# SIOV metal oxide varistors

## Leaded varistors, SuperioR, S20 series

**Series/Type:** **S20**

Date: December 2007

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## Construction

- Round varistor element, leaded
- Coating: epoxy resin, flame-retardant to UL 94 V-0
- Terminals: tinned copper wire

## Features

- High-energy SuperioR series E3
- Very high surge current ratings of 12 kA
- High energy ratings up to 320 J
- PSpice models

## Approvals

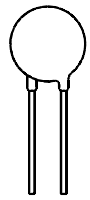
- UL
- CSA
- CECC
- VDE
- IEC

## Delivery mode

- Bulk (standard), taped versions on reel or in Ammo pack upon request.
- For further details refer to chapter “Taping, packaging and lead configuration” for leaded varistors.

## General technical data

| | | | |
|---|---|---|---|
| Climatic category | to IEC 60068-1 | 40/85/56 | |
| Operating temperature | to CECC 42 000 | –40 … + 85 | °C |
| Storage temperature | | –40 … +125 | °C |
| Electric strength | to CECC 42 000 | ≥2.5 | $kV_{RMS}$ |
| Insulation resistance | to CECC 42 000 | ≥10 | MΩ |
| Response time | | <25 | ns |

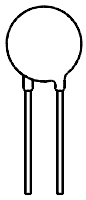


**Maximum ratings** ($T_A$ = 85 °C)

| Ordering code | Type (untaped) SIOV- | $V_{RMS}$ V | $V_{DC}$ V | $i_{max}$ (8/20 µs) A | $W_{max}$ (2 ms) J | $P_{max}$ W |
|---|---|---|---|---|---|---|
| B72220S3111K101 | S20K115E3 | 115 | 150 | 12000 | 110 | 1.0 |
| B72220S3131K101 | S20K130E3 | 130 | 170 | 12000 | 130 | 1.0 |
| B72220S3141K101 | S20K140E3 | 140 | 180 | 12000 | 140 | 1.0 |
| B72220S3151K101 | S20K150E3 | 150 | 200 | 12000 | 150 | 1.0 |
| B72220S3171K101 | S20K175E3 | 175 | 225 | 12000 | 180 | 1.0 |
| B72220S3211K101 | S20K210E3 | 210 | 270 | 12000 | 210 | 1.0 |
| B72220S3231K101 | S20K230E3 | 230 | 300 | 12000 | 220 | 1.0 |
| B72220S3251K101 | S20K250E3 | 250 | 320 | 12000 | 250 | 1.0 |
| B72220S3271K101 | S20K275E3 | 275 | 350 | 12000 | 260 | 1.0 |
| B72220S3301K101 | S20K300E3 | 300 | 385 | 12000 | 290 | 1.0 |
| B72220S3321K101 | S20K320E3 | 320 | 420 | 12000 | 320 | 1.0 |

