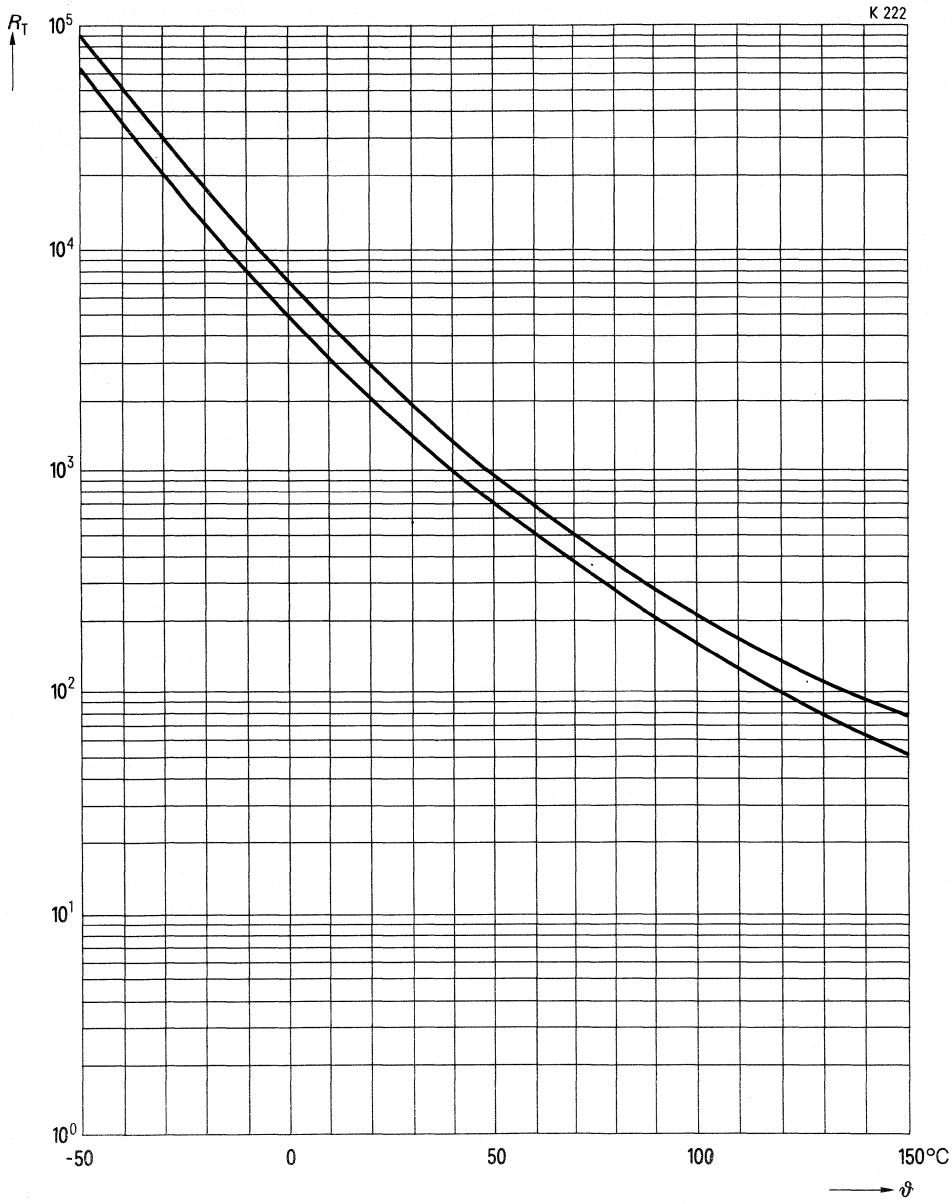
Power rating	at 25°C	P_{25}	250 mW
	at 60°C	P_{60}	190 mW
Rated temperature		ϑ_R	20 °C
Rated resistance		R_R	2.5 kΩ
Tolerance [1]		ΔR_R	±10 %
B value		B	approx. 3560 K
Tolerance[1]		ΔB	±5%
Resistance at 80°C		R_{80}	325 Ω
Tolerance[1]		ΔR_{80}	±10 %
Thermal conductance in air		G_{thA}	2 mW/K
Thermal time constant		τ_{th}	20 s
Thermal capacitance		C_{th}	40 mJ/K

Voltage-current characteristic $V = f(I)$



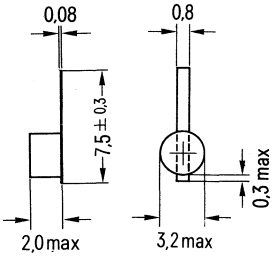
[1]) AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature (deviation limits)



NTC thermistor with 680 Ω and 2.5 kΩ

Application	Temperature compensation in thick film circuits
Version	NTC thermistor disc for solder mounting
Terminals	Silver strip
Marking	None



Weight: approx. 0.1 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**FKF**
Lower category temperature	**F** − 55°C
Upper category temperature	**K** +125°C
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

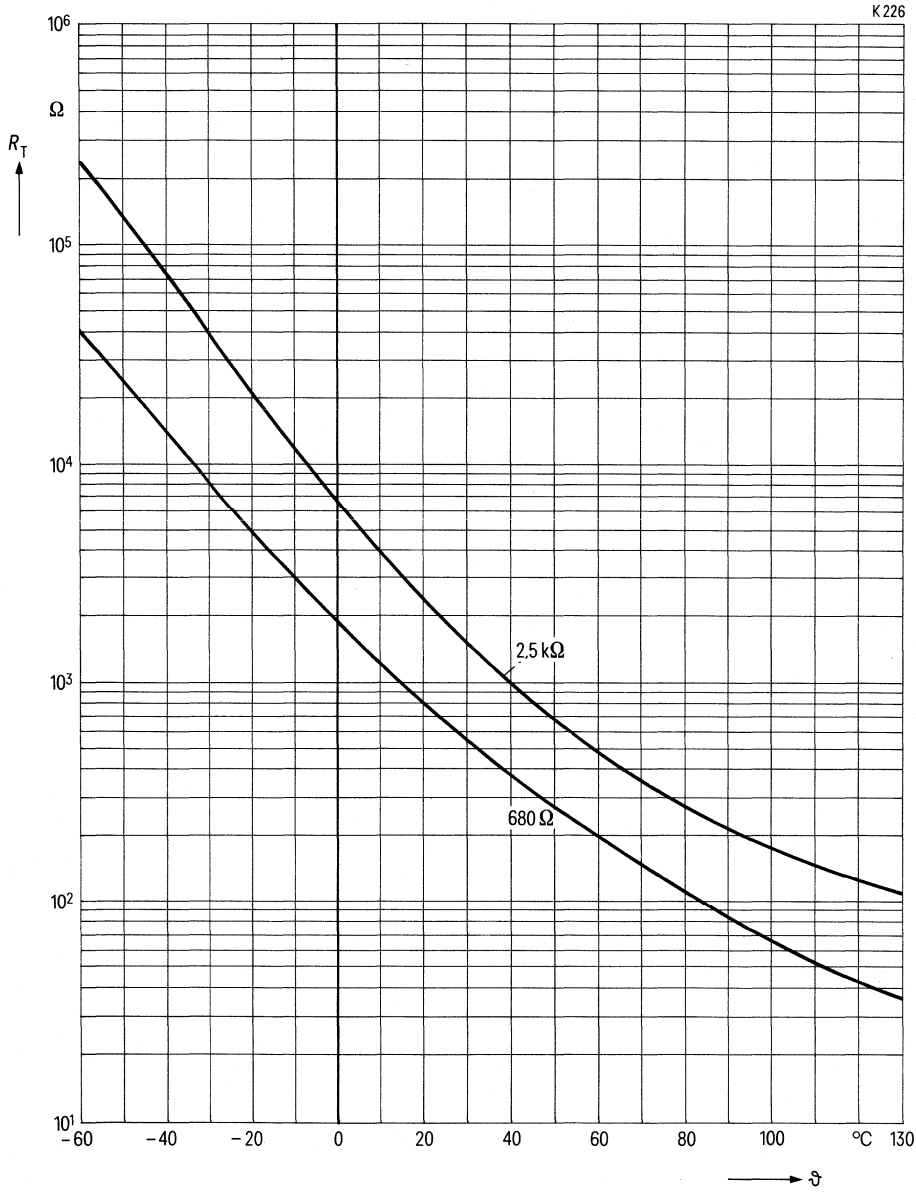
Type	Rated resistance	Tolerance	*B* value	Ordering code
K 226/5%/680 Ω	680 Ω	± 5%	3300 K	Q63022−K6681−J
K 226/S1/2.5 kΩ	2.5 kΩ	±10%	3560 K	Q63022−K6252−S1

Characteristic data

Type	K 226	5%/680 Ω	S1/2.5 kΩ	Unit
Power rating at 25°C	P_{25}	approx. 100	approx. 100	mW
Rated temperature	ϑ_R	25	20	°C
Rated resistance	R_R	680	2.5 k	Ω
Tolerance [1]	ΔR_R	±5	±10	%
Resistance at 80°C	R_{80}	–	325	Ω
Tolerance[1]	ΔR_{80}	–	±10	%
B value	*B*	3300	3560	K
Tolerance[1]	ΔB	±5	±5	%
Max. soldering temperature	$\vartheta_{sold\,M}$	250	250	°C
Max. soldering time	$t_{sold\,M}$	5	5	s

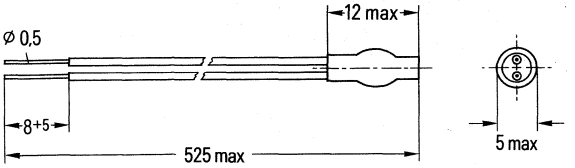
[1]) AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 1.8 kΩ and 10 kΩ

Application	Temperature monitoring of motor and transformer windings
Version	NTC thermistor insulated with shrunk sleeve
Terminals	Silicon litz wires, tinned ends
Marking	See table for code colors of litz wires



Weight: approx. 5.5 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**FHF**
Lower category temperature	**F** – 55°C
Upper category temperature	**H** +150°C [1]
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

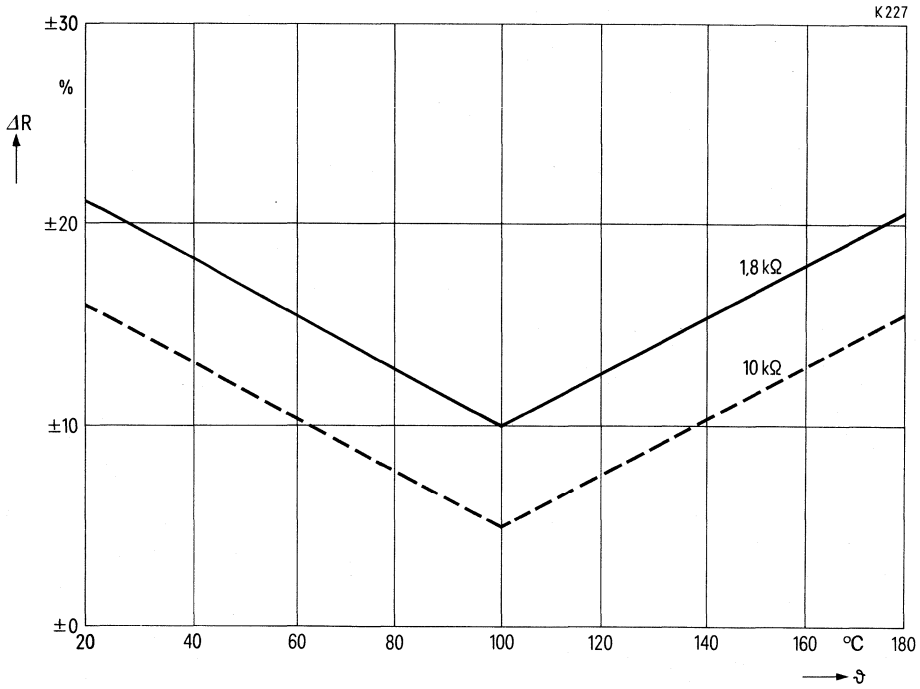
Type	Rated resistance	*B* value	Code color	Ordering code
K 227/S1/1.8 kΩ	1.8 kΩ	4250 K	red/gray	Q63022–K7182–S1
K 227/5%/10 kΩ	10 kΩ	4560 K	black/gray	Q63022–K7103–J

[1]) The upper category temperature may be exceeded up to 180°C for a maximum of 50 hours.

Characteristic data

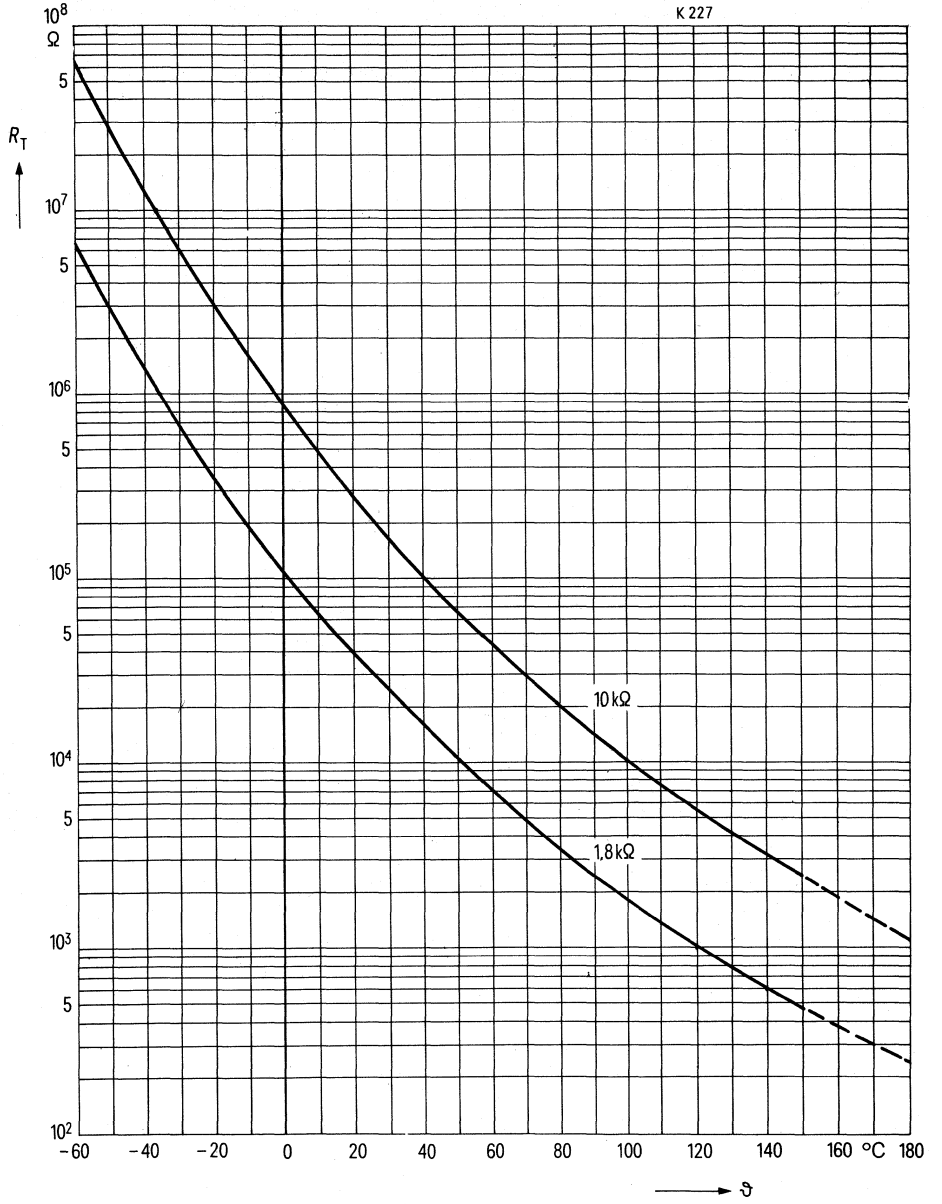
Type	K 227	S1/1.8 kΩ	5%/10 kΩ	Unit
Rated temperature	ϑ_R	100	100	°C
Rated resistance	R_R	1.8	10	kΩ
Tolerance[1)]	ΔR_R	±10	±5	%
B value	*B*	4250	4560	K
Tolerance[1)]	ΔB	±5	±5	%
Thermal time constant	τ_{th}	4.5	4.5	s
Insulation resistance	R_{is}	>100	>100	MΩ
Test voltage	V_{test}	2500	2500	V
Test duration	t_t	1	1	s

Resistance tolerance $\Delta R = f(\vartheta)$
versus temperature



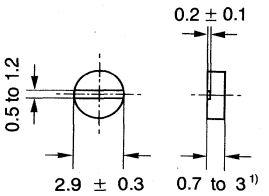
[1)] AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 2.2 kΩ to 100 kΩ

Application	Temperature compensation and monitoring in thin and thick film circuits
Version	NTC thermistor chip, slotted on one side
Terminals	Two semicircular contact surfaces
Marking	None



Weight: approx. 0.1 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**IHF**
Lower category temperature	**I** − 10°C
Upper category temperature	**H** +100°C
Humidity category	**F** Average relative humidity ⩽ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

Type	Rated resistance	Tolerance	*B* value	Ordering code
K 228/20%/ 2.2 kΩ	2.2 kΩ	±20%	3530 K	Q63022−K8222−M
K 228/25%/ 4.7 kΩ	4.7 kΩ	±25%	3560 K	Q63022−K8004−N47
K 228/25%/ 25 kΩ	25 kΩ	±25%	3950 K	Q63022−K8025−N40
K 228/25%/ 35 kΩ	35 kΩ	±25%	4100 K	Q63022−K8035−N40
K 228/25%/100 kΩ	100 kΩ	±25%	4300 K	Q63022−K8100−N40
K 228/10%/100 kΩ	100 kΩ	±10%	4300 K	Q63022−K8100−K40
K 228/ 5%/100 kΩ	100 kΩ	± 5%	4300 K	Q63022−K8100−J40

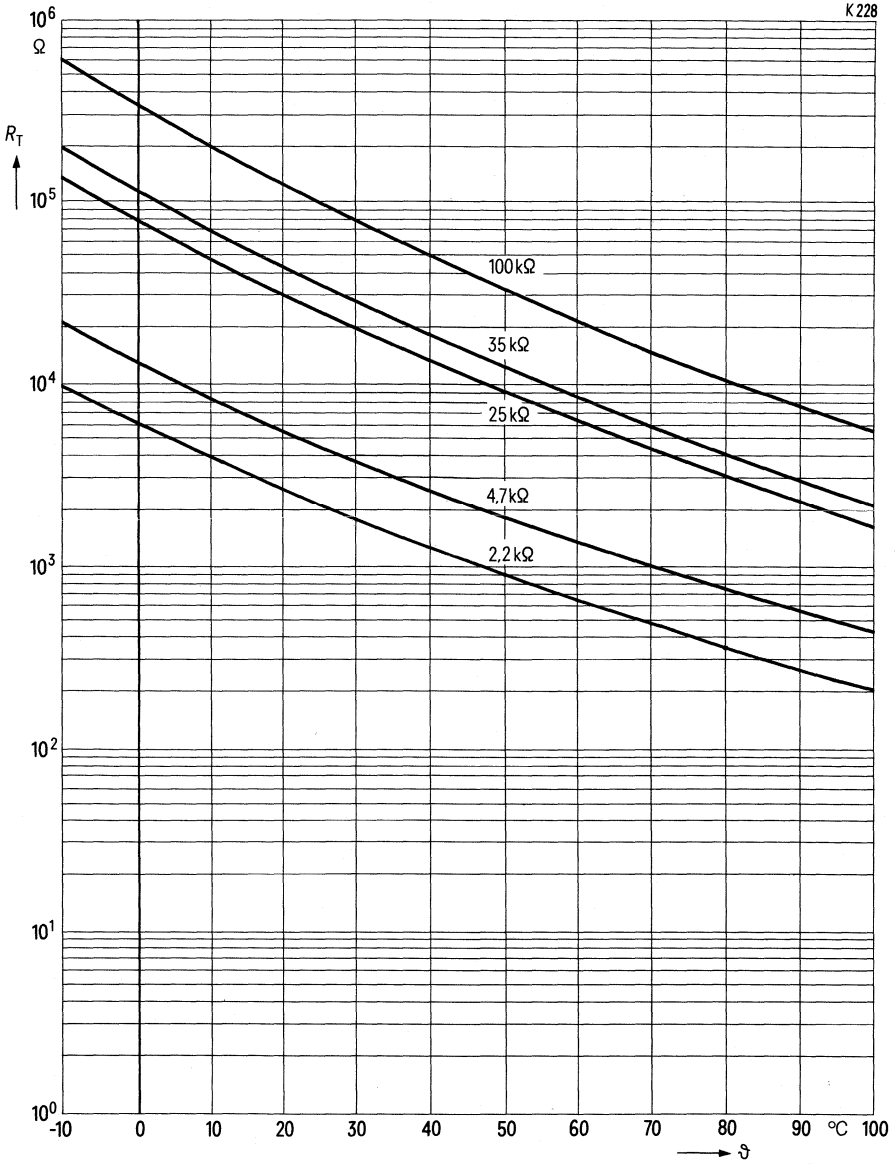
[1]) According to the resistance value

Characteristic data

Power rating at 25°C	P_{25}	approx. 100 mW
Rated temperature	ϑ_R	25 °C
Rated resistance	R_R	See table
Tolerance[1)]	ΔR_R	±25 %
B value	B	See table
Tolerance[1)]	ΔB	± 5 %
Thermal capacitance	C_{th}	30 mJ/K
Max. soldering temperature	$\vartheta_{sold\,M}$	250 °C
Max. soldering time	$t_{sold\,M}$	5 s

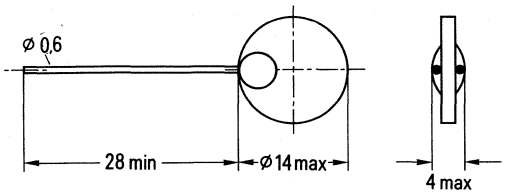
[1]) AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistor with 33 Ω

Application	Suppression of initial current surges, e.g. in switching power supply units
Version	NTC thermistor disc, unpainted
Terminals	Leads made of silver
Marking	The resistance value is stamped on the component
Quality characteristic	High surge current carrying capability due to special contacting method



Weight: approx. 2.0 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**FHF**
Lower category temperature	**F** − 55°C
Upper category temperature	**H** +155°C
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

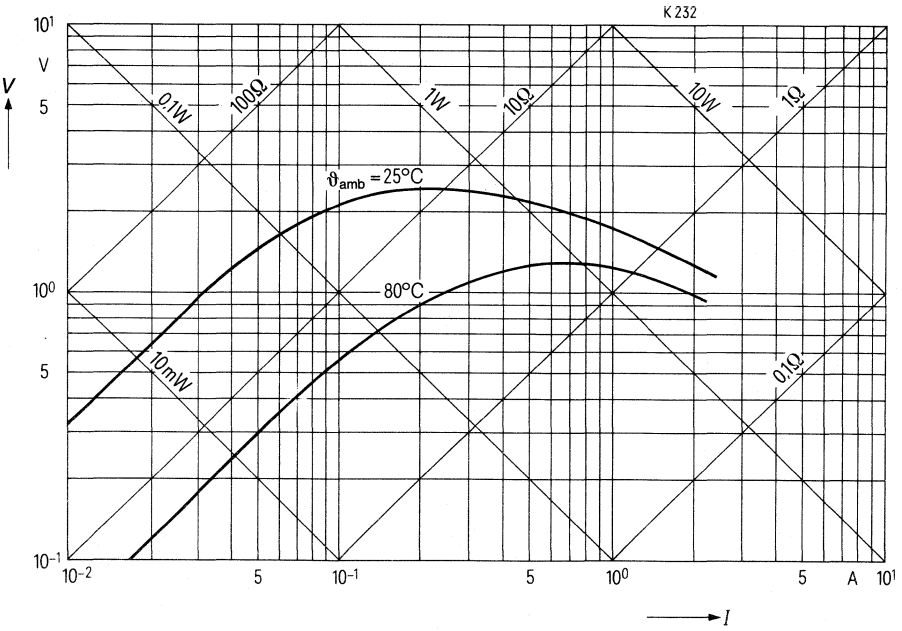
Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

Type	Rated resistance	Max. continuous current	Ordering code
K 232/20%/33 Ω	33 Ω	2 A	Q63023−K2330−M

