

NTC thermistors for temperature measurement

Probe assemblies

Series/Type: B57045K
Date: March 2013

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EPCOS AG is a TDK Group Company.

Applications

- Temperature compensation, measurement and control (chassis mounting)

Features

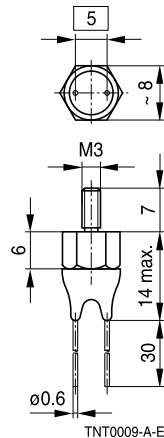
- Cost-effective
- Good thermal coupling through screw-type case (thread M3)
- Electrically isolated aluminum case
- Tinned copper leads

Options

- Tighter resistance tolerance available on request.

Delivery mode

Bulk

Dimensional drawing


Dimensions in mm
Approx. weight 1 g

General technical data

| | | | | |
|-------------------------------|----------------|------------------|-------------|------|
| Climatic category | (IEC 60068-1) | | 55/125/56 | |
| Max. power | (at 25 °C) | P_{25} | 450 | mW |
| Resistance tolerance | | $\Delta R_R/R_R$ | ± 10 | % |
| Rated temperature | | T_R | 25 | °C |
| Dissipation factor | (in air) | δ_{th} | approx. 9 | mW/K |
| Dissipation factor | (on chassis) | δ_{th} | approx. 20 | mW/K |
| Thermal cooling time constant | (in air) | τ_c | approx. 75 | s |
| Thermal cooling time constant | (on chassis) | τ_c | approx. 15 | s |
| Torque | | | approx. 0.5 | Nm |
| Insulation resistance | (V = 100 V DC) | R_{ins} | > 100 | MΩ |
| Test voltage | (t = 1 s) | V_{rest} | 2500 | V AC |

Electrical specification and ordering codes

| R_{25} Ω | No. of R/T characteristic | $B_{25/100}$ K | Ordering code |
|----------------------|------------------------------|-------------------|-----------------|
| 1 k | 1011 | 3730 \pm 3% | B57045K0102K000 |
| 2.2 k | 1013 | 3900 \pm 3% | B57045K0222K000 |
| 4.7 k | 4001 | 3950 \pm 3% | B57045K0472K000 |
| 6.8 k | 2903 | 4200 \pm 3% | B57045K0682K000 |
| 10 k | 2904 | 4300 \pm 3% | B57045K0103K000 |
| 33 k | 1012 | 4300 \pm 3% | B57045K0333K000 |
| 47 k | 4003 | 4450 \pm 3% | B57045K0473K000 |
| 68 k | 2005 | 4600 \pm 3% | B57045K0683K000 |
| 100 k | 2005 | 4600 \pm 3% | B57045K0104K000 |
| 150 k | 2005 | 4600 \pm 3% | B57045K0154K000 |

Reliability data

| Test | Standard | Test conditions | $\Delta R_{25}/R_{25}$ (typical) | Remarks |
|---------------------------------------|----------------|---|-------------------------------------|-------------------|
| Storage in dry heat | IEC 60068-2-2 | Storage at upper category temperature T: 125 °C t: 1000 h | < 3% | No visible damage |
| Storage in damp heat, steady state | IEC 60068-2-78 | Temperature of air: 40 °C Relative humidity of air: 93% Duration: 56 days | < 3% | No visible damage |
| Endurance | | P_{max} : 450 mW t: 1000 h | < 3% | No visible damage |
| Long-term stability (empirical value) | | Temperature: 100 °C t: 10000 h | < 5% | No visible damage |

Note

- 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).
- Avoid dewing and condensation unless thermistor is specified for these conditions.