**Characteristics** ($T_A$ = 25 °C)

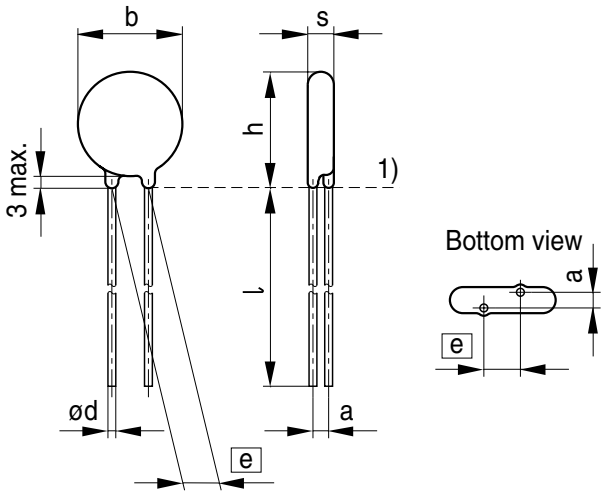
| Ordering code | Type (untaped) SIOV- | $V_v$ (1 mA) V | $\Delta V_v$ (1 mA) % | $v_{c, max}$ ($i_c$) V | $i_c$ A | $C_{typ}$ (1 kHz) pF |
|---|---|---|---|---|---|---|
| B72220S3111K101 | S20K115E3 | 180 | ±10 | 300 | 100 | 1520 |
| B72220S3131K101 | S20K130E3 | 205 | ±10 | 340 | 100 | 1340 |
| B72220S3141K101 | S20K140E3 | 220 | ±10 | 360 | 100 | 1240 |
| B72220S3151K101 | S20K150E3 | 240 | ±10 | 395 | 100 | 1160 |
| B72220S3171K101 | S20K175E3 | 270 | ±10 | 455 | 100 | 1000 |
| B72220S3211K101 | S20K210E3 | 330 | ±10 | 550 | 100 | 830 |
| B72220S3231K101 | S20K230E3 | 360 | ±10 | 595 | 100 | 760 |
| B72220S3251K101 | S20K250E3 | 390 | ±10 | 650 | 100 | 700 |
| B72220S3271K101 | S20K275E3 | 430 | ±10 | 710 | 100 | 630 |
| B72220S3301K101 | S20K300E3 | 470 | ±10 | 775 | 100 | 580 |
| B72220S3321K101 | S20K320E3 | 510 | ±10 | 840 | 100 | 540 |



## Leaded varistors

## SuperioR, S20 series

### Dimensional drawing




1) Seating plane to IEC 60717

VAR0408-C

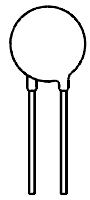
### Weight

| Nominal diameter<br>mm | $V_{RMS}$<br>V | Weight<br>g |
|---|---|---|
| 20 | 115 … 320 | 4.0 … 7.0 |

The weight of varistors in between these voltage classes can be interpolated.

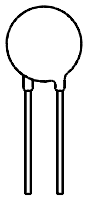
### Dimensions

| Ordering code | e ±1<br>mm | a ±1<br>mm | $b_{max}$<br>mm | $s_{max}$<br>mm | $h_{max}$<br>mm | $l_{min}$<br>mm | d ±0.05<br>mm |
|---|---|---|---|---|---|---|---|
| B72220S3111K101 | 10.0 | 1.8 | 22.5 | 4.8 | 26.0 | 25.0 | 1.0 |
| B72220S3131K101 | 10.0 | 2.0 | 22.5 | 5.0 | 26.0 | 25.0 | 1.0 |
| B72220S3141K101 | 10.0 | 2.1 | 22.5 | 5.1 | 26.0 | 25.0 | 1.0 |
| B72220S3151K101 | 10.0 | 2.2 | 22.5 | 5.2 | 26.0 | 25.0 | 1.0 |
| B72220S3171K101 | 10.0 | 2.3 | 22.5 | 5.3 | 26.0 | 25.0 | 1.0 |
| B72220S3211K101 | 10.0 | 2.4 | 22.5 | 5.4 | 26.0 | 25.0 | 1.0 |
| B72220S3231K101 | 10.0 | 2.9 | 22.5 | 5.9 | 26.0 | 25.0 | 1.0 |
| B72220S3251K101 | 10.0 | 3.1 | 22.5 | 6.1 | 27.0 | 25.0 | 1.0 |
| B72220S3271K101 | 10.0 | 3.3 | 22.5 | 6.3 | 27.0 | 25.0 | 1.0 |
| B72220S3301K101 | 10.0 | 3.6 | 22.5 | 6.6 | 27.0 | 25.0 | 1.0 |
| B72220S3321K101 | 10.0 | 3.8 | 22.5 | 6.8 | 27.0 | 25.0 | 1.0 |