Characteristic data

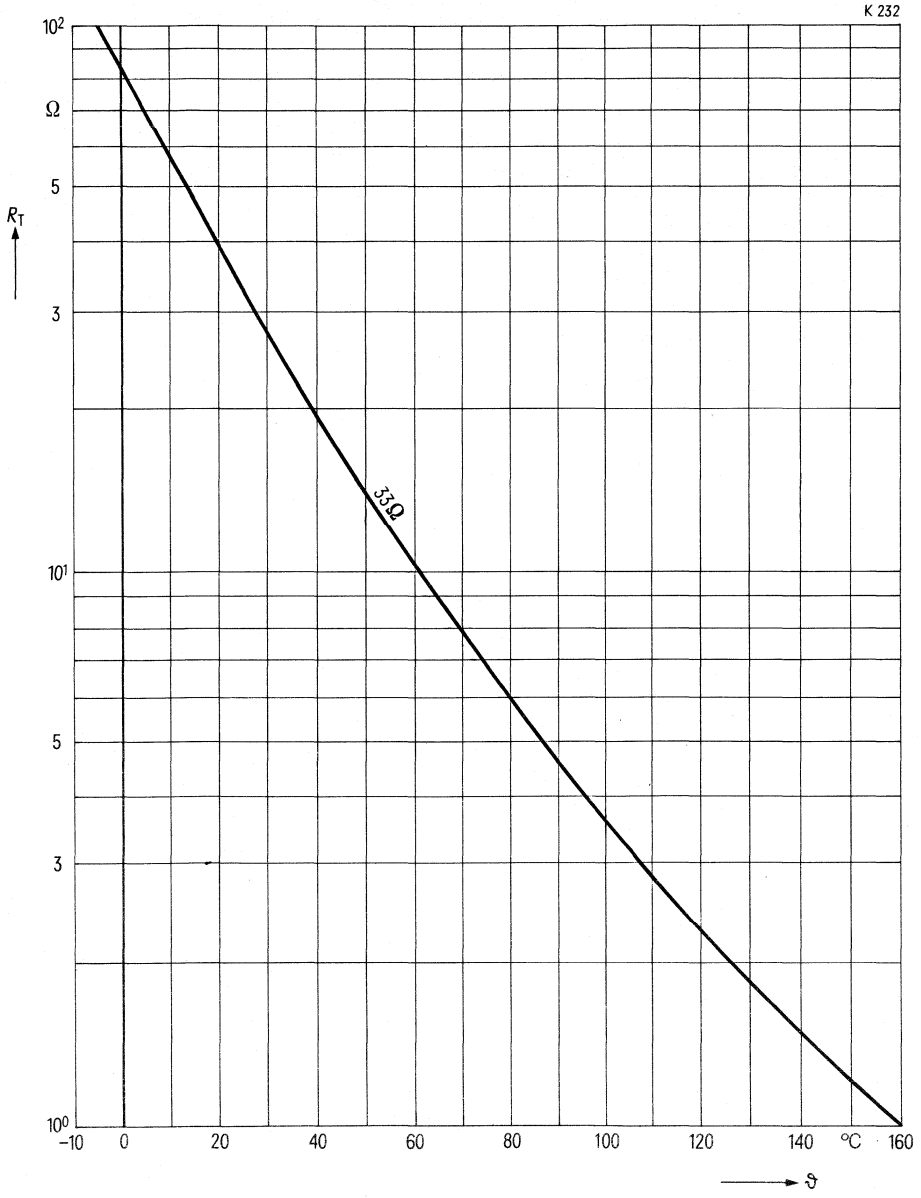
Power rating at $\leq 80°C$	$P_{\leq 80}$	4 W
Rated temperature	ϑ_R	25 °C
Rated resistance	R_R	33 Ω
Tolerance [1]	ΔR_R	±20 %
B value	B	3290 K
Tolerance[1]	ΔB	±5 %
Thermal conductance in air	G_{thA}	16 mW/K
Thermal time constant	τ_{th}	50 s
Thermal capacitance	C_{th}	800 mJ/K
Rated current	I_R	2 A
Resistance value at $I=I_R$	R_{hot}	≤1
Max. permissible current, intermittent	I_1	10 A
Min. permissible hot resistance	R_{min}	0.4 Ω

Voltage-current characteristics $V = f(I)$



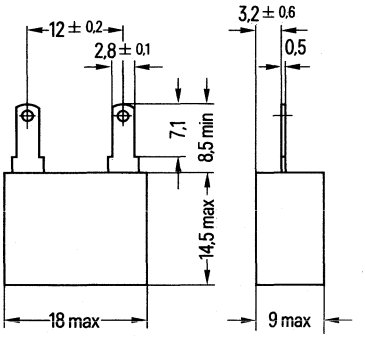
[1]) AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistor with 9.4 kΩ

Application	Temperature monitoring and regulation in refrigerators and deep freezing equipment
Version	Plastic case, sealed
Terminals	Flat plugs 2.8 × 0.5 mm for AMP Faston sockets
Marking	Type designation impressed on the component
Quality characteristic	High measuring accuracy due to close resistance tolerances



Weight: approx. 4.5 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**FME**
Lower category temperature	**F** − 55°C
Upper category temperature	**M** +100°C
Humidity category	**E** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days Seldom and slight dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

Type	Rated resistance	Tolerance	*B* value	Ordering code
K 243/S2/9.4 kΩ	9.4 kΩ	±3.5%	3560 K	Q63024−K3942−S2

Characteristic data

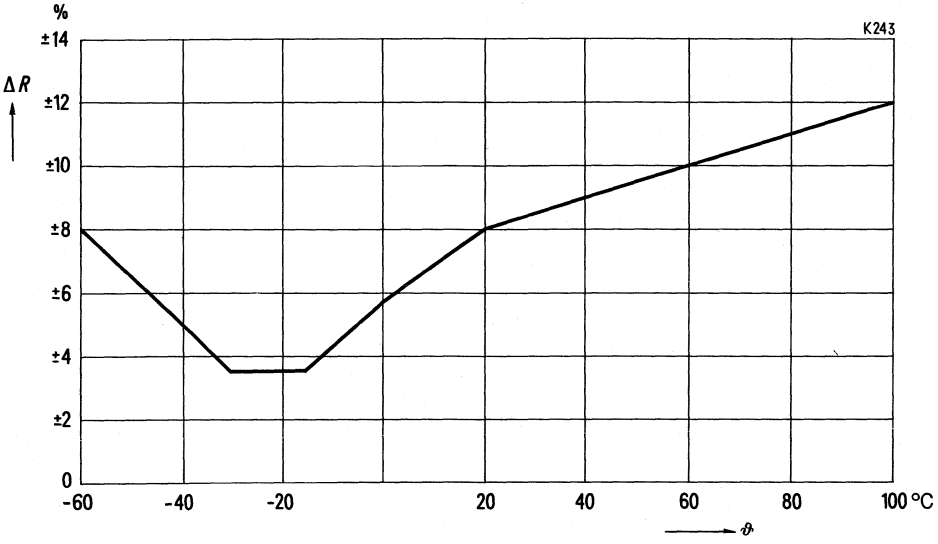
Power rating	at −30°C	P_{-30}	300 mW
	at +25°C	P_{25}	300 mW
Rated temperature		ϑ_R	−30 °C
Rated resistance		R_R	9.4 kΩ
Tolerance [1]		ΔR_R	±3.5 %
B value		*B*	3560 K
Thermal conductance in air		G_{thA}	12 mW/K
Thermal in case of chassis mounting		G_{thC}	≥20 mW/K
Thermal time constant in case of chassis mounting		τ_{thC}	approx. 180 s approx. 45 s

Resistance-temperature characteristic

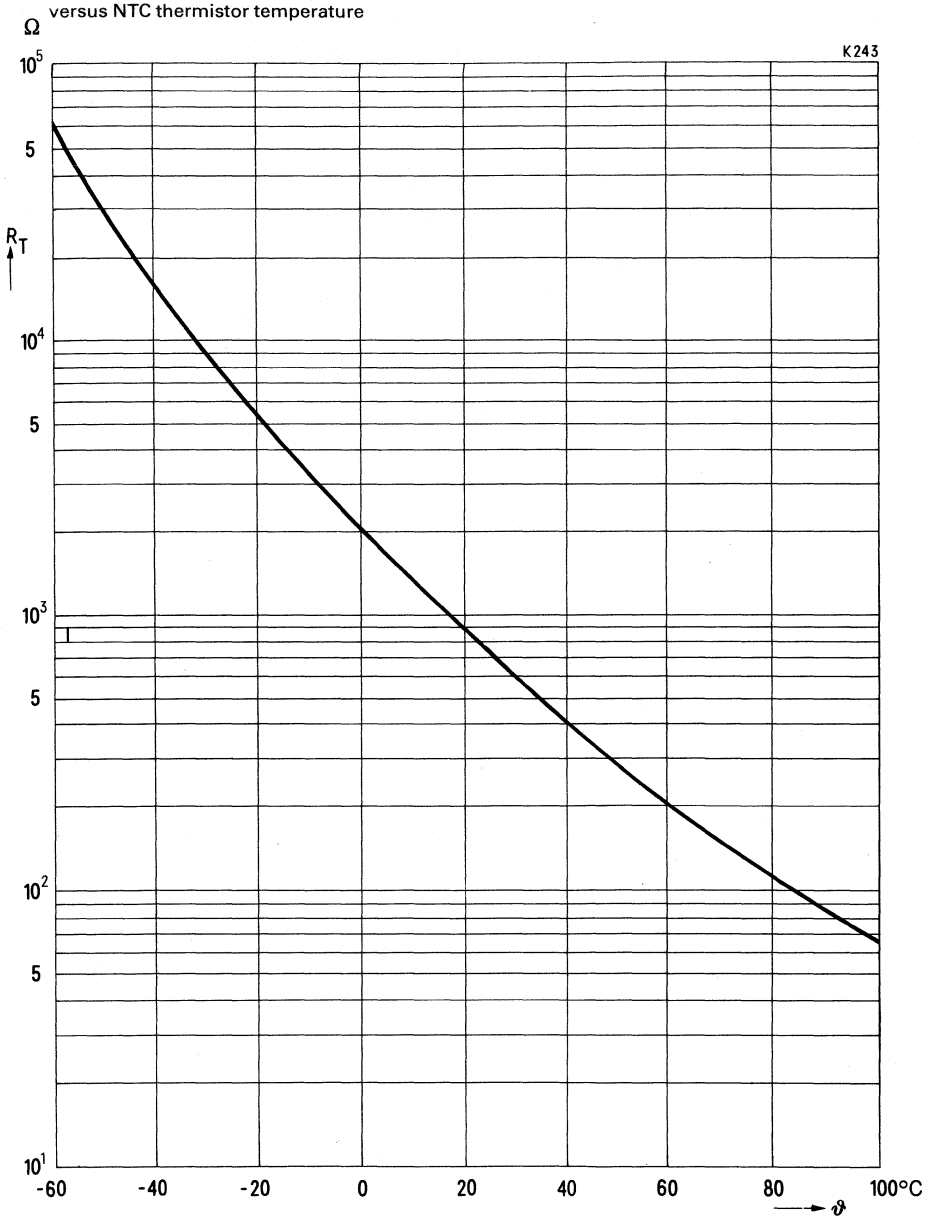
Temperature °C	Resistance kΩ	Temperature °C	Resistance kΩ	Temperature °C	Resistance kΩ
−55	44	−22	6.10	15	1.08
−50	31	−21	5.79	20	0.89
−45	23	−20	5.49	25	0.73
−40	16.7	−19	5.22	30	0.61
−35	12.5	−18	4.96	40	0.42
−30	9.40	−17	4.71	50	0.30
−29	8.89	−16	4.48	60	0.21
−28	8.42	−15	4.26	70	0.157
−27	7.97	−10	3.30	80	0.116
−26	7.55	− 5	2.52	90	0.087
−25	7.15	0	2.09	100	0.067
−24	6.78	5	1.66		
−23	6.43	10	1.34		

[1]) AQL = 0.65%

Permissible deviation of the resistance values

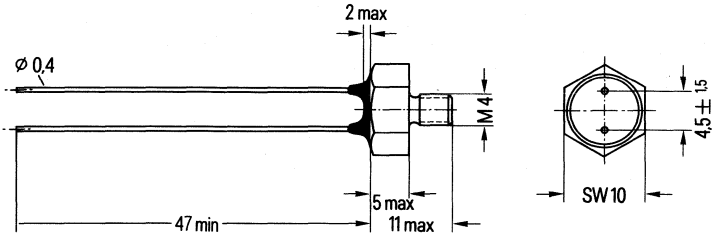


NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 500 Ω to 40 kΩ

Application	Temperature compensation with high load, measuring sensors for control circuits, e.g. in heating technology
Version	Metal case, insulated terminals
Terminals	Leads made of silver
Marking	Rated resistance and tolerance are stamped on the component



Weight: approx. 1.5 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**FKF**
Lower category temperature	**F** − 55°C
Upper category temperature	**K** +125°C
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

Minimum storage temperature $\vartheta_{stg\ min}$ −25°C
Maximum storage temperature $\vartheta_{stg\ max}$ +65°C

Type	Rated resistance	Tolerance	*B* value	Ordering code
K 252/10%/500 Ω*	500 Ω	±10%	3400 K	Q63025-K2501-K
K 252/10%/ 1 kΩ	1 kΩ	±10%	3530 K	Q63025-K2013-K
K 252/10%/ 6 kΩ*	6 kΩ	±10%	3950 K	Q63025-K2063-K
K 252/10%/ 40 kΩ	40 kΩ	±10%	4250 K	Q63025-K2044-K
K 252/20%/500 Ω	500 Ω	±20%	3400 K	Q63025-K2501-M
K 252/20%/ 1 kΩ	1 kΩ	±20%	3530 K	Q63025-K2102-M
K 252/20%/ 6 kΩ	6 kΩ	±20%	3950 K	Q63025-K2063-M
K 252/20%/ 40 kΩ	40 kΩ	±20%	4250 K	Q63025-K2044-M

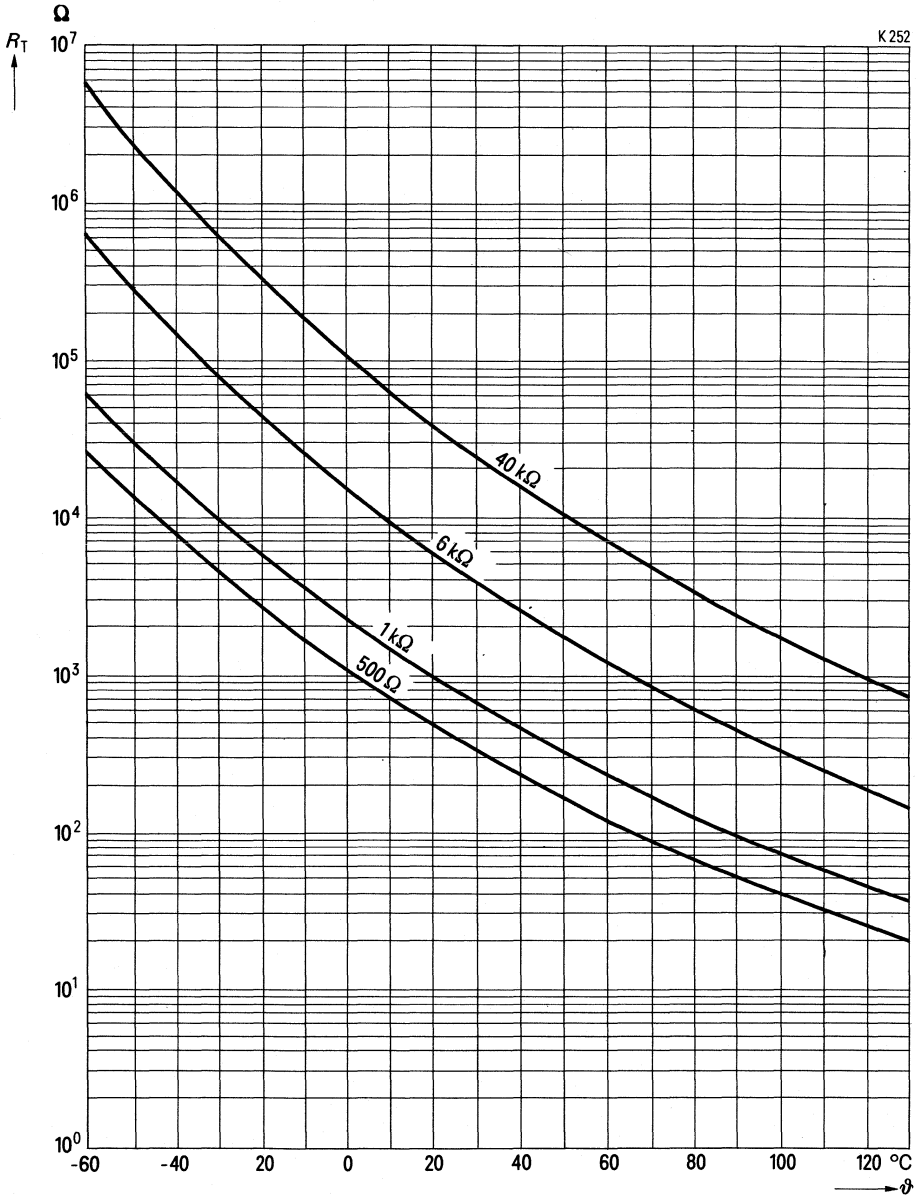
*) Other tolerance values are available upon request.

Characteristic data

Power rating at 25°C	P_{25}	400 mW
at 60°C	P_{60}	450 mW
Rated temperature	ϑ_R	20 °C
Rated resistance	R_R	See tabe
Tolerance[1)]	ΔR_R	See table
B value	B	See table
Tolerance[1)]	ΔB	± 5 %
Thermal conductance in case of chassis mounting	G_{thC}	≥30 mW/K
Thermal time constant	τ_{thC}	approx. 20 s
Insulation resistance	R_{is}	>100 MΩ
Test voltage	V_{test}	250 V
Test duration	t_t	1 s

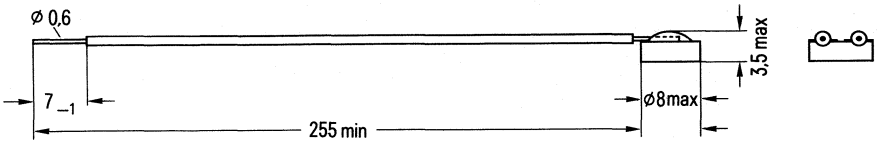
[1)] AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 1 and 2 kΩ

Application	Temperature sensors for heating systems and air conditioners
Version	NTC thermistor disc, unpainted
Terminals	Silicon litz wires
Marking	None
Quality characteristic	High reliability due to special production and aging methods



Weight: approx. 4.5 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**FKF**
Lower category temperature	**F** – 55°C
Upper category temperature	**K** +125°C
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

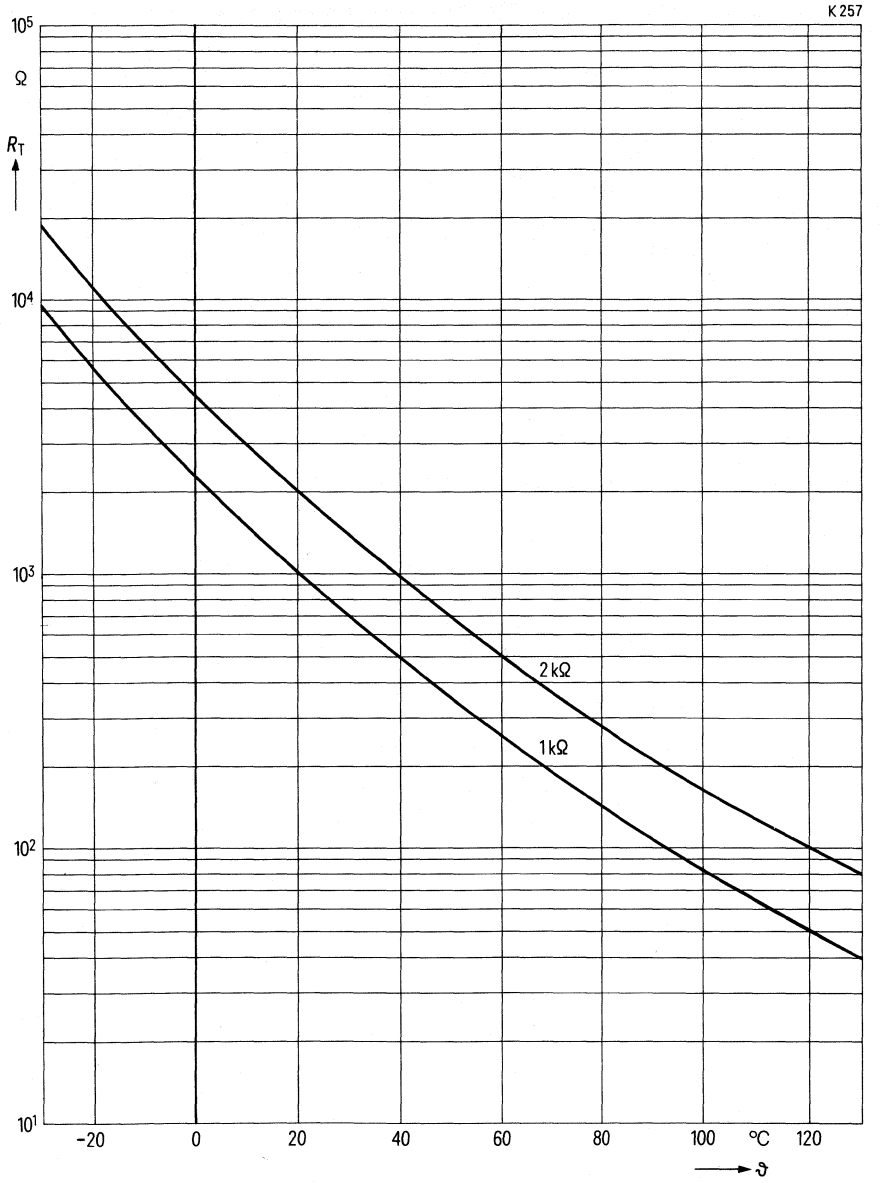
Type	Rated resistance	Tolerance	*B* value	Ordering code
K 257/5%/1 kΩ	1 kΩ	±5%	3400 K	Q63025–K7102–J
K 257/5%/2 kΩ	2 kΩ	±5%	3400 K	Q63025–K7202–J

Characteristic data

Type	K 257/5%	1 kΩ	2 kΩ	Unit
Power rating at 25°C	P_{25}	150	150	mW
at 60°C	P_{60}	150	150	mW
Rated temperature	ϑ_R	20	20	°C
Rated resistance	R_R	1000	2000	Ω
Tolerance [1]	ΔR_R	±5	±5	%
Max. resistance change after 10000 hours	$\Delta R_{10.}$	3	3	%
B value	B	3400	3400	K
Tolerance[1]	ΔB	±4.4	±4.4	%
Thermal conductance in air	G_{thA}	approx. 8	approx. 8	mW/K
Thermal time constant	τ_{th}	approx. 30	approx. 30	s
Thermal capacitance	C_{th}	approx. 250	approx. 250	mJ/K
Resistance relation	R_{25}/R_{100}	10±1	10±1	–

[1]) AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



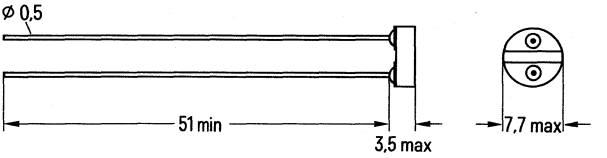
NTC thermistors with 500 Ω to 2 kΩ

Application Temperature measurement and regulation

Version NTC thermistor disc, unpainted; for cementing onto surfaces

Terminals Leads, tinned

Marking None



Weight: approx. 0.6 g
Dimensions in mm

Climatic category **FKF**
in accordance with DIN 40040

Lower category temperature **F** − 55°C
Upper category temperature **K** +125°C
Humidity category **F** Average relative humidity ≤ 75%
95% continuously on 30 days per year
85% occasionally on the remaining days
No dew precipitation is permissible

Storage temperatures
Minimum storage temperature $\vartheta_{stg\ min}$ −25°C
Maximum storage temperature $\vartheta_{stg\ max}$ +65°C

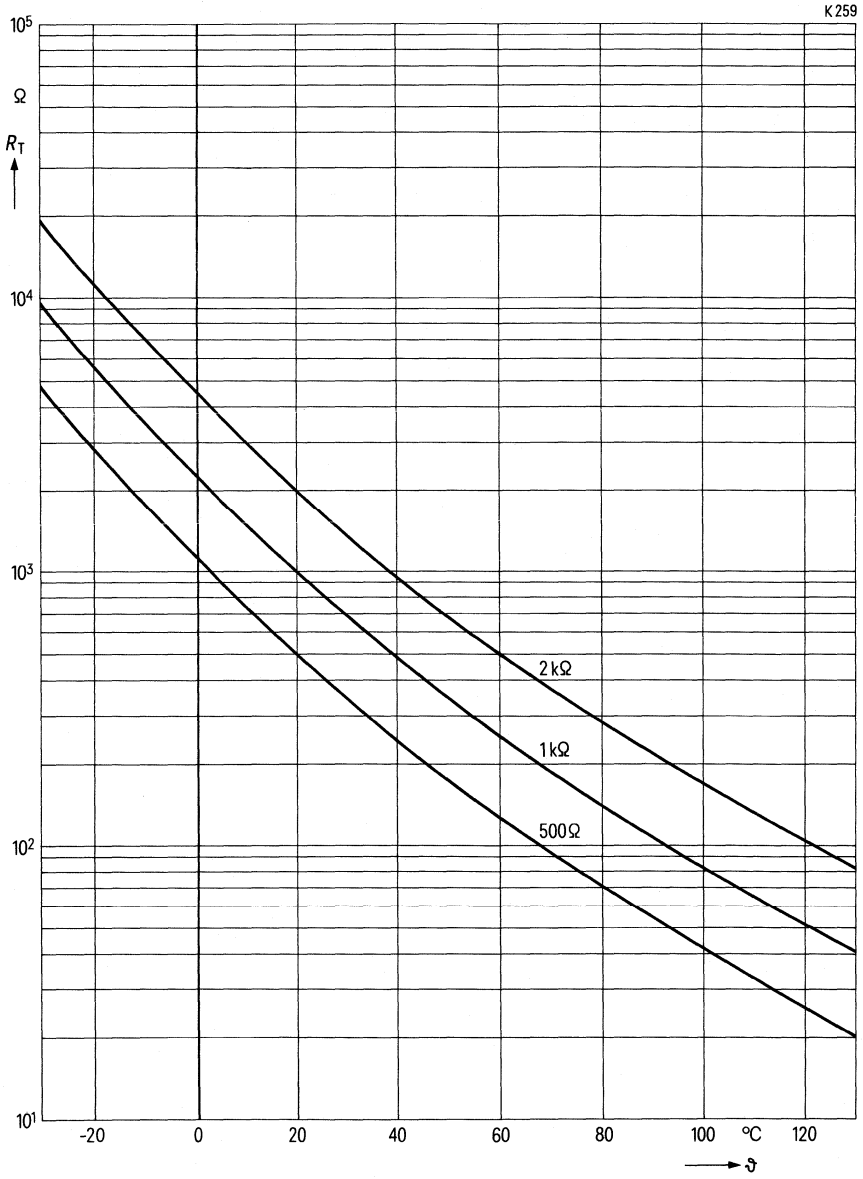
Type	Rated resistance	Tolerance	*B* value	Ordering code
K 259/5%/500 Ω	500 Ω	±5%	3400 K	Q63025−K9501−J
K 259/5%/ 1 kΩ	1 kΩ	±5%	3400 K	Q63025−K9102−J
K 259/5%/ 2 kΩ	2 kΩ	±5%	3400 K	Q63025−K9202−J