R/T characteristics

| R/T No. | 1011 | | 1012 | | 1013 | |
|---------|---------------------------------|---------|---------------------------------|---------|---------------------------------|---------|
| T (°C) | B _{25/100} = 3730 K | | B _{25/100} = 4300 K | | B _{25/100} = 3900 K | |
| | R _T /R ₂₅ | α (%/K) | R _T /R ₂₅ | α (%/K) | R _T /R ₂₅ | α (%/K) |
| -55.0 | 70.014 | 6.9 | 87.237 | 6.8 | 77.285 | 7.0 |
| -50.0 | 49.906 | 6.7 | 62.264 | 6.7 | 54.938 | 6.7 |
| -45.0 | 36.015 | 6.4 | 44.854 | 6.5 | 39.507 | 6.5 |
| -40.0 | 26.296 | 6.2 | 32.599 | 6.3 | 28.722 | 6.3 |
| -35.0 | 19.411 | 6.0 | 23.893 | 6.1 | 21.099 | 6.1 |
| -30.0 | 14.479 | 5.8 | 17.654 | 6.0 | 15.652 | 5.9 |
| -25.0 | 10.903 | 5.6 | 13.098 | 5.8 | 11.715 | 5.7 |
| -20.0 | 8.2923 | 5.4 | 9.8059 | 5.7 | 8.8541 | 5.6 |
| -15.0 | 6.3591 | 5.2 | 7.4266 | 5.5 | 6.7433 | 5.4 |
| -10.0 | 4.9204 | 5.1 | 5.6677 | 5.4 | 5.1815 | 5.2 |
| -5.0 | 3.8279 | 4.9 | 4.3213 | 5.3 | 4.0099 | 5.1 |
| 0.0 | 3.0029 | 4.8 | 3.3208 | 5.1 | 3.1283 | 4.9 |
| 5.0 | 2.3773 | 4.6 | 2.5842 | 5.0 | 2.4569 | 4.8 |
| 10.0 | 1.8959 | 4.5 | 2.0238 | 4.9 | 1.9438 | 4.6 |
| 15.0 | 1.5207 | 4.3 | 1.5858 | 4.8 | 1.5475 | 4.5 |
| 20.0 | 1.228 | 4.2 | 1.2507 | 4.7 | 1.2403 | 4.4 |
| 25.0 | 1.0000 | 4.1 | 1.0000 | 4.5 | 1.0000 | 4.3 |
| 30.0 | 0.81779 | 3.9 | 0.7964 | 4.4 | 0.81104 | 4.1 |
| 35.0 | 0.67341 | 3.8 | 0.64053 | 4.3 | 0.66146 | 4.0 |
| 40.0 | 0.55747 | 3.7 | 0.51772 | 4.2 | 0.54254 | 3.9 |
| 45.0 | 0.46357 | 3.6 | 0.41958 | 4.1 | 0.44727 | 3.8 |
| 50.0 | 0.3874 | 3.6 | 0.34172 | 4.1 | 0.37067 | 3.7 |
| 55.0 | 0.32368 | 3.5 | 0.27877 | 4.0 | 0.30865 | 3.6 |
| 60.0 | 0.272 | 3.4 | 0.22861 | 3.9 | 0.25825 | 3.5 |
| 65.0 | 0.23041 | 3.3 | 0.18872 | 3.8 | 0.21707 | 3.4 |
| 70.0 | 0.19604 | 3.2 | 0.15645 | 3.7 | 0.18323 | 3.3 |
| 75.0 | 0.16735 | 3.1 | 0.13012 | 3.6 | 0.15535 | 3.3 |
| 80.0 | 0.14342 | 3.0 | 0.10863 | 3.6 | 0.13223 | 3.2 |
| 85.0 | 0.12347 | 3.0 | 0.091115 | 3.5 | 0.11302 | 3.1 |
| 90.0 | 0.10668 | 2.8 | 0.0767 | 3.4 | 0.096951 | 3.0 |
| 95.0 | 0.092734 | 2.8 | 0.064867 | 3.3 | 0.083487 | 3.0 |
| 100.0 | 0.080903 | 2.8 | 0.055047 | 3.3 | 0.072139 | 2.9 |
| 105.0 | 0.070616 | 2.7 | 0.046797 | 3.2 | 0.062559 | 2.8 |
| 110.0 | 0.061826 | 2.6 | 0.039904 | 3.1 | 0.054425 | 2.8 |
| 115.0 | 0.054282 | 2.6 | 0.034255 | 3.1 | 0.047508 | 2.7 |
| 120.0 | 0.047793 | 2.5 | 0.029498 | 3.0 | 0.041594 | 2.6 |
| 125.0 | 0.042249 | 2.4 | 0.025448 | 3.0 | 0.036532 | 2.6 |