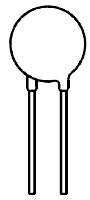
## Reliability data

| Test | Test methods/conditions | Requirement |
|---|---|---|
| Varistor voltage | The voltage between two terminals with the specified measuring current applied is called $V_v$ (1 $mA_{DC}$ @ 0.2 … 2 s). | To meet the specified value. |
| Clamping voltage | The maximum voltage between two terminals with the specified standard impulse current (8/20 µs) applied. | To meet the specified value. |
| Max. AC operating voltage | CECC 42 000, test 4.20<br>1000 h at UCT<br>After having continuously applied the maximum allowable voltage at UCT ±2 °C for 1000 h, the specimen shall be stored at room temperature and normal humidity for 1 to 2 h.<br>Thereafter, the change of $V_v$ shall be measured. | $\|\Delta V/V$ (1 mA)$\|$ ≤10% |
| Surge current derating, 8/20 µs | CECC 42 000, test C 2.1<br>100 surge currents (8/20 µs), unipolar, interval 30 s, amplitude corresponding to derating curve for 100 impulses at 20 µs | $\|\Delta V/V$ (1 mA)$\|$ ≤10%<br>(measured in direction of surge current)<br>No visible damage |
| Surge current derating, 2 ms | CECC 42 000, test C 2.1<br>100 surge currents (2 ms), unipolar, interval 120 s, amplitude corresponding to derating curve for 100 impulses at 2 ms | $\|\Delta V/V$ (1 mA)$\|$ ≤10%<br>(measured in direction of surge current)<br>No visible damage |
| Electric strength | CECC 42 000, test 4.7<br>Metal balls method, 2500 $V_{RMS}$, 60 s<br>The varistor is placed in a container holding 1.6 ±0.2 mm diameter metal balls such that only the terminations of the varistor are protruding.<br>The specified voltage shall be applied between both terminals of the specimen connected together and the electrode inserted between the metal balls. | No breakdown |



## Reliability data

| Test | Test methods/conditions | Requirement |
|---|---|---|
| Climatic sequence | CECC 42 000, test 4.16<br><br>The specimen shall be subjected to:<br>a) dry heat at UCT, 16 h<br>b) damp heat, 1st cycle:<br>55 °C, 93% r. H., 24 h<br>c) cold, LCT, 2 h<br>d) damp heat, additional 5 cycles:<br>55 °C/25 °C, 93% r. H., 24 h/cycle.<br>Then the specimen shall be stored at room temperature and normal humidity for 1 to 2 h.<br>Thereafter, the change of $V_v$ shall be measured. Thereafter, insulation resistance $R_{ins}$ shall be measured according to CECC 42 000, test 4.8 at V = 500 V. | $\lvert\Delta V/V\ (1\ mA)\rvert \leq 10\%$<br><br>$R_{ins} \geq 1\ M\Omega$ |
| Fast temperature cycling | IEC 60068-2-14, test Na, LCT/UCT, dwell time 30 min, 5 cycles | $\lvert\Delta V/V\ (1\ mA)\rvert \leq 5\%$<br>No visible damage |
| Damp heat, steady state | The specimen shall be subjected to 40 ±2 °C, 90 to 95% r. H. for 56 days without load / with 10% of the maximum continuous DC operating voltage $V_{DC}$.<br>Then stored at room temperature and normal humidity for 1 to 2 h.<br>Thereafter, the change of $V_v$ shall be measured. Thereafter, insulation resistance $R_{ins}$ shall be measured according to CECC 42 000, test 4.8 at V = 500 V. | $\lvert\Delta V/V\ (1\ mA)\rvert \leq 10\%$<br><br>$R_{ins} \geq 1\ M\Omega$ |
| Solderability | IEC 60068-2-20, test Ta, method 1 with modified conditions for lead-free solder alloys: 245 °C, 3 s:<br><br>After dipping the terminals to a depth of approximately 3 mm from the body in a soldering bath of 245 °C for 3 s, the terminals shall be visually examined. | The inspection shall be carried out under adequate light with normal eyesight or with the assistance of a magnifier capable of giving a magnification of 4 to 10 times. The dipped surface shall be covered with a smooth and bright solder coating with no more than small amounts of scattered imperfections such as pinholes or un-wetted or de-wetted areas. These imperfections shall not be concentrated in one area. |