Characteristic data

Power rating	at 25°C	P_{25}	150 mW
	at 60°C	P_{60}	150 mW
Rated temperature		ϑ_R	20 °C
Rated resistance		R_R	See table
Tolerance [1]		ΔR_R	±5 %
Max. resistance change after 10000 hours		$\Delta R_{10.}$	≥3 %
B value		B	3400 K
Tolerance[1]		ΔB	±5 %
Thermal conductance in air		G_{thA}	8 mW/K
in case of chassis mounting[2]		G_{thC}	≤40 mW/K
Thermal time constant		τ_{th}	30 s
Thermal capacitance		C_{th}	240 mJ/K

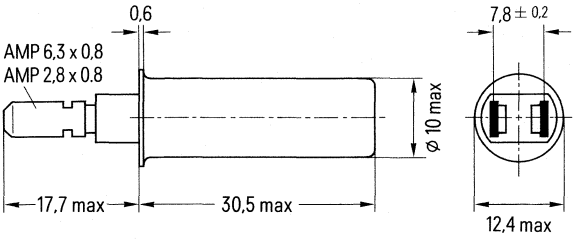
[1]) AQL = 0.65%
[2]) Depending on mounting method

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 330 Ω and 950 Ω

Application	Temperature monitoring, measurement, and regulation of liquids
Version	Stainless steel case, insulated terminals
Terminals	Flat plugs 2.8 × 0.8 mm or 6.3×0.8 mm in accordance with DIN
Marking	Red color dot ≙ 950 Ω
Quality characteristic	Temperature measuring accuracy: < ±1.5 K in the range between 25°C and 100°C



Weight: approx. 8.0 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**IME**
Lower category temperature	**I** − 10°C
Upper category temperature	**M** +100°C
Humidity category	**E** Average relative humidity ⩽ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days Seldom and slight dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −10°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

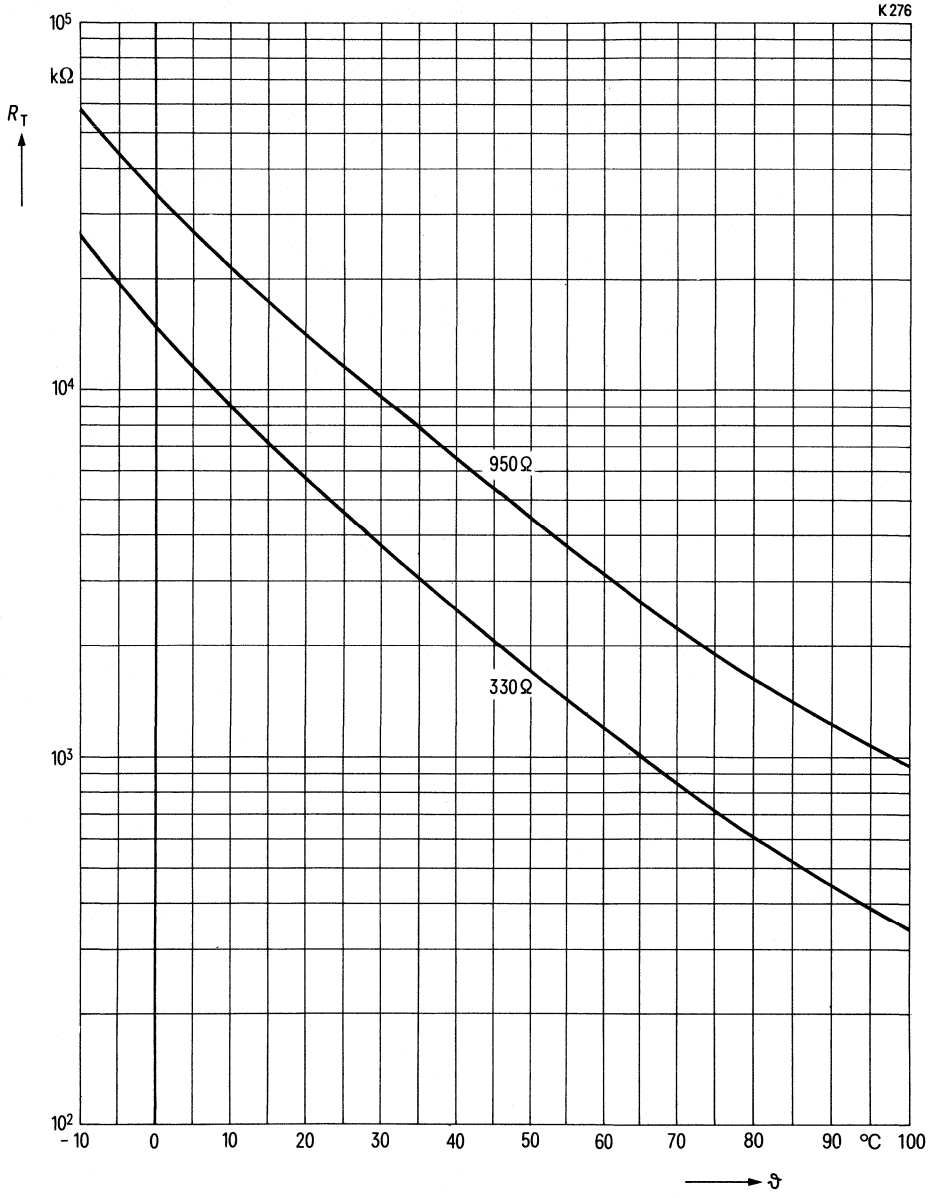
Type	Rated resistance	*B* value	Flat plug	Ordering code
K 276/S2/330 Ω/2.8	330 Ω	3940	2.8 × 0.8	Q63027−K6331−S228
K 276/S2/330 Ω/6.3	330 Ω	3940	6.3 × 0.8	Q63027−K6331−S263
K 276/S2/950 Ω/2.8	950 Ω	3760	2.8 × 0.8	Q63027−K6951−S228
K 276/S2/950 Ω/6.3	950 Ω	3760	6.3 × 0.8	Q63027−K6951−S263

Characteristic data

Power rating at 25°C	P_{25}	1000 mW
at 60°C	P_{60}	500 mW
Rated temperature	ϑ_R	100 °C
Rated resistance	R_R	See table
Tolerance[1)]	ΔR_R	±3.5 %
B value	B	See table
Tolerance[1)]	ΔB	3.0 %
Thermal conductance in water	G_{thW}	12 mW/K
Thermal time constant in water	τ_{thW}	≤20 mW/s
Insulation resistance	R_{is}	>1000 MΩ
Test voltage	V_{test}	2500 V
Test duration	t_t	1 s

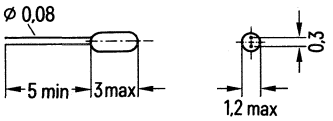
[1)] AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC Thermistors with 100 kΩ

Application	Temperature measurement and regulation at high temperatures
Version	Glass case, hermetically sealed
Terminals	Leads made of a platinum alloy
Marking	None
Quality characteristic	High stability even at high category temperatures



Weight: approx. 6 mg
Dimensions in mm

Climatic category in accordance with DIN 40040	**FBE**
Lower category temperature	**F** − 55°C
Upper category temperature	**B** +350°C
Humidity category	**E** Average relative humidity ⩽ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days Seldom and slight dew precipitation is permissible[1]

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

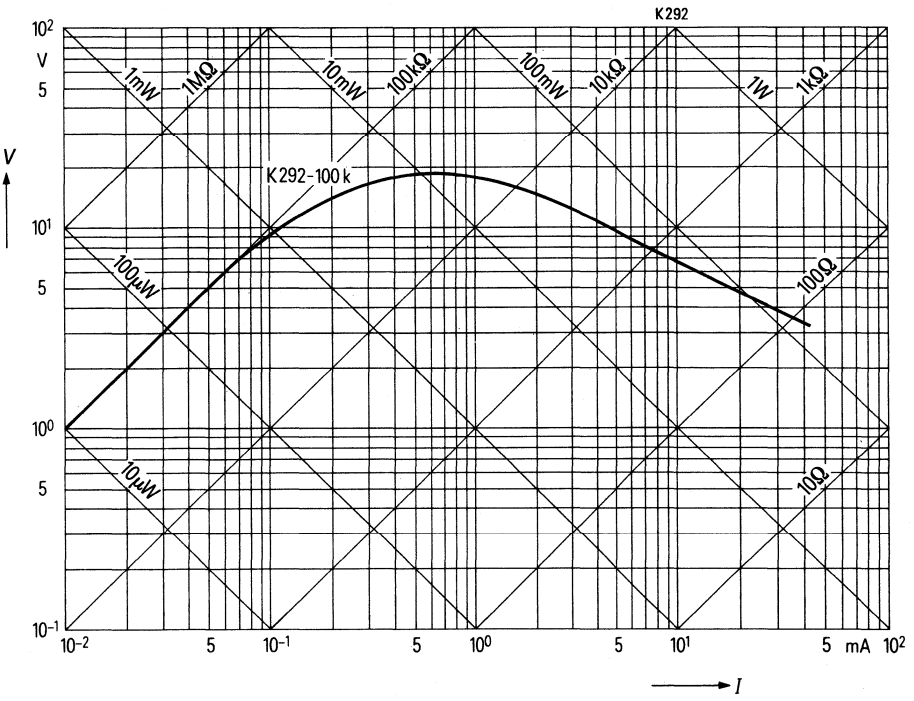
Type	Rated resistance	*B* value	Matching pairs	Ordering code
K 292/20%/100 kΩ	100 kΩ	3950 K	–	Q63029–K2104–M
K 292/20%/100 kΩ/P1	100 kΩ	3950 K	P1	Q63029–K2104–M1
K 292/20%/100 kΩ/P2	100 kΩ	3950 K	P2	Q63029–K2104–M2

[1] Dew precipitation may cause a temporary short circuit at the lead outlets.

Characteristic data

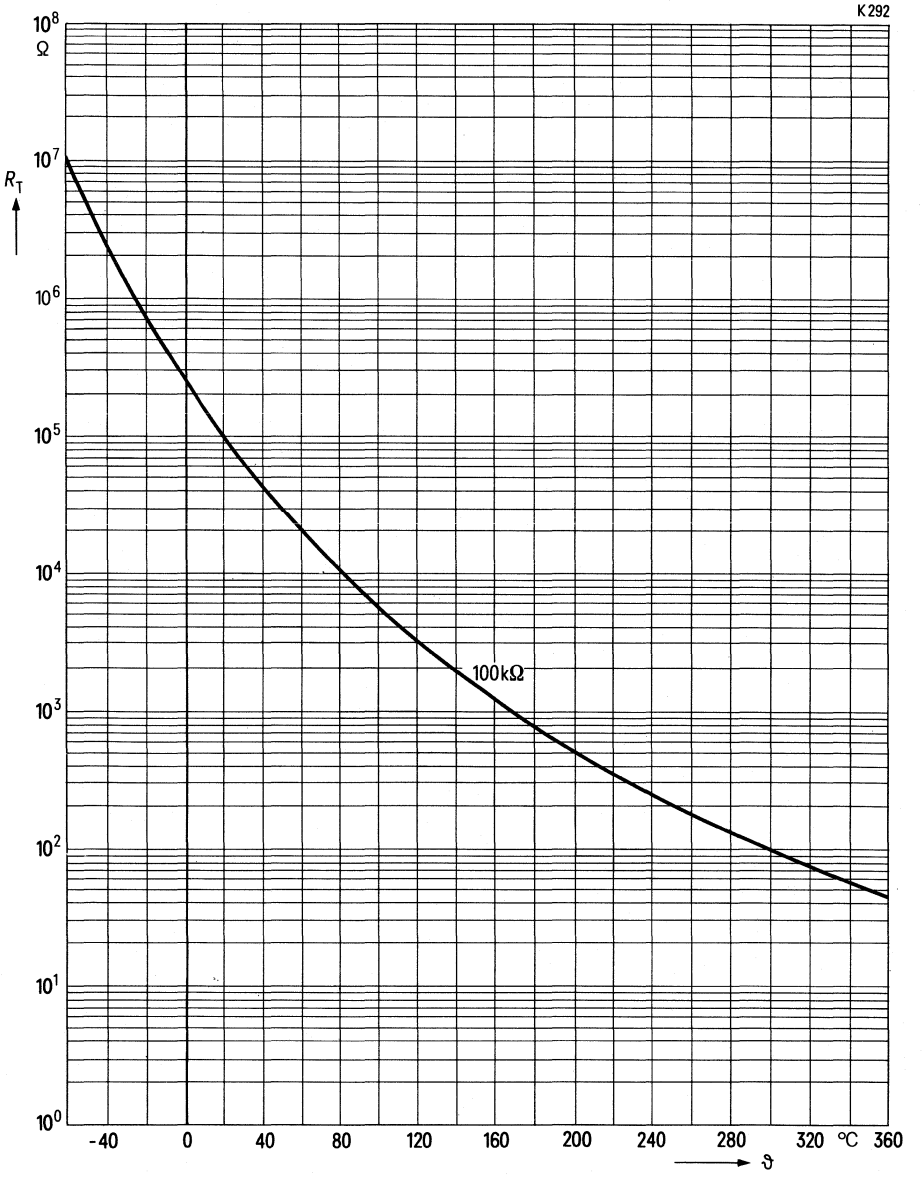
Power rating at 25°C	P_{25}	120 mW
at 60°C	P_{60}	110 mW
Rated temperature	ϑ_R	20 °C
Rated resistance	R_R	100 kΩ
Tolerance[1)]	ΔR_R	±20 %
B value	B	3950 K
Tolerance[1)]	ΔB	±5 %
Thermal conductance in air	G_{thA}	0.4 mW/K
Thermal time constant	τ_{th}	approx. 5 s
Thermal capacitance	C_{th}	2 mJ/K

Voltage-current characteristic $V = f(I)$



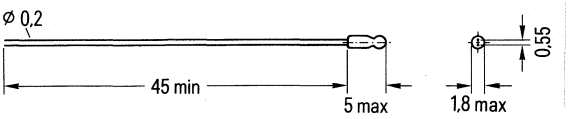
[1)] AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 4.7 kΩ to 100 kΩ

Application	Temperature measurement and regulation; especially suitable for sensing of small measuring points
Version	Glass case, hermetically sealed
Terminals	Leads, tinned
Marking	None
Quality characteristic	High stability due to special production method. DIN designation: NTC thermistor 0206–X–XX–DIN 44072



Weight: approx. 40 mg
Dimensions in mm

Climatic category in accordance with DIN 40040	**FEE**
Lower category temperature	**F** – 55°C
Upper category temperature	**E** +200°C
Humidity category	**E** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days Seldom and slight dew precipitation is permissible[1]

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

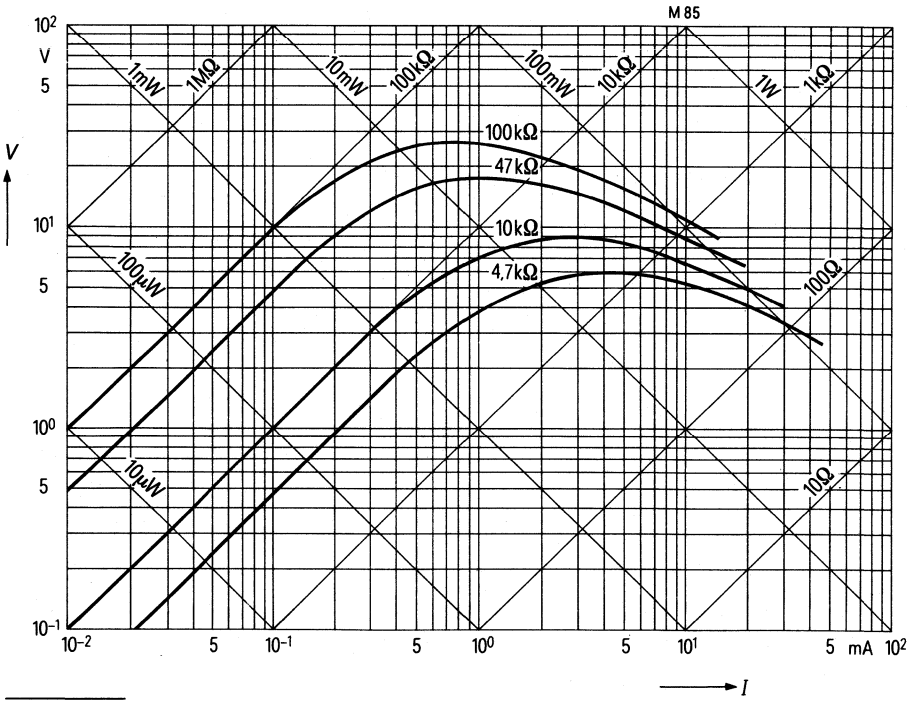
Type	Rated resistance	Tolerance	*B* value	Ordering code
M 85/10%/ 4.7 kΩ	4.7 kΩ	±10%	3430 K	Q63085–M472–K
M 85/10%/ 10 kΩ	10 kΩ	±10%	3430 K	Q63085–M103–K
M 85/10%/ 47 kΩ	47 kΩ	±10%	3950 K	Q63085–M473–K
M 85/10%/100 kΩ	100 kΩ	±10%	3950 K	Q63085–M104–K
M 85/20%/ 4.7 kΩ	4.7 kΩ	±20%	3430 K	Q63085–M472–M
M 85/20%/ 10 kΩ	10 kΩ	±20%	3430 K	Q63085–M103–M
M 85/20%/ 47 kΩ	47 kΩ	±20%	3950 K	Q63085–M473–M
M 85/20%/100 kΩ	100 kΩ	±20%	3950 K	Q63085–M104–M

[1] The dew precipitation may cause a temporary short circuit at the lead outputs.

Characteristic data

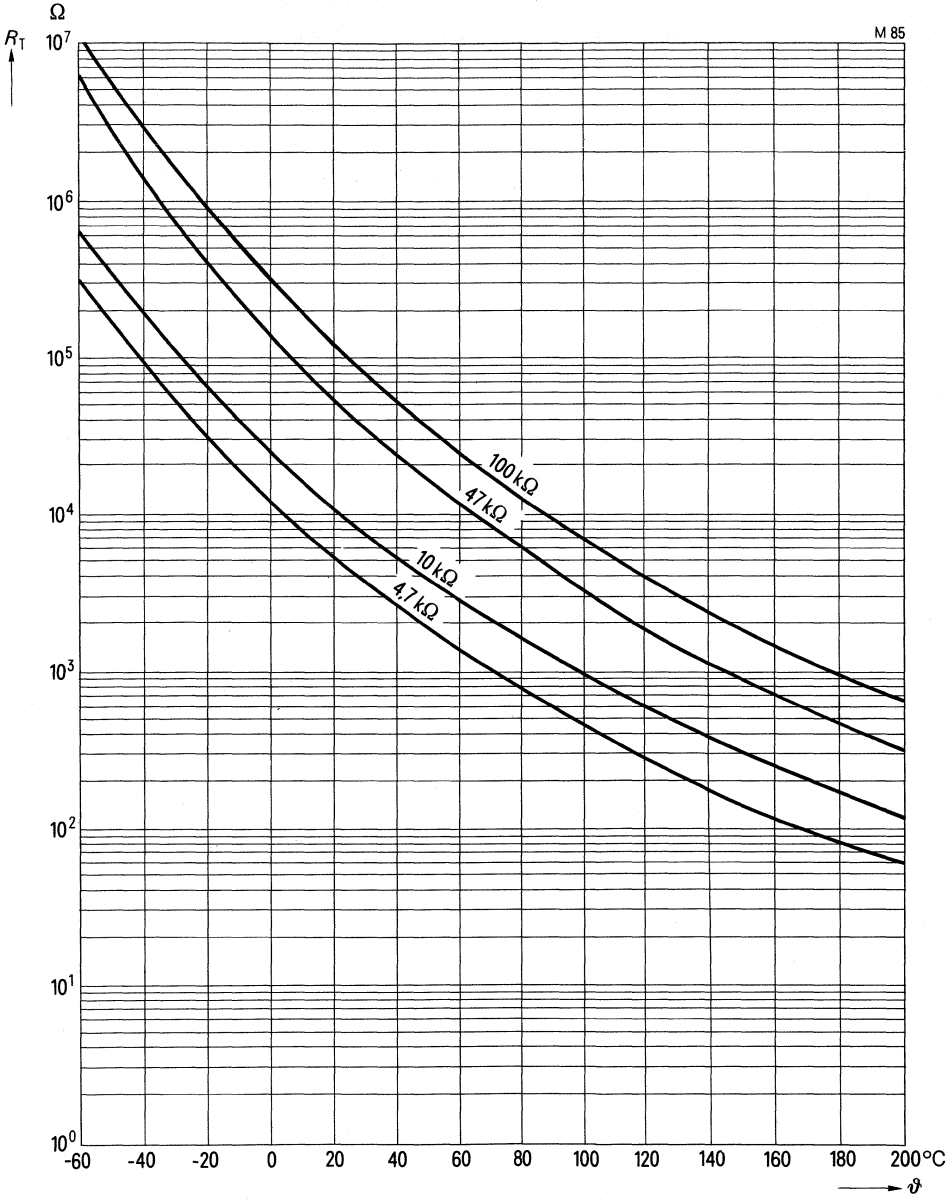
Power rating at 25°C	P_{25}	120 mW
at 60°C	P_{60}	100 mW
Rated temperature	ϑ_R	25 °C
Rated resistance	R_R	See table
Tolerance[1)]	ΔR_R	See table
Max. resistance change after 10000 hours	$\Delta R_{10.}$	≤3 %
B value	B	See table
Tolerance[1)]	ΔB	±5 %
Thermal conductance in air	G_{thA}	0.7 (>0.55) mW/K
in water	G_{thW}	2.0 mW/K
Thermal time constant	τ_{th}	approx. 7 s
Thermal capacitance	C_{th}	0.35 mJ/K
Insulation resistance	R_{is}	>100 MΩ
Test voltage	V_{test}	250 V
Test duration	t_t	1 s

Voltage-current characteristic $V = f(I)$



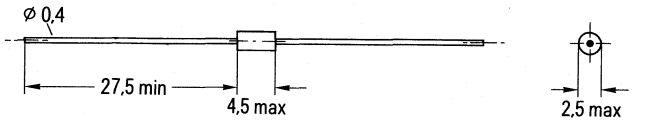
[1)] AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 200 kΩ

Application	Measurement of temperatures and flow rates in gases and liquids
Version	Glass case, hermetically sealed
Terminals	Leads, tinned
Marking	None



Weight: approx. 0.1 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**FHA**
Lower category temperature	**F** − 55°C
Upper category temperature	**H** +155°C
Humidity category	**A** Average relative humidity ⩽ 100% Continuous moisture is permissible
Storage temperatures	
Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

Type	Rated resistance	Tolerance	*B* value	Ordering code
M 87/20%/200 kΩ	200 kΩ	±20%	4400 K	Q63087−M204−M
M 878/20%/200 kΩ[1)]	200 kΩ	±20%	4400 K	Q63087−M8204−M