R/T characteristics

| R/T No. | 2005 | | 2903 | | 2904 | |
|---------|---------------------------------|---------|---------------------------------|---------|---------------------------------|---------|
| T (°C) | B _{25/100} = 4600 K | | B _{25/100} = 4200 K | | B _{25/100} = 4300 K | |
| | R _T /R ₂₅ | α (%/K) | R _T /R ₂₅ | α (%/K) | R _T /R ₂₅ | α (%/K) |
| -55.0 | 120.22 | 7.0 | 120.03 | 7.7 | 121.46 | 7.4 |
| -50.0 | 85.48 | 6.9 | 82.38 | 7.4 | 84.439 | 7.2 |
| -45.0 | 61.004 | 6.8 | 57.248 | 7.2 | 59.243 | 7.1 |
| -40.0 | 43.712 | 6.7 | 40.255 | 7.0 | 41.938 | 6.9 |
| -35.0 | 31.459 | 6.6 | 28.627 | 6.7 | 29.947 | 6.7 |
| -30.0 | 22.746 | 6.6 | 20.577 | 6.6 | 21.567 | 6.6 |
| -25.0 | 16.49 | 6.4 | 14.876 | 6.4 | 15.641 | 6.3 |
| -20.0 | 12.071 | 6.3 | 10.88 | 6.1 | 11.466 | 6.2 |
| -15.0 | 8.8455 | 6.1 | 8.0808 | 5.9 | 8.451 | 6.0 |
| -10.0 | 6.5446 | 6.0 | 6.0612 | 5.8 | 6.2927 | 5.9 |
| -5.0 | 4.8852 | 5.8 | 4.5649 | 5.6 | 4.7077 | 5.7 |
| 0.0 | 3.6781 | 5.6 | 3.4708 | 5.4 | 3.5563 | 5.5 |
| 5.0 | 2.7944 | 5.4 | 2.6625 | 5.2 | 2.7119 | 5.3 |
| 10.0 | 2.1391 | 5.3 | 2.0599 | 5.1 | 2.086 | 5.1 |
| 15.0 | 1.6507 | 5.1 | 1.6069 | 4.9 | 1.6204 | 5.0 |
| 20.0 | 1.2823 | 5.1 | 1.2631 | 4.8 | 1.2683 | 4.8 |
| 25.0 | 1.0000 | 5.0 | 1.0000 | 4.6 | 1.0000 | 4.7 |
| 30.0 | 0.78393 | 4.8 | 0.79593 | 4.5 | 0.7942 | 4.6 |
| 35.0 | 0.61822 | 4.7 | 0.63796 | 4.4 | 0.63268 | 4.5 |
| 40.0 | 0.49053 | 4.6 | 0.51467 | 4.2 | 0.5074 | 4.3 |
| 45.0 | 0.39116 | 4.5 | 0.41887 | 4.1 | 0.41026 | 4.2 |
| 50.0 | 0.31371 | 4.3 | 0.34272 | 4.0 | 0.33363 | 4.1 |
| 55.0 | 0.25338 | 4.2 | 0.28081 | 3.9 | 0.27243 | 4.0 |
| 60.0 | 0.20565 | 4.2 | 0.23141 | 3.8 | 0.2237 | 3.9 |
| 65.0 | 0.16762 | 4.1 | 0.19211 | 3.7 | 0.18459 | 3.8 |
| 70.0 | 0.13726 | 4.0 | 0.16027 | 3.6 | 0.15305 | 3.7 |
| 75.0 | 0.11279 | 3.9 | 0.13421 | 3.5 | 0.12755 | 3.6 |
| 80.0 | 0.093053 | 3.8 | 0.11288 | 3.4 | 0.10677 | 3.5 |
| 85.0 | 0.077177 | 3.7 | 0.095326 | 3.3 | 0.089928 | 3.4 |
| 90.0 | 0.064263 | 3.6 | 0.080828 | 3.2 | 0.076068 | 3.3 |
| 95.0 | 0.053678 | 3.6 | 0.068916 | 3.2 | 0.064524 | 3.3 |
| 100.0 | 0.044996 | 3.5 | 0.058989 | 3.1 | 0.054941 | 3.2 |
| 105.0 | 0.037917 | 3.4 | 0.050701 | 3.0 | 0.047003 | 3.1 |
| 110.0 | 0.032063 | 3.4 | 0.043735 | 3.0 | 0.040358 | 3.0 |
| 115.0 | 0.027161 | 3.3 | 0.037778 | 2.9 | 0.034743 | 3.0 |
| 120.0 | 0.023079 | 3.2 | 0.032736 | 2.8 | 0.030007 | 2.9 |
| 125.0 | 0.01968 | 3.2 | 0.028513 | 2.7 | 0.026006 | 2.8 |
| 130.0 | - | - | - | - | 0.022609 | 2.8 |
| 135.0 | - | - | - | - | 0.01972 | 2.7 |
| 140.0 | - | - | - | - | 0.017251 | 2.6 |
| 145.0 | - | - | - | - | 0.015139 | 2.6 |
| 150.0 | - | - | - | - | 0.013321 | 2.5 |
| 155.0 | - | - | - | - | 0.011754 | 2.5 |