## Reliability data

| Test | Test methods/conditions | Requirement |
|---|---|---|
| Resistance to soldering heat | IEC 60068-2-20, test Tb, method 1A, 260 °C, 10 s:<br>Each lead shall be dipped into a solder bath having a temperature of 260 ±5 °C to a point 2.0 to 2.5 mm from the body of the specimen, be held there for 10 ±1 s and then be stored at room temperature and normal humidity for 1 to 2 h.<br>The change of $V_v$ shall be measured and the specimen shall be visually examined. | $\lvert\Delta V/V\ (1\ mA)\rvert \leq 5\%$<br>No visible damage |
| Tensile strength | IEC 60068-2-21, test Ua1<br>After gradually applying the force specified below and keeping the unit fixed for 10 s, the terminal shall be visually examined for any damage.<br>Force for wire diameter: 1.0 mm = 20 N | $\lvert\Delta V/V\ (1\ mA)\rvert \leq 5\%$<br>No break of solder joint, no wire break |
| Vibration | IEC 60068-2, test Fc<br>Frequency range: 10 … 55 Hz<br>Amplitude: 0.75 mm or 98 m/s²<br>Duration: 6 h (3 · 2 h)<br>Pulse: sine wave<br>After repeatedly applying a single harmonic vibration according to the table above.<br>The change of $V_v$ shall be measured and the specimen shall be visually examined. | $\lvert\Delta V/V\ (1\ mA)\rvert \leq 5\%$<br>No visible damage |
| Bump | IEC 60068-2-29, test Eb<br>Pulse duration: 6 ms<br>Max. acceleration: 400 m/s²<br>Number of bumps: 4000<br>Pulse: half sine | $\lvert\Delta V/V\ (1\ mA)\rvert \leq 5\%$<br>No visible damage |
| Flammability | IEC 60695-2-2 (needle flame test)<br>Severity: vertical 10 s | 5 s max. |