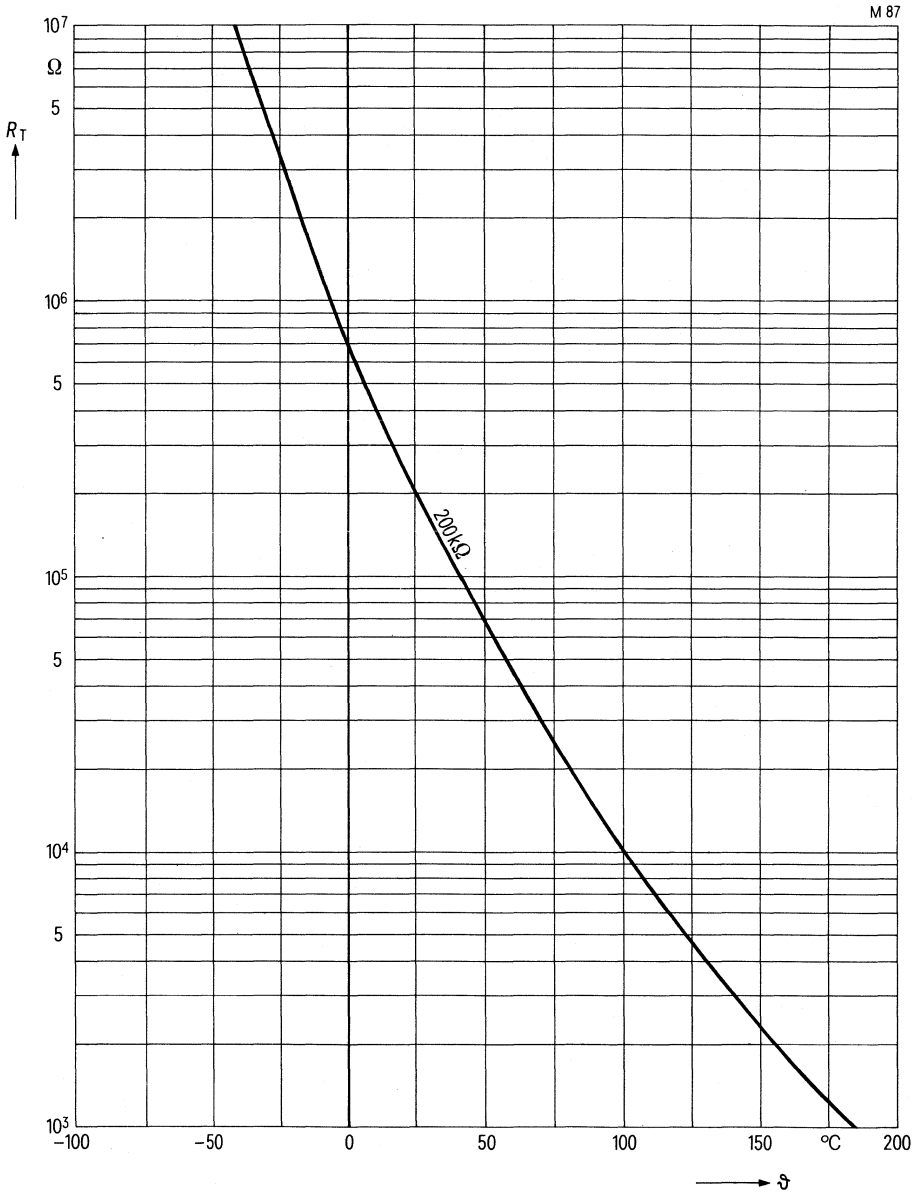
[1)] Reel-packaged version

Characteristic data

Power rating at 25°C	P_{25}	320 mW
at 100°C	P_{100}	140 mW
Rated temperature	ϑ_R	25 °C
Rated resistance	R_R	200 kΩ
Tolerance[1)]	ΔR_R	±20 %
B value	B	4400 K
Tolerance[1)]	ΔB	±5 %
Thermal conductance		
in air	G_{thA}	>2.5 mW/K
in water	G_{thW}	10 mW/K
Thermal time constant	τ_{th}	16 s
Thermal capacitance	C_{th}	40 mJ/K

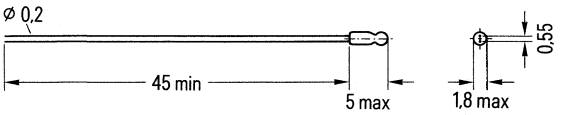
[1)] AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 100 kΩ

Application	Temperature measurement and regulation; especially suitable for sensing of small measuring points
Version	Glass case, hermetically sealed
Terminals	Leads, gold-plated
Marking	None



Weight: approx. 40 mg
Dimensions in mm

Climatic category in accordance with DIN 40040	**FBE**
Lower category temperature	**F** − 55°C
Upper category temperature	**B** +350°C
Humidity class	**E** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days Seldom and slight dew precipitation is permissible[1]

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

Type	Rated resistance	Tolerance	*B* value	Ordering code
M 812/10%/100 kΩ	100 kΩ	±10%	3950 K	Q63081−M2104−K
M 812/20%/100 kΩ	100 kΩ	±20%	3950 K	Q63081−M2104−M

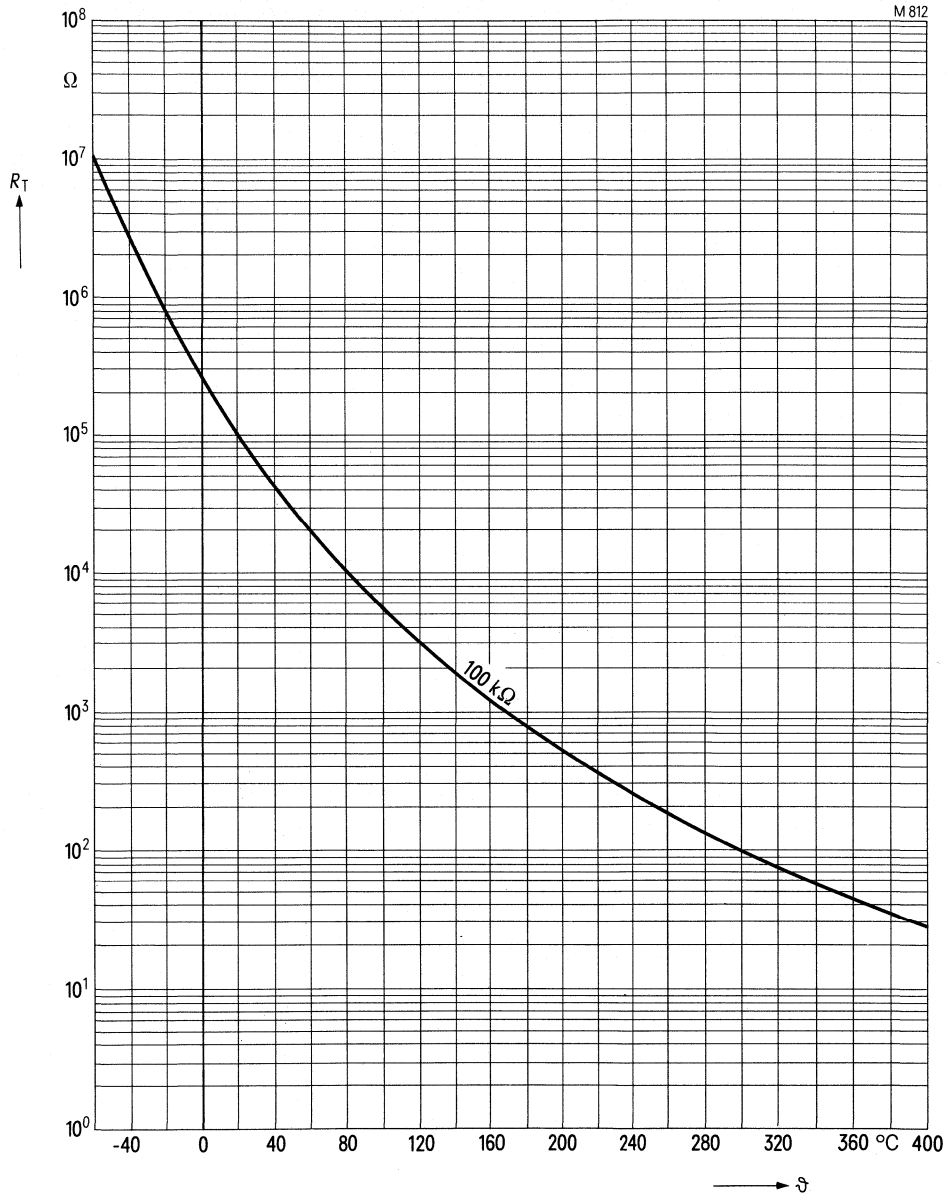
[1] The dew precipitation may cause a temporary short circuit at the lead outputs.

Characteristic data

Type	M 812	10% 100 kΩ	20% 100 kΩ	Unit
Power rating at 25°C	P_{25}	220	220	mW
at 60°C	P_{60}	200	200	mW
Rated temperature	ϑ_R	20	20	°C
Rated resistance	R_R	100	100	kΩ
Tolerance[1]	ΔR_R	±10	±20	%
B value	B	3950	3950	K
Tolerance[1]	ΔB	±5	±5	%
Thermal conductance in air	G_{thA}	0.7	0.7	mW/K
in case of chassis mounting	G_{thC}	2.1	2.1	mW/K
Thermal time constant	τ_{th}	approx. 5	approx. 5	s
Thermal capacitance	C_{th}	0.35	0.35	mJ/K
Insulation resistance	R_{is}	>100	>100	MΩ
Test voltage	V_{test}	250	250	V
Test duration	t_t	1	1	s

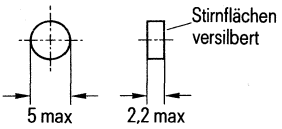
[1]) AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 17 Ω to 2.3 kΩ

Application	Temperature measurements, e.g. automotive cooling water temperature, oil temperature
Version	NTC thermistor disc, lapped in a coplaner way
Terminals	Front surfaces, silver-plated
Marking	None
Quality characteristic	Resistance drift: $<\pm 2\%$ after 20000 temperature changes between room temperature and upper category temperature



Weight: approx. 0.2 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**FHF**
Lower category temperature	**F** − 55°C
Upper category temperature	**H** +155°C
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

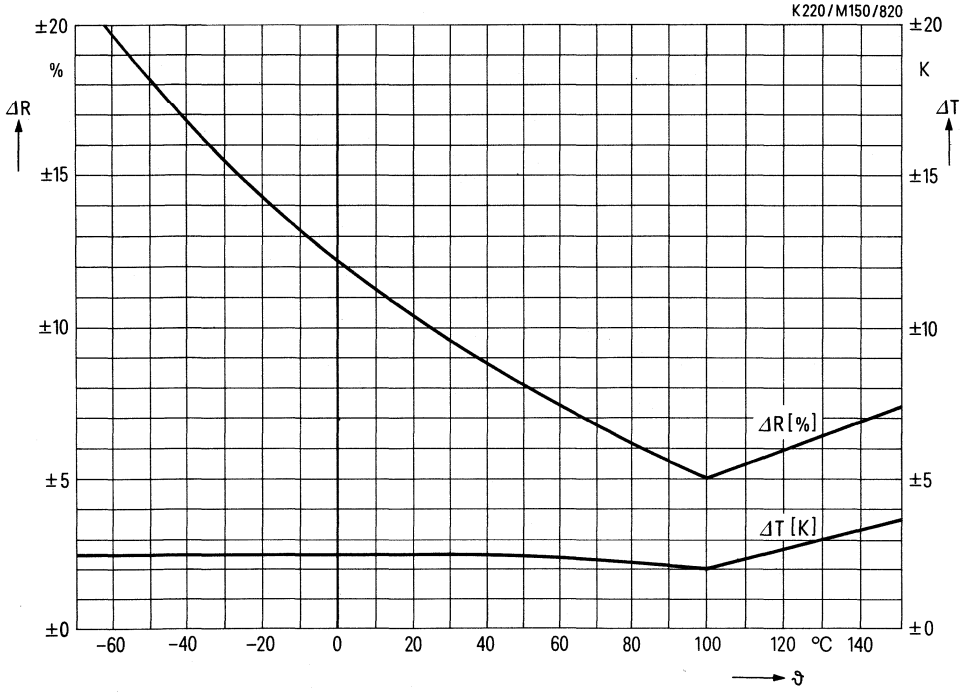
Minimum storage temperature	$\vartheta_{stg\ min}$ − 55°C
Maximum storage temperature	$\vartheta_{stg\ max}$ + 65°C

Type	Rated resistance	Dimensions d [mm]	Dimensions th [mm]	Ordering code
M 820/S1/ 17 Ω	17 Ω	5.5 − 1.1	2.0 − 1.4	Q63082−M 17−S1
M 820/S1/ 19 Ω	19 Ω	5.5 − 1.1	2.0 − 1.4	Q63082−M 19−S1
M 820/S1/ 20 Ω	20 Ω	5.5 − 1.1	2.0 − 1.4	Q63082−M 20−S1
M 820/S1/ 21.05 Ω	21.05 Ω	5.1 − 1.1	2.2 − 1.4	Q63082−M 21−S101
M 820/S1/ 30.7 Ω	30.7 Ω	5.5 − 1.1	2.0 − 1.4	Q63082−M310−S1
M 820/S1/ 39.6 Ω	39.6 Ω	5.1 − 1.1	2.2 − 1.4	Q63082−M 39−S106
M 820/S1/ 77 Ω	77 Ω	5.3 ± 0.3	1.3 ± 0.2	Q63082−M770−S1
M 820/S2/ 84.5 Ω	84.5 Ω	5.1 − 0.7	2.4 − 1.6	Q63082−M840−S2
M 820/S1/ 89.5 Ω	89.5 Ω	5.5 − 1.1	2.0 − 1.4	Q63082−M900−S1
M 820/S1/ 92 Ω	92 Ω	5.5 − 1.1	2.0 − 1.4	Q63082−M920−S1
M 820/S1/144 Ω	144 Ω	5.5 − 1.1	2.0 − 1.4	Q63082−M144−S1
M 820/10%/ 2.3 kΩ	2.3 kΩ	5.5 ±0.7	2.2 − 1.4	Q63082−M232−K

Characteristic data

Power rating	at 25°C	P_{25}	400 mW
	at 60°C	P_{60}	300 mW
Rated temperature		ϑ_R	+100 °C
Rated resistance		R_R	See resistance-temperature characteristic
Tolerance [1]		ΔR_R	See diagram
B value		B	See resistance-temperature characteristic
Thermal conductance in air		G_{thA}	3 mW/K
in case of chassis mounting		G_{thC}	approx. 20 mW/K
Thermal time constant		τ_{th}	approx. 30 s
Thermal capacitance		C_{th}	100 mJ/K

Permissible deviation of the resistance-temperature measurement error



[1]) AQL = 0.65%

Resistance-temperature characteristic

Type	**M 820/S1/17Ω**	**M 820/S1/19Ω**	**M 820/S1/20Ω**	**M 820/S1/21.05Ω**
Temperature °C	Resistance Ω	Resistance Ω	Resistance Ω	Resistance Ω
−60	11.4 k	12.71 k	13.3 k	40.3 k
−50	5.99 k	6.69 k	7.04 k	19.1 k
−40	3.31 k	3.71 k	3.90 k	9.63 k
−30	1.92 k	2.14 k	2.26 k	5.10 k
−20	1.15 k	1.29 k	1.36 k	2.82 k
−10	717	802	844	1.63 k
± 0	460	514	542	971
10	303	339	357	599
20	205	229	241	379
30	142	158	167	247
40	100	112	117	165
50	71.6	80.1	84.3	112
60	52.3	58.4	61.5	77.6
70	38.7	43.3	45.5	54.8
80	29.1	32.5	34.2	39.3
90	22.1	24.7	26.0	28.5
100	17.0	19.0	20.0	21.0
110	13.3	14.9	15.6	15.8
120	10.5	12.8	12.4	12.1
130	8.4	9.4	9.9	9.3
140	6.8	7.6	8.0	7.3
150	5.5	6.2	6.5	5.7

Resistance-temperature characteristic

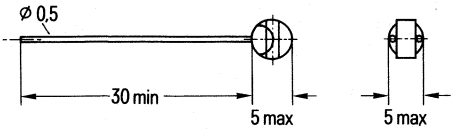
Type	M 820/S1/30.7Ω	M 820/S1/39.6Ω	M 820/S1/77Ω	M 820/S2/84.5Ω
Temperature °C	Resistance Ω	Resistance Ω	Resistance Ω	Resistance Ω
−60	84.5 k	71.3 k	67.1 k	69.5 k
−50	38.7 k	34.1 k	34.4 k	35.9 k
−40	18.8 k	17.2 k	18.6 k	19.5 k
−30	9.68 k	9.17 k	10.5 k	11.1 k
−20	5.21 k	5.10 k	6.20 k	6.55 k
−10	2.93 k	2.96 k	3.79 k	4.02 k
± 0	1.70 k	1.77 k	2.39 k	2.54 k
10	1.03 k	1.10 k	1.55 k	1.65 k
20	637	698	1.03 k	1.10 k
30	406	456	670	753
40	265	305	486	525
50	177	208	344	373
60	120	144	248	269
70	83.7	102	181	198
80	59.1	73.5	135	147
90	42.3	53.6	101	111
100	30.7	39.6	77.0	84.5
110	22.8	29.8	59.7	65.6
120	17.2	22.8	46.8	51.5
130	13.1	17.6	37.0	40.9
140	10.1	13.8	29.6	32.8
150	7.8	10.9	23.9	26.5

Resistance-temperature characteristic

Type	M 820/S1/89.5Ω	M 820/S1/92Ω	M 820/S1/144Ω	M 820/10%/2.3kΩ
Temperature °C	Resistance Ω	Resistance Ω	Resistance Ω	Resistance Ω
−60	73.6 k	75.7 k	235 k	362 k
−50	38.0 k	39.1 k	113 k	167 k
−40	20.6 k	21.2 k	57.8 k	82.0 k
−30	11.7 k	12.1 k	31.0 k	42.5 k
−20	6.94 k	7.14 k	17.4 k	23.0 k
−10	4.26 k	4.37 k	10.1 k	13.0 k
± 0	2.69 k	2.77 k	6.13 k	7.63 k
10	1.75 k	1.80 k	3.82 k	4.62 k
20	1.17 k	1.20 k	2.44 k	2.88 k
30	798	820	1.60 k	1.85 k
40	556	572	1.08 k	1.21 k
50	395	406	739	813
60	285	293	516	556
70	209	215	367	388
80	156	160	265	277
90	117	121	194	197
100	89.5	92.0	144	144
110	69.5	71.4	109	107
120	54.5	56.1	83.4	80.9
130	43.3	44.5	64.7	61.8
140	34.7	35.7	50.7	47.7
150	28.1	28.9	40.1	37.4

NTC thermistors with 1 kΩ to 150 kΩ

Application	Temperature compensation, measurement, and regulation
Version	NTC thermistor disc, painted
Terminals	Leads, tinned
Marking	Resistance value and tolerance are stamped on the NTC[1])
Quality characteristic	High stability due to special production and aging methods



Weight: approx. 0.8 g
Dimensions in mm

Climatic category **FKF**
in accordance with DIN 40040

Lower category temperature	**F** – 55°C
Upper category temperature	**K** +125°C
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

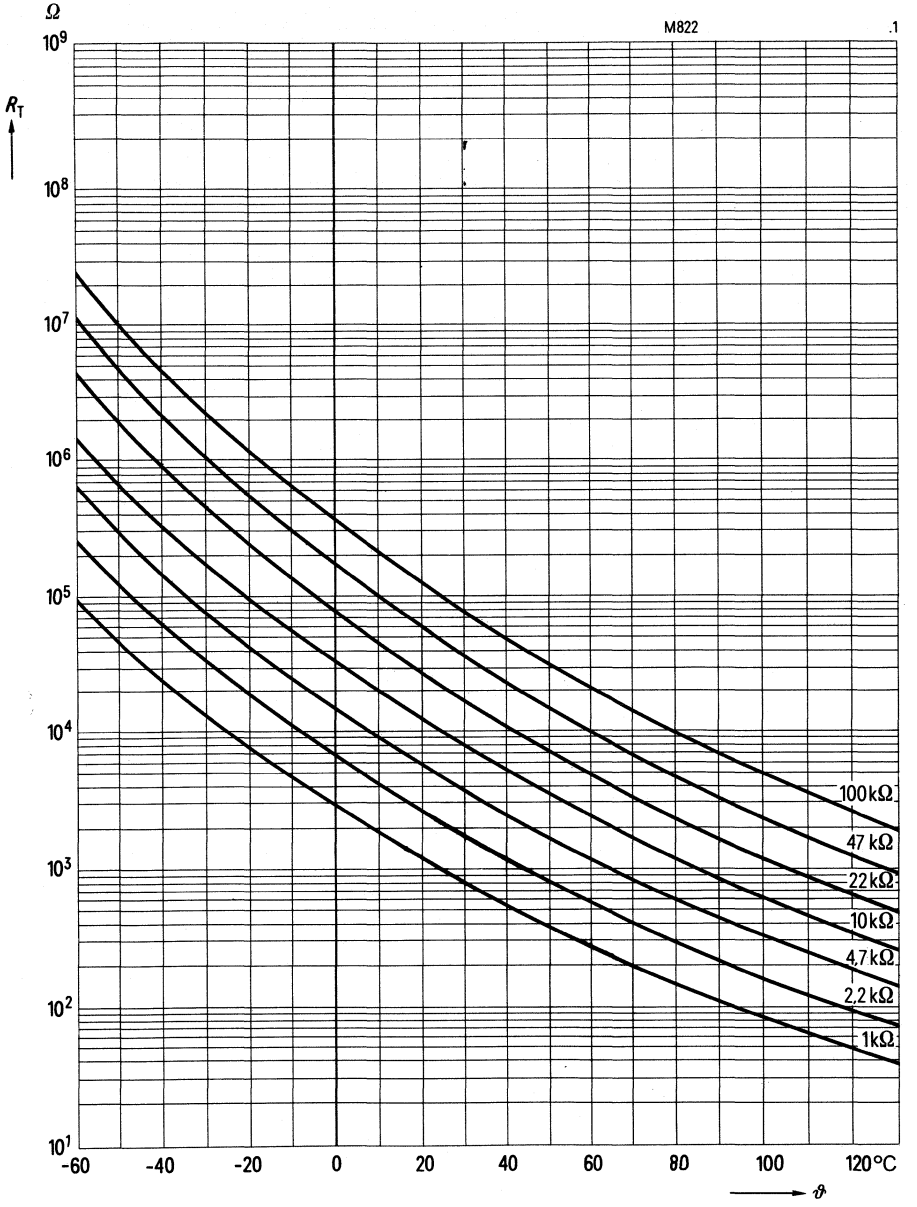
Characteristic data

Type	**M 822**	See table on next page	S2/[3]) 9.4 kΩ	Unit
Power rating at 25°C	P_{25}	600	600	mW
at 60°C	P_{60}	400	400	mW
Rated temperature	ϑ_R	25	–30	°C
Rated resistance	R_R	See table	9.4	kΩ
Tolerance[2])	ΔR_R	See table	±3.5	%
Max. resistance change after 10000 hours	$\Delta R_{10.}$	≤5	≤5	%
B value	*B*	See table	3560	K
Tolerance[2])	ΔB	±5	±5	%
Thermal conductance in air	G_{thA}	7.5(>6)	7.5(>6)	mW/K
Thermal time constant	τ_{th}	approx. 20	approx. 20	s
Thermal capacitance	C_{th}	approx. 150	approx. 150	mJ/K

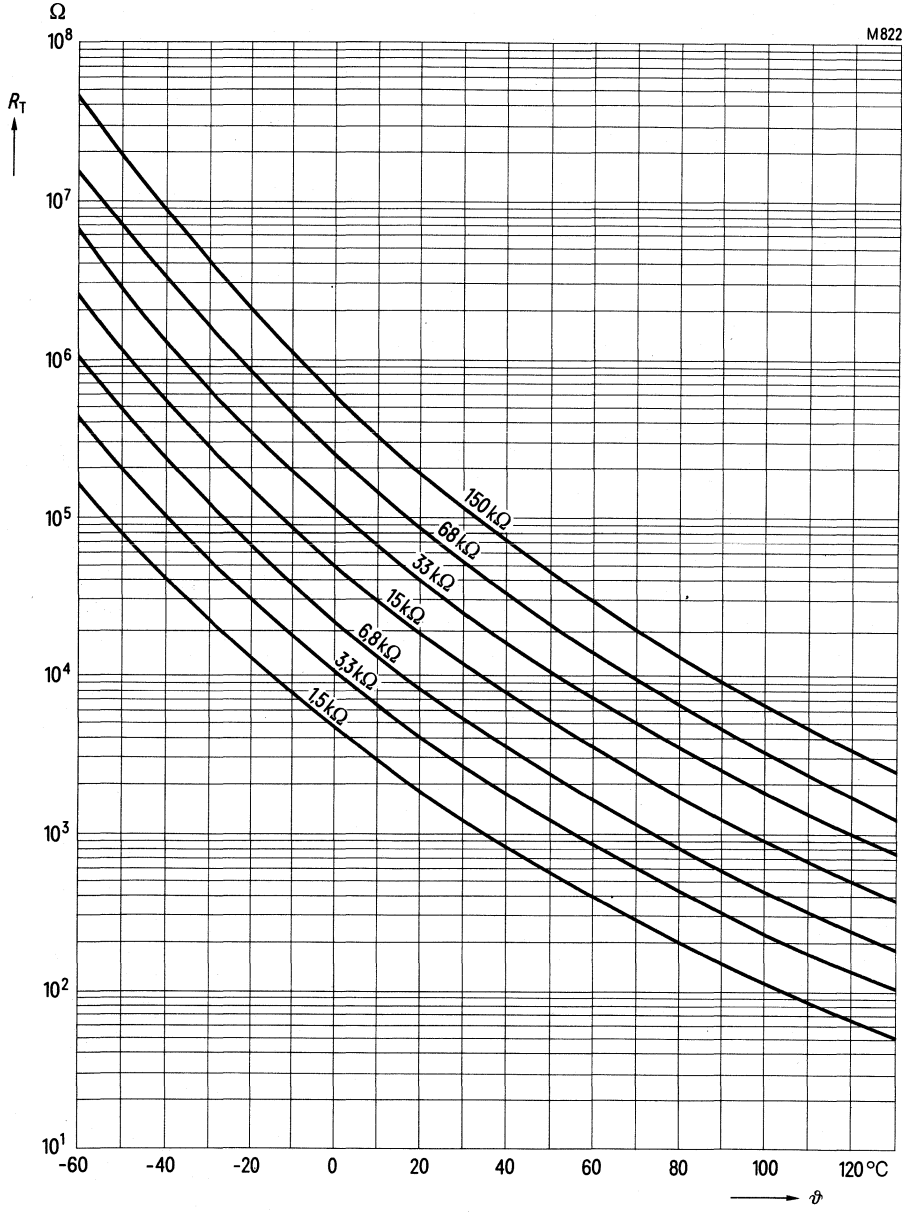
[1]) The resistance tolerance is encoded. One line placed below the resistance value indicates ±10%, two lines indicate ±5%.
[2]) AQL = 0.65%
[3]) Unpainted, no stamps.

