

Aluminum electrolytic capacitors

Capacitors with screw terminals

Series/Type: B41560, B41580

Date: November 2012

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EPCOS AG is a TDK Group Company.

Long-life grade capacitors

Applications

- General industrial electronics
- Professional power supplies

Features

- High reliability, extremely good electrical characteristics
- High CV product, i.e. extremely compact
- High ripple current capability
- All-welded construction ensures reliable electrical contact
- Version with low-inductance design available
- RoHS-compatible

Construction

- Charge-discharge proof, polar
- Aluminum case with insulating sleeve
- Poles with screw terminal connections
- Mounting with ring clips, clamps or threaded stud
- The bases of types with threaded stud are not insulated



B41560

B41580



Specifications and characteristics in brief

| | | |
|---|---|--|
| Rated voltage V_R | 25 ... 100 V DC | |
| Surge voltage V_S | $1.15 \cdot V_R$ | |
| Rated capacitance C_R | 1500 ... 330000 μF | |
| Capacitance tolerance | $\pm 20\% \triangle M$ | |
| Leakage current I_{leak} (20 °C, 5 min) | $I_{\text{leak}} \leq 0.018 \mu\text{A} \cdot \left(\frac{C_R}{\mu\text{F}} \cdot \frac{V_R}{\text{V}} \right)^{0.85} + 4 \mu\text{A}$ | |
| Self-inductance ESL | Approx. 20 nH Capacitors with low-inductance design: $d \geq 64.3 \text{ mm}$: approx. 13 nH | |
| Useful life ¹⁾ | | Requirements: |
| 105 °C; V_R ; $I_{\text{AC,R}}$ | > 3000 h | $\Delta C/C \leq \pm 45\%$ of initial value |
| 85 °C; V_R ; $I_{\text{AC,max}}$ | > 6000 h | ESR ≤ 3 times initial specified limit |
| 40 °C; V_R ; $2.2 \cdot I_{\text{AC,R}}$ | > 250000 h | $I_{\text{leak}} \leq$ initial specified limit |
| Voltage endurance test | | Post test requirements: |
| 105 °C; V_R | 2000 h | $\Delta C/C \leq \pm 15\%$ of initial value |
| | | ESR ≤ 1.3 times initial specified limit |
| | | $I_{\text{leak}} \leq$ initial specified limit |
| Vibration resistance test | To IEC 60068-2-6, test Fc: Frequency range 10 ... 55 Hz, displacement amplitude 0.75 mm, acceleration max. 10 g, duration 3×2 h. Capacitor mounted by its body which is rigidly clamped to the work surface. | |
| IEC climatic category | To IEC 60068-1: 40/105/56 (–40 °C/+105 °C/56 days damp heat test) | |
| Detail specification | Similar to CECC 30301-810 | |
| Sectional specification | IEC 60384-4 | |

Ripple current capability

Due to the ripple current capability of the contact elements, the following current upper limits must not be exceeded:

| | | | |
|---------------------|------------------------|---------|---------|
| Capacitor diameter | $\leq 51.6 \text{ mm}$ | 64.3 mm | 76.9 mm |
| $I_{\text{AC,max}}$ | 34 A | 45 A | 57 A |

1) Refer to chapter "General technical information, 5 Useful life" on how to interpret useful life.



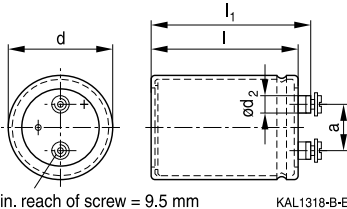
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Dimensional drawings

B41560

Ring clip/clamp mounting



M5: Min. reach of screw = 9.5 mm
9 mm for low inductance design
M6: Min. reach of screw = 12 mm
9.5 mm for low inductance design

B41580

Threaded stud mounting



Positive pole marking: +

Screw terminals with UNF threads are available upon request.