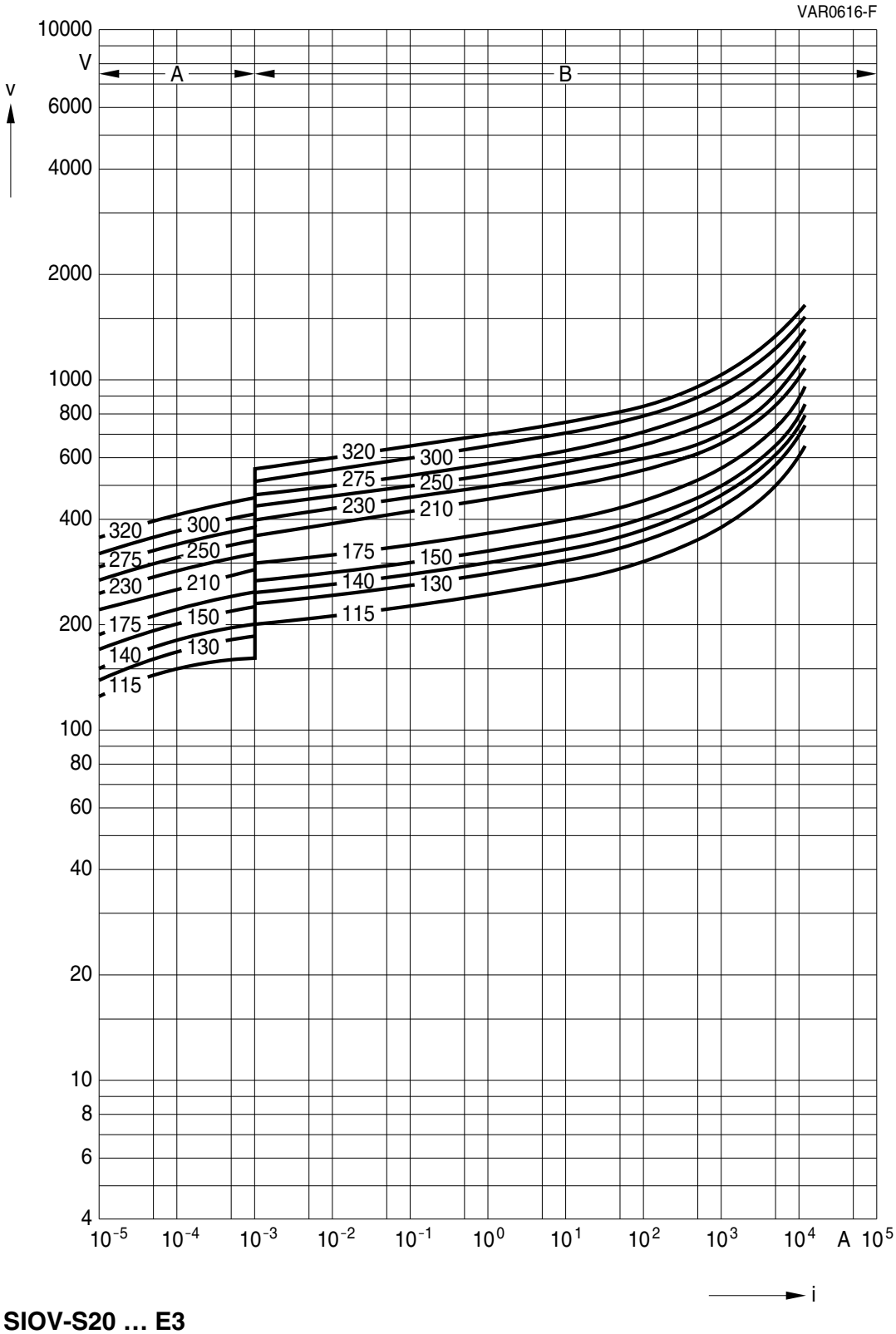
**Note:**

UCT = Upper category temperature
LCT = Lower category temperature
$R_{ins}$ = Insulation resistance to CECC 42 000, test 4.8

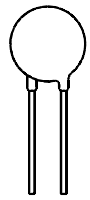
## v/i characteristics

v = f (i) – for explanation of the characteristics refer to “General technical information”, 1.6.3