Type	Rated resistance	Tolerance	*B* value	Ordering code
M 822/10%/ 1 kΩ	1 kΩ	±10%	3700 K	Q63082–M2102–K
M 822/10%/ 1.5 kΩ	1.5 kΩ	±10%	3850 K	Q63082–M2152–K
M 822/10%/ 2.2 kΩ	2.2 kΩ	±10%	3850 K	Q63082–M2222–K
M 822/10%/ 3.3 kΩ	3.3 kΩ	±10%	3950 K	Q63082–M2332–K
M 822/10%/ 4.7 kΩ	4.7 kΩ	±10%	3950 K	Q63082–M2472–K
M 822/10%/ 6.8 kΩ	6.8 kΩ	±10%	4100 K	Q63082–M2682–K
M 822/10%/ 10 kΩ	10 kΩ	±10%	4100 K	Q63082–M2103–K
M 822/10%/ 15 kΩ	15 kΩ	±10%	4150 K	Q63082–M2153–K
M 822/10%/ 22 kΩ	22 kΩ	±10%	4300 K	Q63082–M2223–K
M 822/10%/ 33 kΩ	33 kΩ	±10%	4300 K	Q63082–M2333–K
M 822/10%/ 47 kΩ	47 kΩ	±10%	4450 K	Q63082–M2473–K
M 822/10%/ 68 kΩ	68 kΩ	±10%	4450 K	Q63082–M2683–K
M 822/10%/100 kΩ	100 kΩ	±10%	4450 K	Q63082–M2104–K
M 822/10%/150 kΩ	150 kΩ	±10%	4650 K	Q63082–M2154–K
M 822/5%/ 1 kΩ	1 kΩ	±5%	3700 K	Q63082–M2102–J
M 822/5%/ 1.5 kΩ	1.5 kΩ	±5%	3850 K	Q63082–M2152–J
M 822/5%/ 2.2 kΩ	2.2 kΩ	±5%	3850 K	Q63082–M2222–J
M 822/5%/ 3.3 kΩ	3.3 kΩ	±5%	3950 K	Q63082–M2332–J
M 822/5%/ 4.7 kΩ	4.7 kΩ	±5%	3950 K	Q63082–M2472–J
M 822/5%/ 6.8 kΩ	6.8 kΩ	±5%	4100 K	Q63082–M2682–J
M 822/5%/ 10 kΩ	10 kΩ	±5%	4100 K	Q63082–M2103–J
M 822/5%/ 15 kΩ	15 kΩ	±5%	4150 K	Q63082–M2153–J
M 822/5%/ 22 kΩ	22 kΩ	±5%	4300 K	Q63082–M2223–J
M 822/5%/ 33 kΩ	33 kΩ	±5%	4300 K	Q63082–M2333–J
M 822/5%/ 47 kΩ	47 kΩ	±5%	4450 K	Q63082–M2473–J
M 822/5%/ 68 kΩ	68 kΩ	±5%	4450 K	Q63082–M2683–J
M 822/5%/100 kΩ	100 kΩ	±5%	4450 K	Q63082–M2104–J
M 822/5%/150 kΩ	150 kΩ	±5%	4650 K	Q63082–M2154–J
M 822/S2/ 9.4 kΩ	9.4 kΩ	±3.5%	3560 K	Q63082–M2942–S2

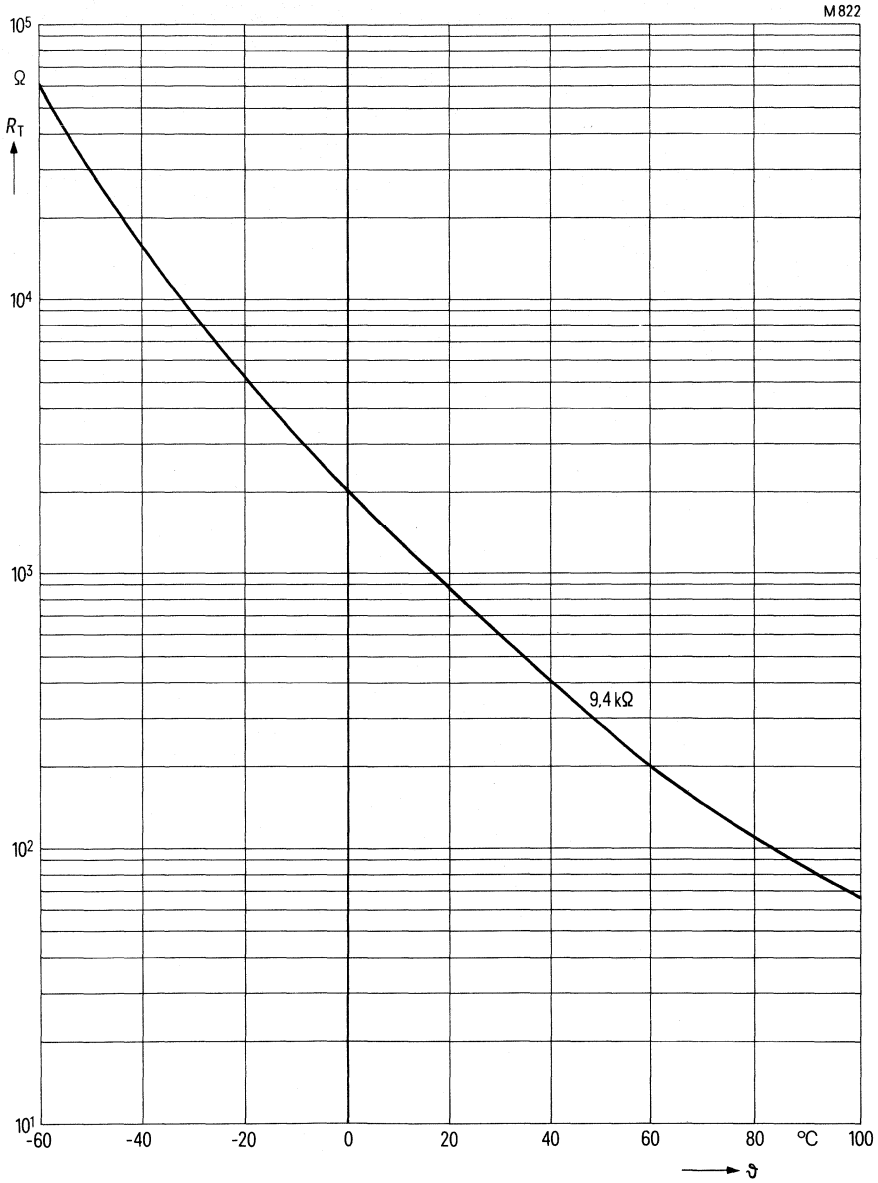
NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



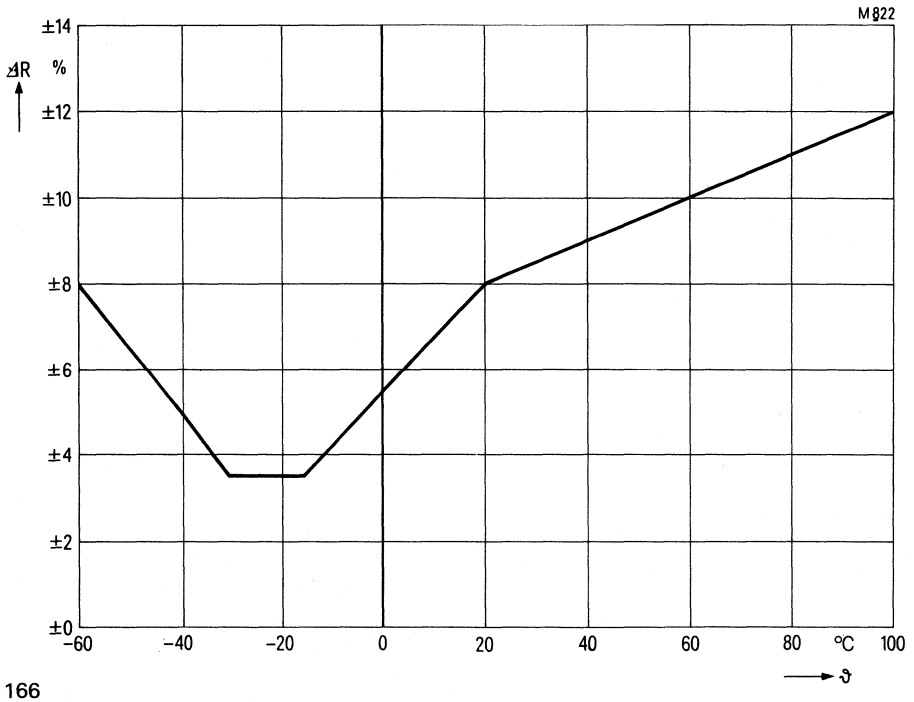
NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature
M 822/S2/9.4 kΩ



Resistance-temperature characteristic
M 822/S2/9.4 kΩ

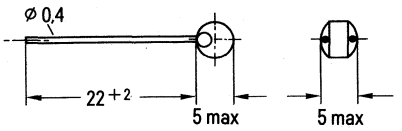
Temperature °C	Resistance kΩ	Temperature °C	Resistance kΩ	Temperature °C	Resistance kΩ
−55	44	−22	6.10	15	1.08
−50	31	−21	5.79	20	0.89
−45	23	−20	5.49	25	0.73
−40	16.7	−19	5.22	30	0.61
−35	12.5	−18	4.96	40	0.42
−30	9.40	−17	4.71	50	0.30
−29	8.89	−16	4.48	60	0.21
−28	8.42	−15	4.26	70	0.157
−27	7.97	−10	3.30	80	0.116
−26	7.55	− 5	2.52	90	0.087
−25	7.15	0	2.09	100	0.067
−24	6.78	5	1.66		
−23	6.43	10	1.34		

Permissible deviation of the resistance values
M 822/S2/9.4 kΩ



NTC thermistor with 245 Ω

Application	For installation in temperature sensors
Version	NTC thermistor disc, unpainted
Terminals	Leads, tinned (material with bad thermal conductivity)
Marking	None



Weight: approx. 0.6 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**FKF**
Lower category temperature	**F** − 55°C
Upper category temperature	**K** +125°C
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

Type	Rated resistance	Tolerance	*B* value	Ordering code
M 827/S1/245 Ω	245 Ω	±5%	3980 K	Q63082−M7245−S1

Characteristic data

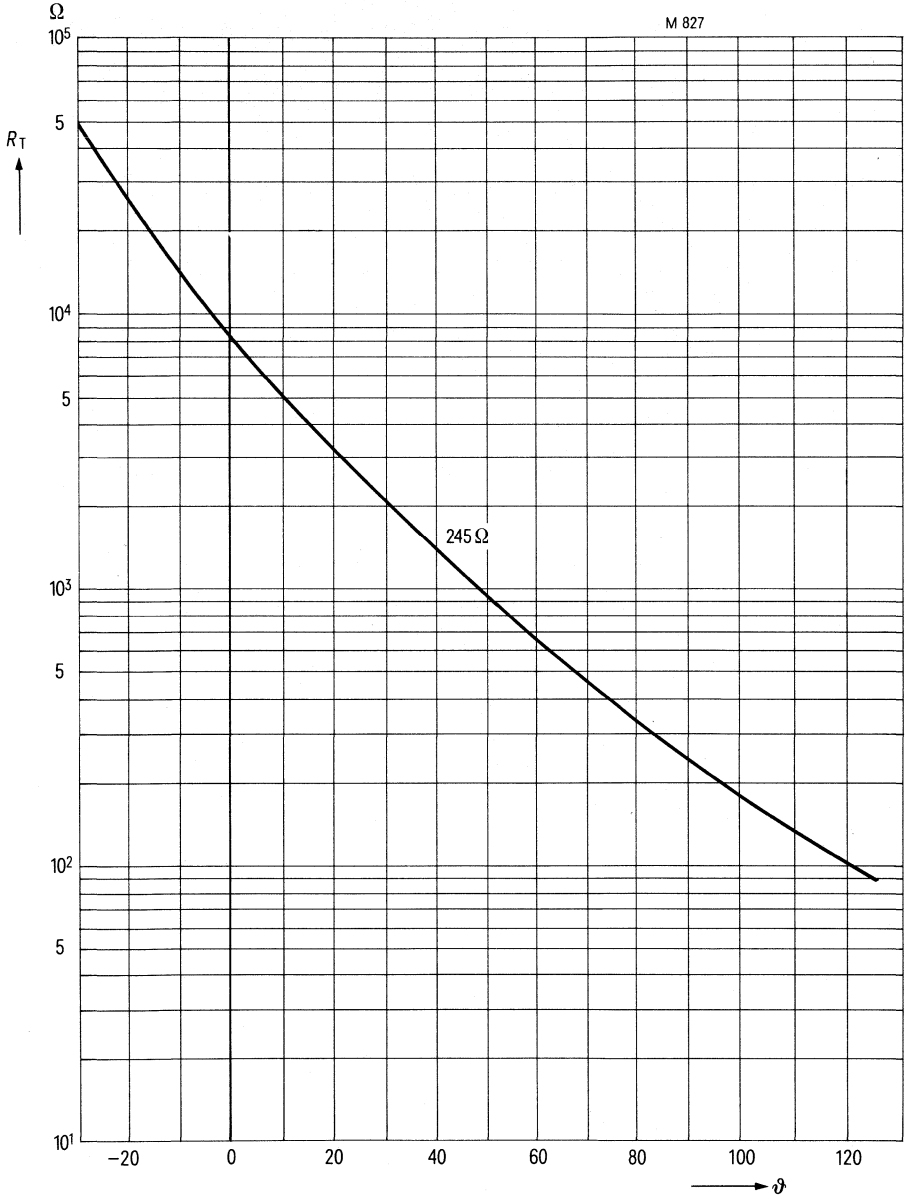
Power rating at 25°C	P_{25}	300 mW
at 60°C	P_{60}	200 mW
Rated temperature	ϑ_R	90 °C
Rated resistance	R_R	245 Ω
Tolerance[1)]	ΔR_R	±5 %
Max. resistance change after 10000 hours	$\Delta R_{10.}$	±3 %
B value	*B*	3980 K
Thermal conductance in air	G_{thA}	approx. 3 mW/K
Thermal time constant	τ_{th}	approx. 80 s
Thermal capacitance	C_{th}	approx. 250 mJ/K

Resistance-temperature characteristic
(Theoretical values)

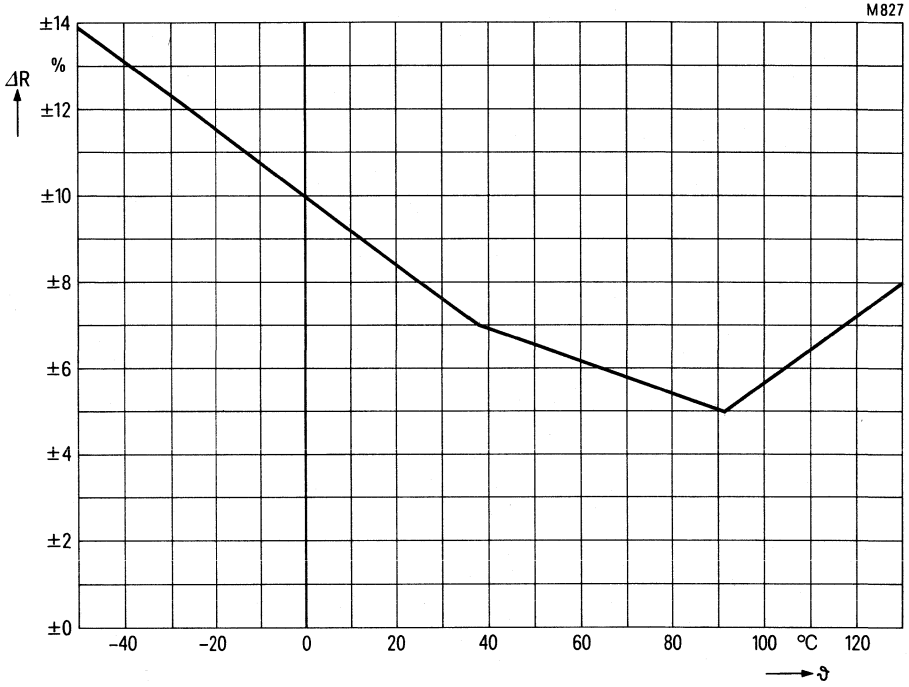
Temperature °C	Resistance kΩ	Temperature °C	Resistance kΩ
−60	400	40	1.430
−50	186	50	0.965
−40	91.5	60	0.666
−30	47.6	70	0.469
−20	26.0	80	0.336
−10	14.8	90	0.245
± 0	8.73	100	0.181
10	5.33	110	0.136
20	3.35	120	0.104
30	2.16	130	0.0799

[1)] AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature

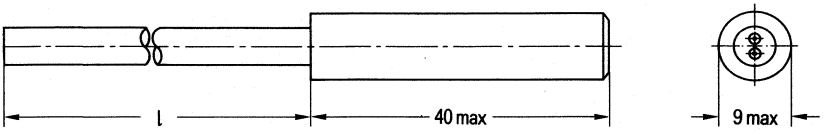


Permissible deviation of the resistance values $\Delta R = f(\vartheta)$



NTC thermistors with 1 kΩ to 22 kΩ

Application	Temperature measurement in air and in liquids
Version	Metal case, NTC thermistor electrically insulated
Terminals	PVC connecting cable, H03VV-F2×075 white, DIN 57281
Marking	Cable mark according to characteristic data



Weight: approx. 120 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**ISD**
Lower category temperature	**I** − 10°C
Upper category temperature	**S** + 70°C
Humidity category	**D** Average relative humidity ≤ 80% 100% continuously on 30 days per year 90% occasionally on the remaining days Dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −10°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +70°C

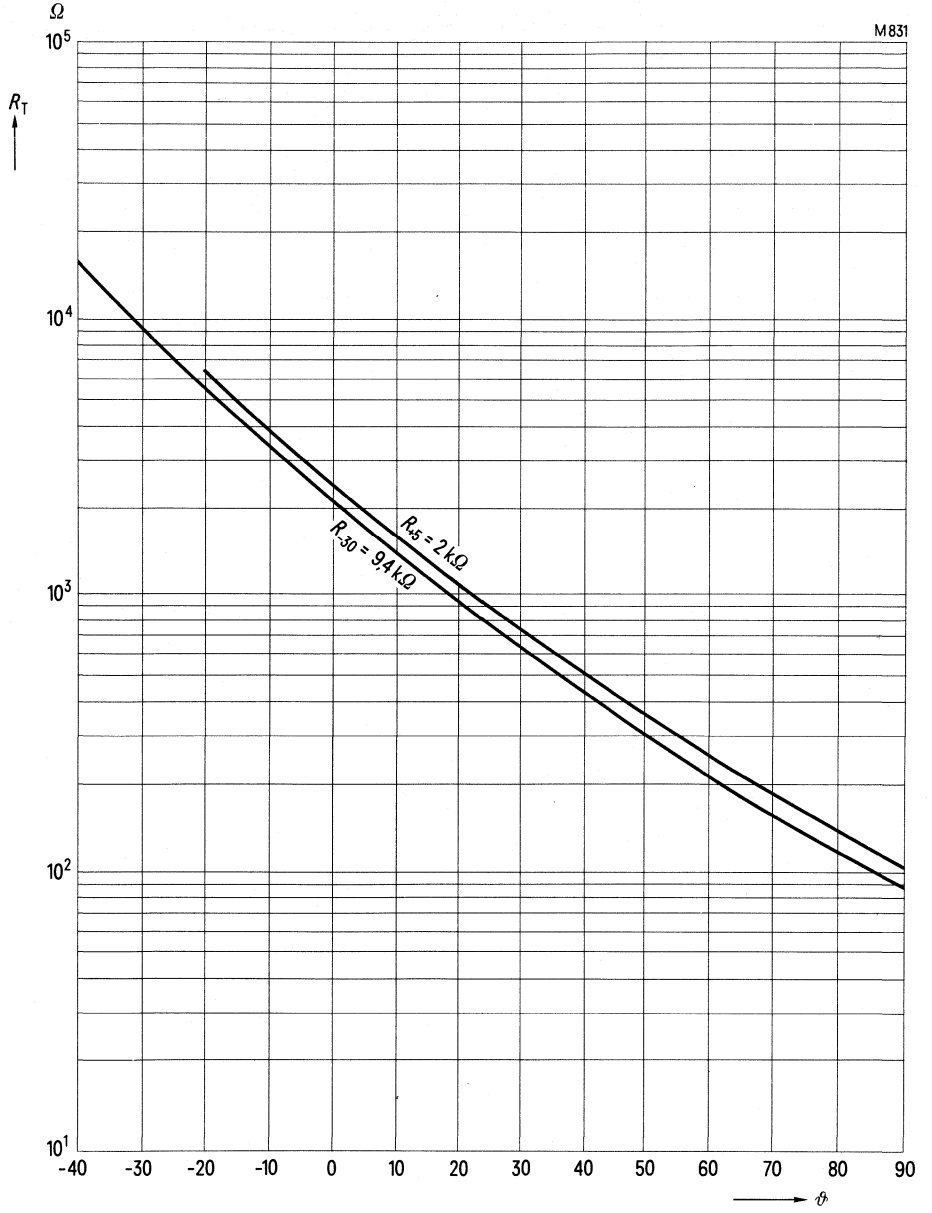
Type	Rated resistance	Tolerance	Ordering code
M 831/10%/1 kΩ/2.1	1 kΩ	±10%	Q63483−M1001−K40
M 831/10%/1.5 kΩ/2.1	1.5 kΩ	±10%	Q63083−M1001−K45
M 831/S1 /2 kΩ/0.5	2 kΩ	±3.5%	Q63383−M1002−S14
M 831/10%/3.3 kΩ/2.1	3.3 kΩ	±10%	Q63483−M1003−K43
M 831/10%/6.8 kΩ/2.1	6.8 kΩ	±10%	Q63483−M1006−K48
M 831/S1 /9.4 kΩ/2.1	9.4 kΩ	±10%	Q63483−M1009−S144
M 831/10%/10 kΩ/2.1	10 kΩ	±10%	Q63483−M1010−K40
M 831/10%/22 kΩ/2.1	22 kΩ	±10%	Q63483−M1022−K40

Characteristic data

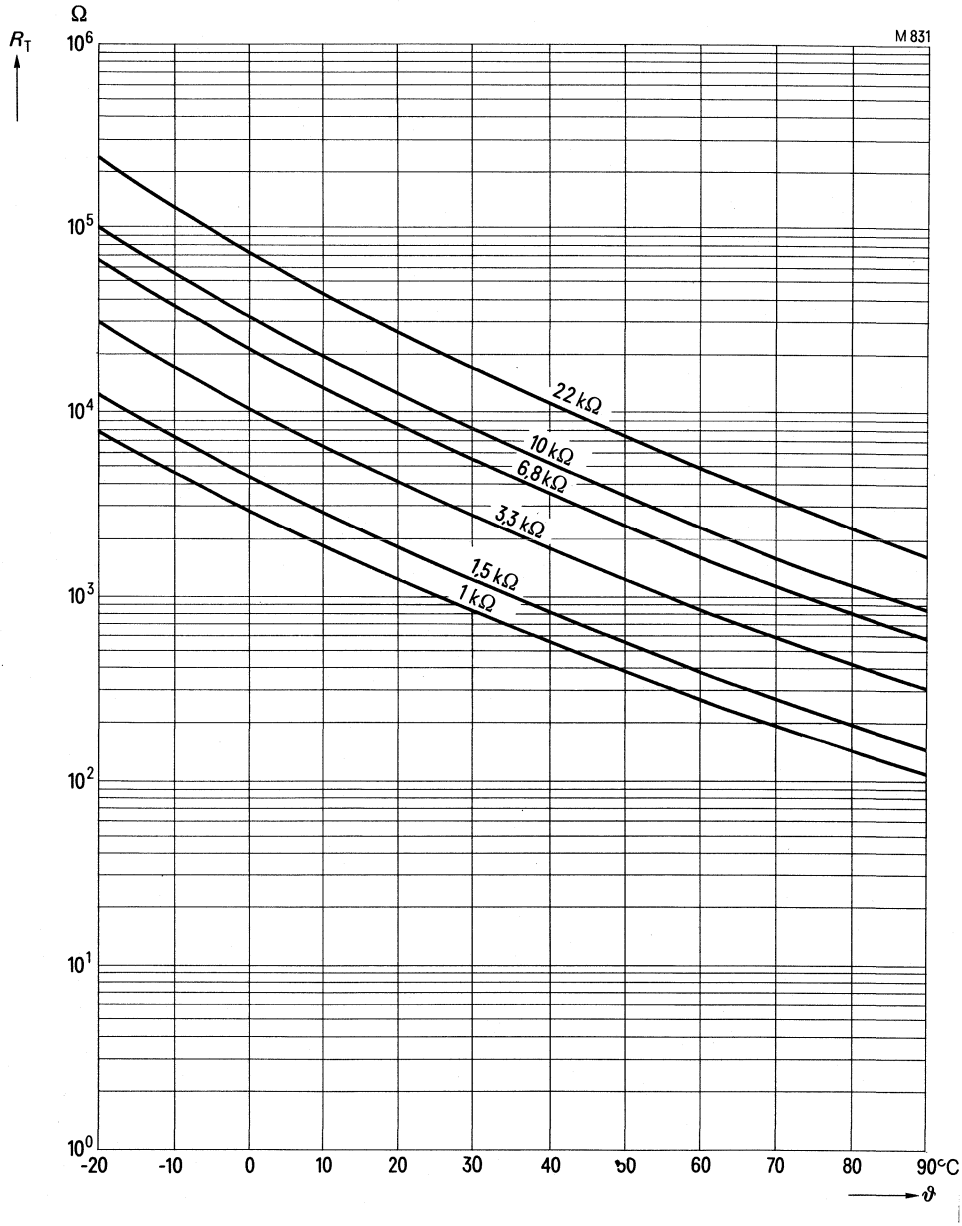
Type	M 831	10% 1 kΩ 2.1	10% 1.5 kΩ 2.1	S1 2 kΩ 0.5	10% 3.3 kΩ 2.1	10% 6.8 kΩ 2.1	S1 9.4 kΩ 2.1	10% 10 kΩ 2.1	10% 22 kΩ 2.1	Unit
Power rating at 25°C	P_{25}	1000	1000	1000	1000	1000	1000	1000	1000	mW
Rated temperature	ϑ_R	25	25	5	25	25	−30	25	25	°C
Rated resistance	R_R	1	1.5	2	3.3	6.8	9.4	10	22	kΩ
Tolerance[1)]	ΔR_R	±10	±10	±3.5	±10	±10	±10	±10	±10	%
B value	*B*	3700	3850	3560	3950	4100	3560	4100	4300	K
Tolerance[1)]	ΔB	±5	±5	±5	±5	±5	±5	±5	±5	%
Thermal conductance										
in air	G_{thA}	11	11	11	11	11	11	11	11	mW/K
in water	G_{thW}	20	20	20	20	20	20	20	20	mW/K
Thermal time constant in air	τ_{thA}	approx. 500	approx. 500	approx. 500	approx. 500	approx. 500	approx. 500	approx. 500	approx. 500	s
in water	τ_{thW}	approx. 22	approx. 22	approx. 22	approx. 22	approx. 22	approx. 22	approx. 22	approx. 22	s
Cable length	*l*	2100	2100	500	2100	2100	2100	2100	2100	mm
Code figure (cable mark)		2	3	–	10	4	1	5	6	–
Insulation resistance	R_{is}	10^3	10^3	10^3	10^3	10^3	10^3	10^3	10^3	MΩ
Test voltage	V_{test}	2500	2500	2500	2500	2500	2500	2500	2500	V
Test duration	t_t	1	1	1	1	1	1	1	1	s

[1)] AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature

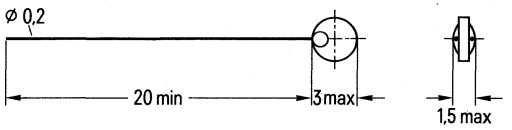


NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 3 kΩ and 5 kΩ

Application	Precision NTC thermistors for very precise temperature measurements in the range between −40°C and +100°C
Version	NTC thermistor, painted
Terminals	Leads made of silver
Marking	None
Quality characteristic	High stability due to particularly selected materials and special production and aging methods.