Dimensions and weights

| Ter- minal | Dimensions (mm) with insulating sleeve | | | | | | | Approx. weight (g) |
|---------------|--|-----------|-------------|-------------|-------|--------------------|---------------|-----------------------|
| | d | $l \pm 1$ | $l_1 \pm 1$ | $l_2 +0/-1$ | d_1 | $d_2 \text{ max.}$ | $a +0.2/-0.4$ | |
| M5 | 35.7 +0/-0.8 | 55.7 | 62.2 | 13 | M8 | 8.2 | 12.7 | 65 |
| M5 | 35.7 +0/-0.8 | 80.7 | 87.2 | 13 | M8 | 8.2 | 12.7 | 105 |
| M5 | 35.7 +0/-0.8 | 105.7 | 112.2 | 13 | M8 | 8.2 | 12.7 | 135 |
| M5 | 51.6 +0/-0.8 | 80.7 | 87.2 | 17 | M12 | 10.2 | 22.2 | 220 |
| M5 | 51.6 +0/-0.8 | 105.7 | 112.2 | 17 | M12 | 10.2 | 22.2 | 280 |
| M5 | 64.3 +0/-0.8 | 105.7 | 112.2 | 17 | M12 | 13.2 | 28.5 | 440 |
| M6 | 76.9 +0/-0.7 | 105.7 | 111.5 | 17 | M12 | 17.7 | 31.7 | 620 |
| M6 | 76.9 +0/-0.7 | 143.2 | 149.0 | 17 | M12 | 17.7 | 31.7 | 840 |

For low-inductance design the following deviation applies:

$d = 64.3 \text{ mm}; l_1 -0.7 \text{ mm}$


Packing

| Capacitor diameter d (mm) | length l (mm) | Packing units (pcs.) |
|---------------------------|---------------|----------------------|
| 35.7 | all | 36 |
| 51.6 | all | 36 |

| Capacitor diameter d (mm) | length l (mm) | Packing units (pcs.) |
|---------------------------|---------------|----------------------|
| 64.3 | all | 25 |
| 76.9 | all | 16 |



For ecological reasons the packing is pure cardboard.



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Special design

- Low-inductance design

| Design | Identification in third block of ordering code | Remark |
|------------------------|--|---|
| Low inductance (13 nH) | M003 | For capacitors with diameter $d \geq 64.3$ mm |

Accessories

The following items are included in the delivery package, but are not fastened to the capacitors:

| | Thread | Toothed washers | Screws/nuts | Maximum torque |
|---------------|--------|-----------------|--|---|
| For terminals | M5 | A 5.1 DIN 6797 | DIN 7985 / ISO 7045-M5 \times 10-5.6-Z | 2.5 Nm thread depth $t \geq 8$ mm |
| | M6 | A 6.4 DIN 6797 | DIN 7985 / ISO 7045-M6 \times 12-5.6-Z | 4.0 Nm thread depth $t \geq 9.5$ mm |
| For mounting | M8 | J 8.2 DIN 6797 | Hex nut BM 8 DIN 439 | 4 Nm |
| | M12 | J 12.5 DIN 6797 | Hex nut BM 12 DIN 439 | 10 Nm |

The following items must be ordered separately. For details, refer to chapter "Capacitors with screw terminals – Accessories".

| Item | Type |
|---|--------|
| Ring clips | B44030 |
| Clamps for capacitors with $d \geq 64.3$ mm | B44030 |
| Insulating parts | B44020 |


Overview of available types

| V_R (V DC) | 25 | 40 | 63 | 100 |
|--------------|----------------------------|--------------|--------------|--------------|
| | Case dimensions d × l (mm) | | | |
| C_R (μF) | | | | |
| 1500 | | | | 35.7 × 55.7 |
| 2200 | | | | 35.7 × 80.7 |
| 3300 | | | | 35.7 × 80.7 |
| 4700 | | | 35.7 × 55.7 | 35.7 × 105.7 |
| 6800 | | | 35.7 × 80.7 | 51.6 × 80.7 |
| 10000 | | 35.7 × 55.7 | 35.7 × 105.7 | 51.6 × 105.7 |
| 15000 | 35.7 × 55.7 | 35.7 × 80.7 | 51.6 × 80.7 | 64.3 × 105.7 |
| 22000 | 35.7 × 80.7 | 35.7 × 105.7 | 51.6 × 105.7 | 76.9 × 105.7 |
| 33000 | 35.7 × 80.7 | 51.6 × 80.7 | 64.3 × 105.7 | 76.9 × 143.2 |
| 47000 | 35.7 × 105.7 | 51.6 × 105.7 | 64.3 × 105.7 | |
| 68000 | 51.6 × 80.7 | 51.6 × 105.7 | 76.9 × 105.7 | |
| 100000 | 51.6 × 105.7 | 64.3 × 105.7 | 76.9 × 143.2 | |
| 150000 | 64.3 × 105.7 | 76.9 × 105.7 | | |
| 220000 | 76.9 × 105.7 | 76.9 × 143.2 | | |
| 330000 | 76.9 × 143.2 | | | |

The capacitance and voltage ratings listed above are available in different cases upon request.

