

# **NTC thermistors for temperature measurement**

Glass-encapsulated sensor for high temperatures

**Series/Type:** B57650H

**Date:** January 2018

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**Applications**

- Temperature measurement for high temperatures

**Features**

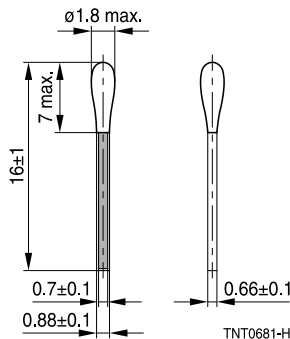
- Glass-encapsulated NTC thermistor, heat-resistant and highly stable
- For temperature measurement up to 650 °C, maximum 1000 h
- Rigid terminals, aluminum oxide rod with silver palladium termination pads on opposite sides
- Short response time
- High measurement accuracy

**Options**

- Alternative design options upon request.

**Delivery mode**

Blister packing

**Dimensional drawing**


Dimensions in mm

Approx. weight 50 mg

**General technical data**

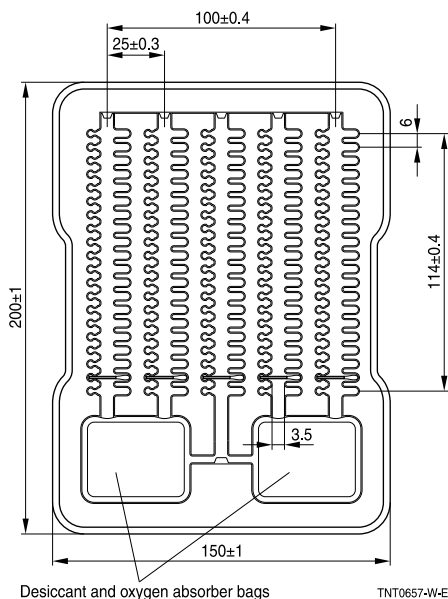
|                               |               |                  |             |      |
|-------------------------------|---------------|------------------|-------------|------|
| Climatic category             | (IEC 60068-1) |                  | 40/600/21   |      |
| Resistance tolerance          |               | $\Delta R_R/R_R$ | $\pm 2$     | %    |
| Rated temperature             |               | $T_R$            | 200         | °C   |
| Dissipation factor            | (in air)      | $\delta_{in}$    | approx. 1.5 | mW/K |
| Thermal cooling time constant | (in air)      | $\tau_c$         | approx. 10  | s    |
| Heat capacity                 |               | $C_{th}$         | approx. 15  | mJ/K |

**Electrical specification and ordering codes**

| $R_R$<br>Ω | $\Delta R_R/R_R$<br>% | $R_{25}$<br>Ω | No. of R/T<br>characteristic | $B_{25/200}$<br>K | Ordering code   |
|------------|-----------------------|---------------|------------------------------|-------------------|-----------------|
| 5000       | $\pm 2$               | 821970        | 6001                         | 4113 $\pm 1\%$    | B57650H0824A001 |

## Blister packing

Dimensions in mm



## Mounting instructions for type H650

The H650 type NTC thermistor is not designed for soldering. The contacting technology to be used shall be evaluated and tested based on the application. Options are clamp contacting, conductive adhesion, silver sintering or welding (e.g. thermo-compression welding based on standard DVS M 2921).

During contacting and handling of the NTC thermistor (e.g. welding), it must be ensured that mechanical stress or thermal shock do not damage the component. To avoid high thermal shocks, a preheating of the component is recommended. Insufficient preheating may cause ceramic cracks.

Ensure that no thermo-mechanical stress occurs due to production processes when thermistors are sealed, potted or overmolded or during their subsequent operation. Ensure that the materials used (sealing/potting compound) are chemically neutral.

Please also note the mounting instructions and cautions and warnings in this data book.