Weight: approx. 0.1 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**GMF**
Lower category temperature	**G** − 40°C
Upper category temperature	**M** +100°C
Humidity category	**F** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

Type	Rated resistance	Tolerance	*B* value	Ordering code
M 841/S1/3 kΩ	3 kΩ	±0.4%	3981 K	Q63084−M1302−S1
M 841/S1/5 kΩ	5 kΩ	±0.4%	3981 K	Q63084−M1502−S1

Characteristic data

Type	M 841/S1	3 kΩ	5 kΩ	Unit
Power rating at 25°C	P_{25}	75	75	mW
at 60°C	P_{60}	40	40	mW
Rated temperature	ϑ_R	25	25	°C
Rated resistance	R_R	3	5	kΩ
Tolerance[1]	ΔR_R	±0.4	±0.4	%
Max. resistance change after 10000 hours	$\Delta R_{10.}$	See below		
B value	*B*	3981	3981	K
Thermal conductance in air	G_{thA}	approx. 1	approx. 1	mW/K
Thermal time constant	τ_{th}	approx. 10	approx. 10	s
Thermal capacitance	C_{th}	approx. 10	approx. 10	mJ/K

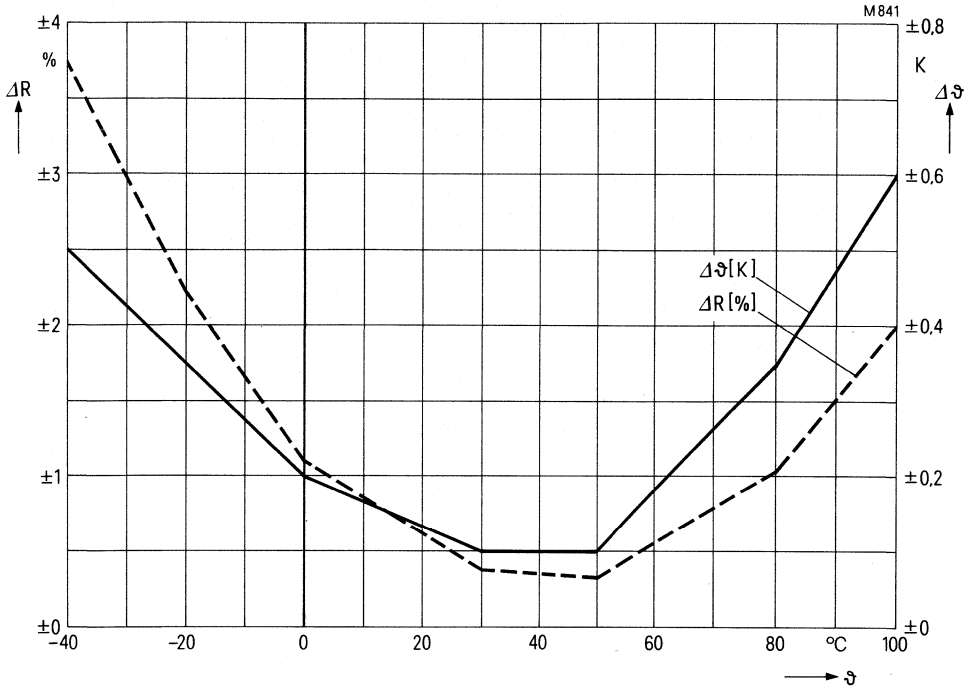
Stability of the electrical values

The maximum resistance change after 10000 operating hours in the temperature range between −40°C and +100°C is $\Delta R_{10.} < 1\%$.

Should the temperature range within which the NTC thermistor is operated, be restricted to values between 0°C and +60°C, then the resistance change during the 10000 operating hours can be expected to be not more than ±0.3% of the initial value.

[1]) AQL = 0.65%

Permissible deviation of the resistance values



Resistance-temperature characteristic

M 841/S1/3 kΩ

Temperature °C	Resistance Ω	Temperature °C	Resistance Ω	Temperature °C	Resistance Ω
−40	101.63k	7	6904	54	930.0
−39	95.06k	8	6576	55	896.1
−38	88.97k	9	6265	56	863.7
−37	83.30k	10	5971	57	832.6
−36	78.03k	11	5692	58	802.8
−35	73.13k	12	5427	59	774.2
−34	68.57k	13	5177	60	746.8
−33	64.33k	14	4939	61	720.5
−32	60.37k	15	4714	62	695.3
−31	56.68k	16	4500	63	671.0
−30	53.24k	17	4297	64	647.8
−29	50.04k	18	4104	65	625.4
−28	47.04k	19	3922	66	604.0
−27	44.24k	20	3748	67	583.4
−26	41.63k	21	3583	68	563.6
−25	39.19k	22	3426	69	544.6
−24	36.91k	23	3277	70	526.3
−23	34.77k	24	3135	71	508.8
−22	32.77k	25	3000	72	491.9
−21	30.90k	26	2872	73	475.6
−20	29.15k	27	2749	74	460.0
−19	27.50k	28	2633	75	445.0
−18	25.97k	29	2522	76	430.5
−17	24.52k	30	2417	77	416.6
−16	23.17k	31	2316	78	403.2
−15	21.89k	32	2221	79	390.3
−14	20.70k	33	2129	80	377.9
−13	19.58k	34	2042	81	365.9
−12	18.52k	35	1959	82	354.4
−11	17.53k	36	1880	83	343.3
−10	16.60k	37	1805	84	332.6
− 9	15.72k	38	1732	85	322.3
− 8	14.90k	39	1664	86	312.3
− 7	14.12k	40	1598	87	302.8
− 6	13.39k	41	1535	88	293.5
− 5	12.70k	42	1475	89	284.6
− 4	12.05k	43	1418	90	276.0
− 3	11.43k	44	1363	91	267.7
− 2	10.86k	45	1311	92	259.7
− 1	10.31k	46	1260	93	252.0
0	9796	47	1213	94	244.6
1	9309	48	1167	95	237.4
2	8850	49	1123	96	230.4
3	8416	50	1081	97	223.7
4	8006	51	1041	98	217.2
5	7618	52	1002	99	211.0
6	7251	53	965	100	204.9

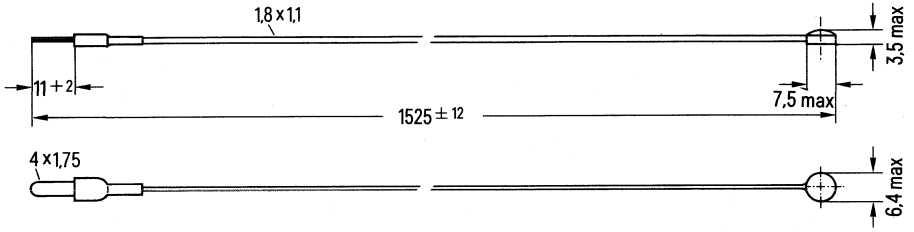
Resistance-temperature characteristic

M 841/S1/5 kΩ

Temperature °C	Resistance Ω	Temperature °C	Resistance Ω	Temperature °C	Resistance Ω
−40	169.4k	7	11507	54	1550
−39	158.4k	8	10960	55	1494
−38	148.3k	9	10442	56	1439
−37	138.8k	10	9951	57	1388
−36	130.1k	11	9486	58	1338
−35	121.9k	12	9045	59	1290
−34	114.3k	13	8628	60	1245
−33	107.2k	14	8232	61	1201
−32	100.6k	15	7856	62	1159
−31	94.47k	16	7500	63	1118
−30	88.74k	17	7162	64	1080
−29	83.39k	18	6841	65	1042
−28	78.40k	19	6536	66	1007
−27	73.74k	20	6246	67	972.3
−26	69.39k	21	5971	68	939.4
−25	65.32k	22	5710	69	907.7
−24	61.51k	23	5461	70	877.2
−23	57.95k	24	5225	71	847.9
−22	54.62k	25	5000	72	819.8
−21	51.50k	26	4786	73	792.7
−20	48.58k	27	4582	74	766.7
−19	45.84k	28	4389	75	741.6
−18	43.28k	29	4204	76	717.5
−17	40.87k	30	4028	77	694.3
−16	38.61k	31	3861	78	672.0
−15	36.49k	32	3701	79	650.5
−14	34.50k	33	3549	80	629.8
−13	32.63k	34	3404	81	609.8
−12	30.87k	35	3266	82	590.6
−11	29.22k	36	3134	83	572.1
−10	27.67k	37	3008	84	554.3
− 9	26.20k	38	2887	85	537.1
− 8	24.83k	39	2773	86	520.6
− 7	23.53k	40	2663	87	504.6
− 6	22.31k	41	2558	88	489.2
− 5	21.16k	42	2458	89	474.3
− 4	20.08k	43	2363	90	460.0
− 3	19.06k	44	2272	91	446.2
− 2	18.09k	45	2184	92	432.9
− 1	17.18k	46	2101	93	420.0
0	16.33k	47	2021	94	407.6
1	15.52k	48	1944	95	395.6
2	14.75k	49	1871	96	384.0
3	14.03k	50	1801	97	372.8
4	13.34k	51	1734	98	362.1
5	12.70k	52	1670	99	351.6
6	12.09k	53	1609	100	341.5

NTC thermistors with 5 kΩ

Application	Surface temperature measurement
Version	Metal case, NTC thermistor electrically insulated
Terminals	Connecting cable with plug
Marking	For plug size see table
Quality characteristic	High stability due to particularly selected materials and special production and aging methods. The semiconductor is also available in a "calibrated version" as a sensor for clinical thermometers.



Weight: approx. 3.5 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**HQC**
Lower category temperature	**H** −25°C
Upper category temperature	**Q** +80°C
Humidity category	**C** Average relative humidity ≤ 95% 100% continuously on 30 days per year 100% occasionally on the remaining days Dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +80°C

Type	Rated resistance	*B* value	Plug	Ordering code
M 846/S2/5 kΩ	5 kΩ	3981 K	4×1.6 mm	Q63084–M6502–S2
M 846/S3/5 kΩ	5 kΩ	3981 K	6×1.0 mm	Q63084–M6502–S3

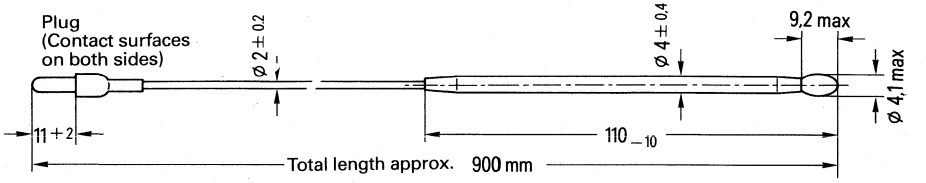
Characteristic data

Type	M 846	S2/5 kΩ	S3/5 kΩ	Unit
Power rating at 25°C	P_{25}	100	100	mW
at 60°C	P_{60}	40	40	mW
Rated temperature	ϑ_R	25	25	°C
Rated resistance	R_R	5000	5000	Ω
Tolerance[1)]	ΔR_R	See page 186		
Max. resistance change after 10000 hours	$\Delta R_{10.}$	See page 186		
B value	*B*	3981	3920	K
Resistance-temperature characteristic		See page 184		
Thermal conductance				
in air	G_{thA}	3	3	mW/K
in water	G_{thW}	20	20	mW/K
Thermal time constant				
in water	τ_{thW}	2.5	2.5	s
in air	τ_{thA}	35	35	mJ/K
Power rating for measurement (<0.1 K intrinsic heating)	P_{meas}	0.25	0.25	mW
Insulation resistance	R_{is}	100	100	MΩ
Test voltage	V_{test}	250	250	V
Test duration	t_t	1	1	s

[1)] AQL = 0.65%

NTC thermistors with 5 kΩ

Application	Universal and interchangeable precision NTC thermistor sensor
Version	The NTC thermistor is encapsulated in ceramic material on the tip of the shaft.
Terminals	Connecting cable with plug
Marking	For plug size see table
Quality characteristic	High stability due to particularly selected materials and special production and aging methods. The sensor is also available in an "officially cablirated version" for clinical thermometers.



Weight: approx. 4.8 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**HQC**
Lower category temperature	**H** −25°C
Upper category temperature	**Q** +80°C
Humidity category	**C** Average relative humidity ≤ 95% 100% continuously on 30 days per year 100% occasionally on the remaining days Dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

Type	Rated resistance	*B* value	Plug	Ordering code
M 847/S1/5 kΩ/01	5 kΩ	3981 K	4×1.6 mm	Q63084−M7502−S101
M 847/S3/5 kΩ	5 kΩ	3920 K	6×1.0 mm	Q63084−M7502−S3

Characteristic data

Type	M 847	S1/5 kΩ	S3/5 kΩ	Unit
Power rating at 25°C	P_{25}	100	100	mW
at 60°C	P_{60}	40	40	mW
Rated temperature	ϑ_R	25	25	°C
Rated resistance	R_R	5000	4951.8	Ω
Tolerance[1)]	ΔR_R	See page 186		
Max. resistance change after 10000 hours	$\Delta R_{10.}$	See page 186		
B value	*B*	3981	3920	K
Resistance-temperature characteristic		See page 184		
Thermal conductance				
in air	G_{thA}	3	3	mW/K
in water	G_{thW}	20	20	mW/K
Thermal time constant				
in air	τ_{thA}	35	35	mJ/K
in water	τ_{thW}	2.5	2.5	s
Power rating for measurement (< 0,1 K intrinsic heating)	P_{meas}	250	250	mW

[1)] AQL = 0.65%

Resistance-temperature characteristic

M 846/S3/5 kΩ
M 847/S3/5 kΩ

Temperature °C	Resistance Ω	Temperature °C	Resistance Ω	Temperature °C	Resistance Ω
−25	62190	15	7727	55	1507
−24	58621	16	7382	56	1453
−23	55279	17	7054	57	1402
−22	52148	18	6742	58	1352
−21	49215	19	6446	59	1305
−20	46464	20	6165	60	1259
−19	43884	21	5898	61	1216
−18	41464	22	5643	62	1174
−17	39192	23	5401	63	1133
−16	37058	24	5171	64	1095
−15	35054	25	4952	65	1058
−14	33170	26	4743	66	1022
−13	31399	27	4544	67	987
−12	28733	28	4355	68	954
−11	28165	29	4175	69	923
−10	26690	30	4003	70	892
− 9	25301	31	3839	71	863
− 8	23992	32	3682	72	835
− 7	22759	33	3533	73	808
− 6	21597	34	3391	74	781
− 5	20501	35	3255	75	756
− 4	19467	36	3126	76	732
− 3	18491	37	3002	77	709
− 2	17570	38	2884	78	686
− 1	16700	39	2771	79	665
± 0	15878	40	2663	80	644
1	15102	41	2560		
2	14368	42	2461		
3	13674	43	2367		
4	13017	44	2277		
5	12396	45	2191		
6	11808	46	2108		
7	11252	47	2029		
8	10725	48	1954		
9	10225	49	1881		
10	9752	50	1812		
11	9303	51	1746		
12	8877	52	1682		
13	8474	53	1621		
14	8091	54	1563		

Resistance-temperature characteristic

M 846/S2/5 k
M 847/S1/5 kΩ/01

Temperature °C	Resistance Ω	Temperature °C	Resistance Ω	Temperature °C	Resistance Ω
−25	65317	15	7856	55	1494
−24	61512	16	7500	56	1440
−23	57952	17	7162	57	1388
−22	54621	18	6841	58	1338
−21	51501	19	6536	59	1290
−20	48580	20	6246	60	1245
−19	45842	21	5971	61	1201
−18	43275	22	5710	62	1159
−17	40868	23	5461	63	1118
−16	38609	24	5225	64	1080
−15	36489	25	5000	65	1042
−14	34499	26	4786	66	1007
−13	32629	27	4583	67	972
−12	30871	28	4389	68	939
−11	29219	29	4204	69	908
−10	27665	30	4028	70	877
− 9	26204	31	3861	71	848
− 8	24828	32	3701	72	820
− 7	23532	33	3549	73	793
− 6	22312	34	3403	74	767
− 5	21163	35	3266	75	742
− 4	20079	36	3134	76	718
− 3	19058	37	3008	77	694
− 2	18094	38	2887	78	672
− 1	17185	39	2773	79	651
± 0	16326	40	2663	80	630
1	15516	41	2558		
2	14750	42	2458		
3	14027	43	2363		
4	13343	44	2272		
5	12697	45	2184		
6	12086	46	2101		
7	11507	47	2021		
8	10960	48	1944		
9	10442	49	1871		
10	9951	50	1801		
11	9486	51	1734		
12	9045	52	1670		
13	8628	53	1609		
14	8232	54	1550		

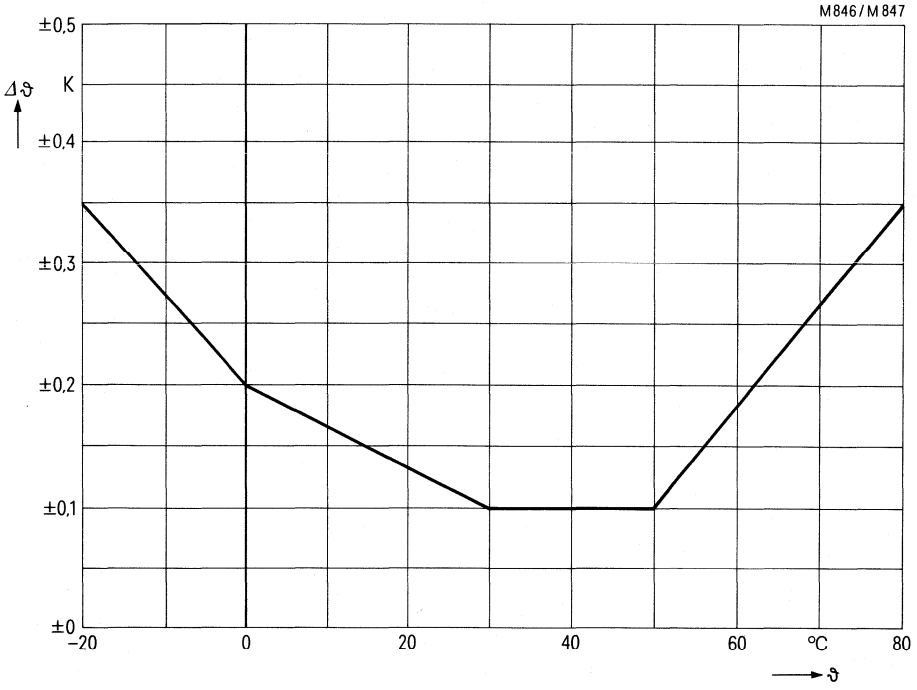
Stability of the electrical values

The maximum resistance change after 10000 operating hours in the temperature range between −25°C and +60°C is $\Delta R_{10.} \leqslant +0.3\%$.

Should the complete permissible temperature range be utilized, then resistance changes up to a maximum of ±1% can occur during the 10000 operating hours.

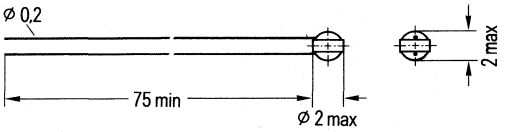
For details on temperature sensors of versions M 846 and M 847, used as temperature sensors for clinical thermometers with official calibration, see page 206.

Minor temperature measurement error



NTC thermistors with 10 kΩ and 60 kΩ

Application	Interchangeable miniature precision NTC thermistors for precise temperature measurements
Version	NTC thermistor disc coated with paint
Terminals	Leads (material with bad thermal conductivity)
Marking	None
Quality characteristic	High stability of the electrical values due to particularly selected materials and special production and aging methods.



Weight: approx. 0.1 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**GMF**
Lower category temperature	**G** – 40°C
Upper category temperature	**M** +100°C [1]
Humidity category	**F** Average relative humidity ⩽ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

Type	Rated resistance	*B* value	Ordering code
M 867/1%/10 kΩ	10 kΩ	3920 K	Q63086–M7103–F
M 867/S1 /60 kΩ	60 kΩ	4224 K	Q63086–M7603–S1

[1]) The upper category temperature may be exceeded up to a value of 125°C for a period of 100 hours.