Other voltage and capacitance ratings are also available upon request.


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Technical data and ordering codes

| C_R 100 Hz 20 °C μF | Case dimensions $d \times l$ mm | ESR_{typ} 100 Hz 20 °C mΩ | ESR_{max} 100 Hz 20 °C mΩ | Z_{max} 10 kHz 20 °C mΩ | $I_{AC,max}$ 100 Hz 40 °C A | $I_{AC,max}$ 100 Hz 85 °C A | $I_{AC,R}$ 100 Hz 105 °C A | Ordering code (composition see below) |
|-----------------------------------|--|--------------------------------------|--------------------------------------|------------------------------------|--------------------------------------|--------------------------------------|-------------------------------------|---|
| $V_R = 25$ V DC | | | | | | | | |
| 15000 | 35.7 × 55.7 | 21 | 42 | 31 | 18 | 11 | 5.3 | B415*0A5159M000 |
| 22000 | 35.7 × 80.7 | 14 | 29 | 22 | 25 | 15 | 7.4 | B415*0A5229M000 |
| 33000 | 35.7 × 80.7 | 15 | 20 | 17 | 30 | 18 | 8.8 | B415*0A5339M000 |
| 47000 | 35.7 × 105.7 | 8.0 | 16 | 13 | 30 | 23 | 11 | B415*0A5479M000 |
| 68000 | 51.6 × 80.7 | 4.8 | 12 | 9.3 | 34 | 26 | 13 | B415*0A5689M000 |
| 100000 | 51.6 × 105.7 | 4.7 | 9.4 | 7.6 | 34 | 32 | 15 | B415*0A5100M000 |
| 150000 | 64.3 × 105.7 | 4.0 | 8.0 | 6.4 | 45 | 38 | 18 | B415*0A5150M00# |
| 220000 | 76.9 × 105.7 | 3.5 | 5.3 | 5.6 | 57 | 40 | 20 | B415*0A5220M00# |
| 330000 | 76.9 × 143.2 | 3.0 | 4.5 | 5.1 | 57 | 50 | 24 | B415*0A5330M00# |
| $V_R = 40$ V DC | | | | | | | | |
| 10000 | 35.7 × 55.7 | 17 | 42 | 37 | 18 | 11 | 5.3 | B415*0A7109M000 |
| 15000 | 35.7 × 80.7 | 12 | 23 | 16 | 25 | 15 | 7.4 | B415*0A7159M000 |
| 22000 | 35.7 × 105.7 | 8.5 | 17 | 14 | 30 | 20 | 9.5 | B415*0A7229M000 |
| 33000 | 51.6 × 80.7 | 6.0 | 12 | 13 | 34 | 23 | 11 | B415*0A7339M000 |
| 47000 | 51.6 × 105.7 | 5.0 | 10 | 10 | 34 | 29 | 14 | B415*0A7479M000 |
| 68000 | 51.6 × 105.7 | 4.5 | 9.0 | 8.4 | 34 | 30 | 15 | B415*0A7689M000 |
| 100000 | 64.3 × 105.7 | 4.1 | 8.2 | 7.0 | 45 | 38 | 18 | B415*0A7100M00# |
| 150000 | 76.9 × 105.7 | 3.6 | 7.2 | 6.0 | 57 | 41 | 20 | B415*0A7150M00# |
| 220000 | 76.9 × 143.2 | 3.3 | 5.0 | 5.4 | 57 | 49 | 24 | B415*0A7220M00# |
| $V_R = 63$ V DC | | | | | | | | |
| 4700 | 35.7 × 55.7 | 30 | 60 | 64 | 15 | 9.2 | 4.4 | B415*0A8478M000 |
| 6800 | 35.7 × 80.7 | 22 | 44 | 46 | 20 | 12 | 6.0 | B415*0A8688M000 |
| 10000 | 35.7 × 105.7 | 14 | 27 | 16 | 28 | 17 | 8.1 | B415*0A8109M000 |
| 15000 | 51.6 × 80.7 | 9.5 | 19 | 14 | 31 | 19 | 9.1 | B415*0A8159M000 |
| 22000 | 51.6 × 105.7 | 7.0 | 14 | 14 | 34 | 25 | 12 | B415*0A8229M000 |
| 33000 | 64.3 × 105.7 | 5.5 | 11 | 12 | 45 | 31 | 15 | B415*0A8339M00# |
| 47000 | 64.3 × 105.7 | 4.8 | 10 | 9.4 | 45 | 35 | 17 | B415*0A8479M00# |
| 68000 | 76.9 × 105.7 | 3.3 | 5.0 | 7.8 | 57 | 39 | 19 | B415*0A8689M00# |
| 100000 | 76.9 × 143.2 | 3.3 | 5.0 | 6.6 | 57 | 48 | 23 | B415*0A8100M00# |