**Reliability data**

| Test                                | Standard                             | Test conditions   | $\Delta R_{100}/R_{100}$<br>(typical) | Remarks           |
|-------------------------------------|--------------------------------------|---|---------------------------------------|-------------------|
| High temperature exposure (storage) |                                      | Temperature of air : +600 °C<br>t: 1000 h   | < 2%                                  | No visible damage |
| Temperature exposure (storage)      |                                      | Temperature of air: +300 °C<br>t: 5000 h  | < 1%                                  | No visible damage |
| Biased humidity                     | MIL-STD-202, method 103              | Temperature of air: +85 °C<br>Relative humidity of air: 85%<br>Test voltage: 0.3 V DC on NTC<br>t: 1000 h   | < 2%                                  | No visible damage |
| Operational life                    | MIL-STD-202, method 108              | Temperature of air: +150 °C<br>Test voltage: 0.2 V DC on NTC<br>t: 1000 h   | < 2%                                  | No visible damage |
| Rapid temperature cycling           | JESD 22, method JA-104               | Lower test temperature: -40 °C<br>Upper test temperature: +200 °C<br>Dwell time at each temperature: 15 min<br>Transition time in air: max. 1 min<br>Number of cycles: 1000 | < 2%                                  | No visible damage |
| Rapid temperature cycling           |                                      | Lower test temperature: +105 °C<br>Upper test temperature: +500 °C<br>Dwell time at each temperature: 5 min<br>Transition time in air: max. 1 min<br>Number of cycles: 1000 | < 2%                                  | No visible damage |
| Mechanical shock                    | MIL-STD-202, method 213, condition C | Acceleration: 40 g<br>Pulse duration: 6 ms<br>Number of bumps in each direction: 3  | < 1%                                  | No visible damage |
| Vibration                           | MIL-STD-202, method 204              | Acceleration: 5 g<br>t: 20 min<br>Number of cycles in each of 3 orientations: 12<br>Frequency range: 10 ... 2000 Hz   | < 1%                                  | No visible damage |

**Note:**

The NTC sensor element is not specified for direct contact with aggressive media including water in any aggregate state (liquid, solid or gas). Direct contact with aggressive media may lead to a defect and malfunction of the NTC sensor element. Customer must take appropriate measures to avoid direct contact with aggressive media, e.g. by covering or housing the NTC sensor element.