Characteristic data

Type	M 867	1%/10 kΩ	S1/60 kΩ	Unit
Power rating at 25°C	P_{25}	55	55	mW
at 60°C	P_{60}	30	30	mW
Rated temperature	ϑ_R	25	25	°C
Rated resistance	R_R	10	60	kΩ
Tolerance[1]	ΔR_R	See page 194, 195		
Max. resistance change after 10000 hours	$\Delta R_{10.}$	See page 192		
B value	*B*	3920	4224	K
Tolerance[1]	ΔB	See tolerance diagram		
Thermal conductance in air	G_{thA}	0.75	0.75	mW/K
Thermal time constant	τ_{th}	10	10	s
Thermal capacitance	C_{th}	7.5	7.5	mJ/K

[1]) AQL = 0.65%

Resistance-temperature characteristic

M 867/1%/10 kΩ
R_{25} = 10 kΩ

Temperature °C	Resistance Ω	Temperature °C	Resistance Ω	Temperature °C	Resistance Ω
−40	320956	±0	32066	40	5378
−39	300534	1	30498	41	5170
−38	281546	2	29016	42	4971
−37	263882	3	27614	43	4780
−36	247442	4	26288	44	4598
−35	232134	5	25034	45	4424
−34	217873	6	23847	46	4258
−33	204580	7	22722	47	4098
−32	192184	8	21658	48	3946
−31	180619	9	20649	49	3799
−30	169824	10	19693	50	3660
−29	159744	11	18787	51	3525
−28	150326	12	17927	52	3397
−27	141523	13	17112	53	3274
−26	133291	14	16338	54	3156
−25	125590	15	15604	55	3043
−24	118382	16	14907	56	2934
−23	111634	17	14245	57	2830
−22	105312	18	13616	58	2731
−21	99387	19	13018	59	2635
−20	93833	20	12450	60	2543
−19	88623	21	11910	61	2455
−18	83735	22	11396	62	2370
−17	79146	23	10908	63	2289
−16	74837	24	10443	64	2211
−15	70789	25	10000	65	2136
−14	66985	26	9579	66	2063
−13	63408	27	9177	67	1994
−12	60044	28	8795	68	1927
−11	56879	29	8430	69	1863
−10	53899	30	8083	70	1802
− 9	51094	31	7752	71	1743
− 8	48451	32	7436	72	1686
− 7	45961	33	7135	73	1631
− 6	43614	34	6848	74	1578
− 5	41400	35	6574	75	1527
− 4	39312	36	6312	76	1478
− 3	37341	37	6062	77	1431
− 2	35481	38	5824	78	1386
− 1	33725	39	5596	79	1342

Resistance-temperature characteristic
(cont'd)

M 867/1%/10 kΩ
R_{25} = 10 kΩ

Temperature °C	Resistance Ω	Temperature °C	Resistance Ω	Temperature °C	Resistance Ω
80	1300	95	823	110	539
81	1260	96	799	111	525
82	1221	97	776	112	511
83	1183	98	754	113	497
84	1147	99	732	114	484
85	1112	100	712	115	472
86	1078	101	692	116	459
87	1045	102	573	117	447
88	1014	103	654	118	436
89	984	104	636	119	425
90	954	105	618	120	414
91	926	106	501	121	404
92	899	107	585	122	393
93	873	108	569	123	384
94	847	109	554	124	374

Resistance-temperature characteristic

M 867/S1/60 kΩ

R_{25} = 60 kΩ

Temperature °C	Resistance Ω	Temperature °C	Resistance Ω	Temperature °C	Resistance Ω
−40	2520130	±0	210588	40	30751
−39	2347774	1	199514	41	29470
−38	2188335	2	189086	42	28250
−37	2040754	3	179263	43	27086
−36	1904105	4	170007	44	25977
−35	1777482	5	161282	45	24918
−34	1660097	6	153055	46	23909
−33	1551220	7	145295	47	22946
−32	1450182	8	137972	48	22026
−31	1356371	9	131060	49	21148
−30	1269226	10	124534	50	20310
−29	1188233	11	118369	51	19510
−28	1112921	12	112545	52	18745
−27	1042858	13	107040	53	18014
−26	977645	14	101835	54	17316
−25	916920	15	96912	55	16648
−24	860345	16	92255	56	16010
−23	807614	17	87848	57	15399
−22	758442	18	83675	58	14815
−21	712567	19	79725	59	14256
−20	669751	20	75982	60	13721
−19	629770	21	72436	61	13208
−18	592421	22	69075	62	12718
−17	557515	23	65889	63	12248
−16	524879	24	62857	64	11798
−15	494351	25	60000	65	11367
−14	465784	26	57280	66	10954
−13	439040	27	54698	67	10558
−12	413993	28	52246	68	10179
−11	390524	29	49917	69	9815
−10	368527	30	47705	70	9466
− 9	347900	31	45603	71	9131
− 8	328550	32	43606	72	8809
− 7	310391	33	41706	73	8501
− 6	293344	34	39899	74	8205
− 5	277333	35	38181	75	7921
− 4	262290	36	36545	76	7548
− 3	248151	37	34989	77	7386
− 2	234858	38	33507	78	7134
− 1	222354	39	32095	79	6892

Resistance-temperature characteristic
(cont'd)

M 867/S1/60 kΩ
R_{25} = 60 kΩ

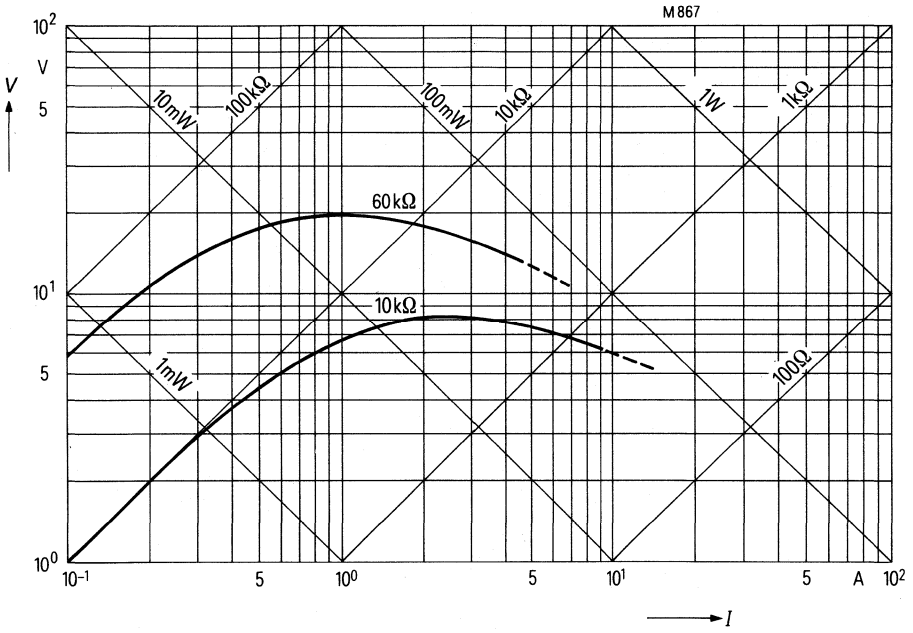
Temperature °C	Resistance Ω	Temperature °C	Resistance Ω	Temperature °C	Resistance Ω
80	6659	95	4066	110	2578
81	6436	96	3940	111	2504
82	6221	97	3819	112	2433
83	6015	98	3701	113	2364
84	5816	99	3588	114	2297
85	5625	100	3479	115	2233
86	5441	101	3374	116	2170
87	5264	102	3273	117	2110
88	5094	103	3175	118	2051
89	4930	104	3080	119	1995
90	4772	105	2989	120	1940
91	4620	106	2901	121	1888
92	4474	107	2816	122	1836
93	4333	108	2734	123	1787
94	4197	109	2655	124	1739

Stability of the electrical values

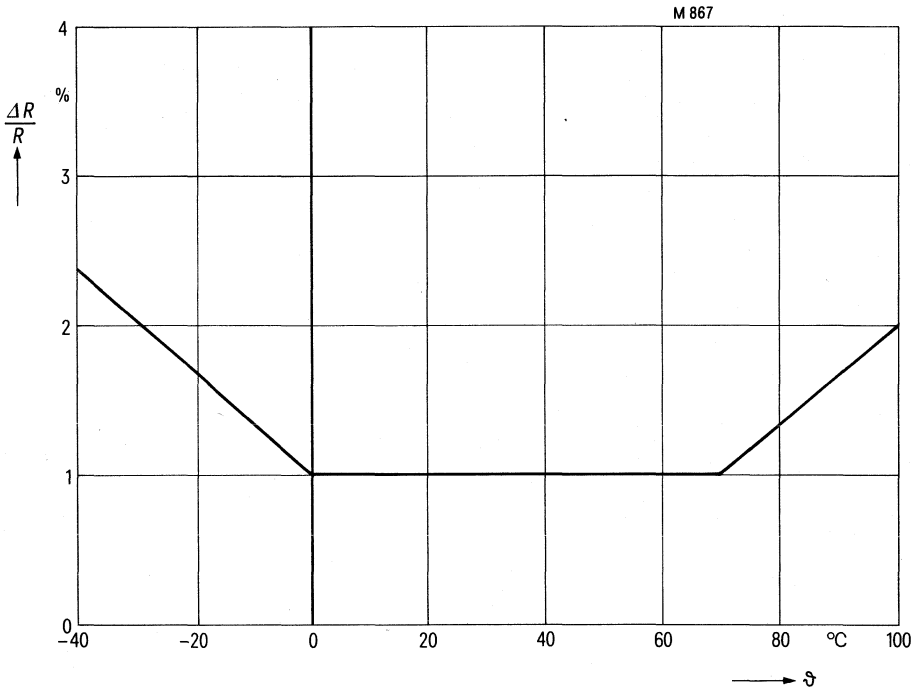
The maximum resistance change after 10000 operating hours in the temperature range between −40°C and +100°C (125°C <100 hours) is $\Delta R_{10.} < 1\%$.

Should the NTC thermistor M867/S1/60kΩ be only operated in the temperature range between 0°C and 80°C, then the requirements of DIN standard 13402 (draft) for clinical thermometer sensors are fulfilled.

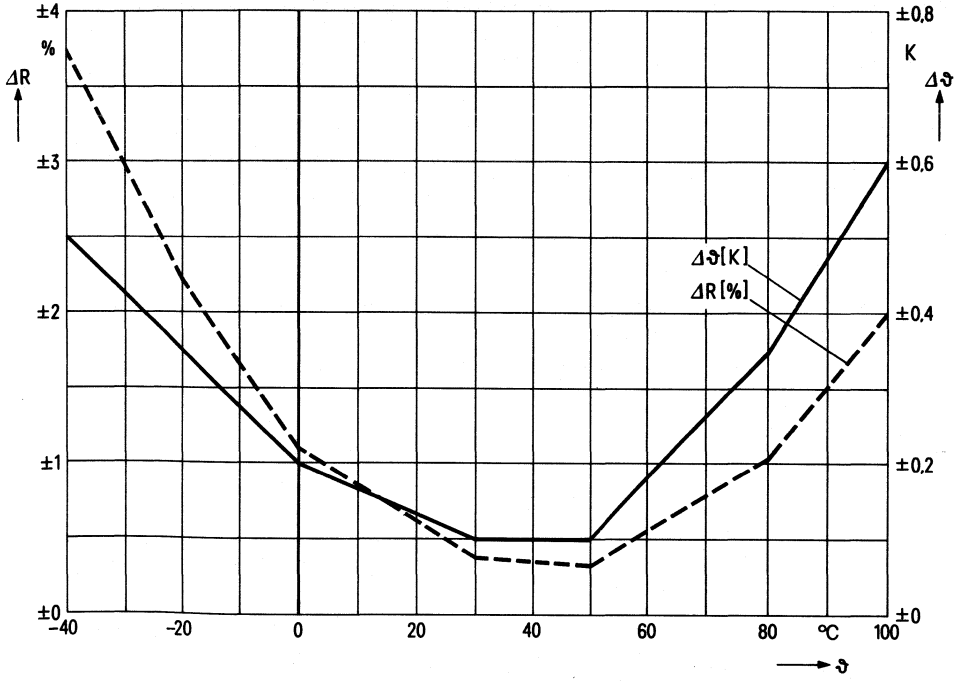
Voltage-current characteristics $V = f(I)$



Tolerance of the resistance values
M 867/1%/10 kΩ

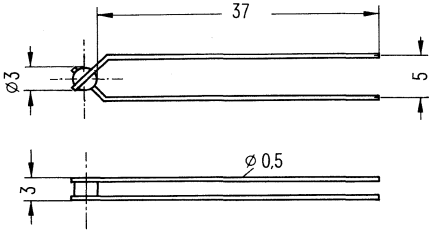


Permissible deviation of the resistance values
M 867/S1/60 kΩ



NTC thermistors with 10 kΩ and 40 kΩ

Application	Measuring and compensation tasks with low electrical load
Version	NTC thermistor disc, unpainted
Terminals	Leads, tinned (material with bad thermal conductivity)
Marking	None



Weight: approx. 0.2 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**FKF**
Lower category temperature	**F** − 55°C
Upper category temperature	**K** +125°C
Humidity category	**F** Average relative humidity ≤ 75% 85% continuously on 30 days per year 75% occasionally on the remaining days No dew precipitation is permissible

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

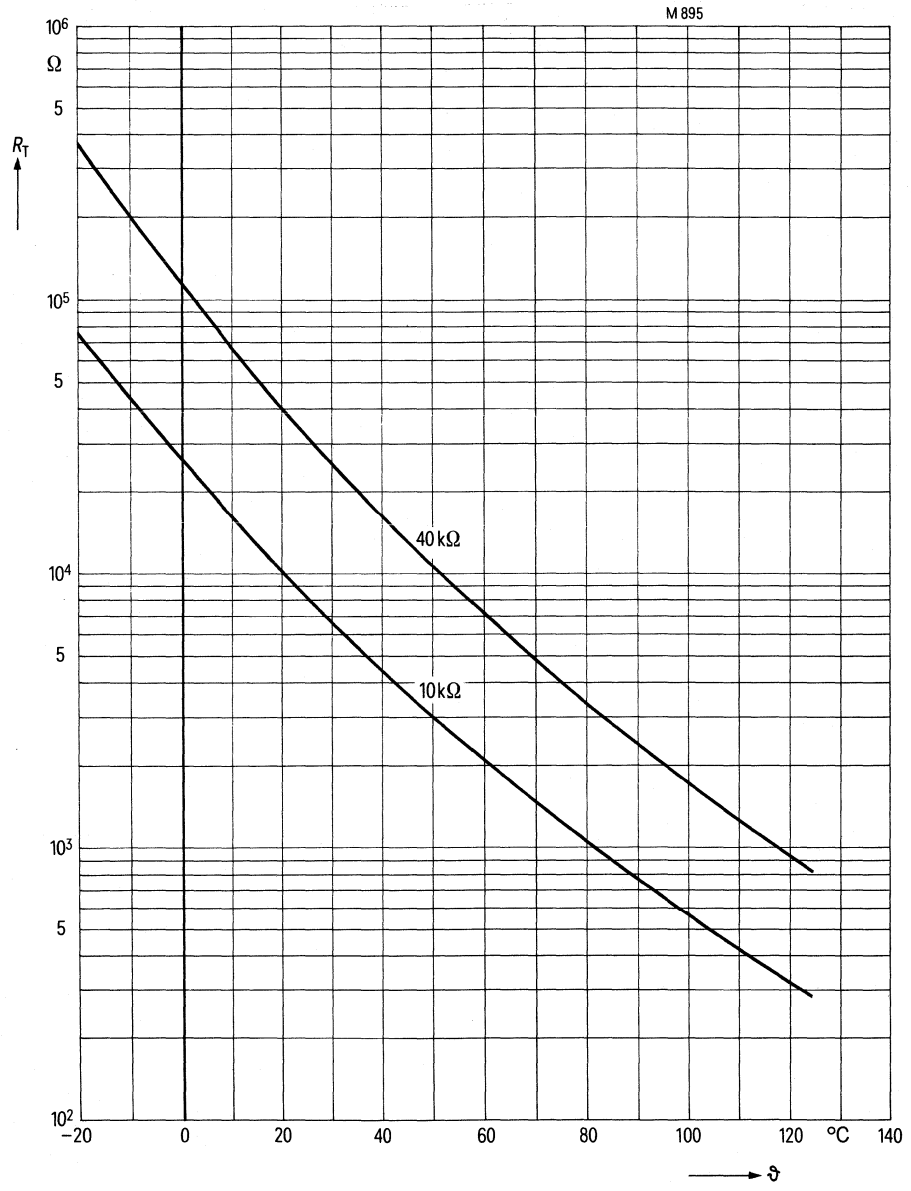
Type	Rated resistance	Tolerance	*B* value	Ordering code
M 895/20%/10 kΩ	10 kΩ	±20%	3950 K	Q63089−M5103−M
M 895/20%/40 kΩ	40 kΩ	±20%	4300 K	Q63089−M5403−M

Characteristic data

Type	M 895	20%/10 kΩ	20%/40 kΩ	Unit
Power rating at 25°C	P_{25}	350	350	mW
at 60°C	P_{60}	225	225	mW
Rated temperature	ϑ_R	20	20	°C
Rated resistance	R_R	10	40	kΩ
Tolerance[1)]	ΔR_R	±20	±20	%
B value	B	3950	4300	K
Tolerance[1)]	ΔB	±5	±5	%
Thermal conductance in air	G_{thA}	>3.5	>3.5	mW/K
Thermal time constant	τ_{th}	12	12	s
Thermal capacitance	C_{th}	approx. 40	approx. 40	mJ/K

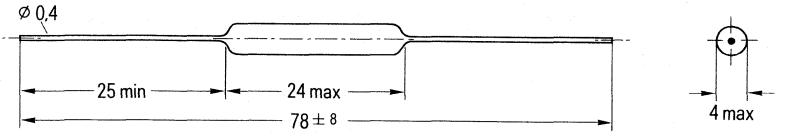
[1)] AQL = 0.65%

NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



NTC thermistors with 10 kΩ and 40 kΩ

Application	Stabilization of voltages and amplitudes, e.g. of amplifier circuits
Version	Glass case, hermetically sealed
Terminals	Leads, tinned
Marking	Type designation is stamped on the component
Quality characteristic	High reliability due to special production and aging methods



Weight: approx. 0.6 g
Dimensions in mm

Climatic category in accordance with DIN 40040	**FKE**
Lower category temperature	**F** − 55°C
Upper category temperature	**K** +125°C
Humidity category	**E** Average relative humidity ≤ 75% 95% continuously on 30 days per year 85% occasionally on the remaining days Seldom and slight dew precipitation is permissible

Storage temperatures

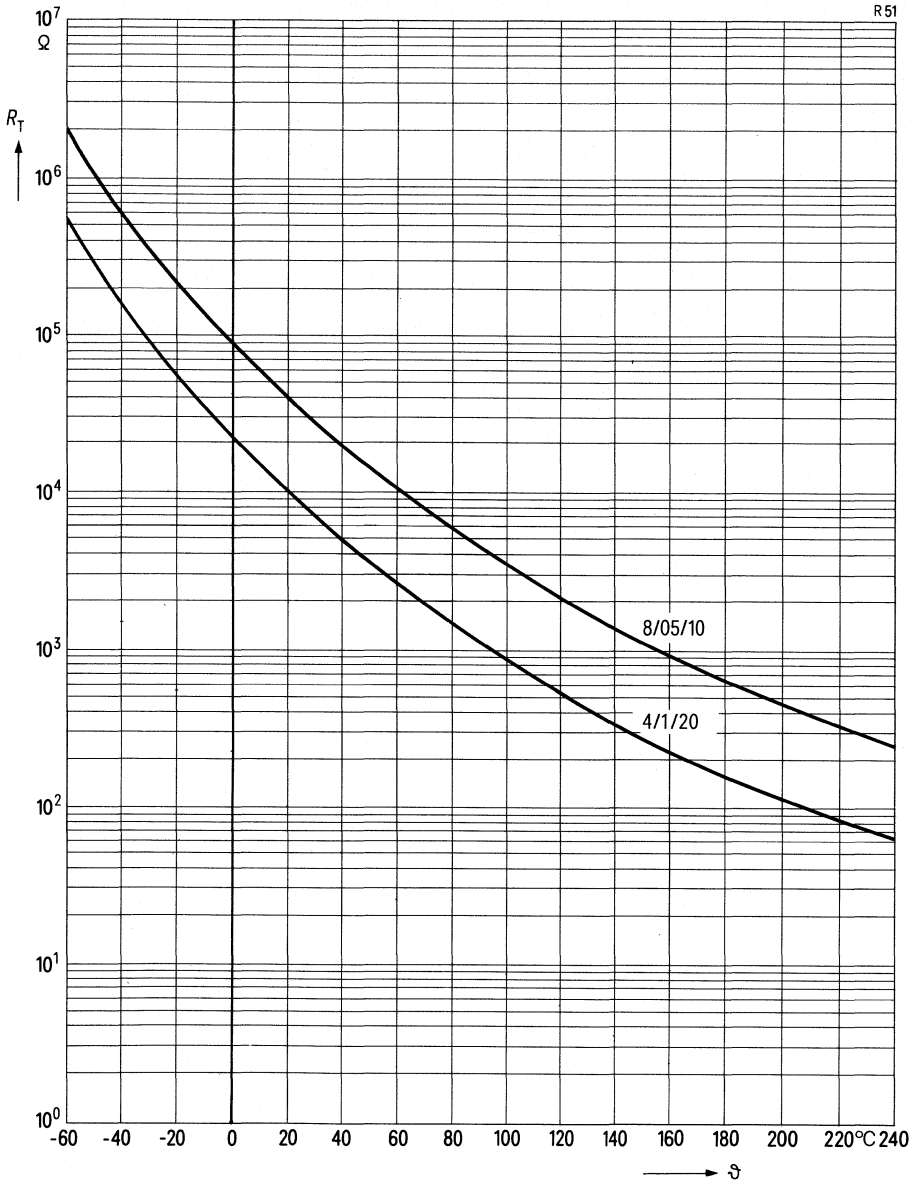
Minimum storage temperature	$\vartheta_{stg\ min}$ −25°C
Maximum storage temperature	$\vartheta_{stg\ max}$ +65°C

Type	Rated resistance	Tolerance	*B* value	Ordering code
R 51–4/1/20/20%	10 kΩ	±20%	3350 K	Q63051–R5
R 51–4/1/20/10%	10 kΩ	±10%	3350 K	Q63051–R6
R 51–4/1/20/ 5%	10 kΩ	± 5%	3350 K	Q63051–R7
R 51–8/0.5/10/20%	40 kΩ	±20%	3350 K	Q63051–R1
R 51–8/0.5/10/10%	40 kΩ	±10%	3350 K	Q63051–R2
R 51–8/0.5/10/ 5%	40 kΩ	± 5%	3350 K	Q63051–R3

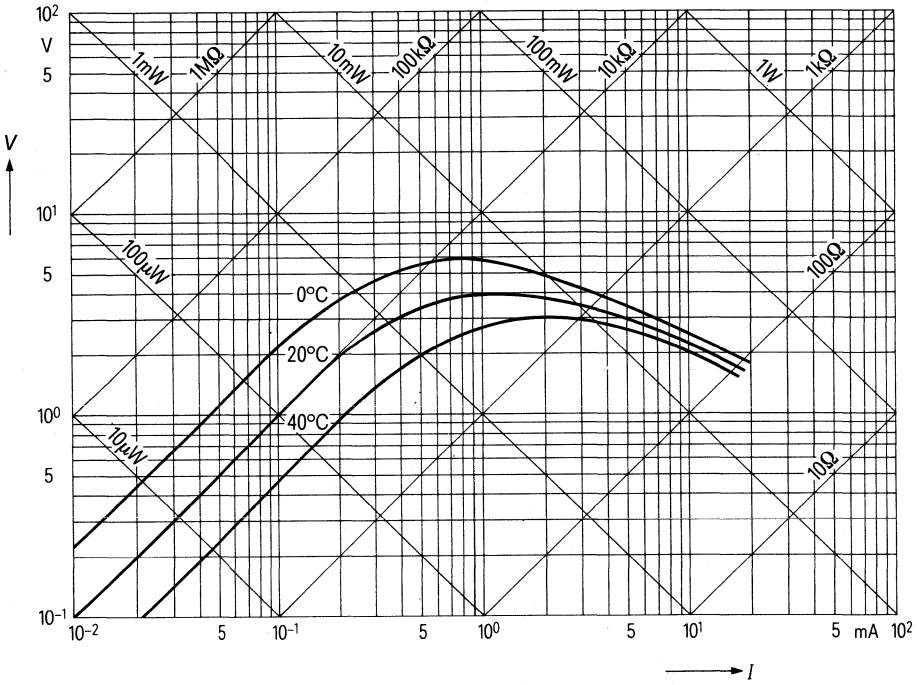
Characteristic data

Type	R 51	4/1 20/20%	4/1 20/10%	4/1 20/5%	8/0.5 10/20%	8/0.5 10/10%	8/0.5 10/5%	Unit
Power rating at 25°C	P_{25}	40	40	40	40	40	40	mW
Rated temperature	ϑ_R	20	20	20	20	30	20	°C
Rated resistance	R_R	10	10	10	40	40	40	kΩ
B value	B	3350	3350	3350	3350	3350	3350	K
Thermal conductance in air	G_{thA}	0.2	0.2	0.2	0.2	0.2	0.2	mW/K
Thermal time constant	τ_{th}	approx. 0.6	approx. 0.6	approx. 0.6	approx. 0.6	approx. 0.6	approx. 0.6	s
Rated current	I_R	20	20	20	10	10	10	mA
Maximum voltage	V_1	4	4	4	8	8	8	V
Current at maximum voltage V_1	I_1	1	1	1	0,5	0.5	0.5	mA
Min. permissible hot resistance	R_{min}	90	90	90	350	350	350	Ω
Series resistance	R_S	110	110	110	500	500	500	Ω
Measuring current	I_{meas}	1.5	1.5	1.5	0.6	0.6	0.6	mA
NTC voltage at I_{meas}	V_R	4	4	4	8	8	8	V
V_R tolerance	ΔV_R	±20	±10	±5	±20	±10	±5	%
Parallel capacitance	C_p	1.5	1.5	1.5	1.5	1.5	1.5	pf
Distortion factor at 3 kHz	$k_{3\,kHz}$	0.1	0.1	0.1	0.1	0.1	0.1	%
at 30 Hz	$k_{30\,Hz}$	0.8	0.8	0.8	0.8	0.8	0.8	%

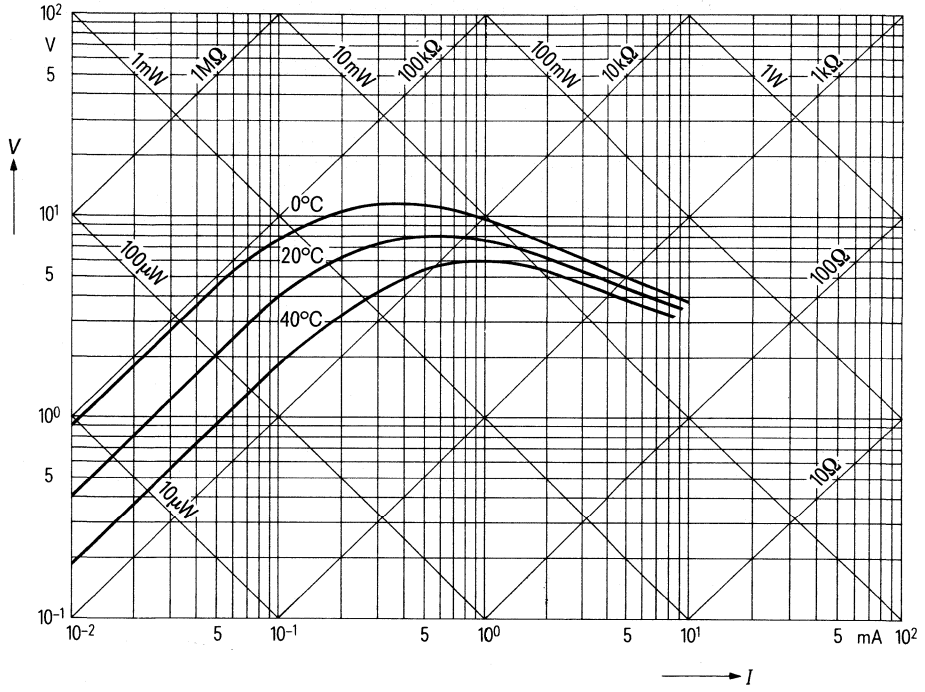
NTC thermistor resistance $R_T = f(\vartheta)$
versus NTC thermistor temperature



Voltage-current characteristics $V = f(I)$
R 51–4/1/20



Voltage-current characteristics $V = f(I)$
R 51–8/0.5/10

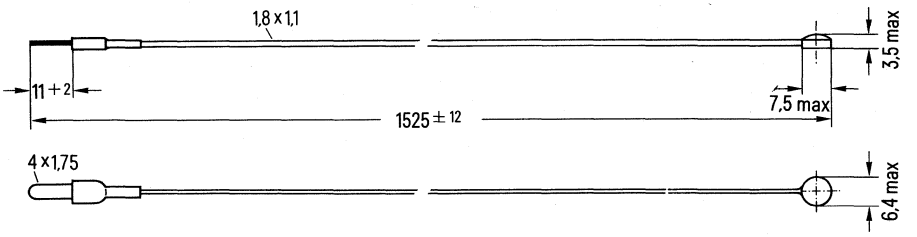


General Information

In the Federal Republic of Germany and in West Berlin, clinical thermometers and clinical thermometer sensors are subject to special calibration requirements settled in the Calibration Law. That is the reason for two different versions of temperature sensor being listed in this data book. The calibrated versions are particularly intended for applications within Germany.