Composition of ordering code

* = Mounting style

6 = for capacitors with ring clip/clamp mounting

8 = for capacitors with threaded stud

= Design

0 = for capacitors with standard inductance

 3 = for capacitors with low inductance (13 nH)
 (only for capacitors with diameter $d \geq 64.3$ mm)


Technical data and ordering codes

| C_R | Case dimensions | ESR_{typ} | ESR_{max} | Z_{max} | $I_{AC,max}$ | $I_{AC,max}$ | $I_{AC,R}$ | Ordering code (composition see below) |
|------------------------------------|-----------------|-------------|-------------|-----------|--------------|--------------|------------|--|
| 100 Hz | $d \times l$ | 100 Hz | 100 Hz | 10 kHz | 100 Hz | 100 Hz | 100 Hz | |
| 20 °C | mm | 20 °C | 20 °C | 20 °C | 40 °C | 85 °C | 105 °C | |
| μF | | $m\Omega$ | $m\Omega$ | $m\Omega$ | A | A | A | |
| $V_R = 100$ V DC | | | | | | | | |
| 1500 | 35.7 × 55.7 | 52 | 104 | 90 | 11 | 7.0 | 3.4 | B415*0A9158M000 |
| 2200 | 35.7 × 80.7 | 35 | 70 | 77 | 16 | 9.9 | 4.7 | B415*0A9228M000 |
| 3300 | 35.7 × 80.7 | 24 | 48 | 53 | 19 | 12 | 5.7 | B415*0A9338M000 |
| 4700 | 35.7 × 105.7 | 18 | 35 | 39 | 26 | 16 | 7.5 | B415*0A9478M000 |
| 6800 | 51.6 × 80.7 | 12 | 24 | 25 | 30 | 18 | 8.7 | B415*0A9688M000 |
| 10000 | 51.6 × 105.7 | 7.0 | 14 | 12 | 34 | 24 | 11 | B415*0A9109M000 |
| 15000 | 64.3 × 105.7 | 5.0 | 10 | 10 | 45 | 30 | 15 | B415*0A9159M00# |
| 22000 | 76.9 × 105.7 | 4.0 | 6.0 | 6.0 | 57 | 35 | 17 | B415*0A9229M00# |
| 33000 | 76.9 × 143.2 | 3.3 | 5.0 | 8.4 | 57 | 44 | 21 | B415*0A9339M00# |

Composition of ordering code

* = Mounting style

- 6 = for capacitors with ring clip/clamp mounting
- 8 = for capacitors with threaded stud

= Design

- 0 = for capacitors with standard inductance
- 3 = for capacitors with low inductance (13 nH)
(only for capacitors with diameter $d \geq 64.3$ mm)



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Useful life¹⁾

depending on ambient temperature T_A under ripple current operating conditions



Frequency factor of permissible ripple current I_{AC} versus frequency f



| V_R (V DC) | ≤ 63 | 100 |
|---------------|-----------|-----|
| $d = 35.7$ mm | a | c |
| $d = 51.6$ mm | a | d |
| $d = 64.3$ mm | a | d |
| $d = 76.9$ mm | b | e |

1) Refer to chapter "General technical information, 5 Useful life" on how to interpret useful life.