**R/T characteristics**

| R/T No. <b>6001</b> |                                 |         |        |                                 |         |        |                                 |         |
|---------------------|---------------------------------|---------|--------|---------------------------------|---------|--------|---------------------------------|---------|
| T (°C)              | B <sub>25/200</sub> = 4113 K    |         | T (°C) | B <sub>25/200</sub> = 4113 K    |         | T (°C) | B <sub>25/200</sub> = 4113 K    |         |
|                     | R <sub>T</sub> /R <sub>25</sub> | α (%/K) |        | R <sub>T</sub> /R <sub>25</sub> | α (%/K) |        | R <sub>T</sub> /R <sub>25</sub> | α (%/K) |
| -40.0               | 22.449                          | 5.6     | 195.0  | 0.0067555                       | 2.1     | 430.0  | 0.00017663                      | 1.2     |
| -35.0               | 17.045                          | 5.4     | 200.0  | 0.0060829                       | 2.1     | 435.0  | 0.00016680                      | 1.1     |
| -30.0               | 13.029                          | 5.3     | 205.0  | 0.0054864                       | 2.0     | 440.0  | 0.00015762                      | 1.1     |
| -25.0               | 10.023                          | 5.2     | 210.0  | 0.0049564                       | 2.0     | 445.0  | 0.00014902                      | 1.1     |
| -20.0               | 7.7599                          | 5.1     | 215.0  | 0.0044846                       | 2.0     | 450.0  | 0.00014098                      | 1.1     |
| -15.0               | 6.0444                          | 4.9     | 220.0  | 0.0040640                       | 2.0     | 455.0  | 0.00013345                      | 1.1     |
| -10.0               | 4.7362                          | 4.8     | 225.0  | 0.0036883                       | 1.9     | 460.0  | 0.00012639                      | 1.1     |
| -5.0                | 3.7326                          | 4.7     | 230.0  | 0.0033522                       | 1.9     | 465.0  | 0.00011978                      | 1.1     |
| 0.0                 | 2.9581                          | 4.6     | 235.0  | 0.0030510                       | 1.9     | 470.0  | 0.00011357                      | 1.1     |
| 5.0                 | 2.3571                          | 4.5     | 240.0  | 0.0027808                       | 1.8     | 475.0  | 0.00010774                      | 1.0     |
| 10.0                | 1.8881                          | 4.4     | 245.0  | 0.0025379                       | 1.8     | 480.0  | 0.00010227                      | 1.0     |
| 15.0                | 1.5202                          | 4.3     | 250.0  | 0.0023193                       | 1.8     | 485.0  | 0.000097134                     | 1.0     |
| 20.0                | 1.2300                          | 4.2     | 255.0  | 0.0021223                       | 1.8     | 490.0  | 0.000092302                     | 1.0     |
| 25.0                | 1.0000                          | 4.1     | 260.0  | 0.0019444                       | 1.7     | 495.0  | 0.000087758                     | 1.0     |
| 30.0                | 0.81680                         | 4.0     | 265.0  | 0.0017836                       | 1.7     | 500.0  | 0.000083481                     | 1.0     |
| 35.0                | 0.67017                         | 3.9     | 270.0  | 0.0016381                       | 1.7     | 505.0  | 0.000079454                     | 1.0     |
| 40.0                | 0.55227                         | 3.8     | 275.0  | 0.0015062                       | 1.7     | 510.0  | 0.000075661                     | 1.0     |
| 45.0                | 0.45705                         | 3.7     | 280.0  | 0.0013866                       | 1.6     | 515.0  | 0.000072087                     | 1.0     |
| 50.0                | 0.37980                         | 3.7     | 285.0  | 0.0012778                       | 1.6     | 520.0  | 0.000068716                     | 1.0     |
| 55.0                | 0.31686                         | 3.6     | 290.0  | 0.0011789                       | 1.6     | 525.0  | 0.000065536                     | 0.9     |
| 60.0                | 0.26538                         | 3.5     | 295.0  | 0.0010888                       | 1.6     | 530.0  | 0.000062535                     | 0.9     |
| 65.0                | 0.22310                         | 3.4     | 300.0  | 0.0010058                       | 1.6     | 535.0  | 0.000059701                     | 0.9     |
| 70.0                | 0.18824                         | 3.4     | 305.0  | 0.00092995                      | 1.5     | 540.0  | 0.000057024                     | 0.9     |
| 75.0                | 0.15938                         | 3.3     | 310.0  | 0.00086088                      | 1.5     | 545.0  | 0.000054494                     | 0.9     |
| 80.0                | 0.13541                         | 3.2     | 315.0  | 0.00079788                      | 1.5     | 550.0  | 0.000052101                     | 0.9     |
| 85.0                | 0.11543                         | 3.2     | 320.0  | 0.00074032                      | 1.5     | 555.0  | 0.000049838                     | 0.9     |
| 90.0                | 0.098719                        | 3.1     | 325.0  | 0.00068765                      | 1.5     | 560.0  | 0.000047695                     | 0.9     |
| 95.0                | 0.084690                        | 3.0     | 330.0  | 0.00063938                      | 1.4     | 565.0  | 0.000045667                     | 0.9     |
| 100.0               | 0.072876                        | 3.0     | 335.0  | 0.00059509                      | 1.4     | 570.0  | 0.000043745                     | 0.9     |
| 105.0               | 0.062896                        | 2.9     | 340.0  | 0.00055438                      | 1.4     | 575.0  | 0.000041924                     | 0.8     |
| 110.0               | 0.054439                        | 2.9     | 345.0  | 0.00051692                      | 1.4     | 580.0  | 0.000040197                     | 0.8     |
| 115.0               | 0.047251                        | 2.8     | 350.0  | 0.00048241                      | 1.4     | 585.0  | 0.000038559                     | 0.8     |
| 120.0               | 0.041124                        | 2.8     | 355.0  | 0.00045059                      | 1.4     | 590.0  | 0.000037004                     | 0.8     |
| 125.0               | 0.035885                        | 2.7     | 360.0  | 0.00042120                      | 1.3     | 595.0  | 0.000035529                     | 0.8     |
| 130.0               | 0.031395                        | 2.6     | 365.0  | 0.00039405                      | 1.3     | 600.0  | 0.000034127                     | 0.8     |
| 135.0               | 0.027535                        | 2.6     | 370.0  | 0.00036893                      | 1.3     | 605.0  | 0.000032795                     | 0.8     |
| 140.0               | 0.024208                        | 2.6     | 375.0  | 0.00034566                      | 1.3     | 610.0  | 0.000031529                     | 0.8     |
| 145.0               | 0.021334                        | 2.5     | 380.0  | 0.00032410                      | 1.3     | 615.0  | 0.000030325                     | 0.8     |
| 150.0               | 0.018845                        | 2.5     | 385.0  | 0.00030411                      | 1.3     | 620.0  | 0.000029180                     | 0.8     |
| 155.0               | 0.016683                        | 2.4     | 390.0  | 0.00028554                      | 1.3     | 625.0  | 0.000028090                     | 0.8     |
| 160.0               | 0.014802                        | 2.4     | 395.0  | 0.00026829                      | 1.2     | 630.0  | 0.000027052                     | 0.7     |
| 165.0               | 0.013157                        | 2.3     | 400.0  | 0.00025225                      | 1.2     | 635.0  | 0.000026063                     | 0.7     |