R/T characteristics

| R/T No. | 4001 | | 4003 | |
|---------|---------------------------------|---------|---------------------------------|---------|
| T (°C) | B _{25/100} = 3950 K | | B _{25/100} = 4450 K | |
| | R _T /R ₂₅ | α (%/K) | R _T /R ₂₅ | α (%/K) |
| -55.0 | 88.052 | 7.3 | 103.81 | 6.8 |
| -50.0 | 61.65 | 7.0 | 73.707 | 6.7 |
| -45.0 | 43.727 | 6.8 | 52.723 | 6.6 |
| -40.0 | 31.395 | 6.5 | 37.988 | 6.5 |
| -35.0 | 22.802 | 6.3 | 27.565 | 6.4 |
| -30.0 | 16.742 | 6.2 | 20.142 | 6.2 |
| -25.0 | 12.367 | 6.0 | 14.801 | 6.1 |
| -20.0 | 9.2353 | 5.6 | 10.976 | 5.9 |
| -15.0 | 7.0079 | 5.4 | 8.1744 | 5.8 |
| -10.0 | 5.3654 | 5.4 | 6.1407 | 5.7 |
| -5.0 | 4.126 | 5.2 | 4.6331 | 5.5 |
| 0.0 | 3.2 | 5.0 | 3.5243 | 5.4 |
| 5.0 | 2.4986 | 4.9 | 2.6995 | 5.3 |
| 10.0 | 1.9662 | 4.7 | 2.0831 | 5.1 |
| 15.0 | 1.5596 | 4.6 | 1.6189 | 5.0 |
| 20.0 | 1.2457 | 4.5 | 1.2666 | 4.9 |
| 25.0 | 1.0000 | 4.4 | 1.0000 | 4.7 |
| 30.0 | 0.80355 | 4.2 | 0.78351 | 4.6 |
| 35.0 | 0.65346 | 4.1 | 0.62372 | 4.5 |
| 40.0 | 0.53456 | 4.0 | 0.49937 | 4.4 |
| 45.0 | 0.43966 | 3.9 | 0.40218 | 4.3 |
| 50.0 | 0.36357 | 3.8 | 0.32557 | 4.2 |
| 55.0 | 0.30183 | 3.7 | 0.26402 | 4.1 |
| 60.0 | 0.25189 | 3.6 | 0.21527 | 4.0 |
| 65.0 | 0.21136 | 3.5 | 0.17693 | 3.9 |
| 70.0 | 0.17819 | 3.4 | 0.14616 | 3.8 |
| 75.0 | 0.15089 | 3.3 | 0.12097 | 3.7 |
| 80.0 | 0.12833 | 3.2 | 0.10053 | 3.7 |
| 85.0 | 0.10948 | 3.1 | 0.083761 | 3.6 |
| 90.0 | 0.093748 | 3.0 | 0.070039 | 3.5 |
| 95.0 | 0.080764 | 2.9 | 0.058937 | 3.4 |
| 100.0 | 0.069842 | 2.9 | 0.049777 | 3.4 |
| 105.0 | 0.060455 | 2.9 | 0.042146 | 3.3 |
| 110.0 | 0.052498 | 2.8 | 0.035803 | 3.2 |
| 115.0 | 0.04574 | 2.7 | 0.030504 | 3.2 |
| 120.0 | 0.039972 | 2.7 | 0.026067 | 3.1 |
| 125.0 | 0.034984 | 2.6 | 0.022332 | 3.0 |
| 130.0 | — | — | 0.019186 | 3.0 |
| 135.0 | — | — | 0.016515 | 2.9 |
| 140.0 | — | — | 0.014253 | 2.9 |
| 145.0 | — | — | 0.012367 | 2.8 |
| 150.0 | — | — | 0.010758 | 2.8 |
| 155.0 | — | — | 0.0093933 | 2.7 |

Cautions and warnings

See "Important notes".

Storage

- Store thermistors only in original packaging. Do not open the package prior to storage.
- 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 (SO_x , Cl etc).
- Use the components as soon as possible after opening the factory seals, i.e. the polyvinyl-sealed packages.
- 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 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.
- Twisting (torsion) by 180° of a lead bent by 90° is permissible at 6 mm from the bottom of the thermistor body.

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.

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. 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.

Symbols and terms

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

| Symbol | English | German |
|---------------|-------------------------------|--------------------------------|
| α | Temperature coefficient | Temperaturkoeffizient |
| Δ | Tolerance, change | Toleranz, Änderung |
| δ_{th} | Dissipation factor | Wärmeleitwert |
| τ_c | Thermal cooling time constant | Thermische Abkühlzeitkonstante |
| τ_a | Thermal time constant | Thermische Zeitkonstante |

Abbreviations / Notes

| Symbol | English | German |
|-------------------|--|---|
| <u>SMD</u> | 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. All dimensions are given in mm. The commas used in numerical values denote decimal points. | Platzhalter für einen Buchstaben. Alle Maße sind in mm angegeben. 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.**
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