Frequency characteristics of ESR

Typical behavior



| | | |
|---------------|------|-----|
| V_R (V DC) | ≤ 63 | 100 |
| $d = 35.7$ mm | a | c |
| $d = 51.6$ mm | a | d |
| $d = 64.3$ mm | a | d |
| $d = 76.9$ mm | b | e |

Impedance Z versus frequency f

Typical behavior at 20 °C





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Cautions and warnings

Personal safety

The electrolytes used by EPCOS have been optimized both with a view to the intended application and with regard to health and environmental compatibility. They do not contain any solvents that are detrimental to health, e.g. dimethyl formamide (DMF) or dimethyl acetamide (DMAC).

Furthermore, some of the high-voltage electrolytes used by EPCOS are self-extinguishing.

As far as possible, EPCOS does not use any dangerous chemicals or compounds to produce operating electrolytes. However, in exceptional cases, such materials must be used in order to achieve specific physical and electrical properties because no alternative materials are currently known. However, the amount of dangerous materials used in our products is limited to an absolute minimum.

Materials and chemicals used in EPCOS aluminum electrolytic capacitors are continuously adapted in compliance with the EPCOS Corporate Environmental Policy and the latest EU regulations and guidelines such as RoHS, REACH/SVHC, GADSL, and ELV.

MDS (Material Data Sheets) are available on the EPCOS website for all types listed in the data book. MDS for customer specific capacitors are available upon request.

MSDS (Material Safety Data Sheets) are available for all of our electrolytes upon request.

Nevertheless, the following rules should be observed when handling aluminum electrolytic capacitors: No electrolyte should come into contact with eyes or skin. If electrolyte does come into contact with the skin, wash the affected areas immediately with running water. If the eyes are affected, rinse them for 10 minutes with plenty of water. If symptoms persist, seek medical treatment. Avoid inhaling electrolyte vapor or mists. Workplaces and other affected areas should be well ventilated. Clothing that has been contaminated by electrolyte must be changed and rinsed in water.



Product safety

The table below summarizes the safety instructions that must be observed without fail. A detailed description can be found in the relevant sections of chapter "General technical information".

| Topic | Safety information | Reference chapter "General technical information" |
|--|---|--|
| Polarity | Make sure that polar capacitors are connected with the right polarity. | 1 "Basic construction of aluminum electrolytic capacitors" |
| Reverse voltage | Voltages polarity classes should be prevented by connecting a diode. | 3.1.6 "Reverse voltage" |
| Mounting position of screw-terminal capacitors | Do not mount the capacitor with the terminals (safety vent) upside down. | 11.1. "Mounting positions of capacitors with screw terminals" |
| Robustness of terminals | The following maximum tightening torques must not be exceeded when connecting screw terminals: M5: 2.5 Nm M6: 4.0 Nm | 11.3 "Mounting torques" |
| Mounting of single-ended capacitors | The internal structure of single-ended capacitors might be damaged if excessive force is applied to the lead wires. Avoid any compressive, tensile or flexural stress. Do not move the capacitor after soldering to PC board. Do not pick up the PC board by the soldered capacitor. Do not insert the capacitor on the PC board with a hole space different to the lead space specified. | 11.4 "Mounting considerations for single-ended capacitors" |
| Soldering | Do not exceed the specified time or temperature limits during soldering. | 11.5 "Soldering" |
| Soldering, cleaning agents | Do not allow halogenated hydrocarbons to come into contact with aluminum electrolytic capacitors. | 11.6 "Cleaning agents" |
| Upper category temperature | Do not exceed the upper category temperature. | 7.2 "Maximum permissible operating temperature" |
| Passive flammability | Avoid external energy, such as fire or electricity. | 8.1 "Passive flammability" |