| R/T No. <b>6001</b> |                                 |         |        |                                 |         |        |                                 |         |
|---------------------|---------------------------------|---------|--------|---------------------------------|---------|--------|---------------------------------|---------|
| T (°C)              | B <sub>25/200</sub> = 4113 K    |         | T (°C) | B <sub>25/200</sub> = 4113 K    |         | T (°C) | B <sub>25/200</sub> = 4113 K    |         |
|                     | R <sub>T</sub> /R <sub>25</sub> | α (%/K) |        | R <sub>T</sub> /R <sub>25</sub> | α (%/K) |        | R <sub>T</sub> /R <sub>25</sub> | α (%/K) |
| 170.0               | 0.011718                        | 2.3     | 405.0  | 0.00023733                      | 1.2     | 640.0  | 0.000025121                     | 0.7     |
| 175.0               | 0.010457                        | 2.3     | 410.0  | 0.00022343                      | 1.2     | 645.0  | 0.000024223                     | 0.7     |
| 180.0               | 0.0093497                       | 2.2     | 415.0  | 0.00021049                      | 1.2     | 650.0  | 0.000023367                     | 0.7     |
| 185.0               | 0.0083749                       | 2.2     | 420.0  | 0.00019841                      | 1.2     | —      | —                               | —       |
| 190.0               | 0.0075152                       | 2.1     | 425.0  | 0.00018715                      | 1.2     | —      | —                               | —       |

## Cautions and warnings

### General

See "Important notes" on page 2.

### Storage

- Store thermistors only in original packaging. Do not open the package prior to processing.
- Storage conditions in original packaging: storage temperature  $-25\text{ }^{\circ}\text{C} \dots +45\text{ }^{\circ}\text{C}$ , relative humidity  $\leq 75\%$  annual mean,  $< 95\%$  maximum 30 days per annum, dew precipitation is inadmissible.
- Do not store thermistors where they are exposed to heat or direct sunlight. Otherwise, the packing material may be deformed or components may stick together, causing problems during mounting.
- Avoid contamination of thermistor surface during storage, handling and processing.
- Avoid storage of thermistors in harmful environments like corrosive gases ( $\text{SO}_x$ , Cl etc).
- Use the components as soon as possible after opening the original packaging.
- Solder thermistors within the time specified after shipment from EPCOS.  
For leaded components this is 24 months, for SMD components with nickel barrier termination 12 months, for leadless components this is 12 months, for SMD components with AgPd termination 6 months.

### Handling

- NTC thermistors must not be dropped. Chip-offs or any other damage must not be caused during handling of NTCs.
- Do not touch components with bare hands. Gloves are recommended.
- Avoid contamination of thermistor surface during handling.
- Washing processes may damage the product due to the possible static or cyclic mechanical loads (e.g. ultrasonic cleaning). They may cause cracks to develop on the product and its parts, which might lead to reduced reliability or lifetime.

### Bending / twisting leads

- A lead (wire) may be bent at a minimum distance of twice the wire's diameter plus 4 mm from the component head or housing. When bending ensure the wire is mechanically relieved at the component head or housing. The bending radius should be at least 0.75 mm.

### Soldering

- Use resin-type flux or non-activated flux.
- Insufficient preheating may cause ceramic cracks.
- Rapid cooling by dipping in solvent is not recommended.
- Complete removal of flux is recommended.

## Mounting

- Ensure that no thermo-mechanical stress occurs due to production processes (curing or overmolding processes) when thermistors are sealed, potted or overmolded or during their subsequent operation. The maximum temperature of the thermistor must not be exceeded. Ensure that the materials used (sealing/potting compound and plastic material) are chemically neutral.
- Electrodes/contacts must not be scratched or damaged before/during/after the mounting process.
- Contacts and housing used for assembly with the thermistor must be clean before mounting.
- Ensure that adjacent materials are designed for operation at temperatures comparable to the surface temperature of the thermistor. Be sure that surrounding parts and materials can withstand the temperature.
- Avoid contamination of the thermistor surface during processing.
- The connections of sensors (e.g. cable end, wire end, plug terminal) may only be exposed to an environment with normal atmospheric conditions.
- Tensile forces on cables or leads must be avoided during mounting and operation.
- Bending or twisting of cables or leads directly on the thermistor body is not permissible.
- Avoid using chemical substances as mounting aids. It must be ensured that no water or other liquids enter the NTC thermistors (e.g. through plug terminals). In particular, water based substances (e.g. soap suds) must not be used as mounting aids for sensors.
- The use of no-clean solder products is recommended. In any case mild, non-activated fluxes should be used. Flux residues after soldering should be minimized.