A = Leakage current
B = Protection level
} for worst-case varistor tolerances



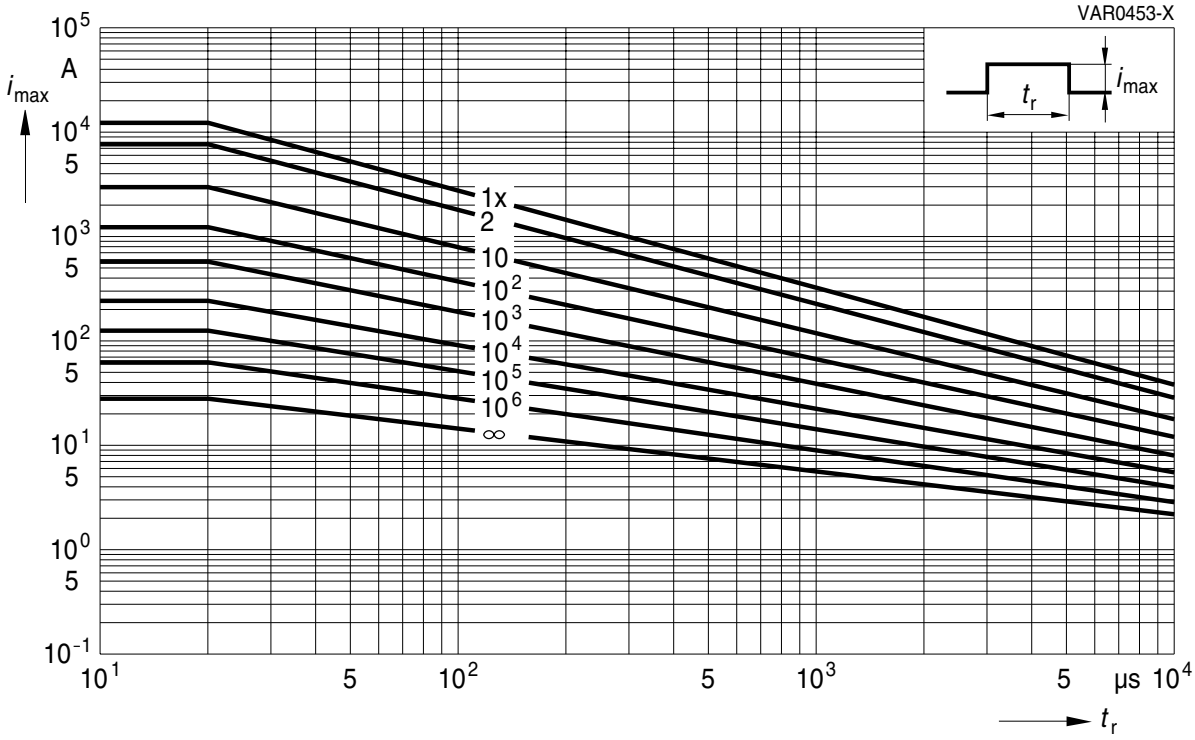

## SIOV-S20 … E3



## Derating curves

Maximum surge current $i_{max} = f(t_r$, pulse train)

For explanation of the derating curves refer to “General technical information”, section 1.8.1




**SIOV-S20 … E3**

## Cautions and warnings

### General

1. EPCOS metal oxide varistors (SIOVs) are designed for specific applications and should not be used for purposes not identified in our specifications, application notes and data books unless otherwise agreed with EPCOS during the design-in-phase.
2. Ensure suitability of SIOVs through reliability testing during the design-in phase. SIOVs should be evaluated taking into consideration worst-case conditions.
3. For applications of SIOVs in line-to-ground circuits based on various international and local standards there are restrictions existing or additional safety measures required.

### Storage

1. Store SIOVs only in original packaging. Do not open the package before storage.
2. Storage conditions in original packaging:

   | | |
   |---|---|
   | Storage temperature: | –25 °C … +45 °C |
   | Relative humidity: | <75% annual average,<br><95% on maximum 30 days a year. |
   | Dew precipitation: | Is to be avoided. |

3. Avoid contamination of an SIOV's surface during storage, handling and processing.
4. Avoid storage of SIOVs in harmful environments that can affect the function during long-term operation (examples given under operation precautions).
5. The SIOV type series should be soldered within the time specified:

   | | |
   |---|---|
   | SIOV-S, -Q, -LS | 24 months |
   | ETFV and SFS types | 12 months. |

### Handling

1. SIOVs must not be dropped.
2. Components must not be touched with bare hands. Gloves are recommended.
3. Avoid contamination of the surface of SIOV electrodes during handling, be careful of the sharp edge of SIOV electrodes.

### Soldering (where applicable)

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

## Mounting

1. Potting, sealing or adhesive compounds can produce chemical reactions in the SIOV ceramic that will degrade the component's electrical characteristics.
2. Overloading SIOVs may result in ruptured packages and expulsion of hot materials. For this reason SIOVs should be physically shielded from adjacent components.

## Operation

1. Use SIOVs only within the specified temperature operating range.
2. Use SIOVs only within the specified voltage and current ranges.
3. Environmental conditions must not harm SIOVs. Use SIOVs only in normal atmospheric conditions. Avoid use in the presence of deoxidizing gases (chlorine gas, hydrogen sulfide gas, ammonia gas, sulfuric acid gas, etc), corrosive agents, humid or salty conditions. Avoid contact with any liquids and solvents.

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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.
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