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| Topic | Safety information | Reference chapter "General technical information" |
|--|---|---|
| Active flammability | Avoid overload of the capacitors. | 8.2 "Active flammability" |
| Maintenance | <p>Make periodic inspections of the capacitors. Before the inspection, make sure that the power supply is turned off and carefully discharge the electricity of the capacitors.</p> <p>Do not apply any mechanical stress to the capacitor terminals.</p> | 10 "Maintenance" |
| Storage | Do not store capacitors at high temperatures or high humidity. Capacitors should be stored at +5 to +35 °C and a relative humidity of $\leq 75\%$. | 7.3 Storage conditions |
| | | Reference chapter "Capacitors with screw terminals" |
| Breakdown strength of insulating sleeves | Do not damage the insulating sleeve, especially when ring clips are used for mounting. | "Screw terminals – accessories" |


Symbols and terms

| Symbol | English | German |
|----------------|---|---|
| C | Capacitance | Kapazität |
| C_R | Rated capacitance | Nennkapazität |
| C_S | Series capacitance | Serienkapazität |
| $C_{S,T}$ | Series capacitance at temperature T | Serienkapazität bei Temperatur T |
| C_f | Capacitance at frequency f | Kapazität bei Frequenz f |
| d | Case diameter, nominal dimension | Gehäusedurchmesser, Nennmaß |
| d_{max} | Maximum case diameter | Maximaler Gehäusedurchmesser |
| ESL | Self-inductance | Eigeninduktivität |
| ESR | Equivalent series resistance | Ersatzserienwiderstand |
| ESR_f | Equivalent series resistance at frequency f | Ersatzserienwiderstand bei Frequenz f |
| ESR_T | Equivalent series resistance at temperature T | Ersatzserienwiderstand bei Temperatur T |
| f | Frequency | Frequenz |
| I | Current | Strom |
| I_{AC} | Alternating current (ripple current) | Wechselstrom |
| $I_{AC,rms}$ | Root-mean-square value of alternating current | Wechselstrom, Effektivwert |
| $I_{AC,f}$ | Ripple current at frequency f | Wechselstrom bei Frequenz f |
| $I_{AC,max}$ | Maximum permissible ripple current | Maximal zulässiger Wechselstrom |
| $I_{AC,R}$ | Rated ripple current | Nennwechselstrom |
| $I_{AC,R} (B)$ | Rated ripple current for base cooling | Nennwechselstromstrom für Bodenkühlung |
| I_{leak} | Leakage current | Reststrom |
| $I_{leak,op}$ | Operating leakage current | Betriebsreststrom |
| l | Case length, nominal dimension | Gehäuselänge, Nennmaß |
| l_{max} | Maximum case length (without terminals and mounting stud) | Maximale Gehäuselänge (ohne Anschlüsse und Gewindebolzen) |
| R | Resistance | Widerstand |
| R_{ins} | Insulation resistance | Isolationswiderstand |
| R_{symm} | Balancing resistance | Symmetrierwiderstand |
| T | Temperature | Temperatur |
| ΔT | Temperature difference | Temperaturdifferenz |
| T_A | Ambient temperature | Umgebungstemperatur |
| T_C | Case temperature | Gehäusetemperatur |
| T_B | Capacitor base temperature | Temperatur des Becherbodens |
| t | Time | Zeit |
| Δt | Period | Zeitraum |
| t_b | Service life (operating hours) | Brauchbarkeitsdauer (Betriebszeit) |



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| Symbol | English | German |
|-----------------|---|--------------------------------------|
| V | Voltage | Spannung |
| V _F | Forming voltage | Formierspannung |
| V _{op} | Operating voltage | Betriebsspannung |
| V _R | Rated voltage, DC voltage | Nennspannung, Gleichspannung |
| V _S | Surge voltage | Spitzenspannung |
| X _C | Capacitive reactance | Kapazitiver Blindwiderstand |
| X _L | Inductive reactance | Induktiver Blindwiderstand |
| Z | Impedance | Scheinwiderstand |
| Z _T | Impedance at temperature T | Scheinwiderstand bei Temperatur T |
| tan δ | Dissipation factor | Verlustfaktor |
| λ | Failure rate | Ausfallrate |
| ε ₀ | Absolute permittivity | Elektrische Feldkonstante |
| ε _r | Relative permittivity | Dielektrizitätszahl |
| ω | Angular velocity; $2 \cdot \pi \cdot f$ | Kreisfrequenz; $2 \cdot \pi \cdot f$ |

Note

All dimensions are given in mm.

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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