## Operation

- Use thermistors only within the specified operating temperature range.
- Use thermistors only within the specified power range.
- Environmental conditions must not harm the thermistors. Only use the thermistors under normal atmospheric conditions or within the specified conditions.
- Contact of NTC thermistors with any liquids and solvents shall be prevented. It must be ensured that no water enters the NTC thermistors (e.g. through plug terminals). For measurement purposes (checking the specified resistance vs. temperature), the component must not be immersed in water but in suitable liquids (e.g. perfluoropolyethers such as Galden).
- Avoid dewing and condensation unless thermistor is specified for these conditions.
- Bending or twisting of cables and/or wires is not permissible during operation of the sensor in the application.
- Be sure to provide an appropriate fail-safe function to prevent secondary product damage caused by malfunction.

This listing does not claim to be complete, but merely reflects the experience of EPCOS AG.

## Display of ordering codes for EPCOS products

The ordering code for one and the same EPCOS product can be represented differently in data



sheets, data books, other publications, on the EPCOS website, or in order-related documents such as shipping notes, order confirmations and product labels. **The varying representations of the ordering codes are due to different processes employed and do not affect the specifications of the respective products.** Detailed information can be found on the Internet under [www.epcos.com/orderingcodes](http://www.epcos.com/orderingcodes)

**Symbols and terms**

| Symbol              | English  | German  |
|---------------------|--|---|
| A                   | Area   | Fläche  |
| AWG                 | American Wire Gauge  | Amerikanische Norm für Drahtquerschnitte                                  |
| B                   | B value  | B-Wert  |
| B <sub>25/100</sub> | B value determined by resistance measurement at 25 °C and 100 °C         | B-Wert, ermittelt durch Widerstandsmessungen bei 25 °C und 100 °C         |
| C <sub>th</sub>     | Heat capacitance   | Wärmekapazität  |
| I                   | Current  | Strom   |
| N                   | Number (integer)   | Anzahl (ganzzahliger Wert)  |
| P <sub>25</sub>     | Maximum power at 25 °C   | Maximale Leistung bei 25 °C   |
| P <sub>diss</sub>   | Power dissipation  | Verlustleistung   |
| P <sub>el</sub>     | Electrical power   | Elektrische Leistung  |
| P <sub>max</sub>    | Maximum power within stated temperature range                            | Maximale Leistung im angegebenen Temperaturbereich                        |
| $\Delta R_B/R_B$    | Resistance tolerance caused by spread of B value                         | Widerstandstoleranz, die durch die Streuung des B-Wertes verursacht wird  |
| R <sub>ins</sub>    | Insulation resistance  | Isolationswiderstand  |
| R <sub>P</sub>      | Parallel resistance  | Parallelwiderstand  |
| R <sub>R</sub>      | Rated resistance   | Nennwiderstand  |
| $\Delta R_R/R_R$    | Resistance tolerance   | Widerstandstoleranz   |
| R <sub>S</sub>      | Series resistance  | Serienwiderstand  |
| R <sub>T</sub>      | Resistance at temperature T (e.g. R <sub>25</sub> = resistance at 25 °C) | Widerstand bei Temperatur T (z.B. R <sub>25</sub> = Widerstand bei 25 °C) |
| T                   | Temperature  | Temperatur  |
| $\Delta T$          | Temperature tolerance  | Temperaturtoleranz  |
| t                   | Time   | Zeit  |
| T <sub>A</sub>      | Ambient temperature  | Umgebungstemperatur   |
| T <sub>max</sub>    | Upper category temperature   | Obere Grenztemperatur (Kategorietemperatur)                               |
| T <sub>min</sub>    | Lower category temperature   | Untere Grenztemperatur (Kategorietemperatur)                              |
| T <sub>op</sub>     | Operating temperature  | Betriebstemperatur  |
| T <sub>R</sub>      | Rated temperature  | Nenntemperatur  |
| T <sub>surf</sub>   | Surface temperature  | Oberflächentemperatur   |
| V                   | Voltage  | Spannung  |
| V <sub>ins</sub>    | Insulation test voltage  | Isolationsprüfspannung  |
| V <sub>op</sub>     | Operating voltage  | Betriebsspannung  |
| V <sub>test</sub>   | Test voltage   | Prüfspannung  |