Temperature Sensors for Clinical Thermometers

Application Medical temperature measurement of skin surface
Version Metal case, NTC thermistor electrically insulated



Weight: approx. 3.2 g
Dimensions in mm

Storage temperatures

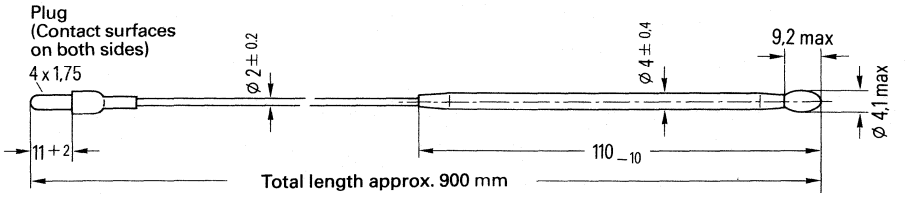
Minimum storage temperature	$\vartheta_{stg\ min}$	0°C
Maximum storage temperature	$\vartheta_{stg\ max}$	+65°C

Characteristic data

Power rating	P_{meas}	0.15 mW
Rated temperature	ϑ_R	25 °C
Rated resistance	R_R	5000 Ω
Series of basic resistance values (see page 208)	R_{ba}	The series of basic resistance values is calculated according to the following empirical equation: $R(\vartheta) = 5000 \times \exp[B(\vartheta)(\frac{1}{T}-\frac{1}{T_o})]$ $B(\vartheta) = 3981\ (0.9683 + 4.83 \times 10^{-4}\vartheta - 1.66 \times 10^{-6}\vartheta^2)$ $T_o = 298.15$ K
Permissible deviation	ΔR_{ba}	±0.1 K in the range between 30°C and 50°C ±0.2 K in the range between 0°C and 30°C
B value	B	3981 K
Thermal conductance		
in air	G_{thA}	3 mW/K
in water	G_{thW}	20 mW/K
Thermal time constant		
in air	τ_{thA}	35 s
in water	τ_{thW}	2.5 s
Insulation resistance	R_{is}	100 MΩ
Test voltage	V_{test}	250 V
Test duration	t_t	1 s

Type	Description	Ordering code
M 846/S2/5 kΩ calibrated	Skin probe HF1	Q63084–M6502–X2

Application Medical temperature measurement of skin surface
Version Metal case, NTC thermistor electrically insulated



Weight: approx. 4.8 g
Dimensions in mm

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$	0°C
Maximum storage temperature	$\vartheta_{stg\ max}$	+65°C

Characteristic data

Power rating	P_{meas}	0.15 mW
Rated temperature	ϑ_R	25 °C
Rated resistance	R_R	5000 Ω
Series of basic resistance values (see page 208)	R_{ba}	The series of basic resistance values is calculated according to the following empirical equation: $R(\vartheta) = 5000 \times \exp[B(\vartheta)(\frac{1}{T}-\frac{1}{T_o})]$ $B(\vartheta) = 3981\ (0.9683 + 4.83 \times 10^{-4}\vartheta - 1.66 \times 10^{-6}\vartheta^2)$ $T_o = 298.15$ K
Permissible deviation	ΔR_{ba}	±0.1 K in the range between 30°C and 50°C ±0.2 K in the range between 0°C and 30°C
B value	B	3981 K
Thermal conductance		
in air	G_{thA}	3 mW/K
in water	G_{thW}	20 mW/K
Thermal time constant		
in air	τ_{thA}	35 s
in water	τ_{thW}	2.5 s
Insulation resistance	R_{is}	100 MΩ
Test voltage	V_{test}	250 V
Test duration	t_t	1 s

Type	Description	Ordering code
M 847/S1/5 kΩ calibrated	Standard probe SF1	Q63084–M7502–X102

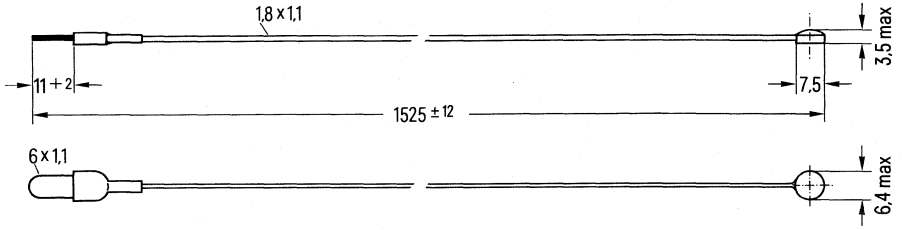
Series of basic resistance values

Temperature °C	Resistance Ω	Ω	Ω	Ω	Ω
0.0	16326.2	16243.0	16160.3	16078.1	15996.4
1.0	15515.7	15437.2	15359.1	15281.5	15204.3
2.0	14750.2	14676.1	14602.3	14528.9	14456.0
3.0	14027.0	13956.9	13887.1	13817.8	13748.9
4.0	13343.3	13277.1	13211.2	13145.6	13080.5
5.0	12697.0	12634.3	12572.0	12510.0	12448.4
6.0	12085.6	12026.4	11967.4	11908.8	11850.5
7.0	11507.3	11451.2	11395.4	11339.9	11284.7
8.0	10959.9	10996.8	10853.9	10801.4	10749.2
9.0	10441.6	10391.4	10341.3	10291.6	10242.1
10.0	9950.9	9903.2	9855.9	9808.8	9761.9
11.0	9488.0	9440.8	9395.9	9351.3	9306.9
12.0	9045.4	9002.6	8960.1	8917.8	8875.7
13.0	8627.8	8567.3	8546.9	8506.8	8466.9
14.0	8231.8	8193.4	8155.1	8117.1	8079.2
15.0	7856.3	7819.8	7783.5	7747.4	7711.5
16.0	7500.0	7465.4	7430.9	7396.7	7362.6
17.0	7161.8	7129.0	7096.3	7063.8	7031.4
18.0	6840.8	6809.6	6778.6	6747.7	6717.0
19.0	6530.0	6506.3	6476.9	6447.5	6418.4
20.0	6246.4	6218.3	6190.3	6162.4	6134.7
21.0	5971.3	5944.5	5917.9	5891.4	5865.1
22.0	5709.8	5684.4	5659.1	5633.9	5608.9
23.0	5461.2	5437.1	5413.0	5389.1	5365.3
24.0	5224.8	5201.9	5179.0	5156.2	5133.6
25.0	5000.0	4978.1	4956.4	4934.7	4913.1
26.0	4780.1	4765.2	4744.5	4723.9	4703.4
27.0	4582.5	4562.6	4542.9	4523.3	4503.8
28.0	4388.6	4369.8	4351.0	4332.3	4313.7
29.0	4204.0	4186.1	4168.2	4150.4	4132.7
30.0	4028.2	4011.1	3994.1	3977.1	3960.3
31.0	3860.7	3844.4	3828.2	3812.1	3796.0
32.0	3701.1	3685.6	3670.1	3654.7	3639.4
33.0	3549.0	3534.2	3519.4	3504.7	3490.1
34.0	3403.9	3389.8	3375.7	3361.7	3347.8
35.0	3265.5	3252.1	3238.6	3225.3	3212.0
36.0	3133.5	3120.7	3107.9	3095.1	3082.5
37.0	3007.6	2995.3	2983.1	2970.9	2958.8
38.0	2887.4	2875.7	2864.0	2852.4	2840.8
39.0	2772.6	2761.4	2750.3	2739.2	2728.2
40.0	2663.1	2652.4	2641.7	2631.1	2620.6
41.0	2555.4	2543.2	2538.0	2527.9	2517.8
42.0	2458.4	2448.6	2438.9	2429.3	2419.7
43.0	2362.8	2353.5	2344.2	2335.0	2325.8
44.0	2271.5	2262.6	2253.7	2244.9	2236.1
45.0	2184.2	2175.7	2167.2	2158.8	2150.4
46.0	2100.7	2092.6	2084.4	2076.4	2068.3
47.0	2020.8	2013.1	2005.3	1997.6	1989.9
48.0	1944.4	1937.0	1929.6	1922.2	1914.8
49.0	1871.3	1864.2	1857.1	1850.0	1843.0

Temperature	0.0°C	0.1°C	0.2°C	0.3°C	0.4°C

Resistance Ω	Ω	Ω	Ω	Ω	Ω	Temperature °C
15915.1	15834.3	15754.0	15674.1	15594.7	15515.7	0.0
15127.5	15051.2	14975.3	14899.9	14824.8	14750.2	1.0
14383.5	14311.4	14239.7	14168.4	14097.5	14027.0	2.0
13680.4	13612.2	13544.4	13477.0	13410.0	13343.3	3.0
13015.6	12951.2	12887.1	12823.4	12760.0	12697.0	4.0
12387.1	12326.1	12265.5	12205.2	12145.3	12085.6	5.0
11792.5	11734.6	11677.4	11620.4	11563.7	11507.3	6.0
11229.8	11175.2	11120.9	11067.0	11013.3	10959.9	7.0
10697.2	10645.5	10594.2	10543.0	10492.2	10441.6	8.0
10192.9	10144.0	10095.3	10046.9	9998.8	9950.9	9.0
9715.3	9668.9	9622.8	9576.9	9531.3	9486.0	10.0
9262.7	9218.8	9175.1	9131.6	9088.4	9045.4	11.0
8833.8	8792.2	8750.8	8709.6	8668.6	8627.8	12.0
8427.2	8387.7	8348.4	8309.4	8270.5	8231.8	13.0
8041.6	8004.1	7966.9	7929.8	7893.0	7856.3	14.0
7675.8	7640.3	7604.9	7569.8	7534.8	7500.0	15.0
7328.7	7295.0	7261.4	7228.0	7194.8	7161.8	16.0
6999.2	6967.2	6935.4	6903.7	6872.2	6840.8	17.0
6686.4	6656.0	6625.8	6595.7	6565.7	6536.0	18.0
6389.3	6360.5	6331.7	6303.1	6274.7	6246.4	19.0
6107.1	6079.7	6052.4	6025.2	5998.2	5971.3	20.0
5838.9	5812.8	5786.9	5761.1	5735.4	5709.8	21.0
5584.0	5559.2	5534.5	5510.0	5485.5	5461.2	22.0
5341.6	5318.0	5294.5	5271.2	5248.0	5224.8	23.0
5111.0	5088.6	5066.3	5044.1	5022.0	5000.0	24.0
4891.7	4870.4	4849.1	4828.0	4807.0	4786.1	25.0
4683.0	4662.7	4642.5	4622.4	4602.4	4582.5	26.0
4484.3	4465.0	4445.8	4426.6	4407.6	4389.6	27.0
4295.2	4276.8	4258.5	4240.2	4222.1	4204.0	28.0
4115.1	4097.5	4080.1	4062.7	4045.4	4028.2	29.0
3943.5	3926.8	3910.2	3893.6	3877.1	3860.7	30.0
3780.0	3764.1	3748.2	3732.4	3716.7	3701.1	31.0
3624.1	3609.0	3593.9	3578.8	3563.9	3549.0	32.0
3475.6	3461.1	3446.7	3432.4	3418.1	3403.9	33.0
3333.9	3320.1	3306.4	3292.7	3279.1	3265.5	34.0
3198.8	3185.6	3172.5	3159.4	3146.5	3133.5	35.0
3069.8	3057.3	3044.8	3032.3	3019.9	3007.6	36.0
2946.8	2934.8	2922.9	2911.0	2899.2	2887.4	37.0
2829.3	2817.9	2806.5	2795.2	2783.9	2772.6	38.0
2717.2	2706.3	2695.4	2684.6	2673.8	2663.1	39.0
2610.1	2599.7	2589.3	2578.9	2568.6	2558.4	40.0
2507.8	2497.8	2487.9	2478.0	2468.2	2458.4	41.0
2410.1	2400.5	2391.1	2381.6	2372.2	2362.8	42.0
2316.7	2307.6	2298.5	2289.5	2280.5	2271.5	43.0
2227.4	2218.7	2210.0	2201.4	2192.8	2184.2	44.0
2142.0	2133.7	2125.4	2117.1	2108.9	2100.7	45.0
2060.3	2052.4	2044.4	2036.5	2028.7	2020.8	46.0
1982.2	1974.6	1967.0	1959.5	1951.9	1944.4	47.0
1907.5	1900.2	1892.9	1885.7	1878.5	1871.3	48.0
1836.0	1829.0	1822.0	1815.1	1808.2	1801.4	49.0
0.5°C	0.6°C	0.7°C	0.8°C	0.9°C	1.0°C	Temperature

Application Medical temperature measurement of skin surface
Version Metal case, NTC thermistor electrically insulated



Weight: approx. 3.5 g
Dimensions in mm

Storage temperatures

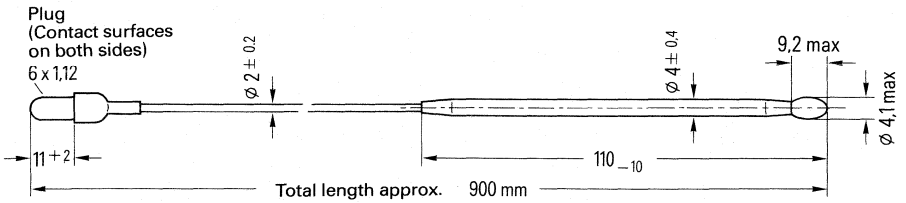
Minimum storage temperature	$\vartheta_{stg\ min}$	0°C
Maximum storage temperature	$\vartheta_{stg\ max}$	+80°C

Characteristic data

Power rating	P_{meas}	0.15 mW
Rated temperature	ϑ_R	25 °C
Rated resistance	R_R	5000 Ω
Series of basic resistance values (see page 212)	R_{ba}	The series of basic resistance values is calculated according to the following empirical equation: $R(\vartheta) = 4951.8 \times \exp[B(\vartheta)(\frac{1}{T}-\frac{1}{T_o})]$ $B(\vartheta) = 3920\,(0.9683 + 4.83 \times 10^{-4}\vartheta - 1.66 \times 10^{-6}\vartheta^2)$ $T_o = 298.15$ K
Permissible deviation	ΔR_{ba}	±0.1 K in the range between 30°C and 50°C ±0.2 K in the range between 0°C and 30°C
B value	B	3920 K
Thermal conductance		
in air	G_{thA}	3 mW/K
in water	G_{thW}	20 mW/K
Thermal time constant		
in air	τ_{thA}	35 s
in water	τ_{thW}	2.5 s
Insulation resistance	R_{is}	100 MΩ
Test voltage	V_{test}	250 V
Test duration	t_t	1 s

Type	Description	Ordering code
M 846/S3/5 kΩ calibrated	Skin probe HF2	Q63084–M6502–X3

Application Medical temperature measurement of skin surface
Version Metal case, NTC thermistor electrically insulated



Weight: approx. 4.8 g
Dimensions in mm

Storage temperatures

Minimum storage temperature	$\vartheta_{stg\ min}$	0°C
Maximum storage temperature	$\vartheta_{stg\ max}$	+80°C

Characteristic data

Power rating	P_{meas}	0.15 mW
Rated temperature	ϑ_R	25 °C
Rated resistance	R_R	5000 Ω
Series of basic resistance values (see page 212)	R_{ba}	The series of basic resistance values is calculated according to the following empirical equation: $R(\vartheta) = 4951.8 \times \exp[B(\vartheta)(\frac{1}{T}-\frac{1}{T_o})]$ $B(\vartheta) = 3920\ (0.9683 + 4.83 \times 10^{-4}\vartheta - 1.66 \times 10^{-6}\vartheta^2)$ $T_o = 298.15$ K
Permissible deviation	ΔR_{ba}	±0.1 K in the range between 30°C and 50°C ±0.2 K in the range between 0°C and 30°C
B value	B	3920 K
Thermal conductance		
in air	G_{thA}	3 mW/K
in water	G_{thW}	20 mW/K
Thermal time constant		
in air	τ_{thA}	35 s
in water	τ_{thW}	2.5 s
Insulation resistance	R_{is}	100 MΩ
Test voltage	V_{test}	250 V
Test duration	t_t	1 s

Type	Description	Ordering code
M 847/S3/5 kΩ calibrated	Standard probe SF2	Q63084-M7502-X3

Series of basic resistance values

Temperature °C	Resistance Ω	Ω	Ω	Ω	Ω
0.0	15878.2	15798.6	15719.4	15640.7	15562.4
1.0	15101.8	15026.2	14951.7	14877.3	14803.3
2.0	14367.9	14296.7	14226.0	14155.6	14085.6
3.0	13673.9	13606.6	13539.7	13473.1	13406.9
4.0	13017.4	12953.8	12890.5	12827.5	12764.9
5.0	12396.3	12336.0	12276.1	12216.5	12157.2
6.0	11808.4	11751.3	11694.6	11638.2	11582.1
7.0	11251.7	11197.7	11144.0	11090.5	11037.4
8.0	10724.5	10673.3	10622.4	10571.8	10521.4
9.0	10225.0	10176.5	10128.2	10080.3	10032.6
10.0	9751.6	9705.6	9659.9	9614.4	9569.2
11.0	9302.8	9259.2	9215.9	9172.7	9129.8
12.0	8877.2	8835.9	8794.8	8753.9	8713.2
13.0	8473.5	8434.3	8395.3	8356.5	8317.9
14.0	8090.5	8053.2	8016.2	7979.4	7942.7
15.0	7726.9	7691.5	7656.4	7621.4	7586.6
16.0	7381.7	7348.1	7314.7	7281.5	7248.5
17.0	7053.8	7022.0	6990.3	6958.7	6927.3
18.0	6742.4	6712.1	6682.0	6652.0	6622.2
19.0	6446.4	6417.7	6389.0	6360.5	6332.2
20.0	6165.1	6137.8	6110.6	6083.5	6056.5
21.0	5897.7	5871.6	5845.8	5820.0	5794.4
22.0	5643.3	5618.5	5593.9	5569.4	5545.0
23.0	5401.3	5377.7	5354.3	5331.0	5307.8
24.0	5171.0	5148.6	5126.3	5104.1	5082.0
25.0	4951.8	4930.5	4909.2	4888.1	4867.1
26.0	4743.1	4722.8	4702.6	4682.5	4662.4
27.0	4544.3	4525.0	4505.7	4486.6	4467.5
28.0	4355.0	4336.6	4318.2	4300.0	4281.8
29.0	4174.6	4157.0	4139.5	4122.1	4104.8
30.0	4002.6	3985.9	3969.2	3952.6	3936.1
31.0	3838.7	3822.7	3806.8	3791.0	3775.3
32.0	3682.4	3667.2	3652.0	3636.9	3621.9
33.0	3533.3	3518.7	3504.3	3489.9	3475.6
34.0	3391.0	3377.1	3363.3	3349.6	3335.9
35.0	3255.2	3242.0	3228.8	3215.7	3202.7
36.0	3125.6	3113.0	3100.4	3087.9	3075.5
37.0	3001.9	2909.8	2977.8	2965.9	2954.0
38.0	2883.7	2872.2	2860.7	2849.3	2837.9
39.0	2770.8	2759.8	2748.9	2738.0	2727.1
40.0	2663.0	2652.4	2642.0	2631.5	2621.2
41.0	2559.9	2549.8	2539.8	2529.8	2519.9
42.0	2461.3	2451.7	2442.1	2432.6	2423.1
43.0	2367.1	2357.9	2348.8	2339.6	2330.6
44.0	2277.0	2268.2	2259.4	2250.7	2242.0
45.0	2190.8	2182.4	2174.0	2165.6	2157.3
46.0	2108.3	2100.2	2092.2	2084.2	2076.3
47.0	2029.3	2021.6	2014.0	2006.3	1998.7
48.0	1953.8	1946.4	1939.0	1931.7	1924.5
49.0	1881.4	1874.3	1867.3	1860.3	1853.3
Temperature	0.0°C	0.1°C	0.2°C	0.3°C	0.4°C

Resistance Ω	Ω	Ω	Ω	Ω	Ω	Temperature °C
15484.6	15407.1	15330.2	15253.6	15177.5	15101.8	0.0
14729.7	14656.5	14583.8	14511.4	14439.5	14367.9	1.0
14016.1	13946.9	13878.1	13809.6	13741.6	13673.9	2.0
13341.1	13275.7	13210.6	13145.8	13081.5	13017.4	3.0
12702.6	12640.7	12579.1	12517.8	12456.9	12396.3	4.0
12098.3	12039.7	11981.4	11923.4	11865.7	11808.4	5.0
11526.2	11470.7	11415.5	11360.6	11306.0	11251.7	6.0
10984.5	10931.9	10879.7	10827.6	10775.9	10724.5	7.0
10471.4	10421.5	10372.0	10322.7	10273.7	10225.0	8.0
9985.1	9937.9	9890.9	9844.2	9797.8	9751.6	9.0
9524.2	9479.4	9434.9	9390.6	9346.6	9302.8	10.0
9087.2	9044.7	9002.5	8960.5	8918.8	8877.2	11.0
8672.7	8632.4	8592.4	8552.6	8512.9	8473.5	12.0
8279.5	8241.3	8203.3	8165.5	8127.9	8090.5	13.0
7906.3	7870.0	7834.0	7798.1	7762.4	7726.9	14.0
7552.0	7517.6	7483.4	7449.3	7415.4	7381.7	15.0
7215.6	7182.9	7150.4	7118.1	7085.9	7053.8	16.0
6896.1	6865.1	6834.2	6803.4	6772.8	6742.4	17.0
6592.5	6563.0	6533.7	6504.4	6475.4	6446.4	18.0
6304.0	6275.9	6248.0	6220.3	6192.6	6165.1	19.0
6029.7	6003.0	5976.5	5950.1	5923.8	5897.7	20.0
5768.9	5743.5	5718.3	5693.1	5668.1	5643.3	21.0
5520.8	5496.6	5472.6	5448.7	5424.9	5401.3	22.0
5284.7	5261.7	5238.9	5216.1	5193.5	5171.0	23.0
5060.0	5038.2	5016.4	4994.8	4973.2	4951.8	24.0
4846.2	4825.4	4804.6	4784.0	4763.5	4743.1	25.0
4642.5	4622.7	4603.0	4583.3	4563.8	4544.3	26.0
4448.5	4429.6	4410.9	4392.1	4373.5	4355.0	27.0
4263.7	4245.7	4227.8	4210.0	4192.3	4174.6	28.0
4087.6	4070.4	4053.4	4036.4	4019.5	4002.6	29.0
3919.7	3903.3	3887.1	3870.9	3854.8	3838.7	30.0
3759.6	3744.0	3728.5	3713.1	3697.7	3682.4	31.0
3606.9	3592.1	3577.3	3562.5	3547.9	3533.3	32.0
3461.3	3447.1	3433.0	3418.9	3404.9	3391.0	33.0
3322.3	3308.8	3295.3	3281.9	3268.5	3255.2	34.0
3189.7	3176.8	3163.9	3151.1	3138.3	3125.6	35.0
3063.1	3050.7	3038.4	3026.2	3014.0	3001.9	36.0
2942.1	2930.3	2918.6	2906.9	2895.3	2883.7	37.0
2826.5	2815.4	2804.2	2793.0	2781.9	2770.8	38.0
2716.3	2705.5	2694.8	2684.1	2673.5	2663.0	39.0
2610.8	2600.6	2590.3	2580.1	2570.0	2559.9	40.0
2510.0	2500.2	2490.4	2480.7	2471.0	2461.3	41.0
2413.7	2404.3	2394.9	2385.6	2376.3	2367.1	42.0
2321.5	2312.5	2303.6	2294.7	2285.8	2277.0	43.0
2233.4	2224.8	2216.2	2207.7	2199.2	2190.8	44.0
2149.1	2140.8	2132.6	2124.5	2116.4	2108.3	45.0
2068.4	2060.5	2052.7	2044.9	2037.1	2029.3	46.0
1991.1	1983.6	1976.1	1968.6	1961.2	1953.8	47.0
1917.2	1910.0	1902.8	1895.6	1888.5	1881.4	48.0
1846.4	1839.5	1832.6	1825.7	1818.9	1812.1	49.0
0.5°C	0.6°C	0.7°C	0.8°C	0.9°C	1.0°C	Temperature

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