| Symbol        | English                       | German                         |
|---------------|-------------------------------|--------------------------------|
| $\alpha$      | Temperature coefficient       | Temperaturkoeffizient          |
| $\Delta$      | Tolerance, change             | Toleranz, Änderung             |
| $\delta_{th}$ | Dissipation factor            | Wärmeleitwert                  |
| $\tau_c$      | Thermal cooling time constant | Thermische Abkühlzeitkonstante |
| $\tau_a$      | Thermal time constant         | Thermische Zeitkonstante       |

**Abbreviations / Notes**

| Symbol            | English  | German  |
|-------------------|--|---|
| <b><u>SMD</u></b> | Surface-mounted devices  | Oberflächenmontierbares Bauelement  |
| *                 | To be replaced by a number in ordering codes, type designations etc.   | Platzhalter für Zahl im Bestellnummerncode oder für die Typenbezeichnung.   |
| +                 | To be replaced by a letter.<br>All dimensions are given in mm.<br>The commas used in numerical values denote decimal points. | Platzhalter für einen Buchstaben.<br>Alle Maße sind in mm angegeben.<br>Verwendete Kommas in Zahlenwerten bezeichnen Dezimalpunkte. |

## Important notes

The following applies to all products named in this publication:

1. Some parts of this publication contain **statements about the suitability of our products for certain areas of application**. These statements are based on our knowledge of typical requirements that are often placed on our products in the areas of application concerned. We nevertheless expressly point out **that such statements cannot be regarded as binding statements about the suitability of our products for a particular customer application**. As a rule, EPCOS is either unfamiliar with individual customer applications or less familiar with them than the customers themselves. For these reasons, it is always ultimately incumbent on the customer to check and decide whether an EPCOS product with the properties described in the product specification is suitable for use in a particular customer application.
2. We also point out that **in individual cases, a malfunction of electronic components or failure before the end of their usual service life cannot be completely ruled out in the current state of the art, even if they are operated as specified**. In customer applications requiring a very high level of operational safety and especially in customer applications in which the malfunction or failure of an electronic component could endanger human life or health (e.g. in accident prevention or lifesaving systems), it must therefore be ensured by means of suitable design of the customer application or other action taken by the customer (e.g. installation of protective circuitry or redundancy) that no injury or damage is sustained by third parties in the event of malfunction or failure of an electronic component.
3. **The warnings, cautions and product-specific notes must be observed.**
4. In order to satisfy certain technical requirements, **some of the products described in this publication may contain substances subject to restrictions in certain jurisdictions (e.g. because they are classed as hazardous)**. Useful information on this will be found in our Material Data Sheets on the Internet ([www.epcos.com/material](http://www.epcos.com/material)). Should you have any more detailed questions, please contact our sales offices.
5. We constantly strive to improve our products. Consequently, **the products described in this publication may change from time to time**. The same is true of the corresponding product specifications. Please check therefore to what extent product descriptions and specifications contained in this publication are still applicable before or when you place an order. We also **reserve the right to discontinue production and delivery of products**. Consequently, we cannot guarantee that all products named in this publication will always be available. The aforementioned does not apply in the case of individual agreements deviating from the foregoing for customer-specific products.
6. Unless otherwise agreed in individual contracts, **all orders are subject to the current version of the "General Terms of Delivery for Products and Services in the Electrical Industry" published by the German Electrical and Electronics Industry Association (ZVEI)**.

## Important notes

7. The trade names EPCOS, CeraCharge, CeraDiode, CeraLink, CeraPad, CeraPlas, CSMP, CTVS, DeltaCap, DigiSiMic, ExoCore, FilterCap, FormFit, LeaXield, MiniBlue, MiniCell, MKD, MKK, MotorCap, PCC, PhaseCap, PhaseCube, PhaseMod, PhiCap, PowerHap, PQSine, PQvar, SIFERRIT, SIFI, SIKOREL, SilverCap, SIMDAD, SiMic, SIMID, SineFormer, SIOV, ThermoFuse, WindCap are **trademarks registered or pending** in Europe and in other countries. Further information will be found on the Internet at [www.epcos.com/trademarks](http://www.epcos.com/trademarks).